

Solid State Storage (SSS) Performance Test Specification (PTS) Enterprise

Version 1.1 Revision h

Abstract: This Working Draft describes a solid state storage device-level test methodology, test suite and reporting format intended to provide an accurate, repeatable and reliable comparison of NAND Flash-based solid state storage products of various form factors and interfaces used in Client and Enterprise applications.

Publication of this Working Draft for review and comment has been approved by the Solid State Storage (SSS) TWG. This draft represents a "best effort" attempt by the SSS TWG to reach preliminary consensus, and it may be updated, replaced, or made obsolete at any time. This document should not be used as reference material or cited as other than a "work in progress." Suggestion for revision should be directed to http://www.snia.org/feedback/.

Working Draft

April 16, 2013

Revision History

Revision	Release Date	Originator	Comments			
	May-2009	Jonathan Thatcher	Initial proposal in SSS TWGInitial Draft Outline			
	Jun-2009	Eden Kim	 Added material re: Definitions, Reference Platform, Test Definitions/Procedures, etc. Content contributions from Eden Kim, Phil Mills, Easen Ho, Dave Landsman, Steven Johnson 			
0.0.0	Jul-7-2009	Dave Landsman	 Major restructure to get overall document sections/styles in place for serious editing and 1st full committee review. Incorporated Calypso material. Added section on Performance Index Re-wrote Scope & Introduction 			
0.0.1	0.0.1 Jul-15-2009 Dave Landsman		 Merged Jonathan Thatcher draft. Merged Chuck Paridon definitions Merged Chuck Paridon test flow (Annex) Further general restructuring/editing. 			
0.0.2 Aug-4-2009 Dave Landsman • Updated Preconditioning and Test sections per Jul 20-22 F2F. • Updated Preconditioning and Test sections per Jul 20-22 F2F. • Integrated Logical/Physical Address conventions into Definition • Other general stylistic and editorial changes.						
0.1	Sep-23-2009	Dave Landsman	Changed versioning to x.y, from x.y.z Miscellaneous edits in Sections 3 & 4 Revised Section 5 (Preconditioning) for clarity Flipped "for loop" in IOPS test (Sec. 6.2) Added QD=1for IOPS test (Sec. 6) Edited "Alternative Extended IOPS Test" (Section 6.6) Added graphic for RPT spec (Annex A) Added rough latency example to sample report (Annex B)			
0.3	Dec-2-2009	Dave Landsman	 Based on slide version of spec (2009-10-23). No revision marks due to major restructure; this is clean version. Removed previous Preconditioning sections. Restructured tests with suite of Client (Sections 6-8) and Enterprise (Sections 9-11) tests. Removed "Idle Test". Revised general flow of tests, plus types of reports. Added new section (Section 5) to provide informative overview of test flow, and other key concepts/definitions. 			
0.4	Dec-12-2009	Dave Landsman	 Clean version; no change bars Changed "Active Use State" to "Steady State" Completely revised Section 5 for better flow. Added new 6 & 7 as prefaces to actual test sections. Changed basic test flow to incorporate methodology where convergence to Steady State must be detected AND maintained for duration of test. Updated Latency test loop parameters and report proposal per discussions w/ Gary Kotzur. 			
0.5 Feb-27-2010 Dave Landsman			 Incorporated TWG changes from V0.4 Updated section 1.2 for better background Updated 1.4 with notes on App Testing and Reference Platform Updated 2.1 with new/modified definitions (steady state, OIO, etc.) Updated 4, in particular 4.2 with test tools requirements. Completely rewrote/restructured Informative Section 5, including notes on Data Patterns and IO demand (QD/TC). More complete explanations of Steady State, Detecting Steady State, etc. Rewrote Section 6 to provide better intro to detailed test flow. Edited all tests per comments in TWG. Deleted sample test report in appendix because need to remove company identification from the sample and a Word bug made it impossible to remove just the name/logo. Will add back later. 			

0.6	Mar-20-2010	Dave Landsman	 Integrated all changes from Mar-8-2010 TWG F2F Rewrote material on IO Demand Updated/Deleted/Checked definitions, & validated per SNIA Dictionary Added "Test Parameters" to required reporting (Sec 3) Revised Section 4 to better address platform requirements Created new IOPS and Throughput Plots 				
0.7	Apr-23-2010	Dave Landsman	Made all changes per comment resolution of V.06e (commentable) Tried to make "shall", "may", etc. more explicit throughout spec Re-ordered Reporting and Platform requirements sections for flow Revised "Reporting Requirements" to be more clear. Added Informative Annex B – PTS Platform Example Added Informative Annex C – Synthetic Application Workloads Restructured sections for flow.				
0.7a	May-19-2010	Dave Landsman	 Integrated changes from V0.7 comment resolution, up through, and including Section 8, Client IOPS test. 				
0.8	June-07-2010	Dave Landsman	 Major update to get to final test structure, report formats, etc. Integrated changes from V0.7a comment resolution. Updated all test sections to new uniform structure. ALL new graphs/charts/tables. Inserted draft Annex A 				
0.9	June-22-2010	Dave Landsman	Continued cleanup.First real edits of Annex A and B, mostly for formatting.				
0.98	Nov-11-2010	Dave Landsman	 Removed Client sections and updated to make it "Enterprise" only. Added Write Saturation Test Changed block size to be the outer loop for Throughput test. Added explanation of pseudo code in "Conventions" Deleted "Test Overview", no longer needed since Enterprise only. Added Client and Enterprise to "Definitions" Modified reporting requirement for when Steady State not reached. Updated references. 				
0.99	Nov-17-2010	Dave Landsman	 Added cache requirements (Sec 3.7 and definitions) Revised definition of Latency (definitions) Updated all tables to go from low-to-high block sizes and 100% Writes (R/W Mix % = 0/100) to 100% Reads (R/W Mix = 100/0) Removed "Workload Independent Preconditioning" step from the Throughput test. 				
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1.1(d)	Feb 20-2012	Eden Kim	 Harmonize w/ PTS-C 1.1(d) Update pseudo code HIR, Cross Stim Rec Addition table of figures & table of plots 				
1.1(e)	Jul-07-2012	Eden Kim	 PTS-E 1.1(e) – TWG comment integration – clean rev (e) 				
1.1(f)	Jul-09-2012	Eden Kim Easen Ho	ECW & DIRTH pseudo code & plots update				
1.1 (g)	Mar-8-2013	Marilyn Fausset	 Editorial work to publish a Working Draft for ballot 				
1.1 (h)	Mar-12-21-2013	Eden Kim	 Added new plots to main sections and Annex A, minor revisions 				

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Intended Audience

This document is intended for use by individuals and companies engaged in the development of this Specification and in validating the tests and procedures incorporated herein. After approvals and release to the public, this Specification is intended for use by individuals and companies engaged in the design, development, qualification, manufacture, test, acceptance and failure analysis of SSS devices and systems and sub systems incorporating SSS devices.

Changes to the Specification

Each publication of this Specification is uniquely identified by a two-level identifier, comprised of a version number and a release number. Future publications of this specification are subject to specific constraints on the scope of change that is permissible from one publication to the next and the degree of interoperability and backward compatibility that should be assumed between products designed to different publications of this standard. The SNIA has defined three levels of change to a specification:

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1 Introduction

1.1 Preamble

This Enterprise Performance Test Specification (PTS-E) 1.1 is a companion specification to the SNIA Solid State Storage Client Performance Test Specification (PTS-C) 1.1. Both Performance Test Specifications (PTS) are intended to be used to obtain reliable and comparative measurement of NAND Flash based solid state storage devices. In both PTS in their present form, the tests and methodologies are designed to use a synthetic, or known and repeatable, test stimulus applied to a solid state storage product at the device level. In these PTS, "device level" refers to measurement of block IO at the physical device level as opposed to file system IO in the host Operating System.

Both of these PTS are based on test and preparation methodologies developed by the SNIA SSS TWG for performance test of NAND based solid state storage. NAND Flash based solid state storage (SSS) performance tends to be highly dependent on the write history of the SSS device, the type of stimulus applied to the SSS device, as well as the test environment (both hardware and software) in which the test stimulus is applied and measurements taken. Much of the preconditioning, test condition set up and parameters take these SSS behaviors into consideration.

These PTS do not require the use a specific test environment, but test tool requirements, capabilities and examples are set forth in the specifications. Care should be taken by the test operator to ensure that the test hardware does not bottleneck the SSS device performance, that the OS or test software tool has minimal contribution to test measurements, and that the same hardware and software test combination is used when comparing performance results of different SSS devices.

This Enterprise PTS-E 1.1 differs from the Client PTS-C 1.1 in the preparation of the Device Under Test (DUT) for steady state performance measurement and in the amount and type of test stimulus applied to the DUT. For example, preconditioning LBA ranges may be limited in the Client PTS-C to less than 100% of the available LBAs while the test stimulus Active Range may be limited to a reduced number of uniquely touched LBAs (see Client PTS-C Specification). The use of limited preconditioning and test active ranges are meant to provide test stimulus that share more characteristics with empirically observed Client workloads.

Readers and industry members are encouraged to participate in the further SNIA SSS TWG works and can contact the TWG at its website portal at http://www.snia.org/feedback/.

1.2 Purpose

Manufacturers need to set, and customers need to compare, the performance of Solid State Storage (SSS) devices. This Specification defines a set of device level tests and methodologies intended to enable comparative testing of SSS devices in Enterprise (see 2.1.5) systems.

Note: While the tests defined in this specification could be applied to SSS devices based on any technology (RAM, NAND, etc.), the emphasis in this specification, in particular regarding Preconditioning and Steady State, is oriented towards NAND.

1.3 Background

A successful device level performance test isolates the device being tested from the underlying test platform (HW, OS, Tools, Applications) so the only limiting variable in the test environment is the device being tested. To achieve this goal with NAND-based SSS devices, in addition to typical system/device isolation issues, the test, and test methodologies, must address attributes unique to NAND-based flash media.

NAND-based SSS device controllers map Logical Addresses (LBA) to Physical Blocks Addresses (LBA) on the NAND media, in order to achieve the best NAND performance and endurance. The SSS device manages this LBA-to-PBA mapping with internal processes that operate independently of the host. The sum of this activity is referred to as "flash management".

The performance of the flash management during a test, and hence the overall performance of the SSS device during the test, depends critically on:

- 1) Write History and Preconditioning: The state of the device prior to the test
- 2) Workload Pattern: Pattern of the I/O (r/w mix, block size, etc.) written to device during test
- 3) Data Pattern: The actual bits in the data payload written to the device

The methodologies defined in the SSS Performance Test Specification (SSS PTS) attempt to create consistent conditions for items 1-3 so that the only variable is the device under test.

Note: Descriptive notes precede each test section to explain the test rationale and examples of possible interpretations of test results. These notes are **informative only** and are set forth as "Descriptive Note" for the reader's convenience.

The importance of the SSS PTS methodologies on SSS performance measurement is shown in Figure 1-1. A typical SSS device, taken Fresh Out of the Box (FOB), and exposed to a workload, experiences a brief period of elevated performance, followed by a transition to Steady State performance. The SSS PTS ensures that performance measurements are taken in the Steady State region, representing the device's performance during its normal working life.





1.4 Scope

- 1) Preconditioning methods
- 2) Performance tests
- 3) Test reporting requirements

1.5 Not in Scope

- 1) Application Workload Tests
- 2) Test Platform (HW/OS/Tools)
- 3) Certification/Validation procedures for this specification
- 4) Device reliability, availability, or data integrity

1.6 Disclaimer

Use or recommended use of any public domain, third party or proprietary software does not imply nor infer SNIA or SSS TWG endorsement of the same. Reference to any such test or measurement software, stimulus tools, or software programs is strictly limited to the specific use and purpose as set forth in this Specification and does not imply any further endorsement or verification on the part of SNIA or the SSS TWG.

1.7 Normative References

1.7.1 Approved references

These are the standards, specifications and other documents that have been finalized and are referenced in this specification.

- IDEMA Document LBA1-02 -- LBA Count for IDE Hard Disk Drives Standard
- JEDEC JESD218 Solid-State Drive (SSD) Requirements and Endurance Test Method
- JEDEC JESD219 Solid-State Drive (SSD) Endurance Workloads

1.7.2 References under development

• ATA/ATAPI Command Set - 2 (ACS-2) – INCITS/T13 2015-D

1.7.3 Other references

• None in this version

2 Definitions, symbols, abbreviations, and conventions

2.1 Definitions

- 2.1.1 **ActiveRange:** Specified as ActiveRange(start:end), where "start" and "end" are percentages. ActiveRange is the range of LBA's that may be accessed by the preconditioning and/or test code, where the starting LBA# = start%*MaxUserLBA and the ending LBA# = end%*MaxUserLBA.
- 2.1.2 **Cache:** A volatile or non-volatile data storage area outside the User Capacity that may contain a subset of the data stored within the User Capacity.
- 2.1.3 **Client:** Single user desktop or laptop system used in home or office.
- 2.1.4 **CPU Usage:** amount of time for which a central processing unit (CPU) is used for processing instructions. CPU time is also measured as a percentage of the CPU's capacity at any given time.
- 2.1.5 **Enterprise:** Servers in data centers, storage arrays, and enterprise wide / multiple user environments that employ direct attached storage, storage attached networks and tiered storage architectures.
- 2.1.6 Fresh Out of the Box (FOB): State of SSS prior to being put into service.
- 2.1.7 **IO Demand:** Measured # of OIOs executing in the host.
- 2.1.8 **Logical Block Address (LBA):** The address of a logical block, i.e., the offset of the block from the beginning of the logical device that contains it.
- 2.1.9 **Latency:** The time between when the workload generator makes an IO request and when it receives notification of the request's completion.
- 2.1.10 **MaxUserLBA:** The maximum LBA # addressable in the User Capacity.
- 2.1.11 **Measurement Window:** The interval, measured in Rounds, during which test data is collected, bounded by the Round in which the device has been observed to have maintained Steady State for the specified number of Rounds (Round x), and five Rounds previous (Round x-4).
- 2.1.12 **Nonvolatile Cache:** A cache that retains data through power cycles.
- 2.1.13 **Outstanding IO (OIO):** The number of IO operations issued by a host, or hosts, awaiting completion.
- 2.1.14 **OIO/Thread:** The number of OIO allowed per Thread (Worker, Process)
- 2.1.15 **Over-Provisioned Capacity:** LBA range provided by the manufacturer for performance and endurance considerations, but not accessible by the host file system, operating system, applications, or user.
- 2.1.16 **Preconditioning:** The process of writing data to the device to prepare it for Steady State measurement.

(a) Workload Independent Preconditioning (WIPC): The technique of running a prescribed workload, unrelated to the test workload, as a means to facilitate convergence to Steady State.

(b) Workload Dependent Preconditioning (WDPC): The technique of running the test workload itself, typically after Workload Independent Preconditioning, as a means to put the device in a Steady State relative to the dependent variable being tested.

2.1.17 **Preconditioning Code:** Refers to the Preconditioning steps set forth in this Specification.

- 2.1.18 **Purge:** The process of returning an SSS device to a state in which subsequent writes execute, as closely as possible, as if the device had never been used and does not contain any valid data.
- 2.1.19 Round: A complete pass through all the prescribed test points for any given test.
- 2.1.20 Queue Depth: Interchangeably refers to the OIO/Thread produced by the Workload Generator.
- 2.1.21 **Steady State:** A device is said to be in Steady State when, for the dependent variable (y) being tracked:
 - a) Range(y) is less than 20% of Ave(y): Max(y)-Min(y) within the Measurement Window is no more than 20% of the Ave(y) within the Measurement Window; and
 - b) Slope(y) is less than 10%: Max(y)-Min(y), where Max(y) and Min(y) are the maximum and minimum values on the best linear curve fit of the y-values within the Measurement Window, is within 10% of Ave(y) value within the Measurement Window.
- 2.1.22 **Test Code:** Refers to the measurement steps set forth in the test sections contained in this Specification.
- 2.1.23 **Transition Zone:** A performance state where the device's performance is changing as it goes from one state to another (such as from FOB to Steady State).
- 2.1.24 Thread: Execution context defined by host OS/CPU (also: Process, Worker)
- 2.1.25 Thread Count (TC): Number of Threads (or Workers or Processes) specified by a test.
- 2.1.26 **Total OIO:** Total outstanding IO Operations specified by a test = (OIO/Thread) * (TC)
- 2.1.27 **User Capacity:** LBA range directly accessible by the file system, operating system and applications, not including Over-Provisioned Capacity.
- 2.1.28 Volatile Cache: A cache that does not retain data through power cycles.

2.2 Acronyms and Abbreviations

- 2.2.1 IOPS: I/O Operations per Second
- 2.2.2 **DUT:** Device Under Test
- 2.2.3 FOB: Fresh Out of Box
- 2.2.4 OIO: Outstanding IO
- 2.2.5 TOIO: Total Outstanding IO
- 2.2.6 R/W: Read/Write
- 2.2.7 **SSSI:** Solid State Storage Initiative
- 2.2.8 **SSS TWG:** Solid State Storage Technical Working Group
- 2.2.9 TC: Thread Count
- 2.2.10 ART: Average Response Time
- 2.2.11 QD: Queue Depth
- 2.2.12 **TP:** Throughput
- 2.2.13 LAT: Latency
- 2.2.14 WSAT: Write Saturation
- 2.2.15 HIR: Host Idle Recovery
- 2.2.16 XSR: Cross Stimulus Recovery
- 2.2.17 ECW: Enterprise Composite Workload

2.2.18 DIRTH: Demand Intensity / Response Time Histogram

2.3 Keywords

The key words "shall", "required", "shall not", "should", "recommended", "should not", "may", and "optional" in this document are to be interpreted as:

- 2.3.1 **Shall:** This word, or the term "required", means that the definition is an absolute requirement of the specification.
- 2.3.2 **Shall Not:** This phrase means that the definition is an absolute prohibition of the specification.
- 2.3.3 **Should:** This word, or the adjective "recommended", means that there may be valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and weighed before choosing a different course.
- 2.3.4 **Should Not:** This phrase, or the phrase "not recommended", means that there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
- 2.3.5 **May:** This word, or term "optional", indicates flexibility, with no implied preference.

2.4 Conventions

2.4.1 Number Conventions

Numbers that are not immediately followed by lower-case b or h are decimal values.

Numbers immediately followed by lower-case b (xxb) are binary values.

Numbers immediately followed by lower-case h (xxh) are hexadecimal values.

Hexadecimal digits that are alphabetic characters are upper case (i.e., ABCDEF, not abcdef).

Hexadecimal numbers may be separated into groups of four digits by spaces. If the number is not a multiple of four digits, the first group may have fewer than four digits (e.g., AB CDEF 1234 5678h).

Storage capacities and data transfer rates and amounts shall be reported in Base-10. IO transfer sizes and offsets shall be reported in Base-2. The associated units and abbreviations used in this specification are:

- A kilobyte (KB) is equal to 1,000 (10³) bytes.
- A megabyte (MB) is equal to 1,000,000 (10⁶) bytes.
- A gigabyte (GB) is equal to $1,000,000,000 (10^9)$ bytes.
- A terabyte (TB) is equal to 1,000,000,000,000 (10¹²) bytes.
- A petabyte (PB) is equal to 1,000,000,000,000 (10¹⁵) bytes
- A kibibyte (KiB) is equal to 2¹⁰ bytes.
- A mebibyte (MiB) is equal to 2²⁰ bytes.
- A gibibyte (GiB) is equal to 2³⁰ bytes.
- A tebibyte (TiB) is equal to 2⁴⁰ bytes.
- A pebibyte (PiB) is equal to 2⁵⁰ bytes

2.4.2 Pseudo Code Conventions

The specification uses an informal pseudo code to express the test loops. It is important to follow the precedence and ordering information implied by the syntax. In addition to nesting/indentation, the main syntactic construct used is the "For" statement.

A "For" statement typically uses the syntax: For (variable = x, y, z). The interpretation of this construct is that the Test Operator sets the variable to x, then performs all actions specified in

the indented section under the "For" statement, then sets the variable to y, and again performs the actions specified, and so on. Sometimes a "For" statement will have an explicit "End For" clause, but not always; in these cases, the end of the For statement's scope is contextual.

Take the following loop as an example:

For (R/W Mix % = 100/0, 95/5, 65/35, 50/50, 35/65, 5/95, 0/100) For (Block Size = 1024KiB, 128KiB, 64KiB, 32KiB, 16KiB, 8KiB, 4KiB, 0.5KiB) - Execute **random IO**, per (R/W Mix %, Block Size), for 1 minute - Record Ave IOPS(R/W Mix%, Block Size)

This loop is executed as follows:

- Set R/W Mix% to 100/0 >>>>> Beginning of Loop 1
- Set Block Size to 1024KiB
- ➢ Execute random IO…
- Record Ave IOPS...
- ➢ Set Block Size to 128KiB
- > Execute...
- ➢ Record…
- ≻ ...
- Set Block Size to 0.5KiB
- ➢ Execute...
- Record...
 Set R/W Mix% to 95/5
- >>>> End of Loop 1
- >>>> Beginning of Loop 2
- Set Block Size to 1024 KiB
- ► Execute...
- ➢ Record…
- ≻ ...

3 Key Test Process Concepts

The performance of an SSS device is highly dependent on its prior usage, the pre-test state of the device and test parameters. This section describes key SSS test methodology concepts.

3.1 Steady State

SSS devices that are Fresh Out of the Box (FOB), or in an equivalent state, typically exhibit a transient period of elevated performance, which evolves to a stable performance state relative to the workload being applied. This state is referred to as a Steady State (Definition 2.1.21).

It is important that the test data be gathered during a time window when the device is in Steady State, for two primary reasons:

- 1) To ensure that a device's initial performance (FOB or Purged) will not be reported as "typical", since this is transient behavior and not a meaningful indicator of the drive's performance during the bulk of its operating life.
- 2) To enable Test Operators and reviewers to observe and understand trends. For example, oscillations around an average are "steady" in a sense, but might be a cause for concern.

Steady State may be verified:

- by inspection, after running a number of Rounds and examining the data;
- programmatically, during execution; or
- by any other method, as long as the attainment of Steady State, per Definition 2.1.21, is demonstrated and documented.

Steady State as defined in Definition 2.1.21 shall meet the Steady State Verification criteria as set forth in each test. Steady State reporting requirements are covered in the respective test sections.

3.2 Purge

The purpose of the Purge process (Definition 2.1.18) is to put the device in a consistent state prior to preconditioning and testing, and to facilitate a clear demonstration of Steady State convergence behavior.

Purge shall be run prior to each preconditioning and testing cycle. If the device under test does not support any kind of Purge method, and the Test Operator chooses to run the PTS, the fact that Purge was not supported/run must be documented in the test report.

The Test Operator may select any valid method of implementing the Purge process, including, but not limited to, the following:

- a) ATA: SECURITY ERASE, SANITIZE DEVICE (BLOCK ERASE EXT)
- b) SCSI: FORMAT UNIT
- c) Vendor specific methods

The Test Operator shall report what method of Purge was used.

3.3 Preconditioning

The goal of preconditioning is to facilitate convergence to Steady State during the test itself.

The SSS PTS defines two types of preconditioning:

- Workload Independent Preconditioning (Definition 2.1.16.1); and
- Workload Dependent Preconditioning (Definition 2.1.16.2)

Note: While Workload Based Preconditioning is not a distinct step in the test scripts (it occurs as part of running the core test loop in each test), it is critically important to achieving valid Steady State results.

3.4 ActiveRange

It is desirable to be able to test the performance characteristics of workloads which issue IO across a wide range of the LBA space vs. those which issue IO across only a narrow range. To enable this, the SSS Performance Specification defines ActiveRange. (Definition 2.1.1)

The test scripts define required and optional settings for ActiveRange.

Figure 3-1 show two examples of ActiveRange.



Figure 3-1 – ActiveRange Diagram

3.5 Data Patterns

All tests shall be run with a random data pattern. The Test Operator may execute additional runs with non-random data patterns. If non-random data patterns are used, the Test Operator must report the data pattern.

Note: Some SSS devices look for and optimize certain data patterns in the data written to the device. It is not feasible to test for all possible kinds of optimizations, which are vendor specific and often market segment specific. The SSS TWG is still trying to characterize "how random is random enough" with respect to data patterns.

3.6 Multiple Thread Guideline

If the Test Operator wishes to run a test using multiple Threads, it is recommended that OIO/Thread, or Queue Depth, for all Threads be equal, so Total OIO is equal to (OIO/Thread) * (Thread Count). This will enable more direct comparisons.

While the Test Operator may select a given OIO for a test, the Test Operator shall use the same Thread Count and OIO/Thread for all steps of a given test.

3.7 Caching

All tests should be run with all volatile write caches disabled. The cache state shall be reported for drives that cannot have write cache disabled.

4 Overview of Common Test Flow

The Steady State tests in the SSS PTS (IOPS, Throughput and Latency) use the same general steps and flow, described in Figure 4-1. Test-specific parameter settings, reports, and other requirements are documented in the test sections themselves.

Basic Test Flow: For (ActiveRange = the specified values) 1) Purge the device Note: Test Operator may use any values for ActiveRange and Test Parameters for this step; no parameter reporting is required. 2) Run Workload Independent Preconditioning Note: Test Operator shall use specified ActiveRange ("For ActiveRange ="), but may choose other Test Parameter values to optimize this step, and shall report them. 3) Run Test (includes Workload Based Preconditioning): a) Set Test Parameters (OIO/Thread, Thread Count, Data Pattern, etc.) as specified in the test script. b) Run test loop until Steady State reached, or a maximum of 25 Rounds. Accumulate/Record intermediate data, as specified in test, for each Round. 4) Post process & plot the Rounds data: a) If Steady State is reached by Round x=25, where the Measurement Window is Round (x-4):x, the Test Operator shall: i) Plot Rounds 1:x per "Steady State Convergence Plot"; ii) Plot Rounds (x-4):x per "Steady State Verification Plot"; and iii) Plot Rounds (x-4):x per "Measurement Plot". b) If Steady State is not reached by Round x=25, the Test Operator shall either: i) Continue at 3b until Steady State reached (x>25), and then report per 4a(i-iii); or ii) Stop at Round x and report per 4a(i-iii). End "For ActiveRange" The Test Operator may re-run the entire "For ActiveRange" loop with alternate test parameters, which may be optional or required, depending on the test. End "Basic Test Flow" Figure 4-1 – Basic Test Flow Note: Steps (2) and (3) must each be run with no interruptions, and there must be no delay between Step (2) and Step (3), to maintain consistent test conditions for all devices.

Note: With respect to the reports in Step (4):

- The **Steady State Convergence Plot** shows general visual convergence to Steady State by plotting the dependent variable (IOPS, Throughput, etc.) for each Round.
- The **Steady State Verification Plot** shows, via either graph or table, that the device has reached Steady State per definition 2.1.21, by examining dependent variable behavior within the Measurement Window.
- The **Measurement Plot** is not one, but a set of, plots/reports, which summarize the test data in the Measurement Window, for the metric being measured.
- The content of these plots, and other test-specific reporting, is specified in each test.
- Examples of these plots are set forth in Annex A.

Common Reporting Requirements 5

The following items, common to all tests, shall be included in the final test report. These items only need to be reported once in the test report. Test-specific report items are defined in the relevant test sections themselves. A sample test report can be found in Annex A.

5.1 General

- 1) Test Date
- Report Date
- Test Operator name
 Auditor name, if applicable
 Test Specification Version

5.2 Test System Hardware

- 1) Manufacturer/Model #
- 2) Mother Board/Model #
- 3) CPU
- 4) DRAM
- 5) Host Bus Adapter
- 6) Primary Storage
- 7) Peripherals

5.3 Test System Software

- 1) Operating System Version
- 2) File System and Version
- 3) Test Software

5.4 Device Under Test

- 1) Manufacturer
- 2) Model Number
- 3) Serial Number
- 4) Firmware Revision
- 5) User Capacity
- 6) Interface/Speed
- 7) Form Factor (e.g., 2.5")
- 8) Media Type (e.g., MLC NAND Flash)
- 9) Optional: Other major relevant features (e.g., NCQ, Hot plug, Sanitize support, etc.)

6 Test Tool Guidelines

The SSS PTS is platform (HW/OS/Tool) agnostic. A sample platform is outlined Annex B. SW tools used to test SSS devices pursuant to this PTS shall have the ability to:

- 1) Act as workload stimulus generator as well as data recorder
- 2) Issue Random and Sequential block level I/O
- 3) Restrict LBA accesses to a particular range of available user LBA space
- 4) Test Active Range shall be able to limit "total unique LBAs used" to a specific value
- 5) Ability to randomly distribute a number of equally sized LBA segments across the test active range.
- 6) Set R/W percentage mix %
- 7) Set Random/Sequential IO mix %
- 8) Set IO Transfer Size
- 9) Generate and maintain multiple outstanding IO requests. Ensure that all steps in the test sequence can be executed immediately one after the other, to ensure that drives are not recovering between processing steps, unless recovery is the explicit goal of the test.
- 10) Provide output, or output that can be used to derive, IOPS, MB/s, maximum latency and average response time (latency if OIO=1) within some measurement period.

The random function for generating random LBA #'s during random IO tests shall be:

- 1) seedable;
- 2) have an output >= 48-bit; and
- 3) deliver a uniform random distribution independent of capacity.

7 IOPS Test

7.1 IOPS Descriptive Note

General Purpose:

Enterprise IOPS test is intended to measure the test SSD IOPS at a range of Random Block Sizes and Read/Write mixes. This Enterprise IOPS test is intended to emulate characteristics of Enterprise workloads. PTS-E Enterprise workload tests use 100% LBAs.

Test Flow:

The Enterprise IOPS test makes use of:

- 1) a preconditioning range of 100% LBAs (Section 2.1);
- 2) a one-step Workload Independent PC (Section 2.1.16 a) consisting of 128KiB SEQ W for 2X (twice) the user capacity; and
- 3) a one-step Workload Dependent PC (WDPC) (Section 2.1.16 b) consisting of the IOPS loop using the ActiveRange until Steady State, as defined, is achieved.

Test Results:

The test results captured during steady state measurement window shall be tabulated and plotted as specified in section 7 and are intended to present the IOPS performance over the 56 element matrix of Read/Write Mixes (aka the "outer loop") and Block Sizes (aka the "inner loop").

Test Interpretation:

A higher value (more IOPS) is better.

7.2 IOPS Pseudo Code

For (ActiveRange(0:100), optional ActiveRange(Test Operator Choice))

- 1 Purge the device. (Note: ActiveRange and other Test Parameters are not applicable to Purge step; any values can be used and none need to be reported.)
- 2 Run Workload Independent Preconditioning
 - 2.1 Set and record test conditions:
 - 2.1.1 Device volatile write cache = disabled
 - 2.1.2 OIO/Thread: Test Operator Choice
 - 2.1.3 Thread Count: Test Operator Choice
 - 2.1.4 Data Pattern: Required = Random, Optional = Test Operator
 - 2.2 Run SEQ Workload Independent Preconditioning Write 2X User Capacity with 128KiB SEQ writes, writing to the entire ActiveRange without LBA restrictions.

3 Run Workload Dependent Preconditioning and Test stimulus. Set test parameters and record for later reporting

- 3.1 Set and record test conditions:
 - 3.1.1 Device volatile write cache = Disabled
 - 3.1.2 OIO/Thread: Same as in step 2.1 above.
 - 3.1.3 Thread Count: Same as in step 2.1 above.
 - 3.1.4 Data Pattern: Required= Random, Optional = Test Operator Choice.
- 3.2 Run the following test loop until Steady State is reached, or maximum of 25 Rounds:
 - 3.2.1 For (R/W Mix % = 100/0, 95/5, 65/35, 50/50, 35/65, 5/95, 0/100)

3.2.1.1 For (Block Size = 1024KiB, 128KiB, 64KiB, 32KiB, 16KiB, 8KiB, 4KiB, 0.5KiB)
3.2.1.2 Execute RND IO, per (R/W Mix %, Block Size), for 1 minute 3.2.1.2.1 Record Ave IOPS (R/W Mix%, Block Size)
3.2.1.2.2 Use IOPS (R/W Mix% = 0/100, Block Size = 4KiB) to detect Steady State.
3.2.1.2.3 If Steady State is not reached by Round x=25, then the Test Operator may either continue running the test until Steady State is reached, or may stop the test at Round x. The Measurement Window is defined as Round x-4 to Round x.
3.2.1.3 End "For Block Size" Loop

3.2.2 End "For R/W Mix%" Loop

4 Process and plot the accumulated Rounds data, per report guidelines in 7.3. End (For ActiveRange)0 loop

Note: It is important to adhere to the nesting of the loops as well as the sequence of R/W Mixes and Block Sizes.

7.3 Test Specific Reporting for IOPS Test

7.3.1 through 7.3.6.3 list the reporting requirements specific to the IOPS test. Reporting requirements common to all tests are documented in Section 5. See also Annex A.

If Steady State was reached at Round x, the Test Operator shall: Plot Rounds 1:x per "IOPS Steady State Convergence Plot"; Plot Rounds (x-4):x per "IOPS Steady State Verification Plot"; and Plot Rounds (x-4):x per "IOPS Measurement Plot."

If Steady State was not reached then the Test Operator may report results per above, picking the last Round run as Round x. In the case where Steady State was not reached, the Test Operator must state this fact in the final report.

7.3.1 Purge Report

The Test Operator shall report the method used to run the Purge operation.

7.3.2 Preconditioning Report

The Test Operator shall report both Workload Independent and Workload Dependent preconditioning information as shown in the Report Headers that follow.

Note on Headers: The individual Report Headers are the same for all pages of the report, except for reference to a specific test ID number if more than one test is used to generate the SNIA Report Header. The plots in the following sections show the test Report Header for the first plot example only. Test Report Headers are omitted for subsequent report pages for the same test report in order to provide more clarity for the related plot or graph.

7.3.3 Steady State Convergence Report

The Test Operator shall generate a Steady State Convergence plot as shown in Plot 7-1, including the test set-up and parameters set forth in the Report Header. See Annex A.

Test Run Date: 11/02/2		2011 02:56 PM	8:43:00 AM							
				IOPS	Test (REQU	IRED) - Rep	oort Page			
SNIA	_	Solid Stat	te Stor	age	TODE Blo	ek Cizo y Di	Af Mix Matei	Re	. PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	10P5 - BIO	CK SIZE X KI	w mix matri	× Pag	e 1 of 6	
Vendor:	BC Co.	SSD	Model:	ABC Co.	SLC-A 100	TEST		LYPSO Systems		
Те	st Pl	atform		Devic	e Under Test	Set Up P	arameters	Test P	Test Parameters	
Ref Test Platform Calypso RTP 2		P 2.0	Mfgr	ABC Co.	Data Pattern	RND	Data Pattern	RND		
Motherboa	rd	Intel 5520	нс	Model No.	SLC-A	AR	100%	AR & Amount	100%	
CPU		Intel XEON 5	1 5580W S/N		123456	AR Segments	N/A	Test Stimulus 1	IOPS Loop	
Memory		8 GB PC1600	00 DDR2 Firmware		er ABCDEF	Pre Condtion 1	SEQ 128K W	RW Mix	Outer Loop	
Operating System		CentOS 6	i.3	Capacity	100 GB	TOIO - TC/QD	TC 2/ QD 16	Block Sizes	Inner Loop	
Test SW		CTS 6.5 1.1	CTS 6.5 1.13.8 Interface		SATA 6Gb/s	Duration	Twice User Capacity	wice User Capacity TOIO - TC/QD		
Test SW Info		1.10.7/1.9	7/1.9.16 NAND Typ		s SLC	Pre Condtion 2	IOPS Loop	IOPS Loop Steady State		
Test ID No.		RS-456	PCIe NVM		N/A	TOIO - TC/QD	TC 2/ QD 16	Test Stimulus 2	N/A	
HBA		LSI 9212-4	ie4i	Purge Metho	od Format Unit	SS Rounds	1-5	TOIO - TC/QD	N/A	
PCIe		Gen 2 x	8	Write Cach	e WCD	Note	-	Steady State	N/A	



Plot 7-1 - IOPS SS Convergence Report

7.3.4 Steady State Verification

The Test Operator shall document the following for Steady State Verification, using Ave 4KiB Random Write IOPS as the dependent variable:

IOPS Test - Steady State Verification Dependent Variable = Ave 4KiB Random Write IOPS ActiveRange = (x,y); OIO/Thread = x; Thread Count = x; Data Pattern = x

- Measurement Window: Start __; End ___
- Ave. value in Measurement Window: ____
- Calculated allowed range in Measurement Window (+-10% of Ave.): Max_; Min __
- Measured range in Measurement Window: Max __; Min __ (pass/fail)
- Slope of best linear fit in Measurement Window (must be <= 10%): __% (pass/fail)
- Correlation coefficient for best linear fit: ____

7.3.5 Steady State Measurement Window

The Test Operator shall include a plot showing the Steady State Measurement Window, as shown in Plot 7-2, including the test set up and parameters set forth in the Report Header (see Annex A to see Report Header).



Steady State Determination Data			
Average IOPS:			16563.0
Allowed Maximum Data Excursion:	3312.6	Measured Maximum Data Excursion:	248.3
Allowed Maximum Slope Excursion:	1656.3	Measured Maximum Slope Excursion:	128.6
Least Squares Linear Fit Formula:		-3	2.143 * R + 16659.425

Plot 7-2 - IOPS SS Measurement Window

7.3.6 Measurement Window Report

The results for the test shall be reported in the following series of tables and graphs (7.3.6.1 - 7.3.6.3) that record and report the data from the Steady State Measurement Window.

7.3.6.1 IOPS Measurement Window Tabular Data

The Test Operator shall include a plot showing an IOPS Tabular Data, as shown in Plot 7-3, including the test set up and parameters set forth in the Report Header. See Annex A.

	IOPS - ALL RW Mix & BS – Tabular Data									
Block Size	Read / Write Mix %									
(KiB)	0/100	5/95	35/65	50/50	65/35	95/5	100/0			
0.5	15,887.4	16,634.7	20,678.6	24,402.8	29,386.2	72,428.4	95,924.3			
4	16,563.0	17,032.2	20,234.2	23,705.2	28,018.6	63,447.7	93,707.0			
8	9,559.8	9,998.4	12,547.1	14,636.6	17,199.1	37,872.9	50,301.2			
16	4,842.2	5,032.3	6,802.5	8,132.1	9,655.8	22,462.2	31,072.8			
32	2,413.3	2,535.4	3,478.4	4,241.3	5,061.7	12,174.7	15,994.2			
64	1,219.2	1,275.7	1,728.4	2,126.1	2,726.3	6,284.6	8,094.9			
128	612.7	632.5	859.1	1,061.4	1,709.4	3,205.7	4,060.8			
1024	74.8	78.0	103.6	126.7	202.7	398.8	514.6			

Plot 7-3 - IOPS Measurement Window Tabular Data

Each entry in the table is the average of the values in the five Rounds comprising the Steady State Measurement Window, for the selected (R/W Mix%, Block Size) element.

7.3.6.2 IOPS Measurement Plot – 2D

The Test Operator shall include a plot showing an IOPS 2D Plot, as shown in Plot 7-4, including the test set up and parameters set forth in the Report Header. See Annex A to view Header.



Plot 7-4 - IOPS Measurement Plot - 2D

7.3.6.3 IOPS Measurement Plot – 3D

The Test Operator shall include a plot showing an IOPS 3D Plot, as shown in Plot 7-5, including the test set up and parameters set forth in the Report Header. See Annex A to view Header.



Plot 7-5 - IOPS Measurement Plot – 3D
8 Throughput Test

8.1 Throughput (TP) Descriptive Note

General Purpose:

Enterprise Throughput test is intended to measure the test SSD Throughput (TP) at two Block Sizes (128KiB and 1024KiB) at Sequential Read/Write (100/0, 0/100) during Steady State. This Enterprise TP test is intended to present the test SSD data transfer rate in MB/s for the prescribed R/W Mixes and Block Sizes. The intent of the TP test is to determine how fast the test SSD can transfer Sequential data without limitation from the IO Bus.

Test Flow:

The Enterprise TP tests are separate tests for each Block Size and makes use of:

- 1) a preconditioning LBA ActiveRange of 100% (section 2.1);
- 2) a one step Workload Independent PC (section2.1.16 a) consisting of 128KiB SEQ W, or optionally 1024KiB for the 1024KiB TP test, for 2X (twice) the user capacity; and
- a one step Workload Dependent PC (WDPC) (section2.1.16 b) consisting of the test stimulus at each Block Size over the ActiveRange until Steady State, as defined, is achieved.

Test Results:

The test results captured during steady state measurement window shall be tabulated and plotted as specified in Section 8.

Test Interpretation:

A higher value (greater MB/s) is better.

8.2 TP Pseudo Code

For (ActiveRange(0:100), optional ActiveRange(Test Operator Choice))

For (Block Size = 128KiB, 1024KiB)

- 1 Purge the device. (Note: ActiveRange Amount and other Test Parameters are not applicable to Purge step; any values can be used and none need to be reported.)
- 2 Workload Independent Preconditioning
 - 1.1. Set and record parameters for later reporting.
 - 2.1.1 Volatile Write cache: disabled
 - 2.1.2 Thread Count: Test Operator Choice
 - 2.1.3 OIO/Thread: Test Operator Choice*
 - 2.1.4 Data Pattern: Required = Random, Optional = Test Operator Choice
 - 2.2 Run SEQ WIPC Write 2X User Capacity w/ 128KiB SEQ writes, or optionally run 1024KiB writes for the 1024KiB TP test, to the entire ActiveRange without any LBA restrictions.

3 Run Workload Dependent Preconditioning and Test Stimulus

- 3.1 Set parameters and record for later reporting
 - 3.1.1 Volatile Write cache: disabled
 - 3.1.2 Thread Count: Same as in step 2.1 above.
 - 3.1.3 OIO/Thread: Same as in step 2.1 above.
 - 3.1.4 Data Pattern: Required = Random, Optional = Test Operator Choice

3.2 Run the following until Steady State is reached, or maximum of 25 Rounds

3.2.1 For (R/W Mix % = 100/0, 0/100)

- 3.2.1.1 Execute SEQ IO, per (R/W Mix%, Block Size) for 1 minute
- 3.2.1.2 Record Ave MB/s (R/W Mix%, Block Size)
- 3.2.1.3 Use Ave MB/s (RW Mix%, Block Size) to detect Steady State.
- 3.2.1.4 If Steady State is not reached by Round x=25, then the Test Operator may continue running the test until Steady State is reached, or may stop the test at Round x. The Measurement Window is defined as Round x-4 to Round x.
- 3.2.1.5 Note that the sequential accesses shall be continuous and use the entire ActiveRange between test steps.

3.2.2 End (For R/W Mix%) Loop

4 Process and plot the accumulated Rounds data, per report guidelines in Section 8.3, based on current values of ActiveRange, etc.

End (For ActiveRange) loop

8.3 Test Specific Reporting for Throughput Test

Sections 8.3.1 through 8.3.7 list the reporting requirements specific to the Throughput test. Reporting requirements common to all tests are documented in Section 5. See also Annex A.

If Steady State was reached at Round x, the Test Operator shall:

- Plot Rounds 1:x per "Throughput Steady State Convergence Plot";
- Plot Rounds (x-4):x per "Throughput Steady State Verification Plot"; and
- Plot Rounds (x-4):x per "Throughput Measurement Plot."

If Steady State was not reached then the Test Operator may report results per above, picking the last Round run as Round x. In the case where Steady State was not reached, the Test Operator must state this fact in the final report.

8.3.1 Purge Report

The Test Operator shall report the method used to run the Purge operation.

8.3.2 Preconditioning Report

The Test Operator shall report both Workload Independent and Workload Dependent preconditioning information as shown in the Report Headers that follow.

Note on Headers: The individual Report Headers are the same for all pages of the report, except for reference to a specific test ID number if more than one test is used to generate the SNIA Report Header. The plots in the following sections show the test Report Header for the first plot example only. Test Report Headers are omitted for subsequent report pages for the same test report in order to provide more clarity for the related plot or graph.

8.3.3 Steady State Convergence Report - Write

The Test Operator shall generate a Steady State Convergence Report Write, as shown in Plot 8-1, including the test set up and parameters set forth in the Report Header. See Annex A to view Header.

Tes	t Ru	n Date:		12/04/20	011 08:21 AM	Report	Run [Date:	3	/04/2013	10:03 AM	
			1	Throughp	ut Test (RE	QUIRED) -	Rep	ort Pag	e			
SNIA		Solid Stat	te Stor	rage	TD - SEO 1	ODAVID 8	SEO	1300:0	8	Rev.	PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	1F - 3EQ 1	1024KID @ .	SEQ	IZOKID		Page	1 of 10	
Vendor: Al		BC Co.	SSD	Model:	ABC Co.	SLC-A 100		TEST	OR	CAL	YPSO Systems	
Te	st Pl	atform		Device	Under Test	Set Up P	Set Up Paramete		Test Pa		rameters	
Ref Test Plat	form	Calypso RT	P.2.0	Mfgr	ABC Co.	Data Pattern		RND	Data P	attern	RND	
Motherboa	Motherboard Intel 5520HC		HC	Model No.	SLC-A	AR	100%		AR & Amount		100%	
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A		Test S	timulus 1	5EQ 1024KiB	
Memory	8 <u> </u>	8 GB PC1600	DDR2	Firmware ver	ABCDEF	Pre Condtion 1	SEC	2 128K/B W	RW	Mix	100:0/0:100	
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	TC 1/ QD 1		Block Sizes		SEQ 1024KiB	
Test SW	r i	CTS 6.5 1.1	13.8	Interface	SATA 6Gb/s	Duration	Twice	User Capacity	то	O - TC/QD	TC 2/QD 16	
Test SW I	nfo	1.10.7/1.9	.16	NAND Type	SLC	Pre Condtion 2	SEC	Q 128KiB W	Ste	ady State	1-5	
Test ID N	o.	R5-897	N. ²	PCIe NVM	N/A	TOIO - TC/QD	TC	2/ QD 16	Test S	timulus 2	SEQ 128KiB	
НВА		LSI 9212-4	le4i	Purge Method	Format Unit	SS Rounds		1 - 5	то	O - TC/QD	TC 2/QD 16	
PCIe		Gen 2 x	8	Write Cache	WCD	Note			Ste	ady State	1 - 5	
		1	Thro	ughput 1	est - SS Co	nvergence	- Wr	ite 102	4Kil	3		

-------------------------------BS=1024





8.3.4 Steady State Convergence Report - Read

The Test Operator shall include a plot showing the Steady State Convergence Report Read, as shown in Plot 8-2, including the test set up and parameters set forth in the Report Header. See Annex A to view Header.



Plot 8-2 - TP SS Convergence Report Read

8.3.5 Steady State Verification Report

The Test Operator shall document the following for Steady State Verification, using, depending on the test Block Size, *Ave 128KiB or 1024KiB Sequential Write MB*/s as the dependent variable:

- Measurement Window: Start __; End __
- Calculated allowed range in Measurement Window (+-10% of Ave.): Max_; Min ___
- Measured range in Measurement Window: Max __; Min __ (pass/fail)
- Slope of best linear fit in Measurement Window (must be <= 10%): __% (pass/fail)
- Correlation coefficient for best linear fit: __

8.3.6 Steady State Measurement Window

The Test Operator shall include a plot showing the Steady State Measurement Window, as shown in Plot 8-3, including the test set up and parameters set forth in the Report Header. See Annex A to view Header.



Steady State Determination Data			
Average ThroughPut:			157.5
Allowed Maximum Data Excursion:	31.5	Measured Maximum Data Excursion:	16.6
Allowed Maximum Slope Excursion:	15.7	Measured Maximum Slope Excursion:	1.9
Least Squares Linear Fit Formula:			0.470 * R + 154.165

Plot 8-3 - TP SS Measurement Window

8.3.7 Measurement Window Report

The results for the test must be reported in the following series of tables and graphs (Plot 8-4 through Plot 8-7) that record and report the data from the Steady State Measurement Window.

8.3.7.1 TP Measurement Window Tabular Data - 1024KiB

The Test Operator shall include a plot showing a Throughput Tabular Data, as shown in Plot 8-4, including the test set up and parameters set forth in the Report Header. See Annex A to view Header.

Tes	t Ru	in Date:		12/04/2	011 08:21 AM	Report	Run I	Date:	3	/04/2013	10:03 AM
			٦	Throughp	out Test (RE	QUIRED) -	Rep	ort Pag	e		
SNIA		Solid Stat	te Stor	rage	тр	- SEO 1024	IV IR			Rev.	PTS-E 1.1
SSS TWG	Perf	formance T	est Sp	ec (PTS)	Contraction of the second	- SEQ 1024	ANID			Page	4 of 10
Vendor:	Vendor: ABC		SSD	Model:	ABC Co.	SLC-A 100		TEST	OR	CAL	YPSO Systems
Te	st Pl	atform		Device	Under Test	Set Up P	aram	eters		ameters	
Ref Test Plat	tform	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern		RND	Data P	attern	RND
Hotherboa	Motherboard Intel 5520HC		HC	Model No.	SLC-A	AR	100%		AR & Amount		100%
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A		Test S	timulus 1	SEQ 1024KIB
Memory	ř. –	8 GB PC1600	DDR2	Firmware ver	ABCDEF	Pre Condtion 1	SEQ 128KiB W		RW Mix		100:0 / 0:100
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	TC 1/ QD 1		Block Sizes		SEQ 1024KiB
Test SW	/	CTS 6.5 1.1	13.8	Interface	SATA 6Gb/s	Duration	Twice User Capacity		TOIO - TC/QD		TC 2/QD 16
Test SW I	nfo	1.10.7/1.9	.16	NAND Type	SLC	Pre Condtion 2	SE	Q 128KiB W	Ste	ady State	1-5
Test ID N	о.	R5-897	8	PCIe NVM	N/A	TOIO - TC/QD	т	2/ QD 16	Test S	timulus 2	SEQ 128KiB
НВА		LSI 9212-4	le4i	Purge Method	Format Unit	SS Rounds		1 - 5	тот	IO - TC/QD	TC 2/QD 16
PCIe		Gen 2 x	8	Write Cache	WCD	Note			Ste	ady State	1-5
		Th	roug	<mark>ghput - A</mark>	LL RW Mix 8	BS – Tabu	lar	Data 10	24	(iB	

Block Size	Read / Write Mix %					
(KiB)	0/100	100/0				
1024	157.5	514.3				

Plot 8-4: TP Measurement Window Tabular Data – 1024KiB

Each entry in the table is the average of the values in the five Rounds comprising the Steady State Measurement Window, for the selected (R/W Mix%, Block Size) element.

8.3.7.2 Measurement Window Summary Data Table 128KiB

The Test Operator shall include a plot showing a Throughput 2D Plot for Block Size 128KiB, as shown in Plot 8-5, including the test set up and parameters set forth in the Report Header. See Annex A.

Tes	t Ru	n Date:		12/04/2	011 08:21 AM	Report	Run Dat	e:	3	3/04/2013 10:03 AM		
			2	Through	put Test (RE	QUIRED) -	Report	Pag	e			
SNIA		Solid Stat	te Sto	rage	TD SEO 1	034418 / 6	EO 12	ov:p	. 1	Rev.	PTS-E 1.1	
SSS TWG	Pert	ormance T	est S	pec (PTS)	IP - SEQ 1024KIB / SEQ 126KIB					Page	9 of 10	
Vendor:	Vendor: ABC Co. S		SSE	O Model:	ABC Co.	ABC Co. SLC-A 100			DR	CAL	YPSO Systems	
Te	Test Platform			Device	e Under Test	Set Up P	aramete	rs	Test Pa		ameters	
Ref Test Plat	form	Calypso RTI	P 2.0	Mfgr	ABC Co.	Data Pattern	RN	D	Data P	attern	RND	
Motherboa	Motherboard Intel 5520H0		HC	Model No.	SLC-A	AR	100%		AR & A	mount	100%	
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A		Test S	imulus 1	SEQ 1024KiB	
Memory	,	8 GB PC1600	DDR2	Firmware ve	r ABCDEF	Pre Condtion 1	SEQ 128KiB W		RW Mix		100:0 / 0:100	
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	TC 1/ QD 1		Block Sizes		SEQ 1024KiB	
Test SW	,	CTS 6.5 1.1	13.8	Interface	SATA 6Gb/s	Duration	Twice User	Capacity	TOI	O - TC/QD	TC 2/QD 16	
Test SW I	nfo	1.10.7/1.9	.16	NAND Type	SLC	Pre Condtion 2	SEQ 12	SKIB W	Ste	ady State	1-5	
Test ID N	o.	R5-891	Y.	PCIe NVM	N/A	TOIO - TC/QD	TC 2/ 0	DD 16	Test S	imulus 2	SEQ 128KiB	
НВА		LSI 9212-4	le4i	Purge Metho	d Format Unit	SS Rounds	1-	5	TO	O - TC/QD	TC 2/QD 16	
PCIe		Gen 2 x	8	Write Cache	WCD	Note			Ste	ady State	1-5	
		T	irou	ighput -	ALL RW Mix	& BS – Tab	ular D	ata 1	28K	iB		

Block Size	Read / Write Mix %					
(KiB)	0/100	100/0				
128	144.5	409.3				

Plot 8-5 - TP Measurement Window Tabular Data – 128KiB

Each entry in the table is the average of the values in the data series $Average_MB/s(x,y)$, recorded in the per-Round MB/s matrices within the Measurement Window, for the selected (R/W Mix%, Block Size) pair.

8.3.7.3 TP Measurement Plot - 2D SEQ 1024KiB

The Test Operator shall include a plot showing a Throughput 2D Plot for Block Size 1024KiB, as shown in Plot 8-6, including the test set up and parameters set forth in the Report Header. See Annex A to view Header.



Plot 8-6 - TP Measurement Plot – 2D SEQ 1024KiB

8.3.7.4 Measurement Plot SEQ 128KiB- 2D

The Test Operator shall include a plot showing a Throughput 2D Plot for Block Size 128KiB, as shown in Plot 8-7, including the test set up and parameters set forth in the Report Header. See Annex A to view Header.



Plot 8-7 - TP Measurement Plot – 2D SEQ 128KiB

9 Latency Test

9.1 Latency (LAT) Descriptive Note

General Purpose:

Enterprise Latency test is intended to measure the test SSD response time at 3 Block Sizes (8KiB, 4KiB and 0.5KiB) and 3 Read/Write mixes (100/0, 65/35, 0/100) using 100% preconditioning and 100% Test ActiveRange. This Latency test is intended to observe how well the test SSD handles a single OIO without the benefit of queuing.

This Enterprise Latency test is intended to present Average and Maximum Response Times (Latency) at a total outstanding IO of 1 (one Thread and a single OIO/Thread (Queue Depth)). The Latency measurement is inherently dependent on the treatment of the outstanding IOs by the host hardware and software test platform. An OIO of 1 is set to normalize the impact of the test system (as OIO >1 may be treated differently by different test hardware).

Test Flow:

The Enterprise Latency test makes use of:

- 1) preconditioning to the entire LBA ActiveRange (section 2.1.1);
- 2) a one step Workload Independent PC (section 2.1.6a) consisting of 128KiB SEQ W for 2X (twice) the user capacity; and
- 3) a one step Workload Dependent PC (WDPC) (section 2.1.6b) consisting of the Latency loop over the LBA ActiveRange until Steady State, as defined, is achieved.

Test Results:

The test results captured during steady state measurement window shall be tabulated and plotted as specified in section 9.3.

Test Interpretation:

A lower value (lower msec) is better.

9.2 LAT Pseudo Code

For (ActiveRange(0:100), optional ActiveRange(Test Operator Choice))

- 1 Purge the device. (Note: Active Range and other Test Parameters are not applicable to Purge step; any values can be used and none need to be reported.)
- 2 Run Workload Independent Preconditioning
 - 2.1 Set test parameters and record for later reporting
 - 2.1.1 Device volatile write cache = disabled
 - 2.1.2 OIO/Thread: 1
 - 2.1.3 Thread Count: 1
 - 2.1.4 Data Pattern: Required = Random, Optional = Test Operator Choice
 - 2.2 Run SEQ Workload Independent Preconditioning Write 2X User Capacity w/ 128KiB sequential writes, writing to the entire ActiveRange.
- 3 Run the Workload Dependent Preconditioning test loop until Steady State is reached, or maximum of 25 Rounds:
 - 3.1 For (R/W% = 100/0, 65/35, 0/100)
 - 3.1.1 For (Block Size = 8KiB, 4KiB, 0.5KiB)
 - 3.1.1.1.1 Execute RND IO per (R/W%, Block Size), for 1 minute
 - 3.1.1.2 Record Max and Ave Latency (R/W%, Block Size)

- 3.1.1.3 Use Ave Latency (R/W Mix%=0/100, Block Size=4KiB) to detect Steady State.
- 3.1.1.4 If Steady State is not reached by Round x=25, then the Test Operator may either continue running the test until Steady State is reached, or may stop the test at Round x. The Measurement Window is defined as Round x-4 to Round x
- 3.1.2 End (For Block Size) Loop
- 3.2 End (For R/W Mix %) Loop
- 4 Process and plot the accumulated Rounds data, per report guidelines in next section.

End "For ActiveRange" loop

9.3 Test Specific Reporting for Latency Test

Sections 9.3.1 through 9.3.6 list the reporting requirements specific to the Latency test. Reporting requirements common to all tests are documented in Section 5. See also Annex A.

If Steady State was reached at Round x, the Test Operator shall:

- Plot Rounds 1:x per "Latency Test Steady State Convergence Plot";
- Plot Rounds (x-4):x per "Latency Test Throughput Steady State Verification Plot"; and
- Plot Rounds (x-4):x per "Latency Test Measurement Plot."

If Steady State was not reached then the Test Operator may report results per above, picking the last Round run as Round x. In the case where Steady State was not reached, the Test Operator must state this fact in the final report.

9.3.1 Purge

The Test Operator shall report the method used to run the Purge operation.

9.3.2 Preconditioning Report

The Test Operator shall report both Workload Independent and Workload Dependent preconditioning information as shown in the Report Headers that follow.

Note on Headers: The individual Report Headers are the same for all pages of the report, except for reference to a specific test ID number if more than one test is used to generate the SNIA Report Header. The plots in the following sections show the test Report Header for the first plot example only. Test Report Headers are omitted for subsequent report pages for the same test report in order to provide more clarity for the related plot or graph.

9.3.3 Steady State Convergence Report

The Test Operator shall generate a Steady State Convergence plot, as shown in Plot 9-1, including the test set up and parameters set forth in the Report Header. See Annex A.

Tes	t Ru	n Date:		06/28/	2011 05:07 AM	Report I	Run Date:		3/04/2013	08:47 AM
				LATEN	CY Test (REQ	UIRED) - R	eport Pa	ge		
SNIA		Solid Stat	te Stor	rage	LATENCY	Decrease 2	rime OTO	100	Rev.	PTS-E 1.1
SSS TWG	Perf	ormance T	'est Sp	ec (PTS)	LATENCY - Response Time 010=1					1 of 6
Vendor:	A	ABC Co. S		Model:	ABC Co.	T SPO	EST NSOR	CAL	YPSO Systems	
Test Platform Dev		Devic	e Under Test	Set Up P	Set Up Parameters		Test Para	rameters		
Ref Test Plat	tef Test Platform Calypso RTP 2.0		Mfgr	ABC Co.	Data Pattern	RND Da		Pattern	RND	
Motherboa	ard	Intel 5520	DHC	Model No.	SLC-A	AR	100%	AR 8	k Amount	100%
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A	Test	Stimulus 1	LAT Loop
Memory		8 GB PC1600	DDR2	Firmware v	er ABCDEF	Pre Condtion 1	SEQ 128K W	/ R	W Mix	Outer Loop
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	TC 1/ QD 1	B	lock Sizes	Inner Loop
Test SW		CTS 6.5 1.3	13.8	Interface	SATA 6Gb/s	Duration	Twice User Capa	acity T	OIO - TC/QD	TC 1/QD 1
Test SW I	Test SW Info 1.10.9/1.9.16		NAND Typ	e SLC	Pre Condtion 2	LAT Loop	s	teady State	3 - 7	
Test ID No. R5-523		5	PCIe NVM	N/A	TOIO - TC/QD	TC 1/ QD 1	Hist	ogram	N/A	
НВА	HBA LSI 9212-4e4i Purg		Purge Meth	od Format Unit	SS Rounds	3 - 7	т	OIO - TC/QD	N/A	
PCIe		Gen 2 x	8	Write Cach	e WCD	Note	-	Note	2	
	S	teady	Stat	e Conve	rgence Plot -	- Average	Latency -	100	% Writes	5



Plot 9-1 - LAT SS Convergence Report

9.3.4 Steady State Verification Report

The Test Operator shall document the following for Steady State Verification, using Ave 4KiB Random Write Latency (ms) as the dependent variable:

- Measurement Window: Start __; End ___
- Ave. value in Measurement Window: ____
- Calculated allowed range in Measurement Window (+-10% of Ave.): Max_; Min ___
- Measured range in Measurement Window: Max __; Min __ (pass/fail)
- Slope of best linear fit in Measurement Window (must be <= 10%): __% (pass/fail)

9.3.5 Steady State Measurement Window

The Test Operator shall include a plot showing the Steady State Measurement Window, as shown in Plot 9-2, including the test set up and parameters set forth in the Report Header. See Annex A to view Report Header.



Steady State Determination Data			
Average Latency (ms):			0.087
Allowed Maximum Data Excursion:	0.017	Measured Maximum Data Excursion:	0.015
Allowed Maximum Slope Excursion:	0.009	Measured Maximum Slope Excursion:	0.007
Least Squares Linear Fit Formula:			-0.002 * R + 0.095

Plot 9-2 - LAT SS Measurement Window

9.3.6 Measurement Window Report

The results for the test must be reported in the following series of tables and graphs (Plot 9-3 through Plot 9-5) that record and report the data from the Steady State Measurement Window.

9.3.6.1 LAT Measurement Window Tabular Data

The Test Operator shall include a plot showing a Latency Tabular Data, as shown in Plot 9-3, including the test set up and parameters set forth in the Report Header. See Annex A to view Report Header.

d Maximum Re	sponse Tim	e - ALL RW	Mix & BS
Av	erage Response	e Time (ms)	
	Rea	d / Write Mix o	%
Block Size (KiB)	0/100	65/35	100/0
0.5	0.0811486	0.1307696	0.1470862
4	0.0865518	0.1386792	0.155532
8	0.1300188	0.1697318	0.171237
Ma	ximum Respons	e Time (ms)	
	Rea	d / Write Mix °	Vo
Block Size (KiB)	0/100	65/35	100/0
0.5	56.8668	39.4566	5.7996
4	32.6272	46.7808	6.2596
8	80.4266	39.3802	12.9866

Plot 9-3 - LAT Measurement Window Tabular Data

Each entry in the <u>Average</u> table is the average values in the five Rounds comprising the Average Latency Steady State Measurement Window, for the selected (R/W Mix%, Block Size) element.

Each entry in the <u>Maximum</u> table is the maximum value in the five Rounds comprising the Maximum Latency Steady State Measurement Window, for the selected (R/W Mix%, Block Size) element.

9.3.6.2 LAT Measurement Window Plots: Average Latency and Maximum Latency 3D Plots

The Test Operator shall include a plot showing a Latency 3D Plot for Average and Maximum Latency, as shown in Plot 9-4 and Plot 9-5, including the test set up and parameters set forth in the Report Header. See Annex A to view Report Header.



Plot 9-4 - AVE LAT - 3D Plot

Maximum Latency vs BS and R/W Mix - 3D Plot



Plot 9-5 - MAX LAT - 3D Plot

10 Write Saturation Test

10.1 Write Saturation (WSAT) Descriptive Note

General Description:

The Enterprise WSAT test is designed to observe how the test SSD responds to continuous RND 4KiB Writes from a PURGED FOB state. This test is intended to demonstrate how the SSDs performance characteristics evolve over TIME and Total GB Written (TGBW) to WSAT Steady State.

Test Flow:

The Enterprise WSAT test makes use of:

- 1) a device PURGE, followed by
- continuous RND 4KiB Writes for 24 hours or 4X the user capacity, whichever occurs first.

Test Results:

The test results captured for the 24 hours or 4X the user capacity shall be tabulated and plotted as specified in section 10.3.

Note: the user may optionally run the WSAT test to Steady State using the average five-round steady state window defined in 2.1.21 using 1-minute test periods separated by 30 minutes of test stimulus.

Test Interpretation:

The test operator is encouraged to observe the initial peak IOPS values, the shape and length of the Transition Zones, and the level of IOPS at the "WSAT Steady State." Less drop off from peak FOB IOPS and a more level settled state with a smaller amplitude variation is better.

10.2 WSAT Pseudo Code

For (ActiveRange(0:100), optional ActiveRange(Test Operator Choice))

- 1 Purge the device. (Note: Active Range and other Test Parameters are not applicable to Purge step; any values can be used and none need to be reported.)
- 2 Run Test stimulus. Set test parameters and record for later reporting
 - 2.1 Set and record test conditions:
 - 2.1.1 Device volatile write cache = Disabled
 - 2.1.2 OIO/Thread: Test Operator Choice.
 - 2.1.3 Thread Count: Test Operator Choice.
 - 2.1.4 Data Pattern: Required= Random, Optional = Test Operator Choice.
 - 2.2 Run the following test stimulus until 4X user Capacity is written, 24 hours, or five round steady state as defined in 10.3.2, whichever occurs first.

2.2.1 Execute RND IO (R/W Mix 100% W, Block Size 4KiB), for 1 minute 2.2.2 Record Ave IOPS, Max and Ave Latency

- 2.3 Process and plot the accumulated Rounds data, per report guidelines in next section.
- End "For ActiveRange" loop

After generating report data for current parameter values, the Test Operator may re-run "For ActiveRange" loop with alternate Test Parameters, if specified in (2), and may also run the entire test again with an optional value (or values) of ActiveRange.

10.3 Test Specific Reporting for Write Saturation Test

Sections 10.3.1 and 10.3.3 list the reporting requirements specific to the Write Saturation test. Reporting requirements common to all tests are documented in Section 5. See also Annex A.

10.3.1 Purge Report

The Test Operator shall report the method used to run the Purge operation.

10.3.2 Steady State Measurement

The test operator shall run the stimulus for the capacity or time set forth in the pseudo code Section 10.2 above OR until Steady State is achieved by calculating a five Round average as defined in 2.1.21 using one-minute test periods separated by 30 minutes of stimulus.

10.3.3 Measurement Report

The Test Operator shall generate Measurement Plots for WSAT plotting IOPS v Time and IOPS v TGBW and should follow the format shown in Plot 10-1 and Plot 10-2.

Note on Headers: The individual Report Headers are the same for all pages of the report, except for reference to a specific test ID number if more than one test is used to generate the SNIA Report Header. The plots in the following sections show the test Report Header for the first plot example only. Test Report Headers are omitted for subsequent report pages for the same test report in order to provide more clarity for the related plot or graph.

Tes	t Ru	n Date:		11/07/1	1 08:40 AM	Report R	un Date:	3	3/14/2013	08:45 AM
			Wri	te Satura	tion Test (I	REQUIRED)	- Report I	Page		
SNIA		Solid Stat	te Sto	rage	WCAT	DND AVER 4	000/ 10/		Rev.	PTS-E 1.1
SSS TWG	Pert	formance T	est Sp	ec (PTS)	WSAT -	KND 4KIB I			Page	1 of 4
Vendor:	A	BC Co.	SSC	Model:	ABC Co.	SLC-A 100	TES	ST	CAL	YPSO Systems
Te	st Pl	atform		Device	Under Test	Set Up Pa	rameters		Test Par	ameters
Ref Test Plat	form	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND	Data F	Pattern	RND
Motherboa	ard	Intel 5520	онс	Model No.	SLC-A	AR	100%	AR & /	Amount	100%
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A	Test S	timulus 1	RND 4KiB
Memory	CPU Intel XEON 5580V Memory 8 GB PC1600 DDR		DDR2	Firmware ver	ABCDEF	Pre Condtion 1	None	TO	IO - TC/QD	TC 2/QD 16
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	5	Ste	ady State	N/A
Test SW	1	CTS 6.5 1.1	13.8	Interface	SATA 6Gb/s	SS Rounds	÷	Tin	ne	6 Hr
Test SW I	nfo	1.10.7/1.9	9.16	NAND Type	SLC	Pre Condtion 2	None	Test S	timulus 2	N/A
Test ID N	о.	R5-452	6	PCIe NVM	N/A	TOIO - TC/QD	•	то	IO - TC/QD	N/A
НВА		LSI 9212-4	le4i	Purge Method	Format Unit	SS Rounds	•	Ste	ady State	N/A
PCIe		Gen 2 x	8	Write Cache	WCD	Note		Tin	ne	N/A
				WSAT 1	IOPS (Linea	r) vs Time (Linear)			



Plot 10-1 - WSAT IOPS v Time



Plot 10-2 - WSAT IOPS v TGBW

11 Host Idle Recovery

11.1 Host Idle Recovery (HIR) Descriptive Note

General Description:

SSD background processes (such as Garbage Collection) may take advantage of Host Idle times to improve performance. The Host Idle Recovery Test applies a sequence of Host Idle times interspersed between periods of RND 4KiB Writes in order to observe if the introduction of Host Idle time results in an improvement in the test SSD IOPS performance.

Note: "Idle" in "Host Idle Test" refers to a period of no commands generated by the host system (sandwiched between periods of Random 4KiB writes) and is to be distinguished from an OS hibernation or other system software timeout. "Host" refers to the OS, application software and hardware that generate IOs to the test SSD.

Test Flow:

The Enterprise Host idle Recovery test makes use of:

- 1. An initial PURGE of the device, followed by
- 2. Application of RND 4KiB until Steady State is achieved, followed by
- 3. Wait State 1 Segment:
 - a. A cycle consisting of RND 4KiB writes for 5 seconds followed by 5 seconds of no host writes is repeated 360 times followed by
 - b. a Return to baseline by executing 1800 seconds of continuous RND 4KiB writes followed by
- 4. Wait State 2 Segment:
 - a. A cycle consisting of RND 4KiB writes for 5 seconds followed by 10 seconds of no host writes is repeated 360 times followed by
 - b. a Return to baseline by executing 1800 seconds of continuous RND 4KiB writes followed by
- 5. Wait State 3 Segment:
 - a. A cycle consisting of RND 4KiB writes for 5 seconds followed by 15 seconds of no host writes is repeated 360 times followed by
 - b. a Return to baseline by executing 1800 seconds of continuous RND 4KiB writes followed by
- 6. Wait State 5 Segment:
 - a. A cycle consisting of RND 4KiB writes for 5 seconds followed by 25 seconds of no host writes is repeated 360 times followed by
 - b. a Return to baseline by executing 1800 seconds of continuous RND 4KiB writes followed by
- 7. Wait State 10 Segment:
 - a. A cycle consisting of RND 4KiB writes for 5 seconds followed by 50 seconds of no host writes is repeated 360 times followed by
 - b. a Return to baseline by executing 1800 seconds of continuous RND 4KiB writes followed by
- 8. Plotting of the results as set forth in section 11.1.

Test Results:

The test output graph will present succeeding Host Idle "wait states" and any increase in performance associated therewith. The graph will present as either a relatively straight line or one with stair-step periods of varied IOPS performance.

Test Interpretation:

The test operator should first consider the IOPS measurement of the test SSD. Second, the test operator should examine the plot for any enhancement relative to the "return to baseline" results that would indicate the test SSD is taking advantage of Host Idle Times for performance enhancement. A relatively flat line response graph could be interpreted that there is no impact on the test SSD IOPS performance because:

- 1) the test SSD is sufficiently limited in performance (low IOPS) that no introduction of Host Idle times will results in meaningful enhancement, or
- 2) the test SSD has high performance (IOPS) and an advanced Garbage Collection algorithm / SSD design that does not need/use additional wait states to improve performance. However, examination of the y-axis value for IOPS can distinguish between a "low performing" SSD (with low IOPS) vs. an "advanced" SSD (with high IOPS).

An increasing staircase graph (ignoring the "return to baseline" portion) could indicate that the test SSD is using the idle periods to invoke "Garbage Collection" or other background processes that allow for improvement in IOPS performance. The height of the maximum staircase compared to the "return to baseline" portion indicates the amount of enhancement in performance due to the introduction of Host Idle times.

11.2 HIR Pseudo Code

For (ActiveRange=100%, optional ActiveRange=Test Operator Choice)

- 1 Purge the device. (Note: Active Range and other Test Parameters are not applicable to Purge step; any values can be used and none need to be reported.)
- 2 Set test parameters and record for later reporting
 - 2.1 Volatile device write cache: Required=Disabled, Optional = Enabled
 - 2.2 OIO/Thread: Test Operator Choice
 - 2.3 Thread Count: Test Operator Choice
 - 2.4 Data Pattern: Required = Random, Optional = Test Operator Choice
- 3 Preconditioning using the BS=4KiB, 100% random, R/W Mix=0%, using the required ActiveRange=100% or the corresponding desired optional ActiveRange.
 - 3.1 Record elapsed time, IOPS, Average Response Time (ART) and Maximum Response Time (MRT) every 1 minute.
 - 3.2 Using the first 1 Minute IOPS, along with subsequent 1 Minute IOPS results that are 30 Minutes apart (these IOPS results are called the Tracking Rounds), run Access Pattern until Steady State (see 2.1.21) is reached, or until the maximum number of Rounds=25 has been reached.

4 Wait State 1 Segment Including Return To Baseline: 100% Write, Random, Block Size of 4KiB

- 4.1 Execute R/W Mix=0/100%, Block Size=4KiB for 5 seconds (Access A), followed by 5 seconds without access activity (Access B). Log Elapsed Time, IOPS, Average Response Time and Maximum Response Time at the end of each Access A period. Repeat (Access A + Access B) combination 360 times.
- 4.2 Execute R/W Mix=0/100%, Block Size=4KiB for 5 seconds. Repeat 360 times for a total of 5*360=1800 seconds (Access C) to re-establish RND 4KiB baseline.

5 Wait State 2 Segment Including Return To Baseline: 100% Write, Random, Block Size of 4KiB

- 5.1 Execute R/W Mix=0/100%, Block Size=4KiB for 5 seconds (Access A), followed by 10 seconds without access activity (Access B). Log Elapsed Time, IOPS, Average Response Time and Maximum Response Time at the end of each Access A period. Repeat (Access A + Access B) combination 360 times.
- 5.2 Execute R/W Mix=0/100%, Block Size=4KiB for 5 seconds. Repeat 360 times for a total of 5*360=1800 seconds (Access C) to re-establish RND 4KiB baseline.

6 Wait State 3 Segment Including Return To Baseline: 100% Write, Random, Block Size of 4KiB

- 6.1 Execute R/W Mix=0/100%, Block Size=4KiB for 5 seconds (Access A), followed by 15 seconds without access activity (Access B). Log Elapsed Time, IOPS, Average Response Time and Maximum Response Time at the end of each Access A period. Repeat (Access A + Access B) combination 360 times.
- 6.2 Execute R/W Mix=0/100%, Block Size=4KiB for 5 seconds. Repeat 360 times for a total of 5*360=1800 seconds (Access C) to re-establish RND 4KiB baseline.

7 Wait State 5 Segment Including Return To Baseline: 100% Write, Random, Block Size of 4KiB

- 7.1 Execute R/W Mix=0/100%, Block Size=4KiB for 5 seconds (Access A), followed by 25 seconds without access activity (Access B). Log Elapsed Time, IOPS, Average Response Time and Maximum Response Time at the end of each Access A period. Repeat (Access A + Access B) combination 360 times.
- 7.2 Execute R/W Mix=0/100%, Block Size=4KiB for 5 seconds. Repeat 360 times for a total of 5*360=1800 seconds (Access C) to re-establish RND 4KiB baseline.
- 8 Wait State 10 Segment Including Return To Baseline: 100% Write, Random, Block Size of 4KiB
 - 8.1 Execute R/W Mix=0/100%, Block Size=4KiB for 5 seconds (Access A), followed by 50 seconds without access activity (Access B). Log Elapsed Time, IOPS, Average Response Time and Maximum Response Time at the end of each Access A period. Repeat (Access A + Access B) combination 360 times.
 - 8.2 Execute R/W Mix=0/100%, Block Size=4KiB for 5 seconds. Repeat 360 times for a total of 5*360=1800 seconds (Access C) to re-establish RND 4KiB baseline.
- 9 Process and plot the accumulated data, per report guidelines in Section 11.3.

11.3 Test Specific Reporting for Host Idle Recovery Test

Sections 11.3.1 and 11.3.2 list the reporting requirements specific to the Host Idle Recovery test. Reporting requirements common to all tests are documented in Section 5, See also Annex A.

Note on Headers: The individual Report Headers are the same for all pages of the report, except for reference to a specific test ID number if more than one test is used to generate the SNIA Report Header. The plots in the following sections show the test Report Header for the first plot example only. Test Report Headers are omitted for subsequent report pages for the same test report in order to provide more clarity for the related plot or graph.

11.3.1 Purge Report

The Test Operator shall report the method used to run the Purge operation.

11.3.2 Measurement Report

The Test Operator shall generate Preconditioning Plot, Preconditioning Steady State Measurement Plot, and Measurement Plots for IOPS for each Wait State plus their corresponding Return To Baselines.

11.3.2.1 Preconditioning IOPS Report

A Preconditioning IOPS Report (HIR IOPS v Time) is shown in Plot 11-1.

Tes	t Run	Date:		08/17/	/2012	2 04:02 PM	Report R	un Date:	0	3/06/2013	3 03:01PM
		Н	ost	Idle R	eco	overy (RE	QUIRED)	- Report	Pag	je	
SNIA		Solid Stat	e Stor	age							PTS-E 1.1
SSS TWG	Perfo	rmance T	est Sp	ec (PTS)	RN	ID 4KIB 55	ws / variabi	e wait Sta	tes	Page	1 of 3
Vendor: ABC		BC Co. SS		o. SSD Model:		ABC Co. Super Drive 256			T SOR	CAL	YPSO Systems
Те	Test Platform De		Devi	ce Under Test		Set Up Pa	rameters		Test Para	ameters	
Ref Test Platform Calypso RTP 2.0		Mfgr		ABC Co.	Data Pattern	RND		Pattern	RND		
Motherboa	ard	Intel S2600	COE	Model No	D .	Super Drive 256	AR	100%	AR		100%
CPU		Intel E5 26	690	S/N		123456	Pre Condtion 1	RND/4KiB	Write	Stimulus	RND/4KiB
Memory		16G PC1600	DDR2	Firmware	ver	ABCDEF	TOIO - TC/QD	TC 2 / QD 16	то	IO - TC/QD	TC 2 / QD 16
Operating Sy	stem	CentOS 6	i.3	Capacity		256 GB	SS Rounds	1-5		ration (S)	5
Test SW		CTS 6.5 1.1	.3.8	Interfac	e	SATA 6Gb/s	Pre Condtion 2	None	Idle State		Host Idle
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND TY	pe	eMLC	TOIO - TC/QD		то	IO - TC/QD	*
Test ID No. R32-		R32-204	0	PCIe NVM		N/A	SS Rounds	2	Duration (S)		5,10,15,25,50
НВА	HBA LSI 9212-4e4i		Purge Met	hod	Security Erase			Wa	it States	1,2,3,5,10	
PCIe		Gen 3 x 1	.6	Write Cac	he	WCD					l
	-		-		Pre	Conditio	ning IOPS P	lot			



----Pre-Writes, BS=4.0000K



11.3.2.2 Preconditioning Steady State Measurement Plot

Pre Conditioning Steady State Measurement Plot ----- IOPS ------ Average ------ Top ------ Bottom ------ Slope --2,000 1,900 CAL 1,800 1,700 Se 1,600 1,500 1,400 1,300 1,200 16 17 18 19 20 21 22 Round

A Preconditioning Steady State Measurement Plot is shown in Plot 11-2.



11.3.2.3 IOPS vs. Time for All Wait States

An IOPS vs. Time for All Wait States Plot is shown in Plot 11-3.



Plot 11-3 - IOPS vs. Time for All Wait States

12 Cross Stimulus Recovery

12.1 Cross Stimulus Recovery (XSR) Descriptive Note:

General Description:

Cross Stimulus Recovery is designed to observe how the test SSD handles transitions from large block sequential writes to small block random writes and returning to large block sequential writes. This test is intended to demonstrate the interaction between two close proximity workloads on a device, such as different workload demands in a virtualized environment.

Test Flow:

The Enterprise Cross Recovery test makes use of:

- 1. An initial PURGE of the device followed by
- 2. An initial sequence of SEQ 1024 KiB Writes for (8) hours, followed by
- 3. A sequence of RND 8 KiB Writes for (6) hours, followed by
- 4. A sequence of SEQ 1024 KiB Writes for (8) hours.
- 5. Plotting of the results as set forth in Section 11.1

Test Results:

The test output graph will present three sustained stimulus measurement segments and the transition between those stimuli. The OIO setting may be selected and reported by the test operator. However, a larger OIO setting may better emulate an extreme demand environment from which a meaningful transition may be observed. The test operator should choose (and report) a different optimal OIO for each stimulus.

Test Interpretation:

The test operator is encouraged to observe the shape and length of the transition zones (rather than looking for a some type of "steady state" zone). The test operator is further encouraged to vary the length of sustained stimulus to highlight performance zones of interest.

12.2 XSR Pseudo Code

For (ActiveRange=100%, optional ActiveRange=Test Operator Choice)

- 1 Purge the device. (Note: Active Range and other Test Parameters are not applicable to Purge step; any values can be used and none need to be reported.)
- 2 Access Group 1: 100% Write, Sequential, Block Size of 1024KiB
 - 2.1 Set test parameters and record for later reporting
 - 2.1.1 Volatile Device write cache = Disabled
 - 2.1.2 OIO/Thread: Test Operator Choice
 - 2.1.3 Thread Count: Test Operator Choice
 - 2.1.4 Data Pattern: Required = Random, Optional = Test Operator Choice
 - 2.2 Execute R/W Mix=0/100, Block Size=1024KiB for a minimum of 8 Hours, with logging of Elapsed Time, IOPS, Average Response Time and Maximum Response Time at 1 minute interval.
- 3 Access Group 2: 100% Write, Random, Block Size of 8KiB
 - 3.1 Set test parameters and record for later reporting
 - 3.1.1 Volatile Device write cache = Disabled
 - 3.1.2 OIO/Thread: Test Operator Choice

3.1.3 Thread Count: Test Operator Choice

- 3.1.4 Data Pattern: Required = Random, Optional = Test Operator Choice
- 3.2 Execute R/W Mix=0/100, Block Size=8KiB for a minimum of 6 Hours, with logging of Elapsed Time, IOPS, Average Response Time and Maximum Response Time at 1 minute interval.

4 Access Group 3: 100% Write, Sequential, Block Size of 1024KiB

- 4.1 Set test parameters and record for later reporting
 - 4.1.1 Volatile Device write cache = Disabled
 - 4.1.2 OIO/Thread: Same as 2.1.2 above
 - 4.1.3 Thread Count: Same as 2.1.3 above
 - 4.1.4 Data Pattern: Required = Random, Optional = Test Operator Choice
- 4.2 Execute R/W Mix=0/100, Block Size=1024KiB for a minimum of 8 Hours, with logging of Elapsed Time, IOPS Average Response Time and Maximum Response Time at 1 minute interval.
- 5 Process and plot the accumulated data, per report guidelines in next section.

12.3 Test Specific Reporting for Cross Stimulus Recovery Test

Sections 12.3.1 and 12.3.2 list the reporting requirements specific to the Cross Stimulus Recovery test. Reporting requirements common to all tests are documented in Section 5: Common Reporting Requirements. See also Annex A.

Note on Headers: The individual Report Headers are the same for all pages of the report, except for reference to a specific test ID number if more than one test is used to generate the SNIA Report Header. The plots in the following sections show the test Report Header for the first plot example only. Test Report Headers are omitted for subsequent report pages for the same test report in order to provide more clarity for the related plot or graph.

12.3.1 Purge Report

The Test Operator shall report the method used to run the Purge operation.

12.3.2 Measurement Report

The Test Operator shall generate Measurement Plots for Cross Stimulus Recovery for each Access Group, along with enlarged plots of the two transitions from SEQ \rightarrow RND and RND \rightarrow SEQ.

12.3.2.1 Throughput vs. Time for All Access Groups

Plot 12-1 shows XSR TP vs. Time.

Tes	t Ru	n Date:		10/18/2	012 4:02:00 PM	Report Ru	In Date:	0	3/06/201	3 05:01PM
Cro	ss :	Stimu	lus	Recove	ery- SEQ-RM	ND-SEQ (RE	QUIRE	D) -	Repor	t Page
SNIA		Solid Stat	te Sto	rage	YCD		CEO 103	Rev.	PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	XSK - SEQ 1024KIB - KND 8KIB - SEQ 1024KIB				Page	1 of 5
Vendor: A		BC Co.	SSD	Model:	XYZ Co. My Drive 100 SPC			ST ISOR	CAL	YPSO Systems
Те	Test Platform		Devic	e Under Test	Set Up Par	ameters	neters		ameters	
Ref Test Platform Calypso RTP 2.0		Mfgr	ABC Co.	Data Pattern	RND	Data I	Pattern	RND		
Motherboa	rd	Intel S2600	COE	Model No.	Super Drive 256	AR	100%	AR	Ĩ.	100%
CPU		Intel E5 20	690	S/N	123456	Pre Condtion 1	None	Test S	timulus 1	SEQ/1024KiB
Memory		16G PC1600	DDR2	Firmware v	er ABCDEF	TOIO - TC/QD	2	то	IO - TC/QD	TC1 / QD32
Operating Sy	stem	CentOS 6	5.3	Capacity	256 GB	SS Rounds		Du	ration (Hr)	8
Test SW		CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	Pre Condtion 2	None	Test Stimulus 2		RND/8KiB
Test SW In	nfo	1.9.97-el6/R	1.13.7	NAND Typ	e eMLC	TOIO - TC/QD	-	то	IO - TC/QD	TC2 / QD16
Test ID No.		R29-80	7	PCIe NVM	N/A	SS Rounds		Du	ration (Hr)	6
НВА		LSI 9212-4	le4i	Purge Meth	od Security Erase					
PCIe		Gen 3 v	16	Write Cach	wcD					



Plot 12-1 - XSR TP vs. Time

12.3.2.2 Throughput vs. Time, Access Groups 1 and 2

Plot 12-2 shows Throughput vs. Time, Access Groups 1 and 2.

TP v Time - All Groups 1 & 2



Cross Stimulus Recovery Test, MLC/SATA

Plot 12-2 - Throughput vs. Time, Access Groups 1 and 2

12.3.2.3 Throughput vs. Time, Access Groups 2 and 3

Plot 12-3 shows Throughput vs. Time, Access Groups 2 and 3.



Plot 12-3 - Throughput vs. Time, Access Groups 2 and 3

12.3.2.4 Average Latency vs. Time, All Access Groups

Plot 12-4 and Plot 12-5 show Average Latency vs. Time, All Access Groups.



Plot 12-4 - Average Latency vs. Time, All Access Groups (1)

Test Run Date:			10/18/20	012 4:02:00 PM	Report R	0	03/06/2013 05:01PM				
Cro	ss	Stimul	us	Recove	ery- SEQ-RM	ND-SEQ (R	EQUIRE	D) -	Repor	t Page	
SNIA		Solid State Storage			XSR - SEO 102	Rev.	PTS-E 1.1				
SSS TWG	Perf	formance T	est S	pec (PTS)			Page	4 of 5			
Vendor:	A	BC Co.	ssc	Model: XYZ Co. My Drive 100 TES SPON				ST	R CALYPSO Systems		
Te	st Pl	atform		Device Under Test		Set Up Parameters			Test Parameters		
Ref Test Platform		Calypso RTP 2.0		Mfgr	ABC Co.	Data Pattern	RND	Data Pattern		RND	
Motherboard		Intel S2600 COE		Model No.	Super Drive 256	AR	100%	AR		100%	
CPU		Intel E5 2690		S/N	123456	Pre Condtion 1	None	Test Stimulus 1		SEQ/1024KiB	
Memory		16G PC1600 DDR2		Firmware v	er ABCDEF	TOIO - TC/QD	-	TOIO - TC/QD		TC1 / QD32	
Operating System		CentOS 6.3		Capacity	256 GB	SS Rounds	-	Duration (Hr)		8	
Test SW		CTS 6.5 1.13.8		Interface	SATA 6Gb/s	Pre Condtion 2	None	Test Stimulus 2		RND/8KiB	
Test SW Info		1.9.97-el6/R1.13.7		NAND Type	e eMLC	TOIO - TC/QD	÷	TOI	O - TC/QD	TC2 / QD16	
Test ID No.		R29-807		PCIe NVM	N/A	SS Rounds		- Duration (6	
НВА		LSI 9212-4e4i		Purge Meth	od Security Erase						
PCIe		Gen 3 x 16 Write C		Write Cach	e WCD						
			A	verage	Latency vs. 1	ime, All Acc	ess Grou	DS			

Cross Stimulus Recovery Test, MLC/SATA LAVG vs Time



Plot 12-5 - Average Latency vs. Time, All Access Groups (2)

12.3.2.5 Maximum Latency vs. Time, All Access Groups

Plot 12-7 and Plot 12-7 show Maximum Latency vs. Time, All Access Groups.



Plot 12-6 - Maximum Latency vs. Time, All Access Groups (1)

Test Run Date:				10/18/20	012 4:02:00 PM	Report Run Date:			03/06/2013 05:01PM		
Cro	ss	Stimul	lus	Recove	ry- SEQ-RN	ND-SEQ (RI	EQUIRE	D) -	Repor	t Page	
SNIA		Solid Stat	te Sto	rage	VCD - SEO 1024VIR - DND RVIR - SEO 1024VIR					PTS-E 1.1	
SSS TWG	Per	formance T	est Sp	ec (PTS)	X3K - 3EQ 102	*KID	Page	5 of 5			
Vendor:	ABC Co. SSD Model			Model:	XYZ Co. M	ly Drive 100	Drive 100 TE: SPON		CAL	LYPSO Systems	
Test Platform			Devic	e Under Test	Set Up Parameters			Test Parameters			
Ref Test Platform		Calypso RTP 2.0		Mfgr	ABC Co.	Data Pattern	RND	Data Pattern		RND	
Motherboard		Intel S2600 COE		Model No.	Super Drive 256	AR	100%	AR		100%	
СРО		Intel E5 2690		S/N	123456	Pre Condtion 1	None	Test Stimulus 1		SEQ/1024KiB	
Memory		16G PC1600 DDR2		Firmware ve	ABCDEF	TOIO - TC/QD	2	TOIO - TC/QD		TC1 / QD32	
Operating System		CentOS 6.3		Capacity	256 GB	SS Rounds	1	Duration (Hr)		8	
Test SW		CTS 6.5 1.13.8		Interface	SATA 6Gb/s	Pre Condtion 2	None	Test Stimulus 2		RND/8KiB	
Test SW Info		1.9.97-el6/R1.13.7		NAND Type	eMLC	TOIO - TC/QD		TOIO - TC/QD		TC2 / QD16	
Test ID No.		R29-807		PCIe NVM	N/A	SS Rounds	*	Duration (Hr)		6	
НВА		LSI 9212-4e4i		Purge Metho	d Security Erase						
PCIe		Gen 3 x 1	16 Write Cach		e WCD					-	
			М	aximum	Latency vs.	Time, All Aco	cess Gro	ups			



Plot 12-7 - Maximum Latency vs. Time, All Access Groups (2)
13 Enterprise Composite Workload

13.1 Enterprise Composite Workload (ECW) Descriptive Note:

General Description:

The workload, transfer size distributions and Random data payload consists of random data distributed across an SSD in a manner similar to enterprise workload traces that are publicly available.

The purpose of this test is to understand Response Times in a mixed IO workload.

Test Flow:

The Enterprise Composite test makes use of:

- 1. An initial PURGE of the device followed by
- 2. Preconditioning to the entire LBA ActiveRange (Section2.1);
 - 1) a one step Workload Independent PC (Section 2.1.16 a) consisting of 128KiB SEQ writes for 2X (twice) the user capacity; and
 - 2) a one step Workload Dependent PC (WDPC) (Section 2.1.16 b) consisting of the Composite Access Pattern of mixed Block Sizes applied with relative block size probabilities and ActiveRange distribution restrictions at an overall R/W mix of 100% write over the LBA ActiveRange until Steady State, as defined, is achieved.
- 3. Running the Composite Access Pattern while varying the Total Outstanding IOs by applying an outer loop of High to Low Thread Count by an inner loop of High to Low Queue Depth with the application of an inter loop Pre Write between each TOIO loop until Steady State, as defined, is reached for the TOIO tracking variable. Note that Queue Depth here refers to the application Queue Depth, or sometimes also referred to as Outstanding IOs issued by a particular application process.
- 4. Using the Steady State data, plot ART v IOPS and CPU Usage v Thread Count for all the Thread Count settings used.
- 5. Selecting a MAX IOPS point representing an operating point where the IOPS is maximum while achieving a reasonable ART; select a MIN IOPS point where TC=1 and QD=1; and select a minimum of 1 additional MID IOPS point(s), using the (Thread Count, OIO/Thread) operating points obtained during the test run such that their IOPS values lie between and equally divides the IOPS value between MinIOPS and MaxIOPS.
- 6. Plotting Response Time Histograms for each of the MAX, MIN and MID IOPS points.

Test Results:

The test output graph will present a plot of Response Time v Composite IO Rate and CPU Utilization v Composite IO Rate.

Test Interpretation:

The test operator can observe a typical Response Time at a given IO Rate and to observe the performance curve and the "knee" (saturation point). Some drives may show a linear relationship between Response Time and IO Rate whereas other drives may show cpu saturation if processes are loaded to the host cpu. The test operator can observe the optimal Average Response Time relative to the IO Rate before saturation.

13.2 ECW Pseudo Code

For (ActiveRange=100%, optional ActiveRange=Test Operator Choice, Access Pattern = Enterprise Composite Workload Access Pattern (ECWAP) as prescribed below)

1 Purge the device. (Note: Active Range and other Test Parameters are not applicable to Purge step; any values can be used and none need to be reported.)

2 Access Pattern

- 2.1 The Enterprise Composite Workload Access Pattern (ECWAP) as prescribed here shall be used as the Workload Dependent Preconditioning and measurement stimulus;
 - 2.1.1 The required Data Pattern shall be random; additional test may be run at the option of the test sponsor using alternate data patterns, such data patterns shall be described such that other test sponsors can exactly repeat the entire sequence of data patterns
 - 2.1.2 Read/Write Ratio shall be 40% Reads and 60% Writes
 - 2.1.3 Block Size Probability Distribution: The Block Sizes issued along with each Block Size's relative access probabilities measured within each of the Measurement Duration of 1 Minute shall be according to the following table. The actual Block Size for each access shall occur randomly according to the assigned access probabilities, as shown in Table 13-1.

Block Size in Bytes (KiB)	Access Probability Within Each Measurement Period				
512 bytes (0.5 KiB)	4%				
1024 bytes (1 KiB)	1%				
1536 bytes (1.5 KiB)	1%				
2048 bytes (2 KiB)	1%				
2560 bytes (2.5 KiB)	1%				
3072 bytes (3 KiB)	1%				
3584 bytes (3.5 KiB)	1%				
4096 bytes (4 KiB)	67%				
8192 bytes (8 KiB)	10%				
16,384 bytes (16 KiB)	7%				
32,768 bytes (32 KiB)	3%				
65,536 bytes (64 KiB)	3%				
Total	100%				

Table 13-1 – ECW Block Size Access Probabilities

2.1.4 Access Range Probability Distribution: The ECWAP shall be issued to the DUT such that the following distribution is achieved with each of the Measurement Periods, as shown in Table 13-2.

% of Access within 1 Measurement Period	Active Range Restriction	Label
50%	First 5%	LBA Group A
30%	Next 15%	LBA Group B
20%	Remaining 80%	LBA Group C

Table 13-2 – ECW Access Range Distribution Restrictions

3 Preconditioning using the Access Pattern, but with R/W Mix=0% (100% Write)

- 3.1 Set test parameters and record for later reporting
 - 3.1.1 Volatile device write cache = Disabled
 - 3.1.2 QD or OIO/Thread: 32
 - 3.1.3 Thread Count: 32
 - 3.1.4 Data Pattern: Required = Random, Optional = Test Operator Choice
- 3.2 Run Access Pattern, using the required ActiveRange=100% or the corresponding desired optional ActiveRange.
 - 3.2.1 Record elapsed time, IOPS, Average Response Time (ART) and Maximum Response Time (MRT) every 1 minute. Note that IOPS is the IOPS achieved for the entire Access Pattern.
 - 3.2.2 Run Access Pattern until Steady State (see 2.1.21) is achieved, or until the maximum number of Rounds=25 has been reached, using the following as the tracking variable for Steady State determination:
 - 3.2.2.1 The overall average IOPS for the specified Access Pattern
 - 3.2.2.2 Use the first 1 Minute overall average IOPS, along with subsequent 1 Minute overall average IOPS results that are 30 Minutes apart for Steady State determination.

4 Run the Access Pattern while varying demand settings:

- 4.1 Set test parameters and record for later reporting
 - 4.1.1 Volatile device write cache = Disabled
 - 4.1.2 Data Pattern: Same as Preconditioning
 - 4.1.3 Vary TC using TC=[32,16,8,6,4,2,1]
 - 4.1.4 Vary QD using QD=[32,16,8,6,4,2,1]
- 4.2 Apply Inter-Round Pre-Write
 - 4.2.1 Apply Access Pattern, using TC=32 and QD=32 for a minimum of 5 minutes and a maximum of either 30 minutes or 10% of the User Capacity, whichever occurring first.
 - 4.2.2 Record elapsed time, IOPS, ART, MRT and Percentage CPU Utilization by System (SYS_CPU) every 1 Minute.
- 4.3 Apply One Round of the Access Pattern:
 - 4.3.1 Apply Access Pattern for 1 Minute at each TC and QD combination, in the order of decreasing TOIO from 1024 (32x32) to 1, using all of the TC/QD combinations that can be generated from TC/QD values given in Sections 4.1.3 and 4.1.4. When multiple TC/QD combinations give rise to equal TOIO values, apply TC/QD combination with the higher TC first.
 - 4.3.2 Record elapsed time, IOPS, ART and MRT and Percentage CPU Utilization by System (SYS_CPU).

- 4.3.3 Repeat 4.2 and 4.3 until Steady State (see 2.1.21) is reached, using the overall average IOPS for the Access Pattern with TC=32 and QD=32 as the tracking variable, or until the maximum number of Rounds=25 has been reached.
- 5 Using Steady State data (or if Steady State not reached, data from the Measurement Window):
 - 5.1 Plot ART versus IOPS using all of the (Thread Count, OIO/Thread) operating points, plotting 1 serie per Thread Count setting for all Thread Count settings used.
 - 5.2 Plot CPU_SYS versus Thread Count and OIO/Thread for all data.

6 Determine MaxIOPS, MinIOPS and a minimum of 1 MidIOPS operating point:

- 6.1 A MaxIOPS point shall be chosen from the (Thread Count, OIO/Thread) operating points, such that:
 - 6.1.1 The MaxIOPS point should be chosen to represent the operating point where the IOPS is maximum while achieving a reasonable ART.

6.1.2 The ART for such MaxIOPS point shall be below 5 mS.

- 6.2 The MinIOPS point is defined to be the operating point where Thread Count=1 and QD=1.
- 6.3 Choose a minimum of 1 additional MidIOPS point(s), using the (Thread Count, OIO/Thread) operating points obtained during the test run such that their IOPS values lie between and, as much as possible, equally divides the IOPS value between MinIOPS and MaxIOPS.

7 Response Time Histogram at Maximum IOPS:

- 7.1 Select a (Thread Count, Queue Depth) operating point that yields maximum IOPS using the lowest number of Total Outstanding IO (TOIO=Thread Count x Queue Depth)
- 7.2 Run Pre-Writes
 - 7.2.1 Execute the Access Pattern as prescribed, but with R/W Mix=0/100 for 60 minutes. Log elapsed time, IOPS, ART and MRT every 1 minute.
- 7.3 Execute the Access Pattern as prescribed, for 10 minutes. Capture all individual IO command completion times such that a response time histogram showing count versus time can be constructed. The maximum time value used in the capture shall be greater or equal to the MRT encountered during the 10 minute capture.

8 Response Time Histogram at Minimum IOPS:

- 8.1 Select a (Thread Count=1, Queue Depth=1) operating point
- 8.2 Run Pre-Writes
 - 8.2.1 Execute the Access Pattern as prescribed, but with R/W Mix=0/100 for 60 minutes. Log elapsed time, IOPS, ART and MRT every 1 minute.
- 8.3 Execute the Access Pattern as prescribed for 10 minutes. Capture all individual IO command completion times such that a response time histogram showing count versus time can be constructed. The maximum time value used in the capture shall be greater or equal to the MRT encountered during the 10 minute capture.
- 9 Response Time Histogram at one or more chosen MidIOPS operating points:
 - 9.1 Select a (Thread Count, Queue Depth) operating point that yields an IOPS result that lies approximately halfway between Maximum IOPS in (6) above, and the Minimum IOPS in (7) above.

- 9.2 Run Pre-Writes:
 - 9.2.1 Execute the Access Pattern as prescribed, but with R/W Mix=0/100 for 60 minutes. Log elapsed time, IOPS, ART and MRT every 1 minute.
- 9.3 Execute the Access Pattern as prescribed for 10 minutes. Capture all individual IO command completion times such that a response time histogram showing count versus time can be constructed. The maximum time value used in the capture shall be greater or equal to the MRT encountered during the 10 minute capture.
- 10 Process and plot the accumulated data, per report guidelines in next section.

13.3 Test Specific Reporting for ECW Test

Sections 13.3.1 and 13.3.2 list the reporting requirements specific to the Enterprise Composite Workload test. Reporting requirements common to all tests are documented in Section 5.

13.3.1 Purge Report

The Test Operator shall report the method used to run the Purge operation.

13.3.2 Measurement Report

The Test Operator shall generate Measurement Plots for ECW for Preconditioning; Steady State Determination; Between Round Pre Writes; Demand Variation IOPS Plots for Thread Count tracking; Steady State for OIO Tracking Variable; Demand Variation Plot; Demand Intensity Plot; CPU Utilization Plot; MAX IOPS Pre Write Plot; MID IOPS Pre Write Plot; and Response Time Histograms for MAX IOPS, MIN IOPS and MID IOPS using the Ranges, Ordinates and Plot Types are listed in Table 13-3. Plots are shown in Sections 13.3.2.1 through 13.3.2.14.

Plot	Plot Title	Range	Ordinate	Plot Type	Description			
1	PC IOPS Plot	IOPS	Round	2D, x-y-spline	IOPS v Tracking Round for the tracking variable for Preconditioning using Access Pattern			
2	PC Steady State Plot	IOPS	Round	2D, x-y-spline	IOPS v Rounds for the tracking variable showing Steady State details			
3	Btw-Round Prewrites Plot	IOPS	Time	2D, x-y-scatter	IOPS v Time showing Between Round Pre-Writes			
4	DV IOPS Plot, TC=Tracking	IOPS	Round	2D, x-y-spline	IOPS v Round for TC of Tracking Variable, ALL QD as separate Series			
5	DV Steady State Plot, Tracking Variable	IOPS	Round	2D, x-y-spline	IOPS v Round for Tracking Variable, showing Steady State details			
6	Demand Variation Plot	IOPS	QD	2D, x-y-spline	IOPS v QD for all TCs as separate series for Steady State results			
7	Demand Intensity Plot	Time	IOPS	2D, x-y-spline	Time (mS) v IOPS for all TC/QD Combinations, each TC plotted as a Series for Steady State results. MaxIOPS MidIOPS(s) MinIOPS points labeled.			
8	System CPU Utilization Plot	%	TC,QD	3D, x-y-z-bar	CPU_SYS (%) v TC & QD for all Steady State results			
9	MaxIOPS Prewrites	IOPS	Time	2D, x-y-spline	MaxIOPS Prewrite: IOPS v Time for Prewrite preceding MaxIOPS Histogram Capture			
10	Max IOPS Histogram	Count	Time	2D, x-y-bar	MaxIOPS Histogram: Count (A.U.) v Time (ms), Legend should indicate MRT for the Histogram Capture			
11	MidIOPS Prewrites	IOPS	Time	2D, x-y-spline	MidIOPS Prewrite: IOPS v Time for Prewrite preceding MidIOPS Histogram Capture			
12	Mid IOPS Histogram	Count	Time	2D, x-y-bar	MidIOPS Histogram: Count (A.U.) v Time (ms), Legend should indicate MRT for the Histogram Capture			
13	MinIOPS Prewrites	IOPS	Time	2D, x-y-spline	MinIOPS Prewrite: IOPS v Time for Prewrite Preceding MinIOPS Histogram Capture			
14	Min IOPS Histogram	Count	Time	2D, x-y-bar	MinIOPS Histogram: Count (A.U.) v Time (ms), Legend should indicate MRT for the Histogram Capture			

Table 13-3 – ECW Measurement Plots

Note on Headers: The individual Report Headers are the same for all pages of the report, except for reference to a specific test ID number if more than one test is used to generate the SNIA Report Header. The plots in the following sections show the test Report Header for the first plot example only. Test Report Headers are omitted for subsequent report pages for the same test report in order to provide more clarity for the related plot or graph.

13.3.2.1 PC IOPS Plot

Tes	t Ru	n Date:		10/14/2012 12:51 AM Report F				un Date:	03	/7/2013	9:26:00 AM	
E	nte	rprise	Co	mposi	te	Workload	Test (RE	QUIRED)	- R	eport I	Page	
SNIA		Solid State Storage			=	FOW Black Circ / Brabability Workland					PTS-E 1.1	
SSS TWG	ormance T	est Sp	ec (PTS)	BIOCK SIZE / Probability workload				bad	Page	2 of 15		
Vendor:	/endor: ABC Co. SSD Model:					ABC Co. Yo	ur Drive 100	TEST SPONSOR		CAL	YPSO Systems	
Test Platform Devi			ice Under Test Set Up Par			rameters		Test Parameters				
Ref Test Plat	Ref Test Platform SNIA RTP 1.0		Mfgr		ABC Co.	Data Pattern	RND	Data Pattern		RND		
Motherboa	Motherboard Intel S2600 COE		COE	Model No.		Your Drive 100	AR	100%	AR		100%	
CPU	CPU Intel E5 2690		S/N		123456	Pre Condtion 1	ECW	Test Stimulus 1		ECW		
Memory	Memory 16G PC1600 DDR2		Firmware ver		ABCDEF	R/W %	0/100 %	R/W %				
Operating System CentOS 6.3		Capacity		100 GB	TOIO - TC/QD	TC 32/QD 32	TC / QD		TC/QD from 1-32			
Test SW CTS 6.5 1.13.8		Interface		SAS 6Gb/s	SS Rounds	2-6 TC		& QD Loops	High to Low TOIO			
Test SW Info 1.9.97-el6/R1.13.7		NAND Type		SLC	Inter-Round Pre W	ECW	Min IOPS Point		TC 1/QD 1			
Test ID No. R30		R30-942		PCIe NVM		N/A	R/W %	0/100	Mid IO	PS Point	User Select	
НВА		LSI 9212-4	e4i	Purge Met	hod	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IOPS Point		User Select	
PCIe Gen 3 x 16		Write Cache		WCD	Duration	30 M or 10% Cap.						
	_				Pr	e Conditio	ning TOPS P	lot				







Plot 13-5 - PC Steady State Plot

13.3.2.3 Btw-Round Prewrites Plot



Plot 13-6 - Between-Round Prewrites

13.3.2.4 DV IOPS Plot, TC=Tracking



Plot 13-7 - DV IOPS Plot, TC=Tracking





Plot 13-8 - DV Steady State Plot, Tracking Variable





Plot 13-9 - Demand Variation Plot

13.3.2.7 Demand Intensity Plot



Plot 13-10 - Demand Intensity Plot



Plot 13-11 - CPU Utilization Plot





Plot 13-12 - MaxIOPS Prewrites



Plot 13-13 - MaxIOPS Histogram



Plot 13-14 - MidIOPS Prewrites



Plot 13-15 - MidIOPS Histogram







Plot 13-17 - MinIOPS Histogram

14 Demand Intensity / Response Time Histogram

14.1 Demand Intensity / Response Time Histogram (DIRTH) Descriptive Note:

General Description:

This test is designed to demonstrate the mode of degradation of an SSD when it is subject to a super saturating IO load. This test will show how well a device handles a workload of increasing demand intensity. This is important to determine where a given OIO combination (in Thread Count and QD) will result in the highest IOPS and / or lowest Response Time. In addition, this test also shows the statistical distribution of response times at a number of operating points below the maximum response time ceiling.

Test Flow:

The Enterprise Demand Intensity / Response Time test makes use of:

- 1. An initial PURGE of the device followed by
- 2. Preconditioning to the entire LBA ActiveRange (Section 2.1.1);
 - 1) a one step Workload Independent PC (Section 2.1.16a) consisting of 128KiB SEQ writes for 2X (twice) the user capacity; and
 - 2) a one step Workload Dependent PC (WDPC) (Section 2.1.16b) consisting of a single Block Size of test operator choice applied at an overall R/W mix of 100% write over the LBA ActiveRange at a Total OIO TC=32, QD=32 until Steady State, as defined, is achieved. Note that Queue Depth here refers to the application Queue Depth, or sometimes also referred to as Outstanding IOs issued by a particular application process.
- 3. Running the Access Pattern while varying the Total Outstanding IOs by applying an outer loop of High to Low Thread Count by an inner loop of High to Low Queue Depth with the application of an inter loop Pre Write between each TOIO loop until Steady State, as defined, is reached for the TOIO tracking variable.
- 4. Using the Steady State data, plot ART v IOPS and CPU Usage v Thread Count for all the Thread Count settings used.
- 5. Selecting a MAX IOPS point representing an operating point where the IOPS is maximum while achieving a reasonable ART; select a MIN IOPS point where TC=1 and QD=1; and select a minimum of 1 additional MID IOPS point(s), using the (Thread Count, OIO/Thread) operating points obtained during the test run such that their IOPS values lie between and equally divides the IOPS value between MinIOPS and MaxIOPS.
- 6. Plotting Response Time Histograms for each of the MAX, MIN and MID IOPS points.

Test Results:

The test output graph will present the IO rate and response time of the device given a varying number of OIO (derived by the combination of TC and QD). The secondary plot will present the time statistics (or histogram) for the selected OIO points.

Test Interpretation:

The DI curve shows the Average Response times. To see Maximum Response Times, the histogram will show time statistics (response times and distributions) at the selected OIO maximum IOPS point. In general, the test operator should view the Response Time histogram with regard to the clustering of response times (tighter grouping is better), response times of the measurements (faster is better), the maximum response times and number of slow response time "outliers."

14.2 DIRTH Pseudo Code

For (ActiveRange=100%, optional ActiveRange=Test Operator Choice, Access Pattern = (R/W Mix=RW1, Block Size=BS1, Random)

- 1 Purge the device. (Note: Active Range and other Test Parameters are not applicable to Purge step; any values can be used and none need to be reported.)
- 2 Preconditioning using the Access Pattern, but with R/W Mix=0%
 - 2.1 Set test parameters and record for later reporting
 - 2.1.1 Volatile device write cache = Disabled
 - 2.1.2 QD or OIO/Thread: 32
 - 2.1.3 Thread Count: 32
 - 2.1.4 Data Pattern: Required = Random, Optional = Test Operator Choice
 - 2.2 Run Access Pattern, using the required ActiveRange=100% or the corresponding desired optional ActiveRange.
 - 2.2.1 Record elapsed time, IOPS, Average Response Time (ART) and Maximum Response Time (MRT) every 1 minute.
 - 2.2.2 Using the first 1 Minute IOPS, along with subsequent 1 Minute IOPS results that are 30 Minutes apart, run Access Pattern until Steady State (see 2.1.21) is reached, or until the maximum number of Rounds=25 has been reached.

3 Run the Access Pattern while varying demand settings:

- 3.1 Set test parameters and record for later reporting
 - 3.1.1 Volatile device write cache = Disabled
 - 3.1.2 Data Pattern: Same as Preconditioning
 - 3.1.3 Vary TC using TC=[32,16,8,6,4,2,1]
 - 3.1.4 Vary QD using QD=[32,16,8,6,4,2,1]
- 3.2 Apply Inter-Round Pre-Write
 - 3.2.1 Apply Access Pattern, using TC=32 and QD=32 for a minimum of 5 minutes and a maximum of either 30 minutes or 10% of the User Capacity, whichever occurring first.
 - 3.2.2 Record elapsed time, IOPS, ART, MRT and Percentage CPU Utilization by System (SYS_CPU) every 1 Minute.
- 3.3 Apply One Round of the Access Pattern:
 - 3.3.1 Apply Access Pattern for 1 Minute at each TC/QD combination, in the order of decreasing TOIO from 1024 (32x32) to 1, using all of the TC/QD combinations that can be generated from TC and QD values given in Sections 3.1.3 and 3.1.4. When multiple TC/QD combinations give rise to equal TOIO values, apply TC/QD combination with the higher TC first.
 - 3.3.2 Record elapsed time, IOPS, ART and MRT and Percentage CPU Utilization by System (CPU_SYS).
 - 3.3.3 Repeat 3.2 and 3.3 until Steady State (see 2.1.21) is reached, using IOPS values for TC=32, QD=32 and Block Size and R/W Mix as specified in the Access Pattern as the tracking variable, or until the maximum number of Rounds=25 has been reached.
- 4 Using Steady State data (or if Steady State not reached, data from the Measurement Window):
 - 4.1 Plot ART versus IOPS using all of the (Thread Count, OIO/Thread) operating points, plotting 1 serie per Thread Count setting for all Thread Count settings used.

4.2 Plot CPU_SYS versus Thread Count and OIO/Thread for all data.

5 Determine MaxIOPS, MinIOPS and a minimum of 1 MidIOPS operating point:

- 5.1 A MaxIOPS point shall be chosen from the (Thread Count, OIO/Thread) operating points, such that:
 - 5.1.1 The MaxIOPS point should be chosen to represent the operating point where the IOPS is maximum while achieving a reasonable ART.
 - 5.1.2 The ART for such MaxIOPS point shall be below 5 mS.
- 5.2 The MinIOPS point is defined to be the operating point where Thread Count=1 and OIO/Thread=1.
- 5.3 Choose a minimum of 1 additional MidIOPS point(s), using the (Thread Count, OIO/Thread) operating points obtained during the test run such that their IOPS values lie between and, as much as possible, equally divides the IOPS value between MinIOPS and MaxIOPS.

6 Response Time Histogram at Maximum IOPS:

- 6.1 Select a (Thread Count, Queue Depth) operating point that yields maximum IOPS using the lowest number of Total Outstanding IO (TOIO=Thread Count x Queue Depth)
- 6.2 Run Pre-Writes
 - 6.2.1 Execute R/W Mix=0/100, Random, Block Size=BS1 for 60 minutes. Log elapsed time, IOPS, ART and MRT every 1 minute.
- 6.3 Execute R/W Mix=RW1, Random IO, Block Size=BS1 KiB for 10 minutes. Capture all individual IO command completion times such that a response time histogram showing count versus time can be constructed. The maximum time value used in the capture shall be greater or equal to the MRT encountered during the 10 minute capture.

7 Response Time Histogram at Minimum IOPS:

- 7.1 Select a (Thread Count=1, Queue Depth=1) operating point
- 7.2 Run Pre-Writes
 - 7.2.1 Execute R/W Mix=0/100, Random, Block Size=BS1 for 60 minutes. Log elapsed time, IOPS, ART and MRT every 1 minute.
- 7.3 Execute R/W Mix=RW1, Random IO, Block Size=BS1 KiB for 10 minutes. Capture all individual IO command completion times such that a response time histogram showing count versus time can be constructed. The maximum time value used in the capture shall be greater or equal to the MRT encountered during the 10 minute capture.

8 Response Time Histogram at one or more chosen MidIOPS operating points:

- 8.1 Select a (Thread Count, Queue Depth) operating point that yields an IOPS result that lies approximately halfway between Maximum IOPS in (6) above, and the Minimum IOPS in (7) above.
- 8.2 Run Pre-Writes:
 - 8.2.1 Execute R/W Mix=0/100, Random, Block Size=BS1 KiB for 60 minutes. Log elapsed time, IOPS, ART and MRT every 1 minute.
- 8.3 Execute R/W Mix=RW1, Random IO, Block Size=BS1 KiB for 10 minutes. Capture all individual IO command completion times such that a response time histogram showing count versus time can be constructed. The maximum time value used in the capture shall be greater or equal to the MRT encountered during the 10 minute capture.
- 9 Process and plot the accumulated data, per report guidelines in next section.

14.3 Test Specific Reporting for DIRTH Test

The following sub-sections list the reporting requirements specific to the Demand Intensity / Response Time Histogram test. Reporting requirements common to all tests are documented in Section 5.

Note on Headers: The individual Report Headers are the same for all pages of the report, except for reference to a specific test ID number if more than one test is used to generate the SNIA Report Header. The plots in the following sections show the test Report Header for the first plot example only. Test Report Headers are omitted for subsequent report pages for the same test report in order to provide more clarity for the related plot or graph.

14.3.1 Purge Report

The Test Operator shall report the method used to run the Purge operation.

14.3.2 Measurement Report

The Test Operator shall generate Measurement Plots for DIRTH for Preconditioning; Steady State Determination; Between Round Pre Writes; Demand Variation IOPS Plots for Thread Count tracking; Steady State for OIO Tracking Variable; Demand Variation Plot; Demand Intensity Plot; CPU Utilization Plot; MAX IOPS Pre Write Plot; MID IOPS Pre Write Plot; MIN IOPS Pre Write Plot; and Response Time Histograms for MAX IOPS, MIN IOPS and MID IOPS using the Ranges, Ordinates and Plot Types listed in Table 14-1 and shown in plots in Sections 14.3.2.1 through 14.3.2.14.

1 PC IOPS Plot IOPS Time 2D, x-y-spline IOPS v Time for tracking variable for Preconditioning using Access Pattern 2 PC Steady State Plot IOPS Round 2D, x-y-spline IOPS v Rounds for the tracking variable showing Steady State details 3 Inter-Round Pre Writes IOPS Time 2D, x-y-spline IOPS v Rounds for the tracking variable showing Steady State details	or ern riable
Preconditioning using Access Pattern 2 PC Steady State Plot IOPS Round 2D, x-y-spline IOPS v Rounds for the tracking variable showing Steady State details 3 Inter-Round Pre Writes IOPS Time 2D, x-y-spline IOPS v Time showing Between Round Pre	ern riable
2 PC Steady State Plot IOPS Round 2D, x-y-spline IOPS v Rounds for the tracking variable showing Steady State details 3 Inter-Round Pre Writes IOPS Time 2D x-v-scatter IOPS v Time showing Between Round Pre	riahle
showing Steady State details	
1.3 Linter-Round Pre Writes LIOPS Linne 120 x-v-scatter LIOPS vilime showing Between Round Pre	
The round rewrites for o time 22, xy solution for o time showing between round rive	und Pre-
Plot Writes	
4 DV IOPS Plot, IOPS Round 2D, x-y-spline IOPS v Round for TC of Tracking Variable	/ariable,
IC=Tracking ALL QD as separate Series	
5 DV Steady State Plot, IOPS Round 2D, x-y-spline IOPS v Round for Tracking Variable,	e,
Tracking Variable showing Steady State details	
6 Demand Variation Plot IOPS QD 2D, x-y-spline IOPS v QD for all TCs as separate series	series for
Steady State results	
7 Demand Intensity Plot Time IOPS 2D, x-y-spline Time (mS) v IOPS for all TC/QD	
Combinations, each TC plotted as a Serie	a Series
for Steady State results. MaxIOPS	
MidIOPS(s) MinIOPS points labeled.	d.
8 CPU Utilization Plot % TC,QD 3D, x-y-z-bar CPU_SYS (%) v TC & QD for all Steady	teady
State results	
9 MaxIOPS Prewrites IOPS Time 2D, x-y-spline MaxIOPS Prewrite: IOPS v Time for	or
Prewrite preceding MaxIOPS Histogram	ogram
Capture	
10 Max IOPS Histogram Count Time 2D, x-y-bar MaxIOPS Histogram: Count (A.U.) v Time	v Time
(ms), Legend should indicate MRT for the	for the
Histogram Capture	
11 MidIOPS Prewrites IOPS Time 2D, x-y-spline MidIOPS Prewrite: IOPS v Time for Prewr	r Prewrite
preceding MidIOPS Histogram Capture	pture
12 Mid IOPS Histogram Count Time 2D, x-y-bar MidIOPS Histogram: Count (A.U.) v Time	v Time
(ms), Legend should indicate MRT for the	for the
Histogram Capture	
13 MinIOPS Prewrites IOPS Time 2D, x-y-spline MinIOPS Prewrite: IOPS v Time for Prewr	r Prewrite
Preceding MinIOPS Histogram Capture	pture
14 Min IOPS Histogram Count Time 2D, x-y-bar MinIOPS Histogram: Count (A.U.) v Time	v Time
(ms), Legend should indicate MRT for the	for the
Histogram Capture	

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Dema	and	Inter	sit	y Resp	onse Time I	Historam	(REQUIR	ED)	- Rep	ort Page		
SNIA		Solid Stat	e Sto	rage			D 65.25 DL	A/	Rev.	PTS-E 1.1		
SSS TWG	WG Performance Test Spec (PTS) DIRTH - OLTP - RN					IP - KNU OK	ID 05.55 K	Page	1 of 14			
Vendor:	/endor: ABC Co. SSD Model				ABC Co. Yo	our Drive 100	TES	T				
Test Platform			Devic	e Under Test	Set Up P	arameters	1	Test Parameters				
Ref Test Plat	Ref Test Platform SNIA RTP 1.0		1.0	Mfgr	ABC Co.	Data Pattern	RND	Data P	attern	RND		
Motherboa	Motherboard Intel S2600 COE		COE	Model No.	Your Drive 100	AR	100%	AR		100%		
CPU	CPU Intel E5 2690		90	S/N	123456	Pre Condtion 1	RND/8KiB	Test St	imulus 1	RND/8KiB		
Memory	nory 16G PC1600 DDR2		Firmware ve	ar ABCDEF	R/W %	0/100	R/V	v %	65/35 %			
Operating Sy	Operating System CentOS 6.3		.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32		QD	TC/QD from 1-32		
Test SW CTS 6.5 1.13.8		3.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	TC & QD Loops		High to Low TOIO			
Test SW Info 1.9.97-el6/R1.13.7		NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min IOPS Point		TC 1/QD 1				
Test ID No. R30-1196		PCIe NVM	N/A	R/W %	0/100	Mid IOPS Point		User Select				
HBA LSI 9212-		LSI 9212-4	e4i	Purge Metho	od Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IOPS Point		User Select		
PCIe		Gen 3 x 1	6	Write Cach	e WCD	Duration	30 M or 10% Cap.		1			
					Pre Conditio	nina IOPS I	Plot					

14.3.2.1 Pre Conditioning Plot









Plot 14-3 - Pre-Conditioning Steady State Plot





Plot 14-4 - Between Round Pre Writes



14.3.2.4 Demand Variation IOPS

Plot 14-5 - DV IOPS Plot, TC=Tracking



Plot 14-6 - DV Steady State Plot, Tracking Variable





Plot 14-7 - Demand Variation Plot

14.3.2.7 Demand Intensity



Plot 14-8 - Demand Intensity Plot

System CPU Utilization Plot



P8 System CPU Utlization During Demand Variation Test

Plot 14-9 - System CPU Utilization Plot



Plot 14-10 - Max IOPS Pre Writes

14.3.2.10 Max IOPS Histogram





Plot 14-11 - Max IOPS Histogram



Plot 14-12 - Mid IOPS Pre Writes

Mid IOPS Histogram



Plot 14-13 - Mid IOPS Histogram


Plot 14-14 - Min IOPS Pre Writes





P14 MinIOPS Response Time Histogram, MRT=53.90 mS



Annex A (normative) Sample Test Report

This annex displays a sample PTS-E version 1.1 SNIA Test Report (displayed in Plot A.1 through Plot A.63). Normative Individual Report Pages contain mandatory Report Headers on each page that set forth required reporting information pertinent to the tests presented on the particular page(s).

A.1 Sample IOPS Test Report Pages

The sample IOPS Test Report pages are shown in **Plot A.1** through Plot A.6.

Test Run Date:		11/02/2	2011 02:56 PM	Report	Run (3/	4/2013 8	3:43:00 AM			
				IOPS	Test (REQU	IRED) - Rep	oort	Page			
SNIA		Solid Stat	te Sto	rage	TOPS - Blog	TOPS - Block Size x BW Mix Matrix					PTS-E 1.1
SSS TWG	Pert	formance T	est Sp	Dec (PTS)	10P3 - BIU	LK SIZE X KI		x main	•	Page	1 of 6
Vendor: ABC Co.			SSC	Model:	ABC Co. SLC-A 100			TEST		CAL	YPSO Systems
Те	st Pl	atform		Devic	e Under Test	Set Up P	aram	eters	Test Pa		ameters
Ref Test Plat	form	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND		Data Pattern		RND
Motherboa	ard	Intel 5520	ЭНС	Model No.	SLC-A	AR		100%	AR & Amount		100%
CPU		Intel XEON 5	580W	S/N	123456	AR Segments		N/A	Test Stimulus 1		IOPS Loop
Memory	,	8 GB PC1600	DDR2	Firmware v	er ABCDEF	Pre Condtion 1	SE	Q 128K W	RW	Mix	Outer Loop
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	т	C 2/ QD 16	Block Sizes		Inner Loop
Test SW	'	CTS 6.5 1.1	13.8	Interface	SATA 6Gb/s	Duration	Twice	User Capacity	тот	O - TC/QD	TC 2/QD 16
Test SW I	nfo	1.10.7/1.9	9.16	NAND Type	e SLC	Pre Condtion 2	l	OPS Loop	Ste	ady State	1 - 5
Test ID N	Test ID No. RS-456		i i	PCIe NVM	N/A	TOIO - TC/QD	TO	2/ QD 16	Test Stimulus 2		N/A
HBA	HBA LSI 9212-44		le4i	Purge Meth	od Format Unit	SS Rounds	1-5		TOIO - TC/QD		N/A
PCIe		Gen 2 x	8	Write Cach	e WCD	Note			Ste	ady State	N/A
		IC	PS	Steady	State Conver	gence Plot	- AI	Block	Size	S	





Plot A.1 – IOPS Steady State Convergence Plot - All Block Sizes

Tes	Test Run Date:			11/02/2	2011 02:56 PM	Report	Run D	Date:	3/	4/2013 8	3:43:00 AM
				IOPS	Test (REQU	(RED) - Rep	oort	Page			
SNIA		Solid Stat	te Sto	rage	TOPS - Blo	TOPS - Block Size x BW Mix Matrix					
SSS TWG	Per	formance T	est Sp	pec (PTS)	10F3 - BIOCK SIZE X KW MIX Matrix						2 of 6
Vendor: ABC Co. S				Model:	ABC Co.	ABC Co. SLC-A 100			OR	CAL	YPSO Systems
Test Platform D			Devic	e Under Test	Set Up P	aram	eters	Test Pa		ameters	
Ref Test Pla	tform	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND		Data Pattern		RND
Motherbo	ard	Intel 5520	ЭНС	Model No.	SLC-A	AR		100%	AR & Amount		100%
CPU		Intel XEON 5	580W	S/N	123456	AR Segments		N/A	Test Stimulus 1		IOPS Loop
Memory	Y	8 GB PC1600	DDR2	Firmware v	er ABCDEF	Pre Condtion 1	SE	Q 128K W	RW	Mix	Outer Loop
Operating Sy	ystem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	TC	2/ QD 16	Blo	ck Sizes	Inner Loop
Test SV	v	CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	Duration	Twice	User Capacity	тол	O - TC/QD	TC 2/QD 16
Test SW I	info	1.10.7/1.9	9.16	NAND Type	SLC	Pre Condtion 2	10	OPS Loop	Steady State		1 - 5
Test ID N	Test ID No. R5-456		i.	PCIe NVM	N/A	TOIO - TC/QD	TC	2/ QD 16	2D 16 Test Stimulus 2		N/A
НВА	HBA LSI 9212-4e4i		le4i	Purge Metho	od Format Unit	SS Rounds	1-5		5 TOIO - TC/QD		N/A
PCIe		Gen 2 x	8	Write Cach	e WCD	Note			Ste	ady State	N/A
	_			TOPS SH	eady State M	leasureme	nt W	indow			



Plot A.2 – IOPS Steady State Measurement Window

Test Run Date:			11/02/2	2011 02:56 PM	Report	Run D	Date:	3/	4/2013 8	3:43:00 AM	
				IOPS	Test (REQU	IRED) - Rep	oort	Page			
SNIA		Solid Sta	te Sto	rage	TOPS - Blo	TOPS - Block Size x BW Mix Matrix					
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	Pag						3 of 6
Vendor: ABC Co.				Model:	ABC Co.	BC Co. SLC-A 100 TE SPON					YPSO Systems
Те	st Pla	atform	·	Devic	e Under Test	Set Up P	aram	eters	Test Pa		ameters
Ref Test Plat	form	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	1	RND	Data Pattern		RND
Hotherboa	ard	Intel 5520	HC	Model No.	SLC-A	AR		100%	AR & Amount		100%
CPU		Intel XEON 5	580W	S/N	123456	AR Segments		N/A	Test St	imulus 1	IOPS Loop
Memory	6 - C	8 GB PC1600	DDR2	Firmware v	er ABCDEF	Pre Condtion 1	SE	SEQ 128K W R		Mix	Outer Loop
Operating Sy	stem	CentOS (5.3	Capacity	100 GB	TOIO - TC/QD	TO	2/ QD 16	Block Sizes		Inner Loop
Test SW	1	CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	Duration	Twice	User Capacity	TOI	O - TC/QD	TC 2/QD 16
Test SW I	nfo	1.10.7/1.9	9.16	NAND Type	sLC	Pre Condtion 2	1	OPS Loop	Stea	ady State	1-5
Test ID N	ID No. R5-456 PCIe NVM N/A		TOIO - TC/QD	TC 2/ QD 16		Test Stimulus 2		N/A			
HBA LSI 9212-4e4i		le4i	Purge Meth	od Format Unit	SS Rounds	1 - 5		TOIO - TC/QD		N/A	
PCIe		Gen 2 x	8	Write Cach	e WCD	Note		-	Stea	ady State	N/A
C		T	DEC	Stoady	State Measu	comont Win	dow	- PND	IAK	iB	

OPS Steady State Measurement Window – RND/4KiB





Steady State Determination Data			
Average IOPS:			16563.0
Allowed Maximum Data Excursion:	3312.6	Measured Maximum Data Excursion:	248.3
Allowed Maximum Slope Excursion:	1656.3	Measured Maximum Slope Excursion:	128.6
Least Squares Linear Fit Formula:		-3	2.143 * R + 16659.425

Plot A.3 – IOPS Steady State Measurement Window - RND/4KiB

Tes	st Ru	n Date:		11/02/201	2011 02:56 PM Report Run Date: 3/4/2013 8:43:00 AM					
				IOPS Te	st (REQUI	RED) - Rep	ort Page			
SNIA		Solid Stat	e Sto	rage		Cino y DM	Mis Matel	Rev.	PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	Dec (PTS)	OPS - BIOCI	K SIZE X KW	Mix Matri	× Page	4 of 6	
Vendor:	A	BC Co.	SSD	Model:	ABC Co. S	5LC-A 100	TEST		YPSO Systems	
Те	est Pl	atform		Device U	nder Test	Set Up Pa	arameters	Test Par	ameters	
Ref Test Plat	tform	Calypso RTF	2.0	Mfgr	ABC Co.	Data Pattern	RND	Data Pattern	RND	
Motherboa	ard	Intel 5520	HC	Model No.	SLC-A	AR	100%	AR & Amount	100%	
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A	Test Stimulus 1	IOPS Loop	
Memory	/	8 GB PC1600	DDR2	Firmware ver	ABCDEF	Pre Condtion 1	SEQ 128K W	RW Mix	Outer Loop	
Operating Sy	stem	CentOS 6	.3	Capacity	100 GB	TOIO - TC/QD	TC 2/ QD 16	Block Sizes	Inner Loop	
Test SW	۷	CTS 6.5 1.1	.3.8	Interface	SATA 6Gb/s	Duration	Twice User Capacity	TOIO - TC/QD	TC 2/QD 16	
Test SW I	nfo	1.10.7/1.9	.16	NAND Type	SLC	Pre Condtion 2	IOPS Loop	Steady State	1 - 5	
Test ID N	lo.	R5-456	9	PCIe NVM	N/A	TOIO - TC/QD	TC 2/ QD 16	Test Stimulus 2	N/A	
HBA		LSI 9212-4	e4i	Purge Method	Format Unit	SS Rounds	1-5	TOIO - TC/QD	N/A	
PCIe		Gen 2 x	8	Write Cache	WCD	Note	-	Steady State	N/A	
				IOPS - AL	L RW Mix 8	& BS – Tab	ular Data			
Block Si	ize				Rea	ad / Write Mix	%			
(KiB)	·	0/100	D	5/95	35/65	50/50	65/35	95/5	100/0	
	0.5	15,8	87.4	16,634.7	20,678.6	24,402.8	29,386.2	72,428.4	95,924.3	
	4	16,5	16,563.0 17,032.2 20,234.2 23,705.2 28,018		28,018.6	63,447.7	93,707.0			
	8	9,5	59.8	9,998.4	12,547.1	14,636.6	17,199.1	37,872.9	50,301.2	
	16	16 4,842.2 5,032.3 6,802.5 8,132.1		9,655.8	22,462.2	31,072.8				
	32	2,4	13.3	2,535.4	3,478.4	4,241.3	5,061.7	12,174.7	15,994.2	
	64	1,2	19.2	1,275.7	1,728.4	2,126.1	2,726.3	6,284.6	8,094.9	
	128	6	12.7	632.5	859.1	1,061.4	1,709.4	3,205.7	4,060.8	
1	1024		74.8 78.0 103.6 126.7 202.7		398.8	514.6				

Plot A.4 – IOPS - All RW Mix & BS - Tabular Data

Test Run Date:				11/02/2011 02:56 PM Report Run Date:					3/	4/2013 8	:43:00 AM
				IOPS	Test (REQU	IRED) - Rep	port	Page			
SNIA		Solid Sta	te Stor	age	TOPS - BIO	IOPS - Block Size x RW Mix Matrix					
SSS TWG	Per	formance T	est Sp	ec (PTS)	101.0 0.0	en oire a m		A HIGGH		Page	5 of 6
Vendor:	A	BC Co.	SSD	Model:	ABC Co.	SLC-A 100	TEST	IST CA		YPSO Systems	
Te	st P	atform		Devic	e Under Test	Set Up P	aram	eters	Test Par		ameters
Ref Test Plat	tform	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND		Data Pattern		RND
Hotherbo	ard	Intel 5520	OHC	Model No.	SLC-A	AR		100%	AR & Amount		100%
CPU		Intel XEON 5	580W	S/N	123456	AR Segments		N/A	Test Stimulus 1		IOP5 Loop
Memory	i):	8 GB PC1600	DDR2	Firmware v	er ABCDEF	Pre Condtion 1	SE	Q 128K W	RW	Mix	Outer Loop
Operating Sy	stem	CentOS I	5.3	Capacity	100 GB	TOIO - TC/QD	т	2/ QD 16	Blo	ck Sizes	Inner Loop
Test SW	1	CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	Duration	Twice	User Capacity	тот	O - TC/QD	TC 2/QD 16
Test SW I	nfo	1.10.7/1.9	9.16	NAND Type	e SLC	Pre Condtion 2	1	OPS Loop	Ste	ady State	1-5
Test ID N	t ID No. R5-456 PCIe NVM		N/A	TOIO - TC/QD	TC	2/ QD 16	Test Stimulus 2		N/A		
НВА	HBA LSI 9212-4e4i		Purge Metho	od Format Unit	SS Rounds	1 - 5		TOIO - TC/QD		N/A	
PCIe		Gen 2 x	8	Write Cach	e WCD	Note	- St		Ste	ady State	N/A
				TOP	S-ALL RW	Mix & BS -	2D P	lot			



Plot A.5 - IOPS - All RW Mix & BS - 2D Plot



Plot A.6 – IOPS -All RW Mix & BS - 3D Columns

A.2 Sample Throughput Test Report Pages

The sample Throughput Test Report pages are shown in Plot A.7 through Plot A.16.

Test Run Date:			12/04/2	011 08:21 AM	Report	Run Date:	3	3/04/2013 10:03 AM		
			٦	hrough	put Test (RE	QUIRED) -	Report Pag	je		
SNIA	NIA Solid State Storage TD SEO 1024Vip & SEO 128Vip								Rev.	PTS-E 1.1
SSS TWG	Pert	formance T	est Sp	ec (PTS)	TP - SEQ .	LUZ4KID &	5EQ 120KI		Page	1 of 10
Vendor:	or: ABC Co. SSD Model: ABC Co. SLC-A 100 TEST SPONSOR							T SOR	CAL	YPSO Systems
Те	st Pl	atform		Device	Under Test	Set Up P	arameters		Test Parameters	
Ref Test Plat	tform	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND	Data I	Pattern	RND
Motherbox	ard	Intel 5520	нс	Model No.	SLC-A	AR	100%	AR &	Amount	100%
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A	Test 5	timulus 1	SEQ 1024KIB
Memory	1	8 G8 PC1600	DDR2	Firmware ve	ABCDEF	Pre Condtion 1	SEQ 128KiB W	RM	/ Mix	100:0 / 0:100
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	T010 - TC/QD	TC 1/ QD 1	Bio	ck Sizes	SEQ 1024KiB
Test SW	v	CTS 6.5 1.1	13.8	Interface	SATA 6Gb/s	Duration	Twice User Capacity	то	10 - TC/QD	TC 2/QD 16
Test SW I	nfo	1.10.7/1.9	.16	NAND Type	SLC	Pre Condtion 2	SEQ 128KiB W	Ste	ady State	1 - 5
Test ID N	lo.	R5-897	6	PCIe NVM	N/A	TOIO - TC/QD	TC 2/ QD 16	Test S	timulus 2	SEQ 128KiB
НВА		LSI 9212-4	2-4e4i Purge Method Format Unit SS Rounds 1-5 T		то	IO - TC/QD	TC 2/QD 16			
PCIe	PCIe Gen 2 x 8 Write		Write Cache	WCD	Note -		Ste	ady State	1 - 5	
			Thro	ughput	Test - SS Co	nvergence	- Write 102	4Ki	В	



Plot A.7 – Throughput Test - SS Convergence - Write 1024KiB

Test Run Date:			12/04/2	011 08:21 AM	Report	Run D	ate:	3	3/04/2013 10:03 AM		
			٦	hrough	out Test (RE	QUIRED) -	Repo	ort Pag	e		
SNIA		Solid Stat	te Stor	age	тр	- SEO 102/	IVIR			Rev.	PTS-E 1.1
SSS TWG	Peri	formance T	est Sp	ec (PTS)		Pag					
Vendor: ABC Co. S				Model:	ABC Co.	SLC-A 100 TES			OR	CAL	YPSO Systems
Te	st Pl	atform		Device	Under Test	Set Up P	Set Up Parameters			Test Par	ameters
Ref Test Plat	tform	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND		Data Pattern		RND
Motherboa	ard	Intel 5520	NHC	Model No.	SLC-A	AR		100%	AR & Amount		100%
CPU		Intel XEON 5	580W	S/N	123456	AR Segments		N/A	Test Stimulus 1		5EQ 1024KiB
Memory	0	8 GB PC1600	DDR2	Firmware ver	ABCDEF	Pre Condtion 1	SEC	128KiB W	RW	Mix	100:0 / 0:100
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	TO	1/ QD 1	Bloc	k Sizes	SEQ 1024KiB
Test SW	r i	CT5 6.5 1.	13.8	Interface	SATA 6Gb/s	Duration	Twice	User Capacity	TOI	0 - TC/QD	TC 2/QD 16
Test SW I	nfo	1.10.7/1.9	9.16	NAND Type	SLC	Pre Condtion 2	SEC	128KiB W	Stea	dy State	1 - 5
Test ID N	Test ID No. R5-897		6	PCIe NVM	N/A	TOIO - TC/QD	TC	2/ QD 16	Test Stimulus 2		SEQ 128KiB
НВА	HBA LSI 9212-4e4i		le4i	Purge Method	Format Unit	SS Rounds	1-5		TOIO - TC/QD		TC 2/QD 16
PCIe		Gen 2 x	8	Write Cache	WCD	Note	- Ste		Stea	dy State	1-5
	_		Thro	uahput	Test - SS Co	nvergence	- Rea	ad 1024	1KiB		



Plot A.8 – Throughput Test - SS Convergence - Read 1024 KiB

Tes	Test Run Date:			12/04/2	011 08:21 AM	Report	Run Da	3,	3/04/2013 10:03 AM		
			٦	Throughp	out Test (RE	QUIRED) -	Repo	rt Pag	e		
SNIA		Solid Sta	te Stor	rage	тр	1	Rev.	PTS-E 1.1			
SSS TWG	Perf	formance T	'est Sp	ec (PTS)	IP - SEQ 1024KIB						3 of 10
Vendor:	Vendor: ABC Co. SS				ABC Co.	SLC-A 100 TE			OR	CAL	YPSO Systems
Те	st Pl	atform		Device	Under Test	Set Up P	Set Up Parameters		Test Pa		meters
Ref Test Plat	tform	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	F	RND		ottern	RND
Motherboa	ard	Intel 5520	онс	Model No.	SLC-A	AR	1	00%	AR & Amount		100%
CPU		Intel XEON 5	580W	S/N	123456	AR Segments		N/A	Test Stimulus 1		SEQ 1024KiB
Memory	1	8 GB PC1600	DDR2	Firmware ver	ABCDEF	Pre Condtion 1	SEQ 1	128KiB W RW		Mix	100:0 / 0:100
Operating Sy	stem	CentOS (5.3	Capacity	100 GB	TOIO - TC/QD	TC 1	/ QD 1	Bloc	k Sizes	SEQ 1024KiB
Test SW	1	CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	Duration	Twice Us	er Capacity	TOI	D - TC/QD	TC 2/QD 16
Test SW I	nfo	1.10.7/1.9	9.16	NAND Type	SLC	Pre Condtion 2	SEQ 1	28KiB W	Stea	dy State	1 - 5
Test ID N	ID No. R5-897 PCIe NVM N/A TOIO -		TOIO - TC/QD	TC 2/ QD 16 Test		Test St	imulus 2	SEQ 128KiB			
НВА		LSI 9212-4e4i Purge Method Format Unit SS Rounds 1 - 5		- 5	TOI	D - TC/QD	TC 2/QD 16				
PCIe		Gen 2 x	8	Write Cache	WCD	Note	ie -		Stea	dy State	1 - 5
		S	tead	ly State	Measureme	t Window	- SEC	/102	4 Kil	3	





Steady State Determination Data			
Average ThroughPut:			157.5
Allowed Maximum Data Excursion:	31.5	Measured Maximum Data Excursion:	16.6
Allowed Maximum Slope Excursion:	15.7	Measured Maximum Slope Excursion:	1.9
Least Squares Linear Fit Formula:			0.470 * R + 154.165

Plot A.9 – Steady State Measurement Window - SEQ/1024 KiB

Test Run Date:				12/04/2011 08:21 AM Report Run Date: 3/0					3/04/2013 10:03 AM		
			٦	hroughp	out Test (RE	QUIRED) -	Rep	ort Pag	e		
SNIA Solid State Storage TP - SEO 1024KiB									1	Rev.	PTS-E 1.1
SSS TWG	Peri	formance T	'est Sp	ec (PTS)	Contraction of the second	- 3LQ 1024	ANID			Page	4 of 10
Vendor:	A	BC Co.	SSD	Model:	ABC Co.	SLC-A 100		TEST	OR	CAL	YPSO Systems
Te	st Pl	latform		Device	Under Test	Set Up P	aram	eters	Test Pa		ameters
Ref Test Plat	tform	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern		RND	Data Pattern		RND
Hotherbo	ard	Intel 5520	NHC	Model No.	SLC-A	AR		100%	AR & Amount		100%
CPU		Intel XEON S	580W	S/N	123456	AR Segments		N/A	Test Stimulus 1		SEQ 1024KiB
Memory		8 GB PC1600	DDR2	Firmware ver	ABCDEF	Pre Condtion 1	SE	2 128KiB W	RW Mix		100:0 / 0:100
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	Т	C 1/ QD 1	Blo	ck Sizes	SEQ 1024KiB
Test SW	/	CTS 6.5 1.1	13.8	Interface	SATA 6Gb/s	Duration	Twice	User Capacity	то	IO - TC/QD	TC 2/QD 16
Test SW I	nfo	1.10.7/1.9	9.16	NAND Type	SLC	Pre Condtion 2	SE	Q 128KiB W	Ste	ady State	1 - 5
Test ID N	lo.	R5-897		PCIe NVM	N/A	TOIO - TC/QD	T	2/ QD 16	Test Stimulus 2		SEQ 128KiB
НВА		LSI 9212-4	le4i	Purge Method	Format Unit	SS Rounds	1 - 5		то	IO - TC/QD	TC 2/QD 16
PCIe	PCIe Gen 2 x 8 Write Ca			Write Cache	WCD	Note			Ste	ady State	1-5
		Th	roug	<mark>Jhput - A</mark>	LL RW Mix 8	& BS – Tabu	lar	Data 10	24	KiB	

Block Size	Read / Write Mix %					
(KiB)	0/100	100/0				
1024	157.5	514.3				

Plot A.10 – Throughput - All RW Mix & BS - Tabular Data 1024KiB

Tes	st Ru	in Date:		12/04/2	011 08:21 AM	Report	Run I	3	3/04/2013 10:03 AI			
			1	Through	put Test (RE	QUIRED) -	Rep	ort Pag	e			
SNIA Solid State Storage TD SEO 1024V/P											PTS-E 1.1	
SSS TWG	Per	formance T	est Sp	ec (PTS)		- 3EQ 1024	IKID			Page	5 of 10	
Vendor:	A	BC Co.	SSD	Model:	ABC Co.	SLC-A 100		TEST	CAL	LYPSO		
Te	st Pl	atform		Device	Under Test	Set Up P	aram	eters	1	Test Par	rameters	
Ref Test Plat	tform	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND		Data Pattern		RND	
Motherboa	ard	Intel 5520	нс	Model No.	SLC-A	AR		100%	AR & Amount		100%	
CPU		Intel XEON 5	580W	S/N	123456	AR Segments		N/A	Test Stimulus 1		SEQ 1024KiB	
Memory	1	8 GB PC1600	DDR2	Firmware ve	r ABCDEF	Pre Condtion 1	SE	Q 128KiB W	RW	Mix	100:0 / 0:100	
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	Т	'C 1/ QD 1	Blo	ck Sizes	SEQ 1024KiB	
Test SW	1	CTS 6.5 1.1	13.8	Interface	SATA 6Gb/s	Duration	Twice	User Capacity	тол	O - TC/QD	TC 2/QD 16	
Test SW I	nfo	1.10.7/1.9	.16	NAND Type	SLC	Pre Condtion 2	SE	Q 128KiB W	Ste	ady State	1-5	
Test ID N	Test ID No. R5		6	PCIe NVM	N/A	TOIO - TC/QD	T	C 2/ QD 16	Test S	timulus 2	SEQ 128KiB	
НВА		LSI 9212-4	le4i	Purge Metho	d Format Unit	SS Rounds		1 - 5	тот	O - TC/QD	TC 2/QD 16	
PCIe Gen 2 x 8			8	Write Cache	e WCD Note -		-	Ste	ady State	1 - 5		
			Thr	oughput	- ALL RW M	ix & BS - 2I	D Ple	ot 1024	KiB			



Plot A.11 – Throughput - All RW Mix & BS - 2D Plot 1024KiB

Tes	t Ru	n Date:		12/04/2	2011 08:21 AM	3	3/04/2013 10:03 AM					
			٦	hrough	put Test (RE	QUIRED) -	Report	Page	e			
SNIA		Solid Stat	te Stor	age	TO							
SSS TWG	Perf	formance T	est Sp	ec (PTS)	2.44	- SEQ 120	NID			Page	6 of 10	
Vendor:	A	BC Co.	SSD	Model:	ABC Co. SLC-A 100 TEST SPONSOR						YPSO Systems	
Te	st Pl	atform		Devic	e Under Test	Set Up P	arameter	s	Test Pa		rameters	
Ref Test Plat	form	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND		Data Pattern		RND	
Motherboa	brd	Intel 5520	HC	Model No.	SLC-A	AR	100%	-	AR & A	mount	100%	
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A		Test St	imulus 1	SEQ 1024Ki8	
Memory	62	8 GB PC1600	DDR2	Firmware v	er ABCDEF	Pre Condtion 1	SEQ 128K	iB W	RW	Mix	100:0/0:100	
Operating Sy	stem	CentOS 6	i.3	Capacity	100 G8	TOIO - TC/QD	TC 1/ Q	D 1	Blo	k Sizes	SEQ 1024Ki8	
Test SW	66	CTS 6.5 1.1	13.8	Interface	SATA 6Gb/s	Duration	Twice User C	apacity	TOI	0 - TC/QD	TC 2/QD 16	
Test SW In	nfo	1.10.7/1.9	.16	NAND Type	s SLC	Pre Condtion 2	SEQ 128K	iB W	Ste	ady State	1-5	
Test ID No. R5-891			PCIe NVM	N/A	TOIO - TC/QD	TC 2/ QC	/ QD 16 Test Stimulus 2		imulus 2	SEQ 128KiB		
HBA LSI 9212-4e4i Purge Method		od Format Unit	SS Rounds	1-5		TOIO - TC/QD		TC 2/QD 16				
PCIe		Gen 2 x	8	Write Cach	e WCD	Note			Ste	ady State	1-5	
			Thre	oughput	Test - SS Co	nvergence	- Write	128	KiB			



Plot A.12 – Throughput Test - SS Convergence - Write 128KiB

Tes	t Ru	in Date:		12/04/2	2011 08:21 AM Report Run Date: 3/04/2013 10:03 AM						10:03 AM	
			1	Through	put Test (RE	QUIRED) -	Repo	ort Pag	е			
SNIA	A Solid State Storage TD - SEO 1024/VIB / SEO 128/VIB Rev. PTS-E 1											
SSS TWG	Pert	formance T	est Sp	ec (PTS)	TP - SEQ I	1024KIB / 3	EQ.	LZOKID	14 	Page	7 of 10	
Vendor:	Vendor: ABC Co. SSD Model: ABC Co. SLC-A 100 TEST SPONSOR										YPSO Systems	
Te	st Pl	atform	·	Device	e Under Test	Set Up P	aram	eters		Test Par	ameters	
Ref Test Plat	form	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND		Data Pattern		RND	
Motherboa	ard	Intel 5520	HC	Model No.	SLC-A	AR		100%	AR & Amount		100%	
CPU		Intel XEON 5	580W	S/N	123456	AR Segments		N/A	Test Stimulus 1		5EQ 1024K/B	
Memory	to –	8 GB PC1600	DDR2	Firmware ve	r ABCDEF	Pre Condtion 1	SEC	128KiB W	RW	Mix	100:0 / 0:100	
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	T	C 1/ QD 1	Block Sizes		SEQ 1024KiB	
Test SW	1	CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	Duration	Twice	User Capacity	TO	O - TC/QD	TC 2/QD 16	
Test SW I	nfo	1.10.7/1.9	0.16	NAND Type	SLC	Pre Condtion 2	SEC	2 128KiB W	Ste	ady State	1 - 5	
Test ID N	Test ID No. R5-891		PCIe NVM	N/A	TOIO - TC/QD	TC	2/ QD 16	Test S	timulus 2	SEQ 128KiB		
НВА		LSI 9212-4	le4i	Purge Metho	d Format Unit	SS Rounds		1-5	тол	O - TC/QD	TC 2/QD 16	
PCIe Gen 2 x 8 Write Ca				Write Cache	wcd	Note			Ste	ady State	1-5	
			Thr	oughput	Test - SS Co	nvergence	- Re	ad 128	KiB			



Plot A.13 – Throughput Test - SS Convergence - Read 128KiB

Tes	t Ru	in Date:		12/04/2	011 08:21 AM	Report	Run D)ate:	3	/04/2013	10:03 AM	
			1	Throughp	out Test (RE	QUIRED) -	Repo	ort Pag	e			
SNIA	SNIA Solid State Storage TP - SEO 1024KiB / SEO 128KiB Rev. PTS-E											
SSS TWG	Peri	formance T	est Sp	pec (PTS)	IF - SEQ I	024KIB / 3	SEQ .	LZOKID	2	Page	8 of 10	
Vendor:	A	BC Co.	SSC	Model:	ABC Co. SLC-A 100 TEST SPONSOR					CAL	YPSO Systems	
Те	st Pl	atform		Device	Under Test	Set Up P	aram	eters	ų – 11	Test Para	ameters	
Ref Test Plat	form	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern		RND		attern	RND	
Motherboa	ard	Intel 5520	онс	Model No.	SLC-A	AR	1	100%	AR & A	mount	100%	
CPU		Intel XEON 5	580W	S/N	123456	AR Segments		N/A	Test S	imulus 1	SEQ 1024KiB	
Memory	r	8 GB PC1600	DDR2	Firmware ver	ABCDEF	Pre Condtion 1	SEC	2 128KiB W	RW	Mix	100:0 / 0:100	
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	T	C 1/ QD 1	Block Sizes		SEQ 1024KiB	
Test SW	1	CTS 6.5 1.1	13.8	Interface	SATA 6Gb/s	Duration	Twice	User Capacity	тот	O - TC/QD	TC 2/QD 16	
Test SW I	nfo	1.10.7/1.9	9.16	NAND Type	SLC	Pre Condtion 2	SEC	2 128KiB W	Ste	ady State	1 - 5	
Test ID N	о.	R5-891	ų į	PCIe NVM	N/A	TOIO - TC/QD	TC	2/ QD 16	6 Test Stimulus		SEQ 128KiB	
НВА	HBA LSI 9212-4e4i Purge Me			Purge Method	Format Unit	SS Rounds 1-5		TOT	O - TC/QD	TC 2/QD 16		
PCIe		Gen 2 x	8	Write Cache	WCD	Note		-	Ste	ady State	1 - 5	
			Stea	dy State	Measureme	nt Window	- SI	EQ/128	KiE			





Steady State Determination Data		
Average ThroughPut:		144.5
Allowed Maximum Data Excursion: 28	9 Measured Maximum Data Excursion:	4.5
Allowed Maximum Slope Excursion: 14	4 Measured Maximum Slope Excursion:	1.2
Least Squares Linear Fit Formula:		0.2931 * R + 142.43



Tes	t Ru	n Date:		12/04/2	2011 08:21 AM Report Run Date: 3/04/2013 10:03 AM						
			1	Through	put Test (RE	QUIRED) -	Report F	Page	e		
SNIA	SNIA Solid State Storage TD SEO 1024/Kip / SEO 128/Kip Rev.										
SSS TWG	Perf	ormance T	est Sp	pec (PTS)	1F - 3EQ 1	024KID / 3	EQ 120	VID.	Page	9 of 10	
Vendor:	A		YPSO Systems								
Те	st Pl	atform		Device	e Under Test	Set Up P	arameters	S	Test Par	ameters	
Ref Test Plat	form	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND	0	Data Pattern	RND	
Motherboa	ard	Intel 5520	DHC	Model No.	SLC-A	AR	100%	A	R & Amount	100%	
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A	Т	est Stimulus 1	SEQ 1024KiB	
Memory		8 GB PC1600	DDR2	Firmware ve	r ABCDEF	Pre Condtion 1	SEQ 128KiB	W	RW Mix	100:0 / 0:100	
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	TC 1/ QD	1	Block Sizes	SEQ 1024KiB	
Test SW	1	CTS 6.5 1.1	13.8	Interface	SATA 6Gb/s	Duration	Twice User Ca	pacity	TOIO - TC/QD	TC 2/QD 16	
Test SW I	nfo	1.10.7/1.9	9.16	NAND Type	SLC	Pre Condtion 2	SEQ 128KiB	w	Steady State	1-5	
Test ID N	o.	R5-891	k.	PCIe NVM	N/A	TOIO - TC/QD	TC 2/ QD 1	16 T	est Stimulus 2	SEQ 128KiB	
НВА	HBA LSI 9212-4e4i Purge Me		Purge Metho	d Format Unit	SS Rounds	1 - 5	1-5 TC		TC 2/QD 16		
PCIe		Gen 2 x	8	Write Cache	wcD	Note	•		Steady State	1 - 5	
		T	nrou	ghput -	ALL RW Mix	& BS – Tab	ular Dat	a 12	8KiB		

Block Size	Read / Write Mix %					
(KiB)	0/100	100/0				
128	144.5	409.3				

Plot A.15 – Throughput -All RW Mix & BS - Tabular Data 128KiB

Tes	t Ru	in Date:		12/04/2	011 08:21 AM	Report	Run D	ate:	3	3/04/2013 10:03 AM		
			N	Throughp	out Test (RE	QUIRED) -	Repo	ort Pag	е			
SNIA	Solid State Storage TD CEO 1004KID / CEO 100KID Rev.											
SSS TWG	Per	formance 1	est Sp	ec (PTS)	1P - 5EQ 1	U24KIB / 3	PEQ 1	ZOKID		Page	10 of 10	
Vendor:	A	BC Co.	SSC	Model:	ABC Co.	ABC Co. SLC-A 100 TEST SPONSOR					YPSO Systems	
Te	st P	atform		Device	Under Test	Set Up P	arame	arameters		Test Par	ameters	
Ref Test Plat	form	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern		RND	Data Pattern		RND	
Motherboa	ard	Intel 5520	онс	Model No.	SLC-A	AR		100%	AR & A	mount	100%	
CPU		Intel XEON 5	5580W	S/N	123456	AR Segments		N/A	Test Stimulus 1		SEQ 1024KiB	
Memory	1	8 GB PC1600	DDR2	Firmware ver	ABCDEF	Pre Condtion 1	SEQ	128KiB W	RW	Mix	100:0 / 0:100	
Operating Sy	stem	CentOS	6.3	Capacity	100 GB	TOIO - TC/QD	TC	1/ QD 1	Blo	ck Sizes	SEQ 1024KiB	
Test SW	1	CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	Duration	Twice U	Jser Capacity	TOI	O - TC/QD	TC 2/QD 16	
Test SW I	nfo	1.10.7/1.9	9.16	NAND Type	SLC	Pre Condtion 2	SEQ	128KiB W	Ste	ady State	1-5	
Test ID N	Test ID No. R5-891		li I	PCIe NVM	N/A	TOIO - TC/QD	TC	2/ QD 16	Test S	timulus 2	SEQ 128KiB	
НВА	HBA LSI 9212-4e4i		4e4i	Purge Method	Format Unit	SS Rounds		1-5 TOIO -		O - TC/QD	TC 2/QD 16	
PCIe	PCIe Gen 2 x 8 W		Write Cache	WCD	Note - S		Ste	ady State	1-5			
			Th	roughput	- ALL RW M	1ix & BS - 2	D Pl	ot 128	KiB			



Plot A.16 – Throughput -All RW Mix & BS - 2D Plot 128KiB

A.3 Sample Latency Test Report Pages

The sample Latency Test Report pages are shown in Plot A.17 through Plot A.22.

Tes	t Ru	n Date:		06/28/	2011 05:07 AM Report Run Date:				3/04/2013 08:47 AM		
				LATEN	CY Test (REQ	UIRED) - R	eport Page	•			
SNIA		Solid Sta	te Stor	age	LATENCY	Rev.	PTS-E 1.1				
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	LATENCY -	Response	11me 010=	-	Page	1 of 6	
Vendor:	A	BC Co.	SSD	Model:	ABC Co.	SLC-A 100	TES	T SOR	CAL	YPSO Systems	
Te	st Pla	atform		Devic	e Under Test	Set Up P	arameters		Test Paramete		
Ref Test Plat	form	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND	Data P	Pattern	RND	
Motherboa	ard	Intel 5520	DHC	Model No.	SLC-A	AR	100%	AR &	Amount	100%	
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A	Test S	timulus 1	LAT Loop	
Memory	(8 GB PC1600	DDR2	Firmware v	er ABCDEF	Pre Condtion 1	SEQ 128K W	RW	Mix	Outer Loop	
Operating Sy	stem	CentOS (5.3	Capacity	100 GB	TOIO - TC/QD	TC 1/ QD 1	Blo	ck Sizes	Inner Loop	
Test SW	,	CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	Duration	Twice User Capacit	то:	IO - TC/QD	TC 1/QD 1	
Test SW I	nfo	1.10.9/1.9	9.16	NAND Typ	e SLC	Pre Condtion 2	LAT Loop	Ste	ady State	3 - 7	
Test ID N	o. 🛛	R5-523	5	PCIe NVM	N/A	TOIO - TC/QD	TC 1/ QD 1	TC 1/ QD 1 Histog		N/A	
НВА		LSI 9212-4e4i Purge Method Format Unit SS Rounds 3 - 7 TO		то	IO - TC/QD	N/A					
PCIe Gen 2 x 8 Write Cach		wcD	Note	-	Note						
	s	teady	Stat	e Conve	ergence Plot -	- Average	Latency - 1	00%	Writes	5	



Plot A.17 – Steady State Convergence Plot - Average Latency - 100% Writes

Tes	st Ru	n Date:		06/28/	/2011 05:07 AM Report Run Date:					3/04/2013 08:47 AM		
				LATEN	CY Test (REQ	UIRED) - R	еро	rt Page				
SNIA		Solid Sta	te Sto	rage	LATENCY -	Response 1	Time	010=1		Rev.	PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	LATENCT	Response	inne	. 010-1	÷.,	Page	2 of 6	
Vendor:	A	BC Co.	SSD	Model:	ABC Co. SLC-A 100 TEST SPONS					OR CALYPSC		
Te	st Pl	atform		Devic	e Under Test	Set Up P	aram	eters		Test Para	ameters	
Ref Test Plat	tform	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern		RND	Data P	attern	RND	
Motherboa	ard	Intel 5520	DHC	Model No.	SLC-A	AR		100%		mount	100%	
CPU		Intel XEON 5	580W	S/N	123456	AR Segments		N/A	Test Stimulus 1		LAT Loop	
Memory	,	8 GB PC1600	DDR2	Firmware v	er ABCDEF	r ABCDEF Pre Condition 1		SEQ 128K W		Mix	Outer Loop	
Operating Sy	stem	CentOS (5.3	Capacity	100 GB	TOIO - TC/QD	Т	C 1/ QD 1	Blo	ck Sizes	Inner Loop	
Test SW	,	CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	Duration	Twice	User Capacity	то	O - TC/QD	TC 1/QD 1	
Test SW I	nfo	1.10.9/1.9	9.16	NAND Type	SLC	Pre Condtion 2	1	LAT Loop	Ste	ady State	3 - 7	
Test ID N	lo.	R5-523	i i	PCIe NVM	N/A	TOIO - TC/QD	Т	C 1/ QD 1	Histog	ram	N/A	
НВА	HBA LSI 9212-4e4i Purge Me		Purge Meth	od Format Unit	SS Rounds	3 - 7		тол	O - TC/QD	N/A		
PCIe		Gen 2 x	8	Write Cach	e WCD	Note		-	Note			
	S	teady S	itate	Convei	gence Plot –	Maximum	Late	e <mark>ncy -</mark> 1	000	% Write	S	



Plot A.18 – Steady State Convergence Plot - Maximum Latency - 100% Writes

Tes	st Ru	in Date:		06/28/2	/2011 05:07 AM Report Run Date:					3/04/2013 08:47 AM		
				LATEN	CY Test (REQ	UIRED) - R	еро	rt Page				
SNIA		Solid Sta	te Sto	rage	LATENCY -	Response 1	Time	010=1		Rev.	PTS-E 1.1	
SSS TWG	Peri	formance T	est Sp	ec (PTS)	EATENCT	Response	inne	. 010		Page	3 of 6	
Vendor:	Vendor: ABC Co. SSD Model: ABC Co. SLC-A 100 TEST SPONSO									CAL	YPSO	
Te	st Pl	latform		Devic	e Under Test	Set Up P	aram	eters		Test Par	ameters	
Ref Test Pla	tform	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern		RND		attern	RND	
Motherbo	ard	Intel 5520	онс	Model No.	SLC-A	AR		100%	AR & Amount		100%	
CPU		Intel XEON 5	5580W	S/N	123456	AR Segments	-	N/A	Test Stimulus 1		LAT Loop	
Memory	1	8 GB PC1600	DDR2	Firmware v	er ABCDEF	Pre Condtion 1	SE	EQ 128K W	RW	Mix	Outer Loop	
Operating Sy	stem	CentOS (6.3	Capacity	100 GB	TOIO - TC/QD	т	C 1/ QD 1	Blo	ck Sizes	Inner Loop	
Test SV	,	CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	Duration	Twice	User Capacity	тот	O - TC/QD	TC 1/QD 1	
Test SW I	nfo	1.10.9/1.9	9.16	NAND Type	SLC	Pre Condtion 2		LAT Loop	Ste	ady State	3 - 7	
Test ID N	Test ID No. R5-523		PCIe NVM	N/A	TOIO - TC/QD	Т	C 1/ QD 1	Histog	ram	N/A		
HBA LSI 9212-4e4i Purge M		Purge Metho	od Format Unit	SS Rounds	3 - 7		тот	O - TC/QD	N/A			
PCIe Gen 2 x 8 Write C				Write Cach	e WCD	Note		•	Note			
			Ste	ady Sta	te Measurem	ent Windo	w –	RND/4	KiB			





Steady State Determination Data			
Average Latency (ms):			0.087
Allowed Maximum Data Excursion:	0.017	Measured Maximum Data Excursion:	0.015
Allowed Maximum Slope Excursion:	0.009	Measured Maximum Slope Excursion:	0.007
Least Squares Linear Fit Formula:			-0.002 * R + 0.095

Plot A.19 – Steady State Measurement Window - RND/4KiB

Tes	st Ru	n Date:		06/28/2	2011 05:07 AM Report Run Date:					3/04/2013 08:47 AM		
				LATENO	CY Test (REQ	UIRED) - R	еро	rt Page				
SNIA		Solid Stat	te Sto	rage	LATENCY - Response Time OTO-1					Rev.	PTS-E 1.1	
SSS TWG	Perf	formance T	Page 4 of 6									
Vendor:	A	BC Co.	SSD	Model:	ABC Co. SLC-A 100 TEST SPONS				OR	CAL	YPSO Systems	
Te	est Pl	atform		Devic	e Under Test	Set Up P	aram	eters		Test Par	ameters	
Ref Test Plat	tform	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND		Data Pattern		RND	
Motherboa	ard	Intel 5520	OHC	Model No.	SLC-A	AR	100%		AR & A	mount	100%	
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A		Test St	timulus 1	LAT Loop	
Memory	,	8 GB PC1600	DDR2	Firmware ve	ABCDEF	Pre Condtion 1	SEQ 128K W		RW Mix		Outer Loop	
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	TC 1/ QD 1		Block Sizes		Inner Loop	
Test SW	/	CTS 6.5 1.3	13.8	Interface	SATA 6Gb/s	Duration	Twice User Capacity		TOIO - TC/QD		TC 1/QD 1	
Test SW I	nfo	1.10.9/1.9	9.16	NAND Type	SLC	Pre Condtion 2	1	AT Loop	Ste	ady State	3 - 7	
Test ID N	ю.	R5-523		PCIe NVM	N/A	TOIO - TC/QD	Т	C 1/ QD 1	Histogram		N/A	
НВА		LSI 9212-4	le4i	Purge Metho	Format Unit	SS Rounds		3 - 7	TO	O - TC/QD	N/A	
PCIe		Gen 2 x	8	Write Cache	e WCD	Note		•	Note			
A	ver	age and	d Ma	ximum	Response Ti	me - ALL R\	W Mi	x & BS	- Ta	abular I	Data	

Average Response Time (ms)										
	Read / Write Mix %									
Block Size (KiB)	0/100	65/35	100/0							
0.5	0.0811486	0.1307696	0.1470862							
4	0.0865518	0.1386792	0.155532							
8	0.1300188	0.1697318	0.171237							

Maximum Response Time (ms)										
Read / Write Mix %										
Block Size (KiB)	0/100	100/0								
0.5	56.8668	39.4566	5.7996							
4	32.6272	46.7808	6.2596							
8	80.4266	39.3802	12.9866							

Plot A.20 – Average and Maximum Response Time - All RW Mix & BS - Tabular Data

Tes	st Ru	n Date:		06/28/2	2011 05:07 AM Report Run Date:					3/04/2013 08:47 AM		
				LATEN	CY Test (REQ	UIRED) - R	eport	Page				
SNIA		Solid Stat	te Sto	rage	LATENCY - Response Time OIO-1					Rev.	PTS-E 1.1	
SSS TWG	Peri	formance T	rmance Test Spec (PTS) Page 5 of 6									
Vendor:	A	BC Co.	SSD	Model:	ABC Co. SLC-A 100 TEST SPONSO				OR	CAL	YPSO Systems	
Те	st Pl	atform		Devic	e Under Test	Set Up P	aramet	ters	J.	Test Par	ameters	
Ref Test Plat	tform	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	F	RND	Data Pattern		RND	
Motherboa	ard	Intel 5520	OHC	Model No.	SLC-A	AR	100%		AR & A	mount	100%	
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A Te		Test St	timulus 1	LAT Loop	
Memory	1	8 GB PC1600	DDR2	Firmware v	er ABCDEF	Pre Condtion 1	SEQ 128K W		RW Mix		Outer Loop	
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	TC 1/ QD 1		Block Sizes		Inner Loop	
Test SW	1	CTS 6.5 1.3	13.8	Interface	SATA 6Gb/s	Duration	Twice Us	er Capacity	TOIO - TC/QD		TC 1/QD 1	
Test SW I	nfo	1.10.9/1.9	9.16	NAND Type	s SLC	Pre Condtion 2	LA	Г Loop	Steady State		3 - 7	
Test ID N	Test ID No. R		5	PCIe NVM	N/A	TOIO - TC/QD	TC 1	I/ QD 1	Histogram		N/A	
НВА		LSI 9212-4	le4i	Purge Metho	od Format Unit	SS Rounds	3 - 7		тот	O - TC/QD	N/A	
PCIe		Gen 2 x	8	Write Cach	e WCD	Note		-	Note	j.	*	
			A	verage	Latency vs B	S and R/W	Mix -	3D PI	ot			



Plot A.21 – Average Latency vs. BS and R/W Mix - 3D Plot

Tes	st Ru	in Date:		06/28/20	011 05:07 AM	Report	1	11/14/2011 08:47 AM		
				LATENCY	Y Test (REQ	UIRED) - R	eport Pag	e		
SNIA		Solid Stat	te Stor	rage	LAT - 0 5 4 8KIB x 8 65.35 W					PTS-E 1.1
SSS TWG	/G Performance Test Spec (PTS) Page 6 of 6									
Vendor:	A	BC Co.	SSD	Model:	ABC Co.	SLC-A 100	ST SOR	CAL	YPSO Systems	
Te	st Pl	atform	<u> </u>	Device	Under Test	Set Up P	arameters		Test Par	ameters
Ref Test Plat	tform	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND	Data P	Pattern	RND
Motherboa	ard	Intel 5520	DHC	Model No.	SLC-A	AR	100%	AR & .	Amount	100%
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A	Test S	timulus 1	LAT Loop
Memory	,	8 GB PC1600	DDR2	Firmware ver	ABCDEF	Pre Condtion 1	SEQ 128K W	RW	/ Mix	Outer Loop
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	TC 1/ QD 1	Blo	ck Sizes	Inner Loop
Test SW	1	CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	Duration	Twice User Capaci	ty то	IO - TC/QD	TC 1/QD 1
Test SW I	nfo	1.10.9/1.9	9.16	NAND Type	SLC	Pre Condtion 2	LAT Loop	Ste	ady State	3 - 7
Test ID N	lo.	R5-523	1	PCIe NVM	N/A	TOIO - TC/QD	TC 1/ QD 1	Histog	gram	N/A
НВА		LSI 9212-4	le4i	Purge Method	Format Unit	SS Rounds	3 - 7	то	IO - TC/QD	N/A
PCIe		Gen 2 x	8	Write Cache	WCD	Note	•	Note		•
			Ma	ximum L	atency vs B	S and R/W	Mix - 3D	Plot		



Plot A.22 – Maximum Latency vs. BS and R/W Mix - 3D Plot

A.4 Sample Write Saturation Test Report Pages

The sample Write Saturation Test Report pages are shown in Plot A.23 through Plot A.26.

Tes	Test Run Date: 11/07/1					11 08:40 AM Report Run Date: 3				
			Wri	te Satura	tion Test (REQUIRED) -	Report	Page		
SNIA		Solid Stat	te Stor	rage	MCAT	Rev.	PTS-E 1.1			
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	WSAI -	RND 4KIB 1	Page	1 of 4		
Vendor:	A	BC Co.	SSD	Model:	ABC Co.	SLC-A 100	ST ISOR	CAL	-YPSO Systems	
Test Platform Device					Jnder Test	Set Up Par	ameters		Test Para	ameters
Ref Test Plat	form	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND	Data Pattern		RND
Motherboa	ard	Intel 5520	нс	Model No.	SLC-A	AR	100%	AR & .	Amount	100%
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A	Test S	itimulus 1	RND 4KiB
Memory		8 GB PC1600	DDR2	Firmware ver	ABCDEF	Pre Condtion 1	None	то	IO - TC/QD	TC 2/QD 16
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD		Ste	ady State	N/A
Test SW		CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	SS Rounds		Tin	ne	6 Hr
Test SW I	nfo	1.10.7/1.9	9.16	NAND Type	SLC	Pre Condtion 2	None	Test S	itimulus 2	N/A
Test ID N	o.	R5-452		PCIe NVM	N/A	TOIO - TC/QD	*	то	IO - TC/QD	N/A
НВА		LSI 9212-4	le4i	Purge Method	Format Unit	SS Rounds	•	Ste	ady State	N/A
PCIe		Gen 2 x	8	Write Cache	WCD	Note	+	Tin	ne	N/A
				WSAT I	OPS (Linea	ar) vs Time (l	Linear)			



Plot A.23 – WSAT IOPS (Linear) vs. Time (Linear)

Tes	t Ru	n Date:		11/07/1	1 08:40 AM	Report Ru	un Date:	3	3/14/2013 08:45 AM		
			Wri	te Satura	tion Test (I	REQUIRED) -	Report	Page			
SNIA		Solid Sta	te Stor	rage	WEAT DND AVED 1000% W					PTS-E 1.1	
SSS TWG Performance Test Spec (PTS)									Page	2 of 4	
Vendor:	A	ABC Co. SSE		Model:	ABC Co.	TEST		CAL	YPSO Systems		
Те	st Pl	atform		Device	Under Test	Set Up Par	rameters		Test Par	ameters	
Ref Test Plat	form	Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND	Data I	Pattern	RND	
Motherboa	ard	Intel 5520	DHC	Model No.	SLC-A	AR	100%	AR &	Amount	100%	
CPU		Intel XEON 5	580W	S/N	123456	AR Segments	N/A	Test S	itimulus 1	RND 4KiB	
Memory	(8 GB PC1600	DDR2	Firmware ver	ABCDEF	Pre Condtion 1	None	то	IO - TC/QD	TC 2/QD 16	
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	5	Steady State		N/A	
Test SW	1	CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	SS Rounds		Tin	ne	6 Hr	
Test SW I	nfo	1.10.7/1.9	9.16	NAND Type	SLC	Pre Condtion 2	None	Test S	itimulus 2	N/A	
Test ID N	o.	R5-452	2	PCIe NVM	N/A	TOIO - TC/QD		то	IO - TC/QD	N/A	
НВА		LSI 9212-4	le4i	Purge Method	Format Unit	SS Rounds	-	Ste	ady State	N/A	
PCIe		Gen 2 x	8	Write Cache	WCD	Note	•	Tin	ne	N/A	
				WSAT	IOPS (LOG) vs Time (L	inear)				



Plot A.24 - WSAT IOPS (Log) vs. Time (Linear)

Test Run D

Write Saturation Test (REQUIRED) - Report Page

1

SNIA SSS TWG	Perf	Solid Stat	te Sto est Sp	rage Dec (PTS)	WSAT -	Rev. Page	PTS-E 1.0 3 of 4											
Vendor:	A	BC Co.	SSC	Model:	ABC Co.	ABC Co. SLC-A 100			CAL	YPSO Systems								
Test Platform Devi			Device L	Inder Test	Set Up Par	ameters		Test Par	ameters									
Ref Test Platform Calypso R		P 2.0	Mfgr	ABC Co.	Data Pattern	RND	Data F	Pattern	RND									
Motherboard Intel 5520H		ЭНС	Model No.	SLC-A	AR	100%	AR &	Amount	100%									
CPU Intel XEON S		580W	S/N	123456	AR Segments	N/A	Test S	timulus 1	RND 4KiB									
Memory		8 GB PC1600	DDR2	Firmware ver	ABCDEF	Pre Condtion 1	None	то	IO - TC/QD	TC 2/QD 16								
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	+	Steady State		N/A								
Test SW		CTS 6.5 1.13.8		CTS 6.5 1.13.8		CTS 6.5 1.13.8		CTS 6.5 1.13.8		CTS 6.5 1.13.8		Interface	SATA 6Gb/s SS Rounds		. т		ne	6 Hr
Test SW In	nfo	1.10.7/1.9	0.16	NAND Type	SLC	Pre Condtion 2	None	Test Stimulus 2		N/A								
Test ID N	Test ID No. R		Ê.	PCIe NVM	N/A	TOIO - TC/QD		TOIO - TC/QD		N/A								
НВА		LSI 9212-4	le4i	Purge Method	Format Unit	SS Rounds		Ste	ady State	N/A								
PCIe		Gen 2 x	8	Write Cache	WCD	Note	-	Tin	ne	N/A								



Plot A.25 – WSAT IOPS (Linear) vs. TGBW (Linear)

Tes	t Ru	n Date:		11/07/1	1 08:40 AM	Report R	un Date:	3	3/14/2013	08:45 AM	
			Wri	te Satura	ation Test (I	REQUIRED) -	Report	Page			
SNIA		Solid Sta	te Sto	rage	WSAT.	WSAT - PND AKIB 100% W					
SSS TWG	Peri	formance T	est Sp	ec (PTS)	WSAT-	KIND 4KID I	00 /0 11		Page	4 of 4	
Vendor:	A	BC Co. SSE		Model:	ABC Co. SLC-A 100		TEST		CAL	YPSO Systems	
Te	st Pl	atform		Device	Under Test	Set Up Par	rameters		Test Par	ameters	
Ref Test Plat	form	Calypso RTP 2.0		Mfgr	ABC Co.	Data Pattern	RND	Data F	Pattern	RND	
Motherboa	ard	Intel 5520	DHC	Model No.	SLC-A	AR	100%	AR & /	Amount	100%	
CPU		Intel XEON S	580W	S/N	123456	AR Segments	N/A	Test S	timulus 1	RND 4KiB	
Memory	'	8 GB PC1600	DDR2	Firmware ver	ABCDEF	Pre Condtion 1	None	то	IO - TC/QD	TC 2/QD 16	
Operating Sy	stem	CentOS 6	j.3 Capacity		100 GB	TOIO - TC/QD	-	Steady State		N/A	
Test SW	1	CTS 6.5 1.	13.8	Interface	SATA 6Gb/s	SS Rounds	-	Tin	ne	6 Hr	
Test SW I	nfo	1.10.7/1.9	9.16	NAND Type	SLC	Pre Condtion 2	None	Test S	timulus 2	N/A	
Test ID N	o.	R5-452	Е.,	PCIe NVM	N/A	TOIO - TC/QD		то	IO - TC/QD	N/A	
HBA		LSI 9212-4	le4i	Purge Method	Format Unit	SS Rounds	-	Ste	ady State	N/A	
PCIe		Gen 2 x	8	Write Cache	WCD	Note		Tin	ne	N/A	
				WSAT	TOPS (LOG	VS TGBW (I	inear)				



Plot A.26 - WSAT IOPS (Log) vs. TGBW (Linear)

A.5 Sample Host Idle Recovery Test Report Pages

The sample Host Idle Recovery Test Report pages are shown in Plot A.27 through Plot A.29.

Tes	Test Run Date: 08/17/					/2012 04:02 PM Report Run Date:				03/06/2013 03:01PM		
		н	ost	Idle R	ec	overy (RE	QUIRED)	- Report	Pag	je		
SNIA		Solid Stat	e Sto	age		DND 41/ID Fo We / Veriable Weit Chates					PTS-E 1.1	
SSS TWG	SS TWG Performance Test Spec (PTS) KNO 4KID SS WS / Variable Walt States Page 1										1 of 3	
Vendor:	A	BC Co. SSI) Model:	ABC Co. Super Drive 256		TEST SPONSOR		CAL	YPSO Systems		
Те	Test Platform Devi					Inder Test	Set Up Pa	rameters		Test Para	ameters	
Ref Test Plat	Ref Test Platform		Calypso RTP 2.0			ABC Co.	Data Pattern	RND	Data P	attern	RND	
Motherboa	Ird	Intel S2600	COE	Model No.		Super Drive 256	AR	100%	AR		100%	
CPU		Intel E5 26	90	S/N		123456	Pre Condtion 1	RND/4KiB Writ		Stimulus	RND/4KiB	
Memory		16G PC1600	DDR2	Firmware ver		ABCDEF	TOIO - TC/QD	TC 2 / QD 16	TO	O - TC/QD	TC 2 / QD 16	
Operating Sy	stem	CentOS 6	.3	Capacity	1	256 GB	SS Rounds	1-5	Dur	ation (S)	5	
Test SW		CTS 6.5 1.1	3.8	Interface		SATA 6Gb/s	Pre Condtion 2	None	Idle State		Host Idle	
Test SW I	ıfo	1.9.97-el6/R	1.13.7	NAND Type		eMLC	TOIO - TC/QD	7	TO	O - TC/QD	-	
Test ID N	o.	R32-204	0	PCIe NVI	м	N/A	SS Rounds	*	Dur	ation (S)	5,10,15,25,50	
НВА		LSI 9212-4	e4i	Purge Met	hod	Security Erase			Wa	t States	1,2,3,5,10	
PCIe		Gen 3 x 1	6	Write Cac	he	WCD						
					Pr	e Conditio	ning IOPS P	lot				



Plot A.27 – Pre Conditioning IOPS Plot

Tes	Test Run Date: 08/17					2012 04:02 PM Report Run Date: 0					03/06/2013 03:01PM		
		н	ost	Idle R	ecc	overy (RE	QUIRED)	- Report	Pag	je			
SNIA		Solid Stat	te Stor	age	DA	D AVIB Se	Rev.	PTS-E 1.1					
SSS TWG	SS TWG Performance Test Spec (PTS) Page 2 of 3										2 of 3		
Vendor:	A	BC Co.	Co. SSD Model:		ABC Co. Super Drive 256			TEST		CAL	YPSO Systems		
Те	st Pl	atform		Devi	ce Ur	nder Test	Set Up Pa	rameters		Test Par	ameters		
Ref Test Plat	Ref Test Platform		Calypso RTP 2.0			ABC Co.	Data Pattern	RND	Data P	attern	RND		
Motherboa	ard	Intel S2600	COE	COE Model No		Super Drive 256	AR	100%	AR		100%		
CPU		Intel E5 26	90 S/N			123456	Pre Condtion 1	RND/4KiB	Write	Stimulus	RND/4KiB		
Memory	<i>,</i>	16G PC1600	DDR2	2 Firmware v		ABCDEF	TOIO - TC/QD	TC 2 / QD 16	TOIO - TC/QD		TC 2 / QD 16		
Operating Sy	stem	CentOS 6	i.3	Capacity		256 GB	SS Rounds	1-5	Duration (S)		5		
Test SW	1	CTS 6.5 1.1	13.8	Interface	e	SATA 6Gb/s	Pre Condtion 2	None	Idle St	ate	Host Idle		
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND TYP	pe	eMLC	TOIO - TC/QD	-	тот	O - TC/QD	-		
Test ID N	io.	R32-204	0	PCIe NV	4	N/A	SS Rounds		Dur	ation (S)	5,10,15,25,50		
НВА		LSI 9212-4	ie4i	Purge Meth	hod	Security Erase			Wa	t States	1,2,3,5,10		
PCIe		Gen 3 x 1	6	Write Cac	he	WCD				1			
	_		Pre	Condit	ion	ing Steady	State Meas	urement	Plot				



Plot A.28 – Pre Conditioning Steady State Measurement Plot

Test Run Date: 08/			08/17/	/201	2 04:02 PM	Report R	Report Run Date: 0			03/06/2013 03:01PM		
		н	ost	Idle R	ec	overy (RE	QUIRED)	- Report	Pag	je		
SNIA		Solid Stat	te Stor	age	DI	ND AVIR Se	Rev.	PTS-E 1.1				
SSS TWG	TWG Performance Test Spec (PTS) RND 4KIB 55 W							vs / variable wait states				
Vendor:	A	BC Co. SSD Mod		Model:		ABC Co. Su	TEST SPONSOR		CAL	YPSO Systems		
Test Platform Devic			ce Under Test Set Up Parar			rameters	meters		Test Parameters			
Ref Test Plat	tform	Calypso RTP 2.0		Mfgr		ABC Co.	Data Pattern	RND	Data Pattern		RND	
Hotherbox	ard	Intel S2600 COE		Model No.		Super Drive 256	AR	100%	AR		100%	
CPU		Intel E5 2690		S/N		123456	Pre Condtion 1	RND/4KiB	Write Stimulus		RND/4KiB	
Memory		16G PC1600 DDR2		Firmware ver		ABCDEF	TOIO - TC/QD	TC 2 / QD 16	TOIO - TC/QD		TC 2 / QD 16	
Operating Sy	stem	CentOS 6.3		Capacity		256 G8	SS Rounds	1-5	Duration (5)		5	
Test SW	!	CTS 6.5 1.13.8		Interface		SATA 6Gb/s	Pre Condtion 2	None	Idle State		Host Idle	
Test SW I	nfo	1.9.97-el6/R1.13.7		7 NAND Type		eMLC	TOIO - TC/QD	÷.	TO	O - TC/QD	-	
Test ID No.		R32-2040		PCIe NVM		N/A	SS Rounds	7	Duration (S)		5,10,15,25,50	
НВА		LSI 9212-4e4i		Purge Method		Security Erase			Wa	it States	1,2,3,5,10	
PCIe		Gen 3 x 1	16	Write Cac	he	WCD						
						C v Time	All Mait Cha	atoc				

Host Idle Recovery Test, MLC/SATA



Plot A.29 - IOPS vs. Time - All Wait States

A.6 Sample Cross Stimulus Recovery Test Report Pages

The sample Cross Stimulus Test Reports pages are shown in Plot A.30 through Plot A.34.

Test Run Date: 10/18				10/18/2	012 4:02:00 PM	Report Ru	Report Run Date:			3 05:01PM
Cro	ss	Stimu	lus	Recove	ery- SEQ-RM	ID-SEQ (RE	QUIRE	D) -	Report	t Page
SNIA		Solid State Storage			XSP - SEO 102	Rev.	PTS-E 1.1			
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	N3K - 3EQ 102		- 3EQ 102-	IKIB	Page	1 of 5
Vendor:	andor: ABC Co. SSD				XYZ Co. M	y Drive 100	ST CA		LYPSO Systems	
Test Platform Devic			e Under Test	ameters	neters Test		Parameters			
Ref Test Plat	form	Calypso RTP 2.0		Mfgr	ABC Co.	Data Pattern	RND	Data Pattern		RND
Motherboard		Intel S2600 COE		Model No	Super Drive 256	AR	100%	AR		100%
CPU		Intel E5 2690		S/N	123456	Pre Condtion 1	None	Test Stimulus 1		SEQ/1024KiB
Memory	,	16G PC1600 DDR2		Firmware v	er ABCDEF	TOIO - TC/QD	2	TOIO - TC/QD		TC1 / QD32
Operating Sy	stem	CentOS 6.3		Capacity	256 GB	SS Rounds		Du	ration (Hr)	8
Test SW	'	CTS 6.5 1.13.8		Interface	SATA 6Gb/s	Pre Condtion 2	None	Test S	timulus 2	RND/8KiB
Test SW Info		1.9.97-el6/R1.13.7		NAND Typ	e eMLC	TOIO - TC/QD	-	TOIO - TC/QD		TC2 / QD16
Test ID No.		R29-807		PCIe NVM	N/A	SS Rounds	-	Duration (Hr)		6
НВА		LSI 9212-4e4i		Purge Meth	od Security Erase					
PCIe		Gen 3 x 1	16	Write Cach	wcD					
	_		_	Т	P v Time - Al	Access Gro	uns			

Cross Stimulus Recovery Test, MLC/SATA LMAX vs Time



Plot A.30 – TP vs. Time - All Access Groups

Test Run Date:			10/18/20	012 4:02:0	00 PM	Report R	Report Run Date: 0			03/06/2013 05:01PM		
Cro	ss	Stimu	lus	Recove	ery- SE	Q-RN	D-SEQ (R	EQUIRE	D) -	Repor	t Page	
SNIA		Solid Stat	te Stor	rage	YCP - CF	0 102	Rev.	PTS-E 1.1				
SSS TWG	Perf	formance T	est Sp	ec (PTS)					TRIB	Page	2 of 5	
Vendor:	A	BC Co.	SSD	Model:	XYZ	Co. M	ly Drive 100	Drive 100 TES SPON		CAL	LYPSO Systems	
Te	Test Platform Devic			Devic	ce Under Test Set Up Paran			rameters	neters Te		Test Parameters	
Ref Test Plat	tform	Calypso RTP 2.0		Mfgr	ABC	Co.	Data Pattern	RND	Data P	attern	RND	
Motherboa	ard	Intel S2600 COE		Model No.	Super D	rive 256	AR	100%	AR		100%	
CPU		Intel E5 2690		S/N	123	456	Pre Condtion 1	None	Test Stimulus 1		SEQ/1024KiB	
Memory	1	16G PC1600 DDR2		Firmware v	er ABC	DEF	TOIO - TC/QD	•	TO	O - TC/QD	TC1 / QD32	
Operating Sy	stem	CentOS 6.3		Capacity	256	GB	SS Rounds	-	Dur	ation (Hr)	8	
Test SW	/	CTS 6.5 1.13.8		Interface	SATA	6Gb/s	Pre Condtion 2	None	Test S	timulus 2	RND/8KiB	
Test SW I	nfo	1.9.97-el6/R1.13.7		NAND Type	e eN	ALC .	TOIO - TC/QD		TOIO - TC/QD		TC2 / QD16	
Test ID No.		R29-807		PCIe NVM	N	/A	SS Rounds	-	Dur	ation (Hr)	6	
НВА		LSI 9212-4e4i		Purge Meth	od Securit	y Erase						
PCIe		Gen 3 x 16		Write Cach	e W	CD]		
					TP v Tim	e - A	II Groups 1	& 2				

Cross Stimulus Recovery Test, MLC/SATA



Plot A.31- TP vs. Time - All Groups 1 & 2

SNIA		Solid Stat	te Stor	rage	XSR - SEO 102	Rev.	PTS-E 1.1				
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	Non Ord Int	X3K - 3EQ 1024KIB - KID OKIB - 3EQ 1024KIB					
Vendor:	A	BC Co.	SSD	Model:	XYZ Co. M	TEST SPONSOR					
Test Platform Devi			Device	Under Test	ameters		Test Par	lest Parameters			
Ref Test Plat	form	Calypso RTP 2.0		Mfgr	ABC Co.	Data Pattern	RND	Data	Pattern	RND	
Motherboa	Motherboard		COE	Model No.	Super Drive 256	AR	100%	AR		100%	
CPU		Intel E5 2690		S/N	123456	Pre Condtion 1	None	Test S	itimulus 1	SEQ/1024KiB	
Memory		16G PC1600 DDR2		Firmware ver	ABCDEF	TOIO - TC/QD	•	то	IO - TC/QD	TC1 / QD32	
Operating System		CentOS 6.3		Capacity	256 GB	SS Rounds		Du	ration (Hr)	8	
Test SW		CTS 6.5 1.13.8		Interface	SATA 6Gb/s	Pre Condtion 2	None Tes		timulus 2	RND/8KiB	
Test SW In	nfo	1.9.97-el6/R1.13.7		NAND Type	eMLC	TOIO - TC/QD			IO - TC/QD	TC2 / QD16	
Test ID No.		R29-807		PCIe NVM	N/A	SS Rounds			ration (Hr)	6	
НВА		LSI 9212-4	le4i	Purge Method	d Security Erase						
PCIe		Gen 3 x 1	16	Write Cache	WCD					17	

Cross Stimulus Recovery Test, MLC/SATA



Plot A.32 - TP vs. Time - Groups 2 & 3

Test Run Date:			10/18/20	012 4:02:00 PM	Report R	Report Run Date:			03/06/2013 05:01PM		
Cro	ss	Stimu	lus	Recove	ery- SEQ-RI	ND-SEQ (RI	EQUIRE	D) -	Repor	t Page	
SNIA		Solid Stat	te Sto	rage	XSR - SEO 102	IKIB	Rev.	PTS-E 1.1			
SSS TWG	Perf	Performance Test Spec (PTS)								4 of 5	
Vendor:	A	BC Co.	SSC) Model:	XYZ Co. N	ly Drive 100	TEST		CAL	YPSO Systems	
Те	Test Platform De		Devic	e Under Test	Set Up Pa	rameters	Test Pa		rameters		
Ref Test Plat	tform	Calypso RTP 2.0		Mfgr	ABC Co.	Data Pattern	RND	Data Pattern		RND	
Motherboa	ard	Intel S2600 COE		Model No.	Super Drive 256	AR	100%	AR		100%	
CPU		Intel E5 2690		S/N	123456	Pre Condtion 1	None	Test Stimulus 1		SEQ/1024KiB	
Memory	1	16G PC1600 DDR2		Firmware v	er ABCDEF	TOIO - TC/QD		TOI	D - TC/QD	TC1 / QD32	
Operating Sy	stem	CentOS 6.3		Capacity	256 GB	SS Rounds		Dura	ation (Hr)	8	
Test SW	/	CTS 6.5 1.13.8		Interface	SATA 6Gb/s	Pre Condtion 2	None	Test St	imulus 2	RND/8KiB	
Test SW I	nfo	1.9.97-el6/R1.13.7		NAND Type	e eMLC	TOIO - TC/QD	÷	TOIO - TC/QD		TC2 / QD16	
Test ID No.		R29-807		PCIe NVM	N/A	SS Rounds	-	Dura	ation (Hr)	6	
НВА		LSI 9212-4e4i		Purge Meth	od Security Erase						
PCIe		Gen 3 x 1	16	Write Cach	e WCD						
			M	aximum	Latency vs.	Time, All Ac	cess Gro	ups			

Cross Stimulus Recovery Test, MLC/SATA LAVG vs Time



Plot A.33 – Maximum Latency vs. Time, All Access Groups
Tes	st Ru	in Date:		10/18/20	12 4:02:00 PM	Report Ru	in Date:	0	3/06/201	3 05:01PM	
Cro	ss	Stimu	us	Recove	ry- SEQ-RN	ID-SEQ (RI	EQUIRE	D) -	Repor	t Page	
SNIA		Solid Stat	te Stor	age	XSP - SEO 102	WIR - PND SKIR	- SEO 102/	4KiR	Rev.	PTS-E 1.1	
SSS TWG	Pert	formance T	est Sp	ec (PTS)	YOU DEGINE	TRID RITE ORID	254 102	TRID	Page	5 of 5	
Vendor:	Vendor: ABC Co. S		SSD	Model:	XYZ Co. M	ly Drive 100	TE	ST	CAL	LYPSO	
Те	Test Platform		Devic	e Under Test	Set Up Par	ameters		Test Par	ameters		
Ref Test Platform		Calypso RT	P 2.0	Mfgr	ABC Co.	Data Pattern	RND	Data Pattern		RND	
Motherbo	ard	Intel S2600 COE		Model No.	Super Drive 256	AR	100%	AR		100%	
CPU		Intel E5 2690		S/N	123456	Pre Condtion 1	None	Test S	timulus 1	SEQ/1024KiB	
Memory	v	16G PC1600	DDR2	Firmware ve	ABCDEF	TOIO - TC/QD	-	то	IO - TC/QD	TC1 / QD32	
Operating Sy	stem	CentOS 6	i.3	Capacity	256 GB	SS Rounds	2	Du	ration (Hr)	8	
Test SV	v	CTS 6.5 1.1	13.8	Interface	SATA 6Gb/s	Pre Condtion 2	None	Test S	timulus 2	RND/8KiB	
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	eMLC	TOIO - TC/QD		то	IO - TC/QD	TC2 / QD16	
Test ID N	lo.	R29-80	7	PCIe NVM	N/A	SS Rounds		Dui	ration (Hr)	6	
НВА		LSI 9212-4	e4i	Purge Metho	d Security Erase						
PCIe		Gen 3 x 1	16	Write Cache	e WCD						
-			Δ	verage	latency vs. T	ime, All Acc	ess Grou	ins			



Plot A.34 – Average Latency vs. Time, All Access Groups

A.7 Sample Enterprise Composite Workload Test Report Pages

The sample Enterprise Composite Workload Test Report pages are shown in Plot A.35 through Plot A.49.

Report R	un Date:	03/7/2013	9:26:00 AM	
Test (REC	QUIRED)	- Report	Page	
		Rev.	PTS-E 1.1	
ize / Probabi	mity worki	Page	1 of 15	
our Drive 100	TEST		YPSO Systems	
Set Up Pa	arameters	Test Par	Test Parameters	
Data Pattern	RND	Data Pattern	RND	
AR	100%	AR	100%	
Pre Condtion 1	ECW	Test Stimulus 1	ECW	
R/W %	0/100 %	R/W %		
TOIO - TC/QD	TC 32/QD 32	TC / QD	TC/QD from 1-32	
SS Rounds	2-6	TC & QD Loops	High to Low TOIO	
Inter-Round Pre W	ECW	Min IOPS Point	TC 1/QD 1	
R/W %	0/100	Mid IOPS Point	User Select	
TOIO - TC/QD	TC 32/QD 32	Max IOPS Point	User Select	
Duration	30 M or 10% Cap.			
-	TOIO - TC/QD Duration	TOID - TC/QD TC 32/QD 32 Duration 30 M or 10% Cap.	TOID - TC/QD TC 32/QD 32 Max 10PS Point Duration 30 M or 10% Cap. Access Probabilities - 40:60 RW	

Block Size in Bytes (KiB)	Access Probability Within Each Measurement Period
512 bytes (0.5 KiB)	4%
1024 bytes (1 KiB)	1%
1536 bytes (1.5 KiB)	1%
2048 bytes (2 KiB)	1%
2560 bytes (2.5 KiB)	1%
3072 bytes (3 KiB)	1%
3584 bytes (3.5 KiB)	1%
4096 bytes (4 KiB)	67%
8192 bytes (8 KiB)	10%
16,384 bytes (16 KB)	7%
32,768 bytes (32 KB)	3%
65,536 bytes (64 KB)	3%
Total	100%

% of Access within 1 Measurement Period	Active Range Restriction	Label
50%	First 5%	LBA Group A
30%	Next 15%	LBA Group B
20%	Remaining 80%	LBA Group C



Tes	t Ru	n Date:		10/14	/201	2 12:51 AM	Report R	un Date:	03	/7/2013	9:26:00 AM	
E	nte	rprise	Co	mposi	te	Workload	Test (RE	QUIRED)	- R	eport	Page	
SNIA		Solid Stat	e Sto	rage	50	W Block Si	zo / Probabl	ility Workly	her	Rev.	PTS-E 1.1	
SSS TWG	Perf	formance T	est Sp	pec (PTS)	ECW BIOCK SIZE / Probability Workload						2 of 15	
Vendor:	A	BC Co.	SSI	D Model:		ABC Co. Yo	ur Drive 100	SPONS	OR	CAL	LYPSO	
Test Platform Dev				Devi	ce U	Inder Test	Set Up Pa	arameters	Test Pa		ameters	
Ref Test Plat	Ref Test Platform		SNIA RTP 1.0			ABC Co.	Data Pattern	RND	Data Pattern		RND	
Motherboa	ard	Intel S2600	COE	Model No	.	Your Drive 100	AR	100%	AR		100%	
CPU		Intel E5 26	90	S/N		123456	Pre Condtion 1	ECW	Test S	timulus 1	ECW	
Memory	1	16G PC1600	DDR2	Firmware	ver	ABCDEF	R/W %	0/100 %	R/\	N %	-	
Operating Sy	stem	CentOS 6	.3	Capacit	y	100 GB	TOIO - TC/QD	TC 32/QD 32	тс	/ QD	TC/QD from 1-32	
Test SW	'	CTS 6.5 1.1	3.8	Interfac	e	SAS 6Gb/s	SS Rounds	2 - 6	тс	& QD Loops	High to Low TOIO	
Test SW I	nfo	1.9.97-el6/R1	.13.7	NAND Ty	pe	SLC	Inter-Round Pre W	ECW	Min IC	PS Point	TC 1/QD 1	
Test ID N	Test ID No.			PCIe NV	м	N/A	R/W %	0/100	Mid IO	PS Point	User Select	
НВА		LSI 9212-4	e4i	Purge Met	hod	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max I	OPS Point	User Select	
PCIe		Gen 3 x 1	6	Write Cac	he	WCD	Duration	30 M or 10% Cap.				
					Pr	e Conditio	ning TOPS P	lot				



P1 WIPC TC32-QD32, IOPS vs Round

Plot A.36 – Pre Conditioning IOPS vs. Round Plot

Tes	st Ru	n Date:		10/14	/20	012 12:51 AM	Report R	un Date:	0	3/7/2013	9:26:00 AM
E	nte	rprise	Co	mposi	te	Workload	Test (RE	QUIRE	D) - R	eport	Page
SNIA		Solid Stat	e Stor	age		CW Block Si	ro / Brobabl	ility West	klaad	Rev.	PTS-E 1.1
SSS TWG	Perf	formance T	est Sp	ec (PTS)	Ŀ	CW BIOCK SI	ze / Probabi	inty wor	Rioau	Page	3 of 15
Vendor:	A	BC Co.	sst) Model:		ABC Co. Yo	ur Drive 100	SP	TEST ONSOR	CAI	-YPSO Systems
Те	Test Platform De				ce	Under Test	Set Up Pa		Test Pa	ameters	
Ref Test Platform SNIA RTP 1.0		1.0	Mfgr		ABC Co.	Data Pattern	RND	Data	Pattern	RND	
Motherboa	ard	Intel S2600	COE	DE Model No.		Your Drive 100	AR	100%	AR		100%
CPU		Intel E5 26	90	S/N		123456	Pre Condtion 1	ECW	Test	Stimulus 1	ECW
Memory	r i	16G PC1600	DDR2	Firmware	ver	ABCDEF	R/W %	0/100 %	R	/W %	•
Operating Sy	stem	CentOS 6	.3	Capacit	y	100 GB	TOIO - TC/QD	TC 32/QD 3	32 то	C / QD	TC/QD from 1-32
Test SW	'	CTS 6.5 1.1	3.8	Interfac	e	SAS 6Gb/s	SS Rounds	2 - 6	т	C & QD Loops	High to Low TOIO
Test SW I	nfo	1.9.97-el6/R	.13.7	NAND Ty	pe	SLC	Inter-Round Pre W	ECW	Min J	OPS Point	TC 1/QD 1
Test ID N	о.	R30-942		PCIe NV	м	N/A	R/W %	0/100	Mid 1	OPS Point	User Select
НВА		LSI 9212-4	e4i	Purge Met	hod	Format Unit	TOIO - TC/QD	TC 32/QD 3	32 Max	IOPS Point	User Select
PCIe		Gen 3 x 1	6	Write Cac	he	WCD	Duration	30 M or 10%	Cap.		
				Pre	• C	onditioning	Steady Sta	te Plot			



P2 WIPC Steady State Check TC32-QD32

Plot A.37 – Pre Conditioning Steady State Plot

Tes	st Ru	n Date:		10/13	/201	2 08:27 PM	Report R	tun Da	te:	03,	/7/2013	9:26:00 AM
E	nte	rprise	Co	mposi	te	Workload	Test (RE	QUIF	RED)	- Re	eport l	Page
SNIA		Solid Stat	e Sto	rage	EC	W Block Si	ze / Probabl	ility 1	Norki	her	Rev.	PTS-E 1.1
SSS TWG	Per	formance T	est Sp	pec (PTS)	Lett block blze / Probability Workide					Jau	Page	4 of 15
Vendor:	A	BC Co.	ssi	D Model:		ABC Co. Yo	ur Drive 100		TEST SPONS	OR	CAL	YPSO Systems
Те	st Pl	atform		Devi	ce U	nder Test	Set Up Pa	aramet	ers	Γ.	Test Par	ameters
Ref Test Platform SNIA RTP 1.0		1.0	Mfgr		ABC Co.	Data Pattern	R	ND	Data Pattern		RND	
Motherboa	ard	Intel S2600	COE	Model N	D .	Your Drive 100 AR		1	00%	AR		100%
CPU		Intel E5 26	90	S/N		123456 Pre Condtion 1		E	cw	Test St	imulus 1	ECW
Memory	,	16G PC1600	DDR2	Firmware	ver	ABCDEF	R/W %	0/100 %		R/V	V %	-
Operating Sy	stem	CentOS 6	.3	Capacit	Y	100 GB	TOIO - TC/QD	TC 32	/QD 32	TC ,	QD	TC/QD from 1-32
Test SW	/	CTS 6.5 1.1	3.8	Interfac	e	SAS 6Gb/s	SS Rounds	3	2 - 6	TC 8	k QD Loops	High to Low TOIO
Test SW I	nfo	1.9.97-el6/R1	.13.7	NAND Ty	pe	SLC	Inter-Round Pre W	E	cw	Min IO	PS Point	TC 1/QD 1
Test ID N	ю.	R30-940)	PCIe NV	м	N/A	R/W %	0,	100	Mid IO	PS Point	User Select
НВА		LSI 9212-4	e4i	Purge Met	hod	Format Unit	TOIO - TC/QD	TC 32	/QD 32	Max IO	PS Point	User Select
PCIe		Gen 3 x 1	6	Write Cac	he:	WCD	Duration	30 M or	10% Cap.			
					Be	tween Rou	ind Pre Wri	tes				

P3 Between Round Pre-Writes



Between Round Pre-Writes, BS=4.0000K



Tes	t Ru	n Date:		10/13/	/20	12 08:27 PM	Report R	un Date:	03	/7/2013	9:26:00 AM
E	nte	rprise	Co	mposi	te	Workload	Test (RE	QUIRED	- R	eport	Page
SNIA		Solid Stat	e Stor	rage	F	CW Block Si	ze / Probabl	ility Work	head	Rev.	PTS-E 1.1
SSS TWG	Pert	formance T	est Sp	ec (PTS)	Lett block blze / Frobability Workibda					Page	5 of 15
Vendor:	A	BC Co.	sst) Model:		ABC Co. Yo	ur Drive 100	TES	SOR	CAL	YPSO Systems
Test Platform				Devi	ce l	Under Test	Set Up Pa		Test Paramete		
Ref Test Plat	Ref Test Platform		TP 1.0 Mfgr			ABC Co.	Data Pattern	RND	Data P	Pattern	RND
Motherboa	ard	Intel S2600 COE		Model No.		o. Your Drive 100 AR		100%	AR		100%
CPU		Intel E5 2690		S/N		123456	Pre Condtion 1	ECW	Test S	timulus 1	ECW
Memory	'	16G PC1600	DDR2	Firmware	ver	ABCDEF	R/W %	0/100 %	R/1	W %	-
Operating Sy	stem	CentOS 6	.3	Capacity	Y	100 GB	TOIO - TC/QD	TC 32/QD 32	тс	/ QD	TC/QD from 1-32
Test SW	'	CTS 6.5 1.1	3.8	Interfac	e	SAS 6Gb/s	SS Rounds	2 - 6	тс	& QD Loops	High to Low TOIO
Test SW I	nfo	1.9.97-el6/R1	.13.7	NAND Typ	pe	SLC	Inter-Round Pre W	ECW	Min IC	PS Point	TC 1/QD 1
Test ID N	о.	R30-940		PCIe NV	м	N/A	R/W %	0/100	Mid IC	PS Point	User Select
НВА		LSI 9212-4	e4i	Purge Met	hod	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max I	OPS Point	User Select
PCIe		Gen 3 x 1	6	Write Cac	he	WCD	Duration	30 M or 10% Cap			
					D	V TOPS Plat	TC-Track	ina			

DV IOPS Plot, TC=Tracking

P4 TC=32 IOPS vs Round, All QD



Plot A.39 – DV IOPS Plot, TC=Tracking

Tes	st Ru	in Date:		10/13/	/20	12 08:27 PM	Report R	un Date:	03	/7/2013	9:26:00 AM
E	nte	rprise	Co	mposi	te	Workload	Test (RE	QUIRED)	- R	eport	Page
SNIA		Solid Stat	e Sto	rage		CW Block Si	zo / Brobabl	lility Workl	oad	Rev.	PTS-E 1.1
SSS TWG	Per	formance T	est Sp	ec (PTS)		CVV BIOCK SI	ze / Probabl		oau	Page	6 of 15
Vendor:	A	BC Co.	ssi) Model:		ABC Co. Yo	ur Drive 100	TES	T	CAL	YPSO Systems
Test Platform				Devi	ce l	Under Test	Set Up Pa	arameters		Test Par	ameters
Ref Test Plat	Ref Test Platform		TP 1.0 Mfgr			ABC Co.	Data Pattern	RND	Data Pattern		RND
Motherbo	ard	Intel S2600	COE	E Model No.		Your Drive 100	AR	100%	AR		100%
CPU		Intel E5 26	90 S/N			123456	Pre Condtion 1	ECW	Test St	timulus 1	ECW
Memory	,	16G PC1600	DDR2	Firmware	ver	ABCDEF	R/W %	0/100 %	R/V	V %	
Operating Sy	stem	CentOS 6	.3	Capacity	y	100 GB	TOIO - TC/QD	TC 32/QD 32	TC	/ QD	TC/QD from 1-32
Test SW	,	CTS 6.5 1.1	3.8	Interfac	e	SAS 6Gb/s	SS Rounds	2 - 6	TC	& QD Loops	High to Low TOIO
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Ty	pe	SLC	Inter-Round Pre W	ECW	Min IO	PS Point	TC 1/QD 1
Test ID N	ю.	R30-940)	PCIe NV	м	N/A	R/W %	0/100	Mid IO	PS Point	User Select
НВА		LSI 9212-4	e4i	Purge Met	hod	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IC	PS Point	User Select
PCIe		Gen 3 x 1	.6	Write Cac	he	WCD	Duration	30 M or 10% Cap.			
-	_			DV St	02	dy State Pl	at Tracking	Variable	-		

P5 Demand Variation Steady State Check TC32-QD32



Plot A.40 – DV Steady State Plot, Tracking Variable

Tes	t Ru	n Date:		10/13/	/20	012 08:27 PM	Report R	un Date:	03	/7/2013	9:26:00 AM
E	nte	rprise	Co	mposi	te	Workload	Test (RE	QUIRED)	- R	eport F	Page
SNIA		Solid Stat	e Stor	age	F	CW Block Si	ze / Probabl	ility Workle	ad	Rev.	PTS-E 1.1
SSS TWG	Perf	ormance T	est Sp	ec (PTS)						Page	7 of 15
Vendor:	SSE	SSD Model:		ABC Co. Yo	ur Drive 100	TEST	OR	CAL	YPSO Systems		
Те	st Pl	atform		Devi	ce	Under Test	Set Up Pa	rameters	Test Pa		ameters
Ref Test Plat	form	SNIA RTP :	1.0	Mfgr		ABC Co.	Data Pattern	RND	Data P	attern	RND
Motherboa	rd	Intel S2600	COE	Model No	о.	Your Drive 100	AR	100%	AR		100%
CPU		Intel E5 26	90	S/N		123456	Pre Condtion 1	ECW	Test S	timulus 1	ECW
Memory		16G PC1600	DDR2	Firmware	ver	ABCDEF	R/W %	0/100 %	R/1	N %	
Operating Sys	stem	CentOS 6	.3	Capacit	y	100 GB	TOIO - TC/QD	TC 32/QD 32	TC / QD		TC/QD from 1-32
Test SW		CTS 6.5 1.1	3.8	Interfac	e	SAS 6Gb/s	SS Rounds	2 - 6	тс	& QD Loops	High to Low TOIO
Test SW In	fo	1.9.97-el6/R	.13.7	NAND TY	pe	SLC	Inter-Round Pre W	ECW	Min IC	PS Point	TC 1/QD 1
Test ID No	b .	R30-940	1	PCIe NV	м	N/A	R/W %	0/100	Mid IOPS Point		User Select
НВА	HBA LSI 9212-4e4		e4i	4i Purge Meth		Format Unit	TOIO - TC/QD	TC 32/QD 32	Max I	OPS Point	User Select
PCIe		Gen 3 x 1	6	Write Cac	he	WCD	Duration	30 M or 10% Cap.			
						Demand Va	riation Plo	t			



Plot A.41 – Demand Variation Plot

Tes	st Ru	n Date:		10/13/	/201	2 08:27 PM	Report R	un Date:	03	/7/2013	9:26:00 AM
E	nte	rprise	Co	mposi	te	Workload	Test (RE	QUIRED)	- R	eport I	Page
SNIA		Solid Stat	te Sto	rage	-	W. Black C	no / Drohahl	ility Monthl		Rev.	PTS-E 1.1
SSS TWG	Pert	ormance T	est Sp	ec (PTS)	E	W BIOCK SI	ze / Probabi	inty worki	Dau	Page	8 of 15
Vendor:	A	BC Co.	ssi	O Model:		ABC Co. Yo	our Drive 100	TES	r ior	CAL	YPSO Systems
Te	st Pl	atform		Devi	ce U	Inder Test	Set Up Pa	rameters		Test Par	ameters
Ref Test Plat	Ref Test Platform SNIA RT		1.0	Mfgr		ABC Co.	Data Pattern	RND	Data Pattern		RND
Motherboa	ard	Intel S2600	COE	OE Model No.		Your Drive 100	AR	100%	AR		100%
CPU		Intel E5 26	590	S/N	123456		Pre Condtion 1	ECW	Test S	timulus 1	ECW
Memory	1	16G PC1600	DDR2	Firmware	ver ABCDEF		R/W %	0/100 %	R/\	N %	
Operating Sy	stem	CentOS 6	i.3	Capacity	y	100 GB	TOIO - TC/QD	TC 32/QD 32	TC	/ QD	TC/QD from 1-32
Test SW	1	CTS 6.5 1.1	13.8	Interfac	e	SAS 6Gb/s	SS Rounds	2 - 6	TC	& QD Loops	High to Low TOIO
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Ty	pe	SLC	Inter-Round Pre W	ECW	Min IO	PS Point	TC 1/QD 1
Test ID N	ю.	R30-940	D	PCIe NV	м	N/A	R/W %	0/100	Mid IO	PS Point	User Select
НВА		LSI 9212-4	le4i	Purge Met	hod	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IC	OPS Point	User Select
PCIe		Gen 3 x 1	16	Write Cac	he	WCD	Duration	30 M or 10% Cap.		Ĵ	
						Domand Tr	toncity Plo	•			





Plot A.42 – Demand Intensity Plot

Tes	t Ru	n Date:		10/13/	/20)12 08:27 PM	Report R	un Date:	0	3/7/2013	9:26:00 AM	
E	nte	rprise	Co	mposit	te	Workload	Test (RE	QUIRED) - R	eport	Page	
SNIA		Solid Stat	e Stor	rage		CWL BLack CI	no / Duchahl	III A. Maran	dend	Rev.	PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	ECW BIOCK Size / Probability Workload					Page	9 of 15	
Vendor:	A	BC Co.	sso	Model:		ABC Co. Yo	ur Drive 100	TEST		CAI	LYPSO Systems	
Те	st Pl	atform		Devi	ce	Under Test	Set Up Pa	Set Up Parameters		Test Par	ameters	
Ref Test Plat	form	SNIA RTP 1.0		Mfgr		ABC Co.	Data Pattern	RND	Data	Pattern	RND	
Motherboa	ard	Intel S2600	COE	OE Model No.		Your Drive 100	AR	100%	AR		100%	
CPU		Intel E5 26	90	S/N		123456	Pre Condtion 1	ECW	Test	Stimulus 1	ECW	
Memory		16G PC1600	DDR2	Firmware	ver	ABCDEF	R/W %	0/100 %	R/	′W %	-	
Operating Sy	stem	CentOS 6	.3	Capacity	y	100 GB	TOIO - TC/QD	TC 32/QD 32	т	:/QD	TC/QD from 1-32	
Test SW		CTS 6.5 1.1	3.8	Interface	e	SAS 6Gb/s	SS Rounds	2 - 6	т	& QD Loops	High to Low TOIO	
Test SW I	nfo	1.9.97-el6/R1	.13.7	NAND Typ	pe	SLC	Inter-Round Pre W	ECW	Min I	OPS Point	TC 1/QD 1	
Test ID N	o.	R30-940		PCIe NVM	м	N/A	R/W %	0/100	Mid I	OPS Point	User Select	
НВА		LSI 9212-4	e4i	Purge Meth	hod	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max	OPS Point	User Select	
PCIe		Gen 3 x 1	6	Write Cac	:he	WCD	Duration	30 M or 10% C	ap.			
					S	vstem CPU I	Jtilization P	lot				

P8 System CPU Utlization During Demand Variation Test



Plot A.43 – System CPU Utilization Plot

Tes	Test Run Date:			10/13/2012 07:11 PM Report Run Date: 03/7/2013 10:18:00 AM								
E	nte	rprise	Co	mposi	te	Workload	Test (RE	QUIRED)	- R	eport	Page	
SNIA SSS TWG	Perf	Solid Stat ormance T	e Stor est Sp	age ec (PTS)	EC	CW Block Si	ze / Probabl	lility Workle	bad	Rev. Page	PTS-E 1.1 10 of 15	
Vendor:	A	BC Co.	SSC	Model:	ABC Co. Your Drive 100			TEST			YPSO Systems	
Te	st Pl	atform		Devi	ce U	Inder Test	Set Up Pa	arameters		Test Par	ameters	
Ref Test Plat	form	SNIA RTP	1.0	Mfgr		ABC Co.	Data Pattern	RND	Data P	attern	RND	
Motherboa	ard	Intel S2600	COE	Model No	b .	Your Drive 100	AR	100%	AR		100%	
CPU		Intel E5 26	90	S/N		123456	Pre Condtion 1	ECW	Test S	timulus 1	ECW	
Memory		16G PC1600	DDR2	Firmware	ver	ABCDEF	R/W %	0/100 %	R/W %			
Operating Sy	stem	CentOS 6	.3	Capacit	v	100 GB	TOIO - TC/QD	TC 32/QD 32	тс	/ QD	TC/QD from 1-32	
Test SW		CTS 6.5 1.1	.3.8	Interfac	e	SAS 6Gb/s	SS Rounds	2 - 6	тс	& QD Loops	High to Low TOIO	
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Ty	pe	SLC	Inter-Round Pre W	ECW	Min IO	PS Point	TC 1/QD 1	
Test ID N	o.	R30-938	3	PCIe NV	м	N/A	R/W %	0/100	Mid IO	PS Point	User Select	
НВА		LSI 9212-4	e4i	Purge Met	hod	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IC	OPS Point	User Select	
PCIe		Gen 3 x 1	.6	Write Cac	he:	WCD	Duration	30 M or 10% Cap.		Î		
	-					Max TOPS	Pre Writes	-	en -			





Tes	t Ru	n Date:		10/13/2	012	7:11:00 PM	Report R	un Date:	03	/7/2013 1	10:18:00 AM	
E	nte	rprise	Co	mposi	te	Workload	Test (RE	QUIRED)	- R	eport	Page	
SNIA		Solid Stat	e Sto	rage	EC	W Block Si	ze / Probabl	ility Workl	had	Rev.	PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	ec (PTS)		DIOCK SI	20 / 110040	inty worki	bau	Page 11 of 15		
Vendor:	A	BC Co.	SSI) Model:		ABC Co. Yo	ur Drive 100 TEST SPONSOR			CALYPSO		
Те	st Pl	atform		Devi	ce U	nder Test	Set Up Pa	rameters		Test Par	ameters	
Ref Test Plat	form	SNIA RTP	1.0	Mfgr		ABC Co.	Data Pattern	RND	Data	Pattern	RND	
Motherboa	ard	Intel S2600	COE	Model No	».	Your Drive 100	AR	100%	AR		100%	
CPU		Intel E5 26	90	S/N		123456	Pre Condtion 1	ECW	Test S	Stimulus 1	ECW	
Memory	1	16G PC1600	DDR2	Firmware	ver	ABCDEF	R/W %	0/100 %	R/	W %	2	
Operating Sy	stem	CentOS 6	.3	Capacity	1	100 GB	TOIO - TC/QD	TC 32/QD 32	тс	/ QD	TC/QD from 1-32	
Test SW	1	CTS 6.5 1.1	3.8	Interfac	в	SAS 6Gb/s	SS Rounds	2 - 6	тс	& QD Loops	High to Low TOIO	
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Typ	pe	SLC	Inter-Round Pre W	ECW	Min I	OPS Point	TC 1/QD 1	
Test ID N	о.	R30-938	1	PCIe NV	м	N/A	R/W %	0/100	Mid I	OPS Point	User Select	
НВА		LSI 9212-4	e4i	Purge Met	hod	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max I	OPS Point	User Select	
PCIe		Gen 3 x 1	6	Write Cac	he	WCD	Duration	30 M or 10% Cap.				
						Max IOPS	Histogram					





Plot A.45 – Max IOPS Histogram

Tes	t Ru	n Date:		10/13/2	2012	3:26:00 PM	Report R	un Date:	03	3/7/2013 1	11:02:00 AM	
E	nte	rprise	Co	mposi	te ۱	Workload	Test (RE	QUIRED)	- R	eport	Page	
SNIA		Solid Stat	e Stor	age	170	W. Black C	na / Duahahi	Illian Menulul	Level 1	Rev.	PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	EC	W BIOCK SI	ze / Probabi	inty worki	oau	Page 12 of 15		
Vendor:	A	BC Co.	ssa) Model:		ABC Co. Yo	ur Drive 100	CALY	LYPSO Systems			
Те	st Pl	atform		Devi	ce U	nder Test	Set Up Pa	arameters		Test Par	ameters	
Ref Test Plat	form	SNIA RTP :	1.0	Mfgr		ABC Co.	Data Pattern	RND	Data	Pattern	RND	
Motherboa	rd	Intel S2600	COE	Model No	.	Your Drive 100	AR	100%	AR		100%	
CPU		Intel E5 26	90	S/N		123456	Pre Condtion 1	ECW	Test 9	Stimulus 1	ECW	
Memory		16G PC1600	DDR2	Firmware	ver	ABCDEF	R/W %	0/100 %	R/	'W %	9	
Operating Sy	stem	CentOS 6	.3	Capacity	Y	100 GB	TOIO - TC/QD	TC 32/QD 32	тс	: / QD	TC/QD from 1-32	
Test SW		CTS 6.5 1.1	3.8	Interfac	e	SAS 6Gb/s	SS Rounds	2 - 6	тс	& QD Loops	High to Low TOIO	
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Ty	pe	SLC	Inter-Round Pre W	ECW	Min I	OPS Point	TC 1/QD 1	
Test ID N	o.	R30-932	2	PCIe NV	м	N/A	R/W %	0/100	Mid I	OPS Point	User Select	
HBA		LSI 9212-4	e4i	Purge Met	hod	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max 1	OPS Point	User Select	
PCIe		Gen 3 x 1	6	Write Cac	he	WCD	Duration	30 M or 10% Cap.		()		
						Mid TOPS	Pre Writes					



Plot A.46 – Mid IOPS Pre Writes

Tes	t Ru	n Date:		10/13/2	2012	2 3:26:00 PM	Report R	un Date:	03	/7/2013 1	11:02:00 AM
E	nte	rprise	Co	mposi	te	Workload	Test (RE	QUIRED)	- R	eport	Page
SNIA SSS TWG	Perf	Solid Stat	e Stor est Sp	age ec (PTS)	EC	CW Block Si	ze / Probabl	ility Workle	oad	Rev. Page	PTS-E 1.1 13 of 15
Vendor:	A	BC Co.	sst	Model:		ABC Co. Yo	ur Drive 100	TEST	r OR	CAL	YPSO Systems
Те	st Pl	atform		Devi	ce U	Inder Test	Set Up Pa	rameters		Test Par	ameters
Ref Test Plat	form	SNIA RTP	1.0	Mfgr		ABC Co.	Data Pattern	RND	Data	Pattern	RND
Motherboa	ard	Intel S2600	COE	Model No	b .	Your Drive 100	AR	100%	AR		100%
CPU		Intel E5 26	90	S/N		123456	Pre Condtion 1	ECW	Test s	Stimulus 1	ECW
Memory		16G PC1600	DDR2	Firmware	ver	ABCDEF	R/W %	0/100 %	R/	W %	-
Operating Sy	stem	CentOS 6	.3	Capacity	y	100 GB	TOIO - TC/QD	TC 32/QD 32	тс	/ QD	TC/QD from 1-32
Test SW		CTS 6.5 1.1	3.8	Interfac	e	SAS 6Gb/s	SS Rounds	2 - 6	тс	& QD Loops	High to Low TOIO
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Ty	pe	SLC	Inter-Round Pre W	ECW	Min I	OPS Point	TC 1/QD 1
Test ID N	o.	R30-932		PCIe NV	м	N/A	R/W %	0/100	Mid I	OPS Point	User Select
НВА		LSI 9212-4	e4i	Purge Met	hod	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max I	OPS Point	User Select
PCIe		Gen 3 x 1	6	Write Cac	he:	WCD	Duration	30 M or 10% Cap.			
						Mid IOPS	Histogram				



Plot A.47 – Mid IOPS Histogram

Tes	t Ru	n Date:		10/13/2	2012	1:25:00 PM	Report R	un Date:	03	/7/2013 1	1:35:00 AM	
E	nte	rprise	Co	mposi	te \	Workload	Test (RE	QUIRED)	- R	eport l	Page	
SNIA		Solid Stat	e Stor	age	-		na / Duckski			Rev.	PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	EC	W BIOCK SI	ze / Probabi	mity working	Dad	Page 14 of 1		
Vendor:	A	BC Co.	ssa) Model:		ABC Co. Yo	ur Drive 100	TEST	r OR	CAL	(PSO Systems	
Те	st Pl	atform		Devi	ce U	nder Test	Set Up Pa	rameters		Test Par	ameters	
Ref Test Plat	form	SNIA RTP :	1.0	Mfgr		ABC Co.	Data Pattern	RND	Data	Pattern	RND	
Motherboa	Ird	Intel S2600	COE	Model No	.	Your Drive 100	AR	100%	AR	<u> </u>	100%	
CPU		Intel E5 26	90	S/N		123456	Pre Condtion 1	ECW	Test S	itimulus 1	ECW	
Memory		16G PC1600	DDR2	Firmware	ver	ABCDEF	R/W %	0/100 %	R/	W %	-	
Operating Sy	stem	CentOS 6	.3	Capacit	/	100 GB	TOIO - TC/QD	TC 32/QD 32	TC	/ QD	TC/QD from 1-32	
Test SW	1	CTS 6.5 1.1	3.8	Interfac	e	SAS 6Gb/s	SS Rounds	2 - 6	тс	& QD Loops	High to Low TOIO	
Test SW In	nfo	1.9.97-el6/R	1.13.7	NAND Ty	pe	SLC	Inter-Round Pre W	ECW	Min I	OPS Point	TC 1/QD 1	
Test ID N	o.	R30-915	;	PCIe NV	м	N/A	R/W %	0/100	Mid I	OPS Point	User Select	
НВА		LSI 9212-4	e4i	Purge Met	hod	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max I	OPS Point	User Select	
PCIe		Gen 3 x 1	6	Write Cac	he	WCD	Duration	30 M or 10% Cap.				
	_					Min IOPS	Pre Writes					



Plot A.48 – Min IOPS Pre Writes

Tes	t Ru	n Date:		10/13/2	012	2 1:25:00 PM	Report R	un Date:	03	/7/2013 1	1:35:00 AM	
E	nte	rprise	Co	mposi	te	Workload	Test (RE	QUIRED)	- R	eport	Page	
SNIA		Solid Stat	e Sto	rage			no / Duckski		-	Rev.	PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	E	LW BIOCK SI	ze / Probab	mity worki	bad	Page	15 of 15	
Vendor:	A	BC Co.	ssi) Model:		ABC Co. Yo	ur Drive 100	TES	r OR	CALY	YPSO	
Те	st Pl	atform		Devi	ce U	Inder Test	Set Up Pa	arameters		Test Par	ameters	
Ref Test Plat	form	SNIA RTP :	1.0	Mfgr		ABC Co.	Data Pattern	RND	Data	Pattern	RND	
Motherboa	ard	Intel S2600	COE	Model No	.	Your Drive 100	AR	100%	AR		100%	
CPU		Intel E5 26	90	S/N		123456	Pre Condtion 1	ECW	Test S	Stimulus 1	ECW	
Memory	,	16G PC1600	DDR2	Firmware	ver	ABCDEF	R/W %	0/100 %	R/	W %	÷	
Operating Sy	stem	CentOS 6	.3	Capacity	Y	100 GB	TOIO - TC/QD	TC 32/QD 32	тс	/ QD	TC/QD from 1-32	
Test SW	'	CTS 6.5 1.1	3.8	Interfac	e	SAS 6Gb/s	SS Rounds	2 - 6	тс	& QD Loops	High to Low TOIO	
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Typ	pe	SLC	Inter-Round Pre W	ECW	Min I	OPS Point	TC 1/QD 1	
Test ID N	o.	R30-915		PCIe NV	м	N/A	R/W %	0/100	Mid I	OPS Point	User Select	
HBA		LSI 9212-4	e4i	Purge Met	hod	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max 1	OPS Point	User Select	
PCIe		Gen 3 x 1	6	Write Cac	he	WCD	Duration	30 M or 10% Cap.				
						Min IOPS	Histogram					



Plot A.49 – Min IOPS Histogram

A.8 Sample DIRTH Test Report Pages

The sample Demand Intensity Response Time Test Report pages are shown in Plot A.50 through Plot A.61.

Tes	t Ru	n Date:		12/26/2	2012 12:51 AM	Report I	Run Date:	03/8/201	3 7:43:00 AM
Dema	and	Inter	sity	Resp	onse Time I	Historam	(REQUIR	ED) - Re	port Page
SNIA		Solid Stat	e Stor	age	DIDTH OF			R	ev. PTS-E 1.1
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	DIRIH - OL	IP - KNU SK	IB 05:35 KV	Pa	ge 1 of 14
Vendor:	А	BC Co.	sst	Model:	ABC Co. Yo	our Drive 100	TEST	OR CA	ALYPSO Systems
Те	st Pl	atform		Devic	e Under Test	Set Up P	arameters	Test I	Parameters
Ref Test Plat	form	SNIA RTP	1.0	Mfgr	ABC Co.	Data Pattern	RND	Data Pattern	RND
Motherboa	Motherboard Intel S2600 COE		COE	Model No.	Your Drive 100	AR	100%	AR	100%
CPU		Intel E5 26	i90	S/N	123456	Pre Condtion 1	RND/8KiB	Test Stimulus 1	RND/8KiB
Memory	ţ	16G PC1600	DDR2	Firmware ve	er ABCDEF	R/W %	0/100	R/W %	65/35 %
Operating Sy	stem	CentOS 6	i.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32	TC / QD	TC/QD from 1-32
Test SW		CTS 6.5 1.1	13.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	TC & QD Loop	High to Low TOIO
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min IOPS Point	TC 1/QD 1
Test ID N	o.	R30-119	6	PCIe NVM	N/A	R/W %	0/100	Mid IOPS Point	User Select
НВА		LSI 9212-4	e4i	Purge Metho	od Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IOPS Point	User Select
PCIe Gen 3 x 16 Write C				Write Cach	e WCD	Duration	30 M or 10% Cap.		
					Pre Conditio	ning IOPS I	Plot		





Plot A.50 – DIRTH Pre Conditioning IOPS Plot

Tes	st Ru	n Date:		12/26/2	012 12:51 AM	Report I	Run Date:	03/8/2013	7:43:00 AM
Dem	and	Inter	sit	y Respo	nse Time I	Historam	(REQUIR	ED) - Rep	ort Page
SNIA		Solid Stat	te Stor	age		TD - DND PK	B 65.25 DW	Rev	PTS-E 1.1
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	DIKIH-UL	IP - KILD OK	16 05.55 KV	Pag	e 2 of 14
Vendor: ABC Co. SS				Model:	ABC Co. Yo	our Drive 100	TEST		
Te	est Pl	atform		Device	Under Test	Set Up P	arameters	Test Pa	rameters
Ref Test Plat	tform	SNIA RTP	1.0	Mfgr	ABC Co.	Data Pattern	RND	Data Pattern	RND
Motherboa	ard	Intel S2600	COE	Model No.	Your Drive 100	AR	100%	AR	100%
CPU		Intel E5 2690		S/N	123456	Pre Condtion 1	RND/8KiB	Test Stimulus 1	RND/8KiB
Memory	1	16G PC1600	DDR2	Firmware ver	ABCDEF	R/W %	0/100	R/W %	65/35 %
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32	TC / QD	TC/QD from 1-32
Test SW	/	CTS 6.5 1.1	13.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	TC & QD Loops	High to Low TOIO
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min IOPS Point	TC 1/QD 1
Test ID N	ю.	R30-119	6	PCIe NVM	N/A	R/W %	0/100	Mid IOPS Point	User Select
НВА		LSI 9212-4	le4i	Purge Method	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IOPS Point	User Select
PCIe		Gen 3 x 1	16	Write Cache	WCD	Duration	30 M or 10% Cap.		
				Dro	Conditioning	Stoady Sta	to Plot		

Pre Conditioning Steady State Plot



Plot A.51 – DIRTH Pre Conditioning Steady State Plot

Tes	st Ru	n Date:		12/26/2	012 12:51 AM	Report I	Run Date:	03/8/2013	7:43:00 AM
Dem	and	Inter	sit	y Respo	onse Time I	Historam	(REQUIR	ED) - Rep	ort Page
SNIA		Solid Stat	e Stor	rage	DIRTH - OL	TD - DND SK	IR 65.35 PV	Rev	PTS-E 1.1
SSS TWG	Pert	formance T	est Sp	ec (PTS)	DIKIN-UL	IF - KILD OK	10 05.35 K	Page	a 3 of 14
Vendor:	Vendor: ABC Co. S		sst	Model:	ABC Co. Yo	our Drive 100	TES		LYPSO Systems
Те	st Pl	atform		Device	e Under Test	Set Up P	arameters	Test Pa	rameters
Ref Test Plat	tform	SNIA RTP	1.0	Mfgr	ABC Co.	Data Pattern	RND	Data Pattern	RND
Motherboa	ard	Intel S2600	COE	Model No.	Your Drive 100	AR	100%	AR	100%
CPU		Intel E5 2690		S/N	123456	Pre Condtion 1	RND/8KiB	Test Stimulus 1	RND/8KiB
Memory	(16G PC1600	DDR2	Firmware ve	r ABCDEF	R/W %	0/100	R/W %	65/35 %
Operating Sy	stem	CentOS 6	.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32	TC / QD	TC/QD from 1-32
Test SW	/	CTS 6.5 1.1	3.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	TC & QD Loops	High to Low TOIO
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min IOPS Point	TC 1/QD 1
Test ID N	lo.	R30-119	6	PCIe NVM	N/A	R/W %	0/100	Mid IOPS Point	User Select
НВА		LSI 9212-4	e4i	Purge Metho	d Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IOPS Point	User Select
PCIe		Gen 3 x 1	6	Write Cache	WCD	Duration	30 M or 10% Cap.		
					Detrois Der	and Dee Mart			

Between Round Pre Writes

P3 Between Round Pre-Writes Between Round Pre-Writes, BS=RND 4KiB



Plot A.52 – DIRTH Between Round Pre Writes

Tes	t Ru	n Date:		12/26/2	012 12:51 AM	Report F	Run Date:	03/8/	2013	7:43:00 AM	
Dem	and	Inter	sit	y Respo	onse Time I	Historam	(REQUIR	ED) -	Repo	ort Page	
SNIA		Solid Stat	e Sto	rage					Rev.	PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	pec (PTS)	DIRTH - UL	IP - KND OK	IB 05:35 KV		Page	4 of 14	
Vendor: ABC Co. St			ssi	D Model:	ABC Co. Yo	our Drive 100	TES			LYPSO	
Te	st Pl	atform		Device	e Under Test	Set Up P	arameters	Те	est Par	ameters	
Ref Test Plat	form	SNIA RTP	1.0	Mfgr	ABC Co.	Data Pattern	RND	Data Patte	rn	RND	
Motherboa	ard	Intel S2600	COE	Model No.	Your Drive 100	AR	100%	AR		100%	
CPU	CPU		Intel E5 2690		123456	Pre Condtion 1	RND/8KiB	Test Stimu	lus 1	RND/8KiB	
Memory	í.	16G PC1600	DDR2	Firmware ve	r ABCDEF	R/W %	0/100	R/W %		65/35 %	
Operating Sy	stem	CentOS 6	i.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32	TC / QD		TC/QD from 1-32	
Test SW	1	CTS 6.5 1.1	13.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	TC & QC	Loops	High to Low TOIO	
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min IOPS F	Point	TC 1/QD 1	
Test ID N	o.	R30-119	6	PCIe NVM	N/A	R/W %	0/100	Mid IOPS P	Point	User Select	
НВА		LSI 9212-4	e4i	Purge Metho	d Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IOPS	Point	User Select	
PCIe		Gen 3 x 1	6	Write Cache	WCD	Duration	30 M or 10% Cap.				
	_				DV TODE DI	TC-Track	la a		_		

DV IOPS Plot, TC=Tracking



Plot A.53 – DIRTH DV IOPS Plot, TC=Tracking

nd Inten Solid Stat	sity Resp	onse Time I	Historam	REOUIR	ED) - Ren	ant Dama
Solid Stat	e Storage				LD) - Kep	ort Page
	corage	DIPTH - OL	TD - PND SK	B 65-35 PM	Rev	PTS-E 1.1
ertormance i	est Spec (PTS)	DIKIN-UL	IF - KILD OK	10 05.55 KV	Page	5 of 14
ABC Co.	SSD Model:	ABC Co. Yo	our Drive 100	TEST		LYPSO Systems
Platform	Devi	ce Under Test	Set Up Pa	arameters	Test Pa	rameters
m SNIA RTP 1	L.O Mfgr	ABC Co.	Data Pattern	RND	Data Pattern	RND
Intel S2600	COE Model No	• Your Drive 100	AR	100%	AR	100%
Intel E5 26	90 S/N	123456	Pre Condtion 1	RND/8KiB	Test Stimulus 1	RND/8KiB
16G PC1600 I	DDR2 Firmware	ver ABCDEF	R/W %	0/100	R/W %	65/35 %
CentOS 6	.3 Capacity	/ 100 GB	TOIO - TC/QD	TC 32/QD 32	TC / QD	TC/QD from 1-32
CTS 6.5 1.1	3.8 Interface	sAS 6Gb/s	SS Rounds	2 - 6	TC & QD Loops	High to Low TOIO
1.9.97-el6/R1	.13.7 NAND Typ	SLC SLC	Pre Condtion 2	Inter Rnd Pre Write	Min IOPS Point	TC 1/QD 1
R30-1196	5 PCIe NV	N/A	R/W %	0/100	Mid IOPS Point	User Select
LSI 9212-4	e4i Purge Metl	rod Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IOPS Point	User Select
Gen 3 x 1	6 Write Cac	he WCD	Duration	30 M or 10% Cap.		
	erformance To ABC Co. Platform n SNIA RTP 1 Intel S2600 Intel S2600 Intel S2600 CentOS 6 CTS 6.5 1.1 1.9.97-el6/R1 R30-1199 LSI 9212-44 Gen 3 x 1	erformance Test Spec (PTS) ABC Co. SSD Model: Platform SNIA RTP 1.0 Mfgr Intel S2600 COE Model NG Intel E5 2690 S/N 16G PC1600 DDR2 Firmware CentOS 6.3 Capacity CTS 6.5 1.13.8 Interface 1.9.97-el6/R1.13.7 NAND Typ R30-1196 PCIE NVf LSI 9212-4e4i Gen 3 x 16 Write Cac	erformance Test Spec (PTS) ABC Co. SSD Model: ABC Co. Ye Platform Device Under Test n SNIA RTP 1.0 Mfgr ABC Co. Intel S2600 COE Model No. Your Drive 100 Intel E5 2690 S/N 123456 16G PC1600 DDR2 Firmware ver ABCDEF m CentOS 6.3 Capacity 100 GB CTS 6.5 1.13.8 Interface SAS 6Gb/s 1.9.97-el6/R1.13.7 NAND Type SLC R30-1196 PCIe NVM N/A LSI 9212-4e4i Purge Method Format Unit Gen 3 x 16 Write Cache WCD	erformance Test Spec (PTS) ABC Co. SSD Model: ABC Co. Your Drive 100 Platform Device Under Test Set Up Pattern n SNIA RTP 1.0 Mfgr ABC Co. Data Pattern n Intel S2600 COE Model No. Your Drive 100 AR Intel S2600 COE Model No. Your Drive 100 AR Intel S2600 COE Model No. Your Drive 100 AR Intel S2600 COE Model No. Your Drive 100 AR Intel S2600 COE Model No. Your Drive 100 AR Intel S2600 COE Model No. Your Drive 100 AR Intel S2600 COE Model No. Your Drive 100 AR Intel S2600 COE Firmware ver ABCDEF R/W % CentOS 6.3 Capacity 100 GB T010 - TC/QD CTS 6.5 1.13.8 Interface SAS 6Gb/s SS Rounds 1.9.97-el6/R1.13.7 NAND Type SLC Pre Condition 2 R30-1196 PCIE NVM N/A R/W % LSI 9212-4e4i Purge Method Format Unit T010 - TC/QD <t< td=""><td>erformance Test Spec (PTS) ABC Co. SSD Model: ABC Co. Your Drive 100 TEST SPONS Platform Device Under Test Set Up Parameters RND n SNIA RTP 1.0 Mfgr ABC Co. Data Pattern RND Intel S2600 COE Model No. Your Drive 100 AR 100% Intel S2600 COE Model No. Your Drive 100 AR 100% Intel E5 2690 S/N 123456 Pre Condtion 1 RND/8KiB 16G PC1600 DDR2 Firmware ver ABCDEF R/W % 0/100 m CentOS 6.3 Capacity 100 GB TOIO - TC/QD TC 32/QD 32 CTS 6.5 1.13.8 Interface SAS 6Gb/s SS Rounds 2 - 6 1.9.97-el6/R1.13.7 NAND Type SLC Pre Condtion 2 Inter Rnd Pre Write R30-1196 PCIE NVM N/A R/W % 0/100 LSI 9212-4e4i Purge Method Format Unit TOIO - TC/QD TC 32/QD 32 Gen 3 x 16 Write Cache WCD Duration 30 M or 10% Cap.</td><td>Page Page Test Spec (PTS) TEST SPONSOR TEST SPONSOR Test Page Platform Device Under Test Set Up Parameters Test Page n SNIA RTP 1.0 Mfgr ABC Co. Data Pattern RND Data Pattern Intel S2600 COE Model No. Your Drive 100 AR 100% AR Intel S2600 COE Model No. Your Drive 100 AR 100% AR Intel S2600 COE Model No. Your Drive 100 AR 0/100 R/W % Intel E5 2690 S/N 123456 Pre Condtion 1 RND/8KiB Test Stimulus 1 16G PC1600 DDR2 Firmware ver ABCDEF R/W % 0/100 R/W % m CentOS 6.3 Capacity 100 GB TOIO - TC/QD TC 32/QD 32 TC / QD cTS 6.5 1.13.8 Interface SAS 6Gb/s SS Rounds 2 - 6 TC & QD Loops 1.9.97-el6/R1.13.7 NAND Type SLC Pre Condtion 2 Inter Rnd Pre Write Min IOPS Point</td></t<>	erformance Test Spec (PTS) ABC Co. SSD Model: ABC Co. Your Drive 100 TEST SPONS Platform Device Under Test Set Up Parameters RND n SNIA RTP 1.0 Mfgr ABC Co. Data Pattern RND Intel S2600 COE Model No. Your Drive 100 AR 100% Intel S2600 COE Model No. Your Drive 100 AR 100% Intel E5 2690 S/N 123456 Pre Condtion 1 RND/8KiB 16G PC1600 DDR2 Firmware ver ABCDEF R/W % 0/100 m CentOS 6.3 Capacity 100 GB TOIO - TC/QD TC 32/QD 32 CTS 6.5 1.13.8 Interface SAS 6Gb/s SS Rounds 2 - 6 1.9.97-el6/R1.13.7 NAND Type SLC Pre Condtion 2 Inter Rnd Pre Write R30-1196 PCIE NVM N/A R/W % 0/100 LSI 9212-4e4i Purge Method Format Unit TOIO - TC/QD TC 32/QD 32 Gen 3 x 16 Write Cache WCD Duration 30 M or 10% Cap.	Page Page Test Spec (PTS) TEST SPONSOR TEST SPONSOR Test Page Platform Device Under Test Set Up Parameters Test Page n SNIA RTP 1.0 Mfgr ABC Co. Data Pattern RND Data Pattern Intel S2600 COE Model No. Your Drive 100 AR 100% AR Intel S2600 COE Model No. Your Drive 100 AR 100% AR Intel S2600 COE Model No. Your Drive 100 AR 0/100 R/W % Intel E5 2690 S/N 123456 Pre Condtion 1 RND/8KiB Test Stimulus 1 16G PC1600 DDR2 Firmware ver ABCDEF R/W % 0/100 R/W % m CentOS 6.3 Capacity 100 GB TOIO - TC/QD TC 32/QD 32 TC / QD cTS 6.5 1.13.8 Interface SAS 6Gb/s SS Rounds 2 - 6 TC & QD Loops 1.9.97-el6/R1.13.7 NAND Type SLC Pre Condtion 2 Inter Rnd Pre Write Min IOPS Point

DV Steady State Plot, Tracking Variable

P5 Demand Variation Steady State Check TC32-QD32



Plot A.54 – DIRTH DV Steady State Plot, Tracking Variable

Tes	st Ru	n Date:	12/26/2012 12:51 AM Report Run Date: 03/8/20						3 7:43:00 AM
Dem	and	Inter	sit	y Respo	nse Time I	Historam	(REQUIR	ED) - Re	port Page
SNIA		Solid Stat	e Sto	rage	DIRTH - OI		R 65.25 DW	Re	v. PTS-E 1.1
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	DIKIH-UL	IP - KND OK	15 05.55 KV	Pa	ge 6 of 14
Vendor:	A	BC Co.	ssi	O Model:	ABC Co. Yo	our Drive 100	TEST		LYPSO Systems
Те	st Pl	atform		Device	Under Test	Set Up P	arameters	Test P	arameters
Ref Test Plat	tform	SNIA RTP	1.0	Mfgr	ABC Co.	Data Pattern	RND	Data Pattern	RND
Motherbo	ard	Intel S2600	COE	Model No.	Your Drive 100	AR	100%	AR	100%
CPU		Intel E5 26	i90	S/N	123456	Pre Condtion 1	RND/8KiB	Test Stimulus 1	RND/8KiB
Memory	v	16G PC1600	DDR2	Firmware ver	ABCDEF	R/W %	0/100	R/W %	65/35 %
Operating Sy	stem	CentOS 6	.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32	TC / QD	TC/QD from 1-32
Test SV	v	CTS 6.5 1.1	3.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	TC & QD Loop	s High to Low TOIO
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min IOPS Point	TC 1/QD 1
Test ID N	lo.	R30-119	6	PCIe NVM	N/A	R/W %	0/100	Mid IOPS Point	User Select
НВА	нва լ		e4i	Purge Method	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IOPS Point	User Select
PCIe		Gen 3 x 1	.6	Write Cache	WCD	Duration	30 M or 10% Cap.		
					Demand V	ariation Plo	t		



Plot A.55 – DIRTH Demand Variation Plot

Tes	Test Run Date:			12/26/2	2012 12:51 AM	Report F	Report Run Date:			7:43:00 AM	
Dem	and	Inter	sit	y Respo	onse Time	Historam	(REQUIR	ED)	- Repo	ort Page	
SNIA		Solid Stat	te Sto	rage			D 65.25 DV	2	Rev.	PTS-E 1.1	
SSS TWG	Pert	ormance T	est Sp	ec (PTS)	s) DIRTH - OLTP - KND 8KIB 65:35 KW					7 of 14	
Vendor:	A	BC Co.	ssi	D Model:	ABC Co. Ye	SC Co. Your Drive 100 TEST SPONSOR				LYPSO Systems	
Test Platform Devic				Devic	e Under Test	Set Up P	arameters		Test Par	ameters	
Ref Test Pla	tform	SNIA RTP	1.0	Mfgr	ABC Co.	Data Pattern	RND	Data P	attern	RND	
Motherbo	ard	Intel S2600	COE	Model No.	Your Drive 100	AR	100%	AR		100%	
CPU		Intel E5 26	590	S/N	123456	Pre Condtion 1	RND/8KiB	Test St	timulus 1	RND/8KiB	
Memory	Ý	16G PC1600	DDR2	Firmware ve	ABCDEF	R/W %	0/100	R/V	V %	65/35 %	
Operating Sy	stem	CentOS 6	5.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32	TC ,	/ QD	TC/QD from 1-32	
Test SV	v	CTS 6.5 1.1	13.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	TC	& QD Loops	High to Low TOIO	
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min IO	PS Point	TC 1/QD 1	
Test ID No.		R30-1196		PCIe NVM	N/A	R/W %	0/100	Mid IO	PS Point	User Select	
HBA LSI 9212-		LSI 9212-4	le4i	Purge Metho	od Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IC	PS Point	User Select	
PCIe		Gen 3 x 1	16	Write Cache	e WCD	Duration	30 M or 10% Cap.				
					Domand T	ntoncity Plo	+				

emand Int

P7 RND/8KiB, R/W=65/35% Demand Intensity



Plot A.56 – DIRTH Demand Intensity Plot

Test Run Date:				12/26/2	012 12:51 AM	Report F	Run Date:	03	/8/2013	7:43:00 AM
Dema	and	Inter	sity	y Respo	onse Time I	Historam	(REQUIR	ED)	- Rep	ort Page
SNIA		Solid Stat	e Stor	rage						PTS-E 1.1
SSS TWG	Performance Test Spec (PTS) DIRTH - OLTP - RND 8KIB 65:35 RW							<i>••</i>	Page	8 of 14
Vendor:	A	BC Co.	SSC	Model:	ABC Co. Your Drive 100 TEST SPONSOR			r OR	CAL	YPSO Systems
Te	st Pl	atform		Device	e Under Test	Set Up P	arameters	1	Test Par	ameters
Ref Test Plat	form	SNIA RTP	1.0	Mfgr	ABC Co.	Data Pattern	RND	RND Data Pattern		RND
Motherboa	ard	Intel S2600	COE	Model No.	Your Drive 100	AR	100%	AR		100%
CPU		Intel E5 26	90	S/N	123456	Pre Condtion 1	RND/8KiB	Test Stimulus 1		RND/8KiB
Memory		16G PC1600	DDR2	Firmware ve	r ABCDEF	R/W %	0/100	R/W %		65/35 %
Operating Sy	stem	CentOS 6	.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32	TC ,	/ QD	TC/QD from 1-32
Test SW	1	CTS 6.5 1.1	3.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	TC a	& QD Loops	High to Low TOIO
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min IO	PS Point	TC 1/QD 1
Test ID No.		R30-119	6	PCIe NVM	N/A	R/W %	0/100	Mid IO	PS Point	User Select
HBA LS		LSI 9212-4	LSI 9212-4e4i Purge Metho		d Format Unit	TOIO - TC/QD	TC 32/QD 32 Max		PS Point	User Select
PCIe	PCIe Gen 3 x 16		6	Write Cache	WCD	Duration	30 M or 10% Cap.			
				9	System CPU	Utilization I	Plot			

P8 System CPU Utlization During Demand Variation Test



Plot A.57 – DIRTH System CPU Utilization Plot

Test Run Date:			12/27/2	2012 04:22 AM	Report F	Report Run Date:			1:07:00 AM		
Dema	and	Inter	sity	y Respo	onse Time I	Historam	(REQUIR	ED) -	Repo	ort Page	
SNIA		Solid Stat	e Stor	age	DIDTU OU		D 65.25 DW		Rev.	PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	DIRTH - UL	- OLIP - RND 8KIB 65:35 RW				9 of 14	
Vendor:	endor: ABC Co. SS				ABC Co. Yo	ur Drive 100 TES SPONS				LYPSO Systems	
Test Platform Devic					e Under Test	Set Up P	arameters	1	est Par	ameters	
Ref Test Plat	form	SNIA RTP	1.0	Mfgr	ABC Co.	Data Pattern	RND	Data Pat	tern	RND	
Motherboa	ard	Intel S2600	COE	Model No.	Your Drive 100	AR	100%)% AR		100%	
CPU		Intel E5 26	90	S/N	123456	Pre Condtion 1	RND/8KiB	Test Stimulus 1		RND/8KiB	
Memory	,	16G PC1600	DDR2	Firmware ve	ABCDEF	R/W %	0/100	R/W	%	65/35 %	
Operating Sy	stem	CentOS 6	.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32	TC / C	ĮD	TC/QD from 1-32	
Test SW	,	CTS 6.5 1.1	3.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	TC & C	2D Loops	High to Low TOIO	
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min IOPS	Point	TC 1/QD 1	
Test ID No. R30-1203		3	PCIe NVM	N/A	R/W %	0/100	0/100 Mid IOPS Pr		User Select		
HBA LSI 9212		LSI 9212-4	e4i	Purge Metho	d Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IOP	5 Point	User Select	
PCIe		Gen 3 x 1	6	Write Cache	e WCD	Duration	30 M or 10% Cap.				
					May TOPS	Dre Writes					







Test Run Date:			12/27/2012 04:22 AM			Run Date:	03	/7/2013 1	1:07:00 AM	
Dema	and	Inter	sity	Respo	onse Time I	Historam	(REQUIR	ED)	- Repo	ort Page
SNIA		Solid Stat	e Stor	age						
SSS TWG	Perf	ormance T	est Sp	ipec (PTS) DIRTH - OLT		IP - KND 8KIB 65:35 RW			Page	10 of 14
Vendor:	A	BC Co.	SSC	Model:	ABC Co. Your Drive 100 TEST SPONSO			OR		
Test Platform Devic			Device	e Under Test	Set Up P	arameters		Test Par	ameters	
Ref Test Plat	form	SNIA RTP	1.0	Mfgr	ABC Co.	Data Pattern	RND	Data	Pattern	RND
Motherboa	ard	Intel S2600	COE	Model No.	Your Drive 100	AR	100%	AR		100%
CPU		Intel E5 26	90	S/N	123456	Pre Condtion 1	RND/8KiB	Test s	Stimulus 1	RND/8KiB
Memory	(16G PC1600	DDR2	Firmware ve	r ABCDEF	R/W %	0/100	R/	W %	65/35 %
Operating Sy	stem	CentOS 6	.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32	тс	/ QD	TC/QD from 1-32
Test SW	1	CTS 6.5 1.1	3.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	тс	& QD Loops	High to Low TOIO
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min I	OPS Point	TC 1/QD 1
Test ID No.		R30-120	3	PCIe NVM	N/A	R/W %	0/100	Mid I	OPS Point	User Select
HBA LSI 9212-4e4i		e4i	Purge Metho	d Format Unit	TOIO - TC/QD	TC 32/QD 32	Max I	OPS Point	User Select	
PCIe		Gen 3 x 1	6	Write Cache	WCD	Duration	30 M or 10% Cap.			
					Max IOPS	Histogram				





Test Run Date:				12/27/2012 3:12:00AM			Report Run Date:			1:00:00 PM
Dema	and	Inter	sity	Respo	nse Time I	listoram	(REQUIR	ED)	- Repo	ort Page
SNIA		Solid Stat	e Stor	age						PTS-E 1.1
SSS TWG	Performance Test Spec (PTS) DIRTH - OLTP - RND 8KiB 65						IB 65:35 KW		Page	11 of 14
Vendor:	ndor: ABC Co. SSD Mod				ABC Co. Yo	ur Drive 100	TEST	r OR	CAL	(PSO Systems
Те	st Pl	atform		Device	Under Test	Set Up P	arameters		Test Par	ameters
Ref Test Plat	form	SNIA RTP	1.0	Mfgr	ABC Co.	Data Pattern	RND	Data Pattern		RND
Motherboa	ard	Intel S2600	COE	Model No.	Your Drive 100	AR	100%	AR		100%
CPU		Intel E5 26	90	S/N	123456	Pre Condtion 1	RND/8KiB	Test s	Stimulus 1	RND/8KiB
Memory		16G PC1600	DDR2	Firmware ve	ABCDEF	R/W %	0/100	R/	W %	65/35 %
Operating Sy	stem	CentOS 6	.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32	тс	/ QD	TC/QD from 1-32
Test SW		CTS 6.5 1.1	3.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	тс	& QD Loops	High to Low TOIO
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min I	OPS Point	TC 1/QD 1
Test ID No.		R30-120	2	PCIe NVM	N/A	R/W %	0/100	Mid I	OPS Point	User Select
НВА		LSI 9212-4	e4i	Purge Method	Format Unit	TOIO - TC/QD	TC 32/QD 32	Max I	OPS Point	User Select
PCIe	PCIe Gen 3 x 16		6	Write Cache	WCD	Duration	30 M or 10% Cap.			
					Mid IOPS	Pre Writes				





Test Run Date:				12/27/20	012 3:12:00AM	Report F	Run Date:	03/7/2013 1:00:00 PM		
Dema	and	Inter	sit	y Respo	onse Time I	listoram	(REQUIR	ED) - Rep	ort Page	
SNIA	(a.)	Solid Stat	e Sto	rage	DIRTH - OL	TP - RND SK	B 65:35 RW	Rev	. PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	Dainin OL	IT KILD OK	05.55 10	Pag	e 12 of 14	
Vendor:	A	BC Co.	ssi	Model:	ABC Co. Yo	OR CAL	CALYPSO			
Те	Test Platform Dev			Device	e Under Test	Set Up P	arameters	Test Pa	arameters	
Ref Test Plat	form	SNIA RTP	1.0	Mfgr	ABC Co.	Data Pattern	RND	Data Pattern	RND	
Motherboa	Motherboard Intel S2600 COE		COE	Model No.	Your Drive 100	AR	100%	AR	100%	
CPU		Intel E5 26	90	S/N	123456	Pre Condtion 1	RND/8KiB	Test Stimulus 1	RND/8KiB	
Memory		16G PC1600	DDR2	Firmware ve	r ABCDEF	R/W %	0/100	R/W %	65/35 %	
Operating Sy	stem	CentOS 6	.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32	TC / QD	TC/QD from 1-32	
Test SW		CTS 6.5 1.1	3.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	TC & QD Loops	High to Low TOIO	
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min IOPS Point	TC 1/QD 1	
Test ID No.		R30-120	2	PCIe NVM	N/A	R/W %	0/100	Mid IOPS Point	User Select	
HBA LSI 9212-4e4i		e4i	Purge Metho	d Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IOPS Point	User Select		
PCIe		Gen 3 x 1	6	Write Cache	wcD	Duration	30 M or 10% Cap.			
					Mid IOPS	Histogram				





Test Run Date:			1/19/201	.3 7:14:00 AM	Report F	Report Run Date:			1:15:00 PM	
Dema	and	Inter	sity	Respo	nse Time I	Historam	(REQUIR	ED)	- Rep	ort Page
SNIA		Solid Stat	e Stor	age		Rev.	PTS-E 1.1			
SSS TWG	Performance Test Spec (PTS) DIRTH - OLTP - RND 8KIB 65:35 RW							Page	13 of 14	
Vendor:	ndor: ABC Co. SSD Model:				ABC Co. Your Drive 100 TEST SPONSO			r OR		
Те	st Pl	atform		Device	Under Test	Set Up P	arameters		Test Par	ameters
Ref Test Plat	form	SNIA RTP	1.0	Mfgr	ABC Co.	Data Pattern	RND	ND Data Pattern		RND
Motherboa	ard	Intel S2600	COE	Model No.	Your Drive 100	AR	100%	AR		100%
CPU		Intel E5 26	90	S/N	123456	Pre Condtion 1	RND/8KiB	Test 5	Stimulus 1	RND/8KiB
Memory	r i	16G PC1600	DDR2	Firmware ve	ABCDEF	R/W %	0/100	R/	W %	65/35 %
Operating Sy	stem	CentOS 6	.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32	тс	/ QD	TC/QD from 1-32
Test SW	'	CTS 6.5 1.1	3.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	тс	& QD Loops	High to Low TOIO
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min I	OPS Point	TC 1/QD 1
Test ID No.		R30-1298		R30-1298 PCIe NVM		R/W %	0/100	Mid I	OPS Point	User Select
НВА		LSI 9212-4	e4i	Purge Method	f Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IOPS Point		User Select
PCIe		Gen 3 x 1	.6	Write Cache	WCD	Duration	30 M or 10% Cap.	1	j	
					Min TOPS	Pre Writes	1			





Test Run Date:				1/19/201	3 7:14:00 AM	Report F	Run Date:	03/7/2013 1:15:00 PM		
Dema	and	Inten	sit	y Respo	onse Time I	listoram	(REQUIR	ED) - Re	eport Page	
SNIA		Solid Stat	e Stor	age				, F	ev. PTS-E 1.1	
SSS TWG	Perf	ormance T	est Sp	ec (PTS)	DIRTH - OL	IP - RND 8K	IB 65:35 KW	P	age 14 of 14	
Vendor:	A	BC Co.	ssa) Model:	ABC Co. Yo	our Drive 100 TES SPONS			LYPSO	
Те	st Pl	atform		Device	Under Test	Set Up Pa	arameters	Test	Parameters	
Ref Test Plat	form	SNIA RTP :	1.0	Mfgr	ABC Co.	Data Pattern	RND	Data Pattern	RND	
Motherboa	ard	Intel S2600	COE	Model No.	Your Drive 100	AR	100%	AR	100%	
CPU		Intel E5 26	90	S/N	123456	Pre Condtion 1	RND/8KiB	Test Stimulus 1	RND/8KiB	
Memory		16G PC1600	DDR2	Firmware ve	r ABCDEF	R/W %	0/100	R/W %	65/35 %	
Operating Sy	stem	CentOS 6	.3	Capacity	100 GB	TOIO - TC/QD	TC 32/QD 32	TC / QD	TC/QD from 1-32	
Test SW		CTS 6.5 1.1	3.8	Interface	SAS 6Gb/s	SS Rounds	2 - 6	TC & QD Loo	High to Low TOIO	
Test SW I	nfo	1.9.97-el6/R	1.13.7	NAND Type	SLC	Pre Condtion 2	Inter Rnd Pre Write	Min IOPS Point	TC 1/QD 1	
Test ID No.		R30-129	8	PCIe NVM	N/A	R/W %	0/100	Mid IOPS Point	User Select	
HBA		LSI 9212-4	e4i	Purge Metho	d Format Unit	TOIO - TC/QD	TC 32/QD 32	Max IOPS Point	t User Select	
PCIe		Gen 3 x 1	6	Write Cache	WCD	Duration	30 M or 10% Cap.			
					Min IOPS	Histogram				



P14 MinIOPS Response Time Histogram, MRT=53.90 mS



Annex B (informative) Reference Test Platform Example

This annex describes the hardware/software Reference Test Platform (RTP) that was used by the SSS TWG to do the bulk of the research and validation of the SSS PTS.

The RTP is not required to run the SSS PTS tests; it is an example of a platform that was used to validate and run the PTS.

In addition to the RTP, other hardware/software platforms and software tools were used in the development and refinement of the PTS, such as Calypso CTS, IOmeter, Vdbench and inhouse stimulus generators running on various versions of the Windows and Linux OS.

B.1 RTP Configurations

The RTP is designed to enable the testing of SSS devices. It can be configured for Standard test or extended for the testing of higher performance SSS products.

The table below shows the two currently defined configurations of the RTP. The validation of the PTS was performed using the RTP 2.0 configuration. The RTP 3.0 is recommended for use with enterprise class PCIe and SAS SSDs utilizing Gen 3 motherboards.

Component	RTP 2.0	Notes	RTP 3.0	Notes
Chassis	Intel SC5650DP or similar	5u	Intel P4308XXMHJC	4u
Motherboard	Gen 2 Intel S5520HC	1	Gen 3 Intel S2600	COE or CP2
Processor	Intel 3.2GHz quad core W5580	1 or 2	Intel 3.1GHz 8 core E2687L or E2690W	1 or 2
Main Memory	1333MHz DDR3, ECC	12GB – 96GB	1600Mhz ECC DDR3	32GB to 64GB
Boot Drive(s)	500GB SATA 7200 RPM HDD	1	1.0 TB Dual SATA SSD	RAID1
SAS/SATA HBA	LSI 6Gb/s 9212-4i4e	1	12Gb/s TBD	
Operating System	Linux	CentOS 6.3	Linux	CentOS 6.3
Test Software	Calypso CTS	CTS 6.5	Calypso CTS	CTS 6.5

B.2 RTP Components

This section contains a more detailed description of the components used in the RTP.

Chassis:

The RTP 2.0 chassis is an Intel SC5650DP. The chassis has a limited effect on performance, so a similar chassis could be used, but it should have a 600W or larger power supply.

The RTP 3.0 uses an Intel P4308XXMHJC 4U. The chassis has more impact on the testing of higher performance PCIe and SAS devices due to the use of Gen 3 Motherboards and the increased power and heat dissipation associated with higher performance PCIe and SAS DUTs. The RTP 3.0 chassis has an increased internal airflow specification for higher power and heat.

Motherboard:

The RTP 2.0 motherboard is a Gen 2 Intel S5520HC. A similar motherboard can be used, and if so, must be disclosed. To support the testing of higher performance DUTs, it is recommended to populate two processor sockets for dual CPU usage.

The RTP 3.0 motherboard is a Gen 3 Intel S2600 COE / CP2 with dual CPU sockets. While a similar motherboard can be used, it is recommended to use this specific motherboard for comparative performance test as the motherboard can have significant impact on performance.

CPU:

The processor used in the RTP 2.0 is a quad core Intel S5520HC. The Standard configuration has one CPU, and while the higher performance configuration has two CPUs.

The processors used in the RTP 3.0 are eight core Intel E26876L or E2690W. The Standard configuration has one CPU, and while the higher performance configuration has two CPUs.

Memory:

The RTP 2.0 main memory utilizes 1333MHz DDR3 DIMMs with ECC. The Standard configuration has 12GB of RAM while the higher Performance configuration has 96GB of RAM.

The RTP 3.0 main memory utilizes 1600MHz DDR3 DIMMs with ECC. The Standard configuration has 32GB while and the higher Performance configuration has 64GB of RAM.

It is advisable to install the memory in multiples of three DIMMs, to optimize performance.

Boot Drive(s):

The Boot HDD used in the RTP 2.0 is a 500GB SATA 7200 RPM HDD with a SATA interface. It is not clear what impact the HDD has on performance testing, so it is recommended to use (and disclose) the highest performance SATA drive that is widely available.

The RTP 3.0 uses dual 1.0 TB SSDs in RAID1 with a SAS/SATA connection.

HBA:

The RTP 2.0 uses an LSI 9212-4i4e Host Bus Adaptor containing the IT firmware set. Other sufficiently high performance HBAs are available, but were not tested.

The RTP 3.0 described above will be used to qualify and select 12Gb/s SAS/SATA HBAs and future HBAs for SFF 8639 PCIe SSDs as they become available in the market.

DUT Power Supply:

The RTP hardware platform has a dedicated DUT power supply for all test SAS/SATA DUT bays separate from the main power supply. The DUT power supply shall provide adequate power to simultaneously run all test DUTs with a surplus of 25% of the rated peak voltage draw.

Operating System (OS):

Both RTP 2.0 and 3.0 utilize Linux Community Enterprise OS (CentOS) version 6.3. The OS kernel revision used shall be disclosed.

Test Software:

The test software used to validate the RTP / PTS 1.1 is CTS 6.5 made by Calypso Systems, Inc. (www.calypsotesters.com).

The Calypso test software requires CentOS 6.3 Linux OS.