USB Implementers Forum Interoperability Test Procedures For PC to PC Bridge

Revision 1.2 – May 2014

SUMMARY OF CHANGES

Revision:	Author:	Section:	Change:
1.0	Martin Franke	All	Document Created
1.1	Martin Franke	Chapter 1	Defined maximum possible speed for PC to PC Bridge devices
		Chapter 2 - 3	More detail added to pass/fail cases
		Chapter 3	Made allowance for PC to PC Bridge file transfer not completing on resume from S3 or S4
1.2	Martin Franke	Chapter 4	Added chapter providing guidelines for remaining tests.

1   PC to PC Bridge Interoperability Testing

A PC to PC bridge does not fall into any of the device categories listed in the USB-IF interoperability test procedures. As a result this secondary document exists to provide an interoperability test scenario for such a device and if applicable any associated software.

Generally USB devices must always operate at their maximum possible speed (for example a SuperSpeed device attached to a Hi Speed port must operate at Hi Speed). However for PC to PC bridge cables this rule changes slightly. It is acceptable for a PC to PC Bridge to operate both sides at the maximum possible speed of the side attached to the slowest link. For example, if one side is attached to Hi Speed and the other side attached to SuperSpeed it would be allowable for both sides to operate at Hi Speed. It is considered a failure if the link ever drops to a speed lower than the maximum possible speed of the slowest link.

More information regarding interoperability testing is available in the Interoperability Test Procedures available from the USB-IF at www.usb.org/developers/compliance/. This test procedure should be used in correlation with the xHCI Interoperability Test Procedure and throughout this document references will be made to it. Please forward any questions regarding interoperability testing to TechAdmin@usb.org.

1.1 Equipment

Test topologies are subject to change. Please refer to www.usb.org/developers/compliance on the USB-IF, Inc. Web site for the latest updates to the xHCI Interoperability test procedures.

All references to SuperSpeed hubs in this document are to USB 3.0 hubs with High-speed and SuperSpeed functionality.

Item	Description/Model	Qty
USB host system	1. A computer containing an available slot for a Certified USB xHCI controller or an integrated Certified USB xHCI controller. 2. A multiple core processor is required	2
SS hub(self-powered)	Any Certified SuperSpeed USB 3.0 self-powered hub with at least 4 downstream ports	5
SuperSpeed Interoperability Tree - Device	See Chapter 2 of the xHCI Interoperability Test Procedure	1

This document refers to the two controllers used in testing as xHCI 1 and xHCI 2 and the systems as PC 1 and PC 2 (where xHCI 1 is connected to PC 1 and xHCI 2 is connected to PC 2).

For more information about correct equipment to use please see Chapter 1 of the xHCI Interoperability Test Procedure.

1.2 Software

The operating system software required is Windows 8.

1.2.1 Install the Operating System

Install Windows 8.1 on both systems by either installing a fresh copy or from a previously saved image of the prepared system.

See Chapter 1 of the xHCI Interoperabilty Test Procedure for full instructions on how to configure both systems. Be sure that the systems supports both S3 and S4 low power states. Enable driver verifier and selective suspend as specified in that document as well.

2   USB PC to PC Bridge Interoperability Test Steps

Construct the PC to PC Bridge Interoperability Tree as outlined in Figure 2-1 using a Device Test tree from Chapter 2 of the xHCI Interoperability Test Procedure for the SuperSpeed Interoperability Tree. Use 5 additional hubs and a second xHCI controller on the other side of the bridge. If the host system(s) contain an embedded hub remove the middle hub from the applicable tree. Do <u>not</u> attach the PC to PC Bridge Interoperability Tree to the xHCI controller yet.
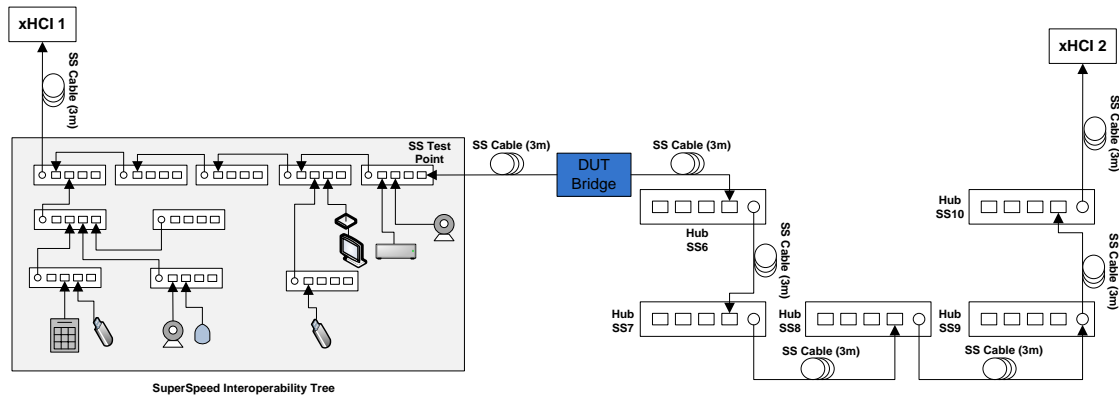
Figure 2-1: PC to PC Bridge Interoperability Tree

2.1   Interoperability Tests

1.   xHCI Controller Driver Installation

Turn off the USB Host System and install the xHCI controller into the USB Host System if it is not already integrated.

Power on the USB Host Systems. One of three scenarios is acceptable for the USB Host Systems to install the xHCI controller driver:

o   The OS identifies and automatically installs the xHCI controller driver.

o   The OS displays that it cannot find the driver for the xHCI controller. Follow the vendor-recommended install procedure to complete the driver install.

o   If the xHCI controller is already integrated into the USB Host System, then the OS displays nothing, as it has already attempted install for the xHCI controller with the initial install of the OS. Follow the vendor-recommended install procedure to complete the driver install.

- **Pass**:
  1.   (The OS identifies and automatically installs the xHCI controller driver
     OR
  2.   The vendor-recommended install procedure installs the xHCI controller driver)
     AND
  3.   The xHCI controller driver is installed correctly and operates

- **Fail**:
  1. The xHCI controller driver does not install
     OR
  2. The xHCI controller driver is installed correctly but is non-operational

2. **Peripheral Enumeration and Driver Installation**

   Do <u>not</u> install any drivers or software for any device in the PC to PC Bridge Interoperability Tree prior to attaching the PC to PC Bridge Interoperability Tree to the xHCI controller.

   Attach the PC to PC Bridge Interoperability Tree by connecting SS1 into any port on the xHCI 1 controller and SS10 into any port of xHCI 2.

   For each device in the PC to PC Bridge Interoperability Tree (including the DUT) follow the vendor-recommended install procedure. Ensure that all drivers listed for each device in the PC to PC Bridge Interoperability Tree match what is currently being tested under Driver Verifier. To display the existing drivers being verified by Driver Verifier on both systems:

   - Open the run box (press the Windows Key + R together).
   - Type the command "Verifier".
   - Select "Display existing settings"

   Enable driver verifier for any remaining drivers that are used in the Interoperability tree. Driver verifier must be enabled on both systems.

   - **Pass**:
     1. All PC to PC Bridge Interoperability Tree devices enumerate
        AND
     2. All PC to PC Bridge Interoperability Tree devices drivers are installed either automatically or through the vendor recommended install procedure
        AND
     3. All PC to PC Bridge Interoperability Tree devices do not require a reboot
        AND
     4. All PC to PC Bridge Interoperability Tree devices are correctly identified by Device Manager and no yellow exclamation point is shown for any device
        AND
     5. Software installs without any software crashes or a blue screen
        OR
     6. No software required

   - **Fail**:
     1. Any device cannot be installed because it requires driver installation or application software <u>BEFORE</u> the device is ever plugged in
        OR
     2. Any device does not enumerate or blue screens during enumeration
        OR
     3. Any device requires a reboot
        OR
     4. Any device is incorrectly identified by Device Manager or any device is flagged as not operational (yellow exclamation point)
        OR
     5. Installation software crashes or causes a blue screen

3. **Interoperability**

   o Operate all the devices in the PC to PC Bridge Interoperability Tree.

      • Whenever the test steps state to operate all of the devices in the PC to PC Bridge Interoperability Tree, this involves operating the following steps concurrently:

         • Operate the microphone in the Video Cameras by speaking into the microphone and viewing the input sound monitor

            ▪ This can be found under Control Panel -> Hardware and Sound -> Sound under the "Recording" tab

         • View streaming video from the SS Video Camera

         • View streaming video from the FS Video Camera

            Poor video quality may be seen when Driver Verifier is enabled. If there was poor quality, continue testing with the Driver Verifier enabled for all Interoperability steps. Repeat all Interoperability steps with Driver Verifier off. USB-IF will compare Interoperability results with Driver Verifier Enabled and Disabled to determine Pass/Fail for certification.

         • Transfer a 30+ MB file from the SS Low Power Drive to the FS Drive

         • Transfer a 1+ GB file from the HS Drive to the SS Low Power Drive

         • Watch video and listen to audio from monitor attached to USB Display Adapter

         • Transfer a 1+ GB file from PC 1 to PC 2 (Initiate transfer on PC 1)

         • Transfer a 1+ GB file from PC 2 to PC 1 (Initiate transfer on PC 1)

         • Strike keys on keypad

         • Move the mouse

   o Verify that all devices are operating concurrently. Verify the Device Speed using Microsoft's USBView utility on both systems and be sure that all devices are operating at maximum possible speed (See Chapter 1 for more information regarding maximum possible speed on PC to PC Bridge devices).

      • **Pass**:
         1. All PC to PC Bridge Interoperability Tree devices operate correctly
            AND
         2. All devices operate at maximum possible speed as defined in Chapter 1

      • **Fail**:
         1. One or more PC to PC Bridge Interoperability Tree device fail to operate correctly
            OR
         2. Any device operates at less than maximum possible speed as defined in Chapter 1

OR
3. System blue screens / locks up
OR
4. Any application freeze or crash

4. All Devices Tests

o Run tests 1-6 as specified in Chapter 3.

5. Topology Change 1

o Operate all the devices in the PC to PC Bridge Interoperability Tree except the PC to PC Bridge.

o While operating the devices, detach the Bridge from SS5 and attach it to HS5 on the PC to PC Bridge Interoperability Tree as shown in Figure 2-2.

Figure 2-2: PC to PC Bridge Tree Topology Change 1

o Operate all of the devices in the PC to PC Bridge Interoperability Tree.

6. All Devices Tests

o Run tests 1-6 as specified in Chapter 3.

7. Topology Change 2

o Operate all the devices in the PC to PC Bridge Interoperability Tree except the PC to PC Bridge.

o While operating the devices, detach the Bridge from HS5 and attach it to FS1 on the PC to PC Bridge Interoperability Tree as shown in Figure 2-3.
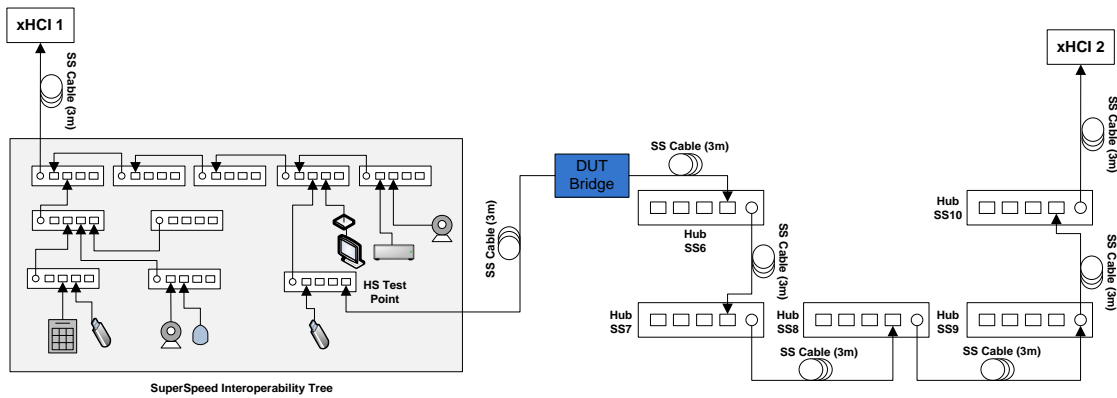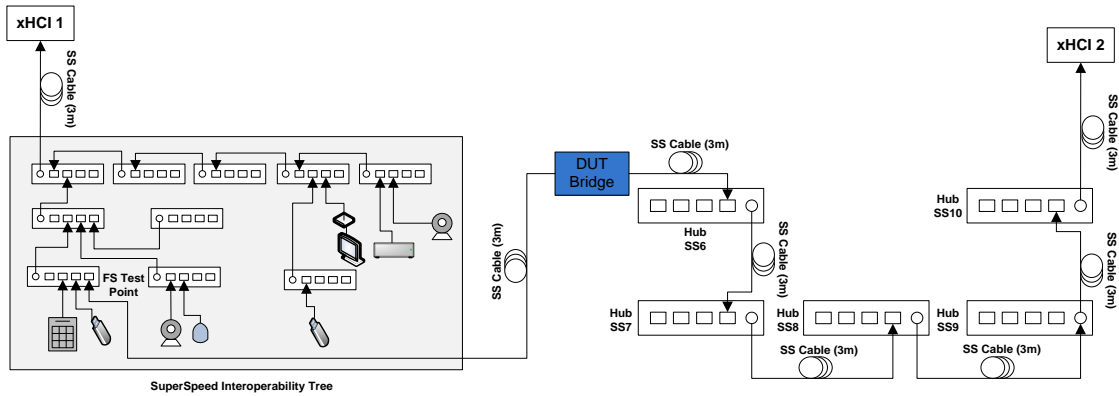
Figure 2-3: PC to PC Bridge Tree Topology Change 2

- o Operate all of the devices in the PC to PC Bridge Interoperability Tree.

8. **Root Port Testing**

- o Connect DUT as shown in Figure 2-4.
- o Run tests 1-6 as specified in Chapter 3.
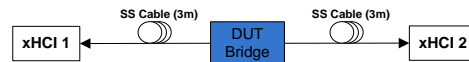
Figure 2-4: PC to PC Bridge Topology

9. **Enumeration Verification**

A PC to PC Bridge should be able to enumerate if only one side is connected to a host controller. To verify this:

- o Connect DUT as shown in Figure 2-5 connecting only one side to xHCI 1.
- o Verify Device enumerates correctly without opposite side being attached
- o Repeat with other side of device
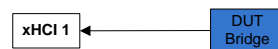
Figure 2-5: PC to PC Bridge Enumeration Topology

- • **Pass**:
  Device successfully enumerates on xHCI 1

- • **Fail**:
  Devices fails to enumerate successfully on xHCI 1

2.2 Current Measurement

Devices operating at SuperSpeed are allowed to draw a maximum configured current of 900mA and unconfigured current of 150mA. Devices operating at High-speed or below may draw a maximum configured current of 500mA and unconfigured current of 100mA. Devices must report their maximum configured current draw and their power configuration as self or bus powered to the host and must operate within the regions reported. Additionally any device that is in the suspended state may draw no more than 2.5mA.

A USB PC to PC Bridge is similar to having two separate devices that are inwardly attached to each other. In this case each connector may draw up to the maximum current load. It is also possible that each connector can be in a different state at the same time. For this reason it is necessary to measure the current on each side of the device while trying all power states on the opposite side.

If the device has external power, check whether it enumerates without it and if so then run tests with device configured as both bus-powered and self-powered.

o   Install USB30CV from the USB-IF SuperSpeed Tools page on both PC 1 and PC 2.
o   Connect a SuperSpeed Current Measurement Fixture to one side of the DUT and connect the current measurement fixture to xHCI 1. Connect the other side of the DUT to xHCI 2. Connect a Multimeter to the fixture. See Figure 2-6.
o   Open the "Current Measurement [3.0 devices]" test in Command Verifier on both Systems.
o   Read the value of "Max Power Consumption" from the log.
o   Read device type from the log: bus-powered, self-powered or both.
o   Measure and record the current draw for each of the 36 points in Table 1 labeled "Measure X" (where "X" is the test number) as both self and bus powered if applicable.

		xHCI 2					
	State	Unconfigured	Configured	U0	U1	U2	U3
xHCI 1	Unconfigured	Measure 1	Measure 2	Measure 3	Measure 4	Measure 5	Measure 6
	Configured	Measure 7	Measure 8	Measure 9	Measure 10	Measure 11	Measure 12
	U0	Measure 13	Measure 14	Measure 15	Measure 16	Measure 17	Measure 18
	U1	Measure 19	Measure 20	Measure 21	Measure 22	Measure 23	Measure 24
	U2	Measure 25	Measure 26	Measure 27	Measure 28	Measure 29	Measure 30
	U3	Measure 31	Measure 32	Measure 33	Measure 34	Measure 35	Measure 36

Table 1: Current Measurement Points

o   Operate the device and measure its highest operating current.
o   Move Current Measurement Fixture between xHCI 2 and bridge and attach other side of bridge to xHCI 1.
o   Repeat all measurements with this configuration.
o   Repeat all steps again with device operating at High-speed by changing SuperSpeed cables with High-speed cables (Note: U0, U1, U2 and U3 are not applicable in High-speed mode) use CV tests labeled "Current Measurement Test [2.0 Devices]"
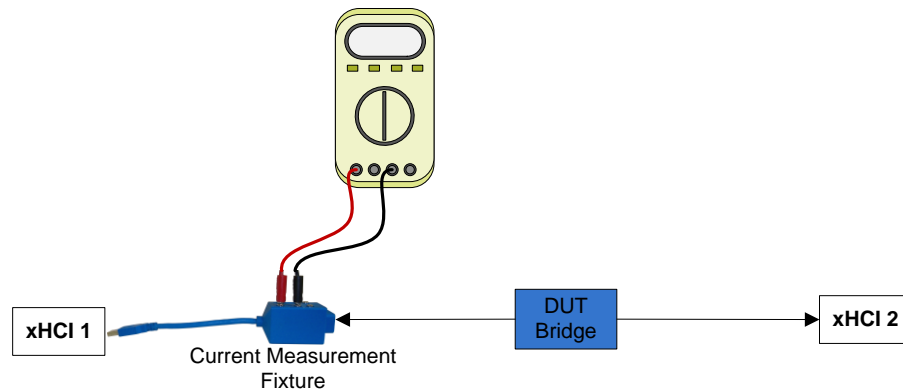
Figure 2-6: Current Measurement Topology

- **Pass**:
  1. Device reports Self-Powered and does not operate as Bus-Powered
     OR
  2. Device reports Both-Powered or Bus-Powered and can operate as Bus-Powered
     AND
  3. Max Power Consumption reported is 900mA or less when operating at SuperSpeed and 500mA or less when operating at High-speed or Full-Speed
     AND
  4. Measured Unconfigured Current is 150mA or less when operating at SuperSpeed and 100mA or less when operating at High-speed or Full-Speed
     AND
  5. Measured Current during device operation, U0, U1 and U2 is less than or equal to reported Max Power Consumption
     AND
  6. Measured Current in U3 is less than or equal to 2.5mA and reported Max Power Consumption

- **Fail**:
  1. Device reports Self-Powered but is capable of enumerating as Bus-Powered
     OR
  2. Max Power Consumption reported is greater than 900mA when operating at SuperSpeed or greater than 500mA when operating at High-speed or Full-Speed
     OR
  3. Measured Unconfigured Current is greater than 150mA when operating at SuperSpeed or greater than 100mA when operating at High-speed or Full Speed
     OR
  4. Measured Current during device operation, U0, U1 or U2 is greater than reported Max Power Consumption
     OR
  5. Measured Current in U3 is greater than 2.5mA or reported Max Power Consumption

2.3   U1/U2 Test Steps

- o   Connect a USB 3.0 hub to an exposed host port on xHCI 1.
- o   Connect one side of the Bridge to a downstream hub port with a USB Protocol Analyzer between the hub and device.
- o   Connect the other side of the Bridge to xHCI 2
- o   Trace USB traffic including idle device time and normal DUT operation.
- o   Verify that the link successfully enters U1 or U2.
- o   Verify that the hub correctly sends a deferred packet to the DUT and to the host.
- o   Verify that the DUT correctly sends an ERDY after the deferred packet.

- o Verify that the host re-sends the packet with the deferred bit cleared.
- o Verify that the DUT completes the re-sent packet.

- **Pass**:
    1. Link successfully enters U1 or U2
       AND
    2. Link returns to U0 and the original packet that was sent during U1/U2 is successfully completed

- **Fail**:
    1. Link remains in U0
       OR
    2. Re-Sent packet does not complete correctly

2.4   L1 Test Steps

- o Connect a USB Bridge to the LPM PDK host with a USB Protocol Analyzer in between the device and the LPM PDK host (xHCI 1) with a High-speed cable, connect the other side to xHCI 2.
- o Operate the device.
- o Trace USB traffic including enumeration, idle device time and normal DUT operation.
- o Verify that the device successfully enters L1.
- o Verify that the device successfully resumes to L0 and functions normally.
- o Repeat the test steps on the other side of the DUT.

- **Pass**:
  Device successfully enters and exits L1 and device operates normally

- **Fail**:
  If device does not enter L1 and does not operate normally

3   USB PC to PC Bridge Interoperability Test Steps

This chapter outlines the test steps to perform when testing the PC to PC bridge. Batch files listed in this chapter are defined in Chapter 1 of the xHCI Interoperability Test Procedure.

1. **Inactive Detach & Reattach**

   o   Stop all PC to PC Bridge Interoperability Tree device operation. Close any software that is used for any PC to PC Bridge Interoperability Tree device operation. If there are file transfers in progress let them finish first.

   o   Detach the entire PC to PC Bridge Interoperability Tree from the xHCI 1.

   o   Reattach the entire PC to PC Bridge Interoperability Tree to the same port on xHCI 1.

   o   Operate all the devices in the PC to PC Bridge Interoperability Tree. Verify that all devices are operating concurrently. Verify the Device Speed using the USBView utility on both systems.

   - **Pass**:
     1. All PC to PC Interoperability Tree devices operate correctly
        AND
     2. All devices operate at maximum possible speed as defined in Chapter 1

   - **Fail**:
     1. System blue screens / locks up
        OR
     2. One or more PC to PC Interoperability Tree devices fail to operate correctly on reattach
        OR
     3. Any device operates at less than maximum possible speed as defined in Chapter 1

2. **Active Sleep/Remote Wake**

   o   Operate all the devices in the PC to PC Bridge Interoperability Tree.

   o   While operating the devices, use the Hybrid Sleep batch file to put PC 1 into sleep mode.

   o   Wait 60 seconds then wake the system with the mouse on the SuperSpeed Interoperability Tree. Note: If the PC to PC Bridge supports remote wake use it to wake the system instead.

   o   Upon resuming it is acceptable for the PC to PC Bridge file transfers to quit transferring. However if the file transfers do complete upon resume then the data must not be corrupted.

   o   Operate all devices in the PC to PC Bridge Interoperability Tree. Verify that all devices are operating concurrently. Verify the Device Speed using the USBView utility on both systems.

   o   While operating the devices, use the Hybrid Sleep batch file to put PC 1 and PC 2 into sleep.

- Wait 60 seconds then wake PC 2

- Wait until PC 2 has fully resumed and wake PC 1

- Upon resuming it is acceptable for the PC to PC Bridge file transfers to quit transferring. However if the file transfers do complete upon resume then the data must not be corrupted.

- Again operate all devices in the PC to PC Bridge Interoperability Tree. Verify that all devices are operating concurrently. Verify the Device Speed using the USBView utility on both systems.

- **Pass**:
  1. System sleeps
     AND
  2. System resumes
     AND
  3. All devices are operational
     AND
  4. In the case that PC to PC Bridge file transfers complete, data is not corrupted
     AND
  5. Any other file transfers complete successfully and are not corrupted
     AND
  6. All devices operate at maximum possible speed as defined in Chapter 1

- **Fail**:
  1. System does not sleep
     OR
  2. System does not resume
     OR
  3. System blue screens / locks up
     OR
  4. Any device is not functional or does not continue operation
     OR
  5. Transferred data is corrupted from PC to PC Bridge transfer (if file transfers completed)
     OR
  6. Any other file transfers do not complete successfully or are corrupted
     OR
  7. Any application freeze or crash
     OR
  8. Any device operates at less than maximum possible speed as defined in Chapter 1

3. **Active S4 Hibernation/Resume**

- Operate all the devices in the PC to PC Bridge Interoperability Tree.

- While operating the devices, use the Hibernate batch file to put PC 1 into hibernate.

- Resume the system after 60 seconds.

- Upon resuming it is acceptable for the PC to PC Bridge file transfers to quit transferring. However if the file transfers do complete upon resume then the data must not be corrupted.

o Operate all devices in the PC to PC Bridge Interoperability Tree. Verify that all devices are operating concurrently. Verify the Device Speed using the USBView utility on both systems.

o While operating the devices, use the Hibernate batch file to put PC 1 and PC 2 into hibernate.

o Wait 60 seconds then wake PC 2

o Wait until PC 2 has fully resumed and wake PC 1

o Upon resuming it is acceptable for the PC to PC Bridge file transfers to quit transferring. However if the file transfers do complete upon resume then the data must not be corrupted.

o Again operate all devices in the PC to PC Bridge Interoperability Tree. Verify that all devices are operating concurrently. Verify the Device Speed using the USBView utility on both systems.

- **Pass**:
  1. System hibernates
     AND
  2. System resumes
     AND
  3. All devices are operational
     AND
  4. In the case that PC to PC Bridge file transfers complete, data is not corrupted
     AND
  5. Any other file transfers complete successfully and are not corrupted
     AND
  6. All devices operate at maximum possible speed as defined in Chapter 1

- **Fail**:
  1. System does not hibernate
     OR
  2. System does not resume
     OR
  3. System blue screens / locks up
     OR
  4. Any device is not functional or does not continue operation
     OR
  5. Transferred data is corrupted from PC to PC Bridge transfer (if file transfers completed)
     OR
  6. Any other file transfers do not complete successfully or are corrupted
     OR
  7. Any application freeze or crash
     OR
  8. Any device operates at less than maximum possible speed as defined in Chapter 1

4. **Warm boot**

o Stop all PC to PC Bridge Interoperability Tree device operation. Close any software that is used for any PC to PC Bridge Interoperability Tree device operation. If there are file transfers in progress let them finish first.

o Restart PC 1

- After systems reboot operate all the devices in the PC to PC Bridge Interoperability Tree. Verify that all devices are operating concurrently. Verify the Device Speed using the USBView utility on both systems.

- **Pass**:
  All PC to PC Bridge Interoperability Tree devices operate correctly on resume

- **Fail**:
  One or more PC to PC Bridge Interoperability Tree devices fail to operate correctly on resume

5. **Cold boot**

- Stop all PC to PC Bridge Interoperability Tree device operation. Close any software that is used for any PC to PC Bridge Interoperability Tree device operation. If there are file transfers in progress let them finish first.

- Turn off PC 1 by double-clicking on the ColdBoot.bat batch file.

- After system boots operate all the devices in the PC to PC Bridge Interoperability Tree. Verify that all devices are operating concurrently. Verify the Device Speed using the USBView utility on both systems.

- Repeat this time doing Cold Boot on PC 1 and PC 2 at the same time.

- **Pass**:
  All PC to PC Bridge Interoperability Tree devices operate correctly on resume

- **Fail**:
  One or more PC to PC Bridge Interoperability Tree devices fail to operate correctly on resume

6. **Hybrid boot**

- Stop all PC to PC Bridge Interoperability Tree device operation. Close any software that is used for any PC to PC Bridge Interoperability Tree device operation. If there are file transfers in progress let them finish first.

- Turn off PC 1 by double-clicking on the HybridBoot.bat file.

- After system boots operate all the devices in the PC to PC Bridge Interoperability Tree. Verify that all devices are operating concurrently. Verify the Device Speed using the USBView utility on both systems.

- Repeat this time doing Hybrid Boot on PC 1 and PC 2 at the same time.

- **Pass**:
  All PC to PC Bridge Interoperability Tree devices operate correctly on resume

- **Fail**:
  One or more PC to PC Bridge Interoperability Tree devices fail to operate correctly on resume

4 Rules for Other PC-PC Bridge Tests

For remaining tests one randomly chosen side of the PC-PC Bridge must be enumerated on a second system that has an earth ground (e.g. a desktop PC). Tests follow the same procedure as standard USB devices. Remaining tests include but are not limited to:

- Command Verifier Tests
- Link Layer Tests
- Electrical Tests