

# FastFormat Technology Helps Future-Proof Systems

## Technology Paper

### What Is FastFormat™ Technology?

With the adoption of Advanced Format technology, the computing world is migrating away from the 512-byte disk sector sizes that have been standard in computing since the 1980s and into larger 4K sectors. Some problems and inefficiencies arise, though, when organizations transition from 512-byte storage to 4K.

Seagate® FastFormat feature enables both legacy 512-byte emulation (512e) and 4K native (4Kn) formats to be supported on a single SAS drive. FastFormat enables you to future-proof systems by performing fast formats (per the T10 specification lead by Seagate) to convert the host block size between 5xx-byte emulation sizes (512, 520, etc.) and 4K sizes (4096, 4160, etc.). Switching between 4Kn and 512e formats at any time can happen in a matter of seconds via a simple drive format command with the FastFormat bit set. This not only reduces the time and effort to transition to 4K, it also eliminates the need to purchase multiple HDDs (512e and 4Kn) to accommodate different system configurations or the hours it takes to completely write a drive to the new format.

### Why Is FastFormat Needed?

Storage devices with larger, more space-efficient 4K physical sectors free up capacity for additional user data and allow enhanced data protection and correction algorithms, which provide increased data reliability. While transitioning to 4K sectors began in 2011, many host computer hardware and software components still assume that hard drive use 512-byte sector boundaries. This includes a broad range of items, including chipsets, operating systems, database engines, hard drive partitioning and imaging tools, backup and file system utilities, and other software applications.

To maintain compatibility with legacy computing components, hard drives use 512e formats to translate 4K sectors into 512-byte sectors on the fly. This translation allows legacy systems to continue operating in 512 byte sectors without changing hardware or software by using the new 512e formats. However, new systems designed for 4K sector sizes don't use the 512e drives, so customer transitioning from 512 to 4K will need to support both configurations. This creates a storage purchasing and management headache for IT, as they must purchase and maintain multiple drives with different formats on different systems. FastFormat eliminates the need to purchase and manage both types of drives by allowing the user to change the format from 512e to 4Kn in seconds to support the different system configurations.

## How Does FastFormat Work?

Fundamentally, FastFormat changes the drive's tables and keeps data and pointers aligned, making it quick and easy to switch formats between 512e and 4Kn. Because both 512e and 4Kn are both supported on a single drive, when you're ready to switch to 4K, you don't have to replace existing drives. With FastFormat, you simply back up your data, issue a single format command with the FastFormat bit set, and the drive formats into either 512e or 4Kn format, as requested. There is no swapping out of drives; you simply continue using the same drive. This makes it significantly easier and faster to transition to 4K when the time is right for your organization, thus eliminating the need to purchase redundant HDDs and replace existing drives. This improves storage ROI, reduces storage expenses and enables IT staff to work on higher-priority initiatives.

## Who Gains the Most From FastFormat?

FastFormat is ideal for organizations transitioning their systems from 512e to 4K sector sizes or that are looking to improve storage ROI. FastFormat can also aid high-performance Tier 1 enterprise servers; blade, rack and tower servers hosting transaction-based applications; and space-constrained data centers as they are supporting both systems.

### FastFormat Benefits

Seagate FastFormat technology provides many benefits. This easy yet powerful feature:

- Makes transitioning to 4K easy and lets you switch whenever you're ready
- Simplifies HDD management and supply chain complexities by reducing the number of drives you must purchase and manage
- Eliminates having to download a new code to convert the host block size between 5xx emulation sizes (512, 520, etc.) and 4K sizes (4096, 4160, etc.)
- Saves IT time and effort because it reduces reformatting time to seconds, and IT doesn't have to replace 512e drives with new 4Kn drives
- Gets you to 4K faster because you spend less time updating storage systems—simply reformat what's already installed
- Increases storage ROI by using higher-capacity, higher-performance, dual-format drives
- Increases system performance by enabling you to use 4Kn drives in 4K-aligned systems
- Reduces storage expenses because you don't have to purchase multiple drives for the same system

### Technical Tips

- All 4Kn/512e drives ship in 512-byte emulation mode but can be easily reformatted to 4Kn (and vice versa) with the FastFormat feature.
- FastFormat only works with 512e and 4Kn. You can't use FastFormat with 512-byte native drives.
- FastFormat reformats the drive, so all data on the drive will be lost once you issue the command. Don't forget to back up your data *before* issuing FastFormat!
- T10 fast format conversion between 4K and 512E configurations is possible only if sector sizes are exact multiples of 8.
- The new sector size will take effect only after a fast format.

Table 1. Allowed Sector Size Conversions With FastFormat Technology

512E/4096
512E+PI/4160
520E/4160
524E/4192
528E/4224
520E+PI/528E
512E+PI/520E
4096+PI/4104

### Mode Select -Parameter List Header

1. Set Write buffer: // Set Block Descriptor Length = 0x08, Number of LBA's = 0xFFFFFFFF
2. 00 00 00 00 00 00 00 08 FF FFFFFFF0 00  
**02 00** // Set block size to **0512 (0x0200)**  
**10 00** // Set block size to **4096 (0x1000)**
3. Then Send Mode Select Command
4. cdb: 55 01 00 00 00 00 00 10 00 //(SP bit = 1, Parameter list = 0x10)

Figure 1. Mode Select Command Example

Format Unit -Parameter List Header
1. Set Write buffer: // Set IMMED = 1 00 02 00 00
2. Then Send Format Unit Command
3. cdb: 04 14 00 00 01 00 //(FMTDAT = 1, DEFECT LIST FORMAT = 010b, FFMT = 01b)

Figure 2. Format Command Example

## 4K vs. 512-Byte Sector Size: Background

Disk formatting is the process of preparing a storage device, such as a hard disk drive, for initial use. The formatting operation typically creates one or more new file systems which are then used to control how data is stored and retrieved. By separating the data into pieces and giving each piece a name, the information is easily isolated and identified. The file system lets the computer know where one piece of information stops and the next begins.

For over 30 years, data stored on hard drives has been formatted into small logical blocks called sectors. A block is a contiguous number of bytes and is the minimum unit of storage read from and written to a disk by a disk driver. Historically, Serial-Attached SCSI (SAS) and Serial ATA (SATA) drives subdivided each track on the disk into one or more contiguous sets of fixed-size, 512-byte blocks that contained user data and associated control information.

### The structure of this sector layout was designed as follows:

- Gap section: The gap separates sectors.
- Sync section: The sync mark indicates the beginning of the sector and provides timing alignment.
- Address Mark section: The address mark contains data to identify the sector's number and location. It also provides status about the sector itself.
- Data section: The data section contains all of the user's data.
- ECC section: The ECC section contains error correction codes that are used to repair and recover data that might be damaged during the reading or writing process.

This low-level format served the industry well for many years. However, as hard drive capacities increased, sector size has increasingly become a limiting design element in improving drive capacities and error correction efficiency. For example, compare the sector size to the total capacity of earlier to more recent hard drives and you'll see that sector resolution (the ratio of sectors as a percent of total storage) has become very fine

and increasingly inefficient, which limits capacity improvements and increases the risk of media defects. These limitations make error correction increasingly difficult.

Capacity	Total Sectors	Sector Resolutions
40MB	80,000	.001%
400GB	800,000,000	.0000001%

As noted earlier, many host-computer hardware and software components assume the hard drive is configured for 512-byte sector boundaries. To maintain compatibility with legacy computing components, many hard disk drive suppliers support Advanced Format technologies on the recording media coupled with 512-byte conversion firmware, which translates the 4K sectors into 512-byte sectors on the fly to give legacy components something they can understand. Hard drives configured with 4096-byte physical sectors with 512-byte firmware are referred to as Advanced Format 512e or 512 emulation drives.

Beginning in 2011, and in conjunction with The International Disk Drive Equipment and Materials Association (IDEMA), the storage industry began transition of hard disk drive (HDD) processing from the historical sector lengths of 512- to 520-byte increments to increments of 4096 bytes per sector using a technology referred to as Advanced Format.

The Advanced Format standard employs the same *gap*, *sync* and *address mark* configuration as the traditional 512-byte sector layout, but it does so by combining eight 512-byte sectors into one data field.

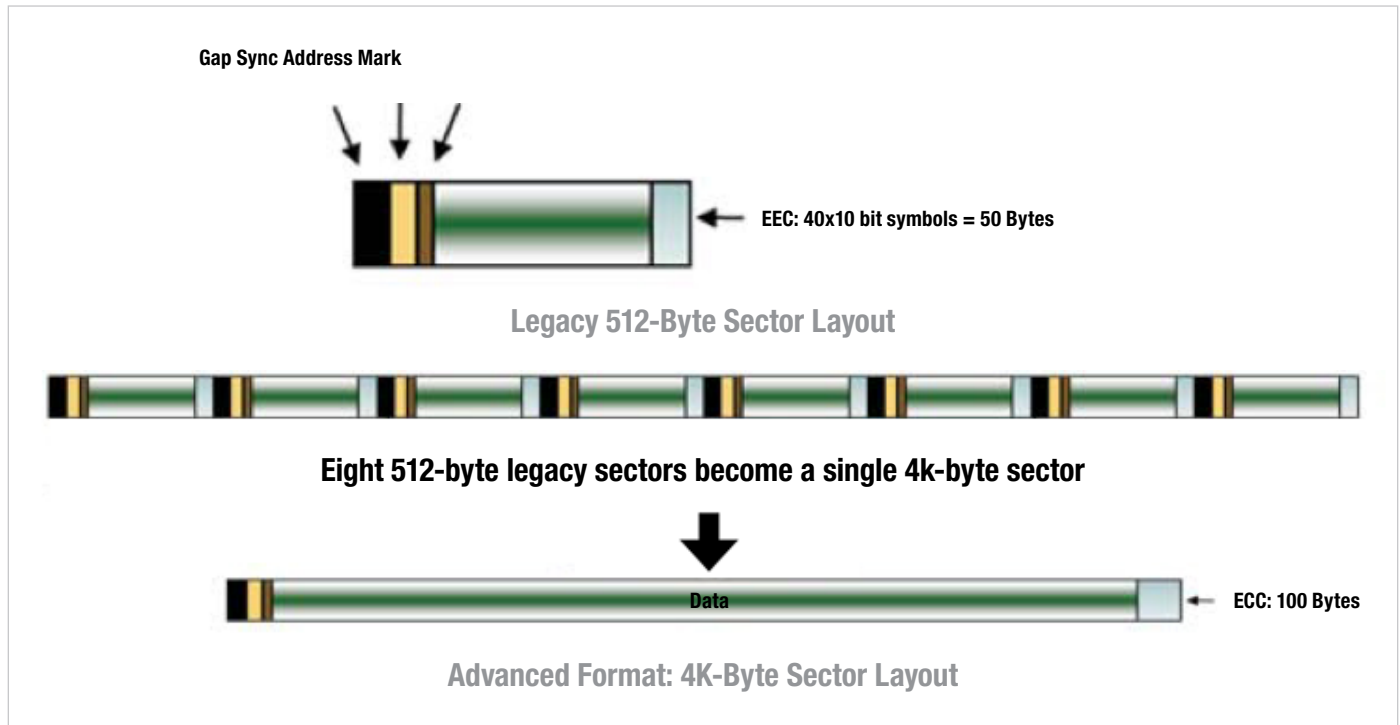


Figure 3. 512-Byte vs. 4K Sector Layouts

4K sectors use the HDD storage surface media more efficiently by combining data that would have been stored in eight 512-byte sectors into one single sector that is 4096 bytes (4 KiB) in length. Key design elements of the traditional 512-byte sector architecture are maintained—specifically, the identification and synchronization marks at the beginning and the error correction coding (ECC) area at the end of the sector. Between the sector header and ECC areas, eight 512-byte sectors are combined, eliminating the need for redundant header areas between each chunk of 512-byte data. The industry settled on the 4K block length for several reasons, including its correspondence to the paging size used by processors and some operating systems, as well as its correlation to the size of standard transactions in relational database systems.

Format efficiency gains resulting from the 4K sector structure range from 7% to 11% of a platter’s physical space. It uses the same number of bytes for gap, sync and address mark, but increases the ECC field to 100 bytes to accommodate improved ECC algorithms. This yields higher capacity points while also improving data integrity.

## Endnotes

- [www.idema.org](http://www.idema.org)
- <http://www.seagate.com/tech-insights/advanced-format-4k-sector-hard-drives-master-ti/>
- Swinburne, Richard, “The Facts: 4K Advanced Format Hard Disks.”
- Curtis E. Stevens, “Advanced Format in Legacy Infrastructures: More Transparent than Disruptive.”

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