SD Express – a comparison to CFexpress

July 1, 2019 |
Wes Brewer

TWO NEW STANDARDS ARE DRIVING THE NEXT GENERATION OF HIGH PERFORMANCE IN REMOVABLE STORAGE

Recently, the SD Association – the governing body for SD card development and standardization – announced the addition of revision 7.1 of the card SD specification. This latest revision updates section 8.0 which describes an NVMe compliant, PCIe interface option for both bull size SD and smaller size, microSD. Like the announcements of CFexpress 1.0 and 2.0, made by the CompactFlash Association in August of 2016 and February of 2019 respectively, the PCIe interface, with adoption of NVMe 1.3, provides a scalable path for improved performance in flash-based storage devices while conforming to industry standards already in use on other devices such as SSDs.

The purpose of this short white paper is to provide an objective look at the differences between the two competing standards and various form factor options.

Overview:

The major differences between the SD Express and the CFexpress standards lie in the number of PCIe lanes used as well as the physical form factors for each. As highlighted in an earlier white paper by ProGrade Digital, the CFexpress, Type B form factor utilizes two PCIe lanes and has a maximum transfer rate of >2GB/sec. Variants of this base form factor known as Type A and Type C, allow further flexibility in size and performance while leveraging all of the advantages of PCIe Gen 3 interface. The SD Express standard utilizes only a single PCIe lane for both full size SD Express and microSD Express – setting the data transfer performance of both options to 1.0GB/sec. The three variants of CFexpress (A, B and C form factors) allow full scaling of capacity and performance based on the desired application needs.

A simple comparison table below highlights all the major differences in a glance:

	CFexpress Type A	**CFexpress Type B**	**CFexpress Type C**	**microSD Express**	**SD Express**
PCIe Lanes	Gen 3, 1 lane	Gen 3, 2 lanes	Gen 3, 4 lanes	Gen 3, 1 lane	Gen 3, 1 lane
PCIe Performance	Up-to 1GB/sec	Up-to 2GB/sec	Up-to 4GB/sec	Up-to 1GB/sec	Up-to 1GB/sec
Backward Compatibility	None	XQD 1.0/2.0**	None	microSD UHS-I (SDR 104*)	SD UHS-I (SDR 104*)
Card Mfg. Royalty	No	No	No	Yes – 3C LLC	Yes – 3C LLC
Size	20.0 x 28.0 x 2.8mm	38.5 x 29.6 x 3.8mm	54.0 x 74.0 x 4.8mm	11.0 x 15.0 x 1.0mm	32.0 x 24.0 x 2.1mm

**SDR 104 and all traditional SD speed classes are optional*

***Compatibility in XQD hosts may require a FW upgrade or special device driver*

As shown, performance, backward compatibility and physical size are key differentiators. Royalties for SD card makers is another key point – there is a royalty for SD and no royalty for CFexpress.

While SD royalties have long been absorbed by manufacturers and consumers alike, there is clearly an opportunity to produce a lower cost card with CFexpress – at like capacity points. For a clear comparison of the pluses and minuses for each standard, the table below provides a starting point for a more detailed discussion:

	CFexpress		SDexpress
Pluses	・Compatible w/ XQD hosts **		・Compatible w/ some SD hosts
	・2-4x faster than SD Express for Type B & C		・microSD Express smaller than CFexpress Type A
	・Single port host ASIC only		・1.3/1.2V support for Mobile apps
	・Metal housing for heat dissipation		
	・No royalty		
Minuses	・Type B, C physically larger than SD		・Single lane PCIe only ・All SD speed classes "optional"
			・Royalty to card manufacturers
			・Must have two controller functions in card & host
			・Dual port Host ASIC required – possible pad limit

Backward Compatibility - SD:

On the surface, it appears that SD backward compatibility is supported in the new SD Express standard – and this is true to a certain extent. Upon deeper evaluation however, there are couple of areas that could be problematic for users of legacy devices trying to use the SD Express card in their older cameras.

1) Speed Classes that may not be supported in SD Express: Speed Class (SC), UHS SC and Video SC are all optional, i.e., not required.
    a. SC comprises the old C4, C6 and C10 designations. Many older high-end devices require the C10 speed class to record 4K video.
    b. UHS SC comprises the old U1 and U3 designations. Many devices like the Sony A7R III require U3 capability to support 4K video
    c. Video SC comprises the current V30, V60 and V90 video speed designations. Newer devices like the Panasonic GH5S require V90 to support the highest 4K capture rate
2) UHS-II is not supported in SD Express – UHS-I is.
    a. In UHS-I mode: DS, HS, SDR12, SDR25 and SDR50 modes are mandatory.
    b. SDR 104 is optional and is the highest performance transfer mode for UHS-I cameras traditionally. Due to 2a and 2b limitations, the card may only run at 50MB/sec in SD mode.
3) Two controllers per card:
    a. Due to the need for support of both the SD bus in SD Express, there is added cost and complexity associated with providing backward compatibility due to the need of having two functionally different controller functions in each card.

Backward Compatibility - CFexpress:

The main topic of backward compatibility for CFexpress Type B is to the XQD standard, used primarily in Nikon DSLRs and select Sony pro camcorders. Since the CFexpress card can run in single lane PCIe mode, it is possible for some of these cameras to upgrade their firmware to support the CFexpress – likely at a slower capture rate than 2 lane mode.

Voltage support:

The new SD Express can also take advantage of 1.8V and future 1.2V operation. These two lower voltage options have interest for mobile applications in particular, but it is not clear which full-size SD hosts – cameras or otherwise – would take advantage of these low voltage options. The CFexpress card runs only at 3.3V – a standard operating voltage range for removable storage for more than 20 years.

Heat Dissipation:

The form factors of CFexpress allow for a metal housing to be utilized. The advantage of this – particularly on Type B and C form factors is that they are physically larger than SD which allows more heat dissipation by pure volume. But, perhaps more importantly, the ability to utilize a metal housing allows heat to be drawn off of the enclosure which in-turn allows the card to run cooler during long extended high-speed recording sessions – such as recording 4K raw video. The SD Express form factor does not offer a provision for extracting heat from the case during high speed operation.

Royalties:

The SD Association administers a card manufacturers royalty which is payable to the 3C LLC (SanDisk, Panasonic, Toshiba). This royalty is not insignificant and adds cost to the card – ultimately resulting in either higher consumer prices or lower manufacturer's margin. For this reason, there has been an interest to move away from new standards that require a royalty – both by host manufacturers and card manufacturers alike.

Summary:

It is possible there will be adoption of two PCIe based card standards. Some applications that desire a smaller mechanical footprint and don't require two lane performance levels, may favor SD Express. For many professionally focused camera applications, the CFexpress standard has a good chance of winning out. This will primarily be driven by the performance scalability of 1, 2 or 4 lanes of PCIe, robust and more ergonomically friendly form factors and lack of a manufacturer's royalty. Backward compatibility challenges of SD Express could further drive camera vendors to adopt CFexpress and the additional benefit of a metal housing on CFexpress is another plus. The great news about both new standards is that device makers have a range of choices – something to fit everyone need.

Definition of Terms:

PCIe	Peripheral Component Interconnect Express https://en.wikipedia.org/wiki/PCI_Express
NVMe	NVM Express https://en.wikipedia.org/wiki/NVM_Express
XQD	A type of PCIe based memory card overseen by the CompactFlash Association https://en.wikipedia.org/wiki/XQD_card
UHS	Ultra High Speed – a specification pertaining to SD Cards https://en.wikipedia.org/wiki/Secure_Digital
VSC	Video Speed Class – a specification pertaining to SD Cards https://en.wikipedia.org/wiki/Secure_Digital
CFexpress Type A	A single lane PCIe based memory card overseen by the CompactFlash Association which has a proposed outline dimension of: 20mm x 28mm x 2.8mm https://en.wikipedia.org/wiki/CFexpress
CFexpress Type B	A dual lane PCIe based memory card overseen by the CompactFlash Association which has a proposed outline dimension of: 38.5 mm × 29.8 mm × 3.8 mm https://en.wikipedia.org/wiki/CFexpress
CFexpress Type C	A quad lane PCIe based memory card overseen by the CompactFlash Association which has a proposed outline dimension of: 54.0 x 74.0 x 4.8mm https://en.wikipedia.org/wiki/CFexpress