



**SD Standards —
Universal, High Performance Mobile Storage**



SD Association

SD Standard and Bus Interface

SD specifications define a variety of memory card capacities, bus interfaces and Speed Classes, giving manufactures a great deal of flexibility in developing new products to satisfy any consumer need. The industry standard is used by a myriad of consumer and industrial devices expanding its application to various IoT and emerging new digital generation products like drones, VR, surveillance cameras, etc. Moreover, the cards feature outstanding interoperability and compatibility between devices. Expanding capacity with SDUC allows cards to reach capacities up to 128TB. SDUC, SDXC and SDHC memory cards can use new bus interface of SD Express, which deploys PCIe and NVMe technology, creating versatile, portable and convenient SD memory cards that continue to lead the removable flash memory card market for the evolving digital landscape.

SD Express

Next generation SD Express memory cards, serve as removable Solid State Drives (SSD), achieve speeds of up to 3940 MB/s with PCIe technology, maintaining its backward compatibility and performance, with the advanced NVMe protocol, delivers faster access to data files than today's SD platform. These cards support content applications and data generated by highly capable system architectures delivering speeds essential for high-resolution content applications such as super-slow motion video, RAW continuous burst mode and 8K video capture and playback, 360 degree videos, speed hungry applications running on cards and mobile computing devices, ever evolving gaming systems, multi-channel IoT devices, numerous automotive storage needs, to name a few. The PCIe interface is added in addition to the existing SD UHS-I interface allowing a card with SD Express to operate in billions of existing SD host products in the market today.

	SD Memory Card				SD Express Memory Card	
Pin Layout						
PCIe Bus Interface					3940MB/sec PCIe Gen.4x2 1970MB/sec PCIe Gen.3x2 985MB/sec PCIe Gen.4x1 PCIe Gen.3x1	
SD Bus Interface	25MB/sec	104MB/sec UHS-I	312MB/sec UHS-II	624MB/sec UHS-III	UHS-I	
	High Speed		High Speed		High Speed	
Capacity (file system)	Ultra Capacity Up to 128TB (exFAT) 					
	Extended Capacity Up to 2TB (exFAT) 					
	High Capacity Up to 32GB (FAT32) 					

FAT File System

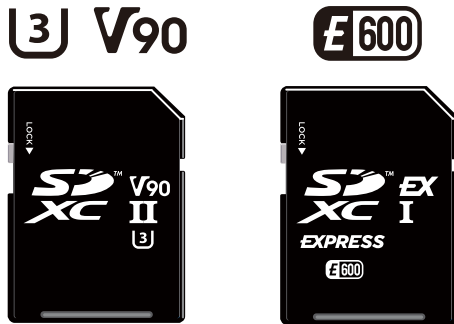
SDUC standard increased memory capacity more than 2TB to an extremely high capacity of 128TB, dramatically altering the digital-user experience. Moreover, adoption of the exFAT file system has enabled recording of 4K and 8K videos and handling even larger files.

Host Device and Card Compatibility

Host Device	SD Card				
		(2GB or less) FAT 12/16	(Over 2GB to 32GB) FAT32	(Over 32GB to 2TB) exFAT	(Over 2TB to 128TB) exFAT
SD compatible	✓	N/A	N/A	N/A	N/A
SDHC compatible	✓	✓	N/A	N/A	N/A
SDXC compatible	✓	✓	✓	N/A	N/A
SDUC compatible	✓	✓	✓	✓	✓

Speed Classes

Speed Class indicates a memory card's minimum write speed. This distinction is especially needed when recording video, which requires a constant minimum write speed. Users can find out the speed of a card by the clearly indicated Speed Class, UHS Speed Class, Video Speed Class and SD Express Speed Class mark.



Card's Interface	Minimum Sequential Write Speed	Speed Class				Corresponding Video Format Speeds vary by recording/playback device requirements.
		Speed Class	UHS Speed Class	Video Speed Class	SD Express Speed Class	
PCIe/NVMe Interface	600MB/sec				E600	8K Multi-Streams & 8K Intra Video* 7680 x 4320 pix
	450MB/sec				E450	
	300MB/sec				E300	
	150MB/sec				E150	
SD Interface	90MB/sec			V90		8K Video 7680 x 4320 pix
	60MB/sec			V60		
	30MB/sec		U3	V30		4K Video 3840 x 2160 pix
	10MB/sec	U10	U1	V10		
	6MB/sec	U6		V6		HD/Full HD Video 1920 x 1080 pix
	4MB/sec	U4				
	2MB/sec	U2				Standard Video 640 x 480 pix

*Intra Video, is a compression technique performed relative to information contained within only the current frame in a video and is usually larger in size. (https://en.wikipedia.org/wiki/Intra-frame_coding)

Application Performance Classes

With the expanded usage of SD memory cards for storing applications and application data, there is a growing need for a combination of Random and Sequential performance levels. This demand becomes even stronger with the introduction of Android's Adopted Storage Device capability. The Application Performance Class was introduced by SD 5.1 specification with the first App Performance Class 1 (A1), to address these new application-intensive market demands followed by Class 2 (A2). These new classes assure minimum random and sequential performance speeds to meet both run and store execution time requirements under given conditions, while still providing storage of pictures, videos, music, documents and other data.

Application Performance Class Specification Table

Application Performance Class	Pictograph	Minimum Random Read	Minimum Random Write	Minimum Sustained Sequential Write
Class 1 (A1)*	A1 APP PERFORMANCE	1500 IOPS	500 IOPS	10MBytes/sec
Class 2 (A2)**	A2 APP PERFORMANCE	4000 IOPS	2000 IOPS	10MBytes/sec

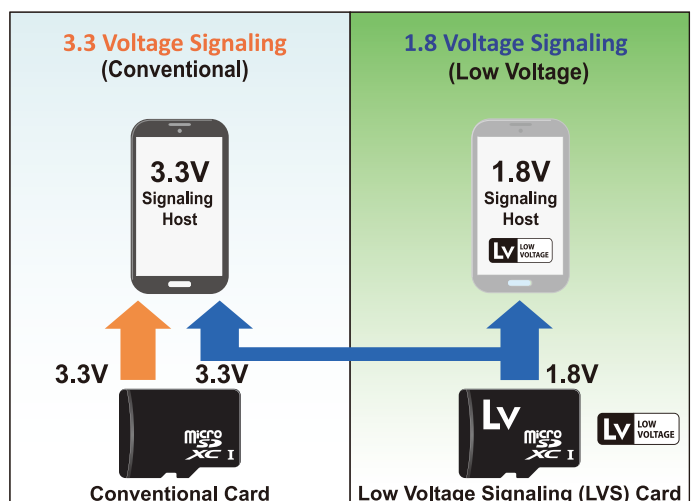
*The detailed preconditions and test are defined in SD 5.1 Part 1 Physical specification.

**The detailed preconditions and test are defined in SD 6.0 Part 1 Physical specification.

Low Voltage Signaling

This new feature lets product manufacturers take advantage of new SOC designs enabling smartphones to offer higher performance with less power consumption. While conventional SD memory cards have used 3.3V signaling interface, the new SD 6.0 specification introduces Low Voltage Signaling (LVS) with 1.8V signaling to let an LVS host device start in UHS-I mode directly, without 3.3V initialization process, after power up. The LVS card is usable by both conventional hosts connected by 3.3V signaling and LVS hosts connected by 1.8V signaling. An LVS host cannot use conventional cards except when UHS-II mode is available.

Low Voltage Signaling Card Feature



SD Memory Card Formatter

SD Memory Card Formatter is designed to optimize the performance of memory cards that conform to SD/SDHC/SDXC standards. Cards formatted with SD Memory Card Formatter maximize its performance and Speed Class capabilities and exhibit increased compatibility between different devices.

Note:


























SD memory cards formatted using a utility bundled with your computer may not perform optimally. SD Association recommends formatting SD memory cards using SD Memory Card Formatter available for downloading it for free from our website.

Compatible Operating Systems

	SD/SDHC/SDXC
Windows	Windows 7, Windows 8, Windows 8.1, Windows 10 Version 1511, Windows 10 Version 1607, Windows 10 Version 1703, Windows 10 Version 1709, Windows 10 Version 1803, Windows 10 Version 1809, Windows 10 Version 1903, Windows 10 Version 1909, Windows 10 Version 2004, Windows 10 Version 20H2, Windows 10 Version 21H1, Windows 10 Version 22H2 (All 32/64-bit), Windows 11 Version 21H2 (64-bit)
Mac OS	Mac OS X 10.7 Lion, Mac OS X 10.8 Mountain Lion, Mac OS X 10.9 Mavericks, Mac OS X 10.10 Yosemite, Mac OS X 10.11 El Capitan, macOS 10.12 Sierra, macOS 10.13 High Sierra, macOS 10.14 Mojave, macOS 10.15 Catalina, macOS 11 Big Sur, macOS 12 Monterey Note: If you have a Mac with Apple silicon, e.g. M1, you might be asked to install Rosetta in order to open the SD Memory Card Formatter.
Linux OS	Debian 10, x86_64, Debian 11, x86_64, Debian 11, ARM64/ Ubuntu 20.04, x86_64/ Raspberry Pi OS, ARM64 2022-04-07/ Fedora 35, x86_64, Fedora 35, ARM64/ Arch Linux, 2022.06.06 (5.17)

About the SD Association

Founded in January 2000 by Panasonic, SanDisk (now Western Digital) and Toshiba (now KIOXIA), the SDA was dedicated to establishing SD as a standard for memory cards. Today, the SDA has grown from 14 members to around 800 members focused on developing and promoting SDA specifications. Today, SD memory cards are the undisputed market leader and consumers first choice in cards.

Spec Version (Release Year)	Capacity & Form Factor	File System	Bus Interface	Speed Class	Others
2020-2023 Ver. 9.10 (2023) Ver. 9.00 (2022) Ver. 8.00 (2020/2023)			SD & microSD Express PCIe Gen.4 x 1 Lane SD Express PCIe Gen.3 & 4 x 2 Lane  	SD Express New Speed Class     (Ver.9.10)	Secure/Fast Boot TCG Storage Security Trusted Computing Group® RPMB Replay Protected Memory Block (Ver.9.00)*1
2018~2019 Ver. 7.10 (2019) Ver. 7.00 (2018)	 	exFAT (Ver.7.00)	SD & microSD Express PCIe Gen.3 x 1 Lane  		Low Voltage Signaling  (Ver.6.00)
2016~2017 Ver. 6.00 (2017) Ver. 5.10 (2016) Ver. 5.00 (2016)			UHS-III  	Video Speed Class V6 V10 V30 V60 V90 (Ver.5.00)	App Performance Class A1 A2 (Ver.5.10) (Ver.6.00)
2011~2013 Ver. 4.20 (2013) Ver. 4.00 (2011)			UHS-II  	UHS Speed Class 3 3 (Ver.4.20)	microSD (Ver.4.00) iSDIO  Wireless LAN SD (Ver.4.20)
2000 ~ 2010 Ver. 3.01 (2010) Ver. 3.00 (2009) Ver. 2.00 (2006) Ver. 1.20 (2005) Ver. 1.10 (2004) Ver. 1.01 (2000)	     	exFAT (Ver.3.00) FAT32 (Ver.2.00) FAT12/16 (Ver.1.01)	UHS-I   Default Speed DS (Ver.1.01) High Speed HS (Ver.1.10)	UHS Speed Class 1 1 (Ver.3.01) CLASS 10 (Ver.3.00) CLASS 6 (Ver.2.00) CLASS 4 (Ver.2.00) CLASS 2 (Ver.2.00)	 (Ver.2.00)

*1 Targeted for embedded or semi-embedded applications supporting through SD Interface and/or PCIe interface (SD Express) cards.