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TECH BRIEF

SSD Endurance Explained

Endurance Specifications vs. Workloads

Endurance is an important specification when choosing an SSD for enterprise servers and external storage arrays, to ensure the SSD lasts through the platform's expected lifespan or warranty period. SSDs are based upon flash NAND memory which has a fixed number of P/E cycles and spare flash memory blocks. Once exhausted, the SSD becomes read-only and is typically replaced.

OEMs and/or System Integrators should select SSDs rated for the expected end-customer workload which can be read-intensive, write-intensive, or mixed-use (read/writes). For read-intensive workloads like read caches and business intelligence applications, an SSD with lower endurance can be deployed. For write-intensive or mixed-use workloads, such as smart video or SQL databases for OLTP, an SSD rated with a higher endurance should be deployed. SSDs with higher endurance specifications often use more physical NAND (via over provisioning) to absorb a higher write workload. This results in either less usable capacity as more NAND is dedicated for more write transactions leading to more P/E cycles on the NAND or higher price SSDs since more NAND or more expensive NAND is included on the drive. Therefore, attention to both the drive's endurance spec and warranty period can help avoid issues of over utilization of the drive's capabilities.

PBW and DW/D

The drive's warranty period and capacity are always used in the SSD's endurance specification and should always be considered. The endurance specification is typically stated as either Total Petabytes Written (PBW) or Drive Writes per Day (DW/D).

Most commonly, the SSD manufacturer will specify the endurance as a DW/D for a given set of SSD capacities. DW/D is the endurance specification which is the maximum times per day the entire volume of the drive should be written during its warranty period. This specification is a function of the PBW specification (sometimes not provided) and its warranty period. DW/D is expressed as the following equation:

Total DW/D =
[PBW] / ([SSD Capacity][365 days/year]*[Warranty length in years])*

Therefore, if an OEM knows how many times per day the entire volume is written over its warranty period, the OEM can choose an SSD based upon DW/D endurance specification such as 0.8, 1, or 3 DW/D.

PBW is the endurance specification which states the maximum number of petabytes which can be written to the drive before it becomes read-only or needs to be replaced. If an OEM knows the workload's write intensity to the drive, then they can select an SSD based upon its capacity and DW/D rating to match the expected use of the drive (PBW) over its warranty period. PBW is expressed as the following equation:

Total PBW =
[SSD Capacity][DW/D]*[365 days/year]*[Warranty length in years]*

For example, an OEM should choose a higher DW/D rated SSD for write-intensive workloads to ensure the PBW specification is never exceeded. Optionally, an OEM could choose to increase capacity while using a lower DW/D rated SSD.

How to Compare Endurance Specifications

Compare the total PBW of an Ultrastar® DC SN640 NVMe™ SSD with DW/D = 0.8 and a 5-year limited warranty[1] to an SSD with higher DW/D and shorter 3-year warranty period. Despite a lower DW/D, users may be able to write more data to the Ultrastar DC SN640 and enjoy a longer warranty period.

	Ultrastar DC SN640	Other NVMe SSD
Limited Warranty	5 years	3 years
DW/D	0.8	1.3

Capacity	Total PBW	Total PBW
960GB	1.40	1.37
1920GB	2.80	2.73
3840GB	5.61	5.47
7680GB	11.21	10.93

Next compare the total PBW of an Ultrastar DC SN640 NVMe SSD with 0.8 DW/D and a 5-year limited warranty to a 2 DW/D with the same warranty period. A lower capacity drive with a higher DW/D rating can absorb 2x as much writes over the same 5 year warranty period.

	Ultrastar DC SN640	Ultrastar DC SN640
Limited Warranty	5 years	5 years
DW/D	0.8	2

Capacity	Total PBW	Capacity	Total PBW
960GB	1.40	800GB	2.92
1920GB	2.80	1600GB	5.84
3840GB	5.61	3200GB	11.68
7680GB	11.21	6400GB	23.36

Conclusion

PBW and warranty are 2 key considerations for—

1. How much data can be written to a drive over the life of that drive.
2. How long the drive will last before needing to be replaced.

PBW is calculated from DW/D and the warranty period. An OEM or System Integrator may be able to write more data to an Ultrastar DC SN640 NVMe SSD with 0.8 DW/D and a 5-year limited warranty compared to an NVMe SSD that specifies a higher 1.3 DW/D yet has a lower 3-year warranty. The higher 5-year warranty period also serves to satisfy a common warranty period with enterprise platforms.

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[1] The warranty for the product will expire on the earlier of (1) the date when the flash media has reach one-percent (1%) of its remaining life or (ii) the expiration of the time period associated with the product. Details of Western Digital's warranties are available at www.westerndigital.com/support