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Wilk Elektronik S.A.

GOODRAM Industrial SD 3.0 (SLC, MLC, pSLC)

Version 1.0

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1. Introduction

1.1. General Description

The Secure Digital (SD) card version 3.0 is fully compliant with the specification released by 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] Specifications.

The SD 3.0 card is based on 9-pin interface, designed to operate at a maximum operating frequency of 100MHz. 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 which is called SDXC (Extended Capacity SD Memory Card).

Secure Digital 3.0 card is one of the most popular cards today based on its high performance, good reliability and wide compatibility.

1.2. Flash Management

- **Error Correction Code (ECC)**

Flash memory cells will deteriorate with use, which might generate random bit errors in the stored data. Thus, PS8032 applies 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.

- **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.

It 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.

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- **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”. It 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.

- **Smart Function**

SMART, an acronym for Self-Monitoring, Analysis and Reporting Technology, is an special function that allows a memory device to automatically monitor its health. It provides a program named SmartInfo Tool to observe ’s SD cards. **Note that this tool can only support ’s PS8032 controller and industrial SD cards.** This tool will display the controller version, flash type, firmware version, endurance life ratio, good block ratio, and so forth. In addition, a warning message will appear under the following 3 conditions:

(1) When the life ratio remained is less than **10%**,

(2) When the amount of abnormal power on is more than **3,500** cycles, and

(3) When there are less than **5** usable blocks for replacing bad blocks.

- **Auto-Read Refresh**

Auto-Read Refresh is especially applied on devices that read data mostly but rarely write data, such as GPS. When blocks are continuously read, then the device cannot activate wear leveling since it can only be applied while writing data. Thus, errors will accumulate and become uncorrectable. Accordingly, to avoid errors exceed the amount ECC can correct and blocks turn bad, ’s firmware will automatically refresh the bit errors when the error number in one block approaches the threshold, ex., 24 bits.

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- **Pseudo SLC (pSLC)**

Pseudo SLC can be considered as an extended version of MLC. While MLC contains fast and slow pages, pSLC only applies fast pages for programming. The concept of pSLC is demonstrated in the two tables below. The first and second bits of a memory cell represent a fast and slow page respectively, as shown in the left table. Since only fast pages are programmed when applying pSLC, the bits highlighted in red are used, as shown in the right table. Accordingly, because only fast pages are programmed, pSLC provides better performance and endurance than MLC. Moreover, pSLC performs similarly with SLC, yet pSLC is more cost-effective.

MLC Flash	
1st Bit (Fast page)	2nd Bit (Slow page)
1	1
1	0
0	1
0	0

Pseudo SLC Flash	
1st Bit (Fast page)	2nd Bit (Slow page)
1	1
1	0
0	1
0	0

Cell Content of MLC (Left) and pSLC (Right)

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2. Product Specifications

- Capacity
  - SLC: 4GB up to 32GB (Diamond & Gold)
  - MLC: 4GB up to 64GB (Diamond & Gold)
  - pSLC: 2GB up to 32GB (Diamond & Gold)
- Operation Temp. Range
  - Gold Series: -25~85°C (SLC & MLC)
  - Diamond Series: -40~+85°C (SLC & MLC)
- Storage Temp. Range
  - -40~+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: SDSC card (capacity less than and including 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

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

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- 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	Sequential	
			Read (MB/s)	Write (MB/s)
4GB	UHS-I	TSB 24nm 4GB x 1	27	23
8GB	UHS-I	TSB 24nm 8GB x 1	27	25
16GB	UHS-I	TSB 24nm 16GB x 1	27	25
32GB	UHS-I	TSB 24nm 16GB x 2	27	25

    - MLC

Capacity	Mode	Flash Structure	Sequential	
			Read (MB/s)	Write (MB/s)
4GB	UHS-I	TSB 19nm 4GB x 1	26	10
8GB	UHS-I	TSB 19nm 8GB x 1	26	10
16GB	UHS-I	TSB 19nm 16GB x 1	26	10
32GB	UHS-I	TSB 19nm 32GB x 1	26	10
64GB	UHS-I	TSB 19nm 32GB x 2	26	15

    - pSLC

Capacity	Mode	Flash Structure	Sequential	
			Read (MB/s)	Write (MB/s)

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2GB	Non-UHS	TSB 19nm 4GB x 1	20	20
4GB	UHS-I	TSB 19nm 8GB x 1	26	24
8GB	UHS-I	TSB 19nm 16GB x 1	26	24
16GB	UHS-I	TSB 19nm 32GB x 1	26	24
32GB	UHS-I	TSB 19nm 32GB x 2	26	24

NOTES:

1. The performance is obtained from TestMetrix Test.
2. Samples are made of Toshiba 24nm SLC and 19nm MLC Toggle NAND Flash.
3. Performance may vary from flash configuration and platform.
4. The table above is for your reference only. The criteria for MP (mass production) and for accepting goods shall be discussed based on different flash configuration.

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3. Environmental Specifications

3.1. Environmental Conditions

- **Temperature and Humidity**
    - **Storage Temperature Range**
    - **-40°C ~ 85°C**
- **Operation Temperature Range**
    - **Gold grade: -25°C ~ 85°C**
    - **Diamond grade: -40°C ~ 85°C**

High Temperature Test Condition (Gold Series)

	Temperature	Humidity	Test Time
Operation	85°C	0% RH	168 hours
Storage	85°C	0% RH	500 hours

Result: No any abnormality is detected.

High Temperature Test Condition (Diamond Series)

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

Result: No any abnormality is detected.

Low Temperature Test Condition (Gold Series)

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

Result: No any abnormality is detected.

Low Temperature Test Condition (Diamond Series)

	Temperature	Humidity	Test Time

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Operation	-40°C	0% RH	168 hours
Storage	-40°C	0% RH	500 hours

Result: No any abnormality is detected.

High Humidity Test Condition (Gold Series)

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

Result: No any abnormality is detected.

High Humidity Test Condition (Diamond Series)

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

Result: No any abnormality is detected.

Temperature Cycle Test (Gold Series)

	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.

Temperature Cycle Test (Diamond Series)

	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.

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- **Shock**

Shock Specification

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

Result: No any abnormality is detected when power on.

- **Vibration**

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**

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**

Bending Specification

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

Result: No any abnormality is detected when power on.

- **Torque**

Torque Specification

	Force	Action

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

Result: No any abnormality is detected when power on.

- **Electrostatic Discharge (ESD)**

Contact ESD Specification

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

- **EMI Compliance**
  - **FCC: CISPR22**
  - **CE: EN55022**
  - **BSMI 13438**

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4. SD Card Comparison

Comparing SD3.0 Standard and SD3.0 SDXC

	SD3.0 Standard (Backward compatible to 2.0 host)	**SD3.0 SDHC (Backward compatible to 2.0 host)**	**SD3.0 SDXC**
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 2.0v – 2.7v (for initialization)	Not Support	Not Support	Not 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)

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5. Electrical Specifications

5.1. Power Consumption

The table below is the power consumption of PS8032 with different flash memory types.

Power Consumption of PS8032 Industrial SD card

Flash Mode	Max. Power Up Current (uA)	Max. Standby Current (uA)	Max. Read Current (mA)	Max. Write Current (mA)
Single Flash[Note1] (1 x 8bit)	150	150	100	100
SDR/DDR	250	250	200	200

NOTE:

1. Data transfer mode is single channel.

5.2. DC Characteristic

- **Bus Operation Conditions for 3.3V Signaling**

Threshold Level for High Voltage Range

Parameter	Symbol	Min.	Max	Unit	Condition
Supply Voltage	VDD	2.7	3.6	V	
Output High Voltage	VOH	0.75*VDD		V	IOH=-2mA VDD Min
Output Low Voltage	VOL		0.125*VDD	V	IOL=2mA VDD Min
Input High Voltage	VIH	0.625*VDD	VDD+0.3	V	
Input Low Voltage	VIL	VSS-0.3	0.25*VDD	V	
Power Up Time			250	ms	From 0V to VDD min

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	

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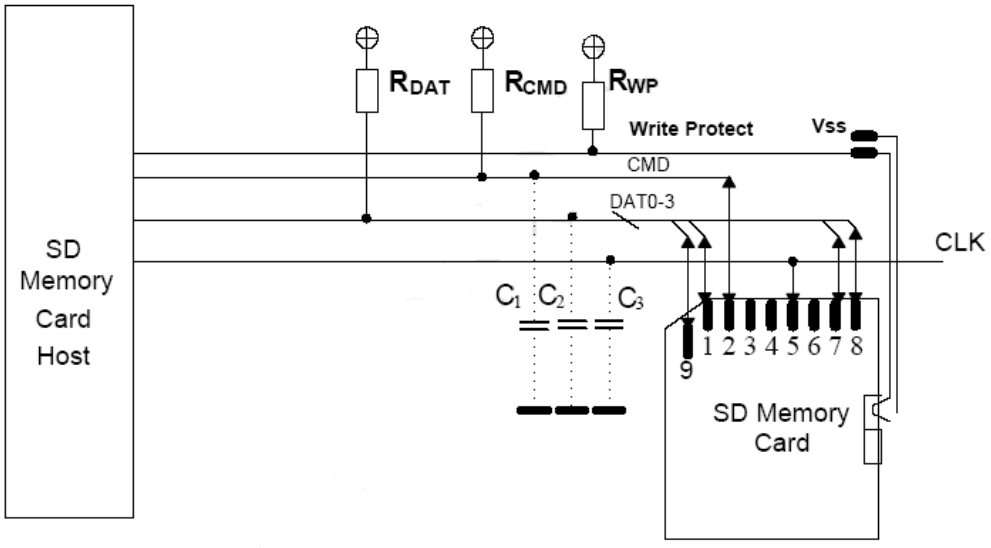
Threshold Level for 1.8V Signaling

Parameter	Symbol	Min.	Max	Unit	Condition
Supply Voltage	VDD	2.7	3.6	V	
Regulator Voltage	VDDIO	1.7	1.95	V	Generated by VDD
Output High Voltage	VOH	1.4	-	V	IOH=-2mA
Output Low Voltage	VOL	-	0.45	V	IOL=2mA
Input High Voltage	VIH	1.27	2.00	V	
Input Low Voltage	VIL	Vss-0.3	0.58	V	

Input Leakage Current for 1.8V Signaling

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

- **Bus Signal Line Load**



Bus Circuitry Diagram

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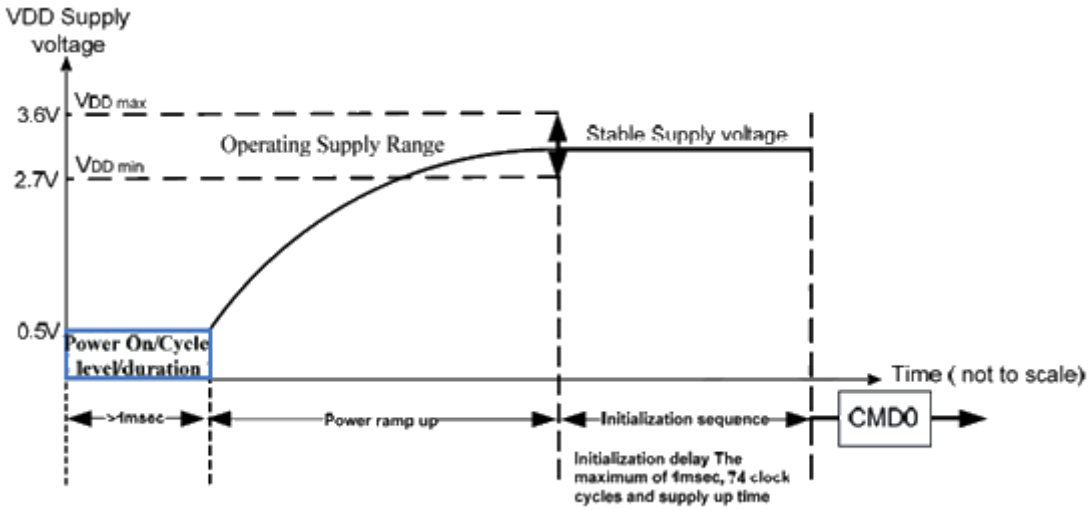
- **Bus Operation Conditions – Signal Line's Load**

Total Bus Capacitance = CHOST + CBUS + N CCARD

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 CHOST+CBUS shall not exceed 30 pF
Card Capacitance for each signal pin	CCARD		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	CC		5	uF	To prevent inrush current

- **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.

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- **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.

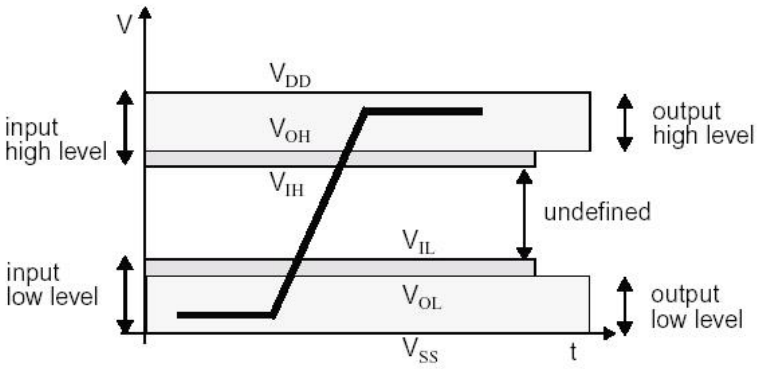
(3) The maximum ramp up time should be 35ms for 2.7-3.6V power supply.

- **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).

5.3. AC Characteristic



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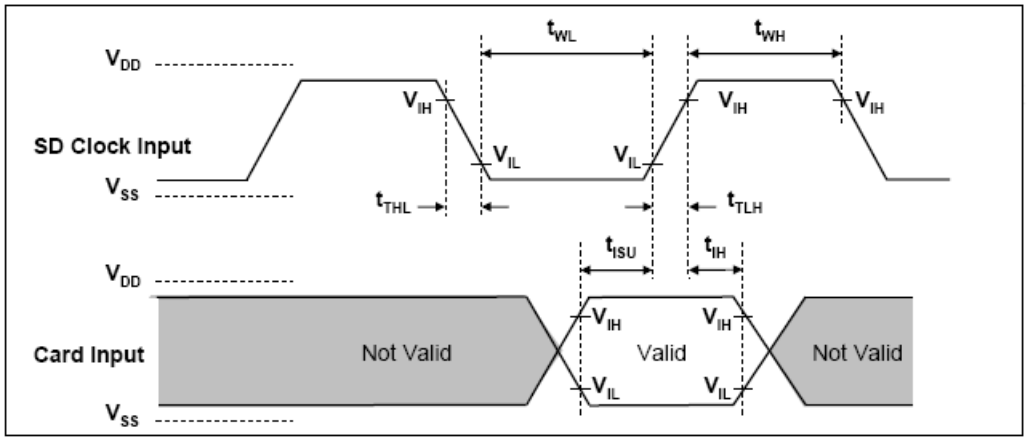
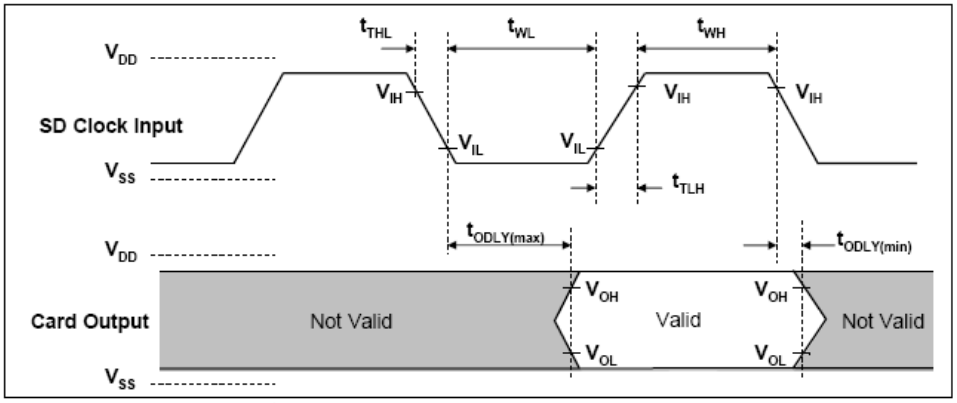
- SD Interface Timing (Default)



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}≤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)

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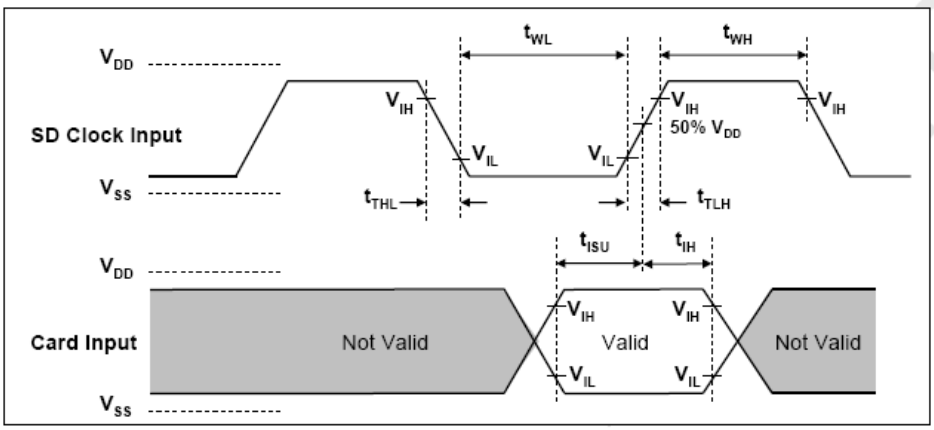
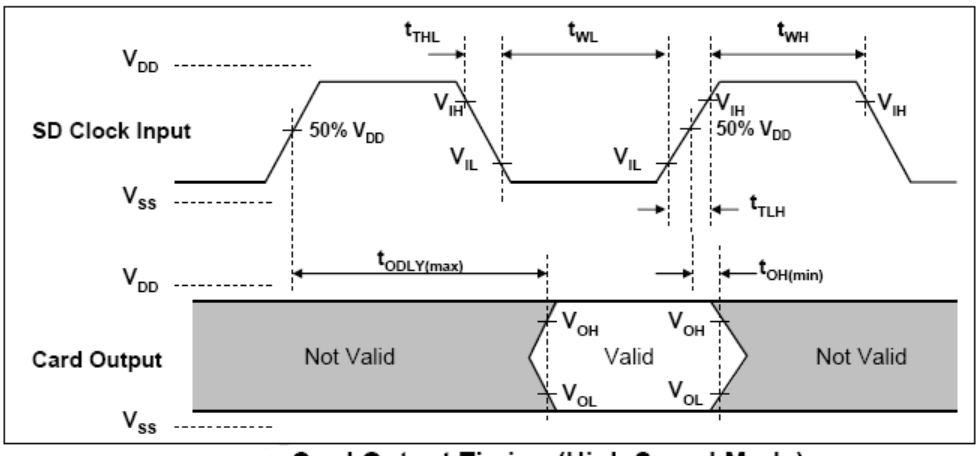
Input hold time	t_{IH}	5		ns	C_{card}≤10 pF (1 card)
Outputs CMD, DAT (referenced to CLK)					
Output Delay time during Data Transfer Mode	t_{ODLY}	0	14	ns	C_L≤40 pF (1 card)
Output Delay time during Identification Mode	tODLY	0	50	ns	C_L≤40 pF (1 card)

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

- 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} ≤ 10 pF (1 card)
Clock low time	t_{WL}	7		ns	C_{card} ≤ 10 pF

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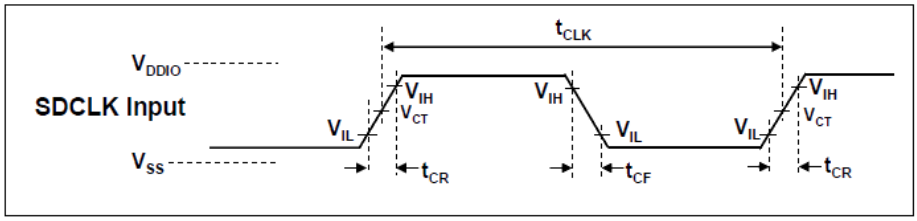
					(1 card)
Clock high time	t_{WH}	7		ns	$C_{card} \leq 10$ pF (1 card)
Clock rise time	t_{TLH}		3	ns	$C_{card} \leq 10$ pF (1 card)
Clock fall time	t_{THL}		3	ns	$C_{card} \leq 10$ pF (1 card)
Inputs CMD, DAT (referenced to CLK)					
Input set-up time	t_{ISU}	6		ns	$C_{card} \leq 10$ pF (1 card)
Input 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	CL ≤ 15 pF (1 card)

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

- **SD Interface Timing (SDR12, SDR25 and SDR50 Modes)**

Input



Clock Signal Timing

Clock Signal Timing

Symbol	Min	Max	Unit	Remark
tCLK	4.80	-	ns	208MHz (Max.), Between rising edge, VCT= 0.975V
tCR, tCF	-	0.2* tCLK	ns	tCR, tCF < 2.00ns (max.) at 100MHz, CCARD=10pF
Clock Duty	30	70	%	

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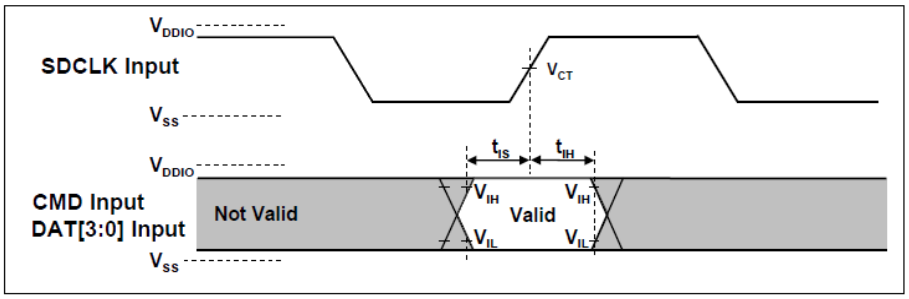
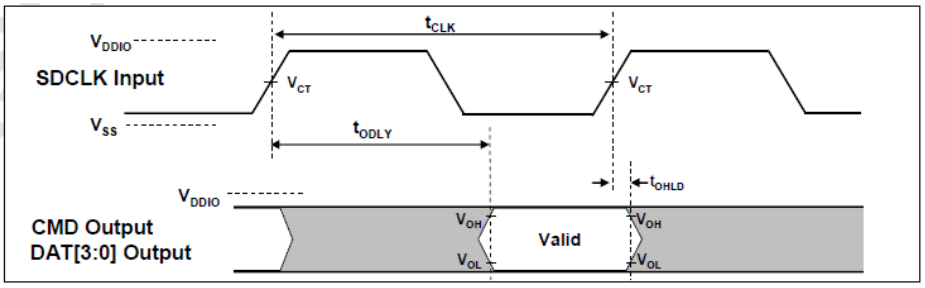
SDR50 Input Timing



Card Input Timing

Symbol	Min	Max	Unit	SDR50 Mode
tIs	3.00	-	ns	CCARD =10pF, VCT= 0.975V
tIH	0.80	-	ns	CCARD =5pF, VCT= 0.975V

Output

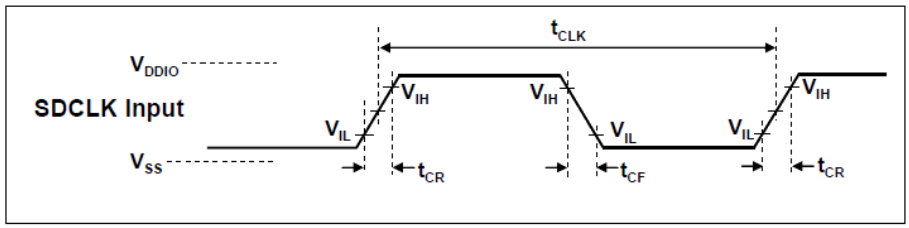


Output Timing of Fixed Data Window

Output Timing of Fixed Data Window

Symbol	Min	Max	Unit	Remark
tODLY	-	7.5	ns	tCLK>=10.0ns, CL=30pF, using driver Type B, for SDR50
tODLY	-	14	ns	tCLK>=20.0ns, CL=40pF, using driver Type B, for SDR25 and SDR12,
TOH	1.5	-	ns	Hold time at the tODLY (min.), CL=15pF

SD Interface Timing (DDR50 Mode)



Clock Signal Timing

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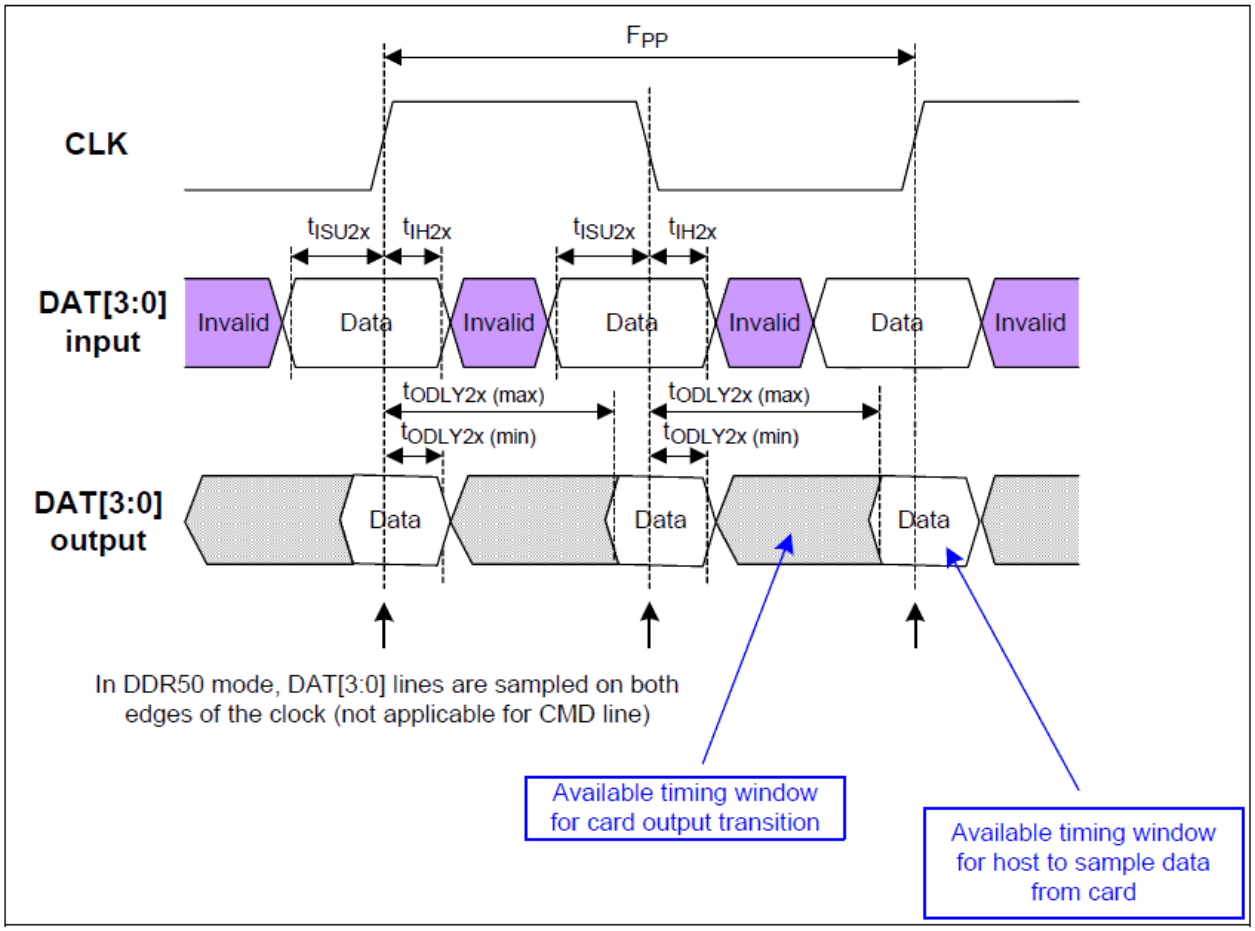
Symbol	Min	Max	Unit	Remark
tCLK	20	-	ns	50MHz (Max.), Between rising edge
tCR, tCF	-	0.2* tCLK	ns	tCR, tCF < 4.00ns (max.) at 50MHz, CCARD=10pF
Clock Duty	45	55	%	



Timing Diagram DAT Inputs/Outputs Referenced to CLK in DDR50 Mode

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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)

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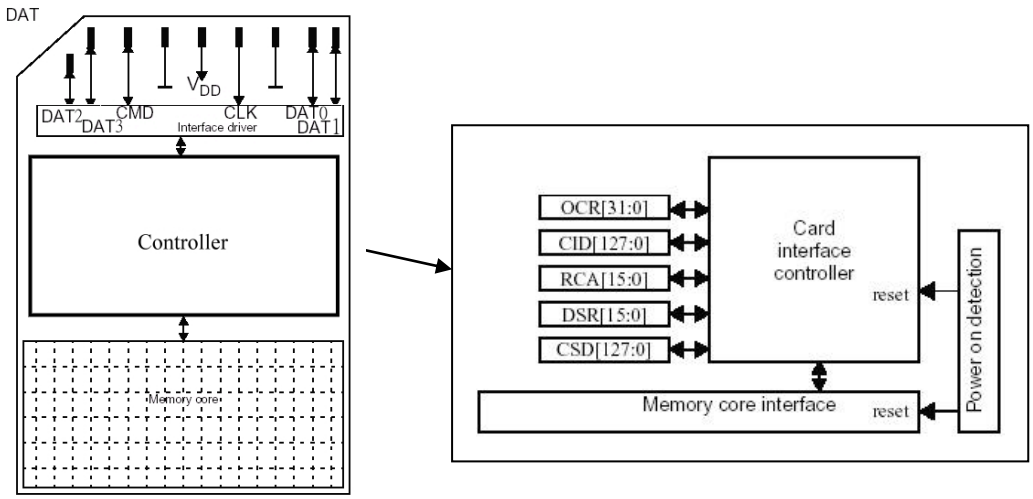
6. Interface

6.1. Pad Assignment and Descriptions



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

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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**
RCA1	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**

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

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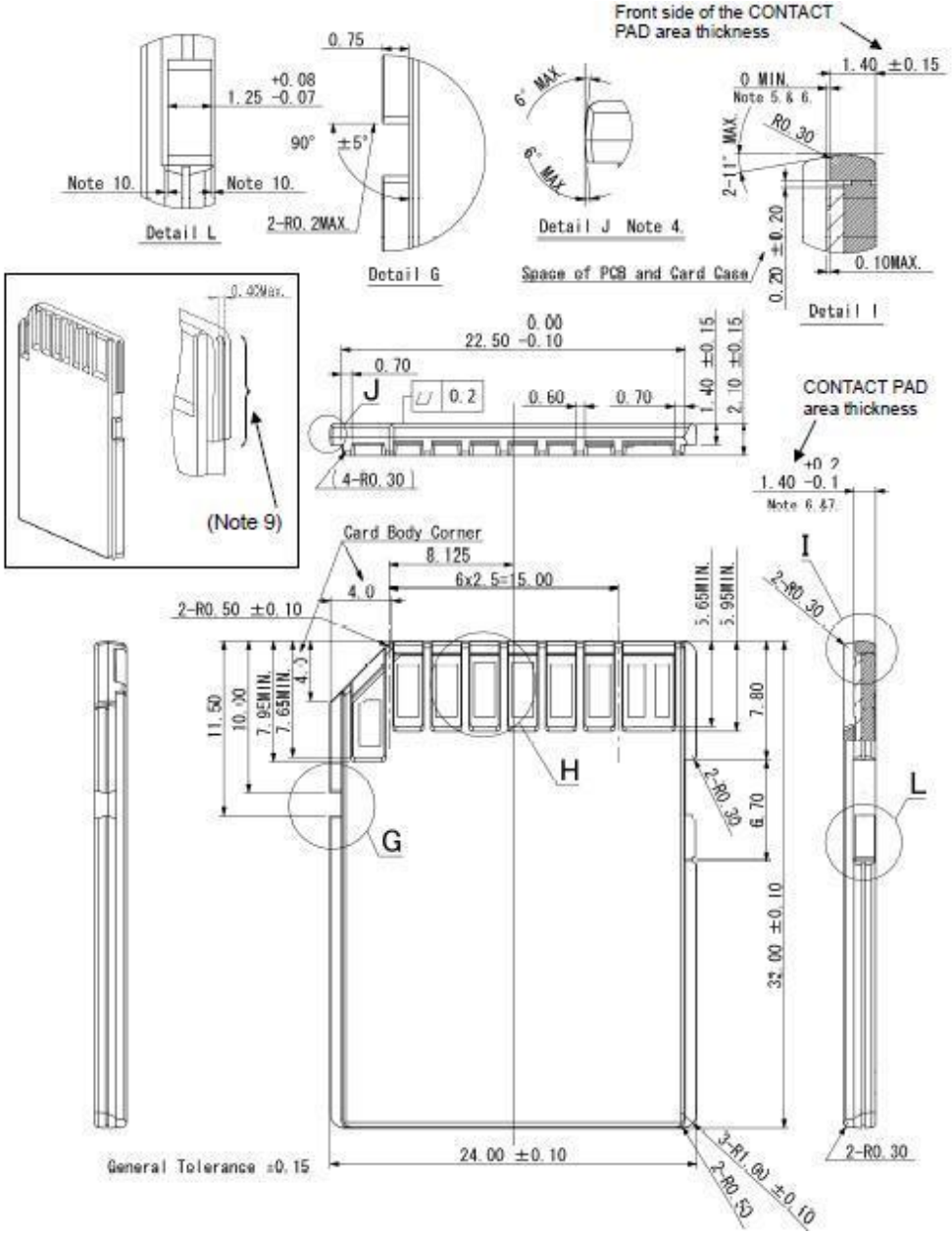
7. Physical Dimension

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



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Warning

• Do not bend, crush, drop, or place heavy objects on top of the Product. Do not use tweezers, pliers, or similar items that could damage the Product. Take particular care when inserting or removing the Product. Stop using the Product when the Product does not work properly. Failure to follow these instructions could result in fire, damage to the Product and/or other property, and/or personal injury including burns and electric shock.
• Keep out of reach of small children. Accidental swallowing may cause suffocation or injury. Contact a doctor immediately if you suspect a child has swallowed the Product. .
• Do not directly touch the interface pins, put them in contact with metal, strike them with hard objects, or cause them to short. Do not expose to static electricity.
• Do not disassemble or modify the Product. This may cause electric shock, damage to the Product, or fire.

Notes on usage

• The Product contains nonvolatile semiconductor memory. Do not use the Product in accordance with a method of usage other than that written in the manual. This may cause the destruction or loss of data.
• To protect against accidental data loss, you should back up your data frequently on more than one type of storage media. **** Corporation assumes no liability for destruction or loss of data recorded on the Card for any reason.
• When used over a long period of time or repeatedly, the reading, writing and deleting capabilities of the Product will eventually fail, and the performance speed of the Product may decrease below the original speed specific to the Product's applicable class.
• If the Product is to be transferred or destroyed, note that the data it contained may still be recoverable unless it is permanently deleted by third-party deletion software or similar means beforehand.

Product applications and design.

Product is intended for use in general electronics applications (e.g., computers, personal equipment, office equipment, measuring equipment, industrial robots and home electronics appliances) or for specific applications as expressly stated in this document. Product is neither intended nor warranted for use in equipment or systems that require extraordinarily high levels of quality and/or reliability and/or a malfunction or failure of which may cause loss of human life, bodily injury, serious property damage or serious public impact (“Unintended Use”). Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, devices related to electric power, and equipment used in finance-related fields. Do not use Product for Unintended Use unless specifically permitted in this document.

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