

USB-IF Embedded Host Compliance Plan

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A. Introduction

Ease of use, reliability, flexibility and low cost of USB has made it an attractive interconnect for an ever widening range of devices and is finding its way into an increasing range of specialized applications. As a mature technology, vendors are stretching USB's flexibility in ways unimagined by the original USB architects. USB host controllers embedded into non-PC product and multiple USB attachment points on a single device are samples on how USB is being utilized in new and complex, yet elegant, ways.

An embedded USB host has limited capabilities due to restricted hardware resources and can only be used for an application specific purpose. A USB host that does not have restricted hardware resources or can be used for general purpose computing is not considered embedded and will be tested as a standard host system (i.e. standard personal computer running Windows XP). The USB-IF reserves the right to judge a device as being an embedded or standard host.

In order to maintain the excellent ease of use expected by users of USB today, this document identifies compliance requirements and test procedures for certifying USB devices implementing an embedded host. Compliance testing helps to ensure a positive, reliable and predictable user experience with USB product.

References to documents are surrounded by brackets and identify the title of the document and section number separated by a colon. Abbreviations for document titles can be found on page 7. Thus, **[ECN1:6.4.3]** identifies "Mini-B Connector Engineering Change Notice," Section 6.4.3 "Low-speed Captive Cable Assemblies."

A.1 Terminology

A-Device	The reference name of the device when a series-A plug is connected to its receptacle. The A-Device is responsible for supplying power to the USB bus.
A-plug	The male end of a Series-A connector.
A-receptacle	The female end of a Series-A connector. A-receptacles always provide downstream connectivity.
Attach(ed)	A USB peripheral that has its upstream connector physically inserted into a downstream USB port. The peripheral may or may not have its pull-up asserted.
B-Device	The reference name of the device when a series-B plug is connected to its receptacle. Devices with a captive cable are always a B-Device.
B-plug	The male end of a Series -B connector.
B-receptacle	The female end of a Series -B connector. B-receptacles always provide upstream connectivity.
Battery-Powered	A device that obtains its power from a battery. If the device charges its battery from USB, then the device is considered Bus-Powered; otherwise, the device is considered Self-Powered. Battery-Powered devices may be low-power or high-power devices.
Bus-Power	A device that obtains its power from VBus of USB. This includes Battery-Powered devices that charge from USB as well.
Captive Cable	A cable that is hardwired or has a proprietary connection means to a device. [ECN1:6.4.2] A captive cable must always implement a series-A plug at the opposite end.
Class Support	Hosts that identify and enumerate connected peripherals by their class (bDeviceClass and bDeviceSubClass of the Standard Device Descriptor [USB2:9.6.1]) Embedded hosts are not permitted to declare class support to consumers.
Connect(ed)	A USB peripheral that is physically attached to a downstream USB port and has asserted its pull-up.
Detach(ed)	A USB peripheral that has its upstream connector physically removed from the downstream USB port.
Disconnect(ed)	A USB peripheral that has transitioned from the connected state to the attached state by removing its pull-up.
Downstream	The view of the bus and its connected peripherals from the host's perspective. Applies only to A-receptacles.
DRD	see <u>Dual Role Device</u>
Dual Role Device	A device that implements both host and peripheral capabilities. DRD's have downstream and upstream ports.
Embedded Host	A USB host device with limited hardware resources. An embedded host's capability is application specific with no ability (or restricted ability) to dynamically add new device support.

Examples of an embedded host:

- printer with “walk up print” capability
- personal digital assistants
- digital picture frame
- set-top box

Examples of what is not an embedded host:

- personal computer
- workstations
- hand-held PC

Full-Function Host

A device, like a personal computer, that has sufficient hardware resources to support almost all USB peripherals. Full function hosts have the ability to load new drivers and have a rich user interface. Full-function hosts have no need for a targeted peripherals list. Apple Computer’s Mac is an example of a full-function host and is not considered an embedded host.

High-Power

Downstream ports capable of sourcing greater than 100mA. High-power hosts, including OTG and embedded hosts, must be able to reliably source at least 500mA continuously.

Host

The computer containing the USB Host Controller to which USB devices are attached.

Host Negotiation Protocol

An OTG specific protocol that enables two interconnected OTG devices to exchange roles as host.

HNP

see Host Negotiation Protocol

Hub

A device that enables multiple downstream peripherals to attach to a single upstream connection.

Limited Host

A USB host with no ability (or restricted ability) to dynamically add new device support. Must provide a targeted peripherals list.

Low-Power

Downstream ports capable of sourcing 100mA or less.

Mini-A plug

A miniature A-plug as defined in the “On-The-Go Supplement, Release 1.0a.”

Mini-A receptacle

A miniature A-receptacle as defined in the “On-The-Go Supplement, Release 2.0.”

Mini-AB receptacle

A miniature receptacle that accepts Mini-A plugs and Mini-B plugs as defined in the “On-The-Go Supplement” Devices that implement a Mini-AB receptacle are defined to be OTG. The Mini-AB receptacle provides upstream and downstream connections in a single receptacle.

Mini-B plug

A miniature B-plug as defined in the “USB 2.0 Specification Engineering Change Notice (ECN) #1: Mini-B connector.”

Mini-B receptacle

A miniature B-receptacle as defined in the “USB 2.0 Specification Engineering Change Notice (ECN) #1: Mini-B connector.”

On-The-Go	A dual role device that supports SRP and HNP as defined in the “On-The-Go Supplement to the USB 2.0 Specification,” Release 1.0a.
OTG	see <u>O</u> n- <u>T</u> he- <u>G</u> o
Self-Power	A device that obtains its power from an external source and not from USB.
Series A connector:	Refers to either A-plug or A-receptacle.
Series B connector:	Refers to either B-plug or B-receptacle.
Session Request Protocol	A means for a peripheral to get a host system to turn-on VBUS and start a session.
SRP	see <u>S</u> ession <u>R</u> quest <u>P</u> rotocol
Standard-A plug	The original A-plug as defined in the “Universal Serial Bus Specification, Revision 2.0”
Standard-A receptacle	The original A-receptacle as defined in the “Universal Serial Bus Specification, Revision 2.0”
Standard-B plug	The original B-plug as defined in the “Universal Serial Bus Specification, Revision 2.0”
Standard-B receptacle	The original B-receptacle as defined in the “Universal Serial Bus Specification, Revision 2.0”
Standard Host	see Full-function host
Targeted Peripherals List	A list of specific peripherals, identified by make and model, that an embedded or limited host supports.
TPL	<u>T</u> argeted <u>P</u> eripherals <u>L</u> ist
Upstream	The view of the bus towards the host from the peripheral’s perspective. Applies only to B-receptacles and A-plugs.

A.2 Specification Reference Abbreviations

ECN1	“Mini-B Connector Engineering Change Notice” http://www.usb.org/developers/docs/
EHSET	“Embedded High-speed Electrical Test Fixture” http://www.usb.org/developers/onthego/
EICTP	“Full and Low-Speed Electrical and Interoperability Compliance Test Procedure” http://www.usb.org/developers/docs/
HHSETP	“Host High-speed Electrical Test Procedure” http://www.usb.org/developers/docs/
OTG	“USB On-The-Go Supplement to the USB 2.0 Specification” http://www.usb.org/developers/onthego/
OTGCP	“USB On-The-Go Compliance Plan for the USB 2.0 Specification” http://www.usb.org/developers/onthego/
USB2	“Universal Serial Bus Specification,” Revision 2.0 http://www.usb.org/developers/docs/

A.3 Summary

The USB-IF Embedded Host Compliance Plan is developed by the USB 2.0 Compliance Committee under the direction of the Universal Serial Bus-Implementers Forum, Inc. Embedded host products must pass the compliance test procedures defined in this document in order to be posted on the USB-IF Integrators List and display the USB-IF logo in conjunction with the product (provided the vendor has signed the USB-IF Trademark License Agreement).

The USB On-the-Go Supplement defines requirements for an embedded host and is the guiding document for embedded USB hosts in general. The core USB 2.0 Specification and its associated supplements and errata shall be enforced wherever deficiencies in this document may arise.

Embedded hosts must fully comply with the “Universal Serial Bus Specification,” Revision 2.0 including all associated errata and supplements unless otherwise noted. Embedded hosts may implement features defined in the USB On-The-Go Supplement. Please note, however, that only OTG devices can implement HNP and only OTG devices can implement the mini-AB receptacle.

In order for an embedded host to receive certification, all required tests must be successfully executed on it and pass. If a particular vendor’s design prevents a required test from being run, then certification cannot be granted.

1. All embedded hosts must pass downstream signal quality tests as performed on standard hosts at each supported speed.
 - a. High-speed embedded hosts must support test modes [**USB2:7.1.20**]
 - b. High-speed embedded hosts must support the high-speed electrical test modes as described in Section 6.6.6.1 of the “USB On-The-Go Supplement,” Revision 1.2.
2. An embedded host must support one of the following combinations of speeds based on the requirements of its Targeted Peripherals List:
 - a. High-speed, full-speed and low-speed
 - b. High-speed and full-speed
 - c. Full-speed only
 - d. Full-speed and low-speed
 - e. Low-speed only

Should a particular speed be not supported, the “no silent failure” rule still applies when corresponding devices are attached. For more information on “no silent failures,” please see item 13 in this section.

3. An embedded host is required to support the Control transport. An embedded host may support none, one or more of the Interrupt, Bulk and Isochronous transports.
4. An embedded host may optionally support USB suspend. If USB suspend is supported, then resume signaling must be supported.
5. An embedded host may support SRP as described in the “USB On-The-Go Supplement.” If VBus on USB is ever turned-off while the host is operating, SRP must be supported.
6. When multiple downstream ports exist:
 - All downstream ports must be able to operate concurrently and independently
 - All downstream ports must provide the same maximum current capability

- All downstream ports must support the same speeds
 - All downstream ports must support the same peripherals
 - The mini-A receptacle is prohibited for use by hosts
7. Unlike standard hosts and hubs, low-power embedded hosts may source any current between 8mA and 100mA [OTG:5.1.1]. Embedded hosts that can source more than 100mA must be able to source at least 500mA [OTG:5.1.1]. The power source capability of each downstream port must be at least 8mA [OTG:3.2] and needs to be sufficient to operate each and every device on the Targeted Peripherals List.
 8. Embedded hosts must pass Power Provider Drop tests at their source current rating [USB2:7.2.2], [OTGCP:5.5.1.1] and [EICTP:B.2]
 - a. High –power embedded hosts must pass drop tests with 500mA loads. [EICTP:B.2]
 - b. Low-power embedded hosts must pass drop tests as described in. [OTGCP:5.5.1.1] and [OTGCP:5.5.6.1].
 9. Embedded hosts that have multiple downstream ports must pass the Power Provider Droop tests while loaded at their power source rating. [EICTP:B.2].
 10. A Targeted Peripherals List must be provided with the product [OTG:3.3]. This list must be published to the consumer and must be provided to the USB-IF in addition to required checklists.
 - a. The Targeted Peripherals List must define specific products only with the exception of the hub class.
 - b. Although embedded hosts may support device classes, the Targeted Peripherals List must not declare support of a class. Only specific products may be listed on a TPL. The hub class, however, may be declared as supported on the TPL.
 11. A representative device of each transport, power and speed must be supplied to the test facility or workshop for interoperability testing.
 12. Hub support is optional [OTG:3.12].
 - a. If hubs are supported, one or more tiers of hubs may be supported.
 - b. Hubs must be supported by class
 - c. If hubs are supported, high-speed hosts must support high-speed hubs.
 - d. If hubs are supported by class, the embedded host must have a source current rating of 500mA.
 13. The USB On-The-Go Supplement introduces the concept of “No Silent Failures.” [OTG:3.4] The concept of “No Silent Failures” shall apply to any host regardless of whether it is OTG or embedded.
 - a. A means to communicate the status of a connected USB peripheral to the user must be provided. The content of messages is not regulated, but accuracy of the content cannot be misleading or incorrect.
 14. Embedded hosts may provide functions via USB that require upstream port(s). No exceptions or leniency is given to upstream USB implementations. Any and all upstream USB ports must pass standard USB-IF Compliance Tests as required for normal USB peripherals. [EICTP:A.2]

Other technologies may utilize USB as their foundation. The USB-IF may or may not endorse or support such technologies. The USB-IF may deny certification to implementations that fail any of the USB-IF compliance tests or cannot be tested. However, in order to display the USB-IF logo, the device must pass all USB compliance tests required by the USB-IF. By way of example:

1. Products that implement PictBridge technology or PoweredUSB technology must pass USB-IF Compliance Tests as outlined in this document in order to display the USB-IF Logo.
2. If used by a technology, USB-IF defined classes must be fully supported by the host or device. For example, if the Still Image class is implemented as part of PictBridge, the class must be fully supported by the host or peripheral.

B. Regulations

B.1 USB Certified Logo Qualification

Once a product has passed all compliance tests and the vendor has submitted all required documentation and there is a signed logo license agreement, the USB Certified Logo may be used. The USB Certified Logo comes in four forms: Basic Speed, High-Speed, Basic Speed On-The-Go and High-Speed On-The-Go. Only one USB Certified Logo may be used with a product.



Basic-Speed Version



Hi-Speed Version



On-The-Go
Basic-Speed Version



On-The-Go
Hi-Speed Version

- The USB On-The-Go logos are for use only by devices that pass the USB On-The-Go Compliance Program. On-The-Go devices must use the USB On-The-Go Certified Logo.
- Embedded hosts that do not have USB peripheral functionality qualify for either the Basic Speed or High-Speed Logo depending on the highest signaling speed of the host.
- The Basic Speed logo represents low-speed, full-speed or both low and full-speed capable embedded hosts that do not have USB peripheral capability.
- The High-speed logo may represent high-speed capable embedded hosts that do not have USB peripheral capability.
- Embedded hosts that implement USB peripheral functionality qualify for the logo that represents the highest signaling speed of the upstream port.

B.2 Checklists

The USB-IF provides checklists to help designer of desktop PCs, laptops, or other computers with USB ports to assess their products' compliance with the Universal Serial Bus Specification, Revision 2.0 and associated errata and supplements. Checklists are also used, in part, to qualify a USB device for the USB-IF Integrators List. In order to be listed on the Integrators List, an embedded host must pass all required certification tests and all appropriate checklists must be completed and submitted to the USB-IF.

All USB hosts must complete the "USB Compliance Checklist for Systems" which can be found on the USB-IF website.

B.3 Targeted Peripherals List (TPL)

Unlike standard USB hosts, the limited nature of embedded hosts means that they cannot support all USB peripherals. Thus, embedded hosts must be intended for a target market that uses specific devices. The list of specific devices that an embedded host supports is called a Targeted Peripherals List or TPL [OTG:3.3]. As with checklists, the TPL must be submitted to the USB-IF in order to be listed on the Integrators List and use the USB Certified Logo.

A TPL must be provided to the USB-IF authorized test engineer at the time of certification testing.

The TPL submitted to the USB-IF must include the information in Section E about each supported device.

C. Compliance Program

C.1 Electricals

C.1.1 Drop Testing

The ability of downstream ports to maintain proper voltage under load is crucial. Thus, VBus Drop voltage tests are required of all downstream ports. Should the embedded host be a dual role device, then the peripheral functions must be powered and operating during this test.

Low-power embedded hosts may source any current between 8mA and 100mA. Otherwise, the embedded host is high-power and must support 500mA loads.

High-power embedded Hosts must pass Drop testing as described in Section B.2.2.2.1 Self-Powered Hubs of the EICTP:

- High-powered embedded hosts must pass using 500mA loads

Low-power embedded hosts that do not support hubs by class must pass the following tests:

- OTGCP Section 5.5.1.1 A-UUT Output Voltage (VA_VBUS_OUT)
- OTGCP Section 5.5.6.1 A-UUT VBUS Valid (VA_VBUS_VLD)

C.1.2 Droop Testing

Embedded Hosts that have multiple downstream ports must pass Droop tests.

Embedded Hosts that support hubs by class and has multiple downstream ports must pass Droop testing as described in Section B.2.3 of the EICTP. Should the embedded host be a dual role device, then the peripheral functions must be powered and operating during this test.

- High-power embedded hosts must pass Droop Testing with 500mA loads
- Low-power embedded hosts must pass Droop testing while providing loads at the current rating.

C.1.3 SRP Testing

Embedded Hosts that support SRP must pass the following tests:

- Section 5.5.1.2 A-UUT VBUS Rise Time (TA_VBUS_RISE) of the OTGCP
- Section 5.5.6.2 A-UUT Session Valid (VA_SESS_VLD) of the OTGCP

C.1.4 Signal Quality

All hosts must meet signal integrity parameters as specified in the USB 2.0 Specification. No exceptions are granted to OTG or other embedded hosts.

- Embedded hosts that support Full-Speed or Low-Speed must pass Section B.3.3.2 Host Downstream Signal Quality Testing of the EICTP
- Embedded hosts that support High-Speed must support the Embedded HSET tool [EHSET] and must pass tests listed in "Host High-speed Electrical Test Procedures" [HHSETP]

C.2 Interoperability

Because an embedded USB host is considered limited, Interoperability tests are restricted to peripherals on the host's targeted peripherals list. In addition to the TPL, 5 tiers and fewer of hubs must be tested.

1. Enumeration:

Execute each test only if it is appropriate for the peripheral and host. Verify operation of the peripheral after each test.

- a. A-plug Attach Test: Connect the B-end of the cable to the peripheral before attaching the A-plug to the host
- b. B-plug Attach Test: Connect the A-plug to the host before attaching the B-plug to the peripheral
- c. Power-on host Test: With the host power turned off, attach the peripheral and power-on the host
- d. Reset host Test: With the peripheral attached, reset the host
- e. Power-on peripheral Test: With the power of the peripheral turned off, attach the peripheral to the host and power-on the peripheral
- f. Dynamic Attach Test: With the peripheral attached and enumerated, disconnect and connect the peripheral
- g. Topology Change Test: If multiple downstream ports exist, attach the peripheral to different ports.

2. Operation:

- a. Peripheral Operation Test: Verify that the peripheral operates as designed
- b. Host suspend/resume Test: With the peripheral attached and enumerated, suspend and then resume the host. Verify operation of the peripheral
- c. Suspend-Disconnect Test: Detach the peripheral while the host is suspended. Verify host does not behave abnormally upon resume.
- d. Suspend-Attach Test: Attach the peripheral while the host is suspended. Verify the peripheral operates as expected when the host is resumed.
- e. Peripheral remote wakeup Test: Enable remote wake-up of the peripheral. Suspend the host. Resume the host using the peripheral
- f. Topology Change Test: If multiple downstream ports exist, do a topology change with the peripheral while the host is suspended. Verify the peripheral operates as expected when the host is resumed.
- g. Concurrent Downstream Operation: If multiple downstream ports exist, verify that all ports enumerate and operate devices concurrently and independently.

3. Hubs:

- a. Maximum Tier Test: Attach 5 tiers of hubs. Either the last tier of hub will be enumerated, or a "Too many hubs" or similar message appears or a "hub not supported" similar message appears.
 - i. If a message appears, reduce the number of tiers by one until the message disappears. The remaining number of hubs indicates hub tiers supported. Verify the supported tier with the vendor.
- b. Peripheral Operation Test: If applicable, verify peripheral operation behind maximum supported hub tier.

4. Messaging (No Silent Failure):
 - a. Unsupported device message. Attach a device that is known not to be supported. An appropriate message should be displayed.
 - b. If hubs are not supported, a “Hubs not supported” or similar message must appear. A generic “device not supported” message is not acceptable on a hub connect.

D. Record Results

D.1 Collect Device Information

- 1) Number of downstream ports:
- 2) Is there a hub embedded behind one or more downstream ports?
- 3) What is the maximum source current rating of the downstream ports?
- 4) Are hubs supported?
- 5) Is there an upstream port on the Device?
- 6) Is a Targeted Peripherals List available?

D.2 Drop

Is the device a dual role device?

Yes – Turn on and enable all functions and continue...

No – Continue...

Can the device operate from batteries?

Yes – Enable the device to operate under battery-power and continue...

No – Continue...

Are hubs supported by class?

Yes – Follow Section B.2.2.2.1 Self-Powered Hubs of the EICTP

No – Continue...

Are downstream ports high-power?

Yes – Follow Section B.2.2.2.1 Self-Powered Hubs of the EICTP

No – Load voltage must be $\geq 4.40V$ for the following sections:

5.5.1.1 A-UUT Output Voltage (VA_VBUS_OUT) of the OTGCP.

5.5.6.1 A-UUT VBUS Valid (VA_VBUS_VLD) of the OTGCP

	Port 1	Port 2	Port 3	Port 4
Measured Load Voltage				
Pass / Fail				

D.3 Droop

Are multiple downstream ports available?

Yes – Droop tests are required, continue...

No – Droop tests are not required, skip this test...

Is the device a dual role device?

Yes – Turn on and enable all functions and continue...

No – Continue...

Does the device operate from batteries?

Yes – Enable the device to operate under battery-power and continue...

No – Use 500mA loads. Load voltage must be > 4.75V. Continue...

Are downstream ports high-power?

Yes – Use 500mA loads. Follow Section B.2.3 Droop Testing of the EICTP

No – Use 100mA loads. Follow Section B.2.3 Droop Testing of the EICTP
“Unsupported Device” message is acceptable for the 100mA result.

	Port 1	Port 2	Port 3	Port 4
No Load Voltage				
Load Voltage				
VBUS Droop (Difference between No Load Voltage and Load Voltage < 330mV)				
Pass / Fail				

D.4 Signal Quality

Does the host support low-speed?

Yes -- Section B.3.3.1 Host Downstream Signal Quality Testing of the EICTP must be performed. Continue...

No -- Continue...

Does the host support full-speed?

Yes -- Section B.3.3.2 Host Downstream Signal Quality Testing of the EICTP must be performed. Continue...

No -- Continue...

Does the host support high-speed?

Yes -- The "Host High-speed Electrical Test Plan" (HHSETP) should be followed using the "Embedded High-speed Electrical Test Fixture" (EHSET)

No -- End of test.

D.5 SRP

Is USB VBus ever turned-off while the host system is operating?

Yes -- The following tests must be performed:

5.5.1.2 A-UUT VBUS Rise Time (TA_VBUS_RISE) of the OTGCP

5.5.6.2 A-UUT Session Valid (VA_SESS_VLD) of the OTGCP

No -- SRP cannot be tested, skip this test

D.6 Interoperability

1. Enumeration:

Attach A-plug first:	Pass	Fail	
Attach B-plug first:	Pass	Fail	
Power-on host:	Pass	Fail	N/A
Reset host:	Pass	Fail	N/A
Power-on peripheral:	Pass	Fail	N/A
Dynamic Attach:	Pass	Fail	
Topology Change:	Pass	Fail	

2. Operation:

Peripheral operation:	Pass	Fail	
Host suspend/resume:	Pass	Fail	N/A
Suspend-Disconnect:	Pass	Fail	N/A
Suspend-Attach:	Pass	Fail	N/A
Peripheral remote wakeup:	Pass	Fail	N/A
Topology Change:	Pass	Fail	N/A
Concurrent Downstream Operation:	Pass	Fail	N/A

3. Hubs:

Maximum tier of hubs supported or Maximum number of hubs supported: 0 1 2 3 4 5

Peripheral operation behind maximum hub tier: Pass Fail N/A

4. Messaging:

No Silent Failure:	Pass	Fail
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E. Targeted Peripheral List (TPL) Form

E.1 Host Information:

Enter the following information only once.

Vendor Name:

Product Name:

Product Model:

Product Revision:

SRP Support:

Downstream Ports:

Signaling Speeds Supported: ☐ Low ☐ Full ☐ High

Supported Transports: ☐ Control; ☐ Bulk; ☐ Interrupt; ☐ Isochronous

Messaging Interface: ☐ Graphic Screen; ☐ Text Screen; ☐ Indicator Lights; ☐ _____

Max Current Capability: _____ mA

E.2 Targeted Peripherals Information:

Enter the following information for each supported peripheral.

Vendor Name:

Product Name:

Model:

Revision:

Vendor ID:

Product ID:

Device Class:

SRP Support: Y N

HNP Support: Y N

* Maximum Operating Power (mA):

† Maximum USB Signaling Speed:

* Obtained from the bMaxPower field of the device's Standard Configuration Descriptor

† Maximum signaling speed when connected to a high-speed host