innodisk

Total Solution For Industrial Flash Storage

CFast 3SE

Customer: _____

Customer Part Number: _____

InnoDisk Part Number: _____

InnoDisk Model Name: _____

Date: _____

InnoDisk Approver	Customer Approver

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Revision History

Revision	Description	Date
Preliminary	First Released	June, 2013

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1. Product Overview

1.1 Introduction of InnoDisk CFast 3SE

The Innodisk CFast 3SE operates at SATA III 6.0 Gb/s, which offers data transfer rate of read up to 470MB/sec. and of sequential write up to 250MB/s. Compliant with CFast 2.0 standard, it is designed with 7+17 pin connector and is SATA compatible. Due to the idle power saving, it reduces 35% power consumption. CFast 3SE is featured as small form factor, and suitable for most industrial application.

CFast 3SE can work under harsh environment, and complies with ATA protocol. Without additional driver, the disk can be configured as a boot device or data storage device. CFast 3SE support hardware write protect to prevent modification of valuable data on a device. Besides, through Innodisk's enhanced power cycling technology and more capacitors, CFast 3SE prevents data loss caused by sudden power failure. By using Innodsik's iSMART, users can not only monitor the operation status of SSD, but also visualize Wear-Leveling status with graphics.

1.2 Product View and Models

Innodisk CFast 3SE is available in follow capacities within SLC flash ICs.

CFast 3SE 04GB CFast 3SE 08GB

CFast 3SE 16GB CFast 3SE 32GB

CFast 3SE 64GB

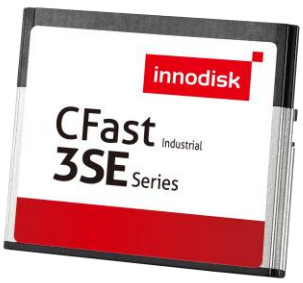


Figure 1: Innodisk CFast 3SE

1.3 SATA Interface

Innodisk CFast 3SE supports SATA III interface, and compliant with SATA I and SATA II. SATA III interface can work with Serial Attached SCSI (SAS) host system, which is used in server computer. Innodisk CFast 3SE is compliant with Serial ATA Gen 1, Gen 2 and Gen 3 specification (Gen 3 supports 1.5Gbps /3.0Gbps/6.0Gbps data rate).

1.4 CFast 2.0 Form Factor

CFast 3SE compliant with CFast 2.0 standard, it is designed with 7+17 pin connector and is SATA compatible. CFast 2.0 leverage the same connector interface as CFast 1.1 and the SATA-3 interface for higher performance. CFast 3SE mechanical dimensions : 42.8mm x 36.4mm x 3.6mm.

2. Product Specifications

2.1 Capacity and Device Parameters

CFast 3SE device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	LBA	Cylinders	Heads	Sectors	User Capacity(MB)
04GB	7835184	7773	16	63	3825
08GB	15649200	15525	16	63	7641
16GB	31277232	16383	16	63	15272
32GB	62533296	16383	16	63	30533
64GB	125045424	16383	16	63	61057

2.2 Performance

Burst Transfer Rate: 3.0Gbps

Table 2: Performance

Capacity	04GB	08GB	16GB	32GB	64GB
Sequential Read (max.)	220	360	440	470	470
Sequential Write (max.)	60	110	130	250	250

Note: Base on CrystalDiskMark 3.01 with file size 1000MB

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: InnoDisk CFast 3SE Power Requirement

Item	Symbol	Rating	Unit
Input voltage	V_{IN}	+3.3 DC +- 5%	V

2.3.2 Power Consumption

Table 4: Power Consumption

Mode	Power Consumption (mA)
Read	240 (max.)
Write	320 (max.)
Idle	110 (max.)

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for CFast 3SE

Temperature	Range
Operating	Standard Grade: 0°C to +70°C
	Industrial Grade:-40°C to +85°C
Storage	-55°C to +95°C

2.4.2 Humidity

Relative Humidity: 10-95%, non-condensing

2.4.3 Shock and Vibration

Table 6: Shock/Vibration Testing for CFast 3SE

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

2.4.4 Mean Time between Failures (MTBF)

Table 7 summarizes the MTBF prediction results for various CFast 3SE 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 7: CFast 3SE MTBF

Product	Condition	MTBF (Hours)
Innodisk CFast 3SE	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

CFast 3SE conforms to CE and FCC requirements.

2.6 RoHS Compliance

CFast 3SE is fully compliant with RoHS directive.

2.7 Reliability

Parameter	Value
Read Cycles	Unlimited Read Cycles
Wear-Leveling Algorithm	Support
Bad Blocks Management	Support
Error Correct Code	Support
Flash endurance	100,000 P/E cycles
TBW(Sequential Write)	
04GB	360
08GB	720
16GB	1440
32GB	2880
64GB	5760

2.8 Transfer Mode

CFast 3SE support following transfer mode:

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

2.9 Pin Assignment

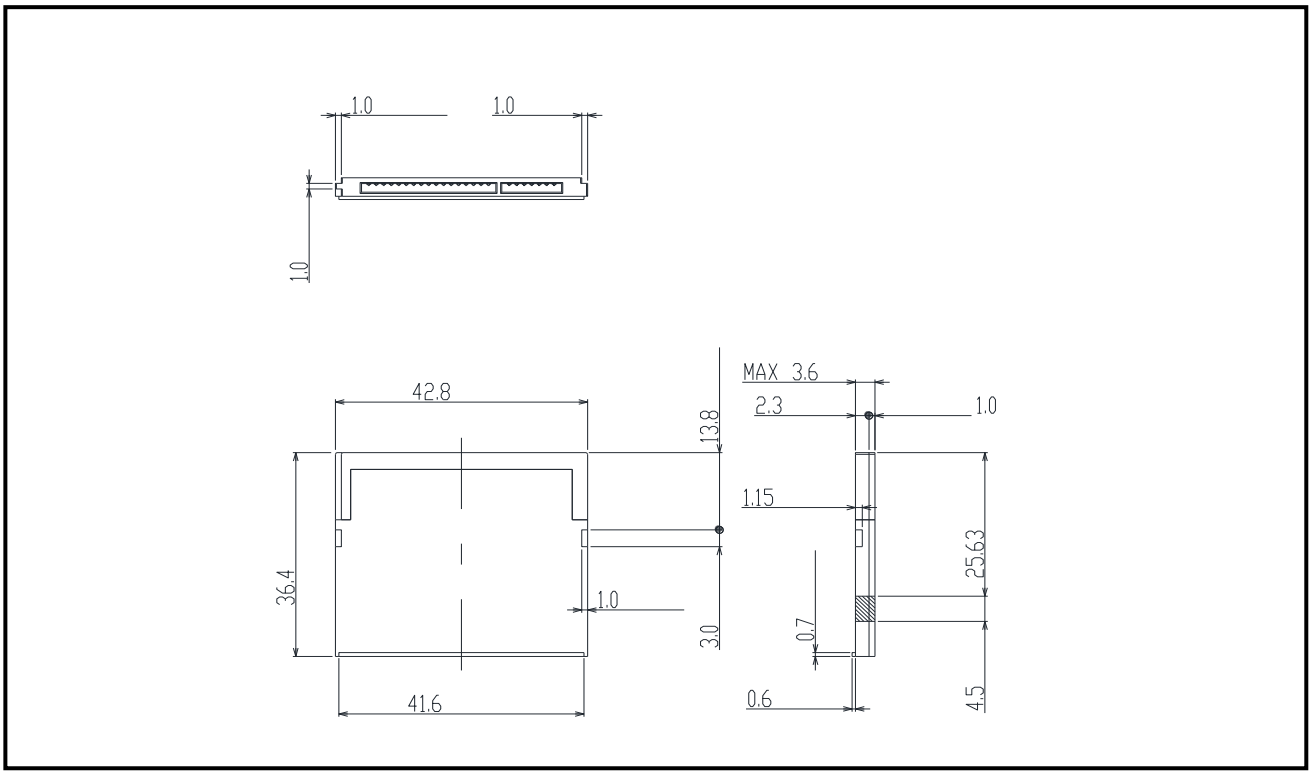
Innodisk CFast 3SE uses a standard SATA pin-out. See Table 8 for CFast 3SE pin assignment.

Table 8: InnoDisk CFast 3SE Pin Assignment

Name	Type	Description
S1	SGND	Ground for signal integrity
S2	A+	Differential Signal Pair A
S3	A-	
S4	SGND	Ground for signal integrity
S5	B-	Differential Signal Pair B
S6	B+	

S7	SGND	Ground for signal integrity
Key and Spacing separate signal and power segments		
P1	CDI	Card Detect In
P2	PGND	Device Ground
P3	DEVSLP	Device sleep
P4	TBD	Reserved
P5	TBD	Reserved
P6	TBD	Reserved
P7	PGND	Device Ground
P8	LED1	LED Output
P9	LED2	LED Output
P10	TBD	Reserved
P11	TBD	Reserved
P12	IFDet	NA
P13	PWR	Device Power (3.3V)
P14	PWR	Device Power (3.3V)
P15	PGND	Device Ground
P16	PGND	Device Ground
P17	CDO	Card Detect Out

2.10 Mechanical Dimensions



2.11 Assembly Weight

An InnodiskCFast 3SE within SLC flash ICs, 64GB's weight is 8 grams approx. The total weight of card will be less than 10 grams.

2.12 Seek Time

Innodisk CFast 3SE is not a magnetic rotating design. There is no seek or rotational latency required.

2.13 Hot Plug

The card support hot plug function and can be removed or plugged-in during operation. User has to avoid hot plugging the card 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.

2.14 NAND Flash Memory

Innodisk CFast 3SE uses single Level Cell (SLC) NAND flash memory, which is non-volatility, memory storage. There are two statuses 0 or 1 of one cell. Read or Write data to flash memory for SSD is control by microprocessor.

3. Theory of Operation

3.1 Overview

Figure 2 shows the operation of Innodisk CFast 3SE from the system level, including the major hardware blocks.

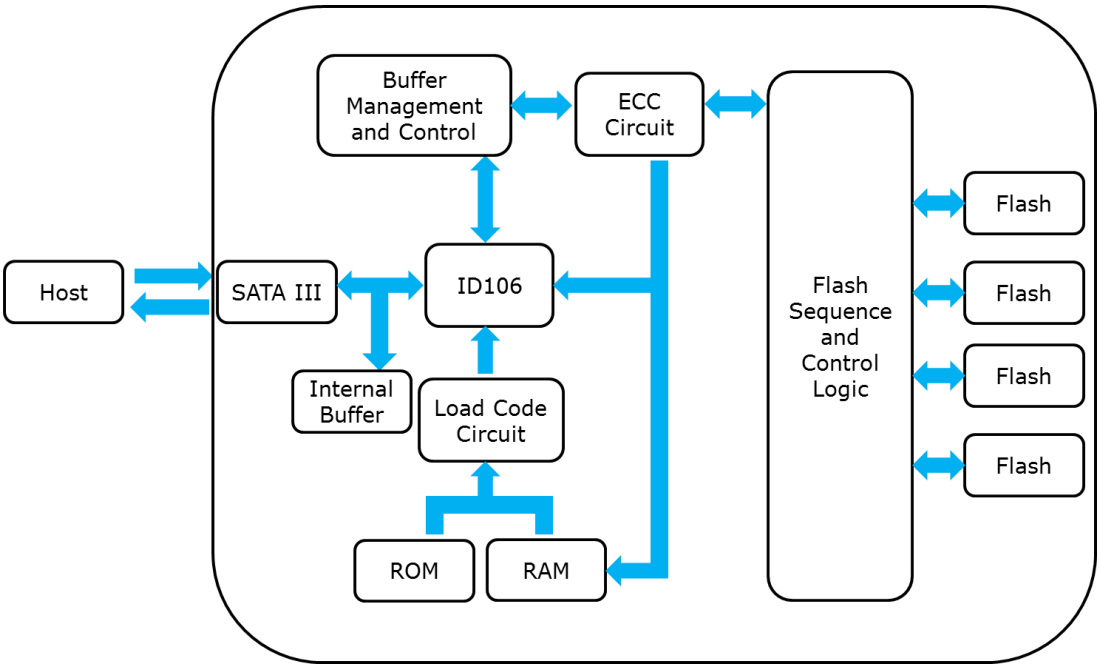


Figure 2: Innodisk CFast 3SE Block Diagram

Innodisk CFast 3SE integrates a SATA III 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.

3.2 SATA III Controller

Innodisk CFast 3SE is designed with ID 106, a SATA III 6.0Gbps (Gen. 3) controller. The Serial ATA physical, link and transport layers are compliant with Serial ATA Gen 1, Gen 2 and Gen 3 specification (Gen 3 supports 1.5Gbps/3.0Gbps/6.0Gbps data rate). The controller has 4 channels for flash interface.

3.3 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 40 bits per 1024 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.

3.4 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 CFast 3SE 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.

3.5 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.

3.6 Power Cycling

Innodisk's power cycling management is a comprehensive data protection mechanism that functions before and after a sudden power outage to SSD. Low-power detection terminates data writing before an abnormal power-off, while table-remapping after power-on deletes corrupt data and maintains data integrity. Innodisk's power cycling provides effective power cycling management, preventing data stored in flash from degrading with use.

3.7 Garbage Collection

Garbage collection technology is used to maintain data consistency and perform continual data cleansing on SSDs. It runs as a background process, freeing up valuable controller resources while sorting good data into available blocks, and deleting bad blocks.

4. Installation Requirements

4.1 CFast 3SE Pin Directions

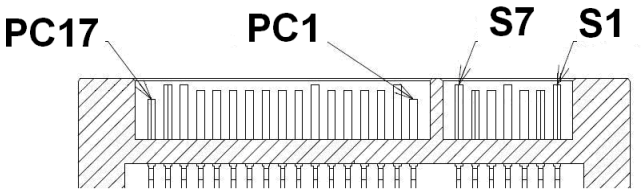


Figure 3: Signal Segment and Power Segment

4.2 Electrical Connections for CFast 3SE

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.

4.3 Device Drive

No additional device drives are required. Innodisk CFast 3SE can be configured as a boot device.

5. 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	**E**	**C**	**F**	**A**	**-**	**3**	**2**	**G**	**D**	**0**	**6**	**S**	**C**	**1**	**Q**	**B**	**-**	**X**	**X**
Description	Disk	CFast 3SE					Capacity			Category			FW	Operation Temp.	Internal Control	CH.	Flash Type	-	Customized Code	

Definition	
Code 1st (Disk)	**Code 13th (Firmware version)**
D : Disk	S: Standard Firmware version
Code 2nd ~ 5th (Form Factor)	**Code 14th (Operation Temperature)**
ECFA: CFast 3SE	C: Standard Grade (0℃~ +70℃)
Code 7th ~9th (Capacity)	W: Industrial Grade (-40℃~ +85℃)
04G: 04GB	**Code 15th (Internal control)**
08G: 08GB	**Code 16th (Channel of data transfer)**
16G: 16GB	D: Dual Channels
32G: 32GB	Q: Four Channels
64G: 64GB	**Code 17th (Flash Type)**
	B: Toshiba SLC
Code 10th ~12th (Series)	**Code 19th~20th (Customized Code)**
D06: CFast 3SE	

Appendix

CE/FCC/RoHS (TBD)