

***RoHS Compliant***

# **Industrial Micro SD 3.0**

***Specifications***

**September 28<sup>th</sup>, 2011**

***Version 1.0***



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## FEATURES:

- **Fully compatible with SD Card Association specifications**
  - Part 1, Physical Layer Specification, Version 3.1 Final
  - Part 3, Security Specification, Version 3.0 Final
- **Capacity range**
  - 4, 8, 16 GB
- **Performance\***
  - Sustained Read: Up to 20 MB/sec
  - Sustained Write: Up to 14 MB/sec
- **SD-protocol compatible**
- **Supports SD SPI mode**
- **Backward compatible with 2.0**
- **Upgradable to Micro SDHC via FAT32**
- **NAND Flash Type: MLC**
- **Operating frequency: up to 100 MHz**
- **Intelligent endurance design**
  - Built-in advanced ECC algorithm
  - Implements global wear-leveling algorithms to substantially increase longevity of flash media
  - Flash bad-block management
  - Built in write protect
  - Copyright protection mechanism: SDMI standard compatible
- **Temperature ranges**
  - Operating temperature: -25 ~ +85°C
  - Storage temperature: -40°C ~ +85°C
- **Operating voltage: 2.7V ~ 3.6V**
- **Physical dimension : 15mm(L) x 11mm(W) x 1mm(H)**
- **RoHS Compliant**

\*Vary from capacities. Performance values presented here are typical and may vary depending on settings and platforms.

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## 1. General Description

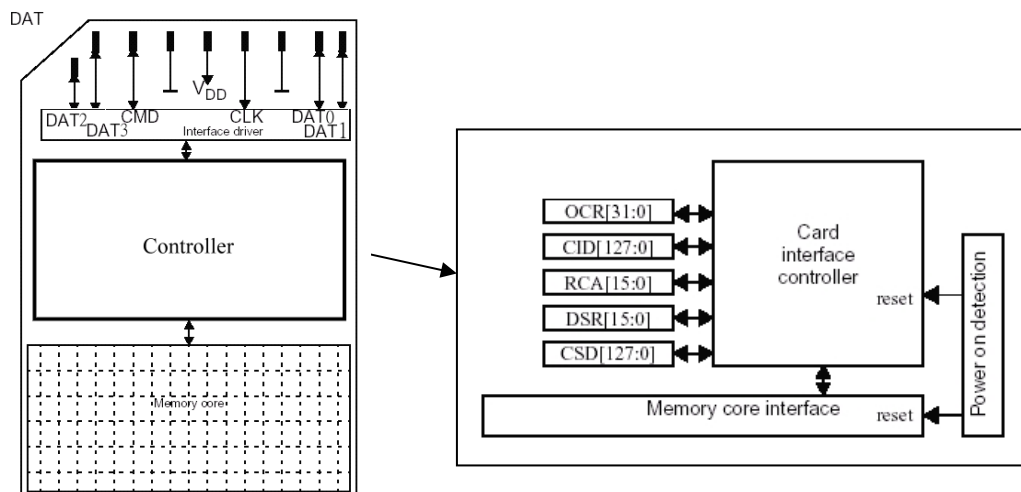
As the demand of reliable and high-performance data storage in a small form factor increases, Apacer's Micro SD card 3.0 is designed specifically for multiple applications by offering high endurance, reliability, and agility, where extreme traceability, enhanced data integrity, and exceptionally velocity are required.

The Micro SD 3.0 card fully complies with SD Card Association standard. The Command List is compatible with [Part 1 Physical Layer Specification Ver3.1 Final] definitions, while the Card Capacity of Non-secure Area, Secure Area supports [Part 3 Security Specification Ver3.0 Final] Specifications. Regarding its operation efficiency, it can operate at maximum frequency up to 100 MHz and is able to alternate communication protocols between SD and SPI modes. For data read/write speed, the card can perform up to 19 MB/sec.

The card also comes with endurance features for data error detection and correction, ESD protection, built-in permanent/temporary write protection, password protection, and SDMI standard compliant copyright protection mechanism.

### 1.1 Product Function Block

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



### 1.2 Functional description

The Micro SD device contains a high level, intelligent flash management that provides many capabilities including:

- Host independence from details of erasing and programming flash memories.
- Powerful ECC algorithms
- Global wear-leveling algorithms
- Power management for low power operation

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### **1.2.1 Flash Management**

The SD controller contains logic/physical flash block mapping and bad block management system. It will manage all flash block including user data space and spare block.

The Micro SD also contains a sophisticated defect and error management system. It does a read after write under margin conditions to verify that the data is written correctly (except in the case of write pre-erased sectors). In case that a bit is found to be defective, the SD will replace this bad bit with a spare bit within the sector header. If necessary, the Micro SD will even replace the entire sector with a spare sector. This is completely transparent to the master (host device) and does not consume any user data space.

### **1.2.2 Powerful ECC Algorithms**

The powerful ECC algorithms will enhance flash block use rate and whole device life. The SD controller has an innovative algorithm to detect, correct and/or recover the data.

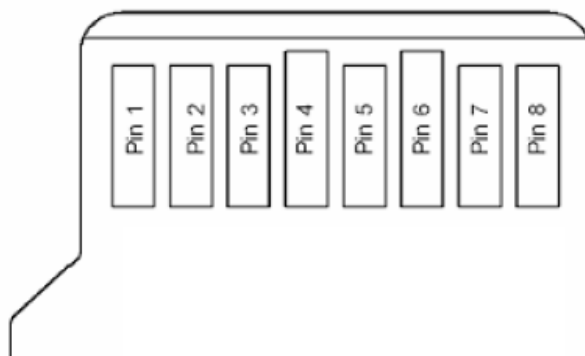
### **1.2.3 Power Management**

A power saving feature of the Micro SD is automatic entrance and exit from sleep mode. Upon completion of an operation, the SD will enter the sleep mode to conserve power if no further commands are received within X seconds, where X is programmable by software. The master does not have to take any action for this to occur. The SD is in sleep mode except when the host is accessing it, thus conserving power.

Any command issued by the master to the Micro SD will cause it to exit sleep mode and response to the master.

## 2. Electrical characteristics

### 2.1 Card Architecture



### 2.2 Pin Assignment

| Pin | SD Mode              |                               | SPI Mode |                       |
|-----|----------------------|-------------------------------|----------|-----------------------|
|     | Name                 | Description                   | Name     | Description           |
| 1   | DAT2                 | Data line[bit 2]              | Reserved |                       |
| 2   | CD/DAT3 <sup>2</sup> | Card Detect/Data line [bit 3] | CS       | Chip select           |
| 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]              | Reserved |                       |

## 2.3 Capacity Specification

The following table shows the specific capacity for the SD 3.0 card (designed with 24nm MLC flash).

| Capacity | Total (LBA) Sectors | Total Partition Sectors | User Data Sectors | User Data Bytes |
|----------|---------------------|-------------------------|-------------------|-----------------|
| 4 GB     | 7,774,208           | 7,766,016               | 7,757,824         | 3,972,005,888   |
| 8 GB     | 15,564,800          | 15,556,608              | 15,548,416        | 7,960,788,992   |
| 16 GB    | 31,260,672          | 31,252,480              | 31,244,288        | 15,997,075,456  |

## 2.4 Performance

Performances of the SD 3.0 card are shown in the table below.

| Modes \ Capacity | 4 GB | 8 GB | 16 GB |
|------------------|------|------|-------|
| Read (MB/s)      | 18   | 20   | 19    |
| Write (MB/s)     | 11   | 14   | 13    |

Note: results may vary depending on settings and platforms.

## 2.5 Absolute Maximum Ratings

| Symbol          | Parameter               | Min.         | Max.         | Unit |
|-----------------|-------------------------|--------------|--------------|------|
| $V_{DD}$        | Power Supply Voltage    | 2.7          | 3.6          | V    |
| $V_{DD}-V_{SS}$ | DC Power Supply Voltage | -0.3         | +3.3         | V    |
| $V_{IN}$        | Input Voltage           | $V_{SS}-0.3$ | $V_{DD}+0.3$ | V    |

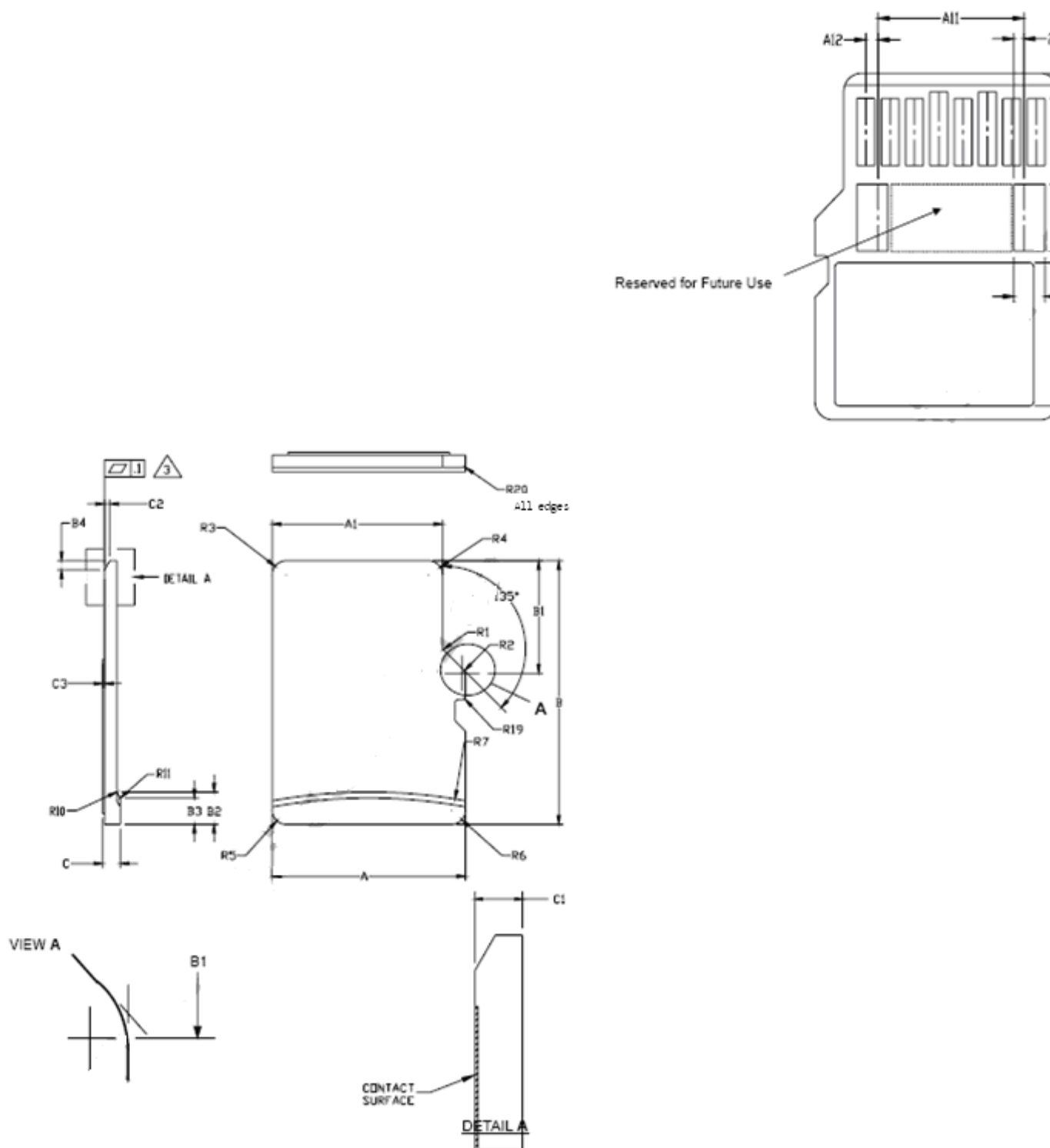
## 2.6 Power consumption (typical)

| Modes                  | Max Read (mA) | Max Write (mA) | Power On | Stand By |
|------------------------|---------------|----------------|----------|----------|
| Single flash (1x8bit)* | 100@ 3.6V     | 100@ 3.6V      | 150(uA)  | 150(uA)  |

\*Data transfer mode in single channel

## 3. Physical Characteristics

### 3.1 Physical Dimension



**Industrial Micro SD 3.0**  
**AP-MSDXXGCX4P-XTM**

| COMMON DIMENSIONS |       |       |       |
|-------------------|-------|-------|-------|
| SYMBOL            | MIN   | NOM   | MAX   |
| A                 | 10.90 | 11.00 | 11.10 |
| A1                | 9.60  | 9.70  | 9.80  |
| A2                | -     | 3.85  | -     |
| A3                | 7.60  | 7.70  | 7.80  |
| A4                | -     | 1.10  | -     |
| 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                | 0.70  | 0.80  | 0.90  |
| R6                | 0.70  | 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               | 0.02  | -     | 0.15  |

Notes:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
2. DIMENSIONS ARE IN MILLIMETERS.
3.  COPLANARITY IS ADDITIVE TO C1 MAX THICKNESS.

## 3.2 Environmental Specifications

| Climatic Testing                 |           |                                  |           |
|----------------------------------|-----------|----------------------------------|-----------|
| Test Item                        | DUT State | Test Condition (Gold Series)     |           |
|                                  |           | Temperature                      | Duration  |
| High Temperature                 | Storage   | 85°C                             | 500 Hours |
|                                  | Operation | 85°C                             | 168 Hours |
| Low Temperature                  | Storage   | - 40°C                           | 300 Hours |
|                                  | Operation | - 25°C                           | 168 Hours |
| High Temperature & High Humidity | Storage   | 40°C 95%                         | 500 Hours |
|                                  | Operation | 40°C 95%                         | 4 Hour    |
| Thermal Cycling                  | Storage*  | - 40°C ~ 85°C<br>30min hold each | 20 Cycles |

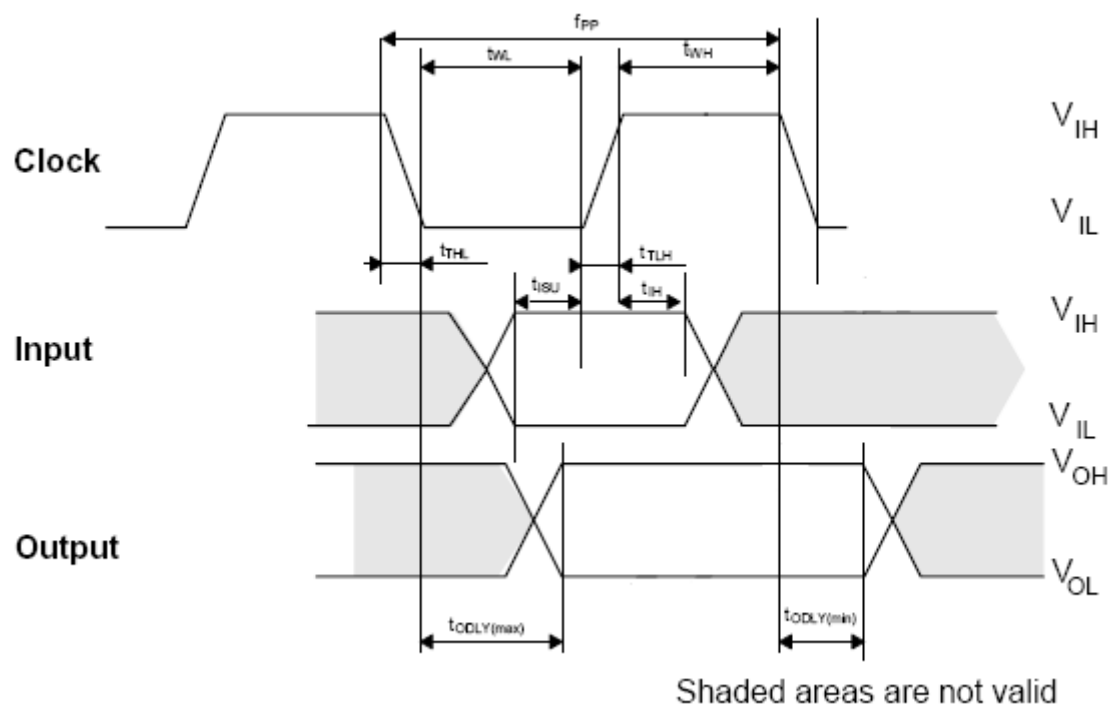
| Durability Testing |               |
|--------------------|---------------|
| Test Item          | Descriptions  |
| Insertion/Removal  | 10,000 cycles |

**Industrial Micro SD 3.0**  
**AP-MSDXXGCX4P-XTM**

|                         |                                                                                                                                                                                                                                                                                 |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bending                 | 10nt/Stimes for 6 faces and 4 corners (each drop was performed 3 times, total of 30 drops)                                                                                                                                                                                      |
| Electrostatic Discharge | Contact discharge: HCP & VCP<br>Air discharge: ALL – VSS ( $\pm$ ),<br>ALL – VCC ( $\pm$ )<br>VCC – VSS ( $\pm$ ),<br>ALL – ALL ( $\pm$ )                                                                                                                                       |
| Ultraviolet Radiation   | Units are non-operating. UVB bandwidth : 313nm. Test irradiation : 0.63 w/m <sup>2</sup> /nm.<br>Radiation cycle : Radiation on for 4 hours at temperature 60°C, then radiation off for 4 hours at temperature 50°C. Number of cycle : 6 cycles.<br>Duration of test : 48 hours |
| Drop                    | 1.Sm free fall, 10times                                                                                                                                                                                                                                                         |
| Salt Water Spray        | 3+/-1%NaCl; 35°C; 24hrs                                                                                                                                                                                                                                                         |
| Torque                  | 0.SN-m or 0.2Sdegree S time; 30sec/direction                                                                                                                                                                                                                                    |

## 4. AC Characteristics

### 4.1 Micro SD Interface Timing (Default)

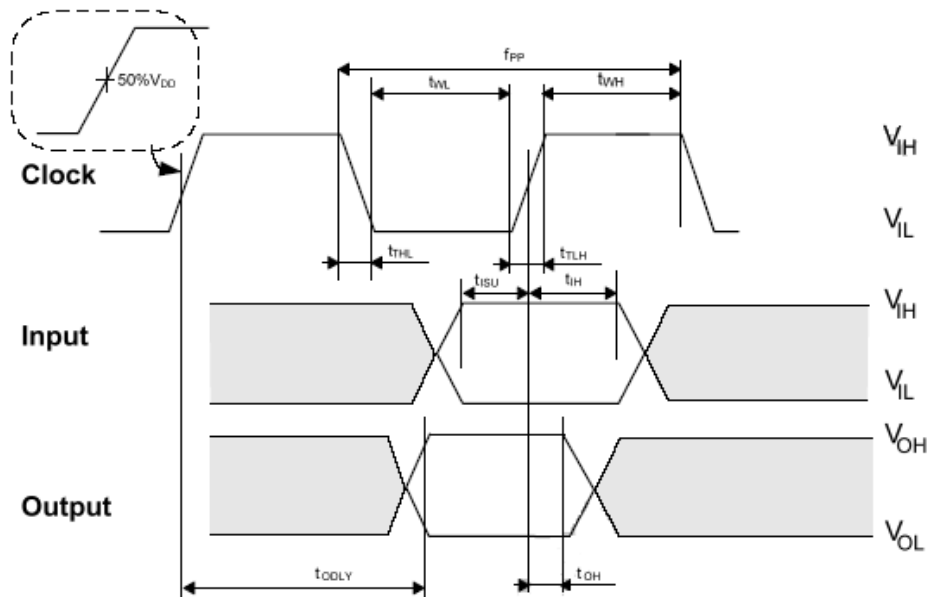


| SYMBOL                                                                                              | PARAMETER                           | MIN                   | MAX | UNIT | Note                              |
|-----------------------------------------------------------------------------------------------------|-------------------------------------|-----------------------|-----|------|-----------------------------------|
| <b>Clock CLK (All values are referred to min(<math>V_{IH}</math>) and max(<math>V_{IL}</math>))</b> |                                     |                       |     |      |                                   |
| $f_{PP}$                                                                                            | Clock frequency Data Transfer Mode  | 0                     | 25  | MHz  | $C_{card} \leq 10$ pF<br>(1 card) |
| $f_{OD}$                                                                                            | Clock frequency Identification Mode | 0 <sub>(1)</sub> /100 | 400 | kHz  | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{WL}$                                                                                            | Clock low time                      | 10                    | -   | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{WH}$                                                                                            | Clock high time                     | 10                    | -   | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{TLH}$                                                                                           | Clock rise time                     | -                     | 10  | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{THL}$                                                                                           | Clock fall time                     | -                     | 10  | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{ISU}$                                                                                           | Input setup time                    | 5                     | -   | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{IH}$                                                                                            | Input hold time                     | 5                     | -   | ns   | $C_{card} \leq 10$ pF<br>(1 card) |

|            |                                              |   |    |    |                              |
|------------|----------------------------------------------|---|----|----|------------------------------|
| $t_{ODLY}$ | Output delay time                            | 0 | 14 | ns | $C_L \leq 40$ pF<br>(1 card) |
| $t_{ODLY}$ | Output Delay time during Identification Mode | 0 | 50 | ns | $C_L \leq 40$ pF<br>(1 card) |

(1)0Hz means to stop the clock. The given minimum frequency range is for cases that requires the clock to be continued.

## 4.2 Micro SD Interface Timing (High Speed Mode)



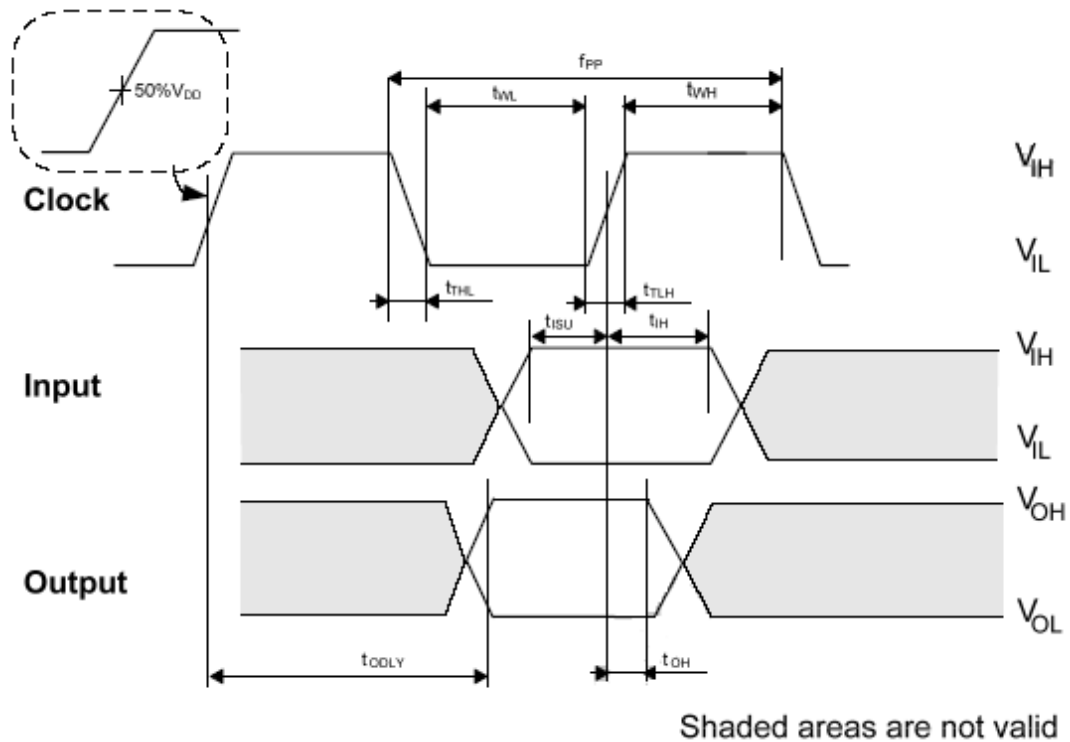
Shaded areas are not valid

| SYMBOL     | PARAMETER                          | MIN | MAX | UNIT | Note                              |
|------------|------------------------------------|-----|-----|------|-----------------------------------|
| $f_{PP}$   | Clock frequency data transfer mode | 0   | 50  | MHz  | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{WL}$   | Clock low time                     | 7   | -   | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{WH}$   | Clock high time                    | 7   | -   | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{TLH}$  | Clock rise time                    | -   | 3   | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{THL}$  | Clock fall time                    | -   | 3   | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{ISU}$  | Input setup time                   | 6   | -   | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{IH}$   | Input hold time                    | 2   | -   | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{ODLY}$ | Output delay time                  |     | 14  | ns   | $C_L \leq 40$ pF<br>(1 card)      |
| $T_{OH}$   | Output hold time                   | 2.5 | 50  | ns   | $C_L \leq 15$ pF<br>(1 card)      |
| $C_L$      | System capacitance of each line*   |     | 40  | pF   | $C_L \leq 15$ pF<br>(1 card)      |

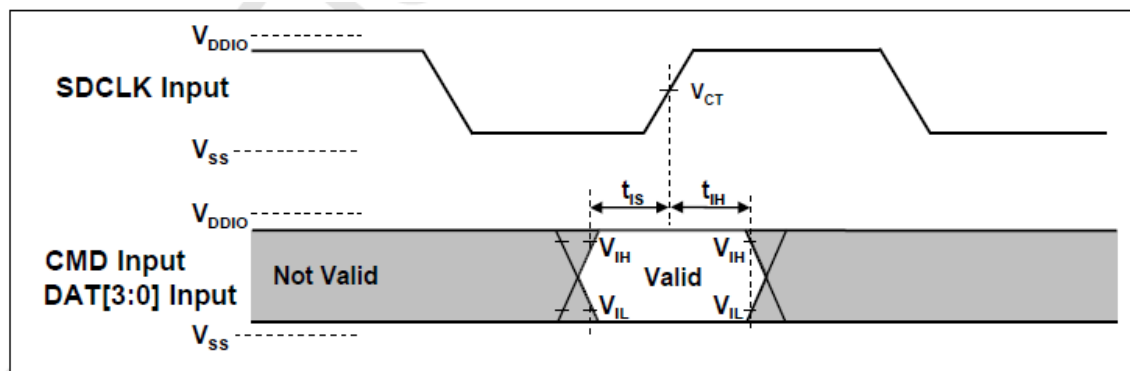
\*In order to satisfy severe timing, host shall run on only one card

### 4.3 SD Interface Timing (SDR12, SDR25 and SDR50 Modes) Input

| 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        | %    |                                                 |



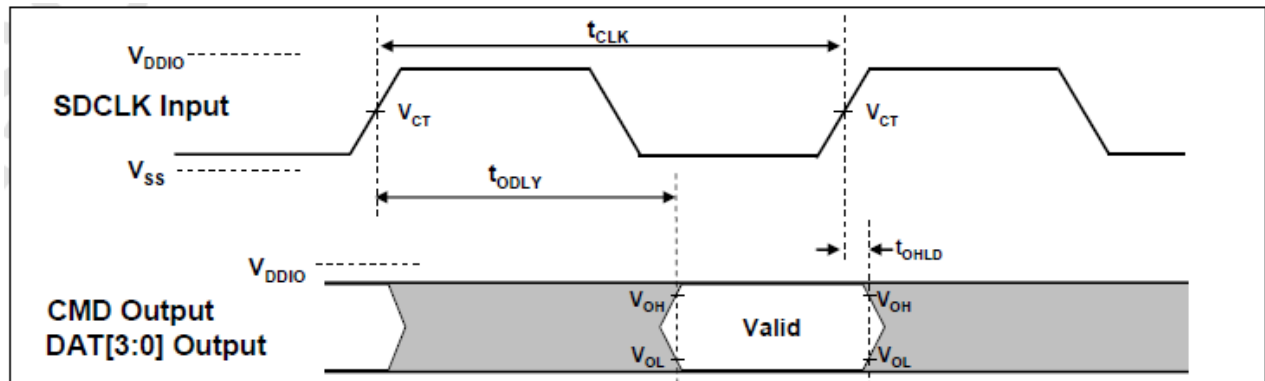
#### 4.3.1 SDR50 Input Timing



Card Input Timing

| Symbol          | Min  | Max | Unit | SDR50 Mode               |
|-----------------|------|-----|------|--------------------------|
| t <sub>ls</sub> | 3.00 | -   | ns   | CCARD =10pF, VCT= 0.975V |
| t <sub>lH</sub> | 0.80 | -   | ns   | CCARD =5pF, VCT= 0.975V  |

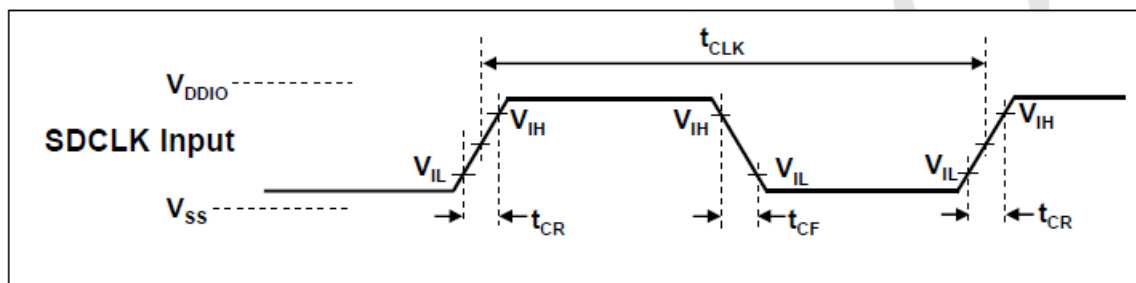
#### 4.3.2 Output



Output Timing of Fixed Data Window

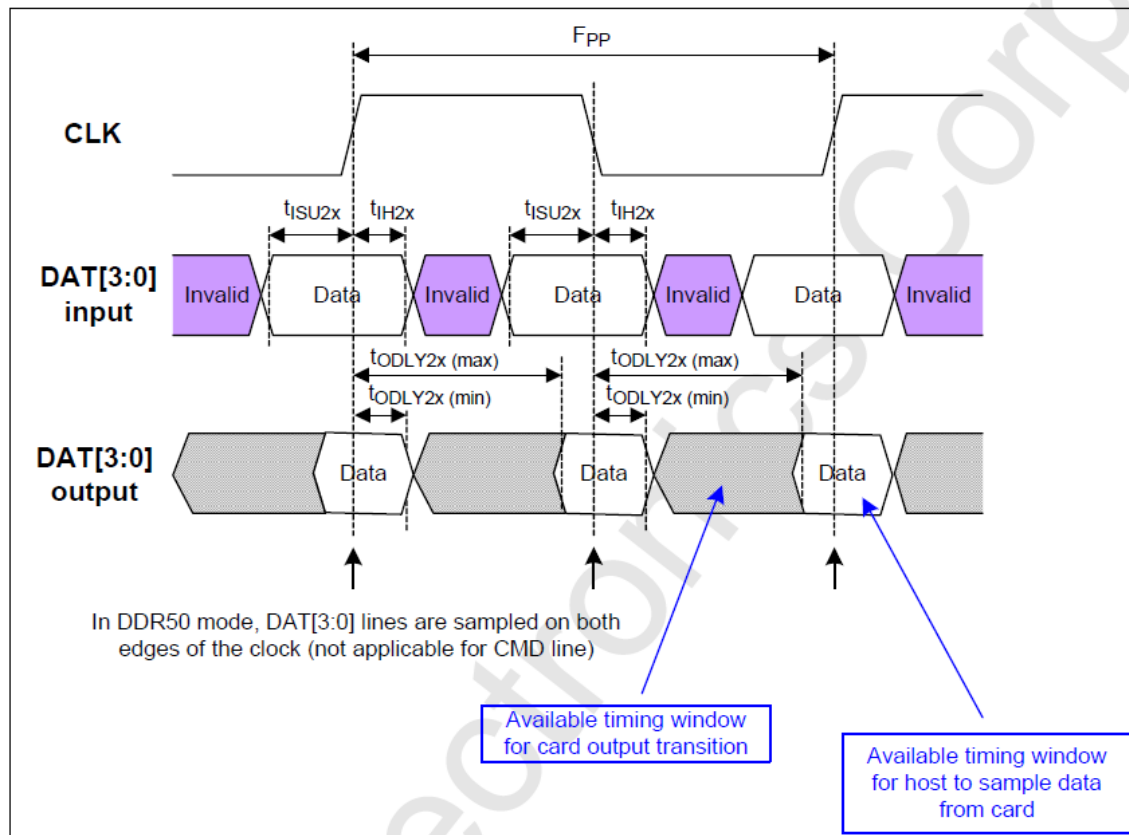
| Symbol            | Min | Max | Unit | Remark                                                                        |
|-------------------|-----|-----|------|-------------------------------------------------------------------------------|
| t <sub>ODLY</sub> | -   | 7.5 | ns   | t <sub>CLK</sub> ≥ 10.0ns, CL=30pF, using driver Type B, for SDR50            |
| t <sub>ODLY</sub> | -   | 14  | ns   | t <sub>CLK</sub> ≥ 20.0ns, CL=40pF, using driver Type B, for SDR25 and SDR12, |
| t <sub>OH</sub>   | 1.5 | -   | ns   | Hold time at the t <sub>ODLY</sub> (min.), CL=15pF                            |

#### 4.3.3 SD Interface Timing (DDR50 Mode)



Clock Signal Timing

| Symbol                            | Min | Max                   | Unit | Remark                                                                 |
|-----------------------------------|-----|-----------------------|------|------------------------------------------------------------------------|
| t <sub>CLK</sub>                  | 20  | -                     | ns   | 50MHz (Max.), Between rising edge                                      |
| t <sub>CR</sub> , t <sub>CF</sub> | -   | 0.2* t <sub>CLK</sub> | ns   | t <sub>CR</sub> , t <sub>CF</sub> < 4.00ns (max.) at 50MHz, CCARD=10pF |
| Clock Duty                        | 45  | 55                    | %    |                                                                        |



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

#### 4.3.4 Bus Timings – Parameters Values (DDR50 Mode)

| Symbol                                                          | Parameters                                  | Min | Max  | Unit | Remark                            |
|-----------------------------------------------------------------|---------------------------------------------|-----|------|------|-----------------------------------|
| <b>Input CMD (referenced to CLK rising edge)</b>                |                                             |     |      |      |                                   |
| $t_{ISU}$                                                       | Input set-up time                           | 6   | -    | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{IH}$                                                        | Input hold time                             | 0.8 | -    | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| <b>Output CMD (referenced to CLK rising edge)</b>               |                                             |     |      |      |                                   |
| $t_{ODLY}$                                                      | Output Delay time during Data Transfer Mode | -   | 13.7 | ns   | $C_L \leq 30$ pF<br>(1 card)      |
| $T_{OH}$                                                        | Output Hold time                            | 1.5 | -    | ns   | $C_L \geq 15$ pF<br>(1 card)      |
| <b>Inputs DAT (referenced to CLK rising and falling edges)</b>  |                                             |     |      |      |                                   |
| $t_{ISU2x}$                                                     | Input set-up time                           | 3   | -    | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| $t_{IH2x}$                                                      | Input hold time                             | 0.8 | -    | ns   | $C_{card} \leq 10$ pF<br>(1 card) |
| <b>Outputs DAT (referenced to CLK rising and falling edges)</b> |                                             |     |      |      |                                   |
| $t_{ODLY2x}$                                                    | Output Delay time during Data Transfer Mode | -   | 7.0  | ns   | $C_L \leq 25$ pF<br>(1 card)      |
| $T_{OH2x}$                                                      | Output Hold time                            | 1.5 | -    | ns   | $C_L \geq 15$ pF<br>(1 card)      |

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## 5. Product Ordering Information

### 5.1 Valid Combinations

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| <i>Capacity</i> | <i>AP/N</i>        |
|-----------------|--------------------|
| 4 GB            | AP- MSD04GCS4P-XTM |
| 8 GB            | AP-MSD08GCD4P-XTM  |
| 16 GB           | AP-MSD16GCH4P-XTM  |

**Note:** Valid combinations are those products 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.

## Revision History

| Revision | Description                                                                                 | Date       |
|----------|---------------------------------------------------------------------------------------------|------------|
| 0.1      | Preliminary                                                                                 | 08/24/2011 |
| 0.2      | Added Durability Testing<br>-- items and descriptions of Durability Testing have been added | 08/29/2011 |
| 0.3      | Added 8/16 GB to the capacity                                                               | 09/06/2011 |
| 1.0      | Official release                                                                            | 09/28/2011 |

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## Global Presence

|                              |                                                                                                                                                                                                                                                       |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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