Universal Serial Bus Implementers Forum On-The-Go Electrical Test Procedure

Revision 1.0

August 20, 2003

Revision History

Rev	Date	Filename	Comments
0.10	25-Feb-2003	OTG Test Procedure.DOC	Initial draft revision (outline)
0.20	27-Feb-2003	OTG Test Procedure.DOC	Initial draft revision (complete text with author comments in red)
0.30	21-Mar-2003	OTG Test Procedure Rev0_30.DOC	Initial draft revision (Implemented changes requested from March 5th review & March 13th teleconference. Removed all author comments.)
0.90rc1	17-Jun-2003	OTG Test Procedure Rev0_90rc1.DOC	Corrected references to OTG Specification document sections to reflect latest OTG specification section numbers. Changed procedure to reflect feedback from April 2003 Plugfest and subsequent discussion.
0.90rc2	2-Jul-2003	OTG Test Procedure Rev0_90rc2.DOC	Added Picture of OET, and text to describe the switch settings
0.9	15-Jul-2003	OTG Test Procedure Rev0_90.DOC	Removed RC2 notation from title and header.
1.0	20 Aug 2003	OET Test Procedure R1_0.DOC	Move document to 1.0

Please send comments via electronic mail to <techsup@usb.org>.

USB-IF On-The-Go Electrical Test Procedure

DISCLAIMER OF WARRANTIES

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

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

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

LICENSE FOR INTERNAL USE ONLY

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

Table of Contents

Figure Listings

1 Introduction

The USB-IF On-The-Go (OTG) electrical test procedures are developed by the USB 2.0 Compliance Committee under the direction of USB-IF, Inc. The source document for the USB-IF On-The-Go Electrical Test Procedure document is the On-The-Go Compliance Plan for the USB 2.0 Specification, Chapter 5.

The OTG tests in the USB-IF On-The-Go Electrical Test Procedure document are a subset of tests needed to obtained OTG compliance. OTG devices, SRP capable hosts and SRP capable peripherals must pass this subset of tests in addition to the other tests specified in the On-The-Go Compliance Plan for the USB 2.0 Specification document.

2 Purpose

This USB-IF On-The-Go Electrical Test Procedure documents a series of tests used to evaluate USB OTG devices, SRP capable hosts and SRP capable peripherals electrical characteristics. These tests are also used to evaluate the electrical characteristics of USB OTG or SRP capable silicon that has been incorporated in ready-to-ship products, reference designs, proofs of concept and one of a kind prototypes of peripherals, add-in cards, motherboards, or systems.

3 Acronyms and Terms

This chapter lists and defines terms and abbreviations used throughout this specification.

A-Device	A device with a Standard-A or Mini-A plug inserted into its receptacle. An A-Device supplies power to VBUS; is host at the start of a session; and under certain conditions as described in the On-The-Go Supplement to the USB 2.0 Specification, the A-Device will relinquish the role of host to a dual-role B-Device.
B-Device	A device with a Standard-B or Mini-B plug inserted into its receptacle. The B-Device is a peripheral at the start of a session. If the device is dual-role, it may be granted the role of host from the A-Device (see On-The-Go Supplement to the USB 2.0 Specification for details).
Dual-role device	A device that that has the following features and characteristics (see On-The-Go Supplement to the USB 2.0 Specification for details): • Limited Host capability • Full-speed operation as peripheral (high-speed optional) • Full-speed support as host (low-speed and high-speed optional) • Targeted Peripheral List • Session Request Protocol • Host Negotiation Protocol • One, and only one, Mini-AB receptacle • Minimum 8 mA output current on VBUS • Means for communicating messages to user

DUT	Device under Test
Host	A physical entity that is attached to a USB cable and is acting in the role of the USB host as defined in the USB Specification, Revision .20.
OET	OTG Electrical Tester
OTG	On-The-Go
Peripheral	A physical entity that is attached to a USB cable and is currently operating as a "device" as defined in the USB Specification, Revision 2.0. The Peripheral responds to low level bus requests from the Host.
Session	The period of time that VBUS is above a device's session valid threshold. For an A-Device, the session valid threshold is VA_SESS_VLD, while for a B-Device it is VB_SESS_VLD.
SRP	Service Request Protocol (Defined in the On-The-Go Supplement to the USB 2.0 Specification.)
USB	Universal Serial Bus
USB-IF	USB Implementers Forum

4 Device Under Test and Test Equipment Requirements

4.1 Device Under Test Requirements

The device under test must have the following capabilities to be tested by this procedure.

- When the DUT is an A-Device: VBUS must be able to be turned on by the test operator. If VBUS is not turned off automatically by the DUT after a no connect condition, then the test operator must also be able to turn VBUS off. Note that when the test operator turns on VBUS, it must remain on for a minimum of 1 second, (TA_WAIT_BCON time).
- When the DUT is a B-Device: SRP must be able to be initiated by the test operator.

The following information must be supplied to the test operator.

- The test operator must be notified if the device is able to detect VBUS pulsing.
- The test operator must be notified of the port's maximum rated current.

4.2 Equipment Required

This test procedure is written with a set of specific test equipment used to develop this procedure. Substitution of equivalent test equipment will require some minor adaptation of the procedure.

- Digital Sampling Oscilloscope:
  - Tektronix TDS5104 digital sampling oscilloscope or equivalent.
    - Tektronix P6245 FET probes, qty = 2. Tektronix P6243 FET probes may also be used.

- 6 _ Digital Multimeter – Keithley Model 2000 Multimeter or equivalent
    - Multimeter leads – one each of black and red color
- Power Supply – Agilent E3631A or equivalent
    - Power supply leads – one each of black and red color
- On-The-Go Electrical Tester (OET)
    - Information and sourcing for the OET is available from USB-IF, at http://www.usb.org/developers/compliance .

4.3 Equipment Setup

4.3.1 Tektronix TDS5104 Digital Sampling Oscilloscope

Turn on the oscilloscope to allow for 20 minutes of warm up time prior to use. Perform the signal path compensation procedure built into the TDS5104 (in the Utility menu) after warm up. If the ambient temperature changes more than 5 °C (9 °F) after compensation has been performed, then repeat the compensation procedure. The compensation is to be performed with the probes disconnected from the oscilloscope. Attach the two P6245 FET probes to channels 1 and 2 after the compensation adjustments have been performed. Calibrate the two probes to minimize gain and offset errors.

Load Oscilloscope default setups.

Set Oscilloscope to the following initial settings (settings continue on next page):

Ch1 Display	On
Ch1 Position	-2.0div
Ch1 Scale	1.0V/div
Ch1 Offset	0V
Ch1 Coupling	DC
Ch1 Bandwidth	Full
Ch2 Display	Off
Ch2 Position	-2.0div
Ch2 Scale	1.0V/div
Ch2 Offset	0V
Ch2 Coupling	DC
Ch2 Bandwidth	Full
Ch3 Display	Off
Ch4 Display	Off
Acquisition Mode	Sample
Record Length	500000 points
Fast Acquisitions	Off
Roll Mode	Auto
Equivalent Time	Off
Horiz Scale	200ms/div
Horiz Position	10%
Horiz Delay	Off
Trigger Mode	Stop after Single Sequence
Trigger Holdoff	Default
Trigger Type	Edge

Trigger Source	Ch1
Trigger Coupling	DC
Trigger Level	4.4V
Trigger Slope	Rising
Cursors	On
Cursor Type	Vertical Bars
Cursor 1 Position	10 mSec
Cursor 2 Position	1.0 Sec
Measurement Gating	Cursor
Measurements	Max(C1) Mean(C1) Min(C1) Rise(C1) Dely(C1,C2) Max(C2) Pos Wid(C2)
Rise Time Measurement Reference Levels	Absolute High = 4.4V Low = .2V
Delay/Pulse Measurement Setup	Source 1 = Ch1 Source 2 = Ch2 Direction = Forward Delay Edge1 = Rising Delay Edge1 Mid Ref = 4.0V Delay Edge2 = Rising Delay Edge2 Mid Ref = 2.7V

4.3.2 Keithley Model 2000 Multimeter

Turn on the multimeter to allow for 1 hour of warm up time prior to use. Set the multimeter to perform DC voltage measurements using the 0 to 10 volt range.

4.3.3 Agilent E3631A Power Supply

Turn on the power supply to allow for 1 hour of warm up time prior to use. The 0 – 6 volt output is used in the range of 0 to 4.05 volts. The other outputs of the supply are unused.

Set power supply to the following initial settings:

Store/Recall 1	750mV & 600 mA on 6V out 0.0V on +25V out 0.0V on -25V out
Store/Recall 2	2.05V & 600 mA on 6V out 0.0V on +25V out 0.0V on -25V out
Store/Recall 3	4.05V & 600 mA on 6V out 0.0V on +25V out 0.0V on -25V out

0 to 6V Output Current Limit (for equipment safety)	600 mA
0 to 6V Output	0.0V
0 to +25V Output	0.0V
0 to -25V Output	0.0V
Output	Off

The recall function of the power supply will be used during the tests.

4.3.4 On-The-Go Electrical Tester (OET)

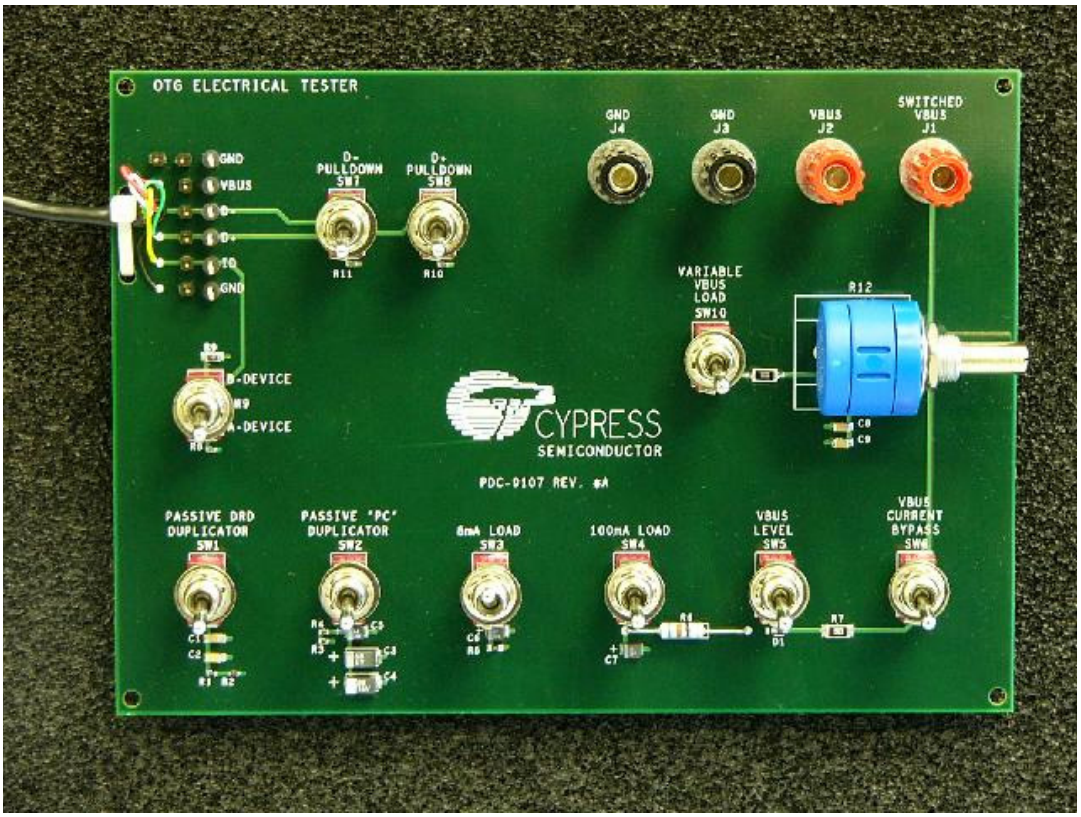

Figure 4.3-1 OTG Electrical Test Fixture Rev A.

For all switches except SW9 placing the toggle switch in the up position is "On" and placing the toggle switch in the down position is "Off". The SW9 positions are labeled A-Device and B-Device on the board.

Set the OET switches to the following settings

Mode	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
8 mA Load	OFF	OFF	**ON**	OFF	OFF	OFF	OFF	OFF	A-Device	OFF

Make the following connections to the OET

Connect the channel 1 probe of the oscilloscope to the VBUS test point of the OET. Connect the probe's ground to the GND test point nearest to the VBUS test point.

Connect the channel 2 probe of the oscilloscope to the D+ test point of the OET. Connect the probe's ground to the GND test point nearest to the D+ test point.

Connect the black multimeter lead from INPUT LOW to J3, GND terminal, of the OET.

Connect the red multimeter lead from INPUT HI to J2, VBUS terminal, of the OET.

Connect the black power supply lead from the power supply 6 volt supply negative output to J4, GND terminal, of the OET.

Connect the red power supply lead from the power supply 6 volt supply positive output to J1, VBUS terminal, of the OET.

See the below figure for the interconnect diagram.

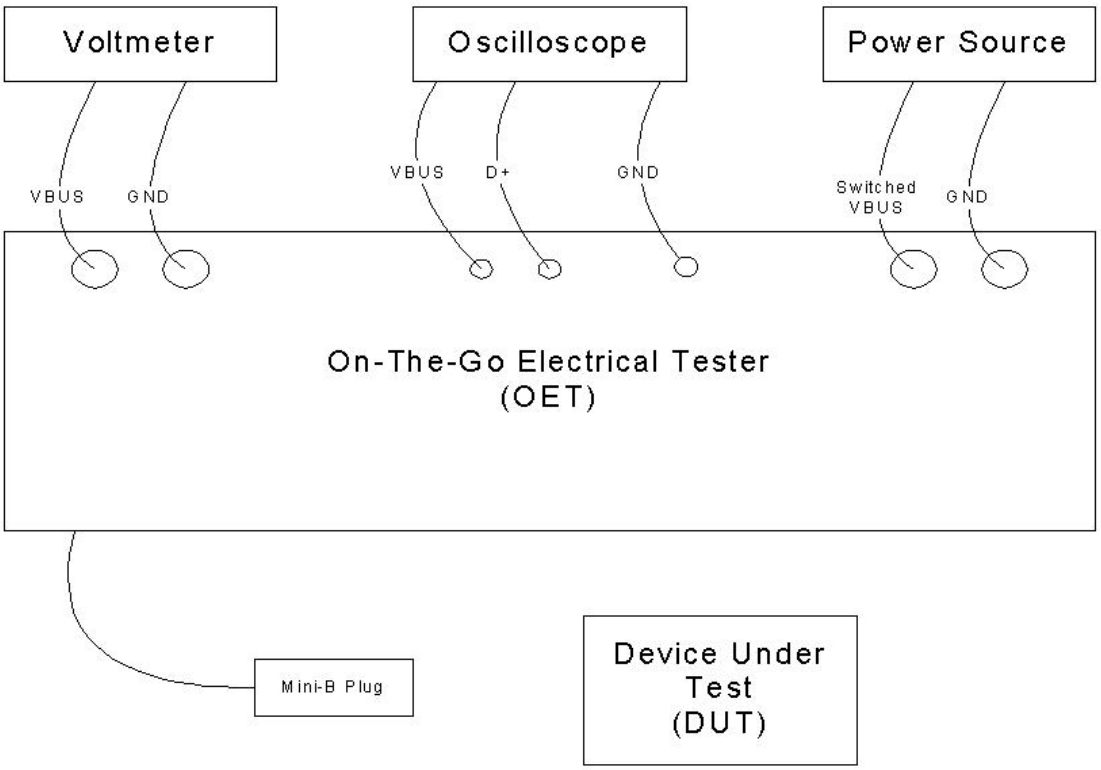

Figure 4.3-2 OTG Electrical Test Setup

5 Test Procedure

5.1 Test Record

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

5.2 Vendor and Product Information

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

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

5.3 Test Equipment List & Calibration Data

List test equipment used and calibration dates in Appendix A. Equipment calibration should be traceable to National Institute of Standards and Technology (NIST).

5.4 Additional Test Records

Additional tests specified in the On-The-Go Compliance Plan for the USB 2.0 Specification document are not part of this test procedure. Those results are to be supplied as specified by the On-The-Go Compliance Plan for the USB 2.0 Specification and their respective test procedures.

5.5 Test Title Format

The test titles use the following format:

Test Name (OTG Supplement to the USB 2.0 Specification Symbol) (OTG Compliance Checklist ID)

5.6 A-Device Output Voltage ($V_{A\_VBUS\_OUT}$) (E1, E8)

Set the OET switches to the following settings.

Mode	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
8 mA Load	OFF	OFF	**ON**	OFF	OFF	OFF	OFF	OFF	A-Device	OFF

1. Verify test equipment is on and has been on for the required warm up times.
2. Set the oscilloscope to the initial settings in section 4.3.1.
3. Apply power to A-Device under test. Connect the A-Device to the OET.
4. If VBUS is not off, turn it off. Confirm that VBUS is off by observing the multimeter reading. The multimeter reading should be less than 200 mV.
5. Arm the oscilloscope for trace capture.
6. Using the device under test manufacturer's documented procedure, turn VBUS on.
7. The oscilloscope should trigger and the trace should rise above 4.4 volts. If the oscilloscope does not trigger, the device fails the test. If the oscilloscope triggered; record the minimum and mean voltages in appendix A, section A.5.6. These are the readings, Min(C1) and Mean(C1), on the oscilloscope. Also record the port's maximum rated current.

   Below is an example oscilloscope capture of a passing event:

Figure 5.6-1 A-Device Output Voltage (VA_VBUS_OUT)

8. If the minimum and mean voltages are within the range of 4.4 V to 5.25 V and VBUS is greater than 4.4 volts after reaching 4.4 volts for at least 1 second, then the test passes.
9. Disconnect the A-Device from the OET.

5.7 VBUS Rise Time (TA_VBUS_RISE) (E3)

Set the OET switches to the following settings.

Mode	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
8 mA Load	OFF	OFF	**ON**	OFF	OFF	OFF	OFF	OFF	A-Device	OFF

1. Verify test equipment is on and has been on for the required warm up times.
2. Set the oscilloscope to the initial settings in section 4.3.1 with the following exceptions:

Horiz Scale	20ms/div
Trigger Level	300mV
Cursors	Off
Measurement Gating	Off

   The settings for this test are identical to the previous test except for those listed above.
3. Apply power to A-Device under test if not already on. Connect the A-Device to the OET.
4. If VBUS is not off, turn it off. Confirm that VBUS is off by observing the multimeter reading. The multimeter reading should be less than 200 mV.
5. Arm the oscilloscope for trace capture.
6. Using the device under test manufacturer's documented procedure, turn VBUS on.
7. The oscilloscope trace should trigger and rise above 4.4 volts. Record the rise time of the trace from .2V to 4.4 V in appendix A section A.5.7. This is the reading, Rise (C1), on the oscilloscope.

   Below is an example oscilloscope capture of a passing event:

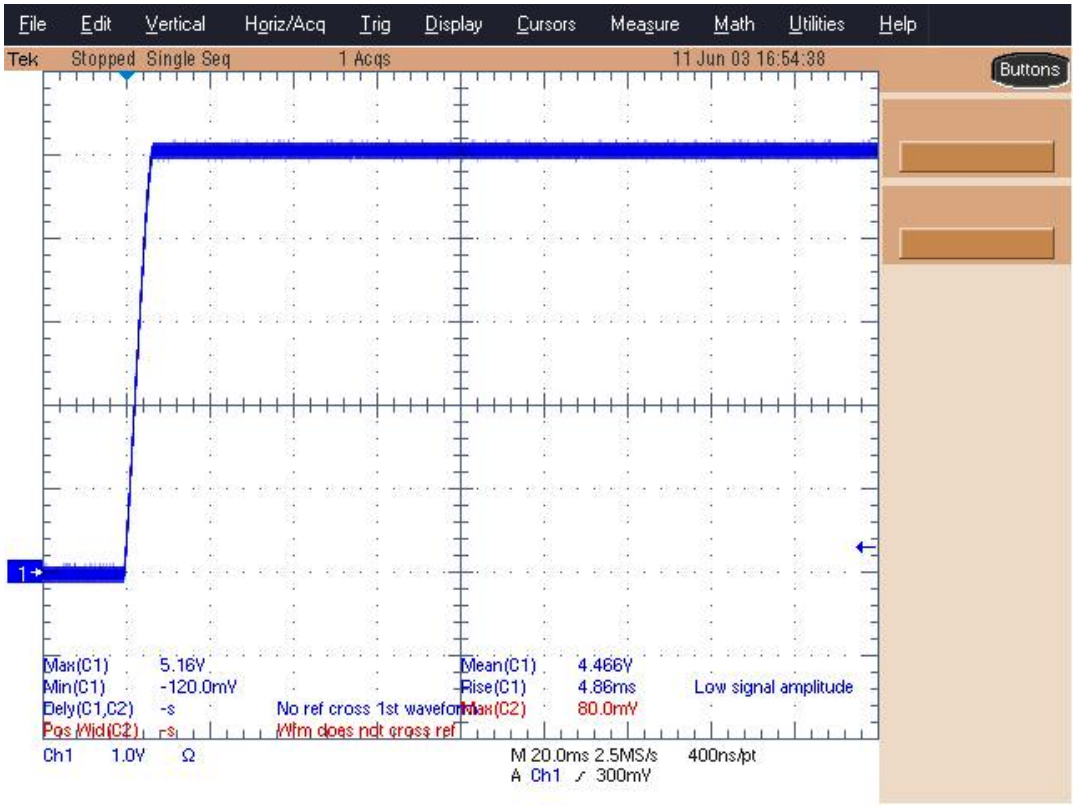

Figure 5.7-1 VBUS Rise Time (TA_VBUS_RISE)

8. If the rise time is under 100 milliseconds then the device passes.
9. Disconnect the A-Device from the OET.

5.8 B-Device (SRP capable) to OTG Device Output Voltage ($V_{B\_DRD\_OUT}$) (E5)

Set the OET switches to the following settings.

Mode	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
Passive OTG Device Duplicator	**ON**	OFF	OFF	OFF	OFF	OFF	**ON**	**ON**	B-Device	OFF

1. Verify test equipment is on and has been on for the required warm up times.
2. Set the oscilloscope to the initial settings in section 4.3.1 with the following exceptions:

Horiz Scale	10ms/div
Trigger Level	300mV
Cursors	Off
Measurement Gating	Off

The settings for this test are identical to the previous test except for Horiz Scale.

3. Apply power to B-Device under test if not already on. Connect the B-Device to the OET.
4. Confirm that VBUS is off by observing the multimeter reading. The multimeter reading should be less than 200 mV. VBUS should be off, since the DUT is a B-Device.
5. Arm the oscilloscope for trace capture.
6. Using the device under test manufacturer's documented procedure, initiate SRP.
7. The oscilloscope trace should trigger and rise above 2.1 volts. Record the peak VBUS voltage value in appendix A section A.5.8. This is the reading, Max(C1), on the oscilloscope.

   Below is an example oscilloscope capture of a passing event:

Figure 5.8-1 B-Device (SRP capable) to OTG Device Output Voltage (VB_DRD_OUT)

8. If the peak time VBUS voltage is greater than or equal to 2.1 volts and less than 5.25 volts then the device passes.
9. Disconnect the B-Device from the OET.

5.9 B-Device (SRP capable) to Host Output voltage ($V_{B\_HST\_OUT}$) (E6)

Set the OET switches to the following settings.

Mode	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
Passive "PC" Duplicator	OFF	**ON**	OFF	OFF	OFF	OFF	**ON**	**ON**	B-Device	OFF

1. Verify test equipment is on and has been on for the required warm up times.
2. Set the oscilloscope to the initial settings in section 4.3.1 with the following exceptions:

Horiz Scale	10ms/div
Trigger Level	300mV
Cursors	Off
Measurement Gating	Off

   The settings for this test are identical to the previous test.
3. Apply power to B-Device under test if not already on. Connect the B-Device to the OET.
4. Confirm that VBUS is off by observing the multimeter reading. The multimeter reading should be less than 200 mV. VBUS should be off, since the DUT is a B-Device.
5. Arm the oscilloscope for trace capture.
6. Using the device under test manufacturer's documented procedure, initiate SRP.
7. The oscilloscope trace should trigger. Record the peak VBUS voltage value in appendix A section A.5.9. This is the reading, Max(C1), on the oscilloscope.

   Below is an example oscilloscope capture of a passing event:

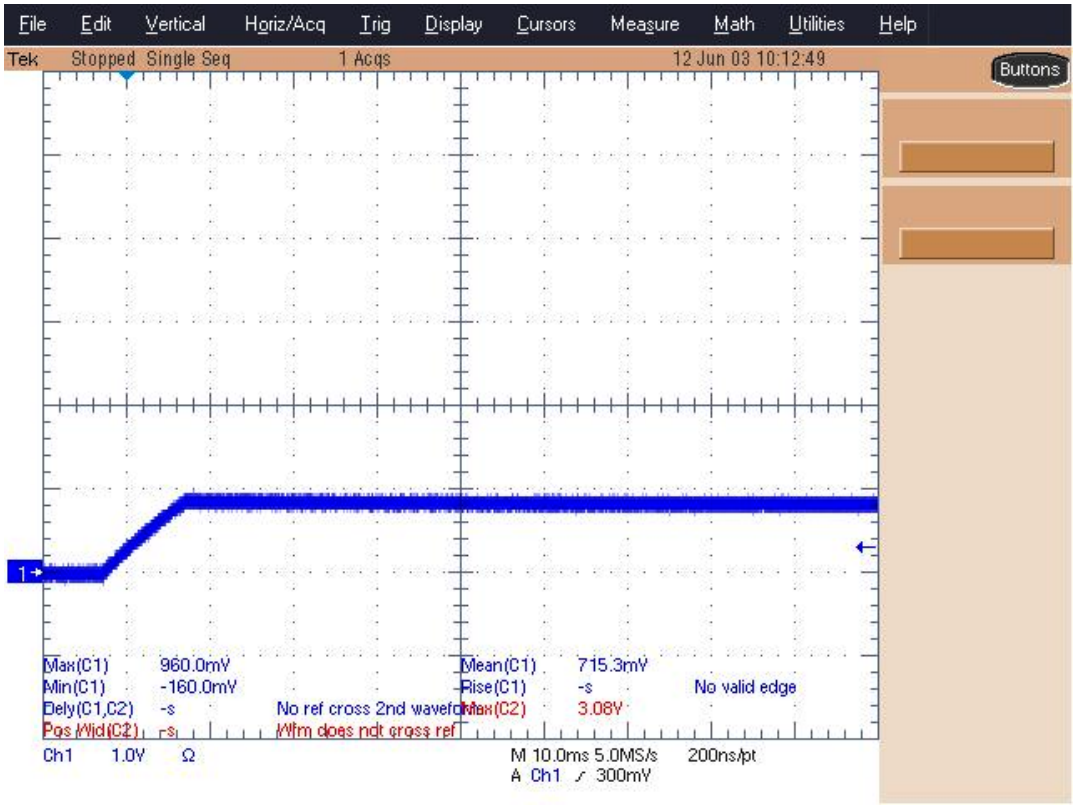

Figure 5.9-1 B-Device (SRP capable) to Host Output voltage ($V_{B\_HST\_OUT}$)

8. If the peak time V_{BUS} voltage is less than or equal to 2.0 volts then the device passes.
9. Disconnect the B-Device from the OET.

5.10 A-Device V_{BUS} Valid ($V_{A\_VBUS\_VLD}$) (E1, E2)

Set the OET switches to the following settings.

Mode	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
100 mA Load	OFF	OFF	OFF	**ON**	OFF	OFF	OFF	OFF	A-Device	OFF

1. Verify test equipment is on and has been on for the required warm up times.
2. Set the oscilloscope to the initial settings in section 4.3.1 .

   The settings for this test are identical to the previous test except for horiz scale, trigger level, cursors and measurement gating. Horiz scale changes to 200ms / div, trigger level to 4.4 V, cursors to on, and measurement gating to on.
3. Apply power to A-Device under test. Connect the A-Device to the OET.
4. If V_{BUS} is not off, turn it off. Confirm that V_{BUS} is off by observing the multimeter reading. The multimeter reading should be less than 200 mV.

5. Arm the oscilloscope for trace capture.
6. Using the device under test manufacturer's documented procedure, turn VBUS on.
7. Record the port's maximum current in appendix A, section A.5.10.
8. If the A-Device under test cannot support a load greater than 100 mA, then the A-Device must display a message to the operator that indicates the connected device is not supported. Record the message in appendix A section A.5.10. If the message was displayed, the oscilloscope may not have triggered. If the oscilloscope did not trigger, indicate N/A for the minimum and mean VBUS voltages in appendix A section A.5.10. If the oscilloscope did trigger, record the minimum and mean VBUS voltages in appendix A section A.5.10. These are the readings, Min(C1) and Mean(C1), on the oscilloscope. If the minimum VBUS voltage is greater than 4.4 volts and the not supported message is displayed, then the device fails the test.
9. If the A-Device under test can support a load greater than 100 mA, then the oscilloscope should trigger and the trace should rise above 4.4 volts. Record the minimum and mean VBUS voltages in appendix A section A.5.10. These are the readings, Min(C1) and Mean(C1), on the oscilloscope. If the A-Device under test can support a load greater than 100 mA, no message is displayed; but the minimum voltage must be greater than 4.4 volts, the mean voltage must be within the range of 4.75 V to 5.25 V, and both voltages must meet these requirements for at least one second after VBUS reaches 4.4 volts to pass.

   Below is an example oscilloscope capture of a device that can support a load greater than 100 mA:

Figure 5.10-1 A-Device VBUS Valid (VA_VBUS_VLD)

10. Disconnect the A-Device from the OET.

5.11 A-Device Session Valid ($V_{A\_SESS\_VLD}$) (E19)

This test is only applicable to A-Devices that respond to VBUS pulsing. If the device under test does not respond to VBUS pulsing, indicate that in appendix A section A.5.11 by checking the "Device does not support VBUS SRP pulsing" box.

Set the OET switches to the following settings.

Mode	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
Pre-A-Device VBUS Level	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	A-Device	OFF

1. Verify test equipment is on and has been on for the required warm up times.
2. Set the oscilloscope to the initial settings in section 4.3.1 .

   The settings for this test are identical to the previous.
3. Verify power supply voltage output is set for 0 volts and that the power supply has been set to the initial settings in section 4.3.3.
4. Apply power to A-Device under test if not already on. Connect the A-Device to the OET.
5. If VBUS is not off, turn it off. Confirm that VBUS is off by observing the multimeter reading. The multimeter reading should be less than 200 mV.
6. Using the power supply recall 1 function, increase the power supply voltage to 750 mV.
7. Arm the oscilloscope for trace capture.
8. Set switch SW5 of the OET to on.
9. Verify that the oscilloscope did not trigger. If the oscilloscope triggered, the device has failed this test.
10. Confirm that VBUS is still off by observing the multimeter reading. The multimeter reading should be less than 760 mV.
11. In the next step, the power supply voltage will be increased to 2.05 volts. One of two events is expected to occur. The expected event is for the A-Device to switch VBUS on when the VBUS VA_SESS_VLD threshold voltage is reached. In this case, the voltage will change from the threshold voltage to greater than 4.4 V even though the power supply was only increased to 2.05 volts. The VBUS VA_SESS_VLD threshold voltage required to pass is from .8 to 2.0 volts inclusive. The unexpected event that may occur is that the VBUS voltage remains at 2.05 V without the A-Device turning VBUS on. If this occurs, the A-Device fails the test.
12. Arm the oscilloscope for trace capture.
13. Using the power supply recall 2 function, increase the power supply voltage to 2.05 volts.
14. The oscilloscope should trigger and the trace should rise above 4.4 volts. If the oscilloscope does not trigger, the device fails the test. If the oscilloscope triggered; record the minimum voltage in appendix A, section A.5.11. This is the reading, Min(C1), on the oscilloscope. Also record the port's maximum rated current.

    Below is an example oscilloscope capture of a passing event:

Figure 5.11-1 A-Device Session Valid (VA_SESS_VLD)

15. If an A-Device responds to VBUS SRP pulsing, its session valid detection threshold voltage must be in the range from .8 V to 2.0 V to pass. VBUS must also be greater than 4.4 volts after reaching 4.4 volts for at least 1 second to pass.
16. Set the power supply voltage output to 0 volts.
17. Disconnect the A-Device from the OET.

5.12 B-Device VBUS Valid (VB_SESS_VLD) (E20)

Set the OET switches to the following settings.

Mode	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
Pre- VBUS Current Bypass Test	OFF	OFF	OFF	OFF	OFF	OFF	**ON**	**ON**	B-Device	OFF

1. Verify test equipment is on and has been on for the required warm up times.

2. Set the oscilloscope to the initial settings in section 4.3.1 with the following exception:

Ch2 Display	On
Horiz Position	90%
Trigger Source	Ch2
Trigger Level	2.5V
Cursors	Off
Measurement Gating	Off

   The settings for this test are identical to the previous test except for the items listed above.

3. Verify power supply voltage output is set for 0 volts and that the power supply has been set to the initial settings in section 4.3.3.
4. Apply power to B-Device under test if not already on. Connect the B-Device to the OET.
5. Using the power supply recall 1 function, increase the power supply voltage to 750 mV.
6. Arm the oscilloscope for trace capture.
7. Set switch SW6 of the OET to on.
8. Verify that the data channel did not trigger. If the data channel triggered, the device has failed this test.
9. Confirm that VBUS is still off by observing the multimeter reading. The multimeter reading should be less than 760 mV.
10. Using the power supply recall 3 function, increase the power supply voltage to 4.05 volts.
11. The oscilloscope should have triggered. Confirm that the data channel has risen to 2.7V or higher, (oscilloscope Max(C2) measurement minus noise). Record in appendix A section A.5.12 the time from when VBUS voltage reached 4 volts to when the data channel reached 2.7 volts (Dely(C1,C2) measurement from oscilloscope). If the data channel transition preceded the VBUS voltage reaching 4 volts, this will be negative number. If the oscilloscope did not trigger, the device has failed this test.

    Below is an example oscilloscope capture of a passing event:

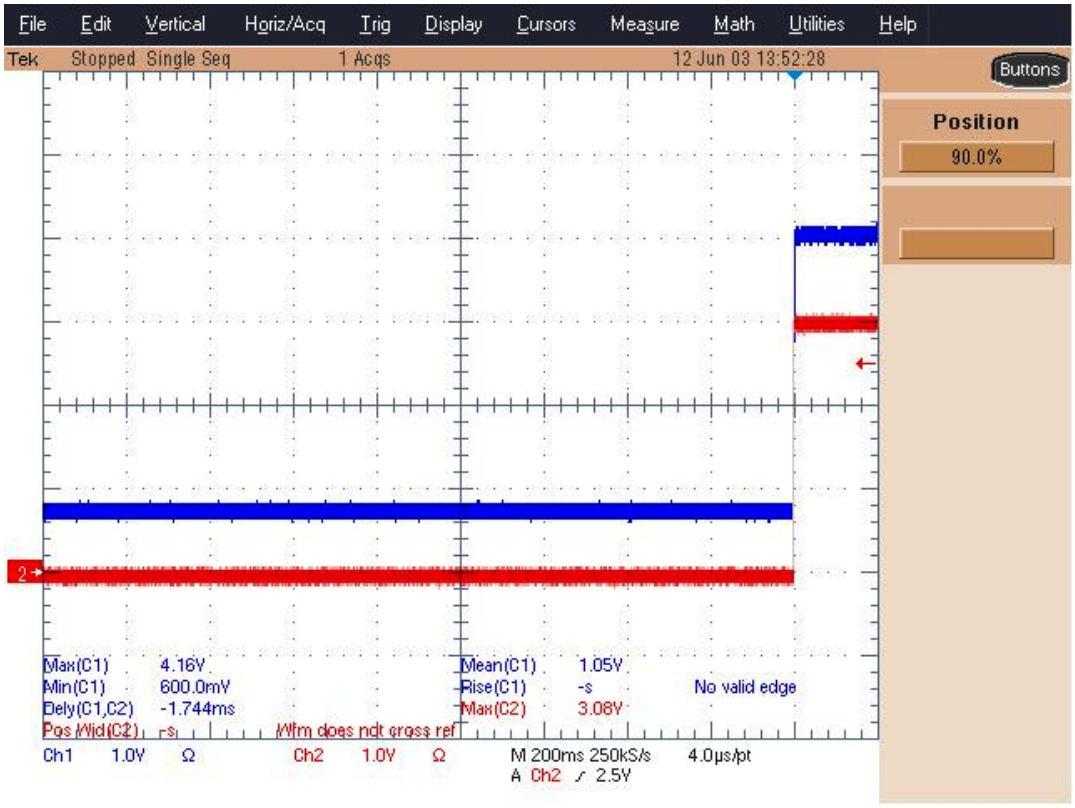

Figure 5.12-1 B-Device VBUS Valid (VB_SESS_VLD)

12. If the device did not assert the data line when VBUS voltage is less than .8 volts and the device asserted the data line within 1 second of VBUS voltage reaching 4 volts then the device passes.
13. Set switch SW6 of the OET to off.
14. Set the power supply voltage output to 0 volts and set output to off.
15. Disconnect the B-Device from the OET.

5.13 Data-Line Pulsing Test (TB_DATA_PLS) (E22)

Set the OET switches to the following settings.

Mode	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
Passive OTG Device Duplicator	**ON**	OFF	OFF	OFF	OFF	OFF	**ON**	**ON**	B-Device	OFF

1. Verify test equipment is on and has been on for the required warm up times.
2. Set the oscilloscope to the initial settings in section 4.3.1 with the following exception:

Ch1 Display	Off

Ch2 Display	On
Horiz Scale	2ms/div
Trigger Source	Ch2
Delay/Pulse Measurement Setup	Mid Ref = 1.5V
Trigger Level	2.5V
Cursors	Off
Measurement Gating	Off

The settings for this test are identical to the previous test except for Ch1 Display, Horiz Scale, Horiz Position and Mid Ref. Horiz Position is changed to 10%. The others are set as indicated above.

3. Apply power to B-Device under test if not already on.
4. Connect the B-Device to the OET.
5. Arm the oscilloscope for trace capture.
6. Using the device under test manufacturer's documented procedure, initiate SRP.
7. The oscilloscope trace should trigger with a pulse high voltage of at least 2.7 and less than 3.6 volts. Record the data line high pulse amplitude and the data line high pulse width in appendix A section A.5.13, (Max(C2) measurement minus noise & Pos Wid(C2) measurement from oscilloscope).

   Below is an example oscilloscope capture of a passing event:

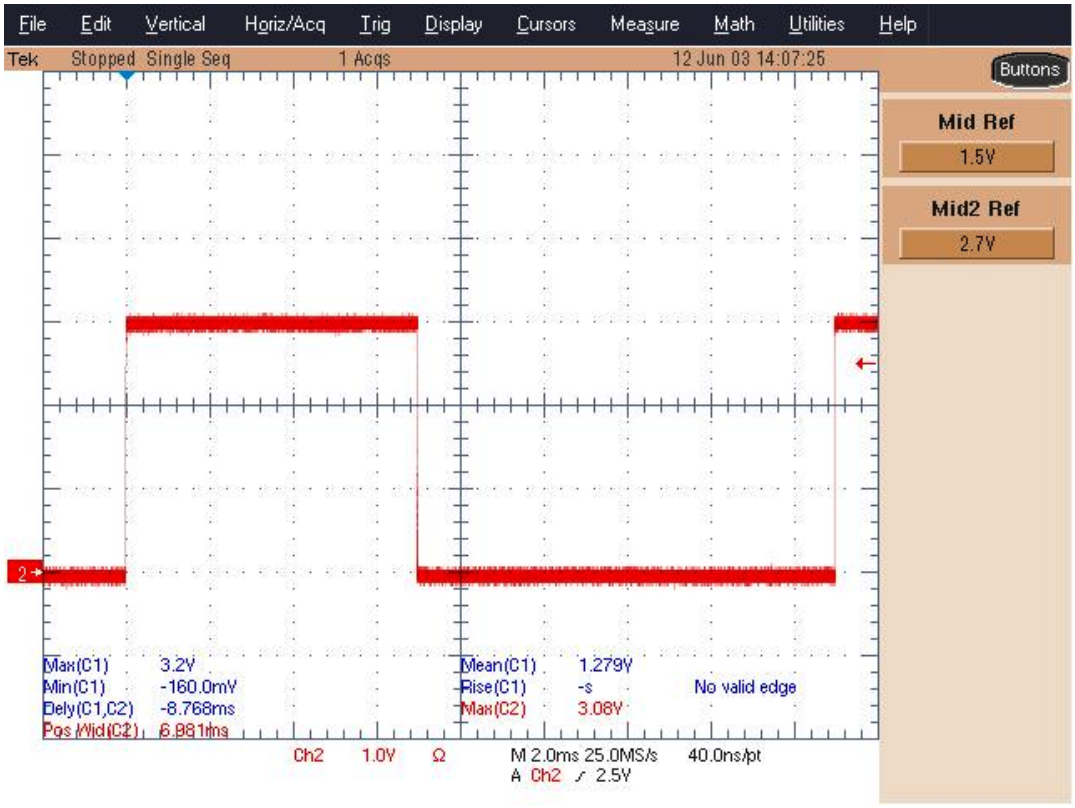

Figure 5.13-1 Data-Line Pulsing Test (TB_DATA_PLS)

8. If the B-Device SRP data line pulse is from 5 ms to 10 ms then the device passes.
9. Disconnect the B-Device from the OET.

Appendix A

A.5 OTG Electrical Test Data

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

A.5.1 Vendor and Product Information

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

A.5.2 Test Equipment List & Calibration Data

List test equipment used and calibration dates below. Equipment calibration should be traceable to National Institute of Standards and Technology (NIST).

Test Equipment	Calibration Date

A.5.3 A-Device Output Voltage ($V_{A\_VBUS\_OUT}$) (E1, E8)

E1, E8 An A-Device must be able to source a minimum of 8mA from VBUS while maintaining the VBUS voltage from 4.4 to 5.25 volts.

Reference documents: *OTG Supplement to USB2.0 Specification Rev 1.0a*, Section 5.1.1

Parameter	Specification Requirement	Test Data
VBUS minimum voltage:	4.4 V	
VBUS maximum mean voltage:	5.25 V	
Port's maximum rated current:	Enter maximum rated current	

- ❑ Pass
- ❑ Fail

Comments:

A.5.4 V_{BUS} Rise Time ($T_{A\_VBUS\_RISE}$) (E3)

E3 When attached as an A-Device, the VBUS rise time from 0 V to 4.4 V must be less than or equal to 100 milliseconds when driving an external load capacitance of 10 µF.

Reference documents: *OTG Supplement to USB2.0 Specification Rev 1.0a*, Section 5.1.3

Parameter	Specification Requirement	Test Data
VBUS rise time:	Less than or equal to 100 milliseconds	

- ❑ Pass
- ❑ Fail

Comments:

A.5.5 B-Device (SRP capable) to OTG Device Output Voltage ($V_{B\_DRD\_OUT}$) (E5)

E5 During VBUS SRP pulsing to an OTG device, the VBUS peak voltage must be at least 2.1 V but not exceed 5.25 V.

Reference documents: *OTG Supplement to USB2.0 Specification Rev 1.0a*, Section 5.3.4

Parameter	Specification Requirement	Test Data
VBUS peak voltage:	2.1 V minimum 5.25 V maximum	

- ❑ Pass
- ❑ Fail

Comments:

A.5.6 B-Device (SRP capable) to Host Output voltage ($V_{B\_HST\_OUT}$) (E6)

E6 During VBUS SRP pulsing to a standard host, , the VBUS peak voltage must not exceed 2.0 V.

Reference documents: *OTG Supplement to USB2.0 Specification Rev 1.0a*, Section 5.3.4

Parameter	Specification Requirement	Test Data
VBUS peak voltage:	2.0 V maximum	

- ❑ Pass
- ❑ Fail

Comments:

A.5.7 A-Device V_{BUS} Valid ($V_{A\_VBUS\_VLD}$) (E1)

E1 If an A-Device is not capable of providing at least 100 mA of current, then the A-Device must indicate a low voltage condition. If the A-Device under test can support a load greater than 100 mA, no message is required, but VBUS voltage must be from 4.75 V to 5.25 V to pass.

Reference documents: *OTG Supplement to USB2.0 Specification Rev 1.0a*, Sections 3.4, 5.1.1

Parameter	Specification Requirement	Test Data
Port's maximum rated current:	Enter maximum rated current	
Message indicated:	To pass, a message must be reported if maximum rated current less than 100 mA and VBUS less than 4.4 V. Enter actual message reported or indicate failure of test. If maximum rated current less than 100 mA and VBUS not less than 4.4 V, then no message should be generated. Enter lack of message by entering "No message since VBUS not less than 4.4 V". If message was displayed, indicate failure of test. If maximum rated current greater than 100 mA then enter "N/A".	
VBUS minimum voltage:	If no message displayed, must be greater than 4.4 V.	

VBUS mean voltage:	If no message displayed and maximum rated current less than or equal to100 mA, must be less than 5.25 V. If maximum rated current greater than 100 mA, must be 4.75 V to 5.25 V.	

- ❑ Pass
- ❑ Fail

Comments:

A.5.8 A-Device Session Valid ($V_{A\_SESS\_VLD}$) (E19)

E19 If an A-Device responds to VBUS SRP pulsing, its session valid detection threshold voltage must be in the range from .8 V to 2.0 V.

Reference documents: *OTG Supplement to USB2.0 Specification Rev 1.0a*, Section 5.3.6

Parameter	Specification Requirement	Test Data
VBUS minimum voltage:	4.4 V	
Port's maximum rated current:	Enter maximum rated current	

- ❑ Pass
- ❑ Fail
- ❑ Device does not support VBUS SRP pulsing

Comments:

A.5.9 B-Device V_{BUS} Valid ($V_{B\_SESS\_VLD}$) (E20)

E20 A B-Device must not assert either the D+ or D- data-line when VBUS voltage is less than the session valid threshold. In addition, the B-Device must assert either the D+ or D- data-line within 1 second after VBUS B-Device session valid threshold is exceeded if the B-Device did not initiate the session with SRP.

Reference documents: *OTG Supplement to USB2.0 Specification Rev 1.0a*, Section 5.3.7

Parameter	Specification Requirement	Test Data
V_{BUS} @ 4 V to D+ or D- Time (This may be a negative number):	Less than 1 second	

- ❑ Pass
- ❑ Fail

Comments:

A.5.10 Data-Line Pulsing Test ($T_{B\_DATA\_PLS}$) (E22)

E22 A B-Device SRP D+ or D-data line pulse must be 5 milliseconds to 10 milliseconds in duration. Pulse high voltage must be from 2.7 to 3.6 volts.

Reference documents: *OTG Supplement to USB2.0 Specification Rev 1.0a*, Section 5.3.3; *USB 2.0 Specification*, Section 7.1.4

Parameter	Specification Requirement	Test Data
SRP D+ or D- data line pulse width time:	5 ms minimum 10 ms maximum	
SRP D+ or D- data line pulse high voltage:	2.7 V minimum 3.6 V maximum	

- ❑ Pass
- ❑ Fail

Comments: