

# Industrial SD Card

## 3ME3

**Total Solution For  
Industrial Flash Storage**

**Customer:** \_\_\_\_\_

**Customer**

**Part**

**Number:** \_\_\_\_\_

**Innodisk**

**Part**

**Number:** \_\_\_\_\_

**Innodisk**

**Model Name:** \_\_\_\_\_

**Date:** \_\_\_\_\_

<b>Innodisk Approver</b>	<b>Customer Approver</b>

# Table of contents

- 1. PRODUCT OVERVIEW .....7**
  - 1.1 INTRODUCTION OF INNODISK INDUSTRIAL SD 3ME3 .....7**
  - 1.2 PRODUCT VIEW AND MODELS .....7**
  - 1.3 SD 3.0 INTERFACE .....7**
  
- 2. PRODUCT SPECIFICATIONS .....8**
  - 2.1 CAPACITY AND DEVICE PARAMETERS .....8**
  - 2.2 PERFORMANCE .....8**
  - 2.3 ELECTRICAL SPECIFICATIONS .....8**
    - 2.3.1 Power Requirement .....8**
    - 2.3.2 Power Consumption .....8**
  - 2.4 ENVIRONMENTAL SPECIFICATIONS .....9**
    - 2.4.1 Temperature Ranges .....9**
    - 2.4.2 Humidity .....9**
    - 2.4.3 Shock and Vibration .....9**
    - 2.4.4 Mean Time between Failures (MTBF) .....9**
  - 2.5 CE AND FCC COMPATIBILITY .....9**
  - 2.6 RoHS COMPLIANCE .....9**
  - 2.7 RELIABILITY .....10**
  - 2.8 TRANSFER MODE .....10**
  - 2.9 PIN ASSIGNMENT .....10**
  - 2.10 MECHANICAL DIMENSIONS .....11**
  - 2.11 ASSEMBLY WEIGHT .....11**
  - 2.12 SEEK TIME .....11**
  - 2.13 HOT PLUG .....11**
  - 2.14 NAND FLASH MEMORY .....11**
  - 2.15 CARD IDENTIFICATION REGISTER .....11**
  - 2.16 SMART LIST .....12**
  
- 3. THEORY OF OPERATION .....13**
  - 3.1 OVERVIEW .....13**
  - 3.2 SD 3.0 CONTROLLER .....13**
  - 3.3 ERROR DETECTION AND CORRECTION .....13**
  - 3.4 WEAR-LEVELING .....13**
  - 3.5 BAD BLOCKS MANAGEMENT .....14**
  - 3.6 GARBAGE COLLECTION .....14**
  - 3.7 POWER CYCLING .....14**
  
- 4. INSTALLATION REQUIREMENTS .....15**
  - 4.1 INDUSTRIAL SD CARD PIN DIRECTIONS .....15**

**4.2 DEVICE DRIVE ..... 15**

**5. PART NUMBER RULE .....16**

## REVISION HISTORY

Revision	Description	Date
Preliminary	First release	June, 2017
1.0	Officially release	August, 2017
1.1	Add Power cycling function	March, 2018
1.2	Add P/E cycle	May, 2020
1.3	Operating temperature correction	July, 2022
1.4	Add CID & SMART List	August, 2022
1.5	Update PN rule	June, 2024

## List of Tables

**TABLE 1: DEVICE PARAMETERS**.....8

**TABLE 2: PERFORMANCE** .....8

**TABLE 3: INNODISK INDUSTRIAL SD CARD POWER REQUIREMENT** .....8

**TABLE 4: POWER CONSUMPTION** .....8

**TABLE 5: TEMPERATURE RANGE FOR INDUSTRIAL SD CARD**.....9

**TABLE 6: SHOCK/VIBRATION TESTING FOR INDUSTRIAL SD CARD**.....9

**TABLE 7: INDUSTRIAL SD CARD MTBF** .....9

**TABLE 8: INNODISK INDUSTRIAL SD 3ME3 PIN ASSIGNMENT**.....10

**TABLE 9 INNODISK INDUSTRIAL SD CARD CID TABLE**.....11

**TABLE 10.SMART LIST** .....12

## List of Figures

<b>FIGURE 1: INNODISK INDUSTRIAL SD 3ME3 .....</b>	<b>7</b>
<b>FIGURE 2: INNODISK INDUSTRIAL SD 3ME3 BLOCK DIAGRAM.....</b>	<b>13</b>
<b>FIGURE 3: SIGNAL SEGMENT AND POWER SEGMENT.....</b>	<b>15</b>

# 1. Product Overview

## 1.1 Introduction of Innodisk Industrial SD 3ME3

Innodisk 3ME3 is an industrial-grade SD card solution with an integrated industrial controller, which is designed for embedded applications. With enhanced flash technologies and a powerful configurable BCH ECC engine, SD 3ME3 can achieve high-speed data transfer rates.

Innodisk industrial SD 3ME3 provides a wide range of capacities from 8GB to 128GB with MLC NAND Flash, and is fully compliant with SD3.0 and SD2.0 specifications.

Innodisk industrial SD 3ME3 are specifically designed for industrial PC and embedded applications for high performance. With its low power consumption and the above mentioned features, Innodisk industrial SD 3ME3 can be applied for industrial automation, SBC (single-board computer), medical equipment, infotainment, and mobile applications.

## 1.2 Product View and Models

Innodisk Industrial SD 3ME3 is available from 8GB up to 128GB capacities within MLC Flash IC.



**Figure 1: Innodisk Industrial SD 3ME3**

## 1.3 SD 3.0 Interface

Innodisk Industrial SD 3ME3 support SD 3.0 interface, and backward compliant to SD 2.0 interface.

## 2. Product Specifications

### 2.1 Capacity and Device Parameters

Innodisk Industrial SD card device parameters are shown in Table 1.

**Table 1: Device parameters**

Capacity	User Capacity(MB)
8GB	7744
16GB	15488
32GB	30976
64GB	61952
128GB	123904

### 2.2 Performance

Burst Transfer Rate: up to 104 MB/s in SD 3.0 SDR104

**Table 2: Performance**

Capacity	8GB	16GB (128Gb*1)	16GB (64Gb*2)	32GB	64GB	128GB
<b>Class</b>	10	10	10	10	10	10
<b>Sequential Read (max.)</b>	84 MB/sec	83 MB/sec	81 MB/sec	81 MB/sec	80 MB/sec	80 MB/sec
<b>Sequential Write (max.)</b>	26 MB/sec	24 MB/sec	43 MB/sec	48 MB/sec	46 MB/sec	46 MB/sec

Note: Base on CrystalDiskMark 5.1.2 with file size 1000MB

### 2.3 Electrical Specifications

#### 2.3.1 Power Requirement

**Table 3: Innodisk Industrial SD card Power Requirement**

Item	Symbol	Rating	Unit
Input voltage	V <sub>IN</sub>	2.7V~3.6V	V

#### 2.3.2 Power Consumption

**Table 4: Power Consumption**

Mode	Power Consumption (mA)
Read	140 (max.)
Write	158 (max.)
Idle	0.2 (max.)



\* Target: Industrial SD 3ME3 MLC 128GB

## 2.4 Environmental Specifications

### 2.4.1 Temperature Ranges

**Table 5: Temperature range for Industrial SD card**

Temperature	Range
Operating	Standard Grade: -25°C to +85°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 Industrial SD card**

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 Industrial SD card 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: Industrial SD card MTBF**

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

## 2.5 CE and FCC Compatibility

Industrial SD card conforms to CE and FCC requirements.

## 2.6 RoHS Compliance

Industrial SD card 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(Sequential Write)	MLC
8GB	21.8
16GB	43.6
32GB	87.2
64GB	174.5
128GB	349

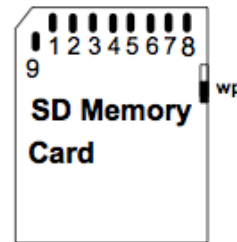
## 2.8 Transfer Mode

Industrial SD 3ME3 support following transfer mode:

SD 3.0 / SD 2.0

## 2.9 Pin Assignment

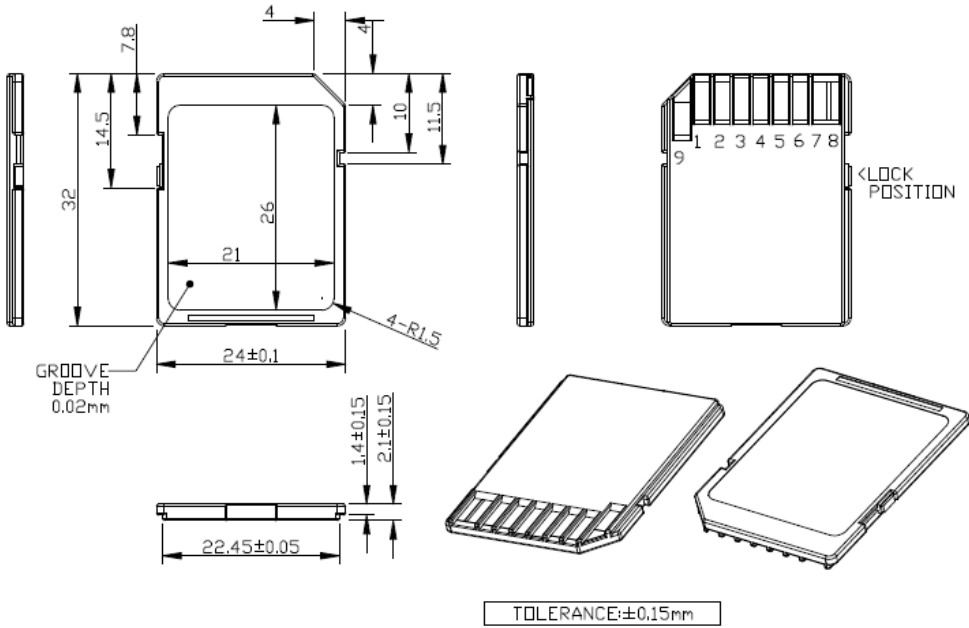
Innodisk Industrial SD 3ME3 compliant with standard SD SPEC., please refer to Table 8 for pin assignment.



**Table 8: Innodisk Industrial SD 3ME3 Pin Assignment**

Pin #	SD Mode			SPI Mode		
	Name	Type <sup>1</sup>	Description	Name	Type <sup>1</sup>	Description
1	CD/DAT3 <sup>2</sup>	I/O/PP <sup>3</sup>	Card Detect/Data Line [Bit 3]	CS	I <sup>3</sup>	Chip Select (Neg. True)
2	CMD	I/O/PP	Command/Response	DI	I	Data In
3	V <sub>SS1</sub>	S	Supply voltage ground	V <sub>SS</sub>	S	Supply voltage ground
4	V <sub>DD</sub>	S	Supply voltage	V <sub>DD</sub>	S	Supply voltage
5	CLK	I	Clock	SCLK	I	Clock
6	V <sub>SS2</sub>	S	Supply voltage ground	V <sub>SS2</sub>	S	Supply voltage ground
7	DAT0	I/O/PP	Data Line [Bit 0]	DO	O/PP	Data Out
8	DAT1 <sup>4</sup>	I/O/PP	Data Line [Bit 1]	RSV		
9	DAT2 <sup>5</sup>	I/O/PP	Data Line [Bit 2]	RSV		

### 2.10 Mechanical Dimensions



### 2.11 Assembly Weight

An Innodisk Industrial SD card 3.0 within MLC flash ICs, 8GB’s weight is 2 grams approx.

### 2.12 Seek Time

Innodisk Industrial SD card is not a magnetic rotating design. There is no seek or rotational latency required.

### 2.13 Hot Plug

The SD card support hot plug function and can be removed or plugged-in during operation.

### 2.14 NAND Flash Memory

Innodisk Industrial SD 3ME3 uses Multi Level Cell (MLC) NAND flash memory, which is non-volatility, high reliability and high speed memory storage.

### 2.15 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'	---

## 2.16 SMART List

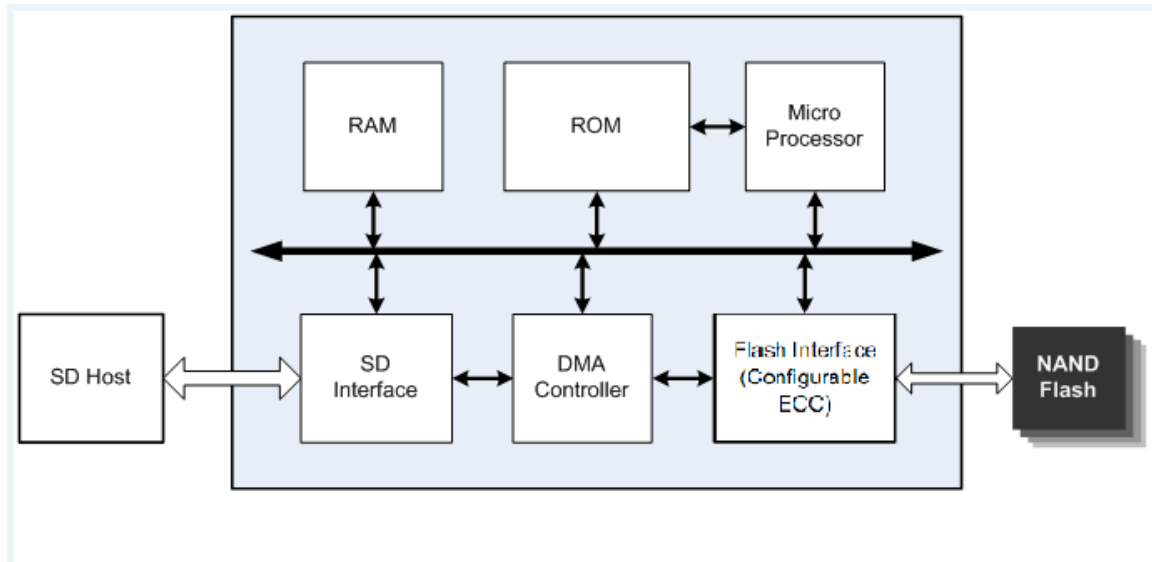
**Table 10.SMART List**

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 2 shows the operation of Innodisk Industrial SD 3ME3 from the system level, including the major hardware blocks.



**Figure 2: Innodisk Industrial SD 3ME3 Block Diagram**

Innodisk Industrial SD 3ME3 integrates a SD 3.0 controller and NAND flash memories. Communication with the host occurs through the host interface, using the standard SD interface.

## 3.2 SD 3.0 Controller

Innodisk Industrial SD 3ME3 is designed with a SD 3.0 controller, which has single channel 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 up to 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

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 Industrial SD 3ME3 uses a global 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 product is shipped, or may develop during the life time of the SD card. When the Bad Blocks is detected, it will be flagged, and not be used anymore. The SD card 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 card. It runs as a background process, freeing up valuable controller resources while sorting good data into available blocks, and deleting bad blocks. It also significantly reduces write operations to the drive, thereby increasing the SD'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. Installation Requirements

## 4.1 Industrial SD card Pin Directions

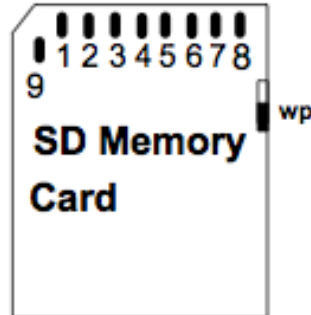


Figure 3: Signal Segment and Power Segment

## 4.2 Device Drive

No additional device drives are required.

## 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
	<b>D</b>	<b>E</b>	<b>S</b>	<b>D</b>	<b>C</b>	-	<b>1</b>	<b>6</b>	<b>G</b>	<b>S</b>	<b>0</b>	<b>2</b>	<b>B</b>	<b>C</b>	<b>1</b>	<b>D</b>	<b>C</b>	-	<b>X</b>	<b>X</b>
Description	Disk	Industrial SD card					Capacity			Category			Flash Mode	Operation Temp.	Internal Control	CH.	Flash	-	Customized Code	
<b>Definition</b>																				
<b>Code 1<sup>st</sup> (Disk)</b>											<b>Code 13<sup>th</sup> (Flash Mode)</b>									
D : Disk											B: Toshiba 15nm									
<b>Code 2<sup>nd</sup> ~ 5<sup>th</sup> (Form Factor)</b>											<b>Code 14<sup>th</sup> (Operation Temperature)</b>									
ESDC: Industrial SD 3ME3											C: Standard Grade (-20°C ~ +85°C)									
<b>Code 7<sup>th</sup> ~9<sup>th</sup> (Capacity)</b>											<b>Code 15<sup>th</sup> (Internal control)</b>									
08G: 8GB											W: Industrial Grade (-40°C ~ +85°C)									
16G: 16GB																				
<b>Code 16<sup>th</sup> (Channel of data transfer)</b>																				
32G: 32GB											S: Single Channel									
64G: 64GB											D: Dual Channels									
A28: 128GB											<b>Code 17<sup>th</sup> (Flash Type)</b>									
											C: Toshiba MLC									
<b>Code 10<sup>th</sup> ~12<sup>th</sup> (Series)</b>											<b>Code 19<sup>th</sup>~20<sup>th</sup> (Customized Code)</b>									
S02: SMI 2702BAC																				