Amtron Technology, Inc.

Industrial Grade microSD Card

AD Series

Product Datasheet

V2.1

Table of Contents

1. INTRODUCTION

1.1. Description

Amtron industrial grade AD series micro Secure Digital (microSD) cards are fully compliant with SD Association SD Card specification 3.0. These microSD cards are designed with the highest endurance single-level cell (SLC) NAND flash memory. Industrial grade microSD cards built with economical yet durable and reliable pseudo SLC (pSLC) NAND flash, multi-level Cell (MLC) NAND flash, and triple-level cell (TLC) are also available. These microSD 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 4GB (SLC), 2GB to 64GB (pSLC), 4GB to 128GB (MLC), and 4GB to 256GB (TLC).

1.2. Product Features

- Single Level Cell (SLC) NAND Flash [Optional pSLC, MLC, and TLC NAND flash]
- RoHS compliant [Lead free]
- Compliant with SD Association SD Card Specification 3.0
- Support SD SPI mode
- High speed:
  - SLC: Read 50 MB/s max., Write 40 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.
  - TLC: Read 90 MB/s max., Write 30 MB/s max.
- Endure severe thermal and dynamic environments
- Error detection and correction
- Very low power consumption
- MTBF > 3,000,000 hours (SLC)
- Support S.M.A.R.T. Command
- Controlled Bill of Materials (BOM)

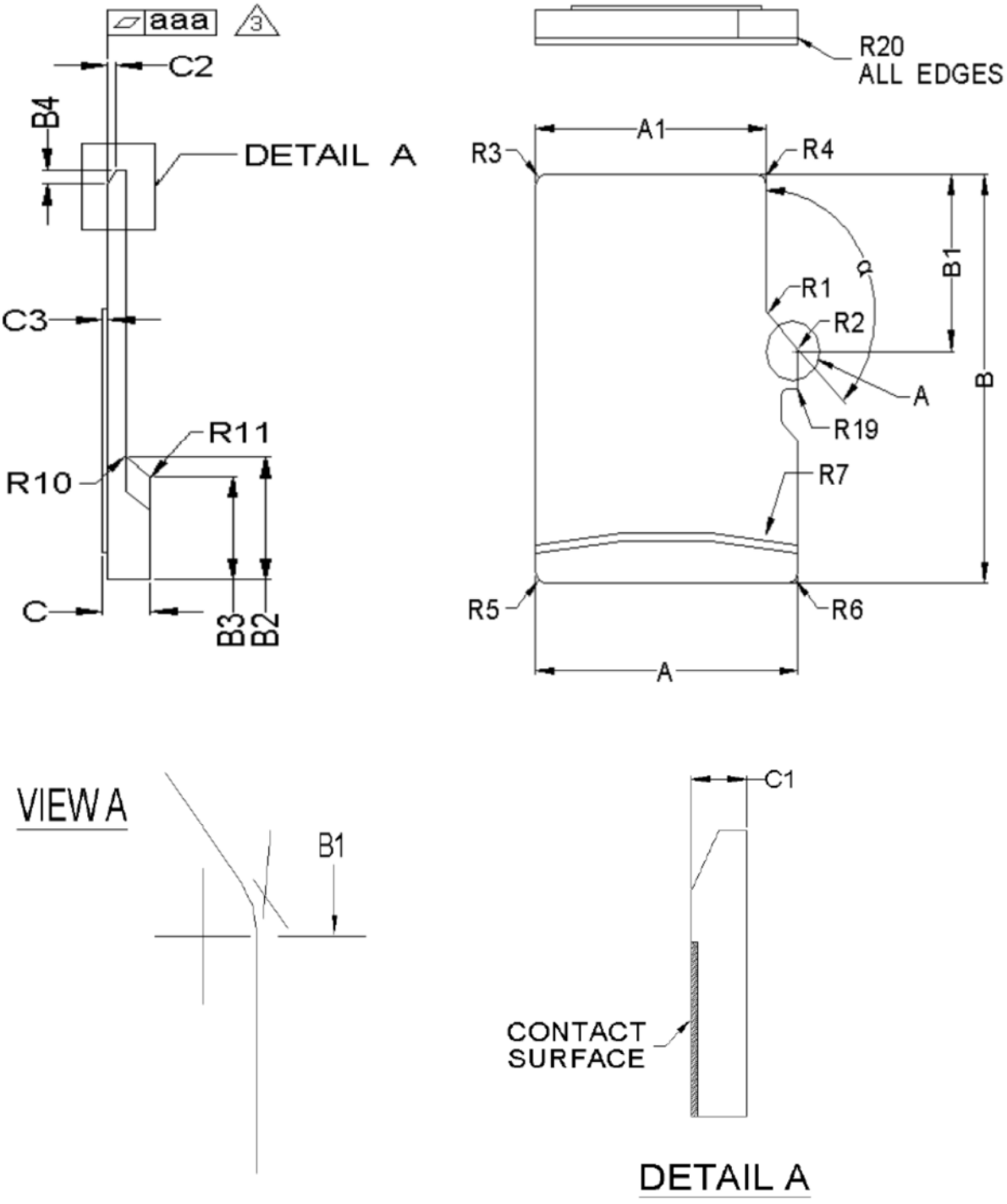
1.3. Product Overview

- **NAND Flash Type**
  - SLC, pSLC, MLC, TLC
- **Capacity**
  - SLC: 128MB up to 4GB
  - pSLC: 2GB up to 64GB
  - MLC: 4GB up to 128GB
  - TLC: 4GB up to 256GB
- **Bus Speed Mode**
  - Non-UHS: 128MB to 2GB
  - UHS-I: 4GB to 256GB
- **Performance**
  - SLC: Read 50 MB/s, Write 40 MB/s
  - pSLC: Read 95 MB/s, Write 90 MB/s
  - MLC: Read 95 MB/s, Write 90 MB/s
  - TLC: Read 90 MB/s, Write 30 MB/s
- **Power Consumption** [2]
  - Power Up Current < 250uA
  - Standby Current < 1000uA
  - Read Current < 400mA
  - Write Current < 400mA
- **MTBF** [1]
  - More than 3,000,000 hours (SLC)
- **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 (Wide): -40°C ~ 85°C
  - Storage: -40°C ~ 85°C
- **Compliant**
  - RoHS
  - CE & FCC

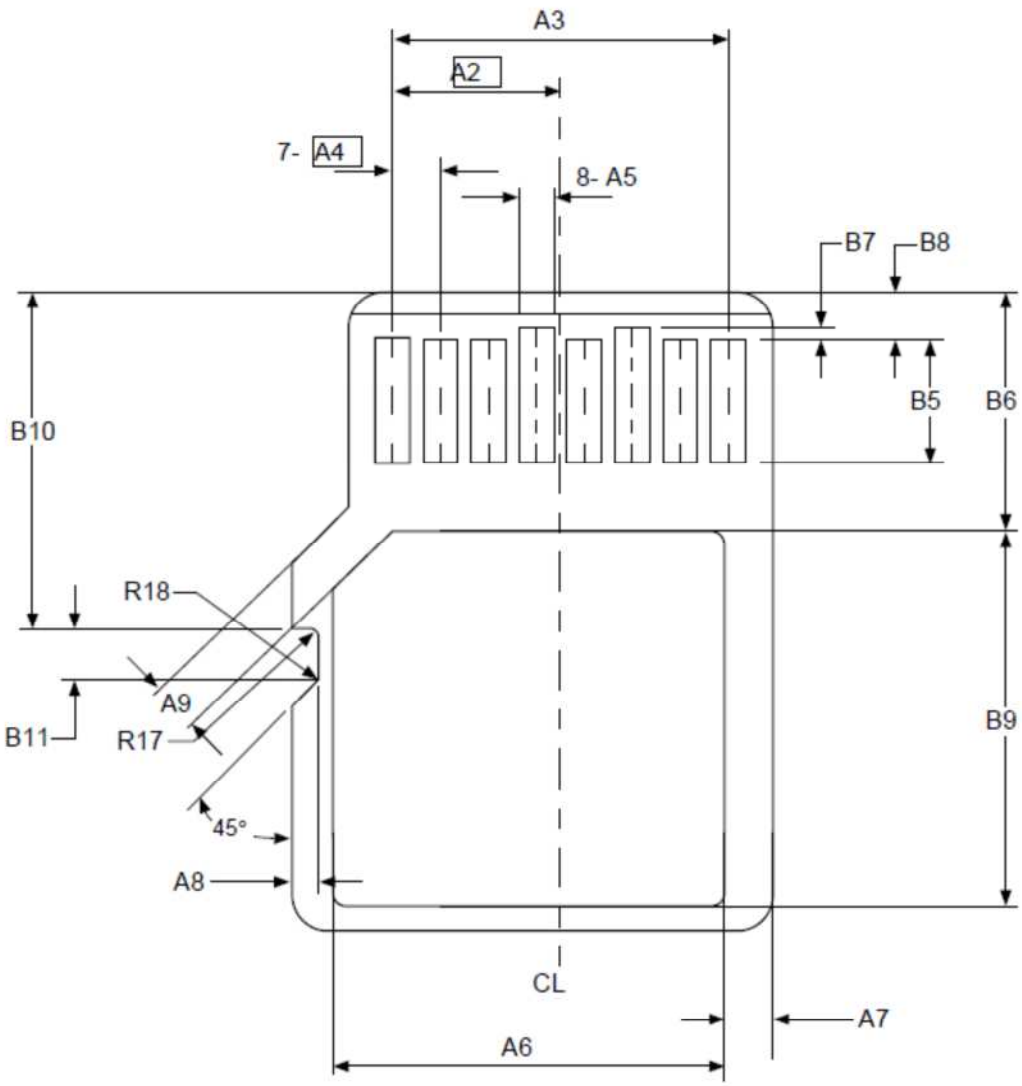
Note:

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



Top View



Bottom 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	7.80	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	0.00	-	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	4	-	0.15	
α	133°	135°	137°	
aaa			0.10	

Notes :

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M - 1994.
2. DIMENSIONS ARE IN MILLIMETERS.
3. COPLANARITY IS ADDITIVE TO C1 MAX THICKNESS.
4. ALL EDGES SHALL NOT BE SHARP AS TESTED PER UL1439 "Test for Sharpness of Edges on Equipment."
5. Refer to Appendix E about test method of warpage.

2. PRODUCT SPECIFICATIONS

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

- **Capacity**
  - SLC: 128MB to 4GB
  - pSLC: 2GB to 64GB
  - MLC: 4GB to 128GB
  - TLC: 4GB to 256GB
- **Operation Temperature Range**
  - Operation (Standard): 0°C to 70°C
  - Operation (Extended): -25°C to 85°C
  - Operation (Wide): -40°C to 85°C
  - Storage: -40°C to 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 microSD 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	SIP	16	4
256MB	Class 6	256MB x 1	SIP	16	10
512MB	Class 6	512MB x 1	SIP	16	10
1GB	Class 6	512MB x 2	SIP	18	10
2GB	Class 6	512MB x 4	SIP	20	20
4GB	UHS-I (Class 10)	512MB x 8	SIP	50	40

- **pSLC:**

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

- **MLC**

Capacity	mode	Flash Structure	Flash Type	Sequential	
				Read (MB/s)	Write (MB/s)
4GB	UHS-I (Class 10)	4GB x 1	SIP	90	10
8GB	UHS-I (Class 10)	8GB x 1	SIP	95	20
16GB	UHS-I (Class 10)	8GB x 2 16GB x 1	SIP	95 95	45 20
32GB	UHS-I (Class 10)	8GB x 4 16GB x 2	SIP	95 95	90 45
64GB	UHS-I (Class 10)	8GB x 8	SIP	95	90
128GB	UHS-I (Class 10)	8GB x 16	SIP	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
Operation	85°C	0% RH	168 hours
Storage	85°C	0% RH	500 hours

Result: No abnormality is detected.

Table 3-2 High Temperature Test Condition (Wide)

	Temperature	Humidity	Test Time
Operation	85°C	0% RH	300 hours
Storage	85°C	0% RH	500 hours

Result: No abnormality is detected.

Table 3-3 Low Temperature Test Condition (Standard)

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

Result: No abnormality is detected.

Table 3-4 Low Temperature Test Condition (Wide)

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

Result: No abnormality is detected.

Table 3-5 High Humidity Test Condition

	Temperature	Humidity	Test Time
Operation	40°C	95% RH	4 hours
Storage	40°C	95% RH	500 hours

Result: No abnormality is detected.

Table 3-6 High Humidity Test Condition

	Temperature	Humidity	Test Time
Operation	55°C	95% RH	4 hours
Storage	55°C	95% RH	500 hours

Result: No abnormality is detected.

Table 3-7 Temperature Cycle Test (Standard)

	Temperature	Test Time	Cycle
Operation	-25°C	30 min	20 Cycles
	85°C	30 min	
Storage	-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
Operation	-40°C	30 min	20 Cycles
	85°C	30 min	
Storage	-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 microSD card	1500G	0.5ms

Result: No abnormality is detected when power on.

Vibration

Table 3-10 Vibration Specification

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

Result: No abnormality is detected when power on.

Drop

Table 3-11 Drop Specification

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

Result: No abnormality is detected when power on.

Bending

Table 3-12 Bending Specification

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

Result: No abnormality is detected when power on.

Torque

Table 3-13 Torque Specification

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

Result: No abnormality is detected when power on.

Salt Spray Test

Table 3-14 Salt Spray Test

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

Result: No abnormality is detected when power on.

Waterproof Test

Table 3-15 Waterproof Test

	Condition	Duration
Industrial microSD 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 abnormality is detected when power on

X-Ray Exposure Test

Table 3-16 X-Ray Exposure Test

	Condition	Duration
Industrial microSD 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 abnormality is detected when power on

Switch Cycle Test

Table 3-17 Switch Cycle Test

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

Result: No abnormality is detected when power on

Durability Test

Table 3-18 Durability Test

	Mating cycle	Result
Industrial microSD card	10000 times	PASS

Result: No abnormality is detected when power on

Electrostatic Discharge (ESD)

Table 3-19 Contact ESD Specification

	Condition	Result
Industrial microSD 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

Table 4-1 Power Consumption of Industrial microSD 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
TLC	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*V_{DD}		V	I_{OH}=-2mA V_{DD} Min
Output Low Voltage	V_{OL}		0.125*V_{DD}	V	I_{OL}=2mA V_{DD} Min
Input High Voltage	V_{IH}	0.625*V_{DD}	V_{DD}+0.3	V	
Input Low Voltage	V_{IL}	V_{SS}-0.3	0.25*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	
All Inputs					
Input Leakage Current		-10	10	uA	
All Outputs					
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}	Vss-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	uA	DAT3 pull-up is disconnected.

4.2.2. Bus Signal Line Load

Table 4-6 Input Leakage Current for 1.8V Signaling

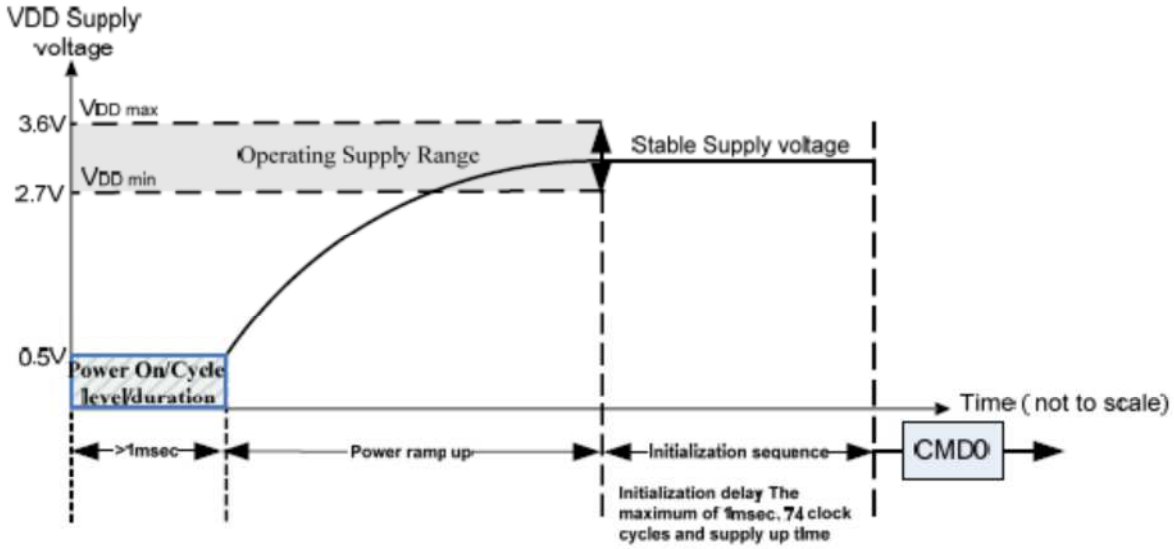
Bus Operation Conditions – Signal Line's Load

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	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)	RDAT3	10	90	kΩ	May be used for card detection
Capacity Connected to Power Line	C_C		5	uF	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 microSD 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.

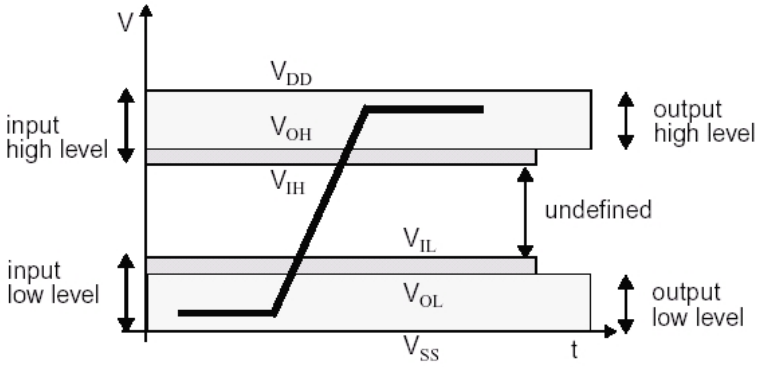
(3) The maximum ramp up time should be 35ms for 2.7-3.6V power supply.

Power Down and Power Cycle

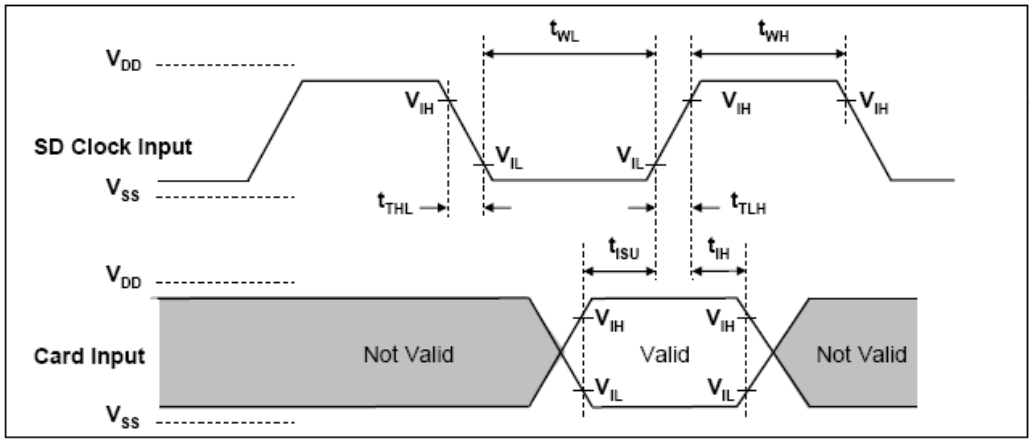
(1) When the host shuts down the power, the card V_{DD} shall be lowered to less than 0.5Volt for a minimum period of 1ms. During power down, DAT, CMD, and CLK should be disconnected or driven to logical 0 by the host to avoid a situation that the operating current is drawn through the signal lines.

(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).

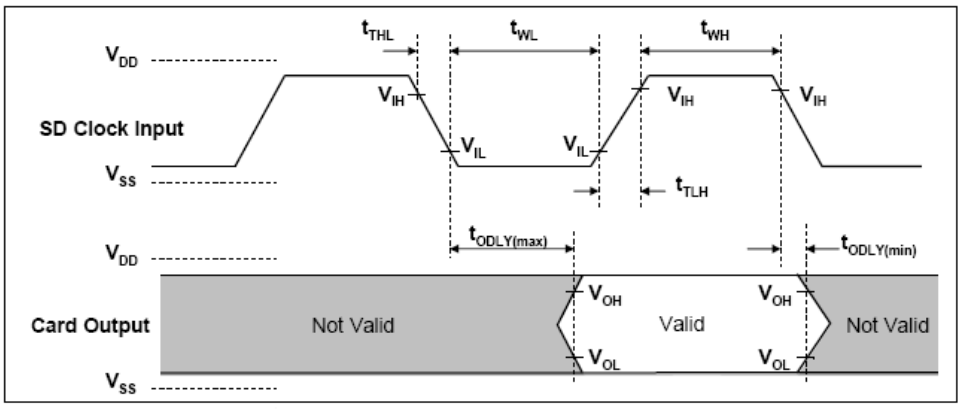
4.3. AC Characteristic



4.3.1. microSD Interface Timing (Default)



Card Input Timing (Default Speed Card)



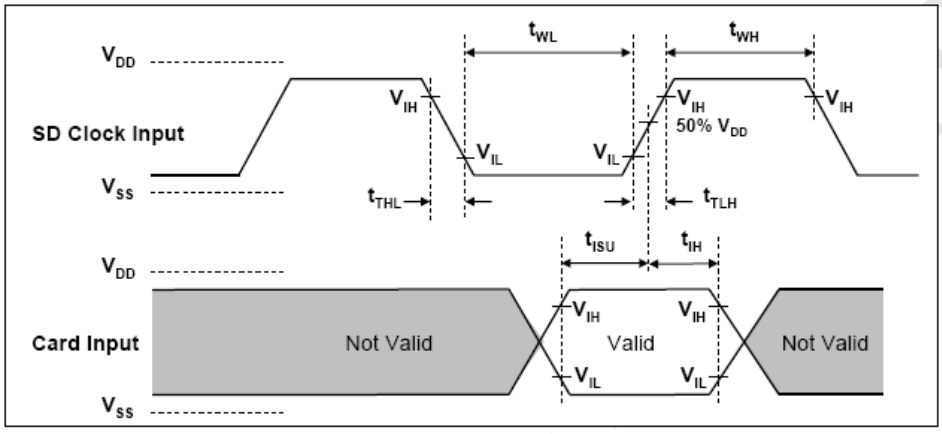
Card Output Timing (Default Speed Mode)

Parameter	Symbol	Min	Max	Unit	Remark
Clock CLK (All values are referred to min(V_{IH}) and max(V_{IL})					

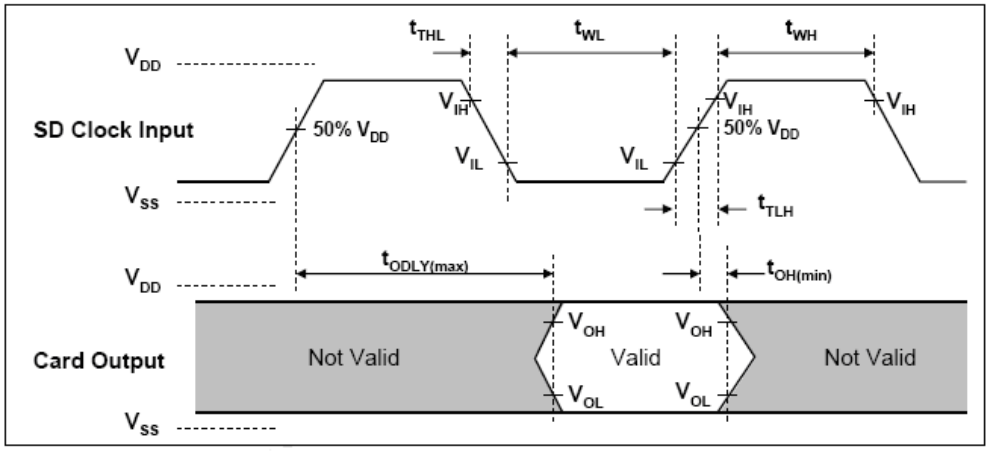
Clock frequency Data Transfer Mode	f_{PP}	0	25	MHz	C_{card}≤10 pF (1 card)
Clock frequency Identification Mode	f_{OD}	0[1]/100	400	kHz	C_{card}≤10 pF (1 card)
Clock low time	t_{WL}	10		ns	C_{card}≤10 pF (1 card)
Clock high time	t_{WH}	10		ns	C_{card}≤10 pF (1 card)
Clock rise time	t_{TLH}		10	ns	C_{card}≤10 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_L≤40 pF (1 card)
Output Delay time during Identification Mode	t_{ODLY}	0	50	ns	C_L≤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. microSD Interface Timing (High-Speed Mode)



Card Input Timing (High Speed Card)



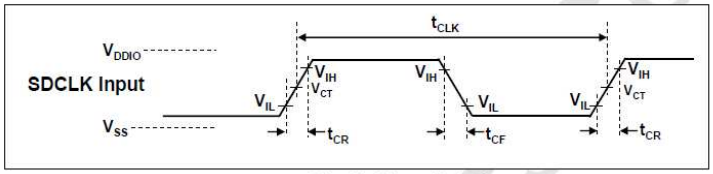
Card Output Timing (High Speed Mode)

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	$C_{card} \leq 10$ pF (1 card)
Inputs CMD, DAT (referenced to CLK)					
Input set-up time	t_{ISU}	6		ns	$C_{card} \leq 10$ pF (1 card)
Input hold time	t_{IH}	2		ns	$C_{card} \leq 10$ pF (1 card)
Outputs CMD, DAT (referenced to CLK)					
Output Delay time during Data Transfer Mode	t_{ODLY}		14	ns	$C_L \leq 40$ pF (1 card)
Output Hold time	T_{OH}	2.5		ns	$C_L \leq 15$ pF (1 card)
Total System capacitance of each line[1]	C_L		40	pF	$C_L \leq 15$ 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 and SDR50 Modes)

Input

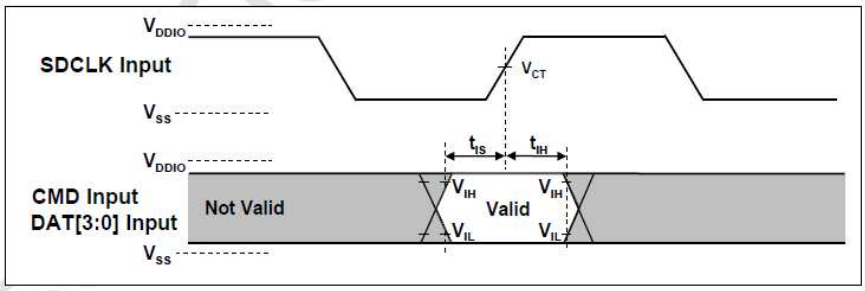


Clock Signal Timing

Table 4-7 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	%	

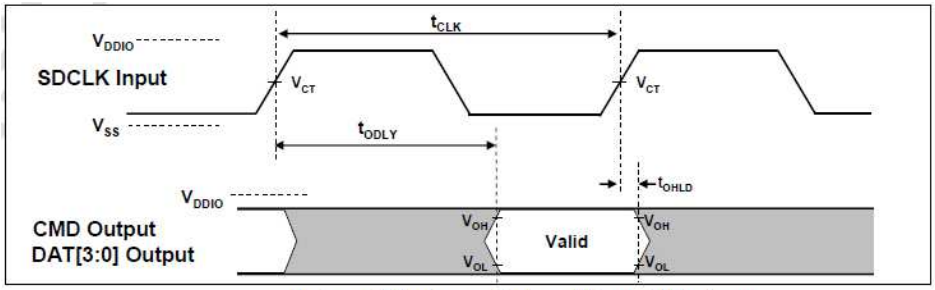
SDR50 Input Timing



Card 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

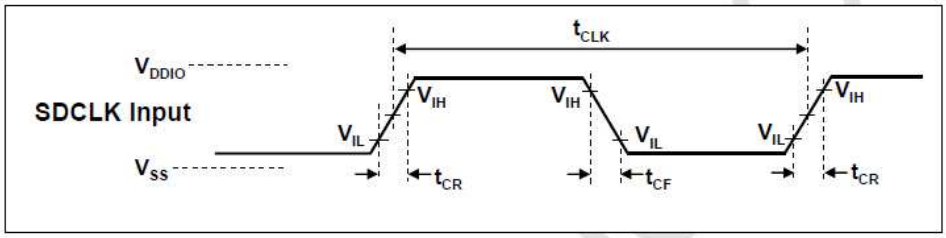


Output Timing of Fixed Data Window

Table 4-8 Output Timing of Fixed Data Window

Symbol	Min	Max	Unit	Remark
t_{ODLY}	-	7.5	ns	t_{CLK}>=10.0ns, C_L=30pF, using driver Type B, for SDR50
t_{ODLY}	-	14	ns	t_{CLK}>=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. microSD Interface Timing (DDR50 Mode)



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	%	

Table 4-9 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}≤□10 pF (1 card)
Input hold time	t_{IH}	0.8	-	ns	C_{card}≤□10 pF (1 card)
Output CMD (referenced to CLK rising edge)					
Output Delay time during Data Transfer Mode	t_{ODLY}		13.7	ns	C_L≤30 pF (1 card)
Output Hold time	T_{OH}	1.5	-	ns	C_L≥15 pF (1 card)
Inputs DAT (referenced to CLK rising and falling edges)					
Input set-up time	t_{ISU2x}	3	-	ns	C_{card}≤□10 pF (1 card)
Input hold time	t_{IH2x}	0.8	-	ns	C_{card}≤□10 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≤25 pF (1 card)
Output Hold time	T_{OH2x}	1.5	-	ns	C_L≥15 pF (1 card)

5. INTERFACE

5.1. Pad Assignment and Descriptions

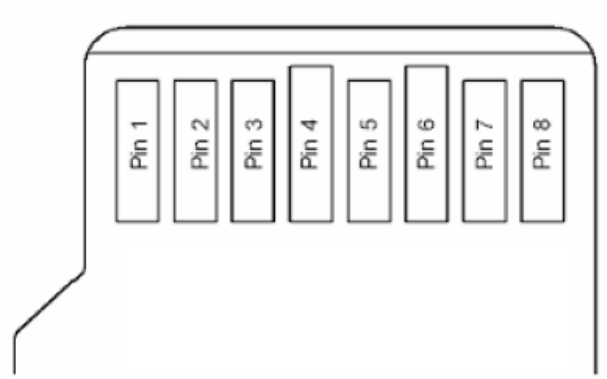


Table 5-1 microSD Memory Card Pad Assignment

pin	SD Mode			SPI Mode		
	Name	Type[1]	Description	Name	Type	Description
1	DAT2	I/O/PP	Data Line[bit2]	RSV		
2	CD/DAT3 [2]	I/O/PP [3]	Card Detect/ Data Line[bit3]	CS	I [3]	Chip Select (neg true)
3	CMD	PP	Command/Response	DI	I	Data In
4	V_{DD}	S	Supply voltage	V_{DD}	S	Supply voltage
5	CLK	I	Clock	SCLK	I	Clock
6	V_{SS}	S	Supply voltage ground	V_{SS}	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 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. ***Mandatory***
RCA [1]	16bit	Relative card address; local system address of a card, dynamically suggested by the card and approved by the host during initialization. ***Mandatory***
DSR	16bit	Driver Stage Register; to configure the card's output drivers. ***Optional***
CSD	128bit	Card Specific Data; information about the card operation conditions. ***Mandatory***
SCR	64bit	SD Configuration Register; information about the SD Memory Card's Special Features capabilities. ***Mandatory***
OCR	32bit	Operation conditions register. ***Mandatory***
SSR	512bit	SD Status; information about the card proprietary features. ***Mandatory***
OCR	32bit	Card Status; information about the card status. ***Mandatory***

6. PART NUMBER DECODER

MSD-AD$X^1X^2X^3X^4X^5X^6X^7$

Item	Series	Capacity	NAND Flash & Temperature Grade	Class	Option
		X^1 X^2 X^3 X^4	**X^5**	**X^6**	**X^7**
MSD	**AD**	**128M** (128MB) **256M** (256MB) **512M** (512MB) **001G** (1GB) **002G** (2GB) **004G** (4GB) **008G** (8GB) **016G** (16GB) **032G** (32GB) **064G** (64GB) **128G** (128GB) **256G** (256GB)	**C** : SLC Standard (0°C ~ +70°C) **D** : SLC Extended (-25°C ~ +85°C) **I** : SLC Wide (-40°C ~ +85°C) **K** : MLC Standard (0°C ~ +70°C) **L** : MLC Extended (-25°C ~ +85°C) **M** : MLC Wide (-40°C ~ +85°C) **P** : pSLC Standard (0°C ~ +70°C) **Q** : pSLC Extended (-25°C ~ +85°C) **F** : pSLC Wide (-40°C ~ +85°C)	**2** : Class 2 **4** : Class 4 **6** : Class 6 **A** : Class 10 **S** : UHS-I Class 1 **T** : UHS-I Class 3	

X^7 Reserved for specific requirement

(Blank) standard