USB Compliance Testing Overview

Introduction

One of the secrets to USB's success has been the compliance-testing program. This program verifies that your device meets the specification and works well with other USB devices. Only devices that have passed compliance testing can wear the USB logo. Compliance testing is performed in two ways: USB Compliance Workshops (Plugfests) and Independent Test Lab testing. Both methods will get your device on the Integrators List, USB's list of compliant devices.

Figure 1. USB Logos

Why is testing done?

The USB IF performs compliance testing to insure that all of our customers have a good experience with USB. This is important because all USB vendors are relying on each other to generate goodwill with the public. If a customer has a bad experience with one USB device, he will be much less willing to invest his time and effort in another one.

What is tested?

Compliance testing verifies that your device operates at several different levels. The gold tree test checks driver behavior under Windows and verifies that your device works in a "real world" scenario without interfering with other devices. The USB Command Verifier checks that your devices correctly implements the SETUP commands required by Chapter 9 of the USB spec. The electrical suites verify that your USB signaling and power are correct.

The gold tree consists of a "known good" PC, an EHCI and UHCI host controller, a five-deep hub stack, a USB video camera, a USB mass-storage device and two HID (Human Interface) devices. The gold tree test checks that your device works well in this tree by hot-plugging your device into many locations in the tree. The gold tree test also verifies device operation at both high-speed and full-speed, during S3 suspend (where VBUS is still present), during Hibernate (where VBUS is removed), and during warm and cold boot of the host. The details of the gold tree test are in the USB test procedure document, available at http://www.usb.org/developers/compliance.

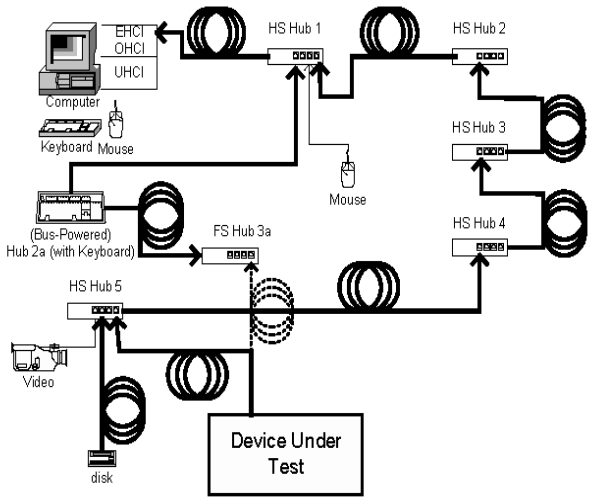

Figure 2. USB Gold Tree

The USB Command Verifier (USBCV) is a Windows program that is available at http://www.usb.org/developers/developers/tools/. The current version runs under Windows 2000 or XP. USBCV installs a special host stack that enables it to directly access the host controller. This program exercises SETUP commands that may not be seen in normal OS operation. If your device is processing SETUP commands under firmware control, this program is sure to turn up a few bugs.

The electrical suites check your device's compliance to the spec for signaling and power. The current consumption test checks suspend current, unconfigured current and configured current at both high and full speeds. The signal quality tests measure your device's transmit eye diagram. The receiver sensitivity tests verify your high-speed squelch and receiver sensitivity at the spec boundaries.

Since most designs are created with qualified transceivers, most of the electrical problems found at Plugfest are current draw issues. The strict 500 uA suspend current limit can be blown by a few floating pins on your device. Bus-powered devices often fail the 100 mA unconfigured current limit or the 500 mA configured current limit. Self-powered devices often fail to check VBUS before connecting their pull-ups to D+ or D-.

What do I need to pass?

In order to pass compliance testing, devices must pass ALL of the USB electrical and Gold Tree suites, plus pass 80% of the compatibility testing. You must also turn in a completed compliance checklist. The compliance checklist is filled out by the board designer. It is a list of common errors in USB designs that will cause test failures. It is also the place where

the designer lists the Test IDs (TIDs) of qualified connectors, cables and silicon used in the design. These IDs are available in the members area of the USB.org website or from your vendor. A list of Cypress' TIDs appears at the end of this application note.

How Do I Get My Device Tested?

Independent labs can test your device for a fee. They will provide a quick compliance test any time one is needed without waiting for a Plugfest. Sending your device to a test lab keeps your engineering resources free for other tasks. Some independent labs can provide debug support for an additional fee.

Plugfests are held every two to three months. They generally start on Tuesday afternoon and run until Friday morning, allowing time for most people to travel on Tuesday and Friday. Plugfests offer an opportunity to examine the cause of any test failures on the spot. Many people can fix their failures and retest during the same Plugfest.

At Plugfest, each system and hub vendor has a fixed test area, called a test suite. Devices and hubs travel from test suite to test suite, performing compatibility tests. Since hub vendors are both a system and a device, they must operate a test suite and travel as a device.

Table 1. Test Labs vs. Plugfests

Test Labs	Plugfest
No personnel needed	3–4 days of engineers' or technicians' time. Hubs require two people: one person runs a system suite, and the other person does device testing
$2–5K cost per item	Free to USB I/F members (except for time, travel, etc.)
Unlimited consulting available (for a fee)	USB experts available to help debug, but you're sharing them with 50 other people who are **also** desperate to pass
Test any time	Only held 4–5 times per year
Exposed to less prototype hardware	Exposed to prototype hosts, hubs and drivers
More secrecy	Less secrecy

What do I do next?

Join the USB I/F or license the USB logo

There are two preferred options for obtaining a Vendor ID, which is required to identify your device. Joining the USB I/F costs $2500 per year. Purchasing a license for the USB logo without joining the USB I/F costs $1500 for a two-year period. Joining the USB I/F provides a number of benefits (from the `USB.org` web site):

- Free Compliance Workshops (Plugfests).
- Waived logo license administration fee.
- Free Vendor ID (if one has not been previously assigned).
- Discounts on developer conferences, products in the e-store, etc.
- Opportunities to participate in USB-IF industry activities, such as IDF and WinHEC booths, etc.
- Opportunities to participate in USB-IF marketing programs, such as retail newsletters, store end caps, featured products, etc.
- Opportunities to participate in USB-IF committees, such as DWG, marketing, and compliance.
- Five free copies of the specification.

Decide on a test house or Plugfest

If you decide to go to plugfest, be aware that they often fill up within a few days after registration opens. Check the web site often and sign up well in advance for Plugfest. Remember that you must be a USB I/F member to attend Plugfest.

Complete your compliance checklist

Many of the common design problems seen in USB devices will be avoided if you read the compliance checklist during the design phase of your device. If you have not yet completed the checklist, it is a compliance requirement.

Pre-test your device

Pre-testing your device is crucial to success in either testing scenario. After all, you wouldn't stage a demo of your device without making sure the demo will succeed. Compliance testing is a demonstration of how your device works in a typical user environment. To pre-test your device, download the compliance testing procedure for your device from `http://www.usb.org/developers/docs#comp test procedures` and run through all of the tests that you can perform with the equipment available. One third of all devices fail at Plugfest. Many of these failures are for simple tests like back-drive of D+ or inrush current.

Qualification by Similarity (from the `USB.org` web site)

When products are very similar testing of one product may also allow other products to be added to the Integrators List. Many OEMs buy USB interface boards that are already on the Integrators List and qualify by similarity.

However, if "significant differences" exist between products, testing of each is required. The definition of "significant differences" is debatable and the final judgement is the responsibility of the compliance review board which reports to the USB-IF board of directors. As decisions are made on what are "significant differences" rules of thumb will be listed here [`http://www.usb.org/developers/compliance/`]. The ultimate responsibility for making sure that various production product models do not have "significant differences" from the

product samples tested lies with each vendor. Audits by USB-IF that reveal discrepancies between shipping product and samples tested will be cause for retest. The effect on rights to use the USB-IF logo are covered in the standard logo license agreement.

Retest required:

- Microcontroller design change (new architecture, or new product family).
- Connector footprint on PCB.

Retest not required:

- Product packaging changes (color, shape etc.).
- Microcontroller vendor change (no board layout change, no firmware change). Retest not required only if new microcontroller is on Integrators List.
- Microcontroller firmware change (changes in fully modular code not associated with USB functions).
- Connector color and aesthetics.

Requirements for retest

Once your device is on the Integrator's List, you are required to keep the USB circuits the same. The retest rules for modified devices are the same as for similar devices above.

Waivers

Waivers allow devices to qualify for the Integrator's List when they are slightly out of spec. For example, the current high-speed test procedure allows devices to pass the high-speed electrical test if they fail in the fifth hub tier. Waivers are temporary agreements between the device manufacturer and the USB I/F. As the current practices of USB design improve, waivers are removed. Waiver decisions are made by the Compliance Review Board (`crb@usb.org`).

More information

There is a wealth of information available about the testing process at the `USB.org` web site.

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

–Compliance home page

`http://www.usb.org/developers/docs#comp_test_procedures`

– Links to all of the test procedures for either Tektronics or Agilent equipment.

`http://www.usb.org/developers/presentations/pres0602/vincent_so.pdf`

– Pages 28 and 29 of this presentation contain a comprehensive list of common electrical failures.

Table 2. Cypress Test ID List as of 3/03

Product	Revision	TID	Test Date
CY16 Series (CS5954AM) USB NAND Flash Drive Controller	1.22	40350250	8/30/2002
CY16 Series (SL1148C) Full-speed USB Microcontroller	1.5	40000776	4/20/2002
CY7C637XX	B	40240586	8/20/2000
enCoRe™ USB (CY7C632xx)	A	40260169	11/10/2000
enCoRe USB (CY7C637xx) Low-speed Microcontroller	B	40230188	5/12/2001
EZ-USB®	E	40240631	9/18/2000
EZ-USB AT2™ (CY7C68300) USB 2.0-to-ATA	A	40340244	6/6/2002
EZ-USB FX™	B	40240630	8/23/2000
EZ-USB FX2™ (CY7C68013) USB 2.0 Microcontroller	D	40000229	11/9/2001
EZ-USB FX2 (CY7C68013) USB 2.0 Microcontroller	E	41000229	11/9/2001
EZ-USB SX2™ (CY7C68001) USB 2.0 SIE	E	40000713	3/1/2002
EZ-USB TX2™ (CY7C68000) USB 2.0 PHY	0	40350107	8/30/2002
ISD-300	A1	40000225	7/24/2001
ISD-300		41000053	4/10/2001
M8 Series (CY7C634xx/635xx/636xx)	C	40230189	8/23/2000
M8 Series (CY7C64013) Full-speed Microcontroller	G	40000152	5/22/2001
M8 Series (CY7C66013) Full-speed Hub + Peripheral Controller	G	30220230	9/1/2000
SL11R	1.2	40240556	7/14/2000
SL811HS USB Host/Peripheral Controller	1.5	40000689	1/22/2002
TetraHub™ (CY7C65640) USB 2.0 Multi-TT Hub Controller	C1	30000089	8/9/2002
USS725D	D	40310207	1/8/2002
CY16 Series (CS5954AM) USB NAND Flash Drive Controller	1.22	40350250	8/30/2002
CY16 Series (SL1148C) Full-speed USB Microcontroller	1.5	40000776	4/20/2002
CY7C637XX	B	40240586	8/20/2000

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