SLC

Micro SATA III Flash Module

HERMES-J Series

(SATA III Disk On Module)

Document No. : 100-xBMSF-JJCTS

Version No. : 02V0

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ISO 9001 : 2015 CERTIFIED

Product Features

- ■ **Flash IC**
    - TOSHIBA NAND Flash IC.
    - Single-Level Cell (SLC) management

- ■ **Compatibility**
    - 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.
    - Thermal Monitor for SSD's temperature.
    - Native Command Queuing (NCQ) support.
    - TRIM maintenance command support.
    - Static wear-leveling algorithm

- ■ **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)=30.0mm x 20.0mm /20.0g

    Horizontal Low Profile w/mounting hole (HO)=

    30.0 mm x 28.8mm /20.0g

- ■ **Power Operating Voltage +5V(+/-) 5%**
    - Read Mode: 55.0 mA (max.)
    - Write Mode: 70.0 mA (max.)
    - Idle Mode: 20.0 mA (max.)

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

- ■ **Performance (Maximum value)** [2, 3]
    - Sequential Read: 220.0 MB/sec. (max.)
    - Sequential Write: 110.0 MB/sec. (max.)

- ■ **Capacity**
    - 4GB, 8GB, 16GB and 32GB

- ■ **Reliability**
    - **TBW:** Up to 187.5 TBW at 32GB Capacity.

      (Client workload by JESD-219A)
    - **MTBF:** > 3,000,000 hours.
    - **ECC:** 40bits per 1024bytes in an ECC block.
    - **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. 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

APRO

Order Information

I. Part Number List

◆ **APRO Industrial micro SATA III Flash Module – Vertical Standard Form Factor**

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Industrial Grade (-40°C ~ +85°C)
	4GB	SBMSF004G-JJCTC-VS(T/F)	WBMSF004G-JJITI-VS(T/F)
	8GB	SBMSF008G-JJCTC-VS(T/F)	WBMSF008G-JJITI-VS(T/F)
	16GB	SBMSF016G-JJCTC-VS(T/F)	WBMSF016G-JJITI-VS(T/F)
	32GB	SBMSF032G-JJCTC-VS(T/F)	WBMSF032G-JJITI-VS(T/F)

◆ **APRO Industrial micro SATA III Flash Module – Vertical Low Profile Form Factor**

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Industrial Grade (-40°C ~ +85°C)
	4GB	SBMSF004G-JJCTC-VL(T/F)	WBMSF004G-JJITI-VL(T/F)
	8GB	SBMSF008G-JJCTC-VL(T/F)	WBMSF008G-JJITI-VL(T/F)
	16GB	SBMSF016G-JJCTC-VL(T/F)	WBMSF016G-JJITI-VL(T/F)
	32GB	SBMSF032G-JJCTC-VL(T/F)	WBMSF032G-JJITI-VL(T/F)

◆ **APRO Industrial micro SATA III Flash Module – Horizontal Standard Form Factor**

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Industrial Grade (-40°C ~ +85°C)
	4GB	SBMSF004G-JJCTC-HS(T/F)	WBMSF004G-JJITI-HS(T/F)
	8GB	SBMSF008G-JJCTC-HS(T/F)	WBMSF008G-JJITI-HS(T/F)
	16GB	SBMSF016G-JJCTC-HS(T/F)	WBMSF016G-JJITI-HS(T/F)
	32GB	SBMSF032G-JJCTC-HS(T/F)	WBMSF032G-JJITI-HS(T/F)

◆ **APRO Industrial micro SATA III Flash Module – Horizontal Low Profile Form Factor**

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Industrial Grade (-40°C ~ +85°C)
	4GB	SBMSF004G-JJCTC-HL(T/F)	WBMSF004G-JJITI-HL(T/F)
	8GB	SBMSF008G-JJCTC-HL(T/F)	WBMSF008G-JJITI-HL(T/F)
	16GB	SBMSF016G-JJCTC-HL(T/F)	WBMSF016G-JJITI-HL(T/F)
	32GB	SBMSF032G-JJCTC-HL(T/F)	WBMSF032G-JJITI-HL(T/F)

◆ **APRO Industrial micro SATA III Flash Module – Horizontal Low Profile w/mounting hole Form Factor**

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Industrial Grade (-40°C ~ +85°C)
	4GB	SBMSF004G-JJCTC-HO(T/F)	WBMSF004G-JJITI-HO(T/F)
	8GB	SBMSF008G-JJCTC-HO(T/F)	WBMSF008G-JJITI-HO(T/F)
	16GB	SBMSF016G-JJCTC-HO(T/F)	WBMSF016G-JJITI-HO(T/F)
	32GB	SBMSF032G-JJCTC-HO(T/F)	WBMSF032G-JJITI-HO(T/F)

II.Part Number Decoder:

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

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**

B : Bare

X3 X4 X5 : **Product category**

MSF : Micro SATA Flash Module

X6 X7 X8 X9 : **Capacity**

004G:	4GB	**016G:**	16GB
008G:	8GB	**032G:**	32GB

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 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

HO : Horizontal Low Profile w/mounting hole Form Factor

X19 X20 : **Reserved for specific requirement**

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

T : Thermal Sensor (optional)

F : Power Pin-7 with fuse (optional)

C : Conformal-coating (optional)

Revision History

Revision	Description	Date
1.0	Initial release.	2017/12/21
1.1	Add the option for thermal sensor	2018/11/2
1.2	Updated Version	2018/11/28
2.0	Updated document form	2019/06/11

Contents

1. Introduction

APRO SLC Industrial Micro SATA III Flash Module HERMES-J Series provides high capacity flash memory Solid State Drive (SSD) that electrically complies with Serial ATA 3.1 (SATA) standard. APRO SLC Industrial Micro SATA III Flash Module HERMES-J Series support SATA 1.5Gbps/3.0Gbps/6.0Gbps data transfer rate with high performance. The main used flash memories are SLC-NAND type flash memory chips. The available disk capacities are 4GB, 8GB, 16GB and 32GB.

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 220.0 MB/sec, and sequential write is up to 110.0 MB/sec.

APRO SLC Industrial Micro SATA III Flash Module HERMES-J Series provides a high level interface to the host computer. This interface allows a host computer to issue commands to the Industrial micro SATA III Flash Module 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 Micro SATA III Flash Module HERMES-J 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 SLC Industrial Micro SATA III Flash Module HERMES-J Series 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 industrial micro SATA III Flash Module controller.
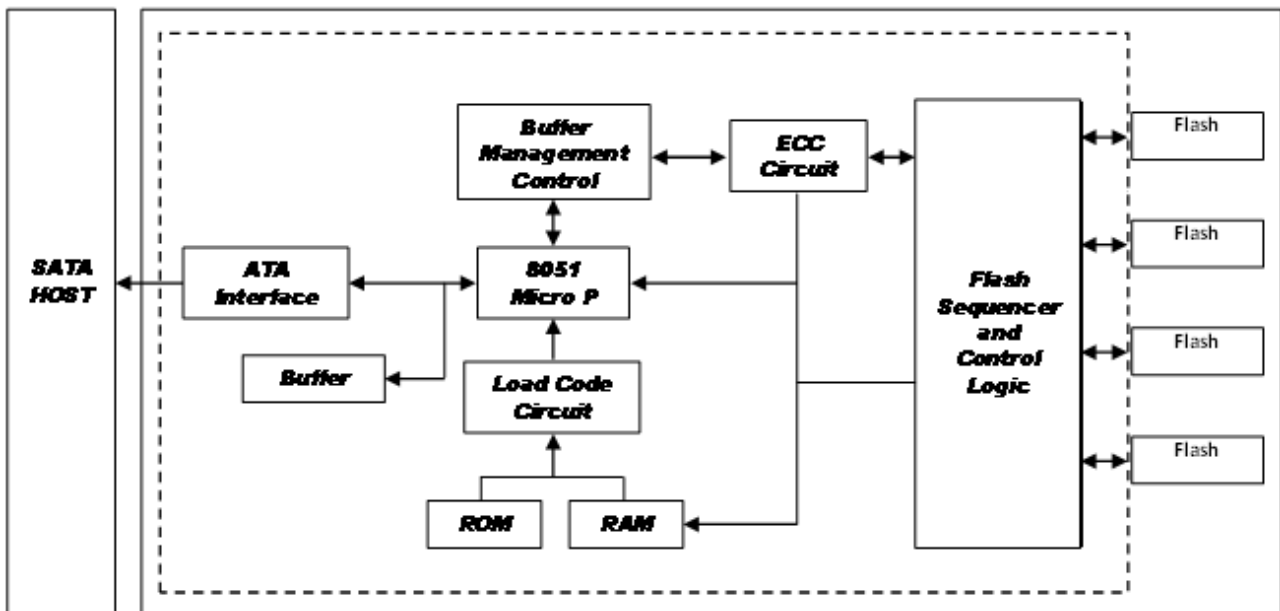

Figure 1: APRO SLC Industrial Micro SATA III Flash Module HERMES-J Series block diagram

1.1. *Scope*

This document describes features, specifications and installation guide of APRO SLC Industrial Micro SATA III Flash Module HERMES-J 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 Micro SATA III Flash Module HERMES-J 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 SLC Industrial Micro SATA III Flash Module HERMES-J 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. *Mean Time Between Failure (MTBF)*

1.4.1. *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.

1.4.2. 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.

1.4.3. 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 (λ) = 10^9 hours (FITs)

MTBF=1/λ

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

Where λ_{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℃

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 Micro SATA III Flash Module		Standard Grade	Industrial Grade
HERMES-J Series		SBMSFxxxG-JJCTC	WBMSFxxxG-JJITI
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:	7 Hz to 2K Hz, 20G, 3 axes	
Shock	Operating & Non-operating:	0.5ms, 1500 G, 3 axes	
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 SLC Industrial Micro SATA III Flash Module HERMES-J Series	
DC Input Voltage (VCC)	5V±5%
Reading Mode :	55.0 mA (max.)
Writing Mode :	70.0 mA (max.)
Idle Mode :	20.0 mA (max.)

Note: If design in Pin7/8 VCC on motherboard, 5V with 1A power supply is requested.

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)			
Maximum Performance	Capacity	4GB	8GB	16GB	32GB
	Sequential Read (MB/s)	180.0	180.0	220.0	220.0
	Sequential Write (MB/s)	60.0	60.0	110.0	110.0

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

2.4. System Reliability

Table 5: System Reliability

Wear-leveling Algorithms	Static wear-leveling algorithms		
Bad Block Management	Supportive		
ECC Technology	40bits per 1024bytes in an ECC block		
Erase counts	NAND SLC Flash Cell Level : 60K P/E Cycles		
TBW (Tera Bytes Written)			
Capacity	4GB	23.4	
	8GB	46.8	
	16GB	93.7	
	32GB	187.5	
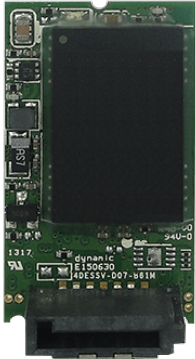
Note:

➢ *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 SLC Industrial Micro SATA III Flash Module HERMES-J Series physical specifications and dimensions.
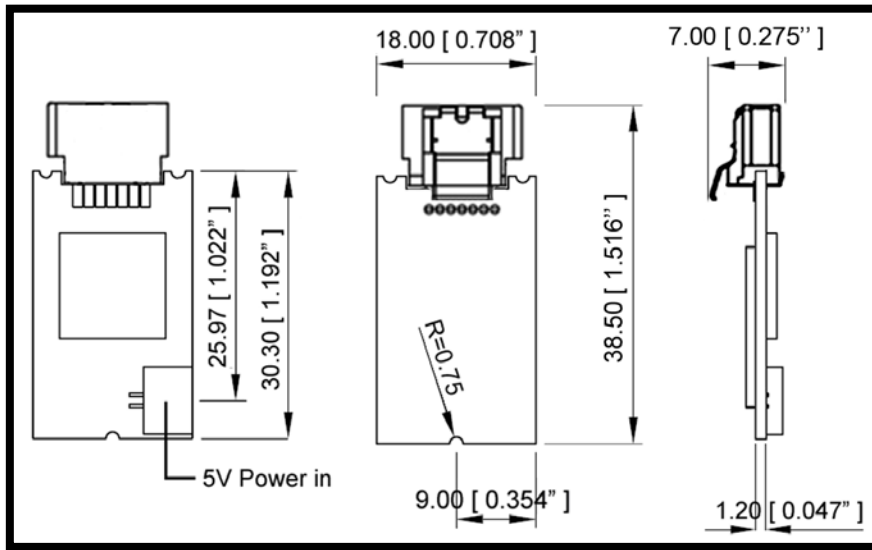
Table 6: Form Factors

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)	Horizontal Type Low Profile Form Factor w/mounting hole (HO)

Refer to Table 6 & 7 for micro SATA III Flash Module HERMES-J Series physical specifications and dimensions.

Table 7: Physical Specifications of APRO SLC Industrial Micro SATA III Flash Module HERMES-J 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)	30.00 mm	20.08 mm	20.00g
Horizontal Type –Low Profile w/mounting hole (HO)	30.00 mm	28.8 mm	20.00g

Vertical Type - Standard Form-factor (VS)
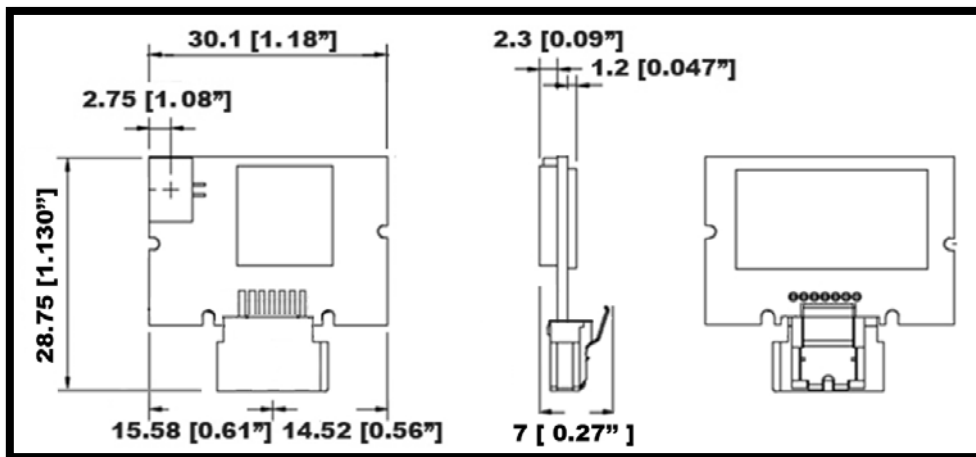
Vertical Type - Low Profile Form-factor (VL)

Horizontal Type - Standard Form-factor (HS)
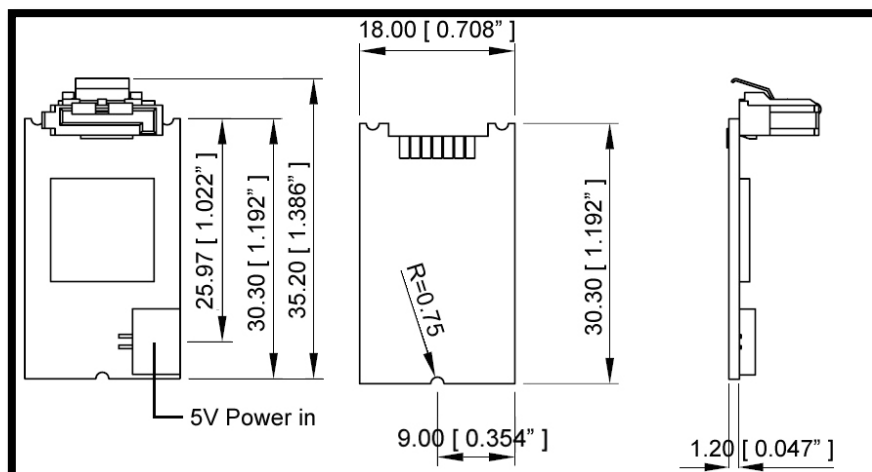
Horizontal Type - Low Profile Form-factor (HL)
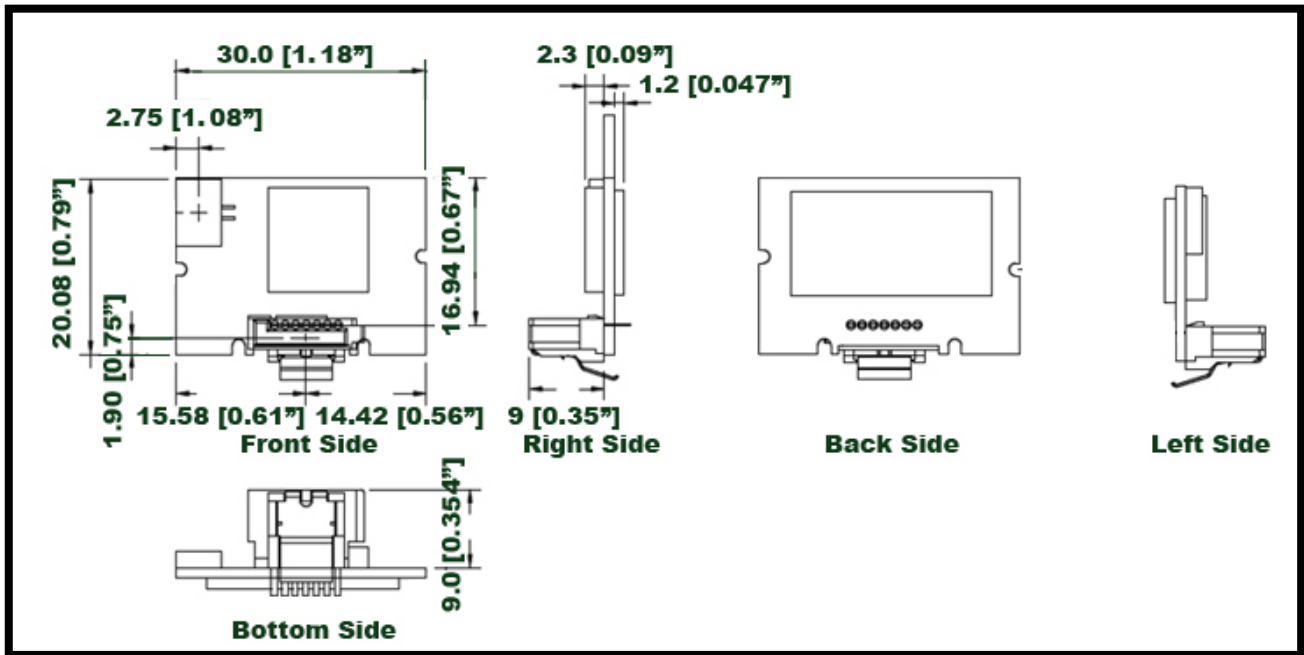
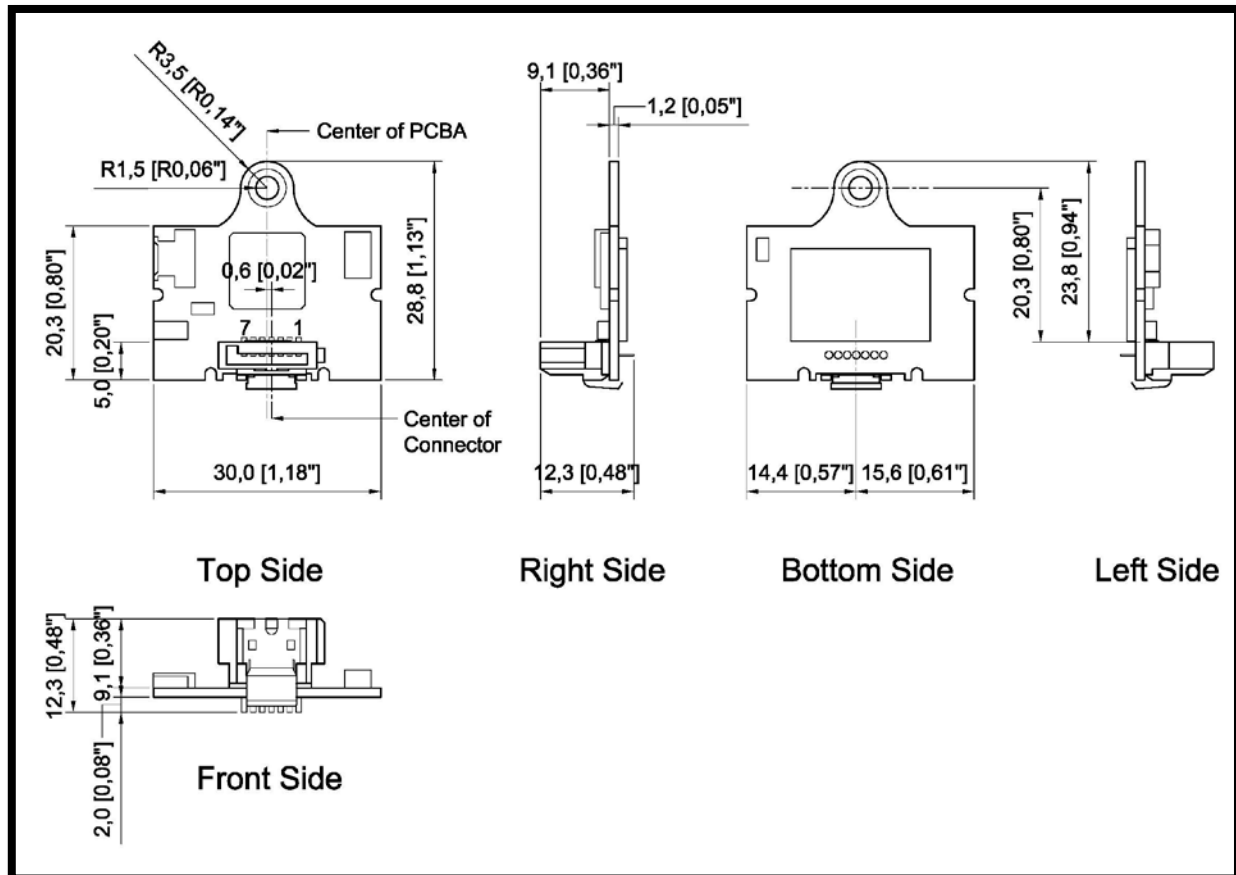**Horizontal Type - Low Profile Form-factor w/mounting hole (HO)**

Figure 2: APRO SLC Industrial Micro SATA III Flash Module HERMES-J 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. Micro SATA III Flash Modules interface

APRO SLC Industrial Micro SATA III Flash Module HERMES-J 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.

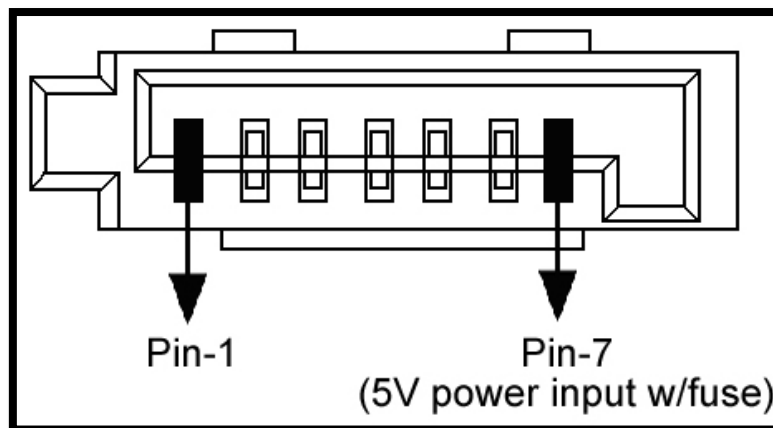Figure 3 is the aspect of the connector of micro SATA III Flash Module.

Figure 3: The connectors of micro SATA III Flash Module HERMES-J Series

3.2. Pin Assignments

Refer to Table 9 for APRO SLC Industrial Micro SATA III Flash Module HERMES-J 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	Shielding/Power

Appendix A: Limited Warranty

APRO warrants your SLC Industrial Micro SATA III Flash Module HERMES-J 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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