APRO Co., Ltd.

MLC

Micro USB Module

HERMIT-C Series

(USB 2.0)

Document No. : 100-xBMUM-HCCTMB

Version No. : 02V2

Date : June, 2019

ISO 9001 : 2015 CERTIFIED

Product Features

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

- **Compatibility**
  - Complete USB specification ver.2.0 and backward compatible ver.1.1
  - High Speed and Full Speed transfer support.
  - USB mass storage device class (MSC)
  - USB Attached SCSI (UASP) support

- **Additional Capabilities**
  - S.M.A.R.T.*[1] (Self-Monitoring, Analysis and Reporting Technology) feature set support.
  - Automatic power-down mode during wait periods for host data or Flash Memory operation completion, automatic sleep mode during host inactivity periods
  - AES-128 and AES-256 support with CBC and XTS modes, high performance on-the-fly encryption /decryption
  - Configurable Early-Acknowledge to avoid any data loss during power fail.
  - Support Static and Global Leveling

- **Mechanical**
  - USB 2.0 female 10-pin @ 2 rows connector.
    Vertical Type: 2.54 mm pin pitch female connector
    Horizontal Type: Both 2.0 mm & 2.54 mm pin-pitch female connector
  - Dimension:
    Vertical Type: 42.0 mm x 26.7 mm
    Horizontal Type: 37.0 mm x 26.7 mm
  - Weight: 10.0 g / 0.35 oz.

- **Power Operating Voltage 5V(+/-) 10%**
  - Read Mode: 83.4 mA (max.)
  - Write Mode: 90.9 mA (max.)
  - Idle Mode: 36.2 mA (max.)

- **Performance (Maximum value)** [2, 3]
  - Sequential Read: 27.9 MB/sec. (max.)
  - Sequential Write: 19.4 MB/sec. (max.)
  - 4KB Random Read (QD32): 7.9 MB/sec. (max.)
  - 4KB Random Write (QD32): 4.5 MB/sec. (max.)
  - 4KB Avg. Read response time: 0.55 ms.
  - 4KB Avg. Write response time: 0.83 ms.

- **Capacity**
  - 4GB, 8GB, 16GB, 32GB, 64GB and 128GB.

- **Reliability**
  - **TBW:** Up to 251.4TBW at 128GB Capacity. (Client workload by JESD-219A)
  - **ECC:** up to 96 bits error correction in 1K Byte data
  - **Temperature:** (Operating)
    Standard Grade: 0ºC ~ +70ºC
    Wide Temp. Grade: -40ºC ~ +85ºC
  - **Vibration:** 70Hz ~ 2K Hz, 15G / 3 axes.
  - **Shock:** 0.5ms, 1500 G, 3 axis.

- **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

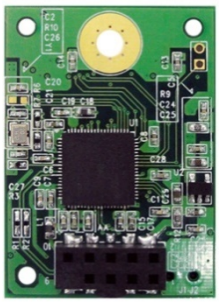
Order Information

I. Part Number List

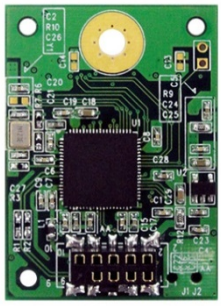
◆ APRO Micro USB Flash Module Vertical Standard HERMIT-C Series

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Wide Temp Grade (-40°C ~ +85°C)
	4GB	SBMUM004G-HCCTMB-VS	WBMUM004G-HCCTMB-VSC
	8GB	SBMUM008G-HCCTMB-VS	WBMUM008G-HCCTMB-VSC
	16GB	SBMUM016G-HCCTMB-VS	WBMUM016G-HCCTMB-VSC
	32GB	SBMUM032G-HCCTMB-VS	WBMUM032G-HCCTMB-VSC
	64GB	SBMUM064G-HCCTMB-VS	WBMUM064G-HCCTMB-VSC
	128GB	SBMUM128G-HCCTMB-VS	WBMUM128G-HCCTMB-VSC

◆ APRO Micro USB Flash Module Horizontal Standard HERMIT-C Series

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Wide Temp Grade (-40°C ~ +85°C)
	4GB	SBMUM004G-HCCTMB-HS	WBMUM004G-HCCTMB-HSC
	8GB	SBMUM008G-HCCTMB-HS	WBMUM008G-HCCTMB-HSC
	16GB	SBMUM016G-HCCTMB-HS	WBMUM016G-HCCTMB-HSC
	32GB	SBMUM032G-HCCTMB-HS	WBMUM032G-HCCTMB-HSC
	64GB	SBMUM064G-HCCTMB-HS	WBMUM064G-HCCTMB-HSC
	128GB	SBMUM128G-HCCTMB-HS	WBMUM128G-HCCTMB-HSC

◆ APRO Micro USB Flash Module Horizontal Low Profile HERMIT-C Series

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Wide Temp Grade (-40°C ~ +85°C)
	4GB	SBMUM004G-HCCTMB-HL	WBMUM004G-HCCTMB-HLC
	8GB	SBMUM008G-HCCTMB-HL	WBMUM008G-HCCTMB-HLC
	16GB	SBMUM016G-HCCTMB-HL	WBMUM016G-HCCTMB-HLC
	32GB	SBMUM032G-HCCTMB-HL	WBMUM032G-HCCTMB-HLC
	64GB	SBMUM064G-HCCTMB-HL	WBMUM064G-HCCTMB-HLC
	128GB	SBMUM128G-HCCTMB-HL	WBMUM128G-HCCTMB-HLC

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**

MUM : Micro USB 2.0 Flash Module

X6 X7 X8 X9 : **Capacity**

004G:	4GB	**032G:**	32GB
008G:	8GB	**064G:**	64GB
016G	16GB	**128G:**	128GB

X11 : **Controller**

H: HERMIT Series

X12 : **Controller version**

A, B, C.....

X13 : **Controller Grade**

C : Commercial grade

X14 : **Flash IC**

T : Toshiba MLC-NAND Flash IC

X15 : **Flash IC grade / Type**

M : MLC -NAND Flash IC

X16 : **MLC Technology**

B : Toshiba 15nm MLC

X18 X19 : **Form Factor – MUM only**

VS : Vertical type Standard form factor

HS : Horizontal type Standard form factor

HL : Horizontal type Low Profile form factor

X20: **Reserved for specific requirement**

C : Conformal-coating (optional)

Revision History

Revision	Description	Date
1.0	Initial release	2016/04/25
1.1	Add. 128GB Capacity	2017/10/25
2.1	Updated performance	2019/04/01
2.2	Updated document form	2019/06/10

Contents

1. Introduction

APRO MLC Micro USB Module (MUM) HERMIT-C Series, is specified as 2.0 High Speed Device, Mass Storage Class; USB-IF (USB Implementers Forum), WHQL (Window Hardware Quality Labs). In addition to being as a removable storage device, APRO MLC MUM HERMIT-C Series can also be configured as a bootable disk for system recovery. Also, its random access performance exceed the minimum requirement of Windows / Linux / VxWorks / QNX Embedded operating system, in which randomly access blocks of information are saved into MUM for boosting up the average performance. They are available in 4GB, 8GB, 16GB, 32GB, 64GB and 128GB capacities by Toshiba 15nm MLC Flash IC.

The operating temperature grade is optional for standard grade 0°C ~ 70°C and wide temp. grade -40°C ~ +85°C. The data transfer performance by sequential read is up to 27.9 MB/sec, and sequential write is up to 19.4 MB/sec; 4k data random read is up to 7.9 MB/sec, and 4k data random write is up to 4.5 MB/sec.

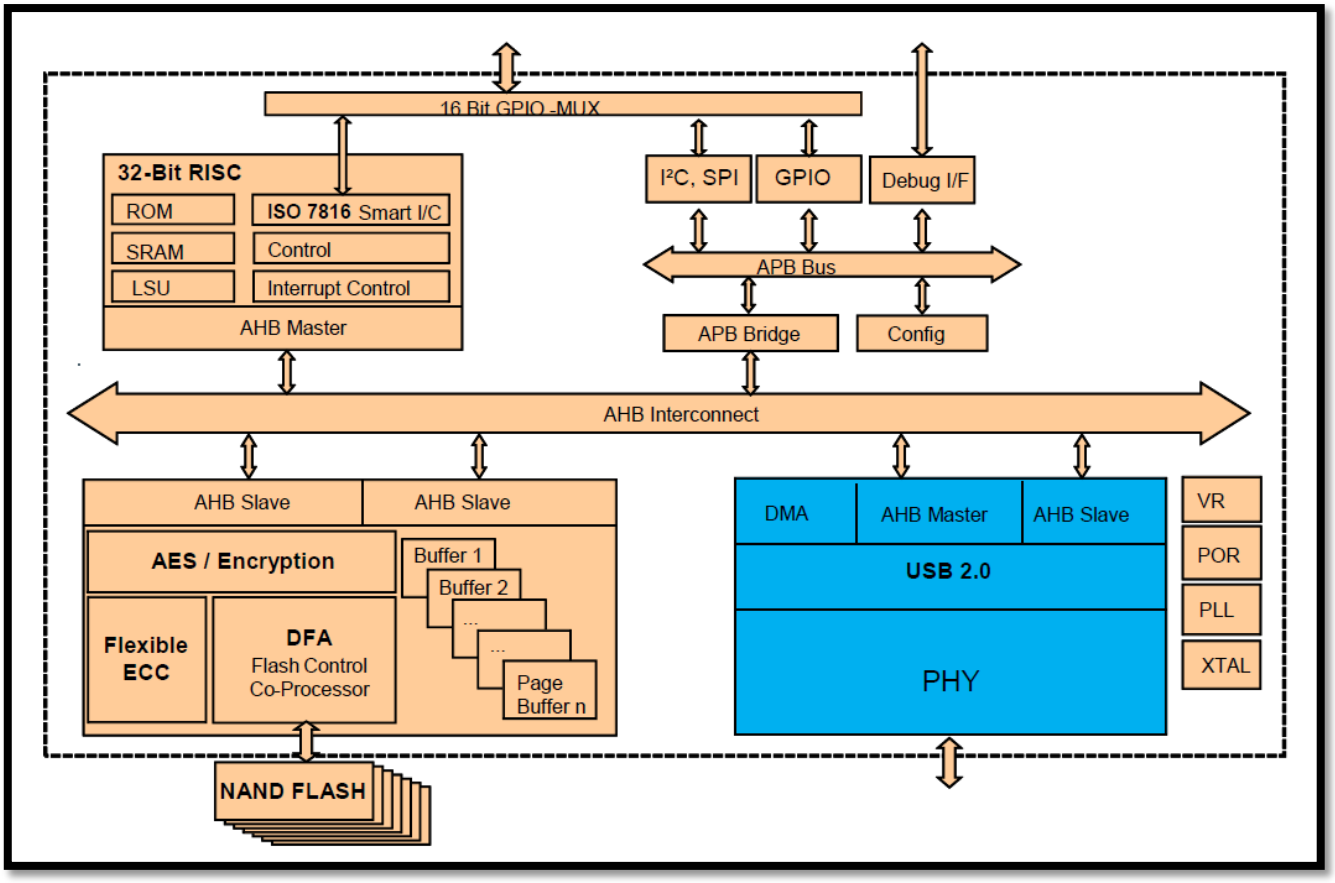


Figure 1: APRO MLC Micro USB Module (MUM) HERMIT-C Series block diagram

1.1. *Scope*

This document describes the key features and specifications of APRO MLC MUM HERMIT-C Series.

1.2. *Flash Management Technology - Static and Global Leveling*

WL is used to allocate data in such a way that the Flash blocks of the system are used equally in terms of consuming their individual write-erase-cycle endurance budget. There is static, dynamic and global WL. Dynamic WL writes on the blocks that do not contain data and are the least worn-out. The static WL chooses the least worn-out block, too, but if this block already contains data, it relocates the data to a free block. This leads to a very even wear-out, but it requires a more complex controller compared to using dynamic WL. WL activities are triggered when achieving a predefined erase count, and it is executed in the background where it is interrupted in case of higher priority host commands. Global WL refers to the procedure of involving all blocks (user blocks, management blocks and free blocks) of a device regardless of whether the respective block is on the same channel or not. Generally, to write on a free block, the WL algorithm selects a block with the lowest erase count from a pool of all the unused blocks of the whole device.

Key take-away: *WL is a key feature of almost every Flash controller. For page-based FTLs it is usually tightly coupled and interleaved with GC. As user data is ultimately moved without host intervention, possible Sudden Power Failure (SPF) may corrupt static data. Controllers need to ensure data integrity in such cases.*

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 USB Module (MUM) HERMIT-C 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. Power Fail Robustness

Flash memory is often used in removable storage applications or battery operated devices where a robust and reliable power source cannot be guaranteed. A user may remove the memory at any time and under these conditions security of data is of paramount importance. APRO MLC Micro USB Module (MUM) HERMIT-C Series has developed a patented concept in order to ensure data integrity when transferring or writing data. By

using certain buffer blocks, information is written in a way that minimizes the delta between an old and a new state. The data system is coherent at all times.

Upon a sudden power fail, the controller is reset and the flash is immediately write-protected. A log of the most recent Flash transactions is kept, where entries are made just before any programming to the Flash. Should the last entry of the log be corrupted, the controller recovers the last valid entry. This minimizes data loss due to power failures and data corruption at the physical layer is prevented completely. Should power loss happen at the very same time when data is written to the flash, this data might get lost. In no case, however, will the overall data system be corrupted.

APRO MLC Micro USB Module (MUM) HERMIT-C Series performs extensive power cycling tests to all controllers and firmware verifying no data corruption due to power failure.

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 USB Module (MUM) HERMIT-C Series		Standard Grade	Wide Temp Grade
		SBMUMxxxG-HCCTMB-xx	WBMUMxxxG- HCCTMB-xx/C
Temperature	Operating: Non-operating:	0ºC ~ +70ºC -20ºC ~ +80ºC	-40ºC ~ +85ºC -50ºC ~ +95ºC
Humidity	Operating & Non-operating:	85 ºC / 95% RH Non-Operating	
Vibration	Frequency/Displacement:	20Hz ~ 70 Hz, 1.52mm / 3 axes.	
	Frequency/Acceleration:	70Hz ~ 2K Hz, 15G / 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 USB Module (MUM) HERMIT-C Series		
DC Input Voltage (VCC)		5V±10%
Maximum average value	**Reading Mode :**	83.4 mA (max.)
	Writing Mode :	90.9 mA (max.)
	Idle Mode :	36.2 mA (max.)

2.3. System Performance

Table 3: System Performances

Data Transfer Mode supporting		USB 2.0					
Maximum Performance	**Capacity**	**4GB**	**8GB**	**16GB**	**32GB**	**64GB**	**128GB**
	Sequential Read (MB/s)	22.7	22.7	22.4	25.9	27.1	27.9
	Sequential Write (MB/s)	13.4	13.4	11.9	18.4	19.4	19.4
	4KB Random Read (MB/s) (QD32)	7.7	7.7	7.8	7.6	7.9	7.9
	4KB Random Write (MB/s) (QD32)	4.6	4.6	4.3	4.6	4.6	4.5

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

2.4. System Reliability

Table 4: System Reliability

Wear-leveling Algorithms		Static and Global Leveling algorithms
Bad Block Management		Supportive
ECC Technology		96 bits per 1K bytes
Erase counts		NAND MLC Flash : 3K P/E Cycles
Endurance		**TBW (Tera Bytes Written)**
Capacity	**4GB**	7.7
	8GB	15.5
	16GB	31.3
	32GB	62.7
	64GB	125.6
	128GB	251.4

Note:

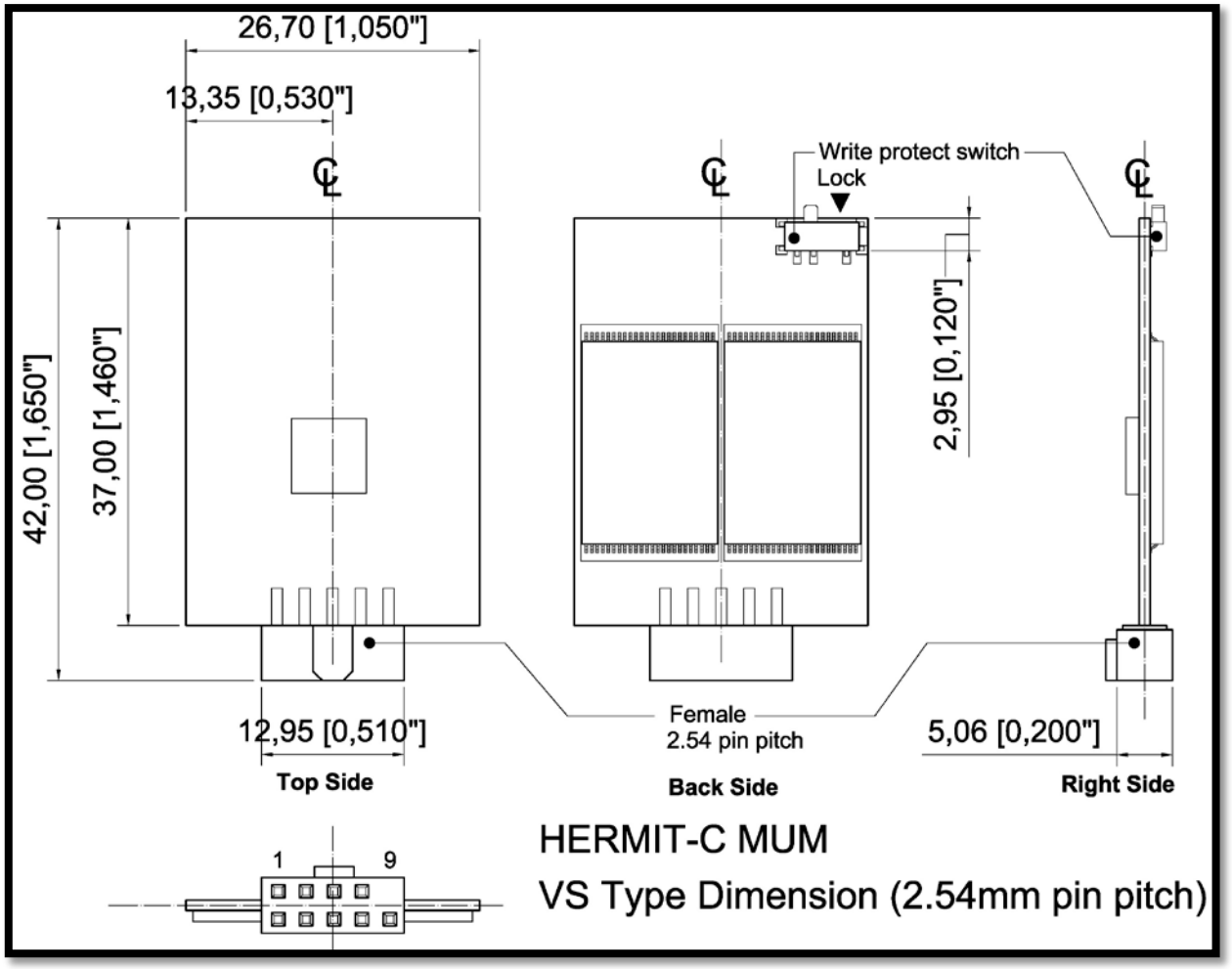
- *Client workload by JESD-219A.*
- *The endurance of disk could be varying based on user behavior, NAND endurance cycles, and write amplification factor. It is not guaranteed by flash vendor.*

2.5. *Physical Specifications*

Refer to Table 5 and see Figure 2 for APRO MLC Micro USB Module (MUM) HERMIT-C Series physical specifications and dimensions.

Table 5: Physical Specifications

Form factor:	HS & HL Type	VS Type
Length:	37.0 mm	42.0
Width:	26.7 mm	26.7
Weight:	10 g / 0.35 oz	



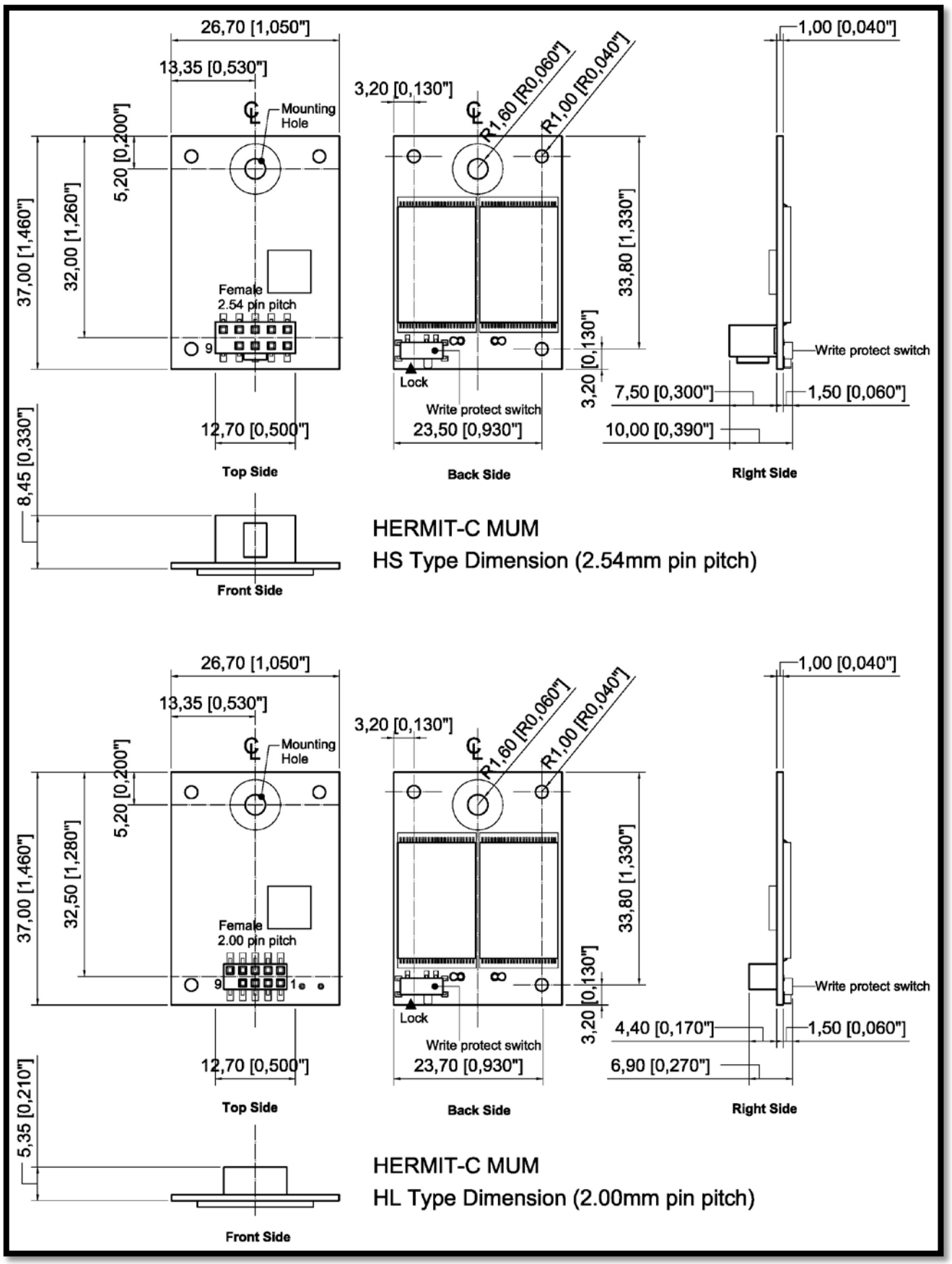


Figure 2: APRO MLC Micro USB Module (MUM) HERMIT-C Series Dimension

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 uses MIL-I-46058C silicon conformal coating

3. Interface Description

3.1. *USB2.0 male connector from host motherboard.*

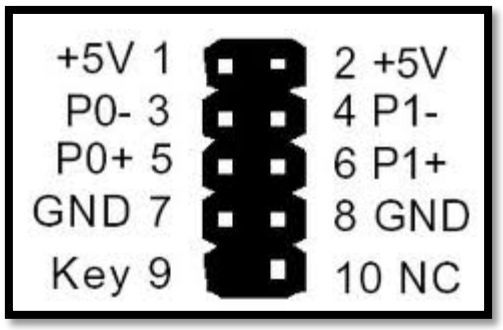


Figure 3: USB 10 pins Host male connector

Pin-1.3.5.7 and Pin-2.4.6.8 are the same pinout

3.2. *Pin Assignments*

There are total of 9 pins in the signal segment. The pin assignments are listed in below table 6.

Table 6 - Pin Assignments

Horizontal Type			
Pin Number	**Signal**	**Pin Number**	**Signal**
Pin 1	NC	**Pin 2**	+5VDC
Pin 3	NC	**Pin 4**	USB -
Pin 5	NC	**Pin 6**	USB +
Pin 7	NC	**Pin 8**	GND
Pin 9	Key	**Pin 10**	NC

Appendix A: Limited Warranty

APRO warrants your MLC Micro USB Module (MUM) HERMIT-C 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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