

UD info Corp.

Industrial SATA Solid State Drive HF3-25DE Series Product DataSheet



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Revision History

Revision	Draft Date	History	Author
1.0	2022/8/17	New release	Golden Lee
1.1	2022/10/17	Added Quick Erase / Write Protect function support	Golden Lee
1.2	2023/2/8	1. Added 512GB pSLC support 2. Added TCG OPAL	Golden Lee
1.3	2023/3/29	Removed safety certification	Golden Lee
1.4	2023/8/23	Added Extend grade: -25°C ~ 85°C series	Golden Lee

Product Overview

<ul style="list-style-type: none"> ● Capacity <ul style="list-style-type: none"> ■ TLC: 64GB up to 2TB ■ pSLC: 32GB up to 512GB ● SATA Interface <ul style="list-style-type: none"> ■ SATA Revision 3.2 ■ SATA Gen3/Gen2/Gen1 interface ● Performance <ul style="list-style-type: none"> ■ Read up to 550 MB/s ■ Write up to 510 MB/s ● Power Consumption^{Note1} <ul style="list-style-type: none"> ■ Active mode: < 1,750 mW ■ Idle mode: < 215 mW ● Reliability^{Note2} <ul style="list-style-type: none"> ■ MTBF > 3,000,000 hours ■ UBER < 1 sector per 10¹⁶ bits ■ TBW^{Note3}: <ul style="list-style-type: none"> ➢ TLC: up to 2,900 TB ➢ pSLC: up to 25,800 TB ● Low Power Management <ul style="list-style-type: none"> ■ DEVSLP Mode (Optional) ● ECC <ul style="list-style-type: none"> ■ LDPC / RAID ECC ■ Low density parity check code (>120bit/KBytes) 	<ul style="list-style-type: none"> ● Temperature Range^{Note4} <ul style="list-style-type: none"> ■ Operation Temperature: <ul style="list-style-type: none"> ➢ Standard grade: 0°C ~ 70°C ➢ Wide grade: -40°C ~ 85°C ➢ Extend grade: -25°C ~ 85°C ■ Storage Temperature: <ul style="list-style-type: none"> ➢ -40°C ~ 85°C ● RoHS Compliant ● EMI Compliant <ul style="list-style-type: none"> ■ EN55032, CISPR 32 (CE) ■ ANSI C63.4 (FCC) ■ CNS 13438 (BSMI) ■ VCCI-CISPR 32 (VCCI) ● Special Features & Flash Management <ul style="list-style-type: none"> ■ Advanced Wear Leveling ■ Bad Block Management ■ TRIM ■ SMART ■ Over-Provision ■ SmartZIP™ ■ TCG Pyrite/OPAL
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Notes:

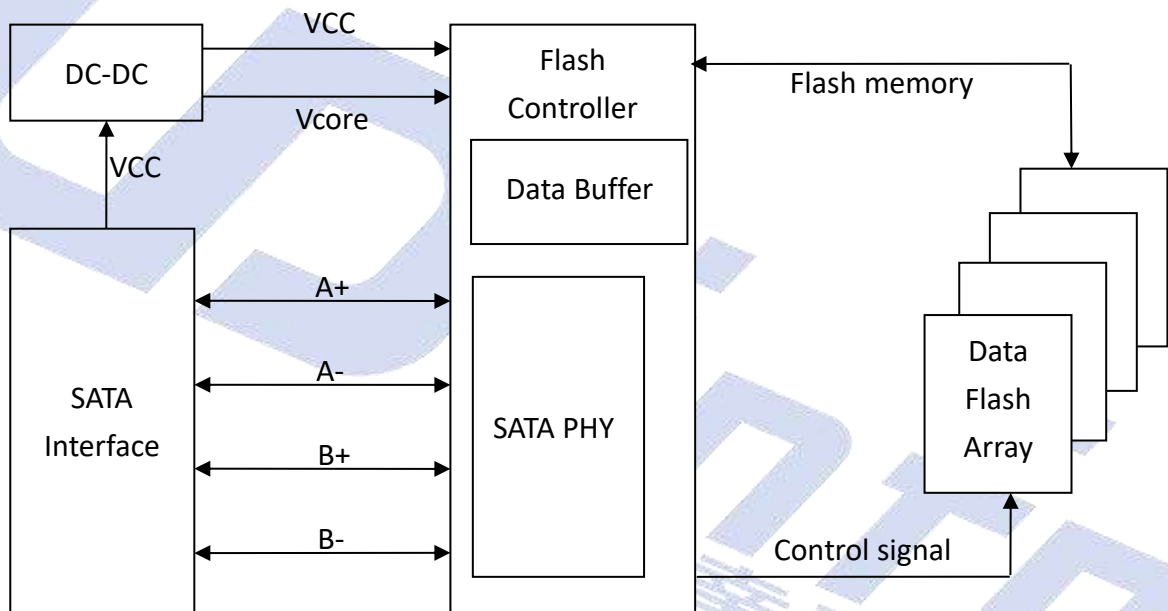
1. Please refer to "4.2 Power Consumption" for details.
2. Please refer to "Environmental Specifications" in chapter 3 for details.
3. Please refer to "2.4 TBW & DWPD" for details.
4. The operation temperature means the case temperature (T_c), in which can be detected via the SMART.

1. INTRODUCTION

1.1. General Description

UDinfo 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 with a wide range capacity available up to 2TB, and performance reaches up to 550MB/s read & 510MB/s write.

1.2. Block Diagram



2.5" SATA SSD Block Diagram

2. PRODUCT SPECIFICATIONS



2.1. Product Specifications

- **Capacity**
 - TLC: From 64GB up to 2TB
 - pSLC: From 32GB up to 512GB
- **Electrical/Physical Interface**
 - SATA Interface
 - Compatible with SATA 1.5Gbps, 3Gbps and 6Gbps interface
 - AC coupling for transmitter and receiver
 - Self-calibrated and embedded termination resistor at transmitter
 - Support expanded register for SATA protocol 48 bits addressing mode
 - Support power management
- **Supported NAND Flash**
 - Kioxia BiCS5 3D-TLC, Toggle 3.0
- **ECC Scheme**
 - Applies the LDPC (Low Density Parity Check) of ECC algorithm
- **Operation Voltage Supply**
 - 5V ± 5%
- **Power Saving Implementation**
 - Idle / Partial / Slumber mode
- **LBA Range**
 - IDEMA standard
- **UART / GPIO function**
- **Support SMART and TRIM commands**
- **Support Hardware Write Protect function (Optional)**
- **Support Hardware Quick Erase function (Optional)**
- **Certification & Compliance**
 - RoHS
 - WHQL

2.2. Device Capacity

Capacity	IDEMA Standard		User Data Size
	512Bytes/Sector	4KBytes/Sector	
	Total Sectors (LBA)	Total Sectors (LBA)	
32GB	62,533,296	7,816,662	Depended on file management
60GB	117,231,408	14,653,926	
64GB	125,045,424	15,630,678	
120GB	234,441,648	29,305,206	
128GB	250,069,680	31,258,710	
240GB	468,862,128	58,607,766	
256GB	500,118,192	62,514,774	
480GB	937,703,088	117,212,886	
512GB	1,000,215,216	125,026,902	
960GB	1,875,385,008	234,423,126	
1TB	2,000,409,264	250,051,158	
1920GB	3,750,748,848	468,843,606	
2TB	4,000,797,360	500,099,670	

Notes:

1. 1 Gigabyte (GB) is equal to 1,000,000,000 Bytes; 1 sector is equal to 512 Bytes.
2. The calculation is following IDEMA Standard.
3. The total actual user data size of the SSD may be less than device capacity due to SSD format, SSD partition, operating system.
EX: OS shows 223.57GB (NTFS) with 240GB SSD.

2.3. Performance

Capacity	Flash Structure	Sequential (MB/s)		4K Random (IOPS)	
		Read	Write	Read	Write
60GB/64GB	64GB x 1, BiCS5 TLC, BGA	380	265	36,500	57,500
120GB/128GB	128GB x 1, BiCS5 TLC, BGA	550	450	44,500	78,500
240GB/256GB	256GB x 1, BiCS5 TLC, BGA	550	485	75,500	82,500
480GB/512GB	256GB x 2, BiCS5 TLC, BGA	550	500	91,500	83,500
960GB/1TB	256GB x 4, BiCS5 TLC, BGA	550	510	96,000	85,500
1920GB/2TB	512GB x 4, BiCS5 TLC, BGA	550	510	93,500	85,000
32GB	128GB x 1, BiCS5 pSLC, BGA	540	465	49,500	78,500
64GB	256GB x 1, BiCS5 pSLC, BGA	550	485	85,500	84,500
128GB	256GB x 2, BiCS5 pSLC, BGA	550	500	96,000	86,000
256GB	256GB x 4, BiCS5 pSLC, BGA	550	510	97,500	87,500
512GB	512GB x 4, BiCS5 pSLC, BGA	550	510	97,000	86,500

Notes:

- Performance may differ according to flash configuration and platform.
- The table above is for reference only.
- Performance is measured with the follow conditions
 - CrystalDiskMark 6.0, 1GB range, QD32T1 for sequential
 - IOmeter, QD32T8, 1GB range for 4K Random
 - Windows 10 professional (x64), Version 1809
- Measurement environment: Room temperature: 20~25°C, humidity: 40~60%RH, DC+5V condition.

2.4. TBW (TeraBytes Written) and DWPD (Drive Write Per Day)

Capacity	Flash Type	TBW	DWPD
60GB/64GB	TLC	65	0.92
120GB/128GB	TLC	90	0.64
240GB/256GB	TLC	220	0.78
480GB/512GB	TLC	540	0.96
960GB/1TB	TLC	1,200	1.07
1920GB/2TB	TLC	3,000	1.29
32GB	pSLC	1,000	28.53
64GB	pSLC	3,000	42.81
128GB	pSLC	6,400	45.66
256GB	pSLC	13,000	46.37
512GB	pSLC	25,800	46.01

Notes:

1. TBW is measured by JEDEC 219A Client workload.
2. TBW may differ according to flash configuration, platform and data written.
3. DWPD is calculated based on 3-year lifetime.
4. $DWPD \text{ (Drive Write Per Day)} = TBW / [365 \times \text{years} \times \text{User Capacity(TB)}]$
5. 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.

2.5. POR/SPOR Standby Ready Time

● POR/SPOR Ready Time

Capacity	POR ready time				SPOR ready time			
	Power On		Identify		Power On		Identify	
	Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.
60GB/64GB	300	500	350	550	5,000	9,000	5,100	9,100
120GB/128GB					5,000		5,100	
240GB/256GB					8,000		8,100	
480GB/512GB					8,000		8,100	
960GB/1TB					8,000		8,100	
1920GB/2TB					8,000		8,100	
32GB					5,000		5,100	
64GB					8,000		8,100	
128GB					8,000		8,100	
256GB					8,000		8,100	
512GB					8,000		8,100	

Unit: ms

Notes:

1. POR/SPOR stands for following:
 - (a) POR (Power On Ready): The ready time variation depends on data recover size.
 - (b) SPOR (Power On Ready after Sudden Power Off): The ready time variation depends on data recover size.
2. Power On/Identify ready time stands for following:
 - (a) Power on Time: From Power On to SSD response after drive ready.
 - (b) Identify Time: Power on Time + host issue Identify Command, response Ack.
3. Measurement environment: Room temperature: 20~25°C, humidity: 40~60%RH, DC+5V condition.

2.6. TCG Opal 2.0

The Opal specification is a set of specifications for self-encrypting drives published by the Trusted Computing Group (TCG), a non-profit organization that develops, defines, and promotes standards and specifications for secure computing. The Opal Security Subsystem Class(SSC) 2.0 defines the details of data management in storage devices and the classes authority for data access, and secures data from theft and tampering by unauthorized persons who are able to gain access to the storage device or host system.

TCG Opal 2.0 Main Features:

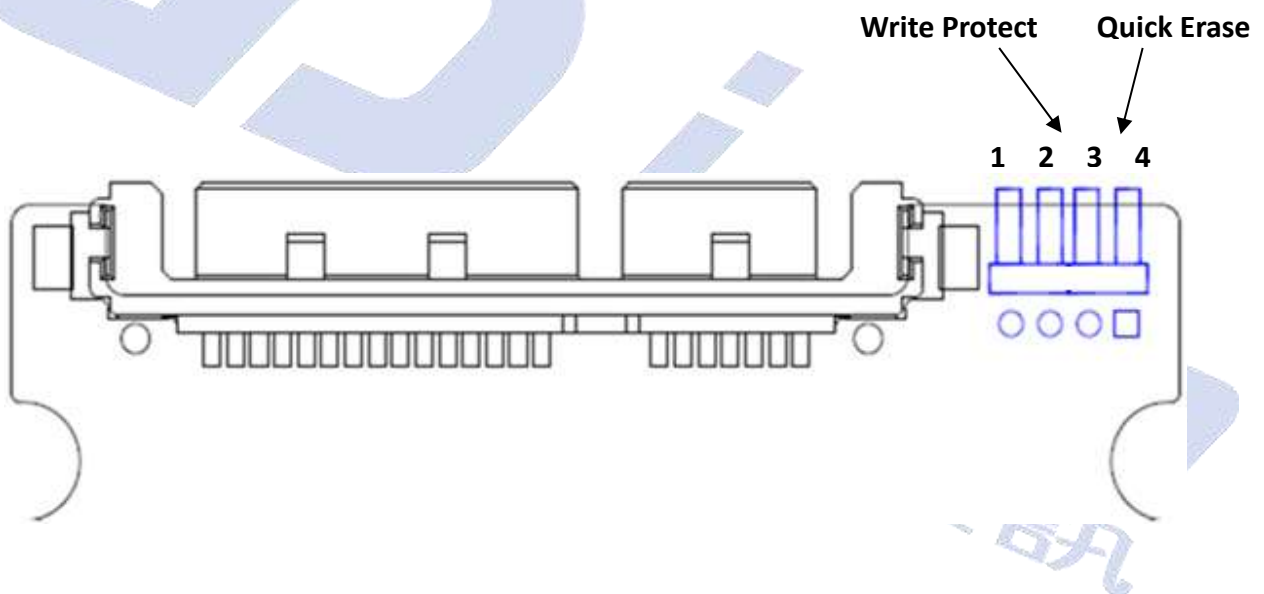
- AES 256-bit Hardware Self Encryption
- Deploy Storage Device & Take Ownership:
The Storage Device is integrated into its target system and ownership transferred by setting or changing the Storage Device's owner credential.
- Activate or Enroll Storage Device:
LBA ranges are configured and data encryption and access control credentials (re)generated and/or set on the Storage Device. Access control is configured for LBA range unlocking.
- Lock & Unlock Storage Device:
Unlocking of one or more LBA ranges by the host and locking of those ranges under host control via either an explicit lock or implicit lock triggered by a reset event. MBR shadowing provides a mechanism to boot into a secure pre-boot authentication environment to handle device unlocking.
- Repurpose & End-of-Life:
Erasure of data within one or more.
- Physical Presence SID (PSID):
PSID is defined by TCG OPAL as a 32-character string and the purpose is to revert SSD back to its manufacturing setting when the drive is still OPAL-activated. PSID code can be printed on a SSD label when an OPAL-activated SSD supports PSID revert feature.

2.7. Write Protect Function (Optional)

The write protect function is triggered by pin2 and pin3 short of pin header. 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.

2.8. 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.



3. ENVIRONMENTAL SPECIFICATIONS



3.1. Environmental Conditions

3.1.1. Temperature Specification

	Mode	Min.	Max.	Unit
Temperature Ranges	Operation (Standard)	0	70	°C
	Operation (Wide)	-40	85	°C
	Storage	-40	85	°C
Humidity (non- condensing)	Operation	5	90	%
	Storage	5	93	%
Temperature Cycle Test	Operation (Standard)	0	70	°C
	Operation (Wide)	-40	85	°C
	Storage	-40	85	°C

Notes:

- The operation temperature means the case temperature, in which can be detected via the S.M.A.R.T. Airflow is suggested and it will allow device to be operated at appropriate temperature for each component during heavy workloads environment.

3.1.2. High Temperature Test Condition

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

Test Reference: IEC 60068-2-2

3.1.3. Low Temperature Test Condition

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

Test Reference: IEC 60068-2-1

3.1.4. High Humidity Test Condition

		Temperature	Humidity	Test Time
Operation	Standard Temperature	40°C	90% RH	72 hours
	Wide Temperature	55°C		
Storage	Standard Temperature	40°C	93% RH	96 hours
	Wide Temperature	55°C		

Test Reference: IEC 60068-2-3

3.1.5. Temperature Cycle Test

		Temperature	Humidity	Test Time
Operation	Standard Temperature	0°C	30 min	20 Cycles
		70°C		
	Wide Temperature	-40°C	30 min	20 Cycles
		85°C		
Storage	Standard Temperature	-40°C	30 min	30 Cycles
		85°C		
	Wide Temperature	-40°C	30 min	50 Cycles
		85°C		

Test Reference: IEC 60068-2-14

3.1.6. Mechanical Specification

Items			Condition
Shock	Non-operational	Acceleration Force	1500G 0-p with half sine wave (0.5ms)
Vibration	Non-operational	Frequency/Displacement	20Hz~80Hz/1.52mm
		Frequency/Acceleration	80Hz~2000Hz/20G p-p with sine wave
Drop	Non-operational	Height of Drop	80cm free fall
		Number of Drop	6 face of each unit
		Conflicting Material	Concrete floor

3.1.7. Electrostatic Discharge (ESD)

Specification	± 4KV
EN 55024 CISPR 24 EN 61000-4-2 IEC 61000-4-2	<ol style="list-style-type: none"> ± 4KV each 25 times, 1 second for 1 time. Contact discharge. Device functions are affected, EUT will be back to normal state.

3.1.8. EMI Compliance

Specification
CE: EN 55032, CISPR 32
FCC: ANSI C63.4
VCCI: VCCI-CISPR 32
BSMI: CNS 13438



3.2. Package Qualification

3.2.1. High Temperature Storage Life Test (HTSL)

Parameter	Test Condition	
Storage	Temperature	Test Duration
	150°C	168/1000 hours

Test Reference: JESD22 A103

3.2.2. Solderability Test

Parameter	Test Condition
Storage	<ol style="list-style-type: none"> 85°C/85% RH 16 hours, bake 1 hour at 125°C. Molten solder temperature: 245±5°C Dwell time: 5 seconds

Note: Spec: > 95% of coating area, pinhole, voids, do not exceed 5% of total area.

3.2.3. Pre-condition Test

Parameter	Test Method	Test Condition
Storage	JESD22-A113	<ol style="list-style-type: none"> Temperature Cycle (-65°C/150°C, 5 cycles) Baking (125°C, 24 hours) Temp & Humidity Soaking (30°C/60% RH, 192 hours) IR Reflow 3 cycles

Note: The parts passing this test will be used to do HAST and TCT.

3.2.4. High Acceleration Stress Test (HAST/unbias)

Parameter	Test Method	Test Condition		
		Ambient Temperature	Ambient Humidity	Test Duration
Storage	JESD22-A110	130°C	85% RH	96 hours

3.2.5. Temperature Cycling Test (TCT)

Parameter	Test Method	Test Condition		
		High Temperature	Low Humidity	Test Duration
Storage	JESD22-A104	150°C	-65% RH	200/500 cycles

3.3. UBER

Capacity	UBER
32GB ~ 2TB	< 1 sector per 10 ¹⁶ bits read

Notes:

1. UBER (Uncorrectable Bit Error Rates) means the uncorrectable error per bits read.
2. UBER = FER (fail rate) / Data Size (user data bit).
3. FER = uncorrectable ECC frame number / total ECC frame number.
4. The LDPC capability > 120bit/KB.

3.4. MTBF

MTBF, an acronym for Mean Time between Failures, is a measure of reliability of a device. Its value represents the average time between a repair and the next failure. The unit of MTBF is in hours. The higher the MTBF value, the higher the reliability of the device.

Our MTBF result is based on simulation software (Relax 7.3). Please note that a lower MTBF should be expected for higher capacity drives, and we apply the lowest MTBF for all capacities.

Capacity	MTBF
32GB ~ 2TB	> 3 million hours

4. ELECTRICAL SPECIFICATIONS



4.1. Supply Voltage

Parameter	Rating
Operating Voltage	5V \pm 5%
Rise Time (Max/Min)	100ms / 0.1ms
Fall Time (Max/Min)	5s / 10ms
Min. Off Time	1s

Notes:

1. Minimum time between power removed from SSD ($V_{cc} < 100$ mV) and power re-applied to the drive.
2. Ensure the voltage of each power domain in SSD has enough time to discharge less than 0.1V.
3. Rise Time during from 10% to 90% of 5V.
4. Fall Time during from 90% to 10% of 5V.

4.2. Power Consumption

Capacity	Flash Structure	Read	Write	Partial	Slumber	Idle
64GB	64GB x 1, BiCS5 TLC, BGA	950	900	55	18	210
128GB	128GB x 1, BiCS5 TLC, BGA	1,150	1,250	55	18	210
256GB	256GB x 1, BiCS5 TLC, BGA	1,200	1,300	55	20	210
512GB	256GB x 2, BiCS5 TLC, BGA	1,200	1,550	55	20	210
1TB	256GB x 4, BiCS5 TLC, BGA	1,350	1,730	60	20	215
2TB	512GB x 4, BiCS5 TLC, BGA	1,450	1,750	60	20	215
32GB	128GB x 1, BiCS5 pSLC, BGA	1,150	1,150	55	15	210
64GB	256GB x 1, BiCS5 pSLC, BGA	1,165	1,200	55	15	200
128GB	256GB x 2, BiCS5 pSLC, BGA	1,200	1,200	55	15	200
256GB	256GB x 4, BiCS5 pSLC, BGA	1,350	1,250	55	15	200
512GB	512GB x 4, BiCS5 pSLC, BGA	1,450	1,450	55	15	200

Unit: mW

Notes:

1. It's average value of power consumption is achieved based on 100% conversion efficiency.
2. Sequential R/W is measured while testing 4000MB sequential R/W 5 times by CrystalDiskMark.
3. Power Consumption may differ according to flash configuration and platform.
4. Measurement environment: Room temperature: 20~25°C, humidity: 40~60%RH, DC+5V condition.

5. INTERFACE



5.1. Pin Assignment and Descriptions

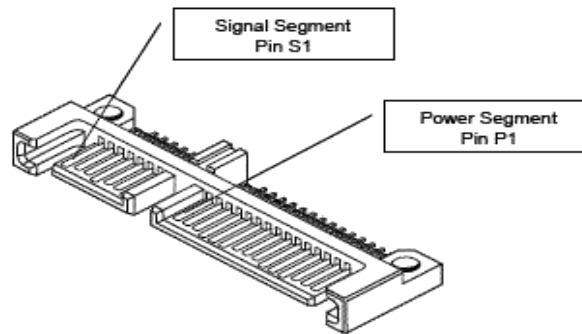


Table 5-1 Signal Segment Pin Assignment and Description

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

Table 5-2 Power Segment Pin Assignment and Description

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)
P14	Not Used (12V)
P15	Not Used (12V)

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	DEVICE CONFIGURATION IDENTIFY DMA	ECh		Identify Device
B1h	C5h	DEVICE 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 (xxxxxxx)
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	00000000h	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)

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Word	F: Fixed V: Variable X: retired/obsolete /reserved	Default Value	Description
62	X	0000h	Obsolete
63	F	0407h	Multi-word DMA modes supported/selected
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	0h	Reserved for the IDENTIFY PACKET DEVICE command
75	F	001Fh	Queue depth
76	F	C50Eh	Serial SATA capabilities
77	F	0006h	Supported Serial ATA Phy speed
78	F	044Ch	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	7D09h	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

Word	F: Fixed V: Variable X: retired/obsolete /reserved	Default Value	Description
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.
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	00000000h	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	0004h	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	0h	Reserved
116	X	0000h	Reserved
117-118	F	00000000h	Words per logical Sector
119	F	4018h	Supported settings
120	F	4018h	Command set/Feature Enabled/Supported
121-126	X	0h	Reserved
127	X	0000h	Obsolete
128	F	0021h	Security status
129-159	V	Varies	Vendor specific
160	X	0000h	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

Word	F: Fixed V: Variable X: retired/obsolete /reserved	Default Value	Description
176-205	F	0h	Current media serial number
206	F	0000h	SCT Command Transport(
207-208	X	00000000h	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	0000h	Reserved
219	X	0000h	NV Cache relate (not support)
220	V	0000h	Write read verify feature set current mode
221	X	0000h	Reserved
222	F	107Fh	Transport major version number
223	F	0000h	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

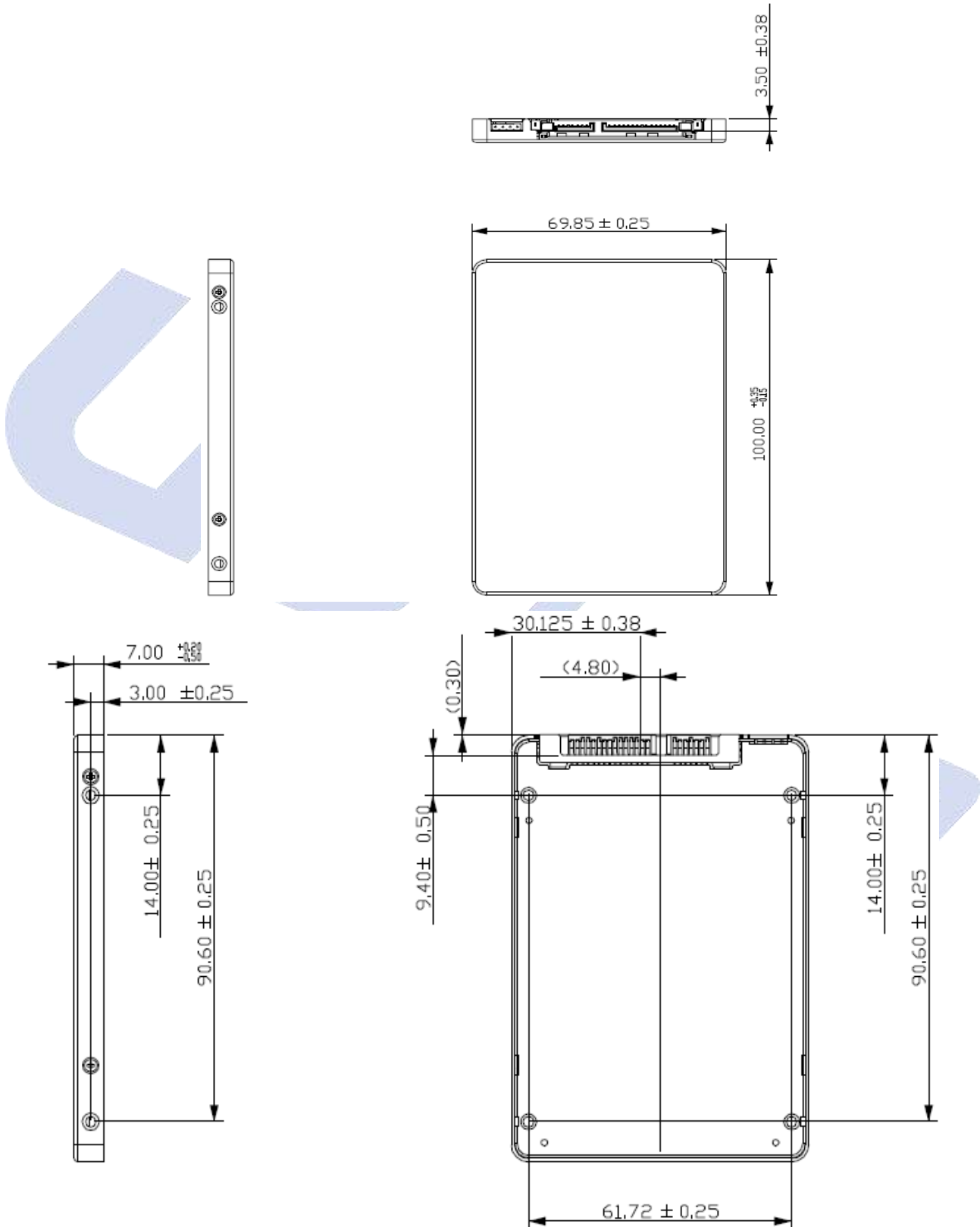
Capacity (GB)	*1 (Word 1/Word 54)	*2 (Word 57-58)	*3 (Word 60-61)	*4 (Word 100-103)
32	3FFFh	FBFC10h	3BA2EB0h	3BA2EB0h
60	3FFFh	FBFC10h	6FCCF30h	6FCCF30h
64	3FFFh	FBFC10h	7740AB0h	7740AB0h
120	3FFFh	FBFC10h	DF94BB0h	DF94BB0h
128	3FFFh	FBFC10h	EE7C2B0h	EE7C2B0h
240	3FFFh	FBFC10h	0FFFFFFFh	1BF244B0h
256	3FFFh	FBFC10h	0FFFFFFFh	1DCF32B0h
480	3FFFh	FBFC10h	0FFFFFFFh	37E436B0
512	3FFFh	FBFC10h	0FFFFFFFh	3B9E12B0h
960	3FFFh	FBFC10h	0FFFFFFFh	6FC81AB0h
1024	3FFFh	FBFC10h	0FFFFFFFh	773BD2B0h
1920	3FFFh	FBFC10h	0FFFFFFFh	DF8FE2B0h
2048	3FFFh	FBFC10h	0FFFFFFFh	EE7752B0h

6.3. S.M.A.R.T. Attributes

Entry	ID	Description
0	0x01	Number of Uncorrectable Errors Accumulated.
1	0x09	Power on Hours Count.
2	0x0C	Power Cycle Count (number of power on/off cycles accumulated)
3	0xA8	SATA PHY Error Count (Only record from power on, when power off this value will clear to zero. These values include all PHY error count, ex data FIS CRC, code error, disparity error, command FIS CRC.....)
4	0xAA	Bad Block Count (early bad count and later bad count)
5	0xAD	Erase Count (max. erase count and average erase count)
6	0xC0	Unexpected Power Loss Count
7	0xC2	Temperature (show 33°C if no thermal sensor)
8	0xDA	Number of Accumulation CRC Error (read/write data FIS CRC error)
9	0xE7	SSD Life Remaining
10	0xF1	Host Write (GB)

7. PHYSICAL DIMENSION

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



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8. TERMINOLOGY



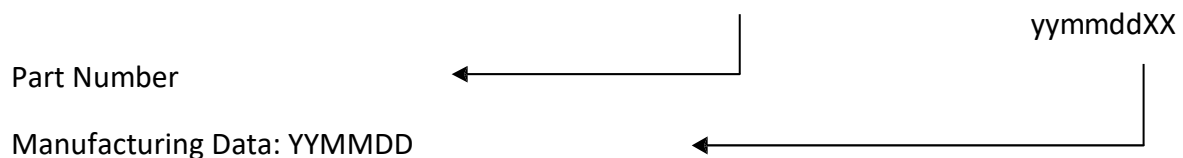
The following table is to list out the acronyms that have been applied throughout the document.

Term	Definitions
ATTO	Commercial performance benchmark application
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

9. BARCODE DESCRIPTION



H F 3 2 5 D E 9 6 0 G B A 2 P



10. PARTNUMBER DECODER



HF3-25DEX⁸X⁹X¹⁰X¹¹X¹²X¹³X¹⁴X¹⁵X¹⁶X¹⁷

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
HF3	25	DE	060GB 120GB 240GB 480GB 960GB 1920G	032GB 064GB 128GB 256GB 512GB 001TB 002TB A: 3D TLC Standard (0°C ~ +70°C) B: 3D TLC Industrial (-40°C ~ +85°C) J: 3D TLC Extend (-25°C ~ +85°C) V: 3D pSLC Standard (0°C ~ +70°C) W: 3D pSLC Industrial (-40°C ~ +85°C)	2	P	blank
X¹⁶X¹⁷ Blank: standard 01: Write Protection (WP) 03: Quick Erase Jumper (QEJ) 06: Conformal Coating (CC) 07: CC + WP 09: CC + QEJ 31: AES + OPAL 44: AES + OPAL + Quick Erase Jumper (QEJ)							