# 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.

| Datalogger | Card Slot | CF Card |
|---|---|---|
| CR200(X) | Not Available | Not Available |
| CR800/850 | Not Available | Not Available |
| CR1000 | CFM100 or NL115 | Yes |
| CR3000 | CFM100 or NL115 | Yes |
| CR5000 | Built In | Yes, with Adapter |
| CR9000(X) | Built In | Yes, with Adapter |

*Table 1. CRBasic Dataloggers and CF Cards*

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 | 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 |

*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 Electronics[2], Samsung found that SLC out performed 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.

|  | Industrial Grade | Commercial Grade |
|---|---|---|
| Operating Temperature | -40º to +85ºC | 0º to +70ºC |
| 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 and that the equipment resumes operation. Campbell Scientific ESD tested several brands of cards, only the FMJ cards passed this testing and operate properly with the datalogger. Campbell Scientific recommends that only FMJ cards be used with Campbell Scientific CRBasic dataloggers. It is not necessary to purchase the cards directly from Campbell Scientific, as long as the FMJ card model number matches Table 4.

| Size (GB) | FMJ Model | CSI Model |
|---|---|---|
| 2 | CFV-2GB-TSI-3522 | CFMC2G |
| 16 | CFV-16GB-TSI-3524 | CFMC16G |

*Table 4. FMJ and Campbell Scientific 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