CFast Card, SATA3

CFX602

Datasheet

Products	Product Description
TS8GCFX602	CFast Card, SATA3, MLC , WD-15
TS16GCFX602	
TS32GCFX602	**Datasheet version**
TS64GCFX602	1.0
TS128GCFX602	
TS256GCFX602	

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Revision History

Revision No.	History	Released Date	Editor by
0.1	First version (WD 15nm)	2021/12/13	TSD
1.0	Revised Scope Pro	2021/12/30	TSD

Transcend CFX602 Features

Part Name	Capacity
TS8GCFX602	8GB
TS16GCFX602	16GB
TS32GCFX602	32GB
TS64GCFX602	64GB
TS128GCFX602	128GB
TS256GCFX602	256GB

FEATURES

- RoHS compliant
- CFast Specification Version 2.0 Compliant
- Power Supply: 3.3V±5%
- Operating Temperature: -5°C to 70°C
- Storage Temperature: -40°C to 85°C
- Humidity (non condensation): 0% to 95%
- Built-in 66bit per 1KByte ECC (Error Correction Code) functionality ensures high reliability of data transfer.
- Global wear-leveling algorithm eliminates excessive write operation and extends product life.
- Support S.M.A.R.T (Self-defined)
- Support Security Command
- Support Device Sleep
- Fully compatible with devices and OS that support the SATA 6Gb/s standard
- Durability of Connector: 10,000 times

PERFORMANCE[1)]

- Data Transfer Rate
  - Sequential Read Up to 500 MB/s
  - Sequential Write Up to 350 MB/s

RELIABILITY[1)]

- TBW
  - 8GB 12TB
  - 16GB 23TB
  - 32GB 45TB
  - 64GB 90TB
  - 128GB 180TB
  - 256GB 360TB
- UBER 10^{-15}
- DWPD 1.31
- MTBF 1,000,000 hours
- Data Retention 1 years
- Warranty 3 years

ENVIRONMENTAL SPECIFICATIONS[1)]

- Temperature
  - Operating -5°C to 70°C
  - Non-operating -40°C to 85°C
- Humidity(non-condensing) 0%~95%
- Shock 1500G, 0.5ms
- Vibration 3G, 5~800Hz

POWER REQUIREMENTS[1)]

- Supply voltage / Tolerance 3.3V±5%
- Active (max) 2.15W
- Idle (max) 0.25W

PHYSICAL DIMENSION

- Width 42.8±0.1mm
- Length 36.4±0.15mm
- Height Max 3.5±0.1mm
- Weight Max 10.3g

Note:

1) For detail information, please refer to document content

Table of Content

1. Introduction

1.1 General Feature Information

Hardware Feature

- SATA 6Gbps
- Transcend Controller TS6560
- 2D MLC NAND Flash
- Temperature operation from -5°C to 70°C
- CFast 2.0 form factor
- Power shield function
- Write Protection function (Optional)

Firmware Feature

- Global wear-leveling function
- Enhance Bad block management function
- BCH ECC(Error Correction Code) function
- TRIM Command function
- Advanced Garbage Collection function
- StaticDataRefresh function
- S.M.A.R.T. function
- DEVSLP mode

Software Feature

- Transcend Scope Pro

1.2 Product List

Form Factor	Part Name	Capacity
CFast 2.0	TS8GCFX602	8GB
	TS16GCFX602	16GB
	TS32GCFX602	32GB
	TS64GCFX602	64GB
	TS128GCFX602	128GB
	TS256GCFX602	256GB

1.3 Ordering Information

T S X X X G C F X 6 0 2

1 2 3 4 5

1 – Transcend

2 – CFast Density

3 – G: Gigabyte; T: Terabyte

4 – SATA device with CFast 2.0

5 – Model name

2. Product Specifications

2.1 Interface and Compliance

- SATA3, compatible to SATA2 and SATA1
- Compatible with ATA/ATAPI-7 Standard
- Native Command Queuing(NCQ) Command Set
- RoHS Compliance
- CE, UKCA, FCC and BSMI Compliance

2.2 Drive Capacity

Actual Capacity				
ModelP/N	UserMaxLBA	Cylinder	Head	Sector
TS8GCFX602	15,649,200	15,525	16	63
TS16GCFX602	31,277,232	16,383	16	63
TS32GCFX602	62,533,296	16,383	16	63
TS64GCFX602	125,045,424	16,383	16	63
TS128GCFX602	250,069,680	16,383	16	63
TS256GCFX602	500,118,192	16,383	16	63

2.3 System Performance

Performance				
ModelP/N	Read	Write	RandomRead (4KBQD32)	RandomWrite (4KBQD32)
TS8GCFX602	140 MB/s	30 MB/s	35 MB/s	25 MB/s
TS16GCFX602	140 MB/s	30 MB/s	35 MB/s	25 MB/s
TS32GCFX602	270 MB/s	55 MB/s	70 MB/s	50 MB/s
TS64GCFX602	500 MB/s	110 MB/s	120 MB/s	100 MB/s
TS128GCFX602	500 MB/s	215 MB/s	130 MB/s	200 MB/s
TS256GCFX602	510 MB/s	340 MB/s	140 MB/s	260 MB/s

Note: Maximum transfer speed recorded

1) 25°C, test on GIGABYTE GA-Z87X-D3H, 4GB, Windows® 7 Professional with AHCI mode, benchmark utility CrystalDiskMark (version 3.0.1), copied file 1000MB.

2) The recorded performance is obtained while the SSD is not operated as an OS disk Physical Specification.

2.4 Supply Voltage

[Table 4] Supply Voltage

Item	Requirements
Allowable voltage	3.3V±5%

2.5 System Power Consumption

Power Requirements		
TS8GCFX602	Write (peak)[1)]	160 mA
	Read (peak)[1)]	165 mA
	Idle	70 mA
TS16GCFX602	Write (peak)[1)]	160 mA
	Read (peak)[1)]	165 mA
	Idle	70 mA
TS32GCFX602	Write (peak)[1)]	200 mA
	Read (peak)[1)]	215 mA
	Idle	70 mA
TS64GCFX602	Write (peak)[1)]	280 mA
	Read (peak)[1)]	300 mA
	Idle	70 mA
TS128GCFX602	Write (peak)[1)]	415 mA
	Read (peak)[1)]	300 mA
	Idle	70 mA
TS256GCFX602	Write (peak)[1)]	620 mA
	Read (peak)[1)]	300 mA
	Idle	70 mA

Note:

1) The power consumption is measured under SSD operation at maximum performance. The value is affected by system operation performance and workload.

2.6 Environment Specifications

Features	Operating[1)]	Non-Operating[2)]
Temperature	-5°C to +70°C	-40°C to 85°C
Temperature Gradient	60°C/Hr	60°C/Hr
Humidity	0% to 95%, non-condensing	
Shock	1500G, duration 0.5 ms, 3 axis[3)]	
Vibration	3G, 5~800Hz, 3 axis[4)]	

Note:

1) The operating specification is regarded as Ambient Temperature. Standard grade (0°C to +70°C) and Industrial grade (-40°C to

+85°C) indicate the temperature conditions for testing devices on programmable temperature and humidity chamber room.
2) The non-operating specification is regarded as storage specification.
3) Refer IEC 68-2-27 standard.
4) Refer IEC 68-2-6 standard.

Recommended Measurement Point

Recommended temperature measurement point is in the center of the connector inserted by the device. Sufficient airflow is recommended for proper operation on heavier workloads within the device operating temperature.

2.7 System Reliability

[Table 1] MTBF Specifications

Parameter	8GB	16GB	32GB	64GB	128GB	256GB
MTBF	1,000,000 hours					

Note:

1) The calculation is based on 25°C.

[Table 2] UBER Specifications

Parameter	8GB	16GB	32GB	64GB	128GB	256GB
UBER	10^{-15}					

Note:

1) Uncorrectable Bit Error Rate (UBER) is a metric for the rate of occurrence of data errors, equal to the number of data errors per bits read as specified in the JESD218 document of JEDEC standard. For the client application, JEDEC recommends that UBER shall be below 10^{-15}.

[Table 3] TBW (Terabytes Written) Specifications

Parameter	8GB	16GB	32GB	64GB	128GB	256GB
TBW	12	23	45	90	180	360

Note:

1) TBW specification follows JESD219A Client workload.

[Table 4] Drive Write Per Day (DWPD) Specifications

Parameter	8GB	16GB	32GB	64GB	128GB	256GB
DWPD[1)]	1.31 (3 Years)					

Note:

1) DWPD is based on [Table 7] Warranty year to calculate.

[Table 5] Data Retention Specifications

Parameter	8GB	16GB	32GB	64GB	128GB	256GB
Data Retention	1 year					

Note:

1) Data retention was measured by assuming that SSD reaches the maximum rated endurance at 30°C under power-off state.
2) The data retention is defined in JESD218 Requirements for standard classes of SSDs.

[Table 6] Power On to Ready

Parameter	8GB	16GB	32GB	64GB	128GB	256GB
Setup time	0.454 s					

[Table 7] Warranty

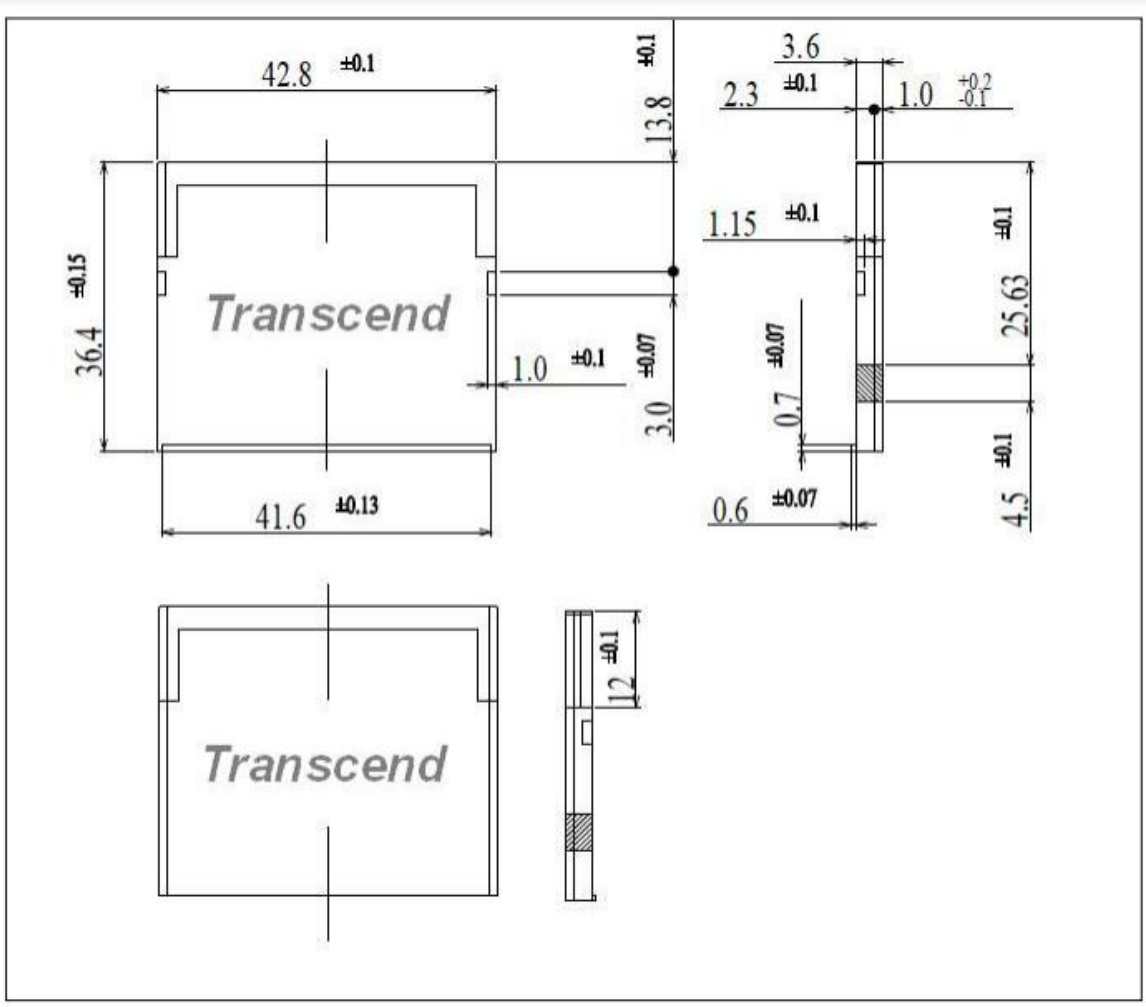
Parameter	8GB	16GB	32GB	64GB	128GB	256GB
Warranty	3 years limited					

[Table 8] Regulations

Parameter	8GB	16GB	32GB	64GB	128GB	256GB
Compliance	CE, UKCA, FCC and BSMI					

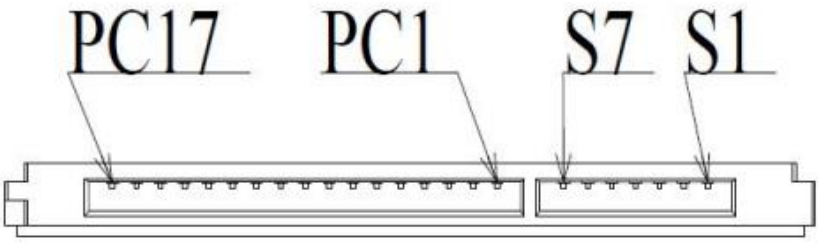
3. Mechanical Specification

Model	Height (mm)	Width (mm)	Length (mm)	Weight (gram)
8GB/16GB/32GB/ 64GB/128GB/256GB	Max 3.6	36.4±0.15	42.8±0.1	Max 10.3g



4. Pin Assignments

4.1 CFast Serial ATA Interface

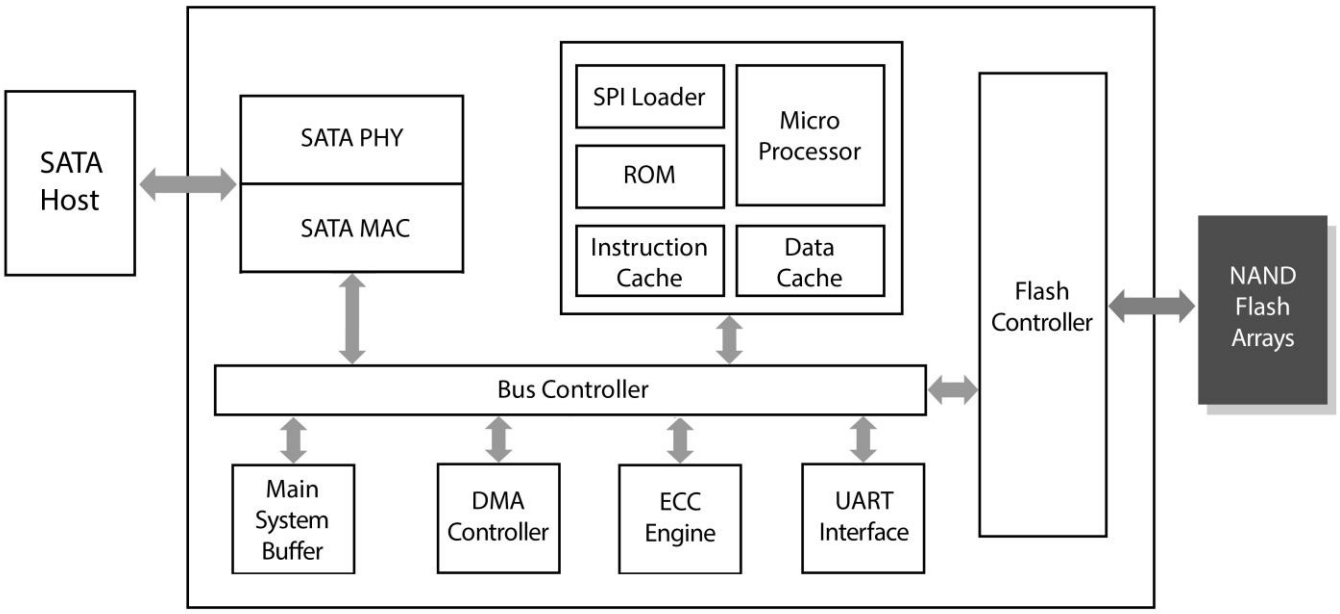


4.2 Pin Assignments

Pin No.	Pin Name
7-pin Signal Segment	
S1	GND
S2	A+
S3	A-
S4	GND
S5	B-
S6	B+
S7	GND
17-pin Power Segment	
PC1	CDI
PC2	GND
PC3	DEVSLP
PC4	NC
PC5	NC
PC6	NC
PC7	GND
PC8	NC
PC9	NC
PC10	Write Protection (Optional)
PC11	Write Protection (Optional)
PC12	GND
PC13	3.3V
PC14	3.3V
PC15	GND
PC16	GND
PC17	CDO

5. Block Diagram and Function Explanations

5.1 Block Diagram



5.2 Function Explanations

5.2.1 Global Wear Leveling Function

Global wear leveling ensures that every block has an even erase count. This helps to extend the life expectancy of an SSD.

There are three main processes in global wear leveling:

(1) Record the block erase count and save this in the wear-leveling table.

(2) Find the static-block and save this in the wear-leveling pointer.

(3) Check the erase count when a block is pulled from the pool of spare blocks. If the block erase count is larger than WEARCNT, then swap the static-block and the over-count-block.

5.2.2 Bad Block Management Function

When the flash encounters ECC fail, program fail or erase fail, the controller will mark the block as a bad block. This will prevent the usage of bad blocks which may result in data loss in the future.

5.2.3 Enhanced S.M.A.R.T. function

Transcend SSD supports S.M.A.R.T. command (Self-Monitoring, Analysis, and Reporting Technology) that allows users to read the health information of the SSD. Transcend also define some innovated S.M.A.R.T. features which allows the user to evaluate the status of the SSD in a much more efficient way.

5.2.4 StaticDataRefresh Technology

Normally, ECC engine corrections take place without affecting the normal operations of the host. As time passes by, the number of error bits, accumulated in the read transaction, exceeds the correcting capability of the ECC engine and causes corrupted data to be sent to the host. In order to prevent such occurrence,

the controller monitors the error bit levels at each read operation. When it reaches the preset threshold value, the controller automatically performs data refresh to “restore” the correct charge levels in the cell. This implementation practically restores the data to its original, error-free state, and hence lengthening data life.

5.2.5 PS(Power shield) Function

Power Shield (PS) is a basic technology supported by all Transcend's embedded SSDs to prevent internal NAND flash data loss in event of a sudden power outage. The internal voltage detection circuit (VDT) of the controller monitors the external power supply. When the external voltage drops from 5V to 4V or from 3.3V to 2.7V, the VDT activates the PS detection mechanism. When a sudden power outage occurs, the internal power shield circuit would trigger the PS function so that the controller will stop accepting new write commands. The write operation is terminated to ensure that the firmware and the data in the NAND flash are undamaged.

When the external voltage drops to a certain level, the internal voltage detection circuit (VDT) of the controller activates the PS mechanism. The SSD controller then stops accepting new write commands from the host, ensuring the integrity of existing data for the NAND flash.

The PS function ensures the safety of the data which has already been written into the flash before sudden power outage.

5.2.6 DEVSLP Function

DevSlp or DevSleep (regarded as device sleep or SATA DEVSLP) is a feature in SATA SSD which allows them to go into a low power "device sleep" mode when sent the appropriate signal, which uses one or two orders of magnitude less power than a traditional idle (about 5 mW). This function can help save more battery power in platform idle, so that the user can operate the platform for longer time.

5.2.7 Transcend Scope Pro

Transcend’s Scope Pro is a convenient software package that helps users monitor and manage SSD status via an intuitive interface. It offers various useful features, including drive information and S.M.A.R.T. status monitoring, diagnostic scan, secure erase, health indication, system clone, and monitoring. For more information, please refer the website link. **https://us.transcend-info.com/Embedded/Software/Monitor**

5.2.8 Other Functions

Transcend SSD embedded a lot of cutting-edge technology. Should you have any technical request, please contact the local support team or send us an e-mail.

6. Technology Term Explanations

6.1 TBW

Terabytes Written (TBW) directly measures how much you can write cumulatively into the drive over its lifetime. Essentially, it just includes the multiplication conducted above in the measurement itself.
For example, if your drive is rated for 365 TBW, that means you can write 365 TB into it before a replacement is required.
If its warranty period is 5 years, that works out to 365 TB ÷ (5 years × 365 days/year) = 200 GB of writes per day. If your drive was 200 GB in size, that's equivalent to 1 DWPD. Correspondingly, if your drive was rated for 3.65 PBW = 3,650 TBW, that works out to 2 TB of writes per day, or 10 DWPD.
As you can see, if you know the drive's size and warranty period, you can always calculate TBW from DWPD and vice-versa with simple multiplications or divisions. The two measurements are very similar.

6.2 DWPD

Drive Writes Per Day (DWPD) measures how many times you could overwrite the drive's entire size each day of its life. For example, suppose your drive is 200 GB and its warranty period is 5 years. If its DWPD is 1, that means you can write 200 GB (its size, one time) into it every single day for the next five years.
If you multiply that out, that's 200 GB per day × 365 days/year × 5 years = 365 TB of cumulative writes before you may need to replace it.
If the DWPD is 10 instead of 1, that means you can write 10 × 200 GB = 2 TB (its size, ten times) into it every day. Correspondingly, that's 3,650 TB = 3.65 PB of cumulative writes over 5 years.

6.3 MTBF – Telcordia SR-332

MTBF (mean time between failures) is a measure of how reliable a hardware product or component is. For most components, the measurement is typically in thousands or even tens of thousands of hours between failures. For example, a SSD may have a mean time between failures of 200,000 hours. A desired MTBF can be used as a quantifiable objective when designing a new product. The MTBF figure can be developed as the result of intensive testing, based on actual product experience, or predicted by analyzing known factors. The manufacturer may provide it as an index of a product's or component's reliability and, in some cases, to give customers an idea of how much service to plan for. In Transcend MTBF data, we use Telcordia SR-332 Issue 4 method to do estimated calculation.

7. Reliability

7.1 Wear-Leveling algorithm

The controller supports static/dynamic wear leveling. When the host writes data, the controller will find and use the block with the lowest erase count among the free blocks. This is known as dynamic wear leveling. When the free blocks' erase count is higher than a threshold value plus data blocks', it will activate the static wear leveling, replacing the less frequently used user blocks with the high erase count free blocks.

7.2 ECC algorithm

Using 66 bit BCH Error Correction Code with each channel, the controller can correct 66 random bit per 1K byte data sector for MLC NAND flash. The hardware executes parity generation and error detection/correction features.

7.3 Bad-block management

When the flash encounters ECC failed, program fail or erase fail, the controller will mark the block as a bad block to prevent the used of this block and caused data lost later on.

8. Command Descriptions

8.1 ATA Command Register

This table and the following paragraphs summarize the ATA command set.

Support ATA/ATAPI Command	Code	Protocol
General Feature Set		
EXECUTE DIAGNOSTICS	90h	Device diagnostic
FLUSH CACHE	E7h	Non-data
IDENTIFY DEVICE	ECh	PIO data-In
INITIALIZE DRIVE PARAMETERS	91h	Non-data
READ DMA	C8h	DMA
READ LOG Ext	2Fh	PIO data-In
READ MULTIPLE	C4h	PIO data-In
READ SECTOR(S)	20h	PIO data-In
READ VERIFY SECTOR(S)	40h or 41h	Non-data
SET FEATURES	EFh	Non-data
SET MULTIPLE MODE	C6h	Non-data
WRITE DMA	CAh	DMA
WRITE MULTIPLE	C5h	PIO data-out
WRITE SECTOR(S)	30h	PIO data-out
NOP	00h	Non-data
READ BUFFER	E4h	PIO data-In
WRITE BUFFER	E8h	PIO data-out
Power Management Feature Set		
CHECK POWER MODE	E5h or 98h	Non-data
IDLE	E3h or 97h	Non-data
IDLE IMMEDIATE	E1h or 95h	Non-data
SLEEP	E6h or 99h	Non-data
STANDBY	E2h or 96h	Non-data
STANDBY IMMEDIATE	E0h or 94h	Non-data
Security Mode Feature Set		
SECURITY SET PASSWORD	F1h	PIO data-out
SECURITY UNLOCK	F2h	PIO data-out
SECURITY ERASE PREPARE	F3h	Non-data
SECURITY ERASE UNIT	F4h	PIO data-out
SECURITY FREEZE LOCK	F5h	Non-data
SECURITY DISABLE PASSWORD	F6h	PIO data-out
SMART Feature Set		
SMART Disable Operations	B0h	Non-data

SMART Enable/Disable Autosave	B0h	Non-data
SMART Enable Operations	B0h	Non-data
SMART Execute Off-Line Immediate	B0h	Non-data
SMART Read LOG	B0h	PIO data-In
SMART Read Data	B0h	PIO data-In
SMART Read THRESHOLD	B0h	PIO data-In
SMART Return Status	B0h	Non-data
SMART SAVE ATTRIBUTE VALUES	B0h	Non-data
SMART WRITE LOG	B0h	PIO data-out
Host Protected Area Feature Set		
Read Native Max Address	F8h	Non-data
Set Max Address	F9h	Non-data
Set Max Set Password	F9h	PIO data-out
Set Max Lock	F9h	Non-data
Set Max Freeze Lock	F9h	Non-data
Set Max Unlock	F9h	PIO data-out
48-bit Address Feature Set		
Flush Cache Ext	EAh	Non-data
Read Sector(s) Ext	24h	PIO data-in
Read DMA Ext	25h	DMA
Read Multiple Ext	29h	PIO data-in
Read Native Max Address Ext	27h	Non-data
Read Verify Sector(s) Ext	42h	Non-data
Set Max Address Ext	37h	Non-data
Write DMA Ext	35h	DMA
Write Multiple Ext	39h	PIO data-out
Write Sector(s) Ext	34h	PIO data-out
NCQ Feature Set		
Read FPDMA Queued	60h	DMA Queued
Write FPDMA Queued	61h	DMA Queued
Other		
Data Set Management	06h	DMA
SEEK	70h	Non-data

8.2 ATA Command Specifications

FLUSH CACHE (E7h)

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

IDENTIFY DEVICE (ECh)

This commands read out 512Bytes of drive parameter information. Parameter Information consists of the arrangement and value as shown in the following table. This command enables the host to receive the Identify Drive Information from the device.

INITIALIZE DEVICE PARAMETERS (91h)

This command enables the host to set the number of logical sectors per track and the number of logical heads minus 1, per logical cylinder for the current CHS translation mode.

READ DMA (C8h)

Read data from sectors during Ultra DMA and Multiword DMA transfer. Use the SET FEATURES command to specify the mode value. A sector count of zero requests 256 sectors.

READ LOG EXT (2Fh)

This 48-bit command is for devices implementing the GPL feature set. It returns the specified log to the host.

READ MULTIPLE (C4h)

This command performs similarly to the Read Sectors command. Interrupts are not generated on each sector, but on the transfer of a block which contains the number of sectors defined by a Set Multiple command.

READ SECTOR(S) (20h)

This command reads 1 to 256 sectors as specified in the Sector Count register from sectors which is set by Sector number register. A sector counts of 0 requests 256 sectors. The transfer beings specified in the Sector Number register.

READ VERIFY SECTOR(S) (40h/41h)

This command verifies one or more sectors on the drive by transferring data from the flash media to the data buffer in the drive and verifying that the ECC is correct. This command is identical to the Read Sectors command, except that DRQ is never set and no data is transferred to the host.

SET FEATURES (EFh)

This command set parameter to Features register and set drive's operation. For transfer mode, parameter is set to Sector Count register. This command is used by the host to establish or select certain features.

SET MULTIPLE MODE (C6h)

This command enables the device to perform READ MULTIPLE and WRITE MULTIPLE operations and establishes the block count for these commands.

WRITE DMA (CAh)

Write data to sectors during Ultra DMA and Multiword DMA transfer. Use the SET FEATURES command to specify the mode value.

WRITE MULTIPLE (C5h)

This command is similar to the Write Sectors command. Interrupts are not presented on each sector, but on the transfer of a block which contains the number of sectors defined by Set Multiple command.

WRITE SECTOR(S) (30h)

Write data to a specified number of sectors (1 to 256, as specified with the Sector Count register) from the specified address. Specify "00h" to write 256 sectors.

NOP (00h)

The device shall respond with command aborted. For devices implementing the Overlapped feature set, subcommand code 00h in the Features register shall abort any outstanding queue. Subcommand codes 01h through FFh in the Features register shall not affect the status of any outstanding queue.

READ BUFFER (E4h)

The READ BUFFER command enables the host to read a 512-byte block of data.

WRITE BUFFER (E8h)

This command enables the host to write the contents of one 512-byte block of data to the device's buffer.

Power Management Feature Set

CHECK POWER MODE (E5h or 98h)

The host can use this command to determine the current power management mode.

IDLE (E3h or 97h)

This command causes the device to set BSY, enter the Idle mode, clear BSY and generate an interrupt. If sector count is non-zero, the automatic power down mode is enabled. If the sector count is zero, the automatic power mode is disabled.

IDLE IMMEDIATE (E1h or 95h)

This command causes the device to set BSY, enter the Idle(Read) mode, clear BSY and generate an interrupt.

SLEEP (E6h or 99h)

This command causes the device to set BSY, enter the Sleep mode, clear BSY and generate an interrupt.

STANDBY (E2h or 96h)

This command causes the device to set BSY, enter the Sleep mode (which corresponds to the ATA "Standby" Mode), clear BSY and return the interrupt immediately.

STANDBY IMMEDIATE (E0h or 94h)

This command causes the drive to set BSY, enter the Sleep mode (which corresponds to the ATA "Standby" Mode), clear BSY and return the interrupt immediately.

9. Security Mode Feature Set

SECURITY SET PASSWORD (F1h)

This command sets user password or master password. The host outputs sector data with PIO data-out protocol to indicate the information defined in the following table.

Security Set Password Data Content 1

Word	Content		
0	Control word		
	Bit 0	Identifier	0=set user password 1=set master password
	Bits 1-7	Reserved	
	Bit 8	Master Password Capability	0=High 1=Maximum
	Bits 9-15	Reserved	
1-16	Password (32 bytes)		
17	Master Password Identifier. This word is valid if word 0 bit 0is set to one.		
18-255	Reserved		

SECURITY UNLOCK (F2h)

This command disables LOCKED MODE of the device. This command transfers 512 bytes of data from the host with PIO data-out protocol. The following table defines the content of this information.

Security Unlock Information 2

Word	Content		
0	Control word		
	Bit 0	Identifier	0=compare user password 1=compare master password
	Bits 1-15	Reserved	
1-16	Password (32 bytes)		
17-255	Reserved		

SECURITY DISABLE PASSWORD (F6h)

Disables any previously set user password and cancels the lock. The host transfers 512 bytes of data, as shown in the following table, to the drive. The transferred data contains a user or master password, in which the drive compares with the saved password. If they match, the drive cancels the lock. The master password is still saved. It is re-enabled by issuing the SECURITY SET PASSWORD command to re-set a user password.

SECURITY ERASE PREPARE (F3h)

This command shall be issued immediately before the Security Erase Unit command to enable erasing and unlocking. This command prevents accidental loss of data on the drive.

SECURITY ERASE UNIT (F4h)

The host uses this command to transfer 512 bytes of data, as shown in the following table, to the drive. The transferred data contains a user or master password, in which the drive compares with the saved password. If they match, the drive deletes user data, disables the user password, and cancels the lock. The master password is still saved. It is re-enabled by issuing the SECURITY SET PASSWORD command to re-set a user password.

SECURITY FREEZE LOCK (F5h)

Causes the drive to enter Frozen mode. Once this command has been executed, the following commands to update a lock result in the Aborted Command error:

- SECURITY SET PASSWORD
- SECURITY UNLOCK
- SECURITY DISABLE PASSWORD
- SECURITY ERASE PREPARE
- SECURITY ERASE UNIT

The drive exits from Frozen mode upon a power-off or hard reset. If the SECURITY FREEZE LOCK command is issued when the drive is placed in Frozen mode, the drive executes the command, staying in Frozen mode.

10. Identify Device Information Default Value

Word Address	Default Value	Total Bytes	Data Field Type Information
0	044Ah	2	General configuration
1	XXXXh	2	Default number of cylinders
2	XXXXh	2	Reserved
3	00XXh	2	Default number of heads
4	0000h	2	Obsolete
5	0240h	2	Obsolete
6	XXXXh	2	Default number of sectors per track
7-8	XXXXh	4	Number of sectors per card (Word 7 = MSW, Word 8 = LSW)
9	0000h	2	Obsolete
10-19	XXXXh	20	Serial number in ASCII (Right Justified)
20	0002h	2	Obsolete
21	0002h	2	Obsolete
22	0000h	2	Obsolete
23-26	XXXXh	8	Firmware revision in ASCII. Big Endian Byte Order in Word
27-46	XXXXh	40	Model number in ASCII (Left Justified) Big Endian Byte Order in Word
47	8001h	2	Maximum number of sectors on Read/Write Multiple command
48	XXXXh	2	Reserved
49	2F00h	2	Capabilities
50	4000h	2	Capabilities
51	0200h	2	PIO data transfer cycle timing mode
52	0000h	2	Obsolete
53	0007h	2	Field Validity
54	XXXXh	2	Current numbers of cylinders
55	XXXXh	2	Current numbers of heads
56	XXXXh	2	Current sectors per track
57-58	XXXXh	4	Current capacity in sectors (LBAs)(Word 57 = LSW, Word 58 = MSW)
59	0101h	2	Multiple sector setting
60-61	XXXXh	4	Total number of sectors addressable in LBA Mode
62	0000h	2	Reserved
63	0207h	2	Multiword DMA transfer. Supports MDMA Mode 0,1,and 2
64	0003h	2	Advanced PIO modes supported
65	0078h	2	Minimum Multiword DMA transfer cycle time per word. In PC Card modes this value shall be 0h
66	0078h	2	Recommended Multiword DMA transfer cycle time. In PC Card modes this value shall be 0h
67	0078h	2	Minimum PIO transfer cycle time without flow control
Word Address	**Default Value**	**Total Bytes**	**Data Field Type Information**
68	0078h	2	Minimum PIO transfer cycle time with IORDY flow control
69	0100h	2	Additional supported
70-74	0000h	10	Reserved
75	001Fh	2	Queue depth

76	070Eh	2	Serial ATA capacities ・Supports Serial ATA Gen3 ・Supports Serial ATA Gen2 ・Supports Serial ATA Gen1 ・Supports PHY event counters log ・Supports receipt of host initiated power management requests ・Supports Native Command Queuing
77	000Xh	2	Serial ATA Additional capabilities
78	014Ch	2	Serial ATA features supported ・Supports DMA Setup Auto-Activate optimization ・Supports software setting preservation ・Device supports initiating power management ・Supports Device Sleep
79	0040h	2	Serial ATA features enabled ・Software settings preservation enabled
80	03FCh	2	Mijor version number (ACS-2)
81	0000h	2	Minor version number
82	746Bh	2	Command sets supported 0
83	7D09h	2	Command sets supported 1
84	4163h	2	Command sets supported 2
85-87	XXXXh	6	Command set/feature enabled
88	007Fh	2	Ultra DMA Mode Supported and Selected
89	0001h	2	Time required for a Normal Erase mode Security Erase Unit command
90	0001h	2	Time required for an Enhanced Erase mode Security Erase Unit command
91	0000h	2	Current Advanced power management value
92	FFFEh	2	Master password identifier
93-99	0000h	14	Reserved
100-103	XXXXh	8	Maximum user LBA for 48-bit address feature set
104	0000h	2	Reserved
105	0008h	2	Maximum number of 512-byte blocks per Data Set Management command
106-127	XXXXh	44	Reserved
128	0001h	2	Security status
129-159	XXXXh	64	Vendor specific
160	0000h	2	Power requirement description
161	0000h	2	Reserved
162	0000h	2	Key management schemes supported
163	0000h	2	CF Advanced True IDE Timing Mode Capability and Setting
164-168	XXXXh	10	Reserved
169	0001h	2	Data Set Management supported
170-216	XXXXh	94	Reserved
217	0001h	2	Non-rotating media (SSD)
218-221	0000h	8	Reserved
222	107Fh	2	Transport major revision (SATA Rev 3.1)
223-254	XXXXh	64	Reserved
255	XXXXh	2	Integrity word

11. SMART Command Support

Value	Command	Value	Command
D0h	Read Data	D5h	Read Log
D1h	Read Attribute Threshold	D6h	Write Log
D2h	Enable/Disable Autosave	D8h	Enable SMART Operations
D3h	Save Attribute Values	D9h	Disable SMART Operations
D4h	Execute OFF-Line Immediate	DAh	Return Status

11.1 SMART Data Structure

BYTE	F / V	Description
0-1	X	Revision code
2-361	X	Vendor specific
362	V	Off-line data collection status
363	X	Self-test execution status byte
364-365	V	Total time in seconds to complete off-line data collection activity
366	X	Vendor specific
367	F	Off-line data collection capability
368-369	F	SMART capability
370	F	Error logging capability 7-1 Reserved 0 1=Device error logging supported
371	X	Vendor specific
372	F	Short self-test routine recommended polling time (in minutes)
373	F	Extended self-test routine recommended polling time (in minutes)
374	F	Conveyance self-test routine recommended polling time (in minutes)
375-385	R	Reserved
386-395	F	Firmware Version/Date Code
396-399	F	Reserved
400-406	V	‘SMI2246XT’
407-415	X	Vendor specific
416	F	Reserved
417	F	Program/write the strong page only
418-419	V	Number of spare block
420-510	V	Vendor specific
511	V	Data structure checksum

Note:

1) F = content (byte) is fixed and does not change.
2) V= content (byte) is variable and may change depending on the state of the device or the commands executed by the device.
3) X= content (byte) is vendor specific and may be fixed or variable.

4) R= content (byte) is reserved and shall be zero.

11.2 SMART Attributes

The following table shows the vendor specific data in byte 2 to 361 of 512-byte SMART data.

Attribute ID (hex)	Raw Attribute Value						Attribute Name
01	MSB	00	00	00	00	00	Read Error Rate
05	LSB	MSB	00	00	00	00	Reallocated sectors count
09	LSB	-	-	MSB	00	00	Power-on hours
0C	LSB	-	-	MSB	00	00	Power Cycle Count
A0	LSB	-	-	MSB	00	00	Uncorrectable sectors count when read/write
A1	LSB	MSB	00	00	00	00	Number of valid spare blocks
A2	LSB	MSB	00	00	00	00	Number of cache data block
A3	LSB	MSB	00	00	00	00	Number of initial invalid blocks
A4	LSB	-	-	MSB	00	00	Total erase count
A5	LSB	-	-	MSB	00	00	Maximum erase count
A6	LSB	-	-	MSB	00	00	Minimum erase count
A7	LSB	-	-	MSB	00	00	Average erase count
A8	LSB	-	-	MSB	00	00	Max erase count of spec
A9	LSB	-	-	MSB	00	00	Remain Life (percentage)
C0	LSB	-	-	MSB	00	00	Power-off retract Count
C2	MSB	00	00	00	00	00	Controller temperature[1)]
C3	LSB	-	-	MSB	00	00	Hardware ECC recovered
C4	LSB	-	-	MSB	00	00	Reallocation event count
C7	LSB	MSB	00	00	00	00	Ultra DMA CRC Error Count
F1	LSB	-	-	MSB	00	00	Total LBA written (each write unit = 32MB)
F2	LSB	-	-	MSB	00	00	Total LBA read (each read unit = 32MB)
F5	LSB	-	-	MSB	00	00	Total write to flash (each write unit = 32MB)

Note:
1) Controller temperature is only presented as a positive value.

12. Contact Information

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