*RoHS Compliant*

# Industrial Secure Digital Card

*H1-M Product Specifications*

**February 12, 2015**

*Version 1.1*

# FEATURES:

- **Fully compatible with SD Memory card standard specification**

    - Part 1, Physical Layer Specification, Ver 3.01 Final

    - Part 2, File System Specification, Ver 3.00

    - Part 3, Security Specification, Ver 3.00 Final

- **Capacity**

    - 4, 8,16, 32, 64, 128 GB

- **Performance**

    - Sustained read: Up to 43 MB/sec

    - Sustained write: Up to 36 MB/sec

- **SD-protocol compatible**

- **Support SPI mode**

- **NAND Flash Type:** MLC

- **Physical dimension:**
  32mm（L）x 24mm（W）x 2.1mm（H）

- **Intelligent endurance design**

    - Built-in advanced ECC algorithm

    - Wear-Leveling algorithms

    - Bad block management

    - S.M.A.R.T utility

    - Auto-Read refresh

- **Temperature ranges**

    - Operating temperature
        Standard: -25 ~ +85°C
        Extended: -40 ~ +85°C

    - Storage temperature: -40°C ~ 85°C

- **Power consumption (typical)**

    - Operating: 160 mA

    - Standby: 275 µA

- **Operation voltage:** 2.7V ~ 3.6V

- **RoHS Recast Compliant**

Note: The values addressed here for Performance and Power consumption are typical and may vary depending on configurations 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 SD card is designed specifically for rigorous applications by offering maximum endurance, reliability, and agility, where extreme traceability, enhanced data integrity, and exceptionally velocity are required.

Regarding compatibility, this industrial SD card is compatible with SD Memory Card Specifications , Physical Layer specification, File System Specification and Part 3 Security Specification. Furthermore, the SD card is compatible with SD protocol. With built in ECC, wear-leveling and bad block management, this industrial SD card serves as an ideal portable storage solution.

## 1.1 Product Function Block

The SD contains a flash controller and flash media with SD standard interface.
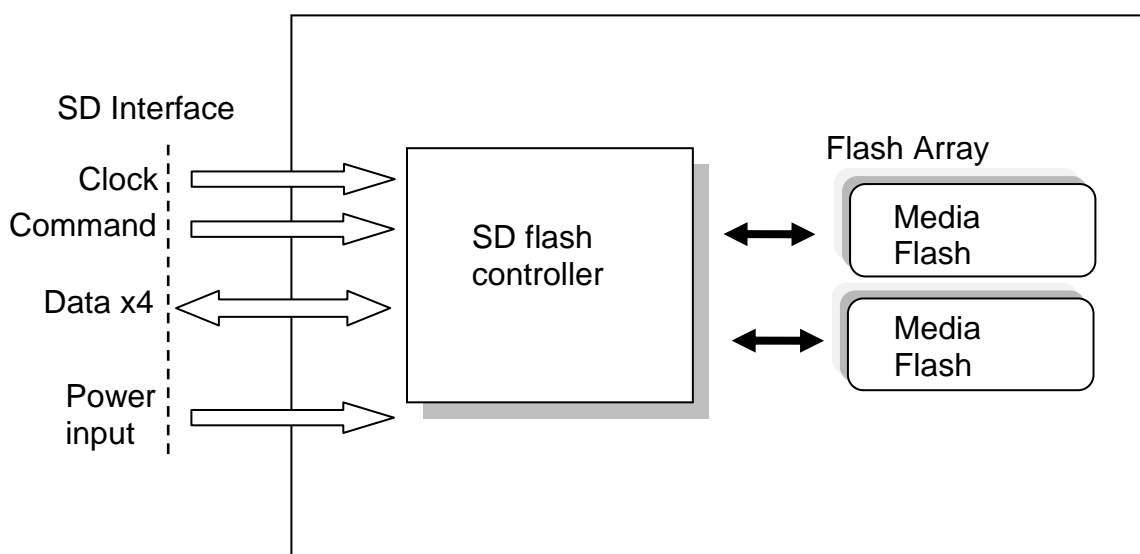


## 1.2 Flash Management

### 1.2.1 Bad Block Management

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

The 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 replaces this bad bit with a spare bit within the sector header. If necessary, the 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 ECC Algorithms
Flash memory cells will deteriorate with use, which might generate random bit errors in the stored data. Thus, this SD card 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.

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## 1.2.3 S.M.A.R.T

S.M.A.R.T. (SMART), an acronym stands for Self-Monitoring, Analysis and Reporting Technology, is an open standard allowing an individual disk drive in the ATA/IDE or SCSI interface to automatically monitor its own health and report potential problems in order to prevent data loss. This failure warning technology provides predictions from unscheduled downtime by observing and storing critical drive performance and calibration parameters. Ideally, this should allow taking hands-on actions to keep from impending drive failure.

Failures are divided into two categories: those that can be predicted and those that cannot. Predictable failures occur gradually over time, and the decline in performance can be detected; on the other hand, unpredictable failures happen very sudden without any warning. These failures may be caused by power surges or related to electronic components. The purpose of the SMART implementation is to predict near-term failures of each individual disk drive and generate a warning to prevent unfortunate loss.

## 1.2.4 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.

Apacer provides 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.

## 1.2.5 Auto-Read Refresh

When continuously being read, NAND flash memory cannot engage wear leveling since this applies while writing data. Subsequently, errors aggregated over time and become uncorrectable. To keep errors from going beyond ECC's capability to recover and memory blocks in good hands, Apacer's Auto-Read Refresh will spontaneously refresh the bit errors when the threshold is triggered by the error count in a block.

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# 2. Electrical Characteristics

## 2.1 Card Architecture
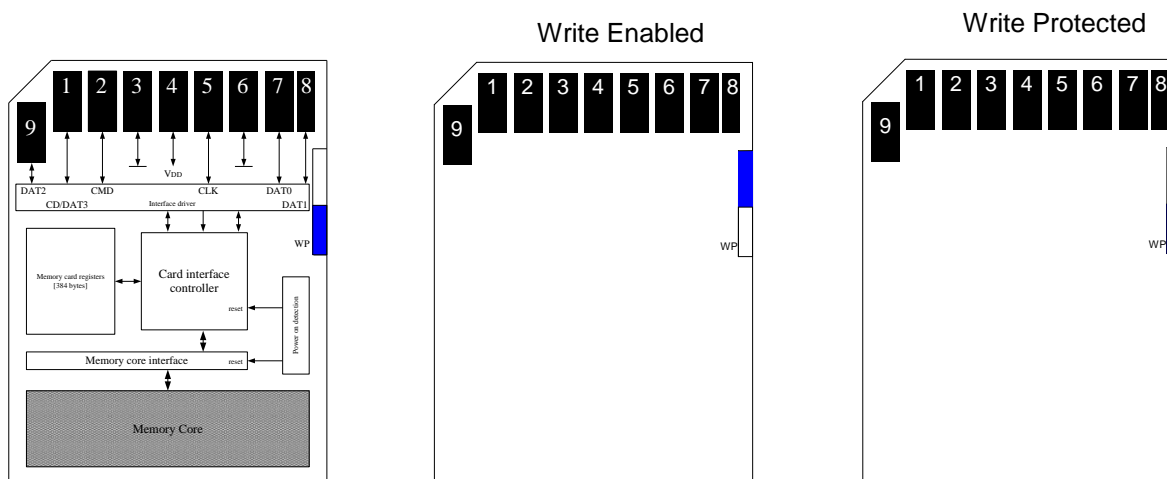


## 2.2 Pin Assignment

| Pin | SD Mode | | SPI Mode | |
|-----|---------|---------|----------|----------|
|     | Name | Description | Name | Description |
| 1 | CD/DAT3 | Card detect/Data line[Bit 3] | CS | Chip select |
| 2 | CMD | Command/Response | DI | Data in |
| 3 | VSS1 | Supply voltage ground | VSS | Supply voltage ground |
| 4 | VDD | Supply voltage | VDD | Supply voltage |
| 5 | CLK | Clock | SCLK | Clock |
| 6 | VSS2 | Supply voltage ground | VSS2 | Supply voltage ground |
| 7 | DAT0 | Data line[Bit 0] | DO | Data out |
| 8 | DAT1 | Data line[Bit 1] | Reserved | |
| 9 | DAT2 | Data line[Bit 2] | Reserved | |

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## 2.3 Capacity Specification

The following table shows the specific capacity for the SD card.

| Capacity | Total Bytes |
|----------|-------------|
| 4 GB | 3,972,005,888 |
| 8 GB | 7,960,788,992 |
| 16 GB | 16,013,852,672 |
| 32 GB | 32,082,198,528 |
| 64 GB | 64,156,073,984 |
| 128 GB | 128,278,593,536 |

Note: the statistics may vary depending on file systems of various OS. User data bytes do not indicate total useable bytes. LBA count addressed in the table above indicates total user storage capacity and will remain the same throughout the lifespan of the device. However, the total usable capacity of the SD is most likely to be less than the total physical capacity because a small portion of the capacity is reserved for device maintenance usages.

## 2.4 Performance

Performances of SD are shown in the table below.

| Performance \ Capacity | 4 GB | 8 GB | 16 GB | 32 GB | 64 GB | 128 GB |
|----------|------|------|-------|-------|-------|--------|
| Sustained Read (MB/s) | 35 | 35 | 43 | 43 | 43 | 43 |
| Sustained Write (MB/s) | 10 | 20 | 36 | 31 | 22 | 23 |

Note: Performances vary from flash configurations or host system settings..

## 2.5 DC Power Supply

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

## 2.6 Power consumption

| Modes \ Capacity | 4 GB | 8 GB | 16 GB | 32 GB | 64 GB | 128 GB |
|----------|------|------|-------|-------|-------|--------|
| Operating (**mA**) | 55 | 70 | 115 | 140 | 150 | 160 |
| Standby (**µA**) | 136 | 150 | 165 | 220 | 245 | 275 |

Note: results are measured under 3.3V.

# 3. Physical Characteristics

## 3.1 Physical Dimension

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

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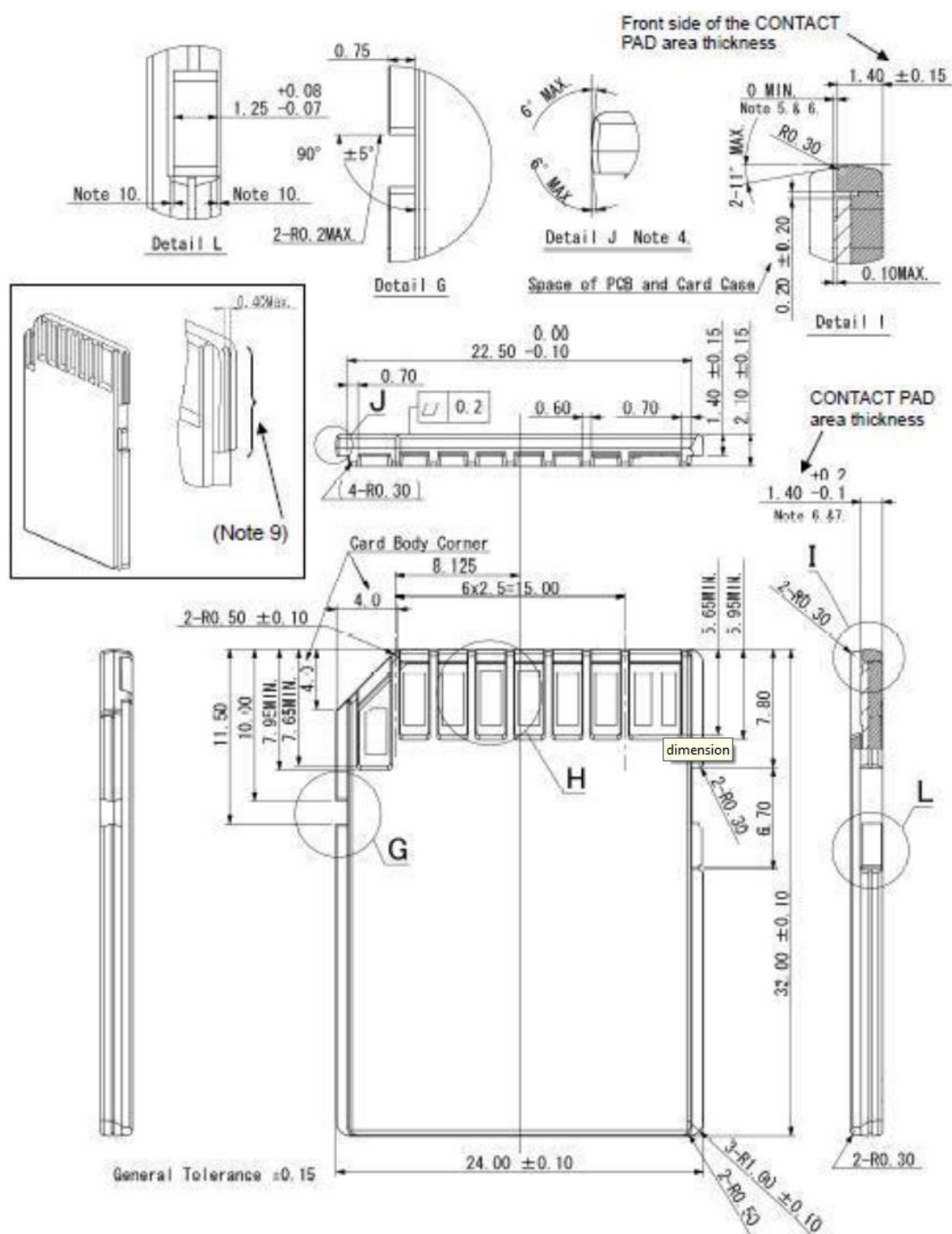
## 3.2 Environmental Specifications

| Environment | Specification |
|---|---|
| Temperature | -25°C to 85°C (Standard)<br>-40°C to 85°C (Extended temp) |
| | -40°C to 85°C (in storage) |
| Humidity | RH 95% under 55°C  (Standard)<br>RH 95% under 55°C  (Extended temp) |
| Shock | 1500G, 0.5ms |
| Vibration | 20Hz~80Hz/1.52mm (frequency/displacement)<br> 80Hz~2000Hz/20G (frequency/displacement)<br>X, Y, Z axis/60mins each |
| Drop | 1.5m free fall, 6 surfaces of each |
| Bending | $\geqq$10N, hold 1min/5times |
| Torque | 0.15N-m or 2.5deg, hold 30 seconds/ 5 times |
| Salt spray | Concentration: 3% NaCl at 35°C (storage for 24 hours) |
| Waterproof | JIS IPX7 compliance, Water temperature 25°C<br>Water depth: the lowest point of unit is locating 1000mm below surface<br>(storage for 30 mins) |
| X-Ray Exposure | 0.1 Gy of medium-energy radiation<br> (70 KeV to 140 KeV, cumulative dose per year) to both sides of the<br>card ;storage for 30 mins) |
| Switch cycle | 0.4~0.5N, 1000 times |
| Durability | 10,000 times mating cycle |
| ESD | Contact: +/-4KV each item 25 times<br>Air: +/-8KV 10 times |

# 4. DC Characteristics

## 4.1 SD Interface Timing (Default)



Shaded areas are not valid
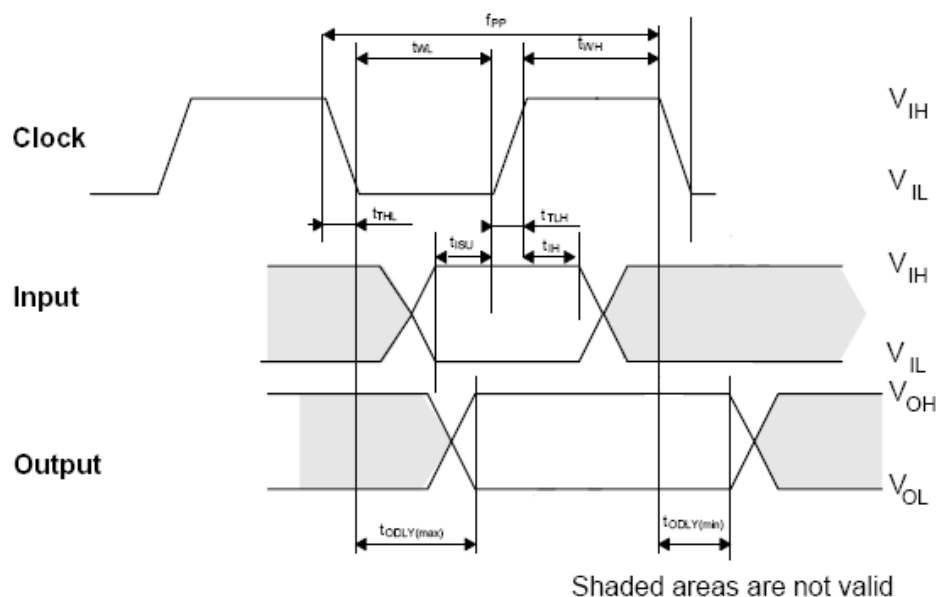
| SYMBOL | PARAMETER | MIN | MAX | UNIT | Note |
|---|---|---|---|---|---|
| **Clock CLK (All values are referred to min($V_{IH}$) and max($V_{IL}$)** | | | | | |
| $f_{PP}$ | Clock frequency Data Transfer Mode | 0 | 25 | MHz | $C_{card}$≤10 pF (1 card) |
| $f_{OD}$ | Clock frequency Identification Mode | 0(1)/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) |
| $t_{ISU}$ | Input setup time | 5 | - | ns | $C_{card}$≤10 pF (1 card) |
| $t_{IH}$ | Input hold time | 5 | - | ns | $C_{card}$≤10 pF (1 card) |
| $t_{ODLY}$ | Output delay time | 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) |

(1)0Hz means to stop the clock. The given minimum frequency range is for cases that requires the clock to be continued.
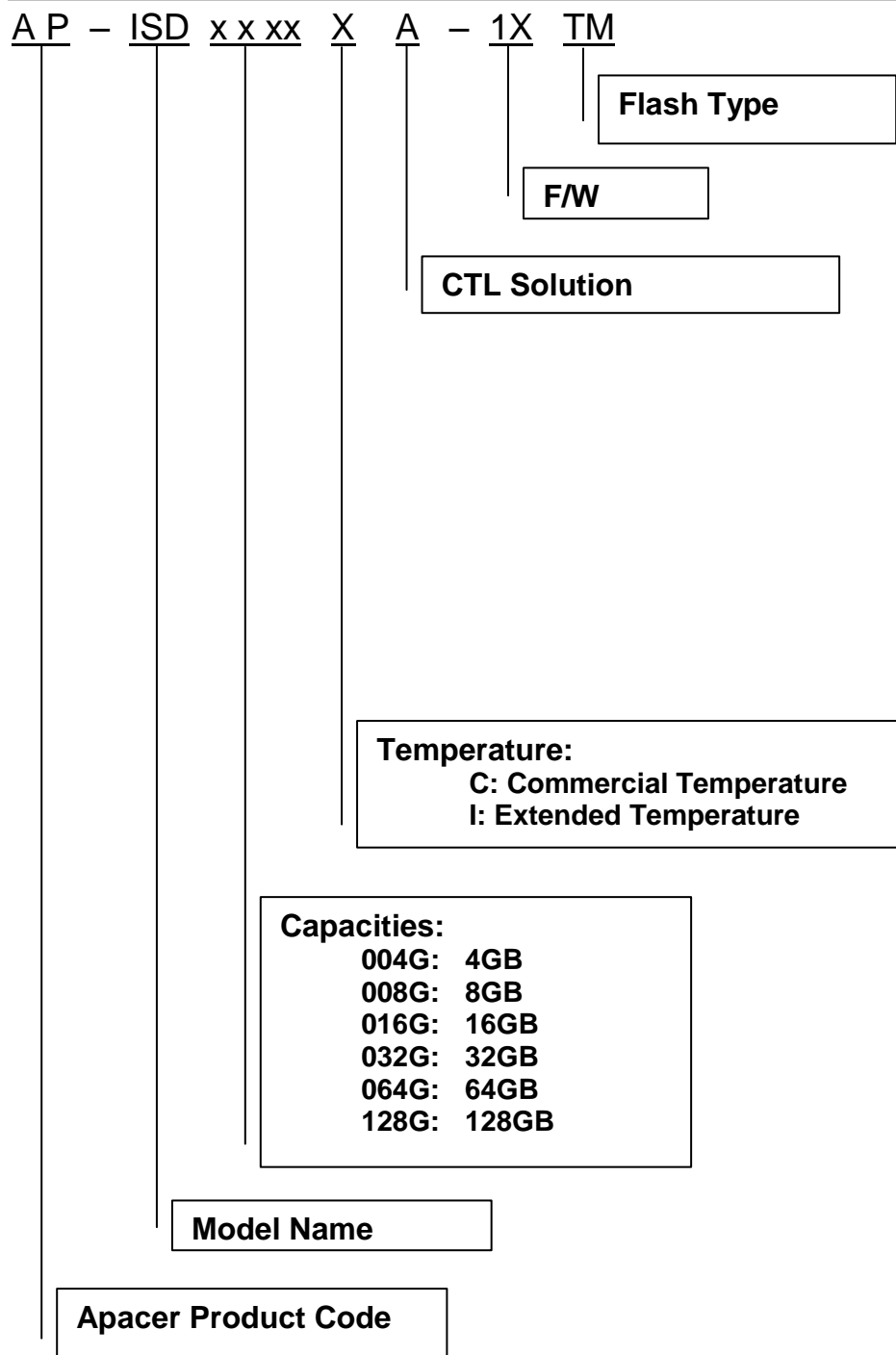
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## 4.2 SD Interface Timing (High Speed Mode)
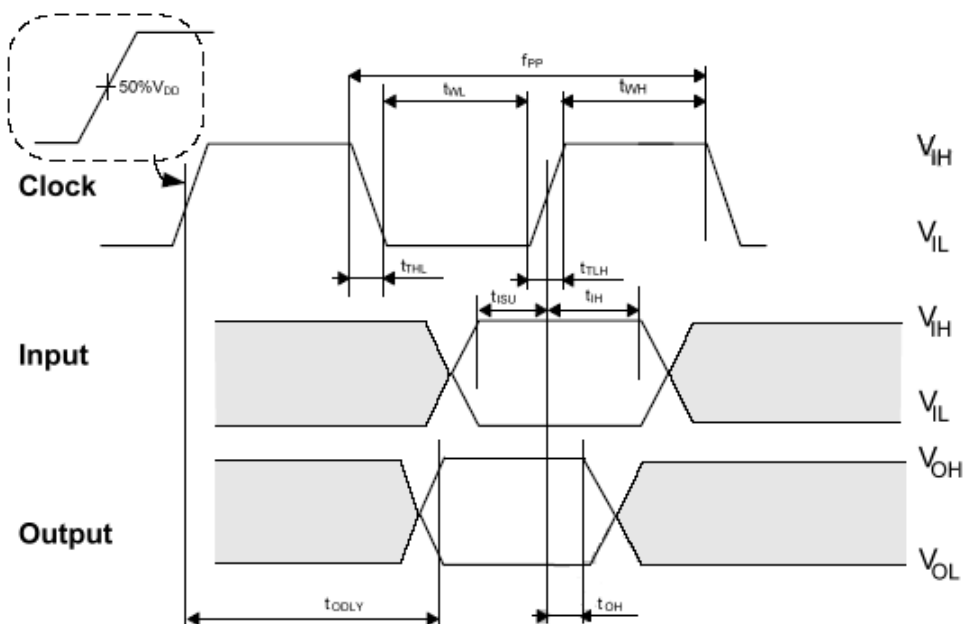


Shaded areas are not valid

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

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

# 5. Product Ordering Information

## 5.1 Product Code Designations

A P – ISD x x xx X A – 1X TM

**Flash Type**

**F/W**

**CTL Solution**

**Temperature:**
  **C: Commercial Temperature**
  **I: Extended Temperature**

**Capacities:**
  **004G: 4GB**
  **008G: 8GB**
  **016G: 16GB**
  **032G: 32GB**
  **064G: 64GB**
  **128G: 128GB**

**Model Name**

**Apacer Product Code**

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## 5.2 Valid Combinations

### 5.2.1 Standard Temperature

| Capacity | AP/N |
|----------|------|
| 4GB | AP-ISD004GCA-1ATM |
| 8GB | AP-ISD008GCA-1ATM |
| 16GB | AP-ISD016GCA-1ATM |
| 32GB | AP-ISD032GCA-1ATM |
| 64GB | AP-ISD064GCA-1CTM |
| 128GB | AP-ISD128GCA-1CTM |

### 5.2.2 Extended Temperature

| Capacity | AP/N |
|----------|------|
| 4GB | AP-ISD004GIA-1ATM |
| 8GB | AP-ISD008GIA-1ATM |
| 16GB | AP-ISD016GIA-1ATM |
| 32GB | AP-ISD032GIA-1ATM |
| 64GB | AP-ISD064GIA-1CTM |
| 128GB | AP-ISD128GIA-1CTM |

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.

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# Revision History

| Revision | Description | Date |
|:---:|:---|:---:|
| 0.1 | Preliminary release | 11/04/2014 |
| 0.2 | Updated 128 GB specifications | 1/27/2015 |
| 0.3 | Updated 32 GB specifications | 2/3/2015 |
| 1.0 | Official release | 2/11/2015 |
| 1.1 | Refined flash management context. | 2/12/2015 |

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