Apacer

RoHS Compliant

PCI Express Flash Drive

Industrial PV93E-E1S BiCS5 Product Specifications

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Specifications Overview:

- **PCIe Interface**
  - Compliant with PCI Express 4.0
  - Compliant with NVMe 1.4
  - Compatible with PCIe Gen4 x4 interface
- **Capacity**
  - 480, 960, 1920, 3840 GB
- **Performance**[1]
  - Interface burst read/write: 8 GB/sec
  - Sequential R/W: Up to 7,460/6,415 MB/sec
  - Random R/W (4K): Up to 1,309K/1,083K IOPS
  - Sustained seq. R/W: Up to 6,645/3,775 MB/sec
  - Sustained rand. R/W: Up to 926K/85K IOPS
  - Random R/W latency: 65/77 µs
  - Random R/W QoS: 0.102/0.342 ms
- **Flash Management**
  - Low-Density Parity-Check (LDPC) Code
  - Global Wear Leveling
  - Flash bad-block management
  - Flash Translation Layer: Page Mapping
  - S.M.A.R.T.
  - TRIM
  - Hyper Cache Technology
  - Over-provisioning
  - SMART Read Refresh™
- **DRAM Cache for Enhanced Random Performance**
- **Enterprise Features**
  - AES 256-bit hardware encryption
  - Signed Firmware
  - CorePower
  - Thermal Sensor
  - Thermal Throttling
  - End-to-End Data Protection
  - Sidefill
  - Heatsink design
- **Temperature Range**
  - Operating (Tc): 0°C to 70°C
  - Storage (Ta): -55°C to 100°C
- **Supply Voltage**
  - 12V ± 5%
- **Power Consumption**[1]
  - Active mode: 10.96 W
  - Idle mode: 2.01 W
  - Inrush current: 1.612 A
- **Connector Type**
  - EDSFF 1C (56 Pin)
- **NAND Flash Type:** 3D TLC (BiCS5)
- **Reliability**
  - MTBF: >3,000,000 hours
  - Data Retention: 10 years
  - Endurance
    - DWPD: >1
    - 480 GB: 1,145 TBW
    - 960 GB: 2,290 TBW
    - 1920 GB: 4,580 TBW
    - 3840 GB: 6,060 TBW
- **Physical Characteristics**
  - Form factor: EDSFF E1.S (9.5mm)
  - Dimensions: 33.75 x 118.75 x 9.50, unit: mm
  - Net weight: 57.78g ± 5%
- **RoHS Compliant**

Note:
1. Varies from capacities. The values for performances and power consumptions presented are typical and may vary depending on flash configurations or platform settings.

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1. General Description

Apacer PV93E-E1S is a high-performance and high endurance NVMe SSD designed as the standard EDSFF E1.S form factor utilizing 112-layer 3D TLC NAND Flash. PV93E-E1S supports PCIe Gen4 x4 interface and provides full compliance with NVMe 1.4 specifications, allowing the PCIe SSD to operate more effectively than SATA SSDs and greatly save on power consumption. PV93E-E1S delivers outstanding, stable performance up to 7,460 MB/s for sequential read and 6,415 MB/s for sequential write and ultra-low latency with optimized QoS. PV93E-E1S also presents better energy efficiency than traditional hard drives, extended endurance of more than 1 drive writes per day for 5 years and all the advantages of NAND Flash management technologies to ensure data integrity and highest levels of reliability, making it particularly suited for read-intensive, mixed-use workload applications.

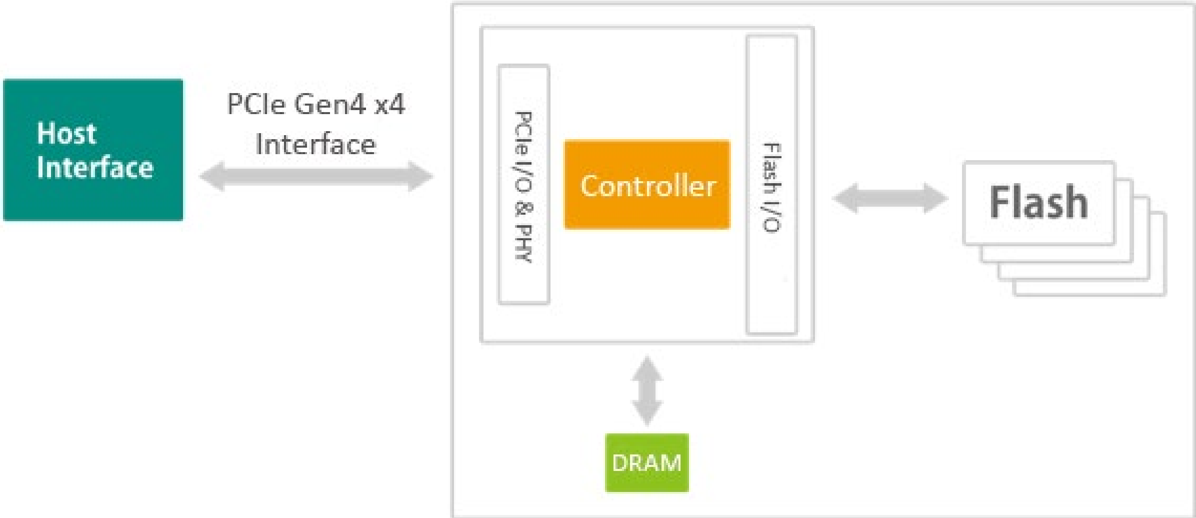
PV93E-E1S features enterprise-class reliability features implemented on both hardware and firmware levels. On the hardware level, PV93E-E1S is not only built with a powerful PCIe controller that supports on-the-module ECC as well as LDPC (Low Density Parity Check) ECC engine to extend SSD endurance and increase data reliability, but also designed with a heatsink to help keep an SSD cool and functioning correctly, while still allowing the drive to deliver high-speed performance. With the support of CorePower, PV93E-E1S ensures data integrity and stability of data transmission in the event of unexpected power loss. This is achieved by implementing a backup power supply with tantalum capacitors, which provide sufficient time to transfer all cached data to NAND flash. To increase product reliability and resistance to various thermal and mechanical shocks, PV93E-E1S also provides Sidefill technology to ensure that products continue to operate normally in high vibration and under extreme environmental changes.

On the firmware level, PV93E-E1S is designed with an error-checking mechanism called End-to-End Data Protection to ensure all data in transit is protected against transient errors. To maintain consistent performance in the process of data transmission, PV93E-E1S is configured with thermal throttling technology coupled with built-in thermal sensor to monitor the temperature of the SSD via S.M.A.R.T health monitoring and dynamically adjust frequency scaling to enhance data reliability and provide sustained performance while overheating.

In addition to data reliability, PV93E-E1S also incorporates a variety of cutting-edge technologies featuring multiple approaches to data protection and security. PV93E-E1S comes with not only AES to provide highly secure hardware encryption, but also Signed Firmware to allow firmware to be updated in a secure way with a digital signature. To add an additional level of protection, PV93E-E1S supports SMART Read Refresh, developed particularly for read-intensive applications, to avoid read disturb errors from occurring to ensure health status of all blocks of NAND flash.

Apacer PV93E-E1S is an enterprise-class SSD designed for server applications that require consistent performance, low latency and continuous large file transfers for 24/7 uptime and reliability. With superior performance, instant responsiveness, advanced power loss protection technology and highest standard of reliability – whether in terms of data security, data integrity and data protection, Apacer PV93E-E1S is an ideal solution for enterprise servers, data centers and cloud service providers.

2. Functional Block



Note: The actual number of NAND flash used on Apacer PV93E-E1S varies from capacities. The illustration is for reference only.

Figure 2-1 Functional Block Diagram

3. Pin Assignments

Table 3-1 defines the signal assignment of the internal NGFF connector for SSD usage, as described in SFF-TA-1009, Revision 2.0 Enterprise and Datacenter SSD Pin and Signal Specification.

Table 3-1 Pin Assignments

Pin No.	PCIe Pin	Description
A1	GND	Return current path
A2	GND	Return current path
A3	GND	Return current path
A4	GND	Return current path
A5	GND	Return current path
A6	GND	Return current path
A7	SMBCLK	SMBCLK: Open Drain with pull-up on host. SMBus Clock.
A8	SMBDATA	SMBDATA: Open Drain with pull-up on host. SMBus Data.
A9	SMRST#	Active low signal. SMRST# is a reset for the management interface.
A10	LED#/ACTIVITY	A10 is used for activity. When idle, logic level is low (LED Solid On). The amber LED is driven by the host signal through the LED/ACTIVITY pin.
A11	CLKREQ#	CLKREQ#: Clock Request is a reference clock request signal defined by the PCI Express Base Specification. It may be supported by a device in single port mode only. If CLKREQ# is supported by the host and the device, then the signal is Open Drain with a pull up on host.
A12	PRSNT0#	Active low signal. This signal indicates to the host that the device is electrically attached.
A13	GND	Return current path
A14	REFCLKn1	NC
A15	REFCLKp1	NC
A16	GND	Return current path
A17	PERn0	PCIe RX Differential signals defined by the PCI Express Card Electromechanical Specification.
A18	PERp0	PCIe RX Differential signals defined by the PCI Express Card Electromechanical Specification.
A19	GND	Return current path
A20	PERn1	PCIe RX Differential signals defined by the PCI Express Card Electromechanical Specification.
A21	PERp1	PCIe RX Differential signals defined by the PCI Express Card Electromechanical Specification.
A22	GND	Return current path
A23	PERn2	PCIe RX Differential signals defined by the PCI Express Card Electromechanical Specification.
A24	PERp2	PCIe RX Differential signals defined by the PCI Express Card Electromechanical Specification.
A25	GND	Return current path
A26	PERn3	PCIe RX Differential signals defined by the PCI Express Card Electromechanical Specification.
A27	PERp3	PCIe RX Differential signals defined by the PCI Express Card Electromechanical Specification.
A28	GND	Return current path
B1	12V	12V power

Table 3-1 Pin Assignments

Pin No.	PCIe Pin	Description
B2	12V	12V power
B3	12V	12V power
B4	12V	12V power
B5	12V	12V power
B6	12V	12V power
B7	MFG	NC
B8	RFU	Reserved for Apacer use only[1]
B9	DUALPORTEN#	NC
B10	PERST0#	PE-Reset is a fundamental reset to the device defined as PERST# by the PCI Express Base Specification.
B11	3.3 Vaux	3.3V power
B12	PWRDIS	Active high signal. Power Disable notifies the device to turn off all systems connected to 12 V power.
B13	GND	Return current path
B14	REFCLKn0	PCIe Reference Clock signals defined by the PCI Express Base Specification.
B15	REFCLKp0	PCIe TX Differential signal defined by the PCI Express M.2 spec
B16	GND	Return current path
B17	PETn0	PCIe TX Differential signals defined by the PCI Express Card Electromechanical Specification.
B18	PETp0	PCIe TX Differential signals defined by the PCI Express Card Electromechanical Specification.
B19	GND	Return current path
B20	PETn1	PCIe TX Differential signals defined by the PCI Express Card Electromechanical Specification.
B21	PETp1	PCIe TX Differential signals defined by the PCI Express Card Electromechanical Specification.
B22	GND	Return current path
B23	PETn2	PCIe TX Differential signals defined by the PCI Express Card Electromechanical Specification.
B24	PETp2	PCIe TX Differential signals defined by the PCI Express Card Electromechanical Specification.
B25	GND	Return current path
B26	PETn3	PCIe TX Differential signals defined by the PCI Express Card Electromechanical Specification.
B27	PETp3	PCIe TX Differential signals defined by the PCI Express Card Electromechanical Specification.
B28	GND	Return current path

Note:
1. Reserved by Apacer, please do not connect to a host.

4. Product Specifications

4.1 Capacity

Capacity specifications of PV93E-E1S are available as shown in Table 4-1.

Table 4-1 Capacity Specifications

Capacity	Total bytes	Total LBA
480 GB	480,103,981,056	937,703,088
960 GB	960,197,124,096	1,875,385,008
1920 GB	1,920,383,410,176	3,750,748,848
3840 GB	3,840,755,982,336	7,501,476,528

Notes:

- Display of total bytes varies from operating systems.
- 1 GB = 1,000,000,000 bytes; 1 sector = 512 bytes.
- LBA count addressed in the table above indicates total user storage capacity and will remain the same throughout the lifespan of the device. However, the total usable capacity of the SSD is most likely to be less than the total physical capacity because a small portion of the capacity is reserved for device maintenance usages.

4.2 Performance

Performance of PV93E-E1S is listed below in Table 4-2 and 4-3.

Table 4-2 Performance

Performance	Unit	480 GB	960 GB	1920 GB	3840 GB
Sequential Read	MB/s	5,525	4,950	7,460	6,700
Sequential Write		1,765	2,980	6,415	6,135
4K Random Read	IOPS	435,000	835,000	1,309,000	1,156,000
4K Random Write		432,000	743,000	1,083,000	1,078,000

Notes:

- Results may differ from various flash configurations or host system setting.
- Sequential read/write is based on CrystalDiskMark 8.0.4 with file size 1,000MB.
- Random read/write is measured using IOMeter with Queue Depth 128.

Table 4-3 Sustained Performance

Performance	Unit	480 GB	960 GB	1920 GB	3840 GB
Sequential Read	MB/s	3,865	5,000	6,645	6,300
Sequential Write		850	1,735	3,230	3,775
4K Random Read	IOPS	281,000	539,000	926,000	914,000
4K Random Write		9,000	2,000	47,000	85,000

Notes:

- Sustained sequential read/write is measured by using FIO with 128KB and 1024KB of data transfer size in Queue Depth 32 by 1 worker.
- Sustained random read/write is measured by using FIO with 4KB of data transfer size in Queue Depth 32 by 16 worker.

4.3 Latency

Table 4-4 Latency

Performance	Unit	480 GB	960 GB	1920 GB	3840 GB
Random Read	µs	65	65	65	65
Random Write		77	27	15	9

Note: Latency is measured by using the SNIA SSS (Solid State Storage) PTS (Performance Test Specification) with 4KB data transfer size in Queue Depth 1 by 1 worker.

4.4 Quality of Service (QoS)

Table 4-5 Quality of Service (QoS)

Quality of Service (99.9%)	Unit	480 GB	960 GB	1920 GB	3840 GB
Random Read	ms	0.100	0.101	0.101	0.102
Random Write		0.342	0.032	0.216	0.031

Notes:
- QoS is measured by using StorScore with Queue Depth 1 on 4KB random read and write.
- QoS is measured as the round-trip time taken for 99.9% of commands to host.

4.5 Environmental Specifications

Environmental specifications of PV93E-E1S are shown in Table 4-6.

Table 4-6 Environmental Specifications

Parameter	Type	Specifications
Temperature	Operating (Tc)	0°C to 70°C
	Non-operating (Ta)	-55°C to 100°C
Vibration	Operating	7.69 GRMS, 20~2000 Hz/random (compliant with MIL-STD-810G)
	Non-operating	4.02 GRMS, 15~2000 Hz/random (compliant with MIL-STD-810G)
Shock	Operating	Acceleration, 50(G)/11(ms)/half sine (compliant with MIL-STD-202G)
	Non-operating	Acceleration, 1500(G)/0.5(ms)/half sine (compliant with MIL-STD-883K)

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.

4.6 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in PV93E-E1S. The prediction result for PV93E-E1S 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.

4.7 Certification and Compliance

PV93E-E1S complies with the following standards:

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

4.8 Endurance

The endurance of a storage device is predicted by TeraBytes Written and Drive Writes Per Day 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 4-7 Endurance Specifications

Capacity	TeraBytes Written	Drive Writes Per Day
480 GB	1,145	1.34
960 GB	2,290	1.34
1920 GB	4,580	1.36
3840 GB	6,060	0.89

Notes:

- 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 cycles: 3K
- WAF may vary from capacity, flash configurations and writing behavior on each platform.
- 1 Terabyte = 1,024GB
- DWPD (Drive Writes Per Day) is calculated based on the number of times that user overwrites the entire capacity of an SSD per day of its lifetime during the warranty period. (3D NAND TLC warranty: 5 years)

4.9 Data Retention

Table 4-8 Data Retention

NAND Flash P/E Cycle	Value
100	10 years

Note: Data retention was evaluated at the temperature of 40°C.

5. Flash Management

5.1 Error Correction/Detection

PV93E-E1S 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.

5.2 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.

5.3 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.

5.4 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.

5.5 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.

5.6 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.

5.7 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.

5.8 SMART Read Refresh™

Apacer's SMART Read Refresh plays a proactive role in avoiding read disturb errors from occurring to ensure health status of all blocks of NAND flash. Developed for read-intensive applications in particular, SMART Read Refresh is employed to make sure that during read operations, when the read operation threshold is reached, the data is refreshed by re-writing it to a different block for subsequent use.

6. Enterprise Features

6.1 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.

6.2 Signed Firmware

Apacer's Signed Firmware technology is a secure way to update firmware. By including a digital signature, a firmware update will be authenticated by the Apacer SSD before a firmware update is performed. This extra layer of protection keeps drives secure.

6.3 CorePower

If the voltage supply is cut, for instance, accidental power off or sudden blackout, the data would be shortly lost. To protect SSD data integrity from this disastrous scenario, Apacer has developed the hardware-based technology named Apacer CorePower. The CorePower equips SSDs with tantalum capacitors that can deliver urgent power current so that the flash controller can take this extended moment to flush cached data and essential metadata into NAND Flash blocks.

In addition to tantalum capacitors which guarantee SSD data integrity, an inbuilt IC detector also serves the same purpose as well as ensures the stability of data transmission. The detector is designed to take proactive measures for the aforementioned disastrous scenario. When supply voltage drops below a minimum threshold, the detector will send out signals to the flash controller notifying it to stop operating to prevent poor performance or erratic operation. In the meanwhile, signals will also be sent to DRAM to have cached data flushed into NAND Flash blocks so as to avoid data loss, similar to the function performed by tantalum capacitors.

PV93E-E1S is equipped with tantalum capacitors which have lower power leakage, higher operating temperature and higher volume-efficiency (high capacitance in small volume) than many other types of capacitors. The compact size and the high reliability are ideal for embedded computing systems.

6.4 Thermal Sensor

Apacer 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.

6.5 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.

6.6 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.

6.7 Sidefill

Apacer's sidefill technology strengthens the connections between solder joints and their board, making them more robust and vibration-resistant. It also allows for heat dissipation to offset thermal damage.

6.8 Heatsink Design

In many applications, SSDs are subject to challenging conditions. If the working environment is already hot, and the SSD's operation causes it to increase in temperature as well, the result could be damage to the hardware or corrupted data. For this reason, Apacer's heatsink design is developed for heat dissipation to cool both the NAND Flash and the Controller IC, while still allowing an SSD to deliver high-speed performance, as well as prevent heat-related damage from occurring.

7. Software Interface

7.1 Command Set

Table 7-1 summarizes the commands supported by PV93E-E1S.

Table 7-1 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

Table 7-2 Admin Commands – NVM Command Set Specific

Opcode	Command Description
80h	Format NVM
84h	Sanitize

Table 7-3 NVM Commands

Opcode	Command Description
00h	Flush
01h	Write
02h	Read
09h	Dataset Management

7.2 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 can inform users of impending failures while there is still time to perform proactive actions, such as copy data to another device.

Table 7-4 SMART (02h)

Byte	Length	Description
0	1	Critical Warning
1-2	2	Composite Temperature
3	1	Available Spare
4	1	Available Spare Threshold
5	1	Percentage Used (Average Erase Count / P/E Cycle Count)
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: Controller Temperature
202-203	2	Temperature Sensor 2: PCB Temperature
204-205	2	Temperature Sensor 3: NAND Flash Temperature
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

Note: Temperature display of the Temperature Sensor from 1 to 8 (corresponding bytes from 200 to 215) is not supported if the return value is 0h.

Table 7-5 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

8. Electrical Specifications

8.1 Operating Voltage

Table 8-1 lists the supply voltage for PV93E-E1S.

Table 8-1 Operating Range

Item	Range
Supply Voltage	12V ± 5%

8.2 Power Consumption

Table 8-2 lists the power consumption for PV93E-E1S.

Table 8-2 Power Consumption

Mode	Unit	480 GB	960 GB	1920 GB	3840 GB
Read	W	6.39	6.29	8.68	8.70
Write		4.34	6.08	10.26	10.96
Idle		2.01	1.95	2.01	2.00

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.

8.3 Inrush Current

Table 8-3 Inrush Current

Inrush Current	480 GB	960 GB	1920 GB	3840 GB
12V	1.612 A			

9. Mechanical Specifications

Table 9-1 Physical Information

Parameter	Unit	480 GB	960 GB	1920 GB	3840 GB
Length	mm	118.75 ± 0.55			
Width		33.75 ± 0.25			
Height		9.50 ± 0.35			
Weight	g ± 5%	55.71	57.43	57.06	57.78

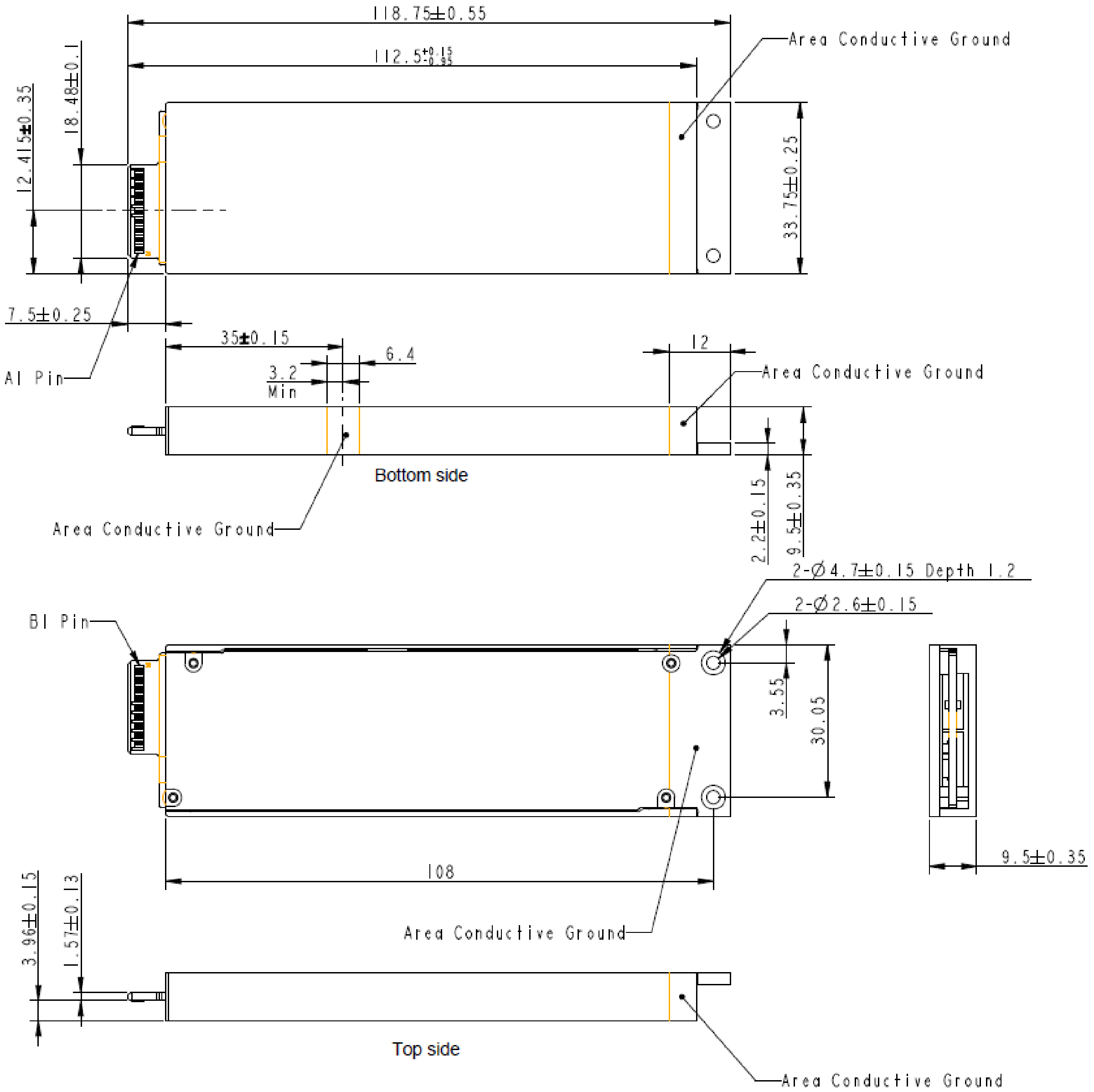


Figure 9-1 Physical Dimensions

10. Product Ordering Information

10.1 Product Code Designations

Apacer's PV93E-E1S SSD is available in different configurations and densities. See the chart below for a comprehensive list of options for the PV93E-E1S series devices.

Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	B	F	2	.	P	2	5	X	G	D	.	0	0	1	0	8

Code 1-3 (Product Line & Form Factor)	PCIe M.2 E1.S
Code 5-6 (Model/Solution)	PV93E
Code 7-8 (Product Capacity)	5K: 480GB 5L: 960GB 5M: 1920GB 5N: 3840GB
Code 9 (Flash Type & Product Temp)	3D TLC Standard Temperature
Code 10 (Product Spec)	E1.S with 9.5mm housing
Code 12-14 (Version Number)	Random numbers generated by system
Code 15-16 (Firmware Version)	Thermal Sensor PLP OP

10.2 Valid Combinations

The following table lists the available models of the PV93E-E1S 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	Valid Combination
480GB	BF2.P25KGD.00108
960GB	BF2.P25LGD.00108
1920GB	BF2.P25MGD.00108
3840GB	BF2.P25NGD.00108

Revision History

Revision	Description	Date
0.1	Preliminary release	4/26/2024
1.0	- Added product photo to the cover page - Updated endurance, inrush current, and weight on Specifications Overview page and Table 4-7, 8-3, and 9-1	5/22/2024

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