



SPC BENCHMARK 1™

FULL DISCLOSURE REPORT

TELECOMMUNICATIONS TECHNOLOGY ASSOCIATION

GLUESYS ANYSTOR-700EK

SPC-1™ v3.10.0

SUBMISSION IDENTIFIER: A32025

SUBMITTED FOR REVIEW: DECEMBER 23, 2022

First Edition – December 2022

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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.

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

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AUDIT CERTIFICATION



Hyo-Sil Kim
 Telecommunications Technology Association
 47, Bundang-ro, Bundang-gu, Seongnam-city
 Gyeonggi-do, 13591
 Republic of Korea

December 22, 2022

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

Gluesys AnyStor-700EK

The results were:

SPC-1 IOPS™	520,028
SPC-1 Price-Performance	\$84.73/SPC-1 KIOPS™
SPC-1 Total System Price	44,060.00
SPC-1 IOPS Response Time	0.182 ms
SPC-1 Overall Response Time	0.143 ms
SPC-1 ASU Capacity	16,106 GB
SPC-1 ASU Price	\$2.74/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 Telecommunications Technology Association, stating the accuracy and completeness of the documentation and testing data provided in support of the audit of this result.

A32025

Gluesys AnyStor-700EK

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A Full Disclosure Report for this result was prepared by InfoSizing, reviewed and approved by Telecommunications Technology Association, and can be found at www.spcresults.org under the Submission Identifier A32025.

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

- The physical capacity of the data repository (38,400 GB).
- The total capacity of the Application Storage Unit (16,106 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

LETTER OF GOOD FAITH



47, Bundang-ro, Bundang-gu, Seongnam-city,
Gyeonggi-do, 13591, Republic of Korea
TEL: 82-31-724-0114

December 21, 2022

From: Telecommunications Technology Association

To: Mr. Doug Johnson, Certified SPC Auditor
InfoSizing
63 Lourdes Drive
Leominster, MA 01453

Subject: SPC-1 Letter of Good Faith for GLUESYS Anystor-700EK

Telecommunications Technology Association is the SPC-1 Test Sponsor for the above listed project. 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 V3.10 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, which appears to read 'Cheolsoon Park', is written over a horizontal line.

Cheol-Soon Park
Vice President,
Telecommunications Technology Association

Date:

A handwritten date 'December 21, 2022' is written in black ink over a horizontal line.

Gluesys AnyStor-700EK

SPC-1 IOPS™	520,028	SPC-1 Price Performance	\$84.73/SPC-1 KIOPS™
SPC-1 IOPS Response Time	0.182 ms	SPC-1 Total System Price	\$44,060.00
SPC-1 Overall Response Time	0.143 ms	SPC-1 Overall Discount	48.50%
		Currency / Target Country	USD / Korea
		Availability Date	December 23, 2022

Extensions

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

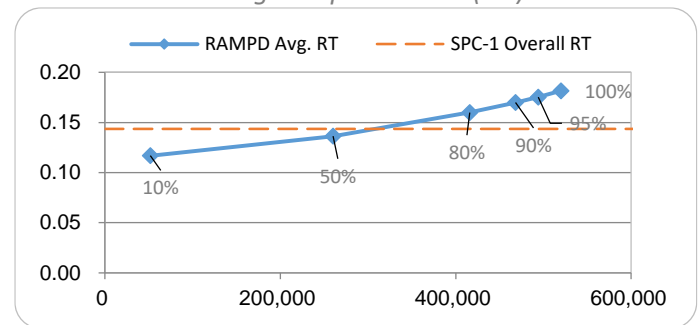
Storage Metrics

SPC-1 Data Protection Level	Protected 1
SPC-1 Physical Storage Capacity	38,400 GB
SPC-1 ASU Capacity	16,106 GB
SPC-1 ASU Price	\$2.74/GB

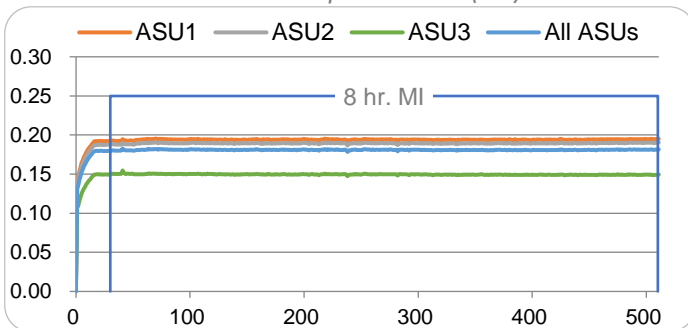
Priced Storage Configuration Summary

- 1 Mellanox 100 Gbps IB HCA (dual port)
- 1 Gluesys AnyStor-700EK
- 1 Controller
- 64 GB Total Cache
- 2 Total Front-End Ports
- 12 Total Storage Devices (NVMe SSD)
- 2 Total RUs

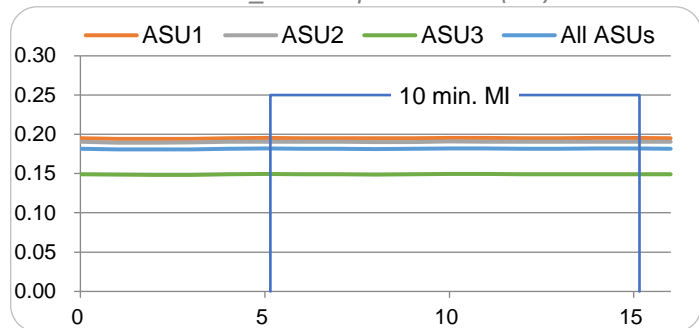
RAMPD Average Response Time (ms) vs. IOPS



SUSTAIN Response Time (ms)



RAMPD_100 Response Time (ms)



PRICING DETAILS

Part No.	Description	Source	Qty	Unit Price	Ext. Price	Disc.	Disc. Price
Hardware & Software							
AS700EK	1x Ampere Altra CPU, up to 80 Arm v8.2+ 64-bit CPU cores at up to 3.30 GHz with Sustained Turbo 64GB Memory(Max. 2TB) NAS O/S(960GB M.2 NVMe Disk) 10/100/1000 Gigabit Ethernet 2Port (UTP) Hot-Swappable 24 NVMe Disk Bay AnyStor Enterprise O/S - Raid: 0, 1, 10, 5, 6 Support Supported Protocol - NFS, CIFS, FTP, iSCSI/iSER AnyManager - Web-Based NAS Management Tool - Cluster Management - Volume Managent & Monitoring - Auto / Manual recovery - Parallel & distributed recovery - Data Replication Management - Online Scale-Out Support - POSIX FS API Support - Monitoring Tool on WEB (WMS) - Data Distributed I/O - Data Replication & NetworkRAID	1	1	42,000.00	42,000.00	50%	21,000.00
DATA Disk	Micron MTFDHAL3T2TDR-1AT1ZABYY	1	12	2,750.00	33,000.00	50%	16,500.00
I/B Cable	MCP1600-E002 IB EDR Cable	1	2	180.00	360.00	0%	360.00
I/B Card	MCX556A-ECAT ConnectX®-5 VPI adapter card, EDR IB (100Gb/s) and 100GbE, dual-port QSFP28, PCIe3.0 x16, tall bracket, ROHS R6	1	2	1,100.00	2,200.00		2,200.00
Hardware & Software Subtotal							40,060.00
Support & Maintenance							
NA	Premium Package 3-Year Support & Maintenance	1	1	8,000.00	8,000.00	50%	4,000.00
Support & Maintenance Subtotal							4,000.00
SPC-1 Total System Price							44,060.00
SPC-1 IOPS™							520,028
SPC-1 Price-Performance™ (\$/SPC-1 KIOPS™)							84.73
SPC-1 ASU Capacity (GB)							16,106
SPC-1 ASU Price (\$/GB)							2.74

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

Warranty: The 3-year maintenance and support included in the above pricing meets or exceeds a 24x7 coverage with a 4-hour response time.

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

Role	Name	Details
Test Sponsor Primary Contact	Telecommunications Technology Association Hyo-Sil Kim	www.tta.or.kr hyosil.kim@tta.or.kr
SPC Auditor	InfoSizing Doug Johnson	www.sizing.com doug@sizing.com

Revision Information

Date	FDR Revision	Details
December 23, 2022	First Edition	Initial Publication

Anomalies, Exceptions, Waivers

There were no anomalies, exceptions or waivers associated with the audit of the Gluesys AnyStor-700EK.

CONFIGURATION INFORMATION

Tested Storage Product Description

Gluesys AnyStor-700EK (AS700EK) is an all-flash storage system that is designed and optimized to deliver outstanding response speed and performance for a wide range of enterprise environments. Due to its flexibility, AS700EK has the storage gateway capability depending on the backbone infrastructure of the business, as well as the storage expansion and data tiering in heterogeneous storage devices. Furthermore, as the AS700EK block storage is derived from its previous scale-out NAS products, it supports NVMeoF protocol for InfiniBand and Ethernet, and also with iSCSI, iSER and file-based protocols.

Host System and Tested Storage Configuration Components

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

Host Systems
1 x KTNF KR580S1 2 x Intel® Xeon® Gold 6140 CPU @2.30 GHz Processor 768 GB Main Memory Red Hat Enterprise Linux 8.6
Tested Storage Configuration
1 x Mellanox 100 Gbps IB HCA (dual port)
1 x Gluesys AnyStor-700EK with: 1 x Storage Controller 1 x Ampere™ Altra™ ARMv8 (2.20GHz, 32MB) 64 GB cache 1 x 100 Gbps IB HCA (dual port) 12 x 3.2 TB Micron 2.5” NVMe SSD

Component Changes in Revised Full Disclosure Report

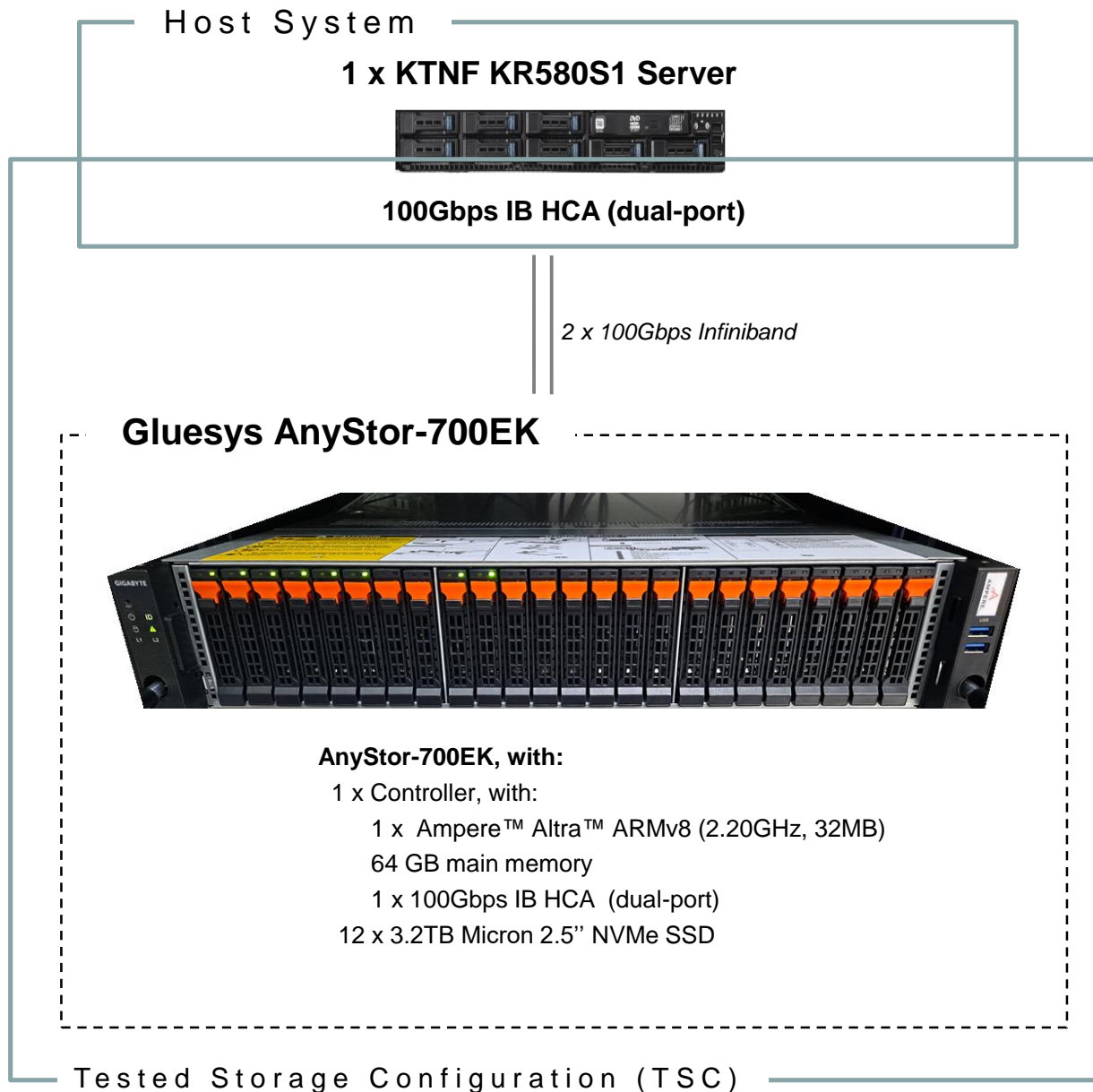
The following table outlines component changes that were made in revisions to this Full Disclosure Report.

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 Tested Storage Configuration (TSC) consisted of a single storage subsystem (Gluesys AnyStor-700EK), driven by a single KTNF KRS580S1 host system. The host had two InfiniBand (IB) connections to the storage subsystem. The connections operated at 100 Gbps.

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*
ASU-1	9	805.3	805.3	7,247.7	45.0%	No
ASU-2	9	805.3	805.3	7,247.7	45.0%	No
ASU-3	1	1,610.6	1,610.6	1,610.6	10.0%	No
SPC-1 ASU Capacity				16,106	*See Space Optimization Techniques	

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
3.2 TB NVMe	12	3,200.0	38,400.0
Total Physical Capacity			38,400
Physical Capacity Utilization			41.94%

Data Protection

The data protection level used for all LVs was **Protected 1 (RAID 1+0)**.

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.

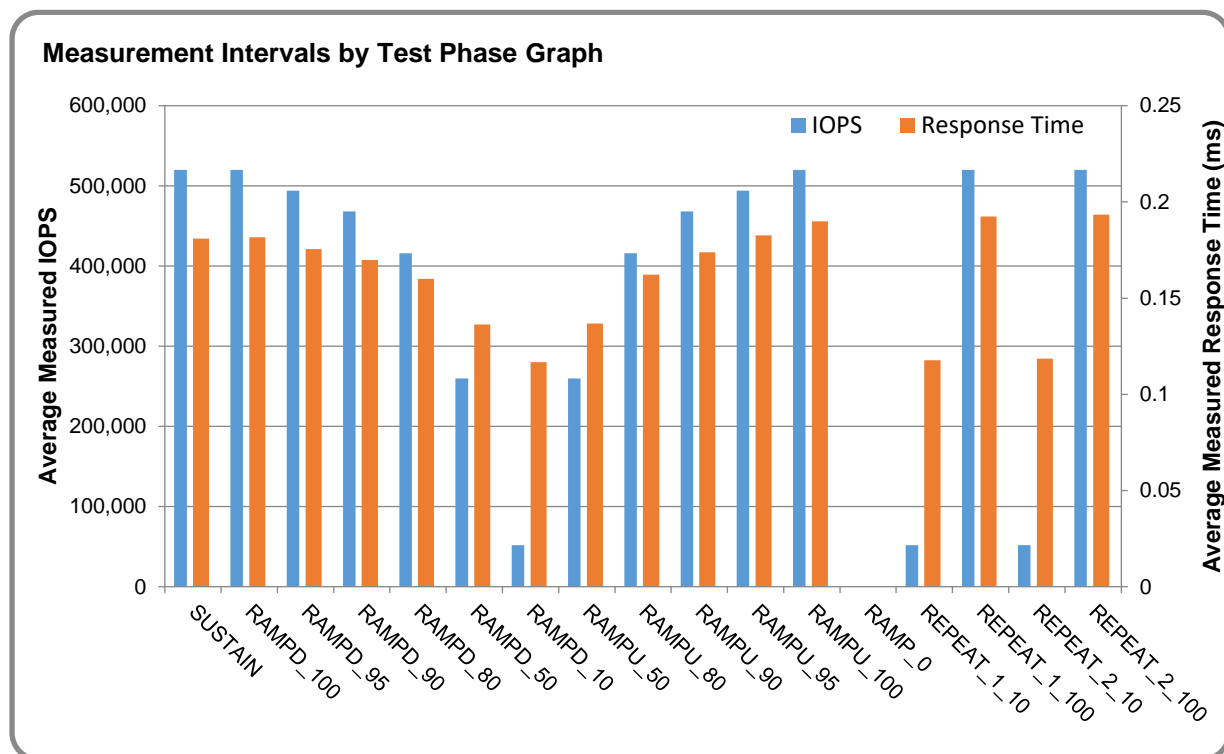
Benchmark Execution Overview

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](#)).

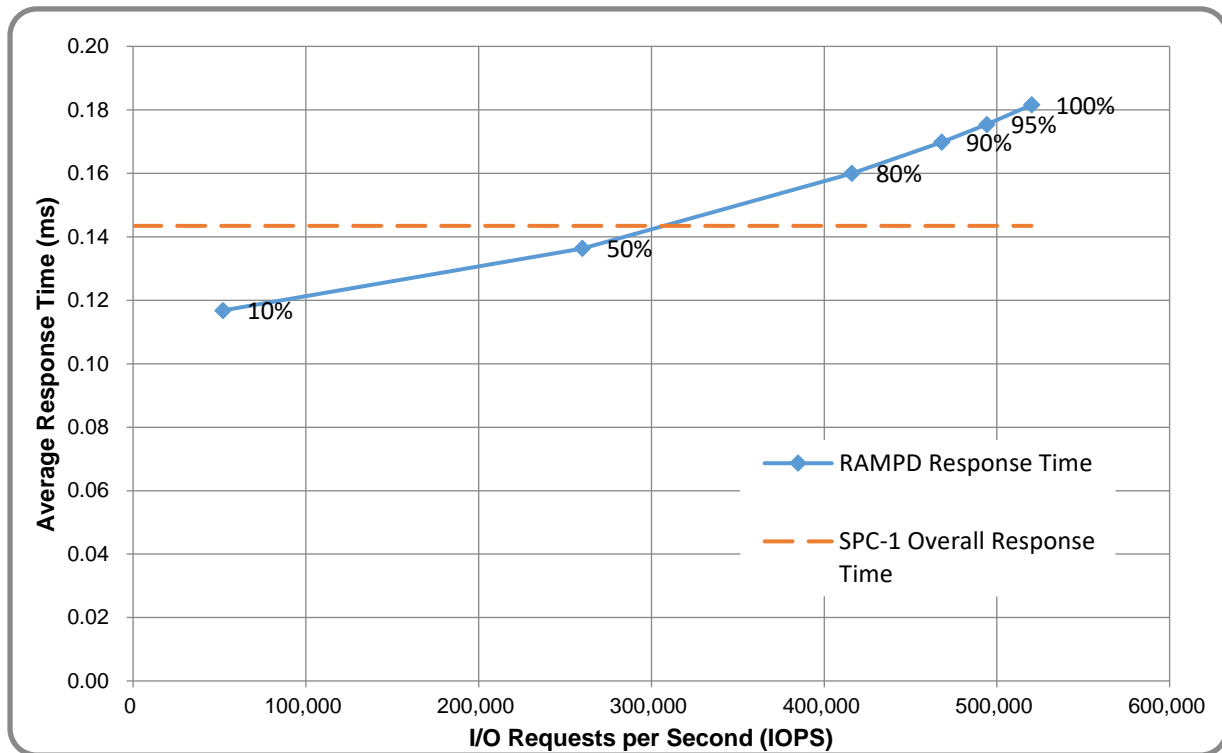
Measurement Intervals by Test Phase Graph

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	08-Dec-22 13:23:42	Requested IOP Level	500 MB/sec
End Time	08-Dec-22 21:56:30	Observed IOP Level	523 MB/sec
Duration	8:32:48	For additional details see the Supporting Files.	

SUSTAIN Test Phase

SUSTAIN – Results File

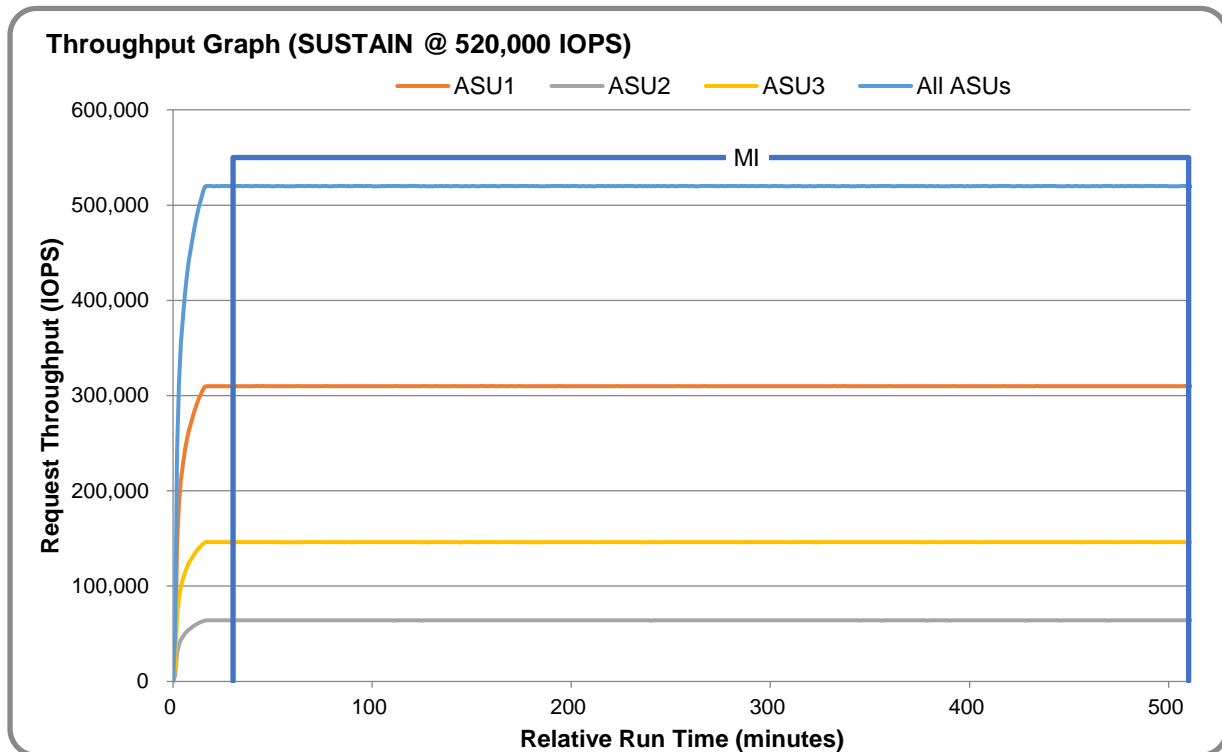
The results file generated during the execution of the SUSTAIN Test Phase is included in the Supporting Files (see [Appendix A](#)) as follows:

- SPC1_METRICS_0_Raw_Results.xlsx

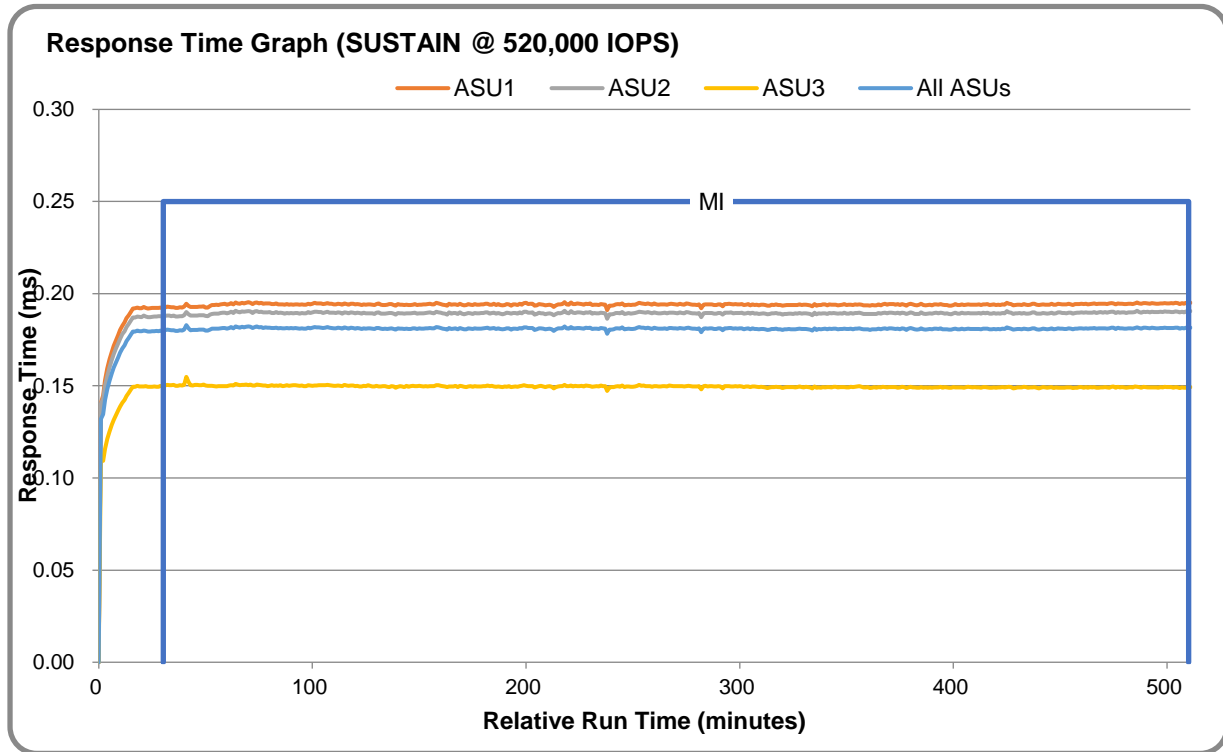
SUSTAIN – Execution Times

Interval	Start Date & Time	End Date & Time	Duration
Transition Period	08-Dec-22 22:01:13	08-Dec-22 22:31:13	0:30:00
Measurement Interval	08-Dec-22 22:31:13	09-Dec-22 06:31:14	8:00:01

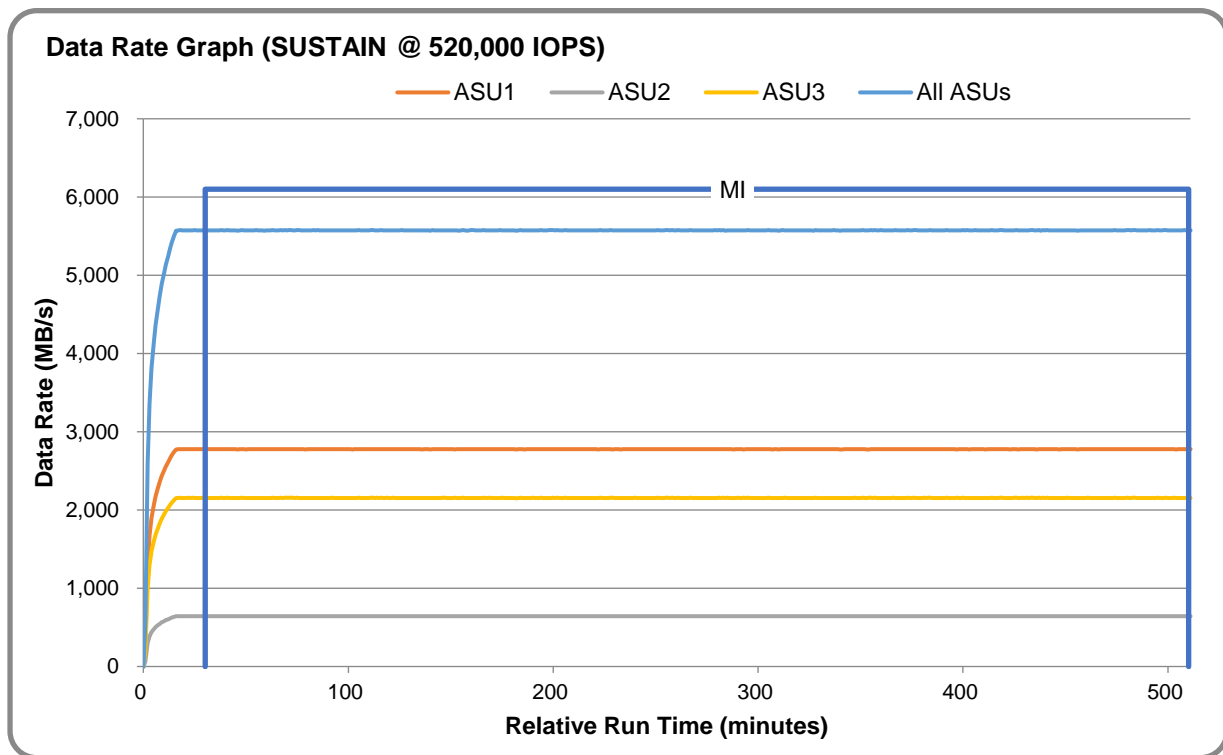
SUSTAIN – Throughput Graph



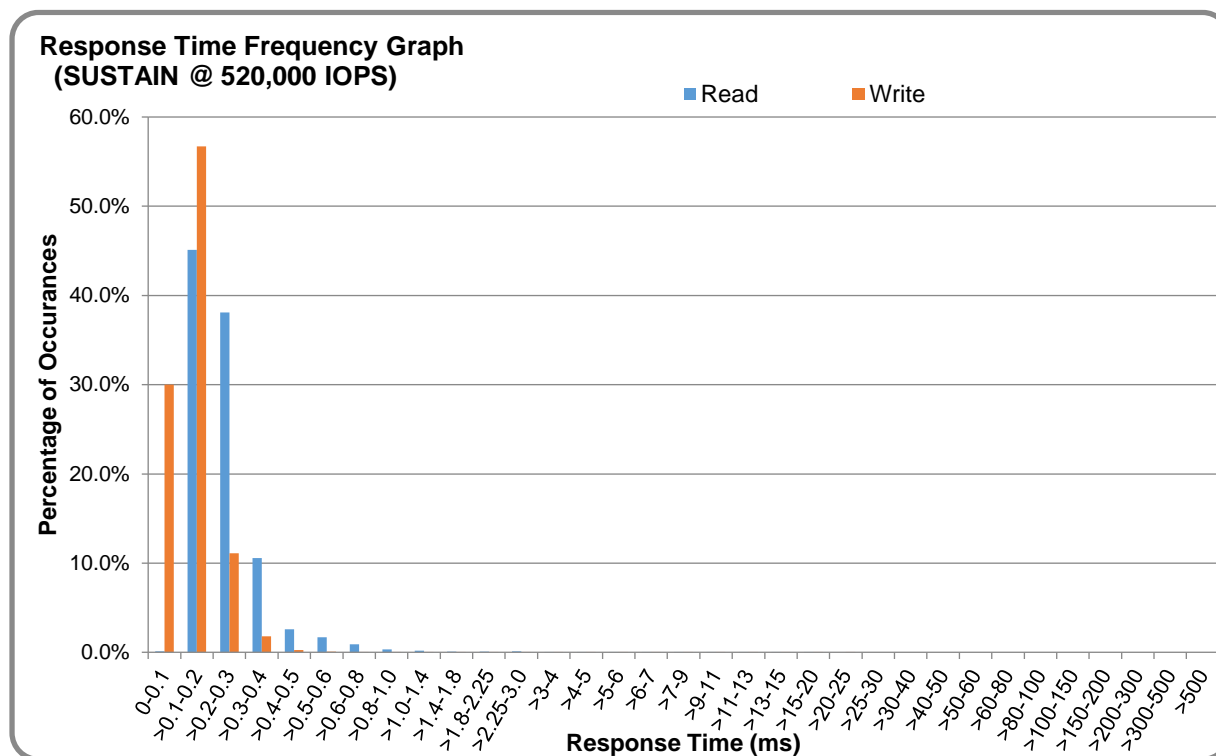
SUSTAIN – Response Time Graph



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
Defined	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Measured	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Variation	0.0010	0.0003	0.0006	0.0003	0.0014	0.0007	0.0009	0.0003
Difference	0.005%	0.001%	0.003%	0.002%	0.010%	0.003%	0.010%	0.003%

RAMPD_100 Test Phase

RAMPD 100 – Results File

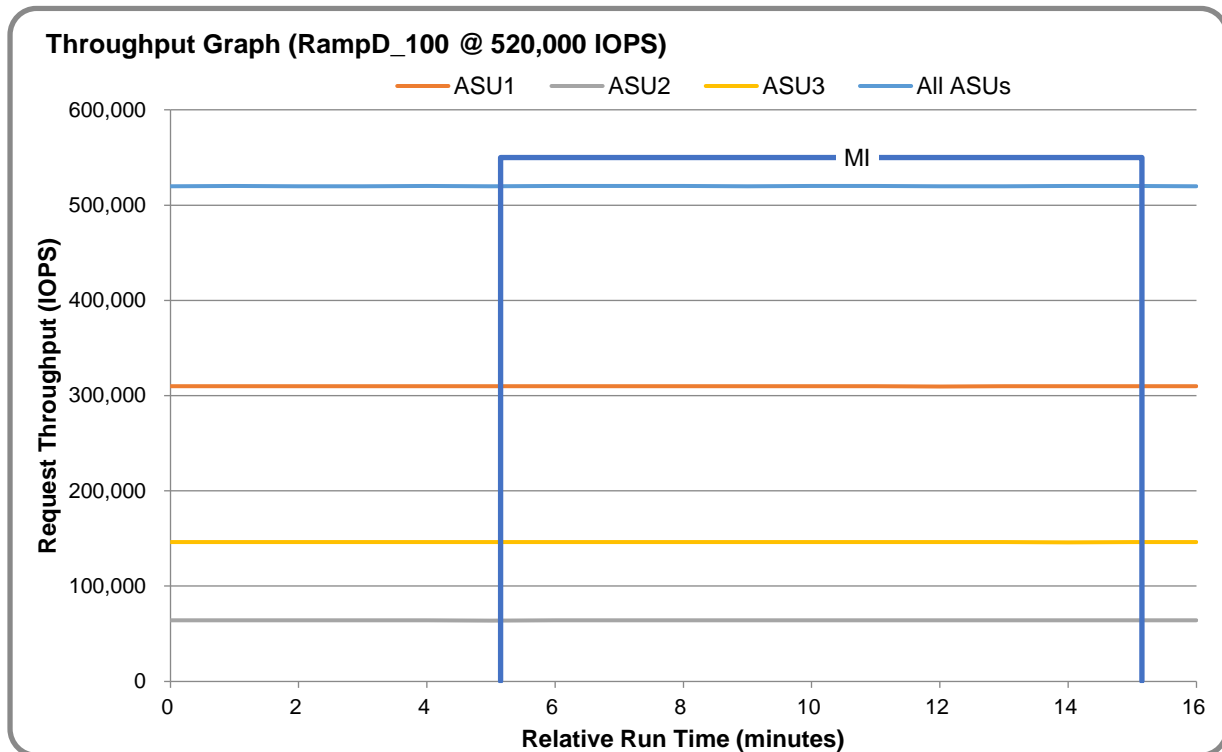
The results file generated during the execution of the RAMPD_100 Test Phase is included in the Supporting Files (see [Appendix A](#)) as follows:

- SPC1_METRICS_0_Raw_Results.xlsx

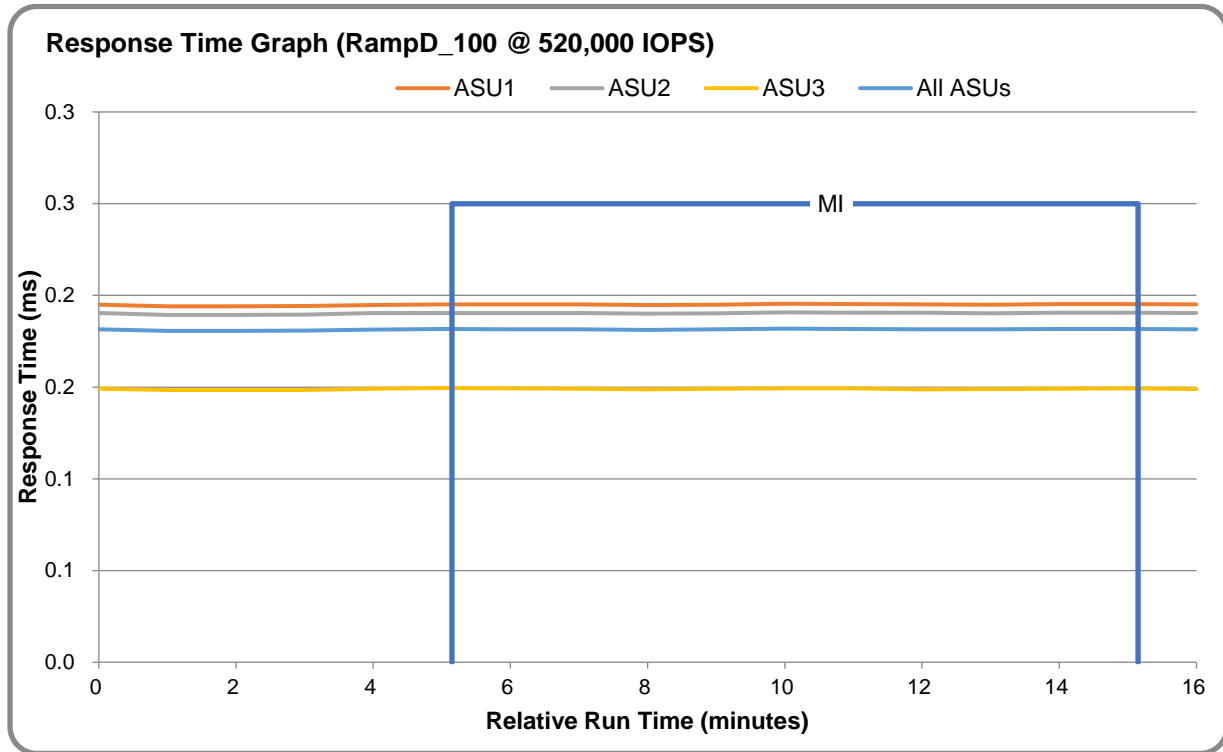
RAMPD 100 – Execution Times

Interval	Start Date & Time	End Date & Time	Duration
Transition Period	09-Dec-22 06:32:13	09-Dec-22 06:37:13	0:05:00
Measurement Interval	09-Dec-22 06:37:13	09-Dec-22 06:47:14	0:10:01

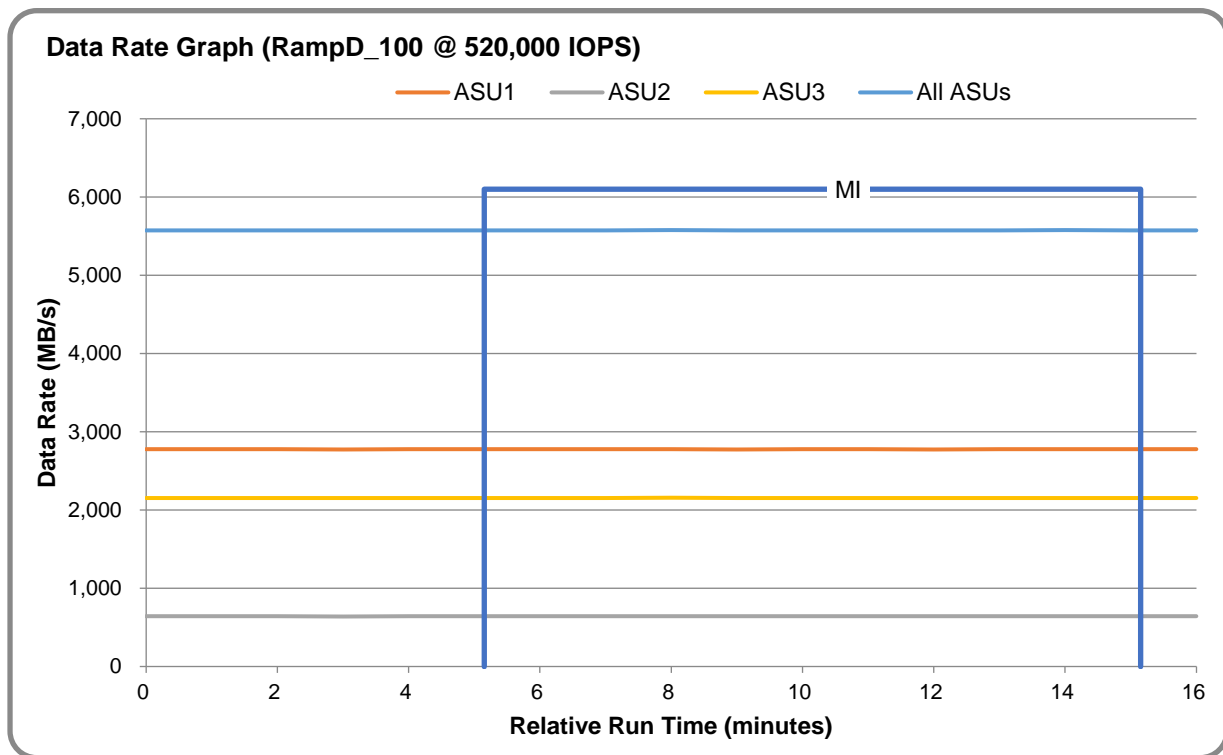
RAMPD 100 – Throughput Graph



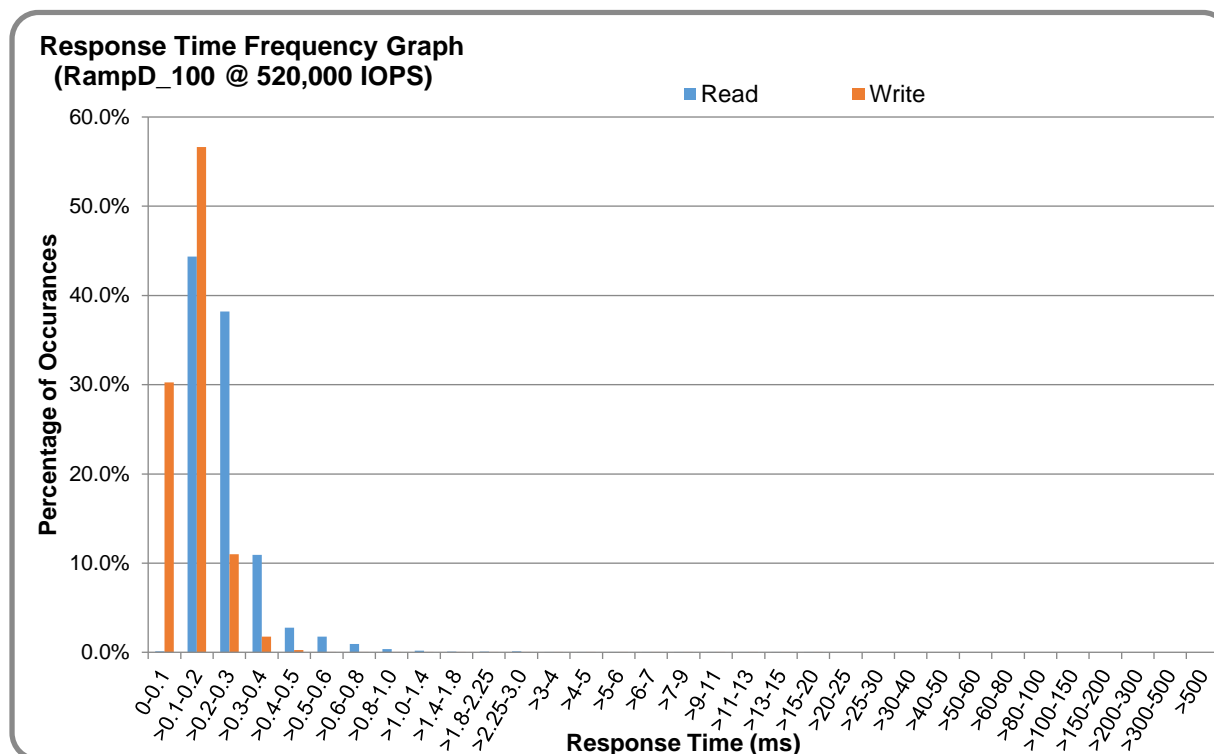
RAMPD 100 – Response Time Graph



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
Defined	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Measured	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Variation	0.0007	0.0003	0.0006	0.0003	0.0012	0.0007	0.0012	0.0003
Difference	0.048%	0.002%	0.016%	0.003%	0.007%	0.024%	0.011%	0.003%

RAMPD 100 – I/O Request Summary

I/O Requests Completed in the Measurement Interval	312,014,669
I/O Requests Completed with Response Time <= 30 ms	312,014,669
I/O Requests Completed with Response Time > 30 ms	0

Response Time Ramp Test

Response Time Ramp Test – Results File

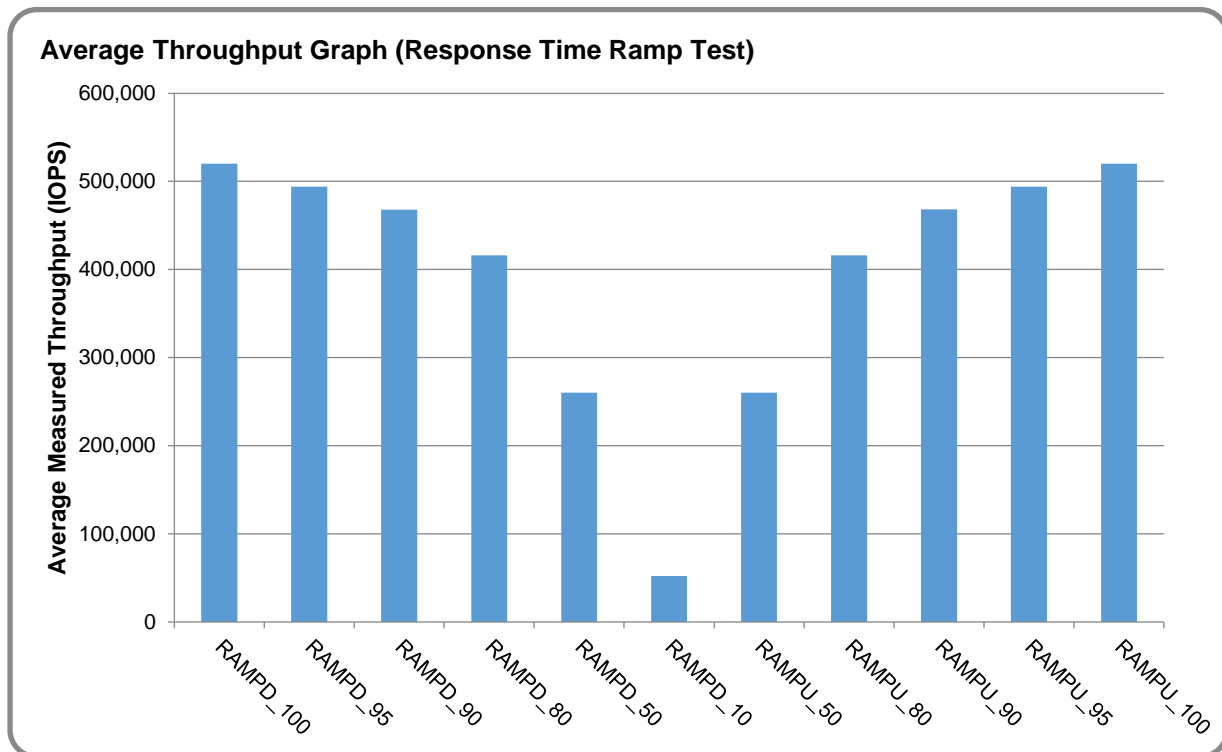
The results file generated during the execution of the Response Time Ramp Test is included in the Supporting Files (see [Appendix A](#)) as follows:

- **SPC1_METRICS_0_Raw_Results.xlsx**

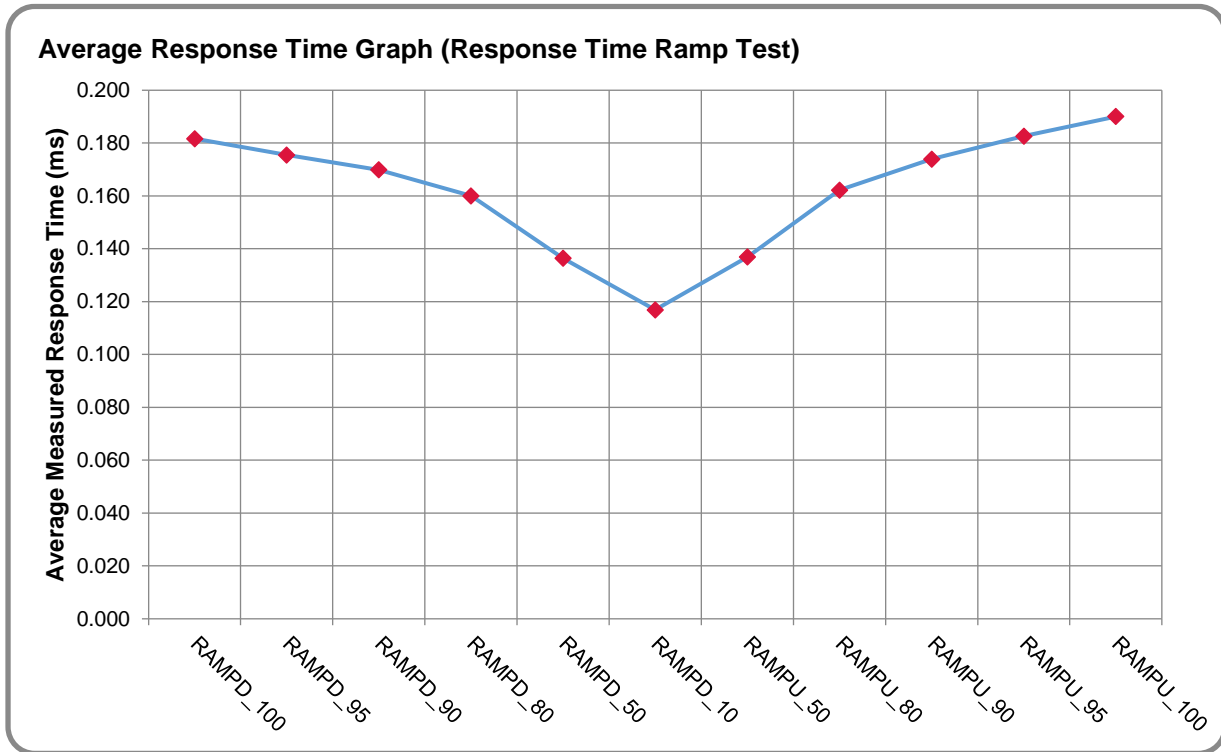
Response Time Ramp Test – Phases

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).

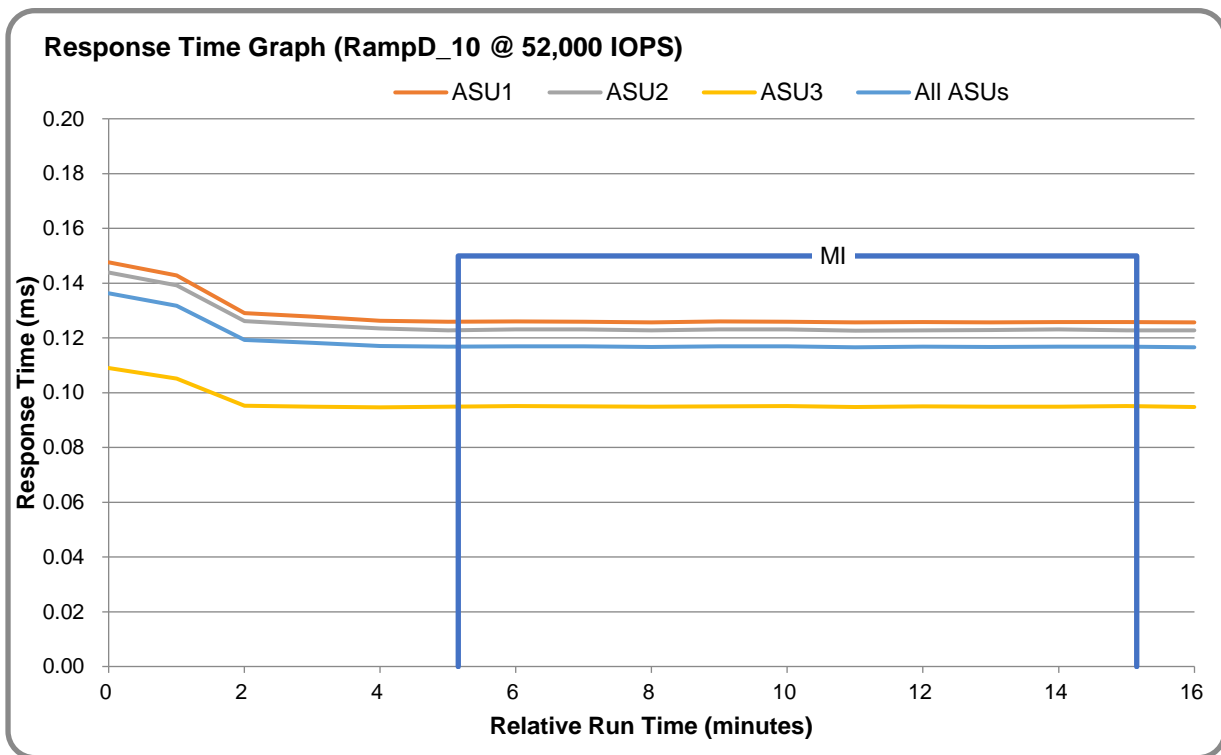
Response Time Ramp Test – Average Throughput Graph



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:

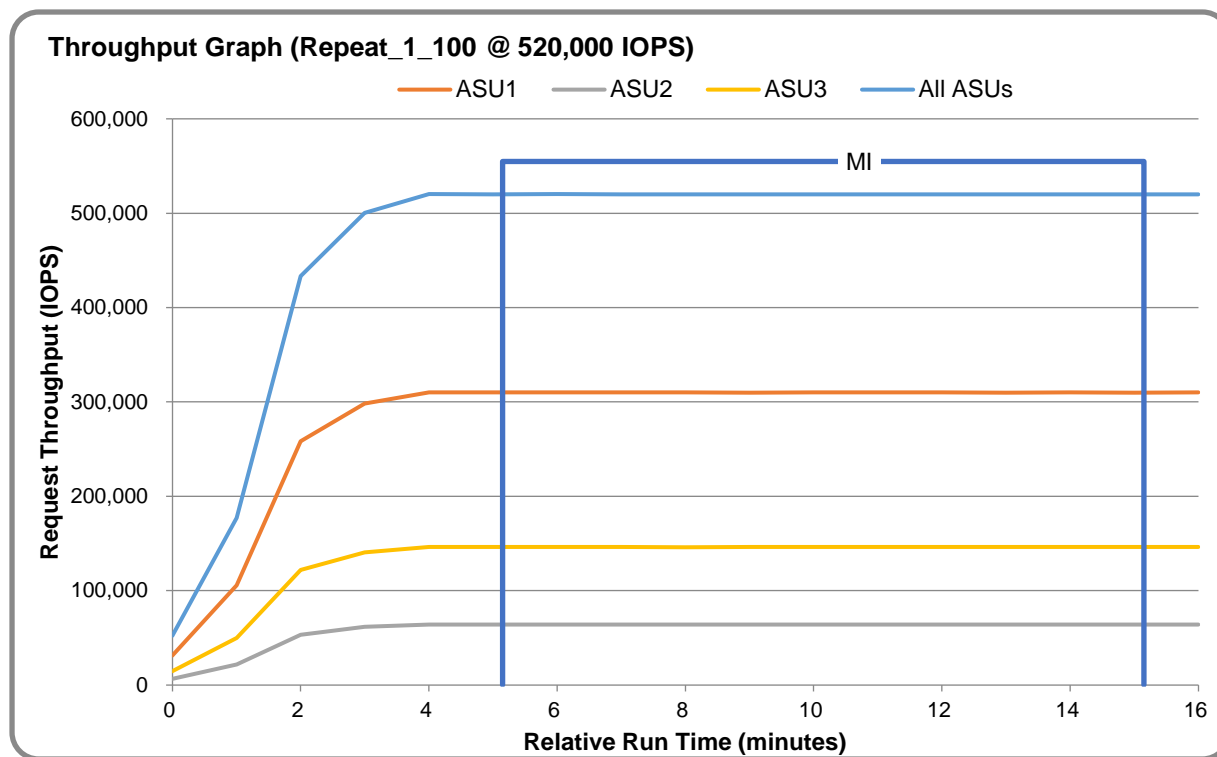
- **SPC1_METRICS_0_Raw_Results.xlsx**

Repeatability Test Results

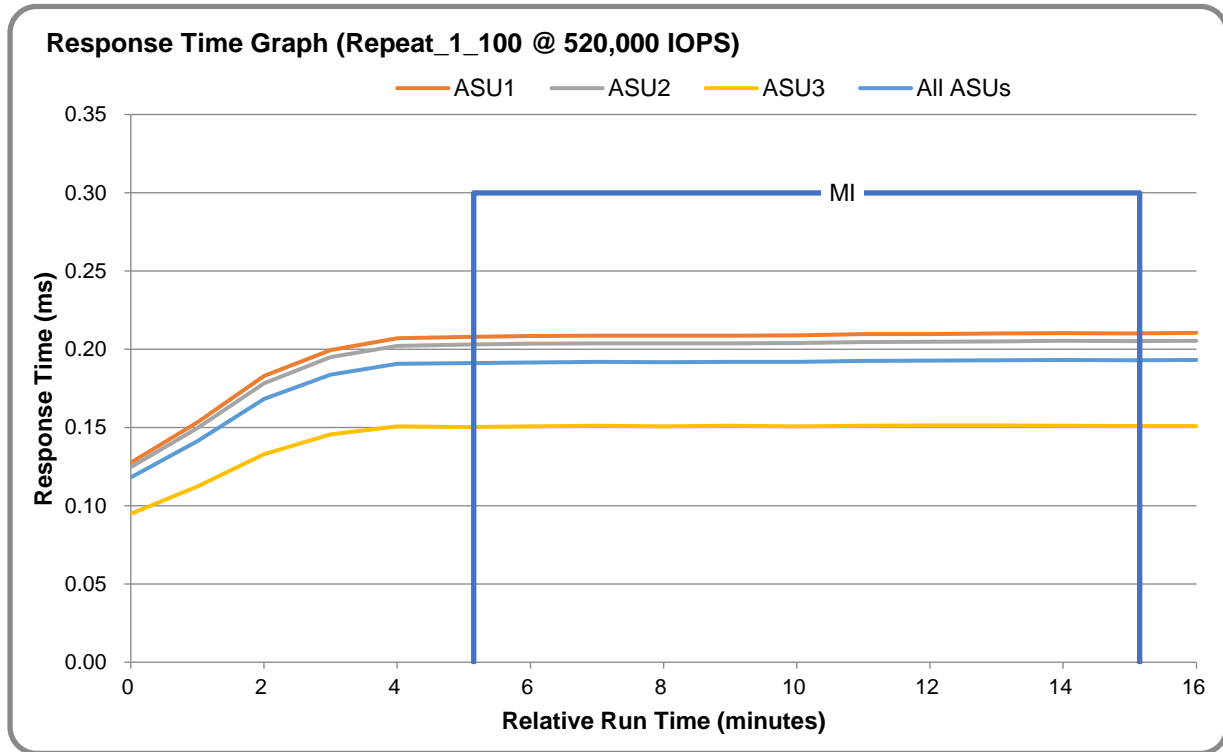
The throughput measurements for the Response Time Ramp Test (RAMPD) and the Repeatability Test Phases (REPEAT_1 and REPEAT_2) are listed in the table below.

Test Phase	100% IOPS	10% IOPS
RAMPD	520,028.8	52,023.3
REPEAT_1	520,058.3	52,022.7
REPEAT_2	520,042.8	52,008.3

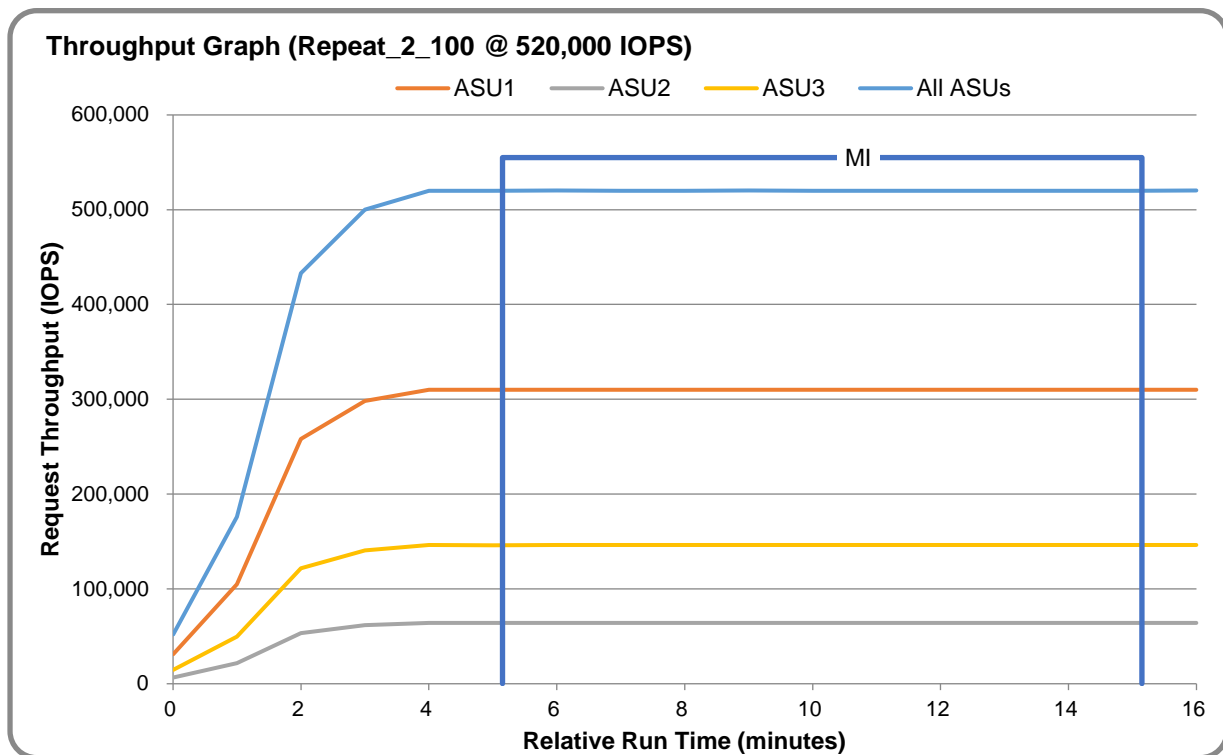
REPEAT 1 100 - Throughput Graph



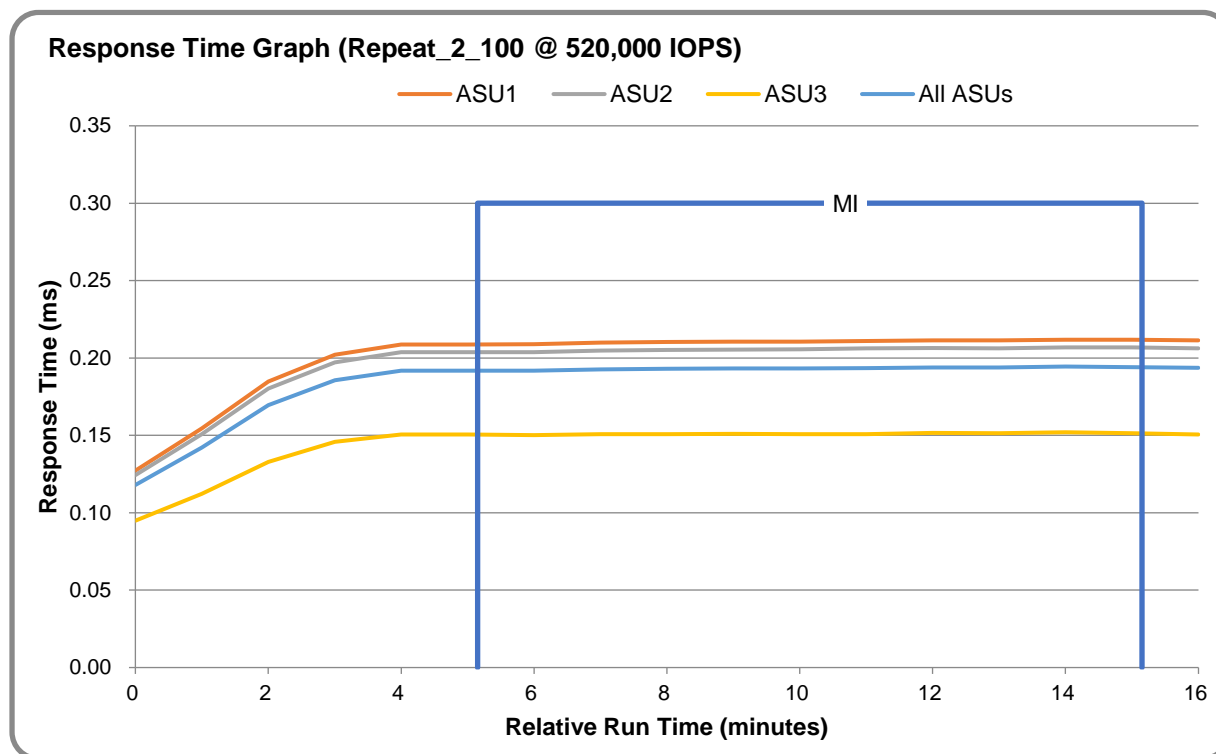
REPEAT 1 100 – Response Time Graph



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
Defined	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Measured	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Variation	0.0010	0.0002	0.0005	0.0004	0.0009	0.0010	0.0007	0.0003
Difference	0.004%	0.015%	0.012%	0.013%	0.045%	0.028%	0.020%	0.011%

REPEAT_2_100 Test Phase

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
Defined	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Measured	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Variation	0.0009	0.0002	0.0007	0.0003	0.0010	0.0005	0.0008	0.0003
Difference	0.010%	0.003%	0.004%	0.002%	0.035%	0.002%	0.012%	0.001%

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

Data Persistence Test Phase: Persist1	
Total Number of Logical Blocks Written	106,846,873
Total Number of Logical Blocks Verified	53,562,808
Total Number of Logical Blocks Overwritten	53,284,065
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks (sec.)	601
Size in bytes of each Logical Block	8,192
Number of Failed I/O Requests in the process of the Test	0

Committed Data Persistence Implementation

The persistence of committed data is implemented at the disk level. Data loss is prevented by using RAID1 arrays. At the controller level, the cache is set to write-through mode.

APPENDIX A: SUPPORTING FILES

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

File Name	Description	Location
/SPC1_RESULTS	Data reduction worksheets	root
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
/C_Tuning	Tuning parameters and options	root
set_host_kernel_parameters.sh	Set host tuning parameters	/C_Tuning
/D_Creation	Storage configuration creation	root
connect_nvme.sh	Connects NVMe; creates LVs	/D_Creation
mkraid.sh	Overprovision NVMe; create RAID volumes	/D_Creation
nvme-binding.sh	Creates NVMe/TCP targets	/D_Creation
/E_Inventory	Configuration inventory	root
get_tsc_config.sh	Collect configuration inventory	/E_Inventory
inventory_start.out	Storage inventory before INIT	/E_Inventory
inventory_end.out	Storage inventory restart	/E_Inventory
/F_Generator	Workload generator	root
1host.HST	Host configuration file	/F_generator
SPC1.asu	Define the LUNs hosting the ASUs	/F_generator
spc1_run.sh	Execute test phases up through PERSIST1	/F_generator
spc1_run_persist2.sh	Execute PERSIST2	/F_generator

APPENDIX B: THIRD PARTY QUOTATION

Gluesys



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見積書

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견적일	2022년 12월 21일
유효기간	2023년 3월 31일
납품 가능일	발주일로부터 4주 이내

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견적 금액 : \$44,060.00 (VAT not included)
건 명 :

귀사의 무궁한 발전을 기원하오며, 아래와 같이 견적합니다. 단위: 달러(V.A.T 별도)

번호	모델	상세내역	수량	소비자단가	공급단가	공급금액
AnyStor-700EK						
1	AS700EK	1x Ampere Altra CPU, up to 80 Arm v8.2+ 64-bit CPU cores at up to 3.30 GHz with Sustained Turbo 64GB Memory(Max. 2TB) NAS O/S(960GB M.2 NVMe Disk) 10/100/1000 Gigabit Ethernet 2Port (UTP) Hot-Swappable 24 NVMe Disk Bay AnyStor Enterprise 전용 O/S -Raid 지원 : 0, 1, 10, 5, 6 Support 지원프로토콜 -NFS, CIFS, FTP, iSCSI/iSER AnyManager -웹 기반의 NAS 관리도구 -Cluster Management -Volume Managent & Monitoring -Auto / Manual recovery -Parallel & distributed recovery -Data Replication Management -Online Scale-Out Support -POSIX FS API Support -Monitoring Tool on WEB (WMS) -Data Distributed I/O -Data Replication & NetworkRAID	1	42,000.00	21,000.00	21,000.00
2	Support & Maintenance	Premium Package 3-Year Support & Maintenance	1	8,000.00	4,000.00	4,000.00
3	DATA Disk	Micron MTFDHAL3T2TDR-1AT1ZABYY	12	20,000.00	16,500.00	16,500.00
4	I/B Cable	MCP1600-E002 1B EDR Cable	2	180.00	360.00	360.00
5	I/B Card	MCX556A-ECAT ConnectX®-5 VPI adapter card, EDR 1B (100Gb/s) and 100GbE, dual-port QSFP28, PCIe3.0 x16, tall bracket, ROHS R6	2	1,100.00	2,200.00	2,200.00
				공급가	44,060.00	
				부가가치세		
				총합계	44,060.00	
비고						
1. 무상유지보수 기간은 납품 설치 후 H/W 3년(36개월) 입니다.						
2. 결제조건 별도 협의.						
3. 위 견적은 건에 한하여 적용 됩니다.						

APPENDIX C: TUNING PARAMETERS AND OPTIONS

The script `set_host_kernel_parameters.sh` was used to configure the operating system parameters on the host system. This script is included in the Supporting Files (see [Appendix A](#)).

APPENDIX D: STORAGE CONFIGURATION CREATION

Step 1 – Create RAID volumes

The **mkraid.sh** script performs over-provisioning on each NVMe device and creates software RAID volumes (RAID 10).

```
mkraid.sh
#!/bin/sh

# NVMe NameSpace Overprovisioning Function
nvme_format () {
    for num in $(seq 0 11)
    do
        echo format /dev/nvme${num}n1
        nvme format -f -s1 /dev/nvme${num}n1 -l=0    # 512B format and Secure Erase
    done
}

nvme_over_provision () {
    for num in $(seq 0 11)
    do
        echo OverProvision 30% /dev/nvme${num}n1
        nvme detach-ns /dev/nvme${num} --namespace-id=1 --controllers=1
        nvme delete-ns /dev/nvme${num} --namespace-id=1
        nvme create-ns /dev/nvme${num} --nsze 0x13972eb80 --ncap 0x13972eb80 --flbas 0 --
dps 0 --nmic 0 # micron 2.8TB
        nvme attach-ns /dev/nvme${num} --namespace-id=1 --controllers=0x1
        nvme format -f -s1 /dev/nvme${num}n1 -l=0    # 512B format and Secure Erase
        nvme reset /dev/nvme${num}
    done
}

# Linux RAID 1 Create Function
mkraid () {
    yes | mdadm --create --verbose /dev/md0 --level=1 --raid-devices 2 \
/dev/nvme0n1 /dev/nvme1n1
    yes | mdadm --create --verbose /dev/md1 --level=1 --raid-devices 2 \
/dev/nvme2n1 /dev/nvme3n1
    yes | mdadm --create --verbose /dev/md2 --level=1 --raid-devices 2 \
/dev/nvme4n1 /dev/nvme5n1
    yes | mdadm --create --verbose /dev/md3 --level=1 --raid-devices 2 \
/dev/nvme6n1 /dev/nvme7n1
    yes | mdadm --create --verbose /dev/md4 --level=1 --raid-devices 2 \
/dev/nvme8n1 /dev/nvme9n1
    yes | mdadm --create --verbose /dev/md5 --level=1 --raid-devices 2 \
/dev/nvme10n1 /dev/nvme11n1
}

#### Main Start
```

```
nvme_over_provision
#nvme_format
mkraid
```

Step 2 – Set-Up NVMeoF/TCP Target on the Storage Subsystem

The **nvme-binding.sh** script creates NVMe/TCP targets (using nvmet kernel driver).

```
nvme-binding.sh
#!/bin/bash

CMD=$1

# Load nvmet kernel driver Function
load_nvmet () {
    modprobe nvme
    modprobe nvme-tcp
    modprobe nvmet
}

# Bind nvmet target Function
bind_md_nvmet () {

    mkdir -p /sys/kernel/config/nvmet/ports/1
    echo "ipv4" > /sys/kernel/config/nvmet/ports/1/addr_adrfam
    echo "tcp" > /sys/kernel/config/nvmet/ports/1/addr_trtype
    echo 11.11.11.11 > /sys/kernel/config/nvmet/ports/1/addr_traddr
    echo 4220 > /sys/kernel/config/nvmet/ports/1/addr_trsvcid

    mkdir -p /sys/kernel/config/nvmet/ports/2
    echo "ipv4" > /sys/kernel/config/nvmet/ports/2/addr_adrfam
    echo "tcp" > /sys/kernel/config/nvmet/ports/2/addr_trtype
    echo 12.12.12.11 > /sys/kernel/config/nvmet/ports/2/addr_traddr
    echo 4220 > /sys/kernel/config/nvmet/ports/2/addr_trsvcid

    for vol in `seq 0 5`
    do
        echo add /dev/md${vol} to nvmetcp
        mkdir -p /sys/kernel/config/nvmet/subsystems/spc-${vol}
        echo 1 > /sys/kernel/config/nvmet/subsystems/spc-${vol}/attr_allow_any_host
        mkdir -p /sys/kernel/config/nvmet/subsystems/spc-${vol}/namespaces/1
        echo -n /dev/md${vol} > \
            /sys/kernel/config/nvmet/subsystems/spc-${vol}/namespaces/1/device_path
        echo 1 > /sys/kernel/config/nvmet/subsystems/spc-${vol}/namespaces/1/enable

        ln -s /sys/kernel/config/nvmet/subsystems/spc-${vol}
        /sys/kernel/config/nvmet/ports/1/subsystems/
```



```
    ln -s /sys/kernel/config/nvmet/subsystems/spc-${vol}
    /sys/kernel/config/nvmet/ports/2/subsystems/
    done
}

clean_nvmet () {

    for vol in `seq 0 5`
    do
        rm -f /sys/kernel/config/nvmet/ports/1/subsystems/spc-${vol}
        rm -f /sys/kernel/config/nvmet/ports/2/subsystems/spc-${vol}

        rmdir /sys/kernel/config/nvmet/subsystems/spc-${vol}/namespaces/1
        rmdir /sys/kernel/config/nvmet/subsystems/spc-${vol}
    done
}

if [ "$CMD" = "load_nvmet" ]; then
    load_nvmet
    bind_md_nvmet
elif [ "$CMD" = "clean_nvmet" ]; then
    clean_nvmet
else
    echo "$0 [load_nvmet|clean_nvmet]"
    exit 1
fi
?>
```

Step 3 – Connect to NVMe/TCP Target on the Host system.

The **connect_nvme.sh** script on the host system discovers and connects NVMe/TCP targets, and create 19 Logical Volumes for ASUs.

```
connect_nvme.sh
#!/bin/sh

modprobe nvme
modprobe nvme-tcp

# nvme discover & connect & volume info update
nvme_connect () {
for subnqn in `nvme discover -t tcp -a 12.12.12.11 -s 4220 | \
grep subnqn | cut -d":" -f2 | cut -d "-" -f2 | sort -h`
do
    nvme connect -t tcp -n spc-${subnqn} -a 12.12.12.11 -s 4220
done
```

```
sleep 1 && nvme list
vgscan && vgchange -ay
}

# Test Volume Create Function
make_vol () {
pvcreate /dev/nvme0n1 /dev/nvme1n1 /dev/nvme2n1 /dev/nvme3n1 /dev/nvme4n1
/dev/nvme5n1
vgcreate LD /dev/nvme0n1 /dev/nvme1n1 /dev/nvme2n1 /dev/nvme3n1 /dev/nvme4n1
/dev/nvme5n1

ISIZE=64 # 6(stripe) x 8 (chunk)
for vol in `seq 0 17`
do
    lvcreate -l192000 -i6 -l${ISIZE} -nvol${vol} LD
done
    lvcreate -l384000 -i6 -l${ISIZE} -nvol18 LD
}

# Main Start
nvme_connect
#make_vol
```

APPENDIX E: CONFIGURATION INVENTORY

The script `get_tsc_config.sh` was used to collect an inventory of the TSC during the execution of `spc1_run.sh` and `spc1_run_persist2.sh`. The following log files were generated.

- `inventory_start.out`
- `inventory_end.out`

These files are included in the Support Files (see [Appendix A](#)).

APPENDIX F: WORKLOAD GENERATOR

The ASUs accessed by the SPC-1 workload generator are defined in SPC1.asu. The test phases up through PERSIST1 are executed by spc1_run.sh. PERSIST2 is executed by spc1_run_persist2.sh.

These files are included in the Support Files (see [Appendix A](#)).