Performance Evaluation Guide

Solidigm Synergy™ 2.0 Software

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Ordering Information

Contact your local Solidigm sales representative for ordering information.

Revision History

Revision	Description	Date
001	• Initial Release	April 2023

Contents

1 Solidigm Synergy™ Performance Evaluation Quick Start

This section recommends a set of steps to quickly get started with testing and evaluating a storage system using Solidigm Synergy™.

Plan

- Identify whether your test target is the platform or a component in a platform-optimized or device-optimized scenario. Determine if the planned tests are appropriate for this scenario. Refer to the Scenarios section for more details.

Setup

- Prepare your system and storage component as dictated by your test goals, referring to the entries in the Setup section.
- See the Benchmark Recommendations section in the appendix for a list of benchmarks relevant to storage recommended by Solidigm. Each benchmark noted in the appendix entry includes a description and tips for running.

Execute

- Run the test(s) and capture the results.

Analyze

- Look at the Analysis section of this guide for Solidigm's recommendations on interpreting and analyzing the results.

2 Overview

If you are evaluating platform or individual component performance in real-world or synthetic scenarios, then this guide presents considerations and recommendations when testing Solidigm™ Solid State Drives.

This guide also provides an overview of different workloads and benchmarks relevant to Solidigm™ Solid State Drives.

The target audience includes publications, OEMs, technical analysts, academia and any who plan to test or evaluate Solidigm™ Solid State Drive performance.

This guide is divided into the following sections:

- **Overview** provides an overview to establish a foundation for testing.
- **Benchmarks** explores software designed to mimic a workload on a component or system and provide an indicator of performance.
- **Setup** This section includes a testing quick start plus examines the system and component configuration settings used to measure performance of a platform or component in real-world or synthetic scenarios.
- **Analysis** explores approaches for analysis and handling variability in result sets.
- **Appendix** presents supplementary material not included in the other sections including discussions on executing a set of tests and covers considerations for specific benchmark tools.

Table 1: Tool References

Product	Download Link
Solidigm Synergy™	https://www.solidigm.com/synergy
Iometer	http://www.iometer.org/
CrystalDiskMark	https://crystalmark.info/en/software/crystaldiskmark/
Procyon	https://benchmarks.ul.com/procyon
PCMark 10	https://benchmarks.ul.com/pcmark10

2.1 Performance Testing

Solidigm recommends the approach to performance evaluation should be reproducible via controls and observation to ensure fair analysis. This guide considers general principles of performance testing and applies them to Solidigm™ Solid State Drives.

Consider the Scenarios section below as one perspective for how to approach performance evaluation. This perspective is the basis of methodology used at Solidigm.

2.2 Scenarios

The **platform-optimized** scenario for evaluating performance is to measure common usage where machines are configured as they are out of the box or as in general practice for most users. Platform-optimized tests evaluate real world usage as machines are naturally configured. Generally, platform-optimized scenarios are associated with **real-world** or **application** testing, but it can also be useful to understand how **synthetic** workloads behave under default conditions.

The contrasting scenario is to configure machines in a **device-optimized** state for measuring usage under manufactured conditions that are uncommon or artificially controlled. In a device-optimized configuration for testing, you may be exploring a boundary condition of the platform which may put some components at an advantage and others at a disadvantage. Generally, device-optimized scenarios are associated with **synthetic** workloads and benchmarks.

Refer to the Setup section for tables of settings associated with platform-optimized and device-optimized scenarios.

2.3 Solidigm Synergy™ Overview

Solidigm Synergy™ 2.0 Software features an intuitive toolkit with real-time insights and actions. The modern, easy-to-use interface provides drive health, activity, and other information for all SSDs, regardless of manufacturer.

The driver component offers numerous innovations to storage performance including Fast Lane, Smart Prefetch, and Dynamic Queue Assignment. This document focuses on evaluating the performance of the entire solution rather than identifying specific workloads and test procedures that showcase these innovations.

3 Benchmarks

Benchmarks are designed to mimic a workload on a component or system and provide an indicator of performance. This section provides an overview of three basic types of benchmarks that can be used to measure system storage performance:

- Application-based Benchmarks
- Trace-based Benchmarks
- Synthetic Benchmarks

For specific benchmark recommendations and information please see the [Benchmark Recommendations] subsection in the Appendix.

3.1 Application-based Benchmarks

Application-based benchmarks emulate end-user behavior by scripting processes of real-world programs. Application-based benchmarks measure the load and execution time of these applications and present the results as a score. Often the scores of applications that are common to a usage are combined into a subsystem score. These subsystem scores are reported along with an overall performance score that is the combination of the subsystem scores.

SYSmark 25, and UL Procyon are examples of application-based benchmarks.

Application-based benchmarks are helpful in determining the User Experience (UX) for a given system. In particular, the scores from an application-based workload are more likely to reflect the real world UX than the results from a purely synthetic workload.

One disadvantage of application-based benchmarks when trying to determine storage device speed is that they focus on CPU, memory, and graphics performance and may not properly weigh storage sub-system speed in the results. They also may not consider end-user perceivable delays such as application loads. Another disadvantage is that the scripted nature of an application-based benchmark is fixed, and the application workload may not be representative of a specific end-user usage model, especially when multiple iterations are repeatedly in sequence. Lastly, due to practical considerations, rather than constrain the total allowable runtime and total size of the benchmark (e.g., download based distribution, total amount of disk space required to run), many application-based benchmarks have a short-run duration and limited storage device usage. Therefore, these benchmarks may not be representative of storage device usage over time as a practical basis.

3.2 Trace-based Benchmarks

Trace-based benchmarks use traces, or recordings of disk I/O operations executed during a certain period of real use or script-based use. The trace is then used to “playback” the system I/O sequence on the drive to be evaluated. Trace-based benchmark results vary in format.

PCMark 10 Storage Benchmark test is an example of a trace-based benchmark. Trace-based benchmarking has many of the advantages of application-based benchmarking if the trace is collected from real-use or a realistic script-based activity. It has the further advantage of highlighting disk I/O behavior while avoiding the bottlenecks caused by the CPU, graphics, and memory subsystems.

One disadvantage of trace-based benchmarking is that the recorded trace may not reflect the true long-term usage of the storage device over weeks or months of time.

3.3 Synthetic Benchmarks

Synthetic benchmarks measure raw drive input/output (I/O) transfer rates. These benchmarks typically use well-defined, synthetic workloads and target only specific components such as Solid-State Drives (SSDs), Hard Disk Drives (HDDs) or other networking devices. These benchmarks format results as raw megabytes (MBs) in Input / Output Operations per Second (IOPS).

Storage subsystem synthetic benchmarks focus on drive performance without considering bottlenecks from other subsystems such as CPU, memory, or graphics. This makes these benchmarks useful for measuring drive performance for changing parameters such as transfer sizes or queue depths. However, because these benchmarks exercise components and systems in ways that do not reflect system usage models, the results may not reflect real-usage cases. For example, one SSD might have better synthetic benchmark scores for 512 KB random reads than other SSDs, but 512 KB random reads may not be a good indicator of overall system performance because of the rarity of that I/O access size in what is important to a given end user experience.

3.4 Benchmark Considerations

To emulate real end user behavior and temporal state, there are three main challenges with typical application and trace-based benchmarks: 1) controlling the repeatability of results, 2) accounting for the effects of "system aging," and 3) accurately modeling the storage footprint.

The repeatability of results can be challenging simply due to the complexity and uncertainty of the system with background processes and other runtime services. In addition, if the storage device contains any sort of media cache (static or dynamic SLC or other media) the initial state of that cache should be controlled to ensure repeatability.

Accounting for the effects of "system aging" can be thought of as three sub-challenges.

- In normal system usage, the unused part of main memory will be preloaded with a complex set of applications, services, OS references, and prefetched data in anticipation of upcoming usage. The state of system memory will directly impact benchmark behavior.

- Multi-iteration benchmarks perform the same sequence of actions in repeated iterations, a behavior not often found in end users. The result of such benchmarks is an unrealistic situation where a modest amount of main memory can contain the necessary data and accessing storage is not required.
- Accurate steady state performance measurements of a storage subsystem that implements any type of caching requires emulation of a warm-up sequence of storage I/O activity.
- The storage footprint of users' systems will vary and can be quite large. Emulating a storage footprint in a workload or benchmark can be challenging because of the sheer size of the files required to achieve it.

3.5 Solidigm Synergy™ Considerations

Evaluating a storage driver follows many of the standard processes and considerations as evaluating a storage component. These are some considerations that may prove useful in differentiating the Solidigm Synergy™ Driver from other storage drivers.

Fast Lane is Solidigm's software innovation that, through a driver/firmware interface, helps intelligently manage the SLC Cache on the QLC-based P41 Plus SSD. Testing this feature will require a specifically designed test, or "priming", procedure that ages the state of the system and exposes the SSD's cache-management policy. A basic example test flow suggestion is:

1) Write test data to the drive.
2) Age the system by writing 25%+ of the drive's capacity.
3) Evaluate performance on the test data written in #1.

Smart Prefetch is a feature of Solidigm Synergy™ Driver that enhances performance of a particular type of I/O pattern: low queue depth sequential I/O, especially on small file sizes. Evaluating this feature will most easily be seen in a device-optimized scenario with a synthetic workload.

Dynamic Queue Assignment is another driver feature that boosts performance on particular I/O: high queue depth random. By allowing the driver to redirect I/O to other logical cores from where it originally arrived, I/O performance is improved in scenarios where system CPUs are a bottleneck.

Solidigm's research shows that these I/O patterns occurs frequently in typical client usage, but it may not be easily seen in trace-based and application-based benchmarks except in very specific configurations that may expose additional latency in competing drivers.

All these test scenarios can be examined competitively with three possible system configurations: 1) Solidigm SSD with Solidigm driver, 2) Solidigm SSD with alternative driver, and 3) alternative SSD with alternative driver.

4 Setup

This section examines the system and component configuration settings used to measure performance of a platform or component in real-world or synthetic scenarios.

The below setup items are recommended to prevent run-to-run and system-to-system variability that impact the ability to reproduce the test and results. If one of the below items is a controlled variable or the target of a test, then modify as desired.

In the following tables a **platform-optimized** and a **device-optimized** value are given for each setting. A device-optimized value may be employed for specific test scenarios while platform-optimized indicates how the system should be normally configured as a default for practical usage.

Refer to the Scenarios section for guidance on when to use platform-optimized or device-optimized settings.

4.1 Device Preparation

These steps detail the procedures necessary to prepare the devices so that they are updated and in a steady state before executing the measurements.

- Verify that the Device Under Test has the latest firmware applied.
  - To view and update the current firmware installed on a Solidigm SSD, make use of the Solidigm Synergy™ Toolkit.
- Perform Secure Erase via the Solidigm Synergy™ Toolkit (or similar NVMe Format operation) on the drive for out-of-the box performance.

4.2 Clear Write Cache

Solidigm™ P41 Plus has an SLC cache in addition to the QLC media. The Solidigm Synergy™ Toolkit includes a functionality called Clear Write Cache which evicts data stored in the SLC cache and stores that data in QLC.

In a Device-Optimized scenario with a synthetic test, the SLC cache should be flushed for the consistency of test conditions. Solidigm recommends a flush of SLC as a part of initial synthetic test preparation. This process will ensure that the entire SLC cache is available to the user for test data.

Flushing the cache between test runs may evict test data from the SLC cache, causing future test runs to perform I/O operations on QLC media. For most consistent results, only consider a SLC cache flush prior to writing test data to the disk.

If evaluating a Solidigm SSD with the Fast Lane feature, such as P41 Plus, the cache flush feature will evict all data managed by the Fast Lane feature. For most consistent results, do not use a manual cache flush in conjunction with Fast Lane.

4.3 BIOS

NOTE: Consumer systems may not expose all BIOS settings. See OEM BIOS documentation for support on setting details.

Table 2: BIOS Settings

Configuration Item	Platform-optimized	Device-optimized
Hyper Threading	Enabled	
EIST (Enhanced Intel Speed Step Technology)	Enabled	Disabled
Intel Turbo Mode	Enabled	
PCIe ASPM (Active State Power Management)	Enabled	Disabled
C-States	Enabled	Disabled
P-States	Enabled	Disabled

4.4 Operating System

While system and device tests should normally be performed across a standardized OS installation, in some test scenarios it may be more appropriate to evaluate OEM systems in their 'out of the box' configuration, to retain any OEM-specific tuning. When testing multiple systems, ensure the installed KB's (or Microsoft Windows patches) are as consistent as possible. Below is a table of relevant configuration settings for Windows 11.

Table 3: Operating System Settings

Configuration Item	Platform-optimized	Device-optimized
Settings > Accounts > Sign-in Options > Additional settings > "Automatically save my restartable apps and restart them when I sign back in"	Disabled	
Settings > Privacy & Security > Windows Security > Virus & threat protection > Manage settings > Real-time protection1	OFF	
Settings > Privacy & Security > Windows Security > Virus & threat protection > Manage settings > Cloud delivered protection	OFF	

Configuration Item	Platform-optimized	Device-optimized
Settings > Privacy & Security > Windows Security > Virus & threat protection > Manage settings > Automatic sample submission	OFF	
Settings > Privacy & Security > Windows Security > Virus & threat protection > Manage settings > Tamper Protection	OFF	
Settings > Privacy & Security > Firewall & network protection > Domain Network | Private Network | Public Network > Windows Defender Firewall	OFF	
Control Panel > Indexing Options	Remove all from "Included Locations"	
Settings > Personalization > Lock Screen > Screen saver settings	None	
Settings > System > About > System Protection > Available Drives > Protection	OFF	
Settings > System > About > Advanced system settings > Advanced > Performance > Settings > Visual Effects	Let Windows choose what's best for my computer	
Settings > System > About > Advanced system settings > Advanced > Performance > Settings > Advanced >	Adjust for best performance of programs	
Settings > System > About > Advanced system settings > Advanced > Performance > Settings > Advanced > Virtual Memory > Change	Automatically manage paging file size for all drives	No paging file
Settings > System > About > Advanced system settings > Advanced > Performance > Settings > Data Execution Protection	Turn on DEP for essential Windows programs and services only	
Control Panel > System and Security > Windows Tools > Defragment and Optimize Drives > Scheduled Optimization > Change settings	Uncheck "Run on a schedule (recommended)"	
Control Panel > System and Security > Windows Tools > Services > Windows Update	Disabled	
Control Panel > System and Security > Windows Tools > Task Scheduler > Task Scheduler Library	Disable all tasks	
Registry Editor > HKEY_LOCAL_MACHINE > SYSTEM > CurrentControlSet > Control > Session Manager > Memory Management > PrefetchParameters > EnablePrefetcher	3	0
Anti-Virus	Disabled	

Note: Real Time Protection will reset to "On" after a reboot. Take particular care to disable this setting and Tamper Protection in Windows Security.

4.5 Power

The following table references two Windows 11 power plans, "Balanced" and "High Performance." The settings in the table describe recommended changes to the default versions of these power plans and assumes that all other settings are left at default. If these plans have been previously modified on the System Under Test the power plans should be removed and recreated from their default templates.

Table 4: Power Settings

Configuration Item	Platform-optimized	Device-optimized
Settings > System > Power > Screen and sleep > "turn off my screen"	Never	
Settings > System > Power > Screen and sleep > "put my device to sleep"	Never	
Control Panel > Hardware and Sound > Power Options > Power Plan (desktop system)	Balanced	High Performance
Control Panel > Hardware and Sound > Power Options > Power Plan (mobile system)	Balanced	
Control Panel > Hardware and Sound > Power Options > Change plan settings > Change advanced power settings > Turn off hard disk after	0 minutes (never)	
[INHERIT] > Internet Explorer > JavaScript Timer Frequency	Plan defaults	Maximum performance
[INHERIT] > Desktop background settings > Slide show	Paused	
[INHERIT] > Wireless Adapter Settings > Power Saving Mode	Plan defaults	Maximum Performance
[INHERIT] > Sleep > Sleep after	0 minutes (never)	
[INHERIT] > Sleep > Allow wake timers	Plan defaults	Enabled
[INHERIT] > USB settings > USB selective suspend setting	Plan defaults	Disabled
[INHERIT] > Intel* Graphics Power Plan	Plan defaults	Maximum performance
[INHERIT] > PCI Express > Link Power Management	Plan defaults	Off
[INHERIT] > Processor power management > Minimum processor state	Plan defaults	100%
[INHERIT] > Processor power management > System cooling policy	Plan defaults	Active
[INHERIT] > Processor power management > Maximum processor state	Plan defaults	100%
[INHERIT] > Display > Turn off display after	0 minutes (never)	
[INHERIT] > Display > Dimmed display brightness	Plan defaults	100%
[INHERIT] > Display > Enable adaptive brightness	Plan defaults	Off

5 Analysis

5.1 Median Recommendation

Solidigm uses and recommends median values for analysis. This practice ensures a measured value from the dataset is reported as a characteristic value. Averages provide useful insight into the characteristics of the data but reported performance must reflect a value that was measured rather than calculated. A minimum of three test runs must be collected to calculate a median value. If more than three test runs are required, data sets should always be comprised of odd-valued numbers of tests from which a median value can be derived.

The configuration recommendations in Setup are designed to minimize variability in test outcomes without affecting the test parameters. If the test still produces data with a high amount of variability, the best approach to minimize that variability is to collect more data and evaluate a larger data set. However, in some test cases this approach is impractical and a quick measurement of the confidence in the data set is required.

5.2 Relative Standard Error

Solidigm uses and recommends relative standard error (RSE) to evaluate variability in a dataset. Relative standard error is the ratio of the standard error of a sample to the sample average. Calculating RSE for a dataset provides the necessary quick measurement of confidence in the dataset. By using relative standard error rather than just standard error or standard deviation, RSE% can be readily compared between different kinds of tests and effective thresholds established.

These thresholds can vary between tests, but in general if RSE is above 5%, Solidigm views the variability as unacceptably high and more datapoints must be collected or the test set must be discarded. Depending on the context, RSE below 5% may also be unacceptable—lower is better and more datapoints carry more weight. If a test set takes more than seven runs to reach acceptable consistency, Solidigm recommends the test set should be discarded or additional work be done to study the source of variability.

The RSE of a sample is defined as:

$$\left|\frac{Standard\ Error\ (of\ the\ sample)}{Sample\ Estimate}\right| = \left|\frac{Standard\ Deviation\ (of\ the\ sample)}{Sample\ Estimate \cdot \sqrt{Number\ of\ Data\ Points\ in\ the\ Sample}}\right| = \left|\frac{s}{\bar{x} \cdot \sqrt{N}}\right|$$

In Microsoft Excel, this can be expressed as a percentage with the following formula:

```
=STDEV.S(range)/SQRT(COUNT(range))/AVERAGE(range)
```

5.3 Performance Deltas

The performance delta between two data points in a test is calculated and stated differently depending on the units of the test and the desired comparison.

5.3.1 Performance Deltas Where Higher is Better

In test cases where higher measured values reflect better test outcomes (score, MB/s, IOPS), the following formulas should be used:

To describe X as "Z% faster than Y":

$$Z = \left(\frac{X}{Y} - 1\right) \times 100$$

To describe X as "Z% as fast as Y":

$$Z = \left(\frac{X}{Y}\right) \times 100$$

To describe X as "Zx faster than Y":

$$Z = \left(\frac{X}{Y} - 1\right)$$

To describe X as "Zx as fast as Y":

$$Z = \frac{X}{Y}$$

If the result of any of these formulas is negative, take the absolute value and change the language to "slower than" or "as slow as."

5.3.2 Performance Deltas Where Lower is Better

In test cases where lower measured values reflect better test outcomes (latencies, elapsed time), the following formulas should be used:

To describe X as "Z% faster than Y":

$$Z = \left(\frac{Y}{X} - 1\right) \times 100$$

To describe X as "Z% as fast as Y":

$$Z = \left(\frac{Y}{X}\right) \times 100$$

To describe X as "Zx faster than Y":

$$Z = \left(\frac{Y}{X} - 1\right)$$

To describe X as "Zx as fast as Y":

$$Z = \frac{Y}{X}$$

If the result of any of these formulas is negative, take the absolute value and change the language to “slower than” or “as slow as.”

6 Appendix

This section presents supplementary material not included in the other sections including discussions on executing a set of tests and covers considerations for specific benchmark tools.

6.1 Benchmark Recommendations

The following table summarizes how Solidigm uses each type of benchmark.

Table 5: Benchmark Types

Benchmark Type	Description
Application-based benchmarks	Used as a part of the functional and performance validation flows. Used to describe storage impact on user experience. Recommended for evaluating platform performance.
Trace-based benchmarks	Used as a part of the functional and performance validation flows. Used to describe storage impact on user experience. Recommended for evaluating storage device performance.
Synthetic Benchmarks	Used to describe raw input/output (I/O) performance. Recommended for evaluating storage device capability.

6.1.1 Procyon

Procyon is an example of an application-based benchmarking tool and can be used to 'score' a platform on its ability to meet user experience indicators

Application-based benchmarks require more than one run to notice substantive gains. A system's behavior will more closely match its real use behavior when evaluated with an application-based workload, than it will with a purely synthetic workload. Application-based benchmarks can sometimes produce a single measure for system performance, which can be used as a product ranking index.

6.1.2 PCMark 10 Storage

PCMark 10 has three storage tests for device-oriented benchmarking which Solidigm recommends:

- Full System Drive Benchmark: uses a wide-ranging set of real-world traces from popular applications and common tasks to fully evaluate the performance of the fastest modern drives. This benchmark includes a comprehensive set of tests spanning >200GB of data.
- Quick System Drive Benchmark: a shorter test with a smaller set of less demanding real-world traces. This benchmark may be used to evaluate smaller system drives that are

unable to run the Full System Drive benchmark. The Quick test is a subset of tests from the Full test.

6.1.3 Iometer

Iometer is a flexible tool that enables storage device application of user-defined workloads.

Iometer test sequences should be crafted with the following considerations:

- Test file size – Solidigm recommends a test file size of 1GB-8GB (2,097,152-16,777,216 sectors). Before testing, additional files may be copied to the device to achieve desired amount of fill.
- Preconditioning for steady state – The customary practice of applying a higher QD sequential or random write before running measured tests of the same type, may not attain steady state performance for SSDs. In addition to the above conditioning pass, to emulate the first (potentially not cached) access of stored data, consider performing an unmeasured 'cold run' of each desired workload.
- Workload duration – Heavy workloads applied at a high duty cycle may push smaller form factor SSDs beyond their expected thermal envelope. This can potentially trigger performance throttled conditions that would not have occurred during normal use. Thermal throttling can be alleviated by:
  - Reducing the duty cycle of the tests to better match real-world usage.
  - Active cooling may be required during testing if duty cycle cannot be reduced.

6.1.4 CrystalDiskMark

CrystalDiskMark is a simple disk benchmark software for measuring sequential and random performance (Read/Write/Mix) and contains profiles for real world and peak performance.

Solidigm recommends using the "Default" and "Default [+ Mix]" profiles for evaluating storage device performance. When using the "Default [+ Mix]" profile, the default setting of "R70%/W30%" is appropriate for approximating end-user mixed workloads.

Additionally in Crystal Disk Mark 8, toggling the application Settings menu from "Default" to "NVMe SSD" introduces two new workloads that also represent valuable data points for quantifying storage device performance.

6.2 Benchmark Resources

6.2.1 PCMark Vantage HDD

Solidigm recommends not to run PCMark Vantage HDD benchmark on mostly empty drives. Performance of the benchmark is skewed under this condition as it performs a replay of existing data on the drive to produce load. This has been fixed in PCMark 10 as the benchmark first puts data on the device and then starts testing.

The PCMark 10 Vantage HDD storage test is an older device-oriented benchmark. The benchmark is a highly sensitive test which produces large differences in score with only minor storage performance changes. The benchmark predates many recent advances in SSD storage, such as TRIM, and consequently needs procedural modification to measure modern storage configurations most effectively. The most important of these is to prevent the benchmark from issuing read operations to drive sectors with no valid data (i.e., sectors that are trimmed).

This is critically important because reading data that was trimmed:

- Is not the intent of the benchmark developers.
- Increases dependency on the non-storage platform components (e.g., CPU and DRAM speed).
- Does not represent a realistic user workload.

To overcome this benchmark behavior, Solidigm recommends that 100GB of data be written to the target drive. Doing so means that most random reads will be issued to initialized data during the benchmark trace replay workload. To accomplish this writing of data, Solidigm uses Iometer to create the file.

The Solidigm recommended procedure to execute PCMark Vantage HDD as follows:

1. Secure Erase disk.
2. Install operating system and benchmark software.
3. Solidigm recommends filling the drive with 100GB of data. If using Iometer IOBW.TST file to do so, set 'Maximum Disk Size' of 207,715,200 sectors (at 512B per sector) when creating the file.
4. 30-minute idle time with PCIe link active.
5. Run PCMark Vantage HDD.
6. Allow for a 10-minute idle time. For additional iterations go to step #5.

6.2.2 Other Device Benchmarks

The following list presents additional examples of device-oriented benchmarks:

- AS SSD
- Anvil's Storage Utilities
- ATTO
- HD Tune
- TxBench