

# MLC

## Semi-Metal USB 2.0

### Generation 5/5L

### HERCULES-PD Series

**Document No. :** 100-xMUFD-MPDTM5

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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, Full Speed and Low Speed transfer support.
- USB Mass Storage Class Specification Rev. 1.0

#### ■ Additional Capabilities

- Support Static Wear Leveling algorithm.
- Supports Windows Series O.S., Mac OS 10.x, and Linux kernel 2.4 operating systems.
- Supports Windows 8, Windows 7 and Windows Vista ReadyBoost function.
- Blue LED status indicator at the bottom cap :

**Ready mode:** LED constant light

**Working mode:** LED flashing

#### ■ Mechanical

- USB 2.0 Type-A Connector
- Dimension:  
**G5:** 47.20 mm x 17.20 mm x 7.80 mm  
**G5L:** 50.70 mm x 17.20 mm x 7.80 mm
- Weight:  
**G5:** 10 g / 0.35 oz.  
**G5L:** 12 g / 0.42 oz.

#### ■ Power Operating Voltage 5V(+/-) 10%

- Read Mode: 101.5 mA (max.)
- Write Mode: 113.1 mA (max.)
- Idle Mode: 67.1 mA (max.)

#### ■ Performance (Maximum value) \*1,

- Sequential Read: 26.0 MB/sec. (max.)
- Sequential Write: 14.9 MB/sec. (max.)

#### ■ Capacity

- **G5:** 4GB, 8GB, 16GB and 32GB.
- **G5L:** 64GB.

#### ■ Reliability

- **TBW:** Up to 15.4 TBW at 64GB Capacity.  
(Client workload by JESD-219A)
- **MTBF:** > 3,000,000 hours.
- **ECC:** up to 72 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. Sequential performance is based on CrystalDiskMark 5.1.2 with file size 500MB.


### Order Information

#### I. Part Number List

##### ◆ APRO Semi Metal USB Flash Disk Generation-5 HERCULES-PD Series

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Wide Temp Grade ( -40°C ~ +85°C )
	<b>4GB</b>	SMUFD004G-MPDTM-5	WMUFD004G-MPDTM-5C
	<b>8GB</b>	SMUFD008G-MPDTM-5	WMUFD008G-MPDTM-5C
	<b>16GB</b>	SMUFD016G-MPDTM-5	WMUFD016G-MPDTM-5C
	<b>32GB</b>	SMUFD032G-MPDTM-5	WMUFD032G-MPDTM-5C

##### ◆ APRO Semi Metal USB Flash Disk Generation-5L HERCULES-PD Series

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Wide Temp Grade ( -40°C ~ +85°C )
	<b>64GB</b>	SMUFD064G-MPDTM-5L	WMUFD064G-MPDTM-5LC

#### 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** — **X17 X18 X19**

#### **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

<b>004G:</b>	4GB	<b>032G:</b>	32GB
<b>008G:</b>	8GB	<b>064G:</b>	64GB
<b>016G:</b>	16GB		

#### **X11** : Controller

**M** : HERCULES Series

#### **X12 X13** : Controller version

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

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

**T** : Toshiba NAND Flash IC

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

**M** : 15nm MLC -NAND Flash IC

#### **X17 X18** : Housing Generation

**5** : Generation 5 housing

**5L** : Generation 5 housing Long type

#### **X19** : Reserved for specific requirement

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

## **Revision History**

Revision	Description	Date
1.0	Initial release	2019/08/15
1.1	Add LED indicator decryptions.	2019/08/29
1.2	Updated MTBF value.	2021/08/31

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### 1. Introduction

APRO MLC Semi-Metal USB Flash Disk Gen-5/5L HERCULES-PD 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 Semi-Metal USB Flash Disk Gen-5/5L HERCULES-PD Series can also be configured as a bootable disk for system recovery. Also, its supports the Windows Series O.S., Mac OS 10.x, and Linux kernel 2.4 operating systems, and supports Windows 8, Windows 7 and Windows Vista ReadyBoost function. They are available in 4GB, 8GB, 16GB, 32GB and 64GB capacities by Toshiba MLC Flash IC.

APRO MLC Semi-Metal USB Flash Disk Gen-5/5L HERCULES-PD Series also offers unique customization for OEM customers by laser carvings.

Figure 1 shows a block diagram of APRO MLC Semi-Metal USB Flash Disk Gen-5/5L HERCULES-PD Series

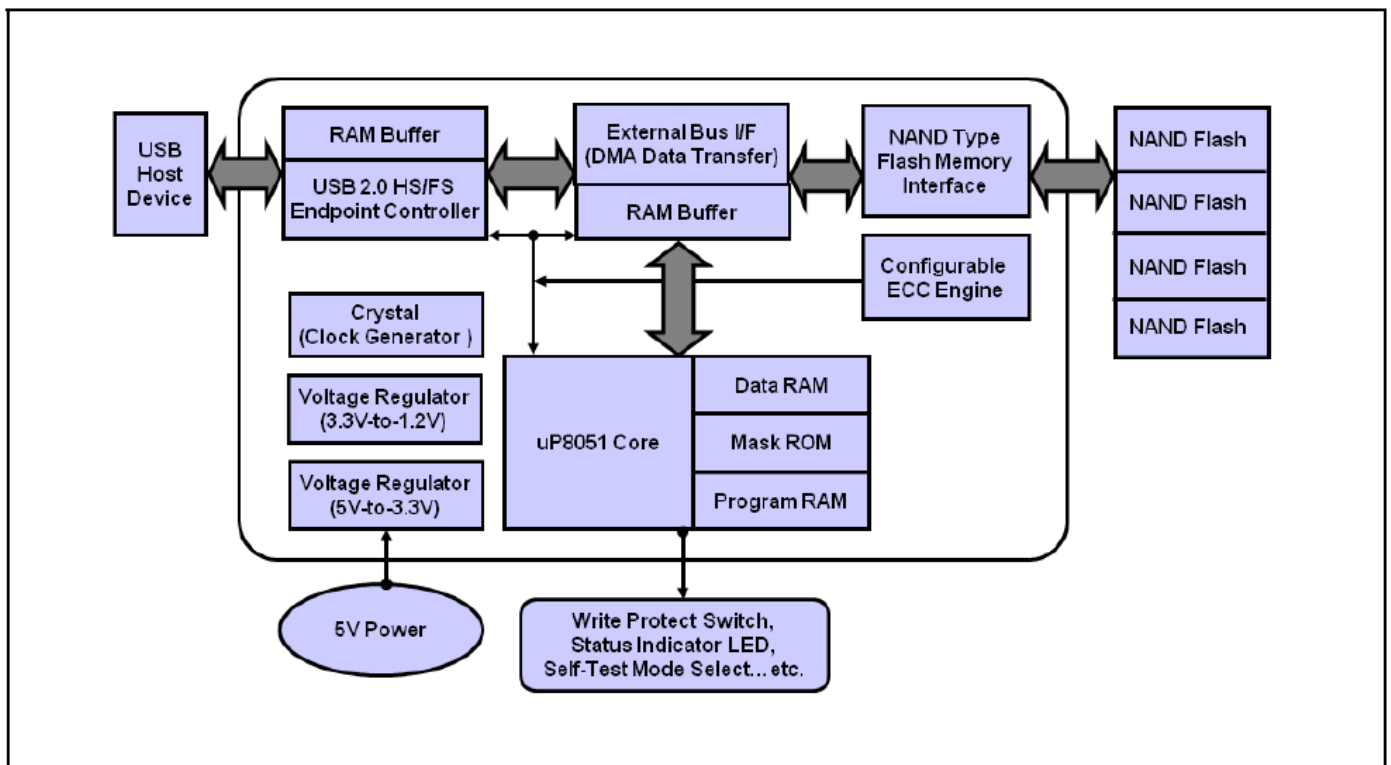


Figure 1: APRO MLC Semi-Metal USB Flash Disk Gen-5/5L HERCULES-PD Series block diagram

### 1.1. Scope

This document describes the key features and specifications of APRO MLC Semi-Metal USB Flash Disk Gen-5/5L HERCULES-PD Series.

### 1.2. Flash Management Technology – Static Leveling

In order to gain the best management for flash memory, APRO MLC Semi-Metal USB Flash Disk Gen-5/5L HERCULES-PD 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 MLC Semi-Metal USB Flash Disk Gen-5/5L HERCULES-PD 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.

### 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 Semi-Metal USB Flash Disk Gen-5/5L		Standard Grade	Wide Temp Grade
HERCULES-PD Series		SMUFDxxxG-MPDTM-5(5L)	WMUFDxxxG-MPDTM-5(5L)C
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 / 910% RH Non-Operating	
Vibration	Frequency/Displacement:	20Hz ~ 70 Hz, 1.52mm / X, Y, Z axis/60 min for each	
	Frequency/Acceleration:	70Hz ~ 2K Hz, 15G / 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 MLC Semi-Metal USB Flash Disk Gen-5/5L HERCULES-PD Series		
DC Input Voltage (VCC)		5V±10%
Maximum average value	Reading Mode :	101.5 mA (max.)
	Writing Mode :	113.1 mA (max.)
	Idle Mode :	67.1 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	
	Sequential Read (MB/s)	26.5	26.5	26.5	26.0	24.0	
	Sequential Write (MB/s)	13.0	13.0	11.5	14.9	16.5	

Note: The performance was measured using CrystalDiskMark by file size 500MB (QD32).

### 2.4. System Reliability

**Table 4: System Reliability**

Wear-leveling Algorithms		Static Wear Leveling algorithms
Bad Block Management		Supportive
ECC Technology		72 bits per 1K bytes
Erase counts		NAND MLC Flash Cell Level : 3K P/E Cycles
Endurance		<b>TBW (Tera Bytes Written)</b>
Capacity	4GB	1.1
	8GB	1.9
	16GB	3.8
	32GB	7.7
	64GB	15.4

Note:

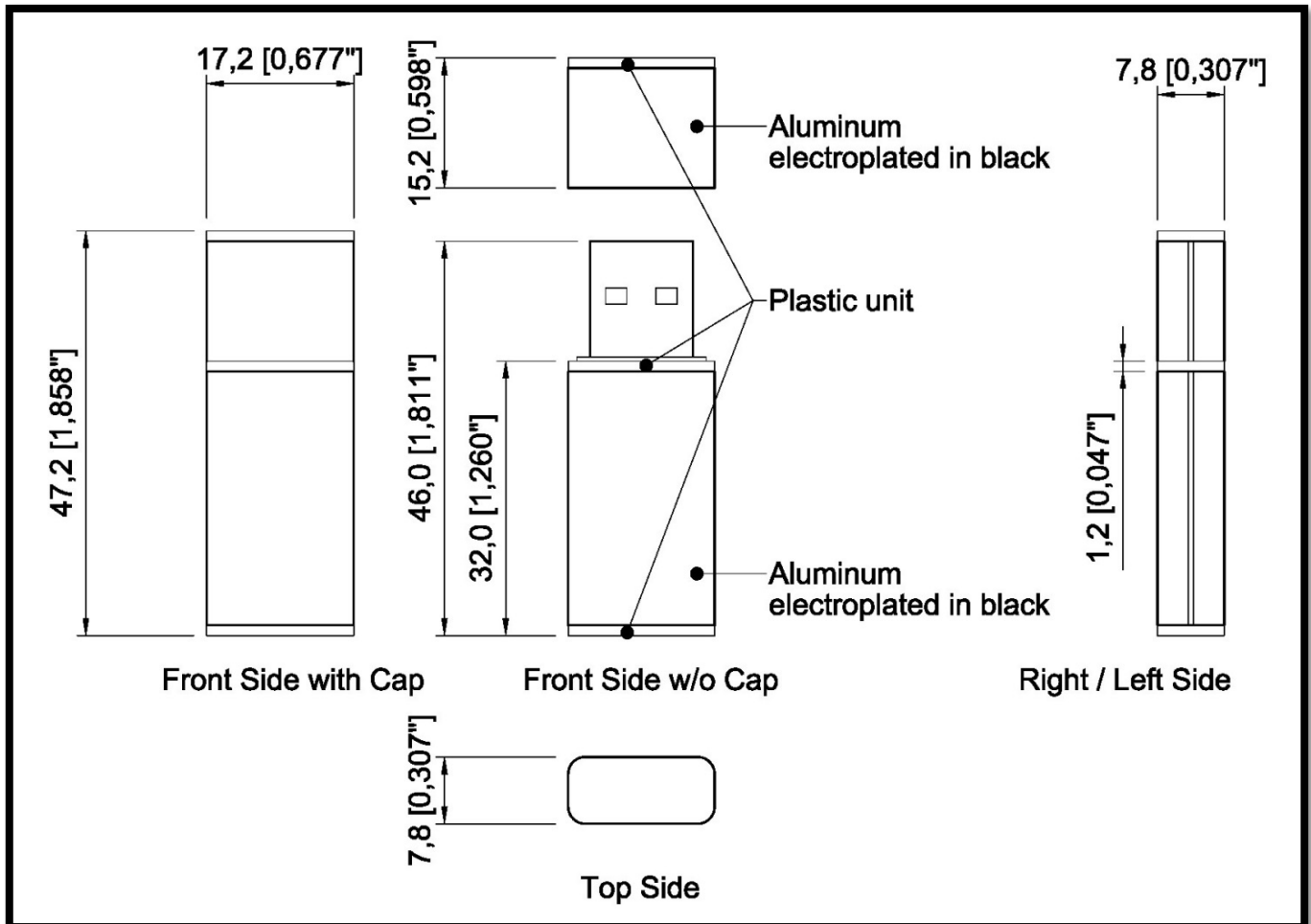
- Client workload by JESD-219A.
- The endurance of disk could be varying based on user behavior, NAND endurance cycles, and write amplification factor. It is not guaranteed by flash vendor.

### 2.5. Physical Specifications

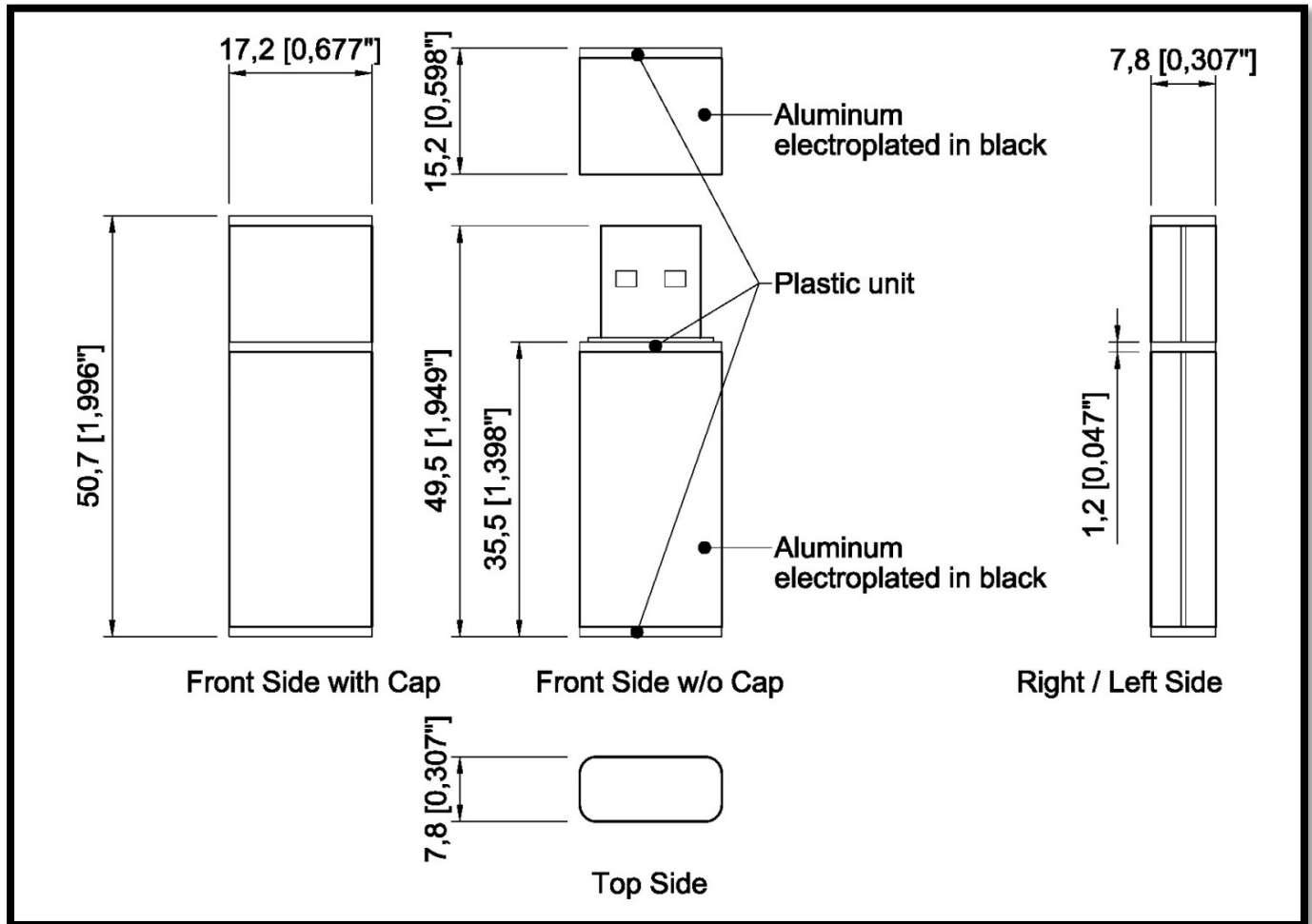
Refer to Table 5 and see Figure 2 for APRO MLC Semi-Metal USB Flash Disk Gen-5/5L HERCULES-PD Series physical specifications and dimensions.

**Table 5: Physical Specifications**

Generation	G5	G5L
Length:	47.20 mm	50.70 mm
Width:	17.20 mm	17.20 mm
Thickness:	7.80 mm	7.80 mm
Weight:	10 g / 0.35 oz.	12 g / 0.42 oz.



### Generation 5



### Generation 5L

Figure 2: APRO MLC Semi-Metal USB Flash Disk Gen-5/5L HERCULES-PD 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 uses MIL-I-46058C silicon conformal coating

### 3. Interface Description

#### 3.1. Semi-Metal USB Flash Disk interface

APRO Semi-Metal USB Flash Disk is equipped with standard USB Type A connector.

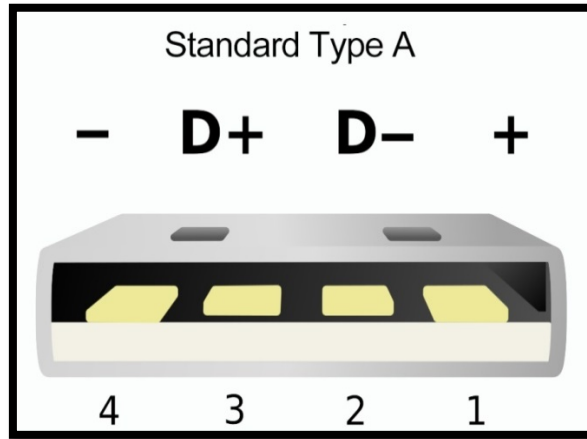


Figure 3: USB Type A Connector

#### 3.2. Pin Assignments

There are total of 4 pins in the USB Type-A Connector. The pin assignments are listed in below table 6.

Table 6 - Pin Assignments

Pin Number	Pin Name	Function
Pin 1	Vcc	Power
Pin 2	USB -	The pairs are used to transmit Address, Data and Command.
Pin 3	USB +	
Pin 4	Vss	Ground

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

APRO warrants your APRO MLC Semi-Metal USB Flash Disk Gen-5/5L HERCULES-PD 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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