GOODRAM Industrial 3D TLC CFast™ Card Silver/Diamond

DATASHEET

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CFast Card for Industrial Applications

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REVISION HISTORY

VERSION	CHANGES	DATE
1.0	Initial release	3.11.2020

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PRODUCT OVERVIEW

- Capacity:
  - 64GB – 256GB
- Flash Type
  - Kioxia BiCS3 TLC
- Controller
  - PS31111-S11
- SATA Interface
  - SATA revision 3.2
  - SATA 1.5Gbps. 3Gbps and 6Gbps interface
- Performance
  - Read: Up to 550MB/s
  - Write: Up to 490MB/s
- Power Consumption Note1
  - Active mode: < 1,440mW
  - Idle mode: < 325mW
  - DEVSLP mode: < 5mW
- RoHS compliant
- MTBF
  - More than 2 000 000 hours
- Advanced Flash Management
  - Static and Dynamic Wear Levelling
  - Bad Block Management
  - TRIM
  - NCQ
  - SMART
  - Over-Provision
  - Firmware Update
  - SmartZIP
- Low Power Management
  - DEVSLP Mode
  - DIPM/HIPM Mode
- Temperature Range
  - Operation
    - Silver: 0 ~ +70°C
    - Diamond: -40°C ~ +85°C
  - Storage: -40C ~ +85°C

Notes:
1. Please see “Power Consumption” for details.

PRODUCT DETAILS

GENERAL DESCRIPTION

CFast™ delivers all the advantages of Flash Disk technology with the Serial ATA III interface and is fully compliant with the standard CFast form factor. Given the features of the low power consumption, small form factor, and high shock-resistance, CFast™ is an attractive solution to replace the conventional [PATA-interfaced] CompactFlash card in industrial applications or markets where performance is a major concern.

FLASH MANAGEMENT

GOODRAM CFast card utilizes all the state of art technologies to ensure full reliability until the specified NAND Flash program/erase cycles parameter is reached. These technologies include but are not limited to:

Error Correction Code (ECC)

Flash memory cells will deteriorate with use, which might generate random bit errors in the stored data. Thus, CFast™ applies the LDPC (Low Density Partial Check) 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 Levelling

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 area get updated more frequently than others, the lifetime of the device would be reduced significantly. Thus, Wear Leveling technique is applied to extend the lifespan of NAND Flash by evenly distributing write and erase cycles across the media. Product has 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”. We implement 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.

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-Provisioning

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.

Firmware Upgrade

Firmware can be considered as a set of instructions on how the device communicates with the host. Firmware will be upgraded when new features are added, compatibility issues are fixed or read/write performance gets improved.

SmartZIP™

Write data to the NAND Flash costs time. To improve the write speed performance, controller launches with compression technique – SmartZIP™. Whether a file could be compressed or not depending on the file type, for file types have redundancy data pattern, through our embedded encode engine, we could reduce the amount of data that is actually written to the Flash. Comparing to the SSD without compression, write efficiency is raised and the SSD endurance is also improved since Flash could be benefit from less data written for longer SSD lifetime.

ADDITIONAL FEATURES

Low Power Management (DIPM/HIPM Mode)

SATA interfaces contain two low power management states for power saving: Partial and Slumber modes. For Partial mode, the device has to resume to full operation within 10 microseconds, whereas the device will spend 10 milliseconds to become fully operational in the Slumber mode. SATA interfaces allow low power modes to be initiated by Host (HIPM, Host Initiated Power Management) or Device (DIPM, Device Initiated Power Management). As for HIPM, Partial or Slumber mode can be invoked directly by the software. For DIPM, the device will send requests to enter Partial or Slumber mode.

DEVSLP Mode

With the increasing need of aggressive power/battery life, SATA interfaces include a new feature, Device Sleep (DEVSLP) mode, which helps further reduce the power consumption of the device. DEVSLP enables the device to completely power down the device PHY and other sub-systems, making the device reach a new level of lower power operation. The DEVSLP does not specify the exact power level a device can achieve in the DEVSLP mode, but the power usage can be dropped down to 5mW or less.

Power Loss Protection: Flushing Mechanism

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, the controller applies the Guaranteed Flush technology, which requests the controller to transfer data to the cache. For the used controller, SDR performs as a cache, and its sizes include 8MB or 32MB. 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.
Additionally, it is critical for a controller to shorten the time the in-flight data stays in the cache. Thus, the controller applies an algorithm to reduce the amount of data resides in the cache to provide a better performance. This SmartCacheFlush technology allows incoming data to only have a “pit stop” in the cache and then move to the NAND flash at once. If the flash is jammed due to particular file sizes (random 4K), the cache will be treated as an “organizer”, consolidating incoming data into groups before written into the flash to improve write amplification. In sum, with Flush Mechanism, the controller proves to provide the reliability required by consumer, industrial and enterprise-level applications.

Advanced Device Security Features (Secure Erase, Write Protect)

Secure Erase is a standard ATA command and will write all “0x00” to fully wipe all the data on hard drives and SSDs. When this command is issued, the SSD controller will erase its storage blocks and return to its factory default settings. When a SSD contains too many bad blocks and data are continuously written in, then the SSD might not be usable anymore. Thus, Write Protect is a mechanism to prevent data from being written in and protect the accuracy of data that are already stored in the SSD.

PERFORMANCE AND POWER CONSUMPTION

Capacity	Flash Structure	Performance		Power Consumption		
		CrystalDiskMark		Read (mW)	Write (mW)	Idle (mW)
		Read (MB/s)	Write (MB/s)			
64GB	64GB x 1	330	225	1,270	1,350	4.9
128GB	64GB x 2	550	450	1,270	1,360	4.9
256GB	128GB x 2	550	490	1,360	1,440	4.9

NOTES:

1. The performance was measured using CrystalDiskMark with SATA 6Gbps host.
2. Samples were built using Kioxia BiCS3 TLC NAND flash.
3. Performance may differ according to flash configuration and platform.
4. 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.

SUPPLY VOLTAGE

PARAMETER	Rating
Operating Voltage	3.3V, +/- 5%

Temperature specification

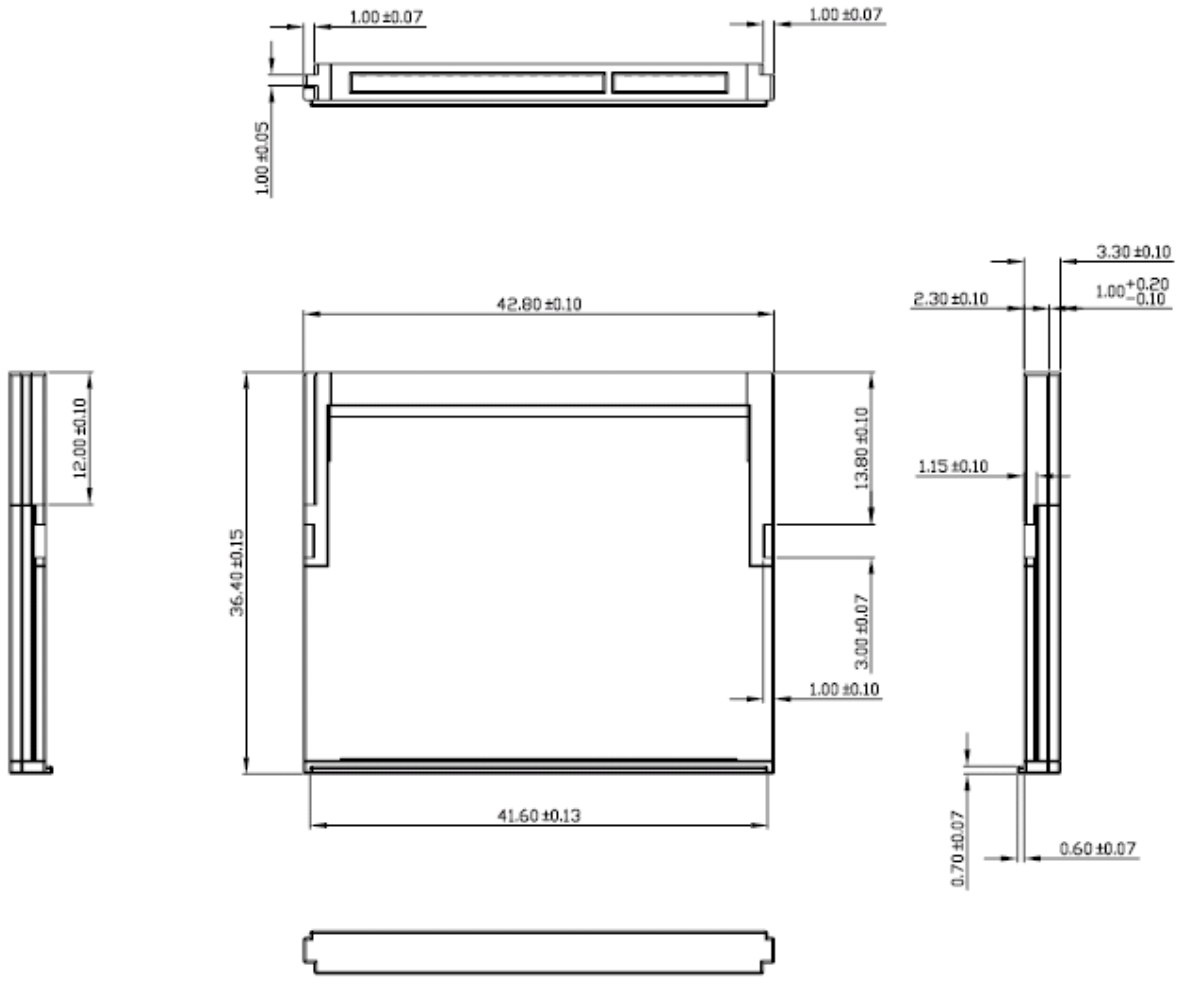
SYMBOL	PARAMETER	MIN.	MAX.	UNIT
T_a	Operating Temperature Silver	0	+70	°C
T_a	Operating Temperature Diamond	-40	+85	°C
T_{st}	Storage Temperature	-40	+85	°C

PRODUCT ORDERING INFORMATION

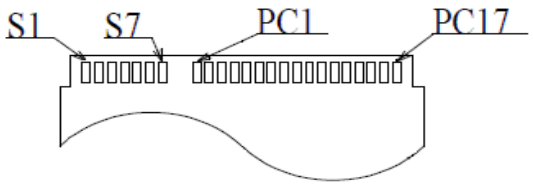
PN	Type	Capacity	Technology	Temp range	Grade
RUCFAT06400SB-P11KID	CFast	64 GB	3D TLC	0~70°C	silver
RUCFAT12800SB-P11KID	CFast	128 GB	3D TLC	0~70°C	silver
RUCFAT25600SB-P11KID	CFast	256 GB	3D TLC	0~70°C	silver
RUCFAT06400DB-P11KID	CFast	64 GB	3D TLC	-40~85°C	diamond
RUCFAT12800DB-P11KID	CFast	128 GB	3D TLC	-40~85°C	diamond
RUCFAT25600DB-P11KID	CFast	256 GB	3D TLC	-40~85°C	diamond

PHYSICAL DIMENSION

CFast™: 36.4mm (L) x 42.8mm (W) x 3.3mm (H)



PIN ASSIGNMENT AND DESCRIPTIONS



Pin #	Segment	Pin Definition	Type	Description	Meting Sequence
S1	SATA	SGND	Signal GND	Ground for signal integrity	1st
S2	SATA	A+	SATA Differential	Signal Pair A	2nd
S3	SATA	A-	SATA Differential	Signal Pair A	2nd
S4	SATA	SGND	Signal GND	Ground for signal integrity	1st
S5	SATA	B-	SATA Differential	Signal Pair B	2nd
S6	SATA	B+	SATA Differential	Signal Pair B	2nd
S7	SATA	SGND	Signal GND	Ground for signal integrity	1st
	Key				
	Key				
PC1	PWR/CTL	CDI	Input	Card Detect In	3rd
PC2	PWR/CTL	PGND	Device GND		1st
PC3	PWR/CTL	DEVSLP	DEVSLP Card Input	DevSleep Power State Enable	2nd
PC4	PWR/CTL			Reserved	2nd
PC5	PWR/CTL			Reserved	2nd
PC6	PWR/CTL			Reserved	2nd
PC7	PWR/CTL	PGND	Device GND		1st
PC8	PWR/CTL	LED1	LED Output	LED Output	2nd
PC9	PWR/CTL	LED2	LED Output	LED Output	2nd
PC10	PWR/CTL			Reserved	2nd
PC11	PWR/CTL			Reserved	2nd
PC12	PWR/CTL	IFDet	GND	Card output, connect to PGND on card	2nd
PC13	PWR/CTL	PWR	3.3V	Device Power (3.3V)	2nd
PC14	PWR/CTL	PWR	3.3V	Device Power (3.3V)	2nd
PC15	PWR/CTL	PGND	Device GND	Device Ground	1st
PC16	PWR/CTL	PGND	Device GND	Device Ground	1st
PC17	PWR/CTL	CDO	Output	Card Detect Out	3rd

SUPPORTED ATA COMMAND LIST

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

B0h	D0h	SMART READ DATA	EFh	90h	06h	Disable Software Settings Preservation (SSP)
B0h	D1h	SMART READ ATTRIBUTE THRESHOLDS	EFh	90h	07h	Disable Device Automatic Partial to Slumber transitions
B0h	D2h	SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE	EFh	90h	09h	Disable Device Sleep
B0h	D3h	SMART SAVE ATTRIBUTE VALUES	EFh	AAh		Enable read look-ahead
B0h	D4h	SMART EXECUTE OFF-LINE IMMEDIATE	EFh	CCh		Enable reverting to power-on defaults
B0h	D5h	SMART READ LOG	F1h			Security Set Password
B0h	D6h	SMART WRITE LOG	F2h			Security Unlock
B0h	D8h	SMART ENABLE OPERATIONS	F3h			Security Erase Prepare
B0h	D9h	SMART DISABLE OPERATIONS	F4h			Security Erase Unit
B0h	DAh	SMART RETURN STATUS	F5h			Security Freeze Lock
B0h	DBh	SMART ENABLE/DISABILE AUTOMATIC OFF-LINE	F6h			Security Disable Password
B1h		Device Configuration	F8h			Read Native Max Address
B4h		Sanitize	F9h			Set Max Address
C4h		Read Multiple	F9h	01h		SET MAX SET PASSWORD
C5h		Write Multiple	F9h	02h		SET MAXLOCK
C6h		Set Multiple Mode	F9h	03h		SET MAX UNLOCK
C8h		Read DMA	F9h	04h		SET MAX FREEZE LOCIK

STANDARDS & REFERENCES

The following table is to list out the standards that have been adopted for designing the product.

STANDARD USED	ACRONYM/SOURCE
RoHS	Restriction of Hazardous Substances Directive; please contact us for further information
CompactFlash™ Card	http://www.compactflash.org/
PC Card Standard Release 8.0	http://www.compactflash.org/
ATA-8 spec	http://www.t13.org
CE	Consumer electronics certification; please contact us for further information.

SAFETY PRECAUTIONS

Do not bend, crush, drop, or place heavy objects on top of the Product. Do not use tweezers, pliers or similar items that could damage the Product. Take particular care when inserting or removing the Product. Stop using the Product when the Product does not work properly. Failure to follow these instructions could result in fire, damage to the Product and/or other property, and/or personal injury including burns and electric shock.

Keep out of reach of small children. Accidental swallowing may cause suffocation or injury. Contact a doctor immediately if you suspect a child has swallowed the Product.

Do not directly touch the interface pins, put them in contact with metal, strike them with hard objects or cause them to short. Do not expose to static electricity.

Do not disassemble or modify the Product. This may cause electric shock, damage to the Product or fire.

NOTES ON USAGE

The Product contains nonvolatile semiconductor memory. Do not use the Product in accordance with a method of usage other than that written in the manual. This may cause the destruction or loss of data.

To protect against accidental data loss, you should back up your data frequently on more than one type of storage media. Wilk Elektronik S.A. assumes no liability for destruction or loss of data recorded on the Card for any reason.

When used over a long period of time or repeatedly, the reading, writing and deleting capabilities of the Product will eventually fail, and the performance speed of the Product may decrease below the original speed specific to the Product's applicable class.

If the Product is to be transferred or destroyed, note that the data it contained may still be recoverable unless it is permanently deleted by third-party deletion software or similar means beforehand.

Product is intended for use in general electronics applications and selected industrial applications and any other specific applications as expressly stated in this document. Product is neither intended nor warranted for use in equipment or systems where failure may cause loss of human life, bodily injury, serious property damage or serious public impact (“Unintended Use”). Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, medical equipment or equipment used to control combustions or explosions. Do not use Product for Unintended Use unless specifically permitted in this document.

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