Solidigm™ D5-P5336

Massive capacity, minimal cost

Presented by:

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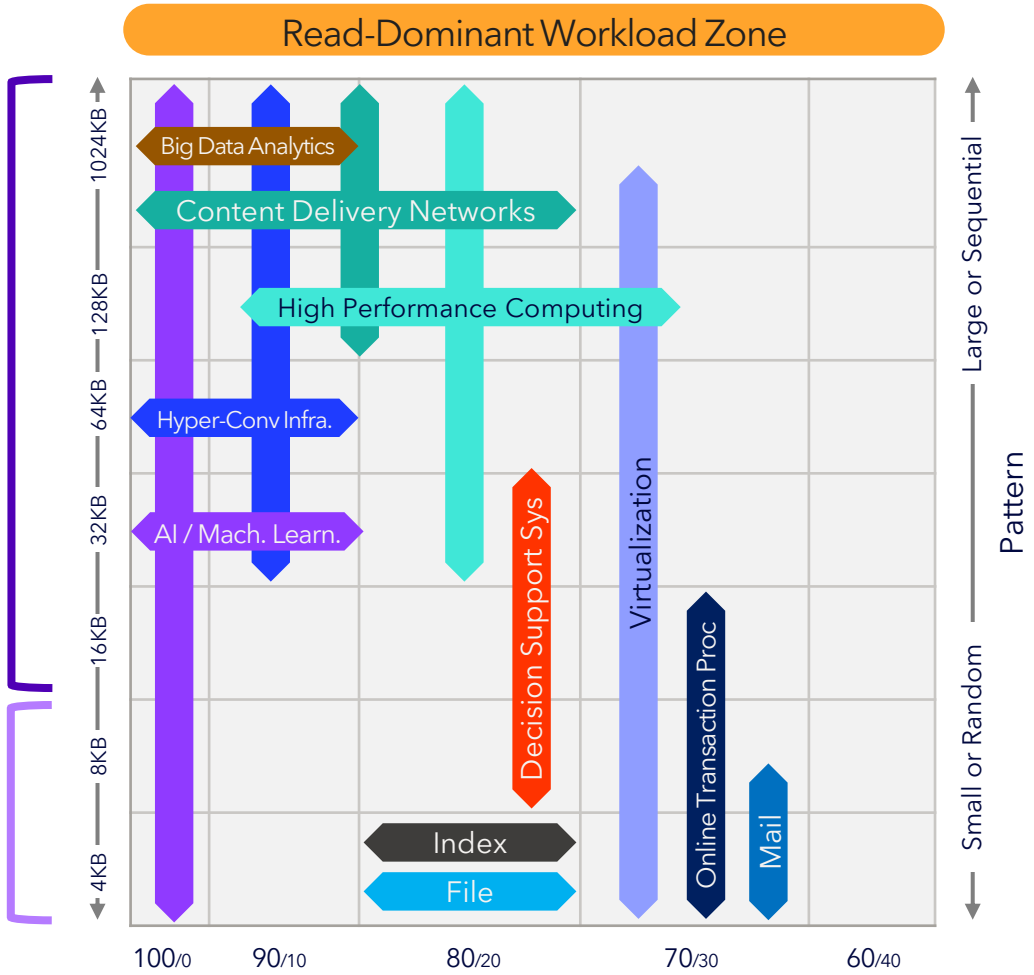
Read activity dominates in the data center

Larger data
transfer sizes

Smaller data
transfer sizes

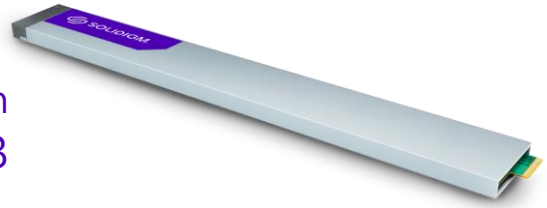


Solidigm™ D5-P5336
The world's highest capacity PCIe SSD[1]

U.2 15mm
7.68TB - 61.44TB

E3.S 7.5mm
7.68TB – 30.72TB

E1.L 9.5mm
15.36TB – 61.44TB

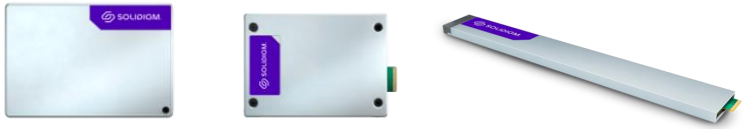


- Accelerate **read intensive** workloads
- **Massive scalability** for high-density storage environments
- **Substantially improve TCO and sustainability** from core to edge infrastructures

[1] Source – Solidigm Comparing 61.44TB Solidigm D5-P5336 to 30.72TB Micron 6500 ION and 30.72TB Kioxia CM7-R and 30.72TB Samsung PM1735 and 15.36TB WD Ultrastar DC SN840. Note that Nimbus 100TB ExaDrive is SAS/SATA.

D5-P5336

7.68TB-61.44TB



U.2 E3.S E1.L

D5-P5430

3.84TB-30.72TB

U.2 E3.S E1.S

	D5-P5336	D5-P5430
Headline	Highest capacity PCIe SSD in the world	Plug & play TLC replacement
Workload	Read-intensive	Mainstream & read-intensive
Use Case	**1) High capacity storage** 2) HDD displacement 3) TLC displacement	1) NVMe entry point 2) TLC displacement

How the D5-P5336 Stacks Up

Product	Sequential Read 128K	Random Read 4K	Endurance Lifetime Petabytes Written (PBW)	Max Cap.
Solidigm D5-P5336[1]	**1.03X**	**1X**	**2.3X**	**4X**
Micron 7450 Pro[2]	1X	1X	1X	1X
Micron 6500 ION[3]	1X	1X	0.6X	2X
Samsung PM9A3[4]	0.98X	1.1X	0.5X	0.5X
Kioxia CD8-R[5]	0.97X	1X	1X	1X

≥ read performance and higher endurance vs. competing TLC

[1] Source: Solidigm. Performance based on maximum data sheet specifications. See appendix for details

Outclassing HDDs

D5-P5336 value vs HDD array

	Enterprise HDD	D5-P5336	
Drive capacity	~20TB	**61.44TB**	**6.3x fewer drives**
Total # of servers			**12.5x fewer servers**
5-year energy cost			**4.9x lower energy cost**

Better value than HDD’s

Source: Solidigm. See Appendix – D5-P5336 TCO and Sustainability Calculations for details.

Rethink **endurance**

DWPD is outdated and deceptive

10TB capacity 1 DWPD **18.25 PBW**	=	20TB capacity 0.5 DWPD **18.25 PBW**

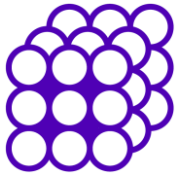
High DWPD does NOT equal high endurance

High PBW (petabytes written) = high endurance

Solidigm QLC has higher PBW than many TLC drives

Endurance Profiler Tool:
https://github.com/intel/endurance_profiler

Solidigm™ D5-P5336.
Our most cost effective, highest capacity SSD



The world's highest capacity PCIe SSD[1]

Similar or better read performance
and higher PBW than TLC SSDs

Reduce operating costs and improve sustainability vs. legacy configurations

Delivered with **industry-leading quality and reliability**[2]

1 Source – Solidigm Comparing 61.44TB Solidigm D5-P5336 to 30.72TB Micron 6500 ION and 30.72TB Kioxia CM7-R and 30.72TB Samsung PM1735 and 15.36TB WD Ultrastar DC SN840. Note that Nimbus 100TB ExaDrive is SAS/SATA.
2. See Q&R appendix

Q&A

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Appendix – D5-P5336 Performance Comparison

Based on maximum datasheet specifications

1. Solidigm D5-P5336: https://www.solidigm.com/products/data-center/d5/p5336.html
2. Micron 7450 Pro: Performance and PBW from highest capacity drive available. https://media-www.micron.com/-/media/client/global/documents/products/product-flyer/7450_nvme_ssd_product_brief.pdf
3. Micron 6500 ION: Performance and PBW detailed at https://www.micron.com/products/ssd/product-lines/6500-ion
4. Samsung PM9A3: Performance and PBW from highest capacity drive available. https://image.semiconductor.samsung.com/resources/data-sheet/Samsung_SSD_PM9A3_Data_Sheet_Rev1.0.pdf
5. Kioxia CD8-R: Performance and PBW from highest capacity drive available. https://americas.kioxia.com/content/dam/kioxia/shared/business/ssd/data-center-ssd/asset/productbrief/dSSD-CD8-R-U2-product-brief.pdf

Appendix – D5-P5336 TCO and Sustainability Calculations

TCO calculations based on internal Solidigm TCO estimator tool. Public tool @ https://estimator.solidigm.com/ssdtco/index.htm will support Solidigm D5-P5336 TCO calculations after product launch.

SOLIDIGM™ D5-P5336 VALUE VS. ALL-HDD ARRAY

All-QLC configuration:
Capacity - Solidigm™ D5 P5336, 61.44TB, U.2, 7000 MB/s throughput, 25W average active write power, 5W idle power, 95% capacity utilization, RAID 1 mirroring, calculated duty cycle 8.9%. Solidigm D5-P5336 61.44TB Standard Distribution Cost used for calculations. Consult your Solidigm salesperson for latest pricing.

All-HDD configuration:
Capacity – Seagate EXOS X20 20TB SAS HDD ST18000NM007D (datasheet), 9.8W average active power, 5.8W idle power, 70% short-stroked throughput calculated to 500 MB/s; Hadoop Triplication, 20% duty cycle. Price based on ServerSupply 20TB pricing as of July 10, 2023, $0.0179/GB
https://www.serversupply.com/HARD%20DRIVES/SAS-12GBPS/20TB-7200RPM/SEAGATE/ST20000NM002D_352787.htm?gclid=CjwKCAjw2K6lBhBXEiwA5RjtCS8vuehEnT0SeCvDB95Y0l7X-Ho2VUmMYoVZ600X0sRdGtaieugddBoCv9QQAvD_BwE

Key common cost component assumptions : Power Cost = $0.15/KWHr; PUE factor = 1.60; Empty Rack Purchase Cost = $1,200; System Cost = $10,000; Rack Cost for Deployment Term = $171,200

Appendix – Solidigm Quality & Reliability

1. **End-to-end data protection**. Source – Solidigm. Enhanced Power Loss Imminent – Additional firmware check validates data is saved accurately upon power restoration. Unclear if others provide this additional firmware check. Robust End-to-End Data Protection – Built-in redundancy where both ECC and CRC can be active at the same time. Protecting all critical storage arrays within the controller – instruction cache, data cache, indirection buffers and phy buffers. ECC coverage of SRAM to over 99% of array is among the highest in the industry.
2. **UBER testing**. Source – Solidigm. Uncorrectable Bit Error Rate (UBER) - tested to 10X higher than JEDEC spec. Solidigm tests to 1E-17 under full range of conditions and cycle counts throughout life of the drive which is 10X higher than 1E-16 specified in JEDEC – Solid State Drive Requirements and Endurance Test Method (JESD218). https://www.jedec.org/standards-documents/focus/flash/solid-state-drives. Silent Data Corruption (SDC) - modeled to 1E-25. Typical Reliability Demonstration Test involve 1K SSDs for 1K hrs to model to 1E-18. Solidigm drives are tested at the neutron source at Los Alamos National Labs to measure SDC susceptibility to 1E-23 and modeled to 1E-25.
3. **SDC resistance.** Source – Solidigm. Drives are tested at the neutron source at Los Alamos National Labs to measure Silent Data Corruption susceptibility to 1E-23 and modeled to 1E-25. Test prefills drives with a certain data pattern. Next, the neutron beam is focused on the center of the drive controller while IO commands are continuously issued and checked for accuracy. If the drive fails and hangs/bricks, the test script powers down the drives and the neutron beam. The drive is subsequently rebooted, and data integrity is checked to analyze the cause of failure. SDC can be observed during run time causing a power down command or after reboot if the neutron beam has hit the control logic hanging the drive as a result of inflight data corruption. Because drives go into a disable logical (brick) state when they cannot guarantee data integrity, brick AFR is used as the measure of error handling effectiveness. Solidigm drives have used this testing procedure across 4 generations. Cumulative testing time across generations is the equivalent of over 6M years of operational life in which zero SDC errors have been detected. The most recent testing used the Solidigm D5-P5520 drives which served as a proxy for the Solidigm D5-P5430 drives since they share the same controller and similar firmware. Competitor drives tested were the Samsung 983 ZET, Samsung PM9A3, Samsung PM1733, Micron 7400, Micron 7450, Kioxia XD6, Toshiba XD5 and, WD SN840.
4. **Industry-leading AFR:** Source – Solidigm AFR data as of Mar 2023. Annual Failure Rate (AFR) is defined by Solidigm as customer returns less units which upon evaluation are found to be fully functional and ready for use.
5. **Real-world Performance.** Source: Solidigm. See Appendix – D5-P5336 Performance Tests for details.
6. **Customer support satisfaction**. Source – Solidigm. Based on analysis of all 2021 call center tickets.

Appendix – Zero SDC Events

Source – Solidigm. Solidigm drives are tested at the neutron source at Los Alamos National Labs to measure Silent Data Corruption susceptibility to 1E-23 and modeled to 1E-25. Test prefills drives with a certain data pattern. Next, the neutron beam is focused on the center of the drive controller while IO commands are continuously issued and checked for accuracy. If the drive fails and hangs/bricks, the test script powers down the drives and the neutron beam. The drive is subsequently rebooted, and data integrity is checked to analyze the cause of failure. SDC can be observed during run time causing a power down command or after reboot if the neutron beam has hit the control logic hanging the drive as a result of inflight data corruption. Because drives go into a disable logical (brick) state when they cannot guarantee data integrity, brick AFR is used as the measure of error handling effectiveness. Solidigm drives have used this testing procedure across 4 generations. Cumulative testing time across generations is the equivalent of over 6M years of operational life in which zero SDC errors have been detected. The most recent testing used the Solidigm D5-P5520 drives which served as a proxy for the Solidigm D5-P5430 drives since they share the same controller and similar firmware. Competitor drives tested were the Samsung 983 ZET, Samsung PM9A3, Samsung PM1733, Micron 7400, Micron 7450, Kioxia XD6, Toshiba XD5 and, WD SN840.