

UD info Corp.

Industrial mSATA Drive MHD-52UB Series Product DataSheet



UD info CORP.

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Revision History

Revision	Draft Date	History	Author
1.0	2016/9/19	New release	Golden Lee
1.1	2016/11/11	Update capacity support from 4GB	Golden Lee
1.2	2016/12/15	1. Remove 4GB & 8GB capacity support 2. Update performance & power consumption	Golden Lee
1.3	2017/4/10	Add hardware write protect function support	Golden Lee
1.4	2017/5/2	Add pSLC support	Golden Lee
1.5	2017/8/1	Add hardware quick erase function support	Golden Lee
1.6	2017/10/12	Add 3D TLC Flash support	Golden Lee
1.7	2017/11/9	Modify TBW	Golden Lee
1.8	2017/12/28	1. Add MLC 4GB / 8GB / 1TB support 2. Add pSLC 2GB/4GB support	Golden Lee
1.9	2018/2/23	Update 3D TLC TBW	Golden Lee
2.0	2018/3/20	Update 3D TLC density support	Golden Lee
2.1	2018/4/11	Add SLC support	Golden Lee
2.2	2018/5/16	Add SLC 64GB/128GB support	Golden Lee
2.3	2018/6/28	Add SLC TBW data	Golden Lee
2.4	2018/8/17	Update 3D Bics3 Capacity and TBW	Golden Lee
2.5	2019/1/18	Add P/N decoder for 3D wide temperature support	Golden Lee
2.6	2019/8/5	Add 3D Bics3 pSLC support	Golden Lee
2.7	2020/2/21	Add 3D Bics4 support	Golden Lee
2.8	2020/4/16	Update P/N decoder	Golden Lee

Product Overview

- **Capacity**
 - MLC: 4GB up to 1TB
 - pSLC: 2GB up to 256GB
 - SLC: 8GB up to 128GB
 - 3D Bics3: 32GB up to 1TB
 - Bics3 pSLC: 8GB up to 256GB
 - 3D Bics4: 128GB up to 1TB
- **SATA Interface**
 - SATA Revision 3.2
 - SATA 1.5Gbps, 3Gbps, and 6Gbps interface
- **Flash Interface**
 - Flash Type: MLC, 3D Bics3/4 TLC, SLC
- **Performance**
 - Read up to 550 MB/s
 - Write up to 500 MB/s
- **TBW (Terabyte Written)** ^{Note2}
 - MLC: 1080 TBW for 1TB
 - pSLC: 1,510 TBW for 256GB
 - SLC: 2,133 TBW for 128GB
 - 3D Bics3: 835 TBW for 1TB
 - Bics3 pSLC: 12,196 TBW for 256GB
 - 3D Bics4: 825 TBW for 1TB
- **MTBF**
 - MLC & Bics3/4: 2,000,000 hours
 - pSLC: 2,500,000 hours
 - SLC: 3,000,000 hours
- **Advanced Flash Management**
 - Static and Dynamic Wear Leveling
 - Bad Block Management
 - TRIM
 - SMART
 - Over-Provision
- **Power Consumption** ^{Note1}
 - Active mode: < 2,690 mW
 - Idle mode: < 330 mW
- **Low Power Management**
 - DIPM/HIPM Mode
 - DEVSLP Mode (Optional)
- **Temperature Range**
 - Operation (Standard): 0°C ~ 70°C
 - Operation (Wide): -40°C ~ 85°C
 - Storage: -40°C ~ 85°C
- **Compliant**
 - RoHS
 - CE & FCC

Notes:

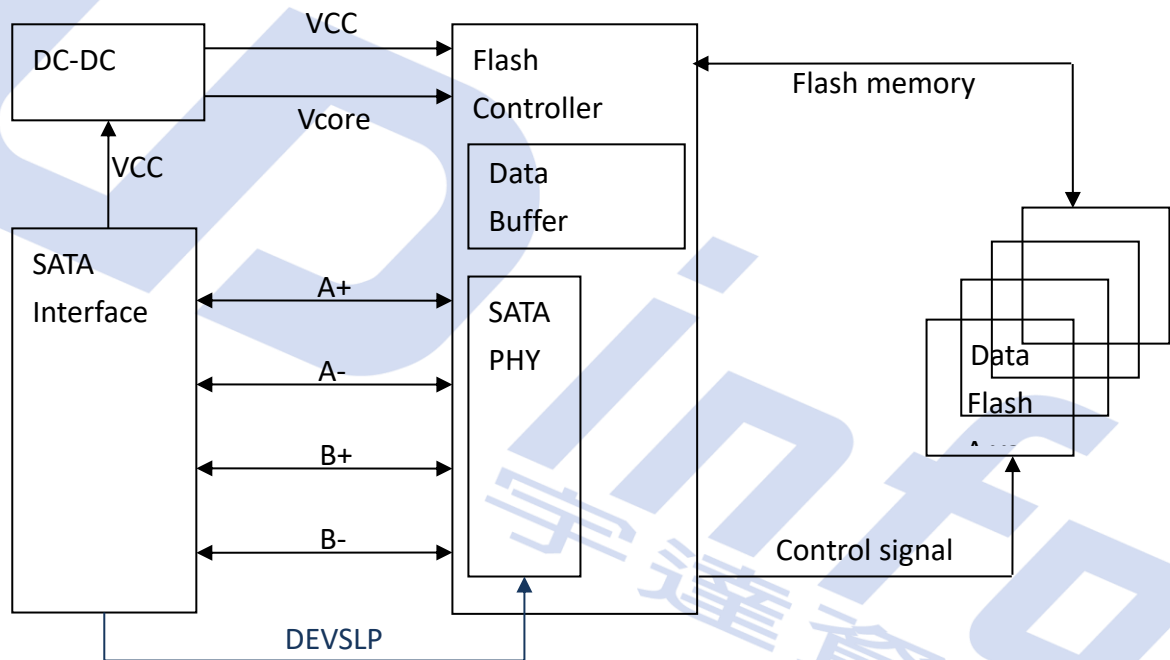
1. Please see "Power Consumption" for details.
2. Please see "TBW (Terabytes Written)" in Chapter 2 for details.

1. INTRODUCTION

1.1. General Description

UDinfo's mSATA delivers all the advantages of flash disk technology with the Serial ATA I/II/III interface and is fully compliant with the standard mSATA form factor, known as JEDEC MO-300 standard. The module is designed to operate at a maximum operating frequency of 200MHz with 30MHz external crystal. Its capacity could provide a wide range up to 1TB. Moreover, it can reach up to 550MB/s read as well as 500MB/s write (with 32MB SDR enabled and measured by CrystalDiskMark v5.0). Meanwhile, the power consumption of the mSATA module is much lower than traditional hard drives.

1.2. Block Diagram



mSATA Block Diagram

2. PRODUCT SPECIFICATIONS



- **Capacity**
 - MLC: From 4GB up to 1TB (support 48-bit addressing mode)
 - pSLC: From 2GB up to 256GB (support 48-bit addressing mode)
 - SLC: From 8GB up to 128GB (support 48-bit addressing mode)
 - 3D Bics3: From 32GB up to 1TB (support 48-bit addressing mode)
 - Bics3 pSLC: From 8GB up to 256GB (support 48-bit addressing mode)
 - 3D Bics4: From 128GB up to 1TB (support 48-bit addressing mode)
- **Electrical/Physical Interface**
 - SATA Interface
 - ◆ Compliant with SATA Revision 3.2
 - ◆ Compatible with SATA 1.5Gbps, 3Gbps and 6Gbps interface
 - ◆ Support power management
 - ◆ Support expanded register for SATA protocol 48 bits addressing mode
 - ◆ Embedded BIST function for SATA PHY for low cost mass production
- **Built-in 2-channel NAND flash interface controller**
 - Compliant with Toggle 1.0 and Toggle 2.0 NAND Flash interface
 - Compliant with ONFI 4.0 interface:
 - ◆ SDR up to mode 5
 - ◆ NV-DDR up to mode 5
 - ◆ NV-DDR2 up to mode 7
 - ◆ NV-DDR3 up to mode 8
- **Supported NAND Flash**
 - Support up to 16 Flash Chip Enables (CE) within single design
 - 15nm/3D-NAND MLC and TLC
 - Support all types of SLC/MLC/TLC/3D-NAND, 8KB/page and 16K/page NAND flash
 - Support ONFI 2.3, ONFI 3.0, ONFI 3.2 and ONFI 4.0 interface: 2 channels at maximum
- **ECC Scheme**
 - Applies the LDPC (Low Density Parity Check) of ECC algorithm
- **UART function**
- **GPIO**

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- Support SMART and TRIM commands
- Support Hardware Write Protect function (optional)
- Support Hardware Quick Erase function (optional)
- Capacity Information

Capacity	Cylinders	Heads	Sectors	Total Sectors	User Data Size
2GB	3,897	16	63	3,928,176	Depended on file management
4GB	7,773	16	63	7,835,184	
8GB	15,525	16	63	15,649,200	
16GB	16,383	16	63	31,277,232	
30GB	16,383	16	63	58,626,288	
32GB	16,383	16	63	62,533,296	
60GB	16,383	16	63	117,231,408	
64GB	16,383	16	63	125,045,424	
120GB	16,383	16	63	234,441,648	
128GB	16,383	16	63	250,069,680	
240GB	16,383	16	63	468,862,128	
256GB	16,383	16	63	500,118,192	
480GB	16,383	16	63	937,703,088	
512GB	16,383	16	63	1,000,215,216	
960GB	16,383	16	63	1,875,385,008	
1TB	16,383	16	63	2,000,409,264	

● Performance

■ MLC:

Capacity	Flash Structure	Flash Type	Sequential	
			Read (MB/s)	Write (MB/s)
4GB	4GB x 1	15nm, TSOP	160	50
8GB	8GB x 1	15nm, TSOP	165	90
16GB	16GB x 1	15nm, TSOP	300	80
30GB/32GB	16GB x 2	15nm, TSOP	550	160
60GB/64GB	16GB x 4	15nm, TSOP	550	310
120GB/128GB	64GB x 2	15nm, BGA	550	460
	32GB x 4	15nm, BGA	550	460
240GB/256GB	64GB x 4	15nm, BGA	550	490
480GB/512GB	128GB x 4	15nm, BGA	550	490
960GB/1TB	256GB x 4	15nm, BGA	550	435

■ pSLC:

Capacity	Flash Structure	Flash Type	Sequential	
			Read (MB/s)	Write (MB/s)
2GB	4GB x 1	15nm, TSOP	160	50
4GB	8GB x 1	15nm, TSOP	165	90
8GB	16GB x 1	15nm, TSOP	300	80
16GB	16GB x 2	15nm, TSOP	550	160
30GB/32GB	16GB x 4	15nm, TSOP	550	310
60GB/64GB	64GB x 2	15nm, BGA	550	460
	32GB x 4	15nm, BGA	550	460
120GB/128GB	64GB x 4	15nm, BGA	550	490
240GB/256GB	128GB x 4	15nm, BGA	550	490

■ SLC:

Capacity	Flash Structure	Flash Type	Sequential	
			Read (MB/s)	Write (MB/s)
8GB	8GB x 1	24nm, BGA	320	70
16GB	8GB x 2	24nm, BGA	540	150
32GB	16GB x 2	24nm, BGA	510	300
64GB	32GB x 2	24nm, BGA	510	310
128GB	32GB x 4	24nm, BGA	480	420

■ 3D Bics3:

Capacity	Flash Structure	Flash Type	Sequential	
			Read (MB/s)	Write (MB/s)
30GB/32GB	32GB x 1	Bics3, TSOP	300	120
60GB/64GB	32GB x 2	Bics3, TSOP	550	250
120GB/128GB	32GB x 4	Bics3, TSOP	550	450
	64GB x 2	Bics3, TSOP	550	450
		Bics3, BGA	550	450
240GB/256GB	64GB x 4	Bics3, TSOP	550	490
	128GB x 2	Bics3, TSOP	550	490
		Bics3, BGA	550	490
480GB/512GB	128GB x 4	Bics3, TSOP	550	490
		Bics3, BGA	550	490
	256GB x 2	Bics3, BGA	550	490
960GB/1TB	256GB x 4	Bics3, BGA	550	500

■ Bics3 pSLC:

Capacity	Flash Structure	Flash Type	Sequential	
			Read (MB/s)	Write (MB/s)
8GB	32GB x 1	Bics3, TSOP	300	110
16GB	32GB x 2	Bics3, TSOP	550	240
	64GB x 1	Bics3, BGA	320	190
32GB	64GB x 2	Bics3, BGA	550	380
64GB	128GB x 2	Bics3, BGA	550	460
128GB	256GB x 2	Bics3, BGA	550	470
256GB	256GB x 4	Bics3, BGA	530	470

■ 3D Bics4:

Capacity	Flash Structure	Flash Type	Sequential	
			Read (MB/s)	Write (MB/s)
120GB/128GB	64GB x 2	Bics4, BGA	540	450
240GB/256GB	64GB x 4	Bics4, BGA	540	480
480GB/512GB	128GB x 4	Bics4, BGA	540	480
906GB/1TB	256GB x 4	Bics4, BGA	540	480

Notes:

1. The performance was estimated based on 2D/3D NAND flash.
2. Performance may differ according to flash configuration and platform.
3. The table above is for reference only.

- **TBW (Terabytes Written)**

- **MLC:**

Capacity	Flash Structure	TBW
4GB	4GB x 1	1
8GB	8GB x 1	3
16GB	16GB x 1	6
32GB	16GB x 2	13
64GB	16GB x 4	30
128GB	64GB x 2 32GB x 4	87
256GB	64GB x 4	198
512GB	128GB x 4	540

- **pSLC:**

Capacity	Flash Structure	TBW
2GB	4GB x 1	4
4GB	8GB x 1	10
8GB	16GB x 1	21
16GB	16GB x 2	49
32GB	16GB x 4	106
64GB	64GB x 2 32GB x 4	215
128GB	64GB x 4	649
256GB	128GB x 4	1510

- **SLC:**

Capacity	Flash Structure	TBW
8GB	8GB x 1	74
16GB	8GB x 2	153
32GB	16GB x 2	325
64GB	32GB x 2	761
128GB	32GB x 4	2133

■ 3D Bics3:

Capacity	Flash Structure	TBW
32GB	32GB x 1	17
64GB	32GB x 2	42
128GB	32GB x 4	75
256GB	128GB x 2	180
512GB	128GB x 4	425
1TB	256GB x 4	835

■ Bics3 pSLC:

Capacity	Flash Structure	TBW
8GB	32GB x 1	188
16GB	64GB x 1	374
32GB	64GB x 2	769
64GB	128GB x 2	1682
128GB	256GB x 2	5034
256GB	256GB x 4	12196

■ 3D Bics4:

Capacity	Flash Structure	TBW
120GB/128GB	64GB x 2	70
240GB/256GB	64GB x 4	155
480GB/512GB	128GB x 4	328
960GB/1TB	256GB x 4	825

Notes:

1. Samples were built using 2D/3D NAND flash.
2. The test followed JEDEC219A client endurance workload.
3. TBW may differ according to flash configuration and platform.
4. The endurance of SSD could be estimated based on user behavior, NAND endurance cycles, and write amplification factor. It is not guaranteed by flash vendor.

3. ENVIRONMENTAL SPECIFICATIONS



3.1. Environmental Conditions

3.1.1. Temperature and Humidity

- Temperature:
 - ◆ Storage: -40°C to 85°C
 - ◆ Operational (Standard grade): 0°C to 70°C
 - ◆ Operational (Wide grade): -40°C to 85°C
- Humidity:
 - ◆ Standard grade: RH 90% under 40°C (operational)
 - ◆ Wide grade: RH 95% under 55°C (operational)

■ High Temperature Test Condition

	Temperature	Humidity	Test Time
Operation (Standard)	70°C	0% RH	72 hours
Operation (Wide)	85°C	0% RH	72 hours
Storage (Standard)	85°C	0% RH	72 hours
Storage (Wide)	85°C	0% RH	168 hours

Result: No any abnormality is detected.

■ Low Temperature Test Condition

	Temperature	Humidity	Test Time
Operation (Standard)	0°C	0% RH	72 hours
Operation (Wide)	-40°C	0% RH	72 hours
Storage (Standard)	-40°C	0% RH	72 hours
Storage (Wide)	-40°C	0% RH	168 hours

Result: No any abnormality is detected.

■ High Humidity Test Condition

	Temperature	Humidity	Test Time
Operation (Standard)	40°C	93% RH	24 hours
Operation (Wide)	55°C	95% RH	72 hours
Storage (Standard)	40°C	95% RH	72 hours
Storage (Wide)	55°C	95% RH	96 hours

Result: No any abnormality is detected.

■ Temperature Cycle Test

	Temperature	Test Time	Cycle
Operation (Standard)	0°C	30 min	10 cycles
	70°C	30 min	
Operation (Wide)	-40°C	30 min	20 cycles
	85°C	30 min	
Storage (Standard)	-40°C	30 min	10 cycles
	85°C	30 min	
Storage (Wide)	-40°C	30 min	50 cycles
	85°C	30 min	

Result: No any abnormality is detected.

3.1.2. Shock

■ Shock Specification

	Acceleration Force	Half Sin Pulse Duration
Non-Operational	1500G	0.5ms
Operational	1500G	0.5ms

Result: No any abnormality is detected when power on.

3.1.3. Vibration

■ Vibration Specification

	Condition		Vibration Orientation
	Frequency/Displacement	Frequency/Acceleration	
Non-Operational	20Hz~80Hz/1.52mm	80Hz~2000Hz/20G	X, Y, Z axis/60 min for each

Result: No any abnormality is detected when power on.

3.1.4. Drop

■ Drop Specification

	Height of Drop	Number of Drop
Non-operational	80cm free fall	6 face of each unit, 2 times

Result: No any abnormality is detected when power on.

3.1.5. Bending

■ Bending Specification

	Force	Action
Non-operational	≥20N	Hold 1min/5times

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Result: No any abnormality is detected when power on.

3.1.6. Electrostatic Discharge (ESD)

■ Contact ESD Specification

Device	Capacity	Temperature	Relative Humidity	+/- 4KV	Result
mSATA	512GB	24.0°C	49% (RH)	Device functions are affected, but EUT will be back to its normal or operational state automatically.	PASS

3.2. MTBF

MTBF, an acronym for Mean Time between Failures, is a measure of a device's reliability. Its value represents the average time between a repair and the next failure. The measure is typically in units of hours. The higher the MTBF value, the higher the reliability of the device. The predicted result of UDinfo's mSATA is more than 3,000,000 hours.

3.3. Certification

- RoHS
- CE / FCC

3.4. Compliance

- SATA III (SATA Rev. 3.2)
- Up to ATA/ATAPI-8 (Including S.M.A.R.T)

4. ELECTRICAL SPECIFICATIONS



4.1. Supply Voltage

Parameter	Rating
Operating Voltage	3.3V , $\pm 5\%$
Rise Time (Max/min)	100ms / 0.1ms
Fall Time (Max/min)	5s / 1ms

4.2. Power Consumption

■ MLC

Capacity	Flash Structure	Flash Type	Read	Write	Partial	Slumber	Idle	DEVSLP
4GB	4GB x 1	15nm, TSOP	700	740	22	16	280	4.9
8GB	8GB x 1	15nm, TSOP	700	740	22	16	280	4.9
16GB	16GB x 1	15nm, TSOP	1180	1200	15	10	262	4.9
32GB	16GB x 2	15nm, TSOP	1185	1300	15	10.5	265	4.9
64GB	16GB x 4	15nm, TSOP	1220	1310	15	10.5	265	4.9
128GB	64GB x 2	15nm, BGA	1270	1600	16	11	280	4.9
	32GB x 4	15nm, BGA	1280	1700	16	11	285	4.9
256GB	64GB x 4	15nm, BGA	1320	2600	16.5	10	285	4.9
512GB	128GB x 4	15nm, BGA	1450	2690	16.5	10.6	285	4.9

Unit: mW

■ pSLC

Capacity	Flash Structure	Flash Type	Read	Write	Partial	Slumber	Idle	DEVSLP
2GB	4GB x 1	15nm, TSOP	1120	1150	13	9	265	4.9
4GB	8GB x 1	15nm, TSOP	1150	1180	13	9	265	4.9
8GB	16GB x 1	15nm, TSOP	1180	1200	15	10	262	4.9
16GB	16GB x 2	15nm, TSOP	1185	1300	15	10.5	265	4.9
32GB	16GB x 4	15nm, TSOP	1220	1310	15	10.5	265	4.9
64GB	64GB x 2	15nm, BGA	1270	1600	16	11	280	4.9
	32GB x 4	15nm, BGA	1280	1700	16	11	285	4.9
128GB	64GB x 4	15nm, BGA	1320	2600	16.5	10	285	4.9
256GB	128GB x 4	15nm, BGA	1450	2690	16.5	10.6	285	4.9

Unit: mW

■ SLC

Capacity	Flash Structure	Flash Type	Read	Write	Partial	Slumber	Idle	DEVSLP
8GB	8GB x 1	24nm, BGA	1,200	1,000	20	15	315	4.9
16GB	8GB x 2	24nm, BGA	1,600	1,270	20	15	320	4.9
32GB	16GB x 2	24nm, BGA	1,600	1,750	20	15	325	4.9
64GB	32GB x 2	24nm, BGA	1,700	1,950	20	15	325	4.9
128GB	32GB x 4	24nm, BGA	1,660	2,250	20	15	325	4.9

Unit: mW

■ 3D Bics3

Capacity	Flash Structure	Flash Type	Read	Write	Partial	Slumber	Idle	DEVSLP
32GB	32GB x 1	Bics3, TSOP	1,100	1,000	15	10	300	4.9
64GB	32GB x 2	Bics3, TSOP	1,215	1,020	15	10	300	4.9
128GB	32GB x 4	Bics3, TSOP	1,300	1,350	20	15	320	4.9
	64GB x 2	Bics3, TSOP	1,300	1,350	15	10	300	4.9
		Bics3, BGA	1,270	1,360	20	15	325	4.9
256GB	64GB x 4	Bics3, TSOP	1,350	1,400	15	10	300	4.9
	128GB x 2	Bics3, TSOP	1,380	1,450	20	15	330	4.9
		Bics3, BGA	1,400	1,450	20	15	330	4.9
512GB	128GB x 4	Bics3, TSOP	1,360	1,450	22	16	320	4.9
		Bics3, BGA	1,500	1,550	22	15	330	4.9
	256GB x 2	Bics3, BGA	1,470	1,520	22	15	325	4.9
1TB	256GB x 4	Bics3, BGA	1,600	1,650	22	15	330	4.9

Unit: mW

■ Bics3 pSLC

Capacity	Flash Structure	Flash Type	Read	Write	Partial	Slumber	Idle	DEVSLP
8GB	32GB x 1	Bics3, TSOP	1,100	1,000	15	10	300	4.9
16GB	32GB x 2	Bics3, TSOP	1,215	1,020	15	10	300	4.9
	64GB x 1	Bics3, BGA	1,215	1,020	15	10	300	4.9
32GB	64GB x 2	Bics3, BGA	1,270	1,360	20	15	325	4.9
64GB	128GB x 2	Bics3, BGA	1,400	1,450	20	15	330	4.9
128GB	256GB x 2	Bics3, BGA	1,470	1,520	22	15	325	4.9
256GB	256GB x 4	Bics3, BGA	1,600	1,650	22	15	330	4.9

Unit: mW

■ 3D Bics4

Capacity	Flash Structure	Flash Type	Read	Write	Partial	Slumber	Idle	DEVSLP
128GB	64GB x 2	Bics4, BGA	1,350	1,330	15	11	215	4.9
256GB	64GB x 4	Bics4, BGA	1,380	1,400	16	12	220	4.9
512GB	128GB x 4	Bics4, BGA	1,400	1,380	16	12	225	4.9
1TB	256GB x 4	Bics4, BGA	1,800	1,600	17	13	230	4.9

Unit: mW

Notes:

1. It's average value of power consumption is achieved based on 100% conversion efficiency.
2. The measured power voltage is 3.3V.
3. Samples were built using 2D/3D NAND flash and measured under normal temperature.
4. Sequential R/W is measured while testing 4000MB sequential R/W 5 times by CyrstalDiskMark.
5. Power Consumption may differ according to flash configuration and platform.

5. INTERFACE



5.1. Pin Assignment and Descriptions

Pin #	mSATA Pin	Description
1	NC	No Connect Reserve for Write Protect (Active high)
2	+3.3V	3.3V Source
3	NC	No Connect
4	DGND	Digital GND
5	NC	No Connect
6	NC	No Connect
7	NC	No Connect
8	NC	No Connect
9	DGND	Digital GND
10	NC	No Connect
11	NC	No Connect
12	NC	No Connect
13	NC	No Connect
14	NC	No Connect
15	DGND	Digital GND
16	NC	No Connect
17	NC	No Connect Reserve for Quick Erase (Active low)
18	DGND	Digital GND
19	NC	No Connect
20	NC	No Connect
21	SATA GND	SATA Ground Return Pin
22	NC	No Connect
23	TXP (out)	Host Receiver Differential Signal Pair
24	+3.3V	3.3V Source
25	TXN (out)	Host Receiver Differential Signal Pair
26	SATA GND	SATA Ground Return Pin
27	SATA GND	SATA Ground Return Pin
28	NC	No Connect
29	SATA GND	SATA Ground Return Pin
30	NC	No Connect

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Pin #	mSATA Pin	Description
31	RXN (in)	Host Transmitter Differential Signal Pair
32	NC	No Connect
33	RXP (in)	Host Transmitter Differential Signal Pair
34	DGND	Digital GND
35	SATA GND	SATA Ground Return Pin
36	NC	No Connect
37	SATA GND	SATA Ground Return Pin
38	NC	No Connect
39	+3.3V	3.3V Source
40	DGND	Digital GND
41	+3.3V	3.3V Source
42	NC	No Connect
43	NC	No Connect
44	DEVSLP	Enter/Exit DevSleep
45	NC	Reserved pin
46	NC	No Connect
47	NC	Reserved pin
48	NC	No Connect
49	DAS	Device Activity Signal
50	DGND	Digital GND
51	GND	Default connect to GND
52	+3.3V	3.3V Source

6. SUPPORTED COMMANDS



6.1. ATA Command List

Op-Code	Command Description	Op-Code	Command Description
00h	NOP	60h	Read FPDMA Queued
06h	Data Set Management	61h	Write FPDMA Queued
10h	Recalibrate	70h	Seek
20h	Read Sectors	90h	Execute Device Diagnostic
21h	Read Sectors without Retry	91h	Initialize Device Parameters
24h	Read Sectors EXT	92h	Download Microcode
25h	Read DMA EXT	93h	Download Microcode DMA
27h	Read Native Max Address EXT	B0h	SMART
29h	Read Multiple EXT	B0h	D0h SMART READ DATA
2Fh	Read Log EXT	B0h	D1h SMART READ DATA ATTRIBUTE THRESHOLD
30h	Write Sectors	B0h	D2h SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE
31h	Write Sectors without Retry	B0h	D3h SMART SAVE ATTRIBUTE VALUES
34h	Write Sectors EXT	B0h	D4h SMART EXECUTE OFF-LINE IMMEDIATE
35h	Write DMA EXT	B0h	D5h SMART READ LOG
37h	Set Native Max Address EXT	B0h	D6h SMART WRITE LOG
39h	Write Multiple EXT	B0h	D8h SMART ENABLE OPERATIONS
3Dh	Write DMA FUA EXT	B0h	D9h SMART DISABLE OPERATIONS
3Fh	Write Long EXT	B0h	DAh SMART RETURN STATUS
40h	Read Verify Sectors	B0h	DBh SMART ENABLE/DISABLE AUTOMATIC OFF-LINE
41h	Read Verify Sectors without Retry	B1h	DEVICE CONFIGURATION OVERLAY
42h	Read Verify Sectors EXT	B1h	C0h DEVICE CONFIGURATION RESTORE
45h	Write Uncorrectable EXT	B1h	C1h DEVICE CONFIGURATION FREEZE LOCK
47h	Read Log DMA EXT	B1h	C2h DEVICE CONFIGURATION IDENTIFY
57h	Write Log DMA EXT	B1h	C3h DEVICE CONFIGURATION SET
B1h	C4h	DEVICES CONFIGURATION IDENTIFY DMA	ECh Identify Device
B1h	C5h	DEVICES CONFIGURATION SET DMA	EFh Set Features
C4h	Read Multiple	EFh	02h Enable 8-bit PIO transfer mode

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Op-Code		Command Description	Op-Code		Command Description
C5h		Write Multiple	EFh	03h	Set transfer mode based on value in Count field
C6h		Set Multiple Mode	EFh	05h	Enable advanced power management
C8h		Read DMA	EFh	10h	Enable use of Serial ATA feature
C9h		Read DMA without Retry	EFh	10h 02h	Enable DMA Setup FIS Auto-Activate optimization
CAh		Write DMA	EFh	10h 03h	Enable Device-initiated interface power state (DIPM) transitions
CBh		Write DMA without Retry	EFh	10h 06h	Enable Software Settings Preservation (SSP)
CEh		Write Multiple FUA EXT	EFh	10h 07h	Enable Device Automatic Partial to Slumber transitions
E0h		Standby Immediate	EFh	10h 09h	Enable Device Sleep
E1h		Idle Immediate	EFh	55h	Disable read look-ahead feature
E2h		Standby	EFh	66h	Disable reverting to power-on defaults
E3h		Idle	EFh	82h	Disable write cache
E4h		Read Buffer	EFh	85h	Disable advanced power management
E5h		Check Power Mode	EFh	90h	Disable use of Serial ATA feature set
E6h		Sleep	EFh	90h 02h	Disable DMA Setup FIS Auto-Activate optimization
E7h		Flush Cache	EFh	90h 03h	Disable Device-initiated interface power state (DIPM) transitions
E8h		Write Buffer	EFh	90h 06h	Disable Software Settings Preservation (SSP)
E9h		Read Buffer DMA	EFh	90h 07h	Disable Device Automatic Partial to Slumber transitions
EAh		Flush Cache EXT	EFh	90h 09h	Disable Device Sleep
EBh		Write Buffer DMA	EFh	AAh	Enable read look-ahead feature
EFh	CCh	Enable reverting to power-on defaults	F4h		Security Erase Unit
F1h		Security Set Password	F5h		Security Freeze Lock
F2h		Security Unlock	F6h		Security Disable Password
F3h		Security Erase Prepare	F8h		Read Native Max Address

6.2. Identify Device Data

The following table details the sector data returned by the IDENTIFY DEVICE command.

Word	F: Fixed V: Variable X: retired/obsolete /reserved	Default Value	Description
0	F	0040h	General configuration bit-significant information
1	X	*1	Obsolete – Number of logical cylinders
2	F	C837h	Specific configuration
3	X	0010h	Obsolete – Number of logical heads (16)
4-5	X	00000000h	Retired
6	X	003Fh	Obsolete – Number of logical sectors per logical track (63)
7-8	X	00000000h	Reserved for assignment by the Compact Flash Association
9	X	0000h	Retired
10-19	V	Varies	Serial number (20 ASCII characters)
20-21	X	0000h	Retired
22	X	0000h	Obsolete
23-26	V	Varies	Firmware revision (8 ASCII characters)
27-46	V	Varies	Model number (xxxxxxxx)
47	F	8010h	7:0- Maximum number of sectors transferred per interrupt on MULTIPLE commands
48	F	4000h	Reserved
49	F	2F00h	Capabilities
50	F	4000h	Capabilities
51-52	X	000000000h	Obsolete
53	F	0007h	Words 88 and 70:64 valid
54	X	*1	Obsolete – Number of logical cylinders
55	X	0010h	Obsolete – Number of logical heads (16)
56	X	003Fh	Obsolete – Number of logical sectors per track (63)
57-58	X	*2	Obsolete – Current capacity in sectors
59	F	0110h	Number of sectors transferred per interrupt on MULTIPLE commands
60-61	V	*3	Maximum number of sector (28bit LBA mode)
62	X	0000h	Obsolete
63	F	0407h	Multi-word DMA modes supported/selected

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Word	F: Fixed V: Variable X: retired/obsolete /reserved	Default Value	Description
64	F	0003h	PIO modes supported
65	F	0078h	Minimum Multiword DMA transfer cycle time per word
66	F	0078h	Manufacturer's recommended Multiword DMA transfer cycle time
67	F	0078h	Minimum PIO transfer cycle time without flow control
68	F	0078h	Minimum PIO transfer cycle time with IORDY flow control
69	F	1F00h	Additional Supported
70	X	0000h	Reserved
71-74	X	000000000000 0000h	Reserved for the IDENTIFY PACKET DEVICE command
75	F	001Fh	Queue depth
76	F	850Eh	Serial SATA capabilities
77	F	0006h	Supported Serial ATA Phy speed
78	F	004Ch	Serial ATA features supported
79	F	0040H	Serial ATA features enabled
80	F	0FF8h	Major Version Number
81	F	0000h	Minor Version Number
82	F	746Bh	Command set supported
83	F	7D01h	Command set supported
84	F	4163h	Command set/feature supported extension
85	F	7469h	Command set/feature supported or enabled
86	F	BC01h	Command set/feature supported or enabled
87	F	4163h	Command set/feature supported or enabled
88	F	007Fh	Ultra DMA Modes
89	F	000Ah	Time required for Normal Erase mode SECURITY ERASE UNIT command
90	F	001Eh	Time required for an Enhanced Erase mode SECURITY ERASE UNIT command
91	F	0000h	Current advanced power management value
92	F	FFFEh	Master Password Revision Code
93	F	0000h	Hardware reset result. The contents of the bits (12:0) of this word can be changed only during the execution of hardware

			reset.
Word	F: Fixed V: Variable X: retired/obsolete /reserved	Default Value	Description
94	X	0000h	Vendor's recommended and actual acoustic management value
95	F	0000h	Stream Minimum Request Size
96	F	0000h	Streaming Transfer Time – DMA
97	F	0000h	Streaming Access Latency – DMA and PIO
98-99	F	0000h	Streaming Performance Granularity
100-103	V	*4	Maximum user LBA for 48 bit Address feature set
104	F	0000h	Streaming Transfer Time – PIO
105	F	0008h	Maximum number of 512-byte blocks per DATA SET MANAGEMENT command
106	F	4000h	Physical sector size/Logical sector size
107	F	0000h	Inter-seek delay for ISO-7779 acoustic testing in microseconds
108-111	F	Varies	Reserved
112-115	X	000000000000 0000h	Reserved
116	X	0000h	Reserved
117-118	F	00000000h	Words per logical Sector
119	F	401Ch	Supported settings
120	F	401Ch	Command set/Feature Enabled/Supported
121-126	X	0h	Reserved
127	X	0h	Obsolete
128	F	0021h	Security status
129-159	V	Varies	Vendor specific
160	X	0h	Compact Flash Association (CFA) power mode 1
161-167	X	0h	Reserved for assignment by the CFA
168	V	Varies	Device Nominal Form Factor
169	F	0001h	DATA SET MANAGEMENT command is supported
170-173	F	0h	Additional Product Identifier
174-175	X	0h	Reserve
176-205	F	0h	Current media serial number
206	F	0039h	SCT Command Transport(

Word	F: Fixed V: Variable X: retired/obsolete /reserved	Default Value	Description
207-208	X	0h	Reserved
209	F	4000h	Alignment of logical blocks within a physical block
210-211	F	0000h	Write-Read-Verify Sector Count Mode 3 (not support)
212-213	F	0000h	Write-Read-Verify Sector Count Mode 2 (not support)
214-216	X	0000h	NV Cache relate (not support)
217	F	0001h	Non-rotating media device
218	X	0h	Reserved
219	X	0h	NV Cache relate (not support)
220	V	0h	Write read verify feature set current mode
221	X	0h	Reserved
222	F	10FFh	Transport major version number
223	F	0h	Transport minor version number
224-229	X	0h	reserved
230-233	F	0h	Extend number of user addressable sectors
234	F	0001h	Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h
235	F	FFFEh	Maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h
236-242	X	0h	Reserved
243	X	0000h	Reserved
244-254	X	0h	Reserved
255	F	XXA5h XX is variable	Integrity word (Checksum and Signature)

■ List of Device Identification for Each Capacity

Capacity (GB)	*1 (Word 1/Word 54)	*2 (Word 57–58)	*3 (Word 60–61)	*4 (Word 100–103)
2	F39h	3BF070h	3BF070h	3BF070h
4	1E5Dh	778E30h	778E30h	778E30h
8	3CA5h	EEC9B0h	EEC9B0h	EEC9B0h
16	3FFFh	FBFC10h	1DD40B0h	1DD40B0h
30	3FFFh	FBFC10h	37E90F0h	37E90F0h
32	3FFFh	FBFC10h	3BA2EB0h	3BA2EB0h
60	3FFFh	FBFC10h	6FCCF30h	6FCCF30h
64	3FFFh	FBFC10h	7740AB0h	7740AB0h
120	3FFFh	FBFC10h	DF94BB0h	DF94BB0h
128	3FFFh	FBFC10h	EE7C2B0h	EE7C2B0h
240	3FFFh	FBFC10h	0FFFFFFFh	1BF244B0h
256	3FFFh	FBFC10h	0FFFFFFFh	1DCF32B0h
480	3FFFh	FBFC10h	0FFFFFFFh	37E436B0
512	3FFFh	FBFC10h	0FFFFFFFh	3B9E12B0h
960	3FFFh	FBFC10h	0FFFFFFFh	6FC81AB0h
1024	3FFFh	FBFC10h	0FFFFFFFh	773BD2B0h

6.3. Write Protect Function

The write protect function is triggered by pin header short. This used to set the device as a write protection device after power up. When the function is triggered, the data can't be written to the device. The device is then set as read only.

6.4. Quick Erase Function

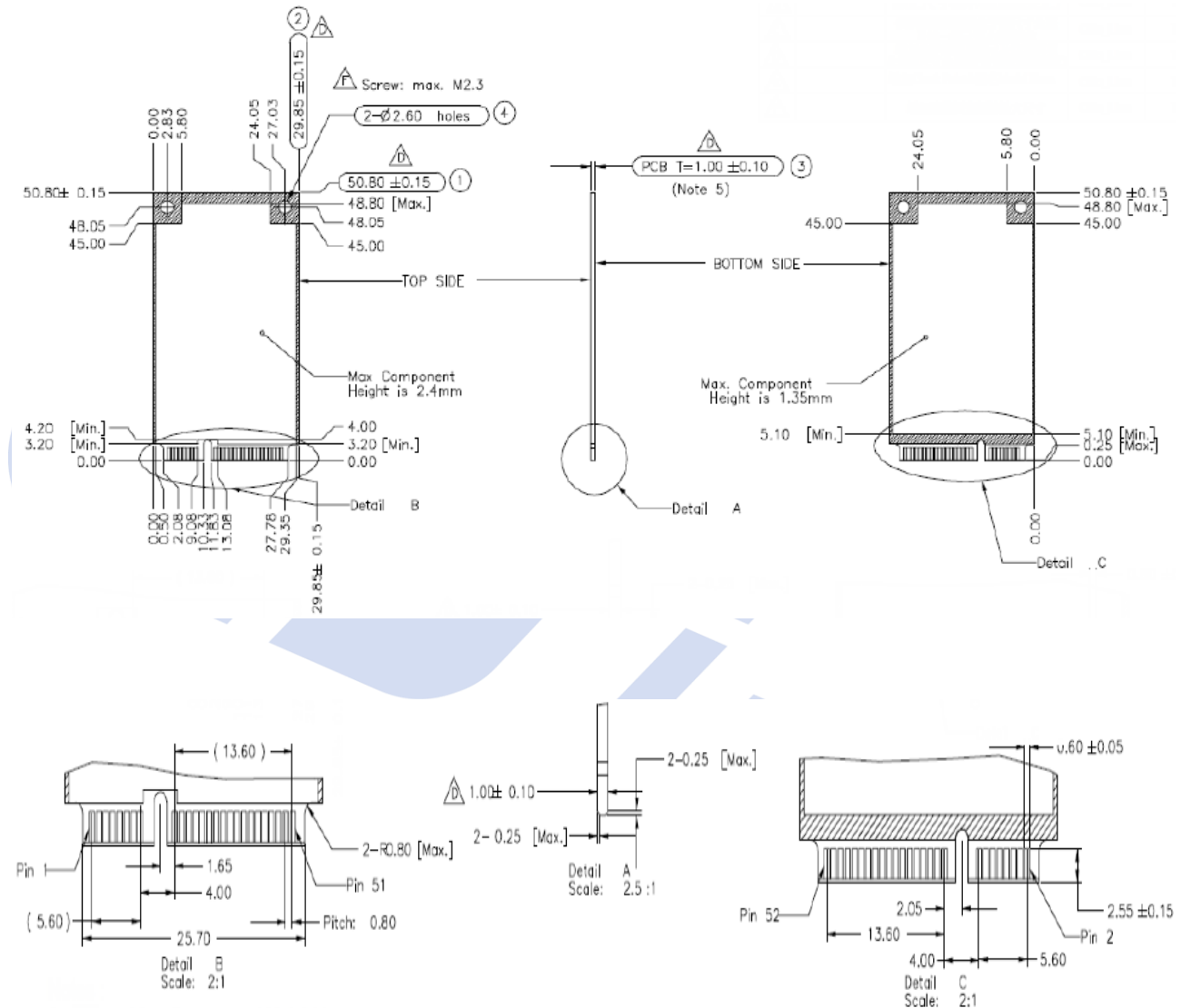
The Quick Erase is a special feature to allow users to erase user data of SSD by hardware trigger. When this feature is triggered by pin header short, the storage blocks of SSD will be erased and the SSD will return to its factory default setting. This feature is particularly useful for emergent circumstances to quickly erase user data.

Note: These two functions can not be existed in one unit due to using the same GPIO.



7. PHYSICAL DIMENSION

Dimension: 50.8mm(L) x 29.85mm(W) x 4mm(H)



Notes :

1.  = Max Component Height is
2.  = No Component
3.  = No Component / Signal Vias / Signal Copper/Print
4. General Tolerance : $\pm 0.1\text{mm}$
- △ 5. Card Thickness applies accross tab and includes plating and/or metalization
- △ 6. Check Point: ① ~ ④
- △ 7. Screw Max. Size M2.3

COMMON TOLERANCE				Finish	.	
DIM	CLASS	A	(B)	C	Material	.
					Angles	
L≤3	±0.05	±0.10	±0.20	Scale : 1 / 1	Unit : mm	
3<L≤6	±0.05	±0.10	±0.20	Drawing by	Otto_Lian	
6<L≤16	±0.10	±0.15	±0.30	Approval	Tom	
16<L≤30	±0.10	±0.15	±0.30	Date	2014/11/03	
30<L≤120	±0.15	±0.20	±0.50	Size : A4	Rev.F	
120<L≤315	±0.20	±0.50	±0.80		Page 1/1	

8. TERMINOLOGY



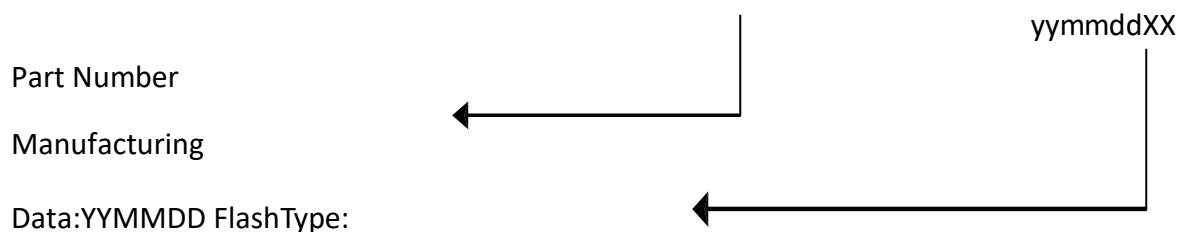
The following table is to list out the acronyms that have been applied throughout the document.

Term	Definitions
ATTO	Commercial performance benchmark application
DEVSLP	Device Sleep Mode
DIPM	Device initiated power management
HIPM	Host initiated power management
LBA	Logical block addressing
MB	Mega-byte
MTBF	Mean time between failures
NCQ	Native command queue
SATA	Serial advanced technology attachment
SDR	Synchronous dynamic access memory
S.M.A.R.T.	Self-monitoring, analysis and reporting technology
SSD	Solid state disk

9. BARCODE DESCRIPTION



M H D 5 2 U B 9 6 0 G B A 2 P



10. PARTNUMBER DECODER


MHD-52UBX⁸X⁹X¹⁰X¹¹X¹² X¹³ X¹⁴ X¹⁵X¹⁶X¹⁷

X ¹ X ² X ³	X ⁴ X ⁵	X ⁶ X ⁷	X ⁸ X ⁹ X ¹⁰ X ¹¹ X ¹²	X ¹³	X ¹⁴	X ¹⁵	X ¹⁶ X ¹⁷
MHD	52	UB	002GB 120GB 004GB 128GB 008GB 240GB 016GB 256GB 030GB 480GB 032GB 512GB 060GB 960GB 064GB 001TB	C: SLC Standard (0°C ~ +70°C) I: SLC Industrial (-40°C ~ +85°C) K: MLC Standard (0°C ~ +70°C) M: MLC Industrial (-40°C ~ +85°C) P: pSLC Standard (0°C ~ +70°C) F: pSLC Industrial (-40°C ~ +85°C) A: 3D TLC Standard (0°C ~ +70°C) B: 3D TLC Industrial (-40°C ~ +85°C) V: 3D pSLC Standard (0°C ~ +70°C) W: 3D pSLC Industrial (-40°C ~ +85°C)	2	P	blank
X ¹⁶ X ¹⁷ Blank: standard 01: Write Protection(WP) 03: Quick Erase Jumper(QEJ) 06: Conformal Coating(CC) 07: CC + WP 09: CC + QEJ 26: Thermal Sensor (TS) 27: Quick Erase with finger pin 38: TS + CC							