Product Information Datasheet

SATA 2.5″ SSD
- HFS064G32MNM
- HFS128G32MNM
- HFS256G32MNM

Rev 0.6

Ordering Information
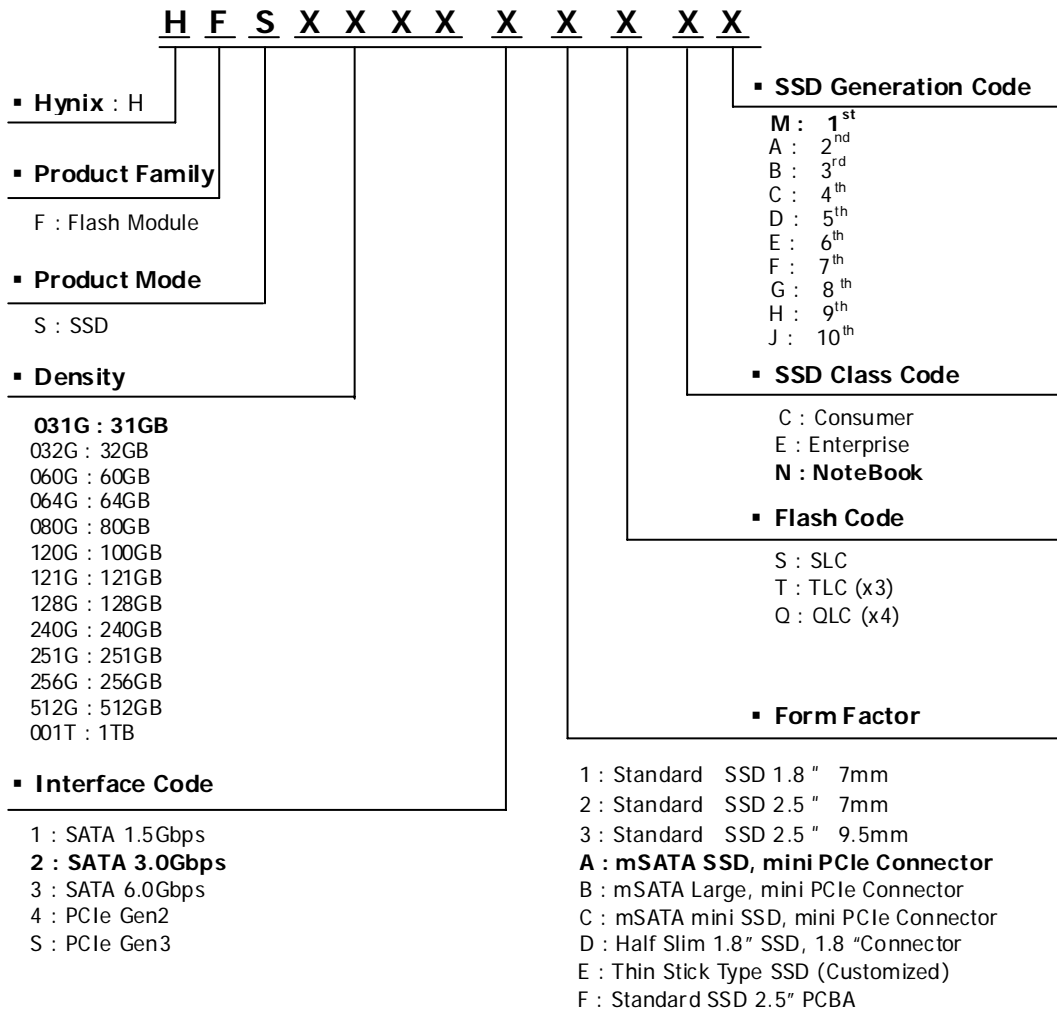
H F S X X X X X X X X X X

- **Hynix** : H

- **Product Family**

  F : Flash Module

- **Product Mode**

  S : SSD

- **Density**

  031G : 31GB
  032G : 32GB
  060G : 60GB
  064G : 64GB
  080G : 80GB
  120G : 100GB
  121G : 121GB
  128G : 128GB
  240G : 240GB
  251G : 251GB
  256G : 256GB
  512G : 512GB
  001T : 1TB

- **Interface Code**

  1 : SATA 1.5Gbps
  2 : SATA 3.0Gbps
  3 : SATA 6.0Gbps
  4 : PCIe Gen2
  S : PCIe Gen3

- **SSD Generation Code**

  M : 1st
  A : 2nd
  B : 3rd
  C : 4th
  D : 5th
  E : 6th
  F : 7th
  G : 8th
  H : 9th
  J : 10th

- **SSD Class Code**

  C : Consumer
  E : Enterprise
  N : NoteBook

- **Flash Code**

  S : SLC
  T : TLC (x3)
  Q : QLC (x4)

- **Form Factor**

  1 : Standard   SSD 1.8 ″ 7mm
  2 : Standard   SSD 2.5 ″ 7mm
  3 : Standard   SSD 2.5 ″ 9.5mm
  A : mSATA SSD, mini PCIe Connector
  B : mSATA Large, mini PCIe Connector
  C : mSATA mini SSD, mini PCIe Connector
  D : Half Slim 1.8″ SSD, 1.8 ″Connector
  E : Thin Stick Type SSD (Customized)
  F : Standard SSD 2.5″ PCBA

Contents

1. Introduction

1.1 General Description

SK hynix SATA Solid State Drive (SSD) is the highest level of SSD performance. SK hynix SATA SSD is the best suited NAND storage solution for products such as Server and Storage or any other products that requires fast speed, low cost, and power saving features. SATA SSD provides more robust and cost effective storage solution for embedded application. Offering standard ATA interface, which is fully compatible with traditional HDD, SSD offers the designer an easy solution to implement in PC-based systems.

The SK hynix SATA SSDs utilize a cost effective System on a Chip (SOC) design to manage a full SATA6 Gb/s bandwidth with the host while managing multiple flash memory devices on multiple channels internally.

- SSD F/F
  STD.2.5" STD

- Interface
  SATA 6.0Gbps

- Connector
  2.5" Standard SATA

- Capacities
  64/128/256GB

- Dimension (typ.)
  2.5" : 69.9 x 100 x 7 mm

- Sequential Performance (256KB, MAX)
  Read: 510MB/s
  Write: 470MB/s

- Random Performance (4KB, MAX)
  Read: 50K IOPS
  Write: 38K IOPS

- Power Consumption
  Active: 0.82W (Typ.)
  Idle :0.26W (Typ.)

- Voltage
  5.0V±5%

- Temperature Range Operating, (Storage)
  0℃ to 70℃ (-55℃ to 95℃)

- MTBF
  1.2M

- BER
  1 error in 10^{15} bits transferred

1.2 Interface

- Fully compliant with SATA revision 3.1, compatible with SATA 6.0Gb/s interface rates
- Fully compliant with ATA-8/ACS-2 Standard
- PIO, DMA, UDMA(up to 6, dependant on host) supported
- SATA 6.0Gb/s Native Command Queuing (NCQ) : up to 32 commands
- Power Saving Modes : HIPM and DIPM (Partial/Slumber mode)
- SATA BIST Support
- S.M.A.R.T. command transport(SCT) technology

2. Product Specifications

2.1 Certifications

Certification	Description
CE Compliant	Indicates conformity with the essential health and safety requirements set out in European Directives
UL Certified	Underwriters Laboratories, Inc. Component Recognition UL60950-1.
FCC Certified	This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
C-Tick Compliant	Compliance with the Australia/New Zealand Standard AS/NZS3548 and Electromagnetic Compatibility(EMC) Framework requirements of Australian Communication Authority(ACA).
BSMI Compliant	Compliance to the Taiwan EMC standard "Limits and methods of measurement of radio disturbance characteristics of information technology equipment, CNS 13438 ClassB."
KCC	Compliance with paragraph 1 of Article 11 of the Electromagnetic Compatibility Control Regulation and meets the Electromagnetic Compatibility (EMC) Framework requirements of the Radio Research Laboratory (RRL) Ministry of Information and Communication Republic of Korea.
RoHS Compliant	Restriction of Hazardous Substance Directive
SATA	IO Indicates certified logo program from Serial ATA International Organization.

2.2 User Addressable LBA by Capacity

Flash	SSD Capacity	No. of LBA
MLC 32Gb	64GB	125,051,184
	128GB	250,069,680
	256GB	500,118,192

Notes 1) Sector Size :512 Bytes
2) User-addressable LBA count = (97696368) + (1953504 x(Desired Capacity in Gbytes-50.0))
From IDEMA (LBA1-02_standard.doc)

2.3 Sustained Bandwidth Performance

Parameter	MB/s		
Density	64GB	128GB	256GB
Sequential Read (max)	485MB/s	510MB/s	510MB/s
Sequential Write (max)	460MB/s	460MB/s	470MB/s

Notes 1) Performance value of SSD varies in host system

2.4 Random Read/Write Input/Output Operations per Second

Access Type	IOPS		
	64GB	128GB	256GB
Random Read (max)	25K	44K	55K
Random Write (max)	83K	85K	85K

Notes 1) Performance measured using IO-meter with queue depth set to 32.
2) Write Cache enabled.

2.5 PCMark* Vantage Benchmark

Benchmark	Score		
	64GB	128GB	256GB
HDD Suite	63,400	72500	72500

Notes Performance tests and ratings are measured with Intel Core 2 Quad CPU Q9300@ 2.5GHz processor and 4GB DRAM running MicroSoft* Windwos 7* Ultimate Edition and Reflects the approximate performance as measured by that configuration. Any difference in system H/W or S/W design or configuration may affect actual performance.

2.6 Supply Voltage

- Operating Voltage for 5V± 5%

2.7 Power Management

- Support Idle/Standby/Sleep/Partial/Slumber.

2.8 Latency Specifications

Read	Write
30us (Typ)	40us(Typ)

Notes 1) Write Cache enabled.
2) Device measured using IOmeter2008.
3) Read/Write latency measured on 4 K transfers.

2.9 Power consumption

Read	Typ	Unit
Active	0.82	W
Idle/Standby	0.26	W
Sleep	0.26	W

Notes Active power is measured during execution of MobileMark* 2007 ** DIPM enabled (Device Initiated Power Management)

2.10 Environment Specification

Read	Mode	Min	Max	Unit
Temperature Ranges	Operating	0	70	℃
	Non- Operating	-40	95	℃
Humidity	Operating	5	95	%
	Non- Operating	5	95	%
	Mode	**Timing/Frequency**		**Max**
Shock*	Operating	0.5ms		1500G
	Non- Operating	0.5ms		1500G
Vibration*	Operating	10~2KHz		20G
	Non- Operating	10~2KHz		20G

Notes 1) Measured w/o condensation.
2) Shock* specification assumes that the SSD is mounted security with the input Vibration applied to the drive mounting screws. Stimulus may be applied in the X, Y or Z axis.
3) Vibration specification assumes that the SSD is mounted security with the input Vibration applied to the drive mounting screws. Stimulus may be applied in the X, Y or Z axis. The measured specification is in root mean SQ. form.
4) Half sine wave sweeping 1 oct/min.

2.11 Reliability

Parameter	Value
Unrecoverable Data Error	1 error in 10^{15} bits transferred
Mean Time Between Failures (MTBF)	1,200,000hr

Notes 1) Unrecoverable Data Error : The unrecoverable Data Error rate will not exceed one sector in the specified number of bits read. In the extremely unlikely event of a unrecoverable Data Error, the drive will report it as a read failure to the host; the sector in error is considered corrupt and is not returned to host

　　　2) MTBF : Calculated based on a part stress analysis. It assumes nominal voltages, with all other parameters Within specified range.

3. Mechanical Information

3.1 Physical information

- Form Factor
   Width(69.9(±0.2) mm) x Length(100(±0.2) mm) x Height(6.8(±0.2) mm)
- Weight (MAX)
   064GB : TBD
   128GB : 66.9g (with Case), 21.6g (without Case)
   256GB : 69.9g (with Case), 24.6g (without Case)
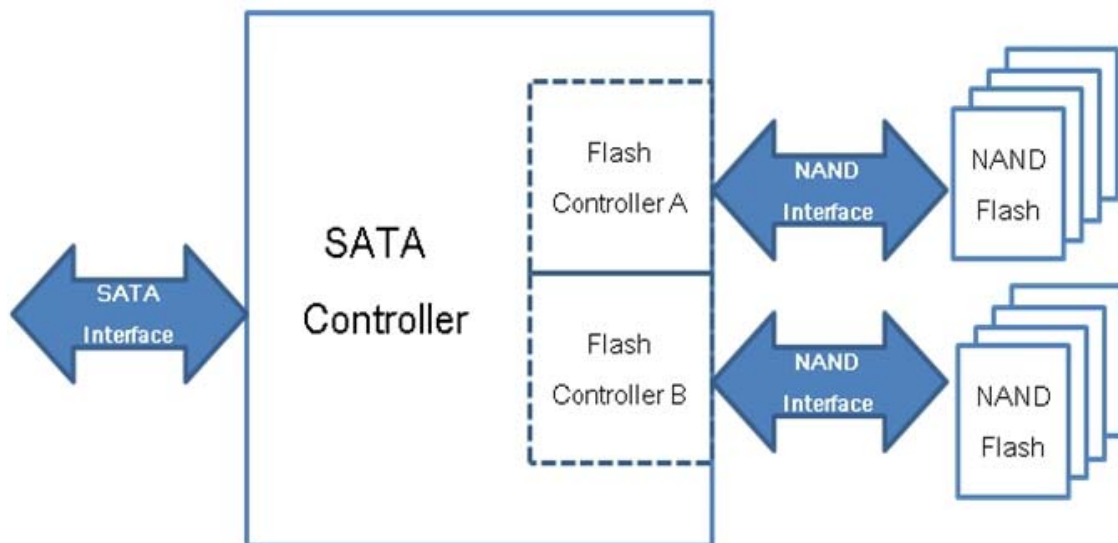
3.2 Block Diagram

Figure 1. Block Diagram
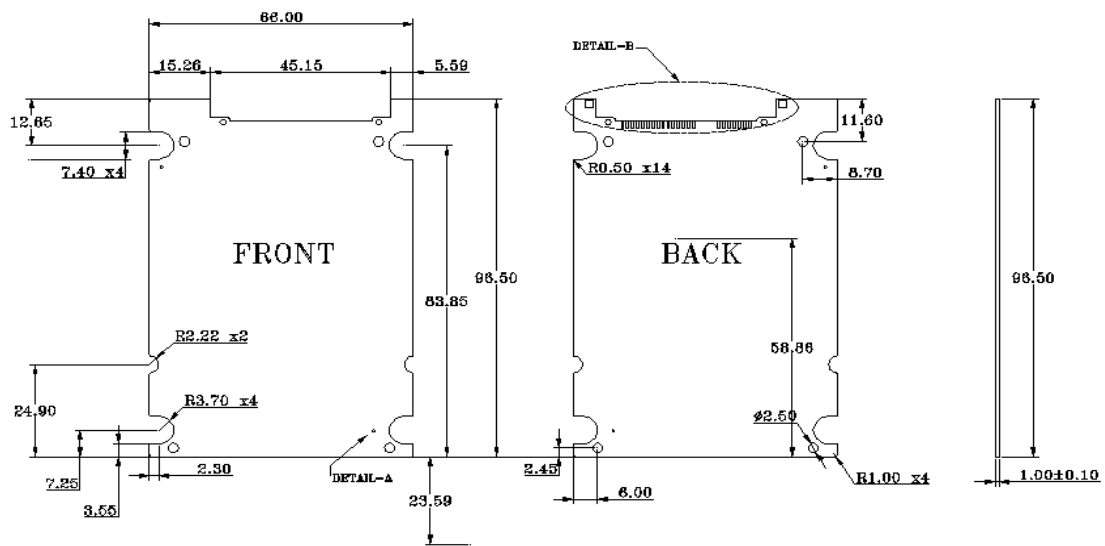
3.3 Physical Dimension

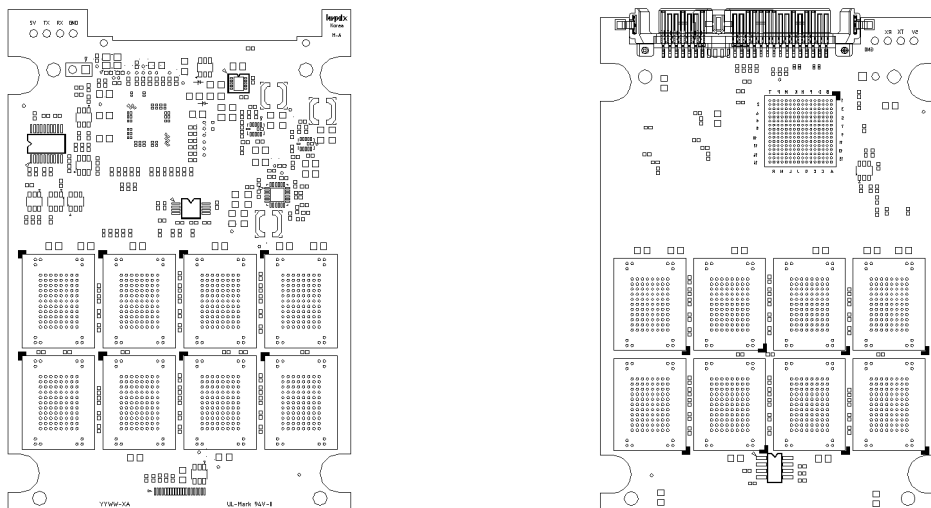**Figure 2 . Physical dimension (Unit Diagram)**
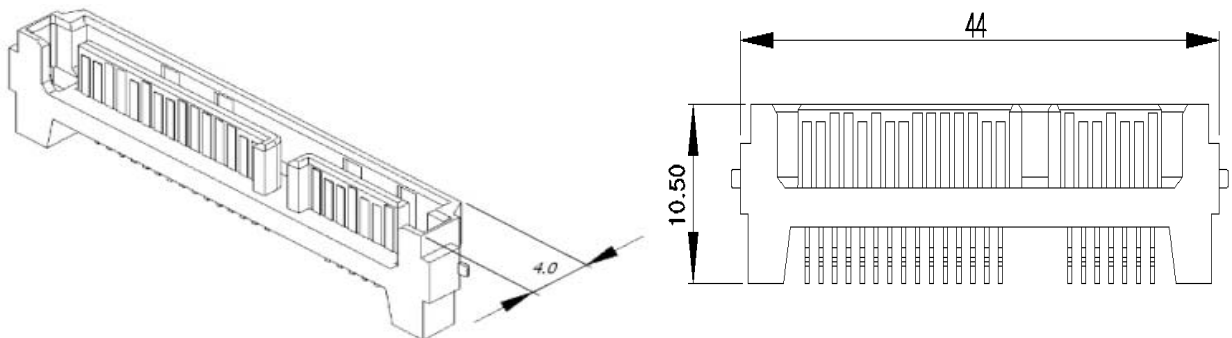

Figure 3. Physical dimension (Mount Diagram)

Figure 4. Connector Physical dimension / Connector Assembly descriptions

3.4 Pin and Signal Description

Parameter	I/O	Pin description
SATA_RX_P	IN	**Serial ATA (SATA) Receive +:** This signal together with SATA_RX_N comprises the differential input pair for the SATA interface. SATA_RX_P is SATA Rx+.
SATA_RX_N	IN	**Serial ATA (SATA) Receive -:** This signal together with SATA_RX_P comprises the differential input pair for the SATA interface. SATA_RX_N is SATA Rx-.
SATA_TX_P	OUT	**Serial ATA (SATA) Transmit +:** This signal together with SATA_TX_N comprises the differential output pair for the SATA interface. SATA_TX_P is SATA Tx+.
SATA_TX_N	OUT	**Serial ATA (SATA) Transmit -:** This signal together with SATA_TX_P comprises the differential output pair for the SATA interface. SATA_TX_N is SATA Tx-.
SATA_RREF	IN	**Serial ATA Reference Resistor:** The Reference Resistor connection pin for the SATA PHY should be connected to this pin. Details are TBD (see reference design and SF-1000 PCB Design Guide for examples).
ALT_SATA_CLK_P	IN	**Alternate SATA PHY Clock +:** This signal together with ALT_SATA_CLK_N comprises an alternate differential clock input for the SATA PHY. The alternate PHY clock is supported as a safety measure; in the event the internally-applied SATA PHY clock exhibits non-optimal jitter or other properties, the alternate PHY clock may be used to clock the SATA PHY.
ALT_SATA_CLK_N	IN	**Alternate SATA PHY Clock -:** This signal together with ALT_SATA_CLK_P comprises an alternate differential clock input for the SATA PHY. The alternate PHY clock is supported as a safety measure; in the event the internally-applied SATA PHY clock exhibits non-optimal jitter or other properties, the alternate PHY clock may be used to clock the SATA PHY.

4. Supported ATA Command Lists

The SK hynix SSD complies with ATA-8/ACS-2. All mandatory and many optional commands and features are supported.

4.1 ATA Feature Set

The tables below summarize the ATA feature set and commands that are supported by the SK hynix SSD

Feature Set	Support
48-Bit Address feature set	YES
Advanced Power Management (APM) feature set	YES
General feature set	YES
General Purpose Logging(GPL) feature set	YES
Long Logical Sector(LLS) feature set non-512	YES
Native Command Queuing(NCQ) feature set	YES
Power Management feature set	YES
Power-Up In Standby(PUIS) feature set	YES
Security feature set	YES
S.M.A.R.T feature set	YES
Software Setting Preservation (SSP) feature set	YES
Trusted Computing feature set	YES
Write-Read-Verify feature set	YES
* Only supported in TCG Security enabled FW	

4.2 ATA Commands

Command Name	Command Code (Hex)	Command Name	Command Code (Hex)
CHECK POWER MODE	E5h	SECURITY DISABLE PASSWORD	F6h
DATA SET MANAGEMENT	06h	SECURITY ERASE PREPARE	F3h
DEVICE CONFIGURATION OVERLAY**	B1h	SECURITY ERASE UNIT	F4h
DOWNLOAD MICROCODE	92h	SECURITY FREEZE LOCK	F5h
DOWNLOAD MICROCODE DMA	93h	SECURITY SET PASSWORD	F1h
EXECUTE DEVICE DIAGNOSTIC	90h	SECURITY UNLOCK	F2h
FLUSH CACHE	E7h	SEEK	70h
FLUSH CACHE EXT	EAh	SET FEATURES	EFh
IDENTIFY DEVICE	ECh	SET MAX ADDRESS	F9h
IDLE	E3h	SET MAX ADDRESS EXT **	37h
IDLE IMMEDIATE	E1h	SET MULTIPLE MODE	C6h
INITIALIZE DEVICE PARAMETERS	91h	SLEEP	E6h
NOP	00h	SMART	B0h
READ BUFFER	E4h	STANDBY	E2h
READ BUFFER DMA	E9h	STANDBY IMMEDIATE	E0h
READ DMA EXT	25h	TRUSTED NON-DATA *	5Bh
READ DMA WITHOUT RETRIES	C9h	TRUSTED RECEIVE *	5Ch
READ FPDMA QUEUED	60h	TRUSTED RECEIVE DMA*	5Dh
READ LOG DMA EXT	47h	TRUSTED SEND *	5Eh
READ LOG EXT	2Fh	TRUSTED SEND DMA *	5Fh
READ LONG WITHOUT RETRY	23h	WRITE BUFFER	E8h
READ MULTIPLE	C4h	WRITE BUFFER DMA	EBh
READ MULTIPLE EXT	29h	WRITE DMA EXT	35h
READ NATIVE MAX ADDRESS	F8h	WRITE DMA WITHOUT RETRIES	CBh
READ NATIVE MAX ADDRESS EXT **	27h	WRITE FPDMA QUEUED	61h
READ SECTOR(S) EXT	24h	WRITE LOG DMA EXT	57h
READ SECTOR(S) WITHOUT RETRY	21h	WRITE LOG EXT	3Fh
READ VERIFY SECTOR(S)	40h	WRITE LONG	32h
READ VERIFY SECTORS(S) WITHOUT RETRY	41h	WRITE LONG without Retry	33h
READ VERIFY SECTOR(S) EXT	42h	WRITE MULTIPLE	C5h
RECALIBRATE	10h	WRITE MULTIPLE EXT	39h
REQUEST SENSE DATA EXT	0Bh	WRITE SECTOR(S) EXT	34h
SANITIZE DEVICE**	B4h	WRITE SECTORS WITHOUT RETRY	31h
		WRITE UNCORRECTABLE EXT	45h
		*Only supported in TCG Security enabled FW	
		** Will be implemented	

5. SMART Support

SK hynix SSD support the S.M.A.R.T(Self-Monitoring, Analysis, and Reporting Technology) Command.

5.1 SMART Command Set

Value (hex)	Command
00-CF	Reserved
D0	SMART read attributes
D1	SMART read threshold
D2	SMART enable/disable attribute autosave
D3	SMART save attribute values
D4	SMART execute off-line immediate
D5	SMART read log sector
D6	SMART write log sector
D7	SMART write attribute threshold
D8	SMART enable operations
D9	SMART disable operations
DA	SMART return status
DC-FF	Reserved (Vendor Specific)
* Note that D1,D3, and D7 are supported, but have been made obsolete in the ATA-8/ACS-2 specification	

5.2 SMART Attributes

The following table shows the proposed SMART attribute support of SK hynix SSD.

ID	Hex	Attribute Name
9	0x09	Power-On Hours (POH)
12	0x0C	Device Power Cycle Count
174	0XAE	Unexpected Power Loss Count
177	0XB1	Wear Range Delta
194	0XC2	Temperature
231	0XE7	SSD Life Left
241	0XF1	Lifetime Writes from Host
242	0XF2	Lifetime Reads from Host

6. Security

6.1 Default setting

The Flash SSD is shipped with master password set to 20h value (ASCII blanks) and the lock function disabled. The system manufacturer/dealer may set a new master password by using the SECURITY SET PASSWORD command, without enabling the lock function.

6.2 Initial setting of the user password

When a user password is set, the drive automatically enters lock mode by the next powered-on.

6.3 SECURITY mode operation from power-on

In locked mode, the Flash SSD rejects media access commands until a SECURITY UNLOCK command is successfully completed.

6.4 Password lost

If the user password is lost and High level security is set, the drive does not allow the user to access any data. However, the drive can be unlocked using the master password.

If the user password is lost and Maximum security level is set, it is impossible to access data. However, the drive can be unlocked using the ERASE UNIT command with the master password. The drive will erase all user data and unlock the drive.

7. Identify Device Data

The SK hynix SSD responds to the ATA IDENTY DEVICE command with a pre-defined string of information on features, hard ware and firmware revision information, and functionality support indicators.

The following table details the sector data returned after issuing an IDENTIFY DEVICE command.

Word	Default Value	Description
0	0C5Ah	General configuration bit-significant information
1	3FFFFh	Obsolete - Number of logical cylinders (16,383)
2	C837h	Specific configuration
3	0010h	Obsolete - Number of logical heads (16)
4-5	0000h	Retired
6	003Fh	Obsolete - Number of logical sectors per logical track (63)
7-8	0000h	Reserved for assignment by the CompactFlashTM Association
9	0000h	Retired
10-19	Varies	Serial number (20 ASCII characters)
20-21	0000h	Retired
22	0004h	Obsolete
23-26	Varies	Firmware revision (8 ASCII characters)
27-46	Varies	Model number (40 ASCII characters)
47	8010h	Maximum number of logical sectors that shall be transferred per DRQ data block on READ/WRITE MULTIPLE commands
48	4000h	Trusted Computing feature set options
49	2F00h	Capabilities
50	4000h	Capabilities
51-52	0200h	Obsolete
53	0007h	Words 88 and 70:64 are valid
54	3FFFh	Obsolete - Number of logical cylinders (16,383)
55	0010h	Obsolete - Number of logical heads (16)
56	003Fh	Obsolete - Number of logical sectors per logical track (63)
57-58	00FBFC10h	Obsolete
59	0110h	Multiple sector setting
60-61	7742130h (64GB) 0DF94BB0h (128GB) 0FFFFFFFh (256GB)	Total number of user addressable logical sectors
62	0000h	Obsolete
63	0007h	Multi-word DMA modes supported/selected
64	0003h	PIO modes supported
65	0078h	Minimum Multiword DMA transfer cycle time per word
66	0078h	Manufacturer's recommended Multiword DMA cycle time
67	0078h	Minimum PIO transfer cycle time without flow control
68	0078h	Minimum PIO transfer cycle time with IORDY flow control
69	4F00h	Additional Supported
70	0000h	Reserved

Word	Default Value	Description
71-74	0000h	Reserved for IDENTIFY PACKET DEVICE command.
75	001Fh	Queue depth
76	C70Eh	Serial ATA capabilities
77	0006h	Serial ATA Additional capabilities
78	004Ch	Serial ATA features supported
79	0040h	Serial ATA features enabled
80	01FCh	Major version number
81	0110h	Minor revision number
82	746Bh	Commands and feature sets supported.
83	7469h	Commands and feature sets supported.
84	6163h	Commands and feature sets supported.
85	7429h	Commands and feature sets supported or enabled.
86	B449h	Commands and feature sets supported or enabled.
87	6163h	Commands and feature sets supported or enabled.
88	207Fh	Ultra DMA modes
89	0001h	Time required for Normal Erase mode SECURITY ERASE UNIT command
90	0000h	Time required for an Enhanced Erase mode SECURITY ERASE UNIT command
91	00FEh	Current advanced power management value
92	FFFEh	Master Password Revision Code
93	0000h	Hardware reset result.
94	0000h	Vendor's recommended and current AAM value.
95	0000h	Stream Minimum Request Size
96	0000h	Streaming Transfer Time - DMA
97	0000h	Streaming Access Latency - DMA and PIO
98-99	0000h	Streaming Performance Granularity (DWord)
100-103	7742130h (64GB) 0D94BB0h (128GB) 1BF244B0h (256GB)	Total Number of User Addressable Logical Sectors for 48-bit commands (QWord).
104	0000h	Streaming Transfer Time - PIO
105	0001h	Maximum number of 512-byte blocks of LBA Range Entries per DATA SET MANAGEMENT command
106	4000h	Physical sector size / Logical Sector Size
107	0000h	Inter-seek delay for ISO-7779 acoustic testing in microseconds
108-111	Varies	Unique ID
12-115	0000h	Reserved for 128 bit world wide name extension to 128 bits
116	0000h	Reserved for TLC
117-118	0000h	Words per Logical Sector
119	401Eh	Commands and feature sets supported (Continued from words 84-82)
120	401Ch	Commands and feature sets supported and enabled (Continued from words 87-85)
121-126	0000h	Reserved for expanded supported and enabled settings
127	0000h	Obsolete
128	0001h	Security status
129-159	0000h	Vendor specific
160	0000h	CFA power mode 1
161-167	0000h	Reserved for CompactFlashTM Association
168	0000h	Device Nominal Form Factor
169	0001h	DATA SET MANAGEMENT is supported
170-175	0000h	Reserved
176-205	0000h	Current media serial number (60 ASCII characters)
206	0021h	SCT Command Transport

Word	Default Value	Description
207-208	0000h	Reserved
209	4000h	Alignment of logical blocks within a larger physical block
210-211	0000h	Write-Read-Verify Sector Count Mode 3 Only
212-213	0100h	Write-Read-Verify Sector Count Mode 2 Only
214-216	0000h	Reserved
217	0001h	Non-rotating media device
218-221	0000h	Reserved
222	103Fh	Transport Major revision number.
223	0000h	Transport Minor revision number.
224-254	0000h	Reserved
255	Variables	Integrity word (Checksum and Signature)

8. Revision History

Date	Revision	Description
Nov. 01. 2011	0.1	Initial Release.
Nov. 22. 2011	0.2	Correct Page 7 - 2.11 Notes 1) will mot -> will not 　　　　　Page 9 - 3.4 "SATA_RX_P -> SATA_TX_P" Delete Page 10 - READ LONG 27h
Mar. 13. 2012	0.3	Correct Page 4 - MTBF 1M -> 1.2M
May. 31. 2012	0.4	Add "64GB"
Jun. 05. 2012	0.5	Correct Page 5 - 2.4 Random Read/Write Input/Output Operations per Second 　　　　　Page 8 - Figure 4. Connector Physical dimension (5.6mm -> 4.0mm)
Jun. 08. 2012	0.6	Correct Page 2 - Ordering Information