

UD info Corp.

Industrial AIC(Add-In Card) PCIe SSD
AIC-HLUE Series
Product DataSheet

UD info CORP.

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Revision History

Revision	Draft Date	History	Author
1.0	2018/5/28	New release	Golden Lee
1.1	2018/6/26	Modify NVMe command set	Golden Lee



Product Overview

- **Capacity**
 - 120GB (128GB) up to 960GB (1024GB)
- **Form Factor**
 - AIC (HHHL)
- **PCIe Interface**
 - NVMe PCIe Gen3 x2
- **Compliance**
 - NVMe 1.3
 - PCI Express Base 3.1
- **Flash Interface**
 - Transfer rate up to 533MBps
 - Up to 8pcs of BGA flash
- **Performance**
 - Read up to 1,600 MB/s
 - Write up to 1,100 MB/s
- **Power Consumption^{Note1}**
 - Active mode: < 4300mW
- **Reliability**
 - MTBF more than 2,000,000 hours
 - Uncorrectable Bit Error Rate(UBER)
< 1 sector per 10¹⁶ bits read
- **Advanced Flash Management**
 - Static and Dynamic Wear Leveling
 - Bad Block Management
 - TRIM
 - SMART
 - Over-Provision
- **Power Saving Modes**
 - Support APST
 - Support ASPM
- **Temperature Range**
 - Operation (Standard): 0°C ~ 70°C
 - Storage: -40°C ~ 85°C
- **Compliant**
 - RoHS
 - CE & FCC
- **Feature Support List:**
 - End to end data path protection
 - Thermal throttling
 - SmartECC
 - SmartRefresh
 - Drive log
 - Support of TCG OPAL^{Note2}
 - Support of TCG Pyrite^{Note2}

Notes:

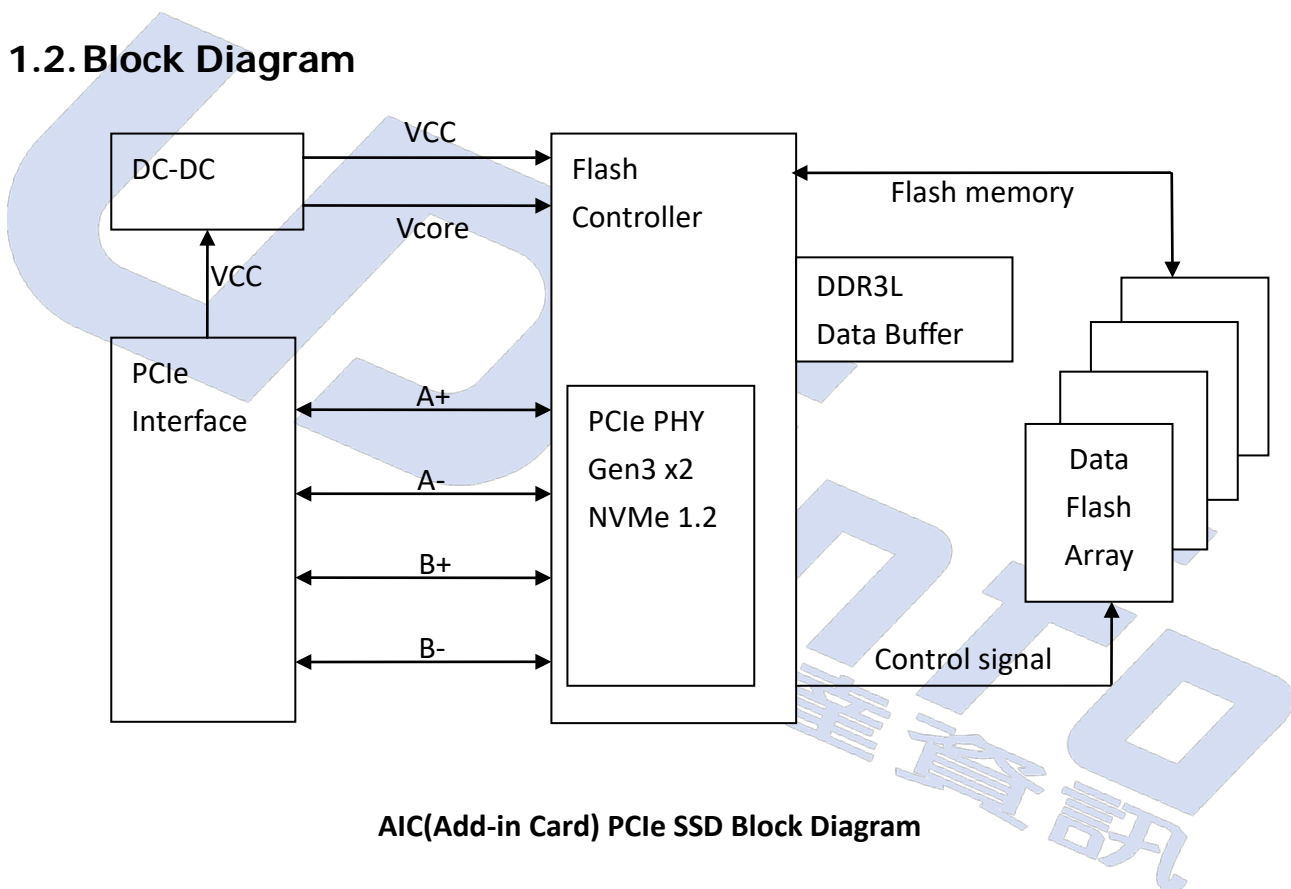
1. Please see "Power Consumption" for details.
2. Supported by a separate firmware version. Further information available upon request.

1. INTRODUCTION

1.1. General Description

UDinfo's AIC(Add-in Card) PCIe SSD delivers all the advantages of flash disk technology with PCIe Gen3 x4 interface, including being compliant with standard AIC(Add-in Card) HHHH form factor. Its capacity could provide a wide range up to 1,024GB and reach up to 1,600MB/s read as well as 1,100MB/s write high performance based on Toshiba's BiCS3 Toggle TLC flash (with 256MB/512MB DDR3L cache enabled and measured by CrystalDiskMark v5.0). Meanwhile, the power consumption of the AIC(Add-in Card) PCIe SSD is much lower than traditional hard drives.

1.2. Block Diagram



AIC(Add-in Card) PCIe SSD Block Diagram

2. PRODUCT SPECIFICATIONS



- **Capacity**
 - 120GB (128GB) up to 960GB (1024GB)
- **Electrical/Physical Interface**
 - PCIe Interface
 - ◆ Compliant with NVMe 1.3
 - ◆ PCIe Ver 3.1
 - ◆ Compatible with PCIe I/II/III x 2 interface
 - ◆ Support up to queue depth 64K
 - ◆ Support power management
- **Supported NAND Flash**
 - Toshiba 3D –NAND; Intel/Micron 3D-NAND; Hynix 3D-NAND
 - Support all types of large block: 8KB/page and 16K/page NAND flash
 - Contain up to 8pcs of BGA flash
- **ECC Scheme**
 - Applies the SECC (Strong ECC) of ECC algorithm
- **Sector Size Support**
 - 512B
 - 4KB
- **UART function**
- **GPIO**
- **Support SMART and TRIM commands**
- **LBA Range**
 - IDEMA standard

- Performance

- 3D TLC:

Capacity	Flash Structure	CE#	Flash Type	Sequential (MB/s)		Random (8GB Burst)	
				Read (MB/s)	Write (MB/s)	Read (K IOPS)	Write (K IOPS)
120GB (128GB)	64GB x 2	4	BGA, BiCS3 TLC	1,500	450	90	100
240GB (256GB)	64GB x 4	8	BGA, BiCS3 TLC	1,600	850	180	150
480GB (512GB)	128GB x 4	16	BGA, BiCS3 TLC	1,600	1,000	220	160
960GB (1024GB)	128GB x 8	32	BGA, BiCS3 TLC	1,600	1,100	230	180

Notes:

1. The performance was estimated based on Toshiba NAND flash.
2. Performance may differ according to flash configuration and platform.
3. The table above is for reference only. The criteria for MP (mass production) and for accepting goods shall be discussed based on different flash configuration.
4. Performance is measured with following conditions
 - (a) CrystalDiskMark 5.1.2, 1GB range, QD=32, Thread=1
 - (b) IOMeter, 8GB range, 4K data size, QD=32 (3) ATTO, transfer size 8192 KB

3. ENVIRONMENTAL SPECIFICATIONS



3.1. Environmental Conditions

3.1.1. Temperature and Humidity

- Temperature:
 - ◆ Storage: -40°C to 85°C
 - ◆ Operational (Standard grade): 0°C to 70°C
- Humidity:
 - ◆ Standard grade: RH 90% under 40°C (operational)

■ High Temperature Test Condition

	Temperature	Humidity
Operation (Standard)	70°C	0% RH
Storage (Standard)	85°C	0% RH

Result: No any abnormality is detected.

■ Low Temperature Test Condition

	Temperature	Humidity
Operation (Standard)	0°C	0% RH
Storage (Standard)	-40°C	0% RH

Result: No any abnormality is detected.

■ High Humidity Test Condition

	Temperature	Humidity
Operation (Standard)	40°C	90% RH
Storage (Standard)	40°C	93% RH

Result: No any abnormality is detected.

■ Temperature Cycle Test

	Temperature
Operation (Standard)	0°C
	70°C
Storage (Standard)	-40°C
	85°C

Result: No any abnormality is detected.

3.1.2. Shock

■ Shock Specification

	Acceleration Force
Non-Operational	1500G

Result: No any abnormality is detected.

3.1.3. Vibration

■ Vibration Specification

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

Result: No any abnormality is detected.

3.1.4. Drop

■ Drop Specification

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

Result: No any abnormality is detected.

3.1.5. Bending

■ Bending Specification

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

Result: No any abnormality is detected.

3.1.6. Torque

■ Contact ESD Specification

	Force	Action
Non-operational	0.5N-m or ±2.5 deg	Hold 1min/5times

Result: No any abnormality is detected.

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. MTBF

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 units of hours. The higher the MTBF value, the higher the reliability of the device. The predicted result of UDinfo's AIC PCIe SSD is up to 2,000,000 hours.

3.3. Certification & Compliance

- RoHS
- WHQL
- PCI Express Base 3.1
- UNH-IOL NVM Express Logo

4. ELECTRICAL SPECIFICATIONS



4.1. Supply Voltage

Parameter	Rating
Operating Voltage	Max = 12V

4.2. Power Consumption

- Power consumption with Toshiba BiCS3 TLC in mW

Capacity	Flash Structure	CE#	Read (Max)	Write (Max)	Read (Avg.)	Write (Avg.)
120GB (128GB)	64GB x 2	4	3200	2500	3200	2400
240GB (256GB)	64GB x 4	8	3500	3000	3500	2900
480GB (512GB)	128GB x 4	16	3700	3200	3700	3100
960GB (1024GB)	128GB x 8	32	4300	3500	4300	3400

Unit: mW

Notes

- Based on E8FM1xxx-series under ambient temperature.
- Use CrystalDiskMark 5.1.2 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]
- Power Consumption may differ according to flash configuration and platform.

5. INTERFACE



5.1. Pin Assignment and Descriptions

The follow table defines the AIC PCIe 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

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

6. SUPPORTED COMMANDS



6.1. NVMe Command List

Table 6-1 Admin Commands

Op-Code	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 6-2 Admin Commands – NVM Command Set Specific

Op-Code	Command Description
80h	Format NVM
81h	Security Send
82h	Security Receive

Table 6-3 NVM Commands

Op-Code	Command Description
00h	Flush
01h	Write
02h	Read
04h	Write Uncorrectable
08h	Write Zeroes
09h	Dataset Management

6.2. Identify Device Data

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

■ Identify Controller Data Structure

Bytes	Description
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)
239:96	Reserved
255:240	Refer to the NVMe Management Interface Specification for definition
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)

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Bytes	Description
311:296	Unallocated NVM Capacity (UNVMCAP)
315:312	Replay Protected Memory Block Support (RPMBS)
511:316	Reserved
NVM Command Set Attributes	
512	Submission Queue Entry Size (SQES)
513	Completion Queue Entry Size (CQES)
515:514	Reserved
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	Reserved
533:532	Atomic Compare & Write Unit (ACWU)
535:534	Reserved
539:536	SGL Support (SGLS)
703:540	Reserved
IO Command Set Attributes	
2047:704	Reserved
2079:2048	Power State 0 Descriptor
2111:2080	Power State 1 Descriptor
2143:2112	Power State 2 Descriptor
2175:2144	Power State 3 Descriptor
2207:2176	Power State 4 Descriptor
...	N/A
3071:3040	Power State 31 Descriptor
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)
119:32	Reserved
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)
120	DF94BB0h
128	EE7C2B0h
240	1BF244B0h
256	1DCF32B0h
480	37E436B0h
512	3B9E12B0h
1024	773BD2B0



6.3. SMART Attributes

■ SMART Attributes (Log Identifier 02h)

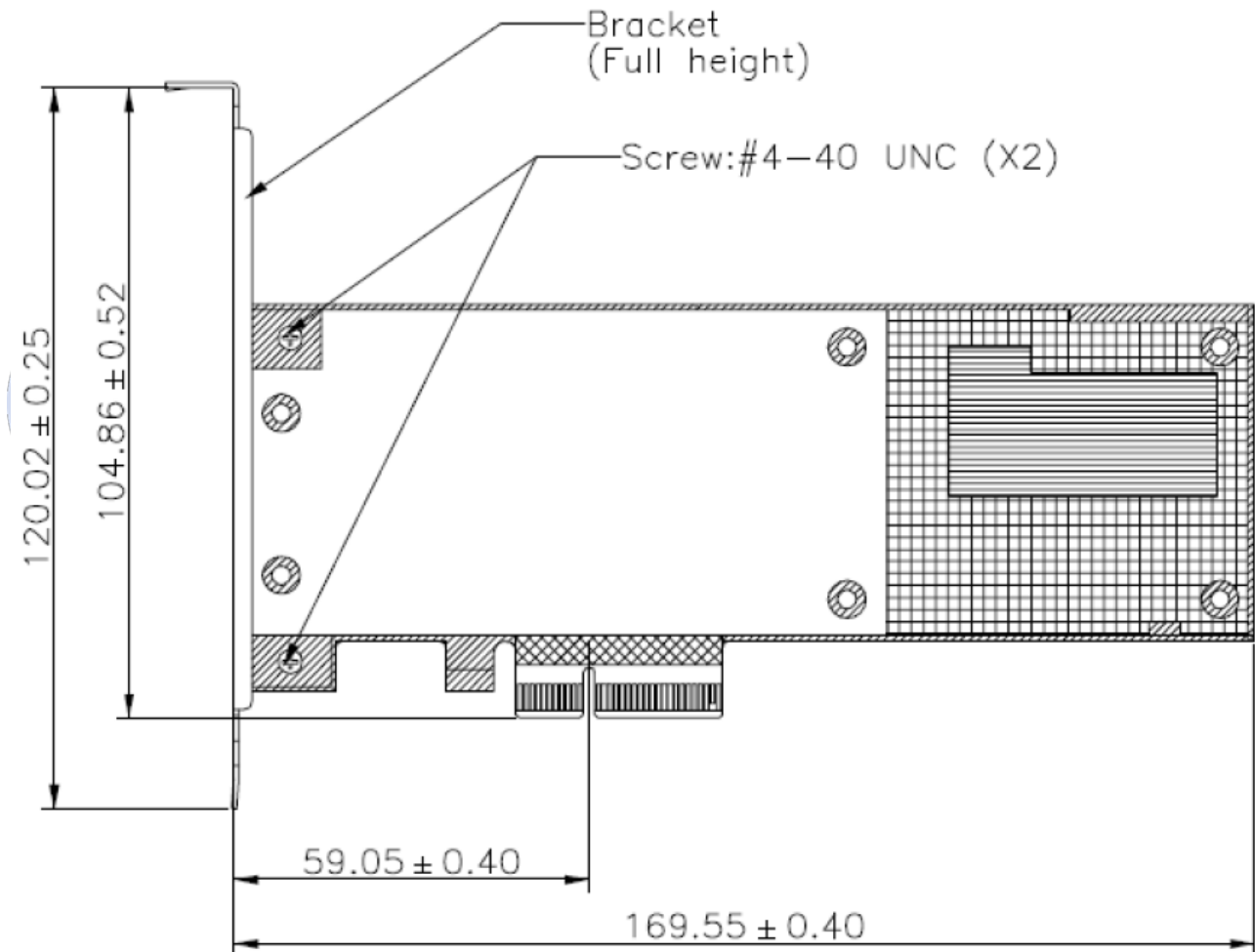
Bytes Index	Bytes	Description
[0]	1	Critical Warning
[2:1]	2	Composite Temperature
[3]	1	Available Spare
[4]	1	Available Spare Threshold
[5]	1	Percentage Used
[31:6]	26	Reserved
[47:32]	16	Data Units Read
[63:48]	16	Data Units Written
[79:64]	16	Host Read Commands
[95:80]	16	Host Write Commands
[111:96]	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
[203:202]	2	Temperature Sensor 2
[205:204]	2	Temperature Sensor 3
[207:206]	2	Temperature Sensor 4

7. PHYSICAL DIMENSION

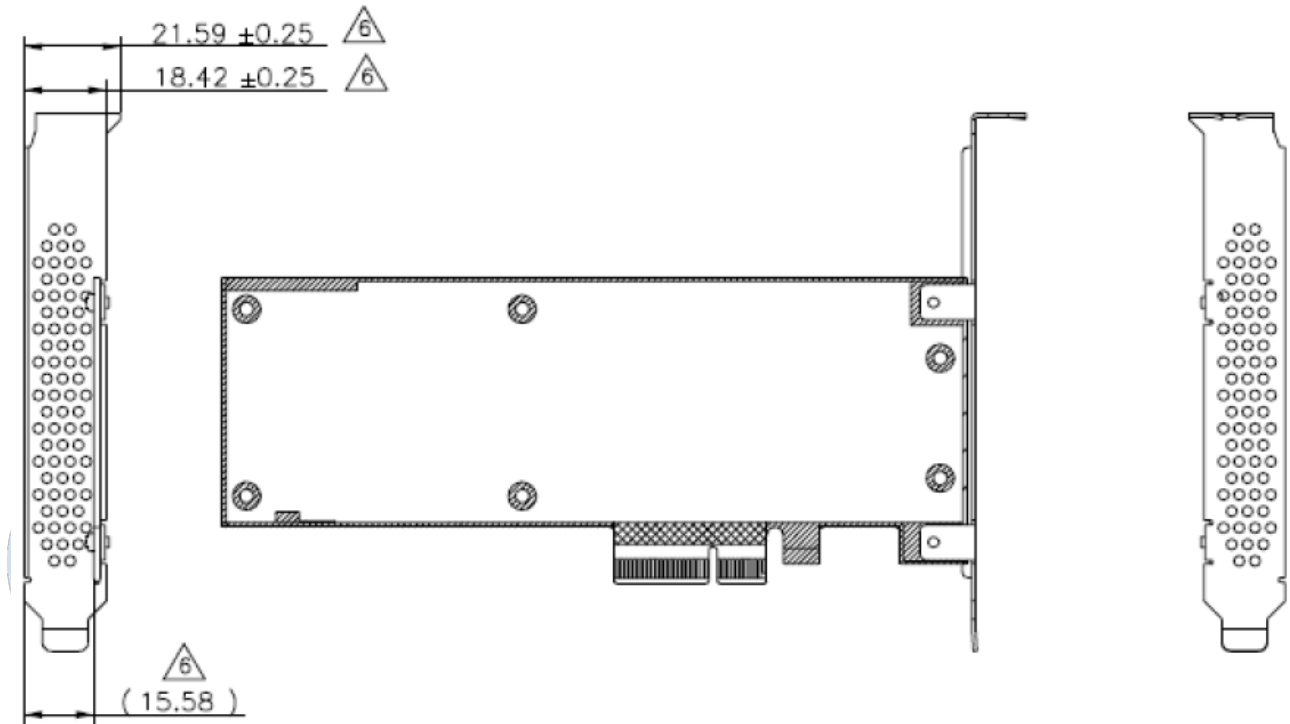


Dimension: 167.65mm (L) x 68.90mm (W) x 17.14mm (H) (HHHL)

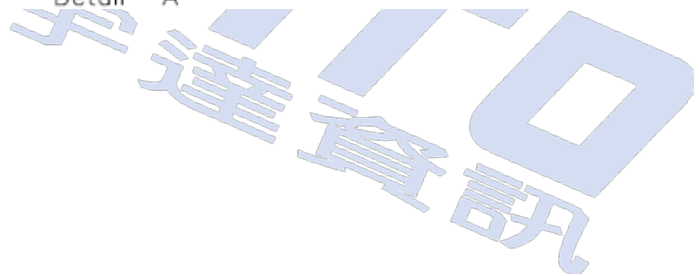
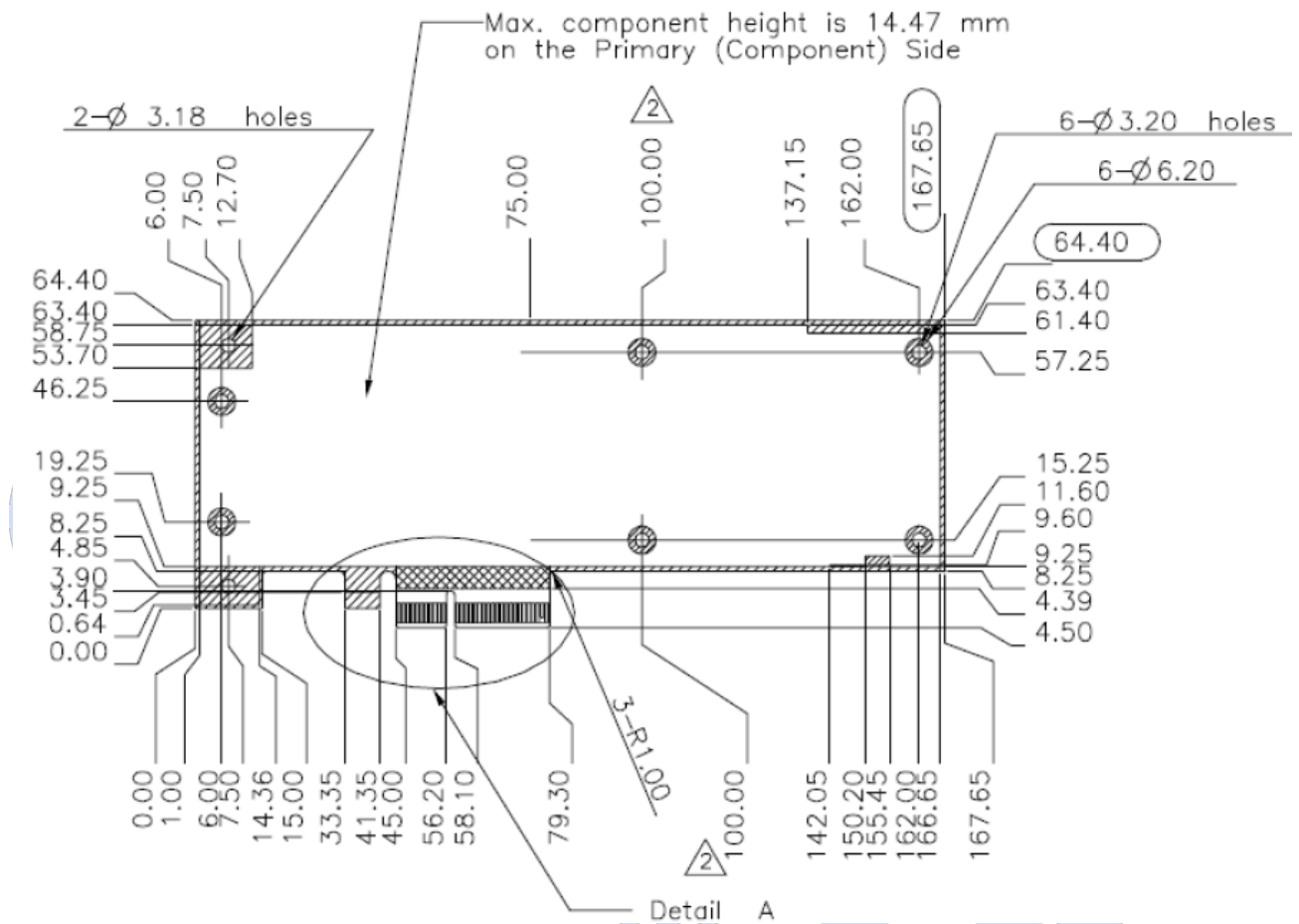
A-side View with Bracket



B-side View with Bracket



Side View without Bracket



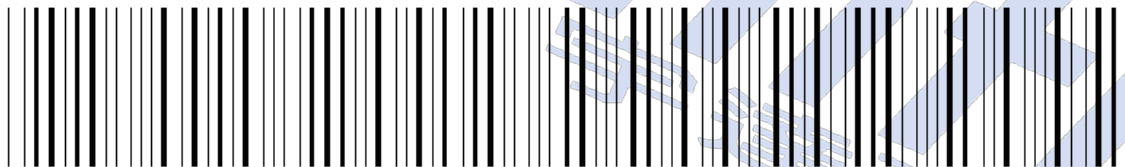
8. TERMINOLOGY



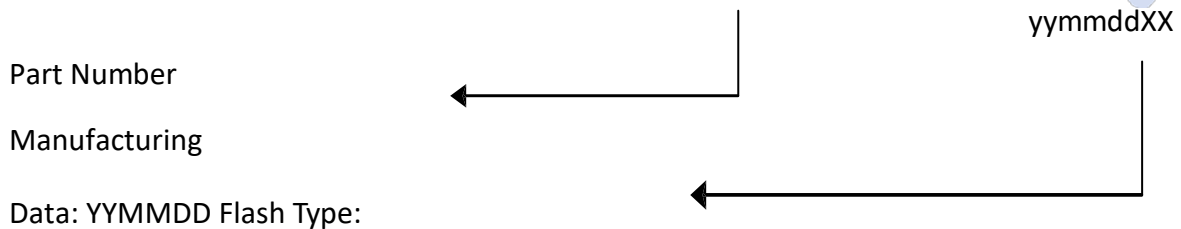
The following table is to list out the acronyms that have been applied throughout the document.

Term	Definitions
ATTO	Commercial performance benchmark application
DDR	Double data rate (SDRAM)
ASPM	Active States Power Management
APST	Autonomous Power State Transition
LBA	Logical block addressing
MTBF	Mean time between failures
PCIe	PCI Express / Peripheral Component Interconnect Express
S.M.A.R.T.	Self-monitoring, analysis and reporting technology

9. BARCODE DESCRIPTION



A I C H L U E 9 6 0 G B A D P



10. PARTNUMBER DECODER



AIC-HLUEX⁸X⁹X¹⁰X¹¹X¹²X¹³X¹⁴X¹⁵X¹⁶X¹⁷

X ¹ X ² X ³	X ⁴ X ⁵	X ⁶ X ⁷	X ⁸ X ⁹ X ¹⁰ X ¹¹ X ¹²	X ¹³	X ¹⁴	X ¹⁵	X ¹⁶ X ¹⁷
AIC	HL	UE	120GB 128GB 240GB 256GB 480GB 512GB 960GB 001TB	A: 3D TLC Standard (0°C ~ +70°C)	D	P	blank

