Extending NAND Leadership with 
Intel® SSD D7-P5510 & 
Intel® SSD D5-P5316

Jonmichael Hands
Sr. Strategic Planner & Product Manager
Launching the Intel® SSD D7-P5510
First to market 144-layer data center TLC 3D NAND

- Accelerates wide range of cloud data center workloads
- U.2 form factor with 3.84TB, 7.68TB capacity
- Available Q4 2020
Introducing the Intel® SSD D5-P5316
The industry’s first 144-layer QLC NAND

- Denser, higher performance and endurance than previous gen industry-leading QLC
- Up to 30.72TB enabling 1PB in 1U
- Available 1H 2021

See Appendix for workloads and configurations. Results may vary.
Expanded 3D NAND Portfolio

Compelling opportunities

**Intel® SSD D7-P5500 & D7-5600, 96-Layer TLC**

First Intel PCIe 4.0 NVMe for enterprise servers

Shipping since 1H’20

**Intel® SSD D7-P5510 144-Layer TLC**

Cloud storage acceleration

Available in Q4’ 20

**Intel® SSD D5-P5316 144-Layer QLC**

Warm storage optimized

Available in 1H’21

Under Embargo until December 16, 2020, 6:00 AM PST
Intel® SSD D7-P5510 Key Specifications

**Performance**¹

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Spec</th>
<th>Gen to gen</th>
</tr>
</thead>
<tbody>
<tr>
<td>4K Rand. Read/Write</td>
<td>Up to 930K/190K IOPS</td>
<td>45% / 41% higher²</td>
</tr>
<tr>
<td>Read/Write Bandwidth</td>
<td>Up to 7000/4194 MB/s</td>
<td>up to 118% / 35% higher³</td>
</tr>
<tr>
<td>Mixed Performance IOPS</td>
<td>400K IOPS</td>
<td>up to 50% higher⁴</td>
</tr>
<tr>
<td>Endurance</td>
<td>1+ DWPD</td>
<td>up to 17% higher⁵</td>
</tr>
<tr>
<td>Average Latency</td>
<td>86/16us</td>
<td>up to 14% better⁶</td>
</tr>
<tr>
<td>Accelerated TRIM time</td>
<td>&lt;100ms</td>
<td>up to ~100x better⁷</td>
</tr>
</tbody>
</table>

**Form Factor & Capacities**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Form Factor</td>
<td>U.2 15mm</td>
</tr>
<tr>
<td>Storage capacity</td>
<td>3.84TB, 7.68TB</td>
</tr>
</tbody>
</table>

See Appendix for workloads and configurations. Results may vary.

**New Features**

- **Health Monitoring**: Improved drive monitoring and management
- **Dynamic Multiple Namespace**: Flexibility for multi-tenant/virtualized environments
- **Cloud performance**: New algorithms and features tuned for cloud workloads

**Data Integrity and Security**

- **End-to-End Data Protection**: Industry-leading protection from silent data corruption⁸
- **PLI**: Protection from unplanned power loss
- **Data Security**: Enterprise security features
# Intel® SSD D7-P5510 Features

Intersection between cloud performance and enterprise security and manageability

<table>
<thead>
<tr>
<th>Health Monitoring</th>
<th>Cloud Workload Optimized</th>
<th>Dynamic Multiple Namespaces</th>
<th>Power Efficient</th>
<th>Data Security</th>
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<tbody>
<tr>
<td>Reliable health monitoring</td>
<td>New high bandwidth TRIM architecture, improved tail latencies, and SGL support</td>
<td>Configurable namespace locking &amp; dynamic multiple namespaces for multi-tenant/virtualized environments</td>
<td>Multiple NVMe power states to optimize for different TDPs</td>
<td>AES-256 HW encryption NVMe Sanitize TCG Opal 2.0.1</td>
</tr>
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</table>

- **Health Monitoring**
  - Reliable health monitoring
  - Enterprise level management with NVMe-MI, Device Self-Test and persistent event logs

- **Cloud Workload Optimized**
  - New high bandwidth TRIM architecture, improved tail latencies, and SGL support

- **Dynamic Multiple Namespaces**
  - Configurable namespace locking & dynamic multiple namespaces for multi-tenant/virtualized environments

- **Power Efficient**
  - Multiple NVMe power states to optimize for different TDPs

- **Data Security**
  - AES-256 HW encryption
  - NVMe Sanitize
  - TCG Opal 2.0.1
Performance Tuned to Solve Real-world Problems
Comparing Intel® SSD D7-P5510 vs competitor PCIe 4.0 SSD

Scale Databases While Maintaining SLA

Deploy More Power Efficient Performance

Higher is Better
Seq. R/Watt 127%
Rand. Wr/Watt 146%
Seq. R/Watt 100%
Rand. Wr/Watt 100%

Better Responsiveness Under Mixed IO

Lower is Better
1.385 ms
0.452 ms
Up to 67% better responsiveness

Intel® SSD D7-P5510
Competitor PCIe 4.0 SSD

Delivering real value across a range of usages

See Appendix for workloads and configurations. Results may vary.
Intel® QLC NAND Leadership
Improving on an industry leading technology

First to market QLC PCIe

Leap forward in 2021

Gen 2 QLC 2018

Gen 4 QLC 2021

Same Quality and Reliability as TLC
- TLC equivalent MTBF, temp range, UBER, retention, warranty uncycled shelf life
- Same ASIC as TLC simplifies qualification

Extending Endurance Leadership
- 4x higher endurance than comp 64-layer QLC\textsuperscript{12}
- 4x higher PBW gen over gen\textsuperscript{13}

Continuous Value Improvement
- Massive improvement in area density\textsuperscript{14}
- Further cost reduction via DRAM optimization\textsuperscript{15}

Greater Performance
- Up to 50% better QoS across read workloads\textsuperscript{16}
- Up to 40% higher write performance at component level\textsuperscript{17}
- TLC equivalent PCIe 4.0 read bandwidth\textsuperscript{18}

See Appendix for workloads and configurations. Results may vary.
## Intel® SSD D5-P5316 Key Specifications – QLC

### Performance

<table>
<thead>
<tr>
<th>Specification</th>
<th>Gen to gen</th>
<th>Spec</th>
<th>Comparison</th>
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<tbody>
<tr>
<td>4K Rand. Read</td>
<td>38%</td>
<td>Up to 800K IOPS</td>
<td>4K Rand. Read</td>
</tr>
<tr>
<td>128K Seq. Read</td>
<td>2x+</td>
<td>Up to 6800 MB/s</td>
<td>128K Seq. Read</td>
</tr>
<tr>
<td>Endurance (Total PB Written)</td>
<td>4x</td>
<td>Up to 18PB (3K P/E Cycles)</td>
<td>Endurance</td>
</tr>
</tbody>
</table>

### Form Factor & Capacity

- **Form Factor**: U.2 15mm/E1.L
- **Storage capacity**: Industry-leading QLC storage capacity up to 30.72TB

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See Appendix for workloads and configurations. Results may vary.
Delivering Disruptive TCO for Capacity Storage

<table>
<thead>
<tr>
<th>TCO $/TB Effective Per Rack</th>
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<tbody>
<tr>
<td>18TB HDD</td>
</tr>
<tr>
<td>30.72TB NVMe</td>
</tr>
<tr>
<td>EC</td>
</tr>
<tr>
<td>Compression</td>
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<tr>
<td>$100</td>
<td>$400</td>
<td>$200</td>
<td>$50</td>
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</table>

4+2 Erasure Code
3:1 Compression

See Appendix (22) for workloads and configurations. Results may vary.
Portfolio Additions Extend 3D NAND Leadership

Launching Intel® SSD D7-P5510
- World’s first to market 144-layer TLC
- Designed for cloud storage
- Delivering real world value across a wide range of usages
- U.2 form factor with 3.84TB, 7.68TB capacity
- Available in Q4 2020

Announcing Intel® SSD D5-P5316
- Built around industry’s first 144-layer QLC
- Denser, higher performance, and higher endurance than our previous gen industry-leading QLC (128GB per die)\textsuperscript{13, 20, 21}
- E1.L and U.2 form factor with up to 30.72TB enabling 1PB in 1U
- Capacity storage replacement
- Available in 1H 2021

See Appendix for workloads and configurations. Results may vary.
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Appendix

1. **Test and System Configuration:** Mainboard: Intel® Server Board S2600WFT, Version: R2208WFTZS, BIOS: SE5C620.86B.00.01.0014.070920180847, Platform architecture: x86_64, CPU: Intel® Xeon® Gold 6140 CPU @ 2.30GHz, CPU Sockets: 2, RAM Capacity: 32G, RAM Model: DDR4, OS version: centos-release-7-5, Build id:1804, kernel: 4.14.74, NVMe Driver: Inbox, Fio version: 3.5, G4SAC PCIe Gen4 switch PCIe card (Microsemi*). P5510, P5316 were tested on JCV10023 and ACV10005 firmware respectively.

2. Up to 45%/41% higher – 45% higher 4K random read QD256 between P5510 (930K IOPS) and P4510 (642K IOPS). 41% higher 4K random write QD256 between P5510 (190K IOPS) and P4510 (135K IOPS).

3. Up to 118%/35% higher – 118% higher 128K sequential read QD256 between P5510 (7.00 GB/s) and P4510 (3.2 GB/s). 35% higher 128K sequential write QD256 between P5510 (4.194 GB/s) and P4510 (3.1 GB/s).

4. Up to 50% higher – 50% higher 4K random 70/30 R/W QD256 between P5510 (400K IOPS) and P4510 (266K IOPS).

5. Up to 17% higher – 17% higher endurance on JEDEC workload between P5510 3.84(1 DWPD) and P4510 4TB (0.85 DWPD).

6. Up to 10% better – 10% better 4K QD1 random read latency between P5510 (86us) and P4510 (95us).

7. More than 100x better – Comparing accelerated TRIM time between P5510 (<100ms) and P4510 (>30s).

8. **Industry-leading Protection From Silent Data Corruption.** Source – Drives tested at source: Los Alamos Neutron Science Center, https://lansce.lanl.gov/facilities/wnr/index.php. 10^6 neutron acceleration factor. Test performed on single port SSDs, Intel® SSD DC S3520, Intel® SSD DC P3520, Intel® SSD DC P3510, Intel® SSD DC P4500, Intel® SSD DC S4500, Intel® SSD DC P4800X, Intel® SSD D7-P55XX, Intel® SSD D7-P56XX Samsung PM953, Samsung PM1725, Samsung PM961, Samsung PM863, Samsung PM963, Samsung 860DCT, Samsung PM883, Samsung PM983, Micron 7100, Micron 5100DC, Micron 9100, Micron 5100, Micron 5200, HGST SN100, Seagate 1200.2, SanDisk CS ECO, Toshiba XGS, Toshiba Z6000 drives. Zero silent data corruption measured in Intel single port drives representing cumulative measurement time > 5 million hours. Neutron radiation is used to determine silent data corruption rates and as a measure of overall end-to-end data protection effectiveness. Among the causes of data corruption in an SSD controller are ionizing radiation, and SRAM instability. Silent errors were measured at run-time and at post-reboot after a drive "hang" by comparing expected data vs actual data returned by drive. The annual rate of data corruption was projected from the rate during accelerated testing divided by the acceleration of the beam (see JEDEC standard JESD89B/C).
Appendix

9. Up to 60% better No-SQL performance Aerospike Certification test vs comp – Samsung 1733 3.84TB can pass up to 50x on the Aerospike Certification Test. Intel® SSD D7-P5510 3.84TB can pass up to 80x, 60% improvement.

10. Up to 46% better performance/watt - 4K random write, QD256 for Samsung 1733 7.68TB (10,504 IOPS/W) and Intel® SSD D7-P5510 7.68TB (15,316 IOPS/W). Percentage change is 46%. Up to 27% better performance/power – 128KB Sequential read, QD128 for Samsung 1733 3.84TB (535 MB/W) and Intel® SSD D7-P5510 3.84TB (680 MB/W), percentage change is 27%.

11. Up to 67% better responsiveness under real workload - 4K random 70/30 R/W QDI for Samsung 1733 3.84TB (1.385ms) and Intel® SSD D7-P5510 3.84TB (0.463ms). Percentage change is -67%.

12. 4x higher endurance than comp – Comparing Intel® SSD D5-P4320 7.68TB (2,803 TBW) to Micron 5210 ION 7.68TB (700 TBW).
   https://www.micron.com/solutions/technical-briefs/micron-5210-ion-ssd

13. 4x higher endurance gen over gen – Comparing endurance (64K random write) between Intel® SSD D5-P5316 30.72TB (18,940 TBW) and Intel® SSD D5-P4326 15.36TB (4,400 TBW).

14. Massive improvement in areal density – P5316 on Intel® 3D NAND floating gate technology. It’s up to 20% higher areal density vs. charge trap flash cells.

15. Cost reduction via DRAM optimization – P5316 moving to a 64K indirection unit SSD data structure resulting in 16x DRAM reduction

16. Up to 50% better QoS across read workloads – Comparing P4326 4KB, 8KB, 64KB Random Read QDI latency for 99.999% wrt to P5316. For 4KB: 1147usec/580usec. 8KB: 590usec/1196usec. 64KB: 730usec/1736usec

17. Up to 40% write performance improvement at the component – Comparing Tprog between Intel® SSD D5-P5316 (1650usec) and Intel® SSD D5-P4326 (2800usec).

18. Matching PCIe 4.0 TLC read bandwidth with QLC technology – Both P5316 (6.8GB/s) and P5510 (7.0GB/s) have similar 128K sequential read QD256.
Appendix

19. Industry-leading QLC storage capacity – P5316 capacity up to 30.72TB.

20. Up to 38% higher random read – Comparing 4K random read between P5316 15.36TB (800K IOPS) and P4326 15.36TB (580K IOPS).

21. 2x+ higher sequential read – Comparing 128K sequential read between P5316 15.36TB (6.8GB/s) and P4326 15.36TB (3.2GB/s).
