InnoDisk FiD 2.5” SATA20000-R

SLC Solution

Datasheet

Rev 1.0

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REVISION HISTORY

Revision	Description	Date
Preliminary	First Released	2009/03/12
Rev 0.1	1. Release industrial grade 2. Remove endurance information 3. Update LBA and power consumption value	2009/04/08
Rev 0.2	Add IOPS @ 4KB random write performance	2009/04/20
Rev 0.3	1. Update performance 2. Update mechanical dimensions 3. Update LBA value	2009/5/19
Rev 0.4	1. Update performance 2. Add MTBF value	2009/5/21
Rev 1.0	1. Wording correction 2. UDMA value update 3. Rev 1.0 release	2009/9/18

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1. Product Overview

1.1 Introduction of InnoDisk FiD 2.5” SATA 20000-R

InnoDisk FiD 2.5” SATA 20000-R series provides high capacity flash memory Solid State Drive (SSD) that electrically complies with Serial ATA (SATA) II 3.0G standard and delivers excellent performance. For SLC solution, sustained read speed can reach up to 235 MB per second (max.) while sustained write reach up to 170 MB per second (max). InnoDisk FiD 2.5” SATA 20000-R is compatible with standard 2.5-inch form factor, which can be applied to notebook. InnoDisk FiD 2.5” SATA 20000-R is designed for industrial field. The SSD have good performance, no latency time and small seek time. It effectively reduces the booting time of operation system and the power consumption is less than hard disk drive (HDD). InnoDisk FiD 2.5” SATA 20000-R can work in harsh environment. The SSD is vibration resistance, and can work in lower or higher temperature than HDD. InnoDisk FiD 2.5” SATA 20000-R complies with ATA protocol, no additional drives are required, and the SSD can be configured as a boot device or data storage device.

1.2 Product View

Figure 1: InnoDisk FiD 2.5” SATA 20000-R

1.3 Product Models

InnoDisk FiD 2.5” SATA 20000-R is available in follows capacities.

FiD 2.5” SATA20000-R 16GB (SLC)

FiD 2.5” SATA20000-R 32GB (SLC)

FiD 2.5” SATA20000-R 64GB (SLC)

FiD 2.5” SATA20000-R 128GB (SLC)

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1.4 SATA Interface

InnoDisk FiD 2.5” SATA 20000-R support SATA II interface, and compliant with SATA I. SATA II interface can work with Serial Attached SCSI (SAS) host system, which is used in server computer. InnoDisk FiD 2.5” SATA 20000-R is compliant with Serial ATA Gen 1 and Gen 2 specifications (Gen2 supports 1.5Gbps /3.0Gbps data rate). SATA connector uses a 7-pin signal segment and a 15-pin power segment.

1.5 2.5-inch form factor

Industrial 2.5-inch standard form factor design with metal material case is easy for installation because 2.5-inch is a popular form factor in industrial field. 2.5-inch is most laptop’s hard disk’s form factor. InnoDisk FiD 2.5” SATA 20000-R SSD can easy install in laptop. InnoDisk FiD 2.5” SATA 20000-R has a compact design 99.88mm (L) x 69.63mm (W) x 9.3mm (H).

1.6 Capacity

InnoDisk FiD 2.5” SATA20000-R provides unformatted 16GB, 32GB, 64GB and 128GB capacities within SLC flash ICs.

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2. Theory of operation

2.1 Overview

Figure 2 shows the operation of InnoDisk FiD 2.5" SATA 20000-R from the system level, including the major hardware blocks.

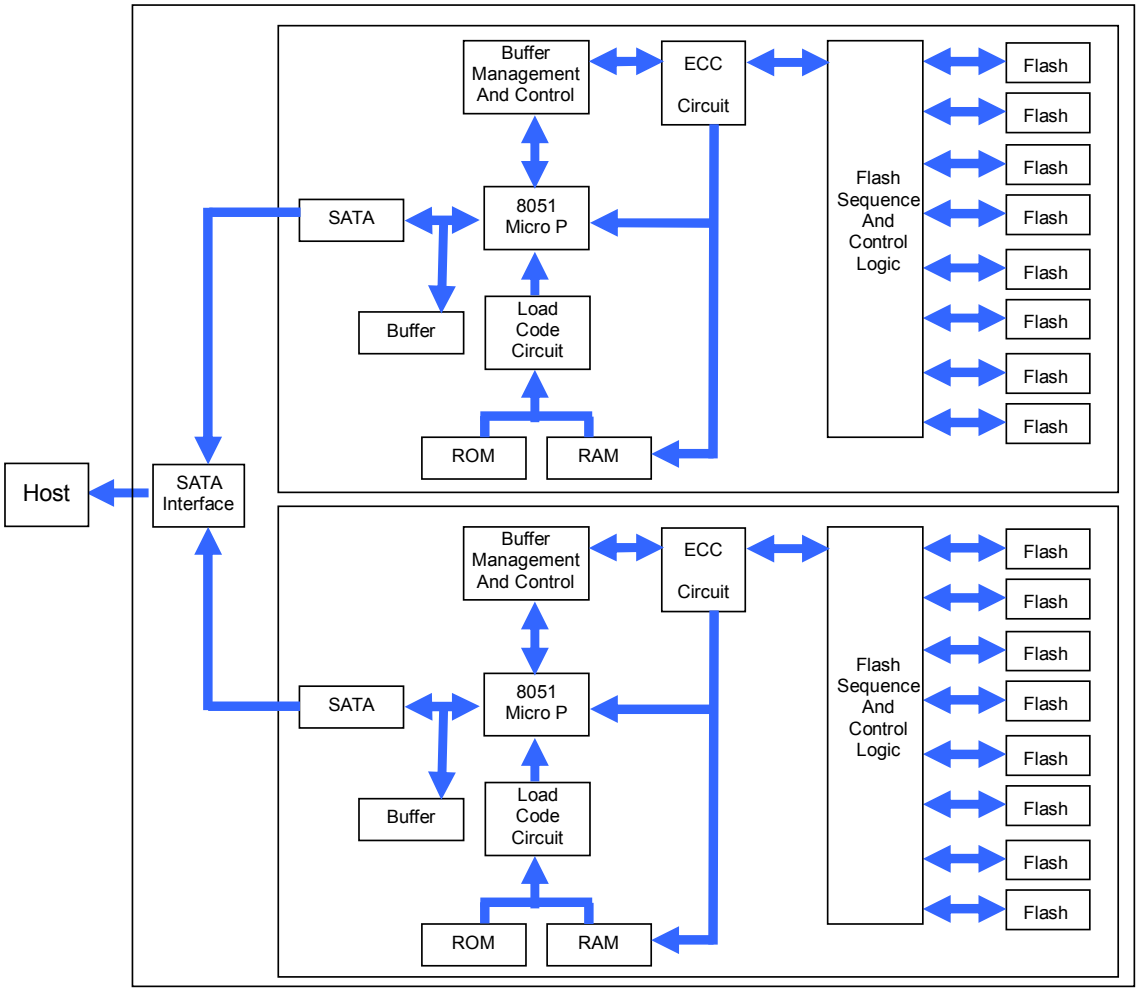

Figure 2: InnoDisk FiD 2.5" SATA 20000-R Block Diagram

InnoDisk FiD 2.5" SATA 20000-R integrates two SATA II controller and one raid controller, and NAND flash memories. Communication with the host occurs through the host interface, using the standard SATA protocol. Communication with the flash device(s) occurs through the flash interface.

2.2 SATA II Controller

The SATA II controller is 3.0 Gbps (Gen. 2), and support hot-plug. The Serial ATA physical, link and transport

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layers are compliant with Serial ATA Gen 1 and Gen 2 specification (Gen 2 supports 1.5Gbps/3.0Gbps data rate). The controller has 8 channels for flash interface.

The controller is equipped with 96KB of internal memory. 64 KB of memory is used for data buffer, and 32 KB is used for general purpose. The internal memory can also be used as an intermediate memory for storing data blocks during a wear-leveling procedure. There are 40KB of internal memory is used for code. A 10KB internal boot ROM includes basic routines for accessing the flash memories and for loading the main code into the internal memory.

2.3 Error Detection and Correction

Highly sophisticated Error Correction Code algorithms are implemented. The ECC unit consists of the Parity Unit (parity-byte generation) and the Syndrome Unit (syndrome-byte computation). This unit implements an algorithm that can correct 8 bits per 512 bytes in an ECC block. Code-byte generation during write operations, as well as error detection during read operation, is implemented on the fly without any speed penalties.

2.4 Wear-Leveling

Flash memory can be erased within a limited number of times. This number is called the ***erase cycle limit*** or ***write endurance limit*** and is defined by the flash array vendor. The erase cycle limit applies to each individual erase block in the flash device.

InnoDisk FiD 2.5” SATA 20000-R uses a static wear-leveling algorithm to ensure that consecutive writes of a specific sector are not written physically to the same page/block in the flash. This spreads flash media usage evenly across all pages, thereby extending flash lifetime.

2.5 Bad Blocks Management

Bad Blocks are blocks that contain one or more invalid bits whose reliability are not guaranteed. The Bad Blocks may be presented while the SSD is shipped, or may develop during the life time of the SSD. The Bad Blocks will not exceed more than 6.7% of the total device volume. When the Bad Blocks is detected, it will be flagged, and not be used anymore. The SSD implement Bad Blocks management, Bad Blocks replacement, Error Correct Code to avoid data error occurred. The functions will be enabled automatically to transfer data from Bad Blocks to spare blocks, and correct error bit. After the reserved block under 20, the SSD will be locked, and the SSD cannot be read and written anymore. Host can send a vendor ATA command to unlock the SSD for backup data or system from SSD.

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3. Installation Requirements

3.1 FiD 2.5 SATA 20000-R Pin Directions

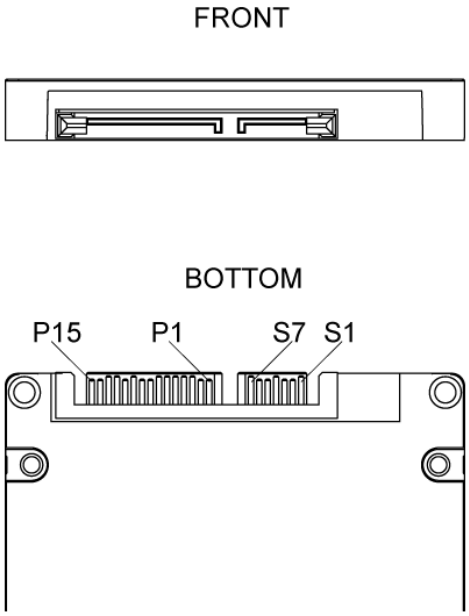

Figure 3: Signal Segment and Power Segment

3.2 Electrical Connections for FiD 2.5 SATA 20000-R

A Serial ATA device may be either directly connected to a host or connected to a host through a cable. For connection via cable, the cable should be no longer than 1meter. The SATA interface has a separate connector for the power supply. Please refer to the pin description for further details.

3.3 Form Factor

Please prepare following things:

- Screw driver.
- Four M3 screws.
- SATA single cable (7-pin, Maximum length I meter).
- SATA power cable (15-pin).

Please turn off your computer, and open your computer's case. Find one of available 2.5-inch slot, and plug the SSD in. To use the screws fix the SSD. Plug in the SATA single cable, and power cable.

Please boot the installation Operation System from CD-ROM, and install Operation System into SSD.

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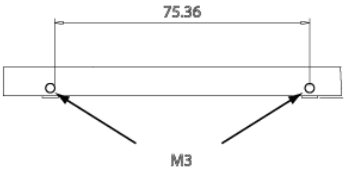

Figure 4: FiD 2.5” SATA 20000-R Mechanical Screw Hole

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4. Specifications

4.1 CE and FCC Compatibility

InnoDisk FiD 2.5” SATA 20000-R conforms to CE and FCC requirements.

4.2 RoHS Compliance

InnoDisk FiD 2.5” SATA 20000-R is fully compliant with RoHS directive.

4.3 Environmental Specifications

4.3.1 Temperature Ranges

Operating Temperature Range:

- Standard Grade: 0°C to +70°C

Storage Temperature Range:

- -55°C to +95°C

4.3.2 Humidity

Relative Humidity: 10-95%, non-condensing

4.3.3 Shock and Vibration

Table 1: Shock/Vibration Testing for InnoDisk FiD 2.5” SATA 20000-R

Reliability	Test Conditions	Reference Standards
Vibration	7 Hz to 2K Hz, 20G, 3 axes	IEC 68-2-6
Mechanical Shock	Duration: 0.5ms, 1500G, 3 axes	IEC 68-2-27

4.3.4 Mean Time between Failures (MTBF)

Table 2 summarizes the MTBF prediction results for various InnoDisk FiD 2.5” SATA 20000-R configurations. The analysis was performed using a RAM Commander™ failure rate prediction.

- **Failure Rate**: The total number of failures within an item population, divided by the total number of life units expended by that population, during a particular measurement interval under stated condition.
- **Mean Time between Failures (MTBF)**: A basic measure of reliability for repairable items: The mean number of life units during which all parts of the item perform within their specified limits, during a particular measurement interval under stated conditions.
-

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Table 2: InnoDisk FiD 2.5” SATA 20000-R MTBF

Product	Condition	MTBF (Hours)
InnoDisk FiD 2.5” SATA 20000-R	Telcordia SR-332 GB, 25°C	6,938,434

4.4 Transfer Mode

InnoDisk FiD 2.5” SATA 20000-R support following transfer mode:

PIO Mode 0~4.

Ultra DMA 0~6.

Serial ATA I 1.5Gbps

Serial ATA II 3.0Gbps

4.5 Pin Assignment

InnoDisk FiD 2.5” SATA 20000-R uses a standard SATA pin-out. See Table 3 for InnoDisk FiD 2.5” SATA 20000-R pin assignments.

Table 3: InnoDisk FiD 2.5” SATA 20000-R Pin Assignment

Name	Type	Description
S1	GND	NA
S2	A+	Differential Signal Pair A
S3	A-	
S4	GND	NA
S5	B-	Differential Signal Pair B
S6	B+	
S7	GND	NA
Key and Spacing separate signal and power segments		
P1	V33	3.3V Power
P2	V33	3.3V Power
P3	V33	3.3V Power, Pre-charge
P4	GND	NA
P5	GND	NA
P6	GND	NA
P7	V5	5V Power, Pre-Charge
P8	V5	5V Power
P9	V5	5V Power
P10	GND	NA
P11	DAS/DSS	Device Activity Signal / Disable Staggered Spinup
P12	GND	NA

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P13	V12	12V Power, Pre-charge
P14	V12	12V Power
P15	V12	12V Power

4.6 Mechanical Dimensions

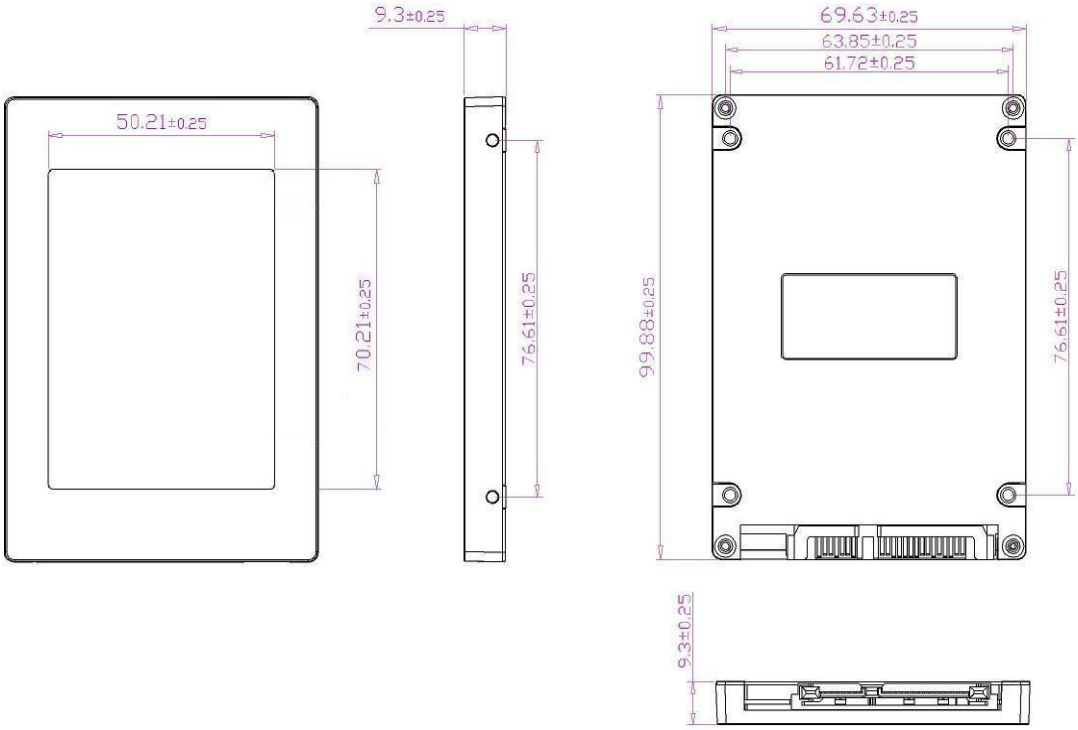

Figure 5: FiD 2.5 SATA 20000-R mechanical dimensions

4.7 Assembly weight

An InnoDisk FiD 2.5" SATA 20000-R within flash ICs, 8GB's weight is 90 grams approx. If the capacity is different, the flash chip's weight needs to be added. However, the total weight of SSD will be less than 95 grams.

4.8 Performance

Burst Transfer Rate : 3.0 Gbps

SLC:

Sustained Read : 235MB/sec (max.)

Sustained Write : 170MB/sec (max.)

4.9 Seek Time

InnoDisk FiD 2.5" SATA 20000-R is not a magnetic rotating design. There is no seek or rotational latency required.

4.10 Hot Plug

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The SSD support hot plug function and can be removed or plugged-in during operation. User has to avoid hot plugging the SSD which is configured as boot device and installed operation system.

Surprise hot plug : The insertion of a SATA device into a backplane (combine signal and power) that has power present. The device powers up and initiates an OOB sequence.

Surprise hot removal: The removal of a SATA device from a powered backplane, without first being placed in a quiescent state.

4.11 NAND Flash Memory

InnoDisk FiD 2.5" SATA 20000-R uses Single Level Cell (SLC) NAND flash memory, which is non-volatility, high reliability and high speed memory storage. There are only two statuses 0 or 1 of one cell. Read or Write data to flash memory for SSD is control by micro processor.

4.12 Electrical Specifications

4.12.1 Power Requirement

Table 4: InnoDisk FiD 2.5" SATA 20000-R Power Requirement

Item	Symbol	Rating	Unit
Input voltage	V_{IN}	+5DC +- 5% 900mA (max.)	V

4.12.2 Power Consumption

Table 5: Power Consumption

Mode	Power Consumption
	SLC
Read	780mA (max.)
Write	760mA (max.)
Idle	480mA (max.)

* Test target: 128GB

4.13 Device Parameters

FiD 2.5 SATA 20000-R device parameters are shown in Table 6.

Table 6: Device parameters

Capacity	LBA	Cylinders	Heads	Sectors
16GB	31064064	16383	16	63
32GB	62390272	16383	16	63
64GB	125042688	16383	16	63
128GB	252182528	16383	16	63

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5. Supported ATA Commands

5.1 Supported ATA Commands

InnoDisk FiD 2.5” SATA 20000-R supports the commands listed in Table 7.

Table 7: ATA Commands

Command Name	Code	PARAMETERS USED					
		SC	SN	CY	DR	HD	FT
CHECK POWER MODE	E5h	X	X	X	O	X	X
IDENTIFY DEVICE	ECh	X	X	X	O	X	X
IDLE	E3h	O	X	X	O	X	X
IDLE IMMEDIATE	E1h	X	X	X	O	X	X
READ MULTIPLE	C4h	O	O	O	O	O	X
READ SECTOR(S)	20h or 21h	O	O	O	O	O	X
READ VERIFY SECTOR(S)	40h or 41h	O	O	O	O	O	X
READ DMA	C8h or C9h	O	O	O	O	O	X
SET FEATURES	EFh	O	X	X	O	X	O
SET MULTIPLE MODE	C6h	O	X	X	O	X	X
SLEEP	E6h	X	X	X	O	X	X
FLUSH CACHE	E7h	X	X	X	O	O	X
STANDBY	E2h	X	X	X	O	X	X
STANDBY IMMEDIATE	E0h	X	X	X	O	X	X
WRITE MULTIPLE	C5h	O	O	O	O	O	X
WRITE SECTOR(S)	30h or 31h	O	O	O	O	O	X
WRITE DMA	CAh or CBh	O	O	O	O	O	X
EXECUTE DIAGNOSTICS	90h	X	X	X	O	X	X
INITIALIZE DEVICE PARAMETERS	91h	O	X	X	O	O	X
SEEK	7xh	X	X	O	O	O	X
RECALIBRATE	10h	X	X	X	O	X	X

5.1.1 Check Power Mode

5.1.1.1 Command Code

E5h

5.1.1.2 Feature Set

Power Management feature set.

- This command is mandatory for devices.

-This command is mandatory when the Power Management feature set is implemented.

5.1.1.3 Protocol

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Non-data command

5.1.1.4 Inputs

Table 8: Check power mode command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	Obs	DEV	Na	Na	Na	Na
Command	E5h							

Device register

DEV shall specify the selected device.

5.1.2 IDENTIFY DEVICE

5.1.2.1 Command Code

ECh

5.1.2.2 Feature Set

General feature set

-Mandatory for all devices.

-Devices implementing the PACKET Command feature set

5.1.2.3 Protocol

PIO data-in

5.1.2.4 Inputs

Table 9: Identify device command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	Obs	DEV	Na	Na	Na	Na
Command	ECh							

Device register

DEV shall specify the selected device.

5.1.2.5 Outputs

5.1.2.5.1 Normal outputs

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Table 10: Identify device command for normal outputs information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register

DEV shall indicate the selected device.

Status register

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

DF (Device Fault) shall be cleared to zero.

DRQ shall be cleared to zero.

ERR shall be cleared to zero.

5.1.2.6 Prerequisites

DRDY set to one.

5.1.2.7 Description

The IDENTIFY DEVICE command enables the host to receive parameter information from the device. When the command is issued, the device sets the BSY bit to one, prepares to transfer the 256 words of device identification data to the host, sets the DRQ bit to one, clears the BSY bit to zero, and asserts INTRQ if nIEN is cleared to zero. The host may then transfer the data by reading the Data register. Table 8 defines the arrangement and meaning of the parameter words in the buffer. All reserved bits or words shall be zero.

Some parameters are defined as a 16-bit value. A word that is defined as a 16-bit value places the most significant bit of the value on signal line DD15 and the least significant bit on signal line DD0. Some parameters are defined as 32-bit values (e.g. words (61:60)). Such fields are transfer using two successive word transfers. The device will first transfer the least significant bits, bits (15:0) of the value, on signal lines DD(15:0) respectively. After the least significant bits have been transferred, the most significant bits, bits(31:16) of the value, shall be transferred on DD(15:0) respectively.

Some parameters are defined as a string of ASCII characters.

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Table 11: Identify device command parameters

Word	Description	Value
0	General Configuration Bit 15 0=ATA device Bit 14:8 Retired Bit 7:6 Obsolete Bit 5:3 Retired Bit 2 Response incomplete Bit 1 Retired Bit 0 reserved	0040h
1	Number of logical cylinders	XXXXh
2	Specific configuration	37C8h
3	Number of logical heads	16
4-5	Retired	0000h
6	Number of logical sectors per logical track	63
7-9	Retired	0000h
10-19	Serial number (ATA String)	20 ASCII characters
20-21	Retired	0000h
22	Obsolete	003Fh
23-26	Firmware revision(ATA String)	8 ASCII characters
27-46	Model number(ATA String)	40 ASCII characters
47	15-8: 80 7-0: 00h Reserved 01h-FFh: Maximum number of sectors that shall be transferred per DRQ data block on READ/WRITE Multiple commands	8001h
48	Trusted Computing feature set options 15 shall be cleared to zero 14 shall be set to one 13:1 Reserved for the Trusted Computing Group 0 0 = Trusted Computing feature set is not supported	4000h
49	Capabilities 15-14: Reserved for the IDENTIFY PACKET DEVICE command. 13: 1=Standby timer values as specified in this standard are supported 0:Standby timer values shall be managed by the device 12: Reserved for the IDENTIFY PACKET DEVICE command 11: 1=IORDY supported 0=IORDY may be disabled 10 1: IORDY may be disabled	2F00h

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	9 1=LBA supported 8 1=DMA supported. 7-0 Retired	
50	Capabilities 15: Shell be cleared to zero 14: Shall be set to one 13:2 Reserved 1 Obsolete 0 0	4000h
51	Obsolete	0280h
52	Obsolete	0000h
53	15 Free-fall control Sensitivity 00h: Vendor's recommended setting 7:3 Reserved 2: 1=the fields reported in word 88 are valid 1: 1=the fields reported in words (70:64) are valid 0: Obsolete	0007h
54	Number of current logical cylinders	XXXXh
55	Number of current logical heads	XXXXh
56	Number of current logical sectors per logical track	XXXXh
57-58	Current capacity in sectors	XXXXh
59	15:9 Reserved 8 0:Multiple sector setting is invalid 7:0 Current setting for number of logical sectors that shall be transferred per DRQ data block on READ/WRITE Multi commands	0001h
60-61	Total number of user address sectors(DWord)	XXXXXXXXh
62	Obsolete	0000h
63	Multi-word DMA transfer(Not support)	0007h
64	15-8 Reserved 7-0 PIO modes supported	0003h
65	Minimum Multiword DMA transfer cycle time per word 15-0 Cycle time in nanoseconds	0078h
66	Manufacturer's recommended Multiword DMA transfer cycle time per word 15-0 Cycle time in nanoseconds	0078h
67	Minimum PIO transfer cycle time without flow control 15-0 Cycle time in nanoseconds	0078h
68	Minimum PIO transfer cycle time with IORDY flow control 15-0 Cycle time in nanoseconds	0078h

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69-74	Reserved	0000h
75	No DMA QUEUED command supports	0000h
76	Serial ATA Capabilities 15:11 Reserved for Serial ATA 10 1= Supports Phy Event Counters 9 1= Supports receipt of host initiated power management Requests 8 0= No Support native Command Queuing 7:3 Reserved for future SATA signaling speed grades 2 1=Supports SATA Gen2 Signaling Speed (3.0Gb/s) 1 1=Support SATA Gen1 Signaling Speed (1.5Gb/s) 0 Shall be cleared to zero	0606h
77	Reserved for Serial ATA	0000h
78	Serial ATA features supported 15:7 Reserved for Serial ATA 6 0=Device not supports Software Settings Preservation 5 Reserved for Serial ATA 4 0= Device not supports in-order data delivery 3 0= Device not supports initiating power management 2 0= Device not supports DMA Setup auto-activation 1 0= Device not supports non-zero buffer offsets 0 Shall be cleared to zero	0000h
79	Serial ATA feature enabled 15:7 Reserved for Serial ATA 6 0=Software Settings Preservation not enabled 5 0=Reserved for Serial ATA 4 0= In-order data delivery not enabled 3 0= Device initiated power management not enabled 2 0= DMA setup auto-activation not enabled 1 0= Non-zero buffer offsets not enabled 0 Shall be cleared to zero	0000h
80-81	ATA Version support (ATA8-ACS)	01FE 0021h
82	Command and feature sets supported 15 0 = Obsolete 14 0 = NOP Command not supported 13 0 = READ BUFFER Command not supported 12 0 = WRITE BUFFER Command not supported 11 0 = Obsolete 10 0 = Host Protected Area Feature Set not supported 9 0 = DEVICE RESET Command not supported	0069h

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	8 0 = SERVICE Interrupt not supported 7 0 = RELEASE Interrupt not supported 6 1 = Look-ahead supported 5 1 = Write Cache supported 4 0 = indicate that the PACKET feature set is not supported 3 1 = mandatory Power Management Feature Set supported 2 0 = Obsolete 1 0 = Security Mode Feature Set not supported 0 1 = SMART Feature Set supported	
83	Command and feature sets supported 15 Shall be cleared to zero 14 Shall be set to one 13 0 = FLUSH CACHE EXT Command not supported 12 1 = mandatory FLUSH CACHE Command supported 11 0 = Device Configuration Overlay feature set not supported 10 0 = 48-Bit Address feature set not supported 9 0 = Automatic Acoustic Management feature set not supported 8 0 = SET MAX security extension not supported 7 0 = See Address Offset Reserved Area Boot, INCITS TR27:2001 6 0 = SET FEATURES subcommand not required to spin-up after power-up 5 0 = Power-Up in Standby feature set supported 4 0 = Removable Media Status Notification feature set not supported 3 0 = Advanced Power Management feature set not supported 2 0 = CFA feature set not supported 1 0 = READ/WRITE DMA QUEUED not supported 0 1 = DOWNLOAD MICROCODE Command supported	5000h
84	Command Set/Feature Supported Extension 15 Shall be cleared to zero 14 Shall be set to one 13-6 Reserved 5 0 = General Purpose Logging feature set not supported 4 reserved 3 0 = Media Card Pass Through Command feature set not supported 2 0 = Media Serial Number not supported	4000h

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	1 0 = SMART self-test not supported 0 1 = SMART Error Logging not supported	
85	Command and feature sets supported or enabled 15 0 = Obsolete 14 0 = NOP Command not enabled 13 0 = READ BUFFER Command not enabled 12 0 = WRITE BUFFER Command not enabled 11 Obsolete 10 0 = Host Protected Area feature set not enabled 9 0 = DEVICE RESET Command not enabled 8 0 = SERVICE Interrupt not enabled 7 0 = RELEASE Interrupt not enabled 6 0 = Look-ahead not enabled 5 0 = Write Cache not enabled 4 Shall be cleared to zero to indicate that the PACKET Command feature set is not supported. 3 1 = Power Management Feature Set enabled 2 0 = Removable Media feature set not enabled 1 0 = Security Mode Feature Set not enabled 0 0 = SMART Feature Set not enabled	0008
86	Command set/feature enabled 15-14 0 = Reserved 13 0 = FLUSH CACHE EXT Command not supported 12 1 = FLUSH CACHE Command supported 11 0 = Device Configuration Overlay not supported 10 0 = 48-Bit Address features set not supported 9 0 = Automatic Acoustic Management feature set not enabled 8 0 = SET MAX security extension not enabled by SET MAX SETPASSWORD 7 0 = Reserved 6 0 = SET FEATURES subcommand required to spin-up after power-up not enabled 5 0 = Power-Up in Standby feature set not enabled 4 0 = Obsolete 3 1 = Advanced Power Management feature set enabled 2 0 = CFA feature set not supported 1 0 = READ/WRITE DMA QUEUED Command not supported 0 1 = DOWNLOAD MICROCODE Command supported	5000h
87	Command and feature sets supported or enabled 15 Shall be cleared to zero	4000h

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	14 Shall be set to one 13 1 = IDLE IMMEDIATE with UNLOAD FEATURE supported 12 0 = Reserved for Technical Report, INCITS TR-37-2004 11 0 = Reserved for Technical Report, INCITS TR-37-2004 10:9 0 = Obsolete 8 0 = 64-Bit World Wide Name not supported 7 0 = WRITE DMA QUEUED FUA EXT Command not supported 6 0 = WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands not supported 5 0 = General Purpose Logging feature set not supported 4 0 = Obsolete 3 0 = Media Card Pass Through Command feature set not supported 2 0 = Media Serial Number is not valid 1 0 = SMART Self-Test not supported 0 0 = SMART Error-Logging not supported	
88	Ultra DMA modes 15 Reserved 14 0 = Ultra DMA mode 6 is not supported 13 1= Ultra DMA mode 5 is selected 0= Ultra DMA mode 5 is not selected 12 1= Ultra DMA mode 4 is selected 0= Ultra DMA mode 4 is not selected 11 1= Ultra DMA mode 3 is selected 0= Ultra DMA mode 3 is not selected 10 1= Ultra DMA mode 2 is selected 0= Ultra DMA mode 2 is not selected 9 1= Ultra DMA mode 1 is selected 0= Ultra DMA mode 1 is not selected 8 1= Ultra DMA mode 0 is selected 0= Ultra DMA mode 0 is not selected 7 Reserved 6 0= Ultra DMA mode 6 is not supported 5 1= Ultra DMA mode 5 and below are supported 4 1= Ultra DMA mode 4 and below are supported 3 1= Ultra DMA mode 3 and below are supported 2 1= Ultra DMA mode 2 and below are supported 1 1= Ultra DMA mode 1 and below are supported 0 1= Ultra DMA mode 0 is supported	XX7Fh

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89	Time required for Normal Erase mode SECURITY ERASE UNIT command	0000h
90	Time required for Enhanced erase mode SECURITY ERASE UNIT command	0000h
91	Current advanced power management level value	0000h
92	Master Password Identifier	0000h
93	Hardware reset result	XXXXh
94	Current automatic acoustic management value 15:8 Vendor's recommended acoustic management value. 7:0 Current automatic acoustic management value.	80FEh
95-126	Reserved	0000h
127	Obsolete	0000h
128	Security Status 15:9 Reserved 8 Security level 0 = high, 1 = Maximum 7:6 Reserved 5 1= Enhanced security erase supported 4 1= Security count expired 3 0= Security frozen. 2 0 = Security not locked 1 0= Security not enabled 0 0= Security not supported	0000h
129-159	Vendor specific	0000h
160	CFA power mode 1(Not support)	0000h
161-175	Reserved	0000h
176-205	Current media serial number	0000h
206-254	Reserved	0000h
255	Integrity word 15:8 Check Sum 7:0 Signature	XXXXh

5.1.3 IDLE

5.1.3.1 Command Code

E3h

5.1.3.2 Feature Set

Power Management Feature Set.

5.1.3.3 Protocol

Non-Data

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5.1.3.4 Inputs

Values other than zero in the Sector Count register when the IDLE command is issued shall determine the time period programmed into the Standby timer.

Table 12: Idle command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Timer period value							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	Obs	Na	Obs	DEV	Na	Na	Na	Na
Command	E3h							

Device register-

DEV shall specify the selected device.

Table 13: Idle command sector count register contents information

Sector Count register contents	Corresponding timeout period
0 (00h)	Timeout disabled
1-240 (01h-F0h)	(value*5)s
241-251 (F1h-FBh)	((Value-240)*30)min
252 (FCh)	21min
253 (FDh)	Period between 8 and 12 hrs
254 (FEh)	Reserved
255 (FFh)	21 min 15 s
NOTE – Times are approximate	

5.1.3.5 Normal Outputs

Table 14: Idle command for normal outputs information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device Register-

DEV shall indicate the selected device.

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Status register-

BSY will be cleared to zero indicating command completion.

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ shall be cleared to zero.

ERR shall be cleared to zero.

5.1.3.6 Error Outputs

Table 15: Idle command for error outputs information

Register	7	6	5	4	3	2	1	0
Error	Na	Na	Na	Na	Na	ABRT	Na	Na
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na			
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

5.1.3.7 Prerequisites

DRDY set to one

5.1.3.8 Description

The IDLE command allows the host to place the device in the idle mode and also set the Standby timer.

5.1.4 Idle Immediate

5.1.4.1 Command Code

E1h

5.1.4.2 Feature Set

Power Management Feature Set.

5.1.4.3 Protocol

Non-Data

5.1.4.4 Inputs

Table 16: Idle immediate command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							

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LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Command	E1h							

Device register-

DEV shall specify the selected device.

5.1.4.5 Normal Outputs

Table 17: Idle immediate command for normal outputs information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device Register-

DEV shall indicate the selected device.

Status register-

BSY will be cleared to zero indicating command completion.

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ shall be cleared to zero.

ERR shall be cleared to zero.

5.1.4.6 Prerequisites

DRDY set to one

5.1.4.7 Description

The IDLE IMMEDIATE command allows the host to immediately place the device in the idle mode.

5.1.5 Read Multiple

5.1.5.1 Command Code

C4h

5.1.5.2 Protocol

PIO data-in

5.1.5.3 Inputs

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Table 18: Read multiple command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Sector Count							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	obs	Na	obs	DEV	LBA(27:24)			
Command	C4h							

Sector Count-

Number of sectors to be transferred. A value of 00h specifies that 256 sectors are to be transferred.

LBA Low-

Starting LBA bits (7:0).

LBA Mid-

Starting LBA bits (15:8)

LBA High-

Starting LBA bits (23:16)

Device –

DEV shall specify the selected device.

Bit (3:0) starting LBA bits (27:24)

5.1.5.4 Normal Output

Table 19: Read multiple command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

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ERR will be cleared to zero.

5.1.5.5 Error Outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The Command Block registers contain the address of the sector where the first unrecoverable error occurred. The amount of data transferred us indeterminate.

Table 20: Read multiple command for error output information

Register	7	6	5	4	3	2	1	0
Error	Na	UNC	MC	IDNF	MCR	ABRT	NM	Obs
Sector Count	Na							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	obs	Na	obs	DEV	LBA(27:24)			
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Error register-

UNC shall be set to one if data is uncorrectable.

IDNF shall be set to one if a user-accessible address is requested could not be found.

LBA Low, LBA Mid, and LBA High, Device

Shall be written with the address of first unrecoverable error.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be set to one if an Error register bit is set to one.

5.1.5.6 Prerequisites

DRDY set to one.

5.1.5.7 Description

This command reads the number of sectors specified in the sector Count register.

The number of sectors per block is defined by the content of word 59 in the IDENTIFY DEVICE response.

5.1.6 Read Sector(s)

5.1.6.1 Command Code

20h

5.1.6.2 Protocol

PIO data-in

5.1.6.3 Inputs

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Table 21: Read sector command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Sector Count							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	obs	Na	obs	DEV	LBA(27:24)			
Command	20h							

Sector Count-

Number of sectors to be transferred. A value of 00h specifies that 256 sectors are to be transferred.

LBA Low-

Starting LBA bits (7:0).

LBA Mid-

Starting LBA bits (15:8)

LBA High-

Starting LBA bits (23:16)

Device –

DEV shall specify the selected device.

Bit (3:0) starting LBA bits (27:24)

5.1.6.4 Normal Output

Table 22: Read sector command for normal outputs information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

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DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

5.1.6.5 Error Outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The Command Block registers contain the address of the sector where the first unrecoverable error occurred. The amount of data transferred us indeterminate.

Table 23: Read sector command for error outputs information

Register	7	6	5	4	3	2	1	0
Error	Na	UNC	MC	IDNF	MCR	ABRT	NM	Obs
Sector Count	Na							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	obs	Na	obs	DEV	LBA(27:24)			
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Error register-

UNC shall be set to one if data is uncorrectable.

IDNF shall be set to one if a user-accessible address is requested could not be found.

LBA Low, LBA Mid, and LBA High, Device

Shall be written with the address of first unrecoverable error.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be set to one if an Error register bit is set to one.

5.1.6.6 Prerequisites

DRDY set to one.

5.1.6.7 Description

This command reads from 1 to 256 sectors as specified in the Sector Count register. A sector count of 0 requests 256 sectors. This transfer shall begin at the sector specified in the LBA Low, LBA Mid, LBA High, and Device registers. The DRQ bit is always set to one prior to data transfer regardless of the presence or absence of an error condition. The device shall interrupt for each DRQ block transferred.

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5.1.7 Read Verify Sector

5.1.7.1 Command Code

40h

5.1.7.2 Protocol

Non-data

5.1.7.3 Inputs

Table 24: Read verify sector command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Sector Count							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	obs	Na	obs	DEV	LBA(27:24)			
Command	40h							

Sector Count-

Number of sectors to be transferred. A value of 00h specifies that 256 sectors are to be transferred.

LBA Low-

Starting LBA bits (7:0).

LBA Mid-

Starting LBA bits (15:8)

LBA High-

Starting LBA bits (23:16)

Device –

The LBA bit shall be set to one to specify the address is an LBA.

DEV shall specify the selected device.

Bit (3:0) starting LBA bits (27:24)

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5.1.7.4 Normal Output

Table 25: Read verify sector command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

5.1.7.5 Error Outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The Command Block registers contain the address of the sector where the first unrecoverable error occurred.

Table 26: Read verify sector command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na	UNC	MC	IDNF	MCR	ABRT	NM	Obs
Sector Count	Na							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	obs	Na	obs	DEV	LBA(27:24)			
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Error register-

UNC shall be set to one if data is uncorrectable.

IDNF shall be set to one if a user-accessible address could not be found.

LBA Low, LBA Mid, and LBA High, Device

Shall be written with the address of first unrecoverable error.

Status register

BSY will be cleared to zero indicating command completion

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DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be set to one if an Error register bit is set to one.

5.1.7.6 Prerequisites

DRDY set to one.

5.1.7.7 Description

This command is identical to the READ SECTOR(s) command, except that the device shall have read the data from the SSD, the DRQ bit is never set to one, and no data is transferred to the host.

5.1.8 Read DMA

5.1.8.1 Command Code

C8h

5.1.8.2 Protocol

DMA

5.1.8.3 Inputs

Table 27: Read DMA command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Sector Count							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	obs	Na	obs	DEV	LBA(27:24)			
Command	C4h							

Sector Count-

Number of sectors to be transferred. A value of 00h specifies that 256 sectors are to be transferred.

LBA Low-

Starting LBA bits (7:0).

LBA Mid-

Starting LBA bits (15:8)

LBA High-

Starting LBA bits (23:16)

Device –

DEV shall specify the selected device.

Bit (3:0) starting LBA bits (27:24)

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5.1.8.4 Normal Output

Table 28: Read DMA command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

5.1.8.5 Error Outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The Command Block registers contain the address of the sector where the first unrecoverable error occurred. The amount of data transferred us indeterminate.

Table 29: Read DMA command for error output information

Register	7	6	5	4	3	2	1	0
Error	ICRC	UNC	MC	IDNF	MCR	ABRT	NM	Obs
Sector Count	Na							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	Obs	Na	obs	DEV	LBA(27:24)			
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Error register-

ICRC shall be set to one if an interface CRC error has occurred during an Ultra DMA data transfer. The content of this bit is not applicable for Multiword DMA transfers.

UNC shall be set to one if data is uncorrectable.

IDNF shall be set to one if a user-accessible address could not be found.

LBA Low, LBA Mid, and LBA High, Device

Shall be written with the address of first unrecoverable error.

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Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be set to one if an Error register bit is set to one.

5.1.8.6 Prerequisites

DRDY set to one. The host shall initialize the DMA channel.

5.1.8.7 Description

The READ DMA command allows the host to read data using the DMA data transfer protocol.

5.1.9 Set Feature

TBD

5.1.10 Set Multiple Mode

5.1.10.1 Command Code

C6h

5.1.10.2 Protocol

Non-data

5.1.10.3 Inputs

If the content of the Sector Count Register is not zero, then the Sector Count register contains the number of sectors per block for the device to be used on all following READ/WRITE MULTIPLE commands. The content of the Sector Count register shall be less than or equal to the value in bits (7:0) in word 47 in the IDENTIFY DEVICE information. The host should set the content of the Sector Count register to 1.

Table 30: Set multiple mode command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Sector per block							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na			
Command	C6h							

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5.1.10.4 Normal Output

Table 31: Set multiple mode command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

5.1.10.5 Error Outputs

Table 32: Set multiple mode command for error outputs information

Register	7	6	5	4	3	2	1	0
Error	Na	Na	obs	Na	Na	ABRT	Na	Na
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	Obs	Na	obs	DEV	Na			
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to one if a device fault has occurred.

DRQ will be cleared to zero

ERR will be set to one if an Error register bit is set to one.

5.1.10.6 Prerequisites

DRDY set to one.

5.1.10.7 Description

This command establishes the block count for READ MULTIPLE, READ MULTI EXT, WRITE

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MULTIPLE.

SSD can only support 1 sector per block.

5.1.11 Set Sleep Mode

5.1.11.1 Command Code

E6h

5.1.11.2 Protocol

Non-data

5.1.11.3 Inputs

Table 33: Set sleep mode for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na			
Command	E6h							

Device register–

DEV shall specify the selected device.

5.1.11.4 Normal Output

Table 34: Set sleep mode for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

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ERR will be cleared to zero.

5.1.11.5 Error Outputs

Table 35: Set sleep mode for error output information

Register	7	6	5	4	3	2	1	0
Error	Na	Na	Na	Na	Na	ABRT	Na	Na
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	Obs	Na	obs	DEV	Na			
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be set to one if a device fault has occurred.

DRQ will be cleared to zero

ERR will be set to one if an Error register bit is set to one.

5.1.11.6 Prerequisites

DRDY set to one.

5.1.11.7 Description

This command is the only way to cause the device to enter Sleep mode.

5.1.12 Flush Cache

5.1.12.1 Command Code

E7h

5.1.12.2 Protocol

Non-data

5.1.12.3 Inputs

Table 36: Flush cache command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na			
Command	E7h							

Device register–

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DEV shall specify the selected device.

5.1.12.4 Normal Output

Table 37: Flush cache command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

5.1.12.5 Error Outputs

Table 38: Flush cache command for error output information

Register	7	6	5	4	3	2	1	0
Error	Na	Na	Na	Na	Na	ABRT	Na	Na
Sector Count	Na							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	Obs	Na	obs	DEV	LBA(27:24)			
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Error register-

ABRT may be set to one if the device is not able to complete the action requested by the command.

LBA Low, LBA Mid, and LBA High, Device

Shall be written with the address of first unrecoverable error.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

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DF (Device Fault) will be cleared to one if a device fault has occurred.

DRQ will be cleared to zero

ERR will be set to one if an Error register bit is set to one.

5.1.12.6 Prerequisites

DRDY set to one.

5.1.12.7 Description

This command is used by the host to request the device to flush the write cache. If there is data in write cache, that data shall be written to the SSD. The BSY bit shall remain set to one until all data has been successfully written or an error occurs.

5.1.13 Standby

5.1.13.1 Command Code

E2h

5.1.13.2 Protocol

Non-data

5.1.13.3 Inputs

The value in the Sector Count register when the STANDBY command is issued shall determine the time period programmed into the Standby timer.

Table 39: Standby command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Time period value							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na			
Command	E2h							

Device register–

DEV shall specify the selected device.

5.1.13.4 Normal Output

Table 40: Standby command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							

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LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

5.1.13.5 Error Outputs

Table 41: Standby command for error output information

Register	7	6	5	4	3	2	1	0
Error	Na	Na	Na	Na	Na	ABRT	Na	Na
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	Obs	Na	obs	DEV	Na			
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Error register-

ABRT may be set to one if the device is not able to complete the action requested by the command.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be set to one if a device fault has occurred.

DRQ will be cleared to zero

ERR will be set to one if an Error register bit is set to one.

5.1.13.6 Prerequisites

DRDY set to one.

5.1.13.7 Description

This command causes the device to enter the Standby mode.

If the Sector Count register is non-zero then Standby timer shall be enabled. The value in the Sector Count register shall be used determine the time programmed into the Standby timer. If the Sector Count register is zero then the Standby timer is disabled.

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5.1.14 Standby Immediate

5.1.14.1 Command Code

E0h

5.1.14.2 Protocol

Non-data

5.1.14.3 Inputs

Table 42: Standby immediate command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na			
Command	E0h							

Device register–

DEV shall specify the selected device.

5.1.14.4 Normal Output

Table 43: Standby immediate command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

5.1.14.5 Error Outputs

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Table 44: Standby immediate command for error output information

Register	7	6	5	4	3	2	1	0
Error	Na	Na	Na	Na	Na	ABRT	Na	Na
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	Obs	Na	obs	DEV	Na			
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Error register-

ABRT may be set to one if the device is not able to complete the action requested by the command.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be set to one if a device fault has occurred.

DRQ will be cleared to zero

ERR will be set to one if an Error register bit is set to one.

5.1.14.6 Prerequisites

DRDY set to one.

5.1.14.7 Description

This command causes the device to immediately enter the Standby mode.

5.1.15 Write Multiple

5.1.15.1 Command Code

C5h

5.1.15.2 Protocol

PIO data-out

5.1.15.3 Inputs

The LBA mid, LBA High, Device, and LBA Low specify the starting sector address to be written. The Sector Count register specifies the number of sectors to be transferred.

Table 45: Write multiple command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Sector Count							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							

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Device	obs	Na	obs	DEV	LBA(27:24)
Command	C5h				

Sector Count-

Number of sectors to be transferred. A value of 00h specifies that 256 sectors shall be transferred.

LBA Low-

Starting LBA bits (7:0)

LBA Mid-

Starting LBA bits (15:8)

LBA High-

Starting LBA bits (23:16)

Device –

The LBA bit shall be set to one to specify the address is an LBA.

DEV shall specify the selected device.

Bits(3:0) starting LBA bits (27:24)

5.1.15.4 Normal Output

Table 46: Write multiple command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

5.1.15.5 Error Outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The Command Block register contain the address of the sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate.

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Table 47: Write multiple command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na	WP	MC	IDNF	MCR	ABRT	NM	Na
Sector Count	Na							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	Obs	Na	obs	DEV	LBA(27:24)			
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Error register-

IDNF shall be set to one if a user-accessible address could not be found. IDNF shall be set to one if an address outside of the range user-accessible address is requested if command aborted is not returned.

ABRT shall be set to one if an error, include an ICRC error, has occurred during an Ultra DMA data transfer. ABRT shall be set to one if an address outside of the range of user-accessible address is requested if IDNF is not set to one.

LBA Low, LBA Mid, and LBA High, Device -

Shall be written with the address of first unrecoverable error.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be set to one if a device fault has occurred.

DRQ will be cleared to zero

ERR will be set to one if an Error register bit is set to one.

5.1.15.6 Prerequisites

DRDY set to one. If bit 8 of IDENTIFY DEVICE word 59 is cleared to zero, a successful SET MULTIPLE MODE command shall proceed a WRITE MULTIPLE command.

5.1.15.7 Description

This command writes the number of sectors specified in the Sector Count register.

The number of sectors per block is defined by the content of word 59 of the IDENTIFY DEVICE response.

When the WRITE MULTIPLE command is issued, the SECTOR Count register contains the number of sectors (not the number of blocks) requested. The device shall interrupt for each DRQ block transferred.

IF the number of requested sectors is not evenly divisible by the block count, as many full blocks as possible are transferred, followed by a final, partial block transfer. The partial block

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transfer is for n sectors, where:

N = Remainder (sector count / block count).

If the WRITE MULTIPLE command is received when WRITE MULTIPLE commands are disabled, the Write Multiple operation shall be rejected with command aborted.

Device errors encountered during WRITE MULTIPLE commands are posted after the attempted device write of the block or partial block transferred. The command ends with the sector in error, even if the error was in the middle of a block. Subsequent blocks are not transferred in the event of an error.

The contents of the Command Block Registers following the transfer of a data block that had a sector in error are undefined. The host should retry the transfer as individual requests to obtain valid error information. Interrupt pending is set when the DRQ bit is set to one at the beginning of each block or partial block.

5.1.16 Write Sector

5.1.16.1 Command Code

30h

5.1.16.2 Protocol

PIO data-out

5.1.16.3 Inputs

The LBA mid, LBA High, Device, and LBA Low specify the starting sector address to be written. The Sector Count register specifies the number of sectors to be transferred.

Table 48: Write sector command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Sector Count							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	obs	LBA	obs	DEV	LBA(27:24)			
Command	30h							

Sector Count-

Number of sectors to be transferred. A value of 00h specifies that 256 sectors shall be transferred.

LBA Low-

Starting LBA bits (7:0)

LBA Mid-

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Starting LBA bits (15:8)

LBA High-

Starting LBA bits (23:16)

Device –

The LBA bit shall be set to one to specify the address is an LBA.

DEV shall specify the selected device.

Bits(3:0) starting LBA bits (27:24)

5.1.16.4 Normal Output

Table 49: Write sector command for inputs information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

5.1.16.5 Error Outputs

An unrecoverable error encountered during the execution if this command results in the termination of the command. The Command Block registers contain the address of the sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate.

Table 50: Write sector command for error outputs information

Register	7	6	5	4	3	2	1	0
Error	Na	WP	MC	IDNF	MCR	ABRT	NM	Na
Sector Count	Na							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	Obs	Na	obs	DEV	LBA(27:24)			
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

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Error register-

IDNF shall be set to one if a user-accessible address could not be found. IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if command aborted is not returned.

ABRT shall be set to one if an error, including an ICRC error, has occurred during an Ultra DMA data transfer. ABRT shall be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.

LBA Low, LBA Mid, and LBA High, Device

Shall be written with the address of first unrecoverable error.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be set to one if a device fault has occurred.

DRQ will be cleared to zero

ERR will be set to one if an Error register bit is set to one.

5.1.16.6 Prerequisites

DRDY set to one.

5.1.16.7 Description

This command writes from 1 to 256 sectors as specified in the Sector Count register. A sector count of 0 requests 256 sectors. The device shall interrupt for each DRQ block transferred.

5.1.17 Write DMA

5.1.17.1 Command Code

CAh

5.1.17.2 Protocol

DMA

5.1.17.3 Inputs

The LBA Mid, LBA High, Device, and LBA Low specify the starting sector address to be written. The Sector Count register specifies the number of sectors to be transferred.

Table 51: Write DMA command for input information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Sector Count							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	obs	LBA	obs	DEV	LBA(27:24)			
Command	CAh							

Sector Count-

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Number of sectors to be transferred. A value of 00h specifies that 256 sectors shall be transferred.

LBA Low-

Starting LBA bits (7:0)

LBA Mid-

Starting LBA bits (15:8)

LBA High-

Starting LBA bits (23:16)

Device –

The LBA bit shall be set to one to specify the address is an LBA.

DEV shall specify the selected device.

Bits (3:0) starting LBA bits (27:24)

Normal Output

Table 52: Write DMA command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

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5.1.17.4 Error Outputs

Table 53: Write DMA command for error outputs information

Register	7	6	5	4	3	2	1	0
Error	ICRC	WP	MC	IDNF	MCR	ABRT	NM	Obs
Sector Count	Na							
LBA Low	LBA(7:0)							
LBA Mid	LBA(15:8)							
LBA High	LBA(23:16)							
Device	Obs	Na	obs	DEV	LBA(27:24)			
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Error register-

ICRC shall be set to one if an interface CRC error has occurred during an Ultra DMA data transfer. The content of this bit is not applicable for Multiword DMA transfers.

IDNF shall be set to one if a user-accessible address could not be found. INDF shall be set to one if an address outside of the range of user-accessible address is requested if command aborted is not returned.

ABRT shall be set to one if an error, including an ICRC error, has occurred during an Ultra DMA data transfer. ABRT shall be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.

LBA Low, LBA Mid, and LBA High, Device

Shall be written with the address of first unrecoverable error.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be set to one if a device fault has occurred.

DRQ will be cleared to zero

ERR will be set to one if an Error register bit is set to one.

5.1.17.5 Prerequisites

DRDY set to one. The host shall initialize the DMA channel.

5.1.17.6 Description

The Write DMA command allows the host to write data using the DMA data transfer protocol.

5.1.18 Execute Device Diagnostic

5.1.18.1 Command Code

90h

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5.1.18.2 Feature Set

General feature set

5.1.18.3 Protocol

Device diagnostic

5.1.18.4 Inputs

Only the command code (90h). All other registers shall be ignored.

Table 54: Execute device diagnostic command for inputs information

Register	7	6	5	4	3	2	1	0
Features	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	Na	Na			
Command	90h							

Device –

DEV shall be ignored.

Normal Outputs

The diagnostic code written into the Error register is an 8-bit code.

Table 55: Execute device diagnostic command for normal outputs information

Register	7	6	5	4	3	2	1	0
Error	Diagnostic Code							
Sector Count	Signature							
LBA Low	Signature							
LBA Mid	Signature							
LBA High	Signature							
Device	Signature							
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Error register-

Diagnostic Code

Sector Count, LBA Low, LBA Mid, LBA High, Device registers

Device signature

Device register

DEV shall be cleared to zero.

Status register

TBD

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Table 56: Execute device diagnostic command for status register information

Code	Description
01h	Device passed
Others	Device failed

5.1.18.5 Error Outputs

Table 9 shows the error information that is returned as a diagnostic code in the Error register.

5.1.18.6 Prerequisites

This command shall be accepted regardless of the state of DRDY.

5.1.18.7 Description

This command shall cause the devices to perform the internal diagnostic tests.

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