

MLC

mSATA Mini SATA III Module

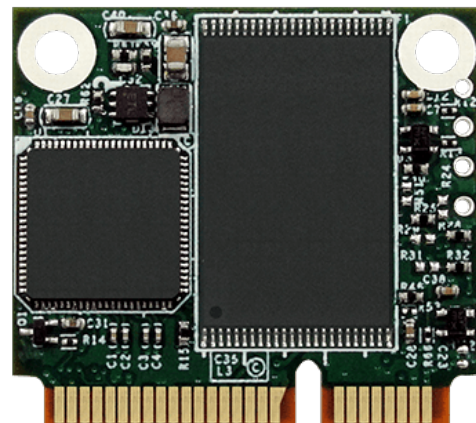
MUSE-D Series

(JEDEC MO-300B)

Document No. : 100-xBMSH-VDCTM

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ISO 9001 : 2015 CERTIFIED



Product Features

■ Flash IC

- TOSHIBA 15nm NAND Flash IC.
- Multi-Level Cell (MLC) management

■ Compatibility

- SATA Revision 3.1
- SATA 1.5Gb/s; SATA 3Gb/s & SATA 6Gb/s 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 Module's temperature.
- Native Command Queuing (NCQ) support.
- TRIM maintenance command support.
- Static wear-leveling algorithm
- Hardware Low Density Parity Check Code, LDPC support.

■ Mechanical

- JEDEC MO-300B full size Solid State Drive
- 52 pos. Edge Connector, PCI Express (PCIe) mini
- Dimension: 26.8 mm x 29.8 mm.
- Weight: 3.5 g / 0.12 oz.

■ Power Operating Voltage 3.3V(+/-) 5%

- Read Mode: 130.0 mA (max.)
- Write Mode: 200.0 mA (max.)
- Idle Mode: 80.0 mA (max.)

■ Performance (Maximum value)^{2,3}

- Sequential Read: 533.0 MB/sec. (max.)
- Sequential Write: 125.0 MB/sec. (max.)
- 4KB Random Read (QD32): 30.0K IOPS.
- 4KB Random Write (QD32): 26.0K IOPS.

■ Capacity

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

■ Reliability

- **TBW:** Up to 210.5 TBW at 128GB Capacity.
(Client workload by JESD-219A)
- **ECC:** Designed with hardware LDPC ECC engine with hard-decision and soft-decision decoding.
- **Temperature:** (Operating)
Standard Grade: 0°C ~ +70°C
Wide Temp. Grade: -40°C ~ +85°C
- **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
3. Typical I/O performance numbers as measured fresh-out-of-the-box (FOB) using IOmeter with a queue depth of 32

Order Information

1. Part Number List

◆ APRO MLC mSATA Mini (half size) SATA III Module MUSE-D Series

| Product Picture | Grade | Standard grade (0°C ~ 70°C) | Wide Temp Grade (-40°C ~ +85°C) |
|---|-------|-----------------------------|-----------------------------------|
|  | 8GB | SBMSH008G-VDCTM-(T) | WBMSH008G-VDCTM-(T)C |
| | 16GB | SBMSH016G-VDCTM-(T) | WBMSH016G-VDCTM-(T)C |
| | 32GB | SBMSH032G-VDCTM-(T) | WBMSH032G-VDCTM-(T)C |
| | 64GB | SBMSH064G-VDCTM-(T) | WBMSH064G-VDCTM-(T)C |
| | 128GB | SBMSH128G-VDCTM-(T) | WBMSH128G-VDCTM-(T)C |

Notes:

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

2. Part Number Decoder:

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

X1 : Grade

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

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

X2 : The material of case

B : Bare PCBA w/o Casing

X3 X4 X5 : Product category

MSH : mSATA Mini SATA III Flash Module

X6 X7 X8 X9 : Capacity

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

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

X17 X18 : 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. | 2017/11/21 |
| 1.1 | Add the option for thermal sensor | 2018/11/02 |
| 1.2 | Updated Version | 2018/11/28 |
| 2.0 | Updated document form | 2019/06/05 |

Contents

| | |
|---|--------|
| Product Features | - 2 - |
| Order Information | - 3 - |
| 1. Part Number List | - 3 - |
| 2. Part Number Decoder: | - 3 - |
| Revision History | - 4 - |
| Contents | - 5 - |
| 1. Introduction | - 6 - |
| 1.1. Scope | - 7 - |
| 1.2. Flash Management Technology - Static Wear Leveling | - 7 - |
| 1.3. Bad Block Management | - 7 - |
| 2. Product Specifications | - 8 - |
| 2.1. System Environmental Specifications | - 8 - |
| 2.2. System Power Requirements | - 8 - |
| 2.3. System Performance | - 8 - |
| 2.4. System Reliability | - 9 - |
| 2.5. Physical Specifications | - 9 - |
| 2.6. Conformal coating | - 10 - |
| 3. Interface Description | - 11 - |
| 3.1. mSATA Mini SATA III Flash Module interface | - 11 - |
| 3.2. Pin Assignments | - 12 - |
| Appendix A: Limited Warranty | - 13 - |

1. Introduction

APRO MLC mSATA Mini (half size) SATA III Module MUSE-D Series provides high capacity flash memory Solid State Drive (Module) that electrically complies with SATA Revision 3.1 standard. APRO MLC mSATA Mini (half size) SATA III Module MUSE-D Series support SATA 1.5Gb/s; SATA 3Gb/s & SATA 6Gb/s data transfer rate with high performance. It is designed with mSATA form factor by JEDEC MO-300B standard.

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.

APRO MLC mSATA Mini (half size) 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 535.0 MB/sec, and sequential write is up to 210.0 MB/sec.

APRO MLC mSATA Mini (half size) SATA III Module MUSE-D Series provide a high level interface to the host computer. This interface allows a host computer to issue commands to the APRO MLC mSATA Mini (half size) 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 mSATA Mini (half size) 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.

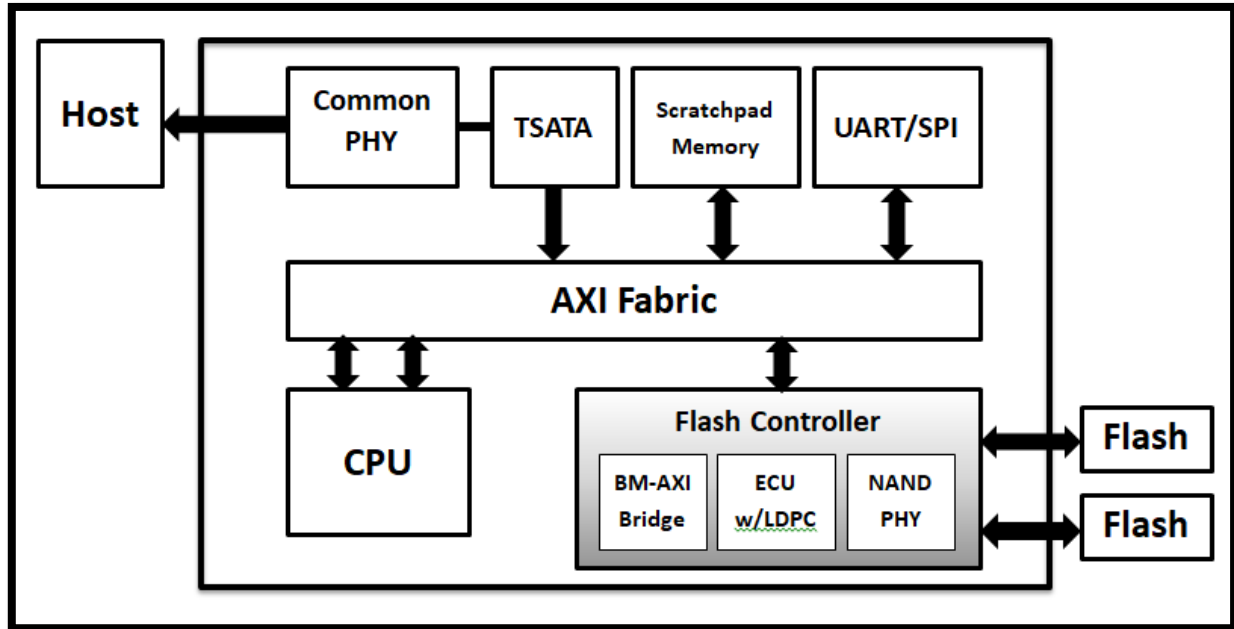


Figure 1: APRO MLC mSATA Mini (half size) SATA III Module MUSE-D Series block diagram

1.1. *Scope*

This document describes features, specifications and installation guide of APRO MLC mSATA Mini (half size) 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 mSATA Mini (half size) 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 mSATA Mini (half size) 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 mSATA Mini (half size) SATA III Module | | Standard Grade | Wide Temp Grade |
|---|----------------------------|---|------------------|
| MUSE-D Series | | SBMSHxxxG-VDCTM | WBMSHxxxG-VDCTMC |
| Temperature | Operating: | 0°C ~ +70°C | -40°C ~ +85°C |
| | Non-operating: | -20°C ~ +80°C | -50°C ~ +95°C |
| Humidity | Operating & Non-operating: | 10% ~ 95% non-condensing | |
| | Frequency/Acceleration: | 70 Hz to 2K Hz, 20G, 3 axes (IEC 68-2-6) | |
| Shock | Operating & Non-operating: | 0.5ms, 1500 G, 3 axes (IEC 68-2-27) | |
| Electrostatic Discharge (ESD) | Temperature: | 24°C | |
| | 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 mSATA Mini (half size) SATA III Module MUSE-D Series | | |
|---|----------------|-----------------|
| DC Input Voltage (VCC) | | 3.3V±5% |
| Maximum average value | Reading Mode : | 130.0 mA (max.) |
| | Writing Mode : | 200.0 mA (max.) |
| | Idle Mode : | 80.0 mA (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 |
| | Sequential Read (MB/s) | 140.5 | 280.0 | 450.0 | 533.0 | 533.0 |
| | Sequential Write (MB/s) | 30.5 | 60.0 | 52.0 | 102.0 | 125.0 |
| | 4KB Random Read IOPS (QD32) | 8.5K | 15.7K | 19.0K | 26.5K | 30.5K |
| | 4KB Random Write IOPS (QD32) | 6.5K | 13.0K | 12.8K | 20.9K | 26.1K |

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 |

Note:

- Client workload by JESD-219A
- The endurance of Module 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 mSATA Mini (half size) SATA III Module MUSE-D Series physical specifications and dimensions.

Table 5: Physical Specifications of APRO MLC mSATA Mini (half size) SATA III Module MUSE-D Series

| | |
|----------------|------------------|
| Length: | 26.8 mm |
| Width: | 29.8 mm |
| Weight: | 3.5 g / 0.12 oz. |

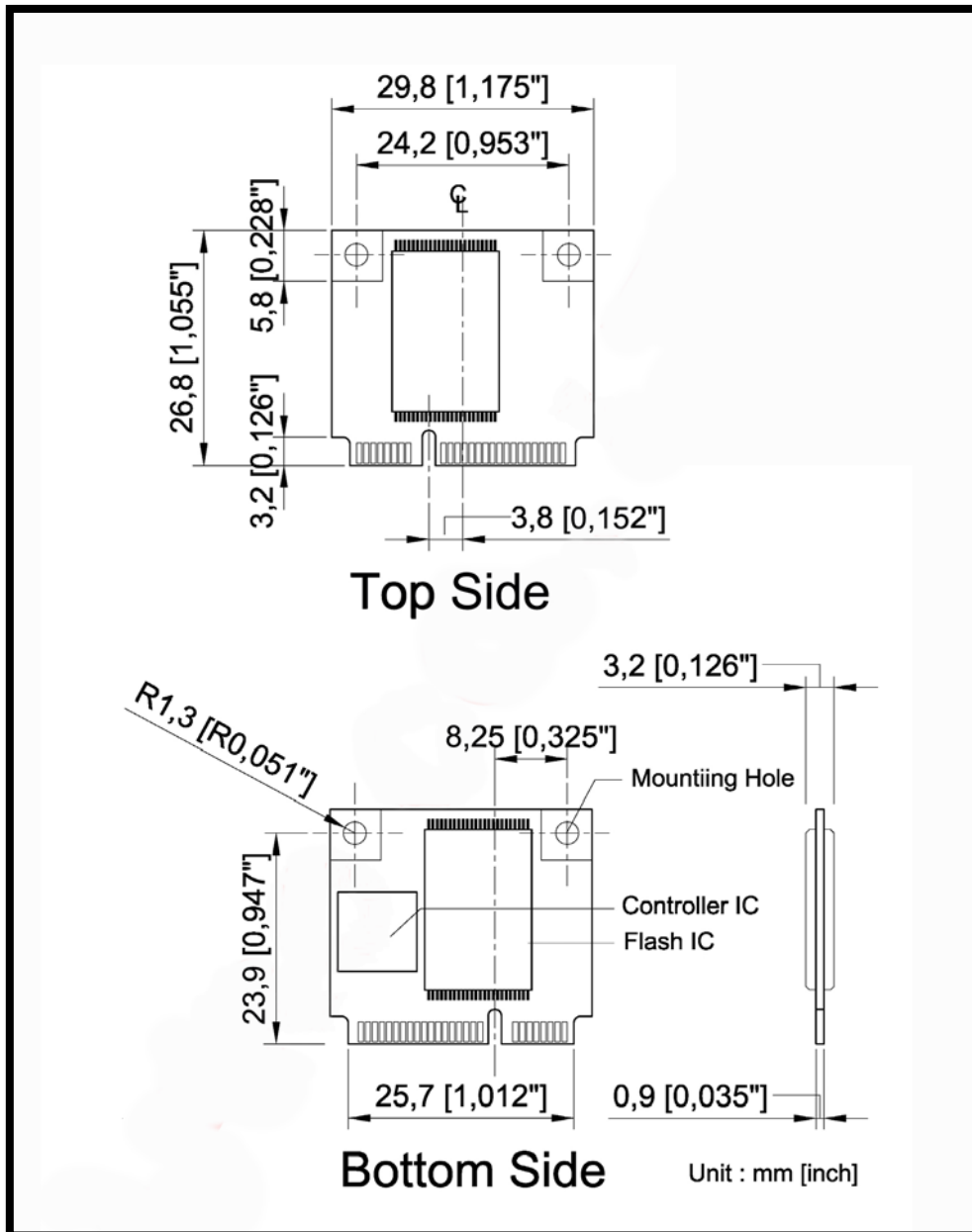


Figure 2: APRO MLC mSATA Mini (half size) SATA III Module MUSE-D Series Dimension

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. mSATA Mini SATA III Flash Module interface

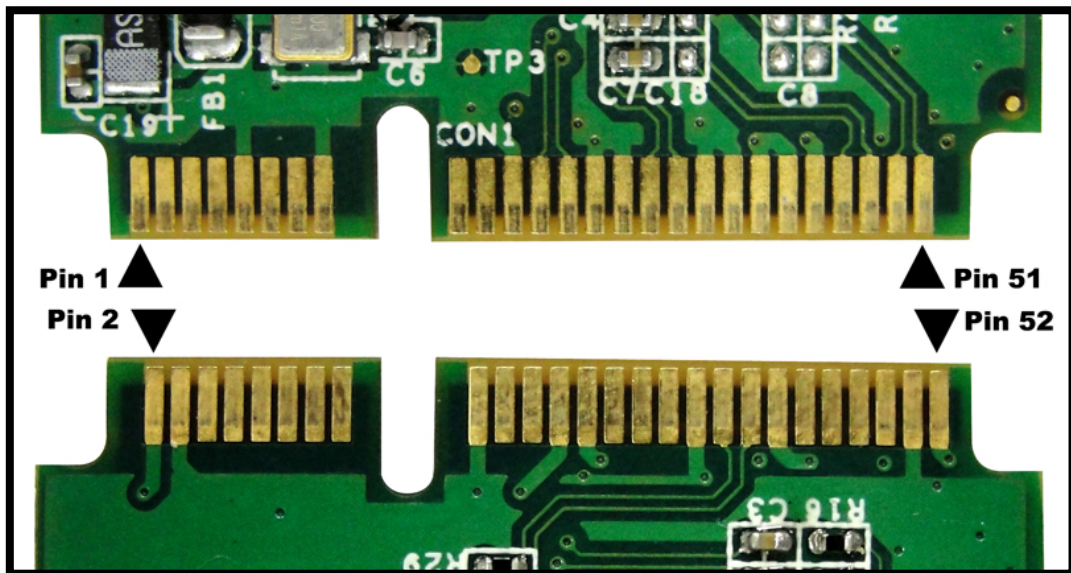
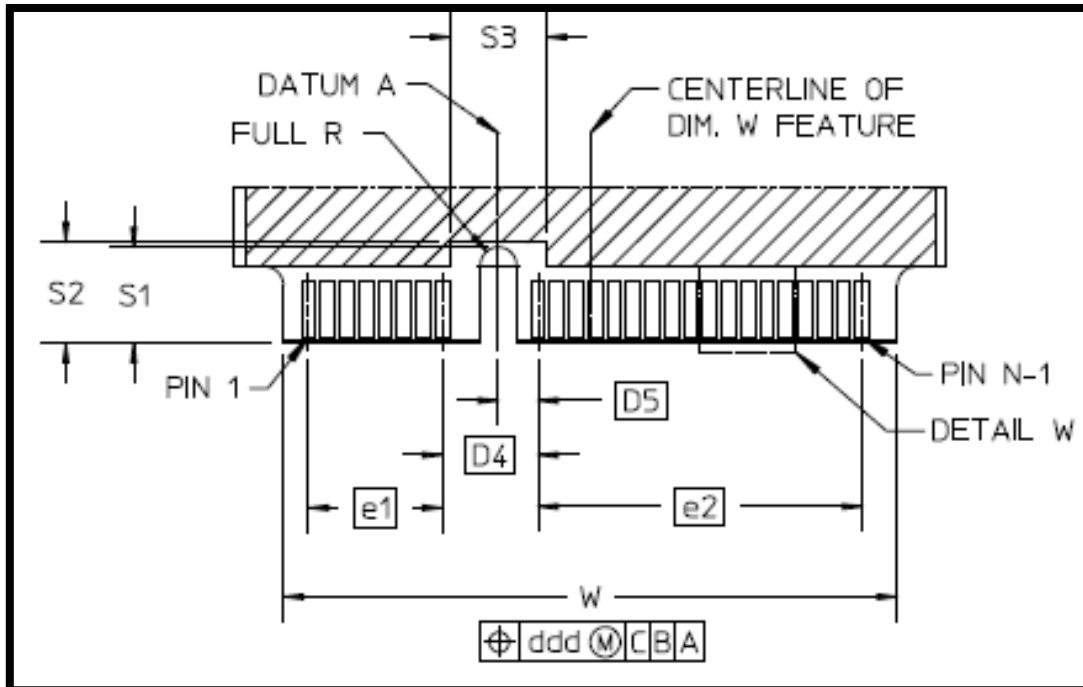


Figure 3: The connectors of Signal Segment and Power Segment

3.2. Pin Assignments

APRO MLC mSATA Mini (half size) SATA III Module MUSE-D Series operates with standard SATA pin-out.

The pin assignments are listed in below table 6.

| Signal Name | Pin # | Pin # | Signal Name |
|-------------|-------|-------|-------------|
| NC | 1 | 2 | +3.3V |
| NC | 3 | 4 | GND |
| NC | 5 | 6 | NC |
| NC | 7 | 8 | NC |
| GND | 9 | 10 | NC |
| NC | 11 | 12 | NC |
| NC | 13 | 14 | NC |
| GND | 15 | 16 | NC |
| | | | |
| NC | 17 | 18 | GND |
| NC | 19 | 20 | NC |
| GND | 21 | 22 | NC |
| TX+ | 23 | 24 | +3.3V |
| TX- | 25 | 26 | GND |
| GND | 27 | 28 | NC |
| GND | 29 | 30 | NC |
| RX- | 31 | 32 | NC |
| RX+ | 33 | 34 | GND |
| GND | 35 | 36 | NC |
| GND | 37 | 38 | NC |
| +3.3V | 39 | 40 | GND |
| +3.3V | 41 | 42 | NC |
| NC | 43 | 44 | DEVSLP |
| NC | 45 | 46 | NC |
| NC | 47 | 48 | NC |
| DAS | 49 | 50 | GND |
| GND | 51 | 52 | +3.3V |

Table 6 - Pin Assignments

Appendix A: Limited Warranty

APRO warrants your MLC mSATA Mini (half size) 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**

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