App. Note Code: 3SM-F
Revision: 4

APPLICATION NOTE

CF Card Information

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CF Card Information

CompactFlash (CF) cards provide a relatively inexpensive, off-the-shelf means of retrieving data from many of our CRBasic dataloggers or expanding the on-board datalogger memory. The datalogger's memory can be expanded to 16 GB or more with the use of these cards. Table 1 lists the compatibility between dataloggers and CF cards.

Table 1. CRBasic Dataloggers and CF Cards

Datalogger	CF Card Compatible	Required Device/Adapter
CR200(X)	no	N/A
CR800/850	no	N/A
CR6	typically uses a microSD card instead of a CF card	
CR1000	yes	CFM100 or NL115 connected to peripheral port
CR3000	yes	CFM100 or NL115 connected to peripheral port
CR5000	yes	CF1 adapter connected to onboard PCMCIA card slot
CR9000X	yes	CF1 adapter connected to onboard PCMCIA card slot

CF cards use NAND (Not AND) Flash (non-volatile) memory which has the following characteristics: high density, low cost per bit, sequential access, scalable, and a single standard. There are two types of NAND Flash memory: Single-Level Cell (SLC) and Multi-Level Cell (MLC). SLC NAND Flash sometimes called Binary Flash, store one bit of data per memory cell and has two states: erased (1) or programmed (0). MLC NAND Flash store two bits of data per memory cell and has four states: erased (11), two thirds (10), one third (01), or programmed (00)[1]. At first glance, the MLC cards seem more desirable, because each cell can hold more information. However, as summarized in Table 2, the increased data storage comes at a price, mainly speed.

Table 2. SLC and MLC Performance Characteristics

	SLC	MLC
Voltage	3.3 V / 1.8 V	3.3 V
Page Size / Block Size	2 kB / 128 kB	512 B / 32 kB or 2 kB / 256 kB
Access Time (maximum)	25 µs	70 µs
Page Program Time	250 µs	1.2 ms
Partial Programming	Yes	No
Endurance	100,000	10,000
Write Data Rate	8 MB/s	1.5 MB/s

There is a notable performance difference between the two types of NAND Flash memory. In a performance study by Samsung Electronics[2], Samsung found that SLC outperformed MLC, offering greater durability, running 300% faster in write mode, and 43% faster in read mode. While MLC Flash increases the overall density of data storage, which therefore decreases cost; it does so at the expense of data reliability, performance and memory management. Furthermore, MLC technology is more prone to failure, data corruption, or incorrect reading due to memory cell degradation from the additional energy required during operations[2].

There are two types of CF cards available today: Industrial Grade and Standard or Commercial Grade. Industrial Grade CF cards are held to a higher standard; specifically they operate over a wider temperature range, offer better vibration and shock resistance, and have faster read/write times than their commercial counterparts (Table 3). The Industrial Grade cards more closely match the operating envelope of the dataloggers and for this reason we recommend you always use extended temperature tested, Industrial Grade CF cards with a datalogger.

Table 3. Comparison of Industrial and Commercial Grade Cards

Specification	Industrial Grade	Commercial Grade
Operating Temperature	–40 to 85 °C	0 to 70 °C
Vibration Proofing	30 Gs	15 Gs
Shock Resistance	2000 Gs	1000 Gs
MTBF @ 25 °C	>4,000,000 hours	>1,000,000 hours
Type of NAND Flash Memory	SLC	MLC typically but some SLC

All Campbell Scientific products are electrostatic discharge (ESD) tested to ensure that in the event of a static discharge neither the equipment nor the data is damaged or lost and that the equipment resumes operation. Campbell Scientific ESD tested several brands of cards, only the FMJ and Swissbit cards passed this testing and operate properly with the datalogger. Campbell Scientific recommends that only cards that have passed out testing be used with Campbell Scientific CRBasic dataloggers. It is not necessary to purchase the cards directly from Campbell Scientific, as long as the manufacturer and model number match Table 4. FMJ cards are distributed by Falcon Electronics (*www.falconelec.com/contact/*).

Table 4. FMJ, Swissbit, and Campbell Scientific CF model numbers

Size (GB)	FMJ Model	Swissbit Model	Campbell Scientific Model
1	CFV-1GB-TSI-3522	not available	not available
2	CFV-2GB-TSI-3522	SFCF2048H1BO2TO-I-M0-543-SMA	CFMC2G
4	CFV-4GB-TSI-3522	SFCF4096H1BO2TO-I-D1-543-SMA	not available
8	CFV-8GB-TSI-3524	SFCF8192H1BO2TO-I-Q1-543-SMA	not available
16	CFV-16GB-TSI-3524	SFCF16GBH1BO4TO-I-Q1-543-SMA	CMC16G
32	CFV-32GB-TSI-3524	SFCF32GBH1BO4TO-I-NC-543-SMA	not available

References

1. "Implementing MLC NAND Flash for Cost-Effective, High-Capacity Memory', written by Raz Dan and Rochelle Singer, September 2003, 91-SR-014-02-8L, REV 1.1, http://dataioinfo.com/pdf/NAND/MSystems/Implementing_MLC_NAND_Flash.pdf

2. "Advantages of SLC NAND Flash Memory", http://memory.com.my/SLC%20VS%20MLC.html

Campbell Scientific Companies

Campbell Scientific, Inc. (CSI)
815 West 1800 North
Logan, Utah 84321
UNITED STATES
www.campbellsci.com • info@campbellsci.com

Campbell Scientific Africa Pty. Ltd. (CSAf)
PO Box 2450
Somerset West 7129
SOUTH AFRICA
www.csafrica.co.za • cleroux@csafrica.co.za

Campbell Scientific Australia Pty. Ltd. (CSA)
PO Box 8108
Garbutt Post Shop QLD 4814
AUSTRALIA
www.campbellsci.com.au • info@campbellsci.com.au

Campbell Scientific (Beijing) Co., Ltd.
8B16, Floor 8 Tower B, Hanwei Plaza
7 Guanghua Road
Chaoyang, Beijing 100004
P.R. CHINA
www.campbellsci.com • info@campbellsci.com.cn

Campbell Scientific do Brasil Ltda. (CSB)
Rua Apinagés, nbr. 2018 ─ Perdizes
CEP: 01258-00 ─ São Paulo ─ SP
BRASIL
www.campbellsci.com.br • vendas@campbellsci.com.br

Campbell Scientific Canada Corp. (CSC)
14532 – 131 Avenue NW
Edmonton AB T5L 4X4
CANADA
www.campbellsci.ca • dataloggers@campbellsci.ca

Campbell Scientific Centro Caribe S.A. (CSCC)
300 N Cementerio, Edificio Breller
Santo Domingo, Heredia 40305
COSTA RICA
www.campbellsci.cc • info@campbellsci.cc

Campbell Scientific Ltd. (CSL)
Campbell Park
80 Hathern Road
Shepshed, Loughborough LE12 9GX
UNITED KINGDOM
www.campbellsci.co.uk • sales@campbellsci.co.uk

Campbell Scientific Ltd. (CSL France)
3 Avenue de la Division Leclerc
92160 ANTONY
FRANCE
www.campbellsci.fr • info@campbellsci.fr

Campbell Scientific Ltd. (CSL Germany)
Fahrenheitstraße 13
28359 Bremen
GERMANY
www.campbellsci.de • info@campbellsci.de

Campbell Scientific Spain, S. L. (CSL Spain)
Avda. Pompeu Fabra 7-9, local 1
08024 Barcelona
SPAIN
www.campbellsci.es • info@campbellsci.es

Please visit www.campbellsci.com to obtain contact information for your local US or international representative.