

# UNH-IOL NVMe Test Consortium

NVMe Integrators List Policy  
*Version 1.2.1*  
*Policy Document*



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*UNH-IOL NVMe Consortium*  
*21 Madbury Rd Suite 100*  
*Durham, NH 03824*

*Tel: +1 603-862-0090*  
*Fax: +1 603-862-4181*  
*Email: [nvmelab@iol.unh.edu](mailto:nvmelab@iol.unh.edu)*

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## MODIFICATION RECORD

2012 October 29 (Version 1.0 DRAFT)

David Woolf: Initial Release

2012 November 19 (Version 1.0 DRAFT)

David Woolf: Changed Windows Driver requirement from being exclusively the Windows OFA reference driver to being any Windows driver.

2012 December 3 (Version 1.0 DRAFT)

David Woolf: Added ‘Definitions’ section. Added requirement for testing against Linux Reference Driver. Clarified requirements for NVMe Devices vs. NVMe Host Platforms.

2013 April 30 (Version 1.0 DRAFT)

David Woolf: Modified information to be included in each device listing.

2013 May 9 (Version 1.0)

David Woolf: Final Release

2013 July 29 (Version 1.1 DRAFT)

David Woolf: Modified information to be included in each device listed. Increased number of test platforms used from 4 to 5, and increased number of passing test platforms from 3 to 4. Specified that a Host Platform need only be tested using one operating system.

2013 August 7 (Version 1.1 DRAFT)

David Woolf: Editorial fixes.

2013 November 7 (Version 1.1 DRAFT)

David Woolf: Added exception for test 1.5 which only needs to be tested with one test platform. Added proposed wording for High Volume Listings policy.

2013 December 13 (Version 1.1 DRAFT)

David Woolf: Reformatted policy document. Removed wording for High Volume Listing Policy. Added wording to clarify that all potential NVMe form factors are eligible for the list, and that drives in the same family but different form factors may be listed by similarity.

2013 December 16 (Version 1.1 DRAFT)

David Woolf: Added cross reference to UNH-IOL equipment list to show what platforms are available for interoperability testing. Removed reference to boot test requirements.

2013 December 19 (Version 1.1)

David Woolf: Added links to UNH-IOL NVMe Test Suites page to help readers find the necessary test procedures.

2014 July 14 (Version 1.1b)

David Woolf: Upgraded requirements for interop testing in section 4. Updated Test Suite references.

2014 September 30 (Version 1.1b)

David Woolf: Downgraded requirements for interop testing in section 4 per direction from NVM Express Organization.

2014 October 20 (Version 1.1b)

David Woolf: Added clarification that devices advertising support for an earlier revision of the NVMe specification may still be eligible for newer revisions of the NVMe Integrators List.

2015 February 12 (Version 1.2)

David Woolf: Added new requirements based on NVMe Promoters group feedback.

2015 April 7 (Version 1.2)

David Woolf: Clarifications, editorial fixes.

2015 April 13 (Version 1.2)

David Woolf: Added Group 7 and Group 8 tests to Table 1.

2015 April 14 (Version 1.2)

David Woolf: Fixed broken web links in Section 4.

2015 November 5 (Version 1.2.1)

David Woolf: Replaced references to SFF-8639 with U.2. Modified requirements for Boot Test to be performed with 2 hosts.

2015 November 23 (Version 1.2.1)

David Woolf: Updated table 2 to reflect updates to conformance test suite.

2015 December 11 (Version 1.2.1)

David Woolf: Updated Table 1 to reflect that interop Test 1.5, may not be required for certain types of FPGA based NVMe IP Devices.

2016 January 28 (Version 1.2.1)

David Woolf: Updated Table 1 to match changes made to the NVMe Interoperability Test Suite v1.2.1 document in November 2015, indicating that the Boot Test is mandatory for hosts.

## **INTRODUCTION**

The University of New Hampshire’s InterOperability Laboratory (IOL) is an institution designed to improve the interoperability of standards-based products by providing a neutral environment where a product can be tested against other implementations of a common standard, both in terms of interoperability and conformance. The NVMe Promoters Group and UNH-IOL have worked closely to define test procedures and policies for a public NVMe Integrators List. This document describes the Integrators List, how to qualify products for it, and policies surrounding the Integrators List. The goal of the NVMe Integrators List is to help implementers evaluate the NVMe functionality of their products.

## **REFERENCES**

The following documents are referenced in this text:

- 1.** NVMe Conformance Test Suite 1.2.1
- 2.** NVMe Interoperability Test Suite 1.2.1

## **Section 1: Integrators List Policies**

**Overview:** This section describes policies and procedures for listing qualifying products on the NVMe Integrators List.

## 1 - Purpose

The following outlines the policies for the NVMe Integrators list (IL) and shows how companies participating in the UNH-IOL NVMe consortium can have their products included in the public NVMe Integrators List.

The NVMe Integrators List will serve as a means for component suppliers to indicate conformance to the NVMe specification and interoperability with other NVMe products. While listing on the Integrators List does not guarantee conformance or interoperability it provides a reasonable degree of confidence that a tested product will work well in a multi-vendor environment.

## 2 - Location

The NVMe Integrators List will be hosted on the UNH-IOL website at [www.iol.unh.edu](http://www.iol.unh.edu). The exact URL will be published by UNH-IOL. This site will be linked to from [nvmeexpress.org](http://nvmeexpress.org). The list will be maintained by UNH-IOL.

## 3 - Definitions

*NVMe Host Platform* - Any combination of PCIe Host hardware (Motherboard or add-in card), NVMe Host Software (OS/Driver), and/or IP, that allows communication with an NVMe enabled SSD. Examples of an NVMe Host Platform are: server, server board, motherboard, add-in card, RAID Controller, or IP device.

*NVMe Device* - an NVMe SSD, SSD Controller, or SSD Controller IP.

*Product Under Test* - The NVMe Host Platform or NVMe Device being tested to determine eligibility for the NVMe Integrators List.

*Interop Partner* - An NVMe Host Platform or NVMe Device that is tested with the Product Under Test according to the NVMe Interop Test Suite Document to determine the eligibility of the Product Under Test for the NVMe Integrators List.

## 4 - Eligibility

Products must meet the following requirements to be eligible for the NVMe Integrators List.

*If the Product Under Test is an NVMe Device:* In order for the product to be eligible for the NVMe Integrators List there must be a UNH-IOL NVMe Conformance Test Report for the product with no failing items. The Test Report must be completed according to the most recent version of the NVMe Conformance Test Suite (CTS) Document available publically on the UNH-IOL website (<https://www.iol.unh.edu/testing/storage/nvme/test-suites>).

The CTS document may include tests for optional features defined in the NVMe specification. If a Product Under Test does not support certain optional features, those items would be marked as ‘Not Applicable’ in the Conformance Test Report, would not be considered a failing item, and would not disqualify a device from the NVMe Integrators List. If a Product Under Test claims support for an optional feature, and that feature is included in the current CTS document, the Product Under Test must pass the test for that feature in order to be eligible for the NVMe Integrators List.

If a Product Under Test advertises support for an earlier revision of the NVMe specification, but supports all mandatory requirements in a newer version of the NVMe specification, the product would still be eligible for listing under the newer version of the NVMe Integrators List Program. This may be the case if a new NVMe Integrators List Program Revision introduced support for new optional features, but no new mandatory features.

Additionally, in order for an NVMe Device product to be eligible for the NVMe Integrators List there must be a UNH-IOL NVMe Interop Test Report for the product. The Test Report must be completed according to the most recent version of the NVMe Interop Test Suite (ITS) Document available publically on the UNH-IOL website (<https://www.iol.unh.edu/testing/storage/nvme/test-suites>).



The Interop Test Report must document test results for tests 1.1, 1.2, 1.3, and 1.4 of the Product Under Test with at least 6 different NVMe Host Platforms, and the product under test must pass those tests with at least 5 of the 6 NVMe Host Platforms.

Among the 5 or more passing NVMe Host Platforms, there must be at least one Linux-based OS and at least one Windows-based OS represented and at least 2 of the following drivers represented:

- NVMe Linux Driver (since Kernel Version 3.3.0)
- Windows OFA Reference Driver 1.3 or 1.4
- Microsoft StorNVMe.sys Driver

Also, the Interop Test Report must document passing test results for test 1.5 of the Product Under Test with at least 2 NVMe Host Platforms. If the product is an FPGA based NVMe IP Device, test 1.5 is not required.

Further, if the Product Under Test uses the U.2 form factor, the Interop Test Report must document passing test results for test 1.6 of the Product Under Test with at least 1 NVMe Host Platform.

*If the Product Under Test is an NVMe Host Platform:* In order for an NVMe Host Platform product to be eligible for the NVMe Integrators List there must be a UNH-IOL NVMe Interop Test Report for the product. The Interop Test Report must document testing of the NVMe Host Platform using a single operating system with at least 6 different NVMe devices, and the Product Under Test must pass with at least 5 of the 6 NVMe Devices. Further information can be found in Table 1.

Note that the number of platforms or devices required for Integrators List Eligibility may increase in the future at the discretion of the NVMe Promoters Group. A complete listing of NVMe Hosts and Devices is available through UNH-IOL for interoperability testing can be found at <https://www.iol.unh.edu/services/testing/NVMe/equipment.php>.

Some tests in the Interop Test Suite and Conformance Test Suite may be defined as optional and are not considered necessary to qualify a Product Under Test for the NVMe Integrators List. Other tests are defined as FYI, which may become mandatory in the future, but currently are not used as part of qualification for the NVMe Integrators List.

The following table summarizes the interop and conformance test requirements, showing which items are optional or mandatory, as well as how many interop partners a test must be performed with. If a Product Under Test indicates support for a feature tested by an Optional test, that test must be performed and the Product Under Test must pass that test if the feature is supported. In the case of a discrepancy between the below table, and the previous text describing these requirements, the text will take priority. Additionally, the Interop Test Suite and the Conformance Test Suite may include notes about which tests are optional or mandatory for Integrators List eligibility. In all cases the information in this NVMe Integrators List Policy document will take precedence over the Interop Test Suite or the Conformance Test Suite.

**Table 1: Interop Test Requirements**

Test Name	Mandatory or Optional	Required number of Interop Partners
1.1 – Storage Device Identified	Mandatory	Pass with 5 of 6 Interop Partners
1.2 – Format Storage Device	Mandatory	Pass with 5 of 6 Interop Partners
1.3 – Write Read Compare	Mandatory	Pass with 5 of 6 Interop Partners
1.4 – Multiple Devices on Bus	Mandatory	Pass with 5 of 6 Interop Partners
1.5 – Boot from NVMe Device	Mandatory for Devices, <u>Optional for FPGA based NVMe IP Devices,</u> <u>Optional for Hosts</u>	Pass with 2 Interop Partners
1.6 – Hotplug NVMe Device	Mandatory for <u>U.2</u> , SFF—8639 Devices, Optional for Hosts	Pass with 1 Interop Partner
1.7 – Dual Port Device	Not Implemented	Not Implemented

**Table 2: Conformance Test Requirements**

Test Name	Mandatory or Optional
<b>Group 1: Admin Command Set</b>	
Test 1.1 – Identify Command	Mandatory
Test 1.2 – Set/Get Features Command	Mandatory
Test 1.3 – Get Log Page Command	Mandatory
Test 1.4 – Create/Delete IO Submission and Completion Queues	Mandatory
Test 1.5 – Abort Command	Mandatory
Test 1.6 – Format NVM Command	Mandatory
<b>Group 2: NVM Command Set</b>	
Test 2.1 – Compare NVM Command	Optional
Test 2.2 – Dataset Management Command	Optional
Test 2.3 – Read Command	Mandatory
Test 2.4 – Write Command	Mandatory
Test 2.5 – Write Uncorrectable Command	Optional
Test 2.6 – Flush Command	Mandatory
Test 2.7 - Write Zeros	Optional
<b>Group 3: NVM Features</b>	
Test 3.1 – Metadata Handling	Optional
Test 3.2 – End to End Data Protection	Optional
Test 3.3 – Power Management	Mandatory
<b>Group 4: Controller Registers</b>	
Test 4.1 – Memory Page Size Maximum (MPSMAX)	Mandatory
Test 4.2 – Memory Page Size Minimum (MPSMIN)	Mandatory
Test 4.3 – Command Sets Supported (CCS)	Mandatory
Test 4.4 – Doorbell Stride (DSTRD)	Mandatory
Test 4.5 – Timeout (TO)	Mandatory
Test 4.6 – Arbitration Mechanism Supported (AMS)	Optional
Test 4.7 – Contiguous Queues Required (CQR)	Mandatory
Test 4.8 – Maximum Queue Entries Supported (MQES)	Mandatory
Test 4.9 – Offset 0Ch INTS Interrupt Mask Set/Clear (IMSC)	Mandatory
Test 4.10 – Offset 14h CC I/O Completions Queue Entry Size (IOCQES)	Mandatory
Test 4.11 – Offset 14h CC I/O Submission Queue Entry Size (IOSQES)	Mandatory
Test 4.12 – Offset 14h: CC – Shutdown Notification (SHN)	Mandatory
Test 4.13 – Offset 14h: CC – Arbitration Mechanism Selected (AMS)	Mandatory
Test 4.14 – Offset 14h: CC – I/O Command Set Selected (CSS)	Mandatory
Test 4.15 – Offset 14h: CC – Enable (EN)	Mandatory
Test 4.16 – Offset 1Ch: CSTS – Shutdown Status (SHST)	Mandatory
Test 4.17 – Offset 1Ch: CSTS – Controller Fatal Status (CFS)	Mandatory
<b>Group 5: System Memory Structure</b>	
Test 5.1 – Page Base Address and Offset (PBAO)	Mandatory
Test 5.2 – Completion Queue Entry	Mandatory
Test 5.3 – Status Field Definition	Mandatory

Test 5.4 – Generic Command Status Definition	Mandatory
Test 5.5 – Command Specific Errors Definition	Mandatory
Test 5.6 – Media Errors Definition	Mandatory
<b>Group 6: Controller Architecture</b>	
Test 6.1 – Conventional Controller Level Reset	Not Performed
Test 6.2 – Function Level Controller Level Reset	Mandatory
Test 6.3 – Controller Reset Controller Level Reset	Mandatory
Test 6.4 – NVM Subsystem Reset	Optional
<b>Group 7: Reservations</b>	
Test 7.1 – Controller and Namespace Support for Reservations	Not Performed
Test 7.2 – Register New Reservation	Not Performed
Test 7.3 – Replace Reservation	Not Performed
Test 7.4 – Replace Reservation – Key Mismatch	Not Performed
Test 7.5 – Replace Reservation – Ignore Existing Key	Not Performed
Test 7.6 – Unregister – Key Mismatch	Not Performed
Test 7.7 – Unregister – Non Registrant	Not Performed
<b>Group 8: Autonomous Power State Transitions</b>	
Test 8.1 – Autonomous Power State Transitions Enabled	Not Performed
Test 8.2 – Return from Non-Operational State	Not Performed
<b>Group 9: Namespace Management</b>	
Namespace Management Identify Command	FYI
Namespace Management Command	FYI
Namespace Attachment Command	FYI

When UNH-IOL issues reports for a product, they will include a notice on whether the Product Under Test is eligible for the Integrators List or not. In order to have an eligible product included on the Integrators List, the participating company must specifically request UNH-IOL to list the eligible products. Products will not be automatically listed. UNH-IOL will not list products that are not eligible. UNH-IOL will not list products that the participating company has not requested to have listed on the Integrators List.

A participating company could request conformance and interop testing according to the most recent version of the CTS and ITS, but not immediately request a product be posted to the IL, perhaps waiting for the product to be announced publically. If the CTS or ITS changes after the product is tested, but before the request for listing occurs, the product would remain eligible for listing, but the listing would indicate which CTS and ITS version the test was performed to.

A participating company may request testing be performed on their product according to the previous version of the CTS or ITS (rather than the most recent version). If the testing is performed using the previous version of the CTS or ITS, within 6 months of the release date of the newest CTS or ITS, the product would be eligible for the Integrators List. If the testing is performed using the previous version of the CTS or ITS, more than 6 months after the release date of the newest CTS or ITS, the product would not be eligible for the Integrators List.

## 5 - Information in Listing

The following information must be provided with each listing request, this information will be included in the listing on the public NVMe Integrators List.

- Product, includes Manufacturer, Model Name and Family Name (i.e. different capacities of one SSD are in a single family)
- Product type (accepted products types are: NVMe SSD, SSD Controller, or SSD Controller IP, server, server board, motherboard, add-in card, RAID Controller, or IP device).
- Operating System (Host Only)
- Driver (Host Only)
- Firmware revision (Device Only)

- Interop Program Revision (i.e. 1.0, 1.1, 1.2 etc...)
- Date of listing
- Test ID
- Further Information (primary contact or website)

IL listing is considered permanent. If the CTS or ITS is revised, listings for previously tested products will remain on the public IL (i.e. listings for products tested against version 1.0, are not removed when version 1.1 becomes available).

### **6 - Listing by Similarity**

It is expected that some products will have differences that do not affect NVMe operation, such as form factor, storage capacity, or endurance parameters. In cases such as this, a participating company can request that certain products be added to a product listing, thus they are listed by similarity. The products listed by similarity must have the same Firmware revision and Model Name, and the listing company confirms that the products are materially similar with no substantive changes to the NVMe interface. A Listing by Similarity request form will need to be submitted to UNH-IOL.