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Datasheet for:

SD Card 3.0

PSFSD3xxxxQxxxx

Legal Information

Revision History

Date	Revision	Description	Checked by
11/8/16	A	Initial release.	
12/12/16	B	Add mechanical drawing. Reformat datasheet. Revise PN's	

Ordering Information

Spec	Viking P/N	Grade	NAND Process	Density GB	Temperature
SD 3.0	VPFSD30512QI7STH	C	TSB 24nm SLC	0.512	-25 to 85°C
SD 3.0	VPFSD31024QI7STH	C	TSB 24nm SLC	1	-25 to 85°C
SD 3.0	VPFSD32048QI7STH	C	TSB 24nm SLC	2	-25 to 85°C
SD 3.0	VPFSD34096QIQSTH	C	TSB 24nm SLC	4	-25 to 85°C
SD 3.0	VPFSD38192QIQSTH	C	TSB 24nm SLC	8	-25 to 85°C

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1 Introduction

Viking SSD's offer the highest flash storage reliability and performance as well as support for many functional features.

1.1 Features

- Flash Type
  - Toshiba 24nm SLC
  - Toshiba 32nm SLC
  - Spansion 32nm SLC
- Bus Speed Mode
  - UHS-I
  - Non-UHS
- Speed Class
  - Class 2/6/10
- Power Consumption [Note]
  - Power Up Current < 250uA
  - Standby Current < 1000uA
  - Read Current < 400mA
  - Write Current < 400mA
- CPRM (Content Protection for Recordable Media)

NOTE: Please see Chapter on Power Consumption for details

- Advanced Flash Management
  - Static and Dynamic Wear Leveling
  - Bad Block Management
- Write Protect with mechanical switch
- Supply Voltage 2.7 ~ 3.6V
- Temperature Range
  - Operation: -25°C ~ 85°C
  - Storage: -25°C ~ 85°C
- RoHS compliant
- EMI compliant

- Performance Overview

Capacity	Class	UHS-I	Flash			TestMetrix Test Test 500MB	
			Density	Process	Bit-per-cell	Read (MB/s)	Write (MB/s)
0.512GB	CL6	Non-UHS	.512Gb*1	24nm	SLC	23	17
1GB	CL6	Non-UHS	.512Gb*2	24nm	SLC	23	22
2GB	CL6	Non-UHS	.512Gb*4	24nm	SLC	23	22
4GB	CL10	UHS-I (Grade 1)	4Gb*1	24nm	SLC	35	35
8GB	CL10	UHS-I (Grade 1)	4Gb*2	24nm	SLC	35	35

1.2 General Description

The Secure Digital (SD) card version 3.0 is fully compliant with the standards released by the SD Card Association. The Command List supports [Part 1 Physical Layer Specification Ver3.01 Final] definitions. Card capacities of non-secure area and secure area support [Part 3 Security Specification Ver3.0 Final]

The SD 3.0 card has a 9-pin interface, designed to operate at a maximum frequency of 208MHz. It can alternate communication protocol between the SD mode and SPI mode. It performs data error detection and correction with very low power consumption. The Card capacity could be more than 64GB and up to 2TB in the future with ex-FAT file system, which is called SDXC (Extended Capacity SD Memory Card). Secure Digital 3.0 cards are one of the most popular cards today due to its high performance, good reliability and wide compatibility.

1.3 Flash Management

1.3.1 Error Correction Code (ECC)

Flash memory cells will deteriorate with use, which might generate random bit errors in the stored data. Thus, Viking SD cards apply the BCH ECC Algorithm, which can detect and correct errors occur during Read process, ensure data been read correctly, as well as protect data from corruption.

1.3.2 Wear Leveling

NAND Flash devices can only undergo a limited number of program/erase cycles, and in most cases, the flash media are not used evenly. If some area get updated more frequently than others, the lifetime of the device would be reduced significantly. Thus, Wear Leveling technique is applied to extend the lifespan of NAND Flash by evenly distributing write and erase cycles across the media.

Viking provides advanced Wear Leveling algorithm, which can efficiently spread out the flash usage through the whole flash media area. Moreover, by implementing both dynamic and static Wear Leveling algorithms, the life expectancy of the NAND Flash is greatly improved.

1.3.3 Bad Block Management

Bad blocks are blocks that include one or more invalid bits, and their reliability is not guaranteed. Blocks that are identified and marked as bad by the manufacturer are referred to as “Initial Bad Blocks”. Bad blocks that are developed during the lifespan of the flash are named “Later Bad Blocks”. Viking implements an efficient bad block management algorithm to detect the factory-produced bad blocks and manages any bad blocks that appear with use. This practice further prevents data being stored into bad blocks and improves the data reliability.

2 PRODUCT SPECIFICATIONS

2.1 Summary

- Support SD system specification version 3.0
- Card capacity of non-secure area and secure area support
  [Part 3 Security Specification Ver3.0 Final] Specifications

- Support SD SPI mode
- Designed for read-only and read/write cards
- Bus Speed Mode (use 4 parallel data lines)
  - Non-UHS Mode
    - Default speed mode: 3.3V signaling, frequency up to 25MHz, up to 12.5 MB/sec
    - High speed mode: 3.3V signaling, frequency up to 50MHz, up to 25 MB/sec
  - UHS 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 104MB/sec
    - DDR50: 1.8V signaling, frequency up to 50MHz, sampled on both clock edges, up to 50MB/sec

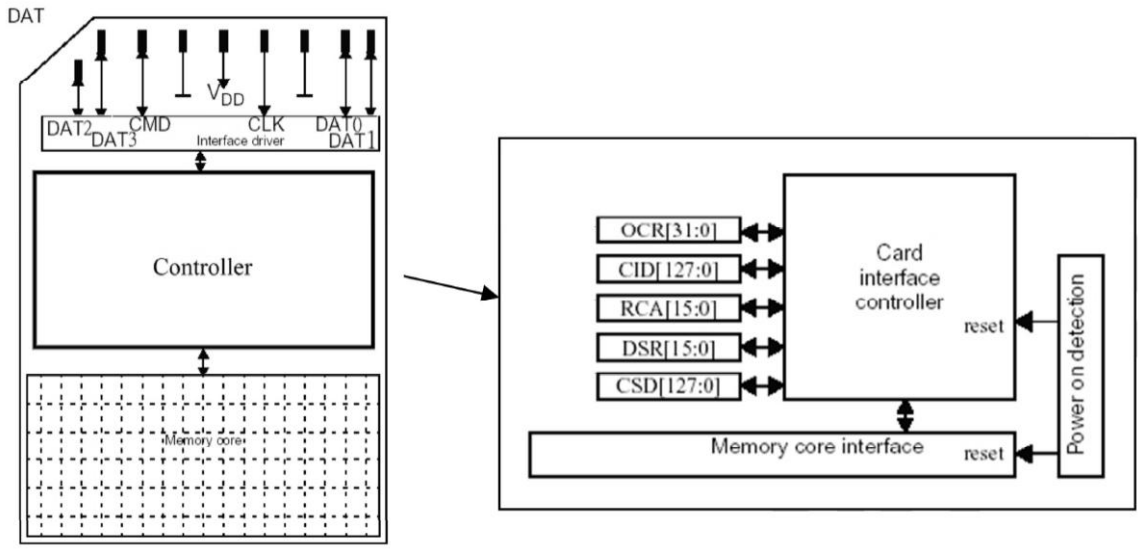
    NOTES:
    1. Timing in 1.8V signaling is different from that of 3.3V signaling.
    2. To properly run the UHS mode, please ensure the device supports UHS-I mode.

- The command list supports
  [Part 1 Physical Layer Specification Ver3.1 Final] definitions

- Copyrights Protection Mechanism
  - Compliant with the highest security of DPRM 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)
- Electrostatic Discharge (ESD)
  - ESD protection in contact pads (contact discharge)
  - ESD protection in non-contact pads (air discharge)
- Operation voltage range: 2.7 ~ 3.6V
- Support Dynamic and Static Wear Leveling

2.2 Block Diagram

Figure 2-1: High-Level Block Diagram



2.3 SD CARD COMPARISON

Table 2-1: Comparing SD3.0 Standard, SD3.0 SDHC and SD3.0 SDXC

	SD3.0 SDSC (Backward compatible to 2.0 host)	SD3.0 SDHC (Backward compatible to 2.0 host)	SD3.0 SDXC
File System	FAT 12/16	FAT32	exFAT
Addressing Mode	Byte (1 byte unit)	Block (512 byte unit)	Block (512 byte unit)
HCS/CCS bits of ACMD41	Support	Support	Support
CMD8 (SEND_IF_COND)	Support	Support	Support
CMD16 (SET_BLOCKLEN)	Support	Support (Only CMD42)	Support (Only CMD42)
Partial Read	Support	Not Support	Not Support
Lock/Unlock Function	Mandatory	Mandatory	Mandatory
Write Protect Groups	Optional	Not Support	Not Support
Supply Voltage 2.7v – 3.6v (for operation)	Support	Support	Support
Total Bus Capacitance for each signal line	40pF	40pF	40pF
CSD Version (CSD_STRUCTURE Value)	1.0 (0x0)	2.0 (0x1)	2.0 (0x1)
Speed Class	Optional	Mandatory (Class 2 / 4 / 6 / 10)	Mandatory (Class 2 / 4 / 6 / 10)

Table 2-2: Comparing UHS Speed Grade Symbols

	U1 (UHS Speed Grade 1)	U3 (UHS Speed Grade 3)
Operable Under	*UHS-I Bus I/F, UHS-II Bus I/F	
SD Memory Card	SDHC UHS-I and UHS-II, SDXC UHS-I and UHS-II	
Performance	10 MB/s minimum write speed	30 MB/s minimum write speed
Applications	Full higher potential of recording real-time broadcasts and capturing large-size HD videos.	Capable of recording 4K2K video.

*UHS (Ultra High Speed), , defines bus-interface speeds up to 312 Megabytes per second for greater device performance. It is available on SDXC and SDHC memory cards and devices.

3 ENVIRONMENTAL SPECIFICATIONS

3.1 Environmental Conditions

3.1.1 Temperature and Humidity

Table 3-1: Temperature Specifications

Conditions	Operating	Shipping	Storage
Temperature- Ambient	-25 to 85°C	-40 to 85°C	-40 to 85°C
Humidity (non-condensing)	95% under 25C	93% under 40C	93% under 40C

3.1.2 Shock and Vibration

Table 3-2: Shock and Vibration Specifications

Stimulus	Description
Shock	1500G, 0.5ms
Vibration	20 – 80 Hz/1.52mm, 80 – 2000 Hz/20G, (X,Y,Z axis / 30 min for each)

3.1.1 Electromagnetic Immunity and EMI Compliance

- FCC: CISPR22
- CE: EN55022
- BSMI 13438

3.1.2 Drop

Table 3-3: Drop Specifications

	Height of Drop	Number of Drop
SD card	150cm free fall	Direction: 6 face; 1 time/face

Result: No any abnormality is detected when power on

3.1.3 Bend

Table 3-4: Bend Specifications

	Force	Action
SD card	≥ 10N	Hold for 1min; total 5 times.

Result: No any abnormality is detected when power on

3.1.4 Toque

Table 3-5: Torque Specifications

	Force	Action
SD card	0.15N-m or ±2.5 deg	Hold 30 second/direction, Total 5 cycles

Result: No any abnormality is detected when power on

3.1.5 Switch

Table 3-6: Switch Specifications

	Force	Number of Switch Cycle
SD card	0.4N-m~5N-m	1000 cycles

Result: No any abnormality is detected when power on

3.1.6 Card Socket Insertions

Table 3-7: Card Socket Insertions

	Number of Mating Cycles	Result
SD card	10000 cycles	Pass

3.1.7 Electrostatic Discharge (ESD)

Table 3-8: Electrostatic Discharge (ESD)

	Condition	Result
SD card	Contact: ±4KV; 5 times/Pin	Pass
	Air: ±15KV; 5 times/Position	Pass

3.2 Power Consumption

The table below is the power consumption of SD card with different bus speed modes.

Table 3-9: Power Consumption

Bus Speed Mode	Max. Power Up Current (uA)	Max. Standby Current (uA)	Max. Read Current (mA)	Max. Write Current (mA)
Default Speed Mode	250	1000	150 @ 3.6V	150 @ 3.6V
High Speed Mode	250	1000	200 @ 3.6V	200 @ 3.6V

NOTES:

1) Power consumptions are measured at room temperature (25C). Standby current might rise to 1600 under 85C.
2) Power consumption of Max. Standby Current is for SD cards under and including 64GB only. For 128GB and 256GB, the power consumption is to be determined.

3.3 DC Characteristic

3.3.1 Bus Operation Conditions for 3.3V Signaling

Table 3-10: Threshold Level for High Voltage Range

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

Table 3-11: Peak Voltage and Leakage Current

Parameter	Symbol	Min	Max.	Unit	Remarks
Peak voltage on all lines		-0.3	VDD+0.3	V	
All Inputs					
Input Leakage Current		-10	10	uA	
All Outputs					
Output Leakage Current		-10	10	uA	

Table 3-12: Threshold Level for 1.8V Signaling

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	V	
Input Low Voltage	V_{IL}	Vss-0.3	0.58	V	

Table 3-13: Input Leakage Current for 1.8V Signaling

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

3.3.2 Bus Signal Line Load

Figure 3-1: Bus Circuitry Diagram

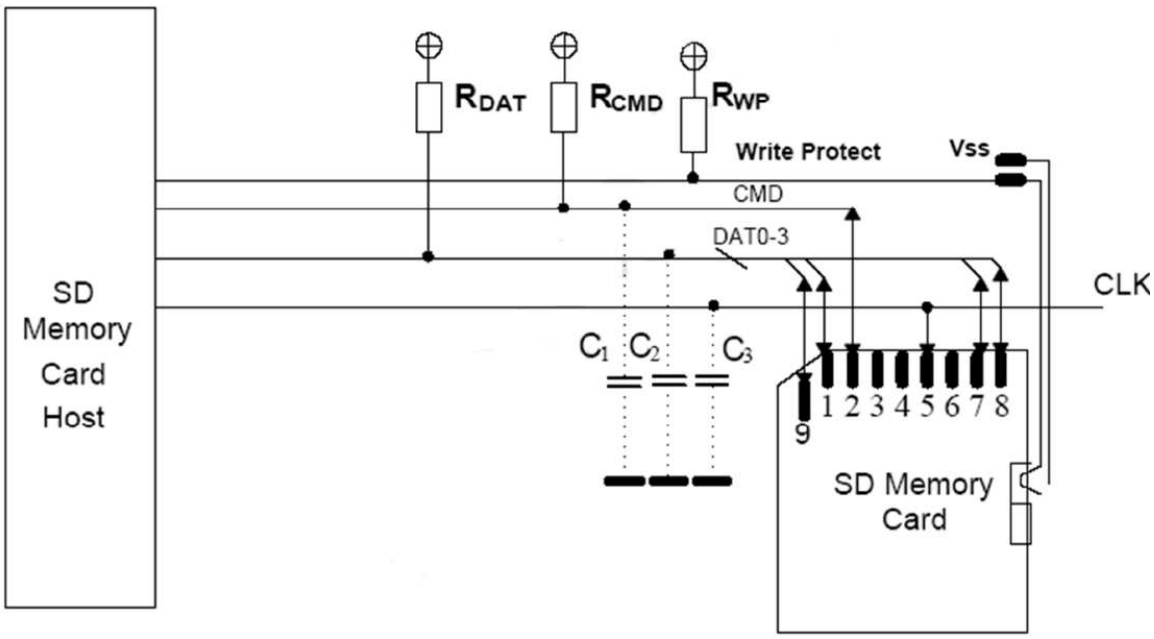


Table 3-14: Bus Operation Conditions – Signal Line's Load

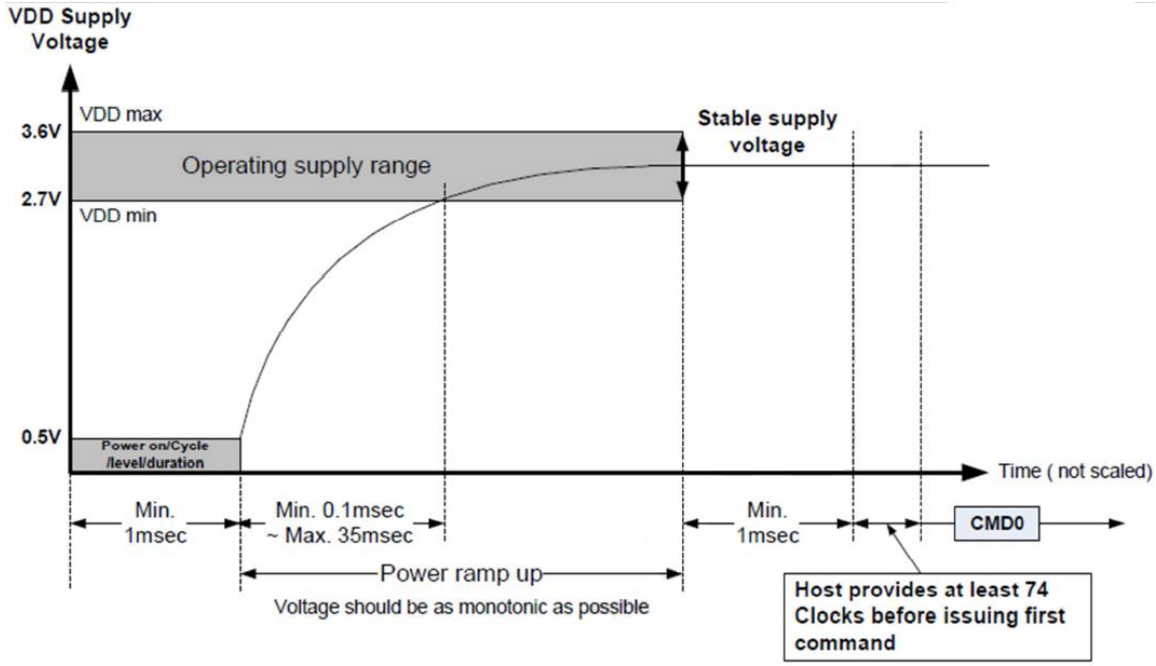
Parameter	Symbol	Min	Max	Unit	Remark
Pull-up resistance	R_{CMD} R_{DAT}	10	100	kΩ	To prevent bus floating
Total bus capacitance for each signal line	C_L		40	pF	1 card C_{HOST}+C_{BUS} shall not exceed 30 pF
Card Capacitance for each signal pin	C_{CARD}		10	pF	
Maximum signal line inductance			16	nH	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

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

3.3.3 Power Up Time of Host

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

Figure 3-2: Power Up Time of Host



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 recommendations 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.

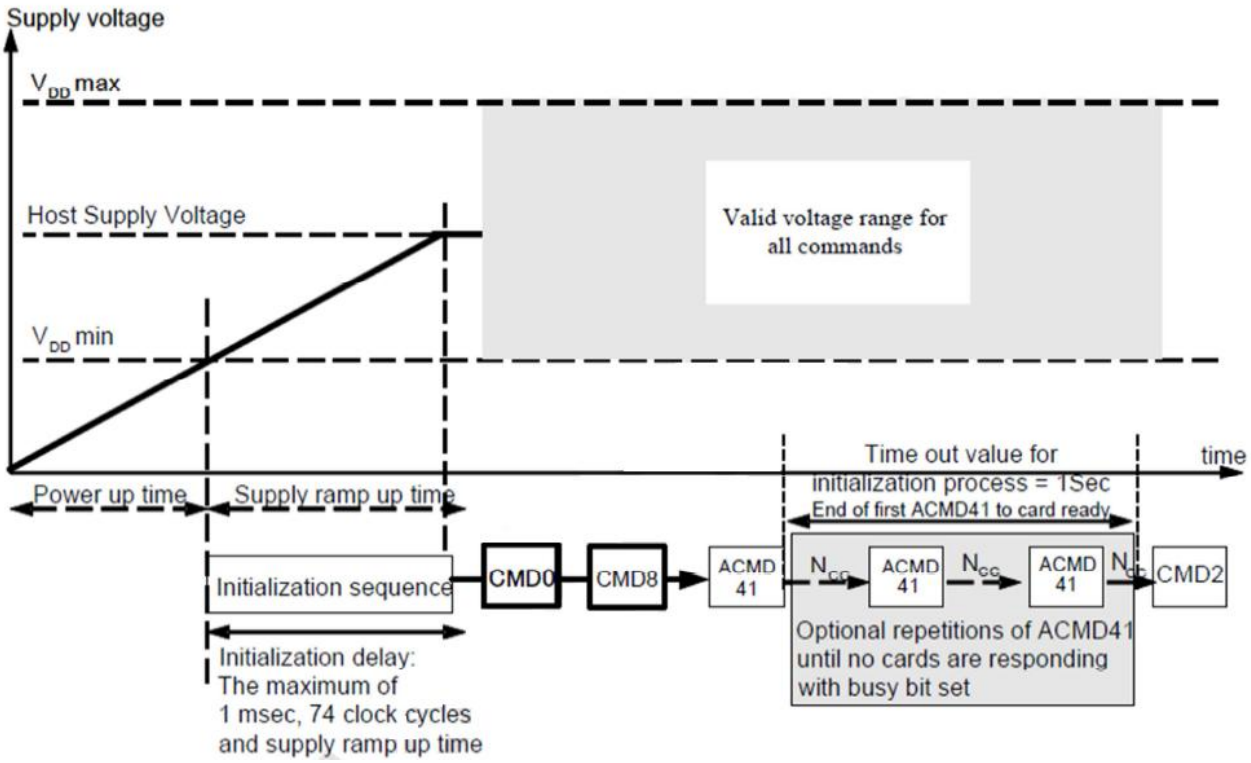
Power Down and Power Cycle

1. 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.
2. 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).

3.3.4 Power Up Time of Card

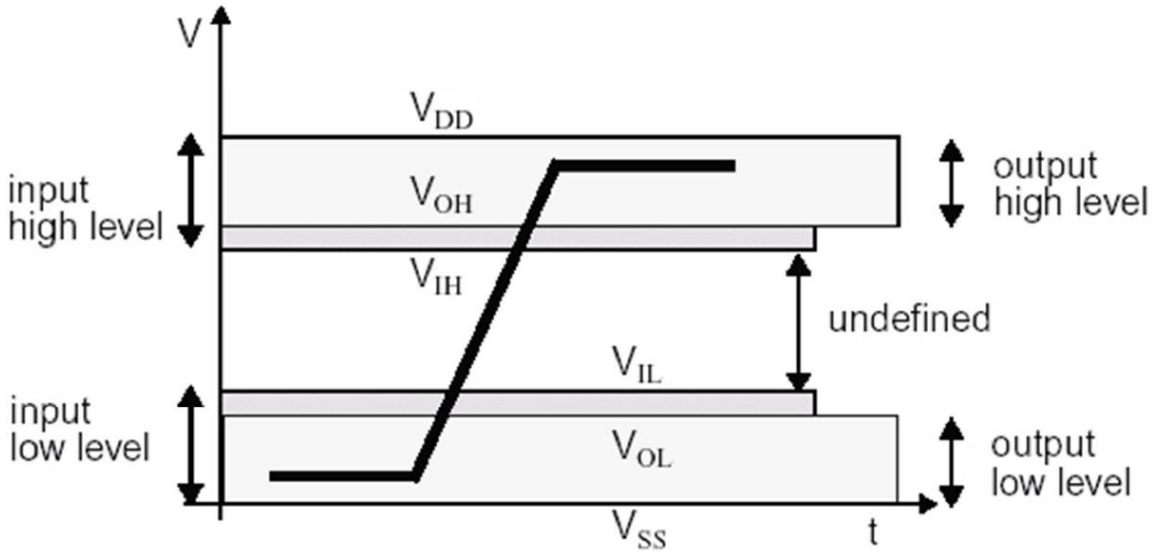
A device shall be ready to accept the first command within 1ms from detecting VDD min. Device may use up to 74 clocks for preparation before receiving the first command.

Figure 3-3: Power Up Time of Card



3.4 AC Characteristic

Figure 3-4: Voltage Levels



3.4.1 SD Interface Timing (Default)

Figure 3-5: Card Input Timing (Default Speed Card)

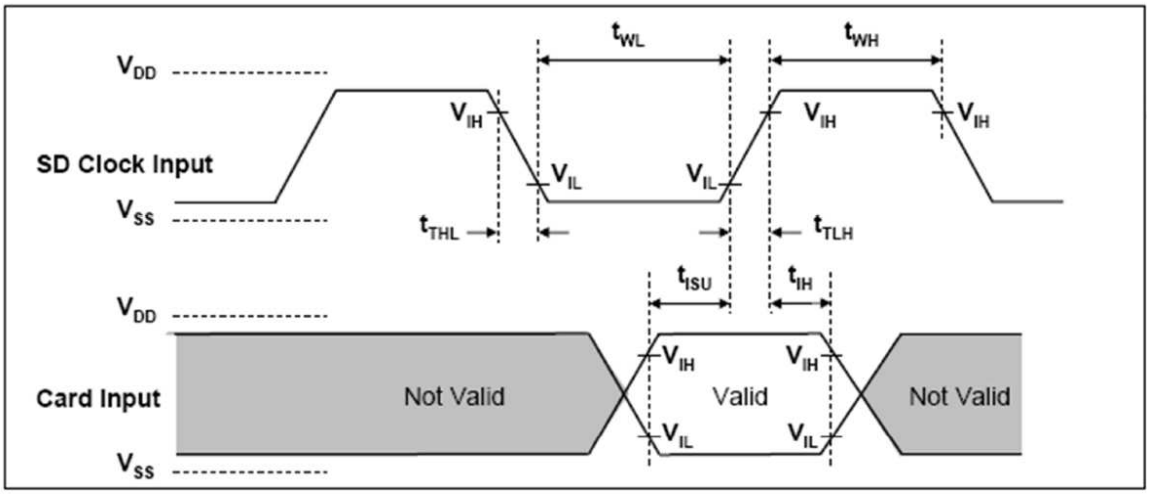


Figure 3-6: Card Output Timing (Default Speed Card)

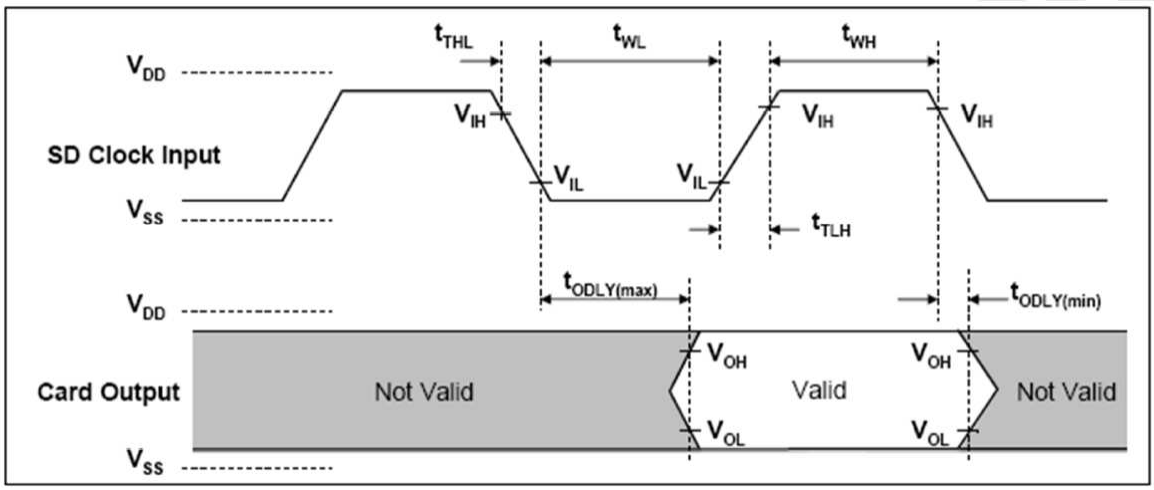


Table 3-15: Timing Specifications

Parameter	Symbol	Min	Max	Unit	Remark
Clock CLK (All values are referred to min(VIH) and max(VIL)					
Clock frequency Data Transfer Mode	fPP	0	25	MHz	C_{card}≤10 pF (1 card)
Clock frequency Identification Mode	f_{OD}	0(1)/100	400	kHz	C_{card}≤10 pF (1 card)
Clock low time	t_{WL}	10		ns	C_{card}≤10 pF (1 card)
Clock high time	t_{WH}	10		ns	C_{card}≤10 pF (1 card)
Clock rise time	t_{TLH}		10	ns	C_{card}≤10 pF (1 card)
Clock fall time	t_{THL}		10	ns	C_{card}≤10 pF (1 card)
Inputs CMD, DAT (referenced to CLK)					
Input set-up time	t_{ISU}	5		ns	C_{card}≤10 pF (1 card)
Input hold time	t_{IH}	5		ns	C_{card}≤10 pF (1 card)
Outputs CMD, DAT (referenced to CLK)					
Output Delay time during Data Transfer Mode	t_{ODLY}	0	14	ns	C_{card}≤40 pF (1 card)
Output Delay time during Identification Mode	t_{ODLY}	0	50	ns	C_{card}≤40 pF (1 card)

Notes:

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

3.4.2 SD Interface Timing (High-Speed Mode)

Figure 3-7: Card Input Timing (High Speed Card)

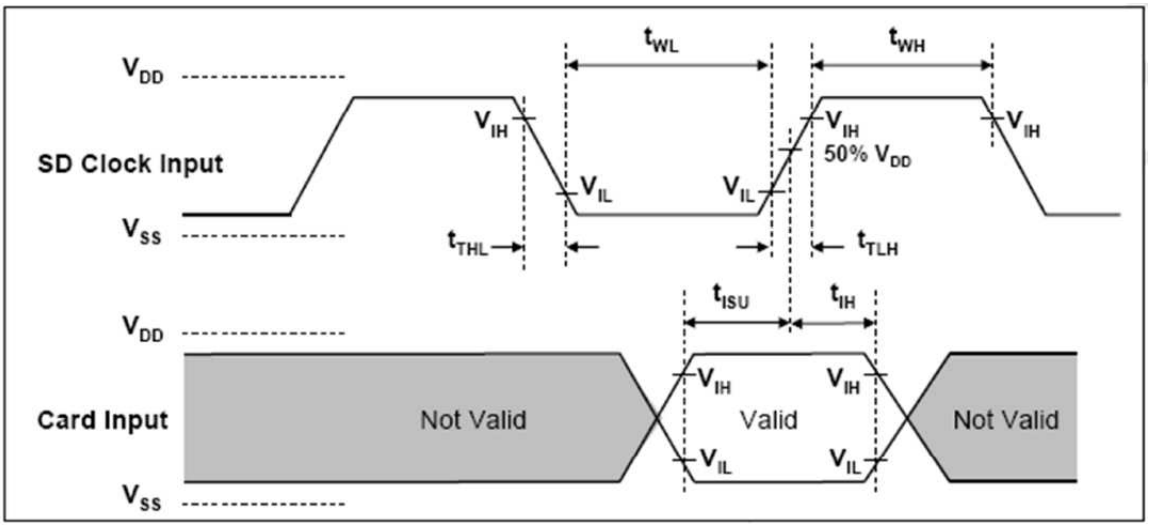


Figure 3-8: Card Output Timing (High Speed Card)