

APPLICATION NOTE



CF Card Information

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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 μ s	70 μ s
Page Program Time	250 μ s	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 Electronics², 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 operations².

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	SFCF2048H1B02TO-I-M0-543-SMA	CFMC2G
4	CFV-4GB-TSI-3522	SFCF4096H1B02TO-I-D1-543-SMA	not available
8	CFV-8GB-TSI-3524	SFCF8192H1B02TO-I-Q1-543-SMA	not available
16	CFV-16GB-TSI-3524	SFCF16GBH1B04TO-I-Q1-543-SMA	CMC16G
32	CFV-32GB-TSI-3524	SFCF32GBH1B04TO-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://datainfo.com/pdf/NAND/MSystems/Implementing_MLC_NAND_Flash.pdf
2. "Advantages of SLC NAND Flash Memory",
<http://memory.com.my/SLC%20VS%20MLC.html>

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