

**Enterprise SATA 2.5 SSD (PHS2506B-Slim)
(PS3112-S12DC) KIC TLC
Specification
ESM1210
ESM1220
ESM1710
ESM1720**

Version 4.3

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Revision History

Revision	Draft Date	History	Author
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4.3	2021/11/25	Add ESM1710 and ESM1720 solutions.	Lian Wang

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Product Overview

ESM1210 Series

- **Capacity**
 - 3840GB
- **Form Factor:** 2.5" SSD
- **SATA Interface & Compliance**
 - SATA Gen3, SATA Revision 3.2
- **Flash Interface:** Transfer rate up to 533MBps
- **Sustained Performance¹**
 - Sequential Read: up to 530 MB/s
 - Sequential Write: up to 500 MB/s
 - Random Read: up to 98K IOPS
 - Random Write: up to 37K IOPS
- **Temperature Range²**
 - Operation: 0°C ~ 70°C²
 - Storage: -40°C ~ 85°C
- **Reliability**
 - MTBF: 1.5million hrs
 - UBER: < 1 sector per 10¹⁷ bits read
 - Power On/Off Cycles: 24 times per day within warranty period
 - DWPD 1
 - TBW: 7492 TB
- **Power³** (Power supply of 2.5" SSD: 5V±10%)
 - Active Write (Typ.) < 3.3 W
 - Active Read (Typ.) < 2.8 W
 - Idle < 1.4 W
- **Environment Specifications**
 - Commercial grade temperature & humidity test
 - Shock: 1500G/0.5ms
 - Vibration: 20Hz~80Hz/1.52mm
80Hz~2000Hz/20G
 - Drop: 80cm height/each face
 - Bending: ≥ 20N force
 - Thermal cycling: -40°C-85°C/1000 cycles with 50% cumulative failure. (IPC-9701)
- **RoHS compliant**
- **HW Pfail : Support Tantalum**

ESM1220 Series

- **Capacity**
 - 240GB, 480GB, 960GB, 1920GB
- **Form Factor:** 2.5" SSD
- **SATA Interface & Compliance**
 - SATA Gen3, SATA Revision 3.2
- **Flash Interface:** Transfer rate up to 533MBps
- **Sustained Performance¹**
 - Sequential Read: up to 530 MB/s
 - Sequential Write: up to 500 MB/s
 - Random Read: up to 97K IOPS
 - Random Write: up to 50K IOPS
- **Temperature Range²**
 - Operation: 0°C ~ 70°C²
 - Storage: -40°C ~ 85°C
- **Reliability**
 - MTBF: 1.5million hrs
 - UBER: < 1 sector per 10¹⁷ bits read
 - Power On/Off Cycles: 24 times per day within warranty period
 - DWPD 1
 - TBW: 545 TB - 240GB
735 TB - 480GB
1500 TB - 960GB
3960 TB - 1920GB
- **Power³** (Power supply of 2.5" SSD: 5V±10%)
 - Active Write (Typ.) < 3.1 W
 - Active Read (Typ.) < 2.8 W
 - Idle < 1.4 W
- **Environment Specifications**
 - Commercial grade temperature & humidity test
 - Shock: 1500G/0.5ms
 - Vibration: 20Hz~80Hz/1.52mm
80Hz~2000Hz/20G
 - Drop: 80cm height/each face
 - Bending: ≥ 20N force
 - Thermal cycling: -40°C-85°C/1000 cycles with 50% cumulative failure. (IPC-9701)
- **RoHS compliant**
- **HW Pfail : Support Aluminum Capacitor**

NOTES:

1. Refer to Chapter 2 for more details.
2. Operation temperature is measured by device temperature sensor. Airflow is suggested and it will allow device to be operated at appropriate temperature for each component during heavy workloads environment.
3. Refer to Chapter 4, Section 4.2 Power Consumption for more details.

Product Overview

ESM1710 Series

- **Capacity**
 - 3840GB
- **Form Factor:** 2.5" SSD
- **SATA Interface & Compliance**
 - SATA Gen3, SATA Revision 3.2
- **Flash Interface:** Transfer rate up to 533MBps
- **Sustained Performance¹**
 - Sequential Read: up to 530 MB/s
 - Sequential Write: up to 500 MB/s
 - Random Read: up to 98K IOPS
 - Random Write: up to 37K IOPS
- **Temperature Range²**
 - Operation: 0°C ~ 70°C²
 - Storage: -40°C ~ 85°C
- **Reliability**
 - MTBF: 1.5million hrs
 - UBER: < 1 sector per 10¹⁷ bits read
 - Power On/Off Cycles: 24 times per day within warranty period
 - DWPD 1
 - TBW: TBD
- **Power³** (Power supply of 2.5" SSD: 5V±10%)
 - Active Write (Typ.) < TBD
 - Active Read (Typ.) < TBD
 - Idle < TBD
- **Environment Specifications**
 - Commercial grade temperature & humidity test
 - Shock: 1500G/0.5ms
 - Vibration: 20Hz~80Hz/1.52mm
80Hz~2000Hz/20G
 - Drop: 80cm height/each face
 - Bending: ≥ 20N force
 - Thermal cycling: -40°C-85°C/1000 cycles with 50% cumulative failure. (IPC-9701)
- **RoHS compliant**
- **HW Pfail : Support Tantalum**

ESM1720 Series

- **Capacity**
 - 480GB, 960GB, 1920GB
- **Form Factor:** 2.5" SSD
- **SATA Interface & Compliance**
 - SATA Gen3, SATA Revision 3.2
- **Flash Interface:** Transfer rate up to 533MBps
- **Sustained Performance¹**
 - Sequential Read: up to 530 MB/s
 - Sequential Write: up to 500 MB/s
 - Random Read: up to 98K IOPS
 - Random Write: up to 50K IOPS
- **Temperature Range²**
 - Operation: 0°C ~ 70°C²
 - Storage: -40°C ~ 85°C
- **Reliability**
 - MTBF: 1.5million hrs
 - UBER: < 1 sector per 10¹⁷ bits read
 - Power On/Off Cycles: 24 times per day within warranty period
 - DWPD 1
 - TBW: TBD
- **Power³** (Power supply of 2.5" SSD: 5V±10%)
 - Active Write (Typ.) < TBD
 - Active Read (Typ.) < TBD
 - Idle < TBD
- **Environment Specifications**
 - Commercial grade temperature & humidity test
 - Shock: 1500G/0.5ms
 - Vibration: 20Hz~80Hz/1.52mm
80Hz~2000Hz/20G
 - Drop: 80cm height/each face
 - Bending: ≥ 20N force
 - Thermal cycling: -40°C-85°C/1000 cycles with 50% cumulative failure. (IPC-9701)
- **RoHS compliant**
- **HW Pfail : Support Aluminum Capacitor**

NOTES:

4. Refer to Chapter 2 for more details.

5. Operation temperature is measured by device temperature sensor. Airflow is suggested and it will allow device to be operated at appropriate temperature for each component during heavy workloads environment.

Refer to Chapter 4, Section 4.2 Power Consumption for more details.

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1. INTRODUCTION



1.1. General Description

This document describes the specifications of Phison Enterprise SATA Gen3 Solid State Drive. Applying to SATA interface, Phison SSD are ideal storage solution for outstanding performance, low latency and Quality of Service.

For enterprise-class, the types of form factors are 2.5-inch SSD and the capacities are 240GB, 480GB, 960GB, 1920GB, and 3840GB.

1.2. SSD List

Form Factor	Capacity	Product Series	DWPD
2.5" SSD	240GB	ESM1220 + KIC BiCS4 cTLC	1
	480GB	ESM1220 + KIC BiCS4 cTLC	1
	960GB	ESM1220 + KIC BiCS4 cTLC	1
	1920GB	ESM1220 + KIC BiCS4 cTLC	1
	3840GB	ESM1210 + KIC BiCS4 cTLC	1
	480GB	ESM1720 + KIC BiCS5 cTLC	1
	960GB	ESM1720 + KIC BiCS5 cTLC	1
	1920GB	ESM1720 + KIC BiCS5 cTLC	1
	3840GB	ESM1710 + KIC BiCS5 cTLC	1

2. PRODUCT SPECIFICATIONS



2.1. Electrical/Physical Interface

- SATA Interface
- Compliant with SATA Revision 3.2
- Compatible with SATA Gen3/ Gen2/ Gen1

2.2. Device Capacity

Table 2-1 User Capacity and Addressable Sectors

	User Addressable Sectors	Bytes per Sector
240GB	468,862,128	512Byte
480GB	937,703,088	
960GB	1,875,385,008	
1920GB	3,750,748,848	
3840GB	7,501,476,528	

NOTES:

1. 1 Gigabyte (GB) is equal to 1,000,000,000 bytes; 1 sector is equal to 512 bytes.
2. The total actual usable capacity of the SSD may be less than the total physical capacity because internal NAND management, SSD format, SSD partition, operating system and so on.

2.3. Performance

- Sequential Read/Write Performance

Table 2-2 Sequential Read / Write Performance

	Product Series	Flash Structure	Flash Type	Sequential Read (128KB)	Sequential Write (128KB)
				Unit: MB/s	Unit: MB/s
240GB	ESM1220	256Gb DDPx5	KIC BiCS4 cTLC	530	450
480GB	ESM1220	256Gb DDPx9	KIC BiCS4 cTLC	530	500
960GB	ESM1220	256Gb QDPx9	KIC BiCS4 cTLC	530	500
1920GB	ESM1220	512Gb QDPx9	KIC BiCS4 cTLC	530	500
3840GB	ESM1210	512Gb ODPx10	KIC BiCS4 cTLC	530	500
480GB	ESM1720	512Gb DDPx5	KIC BiCS5 cTLC	530	430
960GB	ESM1720	512Gb DDPx9	KIC BiCS5 cTLC	530	500
1920GB	ESM1720	512Gb QDPx9	KIC BiCS5 cTLC	530	500
3840GB	ESM1710	512Gb ODPx10	KIC BiCS5 cTLC	530	500

NOTES:

1. Performance is measured with the following conditions

(a) FIO on Linux: 128K sequential write with QD32 and 1 worker for full drive

(b) SSD is unformatted drive.

2. Performance Platform

Operating System	Ubuntu 16.04.3 LTS
Kernel	Linux version 4.14.14-041414-generic
CPU	Intel(R) Xeon(R) Gold 5120 CPU @ 2.20GHz
Motherboard	Intel Corporation S2600WFT
RAM	16077196 kB

3. Performance may differ according to flash configuration and platform.

4. The tables are for reference only. Any criteria for accepting goods shall be further discussed based on different flash configurations.

■ Sustained Random Read / Write Performance

Table 2-3 Sustained Random Read / Write Performance

	Product Series	Flash Structure	Flash Type	4KB Random Read/Write	8KB Random Read/Write
				Unit: IOPS	Unit: IOPS
240GB	ESM1220	256Gb DDPx5	KIC BiCS4 cTLC	94K/29K	55K/14K
480GB	ESM1220	256Gb DDPx9	KIC BiCS4 cTLC	97K/30K	55K/15K
960GB	ESM1220	256Gb QDPx9	KIC BiCS4 cTLC	97K/40K	55K/20K
1920GB	ESM1220	512Gb QDPx9	KIC BiCS4 cTLC	97K/50K	55K/25K
3840GB	ESM1210	512Gb ODPx10	KIC BiCS4 cTLC	98K/37K	58K/19K
480GB	ESM1720	512Gb DDPx5	KIC BiCS5 cTLC	96K/36K	55K/15K
960GB	ESM1720	512Gb DDPx9	KIC BiCS5 cTLC	98K/42K	55K/21K
1920GB	ESM1720	512Gb QDPx9	KIC BiCS5 cTLC	98K/50K	55K/25K
3840GB	ESM1710	512Gb ODPx10	KIC BiCS5 cTLC	98K/37K	58K/20K

NOTES:

1. Performance is measured with the following conditions

(a) FIO on Linux: 4KB random read/write with QD32 and 1 worker for full drive.

(b) SSD is unformatted drive.

2. Performance Platform

Operating System	Ubuntu 16.04.3 LTS
Kernel	Linux version 4.14.14-041414-generic
CPU	Intel(R) Xeon(R) Gold 5120 CPU @ 2.20GHz
Motherboard	Intel Corporation S2600WFT
RAM	16077196 kB

3. 4KB is 4,096 bytes; 8KB is 8,192 bytes.

4. Performance may differ according to flash configuration and platform.
5. The tables are for reference only. Any criteria for accepting goods shall be further discussed based on different flash configurations.

■ **IOPS Consistency**

Table 2-4 IOPS Consistency

	Product Series	Flash Structure	Flash Type	Random Read (4KB)	Random Write (4KB)
				Unit: %	Unit: %
240GB	ESM1220	256Gb DDPx5	KIC BiCS4 cTLC	98	97
480GB	ESM1220	256Gb DDPx9	KIC BiCS4 cTLC	98	96
960GB	ESM1220	256Gb QDPx9	KIC BiCS4 cTLC	98	93
1920GB	ESM1220	512Gb QDPx9	KIC BiCS4 cTLC	98	95
3840GB	ESM1210	512Gb ODPx10	KIC BiCS4 cTLC	99	85
480GB	ESM1720	512Gb DDPx5	KIC BiCS5 cTLC	99	96
960GB	ESM1720	512Gb DDPx9	KIC BiCS5 cTLC	98	96
1920GB	ESM1720	512Gb QDPx9	KIC BiCS5 cTLC	99	92
3840GB	ESM1710	512Gb ODPx10	KIC BiCS5 cTLC	99	85

NOTES:

1. Performance is measured with the following conditions
 - (a) FIO on Linux: 4KB random read/write with QD32 and 1 worker for full drive.
 - (b) SSD is unformatted drive.
2. Performance Platform

Operating System	Ubuntu 16.04.3 LTS
Kernel	Linux version 4.14.14-041414-generic
CPU	Intel(R) Xeon(R) Gold 5120 CPU @ 2.20GHz
Motherboard	Intel Corporation S2600WFT
RAM	16077196 kB

3. IOPS Consistency (%) = (99.9% IOPS) / (Average IOPS) x 100
4. 4KB is 4,096 bytes; 8KB is 8,192 bytes.
5. Performance may differ according to flash configuration and platform.
6. The tables are for reference only. Any criteria for accepting goods shall be further discussed based on different flash configurations.

■ Latency

Table 2-5 Average Latency

	Product Series	Flash Structure	Flash Type	Read (4KB)	Write (4KB)
				Unit: us	Unit: us
240GB	ESM1220	256Gb DDPx5	KIC BiCS4 cTLC	129	31
480GB	ESM1220	256Gb DDPx9	KIC BiCS4 cTLC	125	28
960GB	ESM1220	256Gb QDPx9	KIC BiCS4 cTLC	125	28
1920GB	ESM1220	512Gb QDPx9	KIC BiCS4 cTLC	133	26
3840GB	ESM1210	512Gb ODPx10	KIC BiCS4 cTLC	135	30
480GB	ESM1720	512Gb DDPx5	KIC BiCS5 cTLC	115	25
960GB	ESM1720	512Gb DDPx9	KIC BiCS5 cTLC	115	25
1920GB	ESM1720	512Gb QDPx9	KIC BiCS5 cTLC	115	25
3840GB	ESM1710	512Gb ODPx10	KIC BiCS5 cTLC	120	25

NOTES:

- Performance is measured with the following conditions
 - FIO on Linux with QD1 with 1 worker.
 - SSD is unformatted drive.
- Performance Platform

Operating System	Ubuntu 16.04.3 LTS
Kernel	Linux version 4.14.14-041414-generic
CPU	Intel(R) Xeon(R) Gold 5120 CPU @ 2.20GHz
Motherboard	Intel Corporation S2600WFT
RAM	16077196 kB

- Performance may differ according to flash configuration and platform.
- The tables are for reference only. Any criteria for accepting goods shall be further discussed based on different flash configurations.

■ Quality of Service (QoS)

Table 2-6 Quality of Service (QoS)

	Product Series	Flash Structure	Flash Type	Quality of Service (99%)			
				Read 4KB, QD=1	Write 4KB, QD=1	Read 4KB, QD=32	Write 4KB, QD=32
				Unit: us	Unit: us	Unit: us	Unit: us
240GB	ESM1220	256Gb DDPx5	KIC BiCS4 cTLC	136	39	585	1073
480GB	ESM1220	256Gb DDPx9	KIC BiCS4 cTLC	136	35	436	995
960GB	ESM1220	256Gb QDPx9	KIC BiCS4 cTLC	134	32	387	864
1920GB	ESM1220	512Gb QDPx9	KIC BiCS4 cTLC	142	31	403	708
3840GB	ESM1210	512Gb ODPx10	KIC BiCS4 cTLC	187	33	477	954

480GB	ESM1720	512Gb DDPx5	KIC BiCS5 cTLC	TBD	TBD	TBD	TBD
960GB	ESM1720	512Gb DDPx9	KIC BiCS5 cTLC	TBD	TBD	TBD	TBD
1920GB	ESM1720	512Gb QDPx9	KIC BiCS5 cTLC	TBD	TBD	TBD	TBD
3840GB	ESM1710	512Gb ODPx10	KIC BiCS5 cTLC	TBD	TBD	TBD	TBD

	Product Series	Flash Structure	Flash Type	Quality of Service (99.99%)			
				Read 4KB, QD=1	Write 4KB, QD=1	Read 4KB, QD=32	Write 4KB, QD=32
				Unit: us	Unit: us	Unit: us	Unit: us
240GB	ESM1220	256Gb DDPx5	KIC BiCS4 cTLC	189	119	831	1204
480GB	ESM1220	256Gb DDPx9	KIC BiCS4 cTLC	185	103	577	1138
960GB	ESM1220	256Gb QDPx9	KIC BiCS4 cTLC	211	130	544	2408
1920GB	ESM1220	512Gb QDPx9	KIC BiCS4 cTLC	205	105	536	1908
3840GB	ESM1210	512Gb ODPx10	KIC BiCS4 cTLC	234	102	774	1253
480GB	ESM1720	512Gb DDPx5	KIC BiCS5 cTLC	TBD	TBD	TBD	TBD
960GB	ESM1720	512Gb DDPx9	KIC BiCS5 cTLC	TBD	TBD	TBD	TBD
1920GB	ESM1720	512Gb QDPx9	KIC BiCS5 cTLC	TBD	TBD	TBD	TBD
3840GB	ESM1710	512Gb ODPx10	KIC BiCS5 cTLC	TBD	TBD	TBD	TBD

NOTES:

- Quality of Service (QoS) is measured with the following conditions
 - FIO test: 4KB transfer size, QD=1, 32 on 4KB random read and write workload on whole LBA range of drive once the performance performs on steady state and all background operations run normally.
- Performance Platform

Operating System	Ubuntu 16.04.3 LTS
Kernel	Linux version 4.14.14-041414-generic
CPU	Intel(R) Xeon(R) Gold 5120 CPU @ 2.20GHz
Motherboard	Intel Corporation S2600WFT
RAM	16077196 kB

- According to random 4KB QD=1 and 32 workloads, the result of QoS is the maximum round-trip time which is taken for 99.0 % and 99.99% of commands to host.
- QoS may differ according to flash configuration and platform.
- The tables are for reference only. Any criteria for accepting goods shall be further discussed based on different flash configurations.

3. ENVIRONMENTAL SPECIFICATIONS

3.1. Environmental Conditions

3.1.1. Temperature and Humidity

Table 3-1 High Temperature Test Condition

		Temperature	Humidity
High Temperature Test	Operation	70°C ¹	0% RH
	Storage	85°C	0% RH
Low Temperature Test	Operation	0°C	0% RH
	Storage	-40°C	0% RH
High Humidity Test	Operation	40°C	90% RH
	Storage	40°C	93% RH
Temperature Cycle Test	Operation	0°C - 70°C ¹	—
	Storage	-40°C - 85°C	—

NOTES:

1. Operation temperature is measured by device temperature sensor. Airflow is suggested and it will allow device to be operated at appropriate temperature for each component during heavy workloads environment.

Table 3-2 Mechanical Test Condition

Items			2.5 inch SATA SSD
Shock	Non-operational	Acceleration Force	1500G
Vibration	Non-operational	Frequency/Displacement	20Hz~80Hz/1.52mm
		Frequency/Acceleration	80Hz~2000Hz/20G
Drop	Non-operational	Height of Drop	80cm free fall
		Number of Drop	6 face of each unit
Bending	Non-operational	Force	≥ 20N
		Action	Hold 1min/5times

Table 3-3 Electrostatic Discharge (ESD)

Specification	+/- 4KV
EN 55024, CISPR 24 EN 61000-4-2 and IEC 61000-4-2	Device functions are affected, but EUT will be back to its normal or operational state automatically.

Table 3-4 EMI Compliance

Specification
EN 55032, CISPR 32(CE) AS/NZS CISPR 32(CE) ANSI C63.4 (FCC) CNS 13438 (BSMI) VCCI-CISPR 32 (VCCI)

Table 3-5 Thermal Cycling Storage Test

Condition	Sample Q'ty	Criteria	Reference
-40°C (10min)~85°C (10min) , 20C/min ramp, 1000cycles	33	50% (Preferred 63.2%) cumulative failure is acceptable.	IPC-9701

NOTES:

1. Test condition and criteria is referred to IPC-9701.
2. The cumulative number of failures can't exceed 20 pcs after testing.
3. This test item will be executed when required.

3.2. TBW (TeraBytes Written) and DWPD (Drive Write Per Day)

Table 3-6 TBW & DWPD

	Product Series	Flash Structure	Flash Type	TBW	DWPD
240GB	ESM1220	256Gb DDPx5	KIC BiCS4 cTLC	545	1
480GB	ESM1220	256Gb DDPx9	KIC BiCS4 cTLC	735	1
960GB	ESM1220	256Gb QDPx9	KIC BiCS4 cTLC	1500	1
1920GB	ESM1220	512Gb QDPx9	KIC BiCS4 cTLC	3960	1
3840GB	ESM1210	512Gb ODPx10	KIC BiCS4 cTLC	7492	1
480GB	ESM1720	512Gb DDPx5	KIC BiCS5 cTLC	TBD	1
960GB	ESM1720	512Gb DDPx9	KIC BiCS5 cTLC	TBD	1
1920GB	ESM1720	512Gb QDPx9	KIC BiCS5 cTLC	TBD	1
3840GB	ESM1710	512Gb ODPx10	KIC BiCS5 cTLC	TBD	1

NOTES:

1. The JEDEC Enterprise 219A workload.
2. Based on 5 years.
3. DWPD = TBW/ (365 x 5years x User capacity)

$$= \text{TBW} (\text{TB} \cdot 10^3) / [365 \times 5 \text{years} \times \text{User capacity} (= \text{GB} \cdot 1000^3 / 1024^3)]$$

3.3. Power On/Off Cycles

The definition of power on/off cycles is that the power is withdrawn from the SSD device, and then restored. The test is to simulate the behavior that SSD still can be restored and active normally when host platforms go into suspend and shutdown.

During the Power On/Off cycles test, the SSD can be protective if the SSD encounters 24 times of power on/off per day within warranty period.

3.4. UBER

Table 3-7 UBER

	Flash Type	UBER
240GB	3D NAND	< 1 sector per 10 ¹⁷ bits read
480GB		
960GB		
1920GB		
3840GB		

NOTES:

1. UBER (Uncorrectable Bit Error Rates) means the uncorrectable error per bits read.

3.5. MTBF

MTBF, Mean Time Between Failures, is a measure of reliability of a device. Its value represents the average time between a repair and the next failure. The unit of MTBF is in hours. The higher the MTBF value, the higher the reliability of the device.

Our MTBF result is based on simulation software (Brand/Model). Please note that a lower MTBF should be expected for higher capacity drives, and we apply the lowest MTBF for all capacities.

Table 3-8 MTBF

	MTBF
240GB	1.5 million Hours
480GB	
960GB	
1920GB	
3840GB	

4. ELECTRICAL SPECIFICATIONS



4.1. Supply Voltage

Table 4-1 Supply Voltage

	2.5" SSD
Parameter	Rating
Operating Voltage	5V, +/- 5%
Rise Time (Max/Min)	100 ms / 0.1 ms
Fall Time (Max/Min)	1 s / 10 ms
Min. Off Time ¹ (under 0.1V)	5 s

NOTE:

1. Minimum time between power removed from SSD ($V_{cc} < 100$ mW) and power re-applied to the drive.

4.2. Power Consumption

Table 4-2 Power Consumption

				2.5" SSD		
	Product Series	Flash Structure	Flash Type	Active Write (Typ.)	Active Read (Typ.)	Idle
				Unit: W	Unit: W	Unit: W
240GB	ESM1220	256Gb DDPx5	K1C BiCS4 cTLC	2.7	2.2	1.3
480GB	ESM1220	256Gb DDPx9	K1C BiCS4 cTLC	2.7	2.4	1.3
960GB	ESM1220	256Gb QDPx9	K1C BiCS4 cTLC	2.8	2.7	1.4
1920GB	ESM1220	512Gb QDPx9	K1C BiCS4 cTLC	3.1	2.8	1.4
3840GB	ESM1210	512Gb ODPx10	K1C BiCS4 cTLC	3.3	2.8	1.4
480GB	ESM1720	512Gb DDPx5	K1C BiCS5 cTLC	TBD	TBD	TBD
960GB	ESM1720	512Gb DDPx9	K1C BiCS5 cTLC	TBD	TBD	TBD
1920GB	ESM1720	512Gb QDPx9	K1C BiCS5 cTLC	TBD	TBD	TBD
3840GB	ESM1710	512Gb ODPx10	K1C BiCS5 cTLC	TBD	TBD	TBD

NOTES:

1. Use iometer with QD32 and worker 1 for 128KB sequential write test to measure the power of active write.
2. Use iometer with QD32 and worker 1 for 4KB random read test to measure the power of active read.
3. The power of idle is measured with DIPM off.
4. Power Consumption may differ according to flash configuration and platform.
5. The average value of power consumption is achieved based on 100% conversion efficiency.
6. The measured power voltage of 2.5" SSD is 5V.

5. INTERFACE



5.1. Pin Assignment and Descriptions

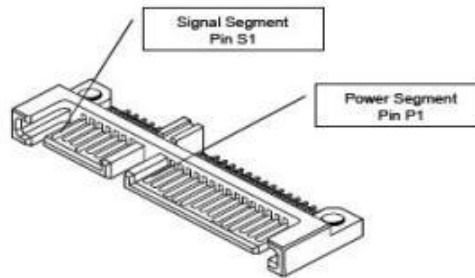


Figure 5-1 2.5" SATA SSD Pin Assignment

Table 5-1 Signal Segment Pin Assignment and Descriptions

Pin Number	Function
S1	GND
S2	A+ (Differential Signal Pair A)
S3	A – (Differential Signal Pair A)
S4	GND
S5	B – (Differential Signal Pair B)
S6	B+ (Differential Signal Pair B)
S7	GND

Table 5-2 Signal Segment Pin Assignment and Description

Pin Number	Function	NOTE
P1	Not Used (3.3V)	
P2	Not Used (3.3V)	
P3	Not connected	
P4	GND	
P5	GND	
P6	GND	
P7	5V pre-charge	
P8	5V	
P9	5V	
P10	GND	
P11	DAS ¹	Tolerated input voltage(max) is 3.3V
P12	GND	
P13	Not Used (12V pre-charge)	
P14	Not Used (12V)	
P15	Not Used (12V)	

6. SUPPORTED COMMANDS



6.1. ATA Command List

The following ATA command list table is followed by ATA8-ACS4 SPEC.

Table 6-1 ATA Command List

Op Code	Support	Description	Op Code	Support	Description	
00h	Y	NOP	B6h	12h	-	NV Cache: QUERY NV CACHE PINNED SET DMA EXT
03h	-	CFA REQUEST EXTENDED ERROR	B6h	13h	-	NV Cache: QUERY NV CACHE MISSES DMA EXT
06h	Y	DATA SET MANAGEMENT	B6h	14h	-	NV Cache: FLUSH NV CACHE
08h	-	DEVICE RESET	C4h	Y	READ MULTIPLE	
0Bh	-	REQUEST SENSE DATA EXT	C5h	Y	WRITE MULTIPLE	
10h	Y	RECALIBRATE	C6h	Y	SET MULTIPLE MODE	
11h-1Fh	-	RECALIBRATE	C7h	-	READ DMA QUEUED	
20h	Y	READ SECTOR(S)	C8h	Y	READ DMA	
21h	Y	READ SECTOR(S) WITHOUT RETRY	C9h	Y	READ DMA WITHOUT RETRY	
22h	-	READ LONG	CAh	Y	WRITE DMA	
23h	-	READ LONG WITHOUT RETRY	CBh	Y	WRITE DMA WITHOUT RETRY	
24h	Y	READ SECTOR(S) EXT	CCh	-	WRITE DMA QUEUED	
25h	Y	READ DMA EXT	CDh	-	CFA WRITE MULTIPLE WITHOUT ERASE	
26h	-	READ DMA QUEUED EXT	CEh	Y	WRITE MULTIPLE FUA EXT	
27h	Y	READ NATIVE MAX ADDRESS EXT	D1h	-	CHECK MEDIA CARD TYPE	
29h	Y	READ MULTIPLE EXT	DAh	-	GET MEDIA STATUS	
2Ah	-	READ STREAM DMA EXT	DEh	-	MEDIA LOCK	
2Bh	-	READ STREAM EXT	DFh	-	MEDIA UNLOCK	
2Fh	Y	READ LOG EXT	E0h	Y	STANDBY IMMEDIATE	
30h	Y	WRITE SECTOR(S)	E1h	Y	IDLE IMMEDIATE	
31h	Y	WRITE SECTOR(S) WITHOUT RETRY	E2h	Y	STANDBY	
32h	-	WRITE LONG	E3h	Y	IDLE	
33h	-	WRITE LONG WITHOUT RETRY	E4h	Y	READ BUFFER	
34h	Y	WRITE SECTOR(S) EXT	E5h	Y	CHECK POWER MODE	
35h	Y	WRITE DMA EXT	E6h	Y	SLEEP	
36h	-	WRITE DMA QUEUED EXT	E7h	Y	FLUSH CACHE	
37h	Y	SET MAX ADDRESS EXT	E8h	Y	WRITE BUFFER	
38h	-	CFA WRITE SECTORS WITHOUT ERASE	E9h	Y	READ BUFFER DMA	
39h	Y	WRITE MULTIPLE EXT	EAh	Y	FLUSH CACHE EXT	

Op Code	Support	Description	Op Code	Support	Description		
3Ah	-	WRITE STREAM DMA EXT	EBh	Y	WRITE BUFFER DMA		
3Bh	-	WRITE STREAM EXT	ECh	Y	IDENTIFY DEVICE		
3Ch	-	WRITE VERIFY	EDh	-	MEDIA EJECT		
3Dh	Y	WRITE DMA FUA EXT	EEh	-	IDENTIFY DEVICE DMA		
3Eh	-	WRITE DMA QUEUED FUA EXT	EFh	01h	-	SET FEATURES: Enable 8-bit PIO transfer mode (CFA feature set only)	
3Fh	Y	WRITE LOG EXT	EFh	02h	Y	SET FEATURES: Enable write cache	
40h	Y	READ VERIFY SECTOR(S)	EFh	03h	Y	SET FEATURES: Set transfer mode based on value in Count field	
41h	Y	READ VERIFY SECTOR(S) WITHOUT RETRY	EFh	05h	Y	SET FEATURES: Enable advanced power management	
42h	Y	READ VERIFY SECTOR(S) EXT	EFh	06h	-	SET FEATURES: Enable Power-Up In Standby feature set	
44h	-	Reserved	EFh	07h	-	SET FEATURES: Power-Up In Standby feature set device spin-up	
45h	O	WRITE UNCORRECTABLE EXT	EFh	0Ah	-	SET FEATURES: Enable CFA power mode 1	
47h	Y	READ LOG DMA EXT	EFh	0Bh	-	SET FEATURES: Enable Write-Read-Verify feature set	
50h	-	FORMAT TRACK	EFh	10h	01h	-	SET FEATURES: Enable use of Serial ATA feature
51h	-	CONFIGURE STREAM	EFh	10h	02h	Y	SET FEATURES: Enable DMA Setup FIS Auto-Activate optimization
57h	Y	WRITE LOG DMA EXT	EFh	10h	03h	Y	SET FEATURES: Enable Device-initiated interface power state (DIPM) transitions
60h	Y	READ FPDMA QUEUED	EFh	10h	04h	-	SET FEATURES: Enable use of Serial ATA feature
61h	Y	WRITE FPDMA QUEUED	EFh	10h	05h	-	SET FEATURES: Enable use of Serial ATA feature
70h	Y	SEEK	EFh	10h	06h	O	SET FEATURES: Enable Software Settings Preservation (SSP)
71-76h	-	SEEK	EFh	10h	07h	Y	SET FEATURES: Enable Device Automatic Partial to Slumber transitions
77h	Y	SET DATE AND TIME EXT	EFh	10h	09h	O	SET FEATURES: Enable Device Sleep

Op Code		Support	Description	Op Code		Support	Description	
79-7Fh		-	SEEK	EFh	43h	-	SET FEATURES: Set Maximum Host Interface Sector Times	
87h		-	CFA TRANSLATE SECTOR	EFh	44h	-	SET FEATURES: Vendor Specific ECC byte	
90h		Y	EXECUTE DEVICE DIAGNOSTIC	EFh	55h	Y	SET FEATURES: Disable read look-ahead feature	
91h		Y	INITIALIZE DEVICE PARAMETERS	EFh	5Dh	-	SET FEATURES: Enable release interrupt	
92h		Y	DOWNLOAD MICROCODE	EFh	5Eh	-	SET FEATURES: Enable service interrupt	
93h		Y	DOWNLOAD MICROCODE DMA	EFh	5Fh	-	SET FEATURES: Enable NDRQ Feature	
94h		-	STANDBY IMMEDIATE	EFh	66h	Y	SET FEATURES: Disable reverting to power-on defaults	
95h		-	IDLE IMMEDIATE	EFh	81h	-	SET FEATURES: Disable 8-bit PIO transfer mode (CFA feature set only)	
96h		-	STANDBY	EFh	82h	Y	SET FEATURES: Disable write cache	
97h		-	IDLE	EFh	85h	Y	SET FEATURES: Disable advanced power management	
98h		-	CHECK POWER MODE	EFh	86h	-	SET FEATURES: Disable Power-Up In Standby feature set	
99h		-	SLEEP	EFh	8Ah	-	SET FEATURES: Disable CFA power mode	
A0h		-	PACKET	EFh	8Bh	-	SET FEATURES: Disable Write-Read-Verify feature set	
A1h		-	IDENTIFY PACKET DEVICE	EFh	90h	01h	-	SET FEATURES: Disable use of Serial ATA feature
A2h		-	SERVICE	EFh	90h	02h	Y	SET FEATURES: Disable DMA Setup FIS Auto-Activate optimization
B0h	D0h	Y	SMART: READ DATA	EFh	90h	03h	Y	SET FEATURES: Disable Device-initiated interface power state (DIPM) transitions
B0h	D1h	Y	SMART: READ ATTRIBUTE THRESHOLDS	EFh	90h	04h	-	SET FEATURES: Disable use of Serial ATA feature

Op Code		Support	Description	Op Code			Support	Description
B0h	D2h	Y	SMART: ENABLE/DISABLE AUTOSAVE	EFh	90h	05h	-	SET FEATURES: Disable use of Serial ATA feature
B0h	D3h	Y	SMART: SAVE ATTRIBUTE VALUES	EFh	90h	06h	Y	SET FEATURES: Disable Software Settings Preservation (SSP)
B0h	D4h	Y	SMART: EXECUTE OFF-LINE IMMEDIATE	EFh	90h	07h	Y	SET FEATURES: Disable Device Automatic Partial to Slumber transitions
B0h	D5h	Y	SMART: READ LOG	EFh	90h	09h	O	SET FEATURES: Disable Device Sleep
B0h	D6h	Y	SMART: WRITE LOG	EFh	AAh		Y	SET FEATURES: Enable read look-ahead feature
B0h	D8h	Y	SMART: ENABLE OPERATIONS	EFh	BBh		-	SET FEATURES: Default ECC byte
B0h	D9h	Y	SMART: DISABLE OPERATIONS	EFh	C2h		-	SET FEATURES: Disable Automatic Acoustic Management feature set
B0h	DAh	Y	SMART: RETURN STATUS	EFh	C3h		-	SET FEATURES: Enable/Disable the Sense Data Reporting feature set
B0h	DBh	Y	SMART: ENABLE/DISABLE AUTOMATIC OFF-LINE	EFh	CCh		Y	SET FEATURES: Enable reverting to power-on defaults
B0h	E0h	-	SMART: Vendor specific	EFh	DDh		-	SET FEATURES: Disable release interrupt
B1h	C0h	Y	DEVICE CONFIGURATION: RESTORE	EFh	DEh		-	SET FEATURES: Disable SERVICE interrupt
B1h	C1h	Y	DEVICE CONFIGURATION: FREEZE LOCK	EFh	DFh		-	SET FEATURES: Disable NDRQ Feature
B1h	C2h	Y	DEVICE CONFIGURATION: IDENTIFY	F1h			Y	SECURITY SET PASSWORD
B1h	C3h	Y	DEVICE CONFIGURATION: SET	F2h			Y	SECURITY UNLOCK
B1h	C4h	Y	DEVICE CONFIGURATION: IDENTIFY DMA	F3h			Y	SECURITY ERASE PREPARE
B1h	C5h	Y	DEVICE CONFIGURATION: SET DMA	F4h			Y	SECURITY ERASE UNIT
B4h	0000h	O	SANITIZE DEVICE: SANITIZE STATUS EXT	F5h			Y	SECURITY FREEZE LOCK
B4h	0011h	O	SANITIZE DEVICE: CRYPTO SCRAMBLE EXT	F6h			Y	SECURITY DISABLE PASSWORD
B4h	0012h	O	SANITIZE DEVICE: BLOCK ERASE EXT	F8h			Y	READ NATIVE MAX ADDRESS
B4h	0014h	O	SANITIZE DEVICE: OVERWRITE EXT	F9h	00h		Y	SET MAX: SET MAX ADDRESS

Op Code		Support	Description	Op Code		Support	Description
B4h	0020h	O	SANITIZE DEVICE: SANITIZE FREEZE LOCK EXT	F9h	01h	Y	SET MAX: SET MAX PASSWORD
B4h	0040h	O	SANITIZE DEVICE: SANITIZE ANTIFREEZE LOCK EXT	F9h	02h	Y	SET MAX: SET MAX LOCK
B6h	00h	-	NV Cache: SET NV CACHE POWER MODE EXT	F9h	03h	Y	SET MAX: SET MAX UNLOCK
B6h	01h	-	NV Cache: RETURN FROM NV CACHE POWER MODE EXT	F9h	04h	Y	SET MAX: SET MAX FREEZE LOCK
B6h	10h	-	NV Cache: ADD LBA(S) TO NV CACHE PINNED SET DMA EXT	F9h	05h	Y	SET MAX: SET MAX SET PASSWORD DMA
B6h	11h	-	NV Cache: REMOVE LBA(S) FROM NV CACHE PINNED SET DMA EXT	F9h	06h	Y	SET MAX: SET MAX UNLOCK DMA

NOTE: "Y" means "Support".

"O" means "Option, default No support".

"-" means "No support".

6.2. Identify Device Command

The following table details the sector data returned by the IDENTIFY DEVICE command of ATA8-ACS4 SPEC.

Table 6-2 List of Device Identification

Word	F: Fixed V: Variable X: retired/obsolete /reserved	Default Value	ATA Identify Parameter
0	F	0040h	General configuration
1	X	*1	Number of cylinders in the default CHS translation
2	F	C837h	Specific configuration
3	X	0010h	Number of heads in the default CHS translation
4..5	X	0000h	Retired
6	X	003Fh	Number of sectors per track in the default CHS translation
7..8	X	0000h	Reserved for CFA
9	X	0000h	Retired
10..19	V	ASCII	Serial number
20..21	X	0000h	Retired
22	X	0000h	Obsolete
23..26	V	ASCII	Firmware revision

27..46	V	ASCII	Model number
47	X	8010h	READ/WRITE MULTIPLE commands function
48	F	4000h	Trusted Computing feature set options
49	F	2F00h	Capabilities
50	F	4000h	Capabilities
51..52	X	0000h	Obsolete
53	F	0007h	Field validity
54	X	*1	Number of current logical cylinders
55	X	0010h	Number of current logical heads
56	X	003Fh	Number of current sectors per track
57..58	X	*2	Current capacity in sectors
59	V	0110h	Multiple sector setting
60..61	V	*3	Total number of user addressable logical sectors for 28-bit commands
62	X	0000h	Obsolete
63	V	0407h	Multiword DMA transfer modes
Word	F: Fixed V: Variable X: retired/obsolete /reserved	Default Value	ATA Identify Parameter
64	F	0003h	Advanced PIO modes modes
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	F	5F20h	Set Max Password(Support)
70..74	X	0000h	Reserved
75	F	001Fh	Queue depth
76	V	E50Eh	Serial SATA capabilities
77	V	0006/0004/0002 h	Serial ATA Additional Capabilities
78	V	004Ch	Serial ATA features supported
79	F	0040h	Serial ATA features enabled
80	F	07F8h	Major version number
81	F	0000h	Minor version number

82	F	746Bh	Commands and feature sets supported
83	F	7D09h	Commands and feature sets supported
84	F	4063h	WWN
85	F	7469h	Commands and feature sets supported or enabled
86	F	BC09h	Commands and feature sets supported or enabled
87	F	4063h	WWN
88	F	007Fh	Ultra DMA Modes
89	F	0001h	Time required for Normal Erase mode SECURITY ERASE UNIT command
90	F	0001h	Time required for Enhanced Erase mode SECURITY ERASE UNIT command
91	F	00FEh	Current APM (advanced power management) level value
92	F	FFFEh	Master password identifier
93	F	0000h	Hardware reset result.
Word	F: Fixed V: Variable X: retired/obsolete /reserved	Default Value	ATA Identify Parameter
94	X	0000h	Obsolete
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	*4	Number of User Addressable Logical Sectors
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/IEC 7779 standard acoustic testing
108..111	V	0000h	World Wide Name
112..115	X	0000h	Reserved
116	X	0000h	Obsolete
117..118	F	0000h	Logical sector size
119	V	4019h	Commands and feature sets supported
120	V	4019h	Commands and feature sets supported or enabled

121..126	X	0000h	Reserved for expanded supported and enabled settings
127	X	0000h	Obsolete
128	F	0021h	Security status
129..159	V	0000h	Vendor specific
160..167	X	0000h	Reserved for CFA
168	V	Varies	Device Nominal Form Factor shows as below: Nominal Form Factor not reported: 0000h 1.25 inch: 0001h 1.5 inch: 0002h 2.5 inch: 0003h 1.8 inch: 0004h mSATA and others: 0005h
169	F	0001h	DATA SET MANAGEMENT command is support
170..173	F	0000h	Additional Product Identifier
174..175	X	0000h	Reserved
Word	F: Fixed V: Variable X: retired/obsolete /reserved	Default Value	ATA Identify Parameter
176..205	F	0000h	Current media serial number
206	V	0000h	SCT Command Transport
207..208	X	0000h	Reserved
209	F	4000h	Alignment of logical sectors within a physical sector
210..211	F	0000h	Write-Read-Verify Sector Mode 3 Count
212..213	F	0000h	Write-Read-Verify Sector Mode 2 Count
214..216	X	0000h	Obsolete
217	F	0001h	Nominal media rotation rate
218	X	0000h	Reserved
219	X	0000h	Obsolete
220	V	0000h	Current mode of the Write-Read-Verify feature set
221	X	0000h	Reserved
222	V	107Fh	Transport major version number
223	F	0000h	Transport minor version number
224..229	X	0000h	Reserved
230..233	F	0000h	Extend Number of User Addressable Sectors
234	F	0001h	Minimum number of 512-byte data blocks per Download Microcode operation

235	F	FFFFh	Maximum number of 512-byte data blocks per Download Microcode operation
236..242	X	0000h	Reserved
243	F	0000h	Security feature 4000 : Self Encrypting Drive
244..254	F	0000h	Reserved
255	V	XXA5h XX is variable	Integrity word (Checksum and Signature)

Table 6-3 List of Device Identification for Each Capacity

Capacity (GB)	*1 (Word 1/Word 54)	*2 (Word 57 – 58)	*3 (Word 60 – 61)	*4 (Word 100 – 103)
240	3FFFh	FBFC10h	FFFFFFFh	1BF244B0h
480	3FFFh	FBFC10h	FFFFFFFh	37E436B0
960	3FFFh	FBFC10h	FFFFFFFh	6FC81AB0
1920	3FFFh	FBFC10h	FFFFFFFh	DF8FE2B0
3840	3FFFh	FBFC10h	FFFFFFFh	1BF1F72B0

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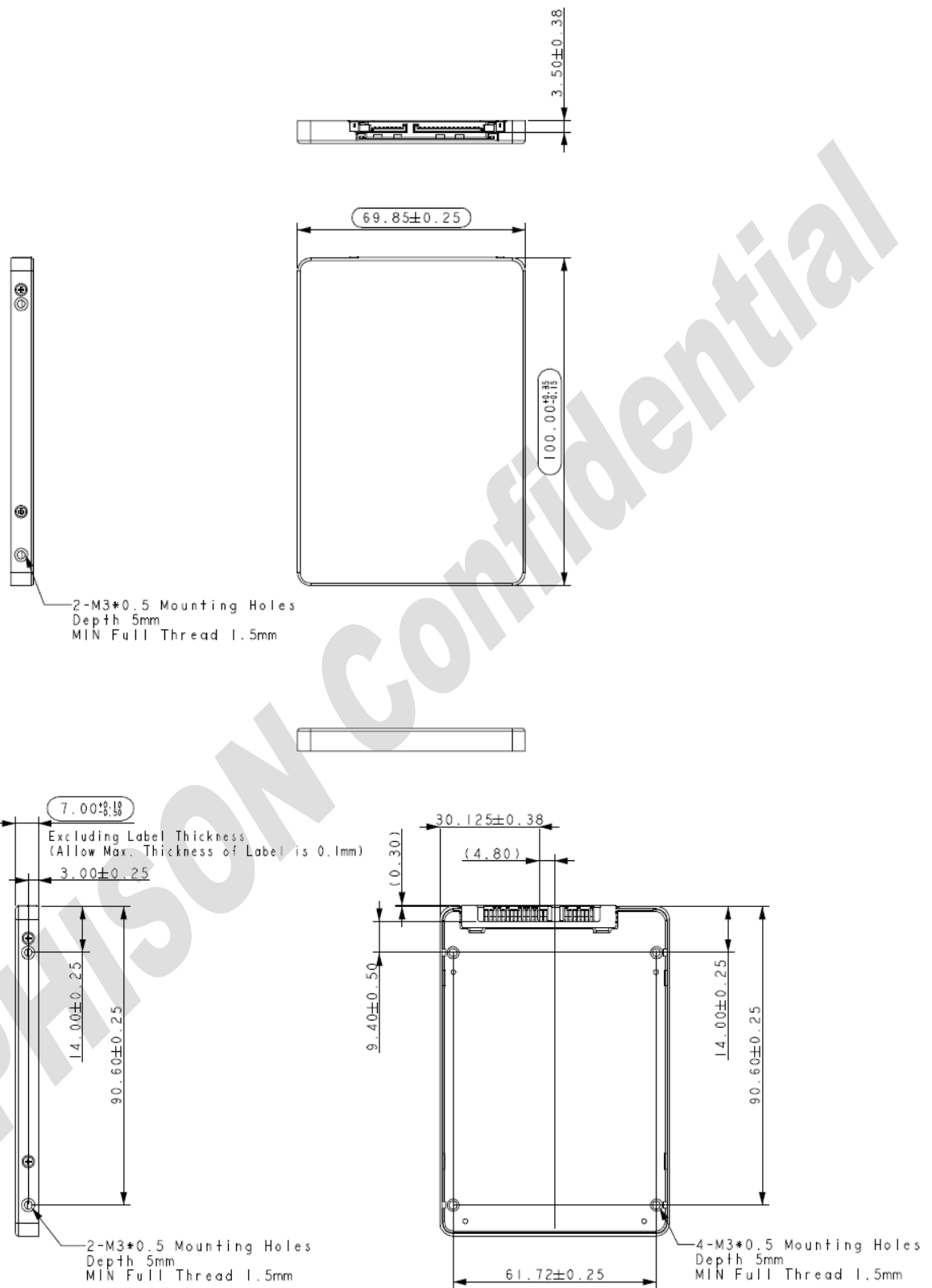
6.3. SMART Attributes

Table 6-4 SMART Attributes

Attribute ID	Description
01h	Number of Accumulation of Uncorrectable Error.
09h	Power on Hours Count.
0Ch	Drive Power Cycle Count (number of accumulation of power on/off cycles)
A8h	SATA PHY Error Count (Only record from power on, when power off this value will clear to zero. These values include all PHY error count, ex data FIS CRC, code error, disparity error, command FIS CRC.....)
AAh	Bad Block Count (early bad count and later bad count)
ADh	Erase Count (max. erase count and average erase count)
C0h	Number of Unexpected Power Loss
C2h	Temperature (show 33C if no thermal sensor)
DAh	Number of Accumulation CRC Error (read/write data FIS CRC error)
E7h	SSD Life Remaining
F1h	Host Write (GB)

7. PHYSICAL DIMENSION

- ❖ 2.5" SSD: 100.00mm (L) x 69.85mm (W) x 7.00mm (H)



8. PRODUCT WARRANTY POLICY



In the event the Product does not conform to the specification within Phison agreed warranty period and such inconformity is solely attributable to Phison's cause, Phison agrees at its discretion replace or repair the nonconforming Product. Notwithstanding the foregoing, the aforementioned warranty shall exclude the inconformity arising from, in relation to or associated with:

- (1) alteration, modification, improper use, misuse or excessive use of the Product;
- (2) failure to comply with Phison's instructions;
- (3) Phison's compliance with customer (including customer's suppliers, subcontractors or downstream customers) indicated instructions, technologies, designs, specifications, materials, components, parts;
- (4) combination of the Product with other materials, components, parts, goods, hardware, firmware or software not developed by Phison; or
- (5) other error or failure not solely attributable to Phison's cause (including without limitation, normal wear or tear, manufacturing or assembly wastage, improper operation, virus, unauthorized maintenance or repair).

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9. REFERENCE



The following table is to list out the standards that have been adopted for designing the product.

Table 9-1 List of References

Title	Acronym/Source
Serial ATA Revision 3.2	http://www.sata-io.org
ATA-8 spec	http://www.t13.org

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10. TERMINOLOGY



The following table is to list out the acronyms that have been applied throughout the document.

Table 10-1 List of Terminology

Term	Definitions
LBA	Logical block addressing
MB	Mega-byte
GB	Giga-byte
TB	Tera-byte
MTBF	Mean time between failures
S.M.A.R.T.	Self-monitoring, analysis and reporting technology
SSD	Solid state disk

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11. APPLICATION NOTES

11.1. Wafer Level Chip Scale Packaging (WLCSP) Handling Precautions

There are a lot of components assembled on a single SSD device. Please handle the drive with care especially when it has any WLCSP (Wafer Level Chip Scale Packaging) components such as PMIC, thermal sensor or load switch. WLCSP is one of the packaging technologies that is widely adopted for making smaller footprints, but any bumps or scratches may damage those ultrasmall parts so gentle handling is strongly recommended.

- ⚠ DO NOT DROP SSD**
- ⚠ INSTALL SSD WITH CARE**
- ⚠ STORE SSD IN A PROPER PACKAGE**

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