



Industrial SD 3.0 Specification

(FxPro I Series, SLC)

Version 1.6

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1. GENERAL DESCRIPTION



1.1. Introduction

FLEXXON industrial FxPro I Series SD 3.0 card has high performance, good reliability and wide compatibility. It can alternate communication protocol between SD mode and SPI mode. It's well adapted for hand-held applications in industrial/medical markets already.

1.2. Product Overview

- ❖ **Flash**
 - SLC
- ❖ **Capacity**
 - 128MB up to 16GB
- ❖ **Support SD system specification version 3.0**
- ❖ **Support SD SPI mode**
- ❖ **Copyrights Protection Mechanism**
 - Compliant with the highest security of SDMI standard
- ❖ **Support CPRM (Content Protection for Recordable Media) of SD Card**
- ❖ **Card removal during read operation will never harm the content**
- ❖ **Password Protection of cards (optional)**
- ❖ **Write Protect feature using mechanical switch**
- ❖ **Built-in write protection features (permanent and temporary)**
- ❖ **Support Dynamic and Static Wear Leveling**
- ❖ **Temperature Range**
 - Operation (Gold) : -25°C ~ 85°C
 - Operation (Diamond) : -40°C ~ 85°C
 - Storage: -40°C ~ 85°C
- ❖ **RoHS Compliant**
- ❖ **SMART Function**
- ❖ **Embedded Mode**

❖ **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

2. PRODUCT SPECIFICATIONS



2.1. Performance

Table 2-1 Performance of SD (FxPro I)

Capacity	Mode	Sequential	
		Read (MB/s)	Write (MB/s)
128MB	Non-UHS	20	20
256MB	Non-UHS	20	20
512MB	Non-UHS	20	20
1GB	Non-UHS	20	20
2GB	Non-UHS	20	20
4GB	UHS-I	35	35
8GB	UHS-I	60	50
16GB	UHS-I	65	55

NOTES:

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

2.2. Power

Table 2-2 Typical Power Consumption of SD (FxPro I)

Capacity	Read (mA)	Write (mA)	Standby (mA)
128MB	40	50	0.2
256MB	40	50	0.2
512MB	40	50	0.2
1GB	50	60	0.2
2GB	60	80	0.2
4GB	40	50	0.2
8GB	50	60	0.2
16GB	60	80	0.2

NOTES:

1. Power consumption may vary from flash configuration and platform.

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 FLEXXON's FxPro I Series SD 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
Storage Temperature	-40°C ~ 85°C
Operating Temperature	Gold Grade: -25°C ~ 85°C Diamond Grade: -40°C ~ 85°C
Storage Humidity	Gold Grade: 40°C, 95% RH Diamond Grade: 55°C, 95% RH
Operating Humidity	Gold Grade: 40°C, 95% RH Diamond Grade: 55°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
Salt Spray	Concentration: 3% NaCl, Temperature: 35°C, 24hours
Waterproof	Water temperature: 25°C Water depth: The lowest point of unit is locating 1000mm below surface. Storage for 30 mins
Switch Cycle	0.4~0.5 N, 1,000 times
Durability	10,000 times
ESD	Contact: +/- 4KV each item 25 times Air: +/- 8KV 10 times

4. ELECTRICAL SPECIFICATIONS



4.1. DC Characteristics

4.1.1. 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_{DD}	2.7	3.6	V	
Output High Voltage	V_{OH}	$0.75 \cdot V_{DD}$		V	$I_{OH} = -2mA$ V_{DD} Min
Output Low Voltage	V_{OL}		$0.125 \cdot V_{DD}$	V	$I_{OL} = 2mA$ 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

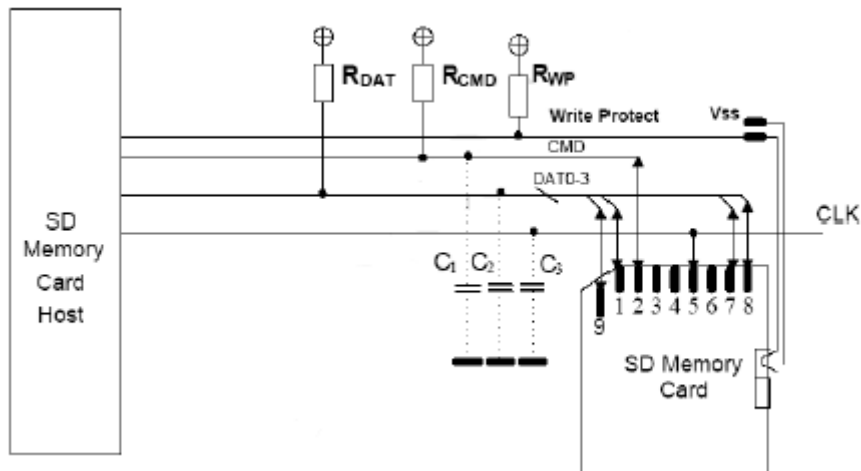
Parameter	Symbol	Min.	Max	Unit	Condition
Supply Voltage	V_{DD}	2.7	3.6	V	
Regulator Voltage	V_{DDIO}	1.7	1.95	V	Generated by V_{DD}
Output High Voltage	V_{OH}	1.4	-	V	$I_{OH} = -2mA$
Output Low Voltage	V_{OL}	-	0.45	V	$I_{OL} = 2mA$
Input High Voltage	V_{IH}	1.27	2.00	V	
Input Low Voltage	V_{IL}	$V_{SS} - 0.3$	0.58	V	

Parameter	Symbol	Min	Max.	Unit	Remarks
Input Leakage Current		-2	2	μA	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	$V_{DD} + 0.3$	V	
All Inputs					
Input Leakage Current		-10	10	μA	
All Outputs					
Output Leakage Current		-10	10	μA	

4.1.2. Bus Signal Line Load



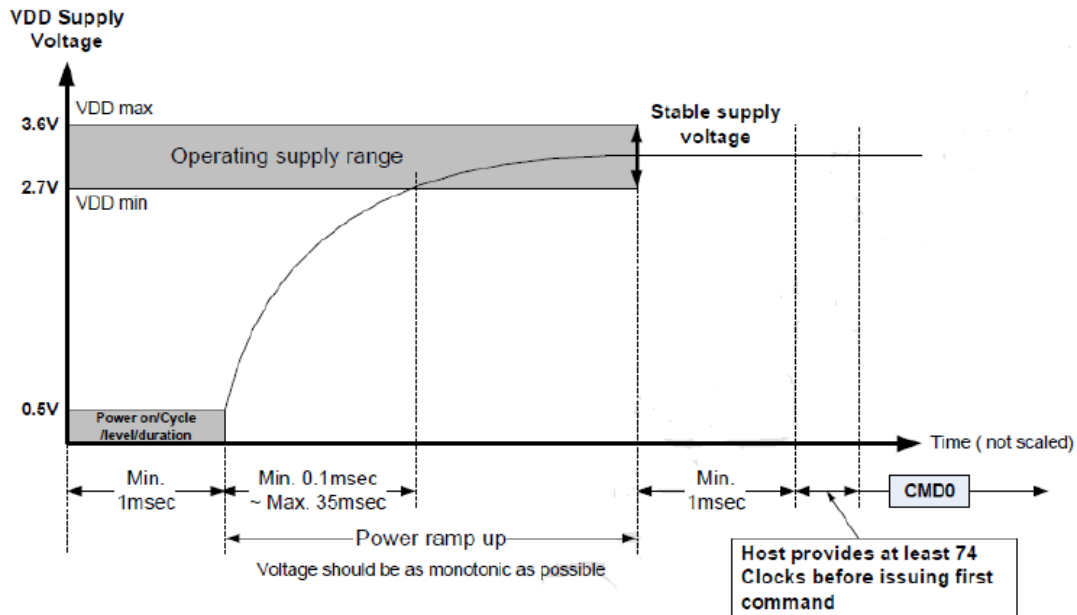
Bus Operation Conditions – Signal Line's Load

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

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 30 pF
Card Capacitance for each signal pin	C_{CARD}		10^1	pF	
Maximum signal line 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

4.1.3. 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.

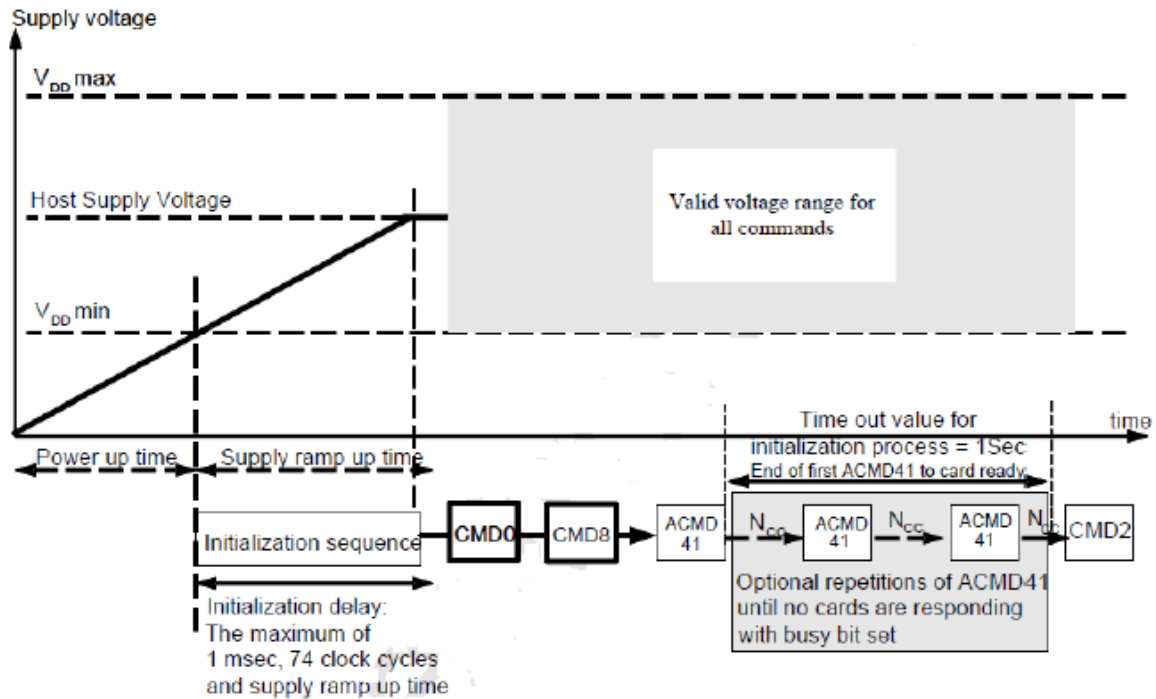
Power Down and Power Cycle

- 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).

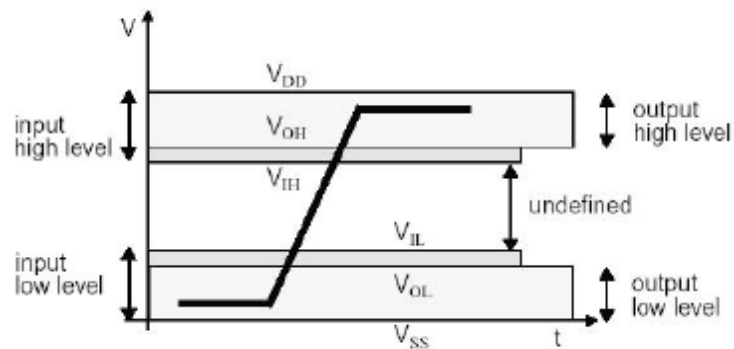
4.1.4. Power Up Time of Card

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

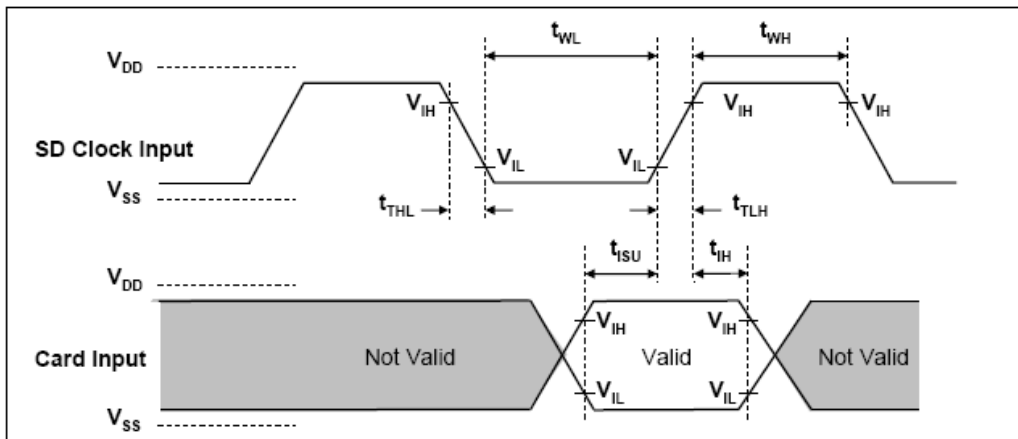
Device may use up to 74 clocks for preparation before receiving the first command.



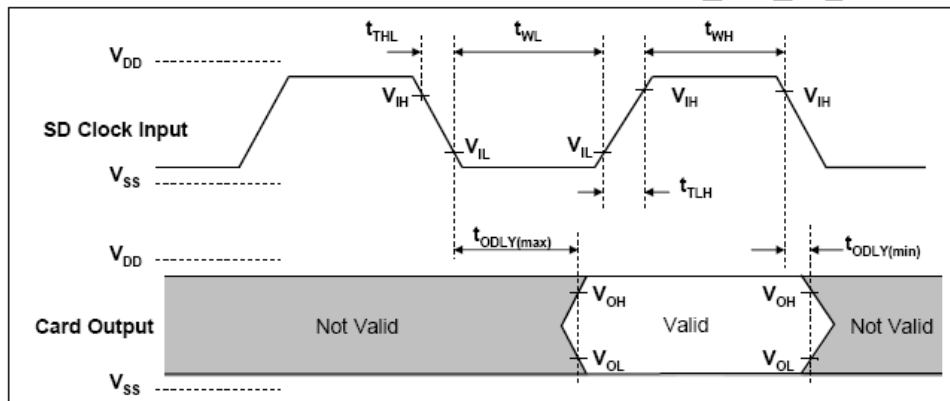
4.2. AC Characteristic



4.2.1. SD Interface timing (Default)



Card Input Timing (Default Speed Card)



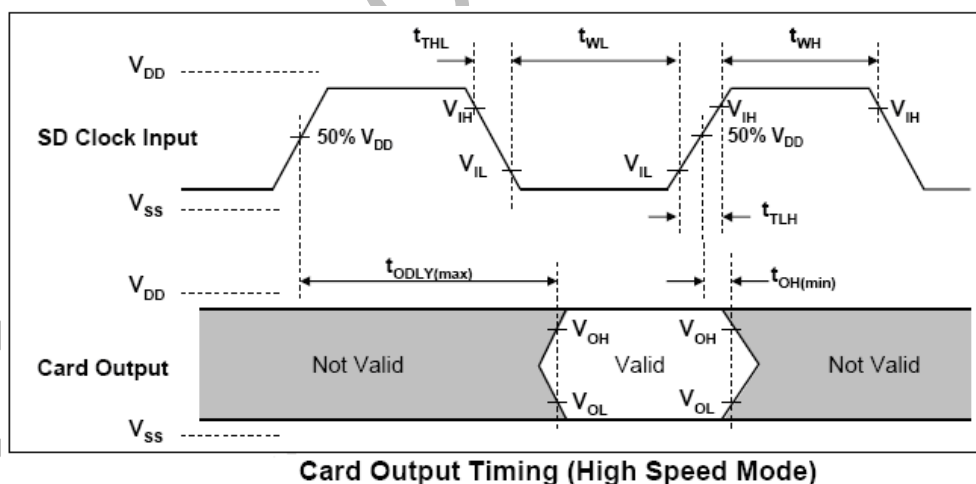
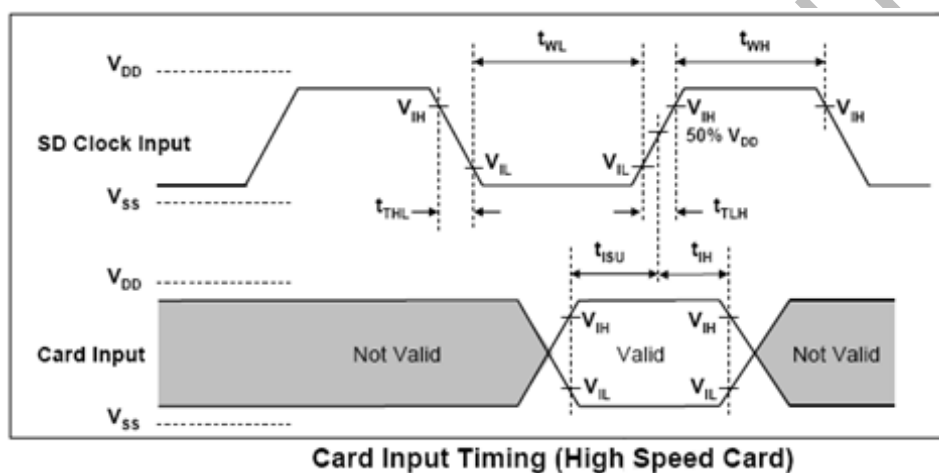
Card Output Timing (Default Speed Mode)

Parameter	Symbol	Min	Max	Unit	Remark
Clock CLK (All values are referred to min(V_{IH}) and max(V_{IL}))					
Clock frequency Data Transfer Mode	f_{PP}	0	25	MHz	$C_{card} \leq 10 \text{ pF}$ (1 card)
Clock frequency Identification Mode	f_{OD}	0 ₍₁₎ /100	400	KHz	$C_{card} \leq 10 \text{ pF}$ (1 card)
Clock low time	t_{WL}	10		ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
Clock high time	t_{WH}	10		ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
Clock rise time	t_{TLH}		10	ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
Clock fall time	t_{THL}		10	ns	$C_{card} \leq 10 \text{ pF}$ (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 Delay time during Identification Mode	t_{ODLY}	0	50	ns	$C_L \leq 40 \text{ pF}$ (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.SD Interface Timing (High-Speed Mode)

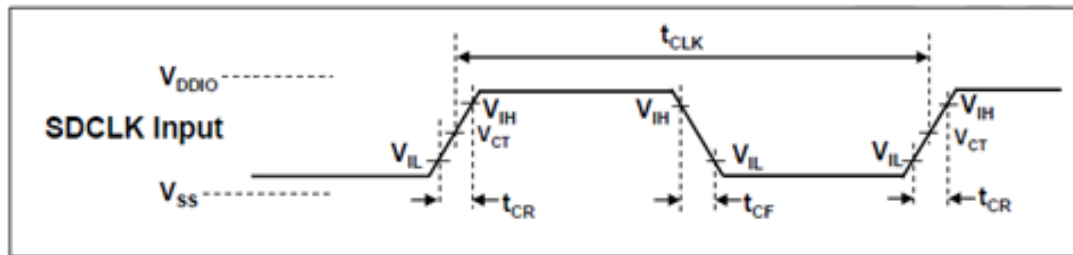


Parameter	Symbol	Min	Max	Unit	Remark
Clock CLK (All values are referred to min(V_{IH}) and max(V_{IL}))					
Clock frequency Data Transfer Mode	f_{PP}	0	50	MHz	$C_{card} \leq 10 \text{ pF}$ (1 card)
Clock low time	t_{WL}	7		ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
Clock high time	t_{WH}	7		ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
Clock rise time	t_{TLH}		3	ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
Clock fall time	t_{THL}		3	ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
Inputs CMD, DAT (referenced to CLK)					
Input set-up time	t_{ISU}	6		ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
Input hold time	t_{IH}	2		ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
Outputs CMD, DAT (referenced to CLK)					
Output Delay time during Data Transfer Mode	t_{ODLY}		14	ns	$C_L \leq 40 \text{ pF}$ (1 card)
Output Hold time	T_{OH}	2.5		ns	$C_L \leq 15 \text{ pF}$ (1 card)
Total System capacitance of each line ¹	C_L		40	pF	$C_L \leq 15 \text{ pF}$ (1 card)

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

4.2.3.SD Interface timing (SDR12, SDR25, SDR50 and SDR104 Modes)

Input:

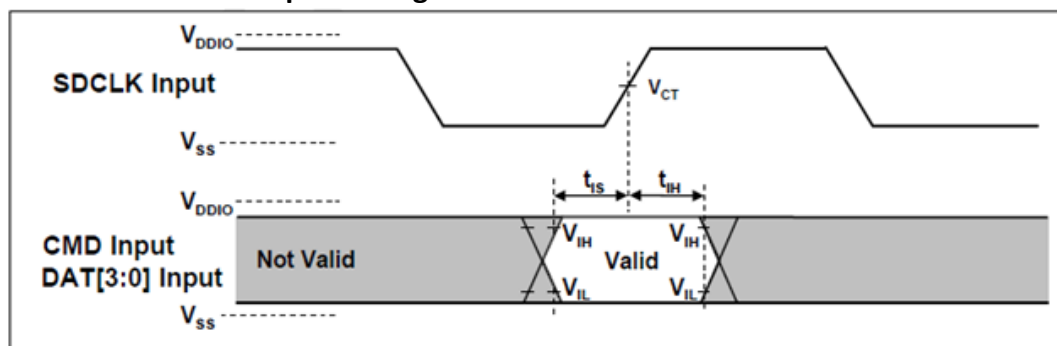


Clock Signal Timing

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

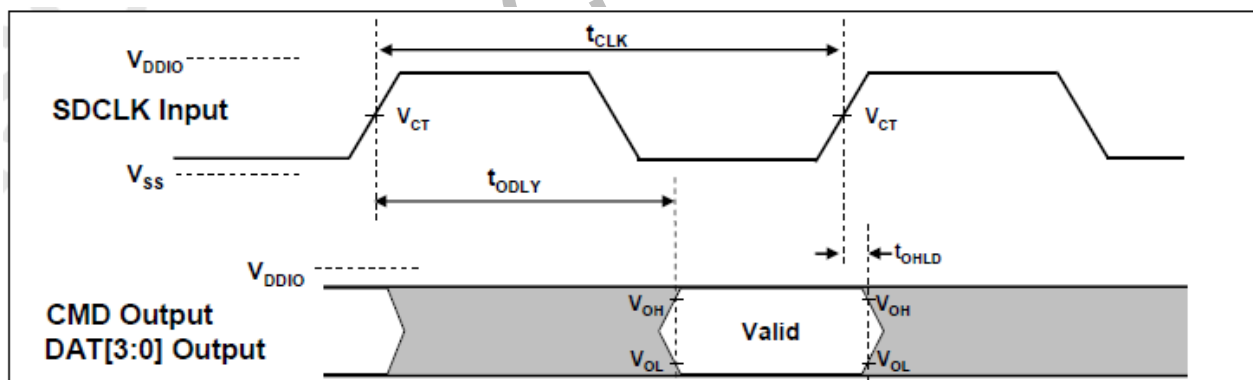
SDR50 and SDR104 Input Timing:



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):

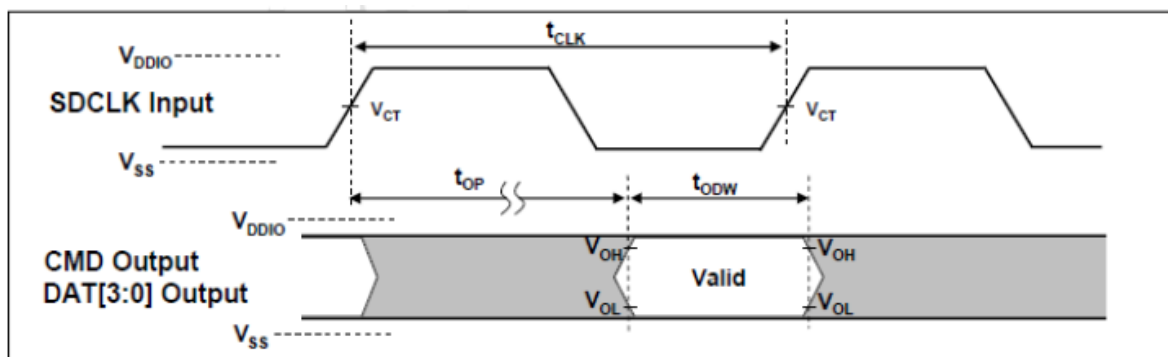


Output Timing of Fixed Data Window

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.), $C_L = 15pF$

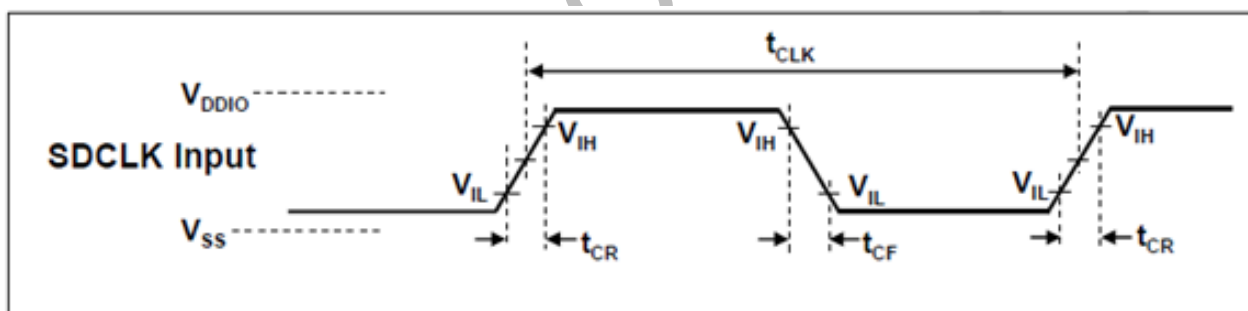
Output Timing of Fixed Data Window

Output (SDR104 Mode):



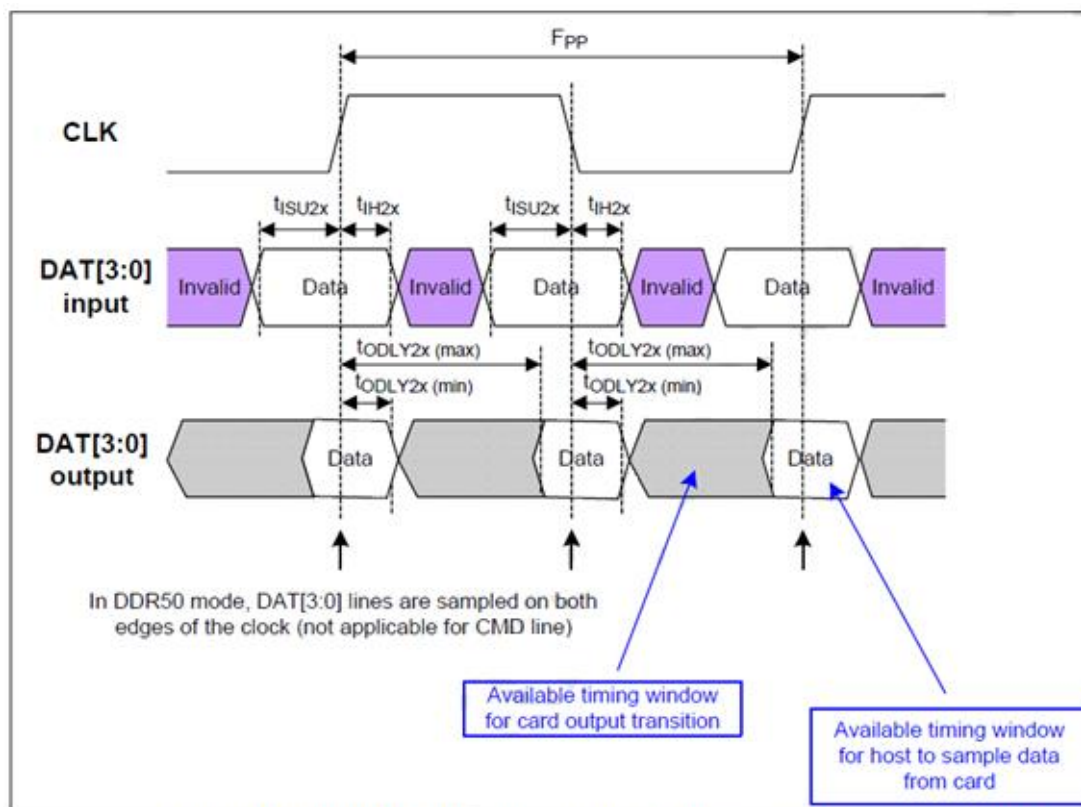
Symbol	Min	Max	Unit	Remark
t_{OP}	0	2	UI	Card Output Phase
Δt_{OP}	-350	+1550	ps	Delay variable due to temperature change after tuning
t_{ODW}	0.60	-	UI	$t_{ODW} = 2.88ns$ at 208MHz

4.2.4.SD 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

Bus Timings – Parameters Values (DDR50 Mode)

Parameter	Symbol	Min	Max	Unit	Remark
Input CMD (referenced to CLK rising edge)					
Input set-up time	t_{ISU}	6	-	ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
Input hold time	t_{IH}	0.8	-	ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
Output CMD (referenced to CLK rising edge)					
Output Delay time during Data Transfer Mode	t_{ODLY}		13.7	ns	$C_L \leq 30 \text{ pF}$ (1 card)
Output Hold time	T_{OH}	1.5	-	ns	$C_L \geq 15 \text{ pF}$ (1 card)
Inputs DAT (referenced to CLK rising and falling edges)					
Input set-up time	t_{ISU2x}	3	-	ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
Input hold time	t_{IH2x}	0.8	-	ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
Outputs DAT (referenced to CLK rising and falling edges)					
Output Delay time during Data Transfer Mode	t_{ODLY2x}	-	7.0	ns	$C_L \leq 25 \text{ pF}$ (1 card)
Output Hold time	T_{OH2x}	1.5	-	ns	$C_L \geq 15 \text{ pF}$ (1 card)

5. PAD ASSIGNMENT



5.1. Pad Assignment and Descriptions

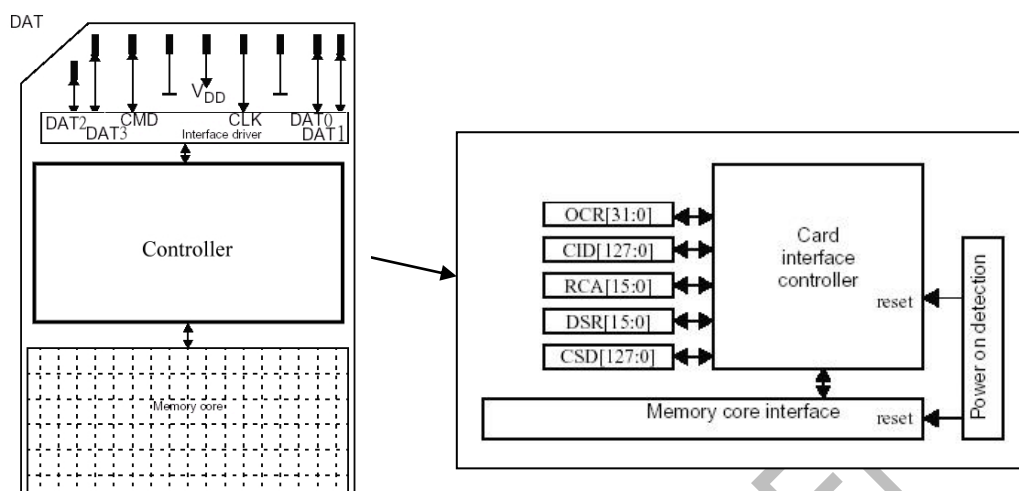


Table 5-1 SD Memory Card Pad Assignment

pin	SD Mode			SPI Mode		
	Name	Type ¹	Description	Name	Type	Description
1	CD/DAT3 ²	I/O/PP ³	Card Detect/ Data Line[bit3]	CS	I ³	Chip Select (net true)
2	CMD	PP	Command/Response	DI	I	Data In
3	V _{SS1}	S	Supply voltage ground	VSS	S	Supply voltage ground
4	V _{DD}	S	Supply voltage	VDD	S	Supply voltage
5	CLK	I	Clock	SCLK	I	Clock
6	V _{SS2}	S	Supply voltage ground	VSS2	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		
9	DAT2	I/O/PP	Data Line[bit2]	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 with SET_CLR_CARD_DETECT (ACMD42) command.
SET_CLR_CARD_DETECT (ACMD42) command.

6. REGISTERS

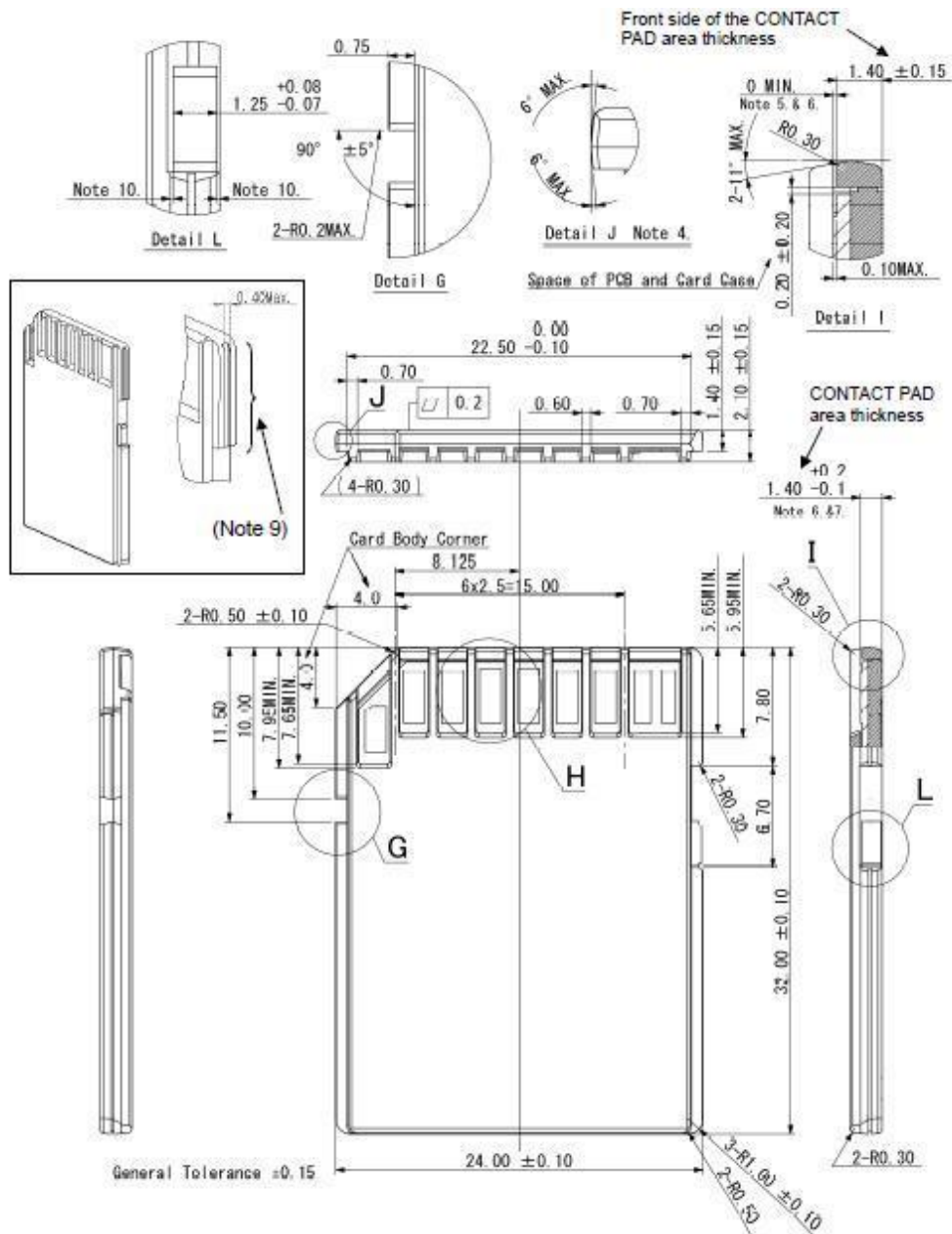


Name	Width	Description
CID	128bit	Card identification number; card individual number for identification.
RCA	16bit	Relative card address; local system address of a card, dynamically suggested by the card and approved by the host during initialization.
DSR	16bit	Driver Stage Register; to configure the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

7. PHYSICAL DIMENSION



Dimension: 32mm(L) x 24mm(W) x 2.1mm(H)



8. ORDERING INFORMATION



Capacity	MPN (Diamond Grade)	MPN (Gold Grade)
128MB	FDMS128MSE-1001	FDMS128MSG-1001
256MB	FDMS256MSE-1001	FDMS256MSG-1001
512MB	FDMS512MSE-1001	FDMS512MSG-1001
1GB	FDMS001GSE-1001	FDMS001GSG-1001
2GB	FDMS002GSE-1001	FDMS002GSG-1001
4GB	FDMS004GSE-1001	FDMS004GSG-1001
8GB	FDMS008GSE-1001	FDMS008GSG-1001
16GB	FDMS016GSE-1001	FDMS016GSG-1001

Revision History

Revision	Release Date	History
1.0	2015/03	First release
1.1	2015/03	Modify table format
1.2	2015/04	Remove DCS
1.3	2015/12	Update Ordering Information
1.4	2017/06	Update Ordering Information
1.5	2019/12	Update Power Consumption in Product Specification
1.6	2021/01	Remove 32GB