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

Version 0.86 - 9 September 2018

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1. Reference

Standard	Description	Revision	Status
USB 2.0 Spec	USB 2.0 Specification with ECN	2.0	Released
OTG & EH Supplement 2.0			Released
OTG & EH Compliance Plan			Released
USB 2.0 Electrical Test Specification		1.06	Released
PIDVID USB 2 0 High Speed Electrical Embedded Host	PIDVID USB 2 0 High Speed Electrical Embedded Host and OTG MOI	1.0	Released
USB2.0, 3.x and Battery Charging 1.2 Drop Droop Load Board	USB2.0/3.2/BC1.2 Drop Droop Test for non-USB Type-C™ Products	1.4.1	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 Embedded Hosts. Device, Hub, Windows based Host are covered in another document.

The High-speed Electrical Compliance Test Procedures verify the electrical requirements of high-speed USB operation of these embedded hosts 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 USB 3.1 Super Speed (5Gb or 10Gb) embedded hosts, since they need to be backward compatible with USB 2.0.

3. Required equipment and software

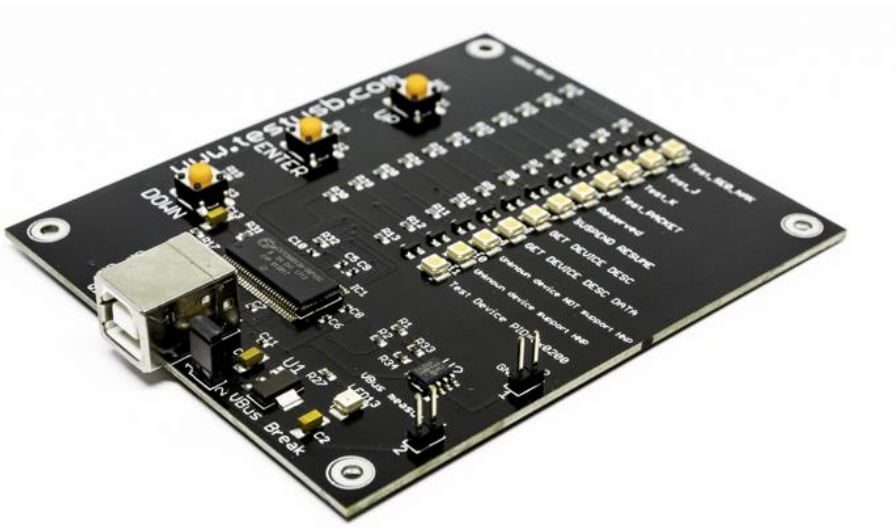
3.1 Oscilloscope, Software, and Accessories

Check with scope vendor.

3.2 High Speed Embedded Host Tester (PIDVID)

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 active 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 (HSET) which is Windows based, to activate the various test modes and operations.
Problem is that HSET only runs on Windows based PC systems and cannot be used for High Speed USB hosts that not run Windows PC systems.
The solution for this problem is that the "On-The-Go and Embedded Host Supplement to the USB Revision 2.0 Specification" defines a method in entering the required high speed electrical test modes.
USB 3.1 Super Speed and Super Speed plus embedded host that support USB 2.0 High Speed should follow the same guidelines as described in this document.
It's important that non-windows based host vendors implement these test modes.

In order to send the required VID and PID the High Speed Embedded Host Tester (PID/VID) of www.TestUSB.com can be used. With this small bus powered device you select the required test mode with the selection switch and plug it into the High Speed embedded Host. Between the Embedded Host and PID/VID the high speed host test fixture is connected in order to make it possible to probe the signals.



3.3 USB 2.0 Test fixtures

3.3.1 USB 2.0 Embedded Host with standard A-Receptacle

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/developers/estoreinfo/

Test fixture Description	Part number	High-Speed Device	Full/Low Speed Device
High Speed USB-IF Host 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
USB2.0 Drop Droop Fixture	TestUSB FS-DD	1	1

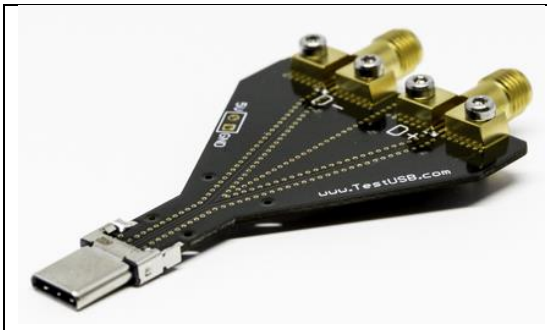
This document covers the high speed signal quality measurement for embedded host with Type-C™ receptacles. It not cover the measurement for embedded hosts with standard A-receptacles. Remaining high speed tests beside signal quality are however covered in this document and require the FS-HUCR fixture.

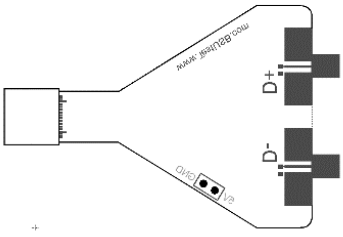
The FS-HUCR and FS-DD can be purchase via:
http://www.fixturesolution.com/product-category/usb-fixtures/

3.3.2 USB 2.0 Embedded Host with Type-C™ receptacle

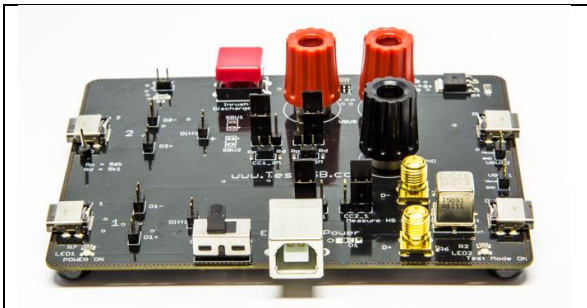
Test fixture Description	Part number	High-Speed Device	Full/Low Speed Device
USB2.0 Type-C™ Signal Quality Test Fixture (Receptacle)	TestUSB FS-HUCR	1	1
USB2.0 Type-C™ Signal Quality Test Fixture (Plug)	TestUSB FS-HUCP	1	n/a
USB2.0 Drop Droop Fixture	TestUSB FS-DD	1	1

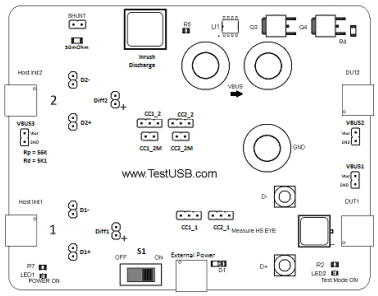
FS-HUCP



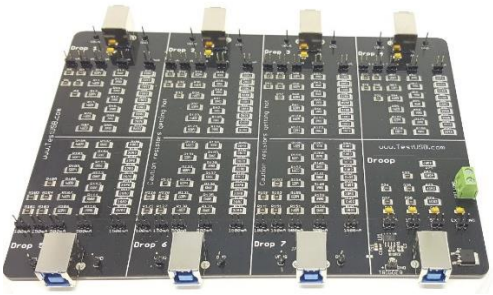


FS-HUCR





FS-DD



The FS-HUCR, FS-HUCP and FS-DD fixture can be purchase via:
http://www.fixturesolution.com/product-category/usb-fixtures/

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
Full Speed device	High and Full Speed devices	Any full speed device	1
Low Speed device	Low Speed devices	Any low speed device	1

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

4 Test Procedure

4.1 Embedded Host Downstream High Speed Signal Quality

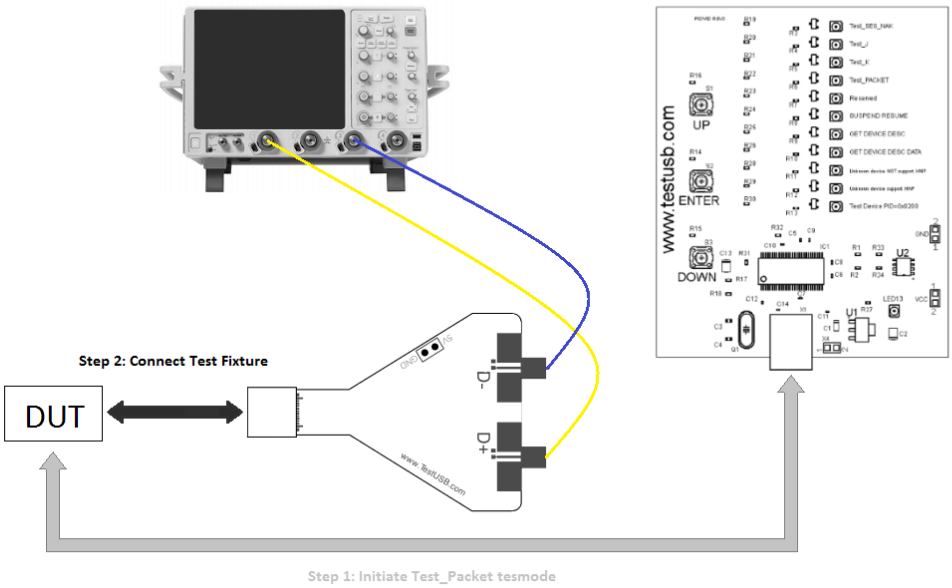
This document covers the high speed signal quality measurement for embedded hosts with Type-C™ receptacles. It not covers the measurement for embedded hosts with standard USB A-receptacle.

This test is measuring the high speed downstream near end Signal Quality (EYE diagram). For this test the host 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. This tool runs in the background of the Keysight N5416A/N5416B USB application.

4.1.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	
1	Oscilloscope USB software	USBET
2	BNC to SMA adapter	Keysight 54855-67604
2	SMA cables	Phase and length matched cable pair for example: e.g. Keysight 15443A
1	Hi-Speed Signal Quality test fixture	TestUSB FS-HUCP
1	PIDVID	In order to force the Embedded Host in the required test modes. http://www.TestUSB/shop.htm
1	Standard-B plug to Type-C™ plug cable	Used to connect the PIDVID to Embedded Host
1	USB cable between PIDVID and Embedded Host under test	If host has: - Standard-A receptacle Any USB A-plug to B-plug cable - Type-C™ receptacle Any USB Type-C™ plug to B-plug cable

4.1.2 Setup Diagram



Connecting the Equipment:

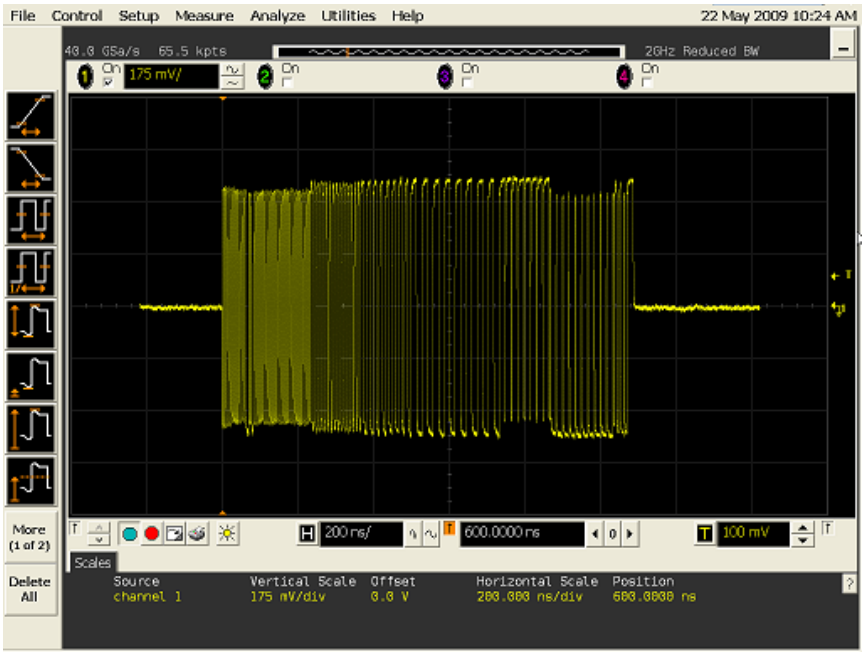
1. Connect the BNC to SMA Adapter's connectors to the Oscilloscope. (In default D+ Channel 1 and D- Channel 3)
1. Attach the SMA cables to the SMA connectors D+ and D- of the on FS-HUCP.

Force the embedded host in the required test mode TEST_PACKET:

2. Power on the Embedded Host under test.
3. Connect the PIDVID to Embedded Host with Std-B to Type-C™ cable and see if white LED Test_SE0_NAK is on.
4. On the PIDVID select with the "UP" or "DOWN" button "TEST_PACKET" and press the "enter" button. This forces the device under test to continuously transmit test packets.
5. Wait till the white LED of "TEST_PACKET" start blinking.
6. Remove the PIDVID from Embedded host under test.

Performing measurement:

7. Connect the FS-HUCP fixture with SMA cables to the embedded host under test.
8. You should see the transmitted test packet on the oscilloscope as below.



9. Follow the scope 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

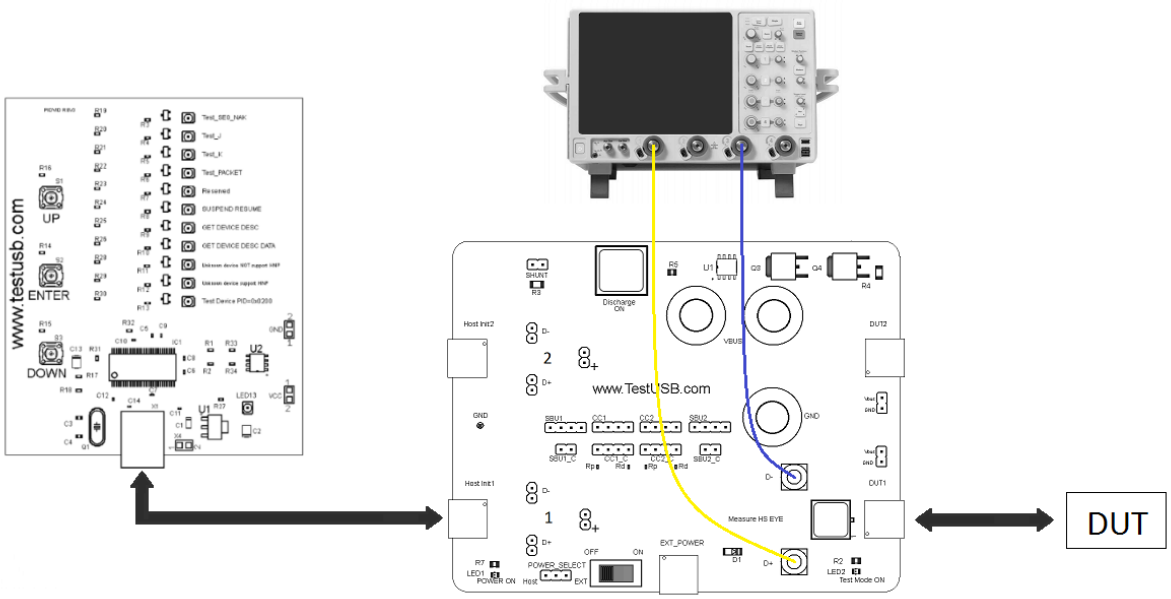
10. Flip/reverse attach the test fixture FS-HUCP to the embedded host under test.
11. Repeat the above instructions 8. and 9. to do the measurement again.
12. A power cycle of the embedded host is required in order to get it out of test mode and proceed the testing.

4.2 Embedded Host Test_J, Test_K and Test_SE0_NAK

4.2.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	
1	Oscilloscope USB software	
2	BNC to SMA adapter	Keysight 54855-67604
2	SMA cables	Phase and length matched cable pair for example: e.g. Keysight 15443A
1	Hi-Speed Signal Quality test fixture	TestUSB FS-HUCR
1	PIDVID	In order to force the Embedded Host in the required test modes. http://www.fixturesolution.com/product/pidvid/
1	USB cable between PIDVID and FS-HUCR	Any USB Type-C™ plug to B-plug cable
	USB cable between FS-HUCR and Embedded Host under test	If host has: - Standard-A receptacle Short USB C-plug to A-plug cable (FS-HC-CP-10-AP) - Type-C™ receptacle Short USB Type-C™ plug to Type-C™ plug cable (FS-HC-CP-10-CP)

4.2.2 Setup Diagram



Connecting the Equipment:

1. Connect the BNC to SMA Adapter's connectors to the Oscilloscope. (In default D+ Channel 1 and D- Channel 3)
2. Attach the SMA cables to the SMA connectors D+ and D- of the on FS-HUCR.

Force the embedded host in the required test mode TEST_J:

3. Power on the Embedded Host under test.
4. Connect Embedded Host under test with a short cable to DUT 1 of the FS-HUCR fixture.
5. Make sure switch S1 is OFF and Test mode LED is OFF.
6. Connect the PIDVID to the Host Init 1 port of the FS-HUCR fixture with a Std-B to Type-C™ cable and see if white LED Test_SE0_NAK is on.
7. On the PIDVID select with the “UP” or “DOWN” button “TEST_J” and press the “enter” button.
8. Wait till the white LED of “TEST_J” start blinking.
9. Flip switch S1 to ON and Test Mode LED is ON.
10. You should see the following on the oscilloscope as below.

11. Follow the scope vendor steps in acquiring the above signal.
12. If host has Type-C™ receptacle flip/reverse attach the short cable at the DUT1 side. If host has A-Receptacle skip step 13. and proceed with step 14.
13. Repeat the above instructions 10. and 11. to do the measurement again.
14. A power off the embedded host is required in order to get it out of test mode and proceed the testing.

Force the embedded host in the required test mode TEST_K:

1. Power on the Embedded Host under test.
2. Connect Embedded Host under test with a short cable to DUT 1 of the FS-HUCR fixture.
3. Make sure switch S1 is OFF and Test mode LED is OFF.
4. Connect the PIDVID to the Host Init 1 port of the FS-HUCR fixture with a Std-B to Type-C™ cable and see if white LED Test_SE0_NAK is on.
5. On the PIDVID select with the “UP” or “DOWN” button “TEST_K” and press the “enter” button.
6. Wait till the white LED of “TEST_K” start blinking.
7. Flip switch S1 to ON and Test Mode LED is ON.
8. You should see the following on the oscilloscope as below.

9. Follow the scope vendor steps in acquiring the above signal.
10. If host has Type-C™ receptacle flip/reverse attach the short cable at the DUT1 side. If host has A-Receptacle skip step 11. and proceed with step 12.
11. Repeat the above instructions 8. and 9. to do the measurement again.
12. A power off the embedded host is required in order to get it out of test mode and proceed the testing.

Force the embedded host in the required test mode Test_SE0_NAK:

1. Power on the Embedded Host under test.
2. Connect Embedded Host under test with a short cable to DUT 1 of the FS-HUCR fixture.
3. Make sure switch S1 is OFF and Test mode LED is OFF.
4. Connect the PIDVID to the Host Init 1 port of the FS-HUCR fixture with a Std-B to Type-C™ cable and see if white LED Test_SE0_NAK is on.
5. On the PIDVID select with the “UP” or “DOWN” button “Test_SE0_NAK” and press the “enter” button.
6. Wait till the white LED of “Test_SE0_NAK” start blinking.
7. Flip switch S1 to ON and Test Mode LED is ON.
8. You should see the following on the oscilloscope as below.

9. Follow the scope vendor steps in acquiring the above signal.
10. If host has Type-C™ receptacle flip/reverse attach the short cable at the DUT1 side. If host has A-Receptacle skip step 11. and proceed with step 13.
11. Repeat the above instructions 8. and 9. to do the measurement again.
12. A power off the embedded host is required in order to get it out of test mode and proceed the testing.

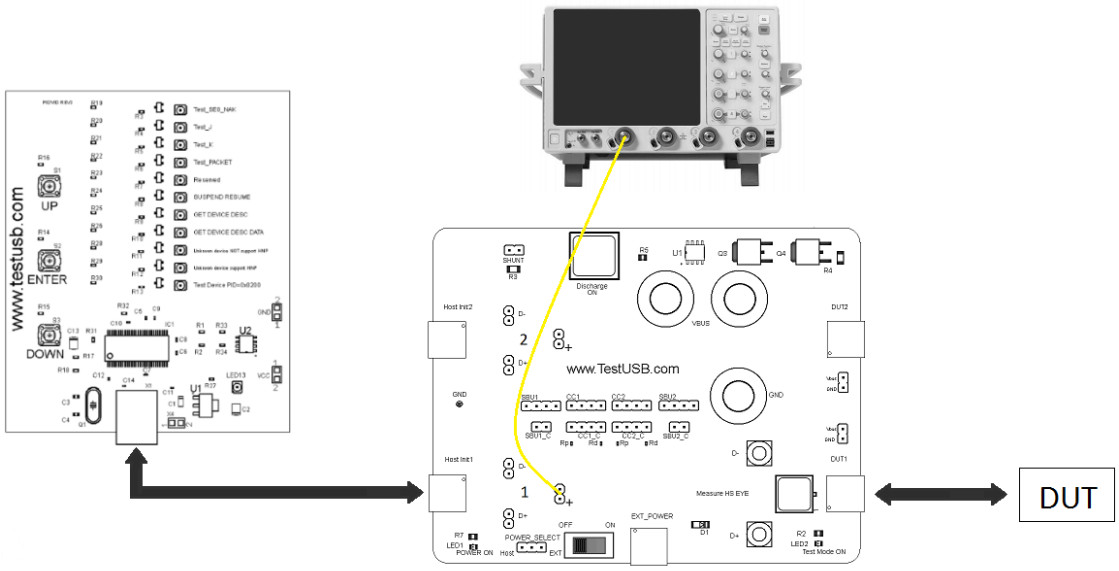
4.3 Device Packet Parameters

The test will measure the sync field (EL_21) EOP field (EL_25), EOP field of SOF (EL_55), the delay between two host packets (EL_23) and the response time of a host to a device packet (EL_22).

4.3.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope Keysight	
1	Differential probe	
1	Oscilloscope USB software	
1	Hi-Speed Signal Quality test fixture	Fixture Solution FS-HUCR
1	Cable between fixture FS-HUCR and PIDVID	Any B-plug to Type-C™ plug cable
1	Cable between fixture FS-HUCR and embedded host under test	If host has: - Standard-A receptacle Any USB A-plug to USB Type-C™ plug - Type-C™ receptacle Any USB Type-C™ plug to USB Type-C™ plug
1	PIDVID	In order to force the Embedded Host in the required modes. http://www.fixturesolution.com/product/pidvid/

4.3.2 Setup Diagram



Connecting the Equipment:

1. Attach the external power to EXT_POWER of the 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.

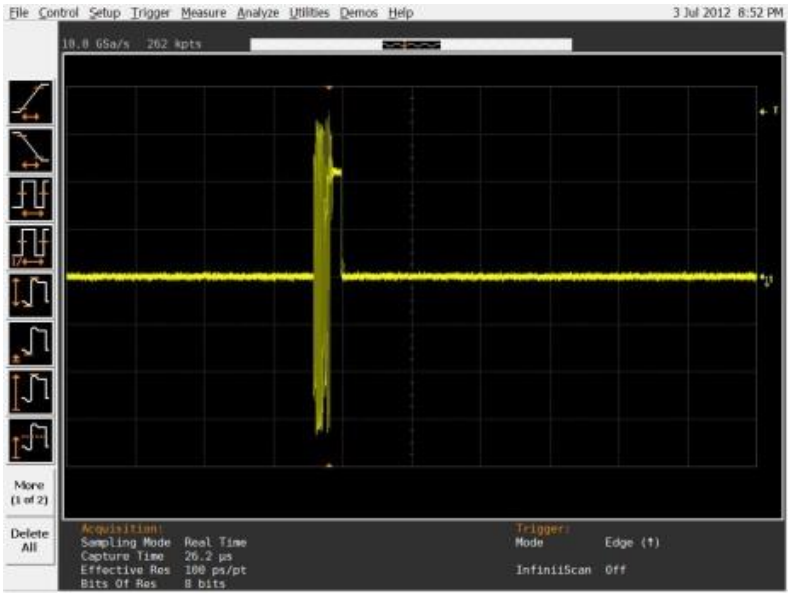
2. Connect the Embedded Host under test to DUT 1 side of the FS-HUCR.
3. Connect to the Host Init 1 the PIDVID with Std-B to Type-C™ cable and see if white LED Test_SE0_NAK is on.
4. Connect the differential probe with the + of the probe to + on the FS-HUCR.

Force the embedded host in sending the required packets:

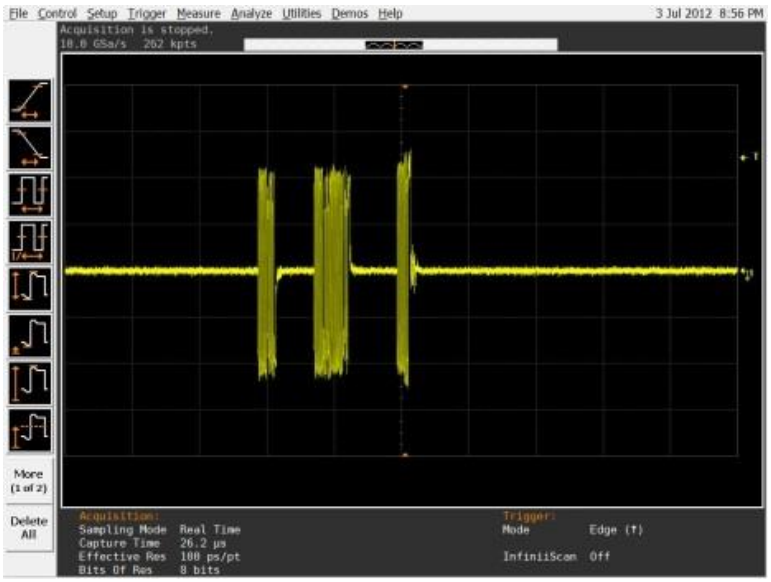
This test is split up into two sub-tests.

Sub-test 1

5. On the PIDVID select with the “UP” or “DOWN” button ”GET_DEVICE_DESCRIPTOR” and press Enter. The white LED will start blinking and the host enumerates the PID/VID and responds to send SOFs for 15 seconds as shown below.



6. After 15 seconds of SOFs the host initiates the setup phase of the GetDescriptor() command. The host sends SETUP and DATA. (first and second packet)



7. Follow the scope vendor steps in acquiring the above signal.
8. The host packets are the first two packets. Measure the sync field (EL_21) EOP field (EL_25) on the first two packets and measure the time between those two (EL_23) packets.

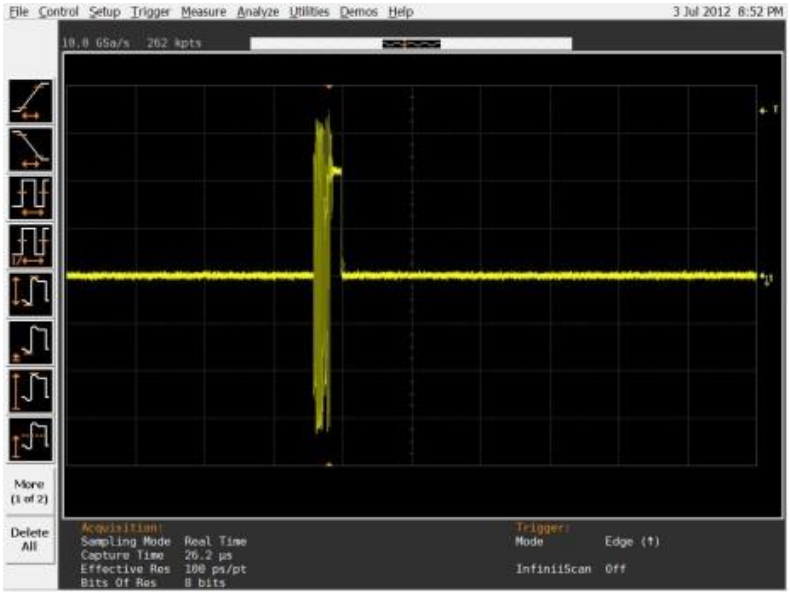
EL_21 Sync Field Length Test

EL_25 EOP Length Test

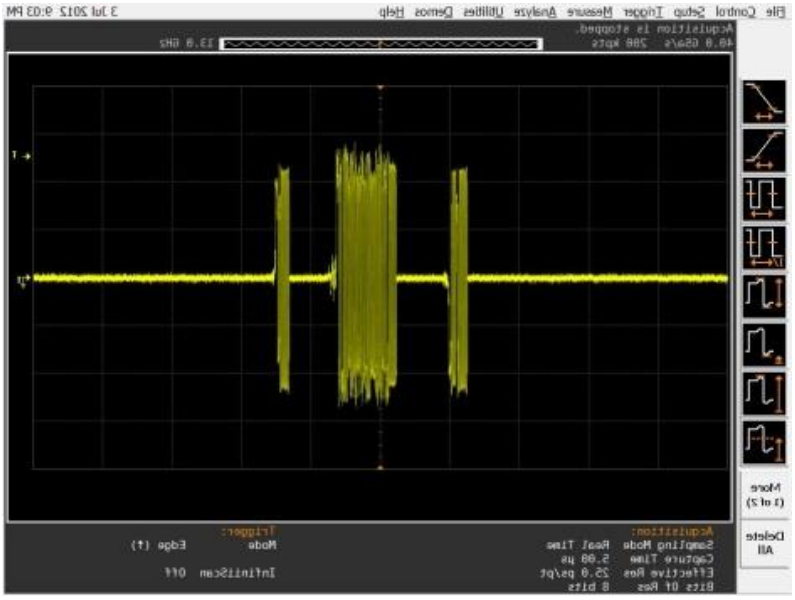
EL_23 Inter-packet Gap Between First 2 host Packets (Host – Host)

Sub-test 2

9. Disconnect and reconnect the PIDVID from FS-HUCR and see if white LED Test_SE0_NAK is on.
10. On the PIDVID select with the “UP” or “DOWN” button ”GET_DEVICE_DESCRIPTOR_DATA” and press Enter The white LED will start blinking and the host enumerates the PID/VID and responds to send SOFs for 15 seconds as shown below.



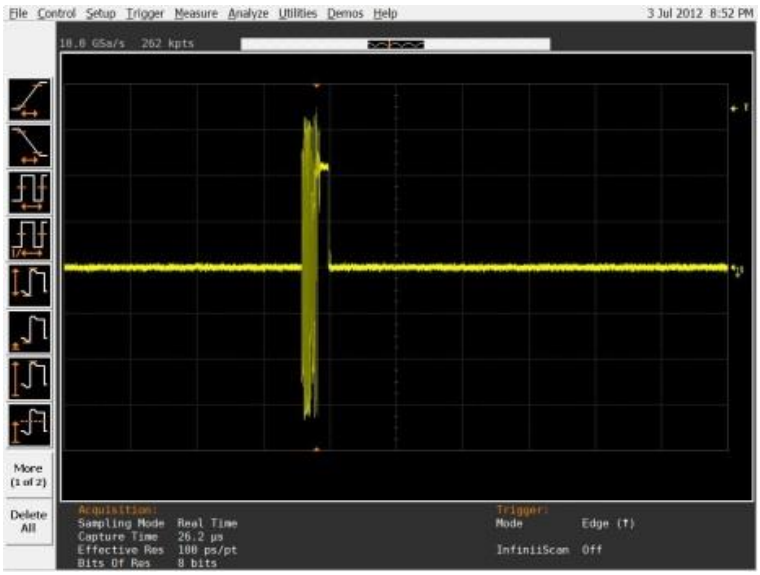
11. After 15 seconds of SOFs the host issues an IN where the PIDVID send a DATA (second packet) and should look like below.



12. Follow the scope vendor steps in acquiring the above signal.
13. It will measure EL_22 the time between DATA (second) and ACK (third).

EL_22 Inter-packet Gap of a host to a device packet (Device – Host)

14. The host will keep sending SOFs as below.



15. Follow the scope vendor steps in acquiring the above signal.

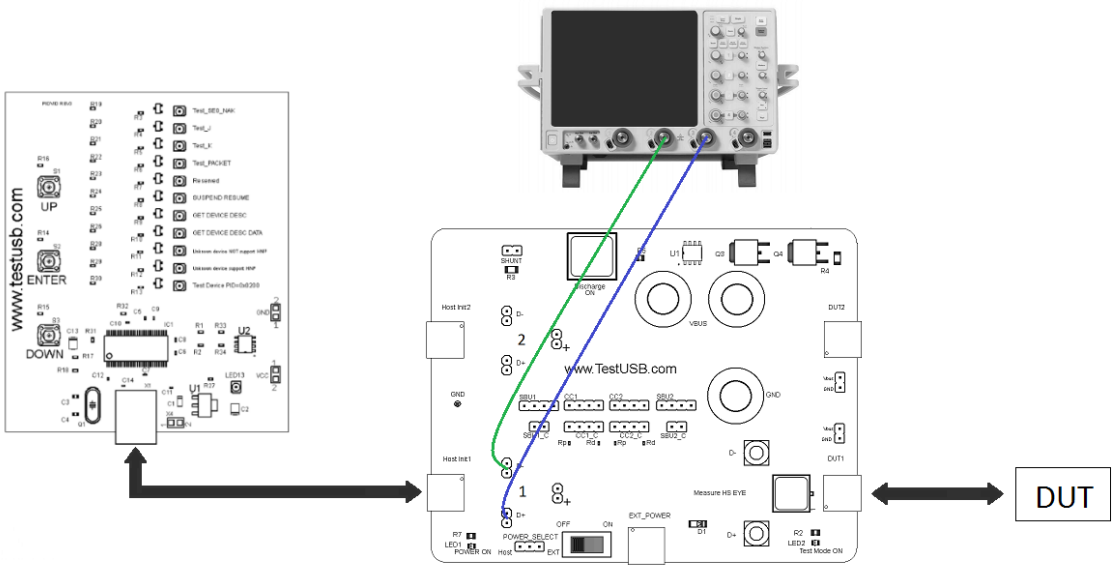
EL_55 SOF EOP Width Test

4.4 Host CHIRP Timing

4.4.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	
2	Differential probe	
1	Hi-Speed Signal Quality test fixture	Fixture Solution FS-HUCR
1	Cable between fixture FS-HUCR and embedded host under test	If host has: - Standard-A receptacle Short USB A-plug to USB Type-C™ plug FS-HC-CP-10-AP - Type-C™ receptacle Short USB Type-C™ plug to USB Type-C™ plug FS-HC-CP-10-CP
1	Any High Speed USB-IF Certified Device	Any known good high speed device can be used for this test. When using the PIDVID not select a Test_Mode there it requires to power cycle of the host.

4.4.2 Setup Diagram



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 yellow Test LED is not lit.
2. Connect the High Speed device to the Host Init 1 on the FS-HUCR using the appropriate cable when the device not have a captive cable.
3. Connect the probe on Channel 2 to the D- pin at zone 1 of the FS-HUCR.

4. Connect the probe on Channel 3 to the D+ pin at zone 1 of the FS-HUCR.
5. Connect the appropriate cable to DUT1

Test Instructions

6. Make sure that the scope is ready for trigger
7. Connect the cable at DUT1 side to the embedded host under test and get the following screen on the scope.

8. Follow the scope vendor steps in acquiring the above signal.

EL_33 CHIRP Timing Response

EL_34 CHIRP J K Width

EL_35 SOF Timing Response

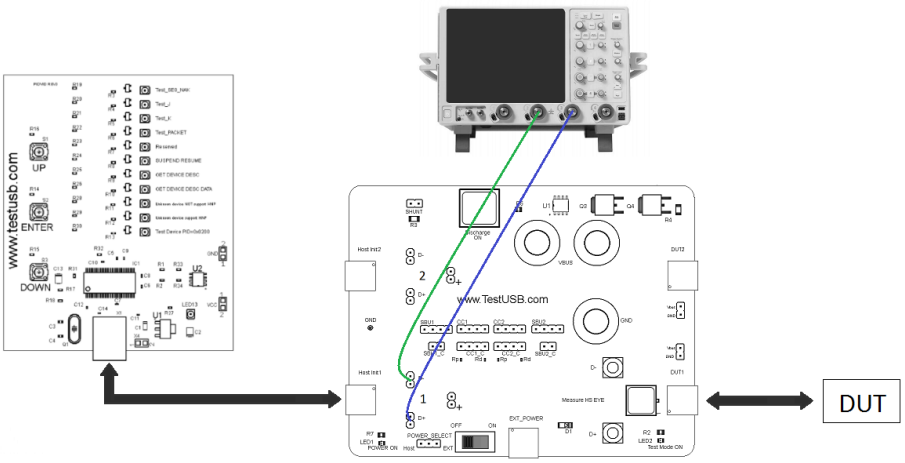
4.5 Host Suspend/Resume Timing

It's not mandatory for an embedded host to support suspend, if the embedded host not support suspend, suspend and resume test should not be performed. This test verifies if the embedded host enters the suspend state and resumes.

4.5.1 Equipment Used

Quantity	Item	Description/ Model
1	Oscilloscope	
2	Differential probe	
1	Hi-Speed Signal Quality test fixture	Fixture Solution FS-HUCR
1	Cable between fixture FS-HUCR and embedded host under test	If host has: - Standard-A receptacle Short USB A-plug to USB Type-C™ plug FS-HC-CP-10-AP - Type-C™ receptacle Short USB Type-C™ plug to USB Type-C™ plug FS-HC-CP-10-CP
1	PIDVID	In order to force the Embedded Host in the required modes. http://www.fixturesolution.com/product/pidvid/
1	Cable between fixture FS-HUCR and PIDVID	Any B-plug to Type-C™ plug cable

4.5.2 Setup Diagram



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 yellow Test LED is not lit.
2. Connect the Embedded Host under test to DUT 1 side of the FS-HUCR with the corresponding cable.
3. Connect to the Host Init 1 the PIDVID with Std-B to Type-C™ cable and see if

white LED Test_SE0_NAK is on.

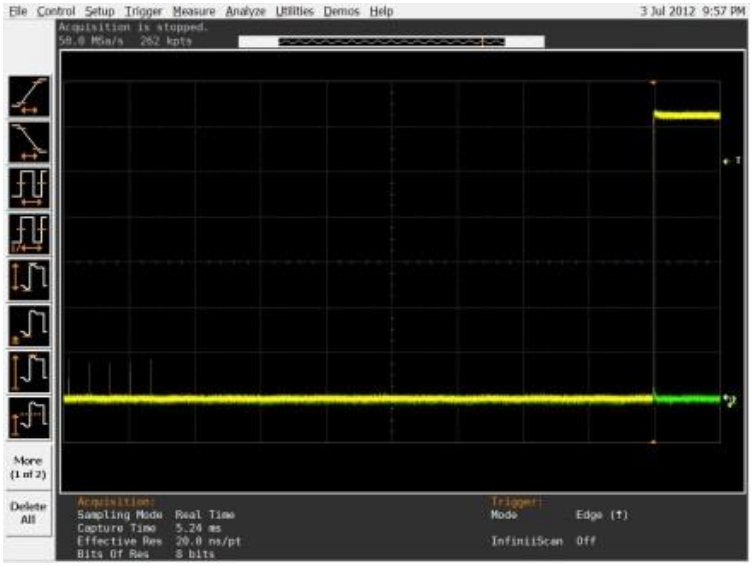
4. Connect the probe on Channel 2 to the D- pin at zone 1 of the FS-HUCR.
5. Connect the probe on Channel 3 to the D+ pin at zone 1 of the FS-HUCR.

Force the embedded host in suspend:

This test is split up into two sub-tests.

Sub-test 1

6. On the PIDVID select with the “UP” or “DOWN” button ”SUSPEND RESUME” and press Enter. The white LED will start blinking and the host enumerates the PIDVID and will enter suspend after 15 seconds as shown below.



7. Follow the scope vendor steps in acquiring the above signal.

Sub-test 2

8. After 15 seconds of suspend state the host shall issue a ResumeK state on the bus, then continue sending SOFs as shown below.

9. Follow the scope vendor steps in acquiring the above signal.

EL_39 Suspend

EL_41 Resume

4.6 Downstream Full Speed Signal Quality Test

Also high speed embedded hosts need to undergo this test.

4.6.1 Equipment Used

Qty	Item	Description/ Model
1	Oscilloscope	
2	Active probes	
1	Cable between Embedded Host under test and FS-HUCR fixture	5m Type-C™ plug to B-plug cable (FS-HC-CP-500-BP)
1	Device Hi-Speed Signal Quality Type-C™ test fixture	Fixture Solution FS-HUCR
1	5V power supply	Any Type-C™ plug to A-plug cable that can take 5V from any USB host.
1	Any Full Speed USB-IF Certified Device	Any known good full speed device can be used for this test.

4.6.2 Setup Diagram

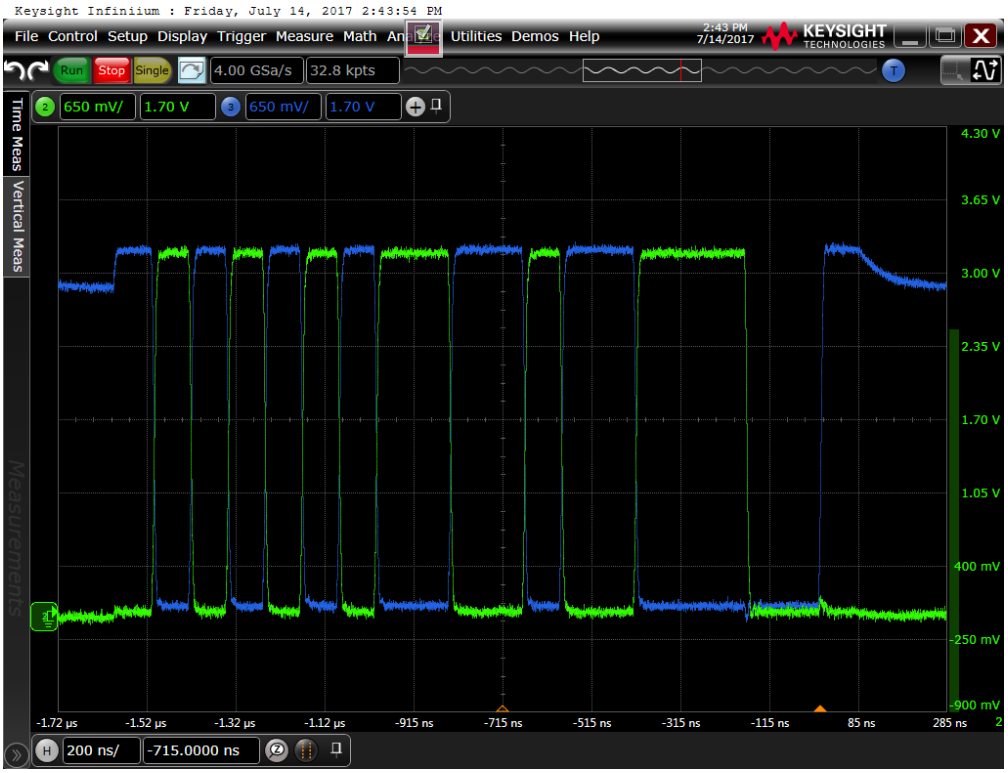
Include graphical representation of the setup here

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 embedded host under test to DUT 1 side of the fixture with the appropriate long cable.
3. Connect the full speed device to the Host Init 1 of the FS-HUCR.
4. Connect the probe on Channel 2 to the D- pin at zone1 of the FS-HUCR.
5. Connect the probe on Channel 3 to the D+ pin at zone1 of the FS-HUCR.

Test Instructions

6. The host should send SOF on the oscilloscope as below.



7. Follow the oscilloscope vendor steps in acquiring the signal eye diagram and calculating the below signal quality compliance test items.
8. If embedded host under test has a Type-C™ receptacle Flip/reverse attach the cable on the embedded host side under test.
9. Repeat the above instructions 6. and 7. to do the measurement again.

4.7 Downstream Low Speed Signal Quality Test

Only applicable when embedded host support low speed device (see TPL)

4.7.1 Equipment Used

Qty	Item	Description/ Model
1	Oscilloscope Keysight	
2	Active probes	
1	Cable between Embedded Host under test and FS-HUCR fixture	N.a Low speed device always has captive cable
1	Device Hi-Speed Signal Quality Type-C™ test fixture	Fixture Solution FS-HUCR
1	5V power supply	Any Type-C™ plug to A-plug cable that can take 5V from any USB host.
1	Any Low Speed device from TPL	Any known good low speed device from the Target Peripheral List can be used for this test.

4.7.2 Setup Diagram

Include graphical representation of the setup here

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 embedded host under test to DUT 1 side of the fixture with the appropriate long cable.
3. Connect the full speed device to the Host Init 1 of the FS-HUCR.
4. Connect the probe on Channel 2 to the D- pin at zone1 of the FS-HUCR.
5. Connect the probe on Channel 3 to the D+ pin at zone1 of the FS-HUCR.

Test Instructions

6. The host should send SOF on the oscilloscope as below.

7. Follow the oscilloscope vendor steps in acquiring the signal eye diagram and calculating the below signal quality compliance test items.
8. If embedded host under test has a Type-C™ receptacle Flip/reverse attach the cable on the embedded host side under test.
9. Repeat the above instructions 6. and 7. to do the measurement again.

4.8 Drop

4.9 Droop

To Be Done

5. Fill out form

ID	Test	Requirement	Measured Value	Status
EL_2	High-Speed transmitter data rate	480 Mb/s +-0.05%	Mb/s	Pass/Fail
EL_3	Data Eye and Mask Test	Not touch near end EYE	Number EYE hits	Pass/Fail
EL_6	Rise and fall times	> 500 ps (*)	ps	Pass/Fail
EL_7	Monotonic edge	Data transition is monotonic		Pass/Fail
EL_21	Sync Field Length Test	(**)	ns	Pass/Fail/NA
EL_25	EOP Length Test	(**)	ns	Pass/Fail/NA
EL_23	Inter-packet Gap Between First 2 host Packets (Host – Host)	(**)	ns	Pass/Fail/NA
EL_22	Inter-packet Gap of a host to a device packet (Device – Host)	(**)	ns	Pass/Fail
EL_55	SOF EOP Width Test	(**)	ns	Pass/Fail
EL_33	CHIRP Timing Response	1ns to 100µs	µs	Pass/Fail
EL_34	CHIRP J K Width	40µs to 60µs	µs	Pass/Fail
EL_35	SOF Timing Response	100µs to 500µs	µs	Pass/Fail
EL_39	Suspend	Enter suspend		Pass/Fail/NA
EL_41	Resume	< 3ms		Pass/Fail/NA
EL_8	Host J Test	Driven data line 400mV +-10% (***) Non driven data lines max 10mV	D+: mV D-: mV	Pass/Fail
EL_8	Host K Test	Driven data line 400mV +-10% (***) Non data driven lines max 10mV	D+: mV D-: mV	Pass/Fail
EL_9	Host SE0_NAK Test	Non data driven lines max 10mV	D+: mV D-: mV	Pass/Fail
	Full Speed Quality			Pass/Fail
	Low Speed Quality			Pass/Fail/NA
	Vbus Drop			Pass/Fail
	Vbus Droop	< 330mV	mV	Pass/Fail/NA

(*) EL_6 waiver low as 100ps:
http://compliance.usb.org/index.asp?UpdateFile=Electrical&Format=Standard#87

(**) EL_22 for products with an internal hub to the embedded host may have an additional delay:
http://compliance.usb.org/index.asp?UpdateFile=Electrical&Format=Standard#43
One HS Hub may truncate up to 4 bits of the sync field and add up to 4 bits to the EOP.
(***) EL_8 only the non-driven lines are pass / fail criteria
http://compliance.usb.org/index.asp?UpdateFile=Electrical&Format=Standard#67
http://compliance.usb.org/index.asp?UpdateFile=Electrical&Format=Standard#92

APPENDIX