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

Version 0.4 – 16 December 2021

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## 1. Reference

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

# 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 highspeed 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, <a href="http://www.usb.org/">http://www.usb.org/</a>

The High-Speed Electrical Test Tool Kit software contains a proprietary EHCl or xHCl driver stack. The Hi-speed Electrical Test Tool software requires the use of a proprietary EHCl or xHCl driver stack. The use of this proprietary EHCl or xHCl driver stack facilitates the electrical testing that requires direct control of the command registers of the USB EHCl host controllers. The end result much more robust test bed environment. Since the proprietary EHCl or xHCl driver stack is designed for debug and test validation purposes, this driver stack does not support the normal functionality as found in the EHCl or xHCl 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 EHCl or xHCl 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 EHCl or xHCl driver stack will automatically switch to the Microsoft EHCl or xHCl 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: <u>http://www.usb.org</u>

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<sup>™</sup> 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: <u>http://www.fixturesolution.com</u>

#### 3.3.2 USB 2.0 Device with Type-C<sup>™</sup> connector

Test fixture Description	Part number	High-Speed	Full/Low Speed
		Device	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: <u>http://www.fixturesolution.com</u>

#### 3.4 USB Cables

Cable Description	Required for device	Part number	Qty
USB 2.0 10cm Type-C <sup>™</sup> Plug to Standard A-plug	All devices	FS-HC-CP-10-P	2
USB 3.X 10cm Type-C <sup>™</sup> Plug to Standard A-receptacle	All devices	FS-SS+C-CP-10-AR-3A	2
USB 2.0 10cm Type-C <sup>™</sup> Plug to Standard C-plug	All devices	FS-HC-CP-10-CP	2
USB 2.0 500cm Type-C <sup>™</sup> Plug to Standard B-plug	with standard-B receptacle	FS-HC-CP-500-BP	1
USB 2.0 200cm Type-C <sup>™</sup> Plug to Standard micro B-plug	with micro-B receptacle	FS-HC-CP-200-uBP	1
USB 2.0 400cm Type-C <sup>™</sup> Plug to Standard Type-C <sup>™</sup> 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 <sup>™</sup> Plug to Standard A-plug	All devices	FS-HC-CP-150-AP	1
USB 2.0 10cm Type-C <sup>™</sup> Plug to Standard A-plug (No Rp)	For debug purpose	FS-HC-CPnRp-10-AP	1
USB 3.X 10cm Type-C <sup>™</sup> 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: <a href="http://www.fixturesolution.com/product-category/usb-cables/">http://www.fixturesolution.com/product-category/usb-cables/</a>

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

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<sup>™</sup> 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.

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	10cm Type-C™ plug to Type-C™ plug cable
	Hi-Speed Signal Quality Type-C <sup>™</sup> test fixture	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 <sup>™</sup> test	For devices with Type-C <sup>™</sup> plug or devices with Type-C <sup>™</sup> receptacle
	fixture	and bus-powered use:
		TestUSB FS-HUCR
		For device with Type-C <sup>™</sup> 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	FS-HC-CP-150-AP
	Signal Quality Type-C™ test fixture	
1	USBHSET for EHCI software application OR	http://www.usb.org
	USBHSET for XHCI software application	

#### 4.1.2 Equipment Used

4.1.2.1 Setup Diagram if Hub upstream has Type-C<sup>™</sup> receptacle and is self-powered If the DUT has a Type-C<sup>™</sup> receptacle and is self-powered the setup is as followed:



Connecting the Equipment – DUT has Type-C<sup>™</sup> 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.
- Attach the SMA cables to the SMA connectors D+ and D- on the USB2.0 Type-C<sup>™</sup> 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<sup>™</sup> 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<sup>™</sup> Hub



Connecting the Equipment

- Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C<sup>™</sup> 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<sup>™</sup> plug directly connect DUT to DUT1 (\*)
  - b. If device has a Type-C<sup>™</sup> 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.
- 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.

HS Electrical Test Tool	×
Select Type Of Test	Select Host Controller For Use In Testing
Device	PCI bus 0, device 29, function 7 8 Ports
C Hub	
C Host Controller/System	
TEST	Exit

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

Select Device NONE VID 0x4b4, PID 0x6830, Address 1, Port	5 Device Control Device Command TEST_PACKET	Device Address
	Status Window	
Enumerate Bus	EXECUTE	Return To Main

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<sup>™</sup> 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, SEONAK

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	10cm Type-C <sup>™</sup> plug to Type-C <sup>™</sup> plug cable
	Hi-Speed Signal Quality Type-C™ test fixture	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 <sup>™</sup> test fixture	For devices with Type-C <sup>™</sup> plug or devices with Type-C <sup>™</sup> 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

- Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C<sup>™</sup> 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<sup>™</sup> plug directly connect DUT to DUT1 (\*)
  - b. If device has a Type-C<sup>™</sup> 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.

HS Electrical Test Tool - Device Test		
Select Device	Device Control	
NONE	Device Command	Device Address
VID Ux4b4, PID Ux683U, Address 1, Port 5	TEST	0
	NONE TEST J	
	TEST_K TEST_SE0_NAK TEST_PACKET	
	SUSPEND	
Enumerate Bus	RESUME RESET DEVICE DESCRIPTOR LOOP DEVICE DESCRIPTOR	eturn To Main
	SET ADDRESS	
	DISABLE WAKEUP	
	SINGLE STEP SET FEATURE SINGLE STEP GET DEV DESC	

- 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.

Keysight Infi	niium : Fri	day, July 14,	2017 2:55:50	PM			.EE DM		
File Control S	etup Display	Trigger Measu	re Math An	Utilities	Demos Help	וֹר	14/2017		
うで Run Sto	P Single	4.00 GSa/s	62 kpts	~~~~	$\sim$	~~~~	∽∽∎∎	.29 V	. <b>↓</b>
1 Th 🗐 💶	100 mV/	298 mV 💿 🚺	L00 mV/ 298	3 mV 🕂	Ì				
									698 mV
									F00
verti									598 mv
<u>↓</u> <u></u> [									498 mV
leas									
									398 mV
<u> </u>									
<u>۳</u> ۳۲									
^									
<u>କ</u> ୍ଲୁମ୍   ୍ଥି									
* <b>r</b>									98.0 mV
			ani ya kata kata kata kata kata kata kata k						-2.0 mV
	00 00	20	1.00	2.00	7	00 000	12.0	140	-102 mV
	02 μs -2.02	5 9840000 us	1.98 µs	3.98 µs	5.98 µs 7.	98 hz - 3198 h	is 12.0 μs	14.0 µs	16.0 µs 3
Results	2.00 µ3/	3.3040000 µ3							
Measurement	Current	Mean	Min	Max	Range (Max-Mir	n) Std Dev	Count		
V avg(3)	11.4354 mV	11.4329 mV	11.1483 mV	11.7476 mV	599.25 µV	111.563 μV	383		
V avg(1)	422.053 mV	422.011 mV	421.699 mV	422.365 mV	666.48 μV	130.307 µV	383		

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<sup>™</sup> 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.

HS Electrical Test Tool - Device Test		
Select Device NDNE VID 0x4b4, PID 0x6830, Address 1, Port 5 Enumerate Bus	Device Control Device Command TEST_K NONE TEST_J TEST_SE0_NAK TEST_PACKET SUSPEND RESUME RESET DEVICE DESCRIPTOR LOOP DEVICE DESCRIPTOR SET ADDRESS ENABLE WAKEUP DISABLE WAKEUP DISABLE STEP SET FEATURE SINGLE STEP SET FEATURE SINGLE STEP GET DEV DESC	Device Address

- 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<sup>™</sup> 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 **SEO\_NAK** from the Device Command drop down menu. Click **[EXECUTE]** once to place the device into SEO\_NAK test mode.

HS Electrical Test Tool - Device Test		
Select Device NONE VID 0x4b4, PID 0x6830, Address 1, Port 5 Enumerate Bus	Device Control Device Command TEST_SEO_NAK NONE TEST_J TEST_K TEST_PACKET SUSPEND RESUME RESET DEVICE DESCRIPTOR LOOP DEVICE DESCRIPTOR SET ADDRESS ENABLE WAKEUP DISABLE WAKEUP SINGLE STEP SET FEATURE SINGLE STEP GET DEV DESC	Device Address

- 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.

Keysight Inf	iniium : F	riday, Ju	ly 14, 2	2017 2:57:	02 PM			2:56		Velout	
File Control	Setup Displ	ay Trigger	Measur	e Math Ar	utilities	Demos	Help	7/14/2			
	op Single	🦻 4.00 G	Sa/s 26	2 kpts		$\sim$			╧┛┓┓	.29 V	<b>Ω</b>
<u>↑</u> ि, ╡	100 mV/	298 mV	3 1	00 mV/ 2	298 mV 🕂	<b>p</b>					
											698 mV
ר <mark>ץ</mark> ' אַר											
											398 mV
Ու											
											298 1110
											198 mV
<b>.</b> ∿U   S											
											98.0 mV
Ĩ, S											-2.0 mV
	Ē										
	4.02.05	2.02.05	20 mc	1.09.00	2.09.05	5.08	7.09	0.09.05	120	140.05	-102 mV
	4.02 μs	5 9840	-20 hs	21.90 µs	5.96 µs	3.96 µs	7.90 µs	9.96 µs	12.0 µs	14.0 µS	10.0 µs
Results	2.00 µ3/	5.5640	300 μ3		<u> </u>						()
Measurement	Current		lean	Min	Max	Range (N	/lax-Min) St	d Dev Co	ount		
V avg(3)	6.26734 m	V 151.2	39 mV	5.75832 mV	424.500 mV	418.742	mV 196	.500 mV	809		
	0.50217 11	205.1				415.015					

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<sup>™</sup> 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 <sup>™</sup> plug or devices with Type-C <sup>™</sup> 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

- Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C<sup>™</sup> 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<sup>™</sup> 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.

HS Electrical Test Tool	×
Select Type Of Test	Select Host Controller For Use In Testing
Device	PCI bus 0, device 29, function 7 8 Ports
C Hub	
C Host Controller/System	
TEST	Exit

- 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]**.

HS Electrical Test Tool - Device Test		
Select Device NONE VID 0x4b4, PID 0x6560, Address 1, Port 5	Device Control Device Command NONE TEST_J TEST_K	Device Address
Enumerate Bus	TEST_SE0_NAK TEST_PACKET SUSPEND RESUME RESET DEVICE DESCRIPTOR LOOP DEVICE DESCRIPTOR SET ADDRESS	etum To Main
	ENABLE WAKEUP DISABLE WAKEUP SINGLE STEP SET FEATURE SINGLE STEP GET DEV DESC	

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.

HS Electrical Test Tool - Device Test	
Relect Device NONE VID 0x4b4, PID 0x6560, Address 1, Port 5	Device Control Device Command Device Address SINGLE STEP SET FEATU  Status Window Operation Successful
Enumerate Bus	Step Return To Main

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<sup>™</sup> 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 <sup>™</sup> plug or devices with Type-C <sup>™</sup> 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<sup>™</sup> 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<sup>™</sup> 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.
- 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.

HS Electrical Test Tool	×
Select Type Of Test	Select Host Controller For Use In Testing
• Device	PCI bus 0, device 29, function 7 8 Ports
C Hub	
C Host Controller/System	
TEST	Exit

- 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<sup>™</sup> 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 <sup>™</sup> plug or devices with Type-C <sup>™</sup> 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

- Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C<sup>™</sup> 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<sup>™</sup> 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.
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15 Electrical Test Tool	×
Select Type Of Test	Select Host Controller For Use In Testing
C Device	PCI bus 0, device 29, function 7 8 Ports
C Hub	
C Host Controller/System	
TEST	Exit

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

HS Electrical Test Tool - Device Test		
Select Device NONE VID 0x4b4, PID 0x6830, Address 1, Port 5	Device Control Device Command SUSPEND NONE TEST_J TEST_K TEST_SE0_NAK TEST_PACKET	Device Address
Enumerate Bus	SUSPEND RESUME RESET DEVICE DESCRIPTOR LOOP DEVICE DESCRIPTOR SET ADDRESS ENABLE WAKEUP DISABLE WAKEUP SINGLE STEP SET FEATURE SINGLE STEP GET DEV DESC	eturn To Main

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.

HS Electrical Test Tool - Device Test		
Select Device	Device Control	
NONE	Device Command	Device Address
VID 0x404, PID 0x6630, Address 1, Port 5	RESUME	0
	NONE TEST_J TEST_K TEST_SED_NAK	
	TEST_PACKET SUSPEND	
	RESUME	, I
Enumerate Bus	DEVICE DESCRIPTOR LOOP DEVICE DESCRIPTOR SET ADDRESS	eturn To Main
	ENABLE WAKEUP	
	SINGLE STEP SET FEATURE SINGLE STEP GET DEV DESC	

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

HS Electrical Test Tool - Device Test		
Select Device NONE VID 0x4b4, PID 0x6830, Address 1, Port 5 Enumerate Bus	Device Control Device Command  NONE TEST_J TEST_K TEST_SE0_NAK TEST_PACKET SUSPEND RESUME RES	Device Address
	DISABLE WAKEUP SINGLE STEP SET FEATURE SINGLE STEP GET DEV DESC	

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

 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.

HS Electrical Test Tool - Device Test		
Select Device NONE VID 0x4b4, PID 0x6830, Address 1, Port 5 Enumerate Bus	Device Control Device Command USUSPEND NONE TEST_J TEST_K TEST_SE0_NAK TEST_PACKET SUSPEND RESUME RESET DEVICE DESCRIPTOR LOOP DEVICE DESCRIPTOR LOOP DEVICE DESCRIPTOR SET ADDRESS ENABLE WAKEUP DISABLE WAKEUP SINGLE STEP SET FEATURE SINGLE STEP GET DEVIDESC	Device Address

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.

HS Electrical Test Tool - Device Test		
Select Device     Select Device     NONE     VID 0x4b4, PID 0x6830, Address 1, Port 5     Enumerate Bus	Device Control Device Command  FESE NONE TEST_J TEST_K TEST_SE0_NAK TEST_PACKET SUSPEND RESUME RESUM	Device Address
	SET ADDRESS ENABLE WAKEUP DISABLE WAKEUP SINGLE STEP SET FEATURE	
	SINGLE STEP GET DEV DESC	

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 <sup>™</sup> plug or devices with Type-C <sup>™</sup> 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<sup>™</sup> plug directly connect DUT to DUT
  - b. If device has a Type-C<sup>™</sup> 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.
- Select SEO\_NAK from the Device Command drop down menu. Click [EXECUTE] once to place the device into SEO\_NAK test mode.

HS Electrical Test Tool - Device Test		
Select Device NONE MID 0x4b4, PID 0x6830, Address 1, Port 5 Enumerate Bus	Device Control Device Command TEST_SEO_NAK NONE TEST_J TEST_K TEST_PACKET SUSPEND RESUME RESET DEVICE DESCRIPTOR LOOP DEVICE DESCRIPTOR SET ADDRESS ENABLE WAKEUP DISABLE WAKEUP SINGLE STEP SET FEATURE SINGLE STEP GET DEV DESC	Device Address

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.



Absolute Values (mV)	Squelch EL_16	No Squelch EL_17
200		FAIL
150	PASS	WAIVER
100		
50	FAIL	PASS
0		

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

# 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	Eq	lnib	me	nt	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 <sup>™</sup> 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

- 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 use4.5m 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.
- Connect with the 10cm cable FS-HC-CP-10-AP to the fixture FS-HUCR at Host Init 1 and Host Init 2
- 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.
- 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.

15 Electrical Test Tool	×
Select Type Of Test	Select Host Controller For Use In Testing
• Device	PCI bus 0, device 29, function 7 8 Ports
C Hub	
C Host Controller/System	
TEST	Exit

- 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.

HS Electrical Test Tool - Device Test		
Select Device NONE VID 0x409, PID 0x58, Address 1, Port 1 VID 0x409, PID 0x58, Address 2, Port 1 VID 0x409, PID 0x58, Address 3, Port 1 VID 0x409, PID 0x58, Address 4, Port 1 VID 0x4bb, PID 0x101, Address 5, Port 1 VID 0x46d, PID 0xc001, Address 6, Port 1	Device Control Device Command NONE TEST_J TEST_K TEST_SE0_NAK TEST_SE0_NAK TEST_PACKET SUSPEND	Device Address
Enumerate Bus	RESUME RESET DEVICE DESCRIPTOR LOOP DEVICE DESCRIPTOR SET ADDRESS	eturn To Main

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<sup>™</sup> 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

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 Equipment Used

4.1.10.1 Setup Diagram current clamp



#### Connecting the Equipment

- Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C<sup>™</sup> 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<sup>™</sup> 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<sup>™</sup> 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.

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

### 4.1.11.1 Equipment Used

## 4.1.11.2 Setup Diagram



## 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 <sup>™</sup> 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<sup>™</sup> connection on the Back Voltage fixture FS-BV if the device use USB Type-C<sup>™</sup> connection.
- Repeat Test Instructions Part 1 step 3 and record DC voltages between GND and Vbus, D+ and D-

Back Voltage before Enumeration – Type-C <sup>™</sup> flip/ reverse attach position			
USB pin	USB pin DC Voltage Before Expected Value		
enumeration (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<sup>™</sup> 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 <sup>™</sup> flip/ reverse attach position			
USB pin	DC Voltage Before	Expected Value	
	enumeration	(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.
- Attach the SMA cables to the SMA connectors D+ and D- on the USB2.0 Type-C<sup>™</sup> 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.

HS Electrical Test Tool - Hub Test	
Hub Selection NONE VID 0x4b4, PID 0x6560, Address 1 4 Ports	Hub Control Hub Command Address
Enumerate Bus	Port Control Port           Port Control         Port           Image: Im
Downstream Devices NONE	TEST_J TEST_K TEST_SE0_NAK TEST_SE0_NAK TEST_FORCE_ENABLE SUSPEND
Downstream Device Control Address	RESUME RESET EXECUTE Return To Main



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<sup>™</sup> 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.
- Attach the SMA cables to the SMA connectors D+ and D- on the USB2.0 Type-C<sup>™</sup> 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].

HS Electrical Test Tool - Hub Test	
Hub Selection NONE VID 0x4b4, PID 0x6560, Address 1 4 Ports	Hub Control Hub Command Address NONE
Enumerate Bus Downstream Devices NONE	Port Control Port  TEST_FORCE_ENABLE  NONE TEST_J TEST_K TEST_K TEST_SE0_NAK TEST_PACKET TEST_FORCE_ENABLE
Downstream Device Control NONE	SUSPEND RESUME RESET EXECUTE Return To Main

12. Select PERENT\_TEST\_PACKET from the Hub Command drop down menu and click [EXECUTE].

HS Electrical Test Tool - Hub Test	
Hub Selection NONE VID 0x4b4, PID 0x6560, Address 1 4 Ports	Hub Control Hub Command Address
Enumerate Bus Downstream Devices NONE	NONE TEST_J TEST_K TEST_SE0_NAK TEST_PACKET SUSPEND RESUME Notify
Downstream Device Control NONE	RESET PARENT TEST_PACKET DEVICE DESCRIPTOR SET ADDRESS ENABLE WAKEUP DISABLE WAKEUP SINGLE STEP SET FEATURE SINGLE STEP GET DEV DESC



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<sup>™</sup> 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	http://www.usb.org
	USBHSET for XHCI software application	

### 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.
- Attach the SMA cables to the SMA connectors D+ and D- on the USB2.0 Type-C<sup>™</sup> 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].

HS Electrical Test Tool - Hub Test	
Hub Selection NONE VID 0x4b4, PID 0x6560, Address 1 4 Ports	Hub Control Hub Command Address NONE   Part Centrol Bost
Enumerate Bus Downstream Devices NONE	Image: Status Window     Disconnect Notify       Operation Successful
Downstream Device Control Address	EXECUTE Return To Main

Keysight Inf	iniium : Fri	day, July 14,	2017 2:55:50	PM	_		2:55 PI		VSIGHT	
	setup Display	Trigger Measu	62 kpts		Demos He		7/14/20		HNOLOGIES	
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		20	1.08	2.09	E 08	7.08	0.02	120	14.0	-102 mV
	<ul> <li>2.00 μs/</li> </ul>	5.9840000 µs	<u>р</u>	3.50 µs	5.90 µs	7.50 µs	5.50 µs	12.0 µs	14.0 µs	100 µs
Results		(								$(\approx$
Measurement	Current	Mean	Min	Max	Range (Max-	Min) Std E	lev Cou	Int		
V avg(3)	11.4354 mV	11.4329 mV	11.1483 mV	11.7476 mV	599.25 µV	111.563	3μV 3	83		
• V avq(1)	422.053 mV	422.011 mV	421.099 mV	422.365 mV	000.48 μV	130.30	-µv 3	<u></u>		

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

EL\_8 Test\_J

- 9. Flip/reverse attach USB Type-C<sup>™</sup> 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].

Hub Selection	Hub Control Hub Command	Address
VID 0x4b4, PID 0x6560, Address 1 4 Ports	NONE	• 0
	Port Control	Port
Enumerate Bus	TEST_K	• 1
	Status Window 🔲 Disconn	ect Notify
NONE	Operation Successful	
Downstream Device Control		
NONE	EXECUTE	Beturn To Main

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										698 mV
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ft <sup>m</sup>										398 mV
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- V 8 🔮										-2.0 mV
	202	20	1.00	2.00	<b>F</b> 00	7.00	0.00	120	10	-102 mV
-4.02	2.00 us/	us -20 hs		3.96 µs	5.96 µs	7.96 µs	9.96 µs	12:0 µs 1	4.0 µs	10.0 µs
Results	(									
Measurement	Current	Mean	Min	Max	Range (Max-M	/lin) Std D	ev Count			
V avq(3)	424.166 mV	184.275 mV	11.1483 mV	424.500 mV	413.352 mV	203.762	2 mV 659			
2 V avq(1)	12.1412 mV	250.313 mV	11.8121 mV	422.365 mV	410.553 mV	202.414	1 mV 659			

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

### EL\_8 Test\_K

- 15. Flip/reverse attach USB Type-C<sup>™</sup> 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\_SEO\_NAK** from the Port Control drop down menu, enter Port number under test and click [EXECUTE].

HS Electrical Test Tool - Hub Test	
Hub Selection NONE VID 0x4b4, PID 0x6560, Address 1 4 Ports	Hub Control Hub Command Address NONE
Enumerate Bus	Port Control Port           Port Control         Port           TEST_SE0_NAK         1           Status Window         Disconnect Notify
Downstream Devices NONE	Operation Successful
Downstream Device Control Address	EXECUTE Return To Main

Keysight Infir	niium : Frid	ay, July 14,	2017 2:57:02	PM						
File Control Se	tup Display	Trigger Measu	re Math Ana	🗹 e Utilities	Demos He	lp	2:56 PM 7/14/201		INOLOGIES	
	Single	4.00 GSa/s	62 kpts	$\sim \sim \sim$	$\sim$		~~~~	─	29 V	1 A
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	2.00 µs/	5.9840000 µs								
Kesuits	Current	Maan	Min	Max	Paper (Max	Min) Std		nt	_	e
V avg(3)	6.26734 mV	151.239 mV	5.75832 mV	424.500 mV	418.742 mV	196.50	0 mV _80	)9		
V avg(1)	6.90217 mV	205.163 mV	6.55244 mV	422.365 mV	415.813 mV	205.74	8 mV 80	)9		

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<sup>™</sup> fixture and measure EL\_9 Test\_SEO\_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

- Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C<sup>™</sup> 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.

🛃 EHCI HS Electrical Test Tool 👘	
Select Type Of Test	Select Host Controller For Use In Testing
C Device	PCI bus 0, device 29, function 0 3 Ports
C Hub	
Host Controller/System	
TEST	Exit

8. The Host Test menu of the HS Electrical Test Tool should appear as below. H5 Electrical Test Tool - Host Test

NONE VID 0x454, PID 0x6560, Address 1, Port 5	Port Control	Port
Enumerate Bus	Status Window III Dis Operation Successful	sconnect Notily
Downstream Device Control Address	Execute	Return To Main

(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.

File	Control	Setup	Measure	Analyze	Utilities	Help			4:31 PM
	Requisit 10.0 SSa	ion is st v/s 262	opped. kpts						1 e _
	0 9	150 mW/	2	2 00		0 P		0 Pn	
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+									
++-						(-1,0-1,0-1,0) = 1,0 <sup>-1</sup> 1,0-1,0 <sup>-1</sup> 1			COCOTATION
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- 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].

EHCI HS Electrical Test Tool - Host Test		
Select Downstream Device NONE VID 0x8087, PID 0x24, Address 1, Port 1	Host Port Control Port Control NONE Status Window	Pott I Disconnect Notify
Enumerate Bus		
Downstream Device Control Address	EXECUTE	Return To Main

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	http://www.usb.org
	OR USBHSET for XHCI software application	
1	Known Good High Speed device	Any known good high speed device

#### 4.2.5.2 Setup Diagram



Connecting the Equipment

- Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C<sup>™</sup> 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.

HS Electrical Test Tool	×
Select Type Of Test	Select Host Controller For Use In Testing
C Device	PCI bus 0, device 29, function 7 8 Ports
Hub	
C Host Controller/System	
TEST	Exit

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.

HS Electrical Test Tool - Hub Test		
Hub Selection NONE VID 0x454, PID 0x5560, Address 1, 4 Ports VID 0x454, PID 0x5550, Address 2, 4 Ports	Hub Control Hub Command NONE	Address
Enumerate Pue	Port Control	Port
Downstream Devices NONE VID 0x4b4, PID 0x6560, Address 2, Port 1	Status Window 📃 Disconne Enumeration Successful	st Natify
Drivenstream Device Control		
NONE	EXECUTE	Return To Main



12. Click OK to close the Test Instructions dialog.

EL\_48 Measure Hub Downstream DelayEL\_42 EL\_43 Measure Truncated Bits from Repeated SYNC FieldEL\_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	http://www.usb.org
	OR USBHSET for XHCI software application	
1	Known Good High Speed device	Any known good high speed device

#### 4.2.6.2 Setup Diagram



Connecting the Equipment

- Attach USB cable (A-plug to B-plug cable) to External Power of the USB2.0 Type-C<sup>™</sup> 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.

HS Electrical Test Tool	×
Select Type Of Test	Select Host Controller For Use In Testing
C Device	PCI bus 0, device 29, function 7-8 Ports
Hub	
C Host Controller/System	
TEST	Exit

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.

is Electrical Test Tool - Hub Test			
Hub Selection	Hub Control		
NONE	Hub Command	Address	
VID 0x4b4, PID 0x6560, Address 1 4 Ports VID 0x4b4, PID 0x6560, Address 2 4 Ports	NONE	0	
	Port Control	Port	
Enumerate Rue	NONE	1	
Enumerate bus	Status Window 🔲 Disconnect Notify		
Downstream Devices	Enumeration Successful		
NONE			
VID 0x404, PID 0x6560, Address 2, Poit 1			
Downstream Device Control Address	1		
NONE	EXECUTE	eturn To Main	
		- and the shall	

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.

HS Electrical Test Tool - Hub Test		
Hub Selection	- Hub Control	
NONE	Hub Command	Address
VID 0x4b4, PID 0x6560, Address 1 4 Ports VID 0x4b4, PID 0x6560, Address 2 4 Ports	NONE	▼ 0
	Port Control	Port
Enumerate Rux	NONE	▼ 1
Downstream Devices	Status Window 🔲 Dis	connect Notify
NONE	Operation Successful	
VID 0x4b4, PID 0x6560, Address 2, Port 1		
Downstream Device Control		
SINGLE STEP SET FEATUR	Execute	Beturn To Main
NONE	Lincourte	
SET ADDRESS		
ENABLE WAKEUP DISABLE WAKEUP		
TEST_PACKET		
SINGLE STEP GET DEV DESC		

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



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	ltem	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

- 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	ltem	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

- 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