USB 2.0 Electrical Compliance Test User Manual

User Manual

EN01A

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CONTENT

1 Introduction

FX-USB2 is a test fixture launched with the USB 2.0 compliance test function of SDS7000A digital oscilloscope, and the two together can easily and quickly complete the USB-IF test on all electrical items of hosts, devices and hubs. This manual contains introductions to the FX-USB2 and USB 2.0 compliance test.

2 Test Items

FX-USB2 and SDS7000A's USB 2.0 compliance test function combine to support the following USB 2.0 electrical compliance measurements:

- **Host Tests**

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

  High-Speed DS Packet Parameters (EL_21, EL_22, EL_23, EL_25, EL_55)

  High-Speed DS Chirp Timing (EL_33, EL_34, EL_35)

  High-Speed DS Suspend Resume (EL_38 EL_39, EL_41)

  High-Speed DS Not Driven Voltage Levels (EL_8, EL_9)

  Full-Speed DS Signal Quality

  Low-Speed DS Signal Quality

  Drop

  Droop

- **Device Tests**

  High-Speed US Signal Quality (EL_2, EL_4/EL_5, EL_6, EL_7)

    Far-end for tethered hubs (EL_5)

    Near-end for un-tethered hubs (EL_4)

  High-Speed US Packet Parameters (EL_21, EL_22, EL_25)

  High-Speed US Chirp Timing (EL_28, EL_29, EL_31)

  High-Speed US Suspend Resume (EL_38 EL_39, EL_40 EL_41)

  High-Speed to Reset (EL_27, EL_29, EL_31)

  Suspend to Reset (EL_28, EL_29, EL_31)

  High-Speed US Not Driven Voltage Levels (EL_8, EL_9)

  High-Speed US Receiver Sensitivity (EL16, EL17, EL18)

  Full-Speed US Signal Quality

  Low-Speed US Signal Quality

  Back Voltage

  Inrush

- **Hub Tests**

  High-Speed Signal Quality

    Downstream: EL_2, EL_6, EL_7, EL_47

    Upstream: EL_2, EL_6, EL_7, EL_46

  High-Speed Packet Parameters

    Downstream: EL_21, EL_22, EL_23, EL_25, EL_55

    Upstream: EL_21, EL_22, EL_25

  High-Speed Chirp Timing

- Downstream: EL_33, EL_34, EL_35
- Upstream: EL_28 EL_29, EL_31

High-Speed Suspend Resume

- Downstream: EL_38 EL_39, EL_41
- Upstream: EL_38 EL_39, EL_40 EL_41

Upstream High-Speed to Reset (EL_27, EL_29, EL_31)

Upstream Suspend to Reset (EL_28, EL_29, EL_31)

High-Speed Not Driven Voltage Levels

Upstream/Downstream: EL_8, EL_9

High-Speed US Repeater (EL_42, EL_43, EL_44, EL_45, EL_48)

High-Speed DS Repeater (EL_42, EL_43, EL_44, EL_45, EL_48)

High-Speed US Receiver Sensitivity

Full-Speed Signal Quality (Upstream/Downstream)

Low-Speed Signal Quality (Upstream/Downstream)

Drop

Droop

Inrush

Back Voltage

3 Test Equipment

The following equipment is required for complete USB 2.0 compliance test.

3.1 SIGLENT Provision

- Oscilloscope (SDS7000A): >2GHz BW, with USB 2.0 compliance software (SDS7000A-CT-USB2) activated as the USB 2.0 electrical compliance analysis tool.
- Fixture (FX-USB2): USB 2.0 electrical compliance test fixture that guides devices and hubs to the relevant test state and provides test points.
- Differential Probe (SAP2500D or SAP5000D): 2GHz or higher bandwidth for HS tests.
- Single-ended probe (SAP2500): 2GHz or higher bandwidth for HS/FS/LS tests.
- Low Bandwidth Probe: 500MHz bandwidth for HS (except Packet Parameters)/FS/LS tests.
- Current Probe: for upstream inrush test only.
- Arbitrary Waveform Generator (SDG7000A): for HS trigger sensitivity test only.

3.2 Additional Equipment

- Certified High-Speed USB self-powered hub (4 ea.): for FS/LS tests.
- Certified Full-Speed USB self-powered hub: for FS/LS tests.
- 5 meter USB cables Type-A to Type-B male (6 ea.): for FS/LS tests.
- 1 meter USB cables Type-A to Type-B male (quantity depending on test items): for HS/FS/LS tests.
- Certified Low-Speed trigger device (e.g. USB mouse): for LS tests.
- Certified Full-Speed trigger device: for FS tests.
- Certified High-Speed trigger device (e.g. USB flash drive): for HS tests.
- Computer (USBHSET installed): for HS host tests.

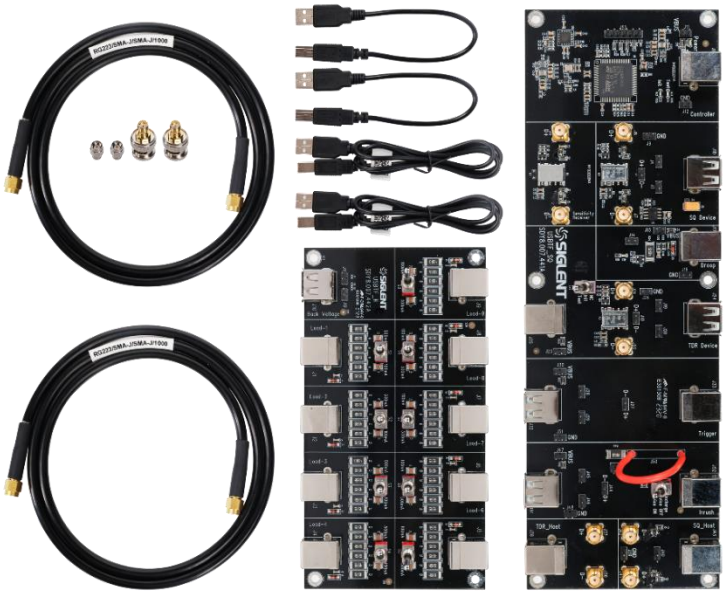
4 Fixture

The FX-USB2 is a test fixture launched to match the USB 2.0 compliance test function of the SDS7000A. The processor on the board can control the devices and hubs to enter the test mode, reset, suspend, etc. according to the user's test requirements, simplifying the test process.
Host tests require the host under test to be placed into test mode autonomously. For related software, please refer to the section "USB IF Official Application".

4.1 Delivery Checklist

The FX-USB2 is placed inside a black suitcase. Please verify that all items listed on the packing list have been delivered. If you note any omissions or damage, please contact SIGLENT customer service center or distributor as soon as possible. If you fail to contact us immediately in case of omission or damage, we will not be responsible for replacement.

Item	Quantity
User manual	1
Signal board (USBTF_SQ)	1
Load board (USBTF_R)	1
SMA cable	2
BNC-SMA adapter	2
Short type-A to type-B cable	2
1 meter type-A to type-B cable	2
50Ω terminal (SMA)	2

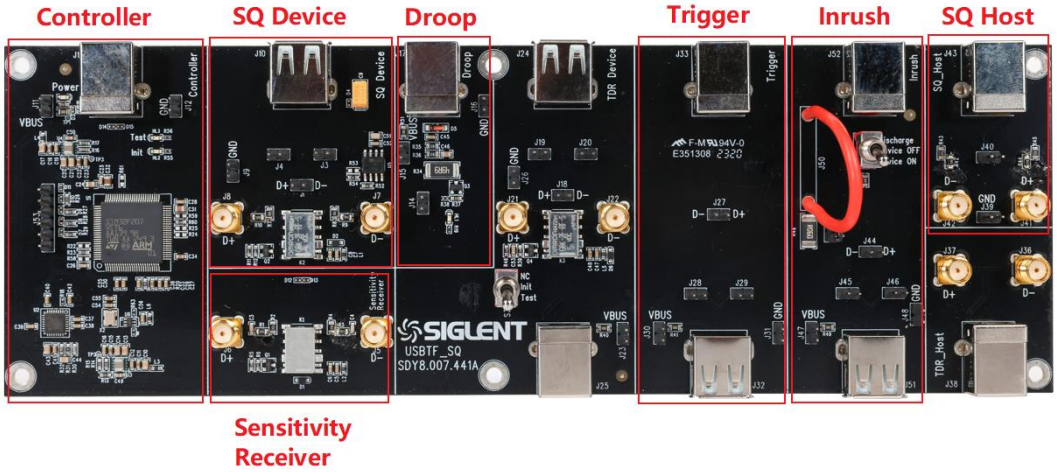


4.2 Introduction to Functional Modules

FX-USB2 includes 2 boards, the signal board (USBTF_SQ) and the load board (USBTF_SR).

4.2.1 Signal board

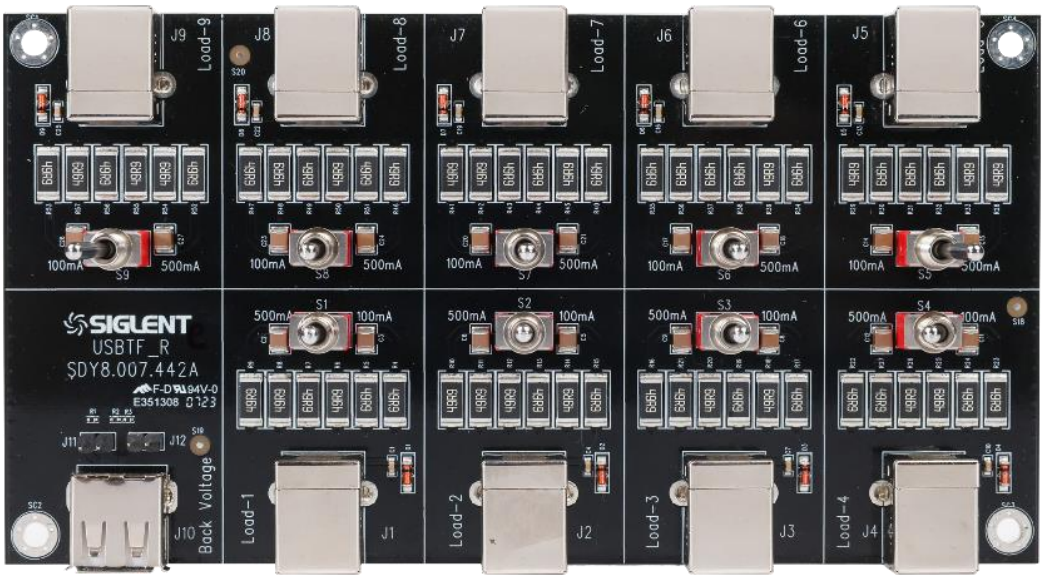
The following figure shows the various modules of the signal board, followed by a general description of the role played by each module in the compliance test.



- Controller: In device tests and hub tests, it controls DUT or hub into test mode, reset, suspend, etc. Also it is the power supply port for the entire fixture.
- SQ Device: HS signal quality, packet parameters, suspend, reset, and not-driven J/K voltage test modules for upstream facing ports.
- Sensitivity Receiver: External signal input point in upstream facing port trigger sensitivity test.
- Droop: Provides 100mA dynamic load for downstream facing port droop.
- Trigger: Provides test point for downstream facing port packet parameters, suspend, repeat, FS, LS, drop.
- Inrush: The upstream facing port inrush test module, and assists the Trigger module to complete the FS and LS tests.
- SQ Host: Downstream facing port HS signal quality test module.

4.2.2 Load Board

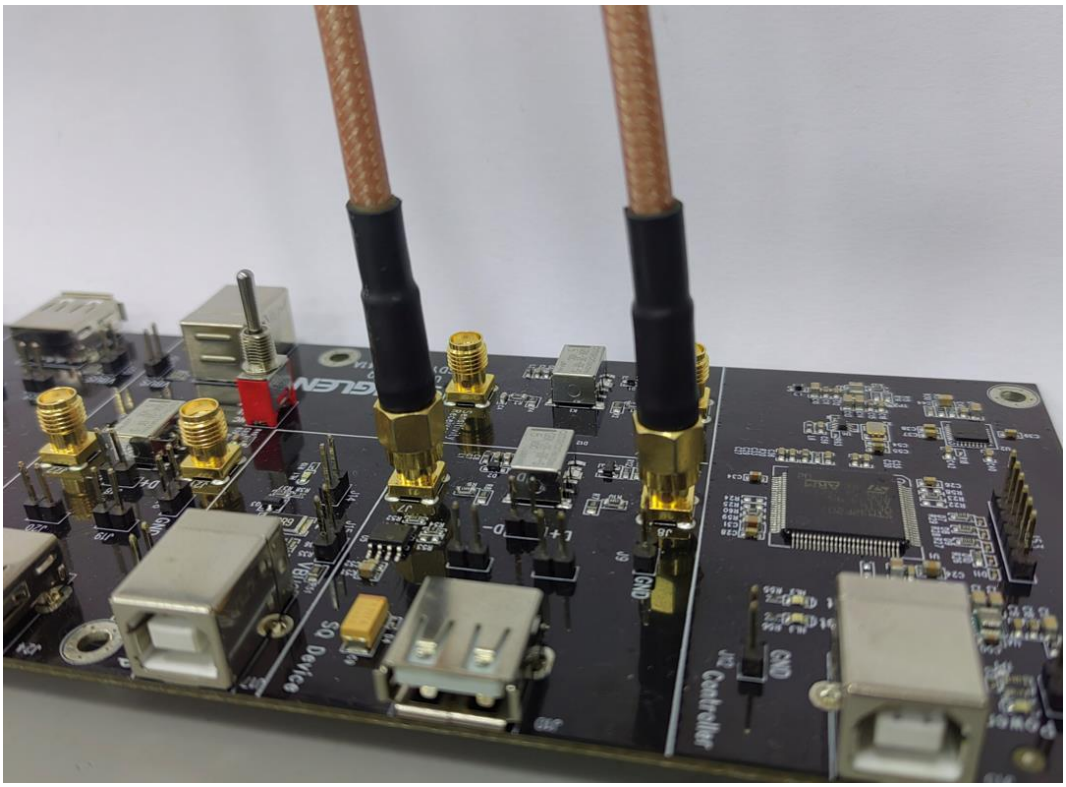
The load board consists of two sections, nine 100mA/500mA loads controlled by twist switches for drop and droop test and Back Voltage for back voltage test of upstream facing port.



4.2.3 Test Point

In each module of the fixture, corresponding test points are provided, and the function of each test point is briefly introduced next.

- **SMA interface:** The SMA interface on the signal board, which is connected to D+ and D-, is connected to the oscilloscope through the SMA cable to complete the signal quality test.



- **Test probes:** Placed in D+, D-, and VBus respectively, as shown below:
  J27 connects D+ and D- to provide test points for differential probes, while J29 connects D+ and J28 connects D-, a GND ground point is also reserved to facilitate the connection of single-ended probes; J30 connects VBus to facilitate the measurement of its voltage.

5 Compliance Test Software

SDS7000A provides USB 2.0 compliance test function, according to Analysis > Compliance Test > Protocol Type Select USB2.0 > Click ON , you can open the compliance test function which is divided into three major parts: Tests Config, Results and Report Setting.

5.1 Tests Config

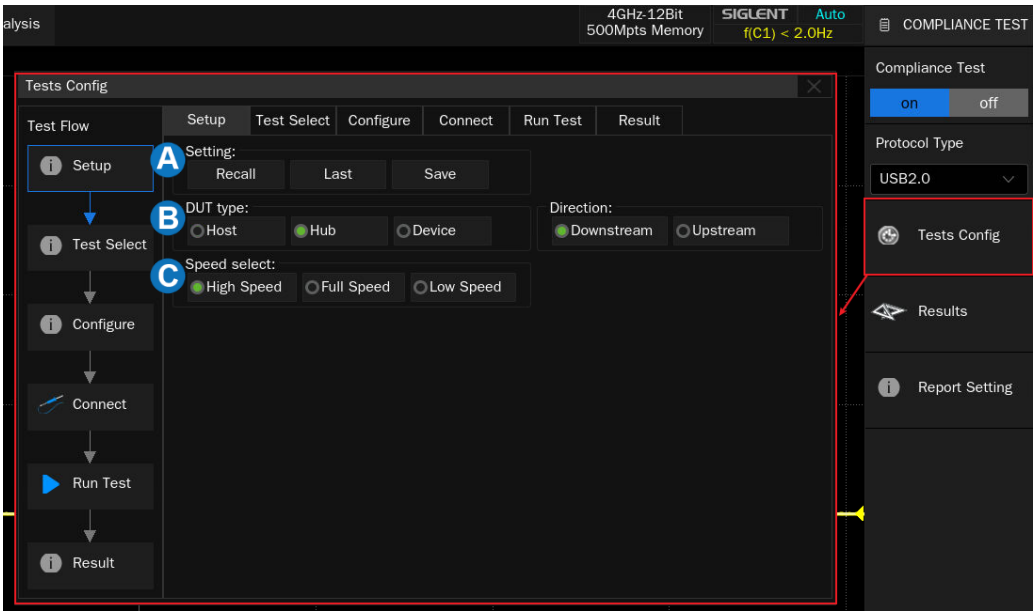
Clicking on Tests Config will pop up the specific test window, as shown in the figure below, which is divided into six steps according to the test flow: Setup, Test Select, Configure, Connect, Run Test, and Result.

▶ **Setup**

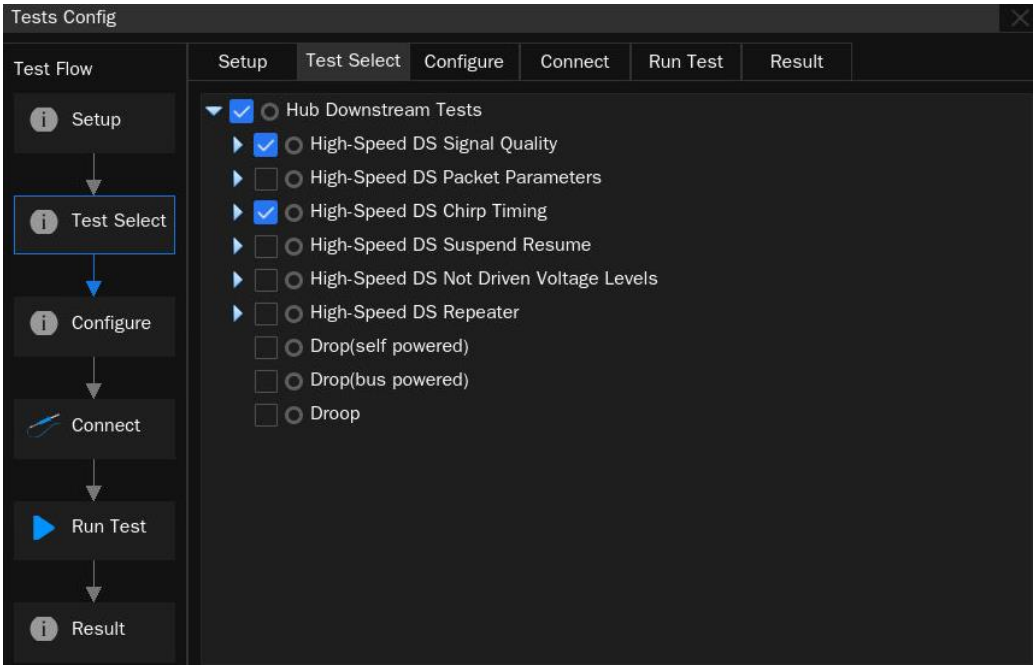
A. Provide three functions of "Recall", "Last" and "Save" for the "Setting".

B. In the "DUT type", select the type of device under test, in which the hub needs to be distinguished between "Downstream" and "Upstream".

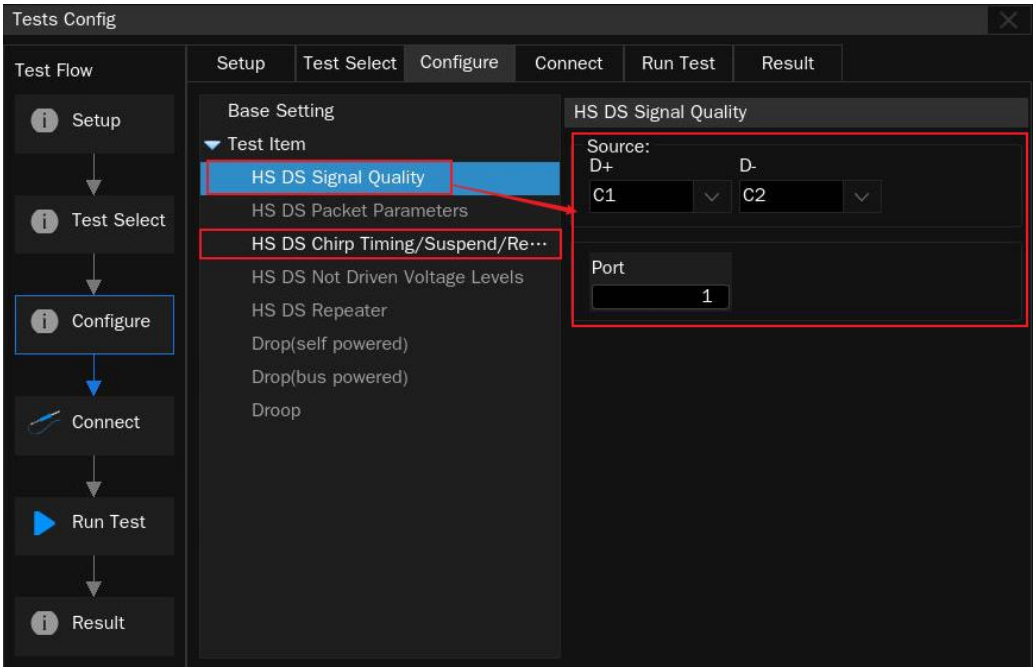
C. Select the rate of the device under test in "Speed select".



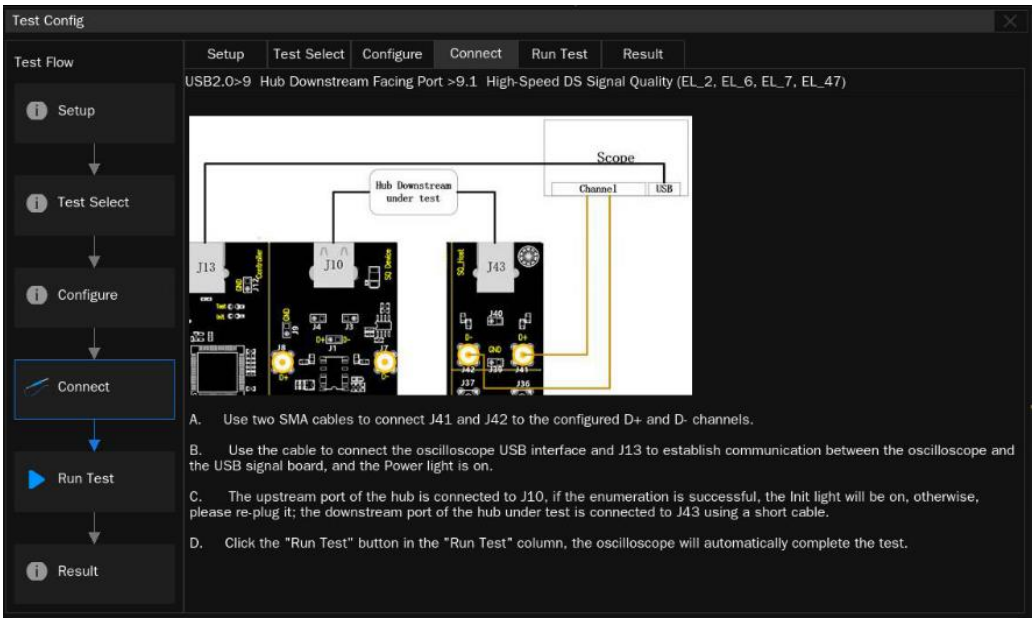
- **Test Select:** Select the items to be tested in this section.



- **Configure:** The test item selected before will be highlighted in this column, click to configure the corresponding test item and set the channel for oscilloscope measurement.



- **Connect:** This column displays the test wiring diagram and test steps, if you select more than one test item at the same time, it will only display the information of the first item to be tested, and the wiring diagram of other test items will have a separate page pop-up prompt after the end of the last test item.

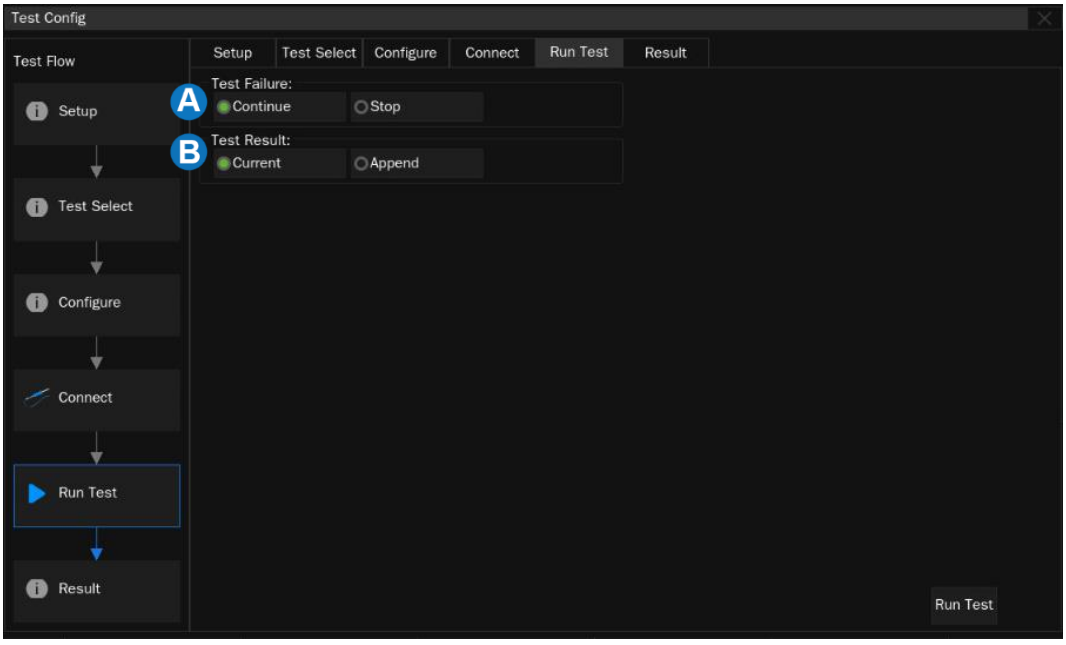


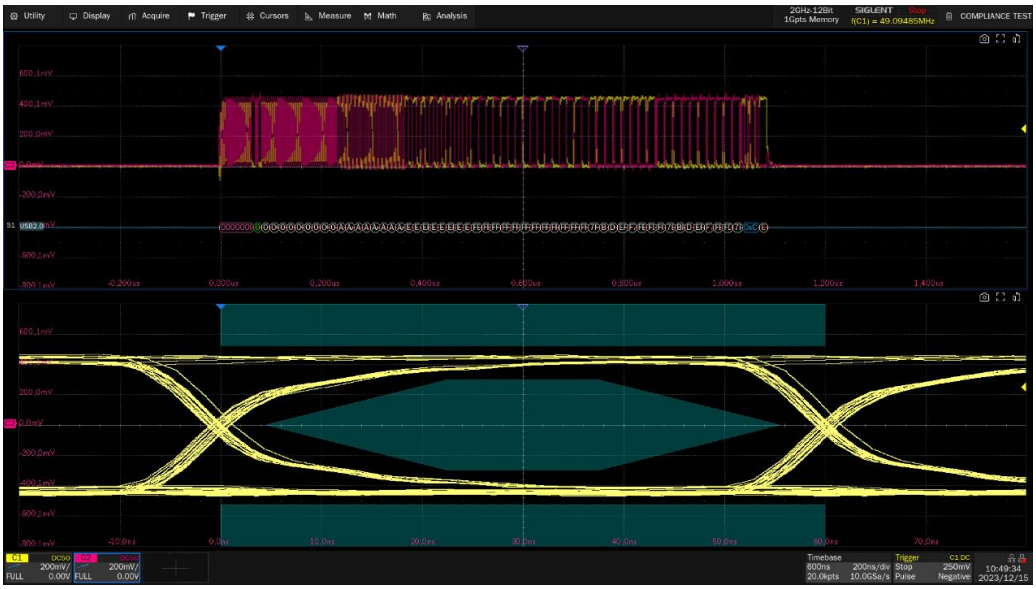
▶ Run Test

A. Supports "Continue" and "Stop" options in "Test Failure".

B. Supports "Current" and "Append" options for "Test result".

Click "Run Test" in the lower right corner to start the round.





In the next test flow, follow the pop-up window to complete the test, and the test results will pop up after all the test items are completed.

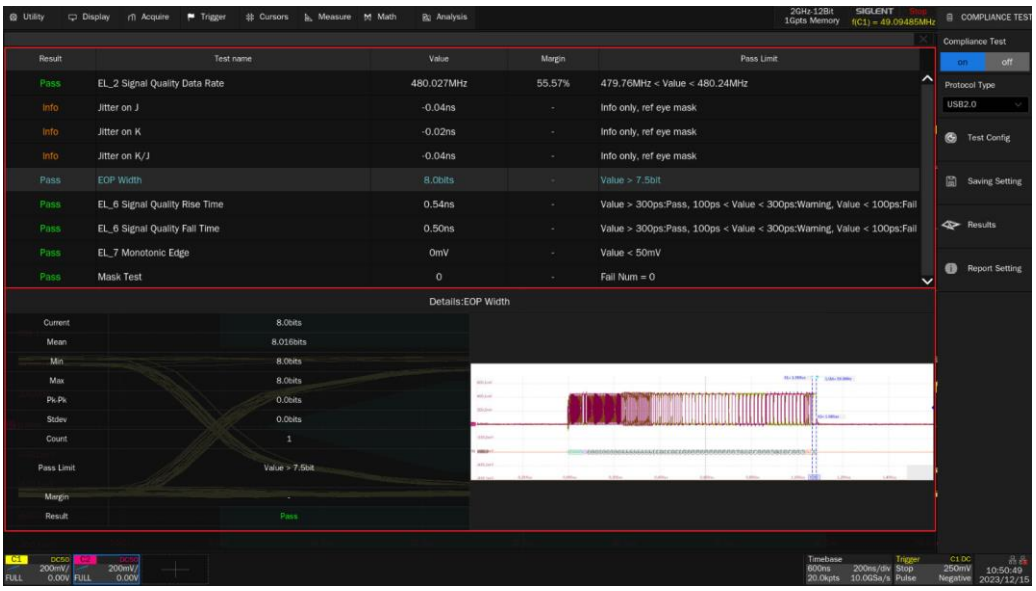
If you select multiple test items in one round of test, there will be a pop-up window prompting the wiring mode of the item when you proceed to the next item, and you can go back to the "Configure" column to modify the source of the test item in the middle of the test, and then click "Run Test" in the pop-up window to continue the test.

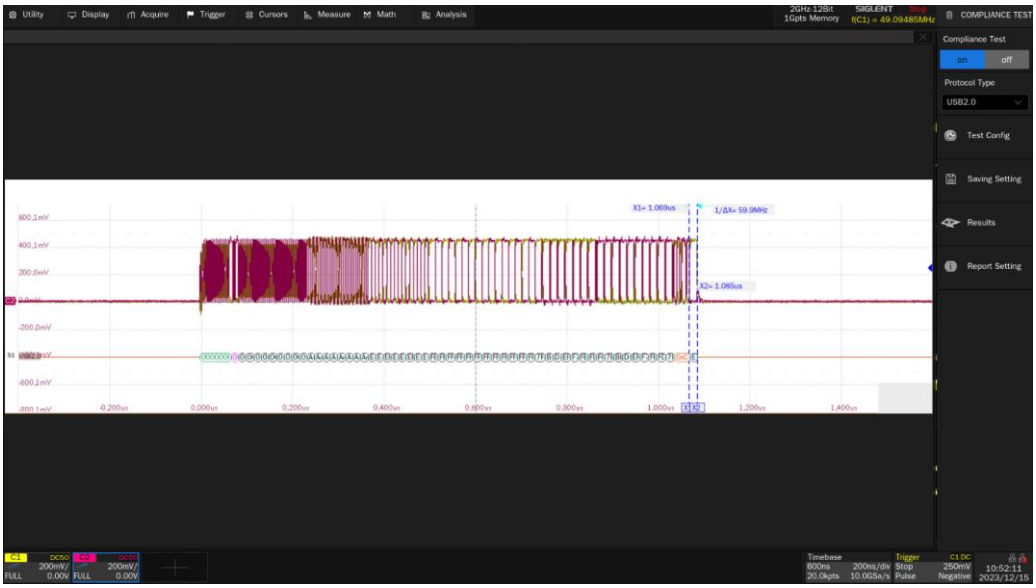
5.2 Results

Click "Results" to view the corresponding test results.

The upper half of the section shows the test items, providing the test results for each item as well as the officially required reference threshold values.

The lower part is the corresponding detail figure, click on the item of interest in the upper part, the lower part can show the corresponding details, click on the figure to view the details.

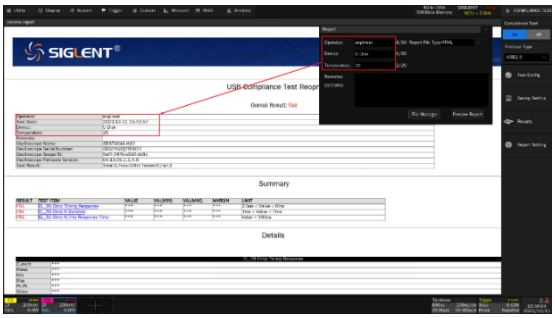


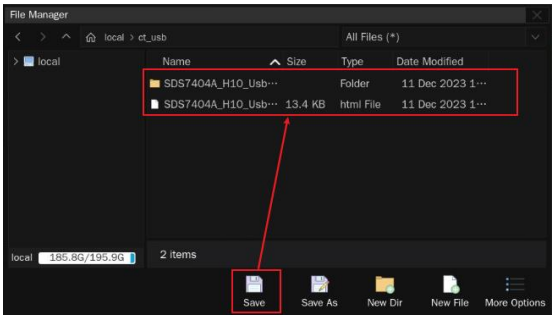


5.3 Report Setting

Click "Report Setting", fill in the relevant test information, select the report type. Click "Preview Report" to view the effect of the generated report in advance. Click "File Manager" to select the path to save and click "Save" to save the test results.

Note: When saved in HTML format, a folder will be generated with the HTML file, if you need to copy, copy both away and keep both under the same path.





The test report includes a summary table of all test results with hyperlinks to the details page, which includes a screenshot of the associated test.

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USB Compliance Test Reoprt

Overall Result: Pass

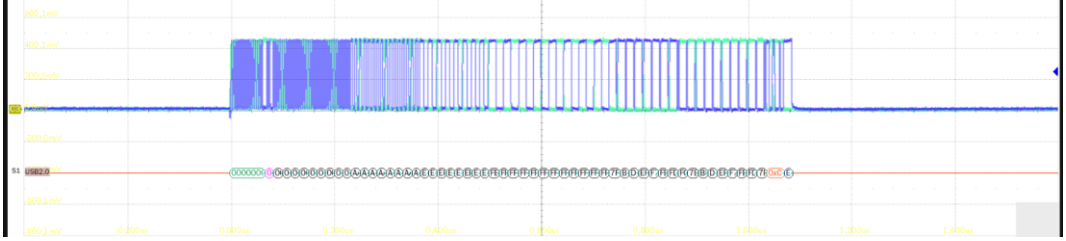
Operator:	
Test Date:	2023-07-07 17:00:31
Device:	
Temperature:	
Remarks:	
Oscilloscope Name:	SDS7404A H12
Oscilloscope Serial Number:	SDS7002030514
Oscilloscope Scope ID:	c392-f947-58da-f342
Oscilloscope Firmware Version:	03.10.1.0.9.0
Test Result:	Total:9,Pass:4,Not Tested:5,Fail:0

Summary

RESULT	TEST ITEM	VALUE	VAL(MIN)	VAL(MAX)	MARGIN	LIMIT
PASS	EL2 Signal Quality Data Rate	480.039MHz	480.039MHz	480.039MHz	58.05%	479.76MHz < Value < 480.24MHz
INFO	Jitter on J	-43ps	-43ps	29ps	-	Info only, ref eye mask
INFO	Jitter on K	-24ps	-50ps	36ps	-	Info only, ref eye mask
INFO	Jitter on K/J	-44ps	-69ps	49ps	-	Info only, ref eye mask
PASS	EOP Width	8.0bits	8.0bits	8.0bits	-	Value > 7.5bit
WARNING	EL6 Signal Quality Rise Time	162ps	149ps	197ps	-	Value > 300ps:Pass, 100ps < Value < 300ps:Warning, Value < 100ps:Fail
WARNING	EL6 Signal Quality Fall Time	234ps	212ps	377ps	-	Value > 300ps:Pass, 100ps < Value < 300ps:Warning, Value < 100ps:Fail
PASS	EL7 Monotonic Edge	0mV	0mV	0mV	-	Value < 50mV
PASS	Mask Test	0	0	0	-	Fail Num = 0

EOP Width

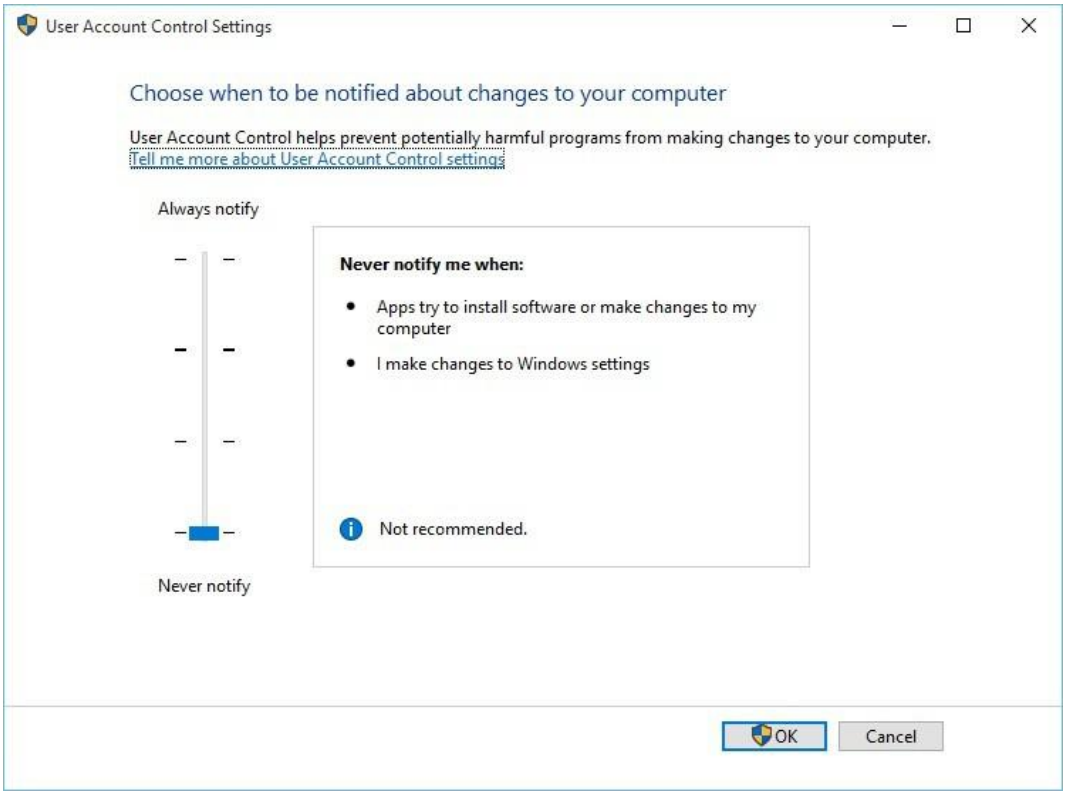
Current	8.0bits
Mean	7.968bits
Min	8.0bits
Max	8.0bits
Pk-Pk	0.0bits
Stdev	0.0bits
Count	1
Pass Limit	Value > 7.5bit
Margin	-
Result	PASS



6 USB IF Official Application

USB IF provides software to assist with USB 2.0 electrical compliance test.

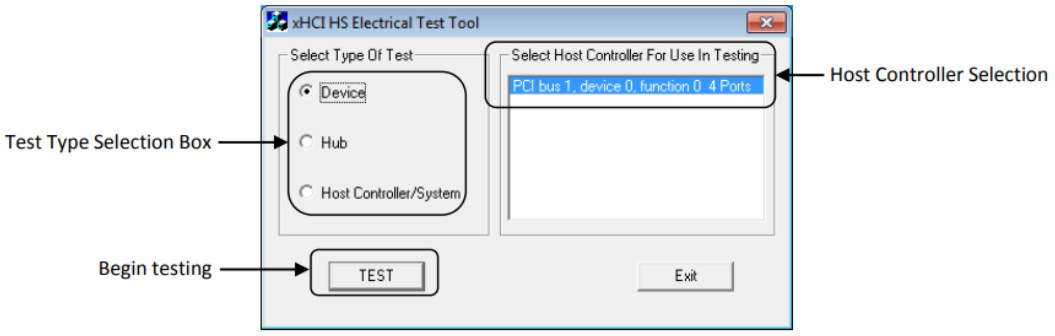
- USBET20: USB IF official electrical analysis tool that to analyze the signal data captured by the oscilloscope, including signal quality and inrush analysis.
  Download address: https://www.usb.org/document-library/usbet20
- USBHSET: stand for USB High-speed Electrical Test Tool, configuration software provided by the USB IF that controls the device under test to enter test mode, send packets, suspend, and reset.
  Download address: https://www.usb.org/document-library/usbhset-ehci-64-bit
  USBHSET is applicable to Windows 7 and Windows 7 Professional. Before installing, User Account Control (UAC) should be disabled in Windows. Choose Start > Control Panel > User Accounts and Family Safety > User Accounts > Change User Account Control Settings . Set the Settings Bar to "Never notify", click "OK", and then restart the computer.



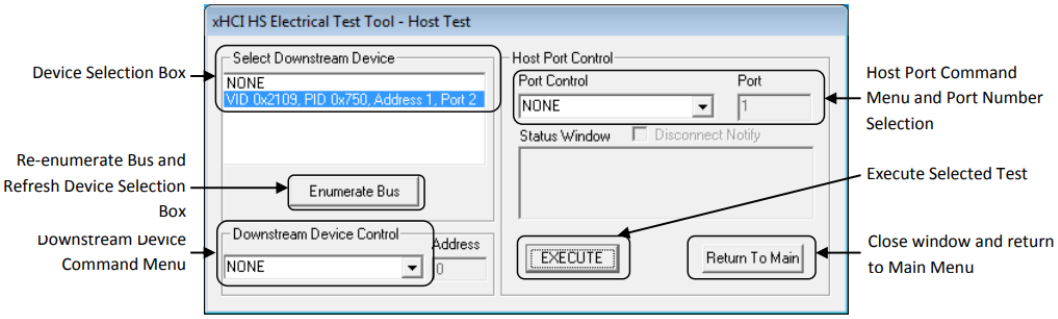
Note: When using the USBHSET software, the corresponding USB hub will be occupied and its external devices will not work properly.

The main interface of USBHSET is shown as below, the left side provides three choices of device, hub and host, this manual will only introduce the host related content, if you want to know more about it, please go to the following URL to view.

https://www.usb.org/sites/default/files/HSETT_Instruction_0_4_1.pdf



Choose "Host Controller/System", click the "Test" button to enter the host test menu.



The Host Control menu provides options for placing the host controller or a device connected to that controller into the electrical test mode. Select the appropriate command from the Port Control or Downstream Device Control Menu. For the root port test, the user must also select the port number of the port under test.

If the test item is related to the device, observe the PID/VID, select the connected device from the Device Selection Box, and then click "EXECUTE", if the device cannot be found, please disconnect the device, insert it and click "Enumerate Bus" again.

▶ USB 2.0 developer documentation is available on the USB Implementers Forum website at https://www.usb.org/documents

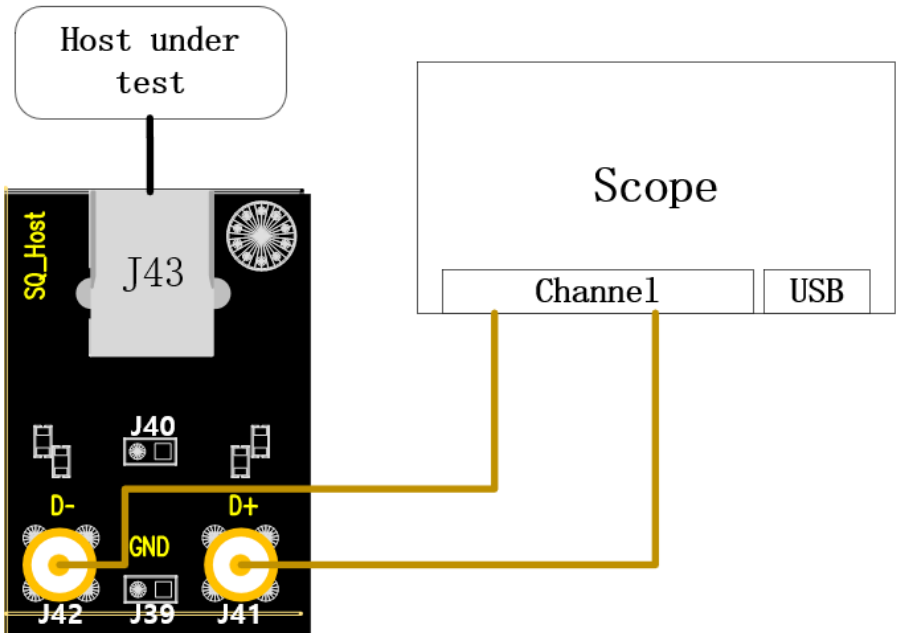
7 Host

When performing USB 2.0 host-related tests, please set up the compliance test function correctly according to the test requirements.

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

7.1.1 Test Steps

7.1.1.1 Test Environment Setup

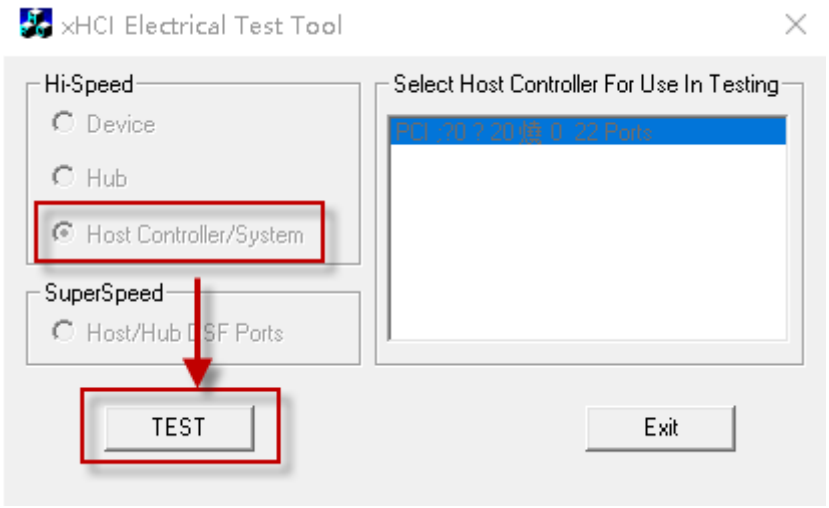


A. Use two equal length SMA cables to connect J41 and J42 to the configured D+ and D- channels.
B. J43 access to host under test.
C. Click the "**Run Test**" button in the "**Run Test**" column to enter the test interface, and a pop-up window will appear to show the specific steps for sending packets using HSETT software. If you are using HSETT software, please send packets in accordance with the pop-up window prompts; And ignore the contents of the pop-up window if you send packets on your own. After sending packets is completed and the waveforms received by the oscilloscope are observed, click "**Run Test**", the oscilloscope will complete the signal analysis.

7.1.1.2 HSETT Sending Packet Setup

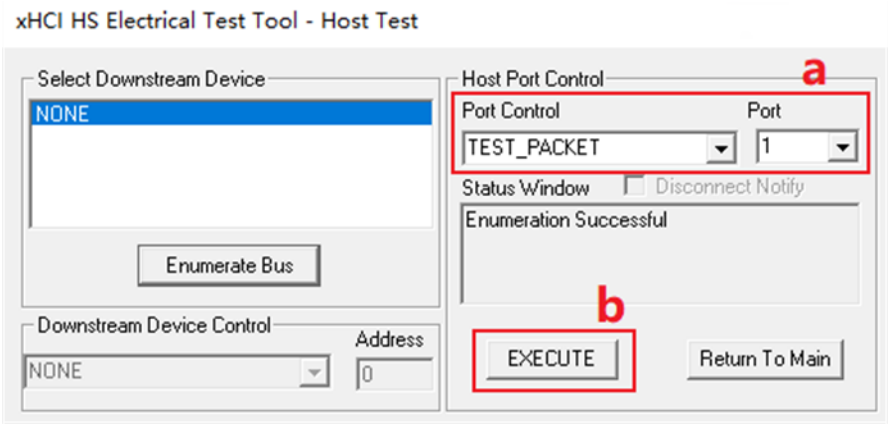
If you are using HSETT software, please follow the instructions in the following steps to send packets. If you are sending packets by yourself, please click "**Run Test**" after observing the waveform captured by the oscilloscope.

The following is the procedure for HSETT:



A. Open the High-speed Electrical Test Tool software and enter the main menu of the software.

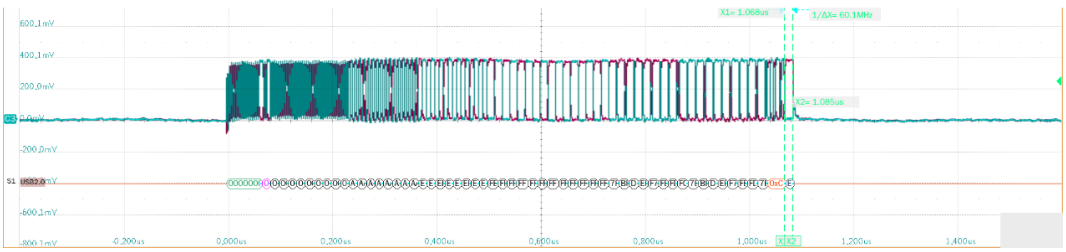
B. Select [**Host Controller/System**] for Test Type, and then click [**TEST**] to enter the Host Test menu.



a. Select [TEST_PACKET] in the drop-down menu of Port Control, and enter the number of the test port of the device under test in Port.

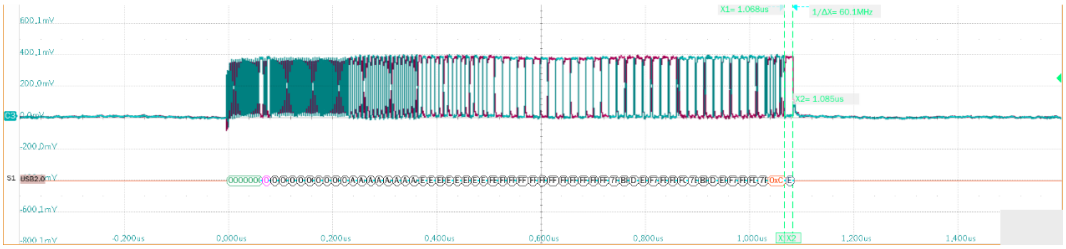
b. Click [EXECUTE].

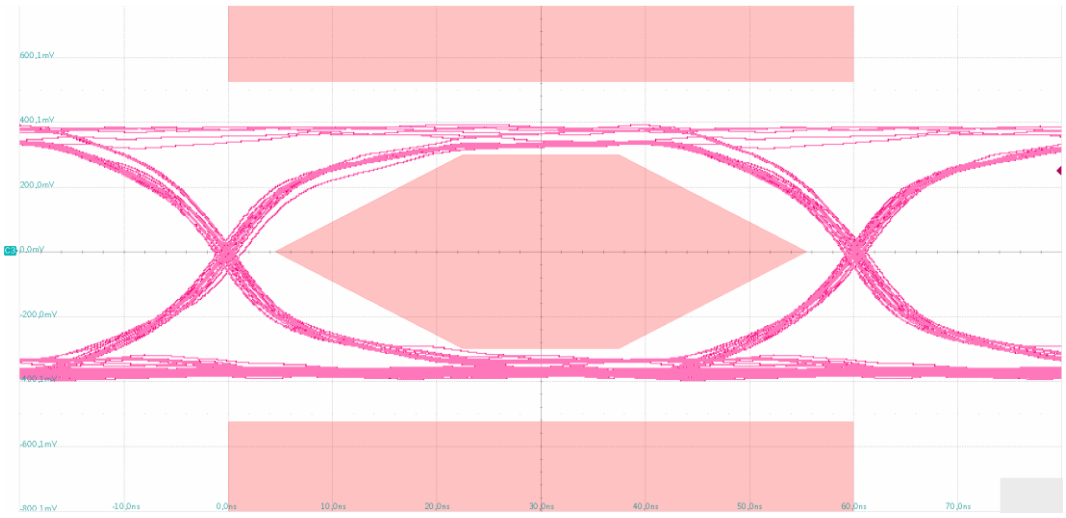
C. After observing the waveform captured by the oscilloscope, the reference waveform is shown below, click "Run Test". If the oscilloscope does not capture the waveform or the waveform differs greatly from the reference waveform, please check if the wiring is correct and start from step A again.



7.1.2 Test Results Reference

- EL_2: A USB 2.0 high-speed transmitter data rate must be 480 Mb/s±0.05%.
- EL_3: A USB 2.0 downstream facing port must meet Template 1 transform waveform requirements measures at TP2.
- EL_6: A USB 2.0 HS driver must have 10% to 90% differential rise and fall times of greater than 300 ps.
- EL_7: A USB 2.0 HS driver must have monotonic data transitions over the vertical openings specified in the appropriate eye pattern template.

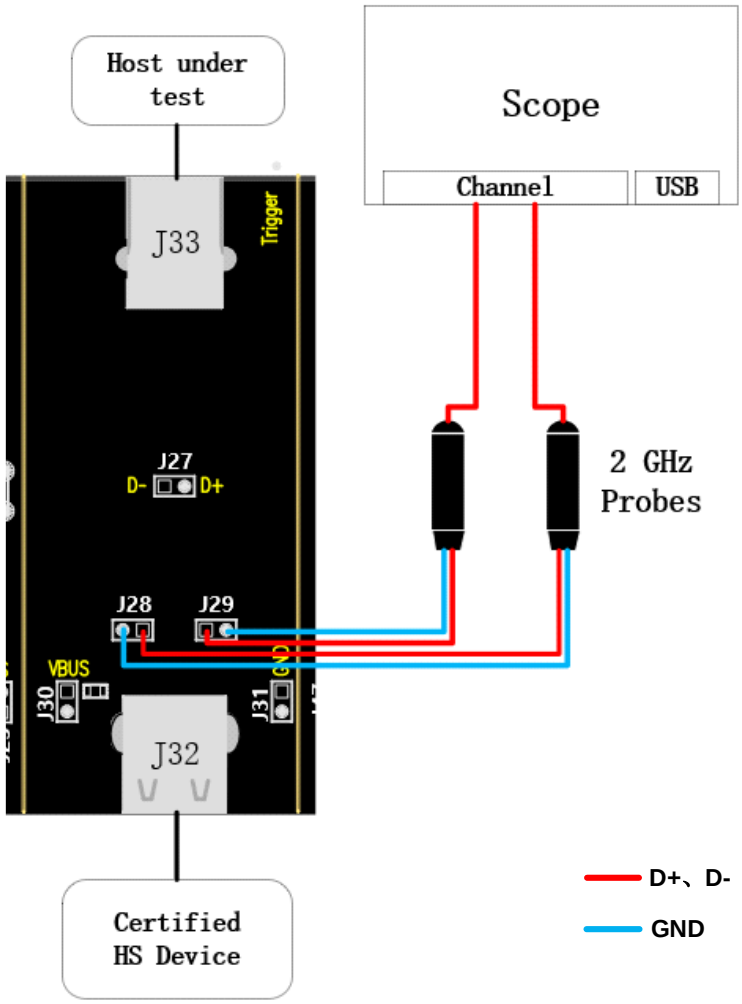




7.2 High-Speed DS Packet Parameters (EL_21, EL_22, EL_23, EL_25, EL_55)

7.2.1 Test Steps

7.2.1.1 Test Environment Setup



A. For "Single Ended", J29 and J28 are the test points for D+ and D- signals respectively, and for "Differential Probe", the test point is J27.

B. The host under test is accessed in J33 and a USB 2.0 certified high-speed device is accessed in J32.

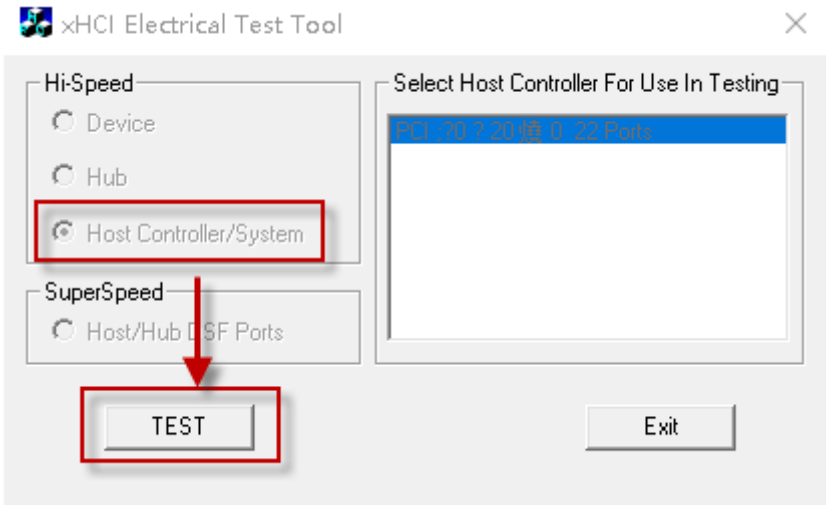
C. Click the "**Run Test**" button in the "**Run Test**" column to enter the test interface, a pop-up window will appear with the specific steps for sending packets using HSETT software. If you use HSETT software, please send packets in accordance with the pop-up window prompts, and if you send packets on your own, ignore the contents of the pop-up window. After sending packets is completed and the waveforms received by the oscilloscope are observed, click "**Run Test**", the oscilloscope will complete the signal analysis.

7.2.1.2 HSETT Sending Packet Setup

7.2.1.2.1 First Time Sending Packets

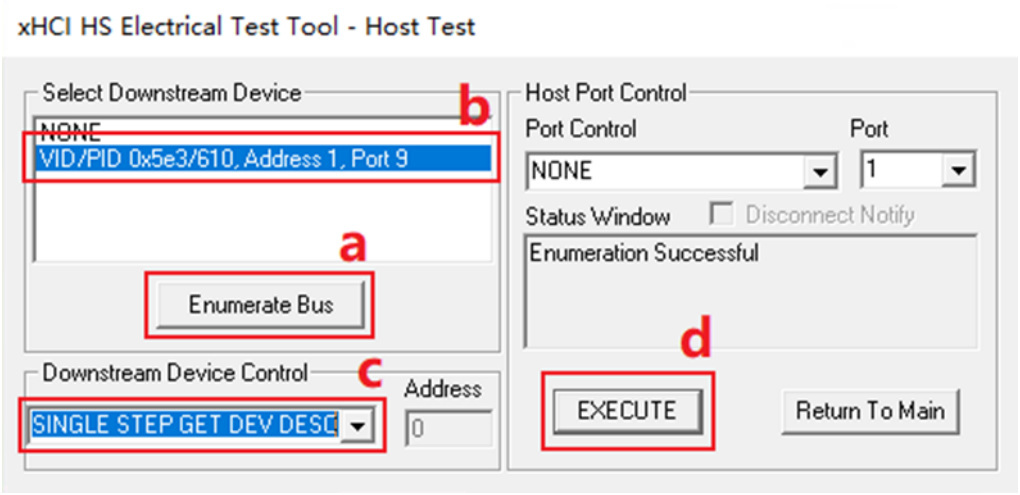
If you are using HSETT software, please follow the instructions in the following steps to send packets. If you are sending packets by yourself, please click "**Run Test**" after observing the waveform captured by the oscilloscope.

The following is the procedure for HSETT:



A. Open the High-speed Electrical Test Tool software and enter the main menu of the software.

B. Select [**Host Controller/System**], and then click [**TEST**] to enter the Host Test menu.



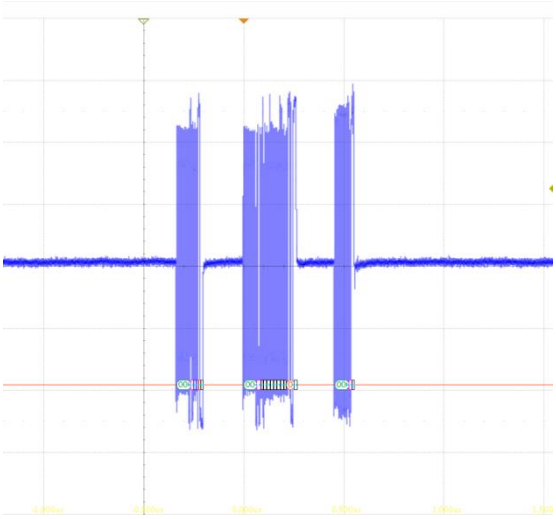
a. Click [Enumerate Bus].

b. Select the device connected to the test port in [Select Downstream Device].

c. Select [SINGLE STEP GET DEV DESC] from the [Downstream Device Control] drop-down menu.

d. Click [EXECUTE].

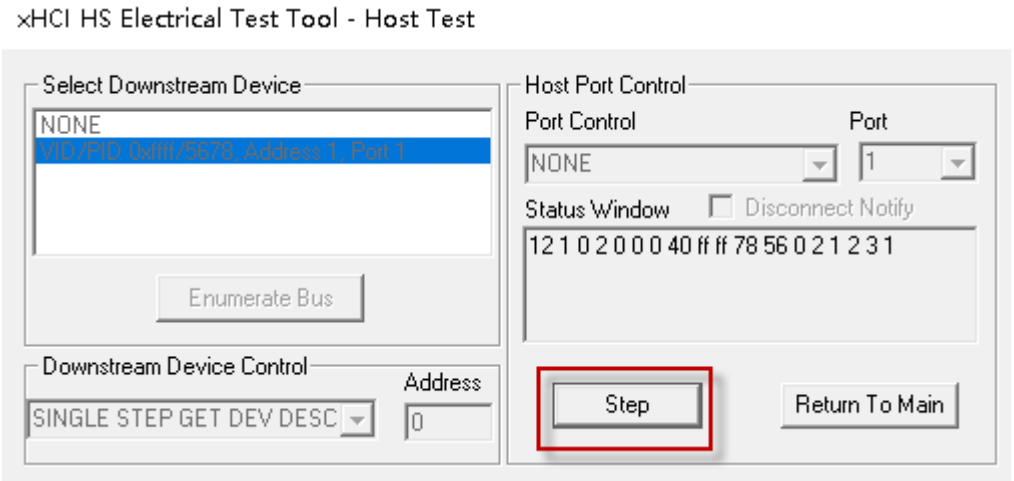
C. After observing the waveforms captured by the oscilloscope, the D+ and D- differential waveforms are referenced as shown in the figure below, click "Run Test". If the oscilloscope does not capture the waveforms or the waveforms differ greatly from the reference waveforms, please check if the wiring is correct and start from step A again.



7.2.1.2.2 Second Sending Packets

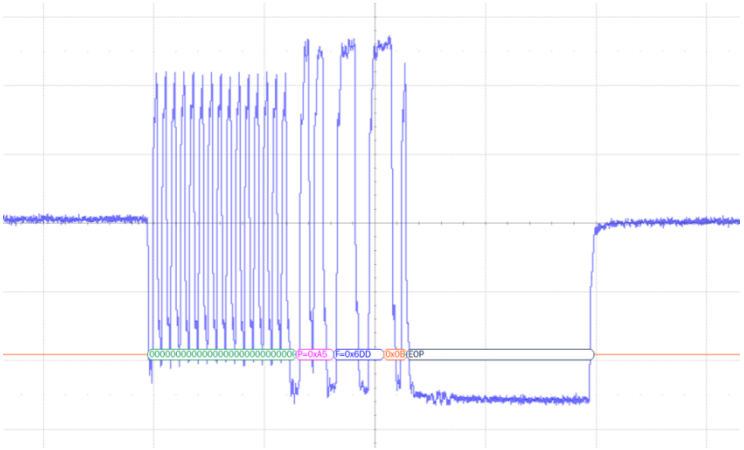
If you are using HSETT software, please follow the instructions in the following steps to send packets. If you are sending packets by yourself, please click "**Run Test**" after observing the waveform captured by the oscilloscope.

The following is the procedure for HSETT:



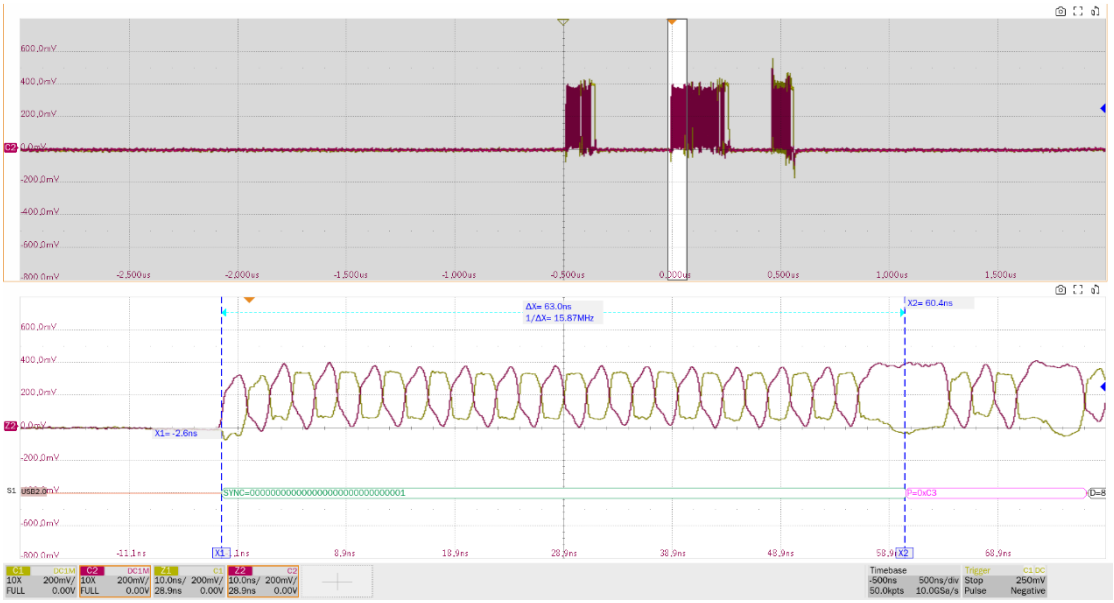
A. Click **[Step]** twice, and then click **[Enumerate Bus]**.

B. After observing the waveforms captured by the oscilloscope, the D+ and D- differential waveforms are referenced as shown in the figure below, and click "**Run Test**".

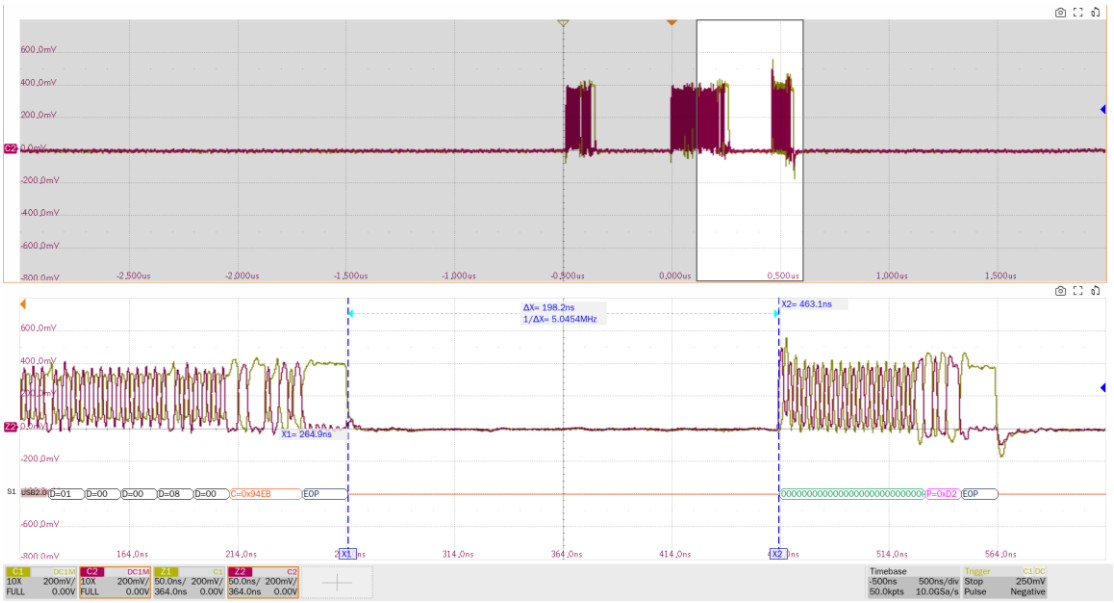


7.2.2 Test Results Reference

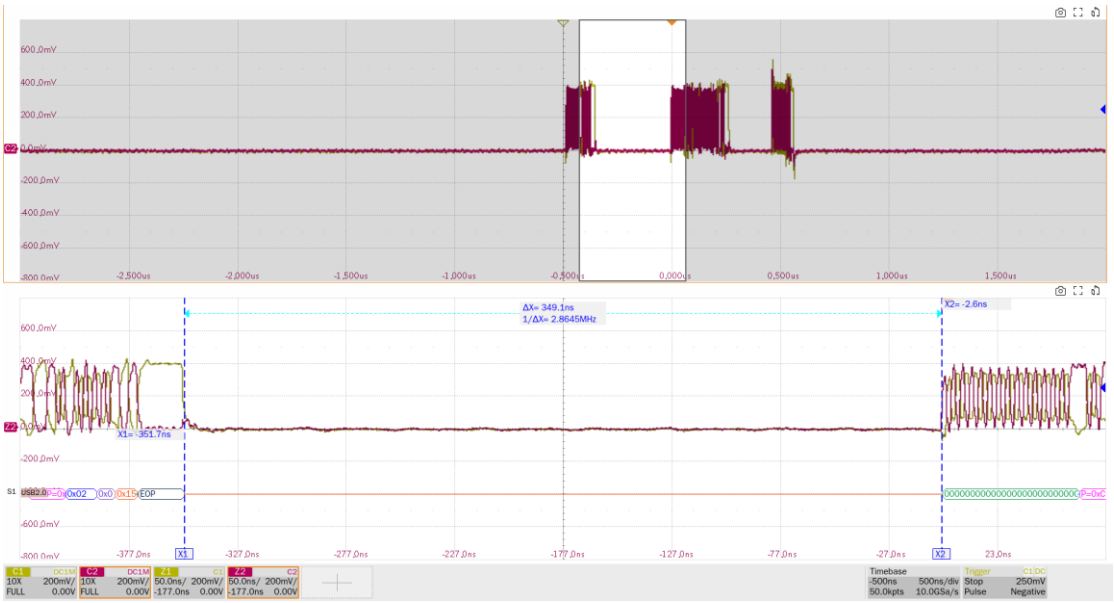
- EL_21: The SYNC field for all transmitted packets (not repeated packets) must begin with a 32 bit SYNC field.



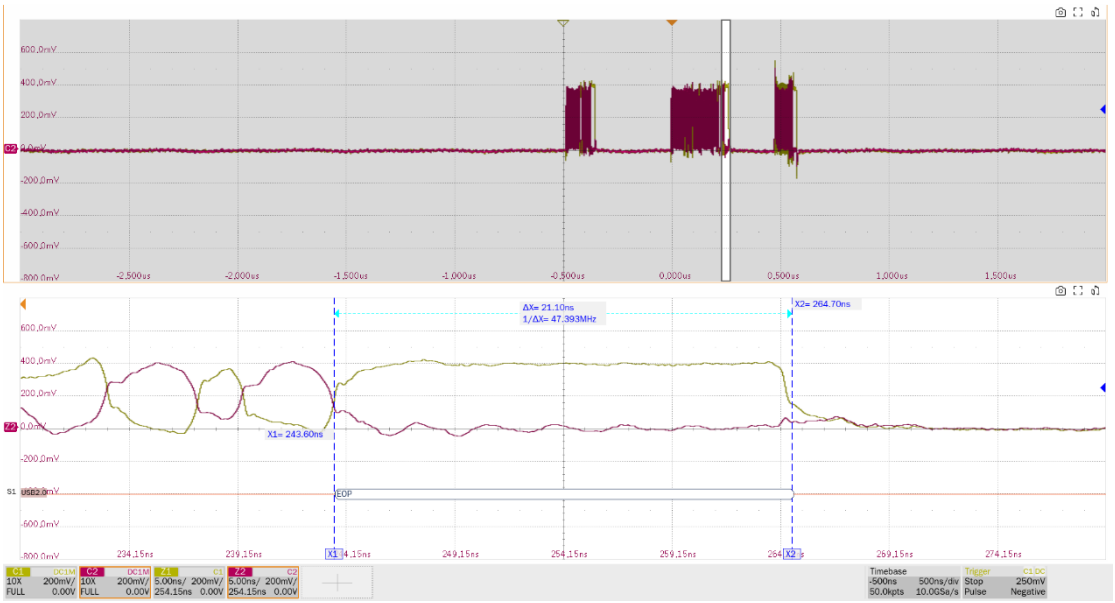
- EL_22: When transmitting after receiving a packet, hosts and devices must provide an inter-packet gap of at least 8 bit times and not more than 192 bit times.



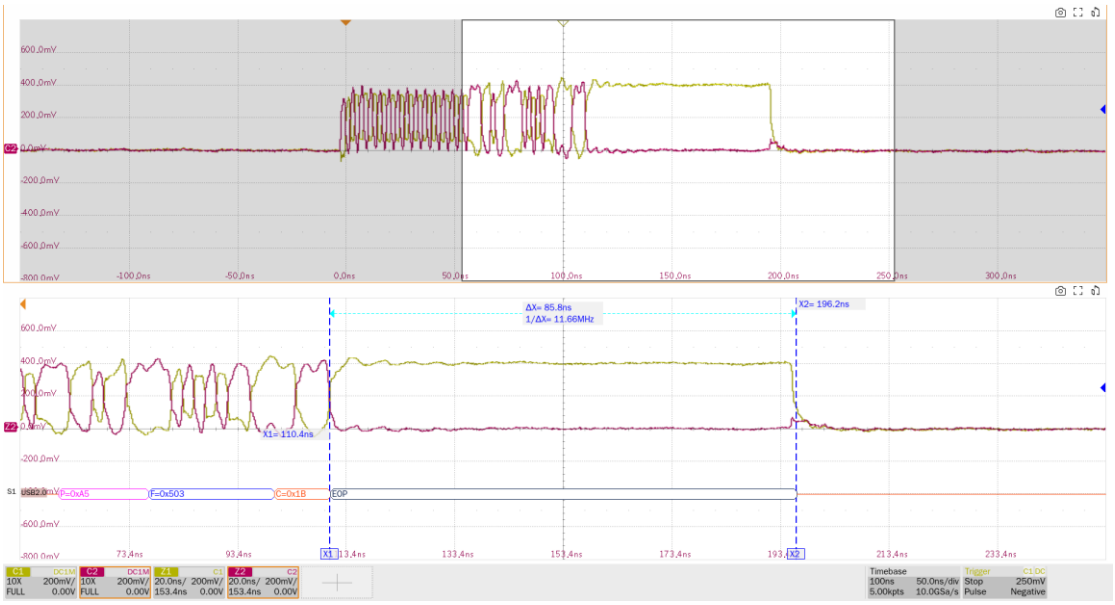
▶ EL_23: Hosts transmitting two packets in a row must have an inter-packet gap of at least 88 bit times and not more than 192 bit times.



▶ EL_25: The EOP for all transmitters' packets (except SOFs) must be an 8 bit NRZ byte of 01111111 without bit stuffing.



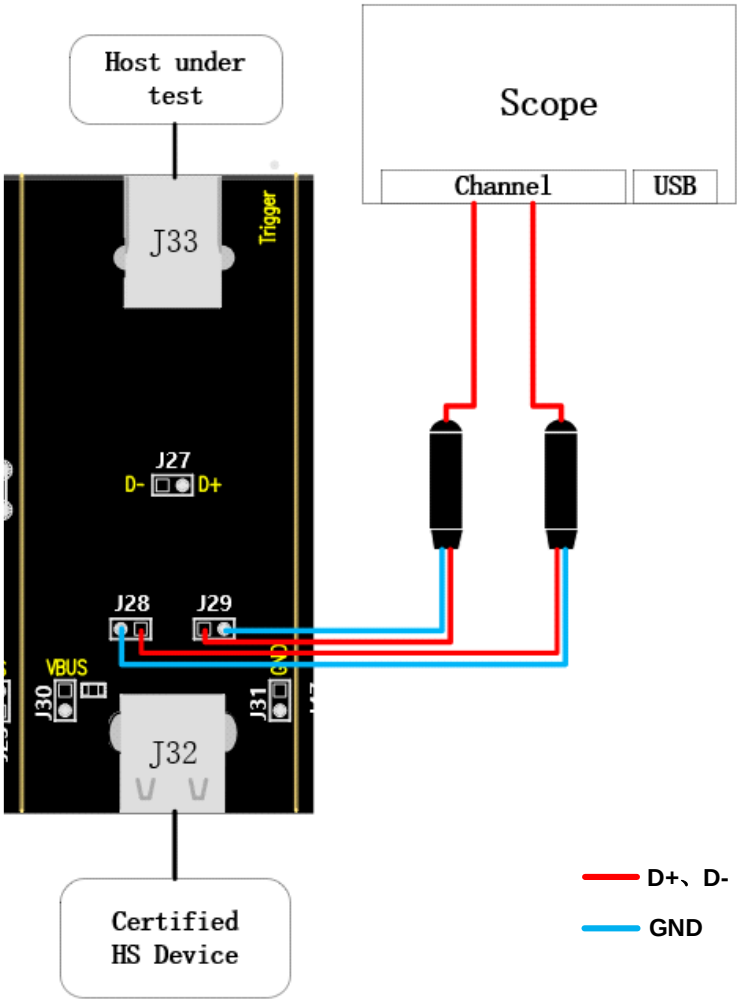
- EL_55: Hosts transmitting SOF packets must provide a 40 bit EOP without bit stuffing where the first symbol of the EOP is a transition from the last data symbol.



7.3 High-Speed DS Chirp Timing (EL_33, EL_34, EL_35)

7.3.1 Test Steps

7.3.1.1 Test Environment Setup



A. J29 and J28 are test points for D+ and D- signals respectively.

B. The host under test is accessed in J33 and a USB 2.0 certified high-speed device is accessed in J32.

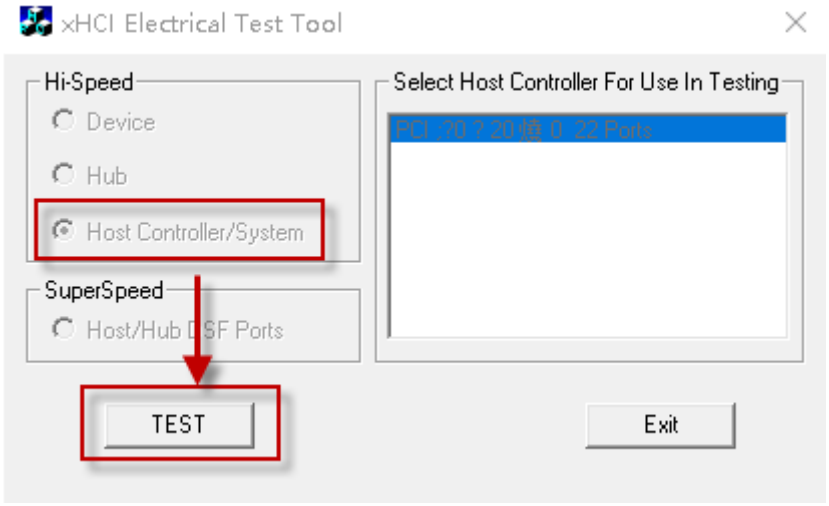
C. Click the "**Run Test**" button in the "**Run Test**" column to enter the test interface, a pop-up window will appear with the specific steps for sending packets using HSETT software. If you use HSETT software, please send packets in accordance with the pop-up window prompts, and if you send packets on your own, ignore the contents of the pop-up window. After sending packets is completed and the waveforms received by the oscilloscope are observed, click "**Run Test"**, the oscilloscope will complete the signal analysis.

7.3.1.2 HSETT Sending Packet Setup

7.3.1.2.1 First Time Sending Packets

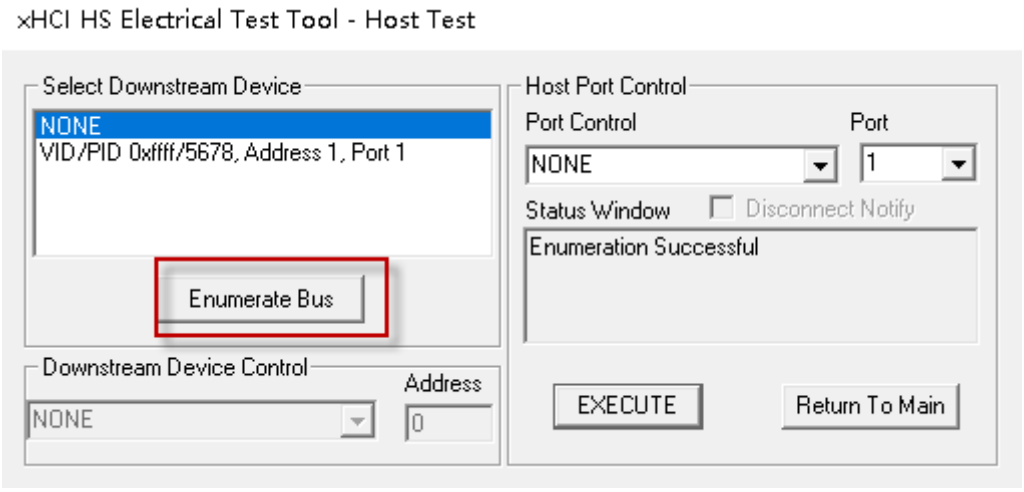
If you are using HSETT software, please follow the instructions in the following steps to send packets. If you are sending packets by yourself, please click "**Run Test**" after observing the waveform captured by the oscilloscope.

The following is the procedure for HSETT:



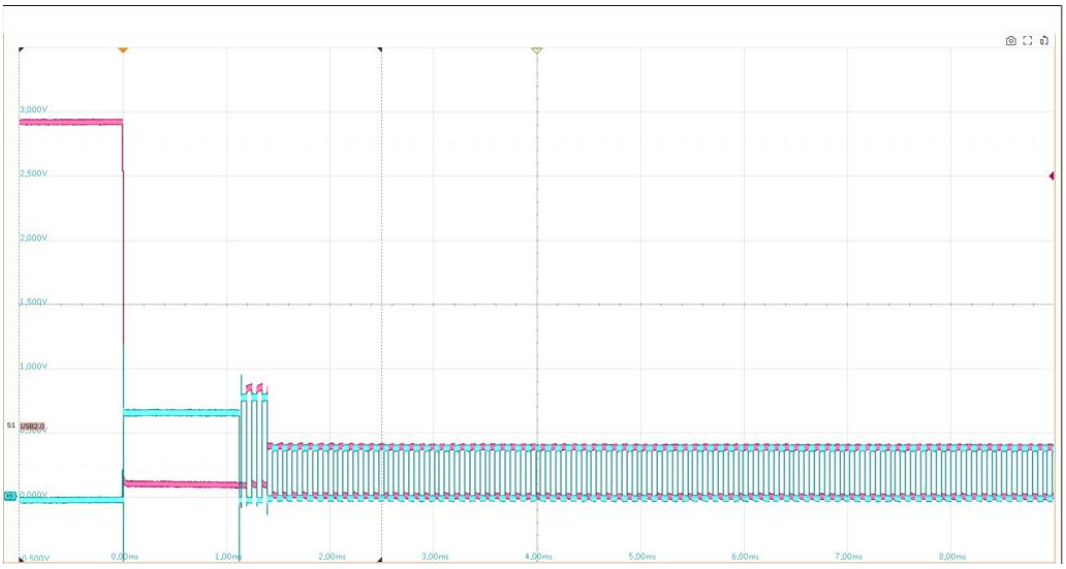
A. Open the High-speed Electrical Test Tool software and enter the main menu of the software.

B. Select [**Host Controller/System**], and then click [**TEST**] to enter the Host Test menu.



C. Click [Enumerate Bus].

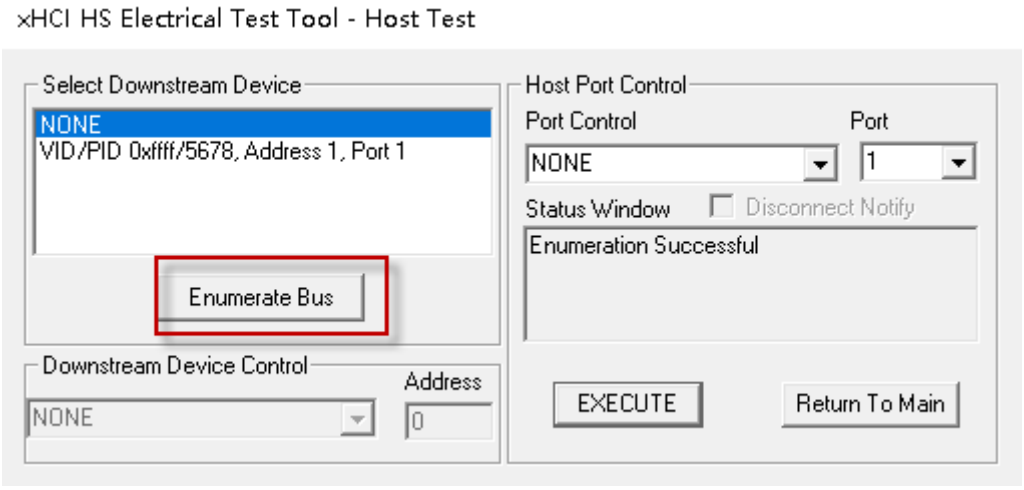
D. After observing the waveforms captured by the oscilloscope, the reference waveform is shown in the figure below, click "Run Test". If the oscilloscope does not capture the waveforms or the waveforms differ greatly from the reference waveforms, please check if the wiring is correct and start from step A again.



7.3.1.2.2 Second Sending Packets

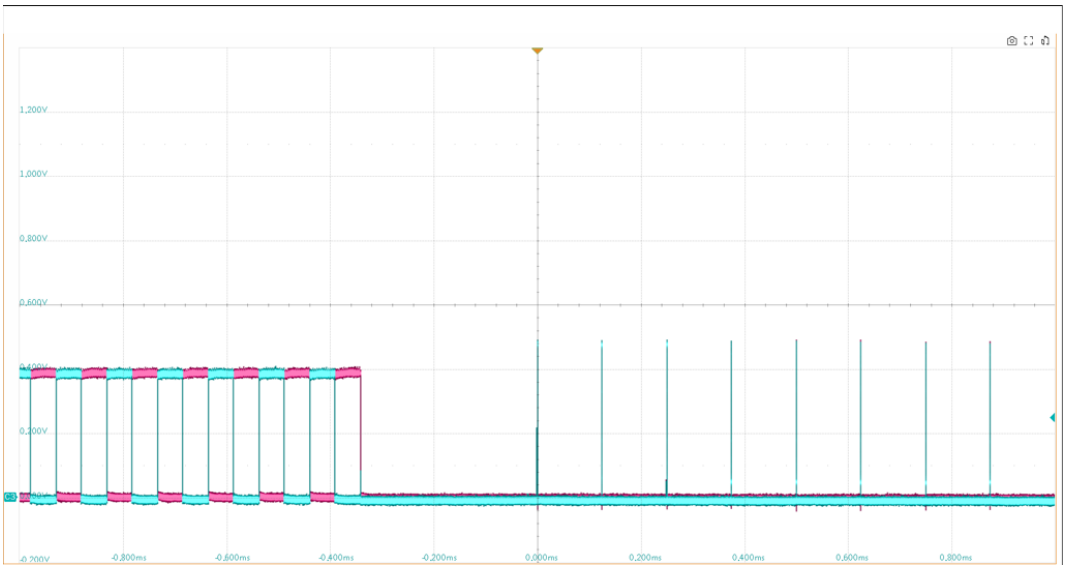
If you are using HSETT software, please follow the instructions in the following steps to send packets. If you are sending packets by yourself, please click "**Run Test**" after observing the waveform captured by the oscilloscope.

The following is the procedure for HSETT:



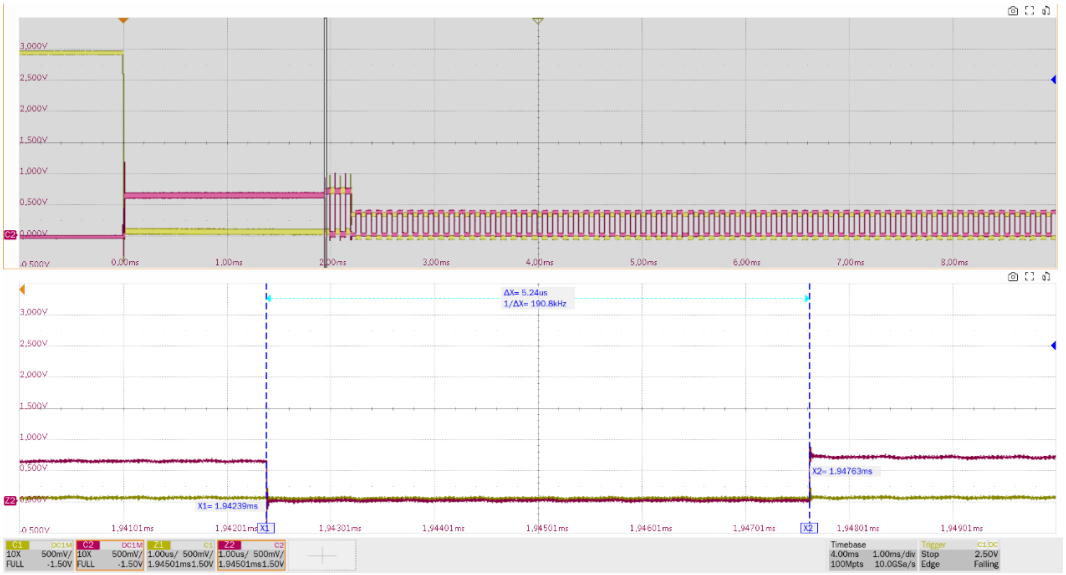
A. Click [Enumerate Bus].

B. After observing the waveforms captured by the oscilloscope, the reference waveform is shown in the figure below, click "Run Test". If the oscilloscope does not capture the waveforms or the waveforms differ greatly from the reference waveforms, please check if the wiring is correct and start from step A again.

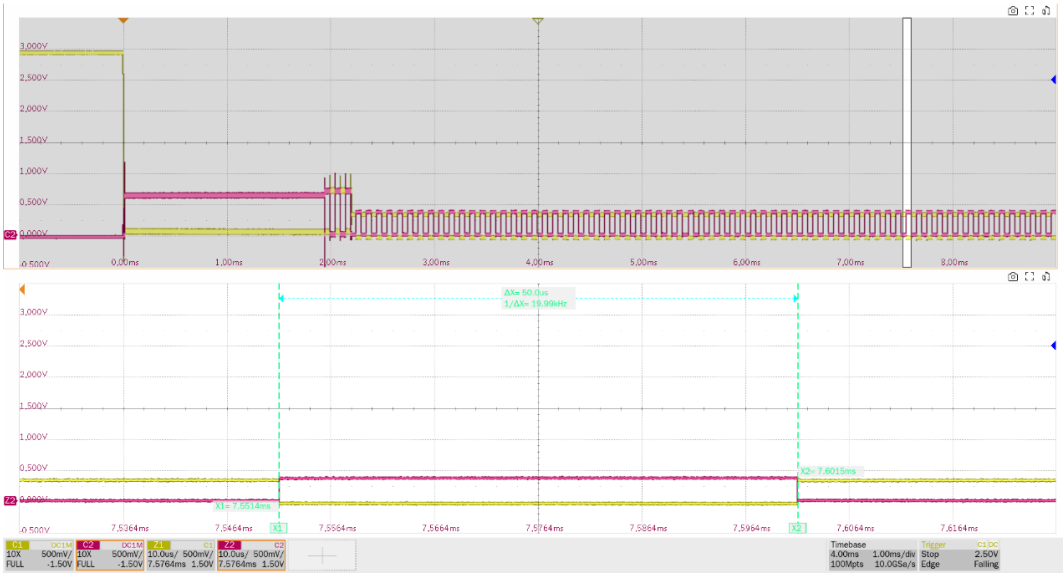


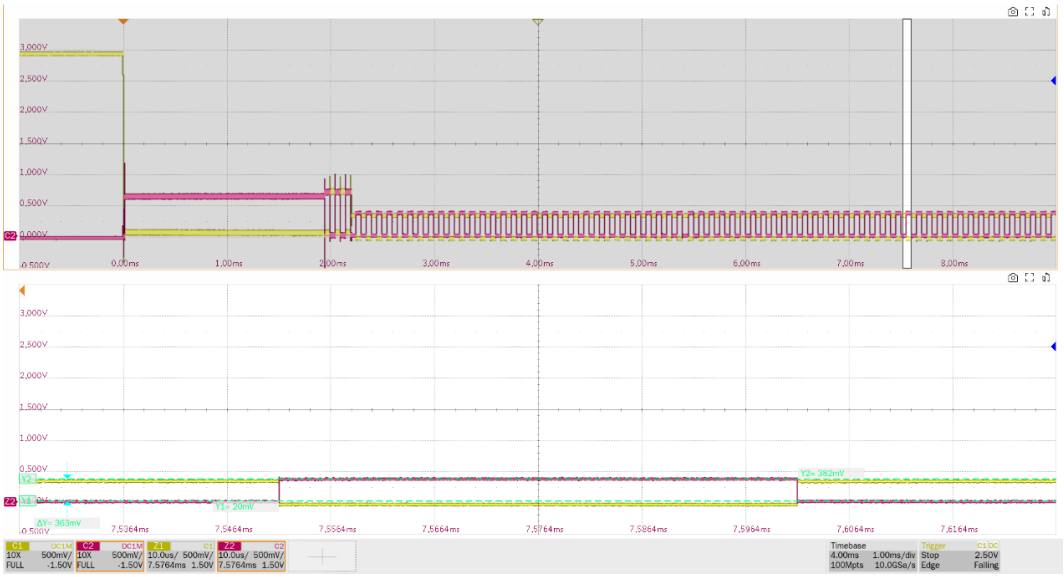
7.3.2 Test Results Reference

- EL_33: Downstream ports start sending an alternating sequence of Chirp K's and Chirp J's within 100us after the device Chirp k stops.



- EL_34: Downstream port Chirp K and Chirp J durations must be between 40us and 60us duration. The amplitude of Chirp J and Chirp K are measured both in this test.





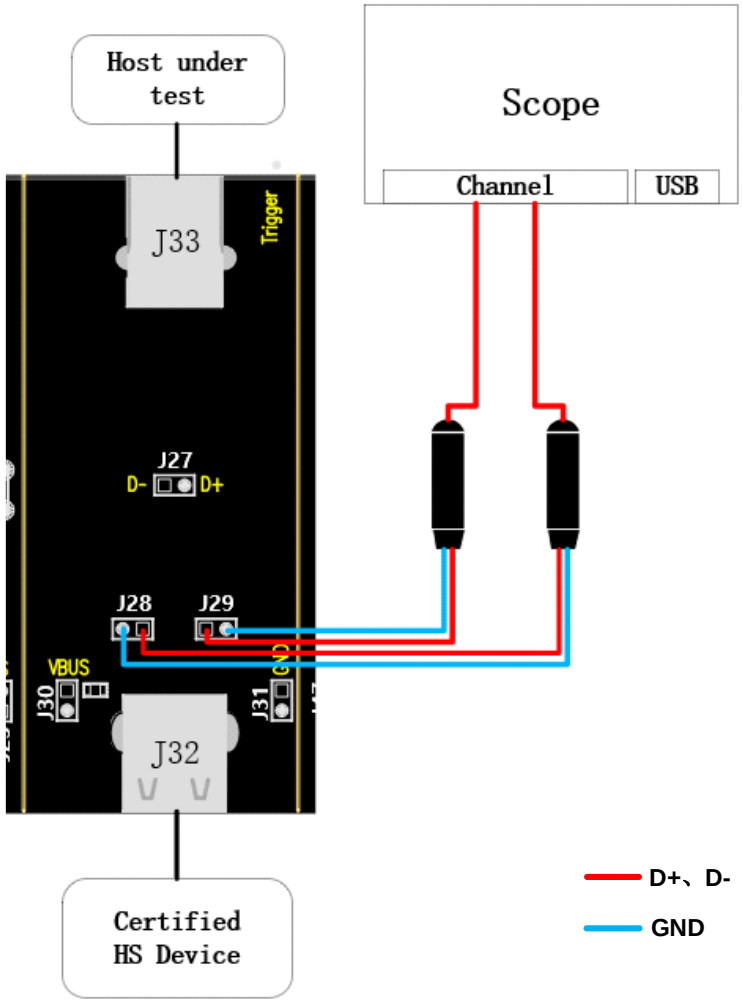
▶ EL_35: Downstream ports must begin sending SOF's no sooner than 100us and no later than 500us from transmission of the last Chirp (J or K).


1.200V
1.000V
0.800V
0.600V
0.400V
0.200V
0.000V
-0.200V
-0.800ms
-0.600ms
-0.400ms
-0.200ms
0.000ms
0.200ms
0.400ms
0.600ms
0.800ms
ΔX= 302.6us
1/ΔX= 3.3047kHz
X2= 0.0s
X1= -302.6us
-351.5us
-251.5us
-201.5us
-151.5us
-101.5us
-51.5us
48.5us
C1 DC1M 10X 200mV/ FULL -600mV
C2 DC1M 10X 200mV/ FULL -600mV
Z1 C1 50.0us/ 200mV/ -151.5us 600mV
Z2 C2 50.0us/ 200mV/ -151.5us 600mV
Timebase 0.00s 200us/div 20.0Mpts 10.0GSa/s
Trigger C2 DC Stop 250mV Pulse Negative

7.4 High-Speed DS Suspend Resume (EL_38 EL_39, EL_41)

7.4.1 Test Steps

7.4.1.1 Test Environment Setup



A. J29 and J28 are test points for D+ and D- signals respectively.

B. The host under test is accessed in J33 and a USB 2.0 certified high-speed device is accessed in J32.

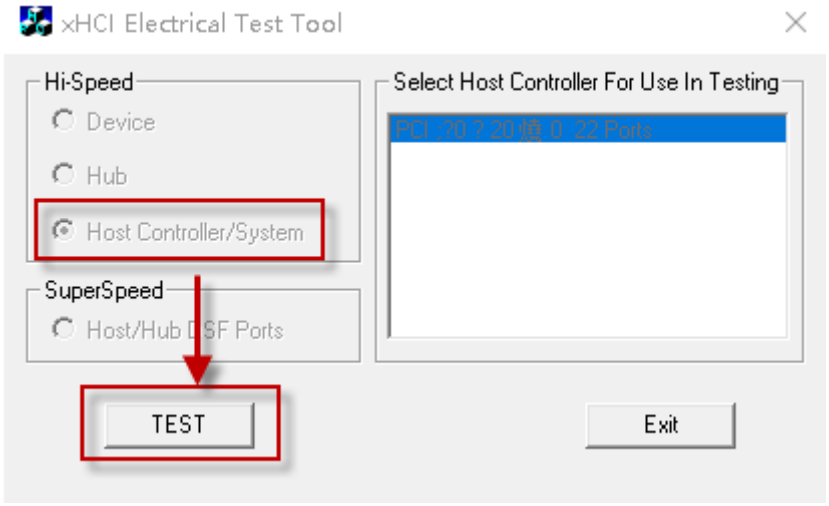
C. Click the "**Run Test**" button in the "**Run Test**" column to enter the test interface, a pop-up window will appear with the specific steps for sending packets using HSETT software. If you use HSETT software, please send packets in accordance with the pop-up window prompts, and if you send packets on your own, ignore the contents of the pop-up window. After sending packets is completed and the waveforms received by the oscilloscope are observed, click "**Run Test"**, the oscilloscope will complete the signal analysis.

7.4.1.2 HSETT Sending Packet Setup

7.4.1.2.1 Suspend Sending Packet Setup

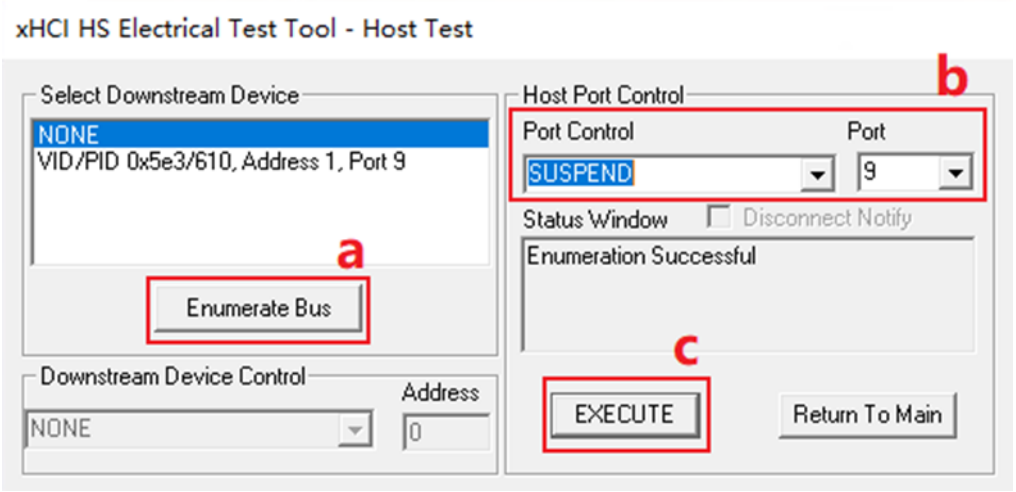
If you are using HSETT software, please follow the instructions in the following steps to send packets. If you are sending packets by yourself, please click "**Run Test**" after observing the waveform captured by the oscilloscope.

The following is the procedure for HSETT:



A. Open the High-speed Electrical Test Tool software and enter the main menu of the software.

B. Select [**Host Controller/System**], and then click [**TEST**] to enter the Host Test menu.



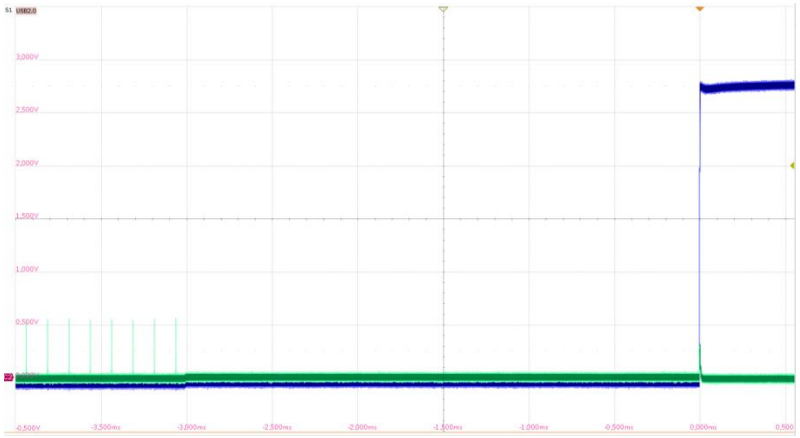
a. Click [Enumerate Bus].

b. Select [SUSPEND] in Port Control, and enter the number of the test port of the device under test in Port.

c. Click [EXECUTE].

C. After observing the waveforms captured by the oscilloscope, the reference waveform is shown in the figure below, click "**Run Test**". If the oscilloscope does not capture the waveforms or the

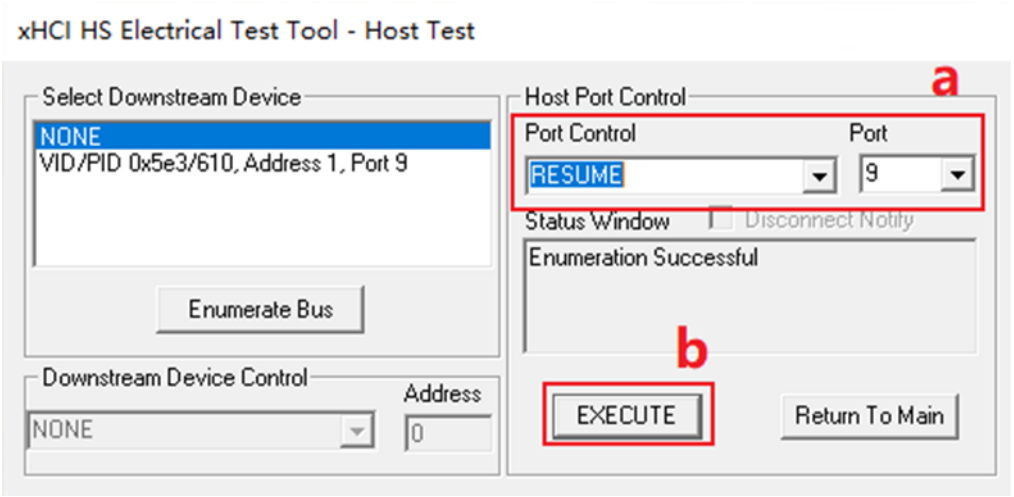
waveforms differ greatly from the reference waveforms, please check if the wiring is correct and start from step A again.



7.4.1.2.2 Resume Sending Packet Setup

If you are using HSETT software, please follow the instructions in the following steps to send packets. If you are sending packets by yourself, please click "**Run Test**" after observing the waveform captured by the oscilloscope.

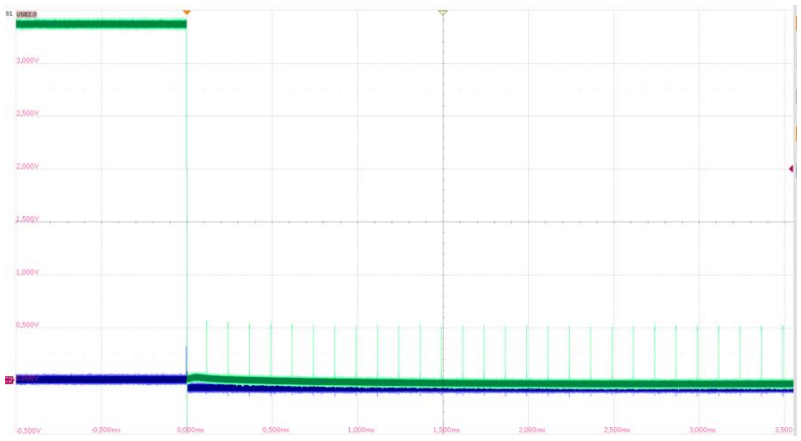
The following is the procedure for HSETT:



a. Select [RESUME] in Port Control, and enter the number of the test port of the device under test in Port.

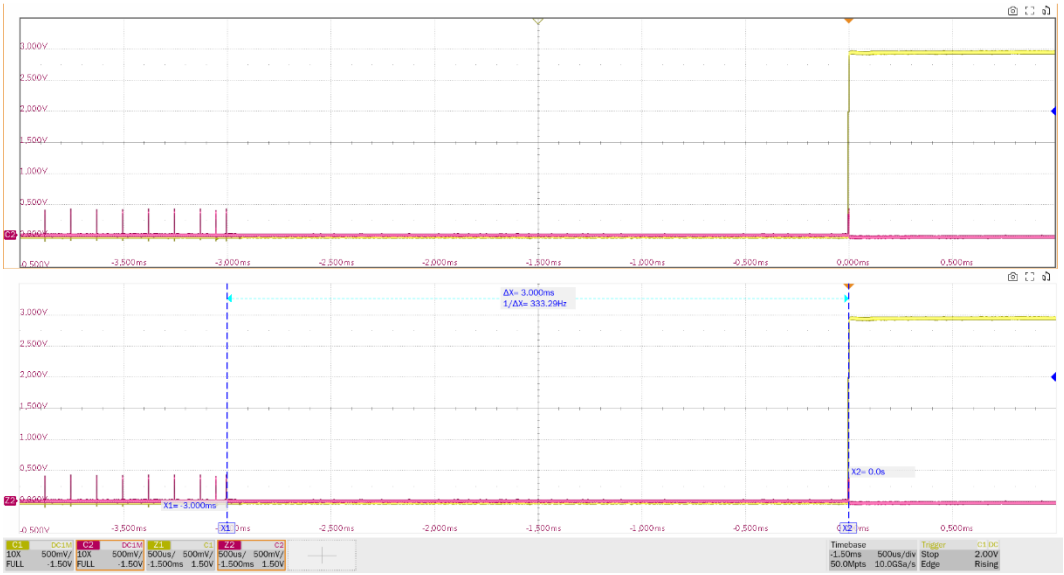
b. Click [EXECUTE].

After observing the waveforms captured by the oscilloscope, the reference waveform is shown in the figure below, click "**Run Test**". If the oscilloscope does not capture the waveforms or the waveforms differ greatly from the reference waveforms, please check if the wiring is correct. Port Control setting [**SUSPEND**], click [**EXECUTE**], then Port Control setting [**RESUME**], and click [**EXECUTE**] to restart this test.

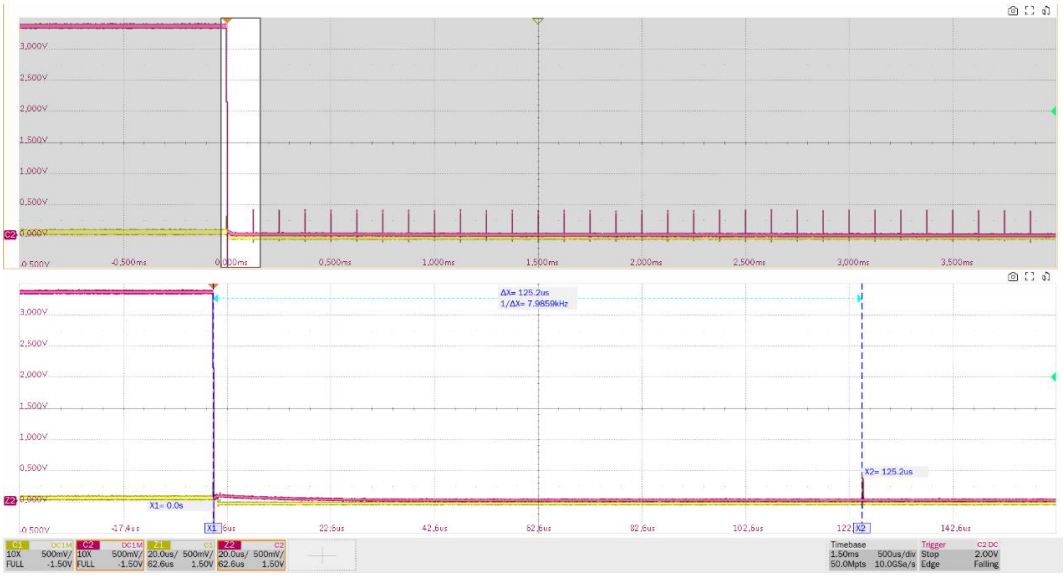


7.4.2 Test Results Reference

- EL_38: The device must revert to full-speed no later than 125us after there is a 3ms idle period on the bus (3.000ms <= t <= 3.125ms). Measure the time interval from the last SOF's of High-Speed to suspend.
- EL_39: The device must support the suspend state.



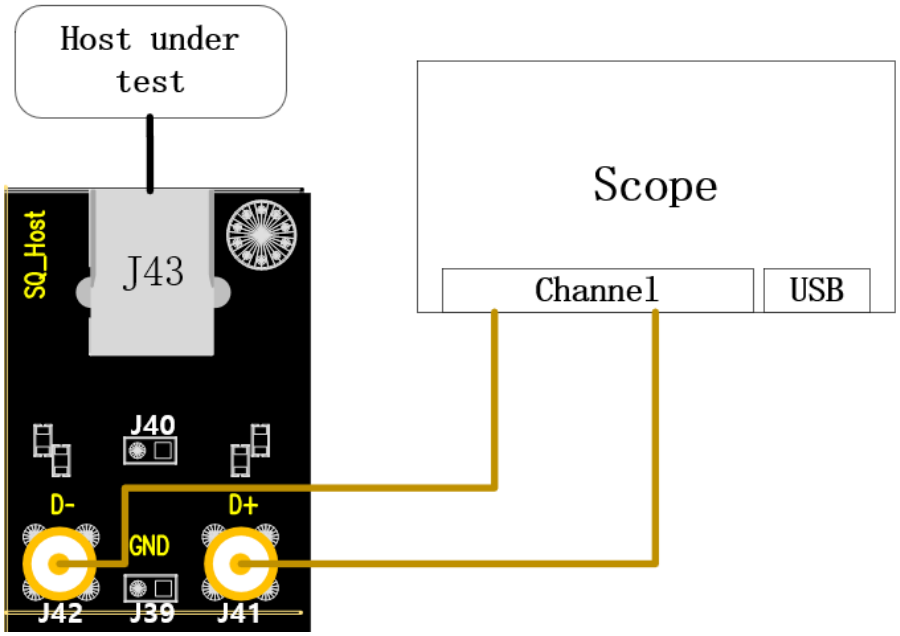
- EL_41: After resuming a port, the host must begin sending SOF’s within 3ms of the start of the idle state.



7.5 High-Speed DS Not Driven Voltage Levels (EL_8, EL_9)

7.5.1 Test Steps

7.5.1.1 Test Environment Setup



A. Use two SMA cables to connect J41 and J42 to the previously configured D+ and D- channels.

B. J43 access to host under test.

C. Click the "**Run Test**" button in the "**Run Test**" column to enter the test interface, a pop-up window will appear with the specific steps for sending packets using HSETT software. If you use HSETT software, please send packets in accordance with the pop-up window prompts, and if you send packets on your own, ignore the contents of the pop-up window. After sending packets is

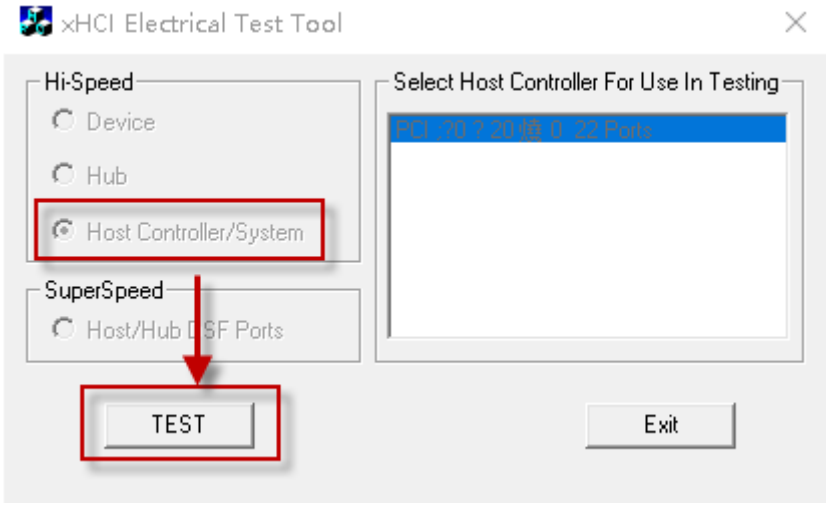
completed and the waveforms received by the oscilloscope are observed, click "**Run Test"**, the oscilloscope will complete the signal analysis.

7.5.1.2 HSETT Sending Packet Setup

7.5.1.2.1 TEST_J Sending Packets Setup

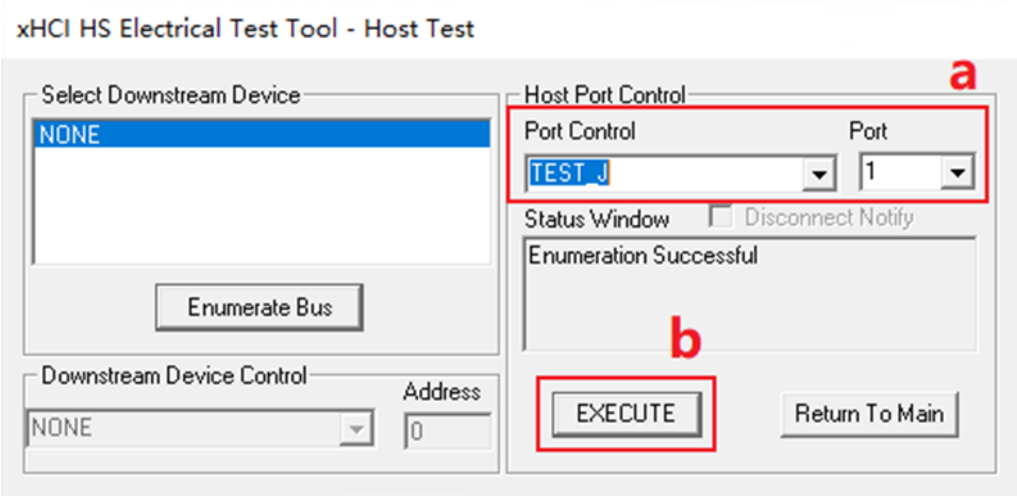
If you are using HSETT software, please follow the instructions in the following steps to send packets. If you are sending packets by yourself, please click "**Run Test**" after observing the waveform captured by the oscilloscope.

The following is the procedure for HSETT:



A. Open the High-speed Electrical Test Tool software and enter the main menu of the software.

B. Select [**Host Controller/System**], and then click [**TEST**] to enter the Host Test menu.



a. Select [TEST_J] in Port Control, and enter the number of the test port of the device under test in Port.

b. Click [EXECUTE].

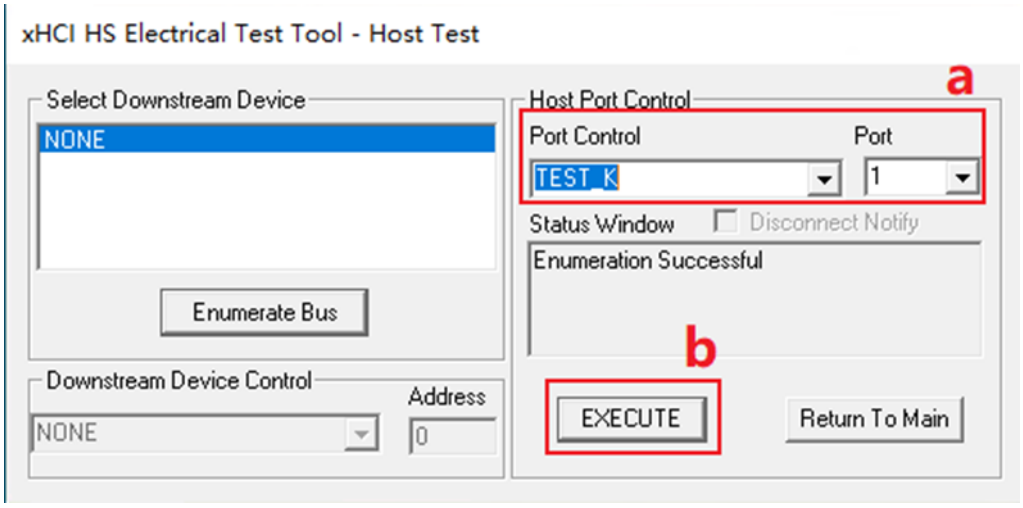
C. After observing the waveform captured by the oscilloscope, click "**Run Test**". If the oscilloscope

does not capture the waveform, or D+ is not high level, D- is not low level, please check whether the wiring is correct, check whether [**TEST_J**] is selected in Port Control, and then click [**EXECUTE**] to restart the test.

7.5.1.2.2 TEST_K Sending Packets Setup

If you are using HSETT software, please follow the instructions in the following steps to send packets. If you are sending packets by yourself, please click "**Run Test**" after observing the waveform captured by the oscilloscope.

The following is the procedure for HSETT:



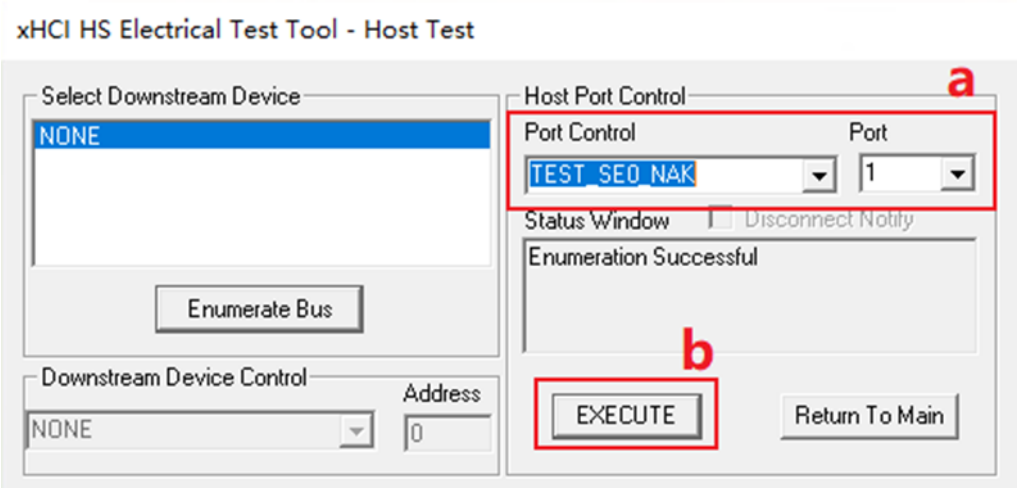
a. Select [TEST_K] in Port Control, and enter the number of the test port of the device under test in Port.
b. Click [EXECUTE].

After observing the waveform captured by the oscilloscope, click "**Run Test**". If the oscilloscope does not capture the waveform, or D+ is not low level, D- is not high level, please check whether the wiring is correct, check whether [**TEST_K**] is selected in Port Control, and then click [**EXECUTE**] to restart the test.

7.5.1.2.3 TEST_SE0_NAK Sending Packets Setup

If you are using HSETT software, please follow the instructions in the following steps to send packets. If you are sending packets by yourself, please click "**Run Test**" after observing the waveform captured by the oscilloscope.

The following is the procedure for HSETT:



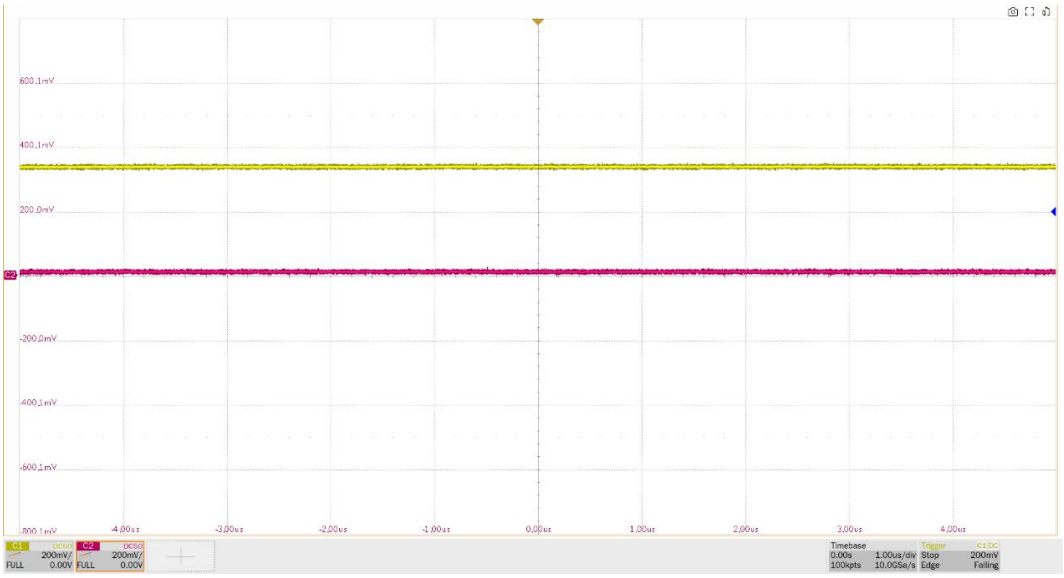
a. Select [TEST_SE0_NAK] in Port Control, and enter the number of the test port of the device under test in Port.

b. Click [EXECUTE].

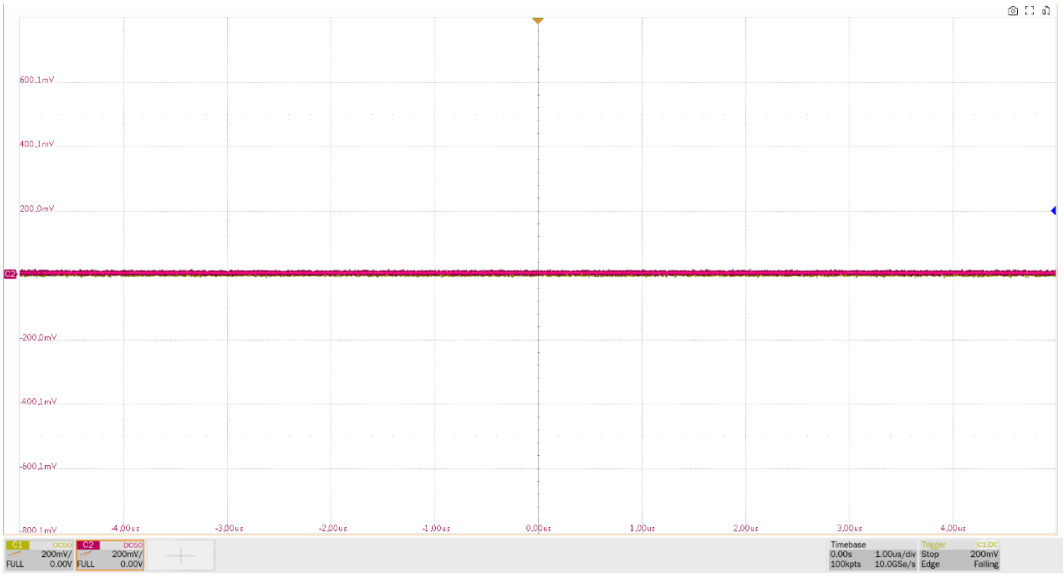
After observing the waveform captured by the oscilloscope, click "**Run Test**". If the oscilloscope does not capture the waveform, or D+ and D- are not low level, please check if the wiring is correct, and check if [**TEST_SE0_NAK**] is selected in Port Control, and then click [**EXECUTE**] to restart the test after confirming that there is no error.

7.5.2 Test Results Reference

▶ EL_8: The voltage measured of J/K not driven should be 360mV to 440mV.

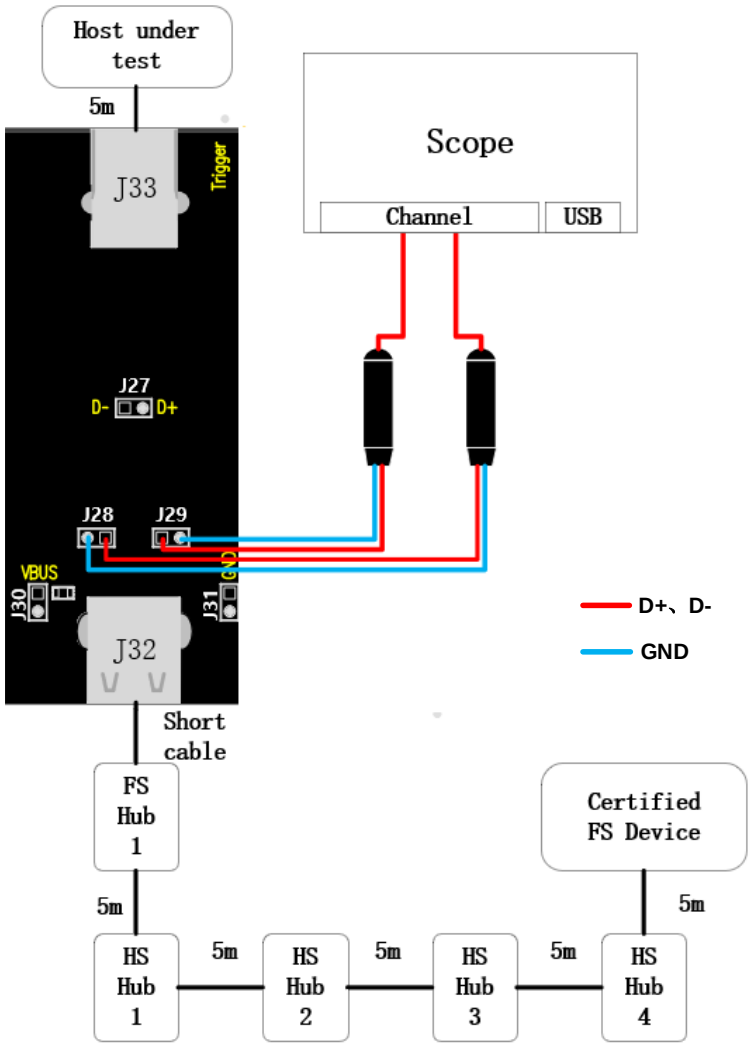


▶ EL_9: When either D+ or D- is not being driven, the output voltage must be 0V±20mV when terminated with precision 45 ohm resistors. This item measures the D+ and D- voltage values in the SE0 state.



7.6 Full-Speed DS Signal Quality

7.6.1 Test Steps



A. J29 and J28 are test points for D+ and D- signals respectively.

B. J33 is connected to the host under test via a 5m USB cable.

C. J32 is connected to the full-speed hub as well as four high-speed hubs according to the wiring diagram, where the full-speed hubs are connected to J32 with a short cable, and the rest are connected with 5m cables; the high-speed hub at the last level is connected to the certified full-speed devices.

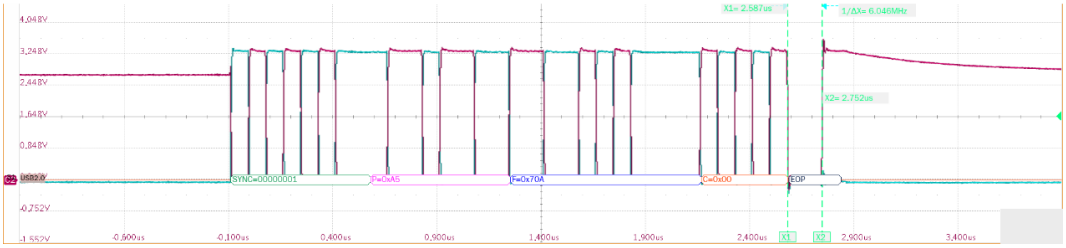
D. When performing this test, please try to connect all self-powered hubs to an external power supply to avoid the test failing due to insufficient power supply to the multi-stage hub connections under bus power.

E. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

7.6.2 Test Results Reference

The full-speed downstream signal quality of the host has the following test items:

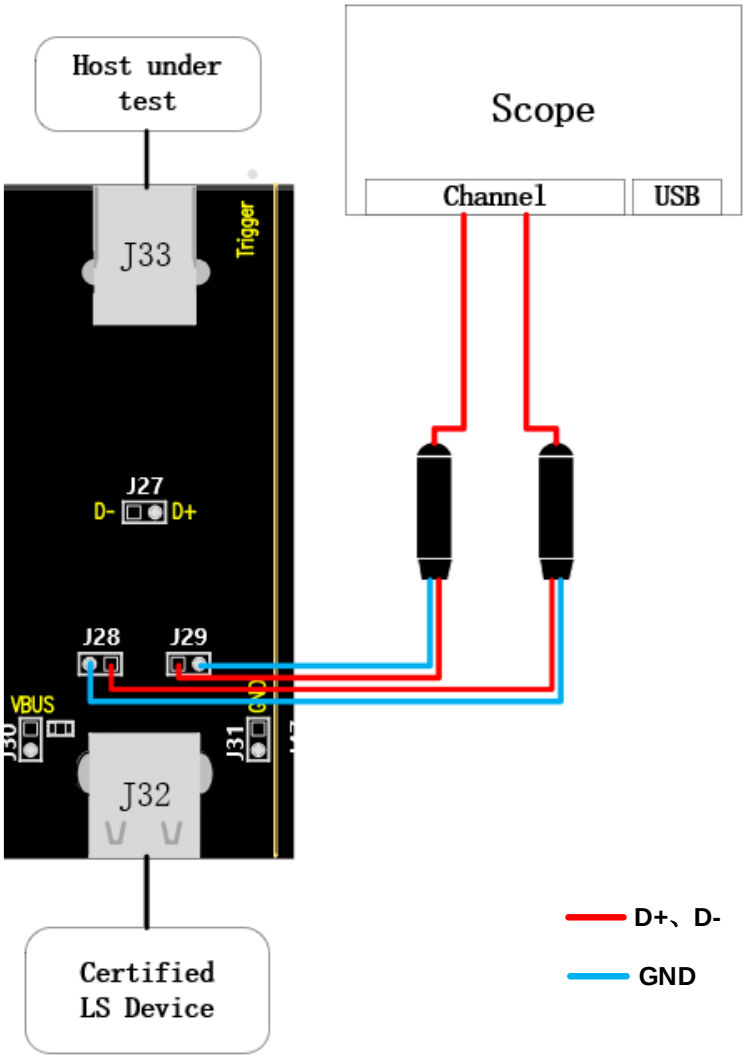
- Measure the EOP width of the full-speed packet, which is required to be in the range of (1.92+1) bit to (2.1+1) bit.



- Measure the voltage amplitude of D+ and D- cross point, which is required to be between 1.3V and 2V.
- Measure the signal speed of the full-speed packet, which is required to be between 11.97 MHz and 12.03MHz.
- Measure the D+/D- rise and fall time at full speed, which is required to be between 4ns and 20ns.
- Measure the edge monotonicity of full-speed signal, which is required no backhooks greater than 500mV exist at its edges.
- Measure the J/K jitter additionally, and the edge width of the eye diagram is the degree of J/K jitter.

7.7 Low-Speed DS Signal Quality

7.7.1 Test Steps



A. J29 and J28 are test points for D+ and D- signals respectively.

B. J33 is connected to the host under test.

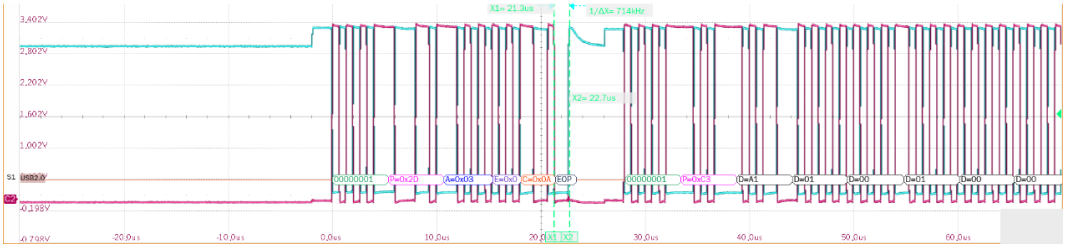
C. J32 access to certified low-speed devices.

D. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

7.7.2 Test Results Reference

The low-speed downstream signal quality of the host has the following test items:

- Measure the EOP width of the full-speed packet, which is required to be in the range of (1.875+1) bit to (2.25+1) bit.

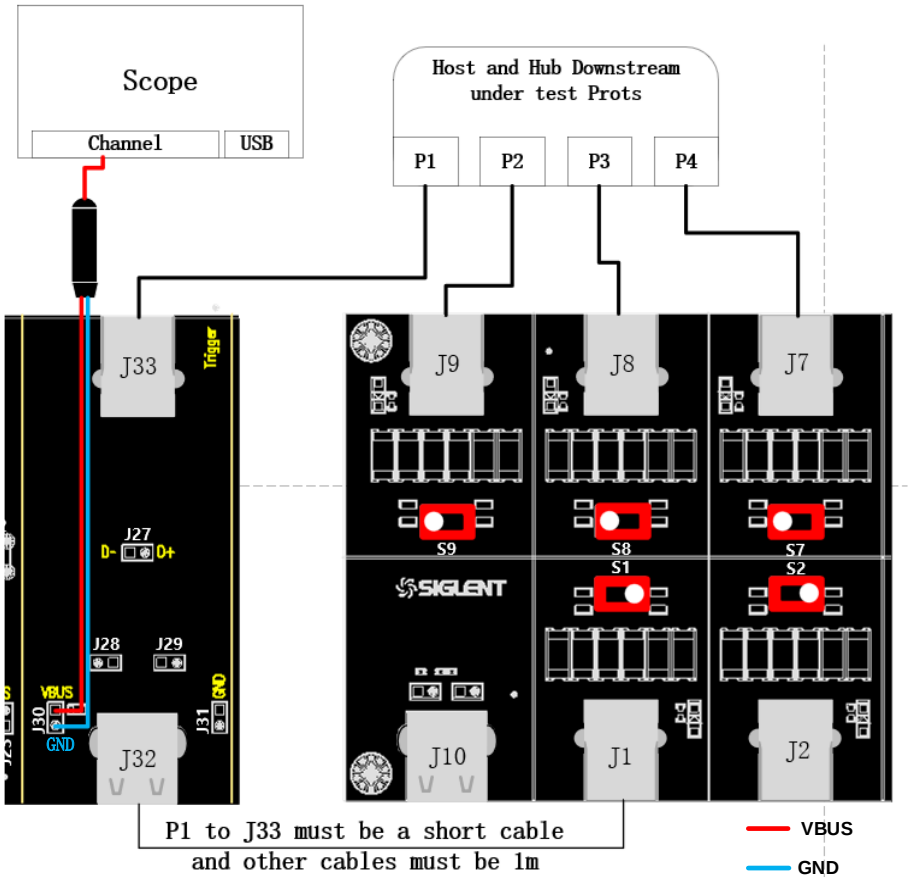


- Measure the voltage amplitude of D+ and D- cross point, which is required to be between 1.3V and 2V.
- Measure the signal speed of the low-speed packet, which is required to be between 1.4775MHz and 1.5225MHz.
- Measure the D+/D- rise and fall time at low speed, which is required to be between 75ns and 300ns.
- Measure the edge monotonicity of low-speed signal, which is required no backhooks greater than 500mV exist at its edges.
- Measure the J/K jitter additionally, and the rise/fall edge width of the eye diagram is the degree of J/K jitter.

7.8 Drop

7.8.1 Test Steps

7.8.1.1 Test Environment Setup



A. J30 is the VBus test point, connect the probe according to the configured oscilloscope channel.

B. The host port under test is connected to J33 of the signal board through a 1m cable, J32 is connected to the load board through a short cable, and the rest of the ports are connected to the load board through 1m cables.

C. Click the "**Run Test**" button in the "**Run Test**" section and follow the pop-up prompts to complete the test.

7.8.1.2 No-load Tests

Please turn the load board's twist switch to the center and click "**Run Test**" after observing the waveform captured by the oscilloscope.

7.8.1.3 Tests with Load

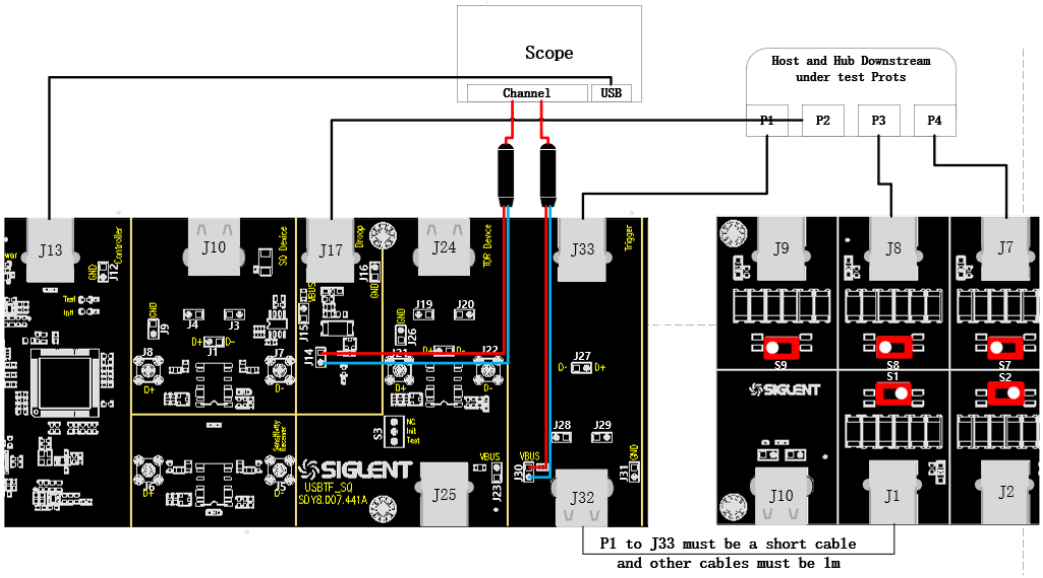
Please turn the switch of the load board to 500mA, and then click "**Run Test**" after observing the waveform captured by the oscilloscope.

7.8.2 Test Results Reference

The VBus voltage of the port under test is 4.75V~5.25V for all ports of the host with no load connected, and 4.75V~5.25V for all ports with 500mA load connected, respectively.

7.9 Droop

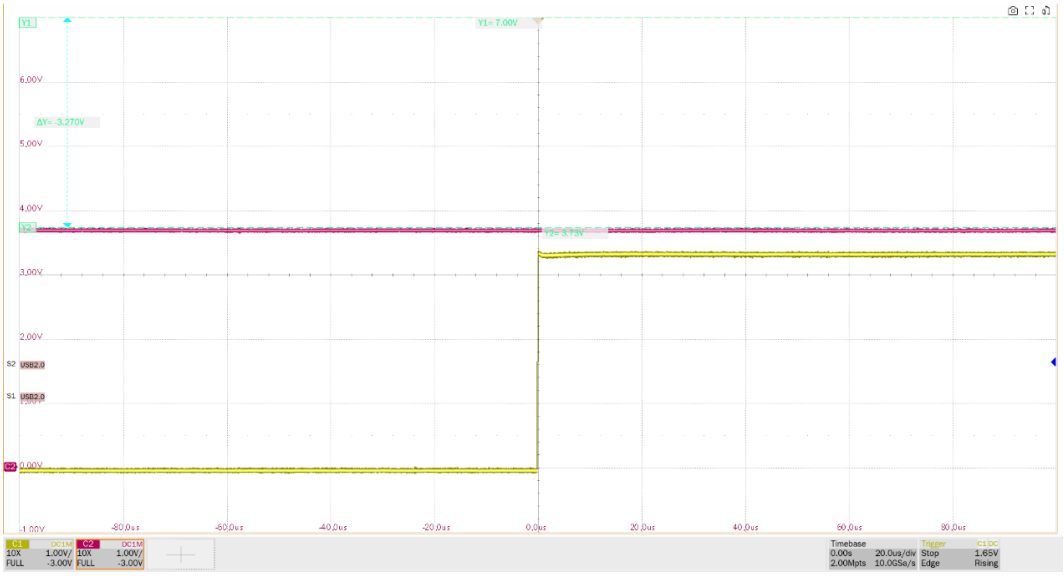
7.9.1 Test Steps



A. Use a 1m cable to connect the test port (e.g. P1 in the figure) to the signal board J33; use a short cable to connect the signal board J32 to any of the load boards; use a 1m cable to connect the port next to the test port (e.g. P2 in the figure) to the USB signal board J17; and use a 1m cable to connect the remaining ports to the USB load board.
B. For the loads used on the USB load board, turn its twist switch to 100mA.
C. Connect the probes according to the channels configured before, J14 is the load-side test point and J30 is the DUT test point.
D. Use a cable to connect USB signal board J13 and oscilloscope, Power light on.
E. Click the "**Run Test**" button in the "**Run Test**" column, check whether the cable connection is the same as the pop-up window, click "**OK**", the oscilloscope will start to capture waveforms.

7.9.2 Test Results Reference

Requires dynamic voltage drop of the port under test to be less than 350mV.

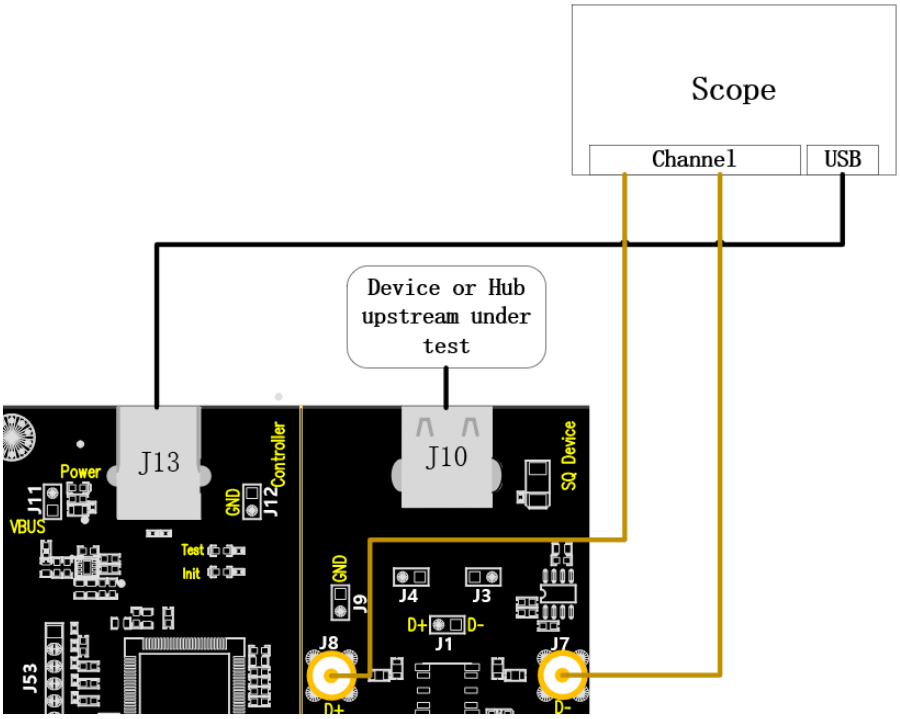

Y1
Y1= 7.00V
6.00V
ΔY= -3.270V
5.00V
4.00V
Y2
Y2= 3.73V
3.00V
2.00V
S2 USB2.0
S1 USB2.0
0.00V
-1.00V
-80.0us
-60.0us
-40.0us
-20.0us
0.0us
20.0us
40.0us
60.0us
80.0us
C1 DC1M 10X 1.00V/ FULL -3.00V
C2 DC1M 10X 1.00V/ FULL -3.00V
Timebase 0.00s 20.0ua/div 2.00Mpts 10.0GSa/s
Trigger C1 DC Stop 1.65V Edge Rising

8 Device

When performing USB 2.0 device-related tests, please set up the compliance test function correctly according to the test requirements.

8.1 High-Speed US Signal Quality (EL_2, EL_4/EL_5, EL_6, EL_7)

8.1.1 Test Steps



A. Use two SMA cables to connect J8 and J7 to the configured D+ and D- channels. J13 establishes communication with the oscilloscope through the cables, and the **Power** light on.

B. Access the DUT in J10, if it is successfully enumerated, the **Init** light will be on, if the **Init** light is not on, please re-plug the DUT.

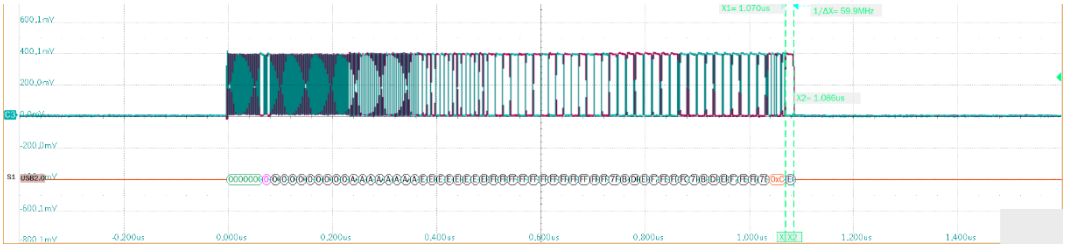
C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light goes out, the **Test** light lights up, the oscilloscope will automatically complete the test.

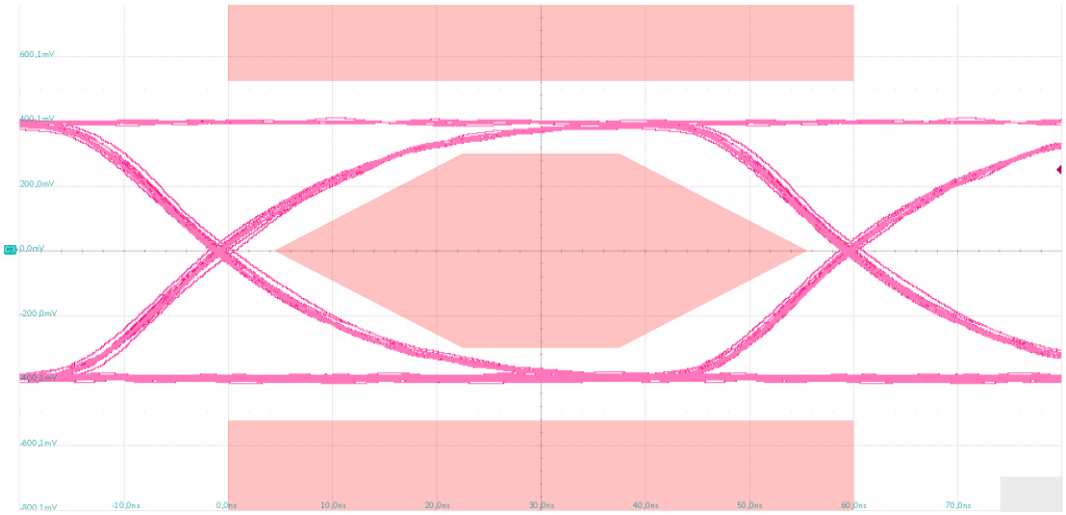
8.1.2 Test Results Reference

- EL_2: A USB 2.0 high-speed transmitter data rate must be 480 Mb/s±0.05%.
- EL_4/EL_5: Select the appropriate eye diagram template according to the type of upstream port, if no cable is attached, select "Near End Template", if cable is attached, select "Far End Template".
- EL_6: A USB 2.0 HS driver must have 10% to 90% differential rise and fall times of greater than 300 ps. However, in the actual measurement, a warning indication will be prompted in 100~300ps, and less than 100ps is judged as a test failure.
- EL_7: A USB 2.0 HS driver must have monotonic data transitions over the vertical openings

specified in the appropriate eye pattern template which is less than 50mV.

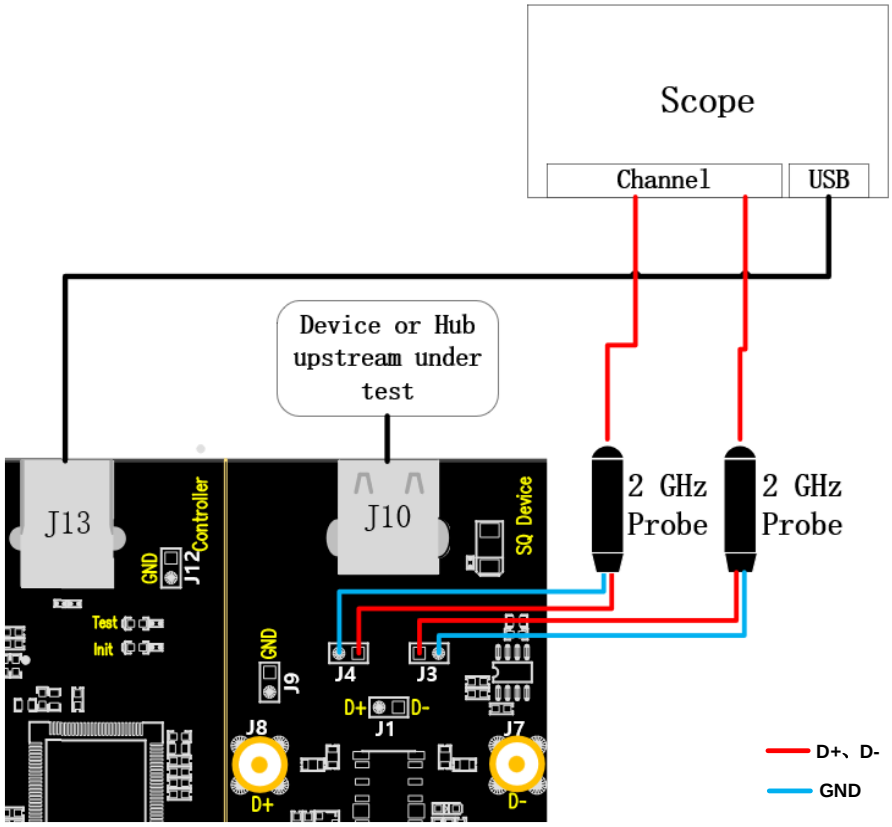
All of the above test items are performed together, with specific waveforms captured before near-end/far-end eye chart analysis.





8.2 High-Speed US Packet Parameters (EL_21, EL_22, EL_25)

8.2.1 Test Steps



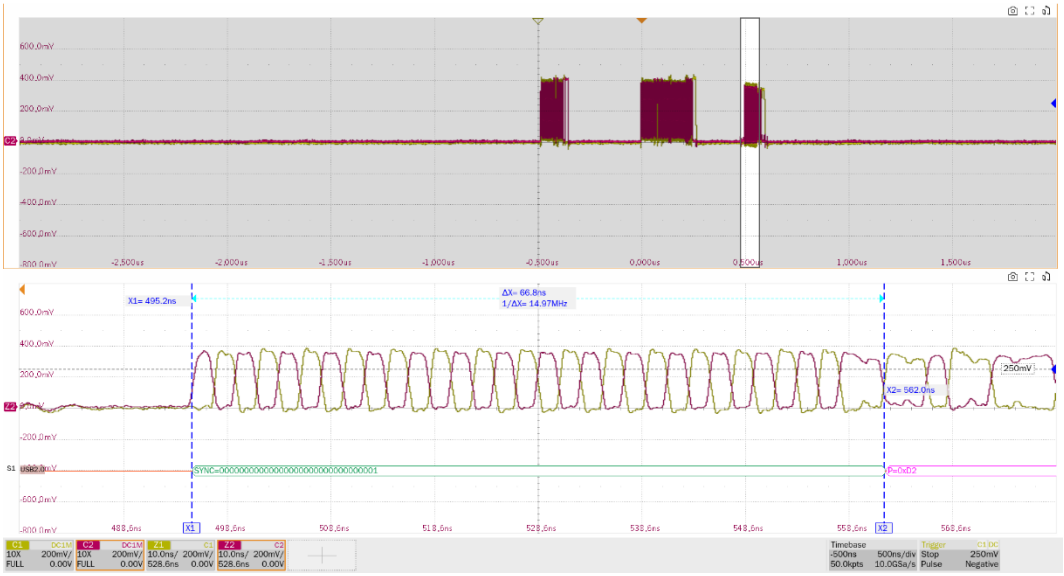
A. For "Single Ended", J4 and J3 are the test points for D+ and D- signals respectively, and for "Differential Probe", the test point is J1. J13 establishes communication with the oscilloscope through the cable, and the Power light lights up.

B. Access the DUT in J10, if it is successfully enumerated, the **Init** light will be on, if the **Init** light is not on, please re-plug the device to be tested.

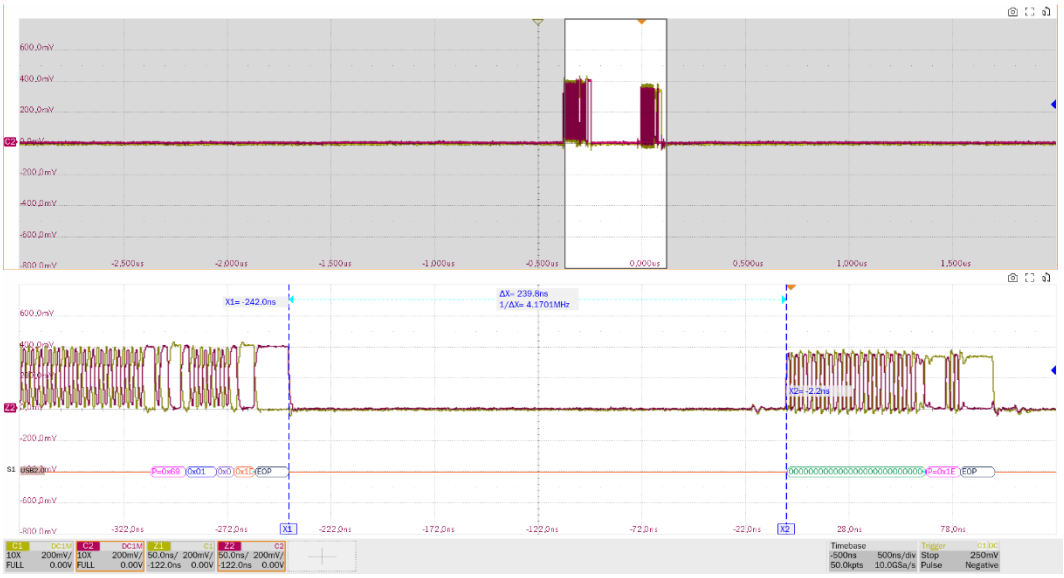
C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light goes out and the **Test** light lights up, the oscilloscope will automatically complete the test, and the test results will pop up when the test is finished.

8.2.2 Test Results Reference

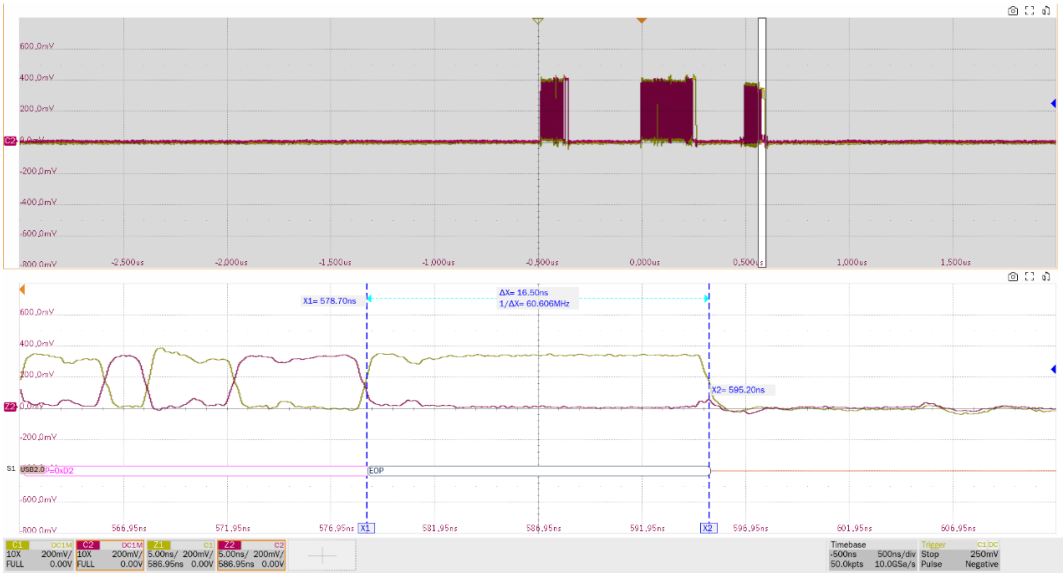
▶ EL_21: The SYNC field for all transmitted packets (not repeated packets) must begin with a 32 bit SYNC field. The number of SYNCs at the beginning of the device answer packet is measured in this item.



- EL_22: When transmitting after receiving a packet, hosts and devices must provide an inter-packet gap of at least 8 bit times and not more than 192 bit times(16.64ns~399.36ns). The oscilloscope displays two packets, measuring the time interval between the first packet (sent by the host) and the second packet (replied by the device).

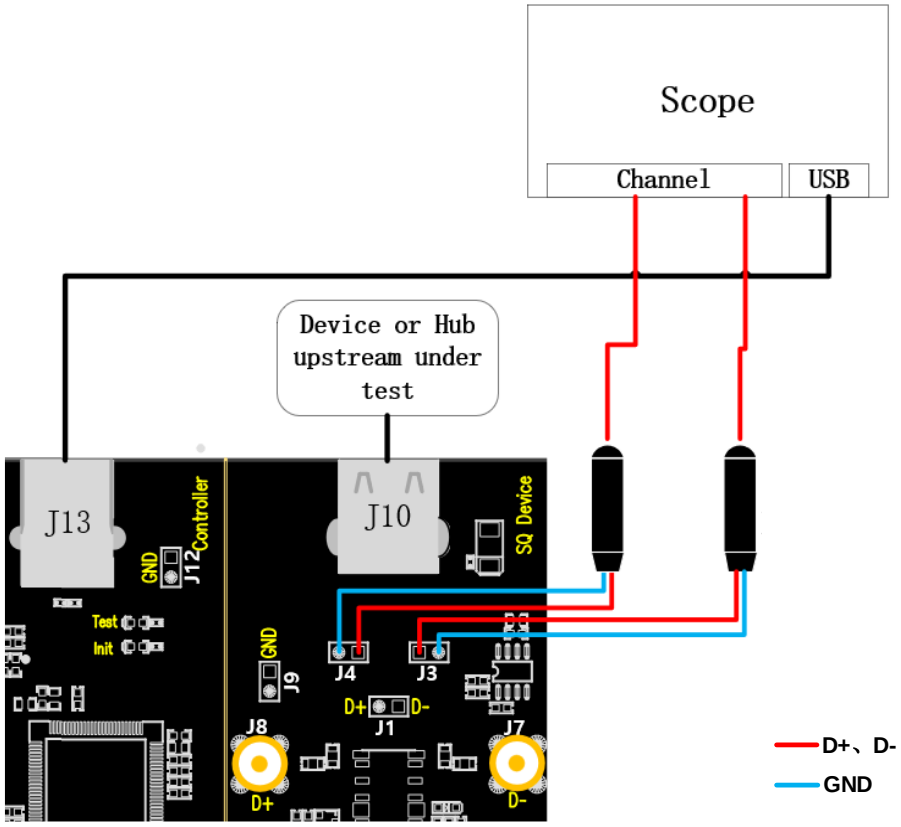


- EL_25: The EOP for all transmitters' packets (except SOFs) must be an 8 bit NRZ byte of 01111111.



8.3 High-Speed US Chirp Timing (EL_28, EL_29, EL_31)

8.3.1 Test Steps



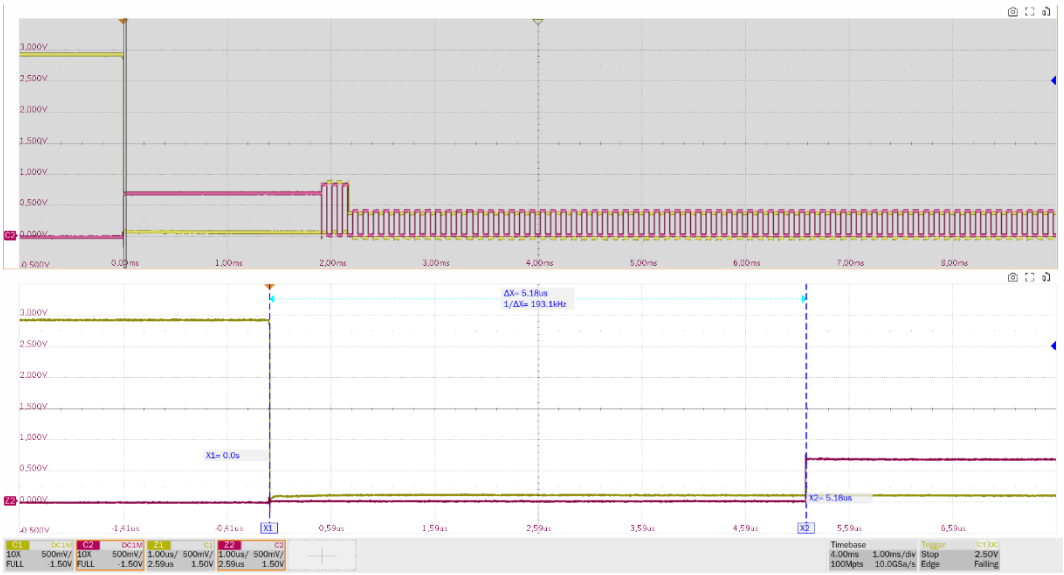
A. J4 and J3 are the test points for D+ and D- signals, respectively. J13 establishes communication with the oscilloscope through the cable, and the **Power** light is on.

B. Access the DUT in J10, if it is successfully enumerated, the **Init** light will be on, if the **Init** light is not on, please re-plug the DUT.

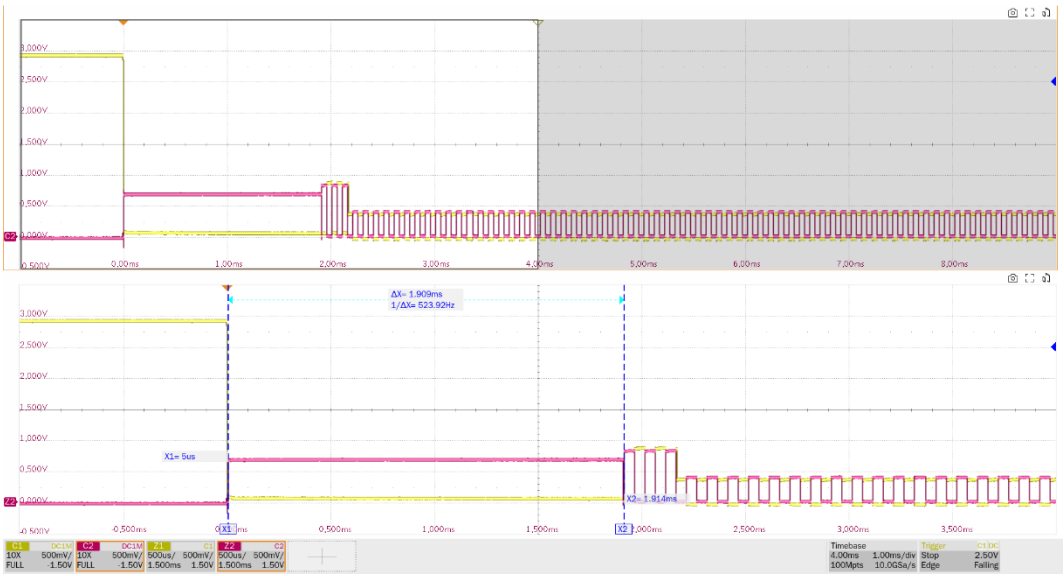
C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light will go out and the Test light will go on, the oscilloscope will automatically complete the test, and the test results will be popped up at the end of the test.

8.3.2 Test Results Reference

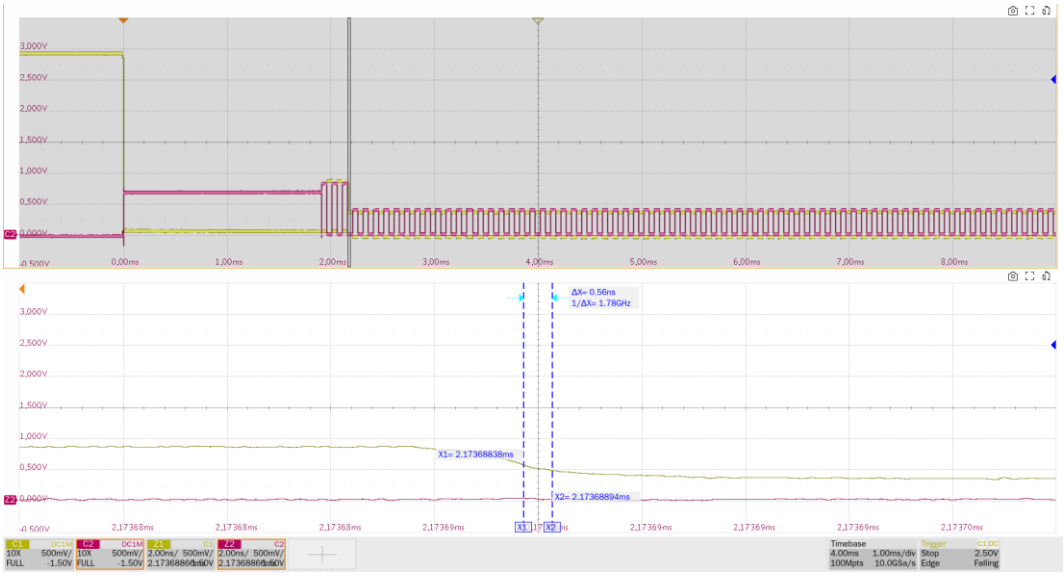
▶ EL_28: Devices must transmit a chirp handshake no sooner than 2.5us and no later than 6.0ms when being reset from a suspended state.



▶ EL_29: The chirp handshake generated by a device must be at least 1ms and no more than 7ms in duration.

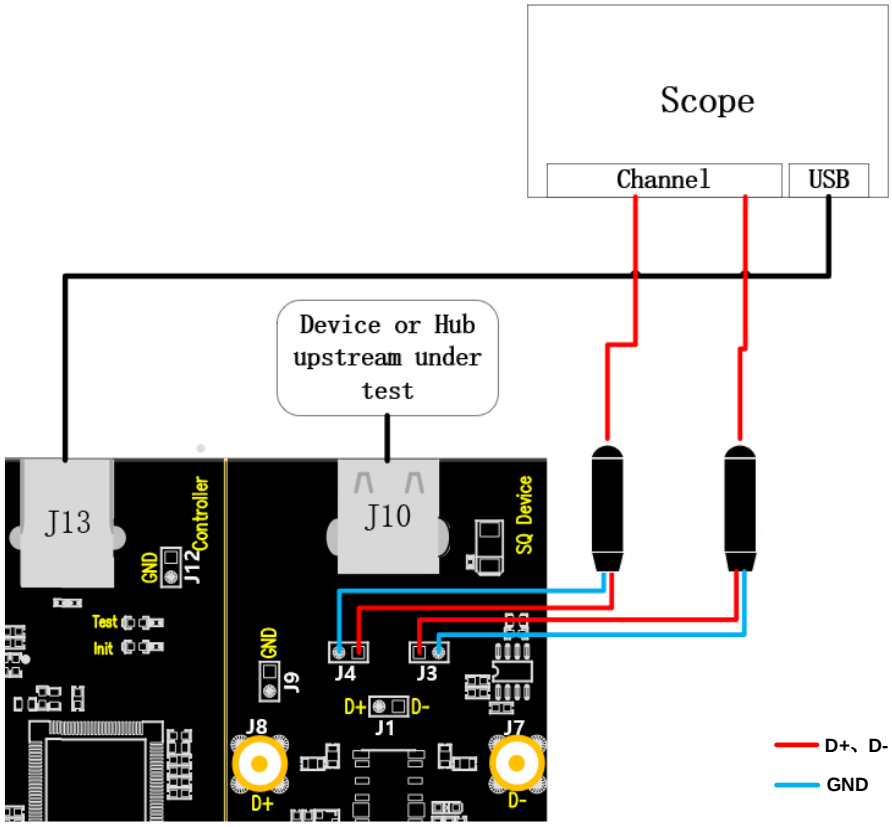


▶ EL_31: During device speed detection, when a device detects a valid K-J-K-J-K-J sequence, the device must disconnect its 1.5K pull-up resistor and enable it high-speed termination within 500us.



8.4 High-Speed US Suspend Resume (EL_38 EL_39, EL_40 EL_41)

8.4.1 Test Steps



A. J4 and J3 are the test points for D+ and D- signals respectively, connect the probes according to the configured oscilloscope channel; J13 establishes communication with the oscilloscope through the cable, and the **Power** light is on.

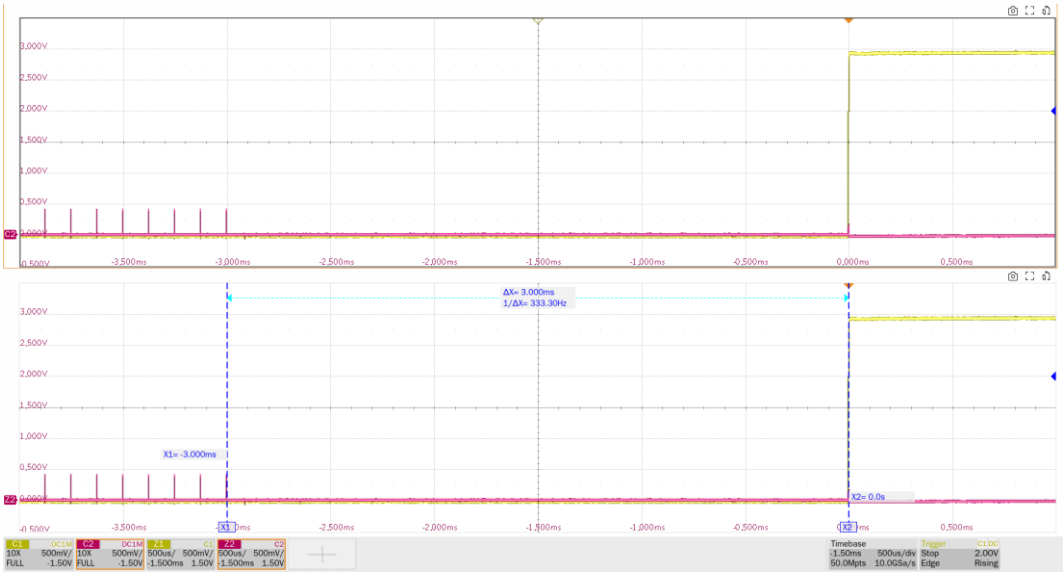
B. Access the DUT in J10, if it is successfully enumerated, the **Init** light will be on, if the **Init** light is

not on, please re-plug the DUT.

C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light will go out and the **Test** light will go on, the oscilloscope will automatically complete the test, and the test results will pop up after the test is finished.

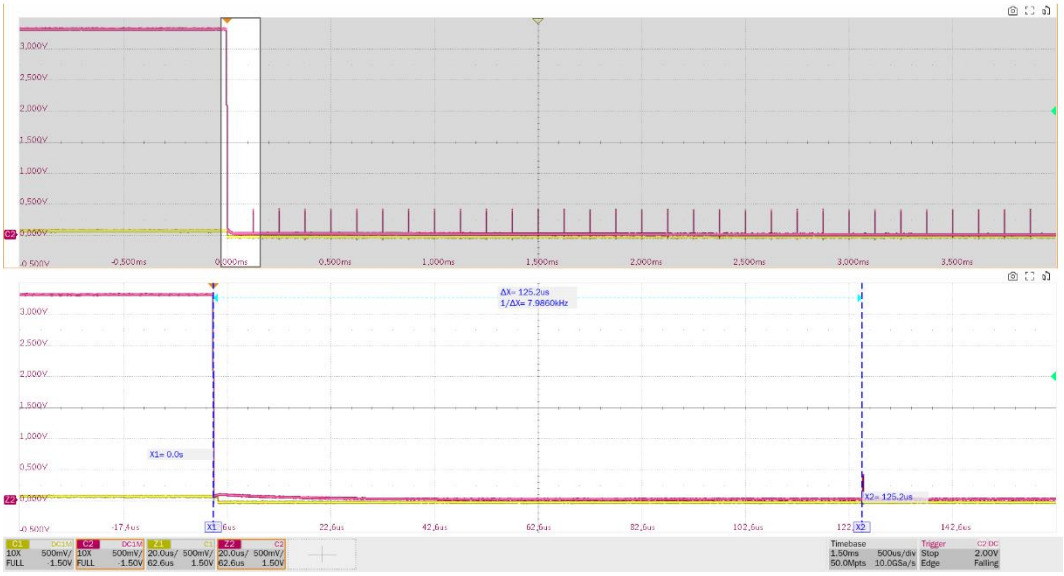
8.4.2 Test Results Reference

- EL_38: A device must revert to full-speed no later than 125us after there is a 3ms idle period on the bus (3.000ms <= t <= 3.125ms). Measure the time interval from the last SOF's at high speed to suspend.
- EL_39: A device must support the suspend state.



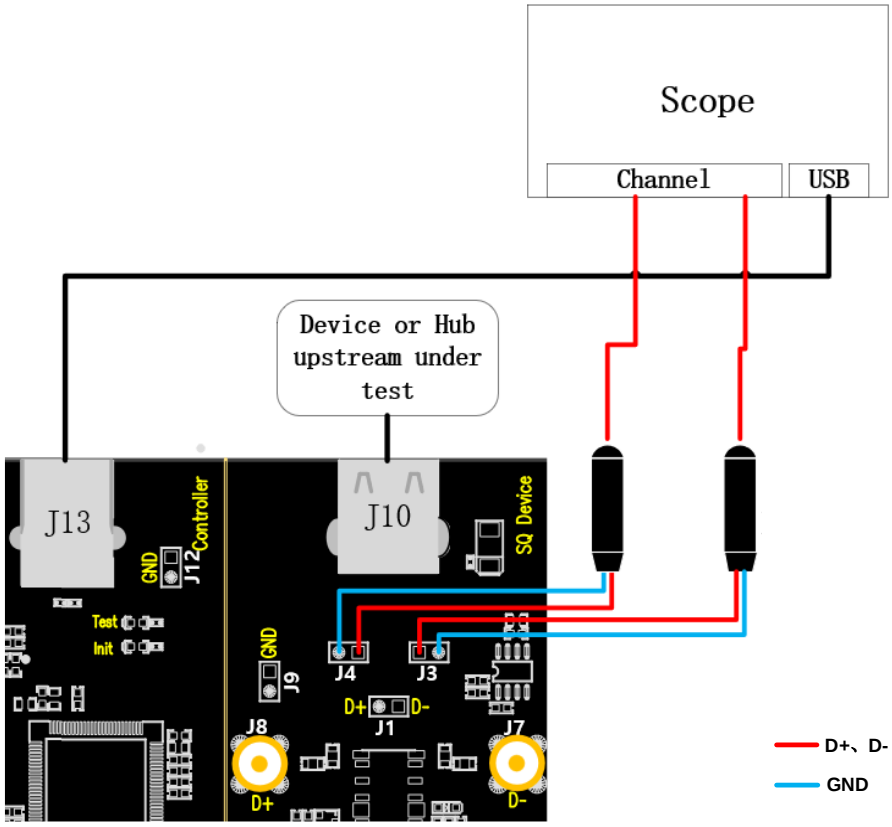
- EL_40: If a device is in the suspend state, and was operating in high-speed before being suspend, then the device must transition back to high speed operation within two bit times from the end of resume signaling.
- EL_41: After resuming a port, the host must begin sending SOF’s within 3ms of the start of the idle state.

Note: The EL_40 test item is a poorly defined measurement of low level from suspend to high speed, so only EL_41 is measured.



8.5 High-Speed to Reset (EL_27, EL_29, EL_31)

8.5.1 Test Steps



A. J4 and J3 are the test points for D+ and D- signals respectively, connect the probes according to the configured oscilloscope channel; J13 establishes communication with the oscilloscope through the cable, and the **Power** light is on.

B. Access the DUT in J10, if it is successfully enumerated, the **Init** light will be on, if the **Init** light is

not on, please re-plug the DUT.

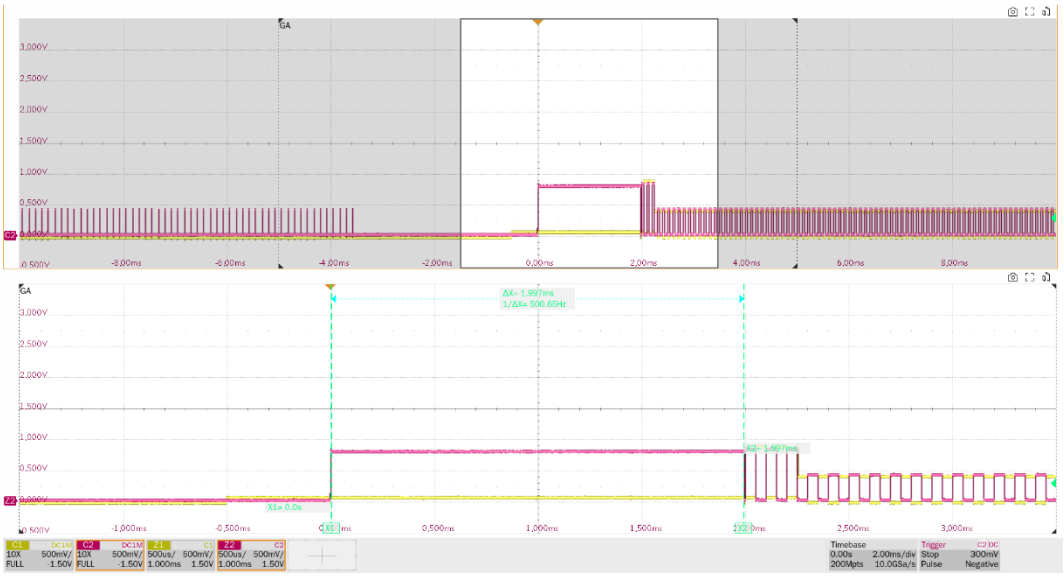
C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light will go out and the **Test** light will go on, the oscilloscope will automatically complete the test, and the test results will pop up after the test is finished.

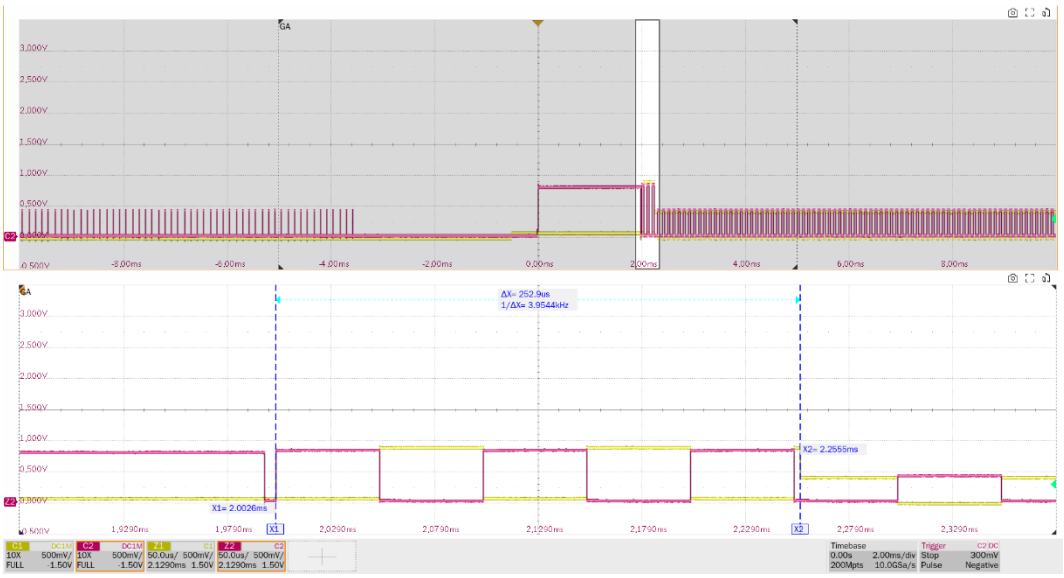
8.5.2 Test Results Reference

▶ EL_27: The response time of reset from the non-suspended state in high speed is measured from the last SOF's of the high-speed to the time of the chirp K generation which is a time interval of 3.1ms~6ms. This section additionally measures the amplitude of the chirp K (720mV to 880mV).

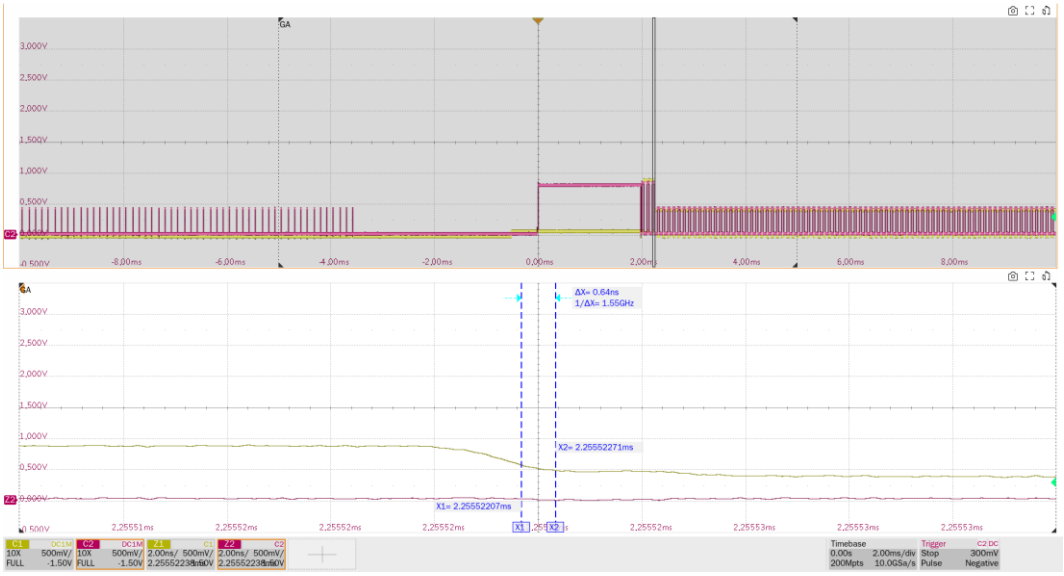
▶ EL_29: The chirp handshake generated by a device must be at least 1ms and no more than 7ms in duration. This section additionally measures the number of J/K number pairs (at least 3)

produced by the device.



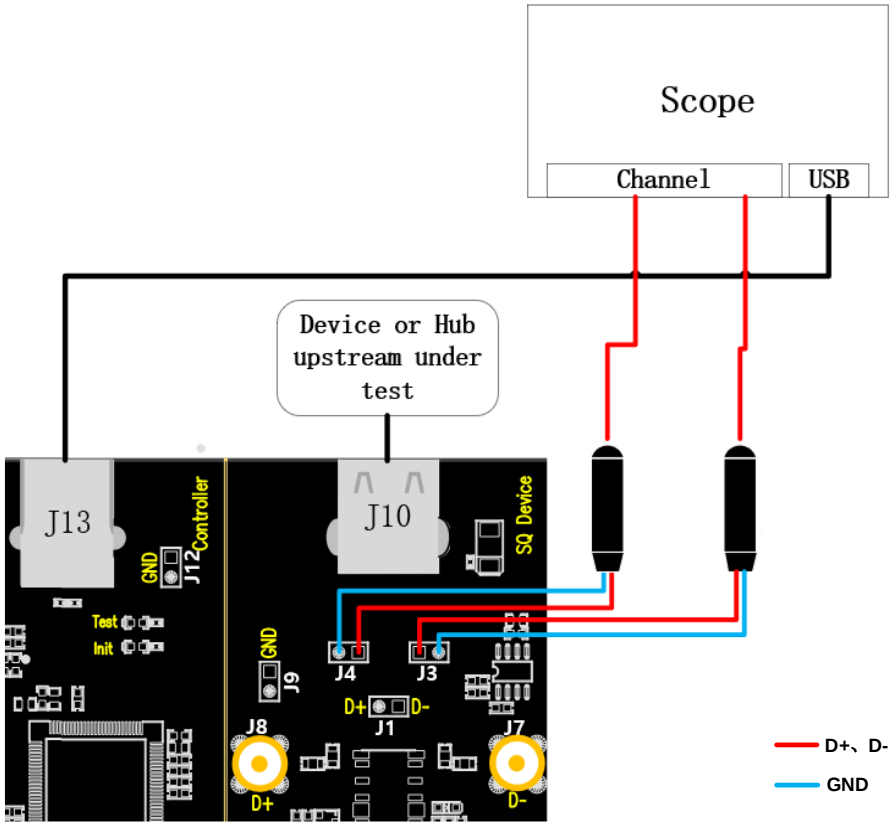


- EL_31: During device speed detection, when a device detects a valid K-J-K-J-K-J sequence, the device must disconnect its 1.5K pull-up resistor and enable it high-speed termination within 500us.



8.6 Suspend to Reset (EL_28, EL_29, EL_31)

8.6.1 Test Steps



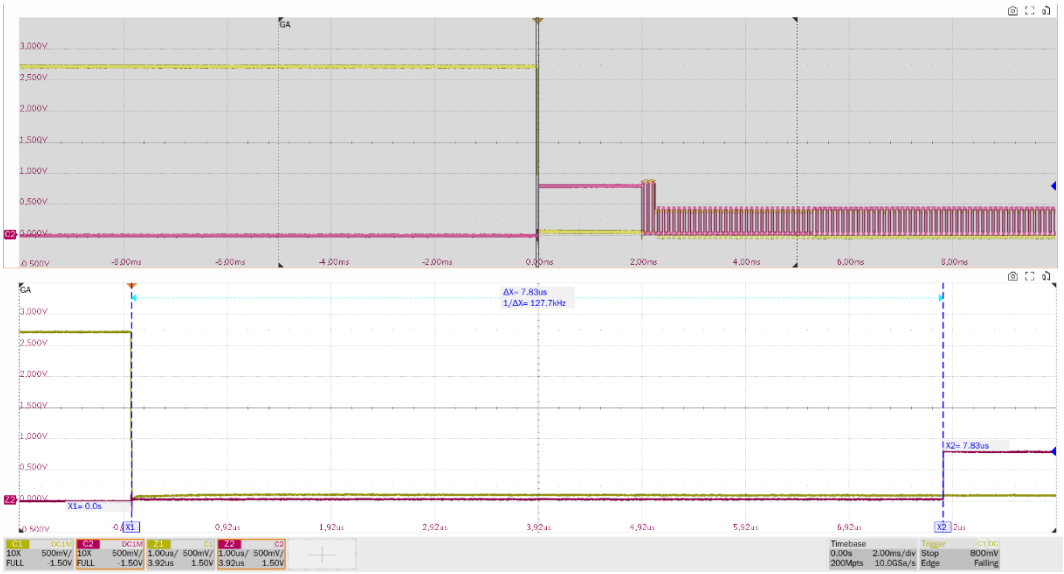
A. J4 and J3 are the test points for D+ and D- signals respectively. J13 establishes communication with the oscilloscope through the cable and the **Power** light is on.

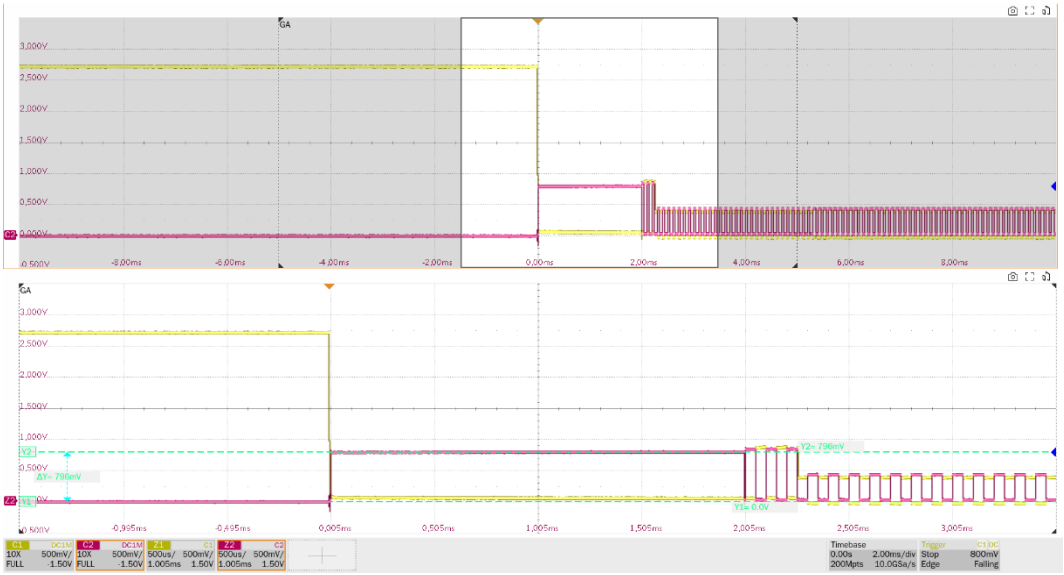
B. Access the DUT in J10, if it is successfully enumerated, the **Init** light will be on, if the **Init** light is not on, please re-plug the DUT.

C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light will go out and the **Test** light will go on, the oscilloscope will automatically complete the test, and the test results will pop up after the test is finished.

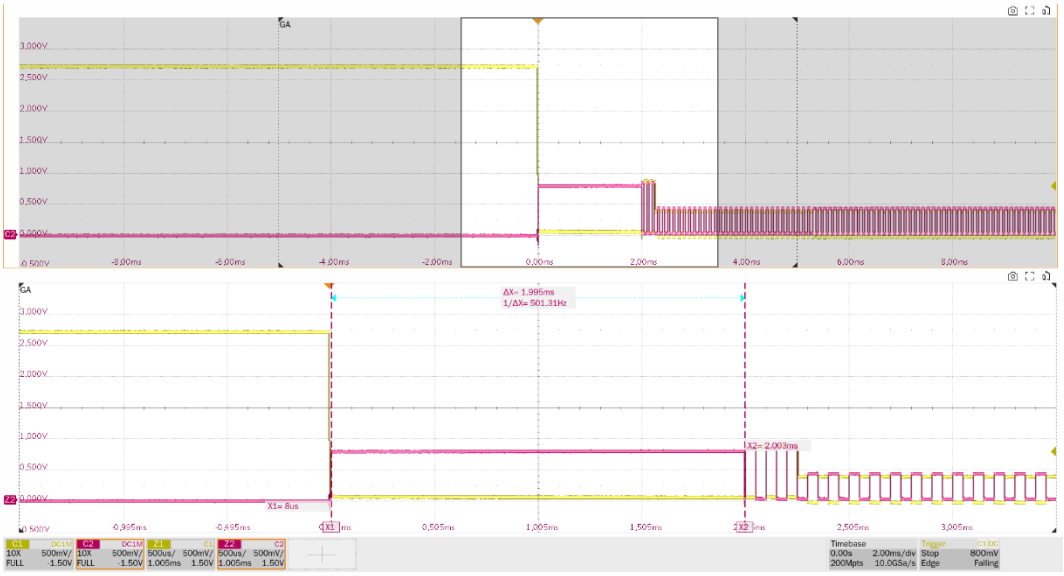
8.6.2 Test Results Reference

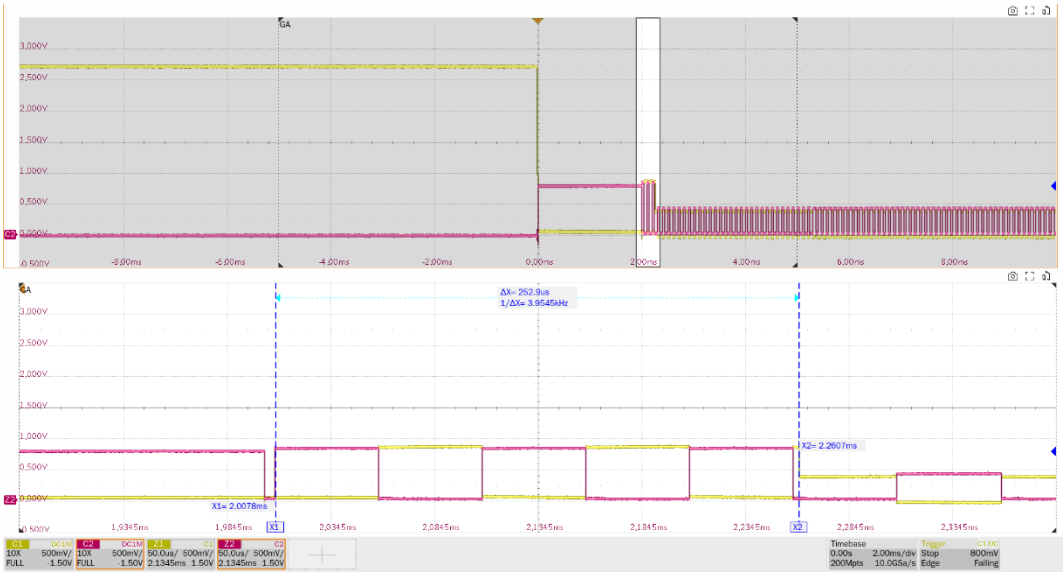
▶ EL_28: Devices must transmit a chirp handshake no sooner than 2.5us and no later than 6.0ms when being reset from a suspend state. This section additionally measures the amplitude of the chirp K (720mV to 880mV).



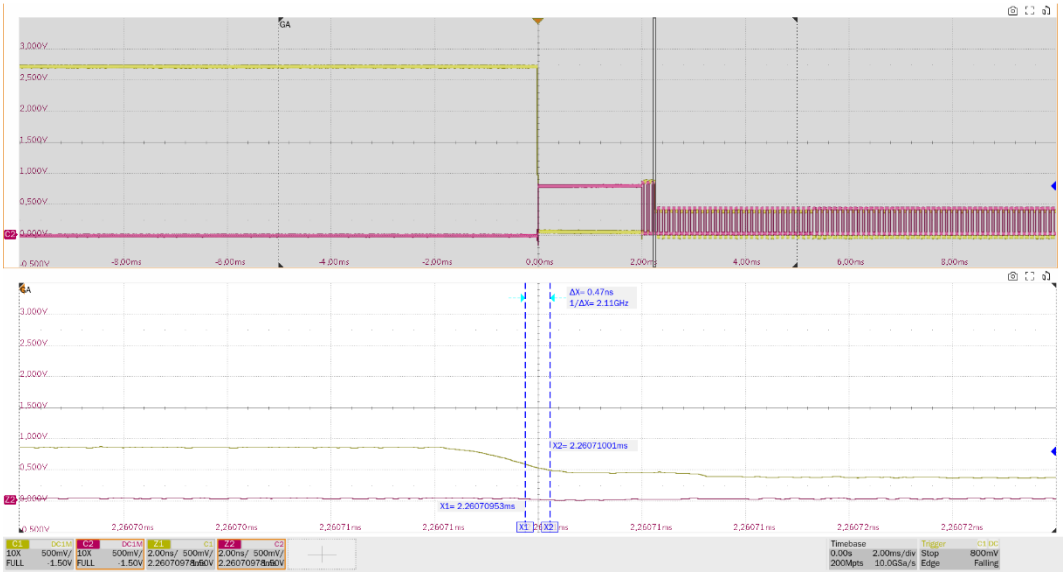


▶ EL_29: The chirp handshake generated by a device must be at least 1ms and no more than 7ms in duration. This section additionally measures the number of K/J pairs (at least 3) after a suspend reset.



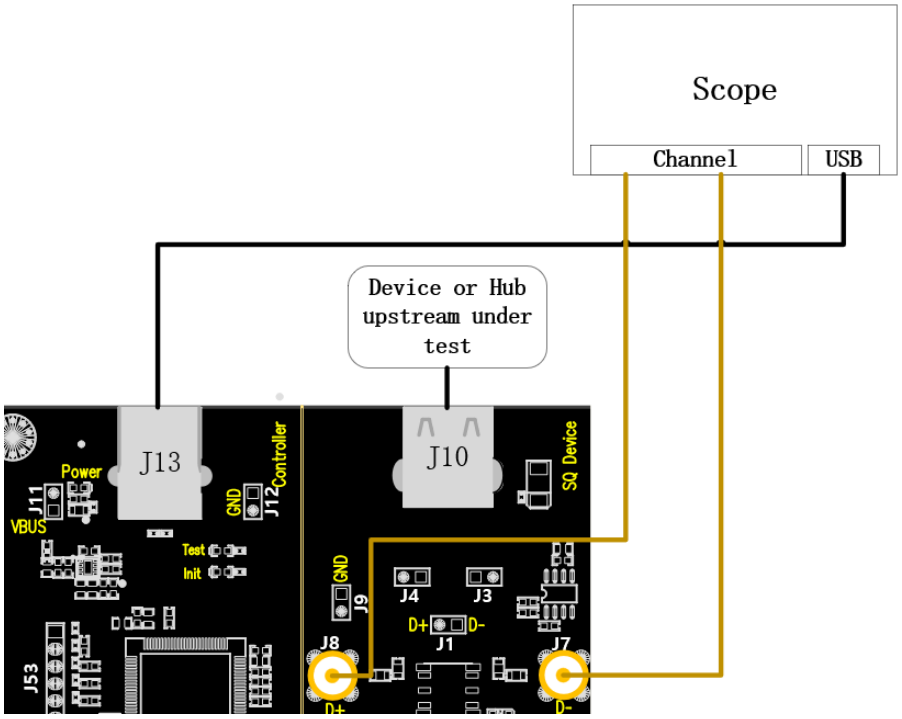


▶ EL_31: During device speed detection, when a device detects a valid K-J-K-J-K-J sequence, the device must disconnect its 1.5K pull-up resistor and enable it high-speed termination within 500us.



8.7 High-Speed US Not Driven Voltage Levels (EL_8, EL_9)

8.7.1 Test Steps



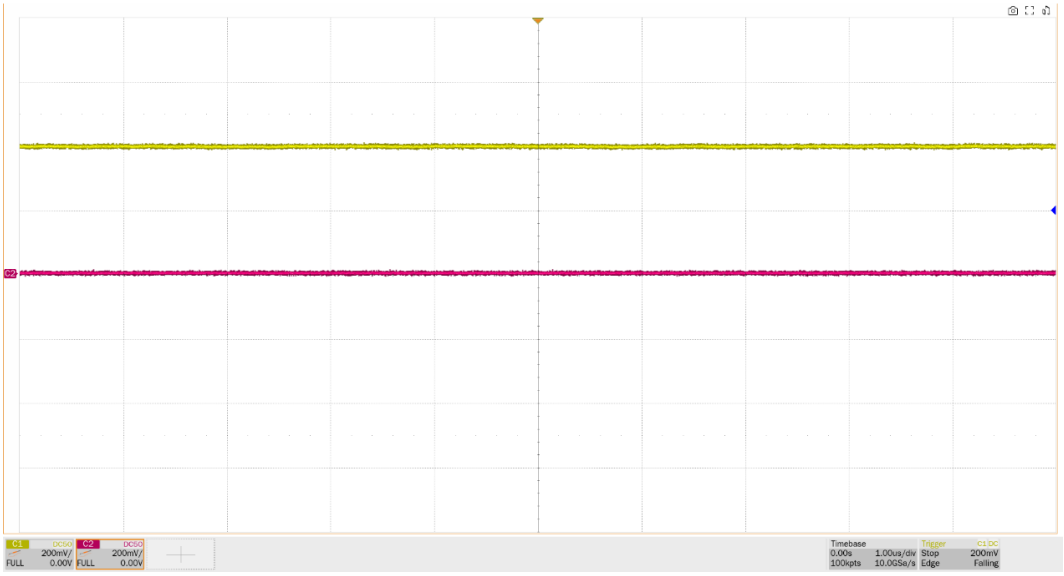
A. Use two SMA cables to connect J8 and J7 to the configured D+ and D- channels. J13 establishes communication with the oscilloscope through the cables and the **Power** light is on.

B. Access the DUT in J10, if it is successfully enumerated, the **Init** light will be on, if the **Init** light is not on, please re-plug the DUT.

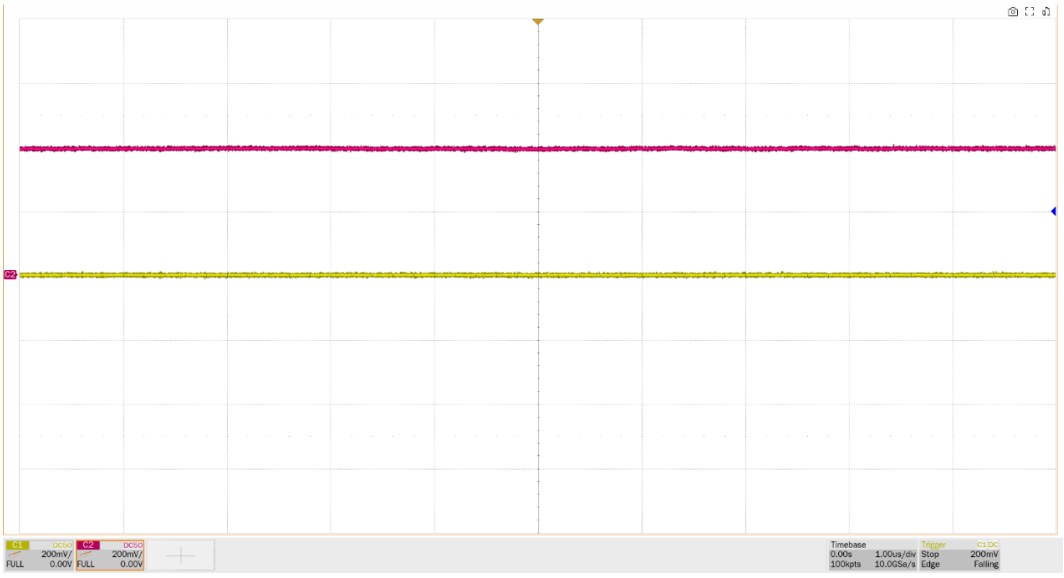
C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light will go out and the **Test** light will go on, and the oscilloscope will automatically complete the test.

8.7.2 Test Results Reference

▶ EL_8: The voltage measured of J/K not driven should be 360mV to 440mV.

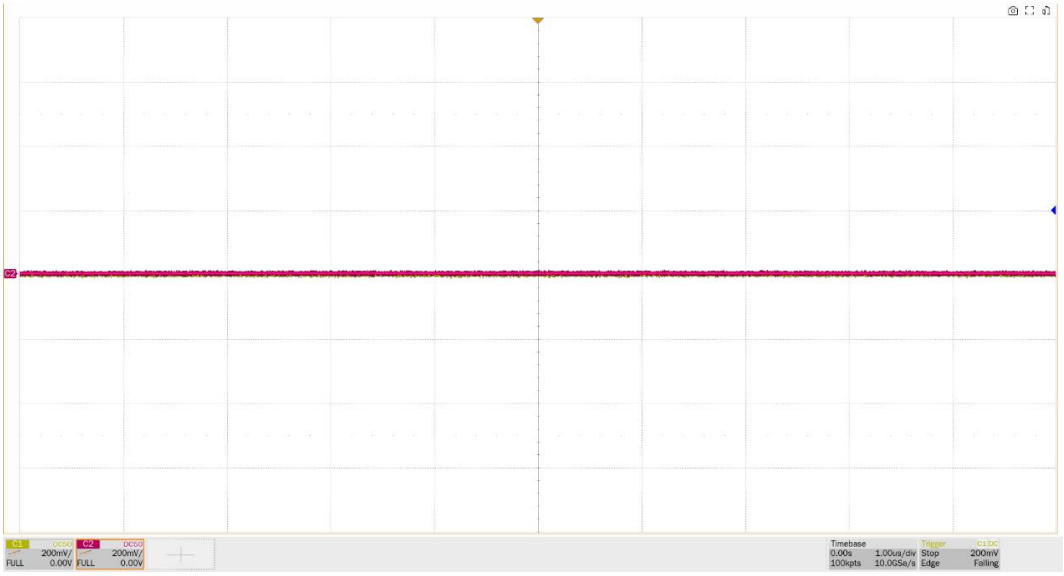


Voltage of J when the upstream is not driven



Voltage of K when the upstream is not driven

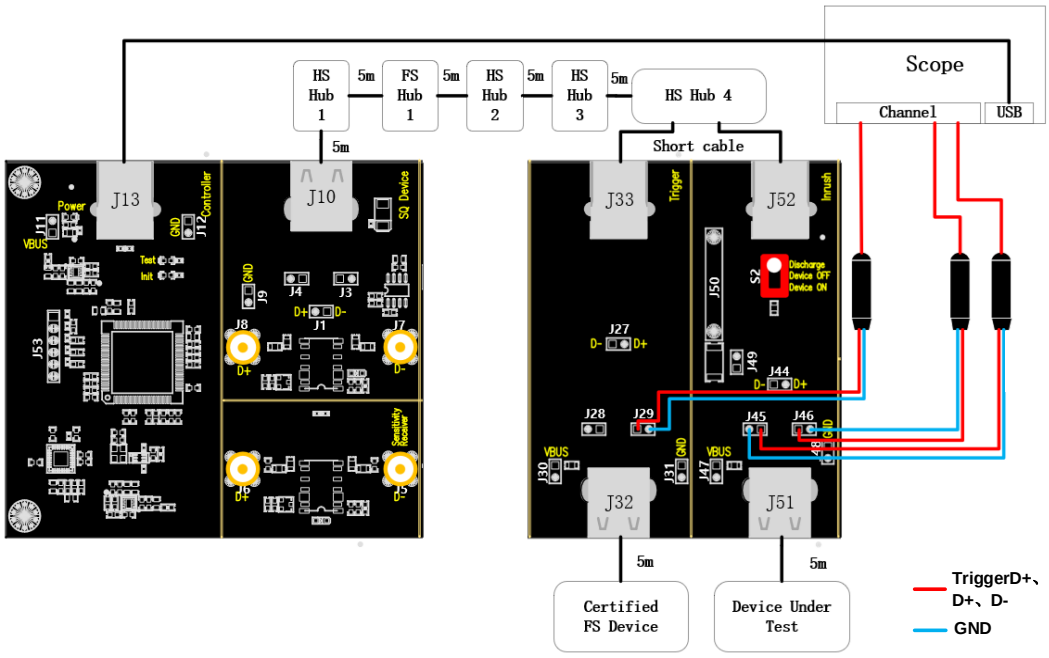
▶ EL_9: When either D+ or D- is not being driven, the output voltage must be 0V±20mV when terminated with precision 45 ohm resistors to ground. This item measures the D+ and D- voltage values in the SE0 state.



Voltage of SE0_NAK in upstream

8.8 Full-Speed US Signal Quality

8.8.1 Test Steps



A. J46 and J45 are the D+ and D- signal test points of the DUT respectively, and J29 is the signal test point for trigger D+.

B. Use a cable to connect the oscilloscope USB interface and J13 to establish communication between the oscilloscope and the USB signal board, and the **Power** light is on.

C. Take a high speed hub (HS Hub 4 in the figure), according to the value in "**Port**", the downstream port of the corresponding position of the high speed hub is connected to J52 through a short

cable, and any other port is connected to J33 through a short cable.

D. The J10 and HS Hub 4 upstream ports are connected to the full-speed hub, as well as three high-speed hubs according to the wiring diagram, all using 5m cables.

E. J32 is connected to a full-speed device that has passed the official USB certification, J51 is connected to the DUT, and S2 is dialed to "**Device ON**".

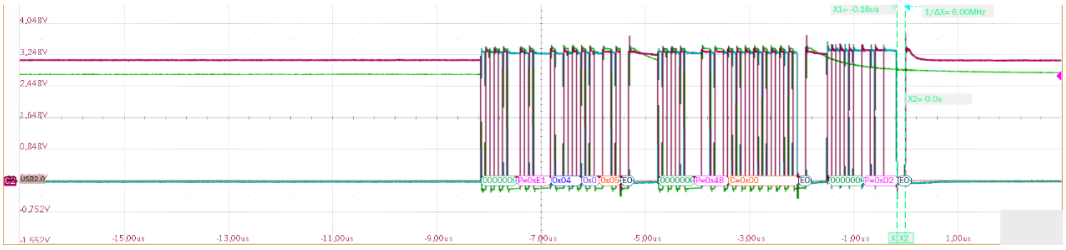
F. When performing this test, please try to connect all self-powered hubs to an external power supply to avoid the test failing due to insufficient power supply to the multi-stage hub connections under bus power.

G. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

8.8.2 Test Results Reference

The full-speed upstream signal quality of the device has the following test items:

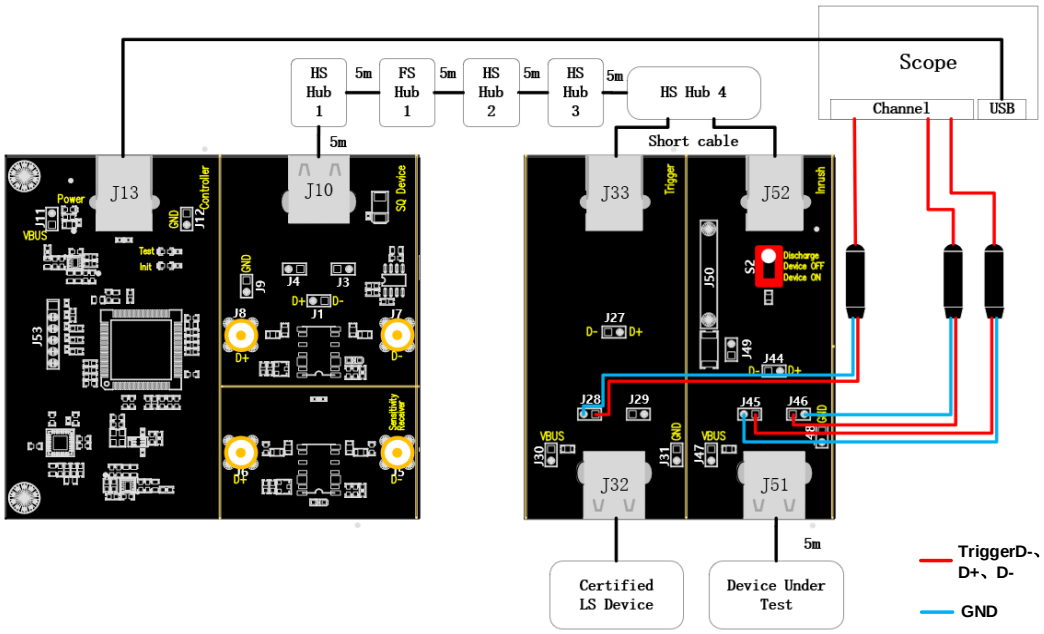
- Measure the EOP width of the full-speed packet, which is required to be in the range of (1.92+1) bit to (2.1+1) bit.



- Measure the voltage amplitude of D+ and D- cross point, which is required to be between 1.3V and 2V.
- Measure the signal speed of the full-speed packet, which is required to be between 11.97 MHz and 12.03MHz.
- Measure the D+/D- rise and fall time at full speed, which is required to be between 4ns and 20ns.
- Measure the edge monotonicity of full-speed signal, which is required no backhooks greater than 500mV exist at its edges.
- Measure the J/K jitter additionally, and the edge width of the eye diagram is the degree of J/K jitter.

8.9 Low-Speed US Signal Quality

8.9.1 Test Steps



A. J46 and J45 are the D+ and D- signal test points of the DUT respectively, and J28 is the signal test point for trigger D+.

B. Use a cable to connect the oscilloscope USB interface and J13 to establish communication between the oscilloscope and the USB signal board, and the **Power** light is on.

C. Take a high speed hub (HS Hub 4 in the figure), according to the value in "**Port**", the downstream port of the corresponding position of the high speed hub is connected to J52 through a short cable, and any other port is connected to J33 through a short cable.

D. The J10 and HS Hub 4 upstream ports are connected to the full-speed hub, as well as three high-speed hubs according to the wiring diagram, all using 5m cables.

E. J32 is connected to a low-speed device that has passed the official USB certification, J51 is connected to the DUT, and S2 is dialed to "**Device ON**".

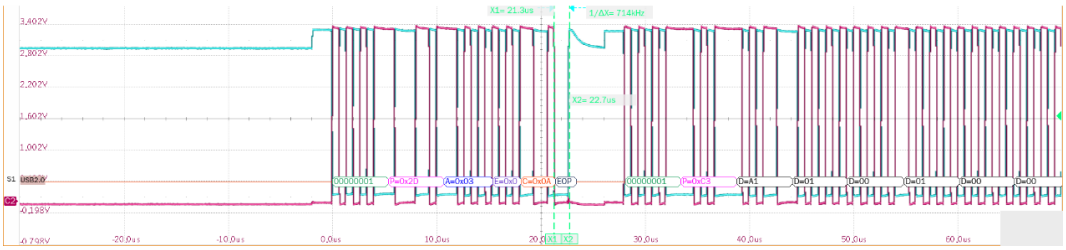
F. When performing this test, please try to connect all self-powered hubs to an external power supply to avoid the test failing due to insufficient power supply to the multi-stage hub connections under bus power.

G. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

8.9.2 Test Results Reference

The low-speed upstream signal quality of the device has the following test items:

- Measure the EOP width of the low-speed packet, which is required to be in the range of (1.875+1) bit to (2.25+1) bit.

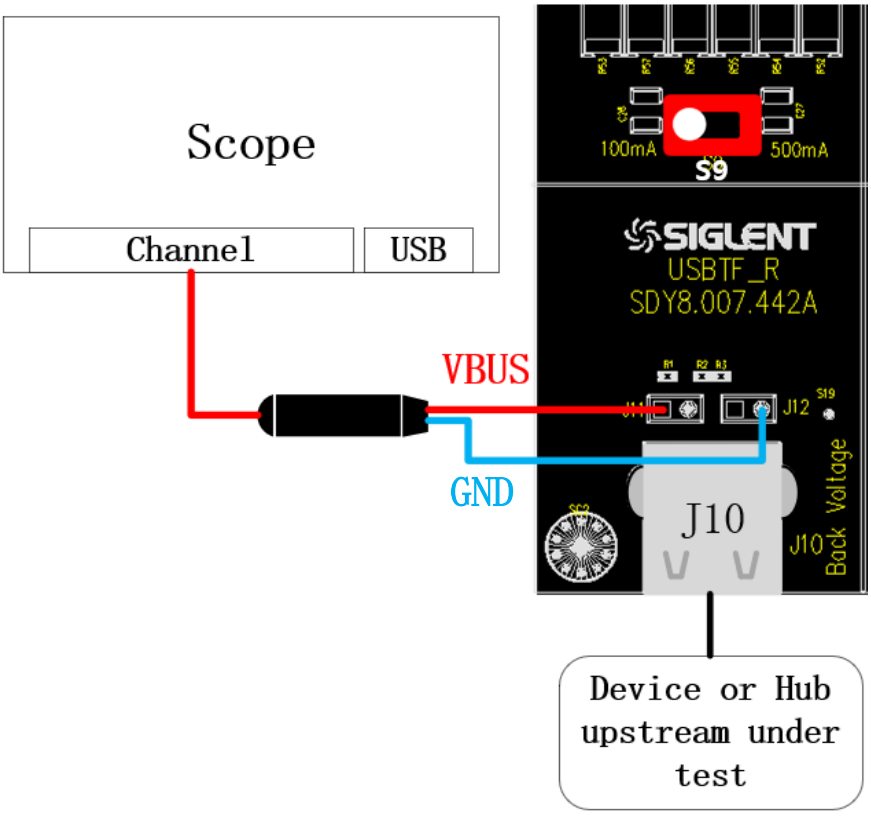


- Measure the voltage amplitude of D+ and D- cross point, the cross point voltage is required to be between 1.3V and 2V.
- Measure the signal speed of the low-speed packet, which is required to be between 1.4775MHz and 1.5225MHz.
- Measure the D+/D- rise and fall time at low speed, which is required to be between 75ns and 300ns.
- Measure the edge monotonicity of low-speed signal, which is required no backhooks greater than 500mV exist at its edges.
- Measure the J/K jitter additionally, and the rise/fall edge width of the eye diagram is the degree of J/K jitter.

8.10 Back Voltage

8.10.1 Test Steps

8.10.1.1 Test Environment Setup



A. In the figure, J11 and J12 are VBus, D-, D+, and GND from left to right, connect the probe according to the configured VBus, D-, and D+ channels.

B. Click the "**Run Test**" button in the "**Run Test**" column and follow the pop-up window to complete the test.

8.10.1.2 Voltage Test before Enumeration

If the device is self-powered, please connect it to an external power source, connect the DUT to the J10 port, and click "**Run Test**".

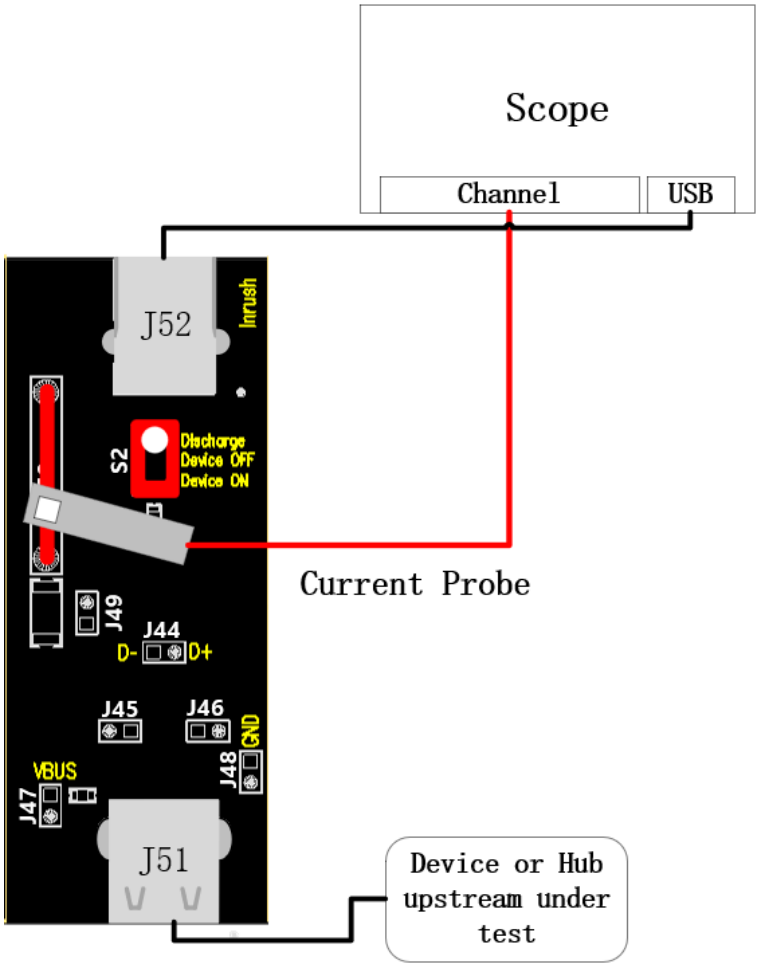
8.10.1.3 Voltage Test after Enumeration

If the device is a self-powered, please connect it to an external power source, connect the DUT to any normal USB port, make it enumerate normally, connect the DUT to J10, and click "**Run Test**".

8.11 Inrush

8.11.1 Test Steps

8.11.1.1 Test Environment Setup



A. Choose any normally powered USB port and connect it to J52 via a cable, and J50 connects to the current probe.

B. After connecting the current probe, open the previously configured oscilloscope test channel, manually configure the current probe multiplier of the channel according to the probe used, set the channel setting to "**200mA/div**", select "**Auto**" for the trigger mode, and then perform the

probe's degaussing.

C. J51 access to the DUT, S2 twist switch to "**Device ON**", check whether the oscilloscope waveform is upward, if not, it means that the probe is connected incorrectly, please flip the probe and then access to J50.

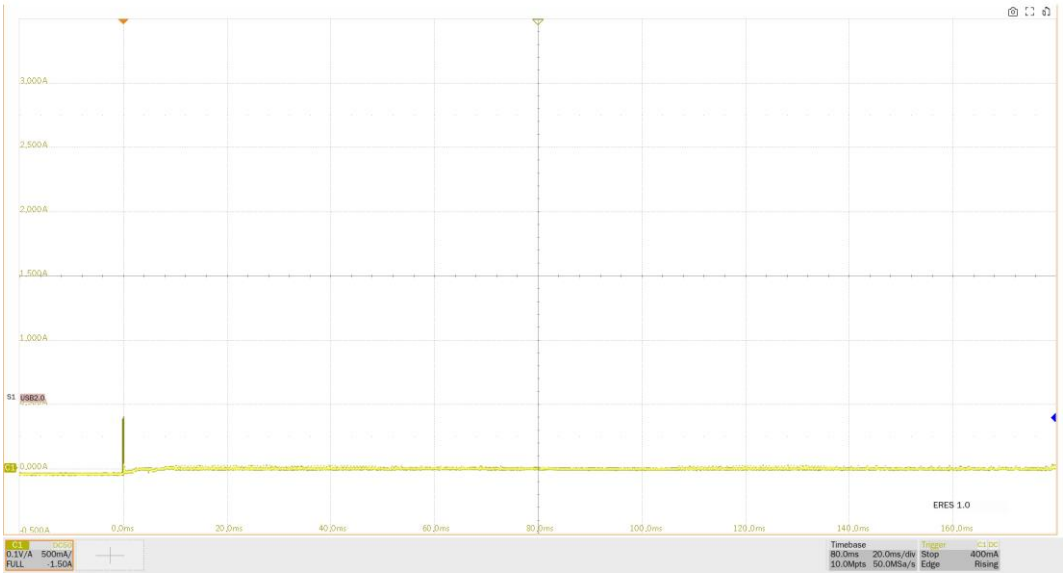
D. Click the "**Run Test**" button in the "**Run Test**" column.

8.11.1.2 Inrush Current Test

A. J51 is connected to the DUT, turn the S2 twist switch to "**Discharge**", wait for one or two seconds, and then unplug the DUT.

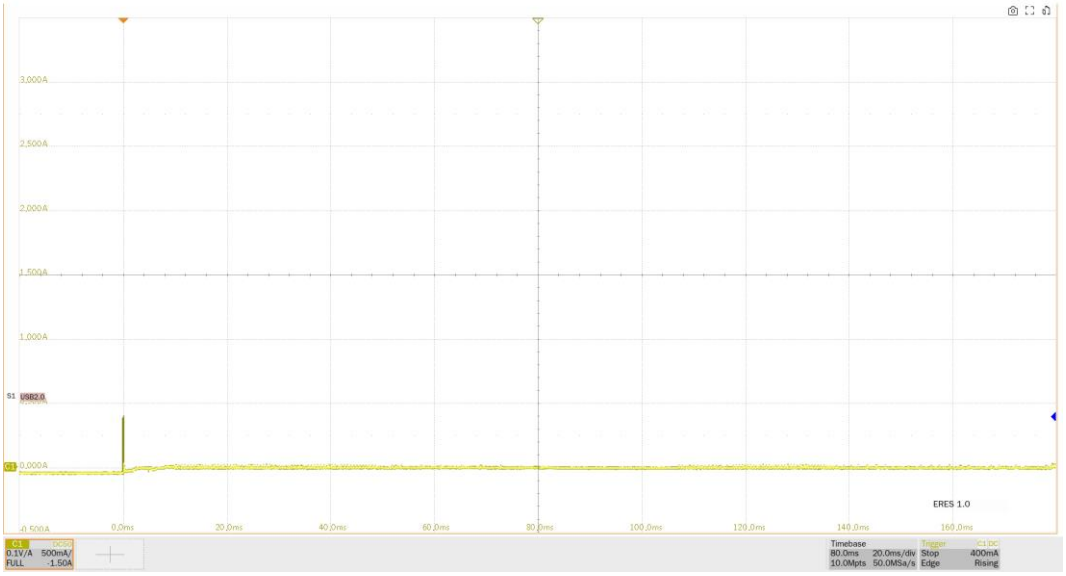
B. S2 twist switch to "**Device ON**".

C. Access the DUT at J51, observe the waveform captured by the oscilloscope and click "**Run Test**", if the waveform captured by the oscilloscope differs greatly from the following reference waveform, please check whether the wiring is correct and restart from step A.



8.11.2 Test Results Reference

▶ Inrush current test results are calculated by taking the first 100mA as the starting point and 100us after the last 100mA as the end point, and calculating the charge between the two, which is required to be less than 50uC.

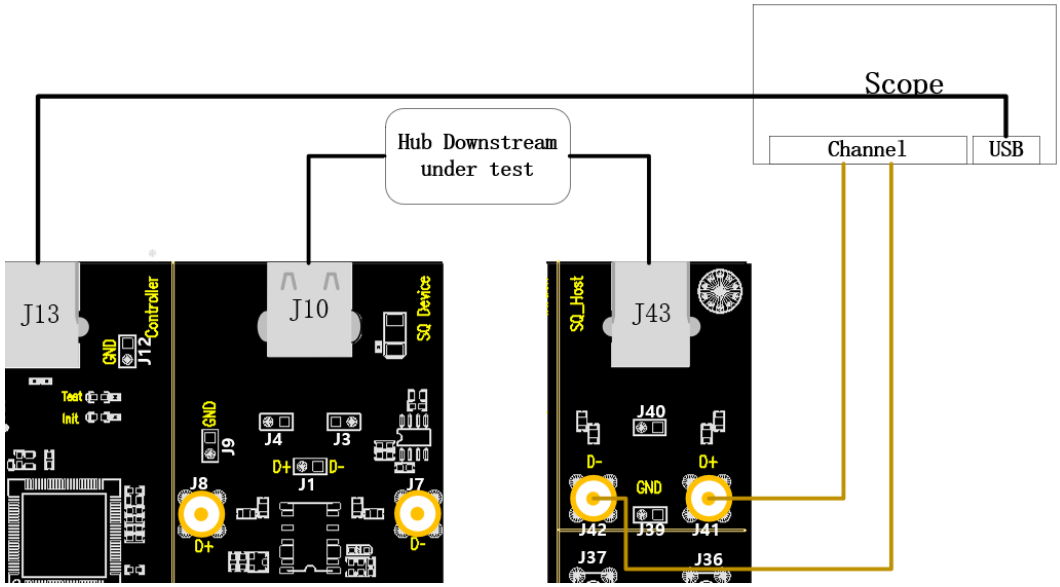

3.000A
2.500A
2.000A
1.500A
1.000A
S1 USB2.0
0.000A
-0.500A
0.0ms
20.0ms
40.0ms
60.0ms
80.0ms
100.0ms
120.0ms
140.0ms
160.0ms
ERES 1.0
C1
0.1V/A 500mA/
FULL -1.50A
Timebase
80.0ms 20.0ms/div
10.0Mpts 50.0MSa/s
Trigger
Stop 400mA
Edge Rising

9 Hub Downstream Facing Port

When performing USB 2.0 hub downstream facing port-related tests, please set up the compliance test function correctly according to the test requirements.

9.1 High-Speed DS Signal Quality (EL_2, EL_6, EL_7, EL_47)

9.1.1 Test Steps



A. Use two SMA cables to connect J41 and J42 to the configured D+ and D- channels.

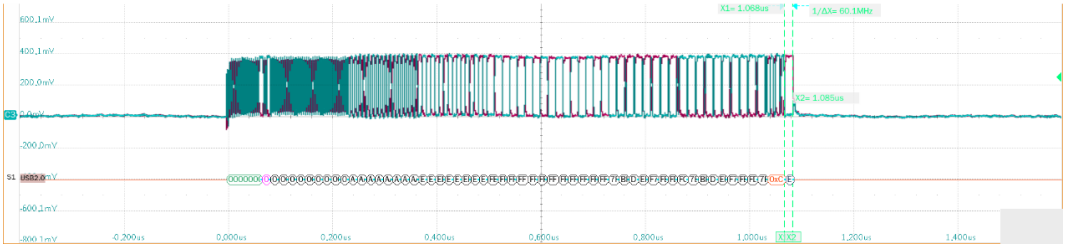
B. Use the cable to connect the oscilloscope USB interface and J13 to establish communication between the oscilloscope and the USB signal board, and the **Power** light is on.

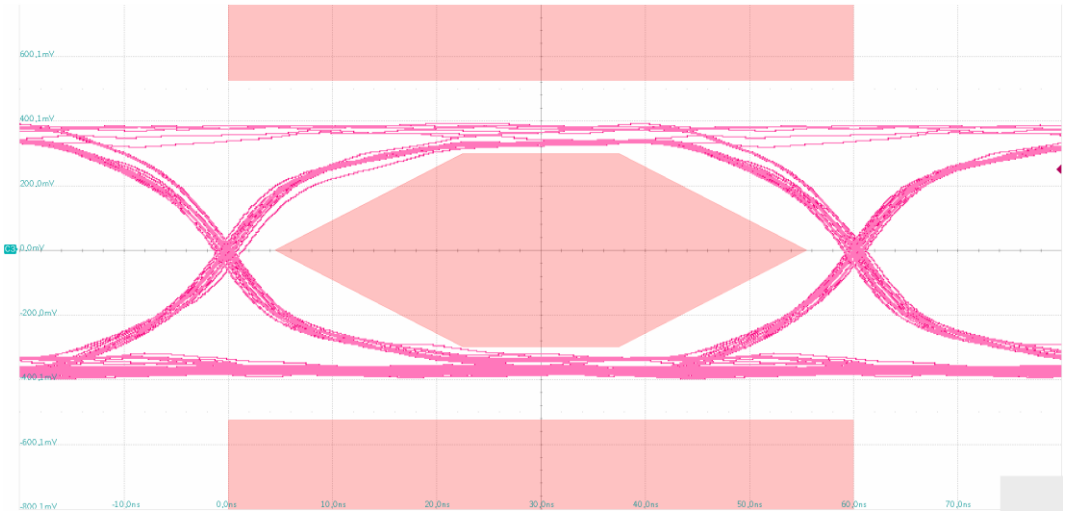
C. The upstream port of the hub is connected to J10, if the enumeration is successful, the **Init** light will be on, otherwise, please re-plug it; the downstream port of the hub under test is connected to J43 using a short cable.

D. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

9.1.2 Test Results Reference

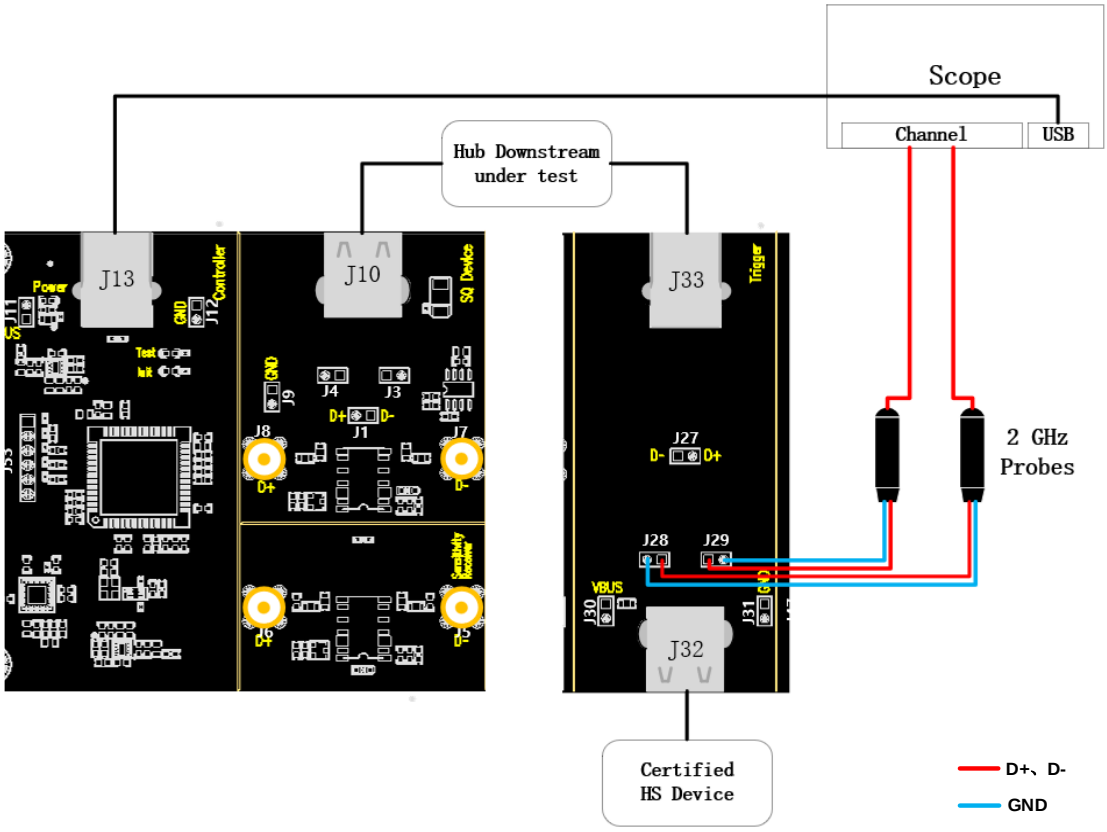
- EL_2: A USB 2.0 high-speed transmitter data rate must be 480 Mb/s±0.05%.
- EL_6: A USB 2.0 HS driver must have 10% to 90% differential rise and fall times of greater than 300 ps.
- EL_7: A USB 2.0 HS driver must have monotonic data transitions over the vertical openings specified in the appropriate eye pattern template which is less than 50mV.
- EL_47: The hub downstream ports are tested using eye diagram template 1, with test point at TP2.





9.2 High-Speed DS Packet Parameters (EL_21, EL_22, EL_23, EL_25, EL_55)

9.2.1 Test Steps



A. For "Single Ended ", J29 and J28 are the test points for D+ and D- signals respectively, and for "Differential Probe", the test point is J27. Connect the oscilloscope and probe according to the configuration of the oscilloscope channel.

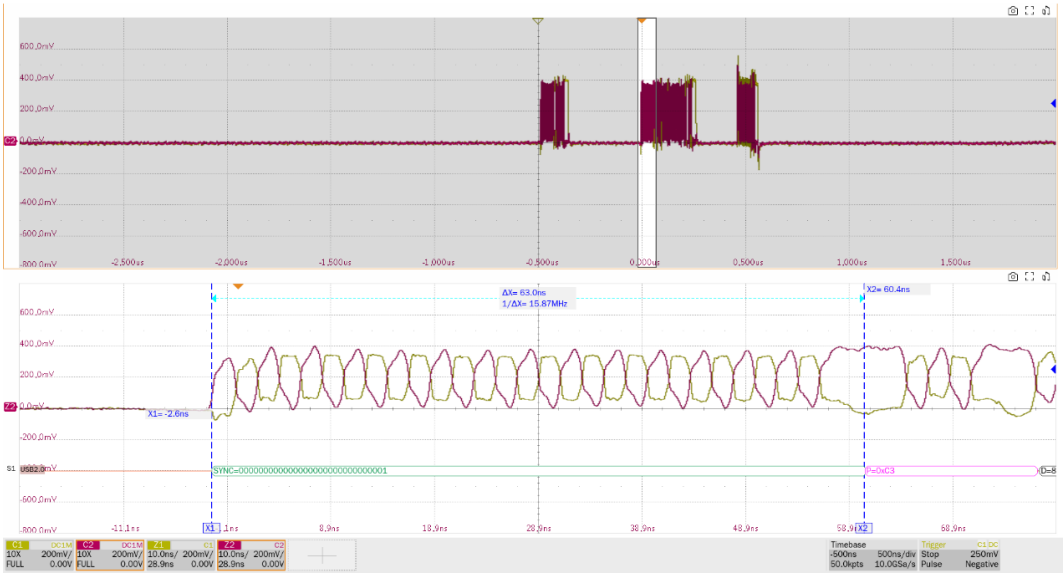
B. Use the cable to connect the oscilloscope USB interface and J13 to establish communication between the oscilloscope and the USB signal board, and the **Power** light is on.

C. The upstream port of the hub is connected to J10, if the enumeration is successful, the **Init** light will be on, otherwise, please re-plug it. The downstream port of the hub under test is connected to J33 using a short cable, and a high-speed device certified by USB 2.0 is accessed at J32.

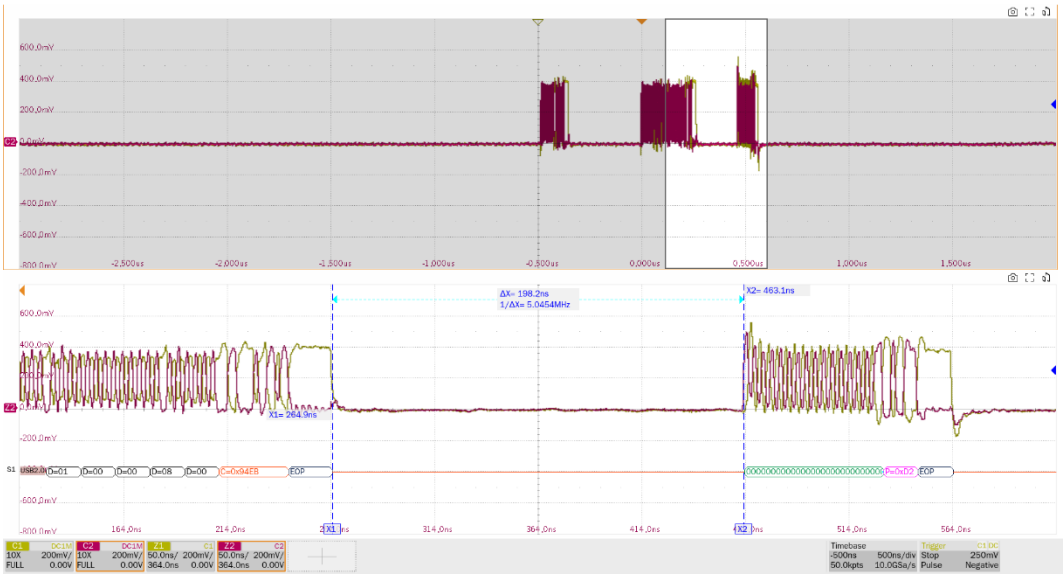
D. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

9.2.2 Test Results Reference

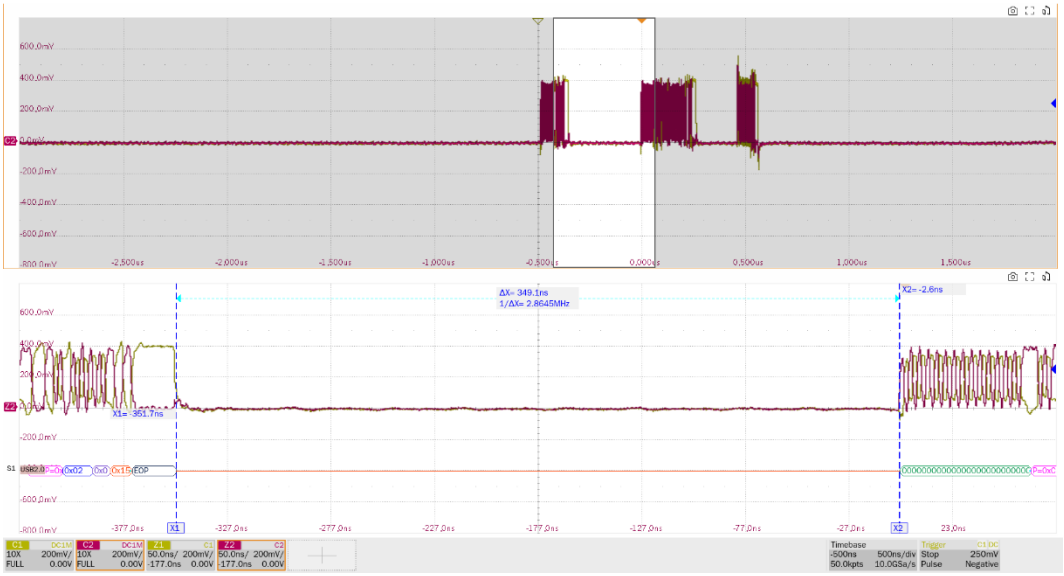
▶ EL_21: The SYNC field for all transmitted packets (not repeated packets) must begin with a 32 bit SYNC field.



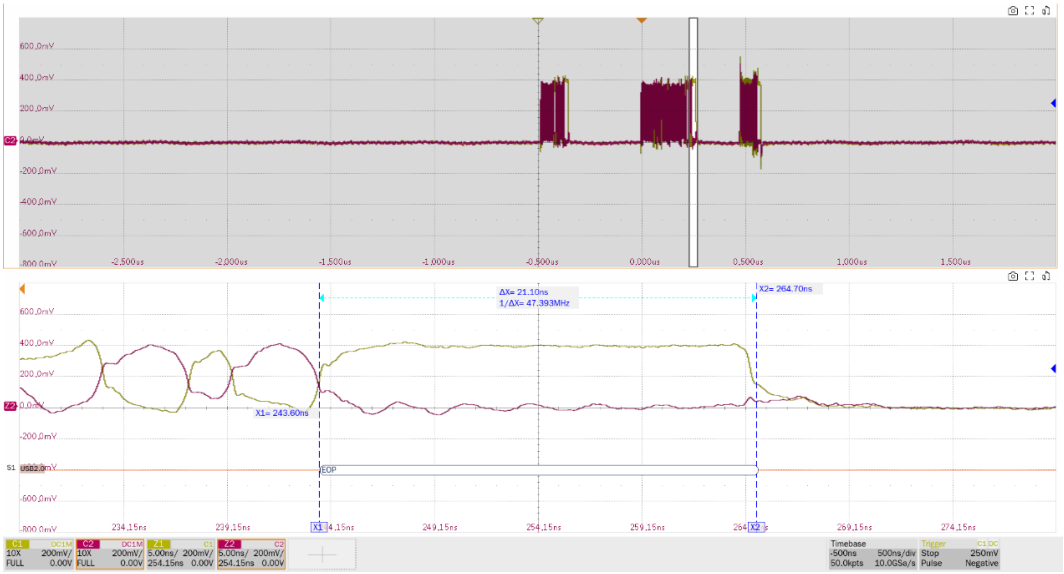
- EL_22: When transmitting after receiving a packet, hosts and devices must provide an inter-packet gap of at least 8 bit times and not more than 192 bit times. Measure the time interval between the first packet (sent by the hub downstream port) and the second packet (replied by the device).



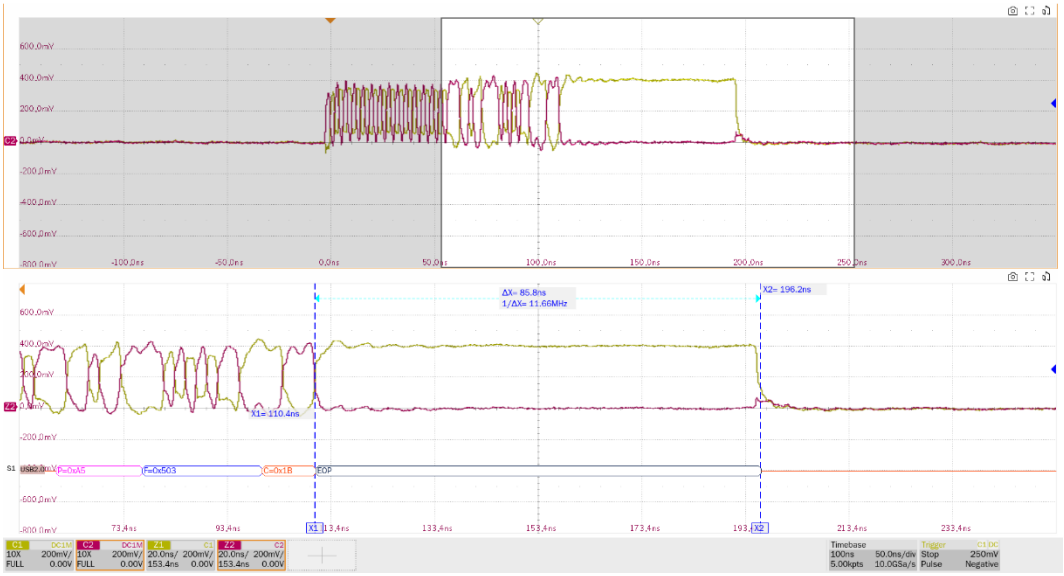
- EL_23: Hosts transmitting two packets in a row must have an inter-packet gap of at least 88 bit times and not more than 192 bit times. Measure the time interval before and after two packets are sent from the downstream port of the hub.



- EL_25: The EOP for all transmitters' packets (except SOFs) must be an 8 bit NRZ byte of 01111111.

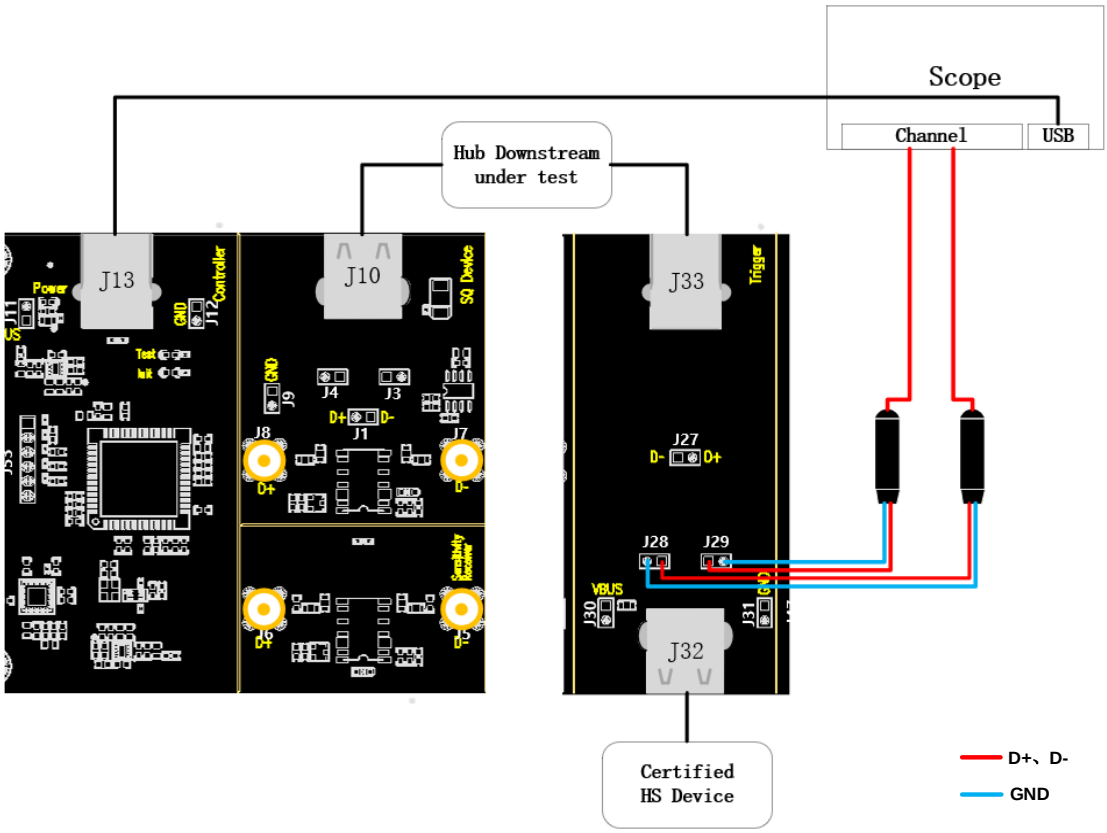


- EL_55: Hosts transmitting SOF packets must provide a 40 bit EOP without bit stuffing. Measure the number of EOP bits for SOF's packets sent from the downstream port of the hub, the test metric is greater than 40bit.



9.3 High-Speed DS Chirp Timing (EL_33, EL_34, EL_35)

9.3.1 Test Steps



A. J29 and J28 are the test points for D+ and D- signals, respectively. Connect the oscilloscope and probe according to the configuration of the oscilloscope channel.

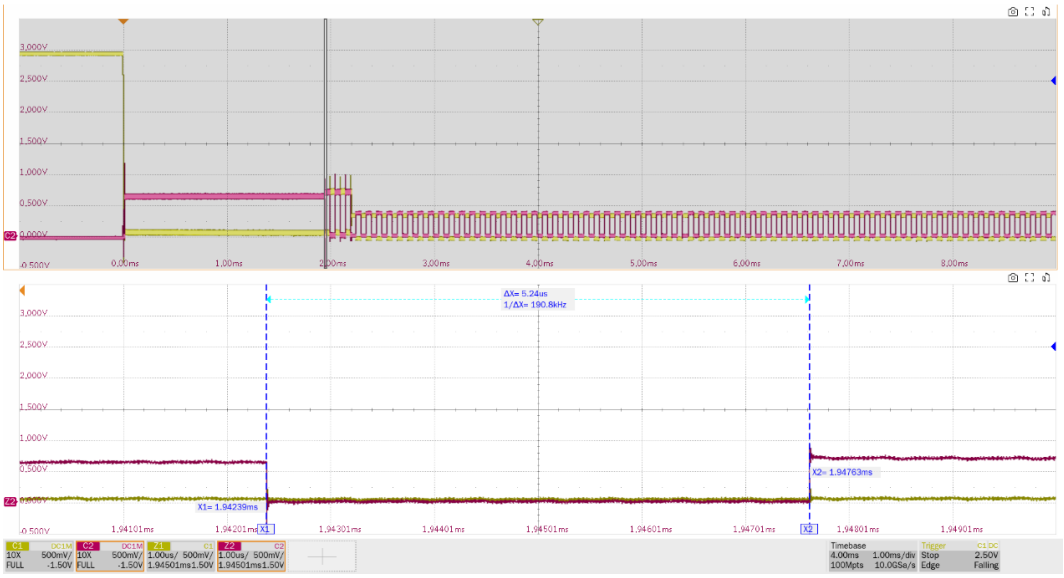
B. Use the cable to connect the oscilloscope USB interface and J13 to establish communication between the oscilloscope and the USB signal board, and the **Power** light is on.

C. The upstream port of the hub is connected to J10, if the enumeration is successful, the **Init** light will be on, otherwise, please re-plug it. The downstream port of the hub under test is connected to J33 using a short cable, and a high-speed device certified by USB 2.0 is accessed at J32.

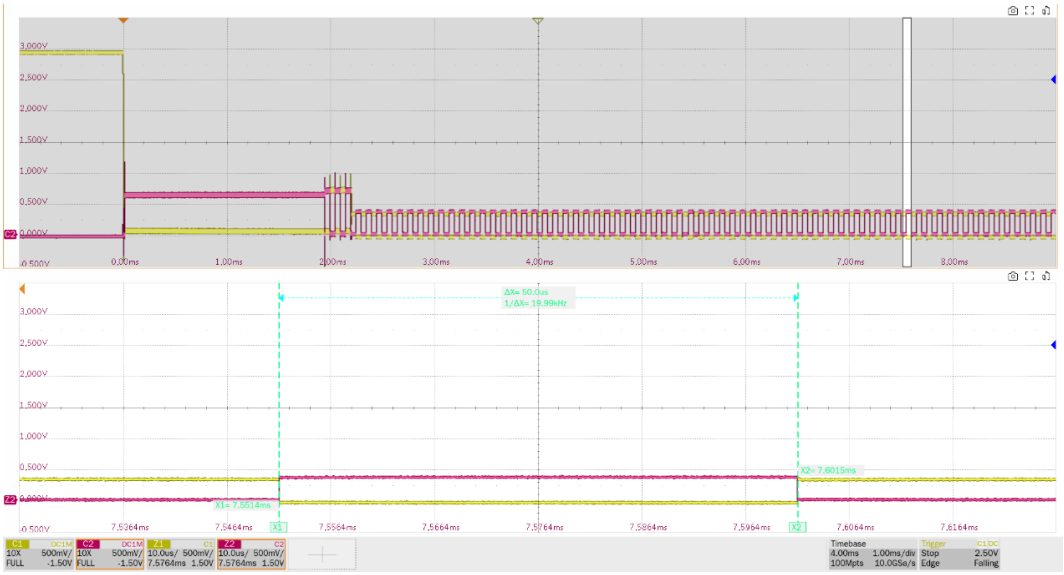
D. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

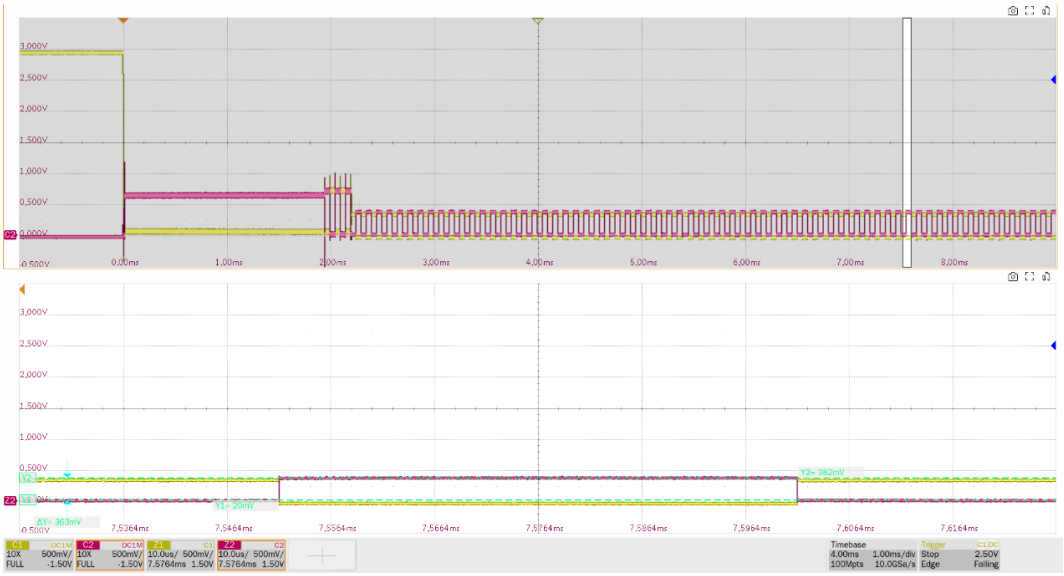
9.3.2 Test Results Reference

▶ EL_33: Downstream ports start sending an alternating sequence of Chirp K's and Chirp J's within 100us after the device Chirp k stops.



▶ EL_34: Downstream port Chirp K and Chirp J durations must be between 40us and 60us duration, the amplitude of chirp J and chirp K are measured simultaneously in this test item.

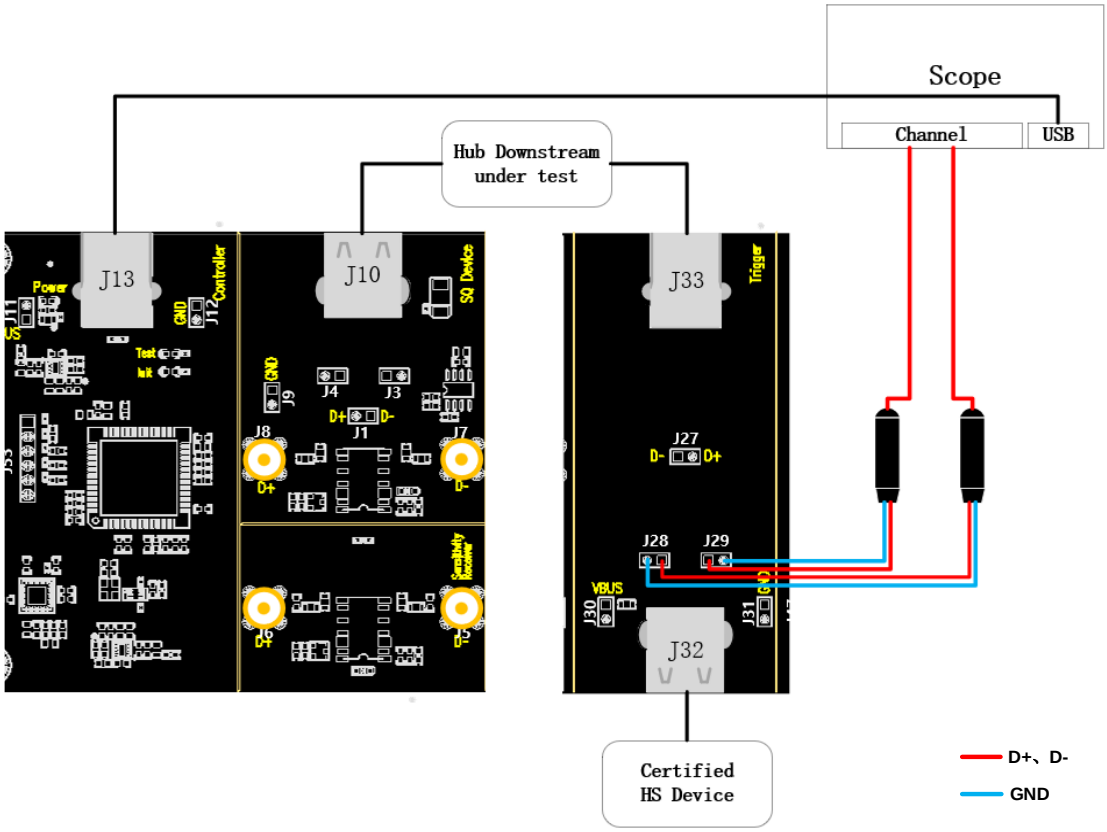




- EL_35: Downstream ports must begin sending SOF's no sooner than 100us and no later than 500us from transmission of the last Chirp (J or K).

9.4 High-Speed DS Suspend Resume (EL_38 EL_39, EL_41)

9.4.1 Test Steps



A. J29 and J28 are test points for D+ and D- signals, respectively.

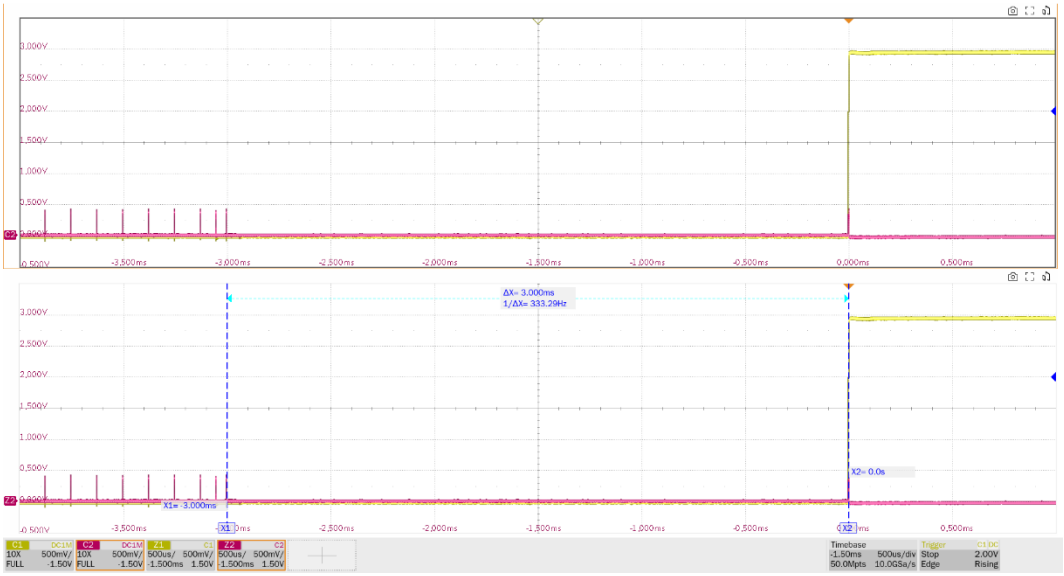
B. Use the cable to connect the oscilloscope USB interface and J13 to establish communication between the oscilloscope and the USB signal board, and the **Power** light is on.

C. The upstream port of the hub is connected to J10, if the enumeration is successful, the **Init** light will be on, otherwise, please re-plug it. The downstream port of the hub under test is connected to J33 using a short cable, and a high-speed device certified by USB 2.0 is accessed at J32.

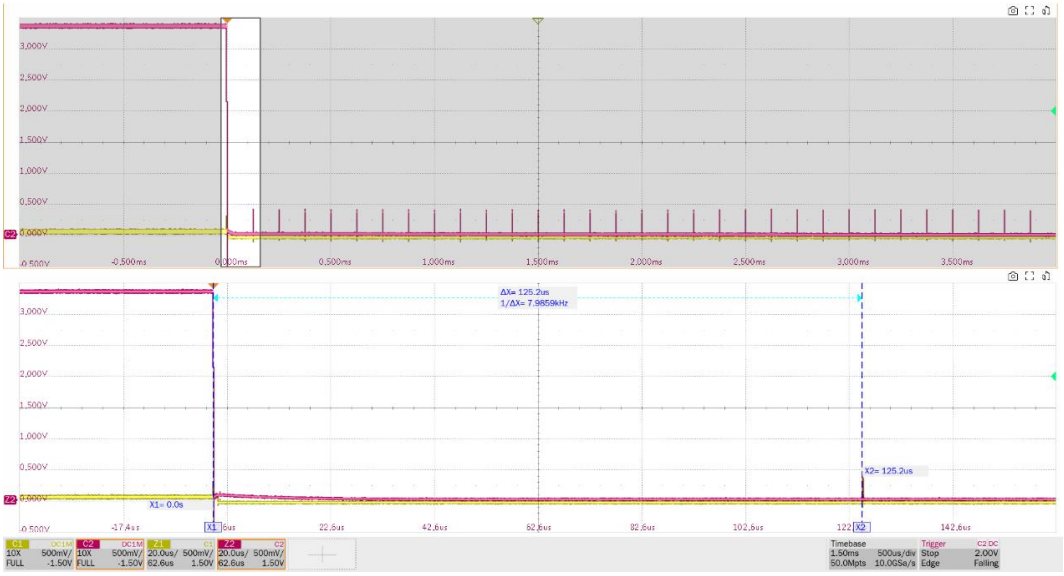
D. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

9.4.2 Test Results Reference

- EL_38: A device must revert to full-speed no later than 125us after there is a 3ms idle period on the bus (3.000ms <= t <= 3.125ms). Measure the time interval from the last SOF's at high speed to suspend.
- EL_39: A device must support the suspend state.

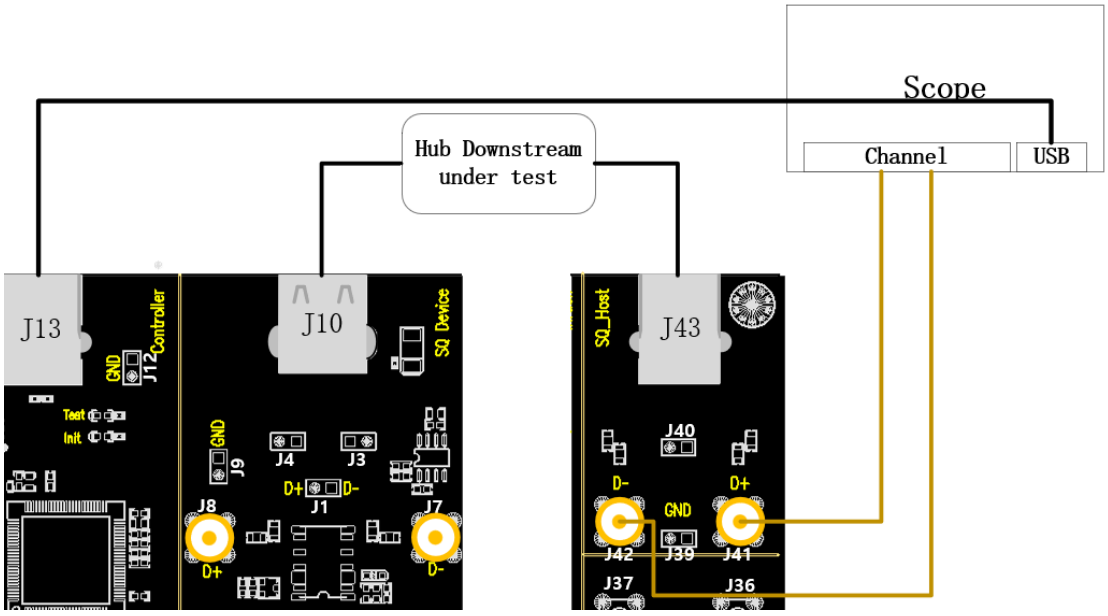


- EL_41: After resuming a port, the host must begin sending SOF's within 3ms of the start of the idle state.



9.5 High-Speed DS Not Driven Voltage Levels (EL_8, EL_9)

9.5.1 Test Steps



A. Use two SMA cables to connect J41 and J42 to the configured D+ and D- channels.

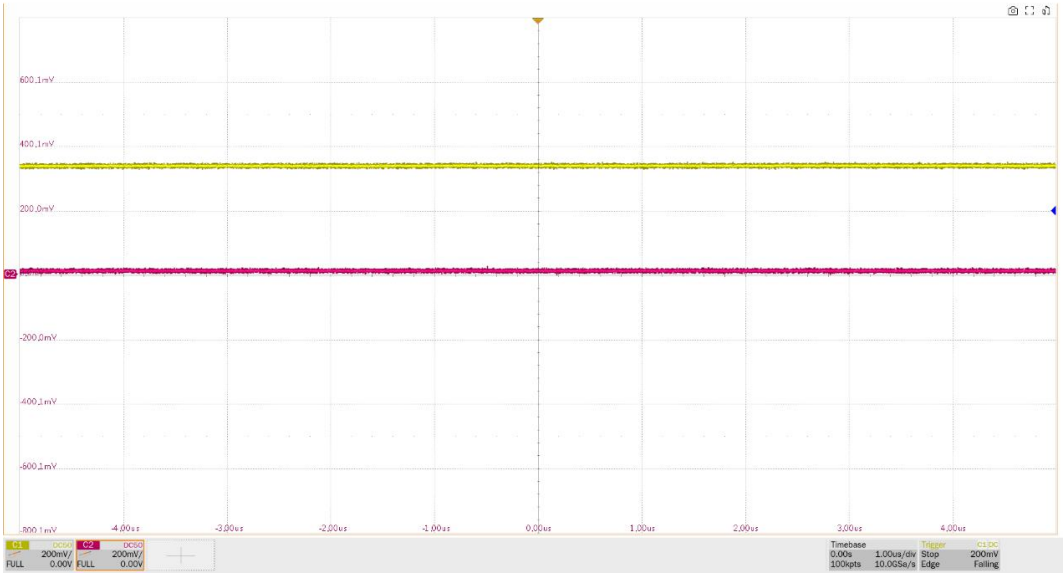
B. Use the cable to connect the oscilloscope USB interface and J13 to establish communication between the oscilloscope and the USB signal board, and the **Power** light is on.

C. The upstream port of the hub is connected to J10, if the enumeration is successful, the **Init** light will be on, otherwise, please re-plug it; the downstream port of the hub under test is connected to J43 using a short cable.

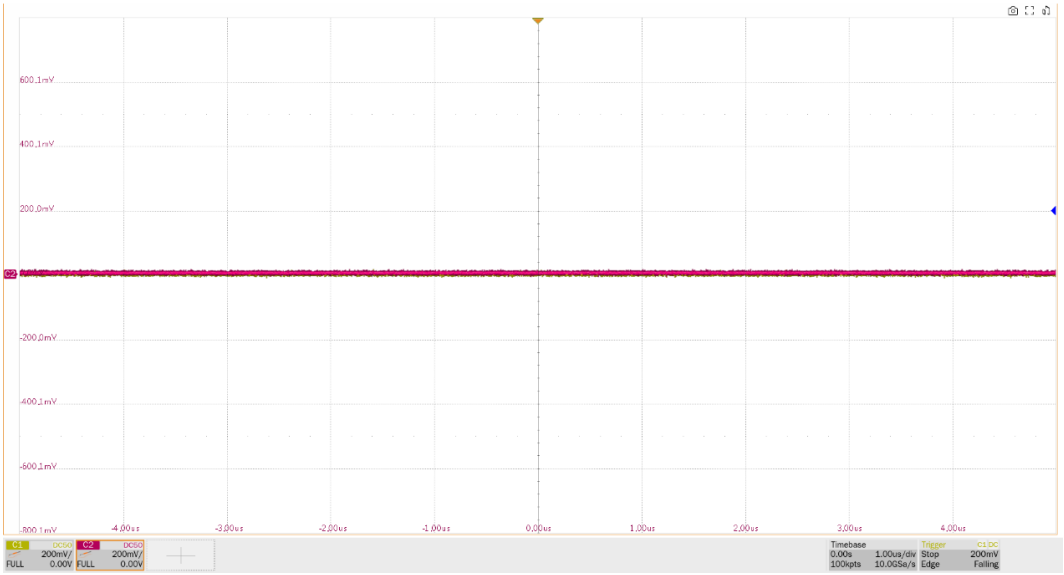
D. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

9.5.2 Test Results Reference

▶ EL_8: The voltage measured of J/K not driven should be 360mV to 440mV.

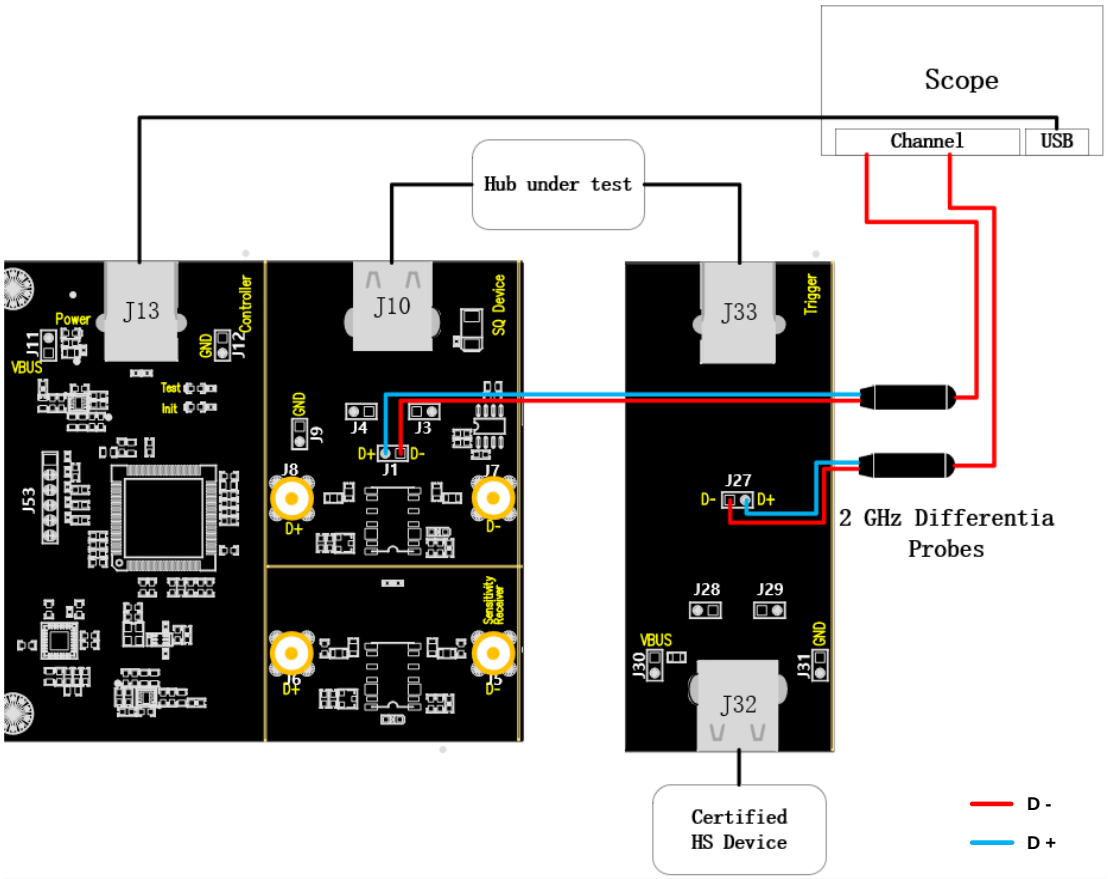


▶ EL_9: When either D+ or D- is not being driven, the output voltage must be 0V±20mV when terminated with precision 45 ohm resistors to ground. This item measures the D+ and D- voltage values in the SE0 state.



9.6 High-Speed DS Repeater (EL_42, EL_43, EL_44, EL_45, EL_48)

9.6.1 Test Steps



A. When using differential probes, J1 corresponds to the repeater upstream test point and J27 corresponds to the repeater downstream test point; when using single-ended probes, J4 and J3 correspond to the D+ and D- of the repeater upstream test point, and J29 and J28 correspond to the D+ and D- of the repeater downstream test point; connect the probes in accordance with the previous oscilloscope channel configuration.

B. Use the cable to connect the oscilloscope USB interface and J13 to establish communication between the oscilloscope and the USB signal board, and the **Power** light is on.

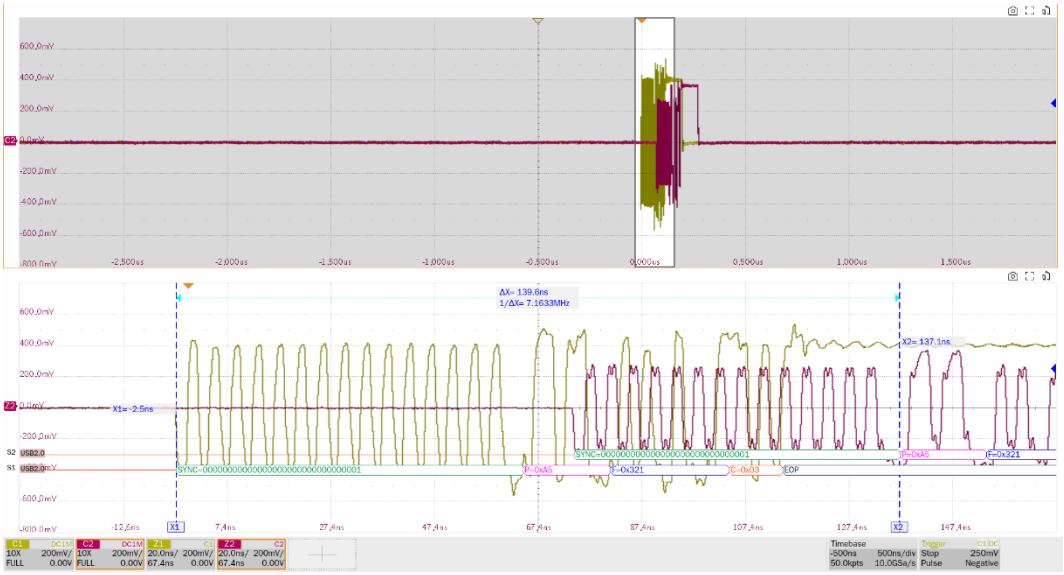
C. The upstream port of the hub is connected to J10, if the enumeration is successful, the **Init** light will be on, otherwise, please re-plug it; the downstream port of the hub under test is connected to J33 using a short cable, and a high-speed device certified by USB 2.0 is accessed at J32.

D. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

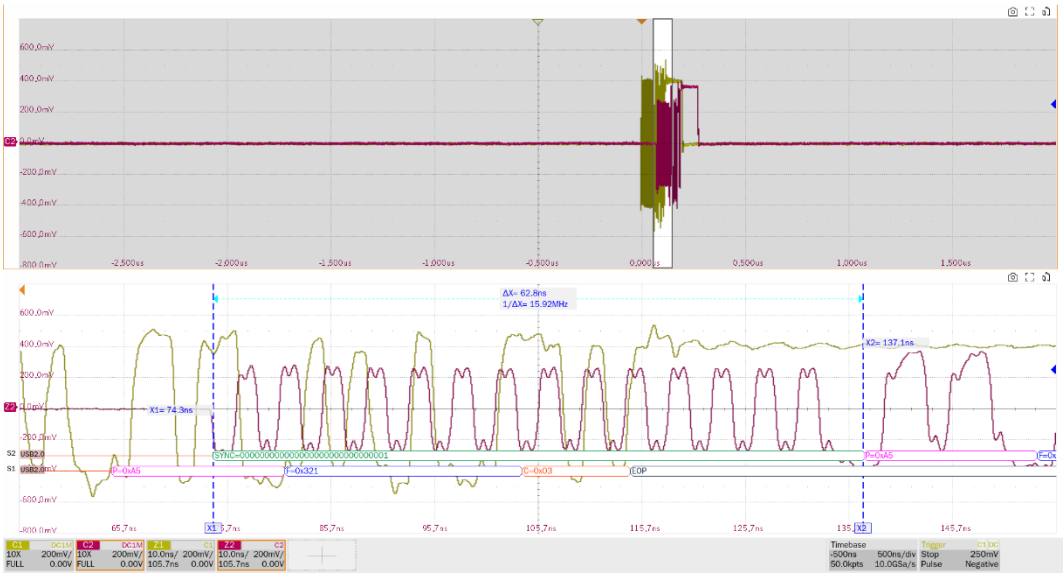
9.6.2 Test Results Reference

▶ EL_42: Hub repeaters must not truncate more than 4 bits from a repeated SYNC pattern. Measure the difference between the number of bits in the SYNC field of the upstream port and

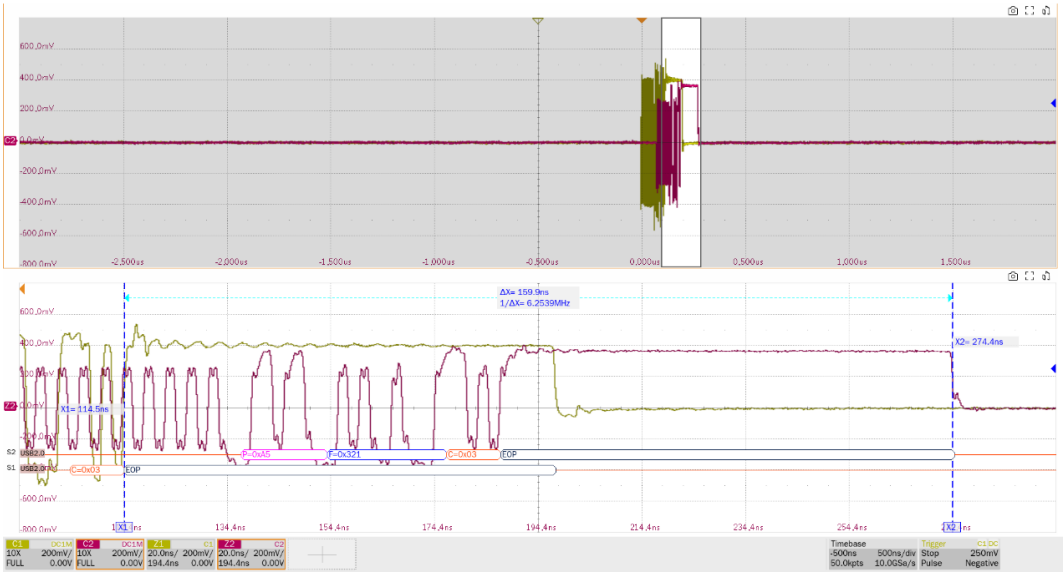
the downstream port of a packet that passes through the hub; the difference between the two must not be greater than 4 bits.



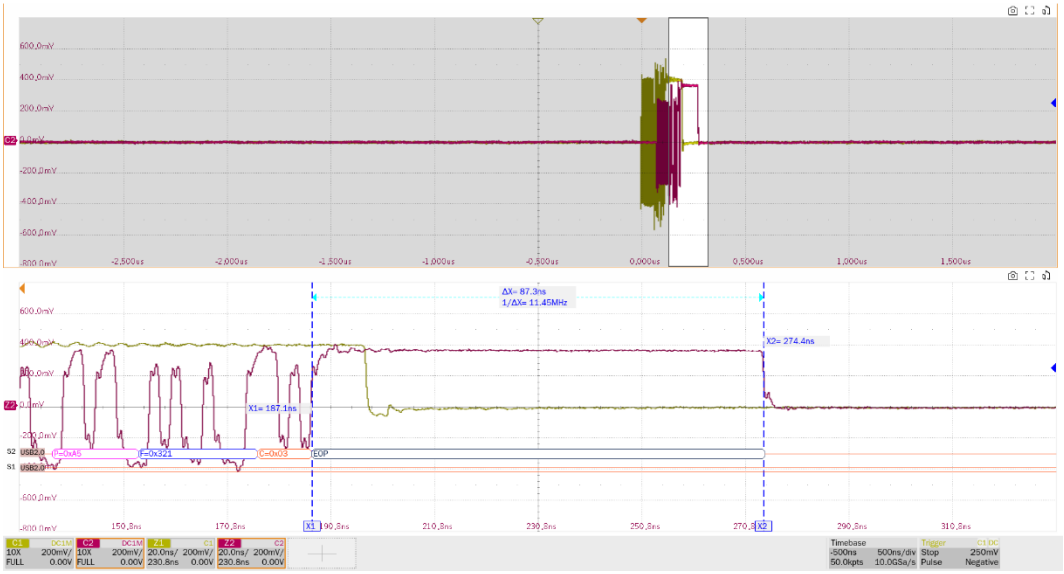
- EL_43: Hubs must no corrupt any repeater bits of the SYNC field. Measure the SYNC field at the downstream port of the hub, test metric >= 12bit.



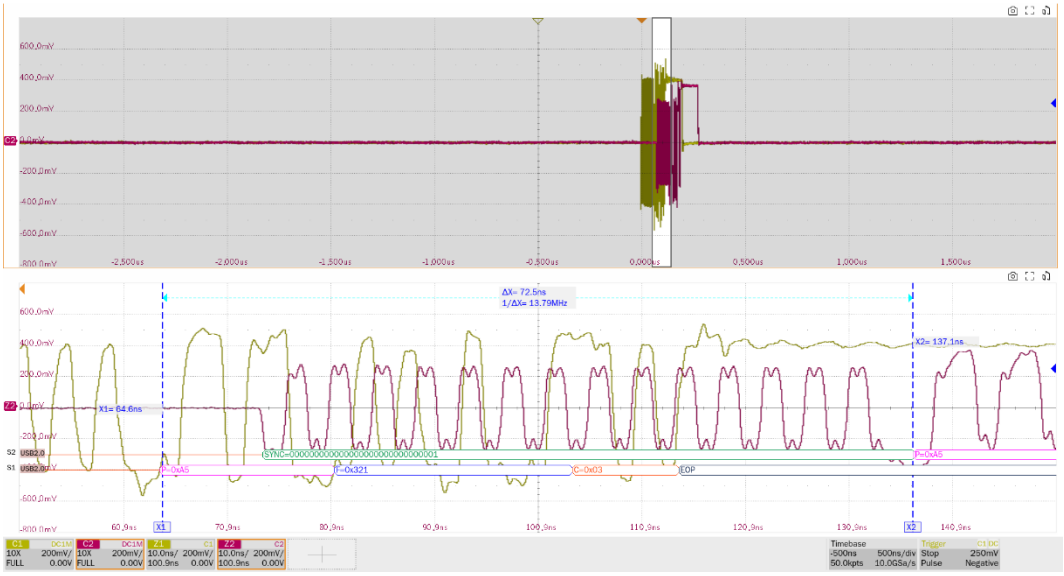
- EL_44: A hub may add at most 4 random bits to the end of the EOP field when repeating a packet. Measure the difference between the number of downstream port EOP bits and the number of upstream port EOP bits of a packet after it passes through the hub, which must not increase by more than 4 bits.



- EL_45: A hub must not corrupt any of the valid EOP bits when repeating a packet. Measure the EOP of the downstream port of the repeater with a test metric >= 8bit.

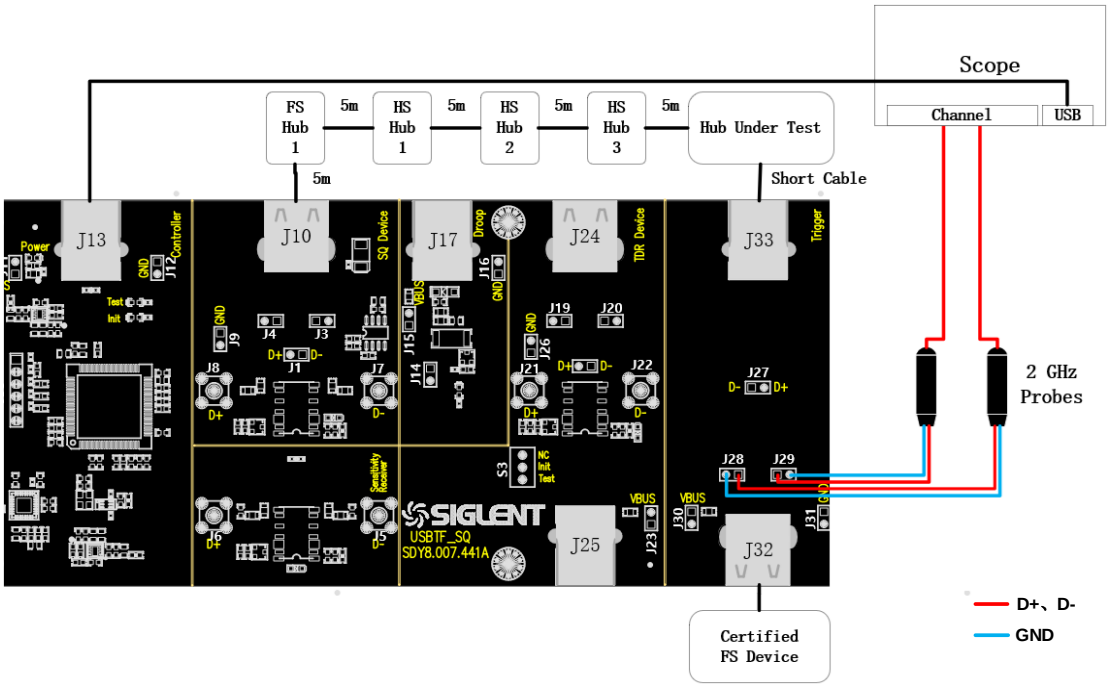


- EL_48: A hub repeater may not delay packets for more than 36 bit time plus 4ns. The delay is measured from the beginning of the end of the hub's input data SYNC field to the end of the output data SYNC field up to the end of the output data SYNC field, and the time interval between the two cannot exceed 36 bits + 4ns.



9.7 Full-Speed DS Signal Quality

9.7.1 Test Steps



A. J29 and J28 are test points for D+ and D- signals respectively.

B. Use the cable to connect the oscilloscope USB interface and J13 to establish communication between the oscilloscope and the USB signal board, and the **Power** light is on.

C. Connect J33 to the downstream port of the hub under test via a short USB cable.

D. Between J10 and the upstream port of the hub under test follow the wiring diagram to access the full-speed hub, as well as three high-speed hubs, all connected using 5m cables.

E. The J32 accesses full-speed devices that have been officially certified.

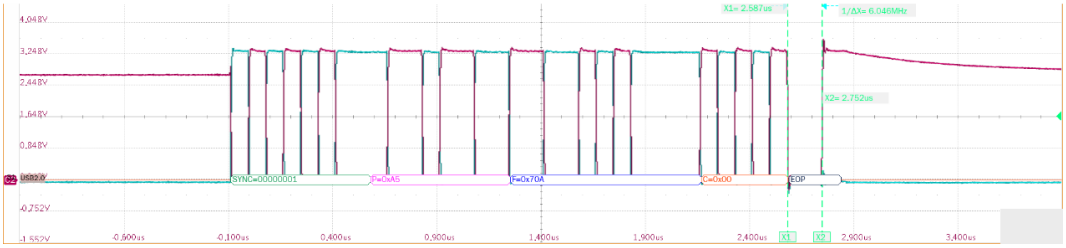
F. When performing this test, please try to connect all self-powered hubs to an external power supply to avoid the test failing due to insufficient power supply to the multi-stage hub connections under bus power.

G. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

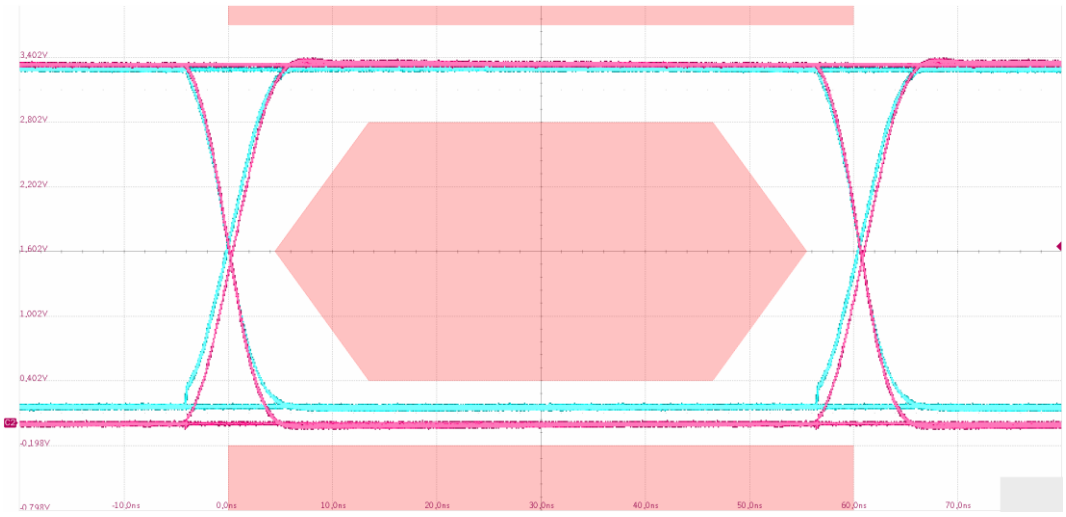
9.7.2 Test Results Reference

The full-speed signal quality of the hub DS port has the following test items:

- Measure the EOP width of the full-speed packet, which is required to be in the range of (1.92+1) bit to (2.1+1) bit.

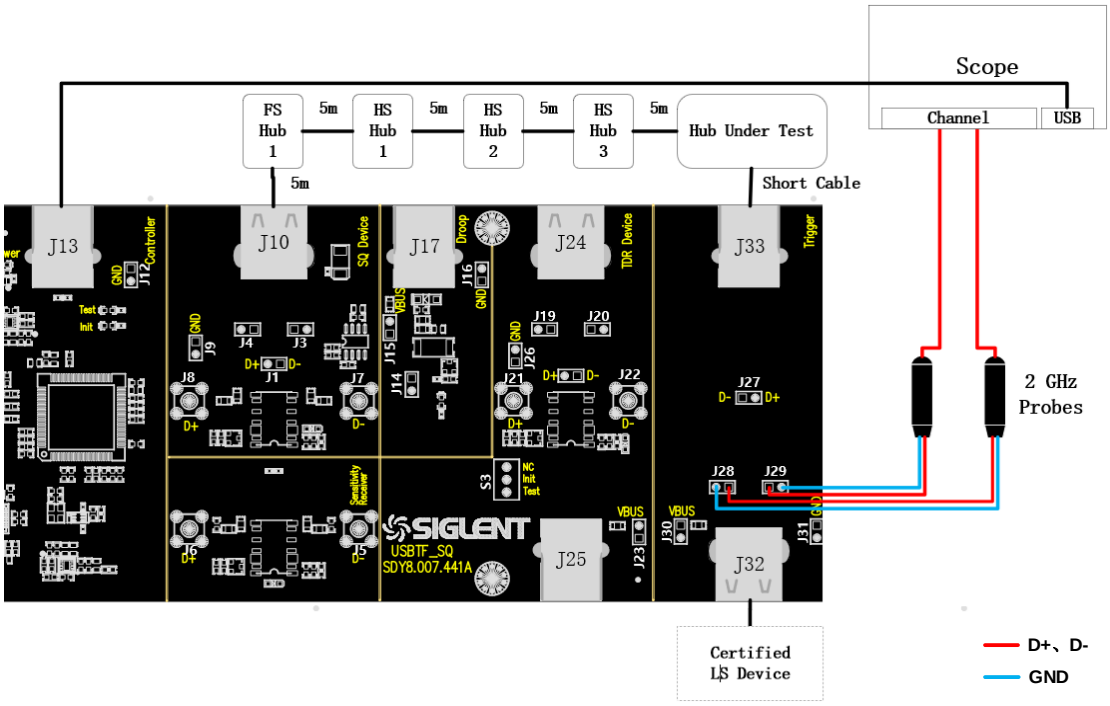


- Measure the voltage amplitude of D+ and D- cross point, which is required to be between 1.3V and 2V.
- Measure the signal speed of the full-speed packet, which is required to be between 11.97 MHz and 12.03MHz.
- Measure the D+/D- rise and fall time at full speed, which is required to be between 4ns and 20ns.
- Measure the edge monotonicity of full-speed signal, which is required no backhooks greater than 500mV exist at its edges.
- Measure the J/K jitter additionally, and the edge width of the eye diagram is the degree of J/K jitter.



9.8 Low-Speed DS Signal Quality

9.8.1 Test Steps



A. J29 and J28 are test points for D+ and D- signals, respectively.

B. Use the cable to connect the oscilloscope USB interface and J13 to establish communication between the oscilloscope and the USB signal board, and the **Power** light is on.

C. The J33 is connected to the downstream port of the hub under test via a short USB cable.

D. Between J10 and the upstream port of the hub under test follow the wiring diagram to access the full-speed hub, as well as the three high-speed hubs, all connected using 5m cables.

E. J32 access to low-speed devices officially certified.

F. When performing this test, please try to connect all self-powered hubs to an external power supply to avoid the test failing due to insufficient power supply to the multi-stage hub connections under bus power.

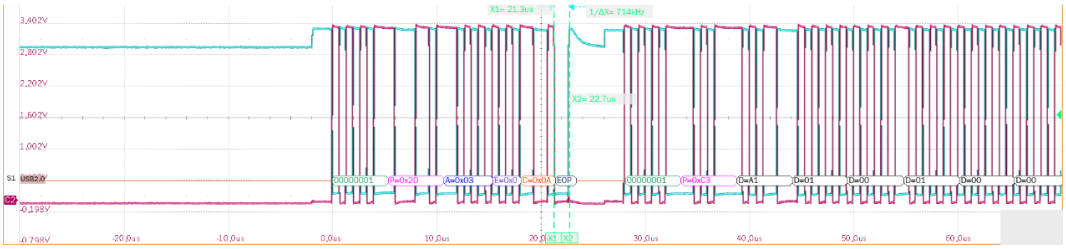
G. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

9.8.2 Test Results Reference

The low-speed downstream signal quality of the hub has the following test items:

▶ Measure the voltage amplitude of D+ and D- cross point, the cross point voltage is required to be between 1.3V and 2V.

- Measure the EOP width of the low-speed packet, which is required to be in the range of (1.875+1) bit to (2.25+1) bit.

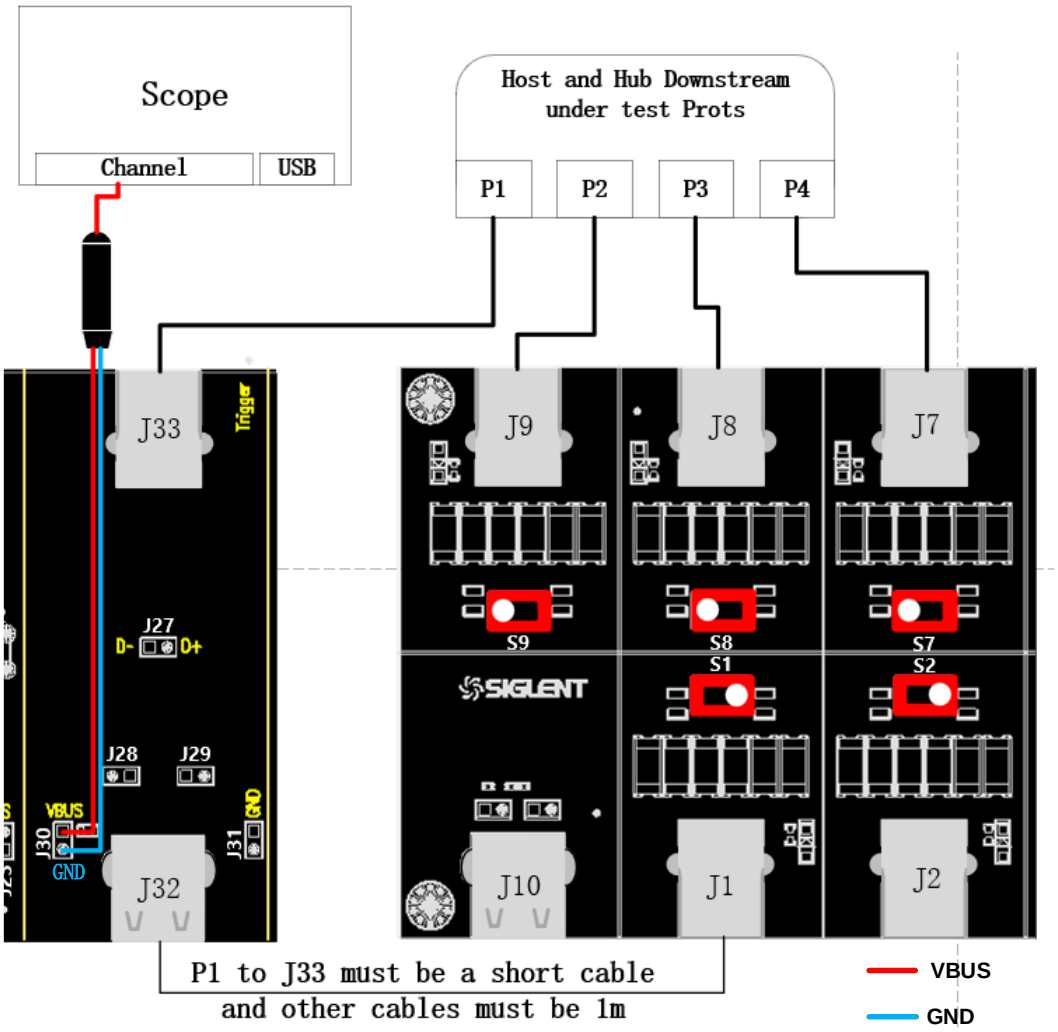


- Measure the signal speed of the low-speed packet, and its full-speed signal speed is required to be between 1.4775MHz and 1.5225MHz.
- Measure the D+/D- rise and fall time at low speed, which is required to be between 75ns and 300ns.
- Measure the edge monotonicity of low-speed signal, which is required no backhooks greater than 500mV exist at its edges.
- Measure the J/K jitter additionally, and the rise/fall edge width of the eye diagram is the degree of J/K jitter.

9.9 Drop(Self-Powered)

9.9.1 Test Steps

9.9.1.1 Test Environment Setup



A. J30 is the voltage test point for the port VBus under test, connect the probe according to the channel configured before.

B. The hub's port under test is connected to J33 of the signal board via a 1m cable, J32 is connected to the load board via a short cable, and the rest of the ports are connected to the load board via 1m cables. Next leave the hub in self-powered state.

C. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

9.9.1.2 No-load Test

Please turn the load board's twist switch to the center and click "**Run Test**" after observing the waveform captured by the oscilloscope.

9.9.1.3 Test with Load

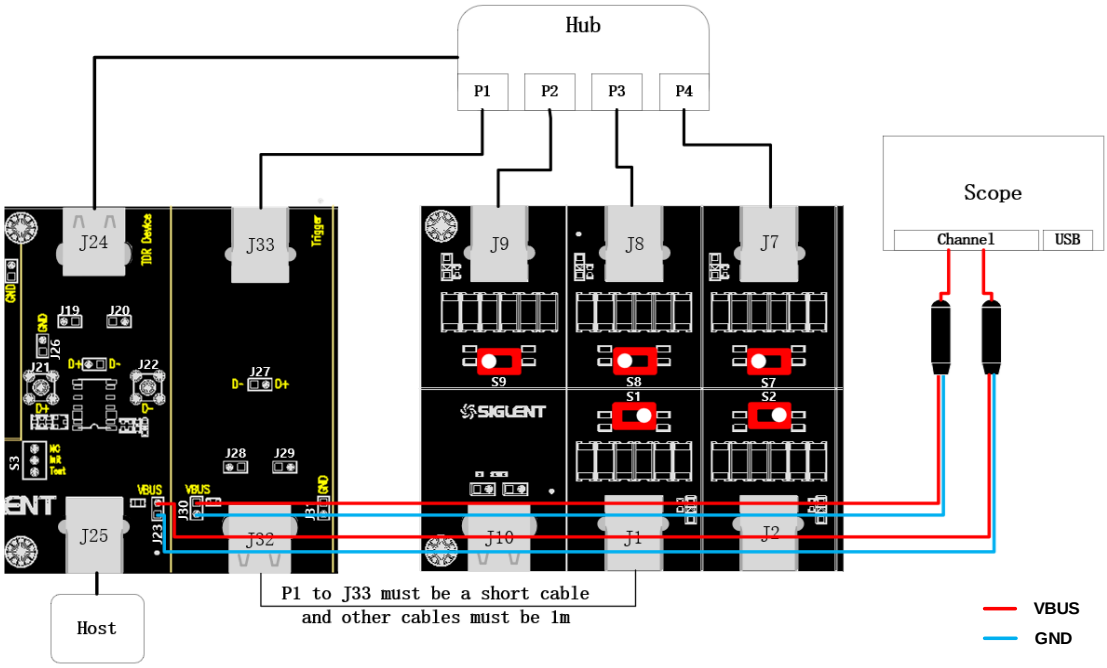
Please turn the switch of the load board to 500mA, and then click "**Run Test**" after observing the waveform captured by the oscilloscope.

9.9.2 Test Results Reference

Measure the VBus voltage of the port under test (4.75V~5.25V) with no load connected to all ports of the hub, and the VBus voltage of the port under test (4.75V~5.25V) with all ports connected to a 500mA load, respectively.

9.10 Drop (Powered by Bus)

9.10.1 Test Steps



A. J23 is the hub upstream port VBus test point and J30 is the hub downstream port VBus test point, connect the probes according to the channels configured before.

B. Find a normally powered host that is connected to signal board J25, the hub upstream port is connected to signal board J24, and the S3 twister switch on the signal board is toggled to the **Init** position with the host powering the hub.

C. The hub's port under test is connected to J33 of the signal board via a 1m cable, J32 is connected to the load board via a short cable, and the rest of the ports are connected to the load board via 1m cables.

D. The twist switch on the load board is toggled to 100mA.

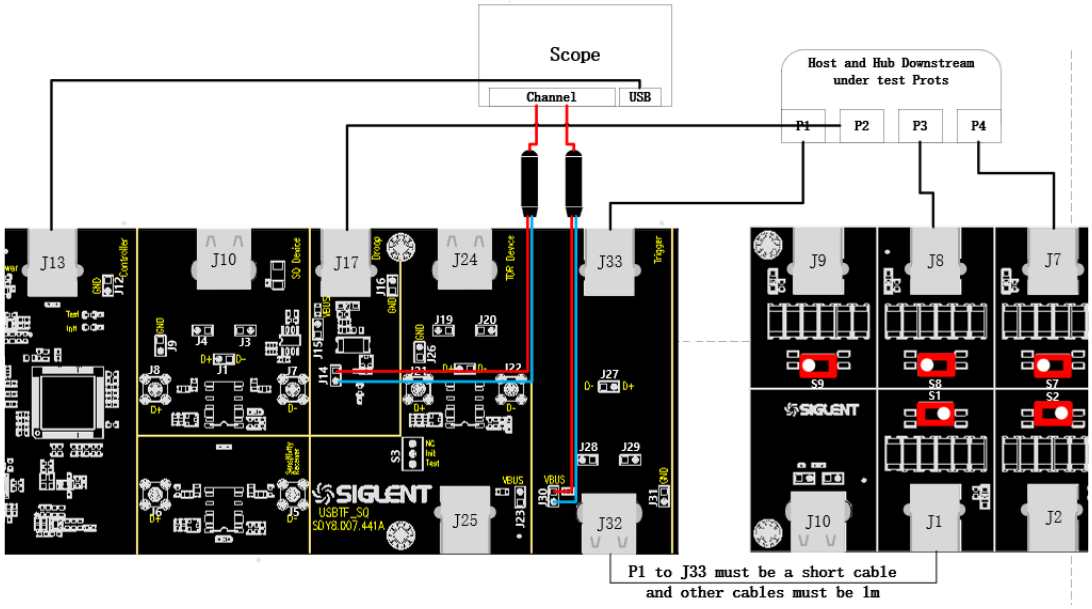
E. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

9.10.2 Test Results Reference

Under bus power supply, if the load of the hub is 100mA, the voltage range of its upstream port is required to be 4.75V~5.25V, and the bus voltage of the downstream port is 4.40V~5.25V, and the voltage drop of both is required to be less than 350mV.

9.11 Droop

9.11.1 Test Steps



A. Use a 1m cable to connect the test port P1 (as shown in the figure) to the signal board J33; use a short cable to connect the signal board J32 to any of the loads on the load board; use a 1m cable to connect port P2 next to the test port to the USB signal board J17; and use a 1m cable to connect the remaining ports to the USB load board.

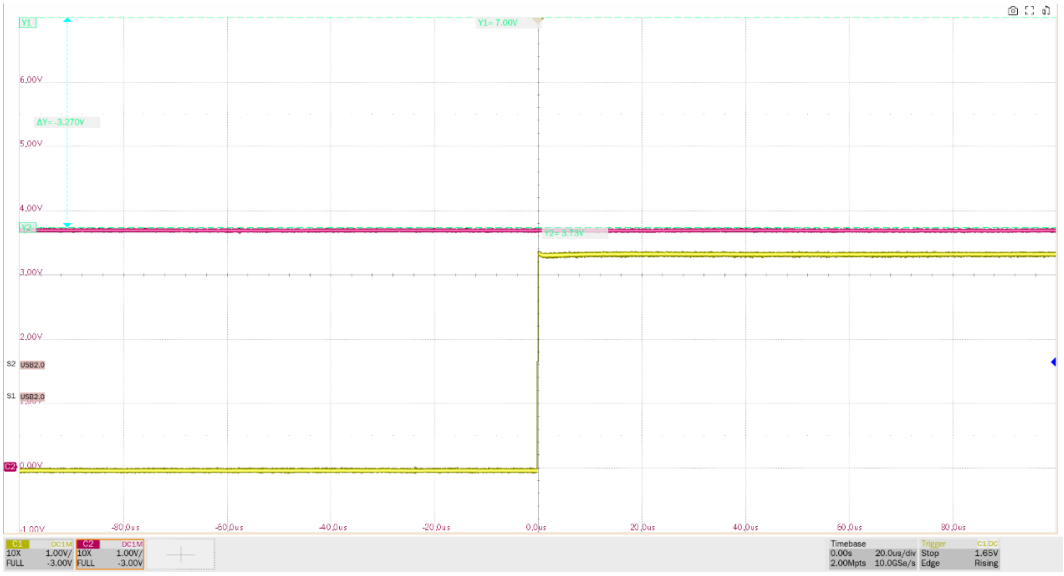
B. For the loads used on the USB load board, turn its twist switch to 100mA.

C. Use the cable to connect the USB signal board J13 and the oscilloscope, the **Power** light is on.

D. Click the "**Run Test**" button in the "**Run Test**" column, check whether the cable connection is the same as the pop-up window, click "**OK**", the oscilloscope will start to capture waveforms.

9.11.2 Test Results Reference

Transient voltage drop of the port under test is required to be less than 350mV.

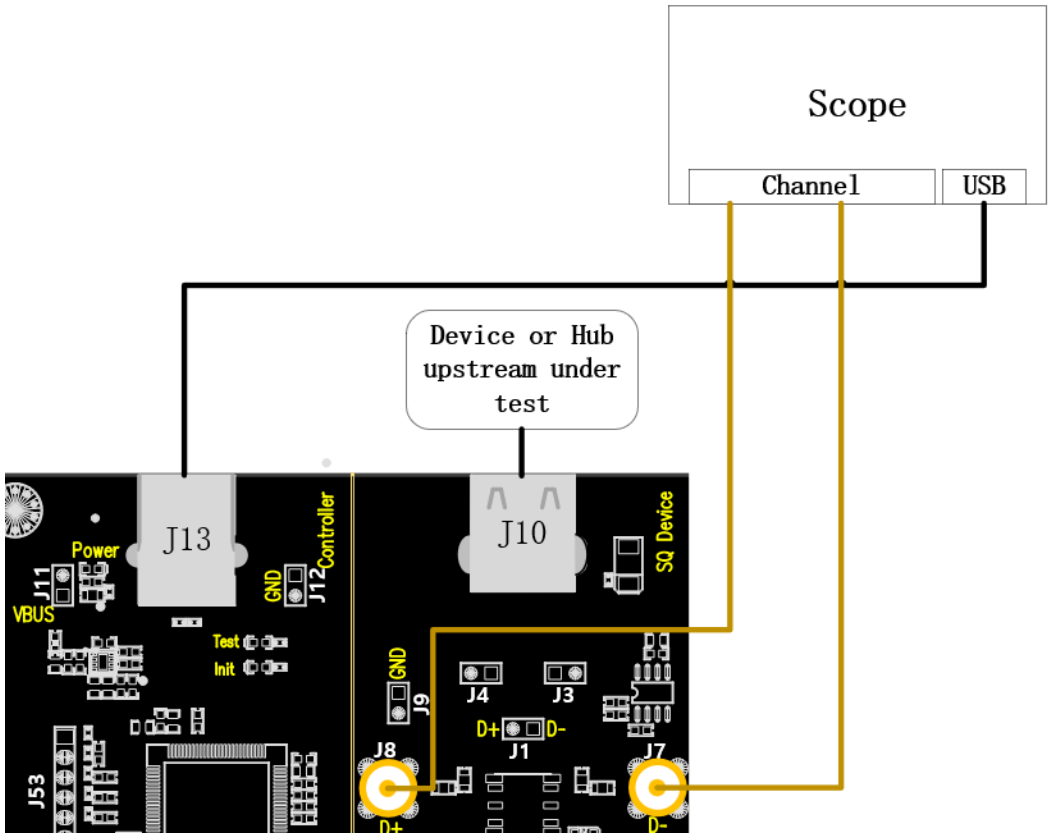


10 Hub Upstream Facing Port

When performing USB 2.0 hub upstream facing port-related tests, please set up the compliance test function correctly according to the test requirements.

10.1 High-Speed US Signal Quality (EL_2, EL_6, EL_7, EL_46)

10.1.1 Test Steps



A. Use two SMA cables to connect J8 and J7 to the D+ and D- channels configured before. J13 establishes communication with the oscilloscope through the cables and the Power light is on.

B. Access the upstream port of the hub under test in J10, if it is successfully enumerated, the **Init** light will be on, if the **Init** light is not on, please re-plug the hub under test.

C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light will go out and the **Test** light will go on, and the oscilloscope will automatically complete the test.

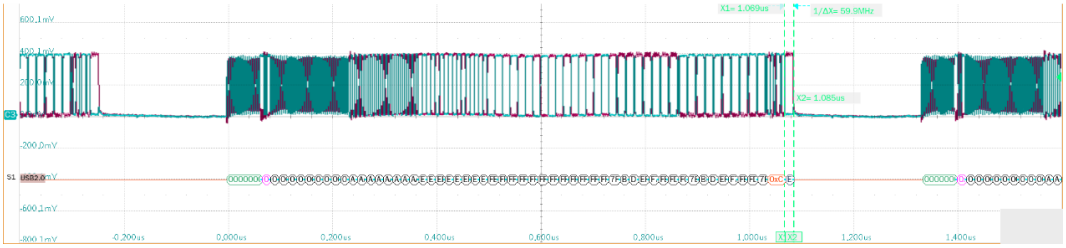
10.1.2 Test Results Reference

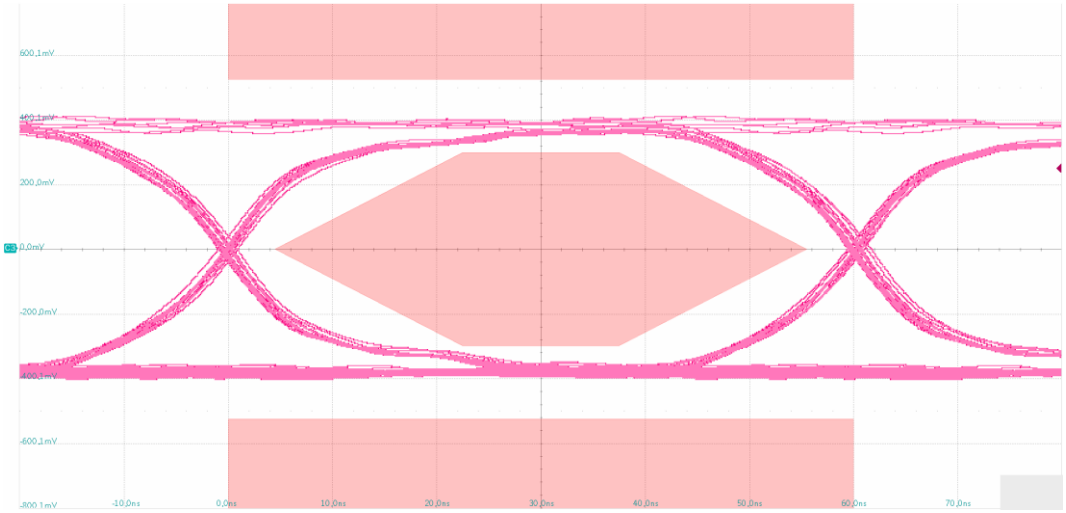
- EL_2: A USB 2.0 high-speed transmitter data rate must be 480 Mb/s±0.05%.
- EL_6: A USB 2.0 HS driver must have 10% to 90% differential rise and fall times of greater than 300 ps.
- EL_7: A USB 2.0 HS driver must have monotonic data transitions over the vertical openings

specified in the appropriate eye pattern template which is less than 50mV.

▸ EL_46: The hub upstream ports are tested using eye diagram template 1, with test point at TP3.

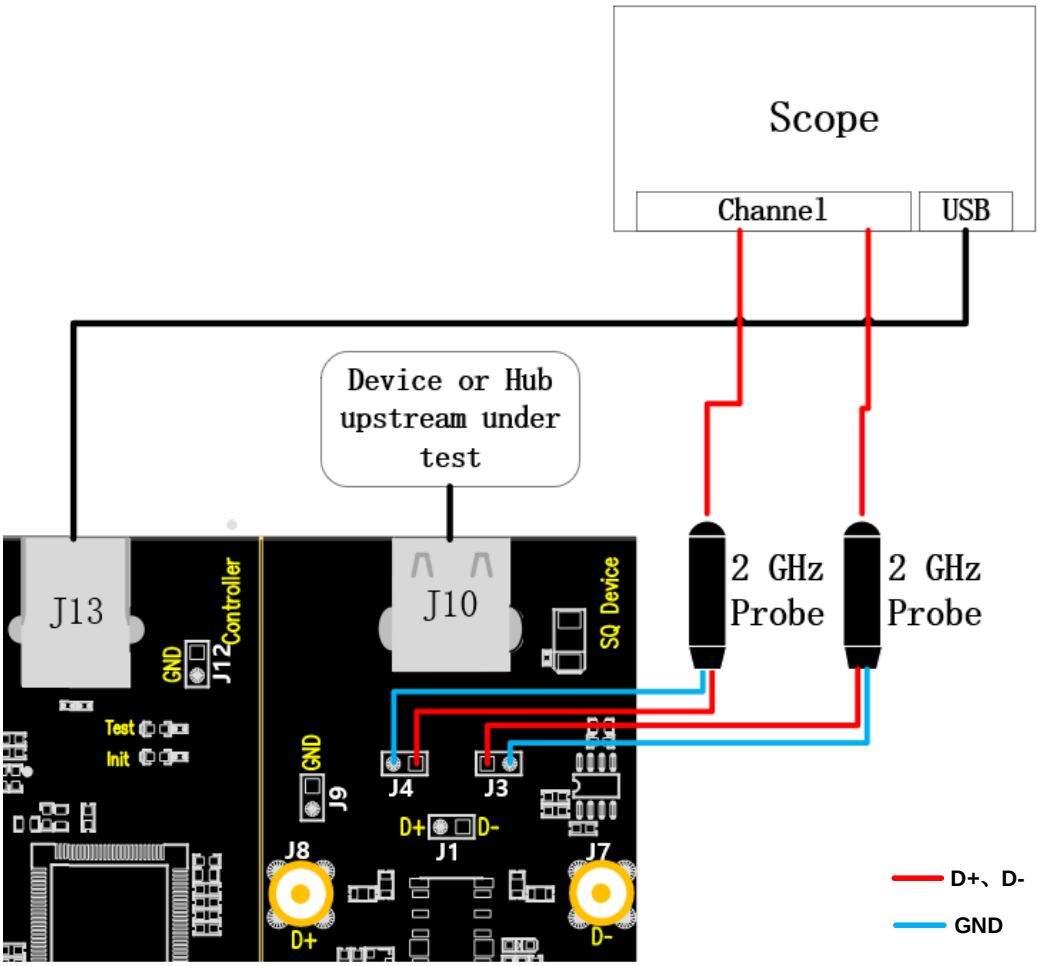
All of the above test items are performed together, and perform near-end eye chart analysis after specific waveforms are captured.





10.2 High-Speed US Packet Parameters (EL_21, EL_22, EL_25)

10.2.1 Test Steps



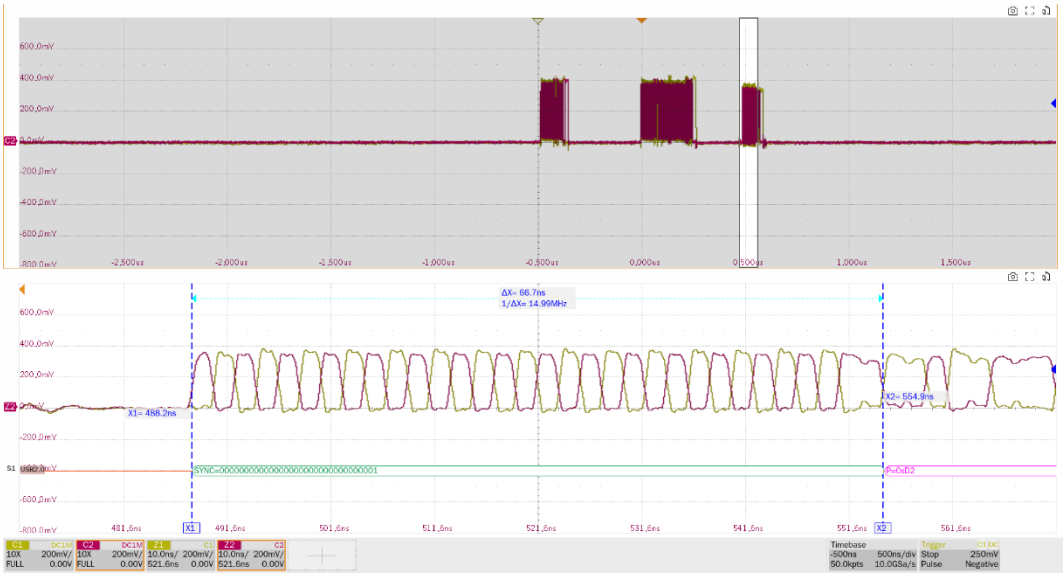
A. For "Single Ended", J4 and J3 are the test points for D+ and D- signals respectively, and for "Differential Probe", the test point is J1. J13 establishes communication with the oscilloscope through the cable, and the **Power** light is on.

B. Access the upstream port of the hub under test in J10, if it is successfully enumerated, the **Init** light will be on, if the **Init** light is not on, please re-plug the hub under test.

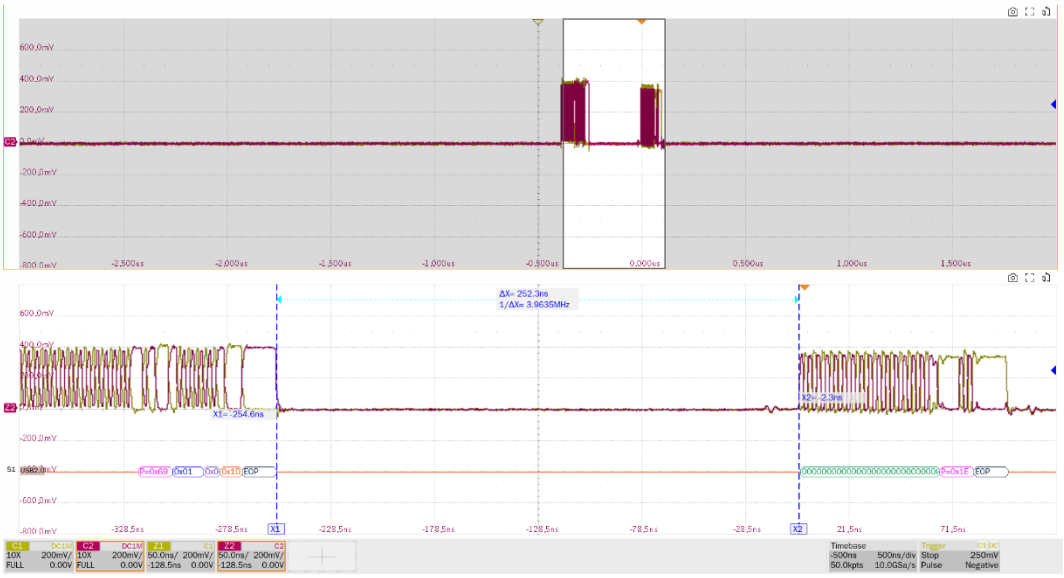
C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light will go out and the **Test** light will go on, the oscilloscope will automatically complete the test, and the test results will pop up after the test is finished.

10.2.2 Test Results Reference

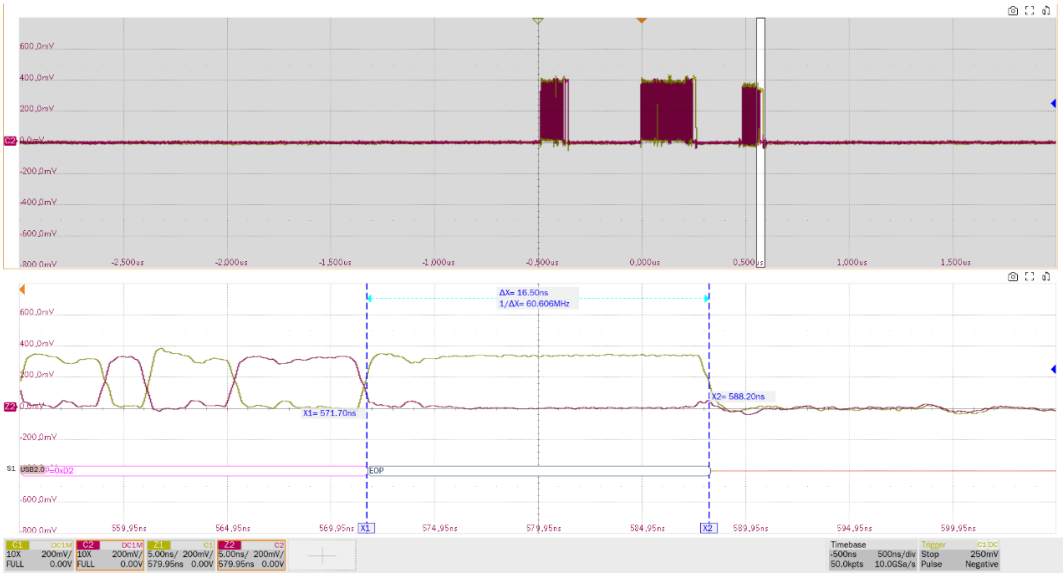
▶ EL_21: The SYNC field for all transmitted packets (not repeated packets) must begin with a 32 bit SYNC field. The number of SYNCs at the beginning of the device answer packet is measured in this item.



- EL_22: When transmitting after receiving a packet, hosts and devices must provide an inter-packet gap of at least 8 bit times and not more than 192 bit times(16.64ns~399.36ns). The oscilloscope displays two packets, measuring the time interval between the first packet (sent by the host) and the second packet (sent by the device).

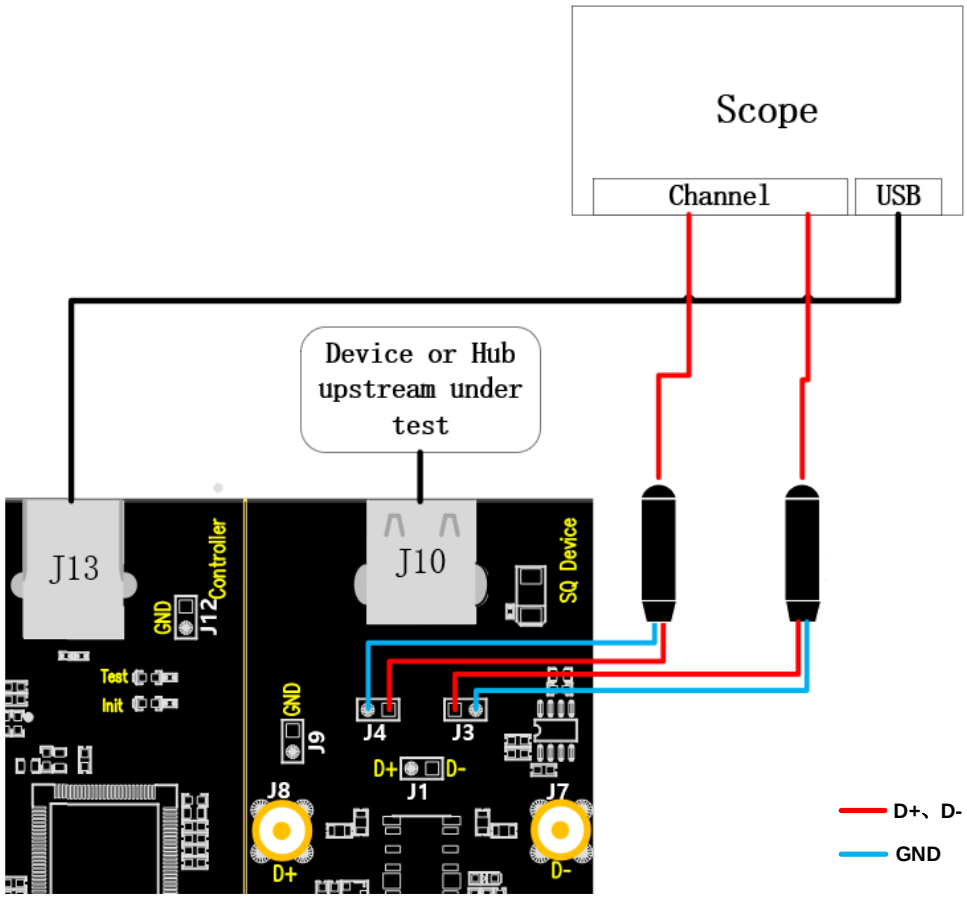


- EL_25: The EOP for all transmitters' packets (except SOFs) must be an 8 bit NRZ byte of 01111111.



10.3 High-Speed US Chirp Timing (EL_28, EL_29, EL_31)

10.3.1 Test Steps



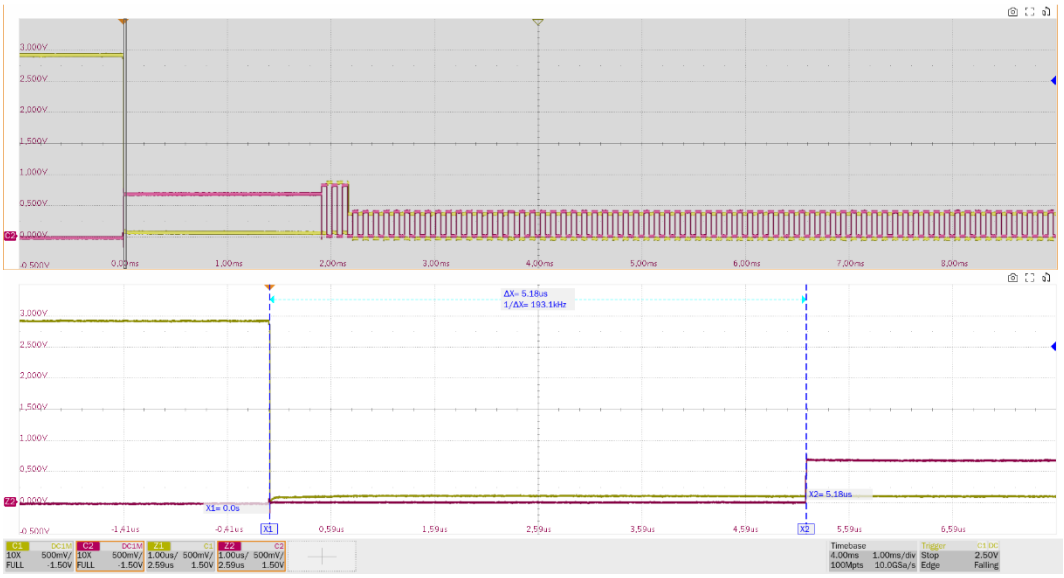
A. J4 and J3 are the test points for D+ and D- signals respectively. J13 establishes communication with the oscilloscope through the cable and the **Power** light is on.

B. Access the upstream port of the hub under test in J10, if it is successfully enumerated, the **Init** light will be on, if the **Init** light is not on, please re-plug the hub under test.

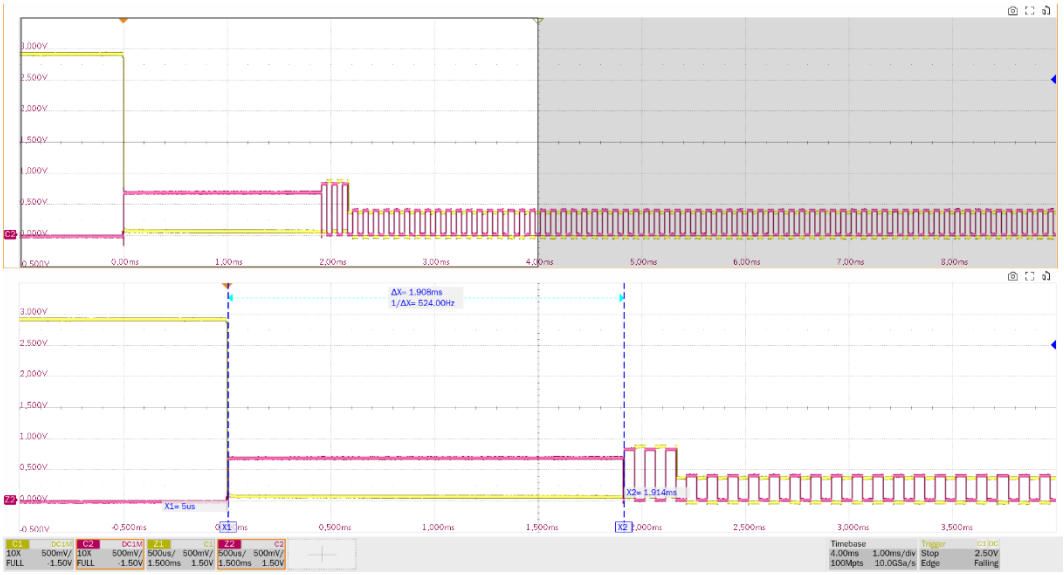
C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light will go out and the **Test** light will go on, the oscilloscope will automatically complete the test, and the test results will pop up after the test is finished.

10.3.2 Test Results Reference

▶ EL_28: Devices must transmit a chirp handshake no sooner than 2.5us and no later than 6.0ms when being reset from a suspended state.

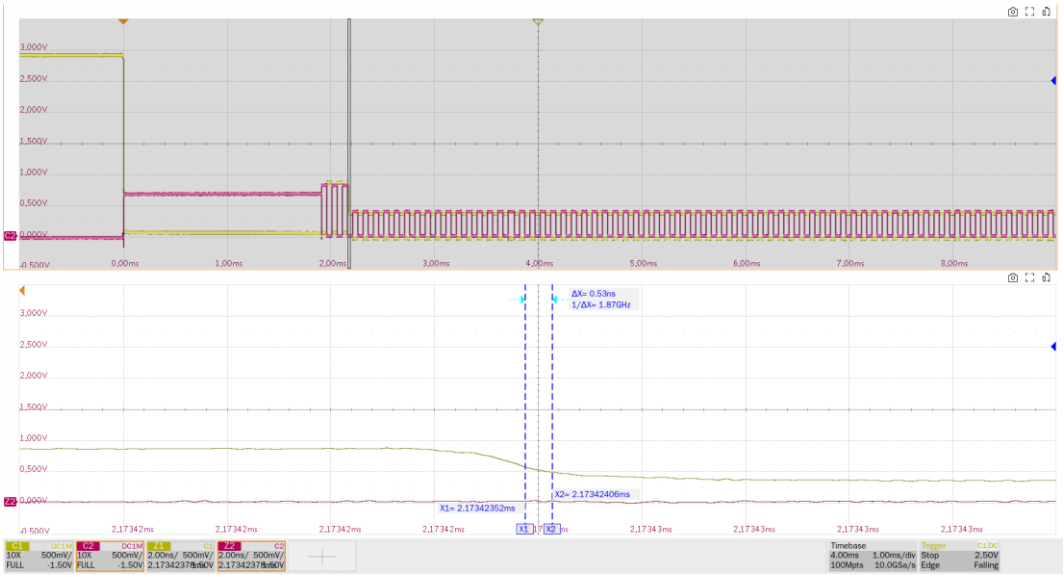


▶ EL_29: The chirp handshake generated by a device must be at least 1ms and no more than 7ms in duration.



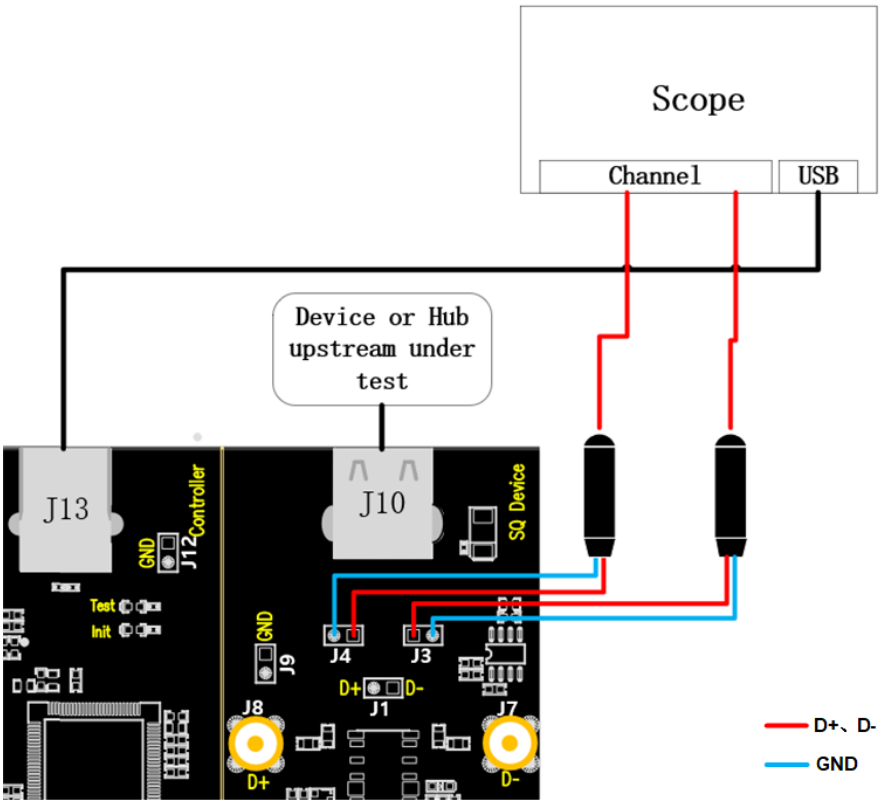
▶ EL_31: During device speed detection, when a device detects a valid K-J-K-J-K-J sequence, the

device must disconnect its 1.5K pull-up resistor and enable it high-speed termination within 500us.



10.4 High-Speed US Suspend Resume (EL_38 EL_39, EL_40 EL_41)

10.4.1 Test Steps



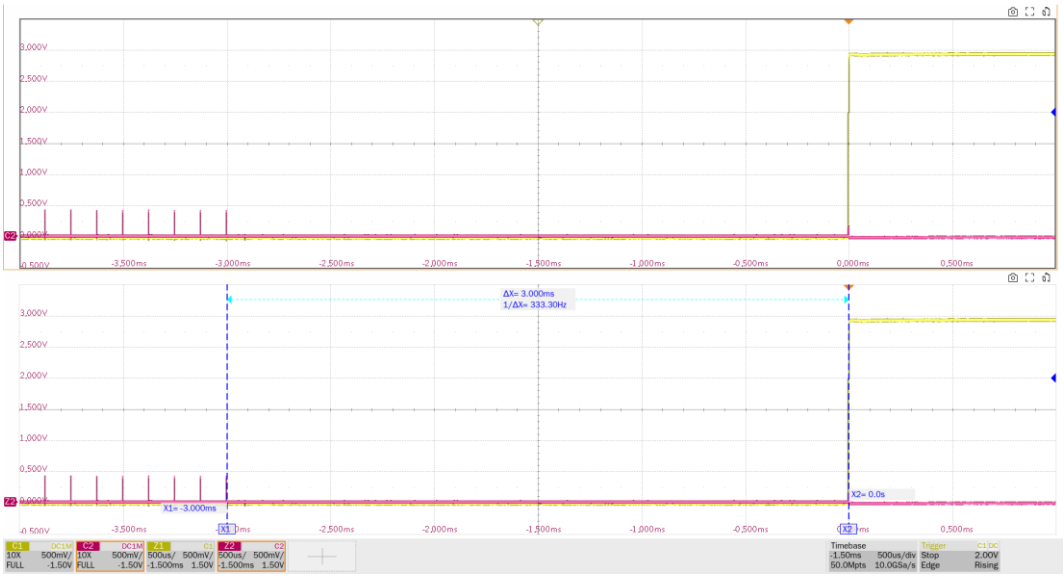
A. J4 and J3 are the test points for D+ and D- signals respectively, connect the probes according to the configured oscilloscope channel; J13 establishes communication with the oscilloscope through the cable, and the **Power** light is on.

B. Access the upstream port of the hub under test in J10, if it is successfully enumerated, the **Init** light will be on, if the **Init** light is not on, please re-plug the hub under test.

C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light will go out and the **Test** light will go on, the oscilloscope will automatically complete the test, and the test results will pop up after the test is finished.

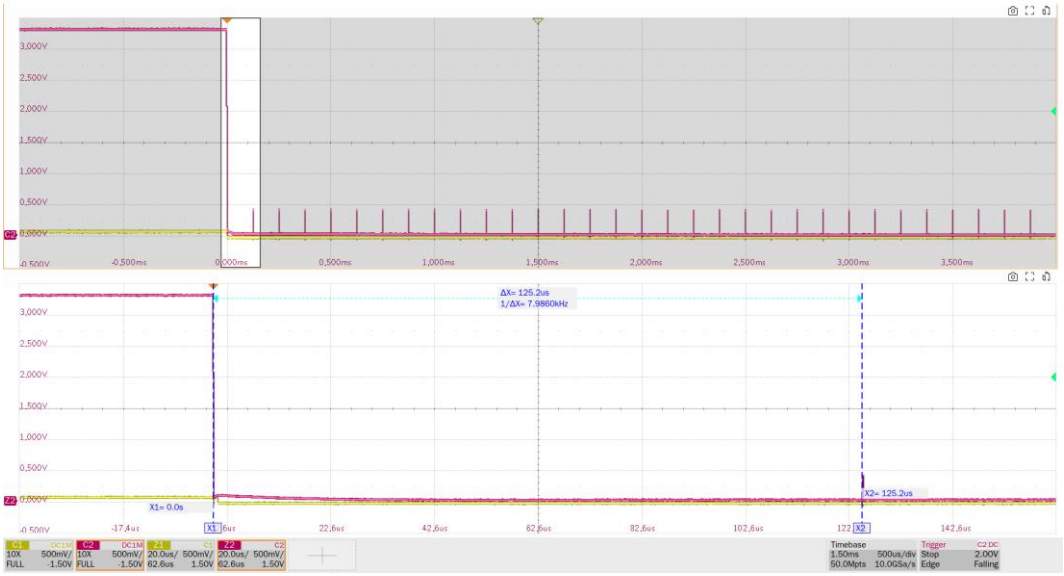
10.4.2 Test Results Reference

- EL_38: A device must revert to full-speed no later than 125us after there is a 3ms idle period on the bus (3.000ms <= t <= 3.125ms). Measure the time interval from the last SOF's at high speed to suspend.
- EL_39: A device must support the suspend state.



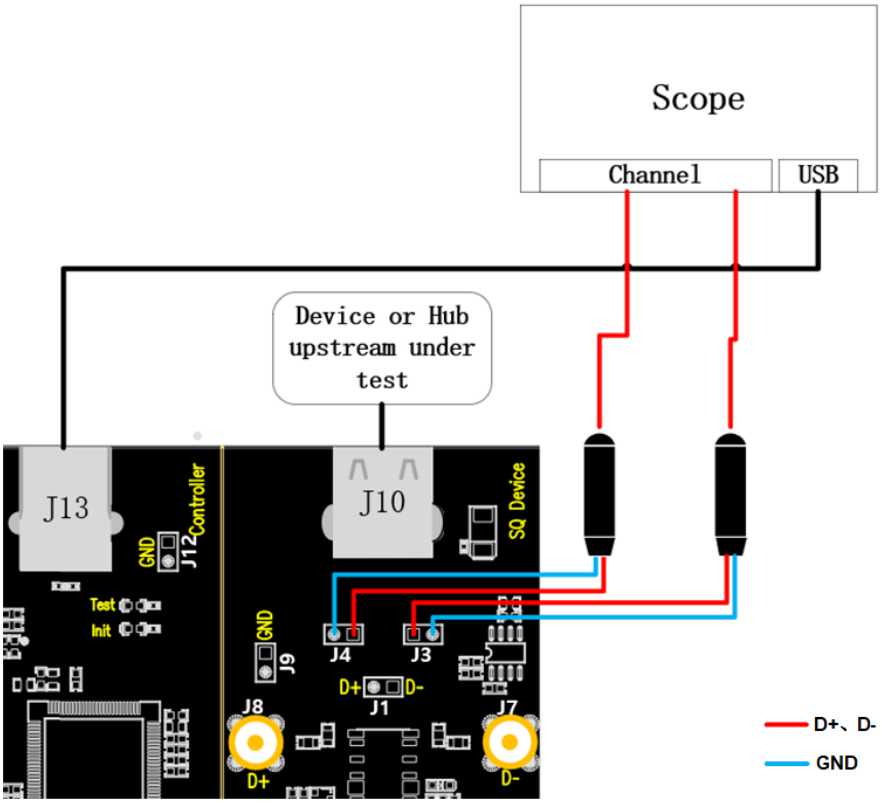
- EL_40: If a device is in the suspend state, and was operating in high-speed before being suspend, then the device must transition back to high speed operation within two bit times from the end of resume signaling.
- EL_41: After resuming a port, the host must begin sending SOF's within 3ms of the start of the idle state.

Note: The EL_40 test item is a poorly defined measurement of low level from suspend to high speed, so only EL_41 is measured.



10.5 High-Speed to Reset (EL_27, EL_29, EL_31)

10.5.1 Test Steps



A. J4 and J3 are the test points for D+ and D- signals respectively, connect the probes according to the configured oscilloscope channel; J13 establishes communication with the oscilloscope through the cable, and the **Power** light is on.

B. Access the upstream port of the hub under test in J10, if it is successfully enumerated, the **Init**

light will be on, if the **Init** light is not on, please re-plug the hub under test.

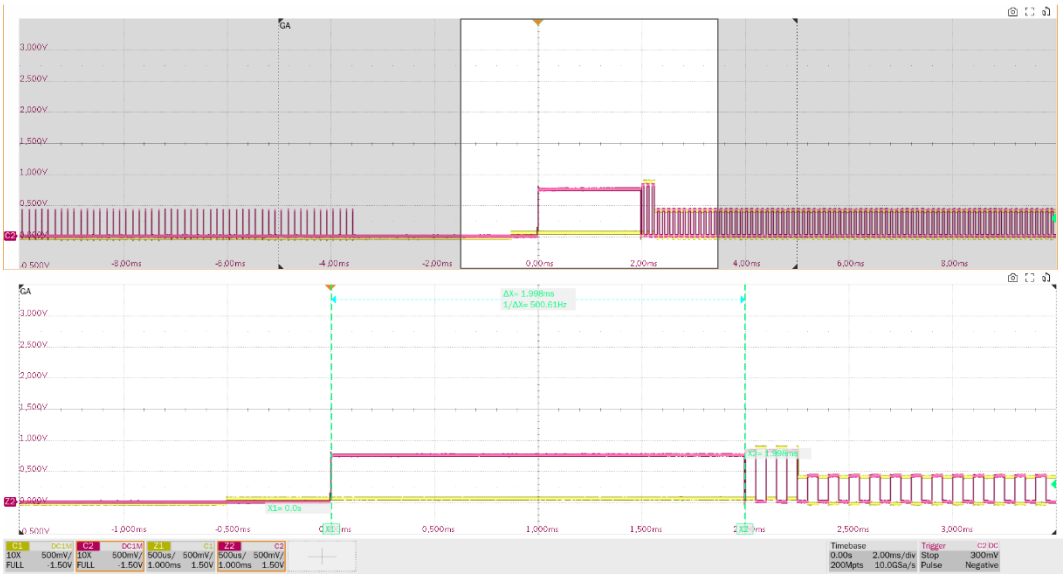
C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light will go out and the **Test** light will go on, the oscilloscope will automatically complete the test, and the test results will pop up after the test is finished.

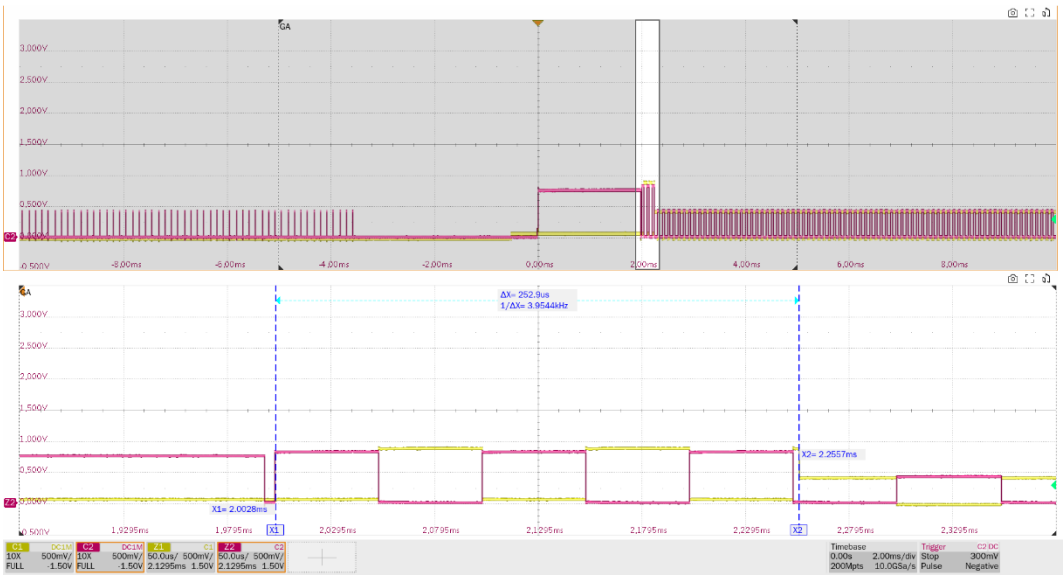
10.5.2 Test Results Reference

▶ EL_27: The response time of reset from the non-suspended state in high speed is measured from the last SOF's of the high-speed to the time of the chirp K generation which is a time interval of 3.1ms~6ms. This section additionally measures the amplitude of the chirp K (720mV to 880mV).

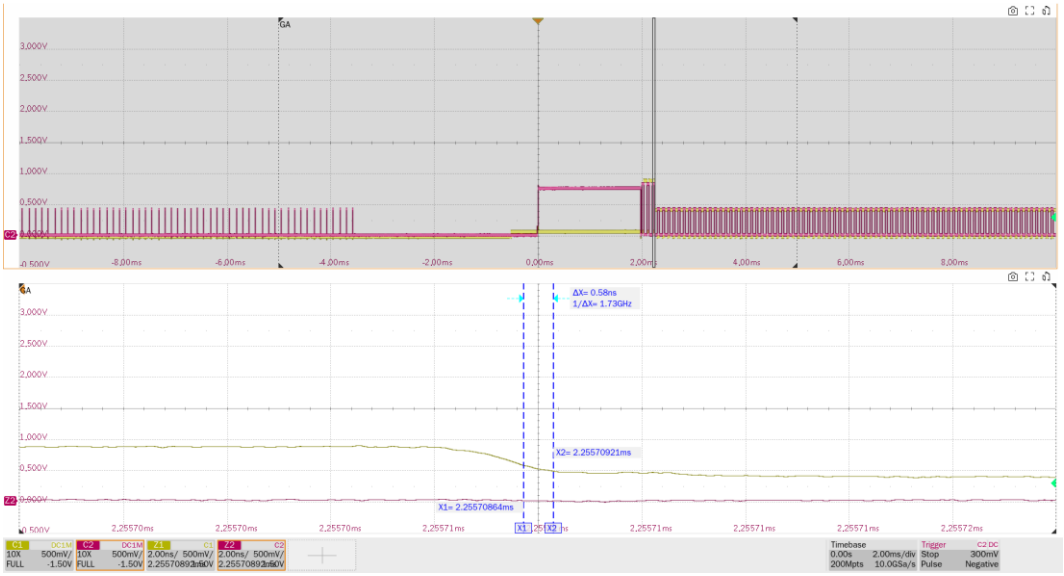
▶ EL_29: The chirp handshake generated by a device must be at least 1ms and no more than 7ms in duration. This section additionally measures the number of J/K number pairs (at least 3)

produced by the device.



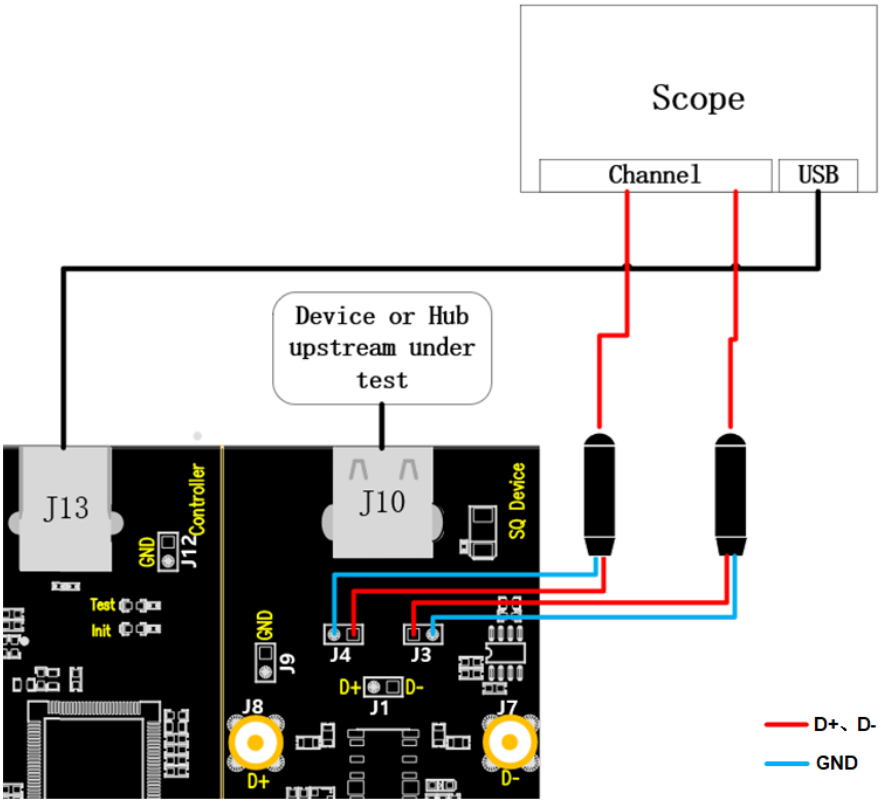


- EL_31: During device speed detection, when a device detects a valid K-J-K-J-K-J sequence, the device must disconnect its 1.5K pull-up resistor and enable it high-speed termination within 500us.



10.6 Suspend to Reset (EL_28, EL_29, EL_31)

10.6.1 Test Steps



A. J4 and J3 are the test points for D+ and D- signals respectively, connect the probes according to the configured oscilloscope channel; J13 establishes communication with the oscilloscope through the cable, and the **Power** light is on.

B. Access the upstream port of the hub under test in J10, if it is successfully enumerated, the **Init**

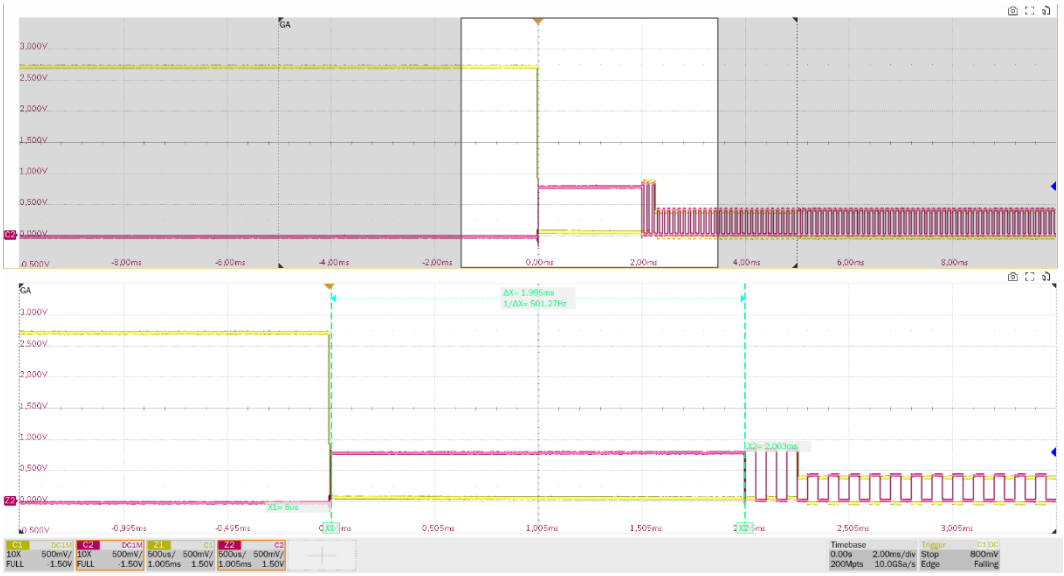
light will be on, if the **Init** light is not on, please re-plug the hub under test.

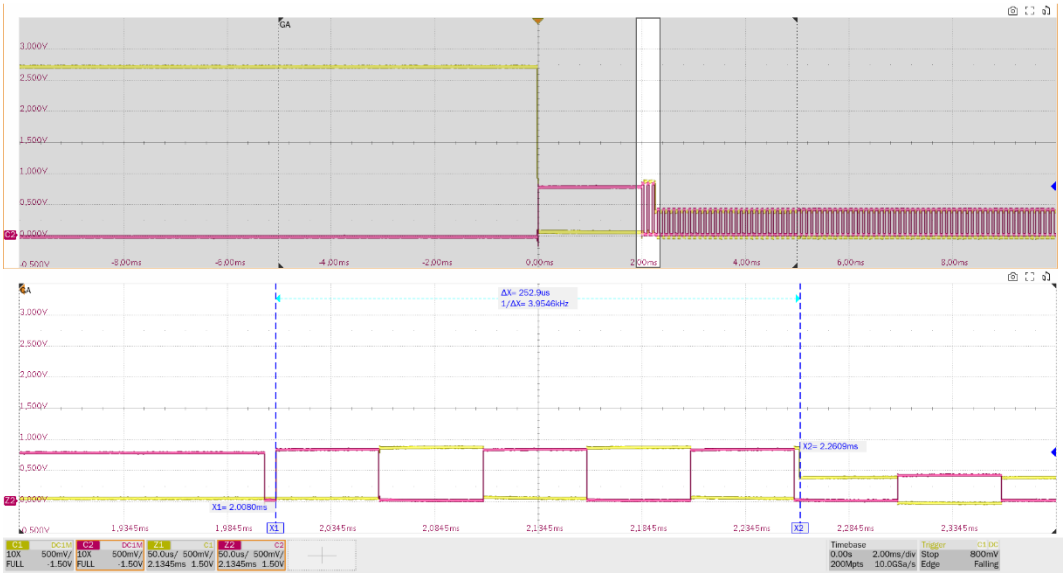
C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light will go out and the **Test** light will go on, the oscilloscope will automatically complete the test, and the test results will pop up after the test is finished.

10.6.2 Test Results Reference

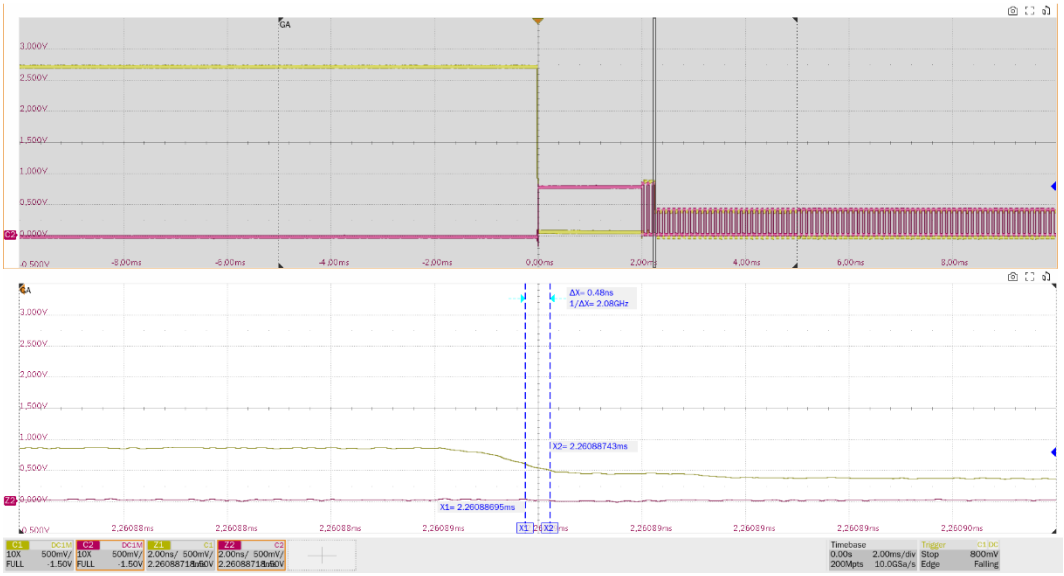
▶ EL_28: Devices must transmit a chirp handshake no sooner than 2.5us and no later than 6.0ms when being reset from a suspend state. This section additionally measures the amplitude of the chirp K (720mV to 880mV).

▶ EL_29: The chirp handshake generated by a device must be at least 1ms and no more than 7ms in duration. This section additionally measures the number of K/J pairs (at least 3) after a suspend reset.



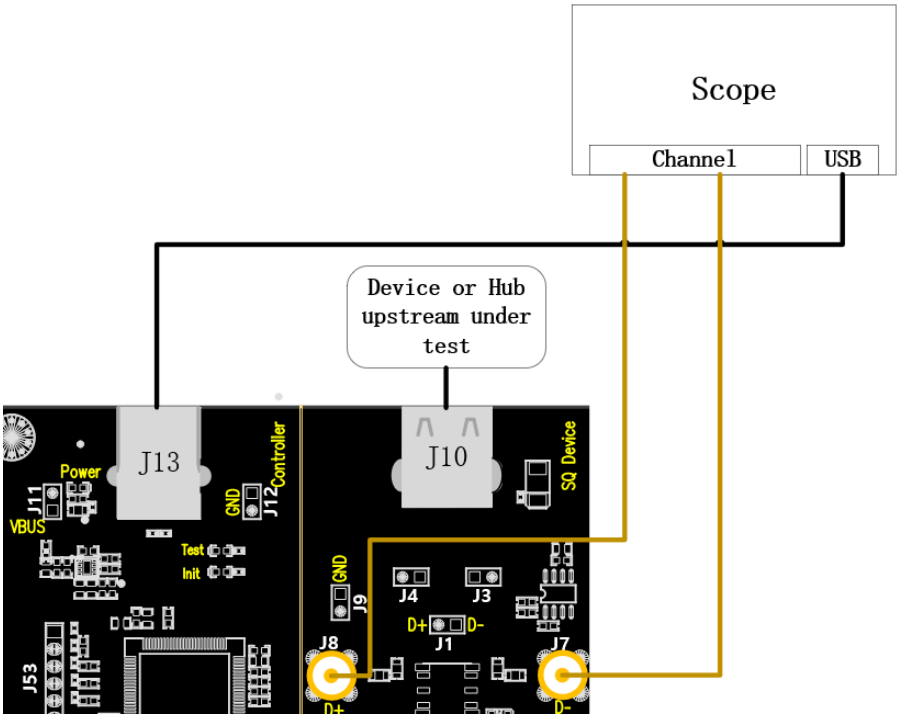


- EL_31: During device speed detection, when a device detects a valid K-J-K-J-K-J sequence, the device must disconnect its 1.5K pull-up resistor and enable it high-speed termination within 500us.



10.7 High-Speed US Not Driven Voltage Levels (EL_8, EL_9)

10.7.1 Test Steps



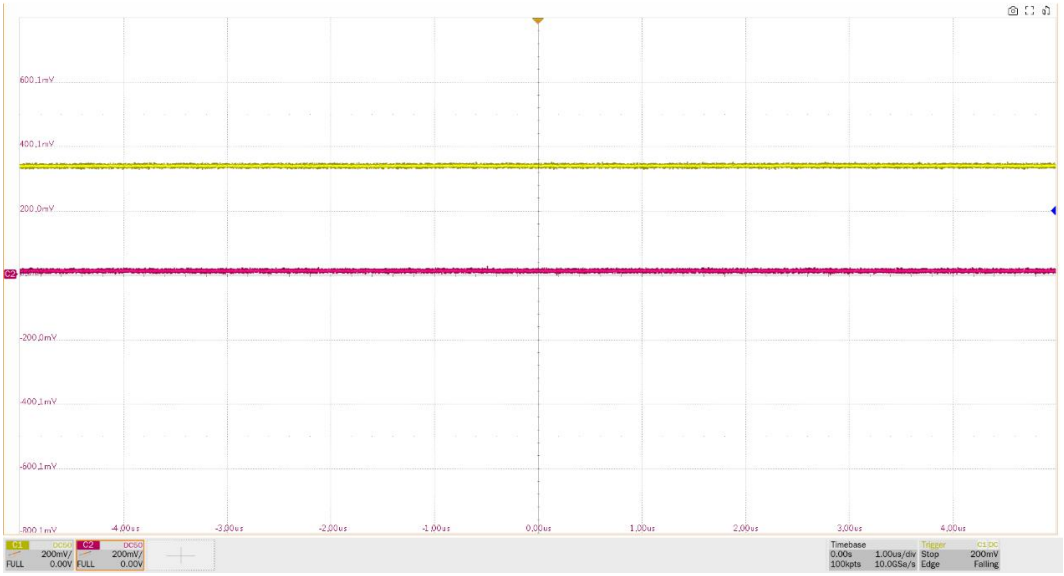
A. Use two SMA cables to connect J8 and J7 to the D+ and D- channels configured before. J13 establishes communication with the oscilloscope through the cables and the **Power** light is on.

B. Access the upstream port of the hub under test in J10, if it is successfully enumerated, the **Init** light will be on, if the **Init** light is not on, please re-plug the hub under test.

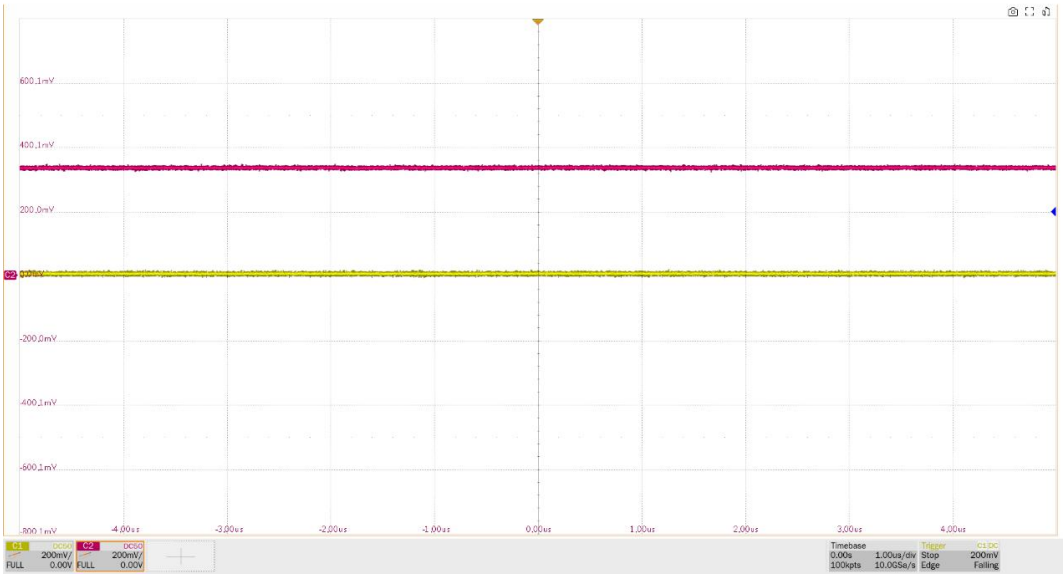
C. Click the "**Run Test**" button in the "**Run Test**" column, the **Init** light will go out and the **Test** light will go on, the oscilloscope will automatically complete the test.

10.7.2 Test Results Reference

▶ EL_8: The voltage measured of J/K not driven should be 360mV to 440mV.

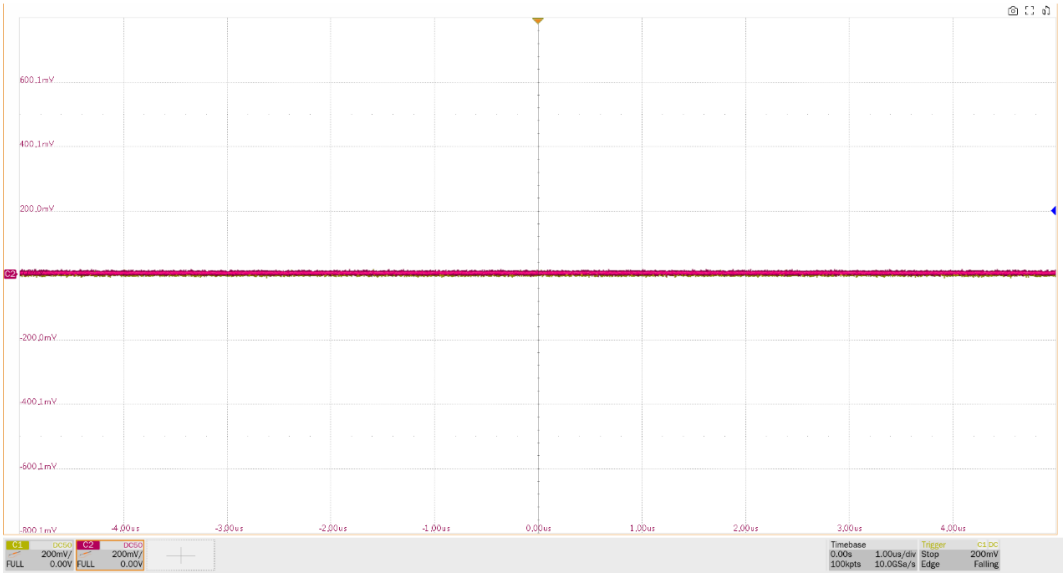


Voltage of J when the upstream is not driven



Voltage of K when the upstream is not driven

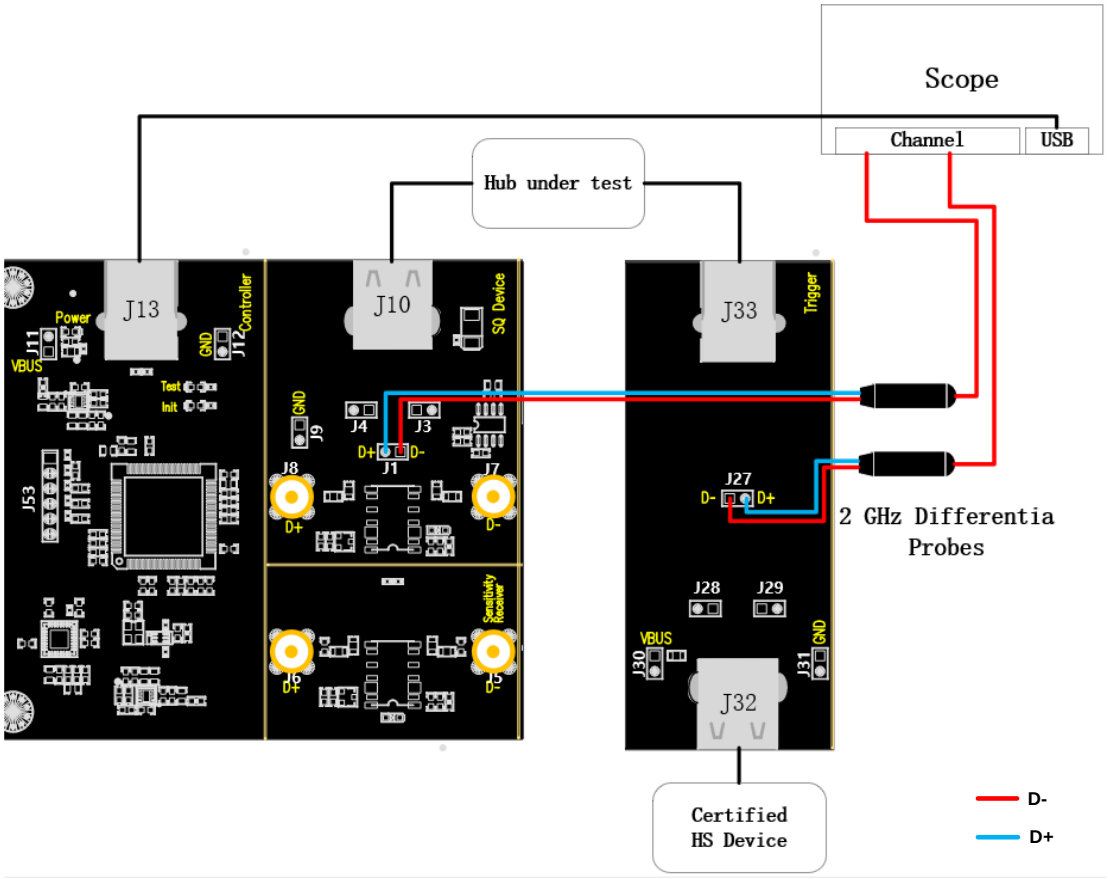
▶ EL_9: When either D+ or D- is not being driven, the output voltage must be 0V±20mV when terminated with precision 45 ohm resistors to ground. This item measures the D+ and D- voltage values in the SE0 state.



Voltage of SE0_NAK in upstream

10.8 High-Speed US Repeater (EL_42, EL_43, EL_44, EL_45, EL_48)

10.8.1 Test Steps



A. When using differential probes, J1 corresponds to the repeater upstream test point and J27

corresponds to the repeater downstream test point; when using single-ended probes, J4 and J3 correspond to the D+ and D- of the repeater upstream test point, and J29 and J28 correspond to the D+ and D- of the repeater downstream test point; connect the probes in accordance with the previous oscilloscope channel configuration.

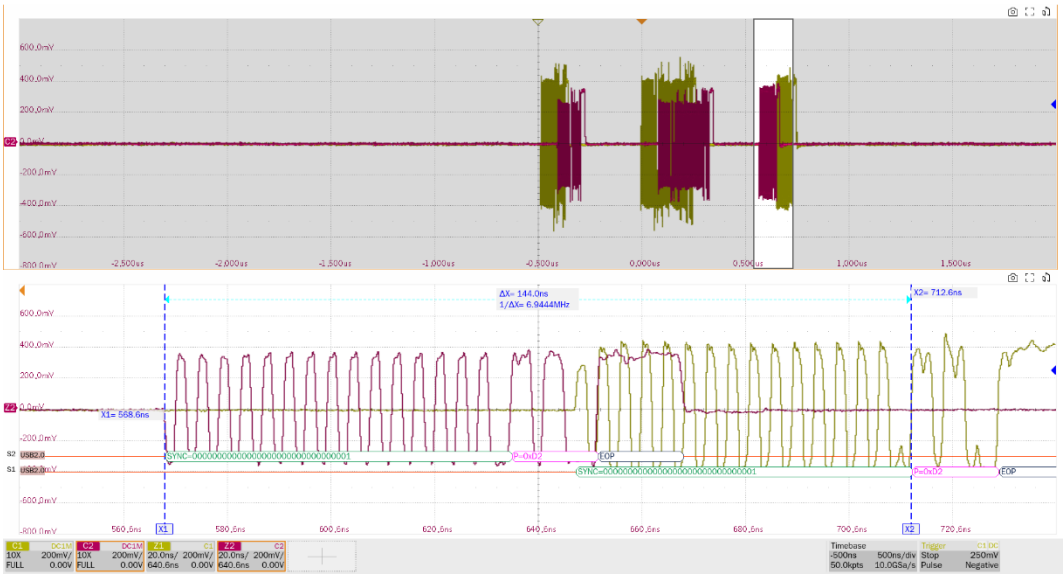
B. Use the cable to connect the oscilloscope USB interface and J13 to establish communication between the oscilloscope and the USB signal board, and the **Power** light is on.

C. The upstream port of the hub is connected to J10, if the enumeration is successful, the **Init** light will be on, otherwise, please re-plug it; the downstream port of the hub under test is connected to J33 using a short cable, and a high-speed device certified by USB 2.0 is accessed at J32.

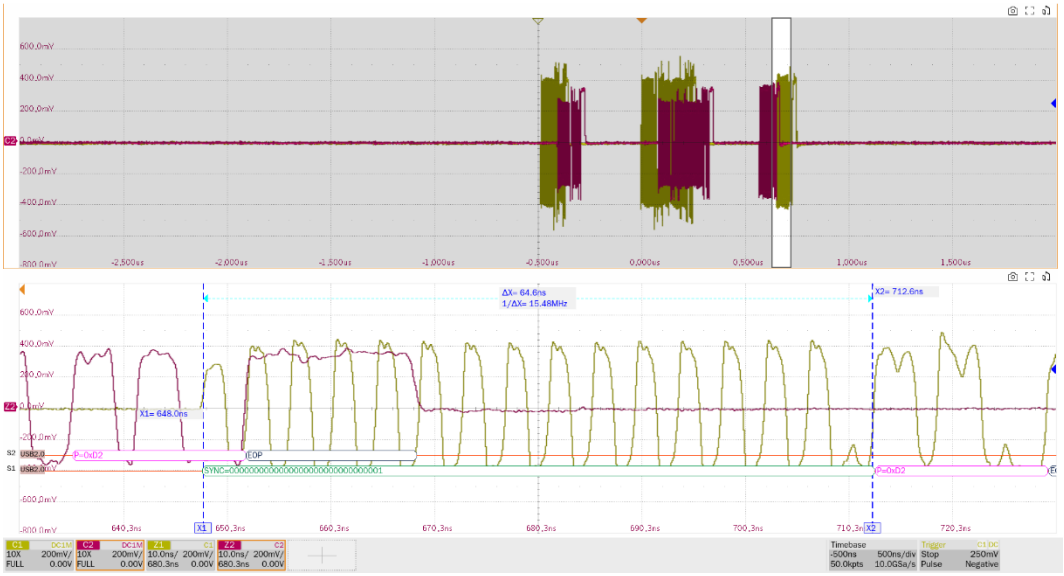
D. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

10.8.2 Test Results Reference

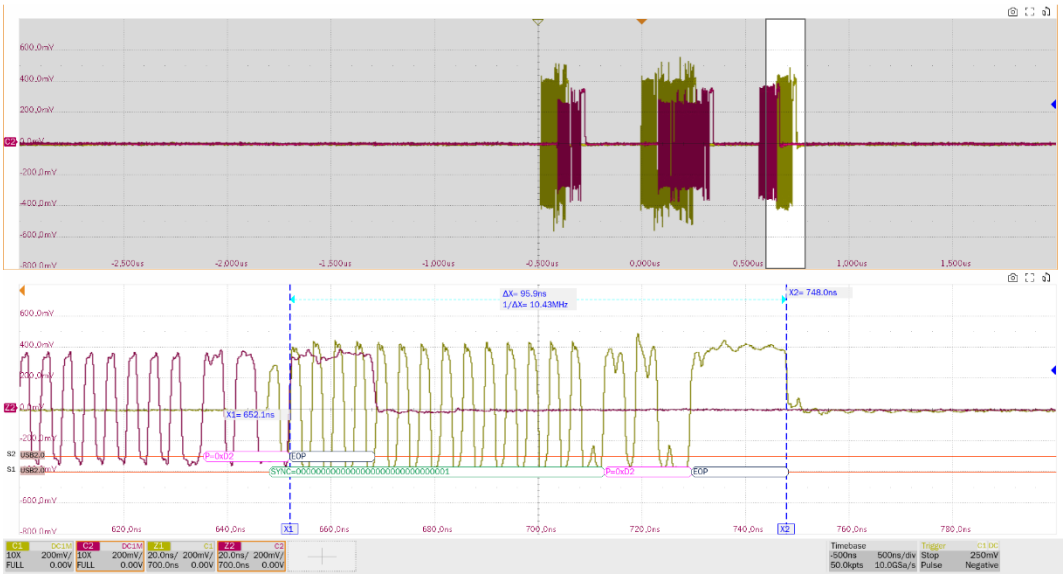
▶ EL_42: Hub repeaters must not truncate more than 4 bits from a repeated SYNC pattern. Measure the difference between the number of bits in the SYNC field of the upstream port and the downstream port of a packet that passes through the hub; the difference between the two must not be greater than 4 bits.



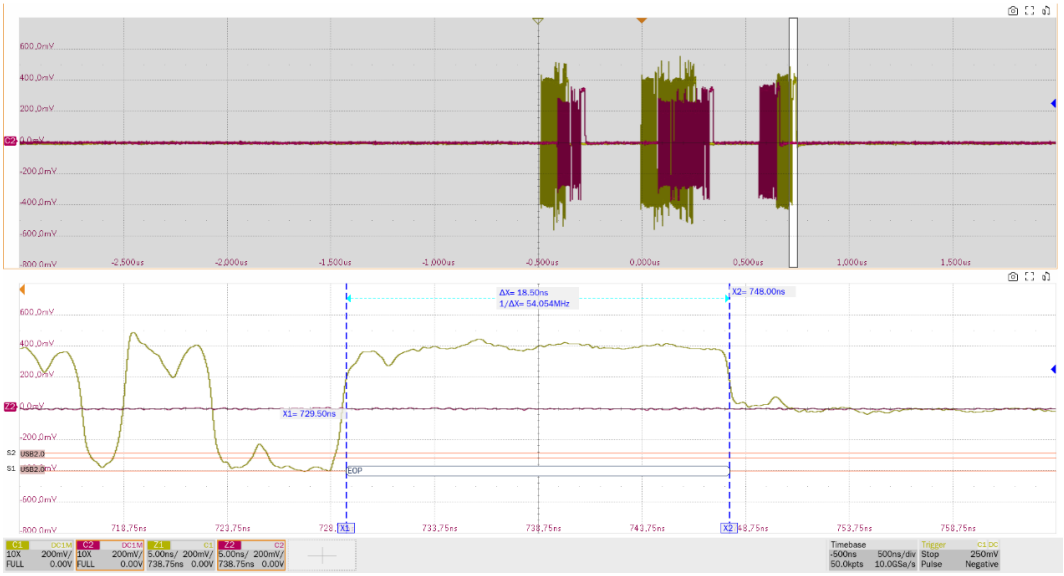
▶ EL_43: Hubs must no corrupt any repeater bits of the SYNC field. Measure the SYNC field at the upstream port of the hub.



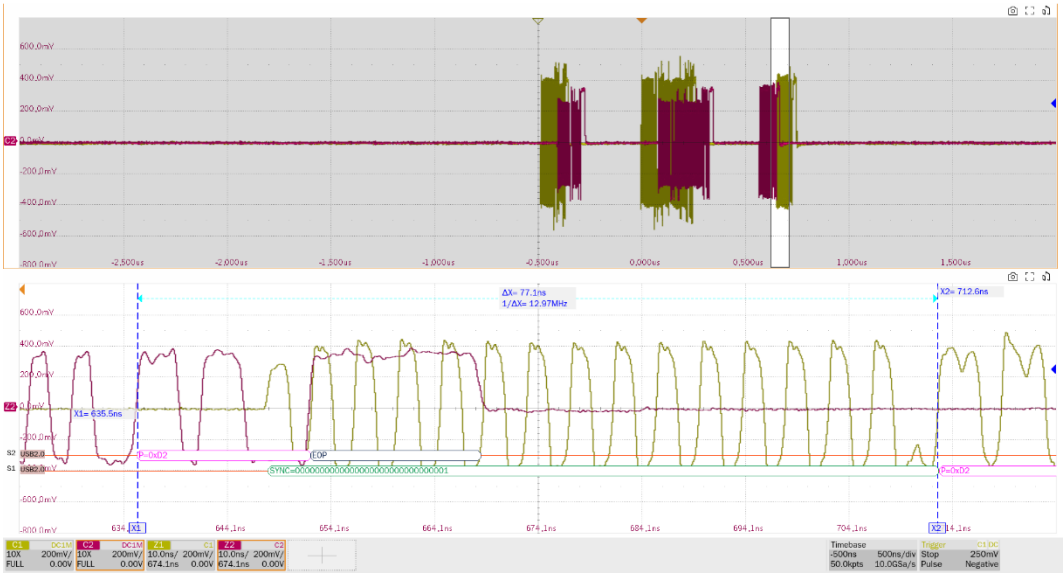
- EL_44: A hub may add at most 4 random bits to the end of the EOP field when repeating a packet. Measure the difference between the number of downstream port EOP bits and the number of upstream port EOP bits of a packet after it passes through the hub, which must not increase by more than 4 bits.



- EL_45: A hub must not corrupt any of the valid EOP bits when repeating a packet. Measure the EOP of the upstream port of the repeater.

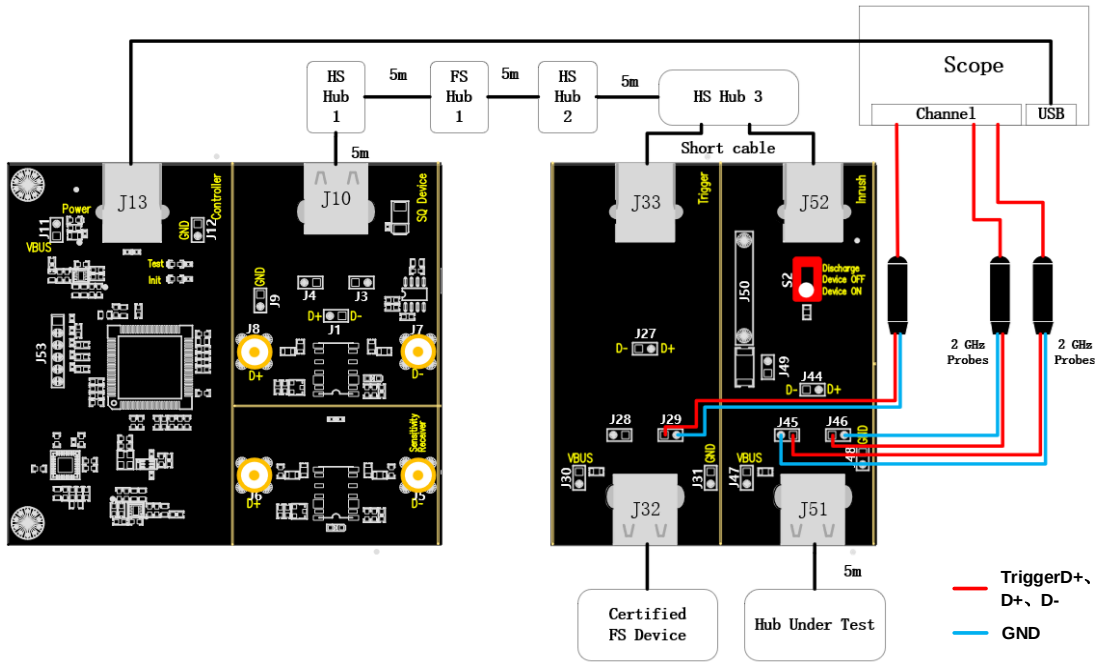


- EL_48: A hub repeater may not delay packets for more than 36bit time plus 4ns. The delay is measured from the beginning of the end of the hub's input data SYNC field to the end of the output data SYNC field up to the end of the output data SYNC field, and the time interval between the two cannot exceed 36 bits + 4ns.



10.9 Full-Speed US Signal Quality

10.9.1 Test Steps



A. J46 and J45 are the D+ and D- signal test points of the DUT respectively, and J29 is the signal test point for trigger D+.

B. Use a cable to connect the oscilloscope USB interface and J13 to establish communication between the oscilloscope and the USB signal board, and the **Power** light is on.

C. Take a high speed hub (HS Hub 3 in the figure), according to the value in "**Port**", the downstream port of the corresponding position of the high speed hub is connected to J52 through a short cable, and any other port is connected to J33 through a short cable.

D. The J10 and HS Hub 3 upstream ports are connected to the full-speed hub, as well as two high-speed hubs according to the wiring diagram, all using 5m cables.

E. J32 is connected to a full-speed device that has passed the official USB certification, J51 is connected to the DUT, and S2 is dialed to "**Device ON**".

F. When performing this test, please try to connect all self-powered hubs to an external power supply to avoid the test failing due to insufficient power supply to the multi-stage hub connections under bus power.

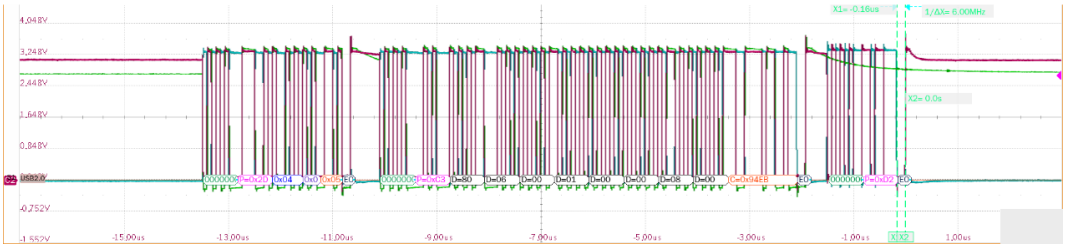
G. Click the "**Run Test**" button in the "**Run Test**" column, the oscilloscope will automatically complete the test.

10.9.2 Test Results Reference

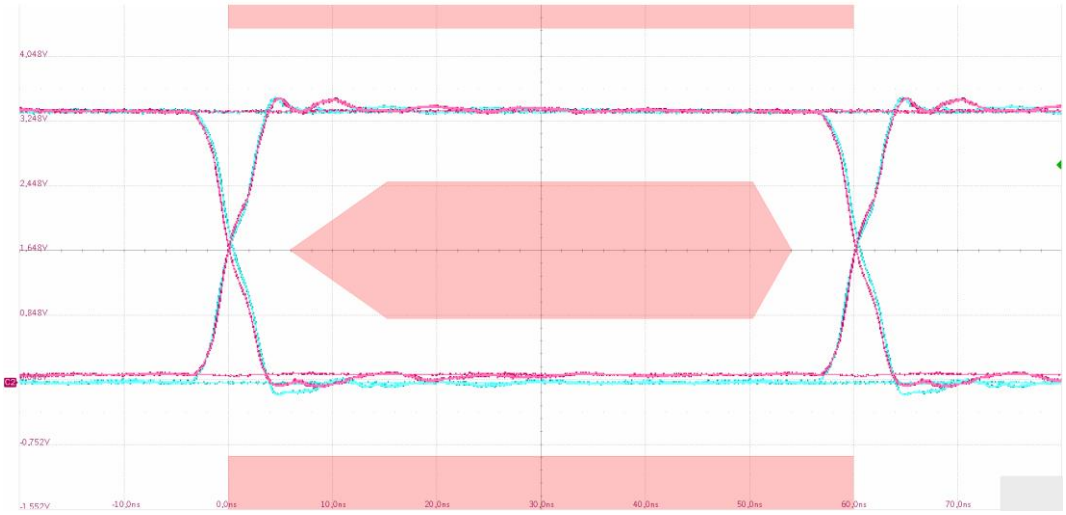
The full-speed upstream signal quality of the device has the following test items:

▶ Measure the EOP width of the full-speed packet, which is required to be in the range of (1.92+1)

bit to (2.1+1) bit.



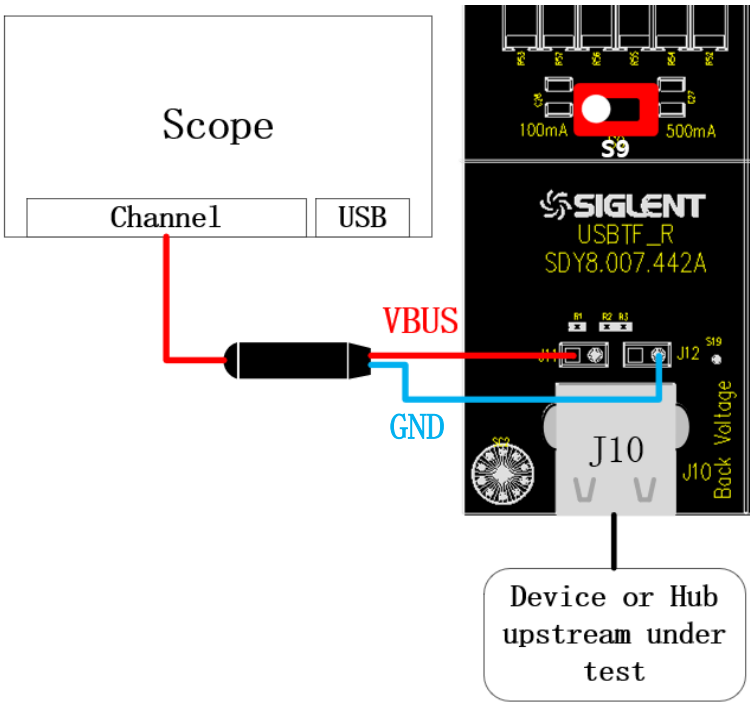
- Measure the voltage amplitude of D+ and D- cross point, the cross point voltage is required to be between 1.3V and 2V.
- Measure the signal speed of the full-speed packet, which is required to be between 11.97 MHz and 12.03MHz.
- Measure the D+/D- rise and fall time at full speed, which is required to be between 4ns and 20ns.
- Measure the edge monotonicity of full-speed signal, which is required no backhooks greater than 500mV exist at its edges.
- Measure the J/K jitter additionally, and the edge width of the eye diagram is the degree of J/K jitter.



10.10 Back Voltage

10.10.1 Test Steps

10.10.1.1 Test Environment Setup



A. In the figure, J11 and J12 are VBus, D-, D+, and GND from left to right, so connect the probe according to the configured VBus, D-, and D+ channels.

B. Click the "**Run Test**" button in the "**Run Test**" column and follow the pop-up window to complete the test.

10.10.1.2 Voltage Test before Enumeration

If the device is self-powered, please connect it to an external power source, connect the DUT to the J10 port, and click "**Run Test**".

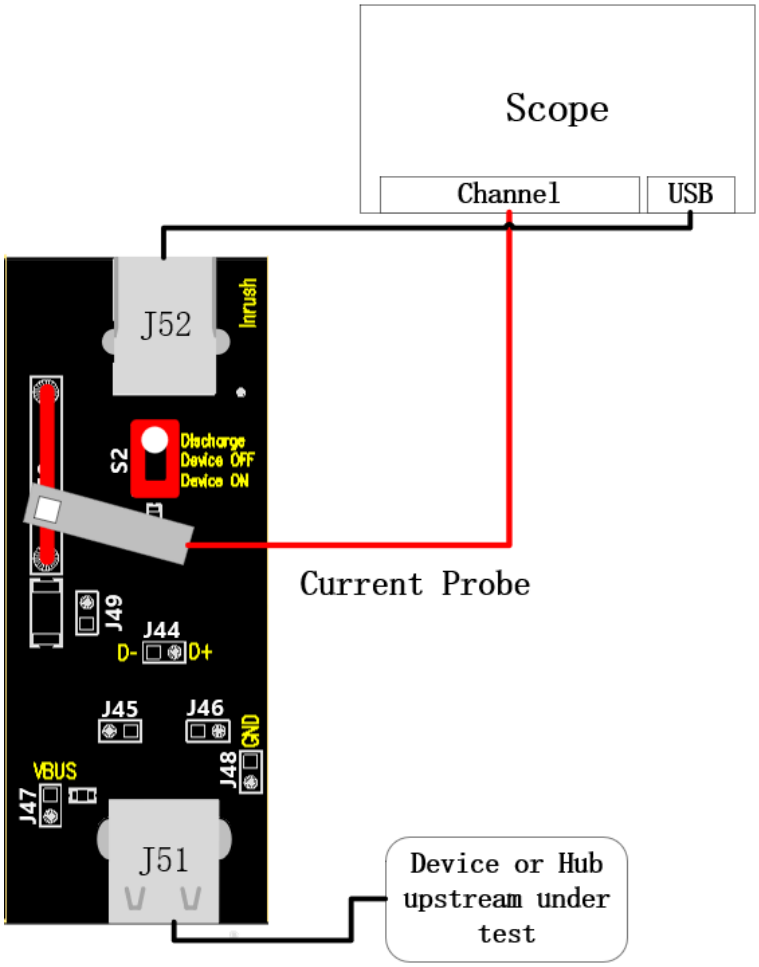
10.10.1.3 Voltage Test after Enumeration

If the device is a self-powered, please connect it to an external power source, connect the DUT to any normal USB port, make it enumerate normally, connect the DUT to J10, and click "**Run Test**".

10.11 Inrush

10.11.1 Test Steps

10.11.1.1 Test Environment Setup



A. Choose any normally powered USB port and connect it to J52 via a cable, and J50 connects to the current probe.

B. After connecting the current probe, open the previously configured oscilloscope test channel, manually configure the current probe multiplier of the channel according to the probe used, set the channel setting to "**200mA/div**", select "**Auto**" for the trigger mode, and then perform the probe's degaussing.

C. J51 access to the DUT, S2 twist switch to "Device ON", check whether the oscilloscope waveform is upward, if not, it means that the probe is connected incorrectly, please flip the probe and then access to J50.

D. Click the "**Run Test**" button in the "**Run Test**" column.

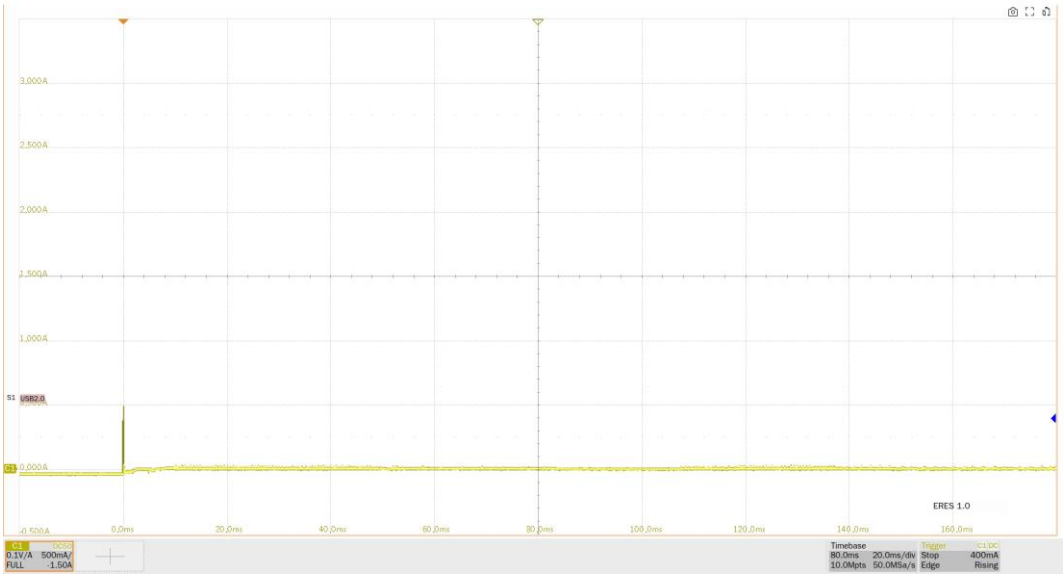
10.11.1.2 Inrush Current Test

A. J51 is connected to the DUT, turn the S2 twist switch to "**Discharge**", wait for one or two seconds,

and then unplug the DUT.

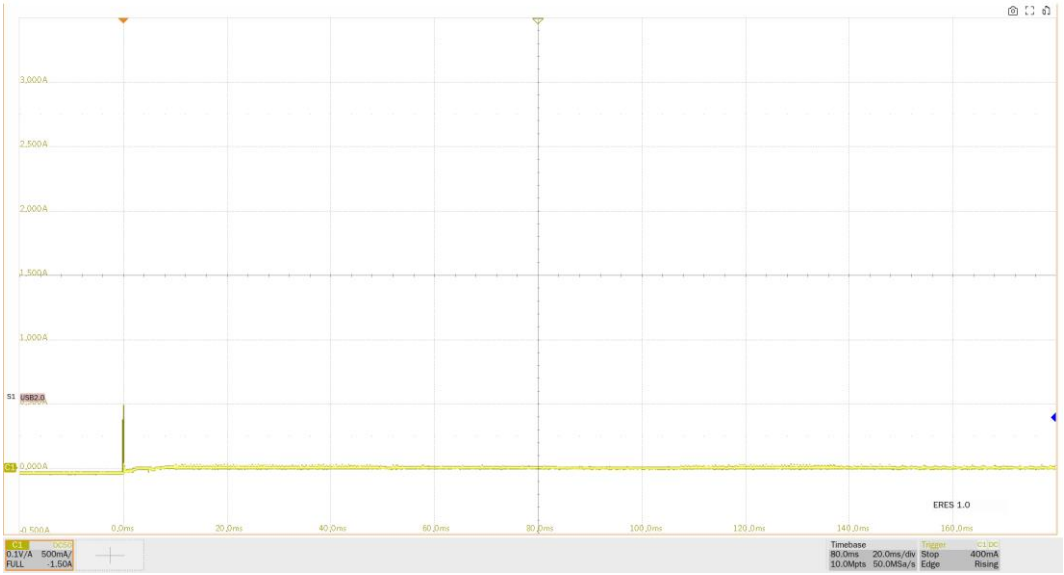
B. S2 twist switch to "**Device ON**".

C. Access the DUT at J51, observe the waveform captured by the oscilloscope and click "**Run Test**", if the waveform captured by the oscilloscope differs greatly from the following reference waveform, please check whether the wiring is correct and restart from step A.



10.11.2 Test Results Reference

▶ Inrush current test results are calculated by taking the first 100mA as the starting point and 100us after the last 100mA as the end point, and calculating the charge between the two, which is required to be less than 50uC.



About SIGLENT

SIGLENT is an international high-tech company, concentrating on R&D, sales, production and services of electronic test & measurement instruments.

SIGLENT first began developing digital oscilloscopes independently in 2002. After more than a decade of continuous development, SIGLENT has extended its product line to include digital oscilloscopes, isolated handheld oscilloscopes, function/arbitrary waveform generators, RF/MW signal generators, spectrum analyzers, vector network analyzers, digital multimeters, DC power supplies, electronic loads and other general purpose test instrumentation. Since its first oscilloscope was launched in 2005, SIGLENT has become the fastest growing manufacturer of digital oscilloscopes. We firmly believe that today SIGLENT is the best value in electronic test & measurement.

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