



PCIe Gen3 2.5-inch NVMe Industrial SSD Datasheet

Product interface

U.2 2.5 Inch (9.5)

capacity

1TB/2TB/4TB/8TB

power dissipation

operating power consumption: 12W (maximum typical value)

Static power consumption: 3.6W (maximum typical value)

Dimension specifications (length * width * height/mm)

2.5" 9.5mm:

 $(100.3 \pm 0.1) \times (69.9 \pm 0.1) \times (9.5 \pm 0.1) \text{mm}$ **reliability**

Mean Time Between Failures (MTBF): 2 million hours

vibration compatibility

Non-working mode: 3.13 Grms (5 Hz ~ 800 Hz)

Shock resistance

Non-working: 1500G, 0.5ms, 3axis

function

1 MB sequential read speed: up to 2000 MB/s (maximum typical value)

1 MB sequential write speed: up to 2000 MB/s (maximum typical value)

4 K random read: up to 200K I/O operations per second (maximum typical value)

4 K random write: Maximum 175K I/O operations (maximum typical value)

temperature

working range: -40°C to +85°C

storage: -40°C to +85°C

Interface specifications and protocols

supports the NVMe 1.3 specification standard

supports PCIe 3.0x4

Adaptive PCIe 3.0/2.0/1.0 x1, x2, x4

supports S.M.A.R. T features.

supports hot swapping

supports TRIM commands

compatibility

supports Windows 7/8.1/10

supports mainstream Linux operating systems

supports Kylin/UOS/Zhongke Fangde/Tianmai/Yihui/Ruihua and other operating systems.

Domestic operating system

Company Statement

This specification shall be subject to all YOTTAWIN handbooks or terms of use provided or made available to the customer. This specification is subject to change and/or being updated without notice.

The customer assumes sole and exclusive responsibility for compliance with safety, environmental, export, trade, and other applicable laws and regulations with respect to this specification. In addition, the customer shall assume sole and exclusive responsibility for any embedded or other use of the devices described in this specification in nuclear or ultra-hazardous applications, as well as in applications that could cause property damage, bodily injury, or death. All specifications are subject to change without notice .

Safety Instructions for Use

For the safety of users, please read and follow all instructions, warning signs, precautions, and notes in this manual before using and operating the equipment.

- Carefully read these safety instructions;
- Save this manual for long-term reference;
- Read the chapter detailing the operating environment of this device.

To prevent damage to the equipment caused by overvoltage, overcurrent, etc., during operation:

- Ensure the use of voltage and power settings;
- Ensure the correctness of the interface signal access level;

Do not attempt to repair the equipment.

In the following cases, the equipment must be repaired by authorized personnel:

- The equipment is immersed in liquid;
- Fail to work AC EVER BLOO Ming to the manual;
- Being dropped, physically damaged, or otherwise impaired;
- There is obvious damage.

catalogue

1 Brief Introduction.....	1
2 Size Of Product.....	2
2.1 capacity.....	2
2.2 service behavior.....	2
2.3 electrical character.....	3
2.4 ambient condition.....	3
2.5 reliability.....	4
2.6 Durability.....	4
3 Mechanical information.....	5
4 Pin and Signal Description.....	6
5 Product Principle Flowchart.....	9
6 Command and Command Set.....	10
7 Model.....	11
8 Install.....	12
8.1 power supply mode.....	12
8.2 Unboxing inspection and precautions.....	12
8.3 Installation and Preparation.....	12
9 Maintenance and Care.....	12
10 Precautions and Requirements.....	12
10.1 transport.....	12
10.2 keep in storage.....	13

1 Brief Introduction

The domestically produced U.2 NVMe series solid-state drives (abbreviated as "NVMe SSD") utilize advanced domestic NVMe SSD controllers and high-grade domestic NAND FLASH chips, featuring large capacity, high speed, strong shock resistance, and high reliability. All components of the NVMe SSD are sourced from domestic components.

- Supports PCIe 4.0×4, with backward compatibility for PCIe 2.0×4 and PCIe 1.0×4;
- Supports NVMe 1.3 protocol with backward compatibility for NVMe 1.2;
- Supports LDPC error correction algorithms;
- Supports soft shutdown;
- Supports wear balance to extend the lifespan of flash memory media;
- Standard 2.5-inch size, weight ≤ 125 grams, specific dimensions: (100.3 ± 0.1) mm $\times$ (69.9 ± 0.1) mm $\times$ (9.5 ± 0.1) mm;
- The SSD control board is designed with fully localized components

2 Size of Product

2.1 capacity

Table1 Capacity Correspondence

Physical Capacity	1TB	2TB	4TB	8TB
Available Capacity	953.87GB	1907.73GB	3815.4GB	7630.87 GB

Note :

1. Due to the need to allocate part of the capacity for flash memory management and maintenance, the available capacity of SSDs will be smaller than their nominal capacity.

2.2 service behavior

Table2 Maximum Read and Write Performance

parameter	1TB	2TB	4TB	8TB	unit
Maximum sequential read performance of 1 MB	1600	1600	1600	2000	MB/s
Maximum sequential write performance of 1 MB	1100	950	950	2000	MB/s
Maximum random read performance of 4KB	150	150	150	200	KIOPS
Up to 4KB maximum random write performance	100	100	100	175	KIOPS

Note :

1. Performance data may deviate slightly due to differences in test tools and test environments.

2.4 KB = 4096 bytes.

3. Sequential read/write testing was conducted on Linux systems using FIO 3.27 with a block size of 1 MB and a queue depth of 1024.

4. Random performance testing was conducted on an empty SSD using FIO 3.27 on a Linux system with a block size of 4 KB and a queue depth of 1024.

Table3 IO response latency

Parameter	1TB	2TB	4TB	8TB	unit
4KB Read Latency (max)		24(Typ)			us
4KB Write Latency (max)		25(Typ)			us

Note :

1. The above latency measurements were obtained using sequential 4KB (4,096 bytes) IO operations with IOMeter configured at queue depth 1 and SSD write cache enabled. Variations in latency data may occur due to differences in testing tools and environments.

2.3 electrical character

Table4 Operating Voltage

Item	Range
Supply Voltage	12V±5%

Table5 Power Consumption

parameter	1TB	2TB	4TB	8TB	unit
Power consumption during write operation	9.3	9.7	10.5	12	W
idle power consumption	2.5	2.7	3.2	3.6	W

Note :

1. The operating power consumption is measured under the following conditions: 1 MB (1,048,576 bytes) IO operations, a queue depth of 1024, sequential write operations on an empty SSD, and the maximum average power consumption is collected from an external independent power supply during read operations.

2.4 ambient condition

Table6 Temperature

environmental parameter	Value	unit	Note
working temperature	-40 ~ +85	°C	
Storage temperature	-55 ~ +85	°C	
Working humidity	5 ~ 95	%	
Storage humidity	95 (non-coagulable)	%	

2.5 reliability

Table7 Reliability Specifications

Reliability parameter		Value	condition
UBER (Uncorrectable Bit Error Rate)	2.5"9.5mm	$1e^{-16}$	
MTBF (Mean Time Between Failures)		2 million hours	

Note :

1. Refer to Table 1 in the JESD218 specification for UBER, FFR, and Workload values.

2.6 Durability

Table8 Tolerability specifications

Durability parameters	1TB	2TB	4TB	8TB	unit
TBW	798	1,597	3,194	6387	TB
Warranty period	3	3	3	3	year

Note :

1. The total write volume (TBW) and warranty period are determined by whichever comes first.

2. TBW: Total Written Data (Terabytes Written), the total amount of data written. (Refer to the JESD219A specification for the TBW write amplification testing value set at 3.5)

3 Mechanical information

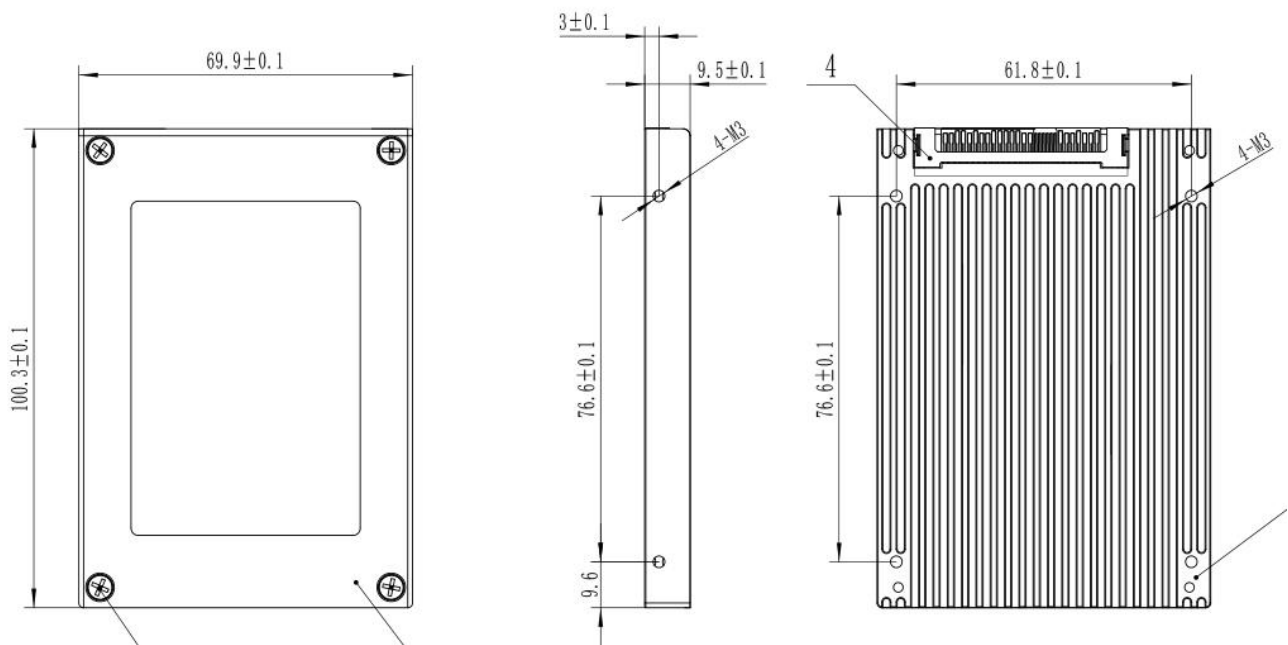


Figure 1 2.5" 9.5mm View (unit: mm)

Table9 Dimension Specifications

specifications	Length (mm)	Width (mm)	Thickness (mm)
2.5" 9.5mm (U.2 interface)	100.3 ± 0.1	69.9 ± 0.1	9.5 ± 0.1

4 Pin and Signal Description

The connector is a 68-pin surface-mount U.2 plug, with interface specifications detailed in Table 10 below.

Table10 Signal Definition for 2.5" U.2 Interface SSD Control Board

Pin number	Signal name	Signal Description	Pin number	Signal name	Signal Description
P1	Wake#	PCIe link wake-up, 3.3V level, functionality not yet developed, may remain idle	S19	GND	GND
P2	SOFE_DES_STATU S	Soft shutdown status indication, 3.3V level	S20	PCIE_TX_1N	Channel 1 TX signal
P3	RSVD	Reserved function, floating	S21	PCIE_TX_1P	Channel 1 TX+ signal
P4	ifDET#	Card presence detection Connect to GND at the disk end and pull up at the host end	S22	GND	GND
P5	GND	GND	S23	PCIE_RX_2P	Channel 2 RX+ signal
P6	GND	GND	S24	PCIE_RX_2N	Channel 2 RX signal
P7	NC	Unconnected	S25	GND	GND
P8	NC	Unconnected	S26	PCIE_TX_2N	Channel 2 TX signal
P9	NC	Unconnected	S27	PCIE_TX_2P	Channel 2 TX+ signal
P10	PRSNT#	Card presence detection Connect to GND at the disk end and pull up at the host end	S28	GND	GND
P11	Activity#	Read/write activity indication, 3.3V level	E1	NC	Unconnected
P12	GND	GND	E2	NC	Unconnected
P13	12V	12V power supply input	E3	3.3V_AUX	The device features a 3.3V AUX power input. It can be connected when the host needs to measure disk temperature after power-down operations. If this function is not required, the input can remain unconnected.
P14	12V	12V power supply input	E4	NC	Unconnected
P15	12V	12V power supply input	E5	PCIE_PERST0#	PCIe reset input, 3.3V LVTTTL level
S1	GND	GND	E6	SOFE_DES_EN	Softly disable the

				#	enable signal to pull down the trigger, defaulting to a 3.3V pull-up on the disk side. Can be left floating when not in use. External reference clock input at 100 MHz, HCSL level
S2	NC	Unconnected	E7	REFCLK+	External reference clock input at 100 MHz, HCSL level
S3	NC	Unconnected	E8	REFCLK-	External reference clock input at 100 MHz, HCSL level
S4	GND	GND	E9	GND	GND
S5	NC	Unconnected	E10	PCIE_RX_0P	Channel 0 RX+ signal
S6	NC	Unconnected	E11	PCIE_RX_0N	Channel 0 RX signal
S7	GND	GND	E12	GND	GND
S8	GND	GND	E13	PCIE_TX_0N	Channel 0 TX signal
S9	NC	Unconnected	E14	PCIE_TX_0P	Channel 0 TX+ signal
S10	NC	Unconnected	E15	GND	GND
S11	GND	GND	E16	UART_TX	Transmits logs through the disk-side log transmission interface, complying with the LVTTTL 3.3V protocol. Leave a test point on the HOST for log tracing to facilitate fault localization.
S12	NC	Unconnected	E17	PCIE_RX_3P	Channel 3 RX+ signal
S13	NC	Unconnected	E18	PCIE_RX_3N	Channel 3 RX signal
S14	GND	GND	E19	GND	GND
S15	UART_RX	Log reception via disk-end interface, LVTTTL 3.3V, with HOST retaining a test point for log connection and fault localization.	E20	PCIE_TX_3N	Channel 3 TX signal
S16	GND	GND	E21	PCIE_TX_3P	Channel 3 TX+ signal
S17	PCIE_RX_1P	Channel 1 RX+ signal	E22	GND	GND
S18	PCIE_RX_1N	Channel 1 RX signal	E23	SMBUS_CLK	SMBUS bus clock line
E24	SMBUS_DAT	SMBUS bus data line	E25	NC	Unconnected

Note :

0. The PCIE_RX signal is the receiving signal at the disk end, while the PCIE_TX signal is the transmitting signal at the disk end. Signal direction must be carefully considered during design.

1. The P1 Wake# signal serves as the PCIe link wake-up function to activate the disk in low-power mode. As

this mode has not yet been implemented, the disk can remain suspended.

2. The P2 SOFE_DES_STATUS signal serves as a soft shutdown status indicator pin, maintaining a default high level of 3.3V. Upon triggering soft shutdown and upon completion of the process, this signal switches to a low level. For functionality requirements, an external LED can be connected to display the disk status; otherwise, it may remain inactive.

3. The P4 ifDET# signal serves as a disk presence indicator, where the disk end is grounded and the host end is pulled high. Upon disk insertion, this signal drops to detect physical insertion. If this function is not required, it can remain inactive.

4. The P10 PRSNT# signal indicates that the disk is in position, with the disk end grounded and the host end elevated. Its function is identical to P4; only one of them needs to be used.

5. The P11 Activity# signal serves as the disk read/write status indicator pin, maintaining a default high level of 3.3V when not in read/write mode. During operations, it generates alternating high-low square waves. For status indication, an external LED can be connected to display flashing signals indicating active disk read/write activities. This function may be disabled when unnecessary.

6. The E3 IFDET# signal serves as the 3.3V_AUX power supply on the host board. In server applications, this power supply is used to drive the SSD temperature sensor. After the SSD is powered on, the host reads the SSD temperature via the SMBus bus. This function can be disabled if not required.

7. The E6 SOFE_DES_EN# signal serves as a soft shutdown enable signal. Soft shutdown is triggered after keeping this signal low for 1 second. If this function is not required, the signal can remain inactive.

8. The S15 UART_RX and E16 UART_TX ports serve as debug serial interfaces for hard drives, not participating in host data transmission but exclusively for debugging purposes. They enable printing of disk operation logs. It is recommended to allocate three 2.54mm pin headers on the motherboard for TX, RX, and GND connections, respectively, facilitating subsequent hard drive debugging and troubleshooting.

9. E24 SMBUS_DAT and E23 SMBUS_CLK are SMBUS bus signals that allow the host to retrieve hard disk information. If this feature is not required, it can be disabled.

5 Product Principle Flowchart

The primary function of the SSD is data storage. The controller interacts with the host end via the U.2 interface, parsing valid data through the NVMe protocol and link verification before distributing it to the flash memory chip array for storage management.

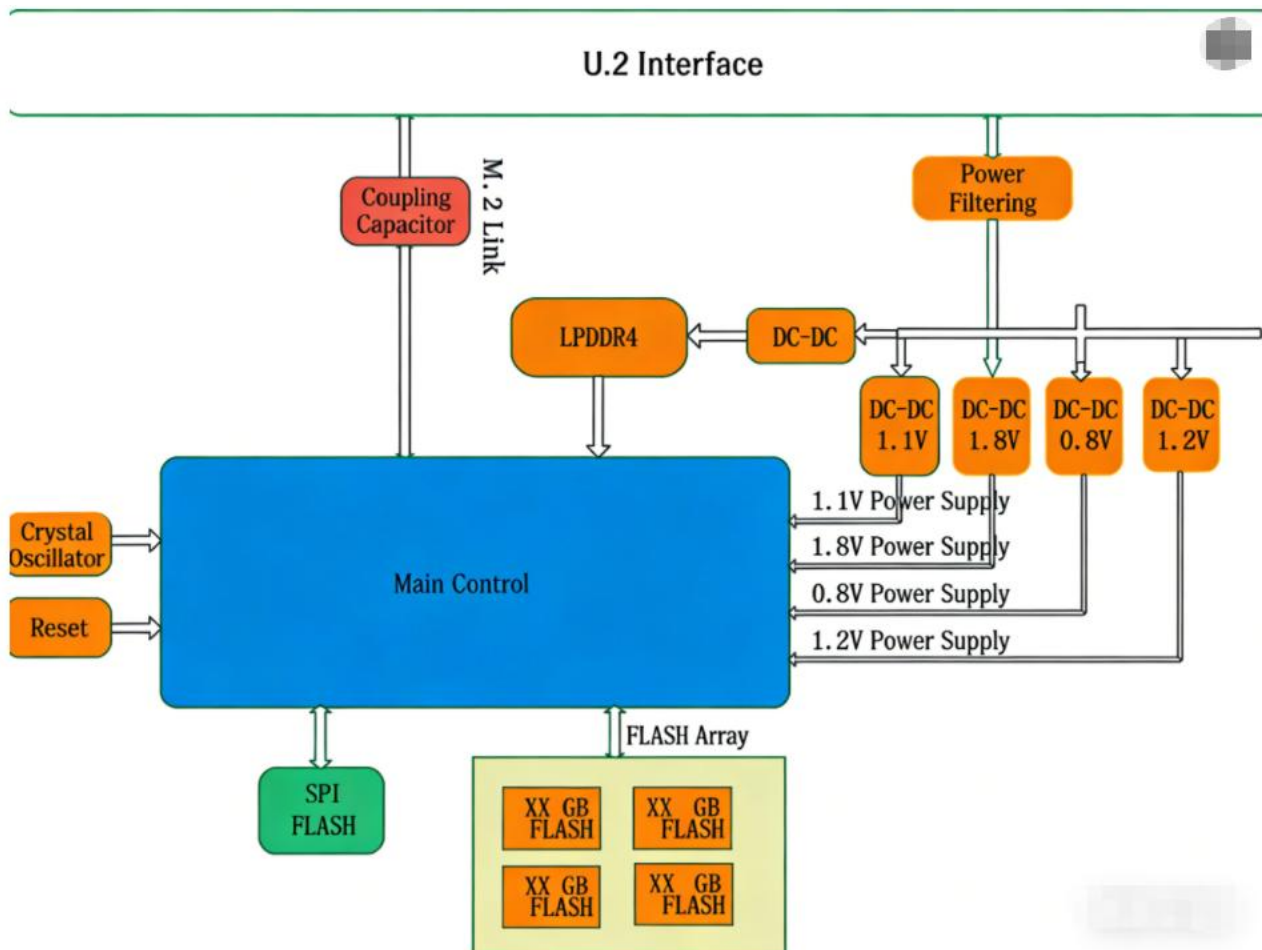


Figure 2 Block diagram of the SSD control board product principle

6 Command and Command Set

The management commands and I/O commands supported in the NVMe 1.3 protocol are listed in the table below.

Table 11 Supported NVMe 1.3 Command List

Command level	order	annotate
Manage command level	Create I/O Submission Queue	Up to 31 I/O SQ, support WRR & RR
	Delete I/O Submission Queue	Up to 31 I/O SQ
	Create I/O Completion Queue	Up to 31 I/O CQ
	Delete the I/O Completion Queue	Up to 31 I/O CQ
	Identify	Support CNS 0–CNS 2
	Set Feature	Saved attribute is not supported
	Get Feature	Saved attribute is not supported
	Get Log Page	Extended data is not supported
	Firmware Image Download	1 slot of images
	Firmware Commit	Support activation without a reset
	Abort	Abort a specific command previously submitted to admin SQ or I/O SQ
	Asynchronous Event Request	Support error status event type and Smart/Health status event type
	Format NVM	Support Secure Erase. Only one LBA format (512 bytes) is supported. No PI & metadata setting supported.
	Device Self-test	Not supported
	Sanitize	Not supported
	Vendor specific	Customizable
I/O Command	Flush	Flush all the cached data to the media

Level	Write	Support FUA. Max transfer size: 512k
	Read	Max transfer size: 512k
	Write Uncorrectable	Not supported
	Dataset Management	Support de-allocation (a.k.a. Trim)

7 Model

Table12 Product Model Table

Product form	model	capacity	remarks
U.2 2.5" 9.5mm	HEPEU2001T50-NIT3W	1T	/
	HEPEU2002T50-NIT3W	2T	
	HEPEU2004T50-NIT3W	4T	
	HEPEU2008T50-NIT3W	8T	

8 Install

8.1 power supply mode

The operating voltage of the electronic board is DC (12 ± 0.6) V.

8.2 Unboxing inspection, and precautions

- a) Before opening the box, inspect whether the product packaging is intact and check for any signs of compression or damage.
- b) After implementing static electricity protection measures, the anti-static bag may be opened to remove the product. Upon removal, visually inspect the product's appearance to ensure it remains intact.

8.3 Installation and Preparation

- a) After implementing electrostatic protection measures, remove the product from the electrostatic protective bag.
- b) Check if the environment is functioning properly;
- c) Check whether the signal and power connectors are functioning properly.

9 Maintenance and Care

Maintenance and servicing of the SSD control board shall be conducted every two years, and the SSD must be powered off during maintenance. Maintenance contents include:

- a) Inspect for physical integrity; wipe the connector with alcohol.
- b) Check for any looseness in connectors and fasteners. If loosening is detected, reinforce them promptly.

10Precautions and Requirements

10.1 transport

- a) Packaged products can be transported by conventional means of transportation. During transportation, appropriate measures should be taken to protect against rain and snow.
- b) Concomitant transportation with corrosive substances such as acids and alkalis is prohibited;
- c) Do not stack heavy objects on top of products;
- d) Handle with care during transportation.

10.2 Keep in storage

The product is recommended to be stored in a dedicated warehouse with a temperature range of 0°C to 35°C, relative humidity not exceeding 80%, and free from strong magnetic fields. The product must not be stored together with acids, alkalis, or corrosive substances.