EC500S8NP M.2 PCIe NVMe SSD

120GB, 240GB, 480GB, 960GB, 1.92TB

The Dataram EC500S8NP is a PCIe NVMe SSD (Solid State Disk) in a M.2 2280 form factor. Designed in full compliance with the PCIe Gen3 x4 interface and NVMe 1.3 specifications for guaranteed compatibility and built with TLC NAND Flash Memory , the drive provides high reliability and performance for a storage medium.

Built with a powerful PCIe controller, the Dataram EC500S8NP delivers outstanding performance in data transfer, reaching up to 125,000/132,000 and 1,645/1,035 MB/s in IOPS and sequential read/write speeds. The extreme thin and light weight form factor makes the Dataram EC500S8NP the ideal choice for mobile computing systems, the IT trend of the near future.

In terms of security, Advanced Encryption Standard (AES) ensure data security and provide users with a peace of mind knowing their data is safeguarded against unauthorized use at all times. Data integrity can be assured at multiple points in the path to enable reliable delivery of data transfers with End-to-End Data Protection. Regarding reliability, the Dataram EC500S8NP is built with a powerful PCIe controller that supports on-the-module ECC as well as an efficient wear leveling scheme. When it comes to power efficiency, the Dataram EC500S8NP is compliant with the PCIe Gen3 x4 interface standard so that it can operate on power management modes, greatly saving on power consumption.

Features

- Advanced LDPC ECC engine
- Global Wear Leveling
- Flash bad-block management
- S.M.A.R.T.
- TRIM support
- Over-Provisioning
- 3D NAND flash memory
- Flash Translation Layer: Page Mapping
- Power Failure Management
- Hyper Cache Technology
- DataRAID™
- NVMe Secure Erase

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Specifications

Model	EC500S8NP
Interface	PCIe Gen3 x4
Connector	M.2 M Key
Form Factor	M.2 2280 Single side, M key: 120 GB M.2 2280 Double side, M key: 240GB ~ 1.92TB
NAND Flash Type	3D TLC
Capacity	120GB, 240GB, 480GB, 960GB. 1.92TB
AES256 (Self Encryption)	Yes
External DRAM	No
Sustained Read Performance (MB/sec)	Up to 1645
Sustained Write Performance (MB/sec)	Up to 1035
ECC Engine	Low-Density Parity-Check (LDPC) Code
IOPS (4K Random Write)	144K
Standard Operating Temperature (°C)	0 ~ + 70
Storage Temperature (°C)	-40 ~ + 100
Thermal Sensor	Yes
Shock	Operation: 50G/11ms (compliant with MIL-STD-202G) Non-operation: 1500G/0.5ms (compliant with MIL-STD-883K)
Vibration	Operation:7.69 Grms, 20~2000 Hz/random (compliant with MIL-STD-810G) Non-operation:4.02 Grms, 15~2000 Hz/random (compliant with MIL-STD-810G)
Operating Voltage	3.3V ±5%
Power Consumption	Active mode: 1205 mA / Idle mode: 245 mA
Dimension (L x W x H)	Single side: 22.00 x 80.00 x 2.38 (mm) Double side: 22.00 x 80.00 x 3.88 (mm)

Performance

Performance\ Capacity	120GB	240GB	480GB	960GB	1.92TB
Sequential Read* (MB/s)	1,460	1,645	1645	1645	1645
Sequential Write* (MB/s)	525	1,035	1605	1655	1685
Random Read IOPS[1]	75,000	125,000	184000	189000	180000
Random Write IOPS[2]	100,000	132,000	139000	144000	133000

Note:

Results may differ from various flash configurations or host system settings.

1) Sequential performance is based on CrystalDiskMark 5.2.1 with file size 1.000MB.
2) Random performance measured using IOMeter with Queue Depth 64.

Endurance

Capacity	Terabytes Written (TBW)	DWPD
120GB	300 TBW	1.370
240GB	590 TBW	1.347
480GB	1104 TBW	1.260
960GB	2102 TBW	1.200
1.92TB	4555 TBW	1.300

This estimation complies with JEDEC JESD-219, enterprise endurance workload of random data with payload size distribution.
Flash vendor guaranteed 3D NAND TLC P/E cycle: 3K
WAF may vary from capacity, flash configurations and writing behavior on each platform.
1 Terabyte = 1024GB
DWPD (Drive Writes Per Day) is calculated based on the number of times a user overwrites the entire capacity of an SSD per day of the lifetime during the warranty period. (3D NAND TLC warranty: 5 years)

Order Number

Product Name	Capacity
EC500S8NP/120G	120GB
EC500S8NP/240G	240GB
EC500S8NP/480G	480GB
EC500S8NP/960G	960GB
EC500S8NP/1.9T	1.92TB

Environmental Specifications

Item	Specifications
Operating temp.	0°C to 70°C (Standard); -40°C to 85°C (Wide)
Non-operating temp.	-40°C to 100°C
Operating vibration	7.69 GRMS, 20~2000 Hz/random (compliant with MIL-STD-810G)
Non-operating vibration	4.02 GRMS, 15~2000 Hz/random (compliant with MIL-STD-810G)
Operating shock	50(G)/11ms/half sine (compliant with MIL-STD-202G)
Non-operating shock	1,500(G)/0.5(ms)/half sine (compliant with MIL-STD-883K)

Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in EC500S8NP. The prediction result for ECS5008NP is more than 3,000,000 hours.

Note: The MTBF is predicated and calculated based on “Telcordia Technologies Special Report, SR- 332, Issue 3” method.

Certification and Compliance

ECS5008AP complies with the following standards:

- CE
- FCC
- RoHS
- MIL-STD-810G

LED Indicator Behavior

Behavior of the ECS5008NP LED indicators:

Location	LED	Description
LED A	DAS	LED blinks when the drive is being accessed

Flash Management

Error Correction/Detection

The ECS5008NP implements a hardware ECC scheme based on the Low Density Parity Check (LDPC). LDPC is a class of linear block error correcting code which has an apparent coding gain over BCH code, because LDPC code includes both hard decoding and soft decoding algorithms. With the error rate decreasing, LDPC can extend SSD endurance and increase data reliability while reading raw data inside a flash chip.

Bad Block Management

Current production technology is unable to guarantee total reliability of NAND flash memory array. When a flash memory device leaves the factory, it comes with a minimal number of initial bad blocks during production or out-of-factory as there is no currently known technology that produce flash chips free of bad blocks. In addition, bad blocks may develop during program/erase cycles. Since bad blocks are inevitable, the solution is to keep them in control. Dataram flash devices are programmed with ECC, page mapping technique and S.M.A.R.T to reduce invalidity or error. Once bad blocks are detected, data in those blocks will be transferred to free blocks and the error will be corrected by designated algorithms.

Global Wear Leveling

Flash memory devices differ from Hard Disk Drives (HDDs) in terms of how blocks are utilized. For HDDs, when a change is made to stored data, like erase or update, the controller mechanism on HDDs performs overwrites on blocks. Unlike HDDs, flash blocks cannot be overwritten and each P/E cycle wears down the lifespan of blocks gradually. Repeatedly, program/erase cycles performed on the same memory cells eventually causes some blocks to age faster than others. This brings flash storages to their end of service term sooner. Global wear leveling is an important mechanism that levels out the wearing of all blocks so that the wearing-down of all blocks can be almost evenly distributed. This increases the lifespan of SSDs.

Power Failure Management

Power Failure Management plays a crucial role when the power supply becomes unstable. Power disruption may occur when users are storing data into the SSD, leading to instability in the drive. However, with Power Failure Management, a firmware protection mechanism is activated to scan pages and blocks once power is resumed. Valid data is transferred to new blocks for merging and the mapping table will be rebuilt. Therefore, data reliability is reinforced, preventing damage to data stored in the NAND Flash.

TRIM

TRIM is a feature which helps improve the read/write performance and speed of solid-state drives (SSD). Unlike hard disk drives (HDD), SSDs are not able to overwrite existing data, so the available space gradually becomes smaller with each use. With the TRIM command, the operating system informs the SSD which blocks of data are no longer in use and removes them permanently. Thus, the SSD performs the erase action, preventing unused data from occupying blocks all the time.

Flash Translation Layer – Page Mapping

Page mapping is an advanced flash management technology whose essence lies in the ability to gather data, distribute the data into flash pages automatically, and then schedules the data to be evenly written. Page-level mapping uses one page as the unit of mapping. The most important characteristic is that each logical page is mapped to any physical page on the flash memory device. This mapping algorithm allows different sizes of data to be written to a block as if the data is written to a data pool and it does not need to take extra operations to process a write command. Thus, page mapping is adopted to increase random access speed and improve SSD lifespan, reduce block erase frequency, and achieve optimized performance and lifespan.

Hyper Cache Technology

Dataram proprietary Hyper Cache technology uses a portion of the available capacity as SLC (1bit-per-cell) NAND flash memory, called Hyper cache mode. When data is written to the SSD, the firmware will direct the data to Hyper Cache mode, providing excellent performance to handle various scenarios in industrial use.

Over-Provisioning

Over-Provisioning (OP) is a certain portion of the SSD capacity exclusively for increasing Garbage Collection (GC) efficiency, especially when the SSD is filled to full capacity or performs a heavy mixed-random workload. OP has the advantages of providing extended life expectancy, reliable data integrity, and high sustained write performance.

DataRAID

Dataram's DataRAID algorithm applies an additional level of protection and error-checking. Using this algorithm, a certain amount of space is given over to aggregating and resaving the existing parity data used for error checking. So, in the event that data becomes corrupted, the parity data is compared to the existing uncorrupted data and the content of the corrupted data is rebuilt.

NVMe Secure Erase

NVMe Secure Erase is an NVMe drive sanitize command currently embedded in most storage drives. Defined in NVMe specifications, NVMe Secure Erase is part of the Format NVM command that allows storage drives to erase all user data areas. The erase process usually runs on the firmware level as most of the NVMe-based storage media currently in the market are built-in with this command. NVMe Secure Erase securely wipes out the user data in the drive and protects it from a malicious attack.

NVMe Support Features

Host Memory Buffer

Host Memory Buffer (HMB) allows HOST to allocate system memory for SSD's exclusive use in order to provide better performance and endurance, especially for DRAM less solutions.

Security & Reliability Features

Advanced Encryption Standard

Advanced Encryption Standard (AES) is a specification for the encryption of electronic data. AES has been adopted by the U.S. government since 2001 to protect classified information and is now widely implemented in embedded computing applications. The AES algorithm used in software and hardware is symmetric so that encrypting/decrypting requires the same encryption key. Without the key, the encrypted data is inaccessible to ensure information security.

Notably in flash memory applications, AES 256-bit hardware encryption is the mainstream to protect sensitive or confidential data. The hardware encryption provides better performance, reliability, and security than software encryption. It uses a dedicated processor, which is built inside the controller, to process the encryption and decryption. This enormously shortens the processing time and makes it efficient.

Thermal Sensor

EC500S8NP Thermal Sensor is a digital temperature sensor with serial interface. By using designated pins for transmission, storage device owners are able to read temperature data.

Thermal Throttling

Thermal throttling monitors the temperature of the SSD equipped with a built-in thermal sensor via S.M.A.R.T. commands. This method ensures the temperature of the device stays within temperature limits by drive throttling, i.e., reducing the speed of the drive when the device temperature reaches the threshold level, so as to prevent overheating, guarantee data reliability, and prolong product lifespan. When the temperature exceeds the maximum threshold level, thermal throttling is triggered to reduce performance step by step to prevent hardware components from being damaged. Performance is only permitted to drop to the extent necessary for recovering a stable temperature to cool down the device's temperature. Once the temperature decreases to the minimum threshold value, transfer speeds will rise back to its optimum performance level.

End-to-End Data Protection

End-to-End Data Protection is a feature implemented in Dataram SSD products that extends error control to cover the entire path from the host computer to the drive and back, and that ensures data integrity at multiple points in the path to enable reliable delivery of data transfers. Unlike ECC which does not exhibit the ability to determine the occurrence of errors throughout the process of data transmission, End-to-End Data Protection allows SSD controller to identify an error created anywhere in the path and report the error to the host computer before it is written to the drive. This error- checking and error-reporting mechanism therefore guarantees the trustworthiness and reliability of the SSD.

Software Interface

Command Set

Summary of the commands supported by EC500S8NP.

Admin Commands

Opcode	Command Description
00h	Delete I/O Submission Queue
01h	Create I/O Submission Queue
02h	Get Log Page
04h	Delete I/O Completion Queue
05h	Create I/O Completion Queue
06h	Identify
08h	Abort
09h	Set Features
0Ah	Get Features
0Ch	Asynchronous Event Request
10h	Firmware Activate
11h	Firmware Image Download

Admin Commands – NVM Command Set Specific

Opcode	Command Description
80h	Format NVM
81h	Security Send
82h	Security Receive
84h	Sanitize

NVM Commands

Opcode	Command Description
00h	Flush
01h	Write
02h	Read
04h	Write Uncorrectable
05h	Compare
08h	Write Zeroes
09h	Dataset Management

S.M.A.R.T.

SMART, an acronym for Self-Monitoring, Analysis and Reporting Technology, is an open standard that allows a hard disk drive to automatically detect its health and report potential failures. When a failure is recorded by SMART, users can choose to replace the drive to prevent unexpected outage or data loss. Moreover, SMART informs users of impending failures while there is still time to perform proactive actions, such as copying data to another device.

SMART (02h)

Byte	Length	Description
0	1	Critical Warning
1-2	2	Composite Temperature (PCB Sensor)
3	1	Available Spare
4	1	Available Spare Threshold
5	1	Percentage Used
6-31	26	Reserved
32-47	16	Data Units Read
48-63	16	Data Units Written
64-79	16	Host Read Commands
80-95	16	Host Write Commands
96-111	16	Controller Busy Time
112-127	16	Power Cycles
128-143	16	Power On Hours
144-159	16	Unsafe Shutdowns
160-175	16	Media And Data Integrity Errors
176-191	16	Number Of Error Information Log Entries
192-195	4	Warning Composite Temperature Time
196-199	4	Critical Composite Temperature Time
200-201	2	Temperature Sensor 1
202-203	2	Temperature Sensor 2
204-205	2	Temperature Sensor 3
206-207	2	Temperature Sensor 4
208-209	2	Temperature Sensor 5
210-211	2	Temperature Sensor 6
212-213	2	Temperature Sensor 7
214-215	2	Temperature Sensor 8
216-511	296	Reserved

SMART (C0h)

Byte	Length	Description
0-255	256	Reserved
256-257	2	SSD Protect Mode
258-261	4	Host Read UNC Count
262-265	4	PHY Error Count
266-269	4	CRC Error Count
270-273	4	Total Early Bad Block Count
274-277	4	Total Later Bad Block Count
278-281	4	Max Erase Count
282-285	4	Average Erase Count
286-289	4	Program Fail Count
290-293	4	Erase Fail Count
294-301	8	Flash Write Sector
302-305	4	Total Spare Block
306-309	4	Current Spare Block
310-313	4	Read Retry Count
314-511	210	Reserved

Electrical Specifications

Operating Voltage

Item	Range
Supply Voltage	3.3V ± 5%

Power Consumption

Capacity Mode	120 GB	240 GB	480 GB	960 GB	1.92 TB
Active (mA)	895	1,030	1,135	1,205	1,235
Idle (mA)	235	235	245	235	240

Note:
*All values are typical and may vary depending on flash configurations or host system settings.
**Active power is an average power measurement performed using CrystalDiskMark with 128KB sequential read/write transfers.

Mechanical Specification

- Length: 80.0 ± 0.2 mm
- Width: 22.0± 0.2 mm
- Thickness: 2.20 ± 0.15 mm
- Weight: < 6.5g

Single Side

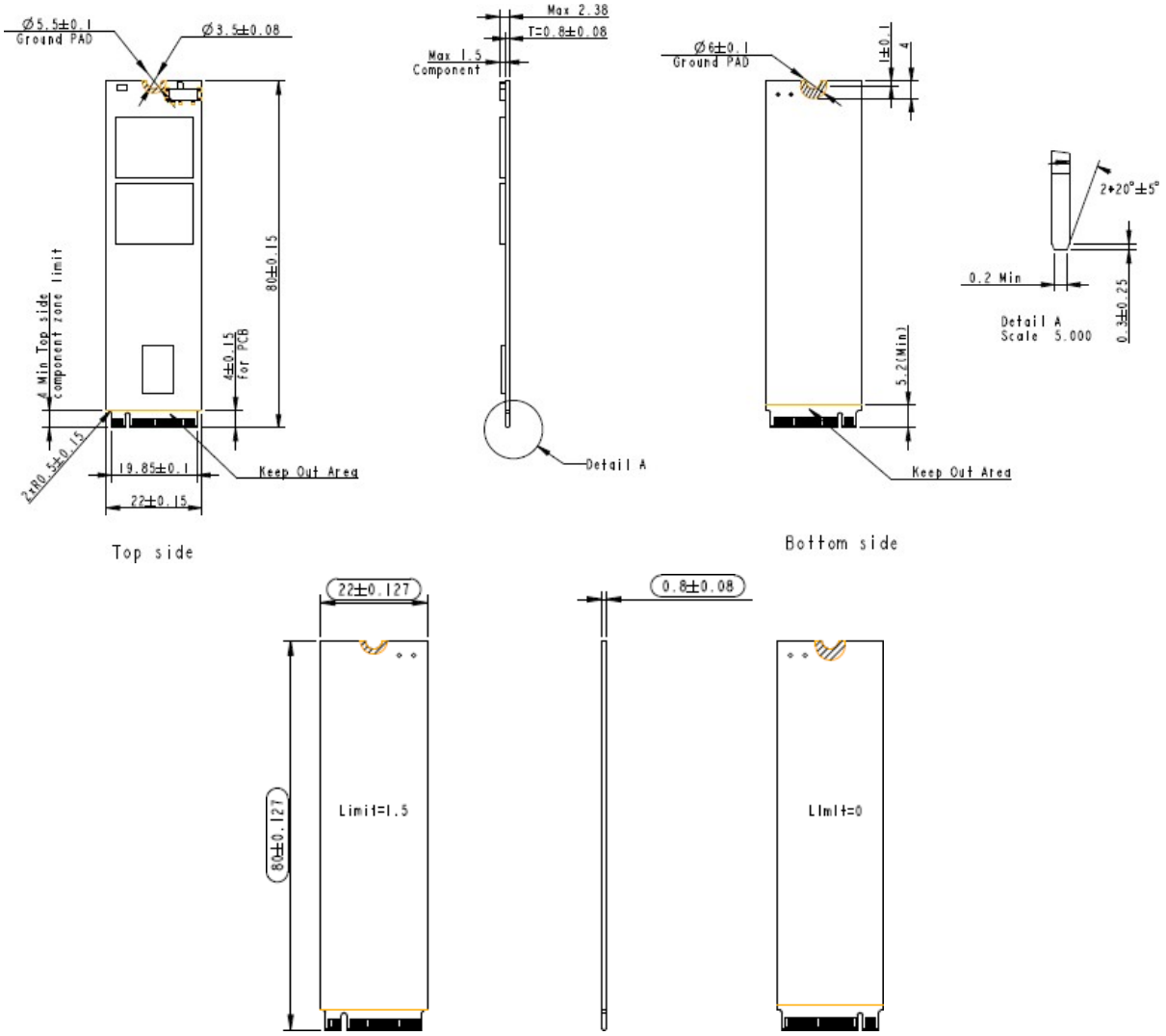

Figure 10-1 Dimensions – Single Side

Double Side