# SERIAL ATTACHED SCSI (SAS) CONSORTIUM

**Clause 10**
**SAS Application Layer Test Suite**
***Version 1.02***

*Technical Document*


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# TABLE OF CONTENTS

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# MODIFICATION RECORD

[1]September 7, 2004 (Version 0.1) DRAFT RELEASE
David Woolf: Initial draft release
[2]April 14, 2005 (Version 0.12) DRAFT RELEASE
David Woolf: added STP Operations tests
[3]July 11, 2005 (Version 0.13) DRAFT RELEASE
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David Woolf: Added to Possible Problems section in test 10.1.5

*The University of New Hampshire*
*InterOperability Laboratory*

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| | |
|---|---|
| Kurtis Kofler | UNH InterOperability Laboratory (UNH-IOL) |
| David Woolf | UNH InterOperability Laboratory (UNH-IOL) |
| Leon Cyril | UNH InterOperability Laboratory (UNH-IOL) |

# INTRODUCTION

The University of New Hampshire's InterOperability Laboratory (IOL) is an institution designed to improve the interoperability of standards based products by providing an environment where a product can be tested against other implementations of a standard. This particular suite of tests has been developed in junction with CATC to help implementers evaluate the functionality of their Serial Attached SCSI (SAS) products. Specifically this Test Suite is directed at verifying the Link layer of SAS Targets, Initiators, and Expanders.

These tests are designed to determine if a SAS product conforms to specifications defined in **ISO/IEC 14776-150, *Serial Attached SCSI (SAS) standard* T10/1562-D, Revision 5** (hereafter referred to as the "SAS Standard"). Successful completion of all tests contained in this suite does not guarantee that the tested device will successfully operate with other SAS products. However, when combined with satisfactory operation in the IOL's interoperability test bed, these tests provide a reasonable level of confidence that the Device Under Test (DUT) will function properly in many SAS environments.

The tests contained in this document are organized in order to simplify the identification of information related to a test, and to facilitate in the actual testing process. Tests are separated into groups, primarily in order to reduce setup time in the lab environment, however the different groups typically also tend to focus on specific aspects of device functionality. A three-number, dot-notated naming system is used to catalog the tests, where the first number always indicates the specific clause of the reference standard on which the test suite is based. The second and third numbers indicate the test's group number and test number within that group, respectively. This format allows for the addition of future tests in the appropriate groups without requiring the renumbering of the subsequent tests.

The test definitions themselves are intended to provide a high-level description of the motivation, resources, procedures, and methodologies specific to each test. Formally, each test description contains the following sections:

**Purpose**

The purpose is a brief statement outlining what the test attempts to achieve. The test is written at the functional level.

**References**

This section specifies all reference material *external* to the test suite, including the specific sub clauses references for the test in question, and any other references that might be helpful in understanding the test methodology and/or test results. External sources are always referenced by a bracketed number (e.g., [1]) when mentioned in the test description. Any other references in the test description that are not indicated in this manner refer to elements within the test suite document itself (e.g., "Appendix 5.A", or "Table 5.1.1-1")

**Resource Requirements**

The requirements section specifies the test hardware and/or software needed to perform the test. This is generally expressed in terms of minimum requirements, however in some cases specific equipment manufacturer/model information may be provided.

**Last Modification**

This specifies the date of the last modification to this test.

**Test Setup**

The setup section describes the initial configuration of the test environment. Small changes in the configuration should not be included here, and are generally covered in the test procedure section (next).

**Procedure**

The procedure section of the test description contains the systematic instructions for carrying out the test. It provides a cookbook approach to testing, and may be interspersed with observable results.

**Observable Results**

This section lists the specific observables that can be examined by the tester in order to verify that the DUT is operating properly. When multiple values for an observable are possible, this section provides a short discussion on how to interpret them. The determination of a pass or fail outcome for a particular test is generally based on the successful (or unsuccessful) detection of a specific observable.

**Possible Problems**

This section contains a description of known issues with the test procedure, which may affect test results in certain situations. It may also refer the reader to test suite appendices and/or other external sources that may provide more detail regarding these issues.

# REFERENCES

The following document is referenced in this text:

[1] T10/Project 1601-DT/Rev 8 – Serial Attached SCSI 1.1 – (SAS – 1.1)
[2] T10/Project 1416-D/Rev 23 – SCSI Primary Commands 3 – (SPC – 3)
[3] T10/Project 1417-D/Rev 16 – SCSI Block Commands 2 – (SBC – 2)

# GROUP 1: APPLICATION LAYER TESTS FOR TARGETS

**Overview:**
This group of tests verifies the specifications of the SCSI and ATA protocols used over SAS defined in SPC3, SBC2, and ATA/ATAPI 5/6, for targets.

**Test 10.1.1 - SCSI CDB – TEST UNIT READY**

**Purpose:** To determine that the DUT, an SSP Target port, properly handles a Test Unit Ready command.

**References:**
[1] SCSI Primary Commands-3 6.33
[2] SCSI Primary Commands-3 Table 184

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** The TEST UNIT READY command [2] provides a means to check if the logical unit is ready. This is not a request for a self-test. If the logical unit is able to accept an appropriate medium-access command without returning CHECK CONDITION status, this command shall return a GOOD status. If the logical unit is unable to become operational or is in a state such that an application client action (e.g., START UNIT command) is required to make the logical unit ready, the command shall be terminated with CHECK CONDITION status, with the sense key set to NOT READY.

**Test Setup:** The DUT and the Testing Station are physically connected.

**Test Procedure:**
1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is a target The Testing Station is instructed to transmit an Identify Address frame indicating that it is a SAS Initiator.
2. The Testing Station is instructed to open an SSP connection to the DUT and transmit a SCSI TEST UNIT READY command to the DUT. Close the connection
3. Allow the DUT to open an SSP connection and transmit a SCSI RESPONSE frame to the received command.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed with GOOD status.

**Possible Problems:** None

**Test 10.1.2 - SCSI CDB – INQUIRY**

**Purpose:** To determine that the DUT, an SSP Target port, properly handles an INQUIRY command.

**References:**
[1] 6.4 SCSI Primary Commands-3
[2] Table 80 SCSI Primary Commands-3
[3] 6.4.2 SCSI Primary Commands-3

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** The INQUIRY command [2] requests that information regarding the logical unit and SCSI target device be sent to the application client. In response to an INQUIRY command received by an incorrect logical unit, the SCSI target device shall return the INQUIRY data with the peripheral qualifier set to the value defined in [3]. The INQUIRY command shall return CHECK CONDITION status only when the device server is unable to return the requested INQUIRY data.

**Test Setup:** The DUT and the Testing Station are physically connected.

**Test Procedure:**
1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is a target The Testing Station is instructed to transmit an Identify Address frame indicating that it is a SAS Initiator.
2. The Testing Station is instructed to open an SSP connection to the DUT and transmit a SCSI INQUIRY command to the DUT with the EVPD and PAGE CODE fields set to zero. Close the connection
3. Allow the DUT to open an SSP connection and transmit DATA, containing standard INQUIRY data, and RESPONSE frames to the received command.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command is completed with GOOD status. Verify that the INQUIRY DATA is consistent with the device type and is formatted according to [2]

**Possible Problems:** None

**Test 10.1.3 - SCSI CDB – START STOP**

**Purpose:** To determine that the DUT, an SSP Target port, properly handles a START STOP command.

**References:**
[1] 5.19 SCSI Block Commands-2
[2] Table 48 SCSI Block Commands-2
[3] 4.15 SCSI Block Commands-2

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** The START STOP UNIT command [2] requests that the device server change the power condition of the logical unit [3] or load or eject the medium. This includes specifying that the device server enable or disable the direct-access block device for medium access operations by controlling power conditions and timers.

**Test Setup:** The DUT and the Testing Station are physically connected.

**Test Procedure:**
1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is a target The Testing Station is instructed to transmit an Identify Address frame indicating that it is a SAS Initiator.
2. The Testing Station is instructed to open an SSP connection to the DUT and transmit a SCSI START STOP command to the DUT. Close the connection
3. Allow the DUT to open an SSP connection and transmit a RESPONSE frame to the received command.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed with GOOD status.

**Possible Problems:** None

**Test 10.1.4 - SCSI CDB – MODE SENSE**

**Purpose:** To determine that the DUT, an SSP Target port, properly handles a MODE SENSE command.

**References:**
[1] SPC-3 6.9 SCSI Primary Commands-3
[2] 7.4.2 SCSI Primary Commands-3
[3] Table 246 SCSI Primary Commands-3
[4] Table 97 SCSI Primary Commands-3

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** The MODE SENSE(6) command [4] provides a means for a device server to report parameters to an application client. It is a complementary command to the MODE SELECT(6) command. Device servers that implement the MODE SENSE(6) command shall also implement the MODE SELECT(6) command. An application client may request any one or all of the supported mode pages from the device server. If an application client issues a MODE SENSE command with a page code or subpage code value not implemented by the logical unit, the command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

**Test Setup:** The DUT and the Testing Station are physically connected.

**Test Procedure:**
1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is a target The Testing Station is instructed to transmit an Identify Address frame indicating that it is a SAS Initiator.
2. The Testing Station is instructed to open an SSP connection to the DUT and transmit a SCSI MODE SENSE(6) command to the DUT with the PAGE CODE field set 02h and the SUBPAGE CODE set to 00h. This will request the Disconnect-Reconnect Mode Page. Close the connection
3. Allow the DUT to open an SSP connection and transmit DATA, containing standard Disconnect Reconnect Mode Parameters, and RESPONSE frames to the received command.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed with GOOD status. Verify that the Mode Parameters returned by the DUT are formatted according to [3] of SPC-3.

**Possible Problems:** None

**Test 10.1.5 - SCSI CDB – MODE SELECT**

**Purpose:** To determine that the DUT, an SSP Target port, properly handles a MODE SELECT command.

**References:**
[1] 3 6.7 SCSI Primary Commands-3
[2] Table 94 SCSI Primary Commands-3

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** March 30, 2012

**Discussion:** The MODE SELECT(6) command [2] provides a means for the application client to specify medium, logical unit, or peripheral device parameters to the device server. Device servers that implement the MODE SELECT(6) command shall also implement the MODE SENSE(6) command. Application clients should issue MODE SENSE(6) prior to each MODE SELECT(6) to determine supported mode pages, page lengths, and other parameters.

**Test Setup:** The DUT and the Testing Station are physically connected. The DUT is not powered on .

**Test Procedure:**
1. Power on the DUT.
2. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is a target The Testing Station is instructed to transmit an Identify Address frame indicating that it is a SAS Initiator.
3. The Testing Station is instructed to open an SSP connection to the DUT and transmit a SCSI MODE SENSE(6) command to the DUT with the PAGE CODE field set 02h and the SUBPAGE CODE set to 00h. This will request the Disconnect-Reconnect Mode Page. Close the connection
4. Allow the DUT to open an SSP connection and transmit DATA, containing standard Disconnect Reconnect Mode Parameters, and RESPONSE frames to the received command.
5. The Testing Station is instructed to open an SSP connection to the DUT and transmit a SCSI MODE SELECT(6) command to the DUT with the PF bit set to 1, the SP bit set to 1. Close the connection.
6. Allow the DUT to open an SSP connection to transmit an XFER_RDY frame.
7. The Testing Station is instructed to open an SSP connection to the DUT and transmit a DATA frame to the DUT containing Mode Parameters for the Disconnect Reconnect Mode Page with a new Maximum Burst Size. Close the connection.
8. Allow the DUT to open an SSP connection to transmit a RESPONSE frame.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed with GOOD status.

**Possible Problems:** Some DUTs may have a default Maximum Burst Size value that cannot be changed. In this case, the Testing Station should use the MODE SENSE command to determine the changeable values on the DUT for Mode Page 2 and then repeat step 7, sending a DATA frame to the DUT containing Mode Parameters for the Disconnect Reconnect Mode Page with a new value for any one of the changeable Mode Parameter values.

**Test 10.1.6 - SCSI CDB – READ CAPACITY**

**Purpose:** To determine that the DUT, an SSP Target port, properly handles a READ CAPACITY command.

**References:**

[1] 5.12 SCSI Block Commands-2
[2] Table 34 SCSI Block Commands-2
[3] Table 36 SCSI Block Commands-2
[4] 4.11 SCSI Block Commands-2
[5] 4.16 SCSI Block Commands-2

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2004

**Discussion:** The READ CAPACITY (10) command [2] requests that the device server transfer 8 bytes of parameter data describing the capacity and medium format of the direct-access block device to the data-in buffer. This command may be processed as if it has a HEAD OF QUEUE task attribute [4]. If the logical unit supports protection information [5], the application client should use the READ CAPACITY (16) command instead of the READ CAPACITY (10) command.

**Test Setup:** The DUT and the Testing Station are physically connected.

**Test Procedure:**

1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is a target The Testing Station is instructed to transmit an Identify Address frame indicating that it is a SAS Initiator.
2. The Testing Station is instructed to open an SSP connection to the DUT and transmit a SCSI READ CAPACITY(10) command to the DUT with the PMI bit set to 0. Close the connection
3. Allow the DUT to open an SSP connection and transmit DATA and RESPONSE frames to the received command.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed with GOOD status. Verify that the DATA returned by the DUT are formatted according to table 36 of SBC-2.

**Possible Problems:** None

**Test 10.1.7 - SCSI CDB – WRITE**

**Purpose:** To determine that the DUT, an SSP Target port, properly handles a WRITE (10) command.

**References:**
[1] 5.27 SCSI Block Commands-2
[2] Table 62 SCSI Block Commands-2

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** The WRITE (10) command [2] requests that the device server transfer the specified logical block(s) from the data-out buffer and write them. Each logical block transferred includes user data and may include protection information, based on the WRPROTECT field and the medium format. Each logical block written includes user data and, if the medium is formatted with protection information enabled, protection information.

**Test Setup:** The DUT and the Testing Station are physically connected.

**Test Procedure:**
1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is a target The Testing Station is instructed to transmit an Identify Address frame indicating that it is a SAS Initiator.
2. The Testing Station is instructed to open an SSP connection to the DUT and transmit a SCSI WRITE command for 2048 bytes. Close the connection
3. Allow the DUT to open an SSP connection to the Testing Station and transmit XFER_RDY.
4. The Testing Station is instructed to open a connection to the DUT and transmit 4 512 byte DATA frames. Close the connection.
5. Allow the DUT to open an SSP connection and transmit a SCSI RESPONSE frame to the received command and data.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed with GOOD status. Verify that the DUT transmitted ACK for every received DATA frame.

**Possible Problems:** None

**Test 10.1.8 - SCSI CDB – READ**

**Purpose:** To determine that the DUT, an SSP Target port, properly handles a READ(10) command.

**References:**
[1] 5.8 SCSI Block Commands-2
[2] Table 28 SCSI Block Commands-2

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** The READ (10) command [2] requests that the device server read the specified logical block(s) and transfer them to the data-in buffer. Each logical block read includes user data and, if the medium is formatted with protection information enabled, protection information. Each logical block transferred includes user data and may include protection information, based on the RDPROTECT field and the medium format. The most recent data value written in the addressed logical block shall be returned.

**Test Setup:** The DUT and the Testing Station are physically connected.

**Test Procedure:**
1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is a target The Testing Station is instructed to transmit an Identify Address frame indicating that it is a SAS Initiator.
2. The Testing Station is instructed to open an SSP connection to the DUT and transmit a SCSI READ command for 2048 bytes. Close the connection
3. The DUT should open a connection to the Testing Station and transmit 4 512 byte DATA frames. The Testing Station is instructed to transmit ACK for each received frame.
4. Allow the DUT to open an SSP connection and transmit a SCSI RESPONSE frame to the received command.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed with GOOD status.

**Possible Problems:** None

**Test 10.1.9 - SCSI CDB – LOG SENSE**

**Purpose:** To determine that the DUT, an SSP Target port, properly handles a LOG SENSE command.

**References:**
[1] 6.6 SCSI Primary Commands-3
[2] Table 93 SCSI Primary Commands-3
[3] 7.2.12 SCSI Primary Commands-3
[4] Table 194 SCSI Primary Commands-3

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** The LOG SENSE command [2] provides a means for the application client to retrieve statistical or other operational information maintained by the SCSI target device about the SCSI target device or its logical units. It is a complementary command to the LOG SELECT command.

**Test Setup:** The DUT and the Testing Station are physically connected.

**Test Procedure:**
1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is a target The Testing Station is instructed to transmit an Identify Address frame indicating that it is a SAS Initiator.
2. The Testing Station is instructed to open an SSP connection to the DUT and transmit a SCSI LOG SENSE command with the PPC and PARAMETER POINTER fields set to 0, a LOG PAGE CODE of 00h (Supported Log Pages), and SP bit of 0. Close the connection
3. The DUT should open a connection to the Testing Station and transmit DATA frames to the DUT.
4. Allow the DUT to open an SSP connection and transmit a SCSI RESPONSE frame to the received command.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed with GOOD status. Verify that the DUT transmitted Log Page data formatted according to [3]. Verify that the DUT reported its supported Log Pages defined in [4].

**Possible Problems:** None

# GROUP 2: APPLICATION LAYER TESTS FOR EXPANDERS

**Overview:**
This group of tests verifies the specifications of the SCSI and ATA protocols used over SAS defined in SPC3, SBC2, and ATA/ATAPI 5/6 for expanders.

**Test 10.2.1 - STP OPERATIONS – IDENTIFY DEVICE**

**Purpose:** To determine that the DUT, an STP Bridge port, properly handles an IDENTIFY DEVICE request.

**References:**

[1] 8.15 AT Attachment with Packet Interface-5/6
[2] Table 27 AT Attachment with Packet Interface-5/6

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** The IDENTIFY DEVICE command enables the host to receive parameter information from the device. Some devices may have to read the media in order to complete this command. When the command is issued, the device sets the BSY bit to one, prepares to transfer the 256 words of device identification data to the host, sets the DRQ bit to one, clears the BSY bit to zero, and asserts INTRQ if nIENis cleared to zero. The host may then transfer the data by reading the Data register. Table 27 defines the arrangement and meaning of the parameter words in the buffer. All reserved bits or words shall be zero.

**Test Setup:** The DUT and the Testing Station are physically connected. The DUT is also connected to a SATA disk drive.

**Test Procedure:**

1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is an expander with an attached target The Testing Station is instructed to transmit an Identify Address frame indicating that it is an initiator.
2. The Testing Station is instructed to open an SMP Connection to the DUT an transmit a REPORT_GENERAL SMP Request. The DUT should transmit a REPORT_GENERAL SMP Response.
3. The Testing Station is instructed to open an SMP Connection to the DUT and transmit a REPORT STA PHY SMP Request to the DUT phy which is attached to the SAS Target. The DUT should transmit a REPORT SATA PHY SMP Response with this information.
4. The Testing Station is instructed to transmit an OpenAddress frame for an STP Connection to the STP Target on the DUT. The Testing Station is instructed to wait for OPEN_ACCEPT.
5. The Testing Station is instructed to transmit a SATA FIS of type Register Host to Device with Command Code IDENTIFY DEVICE.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed.

**Possible Problems:** None

**Test 10.2.2 - STP OPERATIONS – SET FEATURES**

**Purpose:** To determine that the DUT, an STP Bridge port, properly handles a SET FEATURES request.

**References:**
[1] 8.46 AT Attachment with Packet Interface-5/6
[2] Table 44 AT Attachment with Packet Interface-5/6

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** This command is used by the host to establish parameters that affect the execution of certain device features. Table 44 defines these features. At power-on, or after a hardware reset, the default settings of the functions specified by the subcommands are vendor specific.

**Test Setup:** The DUT and the Testing Station are physically connected. The DUT is also connected to a SATA disk drive.

**Test Procedure:**

1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is an expander with an attached target The Testing Station is instructed to transmit an Identify Address frame indicating that it is an initiator.
2. The Testing Station is instructed to open an SMP Connection to the DUT an transmit a REPORT_GENERAL SMP Request. The DUT should transmit a REPORT_GENERAL SMP Response.
3. The Testing Station is instructed to open an SMP Connection to the DUT and transmit a REPORT STA PHY SMP Request to the DUT phy which is attached to the SAS Target. The DUT should transmit a REPORT SATA PHY SMP Response with this information.
4. The Testing Station is instructed to transmit an OpenAddress frame for an STP Connection to the STP Target on the DUT. The Testing Station is instructed to wait for OPEN_ACCEPT.
5. The Testing Station is instructed to transmit a SATA FIS of type Register Host to Device with Command Code SET FEATURES.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed.

**Possible Problems:** None

**Test 10.2.3 - STP OPERATIONS – IDLE**

**Purpose:** To determine that the DUT, an STP Bridge port, properly handles an IDLE request.

**References:**
[1] 8.17 AT Attachment with Packet Interface-5/6
[2] 6.11 AT Attachment with Packet Interface-5/6

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** The IDLE command allows the host to place the device in the Idle mode and also set the Standby timer. INTRQ may be asserted even though the device may not have fully transitioned to Idle mode. If the Sector Count register is non-zero then the Standby timer shall be enabled. The value in the Sector Count register shall be used to determine the time programmed into the Standby timer [2]. If the Sector Count register is zero then the Standby timer is disabled.

**Test Setup:** The DUT and the Testing Station are physically connected. The DUT is also connected to a SATA disk drive.

**Test Procedure:**

1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is an expander with an attached target The Testing Station is instructed to transmit an Identify Address frame indicating that it is an initiator.
2. The Testing Station is instructed to open an SMP Connection to the DUT an transmit a REPORT_GENERAL SMP Request. The DUT should transmit a REPORT_GENERAL SMP Response.
3. The Testing Station is instructed to open an SMP Connection to the DUT and transmit a REPORT STA PHY SMP Request to the DUT phy which is attached to the SAS Target. The DUT should transmit a REPORT SATA PHY SMP Response with this information.
4. The Testing Station is instructed to transmit an OpenAddress frame for an STP Connection to the STP Target on the DUT. The Testing Station is instructed to wait for OPEN_ACCEPT.
5. The Testing Station is instructed to transmit a SATA FIS of type Register Host to Device with Command Code IDLE.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed.

**Possible Problems:** None

**Test 10.2.4 - STP OPERATIONS – SET MULTIPLE MODE**

**Purpose:** To determine that the DUT, an STP Bridge port, properly handles a SET MULTIPLE MODE request.

**References:**

[1] 8.49 AT Attachment with Packet Interface-5/6

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** This command establishes the block count for READ MULTIPLE, READ MULTIPLE EXT, WRITE MULTIPLE, and WRITE MULTIPLE EXT commands. Devices shall support the block size specified in the IDENTIFY DEVICE parameter word 47, bits (7:0), and may also support smaller values. Upon receipt of the command, the device checks the Sector Count register. If the content of the Sector Count register is not zero, the Sector Count register contains a valid value, and the block count is supported, then the value in the Sector Count register is used for all subsequent READ MULTIPLE, READ MULTIPLE EXT, WRITE MULTIPLE, and WRITE MULTIPLE EXT commands and their execution is enabled.

**Test Setup:** The DUT and the Testing Station are physically connected. The DUT is also connected to a SATA disk drive.

**Test Procedure:**

1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is an expander with an attached target The Testing Station is instructed to transmit an Identify Address frame indicating that it is an initiator.
2. The Testing Station is instructed to open an SMP Connection to the DUT an transmit a REPORT_GENERAL SMP Request. The DUT should transmit a REPORT_GENERAL SMP Response.
3. The Testing Station is instructed to open an SMP Connection to the DUT and transmit a REPORT STA PHY SMP Request to the DUT phy which is attached to the SAS Target. The DUT should transmit a REPORT SATA PHY SMP Response with this information.
4. The Testing Station is instructed to transmit an OpenAddress frame for an STP Connection to the STP Target on the DUT. The Testing Station is instructed to wait for OPEN_ACCEPT.
5. The Testing Station is instructed to transmit a SATA FIS of type Register Host to Device with Command Code SET MULTIPLE MODE.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed.

**Possible Problems:** None

**Test 10.2.5 - STP OPERATIONS – WRITE SECTORS**

**Purpose:** To determine that the DUT, an STP Bridge port, properly handles a WRITE SECTORS request.

**References:**

[1] 8.5 AT Attachment with Packet Interface-5/6

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** This command writes from 1 to 256 sectors as specified in the Sector Count register. A sector count of 0 requests 256 sectors. The device shall interrupt for each DRQ block transferred.

**Test Setup:** The DUT and the Testing Station are physically connected. The DUT is also connected to a SATA disk drive.

**Test Procedure:**

1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is an expander with an attached target The Testing Station is instructed to transmit an Identify Address frame indicating that it is an initiator.
2. The Testing Station is instructed to open an SMP Connection to the DUT an transmit a REPORT_GENERAL SMP Request. The DUT should transmit a REPORT_GENERAL SMP Response.
3. The Testing Station is instructed to open an SMP Connection to the DUT and transmit a REPORT STA PHY SMP Request to the DUT phy which is attached to the SAS Target. The DUT should transmit a REPORT SATA PHY SMP Response with this information.
4. The Testing Station is instructed to transmit an OpenAddress frame for an STP Connection to the STP Target on the DUT. The Testing Station is instructed to wait for OPEN_ACCEPT.
5. The Testing Station is instructed to transmit a SATA FIS of type Register Host to Device with Command Code WRITE SECTORS.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed.

**Possible Problems:** None

**Test 10.2.6 - STP OPERATIONS – READ SECTORS**

**Purpose:** To determine that the DUT, an STP Bridge port, properly handles a READ SECTORS request.

**References:**

[1] 8.34 AT Attachment with Packet Interface-5/6

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** This command reads from 1 to 256 sectors as specified in the Sector Count register. A sector count of 0 requests 256 sectors. The transfer shall begin at the sector specified in the LBA Low, LBA Mid, LBA High, and Device registers. The DRQ bit is always set to one prior to data transfer regardless of the presence or absence of an error condition. The device shall interrupt for each DRQ block transferred.

**Test Setup:** The DUT and the Testing Station are physically connected. The DUT is also connected to a SATA disk drive.

**Test Procedure:**

1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is an expander with an attached target The Testing Station is instructed to transmit an Identify Address frame indicating that it is an initiator.
2. The Testing Station is instructed to open an SMP Connection to the DUT an transmit a REPORT_GENERAL SMP Request. The DUT should transmit a REPORT_GENERAL SMP Response.
3. The Testing Station is instructed to open an SMP Connection to the DUT and transmit a REPORT STA PHY SMP Request to the DUT phy which is attached to the SAS Target. The DUT should transmit a REPORT SATA PHY SMP Response with this information.
4. The Testing Station is instructed to transmit an OpenAddress frame for an STP Connection to the STP Target on the DUT. The Testing Station is instructed to wait for OPEN_ACCEPT.
5. The Testing Station is instructed to transmit a SATA FIS of type Register Host to Device with Command Code READ SECTORS.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed.

**Possible Problems:** None

**Test 10.2.7 - STP OPERATIONS – WRITE MULTIPLE**

**Purpose:** To determine that the DUT, an STP Bridge port, properly handles a WRITE MULTIPLE request.

**References:**

[1] 8.60 AT Attachment with Packet Interface-5/6

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** This command writes the number of sectors specified in the Sector Count register. The number of sectors per block is defined by the content of word 59 of the IDENTIFY DEVICE response. When the WRITE MULTIPLE command is issued, the Sector Count register contains the number of sectors (not the number of blocks) requested. The device shall interrupt for each DRQ block transferred.

**Test Setup:** The DUT and the Testing Station are physically connected. The DUT is also connected to a SATA disk drive.

**Test Procedure:**

1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is an expander with an attached target The Testing Station is instructed to transmit an Identify Address frame indicating that it is an initiator.
2. The Testing Station is instructed to open an SMP Connection to the DUT an transmit a REPORT_GENERAL SMP Request. The DUT should transmit a REPORT_GENERAL SMP Response.
3. The Testing Station is instructed to open an SMP Connection to the DUT and transmit a REPORT STA PHY SMP Request to the DUT phy which is attached to the SAS Target. The DUT should transmit a REPORT SATA PHY SMP Response with this information.
4. The Testing Station is instructed to transmit an OpenAddress frame for an STP Connection to the STP Target on the DUT. The Testing Station is instructed to wait for OPEN_ACCEPT.
5. The Testing Station is instructed to transmit a SATA FIS of type Register Host to Device with Command Code WRITE MULTIPLE.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed.

**Possible Problems:** None

**Test 10.2.8 - STP OPERATIONS – READ MULTIPLE**

**Purpose:** To determine that the DUT, an STP Bridge port, properly handles a READ MULTIPLE request.

**References:**

[1] 8.30 AT Attachment with Packet Interface-5/6

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** This command reads the number of sectors specified in the Sector Count register. The number of sectors per block is defined by the content of word 59 in the IDENTIFY DEVICE response. When the READ MULTIPLE command is issued, the Sector Count register contains the number of sectors (not the number of blocks) requested. The device shall interrupt for each DRQ block transferred.

**Test Setup:** The DUT and the Testing Station are physically connected. The DUT is also connected to a SATA disk drive.

**Test Procedure:**

1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is an expander with an attached target The Testing Station is instructed to transmit an Identify Address frame indicating that it is an initiator.
2. The Testing Station is instructed to open an SMP Connection to the DUT an transmit a REPORT_GENERAL SMP Request. The DUT should transmit a REPORT_GENERAL SMP Response.
3. The Testing Station is instructed to open an SMP Connection to the DUT and transmit a REPORT STA PHY SMP Request to the DUT phy which is attached to the SAS Target. The DUT should transmit a REPORT SATA PHY SMP Response with this information.
4. The Testing Station is instructed to transmit an OpenAddress frame for an STP Connection to the STP Target on the DUT. The Testing Station is instructed to wait for OPEN_ACCEPT.
5. The Testing Station is instructed to transmit a SATA FIS of type Register Host to Device with Command Code READ MULTIPLE.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed.

**Possible Problems:** None

**Test 10.2.9 - STP OPERATIONS – WRITE DMA**

**Purpose:** To determine that the DUT, an STP Bridge port, properly handles a WRITE DMA request.

**References:**

[1] 8.55 AT Attachment with Packet Interface-5/6

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** The WRITE DMA command allows the host to write data using the DMA data transfer protocol.

**Test Setup:** The DUT and the Testing Station are physically connected. The DUT is also connected to a SATA disk drive.

**Test Procedure:**

1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is an expander with an attached target The Testing Station is instructed to transmit an Identify Address frame indicating that it is an initiator.
2. The Testing Station is instructed to open an SMP Connection to the DUT an transmit a REPORT_GENERAL SMP Request. The DUT should transmit a REPORT_GENERAL SMP Response.
3. The Testing Station is instructed to open an SMP Connection to the DUT and transmit a REPORT STA PHY SMP Request to the DUT phy which is attached to the SAS Target. The DUT should transmit a REPORT SATA PHY SMP Response with this information.
4. The Testing Station is instructed to transmit an OpenAddress frame for an STP Connection to the STP Target on the DUT. The Testing Station is instructed to wait for OPEN_ACCEPT.
5. The Testing Station is instructed to transmit a SATA FIS of type Register Host to Device with Command Code WRITE DMA.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed.

**Possible Problems:** None

**Test 10.2.10 - STP OPERATIONS – READ DMA**

**Purpose:** To determine that the DUT, an STP Bridge port, properly handles a READ DMA request.

**References:**

[1] 8.25 AT Attachment with Packet Interface-5/6

**Resource Requirements:** SAS Protocol Analyzer and Generator.

**Last Modification:** September 28, 2005

**Discussion:** The READ DMA command allows the host to read data using the DMA data transfer protocol.

**Test Setup:** The DUT and the Testing Station are physically connected. The DUT is also connected to a SATA disk drive.

**Test Procedure:**

1. The Testing Station is instructed to start and complete a phy Reset sequence followed by an Identify sequence with the DUT. Since the DUT is an expander with an attached target The Testing Station is instructed to transmit an Identify Address frame indicating that it is an initiator.
2. The Testing Station is instructed to open an SMP Connection to the DUT an transmit a REPORT_GENERAL SMP Request. The DUT should transmit a REPORT_GENERAL SMP Response.
3. The Testing Station is instructed to open an SMP Connection to the DUT and transmit a REPORT STA PHY SMP Request to the DUT phy which is attached to the SAS Target. The DUT should transmit a REPORT SATA PHY SMP Response with this information.
4. The Testing Station is instructed to transmit an OpenAddress frame for an STP Connection to the STP Target on the DUT. The Testing Station is instructed to wait for OPEN_ACCEPT.
5. The Testing Station is instructed to transmit a SATA FIS of type Register Host to Device with Command Code READ DMA.

**Observable Results:** Verify that the DUT transmits RESPONSE frame indicating that the command completed.

**Possible Problems:** None