RoHS Recast & Halogen-Free Compliant

CFast

Product Specifications for Value-added Version VA2

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Version 1.0

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Features:

- **Standard Serial ATA 2.6 (Gen. 2)**
  - SATA II, 3.0 Gbps
  - ATA-compatible command set
  - ATA modes support
- **Connector type**
  - 7 + 17 pin female connector
- **Power consumption (typical)****
  - Supply voltage: 3.3V
  - Active mode: 360 mA
  - Idle mode: 85 mA
- **Performance****
  - Sustained read: Up to 160 MB/sec
  - Sustained write: Up to 140 MB/sec
- **Capacity**
  - 2, 4, 8, 16, 32, 64 GB
- **NAND Flash Type:** SLC
- **MTBF:** >2,000,000 hours
- **Intelligent endurance design**
  - Built-in hardware ECC, enabling up to 16/24 bit correction per 1K bytes
  - Dynamic/Static wear-leveling scheme
  - Flash bad-block management
  - S.M.A.R.T.
  - Power Failure Management
  - ATA Secure Erase
  - TRIM
- **Temperature ranges**
  - Operation:
    Standard: 0℃ to 70℃
    ET*: -40℃ to 85℃
  - Storage: -40℃ to 100℃
- **RoHS Recast Compliant**
  - Complies with 2011/65/EU
- **Apacer Security Features by hardware architect**
  - Enabled by pin assignments
  - **Full Erase:** securely eliminates data in user and free blocks
  - **Write Protect:** virtual write scheme to protect unauthorized write behaviors
- **Apacer Security Features by vendor-specific software commands*****
  - **CoreEraser:** provides comprehensive drive sanitization methods in 3 classes
  - **CoreProtector:** securely protects your data in the drive at 3 levels.

*Extended Temperature
**Vary from capacities. The values presented in Power consumption and Performances are typical, and may vary depending on different settings and platforms.
***Please see “Security Features” for details.

Table of Contents

1. General Description

CFast emerges as the evolution of the CompactFlash card, by adopting SATA transfer bus rather than PATA, which delivers a much higher data transfer rate required in industrial and enterprise storage usages. Although not backward compatible with its former CF form factor, CFast proves to be a more advanced embedded solution for cache, storage acceleration, communication and networking applications that require small physical fit.

Apacer CFast is designed with a powerful controller that easily breaks the performance limit for CompactFlash by delivering the transfer rate up to 160 MB/s while maintaining the reliability and power efficiency inherited from its former. Leveraging from CompactFlash form factor and SATA interface, CFast can be integrated into host computing system without excessive BIOS configurations and driver installations.

In addition to its performance, Apacer CFast is designed with reliability and data integrity. The CFast card adopts static wear-leveling to average the use of all flash blocks to prolong the lifetime and improve block efficiency of flash media. A built-in powerful ECC engine operates at hardware level for error correction and detection. With its well-organized architecture, CFast is an ideal storage device for industrial, enterprise and mobile applications.

2. Functional Block

Apacer CFast includes a single-chip SATA II Controller and the flash media. The controller integrates the flash management unit to support multi-channel, multi-bank flash arrays. Figure 2-1 shows the functional block diagram.

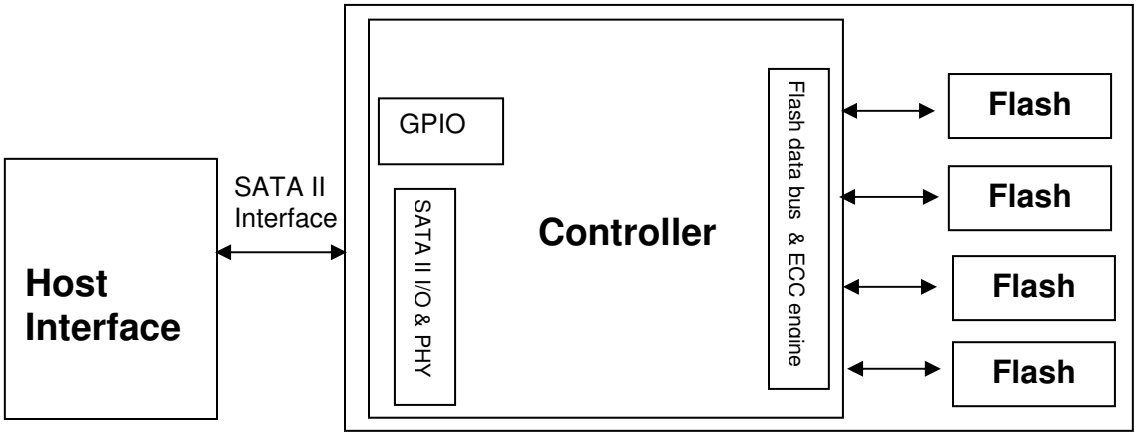


Figure 2-1 Apacer CFast block diagram

3. Pin Assignments

3.1 Pin Assignment

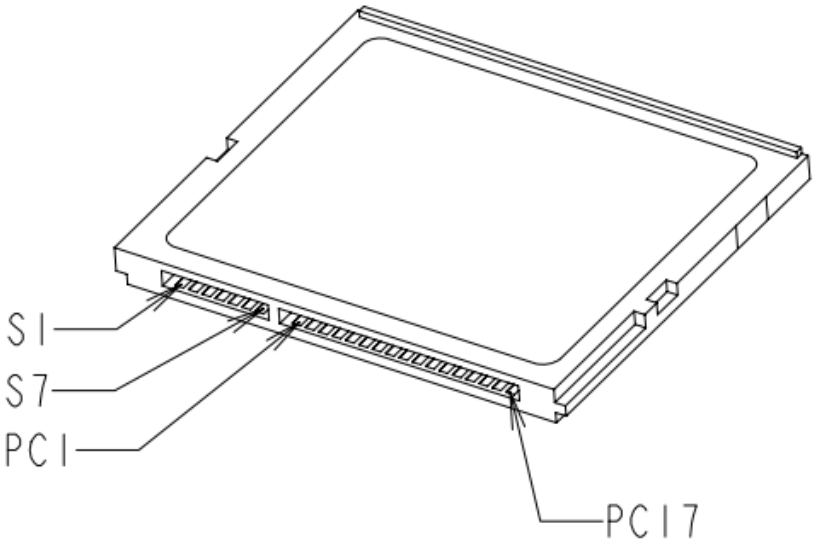
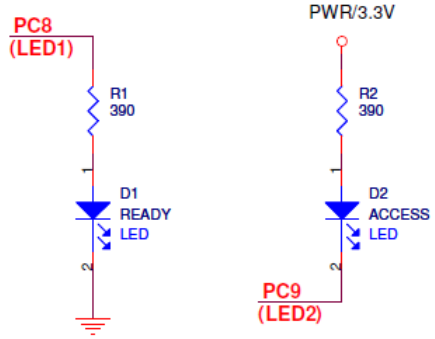


Figure 3-1 Pin Assignment

Table 3-1: Signal segment

PinC	Type	Description
S1	GND	
S2	A+	SATA Differential Signal Pair A
S3	A-	
S4	GND	
S5	B-	SATA Differential Signal Pair B
S6	B+	
S7	GND	



*Refer above for LED output design guide

Table 3-2: Power segment

Pin	Name	Type	Description
PC1	CDI	CMOS Input	Card Detect In
PC2	GND	Device GND	
PC3	TBD	TBD	
PC4	TBD	TBD	
PC5	TBD	TBD	
PC6	TBD	TBD	
PC7	GND	Device GND	
PC8*	LED1	LED Output	Ready
PC9*	LED2	LED Output	Access
PC10	IO1	CMOS I/O	Full Erase**
PC11	IO2	CMOS I/O	Write Protect**
PC12	IO3	CMOS I/O	Reserved I/O
PC13	PWR	3.3V	Device Power (3.3V)
PC14	PWR	3.3V	Device Power (3.3V)
PC15	PGND	Device GND	Device GND
PC16	PGND	Device GND	Device GND
PC17	CDO	CMOS Output	Card Detect Out

**Enabled by adjusting the pin "PC10/11" to low active. For more information regarding Full Erase and Write Protect, please go to section 3.2.

3.2 Security Features by Pin Assignment

Full Erase

The pin 2 of this wafer can trigger “Erase” function, which is defined as “Full Erase” in Apacer security features. Full Erase sanitizes the LBA and eliminates all the physical blocks in User Block and Free Block. Drive will have to be reinitialized upon the completion of the erase action. The device will practically act as a raw disk as cells in the drive would display “FF” (or “00”).

Write Protect

The pin 6 can enable “Write Protect” function. To protect unauthorized data writes, Apacer implements Write Protect that functions as “Virtual Write” that allows write commands to go through the flash controller and data is temporarily stored. But since the process is “virtual”, none of the data has been written to the flash. When the host resets or restarts the system, all the temporarily stored data will disappear.

4. Product Specification

4.1 Capacity

Capacity specification of the CFast is available as shown in Table 4-1. It lists the specific capacity and the default numbers of heads, sectors and cylinders for each product line.

Table 4-1: Capacity specifications

Capacity	Total bytes*	Cylinders	Heads	Sectors	Max LBA
2 GB	2,011,226,112	3897	16	63	3,928,176
4 GB	4,011,614,208	7773	16	63	7,835,184
8 GB	8,012,390,400	15525	16	63	15,649,200
16 GB	16,013,942,784	16383	16	63	31,277,232
32 GB	32,017,047,552	16383	16	63	62,533,296
64 GB	64,023,257,088	16383	16	63	125,045,424

*Display of total bytes varies from file systems.
**Cylinders, heads or sectors are not applicable for these capacities. Only LBA addressing applies
LBA count addressed in the table above indicates total user storage capacity and will remain the same throughout the lifespan of the device. However, the total usable capacity of the CFast is most likely to be less than the total physical capacity because a small portion of the capacity is reserved for device maintenance usages.

4.2 Performance

Performance of CFast product family is available as shown in Table 4-2.

Table 4-2: Performance table

Capacity / Performance	2 GB	4 GB	8 GB	16 GB	32 GB	64 GB
Sustained Read (MB/s)	145	145	150	150	160	160
Sustained Write (MB/s)	55	55	100	100	140	140

Note: Performances results are measured by CrystalDiskMark under Windows 7 and may vary from host system configurations.

4.3 Environmental Specifications

Environmental specification of the CFast follows the MIL-STD-810F testing standards, shown in Table 4-3.

Table 4-3 Environmental specification

Environment		Specification
Temperature	Operation	0℃ to 70℃ (Standard); -40℃ to 85℃ (Extended Temperature)
	Storage	-40℃ to 100℃
Vibration (Non-Operating)		Sine wave : 10~2000Hz, 15G (X, Y, Z axis)
Shock (Non-Operating)		Half sine wave, 1500 G (X, Y, Z ; All 6 axis)

Note: this Environmental Specification table indicates the conditions for testing the device. Real world usages may affect the results.

4.4 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in CFast. Serving as statistical reference, the prediction result for CFast is more than 2,000,000 hours.

Notes about MTBF:

The prediction is based on Bellcore analysis method by assuming device failure rate can be generated by the sum of failure rates in each component.

4.5 Certification and Compliance

CFast complies with the following standards

- CE
- FCC
- RoHS
- MIL-STD
- SATA II (SATA Rev. 2.6)
- Up to ATA/ATAPI-7 (including S.M.A.R.T.)

5. Flash Management

5.1 Error Correction/Detection

CFast implements a hardware ECC which is based on the BCH algorithm. It can detect and correct up to 16 bits or 24 bits error in 1K bytes depending on the NAND flash configuration used.

5.2 Bad Block Management

Current production technology is unable to guarantee total reliability of NAND flash memory array. When a flash memory device leaves factory, it comes with a minimal number of initial bad blocks during production or out-of-factory as there is no currently known technology that produce flash chips free of bad blocks. In addition, bad blocks may develop during program/erase cycles. When host performs program/erase command on a block, bad block may appear in Status Register. Since bad blocks are inevitable, the solution is to keep them in control. Apacer flash devices are programmed with ECC, block mapping technique and S.M.A.R.T to reduce invalidity or error. Once bad blocks are detected, data in those blocks will be transferred to free blocks and error will be corrected by designated algorithms.

5.3 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. On the other hand, NAND flash storage adopts flash as their primary media. 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 earlier. Wear leveling is an important mechanism that level out the wearing of blocks so that the wearing-down of blocks can be almost evenly distributed. This will increase the lifespan of SSDs. Commonly used wear leveling types are Static and Dynamic.

5.4 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.

5.5 ATA Secure Erase

ATA Secure Erase is an ATA disk purging command currently embedded in most of the storage drives. Defined in ATA specifications, (ATA) Secure Erase is part of Security Feature Set that allows storage drives to erase all user data areas. The erase process usually runs on the firmware level as most of the ATA-based storage media currently in the market are built-in with this command. ATA Secure Erase can securely wipe out the user data in the drive and protects it from malicious attack.

5.6 S.M.A.R.T.

S.M.A.R.T. is the abbreviation for Self-Monitoring, Analysis and Reporting Technology, an open standard allowing disk drives to automatically monitor their own health and report potential problems. It provides users critical drive status information and attributes parameters for anticipation purposes. Ideally, this should prevent unexpected drive failure and data loss.

Apacer devices use the standard SMART command B0h to read data out from the drive to activate our S.M.A.R.T. feature that complies with the ATA/ATAPI-7 specifications. Based on the SFF-8035i Rev. 2.0 specifications, S.M.A.R.T. Attribute IDs shall include initial bad block count, bad block count, spare block count, maximum erase count, average erase count 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.

5.7 TRIM

TRIM, though in capital letters usually, is a memory computation command rather than an abbreviation. It is mainly a SATA command that enables the operating system to inform the SSD (Solid State Drive) which blocks of previously stored data are no longer valid, due to erases by the host or operating system, such as file deletions or disk formatting. Once notified, SSD will begin the discard of the invalid LBAs and retain more space for itself, in fact, the discarded is no longer recoverable.

When an LBA is replaced by the operating system, as with overwrite of a file, the SSD is informed that the originally occupied LBA is determined as no longer in use or invalid. The SSD will not save those blocks in garbage collected sectors. Noticeably, a file deletion command by host or operating system never actually erases the actual content, rather, just the file is marked as deleted. This issue is even specifically noticeable for flash based memory devices, such as SSDs. In fact, an SSD will keep garbage collecting the invalid, previously occupied LBAs, if it is not informed that these LBAs can be erased. Thus, the SSD would experience a significant performance downfall.

6. Security Features

6.1 CoreEraser

CoreEraser Technology comes in 3 different classes, indicating different degrees of secure erasure. The Class 1 is defined as Quick Erase. Apacer developed Quick Erase function for urgent cases when there is not enough time for a thorough deletion of the whole drive. Quick Erase eliminates FAT table and the MBR (Master Boot Record) in LBA that manages partition tables and boot sector during system start-up process. With the MBR and FAT table erased, the drive would appear as uninitialized and mapping links between LBA and physical blocks are erased. In order to access the drive, re-initialization and FAT table rebuild are necessary.

CoreEraser Class2 is defined as Full Erase, which functions as a more comprehensive Quick Erase. Full Erase sanitizes the LBA and eliminates all the physical blocks in User Block and Free Block. Drive will have to be reinitialized upon the completion of the erase action. The device will practically act as a raw disk as cells in the drive would display "FF" (or "00").

The Class 3 is named as MIL Erase (Military Erase). Apacer MIL Erase includes a list of globally certified drive purge methods that meet the military and industrial standards, such as NSA 9-12. Most of them sanitize MBR, FAT table as well as user & free blocks by erasing the blocks, overwriting with random data. These certified erase features are widely approved, providing confidence in secure data erasure. The standards included in MIL Erase are DoD 5220.22-M, NSA Manual 130-2, USA-AF AFSSI 5020, USA-Army 380-19, USA Navy NAVSO P-5239-26, NISPOMSUP Chap 8, Sect. 8-501, IREC (IRIG) 106, and NSA 9-12 (Gen.2).

6.2 CoreProtector

CoreProtector comes in with two handy features for internal drive protection: Data Protect, Write Protect and Device Protect.

Data Protect: Apacer SSDs come with a unique 512-byte Security Key when they leave the factory. The key is activated whenever the host boots up. The host BIOS will retrieve the 512-byte key data and the host user can use it as password identifications for accessing certain application programs or booting up process. Failure to match the key will result in aborted operations.
Write Protect: Apacer Write Protect functions as "Virtual Write" that allows write commands to go through the flash controller and data is temporarily stored. But since the process is "virtual", none of the data has been written to the flash. When the host resets or restarts the system, all the temporarily stored data will disappear.
Device Protect: Device Protect is a more comprehensive security solution from Write Protect. Device Protect not only integrates our Write Protect scheme, but also provides protection that prevents unauthorized individuals to read files in the device. When the function is enabled, Device Protect would allow read commands to go through the flash controller, but not able to read actual data in the device. Unauthorized read attempts would retrieve invalid data only.

For more information about security features, please refer to our white papers. Our white papers will be supplied upon request.

7. Software Interface

7.1 ATA Command Set

Table 6-1 summarizes the ATA command set with the paragraphs that follow describing the individual commands and the task file for each.

Table 6-1: Command set

Code	Command	Code	Command
E5h	Check Power Mode	F3h	Security Erase Prepare
06h	Data Set Management	F4h	Security Erase Unit
90h	Execute Device Diagnostic	F5h	Security Freeze Lock
E7h	Flush Cache	F1h	Security Set Password
Eah	Flush Cache EXT	F2h	Security Unlock
Ech	Identify Device	70h	Seek
E3h	Idle	Efh	Set Features
E1h	Idle Immediate	C6h	Set Multiple Mode
91h	Initialize Device Parameters	E6h	Sleep
C8h	Read DMA	B0h	SMART
25h	Read DMA EXT	E2h	Standby
C4h	Read Multiple	E0h	Standby Immediate
29h	Read Multiple EXT	Cah	Write DMA
20h	Read Sector	35h	Write DMA EXT
24h	Read Sector EXT	C5h	Write Multiple
40h	Read Verify Sectors	39h	Write Multiple EXT
42h	Read Verify Sectors EXT	30h	Write Sector
10h	Recalibrate	34h	Write Sector EXT
F6h	Security Disable Password		

8. Electrical Specification

8.1 Operating Voltage

Table 7-1: Operating voltage

Parameter	Symbol	Min	Typ	Max	Units
Power Supply	Vcc	3.135	3.3	3.465	V

8.2 Power Consumption

Table 7-3 Power consumption (typical)

Mode \ Capacity	2 GB	4 GB	8 GB	16 GB	32 GB	64 GB
Active (mA)	255	255	320	345	325	360
Standby (mA)	80	85	85	85	85	85

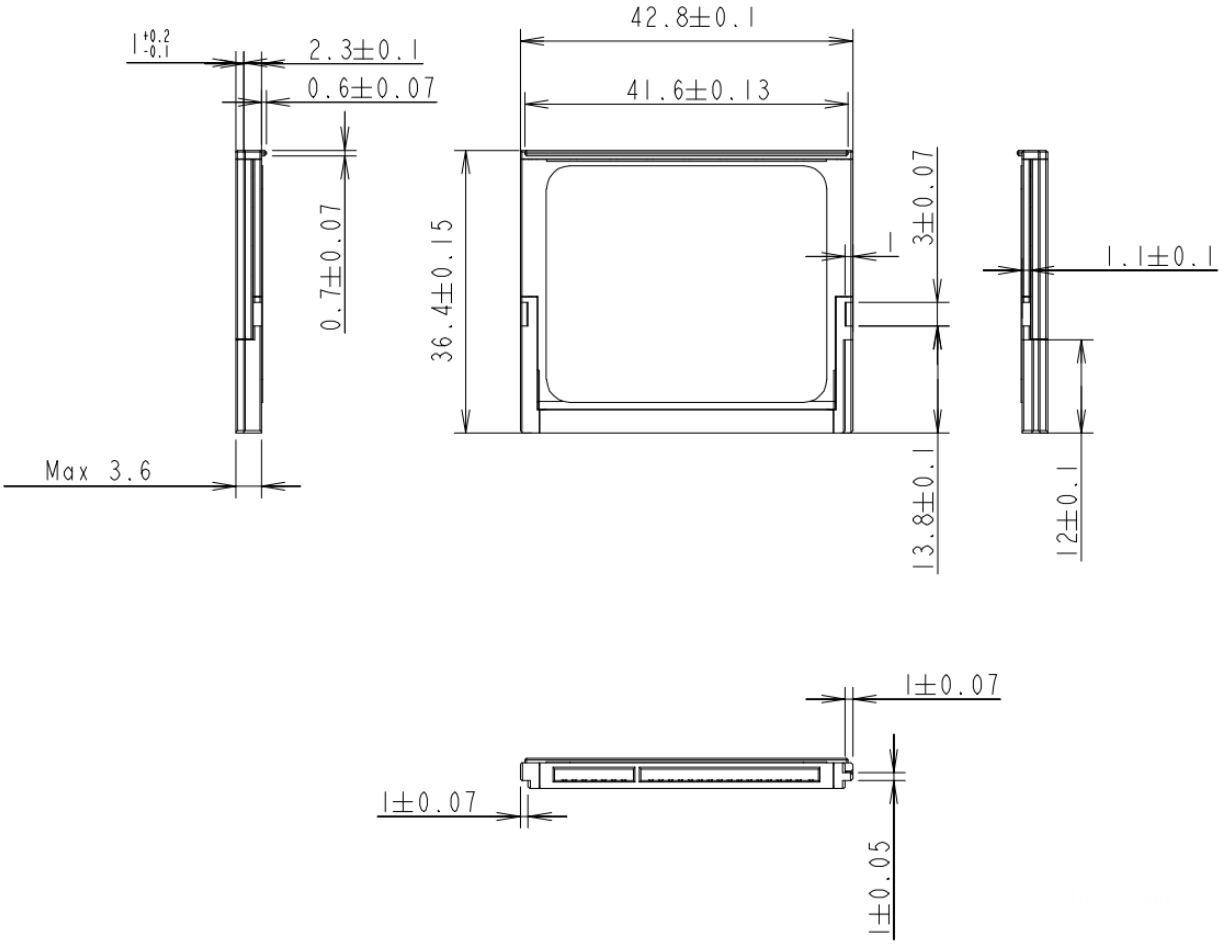
Note: Power consumption may vary from flash configurations and/or platform settings.

9. Physical Characteristics

9.1 Dimensions

TABLE 8-1: CFast physical specification

Length:	36.40 ±0.15 mm
Width:	42.80 ±0.10 mm
Thickness (Including Label Area):	3.6 mm (Max)

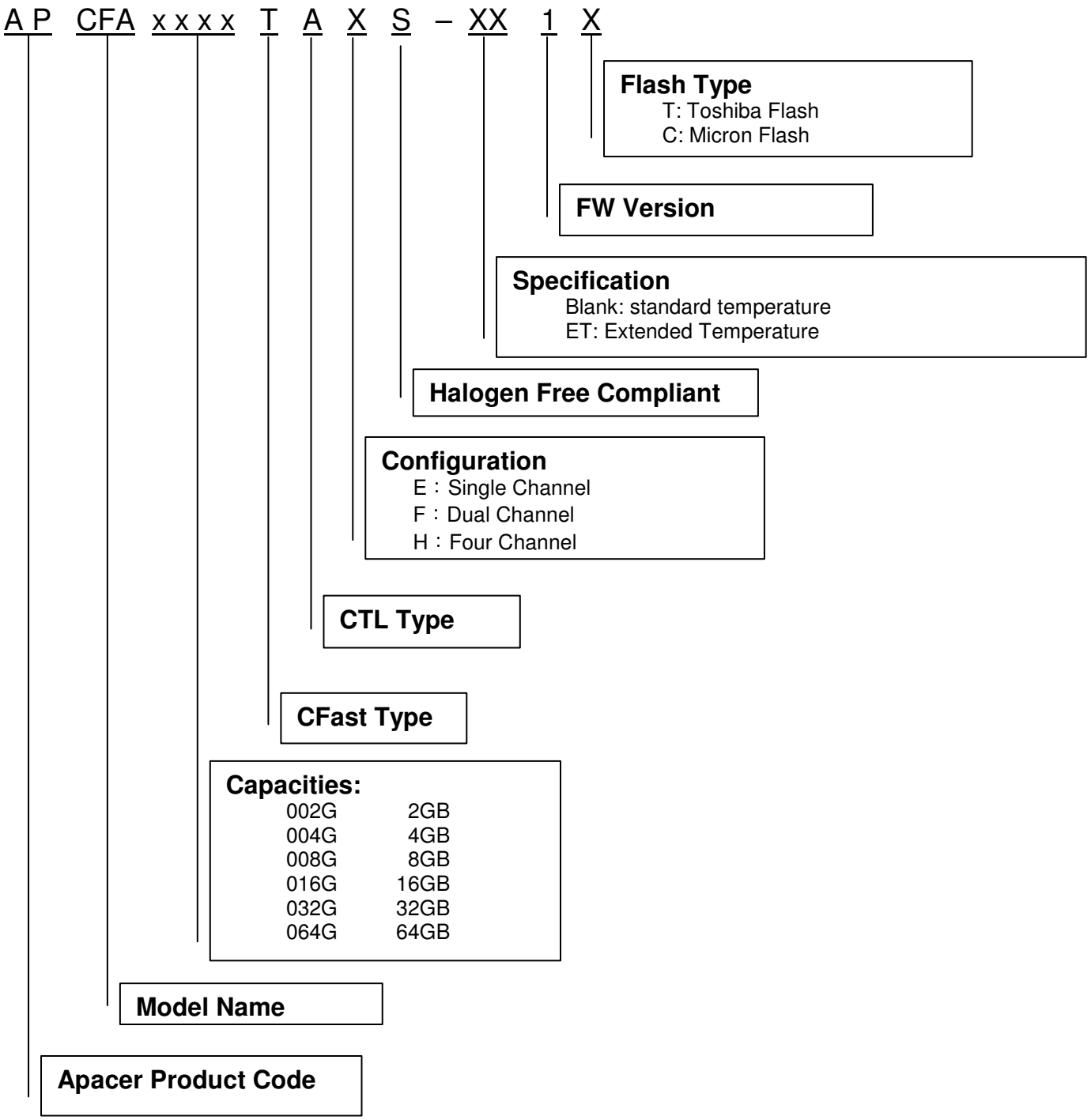


Unit: mm

FIGURE 8-1: Physical dimension

10. Product Ordering Information

10.1 Product Code Designations



10.2 Valid Combinations

10.2.1 VA2

Capacity	*AP/N*	*AP/N—Extended Temp.*
2GB	APCFA002GTAHS-1T	APCFA002GTAHS-ET1T
4GB	APCFA004GTAHS-1T	APCFA004GTAHS-ET1T
8GB	APCFA008GTAHS-1T	APCFA008GTAHS-ET1T
16GB	APCFA016GTAHS-1T	APCFA016GTAHS-ET1T
32GB	APCFA032GTAHS-1C	APCFA032GTAHS-ET1C
64GB	APCFA064GTAHS-1C	APCFA064GTAHS-ET1C

Note:

- Valid combinations list out the available models for mass production.
- Products are normally shipped in unformatted capacities unless required otherwise.
- For customization request, please consult with Apacer sales representatives.

Revision History

Revision	Date	Description	Remark
1.0	01/24/2013	Official release	

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