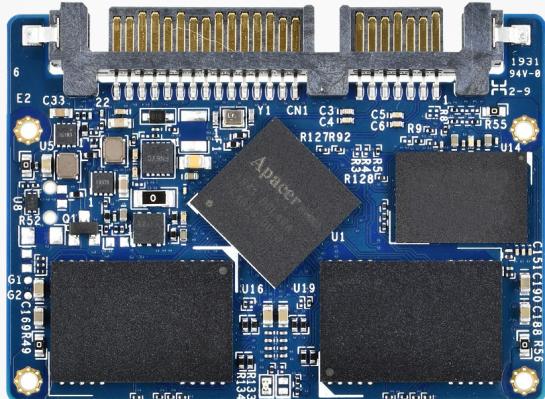


RoHS Recast Compliant

Serial ATA Flash Drive

Industrial SH240-297 BiCS5 Product Specifications



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Version 1.0



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Specifications Overview:

- **Compliance with SATA Revision 3.2**
 - SATA 6 Gb/s interface
 - Backward compatible with SATA 1.5 and 3 Gb/s interfaces
 - ATA command set-4 (ACS-4)
- **Capacity**
 - 40, 80, 160, 320, 640 GB
- **Performance¹**
 - Burst read/write: 600 MB/sec
 - Sequential read: Up to 560 MB/sec
 - Sequential write: Up to 495 MB/sec
 - Random read (4K): Up to 98,000 IOPS
 - Random write (4K): Up to 81,000 IOPS
- **DRAM Cache for Enhanced Random Performance**
- **Flash Management**
 - Low-Density Parity-Check (LDPC) Code
 - Bad Block Management
 - Global Wear Leveling
 - DataDefender™
 - ATA Secure Erase
 - TRIM
 - Flash Translation Layer: Page Mapping
 - Device Sleep
 - SATA Power Management
 - SLC-liteX (P/E cycles: 100K)
 - DataRAID™
 - SMART Read Refresh™
 - S.M.A.R.T.
- **NAND Flash Type:** 3D TLC (BiCS5)
- **MTBF:** >3,000,000 hours
- **Endurance (in drive writes per day: DWPD)**
 - 40 GB: 36.53 DWPD
 - 80 GB: 40.87 DWPD
 - 160 GB: 44.96 DWPD
 - 320 GB: 45.31 DWPD
 - 640 GB: 46.02 DWPD

Note:

1. Varies from capacities. The values for performance and power consumption presented are typical and may vary depending on flash configurations or platform settings. The term idle refers to the standby state of the device.

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1. General Description

Apacer's SH240-297 is a well-balanced solid-state drive (SSD) with a compact form factor and excellent performance. Designed with a SATA 6 Gb/s interface, SH240-297 fully complies with the latest SATA Revision 3.2 specifications and delivers exceptional read/write speeds. For enhanced data efficiency, the SSD's internal controller is engineered with DRAM to optimize random performance, making it an ideal solution for space-constrained industrial or server applications that demand robust and reliable storage.

Utilizing 3D NAND technology for capacities up to 960GB and providing greater power efficiency than 2D NAND, SH240-297 is built with a powerful SATA controller that supports on-the-module ECC, as well as an efficient wear leveling scheme. It also features an LDPC (Low Density Parity Check) ECC engine and SLC-liteX technology with P/E cycles support of up to 100,000 times, extending SSD endurance and enhancing data reliability. Additionally, SH240-297 is equipped with a built-in thermal sensor to monitor the SSD temperature via S.M.A.R.T commands, preventing overheating. For highly-intensive applications, End-to-End Data Protection ensures data integrity at multiple points in the path, enabling reliable data transfers.

In terms of security, SH240-297 offers robust data protection with Advanced Encryption Standard to safeguard against unauthorized access. It also incorporates various advanced features, including flash block management, DataDefender, ATA secure erase, TRIM, page mapping, device sleep, power saving modes, DataRAID, and SMART Read Refresh.

With exceptional performance, proven reliability, and enhanced data protection, SH240-297 is the ideal storage or cache solution for a variety of applications, including industrial, imaging, computing, and enterprise markets.

2. Functional Block

Apacer SH240-297 includes a single-chip controller designed with a DRAM and flash media. The controller integrates the flash management unit to support multi-channel, multi-bank flash arrays. Figure 2-1 shows the functional block diagram.

Note: The actual number of NAND flash used on Apacer SH240-297 varies from capacities. The illustration is for reference only.

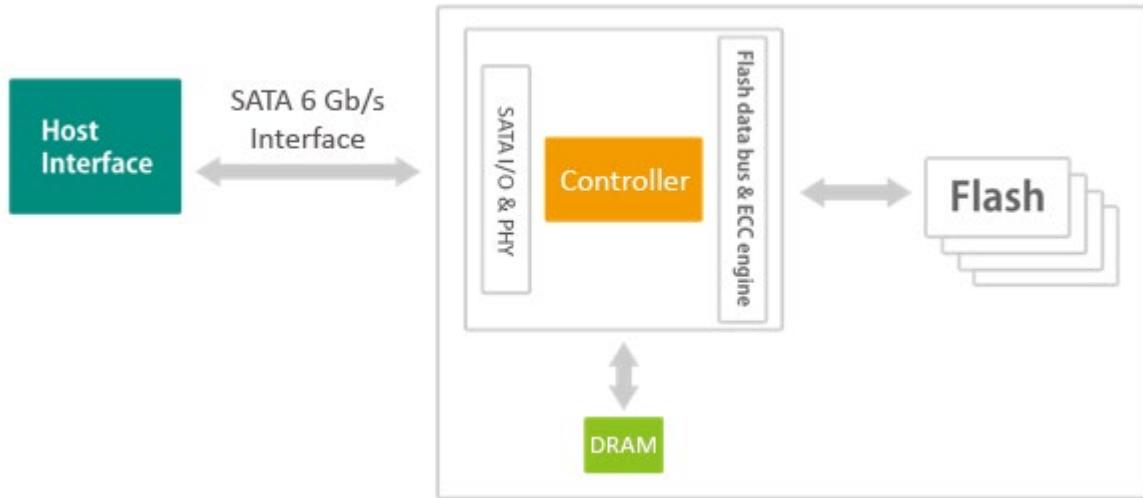


Figure 2-1 Functional Block Diagram

3. Pin Assignments

Table 3-1 describes the signal segment and Table 3-2 for power segment.

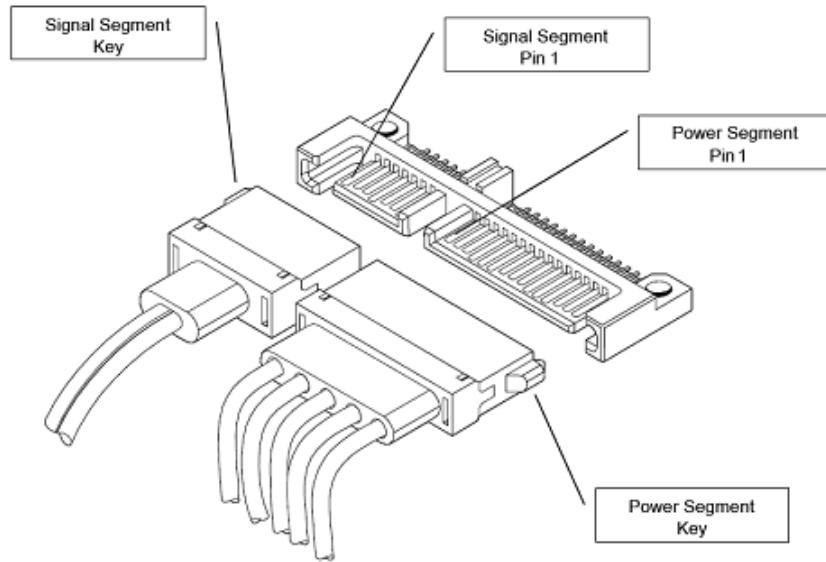


Figure 3-1 SATA Connectors

Table 3-1 Signal Segment

Pin	Type	Description
S1	GND	
S2	RxP	+ Differential Receive Signal
S3	RxN	- Differential Receive Signal
S4	GND	
S5	TxN	- Differential Transmit Signal
S6	TxP	+ Differential Transmit Signal
S7	GND	

Table 3-2 Power Segment

Pin	Signal/Description
P1	Unused (3.3V)
P2	Unused (3.3V)
P3	Device Sleep
P4	Reserved for Apacer use only ¹
P5	Ground
P6	Ground
P7	5V
P8	5V
P9	5V
P10	Ground
P11	Reserved for Apacer use only ¹
P12	Ground
P13	Unused (12V)
P14	Unused (12V)
P15	Unused (12V)

Note:

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

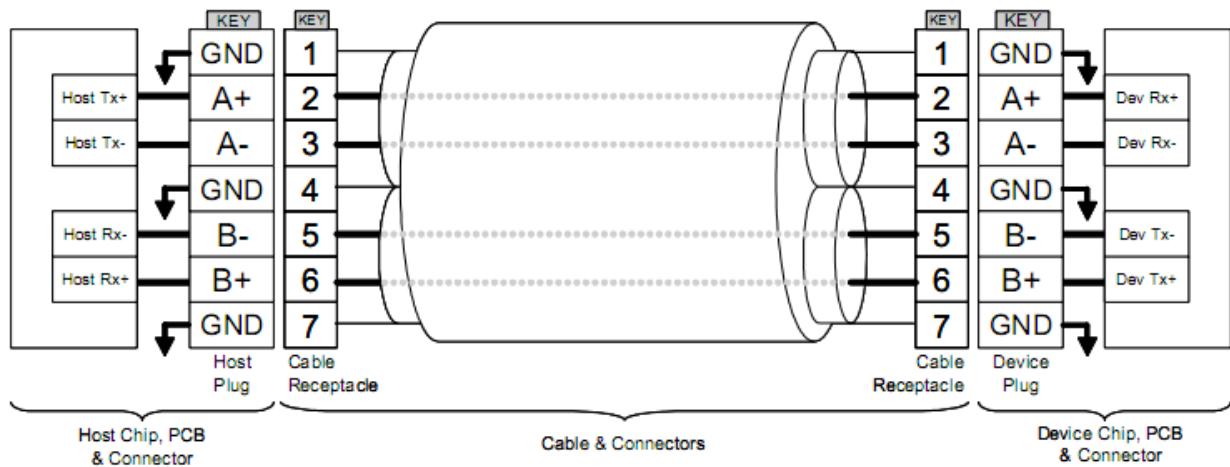


Figure 3-2 SATA Cable/Connector Connection Diagram

The connector on the left represents the Host with TX/RX differential pairs connected to a cable. The connector on the right shows the Device with TX/RX differential pairs also connected to the cable. Notice also the ground path connecting the shielding of the cable to the Cable Receptacle.

4. Product Specifications

4.1 Capacity

Table 4-1 Capacity Specifications

Capacity	Total bytes	Cylinders	Heads	Sectors	Total LBA
40 GB	40,018,599,936	16,383	16	63	78,161,328
80 GB	80,026,361,856	16,383	16	63	156,301,488
160 GB	160,041,885,696	16,383	16	63	312,581,808
320 GB	320,072,933,376	16,383	16	63	625,142,448
640 GB	640,135,028,736	16,383	16	63	1,250,263,728

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

Table 4-2 Performance Specifications

Performance \ Capacity	40 GB	80 GB	160 GB	320 GB	640 GB
Sequential Read (MB/s)	560	560	560	560	560
Sequential Write (MB/s)	455	475	485	495	495
Random Read IOPS (4K)	44,000	74,000	98,000	97,000	97,000
Random Write IOPS (4K)	78,000	80,000	81,000	81,000	81,000

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 32.

4.3 Environmental Specifications

Table 4-3 Environmental Specifications

Parameter	Type	Specifications
Temperature	Operating (Tc)	0°C to 70°C (Standard); -40°C to 85°C (Wide)
	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.

4.4 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in SH240-297. The prediction result for SH240-297 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.

4.5 Certification and Compliance

SH240-297 complies with the following standards:

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

4.6 Endurance

The endurance of a storage device is predicted by 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 4-4 Endurance Specifications

Capacity	Drive Writes Per Day
40 GB	36.53
80 GB	40.87
160 GB	44.96
320 GB	45.31
640 GB	46.02

Notes:

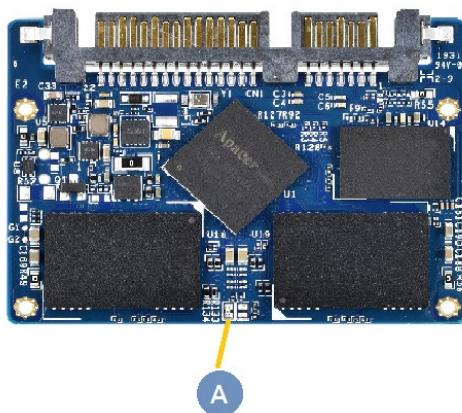
- This estimation complies with JEDEC JESD-219, Enterprise endurance workload of random data with payload size distribution.
- Flash vendor guaranteed 3D SLC-liteX P/E cycles: 100K
- WAF may vary from capacity, flash configurations and writing behavior on each platform.
- 1 Terabyte = 1,024 GB
- DWPD (Drive Write 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 SLC-liteX warranty: 5 years)

4.7 LED Indicator Behavior

The behavior of the SH240-297 LED indicator is described in Table 4-5.

Table 4-5 LED Behavior

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



5. Flash Management

5.1 Error Correction/Detection

SH240-297 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 DataDefender™

Apacer's DataDefender is an advanced technology of power failure management which combines both firmware and hardware mechanisms to ensure data integrity. When power disruption occurs, the low voltage detector will be triggered. When this happens, the SSD's protection mechanism is activated and cuts off data transmission from the host. Once the power supply is resumed, the firmware protection mechanism will ensure the integrity of the firmware as well as the data already written into the NAND flash media.

Note: The controller unit of this product model is designed with a DRAM as a write cache for improved performance and data efficiency. Though unlikely to happen in most cases, the data cached in the volatile DRAM might be potentially affected if a sudden power loss takes place before the cached data is flushed into non-volatile NAND flash memory.

5.5 ATA Secure Erase

ATA Secure Erase is an ATA disk purging command currently embedded in most of the storage drives. Defined in ATA specifications, (ATA) Secure Erase is part of Security Feature Set that allows storage drives to erase all user data areas. The erase process usually runs on the firmware level as most of the ATA-based storage media currently in the market are built-in with this command. ATA Secure Erase can securely wipe out the user data in the drive and protects it from malicious attack.

5.6 TRIM

TRIM is a SATA command that helps improve the read/write performance and efficiency of solid-state drives (SSD). The command enables the host operating system to inform SSD controller which blocks contain invalid data, mostly because of the erase commands from host. The invalid will be discarded permanently and the SSD will retain more space for itself.

5.7 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.

5.8 Device Sleep (DevSleep or DEVSLP) Mode

Device Sleep is a feature that allows SATA devices to enter a low power mode by designating a particular pin as DEVSLP signal with an aim to reducing power consumption.



Figure 5-1 Device Sleep

5.9 SATA Power Management

By complying with SATA 6 Gb/s specifications, the SSD supports the following SATA power saving modes:

- ACTIVE: PHY ready, full power, TX & RX operational
- PARTIAL: Reduces power, resumes in under 10 μ s (microseconds)
- SLUMBER: Reduces power, resumes in under 10 ms (milliseconds)
- HIPM: Host-Initiated Power Management
- DIPM: Device-Initiated Power Management
- AUTO-SLUMBER: Automatic transition from partial to slumber.
- Device Sleep (DevSleep or DEVSLP): PHY powered down; power consumption \leq 5 mW; host assertion time \leq 10 ms; exit timeout from this state \leq 20 ms (unless specified otherwise in SATA Identify Device Log).

Note: The behaviors of power management features would depend on host/device settings.

5.10 SLC-liteX

Apacer's 3D NAND SLC-liteX technology breaks through the limitations of existing technology and provides up to 100,000 P/E cycles, which is over 33 times more than MLC or industrial 3D TLC. Powered by carefully selected NAND components, the firmware structure is specifically optimized to enhance NAND flash stability during daily operations, and the error handling algorithm is significantly improved to avoid any unexpected ECC errors. The longest lifespans are therefore available at reasonable cost.

5.11 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.

5.12 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. Security and Reliability Features

6.1 Advanced Encryption Standard

The Advanced Encryption Standard (AES) is a widely adopted encryption specification for securing electronic data, used by the U.S. government since 2001 and prevalent in embedded computing. AES employs symmetric encryption, meaning the same key is used for both encrypting and decrypting data, ensuring information remains inaccessible without the key. In flash memory applications, AES 256-bit hardware encryption is the standard for protecting sensitive data, offering superior performance, reliability, and security compared to software-based methods. By utilizing a dedicated processor within the controller, hardware encryption significantly speeds up encryption and decryption processes, making it highly efficient for safeguarding confidential information.

6.2 Thermal Sensor

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

6.3 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 ensure 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.

7. Software Interface

7.1 Command Set

This section defines the software requirements and the format of the commands the host sends to SH240-297. Commands are issued to SH240-297 by loading the required registers in the command block with the supplied parameters, and then writing the command code to the Command register.

Table 7-1 Command Set

Code	Command	Code	Command
E5h	CHECK POWER MODE	F4h	SECURITY ERASE UNIT
06h	DATA SET MANAGEMENT	F5h	SECURITY FREEZE LOCK
92h	DOWNLOAD MICROCODE	F1h	SECURITY SET PASSWORD
90h	EXECUTE DEVICE DIAGNOSTIC	F2h	SECURITY UNLOCK
E7h	FLUSH CACHE	70h	SEEK
EAh	FLUSH CACHE EXT	EFh	SET FEATURES
ECh	IDENTIFY DEVICE	C6h	SET MULTIPLE MODE
E3h	IDLE	E6h	SLEEP
E1h	IDLE IMMEDIATE	B0h	SMART
91h	INITIALIZE DEVICE PARAMETERS	E2h	STANDBY
E4h	READ BUFFER	E0h	STANDBY IMMEDIATE
C8h	READ DMA	E8h	WRITE BUFFER
25h	READ DMA EXT	CAh	WRITE DMA
60h	READ FPDMA QUEUED	35h	WRITE DMA EXT
C4h	READ MULTIPLE	3Dh	WRITE DMA FUA EXT
29h	READ MULTIPLE EXT	61h	WRITE FPDMA QUEUED
2Fh	READ LOG EXT	3Fh	WRITE LOG EXT
47h	READ LOG DMA EXT	57h	WRITE LOG DMA EXT
20h	READ SECTOR	C5h	WRITE MULTIPLE
24h	READ SECTOR EXT	39h	WRITE MULTIPLE EXT
40h	READ VERIFY SECTORS	CEh	WRITE MULTIPLE FUA EXT
42h	READ VERIFY SECTORS EXT	30h	WRITE SECTOR
10h	RECALIBRATE	34h	WRITE SECTOR EXT
F6h	SECURITY DISABLE PASSWORD	45h	WRITE UNCORRECTABLE EXT
F3h	SECURITY ERASE PREPARE		

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 7-2 SMART Subcommand Set

Code	SMART Subcommand
D0h	READ DATA
D1h	READ ATTRIBUTE THRESHOLDS
D2h	ENABLE/DISABLE ATTRIBUTE AUTOSAVE
D4h	EXECUTE OFF-LINE IMMEDIATE
D5h	SMART READ LOG
D6h	SMART WRITE LOG
D8h	ENABLE OPERATIONS
D9h	DISABLE OPERATIONS
DAh	RETURN STATUS

Table 7-3 General SMART Attribute Structure

Byte	Description
0	ID (Hex)
1 – 2	Status Flag
3	Value
4	Worst
5*-11	Raw Data

*Byte 5: LSB

Table 7-4 SMART Attribute ID List

ID (Hex)	Attribute Name
9 (0x09)	Power-on Hours
12 (0x0C)	Power Cycle Count
163 (0xA3)	Maximum Erase Count
164 (0xA4)	Average Erase Count
166 (0xA6)	Total Later Bad Block Count
167 (0xA7)	SSD Protect Mode (Vendor Specific)
168 (0xA8)	SATA PHY Error Count
171 (0xAB)	Program Fail Count
172 (0xAC)	Erase Fail Count
175 (0xAF)	Bad Cluster Table Count
192 (0xC0)	Unexpected Power Loss Count
194 (0xC2)	Temperature
231 (0xE7)	Lifetime Left
241 (0xF1)	Total Sectors of Write

8. Electrical Specifications

8.1 Operating Voltage

Table 8-1 Operating Range

Item	Range
Supply Voltage	5V ± 5% (4.75-5.25V)

8.2 Power Consumption

Table 8-2 Power Consumption

Capacity Mode	Unit	40 GB	80 GB	160 GB	320 GB	640 GB
Active (Max.)	mA	390	380	435	435	445
Idle		90	90	95	95	90

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.

9. Mechanical Specifications

Table 10-1 Physical Dimensions

Parameter	Unit	40 GB	80 GB	160 GB	320 GB	640 GB
Length	mm			54.00 \pm 0.15		
Width				39.80 \pm 0.20		
Height				4.00 \pm 0.15		
Weight	g \pm 5%	6.06	6.56	7.56	7.56	8.56

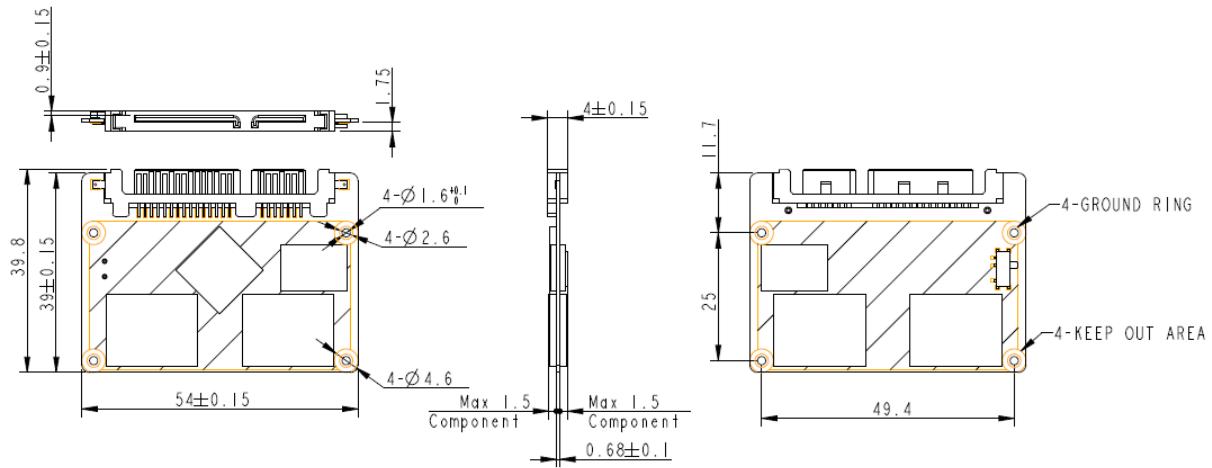


Figure 9-1 Physical Dimensions

10. Product Ordering Information

10.1 Product Code Designations

Apacer's SH240-297 SSD is available in different configurations and densities. See the chart below for a comprehensive list of options for the SH240-297 series devices.

Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	A	9	2	.	2	4	9	X	X	A	.	0	0	1	9	0

Code 1-3 (Product Line & Form Factor)	SATA MO297
Code 5-6 (Model/Solution)	SH240-297
Code 7-8 (Product Capacity)	9H: 40GB 9J: 80GB 9K: 160GB 9L: 320GB 9M: 640GB
Code 9 (Flash Type & Product Temp)	Y: 3D TLC SLC-liteX Standard Temperature Z: 3D TLC SLC-liteX Wide Temperature
Code 10 (Product Spec)	MO297
Code 12-14 (Version Number)	Random numbers generated by system
Code 15-16 (Firmware Version)	SLC-liteX Thermal Sensor DEVSLP

10.2 Valid Combinations

The following table lists the available models of the SH240-297 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	Standard Temperature	Wide Temperature
40GB	A92.249HYA.00190	A92.249HZA.00190
80GB	A92.249JYA.00190	A92.249JZA.00190
160GB	A92.249KYA.00190	A92.249KZA.00190
320GB	A92.249LYA.00190	A92.249LZA.00190
640GB	A92.249MYA.00190	A92.249MZA.00190

Revision History

Revision	Description	Date
1.0	Initial release	6/17/2025

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