

UD info Corp.

Industrial CFexpress PCIe SSD CFX-21DE Series Product DataSheet



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3F-4, No.8, Ln. 609, Sec. 5, Chongxin Rd., Sanchong Dist., New Taipei City 241, Taiwan (R.O.C.)

TEL: +886-2-7713-6050 FAX: +886-2-8511-3151

E-mail: sales@UDinfo.com.tw

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Revision History

Revision	Draft Date	History	Author
1.0	2021/1/13	New release	Golden Lee
1.1	2021/10/1	Add pSLC support	Golden Lee
1.2	2021/10/13	Add Power Loss Protection Lite (PLP Lite) function	Golden Lee
1.3	2021/10/22	Modify Thermal Throttling	Golden Lee
1.4	2022/6/21	Added BiCS5 support	Golden Lee
1.5	2022/8/31	Added BiCS5 wide temperature support	Golden Lee
1.6	2023/3/29	Removed safety certification	Golden Lee
1.7	2023/4/11	Added BiCS5 TLC 2TB & pSLC support	Golden Lee

Product Overview

- **Capacity**
 - TLC: 128GB up to 2TB
 - pSLC: 32GB up to 512GB
- **Form Factor**
 - CFX (Type B)
- **PCIe Interface**
 - NVMe PCIe Gen3 x2
- **Compliance**
 - NVMe 1.3d
 - PCI Express Base 3.1
- **Flash Interface**
 - Transfer rate up to 800MT/s
 - Up to 2pcs of BGA152 flash^{Note1}
 - Up to 4pcs of BGA132/152 flash^{Note1}
- **Performance**^{Note2}
 - Read up to 1,750 MB/s
 - Write up to 1,600 MB/s
- **Power Consumption**^{Note3}
 - Idle mode < 1,500 mW
 - Active mode < 3,800 mW
 - L1.2 < 2 mW
- **Reliability**
 - MTBF 2,000,000 hours
 - UBER^{Note5} < 1 sector per 10¹⁶ bits read
- **Hardware Write Protect (WP) Function Support (optional)**
- **Hardware Power Loss Protection Lite (PLP Lite) support (optional)**
- **Advanced Flash Management**
 - Advanced Wear Leveling
 - Bad Block Management
 - TRIM
 - SMART
 - Over-Provision
- **RoHS Compliant**
- **EMI Compliant**
 - EN55032, CISPR 32 (CE)
 - AS/NZS CISPR 32 (CE)
 - ANSI C63.4 (FCC)
 - CNS 13438 (BSMI)
 - VCCI-CISPR 32 (VCCI)
- **ECC**
 - LDPC / RAID ECC
 - Low density parity check code (>120bit/KBytes)
- **Temperature Range**^{Note4}
 - Operation Temperature:
 - Standard: 0°C ~ 70°C (BiCS4/BiCS5)
 - Wide: -40°C ~ 85°C (BiCS3/BiCS5)
 - Storage Temperature: -40°C ~ 85°C
- **Features Support List**
 - End to end data path protection
 - Thermal throttling
 - Dynamic SLC Cache
 - Secure Erase
 - TCG Pyrite/OPAL^{Note6}

Notes:

1. Difference PCBA:
 - (a) BGA152 *2pcs PCBA for WP function or PLP lite

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- (b) BGA132/152 *4pcs PCBA for non-WP function
- 2. Refer to Chapter 2 for more details.
- 3. Refer to Chapter 4, section 4.2 power consumption for more details.
- 4. The operation temperature means the case temperature, in which can be detected via the S.M.A.R.T.
- 5. Uncorrectable Bit Error Rate (UBER)
- 6. Supported by a separate firmware version. Further information available upon request.

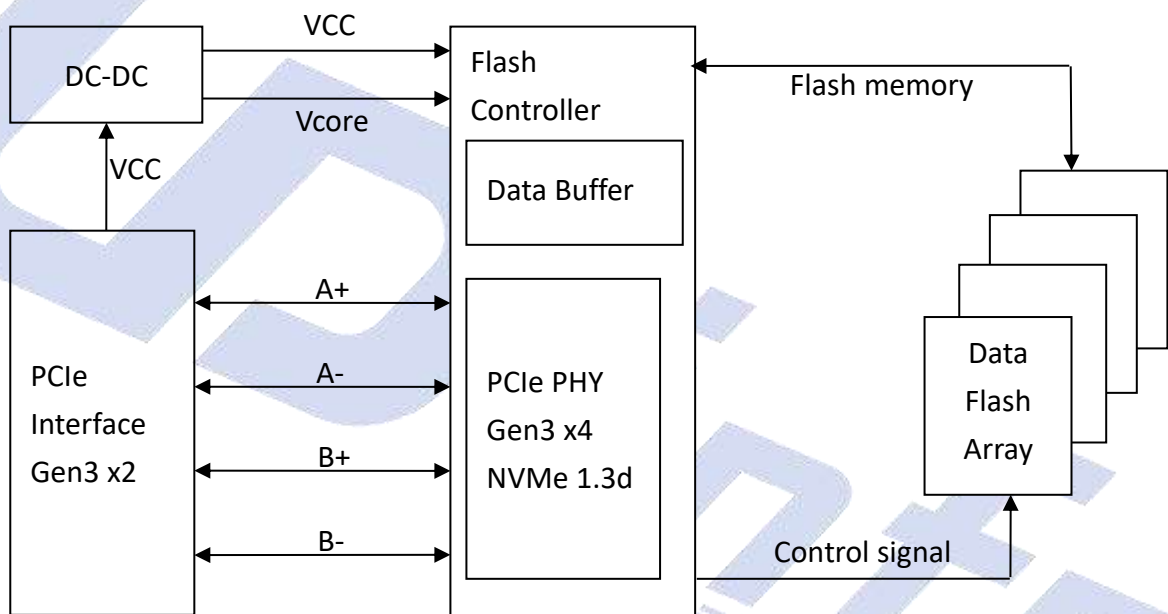


1. INTRODUCTION

1.1. General Description

UDinfo's CF Express PCIe solid state Drive delivers all the advantages of flash disk technology with PCIe Gen3 x2 interface. The CF Express could provide the capacity range from 32GB to 1TB. Moreover, it can reach up to 1,750 MB/s read as well as 1,600 MB/s write high performance. Its lower power consumption makes it an ideal storage choice for high performance embedded platforms.

1.2. Block Diagram



CF Express PCIe SSD Block Diagram

2. PRODUCT SPECIFICATIONS

2.1. Product Specifications

- **Capacity**
 - TLC: 128GB up to 2TB
 - pSLC: 32GB up to 512GB
- **Electrical/Physical Interface**
 - PCI Express Base Ver 3.1 & Compliant with NVMe 1.3d
 - PCIe Gen3 x 4 lane & backward compatible to PCIe Gen2 and Gen1
- **Support Hardware Write Protect function (optional)**
- **Support Hardware Power Loss Protection Lite(PLP Lite) (optional)**
 - PLP Lite is a preventive measure that protect the SSD in an unstable power supply environment.
 - Used large Capacitors to ensure a stable voltage level and ensure data integrity.

2.2. Device Capacity

Capacity	IDEMA Standard		User Data Size
	512Bytes/Sector	4KBytes/Sector	
	Total Sectors (LBA)	Total Sectors (LBA)	
32GB	62,533,296	7,816,662	Depended on file management
64GB	125,045,424	15,630,678	
120GB	234,441,648	29,305,206	
128GB	250,069,680	31,258,710	
240GB	468,862,128	58,607,766	
256GB	500,118,192	62,514,774	
480GB	937,703,088	117,212,886	
512GB	1,000,215,216	125,026,902	
960GB	1,875,385,008	234,423,126	
1TB	2,000,409,264	250,051,158	
1920GB	3,750,748,848	468,843,606	
2TB	4,000,797,360	500,099,670	

Notes:

1. 1 Gigabyte (GB) is equal to 1,000,000,000 Bytes; 1 sector is equal to 512 Bytes.
 2. The calculation is following IDEMA Standard.
 3. The total actual user data size of the SSD may be less than device capacity due to SSD format, SSD partition, operating system.
- EX: OS shows 238.47GB (NTFS) with 256GB SSD.

2.3. Performance

Capacity	Flash Structure	CrystalDiskMark		IOMeter	
		Read (MB/s)	Write (MB/s)	Read (IOPS)	Write (IOPS)
120/128GB	64GB x 2, BGA, Kioxia BiCS3	1,500	450	70K	110K
240/256GB	128GB x 2, BGA, Kioxia BiCS3	1,700	1,000	140K	230K
480/512GB	128GB x 4, BGA, Kioxia BiCS3	1,700	1,400	200K	300K
120/128GB	64GB x 2, BGA, Kioxia BiCS4	1,550	550	70K	120K
240/256GB	128GB x 2, BGA, Kioxia BiCS4	1,700	1,100	130K	230K
480/512GB	128GB x 4, BGA, Kioxia BiCS4	1,700	1,400	210K	295K
960GB/1TB	256GB x 4, BGA, Kioxia BiCS4	1,700	1,400	210K	295K
120/128GB	128GB x 1, BGA, Kioxia BiCS5	1,100	550	50K	110K
240/256GB	128GB x 2, BGA, Kioxia BiCS5	1,700	1,100	100K	240K
480/512GB	256GB x 2, BGA, Kioxia BiCS5	1,700	1,500	180K	350K
960GB/1TB	512GB x 2, BGA, Kioxia BiCS5	1,700	1,500	210K	330K
	256GB x 4, BGA, Kioxia BiCS5	1,700	1,550	210K	330K
1920GB/2TB	512GB x4, BGA, Kioxia BiCS5	1,700	1,550	210K	330K
32GB	64GB x 2, BGA, Kioxia BiCS4 pSLC	1,750	600	160K	140K
64GB	128GB x 2, BGA, Kioxia BiCS4 pSLC	1,750	1200	240K	280K
128GB	128GB x 4, BGA, Kioxia BiCS4 pSLC	1,750	1600	280K	370K
256GB	256GB x 4, BGA, Kioxia BiCS4 pSLC	1,750	1600	280K	370K
128GB	256GB x 2, BGA, Kioxia BiCS5 pSLC	1,700	1400	210K	320K
256GB	256GB x 4, BGA, Kioxia BiCS5 pSLC	1,700	1500	210K	320K
512GB	256GB x 4, BGA, Kioxia BiCS5 pSLC	1,700	1500	210K	320K

Notes:

1. Performance may differ according to flash configuration and platform.
2. Performance specification is under Thermal Throttling inactivated.
3. Performance is measured with the follow conditions
 - (a) CrystalDiskMark 6.0, 1GB range, QD=32T1
 - (b) IOMeter, 1GB range, 4K data size, QD=32T8
 - (c) OS: Win10 64bit was, version 1709
4. Measurement environment: Room temperature: 20~25°C, humidity: 40~60%RH, DC+3.3V condition.

2.4. Thermal Throttling

The purpose of thermal throttling is to prevent any components in a SSD from over-heating during read and write operations. The controller is designed with an on-die thermal sensor and with its accuracy, firmware can apply different levels of throttling to achieve the purpose of protection efficiently and proactively via S.M.A.R.T. reading.

- **Purpose of Thermal Throttling:**
 - In order to keep the optimal performance in the safe range of the temperature.
- **Thermal sensors:**
 - We have external thermal sensor & on-die thermal sensor (internal controller) to detect temperature. There is 1pcs external thermal sensor on PCB, the position depends on different form factor.
 - External thermal sensor would detect flash temperature; On-die thermal sensor detect controller temperature.

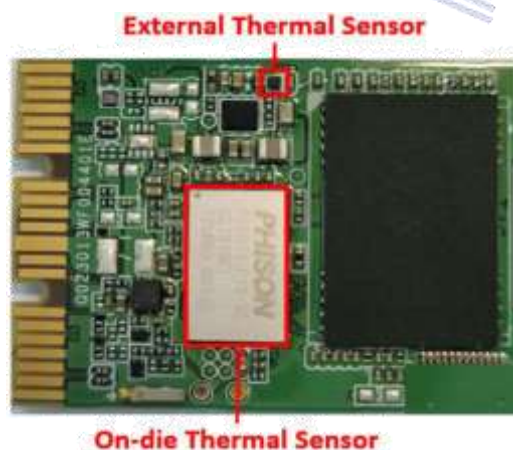


Figure 2-1 Thermal Sensor

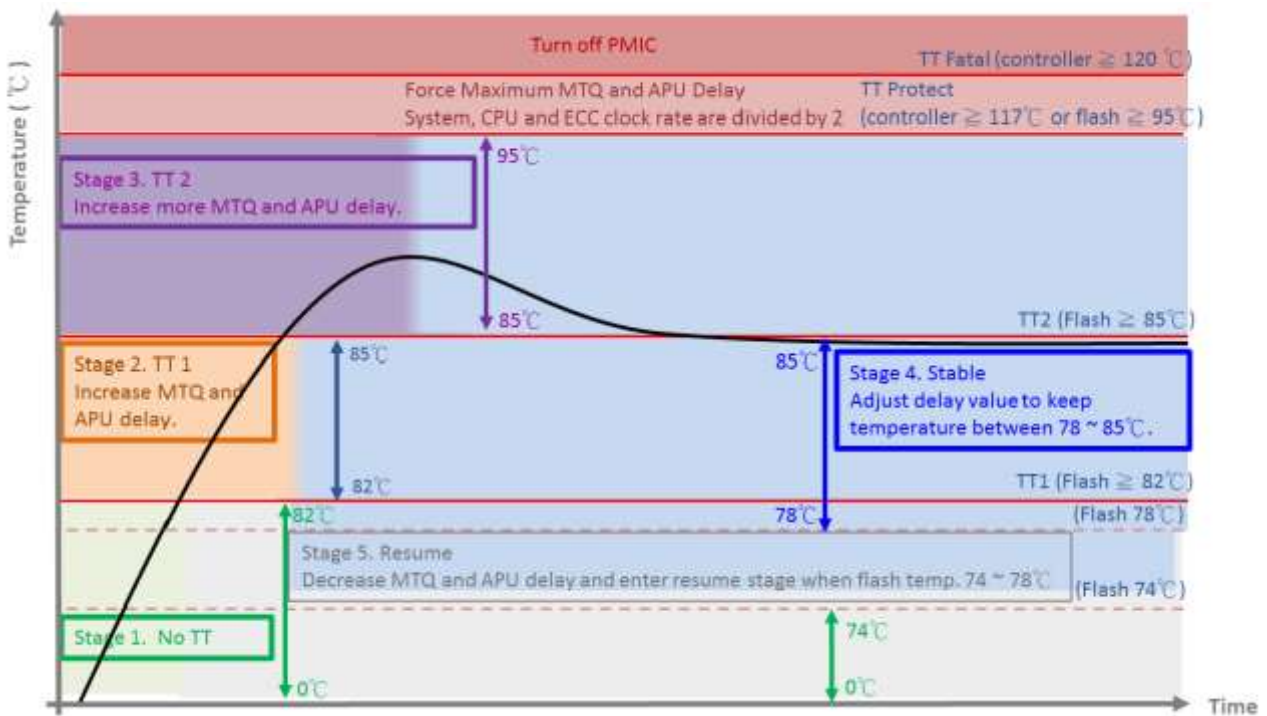


Figure 2-2 Thermal Throttling Schematic

Notes:

1. TT shown on Figure 2-2 means "Thermal Throttling".
2. temp. = temperature
3. MTQ (Multiple Trigger Queue): Trigger multiple jobs to flash at once.
4. APU (Application Unit): APU will handle commands from HOST.

2.5. TCG Opal 2.0

The Opal specification is a set of specifications for self-encrypting drives published by the Trusted Computing Group (TCG), a non-profit organization that develops, defines, and promotes standards and specifications for secure computing. The Opal Security Subsystem Class(SSC) 2.0 defines the details of data management in storage devices and the classes authority for data access, and secures data from theft and tampering by unauthorized persons who are able to gain access to the storage device or host system.

TCG Opal 2.0 Main Features:

- AES 256-bit Hardware Self Encryption
- Deploy Storage Device & Take Ownership:
The Storage Device is integrated into its target system and ownership transferred by setting or changing the Storage Device's owner credential.
- Activate or Enroll Storage Device:
LBA ranges are configured and data encryption and access control credentials (re)generated and/or set on the Storage Device. Access control is configured for LBA range unlocking.
- Lock & Unlock Storage Device:
Unlocking of one or more LBA ranges by the host and locking of those ranges under host control via either an explicit lock or implicit lock triggered by a reset event. MBR shadowing provides a mechanism to boot into a secure pre-boot authentication environment to handle device unlocking.
- Repurpose & End-of-Life:
Erasure of data within one or more.
- Physical Presence SID (PSID):
PSID is defined by TCG OPAL as a 32-character string and the purpose is to revert SSD back to its manufacturing setting when the drive is still OPAL-activated. PSID code can be printed on a SSD label when an OPAL-activated SSD supports PSID revert feature.

3. ENVIRONMENTAL SPECIFICATIONS



3.1. Environmental Conditions

3.1.1. Temperature Specification

	Mode	Min.	Max.	Unit
Temperature Ranges	Operation (Standard)	0	70	°C
	Operation (Wide)	-40	85	°C
	Storage	-40	85	°C
Humidity	Operation	5	90	%
	Storage	5	93	%
Temperature Cycle Test	Operation (Standard)	0	70	°C
	Operation (Wide)	-40	85	°C
	Storage	-40	85	°C

Notes:

- The operation temperature means the case temperature, in which can be detected via the S.M.A.R.T. Airflow is suggested and it will allow device to be operated at appropriate temperature for each component during heavy workloads environment.

3.1.2. Mechanical Specification

Items			Condition
Shock	Non-operational	Acceleration Force	1500G 0-p with half sine wave (0.5ms)
Vibration	Non-operational	Frequency/Displacement	20Hz~80Hz/1.52mm
		Frequency/Acceleration	80Hz~2000Hz/20G p-p with sine wave
Drop	Non-operational	Height of Drop	80cm free fall
		Number of Drop	6 face of each unit
		Conflicting Material	Concrete floor

3.1.3. 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.

3.1.4. EMI Compliance

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

3.2. TBW (Terabytes Written)

Capacity	Flash Type	TBW
120/128GB	64GB x 2, BGA, Kioxia BiCS3	110
240/256GB	128GB x 2, BGA, Kioxia BiCS3	240
480/512GB	128GB x 4, BGA, Kioxia BiCS3	520
120/128GB	64GB x 2, BGA, Kioxia BiCS4	110
240/256GB	128GB x 2, BGA, Kioxia BiCS4	240
480/512GB	128GB x 4, BGA, Kioxia BiCS4	520
960GB/1TB	256GB x 4, BGA, Kioxia BiCS4	1120
120/128GB	128GB x 1, BGA, Kioxia BiCS5	110
240/256GB	128GB x 2, BGA, Kioxia BiCS5	240
480/512GB	256GB x 2, BGA, Kioxia BiCS5	520
960GB/1TB	512GB x 2, BGA, Kioxia BiCS5	1120
1920GB/2TB	512GB x 4, BGA, Kioxia BiCS5	2400
32GB	64GB x 2, BGA, Kioxia BiCS4 pSLC	500
64GB	128GB x 2, BGA, Kioxia BiCS4 pSLC	1000
128GB	128GB x 4, BGA, Kioxia BiCS4 pSLC	2000
256GB	256GB x 4, BGA, Kioxia BiCS4 pSLC	4000
128GB	256GB x 2, BGA, Kioxia BiCS5 pSLC	2000
256GB	256GB x 4, BGA, Kioxia BiCS5 pSLC	4000
512GB	256GB x 4, BGA, Kioxia BiCS5 pSLC	8000

Notes:

1. TBW is measured by JEDEC Client 219A workload.

(a) TLC: Calculated with PE count = 3000.

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(b) pSLC: Calculated with PE count = 30000.

2. TBW may differ according to flash configuration and platform.
3. The SSD supports trim function. If Operation System does not support trim command, performance and TBW will be affected. (Like certain Windows OS, Linux kernel version before 2.6.33, other OS please reference each own user manual)
4. The endurance of SSD could be estimated based on user behavior, NAND endurance cycles, and write amplification factor.

3.3. UBER (Uncorrectable Bit Error Rates)

Capacity	UBER
TLC: 128GB ~ 2TB pSLC: 32GB ~ 512GB	< 1 sector per 10 ¹⁶ bits read

Notes:

1. UBER (Uncorrectable Bit Error Rates) means the uncorrectable error per bits read.
2. UBER = FER (fail rate) / Data Size (user data bit).
3. FER = uncorrectable ECC frame number / total ECC frame number.
4. The LDPC for TLC ECC capability > 120bit/KB.

3.4. MTBF

MTBF, Mean Time between Failures, is a measure of reliability of a device. Its value represents the average time between a repair and the next failure. The unit of MTBF is in hours. The higher the MTBF value, the higher the reliability of the device.

Our MTBF result is based on simulation software (Relx 7.3). Please note that a lower MTBF should be expected for higher capacity drives, and we apply the lowest MTBF for all capacities.

Capacity	MTBF
TLC: 128GB ~ 2TB pSLC: 32GB ~ 512GB	2 million hours

4. ELECTRICAL SPECIFICATIONS



4.1. Supply Voltage

Parameter	Rating
Operating Voltage	3.3V ± 5%
Rise Time (Max/Min)	100ms / 0.1ms
Fall Time (Max/Min)	5s / 1ms
Min. off Time ^{Note1}	1s

Notes:

1. Minimum time between power removed from SSD ($V_{cc} < 100$ mV) and power re-applied to the drive.
2. Ensure the voltage of each power domain in SSD has enough time to discharge less than 0.1V.
3. Rise Time during from 10% to 90% of 3.3V.
4. Fall Time during from 90% to 10% of 3.3V.

4.2. Power Consumption

Capacity	Flash Structure	Read (Max.)	Write (Max.)
120/128GB	64GB x 2, BGA, Kioxia BiCS3	2,600	1,800
240/256GB	128GB x 2, BGA, Kioxia BiCS3	2,900	2,400
480/512GB	128GB x 4, BGA, Kioxia BiCS3	3,100	2,600
120/128GB	64GB x 2, BGA, Kioxia BiCS4	2,400	1,700
240/256GB	128GB x 2, BGA, Kioxia BiCS4	2,500	2,400
480/512GB	128GB x 4, BGA, Kioxia BiCS4	2,600	3,100
960GB/1TB	256GB x 4, BGA, Kioxia BiCS4	2,700	3,100
120/128GB	128GB x 1, BGA, Kioxia BiCS5	2,000	1,500
240/256GB	128GB x 2, BGA, Kioxia BiCS5	2,350	2,300
480/512GB	256GB x 2, BGA, Kioxia BiCS5	2,500	2,300
960GB/1TB	512GB x 2, BGA, Kioxia BiCS5	2,500	2,700
	256GB x 4, BGA, Kioxia BiCS5	2,600	2,500
1920GB/2TB	512GB x 4, BGA, Kioxia BiCS5	3,200	3,200
32GB	64GB x 2, BGA, Kioxia BiCS4 pSLC	3,300	1,900
64GB	128GB x 2, BGA, Kioxia BiCS4 pSLC	3,600	2,700
128GB	128GB x 4, BGA, Kioxia BiCS4 pSLC	3,600	3,300
256GB	256GB x 4, BGA, Kioxia BiCS4 pSLC	3,800	3,700

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128GB	256GB x 2, BGA, Kioxia BiCS5 pSLC	2,700	2,800
256GB	256GB x 4, BGA, Kioxia BiCS5 pSLC	2,800	3,000
512GB	256GB x 4, BGA, Kioxia BiCS5 pSLC	3,200	3,200

Unit: mW

Notes:

1. Use CrystalDiskMark 6.0 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].
2. Power Consumption may differ according to flash configuration and platform.
3. The measured power voltage is 3.3V.
4. Measurement environment: Room temperature: 20~25°C, humidity: 40~60%RH.



5. INTERFACE



5.1. Pin Assignment and Descriptions

The follow table lists the pin assignment of the media.

The I/O column indicates the signal direction viewed from the media: “I” indicates the signal input to the media and “O” indicates the signal output from the media. In the Connection column, “R” indicates the signal is required, “Opt” indicates the signal is optional, and “NC” indicates the signal shall not be connected.

Pin #	Signal	I/O	Media	Host	Notes
21	GND		R	R	
20	PETp0	I	R	R	
19	PETn0	I	R	R	
18	GND		R	R	
17	PERp0	O	R	R	
16	PERn0	O	R	R	
15	GND		R	R	
14	REFCLK+	I	R	R	
13	REFCLK-	I	R	R	
12	INS#	O	R	R	1
11	CLKREQ#	O	R	Opt	2
10	+3.3V		R	R	
9	PERST#	I	R	R	
8	Reserved		NC	NC	
7	Reserved		NC	NC	4
6	PETp1	I	Opt	Opt	
5	PETn1	I	Opt	Opt	
4	GND		R	Opt	3
3	PERp1	O	Opt	Opt	
2	PERn1	O	Opt	Opt	
1	GND		R	R	

Notes

1. A host pull-up resistor in the range of 100K Ω -200K Ω is required on this pin.
2. A host pull-up resistor ($\geq 5k\Omega$) is required on this pin.
3. Note that this pin is assigned to USBEN in XQD specification.
4. If the PCI Express Transmitter differential pair Lane 1 and Receiver differential pair Lane 1 are implemented, this pin shall be connected to ground.

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■ Signal / Pin Descriptions

Category	Signal Name	Description
PCI Express	PETp0	PCI Express 8GT/s two Lane. 2 transmitter differential pairs and 2 receiver differential pairs.
	PETn0	
	PERp0	
	PERn0	
	PETp1	
	PETn1	
	PERp1	
	PERn1	
Auxiliary	REFCLK+	PCI Express differential (and spread-spectrum) reference clock.
	REFCLK-	
	PERST#	PCI Express functional reset.
	INS#	This signal is used for media detection and power control.
	CLKREQ#	This signal is used to indicate when REFCLK is needed for the PCI Express interface.
Power Source	+3.3V	3.3V power
Ground	GND	Ground

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
14h	Device Self-test
15h	Namespace Attachment
18h	Keep Alive

Table 6-2 Admin Commands – NVM Command Set Specific

Op-Code	Command Description
80h	Format NVM
81h	Security Send
82h	Security Receive
84h	Sanitize

Table 6-3 NVM Commands

Op-Code	Command Description
00h	Flush
01h	Write
02h	Read
04h	Write Uncorrectable
05h	Compare
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	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	SN	Serial Number (SN)
63:24	M	Model Number	Model Number (MN)
71:64	M	FW Name	Firmware Revision (FR)
72	M	0x01	Recommended Arbitration Burst (RAB)
75:73	M	Assigned by IEEE/RAC	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	0x0000	Controller ID (CNTLID)
83:80	M	0x00010300	Version (VER)
87:84	M	0x124F80	RTD3 Resume Latency (RTD3R)
91:88	M	0x2191C0	RTD3 Entry Latency (RTD3E)
95:92	M	0x00000100	Optional Asynchronous Events Supported (OAES)
99:96	M	0x00000000	Controller Attributes (CTRATT)
239:100	-	0x00	Reserved
255:240	-	0x00	Refer to the NVMe Management Interface Specification for definition
257:256	M	0x001F	Optional Admin Command Support (OACS)
258	M	0x00	Abort Command Limit (ACL)
259	M	0x03	Asynchronous Event Request Limit (AERL)
260	M	0x12	Firmware Updates (FRMW)
261	M	0x0E	Log Page Attributes (LPA)
262	M	0x0F	Error Log Page Entries (ELPE)
263	M	0x04	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	0x0155	Warning Composite Temperature Threshold (WCTEMP)
269:268	M	0x0157	Critical Composite Temperature Threshold (CCTEMP)
271:270	O	0x2710	Maximum Time for Firmware Activation (MTFA)
275:272	O	0x00	Host Memory Buffer Preferred Size (HMPRE)
279:276	O	0x00	Host Memory Buffer Minimum Size (HMMIN)

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Bytes	O/M	Default Value	Description
295:280	O	Non-zero	Total NVM Capacity (TNVMCAP)
311:296	O	0x00	Unallocated NVM Capacity (UNVMCAP)
315:312	O	0x00	Replay Protected Memory Block Support (RPMBS)
317:316	O	0x001E	Extended Device Self-test Time (EDSTT)
318	O	0x01	Device Self-test Options (DSTO)
319	M	0x04	Firmware Update Granularity (FWUG)
321:320	M	0x0001	Keep Alive Support (KAS)
323:322	O	1	Host Controlled Thermal Management Attributes (HCTMA)
325:324	O	0x111	Minimum Thermal Management Temperature (MNTMT)
327:326	O	0x157	Maximum Thermal Management Temperature (MXTMT)
331:328	O	0x00000006	Sanitize Capabilities (SANICAP)
511:316	-	0	Reserved
NVM Command Set Attributes			
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	0x005F	Optional NVM Command Support (ONCS)
523:522	M	0x0000	Fused Operation Support (FUSES)
524	M	0x01	Format NVM Attributes (FNA)
525	M	0x01	Volatile Write Cache (VWC)
527:526	M	0x00FF	Atomic Write Unit Normal (AWUN)
529:528	M	0x0000	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
IO Command Set Attributes			
2047:704	M	0x00	Reserved
2079:2048	M	0x0081031600401C52 000000000000025800 00025800000316	Power State 0 Descriptor (PSD0)
2111:2080	O	0x0081031600401C52 010101010000025800	Power State 1 Descriptor (PSD1)

Bytes	O/M	Default Value	Description
		00025800000316	
2143:2112	O	0x0081031600401C52 020202020000025800 00025800000316	Power State 2 Descriptor (PSD2)
2175:2144	O	0x0081031600401C52 03030303000003E800 0003E8030003E8	Power State 3 Descriptor (PSD3)
2207:2176	O	0x0081031600401C52 24040404000186A000 00138803000032	Power State 4 Descriptor (PSD4)
...	-	0	(N/A) ...
3071:3040	O	0x00	Power State 31 Descriptor (PSD31)
Vendor Specific			
4095:3072	O	Vendor Reserved	Vendor Specific (VS)

● Identify Namespace Data Structure & NVM Command Set Specific

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

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

- **List of Identify Namespace Data Structure for Each Capacity**

Capacity (GB)	Byte[7:0]: Namespace Size (NSZE)
32	3BA2EB0h
64	7740AB0h
120	DF94BB0h
128	EE7C2B0h
240	1BF244B0h
256	1DCF32B0h
480	37E436B0h
512	3B9E12B0h
960	6FC81AB0h
1024	773BD2B0h

6.3. SMART Attributes

- SMART Attributes (Log Identifier 02h)

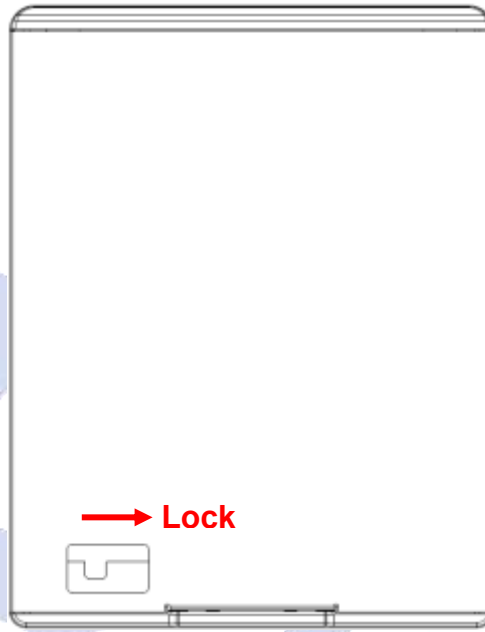
Bytes Index	Bytes	Description
[0]	1	Critical Warning: Error occurred if value of the bits are not zero
[2:1]	2	Composite Temperature: Flash temp value will be detected on-board thermal sensor (Unit: K)
[3]	1	Available Spare: Remaining spare capacity available. (Unit: %)
[4]	1	Available Spare Threshold: Spare capacity threshold. (Unit: %)
[5]	1	Percentage Used: Average of the Flash's block erase count / NAND EOL erase count (Unit: %)
[31:6]	26	Reserved
[47:32]	16	Data Units Read (in LBAs): Contains the number of 512byte data units the host has read from the controller. This value is reported in thousands (i.e, a value of 1 corresponds to 1000 units of 512 bytes read).
[63:48]	16	Data Units Written (in LBAs): Contains the number of 512byte data units the host has written from the controller. This value is reported in thousands (i.e, a value of 1 corresponds to 1000 units of 512 bytes written).
[79:64]	16	Host Read Commands: The number of read commands completed by the controller.
[95:80]	16	Host Write Commands: The number of read commands completed by the controller.
[111:96]	16	Controller Busy Time: The amount of time the controller is busy with I/O commands.
[127:112]	16	Power Cycles: Normal power on/off cycles count
[143:128]	16	Power On Hours (Unit: hour)
[159:144]	16	Unsafe Shutdowns: Abnormal power on/off cycles count
[175:160]	16	Media and Data Integrity Errors: The number of occurrences where the controller detected an unrecovered data integrity error.
[191:176]	16	Number of Error Information Log Entries: The number of Error Information log entries over the life of the controller.
[195:192]	4	Warning Composite Temperature Time: The amount of time that temp. over warning threshold (85°C) but less than critical threshold (95°C). (Unit: min)
[199:196]	4	Critical Composite Temperature Time: The amount of time that temp. over critical threshold (95°C). (Unit: min)
[201:200]	2	Temperature Sensor 1 (Current Temperature) (Unit: K)
[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



6.4. Write Protect Function

The write protect function is triggered by slid switch. This used to set the device as a write protection device after power up. When the function is triggered, the data can't be written to the device. The device is then set as read only.

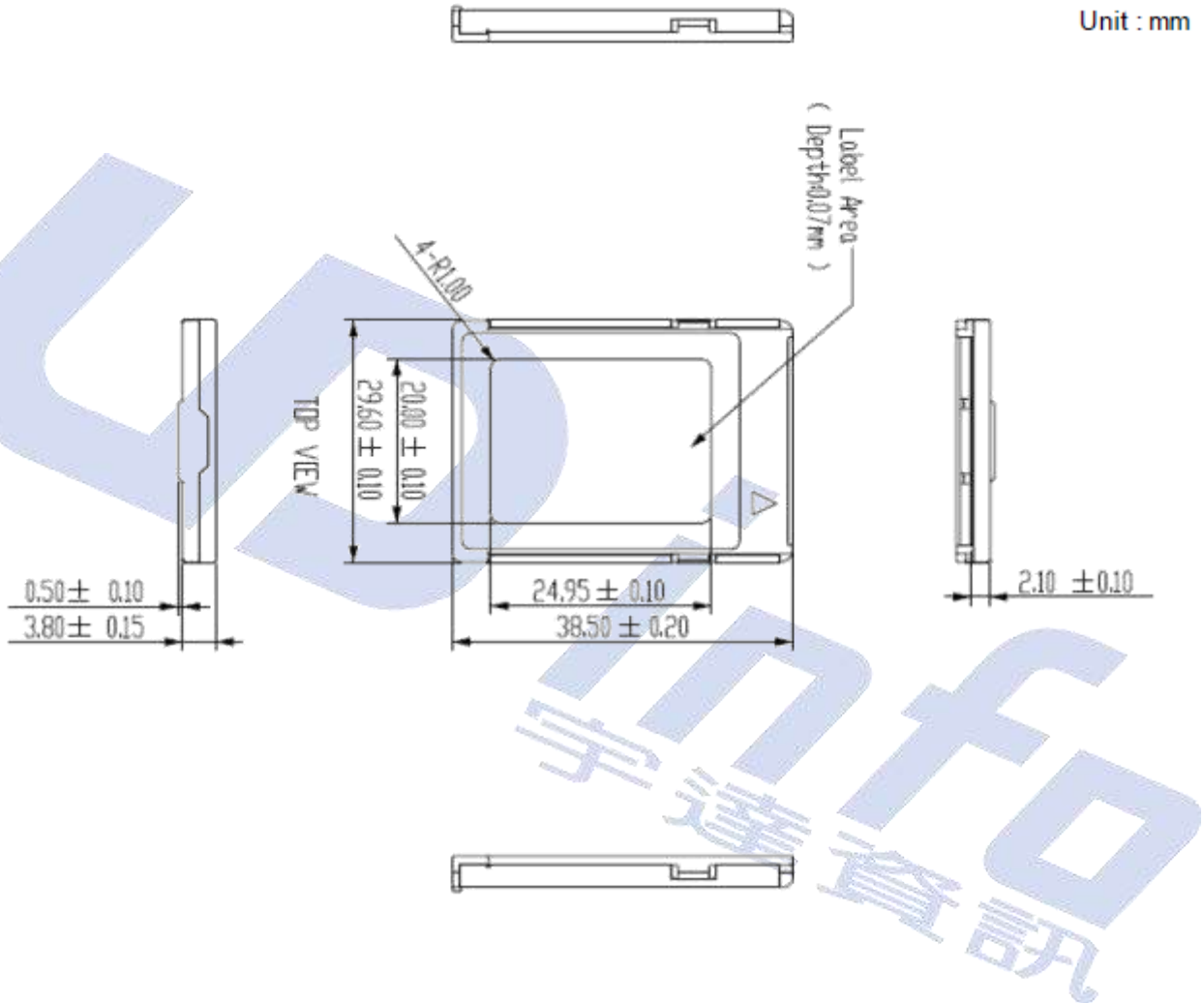


7. PHYSICAL DIMENSION



■ Dimension:

Type B: 38.5mm(L) x 29.6mm(W) x 3.8mm(H)



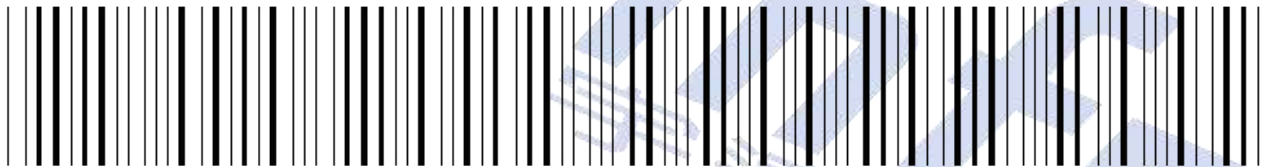
8. TERMINOLOGY



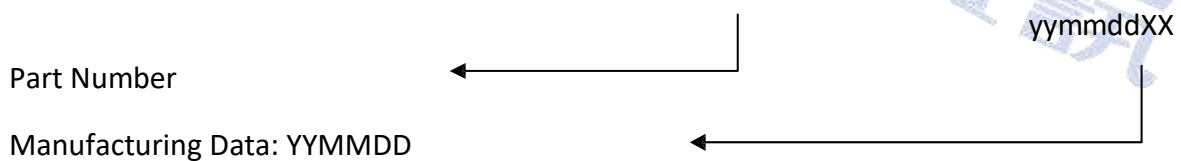
The following table is to list out the acronyms that have been applied throughout the document.

Term	Definitions
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



C F X 2 1 D E 9 6 0 G B A D U



10. PARTNUMBER DECODER



CFX-21DEX⁸X⁹X¹⁰X¹¹X¹²X¹³X¹⁴X¹⁵X¹⁶X¹⁷

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
CFX	21	DE	032GB 120GB 240GB 480GB 960GB 1920G 064GB 128GB 256GB 512GB 001TB 002TB	A: 3D TLC Standard (0°C ~ +70°C) B: 3D TLC Industrial (-40°C ~ +85°C) V: 3D pSLC Standard (0°C ~ +70°C) W: 3D pSLC Industrial (-40°C ~ +85°C)	D	P U	blank
X¹⁵ P: without Write Protect PCB U: with Write Protect or PLP Lite PCB							
X¹⁶X¹⁷ Blank: standard 01: Write Protection (WP) 06: Conformal Coating (CC) 07: CC + WP 33: Power Loss Protection Lite (PLP Lite)							