USB2.0 Type-C™ & Regular USB HUB Electrical Compliance test procedure

Version 0.4 – 16 December 2021

Contents

1. Reference

Standard	Description	Revision	Status
USB 2.0 Spec	USB 2.0 Specification with ECN	2.0	Released
USB 2.0 Electrical Test Specification	USB-IF USB 2.0 Electrical Compliance Test Specification	1.07	Released

2. Background

USB 2.0 Compliance Committee under the direction of USB-IF, Inc develops the USB-IF High-speed Electrical Test Procedures. This document covers the method of measuring the USB 2.0 electrical tests for devices. Hub, Host and Embedded Host are covered in another document.

The High-speed Electrical Compliance Test Procedures verify the electrical requirements of high-speed USB operation of these devices designed to the USB 2.0 specification. In addition to passing the high-speed test requirements, high-speed capable device must also complete and pass the applicable legacy compliance tests identified in this document.

The document covers only the USB 2.0 electrical tests but are applicable for all devices including USB 2.0 Full/Low/High Speed Device. But also, USB 3.x Super Speed (5Gb or 10Gb) devices, since they need to be backward compatible with USB 2.0.

3. Required equipment and software

3.1 Oscilloscope, Software, and Accessories

Check with scope vendor.

3.2 High-Speed Electrical Test Bed Computer USBHSET

In order to perform USB 2.0 High Speed electrical tests a High Speed product must support test modes as defined in section 7.1.20 of the USB 2.0 specification.
To activate a test mode, the USB 2.0 Specification defines the *SetFeature()* command as the desired interface. The USB-IF offers for free a High Speed electrical Test Tool (USBHSET) which is Windows based, to activate the various test modes and operations.

The high-speed electrical test bed computer hosts a USB 2.0 compliance host controller for hi-speed hub or device electrical test, or serves as a test bed host for a USB 2.0 host controller under test. For instructions on configuring this computer, refer to the High-Speed Electrical Test Toolkit Setup Instruction document which comes with the High-Speed Electrical Test Tool Kit software. You can download the High-Speed Electrical Test Tool Kit software (USBHSET) from the developers tools page at the USB Implementers Forum web site, http://www.usb.org/

The High-Speed Electrical Test Tool Kit software contains a proprietary EHCI or xHCI driver stack. The Hi-speed Electrical Test Tool software requires the use of a proprietary EHCI or xHCI driver stack. The use of this proprietary EHCI or xHCI driver stack facilitates the electrical testing that requires direct control of the command registers of the USB EHCI host controllers. The end result much more robust test bed environment. Since the proprietary EHCI or xHCI driver stack is designed for debug and test validation purposes, this driver stack does not support the normal functionality as found in the EHCI or xHCI drivers from Microsoft (or the device vendor). An automatic driver stack switching function has been implemented into the Hi-speed Electrical Test Tool for easy switching between the proprietary EHCI or xHCI driver stack and that from Microsoft. Upon invocation of the HS Electrical Test Tool software, the driver stack will automatically switch to the Intel proprietary EHCI or xHCI driver stack. Upon exit of the HS Electrical Test Tool software, the driver stack will automatically switch to the Microsoft EHCI or xHCI driver stack.

USBHSET XHCI
Is used for USB 3.X host controllers

USBHSET EHCI
Is used for USB 2.0 host controllers

3.3 USB 2.0 Test fixtures

3.3.1 USB 2.0 Device with standard USB connector

Devices with Standard-B; Mini-B; Micro-B and A-plug with captive cable are considered being devices with standard USB connector.

The USB-IF High Speed fixture only require connecting SMA cables that are connected directly to the scope. Do note that the USB-IF fixture is only able in measuring the High Speed Eye diagram and therefore it is still required to use the TestUSB FS-HUCR for the remaining high speed electrical tests. The USB-IF fixtures can be purchased via the USB-IF eStore at: http://www.usb.org

Test fixture Description	Part number	High-Speed Device	Full/Low Speed Device
High Speed USB-IF Device Eye diagram fixture	USB-IF Device test Fixture	1	n/a
USB2.0 Type-C Signal Quality Test Fixture (Receptacle)	TestUSB FS-HUCR	1	1
Back-Voltage fixture	TestUSB FS-BV	1	1

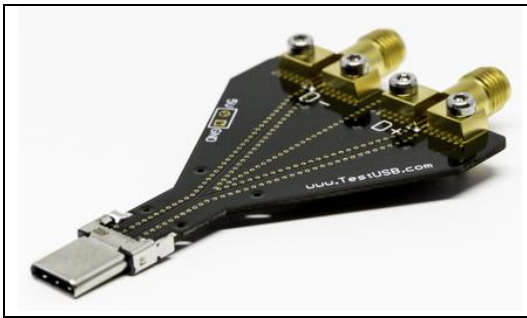
This document covers the high speed signal quality measurement for devices with Type-C™ receptacles and plugs. It not cover the measurement for device with standard USB receptacles or plugs. Remaining high speed tests beside signal quality are however covered in this document and require the FS-HUCR fixture.

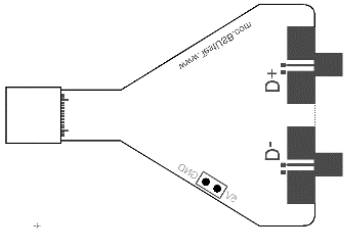
The FS-HUCR and FS-BV fixture can be purchase via:
http://www.fixturesolution.com

3.3.2 USB 2.0 Device with Type-C™ connector

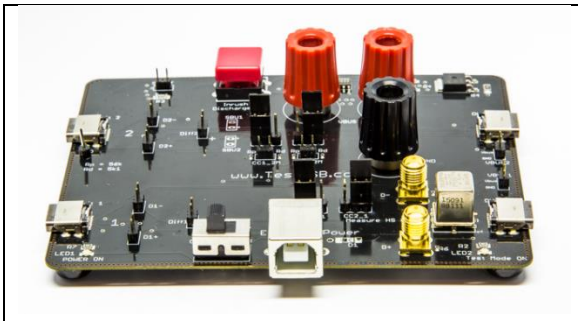
Test fixture Description	Part number	High-Speed Device	Full/Low Speed Device
USB2.0 Type-C Signal Quality Test Fixture (Receptacle)	TestUSB FS-HUCR	1	1
USB2.0 Type-C Signal Quality Test Fixture (Plug)	TestUSB FS-HUCP	1	n/a
Back-Voltage fixture	TestUSB FS-BV	1	1
USB2.0 Type-C Receiver fixture	TestUSB FS-HUCR-RX	1	n/a

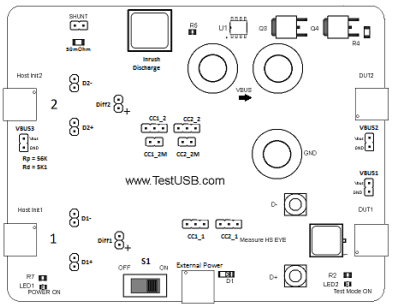
FS-HUCP



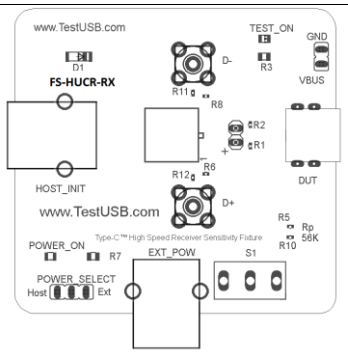


FS-HUCR

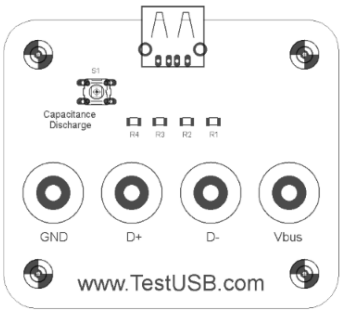




FS-HUCR-RX



FS-BV



The FS-HUCR, FS-HUCP, FS-HUCR-RX, and FS-BV fixture can be purchase via:
http://www.fixturesolution.com

3.4 USB Cables

Cable Description	Required for device	Part number	Qty
USB 2.0 10cm Type-C™ Plug to Standard A-plug	All devices	FS-HC-CP-10-P	2
USB 3.X 10cm Type-C™ Plug to Standard A-receptacle	All devices	FS-SS+C-CP-10-AR-3A	2
USB 2.0 10cm Type-C™ Plug to Standard C-plug	All devices	FS-HC-CP-10-CP	2
USB 2.0 500cm Type-C™ Plug to Standard B-plug	with standard-B receptacle	FS-HC-CP-500-BP	1
USB 2.0 200cm Type-C™ Plug to Standard micro B-plug	with micro-B receptacle	FS-HC-CP-200-uBP	1
USB 2.0 400cm Type-C™ Plug to Standard Type-C™ Plug	with Type-C™ receptacle	FS-HC-CP-400-CP	1
USB 2.0 Type-C™ Plug to Type-C™ Plug (5A)	All devices	FS-HC-CP-140-CP	2
USB 2.0 Type-C™ Plug to Standard A-plug	All devices	FS-HC-CP-150-AP	1
USB 2.0 10cm Type-C™ Plug to Standard A-plug (No Rp)	For debug purpose	FS-HC-CPnRp-10-AP	1
USB 3.X 10cm Type-C™ Plug to Standard A-receptacle (No Rd)	For debug purpose	FS-SS+C- CPnRd -10-AR	1
USB 2.0 Standard A-Plug to B-Plug	To power FS-HUCR	Any cable	1

The above cables can be purchased separate via:
http://www.fixturesolution.com/product-category/usb-cables/

Or the complete above cable set via:
http://www.fixturesolution.com/product/cable-set/

3.5 Miscellaneous Cables and Devices

Description	Required for device	Part number	Qty
Digital multimeter	All devices	Keysight 33401A or equivalent	1
Matched SMA Cable Pair	High Speed devices	50cm SMA cable pair	1
USB 2.0 High Speed USB Hub (at least two downstream ports accessible)	All devices	Any high speed hub	1
USB 2.0 Full Speed USB Hub (at least two downstream ports accessible)	High Speed devices	Any full speed hub	1
Adjacent Full Speed device	High and Full Speed devices	Any full speed device	1
Adjacent Low Speed device	Low Speed devices	Any low speed device	1
USB 3.x Vbus breakout Standard A Plug	Debug and Vbus Voltage/Current measurement	USB 3.x Vbus breakout Standard A Plug	1

A 50cm SMA cable pair can be purchased via:
http://www.fixturesolution.com/product/sma-cable/

4. Test procedure

4.1 USB2.0 Upstream Electrical

4.1.1 Upstream High Speed Signal Quality

This document covers the high speed signal quality measurement for devices with Type-C™ receptacles and plugs. It not covers the measurement for device with standard USB receptacles or plugs.

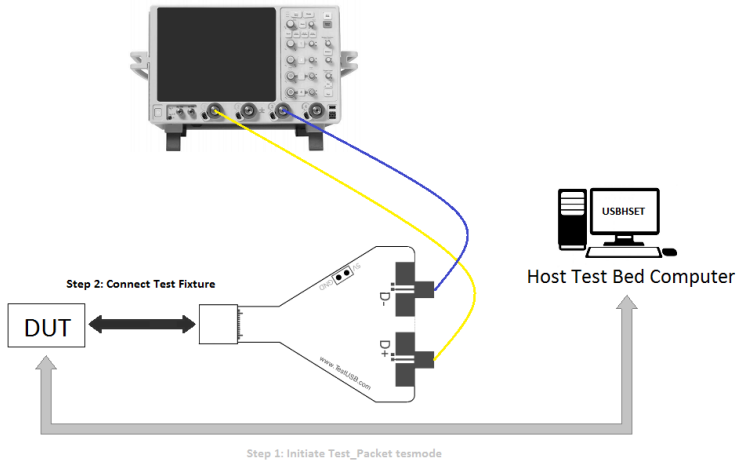
This test is measuring the high speed upstream Signal Quality (EYE diagram). For this test the device need to send out the Test_Packet as defined in section 7.1.20 of the USB 2.0 specification. The USB-IF tool USBET will make the required analyses.

4.1.2 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	USB software	Check with scope vendor
2	BNC - SMA	e.g. Keysight 54855-67604
2	SMA Cables	Matched SMA Cable Pair
1	Cable between Device under test and Device Hi-Speed Signal Quality Type-C™ test fixture	10cm Type-C™ plug to Type-C™ plug cable FS-HC-CP-10-CP
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Device Hi-Speed Signal Quality Type-C™ test fixture	For devices with Type-C™ plug or devices with Type-C™ receptacle and bus-powered use: • TestUSB FS-HUCR For device with Type-C™ receptacle and self-powered use: • TestUSB FS-HUCP
1	5V power supply	Any USB 2.0 A-plug to B-plug cable that can take 5V from any USB host.
1	Cable between USBHSET PC and FS-HUCR Signal Quality Type-C™ test fixture	FS-HC-CP-150-AP
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org

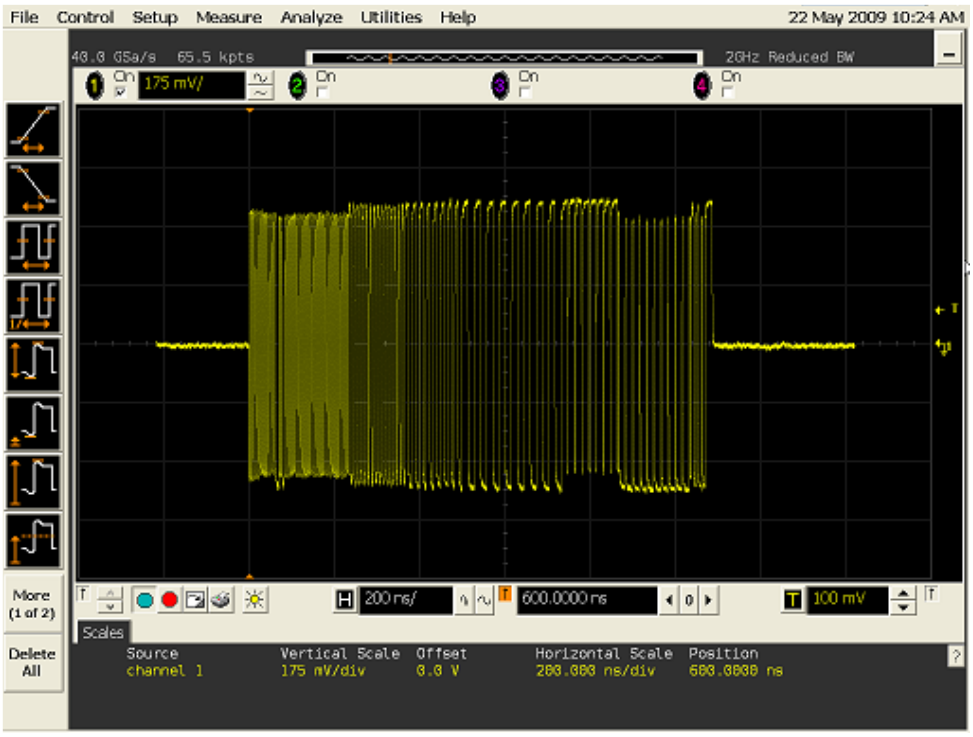
4.1.2.1 Setup Diagram if Hub upstream has Type-C™ receptacle and is self-powered

If the DUT has a Type-C™ receptacle and is self-powered the setup is as followed:



Connecting the Equipment – DUT has Type-C™ receptacle and is self-powered (Test fixture FS-HUCP)

1. Connect the DUT to the Test Bed Computer running USBHSET, using a USB cable.
2. Follow Test Instructions below from step 5. to 8. in order to let the DUT send continuously TEST_PACKET.
3. Detach the DUT from Test Bed Computer running USBHSET. Since the device is self-powered the device keep sending TEST_PACKET till power cycle.
4. Attach the SMA cables to the SMA connectors D+ and D- on the USB2.0 Type-C™ plug test fixture FS-HUCP. In default D+ = Ch1 and D- = Ch3.
5. Connect the test fixture to the DUT and you should see the following.



6. Follow the oscilloscope vendor steps in acquiring the signal eye diagram and calculating the below signal quality compliance test items

   EL_6 Rise Time

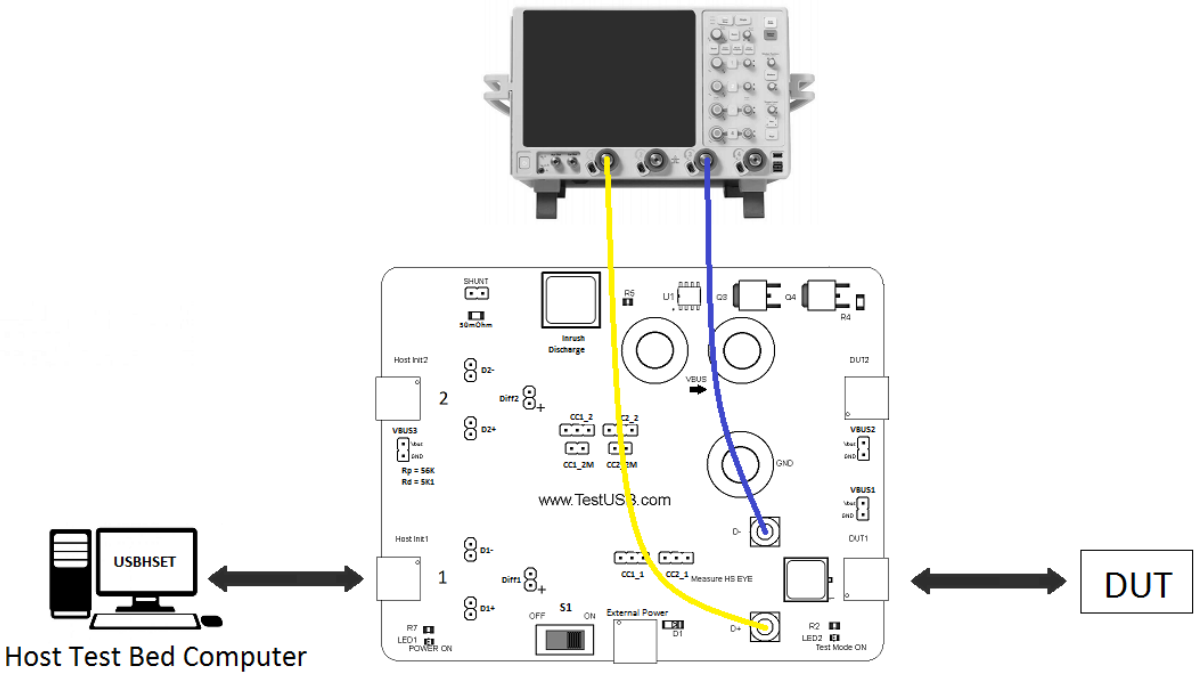
   EL_6 Fall Time

   EL_2 EL_4 EL_5 Data Eye and Mask Test

   EL_7 Non-Monotonic Edge Test

7. For Type-C™ products the measurement need to be done in both positions so flip the fixture and repeat the above step 5 and 6.

4.1.2.2 Setup Diagram for other Type-C™ Hub



Connecting the Equipment

1. Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C™ receptacle fixture FS-HUCR. Leave the TEST switch 'S1' at the OFF position. Verify the red POWER ON LED is lit and the Test Mode ON LED is not lit.
2. Connect the DUT to DUT 1 side of the fixture.
    a. If device has captive Type-C™ plug directly connect DUT to DUT1 (*)
    b. If device has a Type-C™ receptacle and is bus-powered use the corresponding short cable (FS-HC-CP-10-CP) to connect DUT to DUT1
3. Connect the Host Init 1 of the test fixture to a port of the Test Bed Computer running USBHSET, using a using the appropriated USB cable.
4. Attach the SMA cables to the SMA connectors D+ and D- on the test fixture. In default D+ = Ch1 and D- = Ch3

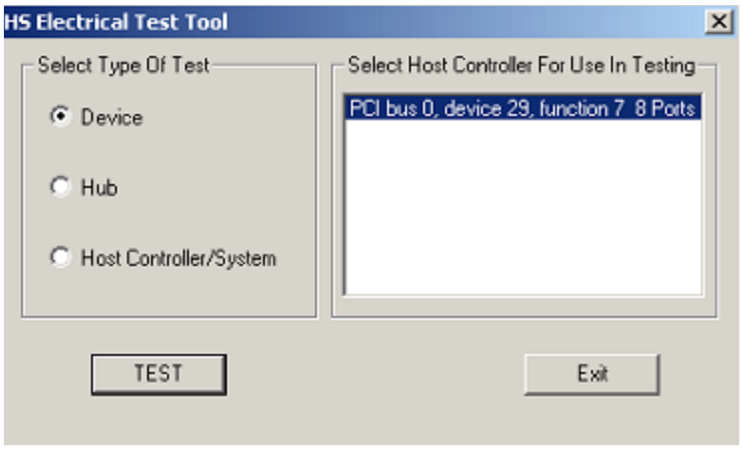
(*) Measurements to be performed using the far end eye template.

CC Jumper setting

In normal circumstances no jumper should be place there the Rp is within the cable between Test Bed Computer.

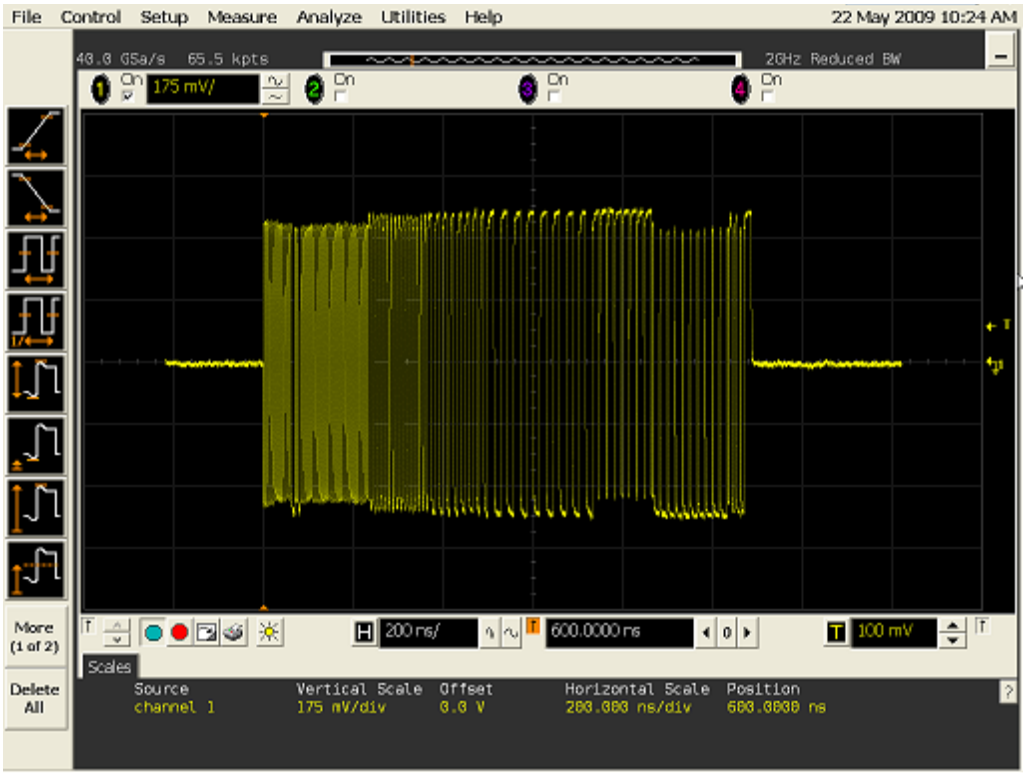
4.1.2.3 Test Instructions

5. Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.
6. Select Device and click the [TEST] button to enter the Device Test menu.



7. The device under test should be enumerated with the device's VID shown together with the root port in which it is connected.
8. Select **TEST_PACKET** from the Device Command drop down menu and click **[EXECUTE]**. This forces the device under test to continuously transmit test packets.

9. Place the Test Switch (S1) in the ON position. Verify the red Test Mode ON LED is lit. You should see the transmitted test packet on the oscilloscope as below.



10. Follow the oscilloscope vendor steps in acquiring the signal eye diagram and calculating the below signal quality compliance test items

    EL_6 Rise Time

    EL_6 Fall Time

    EL_2 EL_4 EL_5 Data Eye and Mask Test

    EL_7 Non-Monotonic Edge Test

8. For Type-C™ products the measurement need to be done in both positions so flip the cable at the DUT1 side of the fixture and repeat step 6 till 10.

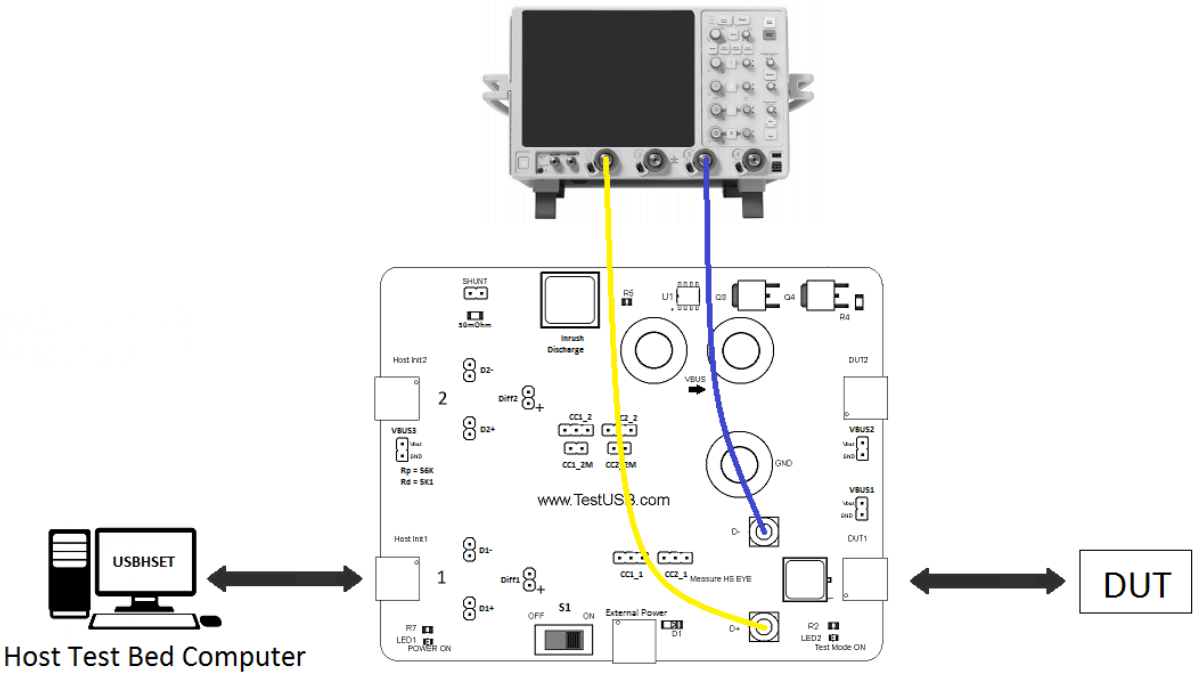
4.1.3 Upstream High Speed Test J/K, SE0NAK

All high speed devices must undergo this test. The following test can also be executed on devices with standard USB connectors.

4.1.3.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	USB software	Check with scope vendor
2	BNC – SMA	e.g. Keysight 54855-67604
2	SMA Cables	Matched SMA Cable Pair
1	Cable between Device under test and Device Hi-Speed Signal Quality Type-C™ test fixture	10cm Type-C™ plug to Type-C™ plug cable FS-HC-CP-10-CP
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Device Hi-Speed Signal Quality Type-C™ test fixture	For devices with Type-C™ plug or devices with Type-C™ receptacle and bus-powered use: • TestUSB FS-HUCR
1	5V power supply	Any USB 2.0 A-plug to B-plug cable that can take 5V from any USB host.
1	Cable between USBHSET PC and FS-HUCR Signal Quality Type-C™ test fixture	FS-HC-CP-150-AP
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org

4.1.3.2 Setup Diagram



Connecting the Equipment

1. Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C™ receptacle fixture FS-HUCR. Leave the TEST switch 'S1' at the OFF position. Verify the red POWER ON LED is lit and the Test Mode ON LED is not lit.
2. Connect the DUT to DUT 1 side of the fixture.
    a. If device has captive Type-C™ plug directly connect DUT to DUT1 (*)
    b. If device has a Type-C™ receptacle and is bus-powered use the corresponding short cable (FS-HC-CP-10-CP) to connect DUT to DUT1
3. Connect the Host Init 1 of the test fixture to a port of the Test Bed Computer running USBHSET, using a using the appropriated USB cable.
4. Attach the SMA cables to the SMA connectors D+ and D- on the test fixture.

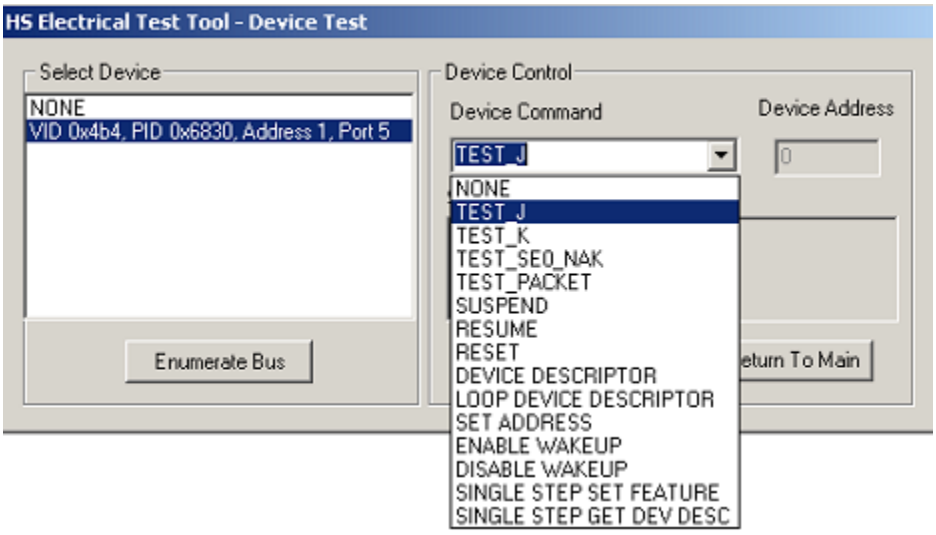
CC Jumper setting

In normal circumstances no jumper should be place there the Rp is within the cable between Test Bed Computer.

4.1.3.3 Test Instructions

Test Instructions EL_8 Test_J part

5. On the Device Test Menu of the HS Electrical Test Tool, click [Enumerate Bus] once.
6. Select TEST_J from the Device Command drop down menu. Click [EXECUTE] once to place the device into TEST_J test mode.



7. Switch the Test Switch (S1) in the ON position. Verify the red Test Mode ON LED is lit.
8. The captured transition should be as in the figure below.

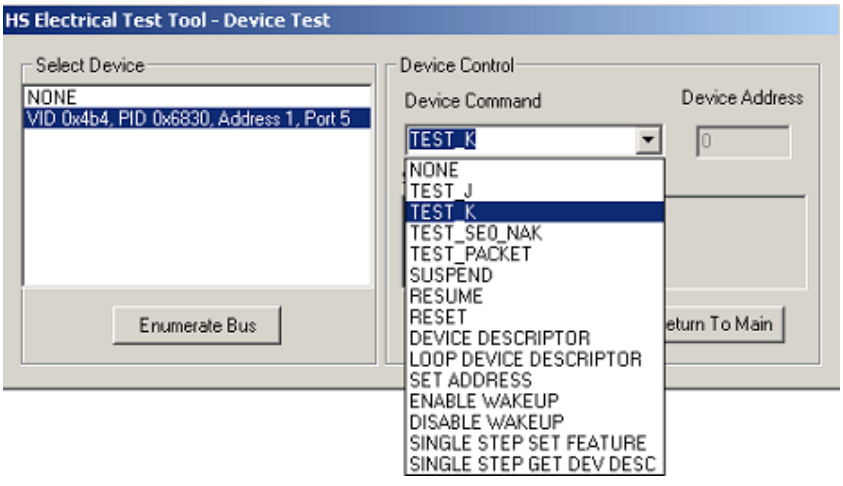
9. Follow the oscilloscope vendor steps in measuring the below compliance test items

EL_8 Test_J

10. Power Cycle USB Device Under Test and flip/ reverse attach USB Type-C™ connection
11. Repeat Test Instructions from step 5.
12. Power Cycle USB Device Under Test

Test Instructions EL_8 Test_K Part

13. On the Device Test Menu of the HS Electrical Test Tool, click [Enumerate Bus] once.
14. Select **TEST_K** from the Device Command drop down menu. Click **[EXECUTE]** once to place the device into TEST_K test mode.



15. Switch the Test Switch (S1) in the ON position. Verify the red Test Mode ON LED is lit.
16. The captured transition should be as in the figure below.

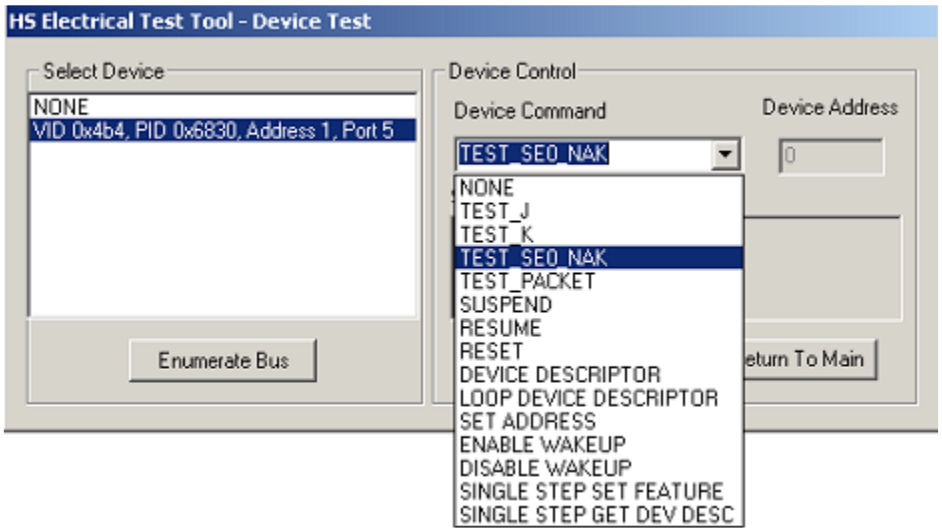
17. Follow the oscilloscope vendor steps in measuring the below compliance test items

EL_8 Test_K

18. Power Cycle USB Device Under Test and flip/ reverse attach USB Type-C™ connection
19. Repeat Test Instructions from step 13.
20. Power Cycle USB Device Under Test

Test Instructions EL_8 Test_SE0 Part

21. On the Device Test Menu of the HS Electrical Test Tool, click [Enumerate Bus] once.
22. Select **SE0_NAK** from the Device Command drop down menu. Click **[EXECUTE]** once to place the device into SE0_NAK test mode.



23. Switch the Test Switch (S1) in the ON position. Verify the red Test Mode ON LED is lit.
24. The captured transition should be as in the figure below.

25. Follow the oscilloscope vendor steps in measuring the below compliance test items

EL_9 Test_SE0_NAK

26. Power Cycle USB Device Under Test and flip/ reverse attach USB Type-C™ connection
27. Repeat Test Instructions from step 21.
28. Power Cycle USB Device Under Test

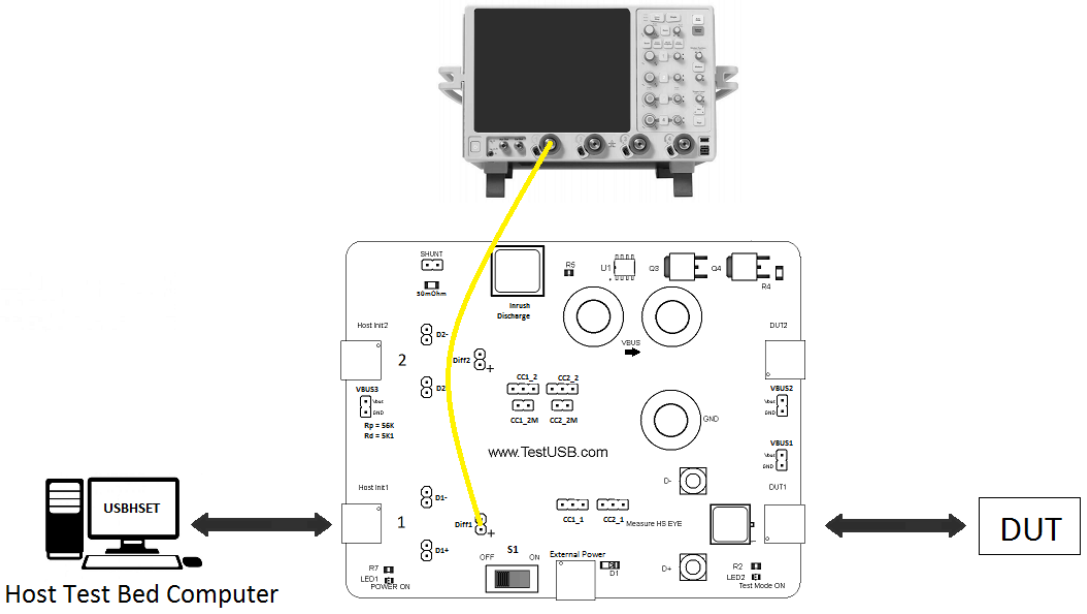
4.1.4 Upstream High Speed Packet Parameters

All high speed devices must undergo this test. The following test can also be executed on devices with standard USB connectors.

4.1.4.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	USB software	Check with scope vendor
1	Differential probe	Check with scope vendor
1	Cable between Device under test and Device Hi-Speed Signal Quality Type-C™ test fixture	10cm Type-C™ plug to Type-C™ plug cable FS-HC-CP-10-CP
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Device Hi-Speed Signal Quality Type-C™ test fixture	For devices with Type-C™ plug or devices with Type-C™ receptacle and bus-powered use: • TestUSB FS-HUCR
1	5V power supply	Any USB 2.0 A-plug to B-plug cable that can take 5V from any USB host.
1	Cable between USBHSET PC and FS-HUCR Signal Quality Type-C™ test fixture	FS-HC-CP-150-AP
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org

4.1.4.2 Setup Diagram



Connecting the Equipment

1. Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C™ receptacle fixture FS-HUCR. Leave the TEST switch 'S1' at the OFF position. Verify the red POWER ON LED is lit and the Test Mode ON LED is not lit.
2. Connect the DUT to DUT 1 side of the fixture.
    a. If device has captive Type-C™ plug directly connect DUT to DUT1
    b. If device has a receptacle use the corresponding short as possible cable to connect DUT to DUT1.
3. Connect the Host Init 1 of the test fixture to a port of the Test Bed Computer running USBHSET, using the appropriated USB cable.
4. If needed apply power to the device.
5. Attach the differential probe to D+/D- of "1" on the test fixture.

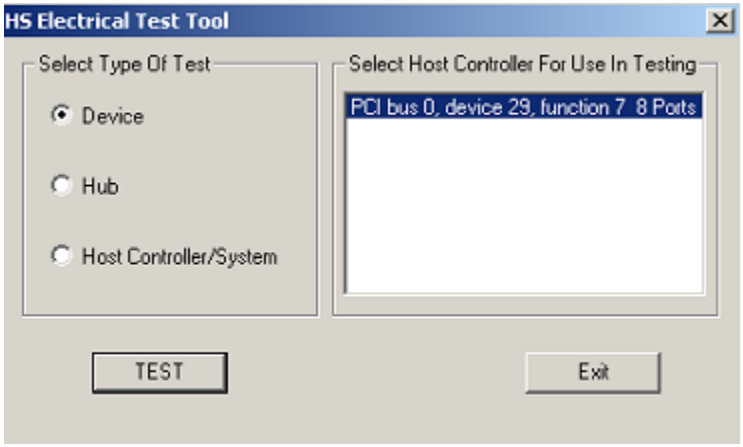
CC Jumper setting

In normal circumstances no jumper should be place there the Rp is within the cable between Test Bed Computer.

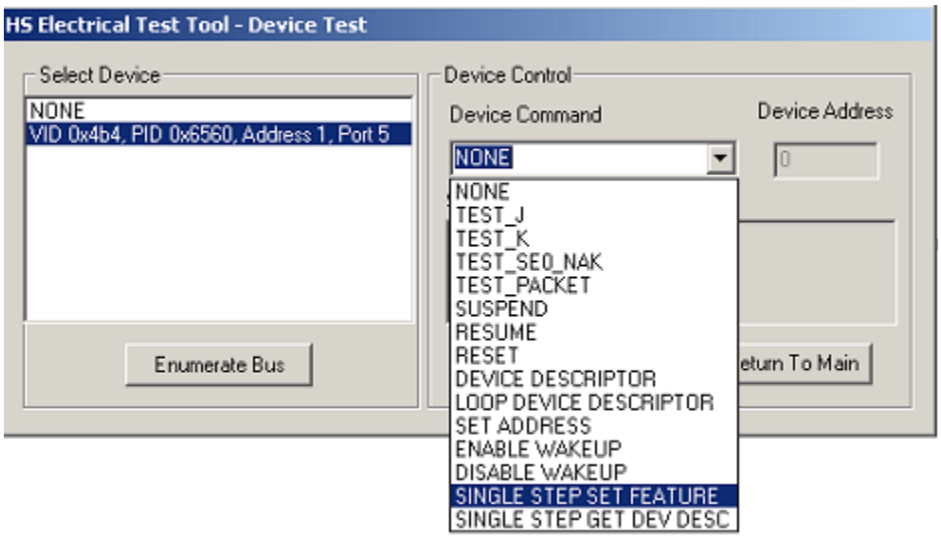
4.1.4.3 Test Instructions

Test Instructions part1

1. Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.
2. Select Device and click the [TEST] button to enter the Device Test menu.



3. The device under test should be enumerated with the device's VID shown together with the root port in which it is connected.
4. Select **SINGLE STEP SET FEATURE** from the Device Command drop down menu and click **[EXECUTE]**.



5. You should see the transmitted test packet on the oscilloscope as below.

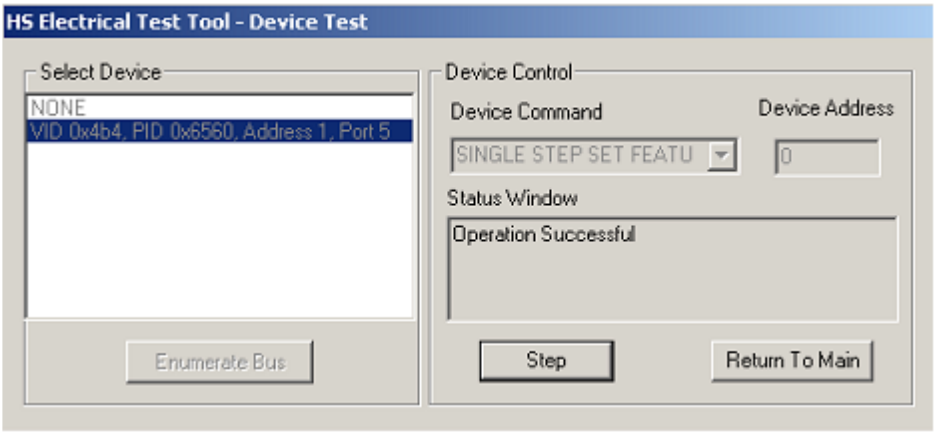
6. Follow the oscilloscope vendor steps in the below compliance test items

EL_21 Sync Field Length Test

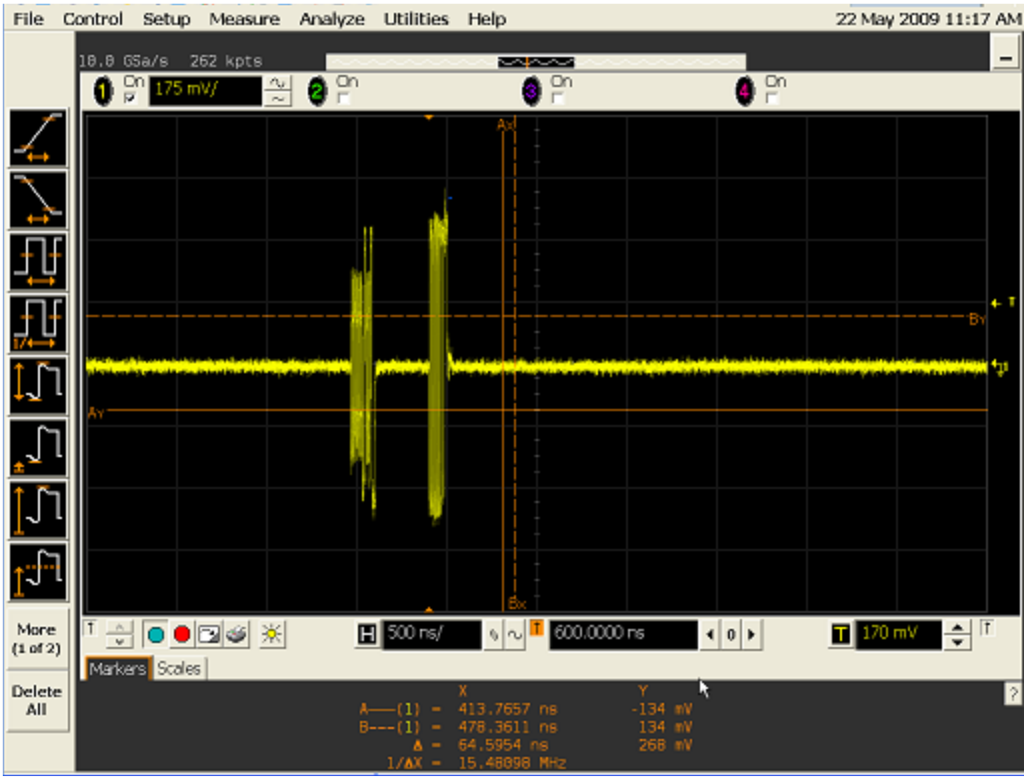
EL_25 EOP Length Test

EL_22 Measure Interpacket Gap Between Second and Third Packets

7. In the Device Test menu of the HS Electrical Test Tool, click **[STEP]** once again. This is the second step of the two-step Single Step Set Feature command.



8. You should see the transmitted test packet on the oscilloscope as below.



9. Follow the oscilloscope vendor steps in the below compliance test items

EL_22 Measure Interpacket Gap Between First and Second Packets

10. Power Cycle USB Device Under Test and flip/ reverse attach USB Type-C™ connection
11. Repeat Test Instructions Part 1; Part 2 and Part 3

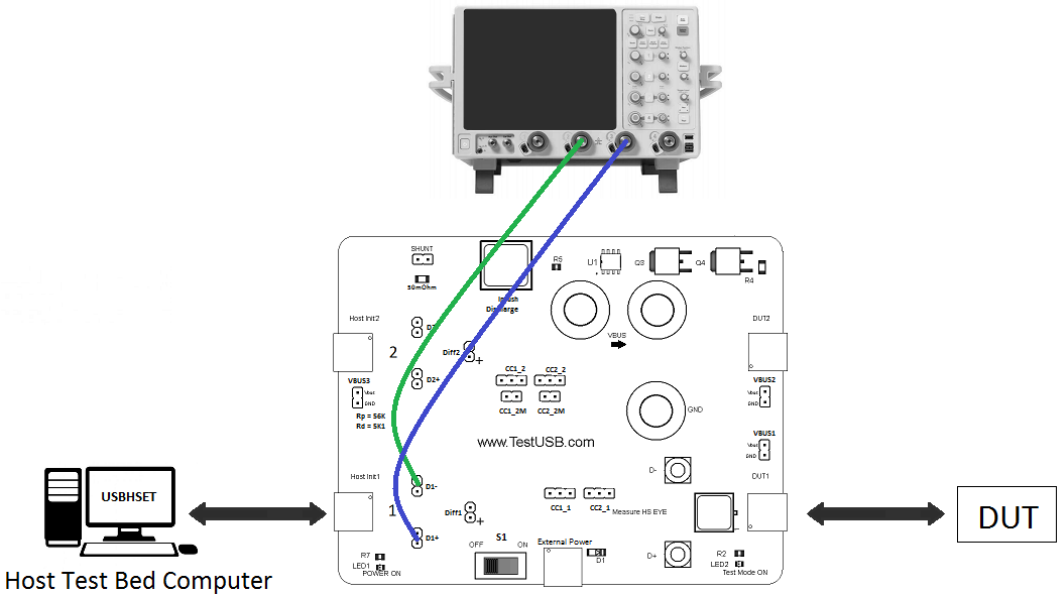
4.1.5 Upstream High Speed CHIRP Timing

All high speed devices must undergo this test. The following test can also be executed on devices with standard USB connectors.

4.1.5.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	USB software	Check with scope vendor
2	Signal ended or differential probe	Check with scope vendor
1	Cable between Device under test and Device Hi-Speed Signal Quality Type-C™ test fixture	10cm Type-C™ plug to Type-C™ plug cable FS-HC-CP-10-CP
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Device Hi-Speed Signal Quality Type-C™ test fixture	For devices with Type-C™ plug or devices with Type-C™ receptacle and bus-powered use: • TestUSB FS-HUCR
1	5V power supply	Any USB 2.0 A-plug to B-plug cable that can take 5V from any USB host.
1	Cable between USBHSET PC and FS-HUCR Signal Quality Type-C™ test fixture	FS-HC-CP-150-AP
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org

4.1.5.2 Setup Diagram



Connecting the Equipment

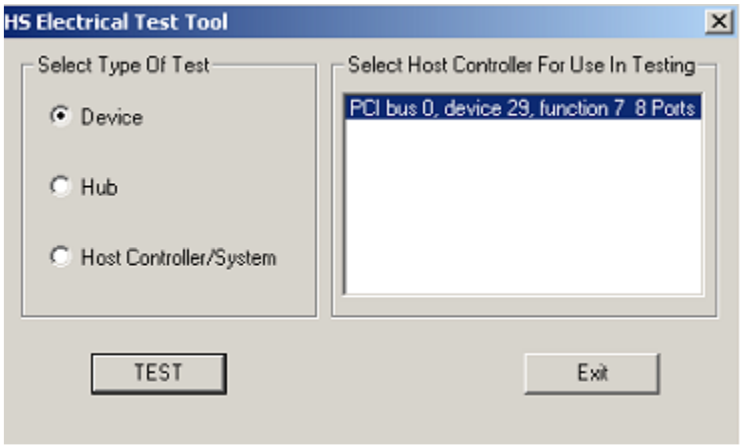
1. Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0

Type-C™ receptacle fixture FS-HUCR. Leave the TEST switch 'S1' at the OFF position. Verify the red POWER ON LED is lit and the Test Mode ON LED is not lit.

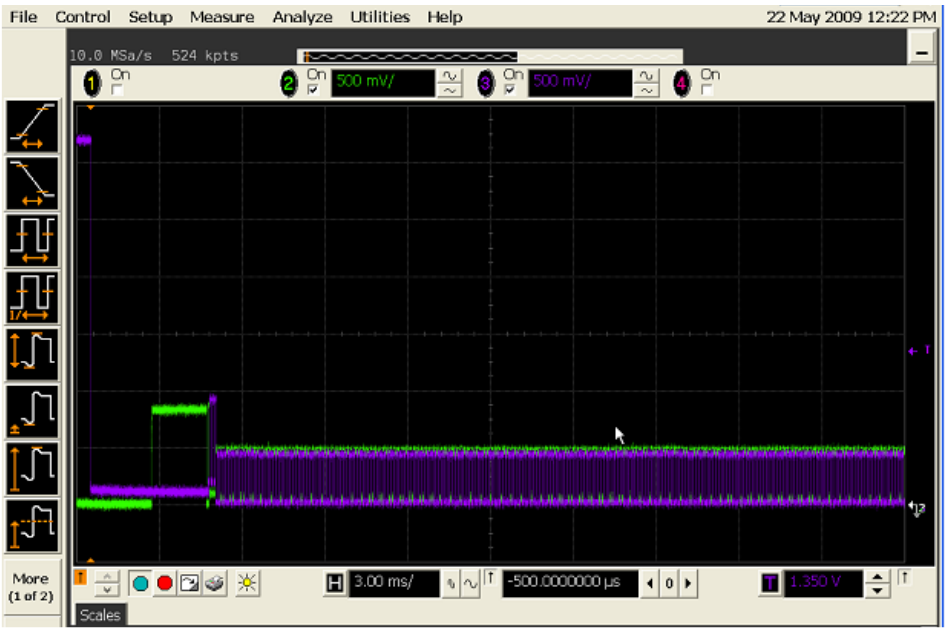
2. Connect the DUT to DUT 1 side of the fixture.
    a. If device has captive Type-C™ plug directly connect DUT to DUT1
    b. If device has a receptacle use the corresponding short cable to connect DUT to DUT1.
3. Connect the Host Init 1 of the FS-HUCR to a Hi-speed capable port of the Test Bed Computer, using a USB cable.
4. Connect the active probe on Channel 2 to the D- pin at "1" of the FS-HUCR. Make sure the probe position is set properly.
5. Connect the active probe on Channel 3 to the D+ pin at "1" of the FS-HUCR. Make sure the probe position is set properly.

4.1.5.3 Test Instructions

6. Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.
7. Select Device and click the [TEST] button to enter the Device Test menu.



8. The device under test should be enumerated with the device's VID shown together with the root port in which it is connected.
9. On the HS Electrical Test Tool software, click [Enumerate Bus] once. You should capture the CHIRP handshake as in the below figure.



10. Follow the oscilloscope vendor steps in the below compliance test items

EL_28 Measure Device CHIRP-K Latency

EL_29 Measure Device CHIRP-K Duration

EL_31 Hi-Speed Terminations Enable and D+ Disconnect Time

11. Flip/reverse attach USB Type-C™ connection
12. Repeat Test Instructions 9. and 10.

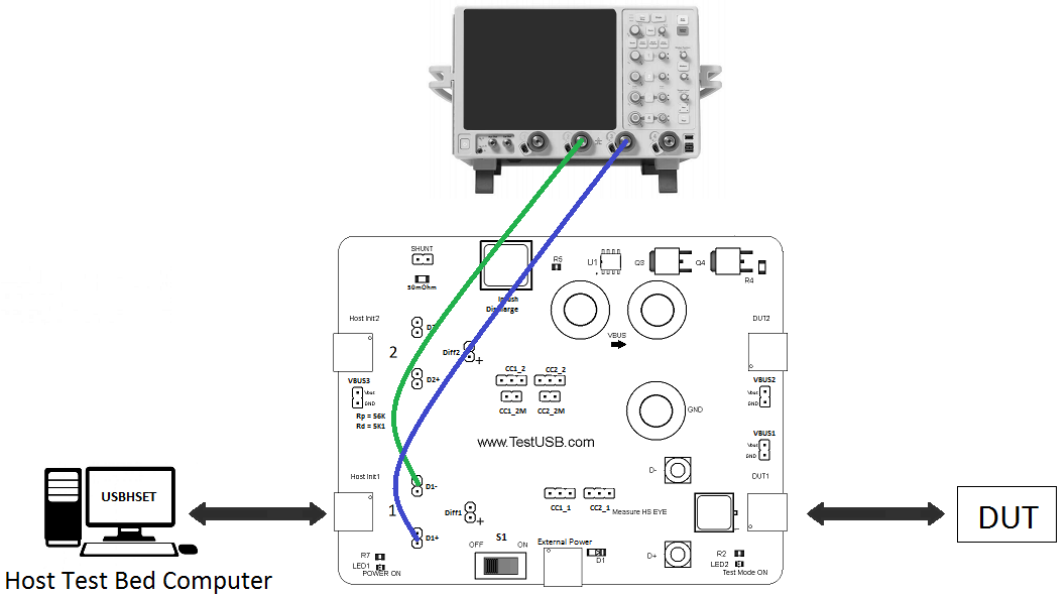
4.1.6 Upstream High Speed Suspend/Resume/Reset Timing

All high speed devices must undergo this test. The following test can also be executed on devices with standard USB connectors.

4.1.6.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	USB software	Check with scope vendor
2	Signal ended or differential probe	Check with scope vendor
1	Cable between Device under test and Device Hi-Speed Signal Quality Type-C™ test fixture	10cm Type-C™ plug to Type-C™ plug cable FS-HC-CP-10-CP
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Device Hi-Speed Signal Quality Type-C™ test fixture	For devices with Type-C™ plug or devices with Type-C™ receptacle and bus-powered use: • TestUSB FS-HUCR
1	5V power supply	Any USB 2.0 A-plug to B-plug cable that can take 5V from any USB host.
1	Cable between USBHSET PC and FS-HUCR Signal Quality Type-C™ test fixture	FS-HC-CP-150-AP
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org

4.1.6.2 Setup Diagram



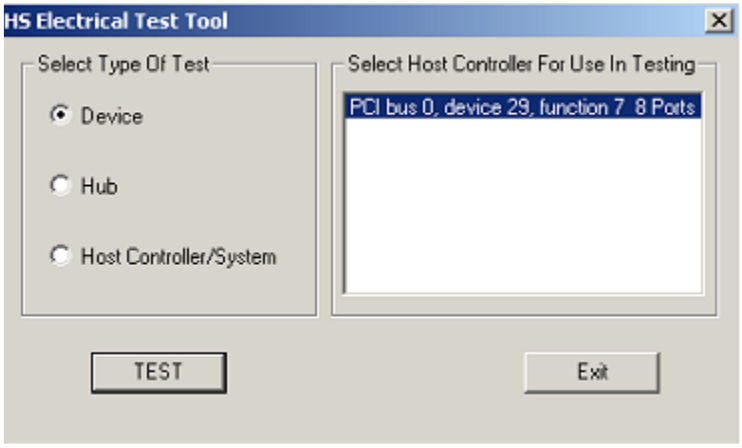
Connecting the Equipment

1. Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C™ receptacle fixture FS-HUCR. Leave the TEST switch 'S1' at the OFF position. Verify the red POWER ON LED is lit and the Test Mode ON LED is not lit.
2. Connect the DUT to DUT 1 side of the fixture.
    a. If device has captive Type-C™ plug directly connect DUT to DUT1
    b. If device has a receptacle use the corresponding short cable to connect DUT to DUT1.
3. Connect the Host Init 1 of the FS-HUCR to a Hi-speed capable port of the Test Bed Computer, using a USB cable.
4. Connect the active probe on Channel 2 to the D- pin at "1" of the FS-HUCR. Make sure the probe position is set properly.
5. Connect the active probe on Channel 3 to the D+ pin at "1" of the FS-HUCR. Make sure the probe position is set properly.

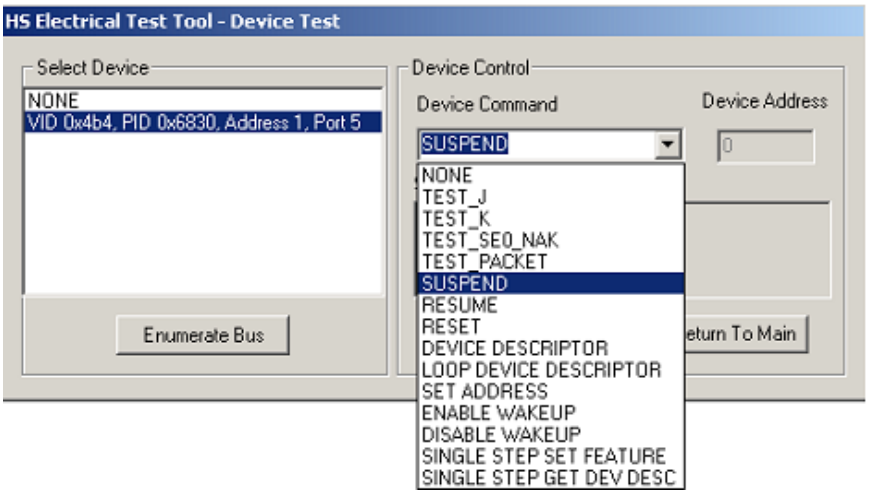
4.1.6.3 Test Instructions

Test Instructions part1

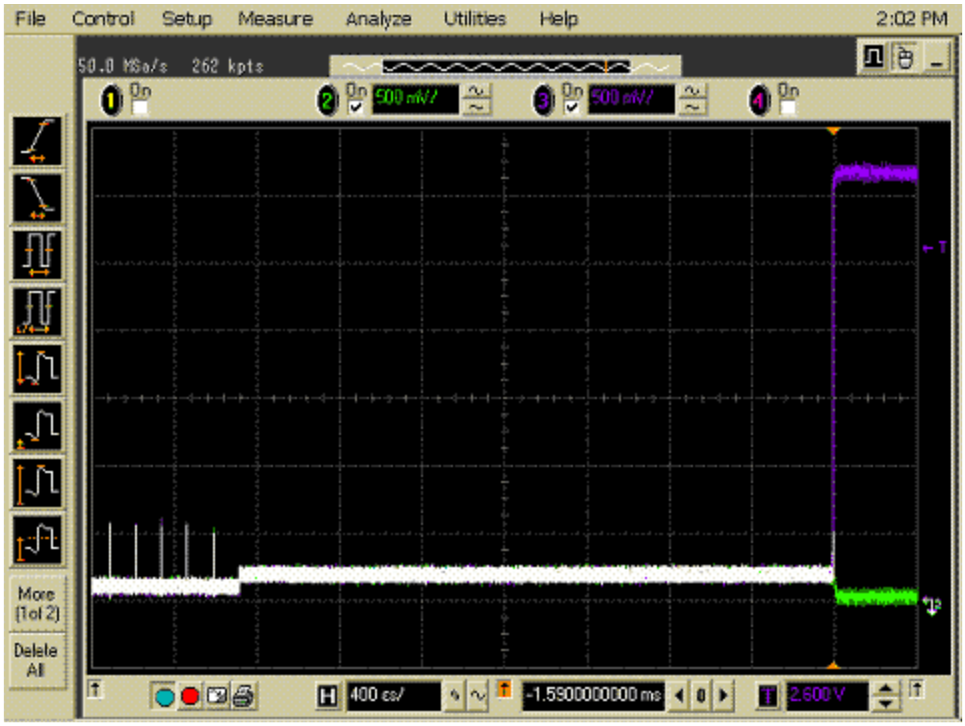
6. Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.
7. Select Device and click the [TEST] button to enter the Device Test menu.



8. The device under test should be enumerated with the device's VID shown together with the root port in which it is connected.
9. Select **SUSPEND** from the Device Command drop down menu and click **[EXECUTE]**.



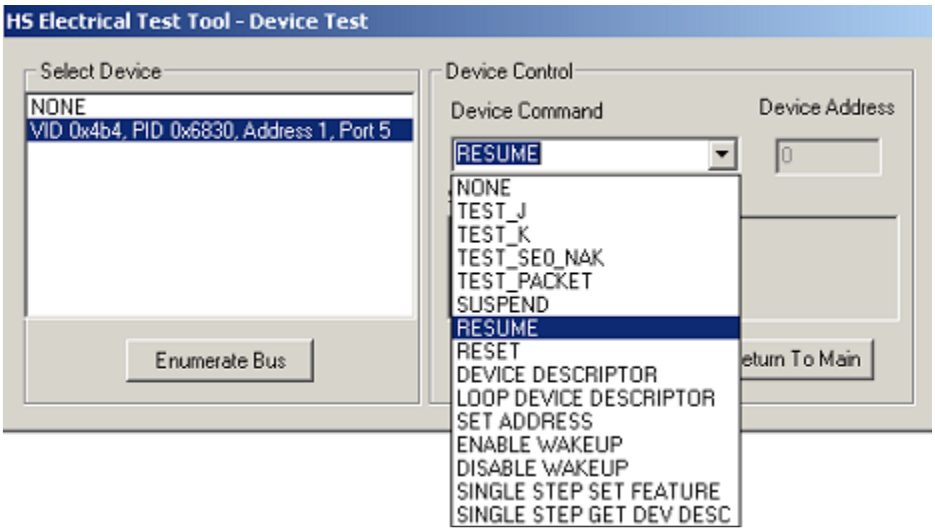
10. You should see the transmitted test packet on the oscilloscope as below.



11. Follow the oscilloscope vendor steps in the below compliance test items

EL_38 Suspend Timing

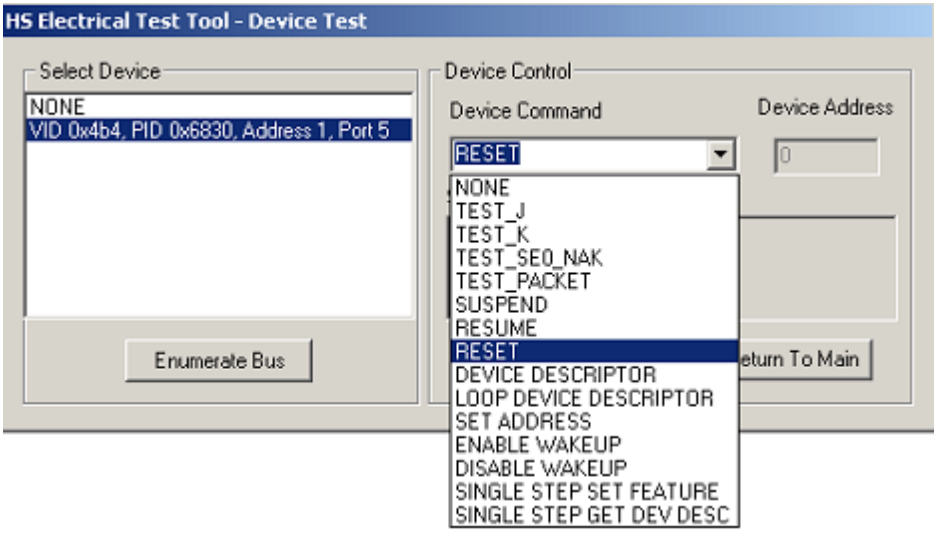
12. On the Device Test Menu of the HS Electrical Test Tool, select **RESUME** from the Device Command drop down menu. Click **[EXECUTE]** once to resume the hub from suspend.



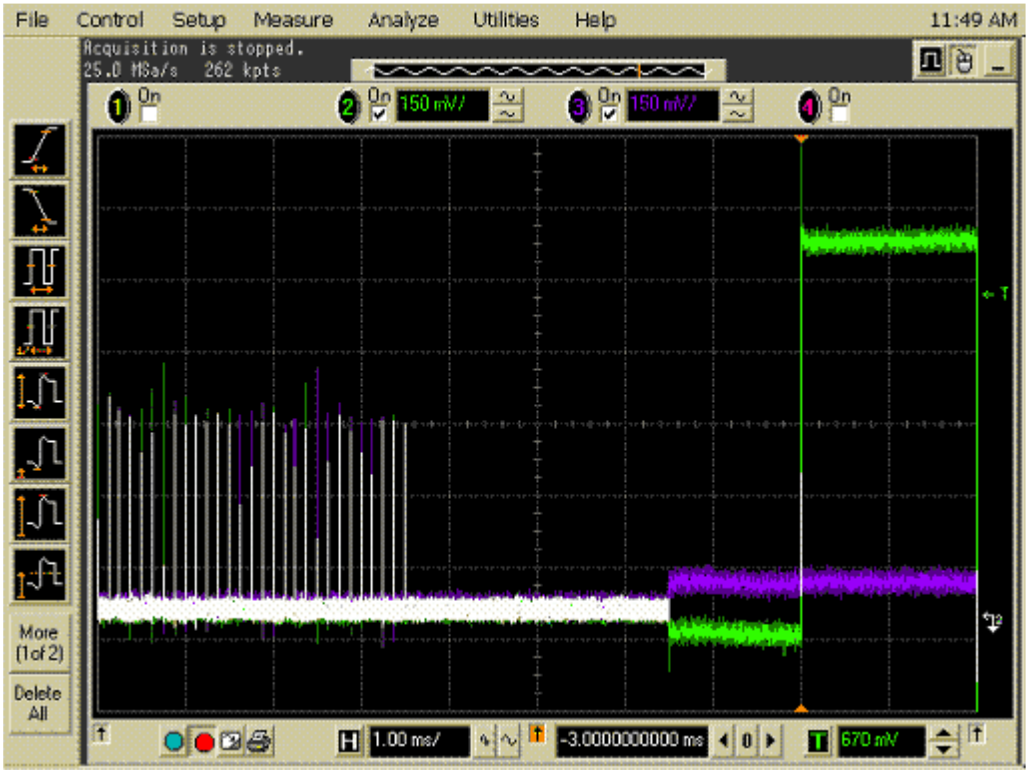
13. The captured transition should be as in the figure below.

14. Follow the oscilloscope vendor steps in the below compliance test items **EL_40 Resume Timing Response**

15. On the Device Test Menu of the HS Electrical Test Tool, select **RESET** from the Device Command drop down menu. Click **[EXECUTE]** once to reset the device operating in high speed. The captured



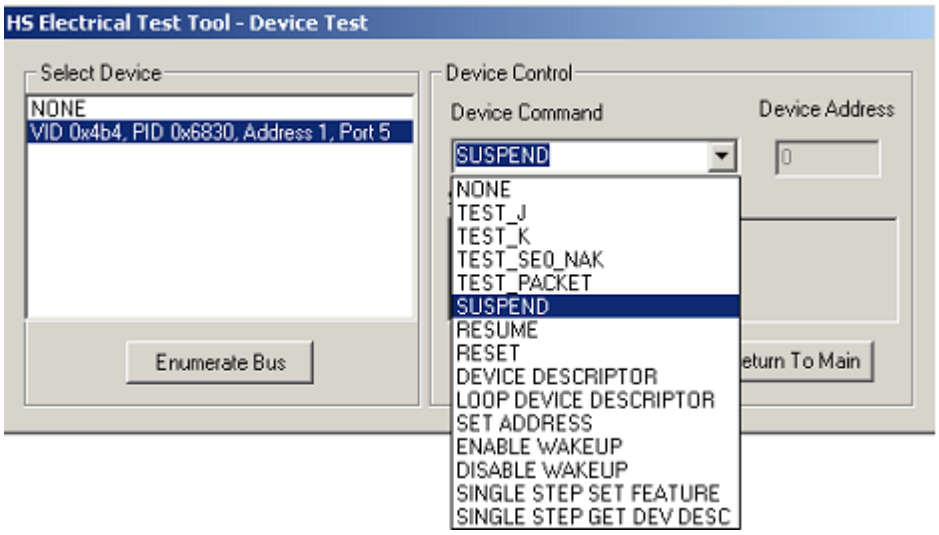
16. Transition should be as in the figure below.



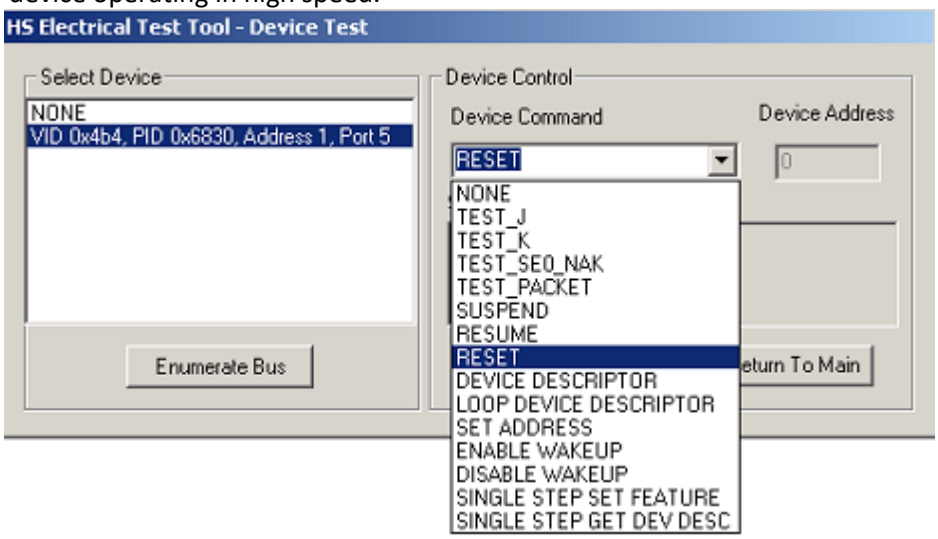
17. Follow the oscilloscope vendor steps in the below compliance test items

EL_27 Response time Reset

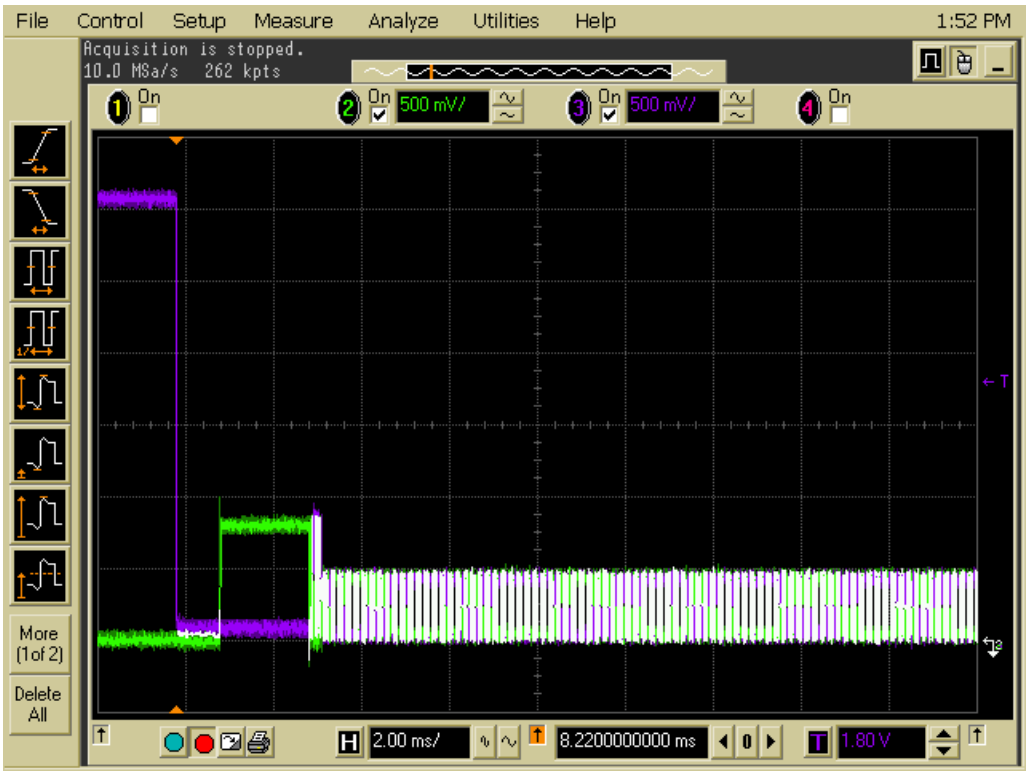
18. On the Device Test Menu of the HS Electrical Test Tool software, select **SUSPEND** from the Device Command drop down menu. Click **[EXECUTE]** once to place the device into suspend.



19. On the Device Test Menu of the HS Electrical Test Tool, select **RESET** from the Device Command drop down menu. Click **[EXECUTE]** once to reset the device operating in high speed.



20. The captured transition should be as in the figure below.



21. Follow the oscilloscope vendor steps in the below compliance test items

EL_28 Device CHIRP Response to Reset from Suspend

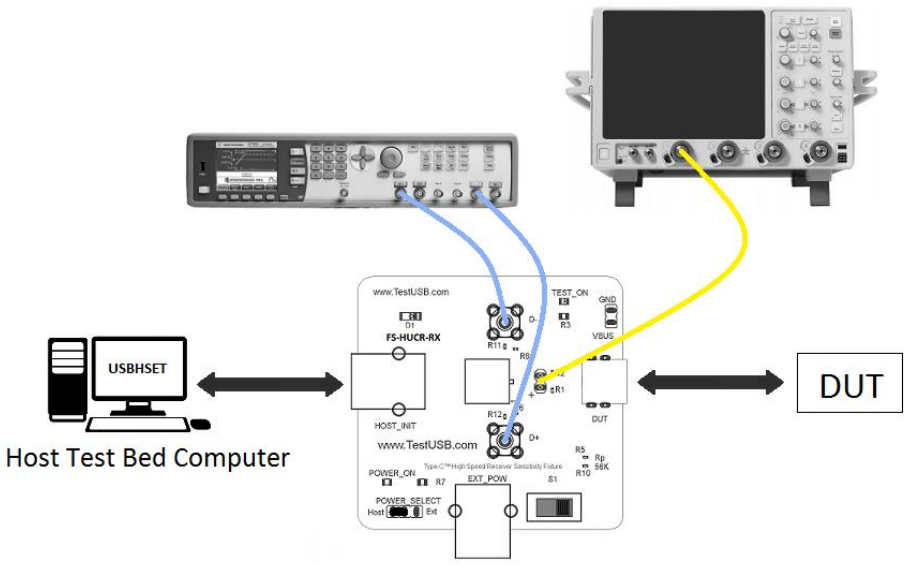
22. Repeat Test Instructions Part 1; Part 2

4.1.7 Upstream High Speed Receiver Sensitivity

4.1.7.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	USB software	Check with scope vendor
1	Differential probe	Check with scope vendor
1	Pattern generator Arbitrate wave generator	Check with generator vendor
2	SMA Cables	Matched SMA Cable Pair
1	Cable between Device under test and Device Hi-Speed Signal Quality Type-C™ test fixture	10cm Type-C™ plug to Type-C™ plug cable FS-HC-CP-10-CP
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Device Hi-Speed High Speed Receiver Sensitivity Fixture	For devices with Type-C™ plug or devices with Type-C™ receptacle and bus-powered use: • TestUSB FS-HUCR-RX
1	5V power supply (if external power is used)	Any USB 2.0 A-plug to B-plug cable that can take 5V from any USB host.
1	Cable between USBHSET PC and FS-HUCR Signal Quality Type-C™ test fixture	Any USB 2.0 A-plug to B-plug cable.
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org

4.1.7.2 Setup Diagram

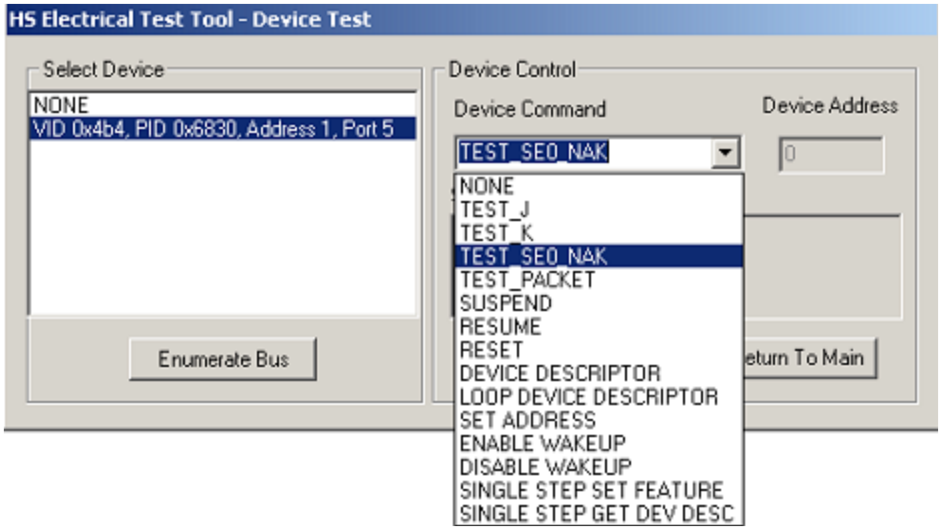


Connecting the Equipment

1. Place the jumper from POWER SELECT to HOST.
2. Connect a USB 2.0 A-plug to B-plug cable between Test Bed Computer running USBHSET and HOST_INIT port of the FS-HUCR-RX fixture.
3. Place the TEST switch 'S1' at the OFF position. Verify the red POWER ON LED is lit and the Test Mode ON LED is not lit.
4. Connect the DUT to DUT side of the fixture.
    a. If device has captive Type-C™ plug directly connect DUT to DUT
    b. If device has a Type-C™ receptacle use the corresponding short cable (FS-HC-CP-10-CP) to connect DUT to DUT
5. Attach the SMA cables to the SMA connectors D+ and D- on the test fixture to the generator.

4.1.7.3 Test Instructions

6. On the Device Test Menu of the HS Electrical Test Tool, click [Enumerate Bus] once.
7. Select **SE0_NAK** from the Device Command drop down menu. Click **[EXECUTE]** once to place the device into SE0_NAK test mode.



8. Switch the Test Switch (S1) in the ON position. Verify the red Test Mode ON LED is lit.

Perform the 12 bit SYNC field test (EL_18)

9. Set the generator to send out a 12bit Sync IN_Token pattern.
10. The captured transition should be as in the figure below.

11. When the DUT respond with NAK to all 12bit Sync packets the test is PASS. When the DUT not respond with NAK to all packets the test FAIL.

Perform the Receiver Sensitivity (EL_17)

12. Set the generator to send out a 32bit Sync IN_Token pattern.
13. The captured transition should be as in the figure below.

14. Lower the voltage at the generator till the DUT still respond to all packets from the generator.
15. Measure the voltage of the generator packets.

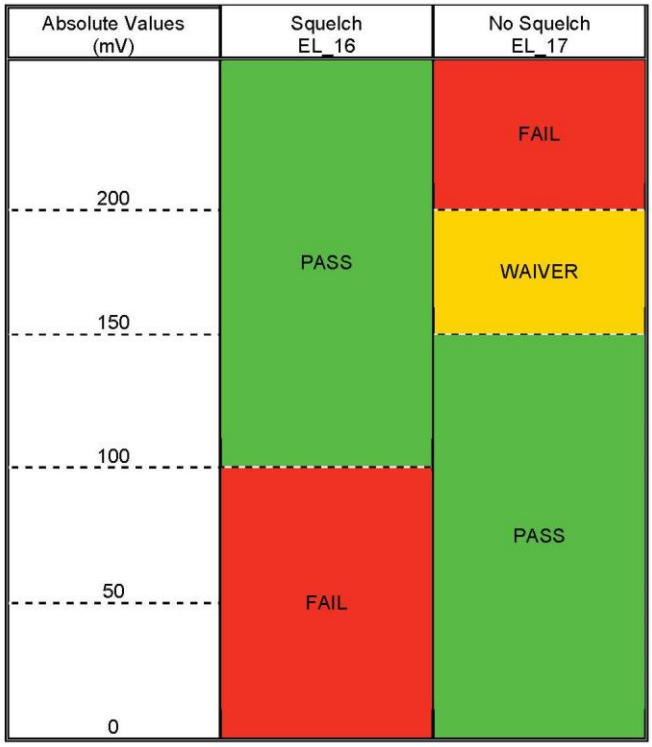
At the top

At the bottom

16. The voltage with highest absolute value is the value to record. When the value is lower than 150mV the result is PASS. When the voltage
    Note that products with captive cables and therefore could not be measured near end can end up with high values

Perform the Receiver Squelch (EL_16)

17. Proceed lowering the voltage of the generator till the device not respond to the IN_Token packets any more.



More info on the receiver measurement can be found at: http://www.testusb.com/HSRx.htm

4.1.8 Upstream Full Speed Signal Quality Test

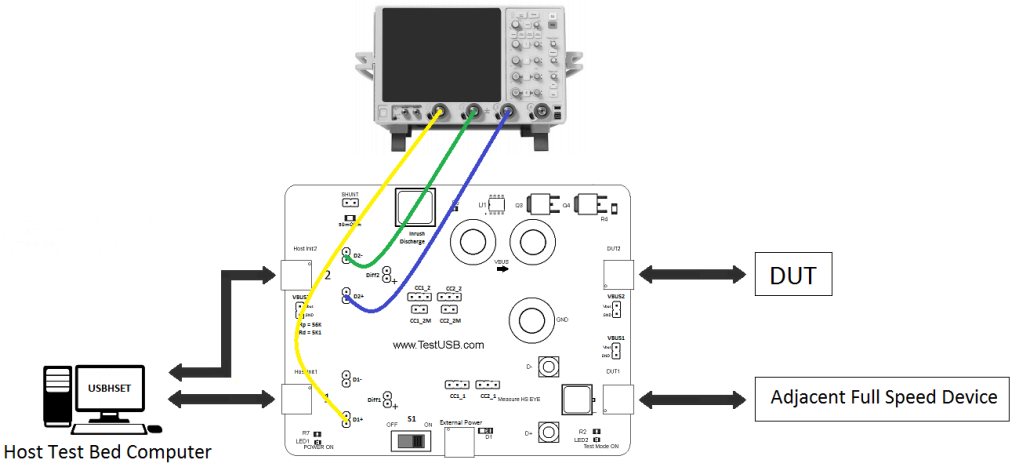
All USB 3.X and USB 2.0 devices must go through this this. Note that the tier of 5 hubs is not required anymore. All high and full speed devices must undergo this test. The following test can also be executed on devices with standard USB connectors.

4.1.8.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	
1	Oscilloscope USB software	USBET
3	Active probes	
1	Oscilloscope USB software	
1	Adjacent Device	Any certified USB2.0 Full Speed Device
1	Cable between Device under test and Device Hi-Speed Signal Quality Type-C™ test fixture	Cable to select depends on the device under test USB connector for: - Standard-B receptacle use 5m Type-C plug to B-plug cable (FS-HC-CP-500-BP) - Mini-B receptacle use 4.5m Type-C plug to Mini B-plug cable (FS-HC-CP-450-mBP) - Micro-B receptacle use 2m Type-C plug to Micro B-plug cable (FS-HC-CP-200-uBP) - Type-C use 4m Type-C plug to Type-C plug cable (FS-HC-CP-400-CP-1A) - Product with captive A-plug cable use 10cm Type-C plug to A-receptacle (FS-SS+C-CP-10-AR-3A)
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Device Hi-Speed Signal Quality Type-C™ test fixture	TestUSB FS-HUCR
1	5V power supply	Any USB 2.0 A-plug to B-plug cable that can take 5V from any USB host.
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org/developers/tools/usb20_tools/#usbhset OR http://www.usb.org/developers/tools/#sigHSETT
(*)	USB Hub	(*) check configurations in setup diagram
2	Cable between HUB/Host and FS-HUCR	FS-HC-CP-10-AP

4.1.8.2 Setup Diagram

Note that the tier of 5 hubs is not required anymore.



Connecting the Equipment

1. Attach the external power to EXT_POWER of the FS-HUCR. Leave the TEST switch at the OFF position. Verify the red Power LED is lit and the Test Mode LED is not lit.
2. Connect the Adjacent Device to DUT 1 side of the fixture
3. Connect the DUT to DUT 2 side of the fixture. Cable to select between DUT and the fixture depend on the USB connector on the DUT:
    a. Standard-B receptacle use
    5m Type-C plug to B-plug cable (FS-HC-CP-500-BP)
    b. Mini-B receptacle use
    4.5m Type-C plug to Mini B-plug cable (FS-HC-CP-450-mBP)
    c. Micro-B receptacle use
    2m Type-C plug to Micro B-plug cable (FS-HC-CP-200-uBP)
    d. Type-C
    4m Type-C plug to Type-C plug cable (FS-HC-CP-400-CP-1A)
    e. Product with captive cable use
    10cm Type-C plug to A-receptacle (FS-SS+C-CP-10-AR-3A)
4. Make the connection as defined in the above setup diagram (*) depending on DUT speed and USBHSET version.
5. Connect with the 10cm cable FS-HC-CP-10-AP to the fixture FS-HUCR at Host Init 1 and Host Init 2
6. Connect the active probe on Channel 2 to the D- pin at “2” of the FS-HUCR. Make sure the probe position is set properly.
7. Connect the active probe on Channel 3 to the D+ pin at “2” of the FS-HUCR. Make sure the probe position is set properly.
8. Connect the active probe on Channel 1 to the D+ pin at “1 “of the FS-HUCR.

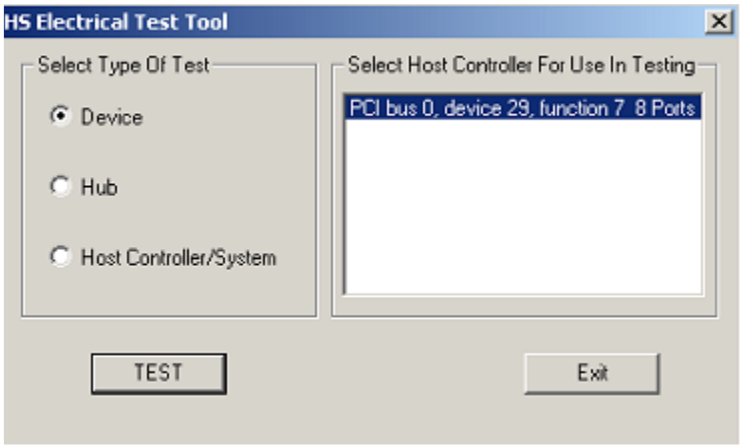
Make sure the probe position is set properly.

CC Jumper setting

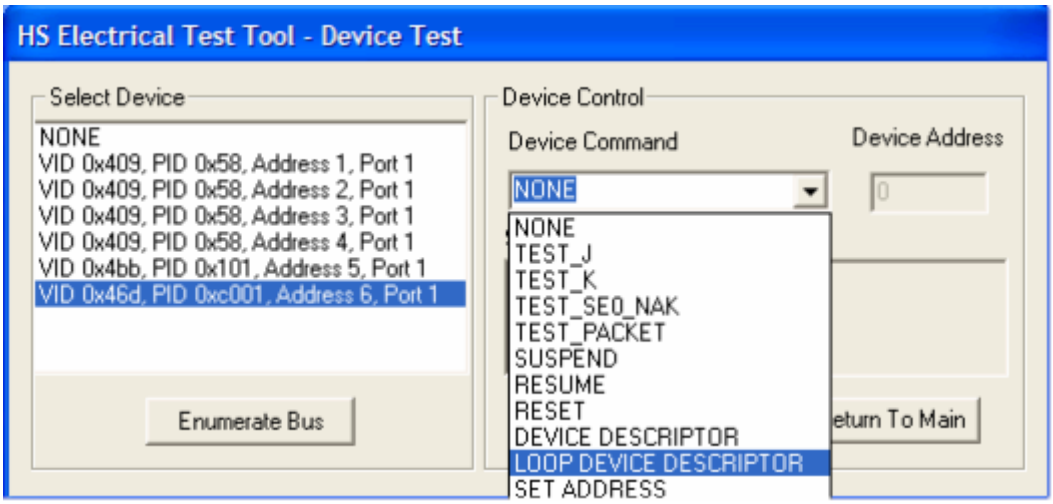
In normal circumstances no jumper should be place there the Rp is within the cable between Test Bed Computer.

4.1.8.3 Test Instructions

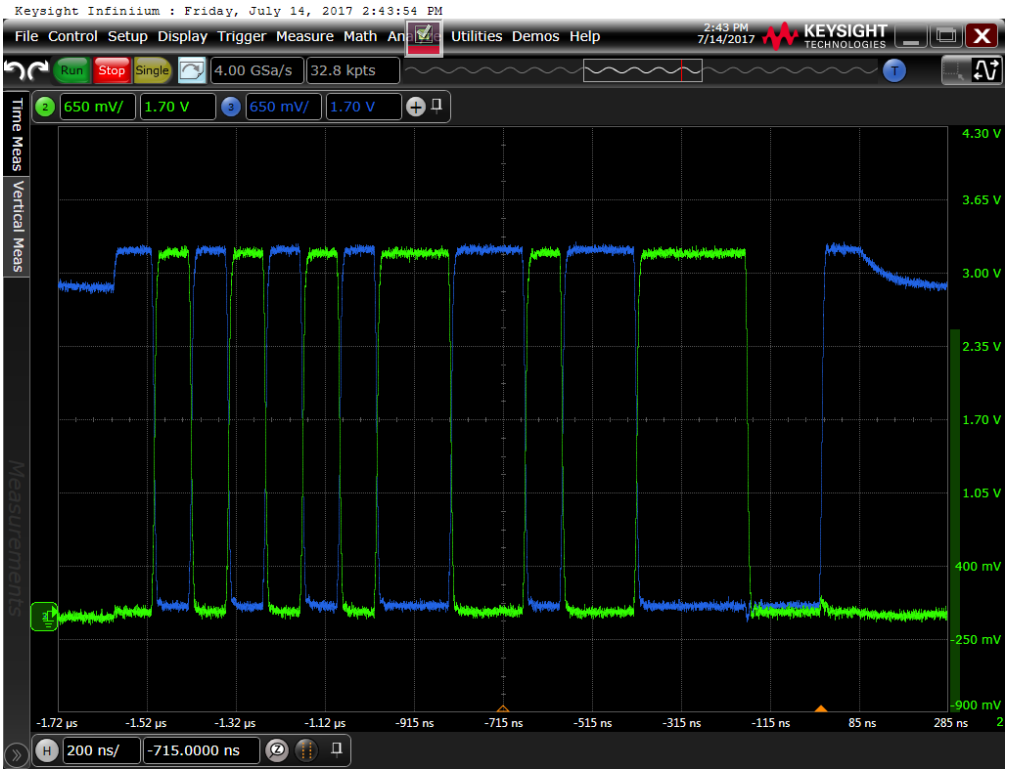
9. Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.
10. Select Device and click the [TEST] button to enter the Device Test menu.



11. The device under test should be enumerated with the device's VID shown together with the root port in which it is connected.
12. Select **LOOP DEVICE DESCRIPTOR** from the Device Command drop down menu and click **[EXECUTE]**. This forces the device under test to continuously transmit test packets.



13. You should see the transmitted test packet on the oscilloscope as below.



14. Follow the oscilloscope vendor steps in acquiring the signal eye diagram and calculating the below signal quality compliance test items

    EL_6 Rise Time

    EL_6 Fall Time

    EL_2 EL_4 EL_5 Data Eye and Mask Test

    EL_7 Non-Monotonic Edge Test

15. If device has USB Type-C™ connection flip/ reverse attach
16. Repeat Test Instructions step 9. till 14.

4.1.9 Upstream Inrush Current

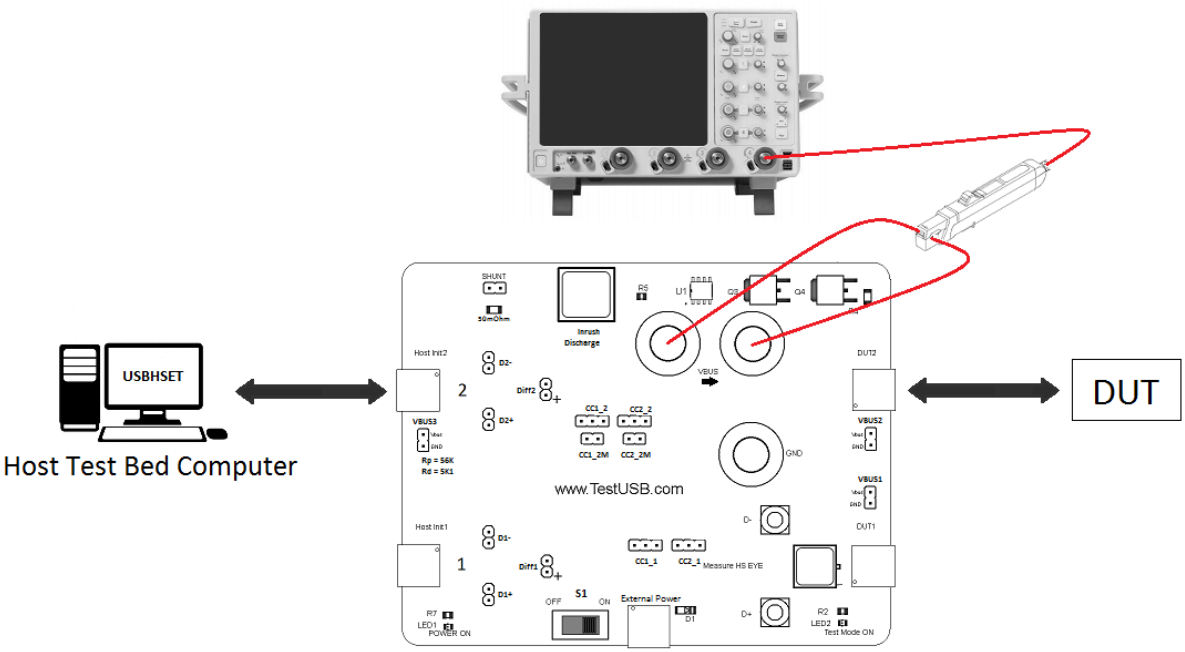
All devices must undergo this test. The following test can also be executed on devices with standard USB connectors.

The purpose of the test is to ensure that the current consumed due to bulk capacitance and peripheral startup does not cause a voltage drop below valid levels that causes other devices to drop out. For this measurement a current probe, scope and Inrush Current Test Fixture is needed. The scope should have a record time of 100ms at 1 Mega sample per second. The calculation of the Inrush can be made with USBET by saving the Inrush waveform as *.csv or *.tsv. Inrush current is measured for a minimum of 100 milliseconds after attach. Attach is defined as voltage rising to a valid level on the peripherals USB power line. Any current exceeding 100 mA during the 100ms interval is considered part of the inrush current event. The inrush current is divided into regions.
A region is an interval where the current exceeds 100 mA until the time the current falls below 100 mA for at least 100 us. There can be multiple inrush regions during the 100 ms period. Pass/Fail determination is done by the region having the highest charge value. The failures for Inrush mostly occur due to a too large capacity between Vbus and GND. The USB 2.0 Spec allows a maximum capacity of 10uF and therefore a maximum Inrush of 50uC.
Therefore, the total sum of capacity may not be higher that 10uF. Also, the device under test cannot consume more that 100mA during this 100ms of the start up. Common failures are that there is somewhere a to high capacitance on Vbus or that the device start consuming to much current in unconfigured state . Note that it is required to have at least a 1uF of capacity this in order to make ADP detection possible.
When doing the measurement make sure that you calibrate the current probe to 0mA before doing the measurement since a current probe will get quickly a DC offset that will result in a wrong measurement. It's also advisable to use the high resolution acquisition modes to reduce "the noise" on the signal

4.1.10 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope Keysight	
1	Oscilloscope USB software	Keysight N5416A/N5416B USB
1	Current probe	Current clamp OR diff probe over the 10mOhm shunt
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Device Hi-Speed Signal Quality Type-C™ test fixture	TestUSB FS-HUCR
1	USB Cable	
1	5V power supply	Any USB 2.0 A-plug to B-plug cable that can take 5V from any USB host.

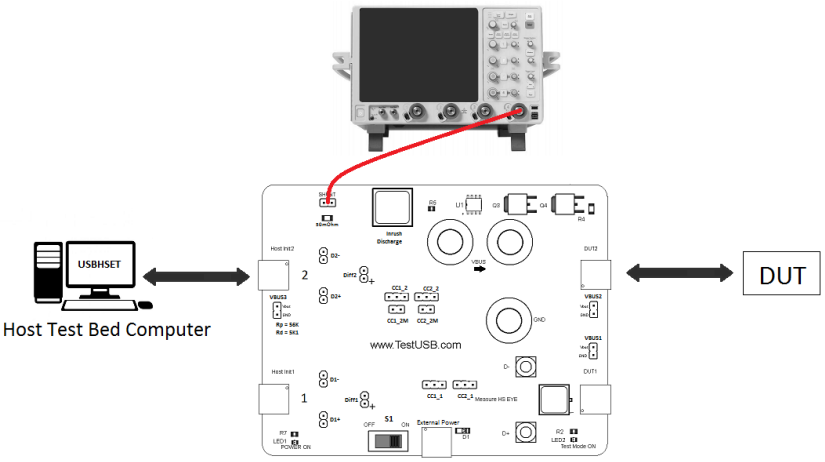
4.1.10.1 Setup Diagram current clamp



Connecting the Equipment

1. Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C™ receptacle fixture FS-HUCR. Verify the red POWER ON LED is lit.
2. Connect the DUT to DUT 2 side of the fixture.
3. Connect the Host Init 2 of the FS-HUCR to a Hi-speed capable port of the Test Bed Computer, using a USB cable.
4. Connect the current clamp on Channel 4 to the Vbus wire loop at VBUS of the FS-HUCR.

4.1.10.2 Setup Diagram current differential probe



Connecting the Equipment

1. Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0

Type-C™ receptacle fixture FS-HUCR. Verify the red POWER ON LED is lit.

2. Connect the DUT to DUT 2 side of the fixture.
3. Connect the Host Init 2 of the FS-HUCR to a Hi-speed capable port of the Test Bed Computer, using a USB cable.
4. Connect the current clamp on Channel 4 to the Vbus wire loop at VBUS of the FS-HUCR.

4.1.10.3 Test Instructions

5. Press and hold the Inrush Discharge switch of the FS-HUCR and hold for 10 seconds.
6. Release the Inrush Discharge switch of the FS-HUCR
7. You should see the Inrush current event on the oscilloscope as below (Please note that the inrush current peak may be larger or smaller)

8. Follow the oscilloscope vendor steps in acquiring Inrush current event and calculating the below compliance test item

Inrush Current

9. Flip/ reverse attach DUT USB Type-C™ connection on the DUT2 side of the FS-HUCR
10. Repeat Test Instructions from step 4.

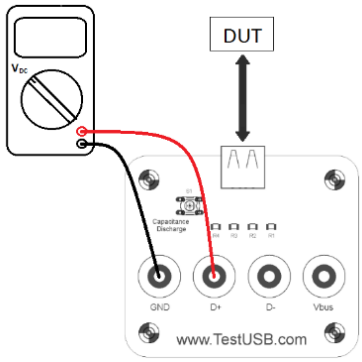
4.1.11 Upstream Back Voltage

All devices must undergo this test. The following test can also be executed on devices with standard USB connectors. No USB device shall supply current on VBUS at its upstream facing port at any time, a USB device may only draw current. The pull-up resistor D+ or D- may only become present when VBUS is High. This can be verified by measuring the Voltage over Vbus and GND, D+ and GND, D- and GND when the device is not connected with the Back Voltage fixture. This test must be performed twice, first before the device under test is enumerated and the second time after it has been enumerated. All values should remain below 400mV. A common failure is that self-powered devices put their pull-up resistor active even when Vbus is not detected. This will result in failure where the voltage is ~3V on the D+ for Full Speed and High Speed devices or on D- for a Low Speed device. Another common mistake is that some device that are self powered or battery powered drive back voltage on Vbus.

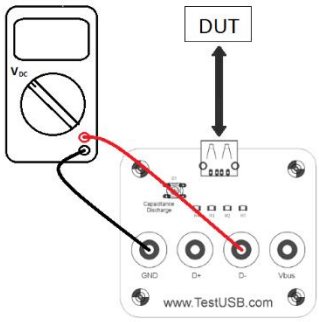
4.1.11.1 Equipment Used

Quantity	Item	Description/ Model
1	Digital Multimeter	
1	Cable between Device under test and back voltage fixture	Any USB cable that fit the device and back voltage fixture
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Device Back-Voltage test fixture	TestUSB FS-BV

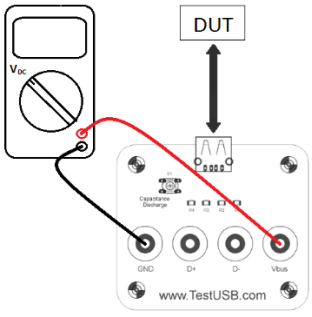
4.1.11.2 Setup Diagram



Vdc between D+ and GND



Vdc between D- and GND



Vdc between Vbus and GND

4.1.11.3 Test Instructions

Test Instructions part1

1. Apply power to the DUT
2. Connect the DUT to the Back Voltage fixture FS-BV with the corresponding USB Cable.
3. Using a DMM measure and record DC voltages between GND and Vbus, D+ and D-

Back Voltage before Enumeration – Type-C™ default position		
USB pin	**DC Voltage Before enumeration**	**Expected Value (VDC)**
Vbus		≤ 400mV
D+		≤ 400mV
D-		≤ 400mV

4. Flip/ reverse attach DUT USB Type-C™ connection on the Back Voltage fixture FS-BV if the device use USB Type-C™ connection.
5. Repeat Test Instructions Part 1 step 3 and record DC voltages between GND and Vbus, D+ and D-

Back Voltage before Enumeration – Type-C™ flip/ reverse attach position		
USB pin	**DC Voltage Before enumeration**	**Expected Value (VDC)**
Vbus		≤ 400mV
D+		≤ 400mV
D-		≤ 400mV

Test Instructions part 2

6. Connect the DUT into a known good host and verify proper enumeration.
7. Detach the DUT from the known good host and connect the DUT to the Back Voltage fixture FS-BV.
8. Using a DMM measure and record DC voltages between GND and Vbus, D+ and D-

Back Voltage after Enumeration – Type-C™ default position		
USB pin	**DC Voltage Before enumeration**	**Expected Value (VDC)**
Vbus		≤ 400mV
D+		≤ 400mV
D-		≤ 400mV

9. Flip/ reverse attach DUT USB Type-C™ connection on the Back Voltage fixture FS-BV
10. Repeat step 6. Till 8 .and record DC voltages between GND and Vbus, D+ and D-

Back Voltage after Enumeration – Type-C™ flip/ reverse attach position		
USB pin	**DC Voltage Before enumeration**	**Expected Value (VDC)**
Vbus		≤ 400mV
D+		≤ 400mV
D-		≤ 400mV

4.2 USB2.0 Downstream Electrical

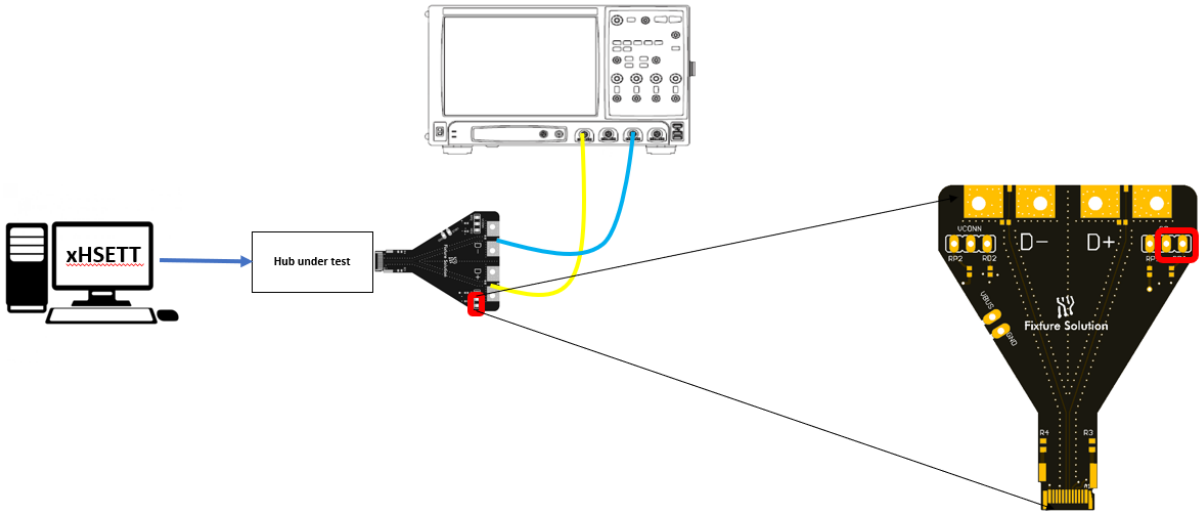
4.2.1 Downstream High Speed Signal Quality

This test is measuring the high speed downstream Signal Quality (EYE diagram). For this test the Hub need to send out the Test_Packet as defined in section 7.1.20 of the USB 2.0 specification. The USB-IF tool USBET will make the required analyses.

4.2.1.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	USB software	Check with scope vendor
2	BNC - SMA	e.g. Keysight 54855-67604
2	SMA Cables	Matched SMA Cable Pair
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Downstream Hi-Speed Signal Quality Type-C™ test fixture	TestUSB FS-HUCP
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org

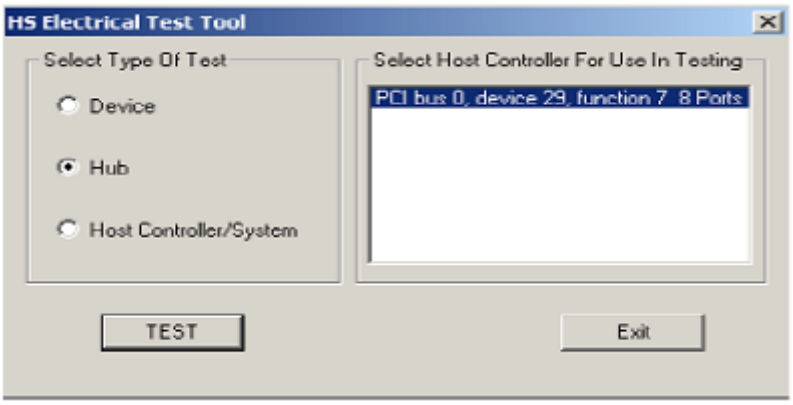
4.2.1.2 Setup Diagram



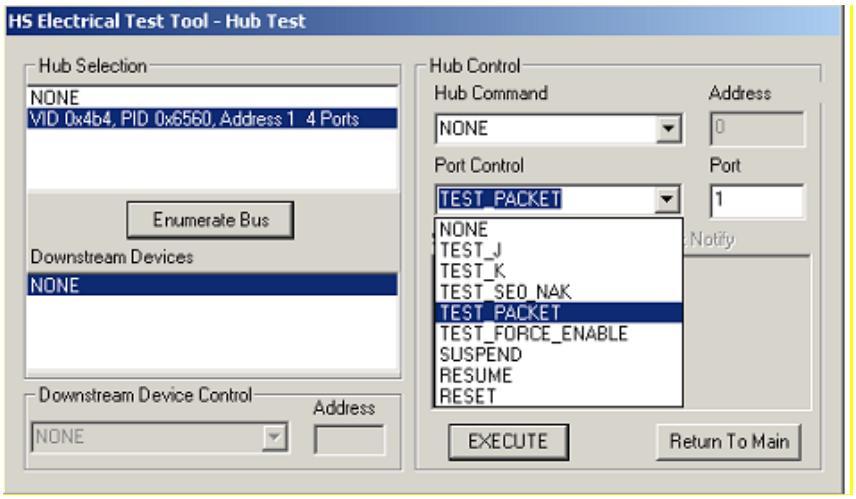
1. Connect the Hub under test upstream port to the Test Bed Computer running xHSETT, using a USB cable.
2. Attach the SMA cables to the SMA connectors D+ and D- on the USB2.0 Type-C™ plug test fixture FS-HUCP. In default D+ = Ch1 and D- = Ch3. It might be required to place jumper at Rd on CC of the FS-HUCP.

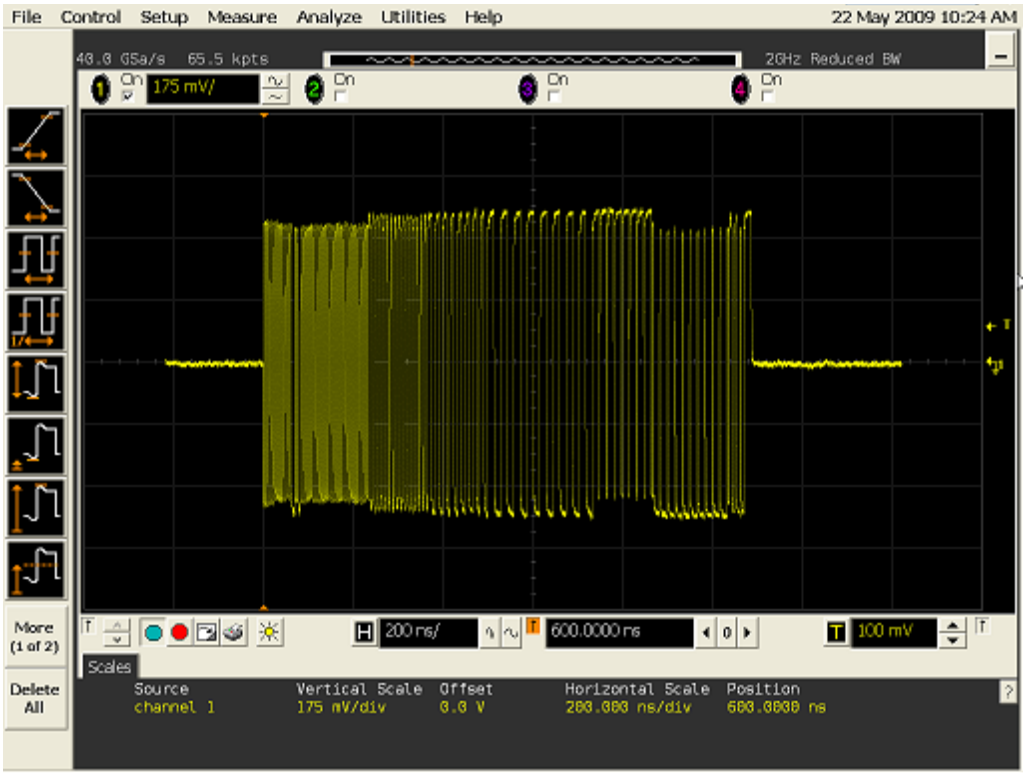
4.2.1.3 Test Instructions

3. Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.
4. Select Device and click the [TEST] button to enter the Hub Test menu.



5. The hub under test should be enumerated with the device's VID shown together with the root port in which it is connected.
6. Select TEST_PACKET from the Port Control drop down menu, enter Port number under test and click [EXECUTE]. This forces the downstream port under test to continuously transmit test packets.





7. Follow the oscilloscope vendor steps in acquiring the signal eye diagram and calculating the below signal quality compliance test items

   EL_6 Rise Time

   EL_6 Fall Time

   EL_2 EL_4 EL_5 Data Eye and Mask Test

   EL_7 Non-Monotonic Edge Test

8. For Type-C™ products the measurement need to be done in both positions so flip the fixture and repeat step 7.

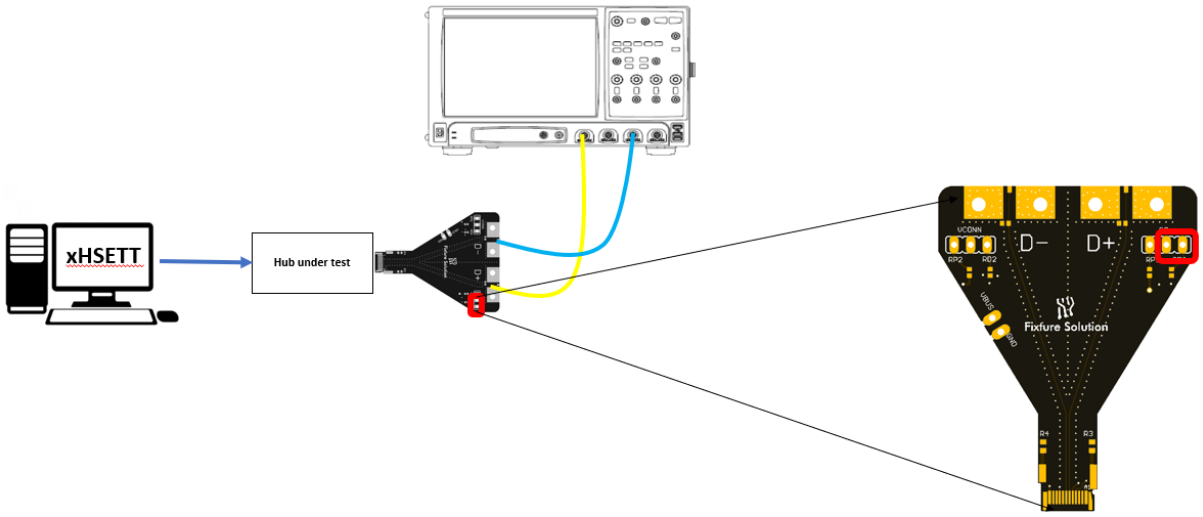
Repeat the above 4.2.1.3 Test Instructions for all accessible downstream ports.

4.2.2 Downstream High Speed Hub Jitter

4.2.2.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	USB software	Check with scope vendor
2	BNC - SMA	e.g. Keysight 54855-67604
2	SMA Cables	Matched SMA Cable Pair
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Downstream Hi-Speed Signal Quality Type-C™ test fixture	TestUSB FS-HUCP
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org

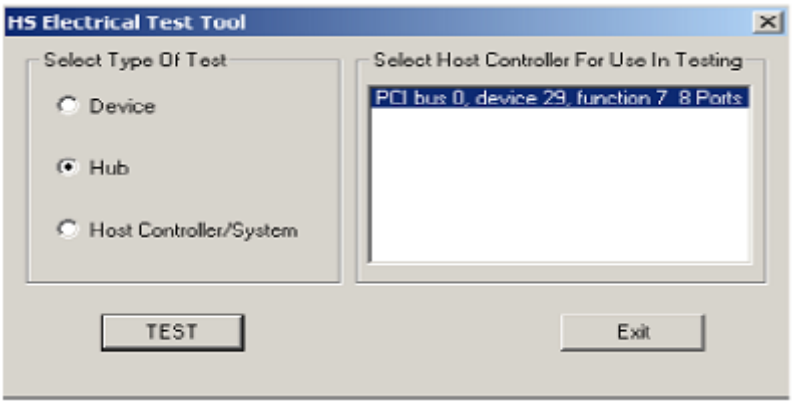
4.2.2.2 Setup Diagram



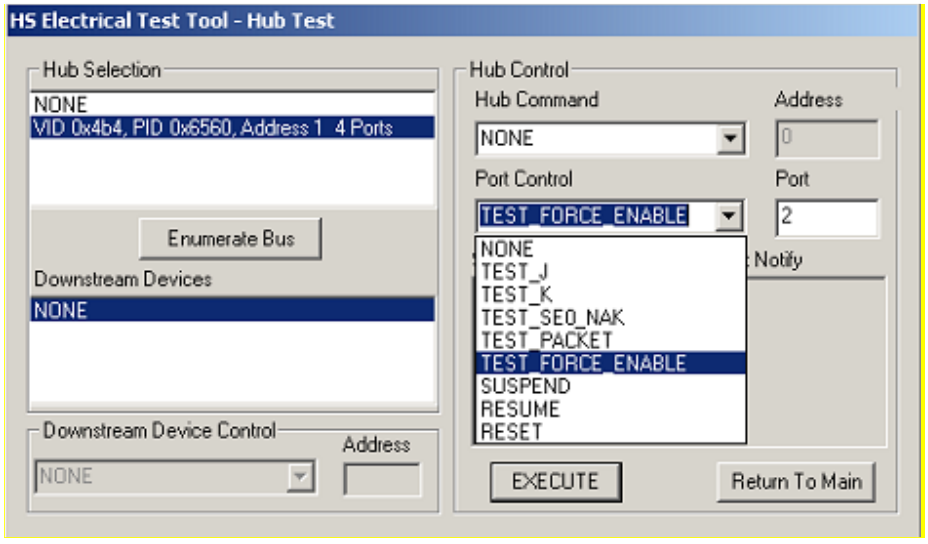
1. Connect the Hub under test upstream port to the Test Bed Computer running xHSETT, using a USB cable.
2. Attach the SMA cables to the SMA connectors D+ and D- on the USB2.0 Type-C™ plug test fixture FS-HUCP. In default D+ = Ch1 and D- = Ch3. It might be required to place jumper at Rd on CC of the FS-HUCP.

4.2.2.3 Test Instructions

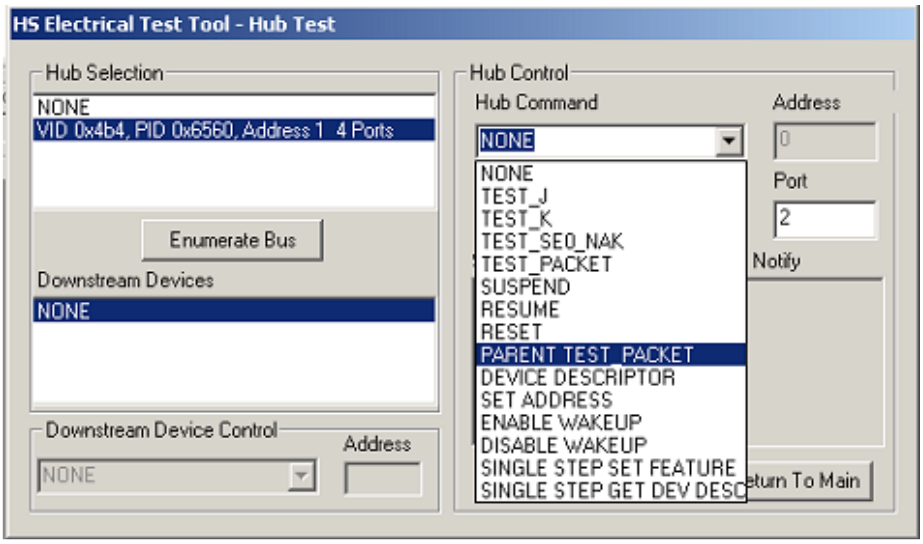
8. Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.
9. Select Hub and click the [TEST] button to enter the Hub Test menu.

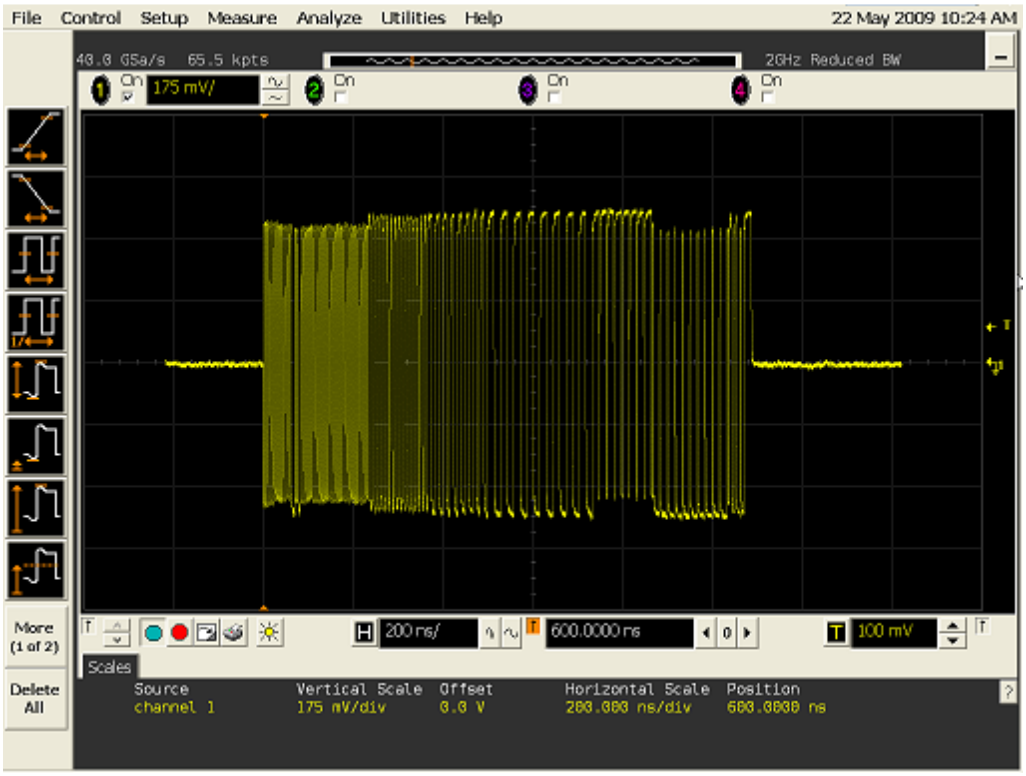


10. The hub under test should be enumerated with the device's VID shown together with the root port in which it is connected.
11. Select TEST_FORCE_ENABLE from the Port Control drop down menu, enter Port number under test and click [EXECUTE].



12. Select PERENT_TEST_PACKET from the Hub Command drop down menu and click [EXECUTE].





13. Follow the oscilloscope vendor steps in acquiring the signal eye diagram and calculating the below signal quality compliance test items

    EL_47

14. For Type-C™ products the measurement need to be done in both positions so flip the fixture and repeat step 13.

Repeat the above 4.2.2.1 Test Instructions for all accessible downstream ports.

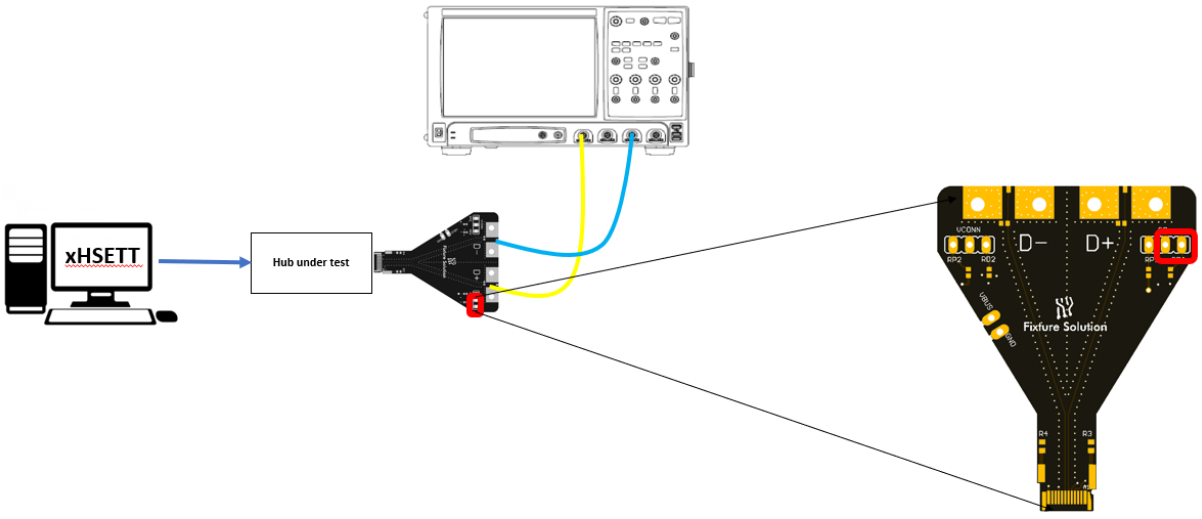
4.2.3 Downstream High Speed Test J/K, SE0_NAK

All high speed devices must undergo this test. The following test can also be executed on devices with standard USB connectors.

4.2.3.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	USB software	Check with scope vendor
2	BNC – SMA	e.g. Keysight 54855-67604
2	SMA Cables	Matched SMA Cable Pair
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Hi-Speed Signal Quality Type-C™ test fixture	TestUSB FS-HUCP
1	Cable between USBHSET PC and Hub under test.	any
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org

4.2.3.2 Setup Diagram



Connecting the Equipment

1. Connect the Hub under test upstream port to the Test Bed Computer running xHSETT, using a USB cable.
2. Attach the SMA cables to the SMA connectors D+ and D- on the USB2.0 Type-C™ plug test fixture FS-HUCP. In default D+ = Ch1 and D- = Ch3. It might be required to place jumper at Rd on CC of the FS-HUCP.

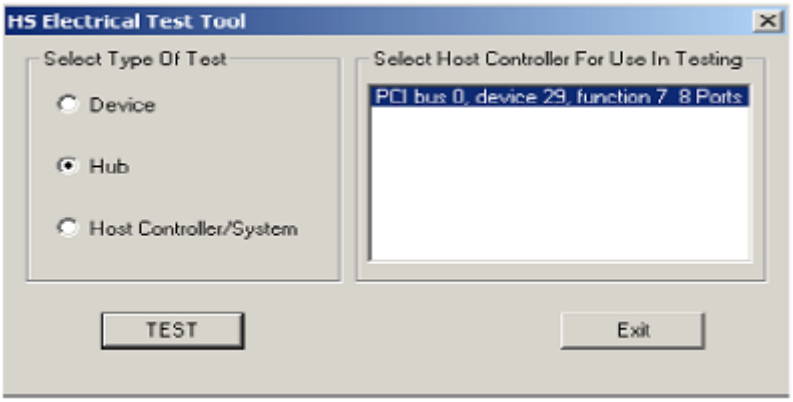
4.2.3.3 Test Instructions

Test Instructions EL_8 Test_J part

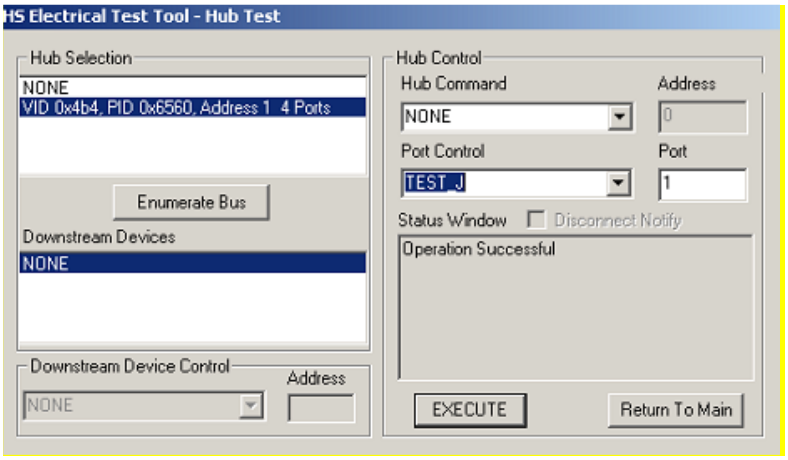
3. Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test

Bed computer.

4. Select Hub and click the [TEST] button to enter the Hub Test menu.



5. The hub under test should be enumerated with the device's VID shown together with the root port in which it is connected.
6. Select **TEST_J** from the Port Control drop down menu, enter Port number under test and click [EXECUTE].



7. The captured transition should be as in the figure below.

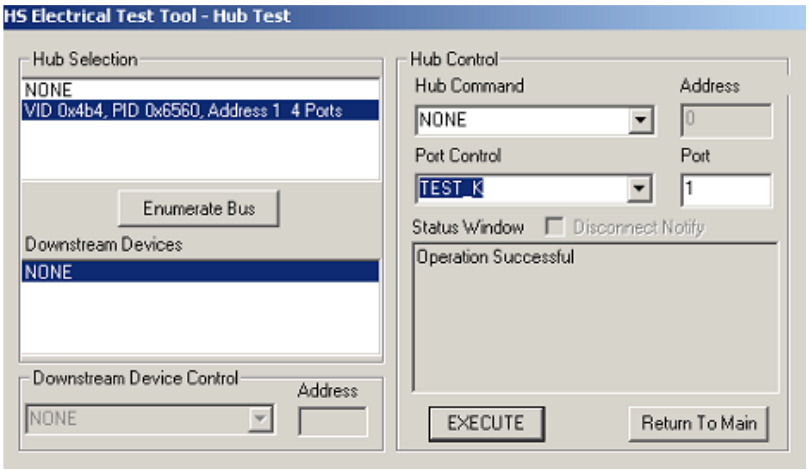
8. Follow the oscilloscope vendor steps in measuring the below compliance test items

EL_8 Test_J

9. Flip/reverse attach USB Type-C™ fixture and measure EL_8 Test_J again.
10. Power Cycle USB Device Under Test

Test Instructions EL_8 Test_K Part

11. On the Device Test Menu of the HS Electrical Test Tool, click [Enumerate Bus] once.
12. Select **TEST_K** from the Port Control drop down menu, enter Port number under test and click [EXECUTE].



13. The captured transition should be as in the figure below.

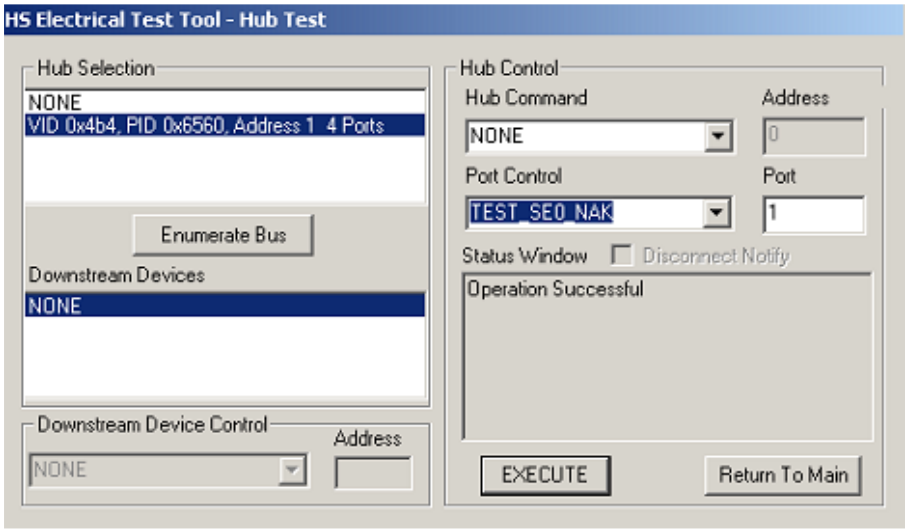
14. Follow the oscilloscope vendor steps in measuring the below compliance test items

EL_8 Test_K

15. Flip/reverse attach USB Type-C™ fixture and measure EL_8 Test_K again.
16. Power Cycle USB Device Under Test

Test Instructions EL_8 Test_SE0 Part

17. On the Device Test Menu of the HS Electrical Test Tool, click [Enumerate Bus] once.
18. Select **TEST_SE0_NAK** from the Port Control drop down menu, enter Port number under test and click [EXECUTE].



19. The captured transition should be as in the figure below.

20. Follow the oscilloscope vendor steps in measuring the below compliance test items

    EL_9 Test_SE0_NAK

21. Flip/reverse attach USB Type-C™ fixture and measure EL_9 Test_SE0_NAK again.
22. Power Cycle USB Device Under Test

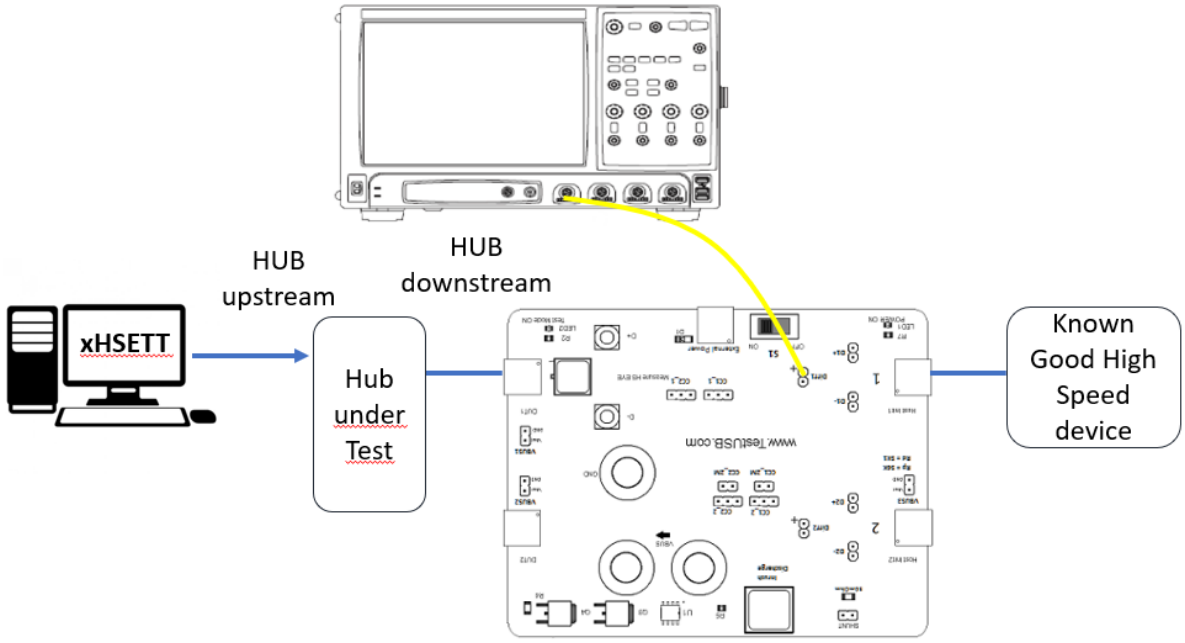
Repeat the above 4.2.2.3 Test Instructions for all accessible downstream ports.

4.2.4 Hub High Speed Packet Parameters - Downstream Facing Port

4.2.4.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	USB software	Check with scope vendor
1	Differential probe	Check with scope vendor
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Hi-Speed Signal Quality Type-C™ test fixture	TestUSB FS-HUCR
1	5V power supply	Any USB 2.0 A-plug to B-plug cable that can take 5V from any USB host.
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org
1	Known Good High Speed device	Any known good high speed device

4.2.4.2 Setup Diagram



Connecting the Equipment

1. Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C™ receptacle fixture FS-HUCR. Leave the TEST switch 'S1' at the OFF position. Verify the red POWER ON LED is lit and the Test Mode ON LED is not lit.
2. Connect the Hub upstream port to the Host running xHSETT.

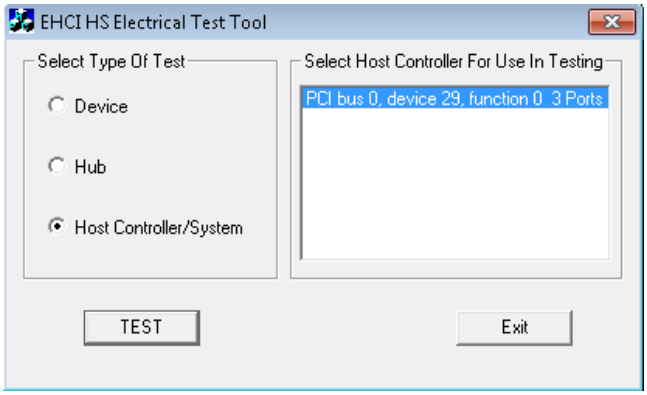
3. Connect the Hub downstream port to DUT 1 side of the fixture.
4. Connect the “Host Init 1” a known good high speed device.
5. Attach the differential probe to D+/D- of “1” on the test fixture.

CC Jumper setting

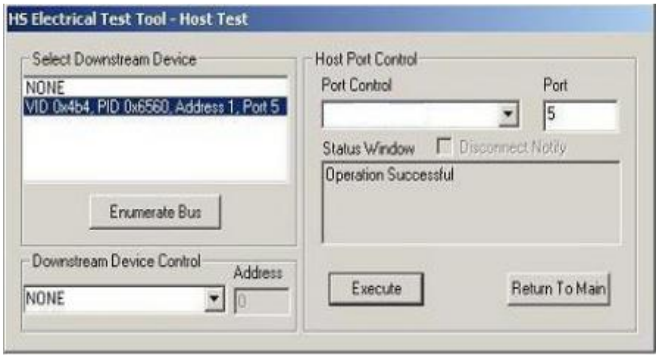
In normal circumstances no jumper should be placed.

4.2.4.3 Test Instructions

6. Exit the Hub Test menu of the HS Electrical Test Tool by clicking the [Return to Main] button.
7. From the HS Electrical Test Tool main menu select Host and click [TEST] to enter the Host Test.

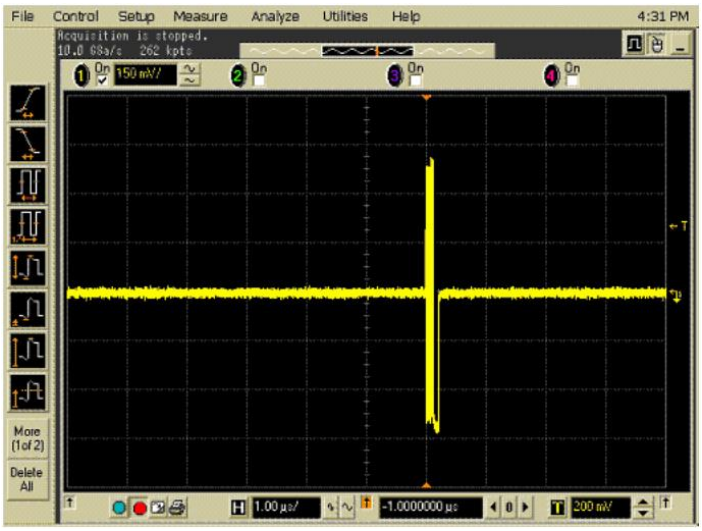


8. The Host Test menu of the HS Electrical Test Tool should appear as below.

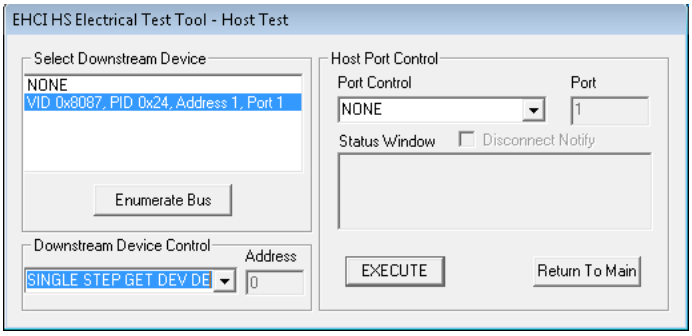


(If the hub is not visible it might be possible you need to flip the Type-C cable at DUT 1 or Host init 1 side)

9. Using the oscilloscope, verify the SOFs (Start Of Frame) packets are being transmitted on the port under test. You may need to lower the trigger level to somewhat below 400 mV.



10. In the Host Test menu of the HS Electrical Test Tool, ensure that the hub under test is selected.
11. Select SINGLE STEP GET DEV DESC from the Downstream Device Control Command window. Click [EXECUTE].



12. You should see the transmitted test packet on the oscilloscope as below.

13. Click OK to close the Test Instructions dialog.

EL_21 Sync Field Length Test EL_25 EOP Length Test

EL_25 EOP Length Test

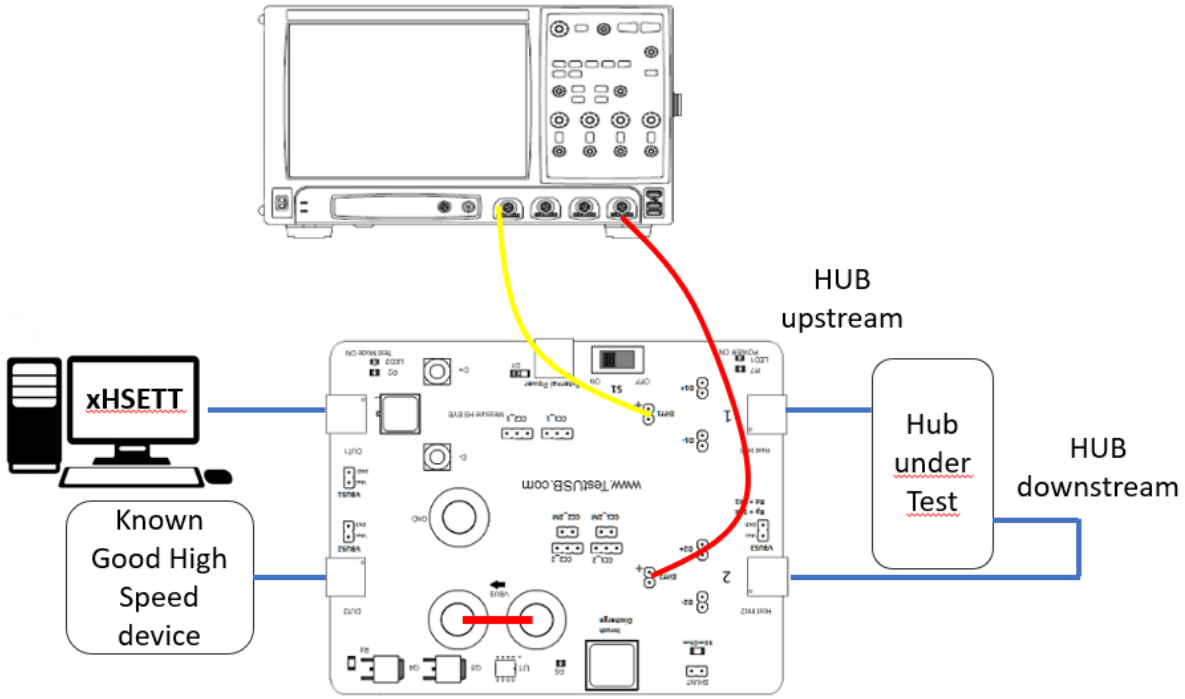
Repeat the above 4.2.4.3 Test Instructions for all accessible downstream ports.

4.2.5 Hub High Speed Repeater Test - Downstream Facing Port

4.2.5.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	USB software	Check with scope vendor
2	Differential probe	Check with scope vendor
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Hi-Speed Signal Quality Type-C™ test fixture	TestUSB FS-HUCR
1	5V power supply	Any USB 2.0 A-plug to B-plug cable that can take 5V from any USB host.
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org
1	Known Good High Speed device	Any known good high speed device

4.2.5.2 Setup Diagram



Connecting the Equipment

1. Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C™ receptacle fixture FS-HUCR. Leave the TEST switch 'S1' at the OFF position. Verify the red POWER ON LED is lit and the Test Mode ON LED is not lit.
2. Connect the DUT1 to the Host running xHSETT.
3. Connect the Hub upstream port to DUT 1 side of the fixture.
4. Connect to "Host Init 2" the Hub downstream port under test.

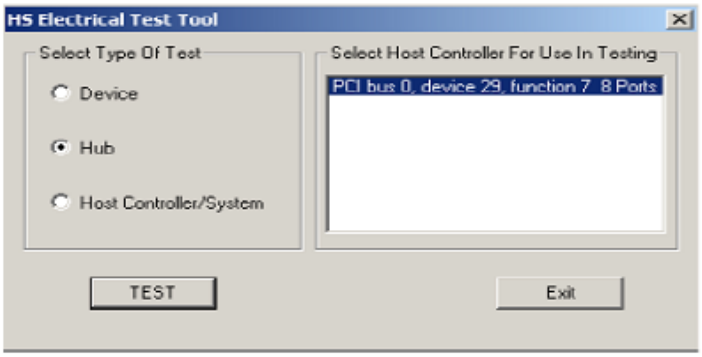
5. Connect to “DUT 2” a known good high speed device.
6. Attach the differential probes to Diff 1 and Diff 2on the test fixture.
7. Make sure the Vbus is shorted with the banana shortbar.

CC Jumper setting

In normal circumstances no jumper should be placed.

4.2.5.3 Test Instructions

8. Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.
9. Select Hub and click the [TEST] button to enter the Hub Test menu.



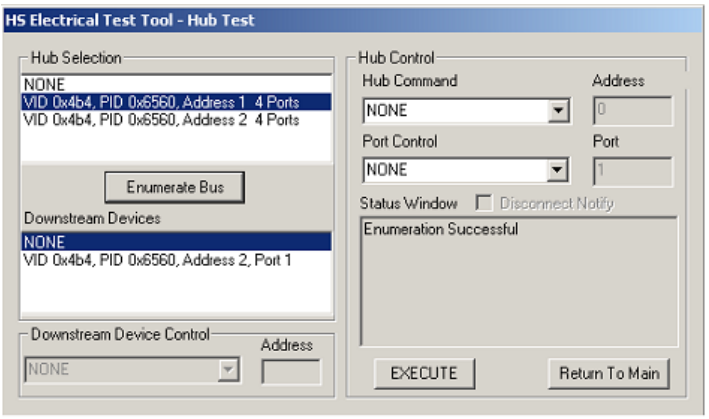
The USB automated test application will prompt you to perform these steps:

10. On the Hub Test menu of the HS Electrical Test Tool, click [Enumerate Bus] once.

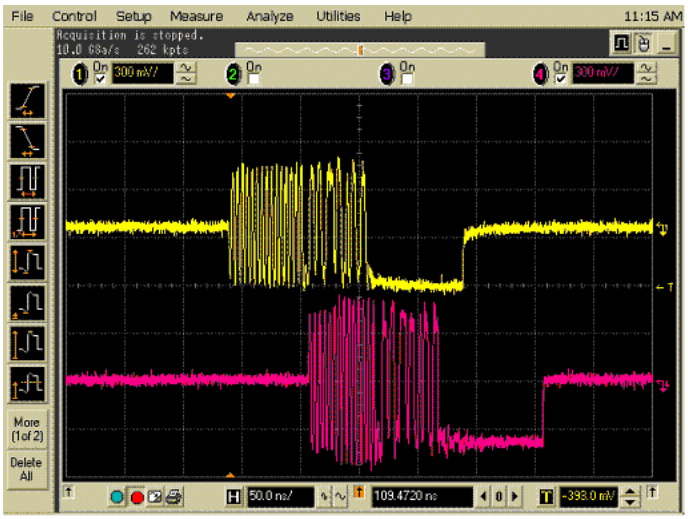
    a) The hub under test should be enumerated with the hub's VID shown together with the USB address.

    (If the hub is not visible it might be possible you need to flip the Type-C cable at DUT 1 or Host init 1 side)

    b) Likewise the known good device should be enumerated with its VID shown together with the hub port in which it is connected.



11. The captured transition should be as in the figure below.



12. Click OK to close the Test Instructions dialog.

EL_48 Measure Hub Downstream Delay
EL_42 EL_43 Measure Truncated Bits from Repeated SYNC Field
EL_44 EL_45 Measure Repeated EOP Width

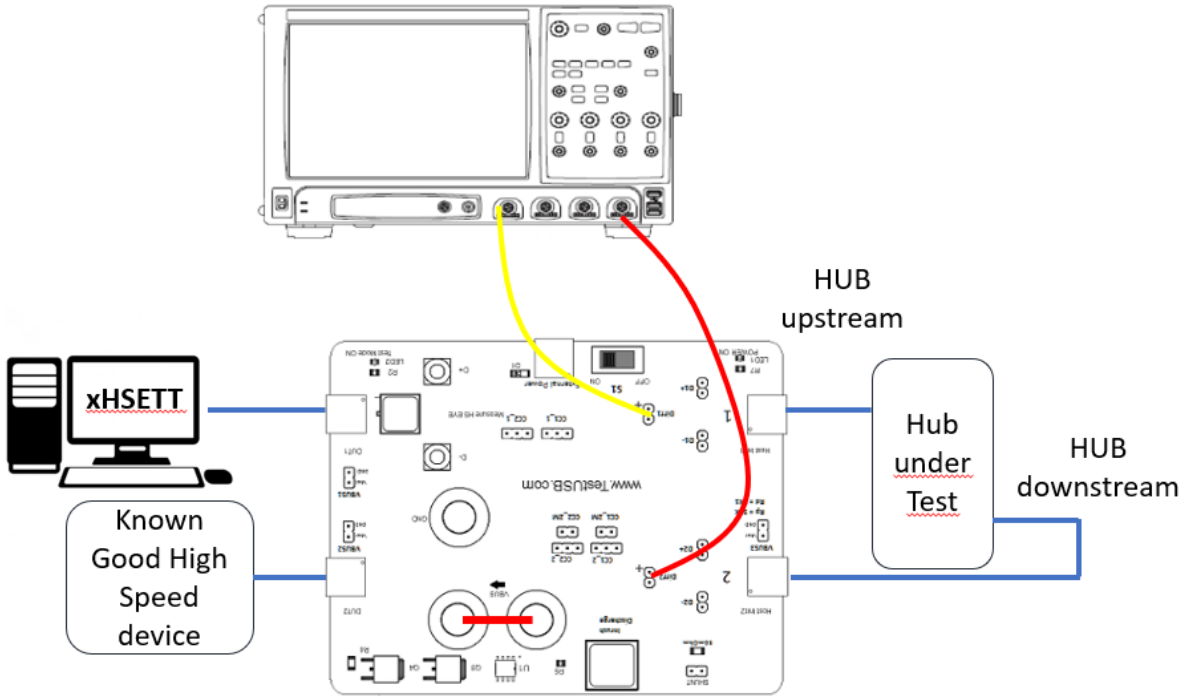
Repeat the above 4.2.5.3 Test Instructions for all accessible downstream ports.

4.2.6 Hub High Speed Repeater Test – Upstream Facing Port

4.2.6.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	USB software	Check with scope vendor
2	Differential probe	Check with scope vendor
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Hi-Speed Signal Quality Type-C™ test fixture	TestUSB FS-HUCR
1	5V power supply	Any USB 2.0 A-plug to B-plug cable that can take 5V from any USB host.
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org
1	Known Good High Speed device	Any known good high speed device

4.2.6.2 Setup Diagram



Connecting the Equipment

1. Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C™ receptacle fixture FS-HUCR. Leave the TEST switch 'S1' at the OFF position. Verify the red POWER ON LED is lit and the Test Mode ON LED is not lit.
2. Connect the DUT1 to the Host running xHSETT.
3. Connect the Hub upstream port to DUT 1 side of the fixture.

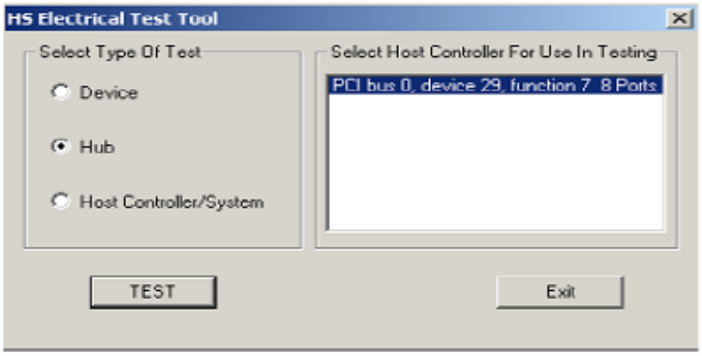
4. Connect to “Host Init 2” the Hub downstream port under test.
5. Connect to “DUT 2” a known good high speed device.
6. Attach the differential probes to Diff 1 and Diff 2on the test fixture.
7. Make sure the Vbus is shorted with the banana shortbar.

CC Jumper setting

In normal circumstances no jumper should be placed.

4.2.6.3 Test Instructions

8. Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.
9. Select Hub and click the [TEST] button to enter the Hub Test menu.



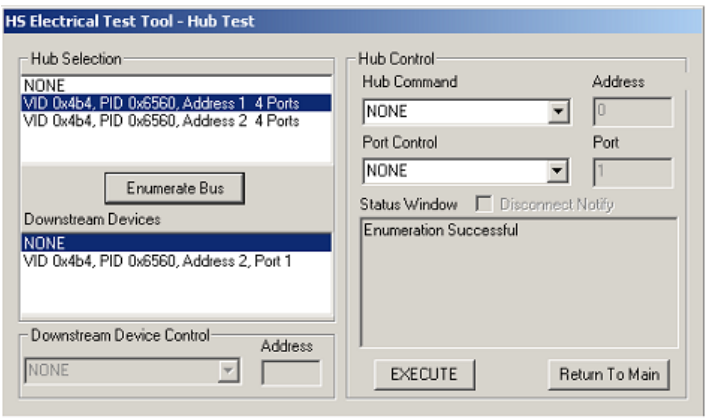
The USB automated test application will prompt you to perform these steps:

10. On the Hub Test menu of the HS Electrical Test Tool, click [Enumerate Bus] once.

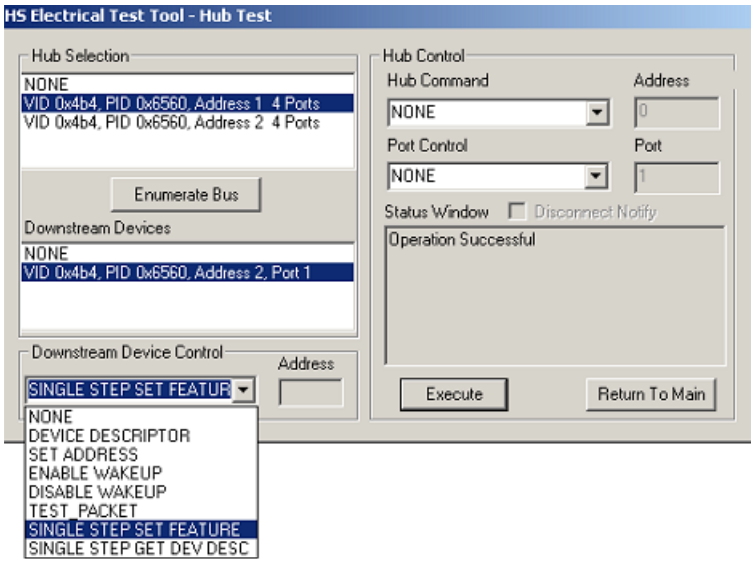
    a) The hub under test should be enumerated with the hub's VID shown together with the USB address.

    (If the hub is not visible it might be possible you need to flip the Type-C cable at DUT 1 or Host init 1 side)

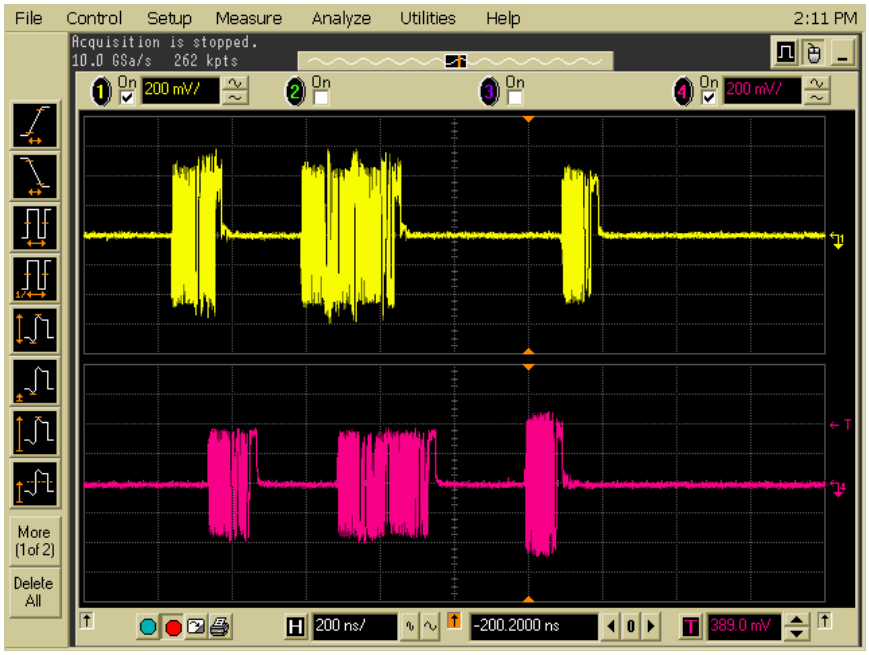
    b) Likewise the known good device should be enumerated with its VID shown together with the hub port in which it is connected.



11. On the Hub Test menu of the HS Electrical Test Tool, select SINGLE STEP SET FEATURE from the Downstream Device Control drop down menu and click [EXECUTE] once.



12. The captured transition should be as in the figure below.



13. Click OK to close the Test Instructions dialog.
    EL_42 EL_43 Measure Truncated Bits from Repeated SYNC Field
    EL_44 EL_45 Measure Repeated EOP Width

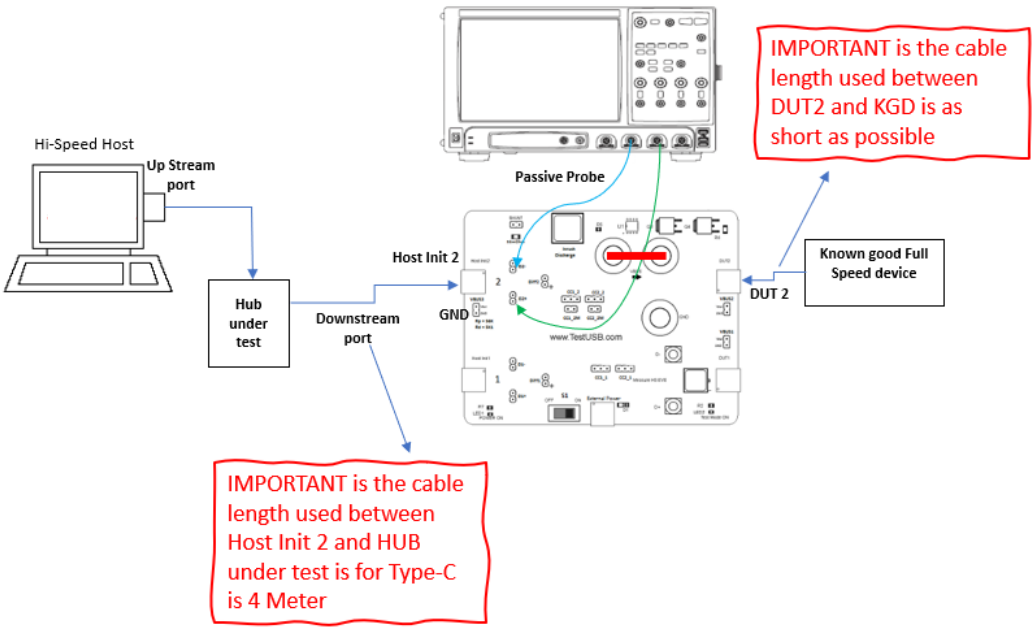
Repeat the above 4.2.6.3 Test Instructions for all accessible downstream ports.

4.2.7 Downstream Full Speed Signal Quality

4.2.7.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	Oscilloscope USB software	Check with scope vendor
2	Probes	Check with scope vendor
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Device Hi-Speed Signal Quality Type-C™ test fixture	TestUSB FS-HUCR
1	Cable between downstream Type-C port under test and Host init2 of test fixture.	4m Type-C plug to Type-C plug cable (FS-HC-CP-400-CP-1A)
1	Known good full speed device (KGD)	Any full speed device

4.2.7.2 Setup Diagram



Connecting the Equipment

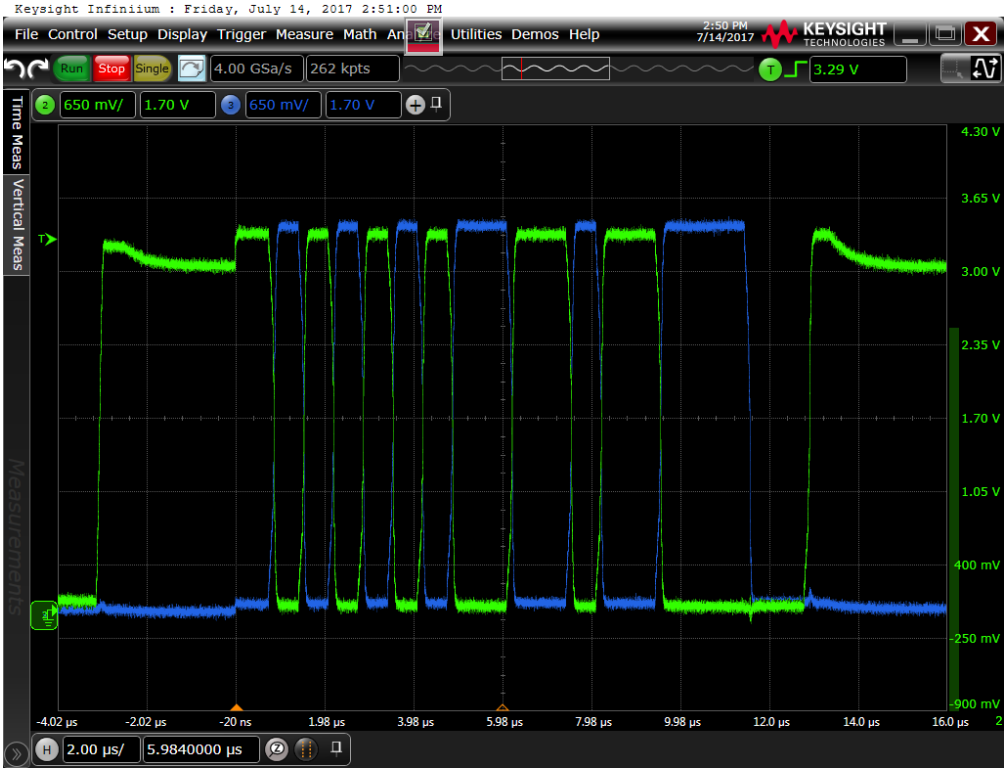
1. Connect the Hub upstream port to the Host running that enumerate the Hub. (xHSETT is not required)
2. Connect the Hub Type-C downstream port with 4m C to C cable (FS-HC-CP-400-CP-1A) to “Host Init 2” side of the fixture.
3. Connect with as short as possible cable to “DUT 2” a known good full speed device.
4. Attach the probes to D+ and D- on the test fixture.
5. Make sure the Vbus is shorted with the banana shortbar.

CC Jumper setting

In normal circumstances no jumper should be placed.

4.2.7.3 Test Instructions

6. Once the full speed device is enumerated the Hub downstream port should send SOF on the oscilloscope as below.
   (If the known good full speed device is not visible it might be possible you need to flip the Type-C cable at DUT2 or Host init 2 side)



7. Follow the oscilloscope vendor steps in acquiring the signal eye diagram and calculating the below signal quality compliance test items.

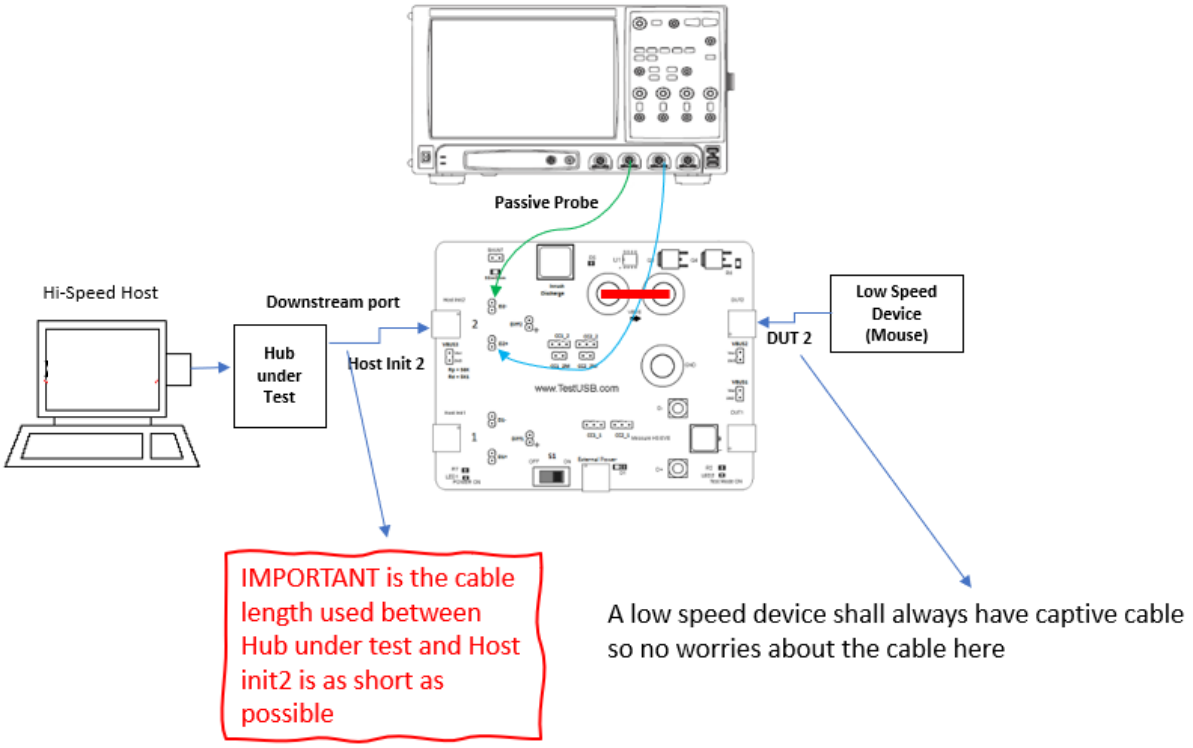
Repeat the above 4.2.7.3 Test Instructions for all accessible downstream ports.

4.2.8 Downstream Low Speed Signal Quality

4.2.8.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	Check with scope vendor
1	Oscilloscope USB software	Check with scope vendor
2	Probes	Check with scope vendor
1	Host test bed computer	Any computer with hi-speed or super speed USB ports
1	Device Hi-Speed Signal Quality Type-C™ test fixture	TestUSB FS-HUCR
1	USBHSET for EHCI software application OR USBHSET for XHCI software application	http://www.usb.org
1	Known good low speed device (KGD)	Any low speed device

4.2.8.2 Setup Diagram



Connecting the Equipment

1. Connect the Hub upstream port to the Host running that enumerate the Hub. (xHSETT is not required)
2. Connect the Hub Type-C downstream port with short to “Host Init 2” side of the fixture.
3. Connect the known low speed device with captive cable to “DUT 2”

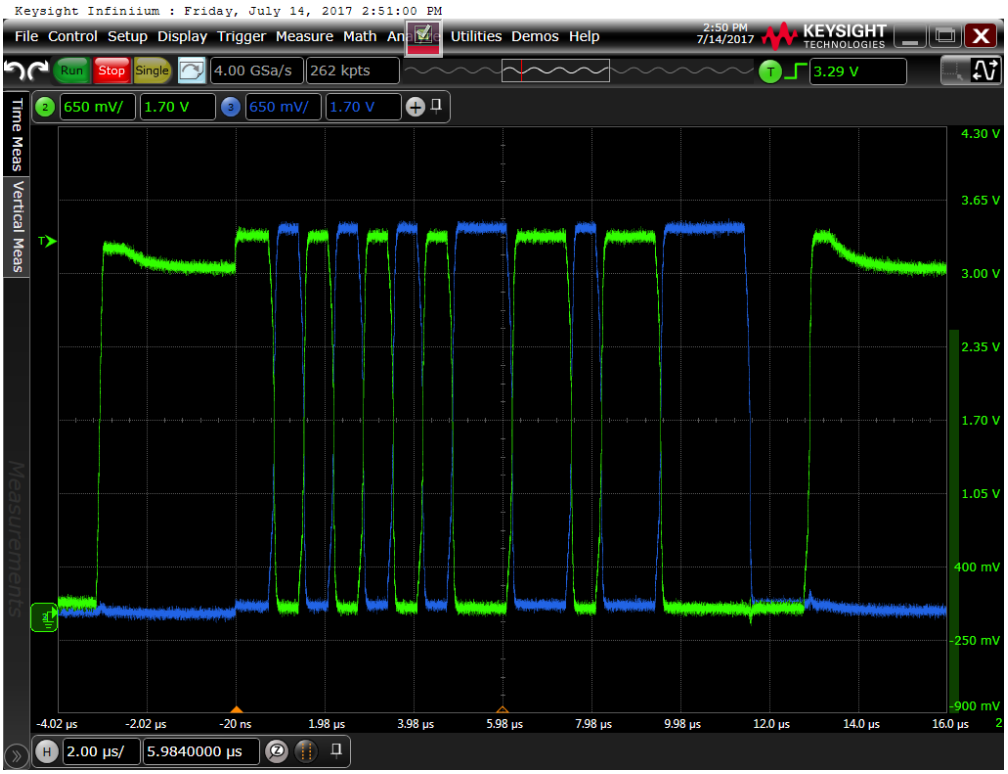
4. Attach the probes to D+ and D- on the test fixture.
5. Make sure the Vbus is shorted with the banana shortbar.

CC Jumper setting

In normal circumstances no jumper should be placed.

4.2.8.3 Test Instructions

6. Once the low speed device is enumerated activate the device (e.g. for mouse move the mouse).
   (If the known good low speed device is not visible it might be possible you need to flip the Type-C cable at DUT2 or Host init 2 side)



7. Follow the oscilloscope vendor steps in acquiring the signal eye diagram and calculating the below signal quality compliance test items.

Repeat the above 4.2.8.3 Test Instructions for all accessible downstream ports