

APPLICATION NOTE

PC/CF Card Information



CAMPBELL SCIENTIFIC, INC.[®]
WHEN MEASUREMENTS MATTER

PC/CF Card Information

PC or 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 up to 2 Gbytes with the use of these cards. Some dataloggers can use either a PC or CF card, and others can only use a CF card with the appropriate expansion module. Table 1 lists the compatibility between dataloggers and cards.

Datalogger	Card Slot	CF Card	PC Card
CR200	Not Available	Not Available	Not Available
CR800/850	Not Available	Not Available	Not Available
CR1000	CFM100 or NL115	Yes	No
CR3000	CFM100 or NL115	Yes	No
CR5000	Built In	Yes, with Adapter	Yes
CR9000(X)	Built In	Yes, with Adapter	Yes

Table 1. CRBasic Dataloggers and PC/CF Cards

PC/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.

	SLC	MLC
Voltage	3.3 V / 1.8 V	3.3 V
Page Size / Block Size	2KB / 128KB	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

Table 2. SLC and MLC Performance Characteristics

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 PC/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 PC/CF cards with a datalogger.

	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	>3,000,000 hours	>1,000,000 hours
Type of NAND Flash Memory	SLC	MLC typically but some SLC

Table 3. Comparison of Industrial and Commercial Grade Cards

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. Campbell Scientific ESD tested several brands of cards, only the Silicon Systems cards passed this testing. Campbell Scientific recommends that only Silicon Systems cards be used with Campbell Scientific CRBasic dataloggers. It is not necessary to purchase the cards directly from Campbell Scientific, as long as the Silicon Systems card model number matches Table 4.

Card Type	Size (Mbytes)	Silicon Systems	CSI
CF	64	SSD-C64MI-3038	CFMC64M
CF	256	SSD-C25MI-3038	CFMC256M
CF	1024	SSD-C01GI-3038	CFMC1G
CF	2048	SSD-C02GI-3038	CFMC2G
PC	1024	SSD-P01GI-3038	Not Available
PC	2048	SSD-P02GI-3038	Not Available

Table 4. Silicon Systems and Campbell Scientific PC/CF model numbers

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, www.data-io.com/pdf/NAND/MSystems/Implementing_MLC_NAND_Flash.pdf
2. "Advantages of SLC NAND Flash Memory", www.mymemory.com.my/SLC%20VS%20MLC.html