

microSDカード
MLC:8-128GB
aMLC:4-64GB

(ET1288+SanDisk 15nm MLC)

データシート

REVISION HISTORY

Revision	Description	Date
V1.1	First released	August 2015
V2.1	For SanDisk 1Znm solution	January 2017
V2.2	Updated part number information	May 2017
V2.3	Added sMLC 4GB~32GB	May 2017
V2.4	Added Product Feature information	June 2017
V2.5	Added MLC 128GB and sMLC 64GB	August 2017
V2.6	1.Added ESD ability and water proof information 2.Modified power consumption information	April 2018
V2.7	Name changed from sMLC to aMLC.	June 2018
V2.8	Added MLC 128GB and aMLC 64GB, 1.3 TBW	June 2020
V2.9	Added 1.2 Product Features and 3.8 Dust proof	July 2020

1. Product Introduction

1.1. Overview

The Industrial microSD Card is designed for demanding industrial applications. The Industrial microSD Card is compatible with SD 3.0 and provides excellent performance. The built-in auto ECC function can detect and correct errors during data transfer. Moreover, the Industrial microSD Card 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. It was designed to meet the high quality, high reliability, high performance, and versatile environmental requirements.

1.2. Product Features

- Interface: 8 pins microSD standard interface
- Compliant SD Card Specification 3.0
- Density support:
 - MLC:8GB~128GB
 - aMLC (Advanced MLC, single bit per cell MLC): 4GB~64GB
- Bus Speed Mode:
 - DS-Default Speed mode: 3.3V signaling, frequency up to 25MHz, up to 12.5MB/sec
 - HS-High Speed mode: 3.3V signaling, frequency up to 50MHz, up to 25MB/sec
 - SDR12: 1.8V signaling, frequency up to 25MHz, up to 12.5MB/sec
 - SDR25: 1.8V signaling, frequency up to 50MHz, up to 25MB/sec
 - SDR50: 1.8V signaling, frequency up to 100MHz, up to 50MB/sec
 - SDR104: 1.8V signaling, frequency up to 208MHz, up to 104MB/sec
 - DDR50: 1.8V signaling, frequency up to 50MHz, sampled on both clock edges, up to 50MB/s
- Operating at -25°C to 85°C
- Flash: MLC NAND Flash (SDTNSGAMA-008G)
- Controller: ET1288
- Program/Erase Cycle: 3,000 Cycles (MLC)
- Program/Erase Cycle: 20,000 Cycles (aMLC)
- Built-in ECC corrects up to 43 bits/1 KB
- Read disturbance management (Auto-Refresh)
- Adaptive wear leveling
- Management of sudden power-fails

- SMART Function support
- Support CPRM (Content Protection for Recordable Media) of SD Card
- Support Water & Dust proof IEC 60529 IP58
- aMLC (Advanced MLC, single bit per cell MLC) support, enhance the performance and product endurance

1.3. TBW (Tera Bytes Written)

Capacity	4GB	8GB	16GB	32GB	64GB	128GB
MLC	—	19.6TB	39.2TB	78.4TB	156.8TB	313.6TB
aMLC	65.3TB	130.6TB	261.2TB	522.4TB	1047.3TB	—

*The endurance of disk could be varying based on user behavior, NAND endurance cycles, and write amplification factor.

It is not guaranteed by flash vendor.

*Client workload by JESD-219A

2. microSD Card Interface Description

2.1 microSD Pin Assignment

Table 1: SD Bus Mode Pin Definition

Pin #	Name	Type	SD Description
1	DAT2	I/O	Data Line [Bit2]
2	CD/DAT3	I/O	Card Detect / Data Line [Bit3]
3	CMD	PP	Command / Response
4	VDD	S	Supply Voltage
5	CLK	I	Clock
6	VSS	S	Supply Voltage Ground
7	DAT0	I/O	Data Line [Bit 0]
8	DAT1	I/O	Data Line [Bit 1]

Notes:

- 1) S: power supply; I: input; O: output using push-pull drivers; PP: I/O using push-pull drivers.
- 2) The extended DAT Lines (DAT1-DAT3) are input on power up. They start to operate as DAT lines after SET_BUS_WIDTH command. The Host shall keep its own DAT1-DAT3 lines in input mode, as well, while they are not used. It is defined so, in order to keep compatibility to Multi-media Cards.
- 3) After power up this line (Pin2) is input with 50Kohm pull-up (can be used for card detection or SPI mode selection). The pull-up should be disconnected by user, during regular data transfer, with SET_CLR_CARD_DETECT (ACMD42) command.

Table 2: SPI Bus Mode Pin Definition

Pin #	Name	Type	SD Description
1	RSV		Reserved
2	CS	I	Chip Select (neg true)
3	DI	I	Data In
4	VDD	S	Supply Voltage
5	SCLK	I	Clock
6	VSS	S	Supply Voltage Ground
7	DO	O	Data Out
8	RSV		Reserved

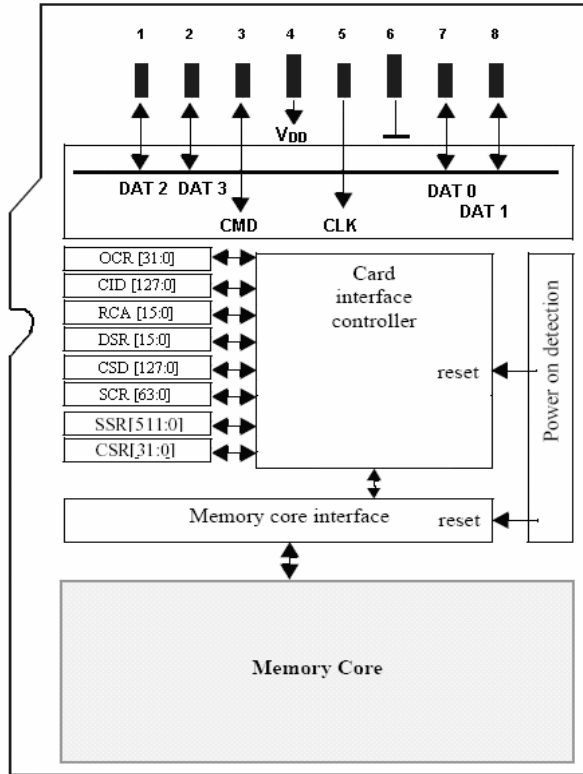


Figure 1: Functional Diagram

3. Specifications

3.1. Performance

Max. Data Transfer Rate

- Read: 90MB/s; Write: 70MB/s

3.2. NAND Flash Memory

Industrial microSD Card uses Multi Level Cell (MLC) NAND Flash memory, which is non- volatility, high reliability and highspeed memory storage.

3.3. Power Requirement

3.3.1. DC Input Voltage

- 2.7V to 3.6V

3.4. Temperature Range

- -25°C to +85°C

3.5. Humidity

Relative Humidity: 5-95%, non-condensing

3.6. Water proof

Water proof level: IEC 60529 IPX8.

Test Condition	Referred standard
Depth of water 1.5m for 30 mins.	IEC 60529 IPX8

3.7. ESD Ability

Test Condition	Referred standard
● Contact discharge: ± 2KV, ± 4KV	SD Spec. Appendix D.1
● Air discharge: ± 4KV, ± 8KV, ± 15KV	SD Spec. Appendix D.2

3.8. Dust proof

Dust proof level: IEC 60529 IP5X.

Test Condition	Referred standard
Depression of 2 KPa, Talcum powder 2kg/m ³ , 8 hrs.	IEC 60529 IP5X

4. Electrical Specifications

4.1. General DC Characteristic

Table 3: Absolute Maximum Ratings

Symbol	Parameter	Min.	Max.	Unit	Note
T _{storage}	Storage Temperature	-40	85	°C	-
T _a	Ambient Operating Temperature	-25	85	°C	-
V _I	3.3V External Input Voltage	-0.3	3.6	V	-

Table 4: Power Consumption

Symbol	Parameter	Min.	Typ.	Max.	Unit
I _{Read}	Read Current at 3.3V (High Speed Mode)	-	85	200	mA
	Read Current at 1.8V (UHS-I Mode)	-	207	800	mA
I _{Write}	Write Current at 3.3V (High Speed Mode)	-	76	200	mA
	Write Current at 1.8V (UHS-I Mode)	-	180	800	mA
I _{STBY}	Standby Current	-	0.53	15	mA

4.2. Bus Operation Conditions for 3.3V Signaling

4.2.1 Threshold Level for High Voltage Range

Table 5: Threshold Level for High Voltage

Parameter	Symbol	Min	Max	Unit	Remark
Supply Voltage	V _{DD}	2.7	3.6	V	
Output High Voltage	V _{OH}	0.75* V _{DD}		V	I _{OH} =2mA V _{DD min}
Output Low Voltage	V _{OL}		0.125* V _{DD}	V	I _{OL} =2mA V _{DD min}
Input High Voltage	V _{IH}	0.625* V _{DD}	V _{DD} +0.3	V	
Input Low Voltage	V _{IL}	V _{ss} -0.3	0.25*V _{DD}	V	
Power Up Time			250	ms	From 0V to V _{DD min}

4.2.2 Peak Voltage and Leakage Current

Table 6: Peak Voltage and Leakage Current

Parameter	Symbol	Min	Max	Unit	Remark
Peak voltage on all lines		-0.3	V _{DD} +0.3	V	
All Inputs					
Input Leakage Current		-10	10	uA	
All Outputs					
Output Leakage Current		-10	10	uA	

4.2.3 Bus Signal Line Load

Table 7: Bus Operating Conditions - Signal Line's Load

Parameter	Symbol	Min	Max	Unit	Remark
Pull-up resistance	R_{CMD} R_{DAT}	10	100	K Ω	To prevent bus floating
Total bus capacitance for each signal line	C_L		40	pF	1 card $C_{HOST}+C_{BUS}$ shall not exceed 30pF
Card capacitance for each signal pin	C_{CARD}		10	pF	
Maximum signal inductance			16	nH	
Pull-up resistance inside card(pin1)	R_{DAT3}	10	90	K Ω	May be used for card detection
Capacity Connected to Power Line	C_C		5	μ F	To prevent inrush current

4.2.4 Bus Signal Levels

As the bus can be supplied with a variable supply voltage, all signal levels are related to the supply voltage.

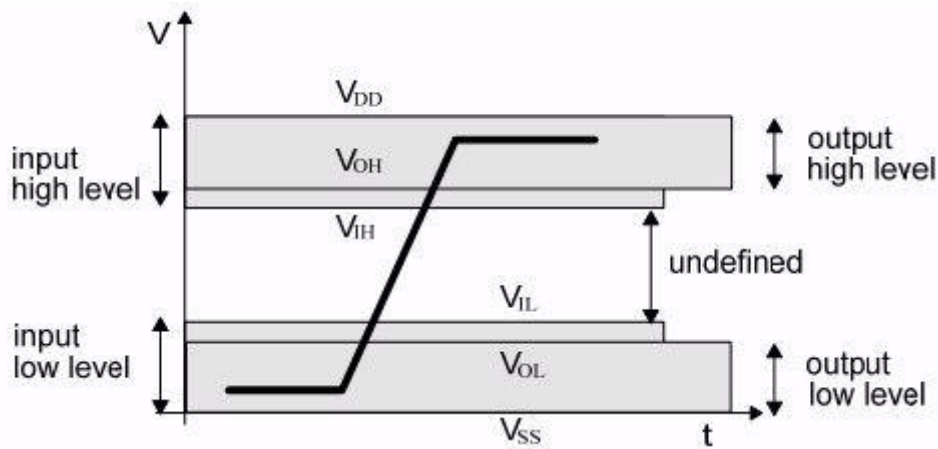


Figure 2: Bus Signal Levels

To meet the requirements of the JEDEC specification JESD8-1A and JESD8-7, the card input and output voltages shall be within the specified ranges shown in Table 6 for any VDD of the allowed voltage range.

4.2.5 Bus Timing (Default)

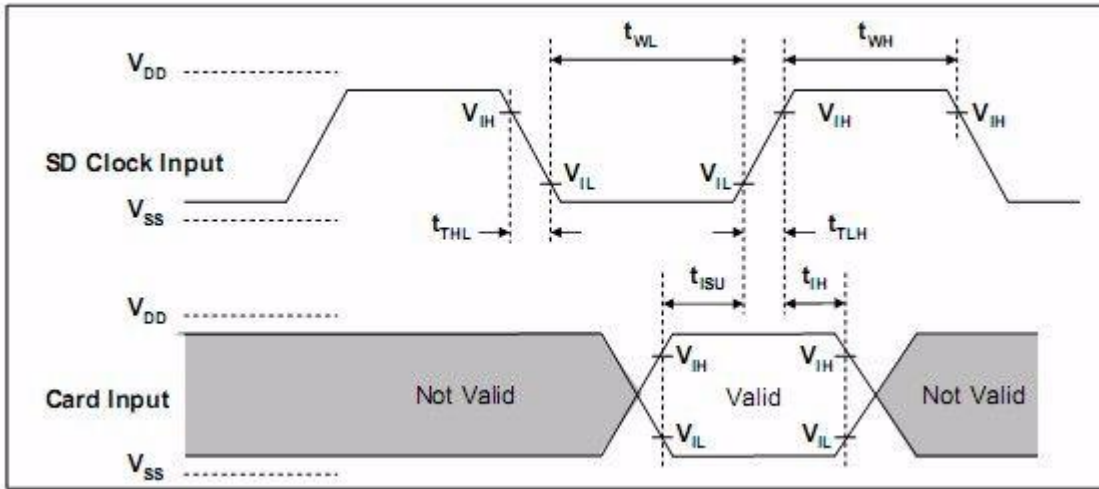


Figure 3: Card input Timing (Default Speed Card)

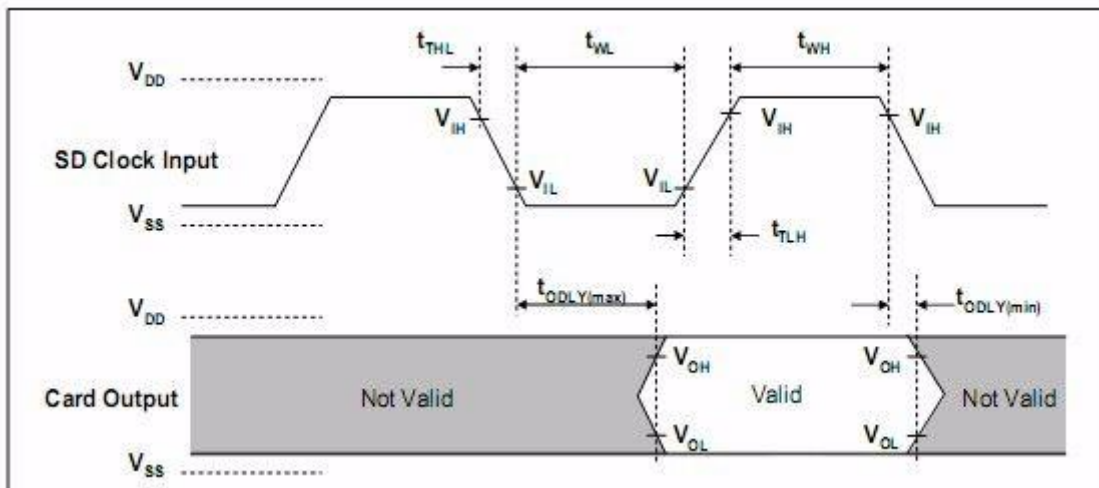


Figure 4: Card Output Timing (Default Speed Mode)

Table 8: Bus Timing-Parameters Values (Default Speed)

Parameter	Symbol	Min.	Max	Unit	Remark
Clock CLK (All values are referred to min (V_{IH}) and max (V_{IL}))					
Clock frequency data transfer	f_{pp}	0	25	MHz	$C_{CARD} \leq 10pF$ (1 card)
Clock frequency Identification	f_{OD}	0 ⁽¹⁾ /100	400	KHz	$C_{CARD} \leq 10pF$ (1 card)
Clock low time	t_{WL}	10		ns	$C_{CARD} \leq 10pF$ (1 card)
Clock high time	t_{WH}	10		ns	$C_{CARD} \leq 10pF$ (1 card)
Clock rise time	t_{TLH}		10	ns	$C_{CARD} \leq 10pF$ (1 card)
Clock fall time	t_{THL}		10	ns	$C_{CARD} \leq 10pF$ (1 card)

Inputs CMD, DAT (referenced to CLK)					
Input set-up time	t_{ISU}	5		ns	$C_{CARD} \leq 10\text{pF}$ (1 card)
Input hold time	t_{IH}	5		ns	$C_{CARD} \leq 10\text{pF}$ (1 card)
Outputs CMD, DAT (referenced to CLK)					
Output Delay time during Data Transfer Mode	t_{ODLY}	0	14	ns	$C_L \leq 40\text{pF}$ (1 card)
Output Hold time	t_{OH}	0	50	ns	$C_L \leq 40\text{pF}$ (1 card)

(1) 0 Hz means to stop the clock. The given minimum frequency range is for cases where continuous clock is required (refer to Chapter 4.4-Clock Control)

4.2.6 Bus Timing (High-Speed Mode)

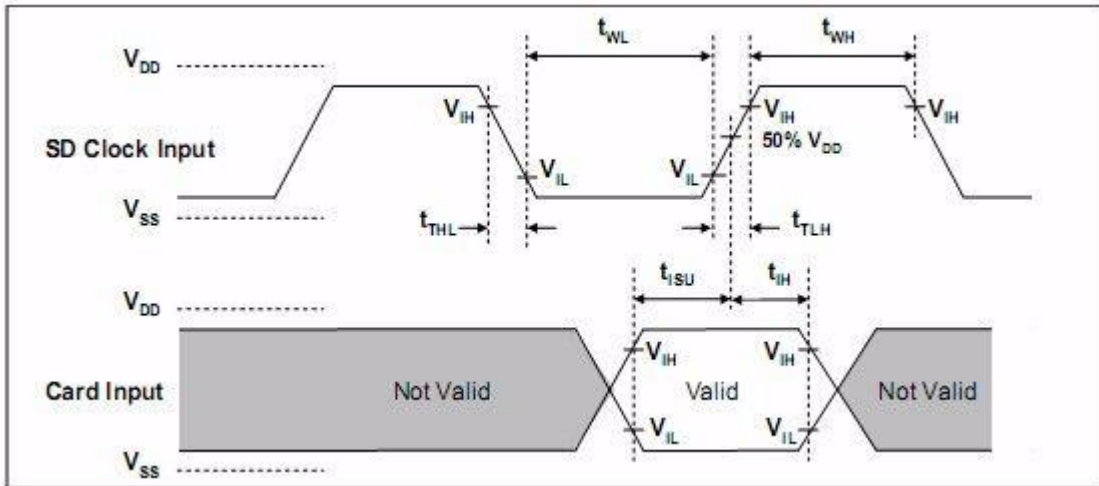


Figure 5: Card Input Timing (High Speed Card)

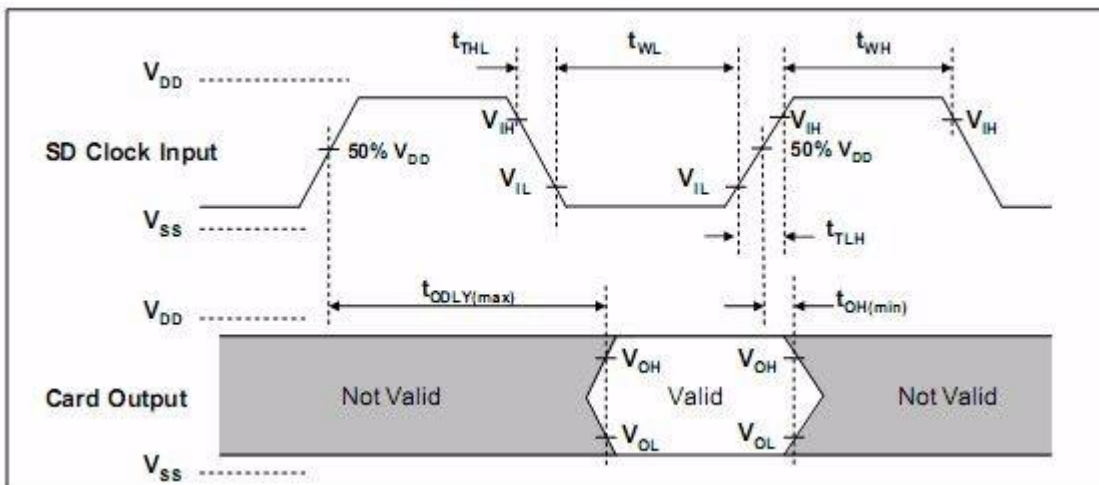


Figure 6: Card Output Timing (High Speed Mode)

Table 9 : Bus Timing - Parameters Values(High Speed)

Parameter	Symbol	Min.	Max	Unit	Remark
Clock CLK (All values are referred to min (V_{IH}) and max (V_{IL}))					
Clock frequency data transfer	f _{pp}	0	50	MHz	C _{CARD} ≤ 10pF (1 card)
Clock low time	t _{WL}	7		ns	C _{CARD} ≤ 10pF (1 card)
Clock high time	t _{WH}	7		ns	C _{CARD} ≤ 10pF (1 card)
Clock rise time	t _{TLH}		3	ns	C _{CARD} ≤ 10pF (1 card)
Clock fall time	t _{THL}		3	ns	C _{CARD} ≤ 10pF (1 card)
Inputs CMD, DAT (referenced to CLK)					
Input set-up time	t _{ISU}	6		ns	C _{CARD} ≤ 10pF (1 card)
Input hold time	t _{ITH}	2		ns	C _{CARD} ≤ 10pF (1 card)
Outputs CMD, DAT (referenced to CLK)					
Output Delay time during Data Transfer Mode	t _{ODLY}		14	ns	C _L ≤ 40pF (1 card)
Output Hold time	t _{OH}	2.5		ns	C _L ≥ 15pF (1 card)
Total System capacitance for each line ¹	C _L		40	pF	1 card

1) In order to satisfy sever timing, host shall drive only one card.

4.3 Bus Operation Conditions for 1.8V Signaling

4.3.1 Threshold Level for High Voltage Range

Table 10: Threshold Level for High Voltage

Parameter	Symbol	Min	Max	Unit	Remark
Supply Voltage	V _{DD}	2.7	3.6	V	
Regulator Voltage	V _{DDIO}	1.7	1.95	V	Generated by V _{DD}
Output High Voltage	V _{OH}	1.4		V	I _{OH} =2mA V _{DD min}
Output Low Voltage	V _{OL}		0.45	V	I _{OL} =2mA V _{DD min}
Input High Voltage	V _{IH}	1.27	2.0	V	
Input Low Voltage	V _{IL}	V _{SS} -0.3	0.58	V	

4.3.2 Peak Voltage and Leakage Current

Table 11: Peak Voltage and Leakage Current

Parameter	Symbol	Min	Max	Unit	Remark
Input Leakage Current		-2	2	uA	DAT3 pull-up is disconnected

4.3.3 Bus Timing Specification in SDR12, SDR25, SDR50 and SDR104 Modes

4.3.3.1 Clock Timing

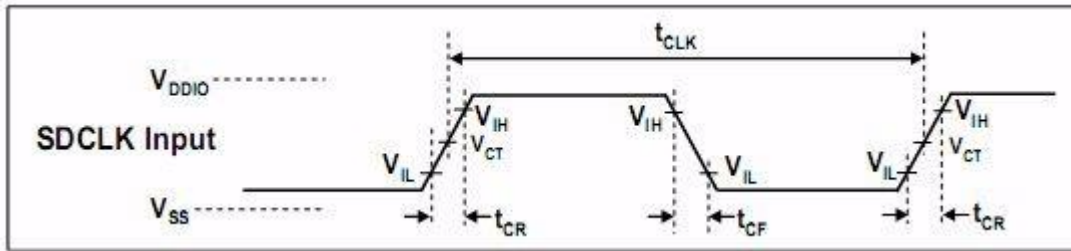


Figure 7: Clock Signal Timing

Table 12: Clock Signal Timing

Symbol	Min	Max	Unit	Remark
t_{CLK}	4.8	-	ns	208MHz (Max.), Between rising edge, $V_{CT}=0.975V$
t_{CR}, t_{CF}	-	$0.2 * t_{CLK}$	ns	$t_{CR}, t_{CF} < 2.00ns$ (max.) at 208MHz, $C_{CARD}=10pF$ $t_{CR}, t_{CF} < 2.00ns$ (max.) at 100MHz, $C_{CARD}=10pF$ The absolute maximum value of t_{CR}, t_{CF} is 10ns regardless of clock frequency
Clock Duty	30	70	%	

4.3.3.2 Card Input Timing

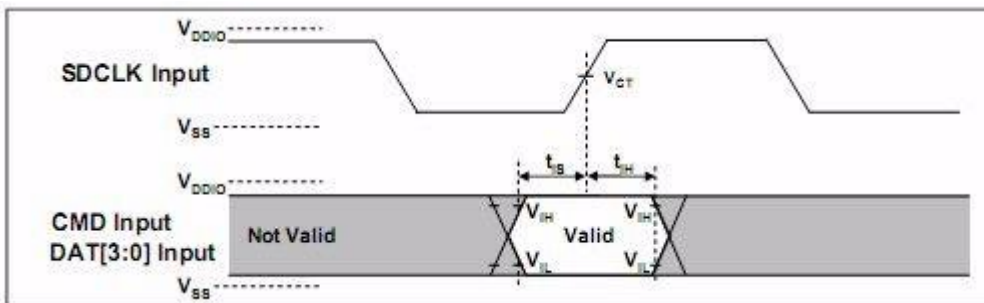


Figure 8: Card Input Timing

Table 13: SDR50 and SDR104 Input Timing

Symbol	Min	Max	Unit	SDR104 mode
t_{IS}	1.40	-	ns	$C_{CARD} = 10pF, V_{CT} = 0.975V$
t_{IH}	0.80		ns	$C_{CARD} = 5pF, V_{CT} = 0.975V$
Symbol	Min	Max	Unit	SDR12, SDR25 and SDR50 modes
t_{IS}	3.00	-	ns	$C_{CARD} = 10pF, V_{CT} = 0.975V$
t_{IH}	0.80	-	ns	$C_{CARD} = 5pF, V_{CT} = 0.975V$

4.3.3.3 Card Output Timing

4.3.3.3.1 Output Timing of Fixed Data Window (SDR12, SDR25 and SDR50)

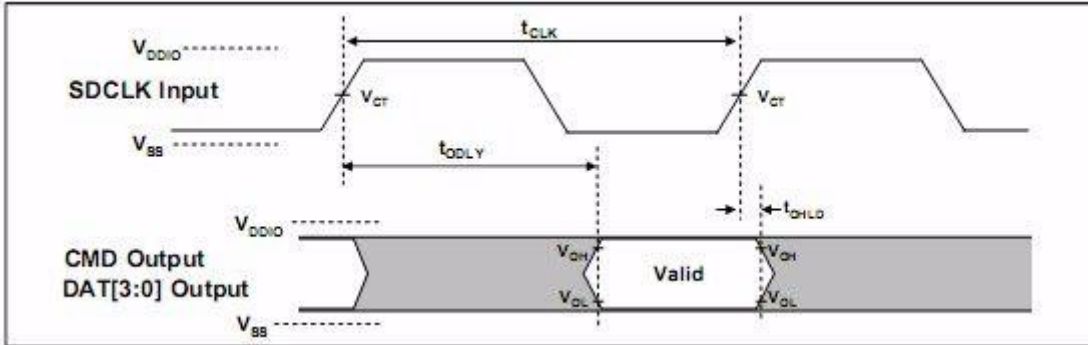


Figure 9: Output Timing of Fixed Date Window

Table 14: Output Timing of Fixed Data Window

Symbol	Min	Max	Unit	Remark
t _{ODLY}	-	7.5	ns	t _{CLK} ≥ 10.0ns, CL=30pF, using driver Type B, for SDR50.
t _{ODLY}		14	ns	t _{CLK} ≥ 20.0ns, CL=40pF, using driver Type B, for SDR25 and SDR12.
t _{OH}	1.5	-	ns	Hold time at the t _{ODLY} (min.). CL=15pF

4.3.3.3.2 Output Timing of Variable Window (SDR104)

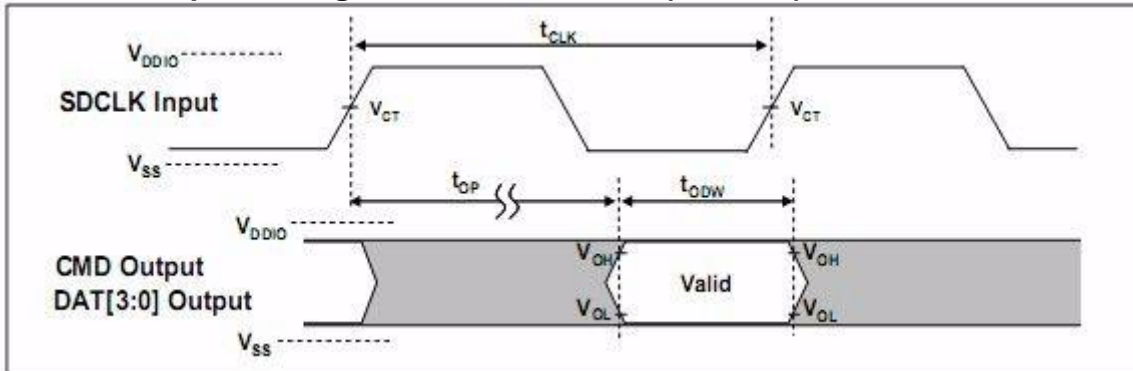


Figure 10: Output Timing of Variable Data Window

Table 15: Output Timing of Variable Data Window

Symbol	Min	Max	Unit	Remark
t _{OP}	-	2	UI	Card Output Phase
Δt _{OP}	-350	+1550	ps	Delay variation due to temperature change after tuning
t _{ODW}	0.60	-	UI	t _{ODW} = 2.88ns at 208MHz

5. Mechanical Dimensions

The mechanical dimensions of industrial microSD card were basically followed the mechanical form factor definitions on microSD card specifications which constructed by SD card association.

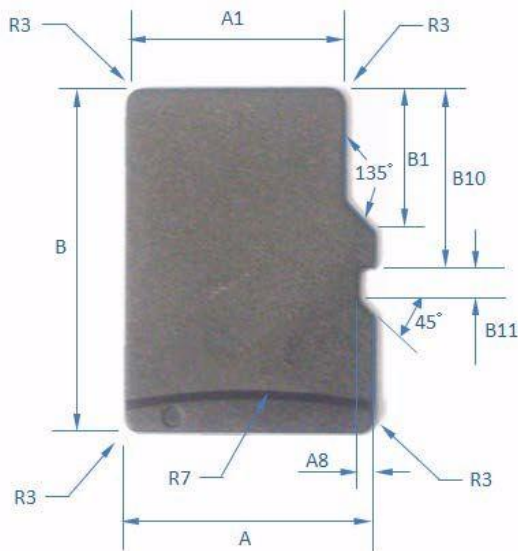


Figure 11: Top View

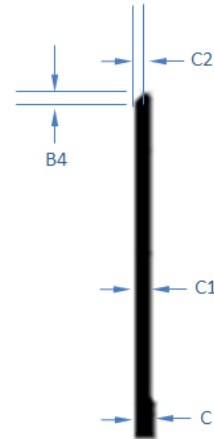


Figure 12: Side View

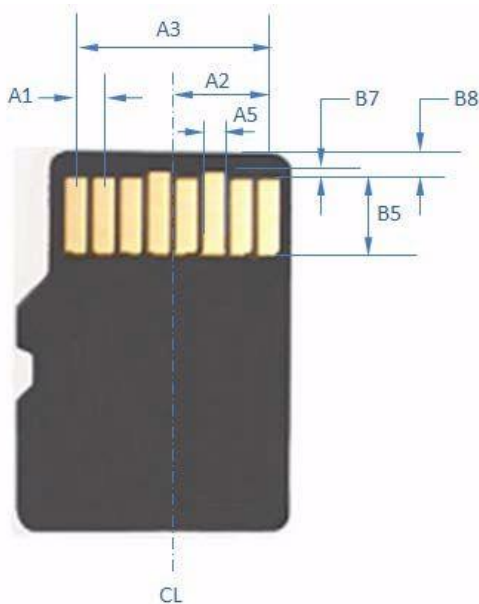


Figure 13: Bottom View

Criteria of microSD				Unit: mm
Dimensions	Min	TYP	Max	Note
A	10.90	11.00	11.10	
A1	9.60	9.70	9.80	
A2		3.85		BASIC
A3	7.60	7.70	7.80	
A4		1.10		BASIC
A5	0.75	0.80	0.85	
A8	0.60	0.70	0.80	
B	14.90	15.00	15.10	
B1	6.13	6.23	6.33	
B4	0.42	0.52	0.62	
B5	2.80	2.90	3.00	
B7	0.20	0.30	0.40	
B8	1.00	1.10	1.20	
B10	7.80	7.90	8.00	
B11	1.10	1.20	1.30	
R3	0.70	0.80	0.90	
R7	29.50	30.00	30.50	
C	0.90	1.00	1.10	
C1	0.60	0.70	0.80	
C2	0.20	0.30	0.40	

6. Ordering Information

Flash Type	Part Number	Capacity
MLC	EMH08GMBWGBECD	8GB
	EMH16GMBWGBECD	16GB
	EMH32GMBWGBECD	32GB
	EMH64GMBWGBECD	64GB
	EMX12GMBWGBECE	128GB
aMLC	EMH04GPBWGBECDA	4GB
	EMH08GPBWGBECDA	8GB
	EMH16GPBWGBECDA	16GB
	EMH32GPBWGBECDA	32GB
	EMX64GPBWGBECEA	64GB