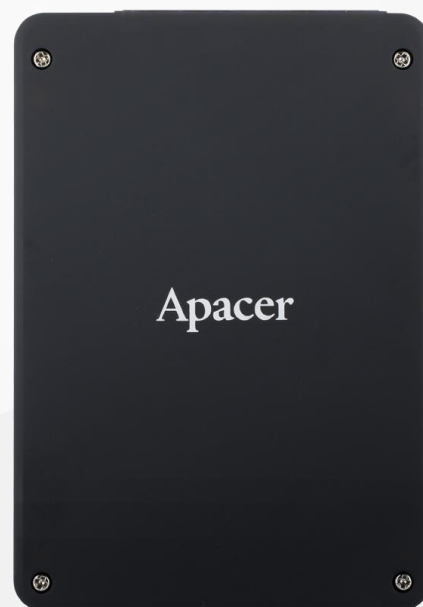


RoHS Compliant
Serial ATA Flash Drive
ST170-25 Product Specifications



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Version 1.9



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Specifications Overview:

- **Compliance with SATA Revision 3.2**
 - SATA 6.0 Gbps interface
 - Backward compatible with SATA 1.5 and 3.0 Gbps interfaces
 - ATA-8 command set
- **Capacity**
 - 60, 120, 240, 480, 960 GB
- **Performance***
 - Burst read/write: 600 MB/sec
 - Sequential read: Up to 560 MB/sec
 - Sequential write: Up to 515 MB/sec
 - Random read (4K): Up to 83,000 IOPS
 - Random write (4K): Up to 85,000 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.
 - Device Sleep
 - ATA Secure Erase
 - TRIM
 - Hyper Cache Technology
 - Over-Provisioning
 - DataRAID™
 - SMART Read Refresh™
- **Endurance (in drive writes per day: DWPD)**
 - 60 GB: 2.89 DWPD
 - 120 GB: 2.46 DWPD
 - 240 GB: 2.74 DWPD
 - 480 GB: 2.58 DWPD
 - 960 GB: 2.7 DWPD
- **Temperature Range**
 - Operating: 0°C to 70°C
 - Storage: -40°C to 100°C
- **Supply Voltage**
 - 5.0 V ± 5%
- **Power Consumption***
 - Active mode: 525 mA
 - Idle mode: 90 mA
- **Connector Type**
 - 7-pin SATA signal connector
 - 15-pin SATA power connector
- **NAND Flash Type: 3D TLC (BiCS3)**
- **MTBF: >1,000,000 hours**
- **Reliability**
 - Thermal Sensor
- **Security**
 - End-to-End Data Protection
- **SATA Power Management Modes**
- **Form Factor**
 - 2.5"
 - Dimensions: 100.00 x 69.85 x 6.90, unit: mm
 - Net Weight: 44.56 g
- **Shock & Vibration****
 - Shock: 1,500 G
 - Vibration: 15 G
- **RoHS Compliant**

*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.

**Non-operating

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1. General Descriptions

1.1 Introduction

Apacer's ST170-25 is a well-balanced solid-state disk (SSD) drive with standard form factor and great performance. Designed in SATA 6.0 Gbps interface, the SSD is able to deliver exceptional read/write speed, making it the ideal companion for heavy-loading industrial or server operations.

ST170-25 utilizes 3D NAND for higher capacity up to 960GB and provides more power efficiency than 2D NAND. Regarding reliability, ST170-25 is implemented with LDPC (Low Density Parity Check) ECC engine to extend SSD endurance and increase data reliability while reading raw data inside a flash chip. In addition, the drive comes with various implementations including powerful hardware ECC engine, power saving modes, wear leveling, flash block management, power failure management, S.M.A.R.T. and TRIM.

1.2 Capacity

Capacity specifications of ST170-25 are available as shown in Table 1-1. It lists the specific capacity and the default numbers of heads, sectors and cylinders for each product line.

Table 1-1 Capacity Specifications

Capacity	Total bytes*	Cylinders	Heads	Sectors	Max LBA
60 GB	60,021,538,816	16,383	16	63	117,231,408
120 GB	120,033,640,448	16,383	16	63	234,441,648
240 GB	240,056,795,136	16,383	16	63	468,862,128
480 GB	480,103,104,512	16,383	16	63	937,703,088
960 GB	960,196,771,840	16,383	16	63	1,875,385,008

*Display of total bytes varies from file systems, which means not all of the bytes can be used for storage.

**Notes: 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.

1.3 Performance

Performance of ST170-25 is listed below in Table 1-2.

Table 1-2 Performance Specifications

Capacity	60 GB	120 GB	240 GB	480 GB	960 GB
Performance					
Sequential Read* (MB/s)	550	560	560	550	550
Sequential Write* (MB/s)	250	455	495	515	510
Random Read IOPS** (4K)	39,000	65,000	83,000	82,000	81,000
Random Write IOPS** (4K)	60,000	81,000	83,000	85,000	85,000

Note:

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

*Sequential performance is based on CrystalDiskMark 5.2.1 with file size 1,000MB.

**Random performance measured using IOMeter with Queue Depth 32.

1.4 Pin Assignments

Table 1-3 describes the SFD signal segment, and Table 1-4, power segment.

Figure 1-1 SATA Connectors

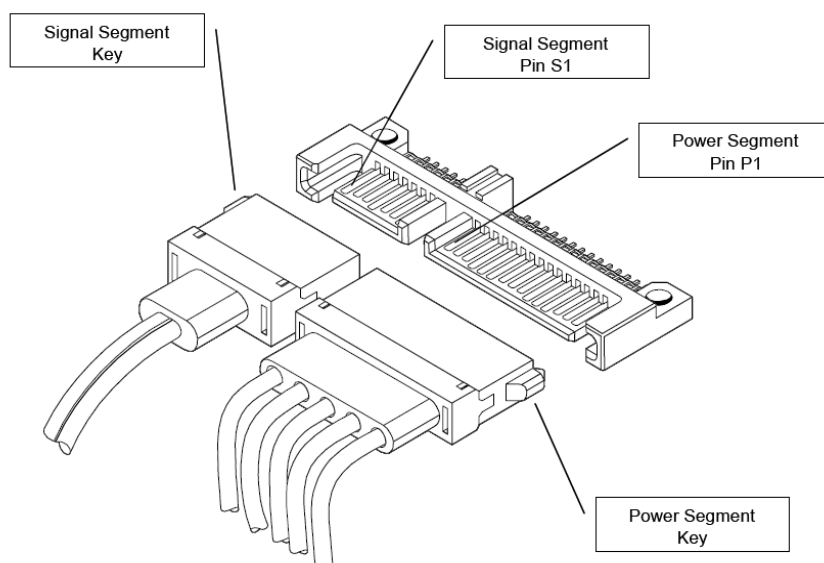


Table 1-3 Signal Segment

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 1-4 Power Segment

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

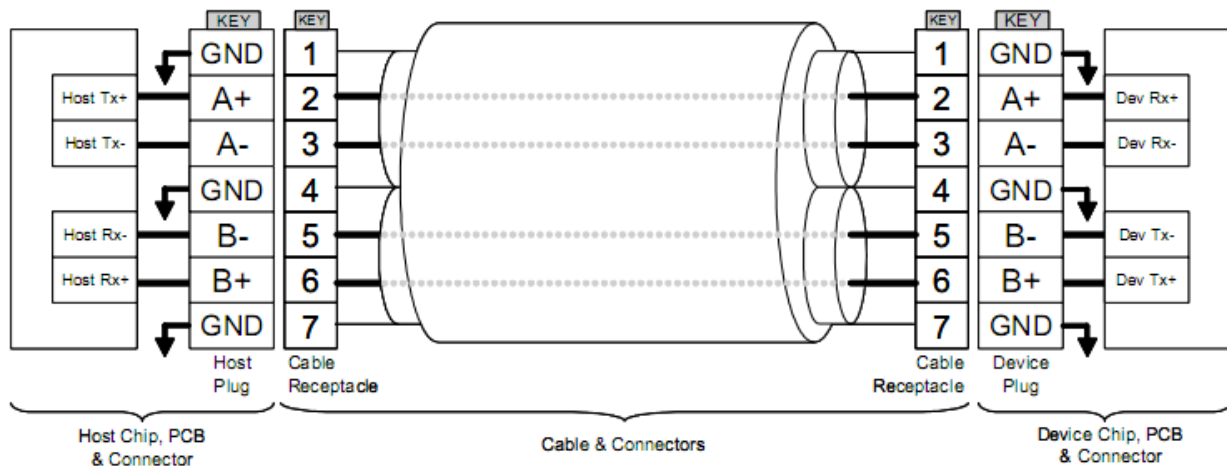


Figure 1-2 SATA Cable/Connector Connection Diagram

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.

2. Software Interface

2.1 Command Set

Table 2-1 summarizes the ATA commands supported by ST170-25.

Table 2-1 Command Set

Code	Command	Code	Command
E5h	Check Power Mode	F6h	Security Disable Password
90h	Execute Diagnostics	F3h	Security Erase Prepare
E7h	Flush Cache	F4h	Security Erase Unit
ECh	Identify Device	F5h	Security Freeze Lock
E3h	Idle	F1h	Security Set Password
E1h	Idle Immediate	F2h	Security Unlock
91h	Initialize Device Parameters	7Xh	Seek
C8h	Read DMA	EFh	Set Features
25h	Read DMA EXT	C6h	Set Multiple Mode
60h	Read FPDMA Queued	E6h	Sleep
47h	Read Log DMA EXT	B0h	S.M.A.R.T.
2Fh	Read Log EXT	E2h	Standby
C4h	Read Multiple	E0h	Standby Immediate
20 or 21h	Read Sector(s)	CAh	Write DMA
40 or 41h	Read Verify Sector(s)	35h	Write DMA EXT
10h	Recalibrate	61h	Write FPDMA Queued
57h	Write Log DMA EXT	3Fh	Write Log EXT
C5h	Write Multiple	30h or 31h	Write Sector(s)

2.2 S.M.A.R.T.

S.M.A.R.T. is an abbreviation for Self-Monitoring, Analysis and Reporting Technology, a self-monitoring system that provides indicators of drive health as well as potential disk problems. It serves as a warning for users from unscheduled downtime by monitoring and displaying critical drive information. Ideally, this should allow taking proactive actions to prevent drive failure and make use of S.M.A.R.T. information for future product development reference.

Apacer devices use the standard SMART command B0h to read data out from the drive to activate our S.M.A.R.T. feature that complies with the ATA/ATAPI specifications. S.M.A.R.T. Attribute IDs shall include initial bad block count, total later bad block count, maximum erase count, average erase count, power on hours and power cycle. When the S.M.A.R.T. Utility running on the host, it analyzes and reports the disk status to the host before the device reaches in critical condition.

Note: Attribute IDs may vary from product models due to various solution design and supporting capabilities.

Apacer memory products come with S.M.A.R.T. commands and subcommands for users to obtain information of drive status and to predict potential drive failures. Users can take advantage of the following commands/subcommands to monitor the health of the drive.

Code	SMART Subcommand
D0h	READ DATA
D1h	READ ATTRIBUTE THRESHOLDS
D2h	Enable/Disable Attribute Autosave
D4h	Execute Off-line Immediate
D5h	Read Log (optional)
D6h	Write Log (optional)
D8h	Enable Operations
D9h	Disable operations
DAh	Return Status

General SMART attribute structure

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

*Byte 5: LSB

SMART attribute ID list

ID (Hex)	Attribute Name
9 (0x09)	Power-on hours
12 (0x0C)	Power cycle count
163 (0xA3)	Max. erase count
164 (0xA4)	Avg. 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

3. Flash Management

3.1 Error Correction/Detection

ST170-25 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.

3.2 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. When host performs program/erase command on a block, bad block may appear in Status Register. 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.

3.3 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.

3.4 Flash Translation Layer – 4K Mapping

4K mapping is a 4K-based firmware technology whose essence lies in the ability to gather data, distribute the data into 4KB blocks automatically, and then schedule the data to be evenly written. This implementation is also evidenced by JEDEC that 4KB is the most frequently used block size for data read/write access, constituting 67% of server workload. Thus, 4K mapping is adopted to increase random access speed and improve SSD lifespan, reduce block erase frequency, and achieve optimized performance and lifespan.

3.5 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.

3.6 Power Failure Management

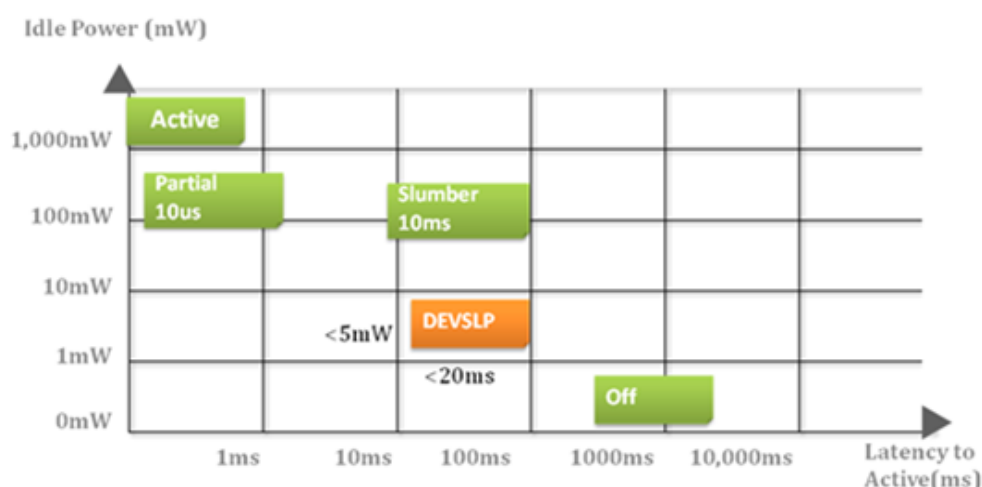
Power Failure Management plays a crucial role when power supply becomes unstable. Power disruption may occur when users are storing data into the SSD, leading to instability in the drive. However, with Power Failure Management, a firmware protection mechanism will be activated to scan pages and blocks 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.

3.7 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.

3.8 DEVSLP (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.



3.9 SATA Power Management

By complying with SATA 6.0 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.

3.10 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.

3.11 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.

3.12 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.

3.13 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.

4. Security & Reliability Features

4.1 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.

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 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.

5. Reliability Specifications

5.1 Environmental

Environmental specifications of ST170-25 product are shown in Table 5-1.

Table 5-1 Environmental Specifications

Environment	Specifications
Temperature	0°C to 70°C (Operating)
	-40°C to 100°C (Storage)
Vibration	Non-operating: Sine wave, 15(G), 10~2000(Hz), Operating: Random, 7.69(Grms), 20~2000(Hz)
Shock	Non-operating: Acceleration, 1,500 G, 0.5 ms Operating: Peak acceleration, 50 G, 11 ms

5.2 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in ST170-25. The prediction result for ST170-25 is more than 1,000,000 hours.

Note: The MTBF is predicated and calculated based on “Telcordia Technologies Special Report, SR-332, Issue 2” method.

5.3 Certification and Compliance

ST170-25 complies with the following standards:

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

5.4 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 5-2 Drive Writes Per Day

Capacity	Drive Writes Per Day
60 GB	2.89
120 GB	2.46
240 GB	2.74
480 GB	2.58
960 GB	2.7

Note:

- This estimation complies with JEDEC random client workload.
- 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 = 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: 2 years)

6. Electrical Specifications

6.1 Operating Voltage

Table 6-1 lists the supply voltage for ST170-25.

Table 6-1 Operating Range

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

6.2 Power Consumption

Table 6-2 lists the power consumption for ST170-25.

Table 6-2 Power Consumption

Capacity Mode	60 GB	120 GB	240 GB	480 GB	960 GB
Active (mA)	245	275	290	525	355
Idle (mA)	70	80	70	90	70

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.

7. Physical Characteristics

7.1 Dimensions

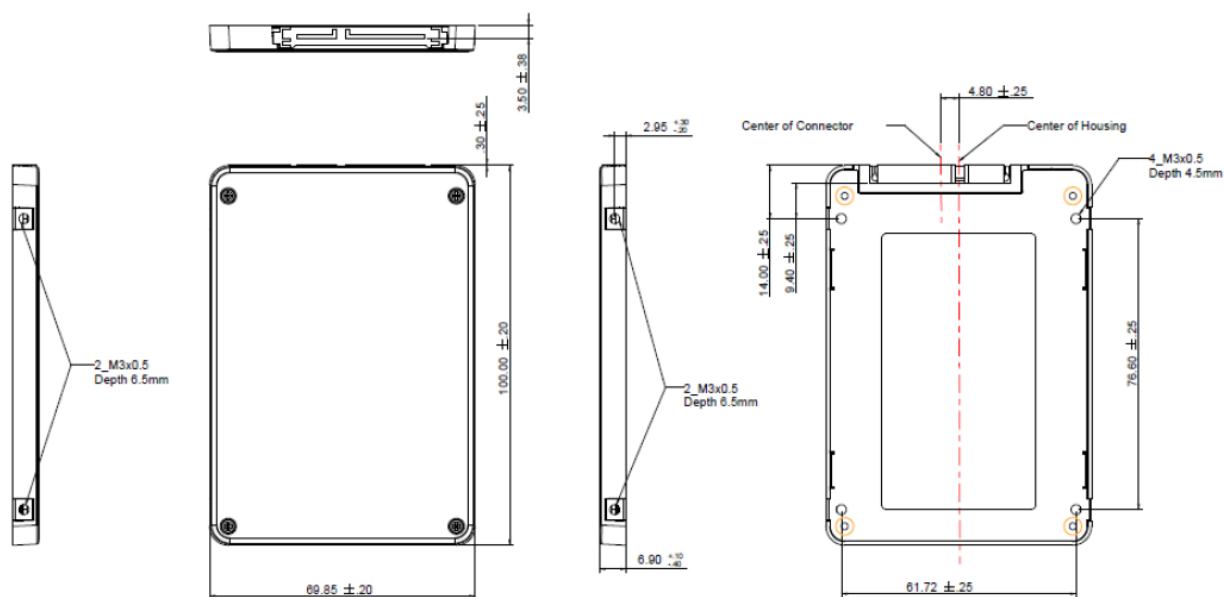


Figure 7-1 Physical Dimensions

7.2 Net Weight

Table 7-1 Net Weight

Capacity	Net Weight (g)
60GB	42.08
120GB	43.12
240GB	43.22
480GB	43.56
960GB	44.56

8. Product Ordering Information

8.1 Product Code Designations

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

Code 1st ~ 3rd (Product Line & form factor)	SATA+25 Half
Code 5th ~ 6th (Model/Solution)	ST170
Code 7th ~ 8th (Product Capacity)	5G: 60GB 5H: 120GB 5J: 240GB 5K: 480GB 5L: 960GB
Code 9th (Flash Type & Product Temp)	G: 3D TLC Standard temperature
Code 10th (Product Spec)	C: 2.5" 7mm plastic housing
Code 12th ~ 14th (Version Number)	Random numbers generated by system
Code 15th ~ 16th (Firmware Version)	11: DEVSLP + Thermal + OP

8.2 Valid Combinations

Capacity	Part Number
60GB	AE2.175GGC.00211
120GB	AE2.175HGC.00311
240GB	AE2.175JGC.00211
480GB	AE2.175KGC.00211
960GB	AE2.175LGC.00211

Note: Valid combinations are those products 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.

Revision History

Revision	Description	Date
0.1	Preliminary release	5/21/2018
1.0	<ul style="list-style-type: none"> - Updated total bytes for all capacities at 1.2 Capacity - Updated 960GB endurance rating at Endurance on Specifications Overview page and 5.4 Endurance - Removed Thermal Management Technique support 	6/13/2018
1.1	Revised the signal/description of pin 11 to DAS at Table 1-4 Power Segment	10/12/2018
1.2	<ul style="list-style-type: none"> - Updated performance for 60-480GB at Performance on Specifications Overview and 1.3 Performance - Updated power consumption for 60-480GB at Power Consumption on Specifications Overview and 6.2 Power Consumption - Updated endurance rating for 120-480GB at Endurance on Specifications Overview and 5.4 Endurance - Updated mechanical spec for 30GB at 7.1 30GB - Updated valid combinations for 60-480GB at 8.2 Valid Combinations 	11/9/2018
1.3	<ul style="list-style-type: none"> - Added JEDEC version JESD-219A to note 1 at 5.4 Endurance - Remove the redundant asterisk mark from note 2 at 5.4 Endurance - Added trademark “TM” to DataDefender 	11/23/2018
1.4	<ul style="list-style-type: none"> - Updated Table 1-4 Power Segment at 1.4 Pin Assignments by specifying pin 3 as Device Sleep pin - Updated 3.8 DEVSLP (DevSleep or DEVSLP) Mode - Updated mechanical spec for 30GB at 7. Physical Characteristics 	1/28/2019
1.5	<ul style="list-style-type: none"> - Updated product photo on the cover page - Removed DataDefender support 	3/28/2019
1.6	Updated endurance rating for 30-60GB at for Endurance on Specifications Overview and 5.4 Endurance	4/25/2019
1.7	<ul style="list-style-type: none"> - Added Power Failure Management, DataRAID and SMART Read Refresh to Flash Management on Specifications Overview page - Added 3.6 Power Failure Management, 3.12 DataRAID and 3.13 SMART Read Refresh 	5/9/2019
1.8	<ul style="list-style-type: none"> - Removed 30GB support - Updated 8. Product Ordering Information 	6/3/2019

Revision	Description	Date
1.9	<ul style="list-style-type: none"> - Updated endurance rating for 120-960GB at Endurance on Specifications Overview page and 5.4 Endurance - Removed JESD-219A from the first note at 5.4 Endurance - Updated technology description for 3.6 Power Failure Management - Updated the description for code 15-16 at 8.1 Product Code Designations 	8/2/2019

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