



**SPC BENCHMARK 1™**

**FULL DISCLOSURE REPORT**

**HUAWEI TECHNOLOGIES CO., LTD.**

**OCEANSTOR 5110F V5 ENHANCED**

**SPC-1™ v3.10.0**

**SUBMISSION IDENTIFIER: A32021**

**SUBMITTED FOR REVIEW: JANUARY 19, 2021**

## **First Edition – January 2021**

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## **Benchmark Specification and Glossary**

The official SPC Benchmark 1™ (SPC-1™) specification is available on the website of the Storage Performance Council (SPC) at [www.spcresults.org](http://www.spcresults.org).

The SPC-1™ specification contains a glossary of the SPC-1™ terms used in this publication.

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# AUDIT CERTIFICATION



Xu Zhong  
 Huawei Technologies Co., Ltd.  
 Huawei Industrial Base, Bantian. Longgang  
 Shenzhen City  
 Guangdong Province  
 China

January 18, 2021

I verified the SPC Benchmark 1™ (SPC-1™ v3.10.0) test execution and performance results of the following Tested Storage Product:

## OceanStor 5110F V5 Enhanced

The results were:

|                             |                               |
|-----------------------------|-------------------------------|
| SPC-1 IOPS™                 | <b>740,523</b>                |
| SPC-1 Price-Performance     | <b>¥2,868.33/SPC-1 KIOPS™</b> |
| SPC-1 Total System Price    | 2,124,062.60                  |
| SPC-1 IOPS Response Time    | 0.615 ms                      |
| SPC-1 Overall Response Time | 0.345 ms                      |
| SPC-1 ASU Capacity          | 19,542 GB                     |
| SPC-1 ASU Price             | ¥108.70/GB                    |

In my opinion, these performance results were produced in compliance with the SPC requirements for the benchmark.

The testing was executed using the SPC-1 Toolkit Version v3.0.2. The audit process was conducted in accordance with the SPC Policies and met the requirements for the benchmark.

A Letter of Good Faith was issued by Huawei Technologies Co., Ltd., stating the accuracy and completeness of the documentation and testing data provided in support of the audit of this result.

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OceanStor 5110F V5 Enhanced

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A Full Disclosure Report for this result was prepared by InfoSizing, reviewed and approved by Huawei Technologies Co., Ltd., and can be found at [www.spcresults.org](http://www.spcresults.org) under the Submission Identifier A32021.

The independent audit process conducted by InfoSizing included the verifications of the following items:

- The physical capacity of the data repository (46,080 GB).
- The total capacity of the Application Storage Unit (19,542 GB).
- The accuracy of the Benchmark Configuration diagram.
- The tuning parameters used to configure the Benchmark Configuration.
- The Workload Generator commands used to execute the testing.
- The validity and integrity of the test result files.
- The compliance of the results from each performance test.
- The compliance of the results from each persistence test.
- The compliance of the submitted pricing model.
- The differences between the tested and the priced configuration, if any.

The Full Disclosure Report for this result was prepared in accordance with the disclosure requirements set forth in the specification for the benchmark.

The following benchmark requirements, if any, were waived in accordance with the SPC Policies:

None.

Respectfully Yours,



Doug Johnson, Certified SPC Auditor

63 Lourdes Dr. | Leominster, MA 01453 | 978-343-6562 | [www.sizing.com](http://www.sizing.com)

# LETTER OF GOOD FAITH



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Tel: 0086-755-28780808  
<http://www.huawei.com/en/>

Date: 14<sup>th</sup> Jan, 2021

From: Huawei Technologies Co., Ltd.

To: Doug Johnson, SPC Auditor  
PerfLabs, Inc. DBA InfoSizing  
63 Lourdes Drive  
Leominster, MA 01453-6709 USA

Subject: SPC-1 Letter of Good Faith for the Huawei OceanStor 5110F V5 Enhanced

Huawei Technologies Co., Ltd. is the SPC-1 Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-1 benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with V3.9 of the SPC-1 benchmark specification.

In addition, we have reported any items in the Benchmark Configuration and execution of the benchmark that affected the reported results even if the items are not explicitly required to be disclosed by the SPC-1 benchmark specification.

Signed:

A handwritten signature in black ink, appearing to be the Chinese characters "黄涛" (Huang Tao).

---

Tao Huang  
Data Storage and Intelligent Vision Product Line

Date:

A handwritten date in black ink, "2021-1-14".

# OceanStor 5110F V5 Enhanced

|                             |                 |                          |                               |
|-----------------------------|-----------------|--------------------------|-------------------------------|
| SPC-1 IOPS™                 | <b>740,523</b>  | SPC-1 Price Performance  | <b>¥2,868.33/SPC-1 KIOPS™</b> |
| SPC-1 IOPS Response Time    | <b>0.615 ms</b> | SPC-1 Total System Price | <b>¥2,124,062.60</b>          |
| SPC-1 Overall Response Time | 0.345 ms        | SPC-1 Overall Discount   | 68.58%                        |

Currency / Target Country: CNY / China  
 Availability Date: Currently Available

Extensions

|                                 |    |
|---------------------------------|----|
| ☆ SPC-1 Data Reduction          | NA |
| ☆ SPC-1 Encryption              | NA |
| ☆ SPC-1 NDU                     | NA |
| ☆ SPC-1 Synchronous Replication | NA |
| ☆ SPC-1 Snapshot                | NA |

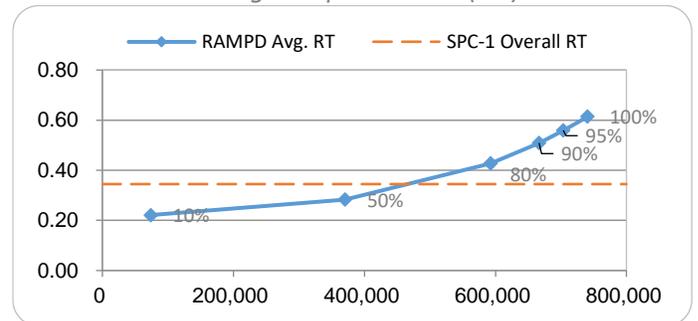
Storage Metrics

|                                 |             |
|---------------------------------|-------------|
| SPC-1 Data Protection Level     | Protected 2 |
| SPC-1 Physical Storage Capacity | 46,080 GB   |
| SPC-1 ASU Capacity              | 19,542 GB   |
| SPC-1 ASU Price                 | ¥108.70/GB  |

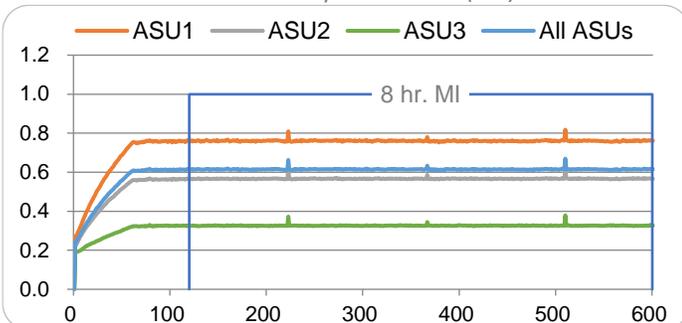
Priced Storage Configuration Summary

- 8 QLogic QLE2692 2-port 16 Gb FC HBAs
- 1 OceanStor 5110F V5 Enhanced
- 4 Active-Active Controllers
- 128 GB Total Cache
- 4 4-port 16 Gb FC Smart I/O Modules
- 24 1,920 GB SSDs
- 4 Total RUs

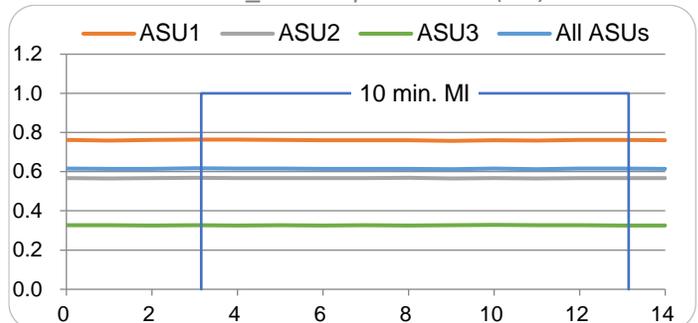
*RAMPD Average Response Time (ms) vs. IOPS*



*SUSTAIN Response Time (ms)*



*RAMPD\_100 Response Time (ms)*



SPC Benchmark 1™ Specification Revision: v3.10.0  
 SPC Benchmark 1™ Workload Generator Revision: v3.0.2

Submitted for Review: January 19, 2021  
 Submission Details: [www.storageperformance.org/r/A32021](http://www.storageperformance.org/r/A32021)

## PRICING DETAILS

| Part No.  | Description  | Source | Qty | Unit Price | Ext. Price   | Disc. | Disc. Price         |
|---|--|--------|-----|------------|--------------|-------|---------------------|
| <b>Hardware &amp; Software</b>                    |  |        |     |            |              |       |                     |
| 5110FV564G2CS25DAC                                | 5110F V5 Enhanced(2U, Dual Ctrl, SAS, AC\240V HVDC, 64GB Cache, 8*1Gb ETH, 4*10Gb ETH, 4*(4*12Gb) SAS, 25*2.5 Inch, SPE36C0225)  | 1      | 2   | 326,606.00 | 653,212.00   | 70%   | 195,963.60          |
| FC4P16G-V5  | 4 ports SmartIO I/O module(SFP+,16Gb FC)   | 1      | 4   | 135,200.00 | 540,800.00   | 70%   | 162,240.00          |
| RDMA4P25G-V5                                      | 4 ports 25Gb RDMA I/O module(SFP28,Scale-out)  | 1      | 4   | 63,649.00  | 254,596.00   | 70%   | 76,378.80           |
| L2-S-SSD1920GV5                                   | 1.92TB SSD SAS Disk Unit(2.5")   | 1      | 24  | 213,456.00 | 5,122,944.00 | 70%   | 1,536,883.20        |
| SN2F01FCPC  | Patch Cord, DLC/PC, DLC/PC, Multi-mode, 3m, A1a.2, 2mm, 42mm DLC, OM3 bending insensitive  | 1      | 16  | 50.00      | 800.00       | 0%    | 800.00              |
| SFP28-AOC-010                                     | Active Optical Cable Assembly,SFP28 AOC,25.78125G,0.01km   | 1      | 8   | 2,190.00   | 17,520.00    | 0%    | 17,520.00           |
| Qlogic QLE2692                                    | Qlogic QLE2692 HBA Card, PCIe 3.0, x8, Dual / 2-ports, 16GFC, SR-Optic, SFP+, Low Profile  | 1      | 8   | 7,063.00   | 56,504.00    | 0%    | 56,504.00           |
| LIC-5110F-BS                                      | Basic Software License (Including DeviceManager, SmartThin, SmartMulti-Tenant, SmartMigration, SmartErase, SmartMotion, SystemReporter, eService, SmartQuota, NFS, CIFS, NDMP, UltraPath)  | 1      | 1   | 51,700.00  | 51,700.00    | 70%   | 15,510.00           |
| <b>Hardware &amp; Software Subtotal</b>           |  |        |     |            |              |       | <b>2,061,799.60</b> |
| <b>Support &amp; Maintenance</b>                  |  |        |     |            |              |       |                     |
| 02354CFR_88136SCH-235_36                          | 5110F V5 Enhanced(2U, Dual Ctrl, SAS, AC\240V HVDC, 64GB Cache, 8*1Gb ETH, 4*10Gb ETH, 4*(4*12Gb) SAS, 25*2.5 Inch, SPE36C0225)_Hi-Care Onsite Premier OceanStor 5110F V5 Controller Enclosure_36Month(s)  | 1      | 2   | 10,746.00  | 21,492.00    | 0%    | 21,492.00           |
| 02354CSC_88136SCH-129_36                          | 1.92TB SSD SAS Disk Unit(2.5")_Hi-Care Onsite Premier OceanStor 1.92TB SSD_36Month(s)  | 1      | 24  | 328.50     | 7,884.00     | 0%    | 7,884.00            |
| 88035NYY_88134UGC-OKR_36                          | Basic Software License (Including DeviceManager, SmartThin, SmartMulti-Tenant, SmartMigration, SmartErase, SmartMotion, SystemReporter, eService, SmartQuota, NFS, CIFS, NDMP, UltraPath)_Hi-Care Application Software Upgrade Support Service OceanStor 5110 V5 Basic Software License_36Month(s) | 1      | 1   | 11,634.00  | 11,634.00    | 0%    | 11,634.00           |
| 8812223353  | OceanStor 5110F V5 Enhanced OceanStor 5100 Series Installation Service - Engineering   | 1      | 1   | 21,253.00  | 21,253.00    | 0%    | 21,253.00           |
| <b>Support &amp; Maintenance Subtotal</b>         |  |        |     |            |              |       | <b>62,263.00</b>    |
| <b>SPC-1 Total System Price</b>                   |  |        |     |            |              |       | <b>2,124,062.60</b> |
| SPC-1 IOPS™                                       |  |        |     |            |              |       | 740,523             |
| <b>SPC-1 Price-Performance™ (\$/SPC-1 KIOPS™)</b> |  |        |     |            |              |       | <b>2,868.33</b>     |
| SPC-1 ASU Capacity (GB)                           |  |        |     |            |              |       | 19,542              |
| <b>SPC-1 ASU Price (\$/GB)</b>                    |  |        |     |            |              |       | <b>108.70</b>       |

**Pricing Details:** All prices are in CNY and reflect prices generally available in China.

**Discount Details:** The discounts shown are based on the storage capacity purchased and are generally available.

**Warranty:** Hi-Care Premier On-Site Service includes: 7\*24 Technical Assistance Center Access. Access to all new software updates and Online Support. 24\*7\*4-hour Onsite Hardware Replacement.

## Differences Between Tested and Priced Storage Configurations

There were no differences between the TSC and the Priced Storage Configuration.

## **PUBLICATION DETAILS**

This section provides contact information for the test sponsor and auditor, a revision history of this document, and a description of any exceptions or waivers associated with this publication.

### **Contact Information**

| <b>Role</b>                         | <b>Name</b>                              | <b>Details</b>  |
|-------------------------------------|--|---|
| <b>Test Sponsor Primary Contact</b> | Huawei Technologies Co., Ltd.<br>Han Mao | <a href="http://www.huawei.com">www.huawei.com</a><br>hanmao@huawei.com |
| <b>SPC Auditor</b>                  | InfoSizing<br>Doug Johnson               | <a href="http://www.sizing.com">www.sizing.com</a><br>doug@sizing.com   |

### **Revision Information**

| <b>Date</b>      | <b>FDR Revision</b> | <b>Details</b>      |
|------------------|---------------------|---------------------|
| January 19, 2021 | First Edition       | Initial Publication |

### **Anomalies, Exceptions, Waivers**

There were no anomalies, exceptions or waivers associated with the audit of the OceanStor 5110F V5 Enhanced.

## CONFIGURATION INFORMATION

### Tested Storage Product Description

The new generation of mid-range hybrid flash storage dedicated to providing the reliable and efficient data services for enterprises.

Cloud-ready operating system, flash-enabled performance, and intelligent management software, delivering top-of-the-line functionality, performance, efficiency, reliability, and ease of use.

Satisfies the data storage requirements of large-database OLTP/OLAP, cloud computing, and many other applications, making it a perfect choice for sectors such as government, finance, telecommunications, and manufacturing.

For more details, visit:

<https://e.huawei.com/cn/products/cloud-computing-dc/storage/hybrid-flash-storage/oceanstor-5X10-v5>

### Host System and Tested Storage Configuration Components

The following table lists the components of the Host System(s) and the TSC.

| Host Systems   |
|--|
| 2 x Huawei FusionServer RH2288H V3<br># x Intel® Xeon® E5-2680 (2.50 GHz, 12-Core, 30 MB L3)<br>128 GB Main Memory<br>CentOS Linux release 7.3.1611 (Core)<br>Huawei OceanStor UltraPath software  |
| Tested Storage Configuration   |
| 8 x QLogic QLE2692 2-port 16 Gb FC HBAs<br>1 x OceanStor 5110F V5 Enhanced, with:<br>4 x Active-Active Controllers, each with:<br>32 GB cache (128 GB total)<br>4 x 4-port 16 Gb FC Smart I/O Modules<br>4 x 25 Gb Smart I/O Modules<br>24 x 1,920 GB SSDs |

### Component Changes in Revised Full Disclosure Report

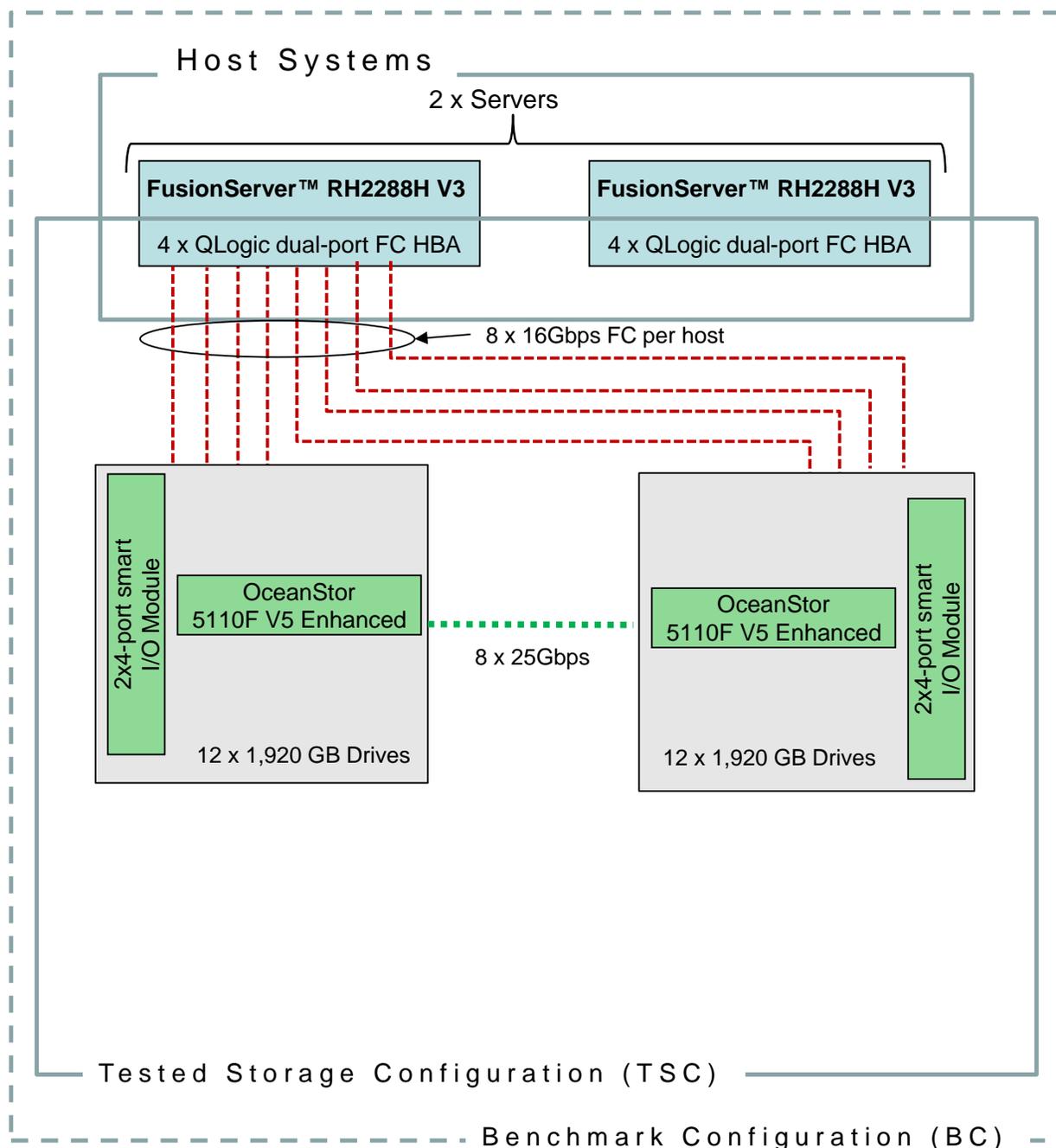
The following table outlines component changes that were made in revisions to this Full Disclosure Report.

| Original Component | Revised Component | Description of Change |
|--------------------|-------------------|-----------------------|
| n/a                | n/a               | Initial submission    |

## Configuration Diagrams

### BC/TSC Configuration Diagram

The following diagram illustrates the Benchmark Configuration (BC), including the Tested Storage Configuration (TSC) and the Host System(s).



### Storage Network Configuration

The configuration utilized direct-attached storage.

## Benchmark Configuration Creation Process

### Customer Tuning Parameters and Options

All the customer tuning parameters and options that have been altered from their default values for this benchmark are included in [Appendix C](#) and in the Supporting Files (see [Appendix A](#)).

### Tested Storage Configuration Creation

A detailed description of how the logical representation of the TSC was created is included in [Appendix D](#) and in the Supporting Files (see [Appendix A](#)).

### Tested Storage Configuration Inventory

An inventory of the components in the TSC, as seen by the Benchmark Configuration, is included in [Appendix E](#) and in the Supporting Files (see [Appendix A](#)).

### Workload Generator Storage Configuration

The SPC-1 Workload Generator storage configuration commands and parameters used to invoke the execution of the tests are included in [Appendix F](#) and in the Supporting Files (see [Appendix A](#)).

### Logical Volume Capacity and Application Storage Unit Mapping

The following table details the capacity of the Application Storage Units (ASUs) and how they are mapped to logical volumes (LVs). All capacities are reported in GB.

|                           | LV per ASU | LV Capacity | Used per LV | Total per ASU | % ASU Capacity                                     | Optimized* |
|---------------------------|------------|-------------|-------------|---------------|--|------------|
| <b>ASU-1</b>              | 18         | 488.5       | 488.5       | 8,793.9       | 45.0%  | No         |
| <b>ASU-2</b>              | 18         | 488.5       | 488.5       | 8,793.9       | 45.0%  | No         |
| <b>ASU-3</b>              | 2          | 977.1       | 977.1       | 1,954.2       | 10.0%  | No         |
| <b>SPC-1 ASU Capacity</b> |            |             |             | 19,542        | *See <a href="#">Space Optimization Techniques</a> |            |

### Physical Storage Capacity and Utilization

The following table details the Physical Capacity of the storage devices and the Physical Capacity Utilization (percentage of Total Physical Capacity used) in support of hosting the ASUs. All capacities are reported in GB.

| Devices                              | Count | Physical Capacity | Total Capacity |
|--------------------------------------|-------|-------------------|----------------|
| SSDs                                 | 24    | 1,920.0           | 46,080.0       |
| <b>Total Physical Capacity</b>       |       |                   | <b>46,080</b>  |
| <b>Physical Capacity Utilization</b> |       |                   | <b>42.41%</b>  |

### Data Protection

The data protection level used for all LVs was **Protected 2 (RAID-10)**, which was accomplished by configuring eight LUNs across two storage pools of 12 drives each.

## Space Optimization Information

### Description of Utilized Techniques

The TSC did not use any space optimization techniques.

### Physical Free Space Metrics

The following table lists the Physical Free Space as measured at each of the required points during test execution. If space optimization techniques were not used, "NA" is reported.

| Physical Free Space Measurement | Free Space (GB) |
|---------------------------------|-----------------|
| After Logical Volume Creation   | NA              |
| After ASU Pre-Fill              | NA              |
| After Repeatability Test Phase  | NA              |

### Space Optimization Metrics

The following table lists the required space optimization metrics. If space optimization techniques were not used, "NA" is reported.

| Metric                          | Value |
|---------------------------------|-------|
| SPC-1 Space Optimization Ratio  | NA    |
| SPC-1 Space Effectiveness Ratio | NA    |

## **BENCHMARK EXECUTION RESULTS**

This portion of the Full Disclosure Report documents the results of the various SPC-1 Tests, Test Phases, and Test Runs.

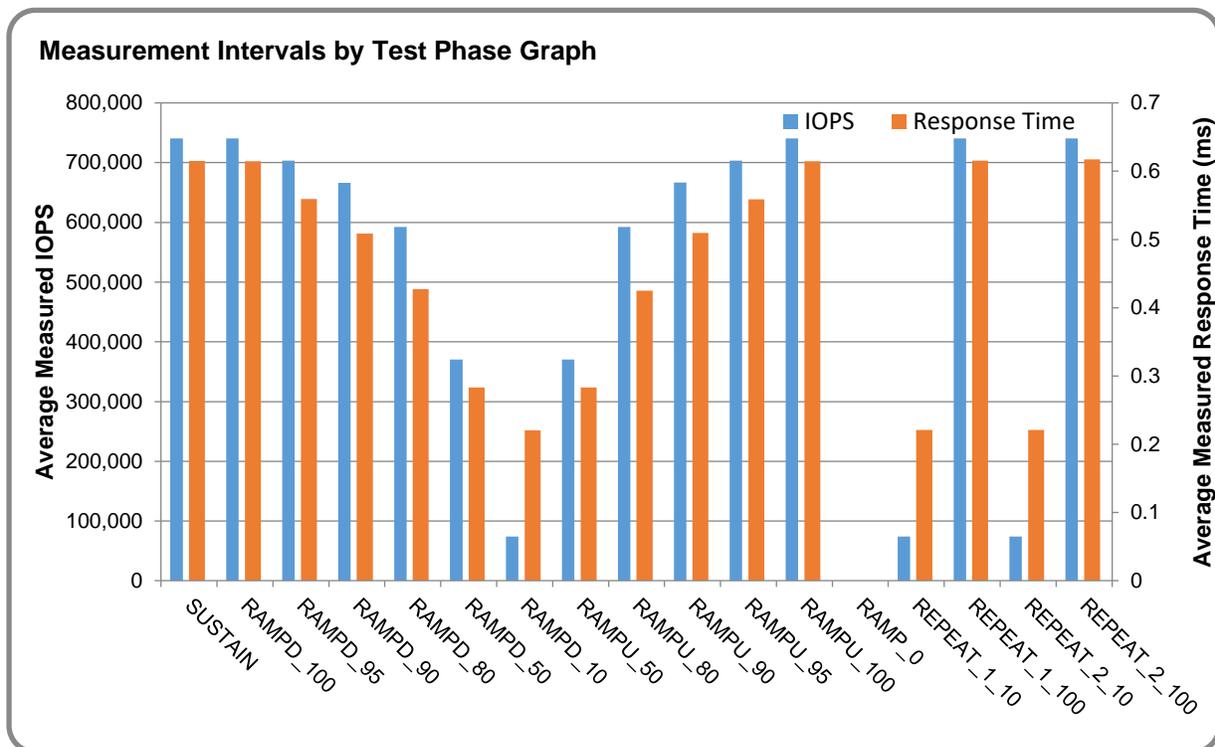
### **Benchmark Execution Overview**

#### **Workload Generator Input Parameters**

The SPC-1 Workload Generator commands and input parameters for the Test Phases are presented in the Supporting Files (see [Appendix A](#)).

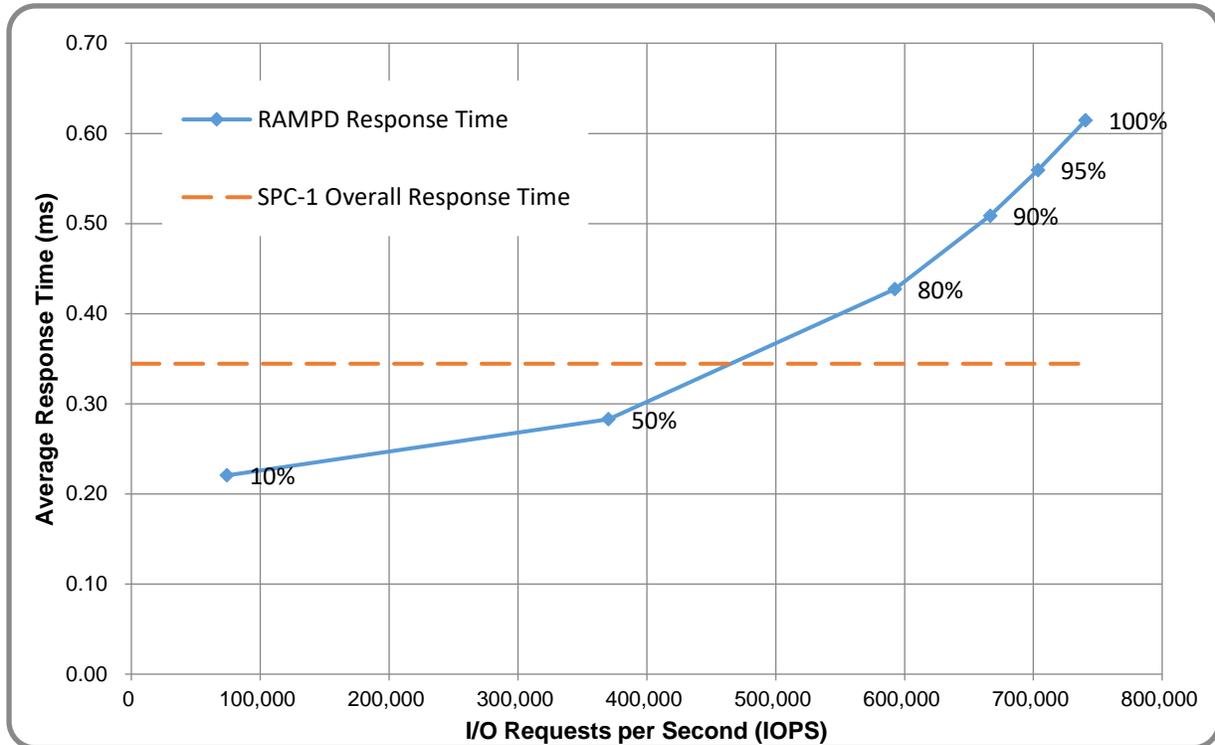
#### **Measurement Intervals by Test Phase Graph**

The following graph presents the average IOPS and the average Response Times measured over the MI of each Test Phase.



### Response Time vs. Throughput Graph

The following graph presents the average Response Times versus the average IOPS for RAMPD\_100 to RAMPD\_10.



### ASU Pre-Fill

The following table provides a summary of the Pre-Fill performed on the ASU prior to testing.

| ASU Pre-Fill Summary |                    |  |              |
|----------------------|--------------------|--|--------------|
| Start Time           | 03-Jan-21 18:20:42 | Requested IOP Level                              | 3,000 MB/sec |
| End Time             | 03-Jan-21 20:05:14 | Observed IOP Level                               | 3,116 MB/sec |
| Duration             | 1:44:32            | For additional details see the Supporting Files. |              |

## SUSTAIN Test Phase

### SUSTAIN – Results File

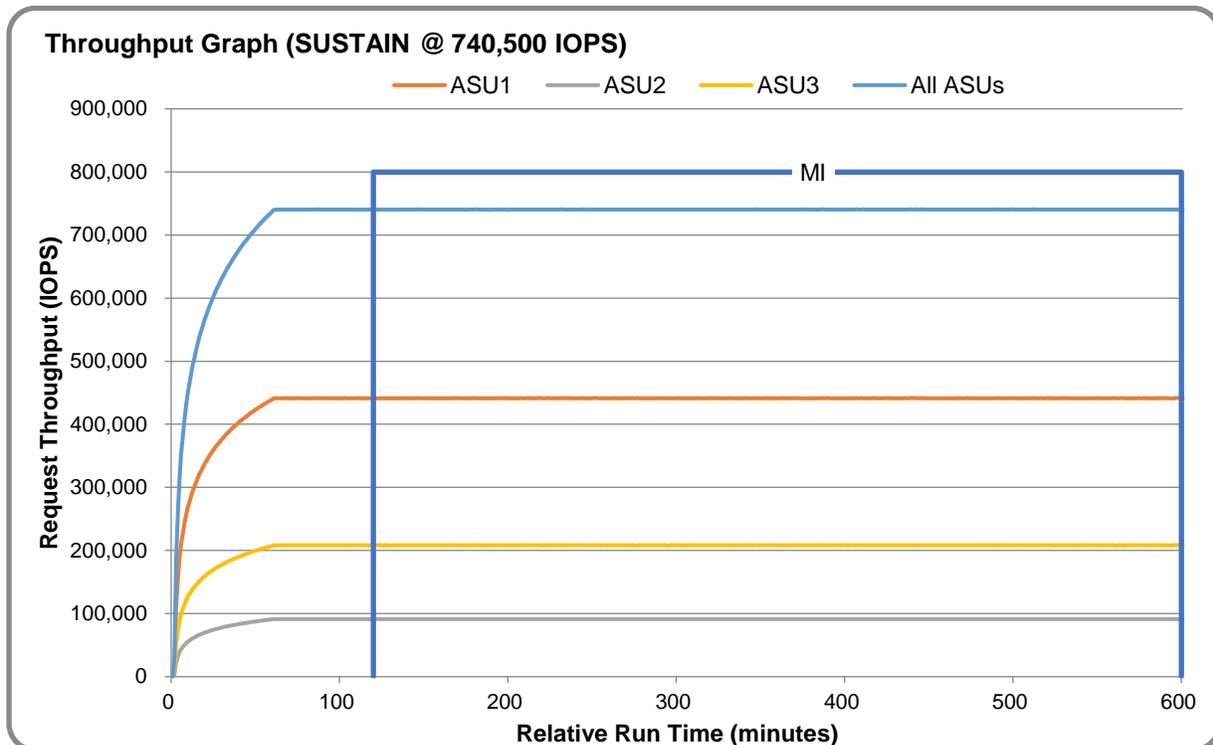
The results file generated during the execution of the SUSTAIN Test Phase is included in the Supporting Files (see [Appendix A](#)) as follows:

- SPC1\_METRICS\_0\_Raw\_Results.xlsx

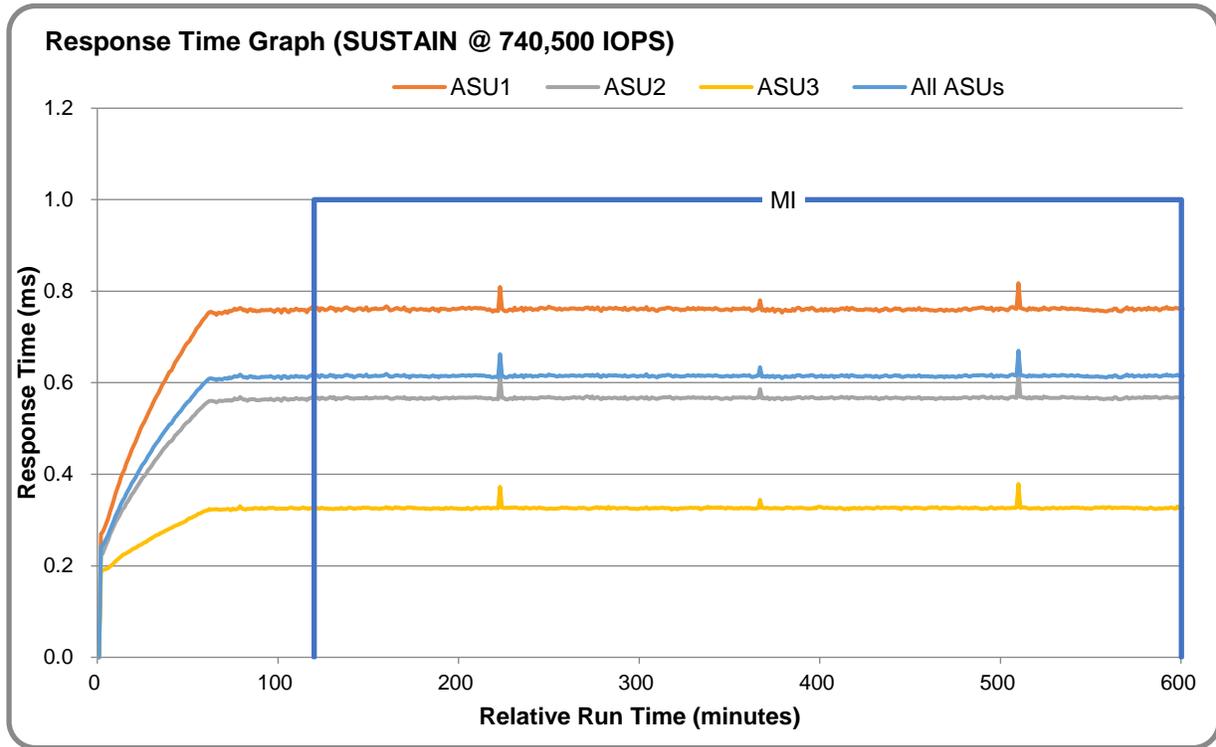
### SUSTAIN – Execution Times

| Interval             | Start Date & Time  | End Date & Time    | Duration |
|----------------------|--------------------|--------------------|----------|
| Transition Period    | 03-Jan-21 20:11:45 | 03-Jan-21 22:11:45 | 2:00:00  |
| Measurement Interval | 03-Jan-21 22:11:45 | 04-Jan-21 06:11:45 | 8:00:00  |

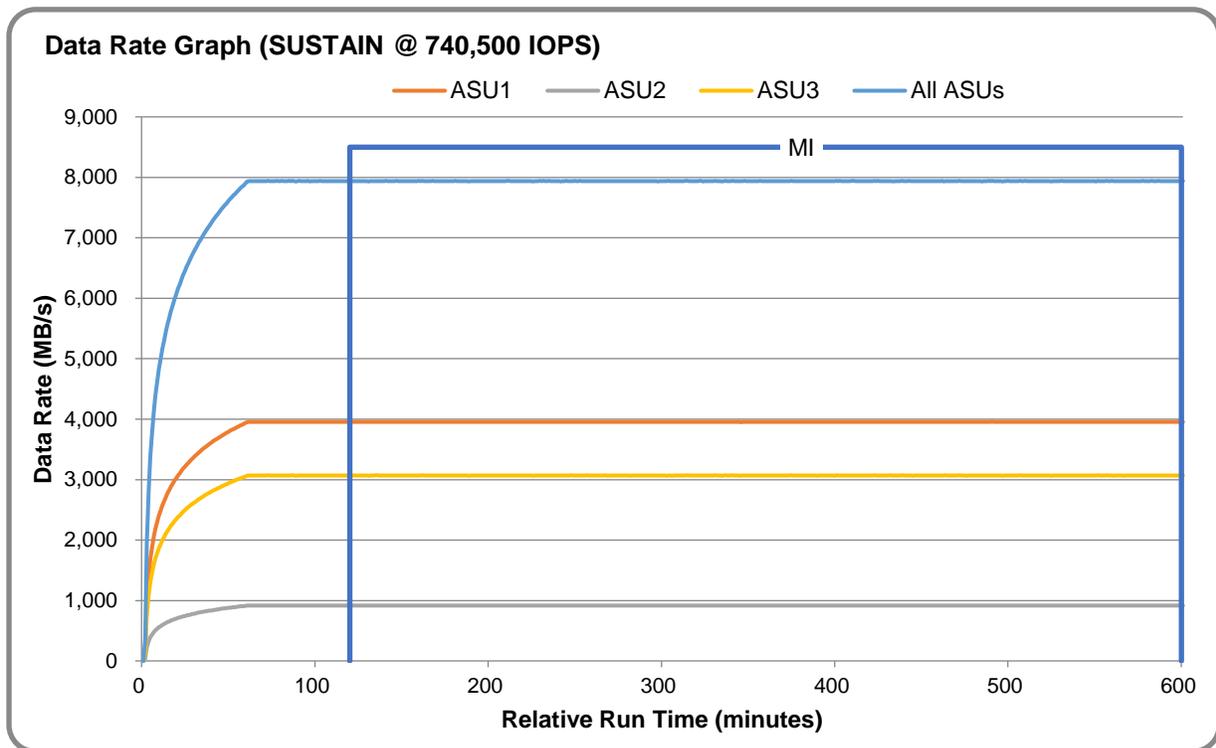
### SUSTAIN – Throughput Graph



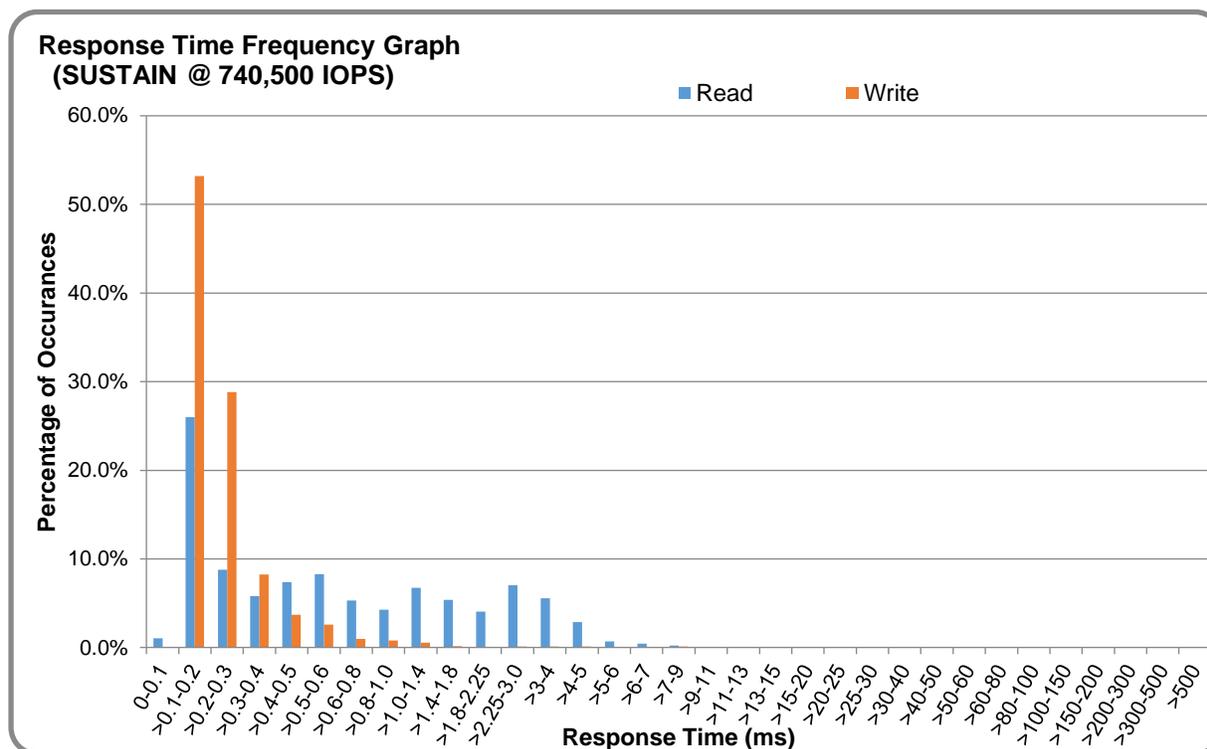
### SUSTAIN – Response Time Graph



### SUSTAIN – Data Rate Graph



### SUSTAIN – Response Time Frequency Graph



### SUSTAIN – Intensity Multiplier

The following table lists the targeted intensity multiplier (Defined), the measured intensity multiplier (Measured) for each I/O stream, its coefficient of variation (Variation), and the percentage of difference (Difference) between Defined and Measured.

|                   | ASU1-1 | ASU1-2 | ASU1-3 | ASU1-4 | ASU2-1 | ASU2-2 | ASU2-3 | ASU3-1 |
|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| <b>Defined</b>    | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| <b>Measured</b>   | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| <b>Variation</b>  | 0.0008 | 0.0002 | 0.0005 | 0.0003 | 0.0011 | 0.0006 | 0.0008 | 0.0002 |
| <b>Difference</b> | 0.003% | 0.001% | 0.000% | 0.001% | 0.000% | 0.001% | 0.011% | 0.000% |

## RAMPD\_100 Test Phase

### RAMPD 100 – Results File

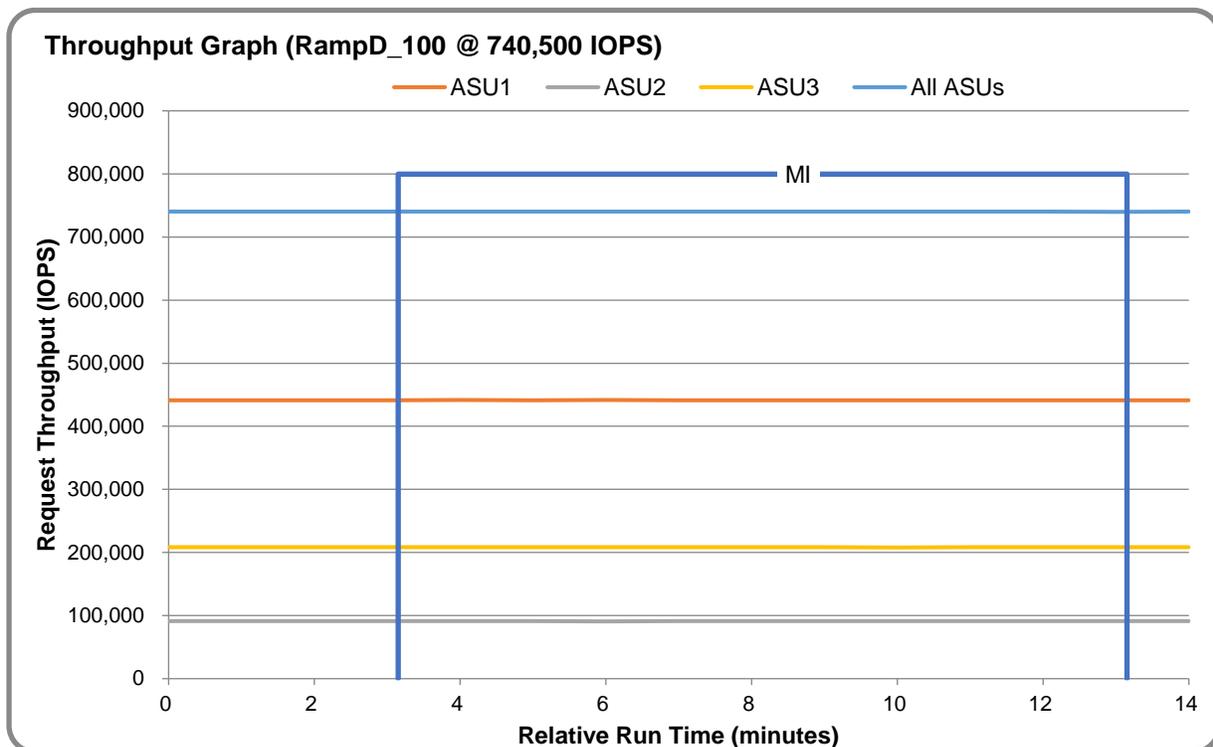
The results file generated during the execution of the RAMPD\_100 Test Phase is included in the Supporting Files (see [Appendix A](#)) as follows:

- SPC1\_METRICS\_0\_Raw\_Results.xlsx

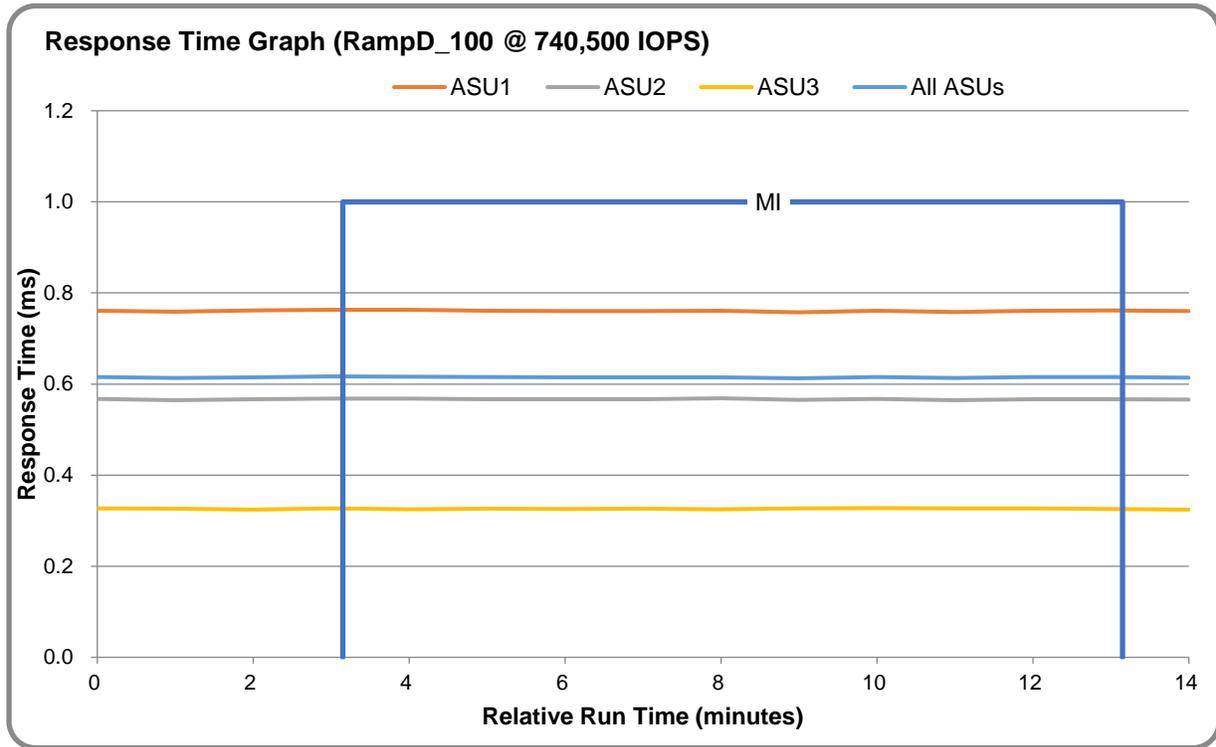
### RAMPD 100 – Execution Times

| Interval             | Start Date & Time  | End Date & Time    | Duration |
|----------------------|--------------------|--------------------|----------|
| Transition Period    | 04-Jan-21 06:12:45 | 04-Jan-21 06:15:45 | 0:03:00  |
| Measurement Interval | 04-Jan-21 06:15:45 | 04-Jan-21 06:25:45 | 0:10:00  |

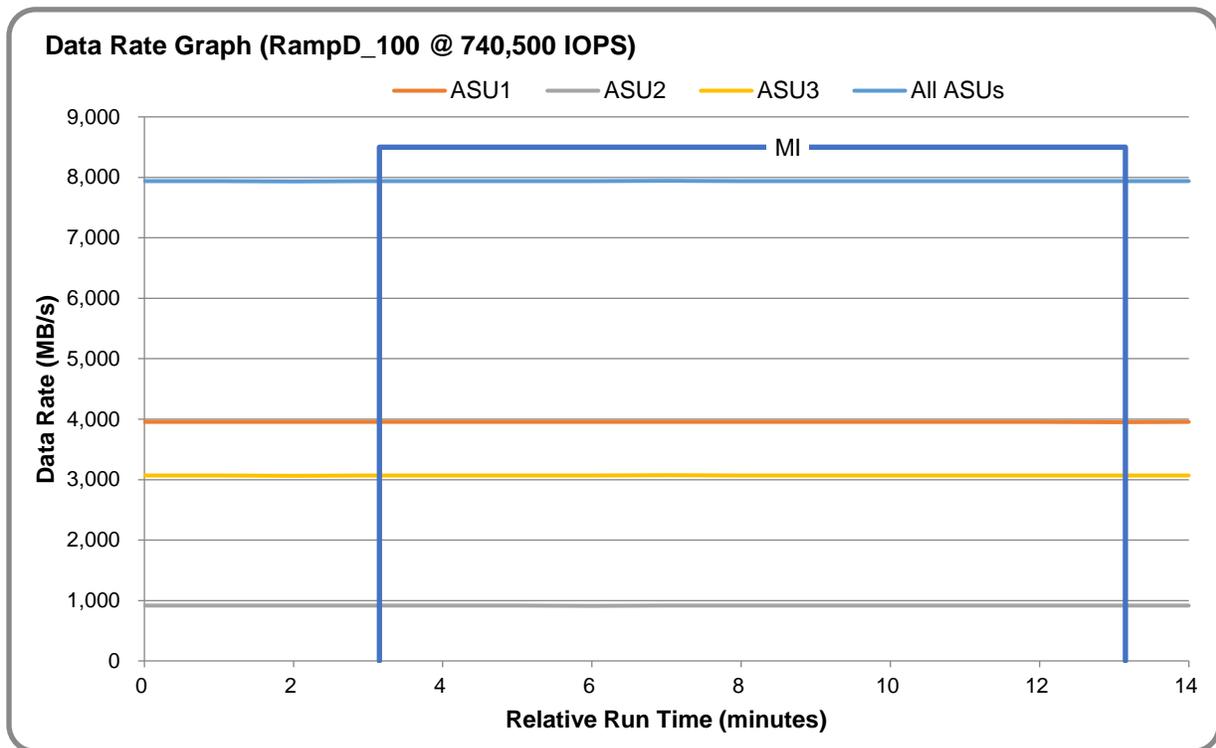
### RAMPD 100 – Throughput Graph



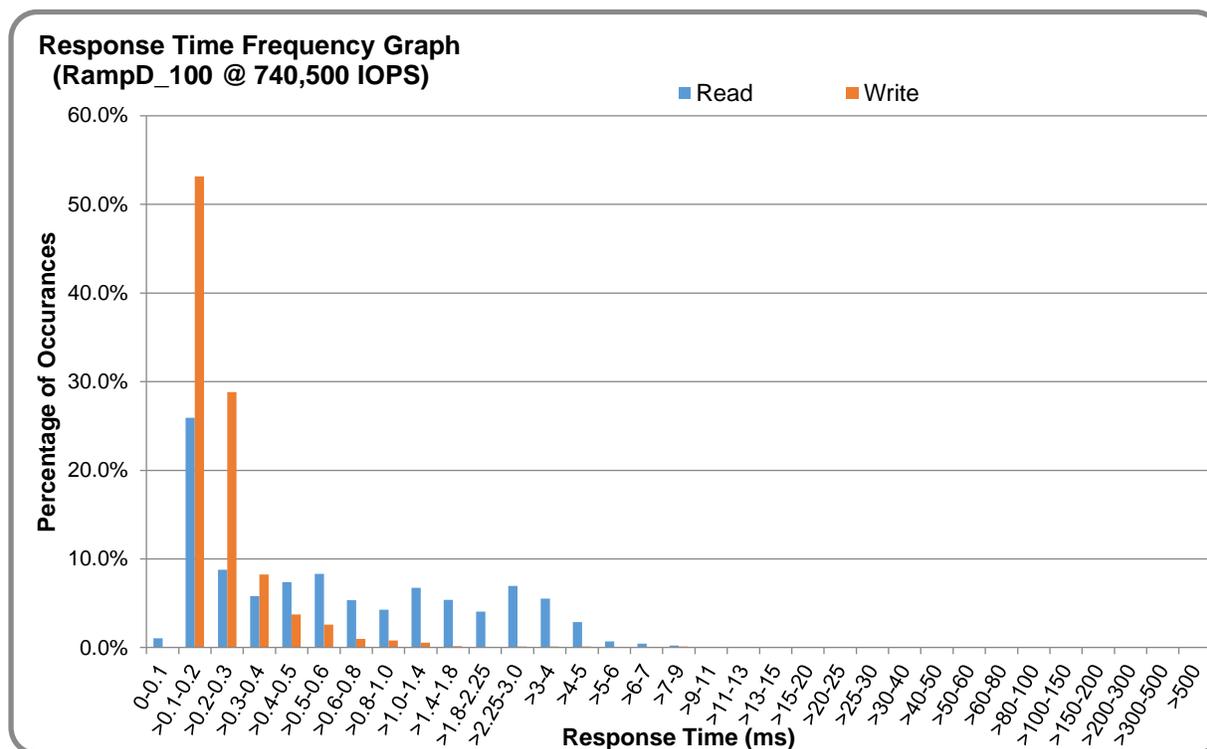
### RAMPD 100 – Response Time Graph



### RAMPD 100 – Data Rate Graph



### RAMPD 100 – Response Time Frequency Graph



### RAMPD 100 – Intensity Multiplier

The following table lists the targeted intensity multiplier (Defined), the measured intensity multiplier (Measured) for each I/O stream, its coefficient of variation (Variation), and the percentage of difference (Difference) between Defined and Measured.

|                   | ASU1-1 | ASU1-2 | ASU1-3 | ASU1-4 | ASU2-1 | ASU2-2 | ASU2-3 | ASU3-1 |
|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| <b>Defined</b>    | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| <b>Measured</b>   | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| <b>Variation</b>  | 0.0007 | 0.0002 | 0.0006 | 0.0003 | 0.0007 | 0.0008 | 0.0009 | 0.0002 |
| <b>Difference</b> | 0.036% | 0.003% | 0.002% | 0.006% | 0.010% | 0.000% | 0.024% | 0.010% |

### RAMPD 100 – I/O Request Summary

|  |             |
|--|-------------|
| <b>I/O Requests Completed in the Measurement Interval</b>    | 444,302,018 |
| <b>I/O Requests Completed with Response Time &lt;= 30 ms</b> | 444,299,138 |
| <b>I/O Requests Completed with Response Time &gt; 30 ms</b>  | 2,880       |

## Response Time Ramp Test

### Response Time Ramp Test – Results File

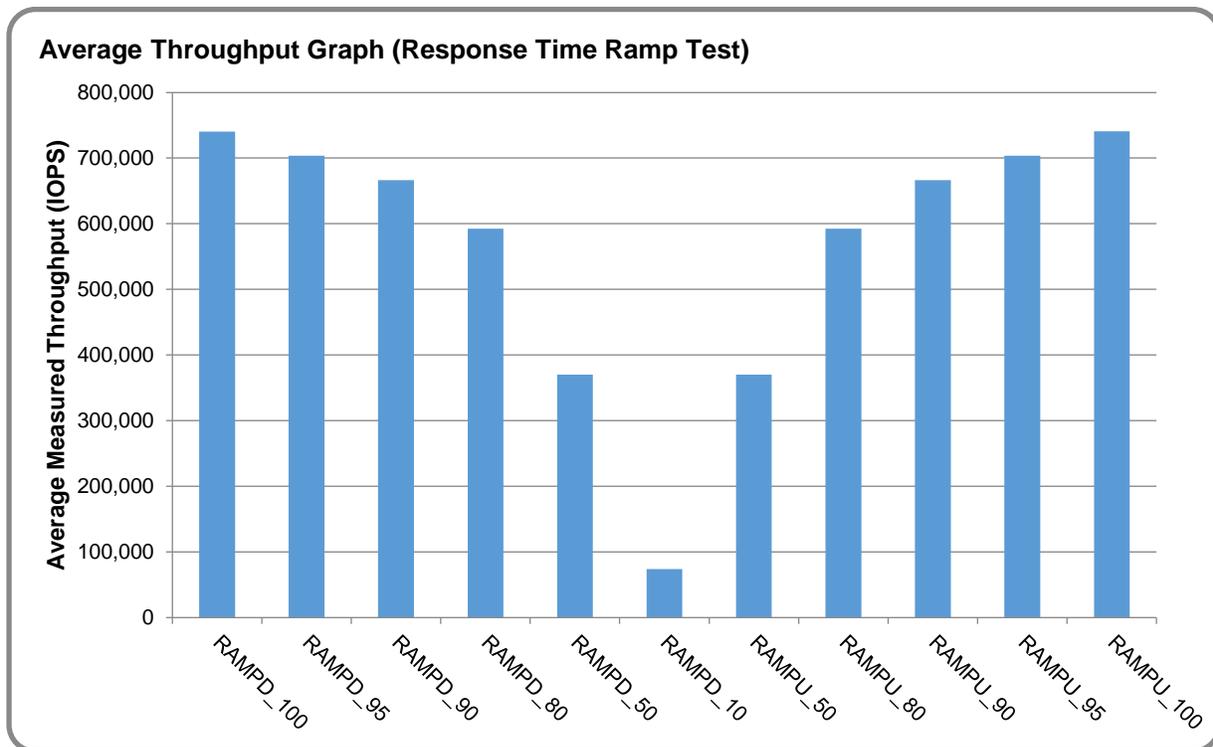
The results file generated during the execution of the Response Time Ramp Test is included in the Supporting Files (see [Appendix A](#)) as follows:

- **SPC1\_METRICS\_0\_Raw\_Results.xlsx**

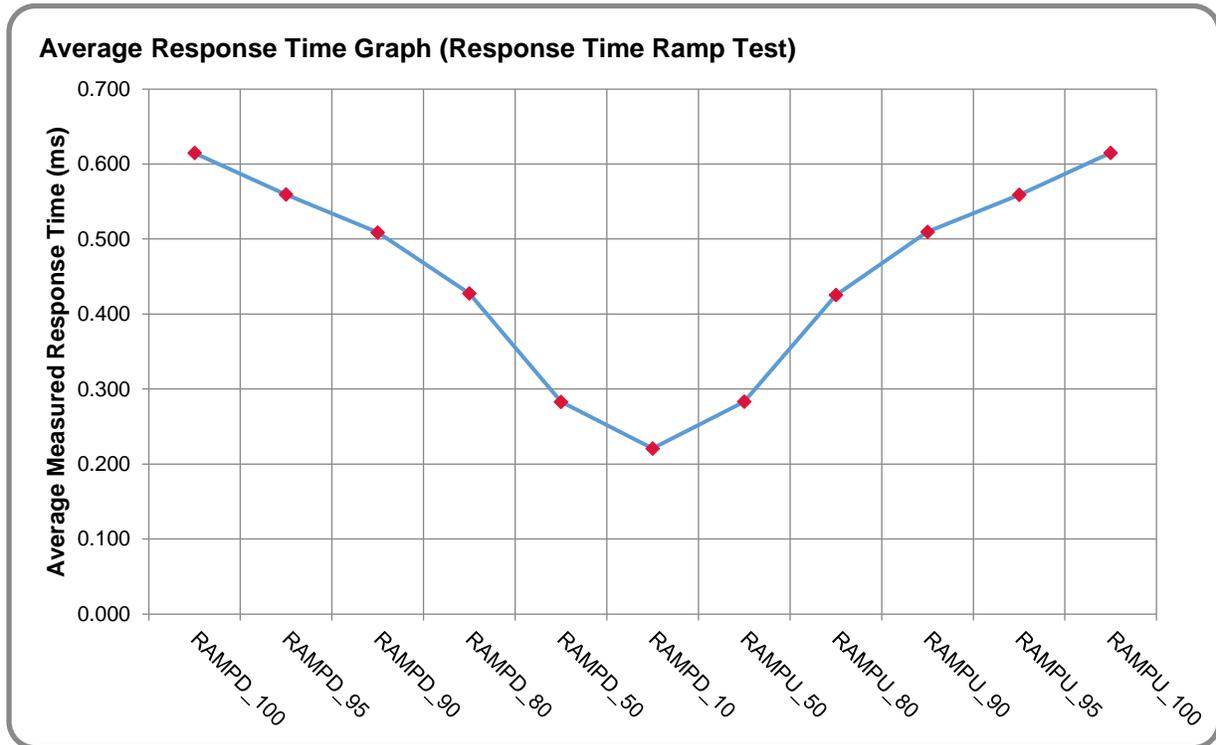
### Response Time Ramp Test – Phases

The Response Time Ramp Test is comprised of 11 Test Phases, including six Ramp-Down Phases (executed at 100%, 95%, 90%, 80%, 50%, and 10% of the Business Scaling Unit) and five Ramp-Up Phases (executed at 50%, 80%, 90%, 95%, and 100% of the Business Scaling Unit).

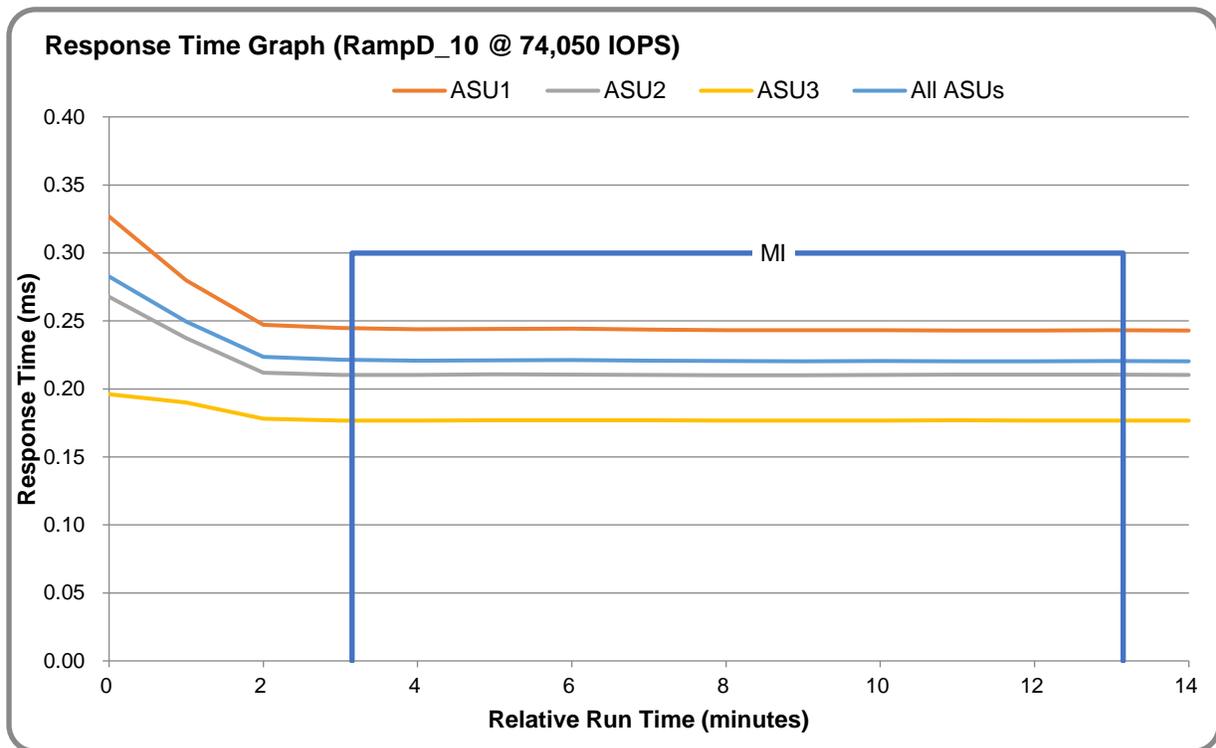
### Response Time Ramp Test – Average Throughput Graph



**Response Time Ramp Test – Average Response Time Graph**



**Response Time Ramp Test – RAMPD 10 Response Time Graph**



## Repeatability Test

### Repeatability Test Results File

The results file generated during the execution of the Repeatability Test is included in the Supporting Files (see [Appendix A](#)) as follows:

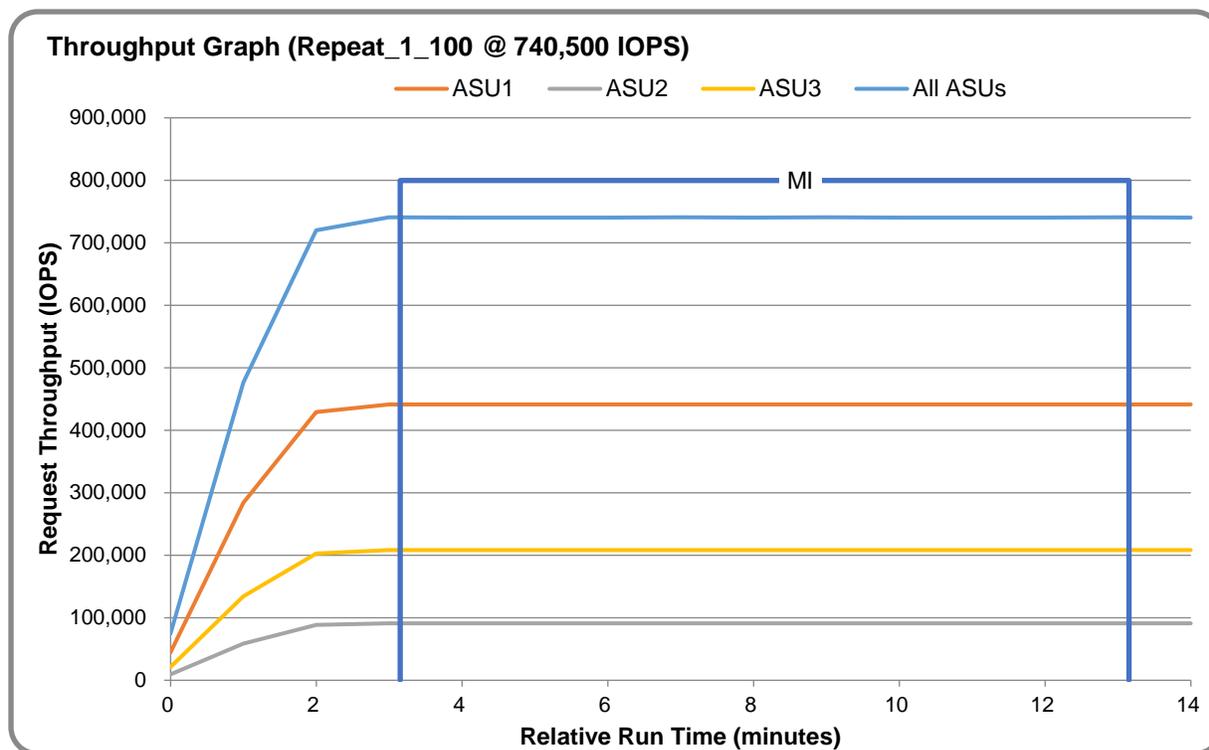
- **SPC1\_METRICS\_0\_Raw\_Results.xlsx**

### Repeatability Test Results

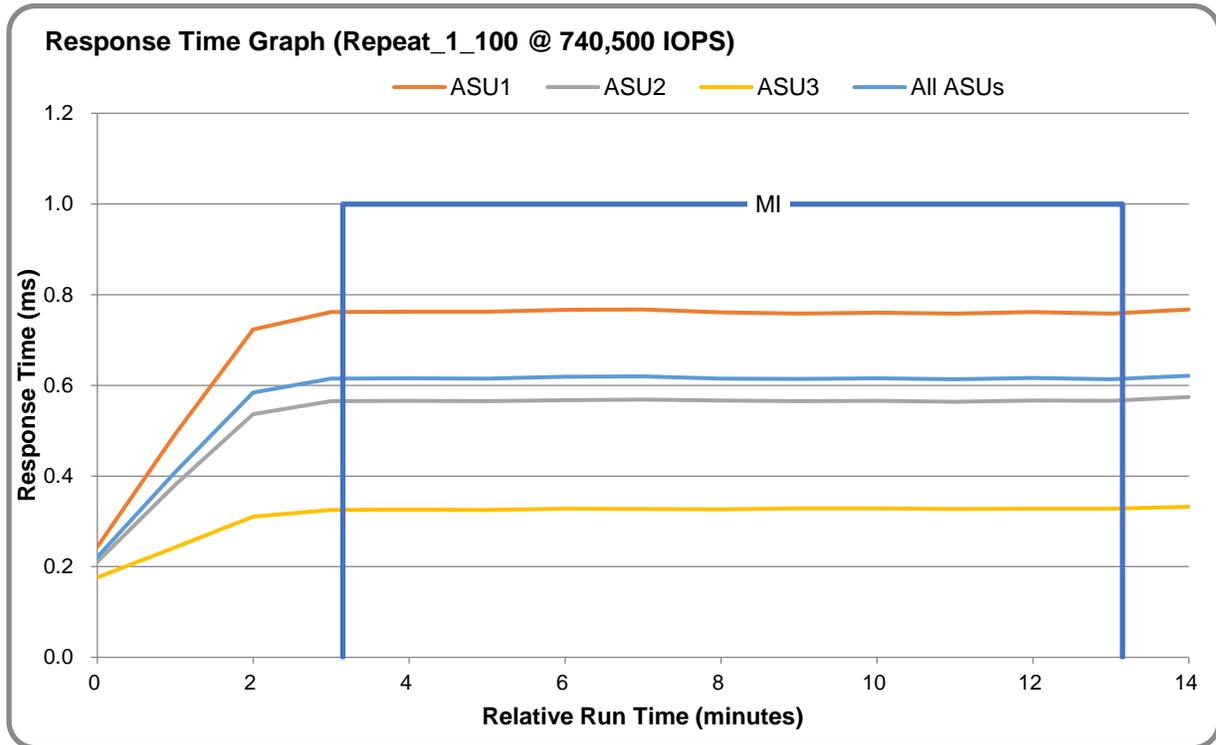
The throughput measurements for the Response Time Ramp Test (RAMPD) and the Repeatability Test Phases (REPEAT\_1 and REPEAT\_2) are listed in the table below.

| Test Phase | 100% IOPS | 10% IOPS |
|------------|-----------|----------|
| RAMPD      | 740,523.7 | 74,052.8 |
| REPEAT_1   | 740,549.8 | 74,050.0 |
| REPEAT_2   | 740,576.2 | 74,065.0 |

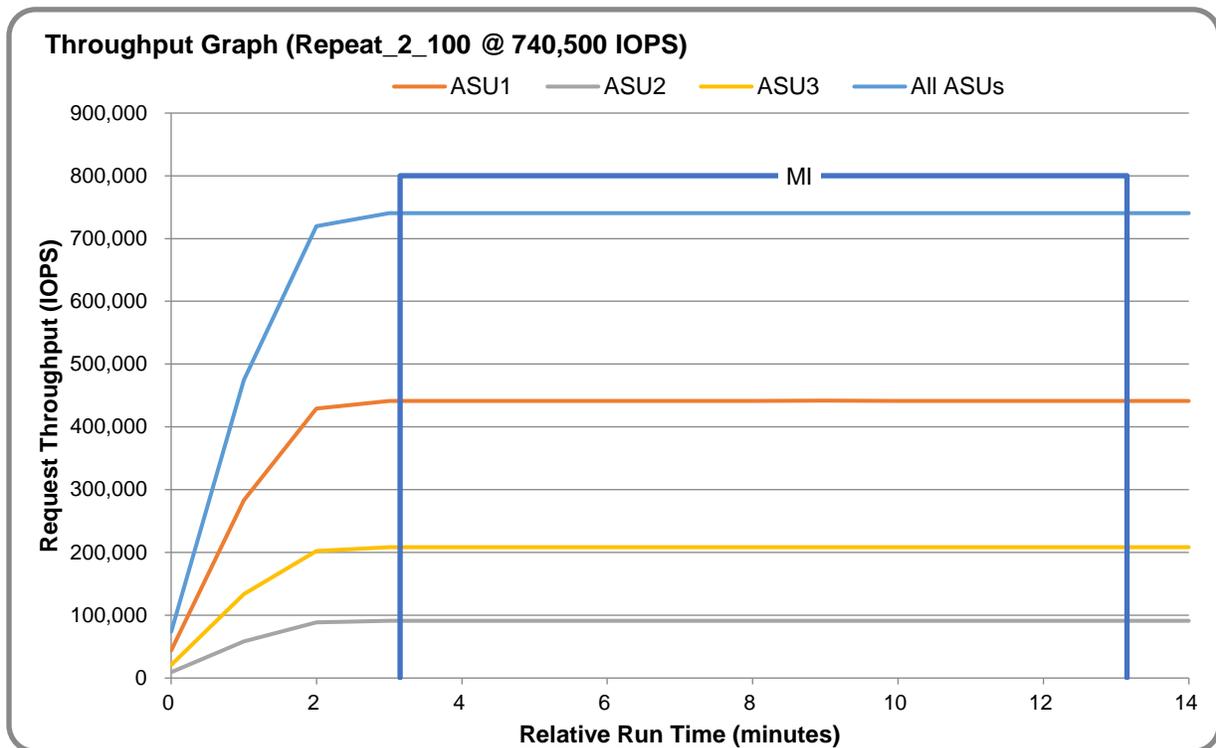
### REPEAT 1 100 - Throughput Graph



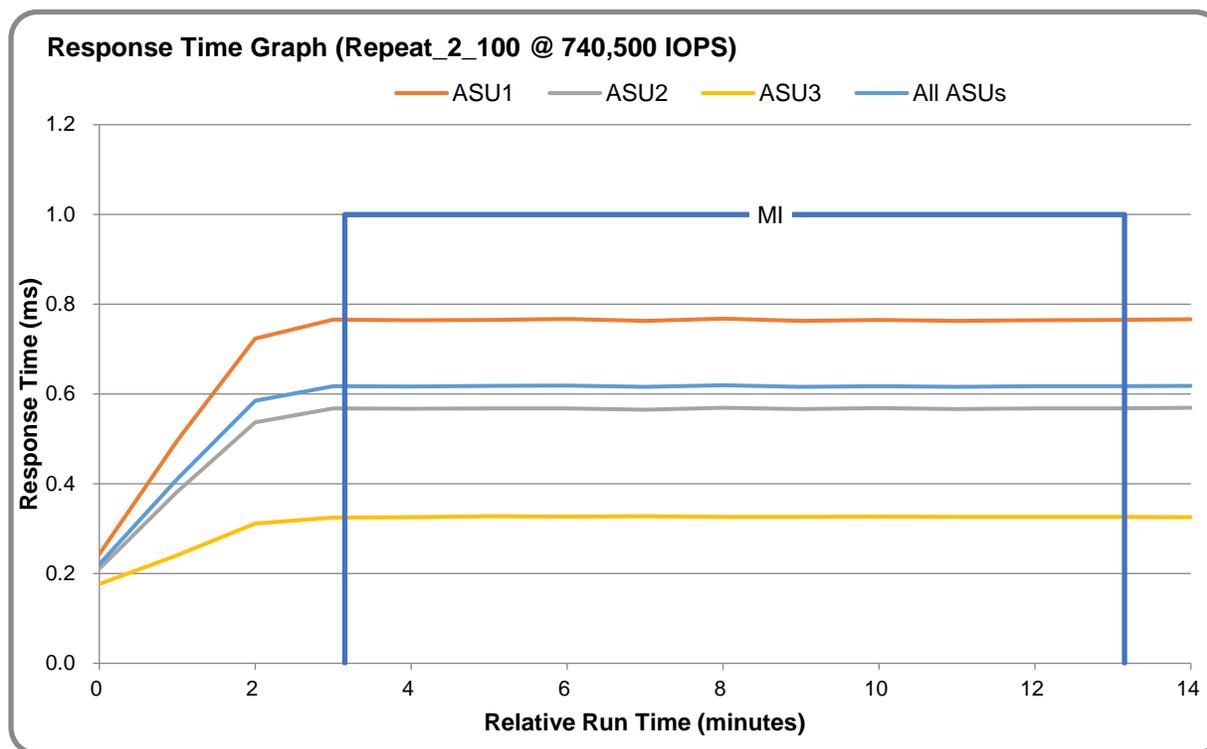
### REPEAT 1 100 – Response Time Graph



### REPEAT 2 100 – Throughput Graph



### REPEAT 2 100 – Response Time Graph



### Repeatability Test – Intensity Multiplier

The following tables lists the targeted intensity multiplier (Defined), the measured intensity multiplier (Measured) for each I/O stream, its coefficient of variation (Variation), and the percent of difference (Difference) between Defined and Measured.

#### REPEAT\_1\_100 Test Phase

|                   | ASU1-1 | ASU1-2 | ASU1-3 | ASU1-4 | ASU2-1 | ASU2-2 | ASU2-3 | ASU3-1 |
|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| <b>Defined</b>    | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| <b>Measured</b>   | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| <b>Variation</b>  | 0.0005 | 0.0002 | 0.0008 | 0.0002 | 0.0010 | 0.0005 | 0.0009 | 0.0002 |
| <b>Difference</b> | 0.050% | 0.016% | 0.007% | 0.015% | 0.092% | 0.008% | 0.007% | 0.009% |

#### REPEAT\_2\_100 Test Phase

|                   | ASU1-1 | ASU1-2 | ASU1-3 | ASU1-4 | ASU2-1 | ASU2-2 | ASU2-3 | ASU3-1 |
|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| <b>Defined</b>    | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| <b>Measured</b>   | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| <b>Variation</b>  | 0.0006 | 0.0001 | 0.0004 | 0.0003 | 0.0008 | 0.0006 | 0.0006 | 0.0002 |
| <b>Difference</b> | 0.014% | 0.001% | 0.004% | 0.013% | 0.091% | 0.016% | 0.012% | 0.007% |

## Data Persistence Test

### Data Persistence Test Results File

The results files generated during the execution of the Data Persistence Test is included in the Supporting Files (see [Appendix A](#)) as follows:

- **SPC1\_PERSIST\_1\_0\_Raw\_Results.xlsx**
- **SPC1\_PERSIST\_2\_0\_Raw\_Results.xlsx**

### Data Persistence Test Execution

The Data Persistence Test was executed using the following sequence of steps:

- The PERSIST\_1\_0 Test Phase was executed to completion.
- The Benchmark Configuration was taken through an orderly shutdown process and powered off.
- The Benchmark Configuration was powered on and taken through an orderly startup process.
- The PERSIST\_2\_0 Test Phase was executed to completion.

### Data Persistence Test Results

| <b>Data Persistence Test Phase: Persist1</b>                    |             |
|---|-------------|
| <b>Total Number of Logical Blocks Written</b>                   | 152,138,861 |
| <b>Total Number of Logical Blocks Verified</b>                  | 79,457,818  |
| <b>Total Number of Logical Blocks Overwritten</b>               | 72,681,043  |
| <b>Total Number of Logical Blocks that Failed Verification</b>  | 0           |
| <b>Time Duration for Writing Test Logical Blocks (sec.)</b>     | 600         |
| <b>Size in bytes of each Logical Block</b>                      | 8,192       |
| <b>Number of Failed I/O Requests in the process of the Test</b> | 0           |

### Committed Data Persistence Implementation

Committed data persistence is implemented at two levels. At the drive level, data loss is prevented using RAID-10 arrays. At the controller level, all caches are mirrored across controllers, where write requests are only completed once the local cache has been successfully mirrored in another controller's cache. In addition, cache content is protected from a loss of power by flushing the cache content to permanent flash memory as soon as a power loss is detected. The flushing action is powered by a battery backup located in each controller.

## **APPENDIX A: SUPPORTING FILES**

The following table details the content of the Supporting Files provided as part of this Full Disclosure Report.

| <b>File Name</b>                    | <b>Description</b>                       | <b>Location</b> |
|-------------------------------------|--|-----------------|
| <b>/SPC1_RESULTS</b>                | <b>Data reduction worksheets</b>         | <b>root</b>     |
| SPC1_INIT_0_Raw_Results.xlsx        | Raw results for INIT Test Phase          | /SPC1_RESULTS   |
| SPC1_METRICS_0_Quick_Look.xlsx      | Quick Look Test Run Overview             | /SPC1_RESULTS   |
| SPC1_METRICS_0_Raw_Results.xlsx     | Raw results for Primary Metrics Test     | /SPC1_RESULTS   |
| SPC1_METRICS_0_Summary_Results.xlsx | Primary Metrics Summary                  | /SPC1_RESULTS   |
| SPC1_PERSIST_1_0_Raw_Results.xlsx   | Raw results for PERSIST1 Test Phase      | /SPC1_RESULTS   |
| SPC1_PERSIST_2_0_Raw_Results.xlsx   | Raw results for PERSIST2 Test Phase      | /SPC1_RESULTS   |
| SPC1_Run_Set_Overview.xlsx          | Run Set Overview Worksheet               | /SPC1_RESULTS   |
| SPC1_VERIFY_0_Raw_Results.xlsx      | Raw results for first VERIFY Test Phase  | /SPC1_RESULTS   |
| SPC1_VERIFY_1_Raw_Results.xlsx      | Raw results for second VERIFY Test Phase | /SPC1_RESULTS   |
| <b>/C_Tuning</b>                    | <b>Tuning parameters and options</b>     | <b>root</b>     |
| aio-max-nr.sh                       | Set maximum asynchronous I/O             | /C_Tuning       |
| nr_requests.sh                      | Increase disk queue depth                | /C_Tuning       |
| scheduler.sh                        | Change the I/O scheduler                 | /C_Tuning       |
| <b>/D_Creation</b>                  | <b>Storage configuration creation</b>    | <b>root</b>     |
| mklun.txt                           | Create the storage environment           | /D_Creation     |
| mkvolume.sh                         | Create the logical volumes               | /D_Creation     |
| <b>/E_Inventory</b>                 | <b>Configuration inventory</b>           | <b>root</b>     |
| profile1_storage.log                | List of storage devices before INIT      | /E_Inventory    |
| profile1_volume.log                 | List of logical volumes before INIT      | /E_Inventory    |
| Profile2_storage.log                | List of storage devices after restart    | /E_Inventory    |
| Profile2_volume.log                 | List of logical volumes after restart    | /E_Inventory    |
| <b>/F_Generator</b>                 | <b>Workload generator</b>                | <b>Root</b>     |
| 2host.HST                           | Host configuration file                  | /F_Generator    |
| full_run.sh                         | Execute all test phases                  | /F_Generator    |
| slave_asu.asu                       | Defines LUNs hosting the ASUs            | /F_Generator    |

## **APPENDIX B: THIRD PARTY QUOTATION**

All components are available directly through the Test Sponsor (Huawei Technologies Co., Ltd.).

## **APPENDIX C: TUNING PARAMETERS AND OPTIONS**

The following scripts were used to set the tuning parameters and options.

- aio-max-nr.sh – set the maximum number of AIO operations to 10485760
- nr\_requests.sh – set nr\_requests to 4096 for each device
- scheduler.sh – set the I/O scheduler to noop for each device

Details are available in the Supporting Files (see [Appendix A](#)).

## **APPENDIX D: STORAGE CONFIGURATION CREATION**

The scripts referenced in Steps 2 and 3 appear in the section, Referenced Scripts.

### **Step 1: Create Disk Domains, Storage Pools, LUNs, LUN Group**

**mklun.txt** is a script including all the CLI commands to create disk domains, storage pools, LUNs and compression is disable:

- Create 2 **disk\_domain**
- Create 2 **storage\_pool**
- Create 8 **lun**
- Create one **lun\_group(lg0)**
- Add the 8 LUNs to **lun\_group, lg0**

```
create disk_domain name=dd0 disk_list=CTE0.0-11 disk_domain_id=0
create disk_domain name=dd1 disk_list=CTE1.0-11 disk_domain_id=1
```

```
create storage_pool name=pool0 disk_type=SSD capacity=9445GB pool_id=0 raid_level=RAID10 disk_domain_id=0
stripe_depth=64KB
```

```
create storage_pool name=pool1 disk_type=SSD capacity=9445GB pool_id=1 raid_level=RAID10 disk_domain_id=1
stripe_depth=64KB
```

```
create lun name=lun1 pool_id=0 capacity=2350GB owner_controller=0A lun_id=1 lun_type=thick
create lun name=lun2 pool_id=0 capacity=2350GB owner_controller=0A lun_id=2 lun_type=thick
create lun name=lun3 pool_id=0 capacity=2350GB owner_controller=0B lun_id=3 lun_type=thick
create lun name=lun4 pool_id=0 capacity=2350GB owner_controller=0B lun_id=4 lun_type=thick
create lun name=lun5 pool_id=1 capacity=2350GB owner_controller=1A lun_id=5 lun_type=thick
create lun name=lun6 pool_id=1 capacity=2350GB owner_controller=1A lun_id=6 lun_type=thick
create lun name=lun7 pool_id=1 capacity=2350GB owner_controller=1B lun_id=7 lun_type=thick
create lun name=lun8 pool_id=1 capacity=2350GB owner_controller=1B lun_id=8 lun_type=thick
```

```
create lun_group name=lg lun_group_id=1
add lun_group lun lun_group_id=1 lun_id_list=1-8
```

### **Step 2: Create Mapping View, Host Group and Host**

Execute the following commands using the OceanStor 5600V5 CLI from the Host System to complete the following:

- Create 2 **hosts**
- Create one **host\_group (hg)**
- Add 2 **hosts** to **hg**
- Add the FC ports' WWN to 2 **hosts**
- Create one **mapping\_view (mv1)**

```
create host name=h1 operating_system=Linux host_id=1
create host name=h2 operating_system=Linux host_id=2
```

```
add host_group host host_group_id=1 host_id_list=1,2
```

```
add host initiator host_id=1 initiator_type=FC wwn=210034800d706fce  
add host initiator host_id=1 initiator_type=FC wwn=210034800d706fcf  
add host initiator host_id=1 initiator_type=FC wwn=210034800d706d96  
add host initiator host_id=1 initiator_type=FC wwn=210034800d706d97  
add host initiator host_id=1 initiator_type=FC wwn=210034800d7072a0  
add host initiator host_id=1 initiator_type=FC wwn=210034800d7072a1  
add host initiator host_id=1 initiator_type=FC wwn=210034800d6fd9f8  
add host initiator host_id=1 initiator_type=FC wwn=210034800d6fd9f9
```

```
add host initiator host_id=2 initiator_type=FC wwn=2100f4e9d4556300  
add host initiator host_id=2 initiator_type=FC wwn=2100f4e9d4556301  
add host initiator host_id=2 initiator_type=FC wwn=2100f4e9d4554962  
add host initiator host_id=2 initiator_type=FC wwn=2100f4e9d4554963  
add host initiator host_id=2 initiator_type=FC wwn=210034800d706da0  
add host initiator host_id=2 initiator_type=FC wwn=210034800d706da1  
add host initiator host_id=2 initiator_type=FC wwn=210034800d6fda8c  
add host initiator host_id=2 initiator_type=FC wwn=210034800d6fda8d
```

```
create mapping_view name=mv mapping_view_id=1 lun_group_id=1 host_group_id=1
```

### **Step 3: Create Volumes on the Master Host System**

Execute the [mkvolume.sh](#) script on the Master Host System to create 38 logical volumes as follows:

#### **1. Create Physical Volume**

Create 8 physical volumes using the **pvcreate** command.

#### **2. Create Volumes Groups**

Create one volume group (**vg1**) using the **vgcreate** command and the following 8 physical volumes:

**/dev/sdb /dev/sdc /dev/sdd /dev/sde /dev/sdf /dev/sdg /dev/sdh /dev/sdi** **Create Logical Volumes**

- Create 18 logical volumes, each with a capacity of 455 GiB, on **vg1** for ASU-1.
- Create 18 logical volumes, each with a capacity of 455 GiB, on **vg1** for ASU-2.
- Create 2 logical volumes, each with a capacity of 910 GiB, on **vg1** for ASU-3.

### **Step 4: Change the Scheduler on each Host System**

Execute the [scheduler.sh](#) script on the Host System to change the I/O scheduler from cfq to noop on each Host System, which will result in all incoming I/O requests inserted into a simple, unordered FIFO queue.

### **Step 5: Change the nr requests on each Host System**

Execute the [nr\\_requests.sh](#) script on the Host System to change nr\_requests from 128 to 4096 on each Host System for each device.

### **Step 6: Change the aio-max-nr on each Host System**

Execute the [aio-max-nr.sh](#) script on the Host System to change the maximum number of AIO operations to 10485760.

### **Referenced Scripts**

**mklun.txt** is a script including all the CLI commands to create disk domains, storage pools, LUNs.

**mkvolume.sh** is a Linux shell script, which is used to create Physical Volumes, Volume Groups, Logical Volumes.

**collectinfo.sh** shows profiles of the storage, including controllers, fans, powers, Disk Domains, storage pools, LUNs, mapping views and disks.

**scheduler.sh** is a Linux shell script, which is used to change the I/O scheduler from **cfq** to **noop** on each Host System, which will result in all incoming I/O requests inserted into a simple, unordered FIFO queue.

**nr\_requests.sh** is a Linux shell script, which is used to change nr\_requests from 128 to 2048 on each Host System for each device.

**aio-max-nr.sh** is a Linux shell script, which is used to change the maximum number of AIO operations to 10485760.

**full\_run.sh** is a Linux shell script, executed on Master Host(host1), show profiles of the storage and volumes, run Init, Verify, Metrics, Repeat,Verify, Persist1 and Persist2 Test.

**slave\_asu.asu** is a configuration file including all the ASU configuration.

**host.HST** is a configuration file including all hosts configuration.

## **APPENDIX E: CONFIGURATION INVENTORY**

An inventory of the TSC was collected during the execution of the script `full_run.sh`. It generated the following log files.

- `profile1_storage.log` – list of configured storage before the INIT phase
- `profile1_volume.log` – list of configured volumes before the INIT phase
- `profile2_storage.log` – list of configured storage after TSC restart
- `profile2_volume.log` – list of configured volumes after TSC restart

The above log files are included in the Supporting Files (see [Appendix A](#)).

## **APPENDIX F: WORKLOAD GENERATOR**

The ASUs accessed by the SPC-1 workload generator, are defined using the script `slave_asu.asu`.

The phases of the benchmark are executed using the script `full_run.sh`. The script pauses at the end of the PERSIST\_1 test phase. Once the TSC has been restarted, the PERSIST\_2 test phase is executed by pressing ENTER from the console where the script has been invoked.

The above scripts are included in the Supporting Files (see [Appendix A](#)).