APRO Co., Ltd.

MLC

M.2 SATA III Module

MUSE-D Series

(2242 & 2280 Form factor)

Document No. : 100-xBMDS-VDCTMB

Version No. : 02V0

Date : June, 2019

ISO 9001 : 2015 CERTIFIED

Product Features

- **Flash IC**
  - TOSHIBA 15nm NAND Flash IC.
  - Multi-Level Cell (MLC) management
- **Compatibility**
  - Compliant with SATA Revision 3.1
  - SATA 1.5Gbps/3.0Gbps/6.0Gbps data transfer rate.
  - ATA-8 command set
- **Additional Capabilities**
  - S.M.A.R.T.*[1] (Self-Monitoring, Analysis and Reporting Technology) feature set support.
  - Thermal Monitor for SSD's temperature.
  - Native Command Queuing (NCQ) support.
  - TRIM maintenance command support.
  - Static wear-leveling algorithm
  - Hardware Low Density Parity Check Code, LDPC support.
- **Mechanical**
  - PCI Express™ M.2(2242/2280)
  - M.2 keying notches in B and M positions.
  - **Dimension:**
  - **2242:** 42 mm x 22 mm.
  - **2280:** 80 mm x 22 mm.
  - **Weight:**
  - **2242:** 5.0 g / 0.17 oz.
  - **2280:** 8.0 g / 0.28 oz.
- **Power Operating Voltage 3.3V(+/-) 5%**

  2242:
  - Read Mode: 210.0 mA (max.)
  - Write Mode: 220.0 mA (max.)
  - Idle Mode: 100.0 mA (max.)

  2280:
  - Read Mode: 250.0 mA (max.)
  - Write Mode: 290.0 mA (max.)
  - Idle Mode: 110.0 mA (max.)
- **Performance (Maximum value)** [2, 3]
  - **2242:**
  - Sequential Read: 550.0 MB/sec. (max.)
  - Sequential Write: 130.0 MB/sec. (max.)
  - 4KB Random Read (QD32): 32K IOPS
  - 4KB Random Write (QD32): 29K IOPS
  - **2280:**
  - Sequential Read: 570.0 MB/sec. (max.)
  - Sequential Write: 150.0 MB/sec. (max.)
  - 4KB Random Read (QD32): 32K IOPS
  - 4KB Random Write (QD32): 26K IOPS
- **Capacity**
  - **2242:** 8GB, 16GB, 32GB, 64GB, 128GB
  - **2280:** 8GB, 16GB, 32GB, 64GB, 128GB and 256GB
- **Reliability**
  - **TBW:** Up to 416 TBW at 256GB Capacity. (Client workload by JESD-219A)
  - **ECC:** Designed with hardware LDPC ECC engine with hard-decision and soft-decision decoding.
  - **Temperature:** (Operating)

    Standard Grade: 0ºC ~ +70ºC

    Wide Temp. Grade: -40ºC ~ +85ºC
  - **Vibration:** 70 Hz to 2K Hz, 20G, 3 axes.
  - **Shock:** 0.5ms, 1500 G, 3 axes
- **Certifications and Declarations**
  - **Certifications**: CE & FCC
  - **Declarations**: RoHS & REACH

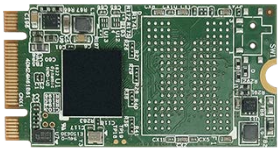
Remarks:

1. Support official S.M.A.R.T. Utility.
2. Typical I/O performance numbers as measured fresh-out-of-the-box (FOB) using IOmeter with a queue depth of 32
3. Sequential performance is based on CrystalDiskMark 5.1.2 with file size 1000MB

Order Information

I. Part Number List

◆ **APRO MLC M.2-2242 Form-factor SATA III Module MUSE-D Series**

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Wide Temp Grade (-40°C ~ +85°C)
	8GB	SBMDS008G-VDCTM4BM(T)	WBMDS008G-VDCTM4BM(T)C
	16GB	SBMDS016G-VDCTM4BM(T)	WBMDS016G-VDCTM4BM(T)C
	32GB	SBMDS032G-VDCTM4BM(T)	WBMDS032G-VDCTM4BM(T)C
	64GB	SBMDS064G-VDCTM4BM(T)	WBMDS064G-VDCTM4BM(T)C
	128GB	SBMDS128G-VDCTM4BM(T)	WBMDS128G-VDCTM4BM(T)C

◆ **APRO MLC M.2-2280 Form-factor SATA III Module MUSE-D Series**

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Wide Temp Grade (-40°C ~ +85°C)
	8GB	SBMDS008G-VDCTM8BM(T)	WBMDS008G-VDCTM8BM(T)C
	16GB	SBMDS016G-VDCTM8BM(T)	WBMDS016G-VDCTM8BM(T)C
	32GB	SBMDS032G-VDCTM8BM(T)	WBMDS032G-VDCTM8BM(T)C
	64GB	SBMDS064G-VDCTM8BM(T)	WBMDS064G-VDCTM8BM(T)C
	128GB	SBMDS128G-VDCTM8BM(T)	WBMDS128G-VDCTM8BM(T)C
	256GB	SBMDS256G-VDCTM8BM(T)	WBMDS256G-VDCTM8BM(T)C

Notes:

C : *Special conformal coating treated on whole PCBA which may support industrial grade operating temperature -40°C ~ +85°C*

II. Part Number Decoder:

X1 X2 X3 X4 X5 X6 X7 X8 X9—X11 X12 X13 X14 X15 X16 X17 X18 X19 X20

X1 : **Grade**

S: Standard Grade – operating temp. 0º C ~ 70 º C

W: Wide Temp Grade- operating temp. -40º C ~ +85 º C

X2 : **The material of case**

B : Bare PCBA w/o Casing

X3 X4 X5 : **Product category**

MDS : M.2 SATA III host interface

X6 X7 X8 X9 : **Capacity**

008G:	8GB	**064G:**	64GB
016GB:	16GB	**128GB:**	128GB
032G:	32GB	**256GB:**	256GB

X11 : **Controller**

V : MUSE Series

X12 : **Controller version**

A, B, C.....

X13 : **Controller Grade**

C : Commercial grade

X14 : **Flash IC**

T : Toshiba NAND Flash IC

X15 : **Flash IC grade / Type**

M : MLC-NAND Flash IC

X16 X17 X18: **Form-Factor**

4: 2242 Type

8: 2280 Type

BM: with two notches in B and M positions use up to two PCI Express lanes and provide broader compatibility at the same time

X19 X20 : **Reserved for specific requirement**

Blank : Standard product w/o thermal sensor and conformal-coating

T : Thermal Sensor (optional)

C : Conformal coating (optional)

Revision History

Revision	Description	Date
1.0	Initial release.	2017/08/01
1.1	Add the option for thermal sensor	2018/11/02
1.2	Updated Version	2018/11/28
2.0	Updated document form	2019/06/13

Contents

1. Introduction

APRO MLC M.2 SATA III Module MUSE-D Series provides high capacity flash memory Solid State Drive (SSD) that electrically complies with SATA Revision 3.1 standard. APRO MLC M.2 SATA III Module MUSE-D Series support SATA 1.5Gbps/3.0Gbps/6.0Gbps data transfer rate with high performance. The available disk capacities are 8GB, 16GB, 32GB, 64GB, 128GB and 256GB. The operating temperature grade is optional for Standard grade 0°C ~ 70°C and wide temp grade with conformal coating supports -40°C ~ +85°C.

APRO MLC M.2 SATA III Module MUSE-D Series provide the ultra-high random speed for heavy-loading embedded or server operations with space constraints for host computing systems; the data transfer performance by 4K random read is 32.0K IOPS and 4K random write is up to 29.0K IOPS; the sequential read is up to 550.0 MB/sec, and sequential write is up to 130.0 MB/sec. which is based on Toshiba's 15nm Toggle MLC flash.

APRO MLC M.2 SATA III Module MUSE-D Series PCB design with two notches in B and M positions use up to two PCI Express lanes and provide broader compatibility at the same time for M/B socket mounting, while the M.2 modules with only one notch in the M position use up to four PCI Express lanes; both examples we provide APRO MLC M.2 SATA III Module MUSE-D Series to be a SATA storage devices.

APRO MLC M.2 SATA III Module MUSE-D Series provides a high level interface to the host computer. This interface allows a host computer to issue commands to the APRO MLC M.2 SATA III Module MUSE-D Series to read or write blocks of memory. A powerful hardware design is architecture multiplied LDPC (Low Density Parity Check) for Error Correcting Coding (ECC). APRO MLC M.2 SATA III Module MUSE-D Series intelligent controller manages interface protocols, data storage and retrieval as well as ECC, bad block management and diagnostics, power management and clock control.

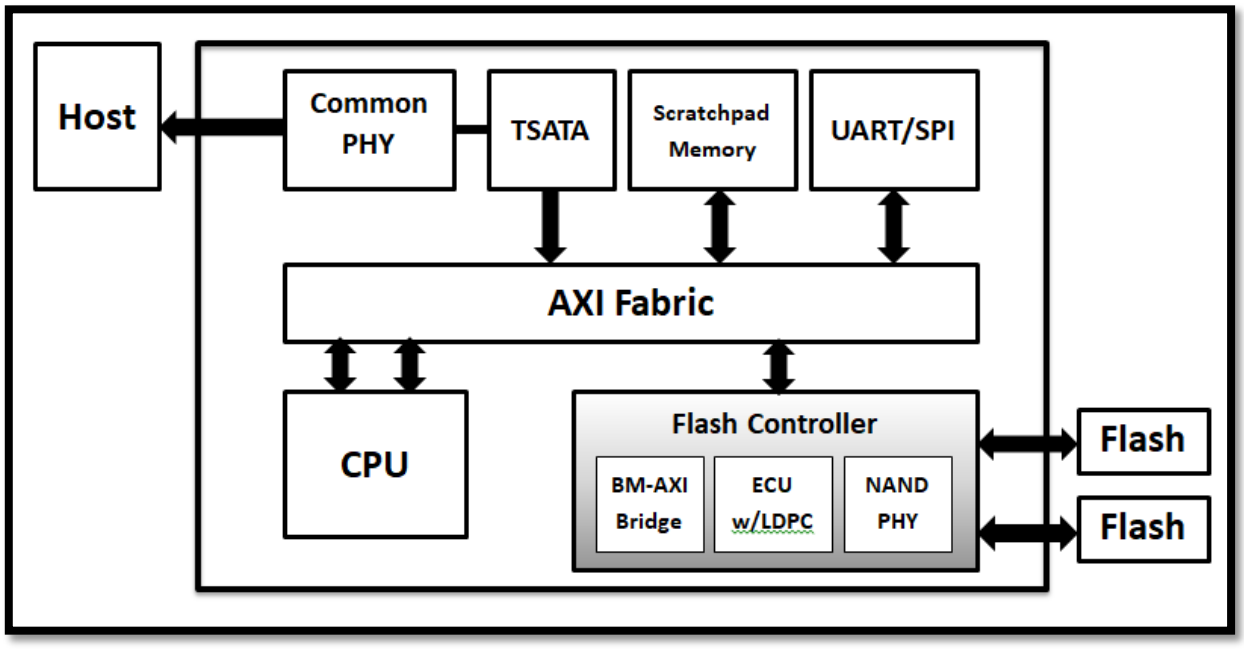


Figure 1: APRO MLC M.2 SATA III Module MUSE-D Series block diagram

1.1. *Scope*

This document describes features, specifications and installation guide of APRO MLC M.2 SATA III Module MUSE-D Series. In the appendix, there provides order information, warranty policy, RMA/DOA procedure for the most convenient reference..

1.2. *Flash Management Technology - Static Wear Leveling*

In order to gain the best management for flash memory, APRO MLC M.2 SATA III Module MUSE-D Series supports Static Wear-leveling technology to manage the Flash system. The life of flash memory is limited; the management is to increase the life of the flash product.

A static wear-leveling algorithm evenly distributes data over an entire Flash cell array and searches for the least used physical blocks. The identified low cycled sectors are used to write the data to those locations. If blocks are empty, the write occurs normally. If blocks contain static data, it moves that data to a more heavily used location before it moves the newly written data. The static wear leveling maximizes effective endurance Flash array compared to no wear leveling or dynamic wear leveling.

1.3. *Bad Block Management*

- **Early Bad Block**

The fault block generated during the manufacturing process of NAND Flash is called Early Bad Block.

- **Later Bad Block**

In the process of use, as the number of operations of writing and erasing increases, a fault block is gradually generated, which is called a Later Bad Block.

Bad block management is a management mechanism for a bad block to be detected by the control IC and mark bad blocks in the NAND Flash and improve the reliability of data access. The bad block management mechanism of the control IC will establish a **Bad Block Table** when the NAND Flash is started for the first time, and will also record the errors found in the process of use in the bad block table, and data is ported to new valid blocks to avoid data loss.

In order to detect the initial bad blocks to handle run time bad blocks, APRO MLC M.2 SATA III Module MUSE-D Series provides the **Bad Block Management** scheme. It remaps a bad block to one of the reserved blocks so that the data contained in one bad block is not lost and new data writes on a bad block is avoided.

2. Product Specifications

For all the following specifications, values are defined at ambient temperature and nominal supply voltage unless otherwise stated.

2.1. System Environmental Specifications

Table 1: Environmental Specification

APRO MLC M.2 SATA III Module MUSE-D Series		Standard Grade SBMDSxxxG-VDCTMBxBM	Wide Temp Grade WBMDSxxxG-VDCTMBxBMC
Temperature	Operating:	0ºC ~ +70ºC	-40ºC ~ +85ºC
	Non-operating:	-20ºC ~ +80ºC	-50ºC ~ +95ºC
Humidity	Operating & Non-operating:	10% ~ 95% non-condensing	
	Frequency / Acceleration:	70 Hz to 2K Hz, 20G, 3 axes	
Shock	Operating & Non-operating:	0.5ms, 1500 G, 3 axes	
Electrostatic Discharge (ESD)	Temperature:	24ºC	
	Relative Humidity:	49% (RH)	
	+/-4KV:	Device functions are affected, but EUT will be back to its normal or operational state automatically.	

2.2. System Power Requirements

Table 2: Power Requirement

APRO MLC M.2-2242 Form-factor SATA III Module MUSE-D Series		
DC Input Voltage (VCC)		3.3V±5%
Maximum average value	Reading Mode :	210.0 mA (max.)
	Writing Mode :	220.0 mA (max.)
	Idle Mode :	100.0 mA (max.)

APRO MLC M.2-2280 Form-factor SATA III Module MUSE-D Series		
DC Input Voltage (VCC)		3.3V±5%
Maximum average value	Reading Mode :	250mA (max.)
	Writing Mode :	290mA (max.)
	Idle Mode :	110mA (max.)

2.3. System Performance

Table 3: System Performances

Data Transfer Mode supporting		Serial ATA Gen-III (6.0Gb/s = 768MB/s)				
Maximum Performance	Capacity	8GB	16GB	32GB	64GB	128GB
	Form-factor	2242				
	Sequential Read (MB/s)	145.0	265.0	450.0	535.0	550.0
	Sequential Write (MB/s)	30.0	50.0	50.0	105.0	130.0
	4KB Random Read IOPS (QD32)	8.5K	15.0K	17.0K	27.0K	32.0K
	4KB Random Write IOPS (QD32)	6.5K	14.5K	12.0K	24.0K	29.0K

Data Transfer Mode supporting		Serial ATA Gen-III (6.0Gb/s = 768MB/s)					
Maximum Performance	Capacity	8GB	16GB	32GB	64GB	128GB	256GB
	Form-factor	2280					
	Sequential Read (MB/s)	145.0	265.0	450.0	535.0	550.0	570.0
	Sequential Write (MB/s)	30.0	50.0	50.0	105.0	130.0	150.0
	4KB Random Read IOPS (QD32)	8.5K	15.0K	17.0K	27.0K	32.0K	32.0K
	4KB Random Write IOPS (QD32)	6.5K	14.5K	12.0K	24.0K	29.0K	26.0K

Note: The performance was measured using CrystalDiskMark by file size 1000MB (QD32).

2.4. System Reliability

Table 4: System Reliability

Wear-leveling Algorithms		Static wear-leveling algorithms
Bad Block Management		Supportive
ECC Technology		Hardware design LDPC (Low Density Parity Check)
Erase counts		NAND MLC Flash Cell Level : 3K P/E Cycles
TBW (Tera Bytes Written)		
Capacity	8GB	15.5
	16GB	31.0
	32GB	62.0
	64GB	124.0
	128GB	210.5
	256GB	416.0

Note:

- *Client workload by JESD-219A.*
- *The endurance of SSD could be varying based on user behavior, NAND endurance cycles, and write amplification factor. It is not guaranteed by flash vendor.*

2.5. *Physical Specifications*

Refer to Table 5 and see Figure 2 for APRO MLC M.2 SATA III Module MUSE-D Series physical specifications and dimensions.

Table 5: Physical Specifications of APRO MLC M.2-2242&2280 Form-factor SATA III Module MUSE-D Series

Form-factor	2242	2280
Length:	42.0 mm	80.0 mm
Width:	22.0 mm	22.0 mm
Weight:	5.0 g / 0.17 oz.	8.0 g / 0.28 oz.

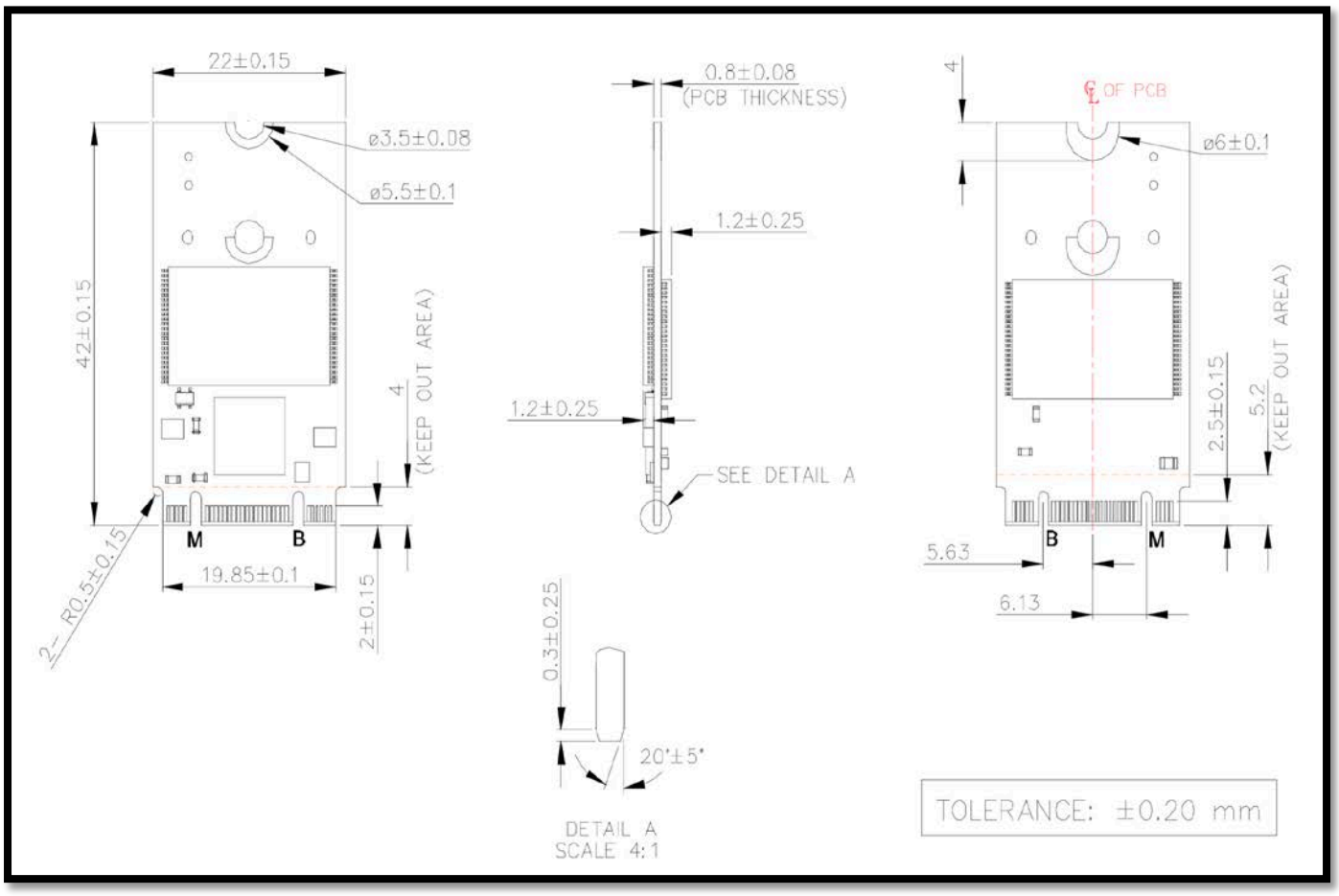


Figure 2: APRO MLC M.2-2242 Form-factor SATA III Module Dimension

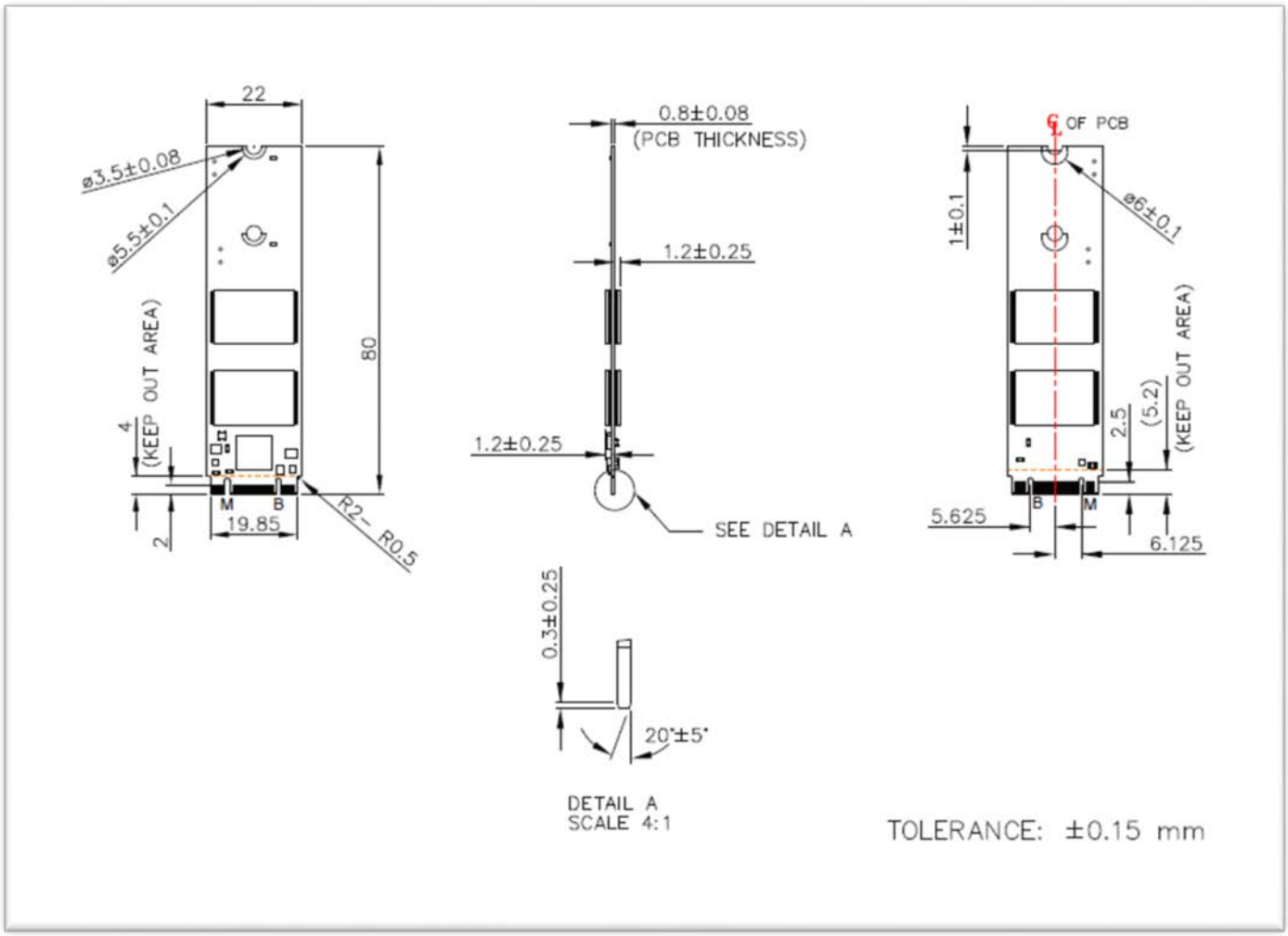


Figure 2: APRO MLC M.2-2280 Form-factor SATA III Module Dimension

2.6. *Conformal coating*

Conformal coating is a protective, dielectric coating designed to conform to the surface of an assembled printed circuit board. Commonly used conformal coatings include silicone, acrylic, urethane and epoxy. APRO applies only silicone on APRO storages products upon requested especially by customers. The type of silicone coating features good thermal shock resistance due to flexibility. It is also easy to apply and repair.

Conformal coating offers protection of circuitry from moisture, fungus, dust and corrosion caused by extreme environments. It also prevents damage from those Flash storages handling during construction, installation and use, and reduces mechanical stress on components and protects from thermal shock. The greatest advantage of conformal coating is to allow greater component density due to increased dielectric strength between conductors.

APRO use MIL-I-46058C silicon conformal coating

3. Interface Description

3.1. M.2 SATA III Module interface

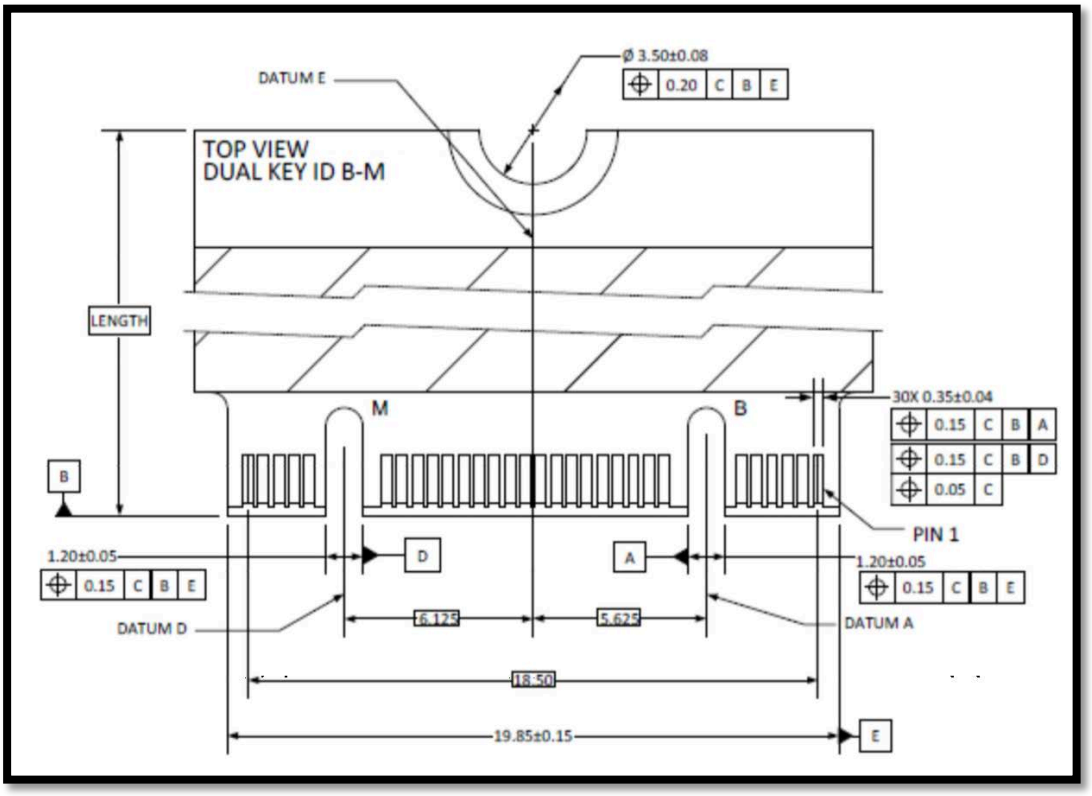


Figure 3: The connectors of Signal Segment and Power Segment

3.2. Pin Assignments

APRO MLC M.2 SATA III Module operates with standard SATA pin-out. The pin assignments are listed in below table 6.

Table 6 - Pin Assignments

74	3.3V	CONFIG_2 = GND	75
72	3.3V	GND	73
70	3.3V	GND	71
68	SUSCLK(32kHz) (I)(0/3.3V)	CONFIG_1 = GND	69
	Module Key	N/C	67
	Module Key	Module Key	
	Module Key	Module Key	
	Module Key	Module Key	
	Module Key	Module Key	
58	Reserved for MFG Clock	GND	57
56	Reserved for MFG Data	N/C	55
54	N/C	N/C	53
52	N/C	GND	51
50	N/C	SATA-A+	49
48	N/C	SATA-A-	47
46	N/C	GND	45
44	N/C	SATA-B-	43
42	N/C	SATA-B+	41
40	N/C	GND	39
38	DEVSLP (I)(0/3.3V)	N/C	37
36	N/C	N/C	35
34	N/C	GND	33
32	N/C	N/C	31
30	N/C	N/C	29
28	N/C	GND	27
26	N/C	N/C	25
24	N/C	N/C	23
22	N/C	CONFIG_0 = GND	21
20	N/C	Module Key	
	Module Key	Module Key	
	Module Key	Module Key	
	Module Key	Module Key	
	Module Key	Module Key	
10	DAS/DSS# (O)(OD)	N/C	11
8	N/C	N/C	9
6	N/C	N/C	7
4	3.3V	N/C	5
2	3.3V	GND	3
		CONFIG_3 = GND	1

Appendix A: Limited Warranty

APRO warrants your MLC M.2-2242 & 2280 Form-factor SATA III Module MUSE-D Series against defects in material and workmanship for the life of the drive. The warranty is void in the case of misuse, accident, alteration, improper installation, misapplication or the result of unauthorized service or repair. The implied warranties of merchantability and fitness for a particular purpose, and all other warranties, expressed or implied, except as set forth in this warranty, shall not apply to the products delivered. In no event shall APRO be liable for any lost profits, lost savings or other incidental or consequential damages arising out of the use of, or inability to use, this product.

BEFORE RETURNING PRODUCT, A RETURN MATERIAL AUTHORIZATION (RMA) MUST BE OBTAINED FROM APRO.

Product shall be returned to APRO with shipping prepaid. If the product fails to conform based on customers' purchasing orders, APRO will reimburse customers for the transportation charges incurred.

WARRANTY PERIOD:

- **MLC (Standard grade / Wide temp. grade) 2 years / Within 3K Erasing Counts**