

The logo for FLEXON, featuring the word "FLEXON" in a bold, purple, sans-serif font. The letter "X" is replaced by a stylized diamond shape composed of four smaller diamonds.

# Industrial microSD 6.1 X-Mask Pro Series (3D TLC)

A stylized diamond logo composed of four smaller diamonds, positioned to the left of a horizontal purple line.

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**Version 1.0**

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# 1. GENERAL DESCRIPTION

## 1.1 Introduction

**FLEXXON X-Mask PRO microSD Card** is compliant with SD 6.1 specification and provides excellent performance, good reliability and wide compatibility. User could mask the entire microSD card by special AP to prevent unauthorized access.

**FLEXXON X-Mask PRO microSD Card** provides security function to prevent the stored data from being stolen, tampered or modified by others. The stored data can only be accessed if the legitimate user can authenticate using the correct password.

**FLEXXON X-Mask PRO microSD Card** is suitable for users who want to store their private and valuable data in a flash storage without the risk of having it being read by unintended people.

The mask function is an additional feature, which will not affect the standard product specification.

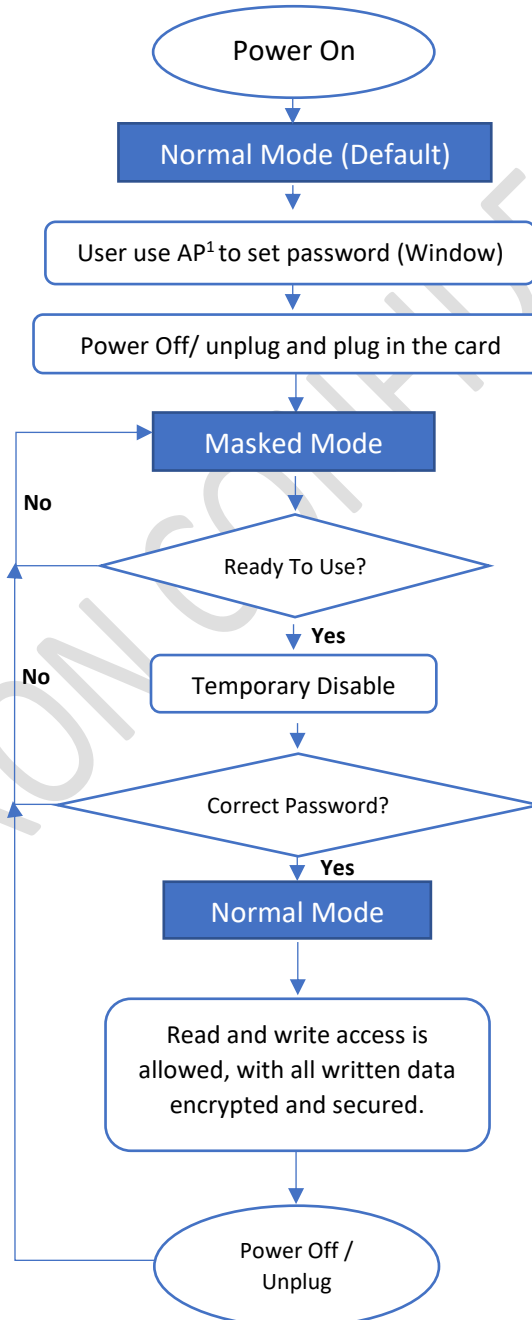
## 1.2 Product Overview

◆ <b>Flash</b> 3D TLC	◆ <b>Support SD System Specification 6.1</b>
◆ <b>Capacity</b> 64GB to 128GB	◆ <b>Support SD SPI Mode</b>
◆ <b>Support Data Crypto</b>	◆ <b>Support Auto Read Refreshment</b>
◆ <b>Read disturbance management</b>	◆ <b>Adaptive wear leveling</b>
◆ <b>Support management of sudden power fails</b>	◆ <b>SMART function support</b>
◆ <b>Temperature Range</b> Operation (Gold): -25°C ~ 85°C	
◆ Storage: -40°C ~ 85°C	

### 1.3 Workflow

**FLEXXON X-Mask PRO microSD Card** is a normal mode by default. User could set the password to enable mask mode. User is required to eject and re-insert the after set the password.

User could access the data by the legal host with security tool and enter correct password. When user power off the host or reinsert the card, the card will return to masked mode.



**Legend:**

AP<sup>1</sup>: Application tool

## 2. PRODUCT SPECIFICATIONS

### 2.1 Performance

Capacity	Sequential	
	Read (MB/s)	Write (MB/s)
64GB	85	25
128GB	85	48

**Table 2-1 Performance of X-Mask PRO microSD**

**NOTES:**

1. The performance is obtained from TestMetrix
2. Performance may vary from flash configuration and platform.

### 2.2 Power

Capacity	Read (mA)	Write (mA)	Standby (uA)
64GB	62	49	200
128GB	63	73	200

**Table 2-2 Typical Power Consumption of X-Mask PRO microSD**

### 2.3 MTBF

MTBF, an acronym for Mean Time Between Failures, is a measure of a device's reliability. Its value represents the average time between a repair and the next failure. The higher the MTBF value, the higher the reliability of the device. The predicted result of X-MASK PRO microSD Card is more than 3,000,000 hours.

### 3. ENVIRONMENTAL SPECIFICATIONS

Test Items	Test Conditions
Storage Temperature	-40°C ~ 85°C
Operating Temperature	Gold: -25°C ~ 85°C
Storage Humidity	40°C, 93% RH
Operating Humidity	25°C, 95% RH
Shock	1500G, Half Sin Pulse Duration 0.5ms
Vibration	80Hz ~ 2000Hz/20G, 20Hz ~ 80Hz/1.52mm, 3 axis/30min
Drop	150cm free fall, 6 face of each unit
Bending	≥ 10N, Hold 1 min/5 times
Torque	0.1N-m or +/-2.5 deg, Hold 30 seconds/5 times
ESD	Contact: +/- 4KV each item 25 times Air: +/- 8KV 10 times

**Table 3-1 Environmental Specification**

## 4. ELECTRICAL SPECIFICATIONS

### 4.1 DC Characteristics

#### 4.1.1 Bus Operation Conditions for 3.3V Signaling

Parameter	Symbol	Min.	Max	Unit	Condition
Supply Voltage	$V_{DD}$	2.7	3.6	V	
Output High Voltage	$V_{OH}$	$0.75 \cdot V_{DD}$		V	$I_{OH} = -2\text{mA}$ $V_{DD}$ Min
Output Low Voltage	$V_{OL}$		$0.125 \cdot V_{DD}$	V	$I_{OL} = 2\text{mA}$ $V_{DD}$ Min
Input High Voltage	$V_{IH}$	$0.625 \cdot V_{DD}$	$V_{DD} + 0.3$	V	
Input Low Voltage	$V_{IL}$	$V_{SS} - 0.3$	$0.25 \cdot V_{DD}$	V	
Power Up Time			250	ms	From 0V to $V_{DD}$ min

**Table 4-1 Threshold Level for High Voltage Range**

Parameter	Symbol	Min.	Max	Unit	Condition
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	$I_{OH} = -2\text{mA}$
Output Low Voltage	$V_{OL}$	-	0.45	V	$I_{OL} = 2\text{mA}$
Input High Voltage	$V_{IH}$	1.27	2.00	V	
Input Low Voltage	$V_{IL}$	$V_{SS} - 0.3$	0.58	V	

**Table 4-2 Threshold Level for 1.8V Signaling**

Parameter	Symbol	Min	Max.	Unit	Remarks
Input Leakage Current		-2	2	$\mu\text{A}$	DAT3 pull-up is disconnected.

**Table 4-3 Input Leakage Current for 1.8V Signaling**

Parameter	Symbol	Min	Max.	Unit	Remarks
Peak voltage on all lines		-0.3	V <sub>DD</sub> +0.3	V	
<b>All Inputs</b>					
Input Leakage Current		-10	10	uA	
<b>All Outputs</b>					
Output Leakage Current		-10	10	uA	

**Table 4-4 Peak Voltage and Leakage Current**

#### 4.1.2 Bus Signal Line Load

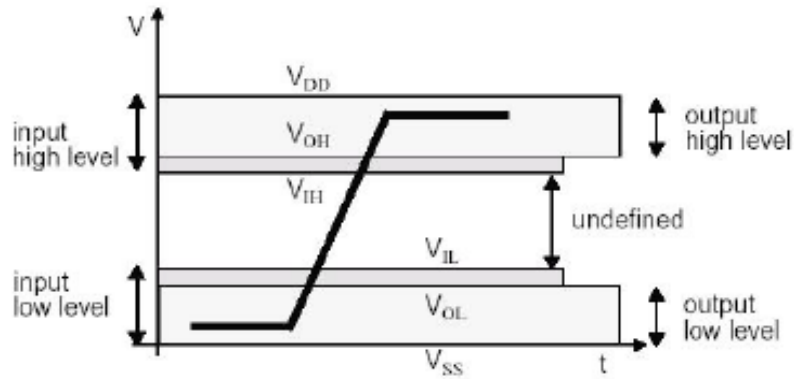
##### Bus Operation Conditions – Signal Line’s Load

$$\text{Total Bus Capacitance} = C_{\text{HOST}} + C_{\text{BUS}} + N C_{\text{CARD}}$$

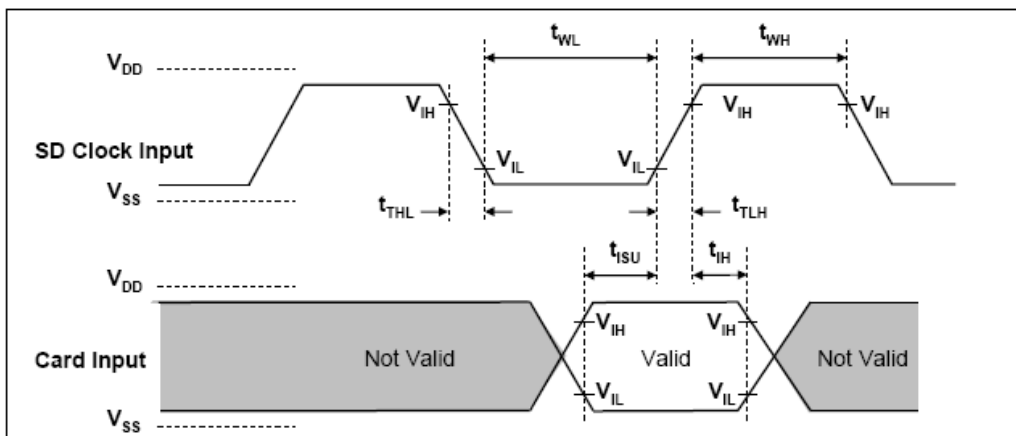
Parameter	symbol	Min	Max	Unit	Remark
Pull-up resistance	R <sub>CMD</sub> R <sub>DAT</sub>	10	100	kΩ	to prevent bus floating
Total bus capacitance for each signal line	C <sub>L</sub>		40	pF	1 card C <sub>HOST</sub> +C <sub>BUS</sub> shall not exceed 30 pF
Card Capacitance for each signal pin	C <sub>CARD</sub>		10 <sup>1</sup>	pF	
Maximum signal line inductance			16	nH	
Pull-up resistance inside card (pin1)	R <sub>DAT3</sub>	10	90	kΩ	May be used for card detection
Capacity Connected to Power Line	C <sub>C</sub>		5	uF	To prevent inrush current

**Table 4-5 Peak Voltage and Leakage Current**

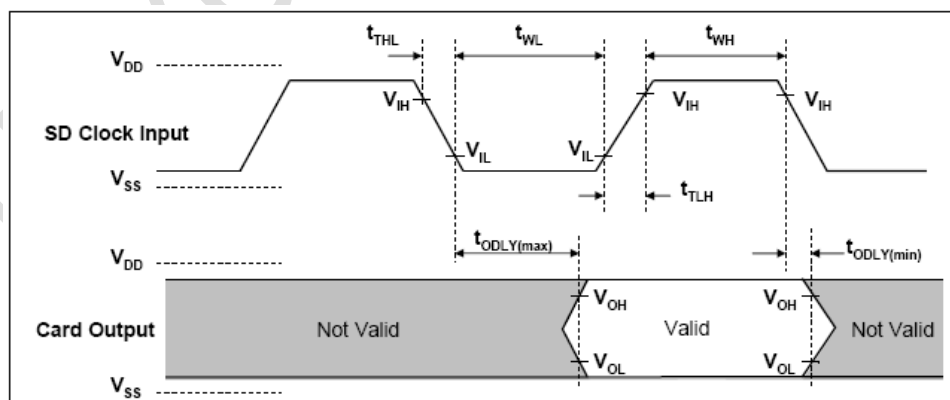
## 4.2 AC Characteristic



### 4.2.1 microSD Interface timing (Default)



Card Input Timing (Default Speed Card)

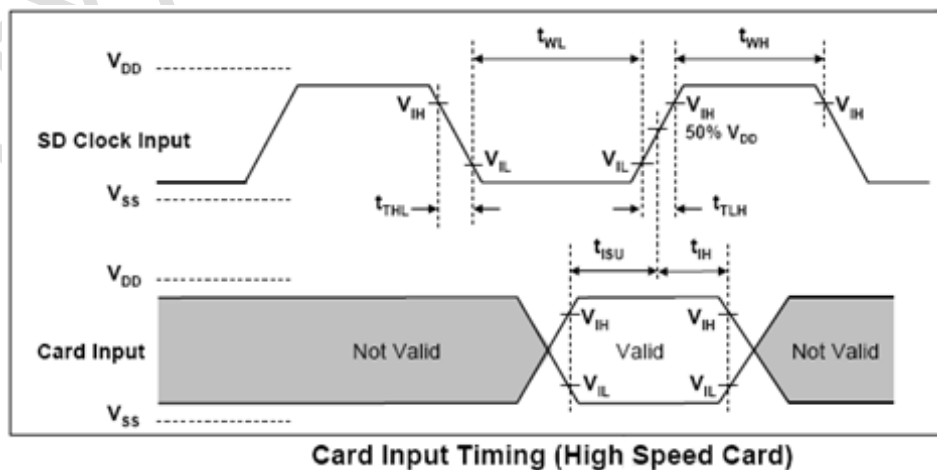


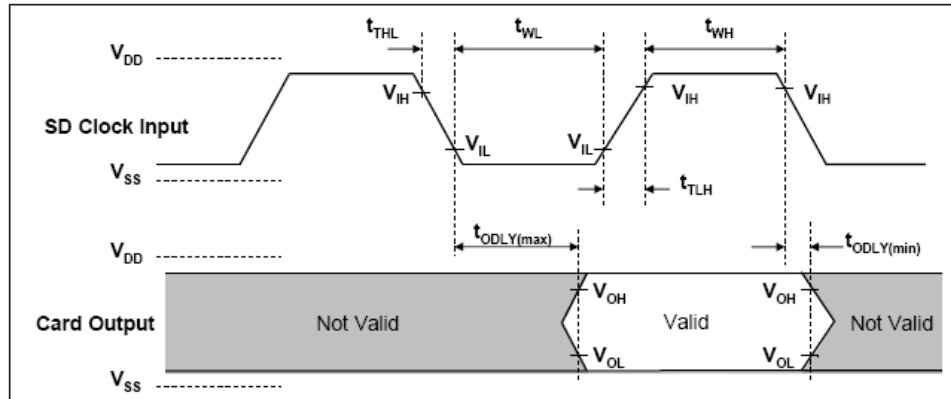
Card Output Timing (Default Speed Mode)

Parameter	Symbol	Min	Max	Unit	Remark
<b>Clock CLK (All values are referred to min(V<sub>IH</sub>) and max(V<sub>IL</sub>))</b>					
Clock frequency Data Transfer Mode	f <sub>PP</sub>	0	25	MHz	C <sub>card</sub> ≤ 10 pF (1 card)
Clock frequency Identification Mode	f <sub>OD</sub>	0 <sup>(1)</sup> /100	400	KHz	C <sub>card</sub> ≤ 10 pF (1 card)
Clock low time	t <sub>WL</sub>	10		ns	C <sub>card</sub> ≤ 10 pF (1 card)
Clock high time	t <sub>WH</sub>	10		ns	C <sub>card</sub> ≤ 10 pF (1 card)
Clock rise time	t <sub>TLH</sub>		10	ns	C <sub>card</sub> ≤ 10 pF (1 card)
Clock fall time	t <sub>THL</sub>		10	ns	C <sub>card</sub> ≤ 10 pF (1 card)
<b>Inputs CMD, DAT (referenced to CLK)</b>					
Input set-up time	t <sub>ISU</sub>	5		ns	C <sub>card</sub> ≤ 10 pF (1 card)
Input hold time	t <sub>IH</sub>	5		ns	C <sub>card</sub> ≤ 10 pF (1 card)
<b>Outputs CMD, DAT (referenced to CLK)</b>					
Output Delay time during Data Transfer Mode	t <sub>ODLY</sub>	0	14	ns	C <sub>L</sub> ≤ 40 pF (1 card)
Output Delay time during Identification Mode	t <sub>ODLY</sub>	0	50	ns	C <sub>L</sub> ≤ 40 pF (1 card)

(1) 0Hz means to stop the clock. The given minimum frequency range is for cases where continues clock is required.

#### 4.2.2 microSD Interface Timing (High-Speed Mode)





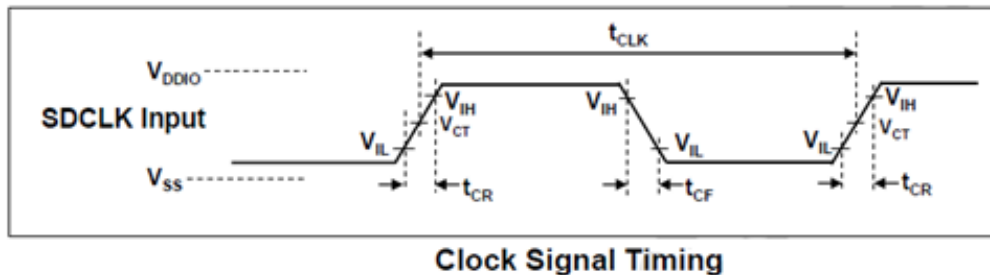
**Card Output Timing (Default Speed Mode)**

Parameter	Symbol	Min	Max	Unit	Remark
<b>Clock CLK (All values are referred to min(V<sub>IH</sub>) and max(V<sub>IL</sub>))</b>					
Clock frequency Data Transfer Mode	f <sub>PP</sub>	0	50	MHz	C <sub>card</sub> ≤ 10 pF (1 card)
Clock low time	t <sub>WL</sub>	7		ns	C <sub>card</sub> ≤ 10 pF (1 card)
Clock high time	t <sub>WH</sub>	7		ns	C <sub>card</sub> ≤ 10 pF (1 card)
Clock rise time	t <sub>TLH</sub>		3	ns	C <sub>card</sub> ≤ 10 pF (1 card)
Clock fall time	t <sub>THL</sub>		3	ns	C <sub>card</sub> ≤ 10 pF (1 card)
<b>Inputs CMD, DAT (referenced to CLK)</b>					
Input set-up time	t <sub>ISU</sub>	6		ns	C <sub>card</sub> ≤ 10 pF (1 card)
Input hold time	t <sub>IH</sub>	2		ns	C <sub>card</sub> ≤ 10 pF (1 card)
<b>Outputs CMD, DAT (referenced to CLK)</b>					
Output Delay time during Data Transfer Mode	t <sub>ODLY</sub>		14	ns	C <sub>L</sub> ≤ 40 pF (1 card)
Output Hold time	T <sub>OH</sub>	2.5		ns	C <sub>L</sub> ≤ 15 pF (1 card)
Total System capacitance of each line <sup>1</sup>	C <sub>L</sub>		40	pF	C <sub>L</sub> ≤ 15 pF (1 card)

(1) In order to satisfy severe timing, the host shall drive only one card.

### 4.2.3 microSD Interface timing (SDR12, SDR25, SDR50 and SDR104 Modes)

**Input:**

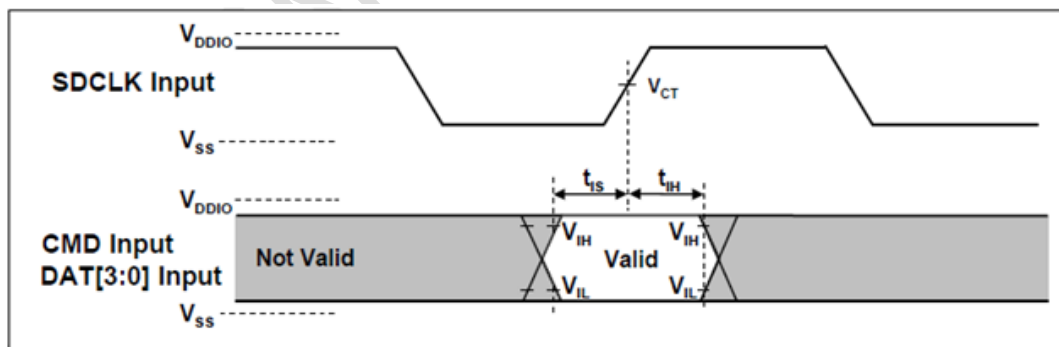


**Clock Signal Timing**

Symbol	Min	Max	Unit	Remark
$t_{CLK}$	4.80	-	ns	208MHz (Max.), Between rising edge, $V_{CT}=0.975V$
$t_{CR}, t_{CF}$	-	$0.2 * t_{CLK}$	ns	$t_{CR}, t_{CF} < 0.96ns$ (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	%	

**Clock Signal Timing**

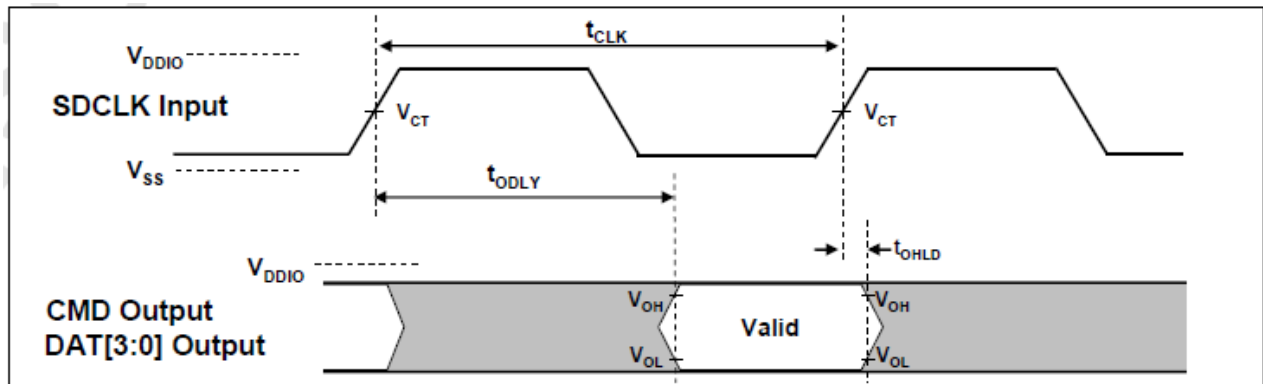
**SDR50 and SDR104 Input Timing:**



**Card Input Timing**

Symbol	Min	Max	Unit	SDR104 Mode
$t_{IS}$	1.40	-	ns	$C_{CARD} = 10pF, V_{CT} = 0.975V$
$t_{IH}$	0.8	-	ns	$C_{CARD} = 5pF, V_{CT} = 0.975V$
Symbol	Min	Max	Unit	SDR50 Mode
$t_{IS}$	3.00	-	ns	$C_{CARD} = 10pF, V_{CT} = 0.975V$
$t_{IH}$	0.8	-	ns	$C_{CARD} = 5pF, V_{CT} = 0.975V$

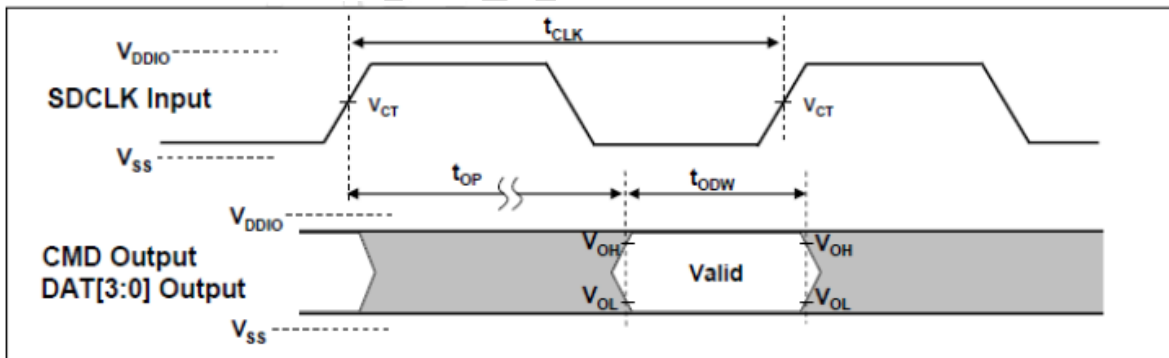
**Output (SDR12, SDR25, SDR50):**



**Output Timing of Fixed Data Window**

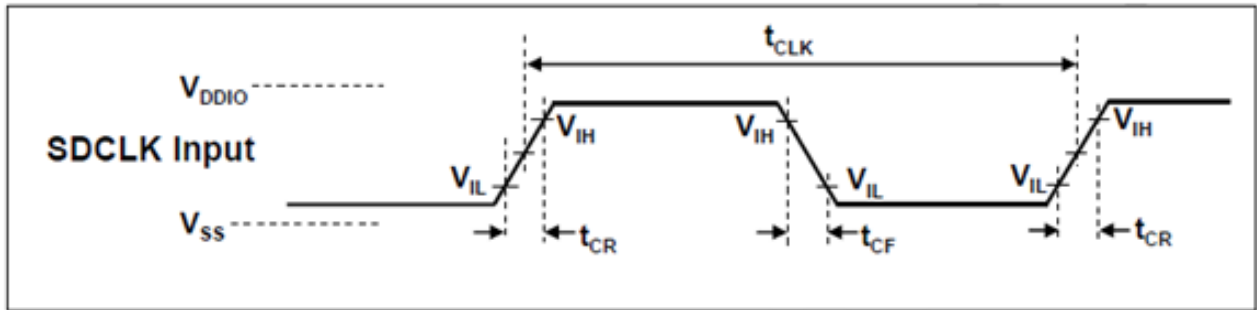
Symbol	Min	Max	Unit	Remark
$t_{ODLY}$	-	7.5	ns	$t_{CLK} \geq 10.0ns$ , $C_L = 30pF$ , using driver Type B, for SDR50
$t_{ODLY}$	-	14	ns	$t_{CLK} \geq 20.0ns$ , $C_L = 40pF$ , using driver Type B, for SDR25 and SDR12,
$T_{OH}$	1.5	-	ns	Hold time at the $t_{ODLY}$ (min.), $C_L = 15pF$

**Output (SDR104 Mode):**



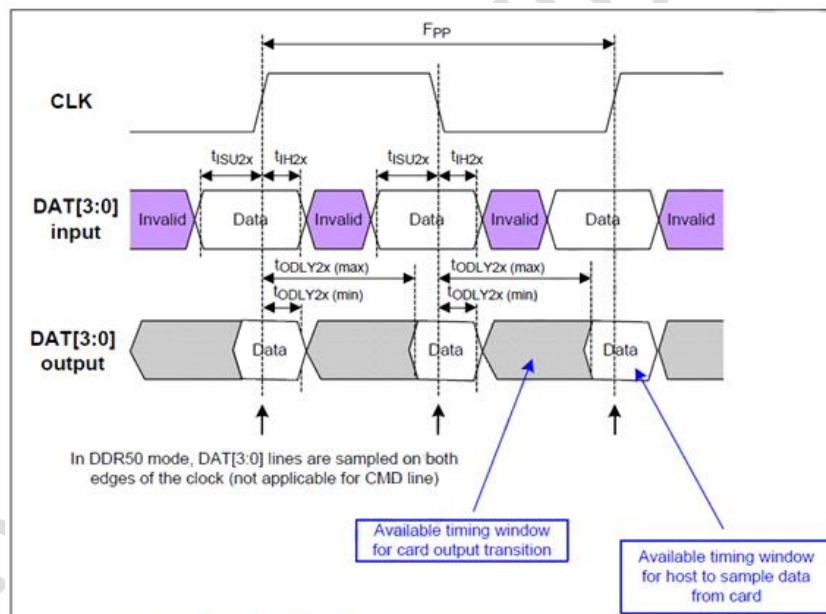
Symbol	Min	Max	Unit	Remark
$t_{OP}$	0	2	UI	Card Output Phase
$\Delta t_{OP}$	-350	+1550	ps	Delay variable due to temperature change after tuning
$t_{ODW}$	0.60	-	UI	$t_{ODW} = 2.88ns$ at 208MHz

#### 4.2.4 microSD Interface timing (DDR50 Modes)



**Clock Signal Timing**

Symbol	Min	Max	Unit	Remark
$t_{CLK}$	20	-	ns	50MHz (Max.), Between rising edge
$t_{CR}, t_{CF}$	-	$0.2 * t_{CLK}$	ns	$t_{CR}, t_{CF} < 4.00ns$ (max.) at 50MHz, $C_{CARD}=10pF$
Clock Duty	45	55	%	

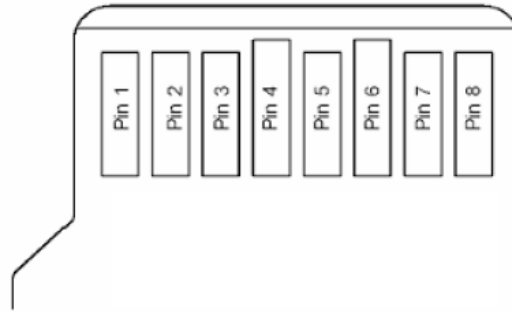


**Timing Diagram DAT Inputs/Outputs Referenced to CLK in DDR50 Mode**

Parameter	Symbol	Min	Max	Unit	Remark
<b>Input CMD (referenced to CLK rising edge)</b>					
Input set-up time	$t_{ISU}$	3	-	ns	$C_{card} \leq 10$ pF (1 card)
Input hold time	$t_{IH}$	0.8	-	ns	$C_{card} \leq 10$ pF (1 card)
<b>Output CMD (referenced to CLK rising edge)</b>					
Output Delay time during Data Transfer Mode	$t_{ODLY}$		13.7	ns	$C_L \leq 30$ pF (1 card)
Output Hold time	$T_{OH}$	1.5	-	ns	$C_L \geq 15$ pF (1 card)
<b>Inputs DAT (referenced to CLK rising and falling edges)</b>					
Input set-up time	$t_{ISU2x}$	3	-	ns	$C_{card} \leq 10$ pF (1 card)
Input hold time	$t_{IH2x}$	0.8	-	ns	$C_{card} \leq 10$ pF (1 card)
<b>Outputs DAT (referenced to CLK rising and falling edges)</b>					
Output Delay time during Data Transfer Mode	$t_{ODLY2x}$	-	7.0	ns	$C_L \leq 25$ pF (1 card)
Output Hold time	$T_{OH2x}$	1.5	-	ns	$C_L \geq 15$ pF (1 card)

**Table 4-6 Bus Timings – Parameters Values (DDR50 Mode)**

## 5. PAD ASSIGNMENT



Pin #	SD Mode			SPI Mode		
	Name	Type <sup>1</sup>	Description	Name	Type	Description
1	DAT2	I/O/PP	Data Line[bit2]	RSV		
2	CD/DAT3 <sup>2</sup>	I/O/PP <sup>3</sup>	Card Detect/ Data Line[bit3]	CS	I <sup>3</sup>	Chip Select (neg true)
3	CMD	PP	Command/Response	DI	I	Data In
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>SS</sub>	S	Supply voltage ground	V <sub>SS</sub>	S	Supply voltage ground
7	DAT0	I/O/PP	Data Line[bit0]	DO	O/PP	Data Out
8	DAT1	I/O/PP	Data Line[bit1]	RSV		

**Table 5-1 microSD Pad Assignment**

**NOTE:**

- (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 MultiMedia Cards.
- (3) At power up this line has a 50KOhm pull up enabled in the card. This resistor serves two functions: Card detection and Mode Selection. For Mode Selection, the host can drive the line high or let it be pulled high to select SD mode. If the host wants to select SPI mode it should drive the line low. For Card detection, the host detects that the line is pulled high. This pull-up should be disconnected by the user during regular data transfer period, with SET\_CLR\_CARD\_DETECT (ACMD42) command.

## 6. REGISTERS

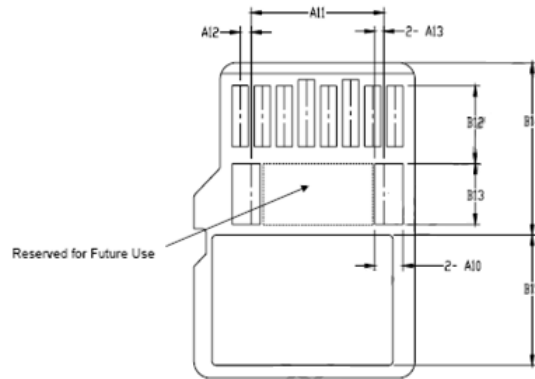
Name	Width	Description
CID	128bit	Card identification number; card individual number for identification.
RCA	16bit	Relative card address; local system address of a card, dynamically suggested by the card and approved by the host during initialization.
DSR	16bit	Driver Stage Register; to configure the card's output drivers.
CSD	128bit	Card Specific Data; Information about the card operation conditions.
SCR	64bit	SD Configuration Register; Information about the SD Memory Card's Special Features capabilities
OCR	32bit	Operation conditions register.
SSR	512bit	SD Status; Information about the card proprietary features.
OCR	32bit	Card Status; Information about the card status.

**Table 6-1 microSD Registers**

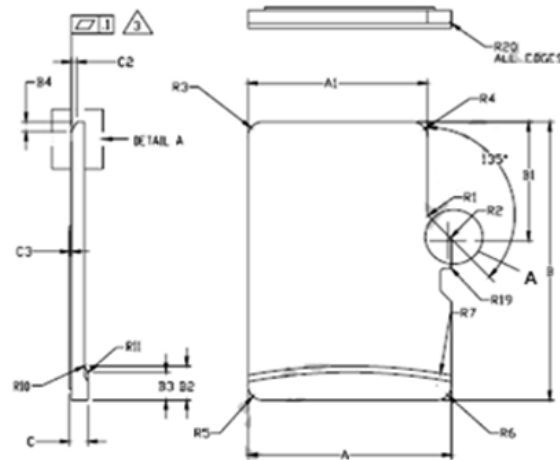
## 7. PHYSICAL DIMENSION

Dimension: 15mm (L) x 11mm (W) x 1mm (H)

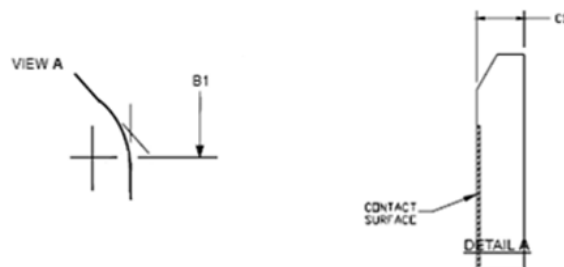
Top View



Bottom View



Side View



Common Dimensions				
Symbol	Min	Nom	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	
A6	-	-	8.50	
A7	0.90	-	-	
A8	0.60	0.70	0.80	
A9	0.80	-	-	
A10	1.35	1.40	1.45	
A11	6.50	6.60	6.70	
A12	0.50	0.55	0.60	
A13	0.40	0.45	0.50	
B	14.90	15.00	15.10	
B1	6.30	6.40	6.50	
B2	1.64	1.84	2.04	
B3	1.30	1.50	1.70	
B4	0.42	0.52	0.62	
B5	2.80	2.90	3.00	
B6	5.50	-	-	
B7	0.20	0.30	0.40	
B8	1.00	1.10	1.20	
B9	-	-	9.00	
B10	7.60	7.90	8.00	
B11	1.10	1.20	1.30	
B12	3.60	3.70	3.80	
B13	2.80	2.90	3.00	
B14	8.20	-	-	
B15	-	-	6.20	
C	0.90	1.00	1.10	
C1	0.60	0.70	0.80	
C2	0.20	0.30	0.40	
C3	-	-	0.15	
D1	1.00	-	-	
D2	1.00	-	-	
D3	1.00	-	-	
R1	0.20	0.40	0.60	
R2	0.20	0.40	0.60	
R3	0.70	0.80	0.90	
R4	0.70	0.80	0.90	
R5	0.60	0.80	0.90	
R6	0.60	0.80	0.90	
R7	29.50	30.00	30.50	
R10	-	0.20	-	
R11	-	0.20	-	
R17	0.10	0.20	0.30	
R18	0.20	0.40	0.60	
R19	0.05	-	0.20	
R20	0.02	-	0.15	

**Notes:**

1. Dimensioning and tolerancing per ASME Y14.5M-1994
2. Dimensions are in millimeters.
3. Coplanarity is additive to C1 Max. thickness

## 8. ORDERING INFORMATION

Capacity	MPN (Gold Grade)
64GB	FDMM064GBG-XM00
128GB	FDMM128GBG-XM00

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## REVISION HISTORY

Revision	Date	Description
1.0	2025/09	First Release

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