APRO Co., Ltd.

MLC

Micro SATA III Flash Module

MUSE-D Series

(SATA III Disk On Module)

Document No. : 100-xBMSF-VDCTM

Version No. : 01V0

Date : November, 2023

ISO 9001 : 2015 CERTIFIED

Product Features

- **Flash IC**
  - KIOXIA 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.

- **Additional Capabilities**
  - S.M.A.R.T.***1** (Self-Monitoring, Analysis and Reporting Technology) feature set support.
  - Native Command Queuing (NCQ) support.
  - TRIM maintenance command support.
  - Static wear-leveling algorithm
  - Support bad Block Management

- **Mechanical**
  - Standard 7 pins SATA female connector
  - Optional built-in power pin as the 7th pin of 7pin header (w/fuse) or power input power cable (w/o fuse)
  - Dimension:

  Vertical Standard (VS)=18.0mm x 38.5mm /20.0g

  Vertical Low Profile (VL)=30.1 mm x 28.7mm /20.0g

  Horizontal Standard (HS)=18.0mm x 30.3mm /20.0g

  Horizontal Low Profile (HL)=40.0mm x 30.0mm /20.0g

- **Power Operating Voltage +5V(+/-) 5%**
  - Read Mode: 110.0 mA (max.)
  - Write Mode: 250.0 mA (max.)
  - Idle Mode: 100.0 mA (max.)

  (Option w/Fuse version that the host SATA Pin7 VCC @ 5V/1A power supply is requested)

- **Performance (Maximum value) *2**
  - Sequential Read: 530.0 MB/sec. (max.)
  - Sequential Write: 120.0 MB/sec. (max.)

- **Capacity**
  - 8GB, 16GB, 32GB, 64GB and 128GB.

- **Reliability**
  - **TBW:** Up to 249.6 TBW at 128GB Capacity. (Client workload by JESD-219A)
  - **ECC:** Designed with hardware LDPC ECC engine Low-density parity-check (LDPC) codes.
  - **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. Sequential performance is based on CrystalDiskMark 5.1.2 with file size 1000MB

Order Information

I. Part Number List

◆ **APRO MLC Micro SATA III Flash Module – Vertical Standard Form Factor**

Product Picture	Grade	Standard grade (0ºC ~ 70ºC)	Wide Temp Grade (-40ºC ~ +85ºC)
	8GB	SBMSF008G-VDCTM-VS(F)	WBMSF008G-VDCTM-VS(F)C
	16GB	SBMSF016G-VDCTM-VS(F)	WBMSF016G-VDCTM-VS(F)C
	32GB	SBMSF032G-VDCTM-VS(F)	WBMSF032G-VDCTM-VS(F)C
	64GB	SBMSF064G-VDCTM-VS(F)	WBMSF064G-VDCTM-VS(F)C
	128GB	SBMSF128G-VDCTM-VS(F)	WBMSF128G-VDCTM-VS(F)C

◆ **APRO MLC Micro SATA III Flash Module – Vertical Low Profile Form Factor**

Product Picture	Grade	Standard grade (0ºC ~ 70ºC)	Wide Temp Grade (-40ºC ~ +85ºC)
	8GB	SBMSF008G-VDCTM-VL(F)	WBMSF008G-VDCTM-VL(F)C
	16GB	SBMSF016G-VDCTM-VL(F)	WBMSF016G-VDCTM-VL(F)C
	32GB	SBMSF032G-VDCTM-VL(F)	WBMSF032G-VDCTM-VL(F)C
	64GB	SBMSF064G-VDCTM-VL(F)	WBMSF064G-VDCTM-VL(F)C
	128GB	SBMSF128G-VDCTM-VL(F)	WBMSF128G-VDCTM-VL(F)C

◆ **APRO MLC Micro SATA III Flash Module – Horizontal Standard Form Factor**

Product Picture	Grade	Standard grade (0ºC ~ 70ºC)	Wide Temp Grade (-40ºC ~ +85ºC)
	8GB	SBMSF008G-VDCTM-HS(F)	WBMSF008G-VDCTM-HS(F)C
	16GB	SBMSF016G-VDCTM-HS(F)	WBMSF016G-VDCTM-HS(F)C
	32GB	SBMSF032G-VDCTM-HS(F)	WBMSF032G-VDCTM-HS(F)C
	64GB	SBMSF064G-VDCTM-HS(F)	WBMSF064G-VDCTM-HS(F)C
	128GB	SBMSF128G-VDCTM-HS(F)	WBMSF128G-VDCTM-HS(F)C

◆ **APRO MLC Micro SATA III Flash Module – Horizontal Low Profile Form Factor**

Product Picture	Grade	Standard grade (0ºC ~ 70ºC)	Wide Temp Grade (-40ºC ~ +85ºC)
	8GB	SBMSF008G-VDCTM-HL(F)	WBMSF008G-VDCTM-HL(F)C
	16GB	SBMSF016G-VDCTM-HL(F)	WBMSF016G-VDCTM-HL(F)C
	32GB	SBMSF032G-VDCTM-HL(F)	WBMSF032G-VDCTM-HL(F)C
	64GB	SBMSF064G-VDCTM-HL(F)	WBMSF064G-VDCTM-HL(F)C
	128GB	SBMSF128G-VDCTM-HL(F)	WBMSF128G-VDCTM-HL(F)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—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

X3 X4 X5 : **Product category**

MSF : Micro SATA Flash Module

X6 X7 X8 X9 : **Capacity**

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

X11 : **Controller**

V : MUSE Series

X12 : **Controller version**

A, B, C…..

X13 : **Controller Grade**

C : Commercial grade

X14 : **Flash IC**

T : Kioxia MLC-NAND Flash IC

X15 : **Flash IC grade / Type**

M : Kioxia 15nm MLC-NAND Flash IC

X17 X18 : **MSF Orient Only**

VS : Vertical Standard Form Factor

VL : Vertical Low Profile Form Factor

HS : Horizontal Standard Form Factor

HL : Horizontal Low Profile Form Factor

X19 X20 : **Reserved for specific requirement**

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

F : Power Pin-7 with fuse (optional)

C : Conformal coating (optional)

Revision History

Revision	Description	Date
1.0	Initial release	2023/11/10

Contents

1. Introduction

APRO MLC Micro SATA III Flash Module MUSE-D Series provides high-capacity flash memory Solid State Drive (SSD) that electrically complies with Serial ATA 3.1 (SATA) standard. APRO MLC Micro SATA III Flash Module MUSE-D Series support SATA 1.5Gbps/3.0Gbps/6.0Gbps data transfer rate with high performance. The main used flash memories are MLC-NAND type flash memory chips. The available disk capacities are 8GB, 16GB, 32GB, 64GB and 128GB

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. The data transfer performance by sequential read is up to 530.0 MB/sec, and sequential write is up to 120.0 MB/sec.

APRO MLC Micro SATA III Flash Module provides a high level interface to the host computer. This interface allows a host computer to issue commands to the MLC Micro SATA III Flash Module to read or write blocks of memory. Each sector is protected by a powerful Low-density parity-check (LDPC) code. (ECC). APRO MLC Micro SATA III Flash Module MUSE-D Series intelligent controller manages interface protocols, data storage and retrieval as well as ECC, defect handling and diagnostics, power management and clock control.

With the great flexibility to meet different SATA interface locations in systems, APRO MLC Micro SATA III Flash Module comes with optional form-factor in vertical type and horizontal type. And the power operating voltage supports 5V. Particularly it is built-in power pin as the 7th pin of 7pin header (w/fuse) or power input power cable (w/o fuse).
Figure 1 shows a block diagram of the used high tech MLC Micro SATA III Flash Module controller.

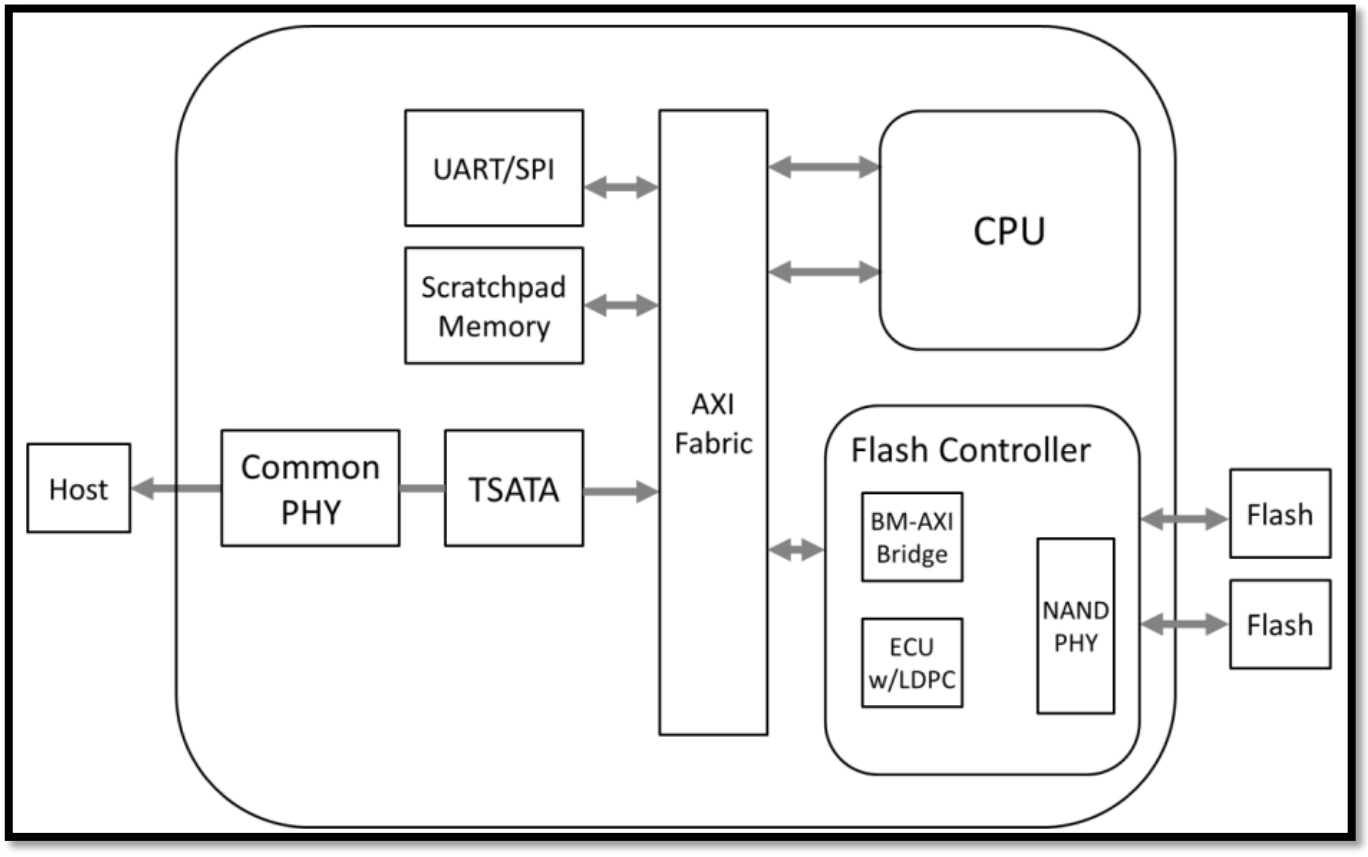


Figure 1: APRO MLC Micro SATA III Flash Module MUSE-D Series block diagram

1.1. *Scope*

This document describes features, specifications and installation guide of APRO MLC Micro SATA III Flash 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*

Flash memory can be programed and erased within a limited number of times, and the limited of the P/E cycle is defined by the flash array vendor. The P/E cycle limited applies to each individual erase block in the flash device.

In order to gain the best management for flash memory, APRO MLC Micro SATA III Flash 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 Latter 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 Micro SATA III Flash 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 Micro SATA III Flash Module MUSE-D Series		Standard Grade SBMSFxxxG-VDCTM	Wide Temp Grade WBMSFxxxG-VDCTM/C
Temperature	**Operating:**	0ºC ~ +70ºC	-40ºC ~ +85ºC
	Non-operating:	-20ºC ~ +80ºC	-50ºC ~ +95ºC
Humidity	**Operating & Non-operating:**	10% ~ 95% non-condensing	
Vibration	**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.	

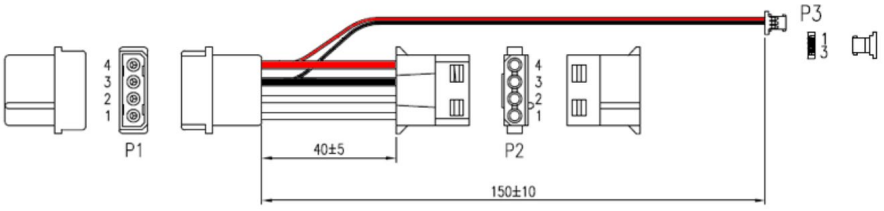
2.2. System Power Requirements

Table 2: Power Requirement

APRO MLC Micro SATA III Flash Module MUSE-D Series		
DC Input Voltage (VCC)		5V±5%
Maximum average value	**Reading Mode :**	110.0 (max.)
	Writing Mode :	250.0 (max.)
	Idle Mode :	100.0 (max.)

Table 3: Power Connector

Pin No.	Connector
Pin 1	Vcc 5V
Pin 2	GND



2.3. *System Performance*

Table 4: System Performances

Data Transfer Mode supporting		Serial ATA Gen-III (6.0Gb/s = 768MB/s)				
Average Access Time		0.4 ms (estimated)				
Maximum Performance	**Capacity**	**8GB**	**16GB**	**32GB**	**64GB**	**128GB**
	Sequential Read (MB/s)	140.0	220.0	340.0	530.0	530.0
	Sequential Write(MB/s)	25.0	25.0	45.0	100.0	120.0
	4KB Random Read (IOPS)	8.8K	10.6K	14.8K	27.0K	30.0K
	4KB Random Write (IOPS)	7.0K	7.0K	12.0K	22.6K	26.8K

Note:

1. *Sequential performance is based on CrystalDiskMark 5.1.2 with file size 1000MB.*
2. *Random performance is based on IO meter with Queue Depth 32.*

2.4. *System Reliability*

Table 5: System Reliability

Wear-leveling Algorithms	Static wear-leveling algorithms	
Bad Blocks Management	Supportive	
ECC Technology	40 bits per 1024 bytes	
Thermal Sensor	Supportive	
Erase counts	NAND MLC Flash Cell Level : 3K P/E Cycles	
TBW	TBW * (Total Bytes Written) Unit: TB	
Capacity	**Sequential workload**	**Client workload**
8GB	23.4	15.6
16GB	46.8	31.2
32GB	93.6	62.4
64GB	187.2	124.8
128GB	374.4	249.6

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.*

2.1. *Physical Specifications*

Refer to Table 6 and see Figure 2 for APRO MLC Micro SATA III Flash Module MUSE-D Series physical specifications and dimensions.

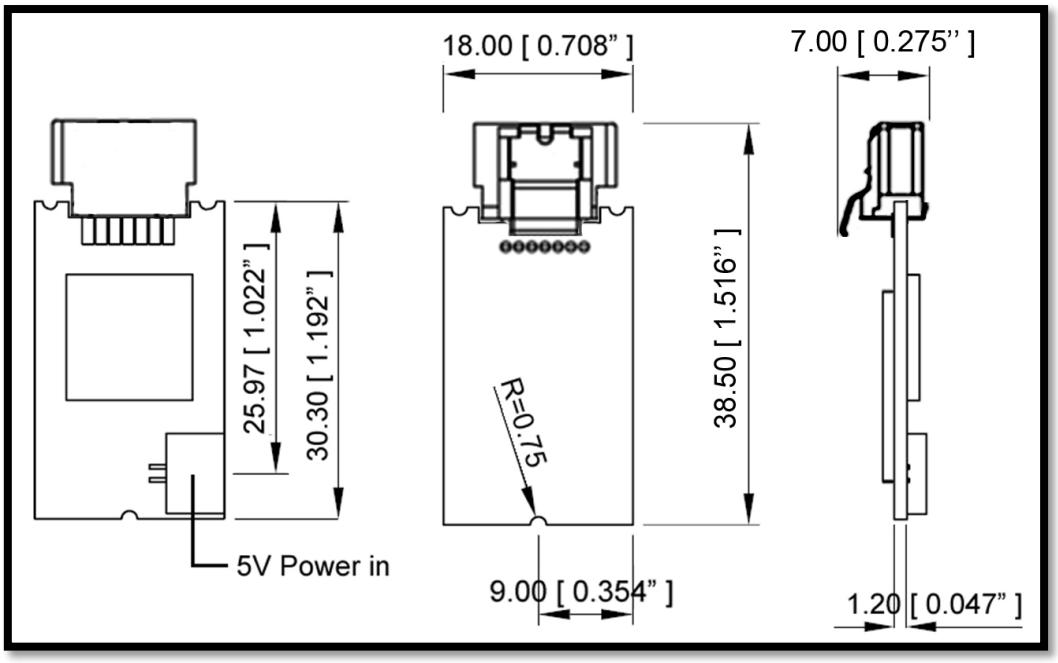
Table 6: Form Factors

Vertical Type Standard Form Factor (VS)	Vertical Type Low Profile Form Factor (VL)
	
Horizontal Type Standard Form Factor (HS)	**Horizontal Type Low Profile Form Factor (HL)**
	

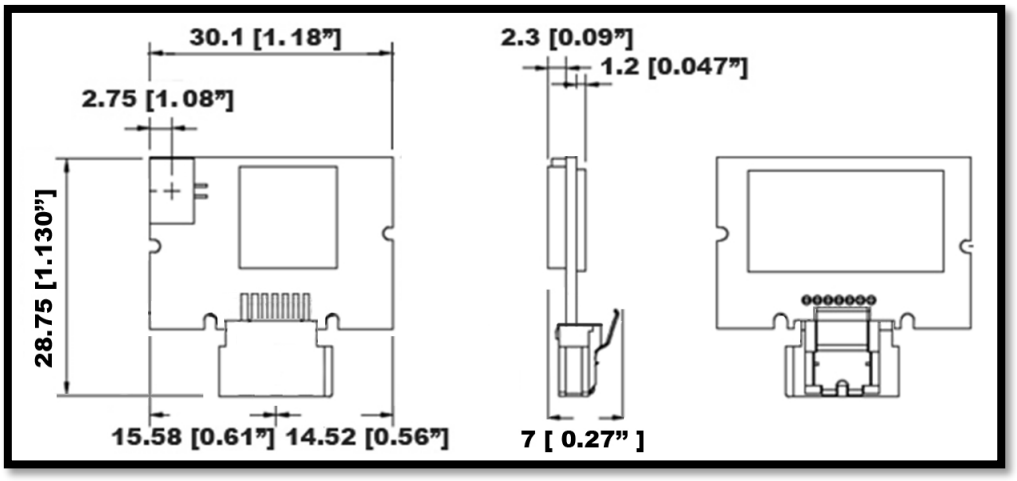
Table 7: Physical Specifications of APRO MLC Micro SATA III Flash Module-MUSE-D Series

Form-factor	Width	Length	Weight
Vertical Type – Standard (VS)	18.00 mm	38.50 mm	20.00g
Vertical Type – Low Profile (VL)	30.10 mm	28.75 mm	20.00g
Horizontal Type – Standard (HS)	18.00 mm	30.30 mm	20.00g
Horizontal Type –Low Profile (HL)	40.00 mm	30.00 mm	20.00g

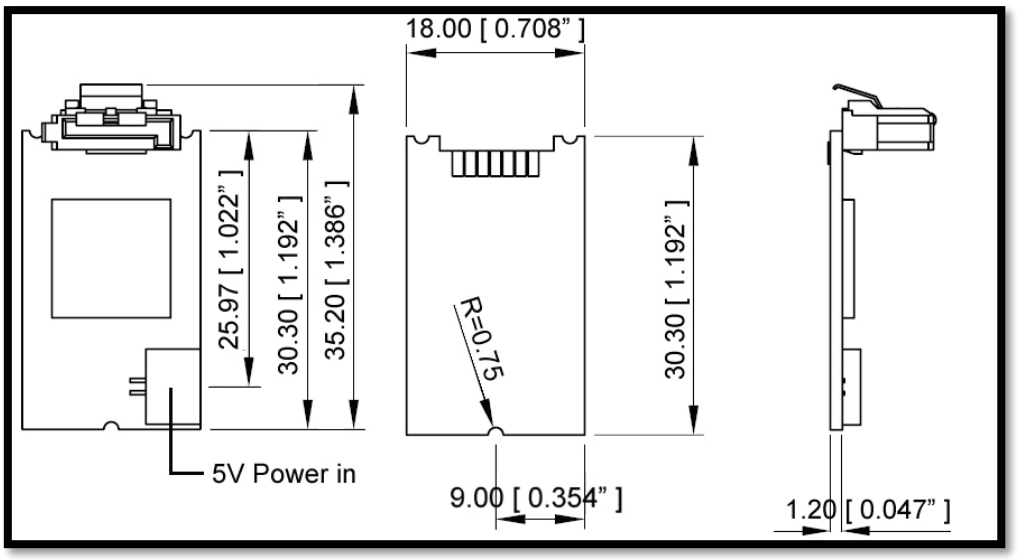
Vertical Type - Standard Form-factor (VS)



Vertical Type - Low Profile Form-factor (VL)



Horizontal Type - Standard Form-factor (HS)



Horizontal Type - Low Profile Form-factor (HL)

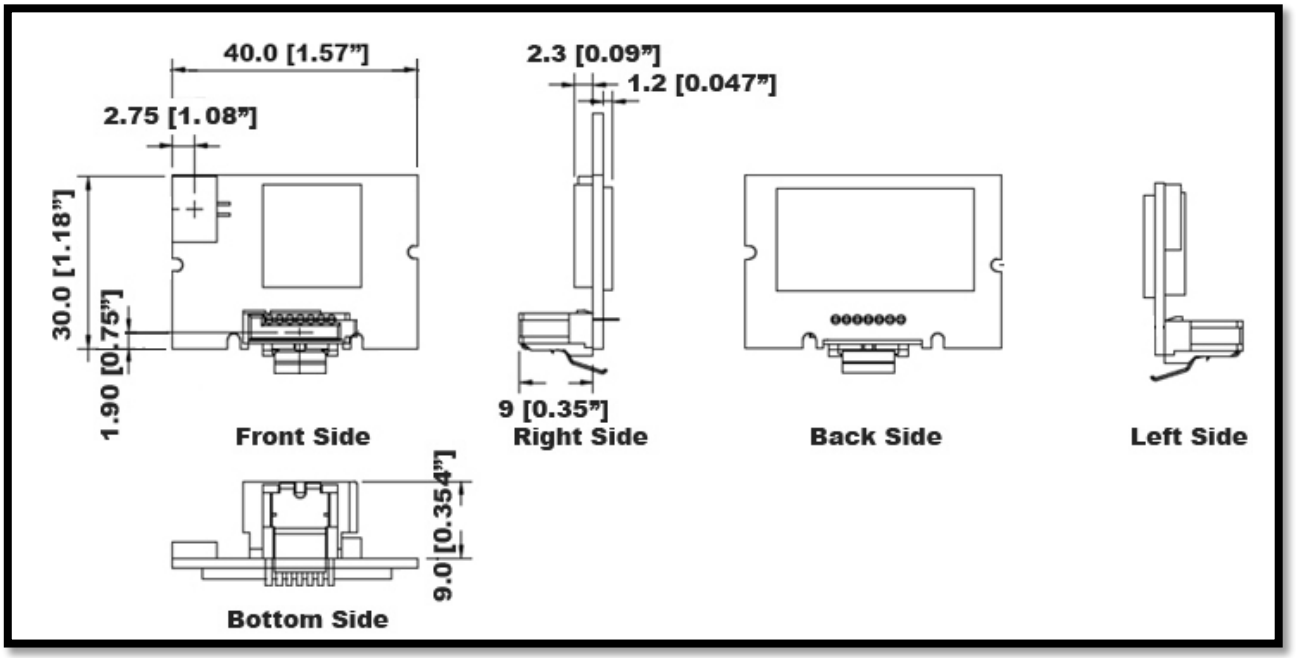


Figure 2: APRO MLC Micro SATA III Flash Module MUSE-D Series Dimension

2.2. *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. Micro SATA III Flash Modules interface

APRO MLC Micro SATA III Flash Modules MUSE-D Series follow standard SATA 1.0a with 7-pin signal segment. The interface is 7-pin female connector. There are 2 solutions for customer's requirement. If customer's motherboard design in SATA interface pin-7 with 5V power output, there is a solution which has built-in power pin as the 7th pin of 7 pins header (w/fuse) , or another solution w/o fuse and for connection via cable.

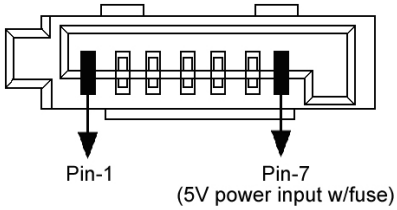


Figure 3: The connectors of micro SATA III Flash Module MUSE-D Series

3.2. Pin Assignments

Refer to Table 8 for APRO MLC Micro SATA III Flash Module MUSE-D Series pin assignments. There are total of 7 pins in the signal segment.

Table 8 - Pin Assignments

Name	Type	Description
S1	GND	Shielding
S2	A+	Differential Signal Pair A
S3	A-	
S4	GND	Shielding
S5	B-	Differential Signal Pair B
S6	B+	
S7	GND/ Vcc*	Shielding/+5V Power*

Note:

Default power supply through an extra power cable. Pin 7 power supply as an optional function

Appendix A: Limited Warranty

APRO warrants your Micro SATA III Flash Modules 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**