

**Amtron Technology, Inc.**

**Industrial Grade SD Card**

AD Series

Product Datasheet

V1.9

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## 1. INTRODUCTION

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### 1.1. Description

Amtron industrial grade AD series Secure Digital (SD) cards are fully compliant with SD Association SD Card specification 3.0. These SD cards are designed with the highest endurance Single Level Cell (SLC) NAND flash memory. SD cards built with economical yet durable and reliable pseudo SLC (pSLC) NAND flash and Multi Level Cell (MLC) NAND flash are also available. These SD cards are offered in industrial wide temperature grade (-40°C to +85°C), extended temperature grade (-25°C to +85°C), and standard temperature grade (0°C to +70°C). Memory capacities are available from 128MB to 32GB (SLC), 2GB to 256GB (pSLC), and 4GB to 512GB (MLC).

### 1.2. Product Features

- Single Level Cell (SLC) NAND Flash [Optional pSLC or MLC NAND flash]
- RoHS compliant [Lead free]
- Compliant with SD Association SD Card Specification 3.0
- Support SD SPI mode
- High speed:
  - SLC: Read 65 MB/s max., Write 55 MB/s max.
  - pSLC: Read 95 MB/s max., Write 90 MB/s max.
  - MLC: Read 95 MB/s max., Write 90 MB/s max.
- Endure severe thermal and dynamic environments
- Error detection and correction
- Very low power consumption
- MTBF > 3,000,000 hours
- Support S.M.A.R.T. Command
- Controlled Bill of Materials (BOM )

### 1.3. Product Overview

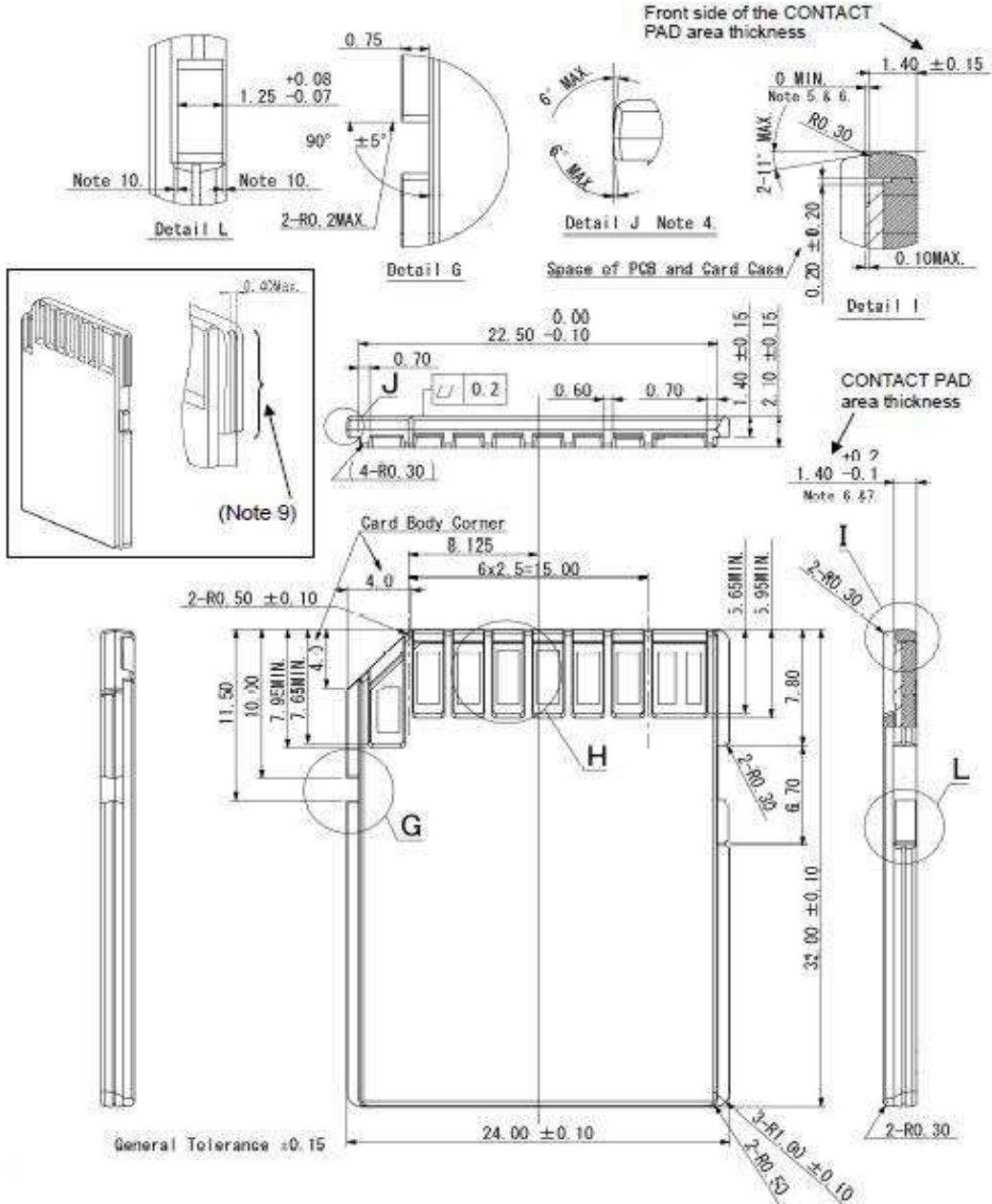
- **NAND Flash Type**
  - SLC, pSLC, MLC
- **Capacity**
  - SLC: 128MB up to 32GB
  - pSLC: 2GB up to 256GB
  - MLC: 4GB up to 512GB
- **Bus Speed Mode**
  - Non-UHS:
    - SLC: 128MB to 2GB
  - UHS-I:
    - SLC: 4GB to 32GB
    - pSLC: 2GB to 256GB
    - MLC: 4GB to 512GB
- **Performance**
  - SLC: Read 65 MB/s, Write 55 MB/s
  - pSLC: Read 95 MB/s, Write 90 MB/s
  - MLC: Read 95 MB/s, Write 90 MB/s
- **Power Consumption<sup>2</sup>**
  - Power Up Current < 250uA
  - Standby Current < 1000uA
  - Read Current < 400mA
  - Write Current < 400mA
- **MTBF<sup>1</sup>**
  - More than 3,000,000 hours
- **Advanced Flash Management**
  - Static and Dynamic Wear Leveling
  - Bad Block Management
  - SMART Function
  - Auto-Read Refresh
  - Embedded mode
  - PPMS
- **CPRM (Content Protection for Recordable Media)**
- **Temperature Range**
  - Operation (Standard): 0°C ~ 70°C
  - Operation (Extended): -25°C ~ 85°C
  - Operation (Industrial): -40°C ~ 85°C
  - Storage: -40°C ~ 85°C
- **Compliant**
  - RoHS
  - CE & FCC

#### Note:

1. 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 measure is typically in unit of hours. The higher the MTBF value, the higher the reliability of the product.
2. See Section 4.1 "Power Consumption" for details.

1.4. Product Dimension

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



## 2. PRODUCT SPECIFICATIONS



For all the following specifications, values are defined at ambient temperature and nominal supply voltage unless otherwise stated.

- **Capacity**
  - SLC: 128MB up to 32GB
  - pSLC: 2GB up to 256GB
  - MLC: 4GB up to 512GB
- **Operation Temp. Range**
  - Operation (Standard): 0°C ~ 70°C
  - Operation (Extended): -25°C ~ 85°C
  - Operation (Industrial): -40°C ~ 85°C
  - Storage: -40°C ~ 85°C
- **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

**Note:** SDHC card (≤ 2GB) only supports non-UHS mode.
  - **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
    - DDR50: 1.8V signaling, frequency up to 50MHz, sampled on both clock edges, up to 50 MB/sec
    - SDR104: 1.8V signaling, frequency up to 208MHz, up to 104 MB/sec

**Note:** Timing in 1.8V signaling is different from that of 3.3V signaling.
- **The command list supports [Part 1 Physical Layer Specification Ver3.01 Final] definitions**

- **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)**
- **+4KV/-4KV ESD protection in contact pads**
- **Operation voltage range: 2.7 ~ 3.6V**
- **Performance**

■ **SLC:**

Capacity	mode	Flash Structure	Flash Type	Sequential	
				Read (MB/s)	Write (MB/s)
128MB	Class 2	128MB x 1	24nm	20	4
256MB	Class 6	256MB x 1	24nm	20	9
512MB	Class 6	256MB x 2	24nm	20	20
		512MB x 1		20	15
1GB	Class 6	512MB x 2	24nm	20	20
		1GB x 1	32nm	20	15
2GB	Class 6	1GB x 2	32nm	20	20
4GB	UHS-I (Class 10)	1GB x 4	32nm	65	40
		4GB x 1	24nm	30	25
8GB	UHS-I (Class 10)	4GB x 2	24nm	65	50
16GB	UHS-I (Class 10)	4GB x 4	24nm	65	55
32GB	UHS-I (Class 10)	4GB x 8	24nm	65	55

■ pSLC:

Capacity	mode	Flash Structure	Flash Type	Sequential	
				Read (MB/s)	Write (MB/s)
2GB	Class 6	4GB x 1	15nm	20	20
4GB	UHS-I (Class 10)	8GB x 1	15nm	90	45
8GB	UHS-I (Class 10)	8GB x 2 16GB x 1	15nm	95 95	90 75
16GB	UHS-I (Class 10)	8GB x 4 16GB x 2	15nm	95 95	90 90
32GB	UHS-I (Class 10)	8GB x 8 16GB x 4	15nm	95	90
64GB	UHS-I (Class 10)	16GB x 8	15nm	95	90
128GB	UHS-I (Class 10)	16GB x 16	15nm	95	90
256GB	UHS-I (Class 10)	16GB x 32	15nm	95	90



■ MLC

Capacity	mode	Flash Structure	Flash Type	Sequential	
				Read (MB/s)	Write (MB/s)
4GB	UHS-I (Class 10)	4GB x 1	15nm	90	10
8GB	UHS-I (Class 10)	8GB x 1	15nm	95	20
16GB	UHS-I (Class 10)	8GB x 2	15nm	95	45
		16GB x 1		95	20
32GB	UHS-I (Class 10)	8GB x 4	15nm	95	90
		16GB x 2		95	45
64GB	UHS-I (Class 10)	16GB x 4	15nm	95	90
128GB	UHS-I (Class 10)	16GB x 8	15nm	95	90
256GB	UHS-I (Class 10)	16GB x 16	15nm	95	90
512GB	UHS-I (Class 10)	16GB x 32	15nm	95	90

## 3. ENVIRONMENTAL SPECIFICATIONS ■ ■ ■

### 3.1. Environmental Conditions

#### *Temperature and Humidity*

- Storage Temperature Range
  - -40°C ~ 85°C
- Operation Temperature Range
  - Standard Temperature: -25°C ~ 85°C
  - Wide Temperature: -40°C ~ 85°C

**Table 3-1 High Temperature Test Condition (Standard)**

	Temperature	Humidity	Test Time
<b>Operation</b>	85°C	0% RH	168 hours
<b>Storage</b>	85°C	0% RH	500 hours

**Result:** No any abnormality is detected.

**Table 3-2 High Temperature Test Condition (Wide)**

	Temperature	Humidity	Test Time
<b>Operation</b>	85°C	0% RH	300 hours
<b>Storage</b>	85°C	0% RH	500 hours

**Result:** No any abnormality is detected.

**Table 3-3 Low Temperature Test Condition (Standard)**

	Temperature	Humidity	Test Time
<b>Operation</b>	-25°C	0% RH	168 hours
<b>Storage</b>	-40°C	0% RH	300 hours

**Result:** No any abnormality is detected.

**Table 3-4 Low Temperature Test Condition (Wide)**

	Temperature	Humidity	Test Time
<b>Operation</b>	-40°C	0% RH	168 hours
<b>Storage</b>	-40°C	0% RH	500 hours

**Result:** No any abnormality is detected.

**Table 3-5 High Humidity Test Condition**

	Temperature	Humidity	Test Time
<b>Operation</b>	40°C	95% RH	4 hours
<b>Storage</b>	40°C	95% RH	500 hours

**Result:** No any abnormality is detected.

**Table 3-6 High Humidity Test Condition**

	Temperature	Humidity	Test Time
<b>Operation</b>	55°C	95% RH	4 hours
<b>Storage</b>	55°C	95% RH	500 hours

**Result:** No any abnormality is detected.

**Table 3-7 Temperature Cycle Test (Standard)**

	Temperature	Test Time	Cycle
<b>Operation</b>	-25°C	30 min	20 Cycles
	85°C	30 min	
<b>Storage</b>	-40°C	30 min	20 Cycles
	85°C	30 min	

**Result:** No any abnormality is detected.

**Table 3-8 Temperature Cycle Test (Wide)**

	Temperature	Test Time	Cycle
<b>Operation</b>	-40°C	30 min	20 Cycles
	85°C	30 min	
<b>Storage</b>	-40°C	30 min	50 Cycles
	85°C	30 min	

**Result:** No any abnormality is detected.

**Shock**

**Table 3-9 Shock Specification**

	Acceleration Force	Half Sin Pulse Duration
Industrial SD card	1500G	0.5ms

**Result:** No any abnormality is detected when power on.

**Vibration**

**Table 3-10 Vibration Specification**

	Condition		Vibration Orientation
	Frequency/Displacement	Frequency/Acceleration	
Industrial SD card	20Hz~80Hz/1.52mm	80Hz~2000Hz/20G	X, Y, Z axis/30 min for each

**Result:** No any abnormality is detected when power on.

**Drop**

**Table 3-11 Drop Specification**

	Height of Drop	Number of Drop
Industrial SD card	150cm free fall	6 face of each unit

**Result:** No any abnormality is detected when power on.

**Bending**

**Table 3-12 Bending Specification**

	Force	Action
Industrial SD card	≥ 10N	Hold 1min/5times

**Result:** No any abnormality is detected when power on.

**Torque**

**Table 3-13 Torque Specification**

	Force	Action
Industrial SD card	0.15N-m or +/-2.5 deg	Hold 30 seconds/5times

**Result:** No any abnormality is detected when power on.

**Salt Spray Test**

**Table 3-14 Salt Spray Test**

	Temperature	Concentration	Duration
Industrial SD card	35°C	3% NaCl	Storage for 24 hours

**Result:** No any abnormality is detected when power on.

**Waterproof Test**

**Table 3-15 Waterproof Test**

	Condition	Duration
Industrial SD card	Water temperature: 25°C Water depth: The lowest point of unit is locating 1000mm below surface.	Submerge for 30 minutes

**Result: JIS IPX7 compliance.** No any abnormality is detected when power on

**X-Ray Exposure Test**

**Table 3-16 X-Ray Exposure Test**

	Condition	Duration
Industrial SD card	0.1 Gy of medium energy radiation (70 keV to 140keV, cumulative does per year) to both sides of the card.	Storage for 30mins

**Result: ISO 7816-1 compliance.** No any abnormality is detected when power on

**Switch Cycle Test**

**Table 3-17 Switch Cycle Test**

	Applied Force	Result
Industrial SD card	0.4~0.5 N 1000 times	PASS

**Result:** No any abnormality is detected when power on

**Durability Test**

**Table 3-18 Durability Test**

	Mating cycle	Result
Industrial SD card	10000 times	PASS

**Result:** No any abnormality is detected when power on

**Electrostatic Discharge (ESD)****Table 3-19 Contact ESD Specification**

	Condition	Result
Industrial SD card	Contact: +/- 4KV each item 25 times Air: +/- 8KV 10 times	PASS

**3.2. Certification**

- RoHS
- CE / FCC

## 4. ELECTRICAL SPECIFICATIONS



### 4.1. Power Consumption

The table below is the power consumption of SD card with different flash memory types.

**Table 4-1 Power Consumption of Industrial SD card**

Flash Mode	Max. Standby Current (uA)	Max. Read Current (mA)	Max. Write Current (mA)
SLC	1000	400	400
pSLC	1000	400	400
MLC	1000	400	400

Note:

1. Data transfer mode is single channel.
2. Power consumption may differ according to flash configuration, SDR configuration, or platform

### 4.2. DC Characteristic

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

**Table 4-2 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

**Table 4-3 Peak Voltage and Leakage Current**

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

Table 4-4 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	2.00	V	
Input Low Voltage	$V_{IL}$	$V_{SS}-0.3$	0.58	V	

Table 4-5 Input Leakage Current for 1.8V Signaling

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

4.2.2. Bus Signal Line Load

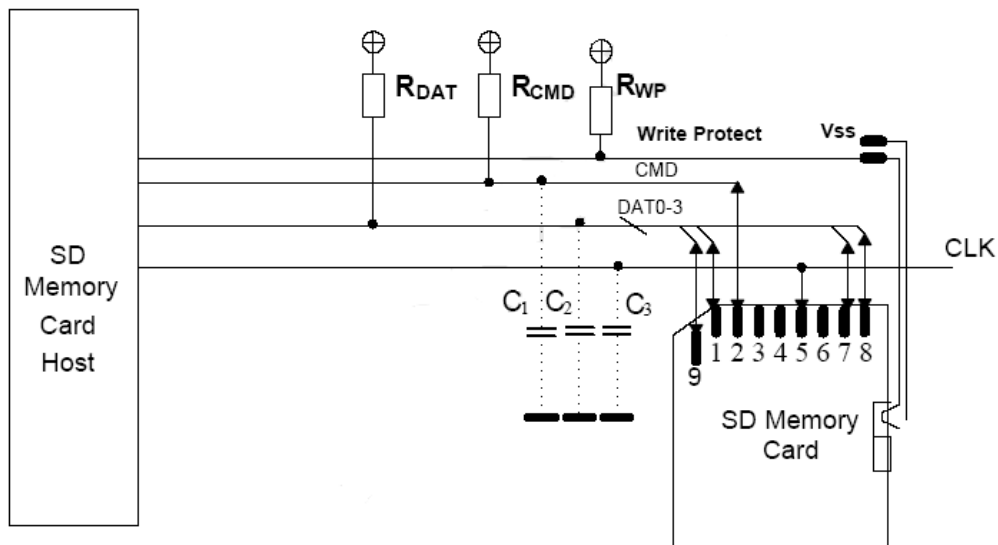


Figure 4-1 Bus Circuitry Diagram



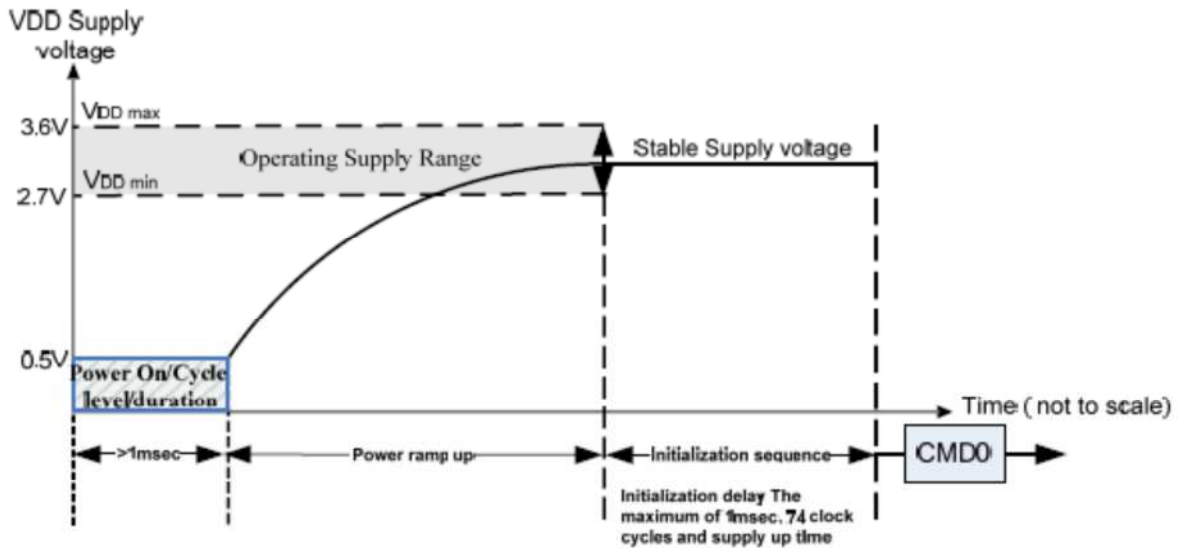
**Bus Operation Conditions – Signal Line’s Load**

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 $\Omega$	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)	RDAT3	10	90	k $\Omega$	May be used for card detection
Capacity Connected to Power Line	$C_C$		5	$\mu$ F	To prevent inrush current

**4.2.3. Power Up Time**

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  $V_{DD}$  (min.) and  $V_{DD}$  (max.) and host can supply SDCLK.

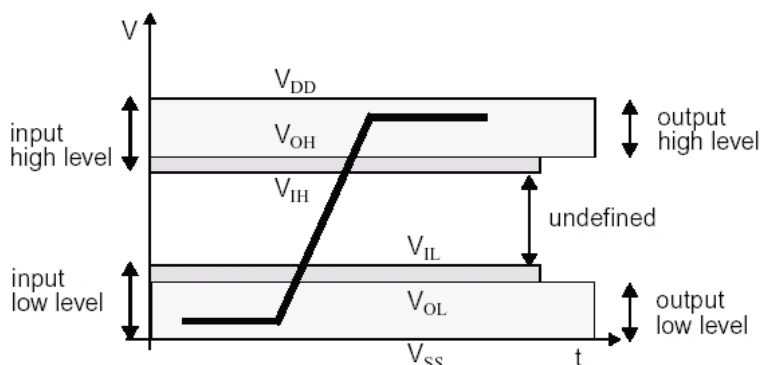
Followings are recommendations of Power ramp up:

- (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.

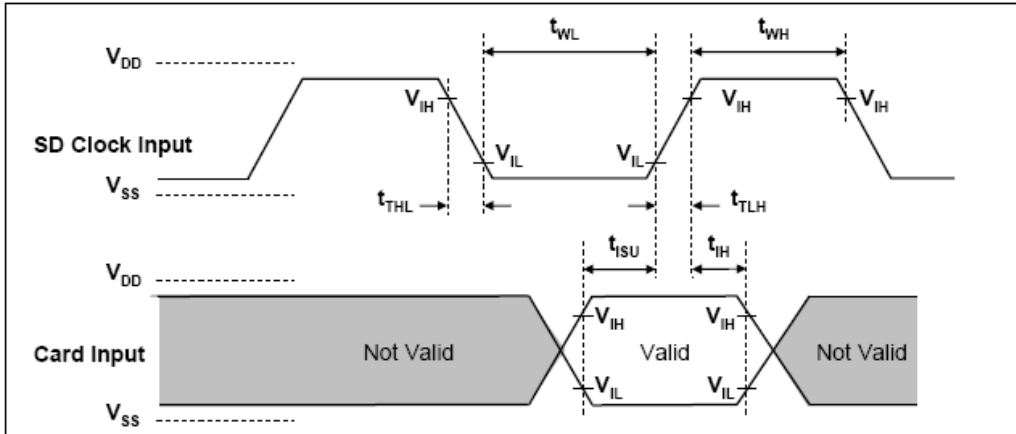
**Power Down and Power Cycle**

- (1) When the host shuts down the power, the card  $V_{DD}$  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  $V_{DD}$  shall be once lowered to less than 0.5Volt for a minimum period of 1ms).

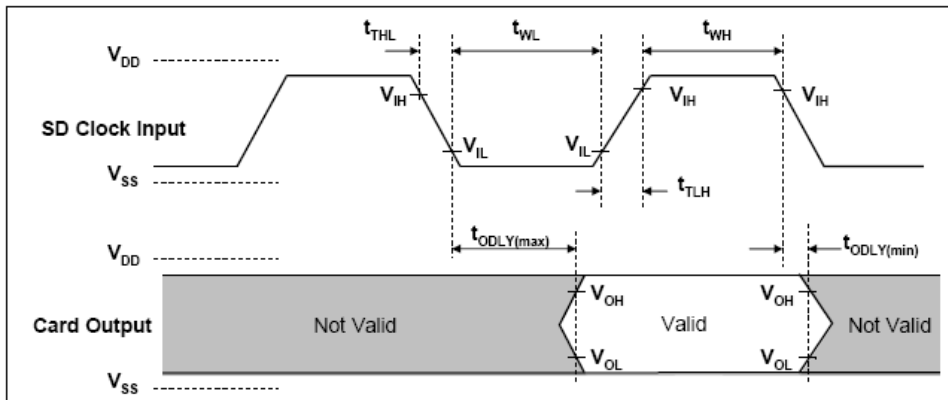
**4.3.AC Characteristic**



4.3.1. SD Interface Timing (Default)



Card Input Timing (Default Speed Card)



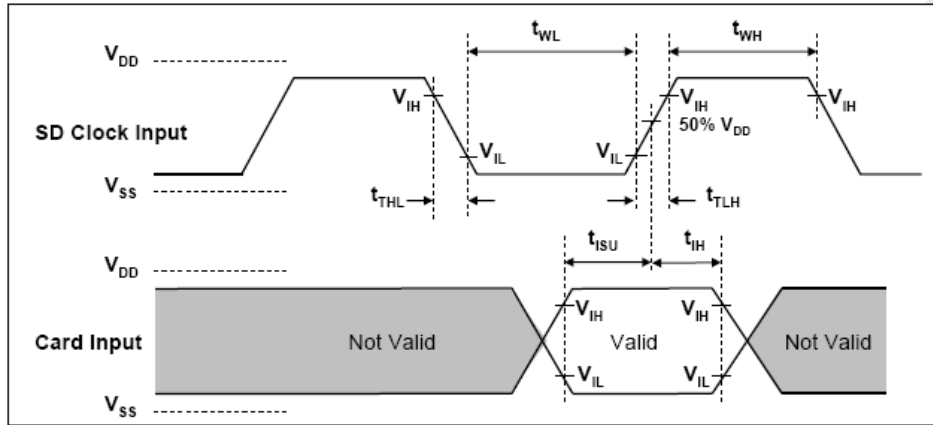
Card Output Timing (Default Speed Mode)

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)

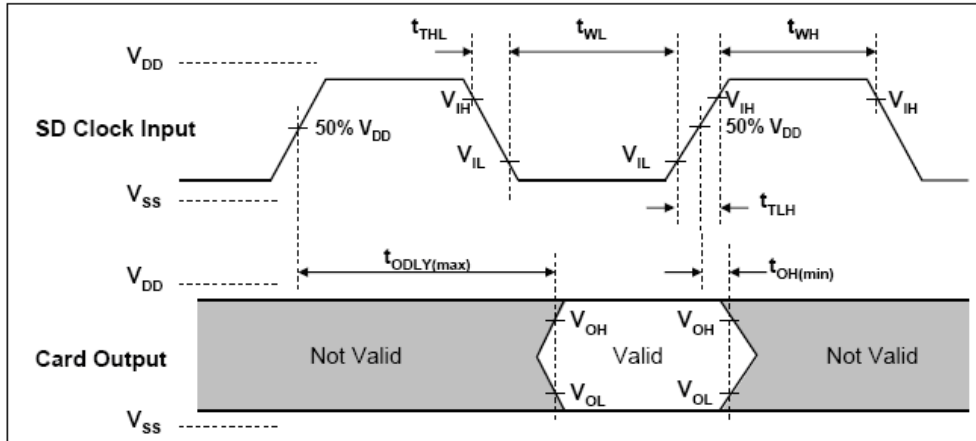
Outputs CMD, DAT (referenced to CLK)					
Output Delay time during Data Transfer Mode	$t_{ODLY}$	0	14	ns	$C_L \leq 40$ pF (1 card)
Output Delay time during Identification Mode	$t_{ODLY}$	0	50	ns	$C_L \leq 40$ pF (1 card)

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

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



Card Input Timing (High Speed Card)



Card Output 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	$C_{card} \leq 10$ pF (1 card)
Clock low time	$t_{WL}$	7		ns	$C_{card} \leq 10$ pF (1 card)
Clock high time	$t_{WH}$	7		ns	$C_{card} \leq 10$ pF (1 card)
Clock rise time	$t_{TLH}$		3	ns	$C_{card} \leq 10$ pF

					(1 card)
Clock fall time	$t_{THL}$		3	ns	$C_{card} \leq 10 \text{ pF}$ (1 card)
<b>Inputs CMD, DAT (referenced to CLK)</b>					
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)
<b>Outputs CMD, DAT (referenced to CLK)</b>					
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 <sup>1</sup>	$C_L$		40	pF	$C_L \leq 15 \text{ pF}$ (1 card)

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

### 4.3.3. SD Interface Timing (SDR12, SDR25 and SDR50 Modes)

#### Input

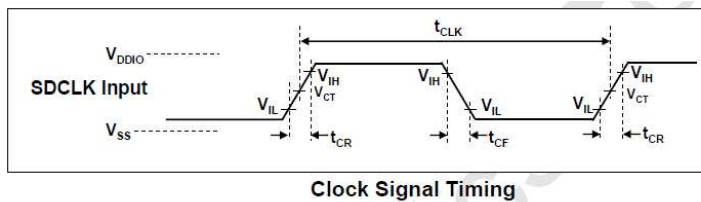
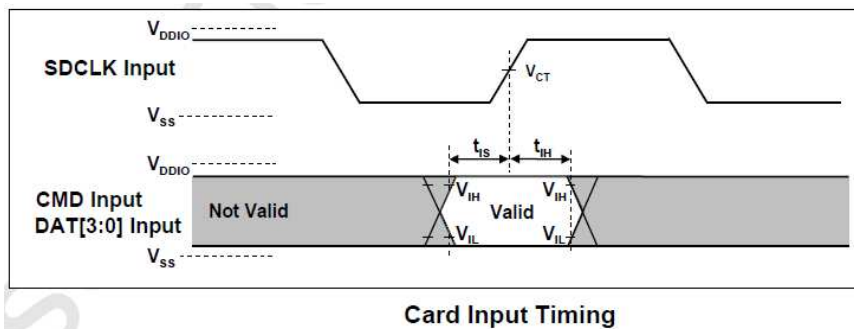


Table 4-6 Clock Signal Timing

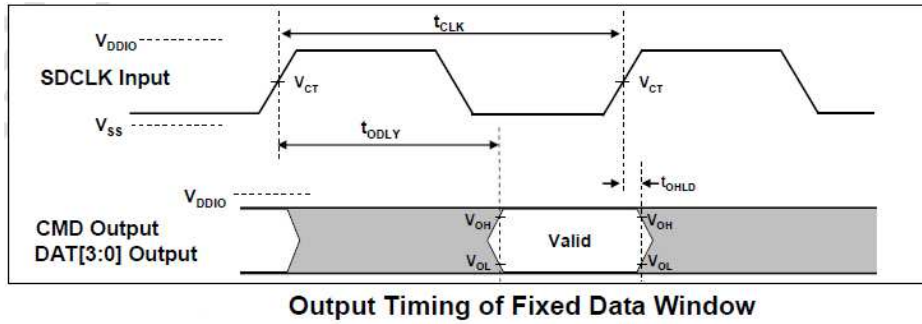
Symbol	Min	Max	Unit	Remark
$t_{CLK}$	4.80	-	ns	208MHz (Max.), Between rising edge, $V_{CT} = 0.975V$
$t_{CR}, t_{CF}$	-	$0.2 * t_{CLK}$	ns	$t_{CR}, t_{CF} < 2.00ns$ (max.) at 100MHz, $C_{CARD} = 10pF$
Clock Duty	30	70	%	

#### SDR50 Input Timing



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

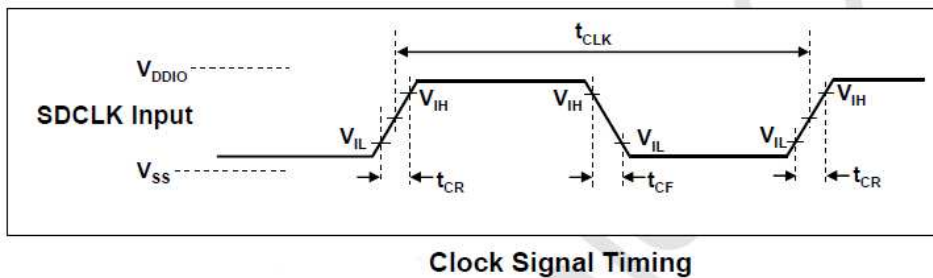
**Output**



**Table 4-7 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.), $C_L = 15pF$

**4.3.4.SD Interface Timing (DDR50 Mode)**



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	%	

**Table 4-8 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. INTERFACE



### 5.1. Pad Assignment and Descriptions

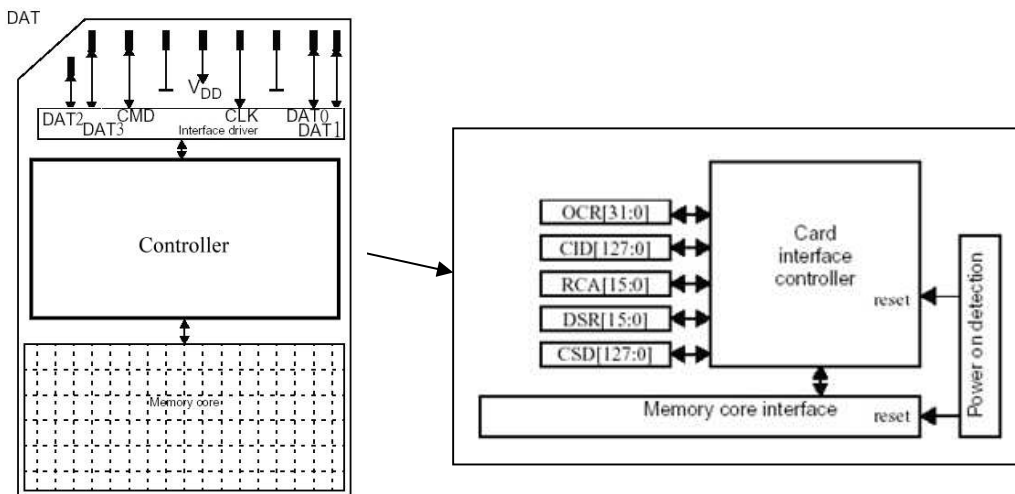


Table 5-1 SD Memory Card Pad Assignment

pin	SD Mode			SPI Mode		
	Name	Type <sup>1</sup>	Description	Name	Type	Description
1	CD/DAT3 <sup>2</sup>	I/O/PP <sup>3</sup>	Card Detect/ Data Line[bit3]	CS	I <sup>3</sup>	Chip Select (net true)
2	CMD	PP	Command/Response	DI	I	Data In
3	V <sub>SS1</sub>	S	Supply voltage ground	V <sub>SS</sub>	S	Supply voltage ground
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>SS2</sub>	S	Supply voltage ground	V <sub>SS2</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		
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 Card (MMC).
- (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.



Name	Width	Description
CID	128bit	Card identification number; card individual number for identification. <b>Mandatory</b>
RCA <sup>1</sup>	16bit	Relative card address; local system address of a card, dynamically suggested by the card and approved by the host during initialization. <b>Mandatory</b>
DSR	16bit	Driver Stage Register; to configure the card's output drivers. <b>Optional</b>
CSD	128bit	Card Specific Data; information about the card operation conditions. <b>Mandatory</b>
SCR	64bit	SD Configuration Register; information about the SD Memory Card's Special Features capabilities. <b>Mandatory</b>
OCR	32bit	Operation conditions register. <b>Mandatory</b>
SSR	512bit	SD Status; information about the card proprietary features. <b>Mandatory</b>
OCR	32bit	Card Status; information about the card status. <b>Mandatory</b>

Note:

(1) RCA register is not used (or available) in SPI mode.

## 6. PART NUMBER DECODER



SDC-ADX<sup>1</sup>X<sup>2</sup>X<sup>3</sup>X<sup>4</sup>X<sup>5</sup>X<sup>6</sup>X<sup>7</sup>

Item	Series	Capacity	NAND Flash & Temperature Grade	Class	Option
		X <sup>1</sup> X <sup>2</sup> X <sup>3</sup> X <sup>4</sup>	X <sup>5</sup>	X <sup>6</sup>	X <sup>7</sup>
SDC	AD	<b>128M</b> (128MB)	<b>C</b> : SLC Standard (0°C ~ +70°C) <b>D</b> : SLC Extended (-25°C ~ +85°C) <b>I</b> : SLC Industrial (-40°C ~ +85°C) <b>K</b> : MLC Standard (0°C ~ +70°C) <b>L</b> : MLC Extended (-25°C ~ +85°C) <b>M</b> : MLC Industrial (-40°C ~ +85°C) <b>P</b> : pSLC Standard (0°C ~ +70°C) <b>Q</b> : pSLC Extended (-25°C ~ +85°C) <b>F</b> : pSLC Industrial (-40°C ~ +85°C)	<b>2</b> : Class 2 <b>4</b> : Class 4 <b>6</b> : Class 6 <b>A</b> : Class 10 <b>S</b> : UHS-I Class 1 <b>T</b> : UHS-I Class 3	
		<b>256M</b> (256MB)			
		<b>512M</b> (512MB)			
		<b>001G</b> (1GB)			
		<b>002G</b> (2GB)			
		<b>004G</b> (4GB)			
		<b>008G</b> (8GB)			
		<b>016G</b> (16GB)			
		<b>032G</b> (32GB)			
		<b>064G</b> (64GB)			
		<b>128G</b> (128GB)			
		<b>256G</b> (256GB)			
		<b>512G</b> (512GB)			
<p><b>X<sup>7</sup></b> Reserved for specific requirement (Blank) standard</p>					