

i.MX 6 Series USB Certification Guide

1. Introduction

The purpose of this document is to describe how to perform the USB Certification Test on the i.MX 6 series family of application processors. This document contains the description of procedures, tools, and criteria for the USB Compliance Test.

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2. Preparing for the test

This chapter lists all required materials for running the compliance test, including equipment, documents, software and other necessary materials.

2.1. Test boards

Tests were performed on the following boards:

- MCIMX6SXSDDB
- MCIMX6SLEVK
- MCIMX6QAICPU1
- MCIMX6DLAICPU1
- MCIMX6ULEVK

2.2. Test environment

- DUT OS: Linux 3.10.31_1.1.0_GA
- Test bed computer OS: WIN7

2.3. Test equipment

The following tables list the test equipment and the tests for which they are required.

Keysight (Agilent) USB electrical test equipment was used in testing, however you may use equipment from other vendors instead, such as Tektronix and Lecroy.

Table 1. Digital oscilloscope, software, and accessories

Test equipment			Tests		
Part Number	Description	Manufacturer	Embedded Host high-speed	Device high-speed	Low/full-speed
N5416A	USB 2.0 automated software	Keysight (Agilent)	1	1	1
DSO9254A	Digital real-time oscilloscope	Keysight (Agilent)	1	1	1
1169A	Differential probe amplifier	Keysight (Agilent)	1	1	—
N5381A	Differential solder in probe head	Keysight (Agilent)	1	1	—
E2697A	Single-ended probe	Keysight (Agilent)	—	—	3
N2774A	Current probe	Keysight (Agilent)	—	—	1
HSEHET Board	High-speed Embedded Host electrical test board	Allion	1	—	—
Packet-Master USB-PET	USB protocol and electrical tester	MQP	1	—	—
33401A	Digital multimeter	Keysight(Agilent)	1	1	1

Test equipment			Tests		
Part Number	Description	Manufacturer	Embedded Host high-speed	Device high-speed	Low/full-speed
P40A-1P2J	DC5V Power Supply	SunPower	1	1	1

Table 2. Test fixtures for the USB electrical test

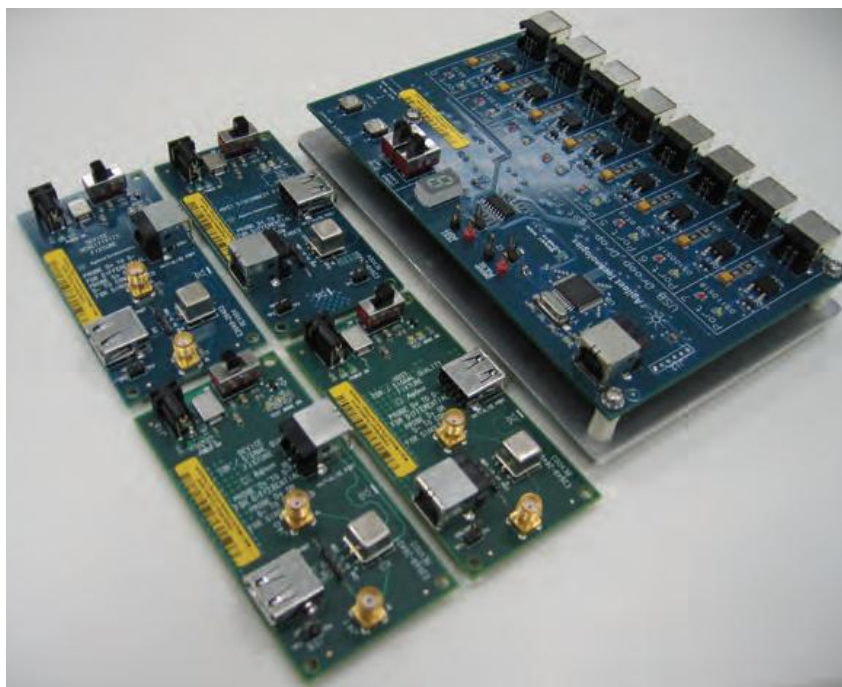
Test fixture			Tests		
Part number	Description	Manufacturer	Embedded Host high-speed	Device high-speed	Low/full-Speed
E2649-66401	Device high-speed signal quality test fixture	Keysight (Agilent)	—	1	—
E2649-66402	Host high speed signal quality test fixture	Keysight (Agilent)	1	—	—
E2649-66405	USB 2.0/3.0 Droop/Drop test fixture	Keysight (Agilent)	—	—	1
E2646A/B	USB inrush (SQiDD) test fixture	Keysight (Agilent)	—	—	1
E2649-66403	Receiver sensitivity test fixture	Keysight (Agilent)	1	—	—

Table 3. Test fixtures for the USB electrical test

Required equipment			Tests		
Part Number	Description	Manufacturer	Embedded Host high-speed	Device high-speed	Low/full-speed
81130A	Pulse/pattern generator	Keysight (Agilent)	—	—	—
82357A	USB/GPIB interface	Keysight (Agilent)	—	1	—
8493C	6 dB attenuators	Keysight (Agilent)	—	1	—
8120-4948 or equivalent	50 ohm coaxial cable with male SMA connectors at both ends	Keysight (Agilent)	—	2	—

Table 4. Miscellaneous cables and devices

Required equipment	Tests		
Description	Embedded Host high-speed	Device high-speed	Low/full-speed
5 meter USB cable (any listed on USB-IF web site)	1	1	6
1.5 meter USB cable (any listed on USB-IF web site)	1	—	—
1 meter USB cable (any listed on USB-IF web site)	—	—	1
4 inch USB cable (any listed on USB-IF web site)	1	1	1
High-speed USB hub (any listed on USB-IF web site)	4	—	4
Full-speed USB hub (any listed on USB-IF web site)	1	—	1
High-speed USB device (any listed on USB-IF web site)	1	1	—
Full-speed USB device (any listed on USB-IF web site)	—	—	1
Low-speed USB device (any listed on USB-IF web site)	—	—	1

**Figure 1. E2649 high-speed test fixture set**

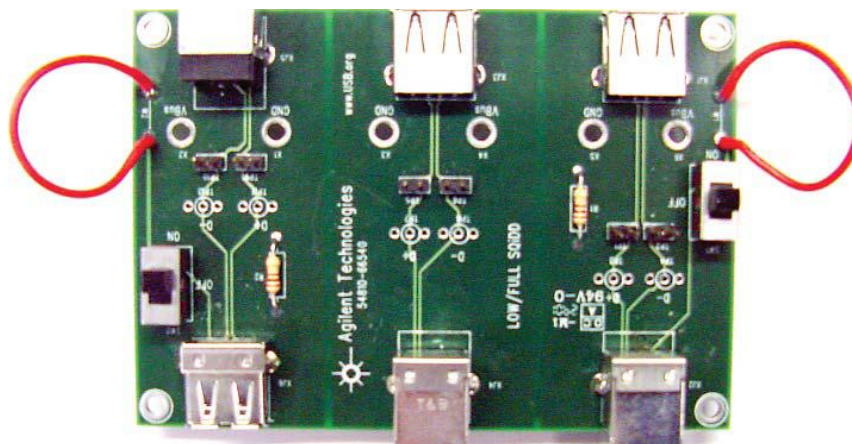


Figure 2. E2646A/B SQiDD test fixture

2.4. Test software

The following table shows the software used for the USB Certification Test.

Table 5. Test software used for USB Certification Test

Name	Version	Description
USBET20	1.20	USB electrical analysis tool
USBHSET	1.2.2.1	Windows-based utility tool used to initiate test modes
USB20CV	1.4.11.0	USB 2.0 command verifier for USB 2.0 device framework testing
USB30CV	1.1.2.0	USB 3.0 command verifier for USB 3.0 device framework testing
GraphicUSB	4.47	Test software for PET test

2.5. USB-IF required tests

Devices that support the features of USB OTG & EH V2.0 will undergo additional testing beyond the tests described in this document. This additional testing is a subset of existing tests for USB peripherals and USB host controllers.

[Table 6](#) describes which tests are required for full USB-IF certification by an EH with a Standard-A or Micro-AB¹ connector.

[Table 7](#) describes which tests are required for full USB-IF certification by a device with a Micro-B connector.

The following symbols are used in these tables:

A – Always required

* Required if feature is supported

** Required if there are multiple downstream ports

¹ USB-IF allows Embedded Host to use the Micro-AB receptacle in 2012.

Table 6. Embedded Host test requirements for a Standard-A connector

USB-IF test ► USB speed ▼	Automated Test Ch6	Manual Test Ch7	Drop/Droop	DS LS SQT	DS FS SQT	DS HS Electrical
High-speed Host	A	A	A/**	*	*	A
Full-speed Host	*	A	A/**	*	*	—
Low-speed Host	*	A	A/**	A	—	—

Table 7. Device test requirements for a Micro-B connector

USB-IF test ► USB speed ▼	IOP Goldtree	Avg Current	Automated Test Ch6 ¹	Manual Test Ch7	USBCV	Back-Voltage	Inrush Current	US LS SQT	US FS SQT	US HS Electrical
Full-speed device	A	A	*	A	A	A	A	*	*	—
High-speed device	A	A	*	A	A	A	A	*	*	A

¹ For the peripheral, if the silicon is only compliant with the general USB 2.0 specification, it is recognized as a standard USB2.0 peripheral. The automated test Ch6 must not be launched. If the silicon is compliant to the supplement of OTG and EH rev. 2.0 (with OTG descriptor in the declaration), the device is recognized as a B-peripheral, and the automated test channel 6 must be launched.

2.6. Compliance checklist and TPL

Before sending the product and accessories to the certification lab, several checklists and TPLs must be prepared. These documents include VID/PID (vendor/product information)¹, features, and accessories your product supports. To get more information about these documents contact your certification lab. The document templates can be downloaded from the USB-IF website:

http://www.usb.org/developers/compliance/check_list/

Checklist:

- Compliance checklist for USB On-The-Go and Embedded Host Supplement revision 2.0
- USB Compliance Checklist Peripheral Silicon (excluding hub silicon)
- USB Compliance Checklist Peripherals (excluding hubs)
- USB Compliance Checklist Systems

Target Peripheral List:

- TPL Form for USB On-The-Go and Embedded Host Supplement revision 2.0
- TPL Hub Form for USB On-The-Go and Embedded Host Supplement revision 2.0

2.7. Register the product in USB-IF

After you get the test reports from your certification lab, you need to submit your product to USB-IF for registration to get the TID.

1. Check that your company is a member of USB-IF, register, and login to your account at https://www.usb.org/members_landing.
2. Click on My Account and then click on Add a Product to enter the Product Register page, select a product type for your product, as shown in the following figure. If you do not know what product type you should choose, consult your test lab.

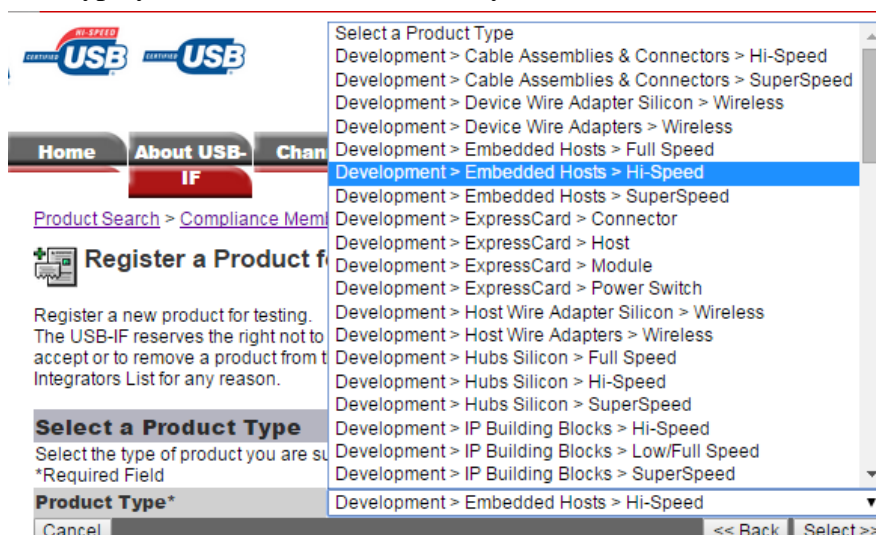


Figure 3. USB product type

¹ Use the VID of your company registered on USB-IF and not the VID of your USB silicon provider. The VID of the Freescale product on USB-IF is 15A2 in hex or 5538 in decimal. You can download the whole [Company List](http://www.usb.org/developers/tools/comp_dump) from the following website: http://www.usb.org/developers/tools/comp_dump.

3. Select the Test Lab, for example Allion Labs, Inc.
4. Fill in the detailed information for your product, including the marketing name¹, the revision, checklists², the product category, and the contact window.
5. Wait for USB-IF to approve your product.

2.8. Compliance test reference documents

To get to know the whole environment settings and detailed test steps of the USB Compliance Test, see the following documents:

- *Universal Serial Bus Implementers Forum Full and Low Speed Electrical and Interoperability Compliance Test Procedure* (USB-IF)
http://www.usb.org/developers/compliance/electrical_tests/USB-IFTestProc1_3.pdf
- *USB On-The-Go and Embedded Host Automated Compliance Plan for the On-The-Go& Embedded Host Supplement* (USB-IF)
http://www.usb.org/developers/onthego/otgeh_compliance_plan_1_2.pdf
- *On-The-Go and Embedded Host Supplement to the USB, Revision 2.0, Specification Revision 2.0* (USB-IF) http://www.usb.org/developers/docs/usb20_docs/usb_20_0702115.zip
- *USB-IF USB 2.0 Certification Mandatory Test Matrix*, (USB-IF)
<http://compliance.usb.org/resources/usb2.0complianceprogram.pdf>
- *Universal Serial Bus Specification* (USB-IF)
http://www.usb.org/developers/docs/usb20_docs/usb_20_0702115.zip
- *USB-IF USB 2.0 Electrical Test Specification*, (USB-IF)
http://www.usb.org/developers/compliance/USB-IF_USB_2_0_Electrical_Test_Spec081005.pdf
- *Embedded Host High Speed Electrical Test Procedure* (USB-IF)
http://www.usb.org/developers/onthego/PIDVID_USB_2_0_High_Speed_Electrical_Embedded_Host_and_OTG_MOI_1_0.pdf
- *Universal Serial Bus Implementers Forum Device Hi-Speed Electrical Test Procedure For Agilent Infiniium* (USB-IF)
http://www.usb.org/developers/compliance/Device_HS_Test_for_Agilent.pdf
- *Universal Serial Bus Implementers Forum Host Hi-Speed Electrical Test Procedure For Agilent Infiniium* (USB-IF)
http://www.usb.org/developers/compliance/electrical_tests/Host_HS_Test_for_Agilent.pdf
- *Agilent N5416A USB 2.0 Compliance Test Option* (Agilent)
http://www.keysight.com/upload/cmc_upload/All/N5416A_USB2_Compliance_App_Testing_Notes.pdf
- *Gold Suite Summary Test Procedure V1.35 Draft* (USB-IF)
<http://compliance.usb.org/resources/GoldSuiteTestProcedure.pdf>

¹ Make sure the marketing name is the same as the product name in checklists.

² Save the checklists and TPLs in a zip file.

- *Allion HSEHET User Manual* (Allion)
<http://www.allion.com/TestTool/Allion-HSEHET-User-Manual.pdf>
- *Universal Serial Bus Rev. 2.0 USB Command Verifier Compliance Test Specification* (USB-IF)
http://www.usb.org/developers/tools/usb20_tools/#usb20cv
- *Universal Serial Bus Rev. 3.1 USB Command Verifier Compliance Test Specification* (USB-IF)
http://www.usb.org/developers/tools/USB30CVSpec_1_4.pdf
- *Universal Serial Bus Mass Storage Class Compliance Test Specification* (USB-IF)
http://www.usb.org/developers/docs/devclass_docs/Mass_Storage_Specification_Overview_v1.4_2-19-2010.pdf
- *i.MX 6Dual/6Quad Applications Processor Reference Manual* ([IMX6DQRM](#))
- *i.MX 6Solo/6DualLite Applications Processor Reference Manual* ([IMX6SDLRM](#))
- *i.MX 6SoloLite Applications Processor Reference Manual* ([IMX6SLRM](#))
- *i.MX 6SoloX Applications Processor Reference Manual* ([IMX6SXRm](#))
- *Configuring USB on i.MX 6 Series* ([AN4589](#))

3. Electrical test procedure and software configuration

3.1. Software configuration for electrical test

Compared to a standard Linux/Android release, you may need to perform the software changes below to implement the certification tests, it is applicable from the imx_3.10.31_1.1.0 Linux BSP GA release. For the release previous to that, you may need to apply the related patches, and some examples may be different for former releases, the user needs to change accordingly. See the detailed information in this document: *How to do USB Compliance Test for 3.10.y kernel*, on the Freescale website: <https://community.freescale.com/docs/DOC-105609>.

3.2. Legacy USB compliance tests

- Upstream Full-Speed Signal Quality Test
- Back-Voltage Test
- Device Inrush Current Test
- Downstream Full-Speed Signal Quality Test
- Downstream Low-Speed Signal Quality Test
- Host Drop Test

3.2.1. Upstream Full Speed Signal Quality Test ¹

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 4](#). Make sure you set the test type configuration option to Full-Speed Far End² before running the test. Connect the equipment and test fixture as shown in [Figure 5](#).
2. Select the HS electrical test tool software on the computer. Select the **Device** and click on the **Test** button to enter the Device Test menu. See [Figure 7](#).
3. On the Device Test Menu of the HS Electrical Test Tool software, click on **Enumerate Bus** once. All devices attached to the host controller should appear in the device enumeration list.
4. Highlight the device under test and select the **Loop Device Descriptor** from the Device Command drop down menu. Click on **Execute** once. The VID of the Freescale product in USB-IF is 15A2 in hex or 5538 in decimal.

¹ i.MX 6 series processors are enumerated as a MSC device, low-speed upstream is not supported. Measure the upstream full speed EYE without the 5 tier of hubs as this has no effect on the signal integrity

² High-speed electrical tests are performed either near-end or far-end depending on the configuration of the product. The terms near-end and far-end are based on which end of the cable the test fixture is attached in relation to the device being tested. All HS peripherals with a B-receptacle are tested near-end (at the peripheral's receptacle). HS devices that have a captive cable are tested far-end (at the end of the captive cable). Full-speed electrical tests are always performed far-end, the length of the cable used in HS electrical tests is not important.
High-speed electrical tests of downstream ports on hosts and hubs are always performed near-end. For detailed explanation of far-end and near-end in USB-IF compliance updates see: <http://compliance.usb.org/index.asp?UpdateFile=Electrical#8>.

- Click on **Run Tests** in the USB Automated Test software on the oscilloscope. After the test is finished you can view the report on the **Html Report** page.

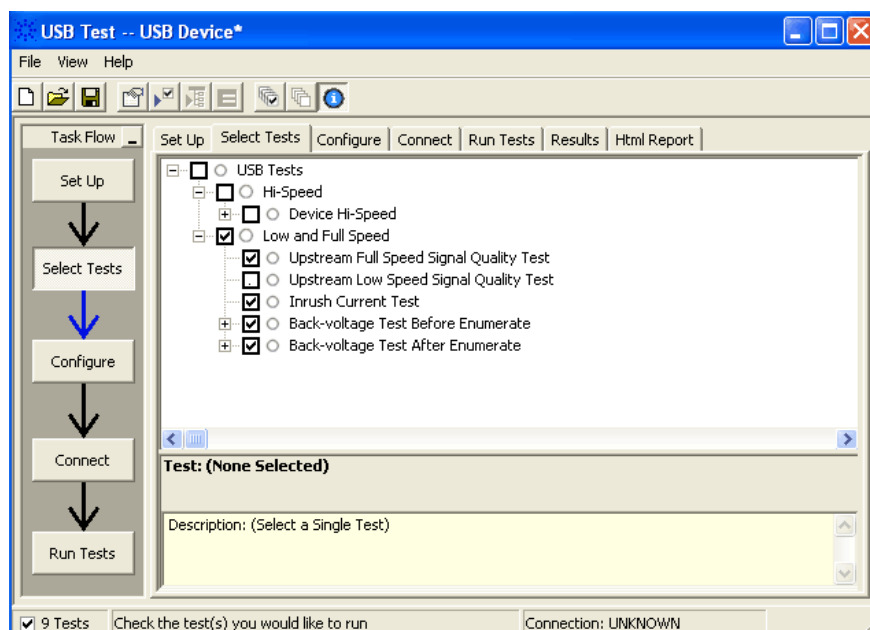


Figure 4. Automated Test software setting for the Upstream FS Signal Test

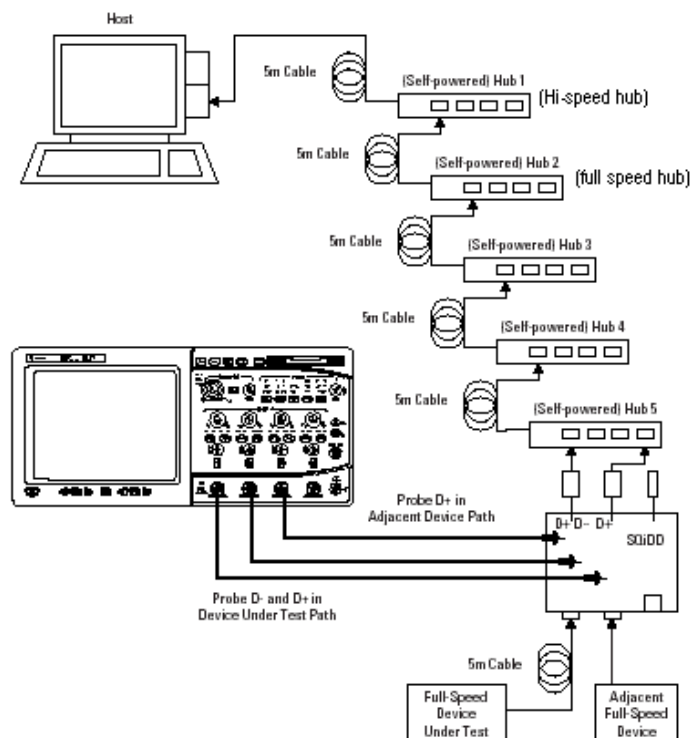


Figure 5. Upstream FS Signal Test environment¹

¹ A full-speed hub here can force the downstream devices to operate in full-speed mode.

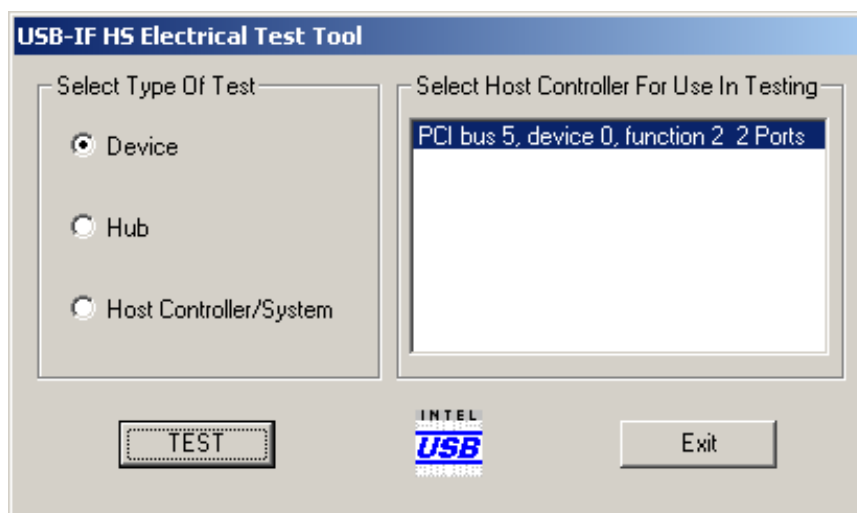


Figure 6. Electrical Test Tool main menu

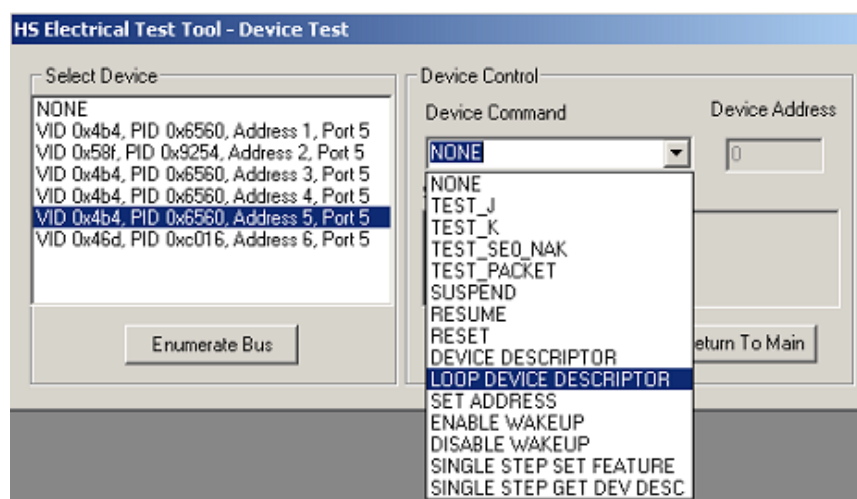


Figure 7. Device Control Command

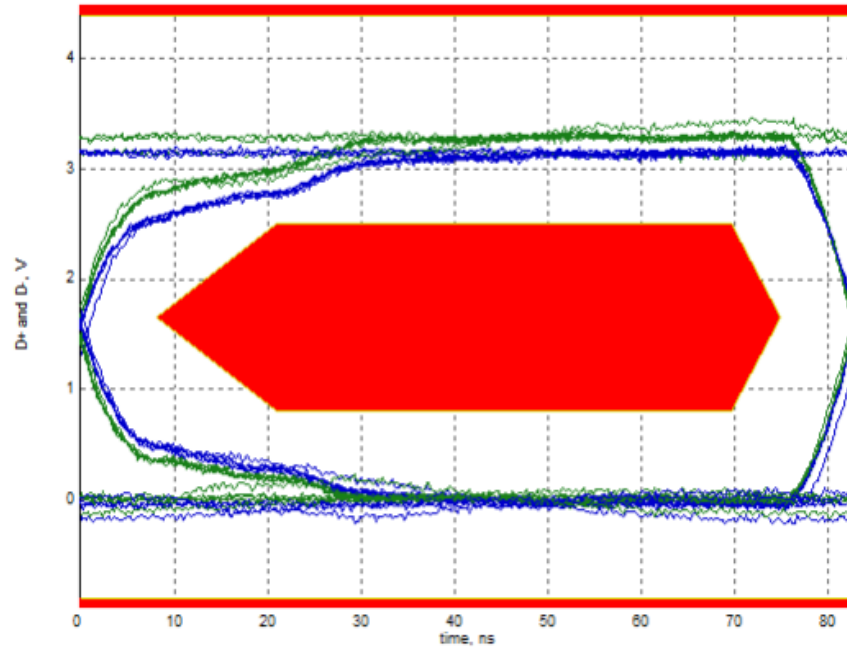


Figure 8. Upstream full-speed eye diagram

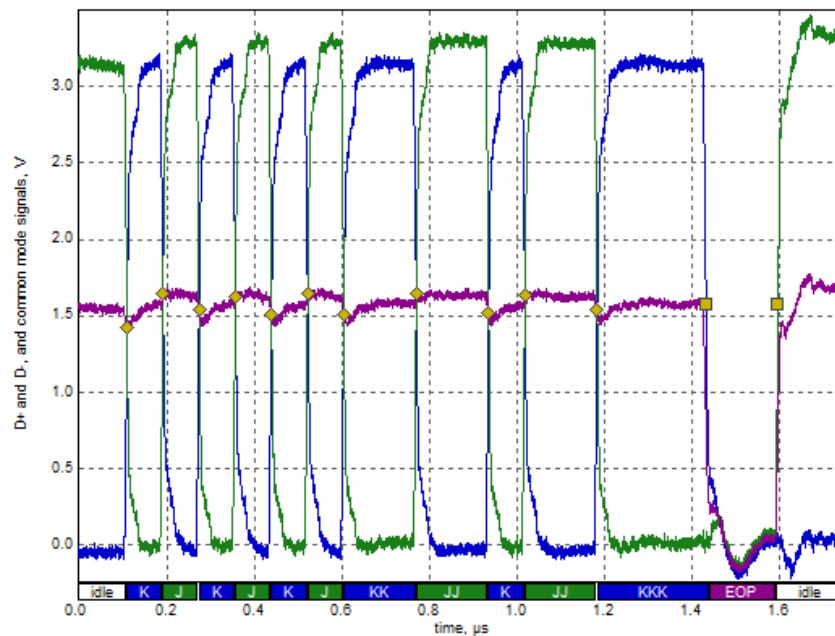


Figure 9. Upstream full-speed waveform

3.2.2. Back-Voltage Test

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 10](#).
2. Connect the power supply to the DUT and connect the device upstream port to the back-voltage test fixture using a known good USB cable as shown in [Figure 11](#). Measure and record DC voltages on **VBUS**, **D+** and **D-**. Voltages should all be less than or equal to 400 mV. Any voltages greater than 400 mV will be recorded as a failure.
3. Plug the DUT into a known good host, and verify proper enumeration. Unplug the USB cable from the host and reconnect the USB cable to the back-voltage test fixture. Measure and record the DC voltages of **VBUS**, **D+** and **D-**. All voltages must be less than or equal to 400 mV. Any voltages greater than 400 mV will be recorded as a failure.
4. After the test is finished, you can view the report on the **Html Report** page.

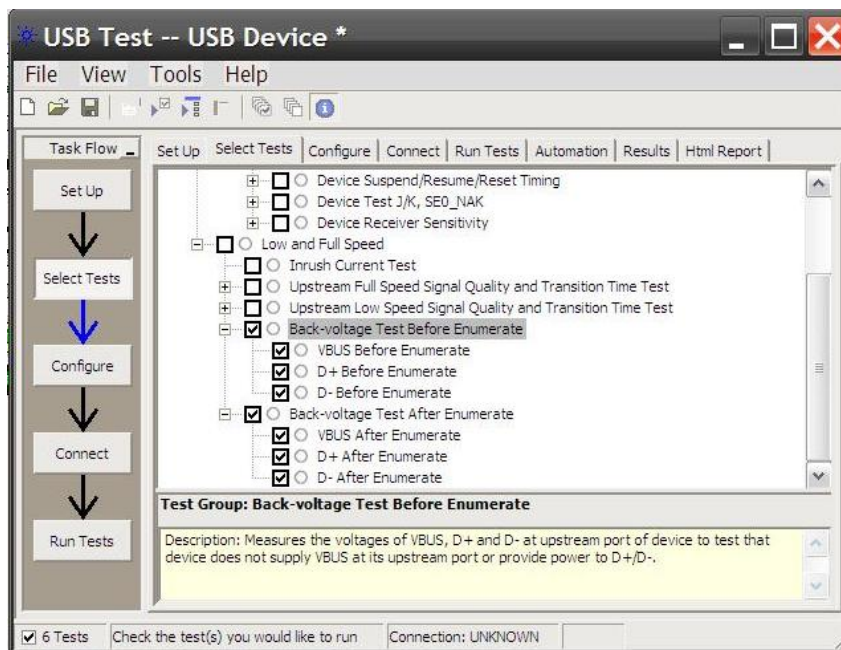


Figure 10. Automated Test software setting for the Back-Voltage Test

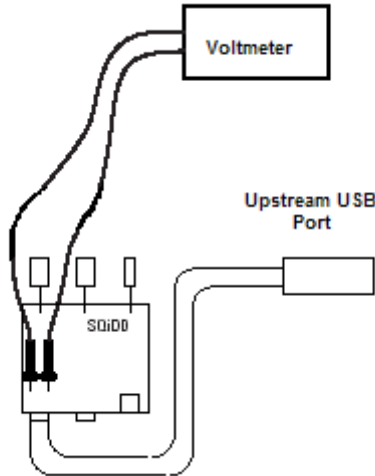


Figure 11. Back-Voltage Test environment

Table 8. Back-Voltage Test record

Test point	DC voltage before enumeration (mV)	DC voltage after enumeration (mV)	Expected value (VDC)
VBUS	72	72	≤ 400 mV
D+	0	0	≤ 400 mV
D-	0	0	≤ 400 mV

3.2.3. Device Inrush Current Test

The USB 2.0 specification enables a maximum capacity of 10 μ F and therefore a maximum inrush of 50 μ C. Note that it is required to have at least 1 μ F of capacity in order to make ADP detection possible. The DUT cannot consume more than 100 mA during the 100 ms starting up period. Inrush current should be measured for a minimum of 100 ms after attachment.

Test instructions:

1. Connect the equipment and test fixture as shown in [Figure 12](#). Use the current probe to capture the **VBUS** current waveform. Ensure the probe direction is the same. When taking the measurement, first calibrate the current probe to 0 mA. A current probe will produce a DC offset that will result in an incorrect measurement if not performed beforehand.
2. Attach the DUT to the SQiDD board, then set the switch on the SQiDD board to the discharge position (opposite the on position).
3. Disconnect the DUT from the SQiDD board, then set the switch on the SQiDD board to the on position.
4. Adjust the oscilloscope settings to match the current test requirement: time base 50 ms/div, Vertical resolution 500 mA/div, sample rate >1 MS/s.
5. Re-connect the DUT to the SQiDD board in order to capture the inrush current waveform, then save the waveform as a *.wfm or *.csv.

- Use the analysis software USBET20 on your computer to analyze the waveform file, then a page will show the test result as shown in [Figure 14](#). Inrush failures mostly occur when **VBUS** and **GND** have too large a capacity between them.

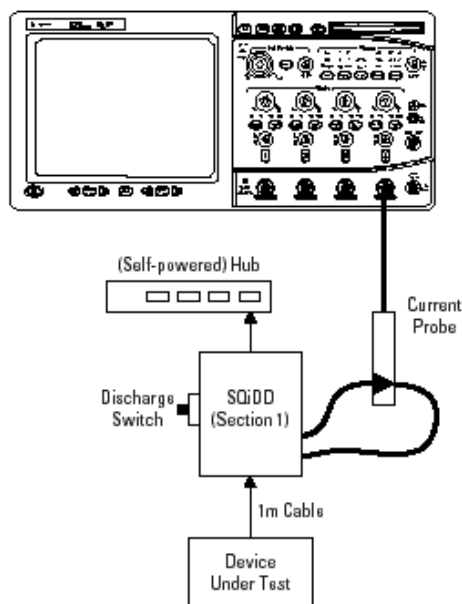


Figure 12. Device Inrush Current Test environment

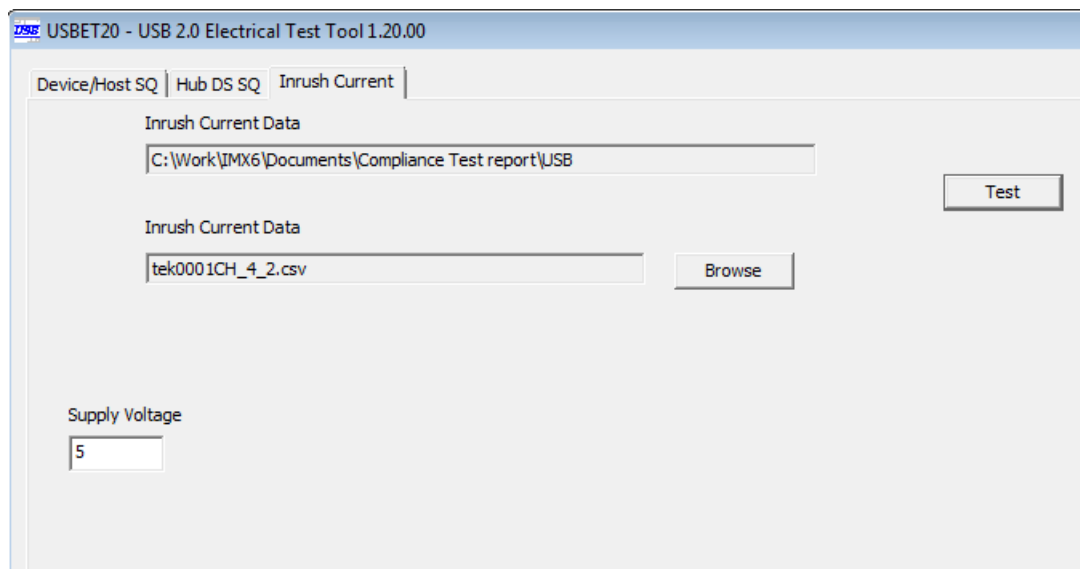


Figure 13. USBET20 operation interface

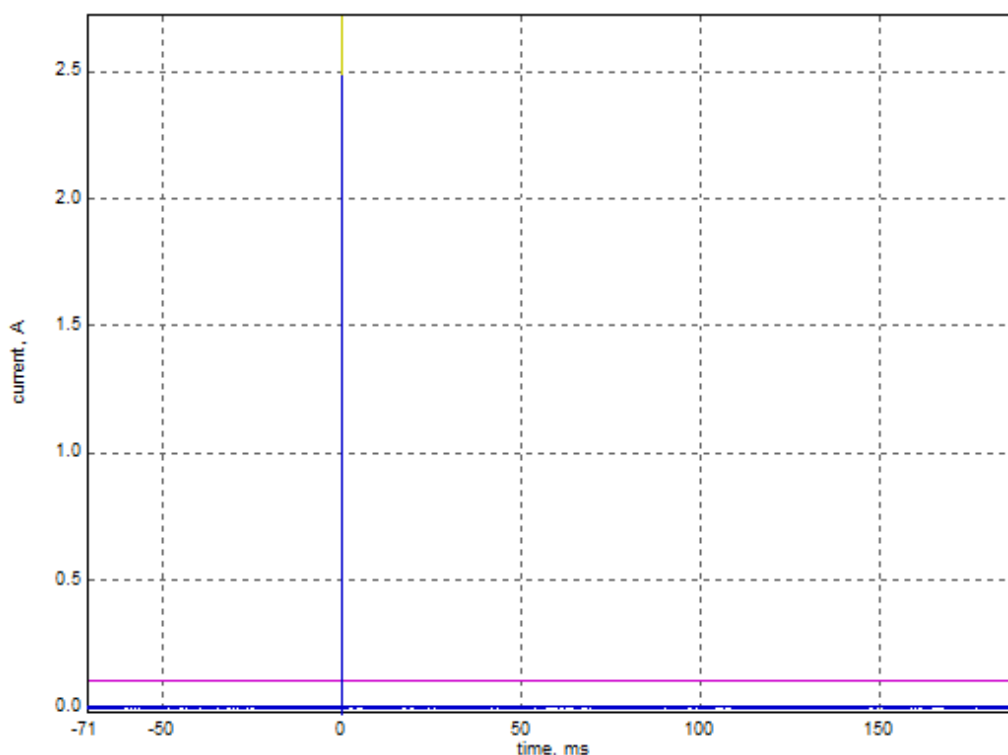


Figure 14. Device Inrush Current Test result

3.2.4. Downstream Full-Speed Signal Quality Test

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 15](#). Make sure you set the test type configuration option to Full-Speed Far End before running the test.
2. Connect the equipment and test fixture as shown in [Figure 16](#).
3. Click on **Run Tests**. After the test is finished you can view the complete report on the **Html Report** page.

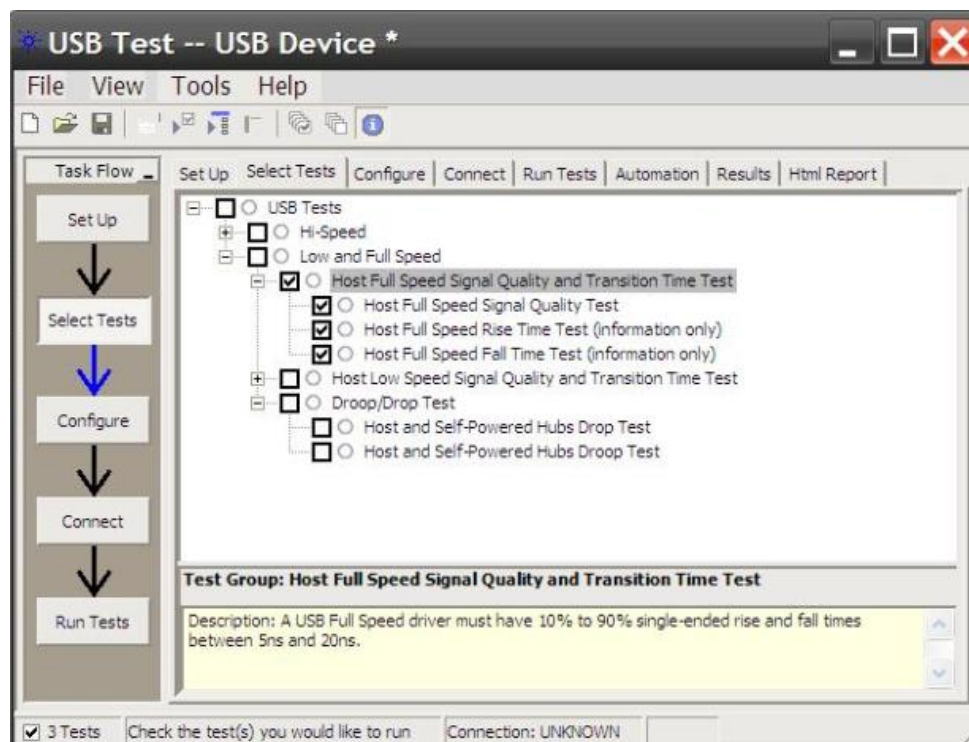


Figure 15. Automated Test software setting for the Downstream FS Signal Test

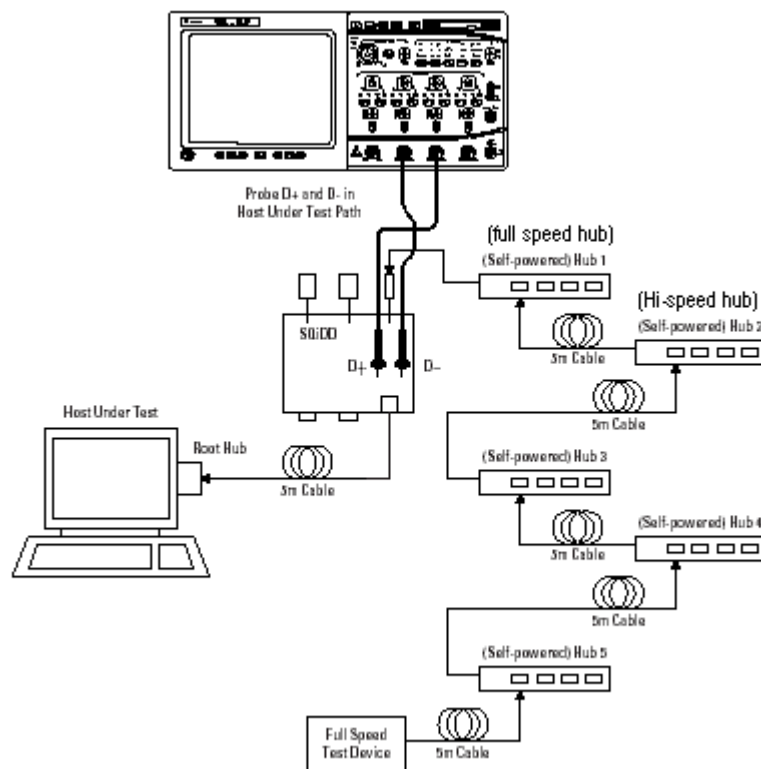


Figure 16. Downstream FS Signal Test environment

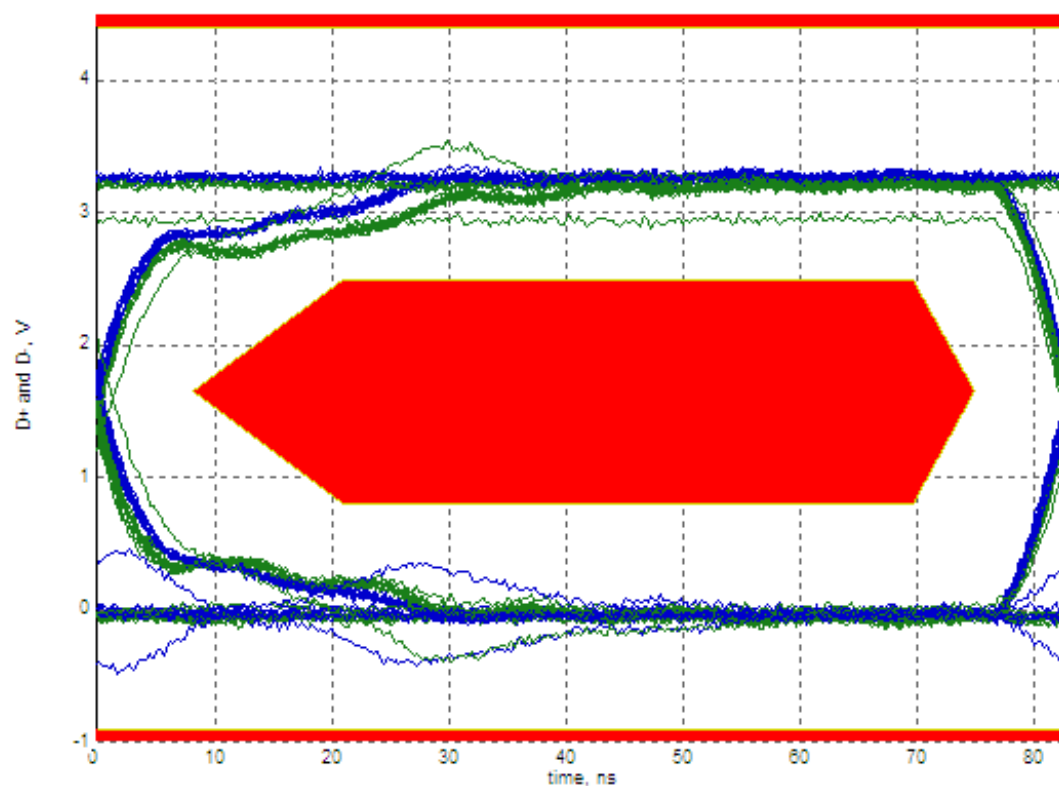


Figure 17. Downstream full-speed eye diagram

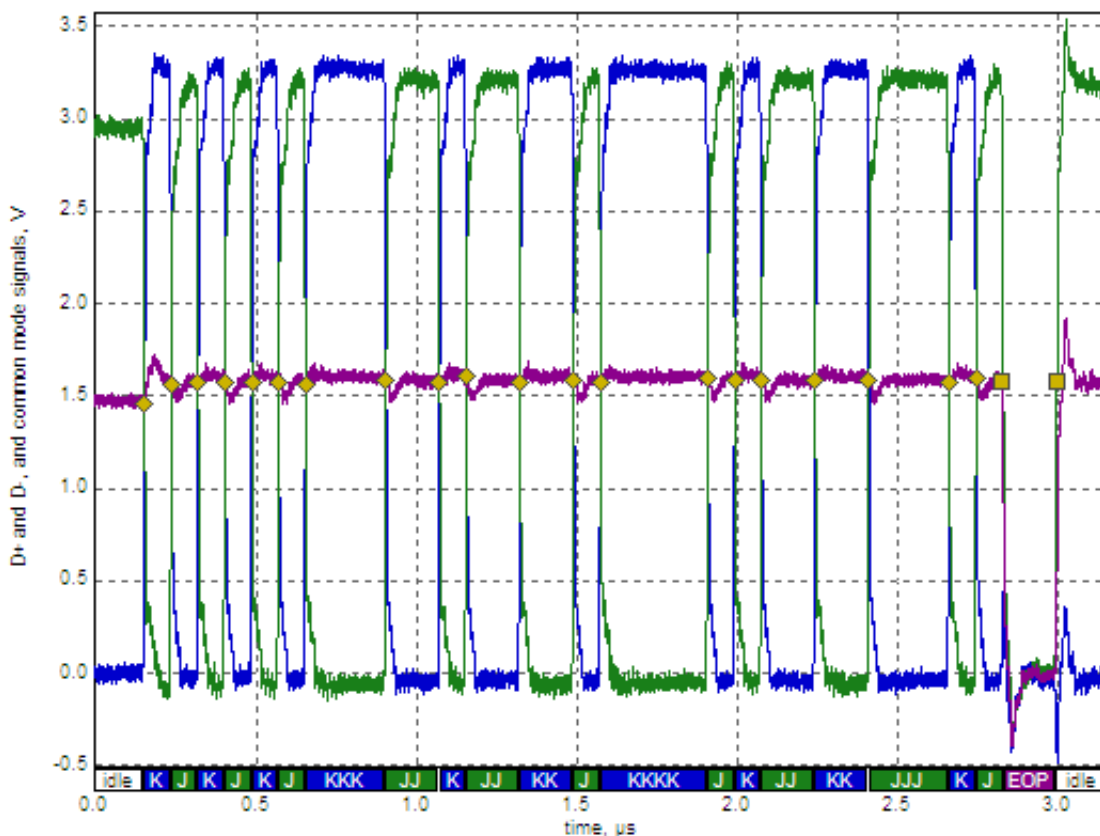


Figure 18. Downstream full-speed waveform

3.2.5. Downstream Low-Speed Signal Quality Test

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 19](#). Ensure that you set the Test Type configuration option to Low-Speed Near End before running the test.
2. Connect the equipment and test fixture as shown in [Figure 1](#).
3. Click on **Run Tests**. After the test is finished you can view the report on the **Html Report** page.

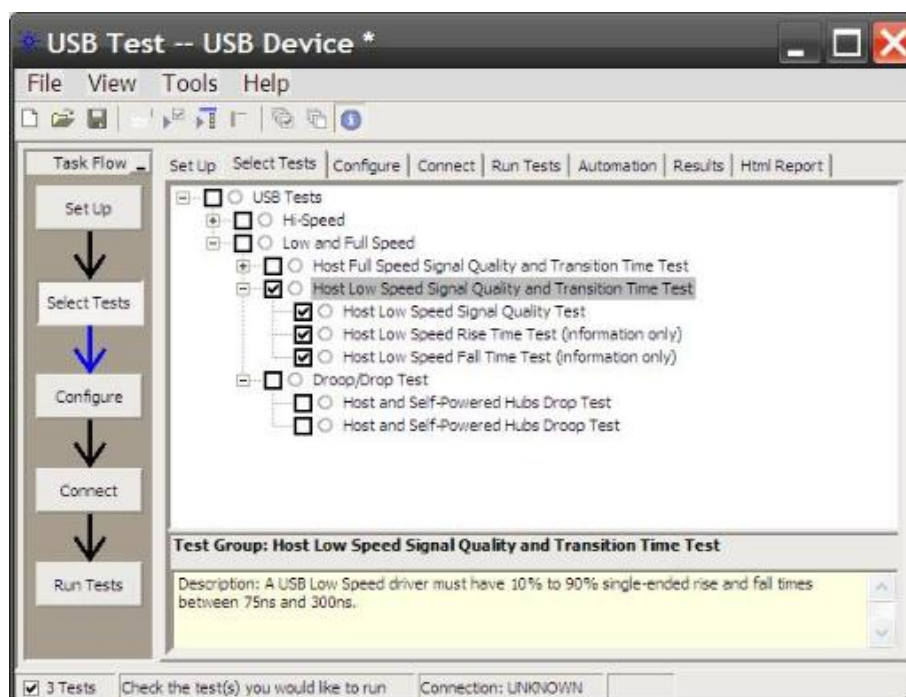


Figure 19. Automated Test software setting for the Downstream LS Signal Test

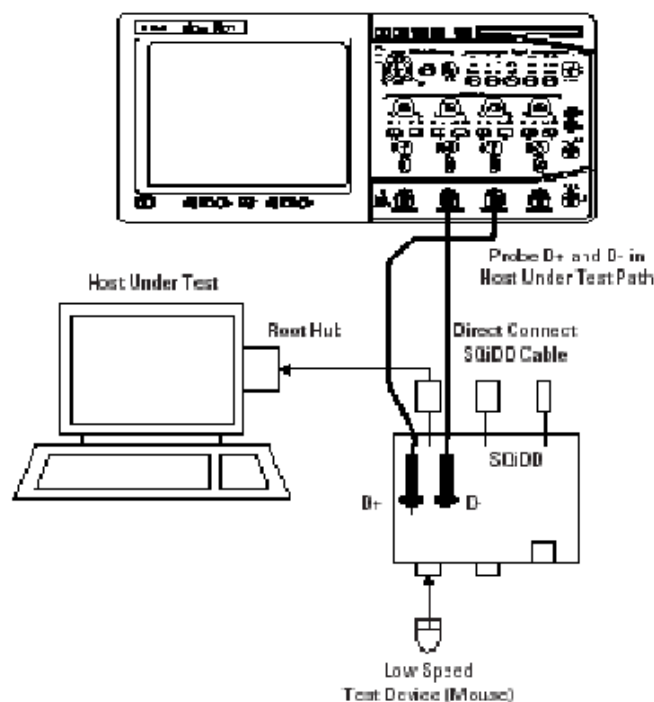


Figure 20. Downstream LS Signal Test environment

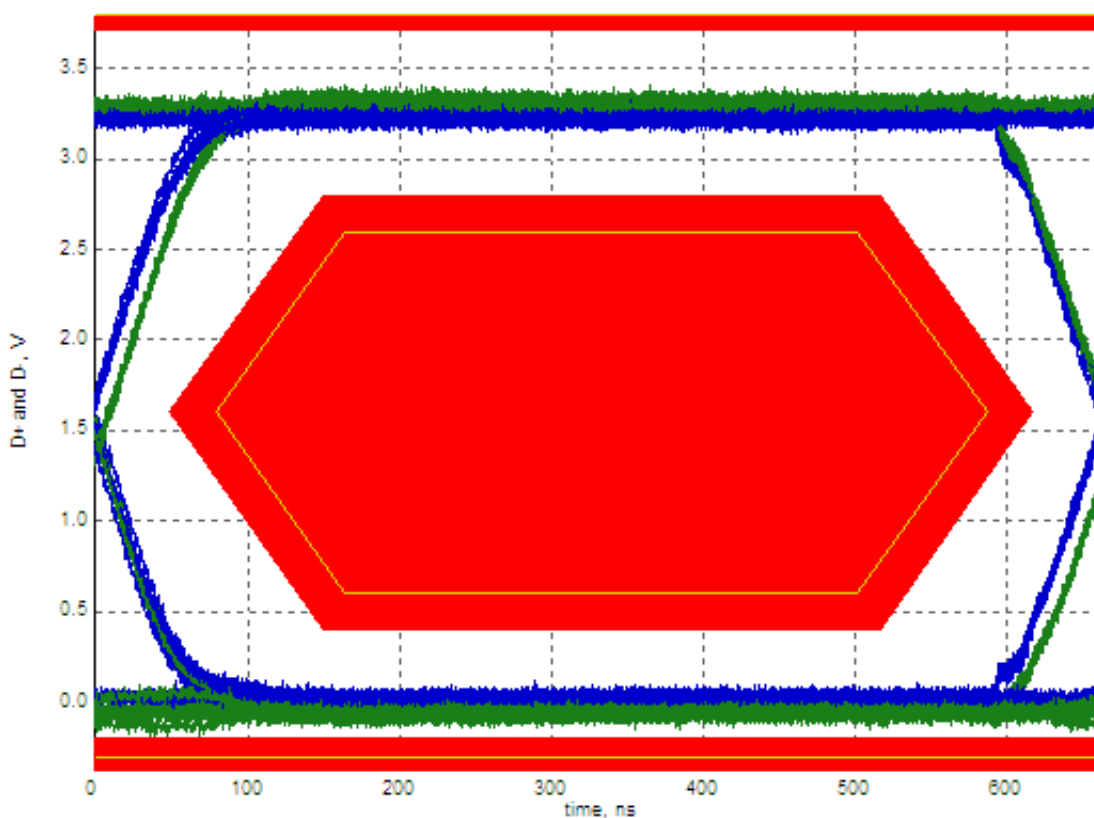


Figure 21. Downstream low-speed eye diagram

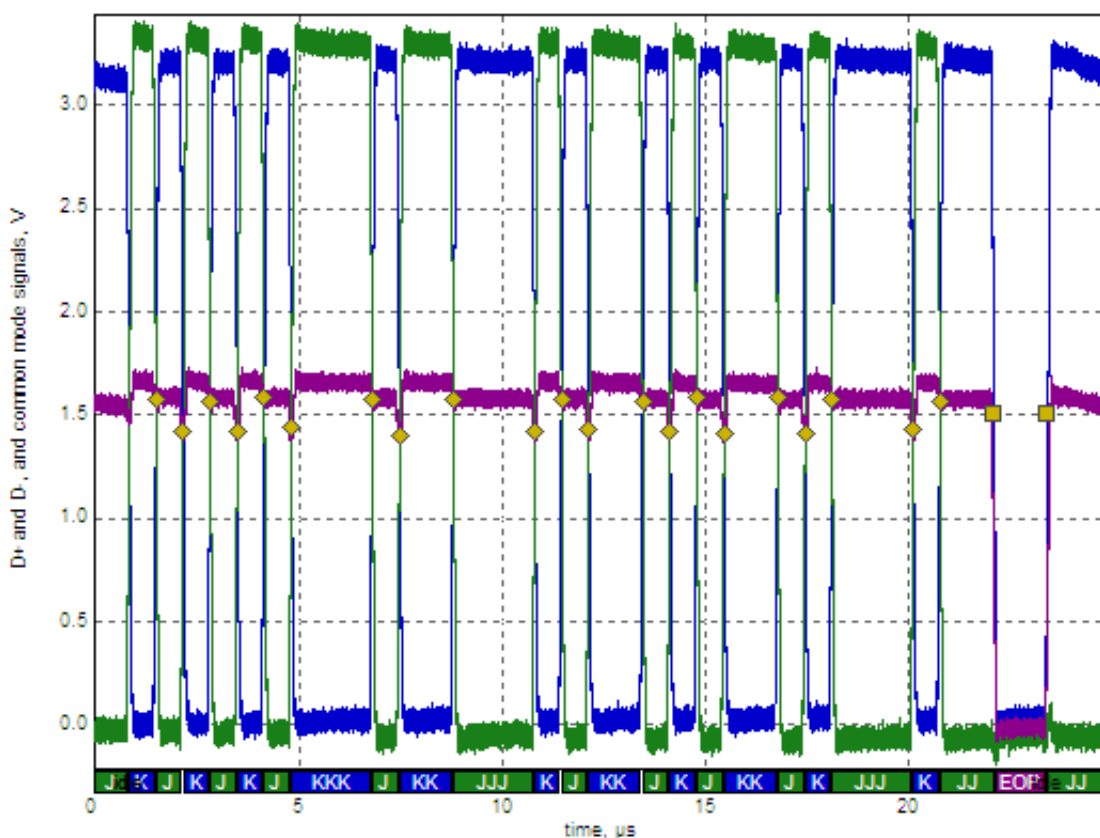


Figure 22. Downstream low-speed waveform

3.2.6. Host Drop and Droop tests

The Drop test is a measure of a host/hub's ability to host full load current while keeping the output voltage above specification. To perform this test, **VBUS** is measured with all downstream ports loaded with 500 mA loads (for host and self-powered hubs). The lowest value measured across all ports must be between 4.75 V and 5.5 V¹ for host and self-powered hubs.

The Droop test is a transient test on adjacent ports. When a device is hot plugged into another port, the droop in VBUS supplied to a port must be less than or equal to 330 mV for host, self-powered, and bus powered hubs. This test is not needed there is only one host port on board.

Test instructions:

1. First, power the test fixture from your computer or a USB charger. The DS1 LED must illuminate (green LED).
2. There are several switches/buttons used for general control of the test fixture. These include:
 - Switch S5 enables you to select either the Droop or Drop test

¹ USB-IF has published an ECN to increase the maximum voltage on VBUS from 5.25 V to 5.5 V in August 2014. The maximum voltage is now 5.5 V.

- Switch S4 enables you to select either the 100 mA or 500 mA load
 - Press and hold S1 for at least three seconds to turn the test fixture on
 - While pressing and holding S2, press S1 to turn the test fixture off
 - When the fixture is on, pressing S2 will enable the left port
 - When the fixture is on, pressing S1 will enable the right port
3. Measure **VBUS** at the downstream USB connector with no cable or device inserted (no load), then record it as V_{NL} .
 4. Measure **VBUS** at the downstream USB connector with 500 mA load, then record it as V_{LOADED} .

Table 9. Host Drop Test Record

Item	Port01_Voltage	Expected value (VDC)
Vnon-load	5.19 V	4.75 V <= VBUS <= 5.5 V
VLoad	5.083 V	4.75 V <= VBUS <= 5.5 V
Vdrop	107 m V	≤ 750m V
Vdroop	—	≤ 330m V

NOTE

Keep the following items in mind while performing the drop test:

When taking the measurement take the cable resistance/voltage drop into account as it can be significant when operating with high currents. For example if you have 0.25 ohm resistance for cable and connectors and a current of 500 mA you will have a voltage drop of 0.125 V. The measurement must be performed as near to the A-Receptacle as possible and if accessible you can measure at the A-receptacle **VBUS/GND** soldering pad. The USB specifications define that the measurements should be taken at the A-receptacle however as the A-receptacle is often difficult to access you may use a fixture and a cable in between. Note that these will give some additional voltage drop. Re-test the **VBUS** drop when changing the power supply during testing.

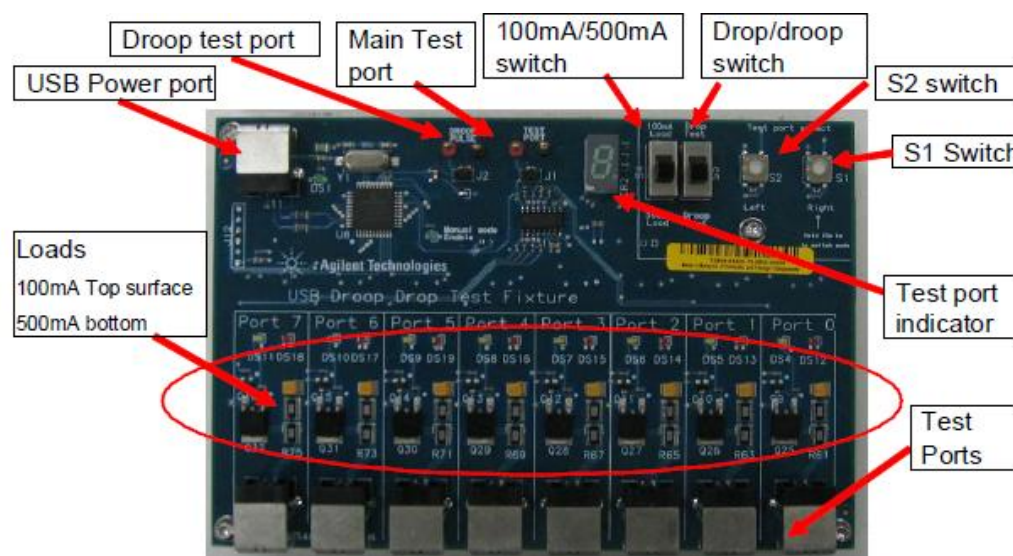


Figure 23. Host Drop/Droop Test fixture

3.3. Device High-Speed Signal Test¹

To perform the high-speed device test you must install the HS Electrical Test Tool software on your computer, which can set the DUT to specific test patterns. To study the detailed description of the test items in the Data Rate Test, see this document [USB-IF USB 2.0 Electrical Test Specification](#). The Device Receiver Sensitivity Test requires additional equipment, a digital signal generator (for example Agilent 81130A) and related accessories.

- Device High-Speed Signal Quality Test
 - **EL_2:** Data Rate Test²
 - **EL_4, EL_5:** Eye Pattern Test
 - **EL_6:** Rise and Fall Time Test
 - **EL_7:** Non-Monotonic Edge Test
- Device Packet Parameters Test
 - **EL_21:** Sync Field Length Test
 - **EL_25:** EOP Length Test
 - **EL_22:** Measure Inter-packet Gap Between First and Second Packets
 - **EL_22:** Measure Inter-packet Gap Between Second and Third Packets
- Device CHIRP Timing Test
 - **EL_28:** Measure Device CHIRP-K Latency
 - **EL_29:** Measure Device CHIRP-K Duration
 - **EL_31:** Device Hi-Speed Terminations Enable and D+ Disconnect Time

¹ For High Speed Device Test, need to install HS Electrical Test Tool software on Computer, which can set DUT into specific test pattern.

² To study the detailed description of the test items, see this document [USB-IF USB 2.0 Electrical Test Specification](#).

- Device Suspend/Reset/Resume Timing Test
 - **EL_38, EL_39:** Device Suspend Timing Response
 - **EL_40:** Device Resume Timing Response
 - **EL_27:** Device CHIRP Response to Reset from Hi-Speed Operation
 - **EL_28:** Device CHIRP Response to Reset from Suspend
- Device Test J/K, SE0_NAK Test
 - **EL_8:** Device J Test
 - **EL_8:** Device K Test
 - **EL_9:** Device SE0_NAK Test
- Device Receiver Sensitivity Test¹
 - **EL_18:** Minimum SYNC Field
 - **EL_17:** Receiver Sensitivity Test
 - **EL_16:** Squelch

¹ The Device Receiver Sensitivity Test requires additional equipment: digital signal generator (for example the Agilent 81130A) and related accessories.

3.3.1.HS Device Electrical Test limits

The following table shows the Electrical Test limits for the HS device.

Table 10. HS Device Electrical Test limits

Test name	Pass limits
EL_2 Data Rate	Within 480 Mb/s +/-0.05%
EL_4 Eye Pattern (without captive cable)	Must meet template 1 transform waveform requirements at TP3
EL_5 Eye Pattern ¹ (with captive cable)	Must meet template 2 transform waveform requirements at TP2
EL_6 Device Rise/Fall Time	>500 ps
EL_7 Device Non-Monotonic Edge Test	Must have monotonic data transitions over the vertical openings
EL_21 Device Sync Field Length Test	32 bits, 65.62 ns <= VALUE <= 67.700 ns
EL_25 Device EOP Length Test	8 bits, 15.600 ns <= VALUE <= 17.700 ns
EL_22 Measure Interpacket Gap Between Second and Third Packets	16.640 ns <= VALUE <= 399.400 ns
EL_22 Measure Interpacket Gap Between First and Second Packets	16.640 ns <= VALUE <= 399.400 ns
EL_28 Measure Device CHIRP-K Latency	2.500 μ s <= VALUE <= 6.000000 ms
EL_29 Measure Device CHIRP-K Duration	1.000 ms <= VALUE <= 7.000 ms
EL_31 Device Hi-Speed Terminations Enable and D+ Disconnect Time	1 ns <= VALUE <= 500.000 μ s
EL_40 Device Resume Timing Response	Must transition back to high speed operation within two bit times from the end of resume time signaling
EL_27 Device CHIRP Response to Reset from Hi-Speed Operation	3.100 ms <= VALUE <= 6.000 ms

Test name	Pass limits
EL_28 Device CHIRP Response to Reset from Suspend	$2.500\ \mu\text{s} \leq \text{VALUE} \leq 6.000000\ \text{ms}$
EL_38 EL_39 Device Suspend Timing Response	$3.000\ \text{ms} \leq \text{VALUE} \leq 3.125\ \text{ms}$
EL_8 Device J Test	$360\ \text{mV} \leq \text{D+} \leq 440\ \text{mV}$ $-10\ \text{mV} \leq \text{D-} \leq 10\ \text{mV}$
EL_8 Device K Test	$360\ \text{mV} \leq \text{D-} \leq 440\ \text{mV}$ $-10\ \text{mV} \leq \text{D+} \leq 10\ \text{mV}$
EL_9 Device SE0_NAK Test	$-10\ \text{mV} \leq \text{D+} \leq 10\ \text{mV}$ $-10\ \text{mV} \leq \text{D-} \leq 10\ \text{mV}$
EL_18 Minimum SYNC Field	Detect the end of the SYNC field within 12 bit times
EL_17 Receiver sensitivity	$\text{VALUE} \leq \pm 200\ \text{mV}$
EL_16 Squelch	$\text{VALUE} \geq \pm 100\ \text{mV}$

- If the product used for certification only has a standard Micro B receptacle and no captive cable, EL_5 should not be used.

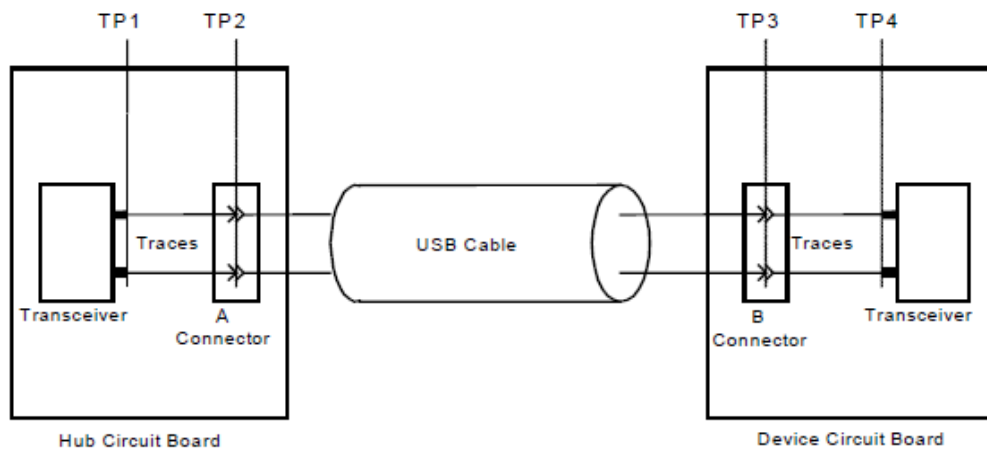


Figure 24. HS signal measurement planes

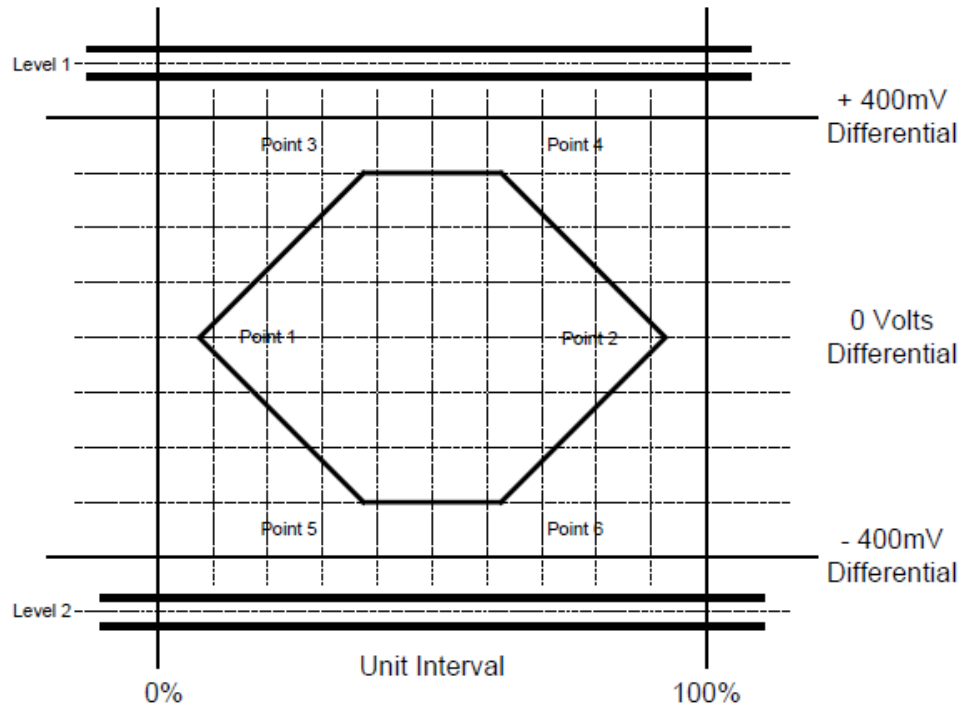


Figure 25. Template 1 for device without a captive cable

3.3.2. Device High-Speed Signal Quality Test

These tests measure the ability of transmitters to do valid high-speed signaling. The high-speed signal quality is measured on upstream ports. A high-speed scope with differential probes is used. Signaling data is captured with the scope and then translated to an eye pattern. The signal quality eye patterns obtained from the measurements must adhere with the transmit eye patterns in the USB 2.0 specification.

Test Instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 26](#), and make sure you set the test type configuration option to Hi-Speed Near End before running the test.
2. Connect the equipment and test fixture as shown in [Figure 27](#).
 - Attach the 5 V power supply to J5 of the Device Hi-Speed signal quality test fixture (E2649- 66401). Leave the **test** switch at the OFF position. Verify the green Power LED is lit and the yellow Test LED is not lit.
 - Connect the **Test Port** of the device high-speed signal quality test fixture into the upstream facing port of the DUT, using the 4 inch USB cable.
 - Connect the **Init Port** of the test fixture to a Hi-Speed capable port of the test bed computer with a 5 meter USB cable.
 - Attach the differential probe on channel 1 to D+/D- of TP2 on the test fixture, Ensure the + polarity on the probe lines up with D+.
3. Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed Computer.

- Select Device and click the **Test** button to enter the Device Test menu. The DUT should be enumerated with the device's VID shown together with the root port in which it is connected.
4. Select the HS Electrical Test Tool software on the hi-speed electrical test bed computer. Select Device and click the **Test** button to enter the Device Test menu. The DUT should be enumerated with the device's VID shown together with the root port in which it is connected.
 5. Select TEST_PACKET from the Device Command drop down menu and click on **Execute**. This forces the DUT to continuously transmit test packets.
 6. Click on the **Run Tests** button of the Automated Test software on the oscilloscope.
 7. Switch the Test Switch (S1) to the **Test** position according to the requirement of the Automated Test Software. Verify the yellow test LED is lit. You should see the transmitted test packet on the oscilloscope as shown in [Figure 30](#).
 8. When the Testing Complete dialog appears, click on **Ok**. The **Results** tab shows the test results, and the **Html Report** shows the complete report.

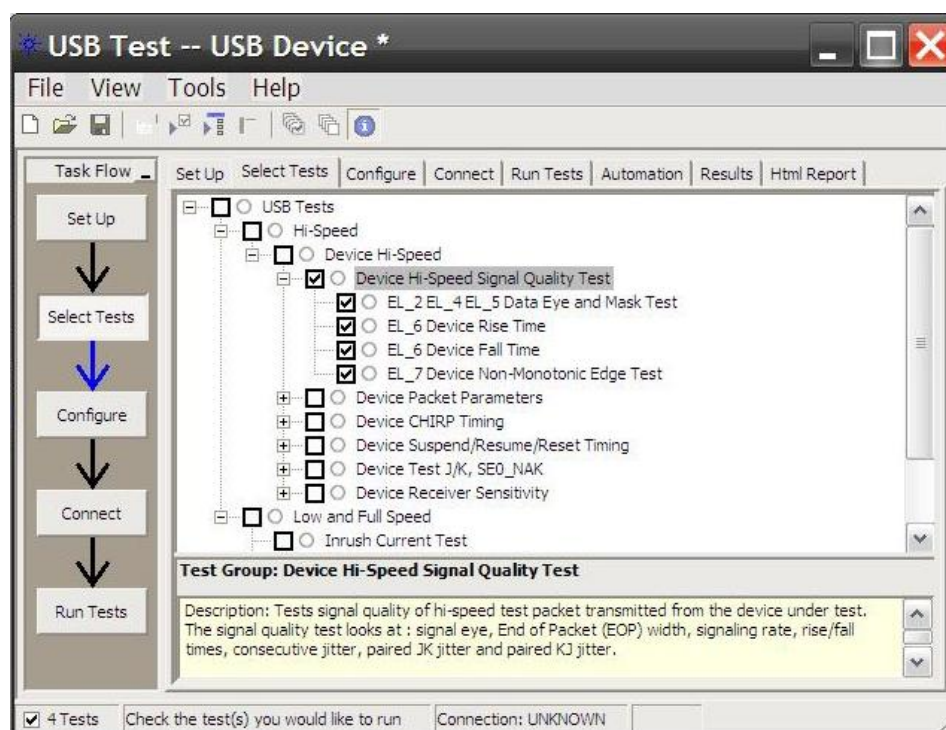


Figure 26. Device HS Signal Quality Test

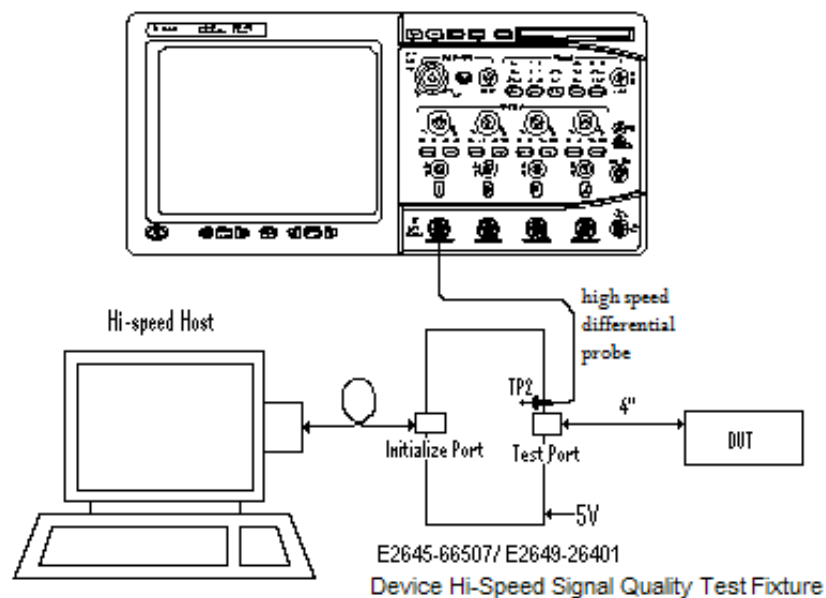


Figure 27. Device Hi-Speed Signal Quality Test environment

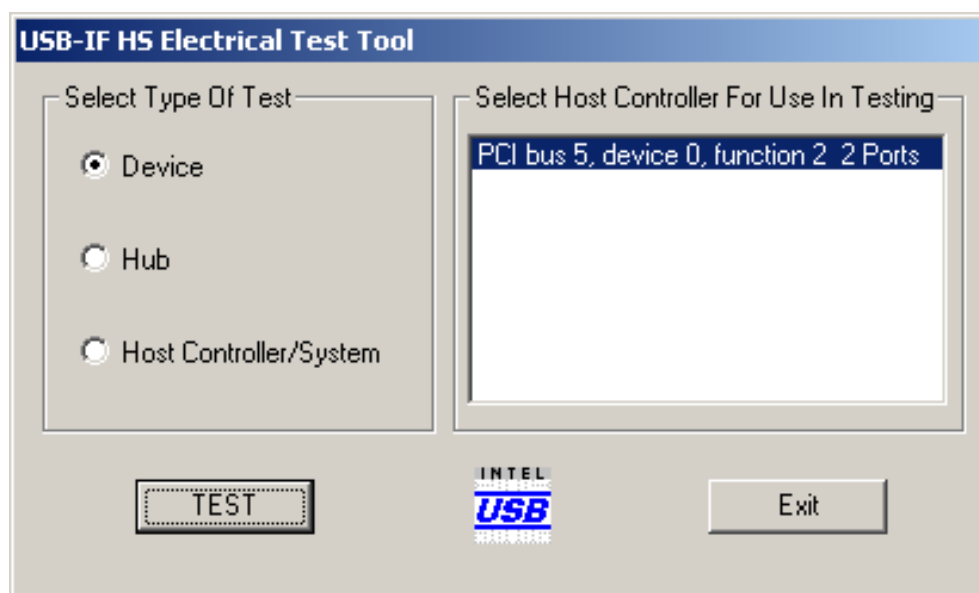


Figure 28. Electrical Test Tool main menu

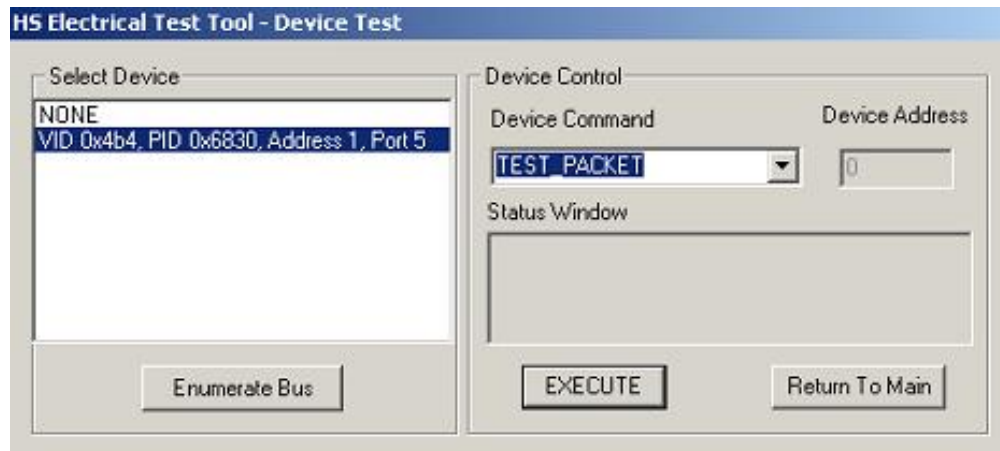


Figure 29. Test_Packet for Eye Diagram Test

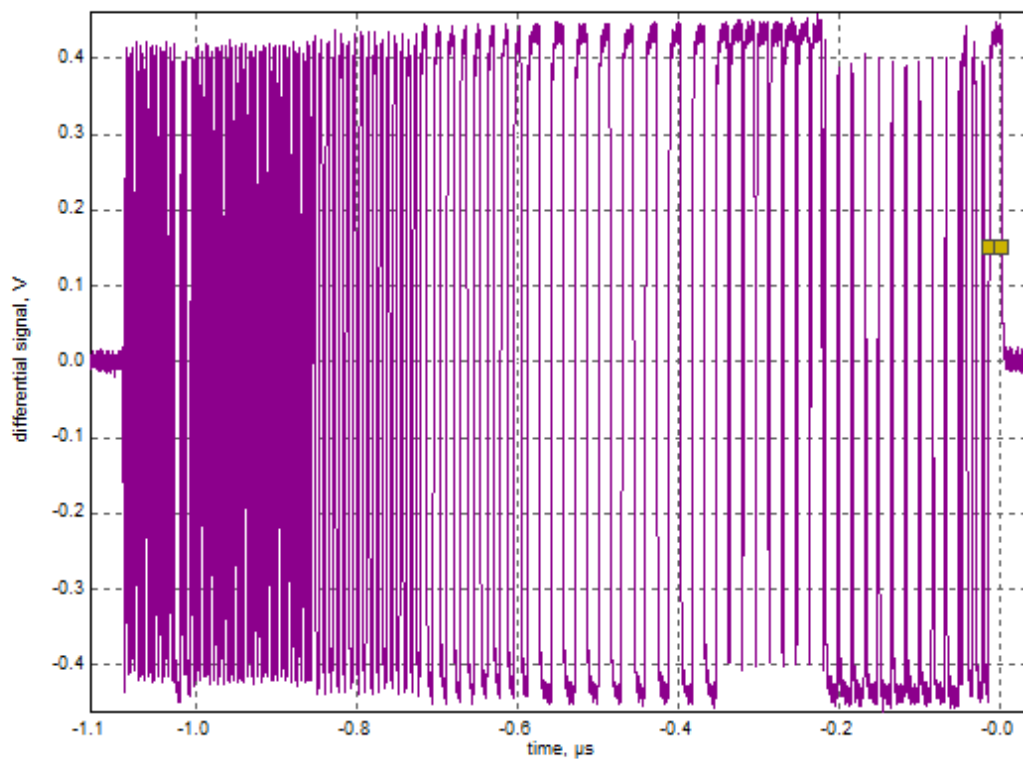


Figure 30. Device Hi-Speed Test packet

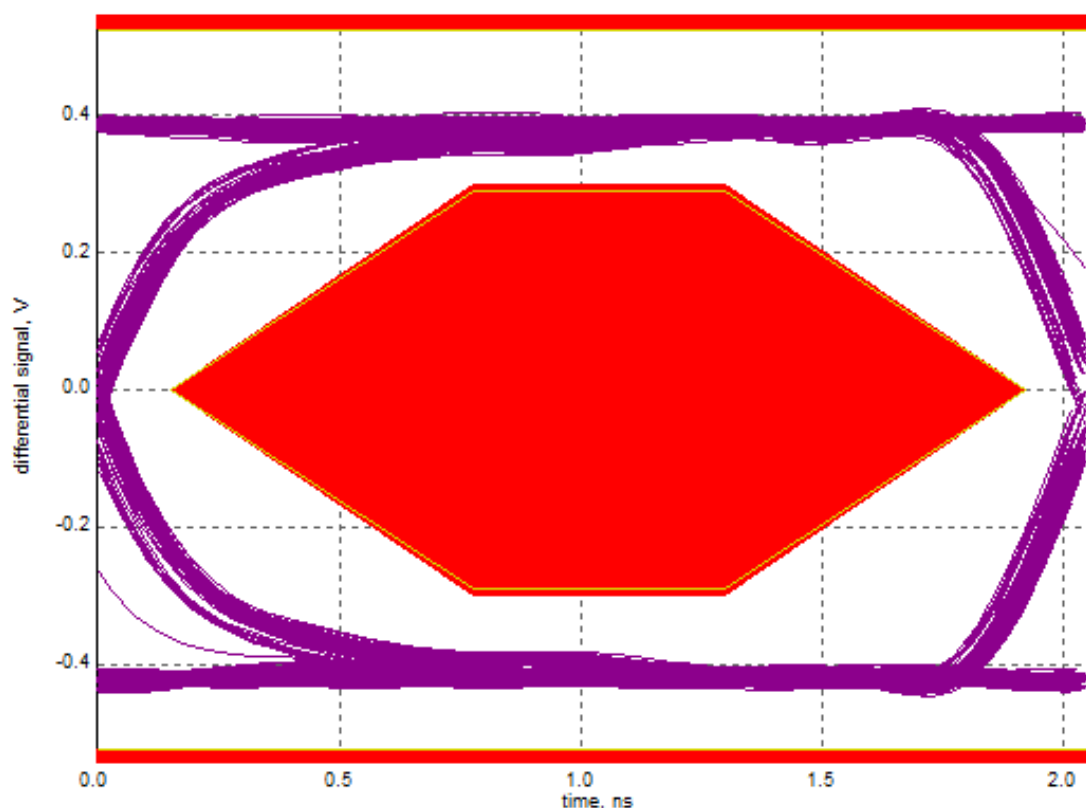


Figure 31. Device HS eye diagram

3.3.3. Device Packet Parameters Test

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 32](#). Set the Test Type configuration option to Hi-Speed Near End before running the test.
2. Connect the equipment and test fixture as shown in [Figure 27](#).
 - Attach the 5 V power supply to J5 of the device hi-speed signal quality test fixture (E2649- 66401). Leave the test switch at the off position. Verify the green power LED is lit and the yellow test LED is not lit.
 - Connect the **Test Port** of the device hi-speed signal quality test fixture into the upstream facing port of the DUT, using the 4 inch USB cable.
 - Connect the **Init Port** of the test fixture to a hi-speed capable port of the test bed computer with a 5 meter USB cable.
 - Attach the differential probe on channel 1 to D+/D- of TP2 on the test fixture, Ensure the + polarity on the probe lines up with D+.
3. Reboot the device to restore the USB device to normal operation.
4. Click on **Enumerate Bus** on the menu of the HS Electrical Test Tool. Using the oscilloscope, verify the **SOF** (Start of Frame) packets are being transmitted on the port under test. You may

need to lower the trigger level to below 400 mV.

5. Select the **Single Step Set Feature** from the Device Command window. Click on **Execute** once. The oscilloscope will measure the sync field length (number of bits) of the third (from device) packet (**EL_21**), **EOP** (End of Packet) width (number of bits) of the third packet (**EL_25**), inter-packet gap between the second (from host) and the third (from device in respond to the host's) packets (**EL_22**), as shown in [Figure 35](#) to [Figure 37](#).
6. In the Device Test menu of the HS Electrical Test Tool, click on **Step** once more. This is the second step of the two-step **Single Step Set Feature** command. The oscilloscope will measure the inter-packet gap between the first (from host) and the second (from device in respond to the host's) packets (**EL_22**), as shown in [Figure 39](#).
7. When the Testing Complete dialog appears, click on **Ok**. The **Results** tab shows the test results, and the **Html Report** shows the complete report.

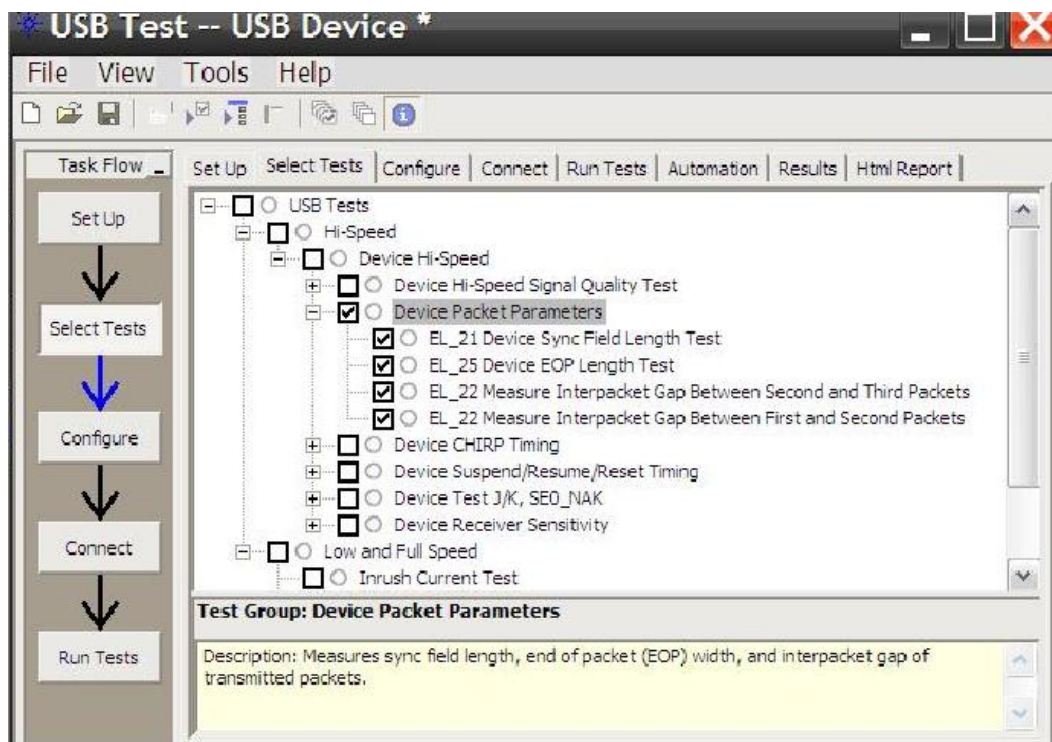


Figure 32. Device Hi-Speed Packet Parameters Test

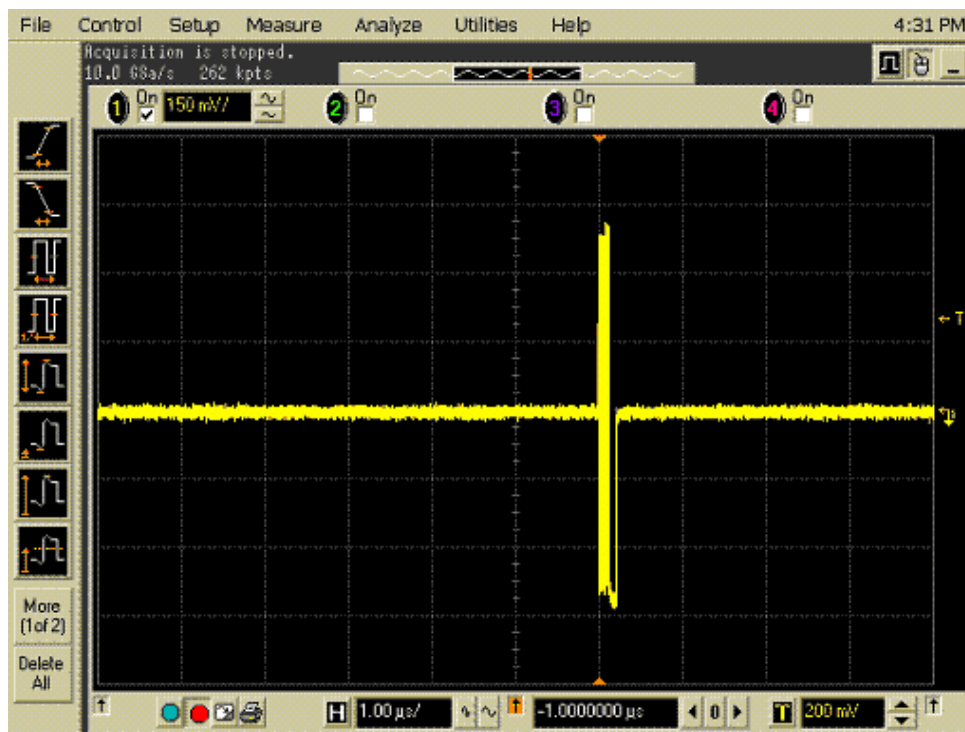


Figure 33. SOF waveform

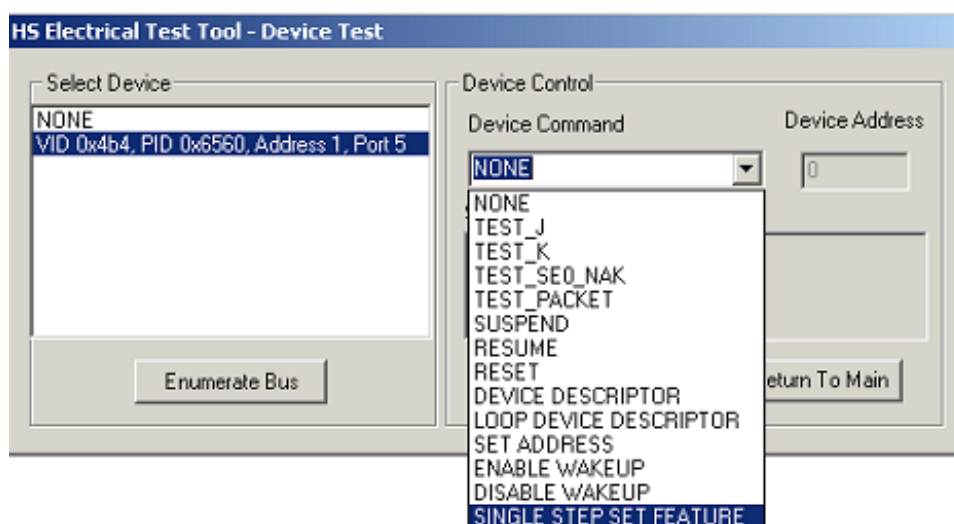


Figure 34. Single Step Set Feature for Packet Parameters Test

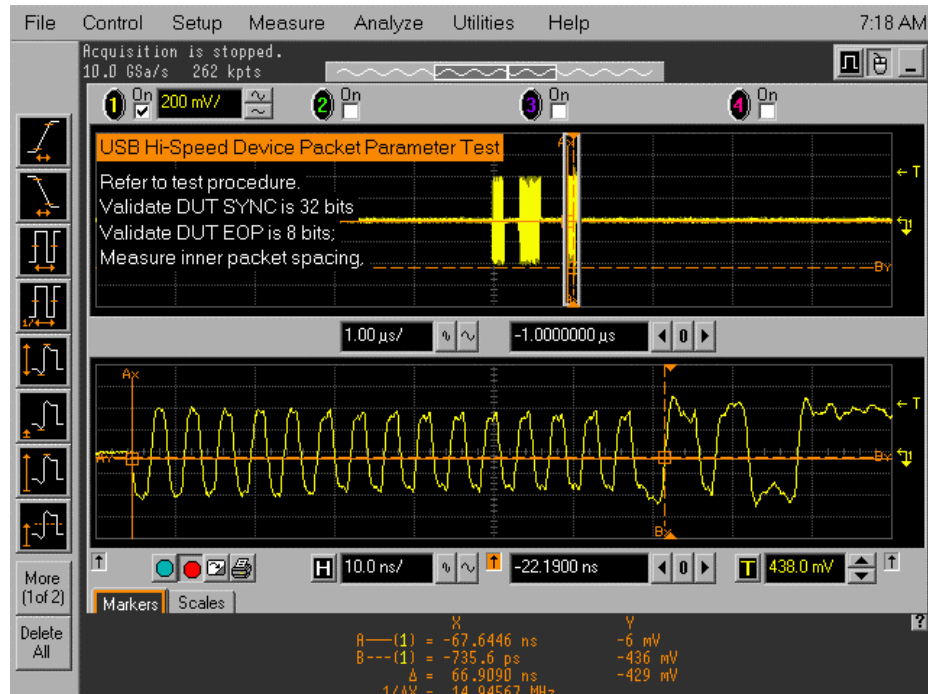


Figure 35. EL_21 device sync field length waveform



Figure 36. EL_25 device EOP length waveform

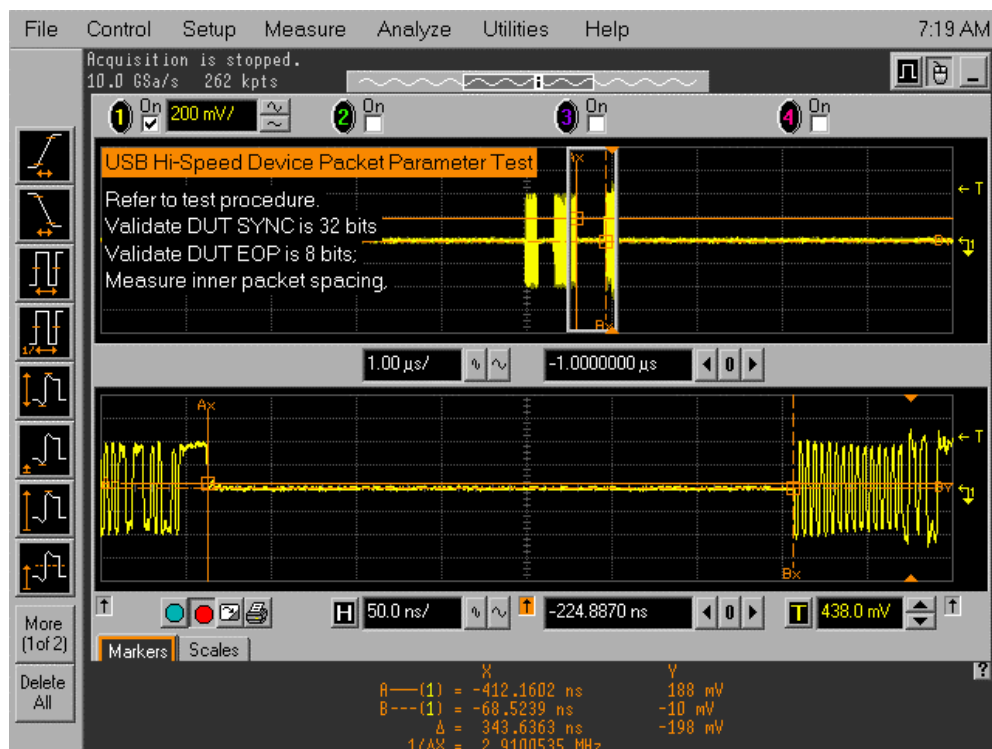


Figure 37. EL_22 device inter-packet gap (between second and third packets) waveform

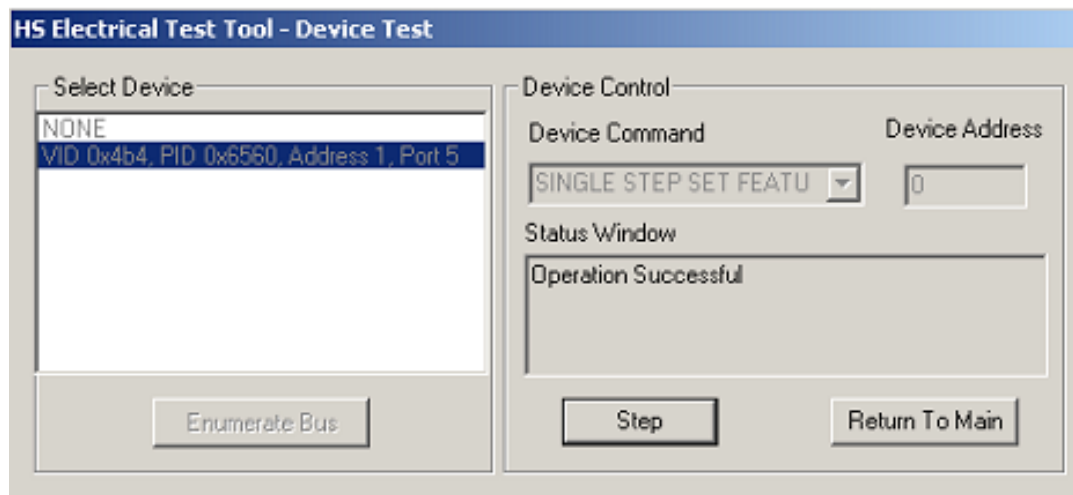


Figure 38. Single Step Set Feature - second step

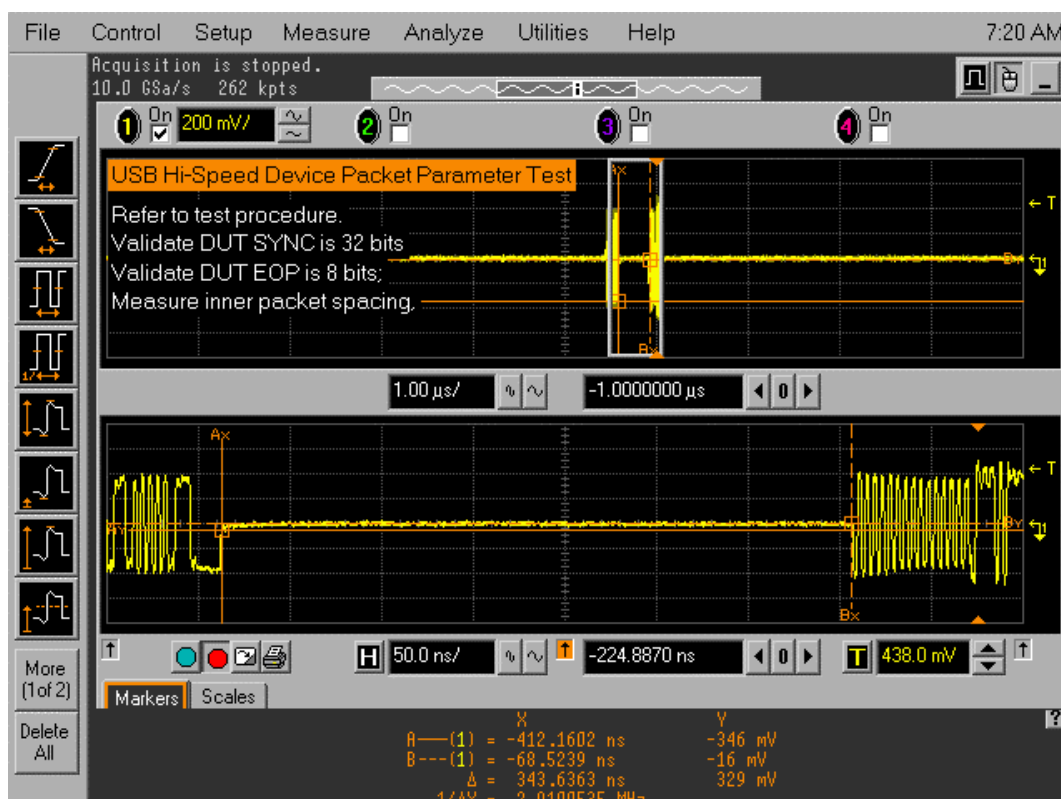


Figure 39. EL_22 Device inter-packet gap (between first and second packets) waveform

3.3.4. Device CHIRP Timing Test

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 40](#), and make sure you set the Test Type configuration option to Hi-Speed Near End before running the test.
2. Connect the equipment and test fixture as shown in [Figure 41](#).
3. Attach the 5 V power supply to J5 of the device hi-speed signal quality test fixture (E2649-66401). Leave the **Test** switch at the off position. Verify the green power LED is lit and the yellow test LED is not lit.
4. Connect the **Test Port** of the device hi-speed signal quality test fixture into the upstream facing port of the DUT, using the 4 inch USB cable.
5. Connect the **Init Port** of the test fixture to a hi-speed capable port of the test bed computer with a 5 meter USB cable.
6. Attach the single end probes on channel 2 to D- of TP2, attach channel 3 to D+ of TP2.
7. Reboot the device to restore the USB device to normal operation.
8. Click on **Enumerate Bus** on the menu of the HS Electrical Test Tool. The oscilloscope will capture and measure the Chirp handshake as shown in [Figure 42](#).
9. When the Testing Complete dialog appears, click on **Ok**. The **Results** tab shows the test

results, and the **Html Report** shows the complete report.

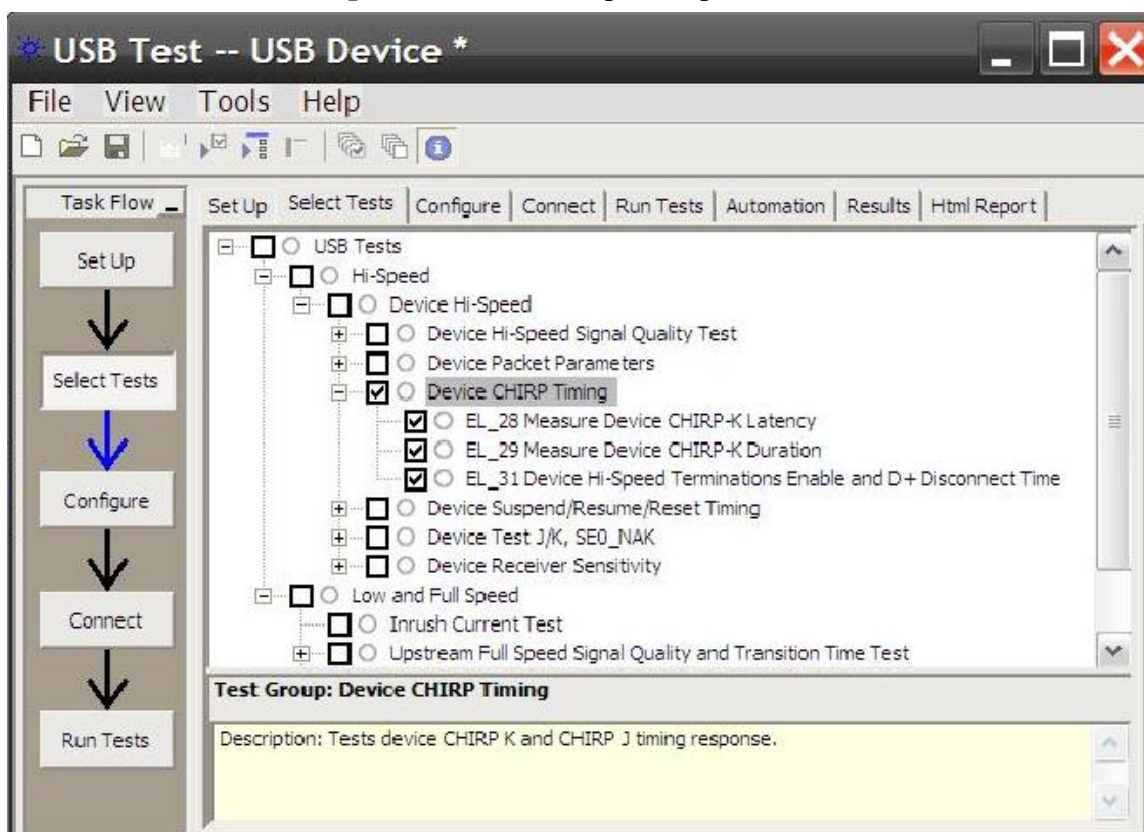


Figure 40. Device Chirp J/K Test

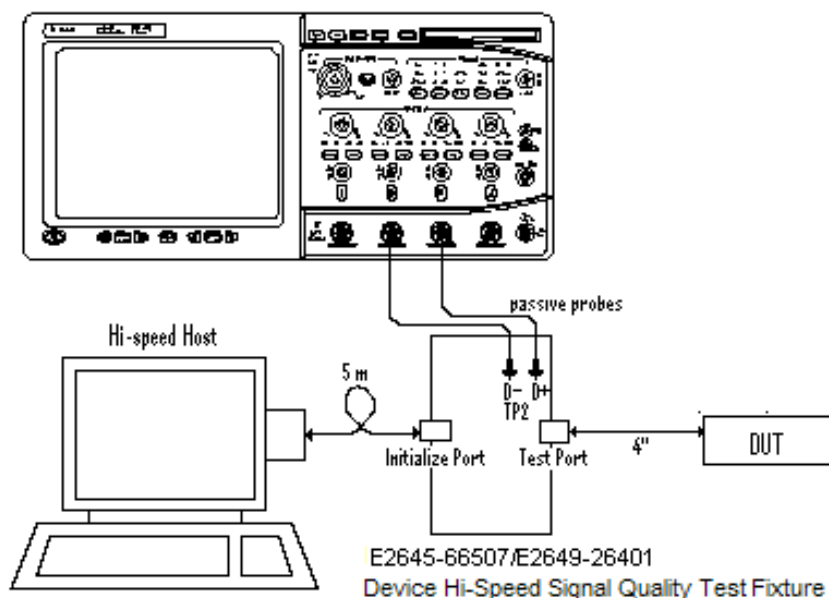


Figure 41. Device Chirp J/K Test environment

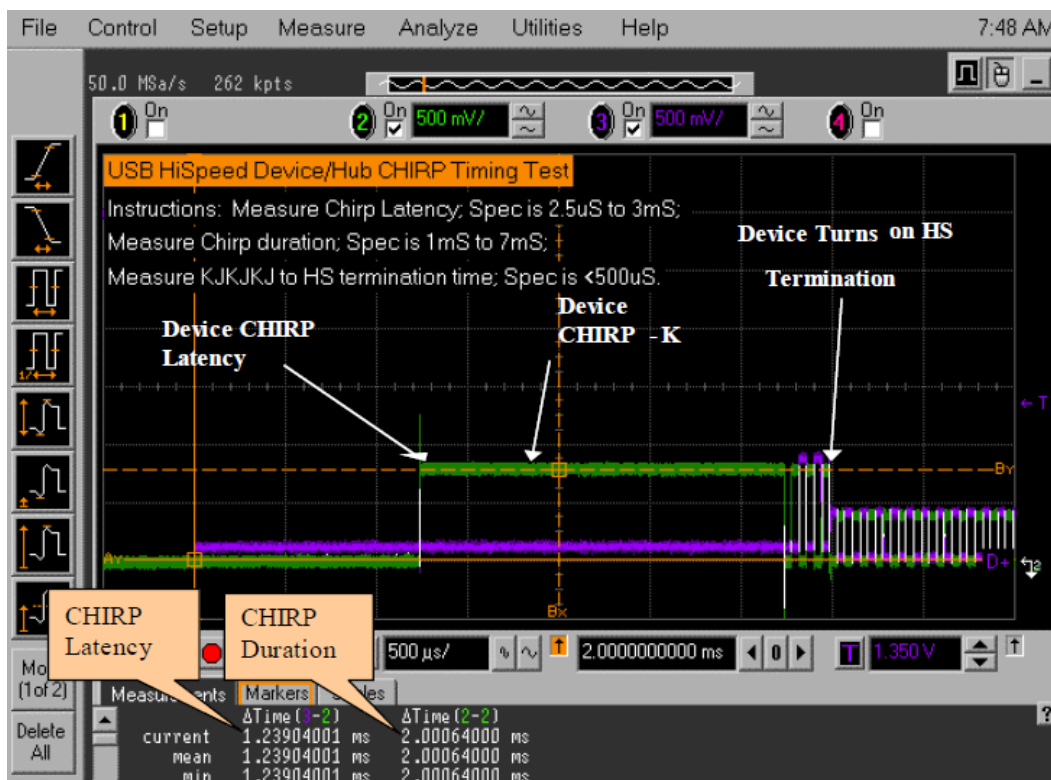


Figure 42. Device CHIRP J/K waveform

3.3.5. Device Suspend/Reset/Resume Timing Test

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 43](#), and make sure you set the test type configuration option to hi-speed near end before running the test.
2. Connect the equipment and test fixture as shown in [Figure 41](#).
3. Attach the 5 V power supply to J5 of the device high-speed signal quality test fixture (E2649-66401). Leave the **Test** switch at the **off** position. Verify the grepower LED is lit and the yellow Test LED is not lit.
4. Connect the **Test Port** of the device high-speed signal quality test fixture into the upstream facing port of the DUT, using the 4 inch USB cable.
5. Connect the **Init Port** of the test fixture to a high-speed capable port of the test bed computer with a 5 meter USB cable.
6. Attach the single end probes on channel 2 to D- of TP2, and on channel 3 to D+ of TP2.
7. Reboot the device to restore the USB device to normal operation.
8. Click on **Enumerate Bus** on the menu of the HS Electrical Test Tool. Choose the correct device, select **Suspend** from the Device Command drop down menu, then click on **Execute**

- once to place the device into suspend. The captured suspend transition should appear as in [Figure 45](#).
9. Select **Resume**, then click on **Execute** once to resume the device from suspend. The captured resume transition should appear as in [Figure 47](#).
 10. Select **Reset**, then click on **Execute** once to reset the device operating in high speed. The captured transition should appear as in [Figure 49](#).
 11. Select **Suspend**, and click on **Execute** to place the device into suspend once more. Then select **Reset** and click on **Execute** once to reset the device from suspend. The captured transition should appear as in [Figure 50](#).
 12. When the Testing Complete dialog appears, click on **Ok**. The **Results** tab shows the test results, and the **Html Report** shows the complete report.

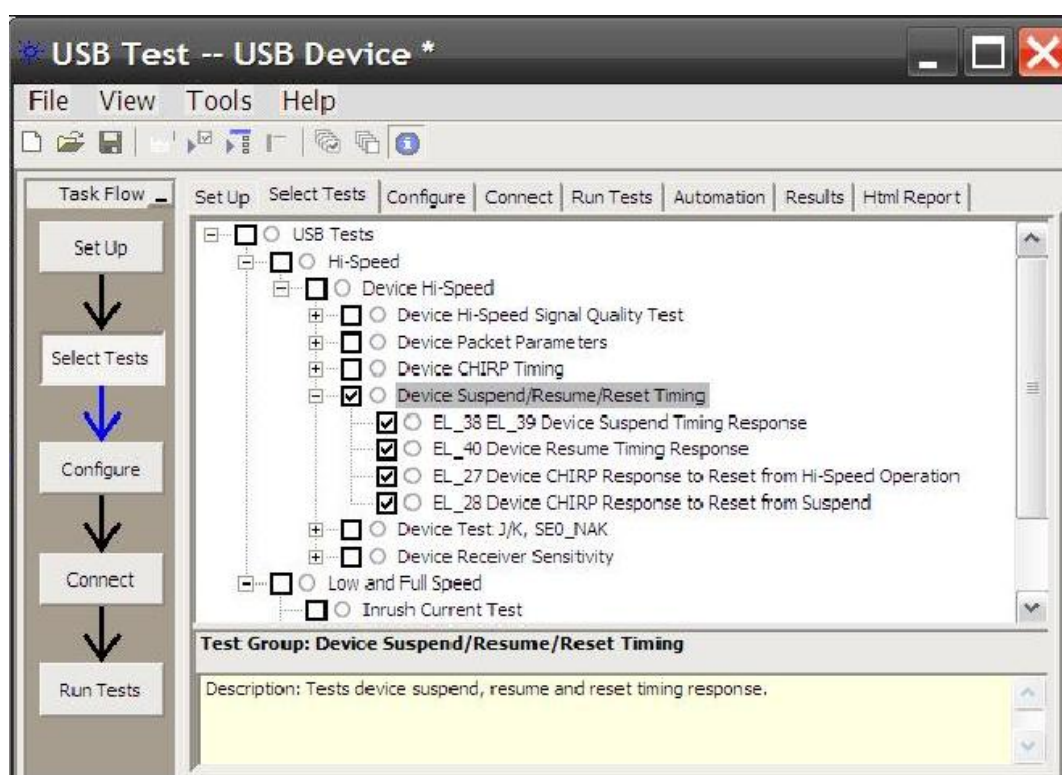


Figure 43. Device Suspend/Reset/Resume Timing Test

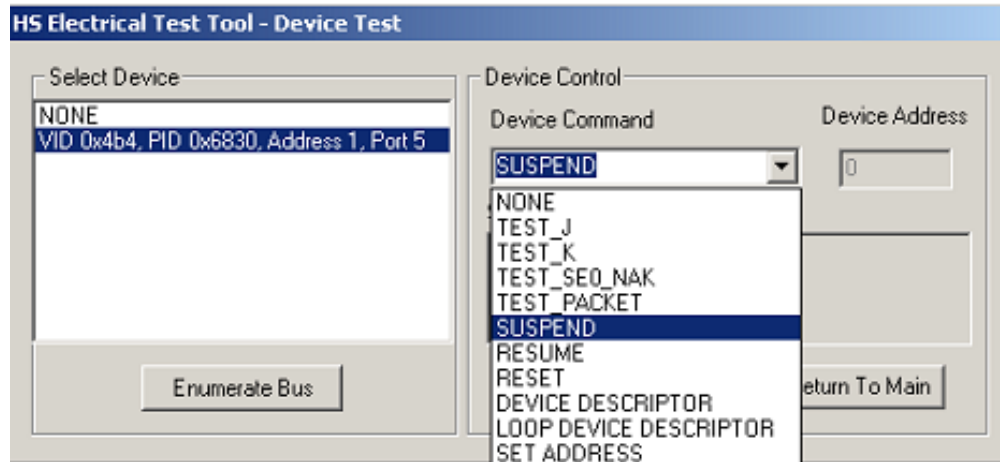


Figure 44. Device suspend command

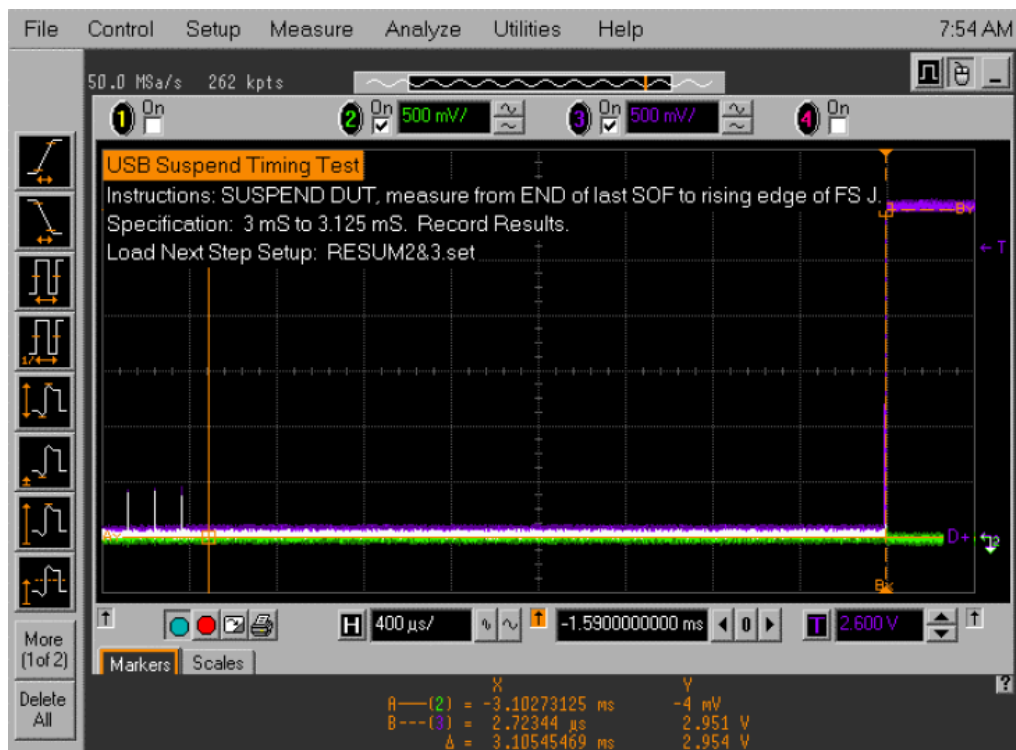


Figure 45. Device suspend waveform

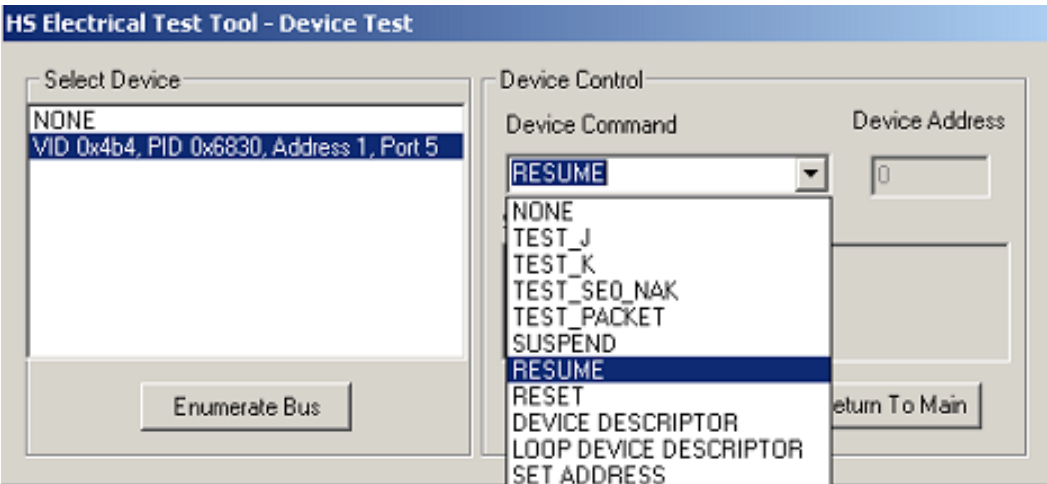


Figure 46. Device resume command

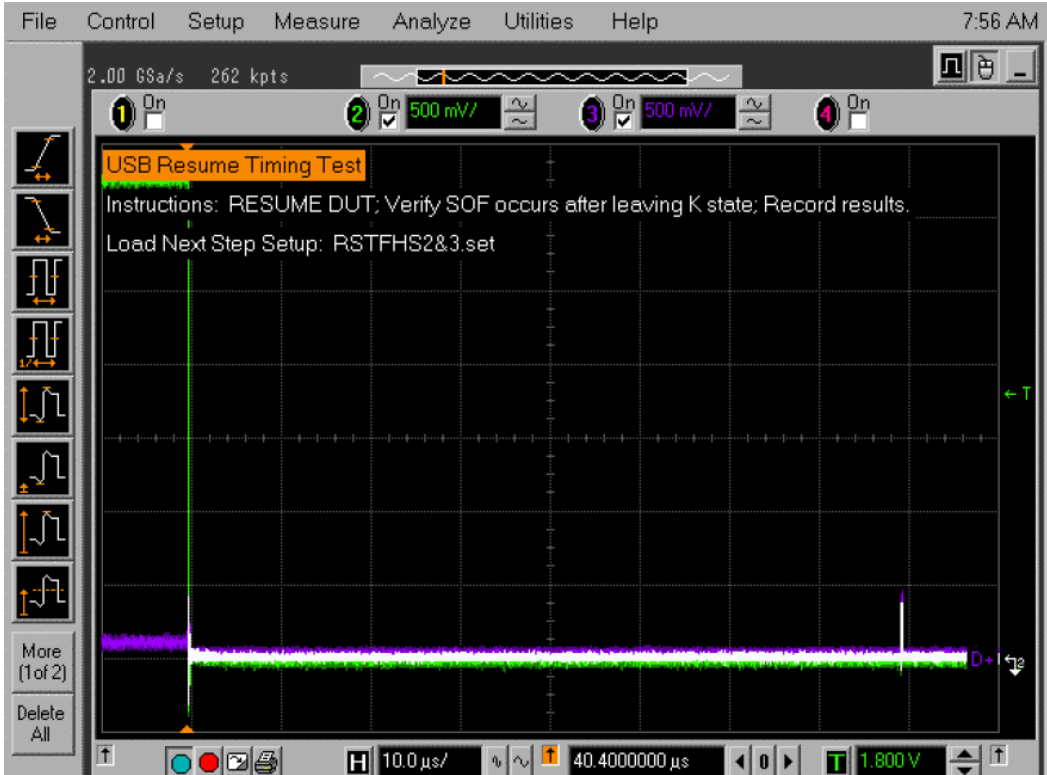


Figure 47. Device resume waveform

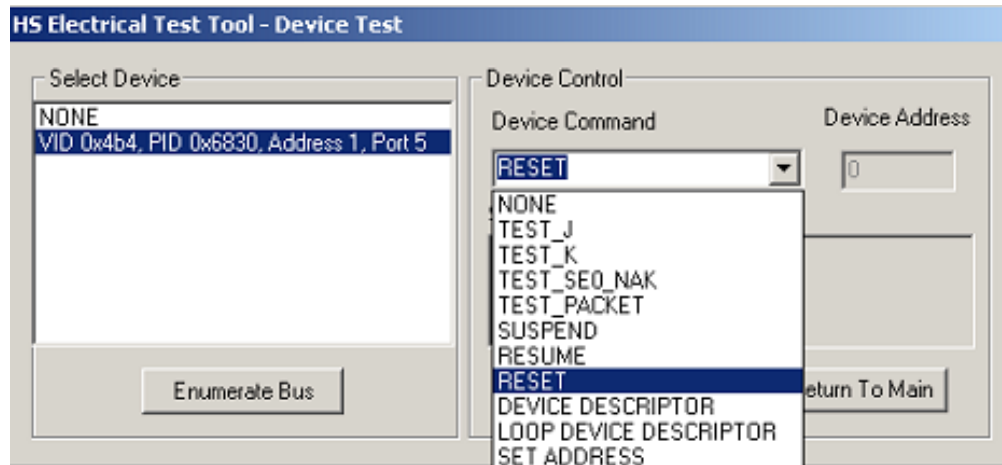


Figure 48. Device reset command

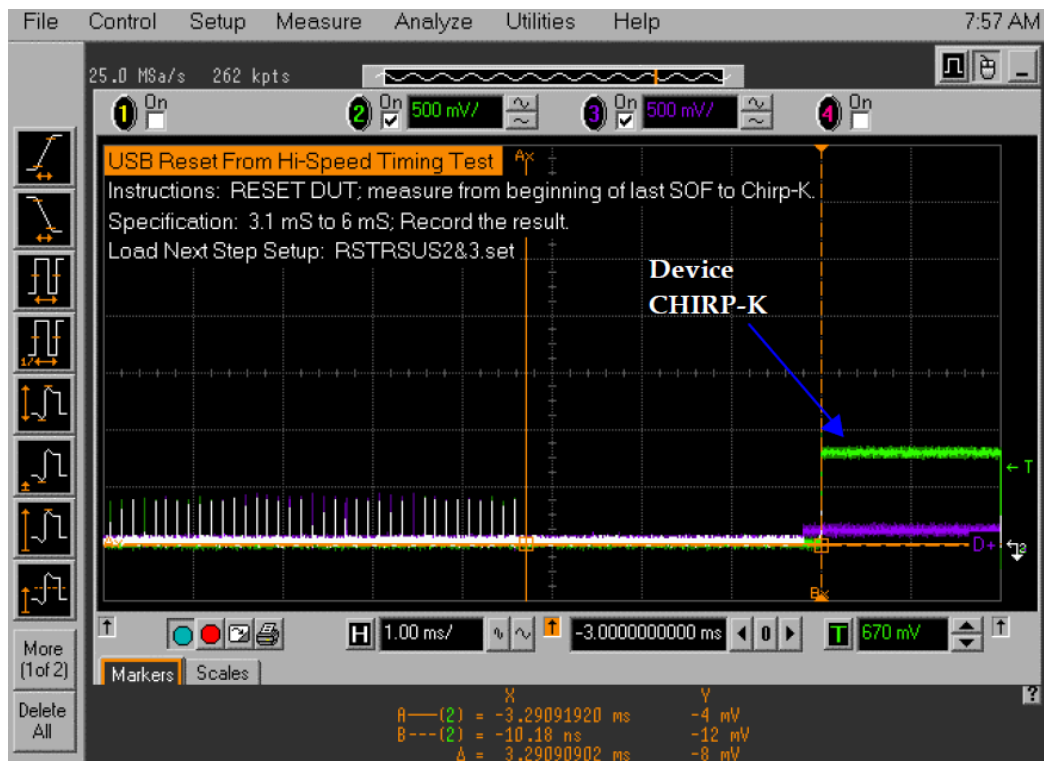


Figure 49. Device reset from high-speed waveform

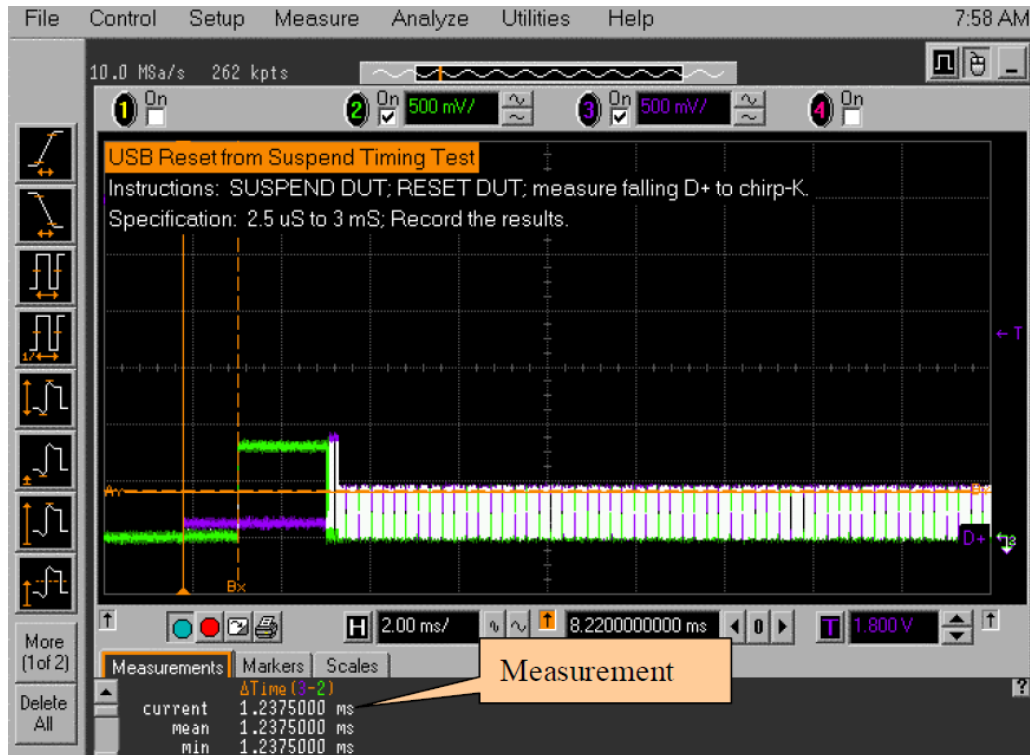


Figure 50. Device reset from suspend waveform

3.3.6. Device Test J/K, SE0_NAK Test

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 51](#).
2. Connect the equipment and test fixture as shown in [Figure 52](#).
 - Attach the 5 V power supply to J5 of the device high-speed signal quality test fixture (E2649- 66401). Leave the **Test** switch at the off position. Verify the green power LED is lit and the yellow test LED is not lit.
 - Connect the **Test Port** of the device high-speed signal quality test fixture into the upstream facing port of the DUT, using the 4 inch USB cable.
 - Connect the **Init Port** of the test fixture to a high-speed capable port of the test bed computer with a 5 m USB cable.
 - Attach the single end probes on channel 2 to D- of TP2, and on channel 3 to D+ of TP2.
3. Reboot the device to restore the USB device to normal operation.
4. Click on **Enumerate Bus** on the menu of the HS Electrical Test Tool. Choose the correct device. Select TEST_J from the Device Command drop down menu, then click on **Execute** once to place the device into TEST_J test mode.
5. Switch the test fixture into the test position. Use a multimeter to measure the DC voltage on the D+/- lines at TP2 with respect to GND, then record the measurement in the pop out dialog.

6. Reboot the device to restore the USB device to normal operation.
7. Click on **Enumerate Bus** on the menu of the HS Electrical Test Tool. Choose the correct device, Select **TEST_K** from the Device Command drop down menu, then click on **EXECUTE** once to place the device into **TEST_K** test mode.
8. Switch the test fixture into the **test** position. Use a multimeter to measure the DC voltage on the D+/- lines at TP2 with respect to GND, then record the measurement in the pop out dialog.
9. Reboot the device to restore the USB device to normal operation.
10. Click on **Enumerate Bus** on the menu of the HS Electrical Test Tool. Choose the correct device, Select **TEST_SE0_NAK** from the Device Command drop down menu, then click on **execute** once to place the device into **TEST_SE0_NAK** test mode.
11. Switch the test fixture to the **test** position. Use a multimeter to measure the DC voltage on the D+/- lines at TP2 with respect to GND, then record the measurement in the pop out dialog.
12. When the Testing Complete dialog appears, click on **Ok**. The **Results** tab shows the test results, and the **Html Report** shows the complete report.

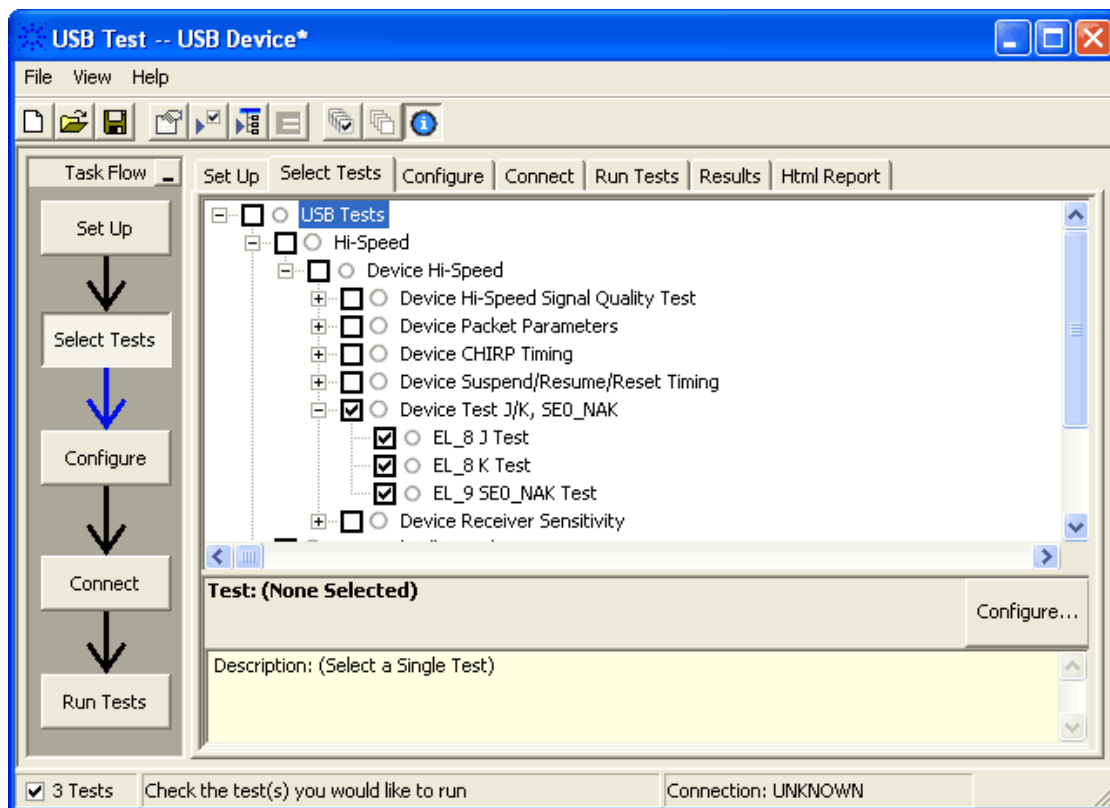


Figure 51. Device Test_J/K, SE0_NAK Test

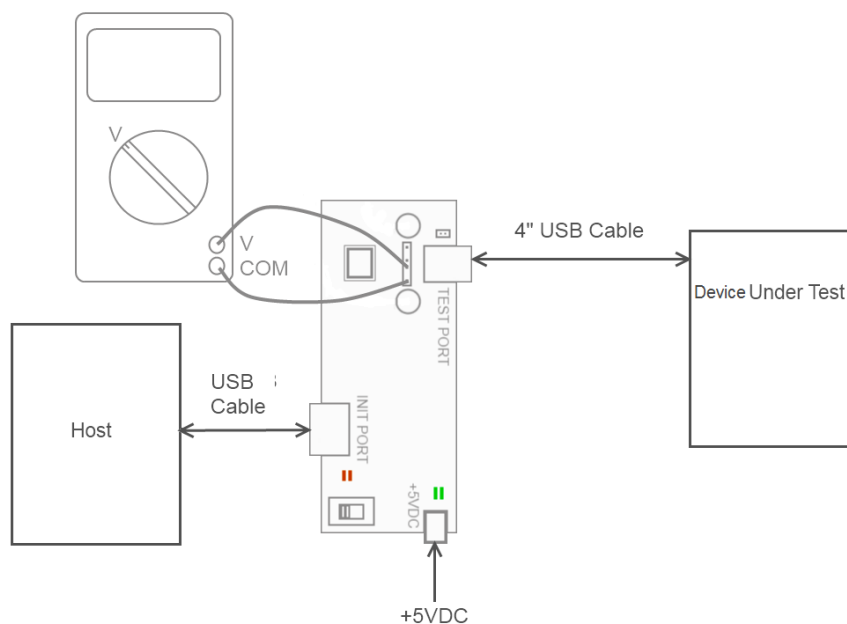


Figure 52. Device Test_J/K, SE0_NAK Test environment

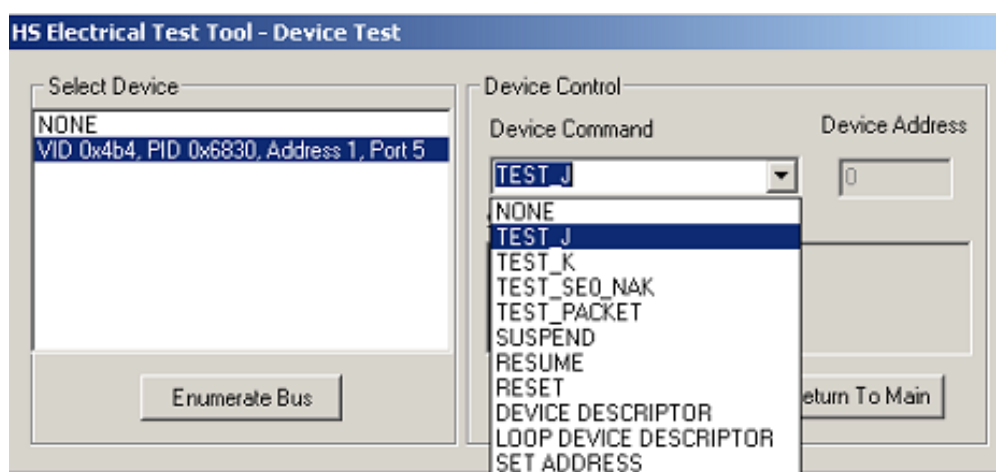


Figure 53. Device Test_J command

Table 11. Host Drop Test record

Test Mode	D+ Voltage(mV)	D- Voltage(mV)	Expected value
J	415	4	360 mV <= D+ <= 440 mV -10 mV <= D- <= 10 mV
K	4	417	360 mV <= D- <= 440 mV -10 mV <= D+ <= 10 mV
SE0_NAK	1	1	-10 mV <= D+ <= 10 mV -10 mV <= D- <= 10 mV

3.3.7. Device Receiver Sensitivity Test

Receiver sensitivity and squelch measurements are to be made at the upstream port pins as defined in the USB 2.0 Specification.

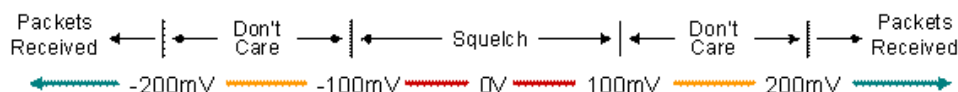
The Transmission Envelope Detector of a A high-speed capable device must be fast enough to enable the HS receiver to detect data transmission, achieve DLL lock, and detect the end of the SYNC field within 12 bit times. When all packets are NAK by the device this test (EL_18) is considered to have passed.

In Section 7.1.7.2 of USB2.0 Spec it requires squelch (EL_16) to occur below 100 mV magnitude. Therefore no packets must be acknowledged between -100 mV and +100 mV. Full squelch may occur at higher voltages, but it is mandatory between -100 mV and +100 mV.

Receiver sensitivity requires all packets to be reliably received down to 150 mV magnitude. Packets may be received at lower voltages, but it is mandatory for all packets to be received at levels above 150 mV magnitude. This measurement is to be made at the upstream pins but the test fixture does not allow this. The USB-IF requires packets to be reliably received at levels above 200 mV (50 mV waiver to compensate for the voltage drop) for EL_17. Packets can, but do not need to be, received between -200 mV and +200 mV.

For a detailed explanation of device receiver sensitivity, see the following:

<http://compliance.usb.org/index.asp?UpdateFile=Electrical&Format=Standard#3>



Combining EL_16 and EL_17 Creates Transmission Detection Envelope

Figure 54. Device sensitivity detection envelope

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 55](#), and ensure sure the Test Type configuration option is set to Hi-Speed Near End before running the test.
2. Connect the equipment and test fixture as shown in [Figure 56](#).
 - Attach the 5 V power supply to J5 of the Device Hi-Speed signal quality test fixture (E2649- 66401). Leave the test switch at the off position. Verify the green power LED is lit and the yellow test LED is not lit.
 - Connect the **Test Port** of the device hi-speed signal quality test fixture into the upstream facing port of the DUT, using the 4 inch USB cable.
 - Connect the **Init Port** of the test fixture to a high-speed capable port of the test bed computer with a 5 meter USB cable.
 - Attach the differential probe on channel 1 to D+/D- of TP2 on the test fixture, Ensure the + polarity on the probe lines up with D+.
3. Connect the 81130A pulse generator to the oscilloscope using the 82357A USB/GPIB Interface.
 - If you choose to use the Agilent 81130A Pulse/Pattern Generator, connect the 8493C 6 dB attenuators to OUTPUT1 and OUTPUT2 of Agilent 81130A Pulse/Pattern Generator.
4. Connect OUTPUT1 to SMA1 (D+) of the E2649- 66403 Device Receiver Sensitivity test

- fixture using the 8120- 4948 SMA cables.
5. Connect OUTPUT2 to SMA2 (D-) of the E2649- 66403 Device Receiver Sensitivity test fixture using the 8120- 4948 SMA cables.
 6. Select the **Memcard** soft key on the 81130A,. If **Memcard** is not in the menu, press the **more** key until **Memcard** is displayed. The content of the memory will appear on the screen. Use the cursor and the rotary knob to select the MIN_ADD1.ST0 setup file. Move the cursor to Perform Operation and turn the knob to select **Recall**. Then press the **Enter** key to load it. This generates **IN** packets (of compliant amplitude) with a 12-bit SYNC field packet pattern.
 7. Reboot the device to restore the USB device to normal operation.
 8. Click on **Enumerate Bus** on the menu of the HS Electrical Test Tool. Choose the right device, Select **TEST_SE0_NAK** from the Device Command drop down menu, then click on **Execute** once to place the device into **TEST_SE0_NAK** test mode.
 9. Set the test fixture Test Switch (S1) to the test position. This switches the data generator in place of the host controller. The data generator emulates the **IN** packets from the host controller.
 10. Verify that all packets from the data generator are **NAK**'d by the port under test as shown in [Figure 58](#). Record the pass/fail in **EL_18**.
 11. Use the cursor and the rotary knob on the 81130A, to select the IN_ADD1.ST0 setup file. Move the cursor to **Perform Operation** and turn the knob to select **Recall**. Then press the **enter** key to load it. This generates “**IN**” packets (of compliant amplitude) with a 32-bit SYNC field packet pattern.
 12. Verify that all packets from the data generator are **NAK**'d by the port under test as shown in [Figure 59](#).
 13. Adjust the output level of each channel as follows:
 - Select the **levels** soft key, then move the cursor to the numeric value for [high] voltage value.
 - Adjust the output level with the rotary knob or using the number keys while monitoring the actual level on the oscilloscope.
 - Use the cursor arrow buttons to select the channel to change.
 - Reduce the amplitude of the data generator packets in 20 mV steps (on the generator before the attenuator) while monitoring the **NAK** response from the device on the oscilloscope. The adjustment should be made to both channels such that OUTPUT1 and OUTPUT2 are matched, as indicated by the data generator readout.
 - Reduce the amplitude until the **NAK** packets become intermittent.
 - At this point, increase the amplitude such that the **NAK** packet is not intermittent.
 - This is just above the minimum receiver sensitivity levels before squelch.
 14. Using the oscilloscope markers to measure the packet amplitude, read the [Ay] and [By] values and record the measurement in **EL_17**.
 15. Further reduce the amplitude of the packet from the data generator in small steps.
 - Maintain the balance between OUTPUT1 and OUTPUT2 until the receiver stops

- responding with a **NAK**.
16. This is the squelch level of the receiver.
 17. Measure the packet amplitude. Read the [Ay] and [By] values and record the measurement in **EL_16**.
 18. When the Testing Complete dialog appears, click on **Ok**. The **Results** tab shows the test results, and the **Html Report** shows the whole report.

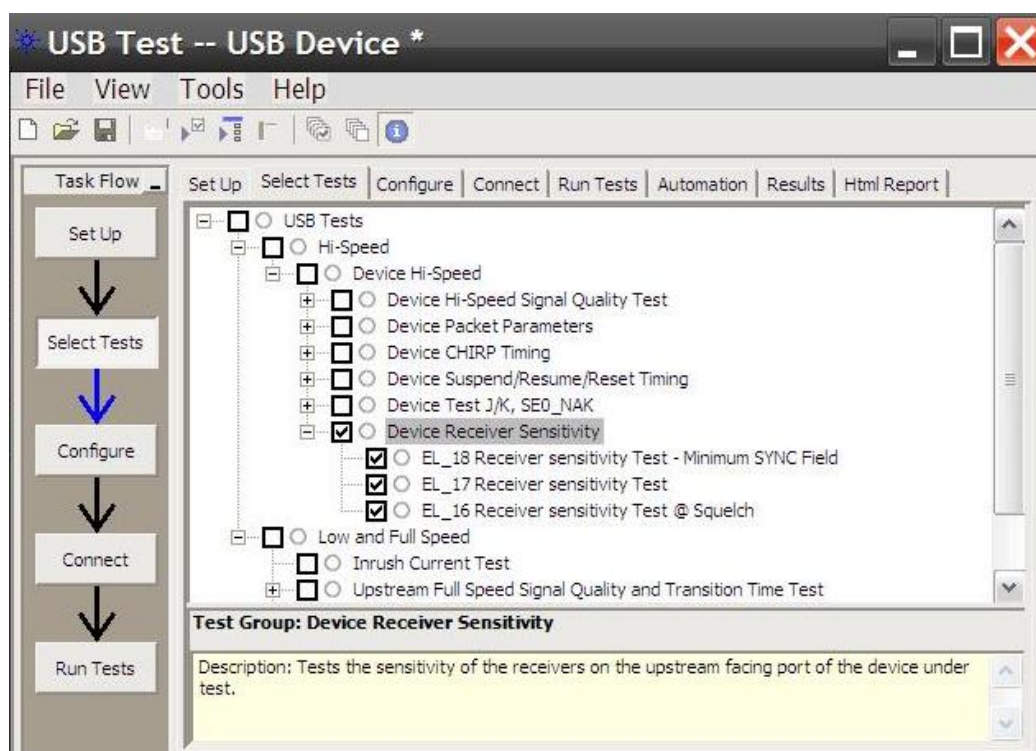


Figure 55. Device Receiver Sensitivity Test

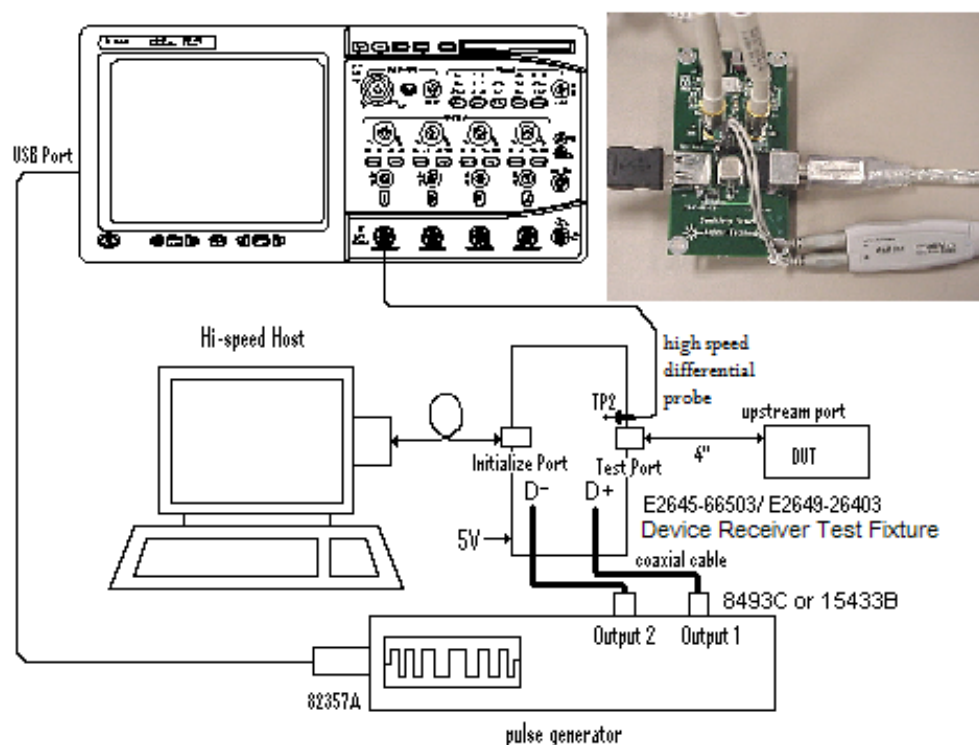


Figure 56. Device Receiver Sensitivity Test environment

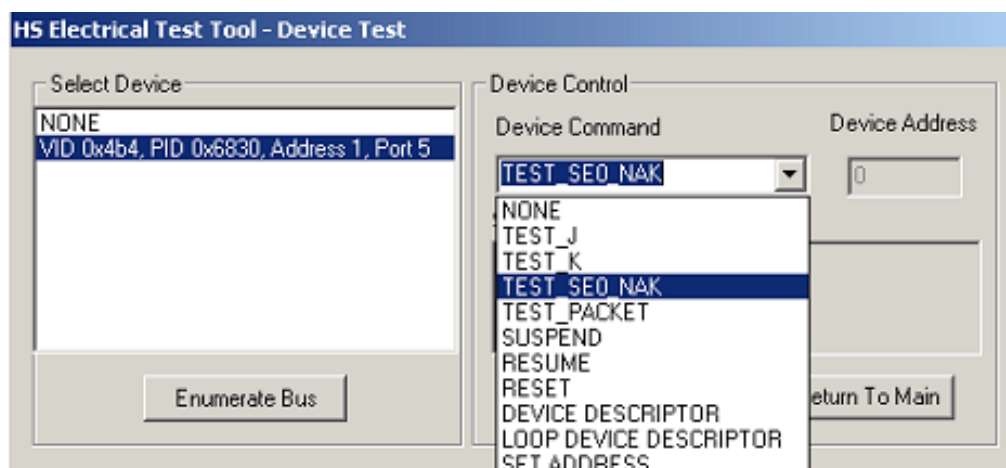


Figure 57. Device Test_SE0_NAK command

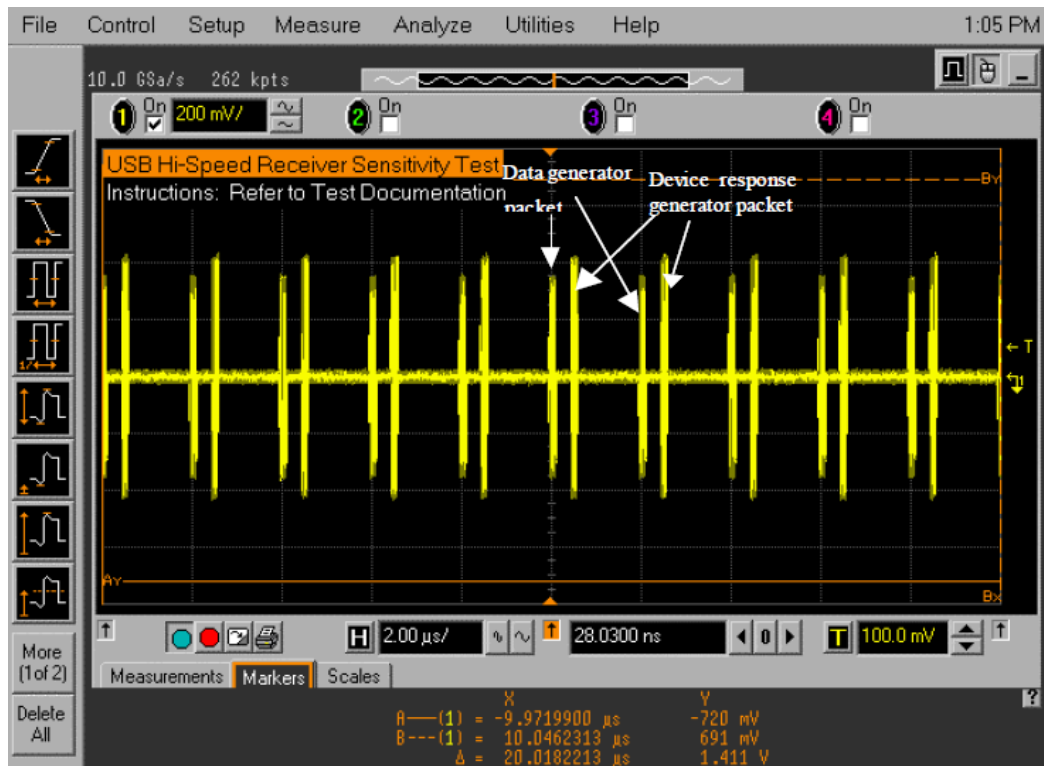


Figure 58. Receiver respond with NAK to IN from data generator

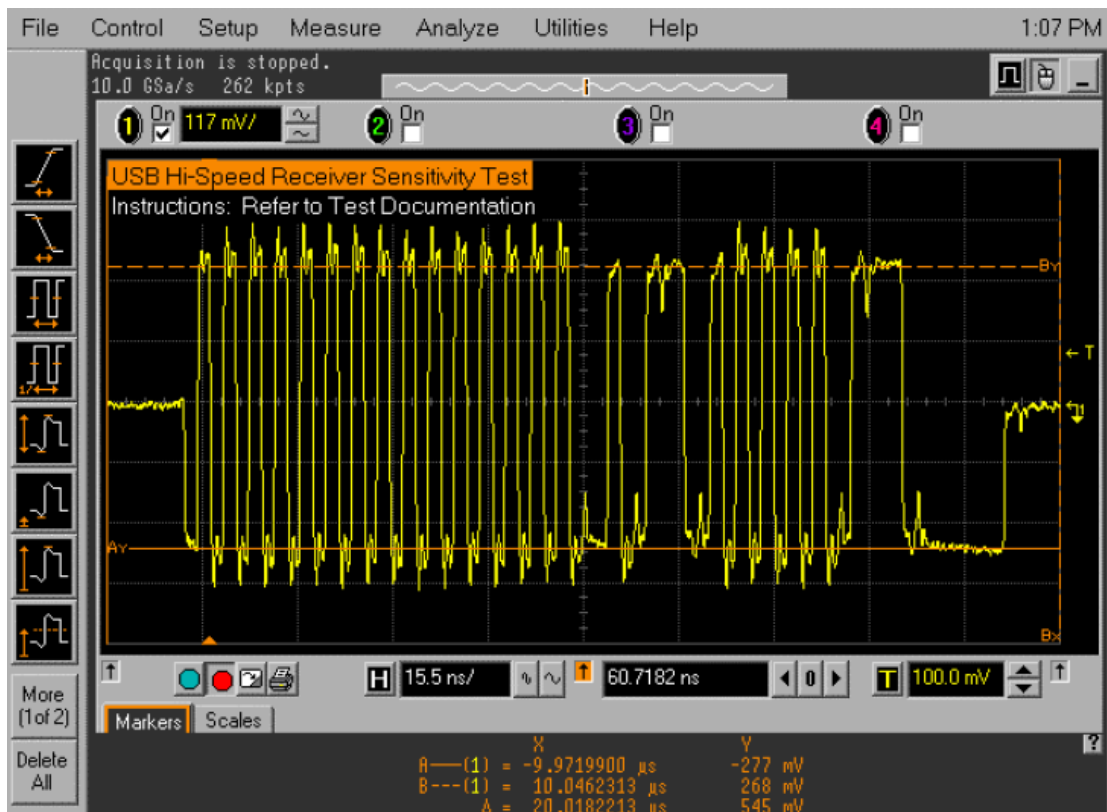


Figure 59. Measuring the packet amplitude

3.4. Host High-Speed Signal Test

- Host High-Speed Signal Quality Test
 - **EL_2:** Data Rate Test
 - **EL_3:** Eye Pattern and Mask Test
 - **EL_6:** Rise and Fall Time Test
 - **EL_7:** Non-Monotonic Edge Test
- Host Packet Parameters Test
 - **EL_21:** Sync Field Length Test
 - **EL_25:** EOP Length Test
 - **EL_23:** Inter-packet Gap Between First 2 Packets Test
 - **EL_22:** Measure Inter-packet Gap Between Host And Device Packet Test
 - **EL_55:** SOF EOP Width Test
- Host CHIRP Timing Test
 - **EL_33:** Measure Host CHIRP response time
 - **EL_34:** Measure Host CHIRP-J/K duration
- Host Suspend/Resume Timing Test
 - **EL_39:** Host Suspend Timing Response
 - **EL_41:** Host Resume Timing Response
- Host Test J/K, SE0_NAK Test
 - **EL_8:** Host J Test
 - **EL_8:** Host K Test
 - **EL_9:** Host SE0_NAK Test

3.4.1. HS host electrical test limits

Table 12. HS host Electrical Test limits

Test name	Pass limits
EL_2 Data rate	Within 480 Mb/s +/-0.05%
EL_3 Data Eye and Mask Test	Must meet Template 1 transform waveform requirements at TP2
EL_6 Host rise/fall time	>500 ps
EL_7 Host Non-Monotonic Edge Test	Must have monotonic data transitions over the vertical openings
EL_21 Sync Field Length Test	32 bits, 65.62 ns <= VALUE <= 67.700 ns
EL_25 EOP Length Test	8 bits, 15.620 ns <= VALUE <= 17.700 ns
EL_23 Inter-packet gap between first 2 Packets Test	183.000 ns <= VALUE <= 399.400 ns
EL_55 SOF EOP Width Test	40 bits, 81.100 ns <= VALUE <= 83.388 ns
EL_22 Inter-packet gap between Host and Device Packet Test	16.640 ns <= VALUE <= 399.90 ns
EL_33 CHIRP timing response	1 ns <= VALUE <= 100.000 μ s
EL_34 CHIRP J/K width	40.000 μ s <= VALUE <= 60.000 μ s

EL_35 SOF Timing Response	100.000 μ s \leq VALUE \leq 500.000 μ s
EL_39 Suspend Timing Response	3.000 ms \leq VALUE \leq 3.125 ms
EL_41 Resume Timing Response	VALUE \leq 3.000 ms
EL_8 Host J Test	360 mV \leq D+ \leq 440 mV -10mV \leq D- \leq 10 mV
EL_8 Host K Test	360 mV \leq D- \leq 440 mV -10 mV \leq D+ \leq 10 mV
EL_9 Host SE0_NAK Test	-10 mV \leq D+ \leq 10 mV -10 mV \leq D- \leq 10 mV

3.4.2. Test method and tool

In USB Certification, the host is a product based on Windows x86 or x64 systems, which can implement the HS Electrical Test Tool to run the Host test. An Embedded Host is a product based on Linux, Android, or other RTOS. USB-IF defines a method of entering the specified test modes via PID/VID detection. See chapter 6.4.1 of On-The-Go and Embedded Host Supplement to the USB specification for further information.

The certification lab provides an HSEHET Board to perform the Host or Embedded Host test. This board can be set to different PIDs, as shown in [Figure 60](#).

Table 13. Test modes product ID definitions

PID	Test Mode
0x0101	Test_SE0_NAK
0x0102	Test_J
0x0103	Test_K
0x0104	Test_Packet
0x0105	Reserved
0x0106	HS_HOST_PORT_SUSPEND_RESUME
0x0107	SINGLE_STEP_GET_DEV_DESC
0x0108	SINGLE_STEP_GET_DEV_DESC_DATA

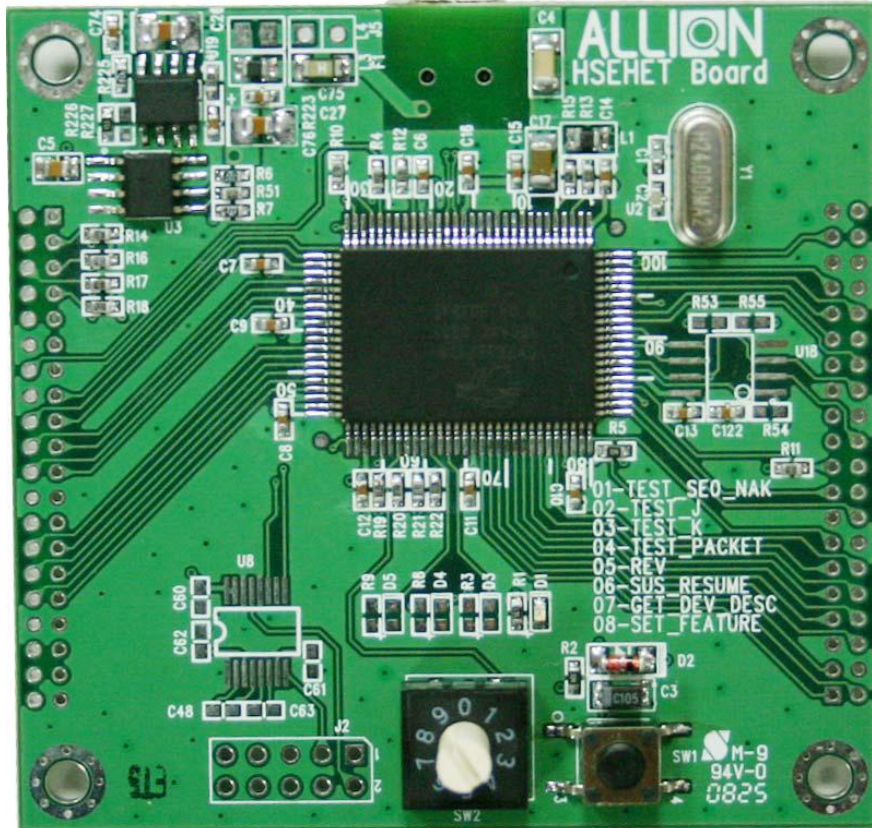


Figure 60. HSEHET board for Host High-Speed Test

3.4.3. Host High-speed Signal Quality Test

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 61](#). Make sure to set the Test Type configuration option to Hi-Speed Near End before running the test.
2. Connect the equipment and test fixture as shown in [Figure 63](#).
3. Attach the 5 V power supply to J5 of the Host Hi-Speed signal quality test fixture (E2649-66402). Leave the test switch at the off position. Ensure the green Power LED is lit and the yellow test LED is not lit.
4. Connect the **Test Port** of the test fixture into the downstream facing port of the DUT, using the 4 inch USB cable.
5. Before connecting the HSEHET Board, select the **Test_Packet**. Then connect the board to the **Init Port** with a 5 meter cable.
6. Attach the differential probe on channel 1 to D+/D- of TP2 on the test fixture. Ensure the + polarity on the probe lines up with D+.
7. Click on the **Run Tests** button of the Automated Test software on the oscilloscope.
8. The host enumerates the HSEHET board and responds to continuously send the **test_packet**.

- Switch the test fixture to switch the termination on. Ensure the yellow test LED is lit.
9. You should see the transmitted test packet on the oscilloscope as shown in [Figure 64](#).
 10. When the Testing Complete dialog appears, click on **Ok**. The **Results** tab shows the test results, and the **Html Report** shows the complete report.

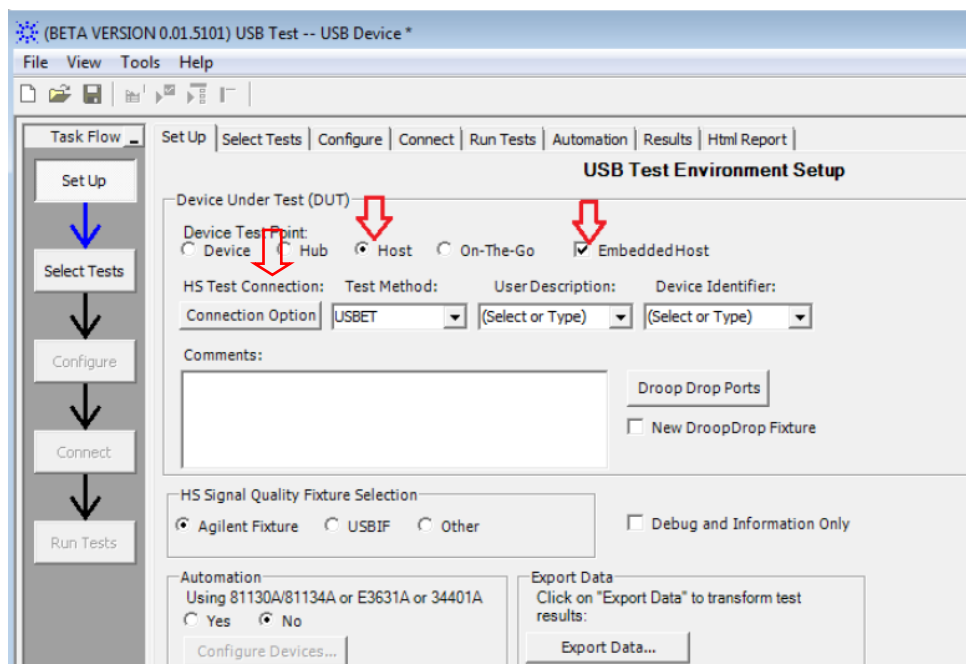


Figure 61. Select Embedded Host for HS Electrical Test¹

¹ Select Embedded Host for non-Windows products. Click on the Connection Option button here to select a differential or single-end probe if you are using the latest software.

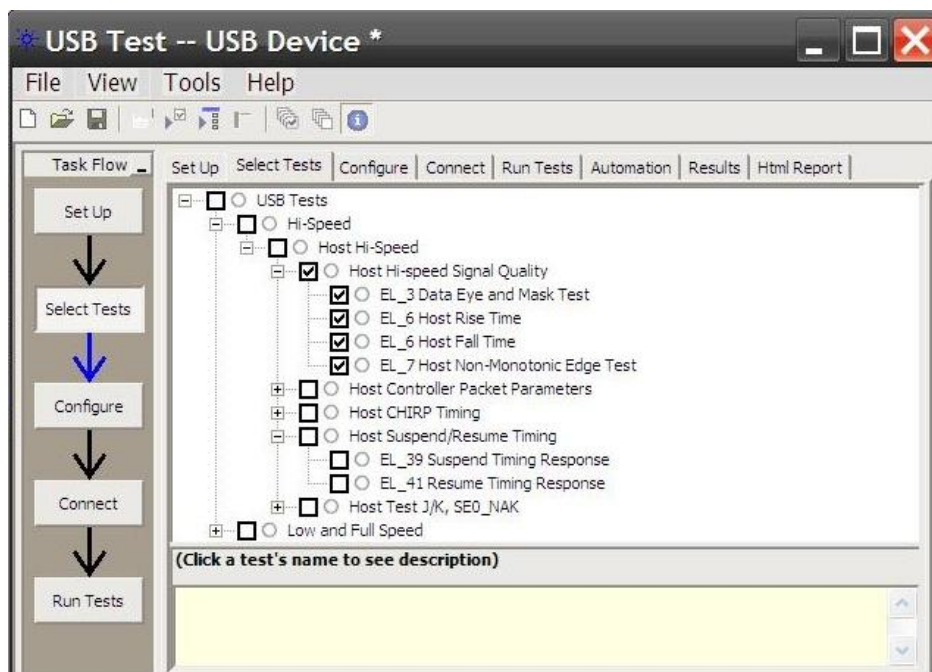


Figure 62. Host HS Signal Quality test

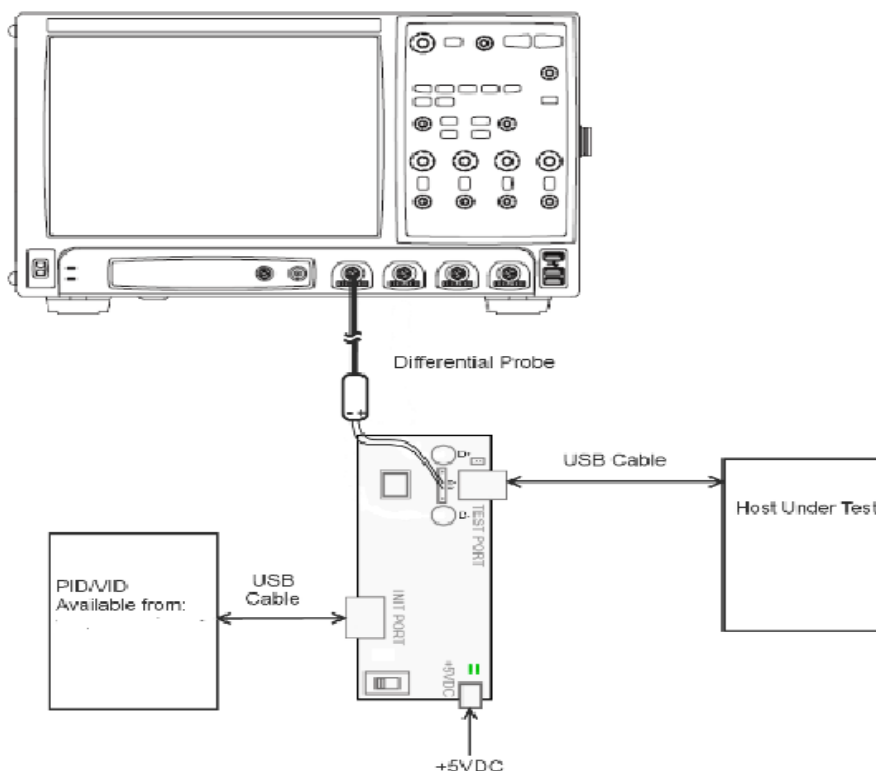


Figure 63. Host HS Signal Quality Test environment

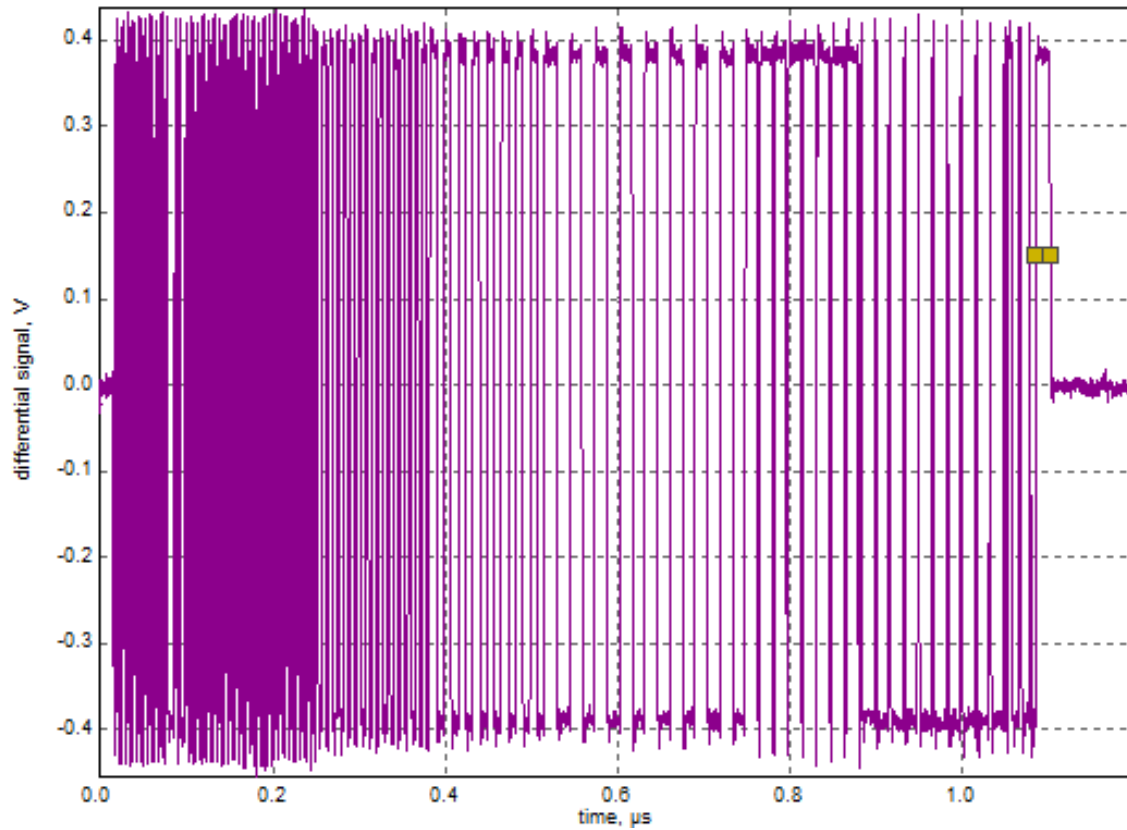


Figure 64. Host HS test packet

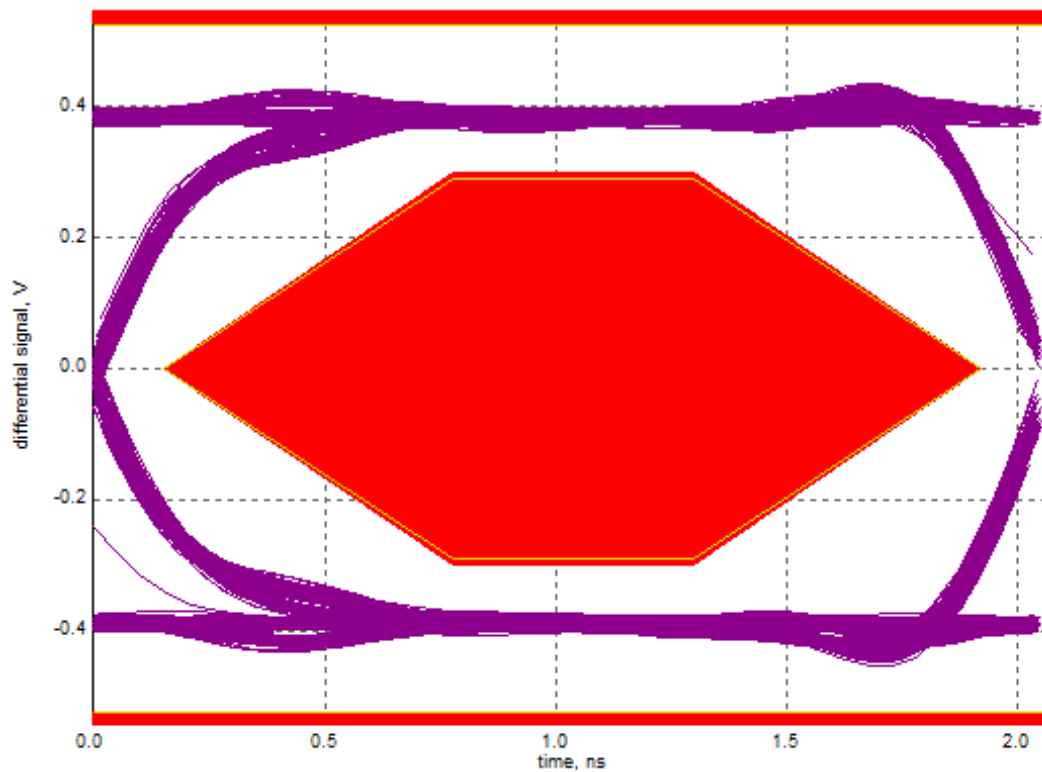


Figure 65. Host HS eye diagram

3.4.4. Host Packet Parameters Test

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 66](#), and make sure you set the Test Type configuration option to Hi-Speed Near End before running the test.
2. Connect the equipment and test fixture as shown in [Figure 63](#).
 - Attach the 5 V power supply to J5 of the Host Hi-Speed signal quality test fixture (E2649- 66402). Leave the test switch at the off position. Verify the green power LED is lit and the yellow test LED is not lit.
 - Connect the **Test Port** of the test fixture into the downstream facing port of the DUT, using the 4 inch USB cable.
 - Before connecting the HSEHET Board, select its correct position at **SINGLE_STEP_GET_DEVICE_DESCRIPTOR**. Then connect the board to the **Init Port** with a 5 meter cable.
 - Attach the differential probe on channel 1 to D+/D- of TP2 on the test fixture. Ensure the + polarity on the probe lines up with D+.
3. Click the **Run Tests** button of the Automated Test software on the oscilloscope.
4. The host enumerates the HSEHET board and responds by sending **SOFs** for 15 seconds. Click on **OK** to close the Test Instruction dialog.
5. After the **SOFs** sending is complete the host initiates the setup phase of the **GetDescriptor()** command. The host sends **SETUP** and **DATA** (first and second packet), then the device sends an **ACK**. You should see the transmitted test packet on the oscilloscope as shown in [Figure 70](#). Click on **OK** to close the Test Instruction dialog.
6. Disconnect the HSEHET Board, select **SINGLE_STEP_GET_DEVICE_DESCRIPTOR_DATA**, then reconnect it to the test fixture.
7. The host enumerates the HSEHET board and requests **GetDescriptor()**, then waits for 15 seconds. The host then initiates an **IN** token, the device responds with a **DATA**, then the host sends an **ACK**. You should see the transmitted test packet on the oscilloscope as shown in [Figure 71](#).
8. When the Testing Complete dialog appears, click on **Ok**. The **Results** tab shows the test results, and the **Html Report** shows the complete report.

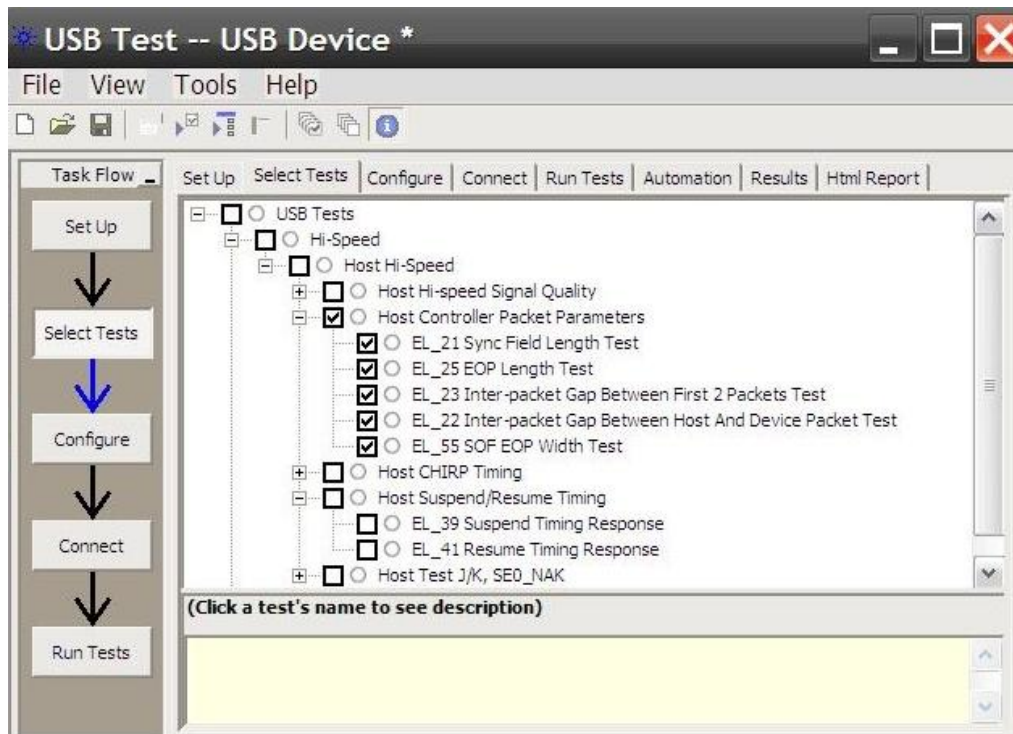


Figure 66. Host HS Packet Parameters Test

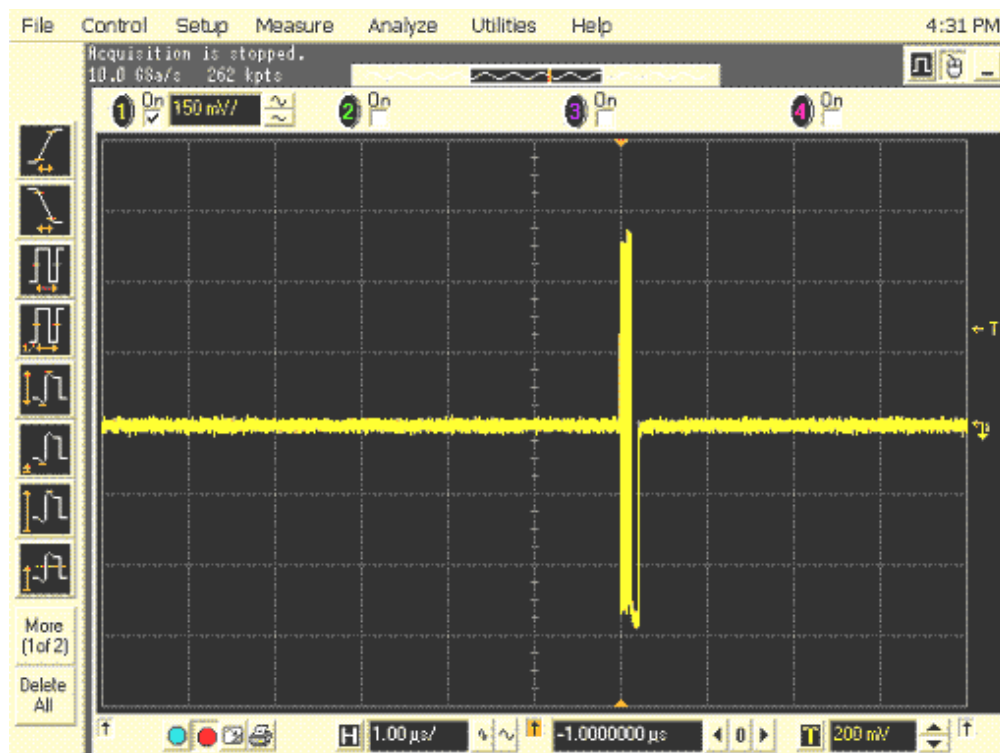


Figure 67. Host SOF waveform

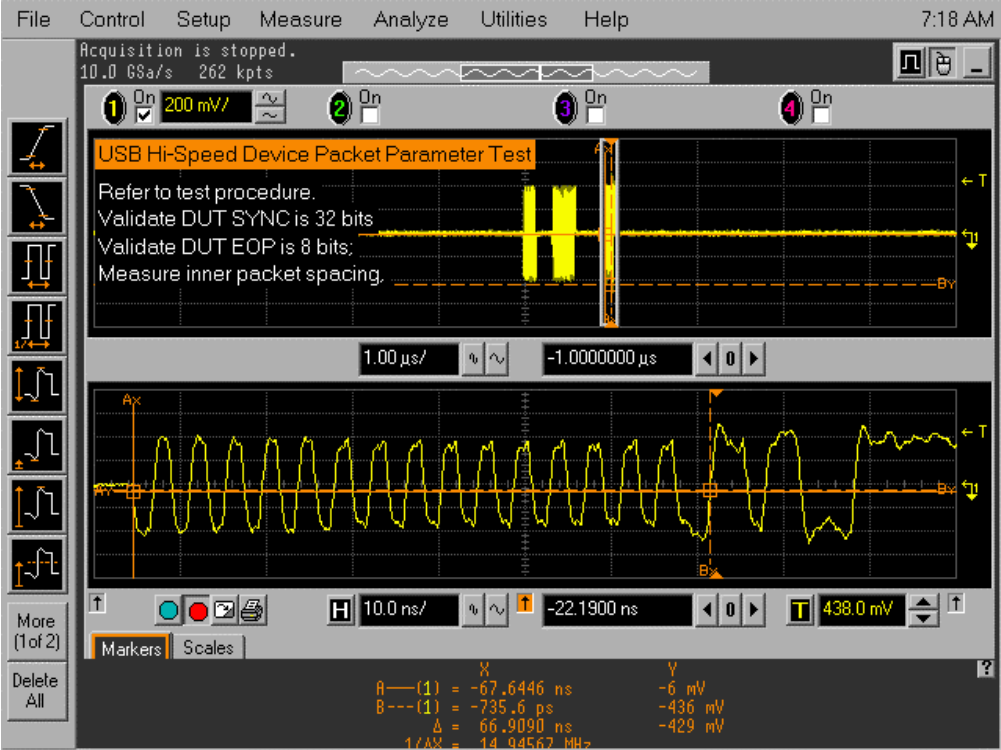


Figure 68. EL_21 host sync field length waveform

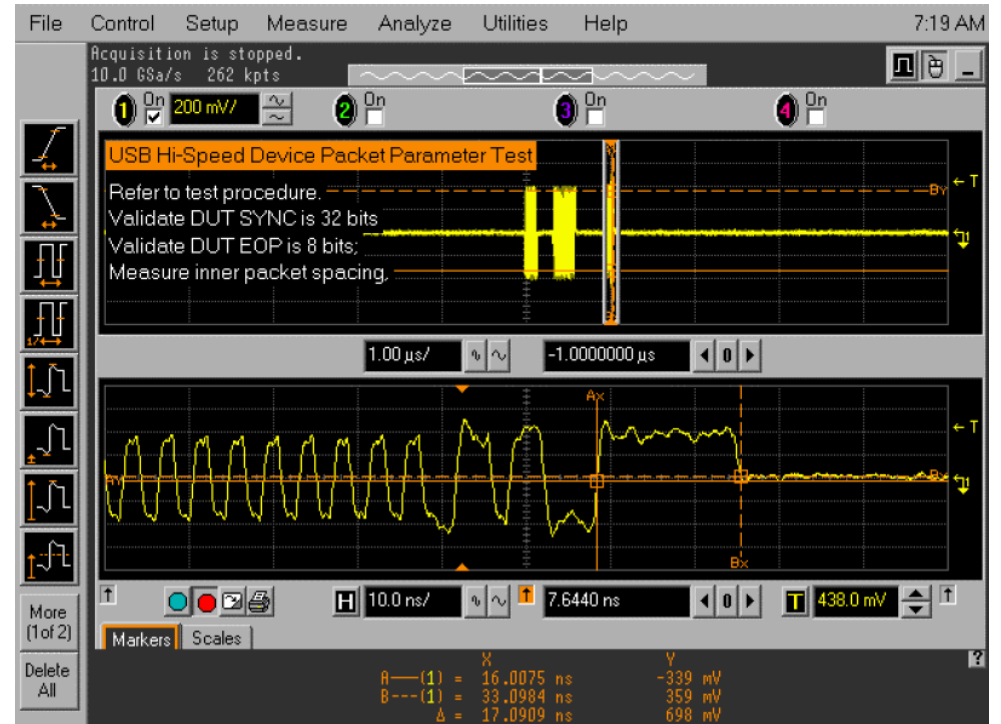


Figure 69. EL_25 host EOP length waveform

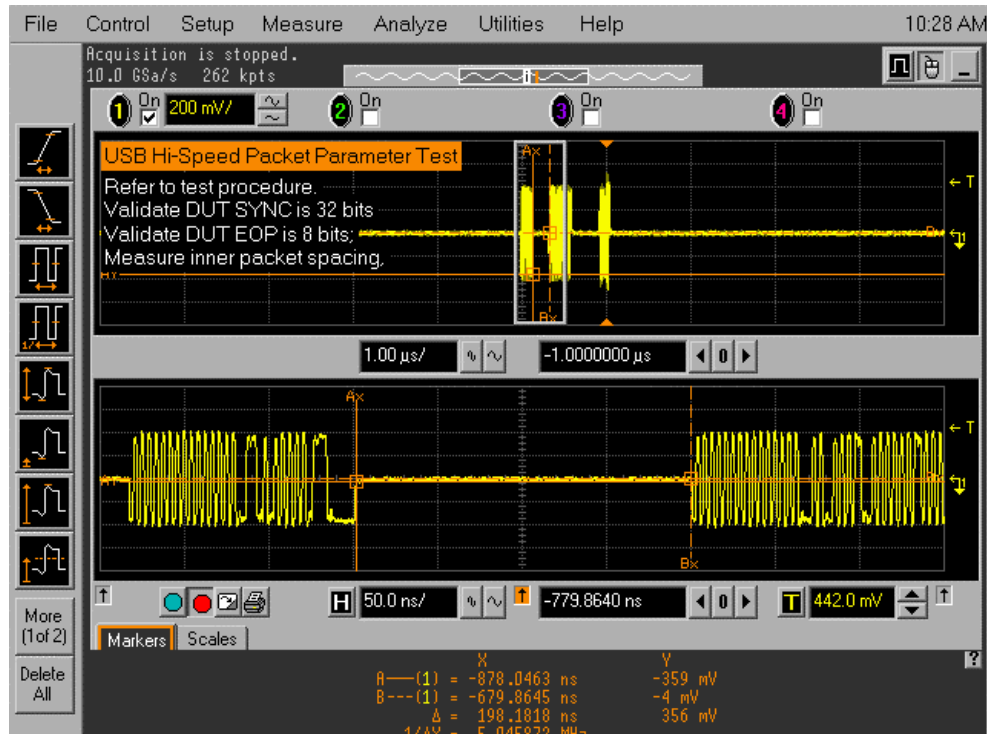


Figure 70. EL_23 host inter-packet gap waveform

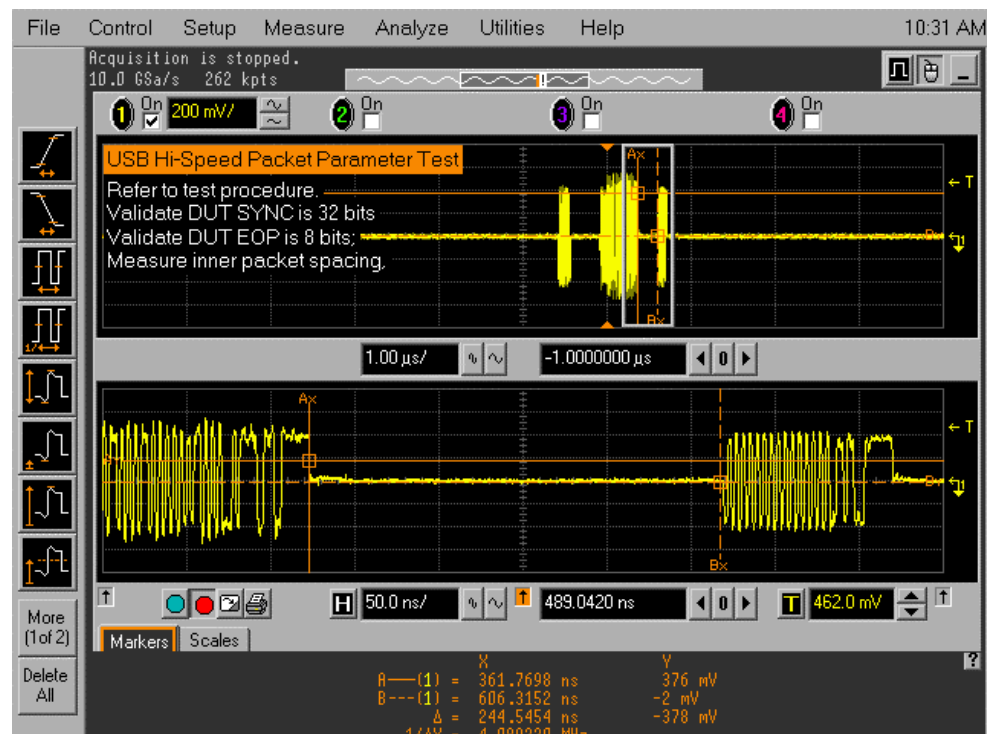


Figure 71. EL_22 Host Inter-packet gap (host response to device) waveform

3.4.5. Host CHIRP Timing Test

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 72](#). Ensure that the Test Type configuration option is set to Hi-Speed Near End before running the test.
2. Connect the equipment and test fixture as shown in [Figure 73](#).
 - Attach the 5 V power supply to J5 of the Host hi-speed signal quality test fixture (E2649-66402). Leave the test switch at the off position. Ensure that the green power LED is on and that the yellow test LED is off.
 - Connect the **Test Port** of the test fixture into the downstream facing port of the DUT using the 4 inch USB cable.
 - Attach the single-ended probes on channel 2 to D-, and attach channel 3 to D+ of TP2 on the test fixture.
3. Click the **Run Tests** button of the Automated Test software on the oscilloscope.
4. Connect a good high-speed device to the initialize port. You must capture the CHIRP handshake as shown in [Figure 74](#).
5. When the Testing Complete dialog appears, click on **Ok**. The **Results** tab shows the test results, and the **Html Report** shows the complete report.

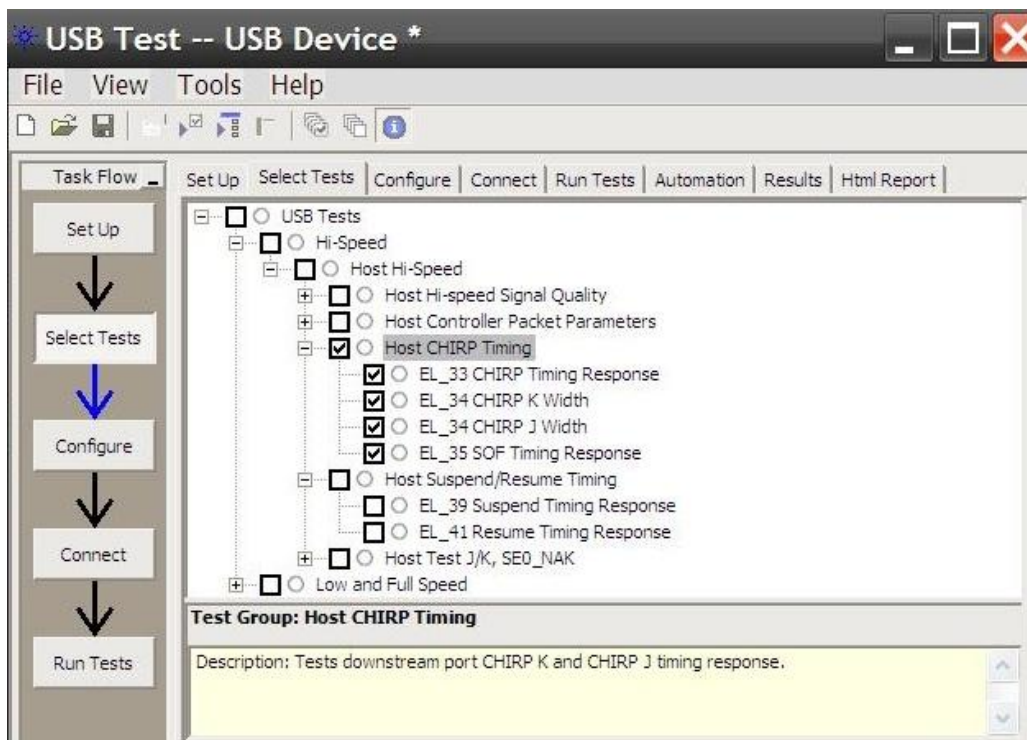


Figure 72. Host CHIRP Timing Test

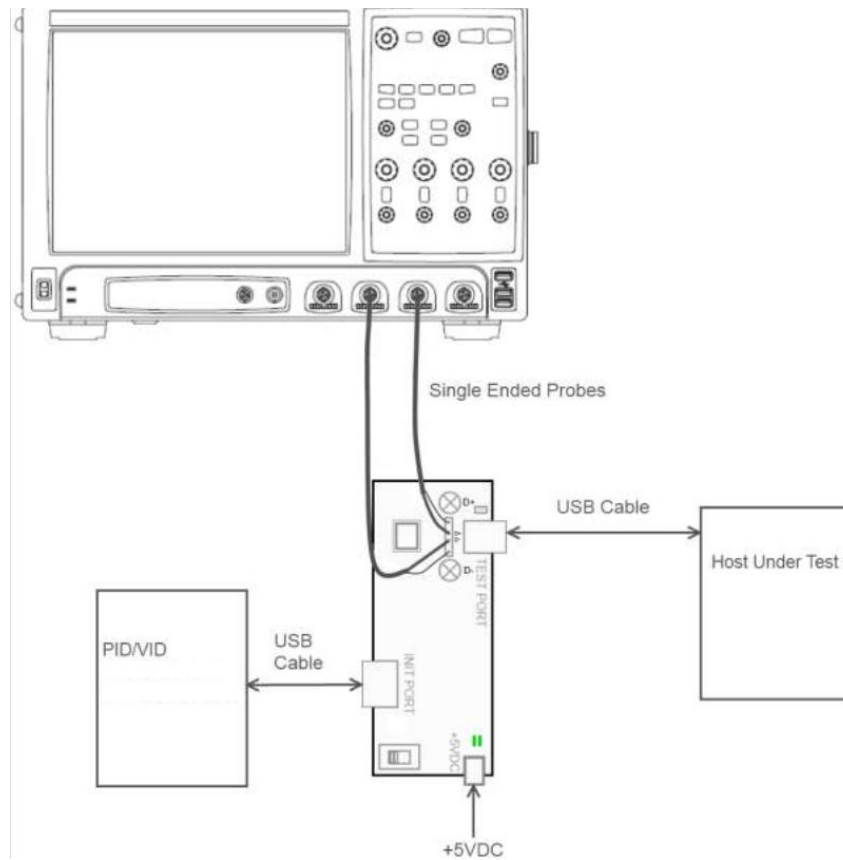


Figure 73. Host CHIRP Timing Test environment

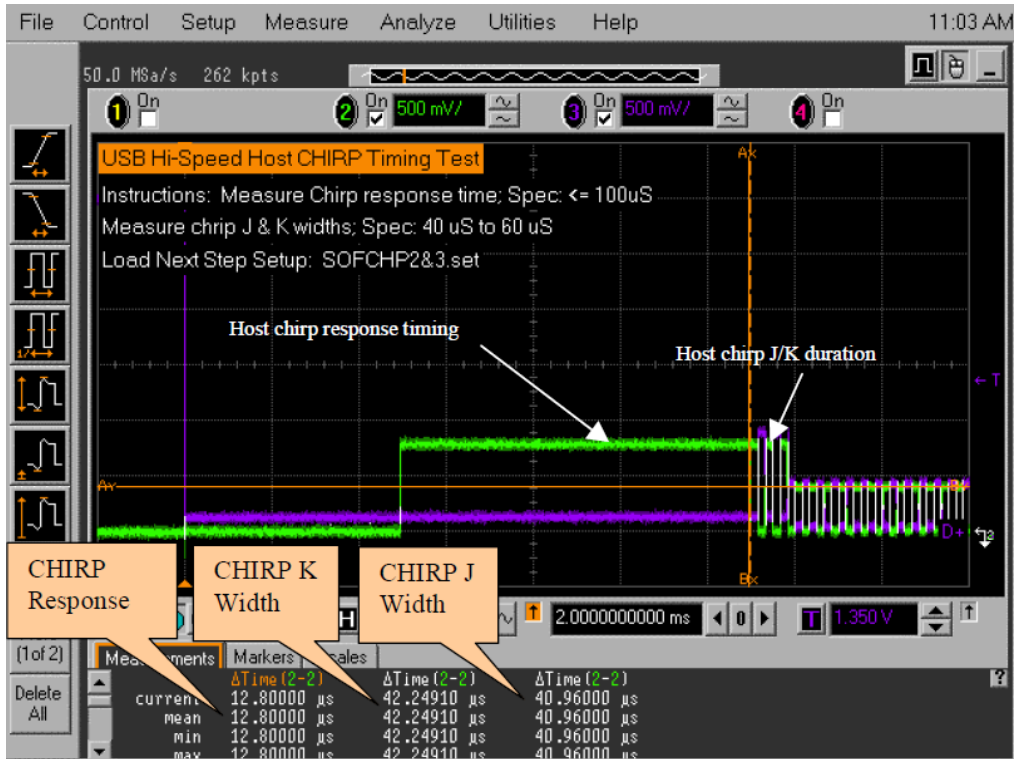


Figure 74. Host CHIRP J/K waveform

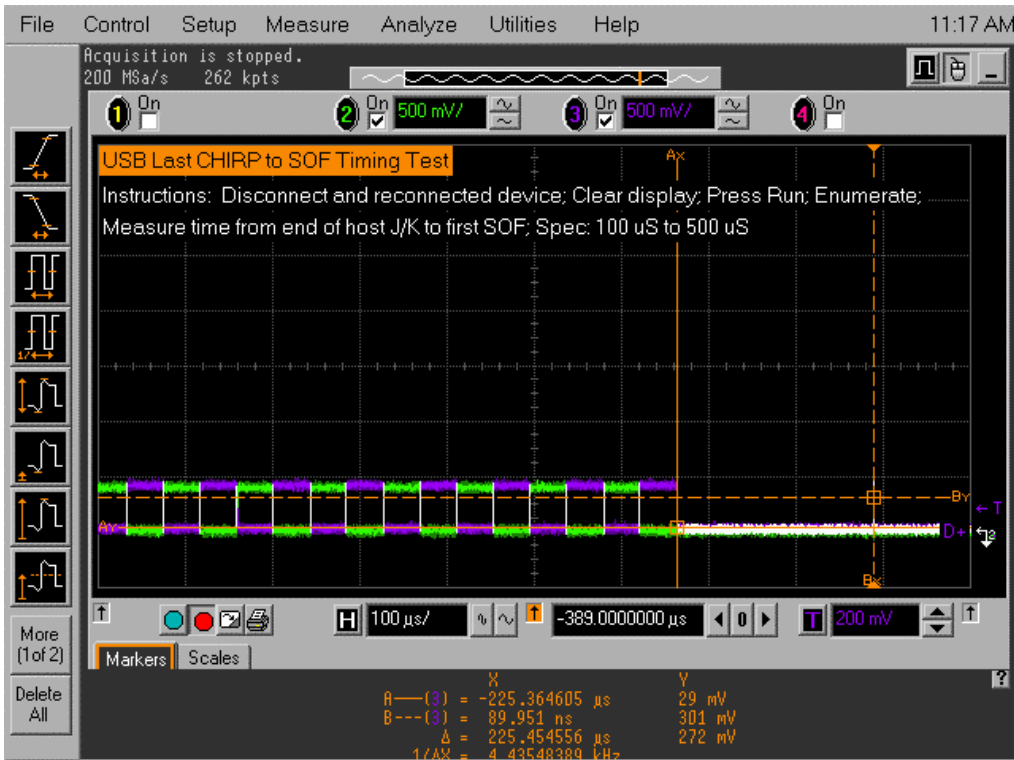


Figure 75. Time between SOF and last chirp-J/K

3.4.6. Host Suspend/Resume Timing Test

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 76](#), and ensure that the Test Type configuration option is set to Hi-Speed Near End before running the test.
2. Connect the equipment and test fixture as shown in [Figure 73](#).
 - Attach the 5 V power supply to J5 of the Host hi-speed signal quality test fixture (E2649-66402). Leave the test switch at the off position. Ensure that the green power LED is on and the yellow test LED is off.
 - Connect the **Test Port** of the test fixture into the downstream facing port of the DUT using the 4 inch USB cable.
 - Attach the single-ended probes on channel 2 to D-, and attach channel 3 to D+ of TP2 on the test fixture.
3. Before connecting the HSEHET Board select **HS_HOST_PORT_SUSPEND_RESUME**. Connect the board to the **Init Port** with a 5 meter cable.

NOTE

The HSEHET board should be attached before clicking on the **Run Tests** button, in case that you capture the Bus Enumeration instead of Suspend transition.

4. Click the **Run Tests** button of the Automated Test software on the oscilloscope.
5. After 15 seconds the host port will enter Suspend state, as shown in [Figure 77](#). The captured transition should be as shown in [Figure 77](#). Click on OK to close the Test Instruction dialog.
6. After 15 seconds of suspend state the host shall issue a Resume K state on the bus, then continue sending SOFs. The captured transition should be as shown in [Figure 78](#).
7. When the Testing Complete dialog appears, click on **Ok**. The **Results** tab shows the test results, and the **Html Report** shows the complete report.

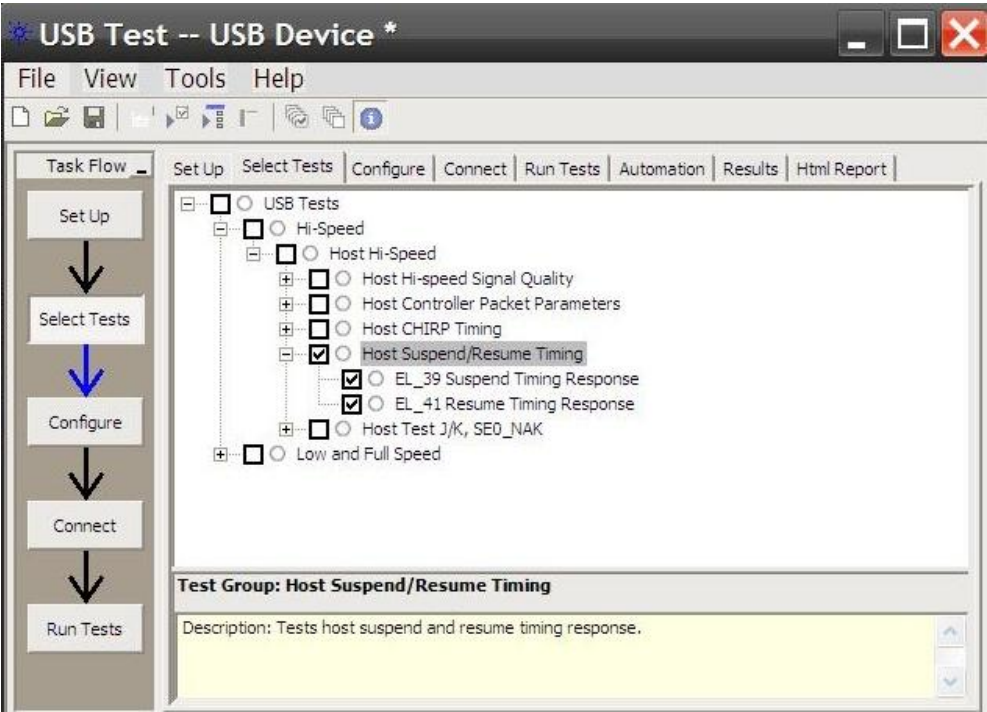


Figure 76. Host Suspend/Resume Timing Test

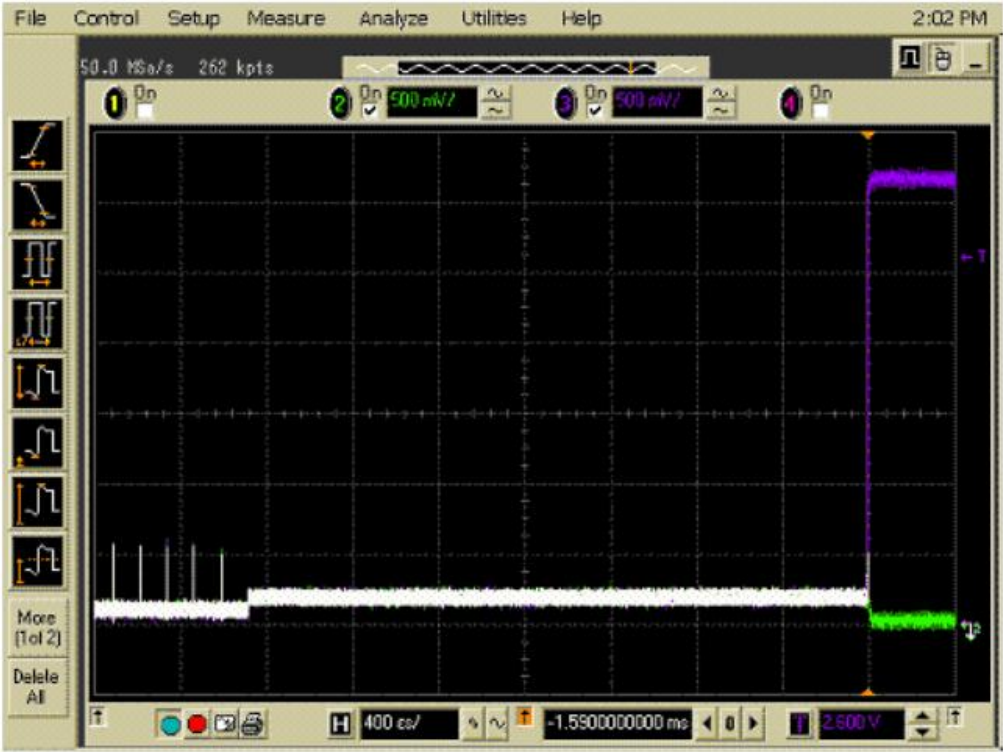


Figure 77. EL_39 host suspend waveform

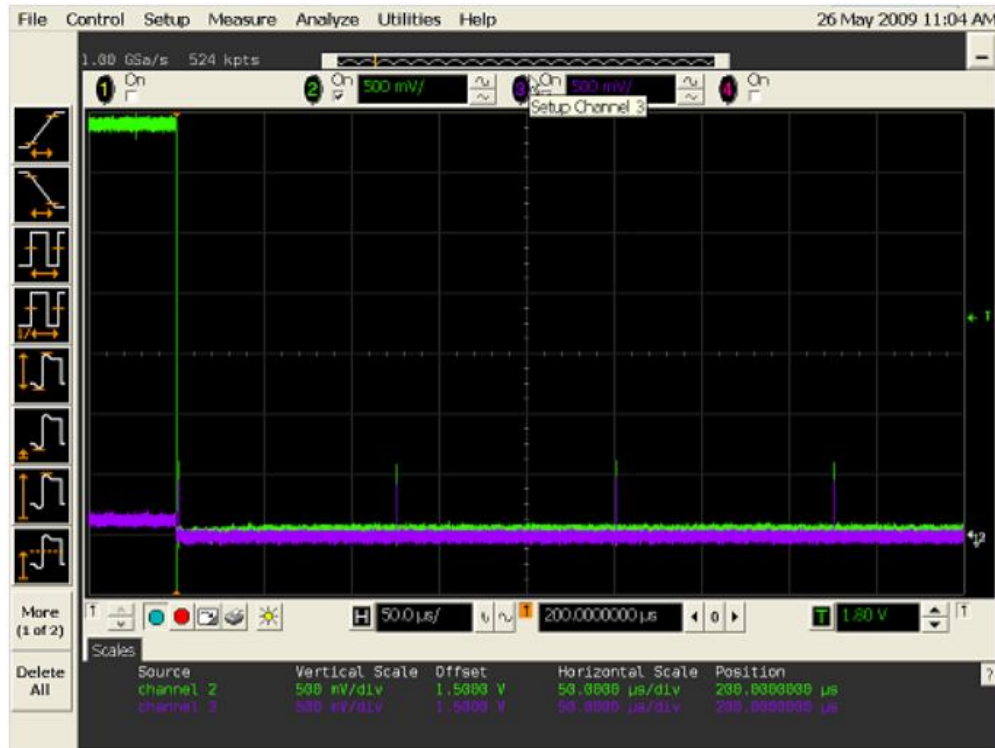


Figure 78. EL_41 host resume waveform

3.4.7. Host test J/K, SE0_NAK Test

Test instructions:

1. Select the test items in the USB Automated Test software on the oscilloscope as shown in [Figure 79](#) and make sure you set the Test Type configuration option to Hi-Speed Near End before running the test.
2. Connect the equipment and test fixture as shown in [Figure 80](#).
 - Attach the 5V power supply to J5 of the Host Hi-Speed signal quality test fixture (E2649-66402). Leave the test switch at the off position. Verify the green power LED is lit and the yellow test LED is not lit.
 - Connect the **Test Port** of the test fixture into the downstream facing port of the DUT, using the 4 inch USB cable.
 - Before connecting the HSEHET Board, put it in the right position by selecting **Test_J**. Then connect the board to the **Init Port** with a 5m cable.
 - Attach the single-ended probes on channel 2 to D-, channel 3 to D+ of TP2 on the test fixture.
3. Click on the **Run Tests** button of Automated Test Software on the oscilloscope.
4. The host enumerates the HSEHET board and enters a hi-speed **J state** (D+ high; D- low). Switch on the test fixture, this switches the termination on. Verify the yellow TEST LED is lit. Use a multimeter to measure the DC voltage on the D+/- lines at TP2 with respect to GND, then record the measurement in the pop out dialog.

5. Switch the test fixture to OFF mode.
6. Press the RESET button on DUT or repower it to reset the system.
7. Detach the HSEHET board from the **Init Port** of the test fixture and select **Test_K**. Then connect the board to the **Init Port** again with a 5 meter cable.
8. The host enumerates the HSEHET board and enters a hi-speed **K state** (D+ low; D- high). Switch on the test fixture, this switches on the termination. Verify the yellow TEST LED is lit. Use a multimeter to measure the DC voltage on the D+/- lines at TP2 with respect to GND, then record the measurement in the pop out dialog.
9. Switch the test fixture to off mode.
10. Remove the HSEHET board from the **Init Port** of the test fixture and select **Test_SE0_NAK**. Then connect the board to the **Init Port** again with a 5 meter cable.
11. The host enumerates the HSEHET board and enters the **SE0 State** (D+ low; D- low). Switch on the test fixture, this switches on the termination. Verify the yellow test LED is lit. Use a multimeter to measure the DC voltage on the D+/- lines at TP2 with respect to GND, then record the measurement in the pop out dialog.
12. When the Testing Complete dialog appears, click on **Ok**. The **Results** tab shows the test results, and the **Html Report** shows the complete report.

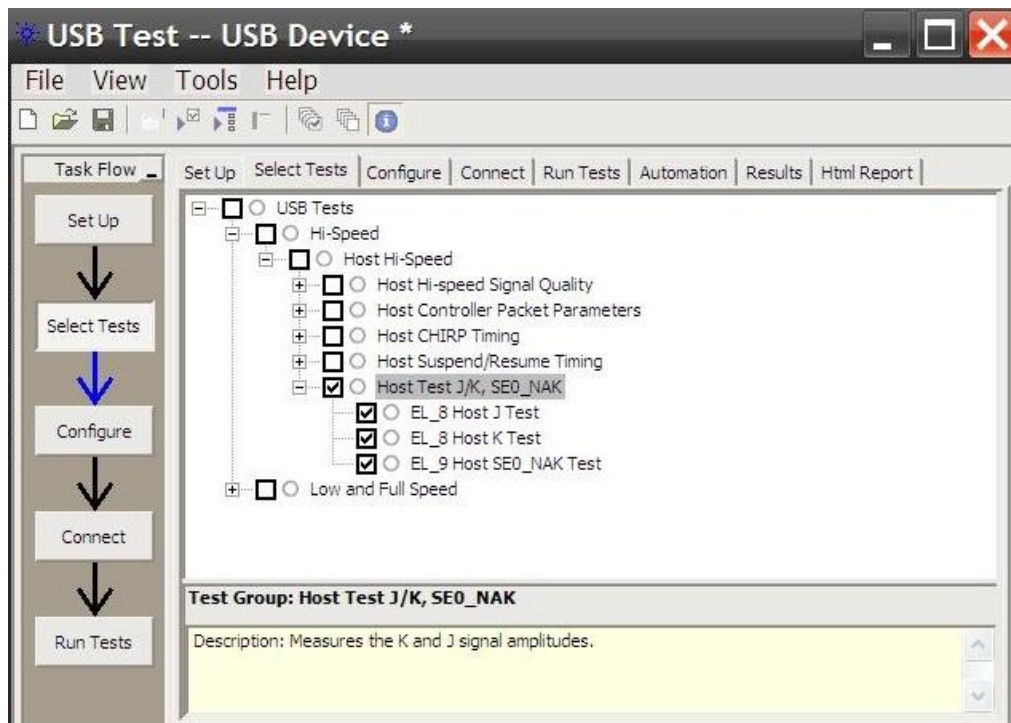


Figure 79. Host Test_J/K, SE0_NAK Test

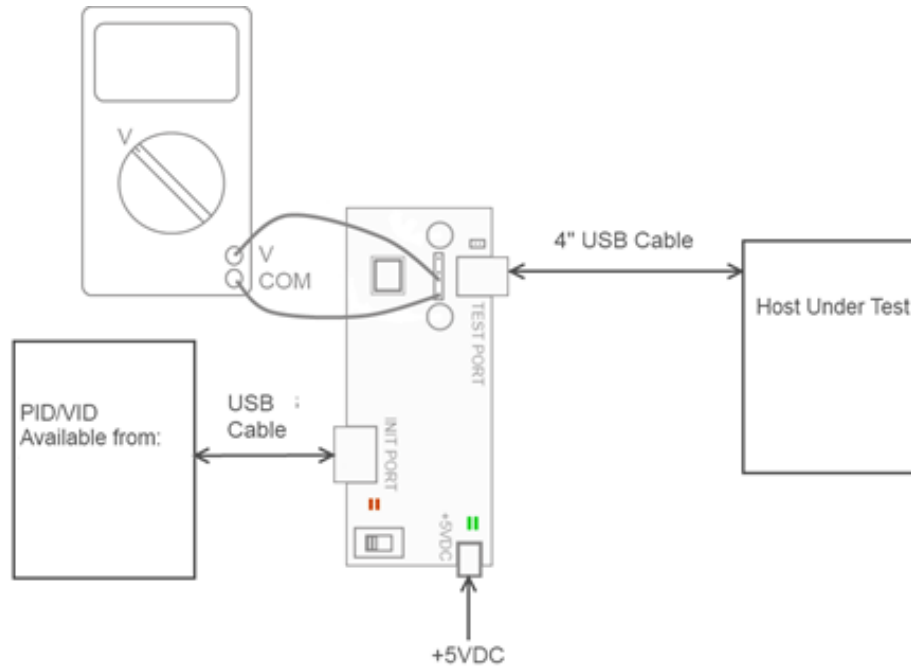


Figure 80. Host Test_J/K, SE0_NAK Test environment

Table 14. Host Drop Test record

Test mode	D+ Voltage(mV)	D- Voltage(mV)	Expected value
J	400	4	360 mV <= D+ <= 440 mV -10 mV <= D- <= 10 mV
K	4	400	360 mV <= D- <= 440 mV -10 mV <= D+ <= 10 mV
SE0_NAK	1	1	-10 mV <= D+ <= 10 mV -10 mV <= D- <= 10 mV

3.5. i.MX 6 series USB PHY registers and software configurations

USB signal integrity depends on many factors, such as circuit design, PCB layout, stack-up, and impedance. Each product may be different from one another, so customers need to fine-tune the parameters in order to obtain the best signal quality.

The test board has routed out two USB Ports: one OTG¹, and one host. Each of the ports has several registers to adjust the signal voltage level and slew rate. See the detailed description of the registers in the document *Configuring USB on i.MX 6 Series* ([AN4589](#)).

3.5.1. USBPHYx_TXn

The USB PHY Transmitter Control Register handles the transmit controls. Bit fields TXCAL45DP and TXCAL45DM, D_CAL adjust the output voltage amplitude.

¹ The software does not support full feature OTG, this port is usually used as a device or Embedded Host, selected by USB_ID.

Command samples:

```

/unit_tests/memtool 0x20c9010 1 // OTG Port Read register data
/unit_tests/memtool 0x20cA010 1 // Host Port Read register data

/unit_tests/memtool 0x20c9010=0x1c060607 //write OTG_PHY_TX1
/unit_tests/memtool 0x20cA010=0x1c060607 //write HOST_PHY_TX

```

Table 15. USBPHYx_TXn register settings

Name	USBPHYx_TXn															
Description	The USB PHY Transmitter Control Register handles the transmit controls.															
Bit #	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reset value	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
Field definitions	RSVD5			TX_EDGECTRL			TX_SYNC_INVERT	TX_SYNC_MUX	RSVD4		TXENCAL45DP	RSVD3	TXCAL45DP			
Bit #	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reset value	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1
Field definitions	RSVD2		TXENCAL45DN	RSVD1	TXCAL45DN				RSVD0				D_CAL			
Signal Names	Description															
TXCAL45DP	Bit fields TXCAL45DP and TXCAL45DM enable changing of the resistance of the high-speed termination. Increasing the termination resistor value will increase the DM/DP signals level. Decode to select a 45 ohm resistance to the USB_DP output pin. Maximum resistance = 0000.															
TXCAL45DN	Decode to select a 45 ohm resistance to the USB_DN output pin. Maximum resistance = 0000.															
D_CAL	With this field the current reference for the high-speed driver can be trimmed. Reducing the resistance will increase the driver current and therefore the amplitude of the transmitted signal will increase. Resistor Trimming Code: 0000 = 0.16% 0111 = Nominal 1111 = +25%															

¹ Remember to connect DUT to the corresponding host/device before adjusting the registers, otherwise the operation might be invalid or may cause the system to crash.

Table 16. USBPHYx_TXn register settings

Name	PMU_REG_3P0																
Description	This register defines the control and status bits for the 3.0 V regulator powered by the host USB VBUS pins.																
Bit #	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
Reset value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Field definitions	Reserved														OK_VDD3P0	BO_VDD3P0	
Bit #	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
Reset value	0	0	0	0	1	1	1	1	0	1	1	1	0	1	1	0	
Field definitions	Reserved			OUTPUT_TRG					REG_3P0_VBUS_SEL		BO_OFFSET			Reserved	ENABLE_ILIMIT	ENABLE_BO	ENABLE_LINREG
Signal Names	Description																
OUTPUT_TRG	Control bits to adjust the regulator output voltage in 25 mV steps. 0x1F - 3.4 V 0x0F - 3.0 V 0x00 - 2.625 V Note that the chip functionality may be limited and not guaranteed near the extremes of the programming range.																
ENABLE_LIN REG	Control bit to enable the regulator output																

3.5.3.USBC_n_PORTSC1

Port control is usually used for status port reset, suspend, and current connect status. Port control is also used to initiate test mode or force signaling and allows software to put the PHY into low power suspend mode and disable the PHY clock.

Command samples:

```

/unit_tests/memtool 0x2184184 1 //OTG Port Read register data
/unit_tests/memtool 0x2184184=0x18441205 //OTG Port Test packet
/unit_tests/memtool 0x2184184=0x18411205 //OTG Port J_STATE
/unit_tests/memtool 0x2184184=0x18421205 //OTG Port K_STATE
/unit_tests/memtool 0x2184184=0x18431205 //OTG Port SE0 (host) / NAK (device)
/unit_tests/memtool 0x2184184=0x18401305 //OTG Port Reset

```

```

/unit_tests/memtool 0x2184184=0x18401285 //OTG Port Suspend
/unit_tests/memtool 0x2184184=0x18401245 //OTG Port Resume

/unit_tests/memtool 0x2184384 1 //Host Port Read register data
/unit_tests/memtool 0x2184384=0x18441205 //Host Port Test packet
/unit_tests/memtool 0x2184384=0x18411205 //Host Port J_STATE
/unit_tests/memtool 0x2184384=0x18421205 //Host Port K_STATE
/unit_tests/memtool 0x2184384=0x18431205 //Host Port SE0 (host) / NAK (device)
/unit_tests/memtool 0x2184384=0x18401305 //Host Port Reset
/unit_tests/memtool 0x2184384=0x18401285 //Host Port Suspend
/unit_tests/memtool 0x2184384=0x18401245 //Host Port Resume

```

Table 17. USBC_n_PORTSC1 register settings

Name	USBC_n_PORTSC1															
Description	This register defines the control and status bits for the 3.0 V regulator powered by the host USB VBUS pin. It is also used to initiate test mode or force signaling and allows software to put the PHY into low-power suspend mode and disable the PHY clock.															
Bit #	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reset value	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Field definitions	PTS_1		STS	PTW	PSPD		PTS_2	PFSC	PHCD	WKOC	WKDC	WKN	PTC			
Bit #	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reset value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Field definitions	PIC		PO	PP	LS		HSP	PR	SUSP	FPR	OCC	OCA	PEC	PE	CSC	CCS
Field	Description															
PTC	Port Test Control - Read/Write. Default = 0000 b. Refer to Port Test Mode for the operational model for using these test modes and chapter 7 of the USB Specification, for details on each test mode. The FORCE_ENABLE_FS and FORCE_ENABLE_LS are extensions to the test mode support specified in the EHCI specification. Writing the PTC field to any of the FORCE_ENABLE_{HS/FS/LS} values will force the port into the connected and enabled state at the selected speed. Writing the PTC field back to TEST_MODE_DISABLE will enable the port state machines to progress normally from that point. NOTE: Low-speed operations are not supported as a peripheral device. Any value other than zero indicates that the port is operating in test mode. Value Specific Test: 0000 TEST_MODE_DISABLE 0001 J_STATE 0010 K_STATE 0011 SE0 (host) / NAK (device) 0100 Packet 0101 FORCE_ENABLE_HS 0110 FORCE_ENABLE_FS 0111 FORCE_ENABLE_LS 1000-1111 Reserved															

Field	Description
PR	<p>Port Reset - Read/Write or Read Only. Default = 0 b.</p> <p>In Host Mode: Read/Write. 1=Port is in Reset. 0=Port is not in Reset. Default 0.</p> <p>When software writes a one to this bit the bus-reset sequence as defined in the USB Specification Revision 2.0 is started. This bit will automatically change to zero after the reset sequence is complete. This behavior is different from EHCI where the host controller driver is required to set this bit to a zero after the reset duration is timed in the driver. In Device Mode: This bit is a read only status bit. Device reset from the USB bus is also indicated in the USBSTS register.</p>
SUSP	<p>Suspend - Read/Write or Read Only. Default = 0 b.</p> <p>1=Port in suspend state. 0=Port not in suspend state.</p> <p>In Host Mode: Read/Write.</p> <p>Port Enabled Bit and Suspend bit of this register define the port states as follows:</p> <p>Bits [Port Enabled, Suspend] Port State</p> <p>0x Disable</p> <p>10 Enable</p> <p>11 Suspend</p> <p>When in suspend state, downstream propagation of data is blocked on this port, except for port reset. The blocking occurs at the end of the current transaction if a transaction was in progress when this bit was written to 1. In the suspend state, the port is sensitive to resume detection. Note that the bit status does not change until the port is suspended and that there may be a delay in suspending a port if there is a transaction currently in progress on the host controller will unconditionally set this bit to zero when software sets the Force Port Resume bit to zero. The host controller ignores a write of zero to this bit. If host software sets this bit to a one when the port is not enabled (that is, Port enabled bit is a zero) the results are undefined.</p>
FPR	<p>Force Port Resume -Read/Write. 1= Resume detected/driven on port. 0=No resume (K-state) detected/driven on port. Default = 0.</p> <p>In Host Mode.</p> <p>Software sets this bit to one to drive resume signaling. The Host Controller sets this bit to one if a J-to-K transition is detected while the port is in the Suspend state. When this bit transitions to a one because a J to K transition is detected, the Port Change Detect bit in the USBSTS register is also set to one. This bit will automatically change to zero after the resume sequence is complete. This behavior is different from EHCI where the host controller driver is required to set this bit to a zero after the resume duration is timed in the driver.</p> <p>In Device mode.</p> <p>After the device has been in Suspend State for 5 ms or more, software must set this bit to one to drive resume signaling before clearing. The Device Controller will set this bit to one if a J-to-K transition is detected while the port is in the Suspend state. The bit will be cleared when the device returns to normal operation. Also, when this bit will be cleared because a K-to-J transition detected, the Port Change Detect bit in the USBSTS register is also set to one.</p>

3.5.4. Other useful commands and scripts

Command samples:

```
echo mem > /sys/power/state           // Let the system enter suspend (standby) mode
echo enabled > /sys/class/tty/ttymx0/power/wakeup      // Set Console as the
system wakeup source
for i in $(find /sys -name wakeup | grep usb);do echo enabled > $i;echo "echo
enabled > $i";done;           // USB remote wakeup (as system wakeup source) is not
enabled by default, user can enable this feature by using this script, after
plugging in the USB device.
```

4. Device Framework Test

4.1. Introduction of Device Framework Test

When testing a USB device or hub you must test the USBCV (Command Verifier). It will automatically test the device framework and the descriptor. All USB 2.0 peripherals seeking certification are required to demonstrate enumeration on the USB 3.0 PDK. Both USB20CV and USB30CV tests are required. These test tools are available on the USB website at, <http://www.usb.org/developers/tools/>. Read the installation guide carefully before you start testing.

For hi-speed peripherals, the Chapter 9 tests must be executed twice, once in full-speed mode and once in hi-speed mode. It is not necessary to run HID, Mass-Storage (MSC), and Video Class (UVC) at both speeds.

Download the *Company List* at http://www.usb.org/developers/tools/comp_dump and save as usb.if in the same directory where USBCV is installed. You can find the company ID from this list. Remember this list changes very regularly, ensure you get the newest version when you use the tools.

Test items:

- USBCV Chapter 9
- USBCV Class Test
- USBCV Current Measurement Test

4.2. USBCV Chapter 9 Test

The Chapter 9 tests cover the device support of the commands set for the in Chapter 9 of the USB specification.

To see the detailed description of test items, see the following documents:

Universal Serial Bus Revision 2.0 USB Command Verifier Compliance Test Specification

Universal Serial Bus Revision 3.1 USB Command Verifier Compliance Test Specification

Test Items:

- TD 9.1: Device Descriptor Test
- TD 9.2: Configuration Descriptor Test
- TD 9.3: Interface Association Descriptor Test
- TD 9.4: Interface Descriptor Test
- TD 9.5: Endpoint Descriptor Test
- TD 9.7: BOS Descriptor Test
- TD 9.9: Halt Endpoint Test
- TD 9.12: Remote Wakeup Test
- TD 9.13: Set Configuration Test
- TD 9.14: Suspend/Resume Test
- TD 9.16: Enumeration Test
- TD 9.17: Other Speed Configuration Descriptor Test

- TD 9.18: Device Qualifier Descriptor Test
- TD 9.21: LPM L 1 Suspend Resume Test

Test instructions:

1. Install USB20CV on the test bed computer with USB2.0 ports, and USB30CV on the test bed Computer with USB3.0 ports.
2. Connect the downstream port of a HS hub to DUT, and the upstream port to the test bed computer. Ensure that the **gold-tree**¹ HS hub is used.
3. Run USB20CV² on your computer. Select **Chapter 9 Tests**, and then click the **Run** button to launch the tests.
4. Select the DUT device in the list, click on **Ok** as shown in [Figure 82](#).
5. After Chapter 9 tests are finished, the USB20CV pop out window shows which other tests need to be done, as shown in [Figure 83](#). The i.MX 6 series acts as a mass storage in Device Mode. If the pop-out box prompts you to do more tests than just the MSC you must check the configuration of the supported device class.
6. Click the **Launch Report Viewer** to view the test report. From the basic Chapter 9 Tests you can get **VID**, **PID**, and other information about the DUT. The VID must be your company **VID**. The **MSC** Serial number characters must be 0-9 or A-F in ASCII 0x0030-0x0039 or 0x0041-0x0046. For self-powered devices ensure that the device is currently **self powered**³, for bus-powered devices, verify that the device is currently **bus powered**.
7. Change the HS hub to a gold-tree FS Hub, then run the test again in full-speed mode.
8. Run USB30CV on your computer and perform the **Chapter 9 Tests** again both in high-speed and full-speed modes.

¹ See gold-tree devices list in [Table 19](#).

² When you run USBCV it will replace the standard Microsoft EHCI host driver with its own test stack driver. Therefore all standard peripherals on your computer such as mouse and u-disk are invalid at this moment.

³ The i.MX 6 series acts as a self-powered device in device mode.

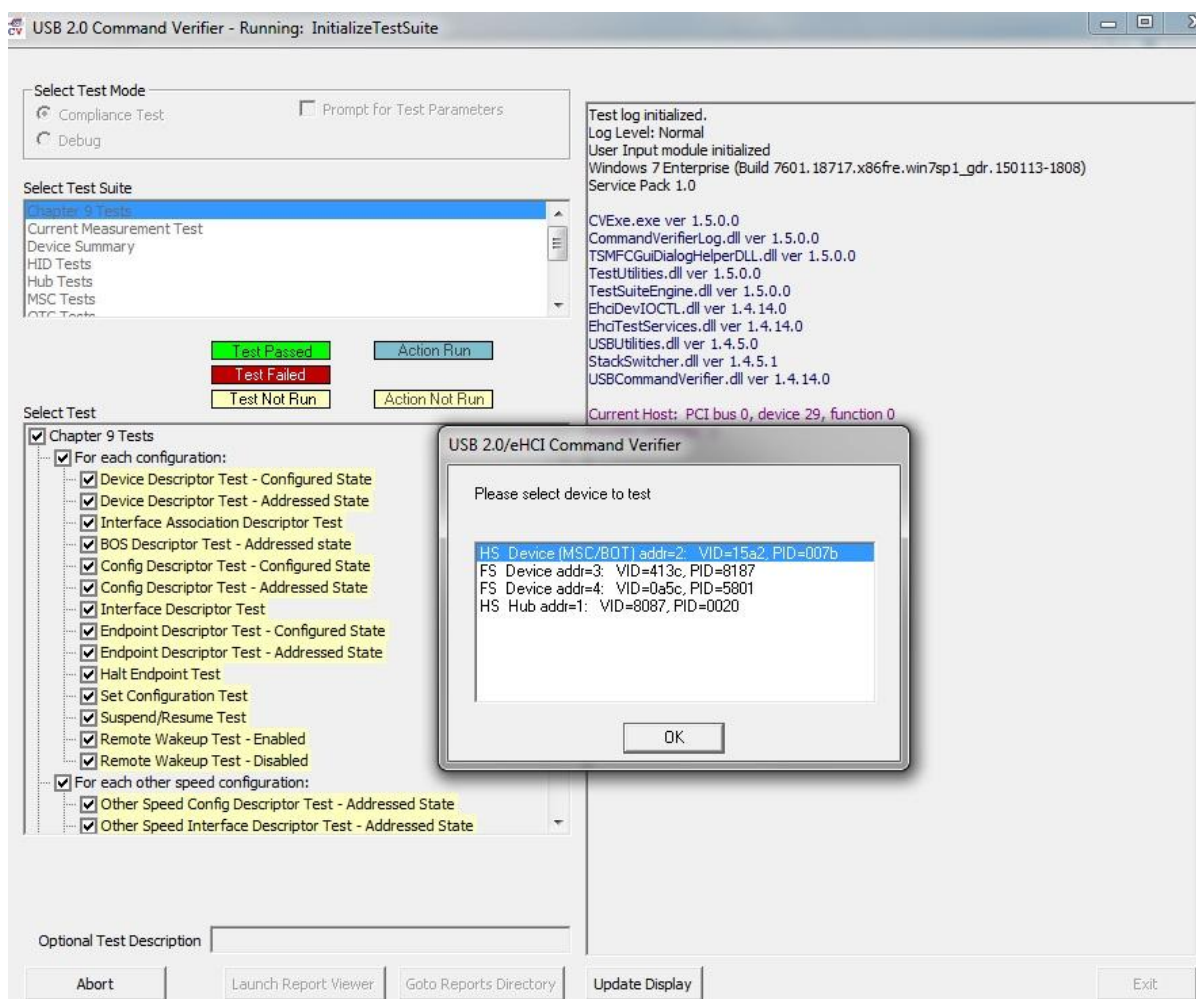


Figure 82. Select USB20CV Chapter 9 Tests

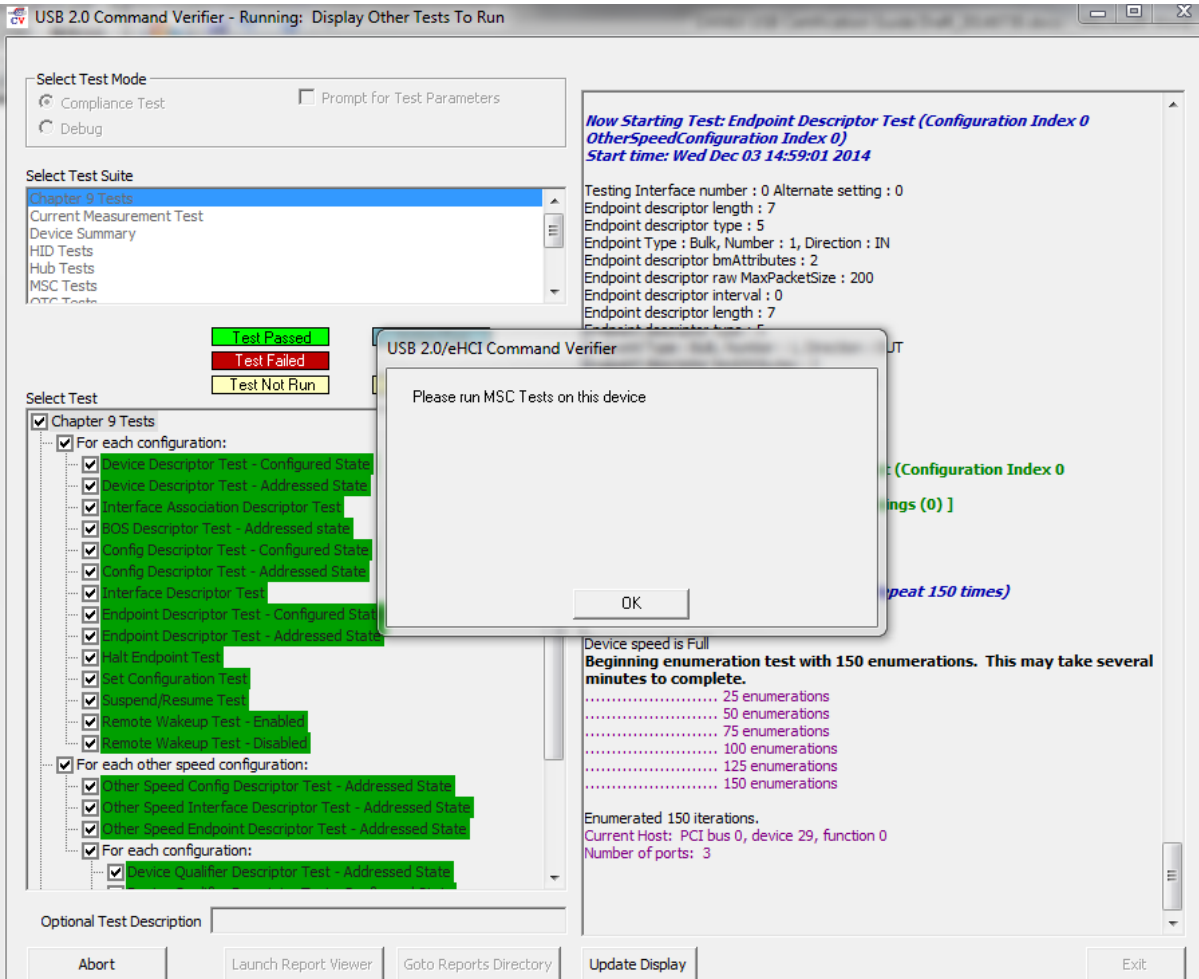


Figure 83. Prompt box after USB20CV Chapter 9 Tests

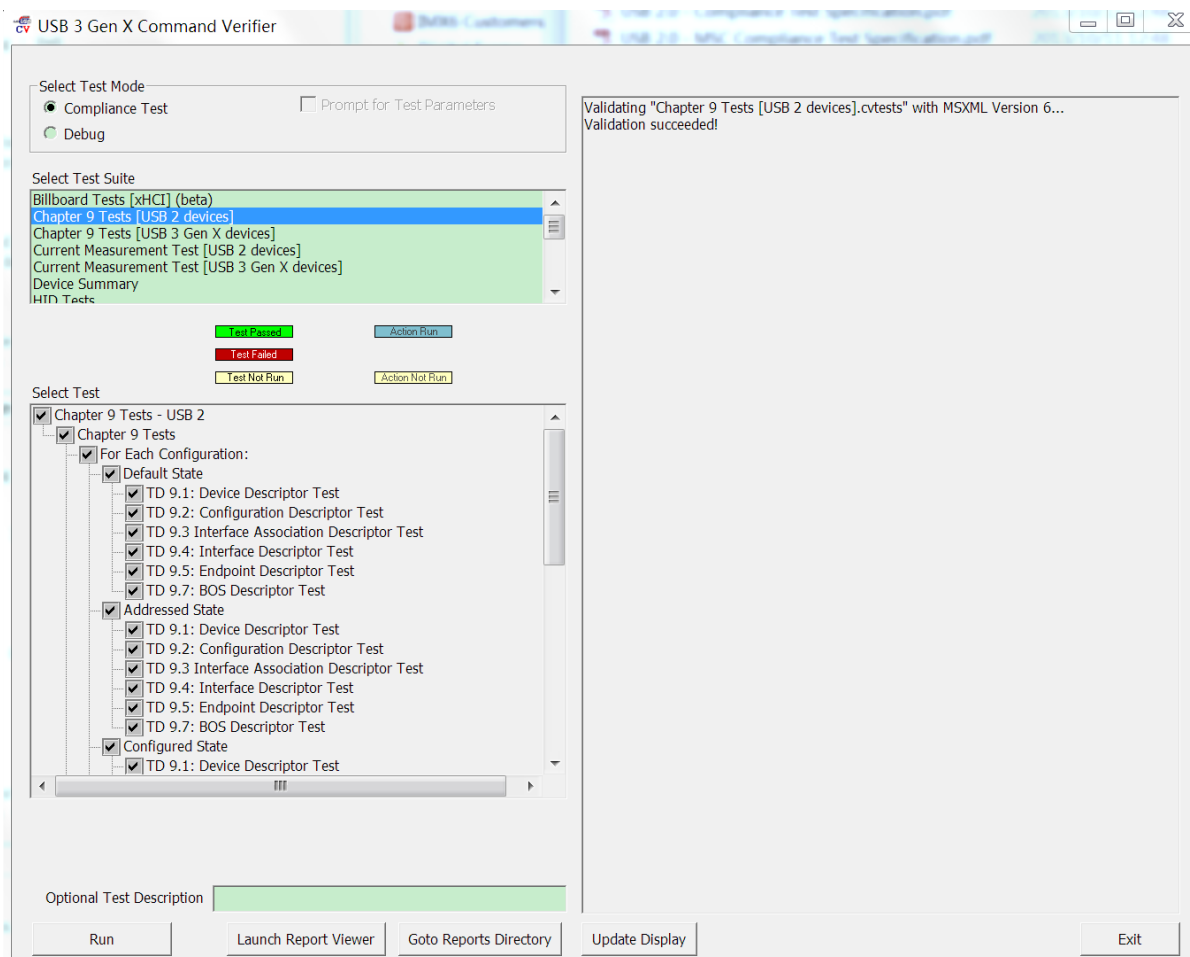


Figure 84. Select USB30CV Chapter 9 Tests

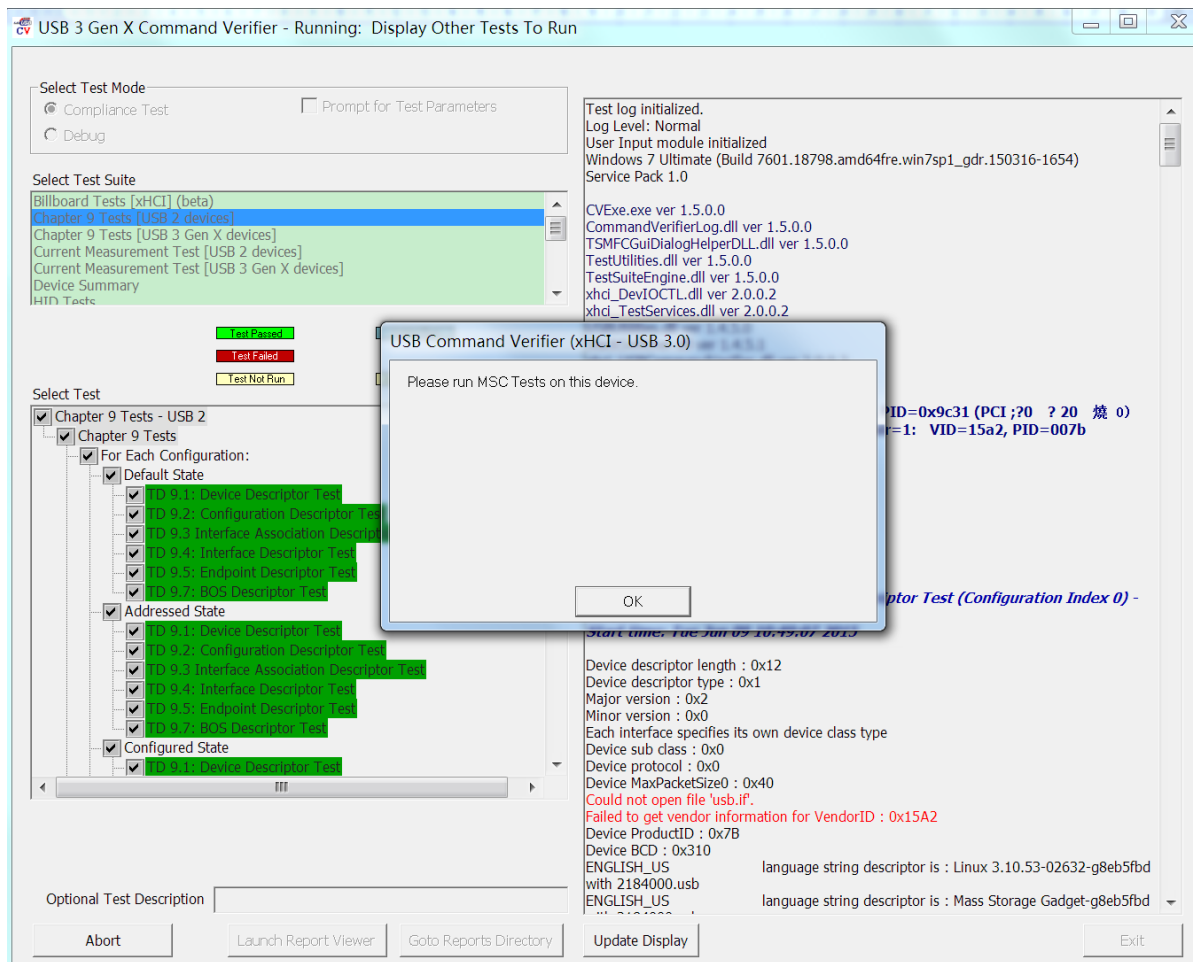


Figure 85. Prompt box after USB30CV Chapter 9 Tests

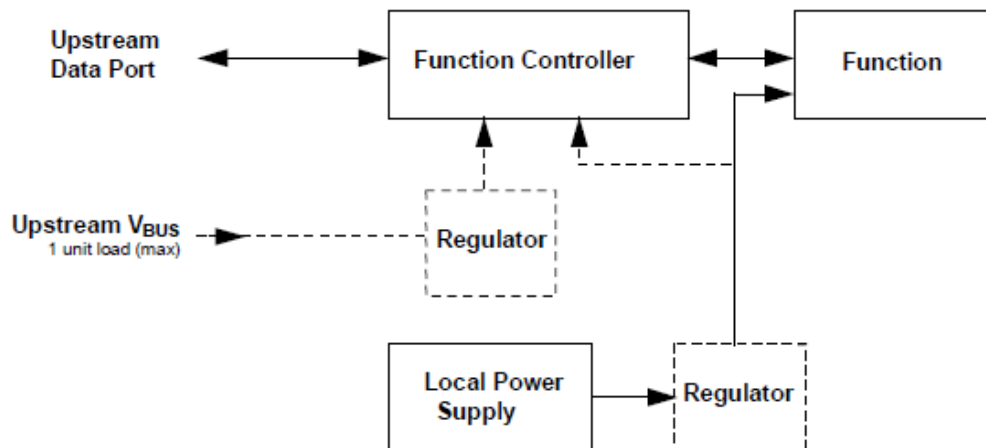


Figure 86. Self-powered function

4.3. USBCV Class Test

Appropriate class tests¹ (HID, HUB, MSC, UVC, PHDC) should be done according to the prompt of Chapter 9 tests, as shown in [Figure 83](#).

See the following documents for a detailed description of test items:

Universal Serial Bus Revision 2.0 USB Command Verifier Compliance Test Specification

Universal Serial Bus Mass Storage Class Compliance Test Specification.

4.3.1. MSC Test

All devices that report a mass storage class interface will be required to pass this test in order to receive logo certification. The tests described will be run on all interfaces that report themselves as MSC.

Test items:

- TD 1.1: Interface Descriptor Test
- TD 1.2: Serial Number Test
- TD 1.3: Class-Specific Request Test
- TD 1.3: Error Recovery Test
- TD 1.5: Case 1 Test
- TD 1.6: Case 2 Test
- TD 1.7: Case 3 Test
- TD 1.8: Case 4 Test
- TD 1.9: Case 5 Test
- TD 1.10: Case 6 Test
- TD 1.11: Case 7 Test
- TD 1.12: Case 8 Test
- TD 1.13: Case 9 Test
- TD 1.14: Case 10 Test
- TD 1.15: Case 11 Test
- TD 1.16: Case 12 Test
- TD 1.17: Case 13 Test
- TD 1.18: Power-Up Test
- TD 1.19: CB Length Test
- TD 1.19: CB Length Test
- TD 2.1: Required Commands Test
- TD 2.2: Optional Commands Test

¹ i.MX 6 series is enumerated as mass storage in device mode, therefore it is only necessary to implement the MSC Test.

Test instructions:

1. Connect the downstream port of a HS hub to the DUT, and connect the upstream port of the HS hub to the test bed computer. Ensure that the gold-tree HS hub is used.
2. Run USB20CV on your computer, select **MSC Tests**, and then click the **Run** button to launch the tests.
3. Select the DUT device in the list and click on **Ok** as shown in Figure 87.
4. During the test, a pop-out dialog will ask you to disconnect and power off DUT, and then repower DUT, as shown in Figure 88.
5. After the test is completed, click on **Launch Report Viewer** to view the test report.
6. Change the HS hub to a gold-tree FS hub, then run the test again in full-speed mode¹.
7. Run USB30CV on your computer, do the MSC Tests again.

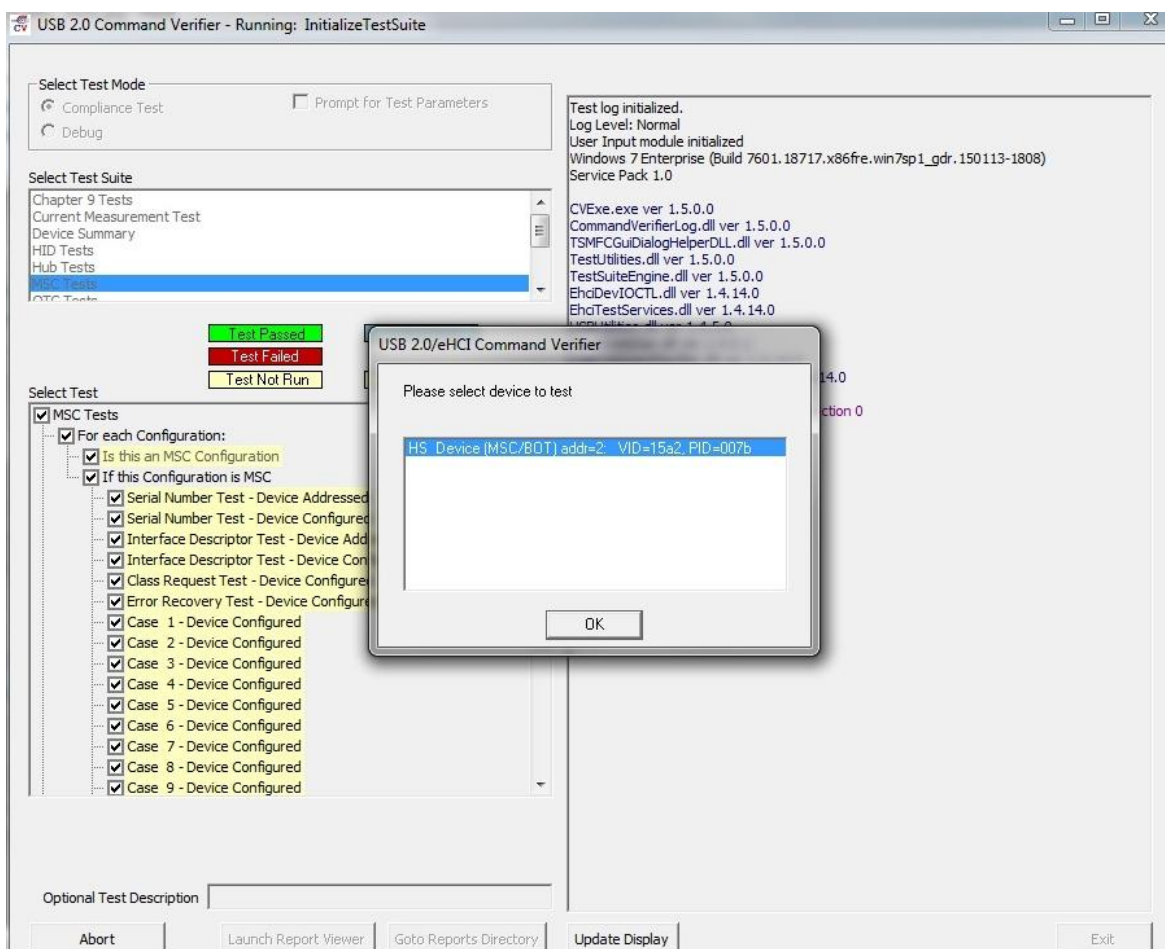


Figure 87. USB20CV MSC Tests

¹ It is only necessary to run these tests once, at either high-speed or full-speed, as described in the explanation in USB-IF Compliance Updates.

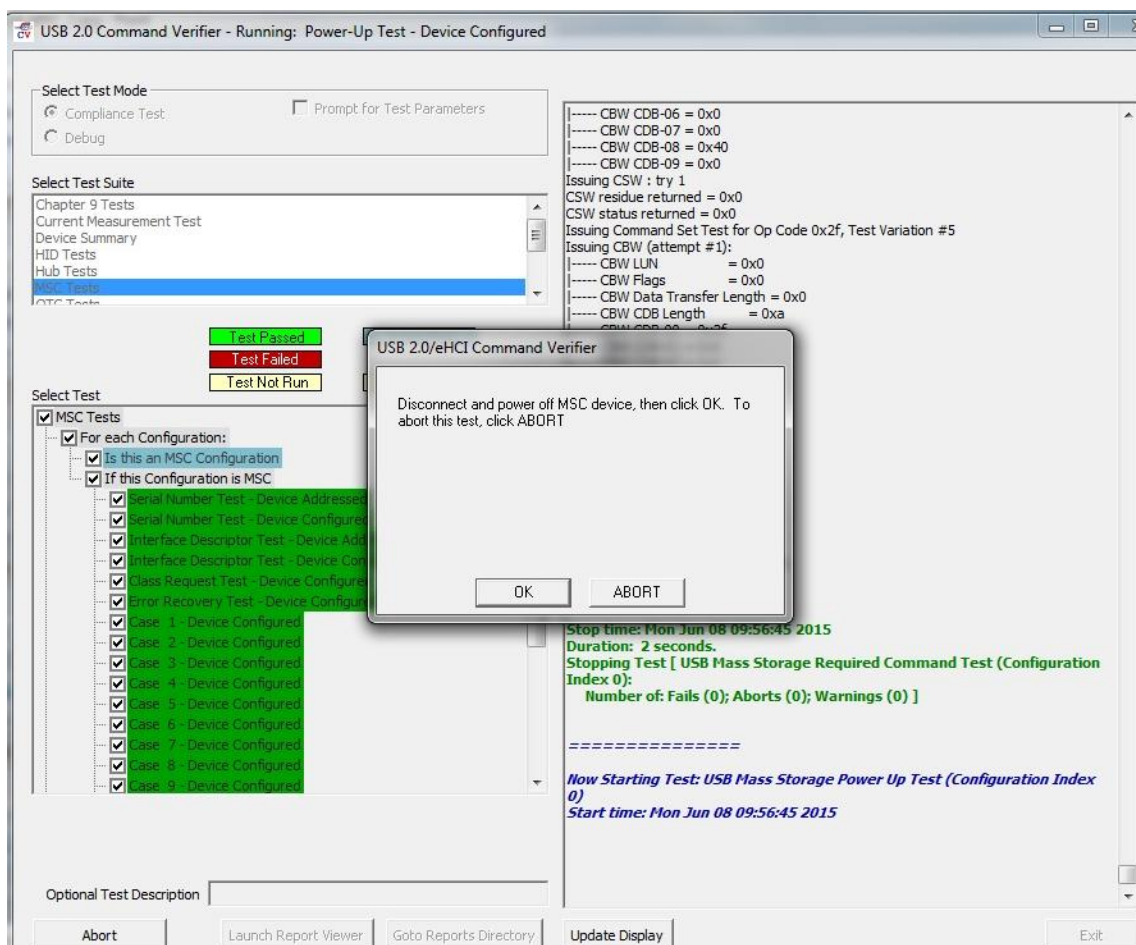


Figure 88. USBCV MSC Tests_Repower device

4.3.2.HID Test

All devices which report a Human Interface Device (HID) interface will be required to pass this test in order to receive logo certification. The tests described in this section shall be run on all interfaces that report themselves as HID.

Test items:

- HID Descriptor Test
- HID Get/Set Idle Test
- HID Get/Set Protocol Test
- HID Report Descriptor Test
- HID Specification Version Test

Test instructions:

1. Connect the downstream port of a HS hub to the DUT, and the upstream port of a HS hub to the test bed computer, ensure that the gold-tree HS Hub is used.
2. Run USB20CV on your computer, select **HID Tests**, and then click the **Run** button to launch the tests.

3. Select the DUT device in the list and click on Ok as shown in [Figure 89](#).
4. After the test is completed click on the **Launch Report Viewer** to view the test report.
5. Change the HS hub to a gold-tree FS Hub, then run the test again in full-speed mode¹.
6. Run USB30CV on your computer, do the **HID Tests** again.

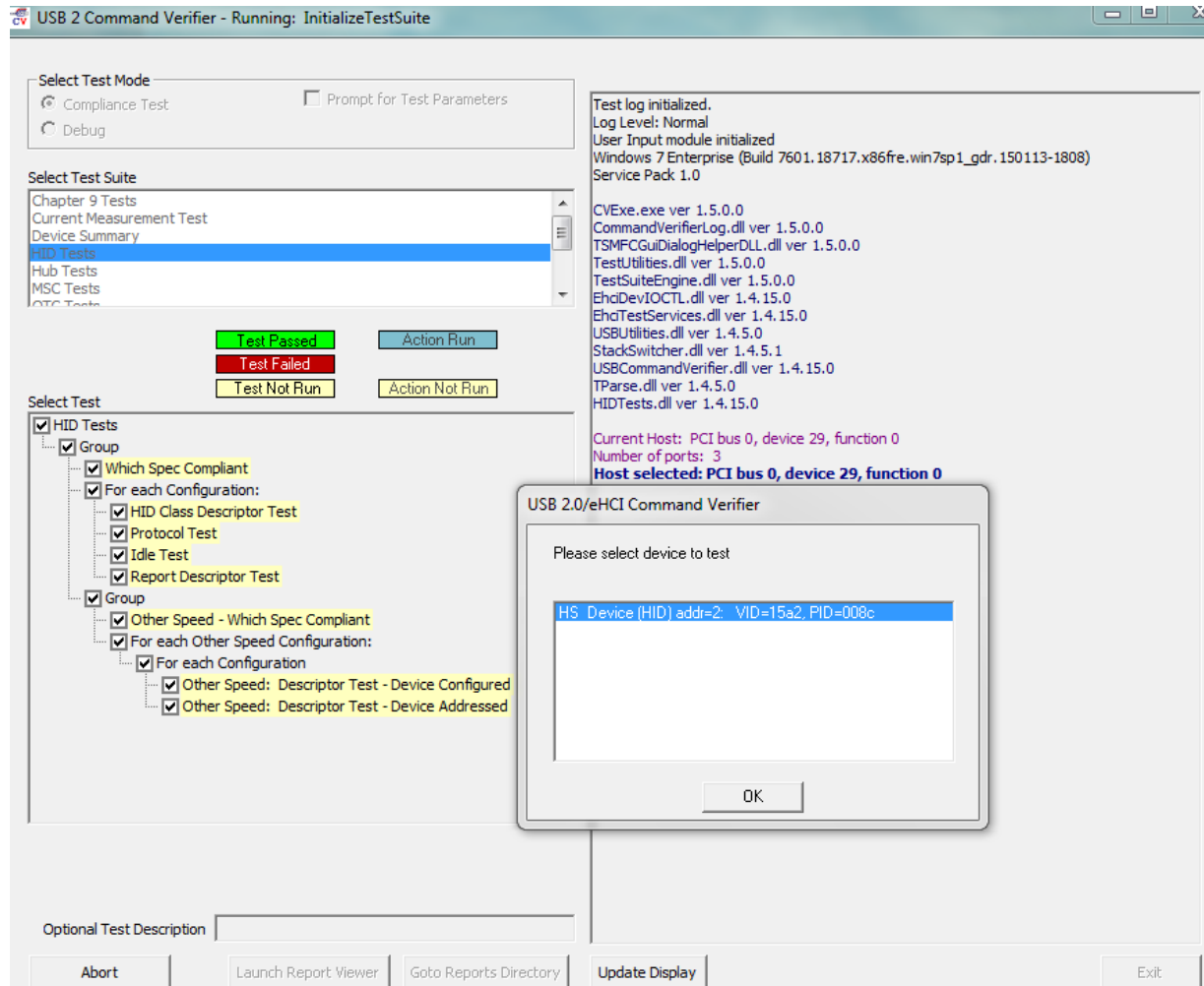


Figure 89. USB20CV HID Tests

4.4. USBCV current measurement test

In order to measure the power distribution of a USB device, the average current is measured during **unconfigured**, **configured**, **active**, and **suspend** states with a digital multimeter and fixture to measure the VBUS current. The circumstances for measuring the average current are dependent on the speed of the device and the power mode the device is in (for instance whether they are self-powered or bus-powered).

For a hi-speed device the average current is measured in hi-speed and full-speed mode. All hi-speed measurements are performed by connecting the DUT after one self-powered hi-speed hub. A full-speed

¹ It is only necessary to run these tests once, at either high-speed or full-speed, as described in the explanation in USB-IF Compliance Updates.

self-powered hub is connected to the first hi-speed hub in order to force a hi-speed DUT to enter its full-speed mode.

A device should also be measured using the supported power mode in the following circumstances:

- When a device is only capable of operating in self-powered mode, all measurements are performed in self-powered mode. This means that the device is unable to enumerate without being connected to an external power supply.
- When a device is capable of operating in bus-powered mode all measurements are performed in bus-powered mode even when the device claims to be self-powered (in its device descriptor).
- When a device has battery-charging capabilities over USB, the power measurements are performed in worst case scenario. This is most likely when the product has a dead battery.

Test items:

- Unconfigured current
- Configured current
- Active current
- Suspend current

Table 18. USBCV current requirements

Device State	Measurement Current	Requirement	Device Feature
Unconfigured	0.17 mA	<=100 mA	All peripheral devices
Configured	—	$\leq bMaxPower^1 \leq 100 \text{ mA}$	Low-power bus-powered device
	0.17 mA	$\leq bMaxPower \leq 100 \text{ mA}$	Self-powered device²
	—	$\leq bMaxPower \leq 500 \text{ mA}$	High-power bus-powered device
Active	—	$\leq 100 \text{ mA}$	Low-power bus-powered device
	—	$\leq 500 \text{ mA}$	High-power bus-powered device
	0.17 mA	$\leq 100 \text{ mA}$	Self-powered device
Suspend	—	$< 0.5 \text{ mA}$	Remote wakeup unsupported device
	0.17 mA	$< 2.5 \text{ mA}$	Remote wakeup supported device
Powered state suspend	0.17 mA	$< 2.5 \text{ mA}$	Battery charging not supported device
	—	$< 100 \text{ mA}$	Battery charging supported device

4.4.1. Unconfigured/Configured Current Test

The USB 2.0 DUT is set to unconfigured/configured state by using the tool USB20CV. For a USB 3.0 device the unconfigured/configured state can be forced by using USB30CV.

¹ bMaxPower is defined as the maximum power consumption of the USB device from the bus in this specific configuration when the device is fully operational, expressed in 2 mA units.

² i.MX 6 series acts as a self-powered device in device mode.

Test instructions:

1. Connect the downstream port of a HS hub to a DUT, and the upstream port of a HS hub to the test bed computer, as shown in [Figure 90](#), ensure that the gold-tree HS hub is used.
2. Insert a multimeter in series of the VBUS line, ensure that the connection is for current test, and the switch is in the correct range.
3. Run USB20CV on your computer, select the **Current Measurement Test**, and then click the **Run** button to launch the tests.
4. Select the **DUT** in the list, click on **Ok**.
5. A pop-out dialog will ask you to measure the **unconfigured current**, as shown in [Figure 91](#). After recording the maximum current value, click on **Ok**.
6. Another pop-out dialog will ask you to measure the **configured current**, as shown in [Figure 92](#).
7. Record the maximum current value, then click on **Ok** to finish the test.

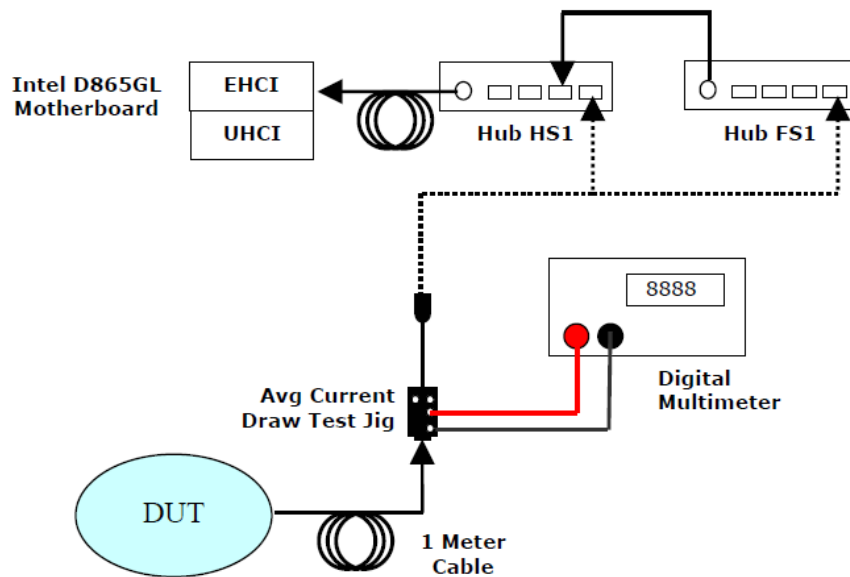


Figure 90. Current measurement environment

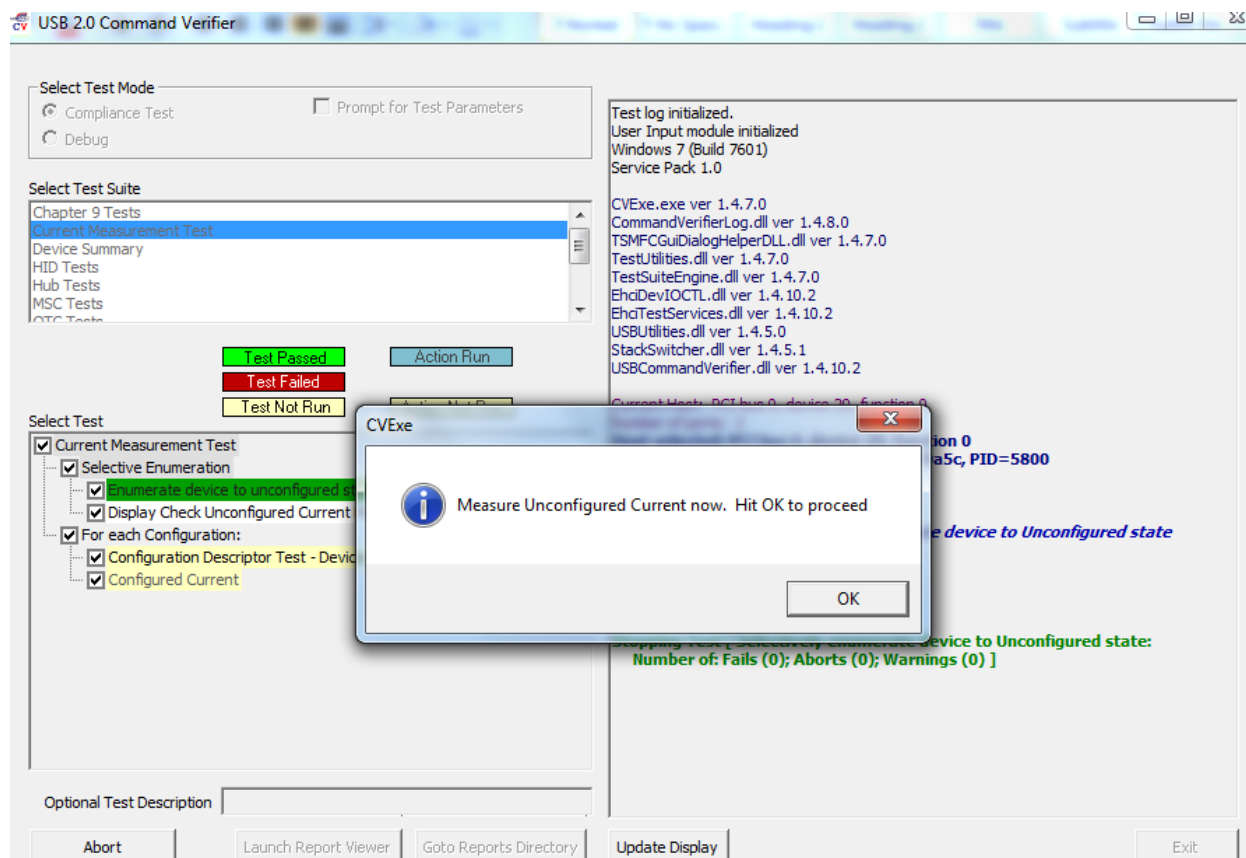


Figure 91. USB20CV Unconfigured Current Measurement Test

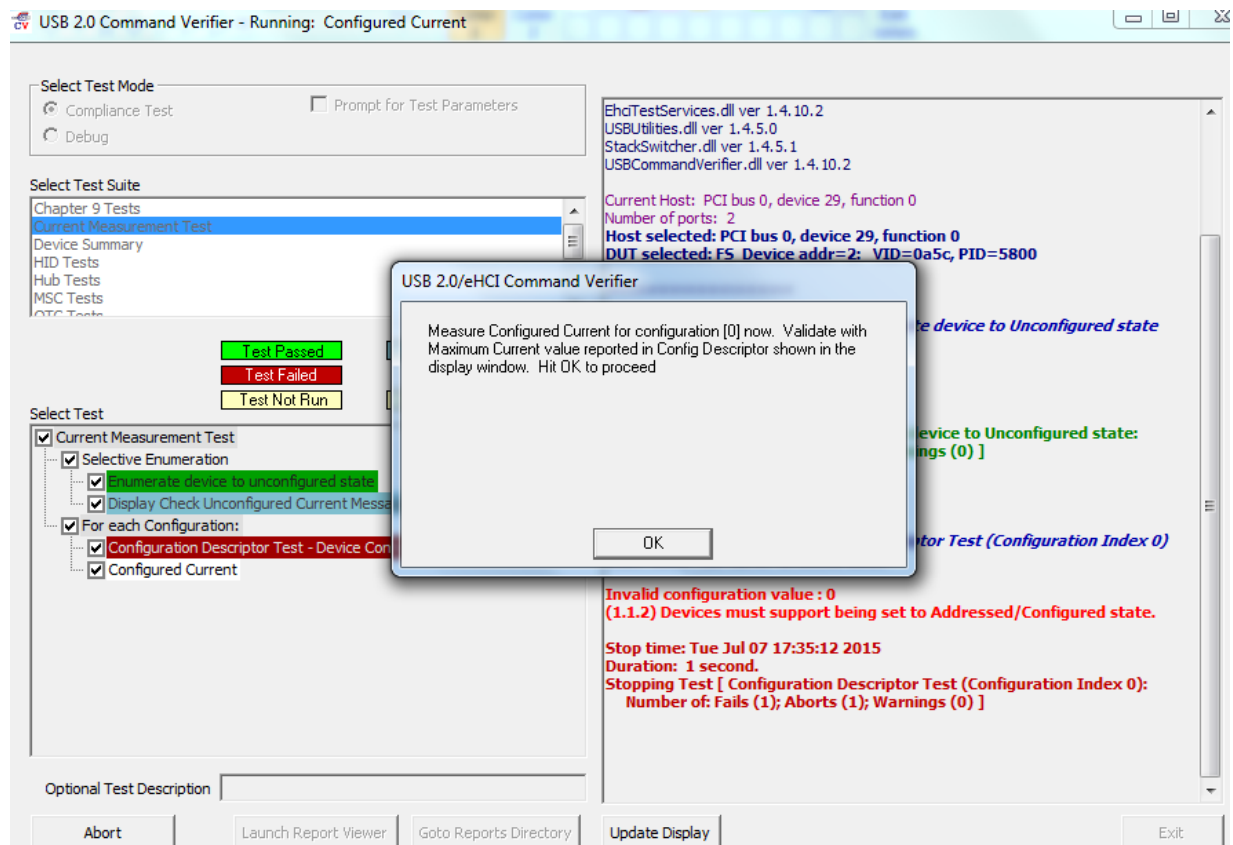


Figure 92. USB20CV Configured Current Measurement Test

4.4.2. Active Current Test

The USB 2.0 DUT is operating correctly and during operation, the device current is measured in worst-case power consumption mode. The active current must remain below the value defined in the bMaxPower field of the descriptor.

Test instructions:

1. Connect the downstream port of a HS hub to the DUT, and the upstream port of a HS hub to the test bed computer, ensure that the gold-tree HS Hub is used.
2. Insert a multimeter in series of the VBUS line. Ensure the connection is for the current test and the switch is in the correct range.
3. Operating the DUT: copy a file from your computer to the DUT which is enumerated as a MSC Device. After the copy is completed, recopy the file to your computer, then copy another file from your computer to the DUT.
4. Record the maximum current value during the bi-direction copying period.

4.4.3. Suspend Current Test

The USB 2.0 DUT is suspended after being correctly enumerated by the host system. If the device supports remote wakeup this feature must be enabled during measurement.

Test Instructions:

1. Connect the downstream port of a HS hub to the DUT, and the upstream port of a HS hub to the test bed computer, ensure that the gold-tree HS hub is used.
2. Insert a multimeter in series of the VBUS line. Ensure the connection is for the current test, and the switch is in the correct range.
3. After the DUT is enumerated as a MSC device, by entering the following command in the Linux console you can force the DUT into suspend mode: `echo mem > /sys/power/state.`
4. Record the maximum current value.

4.4.4.Suspend current powered state

Peripherals are required to support the suspend state whenever VBUS is powered on, even if the bus reset has not occurred.

NOTE

This measurement is not the regular suspend current measurement as described above in [section 4.4.3](#).

Test Instructions:

1. Connect the downstream port of a HS hub to the DUT, and the upstream port of a HS hub to the test bed computer, as shown in [Figure 90](#). Ensure that the gold-tree HS Hub is used.
2. Insert a Multimeter in series of the VBUS line. Ensure the connection is for the current test, and the switch is in the correct range.
3. Run USB20CV on your computer. Select the **Current Measurement Test**, and then click on the **Run** button to launch the tests.
4. Select the DUT in the list, click on OK.
5. After the unconfigured and configured state are completed, do not switch off the USBCV. You must detach and reattach the DUT and then measure the current.
6. Record the maximum current value, then click on OK to finish the test.

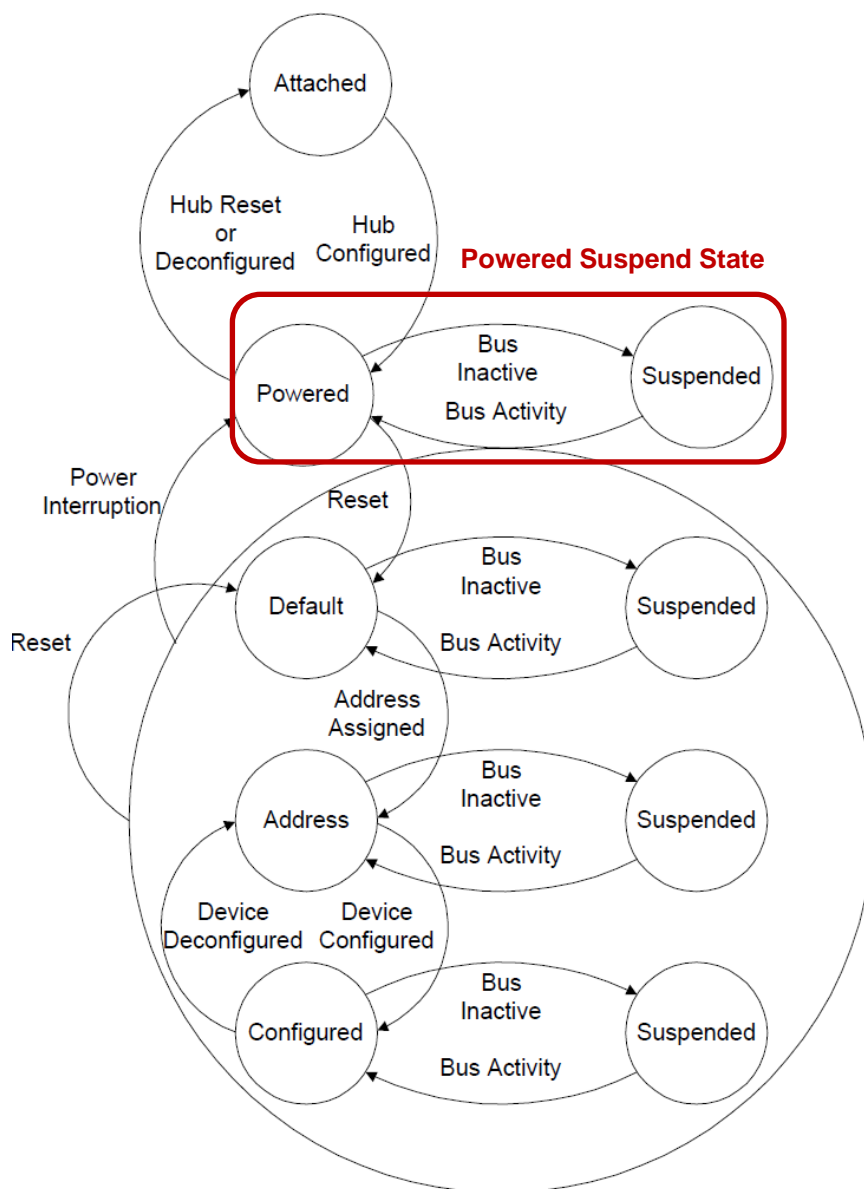


Figure 93. Powered suspend state

5. Interoperability Tests

5.1. Device Interoperability Test

The Device Interoperability test evaluates the device's ability to interoperate with the host system and coexist with other USB devices. The test also provides some insight into usability issues of the device and associated software. See the detailed description of the Embedded Host Interoperability Test and also see the Interoperability section of the *Gold Suite Summary Test Procedure V1.35 Draft*.

Interoperability makes use of an arrangement of USB peripherals known as the Gold Tree. The Gold Tree consists of these characteristics:

- Provides isochronous, bulk, interrupt, and control traffic
- Tests the device behind 5 levels of nested hubs, the maximum allowed
- Tests the device up to 30 meters from the host, the maximum allowed
- Contains a high-speed branch and full-speed speed branch
- EHCI, UHCI and OHCI controllers available for testing

The Gold Tree is to consist of USB-IF certified consumer devices that are widely available in the market. If a specific gold tree device cannot be obtained it may be substituted with a similar certified device.

Table 19. Gold Tree device list

Item	Class	Description	Example Product	Qty
USB host system	—	Multicore processor certified USB EHCI with integrated UHCI certified USB xHCI	DELL XPS8700 (example)	1
EHCI / OHCI	—	PCI host adapter using certified USB EHCI with integrated OHCI	Adaptec, model AUA 4000 PCI adapter	1
xHCI (SuperSpeed host adapter)	—	PCI host adapter using certified USB xHCI	USB-IF SuperSpeed PDK	1
HS hub (Self-powered)	Hub	Hi-speed hub. Minimum of 4 exposed downstream ports	Belkin F5U233	6
FS hub (bus-powered)	Hub	Full-speed hub. Minimum of 2 exposed downstream ports (likely to be a compound device)	Targus Numeric Keypad with 2-port Hub, model PAUK10U	1
USB mouse	HID	Low-speed using interrupt transport	Microsoft basic optical mouse	1
HS Mass Storage	MSC	High-speed using bulk transport	Memorex TravelDrive model 32509051	2
PC Camera	UVC	High-speed using isochronous transport	Logitech QuickCam Ultra Vision P/N: 961471-0403	1
Average current draw test jig	—	Fixture to measure current consumed from VBus	http://www.usb.org/developers/adapters/	1
One meter (or shorter) USB cable	—	Any listed on USB-IF Cables and Connectors Integrators List	—	1
4.5 meter USB cable with mini B-plug	—	Any listed on USB-IF Cables and Connectors Integrators List	—	1
2 meter USB cable with micro USB B-plug	—	Any listed on USB-IF Cables and Connectors Integrators List	—	1
5 meter USB cables	—	Any listed on USB-IF Cables and Connectors Integrators List	—	8

Test items:

- Enumeration and driver installation
- Operation with default drivers
- Interoperability
- Hot detach and reattach
- Warm boot
- Remote wake-up test¹
- S3 Active Suspend Test
- S3 Active Suspend Resume Test
- Root Port Test
- S4 Active Hibernate Test
- S4 Active Hibernate Resume Test
- Topology change UHCI²
- Topology change OHCI²
- Topology change XHCI

Test report:

Table 20. Device interoperability test report

Num	Test Item	Result
1	Enumeration and driver installation	Pass
2	Operation with default drivers	Pass
3	Interoperability	Pass
4	Hot detach and reattach	Pass
5	Warm boot	Pass
6	Remote Wake-Up Test	—
7	S3 Active Suspend Test	Pass
8	S3 Active Suspend Resume Test	Pass
9	Root Port Test	Pass
10	S4 Active Hibernate Test	Pass
11	S4 Active Hibernate Resume Test	Pass
12	Topology change UHCI	Pass
13	Topology change OHCI	Pass
14	Topology change XHCI	Pass

¹If the DUT supports remote wake-up, enable it to wake up the system. If the DUT does not support remote wake-up, this test does not need to be performed. i.MX 6 series is enumerated as a MSC Device, so it does not support remote wake-up.

²The Interoperability Test on OHCI or UHCI is for information purposes only and is not required for the purposes of certification.

5.1.1. Enumeration and driver installation

Test instructions:

1. Construct a tree of USB devices as shown in [Figure 94](#). Attach the Hub HS1 to a root port on the **EHCI** motherboard. Attach the gold tree, via hub HS2, to hub HS1.
2. Plug the DUT into the open port on the multi-TT hub HS5.
3. Do NOT install any drivers or software prior to attaching the device.
4. Use a 5 meter cable if the device does not have a captive cable.
5. If the OS does not possess a native driver, follow OS instructions to install the driver. If the driver still does not load install the software as directed by the software vendor.
6. If the driver loads, PASS with waiver and recommend the driver load via .INF file.
7. If reboot is requested or required as a result of driver (or application) installation, PASS with waiver and recommend removing reboot requirement.
8. Check if DUT and other devices are enumerated.
9. **Pass** is considered when all following items are complete:
 - The DUT enumerates behind HS5 using a 5 meter cable or its own captive cable.
 - The driver installs with an .INF file (provided on a disk or a CD) or is enumerated automatically by the system (class driver).
 - The DUT does not require a reboot.
 - The DUT is correctly identified by Device Manager and no yellow exclamation point is shown for any device.
10. **Fail** is considered when any of the following items occur:
 - The DUT cannot be installed because it requires driver installation or application software before DUT is ever plugged in.
 - The DUT does not enumerate below hub #5.
 - The driver blue screens during enumeration.
 - The DUT requires reboot.
 - The DUT is incorrectly identified by the device manager or a device is flagged as not operational (yellow exclamation point).

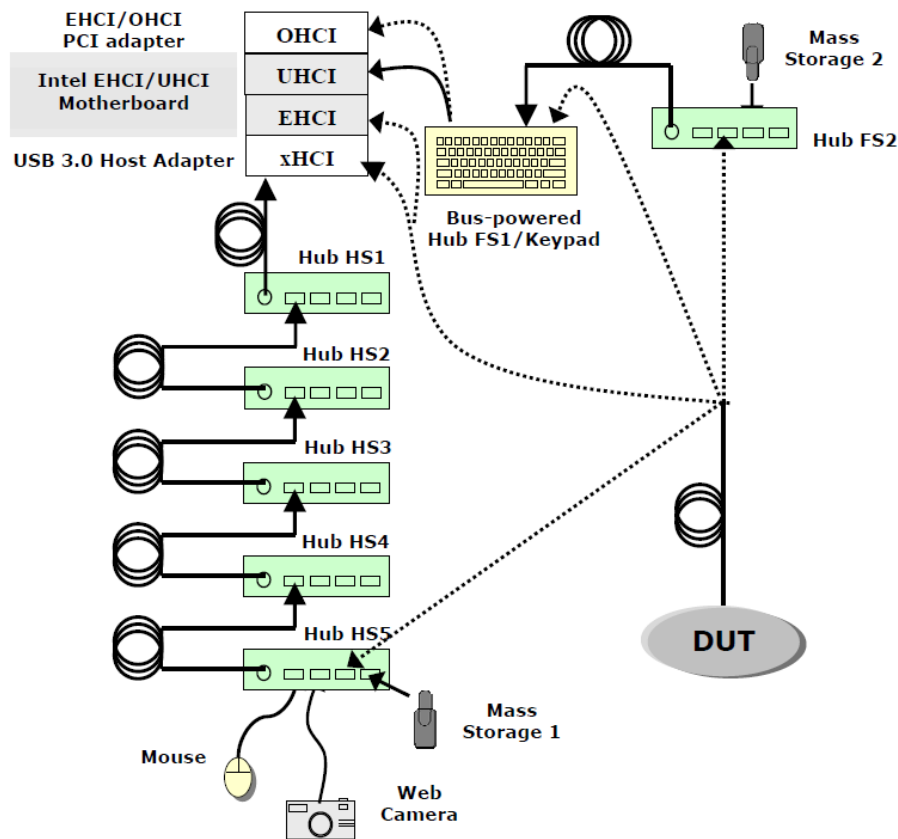


Figure 94. Interoperability Test environment

5.1.2. Operation with default drivers

Test instructions:

1. The DUT demonstrates correct operation using the default driver connected to hub #5 with the 5 meter cable (if cable is not captive).
2. Check if the DUT and other devices are enumerated.
3. **Pass** is considered when the following is complete:
 - The DUT operates as expected with the 5 meter cable (if cable is not captive).
4. **Fail** is considered when any of the following items occur:
 - The DUT cannot be installed because it requires driver installation or application software before DUT is plugged in.
 - The DUT fails to operate.
 - The device/application blue screens or crashes system.
 - The device fails to operate as expected below Hub #5.

5.1.3. Interoperability

Test instructions:

1. Operate all the devices in Gold Tree. Verify that the DUT functions correctly while all other devices are operating concurrently.
 - Operate the device under test.
 - View live video from the Veo camera.
 - Transfer a large file between the Maxtor drive and the JumpDrive Pro.
 - Strike keys on the Logitech keyboard.
 - Disconnect and reconnect the Logitech mouse in the same port on Hub FS3.
 - Move the Logitech Mouse to ensure that it still works.
2. **Pass** is considered when all of the following items are complete:
 - The DUT operates as expected.
 - All Gold Tree devices operate well.
3. **Fail** is considered when any of the following items occur:
 - The DUT fails to operate as expected.
 - One or more Gold Tree devices fail to operate.

5.1.4. Hot detach and reattach

Test instructions:

1. You **MUST** stop the DUT operation.
2. Detach and reattach the DUT to same hub port.
3. Test functionality of the DUT only.
4. **Pass** is considered when all of the following items are completed:
 - The DUT operates as expected.
5. **Fail** is considered when any of the following items occur:
 - The DUT fails to operate as expected.

5.1.5. Warm boot

Test instructions:

1. You **MUST** stop operation of all devices.
2. Restart the computer.
3. Check operation of all USB devices including DUT.
4. **Pass** is considered when all of the following items are completed:
 - DUT operates as expected.
5. **Fail** is considered when any of the following items occur:
 - The device fails to operate as expected.

- One or more Gold Tree devices fail to operate.

5.1.6.Remote Wake-up Test

Test instructions:

1. If the DUT supports remote wake-up, enable the DUT to wake the system (Computer->Manage->Device Manager->DUT->Power Management). If it does not support remote wake-up, go to S3 Active Suspend Tests.
2. While the device under test is actively operating, suspend the system. (Start->Shutdown->Sleep. Wait 5 – 10 seconds after device is fully shutdown.)
3. If the system does not go into suspend, then a message will appear saying that the active DUT will not allow suspend to occur.
4. Use DUT to wake the system, check operation of all USB devices including DUT.
5. **Pass** is considered when all of the following items are complete:
 - The system suspends and wakes up with no problems.
 - All devices including DUT operates as expected.
6. **Fail** is considered when any of the following items occur:
 - The system blue screens or locks up.
 - The system cannot suspend and wake up.
 - The DUT fails to operate as expected.
 - One or more Gold Tree devices fail to operate.

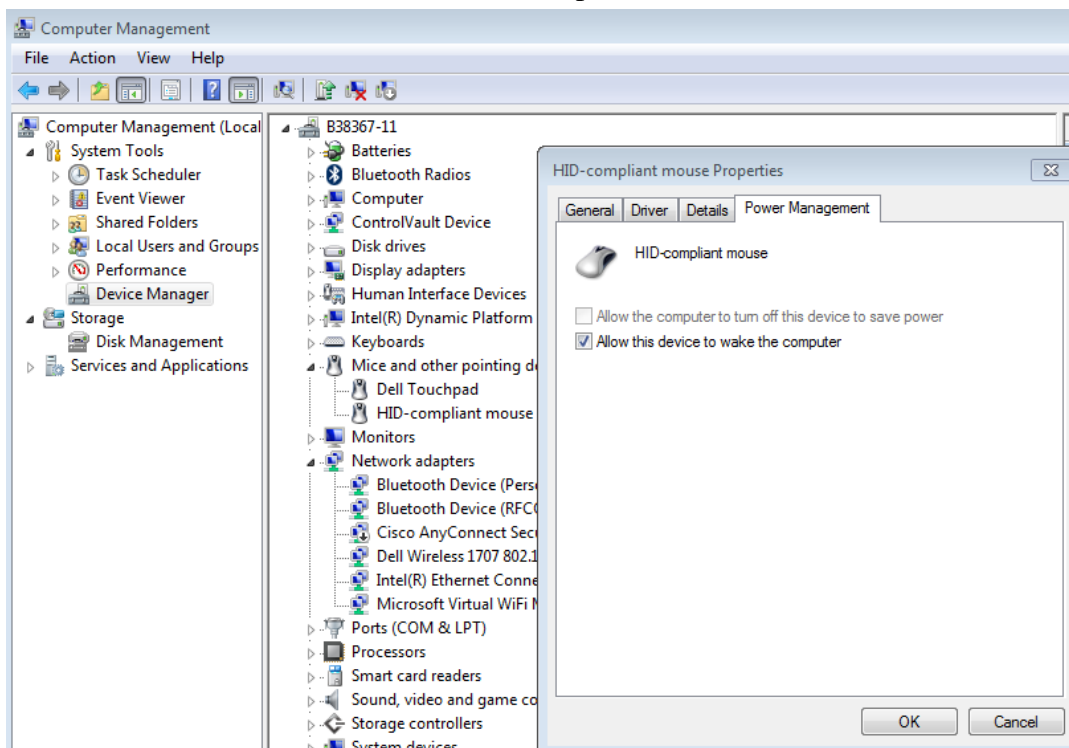


Figure 95. Enable the device to wake up the computer

5.1.7.S3 Active Suspend Test

Test instructions:

1. Disable remote wake-up on all USB devices, including the DUT.
2. Operate the DUT while placing the system into suspend mode (Start->Shutdown->Sleep, wait 5 – 10 seconds after the system shutdown).
3. If the system does not go into suspend mode, then a message will appear saying that the active DUT will not allow suspend to occur.
4. **Pass** is considered when all of the following items are complete:
 - The system suspends with no problems.
 - The system notifies the user that it cannot go into suspend.
5. **Fail** is considered when either of the following items occur:
 - The system does not enter suspend without notification.
 - The system blue screens or locks up.

5.1.8.S3 Active Suspend Resume Test

Test instructions:

1. Place the system into suspend mode as described in [section 5.1.7](#).
2. Wake the system.
3. Check operation of the DUT.
4. **Pass** is considered when all of the following items are completed:
 - The system resumes well.
 - Active operation initiated in the previous step continues without error.
5. **Fail** is considered when either of the following items occur:
 - The system does not resume.
 - The system blue screens or locks up.
 - The DUT is not functional or does not continue operation in the previous step.

5.1.9.Root Port Test

Test Instructions:

1. You **MUST** stop operation of all devices.
2. Plug the DUT into a root port of the system's motherboard.
3. Check operation of all USB devices including the DUT.
4. **Pass** is considered when all of the following items are completed:
 - The DUT operates as expected.
5. **Fail** is considered when any of the following items occur:

- The DUT fails to operate as expected.

5.1.10. S4 Active Hibernate Test

Test instructions:

1. You must stop operation of all devices.
2. Plug the DUT into a root port of the system's motherboard.
3. Operate the DUT while the system enters hibernation (Start->Shutdown->Hibernate, wait 5 to 10 seconds after system has shutdown)
4. **Pass** is considered when all of the following items are complete:
 - The system hibernates with no problems.
5. **Fail** is considered when any of the following items occurs:
 - The system fails to hibernate.
 - The system blue screens or locks up.

5.1.11. S4 active Hibernate Resume Test

Test instructions:

1. Place the system in hibernation as described in [section 5.1.10](#).
2. Turn on the system.
3. Check operation of all USB devices including the DUT.
4. Pass is considered when all of the following items are completed:
 - The system resumes well.
 - Active operation initiated in previous step continues without error.
5. Fail is considered when either of the following items occurs:
 - The system does not resume.
 - The system blue screens or locks up.
 - The DUT is not functional or does not continue operation in the previous step.

5.1.12. Topology change to UHCI

Test instructions:

1. Change the **EHCI** motherboard to **UHCI** motherboard. All other connections remain the same. See [Figure 94](#).
2. Run all tests from [sections 5.1.1](#) to [5.1.11](#).
3. Record the test result.

5.1.13. Topology change to OHCI

Test instructions:

1. Change the **EHCI** motherboard to the **OHCI** motherboard. All other connections remain the same. See [Figure 94](#).
2. Run all tests from [sections 5.1.1](#) to [5.1.11](#).
3. Record the test result.

5.1.14. Topology change to XHCI

Test instructions:

1. Change the **EHCI** motherboard to the **XHCI** motherboard. All other connections remain the same. See [Figure 94](#).
2. Run all tests from [5.1.1](#) to [5.1.11](#).
3. Record the test result.

5.2. Embedded Host Interoperability Test

Targeted Hosts or an OTG acting as a host, are tested for interoperability with peripherals from the device's own Targeted Peripheral List plus other retail USB products which could be attached to the Targeted Host.

Silent failures are not allowed and therefore a clear message shall be generated when any sort of error situation occurs. For example, where hubs are non-supported, a clear Hub not supported or similar error message appears and not a generic not supported or similarly vague error message.

For the detailed description of the Embedded Host Interoperability Test, see Chapter 7 of the *USB On-The-Go and Embedded Host Automated Compliance Plan*.

Test items:

- A-UUT Functionality B-device
- A-UUT Category Functionality B-device
- A-UUT Boot Test
- 7A-UUT Legacy Speed Test
- A-UUT Concurrent and Independently Test
- A-UUT Unsupported Device Message Test
- A-UUT Hub Error Message Test
- A-UUT Hub Functionality Test
- A-UUT Hub Maximum Tier Test
- A-UUT Hub Concurrent and Independently Test
- A-UUT Bus Powered Hub Power Exceeded Test
- A-UUT Maximum Concurrent Device Exceed Message Test
- A-UUT Standby Test
- A-UUT Standby Disconnect Test
- A-UUT Standby Attach Test

- A-UUT Standby Remote Wakeup Test

Test report:

Table 21. Embedded Host Interoperability Test report

Num.	Test item	Result
1	7.3.1 A-UUT Functionality B-device ¹	—
2	7.3.2 A-UUT Category Functionality B-device	Pass
3	7.3.3 A-UUT Boot Test	Pass
4	7.3.4 A-UUT Legacy Speed Test	Pass
5	7.3.5 A-UUT Concurrent and Independently Test ²	—
6	7.3.6 A-UUT Unsupported Device Message Test	Pass
7	7.3.7 A-UUT Hub Error Message Test ³	—
8	7.3.8 A-UUT Hub Functionality Test	Pass
9	7.3.9 A-UUT Hub Maximum Tier Test	Pass
10	7.3.10 A-UUT Hub Concurrent and Independently Test	Pass
11	7.3.11 A-UUT Bus Powered Hub Power Exceeded Test	Pass
12	7.3.12 A-UUT Maximum Concurrently Device Exceed Message Test	Pass
13	7.3.13 A-UUT Standby Test	Pass
14	7.3.14 A-UUT Standby Disconnect Test	Pass
15	7.3.15 A-UUT Standby Attach Test	Pass
16	7.3.16 A-UUT Standby Topology Change Test	Pass
17	7.3.17 A-UUT Standby Remote Wakeup Test	Pass

5.2.1. A-UUT functionality B-device

Purpose	To prove the functionality of an OTG A-device or EH.
Applies to	OTG A-devices and EHes that perform VID/PID detection of TPL peripherals.
Description	Test the functionality of the TPL peripherals.
Test setup	At least one TPL device corresponding to each supported category.
Preconditions	The A-UUT is powered ON. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	TPL2-4, TPL7
Pass Criteria	Prove the functionality of all TPL B-devices in combination with the A-UUT.

Test instructions:

1. Power on the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to a Standard-A Receptacle adapter.
 - If the B-device requires external power, power on the B-device.
2. Attach a B-device taken from the TPL and confirm functionality.

¹ i.MX 6 series does not support peripherals identified by their VID/PID, this test is not needed.

² The Concurrent and Independently test is only applied to an EH with multi ports, i.MX 6 EVK only has one downstream port, so this test is not needed.

³ i.MX 6 series supports hub, this test is not needed.

3. Detach the B-device and check if the device is disconnected correctly.
4. Attach the B-device and prove functionality.
5. Repeat the above steps for each of the different supported categories.

5.2.2.A-UUT category functionality B-device

Purpose	To prove the category functionality of an OTG A-device or EH.
Applies to	OTG A-devices and EHes that support a certain category of device
Description	Test the functionality of each of the supported categories
Test setup	One B-device of each supported category with 500 mA in their descriptor, if not available use a device with highest maximum power descriptor value. If available one B-device of each supported category with an additional interface(s) (composite device). If not available use a device with one interface.
Preconditions	The A-UUT is powered on. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	MSG2, MSG3, TPL2-4, TPL7.
Pass Criteria	Prove the functionality of the B-devices in combination with A-UUT For the composite device it is not mandatory to prove functionality however if the device does not operate a message shall be generated by the A-UUT. If a device does not work an error message will be shown to the user.

Test instructions:

1. Power ON the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.
 - If the B-device requires external power, power on the B-device.
2. Attach a B-device and confirm that it functions correctly.
3. Detach the B-device and ensure that the device is disconnected correctly.
4. Attach the B-device and confirm that it functions correctly.
5. Repeat the above steps for each of the different supported category with five different peripherals.

5.2.3.A-UUT Boot Test

Purpose	To prove the functionality of an OTG A-device or EH after boot.
Applies to	OTG A-devices and EHes.
Description	Observe boot behavior while a B-device is attached.
Test setup	One B-device of each supported category.
Preconditions	The A-UUT is powered OFF. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	C3
Pass Criteria	Prove the functionality of the B-devices in combination with A-UUT. For the composite device it is not mandatory to prove functionality however if the device does not operate a clear message shall be generated by the A-UUT. If a device does not work a clear error message shall be shown to the user.

Test instructions:

1. Power OFF the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.
 - If the B-device requires external power, power on the B-device.
2. Attach a B-device taken and prove that it functions correctly.
3. Power ON the A-UUT.
4. Prove that the B-device functions correctly.
5. Repeat the above steps for each of the different supported category.

5.2.4.A-UUT Legacy Speed Test

Purpose	To prove the functionality of the OTG A-device or EH in full or low-speed.
Applies to	High-speed OTG A-devices and EHes that have a full or low-speed device on their TPL. Perform this test only if it has not been performed in one of the previous tests.
Description	Test the functionality of the full or low-speed TPL device.
Test setup	One supported full-speed (full-speed support is mandatory) or low-speed device.
Preconditions	The A-UUT is powered ON. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	E15, E18
Pass Criteria	The functionality of the full or low-speed device is proven. If a device does not work a clear error message shall be shown to the user.

Test instructions:

1. Power ON the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.

- If the B-device requires external power, power on the B-device.
2. Attach a Full Speed B-device and prove functionality.

5.2.5.A-UUT Concurrent and Independently Test

Purpose	To prove the functionality of all downstream ports.
Applies to	EH with multiple ports.
Description	Test the concurrent and independent functioning of the TPL peripherals on each downstream port.
Test setup	For each downstream port a similar device from the TPL. If detection is made using VID/PID and/or for category support the number of B-devices is equal to the number of ports. This test shall be performed on each supported category.
Preconditions	The A-UUT is powered ON.
Checklist	E17
Pass Criteria	The A-UUT can operate the device concurrently and independently or a selection method is available for the end-user to select a device. Note that a A-UUT is allowed to handle a limited number of concurrent peripherals

Test Instructions:

1. Power on the A-UUT.
 - If the B-device requires external power, power on the B-device.
2. Attach a B-device to port 1.
3. Attach another B-device of the same category to an available downstream port.
4. Continue attaching B-devices of the same category until all ports are full.
5. Prove functionality of each attached B-device:
 - Do they operate concurrently and independently?
 - Or, is a selection method available such that the user can select the active B-device?
6. Remove one device and replace it with a device of another category if multiple categories are supported.
7. Remove all peripherals.
8. Repeat the above steps for each of the different supported category.

5.2.6.A-UUT Unsupported Device Message test

Purpose	To prove that the OTG A-device or EH generates the correct error message when attaching an unsupported device.
Applies to	OTG A-devices and EHes.
Description	Observe error messages when attaching unsupported peripherals.
Test setup	<ul style="list-style-type: none"> - One unsupported low-speed device - One unsupported full-speed device - One unsupported high-speed device - One unsupported super-speed device - One unsupported composite device with more than 8 interfaces.
Preconditions	The A-UUT is powered ON. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	E15, E18.
Pass Criteria	The functionality of the full or low-speed device is proven. If a device does not work a clear error message shall be shown to the user.

Test instructions:

1. Power on the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.
 - If the B-device requires external power, power on the B-device.
2. Attach one of the peripherals listed in the test setup above.
3. Check if a clear message is generated to the end-user.
4. Repeat the above steps for each of the peripherals listed in the test setup.
5. Note that an error message should be generated when attaching a device in a device class which is not already covered by a product on the TPL. It is not permitted to support device classes without listing corresponding products on your TPL.

5.2.7.A-UUT Hub Error Message test

Purpose	To prove that the OTG A-device or EH generates the correct error message when attaching an unsupported device.
Applies to	OTG A-devices and EHes.
Description	Observe error messages when attaching unsupported peripherals.
Test setup	<ul style="list-style-type: none"> - One unsupported low-speed device - One unsupported full-speed device - One unsupported high-speed device - One unsupported super-speed device - One unsupported composite device with more than 8 interfaces.
Preconditions	The A-UUT is powered on. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	E15, E18
Pass Criteria	The functionality of the full or low-speed device is proven. If a device does not work a clear error message shall be shown to the user.

Test instructions:

1. Power on the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.
 - If the B-device requires external power, power on the B-device.
2. Attach the hub.
3. A clear hub not supported message should appear.
4. Attach a TPL device downstream from the hub.
5. Check that the device does not function downstream from the hub.

5.2.8.A-UUT Hub Functionality test

Purpose	To prove that a hub attached to an OTG A-device or EH hub either functions or causes a hub error message.
Applies to	OTG A-devices and EHes which support hub(s).
Description	Test the hub functionality with TPL peripherals.
Test setup	<ul style="list-style-type: none"> - One 4 port high-speed self powered hub (If hub support is performed by VID/PID in TPL use this hub) - At least one TPL device from each category - FS device if listed on TPL (for TT stress).
Preconditions	The A-UUT is powered ON. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	TPL4, MSG2, MSG3, MSG5
Pass Criteria	Prove the functionality of the all device categories listed in TPL attached downstream from one hub

Test instructions:

1. Power ON the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.
 - If the B-device requires external power, power on the B-device.
2. Attach the hub.
3. Attach one supported high-speed device downstream from the hub and prove its functionality.
4. Prove the functionality of each supported category downstream from one hub.
5. Detach the high speed device.
6. Attach one supported full-speed device (if supported) downstream from the hub and prove its functionality.
7. Detach the full-speed device.

5.2.9.A-UUT Hub Maximum Tier test

Purpose	To prove that a hub attached to an OTG A-device or EH hub either functions or causes a hub error message.
Applies to	OTG A-devices and EHes which support hub(s).
Description	Test the hub functionality with TPL peripherals.
Test setup	<ul style="list-style-type: none"> - One 4 port High Speed Self Powered Hub (If hub support is performed by VID/PID in TPL use this Hub) - At least one TPL device from each category - FS device if listed on TPL (for TT stress).
Preconditions	The A-UUT is powered ON. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	TPL4, MSG2, MSG3, MSG5
Pass Criteria	Prove the functionality of the all device categories listed in TPL attached downstream from one hub.

Test instructions:

1. Power on the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.
2. Attach hubs to the maximum tier.
3. Attach one TPL device downstream from the last hub and prove functionality.
4. Attach another hub downstream from the max tier of hubs.
5. Check that an appropriate error message is generated.

5.2.10. A-UUT Hub Concurrent and Independently test

Purpose	To prove that a hub attached to an OTG A-device or EH hub either functions or if it does not function that it causes a hub error message.
Applies to	OTG A-devices and EHes which support hub(s).
Description	Test the hub functionality with TPL peripherals.
Test setup	<ul style="list-style-type: none"> - One 4 port high-speed self powered hub (If hub support is performed by VID/PID in TPL use this hub) - At least one TPL device from each category - FS device if listed on TPL (for TT stress).
Preconditions	The A-UUT is powered ON. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	TPL4, MSG2, MSG3, MSG5
Pass Criteria	Prove the functionality of the all device categories listed in TPL attached downstream from one hub.

Test instructions:

1. Power on the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.

- If the B-device requires external power, power on the B-device.
- 2. Attach a B-device to the hub's downstream port 1.
- 3. Attach similar peripherals to available downstream hub ports.
- 4. Prove the functionality of each attached device.
 - Do they operate concurrently and independently?
 - Or, is a selection method available such that the user can select the active device?
- 5. Detach one device and replace it with a device of another category if multiple categories are supported.
- 6. Detach all peripherals.
- 7. Repeat the above steps for each of the different supported category.

5.2.11. A-UUT Bus Powered Hub Power Exceeded Test

Purpose	To prove that the host generates an appropriate error message when connecting a high power device downstream from a bus powered hub.
Applies to	OTG A-device and EHes which support bus powered hubs.
Description	Check that the A-UUT is able to detect and prevent an over current event on a bus powered hub.
Test setup	A bus powered hub. High power device from the TPL (Max power descriptor >100 mA). If no high power device is available on TPL use other high power device.
Preconditions	The A-UUT is powered ON Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	C5
Pass Criteria	An appropriate error message was generated.

Test instructions:

1. Power on the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.
 - If the B-device requires external power, power on the B-device.
2. Attach a bus powered hub.
3. Attach a high power device downstream from a bus powered hub.
4. Check that an appropriate error message is generated by the A-UUT.

5.2.12. A-UUT Maximum Concurrent Device Exceed Message Test

Purpose	To prove that the specified maximum number of concurrent peripherals function correctly, and either that an error message is given when exceeding this number or that it is able to handle 4 peripherals.
Applies to	OTG A-devices and EHes which support a limited number of peripherals concurrently
Description	Test the A-UUT for appropriate behavior when exceeding the maximum number of supported concurrent peripherals up to a maximum of four.
Test setup	May require hubs to be attached in order to exceed maximum number of peripherals. The number of similar peripherals that the A-UUT is able to handle concurrently plus one up to a maximum of four.
Preconditions	The A-UUT is powered ON. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	MSG1, MSG2, MSG7
Pass Criteria	An appropriate error message was generated.

Test instructions:

1. Power on the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.
 - If the B-device requires external power, power on the B-device.
2. Attach a B-device and prove its functionality.
3. Keep increasing the number of similar peripherals attached until the maximum number is reached, proving their functionality each time.
4. Attach an additional similar peripherals.
5. Check that an appropriate error message is generated by the A-UUT or that it is able to handle 4 peripherals without error.

5.2.13. A-UUT Standby test

Purpose	To prove that the host can handle standby correctly.
Applies to	OTG A-devices and EH products which support standby.
Description	With a B-device connected verify standby operation of the A-UUT.
Test setup	At least one TPL device from each category.
Preconditions	The A-UUT is powered ON. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	C2
Pass Criteria	Compliant standby behavior is observed.

Test instructions:

1. Power on the A-UUT.

- If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.
 - If the B-device requires external power, power on the B-device.
2. Attach a B-device and prove its functionality.
 3. Place the A-UUT in standby (follow the A-UUT vendor guidelines to force the host into standby mode).
 4. Take the A-UUT out of standby mode (A-UUT may also come out of standby automatically on detach).
 5. Prove the functionality of the B-device.
 6. Repeat the above steps for each of the different supported category.

5.2.14. A-UUT Standby Disconnect test

Purpose	To prove the standby functionality of the OTG A-device or EH when a peripheral is detached during standby mode.
Applies to	OTG A-devices and EHes which support standby
Description	Detach TPL peripheral while A-UUT is in standby mode. Verify that the A-UUT operates correctly after the A-UUT leaves standby mode.
Test setup	At least one TPL peripheral.
Preconditions	The A-UUT is powered ON. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	C2
Pass Criteria	Compliant standby behavior is observed.

Test instructions:

1. Power on the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.
 - If the B-device requires external power, power on the B-device.
2. Attach a peripheral and prove its functionality.
3. Place A-UUT into standby (follow A-UUT vendor guidelines to force the host into standby mode).
4. Detach the peripheral.
5. Take the A-UUT out of standby (A-UUT may also come out of standby automatically on detach).
6. Verify that A-UUT operates correctly.
7. If different types of standby modes are supported repeat the test until all modes have been tested.

5.2.15. A-UUT Standby Attach test

Purpose	To prove the standby functionality of the OTG A-device or EH when a peripheral is attached during standby mode.
Applies to	OTG A-devices and EHes which support standby.
Description	Attach a TPL peripheral while the A-UUT is in standby mode. Verify A-UUT operates correctly after the A-UUT leaves standby mode.
Test setup	At least one TPL peripheral.
Preconditions	The A-UUT is powered ON. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	C2
Pass Criteria	Compliant standby behavior is observed.

Test instructions:

1. Power on the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.
 - If the B-device requires external power, power on the B-device.
2. Place the A-UUT into standby (follow A-UUT vendor guidelines to force the host in standby mode).
3. Attach Peripheral.
4. Take the A-UUT out of standby mode (A-UUT may also come out of standby automatically on attach).
5. Verify that A-UUT behaves normally.
6. Prove the functionality of the peripheral.
7. If different types of standby modes are supported repeat the test until all modes have been tested.

5.2.16. A-UUT Standby Topology Change test

Purpose	To prove the standby functionality of the OTG A-device or EH when the topology changes during standby.
Applies to	OTG A-devices and EHes which support standby.
Description	Switch the topology of TPL peripherals while the A-UUT is in standby. Verify that the A-UUT does not behave abnormally after the A-UUT leaves standby mode
Test setup	At least one TPL peripheral.
Preconditions	The A-UUT is powered ON. Use a Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	C2
Pass Criteria	Compliant standby behavior is observed.

Test instructions:

1. Power ON the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.
 - If the B-device requires external power, power on the B-device.
2. Attach a hub (if required).
3. Attach the B-device and prove functionality.
4. Place the A-UUT into standby (follow A-UUT vendor guidelines to force the host in standby mode).
5. Detach the B-device and attach it to another EH port or another downstream hub port.
6. Take the A-UUT out of standby mode standby (A-UUT may also come out of standby automatically on attach).
7. Verify that the A-UUT behaves normally.
8. Prove functionality of the B-device.
9. If different types of standby modes are supported repeat the test until all modes have been tested.

5.2.17. A-UUT Standby Remote Wakeup test

Purpose	To prove the remote wakeup functionality of an OTG A-device or EH.
Applies to	OTG A-devices or EHes which support standby and remote wakeup.
Description	Perform a USB remote wakeup event and verify that the A-UUT operates correctly after the A-UUT leaves standby mode.
Test setup	At least one TPL peripheral which supports remote wakeup.
Preconditions	The A-UUT is powered ON. Use Micro-A plug to Standard-A Receptacle adapter if the product is an OTG device.
Checklist	C2
Pass Criteria	Compliant standby behavior is observed when a remote wakeup event is performed during standby.

Test instructions:

1. Power ON the A-UUT.
 - If the product is an OTG device with a Micro-AB receptacle then attach a Micro-A plug to Standard-A Receptacle adapter.
 - If the B-device requires external power, power on the B-device.
2. Attach the B-device.
3. Prove the functionality of the A-UUT with the B-device.
4. Put the A-UUT into standby (follow A-UUT vendor guidelines to force the host in standby mode).
5. Perform a USB remote wakeup event from the B-device.

6. Prove the functionality of the A-UUT with the B-device.

6. Auto PET tests

6.1. Introduction of PET

The PET (Protocol and Electrical Tester) is a unit that is designed to perform compliance testing or assist with development work leading towards compliance testing on Battery Charging, On-the-Go, and other general USB applications.

The tests in this section test only a partial list of all the possible parameters and compliant behavior. The tests should not be considered as a full validation test plan. For the detailed description of PET Test, see Chapter 6 of USB On-The-Go and Embedded Host Automated Compliance Plan.

The Packet-Master USB-PET is used by most Compliance Test Labs, and is delivered complete with MQP's Windows application **Graphic USB** for generating test reports, and also analyzer-style captures.



Figure 96. Packet-Master USB-PET

6.2. Test environment

The following section outlines the test environment.

6.2.1. Test cables required

The cables required by the PET tester are described below.

Each cable should be labeled, and specify the lead loop resistance value, required to be entered into the test dialog, if the cable is replaced. The tester application contains a check box to specify whether the UUT has a captive cable, as in this case the captive test cable is deemed to be part of the unit under test.

Table 22. Special test cable A

Micro-B plug to Micro-B plug		
Micro-B plug (PET)	Micro-B plug (UUT)	Purpose
1	1	VBUS
2	2	D-
3	3	D+
4	4	ID
5	5	GND

Table 23. Special test cable B

Micro-B plug to Standard-A plug		
Micro-B plug (PET)	Standard-A plug (UUT)	Purpose
1	1	VBUS
2	2	D-
3	3	D+
	—	
5	4	GND

6.2.2. Test set up

The cables required by the PET tester are described below.

Each cable should be labeled and specify the lead loop resistance value required to be entered into the test dialog if the cable is replaced. The tester application contains a check box to specify whether the UUT has a captive cable, as in this case the captive test cable is deemed to be part of the unit under test.

6.2.3. OTG device as Unit-Under-Test

When running a test-suite relating to an OTG device, the first test will prompt you to attach it to the PET using special cable A.

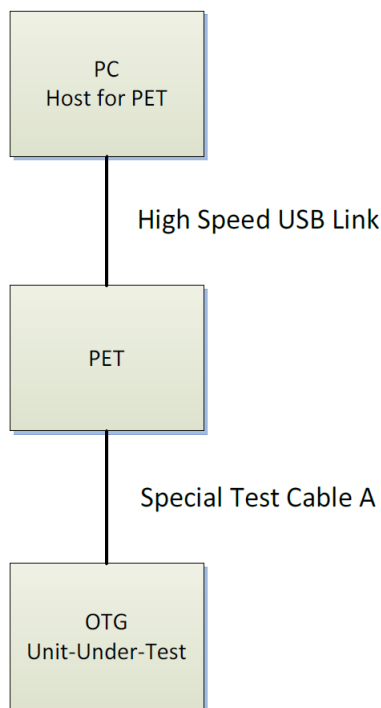


Figure 97. Setup number 1: OTG device

6.2.4. Embedded Host as Unit-Under-Test

When running a test-suite relating to an Embedded Host using a Standard-A receptacle, the first test will prompt you to attach it to the PET using special cable B.

When running a test-suite relating to an Embedded Host using a Micro-AB receptacle, the first test will prompt you to attach it to the PET using special cable A.

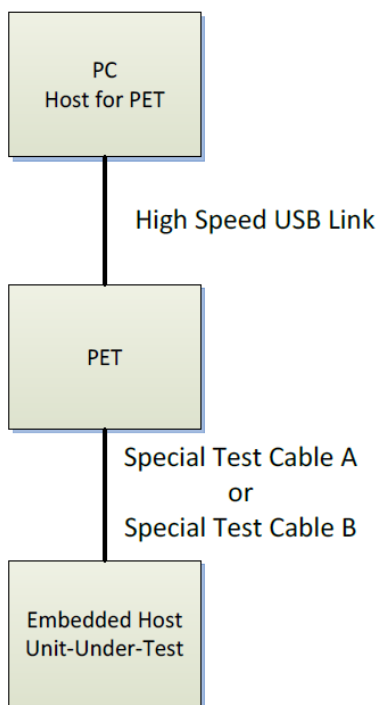


Figure 98. Setup number 2: Embedded Host

6.2.5. Peripheral only as Unit-Under-Test

When running a test-suite relating to a peripheral-only¹ OTG device, the first test will prompt you to attach it to the PET using special cable A.

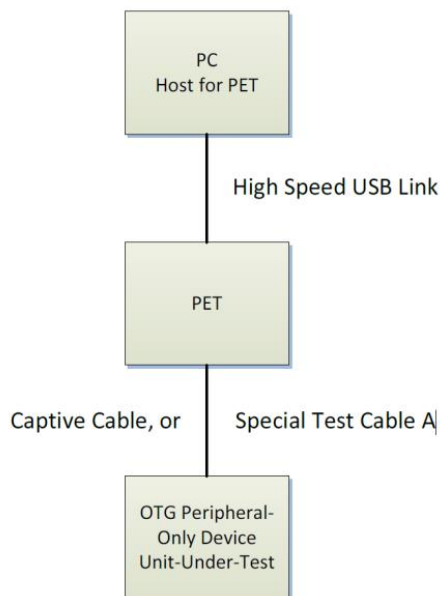


Figure 99. Setup number 3: peripheral only

¹ If the peripheral is not compliant with OTG and the EH rev.2.0 supplement (meaning it is only compliant with the general USB 2.0 specification), then the Auto PET test for peripheral only is not needed.

6.2.6. User input before test runs

Before running any test suite, the PET needs to be informed of a number of parameters by the test operator. Most of the information should be available from the checklist supplied by the vendor. The following tables describe the information required. Typically PET software would modify the available options to those applying to the currently chosen device type.

Table 24. Information obtained from the checklist

Input	Type	Purpose	Checklist ref.
OTG Device	Mutually exclusive check boxes	Automatically selected by UUT items OTG-A or OTG-B.	PI2
Embedded Host		Automatically selected by UUT item Embedded Host.	
Peripheral Only		Automatically selected by UUT item Peripheral Only.	
Uses Micro-AB	Check box	Check this box for an EH which uses a Micro-AB receptacle instead of a Standard-A receptacle. It will be automatically selected for OTG devices.	PI5a
Supports Sessions	Check box	Check this box if the OTG A-UUT or EH with Micro-AB receptacle does not keep VBUS enabled all the time that the ID pin is held low. Check this box for an EH with Standard-A receptacle which does not keep VBUS high all the time it is powered up. In either case it is assumed that SRP or ADP is available to detect the presence of a device.	PI10
SRP as A-device	Check box	Check this box if the UUT, as an A-device, supports detecting and acting on an SRP pulse generated by a connected device.	PI13
HNP as A-device	Check box	Check this box if the UUT, as an A-device, supports HNP to enable the connected B-device to become host if it so requires.	PI13
HNP Polling as A-device	Check box	Check this box if the UUT, as an A-device, supports HNP polling. If it does it is allowed to remain as host for as long as the other device does not set its Host Request Flag.	PI13
ADP as A-device	Check box	Check this box if the UUT, as an A-device, supports ADP probing to detect the presence or otherwise of a connected device.	PI13
SRP as B-device	Check box	Check this box if the UUT, as a B-device, supports generating an SRP pulse in order to start a session (cause the connected A-device to turn on VBUS).	PI20
HNP as B-device	Check box	Check this box if the UUT, as a B-device, supports HNP to allow it to become host if it so requires.	PI20
ADP as B-device	Check box	Check this box if the UUT, as a B-device, supports ADP sensing and probing to detect the presence or otherwise of a connected device.	PI20
FS Not Available	Check box	Check this box if UUT does not fully support full-speed operation. This is not permitted for an OTG device, but may be for an Embedded Host.	PI11, PI18
IA_VBUS_RATED	Edit box	The rated output current of an A-device in mA units.	PI8

Input	Type	Purpose	Checklist ref.
bMaxPower	Edit box	bMaxPower is the highest current, in mA, declared in any of the device's Configuration Descriptors. This value ignores current drawn under the Battery Charging provisions.	PI17
TPWRUP_RDY	Edit box	Maximum time, in seconds, specified by vendor from powering on the UUT until it is ready to perform USB functionality. By default this is set to 30 seconds, but a vendor is permitted to specify a longer time.	PI24
TA_WAIT_BCON max	Edit box	The maximum time, in seconds, that VBUS is left on for by an A-device, in the absence of a B-device connecting. The default value is thirty seconds. A vendor is permitted to specify a longer time, but should be aware that this will have an impact on the time taken for, and therefore possibly the cost of, compliance testing.	PI10
Unknown Dev (No HNP)	Edit boxes	The test will use the VID/PID combination specified during tests for error messages, when an unknown B-device, not capable of HNP, is connected. A default value (1A0A/0201) is used, but any other device not on the UUT's TPL may be defined here.	—
Unknown Dev (HNP)	Edit boxes	The test will use the VID/PID combination specified during tests for error messages, when an unknown B-device, capable of HNP, is connected. A default value (1A0A/0202) is used, but any other device not on the UUT's TPL may be defined here.	—

6.3. A-UUT tests

Test items:

- A-UUT VBUS Voltage and Current Measurements
- A-UUT Bypass Capacitance
- A-UUT SRP
- A-UUT ADP
- A-UUT Leakage
- EH, Capable of ADP and SRP, State Transition Test (Standard-A)
- EH, Capable of ADP but not SRP, State Transition Test (Standard-A)
- EH, Capable of SRP but not ADP, State Transition Test (Standard-A)
- EH with no Session Support State Transition Test (Standard-A)
- EH, Capable of ADP and SRP, (Micro-AB) or OTG-A , Capable of ADP and SRP but not HNP, State Transition Test
- EH, Capable of ADP but not SRP, (Micro-AB) or OTG-A , Capable of ADP but not SRP or HNP, State Transition Test
- EH, Capable of SRP but not ADP, (Micro-AB) or OTG-A , Capable of SRP but not ADP or HNP, State Transition Test

- EH with no Session Support State Transition Test (Micro-AB), or OTG-A with no Session or HNP Support
- A-UUT “Device No Response” for connection timeout
- A-UUT “Unsupported Device” Message
- A-UUT “Device No Response” for HNP enable
- EH using Micro-AB “Incorrect Connection”

Test report:

Table 25. PET A-UUT test report

Num	Test Item	Result
1	6.7.2 A-UUT Initial Power-Up Test	Pass
2	6.7.4 A-UUT VBUS Voltage and Current Measurements	Pass
3	6.7.5 A-UUT Bypass Capacitance	Pass
4	6.7.6 A-UUT SRP	Pass
5	6.7.8 A-UUT ADP	Pass
6	6.7.9 A-UUT Leakage	Pass
7	6.7.14 EH, Capable of ADP and SRP, State Transition Test (Standard-A)	—
8	6.7.15 EH, Capable of ADP but not SRP, State Transition Test (Standard-A)	—
9	6.7.16 EH, Capable of SRP but not ADP, State Transition Test (Standard-A)	—
10	6.7.17 EH with no Session Support State Transition Test (Standard-A) ¹	Pass
11	6.7.18 EH, Capable of ADP and SRP, (Micro-AB) or OTG-A , Capable of ADP and SRP but not HNP, State Transition Test	—
12	6.7.19 EH, Capable of ADP but not SRP, (Micro-AB) or OTG-A , Capable of ADP but not SRP or HNP, State Transition Test	—
13	6.7.20 EH, Capable of SRP but not ADP, (Micro-AB) or OTG-A , Capable of SRP but not ADP or HNP, State Transition Test	—
14	6.7.21 EH with no Session Support State Transition Test (Micro-AB), or OTG-A with no Session or HNP Support	—
15	6.7.22 A-UUT Device No Response for connection timeout	Pass
16	6.7.23 A-UUT Unsupported Device Message	Pass
17	6.7.24 A-UUT Device No Response for HNP enable	—
18	6.7.25 EH using Micro-AB Incorrect Connection ²	—

Test instructions:

1. Install and run **GraphicUSB** on your computer.
2. Click on **Operation** -> **Compliance Tester** on the menu bar. The Test Suite dialog appears as shown in [Figure 100](#).
3. Select the type of unit to be tested using the **Unit Under Test** combo box.

¹ If the Embedded Host uses a standard Type A receptacle, and it does not support ADP, SRP, HNP, session. Therefore only 6.7.17 should be tested.

² Only the Embedded Host using Micro-AB receptacle needs to run this test.

- Then refer to the completed Compliance Checklist, and ensure that the other **Unit Under Test** checkboxes and parameters are correctly entered.
- The appropriate tests will be loaded into the Selected Tests list box. These tests are now ready to automatically run in sequence.
- Specify a Product name so that the reports can be saved into an appropriate folder.
- Click on **Run** to start the test suite.
- A text report file will be created, into which the test results are written, as shown in [Figure 101](#).

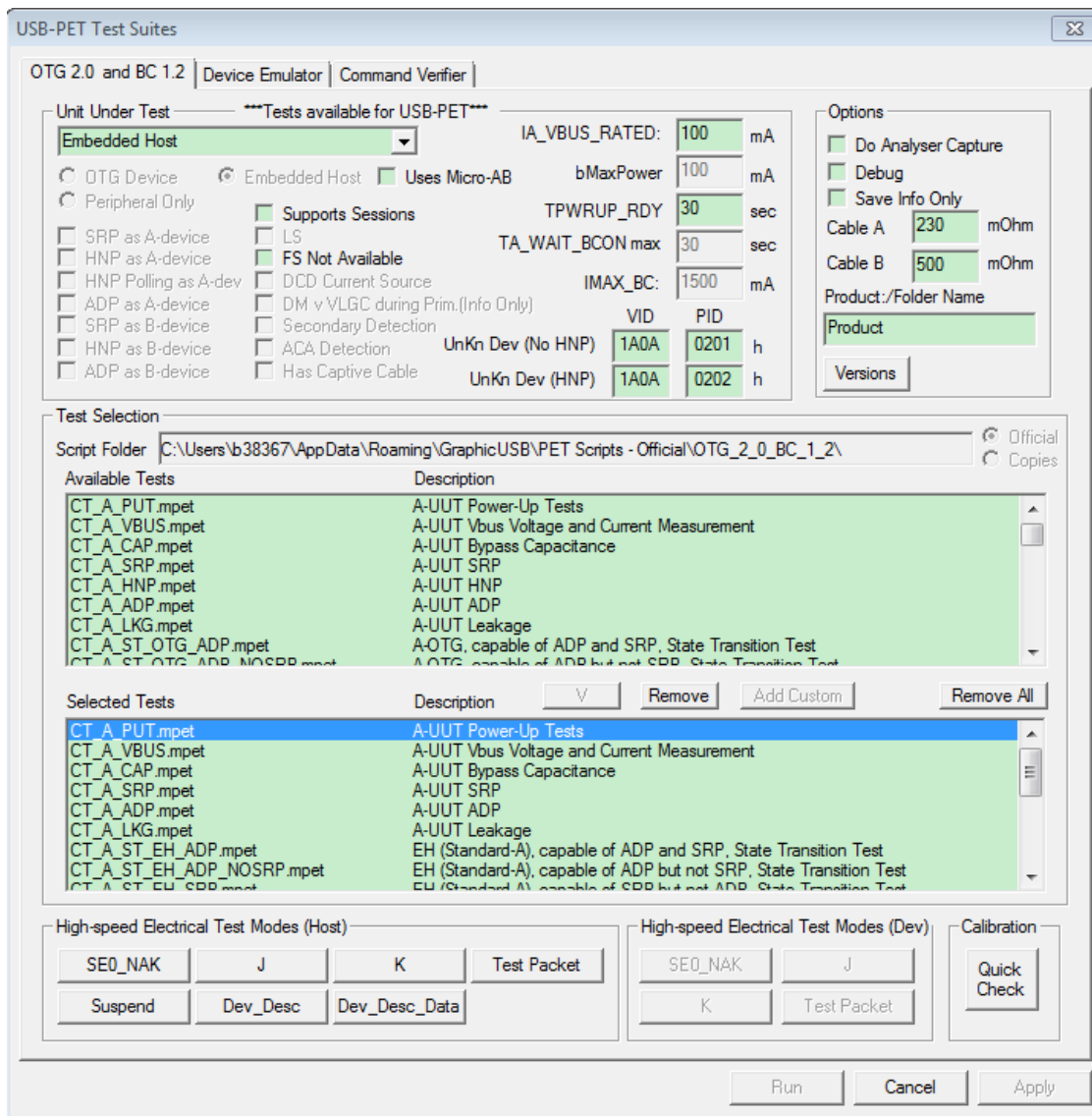


Figure 100. USB-PET Test suites

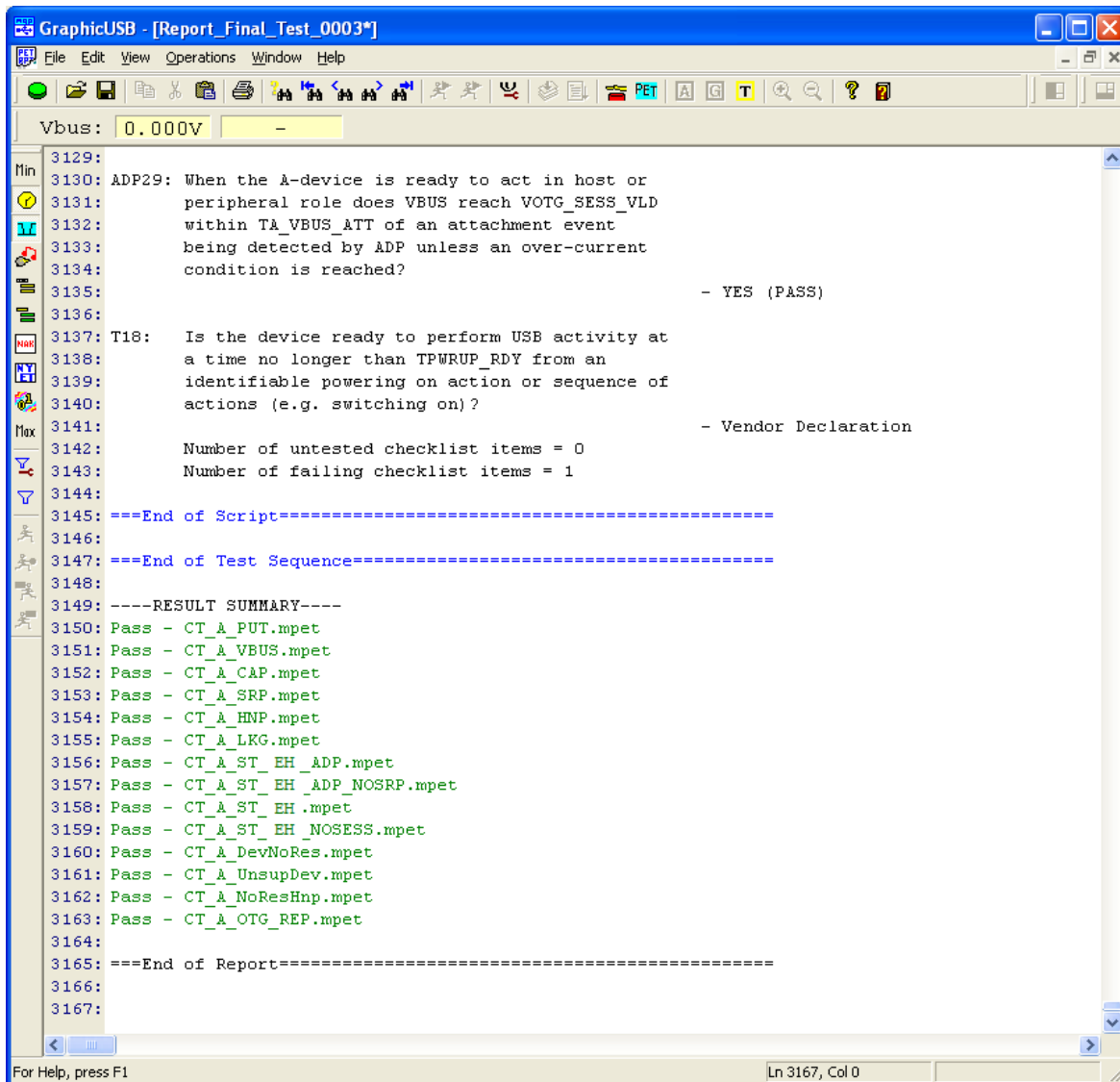


Figure 101. USB-PET Test report

7. Useful links

Freescale i.MX 6 USB Certification Test Guide and Materials:

<https://community.freescale.com/docs/DOC-105609>

USB Spec:

http://www.usb.org/developers/docs/usb20_docs/usb_20_0702115.zip

OTG and Embedded Host related documents:

<http://www.usb.org/developers/onthego/>

OTG and Embedded Host Compliance Test Spec:

http://www.usb.org/developers/onthego/otgeh_compliance_plan_1_2.pdf

Full and Low Speed Compliance Test Spec:

http://www.usb.org/developers/compliance/electrical_tests/USB-IFTestProc1_3.pdf

USB 2.0 Electrical Test Spec:

http://www.usb.org/developers/compliance/USB-IF_USB_2_0_Electrical_Test_Spec081005.pdf

Gold Tree Test procedure:

<http://compliance.usb.org/resources/GoldSuite%20Test%20Procedure.pdf>

Test software and tools:

<http://www.usb.org/developers/tools/>

Checklist and TPL:

http://www.usb.org/developers/compliance/check_list/

http://www.usb.org/developers/compliance/check_list/TPL_form_otgeh2_0_v1.0_fill-in.pdf

Electrical Test procedure for Different Oscilloscopes:

http://www.usb.org/developers/compliance/electrical_tests/

Detailed Electrical Test procedure for Keysight Oscilloscope with N5416A:

http://www.keysight.com/upload/cmc_upload/All/N5416A_USB2_Compliance_App_Testing_Notes.pdf

USB-IF Compliance Updates:

<http://compliance.usb.org/index.html>

Search the TID for certified products:

<http://www.usb.org/kcompliance/view>

Company VID List:

http://www.usb.org/developers/tools/comp_dump

USB-PET User Manual:

<http://www.mqp.com/pdf/manuals/PET%20User%20Manual.pdf>

USB-PET Software:

http://www.mqp.com/sw/GraphicUSB_setup.exe

Independent Test Lab:

<http://www.usb.org/developers/compliance/labs/>

8. Abbreviations

Table 26. Abbreviations used in this document

Term	Definition
Client Computer	Controller computer networked to host PC for remote control desktop connection
DUT	Device Under Test
EHCI	Enhanced Host Controller Interface(USB2.0)
xHCI	Extensible Host Controller Interface(USB3.0)
OHCI	Open Host Controller Interface
UHCI	Universal host controller interface(USB1.1)
Host Computer	Server platform operated by Client PC through remote desktop connection
HSETT	High speed electrical test tool
LAN	Local area network
Legacy-free	Any system that does not have PS/2 and other legacy ports
PCIe	Peripheral Component Interconnect Express Bus
PID	Product Identification Number
PS/2 port	A legacy mouse or keyboard port located on some motherboards
UAC	User Account Control
USB	Universal Serial Bus
VID	Vendor Identification Number
TID	Product Test ID assigned by USB-IF after passing the USB Certification Test

9. Revision history

This table provides a revision history for this document.

Table 27. Revision history

Revision number	Date	Substantive changes
0	10/2015	Initial release

How to Reach Us:

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freescale.com/support

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