Apacer

RoHS Compliant

PCI Express Flash Drive

Professional PCIe M.2 2280 NAS SSD Product Specifications

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Version 2.1

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Specifications Overview:

- **PCIe Interface**
  - Compliant with PCI Express 3.1
  - Compliant with NVMe 1.3
  - Compatible with PCIe Gen3 x4 interface
- **Capacity**
  - 256, 512, 1024, 2048 GB
- **Performance**[1]
  - Interface burst read/write: 4 GB/sec
  - Sequential read: Up to 2,450 MB/sec
  - Sequential write: Up to 2,000 MB/sec
  - Random read (4K): Up to 360,000 IOPS
  - Random write (4K): Up to 240,000 IOPS
- **Flash Management**
  - Low-Density Parity-Check (LDPC) Code
  - Global Wear Leveling
  - Flash bad-block management
  - Flash Translation Layer: Page Mapping
  - Power Failure Management
  - S.M.A.R.T.
  - TRIM
  - Hyper Cache Technology
  - DataRAID™
- **NAND Flash Type:** 3D TLC
- **MTBF:** > 2,000,000 hours
- **Endurance (in Terabytes Written: TBW)**
  - 256 GB: 500 TBW
  - 512 GB: 1,000 TBW
  - 1024 GB: 2,000 TBW
  - 2048 GB: 4,000 TBW
- **Temperature Range**
  - Operating (Tc): 0°C to 70°C
  - Storage (Ta): -40°C to 85°C
- **Supply Voltage**
  - 3.3V ± 5%
- **Power Consumption**[1]
  - Active mode (Max.): 1,200 mW
  - Idle mode: 400 mW
- **NVMe Features**[2]
  - Supports HMB (Host Memory Buffer)
- **Reliability**
  - Thermal Throttling
  - End-to-End Data Protection
- **Connector Type**
  - 75-pin M.2 module pinout
- **Physical Characteristics**
  - Form factor: M.2 2280-S2-M
  - Dimensions: 80.00 x 22.00 x 2.15(max.), unit: mm
- **RoHS Compliant**
- **Warranty: 5 years or TBW (whichever occurs first)**

Notes:
1. Varies from capacities. The values for performances and power consumptions presented are typical and may vary depending on flash configurations or platform settings. The term idle refers to the standby state of the device.
2. Windows 10 (version 1703) onwards supports the HMB (Host Memory Buffer) function.

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1. Product Specifications

1.1 Performance

Performance of Apacer Professional PCIe M.2 2280 NAS SSD is listed below in Table 1-1.

Table 1-1 Performance Specifications

Performance \ Capacity	256 GB	512 GB	1024 GB	2048 GB
Sequential Read (MB/s)	2,300	2,400	2,450	2,450
Sequential Write (MB/s)	1,100	1,700	2,000	2,000
4K Random Read (IOPS)	360,000	360,000	360,000	260,000
4K Random Write (IOPS)	130,000	190,000	240,000	180,000

Notes:
- Results may differ from various flash configurations or host system setting.
- Sequential performance is based on CrystalDiskMark 8.0.4 with file size 1,000MB.
- Random performance measured using IOMeter with Queue Depth 32.

1.2 Environmental Specifications

Environmental specifications of Apacer Professional PCIe M.2 2280 NAS SSD are shown in Table 1-2.

Table 1-2 Environmental Specifications

Parameter	Type	Specifications
Temperature	Operating (Tc)	0°C to 70°C
	Non-operating (Ta)	-40°C to 85°C
Vibration	Non-operating	20G, 20~2000 Hz/random
Shock	Non-operating	1,500G, half-sine wave

Notes:
- This Environmental Specification table indicates the conditions for testing the device. Real world usages may affect the results.
- Tc: case temperature; Ta: ambient temperature. The operating temperature is determined by the case temperature. Adequate airflow is advisable as it enables the device to maintain optimal temperatures, especially in environments with heavy workloads.

1.3 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in Apacer Professional PCIe M.2 2280 NAS SSD. The prediction result for Apacer Professional PCIe M.2 2280 NAS SSD is more than 2,000,000 hours.

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

1.4 Endurance

The endurance of a storage device is predicted by TeraBytes Written based on several factors related to usage, such as the amount of data written into the drive, block management conditions, and daily workload for the drive. Thus, key factors, such as Write Amplifications and the number of P/E cycles, can influence the lifespan of the drive.

Table 1-3 Endurance Specifications

Capacity	TeraBytes Written
256 GB	500
512 GB	1,000
1024 GB	2,000
2048 GB	4,000

Notes:

- The endurance of SSD could be estimated based on users' behaviors, NAND endurance cycles, and write amplification factor. It is not guaranteed by the flash vendor.
- TBW may vary from flash configuration and platform.

1.5 Certification and Compliance

Apacer Professional PCIe M.2 2280 NAS SSD complies with the following standards:

- CE
- UKCA
- FCC
- RoHS

2. Flash Management

2.1 Error Correction/Detection

Apacer Professional PCIe M.2 2280 NAS SSD 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 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.

2.2 Bad Block Management

Current production technology is unable to guarantee total reliability of NAND flash memory array. When a flash memory device leaves 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. Apacer 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 error will be corrected by designated algorithms.

2.3 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 will perform 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 will eventually cause some blocks to age faster than others. This would bring 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 will increase the lifespan of SSDs.

2.4 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 schedule 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 can be 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.

2.5 Power Failure Management

Power Failure Management plays a crucial role when 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 will be activated to scan pages and blocks once power is resumed. Valid data will be transferred to new blocks for merging and the mapping table will be rebuilt. Therefore, data reliability can be reinforced, preventing damage to data stored in the NAND Flash.

2.6 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 can inform the SSD which blocks of data are no longer in use and can be removed permanently. Thus, the SSD will perform the erase action, which prevents unused data from occupying blocks all the time.

2.7 Hyper Cache Technology

Apacer 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 SSD, the firmware will direct the data to Hyper Cache mode, providing excellent performance to handle various scenarios in industrial use.

2.8 DataRAID™

Apacer'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 can be compared to the existing uncorrupted data and the content of the corrupted data can be rebuilt.

3. NVMe Support Features

3.1 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 DRAMless solutions.

4. Reliability Features

4.1 Thermal Throttling

Thermal throttling can monitor the temperature of the SSD equipped with a built-in thermal sensor via S.M.A.R.T. commands. This method can ensure 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 will be 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.

4.2 End-to-End Data Protection

End-to-End Data Protection is a feature implemented in Apacer 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.

5. Electrical Specifications

5.1 Operating Voltage

Table 5-1 lists the supply voltage for Apacer Professional PCIe M.2 2280 NAS SSD.

Table 5-1 Operating Range

Item	Range
Supply Voltage	3.3V ± 5%

5.2 Power Consumption

Table 5-2 lists the power consumption for Apacer Professional PCIe M.2 2280 NAS SSD.

Table 5-2 Power Consumption

Capacity / Mode	Unit	256 GB	512 GB	1024 GB	2048 GB
Active (Max.)	mW	1,000	1,100	1,100	1,200
Idle		300	300	300	400

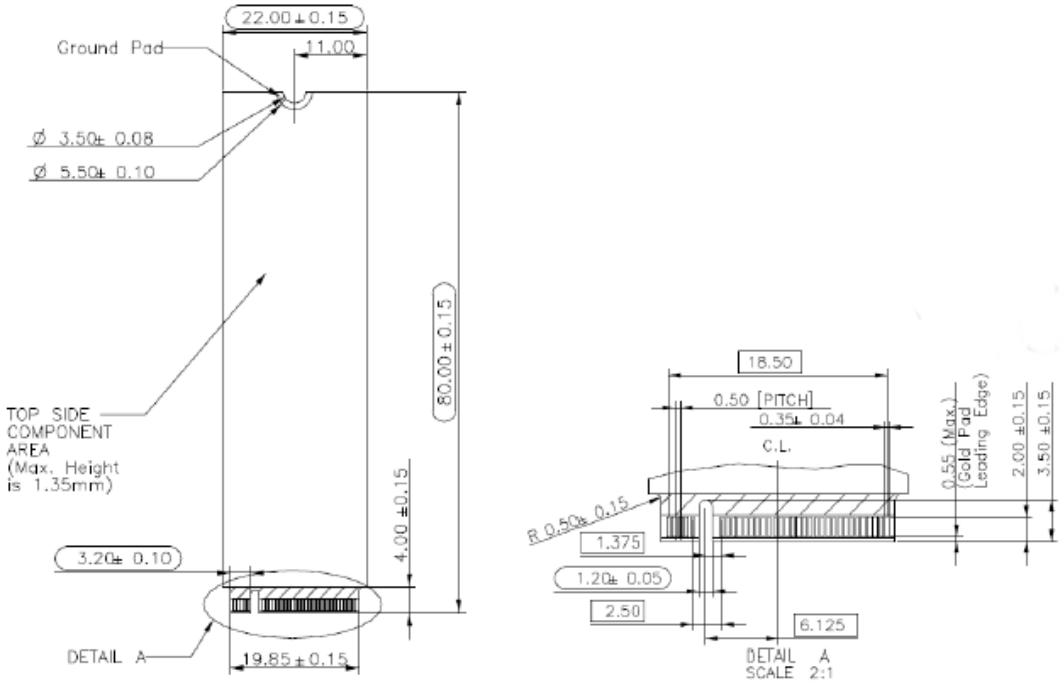
Notes:
- All values are typical and may vary depending on flash configurations or host system settings.
- Power consumption is measured using CrystalDiskMark 8.0.4 with file size 1,000MB.

6. Mechanical Specifications

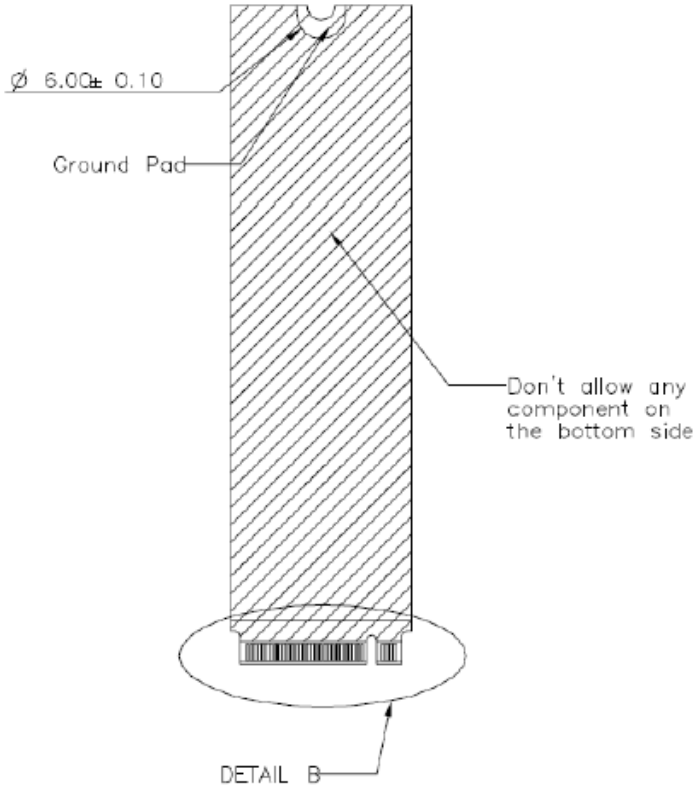
Table 6-1 Physical Dimensions

Parameter	Unit	256 GB	512GB	1024 GB	2048 GB
Length	mm	80.00 ± 0.15			
Width		22.00 ± 0.15			
Height (Max.)		2.15			

Top View



Bottom View



Side View

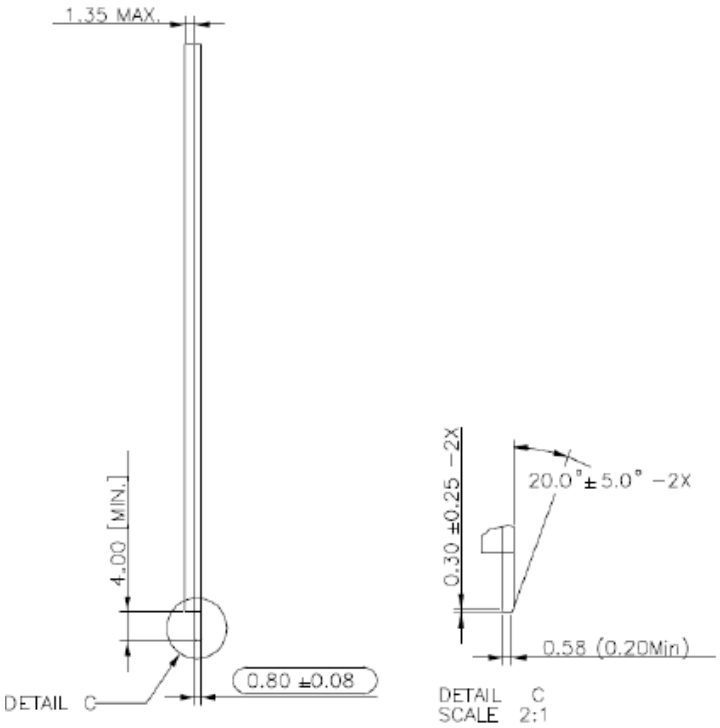


Figure 6-1 Physical Dimensions

Notes :
1.  = Max Component Height
2.  = No Component
3.  = No Component / Signal Vias / Signal Copper / Printing
4. General Tolerance ±0.15mm
5.  are critical dimensions

7. Product Ordering Information

The following table lists the available models of the Apacer Professional PCIe M.2 2280 NAS SSD series which are in mass production or will be in mass production. Consult your Apacer sales representative to confirm availability of valid combinations and to determine availability of new combinations.

Capacity	Retail P/N
256GB	AP256GPP3480-R
512GB	AP512GPP3480-R
1024GB	AP1TPP3480-R
2048GB	AP2TPP3480-R

Revision History

Revision	Description	Date
1.0	Initial release	6/17/2020
1.1	Updated Endurance on Specifications Overview page and 1.4 Endurance	6/23/2020
1.2	Updated warranty period from 3 years to 5 years on Specifications Overview page	8/4/2020
1.3	Updated MTBF on Specifications Overview page and 1.3 Mean Time Between Failures (MTBF) by changing it from >1,500,000 hours to >2,000,000 hours	8/14/2020
1.4	- Changed 1TB to 1024GB - Added 2048GB support	10/27/2020
1.5	Updated idle power consumption for 128-1024GB	10/28/2020
1.6	Updated vibration and shock specs at 1.2 Environmental Specifications	11/12/2020
1.7	- Removed 128GB support - Added HMB, Thermal Throttling and End-to-End Data Protection support - Updated interface burst read/write to 4GB/sec at Performance on Specifications Overview page - Added PCI Express 3.1 compliance to PCIe Interface and Warranty on Specifications Overview page - Updated Performance on Specifications Overview page, 1.1 Performance and the CDM version at the note for Table 1-1 - Added Low-Density Parity-Check (LDPC) Code, Global Wear Leveling, Flash Translation Layer: Page Mapping, Hyper Cache Technology and DataRAID™ to Flash Management on Specifications Overview page - Added 2.1 Error Correction/Detection, 2.3 Global Wear Leveling, 2.4 Flash Translation Layer - Page Mapping, 2.7 Hyper Cache Technology and 2.8 DataRAID™ to 2. Flash Management	1/3/2022
1.8	Updated Power Consumption on Specifications Overview page and Table 5-2	5/31/2022
1.9	- Updated Performance on Specifications Overview page - Updated Table 1-1 - Added UKCA to 1.5 Certification and Compliance	3/7/2023
2.0	Updated Performance on Specifications Overview page and Table 1-1	7/3/2023
2.1	Added a note regarding temperature at Table 1-2	4/1/2024

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