

RoHS Compliant
Serial ATA Flash Drive
AS228A (M.2 SATA) Product Specifications

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Version 2.1

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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
- **Capacity**
 - 16GB - 1024GB
- **Performance***
 - Sequential read: Up to 560 MB/sec
 - Sequential write: Up to 540 MB/sec
 - Random read (4K): Up to 80,896 IOPS
 - Random write (4K): Up to 75,237 IOPS
- **Flash Management**
 - Global Wear Leveling
 - S.M.A.R.T.
 - Power Failure Management
 - TRIM
- **NAND Flash Type:** 3D TLC
- **MTBF:** > 1,500,000 hours
- **Endurance (in Terabytes Written: TBW)**
 - 16 GB: 8 TBW
 - 32 GB: 16 TBW
 - 64 GB: 42 TBW
 - 128 GB: 75 TBW
 - 256 GB: 180 TBW
 - 512 GB: 425 TBW
 - 1024 GB: 835 TBW
- **Temperature Range**
 - Operating:
 - Standard: 0°C to 70°C
 - Storage: -40°C to 70°C
- **Supply Voltage**
 - 3.3V (Operating Voltage)
- **Power Consumption***
 - Active mode:
 - < 1,925 mV
 - Idle mode:
 - < 325 mV
- **Connector Type**
 - Internal NGFF connector (M.2) for SSD usage
- **Form Factor**
 - M.2 2280
 - Dimensions: 80±0.15mm (L) x 22±0.15mm (W) x 2.3±0.08, unit: mm
- **Shock & Vibration****
 - Shock: 1,500 G
 - Frequency/Displacement: 20Hz~80Hz/1.52mm
 - Frequency/Acceleration: 80Hz~2000Hz/20G
- **SATA Power Management Modes**
- **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.

**Non-operating

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1. General Descriptions

1.1 Introduction

Apacer AS228A SSD (Solid State Drive) consists of semiconductor devices using 3D TLC NAND flash memory that provide excellent reliability and high performance for storage media. Apacer AS228A does not contain any moving parts such as platter (disk) and head media, and thus it makes the better storage solution with higher performance, reduced latencies and low power consumption for notebooks, tablets and industrial PCs. Apacer AS228A delivers all the advantages of flash memory technologies and is fully compliant with the Serial ATA I/II/III (SATA) interface and internal NGFF M.2 connector for SSD usage.

1.2 Performance

Performance of Apacer AS228A SSD is listed below in Table 1-2.

Table 1-2 Performance Specifications

Performance	16GB	32GB	64GB	128GB	256GB	512GB	1024GB
Sequential Read (MB/s) CDM	290	300	550	550	550	550	550
Sequential Write (MB/s) CDM	100	125	255	450	490	490	500
Sequential Read (MB/s) ATTO	560	560	560	560	560	560	560
Sequential Write (MB/s) ATTO	540	540	540	540	540	540	540
Random Read IOPS (4K)	16600	18862	35721	65402	84850	75811	80896
Random Write IOPS (4K)	22488	29873	61445	81994	86060	68331	75237

1.3 Pin Assignments

Table 1-3 defines the signal assignment of the internal NGFF connector for SSD usage, described in the PCI Express M.2 Specification version 1.0 of the PCI-SIG.

Table 1-3 Pin Assignment and Description of Apacer AS228A

Pin #	SATA Pin	Description
1	CONFIG_3	Ground
2	3.3V	Supply pin
3	GND	Ground
4	3.3V	Supply pin
5	N/C	No Connect
6	N/C	No Connect
7	N/C	No Connect
8	N/C	No Connect
9	N/C or GND <small>Note</small>	No Connect or Ground
10	DAS/DSS# (O) (OD)	Status indicators via LED devices that will be provided by the system Active Low. A pulled-up LED with series current limiting resistor should allow for 9mA when On.
11	N/C	No Connect
12	Module Key	
13	Module Key	
14	Module Key	
15	Module Key	
16	Module Key	
17	Module Key	
18	Module Key	
19	Module Key	
20	N/C	No Connect
21	CONFIG_0	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	N/C	No Connect
30	N/C	No Connect
31	N/C	No Connect
32	N/C	No Connect
33	GND	Ground
34	N/C	No Connect
35	N/C	No Connect
36	N/C	No Connect
37	N/C	No Connect
38	DEVSLP (I) (0/3.3V)	Device Sleep, Input. When driven high the host is informing the SSD to enter a low power state
39	GND	Ground
40	N/C	No Connect

41	SATA-B+	SATA differential signals in the SATA specification
42	N/C	No Connect
43	SATA-B-	SATA differential signals in the SATA specification
44	N/C	No Connect
45	GND	Ground
46	N/C	No Connect
47	SATA-A-	SATA differential signals in the SATA specification
48	N/C	No Connect
49	SATA-A+	SATA differential signals in the SATA specification
50	N/C	No Connect
51	GND	Ground
52	N/C	No Connect
53	N/C	No Connect
54	N/C	No Connect
55	N/C	No Connect
56	Reserved for MFG Data	No Connect
57	GND	Ground
58	Reserved for MFG Clock	No Connect
59	Module Key	
60	Module Key	
61	Module Key	
62	Module Key	
63	Module Key	
64	Module Key	
65	Module Key	
66	Module Key	
67	N/C	No Connect
68	SUSCLK (I) (0/3.3V)	No Connect
69	CONFIG_1	Ground
70	3.3V	Supply pin
71	GND	Ground
72	3.3V	Supply pin
73	GND	Ground
74	3.3V	Supply pin
75	CONFIG_2	Ground

NOTE: N/C for Socket 2, and GND for Socket 3.

2. Software Interface

2.1 ATA Command Set

Table 2-1 summarizes the ATA commands supported by Apacer AS228A SSD.

Table 2-1 ATA Command Set

Op Code	Description	Op Code	Description
00h	NOP	C9h	Read DMA without Retry
06h	Data Set Management	CAh	Write DMA
10h-1Fh	Recalibrate	CBh	Write DMA without Retry
20h	Read Sectors	CEh	Write Multiple FUA EXT
21h	Read Sectors without Retry	E0h	Standby Immediate
24h	Read Sectors EXT	E1h	Idle Immediate
25h	Read DMA EXT	E2h	Standby
27h	Read Native Max Address EXT	E3h	Idle
29h	Read Multiple EXT	E4h	Read Buffer
2Fh	Read Log EXT	E5h	Check Power Mode
30h	Write Sectors	E6h	Sleep
31h	Write Sectors without Retry	E7h	Flush Cache
34h	Write Sectors EXT	E8h	Write Buffer
35h	Write DMA EXT	E9h	READ BUFFER DMA
37h	Set Native Max Address EXT	EAh	Flush Cache EXT
38h	CFA WriteSectorsWithoutErase	EBh	Write Buffer DMA
39h	Write Multiple EXT	ECh	Identify Device
3Dh	WriteDMA FUA EXT	EFh	Set Features
3Fh	Write Long EXT	EFh 02h	Enable volatile write cache
40h	Read Verify Sectors	EFh 03h	Set transfer mode
41h	Read Verify Sectors without Retry	EFh 05h	Enable the APM feature set
42h	Read Verify Sectors EXT	EFh 10h	Enable use of SATA features et
44h	Zero EXT	EFh 10h 02h	Enable DMA Setup FIS Auto-Activate optimization
45h	WriteUncorrectableEXT	EFh 10h 03h	Enable Device-initiated interface power state (DIPM) transitions
47h	ReadLogDMA EXT	EFh 10h 06h	Enable Software Settings Preservation (SSP)
57h	WriteLogDMA EXT	EFh 10h 07h	Enable Device Automatic Partial to Slumber transitions
60h	Read FPDMA Queued	EFh 10h 09h	Enable Device Sleep
61h	Write FPDMA Queued	EFh 55h	Disable read look-ahead
70h-7Fh	Seek	EFh 66h	Disable reverting to power-on defaults
90h	Execute Device Diagnostic	EFh 82h	Disable volatile write cache
91h	Initialize Device Parameters	EFh 85h	Disable the APM feature set
92h	Download Microcode	EFh 90h	Disable use of SATA feature set
93h	Download MicrocodeDMA	EFh 90h 02h	Disable DMA Setup FIS Auto-Activate optimization
B0h	SMART	EFh 90h 03h	Disable Device-initiated interface power state (DIPM) transitions
B0h D0h	SMART READ DATA	EFh 90h 06h	Disable Software Settings Preservation (SSP)
B0h D1h	SMART READ ATTRIBUTE THRESHOLDS	EFh 90h 07h	Disable Device Automatic Partial

						to Slumber transitions
B0h	D2h	SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE	EFh	90h	09h	Disable Device Sleep
B0h	D3h	SMART SAVE ATTRIBUTE VALUES	EFh	AAh		Enable read look-ahead
B0h	D4h	SMART EXECUTE OFF-LINE IMMEDIATE	EFh	CCh		Enable reverting to power-on defaults
B0h	D5h	SMART READ LOG	F1h			Security Set Password
B0h	D6h	SMART WRITE LOG	F2h			Security Unlock
B0h	D8h	SMART ENABLE OPERATIONS	F3h			Security Erase Prepare
B0h	D9h	SMART DISABLE OPERATIONS	F4h			Security Erase Unit
B0h	DAh	SMART RETURN STATUS	F5h			Security Freeze Lock
B0h	DBh	SMART ENABLE/DISABLE AUTOMATIC OFF-LINE	F6h			Security Disable Password
B1h		Device Configuration	F8h			Read Native Max Address
B4h		Sanitize	F9h			Set Max Address
C4h		Read Multiple	F9h	01h		SET MAX SET PASSWORD
C5h		Write Multiple	F9h	02h		SET MAXLOCK
C6h		Set Multiple Mode	F9h	03h		SET MAX UNLOCK
C8h		Read DMA	F9h	04h		SET MAX FREEZE LOCK

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 S.M.A.R.T. 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 S.M.A.R.T. attribute structure

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

*Byte 5: LSB

S.M.A.R.T. 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
175 (0xAF)	Bad Cluster Table Count
192 (0xC0)	Unexpected Power Loss Count
194 (0xC2)	Temperature
241 (0xF1)	Total sectors of write

3. Flash Management

3.1 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.

3.2 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.

3.3 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.

3.4 SATA Power Management

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.

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

4. Reliability Specifications

4.1 Environmental

Environmental specifications of Apacer AS228A SSD are shown in Table 4-1.

Table 4-1 Environmental Specifications

Environment	Specifications
Temperature	0°C to 70°C (Standard)
	-40°C to 70°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

4.2 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in AS228A. The prediction result for AS228A is more than 2,000,000 hours.

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

4.3 Certification and Compliance

Apacer AS228A SSD complies with the following standards:

- CE
- FCC
- RoHS

4.4 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 4-2 Endurance Specifications

Capacity	TeraBytes Written
16 GB	8.00
32 GB	16.00
64 GB	42.00
128 GB	75.00
256 GB	180.00
512 GB	425.00
1024 GB	835.00

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.
- The estimated values are based on JEDEC Enterprise endurance workload comprised of random data with the payload size distribution with sequential write behavior.

5. Electrical Specifications

5.1 Operating Voltage

Table 5-1 lists the supply voltage for AS228A.

Table 5-1 Operating Range

Item	Range
Supply Voltage	3.3V \pm 5%

5.2 Power Consumption

Table 5-2 lists the power consumption for AS228A.

Table 5-2 Power Consumption

Mode	16GB	32GB	64GB	128GB	256GB	512GB	1024GB
Active (mW)	850	880	1020	1350	1400	1450	1620
Idle (mW)	300	300	300	300	300	320	320

Note:

*All values are typical and may vary depending on flash configurations or host system settings.

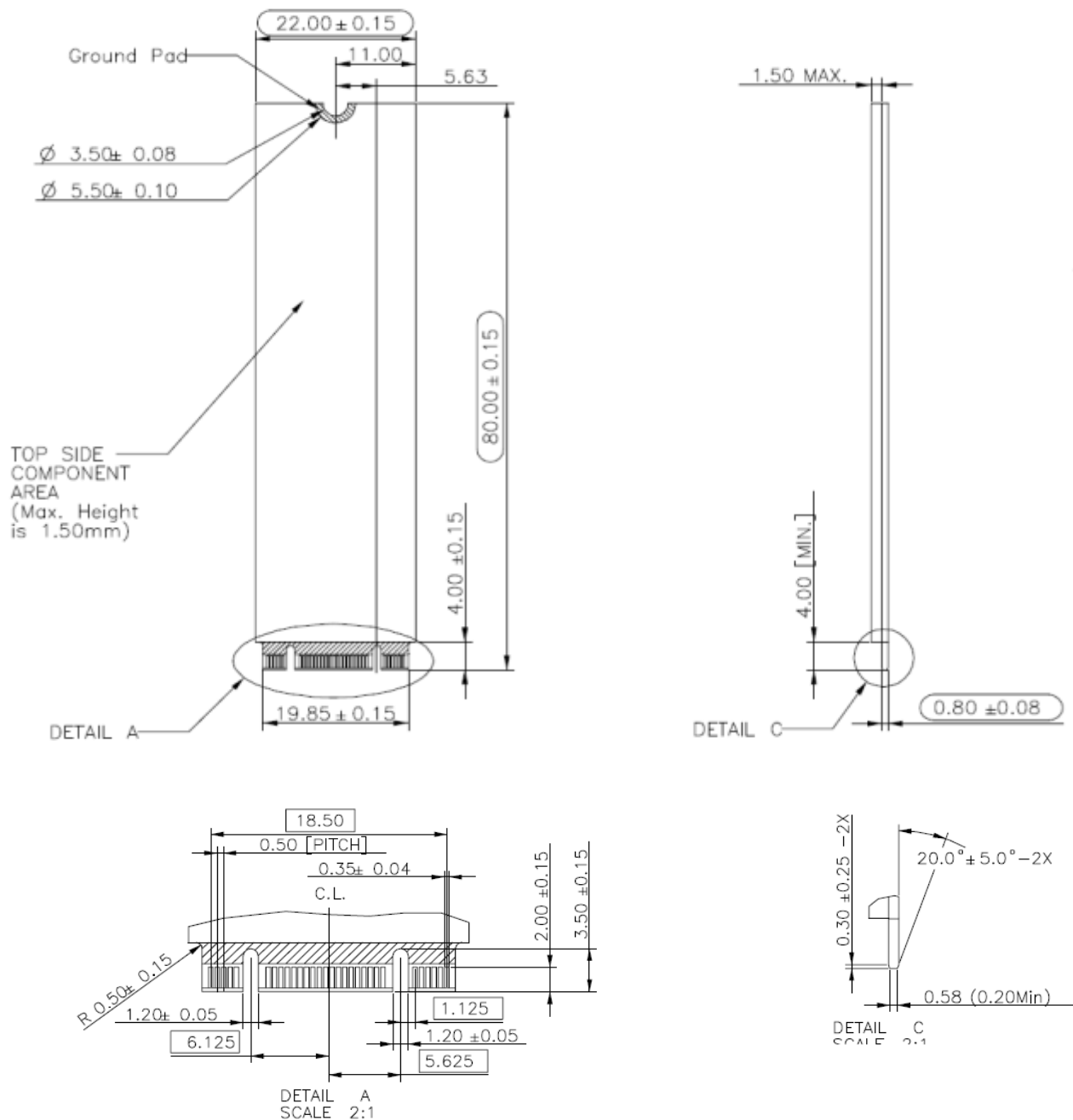
**Active power is an average power measurement performed using CrystalDiskMark with 128KB sequential read/write transfers.

6. Physical Characteristics

6.1 Physical Dimensions

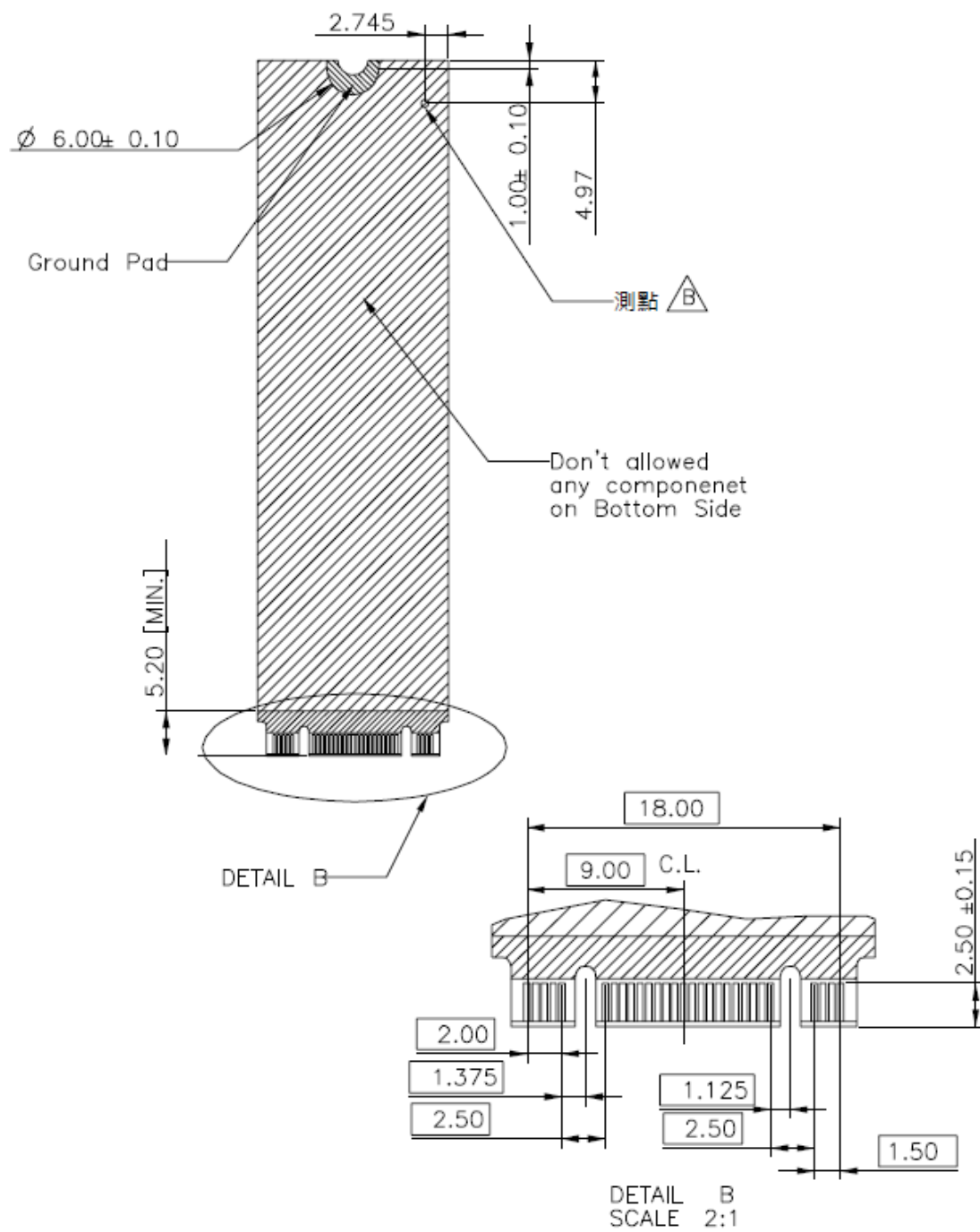
Figure 6-1 Physical Dimensions

Dimension: $80 \pm 0.15\text{mm}$ (L) x $22 \pm 0.15\text{mm}$ (W) x $2.3 \pm 0.08\text{mm}$ (H)



Notes :

1. = Max Component Height
2. = No Component
3. = No Component / Signal Vias / Signal Copper / Printing
4. General Tolerance $\pm 0.15\text{mm}$
5. is IQC inspection dimension



6.2 Part Number Listing

Capacity	Bulk P/N
16GB	85.DCB10.B011C
32GB	85.DCB20.B011C
64GB	85.DCB40.B011C
128GB	85.DCB60.B011C
256GB	85.DCBA0.B011C
512GB	85.DCBE0.B011C
1024GB	85.DCBG0.B011C

Revision History

Revision	Description	Date
1.0	Official release	8/9/2018
2.0	Document layout change	8/20/2018
2.1	Part number added	1/21/2019

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