

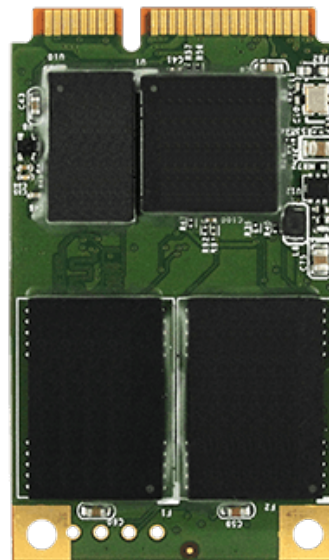
# SLC

## Industrial SLC Mini SATA III Module

### HERMES-HR Series

Supports DRAM Cache

(JEDEC MO-300A)



Document No. : 100-xBMSR-JHTL

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ISO 9001 : 2015 CERTIFIED



### Product Features

#### ■ Flash IC

- TOSHIBA NAND Flash IC.
- Single-Level Cell (SLC) 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.\*<sup>1</sup> (Self-Monitoring, Analysis and Reporting Technology) feature set support.
- Native Command Queuing (NCQ) support.
- TRIM maintenance command support.
- Support Static wear-leveling algorithm
- Designed with a DRAM buffer which is support high transfer rate
- Support Bad Block Management

#### ■ Mechanical

- JEDEC MO-300A full size Solid State Drive
- 52 pos. Edge Connector, PCI Express (PCIe) mini
- Dimension: 50.8 mm x 29.8 mm.
- Weight: 8.0 g / 0.30 oz.

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

- Read Mode: 320.0 mA. (max.)
- Write Mode: 390.0 mA. (max.)
- Idle Mode: 95.0 mA. (max.)

#### ■ Performance (Maximum value) \*<sup>2</sup>

- Sequential Read: 460.0 MB/sec. (max.)
- Sequential Write: 230.0 MB/sec. (max.)

#### ■ Capacity

- 4GB, 8GB, 16GB, 32GB and 64GB.

#### ■ Reliability

- **TBW:** Up to 3,456 TBW at 64GB Capacity.  
(Test by sequential write)
- **MTBF:** > 3,000,000 hours
- **ECC:** Powerful ECC capable of correcting errors up to 40-bit per 1024 bytes.
- **Temperature:** (Operating)  
Standard Grade: 0°C ~ +70°C  
Industrial. 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

### Order Information

#### I. Part Number List

##### ◆ APRO SLC Industrial Mini SATA III Module (mSATA) HERMES-HR Series

| Product Picture   | Grade | Standard grade (0°C ~ 70°C) | Industrial Grade ( -40°C ~ +85°C ) |
|---|-------|-----------------------------|------------------------------------|
|  | 4GB   | SBMSR004G-JHCTC             | WBMSR004G-JHITI                    |
|   | 8GB   | SBMSR008G-JHCTC             | WBMSR008G-JHITI                    |
|   | 16GB  | SBMSR016G-JHCTC             | WBMSR016G-JHITI                    |
|   | 32GB  | SBMSR032G-JHCTC             | WBMSR032G-JHITI                    |
|   | 64GB  | SBMSR064G-JHCTC             | WBMSR064G-JHITI                    |
|   |       |                             |                                    |

#### II. Part Number Decoder:

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

##### **X1** : Grade

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

**W**: Industrial Grade – operating temp. -40° C ~ +85 ° C

##### **X2** : The material of case

**R** : 2.5" rugged metal Casing

##### **X3 X4 X5** : Product category

**MSR** : mini SATA Flash Module (mSATA) SDRAM Cache

##### **X6 X7 X8 X9** : Capacity

**004G**: 4GB      **032G**: 32GB

**008G**: 8GB      **064G**: 64GB

**016G**: 16GB

##### **X11** : Controller

**J** : HERMES Series

##### **X12** : Controller version

**A, B, C.....**

##### **X13** : Controller Grade

**C** : Commercial grade

**I** : Industrial grade

##### **X14** : Flash IC

**T** : Toshiba SLC-NAND Flash IC

##### **X15** : Flash IC grade / Type

**C** : Commercial grade

**I** : Industrial grade

##### **X17** : Reserved for specific requirement

**C** : Conformal-coating (optional)

### *Revision History*

| Revision | Description              | Date       |
|----------|--------------------------|------------|
| 1.0      | Initial release          | 2014/6/13  |
| 1.1      | Voltage value correction | 2018/03/13 |
| 1.2      | Updated Version          | 2018/11/28 |
| 2.0      | Updated Document Format  | 2019/06/12 |

## Contents

|  |        |
|--|--------|
| Product Features .....   | - 2 -  |
| Order Information .....  | - 3 -  |
| <b>I. Part Number List</b> .....                                     | - 3 -  |
| <b>II. Part Number Decoder:</b> .....                                | - 3 -  |
| Revision History .....   | - 4 -  |
| Contents .....   | - 5 -  |
| <b>1. Introduction</b> .....   | - 6 -  |
| <b>1.1. Scope</b> .....  | - 7 -  |
| <b>1.2. Flash Management Technology – Static Wear Leveling</b> ..... | - 7 -  |
| <b>1.3. Bad Block Management</b> .....                               | - 7 -  |
| <b>1.4. DRAM Buffer</b> .....  | - 7 -  |
| <b>1.5. Mean Time Between Failure (MTBF)</b> .....                   | - 8 -  |
| <b>1.5.1. Definition</b> .....                                       | - 8 -  |
| <b>1.5.2. Obtaining MTBF</b> .....                                   | - 8 -  |
| <b>1.5.3. Definitions</b> .....                                      | - 9 -  |
| <b>2. Product Specifications</b> .....                               | - 11 - |
| <b>2.1. System Environmental Specifications</b> .....                | - 11 - |
| <b>2.2. System Power Requirements</b> .....                          | - 11 - |
| <b>2.3. System Performance</b> .....                                 | - 11 - |
| <b>2.4. System Reliability</b> .....                                 | - 12 - |
| <b>2.5. Physical Specifications</b> .....                            | - 12 - |
| <b>2.6. Conformal coating</b> .....                                  | - 13 - |
| <b>3. Interface Description</b> .....                                | - 13 - |
| <b>3.1. Mini SATA III Module (mSATA) interface</b> .....             | - 13 - |
| <b>3.2. Pin Assignments</b> .....                                    | - 14 - |
| <b>Appendix A: Limited Warranty</b> .....                            | - 15 - |

### 1. Introduction

APRO SLC Industrial Mini SATA III Module (mSATA) HERMES-HR Series provides high capacity flash memory Solid State Drive (SSD) that electrically complies with Serial ATA 3.0 (SATA) standard and ATA-8 command set compatible. APRO SLC Industrial Mini SATA III Module (mSATA) HERMES-HR Series support SATA 1.5Gbps/3.0Gbps/6.0Gbps data transfer rate with high performance and designed with a DRAM which is support data buffer for the SSD; the main used flash memories are SLC-NAND type flash memory chips. The available disk capacities are 4GB, 8GB, 16GB, 32GB and 64GB.

The operating temperature grade is optional for standard grade 0°C ~ 70°C and industrial grade supports -40°C ~ +85°C. The data transfer performance by sequential read is up to 460.0 MB/sec, and sequential write is up to 230.0 MB/sec.

APRO SLC Industrial Mini SATA III Module (mSATA) HERMES-HR Series built-in DRAM provide a high level interface to the host computer. This interface allows a host computer to issue commands to the APRO SLC Industrial Mini SATA III Module (mSATA) HERMES-HR Series to read or write blocks of memory. Each sector is protected by a powerful 40 bits per 1024 bytes error correction (ECC). APRO SLC Industrial Mini SATA III Module (mSATA) HERMES-HR Series intelligent controller manages interface protocols, data storage and retrieval as well as ECC, defect handling and diagnostics, power management and clock control.

Figure 1 shows a block diagram of the APRO SLC Industrial Mini SATA III Module (mSATA) HERMES-HR Series.

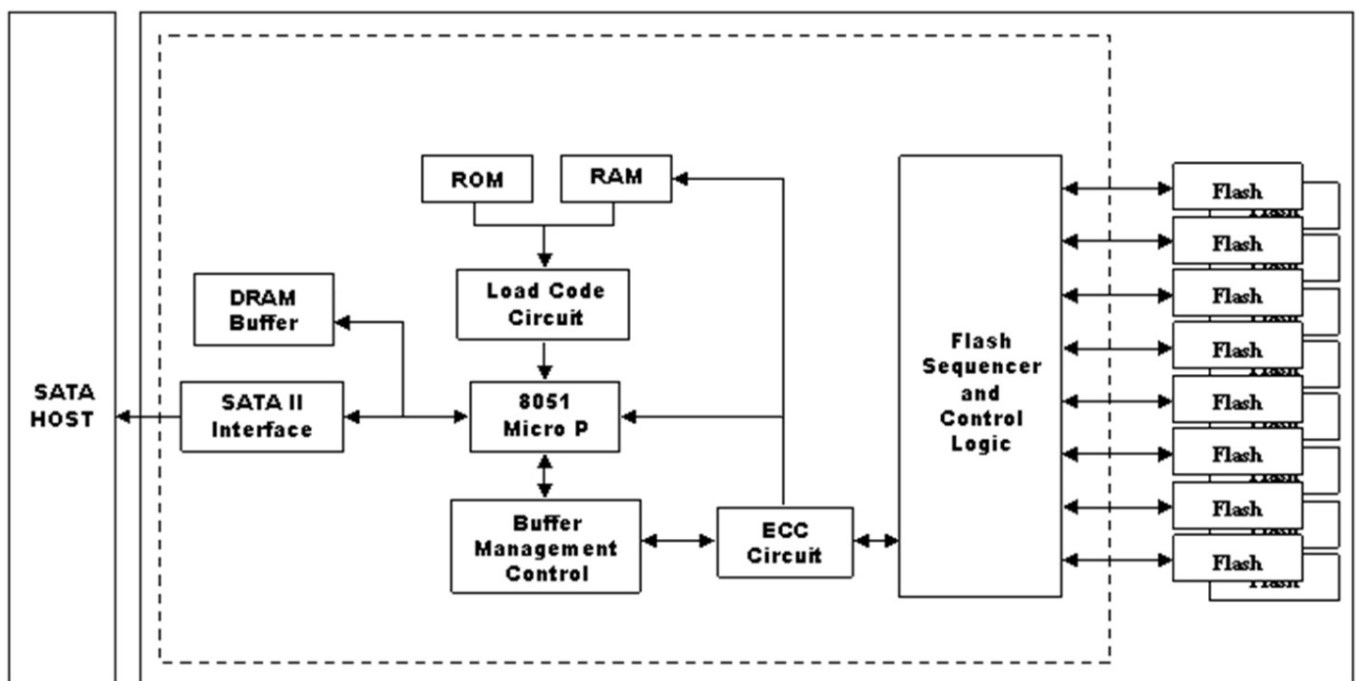


Figure 1: APRO SLC Industrial Mini SATA III Module (mSATA) HERMES-HR Series block diagram

### 1.1. *Scope*

This document describes features, specifications and installation guide of APRO SLC Industrial Mini SATA III Module (mSATA) HERMES-HR 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 SLC Industrial Mini SATA III Module (mSATA) HERMES-HR 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 SLC Industrial Mini SATA III Module (mSATA) HERMES-HR 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.

### 1.4. *DRAM Buffer*

SSDs designed with a DRAM buffer which is support high transfer rate as a data buffer for the SSD; SSD with DRAM buffer is able to deliver excellent random data transfer speed.

- 4GB to 64GB Supports 2GBits DRAM Cache

### 1.5. Mean Time Between Failure (MTBF)

#### 1.5.1. Definition

MTBF (Mean time between failures) is defined as failure or maintenance required for the average time including failure detection and maintenance for the device. For a simple and maintainable unit,  $MTBF = MTTF + MTTR$ .

**MTTF (mean time to failure)** is defined as the expectation of random variables for time to failure.

**MTTR (mean time to restoration)** is the expectation of random variables of time required for restoration which includes the time required for confirmation that a failure occurred, as well as the time required for maintenance.

#### 1.5.2. Obtaining MTBF

There are two methods for obtaining MTBF:

**A. MTBF software estimation method:** by calculating all the MTBF data of all the components included in the bill of material, and the data of the completed products including actual parameters of voltage and electrical current using analysis software, the MTBF of the completed product is estimated.

**B. MTBF sample test method:** by determining a certain number of samples and a fixed time for testing, using a Arrhenius Model and Coffin-Manson Model to obtain parameters, and then using the formula with the parameters, the longevity and in so the reliability is proved.

Arrhenius Model:  $Af = e\{ (1/k \times Ea ( 1/273+Tmax - 1/273+Ttest) )\}$

Coffin-Manson Model:  $Af = ( \Delta Ttest/\Delta Tuse )m$

##### ➤ APRO uses the A method to Estimate MTBF

MTBF is actually obtained by calculation which is just an estimation of future occurrences. The main reason to use the first method is that the data contains the analysis by all the parameters of components and actual parameters of voltage and electrical current of finished products, which is considered adequate and objective.

##### ➤ Interpretation of MTBF Analysis

APRO estimates MTBF using a prediction methodology based on reliability data for the individual components in APRO products. The predicted MTBF based on Parts stress analysis Method of Telcordia Special Report SR-332, for components failure rates. Component data comes from several sources: device life tests, failure analysis of earlier equipment, device physics, and field returns.

The Telcordia model is based on the Telcordia document, Reliability Prediction Procedure for Electronic Equipment, Technical Reference SR-332. This standard basically modified the component models in MIL-HDBK-217 to better reflect the failure rates that AT&T Bell Lab equipment was experiencing in the field and was originally developed by AT&T Bell Lab as the Bellcore model.

This model supports different failure rate calculation methods in order to support the taking into account of stress, burn-in, laboratory, or field data. A Parts Count or Parts Stress analysis is included in Telcordia performance. Relex supports Telcordia Issues 1 and 2 and also Bellcore Issues 4, 5, and 6. Telcordia Issue 2, released in September 2006, are supported by Relex and Telcordia Issue 1, released in May 2001, is replaced with Relex. Refer to Telcordia Issue 2 Fields for information about the fields in Relex Reliability Studio specific to Telcordia Issue 2.



### ➤ Purpose of the analyses

The purpose of these analyses is to obtain early estimation of device reliability during engineering and customer validation stages. The prediction results will expose the reliability of whole assembly, viewed as a set of serially connected electronic components. Rating of the assembly electronic components will show the ratio between actual critical elements parameters and their specification limits. The purpose of component rating is to improve a product's inherent design reliability, increase its number of operating times, and to reduce warranty costs and to achieve a more robust design.

### 1.5.3. Definitions

| Term                              | Definition  |
|-----------------------------------|---|
| Failure                           | The event, or inoperable state, in which any item or part of an item does not, or would not, perform as previously specified.   |
| Failure rate                      | The total number of failures within an item population, divided by the total number of life units expended by that population, during a particular measurement interval under stated condition.   |
| FIT                               | Failures In Time: the number of failures in 1 billion hours.  |
| PPM                               | Part per million: the number of failures in 1 million hours.  |
| Mean Time Between Failures (MTBF) | A basic measure of reliability for repairable items: The mean number of life units during which all parts of the item perform within their specified limits, during a particular measurement interval under stated conditions..   |
| GB                                | Ground, Fixed, Controlled: Nearly zero environmental stress with optimum engineering operation and maintenance. Typical applications are central office, environmentally controlled vaults, environmentally controlled remote shelters, and environmentally controlled customer premise area. |
| GF                                | Ground, Fixed, Uncontrolled: Some environmental stress with limited maintenance. Typical applications are manholes, poles, remote terminals, and customer premise areas subject to shock, vibration, temperature, or atmospheric variations.  |

### ➤ Software & Database

Analysis Software & Analysis Method

Software Name : Relex Reliability Studio 2008

Software Version : Relex Studio 2008

### ➤ Analysis Method

The prediction method used was Telcordia SR-332, Issue 2,

Parts Count

Failure rate ( $\lambda$ ) =  $10^9$  hours (FITs)

MTBF =  $1/\lambda$

$\lambda_{SSi} = \lambda_{Gi} \cdot TT_{Qi} \cdot TT_{Si} \cdot TT_{Ti}$

Where  $\lambda_{Gi}$  : Generic steady-state failure rate for device i

$TT_{Qi}$  : Quality factor for device i

$TT_{Si}$  : Stress factor for device i

$TT_{Ti}$  : Temperature factor for device i

➤ **Calculation Parameter**

Operation Temperature : 25°C

Environment : Ground Benign, Controlled

Operation Stress : 50% (Voltage, Current, Power)

Method : Method I, Case 3

Products are advertised with MTBF up to 1 million hours in the market. Take one million hours as an example, the product's estimated life is 114 years. However, the current rapid progress of technology, advancement of flash storage device's manufacturing process research and development, and the supply period of former flash IC manufacturing processes are crucial to the actual life expectancy of flash products. In short, the MTBF of flash storage is for reference only. Good customer service and technical support provided by manufacturers is the most significant issue regarding to the life-span of products.

**Remark:**

All the details of testing and data are for reference only and do not imply any products performance as a result. MTBF is only an estimated date and is depends on both hardware and software. User shall not assume that all the products have the same MTBF as APRO estimates.

### 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 SLC Industrial Mini SATA III Module (mSATA)<br>HERMES-HR Series |                            | Standard Grade<br>SBMSRxxxG-JHCTC   | Industrial Grade<br>WBMSRxxxG-JHITI |
|--|----------------------------|---|-------------------------------------|
| 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  |                                     |
| Vibration  | Frequency/Acceleration:    | 70 Hz to 2K Hz, 20G, 3 axes   |                                     |
| Shock  | Operating & Non-operating: | 0.5ms, 1500 G, 3 axes   |                                     |
| Electrostatic<br>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 SLC Industrial Mini SATA III Module (mSATA) HERMES-HR Series |                |                  |
|---|----------------|------------------|
| DC Input Voltage (VCC)  |                | 5V±5%            |
| Maximum average value   | Reading Mode : | 320.0 mA. (max.) |
|   | Writing Mode : | 390.0 mA. (max.) |
|   | Idle Mode :    | 95.0 mA. (max.)  |

#### 2.3. System Performance

Table 3: System Performances

|                               |  |       |       |       |       |       |
|-------------------------------|--|-------|-------|-------|-------|-------|
| Data Transfer Mode supporting | Serial ATA Gen-III (6.0Gb/s = 768MB/s) |       |       |       |       |       |
| Random access time.           | 0.1 ms.                                |       |       |       |       |       |
| Maximum<br>Performance        | Capacity                               | 4GB   | 8GB   | 16GB  | 32GB  | 64GB  |
|                               | Sequential Read (MB/s)                 | 250.0 | 400.0 | 400.0 | 460.0 | 460.0 |
|                               | Sequential Write(MB/s)                 | 50.0  | 110.0 | 130.0 | 230.0 | 230.0 |

Note:

- The performance was measured using CrystalDiskMarkv5.0x64 with SATA 6Gbps host.
- Samples were built using Toshiba SLC
- Performance may differ according to flash configuration and platform.

### 2.4. System Reliability

Table 4: System Reliability

|                          |      |  |
|--------------------------|------|--|
| Wear-leveling Algorithms |      | Static wear-leveling algorithms  |
| Bad Block Management     |      | Supportive   |
| ECC Technology           |      | Hardware BCH ECC capable of correcting errors up to 40-bit per 1024 bytes. |
| Erase counts             |      | NAND SLC Flash Cell Level : 60K P/E Cycles                                 |
| TBW (Tera Bytes Written) |      |  |
| Capacity                 | 4GB  | 216.0  |
|                          | 8GB  | 432.0  |
|                          | 16GB | 864.0  |
|                          | 32GB | 1,728.0  |
|                          | 64GB | 3,456.0  |

Note:

- Samples were built using Toshiba SLC NAND flash.
- Test by sequential write.
- The endurance of SSD could be estimated 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 SLC Industrial Mini SATA III Module (mSATA) HERMES-HR Series physical specifications and dimensions.

Table 5: Physical Specifications of APRO SLC Industrial Mini SATA III Module (mSATA) HERMES-HR Series

|         |                  |
|---------|------------------|
| Length: | 50.8 mm          |
| Width:  | 29.8 mm.         |
| Weight: | 8.0 g / 0.30 oz. |

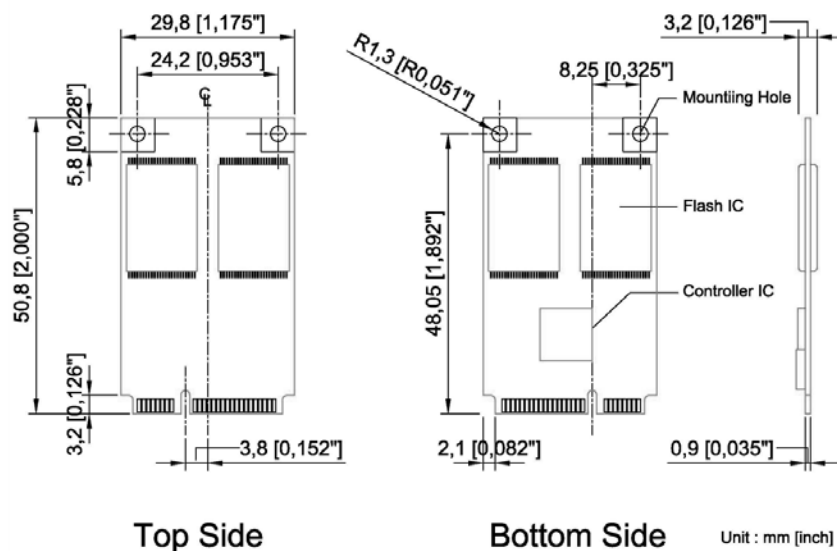


Figure 2: APRO SLC Industrial Mini SATA III Module (mSATA) HERMES-HR Series Dimension

### 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 storage 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. Mini SATA III Module (mSATA) interface

APRO SLC Industrial Mini SATA III Module (mSATA) HERMES-HR Series is equipped with mini PCI-e 52 pins SATA pin out.

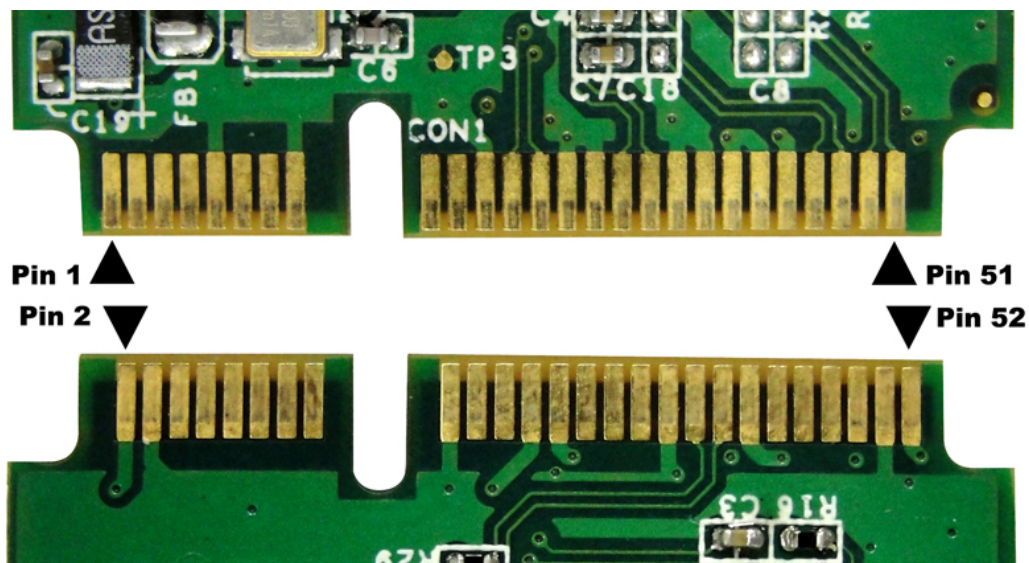


Figure 3: The connectors of Signal Segment and Power Segment

### 3.2. Pin Assignments

APRO SLC Industrial Mini SATA III Module (mSATA) HERMES-HR 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    | NC          |
| NC          | 45    | 46    | NC          |
| NC          | 47    | 48    | NC          |
| NC          | 49    | 50    | GND         |
| GND         | 51    | 52    | + 3.3V      |

Table 6 - Pin Assignments

### **Appendix A: Limited Warranty**

APRO warrants your SLC Industrial Mini SATA III Module (mSATA) HERMES-HR 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:**

- **SLC STD. Grade    3 years / Within 60K Erasing Counts**
- **SLC IND. Grade    5 years / Within 60K Erasing Counts**

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