Apacer

RoHS Recast Compliant

M.2 2242 Flash Drive

SM220-M242 Product Specifications



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Version 1.1

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Specifications Overview:

- **Compliance with SATA Interface**
  - Serial ATA Revision 3.1
  - SATA 6 Gb/s
  - ATA-8 command set
  - Backward compatible with SATA 1.5/3 Gb/s
- **Capacity**
  - 8, 16, 32, 64, 128, 256 GB
- **Performance***
  - Burst read/write: 600 MB/sec
  - Sequential read: Up to 525 MB/sec
  - Sequential write: Up to 355 MB/sec
  - Random read (4K): Up to 76,000 IOPS
  - Random write (4K): Up to 43,000 IOPS
- **Flash Management**
  - Built-in hardware ECC
  - Global Wear Leveling
  - Flash bad-block management
  - Flash Translation Layer: Page Mapping
  - S.M.A.R.T.
  - Power Failure Management
  - Device Sleep (optional)
  - ATA Secure Erase
  - TRIM
  - SMART Read Refresh™
- **Endurance (in Terabytes Written: TBW)**
  - 8 GB: 13 TBW
  - 16 GB: 27 TBW
  - 32 GB: 66 TBW
  - 64 GB: 126 TBW
  - 128 GB: 277 TBW
  - 256 GB: 305 TBW
- **Temperature Range**
  - Operating:
    Standard: 0°C to 70°C
    Wide: -40°C to 85°C
  - Storage: -40°C to 100°C
- **Supply Voltage**
  - 3.3 V ± 5%
- **Power Consumption***
  - Active mode: 690 mA
  - Idle mode: 80 mA
- **Connector Type**
  - 75-pin SATA-based M.2 module pinout
- **Form Factor**
  - M.2 2242-D2-B-M
  - Dimensions: 42.00 x 22.00 x 3.60, unit: ㎜
- **Shock & Vibration****
  - Shock: 1,500 G
  - Vibration: 15 G
- **NAND Flash Type:** MLC
- **MTBF:** >1,000,000 hours
- **Reliability**
  - Thermal Sensor
  - Thermal Management Technique (optional)
- **SATA Power Management**
- **LED Indicators for Drive Behavior**
- **RoHS Recast Compliant (Complies with 2011/65/EU Standard)**

*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

Apacer's SM220-M242 (M.2 2242) is the next generation modularized Solid State Drive (SSD) with the shape of all new M.2 form factor, with the aim to be the more suitable for mobile and compact computers with standard width at only 22.00 mm. SM220-M242 appears in M.2 2242 mechanical dimensions and is believed to be the leading add-in storage solution for future host computing systems.

The M.2 SSD is designed with SATA-based connector pinouts, providing full compliance with the latest SATA Revision 3.1 interface specifications. Aside from SATA compliance, SM220-M242 delivers exceptional performance and power efficiency. On the other hand, the extreme thin and light form factor makes SM220-M242 the ideal choice for mobile computing systems, which appears to be the trend in near future.

Regarding reliability, SM220-M242 is built with a powerful SATA controller that supports on-the-module ECC as well as efficient wear leveling scheme. Since it is operating under SATA 6 Gb/s interface, SM220-M242 is provided with Apacer latest S.M.A.R.T. that are primarily oriented for the latest SATA interface SSD, for drive lifetime monitoring and analyzings.

2. Functional Block

Apacer SM220-M242 includes a single-chip SATA 6 Gb/s and the 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.

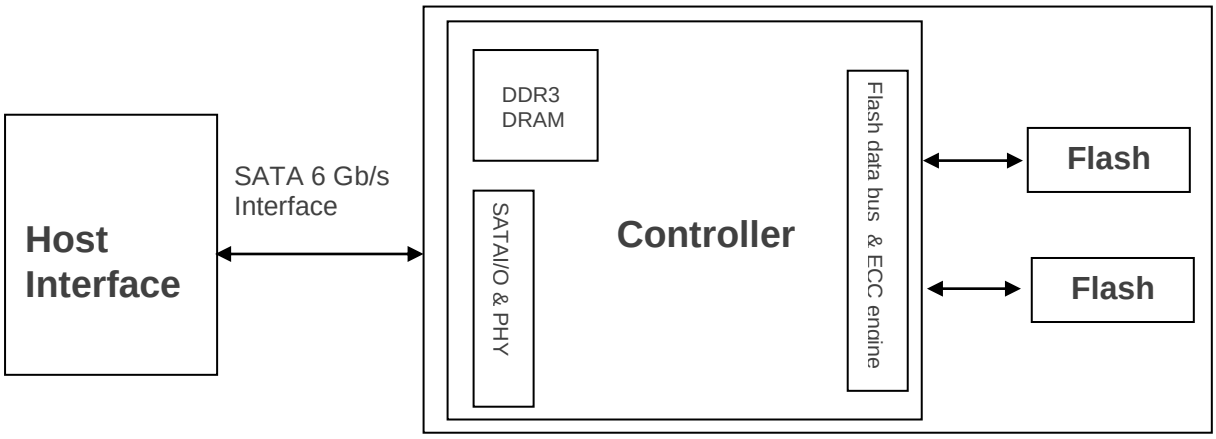


Figure 2-1 Functional Block Diagram

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3. Pin Assignments

This connector does not support hot plug capability. There are a total of 75 pins. 12 pin locations are used for mechanical key locations; this allows such a module to plug into both Key B and Key M connectors.

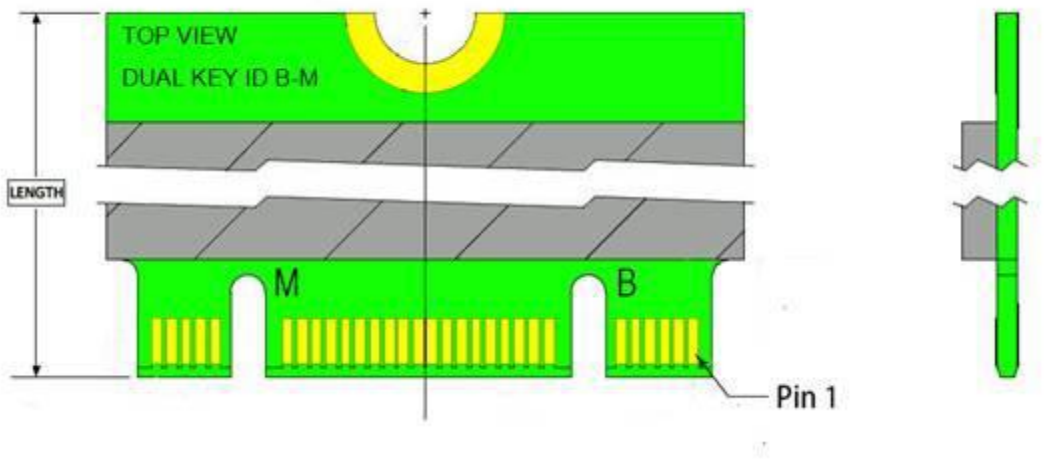


Table 3-1 Pin Assignments

Pin	Type	Description
1	CONFIG_3	Ground (according to M.2 configurations for SSD-SATA definition)
2	3.3V	Supply Pin, 3.3V
3	GND	Ground
4	3.3V	Supply pin, 3.3V
5	No connect	No connect
6	Not available	No connect (used for other purposes)
7	Not available	No connect (used for other purposes)
8	Not available	No connect (used for other purposes)
9	No connect	No connect
10	DAS/DSS	Device Activity Signal/Disable Staggered Spin-up
11	No connect	No connect (used for other purposes)
12	(removed for key)	Mechanical notch B
13	(removed for key)	Mechanical notch B
14	(removed for key)	Mechanical notch B
15	(removed for key)	Mechanical notch B
16	(removed for key)	Mechanical notch B
17	(removed for key)	Mechanical notch B
18	(removed for key)	Mechanical notch B
19	(removed for key)	Mechanical notch B
20	Not available	No connect (used for other purposes)

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Pin	Type	Description
21	CONFIG_0	Ground (according to M.2 configurations for SSD-SATA definition)
22	Not available	No connect (used for other purposes)
23	Not available	No connect (used for other purposes)
24	Not available	No connect (used for other purposes)
25	Not available	No connect (used for other purposes)
26	Not available	No connect (used for other purposes)
27	GND	Ground
28	Not available	No connect (used for other purposes)
29	PERn1	Not used
30	Not available	No connect (used for other purposes)
31	PERp1	Not used
32	Not available	No connect (used for other purposes)
33	GND	Ground
34	Not available	No connect (used for other purposes)
35	PETn1	Not used
36	Not available	No connect (used for other purposes)
37	PETp1	Not used
38	DEVSLP	Device Sleep, input. If driven high the host is informing the SSD to enter a low power state
39	GND	Ground
40	Not available	No connect (used for other purposes)
41	SATA-Rx+	Host receiver differential signal pair
42	Not available	No connect (used for other purposes)
43	SATA-Rx-	Host receiver differential signal pair
44	Not available	No connect (used for other purposes)
45	GND	Ground
46	Not available	No connect (used for other purposes)
47	SATA-Tx-	Host transmitter differential pair
48	Not available	No connect (used for other purposes)
49	SATA-Tx+	Host transmitter differential pair
50	PERST#	Not used
51	GND	Ground
52	CLKREQ#	Not used
53	REFCLKN	Not used
54	PEWAKE#	Not used
55	REFCLKP	Not used
56	MFG1	Manufacturing pin. Use determined by vendor (no connect on a host)

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Pin	Type	Description
57	GND	Ground
58	MFG2	Manufacturing pin. Use determined by vendor (no connect on a host)
59	(removed for key)	Mechanical notch B
60	(removed for key)	Mechanical notch B
61	(removed for key)	Mechanical notch B
62	(removed for key)	Mechanical notch B
63	(removed for key)	Mechanical notch B
64	(removed for key)	Mechanical notch B
65	(removed for key)	Mechanical notch B
66	(removed for key)	Mechanical notch B
67	Not available	No connect (used for other purposes)
68	SUSCLK	Not used
69	CONFIG_1	Ground
70	3.3V	Supply pin, 3.3V
71	GND	Ground
72	3.3V	Supply pin, 3.3V
73	GND	Ground
74	3.3V	Supply pin, 3.3V
75	CONFIG_2	Ground

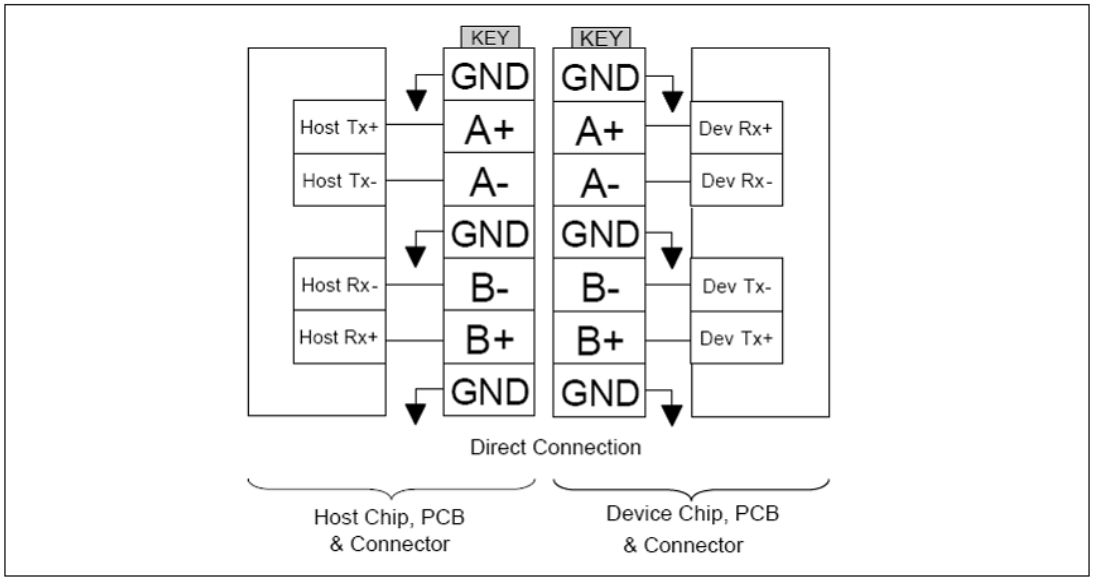


Figure 3-1 Direct Connection between the Host and Device

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4. Product Specifications

4.1 Capacity

Capacity specifications of SM220-M242 are available as shown in Table 4-1. It lists the specific capacity and the default numbers of heads, sectors and cylinders for each product line.

Table 4-1 Capacity Specifications

Capacity	Total bytes*	Cylinders	Heads	Sectors	Max LBA
8 GB	8,012,390,400	15,525	16	63	15,649,200
16 GB	16,013,942,784	16,383	16	63	31,277,232
32 GB	32,017,047,552	16,383	16	63	62,533,296
64 GB	64,023,257,088	16,383	16	63	125,045,424
128 GB	128,035,676,160	16,383	16	63	250,069,680
256 GB	256,060,514,304	16,383	16	63	500,118,192

*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.

4.2 Performance

Performance of SM220-M242 is listed below in Table 4-2.

Table 4-2 Performance Specifications

Capacity / Performance	8 GB	16 GB	32 GB	64 GB	128 GB	256 GB***
Sequential Read* (MB/s)	115	215	215	275	510	525
Sequential Write* (MB/s)	25	50	45	85	180	355
Random Read IOPS (4K)**	15,000	26,000	25,000	46,000	76,000	56,000
Random Write IOPS (4K)**	4,000	10,000	11,000	21,000	43,000	28,000

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.
***256GB adopts 8K mapping algorithm.

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4.3 Environmental Specifications

Environmental specifications of SM220-M242 product are shown in Table 4-3.

Table 4-3 Environmental Specifications

Environment	Specifications
Temperature	0°C to 70°C (Standard); -40°C to 85°C (Wide)
	-40°C to 100°C (Non-operating)
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

4.4 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in SM220-M242. The prediction result for SM220-M242 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.

4.5 Certification and Compliance

SM220-M242 complies with the following standards:

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

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4.6 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 4-4 Endurance Specifications

Capacity	TeraBytes Written
8 GB	13
16 GB	27
32 GB	66
64 GB	126
128 GB	277
256 GB	305

Note:

- The measurement assumes the data written to the SSD for test is under a typical and constant rate.
- The measurement follows the standard metric: 1 TB (Terabyte) = 1,000 GB.
- This estimation complies with JEDEC JESD-219, enterprise endurance workload of random data with payload size distribution.

4.7 LED Indicator Behavior

The behavior of the SM220-M242 LED indicators 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
LED B	PHY	LED blinks when PHY is connected



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5. Flash Management

5.1 Error Correction/Detection

SM220-M242 implements a hardware ECC scheme, based on the BCH algorithm. It can detect and correct up to 40 bits error in 1K bytes.

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. 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.

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 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.

5.5 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.

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5.6 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.

5.7 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.

5.8 DEVSLP (DevSleep or DEVSLP) Mode (optional)

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.



5.9 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.

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5.10 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 µs (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 ≦ 5 mW; host assertion time ≦ 10 ms; exit timeout from this state ≦ 20 ms (unless specified otherwise in SATA Identify Device Log).

Note:
1. The behaviors of power management features would depend on host/device settings.
2. Device Sleep mode is optional, depending on product ordering selections.

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6. Reliability Features

6.1 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.

6.2 Thermal Management Technique (optional)

Thermal management technique 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.

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7. Software Interface

7.1 Command Set

This section defines the software requirements and the format of the commands the host sends to SM220-M242. Commands are issued to SM220-M242 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	F3h	SECURITY ERASE PREPARE
06h	DATA SET MANAGEMENT	F4h	SECURITY ERASE UNIT
90h	EXECUTE DEVICE DIAGNOSTIC	F5h	SECURITY FREEZE LOCK
E7h	FLUSH CACHE	F1h	SECURITY SET PASSWORD
EAh	FLUSH CACHE EXT	F2h	SECURITY UNLOCK
ECh	IDENTIFY DEVICE	70h	SEEK
E3h	IDLE	EFh	SET FEATURES
E1h	IDLE IMMEDIATE	C6h	SET MULTIPLE MODE
91h	INITIALIZE DEVICE PARAMETERS	E6h	SLEEP
C8h	READ DMA	B0h	SMART
25h	READ DMA EXT	E2h	STANDBY
C4h	READ MULTIPLE	E0h	STANDBY IMMEDIATE
29h	READ MULTIPLE EXT	CAh	WRITE DMA
20h	READ SECTOR	35h	WRITE DMA EXT
24h	READ SECTOR EXT	C5h	WRITE MULTIPLE
40h	READ VERIFY SECTORS	39h	WRITE MULTIPLE EXT
42h	READ VERIFY SECTORS EXT	30h	WRITE SECTOR
10h	RECALIBRATE	34h	WRITE SECTOR EXT
F6h	SECURITY DISABLE PASSWORD		

7.2 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.

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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	SMART READ LOG
D6h	SMART WRITE LOG
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

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8. Electrical Specifications

8.1 Operating Voltage

Table 8-1 lists the supply voltage for SM220-M242.

Caution: **Absolute Maximum Stress Ratings –** Applied conditions greater than those listed under "Absolute Maximum Stress Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these conditions or conditions greater than those defined in the operational sections of this data sheet is not implied. Exposure to absolute maximum stress rating conditions may affect device reliability.

Table 8-1 Operating Range

Item	Range
Supply Voltage	3.3V ± 5% (3.135-3.465V)

8.2 Power Consumption

Table 8-2 lists the power consumption for SM220-M242.

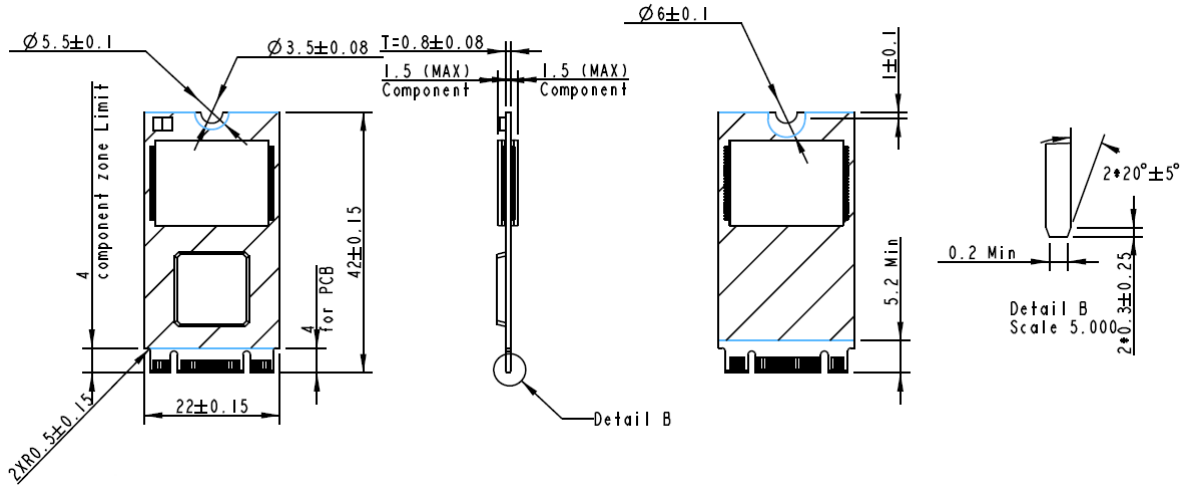
Table 8-2 Power Consumption

Capacity / Mode	8 GB	16 GB	32 GB	64 GB	128 GB	256 GB
Active (mA)	215	250	255	310	440	690
Idle (mA)	80	80	80	80	75	75

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.

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9. Physical Characteristics

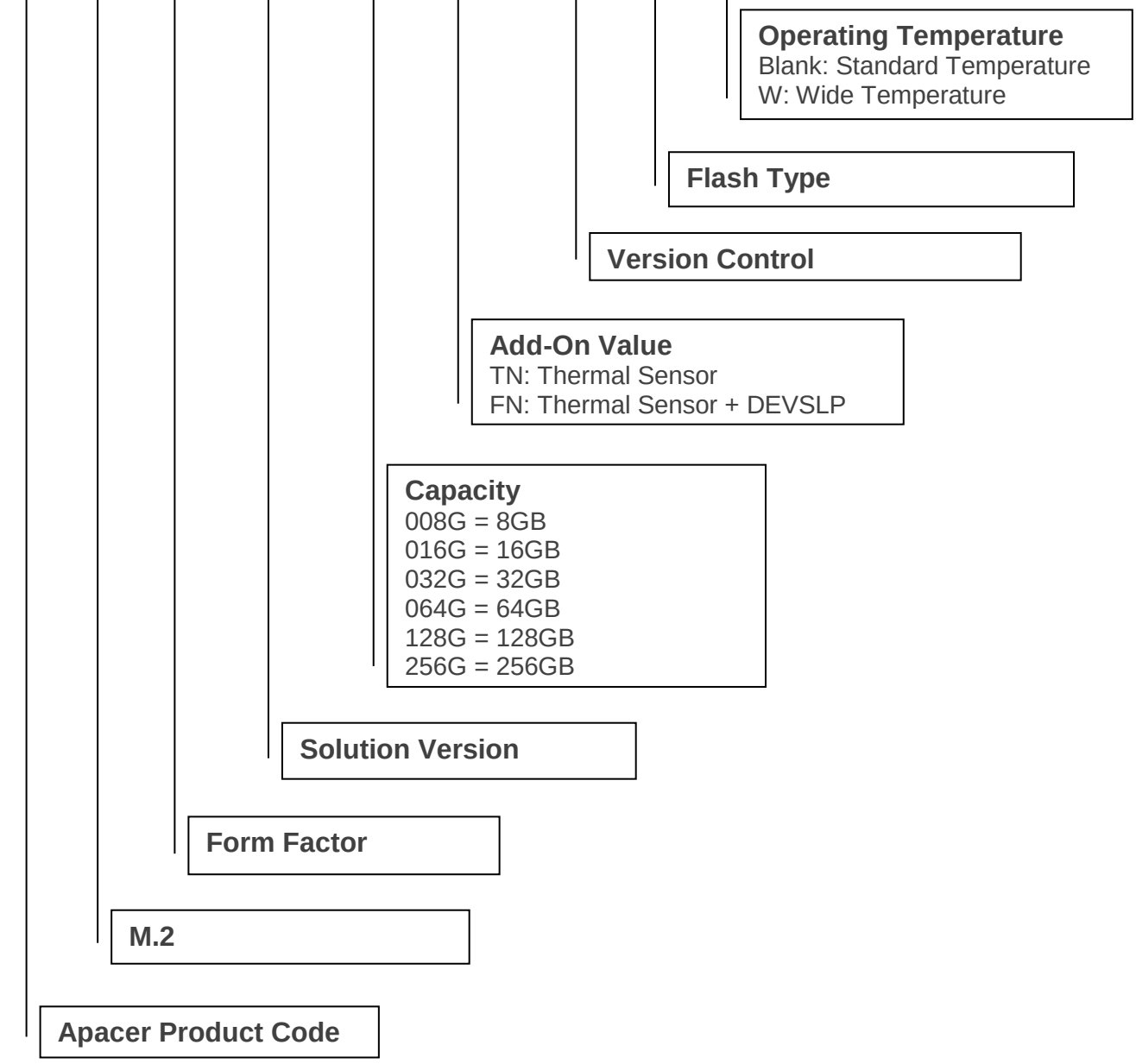


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10. Product Ordering Information

10.1 Product Code Designations

AP M2 T42 SM22 xxxG XN – 6X TMX X



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10.2 Valid Combinations

10.2.1 Without DEVSLP

Capacity	Standard Temperature	Wide Temperature
8GB	APM2T42SM22008GTN-6ETM	APM2T42SM22008GTN-6ETMW
16GB	APM2T42SM22016GTN-6ETM	APM2T42SM22016GTN-6ETMW
32GB	APM2T42SM22032GTN-6ETM	APM2T42SM22032GTN-6ETMW
64GB	APM2T42SM22064GTN-6ETM	APM2T42SM22064GTN-6ETMW
128GB	APM2T42SM22128GTN-6ETMG	APM2T42SM22128GTN-6ETMGW
256GB	APM2T42SM22256GTN-6ETMG	APM2T42SM22256GTN-6ETMGW

10.2.2 With DEVSLP (optional)

Capacity	Standard Temperature	Wide Temperature
8GB	APM2T42SM22008GFN-6FTM	APM2T42SM22008GFN-6FTMW
16GB	APM2T42SM22016GFN-6FTM	APM2T42SM22016GFN-6FTMW
32GB	APM2T42SM22032GFN-6FTM	APM2T42SM22032GFN-6FTMW
64GB	APM2T42SM22064GFN-6FTM	APM2T42SM22064GFN-6FTMW
128GB	APM2T42SM22128GFN-6FTMG	APM2T42SM22128GFN-6FTMGW
256GB	APM2T42SM22256GFN-6FTMG	APM2T42SM22256GFN-6FTMGW

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.

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Revision History

Revision	Description	Date
1.0	Official release	12/26/2019
1.1	- Added SMART Read Refresh to Flash Management on Specifications Overview page - Changed SATA 6.0 Gbps to SATA 6 Gb/s in accordance with SATA naming guidelines - Added 5.9 SMART Read Refresh - Capitalized every letter for commands at 7.1 Command Set and SMART subcommand at 7.2 S.M.A.R.T.	5/15/2020

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