

Welldisk Corp.

Industrial SATA Solid State Drive

W25S31 Series

Product DataSheet



Welldisk CORP.

layer 415 newmaterial chuanyue building FengHui middle road no.7 Beijing haidian district

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Revision History

Revision	Draft Date	History	Author
1.0	2015/12/4	New release	Golden Lee
1.1	2016/1/5	Update code 16 and 17 for PLP function in P/N decoder	Golden Lee
1.2	2016/1/11	Add PLP function description in chapter 7	Golden Lee
1.3	2016/3/31	Add Quick Erase Function	Golden Lee
1.4	2016/4/29	Add SLC Flash Support	Golden Lee



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Product Overview

- **Capacity**
 - SLC: 32GB up to 256GB
 - MLC: 32GB up to 1TB
- **SATA Interface**
 - SATA Revision 3.1
 - SATA 1.5Gbps, 3Gbps, and 6Gbps interface
- **Flash Interface**
 - Flash Type: SLC and MLC
- **Performance**
 - Read up to 530MB/s
 - Write up to 450MB/s
- **Power Consumption^{Note1}**
 - Active mode: < 4000mW
 - Idle mode: < 500mW
- **TBW (Terabyte Written)**
 - SLC: 7492 TBW for 256GB
 - MLC: 1409 TBW for 1TB
- **MTBF**
 - SLC: 3,000,000 hours
 - MLC: 2,000,000 hours
- **Advanced Flash Management**
 - Static and Dynamic Wear Leveling
 - Bad Block Management
 - TRIM
 - SMART
 - Over-Provision
- **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.

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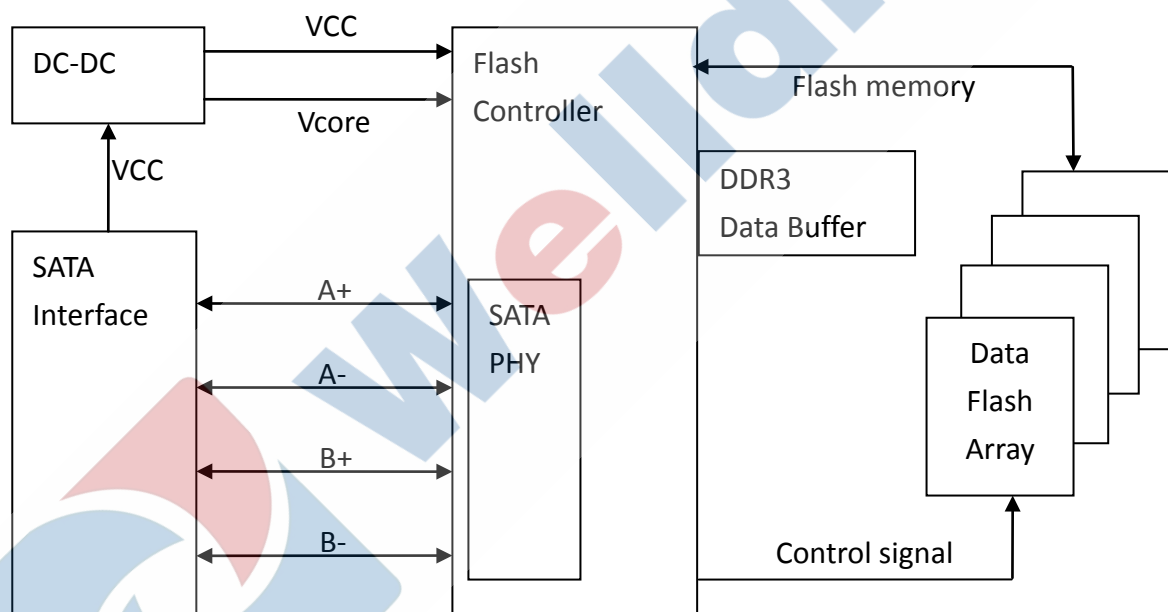
1. INTRODUCTION



1.1. General Description

Welldisk 2.5" SATA SSD delivers all the advantages of flash disk technology with Serial ATA I/II/III interface, including being fully compliant with standard 2.5-inch form factor, providing low power consumption compared to traditional hard drive and hot-swapping when removing/replacing/upgrading flash disks. The device is designed based on the standard 7-pin interface for data segment and 15-pin for power segment, as well as operating at a maximum operating frequency of 300MHz with 50MHz external crystal. Its capacity could provide a wide range up to 1TB. Moreover, it can reach up to 530MB/s read as well as 450MB/s write high performance based on Toshiba's NAND flash (with 512MB/1024MB DDR3 cache enabled and measured by CrystalDiskMark v3.0). Meanwhile, the power consumption of the 2.5" SSD is much lower than traditional hard drives.

1.2. Block Diagram



2.5" SATA SSD Block Diagram

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2. PRODUCT SPECIFICATIONS



- **Capacity**
 - SLC: From 32GB up to 256GB (support 48-bit addressing mode)
 - MLC: From 32GB up to 1TB (support 48-bit addressing mode)
- **Electrical/Physical Interface**
 - SATA Interface
 - ◆ Compliant with SATA Revision 3.1
 - ◆ Industrial Standard ATA/ATAPI-8 and ACS-2 command compliant
 - ◆ Compatible with SATA 1.5Gbps, 3Gbps and 6Gbps interface
 - ◆ Native Command Queuing up to 32 commands
 - ◆ Support SATA Device Sleep mode (Optional)
 - ◆ Supports 28-bit and 48-bit LBA (Logical Block Addressing) mode commands
- **Supported NAND Flash**
 - Supports 1x/1y/2x/2y/3xnm SLC and MLC
 - Supports ONFI 3.0, Toggle 2.0
 - Supports 8KB and 16KB page size
 - Supports 1-plane, 2-plane, and 4-plane operation
- **ECC Scheme**
 - Up to 66 bits / 1K Byte
- **Support SMART and TRIM commands**
- **Support Power Loss Protection (Optional)**
 - Protect data loss, even the last data, during write process when power sudden off.
 - Add-on Polymer Tantalum Capacitors hold-up several milliseconds to keep DRAM data write to NAND Flash.
- **Support Hardware Quick Erase Function (Optional)**

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- Capacity Information

Capacity	Cylinders	Heads	Sectors	Total Sectors	User Data Size
32GB	16,383	16	63	61,865,984	Depended on file management
64GB	16,383	16	63	123,731,968	
128GB	16,383	16	63	247,463,936	
256GB	16,383	16	63	494,927,872	
512GB	16,383	16	63	989,855,744	
1TB	16,383	16	63	1,979,711,488	

- Performance

- SLC:

Capacity	Flash Structure	Flash Type	Sequential	
			Read (MB/s)	Write (MB/s)
32GB	8GB x 4	24nm, BGA	520	245
64GB	8GB x 8	24nm, BGA	530	420
128GB	16GB x 8	24nm, BGA	TBD	TBD
256GB	32GB x 8	24nm, BGA	530	415

- MLC:

Capacity	Flash Structure	Flash Type	Sequential	
			Read (MB/s)	Write (MB/s)
32GB	32GB x 1	15nm, BGA	275	45
64GB	32GB x 2	15nm, BGA	510	90
128GB	32GB x 4	15nm, BGA	510	180
256GB	64GB x 4	15nm, BGA	510	360
512GB	64GB x 8	15nm, BGA	510	450
1TB	128GB x 8	15nm, BGA	530	450

Notes:

- The performance was estimated based on Toshiba SLC and MLC NAND flash.
- Performance may differ according to flash configuration and platform.
- The table above is for reference only.

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- **TBW (Terabytes Written)**

- **SLC:**

Capacity	Flash Structure	TBW
32GB	8GB x 4	936
64GB	8GB x 8	1873
128GB	16GB x 8	3746
256GB	32GB x 8	7492

- **MLC:**

Capacity	Flash Structure	TBW
32GB	32GB x 1	44
64GB	32GB x 2	88
128GB	32GB x 4	176
256GB	64GB x 4	352
512GB	64GB x 8	705
1TB	128GB x 8	1409

Notes:

1. Samples were built using Toshiba SLC and MLC NAND flash.
2. TBW may differ according to flash configuration and platform.
3. 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.

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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.

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■ 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	
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 each

Result: No any abnormality is detected when power on.

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3.1.5. Bending

■ Bending Specification

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

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
W25S31 2.5"SSD	256GB	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 Welldisk's 2.5" SATA SSD is up to 2,000,000 hours.

3.3. Certification

- RoHS
- CE / FCC

3.4. Compliance

- SATA III (SATA Rev. 3.1)
- Up to ATA/ATAPI-8 (Including S.M.A.R.T)

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4. ELECTRICAL SPECIFICATIONS



4.1. Supply Voltage

Parameter	Rating
Operating Voltage	5V

4.2. Power Consumption

■ SLC

Capacity	Flash Structure	Flash Type	Read	Write	Idle	Slumber
32GB	8GB x 4	24nm, BGA	1600	1900	400	65
64GB	8GB x 8	24nm, BGA	1700	2550	400	65
128GB	16GB x 8	24nm, BGA	TBD	TBD	TBD	TBD
256GB	32GB x 8	24nm, BGA	2200	3000	425	90

Unit: mW

■ MLC

Capacity	Flash Structure	Flash Type	Read	Write	Idle	Slumber
32GB	32GB x 1	15nm, BGA	1000	1050	400	65
64GB	32GB x 2	15nm, BGA	1350	1400	400	65
128GB	32GB x 4	15nm, BGA	1400	1950	410	65
256GB	64GB x 4	15nm, BGA	1425	3000	420	65
512GB	64GB x 8	15nm, BGA	1500	3650	420	65
1TB	128GB x 8	15nm, BGA	1650	3850	475	90

Unit: mW

Notes:

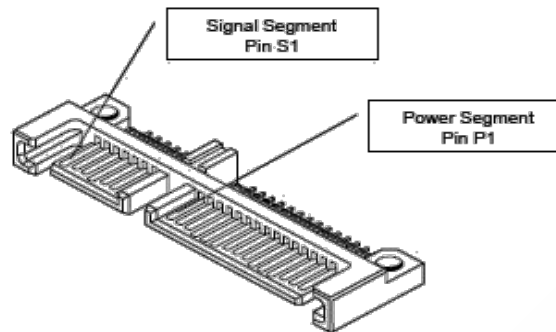
1. It's average value of power consumption is achieved based on 100% conversion efficiency.
2. The measured power voltage is 5V.
3. Samples were built using Toshiba NAND flash and measured under normal temperature.
4. Sequential R/W is measured while testing 4000MB sequential R/W 5 times by CrystalDiskMark.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

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5. INTERFACE



5.1. Pin Assignment and Descriptions



Signal Segment Pin Assignment	Pin Number	Function
	S1	GND
	S2	A+ (Differential Signal Pair A)
	S3	A – (Differential Signal Pair A)
	S4	GND
	S5	B – (Differential Signal Pair B)
	S6	B+ (Differential Signal Pair B)
	S7	GND
Power Segment Pin Assignment	Pin Number	Function
	P1	Not Used (3.3V)
	P2	Not Used (3.3V)
	P3	DEVSLP
	P4	GND
	P5	GND
	P6	GND
	P7	5V pre-charge
	P8	5V
	P9	5V
	P10	GND
	P11	Reserved
	P12	GND
	P13	Not Used (12V pre-charge)
	P14	Not Used (12V)
	P15	Not Used (12V)

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6. SUPPORTED COMMANDS



6.1. ATA Command List

Code	Command Description	Protocol
General Feature Set		
90h	Execute Device Diagnostic	Execute device diagnostic
92h	Download Microcode	PIO data-out
93h	Download Microcode DMA	DMA
E7h	Flush Cache	Non-data
ECh	Identify Device	PIO data-in
91h	Initialize Drive Parameters	Non-data
00h	NOP	Non-data
E4h	Read Buffer	PIO data-in
E9h	Read Buffer DMA	DMA
C8h or C9h	Read DMA	DMA
2Fh	Read Log Ext	PIO data-in
47h	Read Log DMA Ext	DMA
C4h	Read Multiple	PIO data-in
20h or 21h	Read Sector(s)	PIO data-in
40h or 41h	Read Verify Sector(s)	Non-data
EFh	Set Feature	Non-data
C6h	Set Multiple Mode	Non-data
E8h	Write Buffer	PIO data-out
EBh	Write Buffer DMA	DMA
CAh or CBh	Write DMA	DMA
3Fh	Write Log Ext	PIO data-out
57h	Write Log DMA Ext	DMA
C5h	Write Multiple	PIO data-out
30h	Write Sector(s)	PIO data-out
Power Management Feature Set		
E5h or 98h	Check Power Mode	Non-data
E3h or 97h	Idle	Non-data
E1h or 95h	Idle Immediate	Non-data
E6h or 99h	Sleep	Non-data
E2h or 96h	Standby	Non-data
E0h or 94h	Standby Immediate	Non-data

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Code	Command Description	Command Description
Security Mode Feature Set		
F1h	Security Set Password	PIO data-out
F2h	Security Unlock	PIO data-out
F3h	Security Erase Prepare	Non-data
F4h	Security Erase Unit	PIO data-out
F5h	Security Freeze Lock	Non-data
F6h	Security Disable Password	PIO data-out
SMART Feature Set		
B0h	SMART Disable Operations	Non-data
B0h	SMART Enable/Disable Autosave	Non-data
B0h	SMART Enable Operations	Non-data
B0h	SMART Execute OFF-LINE Immediate	Non-data
B0h	SMART Read Log	PIO data-in
B0h	SMART Read Data	PIO data-in
B0h	SMART Read Threshold	PIO data-in
B0h	SMART Return Status	Non-data
B0h	SMART Save Attribute Values	Non-data
B0h	SMART Write Log	PIO data-out
Host Protected Area Feature Set		
F8h	Read Native Max Address	Non-data
F9h	Set Max Address	Non-data
F9h	Set Max Set Password	PIO data-out
F9h	Set Max Lock	Non-data
F9h	Set Max Freeze Lock	Non-data
F9h	Set Max Unlock	PIO data-out
48-bit Address Feature Set		
EAh	Flush Cache Ext	Non-data
24h	Read Sector(s) Ext	PIO data-in
25h	Read DMA Ext	DMA
29h	Read Multiple Ext	PIO data-in
27h	Read Native Max Address Ext	Non-data
42h	Read Verify Sector(s) Ext	Non-data
37h	Set Max Address Ext	Non-data
35h	Write DMA Ext	DMA
3Dh	Write DMA FUA Ext	DMA

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Code	Command Description	Command Description
39h	Write Multiple Ext	PIO data-out
CEh	Write Multiple FUA Ext	PIO data-out
34h	Write Sector(s) Ext	PIO data-out
NCQ Feature Set		
60h	Read FPDMA Queued	DMA Queued
61h	Write FPDMA Queued	DMA Queued
Trusted Computing Feature Set¹		
5Ch	Trusted Receive	PIO data-in
5Dh	Trusted Receive DMA	DMA
5Eh	Trusted Send	DMA
5Fh	Trusted Send DMA	DMA
DCO Feature Set		
B1h	Device Configuration	/
Sanitize Device Feature Set		
B4h	Sanitize Device	/
Miscellaneous and Historical Commands		
06h	Data Set Management	DMA
70h	Seek	Non-data
10h	Recalibrate	Non-data
3Ch	Write Verify	PIO data-out
45h	Write Uncorrectable Ext	Non-data

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6.2. Identify Device Data

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

Word	F / V	Default Value	Description
0	F	0040h	General configuration
1	X	XXXXh	Default number of cylinders
2	V	0000h	Reserved
3	X	00XXh	Default number of heads
4	X	0000h	Obsolete
5	X	0240h	Obsolete
6	F	XXXXh	Default number of sectors per track
7 - 8	V	XXXXh	Number of sectors per card (Word 7 = MSW, Word 8 = LSW)
9	X	0000h	Obsolete
10 - 19	F	XXXXh	Serial number in ASCII (Right justified)
20	X	0002h	Obsolete
21	X	0002h	Obsolete
22	X	0000h	Obsolete
23 - 26	F	XXXXh	Firmware revision in ASCII Big Endian Byte Order in Word
27 - 46	F	XXXXh	Model number in ASCII (Left justified) Big Endian Byte Order in Word
47	F	8001h	Maximum number of sectors on Read/Write Multiple command
48	F	0000h	Reserved
49	F	0F00h	Capabilities
50	F	4000h	Capabilities
51	F	0200h	PIO data transfer cycle timing mode
52	X	0000h	Obsolete
53	F	0007h	Field validity
54	X	XXXXh	Current numbers of cylinders
55	X	XXXXh	Current numbers of heads
56	X	XXXXh	Current sectors per track
57 - 58	X	XXXXh	Current capacity in sectors (LBAs) (Word 57 = LSW , Word 58 = MSW)
59	F	0101h	Multiple sector setting
60 - 61	F	XXXXh	Total number of user addressable logical sectors for 28-bit

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Word	F / V	Default Value	commands (DWord) Description
62	X	0000h	Reserved
63	F	0207h	Multiword DMA transfer Supports MDMA mode 0, 1 and 2
64	F	0003h	Advanced PIO modes supported
65	F	0078h	Minimum Multiword DMA transfer cycle time per word
66	F	0078h	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	4000h	Additional supported
70 - 74	F	0000h	Reserved
75	F	001Fh	Queue depth
76	F	070Eh	Serial ATA capabilities • Supports Serial ATA Gen3 • Supports Serial ATA Gen2 • Supports Serial ATA Gen1 • Supports Phy event counters log • Supports receipt of host initiated power management requests • Supports Native Command Queuing
77	F	0080h	Serial ATA additional capability • DevSleep_to_ReducedPwrState
78	F	0148h	Serial ATA features supported • Supports Device Sleep • Supports software settings preservation • Device supports initiating power management
79	V	0040h	Reserved
80	F	03F0h	Major version number (ACS-2)
81	F	0000h	Minor version number
82	F	742Bh	Command sets supported 0
83	F	7500h	Command sets supported 1
84	F	4023h	Command sets supported 2
85 - 87	V	XXXXh	Command set/feature enabled
88	V	007Fh	Ultra DMA mode supported and selected
89	F	0003h	Time required for a Normal Erase mode Security Erase Unit command

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Word	F / V	Default Value	Description
90	F	0001h	Time required for an Enhanced Erase mode Security Erase Unit command
91	V	0000h	Current advanced power management value
92	V	FFFEh	Master password identifier
93 - 99	V	0000h	Reserved
100 - 103	V	XXXXh	Maximum user LBA for 48-bit address feature set
104	V	0000h	Reserved
105	F	0100h	Maximum number of 512-byte blocks per Data Set Management command
106 - 127	V	0000h	Reserved
128	V	0001h	Security status
129 - 159	X	XXXXh	Vendor specific
160	F	0000h	Power requirement description
161	X	0000h	Reserved
162	F	0000h	Key management schemes supported
163	F	0000h	CF Advanced True IDE Timing mode capability and setting
164 - 168	V	0000h	Reserved
169	F	0001h	Data Set Management supported
170 - 216	V	XXXXh	Reserved
217	F	0001h	Non-rotating media (SSD)
218 - 221	X	0000h	Reserved
222	F	107Fh	Transport major revision (SATA Rev 3.1)
223 - 254	X	0000h	Reserved
255	X	XXXXh	Integrity word

Notes:

1. F = content (byte) is fixed and does not change.
2. V = content (byte) is variable and may change depending on the state of the device or the commands executed by the device.
3. X = content (byte) is vendor specific and may be fixed or variable.

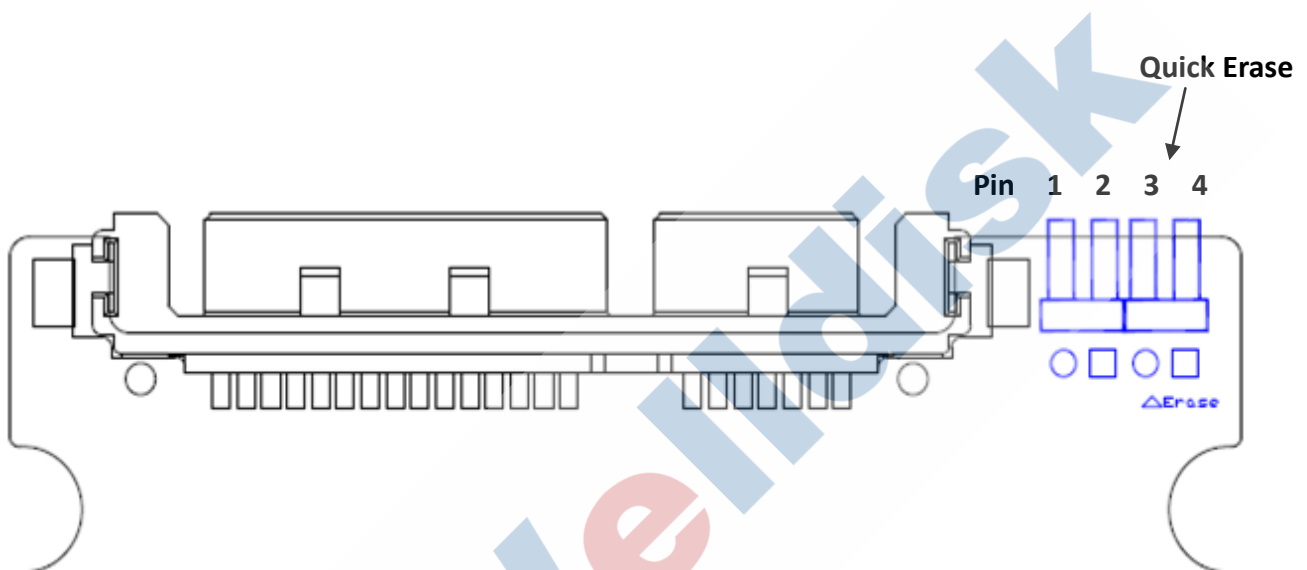
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6.3. Quick Erase Function (Optional)

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 pin3 and pin4 short of pin header, the SSD controller will write all "0x00" to wipe all the data except firmware area, and the SSD will return to its factory default setting. This feature is particularly useful for emergent circumstances to quickly erase user data.



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7. POWER LOSS PROTECTION (PLP)



7.1. General Description

The Power-Loss Protection (PLP) is a scheme to protect data from lost during a sudden power off when SSD drive is under programming or writing. It will ensure the system is stable and the data in the DRAM will be flushed to NAND. It needs to have controller firmware support first with additional power source from PCBA as backup power.

7.2. How to Protect Data?

The SSD drive includes controller, DRAM for temporary data and NAND for non-volatile memory. The PLP needs to have controller firmware support first. When the controller detects the power is dropping to certain level, the controller needs to inform the host and to stop the host from sending more data.

The 2nd step is to flush the data in the DRAM into the NAND flash, since DRAM cannot work when power is off. Therefore it needs enough extra power generated from Polymer Tantalum capacitors add-on PCBA to hold up several mini-seconds to ensure the data is flushed out to NAND completely.

The PLP system of Welldisk is to offer about 45ms to ensure the data is flush out. Since the controller is featured with 4-ch process, if it is full 4-ch operation, the flush time will be short. However, if the flush speed is slower for small capacity, it takes longer time. Welldisk PLP system will make sure all the capacity combinations will have last data stored in NAND flash safely with additional margin.

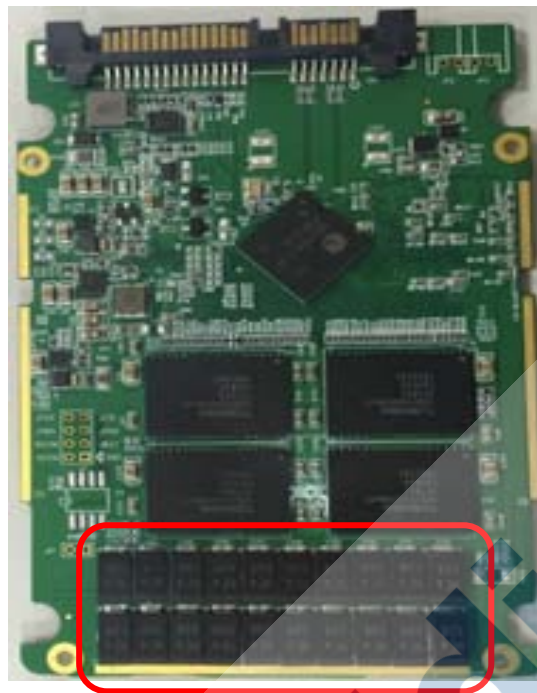
The following figure shows the PCBA of Welldisk SATA SSD with PLP feature by adding Polymer Tantalum capacitors.

Additional figure shows when power is suddenly lost, a trigger to host stops sending data and the data are stored into NAND safely and completely with some margin.

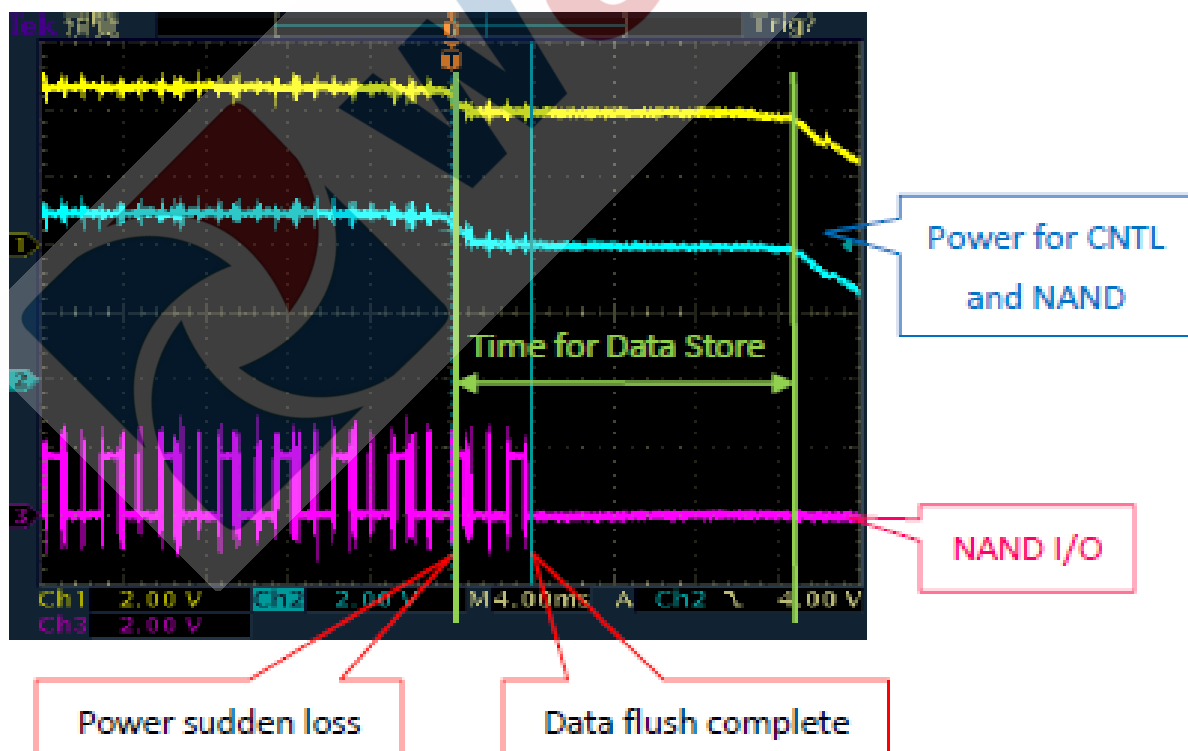
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Polymer Tantalum Capacitors



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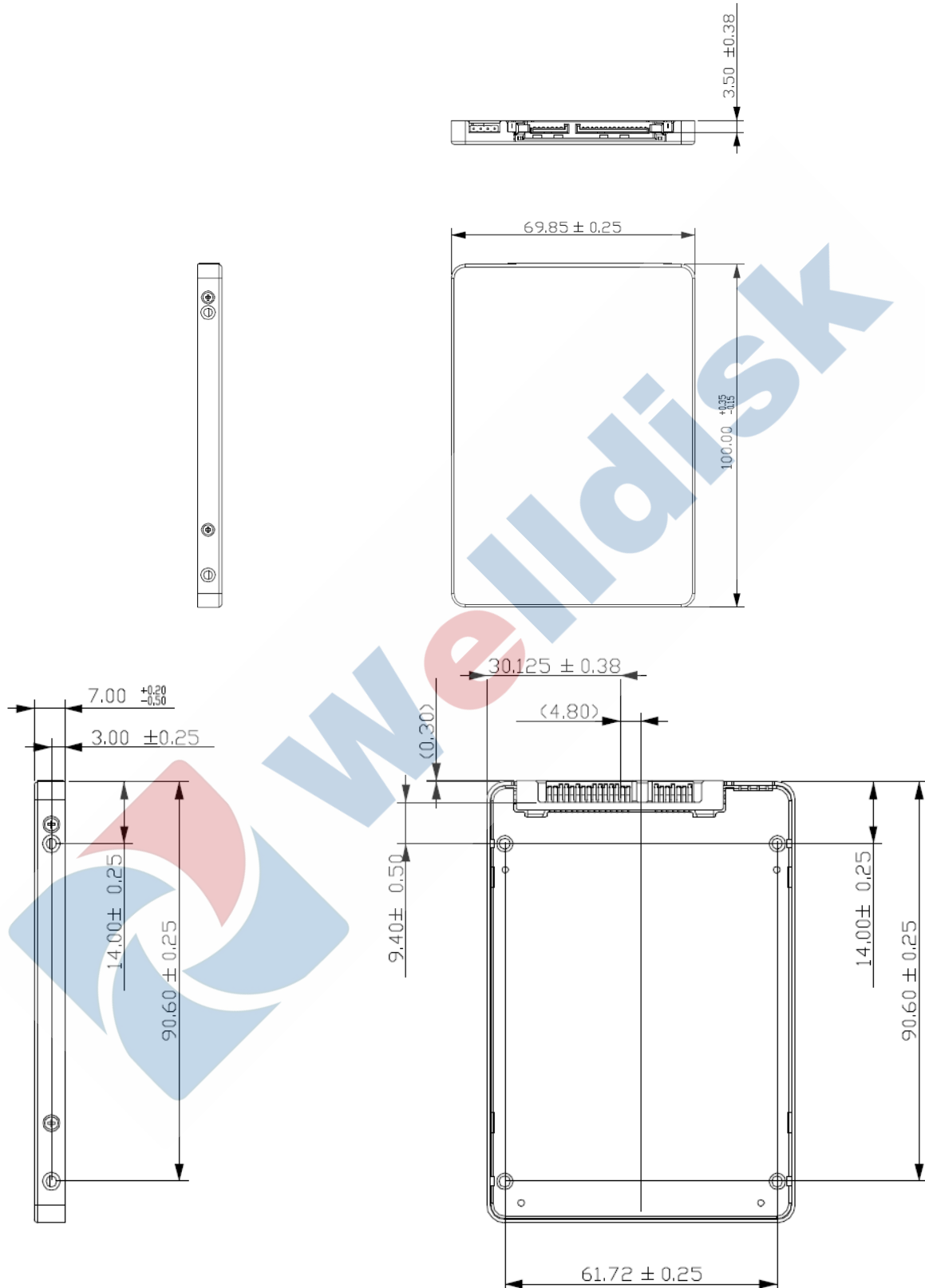
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8. PHYSICAL DIMENSION



Dimension: 100.10mm(L) x 69.85mm(W) x 7.00mm(H)



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9. TERMINOLOGY



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

Term	Definitions
ATTO	Commercial performance benchmark application
DDR	Double data rate (SDRAM)
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
S.M.A.R.T.	Self-monitoring, analysis and reporting technology
SSD	Solid state disk



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11. PARTNUMBER DECODER**W 25 S3 1 – XXXX X****OP. Temperature:**

- F : SLC, Normal, 0~70℃
- W : SLC, Wide, -40~+85℃
- M : MLC, Normal, 0~70℃
- T : MLC, Wide, -40~+85℃

Capacity:

- 016G : 16GB 512G : 512GB
- 032G : 32GB 001T : 1TB
- 064G : 64GB
- 128G : 128GB
- 256G : 256GB

Special definition**Interface:**

- S3 :SATA3

Form Factor:

- 25 : 2.5"

Application

- W : Welldisk Industrial

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