ellisys

Better Analysis.

USB Explorer 280
Examiner Compliance Test Suite

User Manual

Version 1.03

January 18, 2013

ellisys

Copyright, Confidentiality and Disclaimer Statements

This manual is populated throughout with screens captured from a specific version of Ellisys Protocol Analyzer software. All information contained in the screens are samples, and serve as instructional purposes only.

Document Revision History

Date	Revision	Changes
June 20, 2010	0.9	Initial release.
March 09, 2011	0.99	Release Candidate
April 07, 2011	1.0 Draft	Minor corrective edits to 7.22 7.24 7.29
July 6, 2011	1.0 RC	Updated to Link Layer 1.0RC
August 16, 2011	1.0	Updated to latest changes.
October 21, 2011	1.01	Updated to latest Link Layer specification.
September 15, 2012	1.02	Updated to latest Link Layer specification.
January 18, 2013	1.03	Added information on USB30CV.

Reference Publications

Document	Date	Revision
USB 3.0 Link Layer Test Specification	October 26, 2011	1.0
USB 3.0 Specification	November 12, 2008	1.0
USB 3.0 Errata	June 9, 2010	N/A

Ellisys Contact Details

Ellisys	Phone	+41 22 777 77 89
Chemin du Grand-Puits 38	Fax	+41 22 777 77 90
CH-1217 Meyrin Geneva	E-Mail	info@ellisys.com
Switzerland	Web	www.ellisys.com

Conditions of Use and Limited Warranty Terms

These conditions and terms are deemed to be accepted by the customer at the time the product is purchased, leased, lent or used, whether or not acknowledged in writing.

Conditions of Use

The customer is only authorized to use the product for its own activities, whether professional or private. Thus, the customer is, in particular, forbidden to resell, lease or lend the product to any third party. In addition, the customer has, in particular, no right to disassembly, modify, copy, reverse engineer, create derivative works from or otherwise reduce or alter the product. The product may also not be used in any improper way.

Limited Warranty Coverage

Ellisys warrants to the original customer of its products that its products are free from defects in material and workmanship for the warranty period. Subject to the conditions and limitations set forth below, Ellisys will, at its option, either repair or replace any part of its products that prove defective by reason of improper workmanship or materials. Repaired parts or replacement products will be provided by Ellisys on an exchange basis, and will be either new or refurbished to be functionally equivalent to new. If Ellisys is unable to repair or replace the product, it will refund the current value of the product at the time the warranty claim is made. In no event shall Ellisys' liability exceed the original purchase price of product.

Excluded Products and Problems

This limited warranty does not cover any damage to this product that results from improper installation, accident, abuse, misuse, natural disaster, insufficient or excessive electrical supply, abnormal mechanical or environmental conditions, or any unauthorized disassembly, repair, or modification. This limited warranty also does not apply to any product on which the original identification information has been altered, obliterated or removed, has not been handled or packaged correctly, or has been sold as second-hand. This limited warranty only applies to the original customer of the product for so long as the original customer owns the product. This limited warranty is non-transferable.

This limited warranty covers only repair, replacement or refund for defective Ellisys products, as provided above. Ellisys is not liable for, and does not cover under warranty, any loss of data or any costs associated with determining the source of system problems or removing, servicing or installing Ellisys products

Obtaining Warranty Service

To obtain warranty service, you may return a defective product to the authorized Ellisys dealer or distributor from which you purchased the Ellisys product. Please confirm the terms of your dealer's or distributor's return policies prior to returning the product. Typically, you must include product identification information, including model number and serial number with a detailed description of the problem you are experiencing. You must also include proof of the date of original retail purchase as evidence that the product is within the applicable warranty period.

The returned product will become the property of Ellisys. Repaired or replacement product will be shipped at Ellisys' expense. Repaired or replacement product will continue to be covered by this limited warranty for the remainder of the original warranty or 90 days, whichever is longer.

Limitations

THE FOREGOING IS THE COMPLETE WARRANTY FOR ELLISYS PRODUCTS AND SUPERSEDES ALL OTHER WARRANTIES AND REPRESENTATIONS, WHETHER ORAL OR WRITTEN. EXCEPT AS EXPRESSLY SET FORTH ABOVE, NO OTHER WARRANTIES ARE MADE WITH RESPECT TO ELLISYS PRODUCTS AND ELLISYS EXPRESSLY DISCLAIMS ALL WARRANTIES NOT STATED HEREIN, INCLUDING, TO THE EXTENT PERMITTED BY APPLICABLE LAW, ANY WARRANTY THAT MAY EXIST UNDER NATIONAL, STATE, PROVINCIAL OR LOCAL LAW INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ALL WARRANTIES, WHETHER EXPRESS OR IMPLIED, ARE LIMITED TO THE PERIODS OF TIME SET FORTH ABOVE. SOME STATES OR OTHER JURISDICTIONS DO NOT ALLOW THE EXCLUSION OF IMPLIED WARRANTIES OR LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE ABOVE LIMITATIONS MAY NOT APPLY TO YOU.

ELLISYS PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT EQUIPMENT OR FOR APPLICATIONS IN WHICH THE FAILURE OR MALFUNCTION OF THE PRODUCTS WOULD CREATE A SITUATION IN WHICH PERSONAL INJURY OR DEATH IS LIKELY TO OCCUR. ELLISYS SHALL NOT BE LIABLE FOR THE DEATH OF ANY PERSON OR ANY LOSS, INJURY OR DAMAGE TO PERSONS OR PROPERTY BY USE OF PRODUCTS USED IN APPLICATIONS INCLUDING, BUT NOT LIMITED TO, MILITARY OR MILITARY-RELATED EQUIPMENT, TRAFFIC CONTROL EQUIPMENT, DISASTER PREVENTION SYSTEMS AND MEDICAL OR MEDICAL-RELATED EQUIPMENT.

ELLISYS' TOTAL LIABILITY UNDER THIS OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED, IS LIMITED TO REPAIR, REPLACEMENT OR REFUND. REPAIR, REPLACEMENT OR REFUND ARE THE SOLE AND EXCLUSIVE REMEDIES FOR BREACH OF WARRANTY OR ANY OTHER LEGAL THEORY. TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW, ELLISYS SHALL NOT BE LIABLE TO THE CUSTOMER OF AN ELLISYS PRODUCT FOR ANY DAMAGES, EXPENSES, LOST DATA, LOST REVENUES, LOST SAVINGS, LOST PROFITS, OR ANY OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING FROM THE PURCHASE, USE OR INABILITY TO USE THE ELLISYS PRODUCT, EVEN IF ELLISYS HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. SOME STATES OR OTHER JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY TO YOU.

Severability

If any provision or any portion of any provision contained in these terms is held to be invalid, illegal or unenforceable by a court of competent jurisdiction, then the remaining provisions, and if a portion of any provision is unenforceable, then the remaining portion of such provision shall, nevertheless, remain in full force and effect. The parties undertake to negotiate in good faith with a view to replace such invalid, illegal or unenforceable provision or part thereof with another provision not so invalid, illegal or unenforceable with the same or similar effect, and further agree to be bound by the mutually agreed substitute provision.

Warranty Period

The warranty begins on the date of purchase and covers a period of two (2) years.

Governing Law

These conditions and terms shall be governed by and construed in accordance with the law of Switzerland.

Jurisdiction; Venue

The parties consent to the exclusive personal jurisdiction of, and venue in, the District Court of Geneva, Switzerland.

Table of Contents

Table of Figures

About This Manual

Typographic Conventions

Bold is used to indicate menu commands, buttons, and tabs.

Italics are used to indicate fields, pane names, window names and cross references.

`Fixed width` is used to indicate system file names, text typed and code snippets.

A warning symbol- describes a possible critical situation and how to avoid it.

An information symbol- tells you how to respond to a situation that may arise.

A tip symbol- tells you information that will help you carry out a procedure.

Where to Find More Help

Go to the Ellisys website and the following pages for the latest information:

- Ellisys products page - Go to for the latest product information and documentation.
- Application notes and white papers - Go to **www.ellisys.com/technology/** to find up-to-date information about the technology.
- Distributors - Go to **www.ellisys.com/sales/** to find a list of Ellisys distributors.
- Technical support - Go to **www.ellisys.com/support/** to send a question directly to the Ellisys support team.

Terms and Abbreviations

Term / Abbreviation	Definition
CV Test Driver	The driver running on the host controller, provided by USB-IF. This driver has a known behavior in order to run certain tests described in this document.
Link Verification System	The EX280 hardware and application aimed at running the tests on an Upstream or a Downstream Port Under Test. The Link Verification System (Examiner) will act as the opposite port.
LVS	See Link Verification System.
Port Under Test	The port connected to the Link Verification System, upon which the tests are run.
PUT	See Port Under Test.
Upstream Port	A peripheral device (or an upstream-facing hub port). See Figure 3-2 Examiner Setup for Device (or hub upstream port).
Downstream Port	A host controller (or a downstream-facing hub port). See Figure 3-3 Examiner Setup for Host (or hub downstream port).
HUT	Hub Under Test
DFP	Downstream-Facing Port
UFP	Upstream-Facing Port

1. Examiner Overview

1.1 Introduction

The Ellisys Examiner™ Compliance Test Suite is a stand-alone application that is used to verify proper operation of a USB 3.0 host, hub, or device, based on requirements as set forth in the USB 3.0 specification and other relevant documents as provided by the USB Implementers Forum (USB-IF). For more information on documents provided by the USB-IF, please visit www.usb.org.

Figure 1-1 Explorer 280 SuperSpeed USB Protocol Analyzer/Generator

The Examiner application uses an enabled USB Explorer 280 system to emulate a host when testing a device (or hub upstream port), or to emulate a device when testing a host (or hub downstream port). For Chapter 10 testing, two enabled EX280s are used to emulate US and DS ports of the hub under test (HUT). See Section 3, Hardware Setup and Configurations for details.

Optionally, an Explorer 280 analyzer (EX280A) can be placed in-line between the EX280 running Examiner and the port under test (PUT), in order to capture the activity and store traces between Examiner and the PUT for later review.

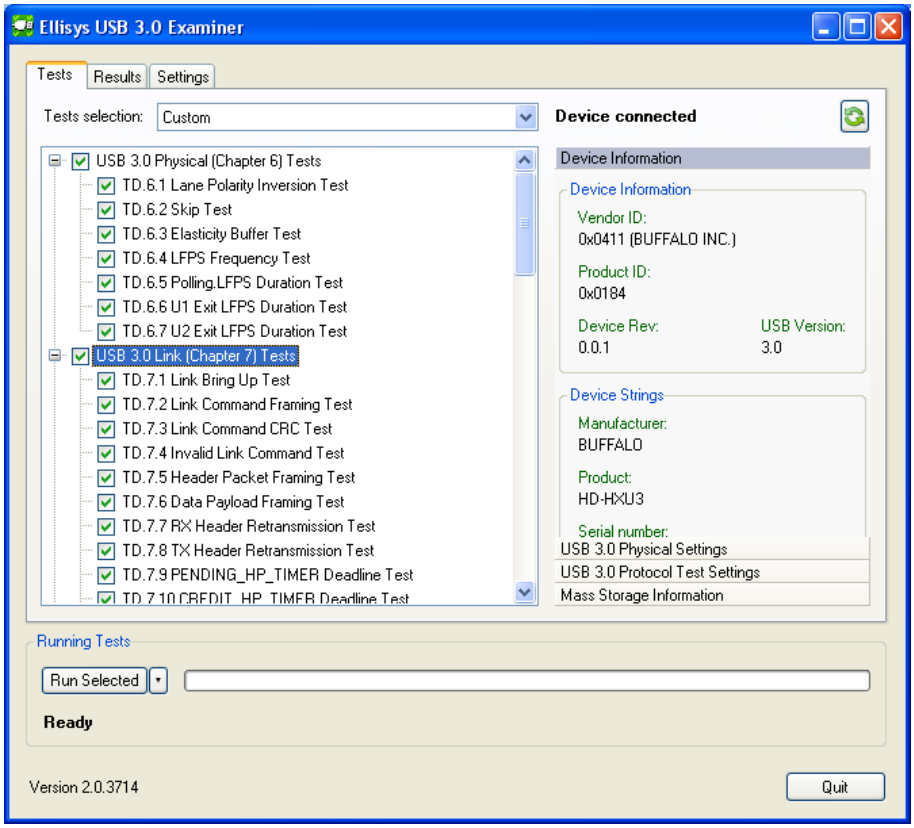
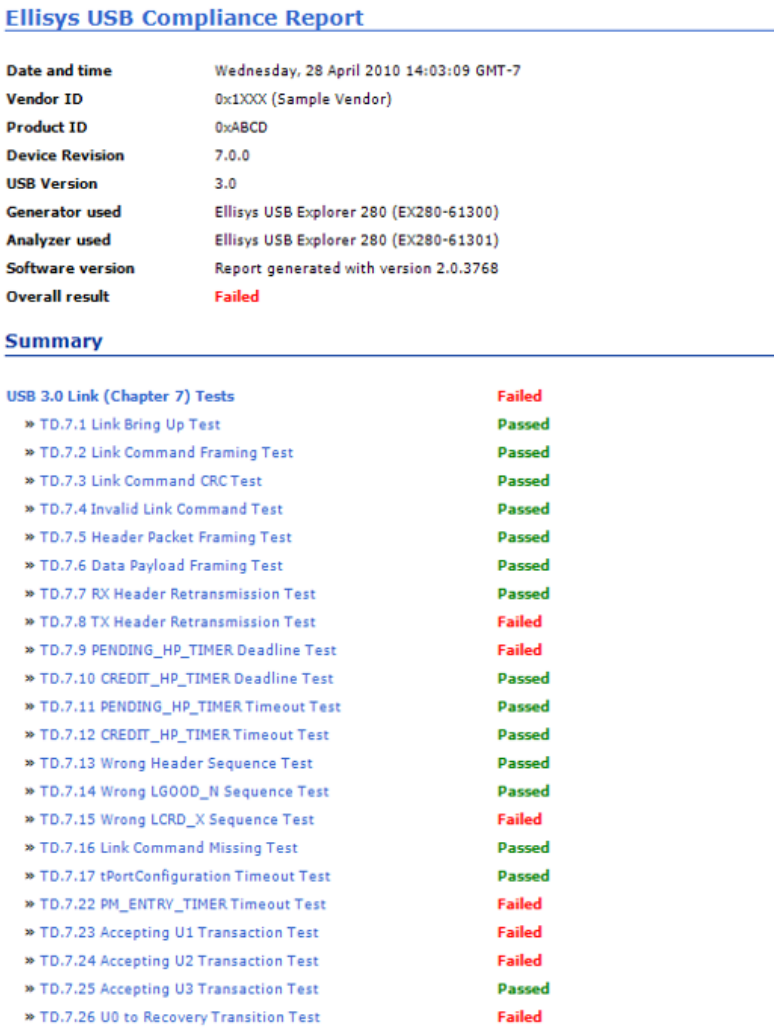


Figure 1-2 Examiner Application

Once initiated by the user, testing progresses automatically, with pass/fail decisions made in hardware by the Explorer 280 system executing the Examiner application. Pass/fail results are provided to the user in real-time during testing and also summarized in an HTML report made available at the completion of testing (see figure 1-3 below), which includes links to automatically saved traces for each test, as captured by the analyzer.



Ellisys USB Compliance Report

Date and time	Wednesday, 28 April 2010 14:03:09 GMT-7
Vendor ID	0x1XXX (Sample Vendor)
Product ID	0xABCD
Device Revision	7.0.0
USB Version	3.0
Generator used	Ellisys USB Explorer 280 (EX280-61300)
Analyzer used	Ellisys USB Explorer 280 (EX280-61301)
Software version	Report generated with version 2.0.3768
Overall result	Failed

Summary

USB 3.0 Link (Chapter 7) Tests	Failed
» TD.7.1 Link Bring Up Test	Passed
» TD.7.2 Link Command Framing Test	Passed
» TD.7.3 Link Command CRC Test	Passed
» TD.7.4 Invalid Link Command Test	Passed
» TD.7.5 Header Packet Framing Test	Passed
» TD.7.6 Data Payload Framing Test	Passed
» TD.7.7 RX Header Retransmission Test	Passed
» TD.7.8 TX Header Retransmission Test	Failed
» TD.7.9 PENDING_HP_TIMER Deadline Test	Failed
» TD.7.10 CREDIT_HP_TIMER Deadline Test	Passed
» TD.7.11 PENDING_HP_TIMER Timeout Test	Passed
» TD.7.12 CREDIT_HP_TIMER Timeout Test	Passed
» TD.7.13 Wrong Header Sequence Test	Passed
» TD.7.14 Wrong LGOOD_N Sequence Test	Passed
» TD.7.15 Wrong LCRD_X Sequence Test	Failed
» TD.7.16 Link Command Missing Test	Passed
» TD.7.17 tPortConfiguration Timeout Test	Passed
» TD.7.22 PM_ENTRY_TIMER Timeout Test	Failed
» TD.7.23 Accepting U1 Transaction Test	Failed
» TD.7.24 Accepting U2 Transaction Test	Failed
» TD.7.25 Accepting U3 Transaction Test	Passed
» TD.7.26 U0 to Recovery Transition Test	Failed

Figure 1-3 Sample HTML Compliance Report

The EX280 unit being used to operate Examiner may be otherwise enabled as an EX280 Generator or EX280 Analyzer (or both, in the case of the EX280 Duo). Examiner is an optional feature and must be specifically enabled on the EX280 hardware. For information on updating an Explorer 280 to include the Examiner functionality, please contact Ellisys.

1.2 Main Features and Areas of Test Coverage

Examiner includes the features and capabilities listed below. Successful completion of Chapter 6/7 tests (commonly referred to as "Link Layer Tests") and Chapter 10 tests for hubs are required for certification by USB-IF. Click here for details from the USB Implementer's Forum (USB-IF). Examiner and the Explorer 280 are approved by USB-IF for these tests.

- Chapter 6/7 Link Layer testing of a DS port (host controller or hub).
- Chapter 6/7 Link Layer testing of an US port (peripheral device or hub).
- Chapter 10 Hub tests (US and DS ports).
- Chapter 9 (Device Framework).
- Electrical tests for Voltage, Power, and Current in U0, U1, U2, and U3 states.
- Mass Storage Class.

Some tests are conducted in three different device states (Default, Addressed, and Configured). Expected results for each state tested may vary.

Default State: The device is attached, powered, but has not been assigned a unique address. Device responds at the default address (0).

Addressed State: Device is attached, powered, and has been assigned a unique (non-zero) address, but has not been configured.

Configured State: Device is attached, powered, has been assigned a unique (non-zero) address, and has been configured by Examiner to use the function provided by the device.

In some cases, Examiner may be referred to as the Link Verification System (LVS). This is intended to maintain consistency with USB-IF compliance documents and procedures. These terms may be considered synonymous within this manual.

2. Installing the Application

2.1 Software Prerequisites

Before installing the Examiner software application, please ensure the computer system on which it will reside meets the requirements listed below. To request the Examiner application, please click here.

- Microsoft Windows XP SP1 or later or Windows 7
- Microsoft Windows Installer 3.0 or later. If the installation does not run smoothly, or if the system indicates a version error, update your Windows installer.
- Microsoft .NET Framework version 2.0 or later.
- Intel Core, 1.5 GHz or compatible processor, or better.
- 512 MB RAM or more.
- 1280 x 1024 screen display resolution with 65,536 colors, or better.
- USB 2.0 EHCI Host Controller.

Examiner requires several software components. Ellisys recommends that you visit the following web pages as needed, to update your versions of Microsoft .NET Framework and Windows:

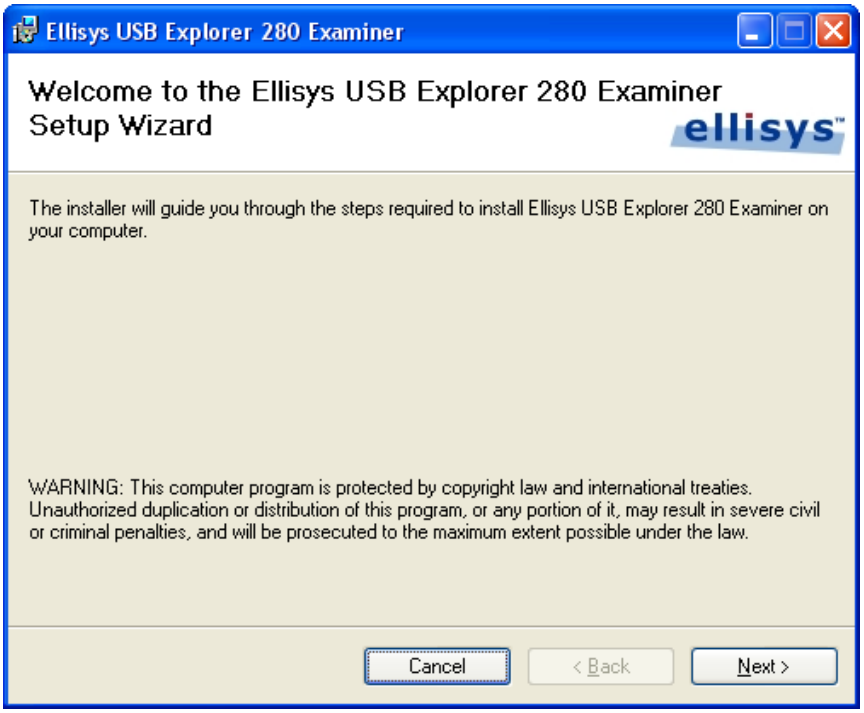
- www.microsoft.com/net to download the Microsoft .NET Framework version 2.0.
- www.update.microsoft.com to update your version of Windows. When using the Windows update service it will automatically download and install the Microsoft .NET Framework version 2.0.

See your system administrator for more information about updating Microsoft .NET Framework and Windows.

2.2 Software Installation

1. Insert the CD-ROM or other storage media that accompanies the product into the computer's CD-ROM (or other) drive, or alternatively, download and launch the installer application from the Ellisys website. Contact Ellisys if you need a link to download the software application.

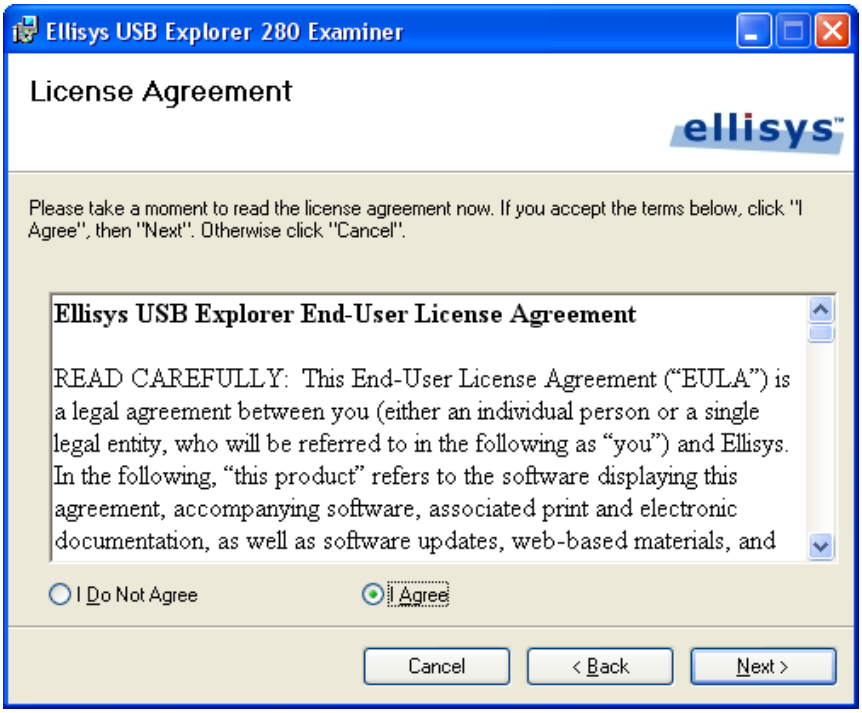
The Examiner *Setup Wizard* screen appears:



If the Examiner Setup Wizard does not appear automatically, navigate to the location of the EllisysUSB30Examiner installer file through the Windows directory and launch the installer directly.

2. Read the WARNING note and click on **Next**.

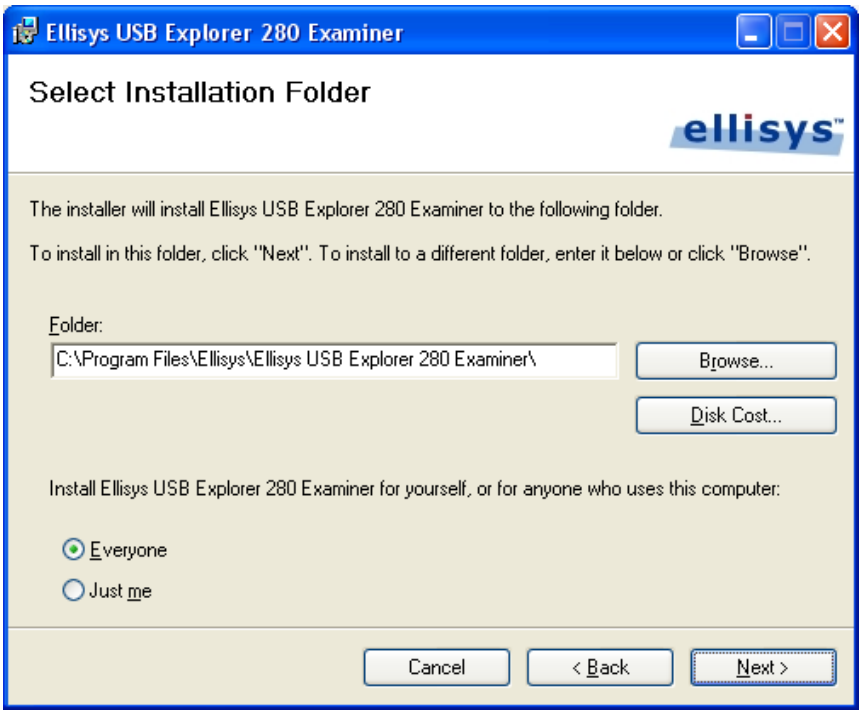
The *License Agreement* screen appears:



3. Read the License Agreement carefully, and then select **I Agree**.

4. Click on **Next**.

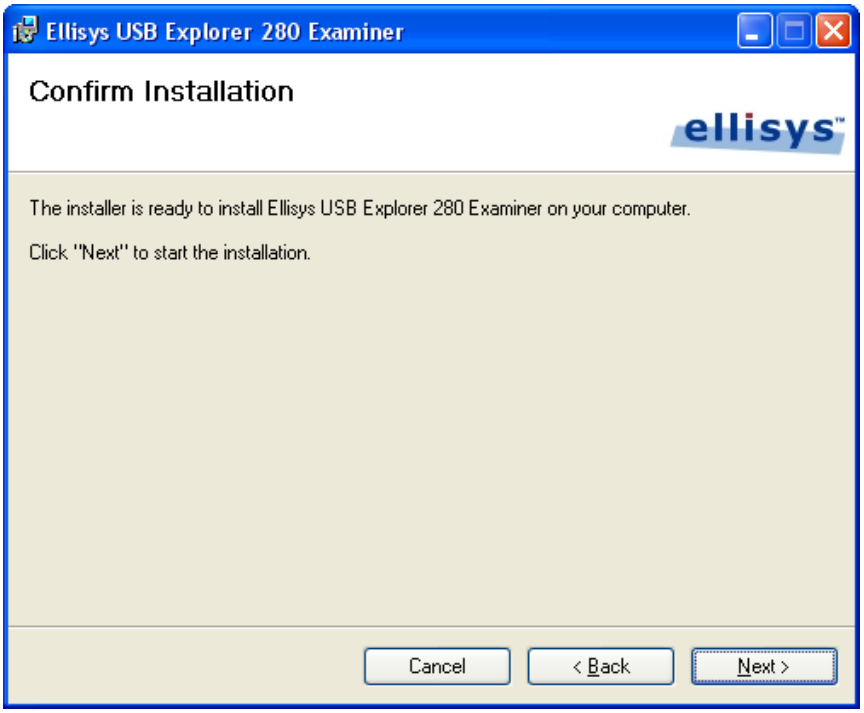
The *Select Installation Folder* screen appears.



5. The default installation folder appears in the *Folder* field. Ellisys recommends that you use the default folder, however if you wish to change this folder, click on **Browse** and navigate to the folder required.

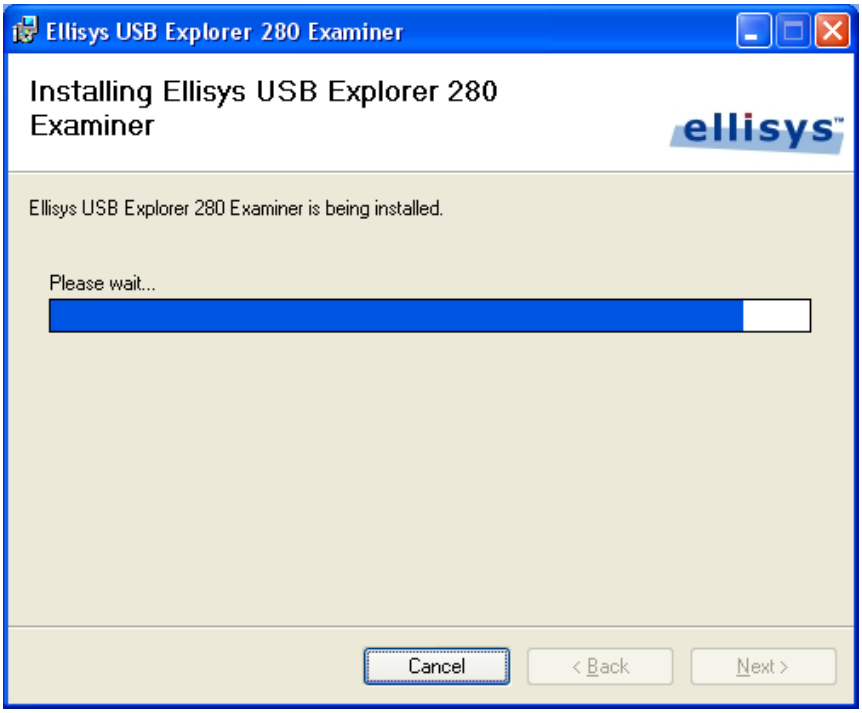
6. Select whether anyone or only the user currently logged on can access the software by selecting either **Everyone** or **Just me**. Click on **Next**.

The *Confirm Installation* screen appears:

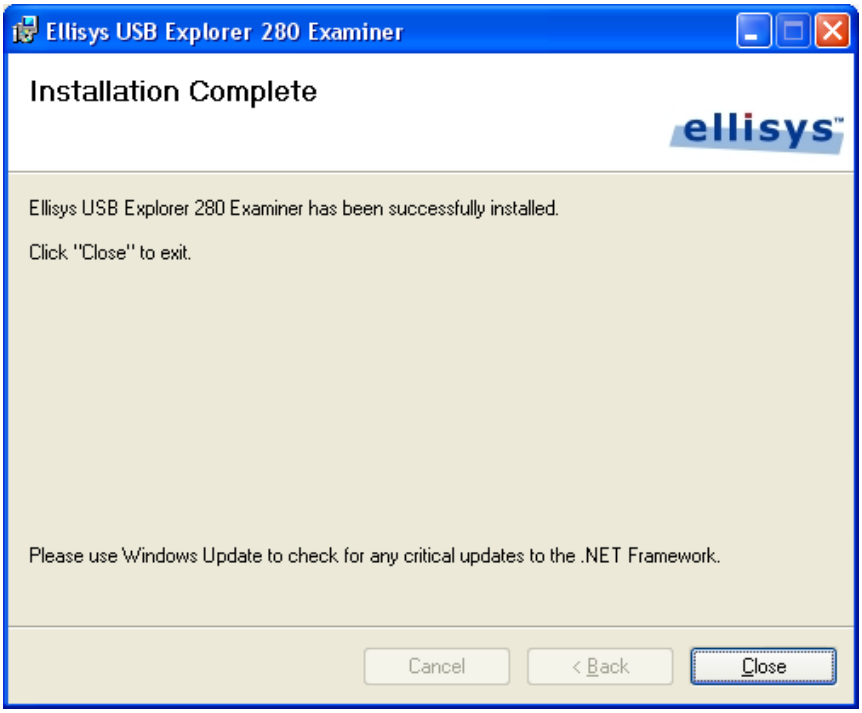


7. Click on **Next** to continue the installation.

An *Installation Progress* screen appears:



When the software has been installed, the *Installation Complete* screen appears:



8. Click on **Close**.

The Ellisys USB Explorer 280 Examiner application is now installed.

After installing Examiner, a New Hardware Wizard will appear the first time the Explorer 280 back-panel USB port is connected to your PC. Refer to section 2.3, Connecting to the Control Computer, for more information about installing the USB driver.

2.3 Connecting to the Control Computer

Examiner, and the USB Explorer 280 Analyzer that may optionally be used in the Examiner setup (see Figure 3-2 and Figure 3-3), are controlled over a high-speed USB 2.0 connection by a PC hosting the Examiner application, enabling the use of any notebook or desktop computer. The USB driver for the Explorer 280 must be installed before Examiner can be used.

Although the unit can upload or download data on a full speed USB 1.1 connection, Ellisys strongly recommends that you connect it to a high speed USB 2.0 port to obtain optimal performance. If you experience problems with Examiner, please ensure the Explorer 280 executing Examiner is connected to a high speed USB 2.0 port before contacting technical support.

Follow the steps below to install the USB driver:

Connect a USB 2.0 cable between the Type B USB receptacle on the Explorer 280 back panel and the PC. If attaching the Explorer 280 for the first time, wait until Windows displays a message indicating that a new device has been found (typically a small bubble indication at the lower-right of the screen), then go to step 3.

To update a previously installed device driver:

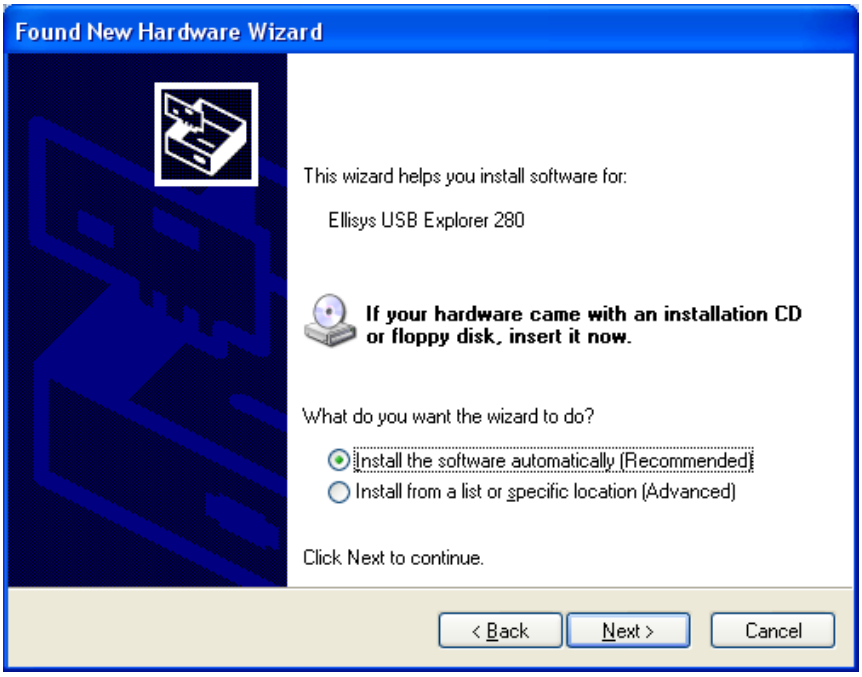
1. Open the Device Manager: Start | Control Panel (on some operating systems, the Device Manager icon is present at this step, if so, proceed to step 4).
2. Double-Click the System icon.
3. Click on the Hardware tab.
4. Click on Device Manager.
5. Click on Ellisys protocol analyzers.
6. Right-click and select Update Driver.

The *Hardware Update Wizard* opens:

7. Select No, not this time.

8. Click on Next.

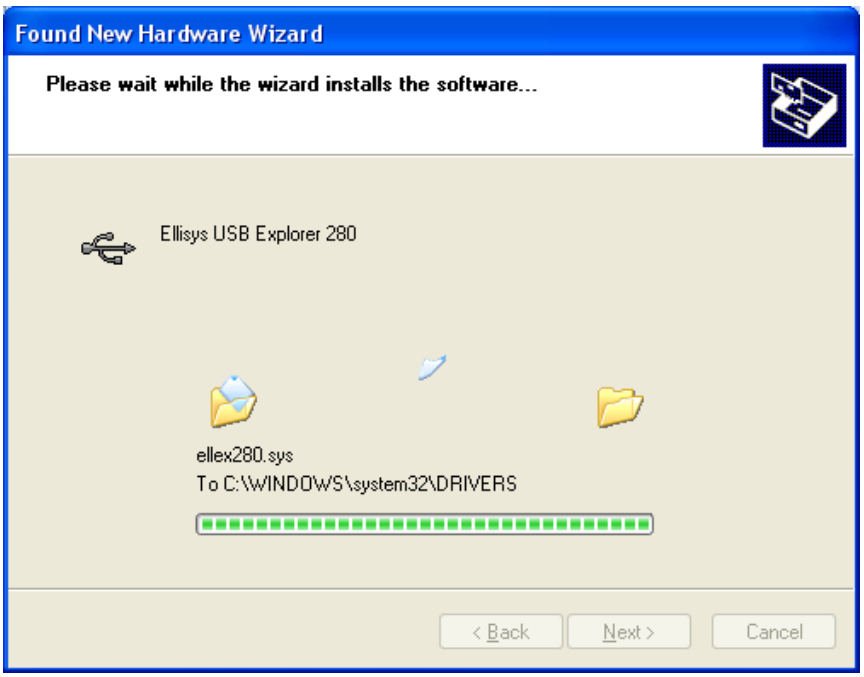
The *Found New Hardware Wizard* appears:



9. Select Install the software automatically (Recommended).

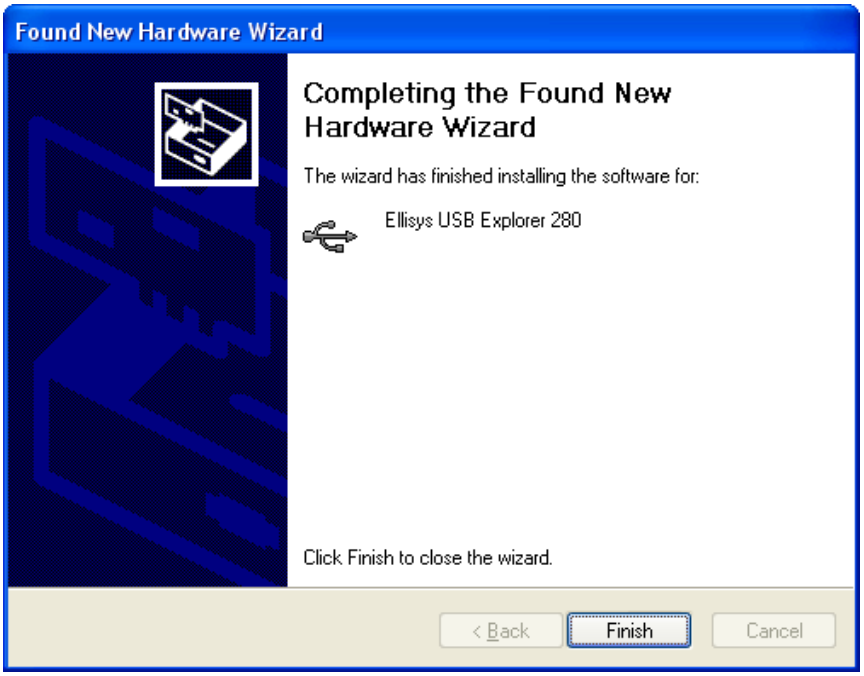
10. Click on Next.

The *Please wait while the wizard installs the software* window appears:



Windows installs the driver.

11. When the installation is complete, the *wizard has finished installing the software* screen appears:



12. Click on **Finish**.

The installation is complete.

3. Hardware Setup and Configurations

Examiner uses the USB Explorer 280 Analyzer/Generator in a traffic generation mode to automatically execute compliance testing against the port under test (PUT). Optionally, an Explorer 280 Analyzer may be used, under automated control of the Examiner application (or manually operated under the EX280 Analyzer application), to capture traffic that occurs during each test that is executed.

This section describes test setups for the following cases:

Section 3.1

Device and Host Link Layer Tests (Chapters 6/7). These are required for USB-IF certification for USB3.0 devices, hubs, and hosts.

Device Framework (Chapter 9), Electrical, and Mass Storage.

Section 3.2

Hub Testing (Chapter 10). This test suite is required for USB-IF certification of USB 3.0 hubs.

Figure 3-1 USB Explorer 280

The Explorer 280 Analyzer and the Explorer 280 Generator are identical in appearance and in hardware design. The functionality of the Explorer 280 (analyzer, generator, or Examiner) is driven by the software application attached to the unit.

3.1 Setup for Link Layer, Device Framework, Electrical, and Mass Storage Testing

To set up Examiner to test a device (or hub upstream port):

Connect as shown in the figure below, connecting a USB 2.0 cable from the Control Computer hosting the Examiner application to the rear control port of the USB Explorer 280 that will execute the Examiner's tests.

Optionally, connect another USB 2.0 cable to the rear control port of an Explorer 280 Analyzer in order to capture the traffic occurring between the PUT and Examiner. Examiner will control the analyzer as well. If not connecting the analyzer, the USB 3.0 cabling may be installed direct from Examiner to the PUT. If the analyzer is used, a second USB 3.0 cable is required between the analyzer and the PUT as shown below.

The DC power supplies for the Examiner unit and the analyzer unit are not shown in the Figure below, but are required.

Figure 3-2 Examiner Setup for Device (or hub upstream port)

To set up Examiner to test a host:

Connect as shown in the figure below, connecting a USB 2.0 cable from the Control Computer hosting the Examiner application to the rear control port of the USB Explorer 280 that will execute the Examiner's tests.

Optionally, connect another USB 2.0 cable to the rear control port of an Explorer 280 Analyzer in order to capture the traffic occurring between the port under test (PUT) and Examiner. Examiner will control the analyzer as well. If not connecting the analyzer, the USB 3.0 cabling may be installed direct from Examiner to the PUT. If the analyzer is used, a second USB 3.0 cable is required between the analyzer and the PUT.

Ensure USB30CV is loaded on the host under test.

The DC power supplies for the Examiner unit and the analyzer unit are not shown in the Figure below, but are required.

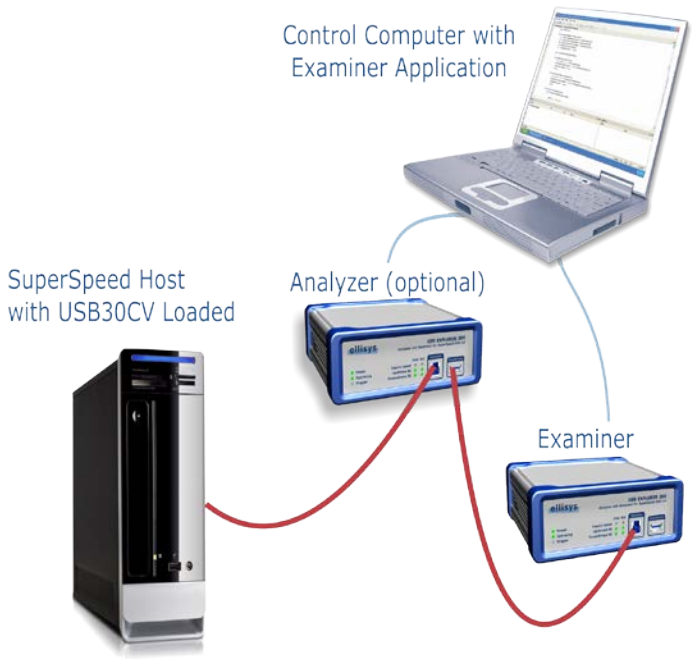


Figure 3-3 Examiner Setup for Testing Host

To set up Examiner to test a hub downstream-facing port:

For testing of a Hub downstream-facing port (DFP), the upstream-facing port of the hub must be connected to a host system that has USB30CV installed. Connect as shown in the figure below.

Ensure USB30CV is loaded on the host system.

The DC power supplies for the Examiner unit and the analyzer unit are not shown in the Figure below, but are required.

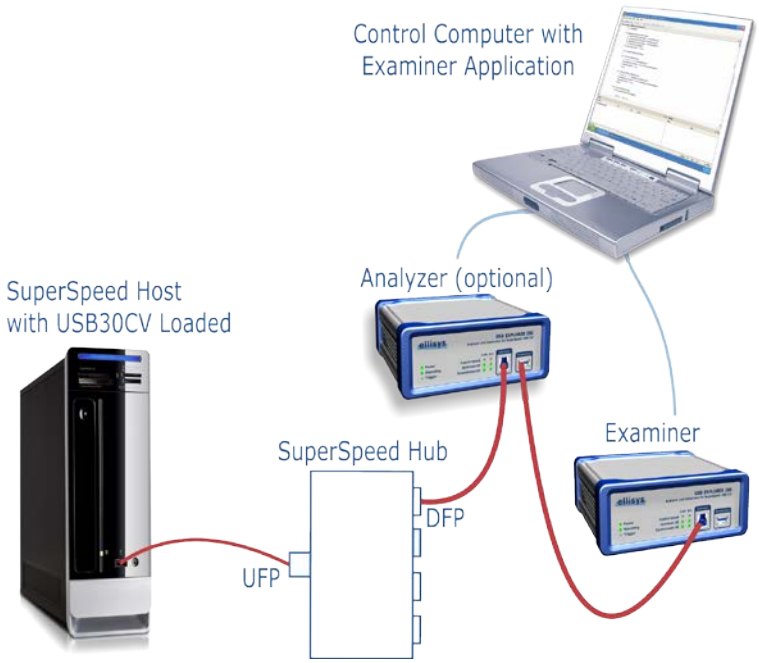


Figure 3-4 Examiner Setup for Testing Hub Downstream-Facing Port

3.2 Setup for Chapter 10 Hub Testing

To set up Examiner to test a hub:

Connect as shown in Figure 3-5 Test Setup for Hub Chapter 10 Tests or Figure 3-6 Test Setup for Hub Chapter 10 Tests (Without Analyzers) below, connecting a USB 2.0 cable from the Control Computer hosting the Examiner application to the rear control ports of both USB Explorer 280's that will execute the Examiner's tests (US and DS).

Optionally, connect USB 2.0 cables to the rear control ports of both Explorer 280 Analyzers, in order to capture the traffic occurring between the US port under test (PUT) and Examiner (US), and between the DS port under test (PUT) and Examiner (DS). Examiner will control the analyzer(s) as well. If not connecting the analyzers, the USB 3.0 cabling may be installed direct from Examiner to the PUT, as shown in Figure 3-5. If the analyzers are used, a second USB 3.0 cable is required between the analyzers and the hub under test (one cable US, one cable DS).

The DC power supplies for the Examiner units and the analyzer units are not shown in the Figure below, but are required.

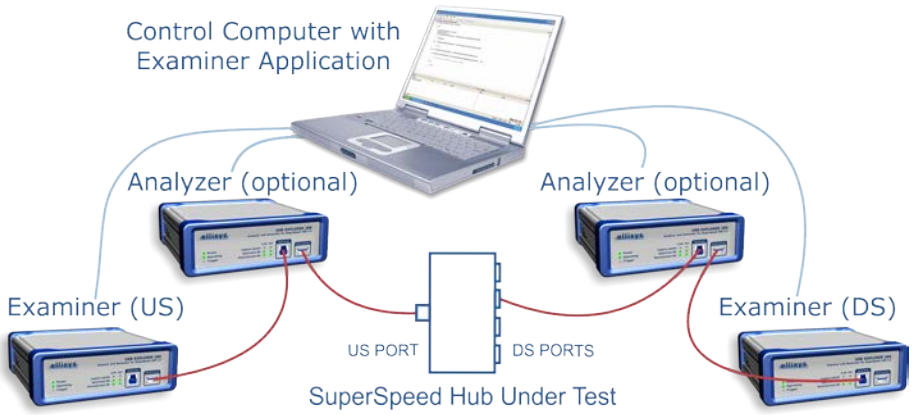


Figure 3-5 Test Setup for Hub Chapter 10 Tests

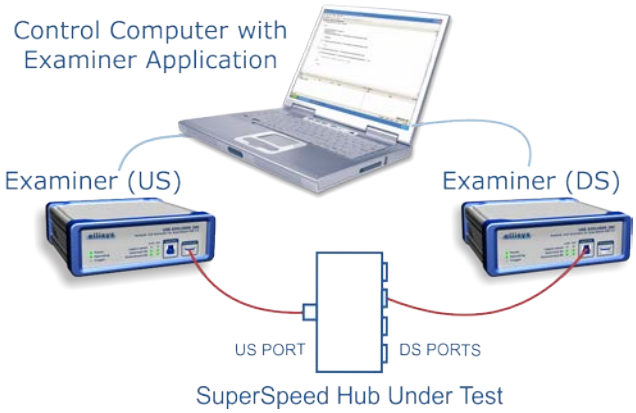


Figure 3-6 Test Setup for Hub Chapter 10 Tests (Without Analyzers)

3.3 Using USB30CV

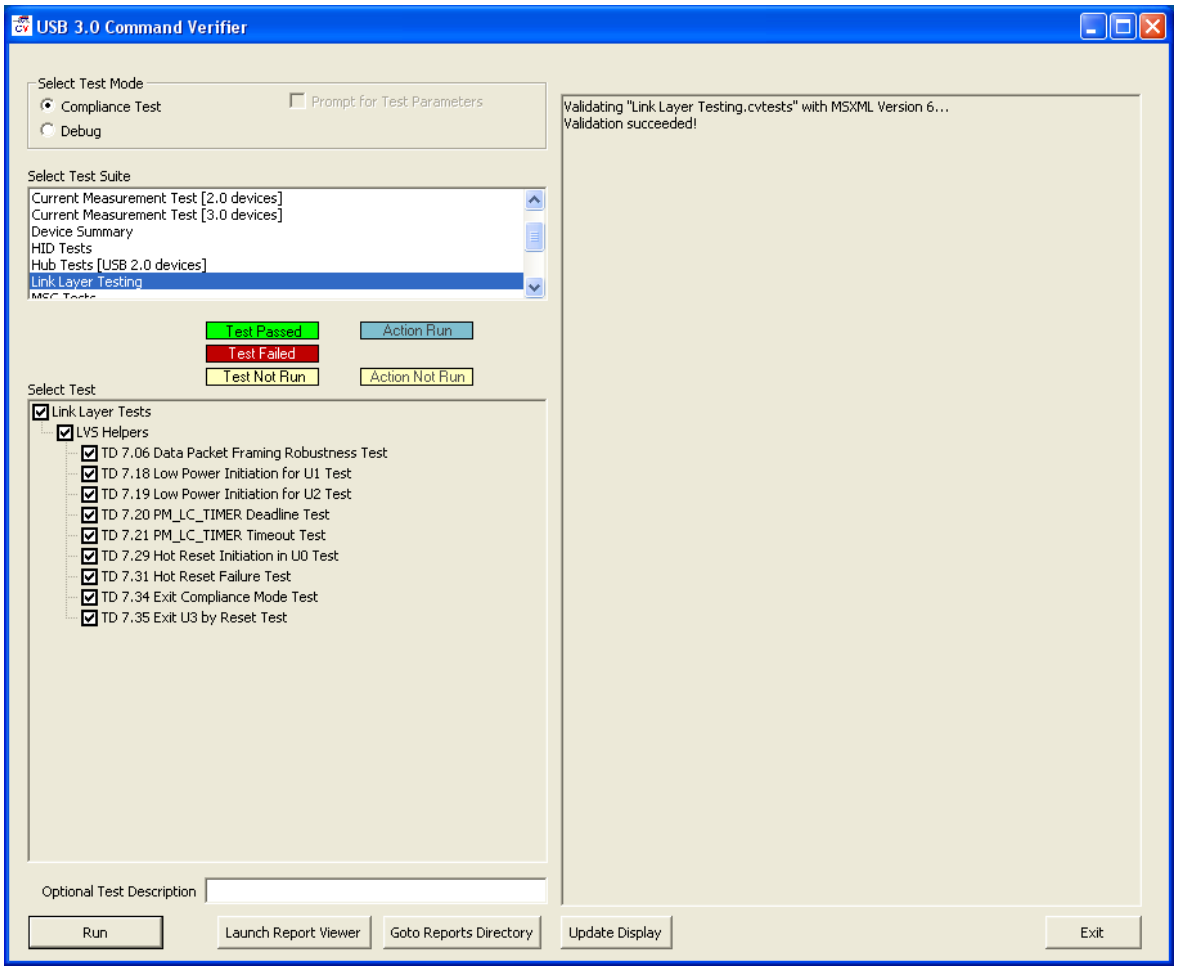
If testing a hub downstream-facing port (DFP), the upstream port of the hub must be connected to a host system with USB30CV installed. USB30CV is an application provided by the USB-IF (www.usb.org) that is used for link layer and hub testing, as well as other compliance test areas outside the scope of this document.

USB30CV will control some of the Link Layer tests in conjunction with Examiner (as shown in the figure below), and will also provide VBUS to the hub, which is required for all Link Layer tests on a hub downstream port.

If testing a host port, please ensure USB3.0CV is loaded on the host under test as USB3.0CV will control some of the Link Layer tests in conjunction with Examiner.

To download USB30CV, follow this link http://www.usb.org/developers/ssusb/ssusbtools

The USB30CV Interface is shown below:



To Initiate USB30CV for support of Link Layer Host and Hub DFP Tests:

1. Setup for Host or Hub DFP tests as described in the figures above.

2. Launch USB30CV on the host system under test, or the host system attached to the upstream-facing port of the hub under test, as applicable.

3. In USB30CV, select **Link Layer Testing** from the **Select Test Suite** box.

4. Click **Run** on the USB30CV application.

The USB30CV advances to the first test to be supported (TD 7.06) and presents a message such as shown below:

At this point, the user will execute the selected Examiner tests (in the Examiner application) until Examiner displays a dialog instructing the user to initiate an action on CV, such as issuing a Get Descriptor request as shown above.

For any further Examiner tests that require USB30CV initiation of host-side actions (such as sending the Get Descriptor request above), Examiner will provide a dialog instructing the user to initiate this action on USB30CV.

To run USB30CV in Debug Mode:

Debug mode on the USB30CV application allows the user to specify which tests are to be run.

1. Select **Debug** from the **Select Test Mode** option on the USB30CV application.

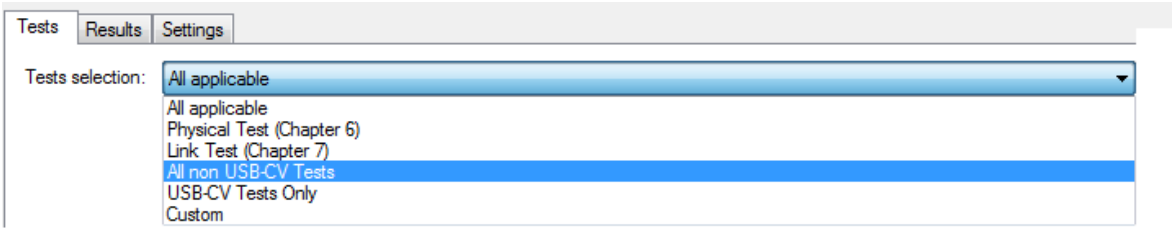
2. Select one (or more) or check boxes associated with the tests desired to be executed in the **Select Test Box** on USB30CV application.

3. Click **Run** on the USB30CV application.

4. Run the selected tests from the Examiner Application.

To Exclude USB30CV tests from Examiner (run all tests except those using USB30CV):

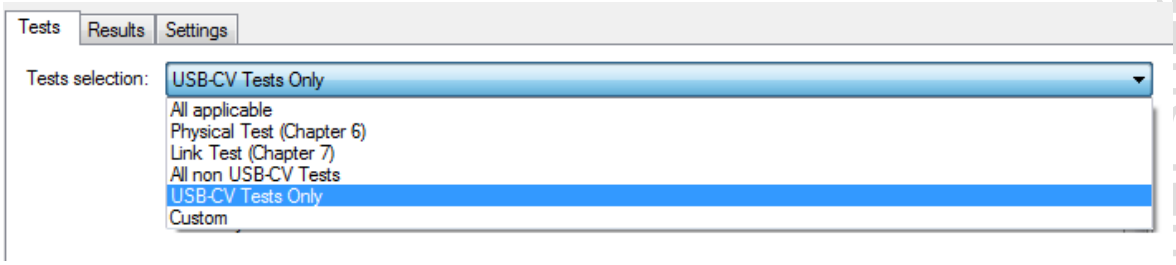
1. Select All Non USB-CV Tests from the Tests Selection drop-down on Examiner.



All tests requiring CV are excluded from the Examiner's test list. USB30CV is not needed for this test selection.

To Run only USB30CV tests:

1. Select USB-CV Tests Only from the Tests Selection drop-down menu on Examiner.



All tests requiring USB30CV are populated in Examiner's Test List. Tests not requiring the use of USB30CV are not available.

3.4 USB Explorer 280 Front Panel Overview

The front panel of the USB Explorer 280 is shown below:

Figure 3-7 USB Explorer 280 Front Panel

Upstream Connector

The Upstream Connector is used in by Examiner when testing a host or hub downstream port.

Downstream Connector

The Downstream Connector is used by Examiner when testing a device or hub upstream port.

Power LED

The Power LED indicates if the unit is correctly powered from the supplied 24VDC/2A power adapter and connected to the control computer.

Constant green: Powered and connected, ready to operate.

Flashing green: Powered but not connected.

Flashing red: Connected but not powered.

Off: Not powered and not connected. The Power LED may also be off if when the unit is in power-saving mode after the control computer has been turned off.

Operating LED

The Operating LED indicates if the unit is actively in use by the Examiner application.

Off: Unit is not in use and available.

Constant green: Unit is in use.

Trigger LED

The Trigger LED indicates whether a trigger event has occurred.

Green flash: Trigger event detected.

Off: No trigger event detected.

Trigger events executed by Examiner are controlled by Examiner's automated programming schema and are not definable by the user.

Link LED

The Link LED indicates the status of the Examiner's upstream and downstream ports. During Examiner testing, only one of Examiner's front-panel ports is used: for testing a host, only the Downstream port is used; for testing a device, only the Upstream port is used.

Off: No receiver detected.

Constant orange: Receiver detected, no 5Gb/s SuperSpeed signaling detected.

Constant green: 5Gb/s SuperSpeed signaling detected, receiver synchronized.

Flashing red: Link is unstable, frequent loss of synchronization.

Receive LED

The Receive LED indicates if payload (Data Packets) or errors (CRC, invalid symbols) are received on a given port.

Off: No payload or errors detected.

Flashing green: Payload detected.

Flashing red: Errors detected.

Transmit LED

The Transmit LED indicates if payload (Data Packets) is transmitted on a given port.

Off: No data sent.

Flashing green: Data Packet sent.

3.5 Explorer 280 Back Panel Overview

The back panel of the USB Explorer 280 is shown below:

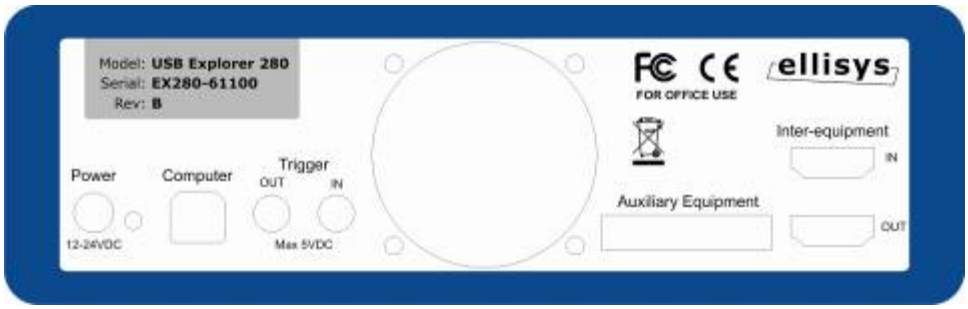


Figure 3-8 USB Explorer 280 Back Panel

Caution - When connecting the USB cable DO NOT force the connector into the unit. The metal part of the connector should not be inserted completely into the connection port. Forcing the connector or inserting all of the metal part of the connector will break the port connection and is not covered by the warranty.

Power

DC jack power input. The nearby LED illuminates constant green if a correct voltage is applied, and illuminates constant red if the voltage is applied reversed.

- Accepted Voltage Range: 12V to 24V DC
- Minimum Power: 18W

Caution - Use only the DC power supply supplied with Examiner. Failure to use the supplied DC adapter may result in damage to the unit.

Computer

Type B USB 2.0 connector. Control port. Attaches to control computer.

Trigger OUT

SMA connector used for sending TTL voltage level shift or pulse to external equipment. Not used by Examiner.

Trigger IN

SMA connector used for accepting TTL voltage level shift or pulse from external equipment. Not used by Examiner.

Auxiliary Equipment

Reserved for future extensions.

Inter-equipment

Reserved for future extensions.

4. User Interface Reference

The Examiner user interface consists of three tabs (*Tests*, *Results*, and *Settings*) for test selection, test results, and environmental settings. Each tab displays specific information and/or allows the user to interact with the software for a given task.

4.1 Tests Tab

On the left, shows tests available and selected. Controls for selecting and executing tests are available. On the right, displays information specific to the connected device under test, and certain test settings.

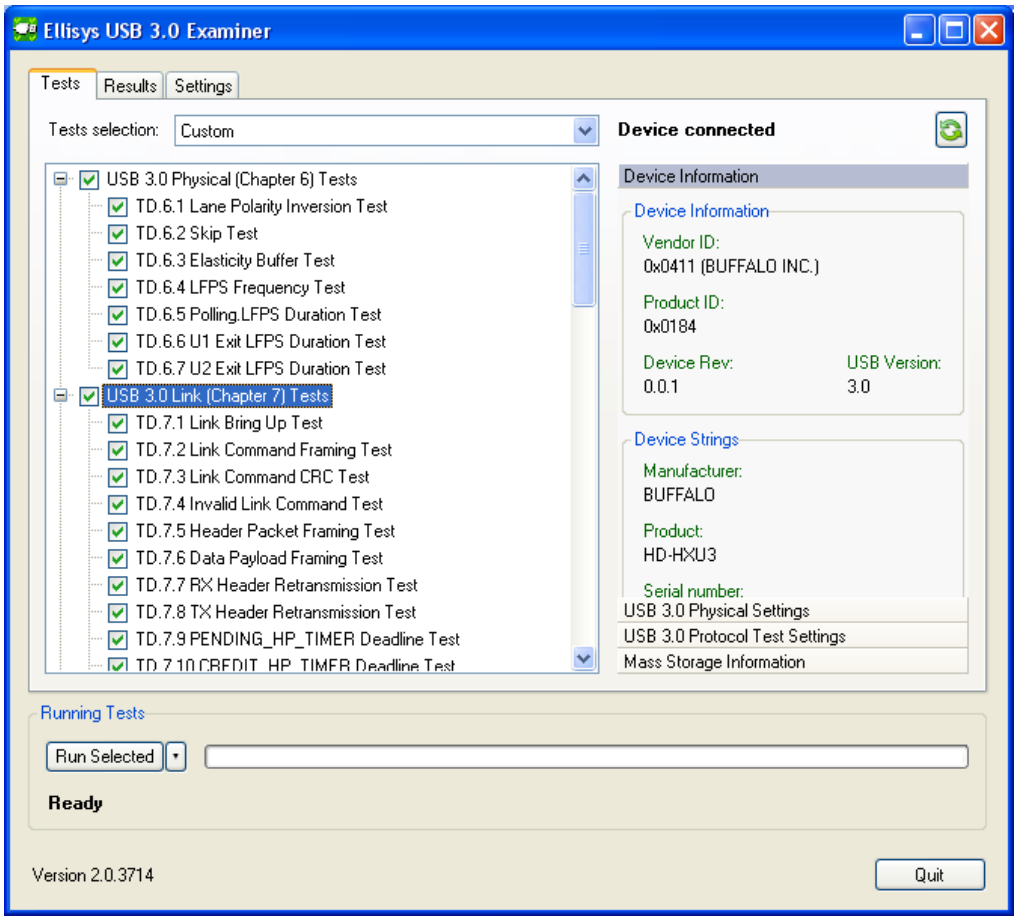


Figure 4-1 Examiner Application - Tests Tab

4.2 Results Tab

Shows a running tally of all tests conducted, including pass/fail indications, a count of tests run, failed, and not completed, supplementary results information, and access to the HTML summary report. Access to the HTML summary report becomes available once all selected tests are finished.

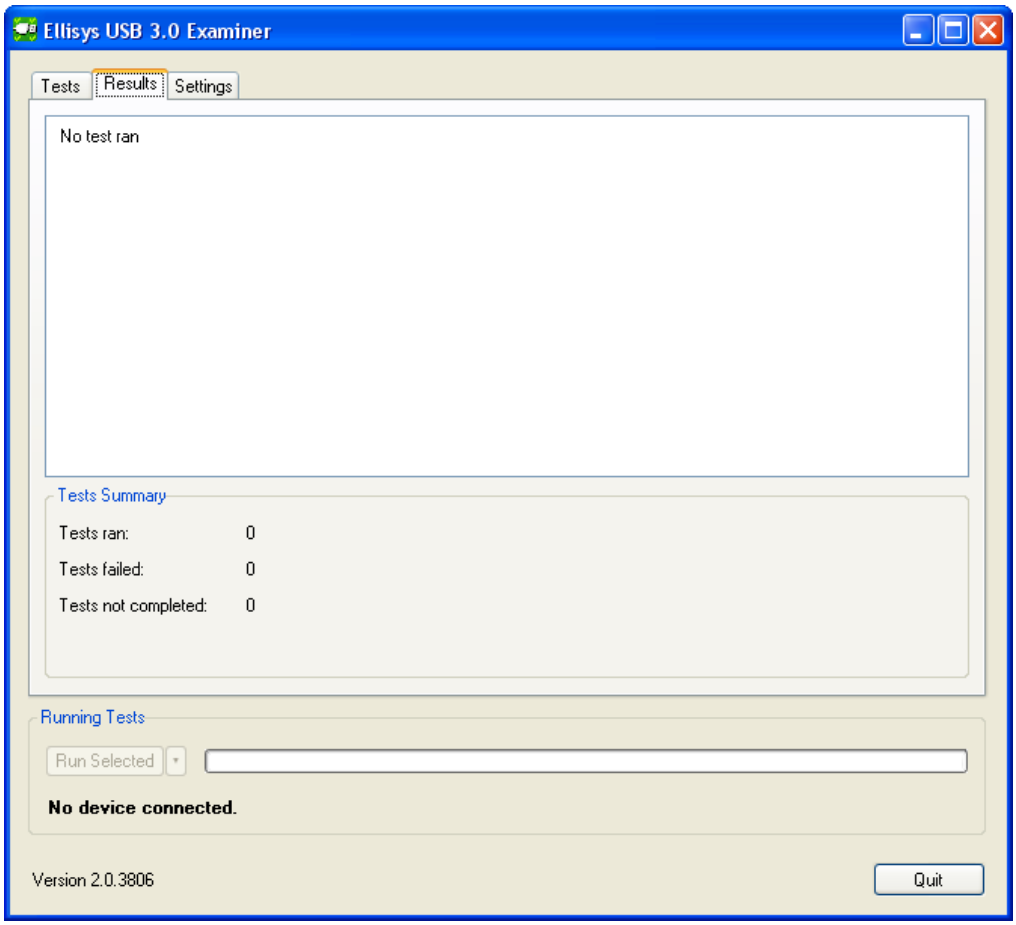


Figure 4-2 Examiner Application - Results Tab

4.3 Settings Tab

Allows for selection of specific EX280 units for Examiner and (optionally) an EX280 Analyzer. An **Identify** button causes the Power LED on the selected EX280 unit to flash when it is selected. Also provides for user input of a path to write/save the HTML Summary Report and individual traces associated with each test executed.

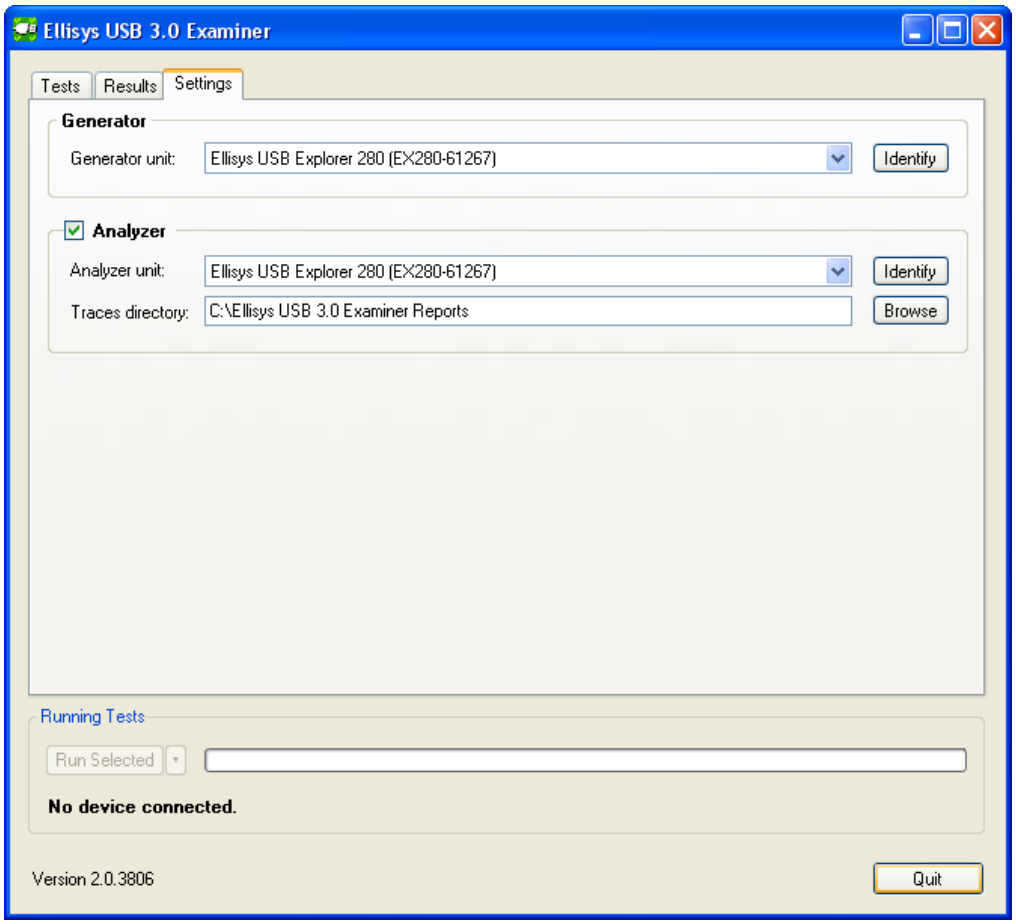


Figure 4-3 Examiner Application - Settings Tab

In some cases, the user may prefer to capture activity between Examiner and the PUT using an EX280A analyzer, without automated control from Examiner (i.e., under the control of the EX280A analyzer application). To do this, uncheck the **Analyzer** box in the *Settings* tab.

5. Electrical Tests

Some tests are conducted in three different device states (Default, Addressed, and Configured). Expected results for each state tested may vary.

Default State: The device is attached, powered, but has not been assigned a unique address. Device responds at the default address (0).

Addressed State: Device is attached, powered, and has been assigned a unique (non-zero) address, but has not been configured.

Configured State: Device is attached, powered, has been assigned a unique (non-zero) address, and has been configured by Examiner to use the function provided by the device.

5.1 U0 Power Consumption

Test Summary

This test verifies that the PUT's power consumption during U0 is within the correct limits for configured, addressed, and default states. Examiner will report current, power, and VBus for each test.

Test Steps and Expected Results

1. Examiner brings the link to the U0 state.
2. Examiner issues one or more standard descriptor requests.
3. Current is measured in the three states shown below (in three separate tests):

Configured

Examiner measures current after issuing Set Address(1) and Set Configuration(1) requests.

Maximum current must be less than 900ma.

Addressed

Examiner measures current after issuing a Set Address request to assign a non-zero address to the device.

✓ **Maximum current must be less than 150ma.**

Default

Examiner measures current after issuing a Device Descriptor request.

✓ **Maximum current must be less than 150ma.**

Specification Reference

Section 11.4.1

5.2 U1 Power Consumption

Test Summary

This test verifies that the PUT's power consumption during the U1 low-power state is within the correct limits. Examiner will place the link into U1 from configured, addressed, and default states, using a Link Management Packet (LMP). Examiner will report current, power, and VBus for each test.

Test Steps and Expected Results

1. Examiner brings the link to the U0 state.
2. Examiner issues one or more standard descriptor requests.
3. Examiner places the device into each device state (configured, addressed, and default) in three separate tests before commanding the device to enter U1 in each test. Current is measured once the link is in U1, as described below.
4. Examiner issues a Set Link Functionality LMP with the *Force_Link_PM_Accept* bit set to one.
5. Examiner issues an LGO_U1 link command.

   ✓ **The device must reply with an LAU link command.**

6. Examiner issues an LPMA link command to place the link into U1.

   ✓ **In all three tests, the device must draw less than 150ma.**

Specification Reference

Section 11.4.1

5.3 U2 Power Consumption

Test Summary

This test verifies that the PUT's power consumption during the U2 low-power state is within the correct limits. Examiner will place the link into U2 from configured, addressed, and default states, using a Link Management Packet (LMP). Examiner will report current, power, and VBus for each test.

Test Steps and Expected Results

1. Examiner brings the link to the U0 state.
2. Examiner issues one or more standard descriptor requests.
3. Examiner places the device into each device state (configured, addressed, and default) in three separate tests before commanding the device to enter U2 in each test. Current is measured once the link is in U2, as described below.
4. Examiner issues a Set Link Functionality LMP with the *Force_Link_PM_Accept* bit set to one.
5. Examiner issues an LGO_U2 link command.

   ✓ **The device must reply with an LAU link command.**
6. Examiner issues an LPMA link command to place the link into U2.

   ✓ **In all three tests, the device must draw less than 150ma.**

Specification Reference

Section 11.4.1

5.4 U3 Power Consumption

Test Summary

This test verifies that the PUT's power consumption during the U3 low-power state is within the correct limits. Examiner will place the link into U3 from configured, addressed, and default states, using the LGO_U3 link command. Examiner will report current, power, and VBus for each test.

Test Steps and Expected Results

1. Examiner brings the link to the U0 state.
2. Examiner issues one or more standard descriptor requests.
3. Examiner places the device into each device state (configured, addressed, and default) in three separate tests before commanding the device to enter U3 in each test. Current is measured once the link is in U3, as described below.
4. Examiner issues an LGO_U3 link command.

   ✓ **The device must reply with an LAU link command.**

5. Examiner issues an LPMA link command to place the link into U3.

   ✓ **In all three tests, the device must draw less than [2.5ma] 150ma.**

Specification Reference

Section 11.4.3

5.5 VBus Acceptance Range Tests

Test Summary

This test verifies that the PUT reaches and maintains U0 across a range of decrementing VBus levels. Examiner will vary the VBus level from 5.30V to 3.60V in 100mV decrements for each test. Examiner will report current, power and VBus for each test.

Test results for VBus levels between 3.60V and 4.40V are below required levels (per specification) and are advisory only.

Test Steps and Expected Results

1. Examiner brings the link to the U0 state using the first VBus level (5.30V).
2. Examiner issues one or more standard descriptor requests.
3. Examiner places the device into each device state (configured, addressed, and default) in three separate tests, each including all VBus range increments.
4. Examiner measures current, power, and VBus during U0.

The device must reach U0 and maintain U0 until Examiner disables the link.

5. Examiner disables the link to force link recovery then repeats the process for the next VBus increment to be tested. This process is repeated until all increments have been tested.

Specification Reference

Section 11.4.5

6. Physical Layer

When viewing Physical Layer and Link Layer test activity in the USB Explorer 280 analyzer software application, it is generally best that the user disable the "grouping" feature (uncheck **Enable Grouping**), located in the **Grouping** drop-down selection in the *USB 3.0 Overview*. Disabling grouping leaves the user with the low-level view needed for a proper understanding of test sequences that are conducted in Chapters 6 and 7 tests. In some tests however, control transfers are used, and in these tests the user may find it more intuitive to leave **Grouping** enabled.

6.1 Lane Polarity Inversion Test

Test Summary

This test verifies that the PUT can properly accommodate reception of reversed polarity.

Test Steps and Expected Results

1. Examiner reverses polarity on its transmit lines prior to the first TSEQ, trains the link, and brings the device to U0.

The PUT must achieve U0 and stay in U0 for at least 50ms.

Specification Reference

Section 7.5.4.4.1#1

6.2 SKP Test

Test Summary

This test verifies that the PUT supports all possible SKP combinations. Here are the combinations to be tested:

- Repetition of one skip ordered set followed by 354 symbols (word aligned)
- Repetition of one skip ordered set followed by 353 symbols (word misaligned)
- Repetition of two skip ordered sets followed by 708 symbols (word aligned)
- Repetition of two skip ordered sets followed by 707 symbols (word misaligned)
- Repetition of three skip ordered sets followed by 1,062 symbols (word aligned)
- Repetition of three skip ordered sets followed by 1,061 symbols (word misaligned)
- Repetition of four skip ordered sets followed by 1,416 symbols (word aligned)
- Repetition of four skip ordered sets followed by 1,415 symbols (word misaligned)

Test Steps and Expected Results

1. Examiner brings the link to U0 as described in TD7.1 (Link Bring-Up Test), then uses the first SKP pattern above (initiated after Examiner completes the TSEQ sequence).

Examiner will keep the link active by sending Link Polling Commands (LUP when it is configured as an Upstream Port and LDN when it is configured as a Downstream Port).

Test passes if the PUT achieves U0 and stays in U0 for at least 100ms.

2. Examiner disables the link after 100ms in U0 and repeats the steps above using the next skip pattern until all skip patterns have been tested.

Specification Reference

Section 6.4.3

6.3 Elasticity Test

Test Summary

This test verifies that the PUT's elasticity buffer supports the whole frequency range of -5,300ppm to 300ppm (reference clock frequency limits of +/- 300ppm, plus the SSC frequency delta of 5000ppm).

Test Steps and Expected Results

1. Examiner configures with an equivalent SSC clock at -5300ppm.

2. Examiner brings the link to U0 as described in TD7.1 (Link Bring-Up Test).

   ✓ **The test passes if the exchanges are met, no timeout is detected, all packets are successfully received, all credits are restored, and the link stays in U0 for at least 50ms.**

3. LVS repeats the above steps with an equivalent SSC clock at +300ppm.

Specification Reference

Section 6.4.3

6.4 LFPS Frequency Test

Test Summary

This test verifies that the PUT's LFPS detector supports the entire LFPS frequency range permitted. Here are the periods to be tested:

- tPeriod = 10 MHz minimum (100ns)
- tPeriod = 50 MHz maximum (20ns)

Test Steps and Expected Results

1. Examiner and the PUT go through the initial steps of the LTSSM (SS.Inactive, Rx.Detect) to reach Polling.LFPS.

2. Examiner will start generating a Polling.LFPS signal having nominal durations of tBurst = 1 us and tRepeat = 10 us. The burst period will be set to the first period listed above.

   ✓ **The test passes if the PUT moves successfully to Polling.RxEQ.**

3. Repeat the steps above with the second period listed above.

Specification Reference

Sections 6.9.1 ● 7.5.4.3.2

6.5 Polling.LFPS Duration Test

Test Summary

This test verifies that the PUT's Polling.LFPS detector supports the entire tBurst and tRepeat duration ranges. Durations to be tested:

- tBurst = 0.6 us and tRepeat = 6 us
- tBurst = 0.6 us and tRepeat = 14 us
- tBurst = 1.4 us and tRepeat = 6 us
- tBurst = 1.4 us and tRepeat = 14 us

Test Steps and Expected Results

1. Examiner and the PUT go through the initial steps of the LTSSM (SS.Disabled, Rx.Detect) to reach Polling.LFPS.

2. Examiner will generate a Polling.LFPS signal having the first durations specified in the list above.

3. Repeat the steps with the following durations listed above.

The test passes if the PUT moves successfully to Polling.RxEQ as per Section 7.5.4.3.2 of the USB 3.0 specification (Exit from Pollling.LFPS).

Specification Reference

- Sections 6.9.1 ● 7.5.4.3.2

7. Link Layer Tests

When viewing Physical Layer and Link Layer test activity in the USB Explorer 280 analyzer software application, it is generally best that the user disable the "grouping" feature (uncheck **Enable Grouping**), located in the **Grouping** drop-down selection in the *USB 3.0 Overview*. Disabling grouping leaves the user with the low-level view needed for a proper understanding of test sequences that are conducted in Chapters 6 and 7 tests. In some tests however, control transfers are used, and in these tests the user may find it more intuitive to leave **Grouping** enabled.

In some cases, Examiner may be referred to as the Link Verification System (LVS). This is intended to maintain consistency with USB-IF compliance documents and procedures. These terms may be considered synonymous within this manual.

Certain link layer tests for downstream-facing ports require the use of the USB30CV tool, operated concurrently with Examiner. USB30CV is available from the USB-IF website.

7.1 Link Bring-Up Test

Test Summary

This test verifies that the Link Verification System (LVS) and the Port under Test (PUT) can reach U0 successfully, and meet other link initialization requirements.

Test Steps and Expected Results

1. Examiner begins the link initialization process.

If Examiner is configured as an Upstream Port:

- Examiner asserts terminations.

The PUT must already be in RxDetect.

The PUT must transmit Polling.LFPS before tRXDetectQuietTimeout (12ms +50%) + tPollingLFPSEstablished (80us +50%) expires.

If Examiner is configured as a Downstream Port:

- Examiner asserts VBUS and terminations.

✓ **The PUT must move to Rx.Detect.**

✓ **The PUT must transmit Polling.LFPS before tRXDetectQuietTimeout (12ms +50%) + tPollingLFPSEstablished (80us +50%) expires.**

2. Examiner transmits Polling.LFPS bursts.

✓ **The PUT must transmit at least 16 consecutive Polling.LFPS.**

✓ **The PUT must transmit at least 4 consecutive Polling.LFPS after receiving one Polling.LFPS.**

✓ **The PUT must NOT progress past Polling.LFPS before Examiner sends at least 2 consecutive Polling.LFPS.**

✓ **The PUT must progress past Polling.LFPS before tPollingLFPSTimeout expires (360ms + 50%).**

3. Examiner transmits TSEQ ordered sets.

✓ **The PUT must transmit TSEQs.**

✓ **The PUT must NOT transmit SKPs, Idles, or any other packet, symbol, or ordered set during TSEQ transmission or between TSEQ ordered sets.**

4. The LVS transmits TS1 ordered sets and waits to receive eight consecutive and identical TS1 or TS2 ordered sets from the PUT.

✓ **The PUT must transmit TS1s.**

✓ **The PUT must NOT transmit TS2s before Examiner sends 8 consecutive and identical TS1s or TS2s.**

✓ **The PUT must NOT interrupt a TS1 ordered set to transmit a SKP (between TS1 ordered sets is permitted).**

✓ **The PUT must NOT transmit IDLEs or any other packet.**

✓ **The PUT must NOT transmit TS1s after tPollingActiveTimeout expires (12ms +50%).**

5. Examiner transmits TS2 ordered sets and readies to complete the Polling.Configuration handshake.

✓ **The PUT must transmit at least 16 consecutive TS2s after receiving one TS2.**

✓ **The PUT must NOT interrupt transmission of a TS2 ordered set to transmit a SKP (between TS2 ordered sets is permitted).**

✓ **The PUT must NOT send IDLEs before Examiner sends at least 8 consecutive TS2s.**

✓ **The PUT must NOT interrupt transmission of TS2s to transmit a SKP (between TS2 ordered sets is permitted).**

✓ **The PUT must NOT continue to send TS2s after tPollingConfigurationTimeout expires (12ms +50%).**

6. Examiner transmits IDLE symbols.

✓ **The PUT must transmit 16 IDLEs after its TS2s.**

✓ **The PUT must NOT send the Header Sequence Number and/or Receiver Header Buffer Credit advertisements before Examiner sends 8 IDLEs.**

✓ **The PUT must NOT enter recovery after IDLEs have been exchanged between the PUT and Examiner.**

✓ **Upon U0 entry, the PUT must transmit the Header Sequence Number and Receiver Header Buffer Credit advertisements before expiration of their respective timeouts: Pending_HP_Timer (3us +50%) and Credit_HP_Timer (5000us +50%).**

Examiner will keep the link active by sending Link Pollings (LUP when it is configured as an Upstream Port and LDN when it is configured as a Downstream Port).

Specification Reference

Sections 7.2.4.1.1#6 ● 8,10-17,22 ● 7.2.4.1.4#2 ● 7.3.4#2 ● 7.5.6.1#5,6 ● 8.4.5#1 8.4.6#1,3 (downstream) ● 8.4.7#1 (upstream)

7.2 Link Command Framing Test

Test Summary

This test verifies that the PUT can tolerate link commands having one symbol error in the LCSTART framing. The Port Configuration transaction will be used for this purpose. Here are the combinations to be tested:

- ERR SLC SLC EPF (incorrect symbol is D0.0)
- SLC ERR SLC EPF (incorrect symbol is D0.1)
- SLC SLC ERR EPF (incorrect symbol is D0.2)
- SLC SLC SLC ERR (incorrect symbol is D0.3)

Test Steps and Expected Results

1. Examiner executes the steps described in TD7.1 (Link Bring-Up Test), to bring the link to U0, but transmits all LCRD_X link commands with an error in the first LCSTART symbol.

   The test passes if the exchanges are met, no timeout is detected, all packets are successfully received, all credits are restored and the link stays in U0 for at least 50ms.

2. Repeat the steps above with an error in the second, third, and fourth LCSTART symbols.

Specification Reference

Section 7.3.4#1, 2

7.3 Link Command CRC Test

Test Summary

This test verifies that the PUT initiates a recovery upon receipt of one corrupt CRC5 in each of the two link command word (one at a time) and then both CRCs corrupted. The Port Configuration transaction will be used for this purpose.

Reference Errata (June 2010) regarding changes to a port's handling of an invalid link command (Core Specification Section 7.3.2).

The tested CRC-5 error conditions are:

- Incorrect CRC-5 in first Link Command Word
- Incorrect CRC-5 in second Link Command Word
- Incorrect CRC in both Link Command Words

Test Steps and Expected Results

1. Examiner executes the steps described in section TD7.1 (Link Bring-Up Test) to bring the link to U0, but transmits all LCRD_X link commands with the first condition listed above.

   The test passes if port under test initiates a recovery sequence (upon expiration of the Credit_HP_Timer at 5000us +50%) as a result of receiving a link command with one or two incorrect CRC5s, and returns to U0 for at least 50ms.

2. Repeat the step above using the second and third conditions listed above.

Specification Reference

Section 7.3.4#2

7.4 Invalid Link Command Test

Test Summary

This test verifies that the PUT will ignore an invalid link command (first and second LCW containing different commands). The tested condition is:

- Link command with LGO_U1 in the first LCW and LGO_U2 in the second LCW, with good CRC-5 calculations on both LCWs.

Test Steps and Expected Results

1. Examiner executes steps described in TD7.1 (Link Bring-Up Test) to bring the link to U0.

2. Examiner sends the link command described above, following the completion of link advertisement sequences.

   The test fails if the port under test replies with LXU or LAU.

   The test passes if the link command is ignored, all exchanges are correct, no timeout is detected, all packets are successfully received by the PUT, all credits are restored and the link stays in U0 for at least 50ms.

Specification Reference

Section 7.3.4#2

7.5 Header Packet Framing Test

Test Summary

This test verifies that the PUT does not invalidate header packets having one symbol error in the HPSTART framing. The Port Configuration transaction will be used for this purpose. Here are the combinations to be tested:

- ERR SHP SHP EPF (incorrect symbol is D0.0)
- SHP ERR SHP EPF (incorrect symbol is D0.1)
- SHP SHP ERR EPF (incorrect symbol is D0.2)
- SHP SHP SHP ERR (incorrect symbol is D0.3)

Test Steps and Expected Results

1. Examiner executes steps as described in TD7.1 (Link Bring-Up Test), to bring the link to U0, but transmits all Header Packets with an error in the first HPSTART symbol.

2. Repeat the above steps with an error in the second, third, and fourth HPSTART symbols.

The test passes if the exchanges are met, no timeout is detected, all packets are successfully received by the PUT, all credits are restored and the link stays in U0 for at least 50ms.

Specification Reference

Section 7.2.4.1.4#1

7.6 Data Payload Framing Test

Test Summary

This test verifies that the PUT does not invalidate data payload packets having a single-character framing error in the DPPSTART and DPPEND framings.

When Examiner is configured as a Downstream Port it will place framing errors on Setup DP Packets. When Examiner is configured as an Upstream Port, it will reply to the Get Device Descriptor request with a DPP containing framing errors. In this case, the Host will run the CV Link Test Stack in

order to have a known and defined behavior.

Combinations to be tested:

Data Start Framing

- ERR SDP SDP EPF (incorrect symbol is D0.0)
- SDP ERR SDP EPF (incorrect symbol is D0.1)
- SDP SDP ERR EPF (incorrect symbol is D0.2)
- SDP SDP SDP ERR (incorrect symbol is D0.3)

Data End Framing

- ERR END END EPF (incorrect symbol is D0.0)
- END ERR END EPF (incorrect symbol is D0.1)
- END END ERR EPF (incorrect symbol is D0.2)
- END END END ERR (incorrect symbol is D0.3)

Test Steps and Expected Results

1. Examiner executes the steps described in TD7.1 (Link Bring-Up Test) to bring the link to U0. At this stage the Downstream Port (either Examiner or the host port under test) is expected to issue a Get Device Descriptor request.

If Examiner is configured as an Upstream Port:

a. Examiner prompts the test operator to have the PUT send a GetDeviceDescriptor request through a USB30CV prompt and then press “OK”.

When Examiner receives the GetDeviceDescriptor request, it closes its prompt.

b. Examiner will respond to the request correctly, but will send the DPP containing the Device Descriptor data with the first framing error listed above.

The test fails if no GetDeviceDescriptor request is received (assuming the test operator has pressed “OK”).

The test passes if the exchanges are met, no timeout is detected, all packets are successfully received by the PUT, all credits are restored and the link stays in U0 for at least 50ms.

If Examiner is configured as a Downstream Port:

a. It will issue a Get Device Descriptor request, but will send the SETUP DP with the first framing error listed above.

The test passes if the exchanges are met, no timeout is detected, all packets are successfully received by the PUT, all credits are restored and the link stays in U0 for at least 50ms.

The test fails if the data exchange fails at the protocol layer (i.e., if the PUT replies with a TP ACK having the sequence number set to zero – indicating the PUT detected a data payload error).

b. Repeat the testing above for each framing error.

Specification Reference

Sections 7.2.4.1.6#1, 2 ● 8.11.4

7.7 RX Header Packet Retransmission Test

Test Summary

This test verifies that the PUT will send an LBAD if a header packet is incorrectly received, and that the retransmission will be correctly handled.

The tested conditions invalidating the header packet are:

- Incorrect CRC-16
- Incorrect CRC-5
- A single K symbol in the HP data (see list below), each to be located (one at a time) at the **second** and **fifth** characters after the start framing ordered set.

  Position 2: SHP SHP SHP EPF DX.X **KX.X** DX.X DX.X

  Position 5: SHP SHP SHP EPF DX.X DX.X DX.X DX.X **KX.X5**

  - K28.2 (SDP)
  - K28.3 (EDB)
  - K28.4 (SUB)
  - K28.6 (Reserved K-symbol)
  - K27.7 (SHP)
  - K29.7 (END)
  - K30.7 (SLC)
  - K23.7 (EPF)

For the K-Character tests, the Packet's CRC-16 is first calculated correctly, then, the K-Character is inserted into the LMP packet. This is done in order to better simulate an in-flight (transmission) error, rather than a chip error on the PUT.

Test Steps and Expected Results

1. Examiner executes steps 1 to 3 of TD7.1 (Link Bring-Up Test) to train the link and exchange Link Advertisements transactions.
2. Examiner and the PUT will exchange Port Configuration transactions, but in this case the first header packet sent by Examiner will be invalid.

If Examiner is configured as an Upstream Port:

a. It waits for the PUT's Port Capability LMP.

b. It transmits its Port Capability LMP with the first invalid condition above.

c. The PUT must respond with an LBAD

d. Examiner transmits a LRTY and then retransmits the packet.

e. Examiner transmits the Port Configuration LMP.

f. Examiner waits for the PUT Port Configuration Ack LMP.

If Examiner is configured as a Downstream Port:

a. It waits for the PUT Port Capability LMP.

b. It transmits its PUT Port Capability LMP with the first invalid condition above.

c. It verifies the PUT replies with an LBAD.

d. It transmits a LRTY and then retransmits the packet.

e. It waits for the Port Configuration LMP.

f. It validates the Port Configuration LMP.

g. It transmits its Port Configuration Ack LMP.

Examiner will keep the link active by sending Link Pollings (LUP when Examiner is configured as Upstream Port, LDN when Examiner is configured as a Downstream Port).

3. Repeat the above steps for each of the invalid conditions listed above.

The test passes if the exchanges are met, no timeout is detected, the PUT responds to the invalid packets with an LBAD, all other packets are successfully received, all credits are restored and the link stays in U0 for at least 50ms.

Specification Reference

Section 7.2.4.1.4#3, #4

7.8 TX Header Retransmission Test

Test Summary

This test verifies that the PUT will correctly retransmit a header packet upon receipt of an LBAD.

Test Steps and Expected Results

1. Do steps 1 to 3 of TD7.1 (Link Bring-Up Test) to bring the link to U0.

2. Examiner will respond to the first packet sent by the PUT with an LBAD.

If Examiner is configured as an Upstream Port:

a. It waits for the PUT's Port Capability LMP.

b. It responds to the PUT with an LBAD.

c. It waits for the PUT to transmit an LRTY.

d. It waits for the retransmitted packet.

e. It verifies that the retransmitted packet is the same as the first packet sent by the device.

f. It transmits its Port Capability LMP and Port Configuration LMP.

g. It waits for the PUT's Port Configuration Ack LMP.

If Examiner is configured as a Downstream Port:

a. It waits for the PUT's Port Capability LMP.

b. It transmits its Port Capability LMP.

c. It responds to the PUT with an LBAD.

d. It waits for the PUT to transmit an LRTY.

e. It waits for the retransmitted packet.

f. It verifies that the retransmitted packet is the same as the first packet sent by the device.

g. It waits for the Port Configuration LMP.

h. It verifies that the Port Configuration LMP is valid.

i. It transmits its Port Configuration Ack LMP.

Examiner will keep the link active by sending Link Pollings (LUP when Examiner is configured as Upstream Port, LDN when Examiner is configured as a Downstream Port).

3. Repeat the above steps for each of the invalid conditions listed above.

The test passes if the exchanges are met, no timeout is detected, the packet that Examiner responded to with an LBAD is retransmitted correctly, all other packets are received successfully, all credits are restored and the link stays in U0 for at least 50ms.

Specification Reference

Section 7.2.4.1.3#1, 2

7.9 PENDING_HP_TIMER Deadline Test

Test Summary

This test verifies that the PUT will accept an LGOOD_N sent at the PENDING_HP_TIMER deadline, minus tLinkTurnAround (i.e., at 2.5us after the end of the PUT's Port Capabilities LMP).

Test Steps and Expected Results

1. Examiner performs the steps described in TD7.1 (Link Bring-Up Test) to bring the link to U0, but transmits all LGOOD_N responses at [PENDING_HP_TIMER – tLinkTurnAround].

The PENDING_HP_TIMER deadline value is 3us. The value of tLinkTurnAround is 500ns and is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

The test passes if the exchanges are met, no timeout is detected, all packets are successfully received, all credits are restored and the link stays in U0 for at least 50ms.

Specification Reference

Section 7.2.4.1.10#2 ● Table 7-7

7.10 CREDIT_HP_TIMER Deadline Test

Test Summary

This test verifies that the PUT will accept an LCRD_X sent at the CREDIT_HP_TIMER deadline, minus tLinkTurnAround (i.e., at 4999.50us after the end of the PUT's Port Capabilities LMP).

Test Steps and Expected Results

1. Examiner performs the same steps described in TD7.1 (Link Bring-Up Test) to bring the link to U0, but transmits all LCRD_X responses at [CREDIT_HP_TIMER – tLinkTurnAround].

The CREDIT_HP_TIMER deadline value is 5000us. The value of tLinkTurnAround is 500ns and is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

The test passes if the exchanges are met, no timeout is detected, all packets are successfully received, all credits are restored and the link stays in U0 for at least 50ms.

Specification Reference

Section 7.2.4.1.10#7 ● Table 7-7

7.11 PENDING_HP_TIMER Timeout Test

Test Summary

This test verifies that the PUT will go to recovery when the PENDING_HP_TIMER expires.

Test Steps and Expected Results

1. Examiner performs steps 1 to 3 of TD7.1 (Link Bring-Up Test) to bring the link to U0.
2. Examiner and the PUT will exchange Port Configuration transactions, but in this case Examiner will not respond to the first packet sent by the PUT.

If Examiner is configured as an Upstream Port:

a. It waits for the PUT's Port Capability LMP.

b. Examiner will not respond to the PUT with a link layer handshake.

c. Examiner transmits its Port Capability LMP and Port Configuration LMP.

If Examiner is configured as a Downstream Port:

a. It waits for the PUT's Port Capability LMP.

b. Examiner transmits its PUT Port Capability LMP.

c. Examiner will not respond to the PUT with a link layer handshake.

The PENDING_HP_TIMER deadline value is 3us, but is given a "calculated test time" expiration of 5.0225us. This calculated test time is defined and explained in the Link Layer Test Specification, Section 4. Please refer to that document for details

Examiner will keep the link active by sending Link Pollings (LUP when Examiner is configured as Upstream Port, LDN when Examiner is configured as a Downstream Port).

The test passes if the PUT goes to recovery when the PENDING_HP_TIMER expires (within the range of 3us to 5.0225us from the end of PUT's LMP).

Specification Reference

Section 7.2.4.1.10#1 ● Table 7-7

7.12 CREDIT_HP_TIMER Timeout Test

Test Summary

This test verifies that the PUT will go to recovery when the CREDIT_HP_TIMER expires.

Test Steps and Expected Results

1. Do steps 1 to 4 of TD7.1 (Link Bring-Up Test), with the exception that Examiner will not send any LCRD_X.

The CREDIT_HP_TIMER deadline value is 5000us, but is given a "calculated test time" expiration of 7.5380us. This calculated test time is defined and explained in the Link Layer Test Specification, Section 4. Please refer to that document for details.

Examiner will keep the link active by sending Link Pollings (LUP when Examiner is configured as Upstream Port, LDN when Examiner is configured as a Downstream Port).

The test passes if the PUT goes to recovery when the CREDIT_HP_TIMER expires (within the range of 5000us to 7.5380us from the end of PUT's LMP).

Specification Reference

Section 7.2.4.1.10#6 ● Table 7-7

7.13 Wrong Header Sequence Test

Test Summary

This test verifies that the PUT will go to recovery when it receives a wrong header sequence number.

Test Steps and Expected Results

1. Do steps 1 to 4 of TD7.1 (Link Bring-Up Test), with the exception that Examiner will send two LMP packets with Header Sequence Number set to 0 (i.e., not sequential).

The test passes if the PUT goes to recovery within tLinkTurnAround after reception of the second LMP packet with the repeated Header Sequence Number of 0.

The value of tLinkTurnAround is 500ns and is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

Specification Reference

Section 7.3.5#1

7.14 Wrong LGOOD_N Sequence Test

Test Summary

This test verifies that the PUT will go to recovery when it receives an incorrect LGOOD_N sequence.

Test Steps and Expected Results

1. Examiner performs steps 1 to 4 of TD7.1 (Link Bring-Up Test) to bring the link to U0, with the exception that Examiner will send an LGOOD_0 for the first LMP packet as expected, but will send again an LGOOD_0 for the second LMP packet.

The value of tLinkTurnAround is 500ns and is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

The test passes if the PUT goes to recovery within tLinkTurnAround after reception of the second LGOOD_0.

Specification Reference

Section 7.3.4#4

7.15 Wrong LCRD_X Sequence Test

Test Summary

This test verifies that the PUT will go to recovery when it receives an incorrect LCRD_X sequence.

Test Steps and Expected Results

1. Examiner performs steps 1 to 4 of TD7.1 (Link Bring-Up Test) with the exception that Examiner will send an LCRD_A for the first LMP packet as expected, but will send again an LCRD_A for the second LMP packet.

The test passes if the PUT goes to recovery within tLinkTurnAround after reception of the second LCRD_A.

The value of tLinkTurnAround is 500ns and is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

Specification Reference

Section 7.3.4#5

7.16 Link Command Missing Test (Upstream Port Only)

Test Summary

This test verifies that the PUT will go to Recovery if no Link Commands are received for more than tU0RecoveryTimeout.

The value of tU0RecoveryTimeout deadline is 1ms, but is given a "calculated test time" expiration of 1.5080ms. This calculated test time is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

Examiner will disable transmission of ITPs for testing an Upstream Port.

Test Steps and Expected Results

1. Examiner performs steps 1 to 4 of TD7.1 (Link Bring-Up Test) to bring the link to U0.
2. Examiner will not send LDNs or any other link commands.

The test fails if the PUT goes to Recovery before the tU0RecoveryTimeout deadline (1ms), or if it does not go to Recovery within tU0RecoveryTimeout expiration (1.5080ms).

Note that the time calculation above is not from the start of U0 to the start of the recovery sequence; it is from the last link command sent by Examiner to the start of the recovery sequence.

Specification Reference

Sections 7.3.4#7, 8 ● 7.5.6.1#3 ● 7.5.6.2#6

7.17 tPortConfiguration Timeout Test

Test Summary

This test verifies that a downstream-facing PUT will go to SS.Inactive and an upstream-facing PUT will go to SS.Disabled if tPortConfiguration expires.

The value of tPortConfiguration deadline is 20us, but is given a "calculated test time" expiration of 20.6us. This calculated test time is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

For both upstream and downstream PUTs, the test will run three parts:

- In the first part, Examiner will not send any LMPs.
- In the second part, Examiner will send a Port Capabilities LMP, but will not send Port Configuration LMP (or Port Configuration ACK LMP).
- In the third part, Examiner will send a Port Configuration LMP (or Port Configuration ACK LMP), but will not send a Port Capabilities LMP.

Test Steps and Expected Results

If Examiner is configured as a Downstream Port:

1. Examiner performs steps 1 to 3 of TD7.1 (Link Bring-Up Test) to bring the link to U0, and does not transmit any LMP.

   ✓ **The test fails if the PUT does not transmit the Port Capabilities LMP.**

   ✓ **The test fails if the PUT does not transition to SS.Disabled after tPortConfiguration calculated test time (20.6us).**

   ✓ **The test fails if the PUT transitions to SS.Disabled before tPortConfiguration deadline (20us), or sends any other packets or LFPS signals at this point.**

2. Examiner performs steps 1 to 3 of TD7.1 (Link Bring-Up Test) to bring the link to U0.
3. Examiner waits for the PUT's Port Capabilities LMP.

   ✓ **The test fails if the PUT does not transmit the Port Capability LMP.**

4. Examiner sends its Port Capabilities LMP, but does not transmit its Port Configuration LMP.

   ✓ **The test fails if the PUT does not transition to SS.Disabled after tPortConfiguration calculated test time (20.6us).**

   ✓ **The test fails if the PUT transitions to SS.Disabled before tPortConfiguration deadline (20us), or sends any other packets or LFPS signals at this point.**

5. Examiner performs steps 1 to 3 of TD7.1 (Link Bring-Up Test) to bring the link to U0.
6. Examiner sends its Port Configuration LMP, but does not transmit its Port Capabilities LMP.

✓ **The test fails if the PUT does not transition to SS.Disabled after tPortConfiguration calculated test time (20.6us).**

✓ **The test fails if the PUT transitions to SS.Disabled before tPortConfiguration deadline (20us), or sends any other packets or LFPS signals at this point.**

If Examiner is configured as an Upstream Port:

1. Examiner performs steps 1 to 3 of TD7.1 (Link Bring-Up Test) to bring the link to U0, and does not transmit any LMP.

✓ **The test fails if the PUT does not transmit the Port Capabilities LMP.**

✓ **The test fails if the PUT does not transition to SS.Inactive after tPortConfiguration calculated test time (20.6us).**

✓ **The test fails if the PUT transitions to SS.Inactive before tPortConfiguration deadline (20us), or sends any other packets or LFPS signals at this point.**

2. Examiner performs steps 1 to 3 of TD7.1 (Link Bring-Up Test) to bring the link to U0.
3. Examiner waits for PUT's Port Capabilities LMP.

✓ **The test fails if the PUT does not transmit the Port Capabilities LMP.**

4. Examiner transmits its Port Capabilities LMP, but does not send a Port Configuration ACK LMP.

✓ **The test fails if the PUT does not transition to SS.Inactive after tPortConfiguration calculated test time (20.6us).**

✓ **The test fails if the PUT transitions to SS.Inactive before tPortConfiguration deadline (20us), or sends any other packets or LFPS signals at this point.**

5. Examiner performs steps 1 to 3 of TD7.1 (Link Bring-Up Test) to bring the link to U0.
6. Examiner transmits its Port Configuration ACK LMP, but does not send a Port Capabilities LMP.

The test fails if the PUT does not transition to SS.Inactive after tPortConfiguration calculated test time (20.6us).

The test fails if the PUT transitions to SS.Inactive before tPortConfiguration deadline (20us), or sends any other packets or LFPS signals at this point.

Specification Reference

Section 7.5.6.2#10, 11

7.18 Low Power Initiation for U1 Test (Downstream Port Only)

Test Summary

This test verifies that the PUT initiates the U1 state

Test Steps and Expected Results

1. Examiner performs steps 1 to 4 of TD7.1 (Link Bring-Up Test) to bring the link to U0.
2. Examiner application prompts the test operator to enable and configure the U1 and U2 inactivity timers through USB30CV. CV will set the U1 Timeout field to 7Fh and the U2 Timeout field to 00h.
3. Examiner waits to receive an LGO_U1 from the PUT.
4. Examiner transmits an LXU, when it receives the LGO_U1.

   The test fails if the PUT sends LPMA (in reply to the LXU).
5. Examiner waits for receiving LGO_U1 from the PUT again.
6. Examiner transmits an LAU, when it receives the LGO_U1.

   The test fails if the PUT does not send an LPMA.

   The test fails if the PUT does not transition to U1.
7. Examiner transmits the U1 Exit LFPS to transition to U0 and waits to receive U1 Exit LFPS from the PUT.

   The test fails if the LFPS handshake does not conform to the following specifications from section 6.9.2:

- Between 300ns – 900ns elapses between the start of Examiner U1 Exit LFPS and the start of the PUT U1 Exit LFPS.
- The PUT U1 Exit LFPS duration is within 600ns – 900ns.

✓ **The test passes if all transactions are correct, no extra packets or LFPS signals are received, and the PUT enters Recovery.**

8. After Examiner completes this test case, clear the U1/U2 registers through the CV prompt.

Specification Reference

Sections 7.2.4.2.2#1 ● 7.2.4.2.3#1,3,4,5,7,8 ● 7.2.4.2.7#2,3 ● 7.5.7.1#2 ● 7.5.7.2#6

7.19 Low Power Initiation for U2 Test (Downstream Port Only)

Test Summary

This test verifies that the PUT initiates U2 state.

Test Steps and Expected Results

1. Examiner performs steps 1 to 4 of TD7.1 (Link Bring-Up Test) to bring the link to U0.
2. Examiner application prompts the test operator to enable and configure the U1 and U2 inactivity timers through USB30CV. CV will set the U1 Timeout field to 00h and the U2 Timeout field to 7Fh.
3. Examiner waits to receive LGO_U2 from the PUT.
4. Examiner transmits an LXU, when it receives the LGO_U2.

✓ **The test fails if the PUT sends LPMA.**

5. Examiner waits to receive LGO_U2 from the PUT again.
6. Examiner transmits an LAU, when it receives the LGO_U2.

✓ **The test fails if the PUT does not send LPMA.**

✓ **The test fails if the PUT does not transition to U2.**

7. Examiner transmits the U2 Exit LFPS to transition to U0 and waits to receive U2 Exit LFPS from the PUT.

The test fails if the LFPS handshake does not conform to the following specifications from section 6.9.2:

- Between 300ns – 2ms elapses between the start of Examiner U2 Exit LFPS and the start of the PUT U2 Exit LFPS.
- The PUT U2 Exit LFPS duration is within 80us – 2ms.
- The PUT enters Recovery within tNoLFPSResponseTimeout (2.0105ms) after the start of its' U2 exit LFPS.

The value tNoLFPSResponseTimeout deadline is 2ms, but is given a "calculated test time" expiration of 2.0105ms. This calculated test time is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

The test passes if all transactions are correct, no extra packets or LFPS signals are received, and the PUT enters Recovery.

8. After Examiner completes this test case, clear the U1/U2 registers through the CV prompt.

Specification Reference

Sections 7.2.4.2.2#1 ● 7.2.4.2.3#1,3,4,5,7,8 ● 7.2.4.2.7#2,3 ● 7.5.8.1#2 ● 7.5.8.2#5

7.20 PM_LC_TIMER Deadline Test (Downstream Port Only)

Test Summary

This test verifies that the PUT accepts an LAU sent at the PM_LC_TIMER deadline.

Test Steps and Expected Results

1. Examiner performs steps 1 to 3 of TD7.18 (Low Power Initiation for U1 Test - Downstream Port Only).

2. Examiner application prompts the test operator to enable and configure the U1 and U2 inactivity timers through USB30CV. CV will set the U1 Timeout field to 7Fh and the U2 Timeout field to 00h.

3. After receipt of the LGO_U1 from the downstream port, Examiner transmits an LAU at [PM_LC_TIMER – tLinkTurnAround], i.e., at 2.5us after the LGO_U1.

The value of PM_LC_TIMER deadline is 3us. The value of tLinkTurnAround is 500ns. See Section 4 of the Link Layer Test Specification for more details.

The test fails if the PUT does not send LPMA after receiving the LAU.

4. Examiner and the PUT exchange U1 Exit LFPS and transition back to U0

At this point, Examiner will reject subsequent LGO_U1 requests from the PUT with LXU.

5. After Examiner completes this test case, clear the U1/U2 registers through the CV prompt.

Specification Reference

Section 7.2.4.1#1,2

7.21 PM_LC_TIMER Timeout Test (Downstream Port Only)

Test Summary

This test verifies that the PUT transitions to Recovery when the PM_LC_TIMER elapses.

Test Steps and Expected Results

1. Examiner performs steps 1 to 3 of 7.18 (Low Power Initiation for U1 Test - Downstream Port Only).

2. Examiner does not transmit LAU when it receives the LGO_U1.

The value of PM_LC_TIMER deadline is 3us, but is given a “calculated test time” expiration of 5.0225us. This calculated test time is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

The test fails if the PUT does not transition to Recovery when the PM_LC_TIMER expires (5.0225us).

3. After Examiner completes this test case, clear the U1/U2 registers through the CV prompt.

Specification Reference

Sections 7.2.4.2.1#1 ● 7.2.4.2.3#6 ● 7.3.4#6

7.22 PM_ENTRY_TIMER Timeout Test (Upstream Port Only)

Test Summary

This test verifies that the PUT transitions to U1 when the PM_ENTRY_TIMER expires.

Test Steps and Expected Results

1. Examiner performs steps 1 to 3 of 7.23 (Accepted Power Management Transaction for U1 Test - Upstream Port Only).

2. Examiner does not transmit LPMA when it receives LAU.

The value of PM_ENTRY_TIMER deadline is 6us, but is given a "calculated test time" expiration of 9.545us. This calculated test time is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

The test fails if the PUT does not transition to U1 when the PM_ENTRY_TIMER expires (9.545us), or if the PUT sends any packet or LFPS.

Specification Reference

Sections 7.2.4.2.1#3 ● 7.2.4.2.3#8,10,12

7.23 Accepted Power Management Transaction for U1 Test (Upstream Port Only)

Test Summary

This test verifies that the PUT transitions to U1 if it receives an LGO_U1.

Test Steps and Expected Results

1. Examiner performs steps 1 to 4 of TD7.1 (Link Bring-Up Test) to bring the link to U0.

2. Examiner transmits the Set Link Function LMP with the *Force_LinkPM_Accept* bit asserted.

3. Examiner transmits LGO_U1 and waits to receive an LAU from the PUT.

The test fails if the PUT does not send an LAU.

4. Examiner transmits an LPMA and then transitions to U1.

The test fails if the PUT does not transition to U1, or if the PUT sends any packet at this point.

5. Examiner waits 50ms from U1 entry then transmits a U1 Exit LFPS to transition to U0, then waits to receive U1 Exit LFPS from the PUT.

The test fails if the LFPS handshake does not conform to the following specifications from section 6.9.2:

- Between 300ns – 900ns elapses between the start of Examiner U1 Exit LFPS and the start of the PUT U1 Exit LFPS.
- The PUT U1 Exit LFPS duration is within 600ns – 900ns.

Specification Reference

Sections 7.2.4.1.1#7,9 • 7.2.4.2.1#4 • 7.2.4.2.2#2,3 • 7.2.4.2.3#2,8,9 7.2.4.2.7#2,3 • 7.5.5.1#2 • 7.5.5.2#2 • 7.5.7.1#2 • 7.5.7.2#2 • 8.4.2#1

7.24 Accepted Power Management Transaction for U2 Test (Upstream Port Only)

Test Summary

This test verifies that the PUT transitions to U2 if it receives an LGO_U2.

Test Steps and Expected Results

1. Examiner performs steps 1 to 4 of TD7.1 (Link Bring-Up Test) to bring the link to U0.

2. Examiner transmits the Set Link Function LMP with the *Force_LinkPM_Accept* bit asserted.

3. Examiner transmits an LGO_U2 and waits to receive an LAU from the PUT.

The test fails if the PUT does not send an LAU.

4. Examiner transmits an LPMA and then transitions to U2.

The test fails if the PUT does not transition to U2, or if the PUT sends any packet at this point.

5. Examiner waits 100ms from U2 entry then transmits a U2 Exit LFPS to transition to U0, then waits to receive U2 Exit LFPS from the PUT.

The test fails if the LFPS handshake does not conform to the following specifications from section 6.9.2:

- Between 300ns – 2ms elapses between the start of Examiner U2 Exit LFPS and the start of the PUT U2 Exit LFPS.
- The PUT U2 Exit LFPS duration is within 80us – 2ms.
- The PUT enters Recovery within tNoLFPSResponseTimeout (U1/U2) after the start of its U2 Exit LFPS

The value tNoLFPSResponseTimeout for U1/U2 is 2ms, but is given a "calculated test time" of 2.0105ms. This calculated test time is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

Specification Reference

Sections 7.2.4.1.1#7,9 • 7.2.4.2.1#4 • 7.2.4.2.2#2,3 • 7.2.4.2.3#2,8,9 7.2.4.2.7#2,3 • 7.5.5.1#2 • 7.5.5.2#2 • 7.5.7.1#2 • 7.5.7.2#2 • 8.4.2#1

7.25 Accepted Power Management Transaction for U3 Test (Upstream Port Only)

Test Summary

This test verifies that the PUT transitions to U3 if it receives an LGO_U3.

Test Steps and Expected Results

1. Examiner performs steps 1 to 4 of TD7.1 (Link Bring-Up Test) to bring the link to U0.

2. Examiner transmits LGO_U3 and waits to receive LAU from the PUT.

The test fails if the PUT does not send LAU.

3. Examiner transmits an LPMA and then transitions to U3.

4. Examiner waits 500ms from U3 entry then transmits the U3 Exit LFPS to transition to U0, then waits to receive U3 Exit LFPS to complete the U3 Exit LFPS handshake

The test fails if the LFPS handshake does not conform to the following specifications from section 6.9.2:

- Between 300ns – 10ms elapses between the start of Examiner U3 Exit LFPS and the start of the PUT U3 Exit LFPS.
- The PUT U3exit LFPS duration is within 80us – 10ms.
- The PUT enters Recovery within tNoLFPSResponseTimeout (U3) after the start of its U3 Exit LFPS.

The value tNoLFPSResponseTimeout for U3 is 10ms, but is given a "calculated test time" of 10.0505ms. This calculated test time is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

Specification Reference

Sections 7.2.4.1.1#7,9 ● 7.2.4.2.1#4 ● 7.2.4.2.4#2,3,7 ● 7.2.4.2.7#2,3 ● 7.5.9.1#3 7.5.9.2#5

7.26 Transition to U0 from Recovery Test

Test Summary

This test verifies that the PUT transitions to U0 when it is in Recovery.

Test Steps and Expected Results

1. Examiner performs steps 1 to 4 of TD7.1 (Link Bring-Up Test) to bring the link to U0.

2. Examiner does not transmit the LGOOD_7 of the Header Sequence Advertisement.

The PUT will transition to Recovery because the PENDING_HP_TIMER will time out.

The PENDING_HP_TIMER deadline value is 3us, but is given a "calculated test time" expiration of 5.0225us. This calculated test time is defined and explained in the Link Layer Test Specification, Section 4. Please refer to that document for details.

3. Both Examiner and the PUT transition to Recovery, and then back to U0.

The test fails if the PUT does not transition to recovery when the PENDING_HP_TIMER expires (from 3us to 5.0225us).

The test fails if the PUT does not transition back to U0 and remain in U0 for at least 50ms.

Specification Reference

Sections 7.2.4.1.1#3,4,7,9 • 7.3.6#17.5.10.3.1#1 • 7.5.10.3.2#1 • 7.5.10.4.2#1 7.5.10.5.1#1 • 7.5.10.5.2#1

7.27 Hot Reset Detection in Polling Test (Upstream Port Only)

Test Summary

This test verifies that the PUT detects the Hot Reset in Polling.

Test Steps and Expected Results

1. Both LVS and PUT detect each other and then transition to Polling.LFPS and Polling.RxEQ.

2. Both LVS and PUT transmit the TS1 ordered sets during Polling.Active.

3. Examiner waits to receive TS2 ordered sets.

4. Examiner initiates a Hot Reset and transmits the TS2 ordered sets with Reset bit asserted.

The test fails if the PUT does not transmit at least 16 TS2 ordered sets with the Reset bit asserted, followed by TWO consecutive TS2 ordered sets with Reset bit de-asserted.

5. Examiner transmits FOUR consecutive TS2 ordered sets with Reset bit de-asserted, and then it transmits Idle Symbols.

The test fails if the PUT does not transmit Sixteen Idle Symbols.

✓ **The test fails if the PUT does not transition to U0.**

✓ **The test fails if the PUT does not transmit the Header Sequence Number Advertisement and the Rx Header Buffer Credit Advertisement once in U0.**

6. Examiner and the PUT exchange Port Configuration transactions.

✓ **The test fails if the Port Configuration exchange sequences are not successful.**

Specification Reference

Sections 7.2.4.1.1#6,8,17,22 ● 7.4.2#4 ● 7.5.4.7.2#4 ● 7.5.12.3.1#1,3,4 7.5.12.3.2#1 ● 7.5.12.4.1#1 ● 7.5.12.4.2#1

7.28 Hot Reset Detection in U0 Test (Upstream Port Only)

Test Summary

This test verifies that the PUT detects the Hot Reset in U0 and does not start the Port Configuration Sequences.

Test Steps and Expected Results

1. Examiner performs steps 1 to 5 of TD7.1 (Link Bring-Up Test) to bring the link to U0.

2. Examiner transmits TS1 ordered sets to initiate the transition to Recovery.

3. Examiner waits to receive TS1 ordered sets from the PUT.

4. Examiner initiates a Hot Reset and transmits the TS2 ordered sets with Reset bit asserted.

✓ **The test fails if the PUT does not transmit at least 16 TS2 ordered sets with the Reset bit asserted, followed by TWO consecutive TS2 ordered sets with Reset bit de-asserted.**

5. Examiner transmits FOUR consecutive TS2 ordered sets with the Reset bit de-asserted, and then transmits Idle Symbols.

✓ **The test fails if the PUT does not transmit 16 Idle symbols**

✓ **The test fails if the PUT does not transition to U0.**

The test fails if the PUT does not transmit the Header Sequence Number Advertisement and the Rx Header Buffer Credit Advertisement once in U0.

Examiner keeps the link active by sending LDNs for 20us.

The test fails if the PUT transmits the Port Capability LMP.

Specification Reference

Sections 7.2.4.1.1#6,8,17,22 ● 7.4.2#2,4 ● 7.5.10.4.1#1 ● 7.5.12.3.1#1,2 7.5.12.3.2#1 ● 7.5.12.4.1#1 ● 7.5.12.4.2#1

7.29 Hot Reset Initiation in U0 Test (Downstream Port Only)

Test Summary

This test verifies that the PUT initiates Hot Reset in U0.

Test Steps and Expected Results

1. Do steps 1 to 5 of TD7.1 (Link Bring-Up Test) to bring the link to U0.
2. Examiner prompts the test operator to initiate a Hot Reset on the PUT through USB30CV.
3. Examiner waits for TS1s from the PUT.

   The test fails if the PUT does not transmit the TS1 ordered sets.
4. Examiner transmits the TS1 ordered sets and waits to receive TS2 ordered sets with Reset bit asserted.

   The test fails if the PUT does not transmit the TS2 ordered sets with Reset bit asserted.
5. Examiner transmits at least 16 TS2 ordered sets with Reset bit asserted, followed by TWO consecutive TS2 ordered sets with Reset bit de-asserted.

   The test fails if the PUT does not transmit FOUR consecutive TS2 ordered sets with Reset bit de-asserted or does not transmit Idle Symbols.
6. Examiner transmits Sixteen Idle Symbols.

The test fails if the PUT does not transmit the Header Sequence Number Advertisement and the Rx Header Buffer Credit Advertisement once in U0.

Examiner keeps the link active by sending LDNs for 20us.

The test fails if the PUT transmits the Port Capability LMP.

Specification Reference

Sections 7.2.4.1.1#6,8,17,22 ● 7.4.2#2,4,10 ● 7.5.4.6.1#1 ● 7.5.4.7.2#3 7.5.10.4.1#1 ● 7.5.12.3.1#1,2 ● 7.5.12.3.2#1 ● 7.5.12.4.1#1 ● 7.5.12.4.2#1

7.30 Recovery on Three Consecutive Failed RX Header Packets Test

Test Summary

This test verifies that the PUT will enter Recovery if it fails to receive a header packet three consecutive times.

Test Steps and Expected Results

1. Examiner performs steps 1 to 3 of the Link Initialization Sequence.
2. Examiner and the PUT will exchange Port Configuration transactions, but in this case the first packet sent by Examiner will have an invalid CRC-5.

<u>If Examiner is configured as an Upstream Port:</u>

a. LVS waits for the PUT's Port Capability LMP.

b. LVS transmits its Port Capability LMP with an invalid CRC-5.

c. LVS verifies that the PUT replies with an LBAD.

d. LVS transmits a LRTY and then retransmits the packet with invalid CRC-5.

e. LVS verifies that the PUT replies with an LBAD.

f. LVS transmits a LRTY and then retransmits the packet with invalid CRC-5.

g. LVS verifies that the PUT initiates Recovery.

If Examiner is configured as a Downstream Port:

a. LVS waits for the PUT Port Capability LMP.

b. LVS transmits its PUT Port Capability LMP with invalid CRC-5.

c. LVS verifies the PUT replies with an LBAD.

d. LVS transmits a LRTY and then retransmits the packet with invalid CRC-5.

e. LVS verifies the PUT replies with an LBAD.

f. LVS transmits a LRTY and then retransmits the packet with invalid CRC-5

g. LVS verifies that the PUT initiates Recovery.

The test passes if the following are true:

- All exchanges are correct, no timeout is detected, and the PUT responds to the first two invalid packets with an LBAD.
- The PUT initiates a Recovery within tLinkTurnAround after the third invalid packet, and does not send an LBAD at this point.
- The Recovery is not initiated before the third invalid packet is received.

The value of tLinkTurnAround is 500ns and is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

Specification Reference

Sections 7.2.4.1.1#7,9 • 7.2.4.1.4#5 • 7.5.10.3.1#1 • 7.5.10.3.2#1 • 7.5.10.4.2#1 7.5.10.5.1#1 • 7.5.10.5.2#1

7.31 Hot Reset Failure Test (Downstream Port Only)

Test Summary

This test verifies that the PUT initiates a Warm Reset when Hot Reset training fails.

Test Steps and Expected Results

1. Examiner performs steps 1 to 3 of the Link Initialization Sequence to bring the link to U0.

2. Examiner software prompts the test operator to initiate a Hot Reset on the PUT through USB30CV.

3. Examiner waits for the PUT to send TS1s.

The test fails if TS1s are not sent by the PUT.

4. When Examiner detects TS1s from the PUT, it starts the tHotResetTimeoutToWarmReset timer. Examiner does not transmit anything in response to the PUT.

The value tHotResetTimeoutToWarmReset deadline is 12ms, but is given a "calculated test time" expiration of 18.5ms. This calculated test time is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

The test fails if the PUT does not transmit a Warm Reset LFPS within tHotResetTimeoutToWarmReset (12ms to 18.5ms).

5. Examiner responds to the Warm Reset LFPS by entering Rx.Detect.

6. Examiner and PUT perform the Link Initialization Sequence to bring Examiner and PUT link to U0.

The test passes if the exchanges are correct, the Port Configuration Transaction is correct, and the link remains in U0 for at least 50ms.

Specification Reference

Sections 7.4.2#6,#8,#14 ● 7.5.3.3.1#1 ● 7.5.10.3.2#5 ● 10.3.1.6#6

7.32 Deprecated

7.33 Exit Compliance Mode Test (Upstream Port Only)

Test Summary

This test verifies that a device exits Compliance Mode when it receives a Warm Reset LFPS.

Test Steps and Expected Results

1. Examiner removes VBUS (to assure a PowerOn Reset).

2. Examiner turns on VBUS, bringing the link to Rx.Detect.

3. Examiner presents terminations and waits for the PUT to present terminations.

4. When Examiner detects Terminations from the PUT, Examiner starts the tPollingLFPSTimeout timer and does not transmit an LFPS.

> The value tPollingLFPSTimeout deadline is 360ms, but is given a "calculated test time" expiration of 542.7005ms. This calculated test time is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

5. When the timer expires, Examiner verifies that the device is in Compliance Mode by sending Ping.LFPS until it can verify that Examiner is receiving a Compliance Pattern (at most by the COMs in the 4th Compliance Pattern).

The test fails if Examiner cannot verify a Compliance Pattern coming from the PUT.

6. Examiner transmits a Warm Reset LFPS and enters Rx.Detect.

7. Examiner and PUT perform the Link Initialization Sequence to bring Examiner and PUT link to U0.

The test passes if all exchanges are correct and the PUT stays in U0 for 50ms.

Specification Reference

Sections 7.4.2#9 ● 7.5.4.3.2#1 ● 7.5.5.1#2 ● 7.5.5.2#2

7.34 Exit Compliance Mode Test (Downstream Port Only)

Test Summary

This test verifies that a downstream port instructed to Reset while in Compliance Mode initiates a Warm Reset.

Test Steps and Expected Results

1. Examiner prompts the test operator to power cycle the PUT machine.

2. Examiner waits for VBUS and terminations from the PUT.

3. When Examiner detects VBUS and terminations from the PUT, Examiner starts the tPollingLFPSTimeout timer and does not transmit an LFPS.

The value tPollingLFPSTimeout deadline is 360ms, but is given a “calculated test time” expiration of 542.7005ms. This calculated test time is defined in the USB 3.0 Link Layer Test Specification, Section 4. Please refer to that document for details.

4. When the timer expires, Examiner verifies that the device is in Compliance Mode by sending Ping.LFPS until it can verify that Examiner is receiving a Compliance Pattern, (at most by the COMs in the 4th Compliance Pattern).

The test fails if Examiner cannot verify a Compliance Pattern coming from the PUT.

5. Examiner prompts the test operator to Reset the PUT through USB30CV and then hit “OK”.

6. Examiner waits to receive a Warm Reset LFPS from the PUT.

The test fails if Examiner does not receive a Warm Reset LFPS before the test operator hits “OK”

7. Examiner closes the prompt automatically when it receives a Warm Reset LFPS.

8. Examiner transitions to Rx.Detect.Reset for the duration of the Warm Reset LFPS.

9. Examiner transitions to Rx.Detect and Examiner and PUT transition through Polling to U0.

The test passes if all exchanges are correct and the link stays in U0 for 50ms.

Specification Reference

Sections 7.4.2#9 ● 7.5.4.3.2#2 ● 7.5.5.1#2 ● 7.5.5.2#1

7.35 Exit U3 by Reset Test (Downstream Port Only)

Test Summary

This test verifies that a downstream port instructed to Reset during U3 initiates a Warm Reset.

Test Steps and Expected Results

1. Perform the Link Initialization Sequence to bring Examiner and PUT link to U0.

2. Examiner software prompts the test operator to Suspend the PUT to U3 through USB30CV.

3. Examiner waits to receive an LGO_U3 from the PUT.

4. Examiner sends an LAU when it receives the LGO_U3 from the PUT.

5. Examiner waits to receive an LPMA from the PUT.

The test fails if Examiner does not receive an LGO_U3, LPMA, or fails to transition to U3.

6. Examiner prompts the test operator to Reset the PUT through USB30CV and then hit “OK”.

7. Examiner waits to receive a Warm Reset LFPS from PUT.

The test fails if no Warm Reset LFPS is received by Examiner before the test operator hits “OK”.

8. When Examiner receives a Warm Reset LFPS, the prompt is closed automatically.

9. Examiner transitions to Rx.Detect.Reset for the duration of the Warm Reset LFPS.

10. Examiner transitions to Rx.Detect and Examiner and PUT transition through Polling to U0.

The test passes if all exchanges are correct and the link stays in U0 for 50ms.

Specification Reference

Sections 7.2.4.2.4#1,4,5 ● 7.5.9.2#2

7.36 Exit U3 Test (Host Downstream Port Only)

Test Summary

This test verifies that a downstream port initiates U3 Exit with a U3 Exit LFPS.

The operator must install the Product-Specific host controller driver to perform this test. This TD cannot be tested with the CV compliance driver.

Test Steps and Expected Results

1. Perform the Link Initialization Sequence to bring Examiner and PUT link to U0.

Examiner will be enumerated by the host PUT as a device.

2. Examiner software prompts the test operator to put the host controller machine to sleep.
3. Examiner waits to receive an LGO_U3 from the PUT.
4. Examiner sends an LAU when it receives an LGO_U3 from the PUT.
5. Examiner waits to receive an LPMA from the PUT.

The test fails if Examiner does not receive an LGO_U3, LPMA, or fails to transition to U3.

6. Examiner prompts the test operator to verify that the host controller machine is in a sleep state.
7. Examiner prompts the test operator to wake the host controller machine.
8. Examiner waits to receive a U3 Exit LFPS from the PUT.

The test fails if no U3 Exit LFPS was sent.

9. Examiner sends a U3 Exit LFPS and Examiner and PUT transition through Recovery to U0 (and stays there for 50ms).

The test passes after the Port Configuration transaction if all exchanges are correct.

Specification Reference

Sections 7.2.4.2.4#1,4,5 ● 7.2.4.2.7#1 ● 7.5.9.1#4 ● 7.5.9.2#5

7.37 Packet Pending Test (Upstream Port Only)

Test Summary

This test verifies the PUT releases its Packet Pending (PP) flag at the end of a control transfer.

Test Steps and Expected Results

1. Perform the Link Initialization Sequence to bring Examiner and PUT link to U0.

2. Examiner sends a SETUP packet to initiate a Device Descriptor transfer. The Packet Pending (PP) bit is set (1) in this packet. This bit remains set (1) through the IN phase.

3. In the Status Phase of the Device Descriptor transfer, Examiner clears (0) the PP bit.

The test fails if the GetDescriptor request is not completed.

4. Examiner sends an LGO_U1 and waits to receive LAU from the PUT.

The test fails if the PUT does not send an LAU.

5. Examiner transmits an LPMA and then transitions to U1.

The test fails if the PUT does not transition to U1, or if the PUT sends any packet at this point.

Specification Reference

Section 8.6.1

8. Mass Storage Class Tests

Tests in this section are derived from the USB Mass Storage Device Compliance Specification, available at www.usb.org.

Examiner will not make these tests available unless the device under test includes a mass storage interface.

In most test cases in this section, testing begins with a sequence that includes an Inquiry command, a Test Unit Ready Command, and a Read Capacity command. If this initial Inquiry command fails to complete, the test is failed. The Test Unit Ready command may be repeated until it is completed successfully. The Read Capacity command is typically used to determine device block size.

In some cases, if an endpoint is stalled, Examiner may issue a Set Feature request to clear the stall.

8.1 Interface Descriptor Test

Test Summary

This test verifies several attributes of the interface and configuration descriptors.

Test Steps and Expected Results

1. Examiner initializes the link to U0.
2. Examiner issues several standard descriptor requests, including a configuration descriptor request after the device is configured.

The test fails if any of the requirements listed below are not met:

- Configuration descriptor must contain at least 9 bytes
- *bInterfaceSubClass* must be in the range 0x01 - 0x06
- bNumEndpoints >= 2
- *bInterfaceProtocol* must be 0x50 (BOT) or 0x00 or 0x01 (CBI) or 0x62 (UAS)
- Interface must have at least one BULK IN endpoint descriptor
- At least one mass storage interface descriptor must exist

Specification Reference

USB Mass Storage Device Compliance Specification TD1.1.

8.2 Serial Number Test

Test Summary

This test verifies several attributes of the interface, configuration, and string descriptors.

Test Steps and Expected Results

1. Examiner initializes the link to U0.

2. Examiner issues several standard descriptor requests, including a configuration descriptor request after the device is configured and requests for string descriptors.

The test fails if any of the requirements listed below are not met:

- Device descriptor must contain at least 18 bytes
- Configuration descriptor must contain at least 9 bytes
- The iSerialNumber != 0
- Language IDs descriptor must contain at least 4 bytes
- *bLength* must be even and greater than or equal to 26
- String descriptor must contain at least 2 bytes
- *bLength* must be the same as first
- bDescriptorType == 0x03
- String descriptor must contain at least 2 bytes
- *bLength* must be the same as first
- bDescriptorType == 0x03
- Serial number characters must be within the range 0-9 or A-F
- Last 12 serial number characters must not all be 0
- String descriptor must contain at least 2 bytes
- *bLength* must be the same as first
- Serial number must still be the same after re-enumeration

Specification Reference

USB Mass Storage Device Compliance Specification TD1.2.

8.3 Class-Specific Request Test

Test Summary

This test verifies that the PUT responds properly to various correct and incorrect class requests, including Get Max LUN requests and BOT requests.

Test Steps and Expected Results

1. Examiner initializes the link to U0.
2. Examiner issues several standard descriptor requests.
3. Examiner sends a correct Get Max LUN request.

The test fails if any of the requirements listed below are not met:

- The PUT must stall or complete this request
- The PUT must return one byte as requested

The PUT must reply with Max LUN in the range of 0x00 through 0x0F inclusive

4. Examiner sends four incorrect Get Max LUN requests, followed by a correct Get Max LUN request.

The test fails if any of the requirements listed below are not met:

- The PUT must stall the first two incorrect requests and complete or stall the last two incorrect requests.
- The PUT must complete or stall the correct Get Max LUN request (the PUT's response must be the same response as received in step 3 above.

5. Examiner sends a correct BOT request, followed by three incorrect BOT requests, followed by a correct BOT request.

The test fails if any of the requirements listed below are not met:

- The PUT must complete both correct requests.
- The PUT must stall the three incorrect requests.

Specification Reference

USB Mass Storage Device Compliance Specification TD1.3.

8.4 Error Recovery Test

Test Summary

Examiner sends a series of correct and incorrect mass storage class commands, Clear Features requests, and Get Status requests, and verifies proper device responses, including several involving halt conditions and stall responses.

Test Steps and Expected Results

1. Examiner initializes the link to U0.

2. Examiner issues several standard descriptor requests, including a configuration descriptor request after the device is configured and requests for string descriptors.

3. Examiner issues a Read Capacity command with an incorrect signature in the command block word.

   ✓ **Device must complete the command transport.**

4. Examiner sends a series of IN and OUT requests, then sends a Get Status to the IN endpoint.

   ✓ **Device must stall the IN requests and respond as halted to the Get Status request.**

   ✓ **Device must stall or complete the OUT requests.**

5. Examiner sends Clear Feature and Get Status requests to the IN and OUT endpoints.

   ✓ **Device IN and OUT endpoint must not be halted.**

6. Examiner sends a mass storage command with a CBW truncated to 30 bytes.

   ✓ **Device must complete the command transport.**

7. Examiner sends a series of IN requests.

   ✓ **Device must stall the IN requests**

8. Examiner sends Clear Feature and Get Status requests to the IN and OUT endpoints.

   ✓ **Device IN and OUT endpoint must not be halted.**

9. Examiner sends a mass storage command with a CBW padded to 32 bytes.

   ✓ **Device must complete the command transport.**

10. Examiner sends a series of IN transactions.

    ✓ **Device must stall the IN requests.**

11. Examiner sends Clear Feature requests to the IN and OUT endpoints.

    ✓ **Device IN and OUT endpoint must not be halted.**

12. Examiner sends a Test Unit Ready command.

Device must complete the Test Unit Ready command.

Specification Reference

USB Mass Storage Device Compliance Specification TD1.4.

8.5 Case 1 Test

Test Summary

Examiner sends a series of mass storage class requests intended to confirm the case:

Hn = Dn: neither host nor device want to transfer data.

Test Steps and Expected Results

1. Examiner initializes the link to U0.

2. Examiner issues several standard descriptor requests and places the device into the configured state.

3. Examiner issues an Inquiry command (Data Transfer Length = 36 bytes), a Test Unit Ready command (Data Transfer Length = 0 bytes), and a Read Capacity command (Data Transfer Length = 8 bytes).

   Multiple Test Unit Ready commands may be issued until the device reports it is ready.

4. To induce the Case 1 behavior, Examiner issues a Test Unit Ready command with CBWDataTransferLength = 0x0000.

The test fails if any of the requirements listed below are not met:

- In each Status Transport, the CSW must be 13 bytes in length.
- In each Status Transport, the Signature must match the CBW.
- In each Status Transport, the *dDataResidue* field must be equal to 0 Bytes.
- In each Status Transport, the *bStatus* field must be equal to 0x00 (Command Passed) or 0x01 (Command Failed).

Specification Reference

USB Mass Storage Device Compliance Specification TD1.5.

8.6 Case 2 Test

Test Summary

Examiner sends a series of mass storage class requests intended to confirm the case:

> *Hn < Di: host wants to transfer no data, device wants to transfer data IN.*

Test Steps and Expected Results

1. Examiner initializes the link to U0.
2. Examiner issues several standard descriptor requests and places the device into the configured state.
3. Examiner issues an Inquiry command (Data Transfer Length = 36 bytes), a Test Unit Ready command (Data Transfer Length = 0 bytes), and a Read Capacity command (Data Transfer Length = 8 bytes).

Multiple Test Unit Ready commands may be issued until the device reports it is ready.

4. To induce the Case 2 behavior, Examiner issues a Read (10) command with CBWDataTransferLength = 0x0000 and Transfer Length = 1 block.
5. Examiner issues a Request Sense command.

The test fails if any of the requirements listed below are not met:

- The CSW must be 13 bytes in length
- The Signature must match the CBW
- The *dDataResidue* field must be equal to 0 Bytes.
- The *bStatus* field must be equal to must be equal to 0x01 (Command Failed) or 0x02 (Phase Incorrect).

Specification Reference

USB Mass Storage Device Compliance Specification TD1.6.

8.7 Case 3 Test

Test Summary

Examiner sends a series of mass storage class requests intended to confirm the case:

> *Hn < Do: host wants to transfer no data, device wants to transfer data OUT.*

Test Steps and Expected Results

1. Examiner initializes the link to U0.
2. Examiner issues several standard descriptor requests and places the device into the configured state.
3. Examiner issues an Inquiry command (Data Transfer Length = 36 bytes), a Test Unit Ready command (Data Transfer Length = 0 bytes), and a Read Capacity command (Data Transfer Length = 8 bytes).

   Multiple Test Unit Ready commands may be issued until the device reports it is ready.

4. To induce the Case 3 behavior, Examiner issues a Write (10) command with CBWDataTransferLength = 0x0000 and Transfer Length = 1 block.
5. Examiner issues a Request Sense command.

The test fails if any of the requirements listed below are not met:

- The returned CSW must be 13 bytes in length.
- The signature must be correct.
- The Tag must match the Tag on the CBW.
- The *dDataResidue* field must be equal to 0 Bytes.
- The *bStatus* field must be equal to must be equal to 0x01 (Command Failed) or 0x02 (Phase Incorrect).

Specification Reference

USB Mass Storage Device Compliance Specification TD1.7.

8.8 Case 4 Test

Test Summary

Examiner sends a series of mass storage class requests intended to confirm the case:

> *Hi > Dn: host wants to transfer data IN, device wants to transfer no data.*

Test Steps and Expected Results

1. Examiner initializes the link to U0.

2. Examiner issues several standard descriptor requests and places the device into the configured state.

3. Examiner issues an Inquiry command (Data Transfer Length = 36 bytes), a Test Unit Ready command (Data Transfer Length = 0 bytes), and a Read Capacity command (Data Transfer Length = 8 bytes).

   Multiple Test Unit Ready commands may be issued until the device reports it is ready.

4. To induce the Case 4 behavior, Examiner issues a Read (10) with CBWDataTransferLength = `BlockSize`, Transfer Length = 0 blocks, and Direction = Data IN.

   The test fails if any of the requirements listed below are not met:

   - The returned CSW must be 13 bytes in length.
   - The signature must be correct.
   - The Tag must match the Tag on the CBW.
   - The *dDataResidue* field must be equal to 0 Bytes.
   - In each Status Transport, the *bStatus* field must be equal to 0x00 (Command Passed) or 0x01 (Command Failed).

Specification Reference

USB Mass Storage Device Compliance Specification TD1.8.

8.9 Case 5 Test

Test Summary

Examiner sends a series of mass storage class requests intended to confirm the case:

> *Hi > Di: host wants to transfer data IN, device wants to transfer less data IN.*

Test Steps and Expected Results

1. Examiner initializes the link to U0.

2. Examiner issues several standard descriptor requests and places the device into the configured state.

3. Examiner issues an Inquiry command (Data Transfer Length = 36 bytes), a Test Unit Ready command (Data Transfer Length = 0 bytes), and a Read Capacity command (Data Transfer Length = 8 bytes).

   Multiple Test Unit Ready commands may be issued until the device reports it is ready.

4. To induce the Case 5 behavior, Examiner issues a Read (10) with CBWDataTransferLength = `BlockSize x2`, Transfer Length = 1 block, and Direction = Data IN.

The test fails if any of the requirements listed below are not met:

- The returned CSW must be 13 bytes in length.
- The signature must be correct.
- The Tag must match the Tag on the CBW.

The *dDataResidue* field must be equal to 0 Bytes.

In each Status Transport, the *bStatus* field must be equal to 0x00 (Command Passed) or 0x01 (Command Failed).

Specification Reference

USB Mass Storage Device Compliance Specification TD1.9.

8.10 Case 6 Test

Test Summary

Examiner sends a series of mass storage class requests intended to confirm the case:

Hi = Di: host and device want to transfer the same amount of data.

Test Steps and Expected Results

1. Examiner initializes the link to U0.
2. Examiner issues several standard descriptor requests and places the device into the configured state.
3. Examiner issues an Inquiry command (Data Transfer Length = 36 bytes), a Test Unit Ready command (Data Transfer Length = 0 bytes), and a Read Capacity command (Data Transfer Length = 8 bytes).

   Multiple Test Unit Ready commands may be issued until the device reports it is ready.

4. To induce the Case 6 behavior, Examiner issues a Read (10) with CBWDataTransferLength = `BlockSize`, Transfer Length = 1 block, and Direction = Data IN.

The test fails if any of the requirements listed below are not met:

- The returned CSW must be 13 bytes in length.
- The signature must be correct.
- The Tag must match the Tag on the CBW.
- The dDataResidue field must be equal to 0 Bytes.
- The bStatus field must be equal to 0x00 (Command Passed) or 0x01 (Command Failed).

Specification Reference

USB Mass Storage Device Compliance Specification TD1.10.

8.11 Case 7 Test

Test Summary

Examiner sends a series of mass storage class requests intended to confirm the case:

> *Hi < Di: host wants to transfer data IN, device wants to transfer more data IN.*

Test Steps and Expected Results

1. Examiner initializes the link to U0.
2. Examiner issues several standard descriptor requests and places the device into the configured state.
3. Examiner issues an Inquiry command (Data Transfer Length = 36 bytes), a Test Unit Ready command (Data Transfer Length = 0 bytes), and a Read Capacity command (Data Transfer Length = 8 bytes).

   Multiple Test Unit Ready commands may be issued until the device reports it is ready.

4. To induce the Case 7 behavior, Examiner issues a Read (10) with CBWDataTransferLength = `BlockSize`, Transfer Length = 2 blocks, and Direction = Data IN.
5. Examiner issues a Request Sense command.

The test fails if any of the requirements listed below are not met:

- The returned CSW must be 13 bytes in length.
- The signature must be correct.
- The Tag must match the Tag on the CBW.
- The *dDataResidue* field must be equal to 0 Bytes.
- The *bStatus* field must be equal to must be equal to 0x01 (Command Failed) or 0x02 (Phase Incorrect).

Specification Reference

USB Mass Storage Device Compliance Specification TD1.11.

8.12 Case 8 Test

Test Summary

Examiner sends a series of mass storage class requests intended to confirm the case:

> *Hi <> Do: host wants to transfer data IN, device wants to transfer data OUT.*

Test Steps and Expected Results

1. Examiner initializes the link to U0.

2. Examiner issues several standard descriptor requests and places the device into the configured state.

3. Examiner issues an Inquiry command (Data Transfer Length = 36 bytes), a Test Unit Ready command (Data Transfer Length = 0 bytes), and a Read Capacity command (Data Transfer Length = 8 bytes).

   Multiple Test Unit Ready commands may be issued until the device reports it is ready.

4. To induce the Case 8 behavior, Examiner issues a Write (10) with CBWDataTransferLength = `BlockSize`, Transfer Length = 1 block and Direction = Data IN.

The test fails if any of the requirements listed below are not met:

- The returned CSW must be 13 bytes in length.
- The signature must be correct.
- The Tag must match the Tag on the CBW.
- The *dDataResidue* field must be equal to 0 Bytes.
- The *bStatus* field must be equal to must be equal to 0x01 (Command Failed) or 0x02 (Phase Incorrect).

Specification Reference

USB Mass Storage Device Compliance Specification TD1.12.

8.13 Case 9 Test

Test Summary

Examiner sends a series of mass storage class requests intended to confirm the case:

Ho > Dn: host wants to transfer data OUT, device wants to transfer no data.

Test Steps and Expected Results

1. Examiner initializes the link to U0.

2. Examiner issues several standard descriptor requests and places the device into the configured state.

3. Examiner issues an Inquiry command (Data Transfer Length = 36 bytes), a Test Unit Ready command (Data Transfer Length = 0 bytes), and a Read Capacity command (Data Transfer Length = 8 bytes).

   Multiple Test Unit Ready commands may be issued until the device reports it is ready.

4. To induce the Case 9 behavior, Examiner issues a Test Unit Ready with CBWDataTransferLength = `BlockSize` and Direction = Data OUT.

The test fails if any of the requirements listed below are not met:

- The returned CSW must be 13 bytes in length.
- The signature must be correct.
- The Tag must match the Tag on the CBW.
- The dDataResidue field must be equal to 512 Bytes.
- The bStatus field must be equal to 0x00 (Command Passed) or 0x01 (Command Failed).

Specification Reference

USB Mass Storage Device Compliance Specification TD1.13.

8.14 Case 10 Test

Test Summary

Examiner sends a series of mass storage class requests intended to confirm the case:

> *Ho <> Di: host wants to transfer data OUT, device wants to transfer data IN.*

Test Steps and Expected Results

1. Examiner initializes the link to U0.

2. Examiner issues several standard descriptor requests and places the device into the configured state.

3. Examiner issues an Inquiry command (Data Transfer Length = 36 bytes), a Test Unit Ready command (Data Transfer Length = 0 bytes), and a Read Capacity command (Data Transfer Length = 8 bytes).

   Multiple Test Unit Ready commands may be issued until the device reports it is ready.

4. To induce the Case 10 behavior, Examiner issues a Read (10) with CBWDataTransferLength = `BlockSize`, Transfer Length = 1 block, and Direction = Data OUT.

   The test fails if any of the requirements listed below are not met:

   - The returned CSW must be 13 bytes in length.
   - The signature must be correct.
   - The Tag must match the Tag on the CBW.
   - The *dDataResidue* field must be equal to 0 Bytes.
   - The *bStatus* field must be equal to must be equal to 0x01 (Command Failed) or 0x02 (Phase Error).

Specification Reference

USB Mass Storage Device Compliance Specification TD1.14.

8.15 Case 11 Test

Test Summary

Examiner sends a series of mass storage class requests intended to confirm the case:

> *Ho > Do: host wants to transfer data OUT, device wants to transfer less data OUT.*

Test Steps and Expected Results

1. Examiner initializes the link to U0.

2. Examiner issues several standard descriptor requests and places the device into the configured state.

3. Examiner issues an Inquiry command (Data Transfer Length = 36 bytes), a Test Unit Ready command (Data Transfer Length = 0 bytes), and a Read Capacity command (Data Transfer Length = 8 bytes).

   Multiple Test Unit Ready commands may be issued until the device reports it is ready.

4. To induce the Case 11 behavior, Examiner issues a Write (10) with CBWDataTransferLength = `BlockSize x2`, Transfer Length = 1 block, and Direction = Data OUT.

The test fails if any of the requirements listed below are not met:

- The returned CSW must be 13 bytes in length.
- The signature must be correct.
- The Tag must match the Tag on the CBW.
- The dDataResidue field must be equal to 512 Bytes.
- The bStatus field must be equal to 0x00 (Command Passed) or 0x01 (Command Failed).

Specification Reference

USB Mass Storage Device Compliance Specification TD1.15.

8.16 Case 12 Test

Test Summary

Examiner sends a series of mass storage class requests intended to confirm the case:

> *Ho = Do: host and device want to transfer to same amount of data OUT.*

Test Steps and Expected Results

1. Examiner initializes the link to U0.

2. Examiner issues several standard descriptor requests and places the device into the configured state.

3. Examiner issues an Inquiry command (Data Transfer Length = 36 bytes), a Test Unit Ready command (Data Transfer Length = 0 bytes), and a Read Capacity command (Data Transfer Length = 8 bytes).

   Multiple Test Unit Ready commands may be issued until the device reports it is ready.

4. To induce the Case 12 behavior, Examiner issues a Write (10) with CBWDataTransferLength = `BlockSize x2`, Transfer Length = 2 blocks, and Direction = Data OUT.

   The test fails if any of the requirements listed below are not met:

   - The returned CSW must be 13 bytes in length.
   - The signature must be correct.
   - The Tag must match the Tag on the CBW.
   - The dDataResidue field must be equal to 0 Bytes.
   - The bStatus field must be equal to 0x00 (Command Passed) or 0x01 (Command Failed).

Specification Reference

USB Mass Storage Device Compliance Specification TD1.16.

8.17 Case 13 Test

Test Summary

Examiner sends a series of mass storage class requests intended to confirm the case:

> *Ho < Do: host wants to transfer data OUT, device wants to transfer more data OUT.*

Test Steps and Expected Results

1. Examiner initializes the link to U0.

2. Examiner issues several standard descriptor requests and places the device into the configured state.

3. Examiner issues an Inquiry command (Data Transfer Length = 36 bytes), a Test Unit Ready command (Data Transfer Length = 0 bytes), and a Read Capacity command (Data Transfer Length = 8 bytes).

   Multiple Test Unit Ready commands may be issued until the device reports it is ready.

4. To induce the Case 13 behavior, Examiner issues a Write (10) with CBWDataTransferLength = `BlockSize`, Transfer Length = 2 blocks, and Direction = Data OUT.

   The test fails if any of the requirements listed below are not met:

   - The returned CSW must be 13 bytes in length.
   - The signature must be correct.
   - The Tag must match the Tag on the CBW.
   - The dDataResidue field must be equal to 0 Bytes.
   - The bStatus field must be equal to must be equal to 0x01 (Command Failed) or 0x02 (Phase Error).

Specification Reference

USB Mass Storage Device Compliance Specification TD1.17.

8.18 bCB Length Test

Test Summary

This test verifies that the device under test ignores all bytes in the CBWCB field beyond what is indicated by bCBWLength.

Examiner sends three Inquiry commands, each padded with different values (0xFF, 0x55, and 0xAA) from Byte 6 through Byte 15 and verifies that the device properly completes these requests.

Test Steps and Expected Results

1. Examiner initializes link to U0.
2. Examiner issues several standard descriptor requests and places the device into the configured state.
3. Examiner issues an Inquiry command padded with 0xFF.

   ✓ **The device must complete the request.**

4. Examiner issues an Inquiry command padded with 0x55.

   ✓ **The device must complete the request.**

5. Examiner issues an Inquiry command padded with 0xAA.

   ✓ **The device must complete the request.**

Specification Reference

USB Mass Storage Device Compliance Specification TD1.19.

8.19 Required Commands Test

Test Summary

This test verifies that the device under test properly supports all required commands. Examiner sends various required mass storage commands and checks that each is completed properly. Examiner also advises on Bootability support.

For PDT (device type) = 07h, 00h, 0Eh, required commands include Inquiry, Read (10), Request Sense, Test Unit Ready, Read Capacity, and Write (10).

For PDT (device type) = 05h, required commands include Inquiry, Read (12), Request Sense, Test Unit Ready, Read Capacity, Start/Stop Unit, Read TOC/PMA/ATIP, and Write (12).

For PDT (device type) = other, required commands include Inquiry, Request Sense, and Test Unit Ready.

Test Steps and Expected Results

1. Examiner initializes link to U0.
2. Examiner issues several standard descriptor requests and places the device into the configured state.
3. Examiner issues an Inquiry, Test Unit Ready, and a Read Capacity command.
4. Examiner issues commands required, including varied Data Transfer Length values on certain commands.

The device must complete each of the commands successfully.

Specification Reference

USB Mass Storage Device Compliance Specification TD2.1.

8.20 Optional Commands Test

Test Summary

This test verifies that the device under test properly fails or completes all optional commands. Examiner sends various optional mass storage commands and checks that each is completed properly. Examiner also advises on Bootability support.

For PDT (device type) = 07h, 00h, 0Eh, optional commands include Mode Sense (10), Read (12), Write (12) Mode Select (6), Mode Select (10), Mode Sense (6), Prevent/Allow Medium Removal, Read Format Capacity, Start/Stop Unit, and Synchronize Cache.

For PDT (device type) = 05h, optional commands include Mode Sense (10), Read (10), Write (10), Mode Select (6), Mode Select (10), Mode Sense (6), Prevent/Allow Medium Removal, Read Format Capacity, and Synchronize Cache.

For PDT (device type) = other, optional command is Mode Sense (10).

Test Steps and Expected Results

1. Examiner initializes link to U0.
2. Examiner issues several standard descriptor requests and places the device into the configured state.
3. Examiner issues an Inquiry, Test Unit Ready, and a Read Capacity command.
4. Examiner issues optional commands.

The device must properly complete or fail each of the optional commands.

Specification Reference

USB Mass Storage Device Compliance Specification TD2.2.

9. Device Framework Tests

Tests in this section are derived from the USB Command Verifier (CV) Compliance Test Specification for the USB 3.0 Architecture, available at www.usb.org.

9.1 Device Descriptor Test

Test Summary

Examiner checks the device descriptor for proper format. The test is performed three times- once each for the default, addressed, and configured states.

Test Steps and Expected Results

1. Examiner initializes link to U0.

2. Examiner issues several standard descriptor requests, including a device descriptor request.

   The device descriptor must contain at least 18 bytes.

   The *bLength* field must be set to 18.

   The *bDescriptorType* field must be set to DEVICE descriptor type.

   The *bcdUSB*.hibyte must be 0x03.

   The *bcdUSB*.lowbyte must be 0x00.

   If the *bDeviceClass* field is 0x00, the *bDeviceSubClass* field must be 0x00.

   The *bMaxPacketSize0* field must be 0x09.

   The *idVendor* field must be in the list of valid entries maintained by the USB-IF.

   The *bNumConfigurations* field must NOT be 0x00.

Specification Reference

USB Command Verifier Compliance Test Specification TD9.1.

9.2 Standard Configuration Descriptor Test

Test Summary

Examiner verifies that the configuration descriptor request is completed properly. The test is performed three times- once each for the default, addressed, and configured states.

Test Steps and Expected Results

1. Examiner initializes link to U0.

2. Examiner issues several standard descriptor requests, including a several Configuration Descriptor requests (both short and long). Various attributes of the Configuration Descriptor are verified. Various attributes of embedded descriptors are also checked (Endpoint, Interface, etc.). The test also verifies that the Other Speed Configuration descriptor request is stalled.

   ✓ **The configuration descriptor must be at least 9 bytes in length.**

   ✓ **The *bLength* field must be equal to 0x09.**

   ✓ **The *bDescriptorType* field must be equal to CONFIGURATION (0x02).**

   ✓ **The *bLength* field must be equal to 0x09.**

   ✓ **Other descriptors types (*bDescriptorType*) included within the Configuration Descriptor response from the device must be equal to ENDPOINT (0x05), INTERFACE (0x04), CS_INTERFACE, or CS_INTERFACE_ASSOCIATION.**

   ✓ **The *bNumInterfaces* field in the Configuration Descriptor must be equal to the quantity of Interface Descriptors.**

   ✓ **The *bNumEndpooints* field in the Interface Descriptor(s) must be equal to quantity of endpoints included in each interface.**

   ✓ **The *bNumEndpooints* field in the Interface Descriptor(s) must NOT be equal to zero.**

- ✓ **Bits D0 through D4 of the *bmAttributes* field in the Configuration Descriptor must be equal to 00000b.**
- ✓ **Bit D7 of the *bmAttributes* field in the Configuration Descriptor must be equal to 1b.**
- ✓ **If the *SelfPowered* bit in the Configuration Descriptor is set to 1b, the bMaxPower field should be set to less than 0x18 (144ma).**
- ✓ **The device must stall the Other Speed Configuration Descriptor request.**

Specification Reference

USB Command Verifier Compliance Test Specification TD9.2.

9.3 Reserved

9.4 Standard Interface Descriptors Test

Test Summary

Examiner verifies that all Interface Descriptors are formatted properly. Some checks are also made on the Configuration Descriptor. The test is performed three times- once each for the default, addressed, and configured states.

Test Steps and Expected Results

1. Examiner initializes link to U0.
2. Examiner issues several standard descriptor requests, including a several Configuration Descriptor requests (both short and long). Various attributes of the Interface Descriptor are verified. If applicable, the Alternate Setting of Interface 0 is changed, and Examiner verifies this changes takes place.

   - ✓ **The configuration descriptor must be at least 9 bytes in length.**
   - ✓ **The *bLength* field in the Configuration Descriptor must be equal to 0x09.**
   - ✓ **The *bDescriptorType* field in the Configuration Descriptor must be equal to CONFIGURATION (0x02).**
   - ✓ **At least one interface must exist.**

✓ **For interface 0, *bInterfaceNumber* must be equal to 0 (0x00).**

✓ **For interface 0, *bAlternateSetting* must be equal to 0 (0x00).**

✓ **The *bLength* filed in the Interface Descriptor(s) must be greater than 8 (1000b).**

✓ **The *bDescriptorType* field in the Interface Descriptor must be equal to INTERFACE (0x04).**

✓ **Examiner verifies that the device's Interface Descriptor changes its alternate setting.**

3. In the Addressed state test, Examiner sets the Interface to 0 then issues a Get Status request to interface 1, followed by a Set Interface request to interface 1. Expected results described above are applicable, in addition to the expected results below.

✓ **The device MUST stall the Get Status request to interface 1.**

✓ **The device MUST stall the Set Interface request to interface 1.**

Specification Reference

USB Command Verifier Compliance Test Specification TD9.4.

9.5 Endpoint Descriptors Test

Test Summary

Examiner verifies that all Endpoint Descriptors are formatted properly. Some checks are also made on the Configuration Descriptor. The test is performed three times- once each for the default, addressed, and configured states.

Test Steps and Expected Results

1. Examiner initializes link to U0.

2. Examiner issues several standard descriptor requests, including a several Configuration Descriptor requests (both short and long). Various attributes of the Endpoint Descriptors are verified.

✓ **The configuration descriptor must be at least 9 bytes in length.**

- **The *bLength* field in the Configuration Descriptor must be equal to 0x09.**
- **The *bDescriptorType* field in the Configuration Descriptor must be equal to CONFIGURATION (0x02).**
- **The Device Descriptor must contain at least 18 bytes.**
- **The *bLength* field in each Endpoint Descriptor must be greater than 6 bytes.**
- **The *bDescriptorType* field in each Endpoint Descriptor must be equal to ENDPOINT (0x05).**
- **The *bEndpointAddress* field in Each Endpoint Descriptor must not equal 0x00 or 0x80.**
- **Bits D6 and D7 in the *bmAttributes* field of each Endpoint Descriptor must be 00b (these bits are reserved).**
- **Bits D13 through and D15 in the *wMaxPacketSize* field of each Endpoint Descriptor must be 000b.**
- **Bits D2 through D5 in the *bmAttributes* field of each Endpoint Descriptor must be 00b (does not apply to isochronous and interrupt endpoints).**
- **The *wMaxPacketSize* field must be 1024 for bulk endpoints. For interrupt and isochronous endpoints, this value must be 1024 if the *bMaxBurst* field (SuperSpeed Endpoint Companion Descriptor) is greater than zero. If *bMaxBurst* is set to zero, this field can be from 0 to 1024 for an isochronous endpoint, and 1 to 1024 for an interrupt endpoint.**

Control Endpoints are not checked in this test.

- **The *bInterval* field must be set to zero for all bulk endpoints. For isochronous and interrupt endpoints, this value must range between 1 and 16.**

Specification Reference

USB Command Verifier Compliance Test Specification TD9.5.

9.6 SuperSpeed Endpoint Companion Descriptors Test

Test Summary

Examiner verifies that all Endpoint Companion Descriptors are formatted properly. Some checks are also made on the Configuration Descriptor. The test is performed three times- once each for the default, addressed, and configured states.

Test Steps and Expected Results

1. Examiner initializes link to U0.

2. Examiner issues several standard descriptor requests, including a several Configuration Descriptor requests (both short and long).

   ✓ **The configuration descriptor must be at least 9 bytes in length.**

   ✓ **The *bLength* field in the Configuration Descriptor must be equal to 0x09.**

   ✓ **The *bDescriptorType* field in the Configuration Descriptor must be equal to CONFIGURATION (0x02).**

   ✓ **A Companion Descriptor must follow all endpoint descriptors (except for the default control pipe).**

   ✓ **Bits D0 through D4 of the *bmAttributes* field in all Companion Descriptors must be between 0 and 16 for bulk endpoints. For control and interrupt endpoints, bits D0 through D7 are reserved and must be set to 0. For isochronous endpoints, D2 through D7 are reserved and must be set to zero, and D0-D1 may not be set to 11b.**

   ✓ **For all endpoint types, D5 through D7 of the *bmAttributes* field in all Companion Descriptors are reserved and must be 000b.**

   ✓ **The *wBytesPerInterval* field in all Companion Descriptors must be zero for non-periodic endpoints.**

Specification Reference

USB Command Verifier Compliance Test Specification TD9.6.

9.7 BOS and Device Capabilities Descriptor Test

Test Summary

Examiner verifies that all BOS Descriptors are formatted properly, including device capability sub-descriptors that are returned with BOS Descriptor requests. The test is performed three times- once each for the default, addressed, and configured states.

Test Steps and Expected Results

1. Examiner initializes the link to U0.

2. Examiner issues several standard descriptor requests, followed by a short (5 bytes) BOS descriptor request and then a longer request based on the value of the *wTotalLength* field returned in the first request.

BOS

- **The first BOS Descriptor request must return at least 5 bytes.**
- **The *bLength* field in the BOS Descriptor must equal 0x05.**
- **The *bNumCaps* field in the BOS descriptor must match the number of device capability descriptors included.**
- **The *bDescriptorType* field in the BOS Descriptor must be equal to BOS (0x0F).**
- **The second request for the BOS descriptor must return a length equal to *wTotalLength* as shown in the returned BOS descriptor data from the first request.**

All Sub-Descriptors

- **The *bDescriptorType* field in the all sub-descriptors must be equal to DEVICE CAPABILITY (0x10).**
- **The *bDevCapabilityType* field in all sub-descriptors must be equal to USB EXTENSION (0X02), SUPERSPEED USB (0x03), or CONTAINER ID (0x04).**

SuperSpeed USB Sub-Descriptor

- **The *bLength* field in the required SuperSpeed USB sub-descriptor must be equal to ten (0x0A).**
- **Bit D0 in the *bmAttributes* field of the SuperSpeed USB sub-descriptor is reserved and must be set to zero.**
- **Bits D2 through D7 in the *bmAttributes* field of the SuperSpeed USB sub-descriptor are reserved and must be set to zero.**

USB 2.0 Extension Sub-Descriptor

- **The *bLength* field in the required USB 2.0 Extension sub-descriptor must be equal to seven (0x07).**
- **Bit D1 in the *bmAttributes* field of the USB 2.0 Extension sub-descriptor (LPM Support) must be set to one.**
- **Bits D2 through D31 of the *bmAttributes* field in the USB 2.0 Extension sub-descriptor are reserved and must be zero.**

Specification Reference

USB Command Verifier Compliance Test Specification TD9.7.

9.8 String Descriptor Test

Test Summary

Examiner issues a series of requests for any supported String descriptors and verifies fields within these descriptors. Various fields in the Device and Configuration descriptors are also checked.

Test Steps and Expected Results

1. Examiner initializes link to U0.
2. Examiner issues several standard descriptor requests, including a request for the Device descriptor and two Configuration descriptor requests.

Device Descriptor

- **The Device descriptor must be at least 18 bytes in length.**

Configuration Descriptor

- **The first Configuration descriptor must be at least 9 bytes in length.**
- **The second Configuration descriptor must be equal in length to the value of the *wTotalLength* field received in the first request.**

3. Examiner issues a request for String 0 (Language ID).

> Examiner may issue more than one request for String 0, and all requirements listed below apply to each request.

- **String 0 must be at least 4 bytes in length.**
- **The *bLength* field must be equal to or greater than 0x04.**
- **The *bLength* field must be a multiple of 2.**
- **The *bDescriptorType* field must be equal to STRING (0x03).**
- **The *bLength* field must equal the number of bytes returned.**

4. Examiner issues requests for any other supported String descriptors.

- **String descriptor must be at least 2 bytes in length.**
- **The *bLength* field must be equal to or greater than 0x02.**
- **The *bDescriptorType* field must be equal to STRING (0x03).**
- **The *bLength* field must equal the number of bytes returned.**

Specification Reference

USB Command Verifier Compliance Test Specification TD9.8.

9.9 Halt Endpoint Test

Test Summary

Examiner issues a series of requests (Get Status, Set Feature, Clear Feature, Get Status) to ensure the device's bulk and interrupt endpoints properly enter and exit a Halt status. Several fields in the Configuration and Interface descriptors are also checked.

Test Steps and Expected Results

1. Examiner initializes link to U0.

2. Examiner issues several standard descriptor requests, including two requests for the configuration descriptor and a Set Configuration (1).

Configuration Descriptor

- ✓ **The configuration descriptor must be at least 9 bytes in length.**
- ✓ **The *bLength* field in the Configuration descriptor must be equal to 0x09.**
- ✓ **The *bDescriptorType* field in the Configuration descriptor must be equal to CONFIGURATION (0x02).**
- ✓ **The configuration descriptor must show at least one interface descriptor.**

Interface Descriptor

- ✓ **The *bInterfaceNumber* field in the first Interface descriptor must be set to one.**
- ✓ **The *bAlternate Setting* field in the first Interface descriptor must be set to zero.**
- ✓ **The *bLength* field in the first Interface descriptor must be greater than 0x08.**
- ✓ **The *bDescriptorType* field in the first Interface descriptor must be set to INTERFACE (0x04).**

3. Examiner issues a Set Interface (0) with ALT= 0, then a Get Interface.

The Interface settings returned in the Get Interface, including the Alternate setting, corresponds with the request.

4. Examiner issues a sequence of Get Status, Set Feature (Halt), Get Status, Clear Feature (Halt), and Get Status to each interrupt and bulk endpoint.

The endpoint under test halts after the Set Feature and is no longer halted after the Clear Feature.

The Device must complete this request.

Specification Reference

USB Command Verifier Compliance Test Specification TD9.9.

9.10 Bad Descriptor Test

Test Summary

Examiner issues a Get Descriptor request with the *wValue* field set to an invalid value and verifies the device stalls this request. Examiner also verifies that the device remains alive after the invalid Get Descriptor request by verifying proper response to a Device Descriptor request.

Test Steps and Expected Results

Configuration Descriptor

1. Examiner issues a request for the Configuration Descriptor.

The Configuration descriptor must be at least 9 bytes in length.

2. Examiner issues a Get Descriptor with the *wValue* field set to 0x42 (invalid).

The Device must stall this request.

3. Examiner issues a Get Device descriptor request.

The Device must complete this request.

Specification Reference

USB Command Verifier Compliance Test Specification TD9.10.

9.11 Bad Feature Test

Test Summary

Examiner issues a Set Feature request with the *wValue* field set to an invalid value and verifies the device stalls this request, as well as a Clear Feature request. Examiner also verifies that the device remains alive after the Set Feature and Clear Feature requests by verifying proper response to a Device descriptor request.

Test Steps and Expected Results

1. Examiner initializes link to U0.
2. Examiner issues several standard descriptor requests.
3. Examiner issues a Set Feature request with the *wValue* field set to 0x66 (invalid).

   The Device must stall this request.
4. Examiner issues a Get Device descriptor request.

   The Device must complete this request.
5. Examiner issues a Clear feature request with the *wValue* field set to 0x66 (invalid).

   The Device must stall this request.
6. Examiner issues a Get Device descriptor request.

Specification Reference

USB Command Verifier Compliance Test Specification TD9.11.

9.12 Reserved

9.13 Set Configuration Test

Test Summary

Examiner verifies that the device will react properly to Set Configuration requests.

Test Steps and Expected Results

1. Examiner initializes link to U0.

2. Examiner issues several standard descriptor requests.

3. Examiner issues a request for the Configuration Descriptor.

   ✓ **The Configuration Descriptor must be at least 9 bytes in length.**

4. Examiner issues a Set Configuration (1) followed by a Get Configuration request.

   ✓ **The device must indicate a change to configuration 1.**

5. Examiner issues a request for the Configuration Descriptor.

   ✓ **The Configuration Descriptor must be at least 9 bytes in length.**

6. Examiner issues a Set Configuration (1) followed by a Get Configuration request.

   ✓ **The device must indicate a change to configuration 1.**

7. Examiner issues a Set Configuration (0) followed by a Get Configuration request.

   ✓ **The device must indicate a change to configuration 0.**

8. Examiner issues a Set Configuration (1) followed by a Get Configuration request.

   ✓ **The device must indicate a change to configuration 1.**

Specification Reference

USB Command Verifier Compliance Test Specification TD9.13.

9.14 Reserved

9.15 Reserved

9.16 Enumeration Test

Test Summary

Examiner brings the link to U0, disables the link then initiates a recovery to bring the link back to U0. Several standard descriptor requests are issued once the link is in U0. This process is repeated to enumerate the device 20 times.

Test Steps and Expected Results

1. Examiner initializes link to U0.

   ✓ **The link must stay in U0 until Examiner disables the link to force a recovery.**

2. Examiner issues several standard descriptor requests.

   ✓ **Each request must be completed.**

3. Examiner disables the link to force a link recovery sequence.

   ✓ **The device must complete a successful recovery and enumeration for each of the 20 cycles.**

Specification Reference

USB Command Verifier Compliance Test Specification TD9.16.

9.17 Reserved

9.18 Bus- or Self-Powered Tests

Test Summary

Examiner verifies that the device properly supports bits indicating the power scheme employed by the device (bus- or self-powered).

Test Steps and Expected Results

1. Examiner initializes link to U0.

2. Examiner issues several standard descriptor requests.

3. Examiner issues a Get Status (Device) request.

Bit D0 (*SelfPowered*) of the data returned in the Get Status request must match the actual power implementation employed by the device (self-powered or bus-powered).

4. Examiner issues a Get Configuration request.

Bit D6 (*SelfPowered*) of the *bmAttributes* field in the Configuration Descriptor must match Bit D0 (*SelfPowered*) of the data previously returned in the Get Status request.

Specification Reference

TBD

9.19 Device Qualifier Test

Test Summary

Examiner verifies that the device qualifier descriptor request is stalled. The test is performed three times- once each for the default, addressed, and configured states.

Test Steps and Expected Results

1. Examiner initializes link to U0.

2. Examiner issues several standard descriptor requests, including a device qualifier request.

The device descriptor must be 18 bytes in length.

The device must stall the device qualifier request.

Specification Reference

TBD

10. Hub Tests

This section in-process. Contact Ellisys for more information.