Ethernet Switching Protocols Consortium

Virtual Local Area Network Conformance Test Suite

Version 2.1

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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 suite of tests has been developed to help implementers evaluate the functionality of their Virtual Local Area Network capable products.

Virtual Local Area Networks (VLANs) are used to split a physical topology into multiple logical topologies. Each of these possibly overlapping topologies is identified by its VLAN Identifier (VID). Frames forwarded by a bridge are associated with one and only one VID.

This test suite covers multiple aspects of C-VLANs, including its handling of the Learning and Forwarding processes, C-VLAN configuration parameters, learning constraints, and frame VID association. This test suite focuses on C-VLAN components.

The purpose of standardized protocols and features is to provide a uniform set of requirements that are met by all implementations. Satisfactory completion of conformance testing helps to instill confidence in users that the implementation will be well-behaved in a live network. Non-conformant implementations of standards-based protocols and features can lead to broken networks, reduced connectivity, network loops or other unintended behaviors, as well as confused or frustrated end-users. This test suite aims to provide one method of verifying conformance to 802.1Q-2011. Successful completion of all tests contained in this suite cannot guarantee that the tested device will operate as desired in all possible environments. However, combined with satisfactory completion of interoperability testing and companion test suites, these tests provide a reasonable level of confidence that the DUT will function well in most Virtual Local Area Network capable environments.

Abbreviations and Acronyms

IEEE 802.1

BPDU	Bridge Protocol Data Unit
CIST	Common Internal Spanning Tree
FCS	Frame Check Seqeuence(a.k.a Cyclic Redundancy Check)
ID	Identifier
LAN	Local Area Network
MAC	Media Access Control
MST	Multiple Spanning Tree
MSTI	Multiple Spanning Tree Instance
MSTP	Multiple Spanning Tree Protocol
PVID	Port VID
RSTP	Rapid Spanning Tree Protocol
SST	Single Spanning Tree
STP	Spanning Tree Protocol
VID	VLAN Identifier
VLAN	Virtual LAN

VLAN Conformance Test Suite

DUT	Device Under Test
DUT.TS	Port on the DUT connected to Test Station (ex.DUT.TS1 refers to the Port on the DUT connected to Test Station 1)
TS	Test Station (ex. TS1 refers to Test Station 1)

Test Organization

This document organizes tests by group based on related test methodology or goals. Each group begins with a brief set of comments pertaining to all tests within that group. This is followed by a series of description blocks; each block describes a single test, which is composed of one or more parts. The format of the description block is as follows:

Test Label: The test label and title constitute the first line of the test block. The test label is the concatenation of the short test suite name, group number, and the test number within the group, separated by periods

Purpose: The Purpose is a brief statement outlining what the test attempts to achieve. It is usually phrased as a simple assertion of the feature or capability to be tested.

References: The References section lists cross-references to the specifications and documentation that might be helpful in understanding and evaluating the test and results.

Resource Requirements: The Resource Requirements section specifies the software, hardware, and test equipment that will be needed to perform the test.

Discussion: The Discussion is a general discussion of the test and relevant section of the specification, including any assumptions made in the design or implementation of the test as well as known limitations.

Test Setup: This diagram shows how the Test Systems, DUT, and any other Devices used should be connected for this test. Elements of the Procedure may change the Layout.
****Configurations are cleared at the end of each Test****

Test Procedure: This section of the test description contains the step-by-step instructions for carrying out the test. These steps include such things as enabling interfaces, disconnecting links between devices, and sending MAC frames from a Test Station. The test procedure also cues the tester to make observations, which are interpreted in accordance with the observable results given for that test part.

****Continuously transmitted frames are stopped at the end of each Test Part****
****Unless noted, less than 0.1 seconds must elapse between execution of Test Steps****

Observable Results: This section lists observable results that can be examined by the tester to verify that the DUT is operating properly. When multiple observable results are possible, this section provides a short discussion on how to interpret them. The determination of a PASS or FAIL for each test is usually based on how the behavior of the DUT compares to the results described in this section.

Possible Problems: This section contains a description of known issues with the test procedure, which may affect test results in certain situations.

Group 1: Port Parameters

Scope: These tests cover the various port parameters used by VLAN aware bridges.

Test VLAN.op.1.1 — VLAN Classification

Purpose: To verify that the DUT associates all incoming frames that are passed to the Ingress Rules with exactly one VLAN.

References: [1] IEEE 802.1Q-2011: sub-clause 6.12
[2] IEEE 802.1Q-2011: sub-clause 12.10.1.3
[3] IEEE 802.1Q-2011: Table 9-2

Resource Requirements: 3 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: Each frame received by a VLAN-aware bridge shall be classified as belonging to exactly one VLAN by associating a VID value with the received frame. If the received frame is either a priority-tagged or untagged frame and port based classification is used, this classification is achieved by using the PVID value associated with the receiving port. If the received frame is VLAN-tagged, this classification is achieved by using the VID carried in the frame itself.

Test Setup: Refer to the default test setup in Appendix A.
Set DUT.TS1's PVID to be 3.
Set DUT.TS1 to be part of the untagged member set of VLAN 3.
Set DUT.TS2 to be part of the tagged member set of VLAN 2.
Set DUT.TS3 to be part of the untagged member set of VLAN 3.

Test Procedure:

Part A: Classification Using the PVID

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit 10 untagged frames.
3. Wait 2 seconds.

Part B: Classification Using the VID in the Received Frame

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit 10 VLAN 2 tagged frames.
3. Wait 2 seconds.

Observable Results:

Part A:

- TS3 must receive all of the frames transmitted from TS1. These frames must be untagged.
- TS2 must receive no traffic.

Part B:

- TS2 must receive all of the frames transmitted from TS1. These frames must be tagged for VLAN 2.
- TS3 must receive no traffic.

Possible Problems: None.

Test VLAN.op.1.2 — Acceptable Frame Types Parameter

Purpose: To determine the value(s) of the Acceptable Frame Types Parameter that the DUT supports.

References: [1] IEEE 802.1Q-2011: sub-clause 6.9

Resource Requirements: 3 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: Associated with each port of a VLAN aware bridge is an Acceptable Frame Types parameter that controls the reception of VLAN-tagged and non VLAN-tagged frames on that port. Valid values for this parameter are *Admit All frames*, *Admit only VLAN-Tagged frames*, and *Admit only Untagged and Priority-Tagged frames*. When set to *Admit only VLAN-Tagged Frames*, any frames received on that port that carry no VID are discarded by the ingress rule checking function of the Forwarding Process.

When set to *Admit All Frames*, all incoming priority-tagged and untagged frames are associated with a VLAN by the Ingress Rules using the PVID of the receiving port. When set to *Admit only Untagged and Priority-Tagged frames*, all incoming frames will only be admitted if they do not have a VLAN tag associated with them. The Egress Rules are then used to forward these frames out the appropriate ports.

Each port of a bridge shall support at least one of these values, and may support all three. Where all three are supported, the implementation shall support the ability to configure the value of the parameter through management and the default value of the parameter shall be *Admit All Frames*.

Test Setup: Refer to the default test setup in Appendix A.
Set DUT.TS1 to be in the tagged member set of VLAN 2 and untagged member set of VLAN 3.
Set DUT.TS2 to be in the tagged member set of VLAN 2.
Set DUT.TS3 to be in the untagged member set of VLAN 3.

Test Procedure:

Part A: Default Behavior

1. Ensure the DUT is configured to the test setup as defined above.
2. Ensure the Acceptable Frame Types Parameter has not been configured.
3. From TS1, transmit 10 untagged frames.
4. From TS1, transmit 10 priority-tagged frames.
5. From TS1, transmit 10 VLAN 2 tagged frames.
6. Wait 2 seconds.

Part B: Admit All Frames

1. Ensure the DUT is configured to the test setup as defined above.
2. If possible, set the Acceptable Frame Types parameter to *Admit All Frames.*
3. From TS1, transmit 10 untagged frames.
4. From TS1, transmit 10 priority-tagged frames.
5. From TS1, transmit 10 VLAN 2 tagged frames.
6. Wait 2 seconds.

Part C: Admit only VLAN-Tagged Frames

1. Ensure the DUT is configured to the test setup as defined above.
2. If possible, set the Acceptable Frame Types parameter to *Admit only VLAN-Tagged frames.*
3. From TS1, transmit 10 untagged frames.
4. From TS1, transmit 10 priority-tagged frames.
5. From TS1, transmit 10 VLAN 2 tagged frames.
6. Wait 2 seconds.

Part D: Admit only Untagged and Priority-Tagged Frames

1. Ensure the DUT is configured to the test setup as defined above.
2. If possible, set the Acceptable Frame Types parameter to *Admit only Untagged and Priority-Tagged frames.*
3. From TS1, transmit 10 untagged frames.
4. From TS1, transmit 10 priority-tagged frames.
5. From TS1, transmit 10 VLAN 2 tagged frames.
6. Wait 2 seconds.

Observable Results:

Part A:

- TS2 should receive all of the VLAN 2 tagged frames.
- TS3 should receive all of the untagged and priority-tagged frames.

Part B:

- TS2 should receive all of the VLAN 2 tagged frames.
- TS3 should receive all of the untagged and priority-tagged frames.

Part C:

- TS2 should receive all of the VLAN 2 tagged frames.
- TS3 should not receive any traffic.

Part D:

- TS2 should receive all of the untagged and priority-tagged frames.

Possible Problems: None.

Test VLAN.op.1.3 — Enable Ingress Filtering

Purpose: To determine the value(s) of the Enable Ingress Filtering parameter that are supported by the DUT.

References: [1] IEEE 802.1Q 2011: sub-clause 8.6.2
[2] IEEE 802.1Q-2011: sub-clause 8.8.8
[3] IEEE 802.1Q-2011: sub-clause 12.10.1.4

Resource Requirements: 2 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: An Enable Ingress Filtering parameter is associated with each port of a VLAN aware bridge. If this parameter is *Set* for a given port, the Ingress Rules checking function of the Forwarding Process shall discard any frame received on that port whose VLAN classification does not include that port in its member set. If this parameter is *Reset*, the Ingress Rules shall not discard frames received on that port on the basis of their VLAN classification. The default value for this parameter shall be *Reset*. The value of this parameter may be configured through management, if supported. If the implementation supports an Enable Ingress Filtering parameter of *Set* on any port, then it shall also support *Reset* on those ports.

This test is applicable if and only if the device supports Ingress Filtering.

Test Setup: Refer to the default test setup in Appendix A.
Set DUT.TS1 to be in the untagged member set of VLAN 2.
Set DUT.TS2 to be in the tagged member set of VLAN 3.

Test Procedure:

Part A: Default Behavior

1. Ensure the DUT is configured to the test setup as defined above.
2. Ensure the Enable Ingress Filtering Parameter has not been configured.
3. From TS1, transmit 10 VLAN 3 tagged frames.
4. Wait 2 seconds.

Part B: Enable Ingress Filtering Parameter Reset

1. Ensure the DUT is configured to the test setup as defined above.
2. If possible, enable Ingress Filtering parameter *Reset* on DUT.TS1.
3. From TS1, transmit 10 VLAN 3 tagged frames.
4. Wait 2 seconds.

Part C: Enable Ingress Filtering parameter Set

1. Ensure the DUT is configured to the test setup as defined above.
2. If possible, enable Ingress Filtering Parameter *Set* on DUT.TS1.
3. From TS1, transmit 10 VLAN 3 tagged frames.
4. Wait 2 seconds.

Observable Results:

Part A:

- TS2 must receive all of the frames transmitted from TS1.

Part B:

- TS2 must receive all of the frames transmitted from TS1.

Part C:

- TS2 must receive no traffic that is transmitted from TS1.
- If the DUT supports both values of the Enable Ingress Filtering parameter, then the default value must be *Reset*.

Possible Problems: None.

Test VLAN.op.1.4 — PVID Configured through Management

Purpose: To verify that the DUT properly supports the configuration of the PVID through management.

References:
[1] IEEE 802.1Q-2011: sub-clause 5.4
[2] IEEE 802.1Q-2011: sub-clause 5.4.1
[3] IEEE 802.1Q-2011: sub-clause 8.8.2
[4] IEEE 802.1Q-2011: sub-clause 35.2.2.8.3
[5] IEEE 802.1Q-2011: Table 9-2

Resource Requirements: A Test Station capable of transmitting and receiving arbitrary MAC frames.

Discussion: In port-based VLAN classification within a bridge, the VID associated with an incoming untagged or priority-tagged frame is determined by the Ingress Rules. The classification mechanism used by the Ingress Rules requires that a specific VID, the PVID, be associated with each port on a bridge. This PVID provides the VID for all untagged and priority-tagged frames received on that port and thus must contain a valid VID. If no PVID has been explicitly configured for a given port, the PVID shall assume the value of the default PVID, 1, as defined in Table 9-2. The acceptable range of VIDs is from 1 to 4094.

Test Setup: Refer to the default test setup in Appendix A.

Test Procedure:

Part A: Setting the Untagged Member Set and PVID to Invalid VIDs

1. Ensure the DUT is configured to the test setup as defined above.
2. Attempt to add DUT.TS1 as an untagged member of VID 0x0000.
3. Attempt to set the PVID of DUT.TS1 to 0x0000.
4. Repeat steps 1 and 2 using a VID of 0x0FFF and 0xFFFE.

Part B: Setting the Tagged Member Set to Invalid VIDs

1. Ensure the DUT is configured to the test setup as defined above.
2. Attempt to add DUT.TS1 as a tagged member of VID 0x0000.
3. Attempt to add DUT.TS1 as a tagged member of VID 0x0FFF.
4. Attempt to add DUT.TS1 as a tagged member of VID 0xFFFE.

Part C: Setting the Untagged Member Set and PVID to Valid VIDs

1. Ensure the DUT is configured to the test setup as defined above.
2. Attempt to add DUT.TS1 as an untagged member of VID 0x0002.
3. Attempt to set the PVID of DUT.TS1 to 0x0002.
4. Repeat steps 1 and 2 using a VID of 0x0080 and 0x0800.

Part D: Setting the Tagged Member Set to Valid VIDs

1. Ensure the DUT is configured to the test setup as defined above.
2. Attempt to add DUT.TS1 as a tagged member of VID 0x0002.
3. Attempt to add DUT.TS1 as a tagged member of VID 0x0080.
4. Attempt to add DUT.TS1 as a tagged member of VID 0x0800.

Observable Results:

Part A:
- No PVID configurations must be accepted.

Part B:
- No PVID configurations must be accepted.

Part C:
- All PVID configurations must be accepted.

Part D:
- All PVID configurations must be accepted.

Possible Problems: None.

Test VLAN.op.1.5 — PVID Assigned to a Port in no VLAN Member Set

Purpose: To verify that the DUT properly supports the default PVID when a Port is not in any VLANs.

References: [1] IEEE 802.1Q-2011: sub-clause 5.4
[2] IEEE 802.1Q-2011: sub-clause 5.4.1
[3] IEEE 802.1Q-2011: sub-clause 8.8.2
[4] IEEE 802.1Q-2011: Table 9-2

Resource Requirements: 2 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: This PVID provides the VID for all untagged and priority-tagged frames received on that port and thus must contain a valid VID. This PVID shall be configurable through management operations if supported. If no PVID has been explicitly configured for a given port, the PVID shall assume the value of the default PVID defined in Table 9-2.

This test is not applicable if a port cannot be removed from all VLANs.

Test Setup: Refer to the default test setup in Appendix A.
Ensure that DUT.TS1 is not in the member set of any VLAN.
Set DUT.TS2 to be in the tagged member set of VLAN 1.

Test Procedure:

Part A: Default VLAN with Enable Ingress Filtering Parameter Reset

1. Ensure the DUT is configured to the test setup as defined above.
2. If possible, enable Ingress Filtering parameter *Reset* on DUT.TS1.
3. From TS1, transmit 10 untagged frames.
4. Wait 2 seconds.

Part B: Default VLAN with Enable Ingress Filtering Parameter Set

1. Ensure the DUT is configured to the test setup as defined above.
2. If possible, enable Ingress Filtering parameter *Set* on DUT.TS1.
3. From TS1, transmit 10 untagged frames.
4. Wait 2 seconds.

Observable Results:

Part A:

- TS2 must receive all of the frames transmitted from TS1. All frames must be received tagged for the default VLAN.

Part B:

- TS1 and TS2 must not receive any traffic.

Possible Problems: None.

Group 2: Frame Reception

Scope: These tests cover the various aspects of the Forwarding Process.

Test VLAN.op.2.1 — Minimum Frame Size

Purpose: To verify that the DUT forwards untagged and tagged frames of minimum size and discards frames less than the minimum size.

References: [1] IEEE 802.1Q-2011: Annex A.6
[2] IEEE 802.1Q-2011: Annex G.2.1
[3] IEEE 802.1Q-2011: Annex G.2.3
[4] IEEE 802.3-2012: Table 4-2

Resource Requirements: 2 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: The minimum size allowed for an Ethernet frame is 64 bytes. Therefore, the DUT should drop any frames that are less than 64 bytes.

There are two compliant methods to use when transmitting a VLAN-tagged frame. One method may result in VLAN-tagged frames with a size less than 68 bytes but at least 64 bytes. The second method is to include additional octets before the FCS field in order for the transmitted frame length to be 68 bytes. This method results in a minimum VLAN-tagged frame size of 68 bytes. VLAN-tagged frames smaller than 64 bytes shall be discarded upon reception.

Test Setup: Refer to the default test setup in Appendix A.
Set DUT.TS1 to be part of the tagged member set of VLAN 2.
Set DUT.TS2 to be part of the tagged member set of VLAN 2.

Test Procedure:

Part A: Minimum Untagged Size

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit 10 untagged 64-byte frames.
3. Wait 2 seconds.

Part B: Less Than Minimum Untagged Size

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit 10 untagged 63-byte frames.
3. Wait 2 seconds.

Part C: Minimum Tagged Size

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit 10 VLAN 2 tagged 64-byte frames.
3. Wait 2 seconds.

Part D: Less Than Minimum Tagged Size

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit 10 VLAN 2 tagged 63-byte frames.
3. Wait 2 seconds.

Observable Results:

Part A:
- TS2 must receive all frames transmitted from TS1.

Part B:
- TS2 must receive no traffic.

Part C:
- TS2 must receive all frames transmitted from TS1.

Part D:
- TS2 must receive no traffic.

Possible Problems: None.

Test VLAN.op.2.2 — Maximum Tagged Size

Purpose: To verify that the DUT forwards VLAN-tagged frames of maximum size and discards those with a size greater than this maximum.

References: [1] IEEE 802.1Q-2011: Annex A.6
[2] IEEE 802.1Q-2011: Annex G.2.1
[3] IEEE 802.1Q-2011: Annex G.2.3
[4] IEEE 802.3-2012: Definition 1.4.184

Resource Requirements: 2 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: A single maximum allowable frame size varies based on implementation. Devices conforming to IEEE 802.3-2008 may choose any one of the values of 1518, 1522, or 2000 and apply this as the maximum frame size for both tagged and untagged frames.

Prior versions of 802.3 allowed for implementations in which the maximum frame size differs for untagged and tagged frames. In such implementations, the maximum frame size for untagged frames is 1518 octets, and the maximum frame size for tagged frames is 1522 octets

In this test, the variable maxSize is used. The value of this variable is specified by the vendor.
maxSize = The maximum frame size specified by the vendor.

Test Setup: Refer to the default test setup in Appendix A.
Set DUT.TS1 to be part of the tagged member set of VLAN 2.
Set DUT.TS2 to be part of the tagged member set of VLAN 2.

Test Procedure:

Part A: Maximum Tagged Size

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit 10 *maxSize* VLAN 2 tagged frames.
3. Wait 2 seconds.

Part B: Maximum Tagged Size Exceeded

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit 10 *maxSize* + 1 VLAN 2 tagged frames.
3. Wait 2 seconds.

Observable Results:

Part A:

- TS2 must receive all frames transmitted from TS1.

Part B:

- TS2 must receive no traffic.

Possible Problems: None.

Test VLAN.op.2.3 — Untagging Minimum-Sized Tagged Frames

Purpose: To verify that the DUT properly untags and forwards VLAN-tagged frames of minimum size.

References: [1] IEEE 802.1Q-2011: sub-clause 8.8.2
[2] IEEE 802.1Q-2011: Annex A.6
[3] IEEE 802.1Q-2011: Annex G.2.1
[4] IEEE 802.1Q-2011: Annex G.2.3

Resource Requirements: 2 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: There are two compliant methods to use when transmitting a VLAN-tagged frame. One method may result in VLAN-tagged frames with a size less than 68 bytes but at least 64 bytes. The second method is to include additional octets before the FCS field in order for the transmitted frame length to be 68 bytes. This method results in a minimum VLAN-tagged frame size of 68 bytes. VLAN-tagged frames smaller than 64 bytes shall be discarded upon reception. When VLAN-tagged frames of size 64 bytes are forwarded over an untagged link, those frames are untagged before being transmitted. This untagging must not result in an untagged frame of size less than 64 bytes.

Test Setup: Refer to the default test setup in Appendix A.
Set DUT.TS1 to be part of the tagged member set of VLAN 2.
Set DUT.TS2 to be part of the untagged member set of VLAN 2.

Test Procedure:

Part A: Untagging Minimum-Sized Tagged Frames

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit 64, 65, 66, 67, and 68 byte VLAN 2 tagged frames..
3. Wait 2 seconds.

Observable Results:

Part A:

- TS2 must receive all frames transmitted from TS1. These frames must be 64 bytes in length and must not contain a VLAN tag.

Possible Problems: None.

Test VLAN.op.2.4 — Regenerating User Priority

Purpose: To verify that the DUT correctly regenerates the User Priority of received frames.

References: [1] IEEE 802.1Q-2011: sub-clause 6.9.4 [2] IEEE 802.1Q-2011: Table 6-5

Resource Requirements: 3 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: The user priority of received frames must be regenerated using the User Priority Regeneration Table – Table 6-5. This regenerated user priority will be used to map the frames to an outgoing traffic class and untagged priority.

If the DUT only supports an Acceptable Frame Types parameter of Admit Only VLAN-tagged Frames, the priority-tagged frames will be discarded by the DUT.

Test Setup: Refer to the default test setup in Appendix A.
Set DUT.TS1's PVID to be 3.
Set DUT.TS1 to be part of the tagged member set of VLAN 2.
Set DUT.TS2 to be part of the tagged member set of VLAN 2.
Set DUT.TS3 to be part of the tagged member set of VLAN 3.

Test Procedure:

Part A: Regenerating User Priority

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit 10 VLAN 2 tagged frames with a varying priority value.
3. From TS1, transmit 10 priority-tagged frames with a varying priority value.
4. Wait 2 seconds.

Observable Results:

Part A:

- TS2 must receive all of the VLAN 2 tagged frames being transmitted from TS1. The User Priority from the frames on egress must be the same as the User Priority from the same frames on ingress.
- TS3 must receive all of the priority-tagged frames being transmitted from TS1. The User Priority from the frames on egress must be the same User Priority on ingress.

Possible Problems: None.

Test VLAN.op.2.5 — Bad FCS Received

Purpose: To verify that the DUT correctly discards received frames that contain an invalid FCS.

References: [1] IEEE 802.1Q 2011: sub-clause 8.5

Resource Requirements: 2 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: A frame that is received with an incorrect FCS shall be dropped upon reception.

Test Setup: Refer to the default test setup in Appendix A.
Set DUT.TS1 to be part of the tagged member set of VLAN 2.
Set DUT.TS2 to be part of the tagged member set of VLAN 2.

Test Procedure:

Part A: Bad FCS Received

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit 10 VLAN 2 tagged frames. The FCS for these frames must be invalid. [1]
3. From TS1, transmit 10 priority-tagged frames. The FCS for these frames must be invalid. [1]
4. From TS1, transmit 10 untagged frames. The FCS for these frames must be invalid.
5. Wait 2 seconds.

Observable Results:

Part A:

- TS2 must not receive any traffic.

Possible Problems: None.

[1] The invalid FCS for these frames should be equal to a FCS for a frame that is untagged.

Group 3: The Forwarding Process

Scope: These tests cover the various aspects of frame reception.

Test VLAN.op.3.1 — VLANs with MSTP

Purpose: To verify that the DUT properly interacts with MSTP when using VLANs.

References: [1] IEEE 802.1Q-2011: sub-clause 8.13.10 [2] IEEE 802.1Q-2011: sub-clause 13.7

Resource Requirements: 3 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: In the event that a Multiple Spanning Tree BPDU is received with a VLAN tag, it shall be discarded upon reception and not used to reconfigure the spanning tree.

In an MSTI environment, multiple spanning trees are used for multiple paths through the network. Each spanning tree instance, or MSTI, has associated VIDs. Each VLAN is mapped to a spanning tree instance and used in the forwarding process.

This test is applicable if and only if the device supports MSTP.

Test Setup: Refer to the default test setup in Appendix A.
Enable MSTP on the device.
Create MSTI 1 through MSTI 3.
Map VLANs 2 and 3 to MSTI 1.
Map VLAN 4 to MSTI 2.
Map VLAN 10 to MSTI 3.
Set DUT.TS1 through DUT.TS4 to be in the tagged member set of VLANs 2, 3, 4, and 10.

Test Procedure:

Part A: VLAN Tagged BPDUs

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit a MST BPDU with a better priority than the DUT. This BPDU must be tagged for VLAN 2.
3. Wait 3 seconds.

Part B: Interaction with an MSTI

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit MST BPDUs every two seconds with the following information.
   a) An MSTI1 message making DUT.TS1 the Root port for MSTI1.
   b) An MSTI2 message making DUT.TS1 an Alternate port for MSTI2.
   c) An MSTI3 message making DUT.TS1 a Designated port for MSTI3
3. From TS2, transmit MST BPDUs every two seconds with the following information.
   a) An MSTI2 message making DUT.TS2 the Root port for MSTI2.
   b) An MSTI3 message making DUT.TS2 an Alternate port for MSTI3.
   c) An MSTI1 message making DUT.TS2 a Designated port for MSTI1.
4. From TS3, transmit MST BPDUs every two seconds with the following information.
   a) An MSTI3 message making DUT.TS3 the Root port for MSTI3.
   b) An MSTI1 message making DUT.TS3 an Alternate port for MSTI1.
   c) An MSTI2 message making DUT.TS3 a Designated port for MSTI2.
5. From TS1, TS2, and TS3, transmit 10 untagged frames.
6. From TS1, TS2, and TS3, transmit 10 VLAN 2 tagged frames.
7. From TS1, TS2, and TS3, transmit 10 VLAN 3 tagged frames.
8. From TS1, TS2, and TS3, transmit 10 VLAN 4 tagged frames.
9. From TS1, TS2, and TS3, transmit 10 VLAN 10 tagged frames.
10. Wait 2 seconds.

Observable Results:

Part A:

- All BPDUs captured by TS1 must have a CIST Root ID equal to the of the DUT's Bridge ID.

Part B:

- TS1 through TS3 must receive all untagged traffic.
- TS1 must receive VLAN 2 and VLAN 3 tagged traffic from TS2.
- TS1 must receive VLAN 10 tagged traffic from TS3.
- TS1 must not receive VLAN 4 traffic.
- TS2 must receive VLAN 2 and VLAN 3 tagged traffic from TS1.
- TS2 must receive VLAN 4 tagged traffic from TS3.
- TS2 must not receive VLAN 10 traffic.
- TS3 must receive VLAN 10 tagged traffic from TS1.
- TS3 must receive VLAN 4 tagged traffic from TS2.
- TS3 must not receive VLAN 2 and VLAN 3 traffic.

Possible Problems: None.

Test VLAN.op.3.2 — VLANs in SST Environments

Purpose: To verify that the DUT properly utilizes VLANs in a SST environment.

References: [1] IEEE 802.1Q 2011: sub-clauses 7.3
[2] IEEE 802.1Q-2011: sub-clause 8.13.10
[3] IEEE 802.1Q 2011: sub-clauses 8.6
[4] IEEE 802.1Q 2011: Figure 8-10

Resource Requirements: 3 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: In the event that a Spanning Tree BPDU is received with a VLAN tag, it shall be discarded upon reception and not used for the reconfiguring of the tree.

When a frame is received on a port of a bridge it is passed to the Forwarding Process for transmission out other ports of the bridge. The Forwarding Process selects its potential transmission ports using the following four restrictions:

1. The port on which the frame was received was in a Forwarding State, and
2. The port considered for transmission is in a Forwarding State, and
3. The port considered for transmission is not the same as the port on which the frame was received, and
4. The size of the *mac_service_data_unit* conveyed by the frame does not exceed the maximum size of *mac_service_data_unit* supported by the LAN to which the port considered for transmission is attached.

For all other ports on the bridge the frame shall be discarded.

This test is applicable if and only if the device supports spanning tree.

Test Setup: Refer to the default test setup in Appendix A.
Enable STP on the device.

Test Procedure:

Part A: VLAN Tagged BPDUs

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit a Configuration BPDU with a better Root Priority than the Bridge Priority of the DUT. This BPDU must also be tagged for VLAN 1.
3. Wait 2 seconds.

Part B: VLANs in SST Environments

1. Ensure the DUT is configured to the test setup as defined above.
2. Set DUT.TS1 and DUT.TS2 to be part of the tagged member set of VLAN 2.
3. Set DUT.TS3 and DUT.TS4 to be part of the tagged member set of VLAN 3.
4. From TS2, transmit Configuration BPDUs every two seconds that make it the Root port.
5. From TS3, transmit Configuration BPDUs every two seconds that make it a Non-Designated port.
6. From TS2, transmit 10 VLAN 2 tagged frames.
7. From TS3, transmit 10 VLAN 3 tagged frames.
8. From TS4, transmit 10 VLAN 3 tagged frames.
9. Wait 2 seconds.

Observable Results:

Part A:

- All BPDUs captured by TS1 must have a CIST Root ID equal to the of the DUT's Bridge ID.

Part B:

- TS2, TS3, and TS4 must not recieve their own traffic.
- TS1 must recieve TS2's traffic.
- TS3 must not recieve TS4's traffic.
- TS4 must not recieve TS3's traffic.

Possible Problems: None.

Test VLAN.op.3.3 — Filtering Frames

Purpose: To verify that the DUT properly discards frames based on entries in the Filtering Database.

References:
[1] IEEE 802.1Q 2011: sub-clause 8.6.1
[2] IEEE 802.1Q 2011: sub-clause 8.6.3
[3] IEEE 802.1Q 2011: sub-clause 8.8.6
[4] IEEE 802.1Q 2011: sub-clause 8.8.9
[5] IEEE 802.1Q 2011: Table 8-3
[6] IEEE 802.1Q 2011: Table 8-5

Resource Requirements: 3 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: When a frame is received on a port of a bridge it is passed to the Forwarding Process for transmission out other ports of the bridge. The Forwarding Process then selects all potential transmission ports and makes filtering decisions based on:

1. The destination MAC address carried in the received frame
2. The VID associated with the received frame
3. The information contained in the Filtering Database for that MAC address and VID
4. The default Group filtering behavior for the potential transmission Port

For each potential transmission port the frame shall be forwarded or discarded (i.e., filtered) on the basis of this information in accordance with the definition of the Filtering Database entry types.

Test Setup: Refer to the default test setup in Appendix A.

Test Procedure:

Part A: Frames Filtered by MAC Address

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS2, transmit 10 untagged frames containing a source address of 00-03-03-AA-02-22.
3. From TS3, transmit 10 untagged frames containing a source address of 00-03-03-AA-03-33.
4. From TS1, transmit 10 untagged frames with the destination address alternating between 00-03-03-AA-02-22 and 00-03-03-AA-03-33.
5. Wait 2 seconds.

Part B: Frames Filtered by VID

1. Ensure the DUT is configured to the test setup as defined above.
2. Add DUT.TS2 to be part of the tagged member set of VLAN 2.
3. Add DUT.TS3 to be part of the tagged member set of VLAN 3.
4. Add DUT.TS1 to be part of the tagged member set of both VLAN 2 and VLAN 3.
5. From TS1, transmit 10 VLAN 2 tagged frames.
6. From TS1, transmit 10 VLAN 3 tagged frames.
7. Wait 2 seconds.

Observable Results:

Part A:

- TS2 must receive all of the frames with the 00-03-03-AA-02-22 destination address.
- TS2 must not receive any of the frames with the 00-03-03-AA-03-33 destination address.
- TS3 must receive all of the frames with the 00-03-03-AA-03-33 destination address.
- TS3 must not receive any of the frames with the 00-03-03-AA-02-22 destination address.

Part B:

- TS2 must receive all of the VLAN 2 tagged frames.
- TS2 must not receive any of the VLAN 3 tagged frames.
- TS3 must receive all of the VLAN 3 tagged frames.
- TS3 must not receive any of the VLAN 2 tagged frames.

Possible Problems: None.

Test VLAN.op.3.4 — Recalculating FCS

Purpose: To verify that the DUT correctly recalculates the FCS when tagging or untagging a frame.

References: [1] IEEE 802.1Q-2011: sub-clause 6.4.1 [2] IEEE 802.1Q-2011: sub-clause 6.7.1

Resource Requirements: 2 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: If a tagged frame is received by a VLAN-aware device and the transmitting port is in the untagged member set of the target VLAN, the frame is required to be untagged before being forwarded. After untagging, the FCS must be recalculated as specified in sub-clause 9.1.

Test Setup: Refer to the default test setup in Appendix A.
Set DUT.TS1 to be part of the untagged member set of VLAN 3.
Set DUT.TS2 to be part of the tagged member set of VLAN 3.

Test Procedure:

Part A: Recalculating FCS

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS1, transmit 10 untagged frames.
3. From TS1, transmit 10 VLAN 3 tagged frames.
4. Wait 2 seconds.

Observable Results:

Part A:

- Verify that the DUT has correctly recalculated the FCS for the frames that it has tagged and untagged.

Possible Problems: None.

Test VLAN.op.3.5 — No Leakage Between VLANs

Purpose: To verify that the DUT does not allow frames to leak into the incorrect VLAN while the network load is high.

References: [1] IEEE 802.1Q 2011: sub-clause 8.6.2
[2] IEEE 802.1Q 2011: sub-clause 8.6.3
[3] IEEE 802.1Q 2011: sub-clause 8.6.4
[4] IEEE 802.1Q 2011: sub-clause 8.6.5

Resource Requirements: 4 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: Frames that are received on a port of a bridge receive a VLAN classification on ingress and, if they are not discarded by the Ingress Rules, are passed to the Forwarding Process and the Learning Process. The Forwarding Process is then responsible for making forwarding or filtering decisions based in part on the VLAN classification of the frame using the Egress Rules. All frames that are not filtered are then stored in queues until such a time that the frames can be submitted to the individual MAC entities for transmission. If frames are received at a faster rate than they can be forwarded these queues will eventually overflow. When this occurs there should not be any leakage of frames destined for one VLAN into another VLAN.

Test Setup: Refer to the default test setup in Appendix A.
Set DUT.TS1 to be part of the tagged member set of VLAN 2 and the untagged member set of VLAN 3.
Set DUT.TS2 to be part of the untagged member set of VLAN 3.
Set DUT.TS3 to be part of the tagged member set of VLAN 2.
Set DUT.TS4 to be part of the tagged member set of VLAN 2.

Test Procedure:

Part A: No Leakage between VLANs

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS3 and TS4, transmit VLAN 2 tagged frames at line rate.
3. Wait 2 seconds.

Observable Results:

Part A:

- TS1 must receive VLAN 2 tagged frames from TS3 and TS4.
- TS2 must not see any traffic from TS3 and TS4.

Possible Problems: None.

Group 4: Learning Constraints

Scope: These tests cover the various aspects of Learning Constraints.

Test VLAN.op.4.1 — SVL vs. IVL Learning

Purpose: To determine whether the DUT correctly implements the default behavior.

References: [1] IEEE 802.1Q-2011: sub-clauses 3.167
[2] IEEE 802.1Q-2011: sub-clause 3.170
[3] IEEE 802.1Q-2011: sub-clause 7.4
[4] IEEE 802.1Q-2011: sub-clause 8.8.8

Resource Requirements: 3 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: In an SVL bridge a single Filtering Identifier (FID) is supported and all VIDs are mapped to it. In an IVL bridge multiple FIDs are supported and only one VID can be mapped to each FID. In an SVL/IVL bridge multiple FIDs are supported with the ability to map multiple VIDs to each FID. In an SVL/IVL bridge it is necessary to provide a set of VLAN Learning Constraints that are used to determine whether a given pair of VLANs is using SVL or IVL.

Shared Learning Constraints (S Constraints) assert that Shared VLAN Learning shall occur between a pair of identified VLANs and are of the form {A S B}, where A and B are the VIDs. An S Constraint is interpreted as meaning that Shared VLAN Learning shall occur between the VLANs identified by the pair of VIDs. Independent Learning Constraints (I Constraints) assert that a given VLAN is a member of a set of VLANs amongst which Independent VLAN Learning shall occur and take the form {A I N}, where A is a VID and N is an Independent Set Identifier. An I Constraint is interpreted as meaning that Independent VLAN Learning shall occur among the set of VLANs comprising VLAN A and all other VLANs identified in I Constraints that carry the same Independent Set Identifier, N. A given VID may appear in any number, including zero, of S Constraints and/or I Constraints.

Test Setup: Refer to the default test setup in Appendix A.
Set DUT.TS1, DUT.TS2, and DUT.TS3 to be part of the tagged member set of VLAN 2 and VLAN 3.

Test Procedure:

Part A: Default Learning Behavior

1. Ensure the DUT is configured to the test setup as defined above.
2. From TS2, transmit 10 VLAN 2 tagged frames containing a source address of 00-04-01-AA-02-22.
3. From TS3, transmit 10 VLAN 3 tagged frames containing a source address of 00-04-01-AA-02-22.
4. From TS1, transmit 10 VLAN 2 tagged frames containing a destination address of 00-04-01-AA-02-22.
5. From TS1, transmit 10 VLAN 3 tagged frames containing a destination address of 00-04-01-AA-02-22.
6. Wait 2 seconds.

Observable Results:

Part A:

- SVL Bridge
  - TS3 must receive traffic from TS1.
  - TS2 must not receive traffic from TS1.
- IVL Bridge
  - TS2 must receive traffic from TS1.
  - TS3 must receive traffic from TS1.

Possible Problems: None.

Test VLAN.op.4.2 — Shared Learning Constraints

Purpose: To determine if the DUT properly implements Shared Learning Constraints.

References: [1] IEEE 802.1Q-2011: sub-clauses 3.167
[2] IEEE 802.1Q-2011: sub-clause 3.170
[3] IEEE 802.1Q-2011: sub-clause 7.4
[4] IEEE 802.1Q-2011: sub-clause 8.8.8

Resource Requirements: 3 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: In an SVL/IVL bridge, the learning of MAC addresses is controlled by using Learning Constraints. There are two types of Learning Constraints: Shared Learning Constraints (S Constraints) and Independent Learning Constraints (I Constraints). An S Constraint takes the form A S B, where A and B are VIDs. An S Constraint is interpreted as meaning that Shared VLAN Learning shall occur between the VLANs identified by the pair of VIDs. An I Constraint takes the form {A I N}, where A is a VID and N is an Independent Set Identifier. An I Constraint is interpreted as meaning that Independent VLAN Learning shall occur among the set of VLANs comprising VLAN A and all other VLANs identified in I Constraints that carry the same Independent Set Identifier, N. A given VID may appear in any number, including zero, of S Constraints and/or I Constraints.

This test is applicable if and only if the device supports configuration of Shared VLAN Learning Constraints.

Test Setup: Refer to the default test setup in Appendix A.
Set DUT.TS1 to be part of the tagged member set of VLAN 2 and VLAN 3.
Set DUT.TS2 to be part of the untagged member set of VLAN 2.
Set DUT.TS3 to be part of the untagged member set of VLAN 3.

Test Procedure:

Part A: Shared Learning Constraints

1. Ensure the DUT is configured to the test setup as defined above.
2. If the DUT allows VLAN Learning Constraints to be configured through management, create an S constraint for the VLAN 2 and VLAN 3.
3. From TS2, transmit 10 VLAN 2 tagged frames containing a source address of 00-04-02-AA-02-22.
4. From TS3, transmit 10 VLAN 3 tagged frames containing a source address of 00-04-02-AA-02-22.
5. From TS1, transmit 10 VLAN 2 tagged frames containing a destination address of 00-04-02-AA-02-22.
6. From TS1, transmit 10 VLAN 3 tagged frames containing a destination address of 00-04-02-AA-02-22.
7. Wait 2 seconds.

Observable Results:

Part A:

- TS3 must receive traffic from TS1.
- TS2 must not receive traffic from TS1.

Possible Problems: None.

Test VLAN.op.4.3 — Independent Learning Constraints

Purpose: To determine if the DUT properly implements Independent Learning Constraints.

References: [1] IEEE 802.1Q-2011: sub-clauses 3.167
[2] IEEE 802.1Q-2011: sub-clause 3.170
[3] IEEE 802.1Q-2011: sub-clause 7.4
[4] IEEE 802.1Q-2011: sub-clause 8.8.8

Resource Requirements: 3 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: There are two types of Learning Constraints: Shared Learning Constraints (S Constraints) and Independent Learning Constraints (I Constraints). In an SVL/IVL bridge, the learning of MAC addresses is controlled by using Learning Constraints. An S Constraint takes the form A S B, where A and B are VIDs. An S Constraint is interpreted as meaning that Shared VLAN Learning shall occur between the VLANs identified by the pair of VIDs. An I Constraint takes the form {A I N}, where A is a VID and N is an Independent Set Identifier. An I Constraint is interpreted as meaning that Independent VLAN Learning shall occur among the set of VLANs comprising VLAN A and all other VLANs identified in I Constraints that carry the same Independent Set Identifier, N. A given VID may appear in any number, including zero, of S Constraints and/or I Constraints.

This test is applicable if and only if the device supports Independent VLAN Learning Constraints.

Test Setup: Refer to the default test setup in Appendix A.
Set DUT.TS1 to be part of the tagged member set of VLAN 2 and VLAN 3.
Set DUT.TS2 to be part of the untagged member set of VLAN 2.
Set DUT.TS3 to be part of the untagged member set of VLAN 3.

Test Procedure:

Part A: Independent Learning Constraints

1. Ensure the DUT is configured to the test setup as defined above.
2. If the DUT allows VLAN Learning Constraints to be configured through management, create an I constraint for the VLAN 2 and VLAN 3.
3. From TS2, transmit 10 VLAN 2 tagged frames containing a source address of 00-04-03-AA-02-22.
4. From TS3, transmit 10 VLAN 3 tagged frames containing a source address of 00-04-03-AA-02-22.
5. From TS1, transmit 10 VLAN 2 tagged frames containing a destination address of 00-04-03-AA-02-22.
6. From TS1, transmit 10 VLAN 3 tagged frames containing a destination address of 00-04-03-AA-02-22.
7. Wait 2 seconds.

Observable Results:

Part A:

- TS2 must receive traffic from TS1.
- TS3 must receive traffic from TS1.

Possible Problems: None.

Test VLAN.op.4.4 — Learning Constraint Inconsistencies and Violations

Purpose: To determine if the DUT properly reports Learning Constraint inconsistencies and violations.

References: [1] IEEE 802.1Q-2011: sub-clauses 3.167
[2] IEEE 802.1Q-2011: sub-clause 3.170
[3] IEEE 802.1Q-2011: sub-clause 7.4
[4] IEEE 802.1Q-2011: sub-clause 8.8.8

Resource Requirements: 3 Test Stations capable of transmitting and receiving arbitrary MAC frames.

Discussion: There are two types of Learning Constraints: Shared Learning Constraints (S Constraints) and Independent Learning Constraints (I Constraints). In an SVL/IVL bridge, the learning of MAC addresses is controlled by using Learning Constraints. An S Constraint takes the form A S B, where A and B are VIDs. An S Constraint is interpreted as meaning that Shared VLAN Learning shall occur between the VLANs identified by the pair of VIDs. An I Constraint takes the form {A I N}, where A is a VID and N is an Independent Set Identifier. An I Constraint is interpreted as meaning that Independent VLAN Learning shall occur among the set of VLANs comprising VLAN A and all other VLANs identified in I Constraints that carry the same Independent Set Identifier, N. A given VID may appear in any number, including zero, of S Constraints and/or I Constraints. Learning Constraint inconsistencies and/or violations may occur when management attempts to create new Learning Constraints or modify the fixed VID to FID allocations. On detection of a violation, the bridge shall issue a Notify Learning Constraint Violation management notification for each inconsistency or violation detected in order to alert any management stations to the existence of the violation.

Test Setup: Refer to the default test setup in Appendix A.

Test Procedure:

Part A: Learning Constraint Inconsistencies and Violations

1. Ensure the DUT is configured to the test setup as defined above.
2. Create an S constraint of the form {2 S 3}.
3. Create an I constraint of the form {3 I 1}.
4. Attempt to create an I constraint of the form {2 I 1}.
5. Remove all of the constraints created above.
6. Create I constraints of the form {3 I 1}, {2 I 1}, {2 I 2}, and {10 I 2}.
7. Attempt to create an S constraint of the form {3 S 10}.
8. Wait 2 seconds.

Observable Results:

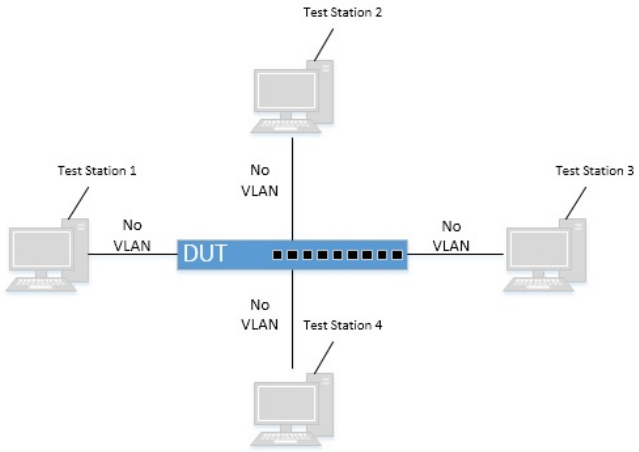
Part A:

- In Step 3, the constraint configuration must not be permitted.
- In Step 6, the constraint configuration must be permitted.

Possible Problems: None.

Appendix A: Default Test Setup

The following diagram describes a general test layout with multiple test stations connected to the DUT.



Each test in the suite uses the following setup for the DUT unless otherwise stated:

- DUT.TS1 through DUT.TS4's PVID must be 1.
- DUT.TS1 through DUT.TS4's must not be a member of any VLAN.
  - If this is not possible, they must be in the untagged memberset of VLAN 1.
- Configure Ageing Time to 300 seconds.
- DUT.TS1 through DUT.TS4's Acceptable Frame Types Parameter must be *Admit All Frames*.
- DUT.TS1 through DUT.TS4's Enable Ingress Filtering Parameter must be *Reset*.
- Spanning Tree must be disabled.

Appendix B: Vendor Specified Support

In order to provide top-tier services to our customers, the technician executing the test suite against a device under test needs to know which options and parameter values the device is claiming support for.
This appendix contains a list of support options which are to be specified by the vendor prior to testing.

Admit Only Frame Types Parameter	☐ *Admit All Frames* ☐ *Admit Only VLAN Tagged Frames* ☐ *Admit Only Untagged and Priority Tagged Frames*
Enable Ingress Filtering Parameter	☐ *Set* ☐ *Reset*
Acceptable VIDs	Minimum: _____ Maximum: _____
Shared VLAN Learning	☐ Supported
Independent VLAN Learning	☐ Supported
Frame Size	Minimum: _____ Maximum: _____
Jumbo Frames	☐ Supported