M.2 2280 PCIe SSD 930L-D Datasheet

(SQF-C8ME4-xxxGDEEx)

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Revision History

Rev.	Date	History
0.1	2023/7/28	1. Preliminary release
0.2	2023/9/18	1. Added voltage protection information
0.3	2023/9/25	1. Revise product overview description and endurance description

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Safety Instructions

1. Read these safety instructions carefully.
2. Keep this User Manual for later reference.
3. Disconnect this equipment from any AC outlet before cleaning. Use a damp cloth. Do not use liquid or spray detergents for cleaning.
4. For plug-in equipment, the power outlet socket must be located near the equipment and must be easily accessible.
5. Keep this equipment away from humidity.
6. Put this equipment on a reliable surface during installation. Dropping it or letting it fall may cause damage.
7. The openings on the enclosure are for air convection. Protect the equipment from overheating. DO NOT COVER THE OPENINGS.
8. Make sure the voltage of the power source is correct before connecting the equipment to the power outlet.
9. Position the power cord so that people cannot step on it. Do not place anything over the power cord.
10. All cautions and warnings on the equipment should be noted.
11. If the equipment is not used for a long time, disconnect it from the power source to avoid damage by transient overvoltage.
12. Never pour any liquid into an opening. This may cause fire or electrical shock.
13. Never open the equipment. For safety reasons, the equipment should be opened only by qualified service personnel.
14. If one of the following situations arises, get the equipment checked by service personnel:
    - The power cord or plug is damaged.
    - Liquid has penetrated the equipment.
    - The equipment has been exposed to moisture.
    - The equipment does not work well, or you cannot get it to work according to the user's manual.
    - The equipment has been dropped and damaged.
    - The equipment has obvious signs of breakage.
15. DO NOT LEAVE THIS EQUIPMENT IN AN ENVIRONMENT WHERE THE STORAGE TEMPERATURE MAY GO BELOW -20° C (-4° F) OR ABOVE 60° C (140° F). THIS COULD DAMAGE THE EQUIPMENT. THE EQUIPMENT SHOULD BE IN A CONTROLLED ENVIRONMENT.
16. CAUTION: DANGER OF EXPLOSION IF BATTERY IS INCORRECTLY REPLACED. REPLACE ONLY WITH THE SAME OR EQUIVALENT TYPE RECOMMENDED BY THE MANUFACTURER, DISCARD USED BATTERIES ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS.

Consignes de sécurité

1. Lisez attentivement ces instructions de sécurité.
2. Conservez ce manuel pour référence ultérieure.
3. Débranchez cet appareil de toute prise secteur avant le nettoyage. Utilisez un chiffon humide. Ne pas utiliser de détergents liquides ou en aérosol pour le nettoyage
4. Pour les équipements enfichables, la prise de courant doit être située près de l'équipement et doit être facilement accessible.
5. Gardez cet équipement à l'abri de l'humidité.
6. Placez cet équipement sur une surface fiable lors de l'installation. Le laisser tomber ou le laisser tomber peut causer des dommages.
7. Les ouvertures sur l'enceinte sont destinées à la convection de l'air. Protégez l'équipement de la surchauffe. NE COUVREZ PAS LES OUVERTURES.
8. Assurez-vous que la tension de la source d'alimentation est correcte avant de connecter l'équipement à la prise de courant.
9. Positionnez le cordon d'alimentation de sorte que personne ne puisse marcher dessus. Ne placez rien sur le cordon d'alimentation.
10. Toutes les mises en garde et avertissements sur l'équipement doivent être notés..
11. Si l'appareil n'est pas utilisé pendant une longue période, débranchez-le de la source d'alimentation pour éviter tout dommage dû à une surtension transitoire.
12. Ne jamais verser de liquide dans une ouverture. Cela pourrait provoquer un incendie ou un choc électrique.
13. N'ouvrez jamais l'équipement. Pour des raisons de sécurité, l'équipement ne doit être ouvert que par du personnel qualifié.
14. Si l'une des situations suivantes se produit, faites vérifier l'équipement par le personnel de service:l:
    - Le cordon d'alimentation ou la fiche est endommagé Liquid has penetrated the equipment.
    - L'équipement a été exposé à l'humidité.
    - L'équipement ne fonctionne pas bien ou vous ne pouvez pas le faire fonctionner conformément au manuel d'utilisation..
    - L'équipement est tombé et endommagé..
    - L'équipement présente des signes évidents de rupture.
15. NE PAS LAISSER CET APPAREIL DANS UN ENVIRONNEMENT O LA TEMPÉRATURE DE STOCKAGE PEUT ÊTRE INFÉRIEURE À -20 ° C (-4 ° F) OU SUPÉRIEURE À 60 ° C (140 ° F). CELA POURRAIT ENDOMMAGER L'ÉQUIPEMENT. L'ÉQUIPEMENT DOIT ÊTRE DANS UN ENVIRONNEMENT CONTRÔLÉ.
16. ATTENTION: DANGER D'EXPLOSION EN CAS DE REMPLACEMENT INCORRECT DE LA PILE. REMPLACEZ UNIQUEMENT AVEC LE MÊME TYPE OU LE TYPE ÉQUIVALENT RECOMMANDÉ PAR LE FABRICANT, DÉJETTEZ LES PILES UTILISÉES SELON LES INSTRUCTIONS DU FABRICANT.

1. Overview

Advantech SQFlash 930L-D Enterprise series M.2 2280 PCIe SSD (Solid State Drive) delivers all the advantages of flash disk technology with PCIe Gen4 x4 interface and is fully compliant with the standard Next Generation Form Factor (NGFF) called M.2 Card Format. The SQFlash 930L-D series offers DWPD 1 high endurance for 5 year warranty, capacity up to 1.9TB and its performance can reach up to 5,500 MB/s (for read) and 2,000 MB/s (for write) based on 3D eTLC NAND flash with DRAM cache. The power consumption of SQFlash 930L-D M.2 2280 is much lower than traditional hard drives, and it goes with large capacitors as for power loss protection, making it the best and sound embedded solution for new platforms.

2. Features

- **PCIe Interface**
  - Compliant with NVMe1.4
  - PCIe Express Base Ver 4.0
  - PCIe Gen 4 x 4 lane & backward compatible to PCIe Gen3, Gen 2 and Gen 1
  - 8 IO queues supported (1 admin queue and 8 IO queue). Each IO queue supports 256 entries.
  - Support power management
- **Operating Voltage：3.3V**
- **Support fourth LDPC generation of ECC algorithm**
- **Built-in tantalum capacitor**
- **AES256、TCG-OPAL、TRIM、AHCI supported**
- **Temperature Ranges[1]**
  - Commercial Temperature
    - 0℃ to 70℃ for operating
    - -40℃ to 85℃ for storage
  - Middle Temperature
    - -20℃ to 85℃ for operating
    - -40℃ to 85℃ for storage

  *Note : 1. Based on SMART Attribute (Byte index [2 :1] of PCIe-SIG standard, which measured by thermal sensor
- **Mechanical Specification**
  - Shock：1,500G / 0.5ms
  - Vibration：20G / 80~2,000Hz
- **Humidty**
  - Humidity：up to 95% on 40℃
- **Acquired RoHS、WHQL、CE、FCC Certificate**
- **Acoustic：0 dB**
- **Dimension (w/ heatsink)：80.0 mm x 22.0 mm x 4.0 mm**

3. Specification Table

■ Performance

		Sequential (MB/sec)		Random (IOPS @4K)	
		Read	**Write**	**Read**	**Write**
3D eTLC (BiCS5)	480 GB	5,500	700	400K	17K
	960 GB	5,500	1,400	600K	34K
	1920 GB	5,500	2,000	800K	58K

1. Performance is measured on a fresh slave drive and based on the following conditions:
   A. CrystalDiskMark 7.0.0, 1GB range, QD=16, Thread=1
   B. IOMeter, 1GB range, 4K data size, QD=128, 16 worker, 4k aligned
2. Performance is based on AMD Gen4 X570 + 8 Core CPU + DDR4 (3200Hz) 16GB.
3. Performance may differ according to flash configuration and platform.
4. The tables are for reference only. Any criteria for accepting goods shall be further discussed based on different flash configurations.

Endurance

JEDEC defined an endurance rating TBW (TeraByte Written), following by the equation below, for indicating the number of terabytes a SSD can be written which is a measurement of SSDs' expected lifespan, represents the amount of data written to the device.

TBW = [(NAND Endurance) x (SSD Capacity)] / WAF

- **NAND Endurance**: Program / Erase cycle of a NAND flash.
  - 3D eTLC (BiCS5): 7,000 cycles
- **SSD Capacity**: SSD physical capacity in total of a SSD.
- **WAF**: Write Amplification Factor (WAF), as the equation shown below, is a numerical value representing the ratio between the amount of data that a SSD controller needs to write and the amount of data that the host's flash controller writes. A better WAF, which is near to 1, guarantees better endurance and lower frequency of data written to flash memory.

WAF = (Lifetime write to flash) / (Lifetime write to host)

- **Endurance measurement is based on JEDEC 219A Enterprise Workload and verified with following workload conditions,**
  - PreCond%full = 100%
  - Trim commands enabled
  - Random data pattern.

3D eTLC (BiCS5)	TBW	DWPD*
480 GB	920	1
960 GB	1900	1
1920 GB	3800	1

* Endurance of 1 drive writes per day (DWPD) for 5 years

4. General Description

■ Error Correction Code (ECC)

Flash memory cells will deteriorate with use, which might generate random bit errors in the stored data. Thus, SQFlash 930L-D series PCIe SSD applies the forth generation LDPC of ECC algorithm, which can detect and correct errors occur during read process, ensure data been read correctly, as well as protect data from corruption.

■ Wear Leveling

NAND flash devices can only undergo a limited number of program/erase cycles, and in most cases, the flash media are not used evenly. If some areas get updated more frequently than others, the lifetime of the device would be reduced significantly. Thus, Wear Leveling is applied to extend the lifespan of NAND Flash by evenly distributing write and erase cycles across the media.

SQFlash provides advanced Wear Leveling algorithm, which can efficiently spread out the flash usage through the whole flash media area. Moreover, by implementing both dynamic and static Wear Leveling algorithms, the life expectancy of the NAND flash is greatly improved.

■ 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”. SQFlash 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.

■ Power Loss Protection

– Flush Manager

Power Loss Protection is a mechanism to prevent data loss during unexpected power failure. DRAM is a volatile memory and frequently used as temporary cache or buffer between the controller and the NAND flash to improve the SSD performance. However, one major concern of the DRAM is that it is not able to keep data during power failure. Accordingly, SQFlash SSD applies the Flush Manager technology, only when the data is fully committed to the NAND flash will the controller send acknowledgement (ACK) to the host. Such implementation can prevent false-positive performance and the risk of power cycling issues.

In addition, it is critical for a controller to shorten the time the in-flight data stays in the controller internal cache. Thus, SQFlash applies an algorithm to reduce the amount of data resides in the cache to provide a better performance. With Flush Manager, incoming data would only have a “pit stop” in the cache and then move to NAND flash directly. Also, the onboard DDR will be treated as an “organizer” to consolidate incoming data into groups before written into the flash to improve write amplification.

– Voltage Stabilizer

While the built-in voltage detector detects an unstable power input (< 3.135 V or > 3.465 V), the controller will issue a power failure interrupt and force a Flush CMD first. At the same time, the whole internal power supply will be switched to Voltage Stabilizer immediately to ensure stable power is supplied throughout the whole drive. This ensures the Flash IC and DDR IC will not operate with unstable power which could lead to data errors or bad data integrity.

■ 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.

SMART

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.

Over-Provision

Over Provisioning refers to the inclusion of extra NAND capacity in a SSD, which is not visible and cannot be used by users. With Over Provisioning, the performance and IOPS (Input/Output Operations per Second) are improved by providing the controller additional space to manage P/E cycles, which enhances the reliability and endurance as well. Moreover, the write amplification of the SSD becomes lower when the controller writes data to the flash.

Thermal Throttling

Thermal Throttling function is for protecting the drive and reducing the possibility of read / write error due to overheat. The temperature is monitored by the thermal sensor. As the operating temperature continues to increase to threshold temperature, the Thermal Throttling mechanism is activated. At this time, the performance of the drive will be significantly decreased to avoid continuous heating. When the operating temperature falls below threshold temperature, the drive can resume to normal operation.

Advanced Device Security Features

- **Advanced Encryption Standard (AES)**

  An AES 256-bit encryption key is generated in the drive's security controller before the data gets stored on the NAND flash. When the controller or firmware fails, the data that is securely stored in the encryption key becomes inaccessible through the NAND flash.

- **OPAL 2.0 support**

  SQFlash 930L-D series supports standard OPAL 2.0 function for advance Self-Encryption Drive (SED) feature sets. Advantech provides also user friendly interface for setting disk / system bonding to prevent SSD be used in non-authorized platforms, which is called Flash Lock function.

- **Secure Erase Function**

  SQFlash 930L-D series supports standard NVMe command for secure erase function; when the SSD controller receive the secure erase command, the erase process will reset all blocks and erase all of the user data in the SSD.

- **Sanitize Fucntion**

  SQFlash 930L-D series default implement NVMe Sanitize Device Feature set, which supports the command set of Block Erase, Overwritten and Crypto Scramble. With the internal AES encryption support, the Crypto Scrambel process will start with resetting AES key. By doing so, existing data will be scrambled within 10ms and cannot be recovered anymore. Moreover, erase flag is set when erase function is triggered, which will ensure the whole erase process can be 100% completed. Even there's power interrupt, after power resume, erase operation will be resume right away as well.

LBA value

Density (GB)	LBA
480	937,703,088
960	1,875,385,008
1920	3,750,748,848

5. Pin Assignment and Description

Pin No.	PCIe Pin	Description
1	GND	Ground
2	3.3V	3.3V source
3	GND	Ground
4	3.3V	3.3V source
5	PETn3	PCIe TX Differential signal defined by the PCI Express M.2 spec
6	N/C	No connect
7	PETp3	PCIe TX Differential signal defined by the PCI Express M.2 spec
8	N/C	No connect
9	GND	Ground
10	LED1#(O)	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	PERn3	PCIe RX Differential signal defined by the PCI Express M.2 spec
12	3.3V	3.3V source
13	PERp3	PCIe RX Differential signal defined by the PCI Express M.2 spec
14	3.3V	3.3V source
15	GND	Ground
16	3.3V	3.3V source
17	PETn2	PCIe TX Differential signal defined by the PCI Express M.2 spec
18	3.3V	3.3V source
19	PETp2	PCIe TX Differential signal defined by the PCI Express M.2 spec
20	N/C	No connect
21	GND	Ground
22	N/C	No connect
23	PERn2	PCIe RX Differential signal defined by the PCI Express M.2 spec
24	N/C	No connect
25	PERp2	PCIe RX Differential signal defined by the PCI Express M.2 spec
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
30	N/C	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	SMB_CLK (I/O)(0/1.8V)	SMBus Clock; Open Drain with pull-up on platform
41	PETn0	PCIe TX Differential signal defined by the PCI Express M.2 spec
42	SMB_DATA (I/O)(0/1.8V)	SMBus Data; Open Drain with pull-up on platform.
43	PETp0	PCIe TX Differential signal defined by the PCI Express M.2 spec
44	ALERT#(O) (0/1.8V)	Alert notification to master; Open Drain with pull-up on platform; Active low.
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)(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	PEWAKE#(I/O)(0/3.3V)	PCIe PME Wake. Open Drain with pull up on platform; Active Low.
55	REFCLKp	PCIe Reference Clock signals (100 MHz) defined by the PCI Express M.2 spec.
56	Reserved for MFG DATA	Manufacturing Data line. Used for SSD manufacturing only. Not used in normal operation. Pins should be left N/C in platform Socket.
57	GND	Ground
58	Reserved for MFG CLOCK	Manufacturing Clock line. Used for SSD manufacturing only. Not used in normal operation. Pins should be left N/C in platform Socket.
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	No connect
68	N/C	No connect
69	N/C	PEDET (NC-PCIe)
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	Ground

6. NVMe Command List

■ Admin Commands

O/M	Command Description	Supported
M	Delete I/O Submission Queue	Supported
M	Create I/O Submission Queue	Supported
M	Get Log Page	Supported
M	Delete I/O Completion Queue	Supported
M	Create I/O Completion Queue	Supported
M	Identify	Supported
M	Abort	Supported
M	Set Features	Supported
M	Get Features	Supported
M	Asynchronous Event Request	Supported
O	Firmware Activate	Supported
O	Firmware Image Download	Supported
O	Device Self-test	Not Supported
O	Format NVM	Supported
O	Security Send	Supported
O	Security Receive	Supported
O	Sanitize	Not Supported

■ I/O Commands

O/M	Command Description	Supported
O	Flush	Supported
O	Write	Supported
O	Read	Supported
O	Write Uncorrectable	Not Supported
O	Compare	Supported
O	Write Zeroes	Supported
O	Dataset Management	Supported

■ Set Feature Commands

O/M	Command Description	Supported
	Reserved	
M	Arbitration	Supported
M	Power Management	Supported
O	LBA Range Type	Not Supported
M	Temperature Threshold	Supported
M	Error Recovery	Supported
O	Volatile Write Cache	Supported
M	Number Of Queues	Supported
M	Interrupt Coalescing	Supported
M	Write Atomicity Normal	Supported
M	Interrupt Vector Configuration	Supported
M	Write Atomicity Normal	Supported
M	Asynchronous Event Configuration	Supported
O	Autonomous Power State Transition	Supported
O	Host Memory Buffer	Not Supported
O	Timestamp	Supported
O	Host Controlled Thermal Management	Supported
O	Non-Operational Power State Config	
	Reserved	
O	Software Progress Marker	Supported

■ Get Log Page Commands

O/M	Command Description	Supported
	Reserved	
M	Error Information	Supported
M	SMAART / Health Information	Supported
M	Firmware Slot Information	Supported
O	Changed Namespace List	Not Supported
O	Device Self-test	Supported
	Reserved	
O	Sanitize Status	Not Supported
	Reserved	

7. Identify Device Data

The Identity Device Data enables Host to receive parameter information from the device. The parameter words in the buffer have the arrangement and meanings defined in below table. All reserve bits or words are zero

■ Identify Controller Data Structure

Bytes	Description
Controller Capabilities and Features	
01:00	PCI Vendor ID (VID)
03:02	PCI Subsystem Vendor ID (SSVID)
23:04	Serial Number (SN)
63:24	Model Number (MN)
71:64	Firmware Revision (FR)
72	Recommended Arbitration Burst (RAB)
75:73	IEEE OUI Identifier (IEEE)
76	Controller Multi-Path I/O and Namespace Sharing Capabilities (CMIC)
77	Maximum Data Transfer Size (MDTS)
79:78	Controller ID (CNTLID)
83:80	Version (VER)
87:84	RTD3 Resume Latency (RTD3R)
91:88	RTD3 Entry Latency (RTD3E)
95:92	Optional Asynchronous Events Supported (OAES)
99:96	Controller Attributes (CTRATT)
101:100	Read Recovery Level support bitmap (rrls)
110:102	Reserved
111	Controller Type, if support NVMe 1.4 shall be set to other than 0 (cntrltype)
127:112	FRU Globally Unique Identifier (fguid[16])
129:128	Command Retry Delay Time 1 (crdt1)
131:130	Command Retry Delay Time 2 (crdt2)
133:132	Command Retry Delay Time 3 (crdt3)
255:134	Reserved
257:256	Optional Admin Command Support (OACS)
258	Abort Command Limit (ACL)
259	Asynchronous Event Request Limit (AERL)
260	Firmware Updates (FRMW)
261	Log Page Attributes (LPA)
262	Error Log Page Entries (ELPE)
263	Number of Power States Support (NPSS)
264	Admin Vendor Specific Command Configuration (AVSCC)
265	Autonomous Power State Transition Attributes (APSTA)
267:266	Warning Composite Temperature Threshold (WCTEMP)
269:268	Critical Composite Temperature Threshold (CCTEMP)
271:270	Maximum Time for Firmware Activation (MTFA)
275:272	Host Memory Buffer Preferred Size (HMPRE)
279:276	Host Memory Buffer Minimum Size (HMMIN)
295:280	Total NVM Capacity (TNVMCAP)
311:296	Unallocated NVM Capacity (UNVMCAP)
315:312	Replay Protected Memory Block Support (RPMBS)
317:316	Extended Device Self-test Time (edstt)
318	Device Self-test Options (dsto)
319	Firmware Update Granularity (fwug)
321:320	Keep Alive Support (kas)
323:322	Host Controlled Thermal Management Attributes (hctma)
325:324	Minimum Thermal Management Temperature (mntmt)
327:326	Maximum Thermal Management Temperature (mxtmt)

331:328	Sanitize Capabilities (sanicap)
335:332	Host Memory Buffer Min. Descriptor Entry Size (hmminds)
337:336	Host Memory Maximum Descriptor Entries (hmmaxd)
339:338	NVM Set ID Maximum (nsetidmax)
341:340	Endurance Group ID Maximum (endgidmax)
342	ANA Maximum Transition Time (anatt)
343	Asymmetric Namespace Access Capabilities (anacap)
347:344	ANA Group ID Maximum (anagrpmax)
351:348	Number of ANA Group IDs (nanagrpid)
355:352	Persistent Event Log Size (pels)
511:356	Reserved
NVM Command Set Attributes	
512	Submission Queue Entry Size (SQES)
513	Completion Queue Entry Size (CQES)
515:514	Maximum Outstanding Commands (maxcmd)
519:516	Number of Namespaces (NN)
521:520	Optional NVM Command Support (ONCS)
523:522	Fused Operation Support (FUSES)
524	Format NVM Attributes (FNA)
525	Volatile Write Cache (VWC)
527:526	Atomic Write Unit Normal (AWUN)
529:528	Atomic Write Unit Power Fail (AWUPF)
530	NVM Vendor Specific Command Configuration (NVSCC)
531	Namespace Write Protection Capabilities (nwpc)
533:532	Atomic Compare & Write Unit (ACWU)
535:534	Reserved
539:536	SGL Support (SGLS)
543:540	Maximum Number of Allowed Namespace, if supports ANA Reporting shall not be 0 and less than NN (mnan)
767:544	Reserved
IO Command Set Attributes	
1023:768	NVM Subsystem NVMe Qualified Name (subnqn)
1791:1024	Reserved
2047:1792	Refer to the NVMe over Fabrics specification
2079:2048	Power State 0 Descriptor (PSD0)
2111:2080	Power State 1 Descriptor (PSD1)
2143:2112	Power State 2 Descriptor (PSD2)
2175:2144	Power State 3 Descriptor (PSD3)
2207:2176	Power State 4 Descriptor (PSD4)
2239:2208	Power State 5 Descriptor (PSD5)
2271:2240	Power State 6 Descriptor (PSD6)
2303:2272	Power State 7 Descriptor (PSD7)
2335:2304	Power State 8 Descriptor (PSD8)
2367:2336	Power State 9 Descriptor (PSD9)
2399:2368	Power State 10 Descriptor (PSD10)
2431:2400	Power State 11 Descriptor (PSD11)
2463:2432	Power State 12 Descriptor (PSD12)
2495:2464	Power State 13 Descriptor (PSD13)
2527:2496	Power State 14 Descriptor (PSD14)
2559:2528	Power State 15 Descriptor (PSD15)
2591:2560	Power State 16 Descriptor (PSD16)
2623:2592	Power State 17 Descriptor (PSD17)
2655:2624	Power State 18 Descriptor (PSD18)
2687:2656	Power State 19 Descriptor (PSD19)
2719:2688	Power State 20 Descriptor (PSD20)
2751:2720	Power State 21 Descriptor (PSD21)

2783:2752	Power State 22 Descriptor (PSD22)
2815:2784	Power State 23 Descriptor (PSD23)
2847:2816	Power State 24 Descriptor (PSD24)
2879:2848	Power State 25 Descriptor (PSD25)
2911:2880	Power State 26 Descriptor (PSD26)
2943:2912	Power State 27 Descriptor (PSD27)
2975:2944	Power State 28 Descriptor (PSD28)
3007:2976	Power State 29 Descriptor (PSD29)
3039:3008	Power State 30 Descriptor (PSD30)
3071:3040	Power State 31 Descriptor (PSD31)
Vendor Specific	
4095:3072	Vendor Specific (VS)

■ Identify Namespace Data Structure & NVM Command Set Specific

Bytes	Description
7:0	Namespace Size (NSZE)
15:8	Namespace Capacity (NCAP)
23:16	Namespace Utilization (NUSE)
24	Namespace Features (NSFEAT)
25	Number of LBA Formats (NLBAF)
26	Formatted LBA Size (FLBAS)
27	Metadata Capabilities (MC)
28	End-to-end Data Protection Capabilities (DPC)
29	End-to-end Data Protection Type Settings (DPS)
30	Namespace Multi-path I/O and Namespace Sharing Capabilities (NMIC)
31	Reservation Capabilities (RESCAP)
32	Format Progress Indicator (FPI)
33	Deallocate Logical Block Features (dlfeat)
35:34	Namespace Atomic Write Unit Normal (NAWUN)
37:36	Namespace Atomic Write Unit Power Fail (NAWUPF)
39:38	Namespace Atomic Compare & Write Unit (NACWU)
41:40	Namespace Atomic Boundary Size Normal (NABSN)
43:42	Namespace Atomic Boundary Offset (NABO)
45:44	Namespace Atomic Boundary Size Power Fail (NABSPF)
47:46	Namespace Optimal IO Boundary (noiob)
64:48	NVM Capacity (NVMCAP)
65:64	Namespace Preferred Write Granularity (npwg)
69:68	Namespace Preferred Deallocation(Trim) Granularity (npdg)
71:70	Namespace Preferred Deallocation(Trim) Alignment (npda)
73:72	Namespace Optimal Write Size (nows)
91:74	Reserved
95:92	ANA Groput Identifier (anagrpid)
98:96	Reserved
99	Namespace Attributes (nsattr)
101:100	NVM Set Identifier (nvmsetid)
103:102	Endurange Group Identifier // NVMe 1.4 add (endgid)
119:104	Namespace Globally Unique Identifier (NGUID)
127:120	IEEE Extended Unique Identifier (EUI64)
131:128	LBA Format 0 Support (LBAF0)
135:132	LBA Format 1 Support (LBAF1)
139:136	LBA Format 2 Support (LBAF2)
143:140	LBA Format 3 Support (LBAF3)
147:144	LBA Format 4 Support (LBAF4)
151:148	LBA Format 5 Support (LBAF5)
155:152	LBA Format 6 Support (LBAF6)
159:156	LBA Format 7 Support (LBAF7)
163:160	LBA Format 8 Support (LBAF8)
167:164	LBA Format 9 Support (LBAF9)
171:168	LBA Format 10 Support (LBAF10)
175:172	LBA Format 11 Support (LBAF11)
179:176	LBA Format 12 Support (LBAF12)
183:180	LBA Format 13 Support (LBAF13)
187:184	LBA Format 14 Support (LBAF14)
191:188	LBA Format 15 Support (LBAF15)
383:192	Reserved
4095:384	Vendor Specific (VS)

List of Identify Namespace Data Structure for Each Capacity

Capacity (GB)	Byte[7:0]: Namespace Size (NSZE)(Hex)	Byte[7:0]: Namespace Size (NSZE)(Dec)
480	37E436B0h	937,703,088
960	6FC81AB0h	1,875,385,008
1920	DF8FE2B0h	3,750,748,848

8. SMART Atrributes

ATTRIBUTE_NAME	Log Identifier	# of Bytes	Byte index	Unit
Critical Warning	02h	1	[0]	-
Composite Temperature	02h	2	[2:1]	°K
Available Spare	02h	1	[3]	%
Available Spare Threshold	02h	1	[4]	%
Percentage Used	02h	1	[5]	%
Reserved	02h		[31:6]	
Data Units Read	02h	16	[47:32]	1000 Sectors
Data Units Written (Host Write)	02h	16	[63:48]	1000 Sectors
Host Read Commands	02h	16	[79:64]	count
Host Write Commands	02h	16	[95:80]	count
Controller Busy Time	02h	16	[111:96]	mins
Power Cycles	02h	16	[127:112]	count
Power on Hours	02h	16	[143:128]	hours
Unsafe Shutdowns	02h	16	[159:144]	count
Media and Data Integrity Errors	02h	16	[175:160]	times
Number of Error Information Log Entries	02h	16	[191:176]	count
Warning Composite Temperature Time	02h	4	[195:192]	mins
Critical Composite Temperature Time	02h	4	[199:196]	mins
Temperature Sensor 1	02h	2	[201:200]	°K
Temperature Sensor 2	02h	2	[203:202]	°K
Temperature Sensor 3	02h	2	[205:204]	°K
Temperature Sensor 4	02h	2	[207:206]	°K
Temperature Sensor 5	02h	2	[209:208]	°K
Temperature Sensor 6	02h	2	[211:210]	°K
Temperature Sensor 7	02h	2	[213:212]	°K
Temperature Sensor 8	02h	2	[215:214]	°K
Thermal Management Temperature 1 Transition Count	02h	4	[219:216]	count
Thermal Management Temperature 2 Transition Count	02h	4	[223:220]	count
Total Time for Thermal Management Temperature 1:	02h	4	[227:224]	Second
Total Time for Thermal Management Temperature 2:	02h	4	[231:228]	Second
Reserved	02h		[511:232]	
Flash Read Sector	C0h	8	[7:0]	sector
Flash Write Sector	C0h	8	[15:8]	sector
UNC Error	C0h	8	[23:16]	count
PHY Error	C0h	4	[27:24]	count
Early Bad Block	C0h	4	[31:28]	count
Later Bad Block	C0h	4	[35:32]	count

Max Erase Count	C0h	4	[39:36]	count
Average Erase Count	C0h	4	[43:40]	count
Current Percent Spares	C0h	8	[51:44]	%
Current Temperature	C0h	2	[53:52]	°K
Lowest Temperature	C0h	2	[55:54]	°K
Highest Temperature	C0h	2	[57:56]	°K
Current Controller Temperature	C0h	2	[61:60]	°K
Spare Blocks	C0h	2	[63:62]	count

9. System Power Consumption

■ Supply Voltage

Parameter	Rating
Operating Voltage	3.3V

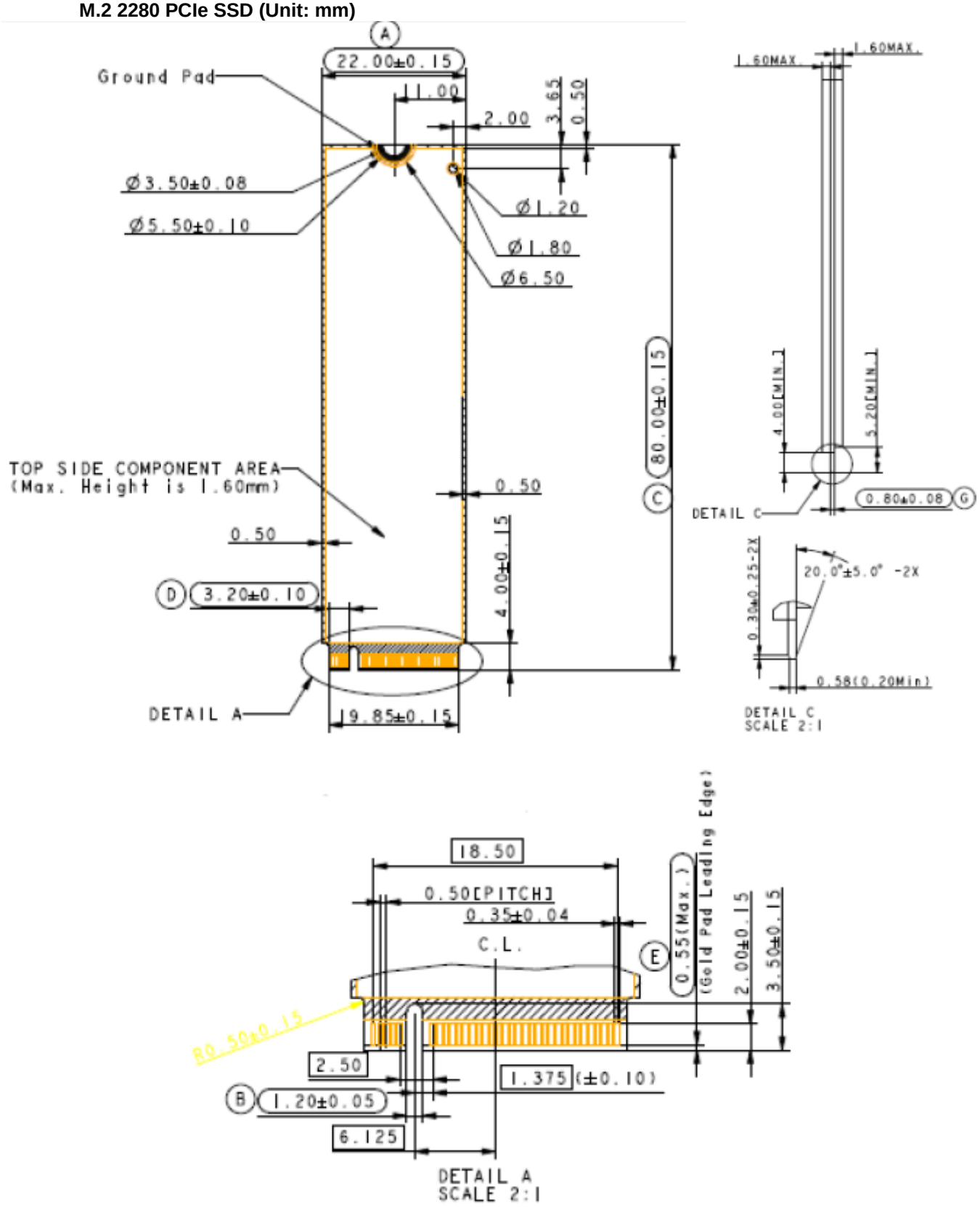
■ Power Consumption

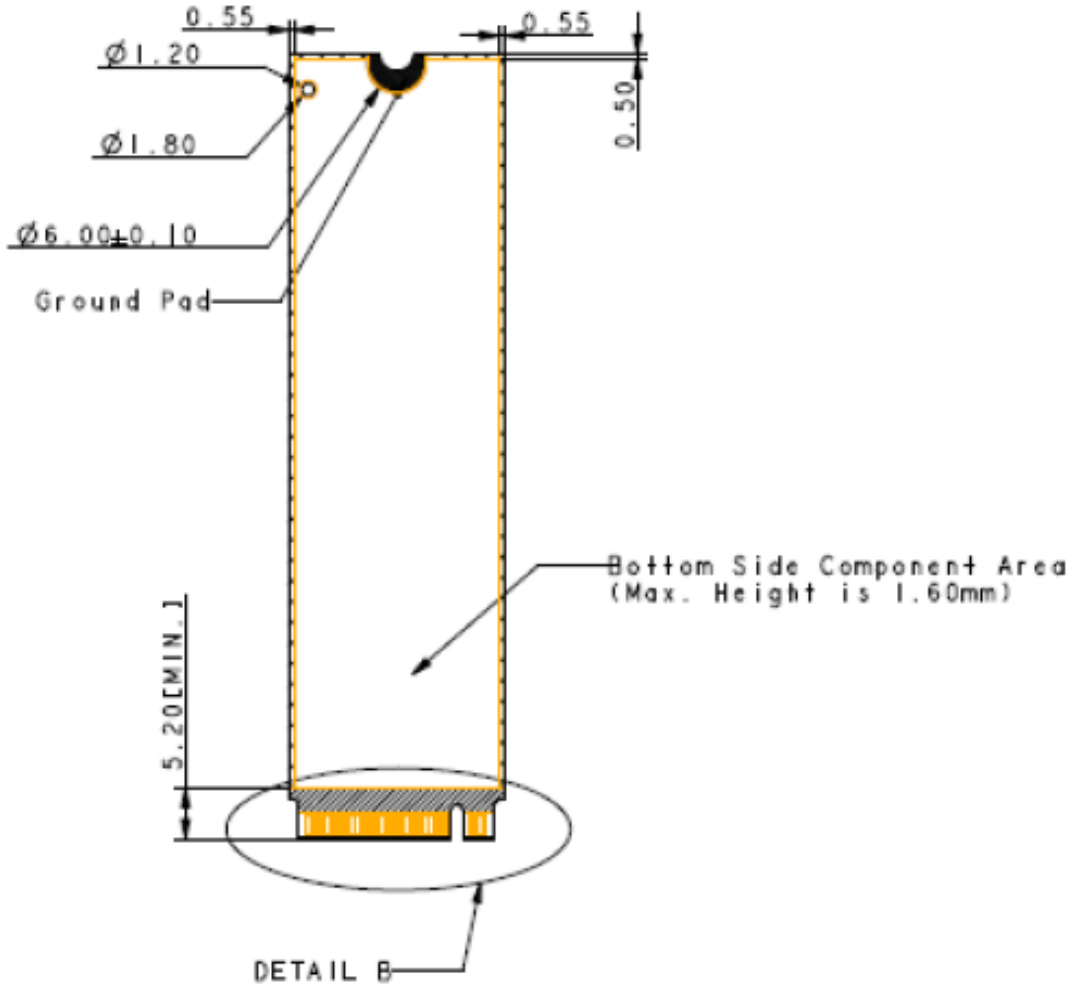
(Unit: W)		Read	Write	Idle
3D eTLC (BiCS5)	480 GB	6.5	10.5	4
	960 GB	9.5	11.55	4
	1920 GB	11.55	11.55	4.2

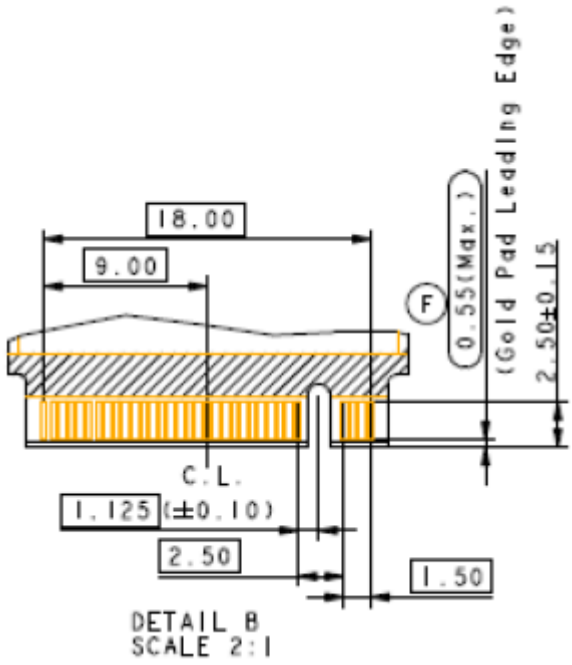
1. Use iometer with QD32 and worker 1 for 128KB sequential read/write & QD32 and worker 8 for 4KB random read/write test to measure the power of active read/write.
2. The power of idle is measured with LPM off.
3. Power Consumption may differ according to flash configuration and platform.
4. The average value of power consumption is achieved based on 100% conversion efficiency.
5. The measured power voltage of M.2 2280 SSD is 3.3V.

10. Physical Dimension

M.2 2280 PCIe SSD (Unit: mm)




0.55
0.55
Ø1.20
Ø1.80
0.50
Ø6.00±0.10
Ground Pad
Bottom Side Component Area
(Max. Height is 1.60mm)
5.20[MIN.]
DETAIL B


18.00
9.00
F
0.55(Max.)
(Gold Pad Leading Edge)
2.50±0.15
C.L.
1.125 (±0.10)
2.50
1.50
DETAIL B
SCALE 2:1

Appendix: Part Number Table

Product	Advantech PN
SQF 930L-D NVMe M.2 2280 SSD (OPAL) 480G 3D eTLC (BiCS5) DWPD=1 (0~70°C)	SQF-C8ME4-480GDEEC
SQF 930L-D NVMe M.2 2280 SSD (OPAL) 960G 3D eTLC (BiCS5) DWPD=1 (0~70°C)	SQF-C8ME4-960GDEEC
SQF 930L-D NVMe M.2 2280 SSD (OPAL) 1920G 3D eTLC (BiCS5) DWPD=1 (0~70°C)	SQF-C8ME4-1K9GDEEC
SQF 930L-D NVMe M.2 2280 SSD (OPAL) 480G 3D eTLC (BiCS5) DWPD=1 (-20~85°C)	SQF-C8ME4-480GDEEM
SQF 930L-D NVMe M.2 2280 SSD (OPAL) 960G 3D eTLC (BiCS5) DWPD=1 (-20~85°C)	SQF-C8ME4-960GDEEM
SQF 930L-D NVMe M.2 2280 SSD (OPAL) 1920G 3D eTLC (BiCS5) DWPD=1 (-20~85°C)	SQF-C8ME4-1K9GDEEM