# Universal Serial Bus 2.0
# Host Compliance
# Test Procedure

YOKOGAWA
Yokogawa Electric Corporation

IM 701985-63E
1st Edition

## Introduction

The USB-IF Hi-Speed Electrical Test Procedures are developed by the USB 2.0 Compliance Committee under the direction of USB-IF, Inc. There are three Hi-Speed Electrical Test Procedures.

- The Host Hi-Speed Electrical Test Procedure is for EHCI host controllers.
- The Hub Hi-Speed Electrical Test Procedure is for hi-speed capable hubs.
- The Device Hi-Speed Electrical Test Procedure is for hi-speed capable devices.

The Hi-Speed Electrical Compliance Test Procedures verify the electrical requirements of hi-speed USB operation of these devices designed to the USB 2.0 specification. In addition to passing the hi-speed test requirements, hi-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 USBIF 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 Appendix B Legacy USB Compliance Test s section in this document.

## Purpose

This USB-IF Hi-speed Electrical Test Procedure documents a series of tests used to evaluate USB peripherals and systems operating at hi-speed. These tests are also used to evaluate the hi-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 Hi-speed Electrical Test Procedure is one of the three USB-IF Hi-speed Electrical Compliance Test Procedures. The other two are Hub USB-IF Hi-speed Electrical Test Procedure and Device USB-IF Hi-speed Electrical Test Procedure. The adoption of the individual procedures based on the device class makes it easier to use.

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## Revisions

- 1st Edition July 2006

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# Contents

**Introduction** ..... **1**

**Purpose** ..... **1**

**Trademarks** ..... **1**

**Revisions** ..... **1**

**1. Equipment Required** ..... **4**

1.1. Equipment Setup ..... 5

1.1.1. DL9240/DL9240L Digital Oscilloscopes ..... 5

1.1.2. Differential Probe ..... 5

1.2 Operating Systems, Software, Drivers, and Setup Files ..... 6

1.2.1. Operating Systems ..... 6

1.2.2. Special Purpose Software ..... 6

1.2.3. Test Equipment Setup Files ..... 6

**2. Test Procedures** ..... **7**

2.1. TEST Record ..... 7

2.2. Vendor and Product Information ..... 7

2.3. Hi-Speed Mode Compatible Host Electrical Tests ..... 7

2.4. Legacy USB Compliance Tests ..... 8

2.5. Starting the USB Compliance Test Software ..... 9

2.6. Host Hi-Speed Signal Quality (EL_2, EL_3, EL_6, EL_7) ..... 12

2.7. Host Controller Packet Parameters (EL_21, EL_22, EL_23, EL_25, EL_55) ..... 21

2.8. Host Disconnect Detect (EL_36, EL_37) ..... 33

2.9. Host CHIRP Timing (EL_33, EL_34, EL_35) ..... 34

2.10. Host Suspend/Resume Timing (EL_38, EL_41) ..... 43

2.11. Host Test J/K, SE0_NAK (EL_8, EL_9) ..... 51

**Appendix A Host Hi-Speed Electrical Test Data** ..... **59**

App. A.1 Vendor and Product Information ..... 59

App. A.2 Legacy USB Compliance Tests ..... 60

App. A.3 Host Hi-speed Signal Quality (EL_2, EL_3, EL_6, EL_7) ..... 60

App. A.4 Host Controller Packet Parameters (EL_21, EL_22, EL_23, EL_25, EL_55) ..... 62

App. A.5 Host Disconnect Detect (EL _36, EL_37) ..... 63

App. A.6 Host CHIRP Timing (EL_33, EL_34, EL_35) ..... 64

App. A.7 Host Suspend/Resume timing (EL_39, EL_41) ..... 65

App. A.8 Host Test J/K, SE0_NAK (EL_8, EL_9) ..... 66

**Appendix B Legacy USB Compliance Tests** ..... **67**

App. B.1 Droop Test ..... 67

App. B.2 Drop Test ..... 73

App. B.3 LS Downstream Signal Quality Test ..... 78

App. B.4 FS Downstream Signal Quality Test ..... 84

**Appendix C USB Electrical Analysis Tool (USBET) .....90**
App. C.1 About USBET.....90
App. C.2 How to start USBET.....90
App. C.3 Low-Speed/Full-Speed/Hi-Speed Signal Quality Test.....91
App. C.4 Inrush Current Test .....91

# 1. Equipment Required

The commercial test equipment listed here are base on positive experience by the USB-IF members in executing the USB hi-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 Oscilloscope System**

- Yokogawa DL9240 or DL9240L: qty = 1
  (Requires the either /C8 or /C10 main unit option)
- Yokogawa PBA2500 Probe: qty = 2
- Yokogawa PBA2500 Probe attachment: qty = 2sets
- Yokogawa PBD2000 Probe: qty = 1
- Yokogawa PBD2000 Probe attachment: qty = 1set
- Yokogawa PB500 Passive Probe: qty = 2 (Legacy USB Compliance Test)

**3 ½ Digital Multimeter**

- Yokogawa Meter & Instrument 733 or 734, or equivalent: qty = 1
- Mini-clip DMM lead, one each in black and red: qty = 1set

**Hi-Speed USB Electrical Test Fixtures**

- Yokogawa USB 2.0 Test Fixture: qty =1
- 5 V Test Fixture Power Supply: qty =1 (* included with Yokogawa USB 2.0 Test Fixture)

**Miscellaneous Cables**

- 1 m USB-IF compliant USB cable: qty = 1
  (for the Legacy USB Compliance Test: qty = 5)
- 5 m USB-IF compliant USB cable: qty = 6 (Legacy USB Compliance Test)
- Modular AC power cord: qty = 1

**Hi-Speed USB Test Bed Computer**

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

**USB Hub**

- Full-Speed USB-IF compliant USB Hub: qty = 1(Legacy USB Compliance Test)
- Hi-Speed USB-IF compliant USB Hub: qty = 1(for the Legacy USB Compliance Test: qty = 4)

**USB Device (Legacy USB Compliance Test)**

- Full-Speed USB-IF compliant PC Camera: qty = 1
- USB-IF compliant Mouse: qty = 1

## 1.1. Equipment Setup

### 1.1.1. DL9240/DL9240L Digital Oscilloscopes

1. Connect the PBD2000 Differential Probe to CH1 of the oscilloscope.
2. Place the attachment on the tip of the differential probe.
3. Connect the PBA2500 Active Probe to CH2 and CH3 of the oscilloscope.
4. Turn ON the power to the oscilloscope and allow a 30 minute warm-up prior to use.

### 1.1.2. Differential Probe

For information on adjusting the offset voltage remaining after warm-up (residual offset voltage), see “PBD2000 Differential Probe User’s Manual” (IM701923-01E).

***Note***

- In certain test situations, there may not be a ground connection between the oscilloscope and the DUT. This may lead to the signal being seen by the differential probe to be modulated up and down due to the mid- frequency switching power supply. Connecting the oscilloscope ground to the DUT ground will be required to establish a common ground reference.
- Phase-correct the probe if necessary.

## 1.2 Operating Systems, Software, Drivers, and Setup Files

### 1.2.1. Operating Systems

Microsoft Windows 2000 or XP Professional is required on the Hi-Speed Electrical Test Bed Computer. Please refer to the Hi-Speed Electrical Test Setup Instruction for steps to configure these computers.

### 1.2.2. Special Purpose Software

The following special purpose software is required.

- **Yokogawa USB Compliance Test Software( busXplorer-USB)**
  To be used in the Hi-Speed Electrical Test Bed Computer.
- **Hi-Speed Electrical Test Tool Software**
  To be used in the Hi-Speed Electrical Test Bed Computer.

***Note***

Hi-Speed Electrical Test Tool is official analysis tool of USB-IF and downloadable from the following USB-IF site.
http://www.usb.org/developers/tools

- **Proprietary EHCI Driver Stack**
  The Hi-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 Hi-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.
- **USB Electrical Analysis Tool(USBET)**
  To be used in the Hi-Speed Electrical Test Bed Computer.

***Note***

USBET is official analysis tool of USB-IF and downloadable from the following USB-IF site.
http://www.usb.org/members/compliance
(USBET is available only for member of USB-IF.)
Please refer to the Appendix C USB Electrical Analysis Tool (USBET) for details.

Please refer to the Hi-Speed Electrical Test Setup Instruction for steps to configure these computers.

### 1.2.3. Test Equipment Setup Files

Setup file for DL9240/DL9240L is available at the following site.
http://www.usb.org/developers/docs#comp_test_procedures

No setup file is needed for DL9240/DL9240L if the Yokogawa USB Compliance Test Software (busXplorler-USB, Model 701985/F30) is installed on the Test Bed Computer

Setup file for DG2040can be obtained by extracting ‘USBHSET.EXE’.
For details about ‘USBHSET.EXE’, please refer to the following web site.
http://www.usb.org/developers/docs#comp_test_procedures

# 2. Test Procedures

## 2.1. TEST Record

Appendix A contains the test result entry forms for these test procedures. Please make copies of 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 an 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 (drop and droop) shall be retained for compliance test submission.

## 2.2. 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, phone number, and 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

## 2.3. Hi-Speed Mode Compatible Host Electrical Tests

Perform the following six tests.

- Host Hi-Speed Signal Quality (EL_2, EL_3, EL_6, EL_7)
- Host Controller Packet Parameters (EL_21, EL_22, EL_23, EL_25, EL_55)
- Host CHIRP Timing (EL_33, EL_34, EL_35)
- Host Suspend/Resume Timing (EL_39, EL_41)
- Host Test J/K, SE0_NAK (EL_8, EL_9)

Perform all these tests and record the measurements and summarized PASS/FAIL status in Appendix A.

## 2.4. Legacy USB Compliance Tests

In addition to the hi-speed electrical tests described in this document, the device under test must also pass the following compliance tests applicable to hi-speed capable the EHCI Host Controller:

- Full speed/Low Speed Downstream Signal Quality
- Drop/Droop
- Interoperability

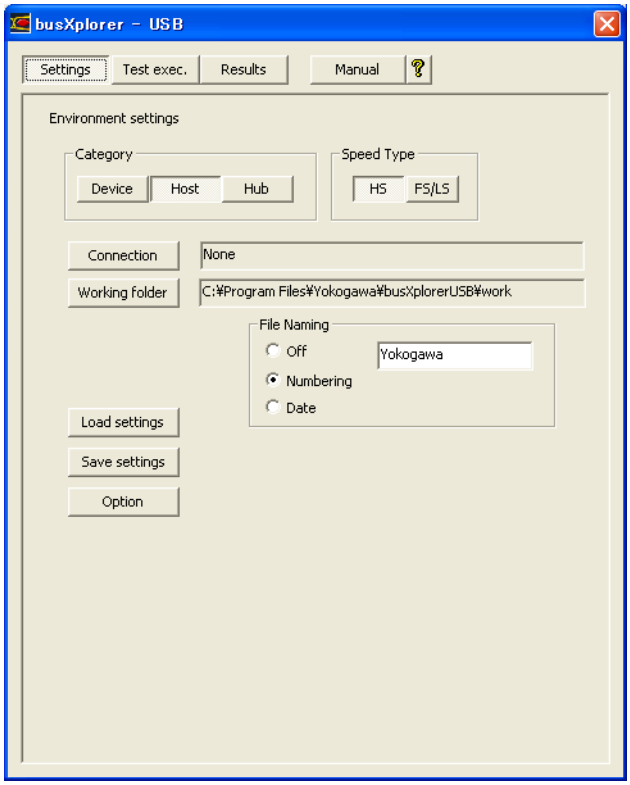
Perform all these tests and record the measurements and summarized PASS/FAIL status in Appendix A.

***Note***

This manual describes Hi-Speed electrical tests and legacy USB compliance tests(Appendix B Legacy USB Compliance Test), but does not describe interoperability tests. For these test procedures, see “USB-IF Full and Low Speed Compliance Test Procedure” (available at: http://www.usb.org/developers/) issued by the USB-IF.

## 2.5. Starting the USB Compliance Test Software

1. Start the busXplorer-USB.
   The environment settings dialog box as shown below opens.

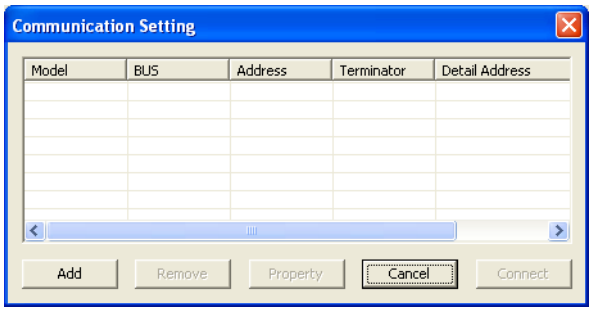



### *Note*

This manual does not describe all of the functions of the busXplorer-USB. For functions not described herein (such as operation of the results display button), see “USB Compliance Test Software User’s Manual” (IM701985-61E).

2. Click the **[Host]** button under Test Category in the environment settings.
3. Select the test items to execute under Speed Type according to the DUT.
   - Select HS and execute the test. All electrical tests are performed.
   - If you select FS/LS and execute the test, only the tests required for FS/LS are executed.
4. Connect the test bed computer and digital oscilloscope via Ethernet.
5. Turn ON the power to the digital oscilloscope.

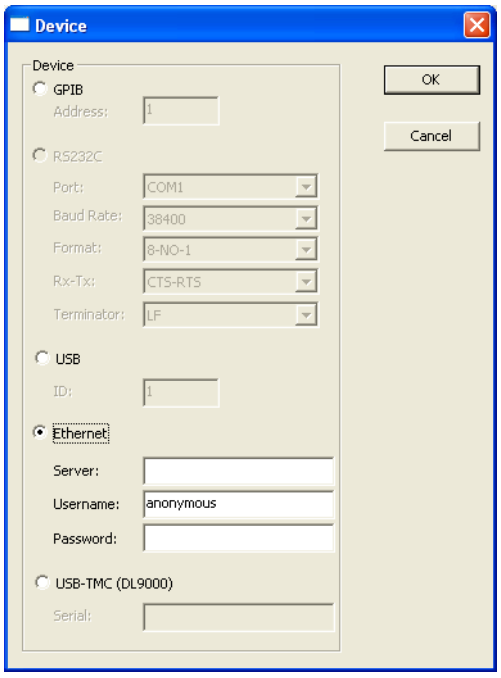
6. Click the **[Connection]** button in the dialog box.
   The connection settings dialog box is displayed.




## Note

If connection destinations are already registered, they are displayed in a list. If the digital oscilloscope to use appears in the list, select it, then click the [Connect] button to start establishing communication with the digital oscilloscope.

7. Click the **[Add]** button.
   The connection method selection dialog box in the figure below opens.



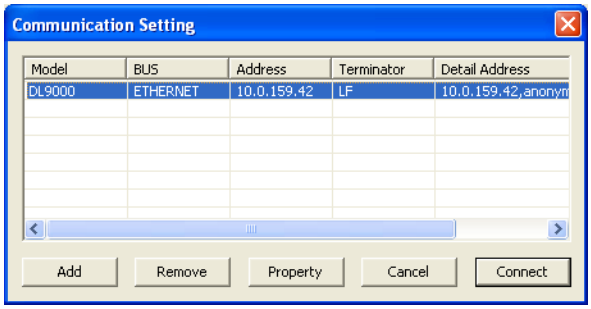

## Note

The busXplorer-USB supports Ethernet only.

8. Select Network, enter the IP address of the digital oscilloscope in the Server box, then click the **[OK]** button.
   Enter the user name and password if required.

**9.** A connection settings dialog box is displayed. Select the digital oscilloscope then click the **[Connect]** button.

- If you select a connection destination in the list and click Properties, the connection method selection dialog box appears allowing you to change settings.
- If you select a connection destination in the list and click Delete, the selected connection destination is deleted.
- The maximum number of connection destinations that can be registered is 16.




**10.** Click the **[Working folder]** button.
A dialog box for browsing folders is displayed.


**11.** Specify a working folder and click the **[OK]** button.
The following data are saved in the working folder.

- Test results files in HTML format
  These are displayed by clicking the [Detail] button in the test results display dialog box.
  Digital oscilloscope screen image data
  These are displayed by clicking the [Image] button in the test results display dialog box.
- Waveform data captured by Digital oscilloscope

File names are automatically assigned to data files. To set a file name, choose Fix in the File Naming box, and enter a file name in the box (of up to twenty alphanumeric characters).

## *Note*

- Environment settings can be saved and recalled. To save settings, click the [Save settings] button to display a dialog box for entering a file name and save location. To load settings, click the [Load settings] button to display a dialog box for opening previously saved settings files.
- To save or change the display color or format of the waveform data displayed by the busXplorer-USB, click the [Option] button, then modify settings as needed.

## 2.6. Host Hi-Speed Signal Quality (EL_2, EL_3, EL_6, EL_7)

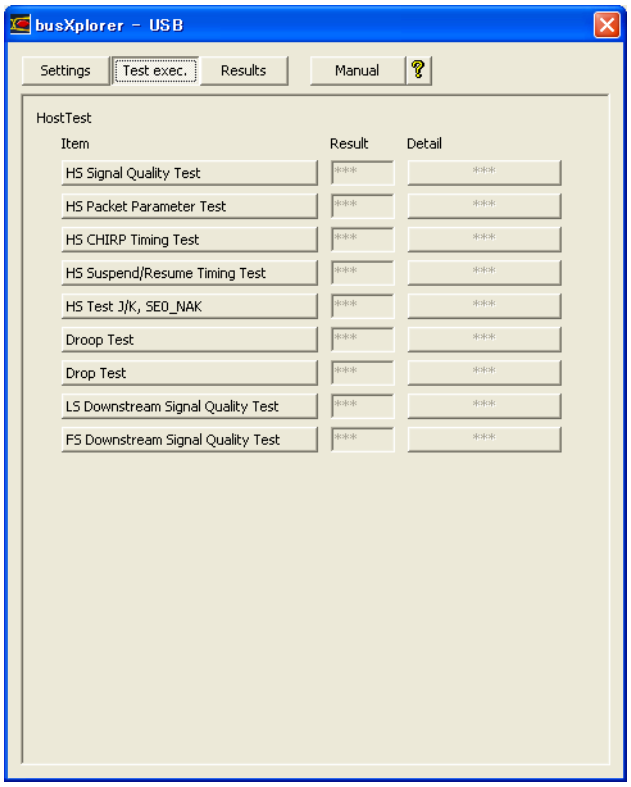
- **USB 2.0 Electrical Test Specification**
  - EL_2
    A USB 2.0 Hi-Speed transmitter data rate must be 480Mb/s ±0.05%.
  - EL_3
    A USB 2.0 downstream facing port must meet Template 1 transform waveform requirements measured at TP2 (each host downstream port).
  - EL_6
    A USB 2.0 HS driver must have 10% to 90% differential rise and fall times of greater than 500ps.
  - EL_7
    A USB 2.0 HS driver must have monotonic data transitions over the vertical openings specified in the appropriate eye pattern template.

- **Instruments Used**

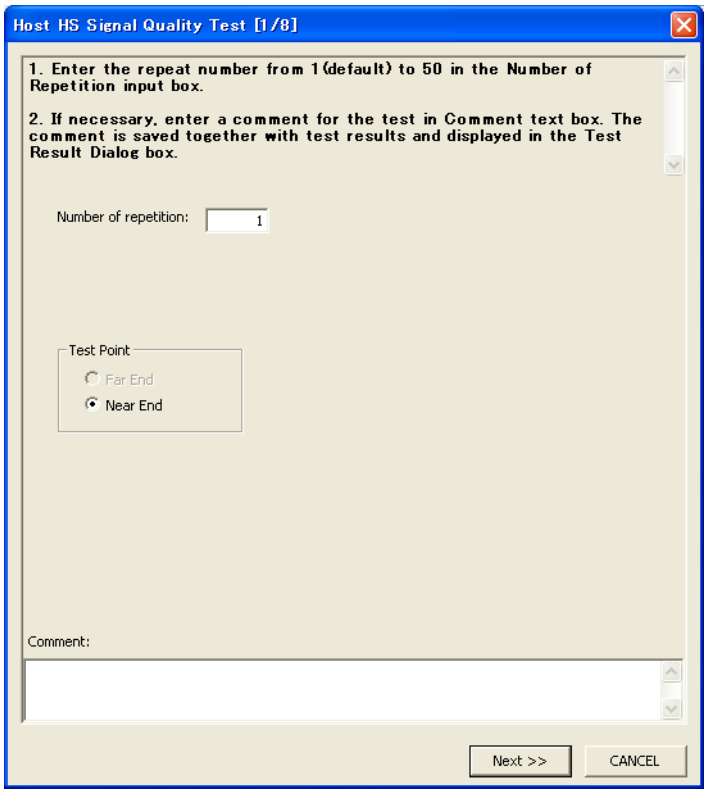
| Name | Q'ty |
|---|---|
| DL9240/DL9240L Digital Oscilloscope | 1 |
| PBD2000 Differential Probe | 1 |
| PBD2000 Probe attachment | 1 set |
| USB-IF compliant 1 m USB 2.0 cable | 1 |
| Test bed computer | 1 |
| USB compliance test fixture | 1 |
| 5 V power supply for test fixture | 1 |

- **Executing the Test**

  ***1.*** Click the **[Test exec.]** button in the busXplorer-USB to display the Host Test selection dialog box.



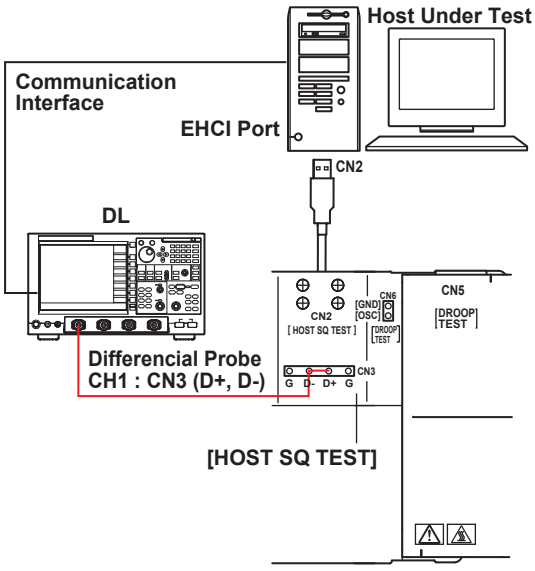
2. Click the **[HS Signal Quality Test]** button in the dialog box.
The Host HS Signal Quality Test dialog box is displayed.




3. Enter the repeat number from 1(default) to 50 in the Number of Repetition input box.

4. If necessary, enter a comment for the test in Comment text box.
The comment is saved together with test results and displayed in the Test Result Dialog box.

5. Click the **[Next]** button in the dialog box of the busXplorer-USB.
The connection diagram as shown below is displayed.

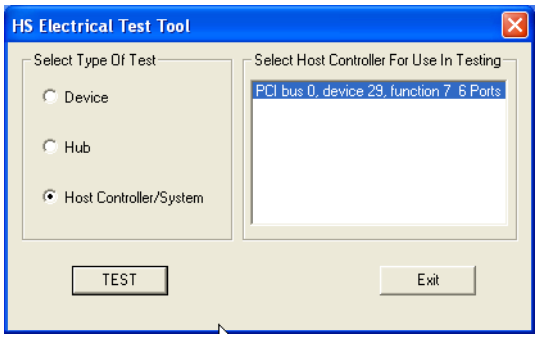


6. Connect the port under test of the host controller to the CN2 connector of the HOST SQ TEST block.
7. Connect the PBD2000 Differential Probe to CH1 of the digital oscilloscope.

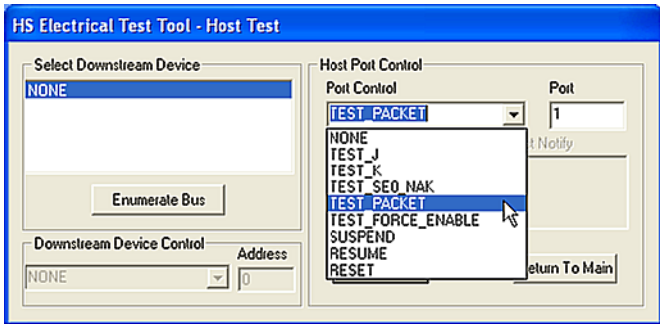
***Note***

After connecting the probe, heat emitted from the probe causes the offset voltage to drift. The probe should nearly stabilize about thirty minutes after applying power.

8. Connect the differential probe to the attachment on the tip to CN3 on the HOST SQ TEST block.
   For the polarity, match up the plus side on the differential probe to D+ (the D+ pin at CN3) and the minus side to D- (the D- pin at CN3).
9. Click the **[Next]** button.
   Following the instructions in the dialog box of the busXplorer-USB, invoke the HS Electrical Test Tool on the test bed computer.
   The HS Electrical Test Tool main menu is displayed, and the host controller is displayed under Select Host Controller For Use in Testing.

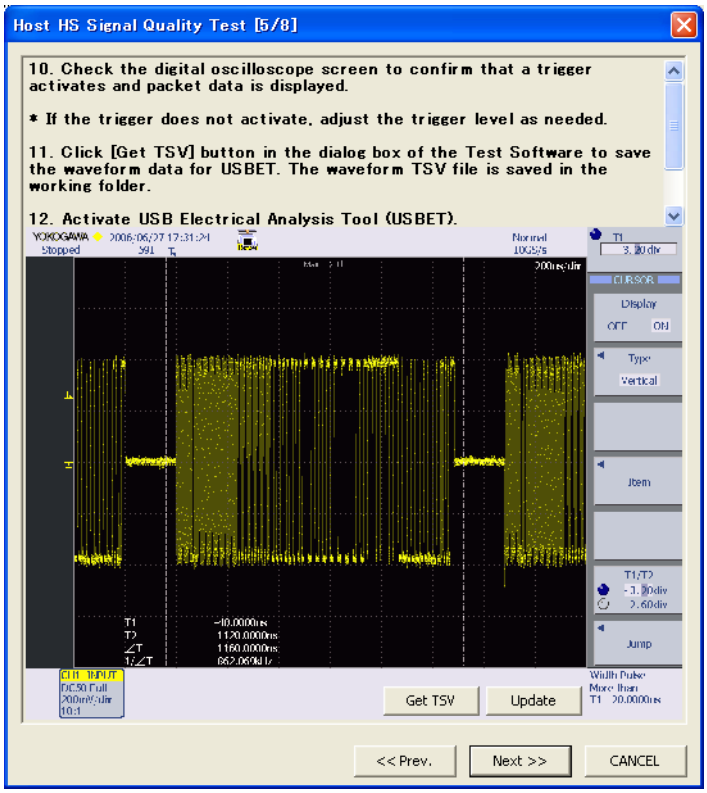



10. Select Host Controller/System under Select Type Of Test in the HS Electrical Test Tool.
11. Click the **[TEST]** button in the HS Electrical Test Tool to enter the HS Electrical Test Tool - Host Test menu.
12. Click **[Next]** button in the dialog box of the busXplorer-USB.
    Following the instructions in the dialog box, select TEST PACKET from the Port Control drop down menu and set the target port number in the HS Electrical Test Tool then click the **[EXECUTE]** button.



***13.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
Following the instructions in the dialog box, check the digital oscilloscope screen to confirm that a trigger activates and packet data is displayed.

- If the trigger does not activate, adjust the trigger level as needed.
- Click the [Update] button to update the image of waveform in the dialog box of the busXplorer-USB.



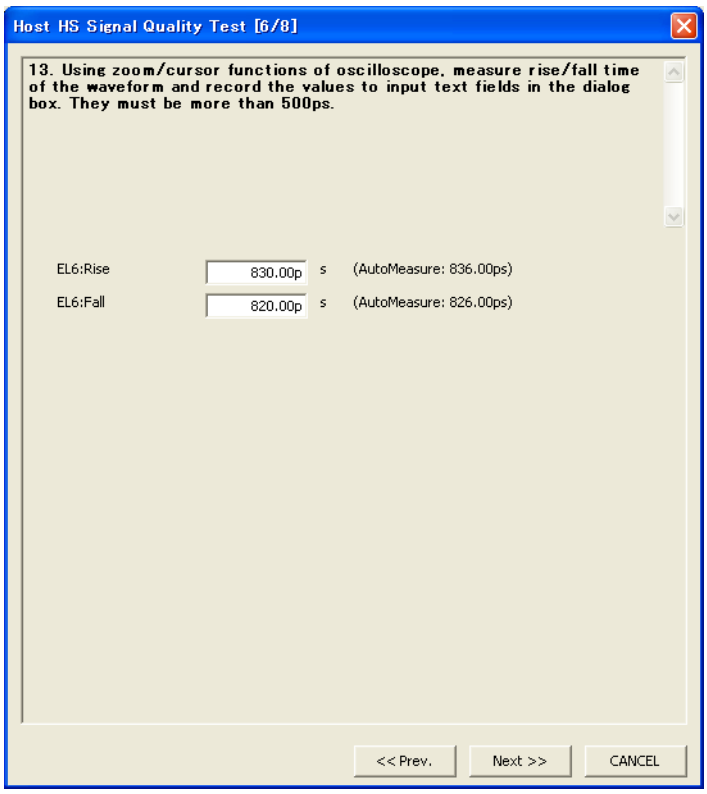

***14.*** Click **[Get TSV]** button in the dialog box of the Test Software to save the waveform data for USBET. The waveform TSV file is saved in the working folder.

***15.*** Activate ‘USB Electrical Analysis Tool (USBET)’.
Select [Signal Quality] tab, click **[Browse]** button of USBET and specify the waveform data file (tsv file). Set an appropriate Test Type (HSNE) then click **[TEST]** to start analysis. Check the test report generated by USBET and verify the result of the test.

## *Note*

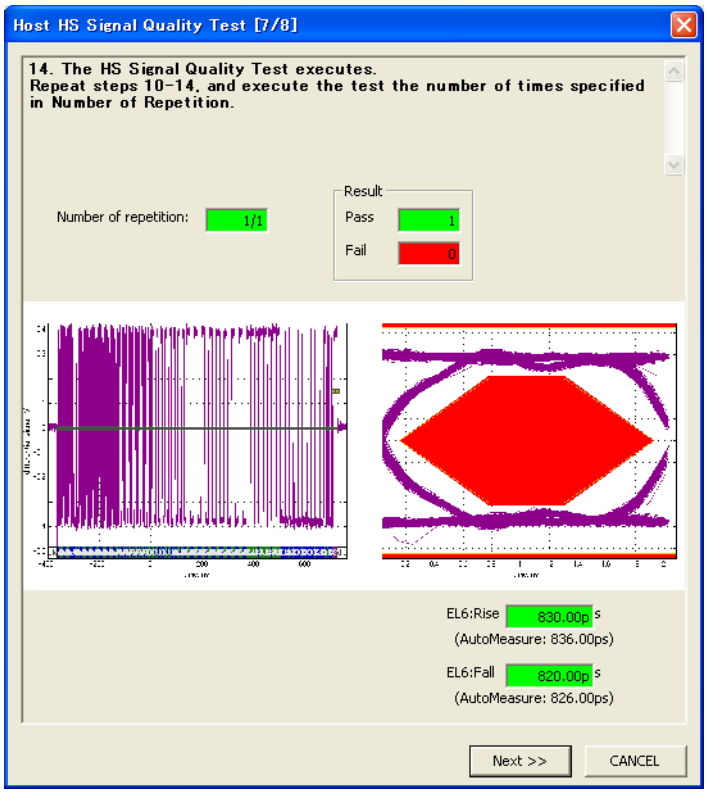
To know how to use USBET, please refer to Appendix C of this document.

***16.*** Click **[Next]** button in the dialog box of the busXplorer-USB.
Following the instructions in the dialog box, using zoom/cursor functions of oscilloscope, measure rise/fall time (10-90%) of the waveform and record the values to input text fields in the dialog box. They must be more than 500 ps.
When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.



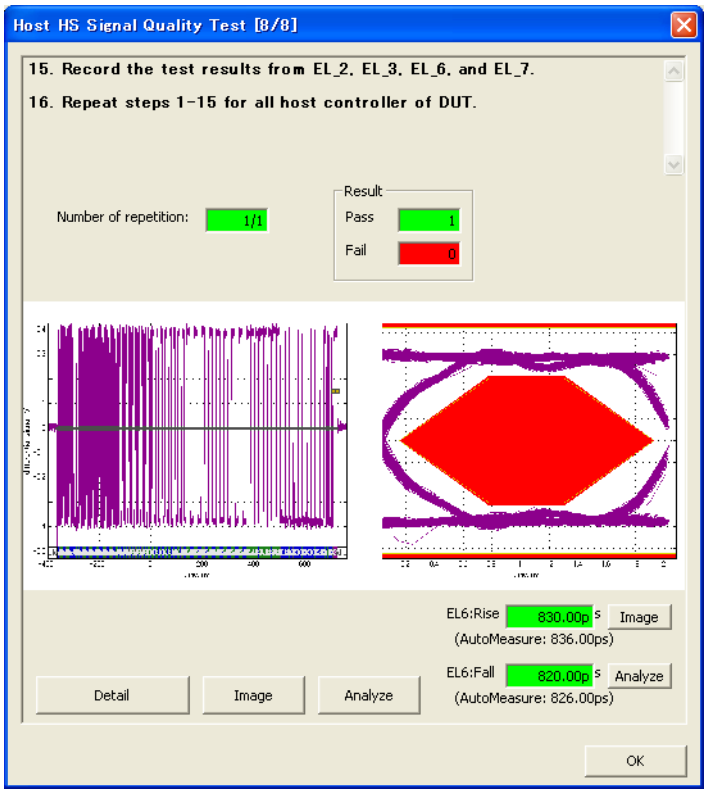
***17.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.

The test results dialog box as shown below is displayed.



***18.*** Click the **[Next]** button of the dialog box of the busXplorer-USB, repeat steps 13-17, and execute the test the number of times specified in “Number of Repetition”.

When the number of tests is completed, the test result dialog box is displayed.



- Click the [Detail] button to display the test results by Internet Explorer as shown below.

Near End High Speed Signal Quality Test
Results for Yokogawa_000

For details on test setup, methodology, and performance criteria, please consult the signal quality test description at the USB-IF Compliance Program web page.

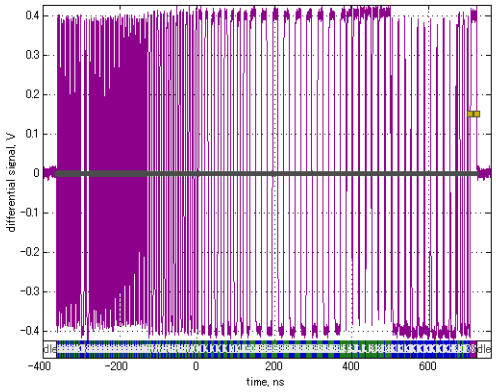
Required Tests

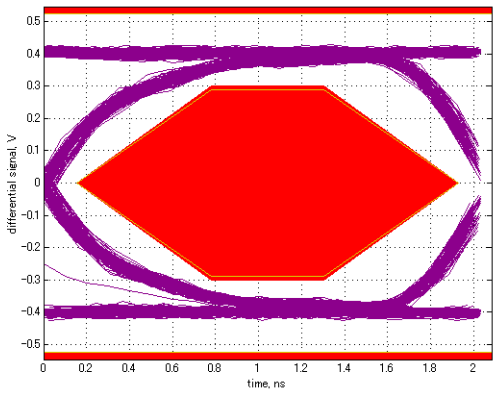
- Overall result: pass!
- Signal eye:
  eye passes
- EOP width: 7.88 bits
  EOP width passes
- Measured signaling rate: 479.9531 MHz
  signal rate passes

Additional Information

- Consecutive jitter range: -49.745ps to 63.552ps, RMS jitter 22.503ps
  Paired JK jitter range: -27.563ps to 24.681ps, RMS jitter 12.433ps
  Paired KJ jitter range: -35.281ps to 25.094ps, RMS jitter 12.085ps

Signal Data and Eye




Tracking Information

- Voltage probes: default, gain accuracy: 1.5%
- Oscilloscope: default, A/D linearity: 1.0%
- Analysis call: usbsigcheck(C:¥Program Files¥Yokogawa¥busXplorer USB¥work¥Device_HS_SignalQuality¥Yokogawa_000.tsv', 'hsne', 1)
- Testing script version: 2.12

- Click the [Image] button to display an image of the digital oscilloscope screen.
- Click the [Analyze] button to start Xviewer and display the waveform data.
  Xviewer must already have been installed.

***Note***

- Test result shown by Internet Explorer is saved in the directory specified as the working folder for the busXplorer-USB.
- Test results can also be confirmed when displayed in the results display dialog box by clicking the results display button in the Test Software.

***19.*** Record the test results in EL_2, EL_3, EL_6, and EL_7.

- Appendix A contains the test result entry form for this test procedure. If necessary, please make copies of Appendix A for use as test record documentation for compliance test submission.
- All files created during tests are saved in the directory specified as the working folder for the busXplorer-USB.

***20.*** Repeat steps 2-19 for all ports of the host controller.

## 2.7. Host Controller Packet Parameters (EL_21, EL_22, EL_23, EL_25, EL_55)

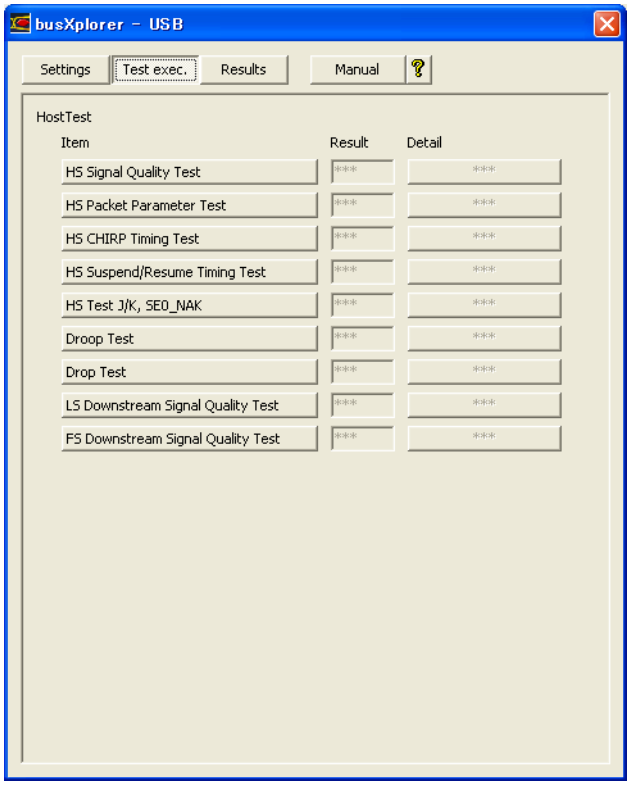
- **USB 2.0 Electrical Test Specification**
  - EL_21
    The SYNC field for all transmitted packets (not repeated packets) must begin with a 32-bit SYNC field.
  - EL_22
    When transmitting after receiving a packet, hosts and devices must provide an inter-packet gap of at least 8 bit times and not more than 192 bit times.
  - EL_23
    Hosts transmitting two packets in a row must have an inter-packet gap of at least 88 bit times and not more than 192 bit times.
  - EL_25
    The EOP for all transmitted packets (except SOFs) must be an 8 bit NRZ byte of 01111111 without bit stuffing. (Note, that a longer EOP is waiverable)
  - EL_55
    Hosts transmitting SOF packets must provide a 40 bit EOP without bitstuffing where the first symbol of the EOP is a transition from the last data symbol.

- **Instruments Used**

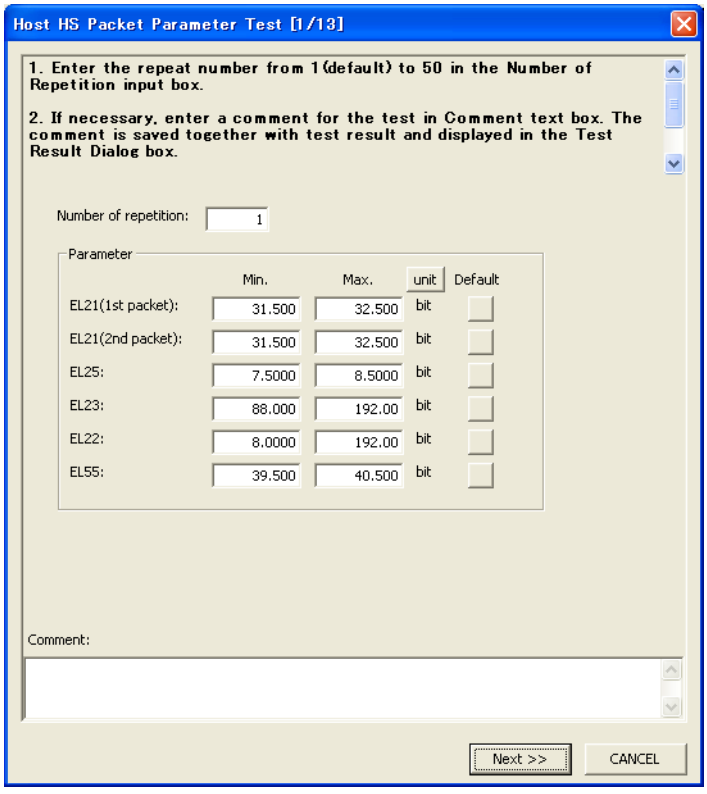
| Name | Quantity |
|---|---|
| DL9240/DL9240L Digital Oscilloscope | 1 |
| PBD2000 Differential Probe | 1 |
| PBD2000 Probe attachment | 1 set |
| USB-IF compliant 1 m USB 2.0 cable | 1 |
| USB-IF Compliant Hi-Speed USB Hub | 1 |
| Test bed computer (PC with the host controllers to be tested installed) | 1 |
| USB compliance test fixture | 1 |
| 5 V power supply for test fixture | 1 |

- **Executing the Test**

  ***1.*** Click the **[Test exec.]** button in the busXplorer-USB to display the Host Test selection dialog box.

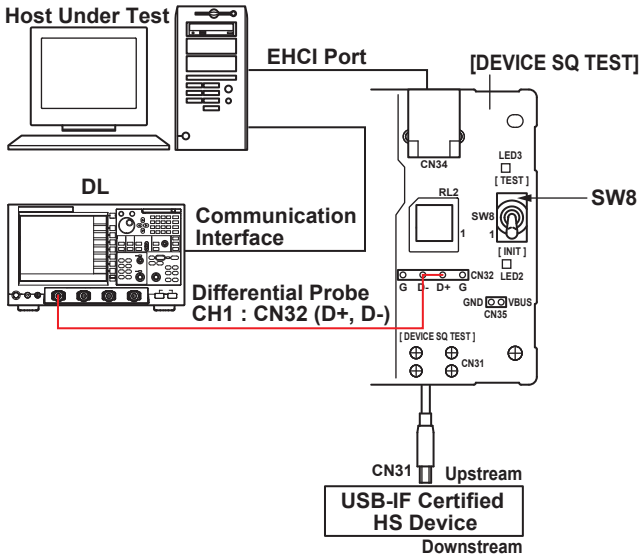



  ***2.*** Click the **[HS Packet Parameter Test]** button in the dialog box. The Host HS Packet Parameter Test dialog box opens.



3. Enter the repeat number from 1(default) to 50 in the Number of Repetition input box.
4. If necessary, enter a comment for the test in Comment text box.
   The comment is saved together with test result and displayed in the Test Result Dialog box.
5. If you wish to change the judgment range, you can edit the judgment criteria for EL_21, EL_25, EL_23, EL_22, and EL_55.
   Default values for the judgment criteria are as follows:
   - EL_21(1st packet)
     Min.: 31.500 bits, Max.: 32.500 bits
   - EL_21(2nd packet)
     Min.: 31.500 bits, Max.: 32.500 bits
   - EL_25
     Min.: 7.5000 bits, Max.:8.5000 bits
   - EL_23
     Min.: 88.000 bits, Max.: 192.00 bits
   - EL_22
     Min.: 8.000 bits, Max.: 192.00 bits
   - EL_55

   Min.: 39.500 bits, Max.: 40.500 bits
   If you click the [Default] button after changing the judgment range, the default values of the judgment range are restored.
6. Click the **[Next]** button in the dialog box of the busXplorer-USB.
   The connection diagram a shown below is displayed.




7. Turn ON the power to the test fixture and verify that the green power supply LED 1 is lit.
8. Connect the USB-IF compliant Hi-Speed USB hub (upstream port side) to the CN31 connector of the DEVICE SQ TEST block and turn ON the power to the hub.
9. Connect the host controller port under test to the CN34 connector of the DEVICE SQ TEST block using a 1 m USB cable.

***10.*** Connect the PBD2000 Differential Probe to CH1 of the digital oscilloscope.

## *Note*

After connecting the probe, heat emitted from the probe causes the offset voltage to drift. The probe should nearly stabilize about thirty minutes after applying power.

***11.*** Connect the differential probe to the attachment on the tip to CN32 on the DEVICE SQ TEST block.

For the polarity, match up the plus side on the differential probe to D+ (the D+ pin at CN32) and the minus side to D- (the D- pin at CN32).

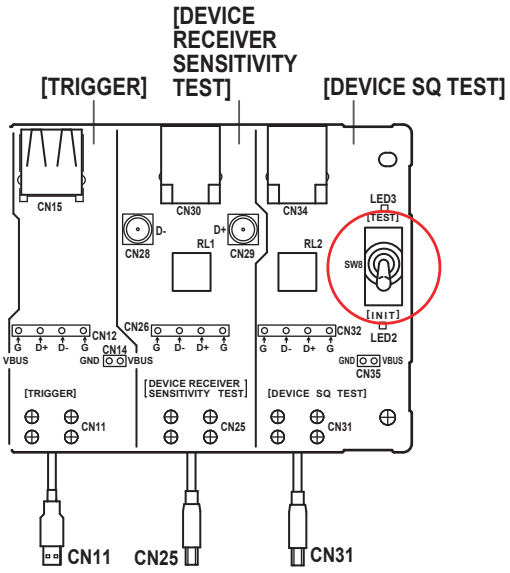
## *Note*

The use of the Device Hi-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.

***12.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.

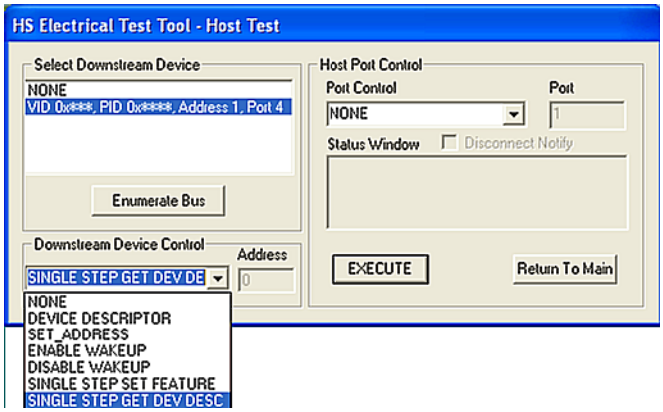
Following the instructions displayed in the dialog box, place SW8 of the test fixture to the INIT position.

Verify LED2 of the test fixture is lit.



**13.** Click **[Next]** button in the dialog box of the busXplorer-USB.
Following the instructions in the dialog box, select SINGLE STEP GET DEV DESC from the Downstream Device Control drop down menu in the HS Electrical Test Tool then click the **[EXECUTE]** button.

If not already running, start the HS Electrical Test Tool. Select Host Controller/System under Select Type of Test, click the TEST button, then confirm the above.




**14.** Click the **[Next]** button in the dialog box of the busXplorer-USB.
Following the instructions in the dialog box, check the digital oscilloscope screen to confirm that a trigger activates and packet is displayed.

- If the trigger does not activate, adjust the trigger level as needed.
  Then, select SINGLE STEP GET DEV DESC again from the Device Command drop down menu in the HS Electrical Test Tool, and click the [EXECUTE] button again.
- Click the [Update] button to update the image of waveform in the dialog box of the busXplorer-USB.

***15.*** Confirm the Sync field of the 1st packet (EL_21). Using the digital oscilloscope's zoom function, adjust the zoom position on the 1st packet. Then set the cursors of the digital oscilloscope on the start and the end points of the Sync field of the 1st packet. The Sync field must be 32 bits.

## *Note*

- Click the [Update] button to update the image of waveform in the dialog box.
- When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.
- When setting the cursor on the Sync field, note that the Sync field starts from the Hi-Speed idle transitions to a falling edge. Count both rising and falling edges until the first two consecutive 1's and include the first 1.

***16.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
To measure the Sync field of the 2nd packet (EL_21), adjust the zoom position on the EOP of the 2nd packet and set the cursors on the start and the end points of the Sync field of the 2nd packet. The Sync field must be 32 bits.


## *Note*

- Click the [Update] button to update the image of waveform in the dialog box.
- When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.
- When setting the cursor on the Sync field, note that the Sync field starts from the Hi-Speed idle transitions to a falling edge. Count both rising and falling edges until the first two consecutive 1's and include the first 1.

**17.** Click the **[Next]** button in the dialog box of the busXplorer-USB.
To measure the EOP width (EL_25), adjust the zoom1 position of the EOP of the 2nd packet. Then set the cursors on the start and the end points of the EOP pulse of the 2nd packet in zoom1. The EOP width must be 8 bits.

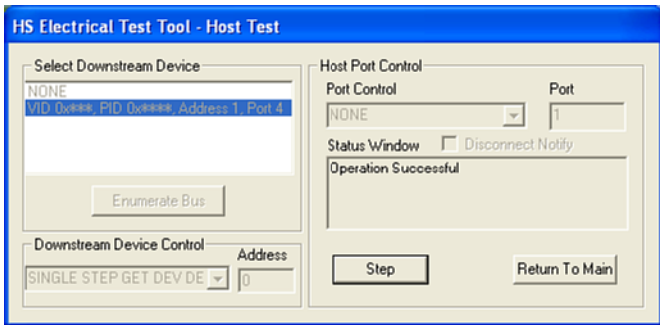
## *Note*

- Note that EOP could appear as a falling pulse or a rising pulse.
- When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.

***18.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
To measure the gap between packets (EL_23), adjust zoom1 position to the end of the 1st packet (from host) and zoom2 position to the start of the 2nd packet (from host). Then set the cursors on the end point of the 1st packet in zoom1 and the start point of the 2nd packet in zoom2. The requirement of the gap is between 88 bits and 192 bits.

- Click the [Update] button to update the image of waveform in the dialog box.
- When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.


***19.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
Following the instructions in the dialog box, select SINGLE STEP GET DEV DESC from the Downstream Device Control drop down menu in the HS Electrical Test Tool, then click the **[STEP]** button two times.



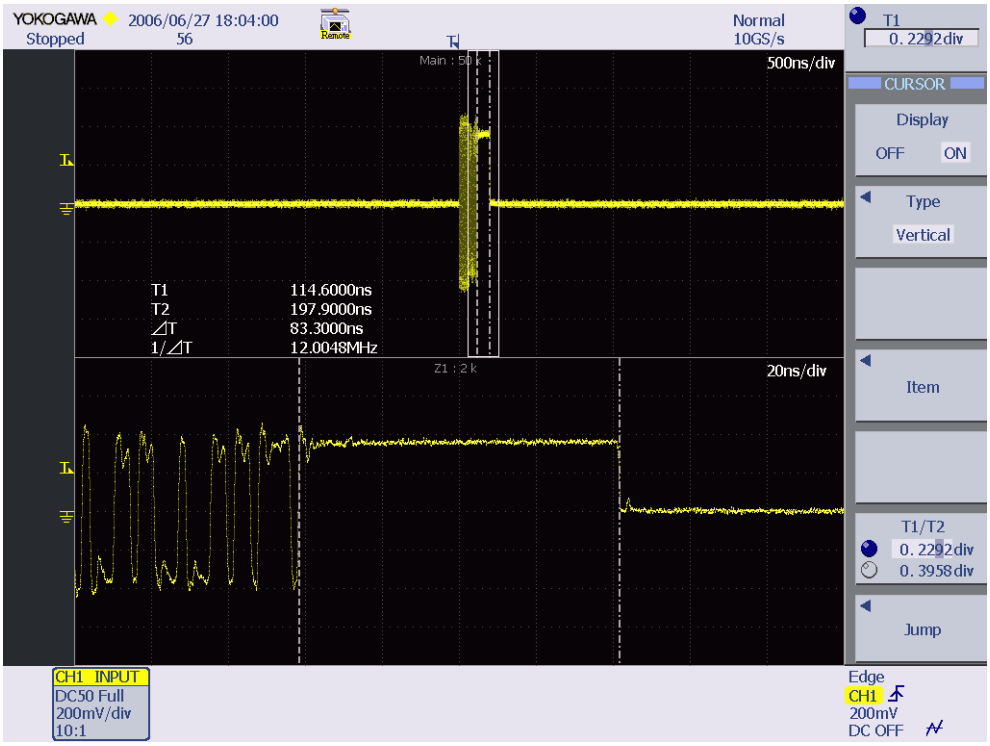
***20.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
Following the instructions in the dialog box, check the digital oscilloscope screen to confirm its trigger activates and packets from the host and device are displayed.

- If the trigger does not activate, adjust the trigger level as needed.
  Then, select SINGLE STEP GET DEV DESC again from the Device Command drop down menu in the HS Electrical Test Tool, and click the [STEP] button again.
- Click the [Update] button to update the image of waveform in the dialog box of the busXplorer-USB.

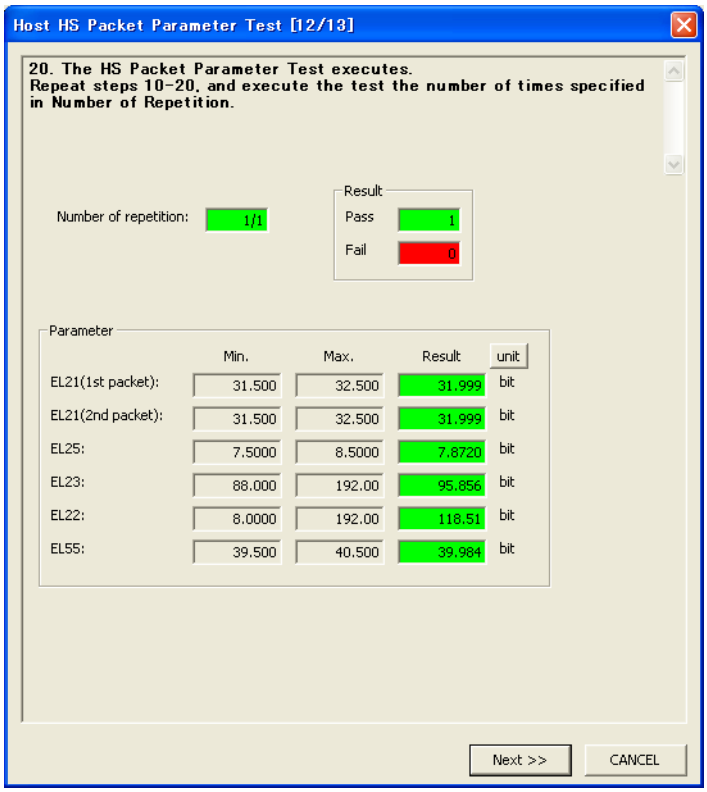

***21.*** To measure the gap between packets (EL_22), adjust zoom1 position to the end of the 2nd packet (from Device) and zoom2 position to the start of the 3rd packet (from Host). Then set the cursors on the end point of the 2nd packet in zoom1 and the start point of the 3rd packet in zoom2. The gap must be between 8bits and 192 bits.
When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.

**22.** Click **[Next]** button in the dialog box of the busXplorer-USB.
To measure the EOP Width(EL_55), adjust zoom1 position to the EOP of SOF. Then set the cursors on the start point of the EOP and the end point of the EOP in zoom1. The EOP width must be 40bits.

- Click the [Update] button to update the image of waveform in the dialog box.
- When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.

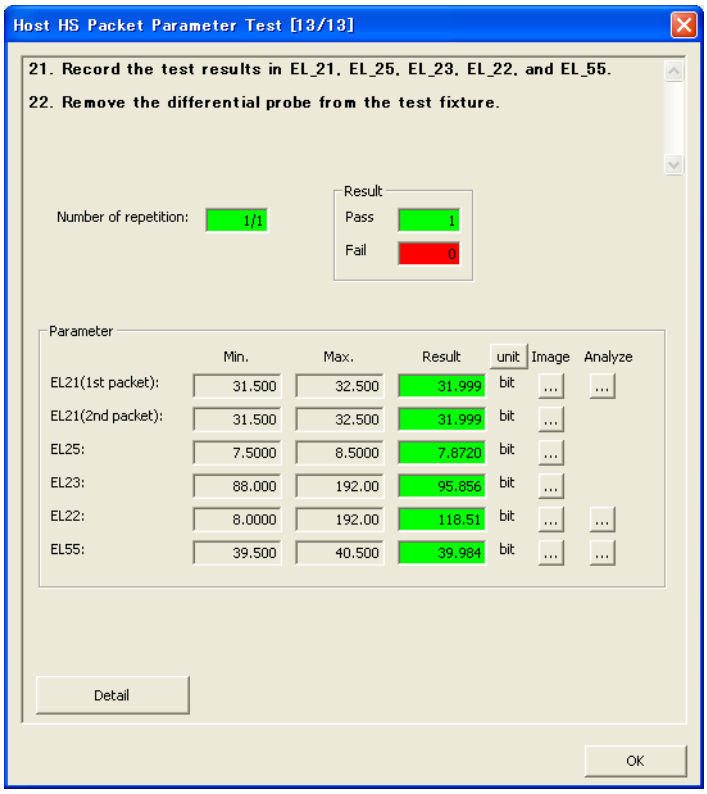


**23.** Click the **[Next]** button in the dialog box of the busXplorer-USB.
The test results dialog box is displayed.



***24.*** Click the **[Next]** button in the dialog box of the busXplorer-USB, repeat steps 13-23, and execute the test the number of times specified in “Number of Repetition.”

- When the number of tests is completed, the test results dialog box as shown below is displayed.
- Click the [Detail] button to display the test results by Internet Explorer.
- Click the [Image] button to display an image of the digital oscilloscope screen.
- Click the [Analyze] button to start Xviewer and display the waveform data. Xviewer must already have been installed.




***25.*** Record the test results in EL_21, EL_25, EL_23, EL_22, and EL_55.

- Appendix A contains the test result entry form for this test procedure. If necessary, please make copies of Appendix A for use as test record documentation for compliance test submission.
- All files created during tests are saved in the directory specified as the working folder for the busXplorer-USB.

***26.*** Repeat steps 2-25 for all ports of the host controller.

***27.*** Remove the differential probe from the test fixture.

## 2.8. Host Disconnect Detect (EL_36, EL_37)

**Please contact the independent test facilities to perform the Disconnect Test. Yokogawa Test Fixture and busXplorler-USB do not support this test.**

***Note***

Disconnect testing is required for uncertified hub silicon and host silicon or certified silicon using an uncertified PHY.

- **USB 2.0 Electrical Test Specification**
  - EL_36
    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.
  - EL_37
    USB 2.0 downstream facing port must detect the hi-speed disconnect state when the amplitude of the differential signal at the downstream facing driver's connector is ≤625 mV.

## 2.9. Host CHIRP Timing (EL_33, EL_34, EL_35)

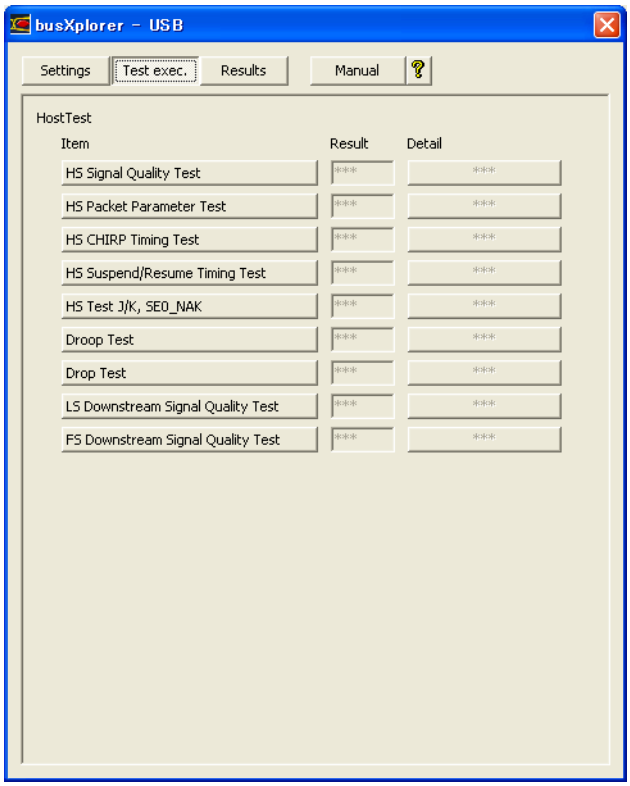
- **USB 2.0 Electrical Test Specification**
  - EL_33
    Downstream ports start sending and alternating sequence of Chirp K's and Chirp J's within 100 µs after the device Chirp K stops.
  - EL_34
    Downstream port Chirp K and Chirp J durations must be between 40 µs and 60 µs duration.
  - EL_35
    Downstream ports begin sending SOFs within 500 µs and not sooner than 100 µs from transmission of the last Chirp (J or K).

- **Instruments Used**

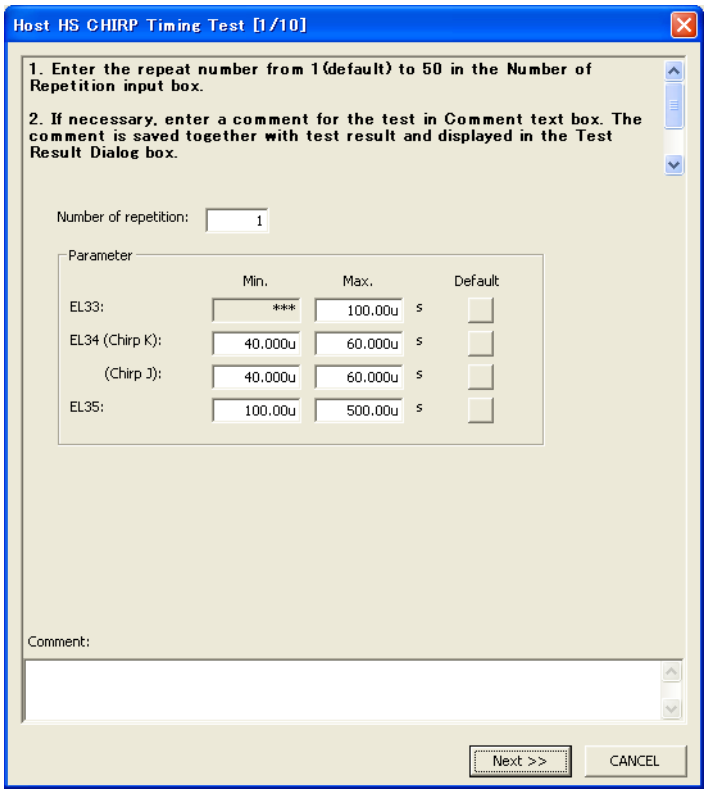
| Name | Quantity |
|---|---|
| DL9240/DL9240L Digital Oscilloscope | 1 |
| PBA2500 Active Probe | 2 |
| PBA2500 Probe attachment | 2 sets |
| USB-IF compliant 1 m USB 2.0 cable | 1 |
| USB-IF Compliant Hi-Speed Hub | 1 |
| Test bed computer | 1 |
| USB compliance test fixture | 1 |
| 5 V power supply for test fixture | 1 |

- **Executing the Test**

  ***1.*** Click the **[Test exec.]** button in the busXplorer-USB to display the Host Test selection dialog box.



2. Click the **[HS CHIRP Timing Test]** button in the dialog box.
The Host HS CHIRP Timing Test dialog box is displayed.



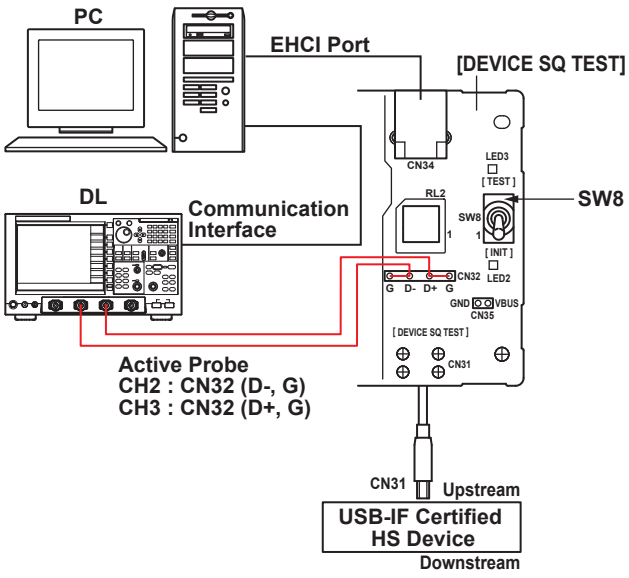

3. Enter the repeat number from 1(default) to 50 in the Number of Repetition input box.

4. If necessary, enter a comment for the test in Comment text box.
The comment is saved together with test result and displayed in the Test Result Dialog box.

5. If you wish to change the judgment range, you can edit the judgment criteria for EL_33, EL_34, and EL_35.
Default values for the judgment criteria are as follows:
   - EL_33
     Max.: 100 μs
   - EL_34 (Chirp K, J)
     Min.: 40.0 μs, Max.: 60.0 μs
   - EL_35
     Min.: 100 μs, Max.: 500.0 μs

   If you click the [Default] button after changing the judgment range, the default values of the judgment range are restored.

6. Click the **[Next]** button.
   A connection diagram as shown below is displayed.



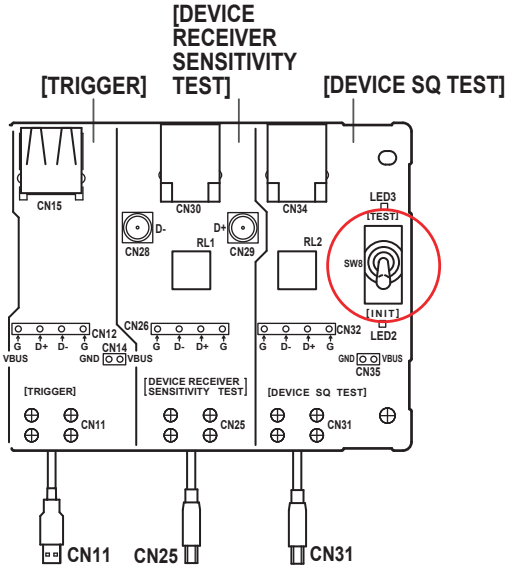

7. Turn ON the power to the test fixture and verify that the green power supply LED1 is lit.
8. Connect the USB-IF compliant Hi-Speed USB hub (upstream port side) to the CN31 connector of the DEVICE SQ TEST block and turn ON the power to the hub.
9. Connect the host controller port under test to the CN34 connector of the DEVICE SQ TEST block using a 1 m USB cable.
10. Connect two PBA2500 active probes, one to CH2 and the other to CH3 of the digital oscilloscope.

***Note***

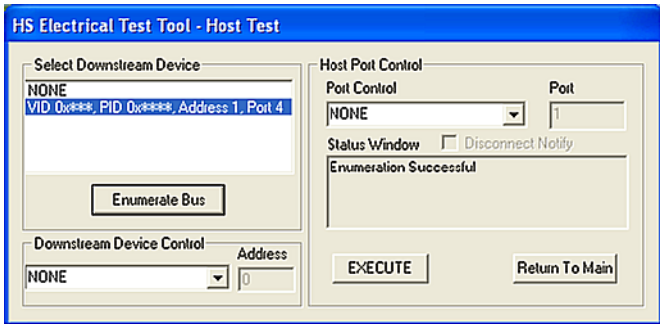
After connecting the probe, heat emitted from the probe causes the offset voltage to drift. The probe should nearly stabilize about thirty minutes after applying power.

11. Attach the attachments on the tips of the active probes, then connect the CH2 probe to GND and D- of CN32, and the CH3 probe to GND and D+ of CN32.

***12.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
Following the instructions in the dialog box, place SW8 of the test fixture to the INIT position.
Verify LED2 of the test fixture is lit.




***13.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
Following the instructions in the dialog box, click the **[Enumerate Bus]** button of the HS Electrical Test Tool. Confirm that the VID, PID, connected address, and port of the DUT are displayed under Select Downstream Device.
If not already running, start the HS Electrical Test Tool. Select Host Controller/System under Select Type of Test, click the TEST button, then confirm the above.

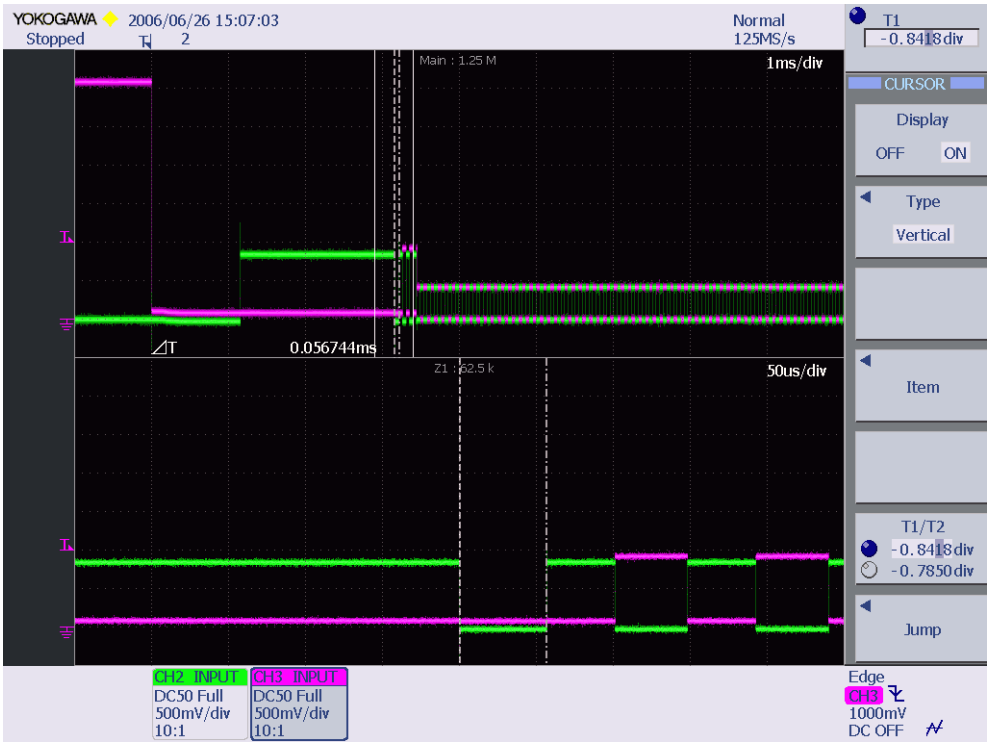



***14.*** Click the **[Next]** button in the dialog box of the busXplorer-USB, check the digital oscilloscope screen to confirm that a trigger activates and CHIRP data is displayed.

- If the trigger does not activate, adjust the trigger level as needed
- Click the [Update] button to update the image of waveform in the dialog box.

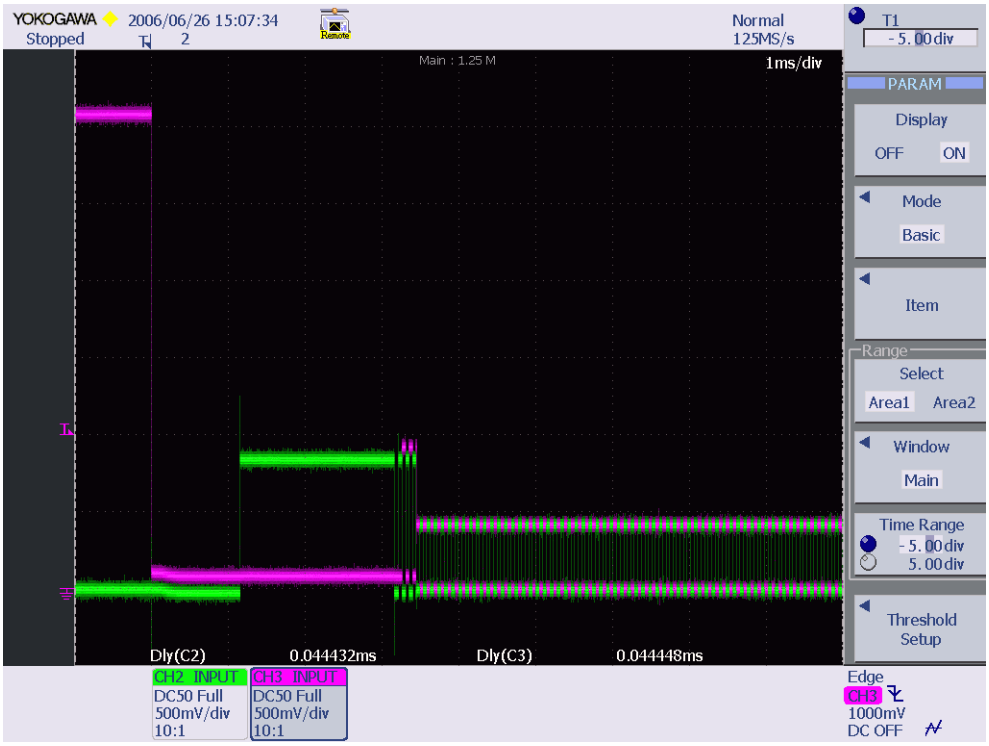
***15.*** Measure the CHIRP response timing (EL33).
Measure the host's CHIRP response timing. Measure the time between the end of CHIRP-K to the beginning of CHIRP-K-J-K-J-K-J. The time must be less than or equal to 100 μs.

- Click the [Update] button to update the image of waveform in the dialog box.
- When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.



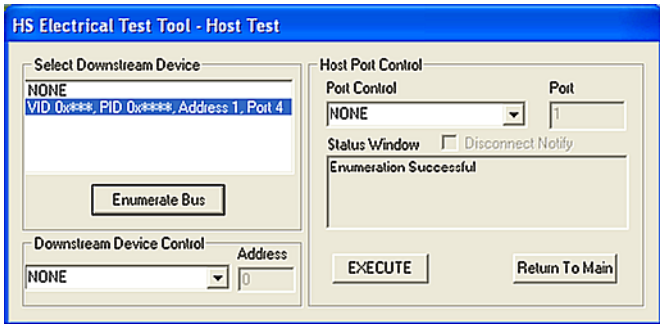
***16.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
Measure the period of CHIRP-K-J-K-J-K-J (EL34).
Measure the individual durations of the Chirp-K and Chirp-J states. The requirement of the duration is between 40 µs and 60 µs.

- Click the [Update] button to update the image of waveform in the dialog box.
- When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.




***17.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
Remove the HS-hub connected to the CN31 connector of the DEVICE SQ TEST block, then reconnect it.

***18.*** Following the instructions in the dialog box of the busXplorer-USB, click the **[Enumerate Bus]** button in the HS Electrical Test Tool. Confirm that the VID, PID, connected address, and port of the DUT are displayed under Select Downstream Device.



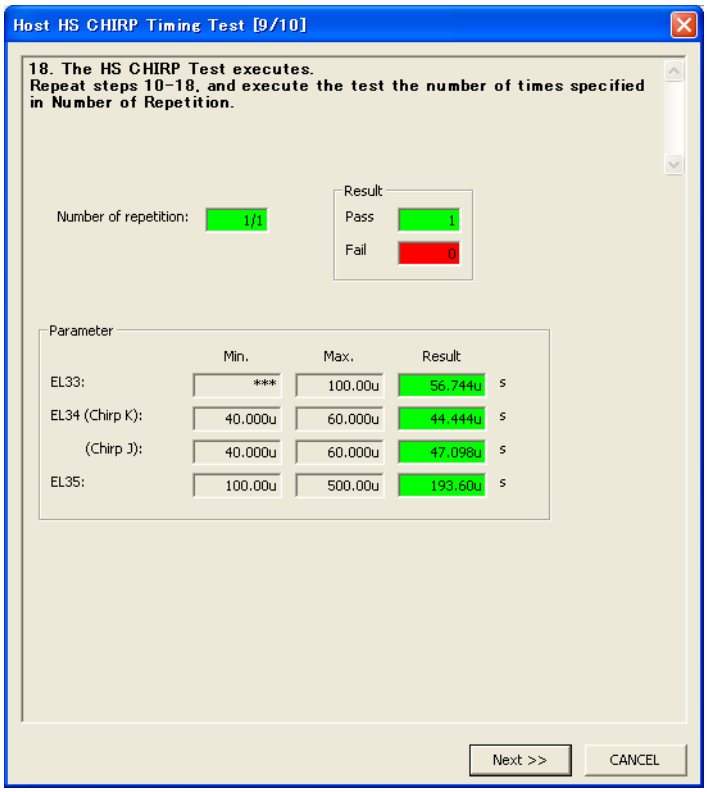
***19.*** Click the **[Next]** button in the dialog box of the busXplorer-USB, check the digital oscilloscope screen to confirm that a trigger activates and CHIRP data is displayed.

- If the trigger does not activate, adjust the trigger level as needed
- Click the [Update] button to update the image of waveform in the dialog box.

***20.*** Measure the time from the end of the CHIRP to SOF (EL35).
To measure the time between the end of the host Chirp-J/K and the first SOF sent by the host, adjust zoom position to the end of the host Chirp-J/K and the first SOF sent by the host. Then set the cursors on the end point of the Chirp-J/K and the start point of the first SOF in zoom. The The time must be between 100 µs and 500 µs.

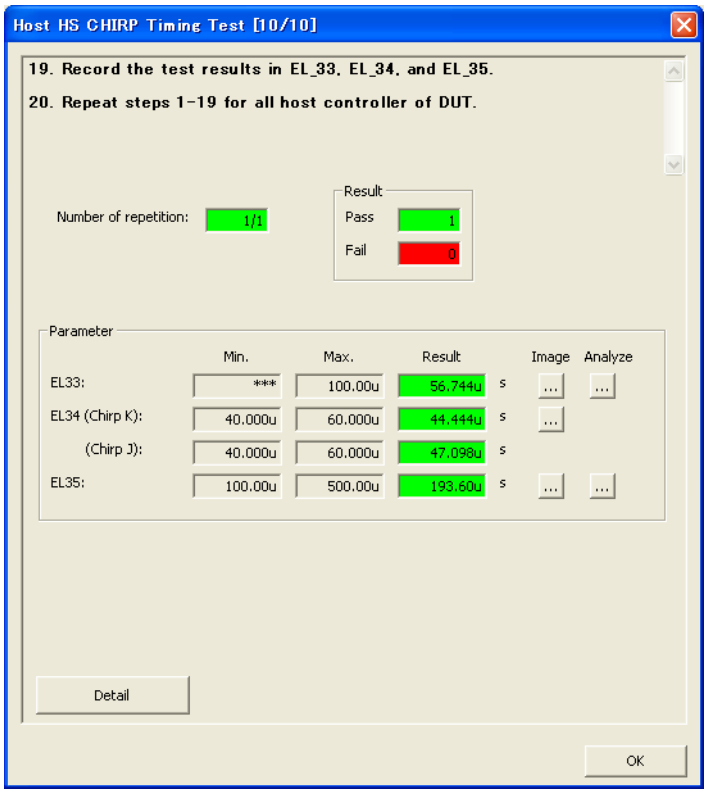
- Click the [Update] button to update the image of waveform in the dialog box.
- When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.

***21.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
The test results dialog box is displayed.



**22.** Click the **[Next]** button in the dialog box of the busXplorer-USB, repeat steps 13-21, and execute the test the number of times specified in “Number of Repetition.”

- When this number of tests is completed, the test results dialog box as shown below is displayed.
- Click the [Detail] button to display the test results by Internet Explorer.
- Click the [Image] button to display an image of the digital oscilloscope screen.
- Click the [Analyze] button to start Xviewer and display the waveform data. Xviewer must already have been installed.




**23.** Record the test results in EL_33, EL_34, and EL_35.

- Appendix A contains the test result entry form for this test procedure. If necessary, please make copies of Appendix A for use as test record documentation for compliance test submission.
- All files created during tests are saved in the directory specified as the working folder for the busXplorer-USB.

**24.** Repeat steps 2-23 for all ports of the host controller.

## 2.10. Host Suspend/Resume Timing (EL_38, EL_41)

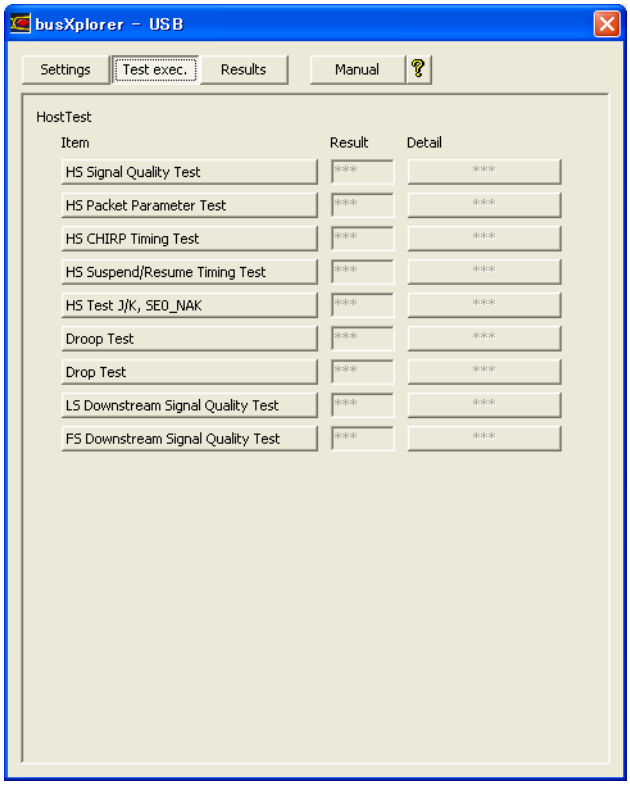
- **USB 2.0 Electrical Test Specification**
  - EL_38
    A device must revert to full-speed termination no later than 125 μs after there is a 3 ms idle period on the bus.
  - EL_41
    After resuming a port, the host must begin sending SOFs within 3 ms of the start of the idle state.

- **Instruments Used**

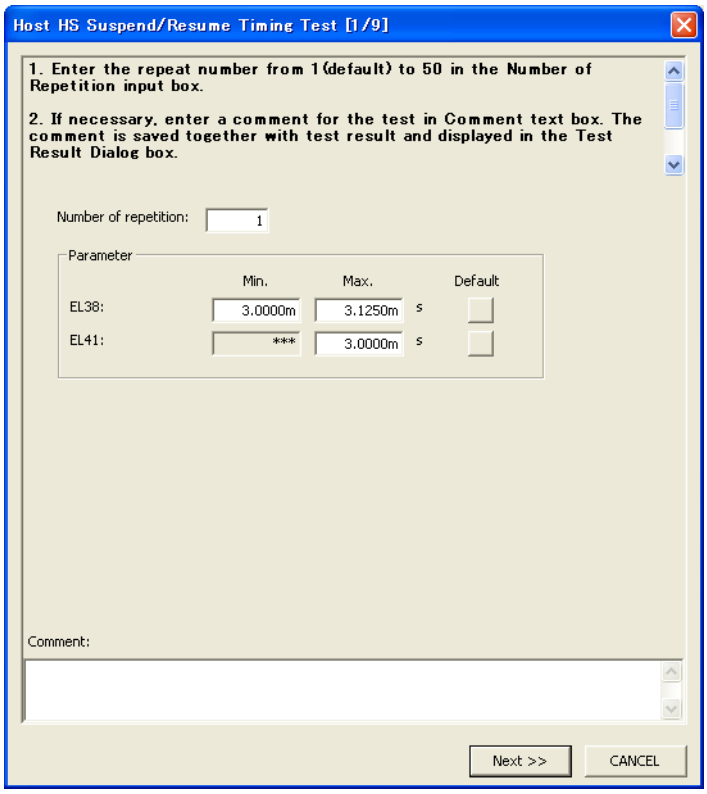
| Name | Quantity |
|---|---|
| DL9240/DL9240L Digital Oscilloscope | 1 |
| PBA2500 Active Probe | 2 |
| PBA2500 Probe attachment | 2 sets |
| USB-IF compliant 1 m USB 2.0 cable | 1 |
| USB-IF Compliant Hi-Speed USB Hub | 1 |
| Test bed computer | 1 |
| USB compliance test fixture | 1 |
| 5 V power supply for test fixture | 1 |

- **Executing the Test**

  ***1.*** Click the **[Test exec.]** button in the busXplorer-USB to display the Host Test selection dialog box.



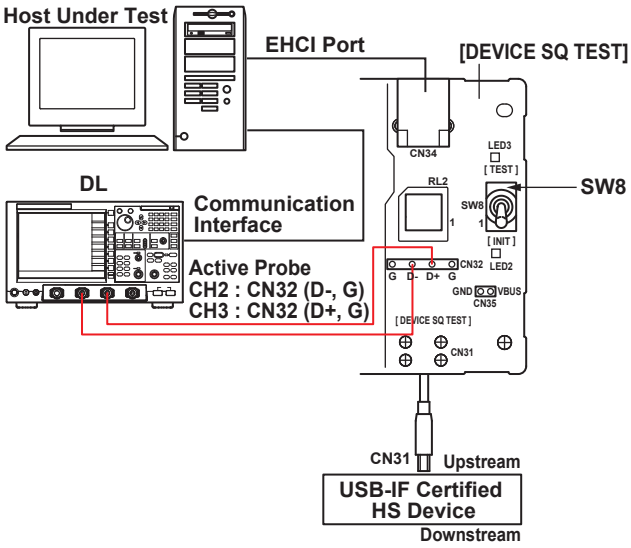
2. Click the **[HS Suspend/Resume Timing Test]** button in the dialog box.
The Host HS Suspend/Resume Timing Test dialog box is displayed.




3. Enter the repeat number from 1(default) to 50 in the Number of Repetition input box. .
4. If necessary, enter a comment for the test in Comment text box.
The comment is saved together with test result and displayed in the Test Result Dialog box.
5. If you wish to change the judgment range, you can edit the judgment criteria for EL_38, EL_41.
Default values for the judgment criteria are as follows:
   - EL_38
     Min.: 3.000 ms, Max.: 3.125 ms
   - EL_41
     Max.: 3.000 ms

   If you click the [Default] button after changing the judgment range, the default values of the judgment range are restored.

6. Click the **[Next]** button in the dialog box of the busXplorer-USB. A connection diagram as shown below is displayed.



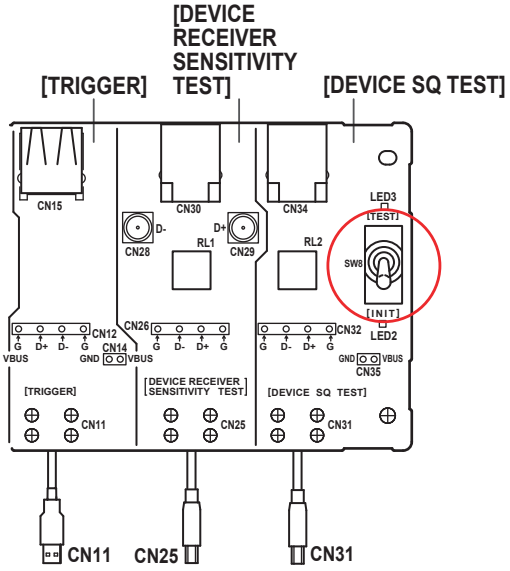

7. Turn ON the power to the test fixture and verify that the green power supply LED1 is lit.
8. Connect the USB-IF compliant Hi-Speed USB hub (upstream port side) to the CN31 connector of the Device SQ TEST block and turn ON the power to the hub.
9. Connect the host controller port under test to the CN34 connector of the DEVICE SQ TEST block using a 1 m USB cable.
10. Connect the PBA2500 active probes to CH2 and CH3 of the digital oscilloscope.

***Note***

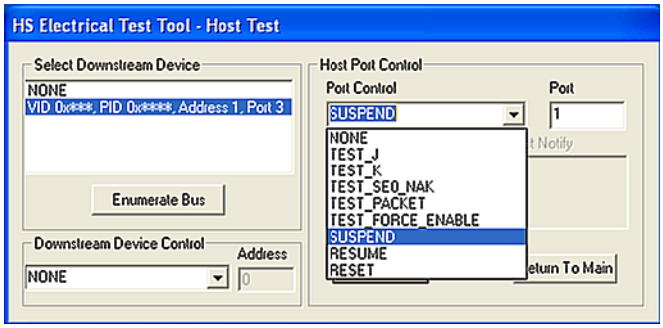
After connecting the probe, heat emitted from the probe causes the offset voltage to drift. The probe should nearly stabilize about thirty minutes after applying power.

11. Attach the attachments on the tips of the active probes, and then connect the CH2 probe to GND and D- of CN32, and the CH3 probe to GND and D+ of test pin CN32.

**12.** Click the **[Next]** button in the dialog box of the busXplorer-USB.
Following the instructions in the dialog box, place SW8 of the test fixture to the INIT position.
Verify LED2 of the test fixture is lit.




**13.** Click the **[Next]** button in the dialog box of the busXplorer-USB, click the **[Enumerate Bus]** button in the HS Electrical Test Tool .Then, select SUSPEND from the Port Control drop down menu and set the target port number in the HS Electrical Test Tool, then click **[EXECUTE]** button.
If not already running, start the HS Electrical Test Tool. Select Host Controller/System under Select Type of Test, click the TEST button, then confirm the above.

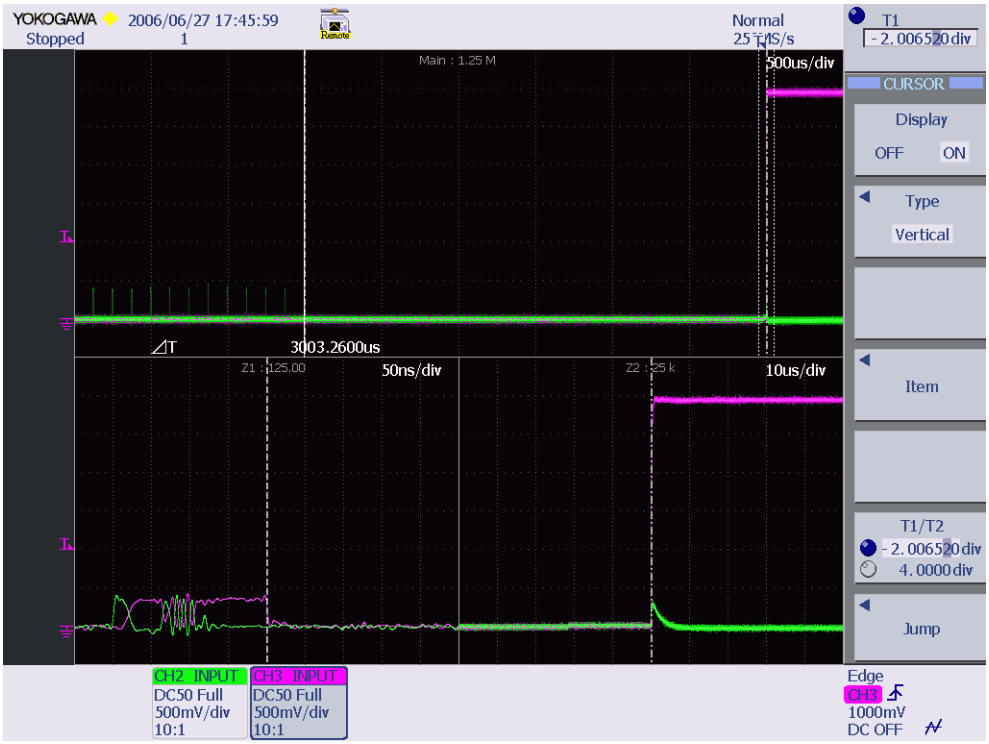



**14.** Click the **[Next]** button in the dialog box of the busXplorer-USB, check the digital oscilloscope screen to confirm that a trigger activates and the Suspend signal is displayed.

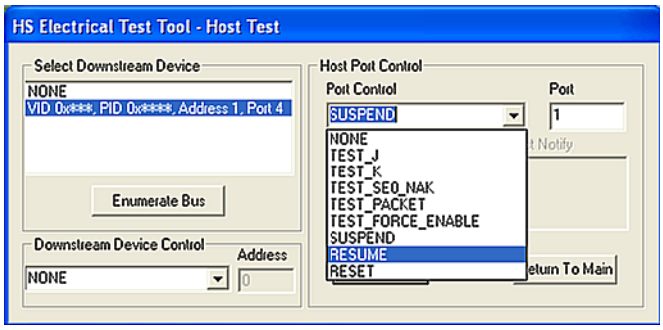
- If the trigger does not activate, adjust the trigger level as needed
- Click the [Update] button to update the image of waveform in the dialog box.

***15.*** Using the oscilloscope's cursor/zoom function, measure the time from the end of the last SOF packet (from host) to the point when the device connects its full speed pull-up resistor on D+ (EL_38). Adjust zoom1 position to the last SOF packet and set T1 cursor on the end of the SOF packet in zoom1. The requirement of the time is between 3.000 ms and 3.125 ms.

- Do not change position of zoom2 and cursor T2.
- Click the [Update] button to update the image of waveform in the dialog box.
- When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.




***16.*** Click **[Next]** in the dialog box of the busXplorer-USB, and then choose RESUME from Port Control drop down menu and set the target port number in the HS Electrical Test Tool, then click the **[EXECUTE]** button.



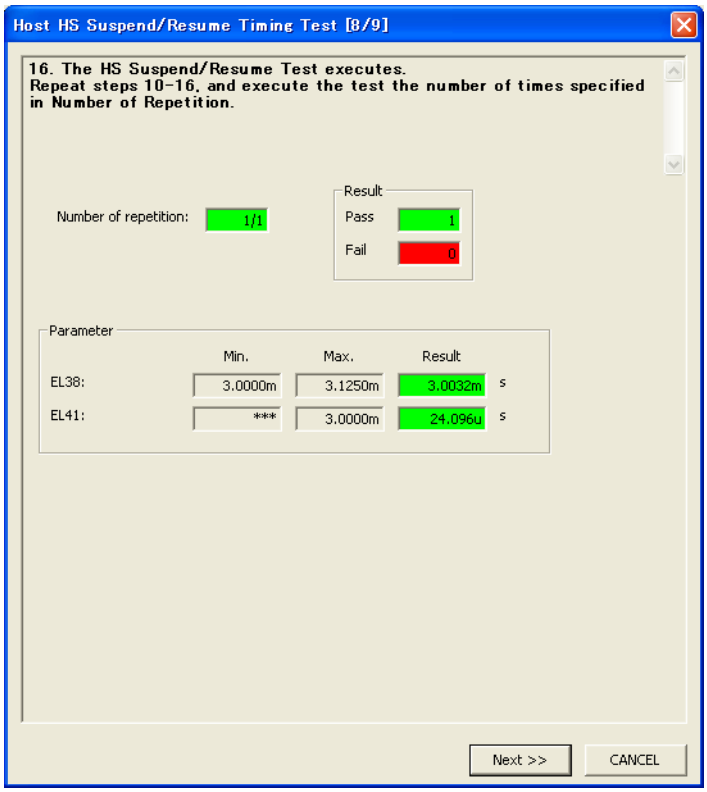
***17.*** Click the **[Next]** button in the dialog box of the busXplorer-USB, check the digital oscilloscope screen to confirm that a trigger activates and the Resume signal is displayed.

- If the trigger does not activate, adjust the trigger level as needed
- Click the [Update] button to update the image of waveform in the dialog box.

***18.*** Resume the HS operation (EL41).
Using the oscilloscope's cursor/zoom function, measure the time from the falling edge of D- to the first SOF issued by the host, adjust zoom2 position to the first SOF packet. Then set the T2 cursors on the start point of the first SOF in zoom2. The requirement of the time must be less than 3.0 ms.

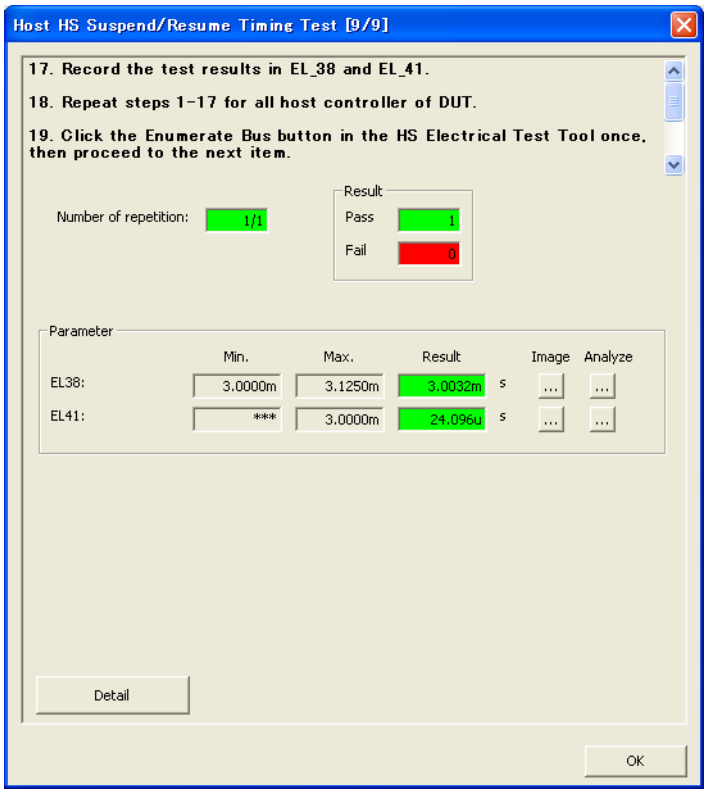
- Do not change position of zoom1 and cursor T1.
- Click the [Update] button to update the image of waveform in the dialog box.

***19.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
The test results dialog box is displayed.



***20.*** Click the **[Next]** button in the dialog box of the busXplorer-USB, repeat steps 13-19, and execute the test the number of times specified in “Number of Repetition.”

- When the number of tests is complete, the test results dialog box as shown below is displayed.
- Click the [Detail] button to display the test results by Internet Explorer.
- Click the [Image] button to display an image of the digital oscilloscope screen.
- Click the [Analyze] button to start Xviewer and display the waveform data. Xviewer must already have been installed.




***21.*** Record the test results in EL_38 and EL_41.

- Appendix A contains the test result entry form for this test procedure. If necessary, please make copies of Appendix A for use as test record documentation for compliance test submission.
- All files created during tests are saved in the directory specified as the working folder for the busXplorer-USB.

***22.*** Repeat steps 2-21 for all ports of the host controller.

***23.*** Click the Enumerate Bus button in the HS Electrical Test Tool once, then proceed to the next item.

***24.*** Remove the Active probes from the test fixture.

## 2.11. Host Test J/K, SE0_NAK (EL_8, EL_9)

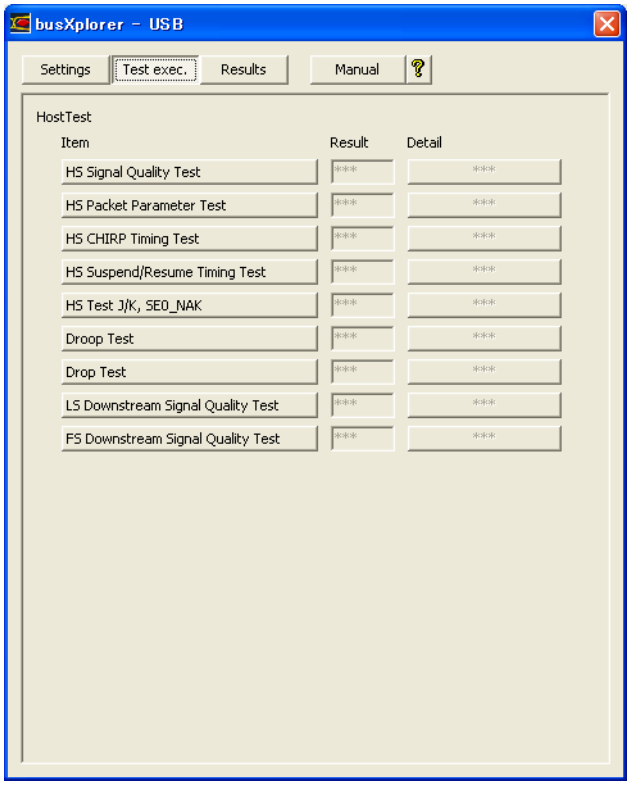
- **USB 2.0 Electrical Test Specification**
  - EL_8
    When either D+ or D- are driven high, the output voltage must be 400 mV ±10% when terminated with precision 45 Ω resistors to ground.
  - EL_9
    When either D+ and D- are not being driven, the output voltage must be 0V ±10 mV when terminated with precision 45 Ω resistors to ground.

- **Instruments Used**

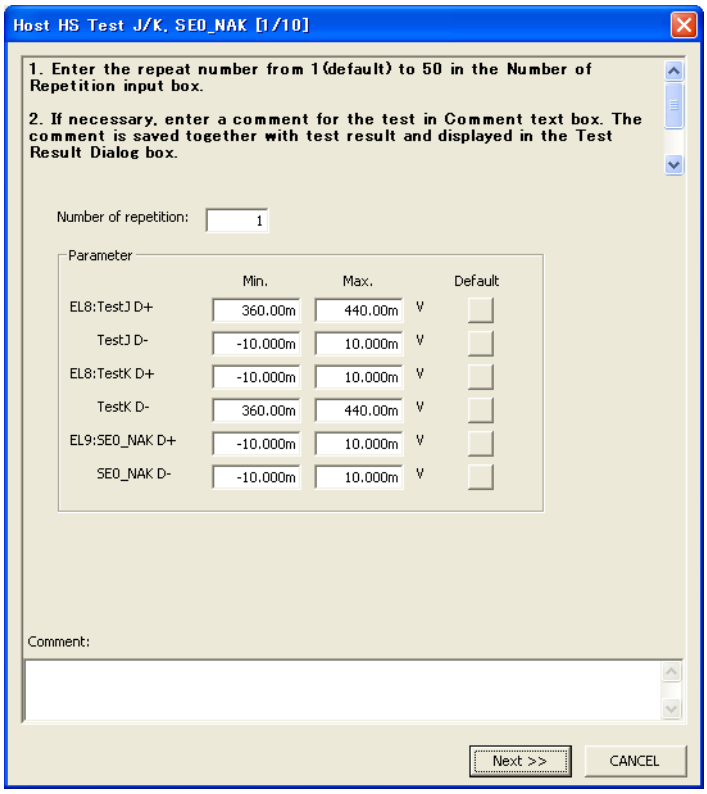
| Name | Quantity |
|---|---|
| Yokogawa Meter & Instrument 3 ½ Digital Multimeter 733/734 | 1 |
| USB-IF compliant 1 m USB 2.0 cable | 1 |
| Test bed computer | 1 |
| USB compliance test fixture | 1 |
| 5 V power supply for test fixture | 1 |

- **Executing the Test**

  ***1.*** Click the **[Test exec.]** button in the busXplorer-USB to display the Host Test selection dialog box.



2. Click the **[HS Test J/K, SE0_NAK]** button.
   The Host J/K, SE0_NAK Test dialog box opens.



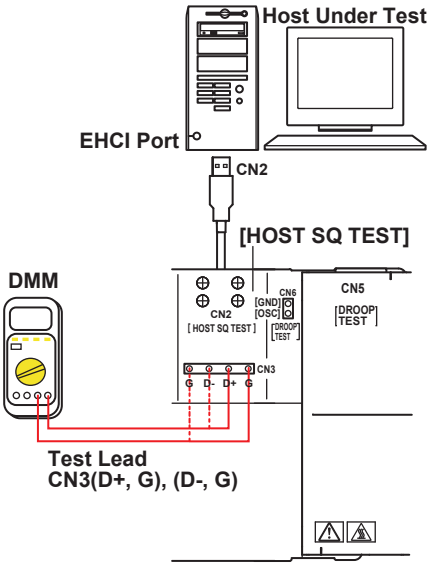

3. Enter the repeat number from 1(default) to 50 in the Number of Repetition input box.

4. If necessary, enter a comment for the test in Comment text box.
   The comment is saved together with test result and displayed in the Test Result Dialog box.

5. If you wish to change the judgment range, you can edit the judgment criteria for EL_8 and EL_9.
   Default values for the judgment criteria are as follows:
   - EL_8
     Test J D+ Min.: 360 mV, Max.: 440 mV
     D- Min.: -10.0 mV, Max.: 10.0 mV
     Test K D+ Min.: -10.0 mV, Max.: 10.0 mV
     D- Min.: 360 mV, Max.: 440 mV
   - EL_9
     SE0_NAK D+ Min.: -10.0 mV, Max.: 10 mV
     SE0_NAK D- Min.: -10.0 mV, Max.: 10.0 mV

   If you click the [Default] button after changing the judgment range, the default values of the judgment range are restored.

6. Click the **[Next]** button in the dialog box of the busXplorer-USB. A connection diagram as shown below is displayed.



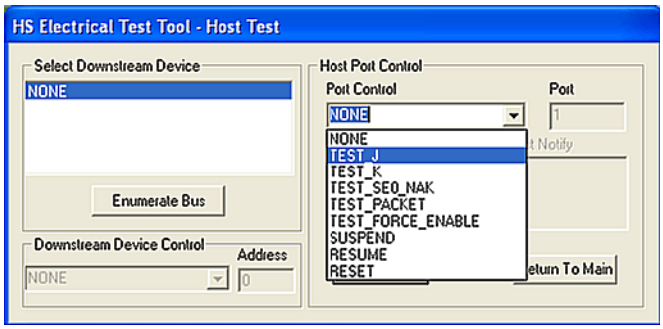

## *Note*

The digital oscilloscope is not necessary to perform this test.

7. Connect the port under test of the host controller to the CN2 connector of the HOST SQ TEST block.

8. Click **[Next]** button in the dialog box of the busXplorer-USB. Following the instructions in the dialog box, select TEST_J from the Port Control drop down menu and set the target port number in the HS Electrical Test Tool, then click the **[EXECUTE]** button.

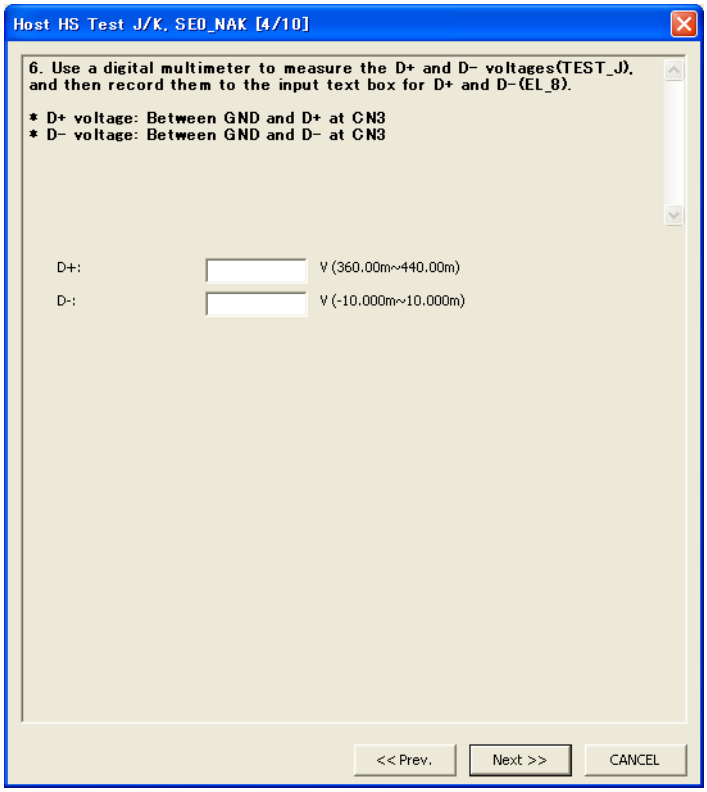
   If not already running, start the HS Electrical Test Tool. Select Host Controller/System under Select Type of Test, click the TEST button, then confirm the above.



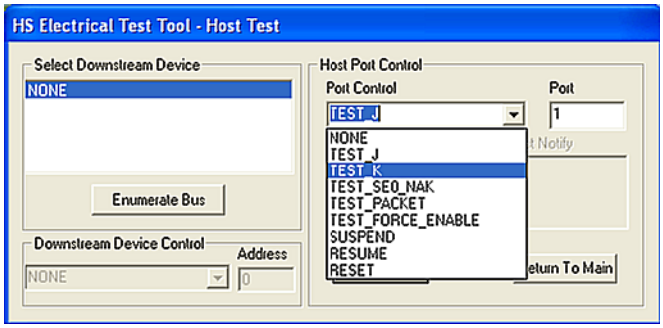
***9.*** Click the **[Next]** button in the dialog box of the busXplorer-USB, use a digital multimeter to measure the D+ and D- voltages (TEST_J), and then record them to the input text box for D+ and D-(EL_8).

- D+ voltage: Between GND and D+ at CN3
- D- voltage: Between GND and D- at CN3

When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.



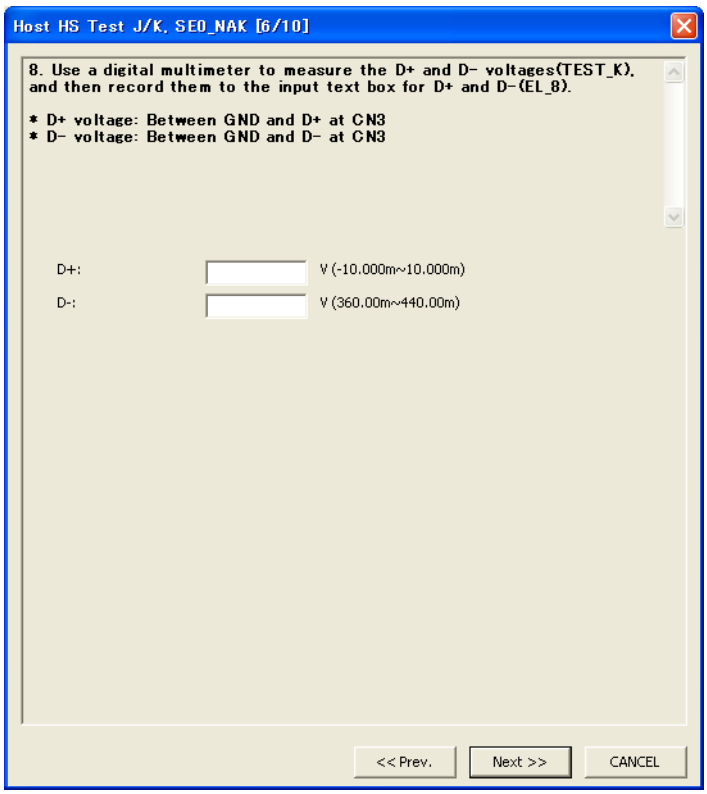

***10.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
Select TEST_K from Port Control drop down menu and set the target port number in the HS Electrical Test Tool, then click the **[EXECUTE]** button.



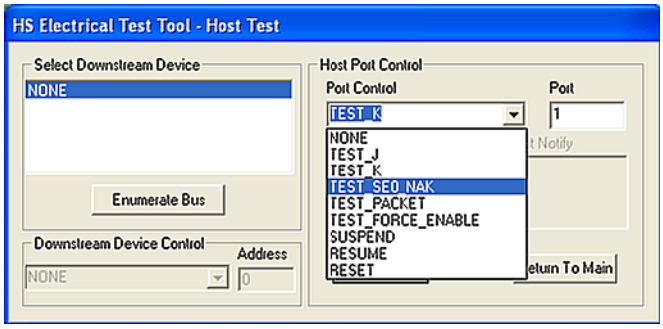
***11.*** Click the **[Next]** button in the dialog box of the busXplorer-USB, use a digital multimeter to measure the D+ and D- voltages (TEST_K), and then record them to the input text box for D+ and D-(EL_8).

- D+ voltage: Between GND and D+ at CN3
- D- voltage: Between GND and D- at CN3

When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.



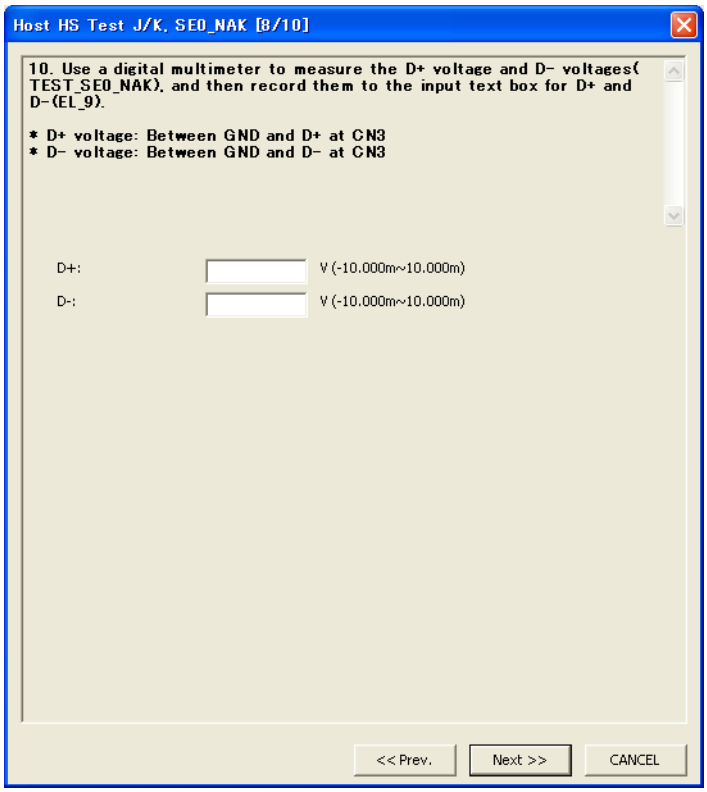

***12.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
Select TEST_SE0_NAK from Port Control drop down menu and set the target port number in the HS Electrical Test Tool, then click the **[EXECUTE]** button.



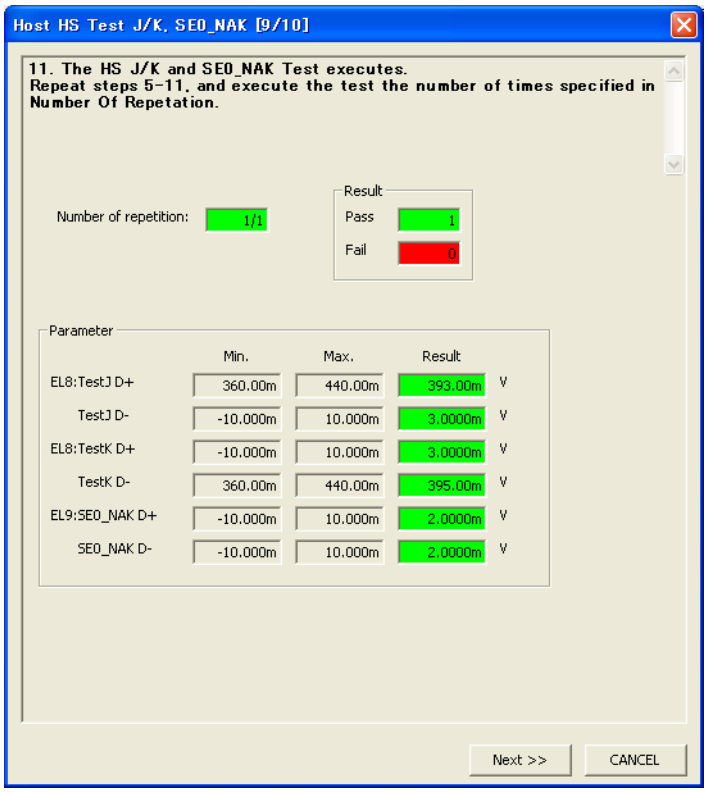
***13.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
Use a digital multimeter to measure the D+ voltage and D- voltages (TEST_SE0_NAK), and then record them to the input text box for D+ and D-(EL_9).

- D+ voltage: Between GND and D+ at CN3
- D- voltage: Between GND and D- at CN3

When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.

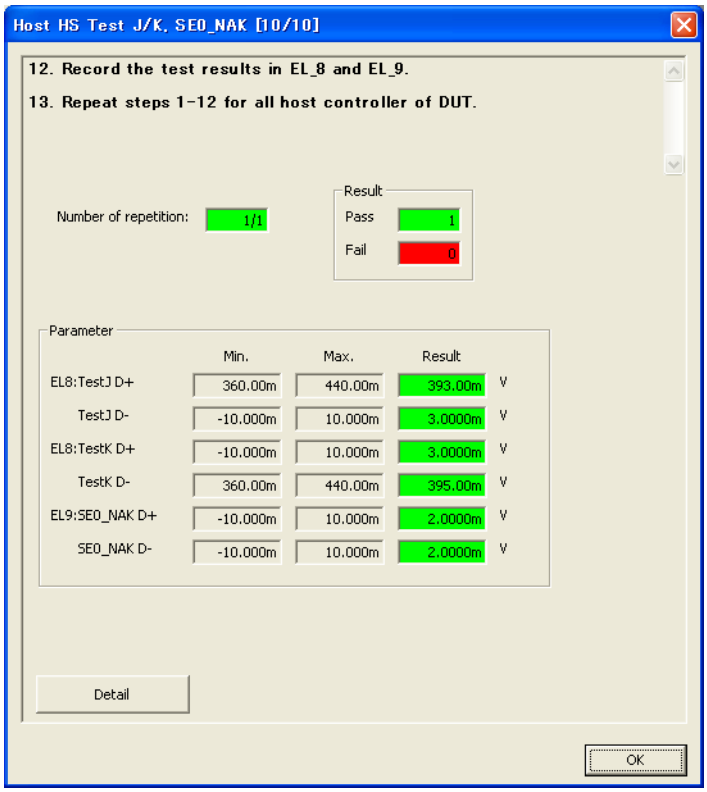


***14.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
The test results dialog box is displayed.



***15.*** Click the **[Next]** button in the dialog box of the busXplorer-USB, repeat steps 8-14, and execute the test the number of times specified in “Number Of Repetation”.

- When this number of tests is completed, the test results dialog box as shown below is displayed.
- Click the Detail button to display the test results by Internet Explorer.




***16.*** Record the test results in EL_8 and EL_9.

- Appendix A contains the test result entry form for this test procedure. If necessary, please make copies of Appendix A for use as test record documentation for compliance test submission.
- All files created during tests are saved in the directory specified as the working folder for the busXplorer-USB.

***17.*** Repeat steps 2-16 for all ports of the host controller.

# Appendix A Host Hi-Speed Electrical Test Data

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

## App. A.1 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 | |

## App. A.2 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

## App. A.3 Host Hi-speed Signal Quality (EL_2, EL_3, EL_6, EL_7)

EL_2 A USB 2.0 Hi-Speed transmitter data rate must be 480 Mb/s ±0.05%.

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

| Port | P1 | P2 | P3 | P4 | P5 |
|---|---|---|---|---|---|
| **PASS** | | | | | |
| **FAIL** | | | | | |
| **N/A** | | | | | |

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** | | | | | |
| **N/A** | | | | | |

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** | | | | | |
| **N/A** | | | | | |

☐ 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.

☐ PASS
☐ FAIL
☐ N/A

Comments:

## App. A.4 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.

Data Packet SYNC field

☐ PASS
☐ FAIL
☐ N/A

Comments:

SOF 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 waiverable)

**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:

## App. A.5 Host Disconnect Detect (EL _36, EL_37)

EL_37 A USB 2.0 downstream facing port must not detect the hi-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** | | | | | |
| **N/A** | | | | | |

Overall Result:
☐ PASS
☐ FAIL
☐ N/A

Comments:

EL_36 A USB 2.0 downstream facing port must detect the hi-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** | | | | | |
| **N/A** | | | | | |

Overall Result:
☐ PASS
☐ FAIL
☐ N/A

Comments:

## App. A.6 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 100 μs after the device Chirp K stops.

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

☐ PASS
☐ FAIL
☐ N/A

Comments:

EL_34 The CHIRP handshake generated by a device must be at least 1 ms and not more than 7 ms in 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 500 μs and not sooner than 100 μs 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:

## App. A.7 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 3 ms of the start of the idle state.

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

☐ PASS
☐ FAIL
☐ N/A

Comments:

## App. A.8 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 ± 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 0 V ± 10 mV 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** | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Signal** | **D+** | **D-** | **D+** | **D-** | **D+** | **D-** | **D+** | **D-** | **D+** | **D-** |
| **Measure WRT Ground (mV)** | | | | | | | | | | |

☐ PASS
☐ FAIL
☐ N/A

Comments:

# Appendix B Legacy USB Compliance Tests

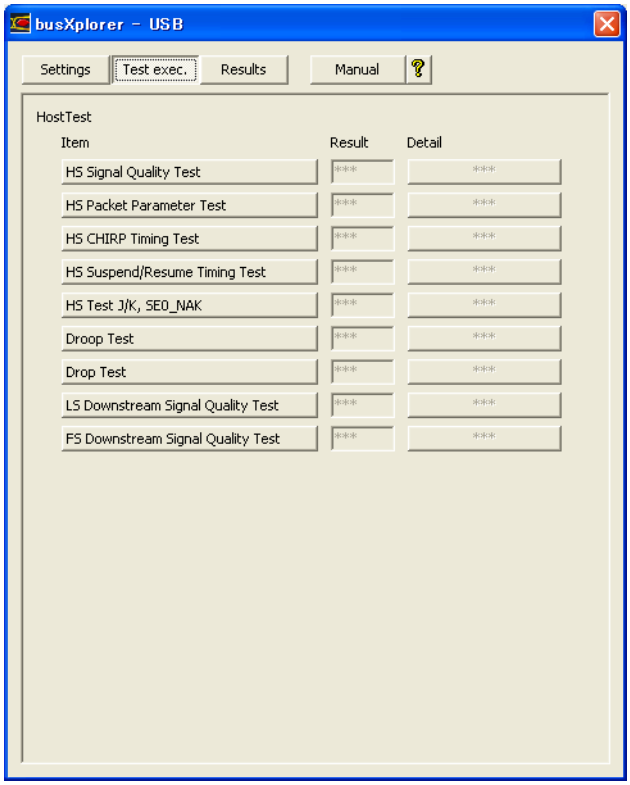
## App. B.1 Droop Test

- **Instruments Used**

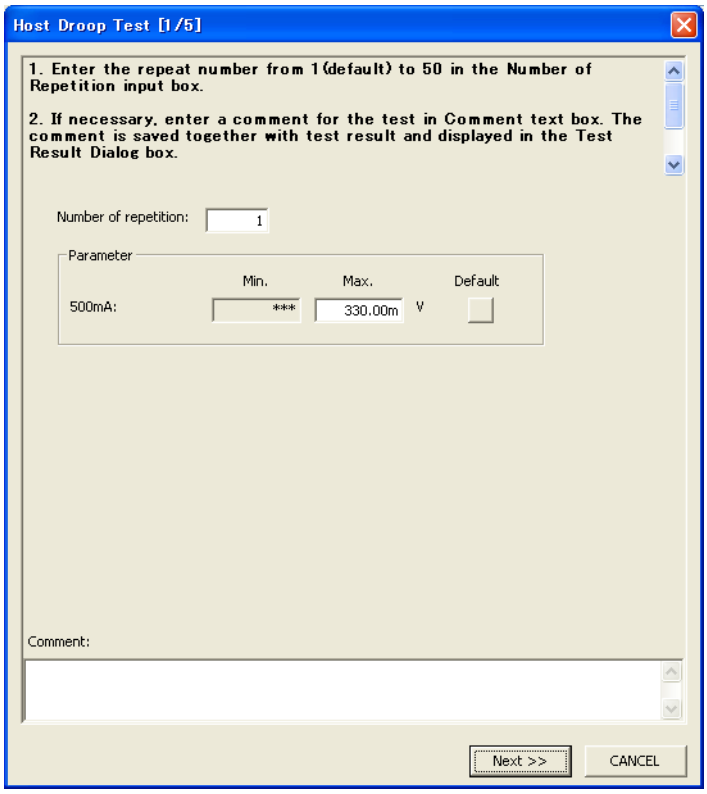
| Name | Quantity |
|---|---|
| DL9240/DL9240L Digital Oscilloscope | 1 |
| PB500 Passive Probe | 2 |
| USB-IF compliant 1 m USB 2.0 cable | 4 |
| Test bed computer | 1 |
| USB compliance test fixture | 1 |
| 5 V power supply for test fixture | 1 |

- **Executing the Test**

  ***1.*** Click the **[Test exec.]** button in the busXplorer-USB to display the Host Test selection dialog box.

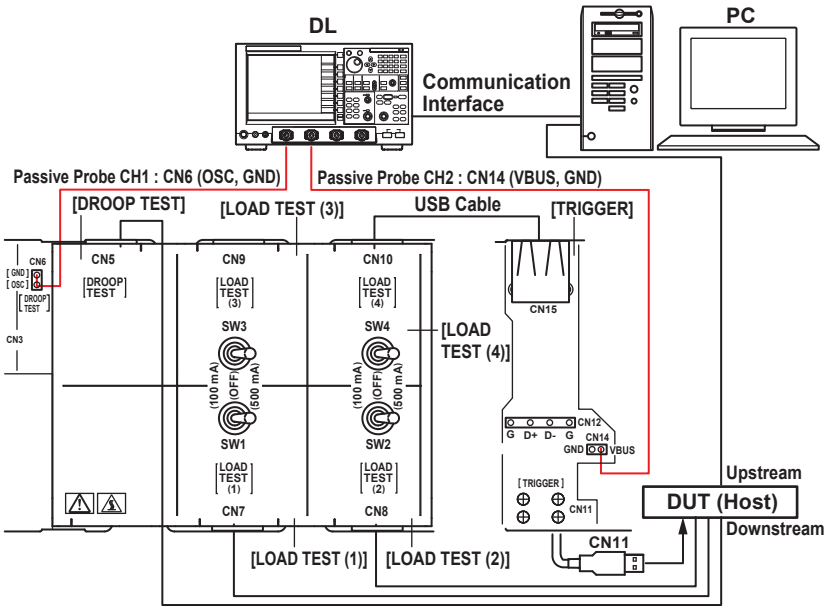


2. Click the **[Droop Test]** button in the dialog box.
The Host Droop Test dialog box is displayed.




3. Enter the repeat number from 1(default) to 50 in the Number of Repetition input box.
4. If necessary, enter a comment for the test in Comment text box.
The comment is saved together with test result and displayed in the Test Result Dialog box.
5. If you wish to change the judgment range, you can edit the judgment criteria for Droop Voltage.
Default values for the judgment criteria are as follows:
VDroop
Max.: 330 mV
If you click the [Default] button after changing the judgment range, the default values of the judgment range are restored.

6. Click the **[Next]** button in the dialog box of the busXplorer-USB.
A connection diagram as shown below is displayed.




7. Turn ON the power to the test fixture and verify that the green power supply LED1 is lit.
8. Connect the port under test of the host controller to the CN11 connector of the TRIGGER block on the test fixture.
9. Connect the CN15 connector of the TRIGGER block to the CN10 connector of the LOAD TEST[4] block with a 1 m USB cable.
10. Connect CN5 of the DROOP TEST block to the other downstream port of the host controller with a 1m USB cable.
    If the host controller has two or more ports, connect them to the CN7 connector on LOAD TEST[1], the CN8 connector on LOAD TEST[2], and CN9 on LOAD TEST[3].
11. Connect two PB500 passive probes, one to CH1 and the other to CH2 of the digital oscilloscope.
12. Connect the CH1 probe to OSC and GND of pin CN6 on the DROOP TEST block, and the CH2 probe to VBUS_and GND at pin CN14 on the TRIGGER TEST block.
13. The settings for SW1 - SW4 are as follows.
    - Self-powered: 500 mA side
    - battery-powered: 100 mA side

**WARNING**

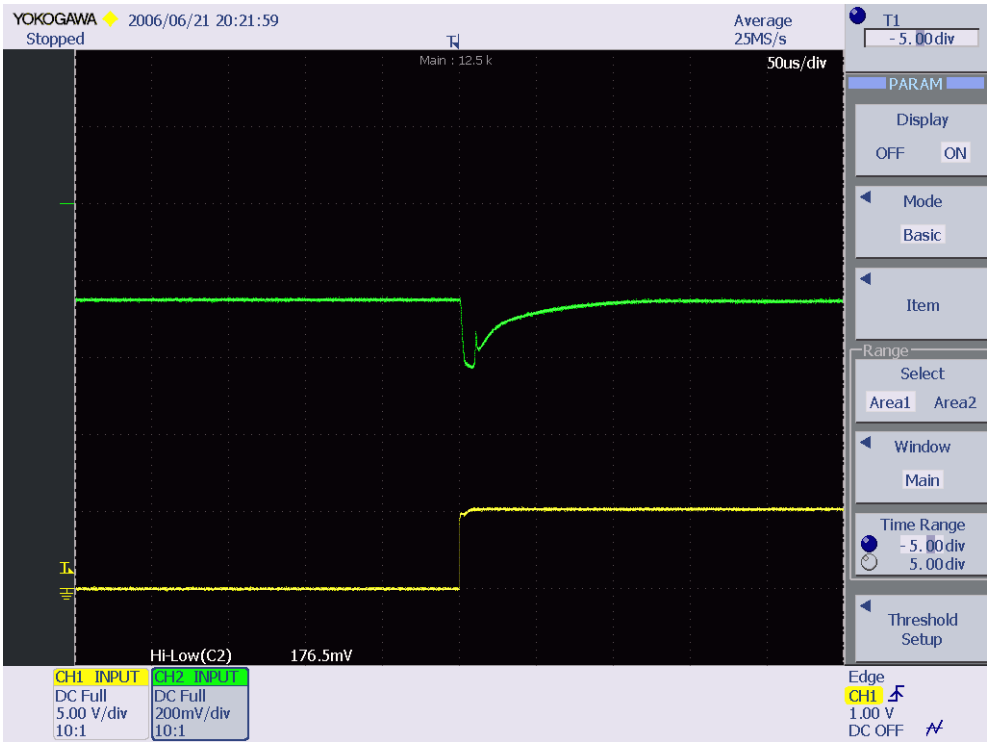
- If you set SW1, SW2, SW3 and SW4 to the 500 mA position, the load resistances inside the top panel cover may become extremely hot. Do not touch them directly. After the test is finished, immediately turn them to the OFF position.
- Since the load resistance of the LOAD TEST part gets hot, after finishing this test, immediately remove the USB cable connected to connectors CN7 to CN10 and disconnect the Vbus supply from the Upstream port, or turn OFF SW1, SW2, SW3 and SW4.

***14.*** Click the **[Next]** button in the dialog box of the busXplorer-USB, and then check the digital oscilloscope screen to confirm that a trigger activates and that the Vbus waveform is displayed.

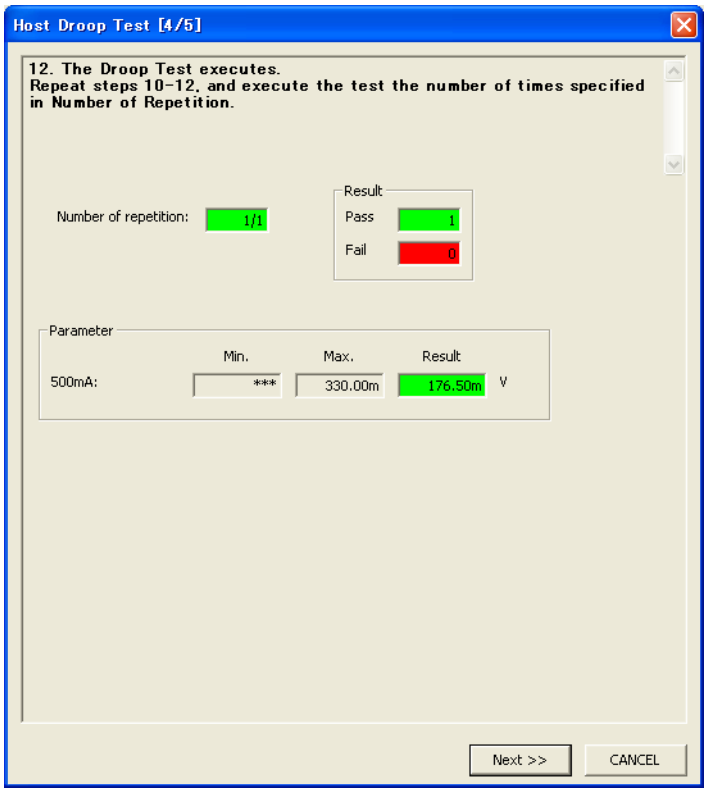
- If the trigger does not activate, adjust the trigger level as needed.
- Click the [Update] button to update the image of waveform in the dialog box.

***15.*** The amplitude of the Vbus Droop voltage is measured. The requirement is 330 mv or less.

When [Next] button is clicked, the measured between packets is judged and Fail message will be displayed if the result is failed.

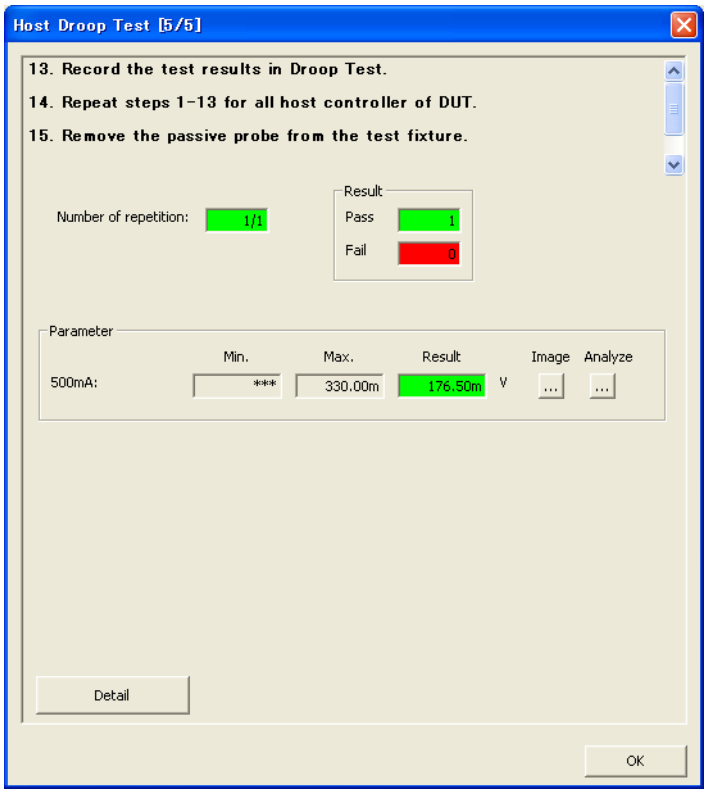


***16.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
The test results dialog box is displayed.



***17.*** Click the **[Next button]** in the dialog box of the busXplorer-USB, repeat steps 14-16, and execute the test the number of times specified in “Number of Repetition.”

- When this number of tests is completed, the test results dialog box as shown below is displayed.
- Click the [Detail] button to display the test results by Internet Explorer.
- Click the [Image] button to display an image of the digital oscilloscope screen.
- Click the [Analyze] button to start Xviewer and display the waveform data. Xviewer must already have been installed.




***18.*** Record the test results in Droop Test.

- Appendix A contains the test result entry form for this test procedure. If necessary, please make copies of Appendix A for use as test record documentation for compliance test submission.
- All files created during tests are saved in the directory specified as the working folder for the busXplorer-USB.

***19.*** Repeat steps 2-18 for all ports of the host controller.

***20.*** Remove the passive probe from the test fixture.

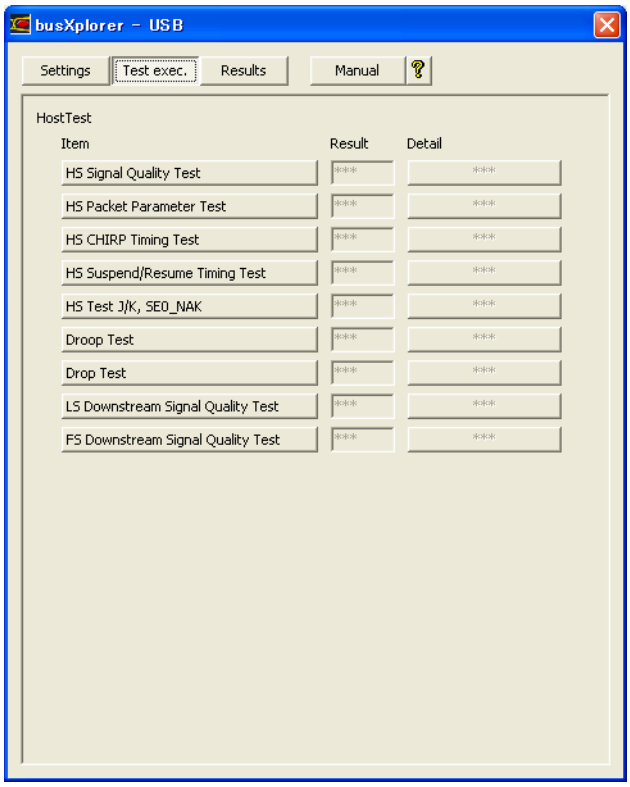
## App. B.2 Drop Test

- **Instruments Used**

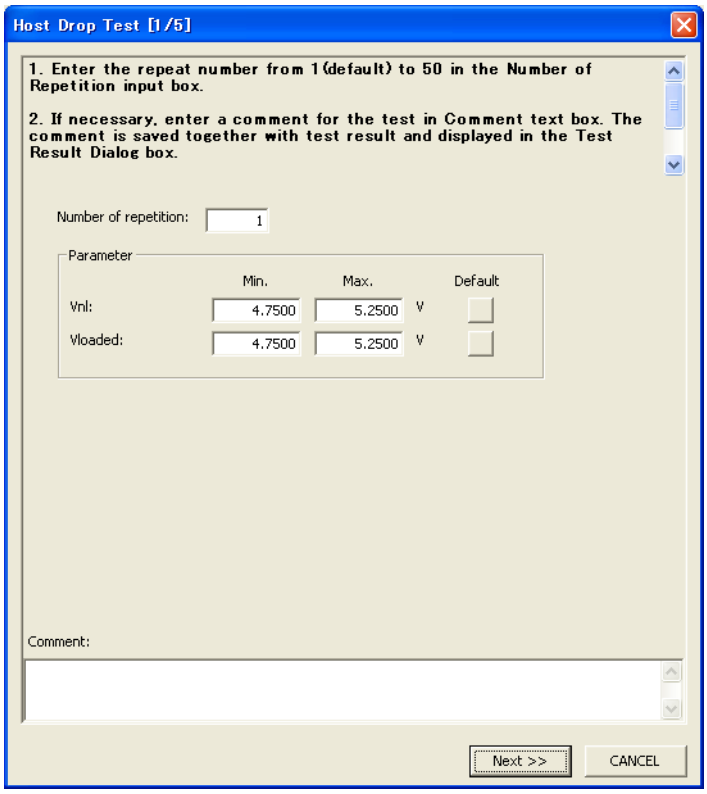
| Name | Quantity |
|---|---|
| Yokogawa Meter & Instrument 3 ½ Digital Multimeter 733/734 | 1 |
| USB-IF compliant 1 m USB 2.0 cable | 5 |
| Test bed computer | 1 |
| USB compliance test fixture | 1 |
| 5 V power supply for test fixture | 1 |

- **Executing the Test**

***1.*** Click the **[Test exec.]** button in the busXplorer-USB to display the Host Test selection dialog box.



2. Click the **[Drop Test]** button in the dialog box.
The Host Drop Test dialog box is displayed.



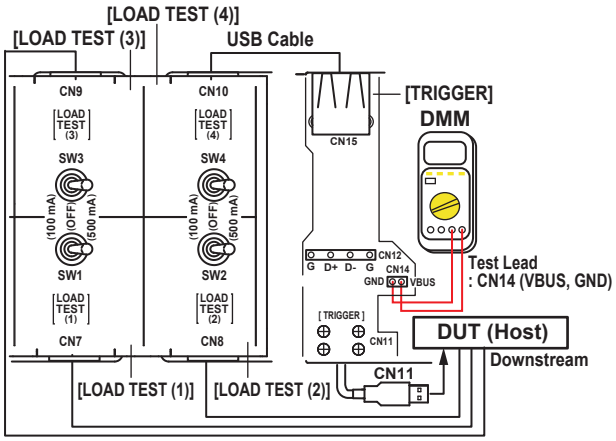

3. Enter the repeat number from 1(default) to 50 in the Number of Repetition input box.

4. If necessary, enter a comment for the test in Comment text box.
The comment is saved together with test result and displayed in the Test Result Dialog box.

5. If you wish to change the judgment range, you can edit the judgment criteria. .
Default values for the judgment criteria are as follows:
   - Vnl
     Min.: 4.75 V, Max.: 5.25 V
   - Vloaded
     Min.: 4.75 V, Max.: 5.25 V

   If you click the [Default] button after changing the judgment range, the default values of the judgment range are restored.

6. Click the **[Next]** button in the dialog box of the busXplorer-USB.
A connection diagram as shown below is displayed.




***Note***

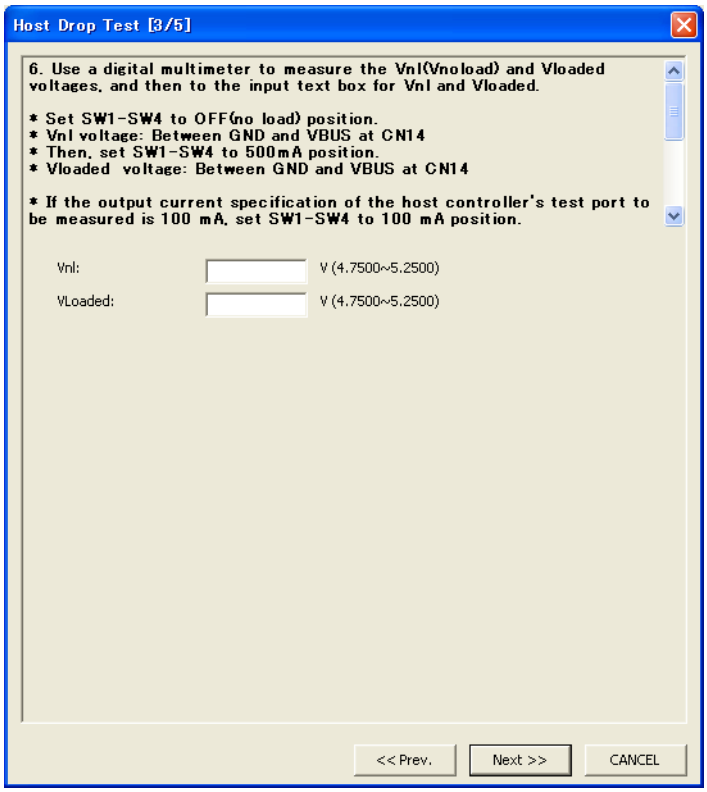
The digital oscilloscope is not necessary to perform this test.

7. Connect the port under test of the host controller to the CN11 connector of the TRIGGER block.
8. Connect the CN15 connector of the TRIGGER TEST block to the CN10 connector of the LOAD TEST[4] block with a 1 m USB cable.
   If the host controller has two or more ports, connect them to the CN7 connector on LOAD TEST[1], the CN8 connector on LOAD TEST[2], and CN9 on LOAD TEST[3].
9. Click the **[Next]** button. Following the instructions in the dialog box that is displayed, use a digital multimeter to measure the Vnl (Vnoload) and Vloaded voltages, and then to the input text box for Vnl and Vloaded.
   - Set SW1 - SW4 to OFF(no load) position.
     Vnl voltage: Between GND and VBUS at CN14
   - Then, set SW1 - SW4 to 500 mA position.
     If the output current specification of the host controller's test port to be measured is 100 mA, set SW1-SW4 to 100 mA position.
     Vloaded voltage: Between GND and VBUS at CN14

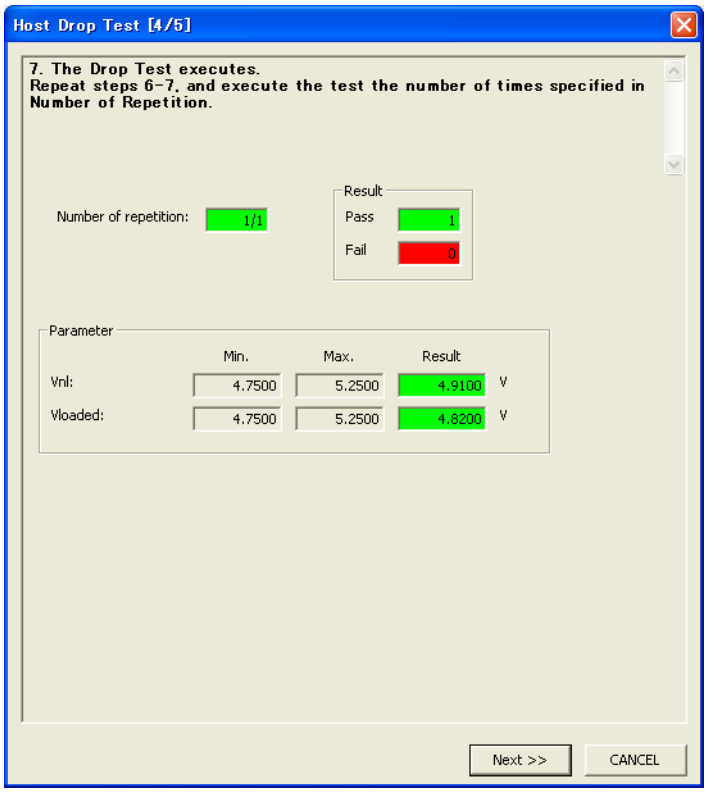
   When [Next] button is clicked, the measured value is judged and Fail message will be displayed if the result is failed.

**WARNING**

- If you set SW1, SW2, SW3 and SW4 to the 500 mA position, the load resistances inside the top panel cover may become extremely hot. Do not touch them directly. After the test is finished, immediately turn them to the OFF position.
- Since the load resistance of the LOAD TEST part gets hot, after finishing this test, immediately remove the USB cable connected to connectors CN7 to CN10 and disconnect the Vbus supply from the Upstream port, or turn OFF SW1, SW2, SW3 and SW4.

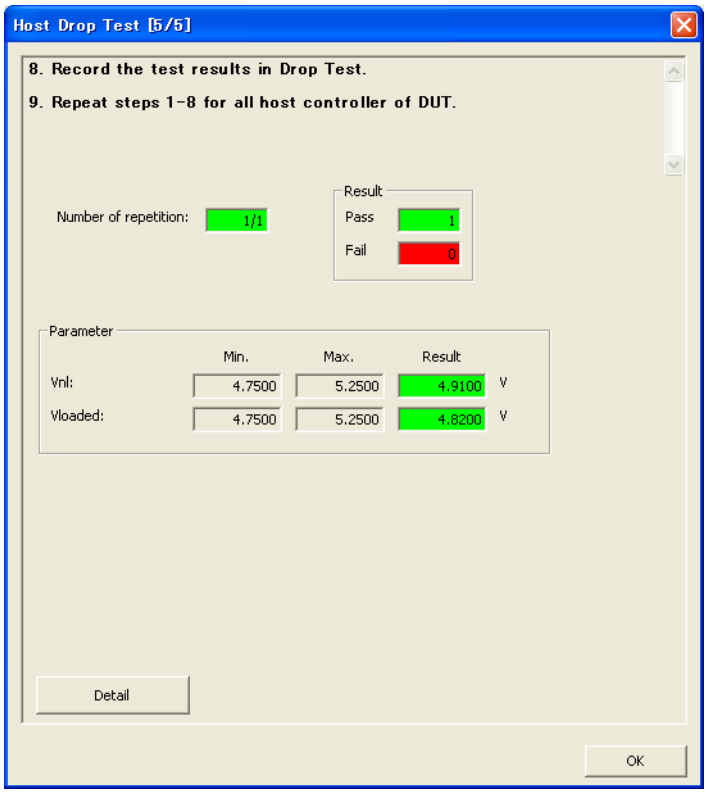



***10.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
The test results dialog box is displayed.



***11.*** Click the **[Next button]** in the dialog box of the busXplorer-USB, repeat steps 9-10, and execute the test the number of times specified in “Number of Repetition.”

- When this number of tests is completed, the test results dialog box as shown below is displayed.
- Click the [Detail] button to display the test results by Internet Explorer.
- Click the [Image] button to display an image of the digital oscilloscope screen.
- Click the [Analyze] button to start Xviewer and display the waveform data. Xviewer must already have been installed.




***12.*** Record the test results in Drop Test.

- Appendix A contains the test result entry form for this test procedure. If necessary, please make copies of Appendix A for use as test record documentation for compliance test submission.
- All files created during tests are saved in the directory specified as the working folder for the busXplorer-USB.

***13.*** Repeat steps 2-12 for all ports of the host controller.

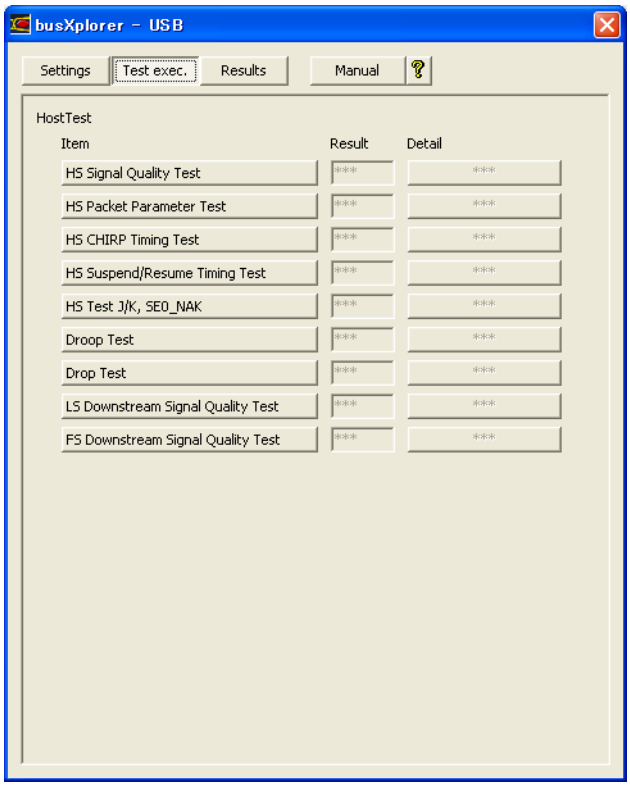
## App. B.3 LS Downstream Signal Quality Test

- **Instruments Used**

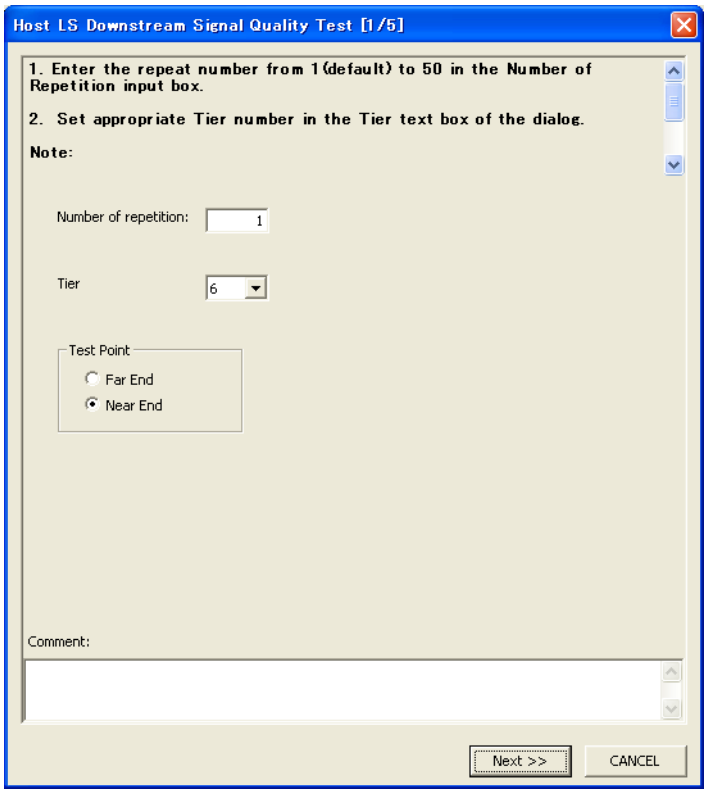
| Name | Quantity |
|---|---|
| DL9240/DL9240L Digital Oscilloscope | 1 |
| PBA2500 Active Probe | 2 |
| PBA2500 Probe Attachment | 2 sets |
| USB-IF Compliant LS Device (Mouse) | 1 |
| Test bed computer | 1 |
| USB compliance test fixture | 1 |
| 5 V power supply for test fixture | 1 |

- **Executing the Test**

***1.*** Click the **[Test exec.]** button in the busXplorer-USB to display the Host Test selection dialog box



2. Click the **[LS Downstream Signal Quality Test]** button in the dialog box.
The Host LS Downstream Signal Quality Test dialog box is displayed.



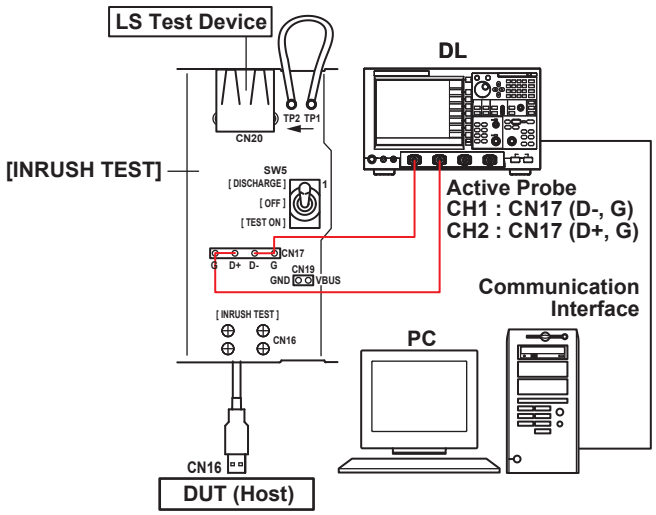

3. Enter the repeat number from 1(default) to 50 in the Number of Repetition input box.
4. Set appropriate Tier number in the Tier text box of the dialog.

***Note***

Normally, leave the Tier setting as 6.

5. If necessary, enter a comment for the test in Comment text box.
The comment is saved together with test result and displayed in the Test Result Dialog box.

6. Click the **[Next]** button in the dialog box of the busXplorer-USB.
A connection diagram as shown below is displayed.



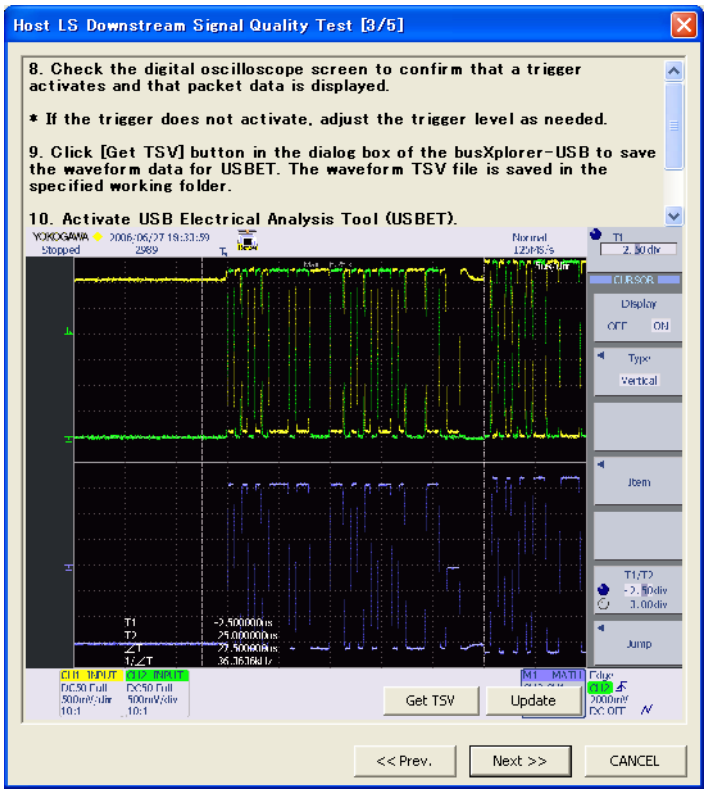

7. Connect the port under test of the host controller to the CN16 connector of INRUSH TEST block.
8. Connect the USB-IF compliant LS device (mouse) to the CN20 connector of INRUSH TEST block.
9. Switch SW5 to the TEST ON position.
10. Connect two PBA2500 active probes to CH1 and CH2 of the digital oscilloscope.
11. Attach the attachments on the tips of the active probes, then connect the CH1 probe to GND and D- of CN17, the CH2 probe to GND and D+ of CN17.

## *Note*

After connecting the probe, heat emitted from the probe causes the offset voltage to drift. The probe should nearly stabilize about thirty minutes after applying power.

**12.** Click the **[Next]** button in the dialog box of the busXplorer-USB, and then check the digital oscilloscope screen to confirm that a trigger activates and that packet data is displayed.

- If the trigger does not activate, adjust the trigger level as needed.
- Click the [Update] button to update the image of waveform in the dialog box of the busXplorer-USB.



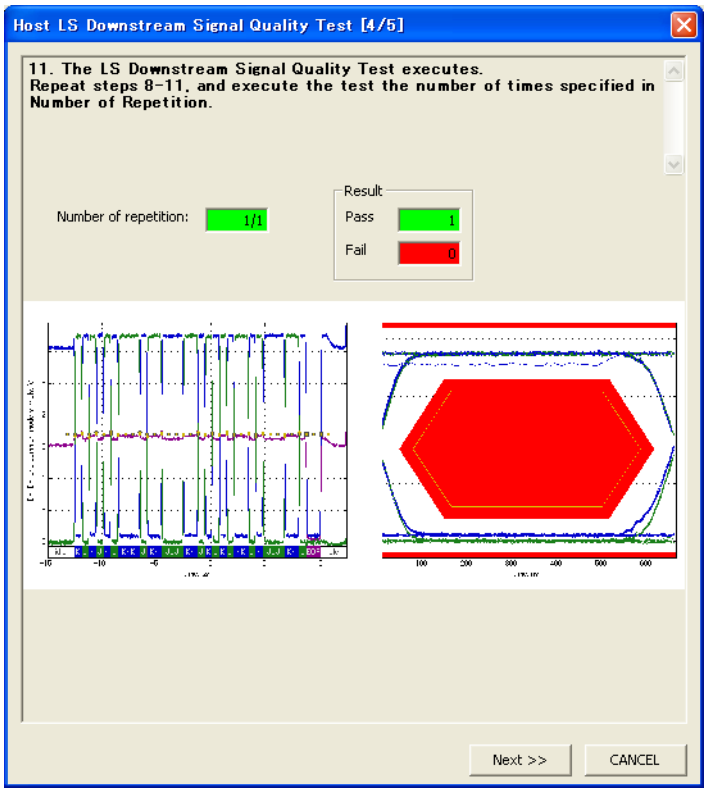

**13.** Click **[Get TSV]** button in the dialog box of the busXplorer-USB to save the waveform data for USBET. The waveform TSV file is saved in the specified working folder.

**14.** Activate 'USB Electrical Analysis Tool (USBET)'.
Select [Signal Quality] tab, click **[Browse]** button of USBET and specify the waveform data file (tsv file). Set an appropriate Test Type (LSNE) then click **[TEST]** to start analysis. Check the test report generated by USBET and verify the result of the test.

## *Note*

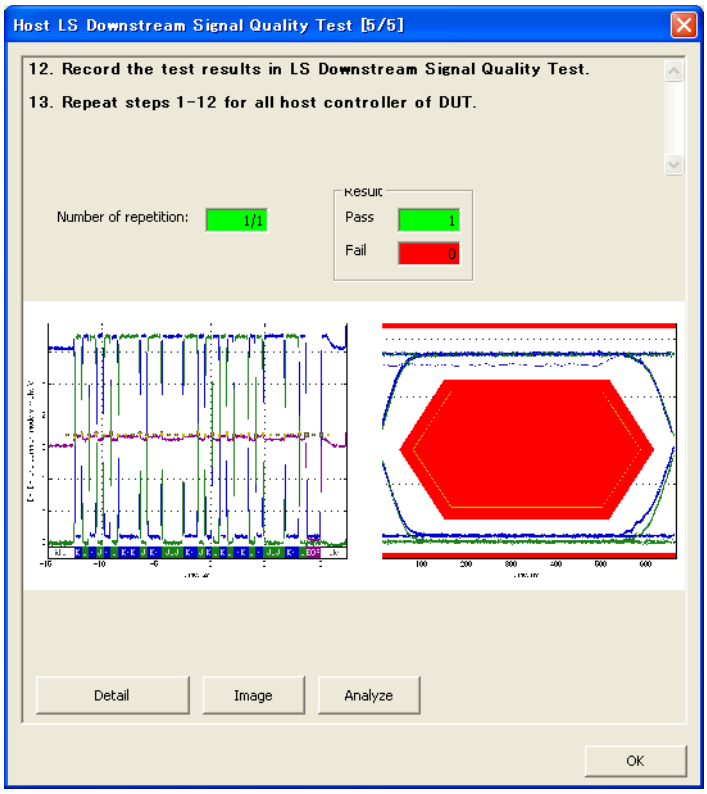
For details about USBET, please refer to Appendix C of this document.

***15.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
The test results dialog box is displayed.



***16.*** Click the **[Next]** button in the dialog box of the busXplorer-USB, repeat steps 12-15, and execute the test the number of times specified in “Number of Repetition.”

- When this number of tests is completed, the test results dialog box as shown below is displayed.
- Click the [Detail] button to display the test results by Internet Explorer.
- Click the [Image] button to display an image of the digital oscilloscope screen.
- Click the [Analyze] button to start Xviewer and display the waveform data. Xviewer must already have been installed.




***17.*** Record the test results in LS Downstream Signal Quality Test.

- Appendix A contains the test result entry form for this test procedure. If necessary, please make copies of Appendix A for use as test record documentation for compliance test submission.
- All files created during tests are saved in the directory specified as the working folder for the busXplorer-USB.

***18.*** Repeat steps 2-17 for all ports of the host controller.

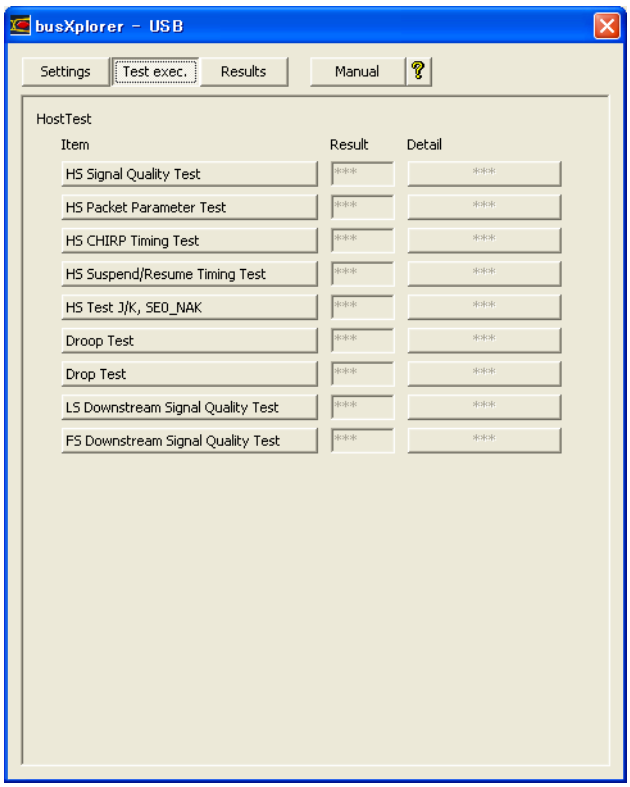
## App. B.4 FS Downstream Signal Quality Test

- **Instruments Used**

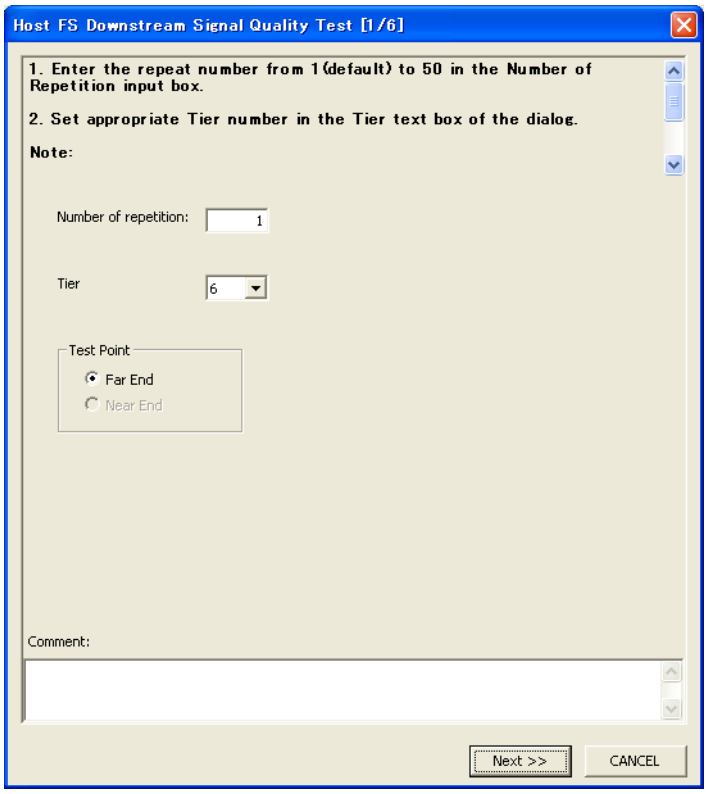
| Name | Quantity |
|---|---|
| DL9240/DL9240L Digital Oscilloscope | 1 |
| PBA2500 Active Probe | 2 |
| PBA2500 Probe Attachment | 2 sets |
| USB-IF Compliant 5m USB2.0 cable | 6 |
| USB-IF Compliant FS Device (Full-Speed PC Camera) | 1 |
| Test bed computer | 1 |
| USB compliance test fixture | 1 |
| 5 V power supply for test fixture | 1 |

- **Executing the Test**

***1.*** Click the **[Test exec.]** button in the busXplorer-USB to display the Host Test selection dialog box.



2. Click the **[FS Downstream Signal Quality Test]** button in the dialog box.
The Host FS Downstream Signal Quality Test dialog box is displayed.



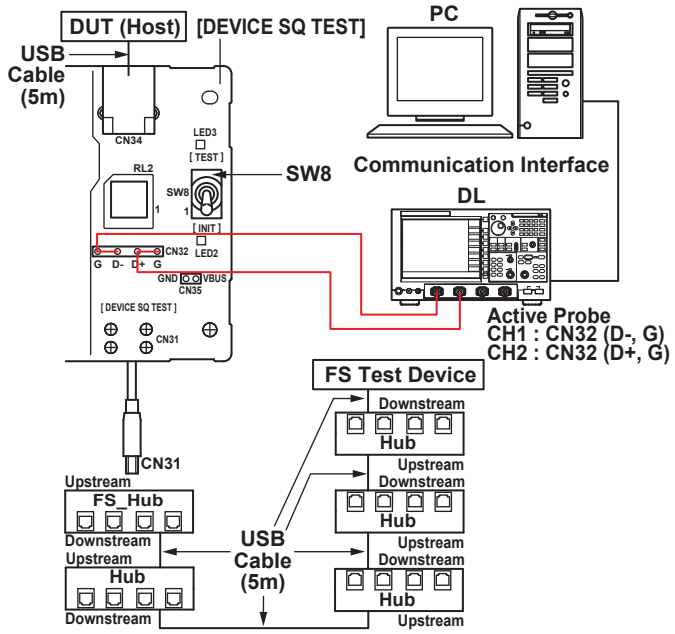

3. Enter the repeat number from 1(default) to 50 in the Number of Repetition input box.
4. Set appropriate Tier number in the Tier text box of the dialog.

***Note***

Normally, leave the Tier setting as 6.

5. If necessary, enter a comment for the test in Comment text box.
The comment is saved together with test result and displayed in the Test Result Dialog box.

6. Click the **[Next]** button in the dialog box of the busXplorer-USB.
   A connection diagram as shown below is displayed.

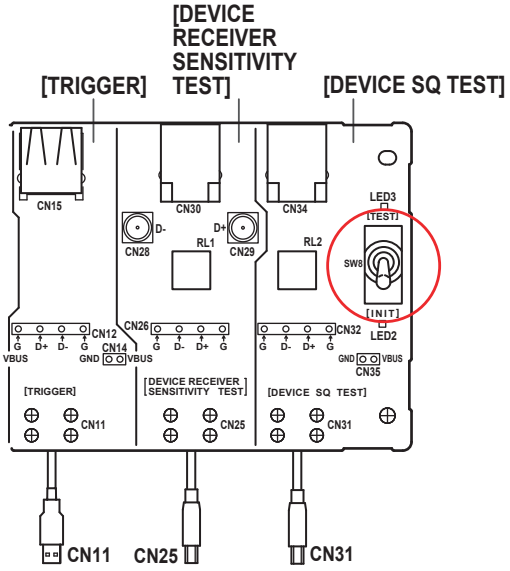



7. Turn ON the power to the test fixture and confirm that the green power supply LED1 is lit.
8. Connect the port under test of the host controller to the CN34 connector of the Device SQ TEST block with a 5 m cable.
9. Link the 5 hubs together in a row using 5 m USB cables and connect one end to the CN31 connector of the Device SQ TEST block.
   If the host controller uses an EHCI port, use a FS-hub for the first hub closest to the host controller, and use HS-hubs for the remaining hubs.
10. Connect the USB-IF compliant FS device to the 5th HUB's downstream port.
11. Connect two PBA2500 active probes to CH1 and CH2 of the digital oscilloscope.
12. Attach the attachments on the tips of the active probes, then connect the CH1 probe to D- and G of CN32, the CH2 probe to D+ and G of CN32.

***Note***

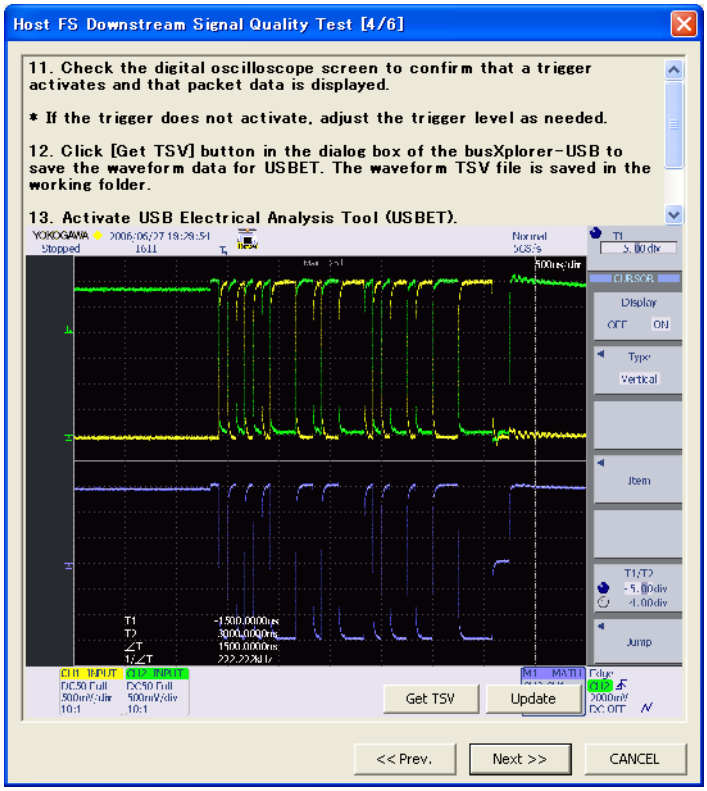
After connecting the probe, heat emitted from the probe causes the offset voltage to drift. The probe should nearly stabilize about thirty minutes after applying power.

***13.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
Following the instructions displayed in the dialog box, place SW8 of the test fixture to the INIT position.
Verify LED2 of the test fixture is lit.




***14.*** Click the **[Next]** button in the dialog box of the busXplorer-USB, and then check the digital oscilloscope screen to confirm that a trigger activates and that packet data is displayed.

- If the trigger does not activate, adjust the trigger level as needed.
- Click the [Update] button to update the image of waveform in the dialog box.



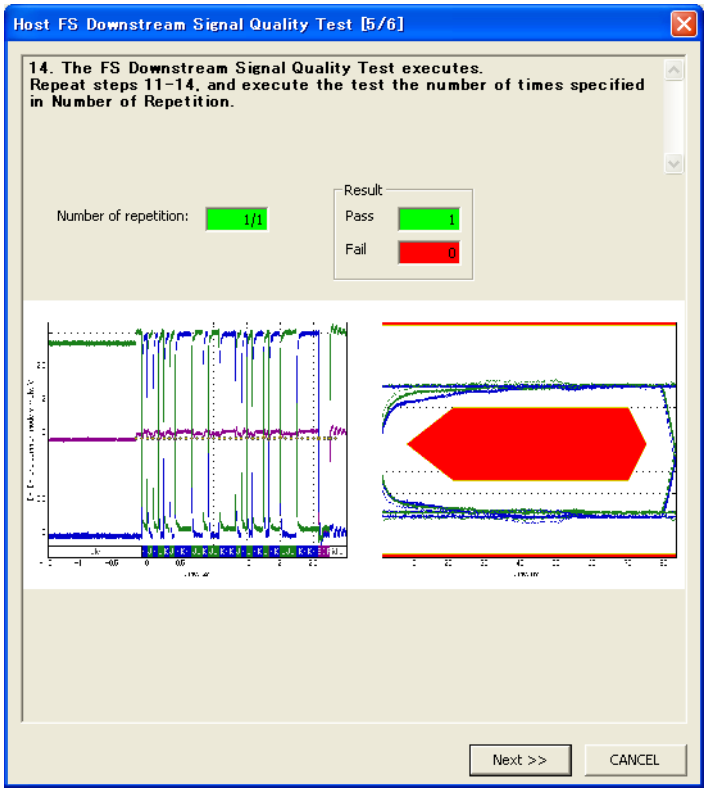
***15.*** Click **[Get TSV]** button in the dialog box of the busXplorer-USB to save the waveform data for USBET. The waveform TSV file is saved in the working folder.

***16.*** Activate 'USB Electrical Analysis Tool (USBET)'.
Select [Signal Quality] tab, click **[Browse]** button of USBET and specify the waveform data file (tsv file). Set an appropriate Test Type (FSFE) then click **[TEST]** to start analysis. Check the test report generated by USBET and verify the result of the test.

## *Note*

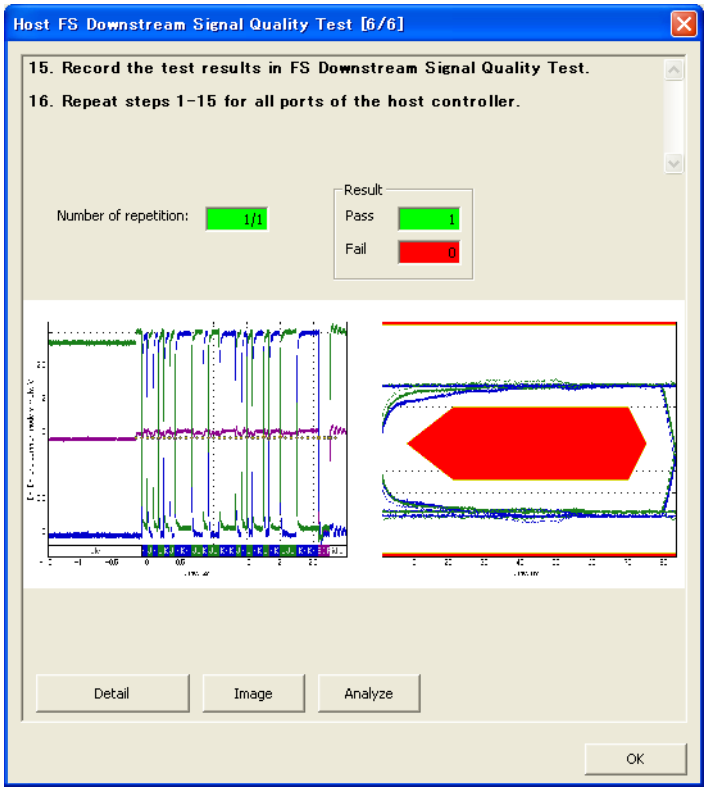
For details about USBET, please refer to Appendix C of this document.

***17.*** Click the **[Next]** button in the dialog box of the busXplorer-USB.
The test results dialog box is displayed.



***18.*** Click the **[Next]** button in the dialog box of the busXplorer-USB, repeat steps 14-17, and execute the test the number of times specified in “Number of Repetition.”

- When the number of tests is completed, the test results dialog box as shown below is displayed.
- Click the [Detail] button to display the test results by Internet Explorer.
- Click the [Image] button to display an image of the digital oscilloscope screen.
- Click the [Analyze] button to start Xviewer and display the waveform data. Xviewer must already have been installed.




***19.*** Record the test results in FS Downstream Signal Quality Test.

- Appendix A contains the test result entry form for this test procedure. If necessary, please make copies of Appendix A for use as test record documentation for compliance test submission.
- All files created during tests are saved in the directory specified as the working folder for the busXplorer-USB.

***20.*** Repeat steps 2-19 for all ports of the host controller.

# Appendix C USB Electrical Analysis Tool (USBET)

## App. C.1 About USBET

In this document, USB Electrical Analysis Tool (USBET) is used to perform Low-Speed/ Full-Speed/Hi-Speed Signal Quality Test and Inrush Current Test.
USBET is official analysis tool of USB-IF and downloadable from the following USB-IF site.
http://www.usb.org/members/compliance
(USBET is available only for Member of USB-IF.)
Please refer to the 'USBET Installation.rtf' of USBET software package to install the software.

## App. C.2 How to start USBET

USBET can be started by either way of the following operations.

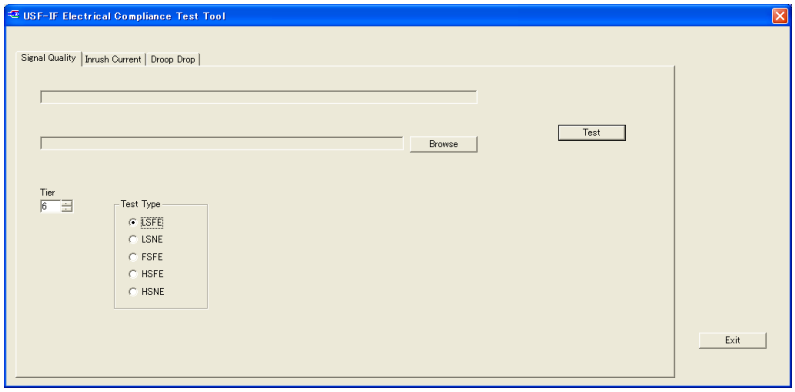
1. Execute (Installed Directory)\USBET.EXE
2. From start menu, click and execute USBET.exe

## App. C.3 Low-Speed/Full-Speed/Hi-Speed Signal Quality Test

1. Click and select ‘Signal Quality’ tab and check the appropriate Test Type.

| Test Type | Description | Tier |
|---|---|---|
| LSFE | Low Speed Signal Quality Test<br>Test Point Far End | (6) |
| LSNE | Low Speed Signal Quality Test<br>Test Point Near End | (6) |
| FSFE | Full Speed Signal Quality Test<br>Test Point Far End | (6) |
| HSFE | High Speed Signal Quality Test<br>Test Point Far End | NA |
| HSNE | High Speed Signal Quality Test<br>Test Point Near End | NA |

2. Setting the Hub Tier number
   Unlike FS electrical tests, the HS electrical tests are not performed behind the maximum number of nestes hubs. So the tier level is not applicable for HS tests. For FS/LS tests, set the appropriate number (normally, 6 is specified).




3. Click **[Browse]** button and select the target tsv file.
4. Click **[Test]** button and execute signal quality analysis.
   After several seconds, test report in html format will be automatically displayed on the screen. Generated report and related files are saved at the same folder where tsv file is located.

## App. C.4 Inrush Current Test

1. Click and select ‘Inrush Current’ tab.
2. Click **[Browse]** button and select the target tsv file
3. Click **[Test]** button and execute inrush current analysis.
   After several seconds, test report in html format will be automatically displayed on the screen. Generated report and related files are saved at the same folder where tsv file is located.