

**Amtron Technology, Inc.**

**Industrial PCIe Add-in Card SSD**

AB Series

Product Datasheet

V1.0

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## 1. INTRODUCTION

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### 1.1. Description

Amtron industrial grade AB series PCIe Add-in Card (AIC) SSD is fully compliant with the standard AIC HHHL form factor. These add-in cards are designed with the PCIe Gen3 x4 interface, to reach up to 3,400MB/s read and 3,000MB/s write high performance based on Toshiba's Toggle TLC flash. These PCIe Add-in Cards are offered in standard temperature grade (0°C to +70°C) and memory capacities are available from 480GB to 8TB. The power consumption of the PCIe SSD Add-in Card is much lower than traditional hard drives, making it an ideal embedded solution.

### 1.2. Product Features

- Standard Add-in Card (AIC) HHHL form factor
- PCI Express Base Version 3.1 and Compliant with NVMe 1.3
- PCIe Gen3 x 4 lane & backward compatible to PCIe Gen2 and Gen1
- RoHS compliant [Lead free]
- Toshiba 3D Triple Level Cell (TLC) NAND Flash
- Capacity from 480GB/512GB up to 7680GB/8TB
- High speed:
  - Read 3,400 MB/s max., Write 3,000 MB/s max.
- Endure severe thermal and dynamic environments
- Very low power consumption
- MTBF > 1,500,000 hours
- Support SMART and TRIM Command
- Optional AES / TCG OPAL support
- Controlled Bill of Materials (BOM )

### 1.3. Product Overview

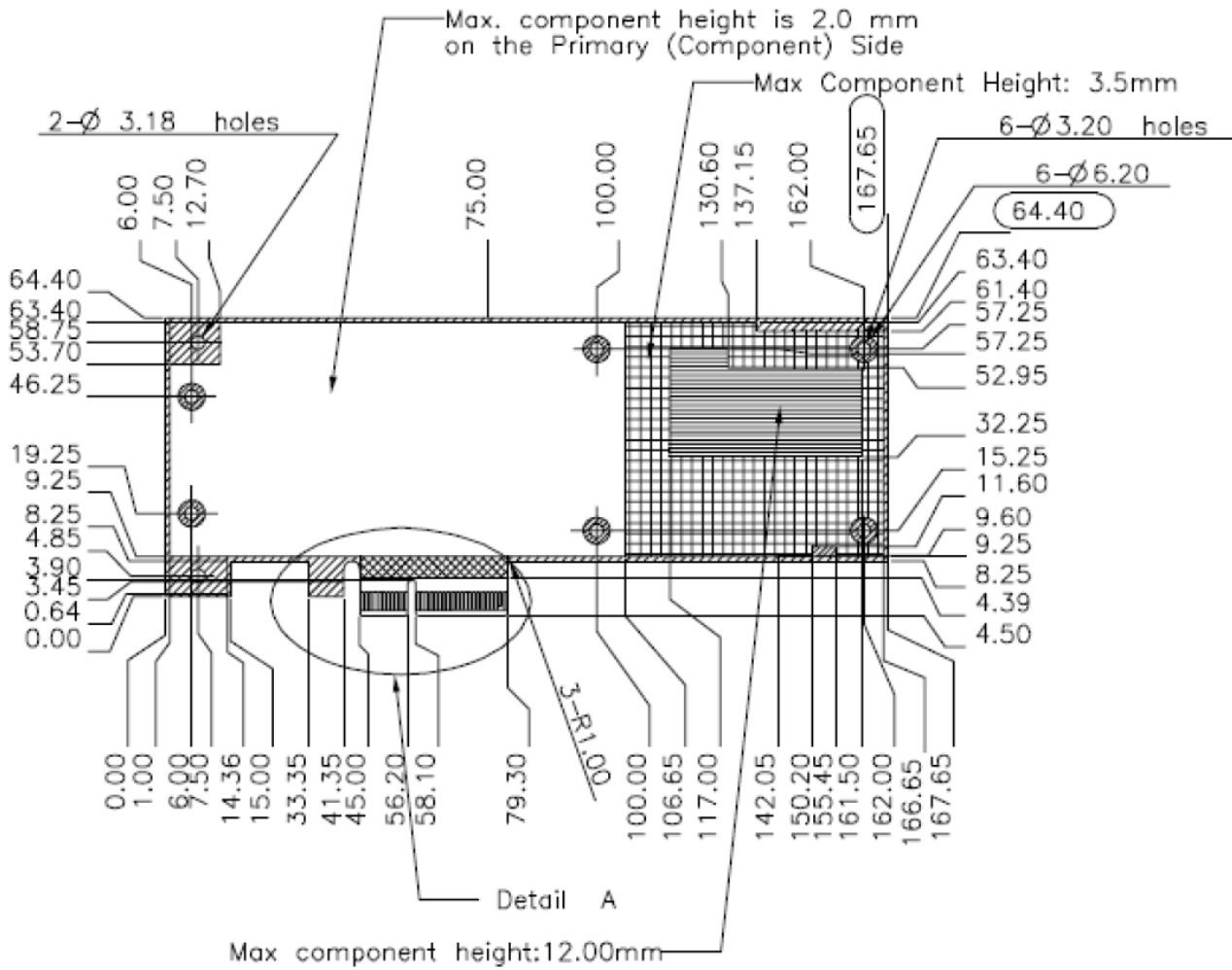
- **PCIe Interface**
  - NVMe PCIe Gen3 x4
- **Form Factor**
  - AIC (HHHL)
- **Compliance**
  - PCI Express Base 3.1
  - NVMe 1.3
  - PCI Express Base 3.1
- **Capacity**
  - 480GB up to 8TB
- **Flash Interface**
  - Flash Type: 3D TLC
  - P Transfer rate up to 533Mbps
  - Up to 16pcs of BGA132 flash
- **Performance**
  - Read up to 3,400 MB/s
  - Write up to 3,000 MB/s
- **Reliability**
  - MTBF <sup>1</sup> > 1,500,000 hours
  - Uncorrectable Bit Error Rate (UBER)  
< 1 sector per 10<sup>16</sup> bits read
- **Power Consumption** <sup>2</sup>
  - Idle mode: < 715mW
- **Advanced Flash Management**
  - Advanced Wear Leveling
  - Bad Block Management
  - TRIM
  - SMART
  - Over-Provision
- **Power Management**
  - Support APST
  - Support ASPM
  - Support L1.2
- **Temperature Range**
  - Operation: 0°C ~ 70°C
  - Storage: -40°C ~ 85°C
- **Features Support List**
  - End to end data path protection
  - Thermal throttling
  - SmartECC™
  - SmartRefresh™
  - Drive log
  - Support of AES / TCG OPAL <sup>3</sup>
- **Compliant**
  - RoHS

#### Note:

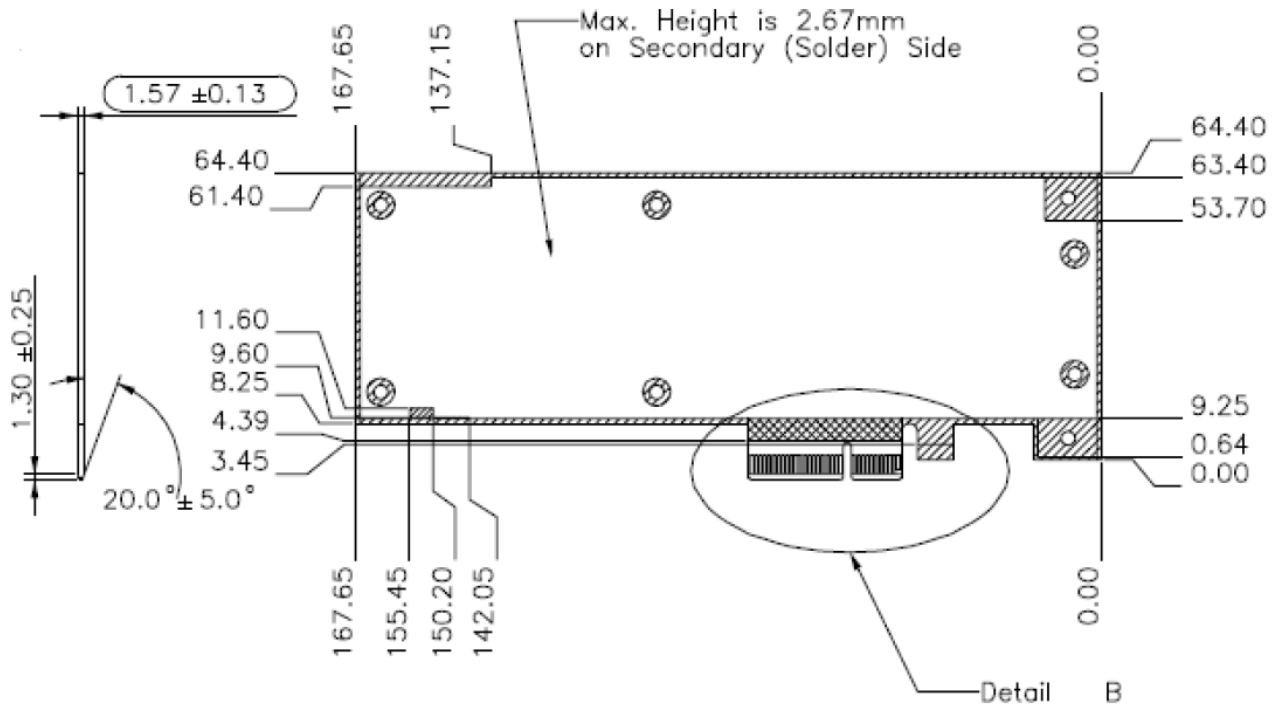
1. MTBF, an acronym for Mean Time Between Failures, is a measure of a device's reliability. Its value represents the average time between a repair and the next failure. The measure is typically in unit of hours. The higher the MTBF value, the higher the reliability of the product.
2. See Section 4.2 "Power Consumption" for details.
3. Optional features support by a separate firmware version. See Section 8 "Part Number Decoder".

1.4. Product Dimension

167.65mm (L) x 68.90mm (W) x 17.14mm (H) [ Standard HHL form factor ]

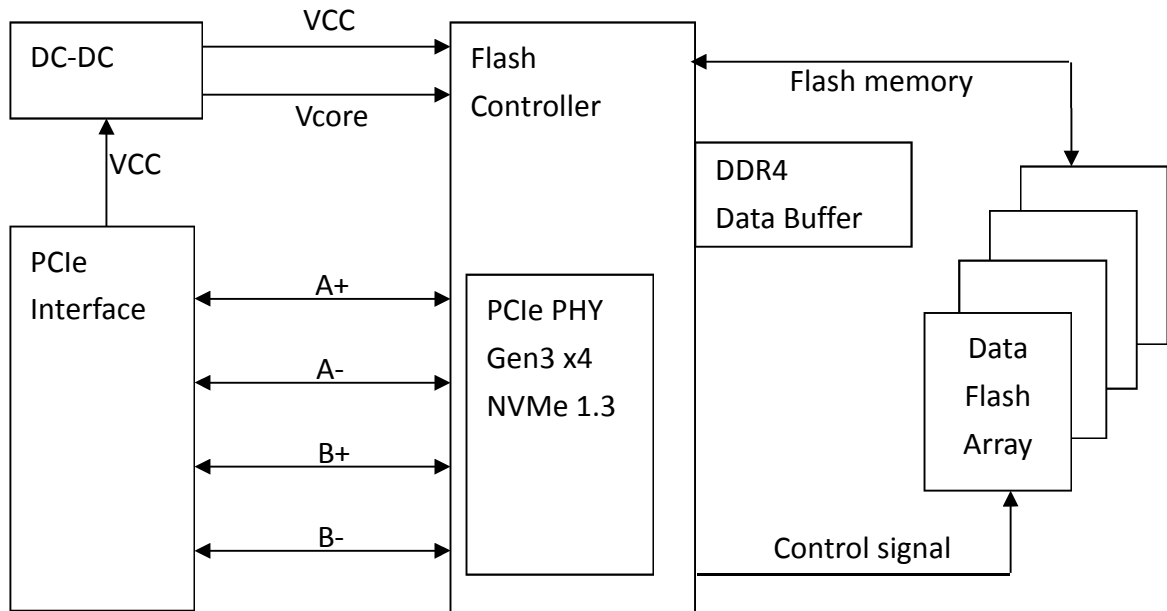


Side View



Side View

1.5. Block Diagram



Add-in Card PCIe SSD Block Diagram

## 2. PRODUCT SPECIFICATIONS



- **Capacity**
  - 480GB/512GB up to 7680GB/8TB
- **Electrical/Physical Interface**
  - PCI Express Base Ver 3.1 and Compliant with NVMe 1.3
  - PCIe Gen3 x 4 lane & backward compatible to PCIe Gen2 and Gen1
  - Support up to QD 256 with 64K queue depth of host I/O.
  - Support power management
- **Supported NAND Flash**
  - Support Toshiba 3D TLC
  - Support up to 16pcs of BGA132/152 flash
  - Support ONFI 2.3/3.0/3.2/4.0 interface.
- **ECC Scheme**
  - Applies LDPC of ECC algorithm
- **Sector Size Support**
  - 512Bytes
  - 4KB
- **UART / GPIO**
- **Support SMART and TRIM commands**
- **LBA Range**
  - IDEMA standard

Capacity	Total Sectors (LBA)	User Data Size
480GB	937,703,088	Depended on file management
512GB	1,000,215,216	
960GB	1,875,385,008	
1TB	2,000,409,264	
1920GB	3,750,748,848	
2TB	4,000,797,360	
3840GB	7,501,476,528	
4TB	8,001,573,552	
7680GB	15,002,931,888	
8TB	16,003,125,936	

- **Performance**

- **BiCS3 TLC**

Capacity	Flash Structure	Flash Type	Sequential		Random	
			Read (MB/s)	Write (MB/s)	Read (IOPS)	Write (IOPS)
480GB/512GB	64GB x 8	BiCS3, BGA132	3,300	2,000	355K	450K
960GB/1TB	128GB x 8	BiCS3, BGA132	3,300	3,000	595K	465K
1920GB/2TB	128GB x 16	BiCS3, BGA132	3,400	3,000	595K	470K
3840GB/4TB	256GB x 16	BiCS3, BGA152	3,300	2,900	595K	460K
7680GB/8TB	512GB x 16	BiCS3, BGA152	3,100	2,700	565K	465K

**Notes:**

1. The performance was estimated based on Toshiba BiCS3 TLC NAND flash.
2. Performance may differ according to flash configuration and platform.
3. The table above is for reference only. Any criteria for accepting goods shall be discussed based on different flash configurations.
4. Performance is measured with the follow conditions
  - (a) CrystalDiskMark 6.0.0, 1GB range, QD=32, Thread=1
  - (b) IOMeter, 1GB range, 4K data size, QD=32

- **TBW (Terabytes Written)**

- **BiCS3 TLC**

Capacity	Flash Type	TBW
480GB	BiCS3 TLC	795
960GB	BiCS3 TLC	1,674
1920GB	BiCS3 TLC	3,358
3840GB	BiCS3 TLC	6,710
7680GB	BiCS3 TLC	13,410

**Notes:**

1. Samples were built using Toshiba BiCS3 TLC NAND flash.
2. The test followed JEDEC218/219A client endurance workload.
3. TBW may differ according to flash configuration and platform.
4. The endurance of SSD could be estimated based on user behavior, NAND endurance cycles, and write amplification factor. It is not guaranteed by flash vendor.



### 3. ENVIRONMENTAL SPECIFICATIONS



#### 3.1. Environmental Conditions

##### 3.1.1. Temperature and Humidity

###### ■ High Temperature Test Condition

	Temperature	Humidity
Operation	70°C	0% RH
Storage	85°C	0% RH

###### ■ Low Temperature Test Condition

	Temperature	Humidity
Operation	0°C	0% RH
Storage	-40°C	0% RH

###### ■ High Humidity Test Condition

	Temperature	Humidity
Operation	40°C	90% RH
Storage	40°C	93% RH

###### ■ Temperature Cycle Test

	Temperature
Operation	0°C
	70°C <sup>Note1</sup>
Storage	-40°C
	85°C

###### Notes:

1. Operation temperature is measured by device temperature sensor. Airflow is suggested and it will allow device to be operated at appropriate temperature for each component during heavy workloads environment.

3.1.2. Shock

■ Shock Specification

	Acceleration Force	Number of Shock
Non-Operational	1500G	6 faces of each unit, 3 times for each face

3.1.3. Vibration

■ Vibration Specification

	Condition	
	Frequency/Displacement	Frequency/Acceleration
Non-Operational	20Hz~80Hz/1.52mm	80Hz~2000Hz/20G

3.1.4. Drop

■ Drop Specification

	Height of Drop	Number of Drop
Non-operational	80cm free fall	6 face of each unit

3.1.5. Bending

■ Bending Specification

	Force	Action
Non-operational	≥ 20N	Hold 1min/5times

3.1.6. Durability

■ Durability

	Condition
operational	1000 mating cycles

3.1.7. Electrostatic Discharge (ESD)

Specification	+/- 4KV
EN 55024, CISPR 24 EN 61000-4-2 and IEC 61000-4-2	Device functions are affected, but EUT will be back to its normal or operational state automatically.

**3.1.8. EMI Compliance**

Specification
EN 55032, CISPR 32 (CE)
AS/NZS CISPR 32 (CE)
ANSI C63.4 (FCC)
VCCI-CISPR 32 (VCCI)
CNS 13438 (BSMI)

**3.2. Certification**

- RoHS
- CE / FCC

## 4. ELECTRICAL SPECIFICATIONS



### 4.1. Supply Voltage

Parameter	Rating
Operating Voltage	12V ±8%
Rise Time (Max/Min)	100ms / 0.1ms
Fall Time (Max/Min)	5s / 1ms
Min. off Time <sup>Note1</sup>	1s

Note:

1. Minimum time between power removed from SSD ( $V_{cc} < 100\text{mW}$ ) and power re-applied to the drive.

### 4.2. Power Consumption

- Power consumption of U.2 PCIe SSD

Capacity	Flash Type	CE#	Read (mW)	Write (mW)	Idle (mW)
480/512GB	64GB x8, Bics3 TLC, BGA	16	6,100	4,830	715
960GB/1TB	128B x8, Bics3 TLC, BGA	32	6,180	5,950	660
1920GB/2TB	128GB x16, Bics3 TLC, BGA	64	7,560	6,050	650
3840GB/4TB	256GB x16, Bics3 TLC, BGA	64	6,000	5,665	670
7680GB/8TB	512GB x16, Bics3 TLC, BGA	64	7,170	5,030	700

Unit: mW

#### Notes

1. Based on ECFM1xxx-series under ambient temperature.
2. Use CrystalDiskMark 6.0.0 with the setting of 1000MB. Sequentially read and write the disk for 5 times, and measure power consumption during sequential Read [1/5]~[5/5] or sequential Write [1/5]~[5/5]
3. Power Consumption may differ according to flash configuration and platform.
4. The measured power voltage is 12V.

## 5. INTERFACE



### 5.1. Pin Assignment and Descriptions

The follow table defines the PCIe AIC SSD Connector Pin assignment and descriptions.

Pin#	Side B		Side A	
	Name	Description	Name	Description
1	+12V	12 V power	PRSNT1#	Hot-Plug presence detect
2	+12V	12 V power	+12V	12 V power
3	+12V	12 V power	+12V	12 V power
4	GND	Ground	GND	Ground
5	SMCLK	SMBus (System Management Bus) clock	JTAG2	TCK (Test Clock), clock input for JTAG interface
6	SMDAT	SMBus (System Management Bus) data	JTAG3	TDI (Test Data Input)
7	GND	Ground	JTAG4	TDO (Test Data Output)
8	+3.3V	3.3 V power	JTAG5	TMS (Test Mode Select)
9	JTAG1	TRST# (Test Reset) resets the JTAG interface	+3.3V	3.3 V power
10	3.3Vaux	3.3 V auxiliary power	+3.3V	3.3 V power
11	WAKE#	Signal for Link reactivation	PERST#	Fundamental reset
12	RSVD	Reserved	GND	Ground
13	GND	Ground	REFCLK+	Reference clock (differential pair)
14	PETp0	Transmitter differential pair, Lane 0	REFCLK-	
15	PETn0	Transmitter differential pair, Lane 0	GND	Ground
16	GND	Ground	PERp0	Receiver differential pair, Lane 0
17	PRSNT2#	Hot-Plug presence detect	PERn0	Receiver differential pair, Lane 0
18	GND	Ground	GND	Ground
19	PETp1	Transmitter differential pair, Lane 1	RSVD	Reserved
20	PETn1	Transmitter differential pair, Lane 1	GND	Ground
21	GND	Ground	PERp1	Receiver differential pair, Lane 1
22	GND	Ground	PERn1	Receiver differential pair, Lane 1
23	PETp2	Transmitter differential pair, Lane 2	GND	Ground
24	PETn2	Transmitter differential pair, Lane 2	GND	Ground

Pin#	Side B		Side A	
	Name	Description	Name	Description
<b>25</b>	GND	Ground	PERp2	Receiver differential pair, Lane 2
<b>26</b>	GND	Ground	PERn2	Receiver differential pair, Lane 2
<b>27</b>	PETp3	Transmitter differential pair, Lane 3	GND	Ground
<b>28</b>	PETn3	Transmitter differential pair, Lane 3	GND	Ground
<b>29</b>	GND	Ground	PERp3	Receiver differential pair, Lane 3
<b>30</b>	RSVD	Reserved	PERn3	Receiver differential pair, Lane 3
<b>31</b>	PRSNT2#	Hot-Plug presence detect	GND	Ground
<b>32</b>	GND	Ground	RSVD	Reserved

## 6. SUPPORTED COMMANDS



### 6.1. NVMe Command List

**Table 6-1 Admin Commands**

Op-Code	O/M	Command Description
00h	M	Delete I/O Submission Queue
01h	M	Create I/O Submission Queue
02h	M	Get Log Page
04h	M	Delete I/O Completion Queue
05h	M	Create I/O Completion Queue
06h	M	Identify
08h	M	Abort
09h	M	Set Features
0Ah	M	Get Features
0Ch	M	Asynchronous Event Request
10h	O	Firmware Activate
11h	O	Firmware Image Download
14h	O	Device Self-test
80h	O	Format NVM
81h	O	Security Send
82h	O	Security Receive
84h	O	Sanitize

**Table 6-2 I/O Commands**

Op-Code	O/M	Command Description
00h	O	Flush
01h	O	Write
02h	O	Read
04h	O	Write Uncorrectable
05h	O	Compare
08h	O	Write Zeroes
09h	O	Dataset Management

**Table 6-3 Set Feature Commands**

Op-Code	O/M	Command Description
00h		Reserved
01h	M	Arbitration
02h	M	Power Management
03h	O	LBA Range Type
04h	M	Temperature Threshold
05h	M	Error Recovery
06h	O	Volatile Write Cache
07h	M	Number of Queues
08h	M	Interrupt Coalescing
09h	M	Interrupt Vector Configuration
0Ah	M	Write Atomicity Normal
0Bh	M	Asynchronous Event Configuration
0Ch	O	Autonomous Power State Transition
0Dh	O	Host Memory Buffer
0Eh	O	Timestamp
10h	O	Host Controlled Thermal Management
11h	O	Non-Operational Power State Config
0Eh – 7Dh		Reserved
80h	O	Software Progress Marker

**Table 6-4 Get Log Page Commands**

Op-Code	O/M	Command Description
00h		Reserved
01h	M	Error Information
02h	M	SMART / Health Information
03h	M	Firmware Slot Information
04h	O	Changed Namespace List
06h	O	Device Self-test
09h – 7Fh		Reserved
81h	O	Sanitize Status
82h - FFh		Reserved



## 6.2. Identify Device Data

The following table details the sector data returned by the IDENTIFY DEVICE command.

### ■ Identify Controller Data Structure

Bytes	O/M	Default Value	Description
01:00	M	0x1987	PCI Vendor ID (VID)
03:02	M	0x1987	PCI Subsystem Vendor ID (SSVID)
23:04	M	TBD	Serial Number (SN)
63:24	M	TBD	Model Number (MN)
71:64	M	TBD	Firmware Revision (FR)
72	M	0x01	Recommended Arbitration Burst (RAB)
75:73	M	TBD *	IEEE OUI Identifier (IEEE)
76	O	0x00	Controller Multi-Path I/O and Namespace Sharing Capabilities (CMIC)
77	M	0x09	Maximum Data Transfer Size (MDTS)
79:78	M	0x0001	Controller ID (CNTLID)
83:80	M	0x00010300	Version (VER)
87:84	M	0x001E8480(2sec)	RTD3 Resume Latency (RTD3R)
91:88	M	0x00989680(10sec)	RTD3 Entry Latency (RTD3E)
95:92	M	0x00000300	Optional Asynchronous Events Supported (OAES)
99:96	M	0x0002	Controller Attributes (CTRATT)
239:100	-	0x00	Reserved
255:240	-	0x00	Refer to the NVMe Management Interface Specification for definition
257:256	M	0x0017	Optional Admin Command Support (OACS)
258	M	0x03	Abort Command Limit (ACL)
259	M	0x03	Asynchronous Event Request Limit (AERL)
260	M	0x1F	Firmware Updates (FRMW)
261	M	0x0C	Log Page Attributes (LPA)
262	M	0x3E	Error Log Page Entries (ELPE)
263	M	4	Number of Power States Support (NPSS)
264	M	0x01	Admin Vendor Specific Command Configuration (AVSCC)
265	O	0x01	Autonomous Power State Transition Attributes (APSTA)
267:266	M	0x0157 (70C)	Warning Composite Temperature Threshold (WCTEMP)
269:268	M	0x0161 (80C)	Critical Composite Temperature Threshold (CCTEMP)
271:270	O	0x0000 (No report)	Maximum Time for Firmware Activation (MTFA)
275:272	O	0x00000000	Host Memory Buffer Preferred Size (HMPRE)
279:276	O	0x00000000	Host Memory Buffer Minimum Size (HMMIN)

Bytes	O/M	Default Value	Description
295:280	O	**	Total NVM Capacity (TNVMCAP)
311:296	O	**	Unallocated NVM Capacity (UNVMCAP)
315:312	O	0x00000000	Replay Protected Memory Block Support (RPMBS)
511:316	-	Non-zero	Reserved
<b>NVM Command Set Attributes</b>			
512	M	0x66	Submission Queue Entry Size (SQES)
513	M	0x44	Completion Queue Entry Size (CQES)
515:514	-	0x0000	Reserved
519:516	M	0x00000001	Number of Namespaces (NN)
521:520	M	0x001F	Optional NVM Command Support (ONCS)
523:522	M	0x0000	Fused Operation Support (FUSES)
524	M	0x00	Format NVM Attributes (FNA)
525	M	0x01	Volatile Write Cache (VWC)
527:526	M	TBD	Atomic Write Unit Normal (AWUN)
529:528	M	TBD	Atomic Write Unit Power Fail (AWUPF)
530	M	0x01	NVM Vendor Specific Command Configuration (NVSCC)
531	-	0x00	Reserved
533:532	O	0x0000	Atomic Compare & Write Unit (ACWU)
535:534	-	0x0000	Reserved
539:536	O	0x00000000	SGL Support (SGLS)
703:540	-	0x00	Reserved
<b>IO Command Set Attributes</b>			
2047:704	-	0x00	Reserved
2079:2048	M	TBD	Power State 0 Descriptor (PSD0)
2111:2080	O	0x00	Power State 1 Descriptor (PSD1)
2143:2112	O	0x00	Power State 2 Descriptor (PSD2)
2175:2144	O	0x00	Power State 3 Descriptor (PSD3)
2207:2176	O	0x00	Power State 4 Descriptor (PSD4)
2239:2208	O	0x00	Power State 5 Descriptor (PSD5)
2271:2240	O	0x00	Power State 6 Descriptor (PSD6)
2303:2272	O	0x00	Power State 7 Descriptor (PSD7)
2335:2304	O	0x00	Power State 8 Descriptor (PSD8)
2367:2336	O	0x00	Power State 9 Descriptor (PSD9)
2399:2368	O	0x00	Power State 10 Descriptor (PSD10)
2431:2400	O	0x00	Power State 11 Descriptor (PSD11)

Bytes	O/M	Default Value	Description
2463:2432	O	0x00	Power State 12 Descriptor (PSD12)
2495:2464	O	0x00	Power State 13 Descriptor (PSD13)
2527:2496	O	0x00	Power State 14 Descriptor (PSD14)
2559:2528	O	0x00	Power State 15 Descriptor (PSD15)
2591:2560	O	0x00	Power State 16 Descriptor (PSD16)
2623:2592	O	0x00	Power State 17 Descriptor (PSD17)
2655:2624	O	0x00	Power State 18 Descriptor (PSD18)
2687:2656	O	0x00	Power State 19 Descriptor (PSD19)
2719:2688	O	0x00	Power State 20 Descriptor (PSD20)
2751:2720	O	0x00	Power State 21 Descriptor (PSD21)
2783:2752	O	0x00	Power State 22 Descriptor (PSD22)
2815:2784	O	0x00	Power State 23 Descriptor (PSD23)
2847:2816	O	0x00	Power State 24 Descriptor (PSD24)
2879:2848	O	0x00	Power State 25 Descriptor (PSD25)
2911:2880	O	0x00	Power State 26 Descriptor (PSD26)
2943:2912	O	0x00	Power State 27 Descriptor (PSD27)
2975:2944	O	0x00	Power State 28 Descriptor (PSD28)
3007:2976	O	0x00	Power State 29 Descriptor (PSD29)
3039:3008	O	0x00	Power State 30 Descriptor (PSD30)
3071:3040	O	0x00	Power State 31 Descriptor (PSD31)
<b>Vendor Specific</b>			
4095:3072	O	Vendor Reserved	Vendor Specific (VS)

\* The OUI shall be a valid IEEE/RAC assigned identifier that may be registered at

<http://standards.ieee.org/develop/regauth/oui/public.html>.

\*\* Depends on the using of capacity

■ Identify Namespace Data Structure & NVM Command Set Specific

Bytes	O/M	Default Value	Description
7:0	M	TBD*	Namespace Size (NSZE)
15:8	M	TBD*	Namespace Capacity (NCAP)
23:16	M	TBD*	Namespace Utilization (NUSE)
24	M	0x00	Namespace Features (NSFEAT)
25	M	0x01	Number of LBA Formats (NLBAF)
26	M	0x00	Formatted LBA Size (FLBAS)
27	M	0x00	Metadata Capabilities (MC)
28	M	0x00	End-to-end Data Protection Capabilities (DPC)
29	M	0x00	End-to-end Data Protection Type Settings (DPS)
30	O	0x00	Namespace Multi-path I/O and Namespace Sharing Capabilities (NMIC)
31	O	0x00	Reservation Capabilities (RESCAP)
32	O	0x00	Format Progress Indicator (FPI)
33	-	0x00	Reserved
35:34	O	0x0000	Namespace Atomic Write Unit Normal (NAWUN)
37:36	O	0x0000	Namespace Atomic Write Unit Power Fail (NAWUPF)
39:38	O	0x0000	Namespace Atomic Compare & Write Unit (NACWU)
41:40	O	0x0000	Namespace Atomic Boundary Size Normal (NABSN)
43:42	O	0x0000	Namespace Atomic Boundary Offset (NABO)
45:44	O	0x0000	Namespace Atomic Boundary Size Power Fail (NABSPF)
47:46	-	0x0000	Reserved
63:48	O	0x00	NVM Capacity (NVMCAP)
103:64	-	0x00	Reserved
119:104	O	TBD **	Namespace Globally Unique Identifier (NGUID)
127:120	O	TBD **	IEEE Extended Unique Identifier (EUI64)
131:128	M	0x02090000	LBA Format 0 Support (LBAF0)
135:132	O	0x00000000	LBA Format 1 Support (LBAF1)
139:136	O	0x00000000	LBA Format 2 Support (LBAF2)
143:140	O	0x00000000	LBA Format 3 Support (LBAF3)
147:144	O	0x00000000	LBA Format 4 Support (LBAF4)
151:148	O	0x00000000	LBA Format 5 Support (LBAF5)
155:152	O	0x00000000	LBA Format 6 Support (LBAF6)
159:156	O	0x00000000	LBA Format 7 Support (LBAF7)
163:160	O	0x00000000	LBA Format 8 Support (LBAF8)
167:164	O	0x00000000	LBA Format 9 Support (LBAF9)

Bytes	O/M	Default Value	Description
171:168	O	0x00000000	LBA Format 10 Support (LBAF10)
175:172	O	0x00000000	LBA Format 11 Support (LBAF11)
179:176	O	0x00000000	LBA Format 12 Support (LBAF12)
183:180	O	0x00000000	LBA Format 13 Support (LBAF13)
187:184	O	0x00000000	LBA Format 14 Support (LBAF14)
191:188	O	0x00000000	LBA Format 15 Support (LBAF15)
383:192	-	0x00	Reserved
4095:384	O	0x00	Vendor Specific (VS)

\* See IDEMA SPEC

\*\* See IEEE EUI-64 SPEC

■ List of Identify Namespace Data Structure for Each Capacity

Capacity (GB)	Byte[7:0]: Namespace Size (NSZE)
480	37E436B0h
512	3B9E12B0h
960	6FC81AB0h
1024	773BD2B0h
1920	DF8FE2B0h
2048	EE7752B0h
3840	1BF1F72B0h
4096	1DCEE52B0h
7680	37E3E92B0h
8192	3B9DC52B0h

### 6.3. SMART Attributes

#### ■ SMART Attributes (Log Identifier 02h)

Bytes Index	Bytes	Description
[0]	1	Critical Warning
[2:1]	2	Composite Temperature
[3]	1	Available Spare
[4]	1	Available Spare Threshold
[5]	1	Percentage Used
[31:6]	26	Reserved
[47:32]	16	Data Units Read
[63:48]	16	Data Units Written
[79:64]	16	Host Read Commands
[95:80]	16	Host Write Commands
[111:96]	16	Controller Busy Time
[127:112]	16	Power Cycles
[143:128]	16	Power On Hours
[159:144]	16	Unsafe Shutdowns
[175:160]	16	Media and Data Integrity Errors
[191:176]	16	Number of Error Information Log Entries
[195:192]	4	Warning Composite Temperature Time
[199:196]	4	Critical Composite Temperature Time
[201:200]	2	Temperature Sensor 1 (N/A)
[203:202]	2	Temperature Sensor 2 (N/A)
[205:204]	2	Temperature Sensor 3 (N/A)
[207:206]	2	Temperature Sensor 4 (N/A)
[209:208]	2	Temperature Sensor 5 (N/A)
[211:210]	2	Temperature Sensor 6 (N/A)
[213:212]	2	Temperature Sensor 7 (N/A)
[215:214]	2	Temperature Sensor 8 (N/A)
[511:216]	296	Reserved

## 7. ACRONYMS



Acronym	Definition
AES	Advanced Encryption Standard
APST	Autonomous Power State Transition
ASPM	Active States Power Management
ATTO	Commercial performance benchmark application
ECC	Error Correcting Code
DDR	Double Data Rate (SDRAM)
LBA	Logical Block Addressing
LDPC	Low-Density Parity Check
MTBF	Mean Time Between Failures
NVMe	Non-Volatile Memory Express
OPAL	Open Physics Abstraction Layer
PCIe	PCI Express / Peripheral Component Interconnect Express
PSID	Physical Security ID
SMART	Self-Monitoring, Analysis and Reporting Technology
TCG	Trusted Computing Group
TLC	Tipple Level Cell
UBER	Uncorrectable Bit Error Rate

## 8. PART NUMBER DECODER



PAC-ABX<sup>1</sup>X<sup>2</sup>X<sup>3</sup>X<sup>4</sup>X<sup>5</sup>X<sup>6</sup>X<sup>7</sup>X<sup>8</sup>

Item	Series	Capacity		NAND Flash & Temperature Grade	Option
		X <sup>1</sup> X <sup>2</sup> X <sup>3</sup> X <sup>4</sup> X <sup>5</sup>		X <sup>6</sup>	X <sup>7</sup> X <sup>8</sup>
PAC	AB	0480G 0960G 1920G 3840G 7680G	0512G 0001T 0002T 0004T 0008T	A : 3D TLC 0°C to +70°C	See below
<p><b>X<sup>7</sup> X<sup>8</sup></b> (Reserved for specific requirement)</p> <p>Blank: Standard</p> <p>06: Conformal Coating</p> <p>31: AES encryption + OPAL (PSID code)</p>					