



# Industrial microSD 3.0 Specification

(FxPrem II Series, MLC)

**Version 1.3**

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# 1. GENERAL DESCRIPTION

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## 1.1. Introduction

FLEXON industrial FxPrem II Series microSD 3.0 card is data crypto solution which provides high data transfer rate, high random IOPS, Power Loss Protection, and read/program disturb management etc. It is designed for high performance, good reliability and wide compatibility. It's well adapted for industrial/medical applications.

## 1.2. Product Overview

- ❖ **Flash**
  - MLC
- ❖ **Capacity**
  - 4GB up to 128GB
- ❖ **Support SD system specification version 3.0**
- ❖ **Support SD SPI mode**
- ❖ **Support Data Crypto**
- ❖ **Support CPRM (Content Protection for Recordable Media) of SD Card (Optional)**
- ❖ **Card removal during read operation will never harm the content**
- ❖ **Password Protection of cards (optional)**
- ❖ **Support Dynamic and Static Wear Leveling**
- ❖ **Management of Power Loss Protection**
- ❖ **Read disturbance management**
- ❖ **Temperature Range**
  - Operation (Gold) : -25°C ~ 85°C
  - Operation (Diamond) : -40°C ~ 85°C
  - Storage: -40°C ~ 85°C
- ❖ **RoHS Compliant**
- ❖ **SMART Function**

**❖ Bus Speed Mode****▪ Non-UHS mode**

- Default speed mode: 3.3V signaling, frequency up to 25MHz, up to 12.5MB/sec
- High speed mode: 3.3V signaling, frequency up to 50MHz, up to 25MB/sec

**▪ UHS-I mode**

- SDR12: SDR up to 25MHz, 1.8V signaling
- SDR25: SDR up to 50MHz, 1.8V signaling
- SDR50: 1.8V signaling, frequency up to 100MHz, up to 50 MB/sec
- SDR104: 1.8V signaling, frequency up to 208MHz, up to 104 MB/sec
- DDR50: 1.8V signaling, frequency up to 50MHz, sampled on both clock edges, up to 50 MB/sec

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## 2. PRODUCT SPECIFICATIONS



### 2.1. Performance

Table 2-1 Performance of microSD (FxPrem II)

Capacity	Sequential	
	Read (MB/s)	Write (MB/s)
4GB	90	27
8GB	90	27
16GB	90	52
32GB	90	80
64GB	90	80
128GB	90	80

**NOTES:**

1. The performance is obtained from TestMetrix Test (@500MB).
2. Samples are made of MLC NAND Flash.
3. Performance may vary from flash configuration and platform.

### 2.2. Power

Table 2-2 Power Consumption of microSD (FxPrem II)

Capacity	Read (mA)	Write (mA)	Standby (uA)
4GB	180	89	220
8GB	180	89	220
16GB	190	120	240
32GB	190	140	290
64GB	190	170	330
128GB	195	175	500

### 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 FLEXON’s FxPrem II Series microSD is more than 3,000,000 hours.

## 2.4. Data Retention

- 10 years if > 90% life remaining (@25C)
- 1 year if < 10% life remaining (@25C)

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### 3. ENVIRONMENTAL SPECIFICATIONS



Test Items	Test Conditions
<b>Storage Temperature</b>	-40°C ~ 85°C
<b>Operating Temperature</b>	Gold Grade: -25°C ~ 85°C Diamond Grade: -40°C ~ 85°C
<b>Storage Humidity</b>	Gold Grade: 40°C, 95% RH Diamond Grade: 55°C, 95% RH
<b>Operating Humidity</b>	Gold Grade: 40°C, 95% RH Diamond Grade: 55°C, 95% RH
<b>Shock</b>	1500G, Half Sin Pulse Duration 0.5ms
<b>Vibration</b>	80Hz ~ 2000Hz/20G, 20Hz ~ 80Hz/1.52mm, 3 axis/30min
<b>Drop</b>	150cm free fall, 6 face of each unit
<b>Bending</b>	≥ 10N, Hold 1 min/5 times
<b>Torque</b>	0.1N-m or +/-2.5 deg, Hold 30 seconds/5 times
<b>Salt Spray</b>	Concentration: 3% NaCl, Temperature: 35°C, 24hours
<b>Waterproof</b>	Water temperature: 25°C Water depth: The lowest point of unit is locating 1000mm below surface. Storage for 30 mins
<b>Switch Cycle</b>	0.4~0.5 N, 1,000 times
<b>Durability</b>	10,000 times
<b>ESD</b>	Contact: +/- 4KV each item 25 times Air: +/- 8KV 10 times

## 4. ELECTRICAL SPECIFICATIONS



### 4.1. Absolute Maximum Rating

Item	Symbol	Parameter	MIN	MAX	Unit
1	V <sub>DD</sub>	Supply Voltage	2.7	3.6	V
2	T <sub>a</sub>	Operating Temperature	-40	+85	°C
3	T <sub>st</sub>	Storage Temperature	-40	+85	°C

### 4.2. DC Characteristics

#### 4.2.1. Bus Operation Conditions for 3.3V Signaling

Table 4-1 Threshold Level for High Voltage Range

Parameter	Symbol	Min.	Max	Unit	Condition
Supply Voltage	V <sub>DD</sub>	2.7	3.6	V	
Output High Voltage	V <sub>OH</sub>	0.75*V <sub>DD</sub>		V	I <sub>OH</sub> =-2mA V <sub>DD</sub> Min
Output Low Voltage	V <sub>OL</sub>		0.125*V <sub>DD</sub>	V	I <sub>OL</sub> =2mA V <sub>DD</sub> Min
Input High Voltage	V <sub>IH</sub>	0.625*V <sub>DD</sub>	V <sub>DD</sub> +0.3	V	
Input Low Voltage	V <sub>IL</sub>	V <sub>SS</sub> -0.3	0.25*V <sub>DD</sub>	V	
Power Up Time			250	ms	From 0V to V <sub>DD</sub> min

Parameter	Symbol	Min.	Max	Unit	Condition
Supply Voltage	V <sub>DD</sub>	2.7	3.6	V	
Regulator Voltage	V <sub>DDIO</sub>	1.7	1.95	V	Generated by V <sub>DD</sub>
Output High Voltage	V <sub>OH</sub>	1.4	-	V	I <sub>OH</sub> =-2mA
Output Low Voltage	V <sub>OL</sub>	-	0.45	V	I <sub>OL</sub> =2mA
Input High Voltage	V <sub>IH</sub>	1.27	2.00	V	
Input Low Voltage	V <sub>IL</sub>	V <sub>SS</sub> -0.3	0.58	V	



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

**Table 4-2 Peak Voltage and Leakage Current**

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	

#### 4.2.2. Bus Signal Line Load

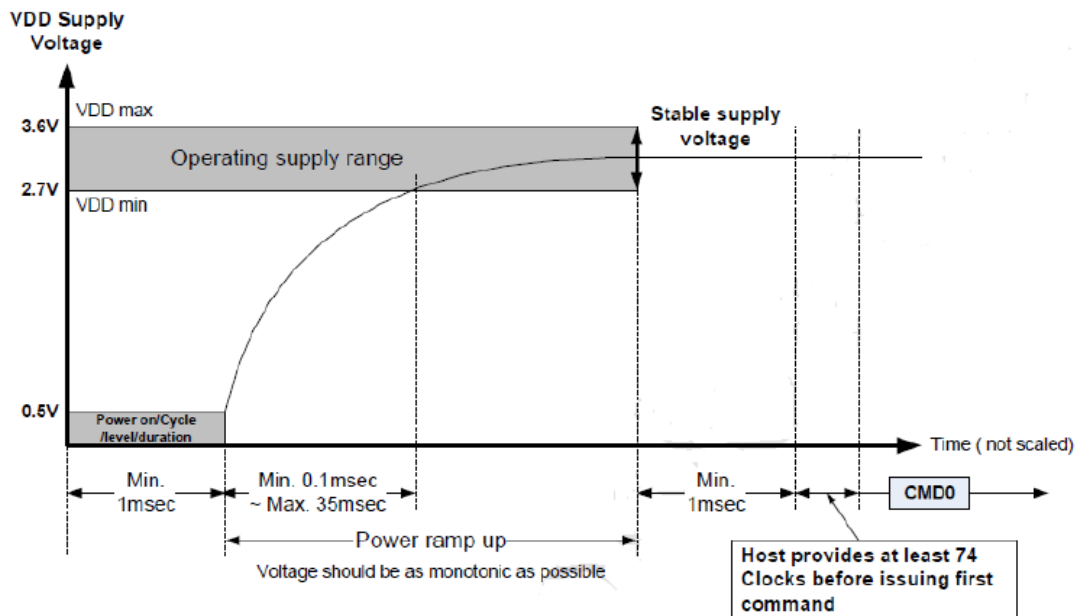
##### Bus Operation Conditions – Signal Line's Load

Total Bus Capacitance = C<sub>HOST</sub> + C<sub>BUS</sub> + N C<sub>CARD</sub>

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

### 4.2.3. Power Up Time of Host

Host needs to keep power line level less than 0.5V and more than 1ms before power ramp up.



#### Power On or Power Cycle

Followings are requirements for Power on and Power cycle to assure a reliable SD Card hard reset.

- (1) Voltage level shall be below 0.5V
- (2) Duration shall be at least 1ms.

#### Power Supply Ramp Up

The power ramp up time is defined from 0.5V threshold level up to the operating supply voltage which is stable between VDD (min.) and VDD (max.) and host can supply SDCLK.

Followings are recommendation of Power ramp up:

- (1) Voltage of power ramp up should be monotonic as much as possible.
- (2) The minimum ramp up time should be 0.1ms.
- (3) The maximum ramp up time should be 35ms for 2.7-3.6V power supply.
- (4) Host shall wait until VDD is stable.
- (5) After 1ms VDD stable time, host provides at least 74 clocks before issuing the first command.

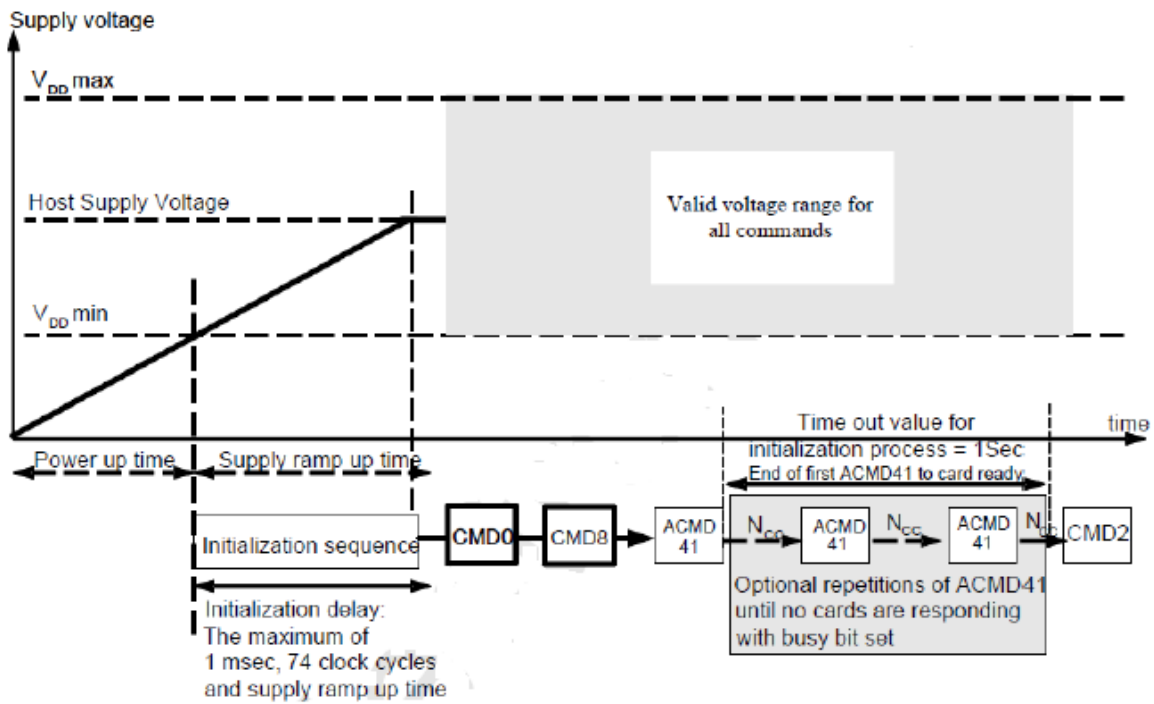
#### Power Down and Power Cycle

- When the host shuts down the power, the card VDD shall be lowered to less than 0.5Volt for a minimum period of 1ms. During power down, DAT, CMD, and CLK should be disconnected or driven to logical 0 by the host to avoid a situation that the operating current is drawn through the signal lines.
- If the host needs to change the operating voltage, a power cycle is required. Power cycle means the power is turned off and supplied again. Power cycle is also needed for accessing cards that are already in *Inactive State*. To create a power cycle the host shall follow the power down description before power up the card (i.e. the card VDD shall be once lowered to less than 0.5Volt for a minimum period of 1ms).

### 4.2.4. Power Up Time of Card

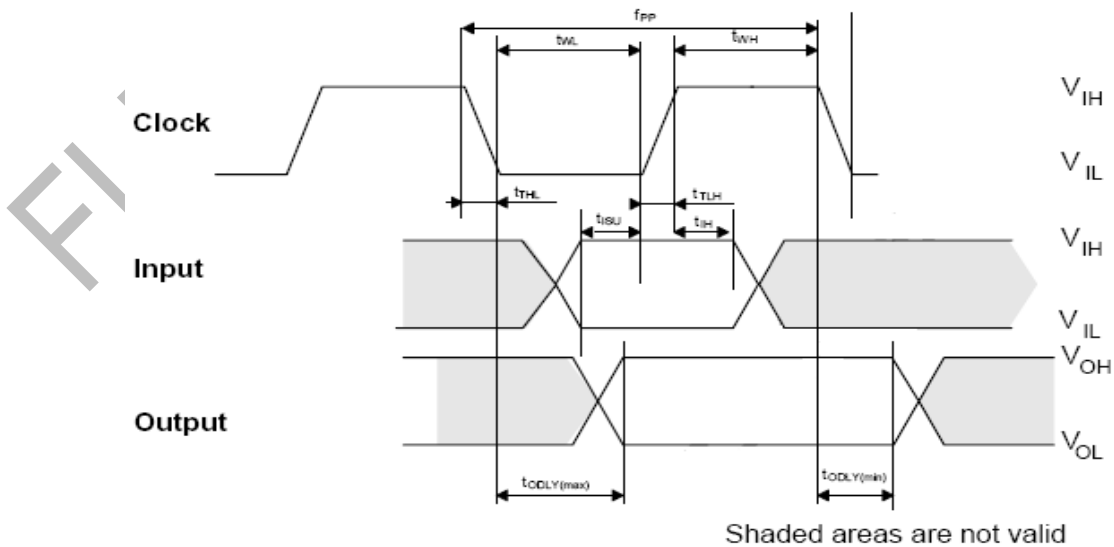
A device shall be ready to accept the first command within 1ms from detecting VDD min.

Device may use up to 74 clocks for preparation before receiving the first command.



### 4.3. AC Characteristic

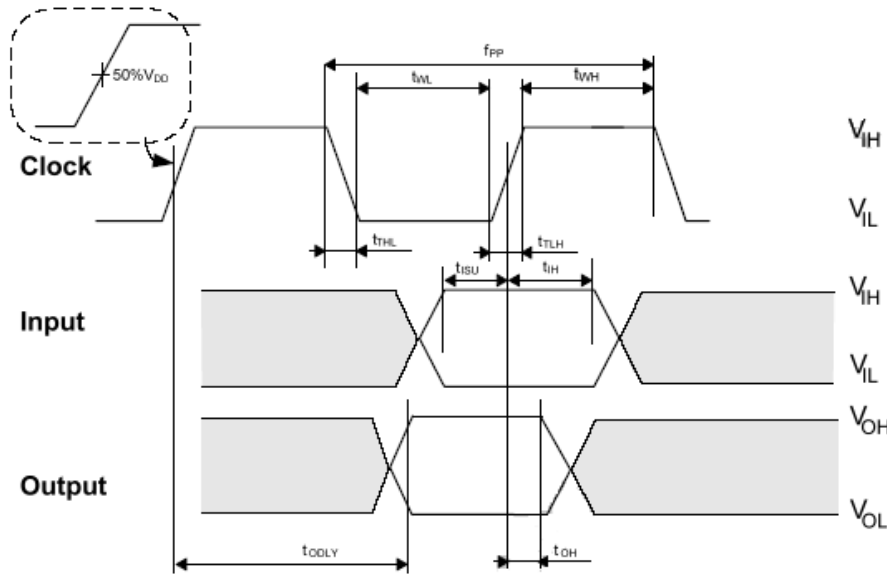
#### 4.3.1. microSD Interface timing (Default)



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 <sub>(1)</sub> /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.

### 4.3.2. microSD Interface Timing (High-Speed Mode)



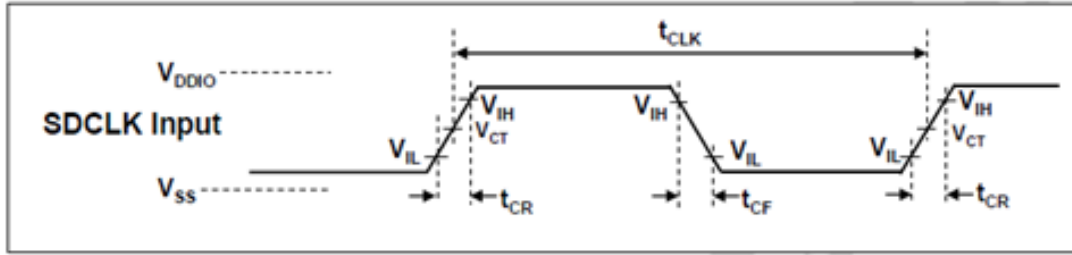
Shaded areas are not valid

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.

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

**Input:**

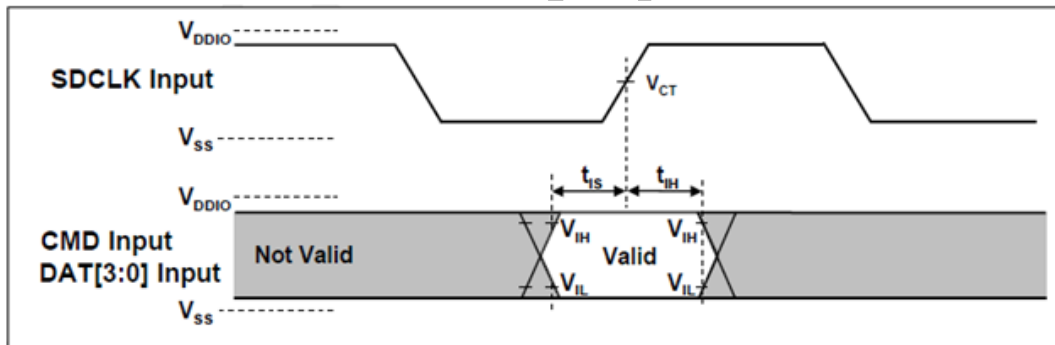


**Clock Signal Timing**

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**

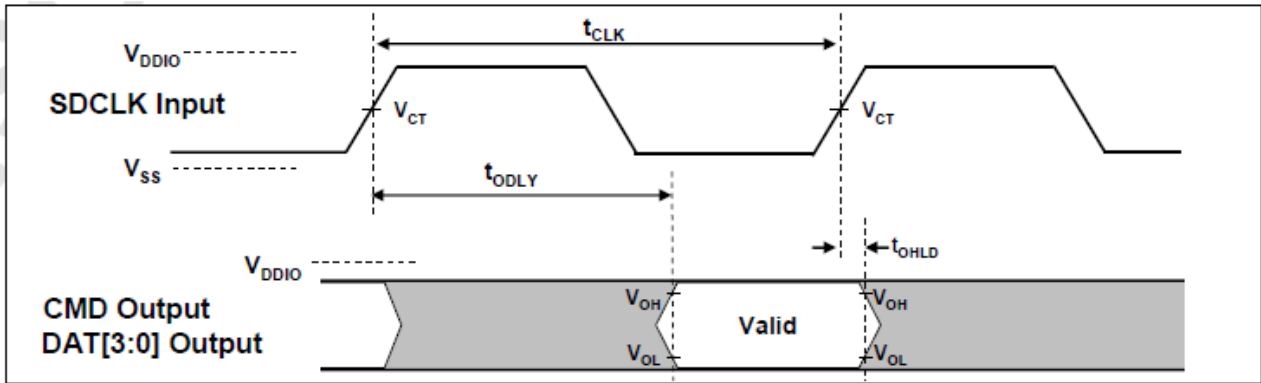
**SDR50 and SDR104 Input Timing:**



**Card Input Timing**

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

**Output:**

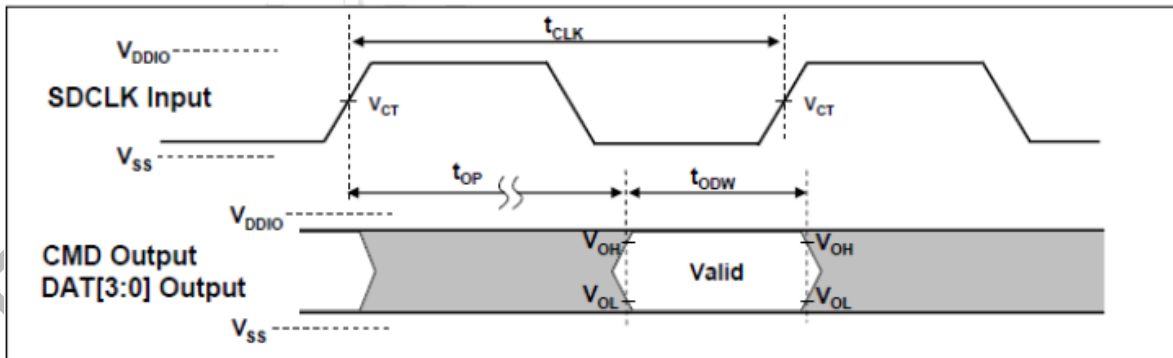


**Output Timing of Fixed Data Window**

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.), $C_L = 15pF$

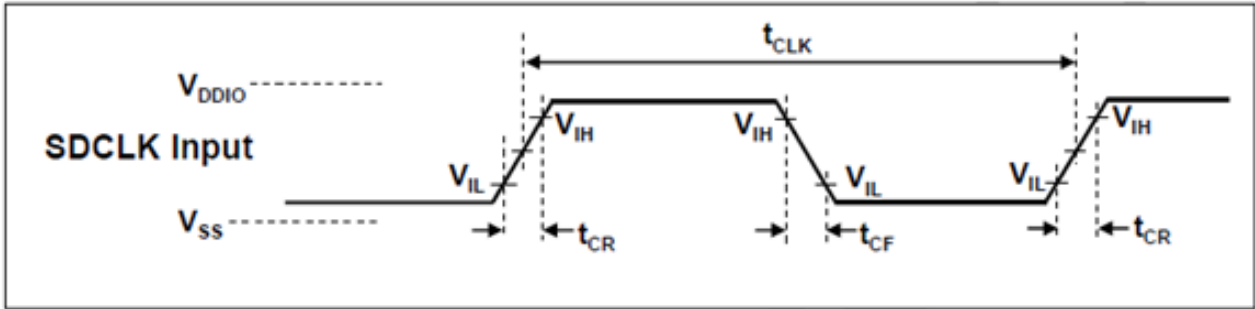
Output Timing of Fixed Data Window

**Output (SDR104 Mode):**



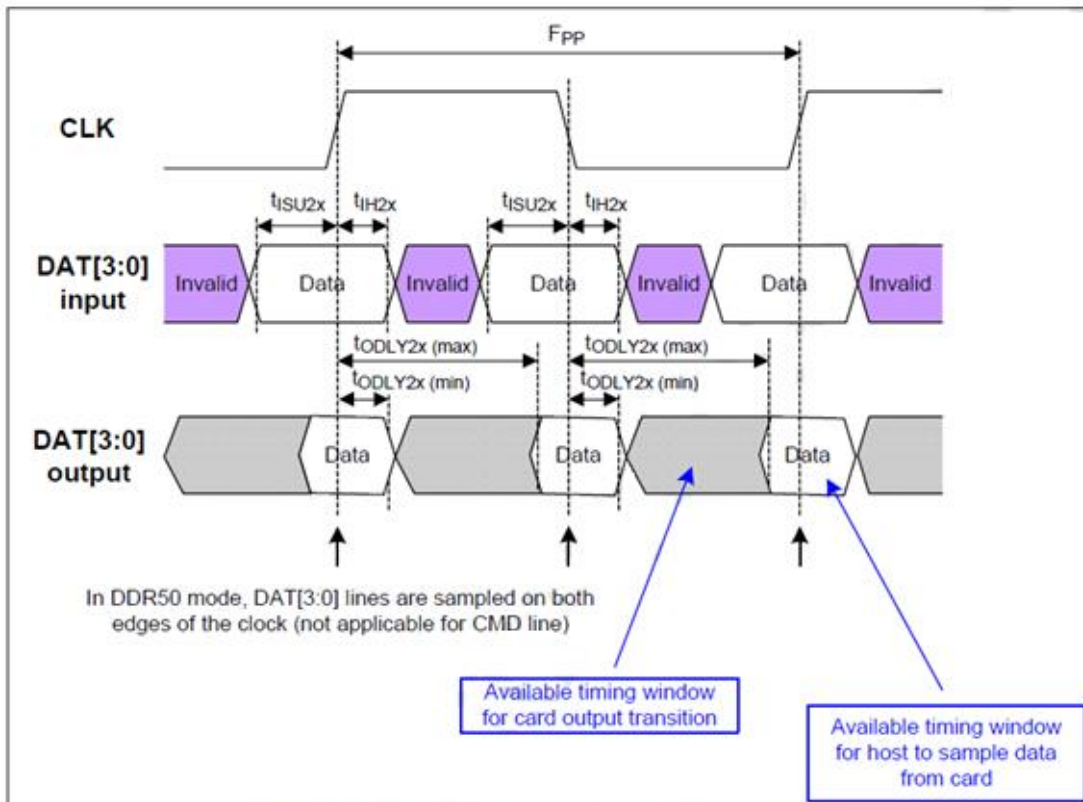
Symbol	Min	Max	Unit	Remark
$t_{OP}$	0	2	UI	Card Output Phase
$\Delta t_{OP}$	-350	+1550	ps	Delay variable due to temperature change after tuning
$t_{ODW}$	0.60	-	UI	$t_{ODW} = 2.88ns$ at 208MHz

### 4.3.4. microSD Interface timing (DDR50 Modes)



**Clock Signal Timing**

Symbol	Min	Max	Unit	Remark
$t_{CLK}$	4.8	-	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**



### Bus Timings – Parameters Values (DDR50 Mode)

Parameter	Symbol	Min	Max	Unit	Remark
<b>Input CMD (referenced to CLK rising edge)</b>					
Input set-up time	$t_{ISU}$	6	-	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)

## 5. PAD ASSIGNMENT

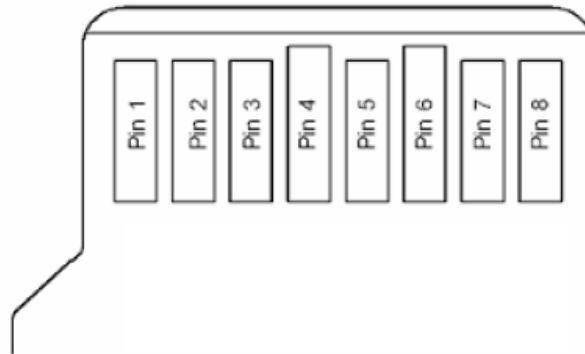


Table 5-1 microSD Memory Card Pad Assignment

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		

- (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



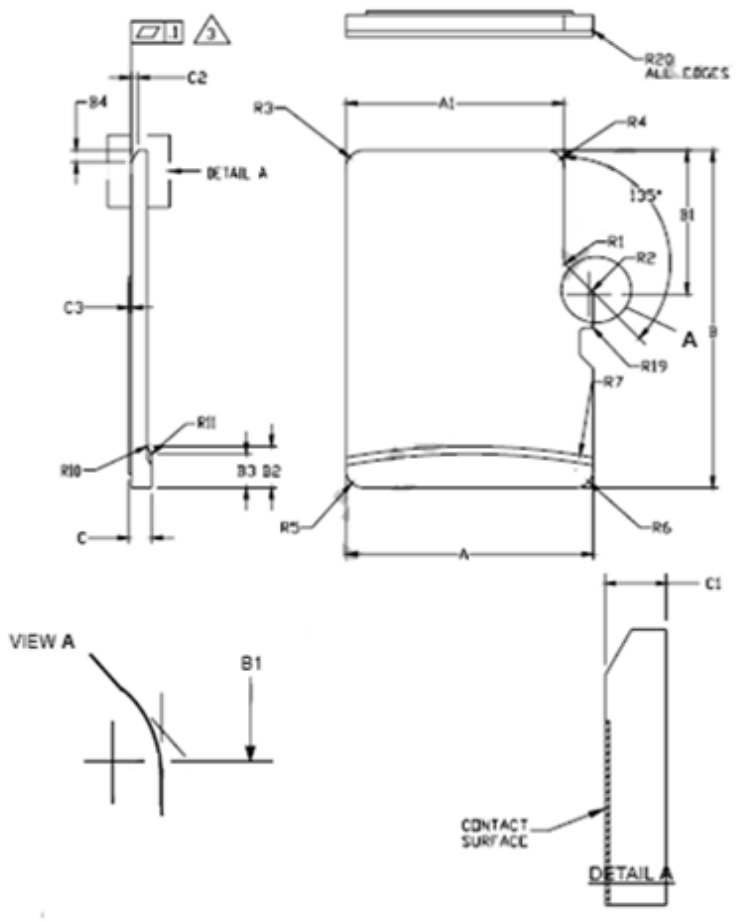
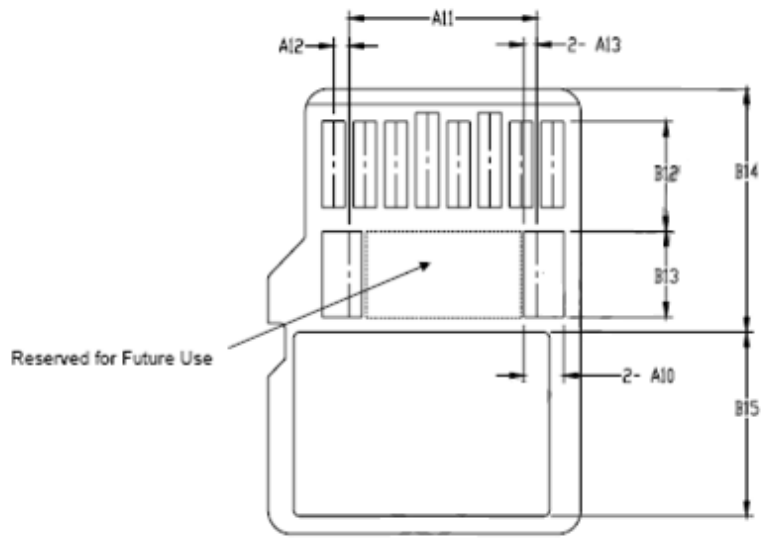
Name	Width	Description
CID	128bit	Card identification number; card individual number for identification.
RCA	16bit	Relative card address; local system address of a card, dynamically suggested by the card and approved by the host during initialization.
DSR	16bit	Driver Stage Register; to configure the 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.

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## 7. PHYSICAL DIMENSION



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



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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	Part Number (Gold)	Part Number (Diamond)
4GB	FDMM004GMG-N200	FDMM004GME-N200
8GB	FDMM008GMG-N200	FDMM008GME-N200
16GB	FDMM016GMG-N200	FDMM016GME-N200
32GB	FDMM032GMG-N200	FDMM032GME-N200
64GB	FDMM064GMG-N200	FDMM064GME-N200
128GB	FDMM128GMG-N200	FDMM128GME-N200

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## Revision History

Revision	Release Date	Description
1.0	2017/07	First release
1.1	2020/06	Update Template
1.2	2020/09	Update Ordering Information
1.3	2021/04	Update Product Overvie

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