



## **SanDisk Extreme® Pro™ CompactFlash® card Technology Backgrounder**

Millions of people around the world rely on flash memory cards to capture, store and share their digital lives and life's work. During the last 20 years, advances in flash memory technology have been a driving force behind consumer electronics including cameras, portable entertainment devices, computers and mobile phones.

For professional photographers, flash memory cards have become the de-facto standard for capturing life's greatest moments. Coupled with advances in camera design and functionality, the evolution of flash memory's performance, reliability and capacity have led the charge in popularizing digital photography's fast rise and appeal.

Faster card speeds mean more opportunity to get the winning shot and less time spent offloading images after a long shoot. The reliability of flash memory cards and the peace of mind that images are stored safely are abundantly important to professional photographers. Higher-capacity cards allow the professional to shoot many images without reloading and to capture images in the widely-preferred RAW format.

Despite the leading role that flash memory cards play, many professional photographers still don't understand what differentiates one card from another. This technology backgrounder will highlight what makes a card fast and reliable by examining the underlying technologies of a SanDisk Extreme® Pro CompactFlash® memory card, the company's most advanced imaging card offering, including:

- SanDisk® Power Core™ Controller and Enhanced Super-Parallel Processing – an architecture invented by SanDisk to increase the card's performance level.
- Error detection and correction codes that help minimize performance lag time.
- Wear leveling algorithms spread data across different blocks of memory over multiple write times. This process arranges data so that erasures and re-writes are distributed evenly across the medium.
- Less components used on the card's print circuit board for increased reliability.
- Durability for extreme temperatures, humidity and accidental drops.

SanDisk, the global leader in flash memory cards, has raised the bar for professional-grade flash memory with the launch of the SanDisk Extreme® Pro™ CompactFlash® memory card with up to 90 megabytes per second (MB/s)<sup>1</sup> read/write performance, available in capacities ranging from 16 to 64 gigabytes (GB)<sup>2</sup>. To measure the rugged reliability required by its most demanding customers, SanDisk tests batches of its cards under extreme conditions such as heat, cold, humidity and accidental drops that many professional photographers may encounter during shoots.

## **“Click”**

In the past, when cameras used film instead of flash memory cards, professional photographers were easily recognizable by the rapid “click-click-click” of motor drives. Today’s professional-grade digital SLR cameras provide the same ability to capture a very rapid sequence of images by holding down the shutter button and taking pictures throughout a series of action sequences. This camera setting is commonly referred to as continuous shooting mode or burst mode.

When a camera’s shutter button is pressed, light hits an image sensor that converts the visual information captured by the photographer into electrical signals. The signals are sent to an analog to digital converter, which switches them to a binary number that’s processed by a chip within the camera’s body and ultimately creates the image file. In today’s standard digital SLRs, this process typically lasts a fraction of a second.

Once the file is generated, it sits in the camera’s internal memory buffer. If in burst mode, this happens in rapid succession until the memory buffer is filled. Until the file is written to the flash memory card, however, it serves as a toll booth waiting for the data to come off “the highway” of a camera’s internal memory buffer. Over time, SanDisk engineers have developed a way to offload the internal buffer to the memory card by making these bits or data storage cells within the card work together for faster performance. Rather than sitting in the toll booth, high-performance flash memory used in the SanDisk Extreme family of products is able to “throttle the engine” and generate higher data transfer speeds.

## **SanDisk® Power Core™ Controller and Algorithms Boost Performance**

When an image is taken using a SanDisk Extreme Pro CompactFlash memory card, the data first travels to the SanDisk Power Core controller, which is specially designed for fast content processing. To support faster data processing speeds, SanDisk employs a dual-lane architecture that effectively increases the amount of traffic that a controller can process.

As soon as an image hits the SanDisk Power Core controller’s “highway,” data is transferred to two off-ramps, allowing for more images to be processed at the same time. After data transfers from high-speed lanes to off-ramps, it’s programmed and stored onto one of the multiple flash memory blocks. SanDisk’s Power Core controller directs data traffic into different memory lanes, helping data find the quickest route to storage. This process of writing and storing multiple images via the SanDisk Power Core controller is known as “Enhanced Super-Parallel Processing (ESP).”

ESP write and read operations are coupled with accelerated flash data bus architecture to allow data to be transferred at an increased rate; than of cards available today with 45MB/s<sup>1</sup> read/write performance. In addition, the ESP architecture streamlines every aspect of read and write data transfer operations through advanced hardware automation. The ESP architecture effectively removes the card as the bottleneck in data storage applications. Photographers benefit from ESP because it enables faster capture of high-resolution images and quicker transfers from card to computer.

The SanDisk Power Core controller’s next-generation Error Correction Code’s hardware engine has been increased from its previous generation, allowing the card to maintain

data-integrity on the fly without impacting performance. This correction process helps the SanDisk Extreme Pro CompactFlash card provide a remarkable combination of speed and reliability.

### **Wear Leveling Firmware and Smart Engineering Enhance Card Reliability**

SanDisk develops its flash controllers and memory chips together. SanDisk engineers conduct extensive testing to measure the compatibility between flash controllers and the flash memory storage medium, and make adjustments to ensure faster performance and reliability of its flash memory cards.

The firmware within SanDisk flash memory controllers increases the reliability of the cards by spreading data across different blocks of memory over multiple write times, in a process known as “wear leveling.” This process arranges data so that erasures and re-writes are distributed evenly across the medium.

To increase overall reliability of SanDisk Extreme Pro CompactFlash cards, the new SanDisk Power Core controller has been designed to be more integrated by using less individual components on the cards’ printed circuit board (PCB). By using fewer components, SanDisk has engineered more reliability into the cards because there’s less chance of individual components failing.

### **Extreme Testing for Card Durability, Inside and Out**

SanDisk internal testing for reliability is where SanDisk professional cards get the SanDisk final seal of approval. SanDisk Extreme flash memory cards must stand up to the rugged environments to which cameras are exposed.

Well before the camera shutter button is pressed, SanDisk has spent considerable time testing its cards to ensure they live up to their reputation. Sample batches of cards are evaluated on the following criteria:

- Extreme temperature protection: SanDisk Extreme cards are tested in ovens at 85 degrees Celsius and in freezers at subzero temperatures of – 25 degrees Celsius.
- High humidity: SanDisk Extreme cards are tested to withstand 90 percent humidity.
- Accidental drops: SanDisk Extreme cards are dropped from nine feet.

The sample cards that are baked, frozen, dropped and subjected to high levels of humidity must operate for extended periods of time after testing.

As flash memory cards continue to play a leading role in high-performance cameras, it’s important to remember that not all cards are ready for center stage. SanDisk is continually pushing the limits of its professional-grade memory cards. The engineering and testing done by SanDisk is extremely valuable considering that flash memory cards do not just capture professionals’ photos and videos: the content represents professional photographers’ livelihoods.

## About SanDisk

SanDisk Corporation is the global leader in flash memory cards, from research, manufacturing and product design to consumer branding and retail distribution. SanDisk's product portfolio includes flash memory cards for mobile phones, digital cameras and camcorders; digital audio/video players; USB flash drives for consumers and the enterprise; embedded memory for mobile devices; and solid state drives for computers. [SanDisk](#) is a Silicon Valley-based S&P 500 company, with more than half its sales outside the United States.

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<sup>1</sup> Based on SanDisk internal testing; performance may vary depending upon host device. 1 megabyte (MB) = 1 million bytes.

<sup>2</sup> 1 gigabyte (GB) = 1 billion bytes

SanDisk's product and executive images can be downloaded from: <http://www.sandisk.com/corporate/media.asp>  
SanDisk's web site/home page address: <http://www.sandisk.com>

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