Video Speed Class:
The new capture protocol of SD 5.0

White Paper | February 2016

Conditions for publication

Publisher and Copyright Holder:

SD Card Association
2400 Camino Ramon, Suite 375
San Ramon, CA 94583 USA
Telephone: +1 (925) 275-6615
Fax: +1 (925) 886-4870
E-mail: help@sdcard.org

Disclaimers:

Trademarks Notice:

Executive Summary

The SD Association (SDA) released the SD 5.0 specification to answer evolving market needs with a Video Speed Class. The SDA now positions the Video Speed Class as the preferred speed class for a variety of new applications.

Video Speed Class provides new capabilities for consumers and a new enabling technology for the SD industry.

From a consumer's, and application developer's, point of view, SD 5.0 enables a new generation of applications that require extended capture performance of up to 90 megabytes per second (MB/s).

From an SD memory card maker's point of view, SD 5.0 reimagines technical mechanisms to provide new SD protocols that enable and optimize use of both the latest and future NAND technology for all SD applications.

From a marketing point of view, SD 5.0 marks an inflection point where the SDA acknowledges that new applications like video will require minimum speed capture and will continually change their bandwidth requirements to achieve the best display in any resolution. For every resolution, there are both lower and higher quality image options for consumers. From now on, applications or product manufacturers need to simply report the bandwidth required to save the data, and consumers will need to match or better this performance with their SD memory card selection.

Video Speed Class for Consumers

Consumer Overview

Video Speed Class joins and extends the existing SD defined speed classes (see Figure 1). We use the phrase speed class as a term that includes three specific protocols: Video Speed Class, UHS Speed Class and Speed Class.

The speed class types include: Speed Class (C2, C4, C6 and C10), UHS Speed Class (U1 and U3) and now Video Speed Class (V6, V10, V30, V60 and V90). Video Speed Class provides equivalents to existing speed classes and adds new capture rates of 60 MB/s and 90 MB/s.

The SDA provides a range of speed class options to consumers so that they can cost-effectively meet the wide array of application speed requirements set by a variety of cameras, video cameras and other devices offering unique features and capabilities. Each of these devices will implement the necessary speed class into the device and, to ensure solid performance, the device needs to be paired with an SD memory card offering the same, or better, capabilities.

Minimum Sequential Write Speed	Speed Classes			Corresponding Video Format
	Speed Class	UHS Speed Class	Video Speed Class (New)	The necessary speed varies by each recording/playback device condition, even in the same format. The expanded ranges below are possible based on the device capabilities (better resolution possible even at lower speeds).
90 MB/sec			V90	8k Video
60 MB/sec			V60	
30 MB/sec		3	V30	4k Video
10 MB/sec	10	1	V10	Full HD / HD Video
6 MB/sec	6		V6	
4 MB/sec	4			Standard Video
2 MB/sec	2			

Figure 1: Speed class support by SD interface and capture bandwidth

Video Speed Class: The new capture protocol of SD 5.0

Video Speed Class and Changing NAND Technology

Video Speed Class was designed to optimize use of modern NAND technology. The earlier speed classes include fixed parameters that are too specific to earlier NAND technology and are difficult to design solutions with the newest NAND technology.

Each of the given speed class methods defines different card access methods closely related to the underlying NAND technology. The match, or mismatch, of each speed class method to a specific NAND technology may lead to SD memory cards that meet Video Speed Class requirements for a given capture rate, yet not meet the requirements for the equivalent Speed Class or UHS Speed Class. As an example, an SD memory card may meet V30 requirements, by supporting 30 MB/s capture using the Video Speed Class protocol, yet only meet C10 requirements, supporting 10 MB/s capture with the Speed Class protocol.

Video Speed Class Meets Changing Video Technology

Today's advanced video capabilities vary greatly based on the application. Variations in resolutions, video CODECs, the amount of compression, the capture frame rate, and possible simultaneous capture of additional information (multiple streams, GPS, etc.) make earlier guidelines difficult to use today. Figure 2 illustrates some of the ranges of resolutions in popular formats, some of the ranges of frame rates for each resolution, some of the possible required recording rates, and some of the speed classes that may be appropriate for any specific combination of these factors.

Resolution has increased so much it makes it difficult to clearly include Standard Definition characteristics in the same figure that includes 8K characteristics. While it may not be in this figure, it is important to know that Video Speed Class does support Standard Definition recording.
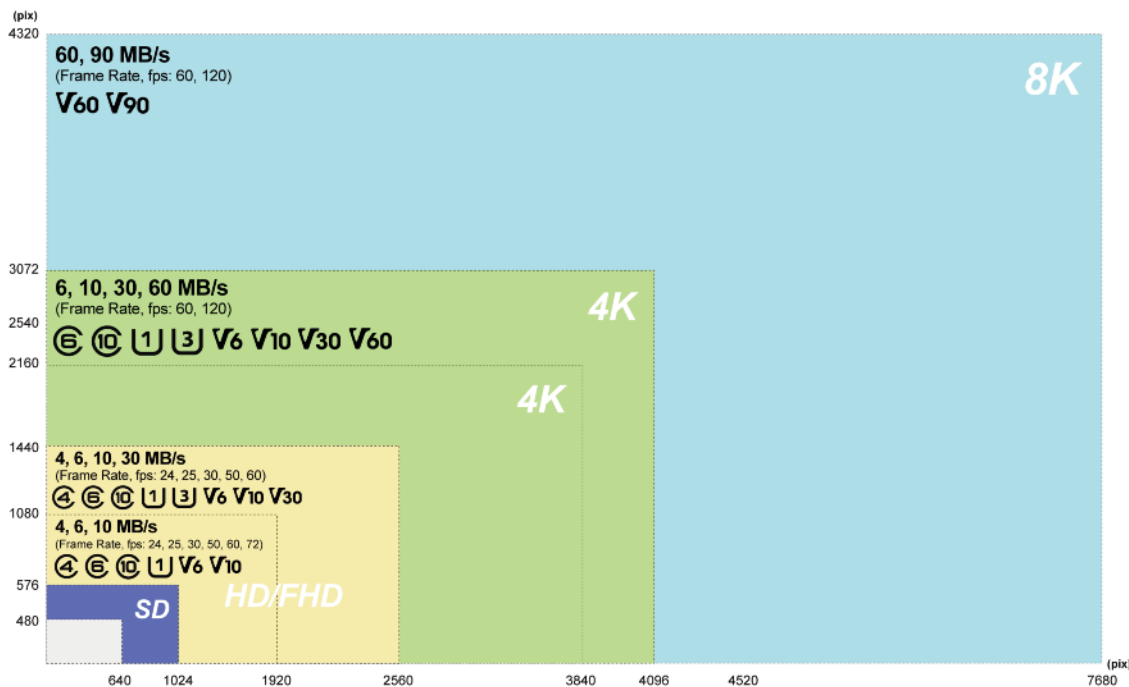
If the application offers multiple options, Video Speed Class is the best choice for future applications.

Despite the large number of variables, one rule remains true: match the SD memory card to your specific application's requirements. The protocol speed and type specified by the application needs to be matched. A guide to help consumers select the right memory card will be provided in device owner's manuals.

Figure 2: Resolutions, frame rates, and SD speed classes

Why Is Video Speed Class the Future for the SD Ecosystem?

One of the basic attributes of the NAND chips used in SD storage is that memory access is asymmetric in a couple of ways:

- An operation that writes data takes longer than an operation that reads the same amount of data
- Relatively small writes (e.g., 4 KB) are easy, but re-writing the same small write may require a much larger write (e.g., 4 MB), which may take longer than expected to complete

The Video Speed Class protocol provides a solution to this re-writing characteristic and supports consistent write performance that minimizes wear. This consistent performance is a natural fit to the recording requirements for video. Video Speed Class was designed to support current and upcoming extensions of video resolution and quality for 4K, 8K, 3D, HDR, 360 degree and high-speed recording.

Video recording devices are expected to be among the first application implementations for Video Speed Class.

However, video capture may not be the only applications that use Video Speed Class. Consistent, fast writing speeds with low wear characteristics are useful to all applications that write to SD memory cards. Video Speed Class also contains mechanisms to interleave writes to unrelated files, enabling random write operations with appropriate OS support. The SDA intends to support libraries to enable such systems, but this will require more development time.

How Does Video Speed Class Work?

There are three major features that combine to make Video Speed Class special:

- SD memory card specified block size
- Current address saving
- Multi-file recording

SD Memory Card Specified Block Size

NAND storage chips feature large physical erase blocks that physically hold data that can be erased in a single operation to enable re-write of that media. The size for erase blocks is typically measured in megabytes. With the introduction of TLC NAND and 3D NAND, the size of an erase block may not be a power of 2, as it was when Speed Class was invented years ago. SD memory cards use one or more of these physical blocks in one or more physical NAND chips at the same time to meet a targeted performance level.

The expression "one or more blocks" is a simplistic way to describe the complicated ways that NAND chips are used in today's SD memory cards. How multiple NAND devices are organized and accessed in parallel is the domain of SD memory card manufacturers, the internal organization of the NAND memory is the domain of NAND memory manufacturers, and the application developers get to figure out how to use the result efficiently. To support SD memory card manufacturers, NAND chip manufacturers and application developers, Video Speed Class contains a defined set of 37 block sizes that range from 8 MB to 512 MB. These 37 block sizes are believed to be sufficient for the foreseeable future, but if needed in the future, this architecture could support more values.

In SD 5.0, SD memory cards supporting Video Speed Class specify their own block size, using a combination of the architecture of the internal NAND and the architecture of the SD memory card's use of those NAND chips to identify logical data that may be physically erased without affecting other data in the SD memory card. Hosts/applications use this information to choose a logical address range of data within the SD memory card that is to be erased. First, the host ensures that any valid data in that address range is moved elsewhere in the SD memory card. Then the host/application commands the SD memory card to erase the data in that address range. After this, the host/application may write sequentially into this address range at the maximum speed of the SD memory card without any wasted write operations or write acceleration.

Current Address Saving

The block size specified by the SD memory card may be very large, up to 512 MB. If the block is not fully used when power is to be removed by the host, then the next address to be written within the block needs to be remembered, so that the partially filled block can be properly resumed when power is re-applied by the current host or the next host.

SD 5.0 has commands to save this next address in the block being written, and to resume the address to continue sequential writing within the block after a power cycle.

Multi-File Recording

Modern video capture has evolved to require interleaving the write operations of multiple files. General use by mobile or laptop storage has similar needs as described earlier in "Why Is Video Speed Class the Future for the SD Ecosystem?"

The following are examples of video functionality that may require interleaving multiple files while writing:

- Saving independent video streams, as recently introduced by new 360 degree cameras for virtual reality videos and drones
- Video capture modes that simultaneously capture high-quality still pictures
- High-quality still pictures that display time-lapse capture
- Saving a trail of GPS coordinates during video capture
- Saving stereoscopic video (3D)
- Saving independent video streams (broadcast video capture)
- Saving both raw and jpg still images
- Random file writing while recording (computer use model)

In SD technology, a difficult part of interleaving such write operations is keeping up with the directory information in the file system tables. SD technology has the capability of accelerating a single directory area, but only in all earlier speed class implementations. In Video Speed Class, this support was increased to support the simultaneous interleaving of eight different files. Support was also added to allow the closure of one update directory and the opening of another.

Conclusion

When available, Video Speed Class is the preferred access method for SD technology. Video Speed Class will:

- Provide much faster recording for the exotic video technology of the future
- Enable the use of future NAND technology in SD memory cards
- Support the new standard protocol for hosts/applications to write efficiently to SD memory cards

The most important advice to consumers and users of all types is to continue matching the SD memory card to an application's recommended speed class to continue enjoying the best recording and playback possible.