APRO Co., Ltd.

aSLC

Semi-Metal USB 3.1

Generation 3EL

HERMIT-E Series

Document No. : 100-xMUFD-HECTMBAS3EL

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ISO 9001 : 2015 CERTIFIED

Product Features

- **Flash IC**
  - TOSHIBA 15nm NAND Flash IC.
  - Multi-Level Cell (MLC) management by enhance endurance technology (aSLC)
- **Compatibility**
  - Compliant to the USB 3.1 standard
  - Implements USB 3.1 Gen1 (SuperSpeed 5Gbps).
  - Supports Full Speed, High Speed and Super Speed transmission
  - USB mass storage device class (MSC)
  - USB Attached SCSI (UASP) support
- **Additional Capabilities**
  - hyMap® Flash Translation Layer offering class-leading random write performance, minimal write amplification, and highest endurance for random usage profiles (e.g. JEDEC Enterprise)
  - S.M.A.R.T.*[1] (Self-Monitoring, Analysis and Reporting Technology) feature set support.
  - 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, Dynamic and Global Leveling
  - Blue LED status indicator at the bottom cap :
    Ready mode: LED constant light
    Working mode: LED flashing
- **Mechanical**
  - Semi-metal casing
  - USB 3.1 standard A interface
  - Dimension: 62.1mm x 17.6mm x 8.4mm
  - Weight: 15.0 g / 0.53 oz.
- **Power Operating Voltage 5V(+/-) 10%**
  - Read Mode: 203.0 mA (max.)
  - Write Mode: 189.8 mA (max.)
  - Idle Mode: 40.2 mA (max.)
- **Performance (Maximum value)** [2, 3]
  - Sequential Read: 147.7 MB/sec. (max.)
  - Sequential Write: 118.3 MB/sec. (max.)
  - 4KB Random Read (QD32): 14.4 MB/sec. (max.)
  - 4KB Random Write (QD32): 11.2 MB/sec. (max.)
  - 4KB Random Read latency time: 0.28 ms.
  - 4KB Random Write latency time: 0.26 ms.
- **Capacity**
  - 4GB, 8GB, 16GB, 32GB, 64GB, 128GB, ~~256GB~~
- **Reliability**
  - **TBW:** Up to 503TBW at 256GB 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
3. Performance values vary by capacity

Order Information

I. Part Number List

◆ **APRO Semi-Metal USB 3.1 Flash Disk HERMIT-E Series**

Product Picture	Grade	Standard grade (0ºC ~ 70ºC)	Wide Temp Grade (-40ºC ~ +85ºC)
	4GB	SMUFD004G-HECTMBAS	WMUFD004G-HECTMBASC
	8GB	SMUFD008G-HECTMBAS	WMUFD008G-HECTMBASC
	16GB	SMUFD016G-HECTMBAS	WMUFD016G-HECTMBASC
	32GB	SMUFD032G-HECTMBAS	WMUFD032G-HECTMBASC
	64GB	SMUFD064G-HECTMBAS	WMUFD064G-HECTMBASC
	128GB	SMUFD128G-HECTMBAS	WMUFD128G-HECTMBASC
	~~256GB~~	~~SMUFD256G-HECTMBAS (EOL)~~	~~WMUFD256G-HECTMBASC (EOL)~~

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 X17 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**

M : Semi-metal

X3 X4 X5 : **Product category**

UFD : USB Flash Disk

X6 X7 X8 X9 : **Capacity**

004G:	4GB	**064G:**	64GB
008G:	8GB	**128G:**	128GB
016G:	16GB	~~**256G:**~~	~~256GB~~
032G:	32GB		

X11 : **Controller**

H : HERMIT 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

X16 :**Flash IC**

B : Toshiba 15nm MLC

X17 X18 : **aSLC Technology**

AS : aSLC Technology extends MLC product's lifespan.

X19 X20 : **Reserved for specific requirement**

C : Conformal-coating (optional)

Revision History

Revision	Description	Date
1.0	Initial release.	2017/09/11
2.0	Updated performance	2019/04/01
2.1	Updated document form	2019/06/14
2.2	Add LED indicator decryptions.	2019/08/29
3.1	256GB EOL	2022/10/31

Contents

1. Introduction

APRO aSLC Semi-Metal USB Flash Disk Generation 3EL HERMIT-E Series, is specified as USB 3.1 Gen1 (SuperSpeed 5Gbps) Device, Mass Storage Class; USB-IF (USB Implementers Forum), WHQL (Window Hardware Quality Labs). In addition to being as a removable storage device, MUFD HERMIT-E 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 MUFD - Generation 3EL for boosting up the average performance. They are available in 4GB, 8GB, 16GB, 32GB, 64GB, 128GB, ~~256GB~~ capacities.

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 147.7 MB/sec, and sequential write is up to 118.3 MB/sec; 4k data random read is up to 14.4 MB/sec, and 4k data random write is up to 11.2 MB/sec.

APRO aSLC Semi-Metal USB Generation 3EL HERMIT-E Series also offers unique customization for OEM customers by laser carvings.

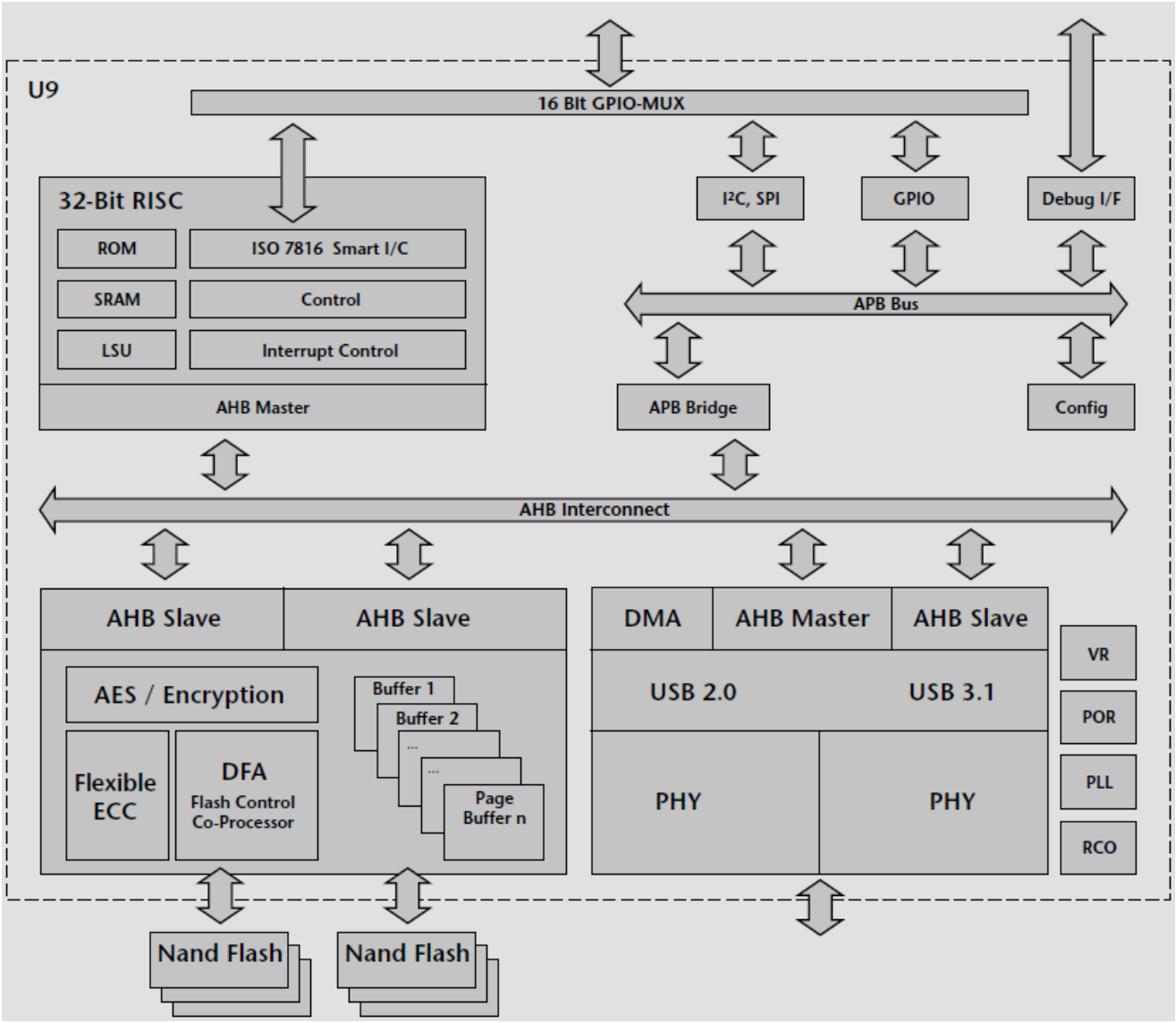

Figure 1: APRO aSLC Semi-Metal USB Generation 3EL HERMIT-E Series block diagram

1.1. *Scope*

This document describes features, specifications and installation guide of APRO aSLC Semi-Metal USB Generation 3EL HERMIT-E Series. In the appendix, there provides order information, warranty policy, RMA/DOA procedure for the most convenient reference.

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

Wear Levelling (WL) is used to systematically utilize all Flash blocks of the system equally in terms of consuming their individual write-erase-cycle endurance budget. hyMap® supports dynamic, static, and global Wear levelling. Dynamic WL requires no copy-overhead but alone would be limited to blocks not containing data. Static WL includes also those blocks containing data. Static data is relocated if needed. This WL activity is triggered at predefined threshold levels. Also these routines are executed in the background and interrupted in case of higher priority host commands.

Global WL refers to the procedure of involving all blocks (user blocks, management blocks, free blocks) of a device and is not limited to flash chips for instance. Generally, the WL algorithm selects a block with the lowest erase count from a pool of unused blocks to be written to (dynamic WL). At some point formerly used blocks enter the pool of unused blocks again as a result of the garbage collection. When a block enters the pool of unused blocks, its erase counter value is compared with the lowest erase counter value of all used blocks (global WL). If the difference exceeds a configurable threshold, the data of a used block with lowest erase count is moved into the block that just became unused and the used block with lowest erase count enters the pool of unused blocks instead (static WL).

The threshold is configurable and defines the granularity and the spread between the block(s) with the "lowest erase counts" and the "highest erase counts". Within hyMap® this is called Adaptive Wear Levelling.

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 aSLC Semi-Metal USB Generation 3EL HERMIT-E 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 aSLC Semi-Metal USB Flash Disk Generation 3EL HERMIT-E 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 aSLC Semi-Metal USB Flash Disk Generation 3EL HERMIT-E Series performs extensive power cycling tests to all controllers and firmware verifying no data corruption due to power failure.

1.5. *No external DRAM no capacitor*

All mapping information is reliably stored on the flash. No external DRAM is used to store vital mapping information in volatile memory and no external capacitor is needed to make sure that DRAM content is stored in the Flash in case of a power fail situation. Hence, there is no additional reliability risk and endurance impact related to implementing these additional components.

1.6. *Reliable Write*

hyMap® is targeted to making MLC Flash as reliable as possible. Since two logical MLC Flash pages are physically correlated, it is possible to destroy data of an older page by writing another new one within the same block (paired pages).hyMap® applies Reliable Write to cope with this occurrence and in order to make MLC power-fail safe.

Note: Detail information of hyMap® technology, please contact with your distributer.

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 aSLC Semi-Metal USB Generation 3EL HERMIT-E Series		Standard Grade	Wide Temp Grade
		SMUFDxxxG-HECTMBAS	WMUFDxxxG-HECTMBASC
Temperature	Operating:	0ºC ~ +70ºC	-40ºC ~ +85ºC
	Non-operating:	-20ºC ~ +80ºC	-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 aSLC Semi-Metal USB Generation 3EL HERMIT-E Series		
DC Input Voltage (VCC)		5V±10%
Maximum average value	Reading Mode :	203.0 mA (max.)
	Writing Mode :	189.8 mA (max.)
	Idle Mode :	40.2 mA (max.)

2.3. System Performance

Table 3: System Performances

Data Transfer Mode supporting		USB 3.0 Super Speed 5Gbps (USB 3.1 Gen1)						
Maximum Performance	Capacity	4GB	8GB	16GB	32GB	64GB	128GB	~~256GB~~
	Sequential Read (MB/s)	98.8	98.1	98.4	145.6	149.0	150.3	~~147.7~~
	Sequential Write (MB/s)	59.6	52.9	52.1	140.5	117.6	115.1	~~118.3~~
	4KB Random Read (MB/s) (QD32)	15.0	14.8	14.8	14.8	14.7	14.4	~~14.4~~
	4KB Random Write (MB/s) (QD32)	10.6	9.9	9.7	11.0	11.0	11.0	~~11.2~~

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

2.4. *System Reliability*

Table 4: System Reliability

Wear-leveling Algorithms		Static, Dynamic and Global Wear Leveling algorithms
Bad Block Management		Supportive
ECC Technology		96 bits per 1K bytes
Erase counts		NAND MLC Flash w/aSLC Technology : 20K 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
	~~**256GB**~~	~~503~~

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 aSLC Semi-Metal USB Generation 3EL HERMIT-E Series physical specifications and dimensions.

Table 5: Physical Specifications

Length:	62.1 mm
Width:	17.6 mm
Thickness:	8.4 mm
Weight:	15.0 g / 0.53 oz.

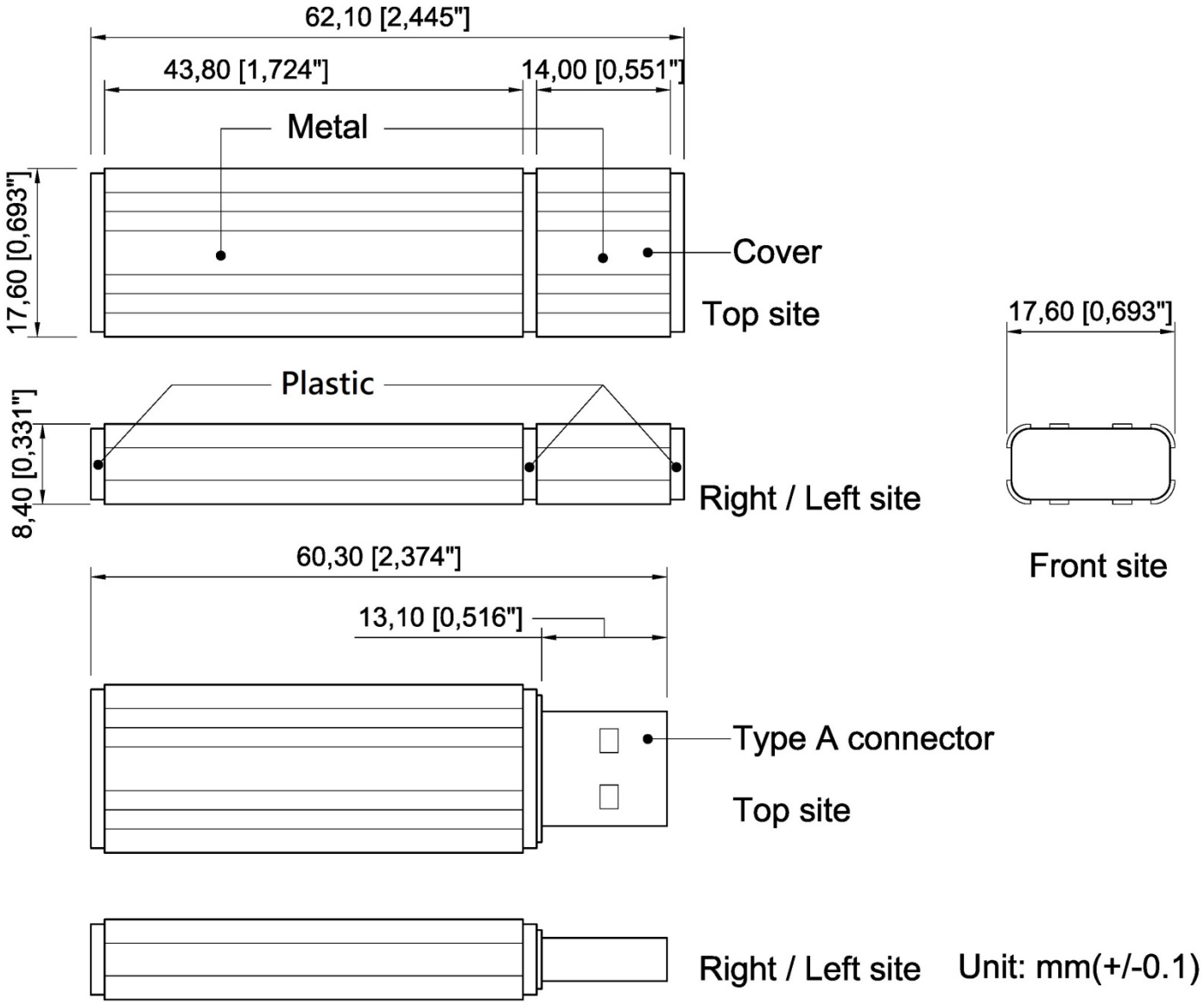

Figure 2: APRO aSLC Semi-Metal USB Generation 3EL HERMIT-E Series Dimension

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. *Semi-Metal USB 3.1 Flash Disk Type A male interface*

APRO aSLC Semi-Metal USB Generation 3EL HERMIT-E Series is equipped with standard 9 pins USB 3.1 Type A male connector.

Figure 3: The Type A male connector of APRO aSLC Semi-Metal USB Generation 3EL HERMIT-E Series

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

Name	Type	Description
1	**VBUS**	Power
2	**D-**	USB2.0 Differential Pair
3	**D+**	
4	**GND**	Ground for power return
5	**StdA_SSRX-**	Super-speed transmitter differential pair
6	**StdA_SSRX+**	
7	**GND_DRAIN**	Ground for signal return
8	**StdA_SSTX-**	Super-speed receiver differential pair
9	**StdA_SSTX+**	

Appendix A: Limited Warranty

APRO warrants your aSLC Semi-Metal USB 3.1 Flash Disk G3EL HERMIT-E 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:

- **aSLC (Standard grade / Wide temp. grade) 2 years / Within 20K Erasing Counts**

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