

CFast 3SE3

Customer: _____

Customer

Part Number: _____

Innodisk

Part Number: _____

Innodisk

Model Name: _____

Date: _____

Innodisk Approver	Customer Approver

Total Solution For
Industrial Flash Storage

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REVISION HISTORY

Revision	Description	Date
1.0	First Released	JUL., 2015
1.1	Add Smart attribute Add CE/FCC certification	SEP., 2015
1.2	Revised SMART command and SMART attribute	DEC., 2016
1.3	Update RoHS and REACH	Aug., 2017
1.4	Add ID109 4GB/8GB related spec. Update REACH, ROHS, add MSL	Feb., 2019
1.5	Update 8GB 2CH performance	Jul., 2021
1.6	Remove Appendix Update performance and power consumption info.	Oct., 2021
1.7	Update Reliability	Aug., 2024
1.8	Update Performance	Nov., 2024

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1. Product Overview

1.1 Introduction of Innodisk CFast 3SE3

The Innodisk CFast 3SE3 operates at SATA III 6.0 Gb/s, which offers data transfer rate of read up to 330MB/s. and of sequential write up to 190MB/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 3SE3 is featured as small form factor, and suitable for most industrial application.

CFast 3SE3 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 3SE3 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 3SE3 prevents data loss caused by sudden power failure. By using Innodisk'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 3SE3 is available in follow capacities within SLC flash ICs.

CFast 3SE3 04GB CFast 3SE3 32GB
CFast 3SE3 08GB CFast 3SE3 64GB
CFast 3SE3 16GB



Figure 1: Innodisk CFast 3SE3

1.3 SATA Interface

Innodisk CFast 3SE3 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 3SE3 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 3SE3 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 3SE3 mechanical dimensions: 42.8mm x 36.4mm x 3.6mm.

2. Product Specifications

2.1 Capacity and Device Parameters

CFast 3SE3 device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	LBA	Cylinders	Heads	Sectors	User Capacity(MB)
4GB	7835184	7773	16	63	3,825
8GB	15649200	15525	16	63	7,641
16GB	31277232	16383	16	63	15,272
32GB	62533296	16383	16	63	30,533
64GB	125045424	16383	16	63	61,057

2.2 Performance

Burst Transfer Rate: 6.0Gbps

Table 2: Performance

Capacity	Unit	CH	4GB	8GB	16GB	32GB	64GB
Sequential Read (max.) *	MB/s	1	30				
Sequential Write (max.) *			25				
4KB Random Read(QD32) **	IOPS		3,200				
4KB Random Write(QD32) **			2,400				
Sequential Read (max.) *	MB/s	2	60	60			
Sequential Write (max.) *			60	50			
4KB Random Read(QD32) **	IOPS		3,200	2,900			
4KB Random Write(QD32) **			3,700	4,400			
Sequential Read (max.) *	MB/s	4		310	250	400	330
Sequential Write (max.) *				100	100	210	190
4KB Random Read(QD32) **	IOPS			10,900	5,600	5,400	11,400
4KB Random Write(QD32) **				11,900	8,900	10,100	14,100

Note: * Performance results are measured in Room Temperature with Out-of-Box devices and may vary depending on overall system setup.

Note: ** Performance results are based on CrystalDiskMark 6.0.2 with typical tolerances for range from 1% to 10%.

Unit of 4KB items is I.O.P.S.

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk CFast 3SE3 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 (W)
Read	1.20 (max.)
Write	1.73 (max.)
Idle	0.27 (max.)

Target: 64GB CFast 3SE3

Note: Current results may vary depending on system components and power circuit design. Please refer to the test report for other capacities

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for CFast 3SE3

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 3SE3

Reliability	Test Conditions	Reference Standards
Vibration	7 Hz to 2K Hz, 20G, 3 axes	IEC 60068-2-6
Mechanical Shock	Duration: 0.5ms, 1500 G, 3 axes	IEC 60068-2-27

2.4.4 Mean Time between Failures (MTBF)

Table 7 summarizes the MTBF prediction results for various CFast 3SE3 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 3SE3 MTBF

Product	Condition	MTBF (Hours)
Innodisk CFast 3SE3	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

CFast 3SE3 conforms to CE and FCC requirements.

2.6 RoHS Compliance

CFast 3SE3 is fully compliant with RoHS directive.

2.7 Reliability

Table 8: CFast 3SE3 TBW

Parameter	Value
Read Cycles	Unlimited Read Cycles
Flash Endurance	60,000 P/E cycles
Wear-Leveling Algorithm	Support
Bad Blocks Management	Support
Error Correct Code	Support
Data Retention	Under 40°C: 1 Year at NAND Life End
TBW*(Total Bytes Written)	Unit:TB
4GB	23.4
8GB	46.8
16GB	93.8
32GB	187.5
64GB	375
*Total bytes written is based on JEDEC 218. (Solid-State Drive Requirements and Endurance Test Method)	
**Lifespan is calculated by device written per day.	

2.8 Transfer Mode

CFast 3SE3 support following transfer mode:

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

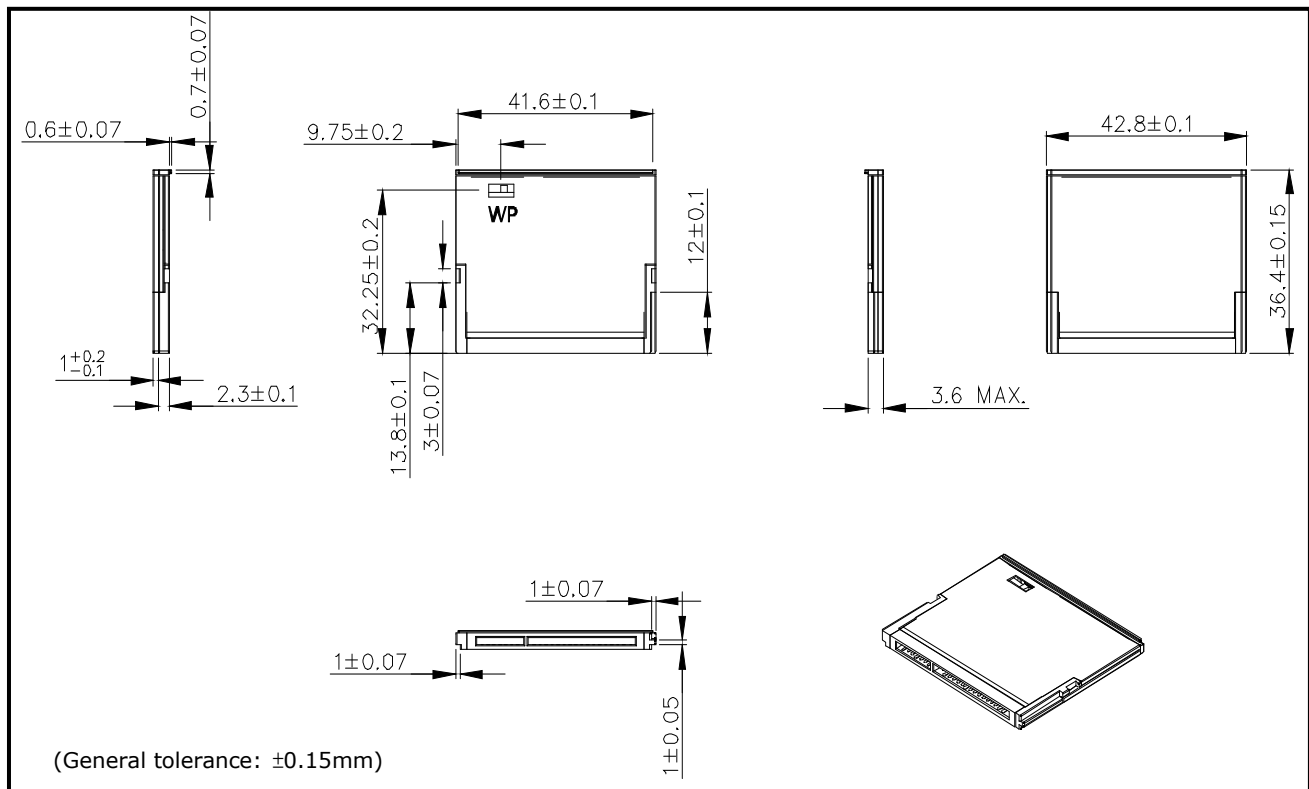
2.9 Pin Assignment

Innodisk CFast 3SE3 uses a standard SATA pin-out. See Table 9 for CFast 3SE3 pin assignment.

Table 9: Innodisk CFast 3SE3 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(ID108)	Device sleep
	TBD (ID109)	Reserved
P4	TBD	Reserved
P5	TBD	Reserved
P6	TBD	Reserved
P7	PGND	Device Ground
P8	LED1	PHY LED (LED are lighted when P8 low active)
P9	LED2	HDDA LED (LED are lighted when P9 low active)
P10	TBD	Reserved
P11	TBD	Reserved
P12	IFDet	GND
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



*Write Protect is optional.

2.11 Assembly Weight

An Innodisk CFast 3SE3 within SLC flash ICs, 64GB's weight is 10 grams approx. The total weight of card will be less than 15 grams.

2.12 Seek Time

Innodisk CFast 3SE3 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 3SE3 uses Single Level Cell (SLC) NAND flash memory, which is non-volatility, high reliability and high speed memory storage.

3. Theory of Operation

3.1 Overview

Figure 2 shows the operation of Innodisk CFast 3SE3 from the system level, including the major hardware blocks.

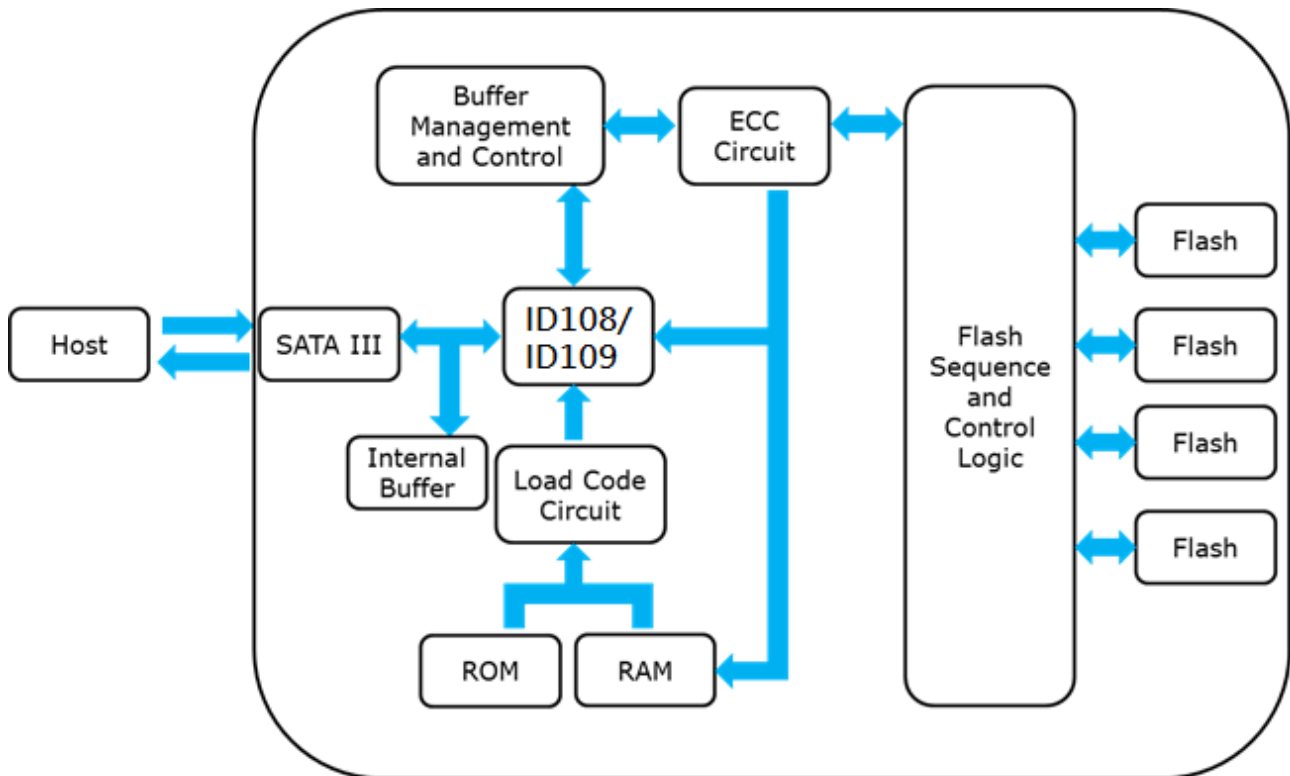


Figure 2: Innodisk CFast 3SE3 Block Diagram

Innodisk CFast 3SE3 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 3SE3 is designed with ID108/ID109, 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 2 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 3SE3 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 3SE3 Pin Directions

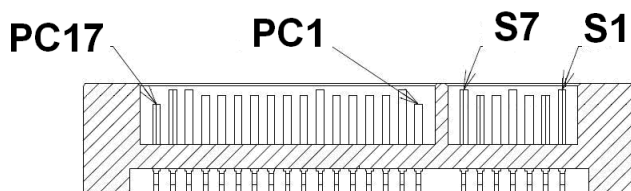


Figure 3: Signal Segment and Power Segment

4.2 Electrical Connections for CFast 3SE3

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.

4.3 Write Protection (Optional)



Innodisk CFast 3SE3 within the write-protect function could prevent the device from modification and deletion. Write-protected data could only be read, that is, users could not write to it, edit it, append data to it, or delete it. When users would like to make sure that neither themselves nor others could modify or destroy the file, users could switch on write-protection. Thus, Innodisk CFast 3SE3 could process write-protect mechanism and disable flash memory to be written-in any data. Only while the system power-off, users could switch on write-protection. Write-protection could not be switched-on, after OS booting.

4.4 Device Drive

No additional device drives are required. Innodisk CFast 3SE3 can be configured as a boot device.

5. SMART Feature Set

Innodisk 3SE3 series support the SMART command set and defines some vendor-specific data to report SMART attributes of SSD.

Table 10: SMART command

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

5.1 SMART Attributes

Innodisk 3SE3 series SMART data attributes are listed in following table.

Table 11: SMART attribute

Attribute ID (hex)	Attribute Name
01	Read Error Rate
05	Later Bad
09	Power-On hours Count
0C	Drive Power Cycle Count
A3	Total Bad Block Count
A5	Max Erase count
A7	Avg Erase count
A9	Device Life
AA	Spare Block Count
AB	Program fail count
AC	Erase fail count
C0	Unexpected Power Loss Count
C2	Temperature
E5	Flash ID
EB	Later Bad Block
F1	Total LBAs written (each write unit = 32MB)
F2	Total LBAs read (each write unit = 32MB)

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	21
	D	E	C	F	A	-	3	2	G	D	0	8	S	C	A	Q	B	(W)	X	X	X
Definition																					
Code 1~2st (Disk)											Code 14th (Operation Temperature)										
DE : Embedded Disk											C: Standard Grade (0℃ ~ +70℃)										
											W: Industrial Grade (-40℃ ~ +85℃)										
Code 2nd ~ 5th (Form Factor)											K: Standard Grade with coating (0℃ ~ +70℃)										
CFA: CFast											T: Industrial Grade with coating (-40℃ ~ +85℃)										
Code 7th ~9th (Capacity)											Code 15th (Internal control)										
04G: 04GB											A~Z: BGA PCB version										
08G: 08GB											1~9: TSOP PCB version										
16G: 16GB																					
32G: 32GB											Code 16th (Channel of data transfer)										
64G: 64GB											S: Single Channel										
											D: Dual Channels										
											Q: Quad Channels										
Code 10th ~12th (Controller)											Code 17th (Flash Type)										
D08: ID108											B: Toshiba SLC										
D09: ID109																					
Code 13th (Flash Mode)											Code 18th (Flash Type)										
S: Synchronous Flash											W: Write Protect										
A: Asynchronous Flash											Code 19th~21th (Customized Code)										