USB 2.0 Flash Module Specification

Version 1.6

Table of Contents

Revision History

Revision	History	Draft Date	Author
1.1	First Release	18-Jan-08	Steven
1.2	Add top view and bottom view	30-May-08	Steven
1.3	Modify pin header define & add 2D diagram	16-Oct-08	Steven
1.4	1. Modify board dimension (Type C) 2. Add 8K page flash in page 3	4-Feb-09	Steven
1.5	Add wear leveling, bad block management and ECC	23-Apr-11	Steven
1.6	Add Low Profile Conector, Update Drawing, Ordering Information Update	18-June-12	Mike H.

A. General Description

The Unity Digital UFM (USB Flash Module) is based on USB 2.0 controller which supports USB 2.0 & 1.1 and interface to NAND Flash Memory. This Flash USB Module is specially designed for motherboard and build-in to the PC / Notebook / IA system.

By using this UFM solution, it will reduce a lot of efforts which was needed from R/D to production, as well as simplifying the RMA problems. It supports USB Mass Storage function and supports for USB boot function from BIOS. This solution provides not only easy to install, but also fast, easy to use and low cost way for user.

B. Features

- **Support Host Interfaces :** USB 2.0 & 1.1 Interface
- **Support USB HID transport:** endpoint 3
- **Support Flash Memory Interfaces :** Build-in NAND Flash Memory
- **USB Interface :**
  - Fully compatible with USB Specification Version 2.0 & 1.1
  - High speed 480Mbit/second supporting
  - Full speed 12Mbit/second supporting
  - Support one CONTROL transfer, one INTERRUPT transfer and two BULK transfer
  - Support four Endpoints :
  - Support Data Payload
  - Support USB power saving mode

- **Build-In NAND Flash Memory Interface**
  - Build-in hardware ECC circuit.
  - Support SLC (Single level cell) 2k-page large block NAND Flash.
  - Support SLC (Single level cell) 4k-page large block NAND Flash.
  - Support MLC (Multi level cell) 2k-page Large Block NAND flash.
  - Support MLC (Multi level cell) 4k-page Large Block NAND flash.
  - Support MLC (Multi level cell) 8k-page Large Block NAND flash.

- **Support In-System Programming through USB Port**

- **Transfer Rate for USB Interface:**
  - "High speed" Up to 480Mbits/sec for USB 2.0
  - "Full speed" Up to12Mbits/sec for USB 1.1

- **Support 3.3V Flash I/O:**
  Internal 3.3V regulator can supply current for controller analog circuit, controller I/O and Flash.

- **Support 1.8V Flash I/O:**
  Internal 1.8V regulator can supply the current for controller core, controller I/O and Flash.

- **Operating Voltage: 2.7~3.6V.**

- **USB bus-powered capability.**

- **Power Saving implemented.**

- **High performance**

- **Working Frequency: 12MHz.**

- **Size: 26.5 x 37.8 x 1.6 mm**

C. Wear Leveling

NAND Type flash have individually erasable blocks, each of which can be put through a finite number of erase cycles before becoming unreliable. It means after certain cycles for any given block, errors can be occurred in a much higher rate compared with typical situation. Unfortunately, in most cases, the flash media will not be used evenly. For certain areas, like file system, the data gets updated more frequently than other areas. Flash media will rapidly wear out in areas of those without swapping with other blocks.

Wear leveling attempts to work around these limitations by arranging data so that erasures and re-writes are distributed evenly across the full medium. In this way, no single sector prematurely fails due to a high concentration of program/erase cycles.

Unity provides advanced wear leveling algorithm, which can efficiently spread out the flash usage through the whole flash media area. By implementing both dynamic and static wear leveling algorithms, the life expectancy of the flash media can be improved significantly.

D. Bad Block Management

Unity Digital's UFM (USB Flash Module) provides bad block management algorithm, which can dynamically marked the bad block and replaced it while a bad block is detected. The bad block management algorithm will maps out the block and this block is no longer used. It can prevent data read / write failures.

E. ECC Management

Unity Digital's UFM (USB Flash Module) provide the hardware ECC management which can recover the error data on the fly based on BCH algorithm. It can give the better lifecycle and reliability.

F. System Performance

Below Table shows the performance parameters of MLC flash-based configurations

Specification	Parameters
Maximum performance for capacity of 2GB, 4GB, 8GB, 16GB, 32GB	
Sequential Read	21.5 MB/sec
Sequential Write	10.2 MB/sec
Random Read	21.7 MB/sec
Random Write	5.1 MB/sec

Note: Benchmark performed using HD Bench on Microsoft Windows Vista

G. ESD

Contact discharge	Up to 4 KV (enclosed in a host)
Air discharge	Up to 8 KV (enclosed in a host)

H. MTBF

The reliability figure of merit most often used for electronic equipment is Mean Time To Failure (MTTF). Unity Digital estimates MTTF using a prediction methodology based on reliability data for the individual components in Unity Digital products.

Component data comes from several sources: device life tests, failure analysis of earlier equipment, device physics, and field returns.

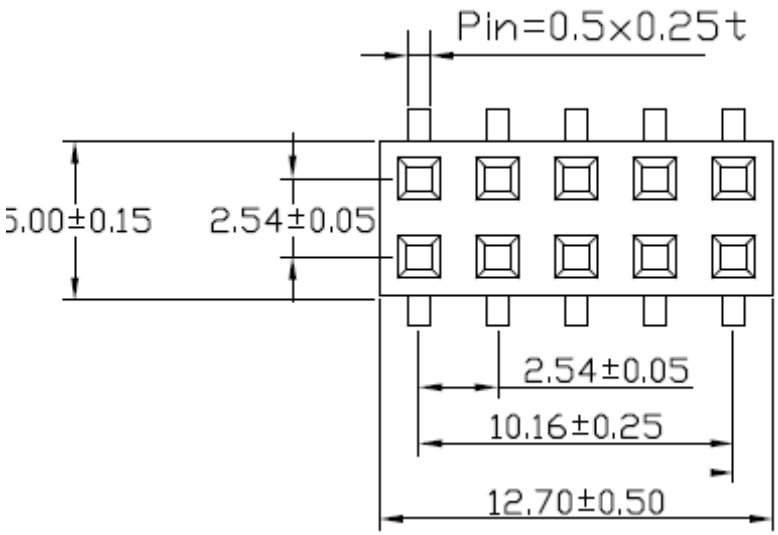
Below Table summarizes the MTTF prediction results for various UFM configurations. The analysis was performed using a Top-level assembly failure rate prediction.

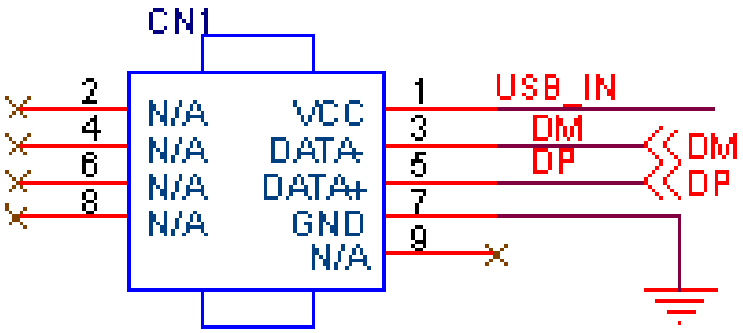
- **Failure Rate:** The total number of failures within an item population, divided by the total number of life units expended by that population, during a particular measurement interval under stated condition.
- **Mean Time To Failures (MTTF):** A basic measure of reliability for repairable items: 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.

Product	Environment	MTBF
UFM	GB, GC- Ground Benign, 25.00℃	1.1M

I. UFM Connector

I1. USB Pin Header Size & Defines – 10pins





2X5 PEN HEAD CONNECTOR SMD

I2. USB Pin Header Description – 10pins

USB Pin Header Description – Type C		
No.	**Pin Name**	**Pin Description**
1	VCC	5.0V USB Bus Power Input
2	NC	Not Connection
3	DM	USB 2.0 data in negative pin terminal.
4	NC	Not Connection
5	DP	USB 2.0 data in positive pin terminal.
6	NC	Not Connection
7	GND	0V regulator ground reference input.
8	NC	Not Connection
9	NC	Not Connection
10	NC	Not Connection

J. System Power Consumption

Item	Power Consumption (mA)	
	1 * Flash	2 * Flash
Normal	66.00	67.03
Suspend	0.38	0.39
Sleep	0.38	0.38
Read	91.08	104.12
Write	93.88	118.74
Un-configured	42.24	42.46

The above values are for reference only, it may change according to the flash memory used.

K. Endurance

The table below indicates the maximum storage capacities (in GB) allowed to be written to UFMs per day for both SLC and MLC flash-based configurations, respectively.

Each storage capacity corresponds to a specific flash capability, and both flash-based UFMs come with a 3-year warranty.

- **SLC flash-based UFM** – User may update 100% of the device capacity 6 times each day within 3 years.
- **MLC flash-based UFM** – User may update 25% of the device capacity each day within 3 years.

Endurance Information

Flash Capability	SLC Flash-Based UFM	MLC Flash-Based UFM
1 GB	< 6 GB	
2 GB	< 12 GB	< 512 MB
4 GB	< 24 GB	< 1 GB
8 GB	< 48 GB	< 2 GB
16 GB		< 4 GB
32 GB		< 8 GB

L. Electrical Specifications

Absolute Maximum Rating

Item	Symbol	Parameter	MIN	MAX	Unit
1	V_{DD}-V_{SS}	DC Power Supply	-0.3	+5.5	V
2	V_{IN}	Input Voltage	V_{SS}-0.3	V_{DD}+0.3	V
3	Ta	Operating Temperature (Commercial)	0	+70	℃
4	Ta	Operating Temperature (Industrial)	-40	+85	℃
5	Tst	Storage Temperature (Commercial)	-40	+85	℃
6	Tst	Storage Temperature (Industrial)	-50	+125	℃

Parameter	Symbol	Min	Typ	MAX	Unit
Operating Temperature (Commercial)	T_a	0	+25	+70	℃
Operating Temperature (Industrial)	T_a	-40	+25	+85	℃
V_{DD} Voltage	V_{DD}	3.0	3.3	3.6	V
		4.5	5.0	5.5	V

M. DC Characters

DC characteristics of 3.3V I/O Cells

Symbol	Parameter	Conditions	MIN	TYP	MAX	Unit
VCCK	Core Power Supply	Core Area	1.62	1.8	1.98	V
VCC3IO	Power Supply	3.3V I/O	3.0	3.3	3.6	V
Temp	Junction Temperature		0	25	115	℃
Vt	Switching threshold	LVTTL		1.5		V
Vt-	Schmitt Trigger Negative Going threshold voltage	LVTTL	0.8	1.1		V
Vt+	Schmitt Trigger Positive Going threshold voltage			1.6	2.0	V
Vol	Output Low voltage	|Iol| = 2 ~ 16 mA			0.4	V
Voh	Output High voltage	|Ioh| = 2 ~ 16 mA	2.4			V
Rpu	Input Pull-Up Resistance	PU=high, PD=low	40	75	190	KΩ
Rpd	Input Pull-Down Resistance	PU=high, PD=low	40	75	190	KΩ
Iin	Input Leakage Current	Vin = VCC3I or 0			1	μA
Ioz	Tri-state Output Leakage Current		-10	±1	10	μA

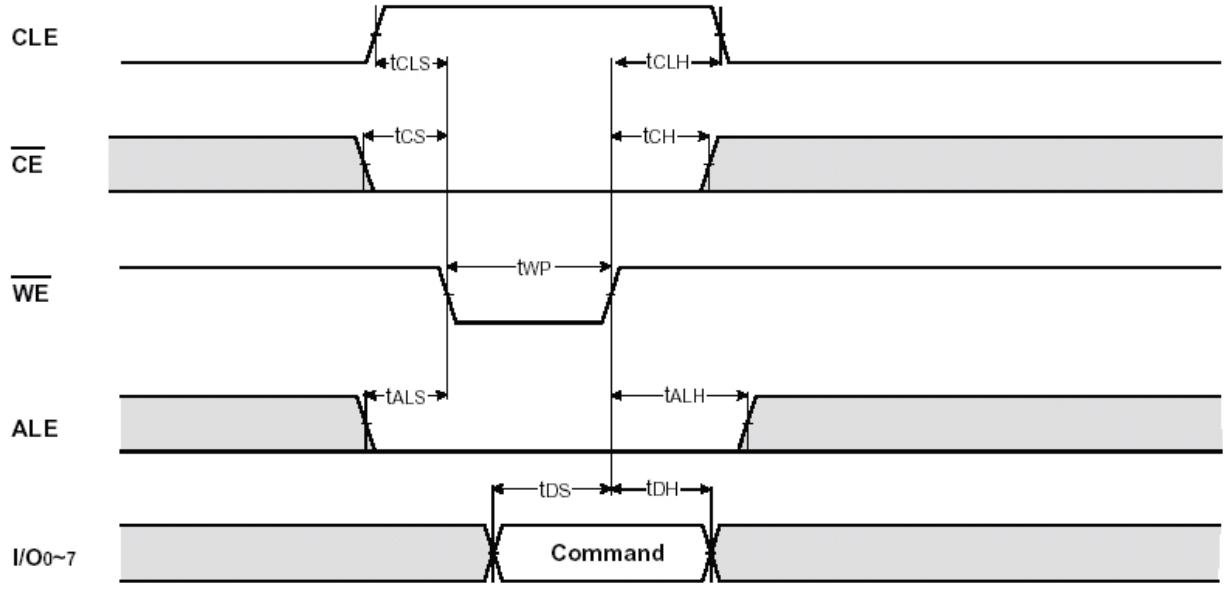
N. AC Characters

N1. Flash Memory Interface Timing

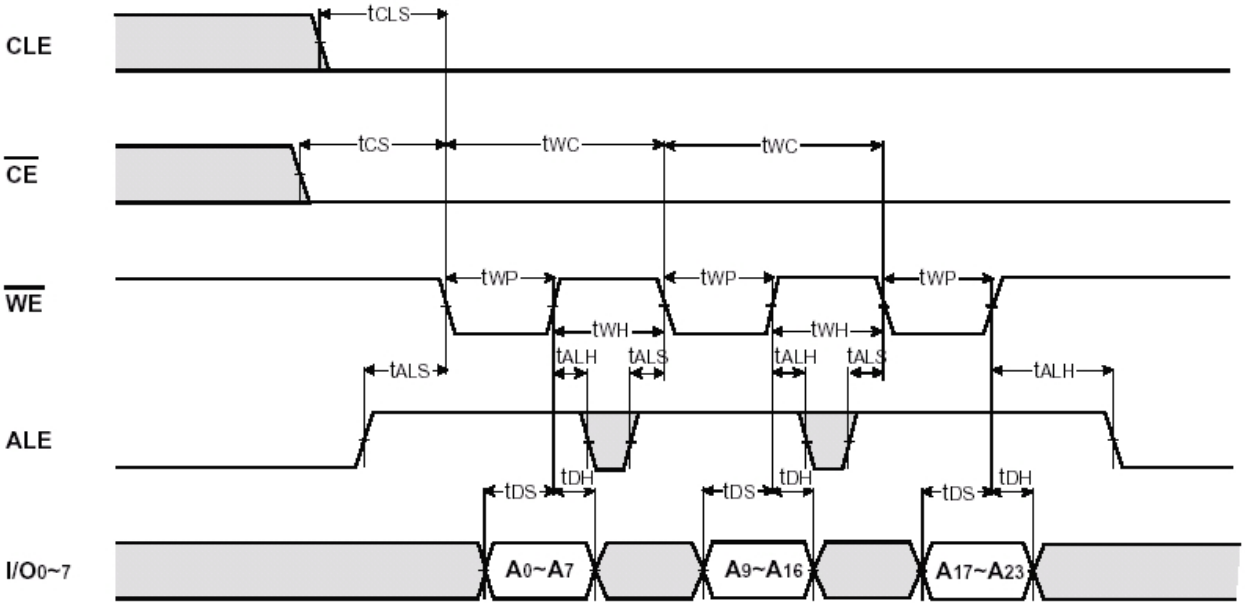
NAND Flash Memory Interface Timing

Parameter	Symbol	Min	Max	Unit
CLE Set-up Time	t_{CLS}	0	-	ns
CLE Hold Time	t_{CLH}	10	-	ns
CE Setup Time	t_{CS}	0	-	ns
CE Hold Time	t_{CH}	10	-	ns
WE Pulse Width	t_{WP}	25	-	ns
ALE Setup Time	t_{ALS}	0	-	ns
ALE Hold Time	t_{ALH}	10	-	ns
Data Setup Time	t_{DS}	20	-	ns
Data Hold Time	t_{DH}	10	-	ns
Write Cycle Time	t_{WC}	45	-	ns
WE High Hold Time	t_{WH}	15	-	ns
Read Cycle Time	t_{RC}	50	-	ns
/RE Pulse Width	t_{RP}	25	-	ns
/RE High Hold Time	t_{REH}	15	-	ns
Ready to /RE Low	t_{RR}	60	-	ns

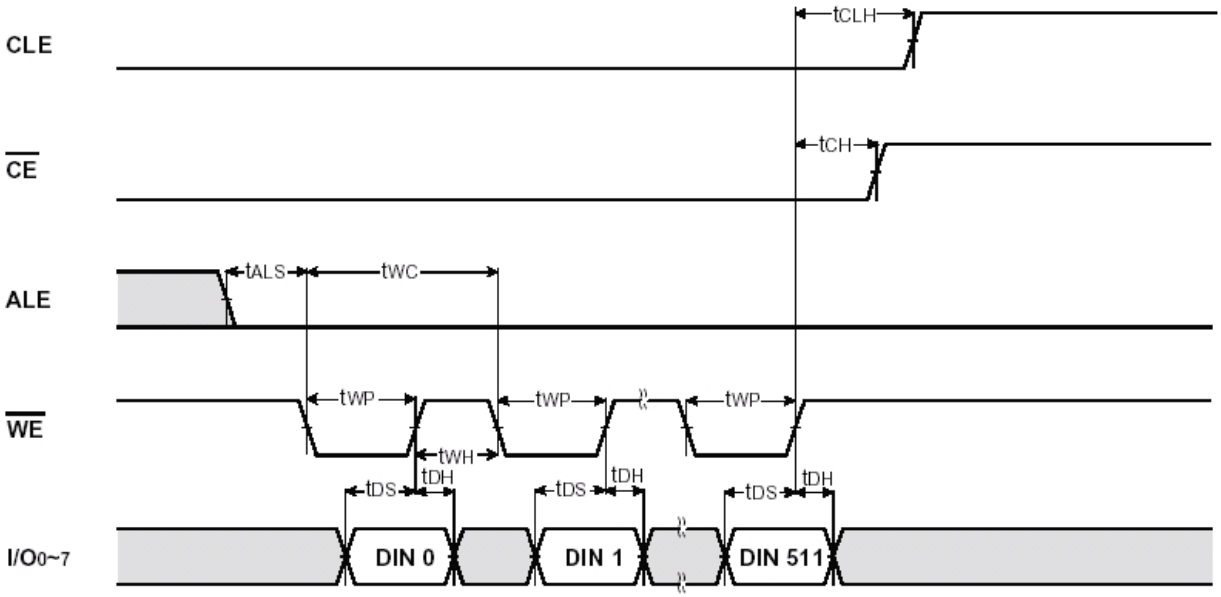
N1.1 Command Latch Cycle



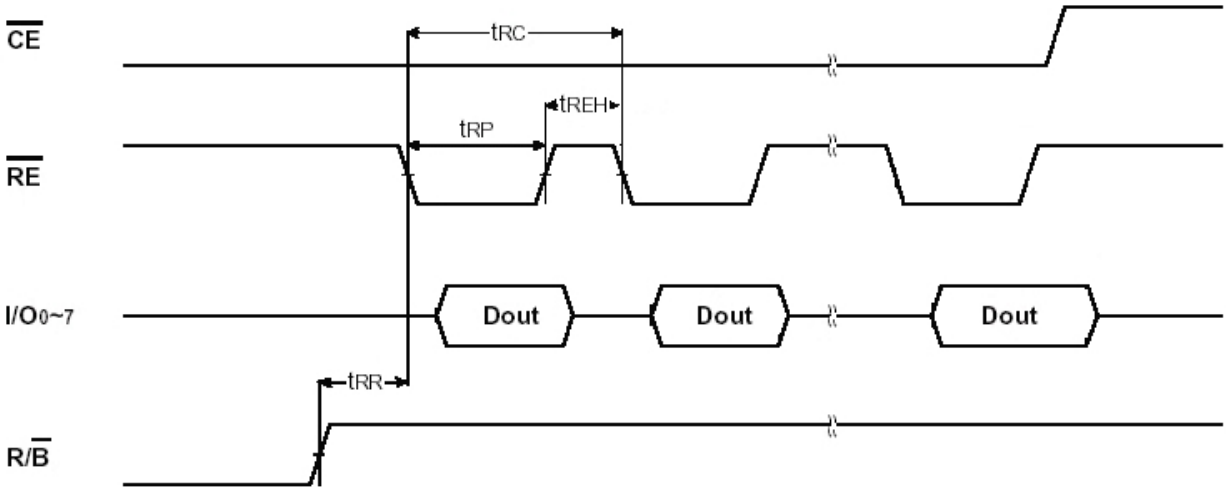
N1.2 Address Latch Cycle



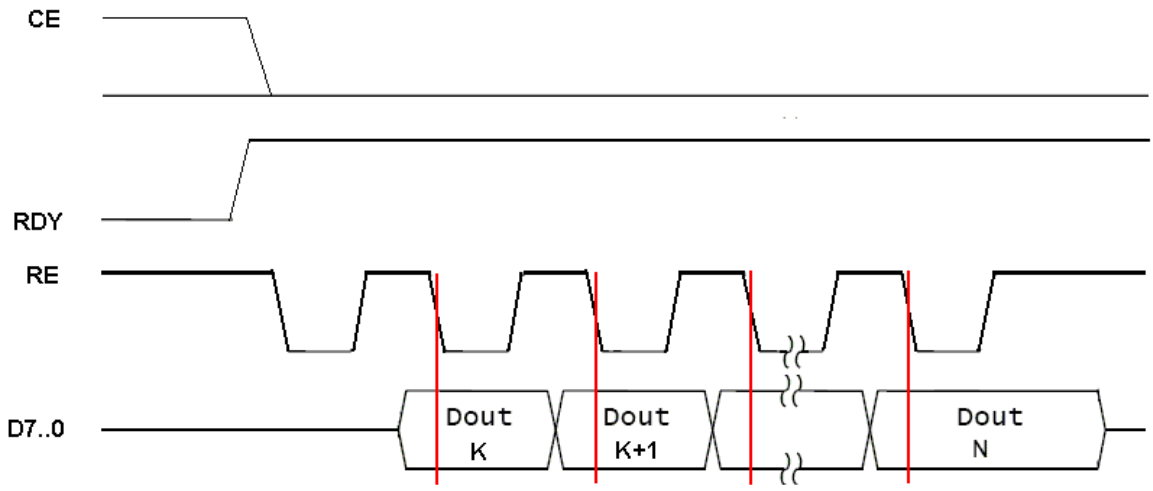
N1.3 Input Data Latch Cycle



N1.4 Sequential Out Cycle after Read (CLE=L, /WE=H, ALE=L)



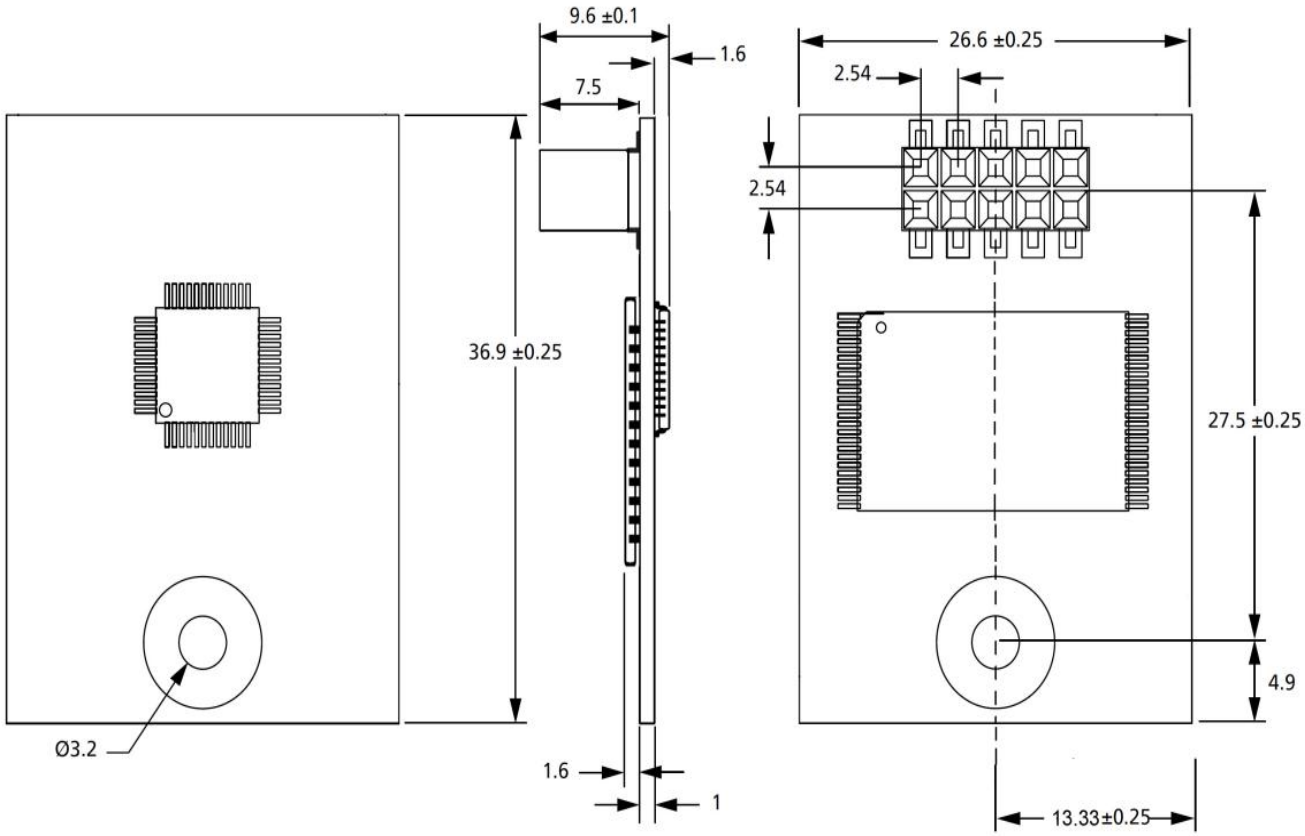
N1.5 EDO mode for data latch



EDO mode to latch the data at the negative edge of RE.

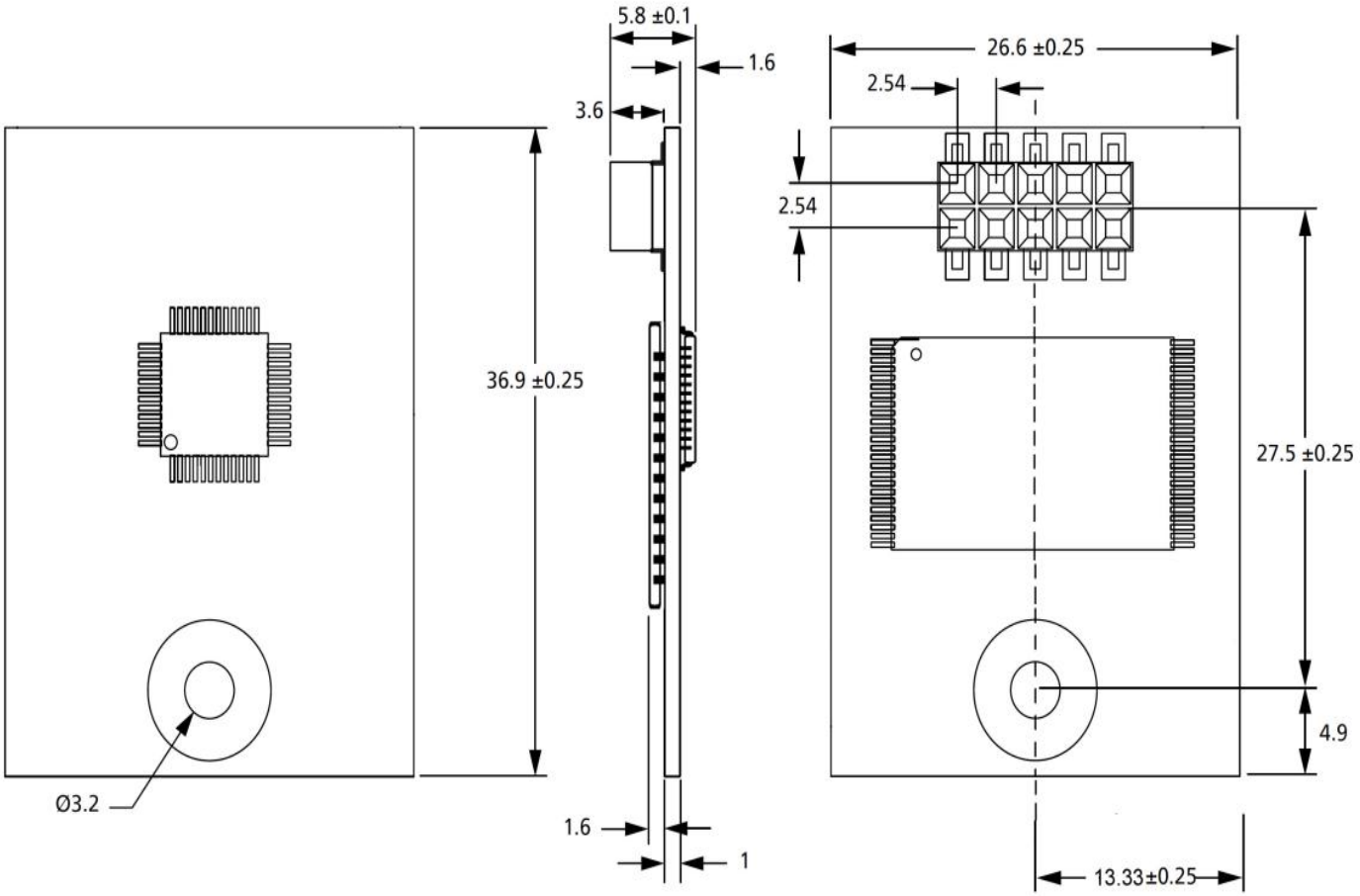
O. PCB Board Dimension

Standard Profile (SP)



Note: 1. All dimensions are in millimeters.

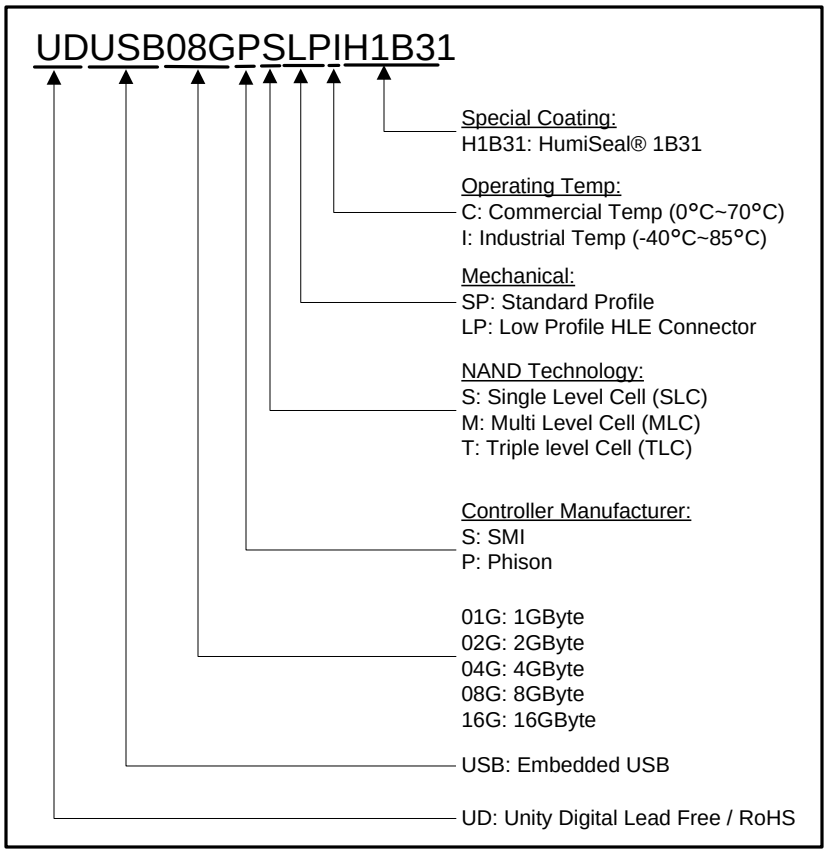
Low Profile (LP)



Note: 1. All dimensions are in millimeters.

ORDERING INFORMATION:

PART NUMBER	DESCRIPTION
UDUSB01GPSLPI	1GB SLC “I” temp Low Profile eUSB
UDUSB02GPSLPI	2GB SLC “I” temp Low Profile eUSB
UDUSB04GPSLPI	4GB SLC “I” temp Low Profile eUSB
UDUSB08GPSLPI	8GB SLC “I” temp Low Profile eUSB
UDUSB16GPSLPI	16GB SLC “I” temp Low Profile eUSB
UDUSB01GPSLPC	1GB SLC “C” temp Low Profile eUSB
UDUSB02GPSLPC	2GB SLC “C” temp Low Profile eUSB
UDUSB04GPSLPC	4GB SLC “C” temp Low Profile eUSB
UDUSB08GPSLPC	8GB SLC “C” temp Low Profile eUSB
UDUSB16GPSLPC	16GB SLC “C” temp Low Profile eUSB
UDUSB01GPSSPI	1GB SLC “I” temp Standard Profile eUSB
UDUSB02GPSSPI	2GB SLC “I” temp Standard Profile eUSB
UDUSB04GPSSPI	4GB SLC “I” temp Standard Profile eUSB
UDUSB08GPSSPI	8GB SLC “I” temp Standard Profile eUSB
UDUSB16GPSSPI	16GB SLC “I” temp Standard Profile eUSB
UDUSB01GPSSPC	1GB SLC “C” temp Standard Profile eUSB
UDUSB02GPSSPC	2GB SLC “C” temp Standard Profile eUSB
UDUSB04GPSSPC	4GB SLC “C” temp Standard Profile eUSB
UDUSB08GPSSPC	8GB SLC “C” temp Standard Profile eUSB
UDUSB16GPSSPC	16GB SLC “C” temp Standard Profile eUSB


UDUSB08GPSLPIH1B31
Special Coating:
H1B31: HumiSeal® 1B31
Operating Temp:
C: Commercial Temp (0°C~70°C)
I: Industrial Temp (-40°C~85°C)
Mechanical:
SP: Standard Profile
LP: Low Profile HLE Connector
NAND Technology:
S: Single Level Cell (SLC)
M: Multi Level Cell (MLC)
T: Triple level Cell (TLC)
Controller Manufacturer:
S: SMI
P: Phison
01G: 1GByte
02G: 2GByte
04G: 4GByte
08G: 8GByte
16G: 16GByte
USB: Embedded USB
UD: Unity Digital Lead Free / RoHS