

RoHS Compliant PCI Express Flash Drive

PV130-M242 Product Specifications



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Version 1.1



Apacer Technology Inc.

1F, No.32, Zhongcheng Rd., Tucheng Dist., New Taipei City, Taiwan, R.O.C

Tel: +886-2-2267-8000 Fax: +886-2-2267-2261

www.apacer.com

Specifications Overview:

- **PCIe Interface**
 - Compliant with NVMe 1.2
 - Compatible with PCIe Gen3 x2 interface
- **Capacity**
 - 60, 120, 240, 480 GB
- **Performance***
 - Interface burst read/write: 2 GB/sec
 - Sequential read: up to 1,590 MB/sec
 - Sequential write: up to 1,030 MB/sec
 - Random read (4K): up to 163,000 IOPS
 - Random write (4K): up to 164,000 IOPS
- **Flash Management**
 - Low-Density Parity-Check (LDPC) Code
 - Global Wear Leveling
 - Flash bad-block management
 - Flash Translation Layer: Page Mapping
 - Power Failure Management
 - S.M.A.R.T.
 - TRIM
 - Hyper Cache Technology
 - Over-Provisioning
 - DataRAID™
- **Security**
 - End-to-End Data Protection
- **Reliability**
 - Thermal Sensor
 - Thermal Management Technique
- **Endurance (in drive writes per day: DWPD)**
 - 60 GB: 1.70 DWPD
 - 120 GB: 1.70 DWPD
 - 240 GB: 1.19 DWPD
 - 480 GB: 2.04 DWPD
- **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: 880 mA
 - Idle mode: 135 mA
- **Connector Type**
 - 75-pin M.2 module pinout
- **Power Management**
 - Supports APST
 - Supports ASPM L1.2
- **NVMe Features****
 - Supports HMB (Host Memory Buffer)
- **NAND Flash Type: 3D TLC (BiCS3)**
- **MTBF: >1,000,000 hours**
- **Form Factor**
 - M.2 2242-S3-B-M: 60GB
 - M.2 2242-D5-B-M: 120-480GB
 - Dimensions:
 - Single side: 42.00 x 22.00 x 2.38, unit: mm
 - Double side: 42.00 x 22.00 x 3.88, unit: mm
- **Shock & Vibration*****
 - Shock: 1,500 G
 - Vibration: 15 G
- **LED Indicators for Drive Behavior**
- **RoHS Compliant**

*The values for performances and power consumptions presented are typical and may vary depending on flash configurations or platform settings.

**Windows 10 (version 1703) onwards supports the HMB (Host Memory Buffer) function.

***Non-operating

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1. General Descriptions

Apacer PV130-M242 (M.2 2242) is the next generation modularized Solid State Drive (SSD) with the shape of all new M.2 form factor, aimed to be the more suitable for mobile and compact computers with standard width at only 22.00 mm. PV130-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 PCIe-based connector pinouts, providing full compliance with the latest PCIe Gen3 x2 interface specifications. Aside from PCIe compliance, PV130-M242 delivers exceptional performance and power efficiency. On the other hand, the extreme thin and light form factor makes PV130-M242 the ideal choice for mobile computing systems, which appears to be the trend in near future.

Regarding reliability, PV130-M242 is built with a powerful PCIe controller that supports on-the-module ECC as well as efficient wear leveling scheme. In terms of power efficiency, PV130-M242 is compliant with PCIe Gen3 x2 interface standard so that it can operate on power management modes, which greatly save on power consumption.

2. Functional Block

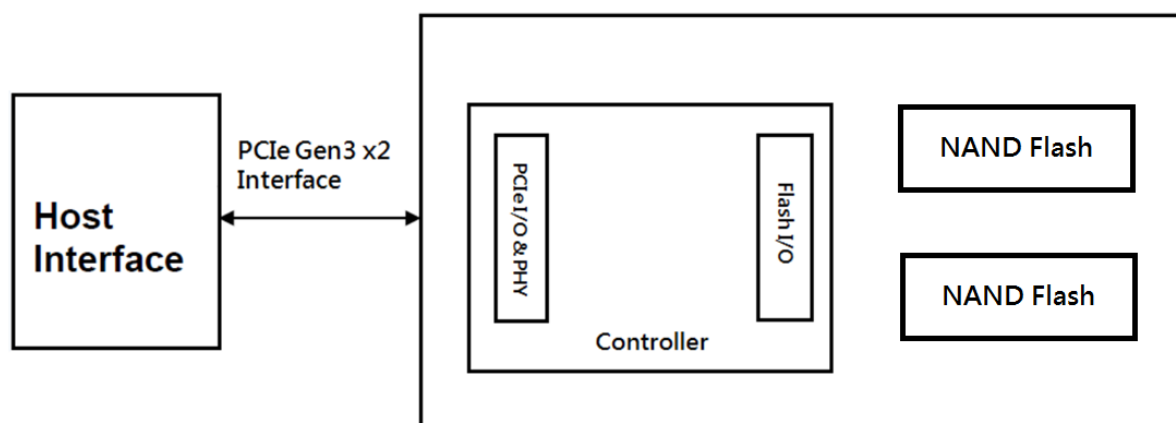


Figure 2-1 Functional Block Diagram

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.

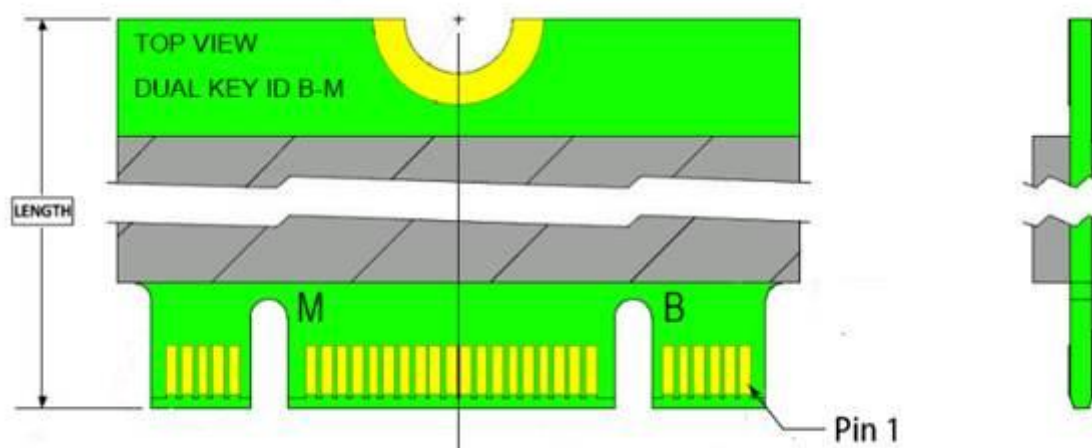


Table 3-1 Pin Assignments

Pin No.	Type	Description
1	GND	CONFIG_3 = GND
2	3.3V	3.3V source
3	GND	Ground
4	3.3V	3.3V source
5	N/C	No connect
6	N/C	No connect
7	N/C	No connect
8	N/C	No connect
9	N/C	No connect
10	LED1#	Open drain, active low signal. These signals are used to allow the add-in card to provide status indicators via LED devices that will be provided by the system.
11	N/C	No connect
12	Module Key B	Module Key
13	Module Key B	
14	Module Key B	
15	Module Key B	
16	Module Key B	
17	Module Key B	
18	Module Key B	
19	Module Key B	
20	N/C	No connect
21	GND	Ground
22	N/C	No connect
23	N/C	No connect
24	N/C	No connect
25	N/C	No connect
26	N/C	No connect
27	GND	Ground
28	N/C	No connect
29	PETn1	PCIe TX Differential signal defined by the PCI Express M.2 spec

Table 3-1 Pin Assignments

Pin No.	Type	Description
30	N/C (WP)	Default: No connect
31	PETp1	PCIe TX Differential signal defined by the PCI Express M.2 spec
32	N/C	No connect
33	GND	Ground
34	N/C	No connect
35	PERn1	PCIe RX Differential signal defined by the PCI Express M.2 spec
36	N/C	No connect
37	PERp1	PCIe RX Differential signal defined by the PCI Express M.2 spec
38	N/C	No connect
39	GND	Ground
40	N/C	No connect
41	PETn0	PCIe TX Differential signal defined by the PCI Express M.2 spec
42	N/C	No connect
43	PETp0	PCIe TX Differential signal defined by the PCI Express M.2 spec
44	N/C	No connect
45	GND	Ground
46	N/C	No connect
47	PERn0	PCIe RX Differential signal defined by the PCI Express M.2 spec
48	N/C	No connect
49	PERp0	PCIe RX Differential signal defined by the PCI Express M.2 spec
50	PERST#(I/O)(0/3.3V)	PE-Reset is a functional reset to the card as defined by the PCIe Mini CEM specification.
51	GND	Ground
52	CLKREQ#(I/O)(0/3.3V)	Clock Request is a reference clock request signal as defined by the PCIe Mini CEM specification; Also used by L1 PM Sub-states.
53	REFCLKn	PCIe Reference Clock signals (100 MHz) defined by the PCI Express M.2 spec.
54	N/C	No connect
55	REFCLKp	PCIe Reference Clock signals (100 MHz) defined by the PCI Express M.2 spec.
56	N/C	No connect
57	GND	Ground
58	N/C	No connect
59	Module Key M	Module Key
60	Module Key M	
61	Module Key M	
62	Module Key M	
63	Module Key M	
64	Module Key M	
65	Module Key M	
66	Module Key M	
67	N/C (Erase)	Default: No connect
68	N/C	No connect
69	NC	CONFIG_1 = No connect
70	3.3V	3.3V source
71	GND	Ground
72	3.3V	3.3V source
73	GND	Ground
74	3.3V	3.3V source
75	GND	CONFIG_2 = Ground

4. Product Specifications

4.1 Capacity

Capacity specifications of PV130-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
60 GB	60,022,480,896	16,383	16	63	117,231,408
120 GB	120,034,123,776	16,383	16	63	234,441,648
240 GB	240,057,409,536	16,383	16	63	468,862,128
480 GB	480,103,981,056	16,383	16	63	937,703,088

*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 PV130-M242 is listed below in Table 4-2.

Table 4-2 Performance Specifications

Capacity	60 GB	120 GB	240 GB	480 GB
Performance				
Sequential Read* (MB/s)	760	1,455	1,590	1,580
Sequential Write* (MB/s)	240	495	950	1,030
Random Read IOPS** (4K)	46,000	86,000	144,000	163,000
Random Write IOPS** (4K)	49,000	100,000	147,000	164,000

Note:

Measured with OS version: Win10 (64bit), version 1803 with HMB (Host Memory Buffer), performance may differ from various flash configurations or host system settings.

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

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

4.3 Environmental Specifications

Environmental specifications of PV130-M242 are shown in Table 4-3.

Table 4-3 Environmental Specifications

Item	Specifications
Operating temp.	0°C to 70°C (Standard); -40°C to 85°C (Wide)
Non-operating temp.	-40°C to 100°C
Operating vibration	7.69 GRMS, 20~2000 Hz/random (compliant with MIL-STD-810G)
Non-operating vibration	4.02 GRMS, 15~2000 Hz/random (compliant with MIL-STD-810G)
Operating shock	50(G), 11(ms), half-sine wave
Non-operating shock	1,500(G), 0.5(ms), half-sine wave

Note: Shock and Vibration specifications are subject to change without notice.

4.4 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in PV130-M242. The prediction result for PV130-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

PV130-M242 complies with the following standards:

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

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 Drive Writes Per Day

Capacity	Drive Writes Per Day
60 GB	1.70
120 GB	1.70
240 GB	1.19
480 GB	2.04

Note:

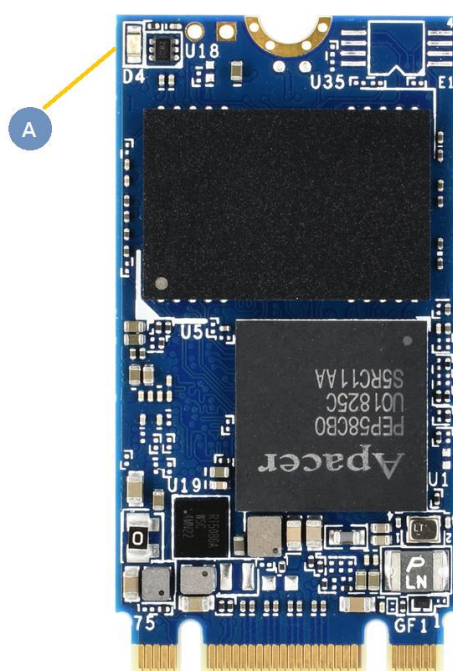
- This estimation complies with JEDEC JESD-219A random client workload.
- Flash vendor guaranteed 3D NAND TLC P/E cycle: 3K
- WAF may vary from capacity, flash configurations and writing behavior on each platform.
- 1 Terabyte = 1,024GB
- DWPD (Drive Writes Per Day) is calculated based on the number 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)

4.7 LED Indicator Behavior

The behavior of the PV130-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



5. Flash Management

5.1 Error Correction/Detection

PV130-M242 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

Bad blocks are blocks that include one or more invalid bits, and their reliability is not guaranteed. Blocks that are identified and marked as bad by the manufacturer are referred to as “Initial Bad Blocks”. Bad blocks that are developed during the lifespan of the flash are named “Later Bad Blocks”. Apacer implements an efficient bad block management algorithm to detect the factory-produced bad blocks and manages any bad blocks that appear with use. This practice further prevents data being stored into bad blocks and improves the data reliability.

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 Power Failure Management

Power Failure Management plays a crucial role when experiencing unstable power supply. Power disruption may occur when users are storing data into the SSD. In this urgent situation, the controller would run multiple write-to-flash cycles to store the metadata for later block rebuilding. This urgent operation requires about several milliseconds to get it done. At the next power up, the firmware will perform a status tracking to retrieve the mapping table and resume previously programmed NAND blocks to check if there is any incompleteness of transmission.

5.6 TRIM

TRIM is a feature which helps improve the read/write performance and speed of solid-state drives (SSD). Unlike hard disk drives (HDD), SSDs are not able to overwrite existing data, so the available space gradually becomes smaller with each use. With the TRIM command, the operating system can inform the SSD which blocks of data are no longer in use and can be removed permanently. Thus, the SSD will perform the erase action, which prevents unused data from occupying blocks all the time.

5.7 Hyper Cache Technology

Apacer proprietary Hyper Cache technology uses a portion of the available capacity as SLC (1bit-per-cell) NAND flash memory, called Hyper cache mode. When data is written to SSD, the firmware will direct the data to Hyper Cache mode, providing excellent performance to handle various scenarios in industrial use.

5.8 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.

5.9 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.

6. NVMe Support Features

6.1 Host Memory Buffer

Host Memory Buffer (HMB) allows HOST to allocate system memory for SSD's exclusive use in order to provide better performance and endurance, especially for DRAMless solutions.

7. Security & Reliability Features

7.1 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.

7.2 Thermal Management Technique

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.

7.3 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 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.

8. Software Interface

8.1 Command Set

Table 8-1 summarizes the commands supported by PV130-M242.

Table 8-1 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 8-2 Admin Commands – NVM Command Set Specific

Opcode	Command Description
80h	Format NVM
81h	Security Send
82h	Security Receive

Table 8-3 NVM Commands

Opcode	Command Description
00h	Flush
01h	Write
02h	Read
04h	Write Uncorrectable
05h	Compare
08h	Write Zeroes
09h	Dataset Management

8.2 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 8-4 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
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
202-203	2	Temperature Sensor 2
204-205	2	Temperature Sensor 3
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

Table 8-5 SMART (C0h)

Byte	Length	Description
2-255	254	Reserved
256-257	2	SSD Protect Mode
258-261	4	ECC Fail Count
262-273	12	Reserved
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	FlashWriteSector
302-511	210	Reserved

9. Electrical Specifications

9.1 Operating Voltage

Table 9-1 lists the supply voltage for PV130-M242.

Table 9-1 Operating Range

Item	Range
Supply Voltage	3.3V \pm 5%

9.2 Power Consumption

Table 9-2 lists the power consumption for PV130-M242.

Table 9-2 Power Consumption

Mode \ Capacity	60 GB	120 GB	240 GB	480 GB
Active (mA)	580	795	860	880
Idle (mA)	135	130	135	130

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.

11. Product Ordering Information

11.1 Product Code Designations

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

Code 1st ~ 3rd (Product Line & form factor)	PCIe
Code 5th ~ 6th (Model/Solution)	PV130-M242
Code 7th ~ 8th (Product Capacity)	5G: 60GB 5H: 120GB 5J: 240GB 5K: 480GB
Code 9th (Flash Type & Product Temp)	G: 3D TLC Standard temperature H: 3D TLC Wide temperature
Code 10th (Product Spec)	A: Single side B+M key B: Double side B+M key
Code 12th ~ 14th (Version Number)	Random numbers generated by system
Code 15th ~ 16th (Firmware Version)	02: Standard

11.2 Valid Combinations

Capacity	Standard Temperature	Wide Temperature
60GB	B72.135GGA.00102	B72.135GHA.00102
120GB	B72.135HGB.00102	B72.135HHB.00102
240GB	B72.135JGB.00102	B72.135JHB.00102
480GB	B72.135KGB.00102	B72.135KHB.00102

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
1.0	Official release	6/13/2019
1.1	Added 6. NVMe Support Features chapter	6/21/2019

Global Presence

Taiwan (Headquarters)

Apacer Technology Inc.

1F., No.32, Zhongcheng Rd., Tucheng Dist.,
New Taipei City 236, Taiwan R.O.C.

Tel: 886-2-2267-8000

Fax: 886-2-2267-2261

amtsales@apacer.com

U.S.A.

Apacer Memory America, Inc.

46732 Lakeview Blvd., Fremont, CA 94538

Tel: 1-408-518-8699

Fax: 1-510-249-9551

sa@apacerus.com

Japan

Apacer Technology Corp.

6F, Daiyontamachi Bldg., 2-17-12, Shibaura, Minato-Ku,
Tokyo, 108-0023, Japan

Tel: 81-3-5419-2668

Fax: 81-3-5419-0018

jpservices@apacer.com

Europe

Apacer Technology B.V.

Science Park Eindhoven 5051 5692 EB Son,
The Netherlands

Tel: 31-40-267-0000

Fax: 31-40-290-0686

sales@apacer.nl

China

Apacer Electronic (Shanghai) Co., Ltd

Room D, 22/FL, No.2, Lane 600, Jieyun Plaza,
Tianshan RD, Shanghai, 200051, China

Tel: 86-21-6228-9939

Fax: 86-21-6228-9936

sales@apacer.com.cn

India

Apacer Technologies Pvt Ltd,

1874, South End C Cross, 9th Block Jayanagar,
Bangalore-560069, India

Tel: 91-80-4152-9061/62

Fax: 91-80-4170-0215

sales_india@apacer.com