Tektronix

High-Speed Electrical Testing - Hub

Universal Serial Bus Measurement Package

www.tektronix.com

2015-05-05

REVISION RECORD SHEET

Version	Completion Date	Initiator	Pages	Nature of Change
0.1	7-17-2014	S. Harrison	56	First Draft

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(EL_2, EL_6, EL_7, EL_46)

Specifying the Equipment-Signal Quality Tests for High Speed Devices for Upstream Testing

- Tektronix digital oscilloscope
- USB2SIGQUAL compliance test fixture
- Two SMA cables (phase matched)
- Host PC
- 1 meter USB 2.0 cable

Typical Equipment Setup-Signal Quality Tests for High Speed Hub (Upstream Testing

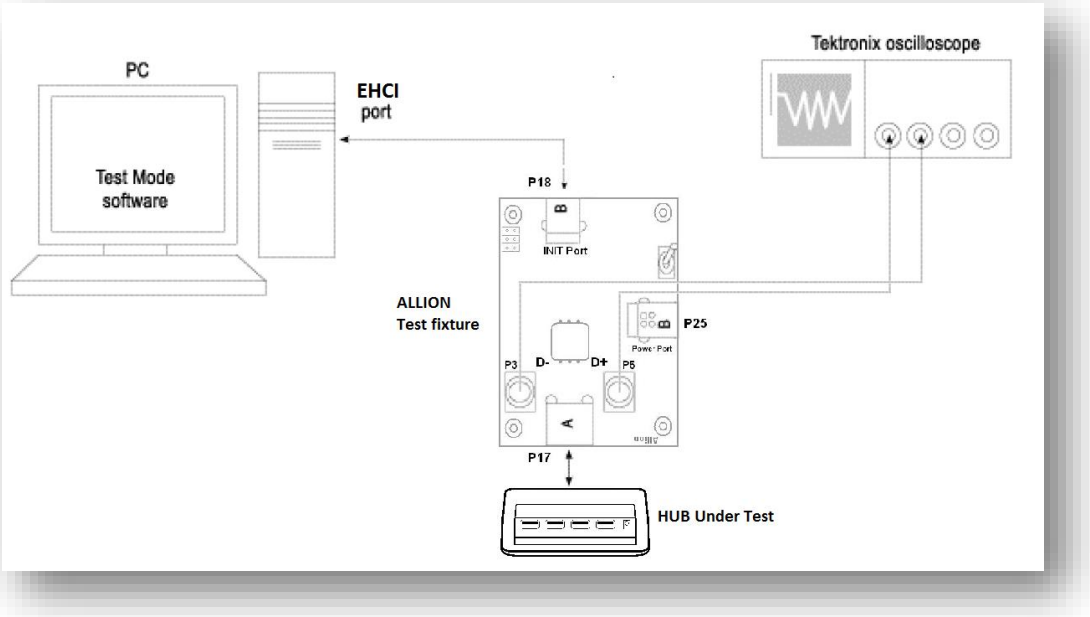


Figure 1: Equipment Setup for Signal Quality Measurement

To setup the equipment for the High Speed Signal Quality test, follow these steps:

1. Using the USB2SIGQUAL; Set the **SW4** switch to the position not labeled **TEST**.

2. Connect a standard USB cable between the Type B-INIT port (P18) and the host PC port.

3. Connect a standard USB cable between the Type A-TEST port (P17) and the Hub Under Test.

4. Connect the two SMA cables from CH1 and CH2 of the oscilloscope to the SMA connections label P3 & P5.

5. Run the High-Speed Electrical Test Tool software on the host PC. EHCI_HSETT main menu shown in figure below.

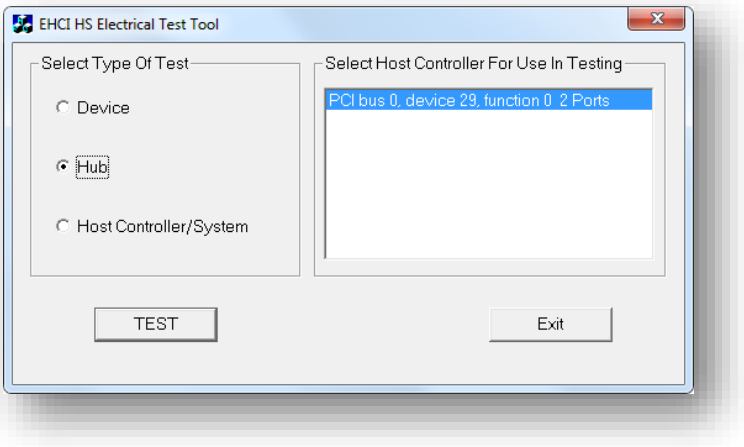


Figure 2: High-Speed Electrical Test Tool - Main Menu

6. Configure the device into the test mode from the host PC controller. Select TEST_PACKET from the Hub Command dropdown menu and click EXECUTE.

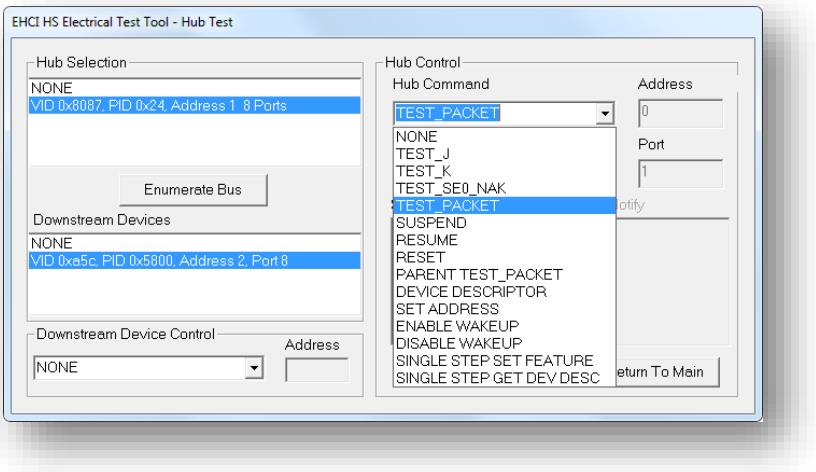


Figure 3: Test Device Packet

7. Set the switch **(SW4)** to the TEST position. This will isolate the unit under test while maintaining the bus power.
8. On the Tektronix scope, set your Math channel to **Ch1 - Ch2**

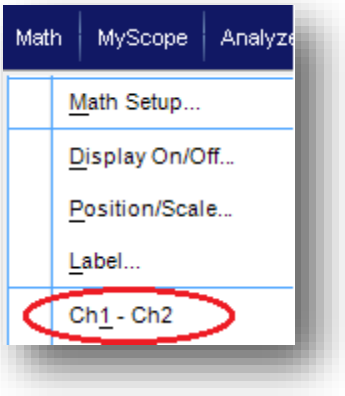


Figure 4: Math Setup

9. Adjust the scope Horizontal scale so that one complete packet is displayed

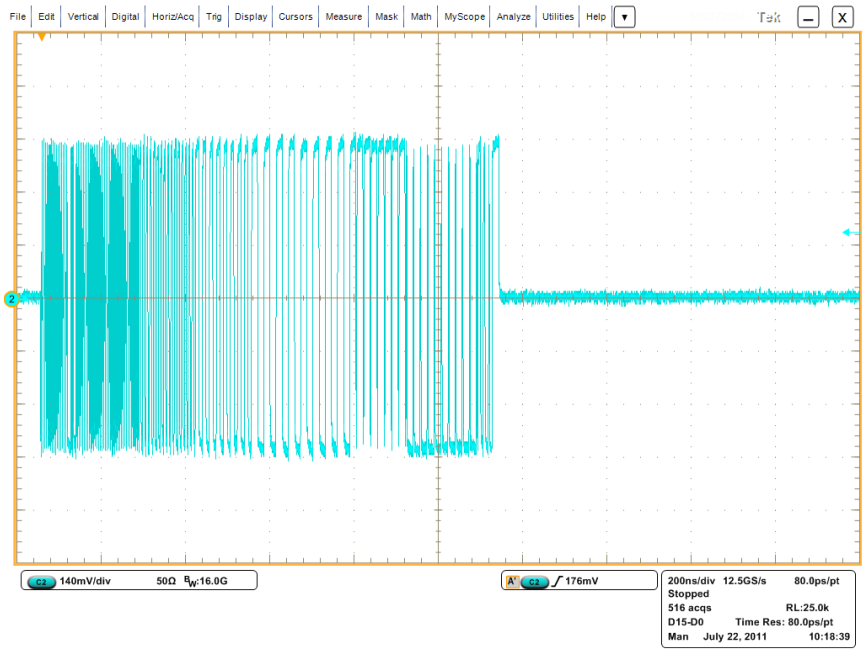


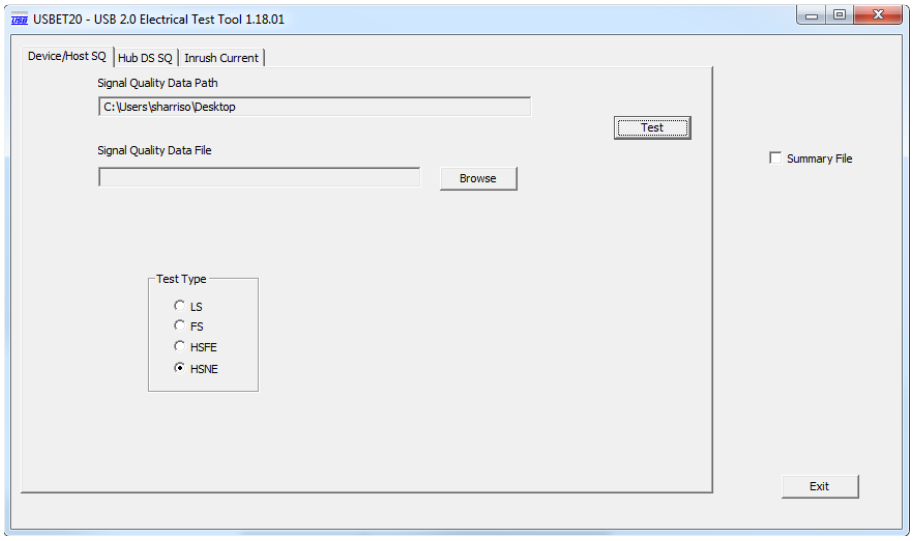
Figure 5: Test Packets

10. Save Math waveform as a CSV (*.csv) or Tek Waveform (*.wfm) for later processing.

Selecting and Configuring Measurements-Signal Quality Tests for High Speed Devices (Upstream Testing)

Launch USB Electrical Analysis Tool 2.0 (Download from USB.org)

11. From the application menu, select Device/Host SQ (tab).



12. Select the Test Type:

- HSNE (High Speed Near End)

13. Browse to the Math waveform saved from the scope.

14. Press Test.

Packet Parameter - Upstream
(EL_21, EL_22, EL_25)

Specifying the Equipment-Packet Parameter Measurement

The following equipment is needed for a Packet Parameter measurement:

- Tektronix digital oscilloscope
- Host PC
- One differential probe
- 1 meter USB2.0 cable

Typical Equipment Setup-Packet Parameter Measurement

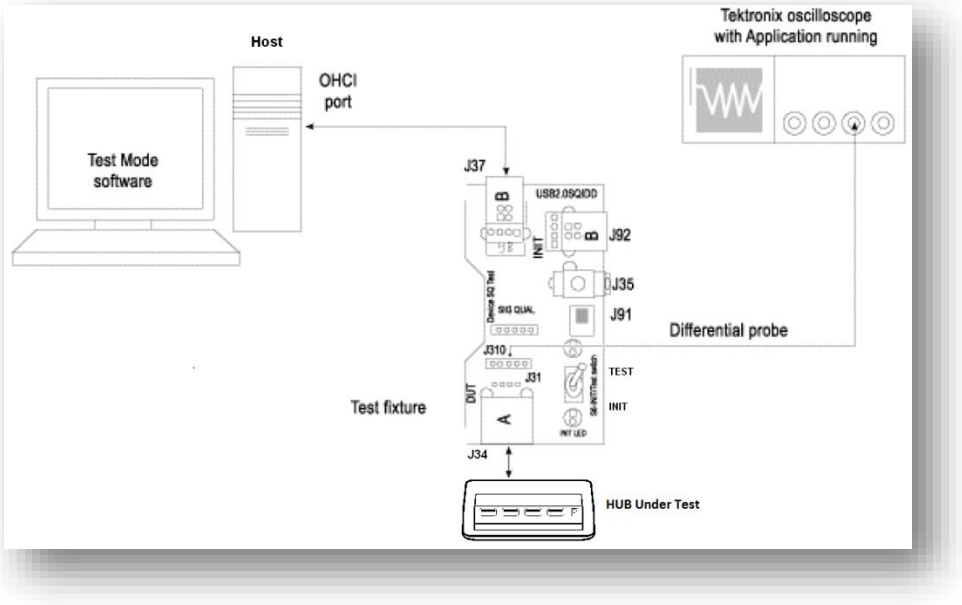


Figure 6: Equipment Setup for Packet Parameter Measurement

Test Fixture Setup

To set up the test fixture, follow these steps:

1. Set the S6 switch to the **Init** position.
2. Connect the standard USB cable between the Device SQ Init port **(J37)** and the host PC port.
3. Connect the A receptacle (marked DUT) from the Device SQ test port **(J34)** to the Hub.
4. Apply the power to the test fixture.
5. Apply the power to the Hub.

6. Attach the differential probe near the device connector on the test fixture **(J31)**.

Oscilloscope Setup

7. Verify that SOFs (Start Of Frame packets) are being transmitted.
8. Go to scope trigger menu to trigger on:

   a. Width: The EOP is required to be NRZ 01111111 without bit stuffing. Since the only other traffic is SOF's, we can trigger on the EOP; 7 x 2.08ns = 14.56ns

   b. Edge: Since we are measuring at the device, its amplitude should be higher than from the host. Set the Edge trigger just below the nominal voltage of 400mV

9. In the HS Electrical Test Tool application- select SINGLE STEP SET FEATURE from the Device Command dropdown menu and click EXECUTE once.

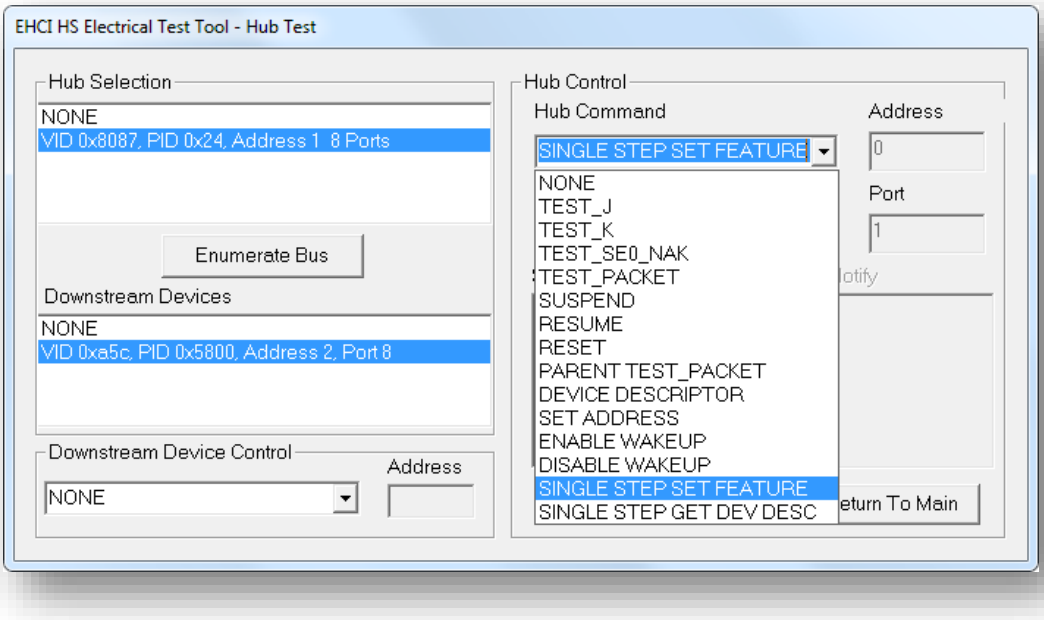


Figure 7: Device Single Step Set Feature

10. The oscilloscope capture should appear as follows:

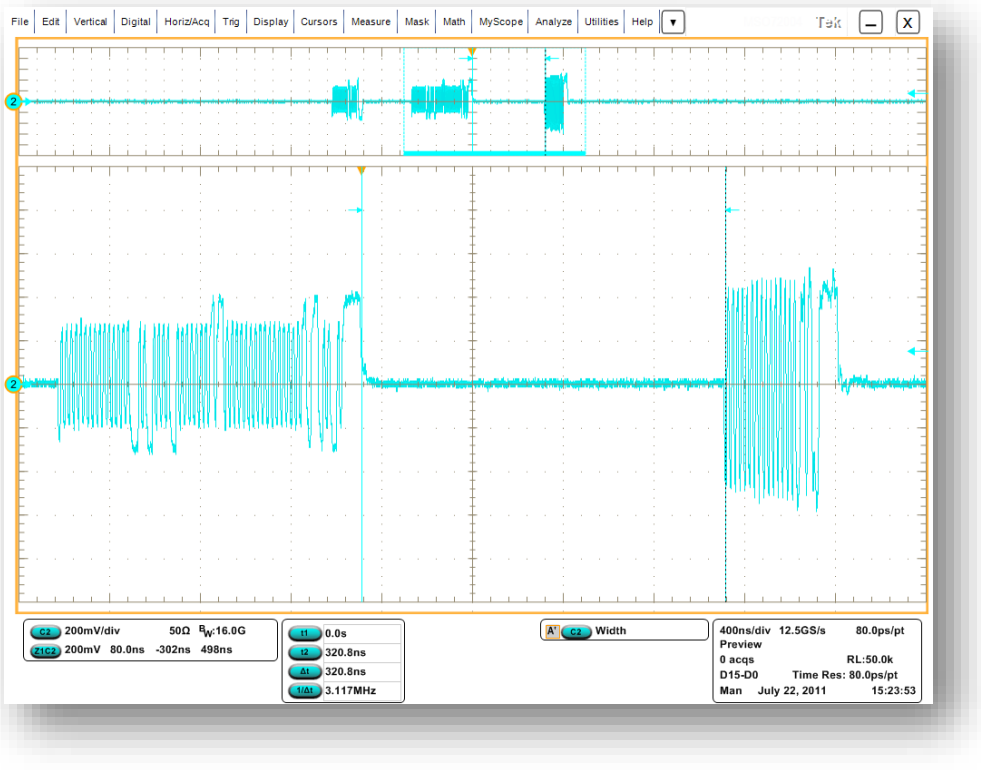


Figure 8: Device Packets

The following EL measurements are to be measured:

11. High Speed Device: EL_21, EL_22, EL_25 (EOPII-InterPacketI&II)

- The synchronous bits (32) from the second packet are to be measured. This is EL_21: The SYNC field for all transmitted packets (not repeated packets) must begin with a 32 bit SYNC field.

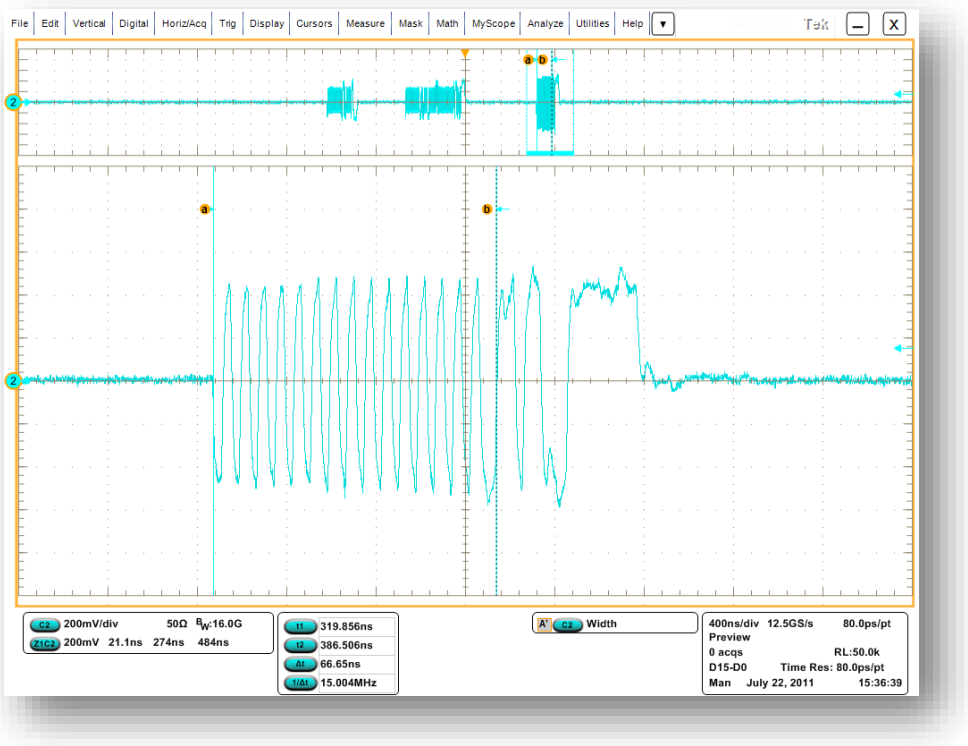


Figure 9: Sync Field - Device Packet

- Transmitting after receiving a packet: EL_22 measures the inter-packet gap between the second (from host) and the third (from device in response to the host) of at least 8 bit times and not more than 192 bit times. As the signal is differential, the EOP can be a positive or a negative pulse

- The results consist of EL_25 EOP (End of Packet) width (number of bits) for all transmitted packets (except SOFs) must be an 8 bit NRZ byte of 0111111111 without bit stuffing. Third packet on oscilloscope

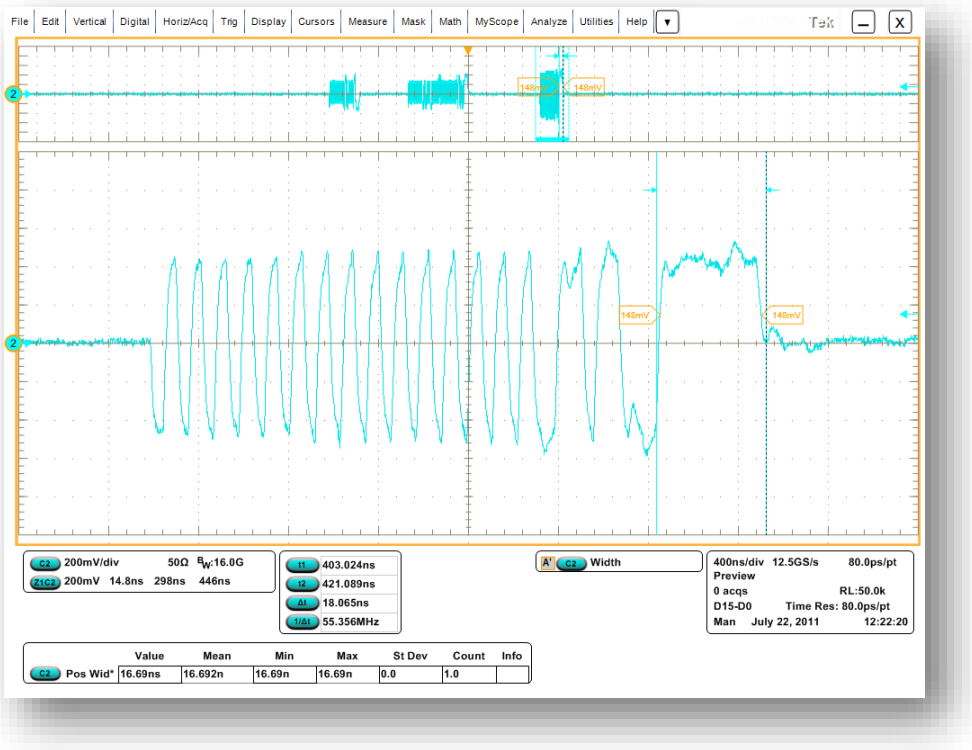


Figure 10: EOP in Device's Packet

12. In the HS Electrical Test Tool application- click STEP once.
13. The oscilloscope capture should appear as follows:

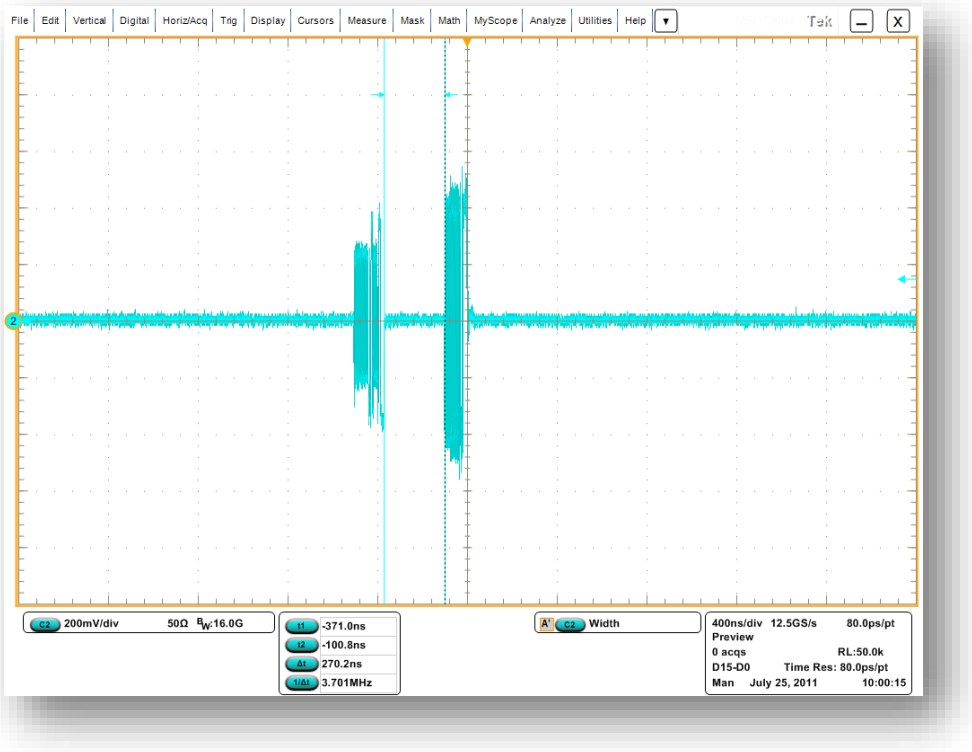


Figure 11: Single Step Set Feature - Second Step

14. The results consist of EL_22 inter-packet gap between the first (from host) and the second (from device in respond to the host's) packets shown on the oscilloscope. The number of bits (8-192) between the packets are to be verified.

Chirp Measurement - Upstream
(EL_28, EL_29, EL_31)

Specifying the Equipment-Chirp

The following equipment is needed to test Chirp measurement:

- Tektronix digital oscilloscope
- TDSUSBF compliance test fixture
- Two Active single-ended probes
- Host PC
- 1 meter USB cable

Typical Equipment Setup-Chirp

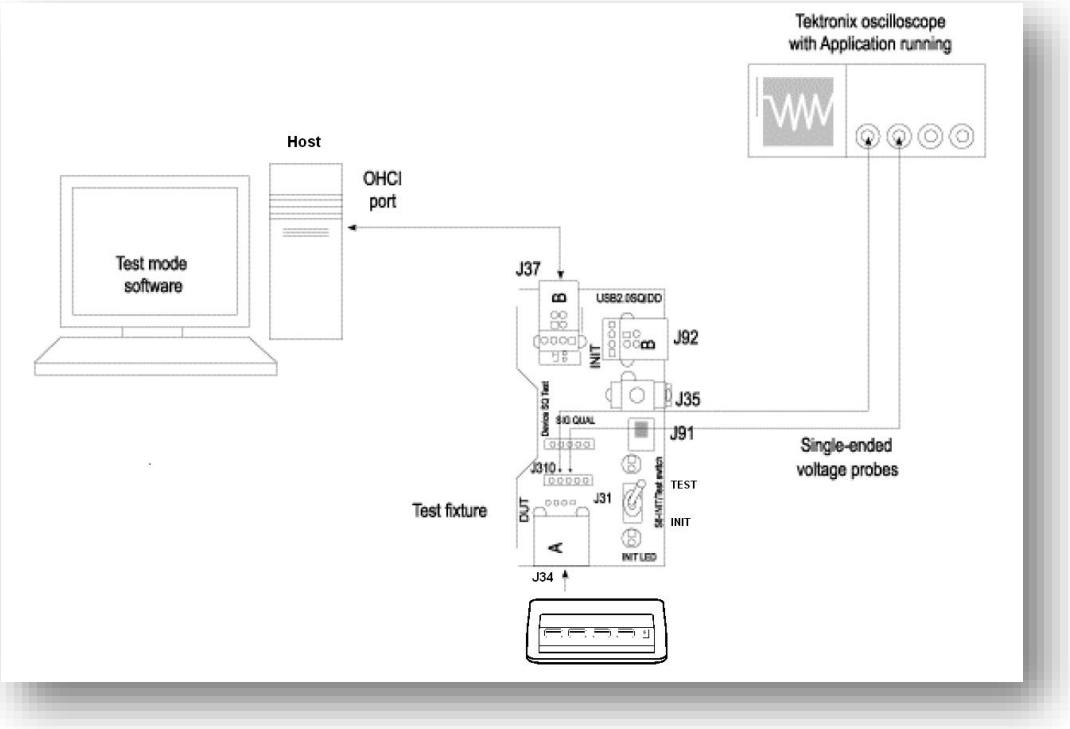


Figure 12: Equipment Setup for Chirp Measurement

To set up the equipment for the Chirp test, follow these steps:

1. Set the S6 switch to the **Init** position.
2. Connect the standard USB cable between the Device SQ Init port **(J37)** and the host PC port.
3. Connect the A receptacle (marked DUT) from the Device SQ test port **(J34)** to the device under test.
4. Connect the single-ended probes to D- and D+ on the test fixture pins **J31**.

Selecting and Configuring Measurement-Chirp

5. Set the scope to trigger at 2.0 volts on the Falling edge of D+.

6. In the EHCI Electrical Test Tool, click Enumerate and observe the chirp signal on the oscilloscope. This will resume the device from suspend state.
   a. Instead of enumerating the device, an alternative method to generate the chirp signal, is to disconnect and reconnect the Device Under Test to the port

Figure 13: Device Chirp-K Latency (EL_29)

- The EL_28 checks the device's CHIRP-K latency in response to the reset from the host port. The time should be between 2.5us and 6.0ms.

- The EL_29 checks the device's CHIRP-K duration. The assertion time should be between 1.0ms and 7.0ms.

- EL_31: When a device detects a valid Chirp K-J-K-J-K-J sequence, the device must disconnect the D+ pull-up resistor (1.5k-ohm). It's evident by the 800mV to 400mV drop in amplitude. The time from the last J pair to the drop

Suspend Measurement
(EL_38, EL_39)

Specifying the Equipment-Suspend Measurement

The following equipment is needed for Suspend measurement:

- Tektronix digital oscilloscope
- TDSUSBF compliance test fixture
- Two Active single-ended probes
- Host PC
- 1 meter USB cable

Typical Equipment Setup-Suspend Measurement

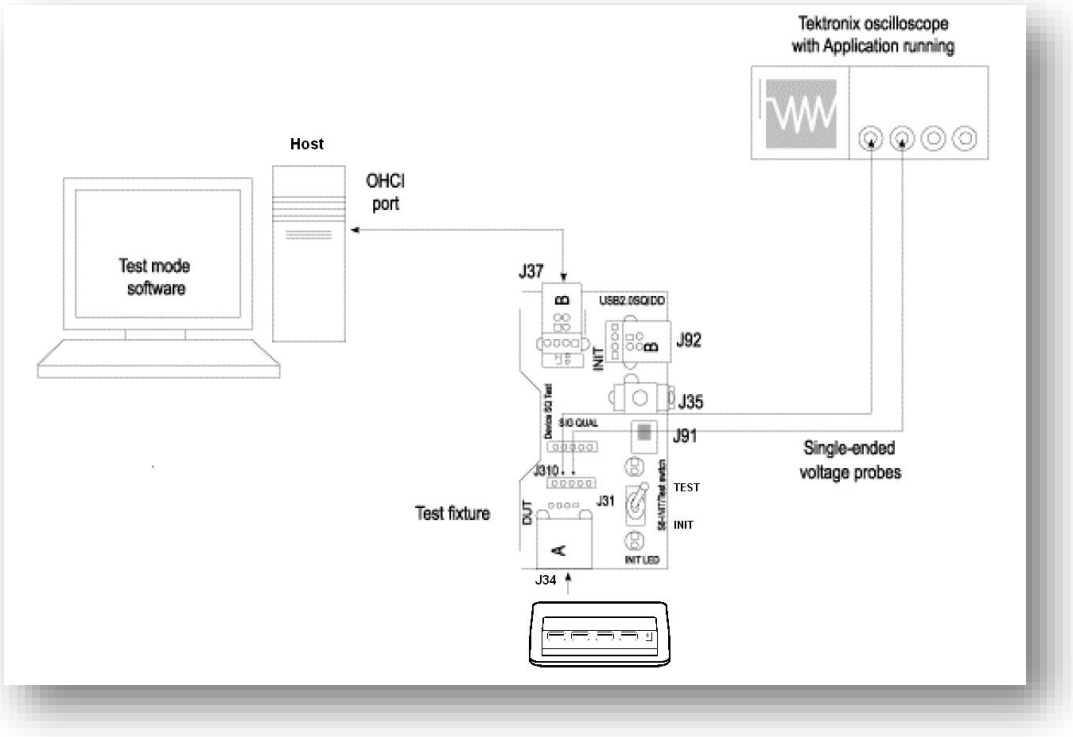


Figure 14: Equipment Setup for Suspend Measurement

Test Fixture Setup

To set up the Device SQ in the test fixture for the Suspend test, follow these steps:

1. Set the S6 switch to the **Init** position.
2. Connect the standard USB cable between the Device SQ Init port **(J37)** and the host PC port.

3. Connect the A receptacle from the Device SQ test port **(J34)** of the test fixture to the Hub Under Test.
4. Connect the single-ended probes of the oscilloscope to the D+ and D– pins **(J31)**.

Selecting and Configuring Measurement-Suspend Measurement

5. Set the scope to trigger on the Rising edge at 2.5V of the D+ line. When suspended, the D+ pull-up resistor will bring the voltage to between 3.0 – 3.6 volts.
6. In the HS Electrical Test Tool application- select SUSPEND from the Hub Command dropdown menu and click EXECUTE once.

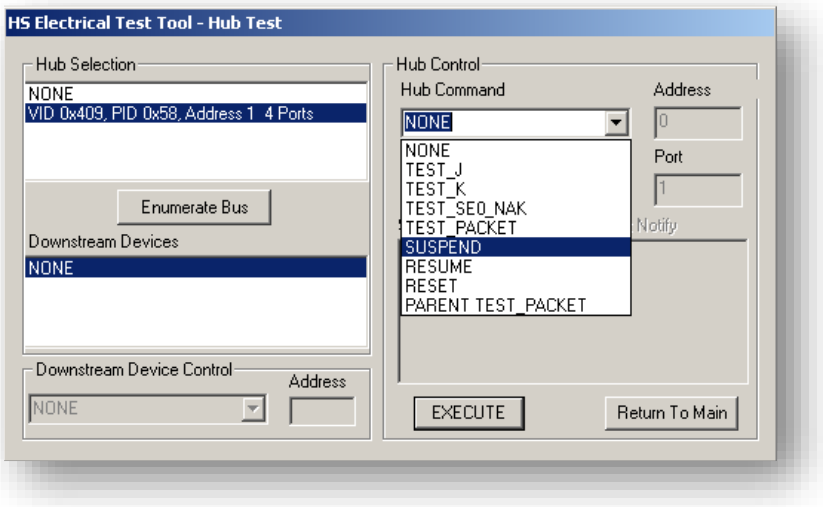


Figure 15: Device Suspend

7. The captured suspend transition should appear as in the following figure.

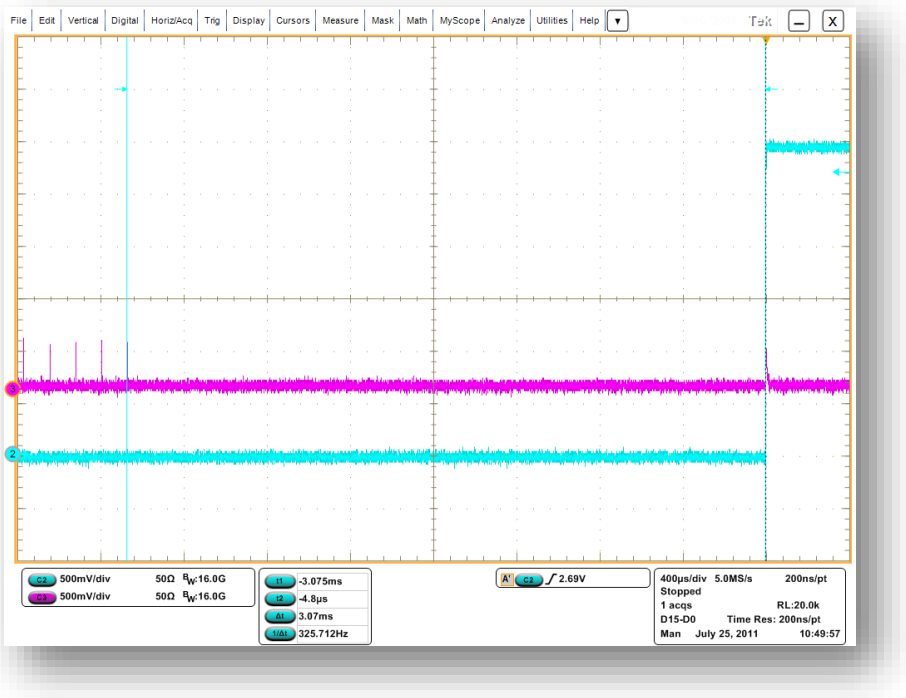


Figure 16: Device Respond to Suspend from High-Speed

8. The result contains EL_38, which is the time interval from the end of last SOF packet issued by the host to when the device attached its full speed pull-up resistor on D+. This is the time between the last SOF packet and the rising edge transition to full speed J-state. Time should be between 3.000 ms and 3.125 ms.

Resume Measurement
(EL_40)

Specifying the Equipment-Resume Measurement

The following equipment is needed for Resume measurement:

- Tektronix digital oscilloscope
- TDSUSBF compliance test fixture
- Two Active single-ended probes
- Host PC
- 1 meter USB cable

Typical Equipment Setup-Resume Measurement

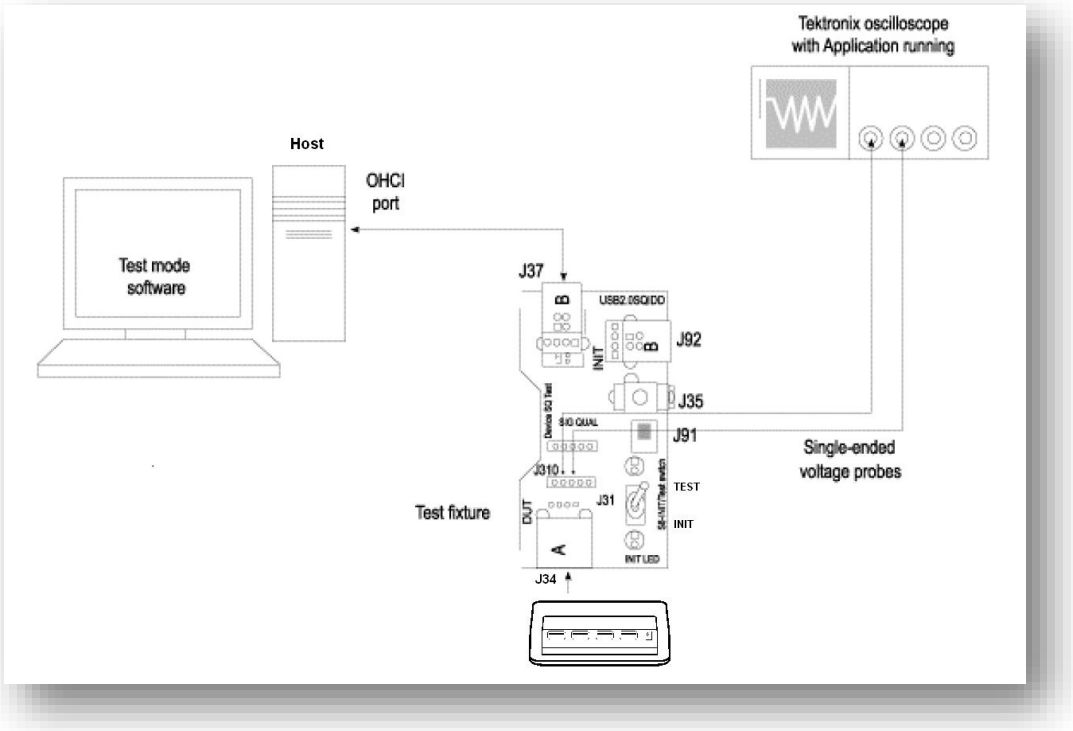


Figure 17: Equipment Setup for Resume Measurement

Test Fixture Setup

To set up for the Resume test, follow these steps:

1. Set the S6 switch to the **Init** position.

2. Connect the standard USB cable between the Device SQ Init port **(J37)** and the host PC port.

3. Connect the A receptacle (marked DUT) from the Device SQ test port **(J34)** to the device under test.

4. Connect the single-ended probes to D+ and D- pin on the test fixture (**J31)**.

Continuing from the SUSPEND measurement

Selecting and Configuring Measurement-Resume

5. Set the scope to trigger on the Falling edge at 2.5V of the D- line. This is to trigger on the D- line resuming from suspended state.

6. In the HS Electrical Test Tool application- select RESUME from the Device Command dropdown and click EXECUTE once. This will resume the device from suspend state.

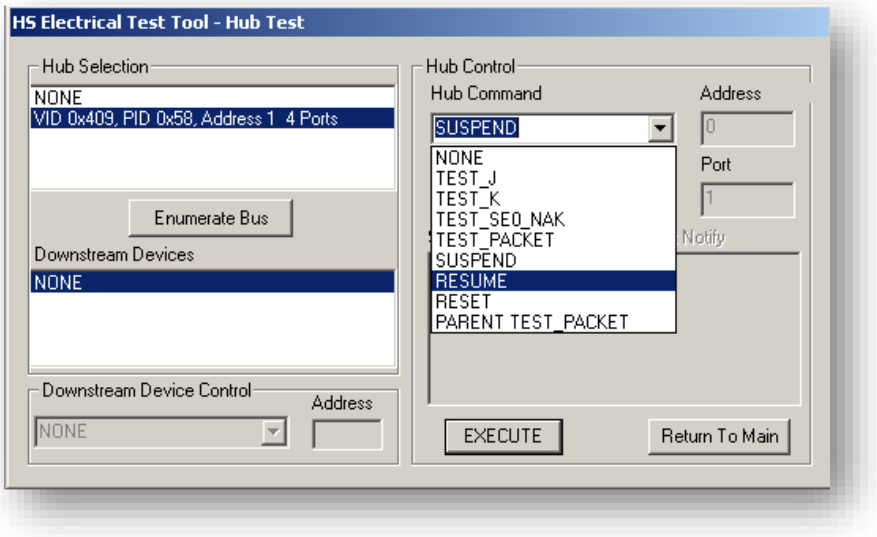


Figure 18: Device Resume

7. The result consists of the time between the falling edge of D+ and the First SOF. This should not exceed 3.0ms. The device should resume the HS operation, which is indicated by the presence of HS SOF packets (with 400mV nominal amplitudes) following the K State driven by the host controller.

Note: Measuring devices transition back to high-speed isn't practical, therefore we measure EL_41: After resuming a port, the host must begin sending SOFs within 3ms of the start of the idle state.

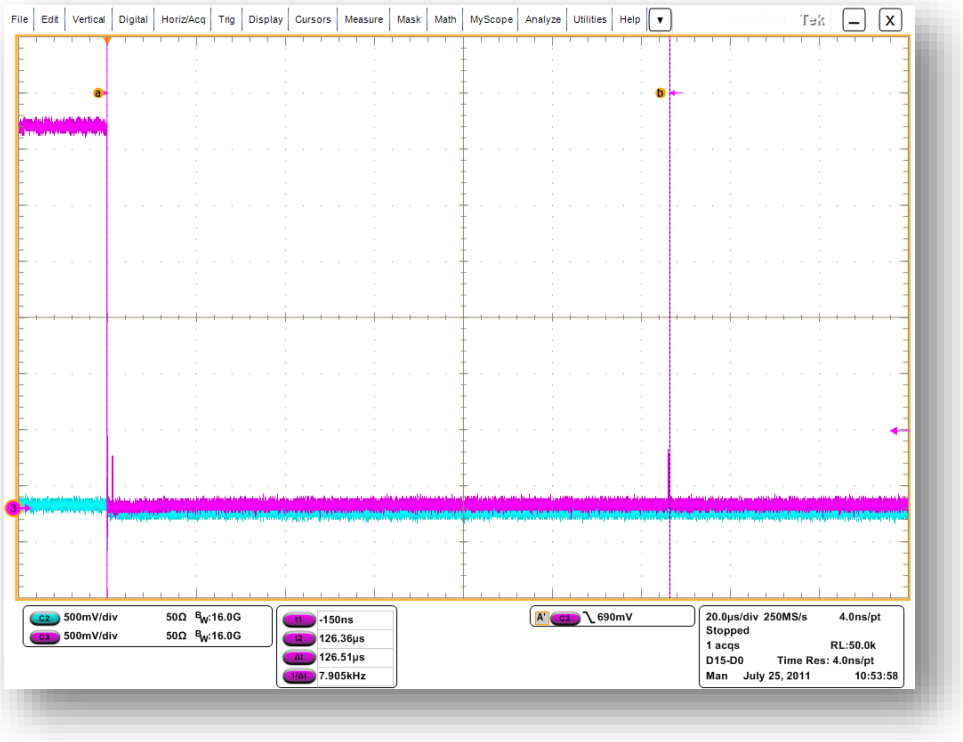


Figure 19: Device Resume to High-Speed (EL_40)

Reset from High Speed Measurement
(EL_27)

Specifying the Equipment-Reset from High Speed Measurement

The following equipment is needed for Reset from High Speed measurement:

- Tektronix digital oscilloscope
- TDSUSBF compliance test fixture
- Two Active single-ended probes
- Host PC
- 1 meter USB cable

Typical Equipment Setup-Reset from High Speed Measurement

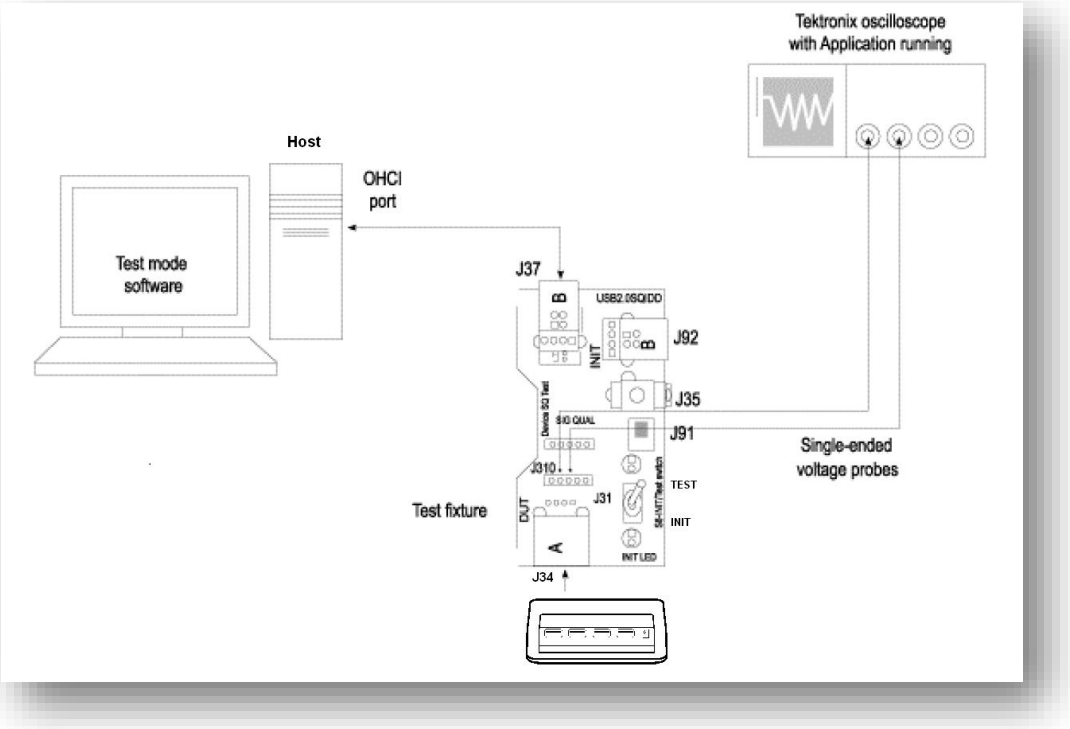


Figure 20: Equipment Setup in Reset from High Speed Measurement

To set up for the Reset from High Speed test, follow these steps:

1. Set the S6 switch to the **Init** position.
2. Connect the standard USB cable between the Device SQ Init port **(J37)** and the host PC port.
3. Connect the A receptacle (marked DUT) from the Device SQ test port **(J34)** to the device under test.

4. Connect the single-ended probes of the oscilloscope to the D+ and D– pins **(J31)**.

Selecting and Configuring Measurement-Reset from High Speed Measurement

5. In the HS Electrical Test Tool application- select RESET from the Device Command dropdown menu and click EXECUTE once.

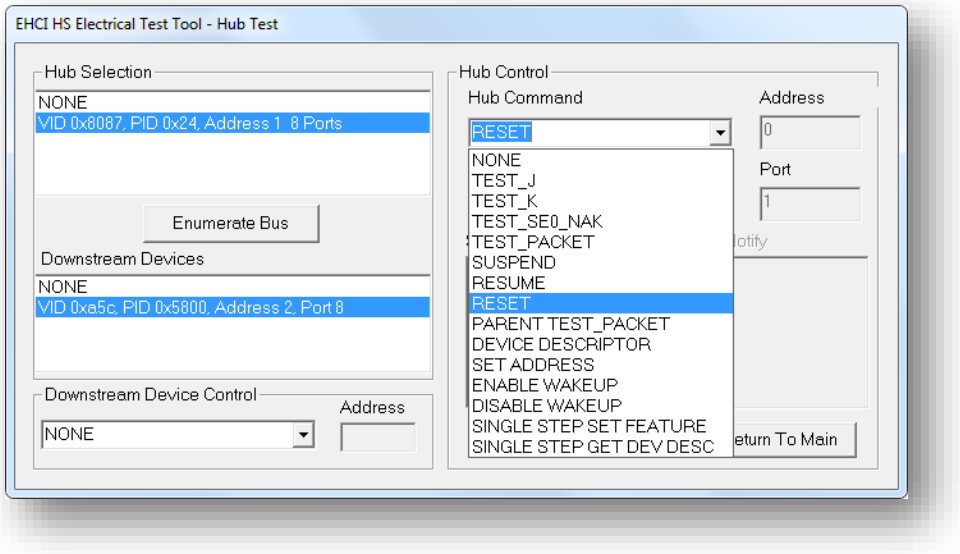


Figure 21: Device Reset

6. The results contain the time between the beginning of the last SOF before the reset and the start of the device Chirp-K. The device should transmit a chirp handshake following the reset. It should be between 3.1ms and 6ms.

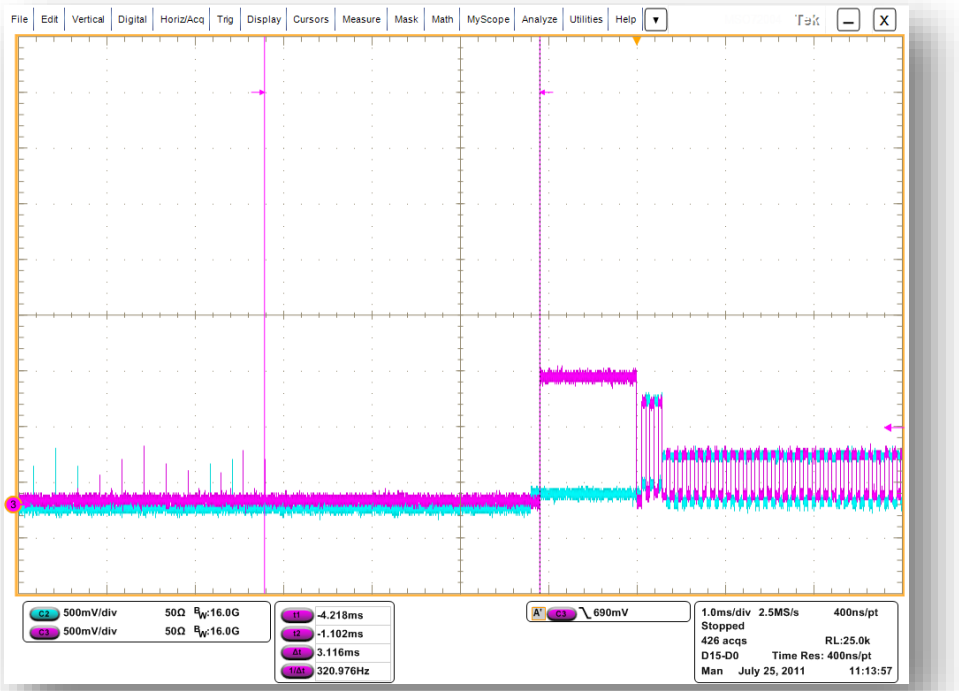


Figure 22: Device Chirp-K in Response to Reset from High-Speed (EL_27)

Reset from Suspend Measurement
(EL_28)

Specifying the Equipment-Reset from Suspend Measurement

The following equipment is needed for Reset from Suspend measurement:

- Tektronix digital oscilloscope
- TDSUSBF compliance test fixture
- Two Active single-ended probes
- Host PC
- 1 meter USB cable

Typical Equipment Setup-Reset from Suspend Measurement

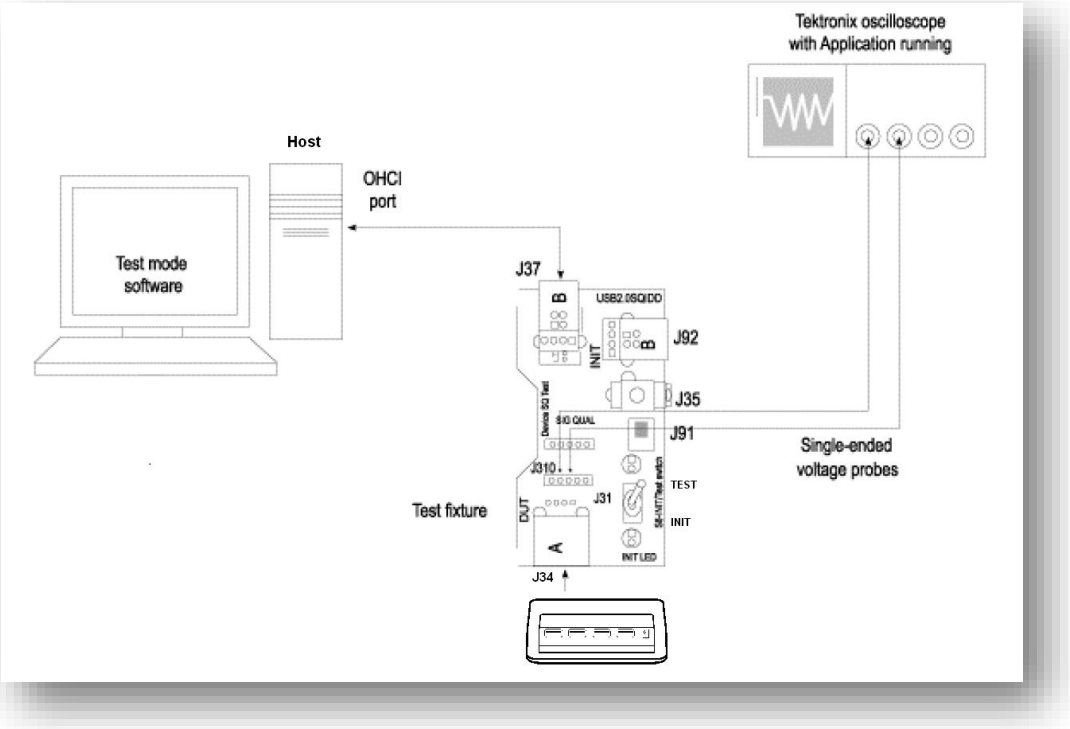


Figure 23: Equipment for Reset from Suspend Measurement

To set up the Device SQ in the test fixture for the Reset from Suspend test, follow these steps:

1. Set the S6 switch to the Init position.
2. Connect one end of a standard USB cable to the B receptacle Device SQ Init port **(J37)** and the other end to the host PC port.

3. Connect the A receptacle (marked DUT) from the Device SQ test port **(J34)** to the Device Under Test.
4. Connect the single-ended probes of the oscilloscope to the D+ and D– pins.

Continuing from the SUSPEND measurement

Selecting and Configuring Measurement-Reset from Suspend Measurement

Follow these steps to select measurements for Reset from Suspend measurement:

5. Set the scope to trigger at 2.0 volts on the Falling edge of D+.
6. In the HS Electrical Test Tool application- select RESET from the Device Command dropdown menu and click EXECUTE once.

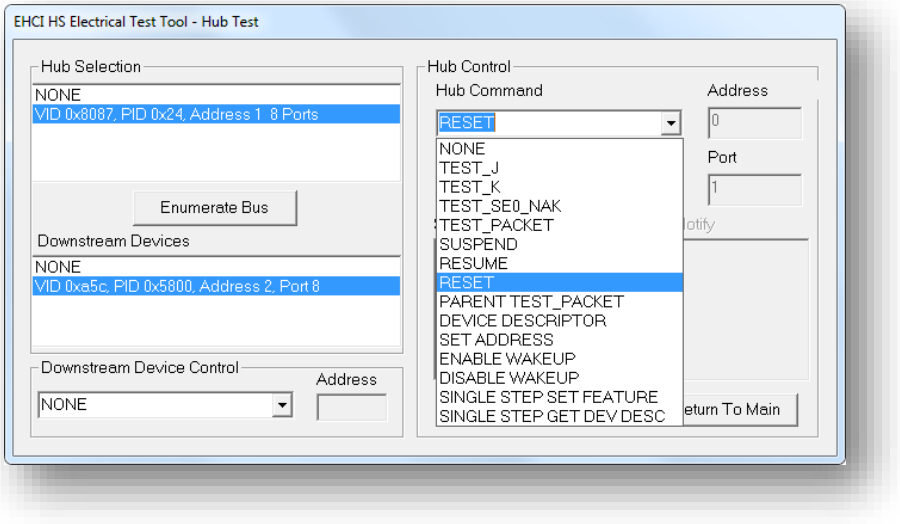


Figure 24: Device Reset

6. The device responds to the reset with the Chirp-K. The results contain the time between the falling edge of the D+ and the start of the device Chirp-K. It should be between 2.5 us and 6 ms.

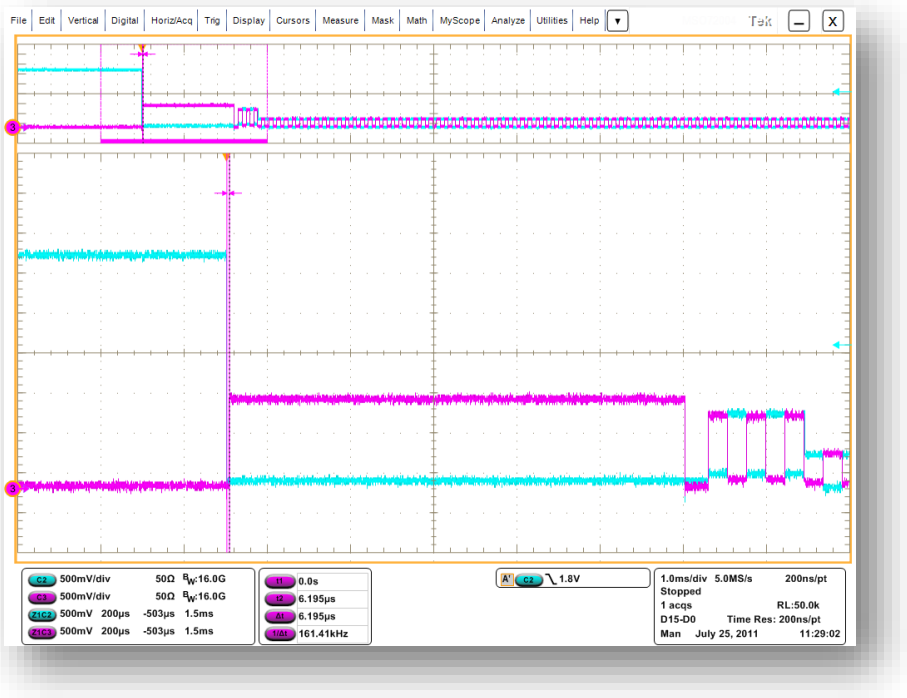


Figure 25: Device Reset from Suspend (EL_28)

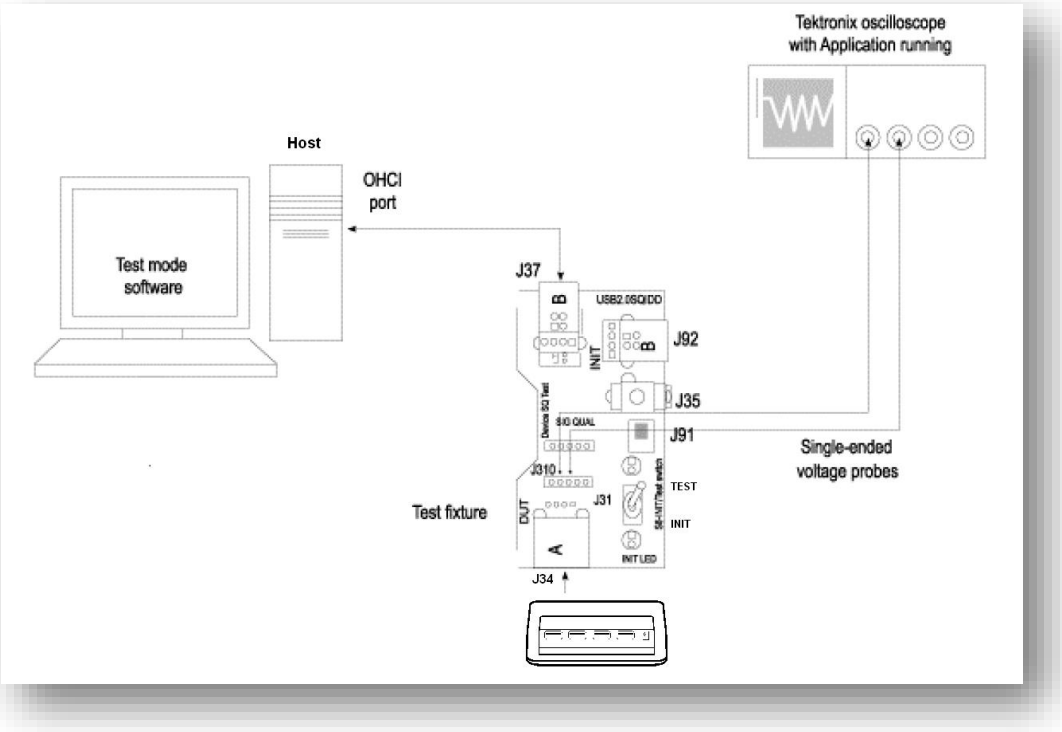
J/K, SE0_NAK – Upstream
(EL_8, EL_9)

Specifying the Equipment-J/K & SE0_NAK

The following equipment is needed to test J/K, SE0_NAK measurement:

- Digital Volt Meter
- TDSUSBF compliance test fixture

Typical Equipment Setup-J/K and SE0_NAK



To set up the equipment for J/K & SE0_NAK, follow these steps:

1. Set the S6 switch to the **Init** position.
2. Connect a standard USB cable between the B receptacle Device SQ Init port **(J37)** and the host PC port.
3. Connect the A receptacle (marked DUT) from the Device SQ test port **(J34)** to the device under test.
4. On the HS Electrical Test Tool application - Device Test menu, select TEST_J from the Device Command dropdown menu. Click EXECUTE once to place the device into TEST_J test mode.

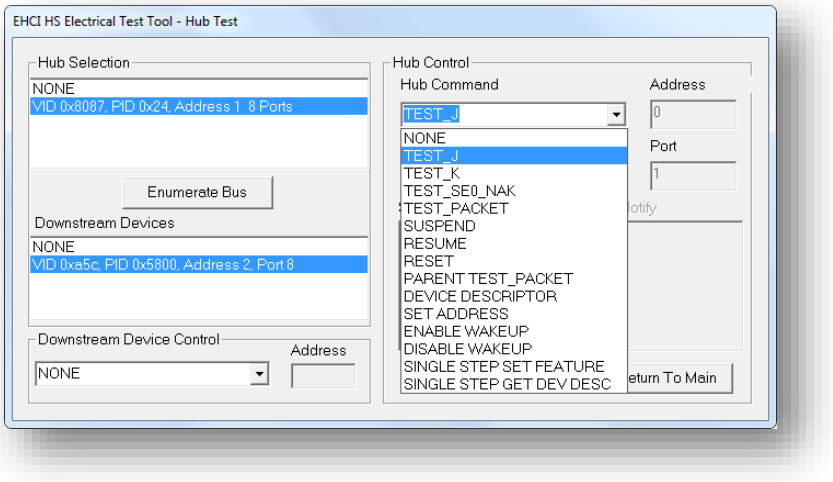


Figure 26: Device TEST_J

5. Switch the test fixture into the TEST position. D+ output voltage must be 400mV +/-10% while D- = 0 +/-10mV.

6. Return the Test switch to the NORMAL position. Cycle the device power. Click Enumerate Bus once to force enumerate the device. This restores the device to normal operation.

7. On the HS Electrical Test Tool application - Device Test menu, select TEST_K from the Device Command dropdown menu. Click EXECUTE once to place the device into TEST_K test mode.

8. Switch the test fixture into the TEST position. D- output voltage must be 400mV +/-10% while D+ = 0 +/-10mV.

9. Return the Test switch to the NORMAL position. Cycle the device power. Click Enumerate Bus once to force enumeration of the device. This restores the device to normal operation.

10. On the HS Electrical Test Tool application - Device Test menu, select TEST_SE0_NAK from the Device Command dropdown menu. Click EXECUTE once to place the device into TEST_SE0_NAK test mode.

11. Switch the test fixture into the TEST position. D+ and D- output voltage must be 0V +/- 10mV.

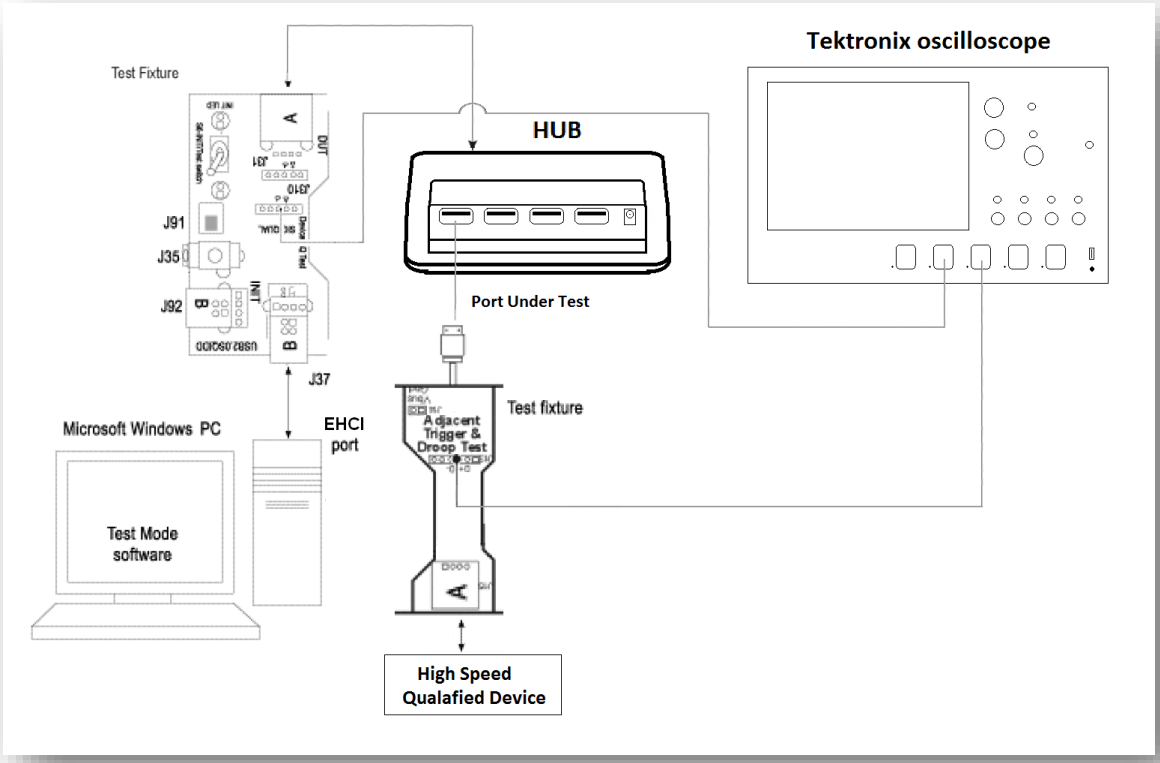
Repeater Test – Upstream
(EL_42, EL_43, EL_44, EL_45)

Specifying the Equipment-J/K & SE0_NAK

The following equipment is needed to test J/K, SE0_NAK measurement:

- Tektronix Digital Oscilloscope
- TDSUSBF compliance test fixture
- Two Differential probes
- 4 inch USB cable

Typical Equipment Setup- Repeater Test



The section used for this device test is Device SQ on the test fixture. To set up the equipment for J/K & SE0_NAK, follow these steps:

1. Set the S6 switch to the **Init** position.
2. Connect a standard USB cable between the B receptacle of the Device SQ Init port **(J37)** and the host PC port.
3. Connect the A receptacle (marked DUT) from the Device SQ test port **(J34)** to the hub under test with the 4 inch USB cable.

4. Attach the Channel 1 differential probe to **J31** of the fixture. Ensure the + polarity on the probe lines up with D+ on the fixture.

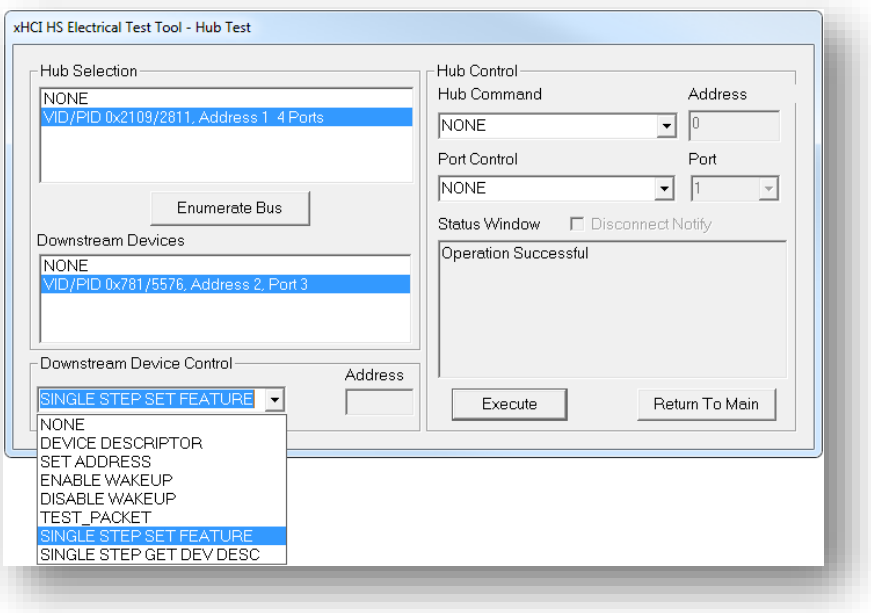
5. Connect the Adjacent trigger section of the test fixture to the downstream port under test of the hub.
6. Attach the Channel 2 differential probe to **J11** of the fixture.
7. Connect a known-good high-speed device to the Init port of this test fixture.
8. Go to scope trigger menu to trigger on:

   a. Width: The EOP is required to be NRZ 01111111 without bit stuffing. Since the only other traffic is SOF's, we can trigger on the EOP; 7 x 2.08ns = 14.56ns

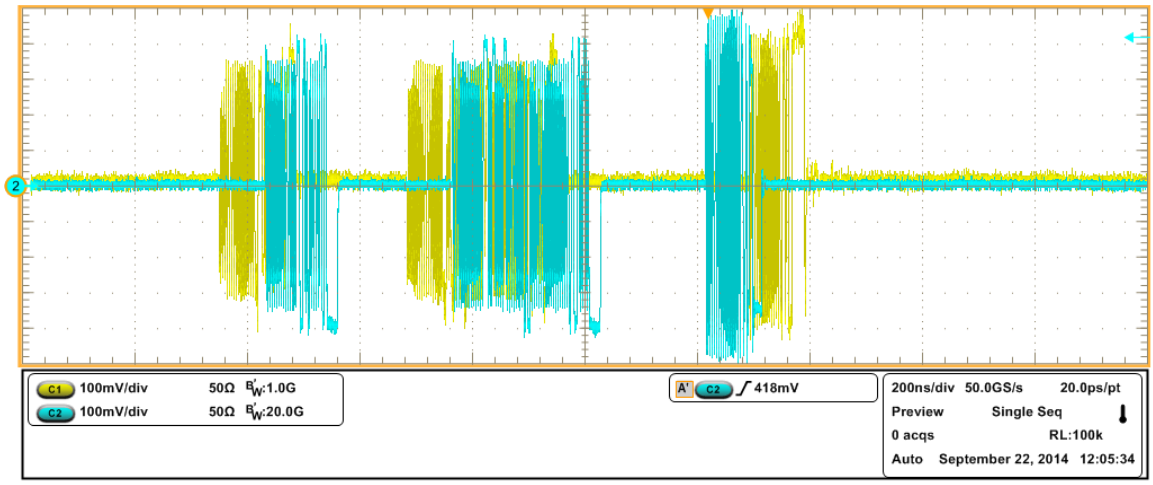
   b. Edge: Since we are measuring at the device, its amplitude should be higher than from the host. Set the Edge trigger just below the nominal voltage of 400mV

9. Adjust the Horizontal Scale to 200ns/div

10. On the HS Electrical Test Tool application – Hub Selection, select **SINGLE STEP SET FEATURE** from the Downstream Device Control.



11. A Single acquisition should appear as follows. The Higher amplitude packets are the response from the device upstream.



- EL_48: Measure the delay between the start of packet between the hub's upstream facing port (Channel 1) and the hub's downstream facing port (Channel 2) on the third packet. This is the delay of the SOF packet through the hub. Verify that this not more than 79us (36 bits plus 4 ns)

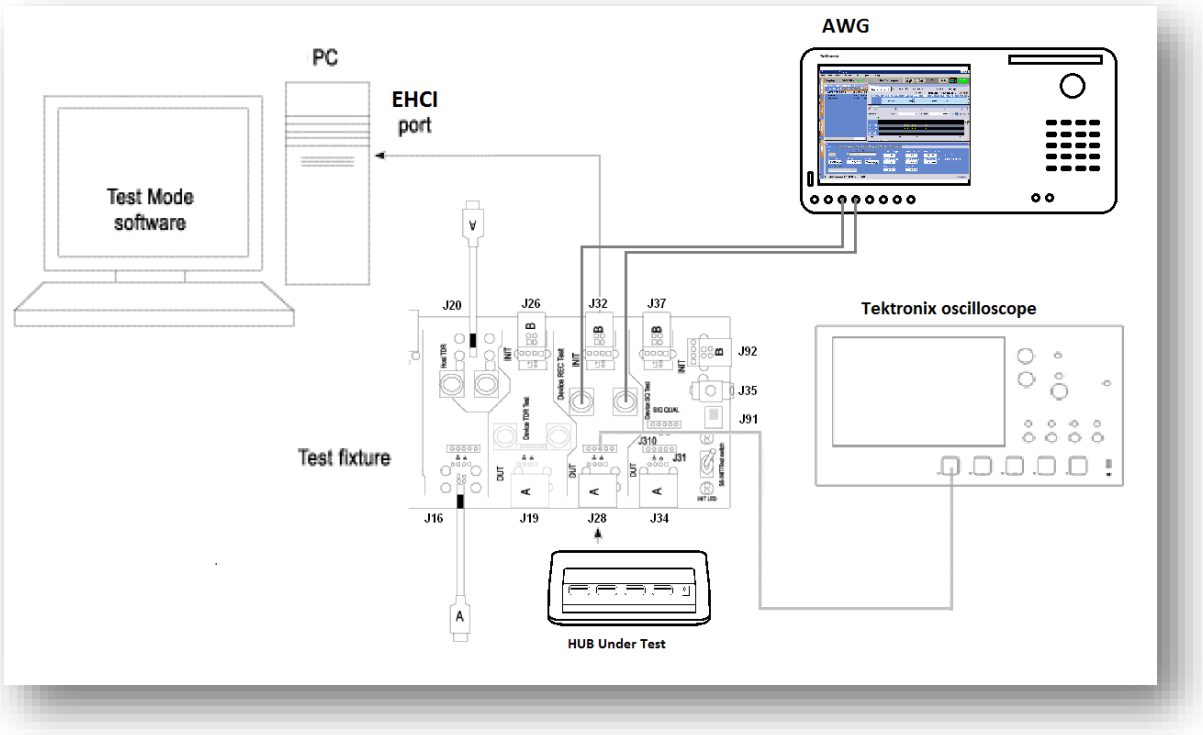
- EL_42: Hub must not truncate more than 4 bits (8.33ns) from a repeated SYNC pattern.
- EL_43: Hubs must not corrupt any repeated bits of the SYNC field.
- EL_44: A hub may add at most 4 random bits (8.33ns) to the end of the EOP field when repeating a packet.
- EL_45: A hub must not corrupt any of the falid EOP bits when repeating a packet.

Receiver Sensitivity - Upstream
(EL_16, EL_17, EL_18)

Specifying the Equipment-Receiver Sensitivity

- Tektronix AWG5000/AWG7000
- Two SMA cables w/ 5x attenuators
- Tektronix digital oscilloscope
- TDSUSBF compliance test fixture
- One differential probe

Typical Equipment Setup-J/K and SE0_NAK



The section used for this device test is Device REC on the test fixture. To set up the equipment for Receiver Sensitivity, follow these steps:

1. Set the S6 switch to the **Init** position.
2. Connect a standard USB cable between the B receptacle Device REC Init port **(J32)** and the host PC port.
3. Connect the A receptacle (marked DUT) from the Device Rec Test port **(J28)** to the Hub Under Test.

4. Connect the differential probe to the test fixture at J25.

5. On the signal generator, select the MIN-ADD1.AWG setup file. This generates IN packets (of compliant amplitude) with a 12-bit SYNC field.

6. Turn on channel 1 on the AWG.

7. On the HS Electrical Test Tool application - Device Test menu, select TEST_SE0_NAK from the Device Command dropdown menu. Click EXECUTE once.

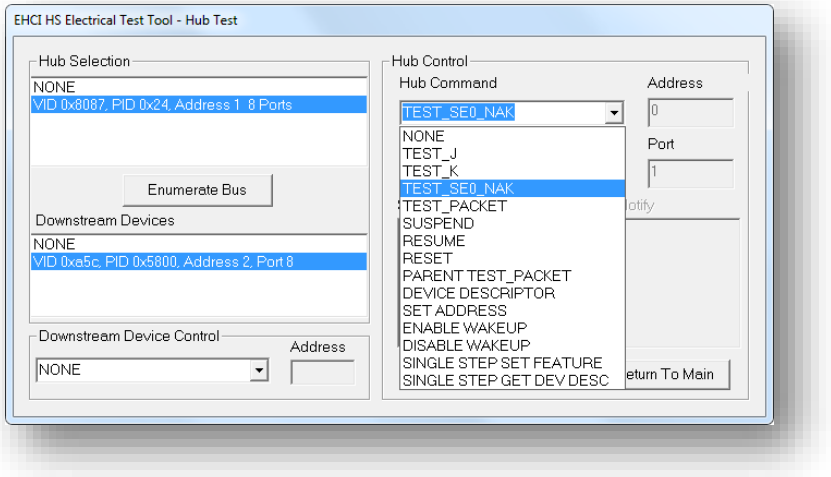


Figure 27: Device TEST_SE0_NAK

8. Place the Test Switch S6 into the TEST position.

9. A NAK response should be present.

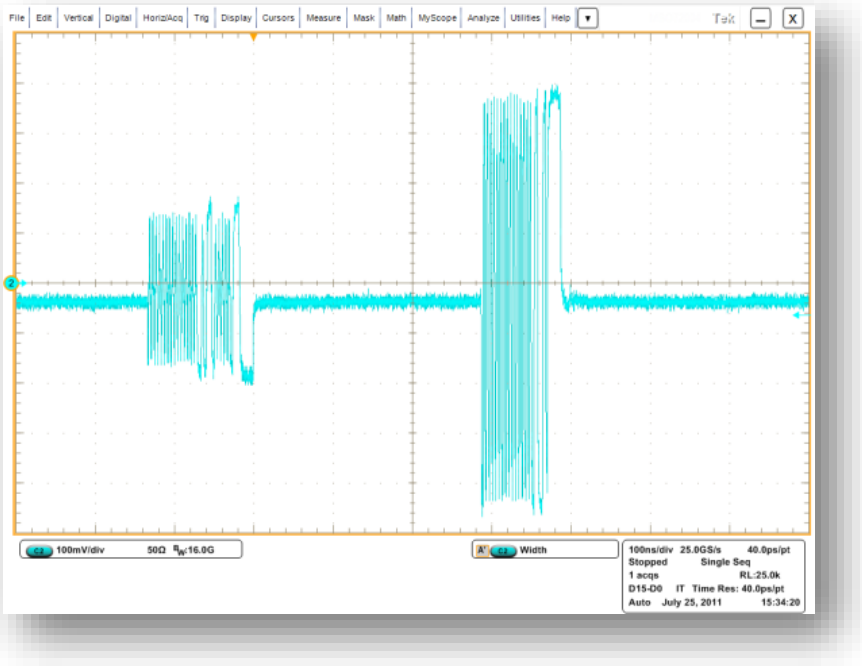


Figure 28: Results of the Receiver Sensitivity Measurement

10. On the data generator, load and run IN-ADD1.AWG setup file.

11. Reduce the amplitude of the data generator packets while monitoring the NAK response from the device on the oscilloscope.

12. Once the NAK packets begin to become intermittent, increase the amplitude till response is stable.

13. EL_17: A high speed capable device must implement a transmission envelope detector that does not indicate squelch when a receiver exceeds +/- 150mV differential amplitude. Amplitude measured from the AWG is EL_17.

14. Measurements should be made from the midpoint plateau (zero voltage) to the Positive Peak and the midpoint plateau to the Negative Peak

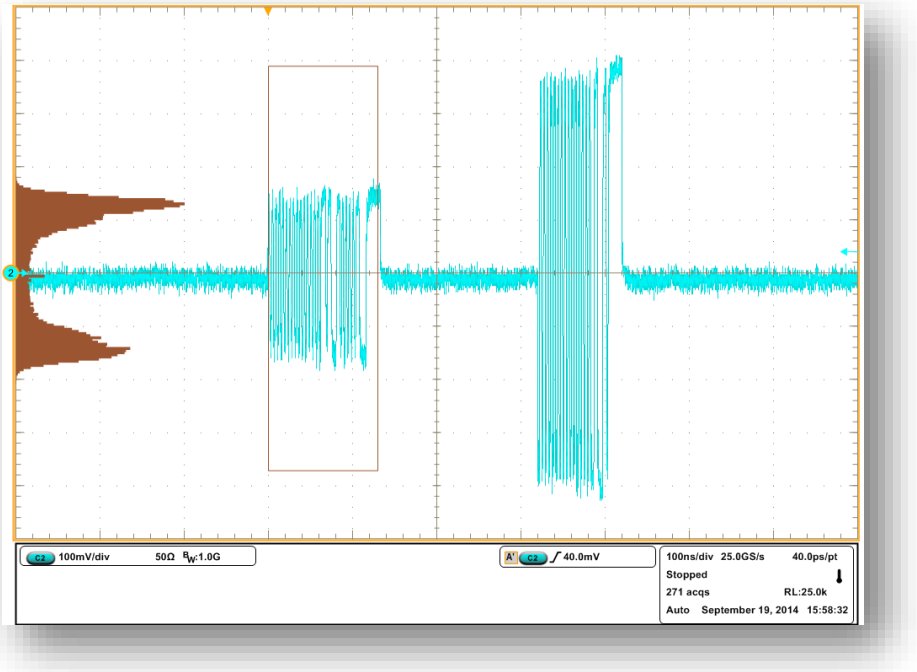


Figure 29: Measuring Differential Voltage Level - Zero to Positive Peak

15. Now reduce the amplitude on the AWG in small steps until the receiver ceases to respond with NAK. This is the squelch level of the receiver.

16. EL_16: A high speed capable device must implement a transmission envelope detector that indicates squelch (i.e. never receives packets) when a receivers input falls below +/- 100mV amplitude.

17. Measurements should be made from the midpoint plateau (zero voltage) to the Positive Peak and the midpoint plateau to the Negative Peak

High-Speed Signal Quality - Downstream
(EL_2, EL_3, EL_6, EL_7)

Specifying the Equipment-Signal Quality Tests for High Speed Devices for Upstream Testing

- Tektronix digital oscilloscope
- USB2SIGQUAL compliance test fixture
- Two SMA cables (phase matched)
- Host PC
- 1 meter USB2.0 cable

Typical Equipment Setup-Signal Quality Tests for High Speed Hub (Downstream Testing)

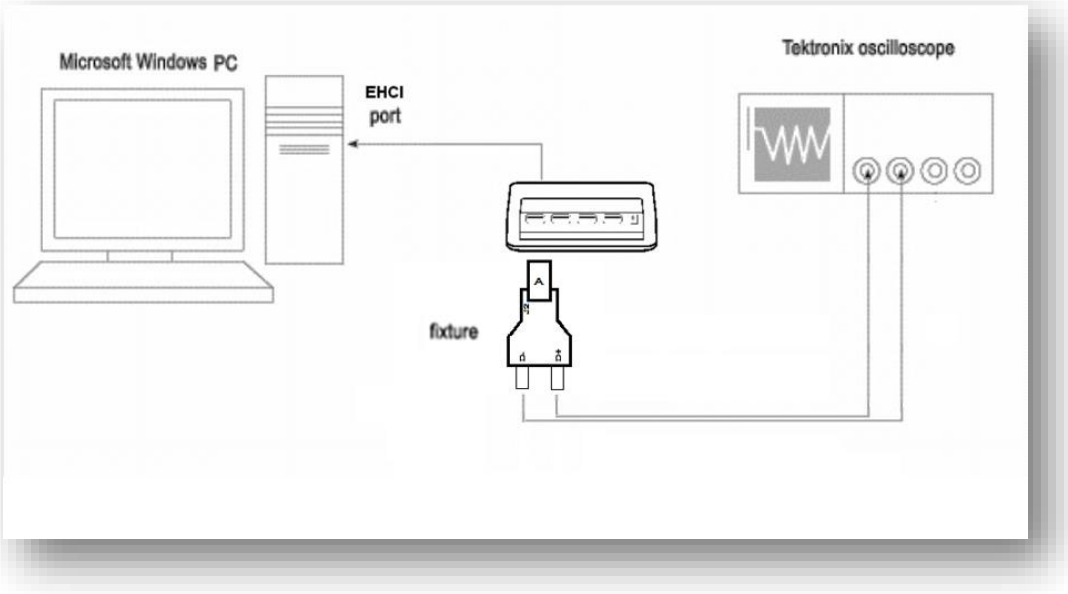


Figure 30: Equipment Setup for Signal Quality Measurement

To setup the equipment for the High Speed Signal Quality test, follow these steps:

1. Connect the USB2SIGQUAL compliance test fixture to the Host port.
2. Connect the two SMA cables from CH1 and CH2 of the oscilloscope to the D+ and D- SMA connections on the fixture.
3. Run the High-Speed Electrical Test Tool software on the host PC. EHCI_HSETT main menu shown in figure below.

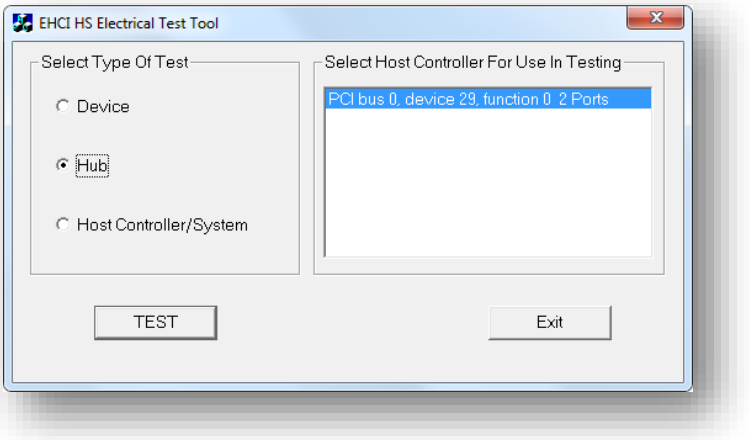


Figure 31: High-Speed Electrical Test Tool - Main Menu

4. Configure the device into the test mode from the host PC controller. Select TEST_PACKET from the Device Command dropdown menu; enter the port number of the hub port being tested; click EXECUTE.

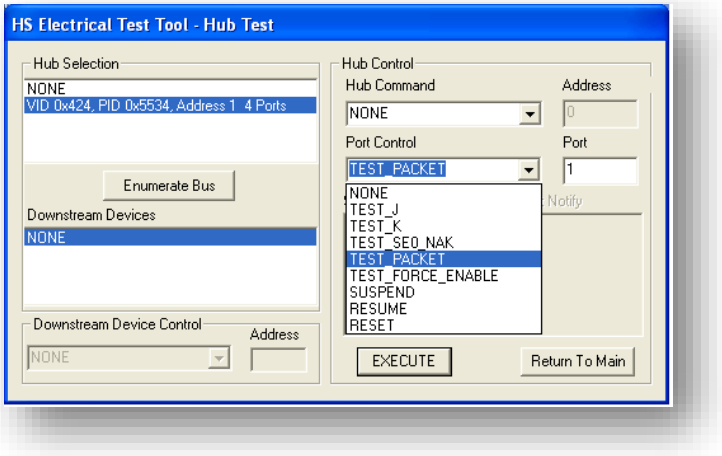


Figure 32: Test Device Packet

Selecting and Configuring Measurements-Signal Quality Tests for High Speed Hub (Downstream Testing)

5. On the Tektronix scope, set your Math channel to **Ch1 - Ch2**

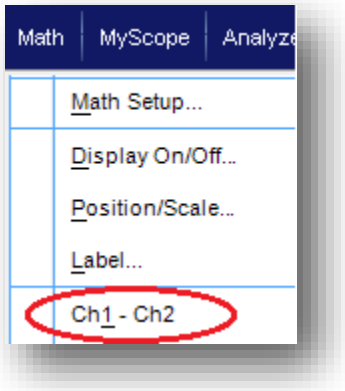


Figure 33: Math Setup

6. Adjust the scope Horizontal scale so that one complete packet is displayed

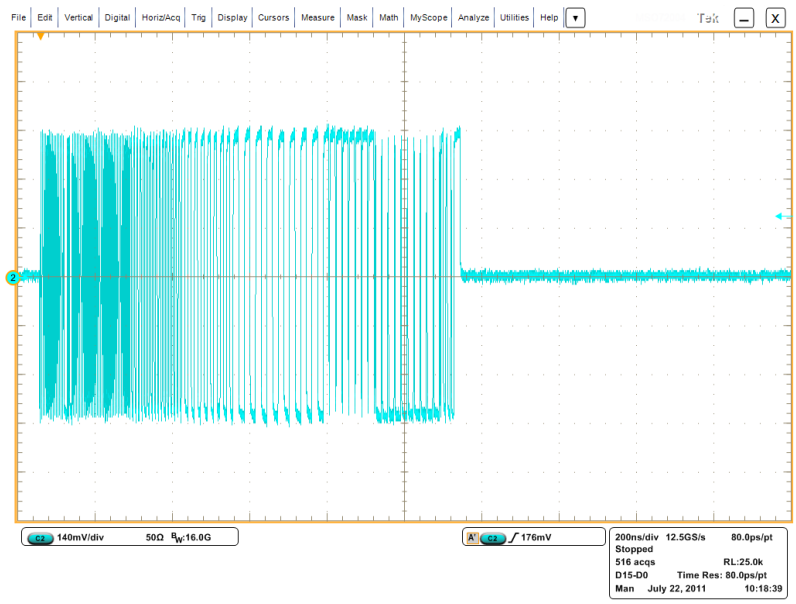


Figure 34: Test Packets

7. Save Math waveform as a CSV (*.csv) or Tek Waveform (*.wfm) for later processing.

Selecting and Configuring Measurements-Signal Quality Tests for High Speed Host (DownStream Testing)

Launch USB Electrical Analysis Tool 2.0 (Download from www.USB.org)

8. From the application menu, select **Device/Host SQ (tab)**.

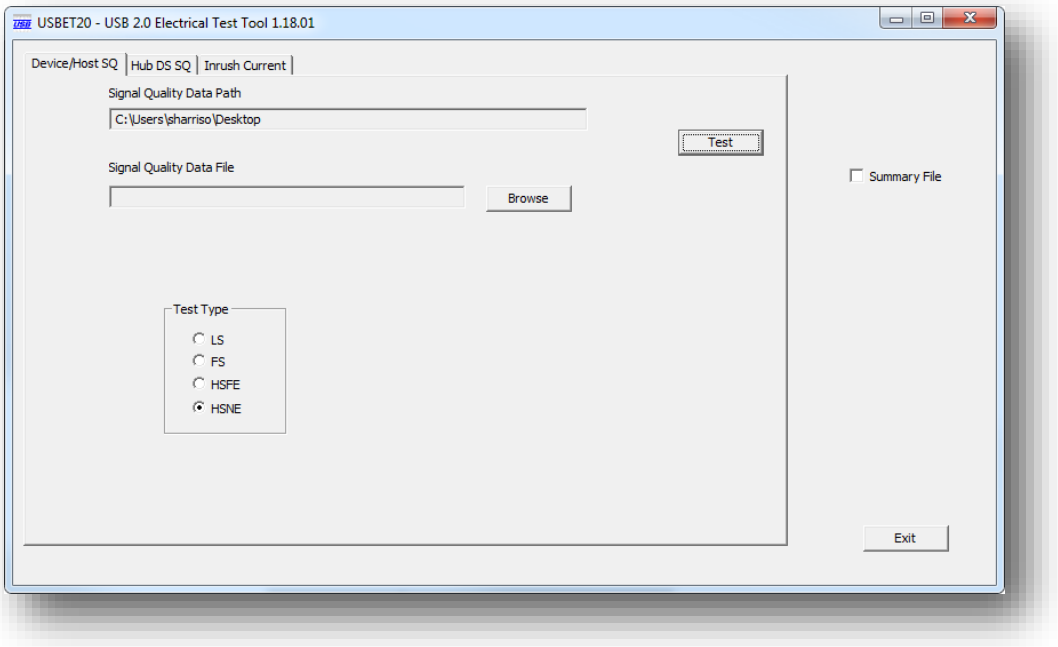


Figure 35: USBET20 Analysis Tool

9. Select the Test Type:
- HSNE (High Speed Near End)

10. Browse to the Math waveform saved from the scope.

11. Press **Test.**

Hub Jitter - Downstream
(EL_47)

Specifying the Equipment-Signal Quality Tests for High Speed Devices for Upstream Testing

The following equipment is needed for signal quality tests on a High Speed device for upstream testing: old

- Tektronix digital oscilloscope
- USB2SIGQUAL compliance test fixture
- Two SMA cables
- 4-inch USB cable

Typical Equipment Setup-Signal Quality Tests for High Speed Hub (Downstream Testing)

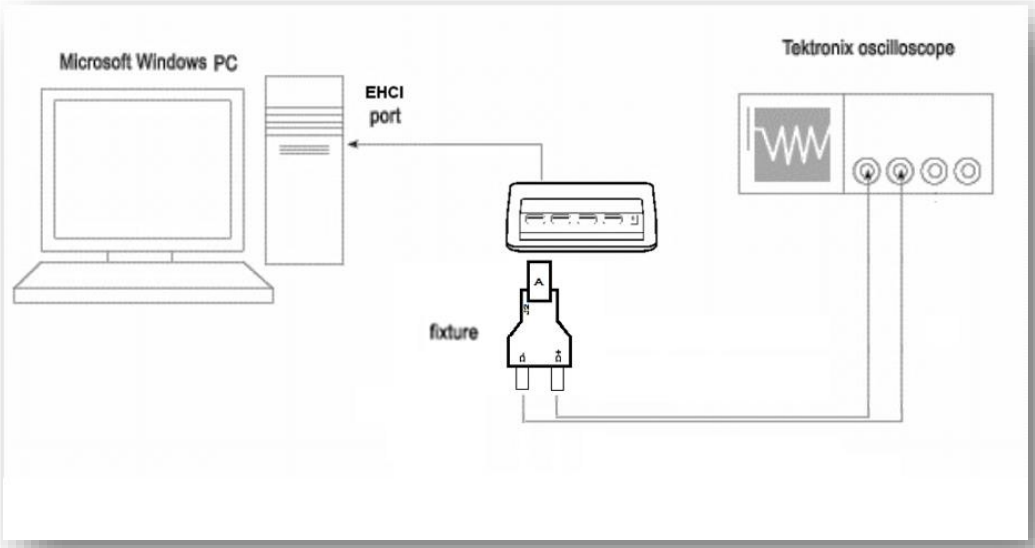


Figure 36: Equipment Setup for Signal Quality Measurement

To setup the equipment for the High Speed Signal Quality test, follow these steps:

1. Connect the USB2SIGQUAL compliance test fixture to the Host port.
2. Connect the two SMA cables from CH1 and CH2 of the oscilloscope to the D+ and D- SMA connections on the fixture.
3. Run the High-Speed Electrical Test Tool software on the host PC. EHCI_HSETT main menu shown in figure below.

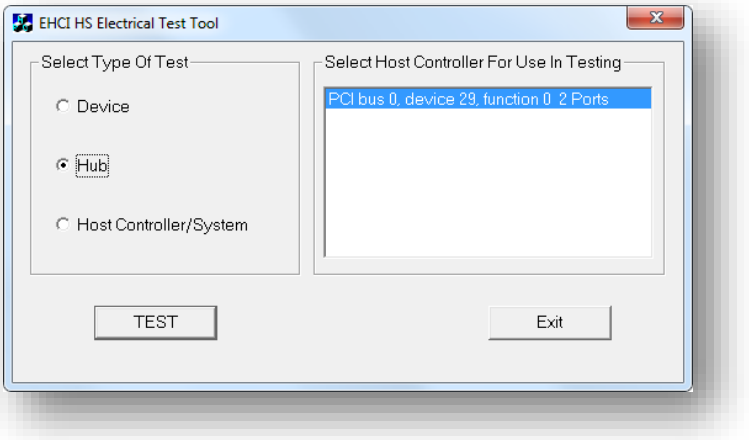


Figure 37: High-Speed Electrical Test Tool - Main Menu

4. Select **TEST_FORCE_ENABLE** from the Port Control dropdown menu. Enter the port number of the hub port being tested and click EXECUTE once.

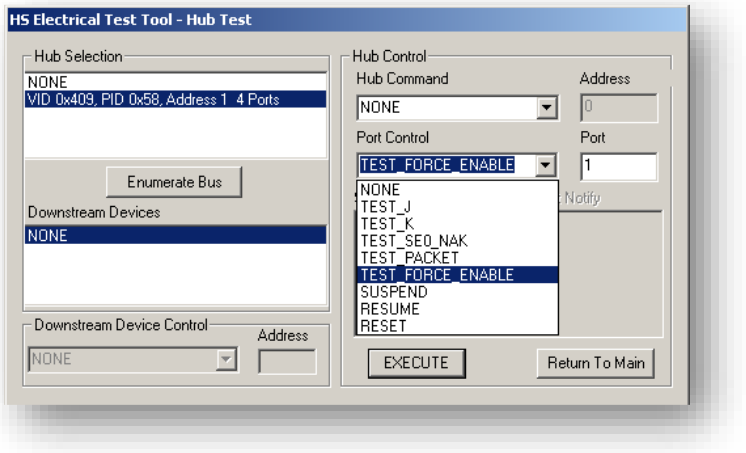


Figure 38: High-Speed Electrical Test Tool - Main Menu

5. Select **PARENT TEST_PACKET** from the Hub Command dropdown menu and click EXECUTE. This forces the parent port in which the hub is connected to continuously output test packets. The hub port under test repeats these test packets and is ready for signal quality and jitter tests.

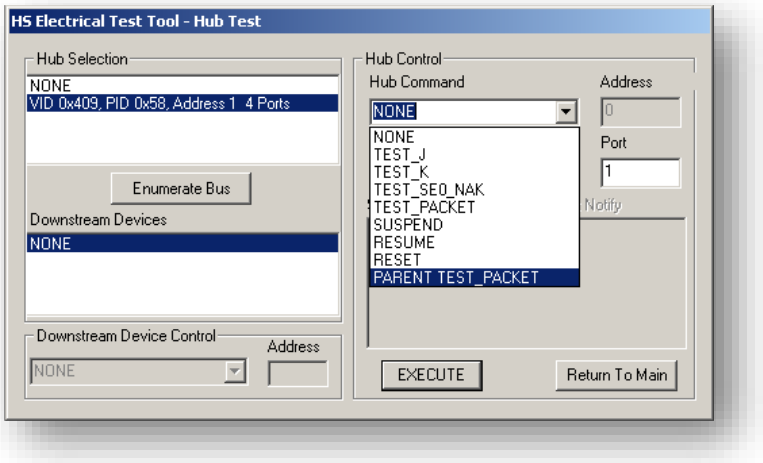


Figure 39: Test Device Packet

Selecting and Configuring Measurements-Signal Quality Tests for High Speed Host (DownStream Testing)

12. On the Tektronix scope, set your Math channel to **Ch1 - Ch2**

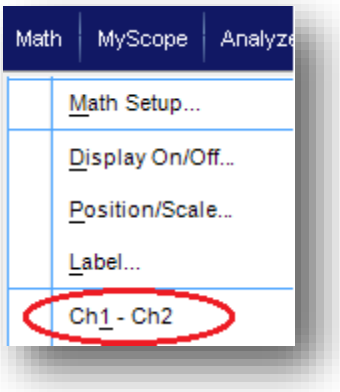


Figure 40: Math Setup

13. Adjust the scope Horizontal scale so that one complete packet is displayed

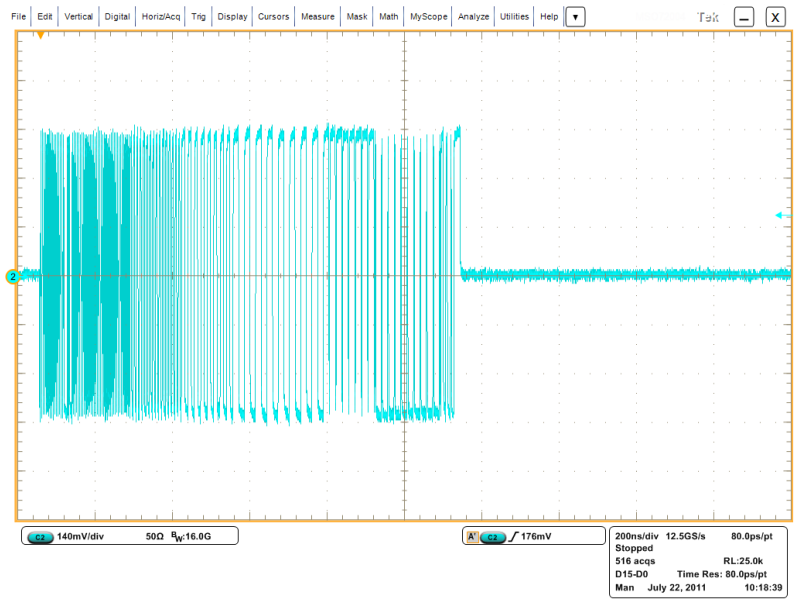


Figure 41: Test Packets

14. Save Math waveform as a CSV (*.csv) or Tek Waveform (*.wfm) for later processing.

Selecting and Configuring Measurements-Signal Quality Tests for High Speed Host (DownStream Testing)

Launch USB Electrical Analysis Tool 2.0 (Download from www.USB.org)

15. From the application menu, select **Device/Host SQ (tab)**.

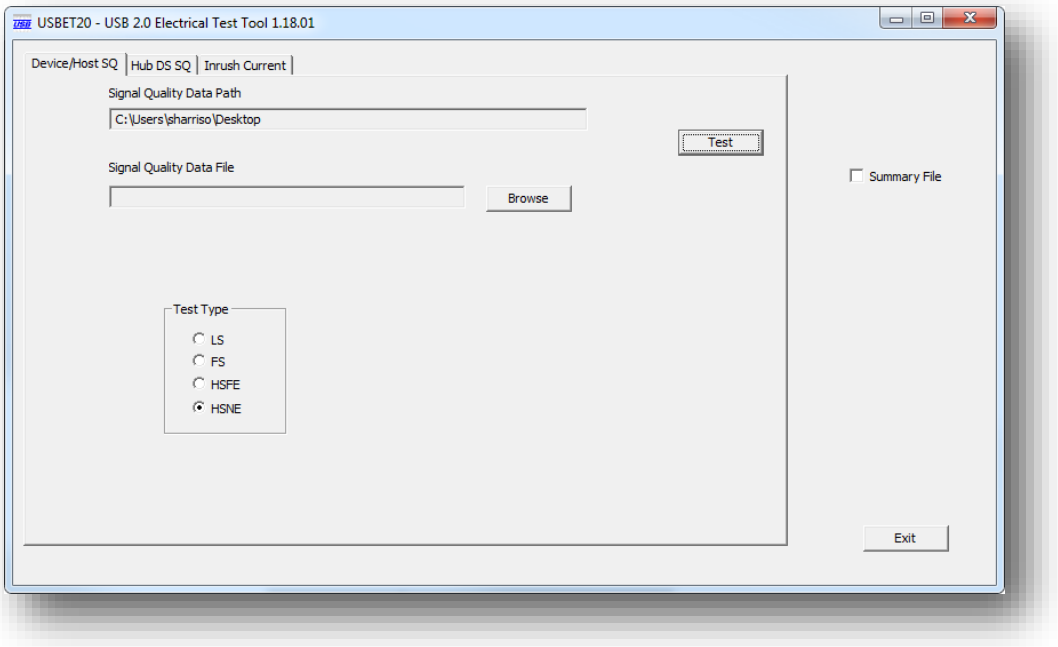


Figure 42: USBET20 Analysis Tool

16. Select the Test Type:
- HSNE (High Speed Near End)

17. Browse to the Math waveform saved from the scope.

18. Press **Test.**

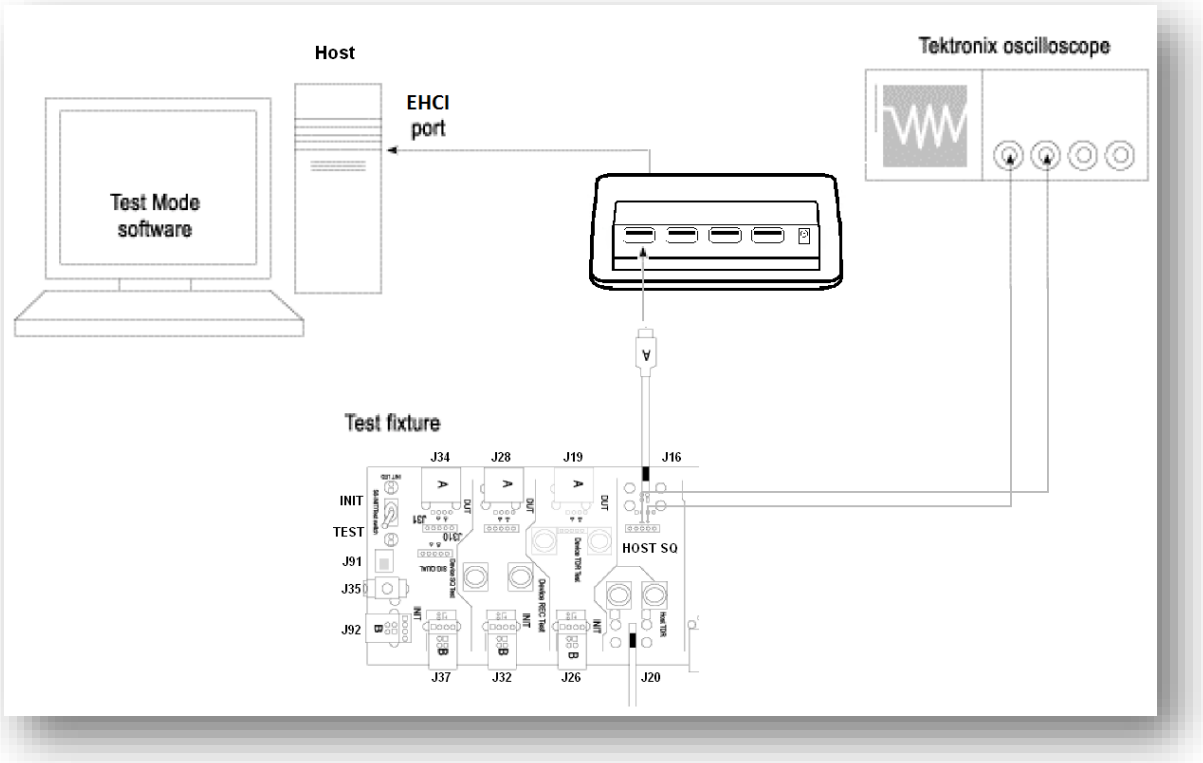
J/K, SE0_NAK – Hub Downstream
(EL_8, EL_9)

Specifying the Equipment-J/K & SE0_NAK

The following equipment is needed to test J/K, SE0_NAK measurement:

- Digital Volt Meter
- TDSUSBF compliance test fixture
- Two single-ended probes

Typical Equipment Setup-J/K and SE0_NAK



The section used for this hub test is Host SQ on the test fixture. To set up the equipment for J/K & SE0_NAK, follow these steps:

1. Connect the Host SQ USB cable **(J16)** to the Hub port under test.

4. On the HS Electrical Test Tool application –select TEST_J from the Port Command dropdown menu. Click EXECUTE once to place the port into TEST_J test mode.

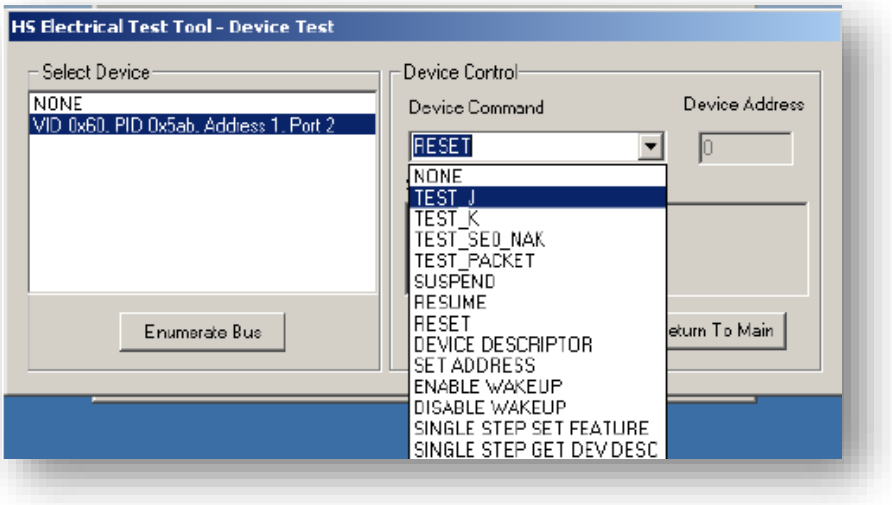


Figure 43: Device TEST_J

5. Connect the single-ended probes; Channel 2 to D- and Channel 3 to D+ on the test fixture pins J15.

6. D+ output voltage must be 400mV +/-10% while D- = 0 +/-10mV.

7. On the HS Electrical Test Tool – Hub Test menu click Enumerate Bus. This restores the device to normal operation.

8. On the HS Electrical Test Tool application - Hub Test menu, select TEST_K from the Port Command dropdown menu. Click EXECUTE once to place the device into TEST_K test mode.

9. Switch the test fixture into the TEST position. D- output voltage must be 400mV +/-10% while D+ = 0 +/-10mV.

10. Return the Test switch to the NORMAL position. Cycle the device power. Click Enumerate Bus once to force enumeration of the device. This restores the device to normal operation.

11. On the HS Electrical Test Tool application - Device Test menu, select TEST_SE0_NAK from the Device Command dropdown menu. Click EXECUTE once to place the device into TEST_SE0_NAK test mode.

12. Switch the test fixture into the TEST position. D+ and D- output voltage must be 0V +/- 10mV.

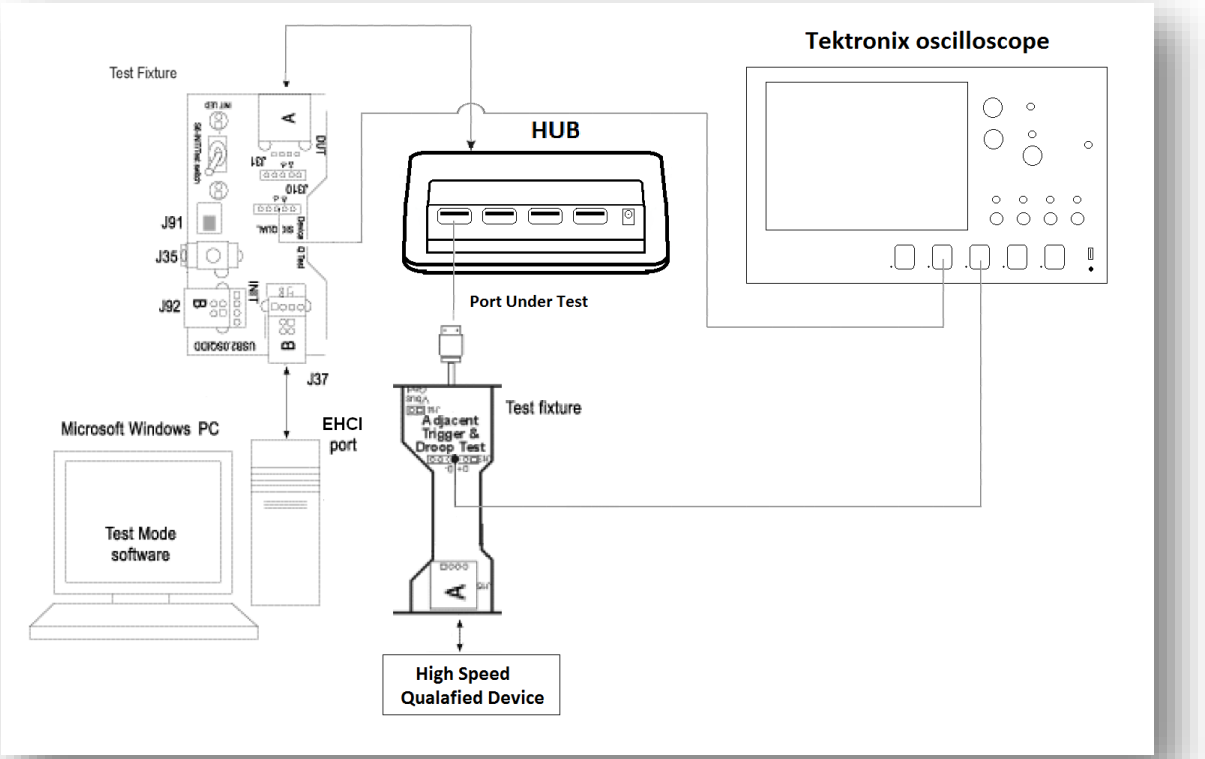
Repeater Test – Downstream
(EL_42, EL_43, EL_44, EL_45, EL_48)

Specifying the Equipment-J/K & SE0_NAK

The following equipment is needed to test J/K, SE0_NAK measurement:

- Tektronix Digital Oscilloscope
- TDSUSBF compliance test fixture
- Two Differential probes
- 4 inch USB cable

Typical Equipment Setup-J/K and SE0_NAK



The section used for this device test is Device SQ on the test fixture. To set up the equipment for J/K & SE0_NAK, follow these steps:

1. Set the S6 switch to the **Init** position.
2. Connect a standard USB cable between the B receptacle of the Device SQ Init port **(J37)** and the host PC port.
3. Connect the A receptacle (marked DUT) from the Device SQ test port **(J34)** to the hub under test with the 4 inch USB cable.

4. Attach the Channel 1 differential probe to **J31** of the fixture. Ensure the + polarity on the probe lines up with D+ on the fixture.

5. Connect the Adjacent trigger section of the test fixture to the downstream port under test of the hub.
6. Attach the Channel 2 differential probe to **J11** of the fixture.
7. Connect a known-good high-speed device to the Init port of this test fixture.

8. On the HS Electrical Test Tool application – Hub Selection, select Enumerate Bus button once.

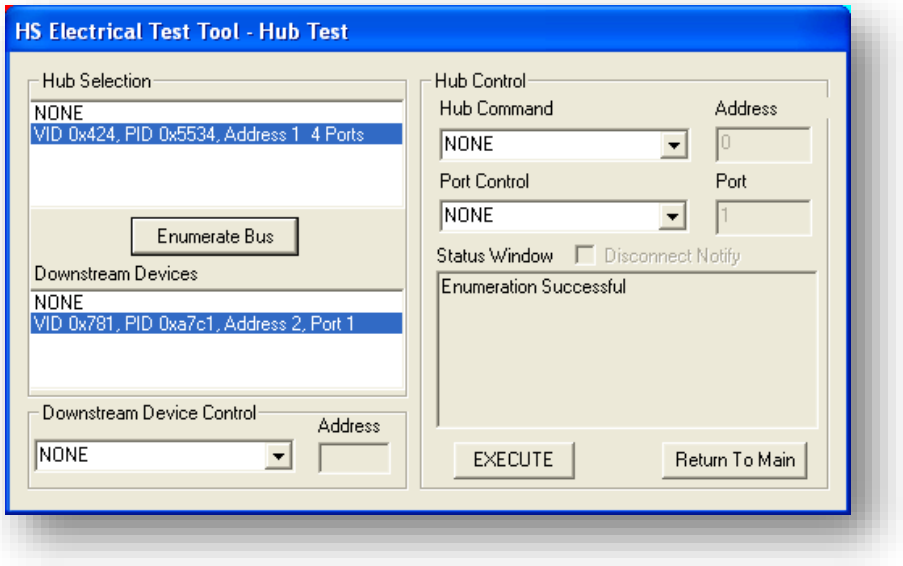


Figure 44: HSET HUB Menu

9. Press Autoset from the oscilloscope; then adjust the Horizontal scale knob to see both SOF's.

10. Using the oscilloscope, verify that the SOF (Start Of Frame) packets are being transmitted on the downstream facing port (Channel 2). A Single acquisition should appear as follows

- EL_48: Measure the delay between the start of packet between the hub's upstream facing port (Channel 1) and the hub's downstream facing port (Channel 2). This is the delay of the SOF packet through the hub. Verify that this not more than 79us (36 bits plus 4 ns)

- EL_42: Hub must not truncate more than 4 bits (8.33ns) from a repeated SYNC pattern.

- EL_43: Hubs must not corrupt any repeated bits of the SYNC field.

- EL_44: A hub may add at most 4 random bits (8.33ns) to the end of the EOP field when repeating a packet.

- EL_45: A hub must not corrupt any of the falid EOP bits when repeating a packet.

Legacy USB Compliance Tests

In addition to the high-speed electrical tests prescribed in this document, the device under test must also pass the following compliance tests applicable to high-speed capable device:

- Full Speed Signal Quality
- Inrush Current

Full-Speed Signal Quality Test – Upstream (Devices)

Specifying the Equipment-Full Speed Signal Quality Tests for Upstream Testing

The following equipment is needed for upstream signal quality check on a low or full speed device:

- Tektronix digital oscilloscope
- TDSUSBF compliance test fixture
- 5 x USB Hubs (One of them Full-Speed)
- 6 x Five Meter USB Cables
- 1 Full Speed USB Certified Device
- Three P6245 or TAP1500 single-ended voltage probes

Typical Equipment Setup-Full Speed Signal Quality Tests for Upstream Testing

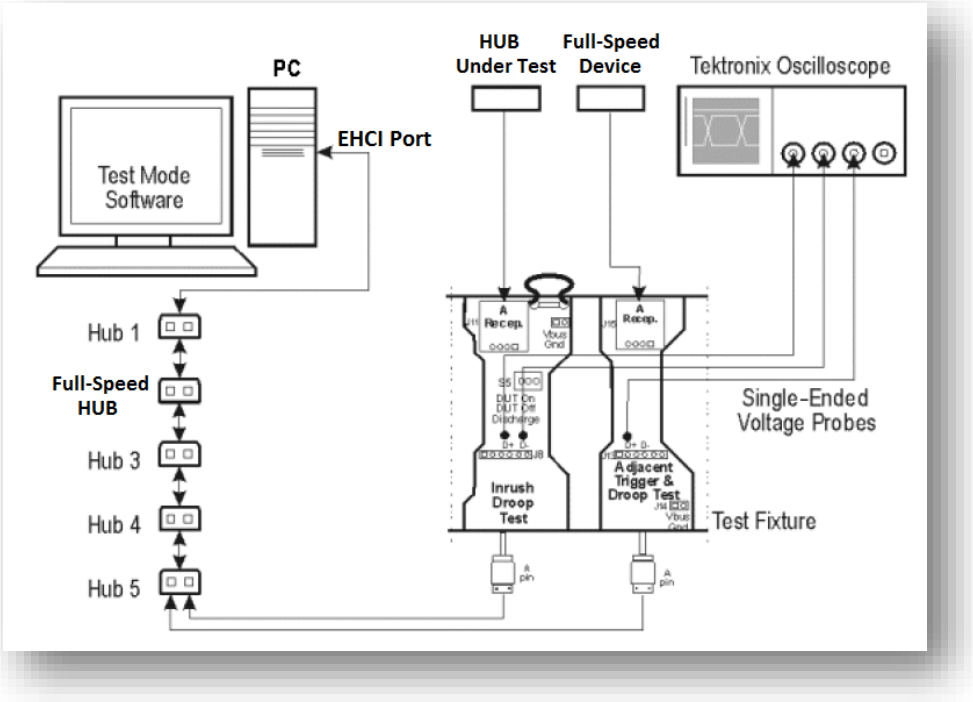


Figure 45: Equipment Setup for Full Speed Signal Quality Measurement

To set up the equipment for Full Speed Signal Quality, follow these steps:

1. **1** Connect the USB Device Under Test (DUT) to the A type USB receptacle of the Inrush Droop section on the test fixture.

2. Connect the Qualifier device to the Adjacent Trigger and Droop section of the test fixture.

3. Connect Ch1 of the D+ probe to the D+ pins on the Inrush Droop section of the test fixture.

4. Connect Ch2 of the D– probe to the D– pins on the Inrush Droop section of the test fixture.

5. Connect the D+ (D- for Low speed) pin of the Adjacent Trigger and Droop Section of the test fixture to Ch3 as shown in the previous figure.

6. Hub #1 is required to be a High Speed Hub and Hub #2 is required to a Full Speed Hub. All Hubs should be self-powered.

7. Run the High-Speed Electrical Test Tool software on the host **PC**.

8. If the device is connected correctly, it should be enumerate on the bottom of the HSETT as shown below.

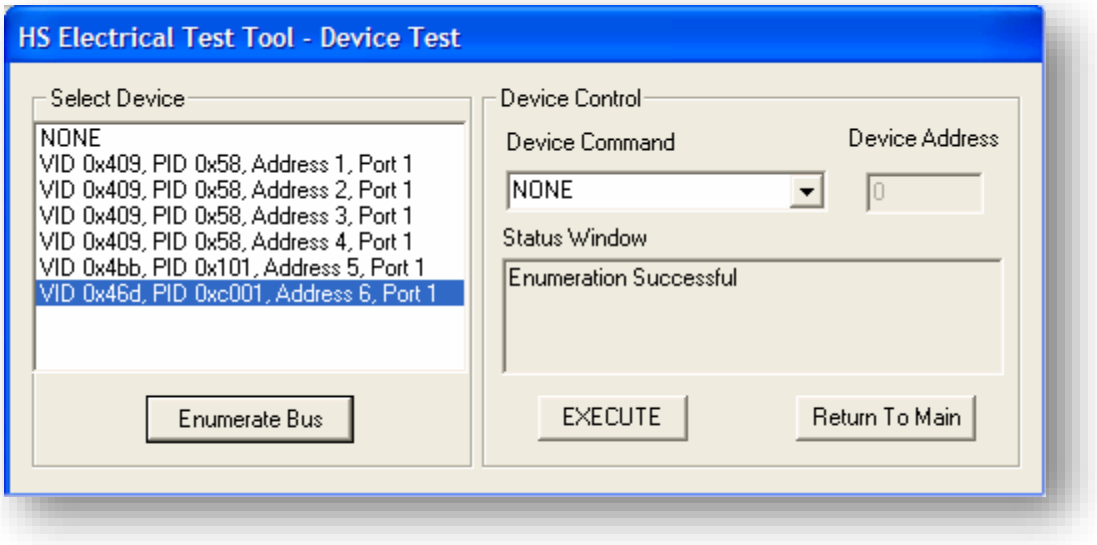


Figure 46: Full-Speed Electrical Test Tool Enumeration

9. Select the LOOP DEVICE DESCRIPTOR option in the Device Command pull down menu and click EXECUTE.

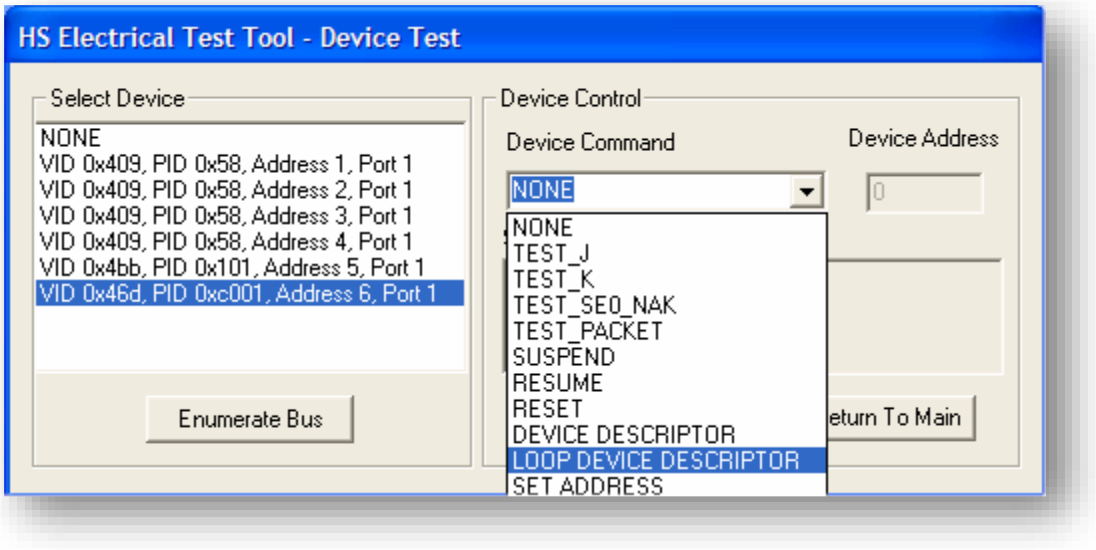


Figure 47: Loop Device Descriptor for Signal Quality Full Speed (Upstream)

10. Set the scope to trigger on **Pattern** 001x; where Ch1 & Ch2 are low and Ch3 (Qualifier Device) is high.

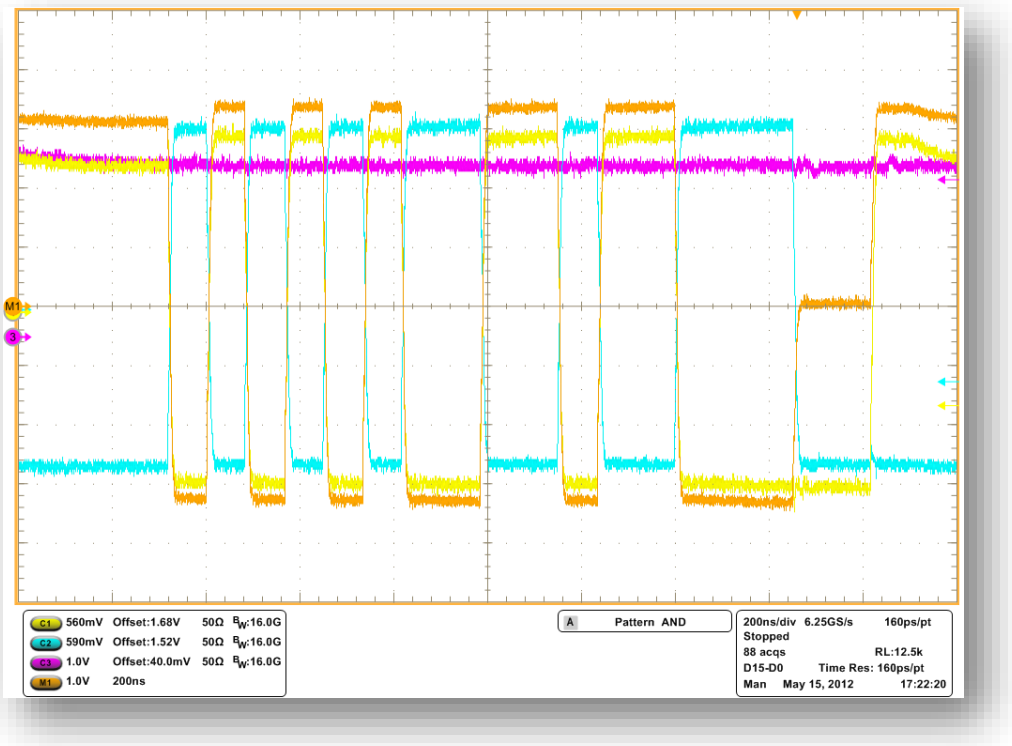


Figure 48: Full Speed Signal Quality trigger

11. Save the waveforms
12. Open USBET20 (download from USB.org)
13. Select the **Device/Host SQ** tab.
14. Browse for your file you saved and select Test

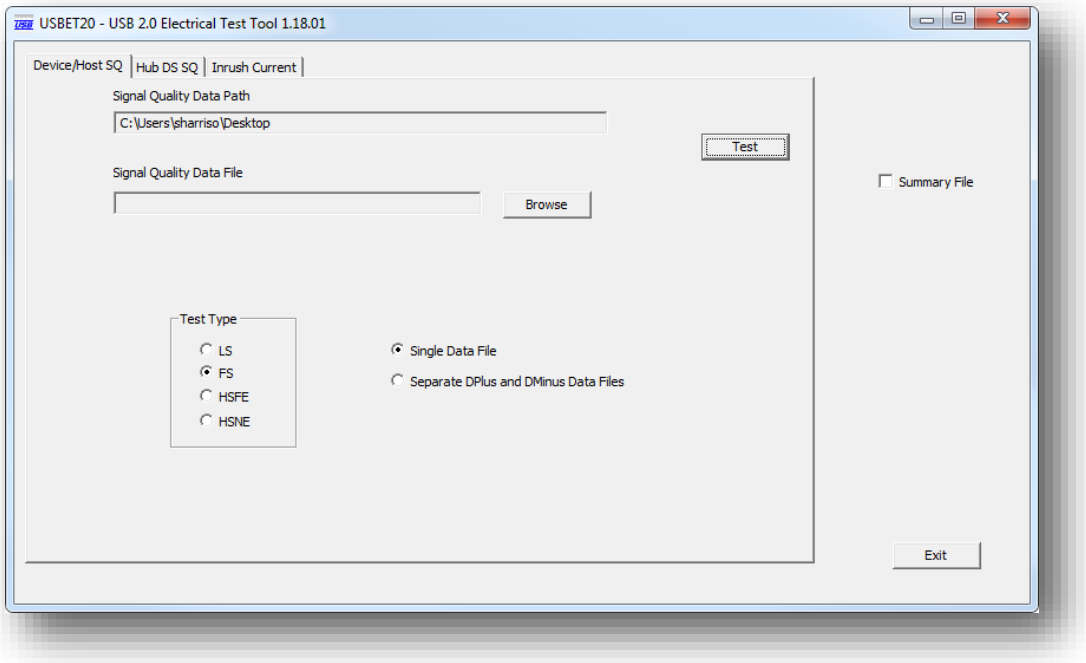


Figure 49: USBET Analysis Tool

Full-Speed Signal Quality Test - Downstream (Host)

Specifying the Equipment-Full Speed Signal Quality Tests for Downstream Testing

- Tektronix digital oscilloscope
- TDSUSBF compliance test fixture
- 4 x USB Hubs (One of them Full-Speed)
- 6 x Five Meter USB Cables
- 1 Full Speed USB Certified Device
- Two P6245 or TAP1500 single-ended voltage probes

Typical Equipment Setup-Full Speed Signal Quality Tests for Downstream Testing

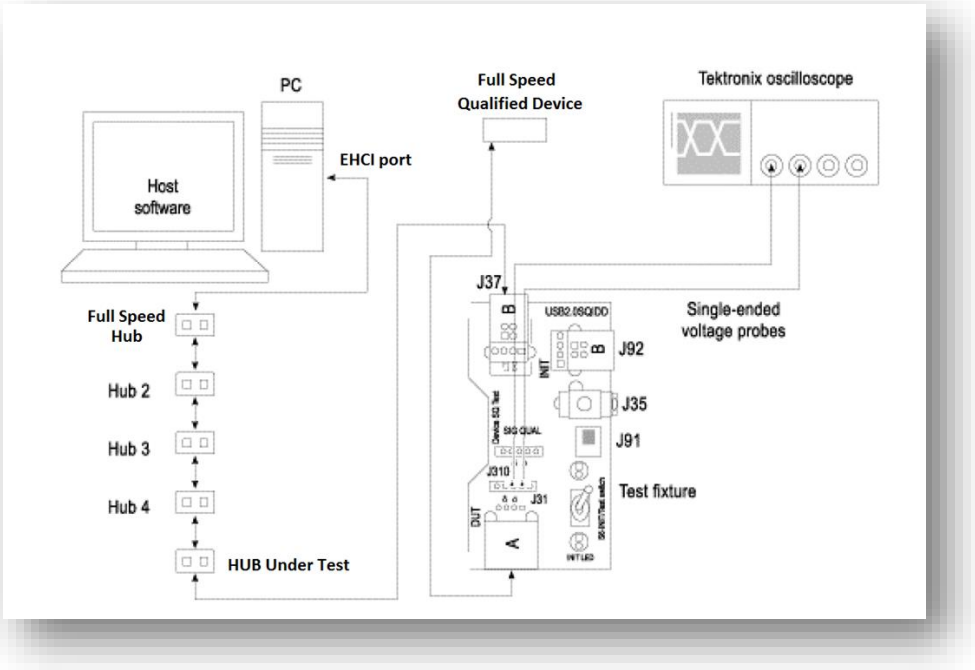


Figure 50: Equipment Setup for Full Speed Signal Quality Measurement

To set up the equipment for Full Speed Signal Quality, follow these steps:

1. Connect the Hub USB port (HUT) to the B type USB receptacle of the Device SQ section **(J37)** on the test fixture.

2. Connect the Full Speed Qualifier device to the A type USB receptacle of the Device SQ **(J34)**.

3. Connect Ch1 probe to the D+ pins **J31**.

4. Connect Ch2 probe to the D– pins **J31**.

5. Hub #1 is required to be a Full Speed Hub. All Hubs should be self-powered.

Selecting and Configuring Measurements-Full Speed Signal Quality Tests for Upstream Testing

1. Set the trigger to trigger on D+ **Rising** edge at 500mV
2. On the Tektronix scope, set your Math channel to **Ch1 - Ch2**

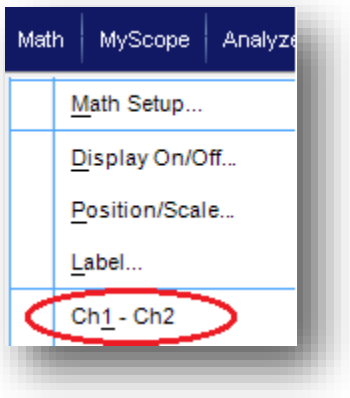


Figure 51: Math Setup

3. Adjust the scope Horizontal scale so that one complete packet is displayed
4. Save Math waveform as a CSV (*.csv) or Tek Waveform (*.wfm) for later processing.
5. Launch USB Electrical Analysis Tool 2.0 (Download from USB.org)
6. From the application menu, select **Hub DS SQ (tab)**.

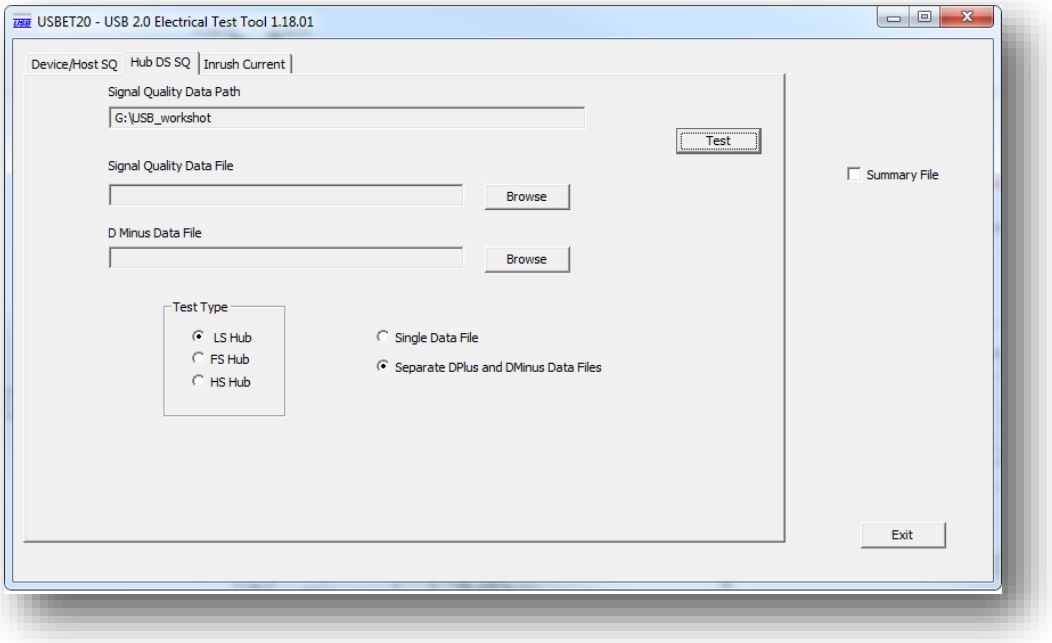


Figure 52: USBET20 Analysis Tool

12. Select the Test Type:
- FS

13. Browse to the Math waveform saved from the scope.

14. Press **Test.**

Droop Test for Hub Ports
(EL_2, EL_3, EL_6, EL_7)

Specifying the Equipment-Signal Quality Tests for High Speed Devices for Upstream Testing

The following equipment is needed for signal quality tests on a High Speed device for upstream testing: old

- Tektronix digital oscilloscope
- TDSUSB2 application
- TDSUSBF compliance test fixture
- Two Active single-ended probes

Typical Equipment Setup-Signal Quality Tests for Hub Droop Test

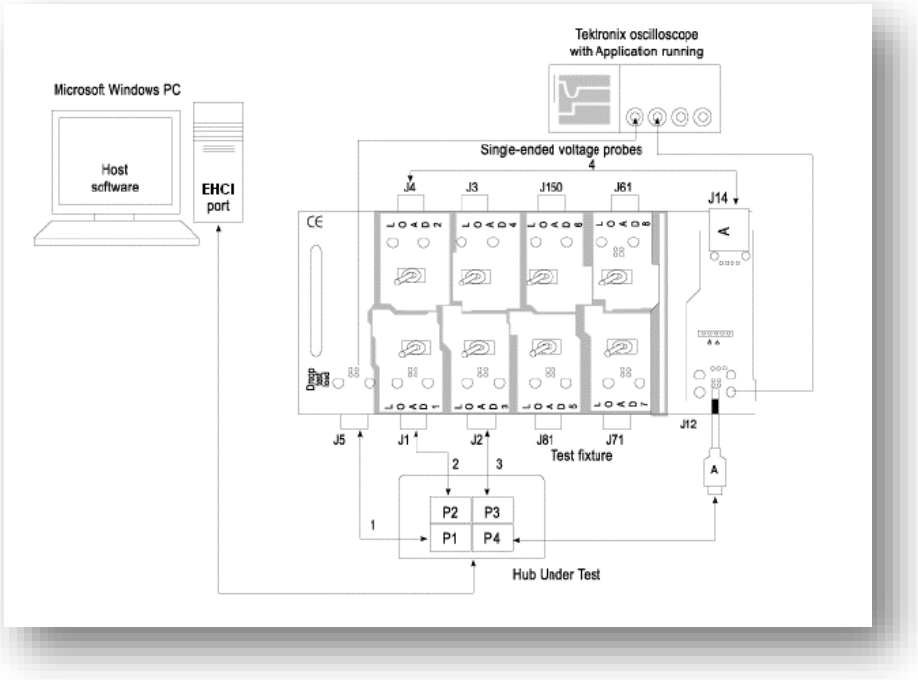


Figure 53: Equipment Setup for Signal Quality Measurement

To setup the equipment for Droop test, follow these steps:

1. Use the Droop and Adjacent Trigger section of the TDSUSBF fixture.
2. Connect Ch1 of the oscilloscope to the Adjacent Trigger VBUS (J13).
3. Connect Ch2 of the oscilloscope to the Droop Load Trigger Timer located on the Droop Test Load Board.
4. Set the Loads to 100mA for bus powered ports & 500mA for self-powered hubs
5. Connect the Droop Test Load (J5) to Port1 of the Hub

6. Connect the Load1 to Port2 of the Hub
7. Connect the Load2 to the A receptacle of the Droop and Adjacent Trigger (J14) section on the test fixture. Connect the A pin dongle from the Droop and Adjacent Trigger section to the Port4 of the Hub. Port4 is the port under test of the hub.
8. Connect the Load3 to Port3 of the Hub. Now all the ports of the HUB are connected.

Selecting and Configuring Measurements-Droop Test for High Speed Hub (Downstream Testing)

Launch the TDSUSB2 software application on the oscilloscope:

1. From the application menu, select Measurement> Select> High speed (tab).

2. Select the tests:

- Droop Test

Configuring the Measurement

Follow the steps to configure the selected measurements:

3. From the application menu, select Measurement> Configure> Configure tab.

4. Configure the following options:

Table 1: Configuring Measurements

Option	Set to
Port	*Port 4*
Hub type	*Self-powered / Bus-powered*
Vbus	Ch1
Trigger	Ch2

18. Select  to acquire the data.

19. Repeat for each of the remaining ports

Inrush Current Test – Upstream Facing Port

Specifying the Equipment-Full Speed Inrush Current Test

- Tektronix digital oscilloscope
- TDSUSBF compliance test fixture
- One TCP202 current probe

Typical Equipment Setup-Inrush Current Test

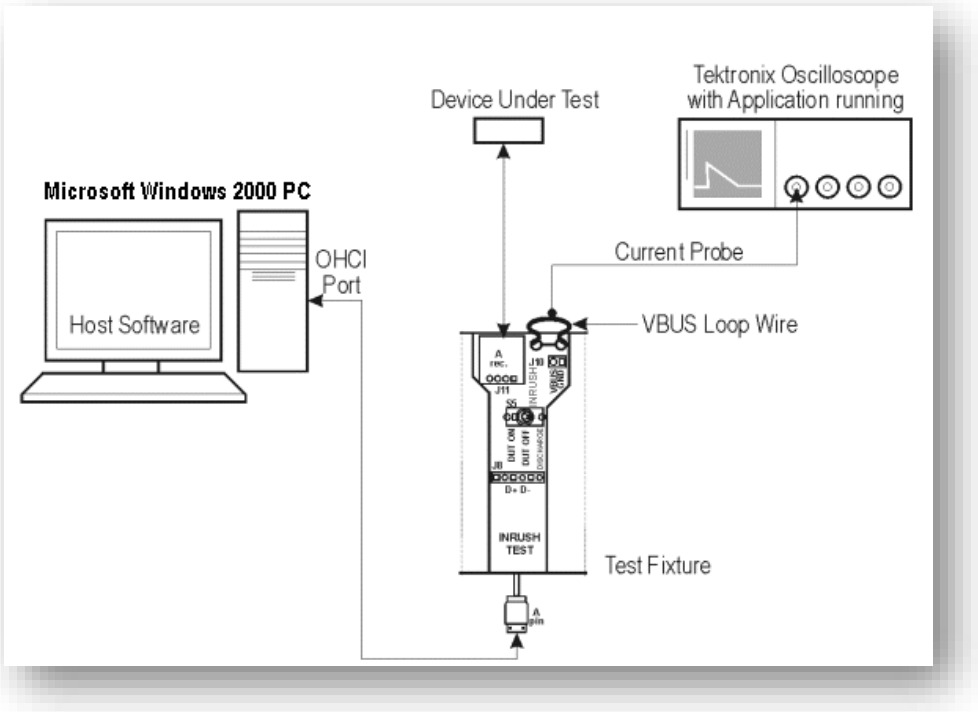


Figure 54: Equipment Setup for Full Speed Inrush Current Test

To set up the equipment for Inrush test, follow these steps:

1. Connect the current probe between the V_{BUS} Loop Wire on the Inrush section on the Test fixture and Ch1 of the oscilloscope.
2. Connect the Device Under Test to the A USB Receptacle of the Inrush section on the SQiDD fixture.
3. Place Switch on SQiDD board to position 3 (**DISCHARGE**) - shorting VBUS to Gnd on DUT to discharge device capacitance.
4. Unplug DUT.

5. Place Switch on SQiDD board to position 1 (**DUT ON**) - Switching VBUS on.
6. Plug in DUT to the SQiDD board. Do not use the switch on the fixture to open/close V_{bus} with the DUT attached since the switch bounce will cause errors in the actual inrush current measurement.
7. Save the Waveform after acquiring

Note: If there is no inrush event found, i.e. the current never rises above 100 mA, the result is considered a failure. A minimum of 1µF (microfarad) is required on all USB peripherals as required by the "Device Capacitance ECN"

8. Open USBET20 (download from USB.org)
9. Select the **Inrush Current** tab.
10. Browse for your file you saved and select Test

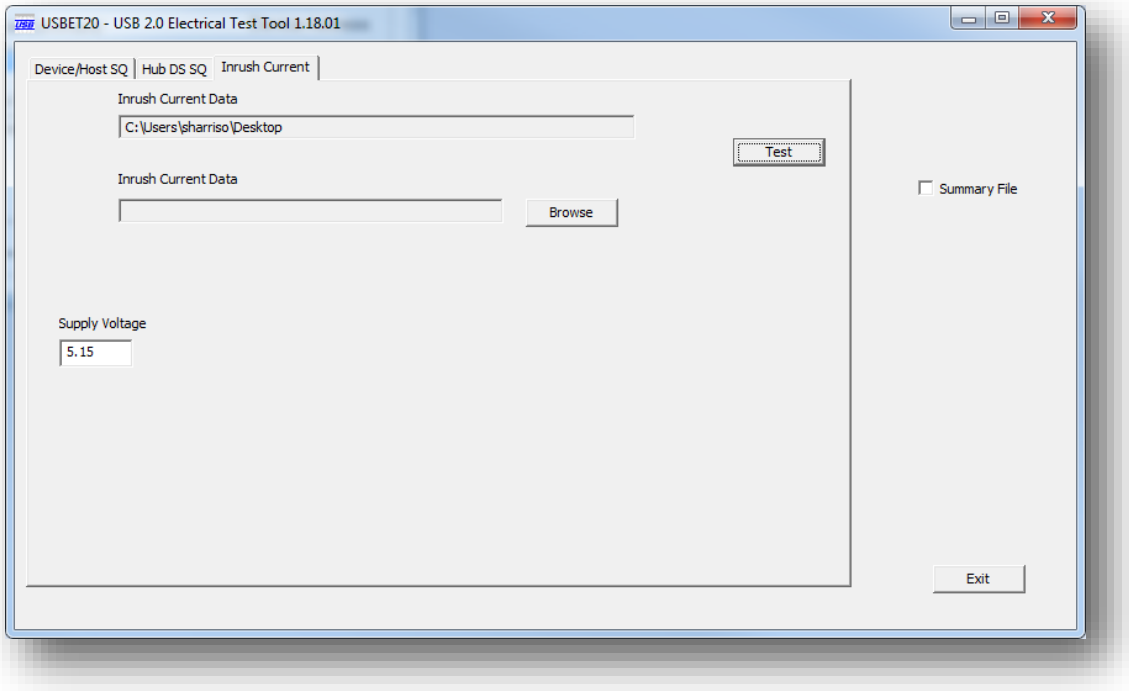


Figure 55: USBET20 Analysis Tool