Apacer

RoHS Recast Compliant

microSDHC 6.1

Industrial MSD-WORM Product Specifications

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Version 1.4

Apacer Technology Inc.
1F, No.32, Zhongcheng Rd., Tucheng Dist., New Taipei City, Taiwan, R.O.C
Tel: +886-2-2267-8000 Fax: +886-2-2267-2261
www.apacer.com

Apacer

Specifications Overview:

- **Capacity**
  - 8, 16, 32, 64, 128 GB
- **Performance**[1]
  - Sequential read: Up to 70 MB/sec
  - Sequential write: Up to 65 MB/sec
- **Flash Management**
  - Built-in advanced ECC algorithm
  - Global Wear Leveling
  - Flash bad-block management
  - Page Mapping
  - S.M.A.R.T.
  - Power Failure Management
  - SMART Read Refresh™
- **NAND Flash Type:** MLC
- **Temperature Range**
  - Operating: -25°C to 85°C
  - Storage: -40°C to 85°C
- **Operating Voltage: 2.7V ~ 3.6V**
- **Power Consumption**[1]
  - Operating (Max.): 235 mA
  - Standby: 460 µA
- **Inherent Characteristics**
  - When writing files, it must adhere to the “one by one” principle. This means that a file must be completely written before starting another one.
  - The "Data Clusters" of the file must be written sequentially.
- **Bus Speed Mode: Support Class 10 with UHS-I**[2]
  - DS: Default Speed up to 25MHz 3.3V signaling
  - HS: High Speed up to 50MHz 3.3V signaling
  - SDR12: SDR up to 25MHz 1.8V signaling
  - SDR25: SDR up to 50MHz 1.8V signaling
  - SDR50: SDR up to 100MHz 1.8V signaling
  - SDR104: SDR up to 208MHz 1.8V signaling
  - DDR50: DDR up to 50MHz 1.8V signaling
- **Product Compatibility**
  - Compatible with SD Card specifications 6.1
    - Part 1, Physical Layer Specification, Ver 6.1 Final
    - Part 2, File System Specification, Ver 3.00
    - Part 3, Security Specification, Ver 3.00 Final
  - Supports SD and SPI modes
  - OS support
    - Windows 7/10
    - Linux Fedora v23 / Ubuntu v16.04
    - Android v5.0/v5.1.1/v7.1/v9.0 (PC)
  - File system support: FAT32 only
  - Not supported: Erase/Lock/Unlock SD commands
- **Physical Dimensions**
  - 15mm (L) x 11mm (W) x 1mm (H)
- **RoHS Recast Compliant (2011/65/EU)**

Notes:
1. Varies from capacities. The values for performances and power consumptions presented are typical and may vary depending on flash configurations or platform settings. The term idle refers to the standby state of the device.
2. Timing in 1.8V signaling is different from that of 3.3V signaling. Operation mode selection command is complaint with SD 3.0, referring to SDA’s Part 1, Physical Layer Specification, Ver 3.01 (Section 3.9).

Table of Contents

1. General Description

Apacer industrial MSD-WORM (Write Once Read Many) Card is a product that provides data storage protection by allowing data to be written once, preventing it from being erased, modified, or overwritten. This write protection function ensures that the data cannot be tampered with once it is written to the device.

Apacer MSD-WORM Card fully complies with microSD card version 6.1. The command list is compatible with [Part 1 Physical Layer Specification Ver6.1 Final] definitions, while the Card Capacity of Non-secure Area, Secure Area supports [Part 3 Security Specification Ver3.0 Final] Specifications. With built-in ECC, wear-leveling and bad block management, this industrial miscroSD card serves as an ideal portable storage solution.

Designed specifically for multiple applications by offering high endurance, reliability, and agility, where extreme flexibility, data integrity, and exceptionally transmission are required, Apacer MSD-WORM Card comes with 8-pin interface designed to operate at a maximum operating 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.

With high performance, good reliability, and wide compatibility, Apacer MSD-WORM Card is one of the most popular cards well adapted for embedded applications ranging from industrial, imaging, computing to enterprise markets.

1.1 Product Functional Block

The microSD contains a card controller and a memory core for the SD standard interface.

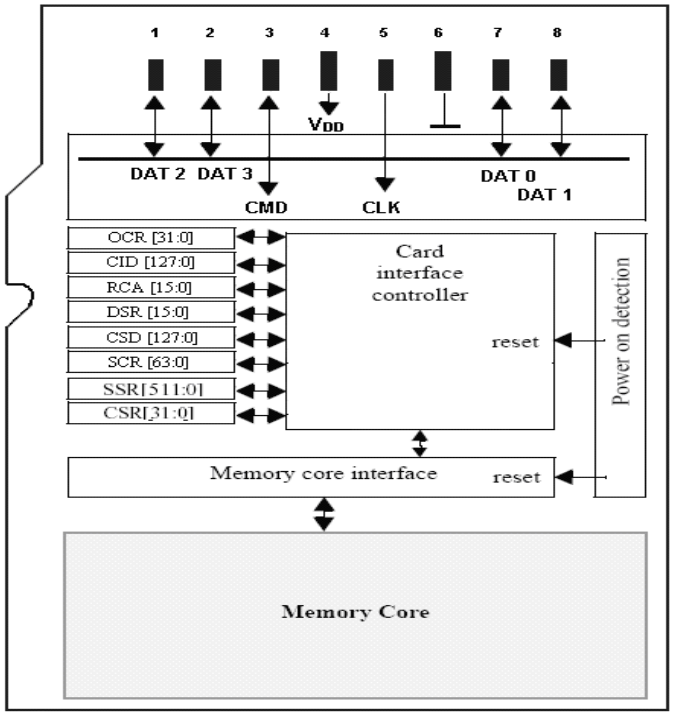


Figure 1-1 Functional Block Diagram

1.2 Flash Management

1.2.1 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”. Apacer 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.

1.2.2 Powerful ECC Algorithms

Flash memory cells can deteriorate with use, which might generate random bit errors in the stored data. Thus, the microSD card applies the advanced ECC Algorithm that can detect and correct errors occurring during the read process, ensure data has been read correctly, as well as protect data from corruption.

1.2.3 Global 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, Global Wear Leveling technique is applied to extend the lifespan of NAND Flash by evenly distributing writes and erase cycles across the media.

Apacer provides Global Wear Leveling algorithm, which can efficiently spread out the flash usage through the whole flash media area. Moreover, by implementing Global Wear Leveling algorithm, the life expectancy of the NAND Flash is greatly improved.

1.2.4 S.M.A.R.T.

SMART, an acronym for Self-Monitoring, Analysis and Reporting Technology, is a special function that allows a memory device to automatically monitor its health. Apacer provides a program named SmartInfo Tool to observe Apacer’s SD and microSD cards. Note that this tool can only support Apacer’s industrial SD and microSD cards. This tool will display firmware version, endurance life ratio, good block ratio, and so forth.

Table 1-1 SMART Attribute ID List

ID (Hex)	Attribute Name
12 (0x0C)	Power Cycle Count
162 (0xA2)	Spare Block Count
163 (0xA3)	Maximum Erase Count
164 (0xA4)	Average Erase Count
165 (0xA5)	Initial Bad Block Count
166 (0xA6)	Later Bad Block Count
192 (0xC0)	Abnormal Shutdown Count

1.2.5 Power Failure Management

Power Failure Management plays a crucial role when power supply becomes unstable. Power disruption may occur when users are storing data into the microSD card, leading to instability in the drive. However, with Power Failure Management, a firmware protection mechanism will be activated to scan pages and blocks once power is resumed. Valid data will be transferred to new blocks for merging and the mapping table will be rebuilt. Therefore, data reliability can be reinforced, preventing damage to data stored in the NAND Flash.

1.2.6 SMART Read Refresh™

Apacer's SMART Read Refresh plays a proactive role in avoiding read disturb errors from occurring to ensure health status of all blocks of NAND flash. Developed for read-intensive applications in particular, SMART Read Refresh is employed to make sure that during read operations, when the read operation threshold is reached, the data is refreshed by re-writing it to a different block for subsequent use.

1.2.7 Page Mapping

Page mapping is an advanced flash management technology whose essence lies in the ability to gather data, distribute the data into flash pages automatically, and then schedule the data to be evenly written. Page-level mapping uses one page as the unit of mapping. The most important characteristic is that each logical page can be mapped to any physical page on the flash memory device. This mapping algorithm allows different sizes of data to be written to a block as if the data is written to a data pool and it does not need to take extra operations to process a write command. Thus, page mapping is adopted to increase random access speed and improve microSD lifespan, reduce block erase frequency, and achieve optimized performance and lifespan.

2. Electrical Characteristics

2.1 Card Architecture

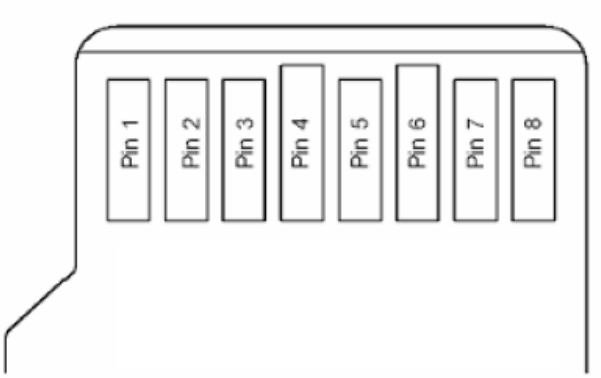


Figure 2-1 Card Architecture

2.2 Pin Assignment

Table 2-1 Pin Assignment

Pin	SD Mode		SPI Mode	
	Name	Description	Name	Description
1	DAT2	Data Line[Bit 2]	RSV	Reserved
2	CD/DAT3	Card Detect/Data Line[Bit 3]	CS	Chip Select (neg true)
3	CMD	Command/Response	DI	Data In
4	VDD	Supply Voltage	VDD	Supply Voltage
5	CLK	Clock	SCLK	Clock
6	VSS	Supply Voltage Ground	VSS	Supply Voltage Ground
7	DAT0	Data Line[Bit 0]	DO	Data Out
8	DAT1	Data Line[Bit 1]	RSV	Reserved

2.3 Capacity Specifications

The following table shows the specific capacity for the MSD-WORM Card.

Table 2-2 Capacity Specifications

Capacity	Total bytes
8 GB	7,734,296,576
16 GB	15,468,593,152
32 GB	30,941,380,608
64 GB	61,886,955,520
128 GB	123,778,105,344

Note: Total bytes are viewed under Windows operating system and were measured by SD format too.

2.4 Performance Specifications

Performances of the MSD-WORM Card are shown in the table below.

Table 2-3 Performance Specifications

Capacity / Performance	8 GB	16 GB	32GB	64 GB	128 GB
Sequential Read (MB/s)	70	70	70	70	70
Sequential Write (MB/s)	23	44	65	65	65

Notes:
- Results may differ from various flash configurations or host system setting, and the above test results are based on the default file structure with FAT 32 file system.
- Sequential read/write is based on H2testw 1.4 with file size 1,000MB.

2.5 DC Power Supply

Table 2-4 Operating Voltage

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{DD}	Power Supply Voltage	2.7	3.3	3.6	V

2.6 Power Consumption

Table 2-5 Power Consumption

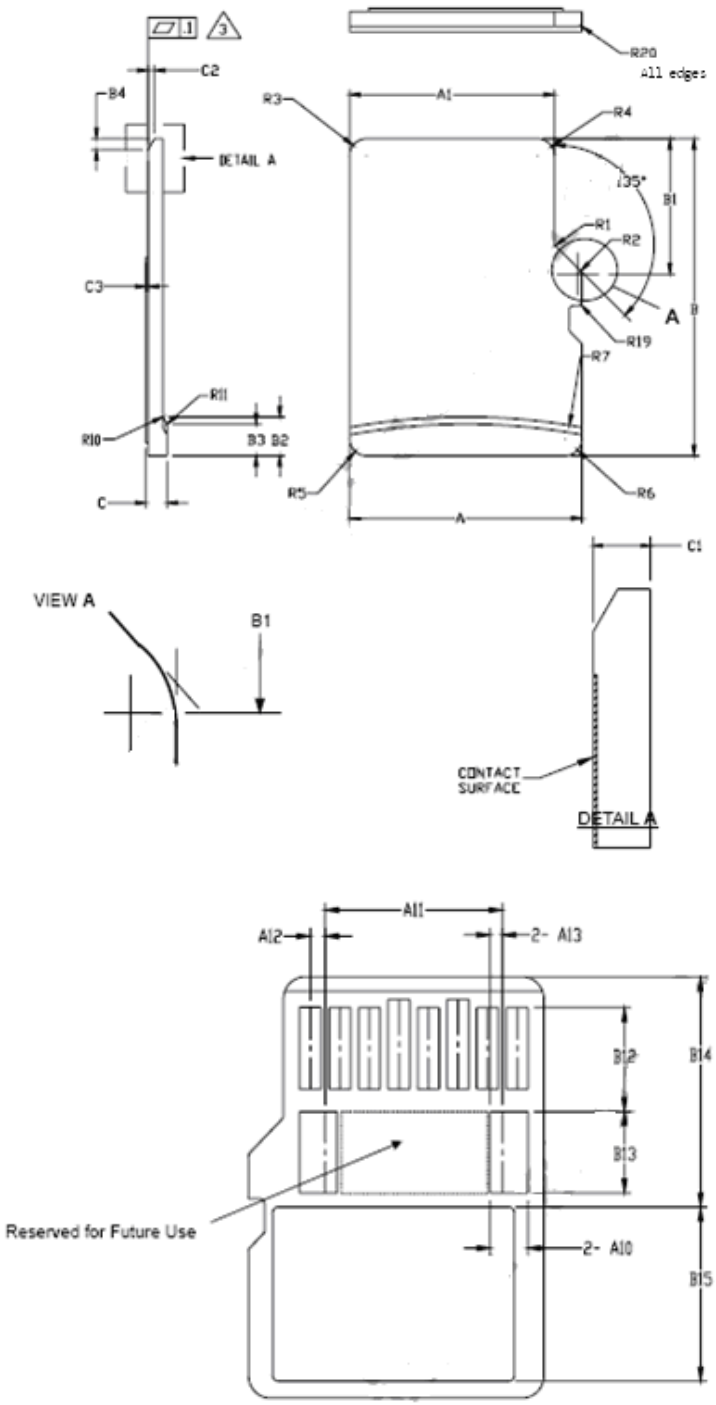
Capacity / Mode	8 GB	16 GB	32GB	64 GB	128 GB
Operating (mA) (Max.)	220	220	225	230	235
Standby (µA)	285	255	280	355	460

Notes:
- All values are typical and may vary depending on flash configurations or host system settings.
- Based on USB 3.0 card reader, power consumption is measured using H2testw 1.4 with file size 1,000MB.

3. Physical Characteristics

3.1 Physical Dimensions

Dimensions: 15mm (L) x 11mm (W) x 1mm (H)



		COMMON DIMENSION			
Item	SYMBOL	MIN	NOM	MAX	NOTE
1	A	10.9	11	11.1	
2	A1	9.6	9.7	9.8	
3	A2	-	3.85	-	BASIC
4	A3	7.6	7.7	7.8	
5	A4	-	1.1	-	BASIC
6	A5	0.75	0.8	0.85	
7	A8	0.6	0.7	0.8	
8	B	14.9	15	15.1	
9	B1'	6.13	6.23	6.33	
10	B2	1.64	1.84	2.04	
11	B3	1.3	1.5	1.7	
12	B4	0.42	0.52	0.62	
13	B5	2.8	2.9	3	
14	B7	0.2	0.3	0.4	
15	B8	1	1.1	1.2	
16	B10	7.8	7.9	8	
17	B11	1.1	1.2	1.3	
18	C1	0.6	0.7	0.8	
19	C2	0.2	0.3	0.4	
20	C4	0.8	-	1.1	
21	C5	0.15	-	-	
22	R1	0.2	0.4	0.6	
23	R2	0.2	0.4	0.6	
24	R3	0.7	0.8	0.9	
25	R4	0.7	0.8	0.9	
26	R5	0.6	0.8	0.9	
27	R6	0.6	0.8	0.9	
28	R7	29.5	30	30.5	
29	R10	-	0.2	-	
30	R11	-	0.2	-	
31	R17	0.1	0.2	0.3	
32	R18	0.2	0.4	0.6	
33	R19	0.05	-	0.2	
34	α	133°	135°	137°	
35	aaa	-	-	0.1	
36		-	45°	-	BASIC

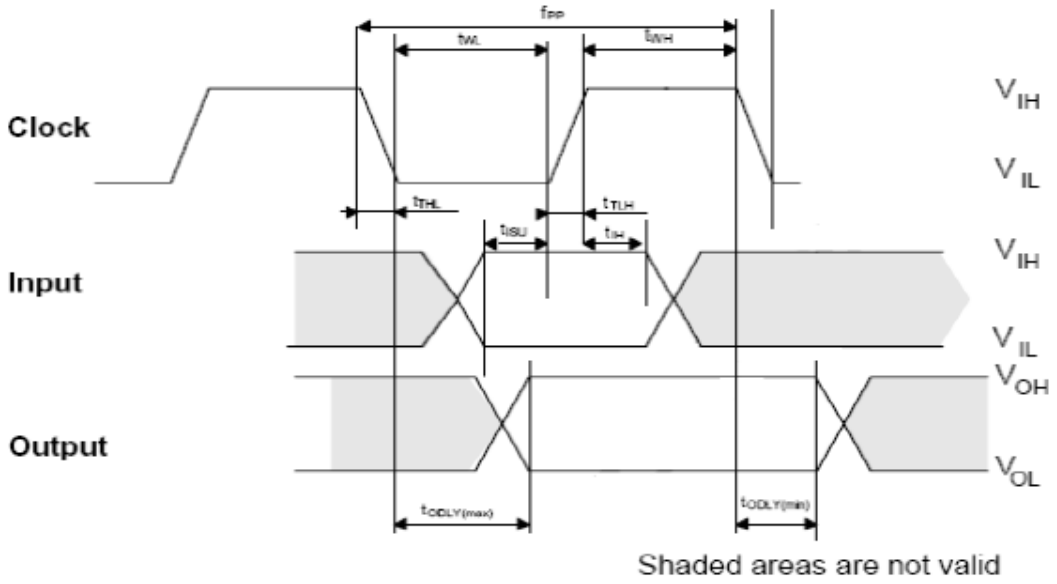
3.2 Durability Specifications

Table 3-1 Durability Specifications

Item	Specifications
Temperature	Operating: -25°C to 85°C Storage:-40°C to 85°C
Shock	1,500G, 0.5ms
Vibration	20Hz~80Hz/1.52mm (frequency/displacement) 80Hz~2000Hz/20G (frequency/displacement) X, Y, Z axis/60mins each
Humidity	85% RH 85°C, 1,000 hrs
Drop	150cm free fall, 6 face of each
Bending	≧10N, hold 1min/5times
Torque	0.1N-m or 2.5deg, hold 5min/5times
Salt spray	Concentration: 3% NaCl at 35°C (storage for 24 hours)
Waterproof	JIS IPX7 compliance Water temperature 25°C Water depth: the lowest point of unit is locating 1000mm below surface (storage for 30 mins)
X-Ray Exposure	0.1 Gy of medium-energy radiation (70 KeV to 140 KeV, cumulative dose per year) to both sides of the card (storage for 30 mins)
Durability	10,000 times mating cycle
ESD	IEC 61000-4-2 & SDA spec

4. AC Characteristics

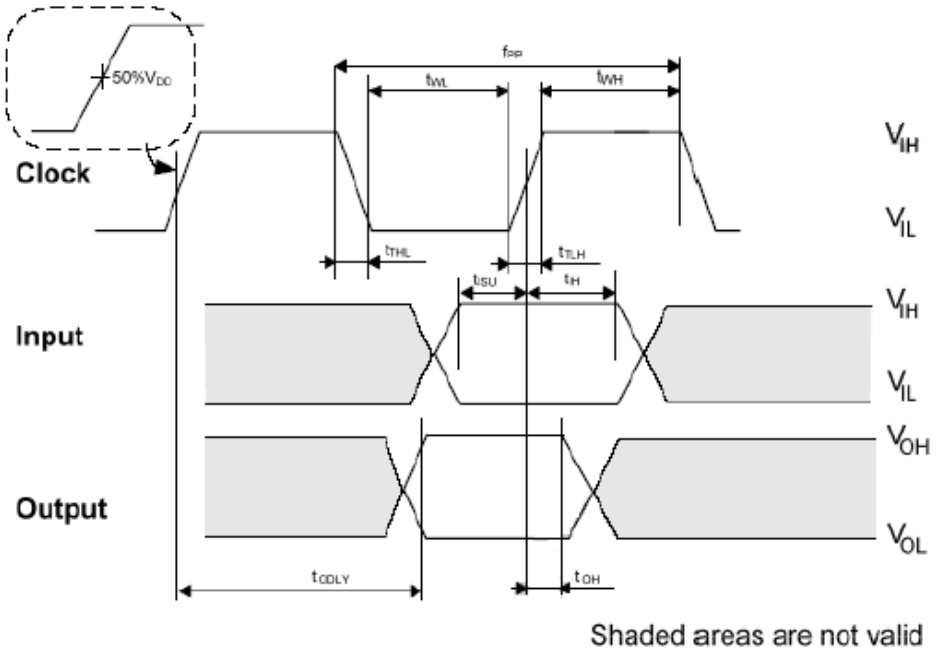
4.1 microSD Interface Timing (Default)



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

*0Hz means to stop the clock. The given minimum frequency range is for cases that require the clock to be continued.

4.2 microSD Interface Timing (High-Speed Mode)

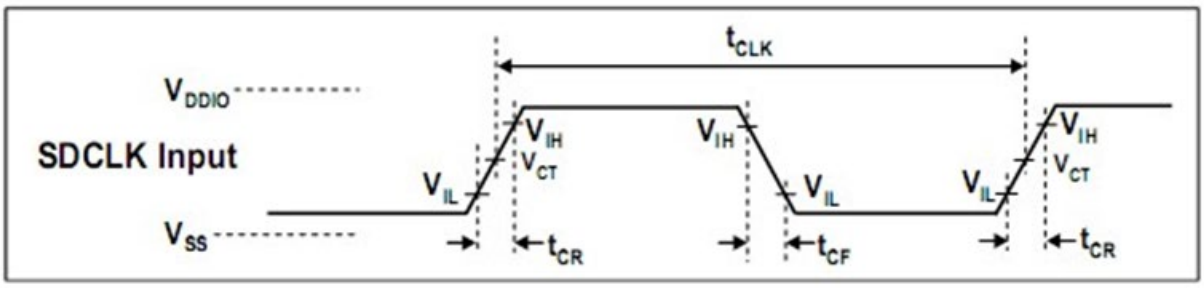


Symbol	Parameter	Min	Max	Unit	Remark
Clock CLK (All values are referred to min(V_{IH}) and max(V_{IL}))					
f_{PP}	Clock frequency Data Transfer Mode	0	50	MHz	C_{card} ≤ 10 pF (1 card)
t_{WL}	Clock low time	7		ns	C_{card} ≤ 10 pF (1 card)
t_{WH}	Clock high time	7		ns	C_{card} ≤ 10 pF (1 card)
t_{TLH}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

*In order to satisfy severe timing, host shall run on only one card

4.3 microSD Interface Timing (SDR12, SDR25, SDR50 and SDR104 Modes)

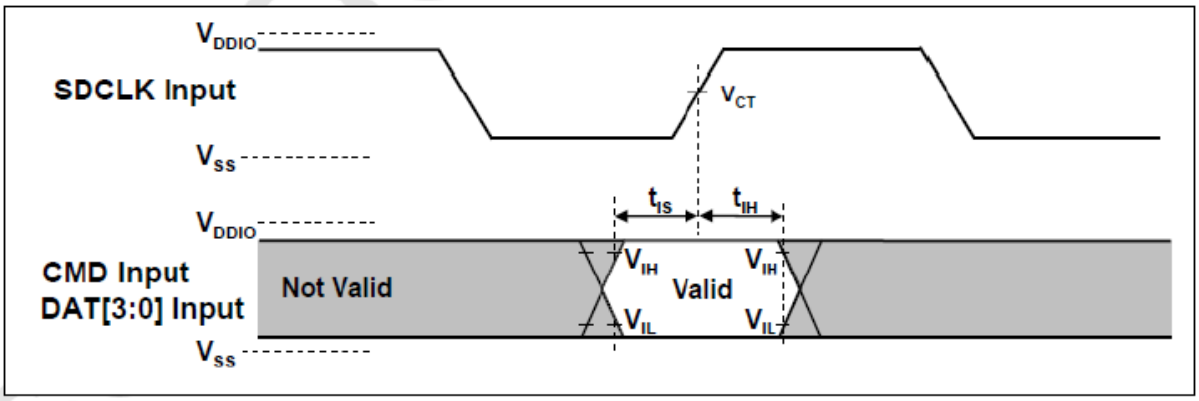
4.3.1 Input



Clock Signal Timing

Symbol	Min	Max	Unit	Remark
t_{CLK}	4.80	-	ns	208MHz (Max.), Between rising edge, V_{CT} = 0.975V
t_{CR}, t_{CF}	-	0.2 t_{CLK}	ns	t_{CR}, t_{CF} < 0.96ns (max.) at 208MHz, C_{CARD}=10pF t_{CR}, t_{CF} < 2.00ns (max.) at 100MHz, C_{CARD}=10pF The absolute maximum value of t_{CR}, t_{CF} is 10ns regardless of clock frequency.
Clock Duty	30	70	%	

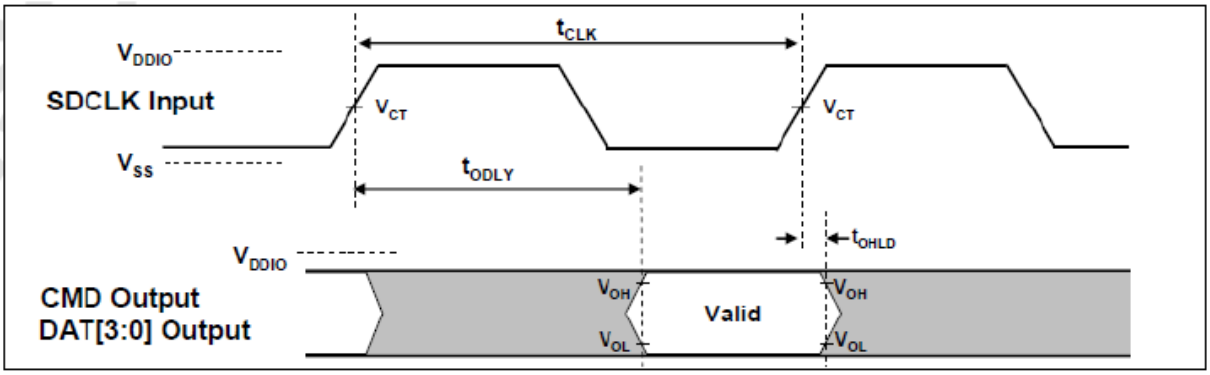
SDR50 and SDR104 Input Timing



Card Input Timing

Symbol	Min	Max	Unit	SDR104 Mode
t_{IS}	1.40	-	ns	C_{CARD} = 10pF, V_{CT} = 0.975V
t_{IH}	0.8	-	ns	C_{CARD} = 5pF, V_{CT} = 0.975V
Symbol	**Min**	**Max**	**Unit**	**SDR50 Mode**
t_{IS}	3.00	-	ns	C_{CARD} = 10pF, V_{CT} = 0.975V
t_{IH}	0.8	-	ns	C_{CARD} = 5pF, V_{CT} = 0.975V

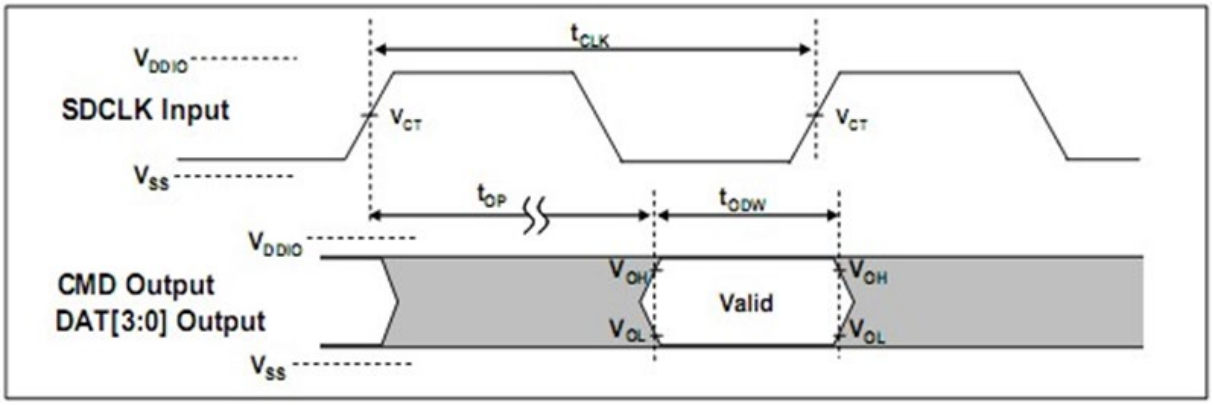
4.3.2 Output



Output Timing of Fixed Data Window

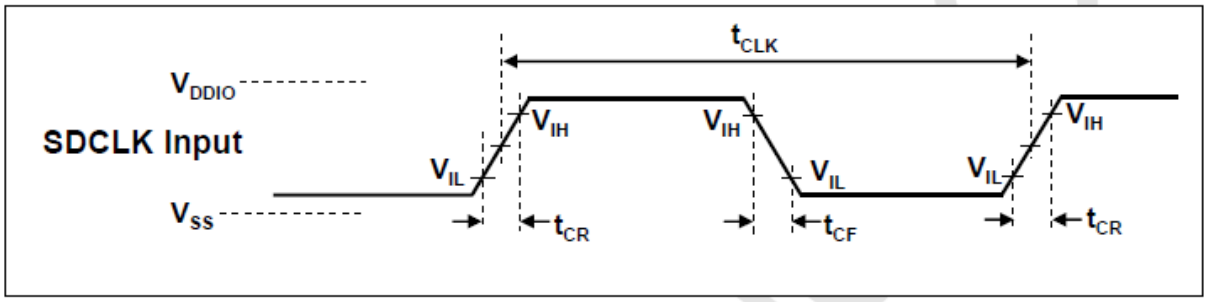
Symbol	Min	Max	Unit	Remark
t_{ODLY}	-	7.5	ns	t_{CLK} ≥10.0ns, C_L=30pF, using driver Type B, for SDR50.
t_{ODLY}	-	14	ns	t_{CLK} ≥20.0ns, C_L=40pF, using driver Type B, for SDR25 and SDR12
T_{OH}	1.5	-	ns	Hold time at the t_{ODLY} (min.). C_L=15pF

Output (SDR104 mode)



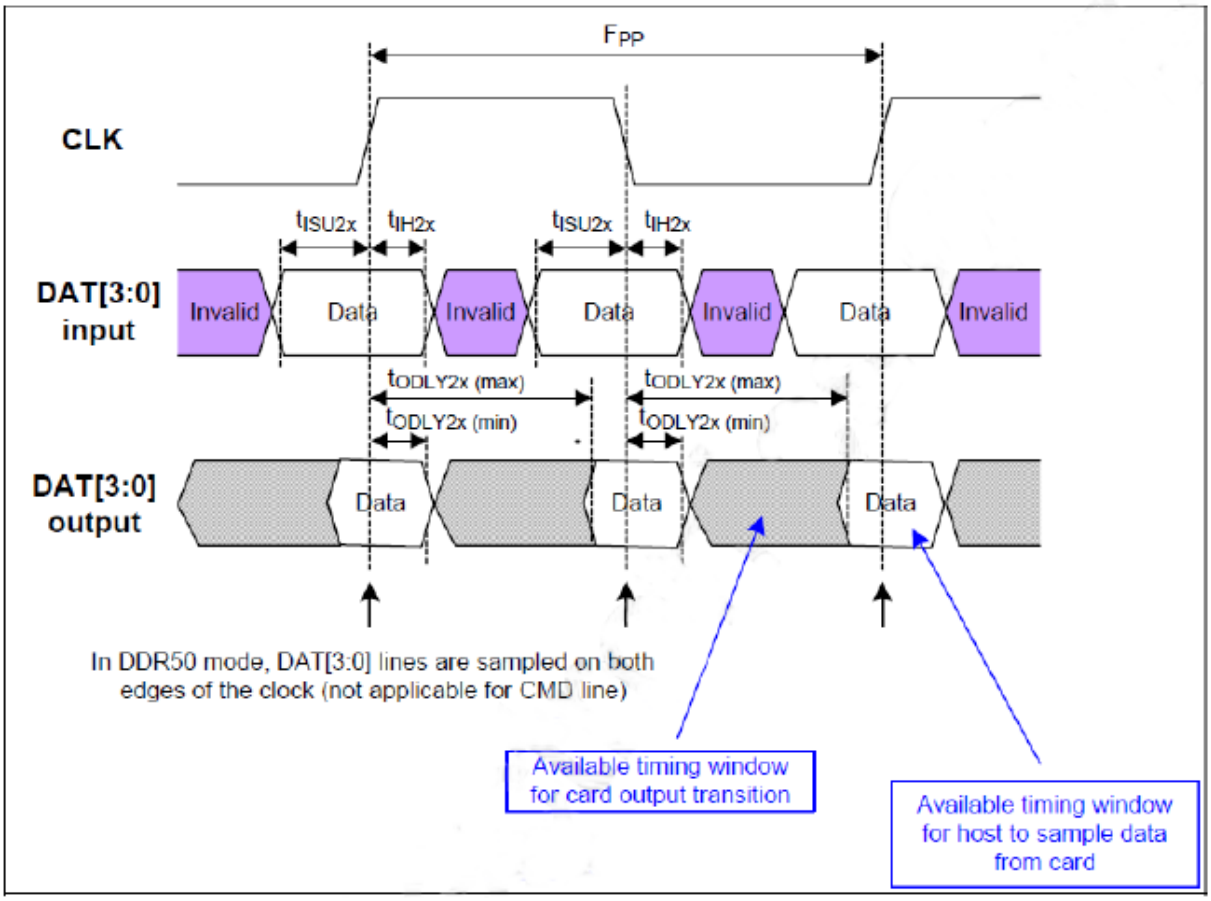
Symbol	Min	Max	Unit	Remark
t_{OP}	0	2	UI	Card Output Phase
$\triangle t_{OP}$	-350	+1550	ps	Delay variable due to temperature change after tuning
t_{ODW}	0.60	-	UI	t_{ODW} = 2.88ns at 208MHz

4.4 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	%	



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

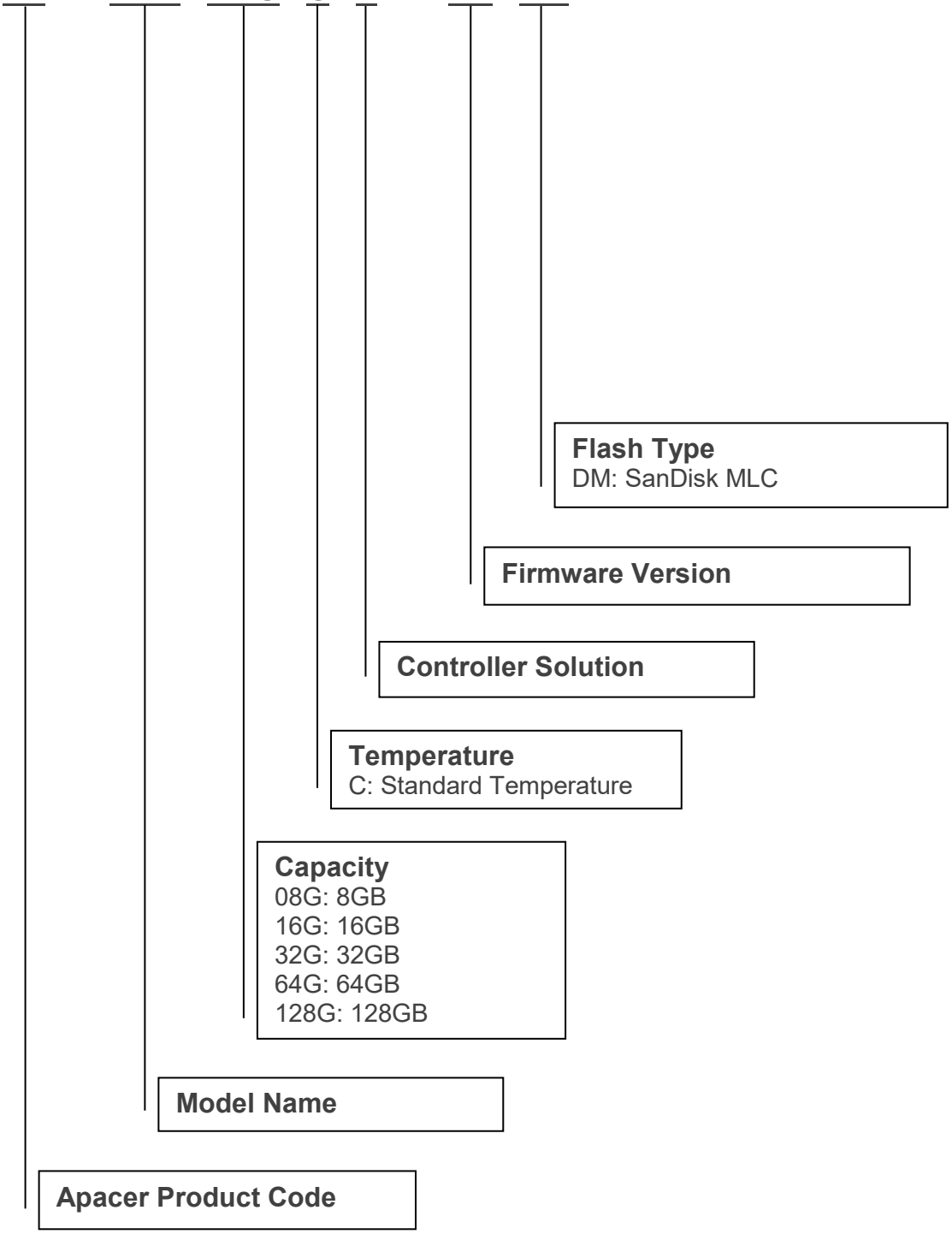
Bus Timings – Parameters Values (DDR50 Mode)

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

5. Product Ordering Information

5.1 Product Code Designations

AP - MSD xxxG C E – 1M DM



5.2 Valid Combinations

The following table lists the available models of the Apacer MSD-WORM Card series which are in mass production or will be in mass production. Consult your Apacer sales representative to confirm availability of valid combinations and to determine availability of new combinations.

Capacity	Valid Combination
8GB	AP-MSD08GCE-1MDM
16GB	AP-MSD16GCE-1MDM
32GB	AP-MSD32GCE-1MDM
64GB	AP-MSD64GCE-1MDM
128GB	AP-MSD128GCE-1MDM

Revision History

Revision	Description	Date
1.0	Initial release	10/5/2023
1.1	Added Table 1-1 to 1.2.4 S.M.A.R.T.	10/23/2023
1.2	Removed “R1-M” from the file name and cover page	11/17/2023
1.3	Revised Product Limitations on Specifications Overview page by breaking it down into OS Support and Inherent Characteristics	12/27/2023
1.4	Changes to Specifications Overview include the following: - Removed “Backward Compatible with 3.0 and 2.0” - Removed “Write performance is 50% lower compared to a standard USB” from Inherent Characteristics - Consolidated compatible specifications and support items to a new section Product Compatibility	1/5/2024

Global Presence

Taiwan (Headquarters)
Apacer Technology Inc.
1F., No.32, Zhongcheng Rd., Tucheng Dist.,
New Taipei City 236, Taiwan R.O.C.
Tel: 886-2-2267-8000
Fax: 886-2-2267-2261
amtsales@apacer.com

U.S.A.
Apacer Memory America, Inc.
46732 Lakeview Blvd., Fremont, CA 94538
Tel: 1-408-518-8699
Fax: 1-510-249-9551
sa@apacerus.com

Japan
Apacer Technology Corp.
6F, Daiyontamachi Bldg., 2-17-12, Shibaura, Minato-Ku,
Tokyo, 108-0023, Japan
Tel: 81-3-5419-2668
Fax: 81-3-5419-0018
jpservices@apacer.com

Europe
Apacer Technology B.V.
Science Park Eindhoven 5051 5692 EB Son,
The Netherlands
Tel: 31-40-267-0000
Fax: 31-40-290-0686
sales@apacer.nl

China
Apacer Electronic (Shanghai) Co., Ltd
Room D, 22/FL, No.2, Lane 600, JieyunPlaza,
Tianshan RD, Shanghai, 200051, China
Tel: 86-21-6228-9939
Fax: 86-21-6228-9936
sales@apacer.com.cn

India
Apacer Technologies Pvt Ltd,
1874, South End C Cross, 9th Block Jayanagar,
Bangalore-560069, India
Tel: 91-80-4152-9061/62
Fax: 91-80-4170-0215
sales_india@apacer.com