

EverGreen

SATA SSD Series

Customer: _____
Customer _____
Part Number: _____
InnoDisk _____
Part Number: _____
InnoDisk _____
Model Name: _____
Date: _____

InnoDisk Approver	Customer Approver

the total solution for
industrial flash storage

Table of contents

REVISION HISTORY.....	4
LIST OF TABLES	6
LIST OF FIGURES	7
1 PRODUCT OVERVIEW	8
1.1 INTRODUCTION OF EVERGREEN / EVERGREEN PLUS* SATA SSD	8
1.2 PRODUCT VIEW.....	8
1.3 PRODUCT MODELS.....	8
1.4 SATA INTERFACE.....	9
1.5 2.5-INCH FORM FACTOR	9
1.6 CAPACITY	9
2 THEORY OF OPERATION.....	10
2.1 OVERVIEW	10
2.2 SATA II CONTROLLER	10
2.3 ERROR DETECTION AND CORRECTION.....	10
2.4 WEAR-LEVELING.....	11
2.5 BAD BLOCKS MANAGEMENT	11
2.6 POWER CYCLING PROTECTION AND CIRCUIT DESIGN	11
3 INSTALLATION REQUIREMENTS	12
3.1 EVERGREEN SATA SSD PIN DIRECTIONS	12
3.2 ELECTRICAL CONNECTIONS FOR EVERGREEN SATA SSD	12
3.3 FORM FACTOR.....	12
3.4 DEVICE DRIVE.....	13
4 SPECIFICATIONS	14
4.1 CE AND FCC COMPATIBILITY	14
4.2 RoHS COMPLIANCE	14
4.3 ENVIRONMENTAL SPECIFICATIONS	14
4.3.1 Temperature Ranges	14
4.3.2 Humidity.....	14
4.3.3 Shock and Vibration	14
4.3.4 Mean Time between Failures (MTBF)	14
4.4 ENDURANCE	15
4.5 TRANSFER MODE	15
4.6 PIN ASSIGNMENT.....	15
4.7 MECHANICAL DIMENSIONS	16
4.8 ASSEMBLY WEIGHT.....	16

4.9 PERFORMANCE	17
4.10 IOPS	17
4.11 SEEK TIME	17
4.12 HOT PLUG	17
4.13 NAND FLASH MEMORY	18
4.14 ELECTRICAL SPECIFICATIONS	18
4.14.1 Power Requirement	18
4.14.2 Power Consumption	18
4.15 DEVICE PARAMETERS	18
4.16 INTEGRATED THERMAL SENSOR	19
5 SUPPORTED ATA COMMANDS	19
5.1 SUPPORTED ATA COMMANDS	19
6 PART NUMBER RULE	21

REVISION HISTORY

Revision	Description	Date
Preliminary	First Released	09/30/2010
Rev. 0.1	1. Add 16GB spec. 2. Updated power consumption	11/17/2010
Rev. 0.2	1. Modify introduction 2. Modify product performance	12/30/2010
Rev.0.3	1. Add 8GB performance	1/1/2011
Rev.0.4	1. Add user capacity	1/20/2011
Rev.0.5	1. Add PN rule	1/24/2011
Rev.0.6	1. Add section of Power cycling protection and circuit design 2. Add IOPS info.	2/24/2011
Rev.0.7	1. Modify PN rule	5/23/2011
Rev. 1.0	1. Modify product performance 2. Updated CHS table with LBA information 3. Updated power consumption	7/29/2011
Rev. 1.1	1. Update mechanical dimensions 2. Modify IOPS info.	8/8/2011
Rev. 1.2	1. Updated 8GB CHS table with LBA information	9/15/2011
Rev. 1.3	1. Add industrial temperature information	10/05/2011
Rev. 2.0	1. Add 512GB information	11/29/2011
Rev. 2.1	Modify performance	3/23/2012
Rev. 3.0	Add Thermal Sensor Function	7/27/2012
Rev. 3.1	1. Modify performance 2. Modify dimension	11/06/2012
Rev. 3.2	1. Add TRIM function	11/14/2012

List of Tables

TABLE 1: SHOCK/VIBRATION TESTING FOR EVERGREEN SATA SSD	14
TABLE 2: EVERGREEN SATA SSD MTBF	15
TABLE 3: EVERGREEN SATA SSD PIN ASSIGNMENT	15
TABLE 4: EVERGREEN SATA SSD POWER REQUIREMENT	18
TABLE 5: POWER CONSUMPTION	18
TABLE 6: DEVICE PARAMETERS	18
TABLE 7: ATA COMMANDS	19

List of Figures

FIGURE 1: EVERGREEN SATA SSD	8
FIGURE 2: EVERGREEN SATA SSD BLOCK DIAGRAM	10
FIGURE 3: SIGNAL SEGMENT AND POWER SEGMENT	12
FIGURE 4: EVERGREEN SATA SSD MLC MECHANICAL DIMENSIONS	16

1 Product Overview

1.1 Introduction of EverGreen / EverGreen Plus* SATA SSD

InnoDisk Evergreen series provides a totally brand new highly cost-effective SSD solution with good performance and longer lifespan. Customer can pay much less than SLC flash but embrace longer life and performance than current MLC flash IC based SSD solution. Evergreen Series SSDs is a **perfect substitute** for traditional HDD, which are applied with an **evolved L² Wear Leveling Architecture**, and significantly improves SSD **random data transfer rate and lifespan**. Furthermore, Evergreen series support TRIM for windows 7, it can improves performance when deleting files.

EverGreen 2.5" SATA SSD provides high capacity flash memory Solid State Drive (SSD) that electrically complies with Serial ATA (SATA) standard, and supports SATA II standard (3.0GHz) with high performance. It has 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).

* **L² Architecture** provides two different versions to enhance sequential performance (EverGreen) and extended lifespan (EverGreen Plus) respectively.

1.2 Product View



Figure 1: EverGreen SATA SSD

1.3 Product Models

EverGreen SATA SSD is available in follow capacities.

EverGreen SATA SSD 8GB	EverGreen SATA SSD 16GB
EverGreen SATA SSD 32GB	EverGreen SATA SSD 64GB
EverGreen SATA SSD 128GB	EverGreen SATA SSD 256GB

1.4 SATA Interface

EverGreen SATA SSD 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. EverGreen SATA SSD is compliant with Serial ATA Gen 1 and Gen 2 specification (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

Industry 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. EverGreen SATA SSD can easy install in laptop. EverGreen SATA SSD has a compact design 69.85mm (W) x 100.10mm (L) x 9.30mm (H).

1.6 Capacity

EverGreen SATA SSD provides unformatted 8GB, 16GB, 32GB, 64GB, 128GB, 256GB and 512GB capacities within MLC flash ICs.

2 Theory of operation

2.1 Overview

Figure 2 shows the operation of EverGreen SATA SSD from the system level, including the major hardware blocks.

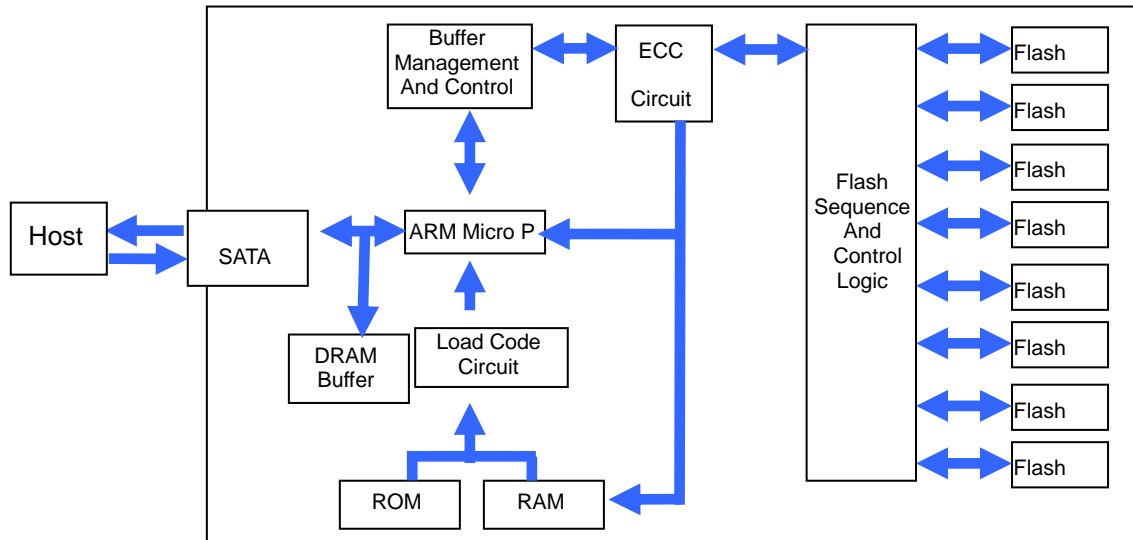


Figure 2: EverGreen SATA SSD Block Diagram

EverGreen SATA SSD integrates a SATA II controller and NAND flash memories. Communication with the host occurs through the host interface, using the standard ATA 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 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 128KB of internal memory. The internal memory is used as an intermediate memory for storing data blocks during a wear-leveling procedure. A 32KB 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 24 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.

EverGreen SATA SSD 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. 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.

2.6 Power cycling protection and circuit design

EverGreen is designed with a unique circuit to prevent abnormal power failure. With its real time power management function, and advanced L² Architecture, EverGreen Plus can effectively prevent power cycling issue, as well as keep data completely be written into disk.

3 Installation Requirements

3.1 EverGreen SATA SSD Pin Directions

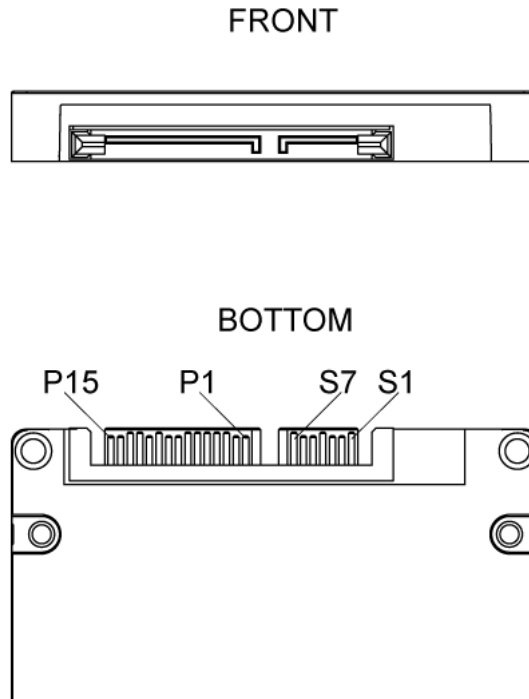


Figure 3: Signal Segment and Power Segment

3.2 Electrical Connections for EverGreen SATA SSD

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 1 meter. 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 1 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.

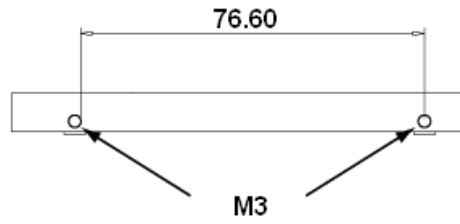


Figure 4: EverGreen SATA SSD Mechanical Screw Hole

3.4 Device drive

No additional device drives are required. The EverGreen SATA SSD can be configured as a boot device.

4 Specifications

4.1 CE and FCC Compatibility

EverGreen SATA SSD conforms to CE and FCC requirements.

4.2 RoHS Compliance

EverGreen SATA SSD 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
- Industrial Grad: -40°C to +85°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 EverGreen SATA SSD

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

4.3.4 Mean Time between Failures (MTBF)

Table 2 summarizes the MTBF prediction results for various EverGreen SATA SSD 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.
-

Table 2: EverGreen SATA SSD MTBF

Product	Condition	MTBF (Hours)
EverGreen SATA SSD	Telcordia SR-332 GB, 25°C	>3,000,000

4.4 Endurance

Read Cycles: Unlimited Read Cycles.

Data Retention: 10 years

Wear-Leveling Algorithm: Support.

Bad Blocks Management: Support

Error Correct Code: Support

4.5 Transfer Mode

EverGreen SATA SSD support following transfer mode:

PIO Mode 0~4

Ultra DMA 0~6

Serial ATA I 1.5Gbps

Serial ATA II 3.0Gbps

4.6 Pin Assignment

EverGreen SATA SSD uses a standard SATA pin-out. See Table 3 for EverGreen SATA SSD pin assignments.

Table 3: EverGreen SATA SSD 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	NC	NA
P2	NC	NA
P3	NC	NA
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
P13	NC	NA
P14	NC	NA
P15	NC	NA

4.7 Mechanical Dimensions

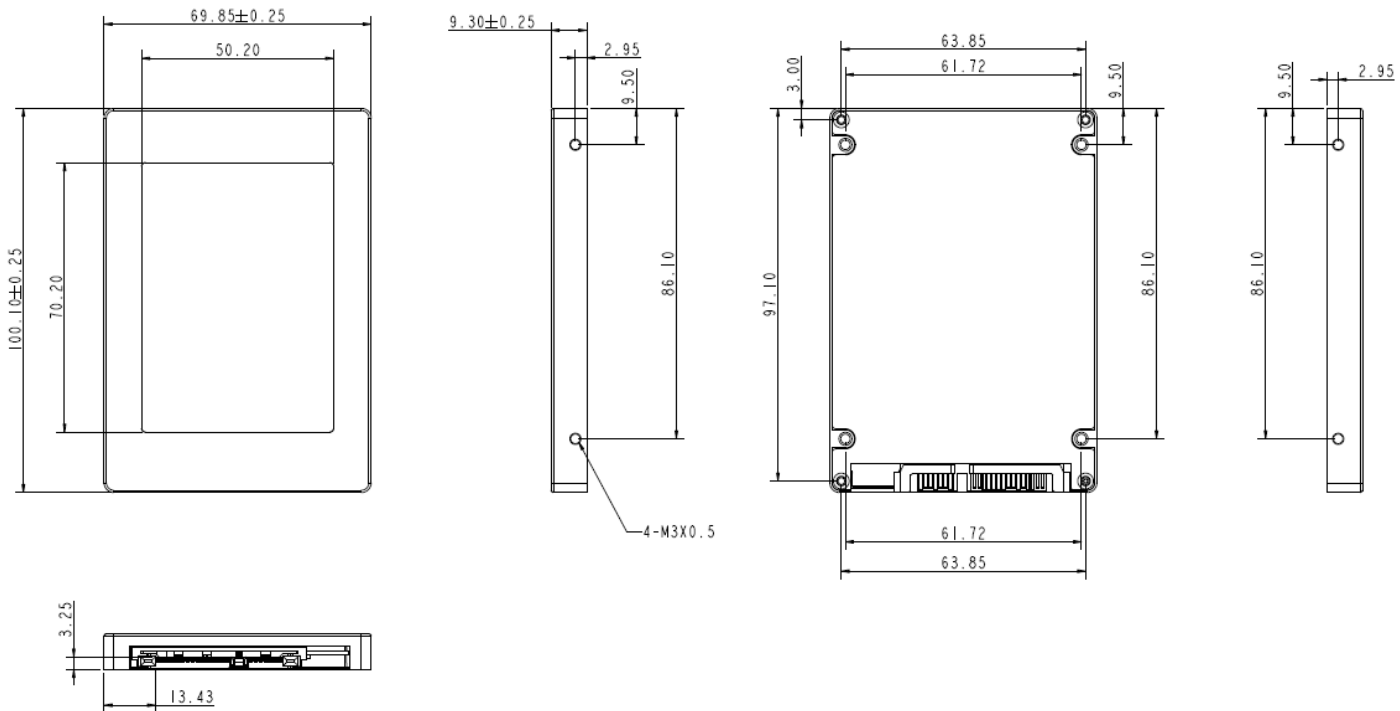


Figure 4: EverGreen SATA SSD MLC mechanical dimensions

4.8 Assembly weight

An EverGreen SATA SSD within MLC flash ICs, 32GB'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.

4.9 Performance

Burst Transfer Rate: 3.0 Gbps

256GB, 512GB:

Sustained Read : 215MB/sec (max.)

Sustained Write : 159MB/sec (max.)

128GB

Sustained Read : 200MB/sec (max.)

Sustained Write : 122MB/sec (max.)

64GB:

Sustained Read : 189MB/sec (max.)

Sustained Write : 80MB/sec (max.)

32GB:

Sustained Read : 210MB/sec (max.)

Sustained Write : 43MB/sec (max.)

16GB:

Sustained Read : 116MB/sec (max.)

Sustained Write : 25MB/sec (max.)

8GB:

Sustained Read : 54MB/sec (max.)

Sustained Write : 12MB/sec (max.)

4.10 IOPS

Random 4 KB Write: 2,000 IOPS (max.); 200 IOPS (min.)

4.11 Seek Time

EverGreen SATA SSD is not a magnetic rotating design. There is no seek or rotational latency required.

4.12 Hot Plug

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.

4.13 NAND Flash Memory

EverGreen SATA SSD uses Multi Level Cell (MLC) NAND flash memory, which is non-volatility, and high speed memory storage. There are four statuses, including 00, 01, 10, and 11, of one cell. Read or Write data to flash memory for SSD is control by microprocessor.

4.14 Electrical Specifications

4.14.1 Power Requirement

Table 4: EverGreen SATA SSD Power Requirement

Item	Symbol	Rating	Unit
Input voltage	V _{IN}	+5DC +- 5% 500mA (max.)	V

4.14.2 Power Consumption

Table 5: Power Consumption

Mode	Power Consumption (mA) *base on 32GB
Read	376
Write	352
Idle	214

4.15 Device Parameters

EverGreen SATA SSD device parameters are shown in Table 6.

Table 6: Device parameters

Capacity	LBA	Cylinders	Heads	Sectors	User capacity (MB)
08GB	15116288	14996	16	63	7831
16GB	30232576	16383	16	63	14762
32GB	60465152	16383	16	63	29524
64GB	120930304	16383	16	63	59048
128GB	241860608	16383	16	63	118096

256GB	483721216	16383	16	63	236192
512GB	976442432	16383	16	63	476778

4.16 Integrated Thermal Sensor

As the speed of the SSD product get faster and faster, overall power consumption continues to increase. Accordingly, it brings a new concern: thermal management. The advantage of Thermal Sensor is that it will allow the SSD to either change the speed or throttle back on the flash accesses to allow the SSD to stay within temperature limits and prevent any reliability failures due to overheating.



5 Supported ATA Commands

5.1 Supported ATA Commands

EverGreen SATA SSD 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
EXECUTE DIAGNOSTICS	90h	X	X	X	O	X	X
FLUSH CACHE	E7h	X	X	X	O	O	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
INITIALIZE DEVICE PARAMETERS	91h	O	X	X	O	O	X
READ DMA	C8h or C9h	O	O	O	O	O	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
RECALIBRATE	10h	X	X	X	O	X	X
SECURITY DISABLE	F6h	X	X	X	O	X	X

PASSWORD							
SECURITY ERASE PREPARE	F3h	X	X	X	O	X	X
SECURITY ERASE UNIT	F4h	X	X	X	O	X	X
SECURITY FREEZE LOCK	F5h	X	X	X	O	X	X
SECURITY SET PASSWORD	F1h	X	X	X	O	X	X
SECURITY UNLOCK	F2h	X	X	X	O	X	X
SEEK	7xh	X	X	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
SMART	B0h	X	X	O	O	X	O
STANDBY	E2h	X	X	X	O	X	X
STANDBY IMMEDIATE	E0h	X	X	X	O	X	X
WRITE DMA	CAh or CBh	O	O	O	O	O	X
WRITE MULTIPLE	C5h	O	O	O	O	O	X
WRITE SECTOR(S)	30h or 31h	O	O	O	O	O	X

Note:

O = Valid,

X = Don't care

SC = Sector Count Register

SN = Sector Number Register

CY = Cylinder Low/High Register

DR = DEVICE SELECT Bit (DEVICE/HEAD Register Bit 4)

HD = HEAD SELECT Bit (DEVICE/HEAD Register Bit 3-0)

FT = Features Register

6 Part Number Rule

CODE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	D	2	S	N	-	A	2	8	J	2	0	A	C	2	E	N				
Description	Disk	2.5" EverGreen SATA SSD			-	Capacity			Category			FW	Operation Temp.	Internal Control	Ch.	Flash	-	Customized Code		
Definition																				
Code 1st (Disk)											Code 12th (Firmware Version)									
D: Flash Disk											A: Standard F/W version									
											B: 2nd F/W version									
Code 2nd ~ 4th (Product Model)											Code 13th (Operation Temperature)									
2SN: 2.5" EverGreen SATA SSD											C: Standard Grade (0°C ~ +70 °C)									
											W: Industrial Grade (-40°C ~ +85 °C)									
Code 6th ~8th (Capacity)											Code 14th (Internal Control Code)									
08G: 8GB											2: 2 nd PCB version, default setting									
16G: 16GB											3: 3 rd PCB version, with Thermal Sensor									
32G: 32GB											Code 15th (Channel of Data Transfer)									
64G: 64GB											D: Dual Channels									
A28: 128GB											Q: Quad Channels									
B56: 256GB											E: Eight Channels									
C12: 512GB																				
Code 9th ~ 11th (Category)											Code 16th (Flash Type)									
J20: EverGreen series											N: Micron MLC									

RoHS 自我宣告書 (RoHS Declaration of Conformity)

- 一、 宜鼎國際股份有限公司（以下稱本公司）特此保證售予貴公司之所有產品，皆符合歐盟 2002/95/EC 關於 RoHS 之規範要求。

InnoDisk Corporation declares that all products sold to the company, are complied with European Union RoHS Directive (2002/95/EC) requirement

- 二、 本公司同意因本保證書或與本保證書相關事宜有所爭議時，雙方宜友好協商，達成協議。

InnoDisk Corporation agrees that both parties shall settle any dispute arising from or in connection with this Declaration of Conformity by friendly negotiations.

Name of hazardous substance	Limited of RoHS ppm (mg/kg)
Cd	< 100 ppm
Pb	< 1000 ppm
Hg	< 1000 ppm
Chromium VI (Cr+6)	< 1000 ppm
Polybromodiphenyl ether (PBDE)	< 1000 ppm
Polybrominated Biphenyls (PBB)	< 1000 ppm

立 保 證 書 人

Company name 公司名稱：InnoDisk Corporation 宜鼎國際股份有限公司

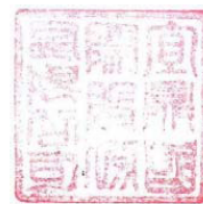
Company Representative 公司代表人：Richard Lee 李鐘亮

Company Representative Title 公司代表人職稱：Chairman 董事長

Date 日期：2011 / 10 / 20



(小章)



(Company Stamp/公司章)