innodisk

Total Solution For Industrial Flash Storage

MicroSD Card

3ME3 Series

Customer: _____

Customer Part Number: _____

Innodisk Part Number: _____

Innodisk Model Name: _____

Date: _____

Innodisk Approver	Customer Approver

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REVISION HISTORY

Revision	Description	Date
V1.0	Official released	Aug.,2021
V1.1	Update power consumption	Oct.,2021
V1.2	Add CID & SMART List	Aug.,2022

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1. Product Overview

1.1 Introduction of MicroSD 3ME3

Innodisk MicroSD 3ME3 is designed for demanding industrial applications and provides excellent performance. Moreover, Innodisk MicroSD 3ME3 supports Ultra High Speed (UHS) interface transfer mode, provides high write/read data transfer rate, high random IOPS, sudden Power-Fails protection, adaptive static wear-leveling, read/program disturb management, etc.

1.2 Product View and Models

Innodisk MicroSD 3ME3 is available in follow capacities within MLC flash ICs.

MicroSD 3ME3 8GB

MicroSD 3ME3 16GB

MicroSD 3ME3 32GB

MicroSD 3ME3 64GB

1.3 SD3.0 Interface

Innodisk MicroSD 3ME3 supports SD3.0 interface, and compliant with SD 2.0 and SD 1.1.

2. Product Specifications

2.1 Capacity and Device Parameters

MicroSD 3ME3 device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	LBA
8GB	15859712
16GB	31719424
32GB	63438848
64GB	126877696

2.2 Performance

Speed Class : Class 10 (10MB/s) ,UHS I

Table 2: Performance

Capacity	8GB	16GB	32GB	64GB
Sequential Read (AVG.)	70 MB/sec	70 MB/sec	75 MB/sec	75 MB/sec
Sequential Write (AVG.)	25 MB/sec	25 MB/sec	25 MB/sec	50 MB/sec
4KB Random** Read (QD32)	1,460 IOPS	1, 430 IOPS	1,430 IOPS	1,350 IOPS
4KB Random** Write (QD32)	125 IOPS	150 IOPS	150 IOPS	150 IOPS

Note: the information is based on CrystalDiskMark 6.0.2 with file size 1000MB test patent

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk MicroSD 3ME3 Power Requirement

Item	Symbol	Rating	Unit
Input voltage	V_{IN}	2.7~3.6	V

2.3.2 Power Consumption

Table 4: Power Consumption

Mode	Power Consumption (mA)			
	8GB	16GB	32GB	64GB
Read (rms)	125	135	140	150
Write (rms)	110	110	110	150
Idle (rms)	0.1	0.1	0.2	0.2
Peak (max)	175	190	200	200

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for MicroSD 3ME3

Temperature	Range
Operating	Standard Grade: -25°C to +85°C Industrial Grade: -40°C to +85°C
Storage	-40°C to +85°C

2.4.2 Shock and Vibration

Table 6: Shock/Vibration Testing for MicroSD 3ME3

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

2.4.3 Mean Time between Failures (MTBF)

Table 7 summarizes the MTBF prediction results for various MicroSD 3ME3 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: MicroSD 3ME3 MTBF

Product	Condition	MTBF (Hours)
Innodisk MicroSD 3ME3	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

MicroSD 3ME3 conforms to CE and FCC requirements.

2.6 RoHS Compliance

MicroSD 3ME3 is fully compliant with RoHS directive.

2.7 Reliability

Parameter	**Value**
Read Cycles	Unlimited Read Cycles
Flash endurance	3,000 P/E cycles
Wear-Leveling Algorithm	Support
Bad Blocks Management	Support
Error Correct Code	Support
TBW* (Total Bytes Written) Unit:TB	
Capacity	**Sequential workload**
08GB	21
16GB	43
32GB	85
64GB	170
*Note: Sequential: Mainly sequential write, tested by Vdbench.	

2.8 Transfer Mode

MicroSD 3ME3 supports following transfer mode:

SD 3.0

SD 2.0

SD 1.1

SPI mode

2.9 Pin Assignment

MicroSD 3ME3 uses a standard SD pin-out. See Table 8 for MicroSD 3ME3 pad assignment.

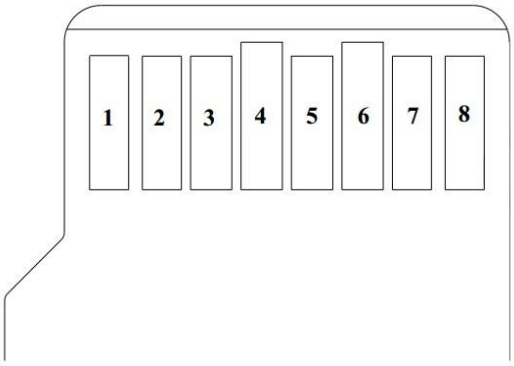
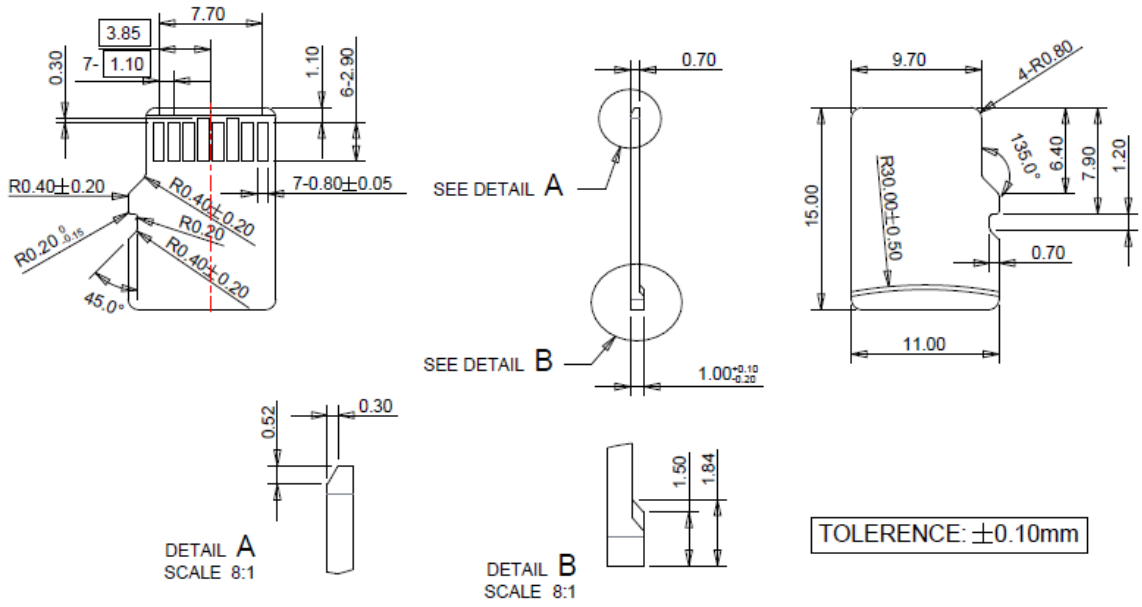


Table 8: Innodisk MicroSD 3ME3 Pad Assignment

Pin #	Name	Type	description
1	DAT2[2,5]	I/O	Data Line [Bit 2]
2	CD/DAT3[2]	I/O[3]	Card Detect/Data Line[Bit 3]
3	CMD	I/O	Command/Response
4	V_{DD}	S	S Supply Voltage
5	CLK	I	Clock
6	V_{SS}	S	S Supply Voltage GND
7	DAT0	I/O	Data Line [Bit 0]
8	DAT1[2,4]	I/O	Data Line [Bit 1]

2.10 Mechanical Dimensions



2.11 Assembly Weight

An Innodisk MicroSD 3ME3 within flash ICs weight is 0.25 grams approximately.

2.12 Seek Time

Innodisk MicroSD 3ME3 is not a magnetic rotating design. There is no seek or rotational latency required.

2.13 NAND Flash Memory

Innodisk MicroSD 3ME3 uses Multi Level Cell (MLC) NAND flash memory, which is non-volatility, high reliability and high speed memory storage. Each cell stores 2 bits or holds four states per cell. Read or Write data to flash memory for SD/MSD is control by microprocessor.

2.14 Card Identification Register

The Card IDentification (CID) register is 128 bits wide. It contains the card identification information used during the card identification phase. Every individual flash card shall have a unique identification number. The structure of the CID register is defined in the following table.

Table 9 Innodisk Industrial SD Card CID Table

CID bit	Width	Name	Field
[127:120]	8	Manufacturer ID	MID
[119:104]	16	OEM/Application ID	OID
[103:64]	40	Product Name	PNM
[63:56]	8	Product Revision	PRV
[55:24]	32	Product Serial Number	PSN
[23:20]	4	Reserved	---
[19:8]	12	Manufacturing Date	MDT
[7:1]	7	CRC7 check sum	CRC
[0]	1	Not used, always ‘1’	---

2.15 SMART List

Table 10.SMART List

Offset	Byte Count	Attribute Name	Description
0x00~0x1F	16	Reserved for Unique ID/Setting	Reserved for Unique ID/Setting
0x10	1	Bus width	00h: 1 bit width 10h: 4 bit width
0x11	1	Source Mode	00h: Not in the Source Mode 01h: In Source Mode
0x12	1	Speed Class	00h: Class 0 01h: Class 2 02h: Class 4 03h: Class 6 04h: Class 10
0x13	1	UHS Speed Grade	00h: Less than 10MB/sec 01h: 10MB/sec and above 02h: Reserved 03h: 30MB/sec and above
0x14~0x17	4	Protected Area Size	Protected Area Size (Bytes)
0x18	1	Total Spare Block Count	Total Spare Block Count
0x19	1	Original Bad Count	Original Bad Block Count
0x1A	1	Run Time Bad Block Count	Run-time Bad Block Count
0x1B	1	Spare Utilization Rate	Spare Utilization Rate
0x1C~0x1F	4	SPOR Failure Count	SPOR Failure Count
0x20~0x23	4	Minimum Erase Count	Minimum Erase Count
0x24~0x27	4	Maximum Erase Count	Maximum Erase Count
0x28~0x2B	4	Total Erase Count	Total Erase Count
0x2C~0x2F	4	Average Erase Count	Average Erase Count

3. Theory of Operation

3.1 Overview

Figure 1 shows the operation of Innodisk MicroSD 3ME3 from the system level, including the major hardware blocks.

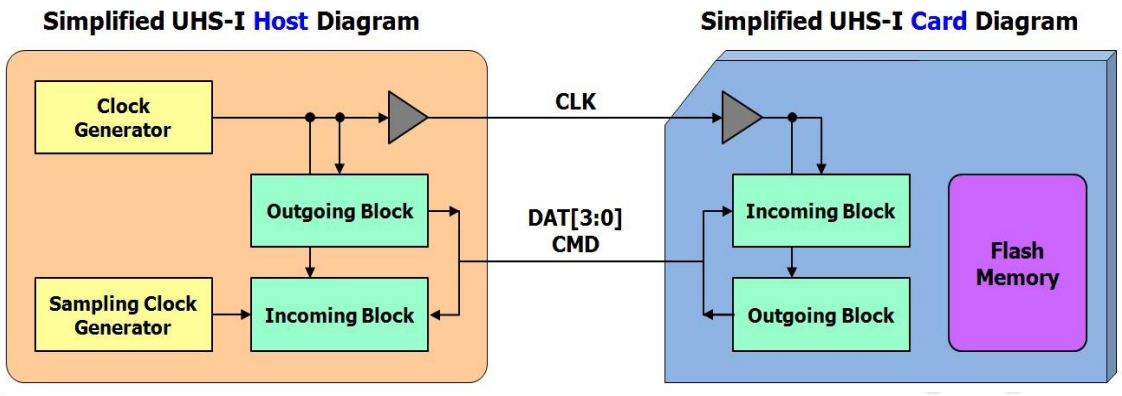


Figure 1: Innodisk MicroSD 3ME3 and Host Block Diagram

Figure 1 shows a typical UHS-I host system that supports removable cards. Host has clock generator which supplies SDCLK to the card. In case of write operation, as clock direction and data direction is the same, write data can be transferred synchronized with SDCLK regardless of transmission line delay.

In case of read operation, as clock direction and data direction is opposite, read data host received is delayed by round-trip delay, output delay and latency of host and card. So receiving data is the most critical for the host. Therefore, host needs to have sampling clock generator to receive response, CRC status and read data block.

3.2 Controller

Innodisk MicroSD 3ME3 is designed with a SD 3.0 controller.

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 43 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

Global and static wear-leveling provides more uniform block usage than dynamic and Zone-based wear-leveling. The essence had scrambled entire blocks to reach the unique probability of P/E cycle and quite longer lifetime.

Innodisk's wear-leveling scheme is accomplished by global adaptive static wear-leveling, which ensures the better endurance and optimizes the system performance of the Flash memory array.

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 SD/MSD is shipped, or may develop during the life time of the SD/MSD. When the Bad Blocks is detected, it will be flagged, and not be used anymore. The SD/MSD 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 Garbage Collection

Garbage collection is used to maintain data consistency and perform continual data cleansing on SD/MSDs. It frees up valuable controller resources while sorting good data into available blocks, and deletes bad blocks. It also significantly reduces write operations to the drive, thereby increasing the SD/MSD's speed and lifespan.

3.7 Power cycling

Innodisk's SD/MSDs provide the complete data protection mechanism during every abnormal power shutdown situation. Such as: power failure at programming data, updating system tables, erasing blocks, etc. The mechanism can maintain the data correctness and increase the reliability of the data stored in the NAND Flash memory.

4. 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**	**S**	**D**	**M**	**-**	**3**	**2**	**G**	**S**	**0**	**2**	**S**	**E**	**1**	**S**	**K**	**-**	**X**	**X**	**X**
Description	Disk	MicroSD					Capacity			Controller			Flash Mode	Operation Temp.	Internal Control	CH.	Flash Type	-	Customized Code		

Definition	
Code 1st (Disk)	**Code 13th (Flash Mode)**
D : Disk	S: Sync. Flash
Code 2nd ~ 5th (Form Factor)	**Code 14th (Operation Temperature)**
ESDM: Micro SD	E: Extended Grade (-25℃~ +85℃)
	W: Industrial Grade (-40℃~ +85℃)
Code 7th ~9th (Capacity)	**Code 15th (Internal control)**
08G: 8GB	1.Product version
16G: 16GB	**Code 16th (Channel of data transfer)**
32G: 32GB	S: Single Chanel
64G: 64GB	**Code 17th**
Code 10th ~12th (Controller)	K: WD MLC
S02: SM2702	**Code 19th~21th (Customized Code)**