



# **PX-xxxG5He-72 Series**

**Half-slim SATA Solid State Drive**

**Engineering Specification**

(for Advantech)

## Document History

| Revision       | Date              | Changes   |
|----------------|-------------------|---|
| Rev 0.1        | 2012/12/28        | First draft release   |
| Rev 0.2        | 2013/1/9          | Added PX-xxxG5He-72 series, update Identify Device data                                   |
| Rev 0.3        | 2013/2/6          | Update Smart attribute<br>Update Current Consumption Sec 5.2 <b>Current Consumption</b>   |
| Rev 0.4        | 2013/3/15         | Update Sec.4.8 Band Performance   |
| Rev 0.5        | 2013/05/23        | Modify Sec 8.3 Identify data<br>Update Sec. 8.1 SMART commands<br>Add Sec 4.19 Compliance |
| <b>Rev 0.6</b> | <b>2013/07/01</b> | <b>Update Sec. 5.2 Max current consumption</b>  |
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## 1 Introduction

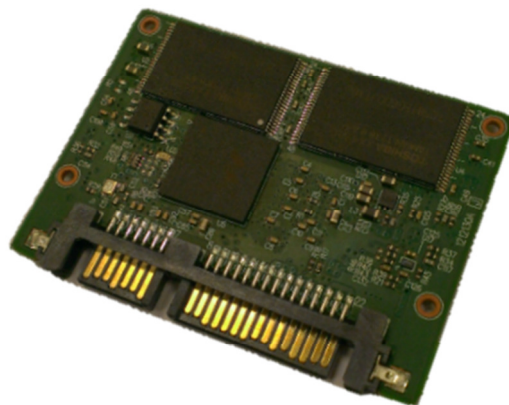
The **PX-xxxG5He-72 series** Half-Slim SATA Solid State Drive (SSD) deliver leading performance in an industry standard Half Slim form factor while simultaneously improving system responsiveness for automotive applications over standard rotating drive media or hard disk drives. By combining leading NAND flash memory technology with our innovative high performance firmware; LITE-ON IT delivers Half Slim SATA SSD drives drop-in replacement with enhanced performance, reliability, ruggedness and power savings. Since there are no rotating platters, moving heads, fragile actuators, or unnecessary delays due to spin-up time or positional seek time that can slow down the storage subsystem, significant I/O and throughput performance improvement is achieved as compared to rotating media or hard disk drives. This document describes the specifications of the **PX-xxxG5He-72 series** Half-Slim SATA Solid State Drive (SSD) form factors.

The **PX-xxxG5He-series-72 Half Slim** SATA SSD key attributes include high performance, low power, increased system responsiveness, high reliability, and enhanced ruggedness as compared to standard automotive SATA hard drives. The **PX-xxxG5He-72 series Half Slim** SATA SSD is available in a Half Slim form factor that is electrically, mechanically, and software compatible with existing Half Slim SATA slots and cables. Our flexible design allows interchangeability with existing mobile hard drives based on the SATA interface standard.

The **PX-xxxG5He-72 series** Half Slim SATA SSD includes the advantage of the **PX-xxxG5He-72 series Half Slim** SATA SSD and comes with standard **MO-297** small form factor. It is suitable for the application with limited space and high performance requirement.

## 2 Features

- **High speed mass storage device**
- **S-ATA III 6.0G interface**
- **No movement parts and noise free**
- **Excellent ability against Shock/Vibration**
- **Fast access performance**
- **Half Slim (MO-297) SSD form factor**



### 3 Block Diagram

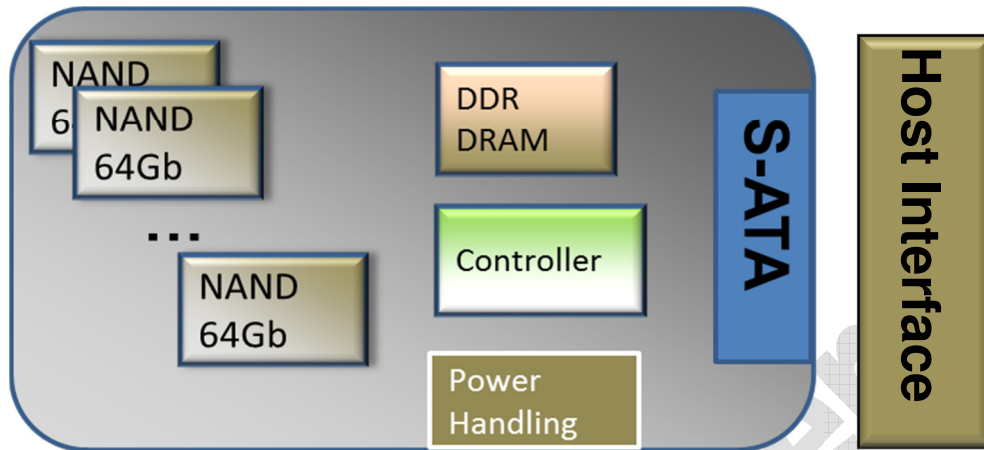


Figure 1 Block Diagram

## 4 Basic Specifications

### 4.0 Key Component and FW Version

**4.0.1 Flash Type:** Toshiba 19nm

**4.0.2 Controller:** Marvell Monet Lite 9188

**4.0.3 FW Version:** 1.00

### 4.1 Capacity

#### 4.1.1 Physical Capacity

32GB, PX-32G5He-72

64GB, PX-64G5He-72

128GB, PX-128G5He-72

#### 4.1.2 User Capacity

| Unformatted capacity | Total user addressable sectors in LBA mode |
|----------------------|--|
| 32GB                 | 62,533,296                                 |
| 64GB                 | 125,045,424                                |
| 128G                 | 250,069,680                                |

**Table 1 User Addressable Sectors**

**Notes:** 1. 1GB=1,000,000,000 bytes and not all of the memory can be used for storage.

2. 1 Sector = 512 bytes

### 4.2 Flash Type

Multi-Level Cell (MLC)

### 4.3 Program/Erase Cycle

3000(global)

### 4.4 ECC Ability

81bits/2KB



#### 4.5 Buffer Memory Size

128-256MB DDR3, consist of FTL Table and write cache data.

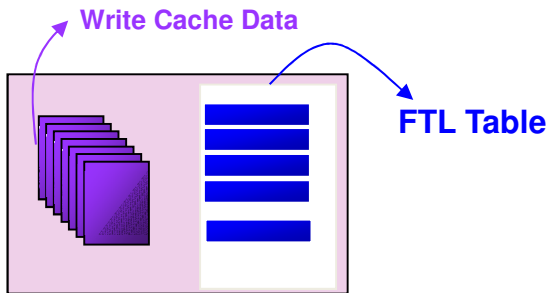


Figure 2 Buffer Memory

#### 4.6 Compatibility

- SATA Revision 3.0 compliant  
Compatible with SATA 1.5Gb/s, 3.0Gb/s & 6.0Gb/s Interface rates
- ATA/ATAPI- 8 compliant
- SSD enhanced SMART ATA feature set
- Native Command Queuing (NCQ) command set
- TRIM supported

#### 4.7 Temperature Sensor (Optional)

The temperature information is available from a built-in temperature sensor between -40 °C to +125 °C with  $\pm 3$  °C accuracy.

#### 4.8 Band Performance

| Capacity | Access Type      | MB/s           |
|----------|------------------|----------------|
| 32GB     | Sequential Read  | Up to 280 MB/s |
|          | Sequential Write | Up to 80 MB/s  |
| 64GB     | Sequential Read  | Up to 280 MB/s |
|          | Sequential Write | Up to 160 MB/s |
| 128G     | Sequential Read  | TBD            |
|          | Sequential Write | TBD            |

Table 2 Maximum Sustained Read and Write Bandwidth

- Notes:**
- 1). Performance measured using CrystalDiskMark.
  - 2). 1 MB/sec = 1,048,576 bytes/sec is used in measuring sequential performance.  
If 1 MB/sec = 1,000,000 bytes/sec is used, performance values become 4.85% higher.

#### 4.9 Read and Write IOPS (IOMETER)

| Capacity | Access Type     | IOPS       |
|----------|-----------------|------------|
| 32 GB    | 4K Read (IOPS)  | 40,000     |
|          | 4K Write (IOPS) | 20,000     |
| 64 GB    | 4K Read (IOPS)  | 50,000     |
|          | 4K Write (IOPS) | 40,000     |
| 128 GB   | TBD (IOPS)      | TBD (IOPS) |
|          | TBD (IOPS)      | TBD (IOPS) |

**Table 3 Random Read/Write Input/output Operations per Second**

- Notes:** 1. Performance measured using IOMETER with queue depth set to 1.  
2. Write cache enabled

#### 4.10 Power On to Ready

| Operating Mode    | Typical (25°C) | Max.(0°C to +70 °C) |
|-------------------|----------------|---------------------|
| Power on to Ready | 1s             | 4s                  |

**Table 4 Latency Specifications**

- Notes:** 1. Write cache enabled  
2. Device measured using Drive Master  
3. Power on to ready time assumes proper shutdown  
(Power removal preceded by Flush Cache or STANDBY command)

#### 4.11 Temperature

| Environment         | Mode                              | Min | Max | Unit    |
|---------------------|-----------------------------------|-----|-----|---------|
| Ambient Temperature | Operating                         | 0   | 70  | °C      |
|                     | Non-operating, Storage            | -40 | 90  | °C      |
| Humidity            | Operation                         | 5   | 95  | %       |
|                     | Non-operation, Storage            | 5   | 95  | %       |
| Thermal Gradient    | Operation, Non-operation, Storage | 5   | -   | °C/ min |

**Table 5 Temperature Relative Specifications**

No permanent damage will occur on the module when it is powered ON at -40°C and +95°C.

There will be no flame / spark / smoke from the module in any condition of short circuit and/or temperature above +95°C.

#### 4.12 Reliability

| Parameter                        | Value  |
|----------------------------------|--|
| Mean Time between Failure (MTBF) | > 1,400,000 hours                              |
| Power on/off cycles              | 25,000 cycles                                  |
| Data Reliability                 | 1 per 10 <sup>13</sup> bits read (max)         |
| Interface                        | 50 cycles of Insert and Removal operation(min) |

**Table 6 Reliability specifications**

**Notes:**

1. MTBF is calculated based on a Part Stress Analysis. It assumes nominal voltage. With all other parameters within specified range.
2. Power on/off cycles is defined as power being removed from the drive, and the restored. Application systems remove power with the Flush Cache command or Standby Immediate command in advance before the system shutdown.
- 3.

#### 4.13 Shock and Vibration

| Item                          | Mode                       | Timing/Frequency    | Max      |
|-------------------------------|----------------------------|---------------------|----------|
| Shock <sup>1</sup>            | Operation<br>Non-operating | At 1 msec half-sine | 1500G    |
|                               | Operation<br>Non-operating | At 2 msec half-sine | 1000G    |
| Random Vibration <sup>2</sup> | Operation                  | 7~800 Hz            | 2.17Grms |
|                               | Non-operation              | 7~800 Hz            | 3.08Grms |

**Table 7 Shock and Vibration**

**Notes:**

1. Shock specifications assume that the SSD is mounted securely with the input vibration applied to the drive mounting screws. Stimulus may be applied in the X, Y or Z axis
2. Vibration specifications assume that the SSD is mounted securely with the input vibration applied to the drive mounting screws. Stimulus may be applied in the X, Y or Z axis. The measured specification is in root mean squared form.

**4.14 Altitude**

Operational Altitude: 5,500 meters  
 Altitude Gradient: 300m / min

**4.15 Angle**

The drives will operate at any Angle or/and Orientation.

**4.16 Rattle Noise**

The drives will have no rattle noise during any operation.

Note: There are no movement parts in the SSD drives; the rattle noise will not be tested.

**4.17 Operating noise**

The operating noise of the module will not exceed 35dBA (20Hz to 20kHz)

Note: There are no movement parts in the SSD drive; the operation noise will not be tested.

**4.18 Electromagnetic Compatibility of PX-xxxG5He-72 series**

Electromagnetic compatibility tests assume the SSD is properly installed in the representative host system. The drive operates properly without errors degradation in performance when subjected to radio frequency (RF) environments defined in the following table.

| Test                    | Description                                    | Performance criteria | Reference standard    |
|-------------------------|--|----------------------|-----------------------|
| Electrostatic discharge | Packaging and Handling<br>Contact ±4KV<br>±8KV | A                    | IEC<br>61000-4-2:2008 |
| Electrostatic discharge | Production and Service<br>Contact ±2KV         | A                    | IEC<br>61000-4-2:2008 |
| Radiated Emission       | -  | -                    | CISPER-22 Class<br>B  |

**Table 8 Radio Frequency Specifications**

**Notes:**

1. Performance criterion A = The device shall continue to operate as intended, i.e., normal unit operation with no degradation of performance.
2. Performance criterion B = The device shall continue to operate as intended after completion of test, however, during the test, some degradation of performance is allowed as long as there is no data loss operator intervention to restore device function.
3. Performance criterion C = Temporary loss of function is allowed. Operator intervention is acceptable to restore device function.
4. Contact electrostatic discharge is applied to drive enclosure during operation.
5. Contact electrostatic discharge is applied to drive enclosure and I/O pins when Non-Operation.

**4.19 Compliance:**

| Certification  | Description  |
|----------------|--|
| RoHS compliant | Restriction of Hazardous Substance Directive   |
| CE compliant   | Indicates conformity with the essential health and safety requirements set out in European Directives Low voltage Directive and EMC Directive          |
| UL certified   | Underwriters Laboratories, Inc. Component Recognition UL60950-1  |
| BSMI           | Compliance to the Taiwan EMC standard "Limits and methods of Radio Disturbance Characteristics of Information Technology Equipment, CNS 13438 Class B" |

**Table 9 Device Compliance**

## 5 Power Supply

### 5.1 Power Interface

| Description                 | Specifications          |
|-----------------------------|-------------------------|
| Nominal Supply (V1)         | +5Vdc +/- 5%            |
| Absolute Voltage            | Min. -0.5V<br>Max. +10V |
| Ripple voltage<br>(0-20MHz) | 150mV p-p max           |
| Supply Rise Time            | 1 – 100ms               |

Table 10 Operating Voltage

### 5.2 Current Consumption

#### PX-64G5He:

| Operation Mode          | Typical | Max.         | Unit |
|-------------------------|---------|--------------|------|
| Read Mode               | 0.37    | -            | A    |
| Write Mode              | 0.42    | -            | A    |
| Standby                 | 0.025   | -            | A    |
| Power On Inrush Current | -       | 1.5 (T<10ms) | A    |

Table 11 Current Consumption

**Note:** Active power is measured using IOMETER Power Consumption with RMS current 5s.

Active Mode: Measured after power on initiation and without activity.

### 5.3 Power ON Reset

| Parameter             | Symbol             | Min. | Typ. | Max | Unit |
|-----------------------|--------------------|------|------|-----|------|
| Detect voltage Rising | V <sub>DET</sub>   | 4.0  | 4.3  | 4.4 | V    |
| Input voltage high    | V <sub>IH</sub>    | 2.0  | -    | -   | V    |
| Delay time            | t <sub>delay</sub> | 5    | -    | 40  | ms   |

Table 12 Power On Reset Characteristics

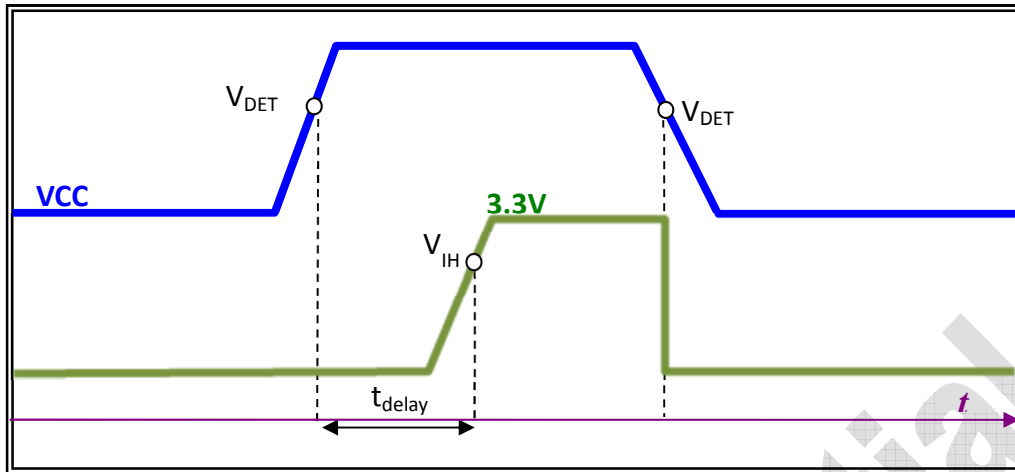


Figure 3 Power On Reset

#### 5.4 Power Off Sequence

**Note:** Power off without Flush Cache command or Standby Immediate Command in advance may cause cache buffer data which received from host and waiting for programming lose. Please implement the power off sequence as the process in the Figure 4 to prevent the data loss

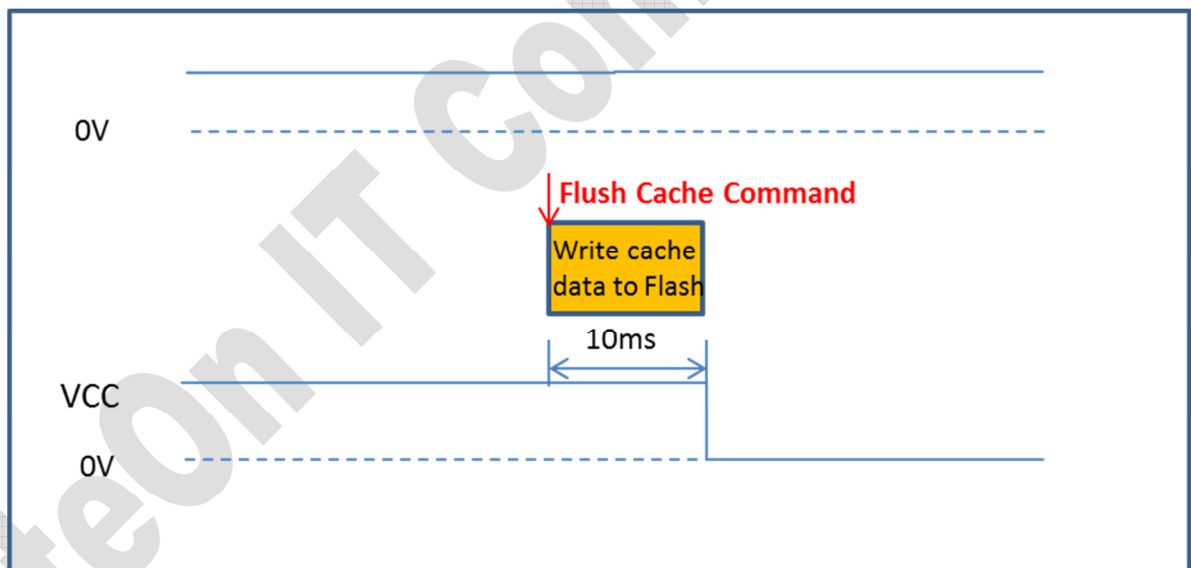


Figure 4 Power off sequence

## 5.5 Power Mode

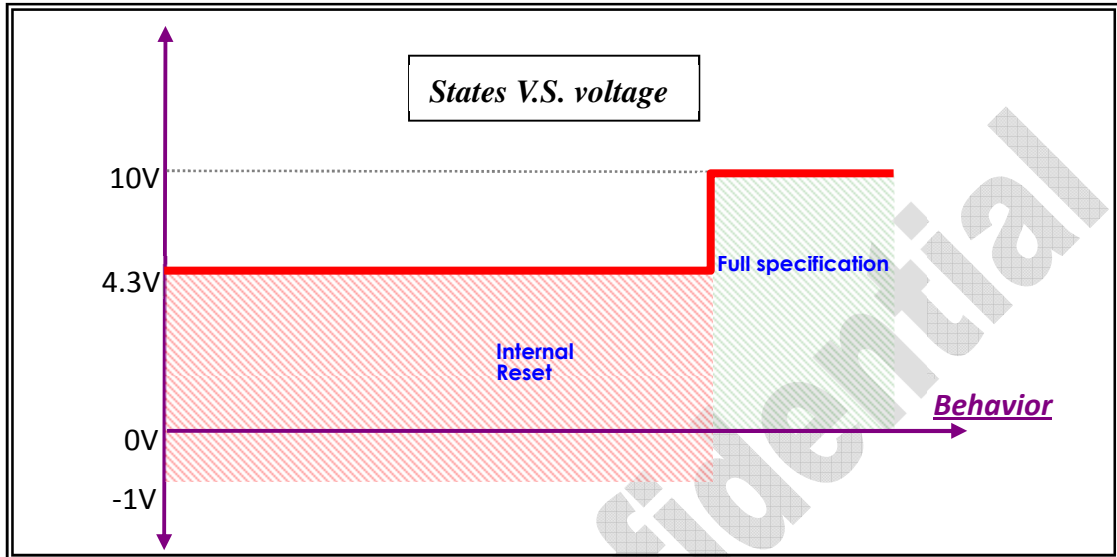


Figure 5 Power Mode

The module has a reset controlled protection implemented.

## 5.6 Temperature Sensor

| Parameter                       | Symbol       | Min. | Typ. | Max  | Unit |
|---------------------------------|--------------|------|------|------|------|
| Temperature range               | -            | -40  | -    | +125 | °C   |
| Resolution                      | $V_{IL}$     | -    | -    | 0.25 | °C   |
| Temperature error<br>-40~+125°C | $T_{ERROR1}$ | -    | -    | ±3   | °C   |
| Temperature error<br>-25~+85°C  | $T_{ERROR2}$ | -    | -    | ±2   | °C   |

Table 13 DC Characteristics



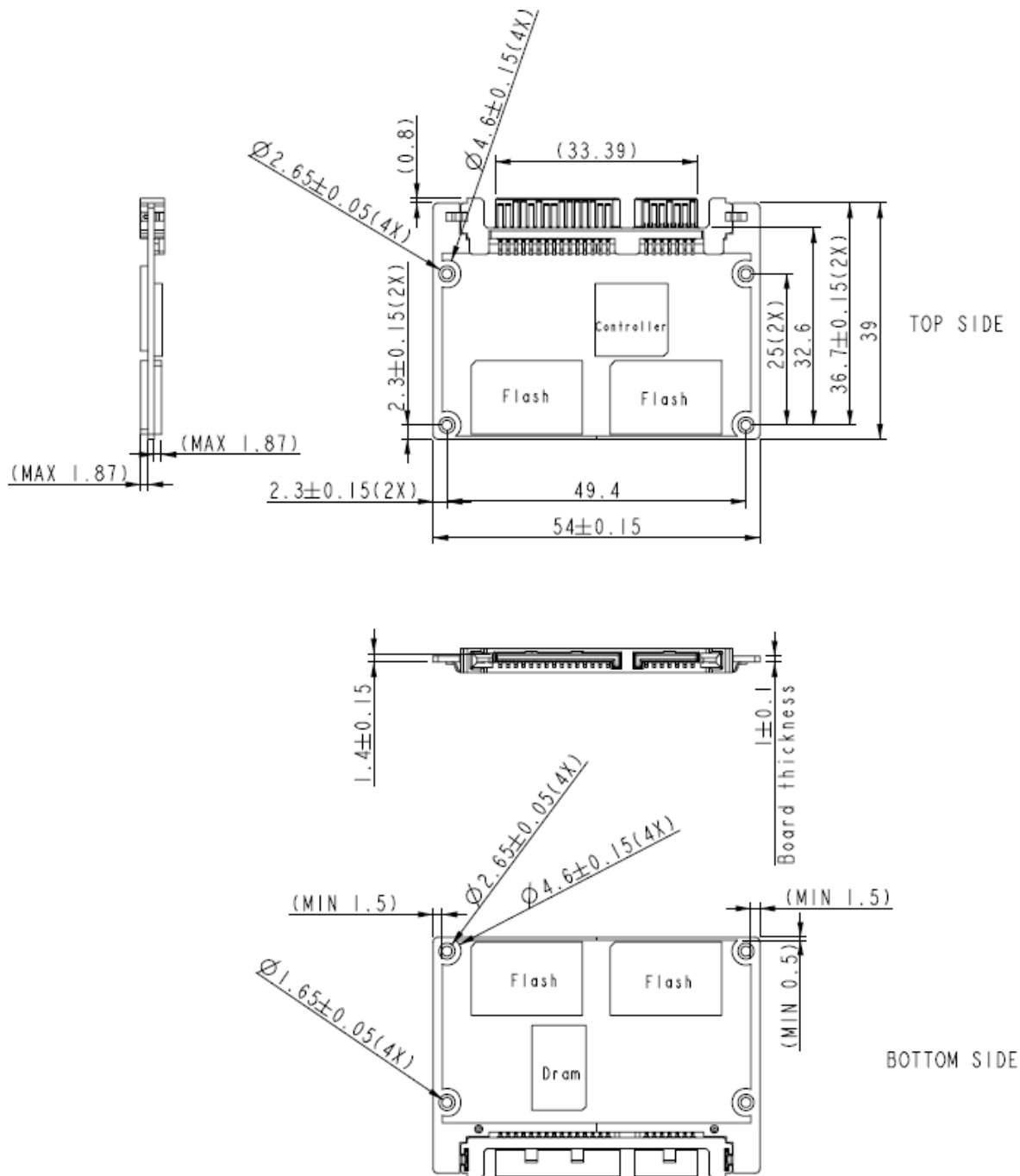
## 6 Outline and Dimension

### 6.1 PX-xxxG5He-72 Half Slim

6.1.1 The module is compliance to Standard MO-297

6.1.2 Dimension: 54.0mm x 39.0mm x 4.5 mm (L x W x H)

6.1.3 Weight: 12 g Max



## 7 Pin Locations and Definition

### 7.1 Pin Location

The data and power connector pin locations of the **PX-xxxG5He-72** series 2.5" SATA 6 Gb/s SSD are as shown below.

### 7.2 Signal Description

**Data Connector:**

| 1  | Type | Description                |
|----|------|----------------------------|
| S1 | GND  |                            |
| S2 | A+   | Differential Signal Pair A |
| S3 | A-   |                            |
| S4 | GND  |                            |
| S5 | B-   | Differential Signal Pair B |
| S6 | B+   |                            |
| S7 | GND  |                            |

**Power Connector:**

| Name | Type            | Description                     |
|------|-----------------|---------------------------------|
| P1   | V <sub>33</sub> | 3.3V Power (No Use)             |
| P2   | V <sub>33</sub> | 3.3V Power (No Use)             |
| P3   | V <sub>33</sub> | 3.3V Power, Pre-change (No Use) |
| P4   | GND             |                                 |
| P5   | GND             |                                 |
| P6   | GND             |                                 |
| P7   | V <sub>5</sub>  | 5V Power, Pre-change            |
| P8   | V <sub>5</sub>  | 5V Power                        |
| P9   | V <sub>5</sub>  | 5V Power                        |
| P10  | GND             |                                 |
| P11  | DAS             | Device Activity Signal          |
| P12  | GND             |                                 |
| P13  | V <sub>12</sub> | 12V Power, Pre-change           |
| P14  | V <sub>12</sub> | 12V Power                       |
| P15  | V <sub>12</sub> | 12V Power                       |

**Table 14 Pin Name****Note:**

1. All pins are in a single row, with a 1.27mm (0.05") pitch
2. Pins P1, P2 and P3 are connected together, although they are not connected internally to the device. The host may put 3.3v on these pins.
3. The mating sequence is
  - The ground pins P4-P6, P10, P12 and the 5V power pin P7
  - The signal pins and the rest of the 5V power pins P8-P9
4. Ground connectors P4 and P12 may contact before the other 1st mate pins in both the power and signal connectors to discharge ESD in a suitably configured backplane connector.
5. Power pins P7, P8 and P9 are internally connected to one another within the device.
6. The host may ground P11 if it is not used for Device Activity Signal (DAS)
7. Pins P13, P14, P15 are connected together, although they are not connected internally to the device.

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## 8 Command Description

### 8.1 ATA Command

The **PX-xxxG5He-72 series Half Slim** and **PX-xxxG5He-72 series Half Slim** SATA SSD support all the mandatory ATA commands defined in the ATA/ATAPI-8 specification.

#### ATA General Feature Command Set

##### General feature Command set (non-packet)

- EXECUTE DEVICE DIAGNOSTIC
- FLUSH CACHE
- IDENTIFY DEVICE
- READ DMA
- READ SECTOR(S)
- READ VERIFY SECTORS(S)
- SEEK
- SET FEATURES
- TRIM (\*ATA/ATAPI-8 specification)
- WRITE DMA
- WRITE SECTOR(S)
- READ MULTIPLE
- SET MULTIPLE MODE
- WRITE MULTIPLE

##### Optional commands

- READ BUFFER
- WRITE BUFFER
- NOP
- DOWNLOAD MICROCODE

##### Power Management Command Set

- CHECK POWER MODE
- IDLE
- IDLE IMMEDIATE
- SLEEP
- STANDBY
- STANDBY IMMEDIATE

**Security Mode Feature Set**

- SECURITY SET PASSWORD
- SECURITY UNLOCK
- SECURITY ERASE PREPARE
- SECURITY ERASE UNIT
- SECURITY FREEZE LOCK
- SECURITY DISABLE PASSWORD

**Host Protected Area Command Set**

- READ NATIVE MAX ADDRESS
- SET MAX ADDRESS
- READ NATIVE MAX ADDRESS EXT
- SET MAX ADDRESS EXT

**Optional commands.**

- SET MAX SET PASSWORD
- SET MAX LOCK
- SET MAX FREEZE LOCK
- SET MAX UNLOCK

**48-Bit Address Command Set**

- READ NATIVE MAX ADDRESS
- FLUSH CACHE EXT
- READ DMA EXT
- READ NATIVE MAX ADDRESS EXT
- READ SECTOR(S) EXT
- READ VERIFY SECTOR(S) EXT
- SET MAX ADDRESS EXT
- WRITE DMA EXT
- WRITE MULTIPLE EXT
- WRITE SECTOR(S) EXT

**SMART Command Set**

- SMART ENABLE OPERATIONS
- SMART DISABLE OPERATIONS
- SMART ENABLE/DISABLE AUTOSAVE
- SMART RETURN STATUS

**Optional commands.**

- SMART EXECUTE OFF-LINE IMMEDIATE
- SMART READ DATA
- SMART READ LOG
- SMART WRITE LOG

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The table below lists the SMART commands.

| Subcommand   | Code | LBA Low value |
|--|------|---------------|
| SMART ATTRIBUTE VALUES (READ DATA)                   | D0h  |               |
| READ ATTRIBUTE THRESHOLDS                            | D1h  |               |
| ENABLE/DISABLE ATTRIBUTE AUTOSAVE                    | D2h  |               |
| SAVE ATTRIBUTE VALUES                                | D3h  |               |
| EXECUTE OFF-LINE IMMEDIATE                           | D4h  |               |
| EXECUTE SMART OFF-LINE ROUTINE                       |      | 00h           |
| EXECUTE SMART SHORT SELF-TEST ROUTINE (OFFLINE)      |      | 01h           |
| EXECUTE SMART EXTENDED SELF-TEST ROUTINE (OFFLINE)   |      | 02h           |
| ABORT OFF-LINE ROUTINE                               |      | 7Fh           |
| EXECUTE SMART SHORT SELF-TEST ROUTINE (CAPTIVE)      |      | 81h           |
| EXECUTE SMART EXTENDED SELF-TEST ROUTINE ( CAPTIVE ) |      | 82h           |
| READ LOG SECTOR                                      | D5h  |               |
| WRITE LOG SECTOR                                     | D6h  |               |
| ENABLE SMART OPERATIONS                              | D8h  |               |
| DISABLE SMART OPERATIONS                             | D9h  |               |
| RETURN SMART STATUS                                  | DAh  |               |
| Enable/Disable Automatic OFFLINE                     | DBh  |               |

## SMART Attributes

- 01h : Raw Read Error Rate
- 05h : Re-allocated Sector Count
- 09h : Power-On Hours Count
- 0Ch : Power Cycle Count
- **ADh : Average Program/Erase Count**
- B1h : Wear Leveling Count
- B2h : Used Reserved Block Count (Worst Case)
- B5h : Program Fail Count (Total)
- B6h : Erase Fail Count (Total)
- BBh : Uncorrectable Error Count
- C0h : Unsafe Shutdown Count
- C2h : Temperature
- C4h : Reallocate Event Count
- C6h : Offline Uncorrected Error Count
- C7h : CRC Error Count
- E8h : Available reserved space
- **F1h : Total Block Written from Host**
- **F2h : Total Block Read from Host**
- **F4h : Maximum Program/Erase Count**
- **F5h : Minimum Program/Erase Count**

## Temperature (Optional)

The **PX-xxxG5He-72 series Half Slim** and **PX-xxxG5He-72 series Half Slim SATA SSD** provide two kinds of command to access temperature information. One is the temperature value which can be got by OP Code 0xFA. The other is the SMART Attribute ID194.

## 8.2 Vendor Specify Command: Get Temperature Command (Optional)

### 8.2.1 OP Code : 0xFA

See the following table for the byte definitions of Return Data:

| Byte         | Value       | Description  |
|--------------|-------------|--|
| <b>0</b>     | Temperature | This byte indicates the current temperature in degrees Celsius. Valid values are D8h to 7Dh (-40 to +125). |
| <b>1-511</b> | 00h         | Reserved   |



### 8.2.2 SMART Attribute C2h

**Attribute ID:** C2h (194 decimal)

**Threshold:** None

**Description:** The Temperature attribute indicates the current drive temperature in degrees Celsius.

See the following table for the byte definitions.

| Byte | Value          | Description  |
|------|----------------|--|
| 0    | C2h            | This is the attribute ID (194 decimal).  |
| 1-2  | 00h            | Set to 0200h to indicate the attribute does not trigger an imminent failure (that is, the pre-fail advisory bit is not set). |
| 3    | 64h            | Each of these bytes is set to a constant value, which is always 64h (100 decimal).   |
| 4    | 64h            |  |
| 5    | As description | This byte indicates the current temperature in degrees Celsius. Valid values are D8h to 7Dh (-40 to +125).                   |
| 6-11 | 00h            | Reserved   |

### 8.3 Identify Device Data

The following table details the sector data returned after issuing an IDENTIFY DEVICE command.

| Word  | F=Fixed<br>V=Variable<br>X=Both | Default Value | Description   |
|-------|---------------------------------|---------------|---|
| 0     | F                               | 0040h         | General configuration bit-significant information         |
| 1     | F                               | 3FFFh         | Obsolete-Number of logical cylinders (16,383)             |
| 2     | F                               | C837h         | Specific configuration                                    |
| 3     | F                               | 0010h         | Obsolete-Number of logical heads (16)                     |
| 4-5   | F                               | 0000h         | Retired   |
| 6     | F                               | 003Fh         | Obsolete-Number of logical sectors per logical track (63) |
| 7-8   | F                               | 0000h         | Reserved for assignment by the Compact Flash Association  |
| 9     | F                               | 0000h         | Retired   |
| 10-19 | V                               | Var.          | Serial number (20 ASCII characters)                       |
| 20-22 | F                               | 0000h         | Retired / Obsolete  |

|       |   |   |  |
|-------|---|---|--|
| 23-26 | V | Var.                                      | Firmware revision (8 ASCII characters)   |
| 27-46 | V | Var.                                      | Model number   |
| 47    | F | 8010h                                     | 7:0 – Maximum number of sectors transferred per interrupt on multiple commands |
| 48    | F | 4000h                                     | Trusted Computing feature set options, bit14 should be 1                       |
| 49    | F | 2F00h                                     | Capabilities   |
| 50    | F | 4000h                                     | Trusted Computing feature set options, bit14 should be 1                       |
| 51-52 | F | 0000h                                     | Obsolete   |
| 53    | F | 0007h                                     | Words 88 and 70:64 valid   |
| 54    | V | Var.                                      | Obsolete - Number of logical cylinders (16,383)                                |
| 55    | V | Var.                                      | Obsolete - Number of logical heads (16)  |
| 56    | V | Var.                                      | Obsolete - Number of logical sectors per logical track (63)                    |
| 57-58 | V | Var.                                      | Capacity(Cylinders*heads*sectors)  |
| 59    | V | 0101h                                     | Number of sectors transferred per interrupt on multiple commands               |
| 60-61 | V | 03BA2EB0h<br>(32G)/<br>07740AB0h<br>(64G) | Total number of user addressable logical sectors for 28-bit commands (DWord)   |
| 62    | F | 0000h                                     | Obsolete   |
| 63    | V | 0007h                                     | Multi-word DMA modes supported/selected  |
| 64    | F | 0003h                                     | PIO modes supported  |
| 65    | F | 0078h                                     | Minimum multiword DMA transfer cycle time per word                             |
| 66    | F | 0078h                                     | Manufacturer's recommended multiword DMA transfer cycle time                   |
| 67    | F | 0078h                                     | Minimum PIO transfer cycle time without flow control                           |
| 68    | F | 0078h                                     | Minimum PIO transfer cycle time with IORDY flow control                        |
| 69-70 | F | 0000h                                     | Reserved(for future command overlap and queuing)                               |
| 71-74 | F | 0000h                                     | Reserved for the IDENTIFY packet DEVICE command                                |
| 75    | F | 001Fh                                     | 4:0 Maximum Queue depth-1=31   |
| 76    | F | 070Eh                                     | Serial ATA capabilities  |
| 77    | F | Var.                                      | Current SATA model   |
| 78    | F | 004Ch                                     | Serial ATA features supported  |

|         |   |   |   |
|---------|---|---|---|
| 79      | F | 0040h   | Serial ATA features enabled   |
| 80      | F | 01FEh   | Major Version Number  |
| 81      | F | 0021h   | Minor Version Number  |
| 82      | F | 346Bh   | Commands and feature sets supported   |
| 83      | F | 7D01h   | Commands and feature sets supported   |
| 84      | F | 4023h   | Commands and feature sets supported   |
| 85      | V | 3469h   | Commands and feature sets supported or enabled  |
| 86      | V | BC01h   | Commands and feature sets supported or enabled  |
| 87      | F | 4023h   | Commands and feature sets supported or enabled  |
| 88      | V | 407Fh   | Ultra DMA modes   |
| 89      | F | 0003h   | Time required for security erase unit completion  |
| 90      | F | 0003h   | Time required for enhanced security erase completion  |
| 91      | F | 0000h   | Current advanced power management value   |
| 92      | V | Var.  | Master Password Identifier  |
| 93      | V | 0000h   | Hardware reset result. The contents of bits (12:0) of this word shall change only during the execution of a hardware reset. |
| 94      | F | 0000h   | Current AAM value   |
| 95      | F | 0000h   | Stream Minimum Request Size   |
| 96      | F | 0000h   | Streaming Transfer Time - DMA   |
| 97      | F | 0000h   | Streaming Access Latency - DMA and PIO  |
| 98-99   | F | 0000h   | Streaming Performance Granularity   |
| 100-103 | V | 03BA2EB0h<br>(32G)<br>/<br>07740AB0h(<br>64G) | Maximum user LBA for 48-bit Address feature set   |
| 104     | F | 0000h   | Streaming Transfer Time - PIO   |
| 105     | F | 0008h   | Maximum number of 512-byte blocks per DATA SET MANAGEMENT command   |
| 106     | F | 4000h   | Physical sector size/logical sector size  |
| 107     | F | 0000h   | Inter-seek delay for ISO-7779 acoustic testing in microseconds  |
| 108-111 | V | 0000h<br>0000h<br>0000h<br>0000h              | Worldwide name  |

|         |   |       |  |
|---------|---|-------|--|
| 112-115 | F | 0000h | Reserved for word wide name extension to 128 bits                                  |
| 116     | F | 0000h | Reserved for TLC   |
| 117-118 | F | 0000h | Words per logical sector   |
| 119     | F | 4010h | Commands and feature sets supported  |
| 120     | F | 4010h | Commands and feature sets supported or enabled                                     |
| 121-126 | F | 0000h | Reserved for expanded supported and enabled settings                               |
| 127     | F | 0000h | Removable Media Status Notification feature set support                            |
| 128     | V | 0021h | Security status  |
| 129-159 | F | 0000h | Vendor specific  |
| 160     | F | 0000h | Compact Flash Association (CFA) power mode 1                                       |
| 161-167 | F | 0000h | Reserved for the CompactFlash Association  |
| 168     | F | 0000h |  |
| 169     | F | 0001h | DATA SET MANAGEMENT command is supported   |
| 170-173 | F | 0000h | Additional Product Identifier (ATA String)   |
| 174-175 | F | 0000h | Reserved   |
| 176-205 | F | 0000h | Current media serial number (ATA string)   |
| 206     | F | 003Dh | SCT Command Transport  |
| 207-208 | F | 0000h | Reserved   |
| 209     | F | 4000h | Alignment of logical blocks within a physical block                                |
| 210-211 | F | 0000h | Write-Read-Verify Sector Count Mode 3 (DWord)                                      |
| 212-213 | F | 0000h | Write-Read-Verify Sector Count Mode 2 (DWord)                                      |
| 214     | F | 0000h | NV Cache Capabilities  |
| 215-216 | F | 0000h | NV Cache Size in Logical Blocks (DWord)  |
| 217     | F | 0001h | Nominal media rotation rate  |
| 218     | F | 0000h | Reserved   |
| 219     | F | 0000h | NV Cache Options   |
| 220     | F | 0000h | 7:0 Write-Read-Verify feature set current mode                                     |
| 221     | F | 0000h | Reserved   |
| 222     | F | 1075h | Transport major version number   |
| 223     | F | 0000h | Transport minor version number   |
| 224-229 | F | 0000h | Reserved   |
| 230-233 | F | 0000h | Extended Number of User Addressable Sectors (QWord)                                |
| 234     | F | 0000h | Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h |
| 235     | F | 0000h | Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h |

|         |   |       |                |
|---------|---|-------|----------------|
| 236-254 | F | 0000h | Reserved       |
| 255     | V | Var.  | Integrity word |

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# References

This document references standards defined by a variety of organizations as listed below.

| Date   | Title  | Location  |
|--|--|---|
| Dec 2008                                     | VCCI   | <a href="http://www.vcci.or.jp/vcci_e/general/join/index.html">http://www.vcci.or.jp/vcci_e/general/join/index.html</a> |
| July 2007                                    | ROHS   | Search for material description datasheet at <a href="http://intel.pcnaalert.com">http://intel.pcnaalert.com</a>        |
| April 2004                                   | ATA-7 Spec. Volume 1   | <a href="http://www.t13.org/">http://www.t13.org/</a>   |
| Aug. 2009                                    | ATA-8 Spec. Rev 2  | <a href="http://www.t13.org/">http://www.t13.org/</a>   |
| 2008<br>2008<br>2004<br>2005<br>2008<br>2008 | International Electro Technical Commission<br>EB61000<br>4-2 Personnel Electrostatic Discharge Immunity<br>4-3 Electromagnetic compatibility (EMC)<br>4-4 Electromagnetic compatibility (EMC)<br>4-5 Electromagnetic compatibility (EMC)<br>4-6 Electromagnetic compatibility (EMC)<br>4-11 (Voltage variations) | <a href="http://www.iec.ch">http://www.iec.ch</a>   |
| 2004   | ENV 50204 (Radiated electromagnetic field from digital radio telephones)   | <a href="http://www.iec.ch">http://www.iec.ch</a>   |
| 2012   | HSR027-12SSDX-0108__LITE-ON IT SSD technology 2012_09_07_V03.pdf   | Lite-On IT  |

# Terms and Acronyms

This document incorporates many industry and device specific words use the following list to define a variety of terms and acronyms.

| Term        | Definition   |
|-------------|--|
| ATA         | Advanced Technology Attachment   |
| ATAPI       | Advanced Technology Attachment Packet Interface  |
| DIPM        | Device Initiated Power Management<br>The ability of the device to request SATA link power state changes  |
| DMA         | Direct Memory Access   |
| DRAM        | Dynamic Random Access Memory   |
| GB          | Giga-byte defined as $1 \times 10^9$ bytes   |
| Hot Plug    | A term used to describe the removal or insertion of a SATA hard drive when the system is powered on  |
| IOPS        | Input output operations per second   |
| LBA         | Logical Block Address  |
| MB          | Mega-bytes defined as $1 \times 10^6$ bytes  |
| MTBF        | Mean time between failure  |
| NOP         | No operation   |
| OS          | Operation System   |
| SMART       | Self-Monitoring, Analysis and reporting Technology<br>An open standard for developing hard drive and software systems that automatically monitors a hard drive's health and reports potential problems |
| SSD         | Solid State Drive  |
| WHQL        | Microsoft* Windows Hardware Quality Labs   |
| Write Cache | A memory device within a hard drive, which is allocated for the temporary storage of data before that data is copied to its permanent storage location   |
| VCCI        | Voluntary Control Council for Interface  |

**Table 18: Glossary of Terms and Acronyms**