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Solidigm™ D5-P5336

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Store and Accelerate Access to Massive Amounts of Data—No Matter Where It Lives

The Solidigm™ D5-P5336 is part of Solidigm's third-generation QLC SSDs for the data center, delivering an industry-leading blend of capacity, read-optimized performance, and value to read- and data-intensive workloads.

Combining read performance exceeding that of some cost-optimized TLC SSDs and capacities up to 61.44TB[1] built on industry-leading NAND density,[2] the D5-P5336 has been architected to efficiently accelerate and scale the increasingly massive datasets found in widely deployed, modern read-intensive workloads while increasing storage density, reducing total cost of ownership (TCO), and enabling a more sustainable storage infrastructure.

Storage Density Matters

Widely adopted modern workloads are becoming even more data hungry. Many AI models are growing as much as 10x in size every two years.[3] Many streaming services are shifting from limited, paid-for capacity to unlimited free capacity.[4] With connected Internet of Things (IoT) devices expected to reach 14.5B by the end of 2023,[5] supported by the tailwind of an accelerating 5G rollout, there is no end in sight to unabated growth in data-rich services and applications.

Accompanying this trend is the decentralization of compute and storage to the edge to improve service levels, reduce cost, and improve agility. As recently as 2018, only 10 percent of enterprise-generated data was created and processed outside of traditional centralized data centers or cloud services. By 2025, Gartner expects 75 percent of that data to be created, processed, and stored at edge locations.[6] Storage challenges such as space, power, cooling, and serviceability become even more acute when considering locality constraints at edge deployments.

Optimized Capabilities for Read-Intensive Workloads

In this environment, modern, data-hungry workloads such as data pipelines and data lakes for AI, machine learning (ML), big data analytics, content-delivery network (CDN), scale-out NAS, object storage, and edge usages are increasingly concerned with storing and accessing vast amounts of data efficiently at speed. The D5-P5336 is optimized for both requirements, with read performance equivalent to TLC SSDs and capacities that are 2–3x higher than alternatives.

The D5-P5336 delivers TLC-equivalent performance for read- and data-intensive workloads.

Product	SR 128K	RR 4K	SW 128K	RW 4K	Max Endurance[7] Lifetime Petabytes Written (PBW)	Max Capacity
Samsung PM9A3[8]	0.98X up to 6700 MB/s	1.1X up to 1.1M IOPS	0.73X up to 4000 MB/s	0.80X up to 200K IOPS	0.5X 14 PBW	0.5X 7.68 TB
Micron 7450 Pro[9]	1X up to 6800 MB/s	1X up to 1.0M IOPS	1X up to 5600 MB/s	1X up to 250K IOPS	1X 28 PBW	1X 15.36 TB
Micron 6500 ION[10]	1X up to 6800 MB/s	1X up to 1.0M IOPS	0.89X up to 5000 MB/s	0.80X up to 200K IOPS	0.6X 16.8 PBW	2X 30.72 TB
Solidigm™ D5-P5336[7]	**1.03X** up to 7000 MB/s	**1X** up to 1.005M IOPS	0.59X up to 3300 MB/s	0.15X up to 38K IOPS	**2.3X** 65 PBW	**4X** 61.44 TB
KIOXIA CD8-R[11]	0.97X up to 6600 MB/s	1X up to 1.05M IOPS	1.07X up to 6000 MB/s	0.78X up to 195K IOPS	1X 28 PBW	1X 15.36 TB

Form factors and capacities supported on the D5-P5336 enable a wider range of 1U and 2U server configurations and TCO opportunities.				
Form Factors	D5-P5316[12]	Micron 6500 ION[10]	D5-P5336[7]	D5-P5336 Advantage
U.2/U.3 15 mm	U.2 15.36–30.72TB	U.3 30.72TB	U.2 7.68–61.44TB	Support for widely adopted U.2; broader capacity range
E3.S 7.5 mm	Not applicable (N/A)	N/A	7.68–30.72TB	Support for E3.S to improve operational efficiency
E1.L 9.5 mm	15.36–30.72TB	30.72TB	15.36–61.44TB	Broader capacity range

Unprecedented Value from the Core to the Edge

Fast reads and massive, affordable capacities position the D5-P5336 quite favorably to reduce TCO and improve sustainability across a range of alternative configurations for read-intensive workloads. The following table shows D5-P5336 value compared to legacy-based solutions when solving for a theoretical 100PB object storage solution.

D5-P5336 TCO Savings[13]	All-TLC SSD Array[14]	Hybrid TLC SSD + HDD Array[15]	All-Nearline SAS/SATA HDD Array[16]
	Up to 2x fewer servers	Up to 15x fewer servers	Up to 12.5x fewer servers
	Up to 20% lower five-year energy cost	Up to 6x lower five-year energy cost	Up to 4.9x lower five-year energy cost
	Up to 17% lower TCO	Up to 61% lower TCO	Up to 47% lower TCO

As noted earlier, the drive's capabilities extend to significant benefits at the edge as well.

D5-P5336 Capability	Edge Advantage vs. HDDs and TLC SSDs
Up to 61.44TB	Store 2–3x more in edge servers[17]
Broad EDSFF portfolio	Store more data in more places and improve operational efficiency
Weight efficiency	Improved portability with up to 3.4x more capacity per gram[18] vs TLC SSDs and up to 13.7x vs HDDs
High PBW	Longer usable life

Deploy with Confidence

Solidigm believes the two most basic requirements of any storage device are to always be available and never return bad data. While no storage can provide an absolute guarantee these requirements are met, we apply our decades of experience and industry-wide deep technical engagements to relentlessly pursue these goals. It starts with design, where we add extra checks into our power-loss protection to ensure data is saved accurately and deliver highly robust full data path protection with error correction code (ECC) covering 99 percent of SRAM.[19] From there, we conduct test and validation procedures that go above and beyond industry specifications and common practices such as testing for Uncorrectable Bit Error Rates (UBER) 10x beyond the JEDEC specification.[20] This obsessiveness pays off when considering results such as annualized failure rate (AFR) in high-volume manufacturing is consistently better than our ≤0.44 percent goal,[21] and testing for resistance to silent data corruption (SDC) at Los Alamos National Labs that spans five product generations across more than 6 million years of simulated drive life has shown zero SDC events.[22]

Solidigm D5-P5336 Key Feature Overview[7]

Product Name	**Solidigm D5-P5336**			
Media	192L QLC NAND			
Power off Retention	3 months @ 40°C			
Indirection Unit	16KB			
User Capacity	7.68TB	15.36TB	30.72TB	61.44TB
Endurance (Five-Year DWPD)[23]	0.42	0.51	0.56	0.58
Endurance (PBW)[23]	5.9	14.1	31.5	65.2
Max Power	25 W			
Idle Power	<5 W			
UBER	< 1 Sector per 10^{17} bits read			
MTBF	2 million hours			
Features	OCP 2.0 support,[24] NVMe 1.4 compliance,[25] FIPS 140-3 Level 2			

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[1] Solidigm D5-P5336 U.2 and E1.L in 15.36TB and 30.72TB shipping now. All other capacities and form factors will ship later in 2023.

[2] Comparing density of Solidigm D5-P5336 of 18.6 Gb/mm² to Micron's highest currently shipping density of 14.55 Gb/mm², Samsung's highest currently shipping density of 10.59 Gb/mm², and KIOXIA's announced highest density of 10.4 Gb/mm², which is not currently shipping.

[3] Towards Data Science. "Parameter counts in Machine Learning." July 2021. https://towardsdatascience.com/parameter-counts-in-machine-learning-a312dc4753d0.

[4] Based on widely available research on streaming services such as Netflix, Hulu, Amazon Prime, and Spotify.

[5] Orion Talent. "The Future of the Data Center Industry: Trends & Analytics for 2022 & Beyond." May 2022. www.oriontalent.com/recruiting-resources/blog/575/data-center-trends.

[6] Gartner. "What Edge Computing Means for Infrastructure and Operations Leaders." October 2018. www.gartner.com/smarterwithgartner/what-edge-computing-means-for-infrastructure-and-operations-leaders.

[7] Solidigm D5-P5336 product specifications and current five-quarter roadmap. Endurance for 100% 16K read/write (RW) for 61.44TB.

[8] 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.

[9] Micron 7450. 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.

[10] Micron 6500 ION. Performance and PBW detailed at www.micron.com/products/ssd/product-lines/6500-ion.

[11] 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.

[12] Solidigm D5-P5316 product brief.

[13] TCO calculations based on internal Solidigm TCO estimator tool. Public tool at https://estimator.solidigm.com/ssdtco/index.htm will support Solidigm D5-P5336 TCO calculations after product launch. Key common consumptions across all comparisons: power cost = $0.15/kWh; PUE factor = 1.60; empty rack purchase cost = $1,200; system cost = $10,000; rack cost for deployment term = $171,200.

[14] **All-QLC configuration**: Capacity: Solidigm D5-P5336, 61.44TB, E1.L 9.5 mm, 7,000MB/s throughput, 25 W average active write power, 5 W idle power, 95 percent capacity utilization, RAID 1 mirroring. **All-TLC configuration**: Capacity: Micron 6500 ION, 30.72 TB, E1.L 9.5 mm, 6,800 MB/s throughput, 20 W average active write power, 5 W idle power, 95 percent capacity utilization, RAID 1 mirroring; www.micron.com/products/ssd/product-lines/6500-ion.

[15] **All-QLC configuration**: Single-layer capacity: Solidigm D5-P5336, 61.44TB, U.2, 7,000MB/s throughput, 16 W average active write power, 5 W idle power, 95 percent capacity utilization, RAID 1 mirroring, calculated duty cycle 8.9 percent. **Hybrid configuration**: Capacity: Seagate EXOS X20 20TB SAS HDD ST18000NM007D (datasheet), 70 percent short-stroked throughput calculated to 500MB/s; 9.4 W average active power, 5.4 W idle power, Hadoop triplication, 20 percent duty cycle. **Cache**: Micron 7450 15.36TB, 6,800 MB/s throughput, 16.6 W average active write power, 5 W idle power, 7 percent cache-to-capacity ratio recommended to meet customer service-level agreements (SLAs); www.micron.com/products/ssd/product-lines/7450.

[16] **All-QLC configuration**: Capacity: Solidigm D5-P5336, 61.44TB, U.2, 7,000MB/s throughput, 25 W average active write power, 5 W idle power, 95 percent capacity utilization, RAID 1 mirroring, calculated duty cycle 8.9 percent. **All-HDD configuration**: Capacity: Seagate EXOS X20 20TB SAS HDD ST18000NM007D (datasheet), 9.8 W average active power, 5.8 W idle power, 70 percent short-stroked throughput calculated to 500MB/s; Hadoop triplication, 20 percent duty cycle.

[17] Edge density advantage vs. HDD comparing 61.44TB D5-P5336 to commonly available maximum capacity of 20TB as represented by 20TB Seagate EXOS 20. HDD capacity does not factor in any over-provisioning required to meet storage performance needs. Max 4 x 3.5" HDD or U.2 drives inspired by Open19 1U half brick server configuration. Edge density advantage vs. TLC SSD comparing 61.44TB D5-P5336 to 30.72TB Micron 6500 ION. Max 4 x U.2 or U.3 drives inspired by Open19 1U half brick server configuration.

[18] Weight efficiency vs. HDD comparing D5-P5336 61.44TB U.2: 61,440GB at 150 g = 409.6 GB/g vs. Seagate EXOS X20 20TB HDD SAS 3.5": 20,000GB at 670 g = 29.9 GB/g. HDD capacity does not factor in any over-provisioning required to meet storage performance needs. Weight efficiency vs. TLC SSD comparing D5-P5336 61.44TB U.2: 61,440GB at 150 g = 409.6GB/g vs. KIOXIA CD6-R 15.36TB U.3: 15,360GB at 130 g = 118.1GB/g.

[19] **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 more than 99 percent of array is among the highest in the industry.

[20] 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)." www.jedec.org/standards-documents/focus/flash/solid-state-drives. Silent Data Corruption (SDC) modeled to 1E-25. Typical reliability demonstration tests involve 1K SSDs for 1K hours 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.

[21] Annualized Failure Rate (AFR) data as of March 2023. AFR is defined by Solidigm as customer returns less units that, upon evaluation, are found to be fully functional and ready for use.

[22] Solidigm drives are tested at the neutron source at Los Alamos National Labs to measure silent data corruption (SDC) susceptibility to 1E-23 and modeled to 1E-25. Tests prefill drives with a certain data pattern. Next, the neutron beam is focused on the center of the drive controller while input/output (I/O) 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 in-flight 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 four generations. Cumulative testing time across generations is the equivalent of more than 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 because 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.

[23] IU-aligned endurance, based on 100 percent RW 16 KB workload calculation.

[24] See D5-P5336 product specification for exceptions and modifications for compliance/support details.

[25] Q1 SKUs compliant with NVMe version 1.4 and NVMe MI 1.1. NVMe 2.0 and NVMe-MI 1.2 support to be targeted in PRQ2 and subsequent releases.

Current characterized errata are available on request.

Contact your Solidigm representative or your distributor to obtain the latest specifications before placing your product order.

For copies of this document, documents that are referenced within, or other Solidigm literature, please contact your Solidigm representative.

All products, computer systems, dates, and figures specified are preliminary based on current expectations, and are subject to change without notice.