

MLC

Semi-Metal USB 3.1

Generation 3EL

HERMIT-E Series



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ISO 9001 : 2015 CERTIFIED



Product Features

■ Flash IC

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

■ 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.
- 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: 62.1 mm x 17.6 mm x 8.4 mm.
- Weight: 15.0 g / 0.53 oz.

■ Power Operating Voltage 5V(+/-) 10%

- Read Mode: 167.7 mA (max.)
- Write Mode: 189.0 Ma (max.)
- Idle Mode: 42.8 Ma (max.)

■ Performance (Maximum value)^{2, 3,}

- Sequential Read: 97.0 MB/sec. (max.)
- Sequential Write: 60.2 MB/sec. (max.)
- 4KB Random Read (QD32): 11.3 MB/sec. (max.)
- 4KB Random Write (QD32): 6.4 MB/sec. (max.)
- Random Read latency time: 0.35 ms.
- Random Write latency time: 0.46 ms.

■ Capacity

- 8GB, 16GB, 32GB, 64GB, 128GB, 256GB
~~512GB~~

■ Reliability

- **TBW:** Up to 125TBW at 512GB Capacity. (Client workload by JESD-219A)
- **ECC Scheme:** up to 96 bits error correction in 1K Byte data
- **Temperature:** (Operating)
Standard Grade: 0°C ~ +70°C
Wide Temp. Grade: -40°C ~ +85°C
- **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 (0°C ~ 70°C)	Wide Temp Grade (-40°C ~ +85°C)
	8GB	SMUFD008G-HECTMB3EL	WMUFD008G-HECTMB3ELC
	16GB	SMUFD016G-HECTMB3EL	WMUFD016G-HECTMB3ELC
	32GB	SMUFD032G-HECTMB3EL	WMUFD032G-HECTMB3ELC
	64GB	SMUFD064G-HECTMB3EL	WMUFD064G-HECTMB3ELC
	128GB	SMUFD128G-HECTMB3EL	WMUFD128G-HECTMB3ELC
	256GB	SMUFD256G-HECTMB3EL	WMUFD256G-HECTMB3ELC
	512GB	SMUFD512G-HECTMB3EL (EOL)	WMUFD512G-HECTMB3ELC (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. 0° C ~ 70 ° C

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

X2 : The material of case

M : Semi-metal

X3 X4 X5 : Product category

UFD : USB Flash Disk

X6 X7 X8 X9 : Capacity

008G:	8GB	128G:	128GB
016G:	16GB	256G:	256GB
032G:	32GB	512G:	512GB
064G:	64GB		

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

X17 X18 X19 : Housing Generation

3EL: Generation 3 housing extra-long type

X20 : Reserved for specific requirement

C : Conformal-coating (optional)

Revision History

Revision	Description	Date
1.0	Initial release.	2017/04/05
1.1	Typo correction:	2017/05/12
	4KB Random Write latency time	
	Page number correction	
1.2	Data transfer rate & ECC Number correction.	2017/05/25
1.3	Add. 512GB Capacity	2017/10/23
2.1	Updated performance	2019/04/01
2.2	Updated document form	2019/06/14
2.3	Add LED indicator decryptions.	2019/08/29
3.1	512GB EOL.	2022/10/31

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1. Introduction

APRO MLC 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 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 8GB, 16GB, 32GB, 64GB, 128GB, 256GB and ~~512GB~~ capacities by Toshiba 15-nm 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 97.0 MB/sec, and sequential write is up to 60.2 MB/sec; 4k data random read is up to 11.3 MB/sec, and 4k data random write is up to 6.4 MB/sec.

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

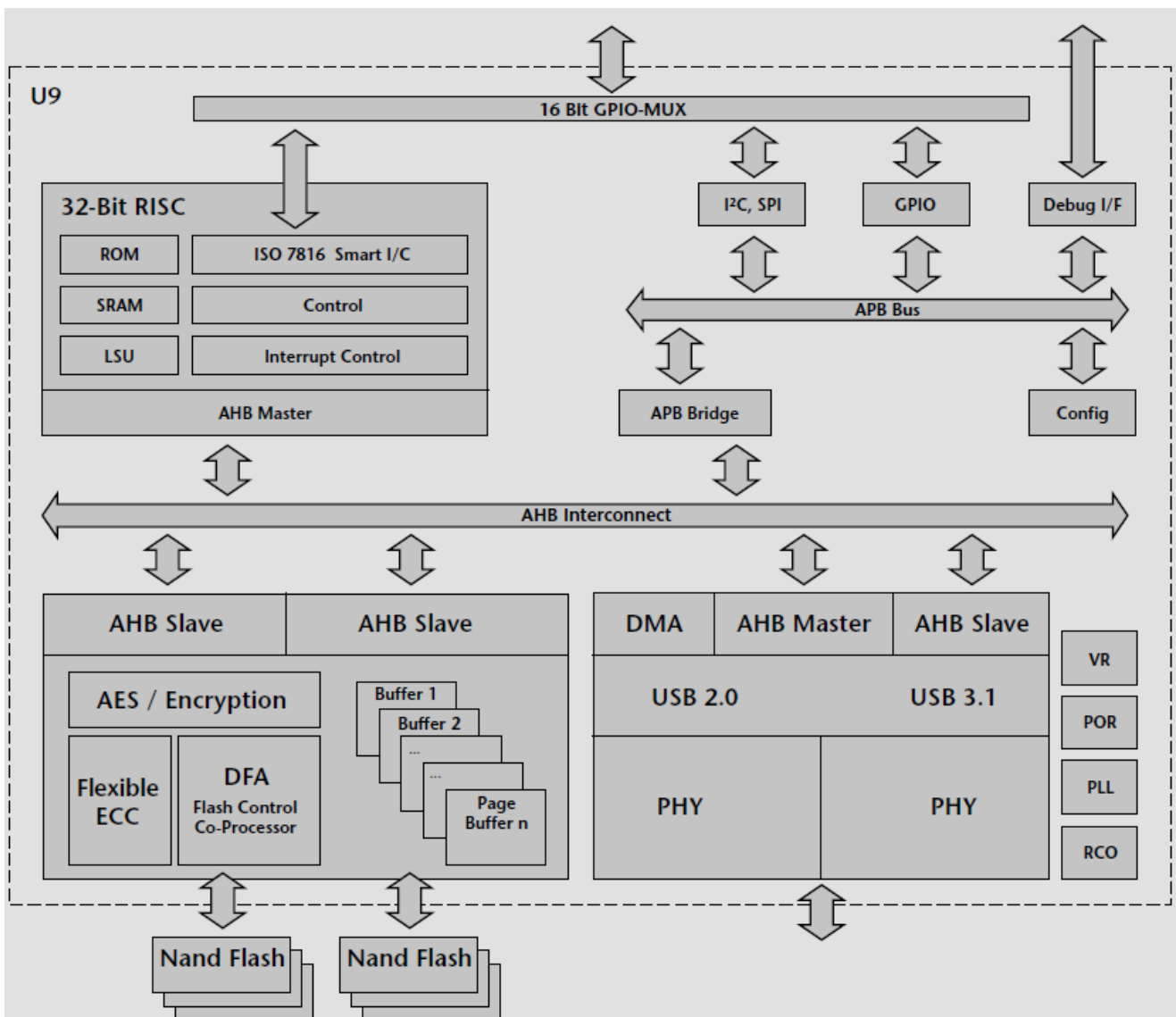


Figure 1: APRO MLC Semi-metal USB 3.1 Flash Disk HERMIT-E Series controller block diagram

1.1. Scope

This document describes features, specifications and installation guide of APRO Semi-Metal USB 3.1 Flash Disk 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 - Dynamic, Static, 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. Power Fail Robustness

Generally, all HERMIT-E Series UFD proved voltage sensing capability and as soon as a power down is recognized, the controller is reset and the flash is write-protected. A log of all recent flash transactions is kept. Should the latest data be corrupt, the controller will recover the latest valid entry before that last failed write.

1.4. 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.

1.5. 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 distributor.

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 Semi-Metal USB 3.1 Flash Disk		Standard Grade	Wide Temp Grade
HERMIT-E Series		SMUFDxxxG-HECTMB3EL	WMUFDxxxG-HECTMB3ELC
Temperature	Operating:	0°C ~ +70°C	-40°C ~ +85°C
	Non-operating:	-20°C ~ +80°C	-50°C ~ +95°C
Humidity	Operating & Non-operating:	85 °C / 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 axis.	
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 Semi-Metal USB 3.1 Flash Disk HERMIT-E Series		
DC Input Voltage (VCC)		5V±10%
Maximum average value	Reading Mode :	167.7mA (max.)
	Writing Mode :	189.0mA (max.)
	Idle Mode :	42.8mA (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	8GB	16GB	32GB	64GB	128GB	256GB	512GB
	Sequential Read (MB/s)	64.7	548	61.7	97.4	96.2	97.0	94.0
	Sequential Write (MB/s)	23.2	21.1	21.3	59.8	57.3	60.2	61.2
	4KB Random Read (MB/s) (QD32)	10.5	10.3	10.0	11.3	11.2	11.3	11.2
	4KB Random Write (MB/s) (QD32)	5.9	5.4	5.4	6.5	6.5	6.4	6.9

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

2.4. System Reliability

Table 4: System Reliability

Wear-leveling Algorithms		Dynamic, Static, and Global Leveling algorithms
Bad Block Management		Supportive
ECC Technology		96 bits per 1K bytes
Erase counts		NAND MLC Flash Cell Level : 3K P/E Cycles
Endurance		TBW (Tera Bytes Written)
Capacity	8GB	1.9
	16GB	3.9
	32GB	7.8
	64GB	15.6
	128GB	31.2
	256GB	62.5
	512GB	125

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 Semi-Metal USB 3.1 Flash Disk G3EL 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.

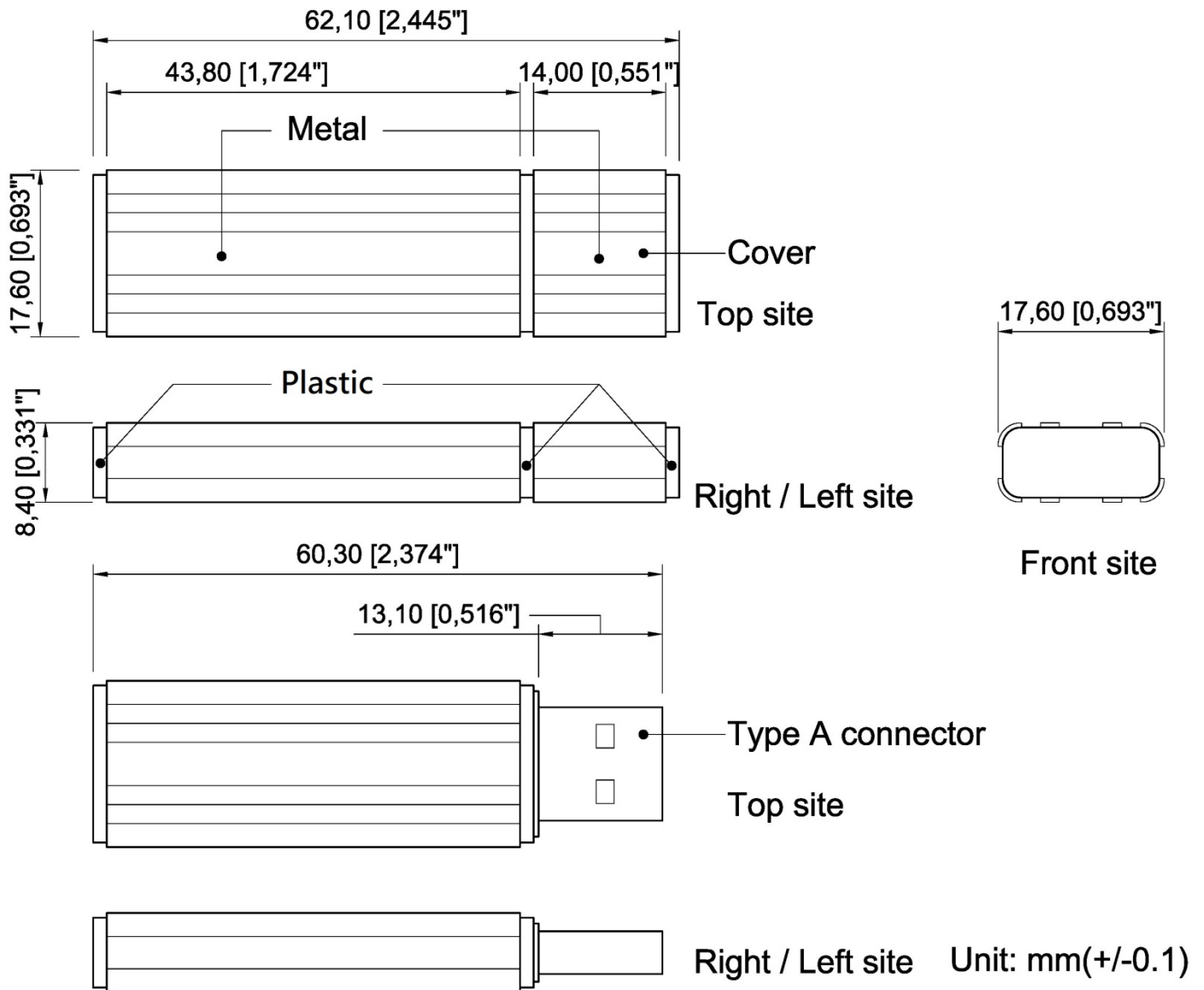


Figure 2: APRO Semi-Metal USB 3.1 Flash Disk HERMIT-E Series G3EL Dimension

2.5.1. 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 uses MIL-I-46058C silicon conformal coating

3. Interface Description

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

APRO Semi-Metal USB 3.1 Flash Disk is equipped with standard 9 pins USB 3.1 Type A male connector.

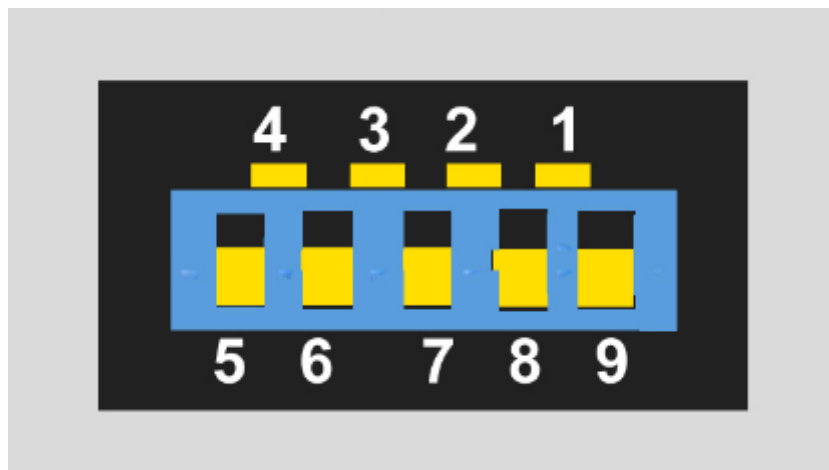


Figure 3: The Type A male connector of APRO Semi-Metal USB 3.1 Flash Disk

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 MLC 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:

- **MLC (Standard grade / Wide temp. grade) 2 years / Within 3K Erasing Counts**

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