

Universal Serial Bus Implementers Forum Host High-speed Electrical Test Procedure For Agilent Infiniium 54846

Revision 1.1

August 23, 2003

Revision History

Rev	Date	Filename	Comments
0.9 (Beta)	Nov-23-2001	Host HS Test for Agilent.DOC	Primary version of High Speed Test Procedure adapted to Agilent test equipment based on the test procedure created by USB-IF (version 0.9)
1.0	Feb-5-2002	Host HS Test for Agilent.DOC	Edit for final release.
1.1	Aug-23-2003	Host HS Test for Agilent 54846.DOC	Substituted differential probe equipment with Agilent 113x InfiniMax Probe. Use Agilent fixture nomenclature. Minor edits.

Please send comments via electronic mail to techsupp@usb.org

USB-IF High-speed Electrical Test Procedure
© Copyright 2001, USB Implementers Forum, Inc.
All rights reserved.

DISCLAIMER OF WARRANTIES

THIS SPECIFICATION IS PROVIDED “AS IS” AND WITH NO WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, NO WARRANTY OF NONINFRINGEMENT, NO WARRANTY OF MERCHANTABILITY, NO WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, NO WARRANTY OF TITLE, AND NO WARRANTY ARISING OUT OF ANY PROPOSAL, SPECIFICATION, OR SAMPLE, ALL OF WHICH WARRANTIES ARE EXPRESSLY DISCLAIMED.

WITHOUT LIMITING THE GENERALITY OF THE FOREGOING, USB-IF AND THE AUTHORS OF THE SPECIFICATION DO NOT WARRANT OR REPRESENT THAT USE OF THE SPECIFICATION WILL NOT INFRINGE THE INTELLECTUAL PROPERTY RIGHTS OF OTHERS. USERS OF THE SPECIFICATION ASSUME ALL RISK OF SUCH INFRINGEMENT, AND AGREE THAT THEY WILL MAKE NO CLAIM AGAINST USB-IF OR THE AUTHORS IN THE EVENT OF CLAIMS OF INFRINGEMENT.

USB-IF IS NOT LIABLE FOR ANY CONSEQUENTIAL, SPECIAL OR OTHER DAMAGES ARISING OUT OF THE USE OF THE SPECIFICATION.

LICENSE FOR INTERNAL USE ONLY

USB-IF HEREBY GRANTS A LICENSE TO REPRODUCE AND TO DISTRIBUTE THIS SPECIFICATION FOR INTERNAL USE ONLY. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, IS GRANTED HERewith, AND NO LICENSE OF INTELLECTUAL PROPERTY RIGHTS IS GRANTED HERewith.

All product names are trademarks, registered trademarks, or servicemarks of their respective owners.

Table of Contents

1	Introduction	5
2	Purpose.....	5
3	Equipment Required.....	5
3.1	Equipment Setup	6
3.1.1	Infiniium 54846 Digital Sampling Oscilloscope	6
3.2	Operating Systems, Software, Drivers, and Setup Files	7
3.2.1	Operating Systems	7
3.3	Special Purpose Software.....	7
3.3.1	Test Equipment Setup Files	8
4	Test Procedure	8
4.1	Test Record.....	8
4.2	Vendor and Product Information	8
4.3	Legacy USB Compliance Tests.....	8
4.4	Host High-speed Signal Quality (EL_2, EL_3, EL_6, EL_7)	9
4.5	Host Controller Packet Parameters (EL_21, EL_22, EL_23, EL_25, EL_55)	14
4.6	Host Disconnect Detect (EL_36, EL_37)	18
4.7	Host CHIRP Timing (EL_33, EL_34, EL_35)	20
4.8	Host Suspend/Resume timing (EL_39, EL_41)	22
4.9	Host Test J/K, SE0_NAK (EL_8, EL_9)	24
A.4	Host High-speed Electrical Test Data	27
A.4.2	Vendor and Product Information	27
A.4.3	Legacy USB Compliance Tests	28
A.4.4	Host High-speed Signal Quality (EL_2, EL_3, EL_6, EL_7)	28
A.4.5	Host Controller Packet Parameters (EL_21, EL_22, EL_23, EL_25, EL_55)	30
A.4.6	Host Disconnect Detect (EL_36, EL_37)	31
A.4.7	Host CHIRP Timing (EL_33, EL_34, EL_35)	32
A.4.8	Host Suspend/Resume timing (EL_39, EL_41)	33
A.4.9	Host Test J/K, SE0_NAK (EL_8, EL_9)	33

1 Introduction

The USB-IF High-speed Electrical Test Procedures are developed by the USB 2.0 Compliance Committee under the direction of USB-IF, Inc. There are three High-speed Electrical Test Procedures. The Host High-speed Electrical Test Procedure is for EHCI host controllers. The Hub High-speed Electrical Test Procedure is for high-speed capable hubs. The Device High-speed Electrical Test Procedure is for high-speed capable devices.

The High-speed Electrical Compliance Test Procedures verify the electrical requirements of high-speed USB operation of these devices designed to the USB 2.0 specification. In addition to passing the high-speed test requirements, high-speed capable products must also complete and pass the applicable legacy compliance tests identified in these documents in order to be posted on the USB-IF Integrators List and use the USB-IF logo in conjunction with the said product (if the vendor has signed the USB-IF Trademark License Agreement). These legacy compliance tests are identified in the Legacy USB Compliance Test section in this document.

2 Purpose

This USB-IF High-speed Electrical Test Procedure documents a series of tests used to evaluate USB peripherals and systems operating at high-speed. These tests are also used to evaluate the high-speed operation of USB silicon that has been incorporated in ready-to-ship products, reference designs, proofs of concept and one of a kind prototypes of peripherals, add-in cards, motherboards, or systems.

This test procedure makes reference to the test assertions in the USB-IF USB2.0 Electrical Test Specification, Version 1.00.

This Host USB-IF High-speed Electrical Test Procedure is one of the three USB-IF High-speed Electrical Compliance Test Procedures. The other two are Hub USB-IF High-speed Electrical Test Procedure and Device USB-IF High-speed Electrical Test Procedure. The adoption of the individual procedures based on the device class makes it easier to use.

3 Equipment Required

The commercial test equipment listed here are base on positive experience by the USB-IF members in executing the USB high-speed electrical tests. This test procedure is written with a set of specific models we use to develop this procedure. In time, there will be other equivalent or better test equipment suitable for use. Some minor adaptation of the procedure will be required in those cases.

- Digital Storage Oscilloscope:
 - Infiniium 54846 or 54846B digital storage oscilloscope from Agilent Technologies
 - USB Test Software: E2645A for 54846A, N2854A for 54846B
 - Agilent 1131A, 1133A, or 1134A InfiniiMax (or equivalent) differential probe, qty = 1
 - Agilent E2669A differential connectivity kit, **OR** E2678A socketed head, qty=1
 - Agilent header adapter (p/n 01131-68703), qty=1, included with E2669A and E2678A purchased after October, 2003.

- Agilent 1161A miniature passive probe, qty = 2
- 3 ½ Digital Multimeter – Agilent 972A or equivalent
 - Mini-clip DMM lead – one each of black and red color
- High-speed USB Electrical Test Fixtures
 - Host high-speed signal quality test fixture, qty = 1
 - Device high-speed signal quality test fixture, qty = 1
 - Disconnect test fixture, qty = 1
 - 5V test fixture power supply, qty = 1

(When using Agilent HS test fixtures, the nomenclature of the test point will be different from Intel's test fixtures. This test procedure is written with the reference to Agilent's test fixtures. Please use the following cross-reference chart when using Intel's test fixture

<u>Intel's Fixtures</u>	<u>Description of the test points</u>	<u>Agilent Fixtures</u>
J7	Test Point	TP2
J8	Power Port	J5
J10	Ground	TP5
J11	Ground	TP5

- Miscellaneous Cables
 - 1M USB cable, qty = 1
 - 5M USB cable, qty = 1
 - Modular AC power cord, qty = 2
- High-speed USB Test Bed Computer

This is the computer that hosts a USB 2.0 compliance host controller for high-speed hub or device electrical test, or serves as a test bed host for a USB 2.0 host controller under test. This OS on this computer is Windows 2000 Professional. Please refer to the High-speed Electrical Test Setup Instruction for steps to configure this computer.

3.1 Equipment Setup

3.1.1 Infiniium 54846 Digital Sampling Oscilloscope

Before turning on the oscilloscope, attach differential probe to Channel-1. Attach the socketed probe head to the differential probe amp. Attach the header adapter to the socketed probe head. The header adapter is needed to connect the differential probe to the test fixtures. When the differential probe is not being used on Channel-1, it can be connected to Channel-2 to keep it warmed up.

When using two 1161A miniature passive probes, disconnect the differential probe from Channel-1 and connect one passive probe to Channel-1 and another to Channel-3. These probe assignments will be used through out the entire test procedure. When the differential probe is not being used on Channel-1, it can be connected to Channel-2 to keep it warmed up.

Turn on the oscilloscope to allow for 10 minutes of warm up time prior to use. Perform the signal path compensation procedure built into the Infiniium 54846 (in the [Calibration...] section of [Utilities] pull down menu) if the ambient temperature has changed more than 5 degrees. The compensation should be performed with the probes disconnected from the oscilloscope.

The differential probe and two miniature passive probes must be calibrated to minimize gain and offset errors. Refer to the oscilloscope instructions.

Note: In certain test situation, there may not be a ground connection between the DSO and the device under test. This may lead to the signal seen by the differential probe to be modulated up and down due to mid frequency switching power supply. Connecting the DSO ground to the DUT ground will be require to establish a common ground reference.

3.2 Operating Systems, Software, Drivers, and Setup Files

3.2.1 Operating Systems

Microsoft Windows 2000 Professional is required on the High-speed Electrical Test Bed Computer. Microsoft Windows 2000 Professional is required on the High-speed Signal Quality Analysis Computer. Please refer to the High-speed Electrical Test Setup Instruction for steps to configure these computers.

3.3 Special Purpose Software

The following special purpose software is required. Please refer to the High-speed Electrical Test Setup Instruction for steps to configure these computers.

- High-speed Electrical Test Tool Software – To be used in the High-speed Electrical Test Bed Computer.
- Proprietary EHCI Driver Stack - The High-speed Electrical Test Tool software requires the use of a proprietary EHCI driver stack. The use of this proprietary EHCI driver stack facilitates the electrical testing that requires direct control of the command registers of the USB EHCI host controllers. The end result much more robust test bed environment. Since the proprietary EHCI driver stack is designed for debug and test validation purposes, this driver stack does not support the normal functionality as found in the EHCI drivers from Microsoft (or the device vendor). An automatic driver stack switching function has been implemented into the High-speed Electrical Test Tool for easy switching between the proprietary EHCI driver stack and that from Microsoft. Upon invocation of the HS Electrical Test Tool software, the driver stack will automatically switch to the Intel proprietary EHCI driver stack. Upon exit of the HS Electrical Test Tool software, the driver stack will automatically switch to the Microsoft EHCI driver stack.
- Infiniium USB test option (E2645A for the 54846A, N2854A for the 54846B) - For performing electrical test on USB devices.

3.3.1 Test Equipment Setup Files

This is 3½ inch floppy diskette that contain the setup files for the test equipment. Please refer to the High-speed Electrical Test Setup Instruction for steps to configure these setup disks. No setup disk is needed for Infiniium 54846 if Infiniium USB test option is installed.

DSO Setup Disk – Contain setup files for Agilent Infiniium 54846 (This disk is not needed for the Infiniium 54846 with Infiniium USB test option or E2645A) (Digital Storage Oscilloscope).

4 Test Procedure

4.1 Test Record

Appendix A contains the test result entry form for this test procedure. Please make copies of the Appendix A for use as test record documentation for compliance test submission. All fields must be filled in. Fields not applicable for the device under test should be indicated as N/A, with appropriate note explaining the reason. The completed test result shall be retained for the compliance test submission.

In addition to the hardcopy test record, the electronic files from the signal quality, and power delivery (inrush, drop and droop) shall be retained for compliance test submission.

4.2 Vendor and Product Information

Collect the following information and enter into a copy of the test record in Appendix A before performing any tests.

1. Test date
2. Vendor name
3. Vendor address and phone, and the contact name
4. Test submission ID number
5. Product name
6. Product model and revision
7. USB silicon vendor name
8. USB silicon model
9. USB silicon part marking
10. USB silicon stepping
11. Test conducted by

4.3 Legacy USB Compliance Tests

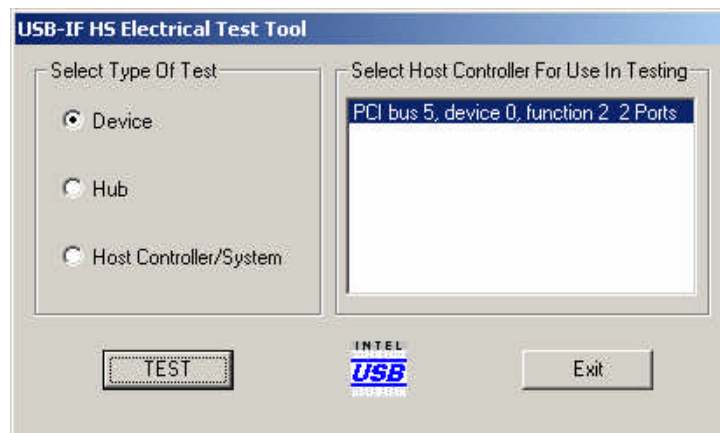
In addition to the high-speed electrical tests prescribed in this document, the host controller under test must also pass the following compliance tests applicable to the EHCI Host Controller:

- Low speed signal quality
- Full speed signal quality
- Drop/Droop
- Interoperability

Perform all these tests and record the measurements and summarized Pass/Fail status in Appendix A.

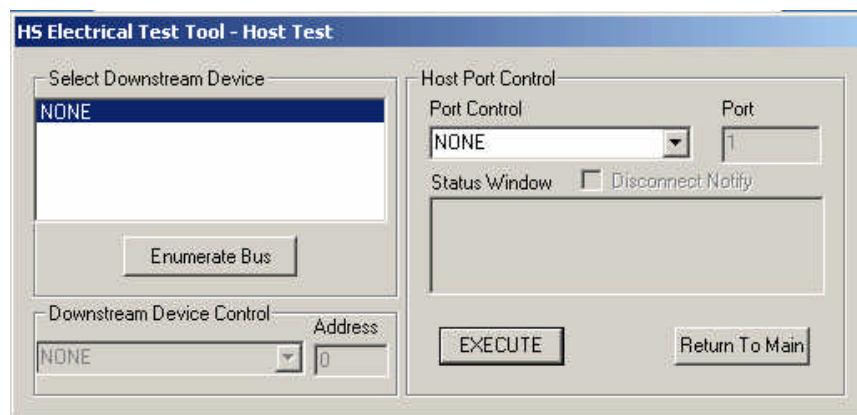
4.4 Host High-speed Signal Quality (EL_2, EL_3, EL_6, EL_7)

1. Turn on the oscilloscope if not already have done so. Attach the differential probetoi Channel-1. Allow about 10 minutes for warm up.
2. Recall HS_SQ_1.SET oscilloscope setup by selecting [Load] >> [Setup...] from the [File] pull down menu.
3. Attach the 5V power supply to J5 of the Host High-Speed Signal Quality test fixture and verify the green Power LED (D1) is lit. Set the Test switch (S1) of the test fixture to TEST and verify the yellow TEST LED is lit.
4. Attach the differential probe to TP2 of the test fixture. Ensure + on probe lines up with D+ on fixture.
5. Invoke the High-speed Electrical Test Tool software on the High-speed Electrical Test Bed computer. The main menu appears and shows the USB2.0 host controller.

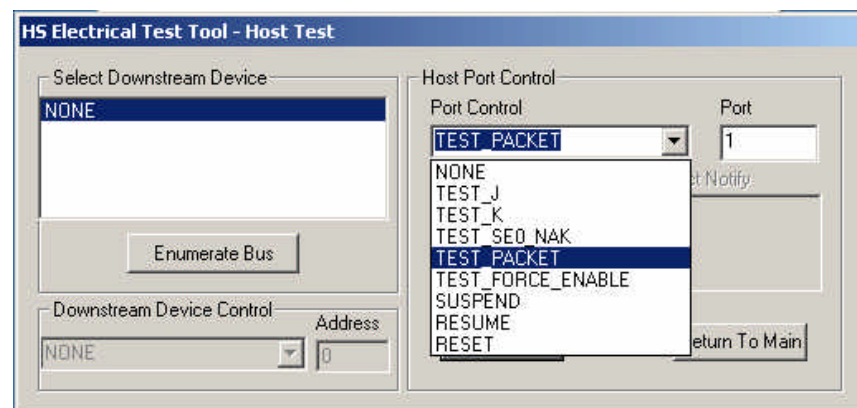


Main Menu

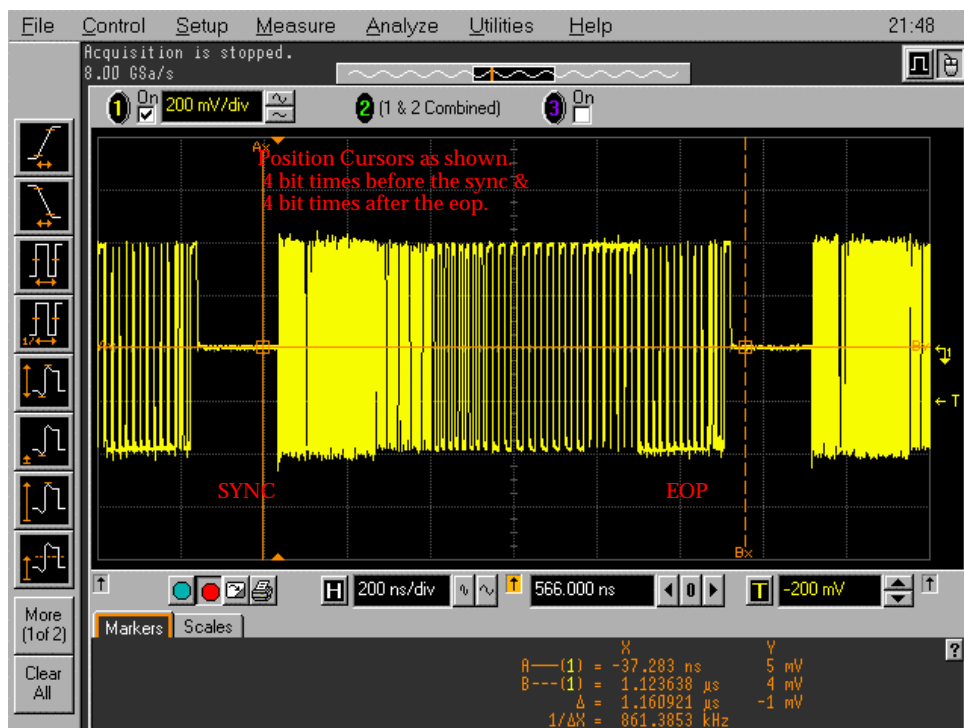
6. Select Host Controller/System and click the [TEST] button to enter the Host Test menu.

Host Test Menu

7. Connect the [TEST PORT] of the Host High-speed Signal Quality test fixture into the port under test of the Host controller.
8. Select TEST_PACKET from the Port Control drop down menu. Enter the port number of the port being tested and click [EXECUTE]. This forces the port under test to continuously transmit test packets.

TEST_PACKET

9. Using the oscilloscope, verify test packets are being transmitted from the port under test. Adjust the trigger level as necessary. If a steady trigger cannot be obtained by adjusting the trigger level, try slight change to the "trigger holdoff". "Holdoff" can be adjusted by selecting [Setup] pull down menu >> [Trigger...] >> [Conditioning...] button.
10. Pause the oscilloscope acquisitions using the [STOP] button.
11. On the oscilloscope place the two vertical cursors around one test packet, one just (about one bit time) before the sync field and the other just (about one bit time) after the EOP (END OF PACKET). Refer to the following figure.



High-speed Test Packet

12. From the Infiniium 54846 [Analyze] pull down menu, select [USB Test] to invoke the USB test.
13. On the USB test option graphical user interface select, select Signal Integrity in [USB Test] section.

High-speed Near End (Leave the [Tier] setting to 6)

USB Test

USB Test
☒ Signal Integrity
☐ Inrush Current
☐ Droop/Drop

Save Results
Data Path
c:\scope\data
Data File
Copy results to floppy
Copy Results

Exit
Help
About

Signal Integrity
Test Type
High-speed Near End
Tier
6

Inrush Current
Supply Voltage
5.000

Droop/Drop
Droop/Drop Test
Self Powered Hub
Volts No Load
5.000
Volts Loaded
4.895

Start Test

USB Test Option

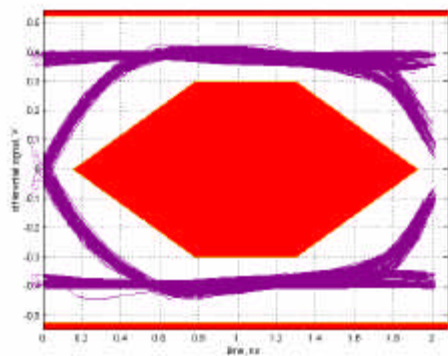
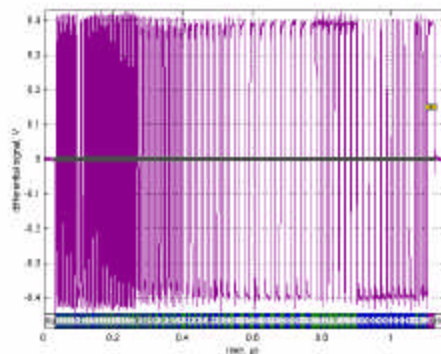
14. Enter a descriptive file name (e.g. TIDxxxxxxx port 1 HSNE.tsv) in [Save Results - Data File] blank .
15. Click [Start Test] at the bottom of USB test option.
16. The result will be displayed on in the Internet Explorer. Verify the Signal Eye, EOP Width, and Signaling Rate all pass. The results displayed in the Internet Explorer are also recorded to an HTML report located in the directory specified in the "Data Path" (e.g. c:\scope\data) .

Required Tests

- Overall result: pass!
- Signal eye:
eye passes
- EOP width: 8.00 bits
EOP width passes
- Receivers: reliable operation on tier 6
receivers pass
- Measured signaling rate: 480.0097MHz
signal rate passes

Additional Information

- Consecutive jitter range: -45.3ps to 63.6ps, RMS jitter 21.6ps
Paired JK jitter range: -38.4ps to 32.9ps, RMS jitter 17.0ps
Paired KJ jitter range: -50.6ps to 43.3ps, RMS jitter 18.3ps

Signal Data, Eye, and Spectrogram

17.

High-speed SQ HTML Report

18. Record the test result in EL_2, EL_3, EL_6, and EL_7.

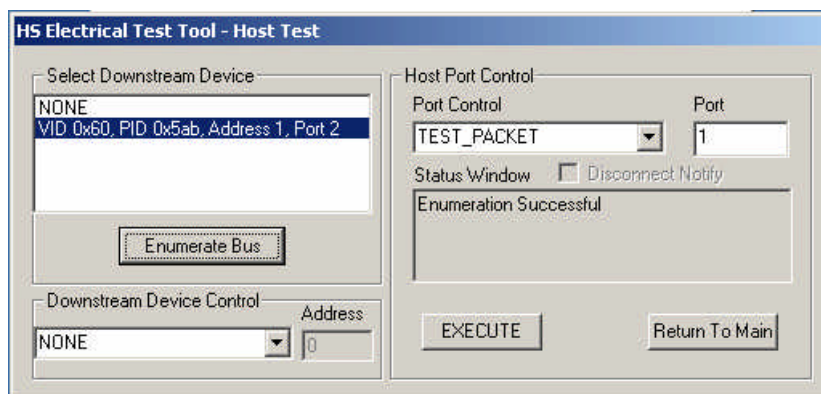
19. Remove the Host Signal Quality test fixture from the port.

20. Repeat steps 7 through 19 for all remaining ports.

21. Save all files created during the tests. To save the results to a floppy disk, insert a floppy to the Infiniium's floppy drive and click on [Copy Results] after closing the Internet Explorer. . Close the Infiniium USB test option by clicking [Exit] button. Remove the Host Signal Quality test fixture from the host controller.

4.5 Host Controller Packet Parameters (EL_21, EL_22, EL_23, EL_25, EL_55)

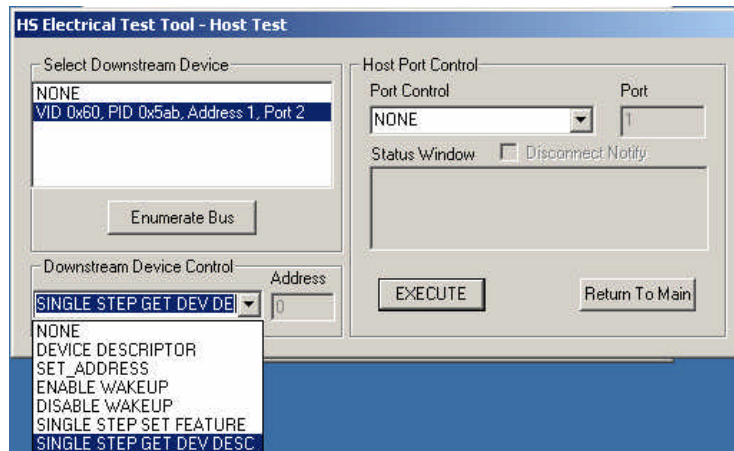
1. Connect the Device Signal Quality test fixture ([TEST PORT]) into B receptacle of a known good high-speed hub. Apply power to the known good hub (refers to as device herein).



Known-Good Device Enumerated

Note: The use of the Device High-speed Signal Quality test fixture makes it possible to trigger on packets generated by the device because the differential probe is located closer to the device transmitter, hence the device packets are larger in amplitude.

2. Attach the differential probe to TP2 on the fixture near the device connector. Ensure + on probe lines up with D+ on fixture.
3. Recall the PACKPARA.SET oscilloscope setup by selecting [Load] >> [Setup...] from the [File] pull down menu.
4. Connect the Device Signal Quality test fixture ([INIT PORT]) into host controller port under test. Click [Enumerate Bus] and verify that the device enumerates properly.
5. Using the oscilloscope, verify SOFs (Start Of Frame packets) are being transmitted on port under test. You may need to lower the trigger level to somewhat below 400mV to obtain a trigger.
6. Now raise the oscilloscope's trigger level slowly just until it does not trigger on the SOFs (or any host traffic). Typically this is around or slightly below 400mV, depending on the device and the length of cable used on the fixture. Ensure the oscilloscope is "RUN"ing and "Trig'd" mode. Use [Sweep] button in the front panel to adjust the mode if oscilloscope is in any other mode.
7. In the Host Test menu of the High-speed Electrical Test Tool software, ensure the device is selected (highlighted). Select SINGLE STEP GET DEV DESC from the Downstream Device Control menu and click [EXECUTE] once.



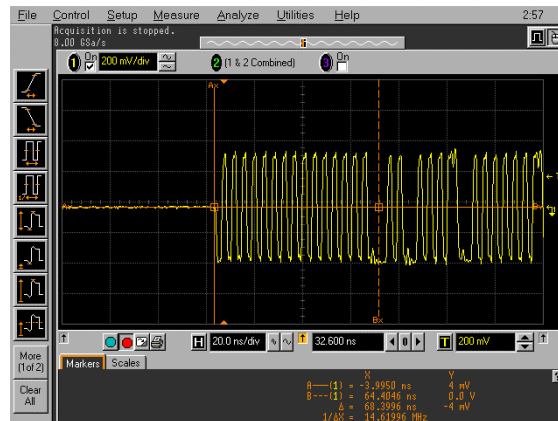
Single Step Get Descriptor

8. The oscilloscope capture should appear as follows. Press [STOP] on the oscilloscope to prevent mistrigger from random noise. If the oscilloscope doesn't trigger on the device traffic the trigger level is set too high. Lower the trigger level slightly (but not so low that it triggers on host SOFs) and repeat from step 6.



Packet from Host and Device

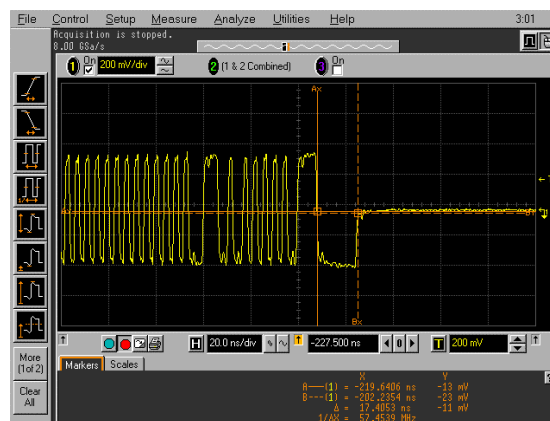
9. Use [Horizontal] knobs or the Zoom Box feature of the oscilloscope, measure the sync field length (number of bits) of the third (from device) packet on the oscilloscope and verify that it is 32 bits per EL_21 (to use the Zoom Box feature, press left button and drag oscilloscope's mouse around the given packet to draw the "Zoom Box", and click inside the box to zoom in). Refer to the figure below for the reference waveform. Note that Sync Field starts from the high-speed idle transitions to a falling edge (due to the first zero). Count both rising and falling edges until the first two consecutive 1's and include the first 1. There must be 32 bits. Record the number in EL_21.



Host Packet Sync Field

10. Measure the EOP length (number of bits) of the second packet on the oscilloscope and verify that it is 8 bits per EL_25. It is advisable to use the markers to measure the EOP pulse width to determine the number of bits, based on 2.08nS/bit (480Mbps). Record the result in EL_25.

Please note that the EOP could appear as a negative going pulse, or a positive going pulse on differential measurement. The figure below illustrates the negative going pulse.



Host Packet EOP

11. Measure the inter-packet gap between the first two packets shown on the oscilloscope by using the marker function of the oscilloscope. Markers can be accessed from [Measure] pull down menu or by pressing the [Marker] keys just below the display. These are back-to-back packets from the host. Compute the bits by dividing the time measure by 2.08nS. The requirement is it must be between 88 bits and 192 bits. (EL_23). Record the computed number of bits in EL_23. The oscilloscope should appear as shown in the following figure.



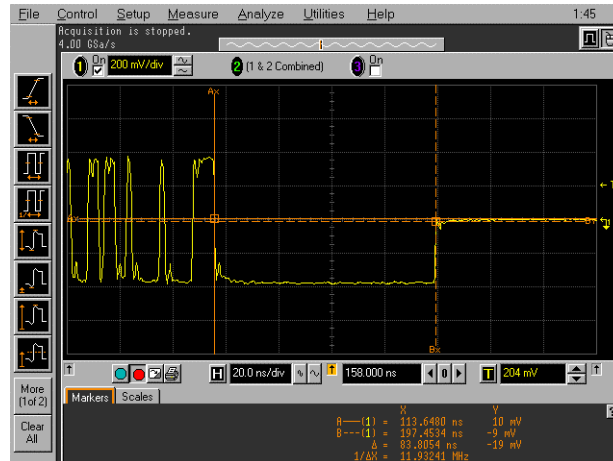
Inter-packet Gap – Between Packets from Host

12. Ensure the oscilloscope is armed in “Trig’d” mode.
13. On the Host Test menu click [EXECUTE] once. The oscilloscope capture should appear as the figure below. Press [STOP] on the oscilloscope to pause it from further trigger.
14. Measure the inter-packet gap between the second and the third packets shown on the oscilloscope. The second (of higher amplitude) is a device packet and the third is the host response. Compute the number of bits by dividing the time measure by 2.08nS. The requirement is it must be between 8 bits and 192 bits. (EL_22). Record the computed number of bits in EL_22.



Inter-packet Gap – Host Respond to Device

15. Press [RUN] button. Adjust the trigger if necessary until the oscilloscope is continuously being triggered by the SOF packets. Press [STOP]. Measure the time period of the EOP width. Compute the number of bits by dividing the time measure by 2.08nS. The requirement is it must be 40 bits. Record the result in EL_55.



EOP Width – SOF Packet

16. Repeat step 4 through 15 for the remaining ports.
17. Remove the Device Signal Quality test fixture and the known good device from the host controller port under test.

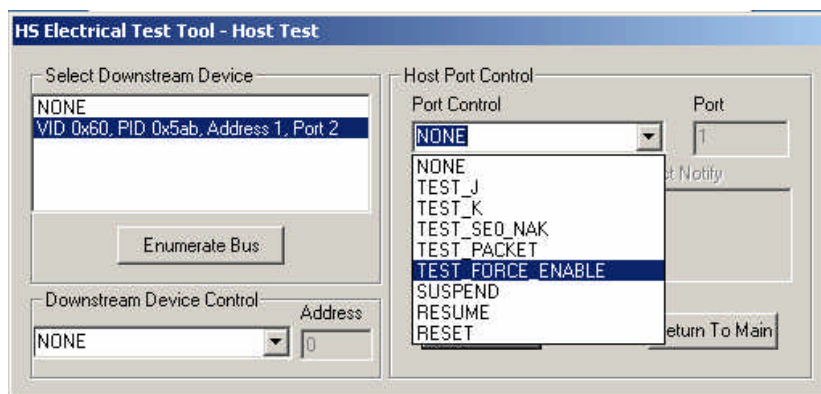
4.6 Host Disconnect Detect (EL_36, EL_37)

This section uses the Disconnect test fixture to verify the disconnect thresholds of the port under test by simulated disconnect condition.

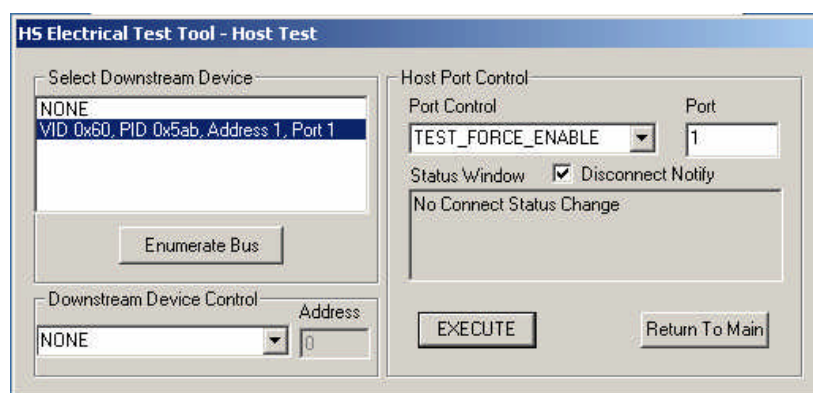
When the TEST switch on the test fixture is in the Test position, the port under test is subjected to a threshold <525mV. The port should not detect a disconnection.

When the TEST switch is in the Normal position, the port under test is subjected to a threshold >625mV. The port should detect a disconnection.

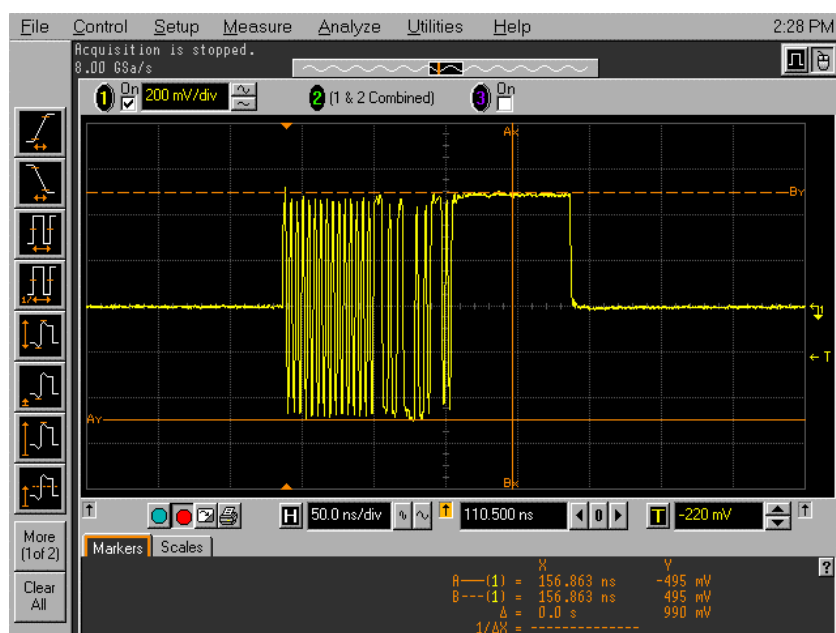
1. Attach the 5V power supply to Disconnect test fixture (J5).
2. Attach the differential probe to TP2. Ensure the + tip on probe lines up with D+ on the fixture. Recall the DISCDETE.SET oscilloscope setup by selecting [Load] >> [Setup...] from the [File] pull down menu.
3. Set the TEST switch to the Test position. Verify the green Power LED (D1) is lit, and the yellow Test LED (D2) is also lit. This sets the test fixture to emulate a must-not-disconnect threshold.
4. Attach the [TEST PORT] of the test fixture to the port under test. In the Host Test menu of the High-speed Electrical Test Tool software select TEST_FORCE_ENABLE from the Port Control window. Enter the port number and click [EXECUTE] once and ensure the operation is successful in the Status Window.



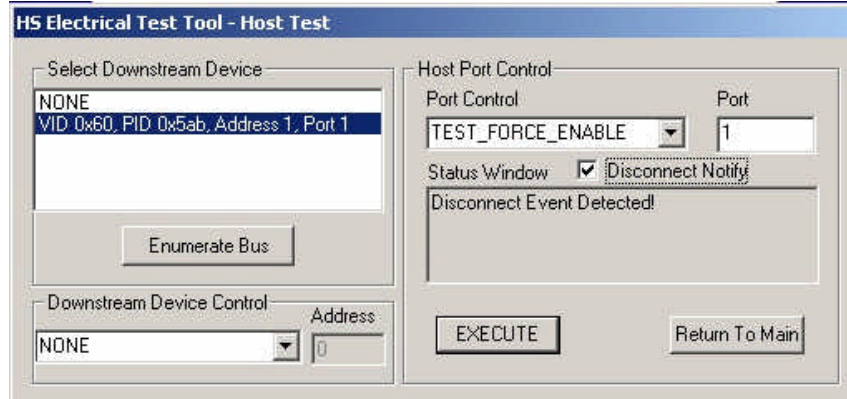
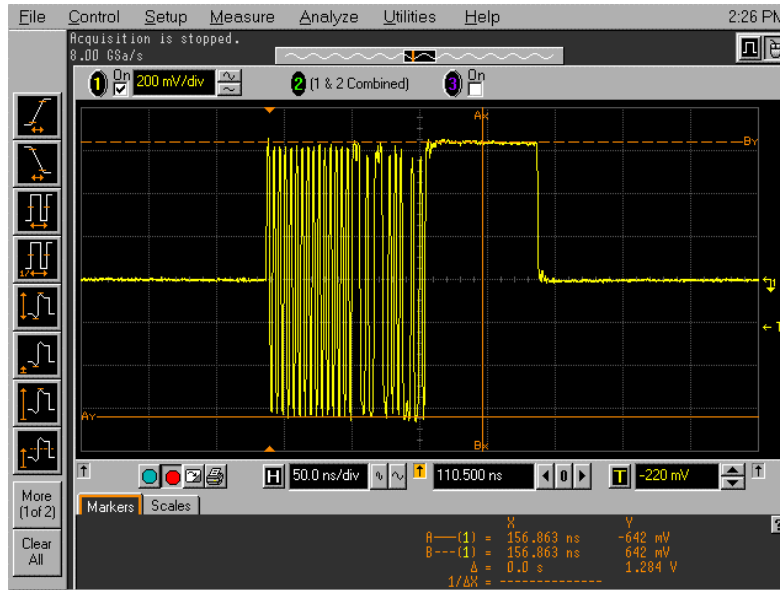
5. Click the Disconnect Notify check box to monitor the disconnect status in the Status Window.



6. Using the oscilloscope, verify the SOF packets are being transmitted from the port under test. The differential amplitude should be less than $\pm 525\text{mV}$. Verify that the Status Window does not display Disconnect Event Detected. Record the pass/fail result in EL_37.



7. Set the TEST switch of the Disconnect test fixture to the Normal position and verify the yellow TEST LED (D2) is not lit.
8. Use the oscilloscope to monitor the differential amplitude of the SOF. It should be greater than $\pm 625\text{mV}$. Verify that the Status Window now displays the Disconnect Event Detected. Record the pass/fail result in EL_36

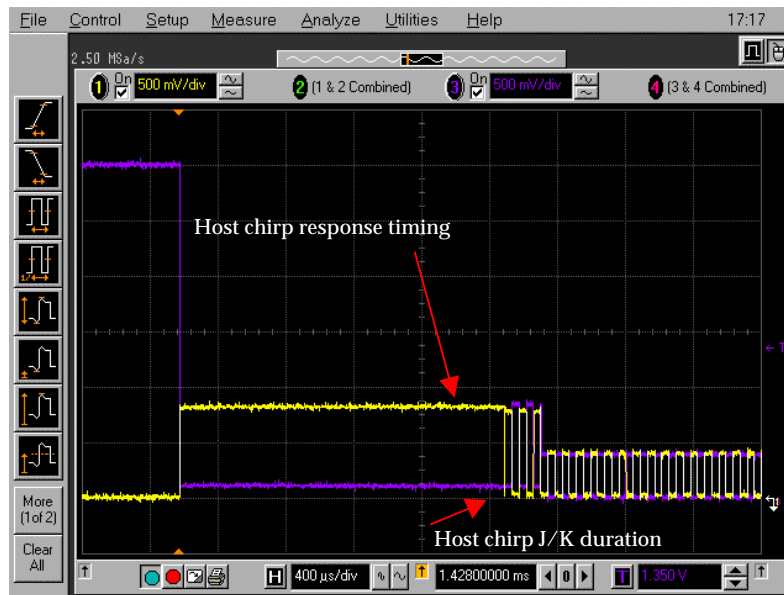


9. Return the TEST switch on the fixture back to the TEST position and verify the yellow TEST LED (D2) is lit.
10. Repeat step 4 through 9 for all the remaining ports.
11. Remove the Disconnect test fixture from the port under test before proceeding.

4.7 Host CHIRP Timing (EL_33, EL_34, EL_35)

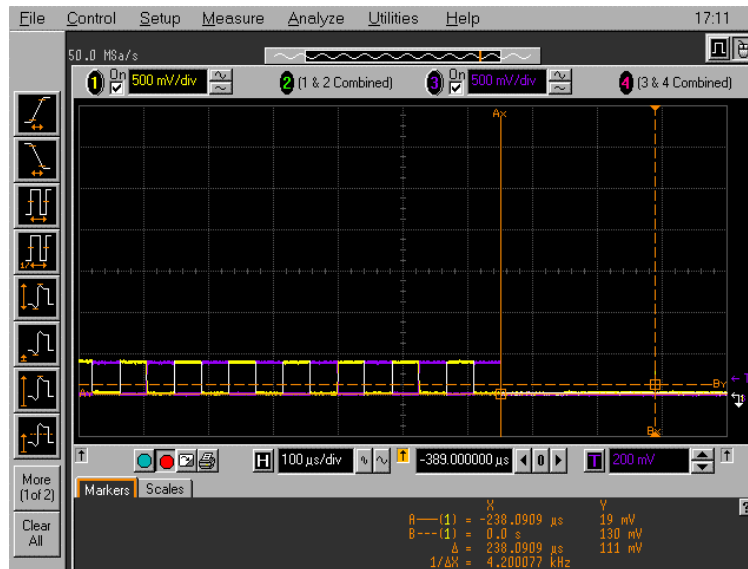
1. Replace the Disconnect test fixture with the Host High-speed Signal Quality test fixture.

2. Connect one 1161A miniature passive probe to Channel-1 and another to Channel-3. Connect these probes to test fixture at TP2. Connect Channel-1 to D- and Channel-3 to D+. Connect the probe grounds to TP5. Attach the differential probe to Ch2 to keep it warmed up
3. Recall the CHRP1&3.SET oscilloscope setup by selecting [Load] >> [Setup...] from the [File] pull down menu.
4. Connect a known-good HS device into the [INIT PORT] of the test fixture.
5. Connect the [TEST PORT] of the fixture to the port under test. Apply power to the known-good HS device.
6. Click [Enumerate Bus] and capture the CHIRP handshake as in the figure below.



High-speed Chirp

7. Measure the host's Chirp response timing ($T_{WTRSTFS}$). This is the time between the device's de-assertion of Chirp-K and the start of alternate Chirp-K and Chirp-J sent by the host. Verify this timing is $T_{WTRSTFS} \leq 100\mu S$. Record the result in EL_33.
8. Measure and record the durations of the individual Chirp-K and Chirp-J states and verify both are between $40\mu S \leq T_{DCHBIT} \leq 60\mu S$ (EL_31). Record the measurement in EL_34.
9. Recall the SOFCHP1&3.SET oscilloscope setup by selecting [Load] >> [Setup...] from the [File] pull down menu.
10. Unplug the known good device and then reattach it.
11. Ensure the oscilloscope trigger is armed (in the trig'd mode).
12. Click [Enumerate Bus] once. The oscilloscope capture should appear as follows.

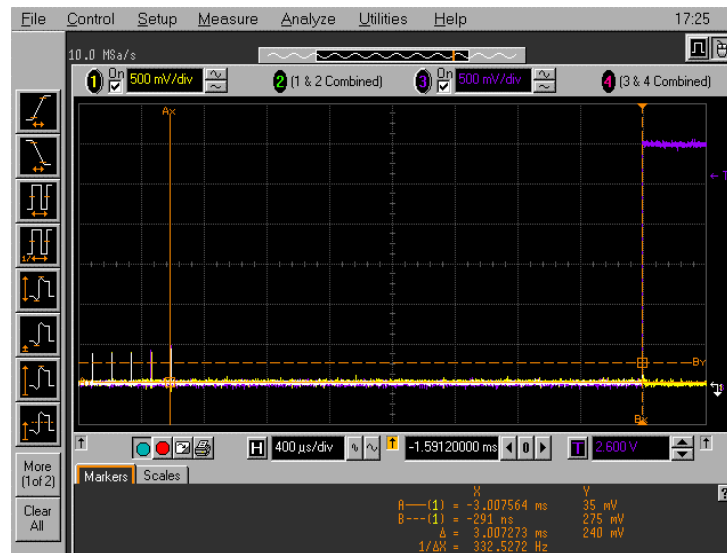
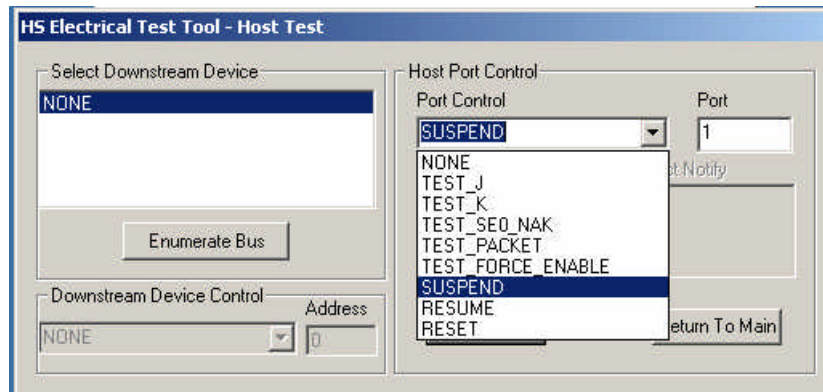


Time between SOF and Last Chirp- (J or K)

13. Measure the time from the end of host Chirp-J/K to the first SOF sent out by the host. Verify this is $100\mu\text{S} \leq T_{\text{DCHSE0}} \leq 500\mu\text{S}$. Record in EL_35.
14. Repeat step 5 through 13 for the remaining down stream facing ports.

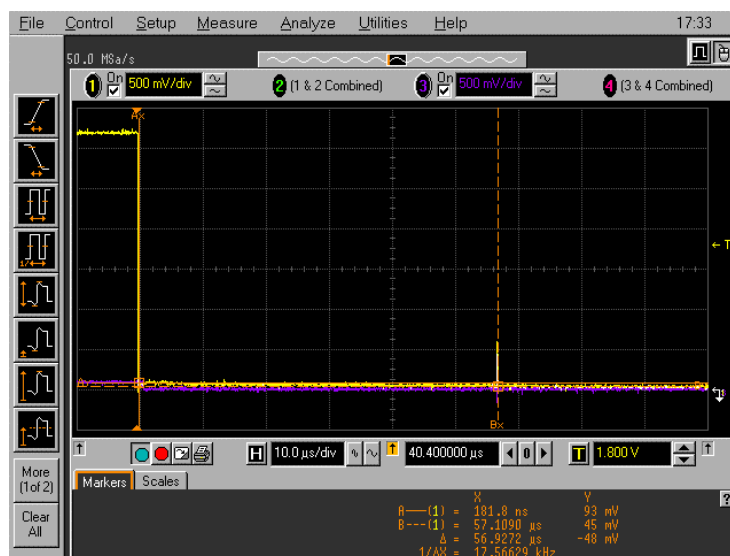
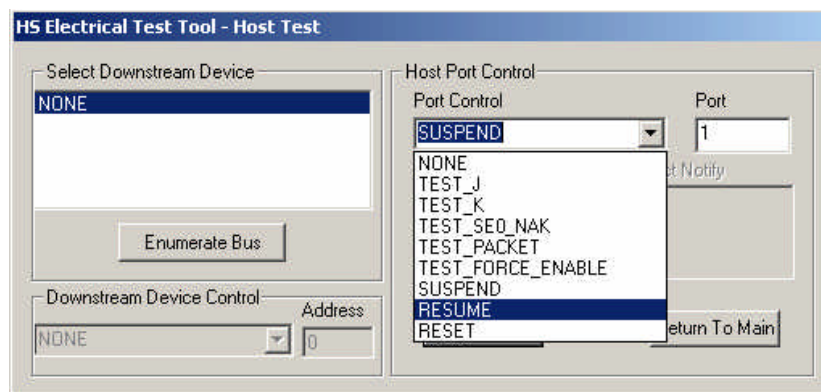
4.8 Host Suspend/Resume timing (EL_39, EL_41)

1. Connect a known good high-speed device into the [INIT PORT] of the Host High-speed Signal Quality test fixture.
2. Connect Channel 1 and Channel 3 1161A miniature passive probes to the test fixture at TP2. Connect Channel-1 to D- and Channel-3 to D+. Connect the probe grounds to TP5. The differential probe can be connected to Ch2 to keep it warmed up.
3. Recall the SUSP1&3.SET oscilloscope setup by selecting [Load] >> [Setup...] from the [File] pull down menu and verify the oscilloscope is armed.
4. Attach the [TEST PORT] of the fixture into the port under test at the host controller.
5. On the Host Test menu, select SUSPEND from the Port Control drop down menu and enter the port number. Click [EXECUTE] once to place the port into suspend. The captured suspend transition should appear as in the figure below.



Device Enters Suspend

6. Observe the time interval from the end of last SOF packet issued by the host to when the device attached its full speed pull-up resistor on D+ (transition to full speed J-state). This time should be between 3.000mS and 3.125mS. No measurement is required as this sequence verify the host supports Suspend state. Record the Pass/Fail result in EL_39.
7. Recall the RESUM1&3.SET oscilloscope setup by selecting [Load] >> [Setup...] from the [File] pull down menu and verify the oscilloscope is armed.
8. On the Host Test menu, select RESUME from the Port Control drop down menu and enter the port number. Click [EXECUTE] once to resume the port. The captured suspend transition should appear as in the figure below.



Time to First EOP from Start of HS Idle

9. Measure the time from the falling edge of D+ to the first SOF issued by the host (EL_41) as shown in the figure above. Record the results in EL_41.

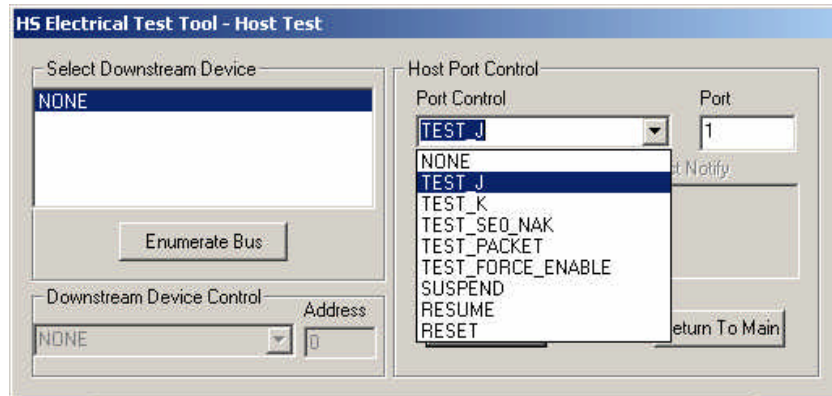
Note: Repeat the suspend and resume a number of times and verify the time from the falling edge of D+ to the first SOF issued by the host never exceeds 3mS.

10. Repeat step 4 through 9 for all the remaining ports.
11. Unplug the know-good device from the test fixture. Click [Enumerate Bus] once before proceeding. Remove the FET probes from the test fixture.

4.9 Host Test J/K, SE0_NAK (EL_8, EL_9)

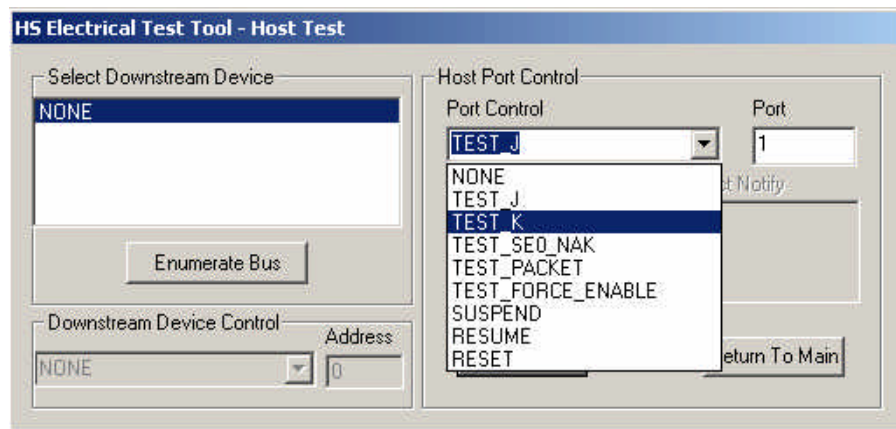
1. Attach the 5V power supply to the Host Signal Quality test fixture (J5) and verify the green Power LED (D1) is lit. Place the TEST Switch (S1) in the Test position. Verify the yellow TEST LED is lit.
2. Attach the [TEST PORT] of the Host Signal Quality test fixture into the port under test.

3. Select TEST_J from the Port Control drop down menu. Enter the port number and click [EXECUTE] once to place the port under test into TEST_J test mode.



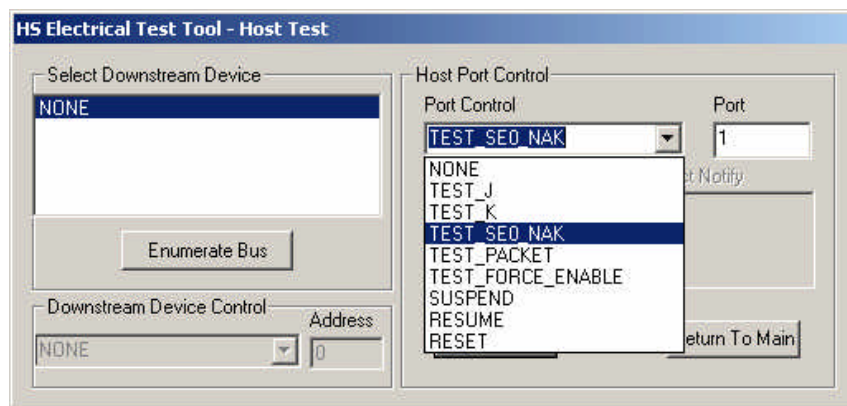
Host Port TEST_J

4. Using a DVM measure the DC voltage on the D+ line at TP2 with respect to ground (pin TP5 are ground pins). Record in section EL_8.
5. Using a DVM measure the DC voltage on the D- line at TP2 with respect to ground. Record in section EL_8.
6. On the Host Test menu, select TEST_K from the Port Control drop down menu. Enter the port number and click [EXECUTE] once to place the port under test into TEST_K test mode.



Host Port TEST_K

7. Using a DVM measure the DC voltage on the D- line at TP2 with respect to ground (pin TP5 are ground pins). Record in section EL_8.
8. Using a DVM measure the DC voltage on the D+ line at TP2 with respect to ground. Record in section EL_8.
9. On the Host Test menu, select TEST_SE0_NAK from the Port Control drop down menu. Enter the port number and click [EXECUTE] once to place the port under test into TEST_SE0_NAK test mode.



Host Port TEST_SE0_NAK

10. Using a DVM measure the DC voltage on the D+ line at TP2 with respect to ground (pin TP5 are ground pins). Record in section EL_9.
11. Using a DVM measure the DC voltage on the D- line at TP2 with respect to ground (pin TP5 are ground pins). Record in section EL_9.
12. Repeat step 2 through 11 for the remaining ports.

Appendix A

A.4 Host High-speed Electrical Test Data

This section is for recording the actual test result. Please use a copy for each device to be tested.

A.4.2 Vendor and Product Information

	Please fill in all fields. Please contact your silicon supplier if you are unsure of the silicon information.
Test Date	
Vendor Name	
Vendor Complete Address	
Vendor Phone Number	
Vendor Contact, Title	
Test ID Number	
Product Name	
Product Model and Revision	
USB Silicon Vendor Name	
USB Silicon Model	
USB Silicon Part Marking	
USB Silicon Stepping	
Tested By	

A.4.3 Legacy USB Compliance Tests

Legacy USB Compliance Checklist

Legacy Test	Downstream Ports					Comments
	P1	P2	P3	P4	P5	
LS SQ						
FS SQ						
Drop/ Droop						
Interop						

P = PASS

F = FAIL

N/A = Not applicable

A.4.4 Host High-speed Signal Quality (EL_2, EL_3, EL_6, EL_7)

EL_2 A USB 2.0 high-speed transmitter data rate must be 480 Mb/s $\pm 0.05\%$.

Reference documents: *USB 2.0 Specification*, Section 7.1.2.2.

Port	P1	P2	P3	P4	P5
PASS					
FAIL					
NA					

Overall Result:

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

EL_3 A USB 2.0 downstream facing port must meet Template 1 transform waveform requirements measured at TP2 (each host downstream port).

Reference documents: *USB 2.0 Specification, Section 7.1.2.2.*

Port	P1	P2	P3	P4	P5
PASS					
FAIL					
NA					

Overall Result:

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

EL_6 A USB 2.0 HS driver must have 10% to 90% differential rise and fall times of greater than 500 ps.

Reference documents: *USB 2.0 Specification, Section 7.1.2.2.*

Port	P1	P2	P3	P4	P5
PASS					
FAIL					
NA					

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

EL_7 A USB 2.0 HS driver must have monotonic data transitions over the vertical openings specified in the appropriate eye pattern template.

Reference documents: *USB 2.0 Specification, Section 7.1.2.2.*

Port	P1	P2	P3	P4	P5
PASS					
FAIL					
NA					

- ☐ Pass
- ☐ Fail

☐ N/A

Comments:

A.4.5 Host Controller Packet Parameters (EL_21, EL_22, EL_23, EL_25, EL_55)

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

Reference documents: *USB 2.0 Specification*, Section 8.2.

SOF SYNC field

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

Data Packet SYNC field

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

EL_25 The EOP for all transmitted packets (except SOFs) must be an 8-bit NRZ byte of 01111111 without bit stuffing. (Note, that a longer EOP is waivable)

Reference documents: *USB 2.0 Specification*, Section 7.1.13.2

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

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

Reference documents: *USB 2.0 Specification*, Section 7.1.18.2.

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

--

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

Reference documents: *USB 2.0 Specification*, Section 7.1.18.2.

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

--

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

Reference documents: *USB 2.0 Specification*, Section 7.1.13.2

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

--

A.4.6 Host Disconnect Detect (EL_36, EL_37)

EL_37 A USB 2.0 downstream facing port must not detect the high-speed disconnect state when the amplitude of the differential signal at the downstream facing driver's connector is ≤ 525 mV.

Reference documents: *USB 2.0 Specification*, Section 7.1.7.3.

Port	P1	P2	P3	P4	P5
PASS					
FAIL					
NA					

Overall:

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

--

--

EL_36 A USB 2.0 downstream facing port must detect the high-speed disconnect state when the amplitude of the differential signal at the downstream facing driver's connector is ≥ 625 mV.

Reference documents: *USB 2.0 Specification*, Section 7.1.7.3.

Port	P1	P2	P3	P4	P5
PASS					
FAIL					
NA					

Overall:

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

A.4.7 Host CHIRP Timing (EL_33, EL_34, EL_35)

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

Reference documents: *USB 2.0 Specification*, Section 7.1.7.5.

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

EL_34 Downstream port Chirp K and Chirp J durations must be between 40us and 60us duration.

Reference documents: *USB 2.0 Specification*, Section 7.1.7.5.

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

EL_35 Downstream ports begin sending SOFs within 500us and not sooner than 100us from transmission of the last Chirp (J or K).

Reference documents: *USB 2.0 Specification*, Section 7.1.7.5.

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

A.4.8 Host Suspend/Resume timing (EL_39, EL_41)

EL_39 A device must support the Suspend state.

Reference documents: *USB 2.0 Specification*, Section 7.1.7.6.

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

EL_41 After resuming a port, the host must begin sending SOFs within 3ms of the start of the idle state.

Reference documents: *USB 2.0 Specification*, Section 7.1.7.7.

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

A.4.9 Host Test J/K, SE0_NAK (EL_8, EL_9)

EL_8 When either D+ or D- are driven high, the output voltage must be 400 mV $\pm 10\%$ when terminated with precision 45 Ω resistors to ground.

Reference documents: *USB 2.0 Specification*, Section 7.1.1.3.

Port	1		2		3		4		5	
Test	D+	D-	D+	D-	D+	D-	D+	D-	D+	D-
TEST_J										
TEST_K										

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments:

EL_9 When either D+ and D- are not being driven, the output voltage must be $0V \pm 10 \text{ mV}$ when terminated with precision 45Ω resistors to ground.

Reference documents: *USB 2.0 Specification*, Section 7.1.1.3.

Port	1		2		3		4		5	
Signal	D+	D-	D+	D-	D+	D-	D+	D-	D+	D-
Measure WRT Ground (mV)										

- ☐ Pass
- ☐ Fail
- ☐ N/A

Comments: