GOODRAM Industrial pSLC
CFast™ Card Silver/Gold/Diamond
DATASHEET

Version: 1.0
Date: September 2019

CFast Card for Industrial Applications

Wilk Elektronik S.A.
Mikołowska 42
43-173 Łaziska Górne, Poland
Tel.: +48 32 736 90 00, Fax.: +48 32 736 90 01
E-mail: sales@goodram.com

This document is subject to change without any notice.

Please contact your Wilk Elektronik S.A. sales representative for details as to environmental matters such as the RoHS compatibility of Product. Please use Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Wilk Elektronik S.A. assumes no liability for damages or losses occurring as a result of noncompliance with applicable laws and regulations.

REVISION HISTORY

VERSION	CHANGES	DATE
1.0	Initial release	24.09.2019

TABLE OF CONTENTS

PRODUCT OVERVIEW

- Capacity:
  - 16GB – 64GB
- Flash Type
  - Toshiba 15nm MLC
- Controller
  - PS3111-S11
- SATA Interface
  - SATA revision 3.2
  - SATA 1.5Gbps. 3Gbps and 6Gbps interface
- Performance
  - Read: Up to 555MB/s
  - Write: Up to 465MB/s
- Power Consumption Note1
  - Active mode: < 1,475mW
  - Idle mode: < 290mW
  - DEVSLP mode: < 5mW
- TBW Note2
  - 215 TBW for 64GB
- 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
    - Gold: -25°C ~ +85°C
    - Diamond: -40°C ~ +85°C
  - Storage: -40C ~ +85°C
- RoHS compliant

Notes:
1. Please see "Power Consumption" for details.
2. Please see "TBW (Terabyte Written)" 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)			
16GB	32GB x 1	350	160	1,000	1,100	4.9
32GB	32GB x 2	555	310	1,040	1,215	4.9
64GB	64GB x 2	555	465	1,090	1,475	4.9

NOTES:

1. The performance was measured using CrystalDiskMark with SATA 6Gbps host.
2. Samples were built using Toshiba 15nm Toggle MLC 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 Gold	-25	+85	°C
T_a	Operating Temperature Diamond	-40	+85	°C
T_{st}	Storage Temperature	-40	+85	°C

TBW

Capacity	Flash Structure	TBW
16GB	32GB x 1	49
32GB	32GB x 2	106
64GB	64GB x 2	215

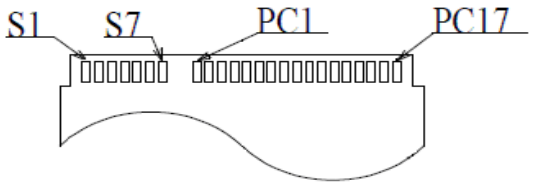
NOTES:

1. Samples were built using Toshiba 15nm Toggle MLC NAND flash.
2. The test followed JEDEC219A client endurance workload.
3. TBW may differ according to flash configuration and platform.
4. The endurance of CF could be estimated based on user behavior, NAND endurance cycles, and write amplification factor. It is not guaranteed by flash vendor.

PRODUCT ORDERING INFORMATION

PN	Type	Capacity	Technology	Temp range	Grade
RUCFAP01600SB-P11TH5	CFast	16 GB	pSLC	0~70°C	silver
RUCFAP03200SB-P11TH5	CFast	32 GB	pSLC	0~70°C	silver
RUCFAP06400SB-P11TH5	CFast	64 GB	pSLC	0~70°C	silver
RUCFAP01600GB-P11TH5	CFast	16 GB	pSLC	-25~70°C	gold
RUCFAP03200GB-P11TH5	CFast	32 GB	pSLC	-25~70°C	gold
RUCFAP06400GB-P11TH5	CFast	64 GB	pSLC	-25~70°C	gold
RUCFAP01600DB-P11TH5	CFast	16 GB	pSLC	-40~85°C	diamond
RUCFAP03200DB-P11TH5	CFast	32 GB	pSLC	-40~85°C	diamond
RUCFAP06400DB-P11TH5	CFast	64 GB	pSLC	-40~85°C	diamond

PIN ASSIGNMENT AND DESCRIPTIONS



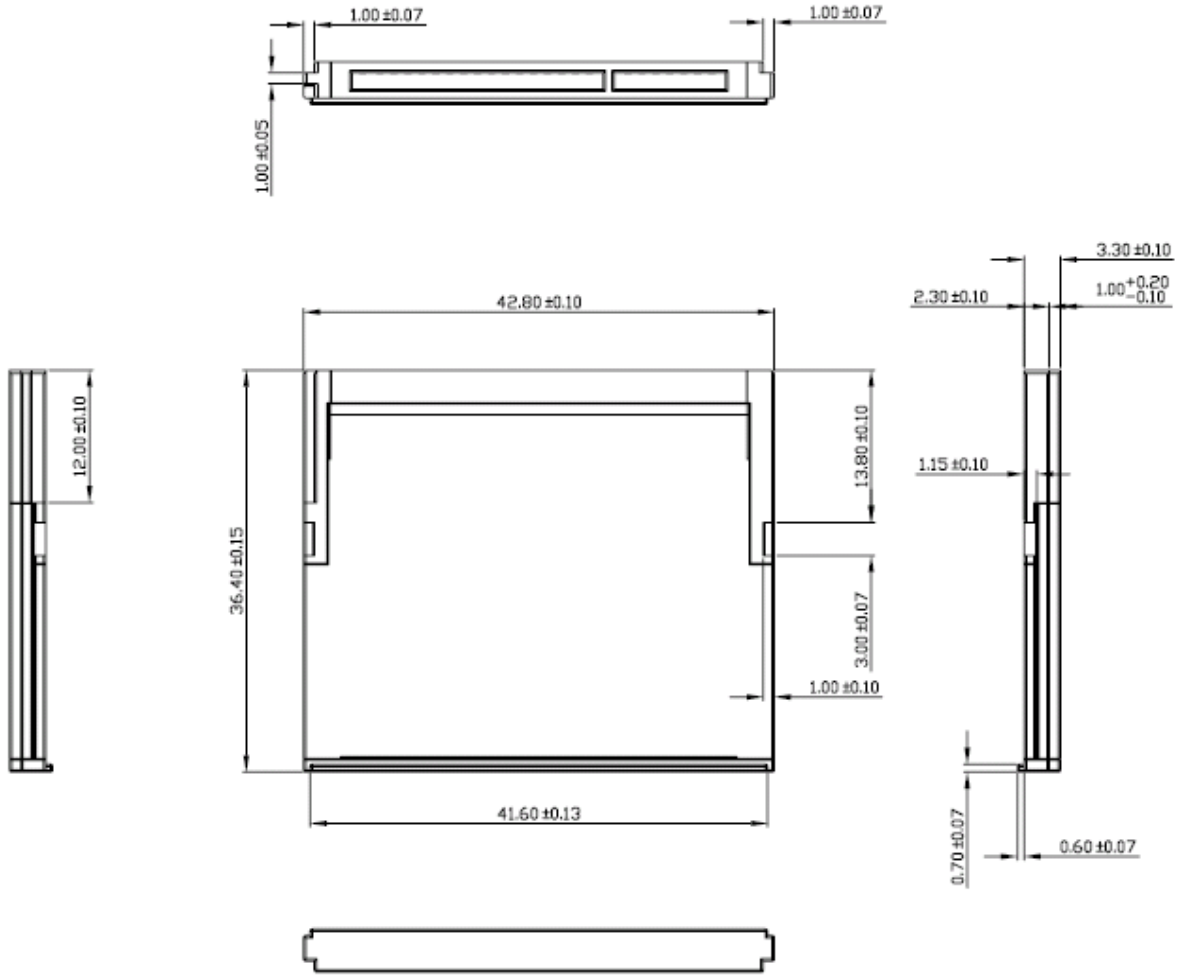
Pin #	Segment	Pin Definition	Type	Description	Meting Sequence
S1	SATA	SGND	Signal GND	Ground for signal integrity	1st
S2	SATA	A+	SATA Differential	Signal Pair A	2nd
S3	SATA	A-	SATA Differential	Signal Pair A	2nd
S4	SATA	SGND	Signal GND	Ground for signal integrity	1st
S5	SATA	B-	SATA Differential	Signal 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	Description	Op Code	Description
00h	NOP	97h	IDLE
06h	Data Set Management	98h	CHECK POWER MODE
10h-1Fh	Recalibrate	99h	SLEEP
20h	Read Sectors	B0h	SMART
21h	Read Sectors without Retry	B1h	DEVICE CONFIGURATION
24h	Read Sectors EXT	C4h	Read Multiple
25h	Read DMA EXT	C5h	Write Multiple
27h	Read Native Max Address EXT	C6h	Set Multiple Mode
29h	Read Multiple EXT	C8h	Read DMA
2Fh	Read Log EXT	C9h	Read DMA without Retry
30h	Write Sectors	CAh	Write DMA
31h	Write Sectors without Retry	CBh	Write DMA without Retry
34h	Write Sectors EXT	CEh	Write Multiple FUA EXT
35h	Write DMA EXT	E0h	Standby Immediate
37h	Set Native Max Address EXT	E1h	Idle Immediate
38h	CFA WRITE SECTORS WITHOUT ERASE	E2h	Standby
39h	Write Multiple EXT	E3h	Idle
3Dh	Write DMA FUA EXT	E4h	Read Buffer
3Fh	Write Long EXT	E5h	Check Power Mode
40h	Read Verify Sectors	E6h	Sleep
41h	Read Verify Sectors without Retry	E7h	Flush Cache
42h	Read Verify Sectors EXT	E8h	Write Buffer
45h	WRITE UNCORRECTABLE EXT	EAh	Flush Cache EXT
60h	Read FPDMA Queued	ECh	Identify Device
61h	Write FPDMA Queued	EFh	Set Features
70h-7Fh	Seek	F1h	Security Set Password
90h	Execute Device Diagnostic	F2h	Security Unlock
91h	Initialize Device Parameters	F3h	Security Erase Prepare
92h	Download Microcode	F4h	Security Erase Unit
93h	DOWNLOAD MICROCODE DMA	F5h	Security Freeze Lock
94h	STANDBY IMMEDIATE	F6h	Security Disable Password
95h	IDLE IMMEDIATE	F8h	Read Native Max Address
96h	STANDBY	F9h	Set Max Address

PHYSICAL DIMENSION

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



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.

Wilk Elektronik S.A does not make any warranty, express or implied, with respect to this document, including as to licensing, Non-infringement, merchantability or fitness for a particular purpose.