USB Battery Charging 1.2 Compliance Plan

Revision 1.0

October 12, 2011

Revision History

Revision	Issue Date	Author	Comment
1.0	Oct 26, 2011	Pat Crowe	First release

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1 Introduction

1.1 General

This compliance plan enables test and certification of USB Portable Devices, Chargers and Charging Ports, Micro-ACAs, Standard-ACAs and ACA-Docks to USB 2.0 specification and to Battery Charging specification revision 1.2.

Charging Ports include Dedicated Charging Ports and Charging Downstream Ports as defined in the Battery Charging Specification revision 1.2. A USB Charger is a device with a Dedicated Charging Port, such as a wall adapter or car power adapter. Herein, USB Chargers are referred to as Dedicated Charging Ports as functionally they are identical.

Previously a USB Portable Device with a battery and charging capability simply took power from a USB port without any control. With BC 1.2, a Portable Device can get more power and the battery can be charged faster. It is important to verify that a Portable Device complies with the BC 1.2 specification while communicating with a Charging Downstream Port and identifying a Dedicated Charger, and ensuring that it continues to operate as a functional USB device.

Many existing dedicated chargers have offered a USB compliant physical connection but lacked a USB compliance program. This led to many chargers having characteristics incompatible with USB specifications.

As well, even though PC host ports go through an extensive certification process, future PCs that claim a USB compliant Charging Port in their feature list will be required to pass compliance checks described in this document. These checks are in addition to those required for a USB compliant Standard Downstream Port.

1.2 Objective of the Compliance Program

The overall objective of the USB Charger and Charging Port compliance program is to mirror the effectiveness of the USB-IF compliance program. The benefits of a compliance program have been proven by the USB initiative: the proliferation of knowledge, more stringent testing, and a higher standard of quality.

1.3 Scope of the Document

This document provides a compliance plan applicable to Portable Devices, USB Chargers and Charging Ports, Micro-ACAs, Standard-ACAs and ACA-Docks, as defined in the BC 1.2 specification.

1.4 Intended Audience

This plan is intended for compliance test labs and workshops. In addition, the document is intended for device manufacturers for pre-certification activities before applying for official compliance certification.

1.5 Reference Document(s)

- Battery Charging 1.2 Specification and Adopters Agreement
  http://www.usb.org/developers/devclass_docs/

- Universal Serial Bus Specification Revision 2.0 Specification
  http://www.usb.org/developers/docs/

2 Acronyms and Terms

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

ACA	Accessory Charger Adapter
BC 1.2	USB-IF Battery Charging Specification version 1.2
CDP	Charging Downstream Port
CMO	Common Mode Offset
CMV	Common Mode Voltage
DBP	Dead Battery Provision
DC	Direct Current
DCD	Data Contact Detect
DCP	Dedicated Charging Port
ETB	Electrical Test Board
FS	Full-speed
HS	High-speed
ID	Identification
LS	Low-speed
MRP	Multiple Role Port (CDP/DCP/SDP)
OTG	On-The-Go
PC	Personal Computer
PD	Portable Device
PET	Protocol and Electrical Tester
PHY	Physical Layer Interface for High Speed USB
PS2	Personal System 2
SDP	Standard Downstream Port
SIE	Serial Interface Engine
SRP	Session Request Protocol
TID	Test Identification Number
TPL	Targeted Peripheral List
USB	Universal Serial Bus
USBCV	USB Command Verifier
USB-IF	USB Implementers Forum
UUT	Unit Under Test
VBUS	Voltage line of the USB interface

3 Scope of Tests

This document describes suites of tests for a number of product types. These tests only cover the additional requirements for these products, relating to the functionality of battery charging. Most of the product types will require further compliance testing to ensure their functionality in other areas, and it is beyond the scope of this document to define those tests.

For example, a Portable Device (PD) may be an OTG device and as such, require to be tested according to the appropriate OTG Supplement Compliance Plan.

The document is divided into suites of tests, each of which represents all or part of the Battery Charging test requirements for a particular product. A given product shall be tested against all the appropriate test suites. The following examples, which are not exhaustive, illustrate this principle.

PD

Test against both:

- ‘PD, except Dead Battery Provision’ tests and
- ‘PD, Dead Battery Provision’ tests.

Simple Charger

Test against:

- DCP tests

Charging Port on Host

Test against:

- CDP tests

Hub

Test against:

- CDP tests
- DCP tests
- SDP tests
- MRP tests

ACA or ACA-Dock

Test against the one appropriate category from:

- Micro-ACA, Separate Charger
- Micro-ACA, Combined Charger
- Standard-ACA, Separate Charger
- Standard-ACA, Combined Charger
- ACA-Dock

4 PET – Protocol and Electrical Tester

The PET is a unit, designed to perform compliance testing or assist with development work leading towards compliance testing on On-the-Go, Battery Charging and other general USB applications. It is described in detail in the document:

- Protocol and Electrical Tester Specification

A brief breakdown of its functional blocks follows.

4.1 Serial Interface Engine (SIE)

A fully functional SIE, with both host and peripheral capabilities, connected via a PHY to the UUT micro-AB receptacle on the front panel. This is under the control of the Script Processor.

4.2 Electrical Test Board (ETB)

This contains circuitry to allow control and measurement of the electrical parameters for USB, OTG and BC specifications. It includes VBUS Generator, ID pin circuitry, data line test mode circuitry, VBUS current and voltage loads, and a variety of voltage and current measuring blocks. Extra connections are provided to enable the testing of Accessory Charger Adapters (ACAs). The ETB functionality required is shown in Figure 4-1.

4.3 Script Processor

Scripts are downloaded to this processor to control the sequence of operations required for a particular test. The processor controls the SIE and ETB as required by the operator. Scripts for all the OTG and BC compliance tests would be provided by the application accompanying the PET.

4.4 USB Analyzer

The PET could also provide full USB analyzer functionality. By designing the analyzer into the PET circuitry the analyzer could be designed to have zero impact on the data line transmission quality.

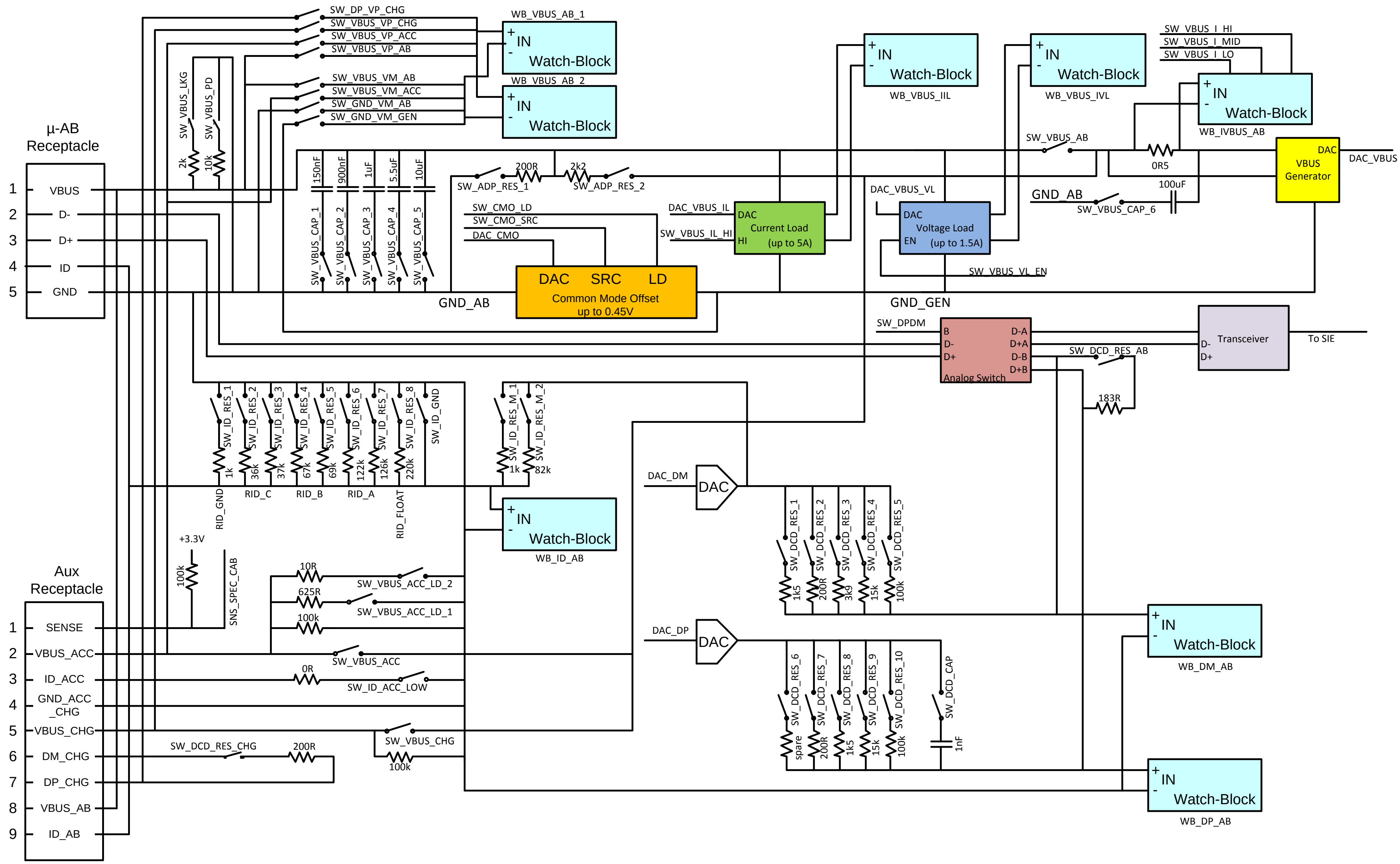

Figure 4-1 ETB Block Diagram

5 Test Cables Required

The cables required by the PET tester are described below.

Each cable should be labeled, and specify the lead loop resistance value, required to be entered into the test dialog, if the lead is replaced. The tester application contains a check box to specify whether the UUT has a captive lead, as in this case the captive test cable is deemed to be part of the unit under test.

5.1 Special Test Cable A

Table 5-1 Special Test Cable A

Micro-B plug to Micro-B plug		
Micro-B plug (PET)	**Micro-B plug (UUT)**	**Purpose**
1	1	VBUS
2	2	D-
3	3	D+
4	4	ID
5	5	GND

This cable has been specified to allow control of the ID pin of the unit-under-test. It is important to use this cable when the test specifies it. The particular resistance of the cable has also been allowed for in the test suite.

5.2 Special Test Cable B

Table 5-2 Special Test Cable B

Micro-B plug to Standard-A plug		
Micro-B plug (PET)	**Standard-A plug (UUT)**	**Purpose**
1	1	VBUS
2	2	D-
3	3	D+
nc		
5	4	GND

Although this is a standard cable configuration, it is important to use the specified cable, as its particular resistance has been allowed for in the test suite.

5.3 Special Test Cable C

Table 5-3 Special Test Cable C

9-pin D-type Assembly			
D-type (PET)	**Standard-A Receptacle (ACA Charger Port)**	**Micro-B Plug (ACA Accessory Port)**	**Purpose**
1 (linked to 4)			Cable Sense
2		1	Accessory VBUS
3		4	Accessory ID
4	4	5	GND
5	1		Charger VBUS
6	2		Charger D-
7	3		Charger D+
8			OTG VBUS
9			OTG ID

This cable is used when testing a Micro-ACA. This is correct for a Micro-ACA with a captive charger port cable. For a Micro-ACA with a Micro-B receptacle as the charger port, connect Special Cable B to the Standard-A receptacle of Special cable C, and plug the other end into the charger port of the ACA.

5.4 Special Test Cable D

Table 5-4 Special Test Cable D

9-pin D-type Assembly			
D-type (PET)	**Standard-A Receptacle (ACA Charger Port)**	**Standard-A Plug (ACA Accessory Port)**	**Purpose**
1 (linked to 4)			Cable Sense
2		1	Accessory VBUS
3			Accessory ID
4	4	4	GND
5	1		Charger VBUS
6	2		Charger D-
7	3		Charger D+
8			OTG VBUS
9			OTG ID

This cable is used when testing a Standard-ACA. This is correct for a Standard-ACA with a captive charger port cable. For a Standard-ACA with a Micro-B receptacle as the charger port, connect Special Cable B to the Standard-A receptacle of Special cable C, and plug the other end into the charger port of the ACA.

5.5 Special Test Cable E

Table 5-5 Special Test Cable E

Micro-A plug to Standard-A receptacle		
Micro-A plug (PET)	**Standard-A receptacle (UUT)**	**Purpose**
1	1	VBUS
2	2	D-
3	3	D+
4 - Connected to pin 5		
5	4	GND

This is a short adapter cable, which may be used to connect a PD with a standard-A plug to the PET.

6 Test Setups

6.1 OTG Device as Unit-Under-Test (Setup no. 1)

When running a test-suite relating to an OTG device, the first test will prompt you to connect it to the PET using 'Special Cable A'. This ***Micro-B plug*** to ***Micro-B plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reasons:

It has 5 cores, instead of the usual 4. This allows the PET to control the ID pin of the UUT.

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

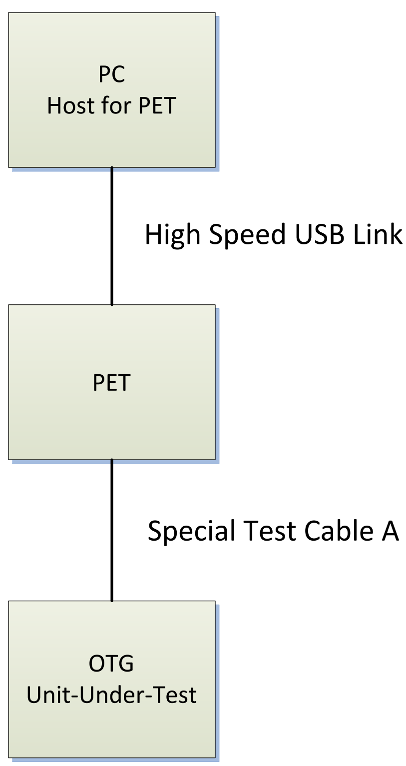

Figure 6-1 Setup No 1 – OTG Device

6.2 Embedded Host as Unit-Under-Test (Setup no. 2)

When running a test-suite relating to an Embedded Host, the first test will prompt you to connect it to the PET using 'Special Cable B'. This ***Micro-B plug*** to ***Standard-A plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

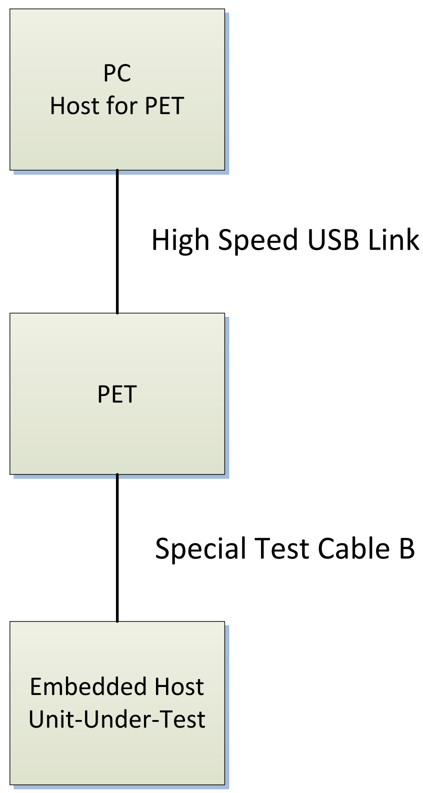

Figure 6-2 Setup No 2 – Embedded Host

6.3 Peripheral Only as Unit-Under-Test (Setup no. 3)

When running a test-suite relating to a Peripheral-Only OTG device with a ***Micro-B receptacle***, the first test will prompt you to connect it to the PET using ‘Special Cable A’. This ***Micro-B plug*** to ***Micro-B plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

Another possibility is that the device has a captive cable with a ***Micro-A plug***. In this case use this, and check the 'Captive Cable' check box, in the 'PET Test Suites' Dialog.

Finally, the device may have a captive cable with a ***Standard-A plug***. In this case, use ‘Special Cable E’ to connect the ***Standard-A plug*** to the ***Micro-AB receptacle*** of the PET, and check the 'Captive Cable' check box, in the 'PET Test Suites' Dialog.

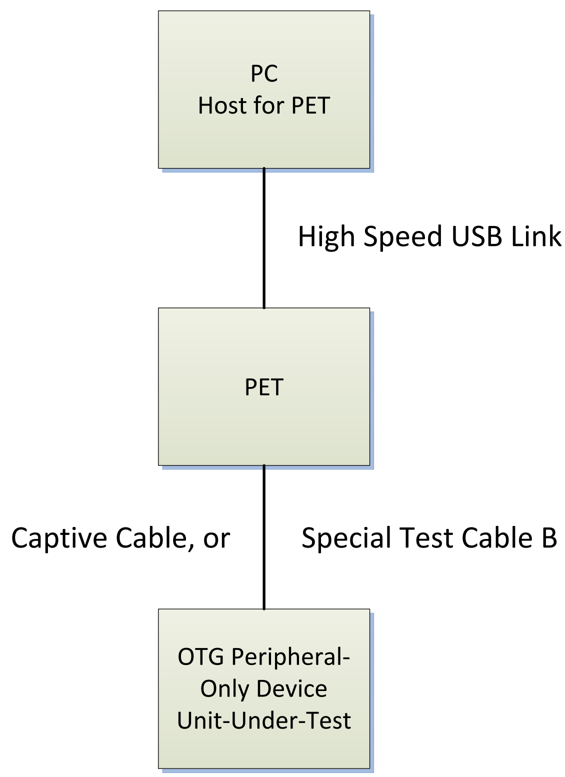

Figure 6-3 Setup No 3 – Peripheral Only

6.4 PD as Unit-Under-Test (Setup no. 4)

A Portable Device (PD) is assumed to have a ***Micro-B receptacle*** or a ***Micro-AB receptacle***. A PD that mates with an ACA-Dock or ACA is required to have a ***Micro-AB receptacle***. The PD may alternatively have a captive cable.

When running a test-suite relating to a PD having a ***Micro-B receptacle*** or a ***Micro-AB receptacle***, the first test will prompt you to connect it to the PET using 'Special Cable A'. This ***Micro-B plug*** to ***Micro-B plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

The other possibility is that the device has a captive cable with a ***micro-A plug***. In this case use this, and check the 'Captive Cable' check box, in the 'PET Test Suites' Dialog.

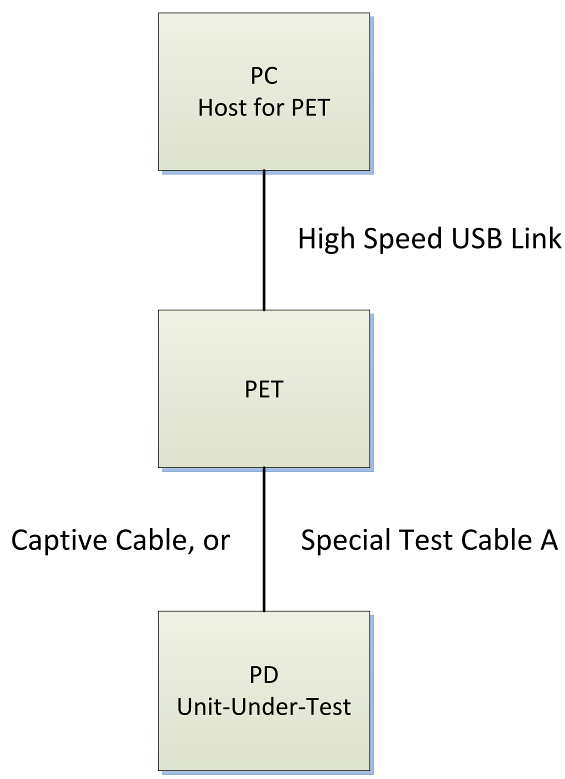

Figure 6-4 Setup No 4 – Portable Device

6.5 CDP (or SDP) as Unit-Under-Test (Setup no. 5)

A Charging Downstream Port (CDP) must be equipped with a Standard-A receptacle.

When running a test-suite relating to a CDP, the first test will prompt you to connect it to the PET using 'Special Cable B'. This ***Micro-B plug*** to ***Standard-A plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

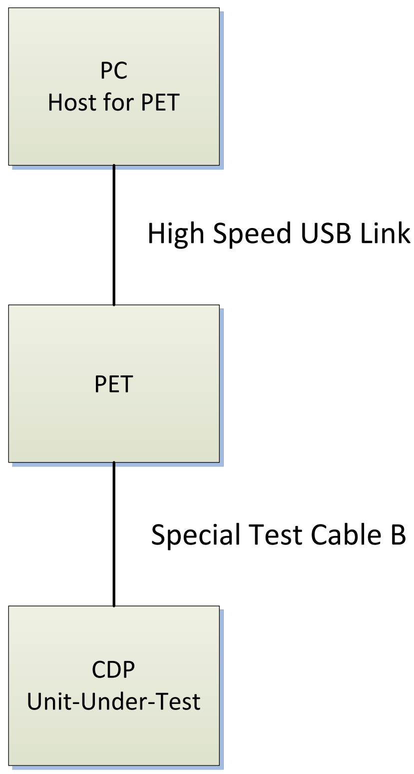

Figure 6-5 Setup No 5 – CDP

6.6 DCP as Unit-Under-Test (Setup no. 6)

A Dedicated Charging Port (DCP) must be equipped with a ***Standard-A receptacle***, or a captive cable terminated with a ***Micro-B plug***.

When running a test-suite relating to a DCP with a ***Standard-A receptacle***, the first test will prompt you to connect it to the PET using ‘Special Cable B’. This ***Micro-B plug*** to ***Standard-A plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

The other possibility is that the device has a captive cable with a ***micro-B plug***. In this case use this, and check the 'Captive Cable' check box, in the 'USB-PET Test Suites' Dialog.

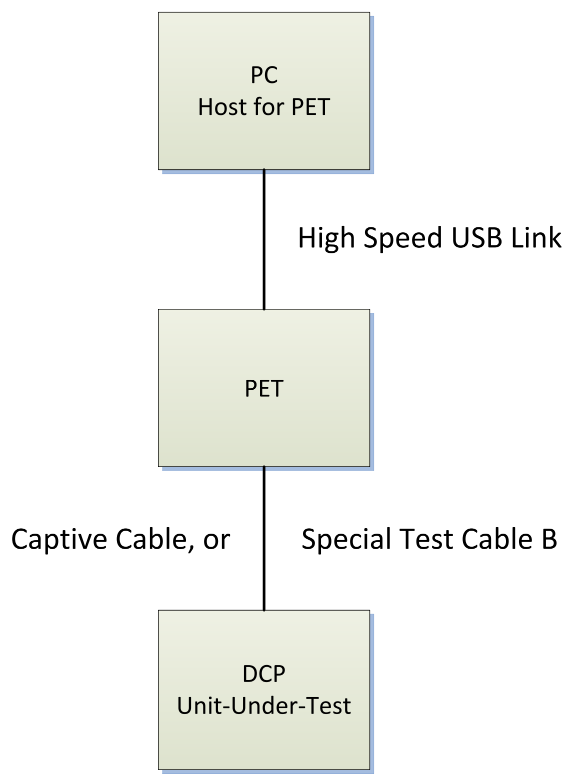

Figure 6-6 Setup No 6 – DCP

6.7 Micro-ACA (Separate Charger) as Unit-Under-Test (Setup no. 7)

An Accessory Charger Adapter having a Micro-AB receptacle for its accessory port (Micro-ACA) must be equipped with:

- a captive cable terminated with a Micro-A plug for its OTG port
- a Micro-B receptacle, or a captive cable with Standard-A plug for its charger port, and of course
- a Micro-AB receptacle for its accessory port

When running a test-suite relating to a Micro-ACA, the first test will prompt you to connect it to the PET using ‘Special Cable C’.

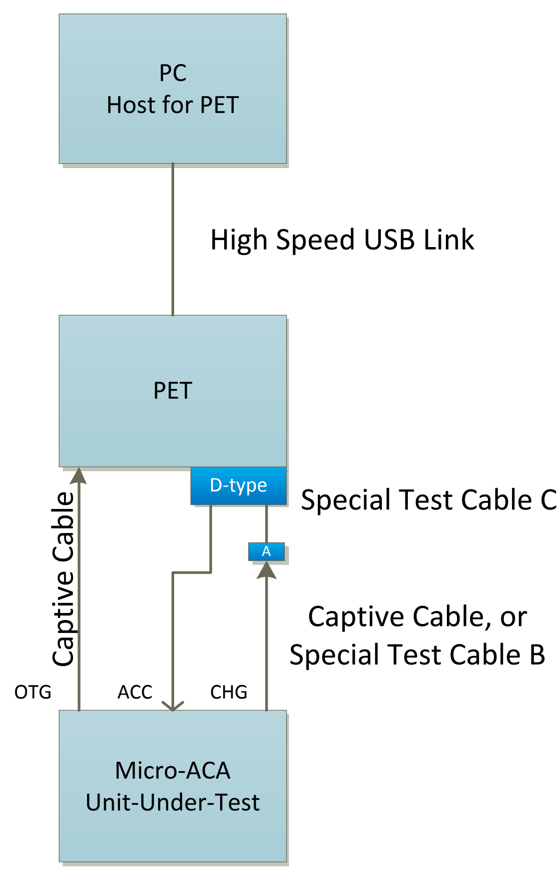

Figure 6-7 Setup No 7 – Micro-ACA

6.8 Micro-ACA (Combined Charger) as Unit-Under-Test (Setup no. 7b)

This is the same as Setup 7 except that there is no charger cable coming from the UUT.

6.9 Standard-ACA (Separate Charger) as Unit-Under-Test (Setup no. 8)

An Accessory Charger Adapter having a Standard-A receptacle for its accessory port (Standard-ACA), must be equipped with:

- a captive cable terminated with a Micro-A plug for its OTG port
- a Micro-B receptacle, or a captive cable with Standard-A plug for its charger port, and of course
- a Standard-A receptacle for its accessory port

When running a test-suite relating to a Standard-ACA, the first test will prompt you to connect it to the PET using 'Special Cable D'.

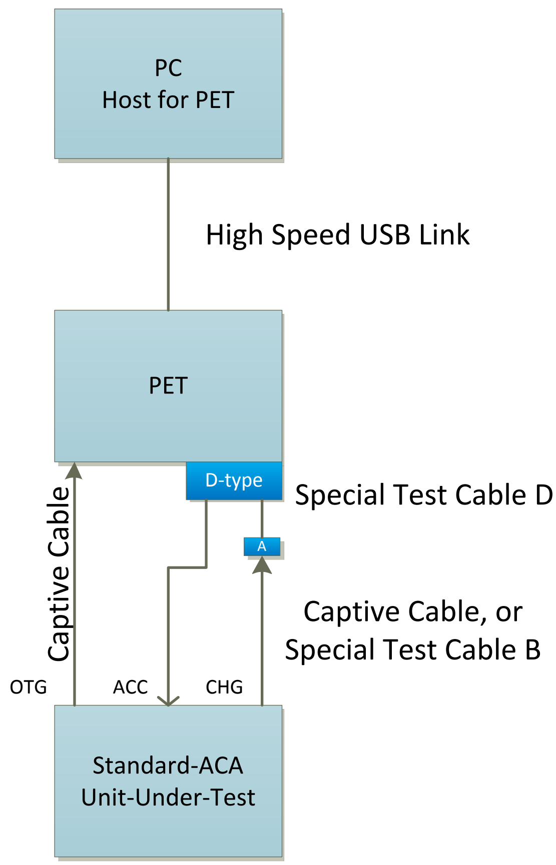

Figure 6-8 Setup No 8 – Standard-ACA

6.10 Standard-ACA (Combined Charger) as Unit-Under-Test (Setup no. 8b)

This is the same as Setup 8 except that there is no charger cable coming from the UUT.

6.11 ACA-Dock as Unit-Under-Test (Setup no. 9)

An ACA-Dock must be equipped with a Micro-A plug, for connecting to the Micro-AB receptacle of a PD. It is represented here as a captive cable. In practice it may comprise part of a fixture, which may be difficult to connect to the PET front panel. In this case it is the responsibility of the vendor to provide a suitable means to connect the ACA-Dock to the Micro-AB receptacle of the PET.

When running a test-suite relating to an ACA-Dock, the first test will prompt you to connect it to the PET using its captive cable.

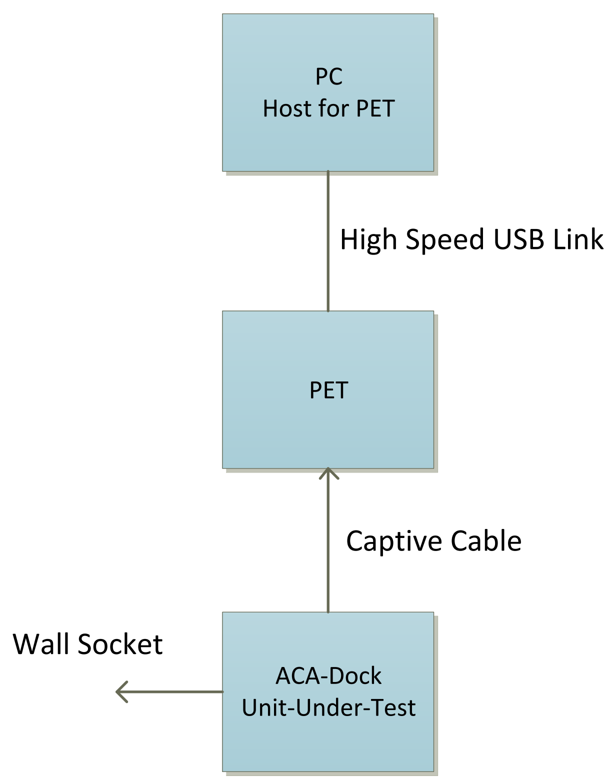

Figure 6-9 Setup No 9 – ACA-Dock

7 Portable Device Compliance

7.1 Submission Materials

7.1.1 Device Specific Information and Materials

Table 7-1 Device Specific Information and Materials for PDs

Item	Function	Value/ Support
1	Captive Cable	Yes ☐ No ☐
2	Apply Dead Battery Provision	Yes ☐ No ☐
3	Weak Battery Threshold	V
4	Maximum Charging Current with Dedicated Charger	_____mA
5	Maximum Charging Current with Charging Downstream Port operating at LS or FS	_____mA
6	Maximum charging current with Charging Downstream Port operating at HS	_____mA
7	Typical and maximum times that UUT with a dead battery will take to connect after being attached to a Standard Downstream Port	Typ. ____m ____s Max. ____m ____s
8	Typical and maximum times that UUT with a dead battery will take to connect after being attached to a Charging Downstream Port	Typ. ____m ____s Max. ____m ____s
9	Maximum current that the UUT can draw from a CDP	_____mA
10	The USB-IF TID for the UUT USB receptacle or captive plug intended to connect the UUT to a host or OTG device.	
11	Supply 2 batteries in a dead state for the Dead Battery Provision test.	
12	Supply 2 batteries in a state just above the weak battery threshold.	
13	Supply 1 good battery.	

7.1.2 Checklist

Table 7-2 Checklist for PDs

ID - Question		Response	Test Number	BC 1.2 Reference
PD1	Can the PD detect when V_{BUS} is greater than a threshold in the range $V_{OTG\_SESS\_VLD}$?	Yes ☐ No ☐	Vendor Declaration	3.2.2 3.3.1
PD2	Can the PD detect when D+ is greater than a threshold in the range V_{DAT_REF} ?	Yes ☐ No ☐	Vendor Declaration	3.3.1
PD3	Can the PD detect when D- is greater than a threshold in the range V_{DAT_REF} ?	Yes ☐ No ☐	Vendor Declaration	3.3.1

PD4	Can the PD detect when D- is greater than a threshold in the range V_{LGC} ?	Yes ☐ No ☐	Vendor Declaration	3.3.1
PD5	[**Optional**] Does PD use a current source I_{DP_SRC} and pull-down resistor R_{DM_DWN} to detect when the data pins have made contact during an attach event?	Yes ☐ No ☐	7.3	3.2.3.1 3.4.1 4.6.2
PD6	If yes, does PD commence Primary Detection within $T_{DCD\_TIMEOUT}$ max after V_{BUS} rises above $V_{OTG\_SESS\_VLD}$, if pin contact has not been detected on D+ or ID pins?	Yes ☐ No ☐	7.3	3.2.3.1 3.3.2 4.6.2
PD7	If no, does PD wait a time of $T_{DCD\_TIMEOUT}$ after the attach event before starting Primary Detection?	Yes ☐ No ☐	7.4	3.2.3.1 3.3.2 4.6.2
PD8	Does PD connect within $T_{SVLD\_CON\_PWD}$ of the attach event?	Yes ☐ No ☐	7.6, 7.7, 7.10, 7.11	3.2.3.1
PD9	Does PD wait for D+ to stay below V_{LGC_LOW} for T_{DCD_DBNC} min before disconnecting I_{DP_SRC} and R_{DM_DWN}?	Yes ☐ No ☐	7.3	3.3.2 3.4.1
PD10	Does PD turn on V_{DP_SRC} and I_{DM_SINK} and maintain them for T_{VDPSRC_ON} during Primary Detection?	Yes ☐ No ☐	7.6, 7.7	3.2.4.1 3.2.4.2 3.2.4.3 3.3.2 3.4.2
PD11	Is the design of V_{DP_SRC} such that an external device is able to pull D+ to 2.2V through R_{DP_UP}?	Yes ☐ No ☐	7.8	3.2.4.4 5
PD12	Does PD compare D- with V_{DAT_REF} during Primary Detection to distinguish between an SDP and a Charging Port?	Yes ☐ No ☐	7.7	3.2.4.1 3.2.4.2 3.2.4.3 3.3.2 4.6.2
PD13	[**Optional**] Does PD compare D- with VLGC during Primary Detection?	Yes ☐ No ☐	Vendor Declaration	3.2.4.1 3.2.4.2 3.2.4.3 3.3.2 4.6.2
PD14	[**Optional**] Does PD implement Secondary Detection?	Yes ☐ No ☐	7.5, 7.6	4.6.2
PD15	If the PD supports Secondary Detection, does the PD turn on V_{DM_SRC} and I_{DP_SINK} and maintain them for T_{VDMSRC_ON} during Secondary Detection?	Yes ☐ No ☐ N/A ☐	7.5, 7.6	3.2.5.1 3.2.5.2 3.3.2 3.4.2
PD16	If the PD supports Secondary Detection, does the PD compare D+ with V_{DAT_REF} during Secondary Detection to distinguish between a DCP and a CDP?	Yes ☐ No ☐ N/A ☐	Vendor Declaration	3.2.5.1 3.2.5.2 3.3.2 3.4.2

PD17	If the PD supports Secondary Detection, and during this detects that it is attached to a DCP, does it disable V_{DM_SRC} and I_{DP_SINK}, and either enable V_{DP_SRC} or pull D+ up to V_{DP_UP} through R_{DP_UP}, within $T_{SVLD\_CON\_PWD}$ of attach, and maintain this for as long as it draws more than I_{SUSP}? If the PD does not support Secondary Detection, and during Primary Detection has detected that it is connected to a DCP or to a CDP, does it pull D+ up to V_{DP_UP} through R_{DP_UP}, within $T_{SVLD\_CON\_PWD}$ of attach, and maintain this for as long as it draws more than I_{SUSP}?	Yes ☐ No ☐	7.5	3.2.5.1 3.3.2
PD18	If the PD supports Secondary Detection, and during this detects that it is attached to a CDP, does it turn off V_{DP_SRC}, V_{DM_SRC} and I_{DP_SINK}, and connect within $T_{SVLD\_CON\_PWD}$ of attach?	Yes ☐ No ☐ N/A ☐	7.6	3.2.5.2 3.3.2 3.4.2
PD19	[**Optional**] Does PD implement ACA Detection?	Yes ☐ No ☐	Vendor Declaration	3.2.6 4.6.2
PD20	If the PD supports ACA detection, does PD have a Micro-AB receptacle?	Yes ☐ No ☐ N/A ☐	Inspection	3.2.6 4.6.4
PD21	If the PD supports ACA detection, is it able to detect being attached to an ACA-Dock when it sees the following conditions: • V_{BUS} > $V_{OTG\_SESS\_VLD}$ • ID at R_{ID_A} • D+ at V_{LGC_HI} • V_{DAT_REF} < D- < V_{LGC}	Yes ☐ No ☐ N/A ☐	7.8	3.2.4.4 3.3.2 3.2.6
PD22	If the PD supports ACA detection, is it able to detect being attached to an ACA with a FS B-device on its accessory port and a charging port attached, when it sees the following conditions: • ID at R_{ID_A} • D- < V_{DAT_REF}	Yes ☐ No ☐ N/A ☐	7.9	3.2.4.5 3.3.2 3.2.6
PD23	If the PD supports ACA detection, is it able to detect being attached to an ACA with a LS B-device on its accessory port and a charging port attached, when it sees the following conditions: • ID at R_{ID_A} • D- > V_{LGC}	Yes ☐ No ☐ N/A ☐	Vendor Declaration	3.2.4.5 3.2.6

PD24	If the PD supports ACA detection, is it able to detect being attached to an ACA having a charging port attached when it sees the following condition: • ID at R_{ID_B}	Yes ☐ No ☐ N/A ☐	7.10	3.2.4.5 3.2.6
PD25	If the PD supports ACA detection, is it able to detect being attached to an ACA with an A-device on its accessory port and a charging port attached, when it sees the following condition: • ID at R_{ID_C}	Yes ☐ No ☐ N/A ☐	7.11	3.2.4.5 3.2.6
PD26	If the PD supports ACA detection, is it able to detect being attached to an ACA with an B-device on its accessory port and no charging port attached, when it sees the following condition: • ID at R_{ID_GND}	Yes ☐ No ☐ N/A ☐	7.12	3.2.6
PD27	If the PD supports ACA detection, does it continue to monitor the ID line after doing Primary detection, and respond correctly to resistance changes?	Yes ☐ No ☐ N/A ☐	Vendor Declaration	3.2.4.5 3.2.6 6.2.7
PD28	Does PD discharge V_{BUS} to less than V_{BUS_LKG} within T_{VLD_VLKG} whenever V_{BUS} is removed?	Yes ☐ No ☐	7.7	4.6.3
PD29	Does PD wait at least $T_{CP\_VDM\_EN}$ after disconnecting, before restarting the charger detection process?	Yes ☐ No ☐	Vendor Declaration	4.6.3
PD30	Does PD draw no more than I_{DEV_CHG} max from a Charging Port? What is the value of I_{MAX_BC}, the actual maximum current drawn? Note: I_{MAX_BC} is the maximum current that the PD can draw from a CDP.	Yes ☐ No ☐ _______mA	7.5, 7.6, 7.8, 7.9, 7.10, 7.11	4.6.1
PD31	Does PD draw no more than I_{CFG_MAX} from a SDP?	Yes ☐ No ☐	7.7	2.1
PD32	Does PD pull output voltage of a Charging Port no lower than V_{DCP_SHTDWN}?	Yes ☐ No ☐	Vendor Declaration	4.6.1
PD33	Does the PD correctly support LS, FS, HS and chirp signaling when the local ground is (I_{MAX_BC} x 0.25Ω + 5mV)* higher than the remote ground, where I_{MAX_BC} is the maximum current that the PD can draw from a CDP? *maximum of 0.375V	Yes ☐ No ☐	7.13, 7.14	3.5

DBP1	Does PD draw no more than I_{UNIT} when PD is not able to connect?	Yes ☐ No ☐	7.15	2.2
DBP2	Does PD reduce current drawn to I_{SUSP} within $T_{SVLD\_CON\_WKB}$ after attach if it is unable to connect and be enumerated?	Yes ☐ No ☐	Vendor Declaration	2.2
DBP3	Does PD enable V_{DP_SRC} within $T_{DBP\_ATT\_VDPSRC}$ of attach and maintain it if it is unable to connect?	Yes ☐ No ☐	7.15	2.2
DBP4	Does PD connect within $T_{DBP\_VDPSRC\_CON}$ of disabling V_{DP_SRC}?	Yes ☐ No ☐	Vendor Declaration	2.2
DBP5	Does PD prevent the use of DBP current to perform tasks unrelated to battery charging?	Yes ☐ No ☐	Vendor Declaration	2.2
DBP6	If the PD uses the DBP, can the device normally operate stand-alone from internal battery power?	Yes ☐ No ☐ N/A ☐	Vendor Declaration	2.2
DBP7	Can the PD, with a dead battery, pass the inrush test?	Yes ☐ No ☐	Vendor Declaration	2.2

7.2 B-UUT Initial Power-up Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates a downstream port.
Purpose	To prepare the PD for the following tests.
Preconditions	To ensure that the PD has been powered up and is ready for the subsequent tests. All following PD tests assume that this test has been run first. In the case of an ADP capable device, this test also confirms functional startup sequence.
Parameters	TB_SRP_FAIL, TB_ADP_PRB, TPWRUP_RDY
Description	The test operator is then instructed to connect up the PD in preparation for the tests, and to perform any actions required to power it up.

7.2.1 Test Procedure

Part 1 – Common to All B-UUT Types

1. The user enters into the PET:
    - whether the UUT is capable of ADP

The test sequence followed depends on the UUT type

- PD capable of ADP
- PD not capable of ADP

Part 2 – For PD UUT capable of ADP

2. Operator: Ensure UUT connected using special cable A or, where the device does not have a micro-AB or micro-B receptacle, a suitable alternative.
3. UUT is either powered or is not powered. PET is not applying VBUS, and not applying capacitance between VBUS and ground, ID pin is not connected to ground.
4. Operator: Turn UUT off, if not already off.
5. Operator: Turn UUT on.
6. Check that UUT performs an ADP probe within TPWRUP_RDY (30 sec or as specified by vendor).
7. To check probe, check that VBUS goes below 0.3V and then rises above 0.5V within 10ms.
8. After the first probe check that either a further probe (or probes) is performed, or that D+ goes high. Wait here till D+ goes high or TPWRUP_RDY times out.
9. Check that D+ stays high for at least 5ms.
10. Check that D+ goes low within 10ms of start of pulse.

11. Check ADP probe is not performed for TB_SRP_FAIL min (5 sec) after start of D+ (SRP) pulse.

12. Check that ADP probe is performed within TB_SRP_FAIL max plus TB_ADP_PRB max (6.0 + 2.6 = 8.6 sec) after start of D+ (SRP) pulse.

13. Now ready for any other B_UUT test.

Part 2 – For PD UUT not capable of ADP

2. Operator: Ensure UUT connected using special cable A or, where the device does not have a micro-AB or micro-B receptacle, a suitable alternative

3. UUT is either powered or is not powered. PET is not applying V_{BUS}, and not applying capacitance between V_{BUS} and ground, ID pin is not connected to ground.

4. Operator: Turn UUT on, if not already on.

5. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10kΩ) to V_{BUS} and turns on V_{BUS}.

6. Check that D+ goes high within T_{PWRUP_RDY} (30 sec).

7. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

8. Wait 5 seconds to allow disconnection to be detected.

9. Now ready for any other B_UUT test.

Following Tests

From now on all test sequences must start and finish with the PET holding V_{BUS} off, and no capacitance or pull-down resistance connected to V_{BUS}. This allows the tests to be performed in any sequence. In between tests, the ID pin is not connected to ground.

7.3 Data Contact Detect Test – With Current Source

Test Setup	Test Setup 4. UUT is a PD, PET simulates a downstream port.
Pre-conditions	Only required if UUT supports DCD using I_{DP_SRC}. The charge state of the battery is not critical in this test, provided it is above the Weak Battery Threshold.
Purpose	To validate a correct data contact detection procedure when the UUT supports DCD using I_{DP_SRC}.
Description	Check that I_{DP_SRC} is maintained for T_{DCD_DBNC} after D+ is pulled low and that $T_{DCD\_TIMEOUT}$ is complied with.
Parameters	R_{DM_DWN} or I_{DM_SINK}, T_{DCD_DBNC}, I_{DP_SRC}
Checklist	PD5, PD6, PD9
Pass Criteria	Step 3: D+ to rises above 2V Step 6: D- does not exceed 0.498V Step 10: D+ is less than 0.375V.

7.3.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on.

DCD using I_{DP_SRC}

1. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V.

2. Start timer when V_{BUS} reaches 0.8V.

3. Wait for D+ to rise above 2V. (If it doesn't within 0.9 second – test fails.) This proves that I_{DP_SRC} is sufficiently large to overcome the UUT's own leakage current. [PD5]

4. Measure and report time till it does.

5. After 1ms of D+ exceeding 2V, measure and report voltage on D+.

6. Connect 0.8V via 15kΩ to D-. Check voltage at D- is in correct range for a pull-down value meeting the specification (i.e. that voltage is not greater than 0.498V and not less than 0.390V). [PD5]

Note: For worst case max R_{DM_DWN} of 24.8K we need a max voltage at D- of 0.498V. For worst case min R_{DM_DWN} of 14.25K we need a min voltage at D- of 0.390V.

7. Disconnect components in previous step.

8. Connect 15kΩ from D+ to 0V.

9. Wait just less than T_{DCD_DBNC} min (<10ms = 9.5ms). [PD9]

10. Check voltage on D+ is less than 0.375V. This proves that I_{DP_SRC} and leakage, together, are low enough to provide a low logic level on D+, even after nearly

T_{DCD_DBNC} min (10ms). (Voltage to be adjusted in actual test script to allow for small tester leakage.)

Note: Highest current sourced by UUT should be IDP_SRC max (13µA) plus V_{DAT_LKG} max (3.6V) across R_{DAT_LKG} min (300K), equals 13 + 12 µA = 25µA. 25µA x 15K = 0.375V.

11. Disconnect everything from V_{BUS}, and switch V_{BUS} off.

12. Wait 2 seconds for disconnect to be detected.

DCD using Timeout

13. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V.

14. Start timer when V_{BUS} reaches 0.8V.

15. Wait for D+ to rise above 2V. (If it doesn't within 0.9 second – test fails.).

16. Check that D+ goes down to voltage in the range V_{DP_SRC} (0.5 to 0.7V) within $T_{DCD\_TIMEOUT}$ (0.3 to 0.9 sec) of D+ going high and within 1 second of V_{BUS} reaching 0.8V. [PD6]

17. Turn off V_{BUS}.

18. Wait 8 seconds, ignoring SRP pulse, for disconnect to be detected.

7.4 Data Contact Detect Test – No Current Source

Test Setup	Test Setup 4. UUT is a PD, PET simulates.
Pre-conditions	Only required if UUT does not support DCD using I_{DP_SRC}. The charge state of the battery is not critical in this test, provided it is above the Weak Battery Threshold.
Purpose	To validate a correct data contact detection procedure when the UUT does not support DCD using I_{DP_SRC}.
Description	Check that Primary Detection commences within $T_{DCD\_TIMEOUT}$ max of VBUS turning on.
Parameters	R_{DM_DWN} or I_{DM_SINK}, T_{DCD_DBNC}, I_{DP_SRC}
Checklist	PD5, PD7
Pass Criteria	Step 3: Time for D+ to go to V_{DP_SRC} is 0.3 to 0.9 sec.

7.4.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on.

DCD using Timeout

1. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V.

2. Start timer when V_{BUS} reaches 0.8V.

3. Connect 15k resistors from 0V to D+, and from 0V to D-.

4. Check that D+ goes up to voltage in the range V_{DP_SRC} (0.5 to 0.7V) within $T_{DCD\_TIMEOUT}$ (0.3 to 0.9 sec) of V_{BUS} going on. [PD7]

5. Disconnect 15k pull-down resistors from D+ and D-.

6. Disconnect capacitance and pull-down resistor from V_{BUS} and switch V_{BUS} off.

7. Wait 8 seconds, ignoring SRP pulse, for disconnect to be detected.

7.5 DCP Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates a DCP.
Pre-conditions	Vendor has declared whether secondary detection is implemented. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the best check on the maximum current drawn.
Purpose	To validate a correct detection procedure when the UUT encounters a DCP.
Description	PET simulates a DCP and monitors activity on D+ and D-, and current drawn.
Parameters	V_{DP_SRC}, V_{DM_SRC}, T_{VDPSRC_ON}, T_{VDMSRC_ON},
Checklist	PD14, PD15, PD17, PD30
Pass Criteria	See below

7.5.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on.

DCD

1. PET connects 200R between D+ and D-.

2. PET connects voltage source of 0V via 100k to D-, to prevent false detection of voltage on D+ etc.

3. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to V_{B_BUS} nom (5V). ID pin is left floating.

Primary Detection

4. Wait for D+ to rise above 0.5V

5. Wait 1ms for D+ to settle.

6. Measure D+ and check voltage is V_{DP_SRC} (0.5 to 0.7V).

7. Wait for slightly less than T_{VDPSRC_ON} min (38ms).

8. Check that D+ voltage is still V_{DP_SRC} (0.5 to 0.7V)

9. Wait for D+ to go below 0.5V, or above 0.8V, or for $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} going on to expire.

$T_{SVLD\_CON\_PWD}$ expires:

Implication is that change between driving V_{DP_SRC}, then driving V_{DM_SRC} and then driving V_{DP_SRC} was not seen by the tester, as no gaps were inserted. We can only assume that this is not a failure. Skip to 'Checking Current Draw'.

D+ goes below 0.5V:

If secondary detection is declared not to be implemented, skip to 'Checking Current Draw'.

If secondary detection is declared to be implemented, proceed with 'Secondary Detection'.

D+ rises above 0.8V:

If D+ rises instead above 0.8V, it will be regarded as a 'device connect'.

If secondary detection is declared not to be implemented, this is a valid procedure, and the tester will report that this sequence has occurred, and skip to 'Checking Current Draw'.

If secondary detection is declared to be implemented, and less than 80ms has passed since D+ first rose above 0.5V, this constitutes a failure because the specified periods TVDPSRC_ON plus TVDMSRC_ON have not been completed. [PD14]

If secondary detection is declared to be implemented, and more than 80ms has passed since D+ first rose above 0.5V, this implies that the change between driving VDP_SRC and then driving VDM_SRC was not seen by the tester. The only possible conclusion here is to assume a pass at this stage, and to skip to 'Checking Current Draw'.

Secondary Detection

10. Wait for D- to rise above 0.5V, or above 0.8V, or for expiration of TSVLD_CON_PWD (1 sec) from VBUS going on.

TSVLD_CON_PWD expires:
This constitutes a failure because neither VDP_SRC nor a pullup to VDP_UP through RDP_UP occurred.

D- goes above 0.5V:
First check if it goes between 0.7V and 0.8V within 1ms. If so this is an error.

Also check if it goes above 0.8V within 1ms. If so go to 'D- goes above 0.8V'.

If voltage stays within VDM_SRC (0.5 to 0.7V), assume this is secondary detection and go to Step 11.

D- goes above 0.8V:
This will be regarded as a 'device connect'. (D+ and D- are connected via 200R.)

If less than 80ms has passed since D+ first rose above 0.5V, this constitutes a failure because the specified periods TVDPSRC_ON plus TVDMSRC_ON have not been completed. [PD14]

Otherwise, proceed to 'Checking Current Draw'.

(In practice we may have missed gap between VDP_SRC and VDM_SRC, and be seeing a gap between VDM_SRC and connect. However this will not invalidate the next steps.)

11. Wait for slightly less than TVDMSRC_ON min (38ms).

12. Check that D- voltage is still VDM_SRC (0.5 to 0.7V). [PD14], [PD15]

13. Wait for D- to go below 0.5V, or above 0.8V, or for TSVLD_CON_PWD max (1 sec) from VBUS going on to expire.

Checking Current Draw

14. If secondary detection is declared to be implemented, display message to test operator 'PD under test should now have detected DCP'.
    If secondary detection is declared not to be implemented, display message to test operator 'PD under test should now have detected DCP or CDP'.
    (This is a development aid.)

15. Check current drawn does not exceed 1.5A from now on. [PD30]

16. Check D+ is held at or above V_{DP_SRC} min (0.5V) for the entire period, starting $T_{SVLD\_CON\_PWD}$ max (1 sec) after V_{BUS} was applied, that current drawn exceeds I_{SUSP} max (2.5mA). *Note that the voltage drop in the cable ground will raise the apparent voltage on D+.* [PD17]

17. Maintain session for 30 seconds from step 14.

18. Disconnect 200R resistor between D+ and D-.

19. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

20. Disconnect voltage source and 100k resistor from D-.

21. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

7.6 CDP Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates.
Pre-conditions	Vendor has declared whether secondary detection is implemented. This test must be performed with a battery just above the Weak Battery Threshold, as this provides the best check on the maximum current drawn.
Purpose	To validate a correct detection procedure when the UUT encounters a CDP. Also to check correct renegotiation behavior.
Description	PET simulates a CDP and monitors activity on D+ and D- , and current drawn.
Parameters	V_{DP_SRC}, T_{VDPSRC_ON}, $T_{SVLD\_CON\_PWD}$, I_{MAX_BC}
Checklist	PD8, PD10, PD14, PD15, PD18, PD28, PD30
Pass Criteria	See below

7.6.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on.

DCD

1. Switch data lines to PET test circuit. PET applies a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V. ID pin is left floating.

2. Connect 0V via 15k resistor to D+. Connect 0V via15k resistor to D-.

Primary Detection

3. Wait for D+ to rise above 0.5V

4. Wait 1ms for D+ to settle.

5. Measure D+ and check voltage is V_{DP_SRC} (0.5 to 0.7V). [PD10]

6. Check value of I_{DM_SINK}, as follows: Change voltage on 15k resistor to D- to 0.6V. Wait 1ms, then check voltage at D- is in correct range for a worst case I_{DM_SINK} of 25µA (i.e. that voltage is not greater than 0.225V). [PD10]

7. Change voltage on 15k resistor to D- to 0V.

8. Wait for 17ms (together with 2ms delay above, this is less than T_{VDMSRC_EN} max).

9. Disconnect 15K resistor from D- and replace with 1K5 from 0.7V.

10. Wait 1ms for D- to settle.

11. Measure voltage on D-. This must be above 0.4V, to prove that I_{DM_SINK} max (175µA) is not exceeded.

12. Wait 19ms (together with 20ms delay above, this is less than T_{VDPSRC_ON} min).

13. Check that D+ voltage is still V_{DP_SRC} (0.5 to 0.7V). [PD10]

14. Wait for D+ to go below 0.5V, or above 0.8V, or for $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} going on to expire.

$T_{SVLD\_CON\_PWD}$ expires:

This is a failure, as the UUT failed to connect within $T_{SVLD\_CON\_PWD}$ (1 sec). [PD8]

D+ goes below 0.5V:

End of primary detection, proceed from step 15.

D+ rises above 0.8V:

If D+ rises instead above 0.8V, it will be regarded as a 'device connect'. [PD8]

If secondary detection is declared not to be implemented, this is a valid procedure, and the tester will report that this sequence has occurred, perform steps 13 and 14, and then skip to 'Checking Current Draw'.

If secondary detection is declared to be implemented, this is a failure, secondary detection was not attempted. [PD14]

15. Disconnect 1K5 resistor from D- and replace with 15K from 0V.

16. Wait 100us (for D- to fall).

If secondary detection is declared not to be implemented, skip to Checking Current Draw.

Secondary Detection

17. Wait for D- to rise above 0.5V

18. Wait 1ms for D- to settle.

19. Measure D- and check voltage is V_{DM_SRC} (0.5 to 0.7V). [PD15]

20. Check value of I_{DP_SINK}, as follows: Change voltage on 15k resistor to D+ to 0.6V. Wait 20ms, then check voltage at D+ is in correct range for a worst case I_{DP_SINK} of 25µA (i.e. that voltage is not greater than 0.225V). [PD15]

21. Change voltage on 15k resistor to D+ to 0V.

22. Wait for 18ms (together with 21ms delays above, this is less than T_{VDMSRC_ON} min).

23. Check that D- voltage is still V_{DM_SRC} (0.5 to 0.7V). [PD14] [PD15]

24. DO NOT Connect 0.6V to D+.

25. Wait for D- to go below 0.5V.

Checking Current Draw

26. If secondary detection is declared to be implemented, display message to test operator 'PD under test should now have detected CDP'.
If secondary detection is declared not to be implemented, display message to test

operator ‘PD under test should now have detected DCP or CDP’.
(This is a development aid.)

27. Switch data lines to transceiver.

28. Check current drawn does not exceed I_{MAX_BC} from now on until end of step 31. [PD30]

29. Check D+ goes high within $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} turning on. [PD8] [If secondary detection supported: PD18]

30. Enumerate UUT (at HS if possible), and Set Configuration 1.

31. Maintain session for 30 seconds from configuration.

Checking Renegotiation

32. Switch data lines to PET test circuit. Turn off V_{BUS} and disconnect pull-down resistance from VBUS.

33. Check that the PD discharges V_{BUS} to less than V_{BUS_LKG} max (0.7V) within T_{VLD_VLKG} max (500ms). [PD28]

34. Wait for T_{VBUS_REAPP} min (100ms).

35. Apply a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turn on V_{BUS} to 5V.

36. Connect 0V via 15k resistor to D+. Connect 0V via15k resistor to D-.

Note: We will emulate an SDP this time to demonstrate that renegotiation was successful.

Renegotiation - Primary Detection

37. Wait for D+ to rise above 0.5V.

38. Wait 1ms for D+ to settle.

39. Measure D+ and check voltage is V_{DP_SRC} (0.5 to 0.7V). [PD10]

Renegotiation - Checking Current Draw

40. Switch data lines to transceiver.

41. Check D+ goes high within $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} turning on.

42. Display message to test operator ‘PD under test should now have detected SDP’.

43. Wait for 150ms (D+ debounce time plus 50ms).

44. Check that current drawn from V_{BUS} does not exceed I_{UNIT} (100mA).

45. Turn off V_{BUS} and disconnect pull-down resistance from V_{BUS}.

46. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

7.7 SDP Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates a SDP.
Pre-conditions	Vendor has declared whether secondary detection is implemented. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the best check on the maximum current drawn.
Purpose	To validate a correct detection procedure when the UUT encounters a SDP.
Description	PET simulates a SDP and monitors activity on D+, and current drawn.
Parameters	V_{DP_SRC}, T_{VDPSRC_ON}, $T_{SVLD\_CON\_PWD}$
Checklist	PD8, PD10, PD12, PD28, PD31
Pass Criteria	See below

7.7.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on.

DCD

1. PET applies a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V. ID pin is left floating.

2. Connect 0V via15k resistor to D+. Connect 0V via15k resistor to D-.

Primary Detection

3. Wait for D+ to rise above 0.5V

4. Wait 1ms for D+ to settle.

5. Measure D+ and check voltage is V_{DP_SRC} (0.5 to 0.7V). [PD10]

6. Check value of I_{DM_SINK}, as follows: Change voltage on 15k resistor to D- to 0.6V. Wait 20ms, then check voltage at D- is in correct range for a worst case I_{DM_SINK} of 25µA (i.e. that voltage is not greater than 0.225V). [PD10]

7. Change voltage on 15k resistor to D- to 0V.

8. Wait for 18ms (together with 21ms delay above, this is less than T_{VDPSRC_ON} min).

9. Check that D+ voltage is still V_{DP_SRC} (0.5 to 0.7V) [PD10]

10. **Do not** connect 0.6V to D-.

11. Wait for D+ to go below 0.5V, or above 0.8V, or for $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} going on to expire.

$T_{SVLD\_CON\_PWD}$ expires:

This is a failure, as the UUT failed to connect within $T_{SVLD\_CON\_PWD}$ (1 sec). [PD8]

D+ goes below 0.5V:

If secondary detection is declared not to be implemented, skip to ‘Checking Current Draw’.

If secondary detection is declared to be implemented, proceed with ‘Secondary Detection’.

D+ rises above 0.8V:

If D+ rises instead above 0.8V, it will be regarded as a legitimate ‘device connect’. Skip to ‘Checking Current Draw’. [PD8]

Secondary Detection

12. Note: If the primary detection identifies an SDP, then Secondary Detection may not occur. In this case there is no purpose in looking for Secondary Detection, even if it does occur. So we will go straight to ‘Checking Current Draw’.

Checking Current Draw

13. Display message to test operator ‘PD under test should now have detected SDP. (This is a development aid.)
14. Check current drawn does not exceed I_{CFG_MAX} (500mA) from now on. [PD12], [PD31]
15. Check D+ goes high within $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} turning on. [PD8]
16. Enumerate UUT (at HS if possible), and Set Configuration 1.
17. Maintain session for 30 seconds from configuration.
18. Turn off V_{BUS} and disconnect pull-down resistance from V_{BUS}.
19. Check that V_{BUS} falls below V_{BUS_LKG} max (0.7V) within T_{VLD_VLKG} max (500ms). [PD28]
20. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

7.8 ACA-Dock Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates ACA-Dock.
Pre-conditions	Only required if UUT supports ACA detection. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the greatest stress on the measurement of R_{ID_A}, owing to the current flowing in the cable ground.
Purpose	Demonstrate that PD UUT responds to R_{ID_A} on ID pin. i.e. The PD is attached to an ACA-Dock that is driving V_{BUS}.
Description	Connect R_{ID_A} to ID pin and check that PD behaves correctly.
Parameters	R_{ID_A}
Checklist	PD11, PD21, PD30
Pass Criteria	Step 9: UUT enumerates the PET.

7.8.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on.

1. Switch data lines to PET test circuit. Set up transceiver (now not connected) to peripheral mode with 1k5 pull-up to 3.3V on D+, and 15k pull-down on D-.

2. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V.

3. Wait 10ms.

4. Simultaneously

    - Connect ID pin to ground via R_{ID_A} min (122k).

    - Connect 0.6V via 200R to D-.

    - Connect 3.3V via 1K5 to D+.

5. Check that D+ remains above V_{LGC_HI} min (2.0V) for $T_{DCD\_TIMEOUT}$ min (0.3 sec). [PD11]

Note: DCD using current source is not available in this case.

6. Display message to test operator ‘PD under test should now have detected ACA-Dock’. (This is a development aid, and may appear up to 0.4sec before actual detection.)

7. Check that SE0 occurs within $T_{A\_BCON\_ARST}$ max (30 sec).

8. On detecting SE0, switch data lines to transceiver. This has the effect of disconnecting the 0.6V from D-, and replaces the test circuit pull-up with the transceiver pull-up.

9. Check that UUT enumerates the PET within 30 seconds. PET responds as test device 0x1A0A/0x0200. [PD21]

10. From now on check current drawn and report. Check that this current does not exceed I_{MAX_BC}. (If current exceeds 1.5A test will terminate to protect tester connectors.) [PD30]

11. Wait 10 seconds.

12. Simulate a detach as follows:

    - Switch off transceiver D+ pullup
    - Switch off transceiver pull-down from D-.
    - Disconnect R_{ID_A} from ID pin
    - Disconnect 0.6V via 200R from D-.
    - Disconnect data line test circuit 3.3V via 1K5 from D+
    - Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

13. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

14. Repeat steps 1-13 using R_{ID_A} max (126k).

End of Test

7.9 ACA-A Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates.
Pre-conditions	Only required if UUT supports ACA detection.
Purpose	Demonstrate that PD UUT responds to R_{ID_A} on ID pin (i.e. the PD is attached to an ACA that has a charger on its Charger Port, and a B-device on its Accessory Port). This test should be performed with a battery just above the Weak Battery Threshold, as this provides the greatest stress on the measurement of R_{ID_A}, owing to the current flowing in the cable ground.
Description	Connect R_{ID_A} to ID pin and check that PD behaves correctly.
Parameters	R_{ID_A}
Checklist	PD22, PD30
Pass Criteria	Step 6: UUT enumerates the PET.

7.9.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on. ID pin not connected.

1. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V
2. Wait 10ms to simulate plug insertion.
3. Connect ID pin to ground via R_{ID_A} min (122k).
4. Display message to test operator ‘PD under test should now have detected ACA-A’. (This is a development aid, and may appear slightly before actual detection.)
5. Connect using D+.
6. Check that UUT resets and enumerates the PET within 30 seconds. PET responds as test device 0x1A0A/0x0200. [PD22]
7. From now on check current drawn and report. Check that this current does not exceed I_{MAX_BC}. (If current exceeds 1.5A test will terminate to protect tester connectors.) [PD30]
8. Wait 10 seconds.
9. Disconnect using D+.
10. Disconnect resistor from ID pin.
11. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.
12. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.
13. Repeat steps 1-12 using R_{ID_A} max (126k).

End of Test

7.10 ACA-B Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates ACA-B.
Pre-conditions	Only required if UUT supports ACA detection.
Purpose	To validate a correct detection procedure when the UUT encounters an ACA-B (i.e. the PD is attached to an ACA that has a charger on its Charger Port, and does not have an accessory on its Accessory Port).
Description	PET simulates an ACA-B and monitors activity on D+, and current drawn.
Parameters	R_{ID_B}
Checklist	PD8, PD24, PD30
Pass Criteria	Step 97: UUT does not connect

7.10.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on. ID pin not connected.

DCD

1. Switch data lines to PET test circuit.
2. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V.
3. Wait 10ms to simulate plug insertion.
4. Connect ID pin to ground via R_{ID_B} min (67k).
5. Connect 0V via 15k resistor to D+. Connect 0V via 15k resistor to D-.
6. Start timer of $T_{SVLD\_CON\_PWD}$ (1 sec).
7. Wait for D+ to exceed V_{LGC} min, or timer to expire.

Timer $T_{SVLD\_CON\_PWD}$ expires:

Proceed to ' Checking Current Draw'

D+ rises above 0.8V:

Check that D+ goes below 0.8V within no more than $T_{B\_DATA\_PLS}$ max (10ms). This represents a valid SRP pulse, which we will ignore. Proceed to ' Checking Current Draw'

Else UUT has attempted to connect – FAIL. [PD8]

Primary Detection

Primary detection is optional, and its parameters are measured elsewhere, so we will ignore it during this test.

Checking Current Draw

8. Display message to test operator ‘PD under test should now have detected R_{ID_B}’. (This is a development aid.)

9. From now on check current drawn and report. Check that this current does not exceed I_{MAX_BC}. (If current exceeds 1.5A test will terminate to protect tester connectors.) [PD30]

10. Check D+ is held below V_{DAT_REF} min (0.25V) from now on. It is possible that SRP pulses are attempted, these should be ignored if they do not exceed $T_{B\_DATA\_PLS}$ max (10ms). [PD24]

11. Maintain session for 15 seconds from step 6.

12. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

13. Disconnect 15k pulldown resistor from D+ and D-.

14. Disconnect ID pin resistor.

15. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

16. Repeat steps 1-15 using R_{ID_B} max (69K).

17. Disconnect data lines from PET test circuit.

End of Test

7.11 ACA-C Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates ACA-C.
Pre-conditions	Only required if UUT supports ACA detection.
Purpose	To validate a correct detection procedure when the UUT encounters an ACA-C. i.e. The PD is attached to an ACA that has a charger on its Charger Port, and an A-device on its Accessory Port. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the greatest stress on the measurement of R_{ID_C}, owing to the current flowing in the cable ground.
Description	PET simulates an ACA-C and monitors activity on D+, enumerates the PD UUT and monitors current drawn.
Parameters	R_{ID_C}
Checklist	PD8, PD25, PD30
Pass Criteria	Step 8: UUT does connect

7.11.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on. ID pin not connected.

DCD

1. Switch data lines to PET test circuit.
2. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V
3. Wait 10ms to simulate plug insertion.
4. Connect ID pin to ground via R_{ID_C} min (36k).
5. Connect 0V via15k resistor to D+. Connect 0V via15k resistor to D-.
6. Start timer of $T_{SVLD\_CON\_PWD}$ (1 sec).
7. Wait for D+ to exceed V_{LGC} min, or timer to expire.

Timer $T_{SVLD\_CON\_PWD}$ expires:

UUT failed to connect – FAIL [PD8] [PD25]

D+ rises above 0.8V:

Check that D+ is high for more than 10ms. If not this is a failure (SRP not allowed). [PD25]

Else UUT has connected – proceed to ‘ Checking Current Draw’.

Primary Detection

Primary detection is optional, and its parameters are measured elsewhere, so we will ignore it during this test.

Checking Current Draw

8. Switch data lines back to transceiver.

9. Display message to test operator ‘PD under test should now have detected R_{ID_C}’. (This is a development aid.)

10. From now on check current drawn and report. Check that this current does not exceed I_{MAX_BC}. (If current exceeds 1.5A test will terminate to protect tester connectors.) [PD30]

11. Enumerate UUT and Set Configuration 1. [PD25]

12. Maintain session for 10 seconds from step 8.

13. Disconnect 15k pulldown resistor from D+ and D-.

14. Disconnect ID pin resistor.

15. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

16. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

17. Repeat steps 1-15 using R_{ID_C} max (37K)

End of Test

7.12 ACA-GND Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates.
Pre-conditions	Only required if UUT supports ACA detection. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the greatest stress on the measurement of R_{ID_GND}, owing to the current flowing in the cable ground.
Purpose	Demonstrate that PD UUT responds to R_{ID_GND} max on ID pin. i.e. the PD is attached to a B-device, or to an ACA that has a B-device on its Accessory Port, but no charger.
Description	Connect R_{ID_GND} max to ID pin and check that PD behaves as A-device.
Parameters	R_{ID_GND}
Checklist	PD26
Pass Criteria	Step 6: V_{BUS} turns on in response to SRP.

7.12.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on.

1. Connect 6.5µF from V_{BUS} to ground.
2. Connect ID pin to ground via R_{ID_GND} max (1k).
3. Wait 3 seconds.
4. If V_{BUS} is on, wait for it to go off, and stay off for 5 seconds.

This deals with ADP and any initial test for a peripheral.

5. Perform SRP for 7.5ms pulse.
6. Check that V_{BUS} rises above $V_{OTG\_SESS\_VLD}$ within $T_{A\_SRP\_RSPNS}$ of rising edge of SRP pulse. [PD26]
7. Disconnect R_{ID_GND}, and capacitance and resistance from V_{BUS}.
8. Wait for V_{BUS} to go off, and stay off for 5 seconds.

End of Test

7.13 Common Mode Test - Full Speed

Test Setup	Test Setup 4. UUT is a PD, PET simulates a SDP.
Pre-conditions	This test should be performed with a good battery in order to minimize extra current flowing in the cable ground, as the PET provides the ground offset itself.
Purpose	This test verifies that a UUT is able to communicate with a charging downstream port at full-speed when cable ground is dropping I_{MAX_BC} x 0.25Ω + 5mV.
Description	This test will apply a maximum of 375mV offset to UUT ground, and then verify UUT will enumerate and work successfully. PET simulates an SDP to reduce the risk that the UUT itself draws a significant current.
Parameters	
Checklist	PD33
Pass Criteria	Step 5: UUT enumerates successfully Step 6: UUT functions as expected

7.13.1 Test procedure

Initial State. Special Test Cable A is connected to PD. V_{BUS} is off, capacitance of 6.5µF is connected to V_{BUS}, data lines switched to PET transceiver.

1. Apply a common mode offset of I_{MAX_BC} x 0.25 Ω + 5mV (a maximum of V_{GND_OFFSET} [0.375V] if I_{MAX_BC} is declared as 1500mA) with PET test socket higher than PET transceiver ground.
2. Turn V_{BUS} on to 5V.
3. Wait for UUT to connect
4. Wait 100ms.
5. Reset and enumerate at Full Speed. Check that enumeration was successful.
6. Continue for 10 seconds, without configuring, to perform a number of standard requests, (e.g. Get Device Descriptor) checking again for failure to respond to transactions. This is achieved by counting the number of failures to respond to transactions, and comparing this to an arbitrary ceiling. (A good device would never fail to respond in practice.) [PD33]
7. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.
8. Remove common mode offset.
9. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

7.14 Common Mode Test - High Speed

Test Setup	Test Setup 4. UUT is a PD, PET simulates a SDP.
Pre-conditions	This test should be performed with a good battery in order to minimize extra current flowing in the cable ground, as the PET provides the ground offset itself.
Purpose	This test verifies that a UUT is able to communicate with a charging downstream port at high-speed when cable ground is dropping I_{MAX_BC} x 0.25Ω + 5mV.
Description	This test will apply a maximum of 375mV offset to UUT ground, and then verify UUT will enumerate and work successfully. PET simulates an SDP to reduce the risk that the UUT itself draws a significant current.
Parameters	
Checklist	PD33
Pass Criteria	Step 5: UUT enumerates successfully Step 6: UUT functions as expected

7.14.1 Test procedure

Initial State. Special Test Cable A is connected to PD. V_{BUS} is off, capacitance of 6.5μF is connected to V_{BUS}, data lines switched to PET transceiver.

1. Apply a common mode offset of I_{MAX_BC} x 0.25 Ω + 5mV (a maximum of V_{GND_OFFSET} [0.375V] if I_{MAX_BC} is declared as 1500mA) with PET test socket higher than PET transceiver ground.

2. Turn V_{BUS} on to 5V.

3. Wait for UUT to connect

4. Wait 100ms.

5. Reset and enumerate at High Speed. Check that enumeration was successful.

6. Continue for 10 seconds, without configuring, to perform a number of standard requests, (e.g. Get Device Descriptor) checking again for failure to respond to transactions. This is achieved by counting the number of failures to respond to transactions, and comparing this to an arbitrary ceiling. (A good device would never fail to respond in practice.) [PD33

7. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

8. Remove common mode offset.

9. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

7.15 Dead Battery Provision Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates an SDP.
Pre-conditions	UUT has been fitted with a ‘Dead Battery’. Assumption is that this remains dead for 30 second duration of test.
Purpose	To verify that the UUT complies with requirements of the ‘Dead Battery Provision – Unconfigured Clause’
Description	This test is performed separately from the other PD tests, as it requires a dead battery to be fitted. V_{BUS} is applied to the device, and the current drawn and D+ voltage are monitored.
Parameters	I_{UNIT}, V_{DP_SRC}
Checklist	DBP1, DBP3
Pass Criteria	Step 4: D+ is below V_{LGC} min Step 9: D+ is at V_{DP_SRC} Step 10: Watch-block has not been triggered.

7.15.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. Any mechanical switches on the PD required for it to be able to power up have been operated.

1. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V. ID pin is left floating.

2. Connect 0V via 15k resistor to D+. Connect 0V via 15k resistor to D-.

3. Wait $T_{SVLD\_CON\_PWD}$ max plus a margin (1 sec + .5 sec = 1.5 sec).

4. Set up a watch-block to monitor the current drawn from V_{BUS}, and be triggered if this current exceeds I_{UNIT} (100mA).

5. Check that D+ is below V_{LGC} min (0.8v). If UUT connects at any time during the remainder of the test, skip to Step15. We must assume that the dead battery provision is no longer required by the UUT.

6. Display message to test operator ‘PD under test should now have detected SDP’. (This is a development aid.)

7. For the next 30 seconds, follow the procedure in steps 8-10

8. Measure the average current drawn from V_{BUS}, sampling every 1ms for a period of 1 second. Record whether this value exceeds I_{SUSP} (2.5mA).

9. If the value does exceed I_{SUSP} for two consecutive averages, then check that D+ is at V_{DP_SRC} (0.5V-0.7V).

10. Check that the watch-block has not been triggered.

11. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

12. Disconnect 15k pull-down resistors.

13. Wait 5 seconds for detachment to be recognized.

14. Skip to End of Test

Enumerating

15. Wait $T_{A\_BCON\_LDB}$ min (100ms) then issue a bus reset to the B-UUT.

16. Check that PET can enumerate UUT (at HS if possible), and Set Configuration 1.

17. For the next 30 seconds, check current drawn does not exceed bMaxPower.

18. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

19. Disconnect 15k pull-down resistors.

20. Wait 5 seconds for detachment to be recognized.

End of Test

Note: Parameters and behavior such as $T_{SVLD\_CON\_WKB}$, $T_{DBP\_VDPSRC\_CON}$ are verified by vendor declaration.

8 Dedicated Charging Port (DCP) Compliance

8.1 Submission Materials

8.1.1 Device Specific Information

The following items are required to be submitted along with the UUT:

Table 8-1 Device Specific Information for DCPs

Item	Function	Value/ Support
1	Evidence the UUT contains on its nameplate and/or end-user documentation, the continuous current rating at which output voltage of 4.75V to 5.25V is provided	
2	Schematics or other proof that UUT output current cannot exceed 5.0 amperes	
3	The USB-IF TID for the UUT standard-A receptacle(s) or micro-B plug(s) (via captive cable)	
4	Schematics or other proof that a single UUT failure will not cause the output voltage on VBUS to exceed V_{CHG_FAIL}?	
5	UUT Charging Port identification label drawing (If additional Charging or non Charging Ports are included in UUT)	
6	Description of UUT output or Charging Port operation and availability when multiple outputs or Charging Ports are present (if applicable)	
7	Description of UUT output or Charging Port operation and availability during Device power states (if applicable)	

8.1.2 Checklist

Table 8-2 Checklist for DCPs

Question		Response	Test Number	BC 1.2 Reference
DCP1	Is the output voltage of the UUT less than V_{CHG_OVRSHT} max for any step change in load current, and also when powering on of off?	Yes ☐ No ☐	8.2	4.1.1
DCP2	Is the output current of the UUT prevented from exceeding I_{CDP} max under any condition?	Yes ☐ No ☐	Vendor Declaration	4.1.2
DCP3	If the UUT switches roles among SDP, CDP and DCP, does it allow V_{BUS} to drop to less than V_{BUS_LKG} and wait for a time T_{VBUS_REAPP} before driving V_{BUS} again?	Yes ☐ No ☐	Vendor Declaration	4.1.3
DCP4	Has it has been shown, using schematics or by some other explanation, that in the case of a single failure in the UUT, the output voltage on V_{BUS} will not exceed V_{CHG_FAIL}?	Yes ☐ No ☐	Vendor Declaration	4.1.5

DCP5	As per provided UUT description: if the UUT provides multiple USB Charging Ports, the active UUT USB Charging Port does not affect operation of any other Charging Port.	Yes ☐ No ☐	Vendor Declaration	4.1.6
DCP6	Does the UUT output a voltage of V_{CHG} (averaged over T_{VBUS_AVG}) for all currents less than I_{DCP} min?	Yes ☐ No ☐	8.5	4.4.1
DCP7	Does the UUT output a voltage less than V_{CHG} max (averaged over T_{VBUS_AVG}) for all currents between I_{DCP} min and I_{DEV_CHG} max?	Yes ☐ No ☐	8.5	4.4.1
DCP8	Is the output voltage of the UUT greater than V_{CHG_UNDSHT} min for any step change in load current from I_{DCP_LOW} to I_{DCP_MID}?	Yes ☐ No ☐	8.2	4.4.2
DCP9	Is the output voltage of the UUT greater than V_{CHG_UNDSHT} min for any step change in load current from I_{DCP_MID} to I_{DCP_HI}, including steps that occur $T_{DCP\_LD\_STP}$ after a transition from I_{DCP_LOW} to I_{DCP_MID}?	Yes ☐ No ☐	8.2	4.4.2
DCP10	Is the duration of any undershoot less than T_{DCP_UNDSHT} ?	Yes ☐ No ☐	8.2	4.4.2
DCP11	Does the output voltage of the UUT drop below V_{CHG} min for less than T_{DCP_UNDSHT}, any step change in load current from I_{DCP_LOW} to I_{DCP_HI} provided the load current is less than I_{DCP} min ?	Yes ☐ No ☐	8.2	4.4.2
DCP12	Does the UUT have a resistance between D+ and D- of R_{DCP_DAT} ?	Yes ☐ No ☐	8.3	4.4.3
DCP13	Does the UUT have a leakage current from D+/D- less than or equal to R_{DAT_LKG} tied to a voltage of V_{DAT_LKG} ?	Yes ☐ No ☐	8.3	4.4.3
DCP14	Does the UUT have a capacitance from D+/D- of C_{DCP_PWR} ?	Yes ☐ No ☐	8.3	4.4.3
DCP15	Does the UUT have a Standard-A receptacle, or a captive cable terminated with a Micro-B plug?	Standard-A ☐ Captive ☐ No ☐	Inspection	4.4.4
DCP16	Does the UUT provide V_{BUS} discharge functionality?	Yes ☐ No ☐	Vendor Declaration	4.1.3

8.2 DCP Overshoot and Undershoot Voltage Test

Test Setup	Test Setup 6. UUT is a DCP, PET simulates a PD.
Pre-conditions	This test must be run before any of the other DCP tests.
Purpose	To verify the DCP meets overshoot and undershoot voltage specifications, for any specified step change in load.
Description	This test changes the VBUS current abruptly, and measures the resulting voltage overshoot and undershoot levels. Note: The DCP can have a Standard-A receptacle or a captive cable. In the case of a captive cable, the BC specification requires voltage measurements to be taken at the Micro-B plug of the captive cable.
Parameters	VCHG_OVERSHT, VCHG_UNDSHT, TDCP_UNDSHT
Checklist	DCP1, DCP6, DCP8, DCP9, DCP10, DCP11, DCP12
Pass Criteria	Step 7 – Maximum voltage during overshoot is less than 6.0V. Step 19 – VBUS is in range 4.75V to 5.25V Step 20 – Minimum voltage during undershoot is above 4.1V. Step 20 – Maximum voltage during overshoot is less than 6.0V. Step 24 – VBUS is in range 4.75V to 5.25V Step 25 – Minimum voltage during undershoot is above 4.1V. Step 25 – Maximum voltage during overshoot is less than 6.0V. Step 28 – Minimum voltage during undershoot is above 4.1V. Step 28 – Maximum voltage during overshoot is less than 6.0V. Step 31 – VBUS is in range 4.75V to 5.25V Step 32 – VBUS is in range 4.75V to 5.25V

8.2.1 Test procedure

Initial State: No load applied. If captive cable equipped, check the ‘Captive Cable’ box in the test dialog.

1. Ensure that UUT is connected via Special Test Cable B, or its captive cable, to the PET.

2. Ensure that DCP is in an unpowered state.

3. Wait for DCP voltage to fall below 0.5V, in case it has just been switched off. (Speed up fall using current load.)

4. Set up voltage watch-block ready to capture overshoot of VCHG_OVRSHT (6.0V) on VBUS.

5. Instruct test operator to plug DCP into ‘wall-socket’, or to perform steps required to bring the DCP from an un-powered state to a powered one.

6. Wait for operator to click ‘OK’.

7. Check watch-block overshoot detector latch was not triggered. [DCP1]

8. Set up voltage watch-block ready to capture undershoot of V_{CHG_UNDSHT} (4.1V), or overshoot of V_{CHG_OVRSHT} (6.0V) on V_{BUS}.

9. With an applied current load of I_{DCP_LOW} min (0mA), check that V_{BUS} average is within appropriate range V_{CHG} (4.75V to 5.25V) over the next T_{VBUS_AVG} max (0.25 sec). [DCP6]

10. Check watch-block overshoot and undershoot detector latches were not triggered. [DCP1][DCP8]

11. Re-program watch-block to allow for voltage drop in cable.

Emulate attaching PD

12. Apply V_{DP_SRC} nom. (0.6V) to D+.

13. Wait T_{VDMSRC_EN} max + 1 ms (= 21ms)

14. Check D- > V_{DAT_REF} min (0.25V). [DCP12]

15. Wait for 1ms more than the remainder of T_{VDPSRC_ON} (40ms – 20ms = 20ms).

16. Take D+ back to 0V.

Load Testing

17. Apply load of I_{DCP_MID} max (100mA) to V_{BUS}.

18. Wait T_{DCP_UNDSHT} max (10ms).

19. Check V_{BUS}, at DCP connector, is in range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable (spot check voltage). [DCP6][DCP10]

20. Check watch-block overshoot and undershoot detector latches were not triggered. [DCP1][DCP8]

21. Re-program watch-block to allow for voltage drop in cable.

22. Increase load on V_{BUS} to I_{DCP} min (500mA), 20ms after rise to I_{DCP} mid.

23. Wait T_{DCP_UNDSHT} max (10ms).

24. Check V_{BUS} average, at DCP connector, is in range V_{CHG} (4.75V to 5.25V), over the next T_{VBUS_AVG} max (0.25 sec), making due allowance for voltage drop in cable. [DCP6]

25. Check watch-block overshoot and undershoot detector latches were not triggered. [DCP1] [DCP9]

26. Remove Current Load.

27. Wait 100ms

28. Check watch-block overshoot and undershoot detector latches were not triggered.

29. Apply load of I_{DCP} min (500mA) to V_{BUS}.

30. Wait T_{DCP_UNDSHT} max (10ms).

31. Check V_{BUS}, at DCP connector, is in range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable (spot check voltage). [DCP1] [DCP9] [DCP11]

32. Check V_{BUS} average, at DCP connector, is in range V_{CHG} (4.75V to 5.25V), over the next T_{VBUS_AVG} max (0.25 sec), making due allowance for voltage drop in cable. [DCP6]

33. Remove Current Load.

34. Wait 100ms

35. Check watch-block overshoot and undershoot detector latches were not triggered. [DCP1] [DCP9]

End of Test

8.3 DCP Handshaking Test

Test Setup	Test Setup 6. UUT is a DCP, PET simulates a PD.
Pre-conditions	DCP Overshoot and Undershoot Voltage Test has been run, and DCP is now switched on.
Purpose	To verify the parameters of detection handshake. This test is particularly designed to verify the behavior of UUTs which switch roles among DCP, CDP and SDP, and may therefore have more complex circuitry on D+ and D- than a simple resistive connection.
Description	Test confirms correct handshake behavior.
Parameters	
Checklist	DCP6
Pass Criteria	Step 5 – Voltage is in range Step 10 - Voltage is in range

8.3.1 Test procedure

Initial State: UUT is connected via Special Test Cable B, or its captive cable, to the PET. No load applied. DCP is switched on. Data lines switched to data measurement circuit.

1. Check V_{BUS} is above $V_{OTG\_SESS\_VLD}$ max (4V). [DCP6]
2. Wait 200ms

Primary Detection

3. Connect voltage source (0.6V) via 200R resistor to D+.
4. Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).
5. Check D- voltage is in range V_{DM_SRC} (0.5V - 0.7V). [DCP12, DCP13]
6. Wait 20ms to complete T_{VDPSRC_ON}.
7. Disconnect voltage source via 200R resistor from D+.

Secondary Detection

8. Connect voltage source (0.6V) via 200R resistor to D-.
9. Wait 21ms.
10. Check D+ voltage is in range V_{DM_SRC} (0.5V - 0.7V). [DCP12, DCP13]
11. Wait 20ms to complete T_{VDMSRC_ON}.
12. Disconnect voltage source via 200R resistor from D-.
13. Wait 5 seconds for UUT to recover.

End of Test

8.4 DCP Resistance and Capacitance Tests

Test Setup	Test Setup 6. UUT is a DCP, PET simulates a PD.
Pre-conditions	
Purpose	To verify that the resistance between D+/D- and data line resistance and capacitance to V_{BUS}/GND is in valid range.
Description	This test measures the resistance of data lines (D+/D-) and then the resistance/capacitance from D+/D- to VBUS and to GND. Also, ID pin resistance is checked for sanity.
Parameters	R_{DCP_DAT}, C_{DCP_PWR}, R_{DAT_LKG}
Checklist	DCP12, DCP13, DCP14
Pass Criteria	Step 6 - Resistance between D+ and D- is less than 200Ω. Step 12 - Resistances between D+/- and GND/V_{OH} are greater than 150kΩ. (R_{DAT_LKG} / 2). Step 15 - Capacitances between D+/- and GND are less than 1nF.

8.4.1 Test procedure

Initial State: UUT is connected via Special Test Cable B, or its captive cable, to the PET. No load applied. DCP is switched on. Data lines switched to data measurement circuit.

Emulate attaching PD

1. Apply V_{DP_SRC} nom. (0.6V) to D+.
2. Wait T_{VDMSRC_EN} max + 1 ms (= 21ms)
3. Check D- > V_{DAT_REF} min (0.25V).
4. Wait for 1ms more than the remainder of T_{VDPSRC_ON} (40ms – 20ms = 20ms).
5. Take D+ back to 0V.

Checking Resistance between D+ and D-

6. Check that resistance from D+ to D- is less than R_{DCP_DAT} max (200R). i.e. Connect 3.0V via 200R resistor to D+, connect 0V via 200R resistor to D-. Measure voltages at D+ and D-. The difference must be less than 1.05V. [DCP12]

Checking leakage from D+ or D-

7. Connect D+ via 100k to 0V
8. Wait 2 seconds to eliminate capacitive effects.
9. Check that voltage at D+ is below 1.44V (Two R_{DAT_LKG} (300k) in parallel, V_{DAT_LKG} = 3.6V).
10. Connect D+ via 100K to 3.3V
11. Wait 2 seconds
12. Check that D+ is greater than 1.98V (Two R_{DAT_LKG} (300k) in parallel, V_{DAT_LKG} = 0V).

This shows that leakage resistance is greater than R_{DAT_LKG} / 2. [DCP13]

Checking Capacitance of D+ or D-

13. Discharge Standard 1nF capacitor and Capacitance under Test
    Connect 0V to D+ via 1nF test capacitor. Connect 0V to D- via 200R resistor. There is a tested, <200R, resistor between D- and D+. This will discharge the standard 1nF capacitor and the capacitance under test to 0V. Wait 10ms.

14. Isolate Capacitances
    Disconnect 0V from test capacitor to isolate it. Disconnect 0V from 200R resistor.

Note: We will now use the D+ voltage watch-block to determine whether, during the charge-sharing process, D+ rises above 1.65V. The watch-block amplifier has a limited band-width by design, so that the watch-block voltage set is lower than 1.65V. The actual value can be found in the test script.

15. Share Charge Between Capacitances
    Set D+ watch-block to be testing for voltage less than the value required. Connect 3.3V to D+ via 1nF test capacitor. Wait 1ms. This allows for charge sharing between standard 1nF capacitor and capacitance under test.

16. Read watch-block to see if voltage on D+ went above 1.65V. If it did, then the capacitance under test is less than 1nF and therefore in specification. [DCP14]

End of Test

8.5 DCP Voltage and Current

Test Setup	Test Setup 6. UUT is a DCP, PET simulates a PD.
Pre-conditions	
Purpose	To verify that the V_{BUS} voltage / current load characteristic meets the specified requirements. These are steady-state tests, hence the 1 second delay in step 3. The test may result in shutdown of the DCP, so this test is placed last in the test sequence, as no recovery time is specified by the Battery Charging 1.2 Specification.
Description	This test measures the voltage at various current loads, in order to confirm correct behavior.
Parameters	V_{CHG}, V_{DCP_SHTDWN}
Checklist	DCP6, DCP7
Pass Criteria	Step 1 - V_{BUS} voltage is in correct range. Step 9 - V_{BUS} voltage is in correct range. Step 12 - V_{BUS} voltage is in correct range.

8.5.1 Test procedure

Initial State: UUT is connected via Special Test Cable B, or its captive cable, to the PET. No load applied. DCP is switched on.

1. I_{DCP} is initially 0mA. Check that V_{BUS} voltage, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), from DCP is within V_{CHG} (4.75 – 5.25V). [DCP6]

Emulate attaching PD

2. Apply V_{DP_SRC} nom. (0.6V) to D+.
3. Wait T_{VDMSRC_EN} max + 1 ms (= 21ms)
4. Check D- > V_{DAT_REF} min (0.25V).
5. Wait for 1ms more than the remainder of T_{VDPSRC_ON} (40ms – 20ms = 20ms).
6. Take D+ back to 0V.
7. Apply load of I_{DCP} min (500 mA) to V_{BUS}.
8. Wait 1 sec to avoid possible transient period (overshoot and undershoot are measured separately).
9. Check that V_{BUS} voltage from DCP, at DCP connector, with samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within V_{CHG} (4.75 – 5.25V), making due allowance for voltage drop in cable. [DCP6]
10. Increase load to I_{DEV_CHG} max (1.5A).
11. Wait 1 sec to avoid possible overshoot.

12. Check that V_{BUS} voltage from DCP, at DCP connector, with samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is below V_{CHG} max (5.25V), making due allowance for voltage drop in cable. The PET reports the voltage measured. [DCP7]

13. Disconnect the current load.

End of Test

9 Charging Downstream Port (CDP) Compliance

9.1 Submission Materials

The following items are required to be submitted along with the UUT:

9.1.1 Device Specific Information

Table 9-1 Device Specific Information for CDPs

Item	Function	Value/ Support
1	Evidence the UUT contains on its nameplate and/or end-user documentation, the continuous current rating at which output voltage of 4.75V to 5.25V is provided	
2	Schematics or other proof that UUT output current cannot exceed 5.0 amperes	
3	The USB-IF TID for the UUT standard-A receptacle(s) or micro-B plug(s) (via captive cable)	
4	Schematics or other proof that a single UUT failure will not cause the output voltage on VBUS to exceed V_{CHG_FAIL}?	
5	UUT Charging Port identification label drawing (If additional Charging or non Charging Ports are included in UUT)	
6	Description of UUT output or Charging Port operation and availability when multiple outputs or Charging Ports are present (if applicable)	
7	Description of UUT output or Charging Port operation and availability during Device power states (if applicable)	

9.1.2 Checklist

Table 9-2 Checklist for CDPs

ID	Question	Response	Test Number	BC 1.2 Section Number
CDP1	Is the output voltage of the UUT less than V_{CHG_OVRSHT} max for any step change in load current, and also when powering on of off?	Yes ☐ No ☐	9.2	4.1.1
CDP2	Is the output current of the UUT prevented from exceeding I_{CDP} max under any condition?	Yes ☐ No ☐	Vendor Declaration	4.1.2
CDP3	If the UUT switches roles among SDP, CDP and DCP, does it allow V_{BUS} to drop to less than V_{BUS_LKG} and wait for a time T_{VBUS_REAPP} before driving V_{BUS} again?	Yes ☐ No ☐	Vendor Declaration	4.1.3
CDP4	Has it has been shown, using schematics or by some other explanation, that in the case of a single failure in the UUT, the output voltage on V_{BUS} will not exceed V_{CHG_FAIL}?	Yes ☐ No ☐	Vendor Declaration	4.1.5

CDP5	As per provided UUT description: if the UUT provides multiple USB Charging Ports, the active UUT USB Charging Port does not affect operation of any other Charging Port.	Yes ☐ No ☐	Vendor Declaration	4.1.6
CDP6	Does the UUT output a voltage of V_{CHG} (averaged over T_{VBUS_AVG}) for all currents less than I_{CDP} min?	Yes ☐ No ☐	9.3	4.2.1
CDP7	Is the output voltage of the UUT greater than V_{CHG_UNDSHT} min for any step change in load current where current is less than I_{CDP} min?	Yes ☐ No ☐	9.2	4.2.3
CDP8	Does the CDP either: A.) Enable V_{DM_SRC} within $T_{CP\_VDM\_EN}$ of a disconnect and disable V_{DM_SRC} within $T_{CP\_VDM\_DIS}$ of a connect, or B.) Enable V_{DM_SRC}, whenever D+ is greater than V_{DAT_REF} and less than V_{LGC}, and disable V_{DM_SRC}, whenever D+ is less than V_{DAT_REF} or greater than V_{LGC}?	Yes ☐ (A ☐ B ☐) No ☐	9.4	3.4.2 4.2.4
CDP9	If the first option of CDP8 is implemented, is the design of V_{DM_SRC} such that an external device is able to pull D- to 2.2V through R_{DM_UP} ?	Yes ☐ No ☐ N/A ☐	9.4	5.
CDP10	If before connecting, a device applies V_{DM_SRC} to D-, does the CDP maintain a voltage of less than V_{DAT_REF} min on D+?	Yes ☐ No ☐	8.4	3.2.5.2
CDP11	If a PD draws more than I_{CFG_MAX} from the CDP, does the CDP correctly support LS, FS, HS and chirp signaling when the local ground is V_{GND_OFFSET} max lower than the remote ground.	Yes ☐ No ☐	9.5, 9.6	3.5
CDP12	Does the UUT have a Standard-A receptacle?	Yes ☐ No ☐	Inspection	4.2.5
CDP13	If the CDP goes into shutdown during a current overload condition, does it recover and output a voltage of V_{CHG} within a time of T_{SHTDWN_REC} when the current overload condition has been removed.	Yes ☐ No ☐	Vendor Declaration	4.2.2

CDP14	Does the UUT provide VBUS discharge functionality?	Yes ☐ No ☐	Vendor Declaration	4.1.3

9.2 CDP Overshoot and Undershoot Voltage Test

Test Setup	Test Setup 5. UUT is a CDP, PET simulates a PD.
Pre-conditions	This must be performed as the first test in the CDP suite.
Purpose	To verify the CDP meets overshoot and undershoot voltage specifications, for any specified step change in load.
Description	This test changes the VBUS current abruptly, and measures the resulting voltage overshoot and undershoot levels.
Parameters	VCHG_OVERSHT, VCHG_UNDSHT
Checklist	CDP1, CDP7
Pass Criteria	Step 8 – Maximum voltage during overshoot is less than 6.0V. Step 10 – VBUS is in range 4.75V to 5.25V Step 18 – VBUS is in range 4.75V to 5.25V Step 19 – Minimum voltage during undershoot is above 4.1V. Step 19 – Maximum voltage during overshoot is less than 6.0V. Step 22 – Minimum voltage during undershoot is above 4.1V. Step 22 – Maximum voltage during overshoot is less than 6.0V.

9.2.1 Test procedure

Initial State: No load applied.

1. Ensure that UUT is connected via Special Test Cable B to the PET.
2. Ensure that CDP is in an un-powered state.
3. Wait for CDP voltage to fall below VBUS_LKG max (0.7V), in case it has just been switched off. (Speed up fall using 100mA current load.)
4. Set up voltage watch-block ready to capture overshoot of VCHG_OVRSHT (6.0V) on VBUS.
5. Instruct test operator to perform steps required to bring the CDP from an un-powered state to a powered one.
6. Wait for operator to click ‘OK’.
7. Wait for VBUS to rise above VCHG min (4.75V).
8. Check watch-block overshoot detector latch was not triggered. [CDP1]
9. Set up voltage watch-block ready to capture undershoot of VCHG_UNDSHT (4.1V), or overshoot of VCHG_OVRSHT (6.0V) on VBUS, allowing for voltage drop in cable.

10. With no current load applied, check that V_{BUS} is within appropriate range V_{CHG} (4.75V to 5.25V). [CDP6]

Emulate attaching PD

11. Apply V_{DP_SRC} nom. (0.6V) to D+.

12. Wait T_{VDMSRC_EN} max + 1 ms (= 21ms)

13. Check D- > V_{DAT_REF} min (0.25V).

14. Wait for 1ms more than the remainder of T_{VDPSRC_ON} (40ms – 20ms = 20ms).

15. Take D+ back to 0V.

Load Testing

16. Apply load of I_{CDP} min (1.5A) to V_{BUS}.

17. Wait 10ms.

18. Check that V_{BUS} voltage from CDP, at CDP connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable.

19. Check watch-block overshoot and undershoot detector latches were not triggered. [CDP1] [CDP7]

20. Remove Current Load.

21. Wait 10ms

22. Check that V_{BUS} voltage from CDP, at CDP connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V).[CDP6]

23. Check watch-block overshoot and undershoot detector latches were not triggered. [CDP1] [CDP7]

End of Test

9.3 CDP Voltage and Current Test

Test Setup	Test Setup 5. UUT is a CDP, PET simulates a PD.
Pre-conditions	CDP Overshoot and Undershoot Voltage Test has been run, and CDP is now switched on.
Purpose	To verify that the V_{BUS} voltage / current load characteristic meets the specified requirements.
Description	This test measures the voltage at various current loads, in order to confirm correct behavior.
Parameters	V_{CHG}
Checklist	CDP6
Pass Criteria	Step 1 - V_{BUS} voltage is in correct range. Step 9 - V_{BUS} voltage is in correct range.

9.3.1 Test procedure

Initial State: Special Cable B is connected to CDP. CDP is switched on.

1. Check that V_{BUS} voltage, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), from CDP is within V_{CHG} (4.75 – 5.25V). [CDP6]

Emulate attaching PD

2. Apply V_{DP_SRC} nom. (0.6V) to D+.
3. Wait T_{VDMSRC_EN} max + 1 ms (= 21ms)
4. Check D- > V_{DAT_REF} min (0.25V).
5. Wait for 1ms more than the remainder of T_{VDPSRC_ON} (40ms – 20ms = 20ms).
6. Take D+ back to 0V.

Load Testing

7. Apply load of I_{CDP} min (1.5A) to V_{BUS}.
8. Wait 1 sec to avoid possible transient period (overshoot and undershoot are measured separately).
9. Check that V_{BUS} voltage from CDP, at CDP connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable. [CDP6]
10. Disconnect the current load.

Note: In order that the test should not damage the tester connectors, no recovery time test is performed. A special test configuration is detailed elsewhere to provide a means of performing this test safely, if required.

End of Test

9.4 CDP Handshaking Test

Test Setup	Test Setup 5. UUT is an CDP, PET simulates a PD.
Pre-conditions	CDP Overshoot and Undershoot Voltage Test has been run, and CDP is now switched on.
Purpose	To verify the parameters of detection handshake.
Description	Test determines which of the two permissible behaviors is implemented, and confirms correct behavior.
Parameters	R_{DP_DWN}, R_{DM_DWN}, V_{DM_SRC}, V_{DAT_REF}, T_{VDMSRC_DIS}, T_{VDMSRC_EN}, $T_{CP\_VDM\_DIS}$, $T_{CP\_VDM\_EN}$, T_{VDMSRC_ON}, R_{DAT_LKG}, V_{DAT_LKG}
Checklist	CDP8, CDP9, CDP10
Pass Criteria	Step 8: D- voltage is still in range V_{DM_SRC} min (0.5V – 0.7V). Step 15: Voltage on D- is greater than 2V. Step 28: Voltage on D- is below V_{DAT_REF} min (0.25V). or Step 35. D- voltage is still in range V_{DM_SRC} min (0.5V – 0.7V). Step 43. Voltage on D- is below V_{DAT_REF} min (0.25V).

9.4.1 Test procedure

Initial State: Special Cable B is connected to CDP. CDP is switched on.

1. Check V_{BUS} is above $V_{OTG\_SESS\_VLD}$ max (4V). [CDP6]
2. Wait 200ms
3. Examine voltage on D-. If this is less than V_{DAT_REF} min (0.25V), skip to step 31.

<u>Behavior 1 – CDP maintains V_{DM_SRC} while device not connected.</u>

Primary Detection

4. Connect voltage source (0.6V) via 200R resistor to D+.
5. Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).

Check V_{DM_SRC} Gets Connected

6. Connect voltage source (0.5V) via 200R resistor to D-.
7. While voltage across 200R is less than 50mV, decrement the D- voltage source in steps of 2mV. Stop if D- voltage falls below V_{DM_SRC} min (0.5V) - FAIL. Else we will now be drawing the required 250µA from V_{DM_SRC}.
8. Check D- voltage is still in range V_{DM_SRC} (0.5V – 0.7V). [CDP8]
9. Disconnect voltage source and 200R from D-.
10. Wait 20ms to complete T_{VDPSRC_ON}

11. Disconnect voltage source (0.6V) via 200R resistor from D+.
12. Wait 100ms.
13. Check if D- is still at V_{DM_SRC} (0.5V - 0.7V). If not – FAIL owing to inconsistent behavior.

D- Pull-up Test

14. Connect 3.3V via 1K5 to D-.
15. Check that D- is greater than 2.2V. [CDP9]
16. Disconnect 3.3V via 1K5 from D-.
17. Wait 5 seconds for UUT to recognize disconnect.

Primary Detection

18. Connect voltage source (0.6V) via 200R resistor to D+.
19. Wait T_{VDPSRC_ON} min (40ms)
20. Disconnect voltage source via 200R resistor from D+.

Secondary Detection

21. Connect voltage source (0.6V) via 200R resistor to D-.
22. Wait 21ms.
23. Check that D+ is below V_{DAT_REF} min (0.25V)
24. Wait 20ms to complete T_{VDMSRC_ON}.
25. Disconnect voltage source via 200R resistor from D-.

Check V_{DM_SRC} Gets Disconnected

26. Connect 3.3V via 1k5 resistor to D+.
27. Wait slightly more than T_{VDMSRC_DIS} max (20ms +1 ms = 21ms)
28. Check that D- voltage is below V_{DAT_REF} min (0.25V). [CDP8]
29. Disconnect 3.3V via 1k5 resistor from D+
30. Wait 5 seconds for UUT to recognize disconnect.

End of Test – Behavior 1

<u>Behavior 2 – CDP only connects V_{DM_SRC} in response to Primary detection.</u>

Primary Detection

31. Connect voltage source (0.6V) via 200R resistor to D+.
32. Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).

Check V_{DM_SRC} Gets Connected

33. Connect voltage source (0.5V) via 200R resistor to D-.
34. While voltage across 200R is less than 50mV, decrement the D- voltage source in steps of 2mV. Stop if D- voltage falls below V_{DM_SRC} min (0.5V) - FAIL. Else we will now be drawing the required 250µA from V_{DM_SRC}.
35. Check D- voltage is still in range V_{DM_SRC} (0.5V – 0.7V). [CDP8]
36. Disconnect voltage source and 200R from D-.
37. Wait 20ms to complete T_{VDPSRC_ON}
38. Disconnect voltage source (0.6V) via 200R resistor from D+.
39. Wait 100ms.
40. Check if D- is still at V_{DM_SRC} (0.5V - 0.7V). If so – FAIL owing to inconsistent behavior.

Secondary Detection

41. Connect voltage source (0.6V) via 200R resistor to D-.
42. Wait 21ms.
43. Check that D+ is below V_{DAT_REF} min (0.25V). [CDP10]
44. Wait 20ms to complete T_{VDMSRC_ON}.
45. Disconnect voltage source via 200R resistor from D-.
46. Wait 5 seconds for UUT to recover.

End of Test – Behavior 2

9.5 CDP Ground Offset Test – Full Speed

Test Setup	Test Setup 5. UUT is an CDP, PET simulates a PD.
Pre-conditions	When running this test, ensure that an isolated computer is used for the tester host (e.g. Laptop).
Purpose	To verify that charging downstream port fulfills USB2.0 specification common mode voltage requirements at full speed.
Description	Insert specified command voltage offset and check UUT can enumerate reference device and operate well.
Parameters	
Checklist	CDP11
Pass Criteria	Step 9: Enumeration is successful.

9.5.1 Test procedure

1. Check V_{BUS} is above $V_{OTG\_SESS\_VLD}$ max (4V).
2. Wait 200ms.

Primary Detection

3. Connect voltage source (0.6V) via 200R resistor to D+.
4. Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).
5. Check D- voltage is in range V_{DM_SRC} (0.5V-0.7V).
6. Switch data lines to transceiver.

CMO Test

7. Apply common mode offset of V_{GND_OFFSET} (0.375 V) with test socket lower than PET transceiver ground.
8. Connect using D+.
9. Allow PET to be reset and enumerated, responding as a Full Speed device. Check that communication is reliable. [CDP11] This is achieved as follows:
    - If we do not receive a Get Device Descriptor request within 30 seconds communication is deemed to have failed.
    - After the Get Device Descriptor setup transaction we NAK the IN transactions for 250 frames duration (mid-frame to mid-frame).
    - During this period we count the successfully received SOF packets; less than 100% success is considered a failure.
    - Assuming success, we now allow enumeration to continue, in whatever form the CDP chooses (we have no way to control the CDP).

Note: we are now confident that we can receive IN packets, and need to check whether the CDP reliably receives packets we send to it.

- We monitor whether any IN transactions timeout when expecting ACK. This would indicate a failure of the CDP to have received our Data0/1 packet. Continue this monitoring until we get suspended, or for a chosen maximum period. A 'pass' requires 100% success in receiving ACKs to IN transactions.

10. Disconnect using D+

11. Remove common mode offset.

9.6 CDP Ground Offset Test – High Speed

Test Setup	Test Setup 5. UUT is an CDP, PET simulates a PD.
Pre-conditions	When running this test, ensure that an isolated computer is used for the tester host (e.g. Laptop).
Purpose	To verify that charging downstream port fulfills USB2.0 specification common mode voltage requirements at high speed.
Description	Insert specified command voltage offset and check UUT can enumerate reference device and operate well.
Parameters	
Checklist	CDP11
Pass Criteria	Step 9: Enumeration is successful.

9.6.1 Test procedure

1. Check V_{BUS} is above $V_{OTG\_SESS\_VLD}$ max (4V).
2. Wait 200ms.

Primary Detection

3. Connect voltage source (0.6V) via 200R resistor to D+.
4. Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).
5. Check D- voltage is in range V_{DM_SRC} (0.5V-0.7V).
6. Switch data lines to transceiver.

CMO Test

7. Apply common mode offset of V_{GND_OFFSET} (0.375 V) with test socket lower than PET transceiver ground.
8. Connect using D+.
9. Allow PET to be reset and enumerated, responding as a High Speed device. Check that communication is reliable. [CDP11] This is achieved as follows:
    - If we do not receive a Get Device Descriptor request within 30 seconds communication is deemed to have failed.
    - After the Get Device Descriptor setup transaction we NAK the IN transactions for 250 frames duration (mid-frame to mid-frame).
    - During this period we count the successfully received SOF packets; less than 100% success is considered a failure.
    - Assuming success, we now allow enumeration to continue, in whatever form the CDP chooses (we have no way to control the CDP).

Note: we are now confident that we can receive IN packets, and need to check whether the CDP reliably receives packets we send to it.

- We monitor whether any IN transactions timeout when expecting ACK. This would indicate a failure of the CDP to have received our Data0/1 packet. Continue this monitoring until we get suspended, or for a chosen maximum period. A 'pass' requires 100% success in receiving ACKs to IN transactions.

10. Disconnect using D+

11. Remove common mode offset.

10 Standard Downstream Port (SDP) Compliance

This section is included in order to allow the testing of a Multiple Role Port, which may behave as a CDP, a DCP or an SDP, depending on circumstances. Its purpose is to check the additional BC requirement placed on an MRP acting as an SDP, namely to take part in detection handshaking correctly.

10.1 Submission Materials

10.1.1 Device Specific Information

The following items are required to be submitted along with the UUT:

Table 10-1 Device Specific Information for SDPs

Item	Function	Value/ Support
1	The USB-IF TID for the UUT standard-A receptacle(s).	

10.1.2 Checklist

Table 10-2 Checklist for DCPs

Question		Response	Test Number	BC 1.2 Reference
SDP1	If before connecting, a device applies V_{DP_SRC} to D+, does the SDP maintain a voltage of less than V_{DAT_REF} min on D-?	Yes ☐ No ☐	10.2	3.2.4.3
SDP2	If before connecting, a device applies V_{DM_SRC} to D-, does the SDP maintain a voltage of less than V_{DAT_REF} min on D+?	Yes ☐ No ☐	10.2	3.2.4.3
SDP3	Does the UUT provide VBUS discharge functionality?	Yes ☐ No ☐	Vendor Declaration	4.1.3

10.2 SDP Handshaking Test

Test Setup	Test Setup 5. UUT is a SDP, PET simulates a PD.
Pre-conditions	SDP is switched on.
Purpose	To verify the parameters of detection handshake. This test is particularly designed to verify the behavior of UUTs which switch roles among DCP, CDP and SDP, and may therefore have more complex circuitry on D+ and D- than a standard downstream port.
Description	Test confirms correct handshake behavior.
Parameters	-
Checklist	SDP1, SDP2
Pass Criteria	Step 5. D- is below 0.25V. Step 10. D+ is below 0.25V.

10.2.1 Test procedure

Initial State: UUT is connected via Special Test Cable B to the PET. No load applied. SDP is switched on. Data lines switched to data measurement circuit.

1. Check V_{BUS} is above $V_{OTG\_SESS\_VLD}$ max (4V).
2. Wait 200ms

Primary Detection

3. Connect voltage source (0.6V) via 200R resistor to D+.
4. Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).
5. Check that D- is below V_{DAT_REF} min (0.25V). [SDP1]
6. Wait 20ms to complete T_{VDPSRC_ON}.
7. Disconnect voltage source via 200R resistor from D+.

Secondary Detection

8. Connect voltage source (0.6V) via 200R resistor to D-.
9. Wait 21ms.
10. Check that D+ is below V_{DAT_REF} min (0.25V). [SDP2]
11. Wait 20ms to complete T_{VDMSRC_ON}.
12. Disconnect voltage source via 200R resistor from D-.
13. Wait 5 seconds for UUT to recover.

End of Test

11 Multiple Role Port (MRP) Compliance

This section is included in order to allow the testing of a Multiple Role Port, which may behave as a CDP, a DCP or an SDP, depending on circumstances. Its purpose is to check that the MRP port behaves correctly when switching between its roles.

11.1 Submission Materials

11.1.1 Device Specific Information

Table 11-1 Device Specific Information for SDPs

Item	Function	Value/ Support
1	Description of how to bring the UUT from an un-powered state to a state where it is acting as a CDP.	
2	Description of how to bring the UUT from a state where it is acting as a CDP, to a state where it is acting as an SDP, if applicable.	
3	Description of how to bring the UUT from a state where it is acting as an SDP, to a state where it is acting as a CDP, if applicable.	
4	Description of how to bring the UUT from a state where it is acting as a CDP, to a state where it is acting as a DCP, if applicable.	
5	Description of how to bring the UUT from a state where it is acting as a DCP, to a state where it is acting as a CDP, if applicable.	

11.1.2 Checklists

Table 11-2 Checklist for MRPs

Question		Response	BC 1.2 Section Number
Information			
MRPI1	Can the MRP act as a CDP? *	Yes ☐ No ☐	4.1.3
MRPI2	Can the MRP act as a SDP?	Yes ☐ No ☐	4.1.3
MRPI3	Can the MRP act as a DCP?	Yes ☐ No ☐	4.1.3
MRPI4	Does the MRP force detection renegotiation when changing from a CDP to an SDP role?	Yes ☐ No ☐ N/A ☐	4.1.3
MRPI5	Does the MRP force detection renegotiation when changing from an SDP to a CDP role?	Yes ☐ No ☐ N/A ☐	4.1.3
MRPI6	Does the MRP force detection renegotiation when changing from a CDP to a DCP role?	Yes ☐ No ☐ N/A ☐	4.1.3
MRPI7	Does the MRP force detection renegotiation when changing from a DCP to a CDP role?	Yes ☐ No ☐ N/A ☐	4.1.3

* The Multiple Role Port compliance test assumes that the MRP can act as a CDP.

Question		Response	Test Number	BC 1.2 Section Number
Requirements				
MRP1	If the MRP forces detection renegotiation when changing from an CDP to a SDP role, does it stop driving VBUS, allow VBUS to drop to less than VBUS_LKG, wait for a time of TVBUS_REAPP and then start driving VBUS?	Yes ☐ No ☐ N/A ☐		4.1.3
MRP2	If the MRP forces detection renegotiation when changing from an SDP to a CDP role, does it stop driving VBUS, allow VBUS to drop to less than VBUS_LKG, wait for a time of TVBUS_REAPP and then start driving VBUS?	Yes ☐ No ☐ N/A ☐		4.1.3
MRP3	If the MRP forces detection renegotiation when changing from an CDP to a DCP role, does it stop driving VBUS, allow VBUS to drop to less than VBUS_LKG, wait for a time of TVBUS_REAPP and then start driving VBUS?	Yes ☐ No ☐ N/A ☐		4.1.3
MRP4	If the MRP forces detection renegotiation when changing from an DCP to a CDP role, does it stop driving VBUS, allow VBUS to drop to less than VBUS_LKG, wait for a time of TVBUS_REAPP and then start driving VBUS?	Yes ☐ No ☐ N/A ☐		4.1.3

11.2 MRP Functional Test

Test Setup	Test Setup 5. UUT is an MRP, PET simulates a PD.
Pre-conditions	MRP is switched on.
Purpose	To verify the parameters of detection renegotiation. This test is designed to verify the behavior of UUTs which switch roles among DCP, CDP and SDP.
Description	Test confirms correct detection renegotiation behavior, where implemented.
Parameters	V_{BUS_LKG}, T_{VBUS_REAPP}
Checklist	MRP1, MRP2, MRP3, MRP4
Pass Criteria	Step 19. If implemented, VBUS goes below 0.7V for at least 100ms. Step 22. If implemented, VBUS goes below 0.7V for at least 100ms. Step 25. If implemented, VBUS goes below 0.7V for at least 100ms. Step 27. If implemented, VBUS goes below 0.7V for at least 100ms.

11.2.1 Test procedure

Initial State: No load applied.

1. Ensure that UUT is connected via Special Test Cable B to the PET.
2. Ensure that UUT is in an un-powered state.
3. Wait for UUT voltage to fall below V_{BUS_LKG} max (0.7V), in case it has just been switched off. (Speed up fall using 100mA current load.)
4. Ask the test operator whether the MRP can act as a CDP. Record the answer. [MRPI1] If answer is 'No', then abandon test.
5. Ask the test operator whether the MRP can act as a SDP. Record the answer. [MRPI2]
6. Ask the test operator whether the MRP can act as a DCP. Record the answer. [MRPI3]
7. If neither MRPI2 nor MRPI3 were answered 'Yes', then abandon test.
8. If MRPI2 was answered ‘No’, skip to step 11.
9. Ask the test operator whether the MRP forces detection renegotiation when changing from a CDP to an SDP role. Record the answer. [MRPI4]
10. Ask the test operator whether the MRP forces detection renegotiation when changing from an SDP to a CDP role. Record the answer. [MRPI5]
11. If MRPI3 was answered ‘No’, skip to step 14.
12. Ask the test operator whether the MRP forces detection renegotiation when changing from a CDP to a DCP role. Record the answer. [MRPI6]
13. Ask the test operator whether the MRP forces detection renegotiation when changing from a DCP to a CDP role. Record the answer. [MRPI7]

14. If none of MRPI4, MRPI5, MRPI6, MRPI7 were answered 'Yes', then abandon test.

15. Instruct test operator to perform steps required to bring the UUT from an un-powered state to a powered one, such that it will be acting in a CDP role, and then to indicate that this has occurred.

16. Wait for operator to click ‘OK’.

17. Wait for V_{BUS} to rise above V_{CHG} min (4.75V).

18. If the answer to MRPI2 is 'No', skip to Step 24.

19. Instruct test operator to perform steps required to change the role of the UUT from a CDP to an SDP, and then to click ‘OK’ to indicate that this has been done.

20. If the answer to MRPI4 was 'No' skip to next step; else monitor V_{BUS} to check whether it went below V_{BUS_LKG} max (0.7V) for T_{VBUS_REAPP} min (100ms), before the operator clicked ‘OK’ in the previous step. [MRP1]

21. Instruct test operator to perform steps required to change the role of the UUT from an SDP to an CDP, and then to click ‘OK’ to indicate that this has been done.

22. If the answer to MRPI5 was 'No' skip to next step; else monitor V_{BUS} to check whether it went below V_{BUS_LKG} max (0.7V) for T_{VBUS_REAPP} min (100ms), before the operator clicked ‘OK’ in the previous step.. [MRP2]

23. If the answer to MRPI3 is 'No', skip to 'End of Test'.

24. Instruct test operator to perform steps required to change the role of the UUT from a CDP to a DCP, and then to click ‘OK’ to indicate that this has been done.

25. If the answer to MRPI6 was 'No' skip to next step; else monitor V_{BUS} to check whether it went below V_{BUS_LKG} max (0.7V) for T_{VBUS_REAPP} min (100ms), before the operator clicked ‘OK’ in the previous step. [MRP3]

26. Instruct test operator to perform steps required to change the role of the UUT from an DCP to an CDP, and then to click ‘OK’ to indicate that this has been done.

27. If the answer to MRPI7 was 'No' skip to 'End of Test'; else monitor V_{BUS} to check whether it went below V_{BUS_LKG} max (0.7V) for T_{VBUS_REAPP} min (100ms), before the operator clicked ‘OK’ in the previous step. [MRP4]

End of Test

12 Micro-ACA Compliance, Separate Charger

Note: There are some discrepancies in the BC 1.2 Specification with regard to the Micro-ACA. Essentially, these relate to the requirement in Table 6-2 of that document that the Accessory switch be closed, in rows 1-3 (i.e. have a resistance of less than 200mΩ) at a time when there is no power available to the Micro-ACA. The presence and/or required value of C_{MACA_VBUS} capacitor(s) is also related to this. As some further work will be required to resolve this issue, it was decided to release this Compliance Plan with the appropriate parts of the Micro-ACA tests left out, with the intention of adding them as soon as a resolution is found.

This situation has no effect on the Standard-ACA tests.

12.1 Submission Materials

12.1.1 Device Specific Information

Table 12-1 Device Specific Information for Micro-ACAs with Separate Charger

Item	Function	Value/ Support
1	The USB-IF TID for the UUT micro-AB receptacle used for the accessory port	
2	The USB-IF TID for the UUT micro-A plug used for the OTG port captive cable	
3	The USB-IF TID for the UUT standard-A plug or micro-B receptacle used for the charger port	

12.1.2 Checklists

Table 12-2 Checklist for Micro-ACAs

Question		Response	Test Number	BC 1.2 Section Number
Questions relating to all Micro-ACAs				
MACA1	Does the UUT have a capacitance from V_{BUS} to ground of C_{MACA_VBUS} on its OTG port?	Yes ☐ No ☐	12.12	6.2.6
MACA2	Does the UUT have a capacitance from V_{BUS} to ground of C_{MACA_VBUS} on its accessory port?	Yes ☐ No ☐	12.12	6.2.6
MACA3	Does the ACA have an indicator showing when the charger port is able to supply power to the other ports?	Yes ☐ No ☐	12.3 - 012.11	6.1
MACA4	Is the Charger Port on the UUT clearly labeled 'Charger Only'? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	Inspection	6.1

MACA5	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_GND} when nothing is connected to its charger port, and a B-device is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_GND} when the unit is not connected to a power source and a B-device is connected to its accessory port?	Yes ☐ No ☐	012.11	4.5.3
MACA6	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_GND} when an SDP is connected to its charger port, and a B-device is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.5	4.5.3
MACA7	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_A} when a DCP or a CDP is connected to its charger port, and a B-device is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_A} when the unit is connected to a power source, and a B-device is connected to its accessory port?	Yes ☐ No ☐	12.8	4.5.3
MACA8	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_B} when a DCP or a CDP is connected to its charger port, and nothing is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_B} when the unit is connected to a power source, and nothing is connected to its accessory port?	Yes ☐ No ☐	12.6	4.5.3

MACA9	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_B when a DCP or a CDP is connected to its charger port, and an A-device not providing VBUS is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_B when the unit is connected to a power source, and an A-device not providing VBUS is connected to its accessory port?	Yes ☐ No ☐	12.7	4.5.3
MACA10	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_C when a DCP or a CDP is connected to its charger port, and an A-device providing VBUS is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_C when the unit is connected to a power source, and an A-device providing VBUS is connected to its accessory port?	Yes ☐ No ☐	12.7	4.5.3
MACA11	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_FLOAT when nothing is connected to its charger port, and nothing is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_FLOAT when the unit is not connected to a power source, and nothing is connected to its accessory port?	Yes ☐ No ☐	12.9	4.5.3
MACA12	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_ FLOAT when an SDP is connected to its charger port, and nothing is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.3	4.5.3

MACA13	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_FLOAT} when nothing is connected to its charger port, and an A-device not supplying V_{BUS} is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_FLOAT} when the unit is not connected to a power source, and an A-device not supplying V_{BUS} is connected to its accessory port?	Yes ☐ No ☐	12.10	4.5.3
MACA14	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_FLOAT} when an SDP is connected to its charger port, and an A-device not supplying V_{BUS} is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.4	4.5.3
MACA15	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_FLOAT} when nothing is connected to its charger port, and an A-device supplying V_{BUS} is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_FLOAT} when the unit is not connected to a power source, and an A-device supplying V_{BUS} is connected to its accessory port?	Yes ☐ No ☐	12.10	4.5.3
MACA16	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_FLOAT} when an SDP is connected to its charger port, and an A-device supplying V_{BUS} is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.4	4.5.3
MACA17	Does the UUT directly connect the data pins of the OTG port directly to the data pins of the accessory port?	Yes ☐ No ☐	Vendor Declaration	4.5.3
MACA18	Does the UUT have a captive cable terminated with a Micro-A plug on its OTG port?	Yes ☐ No ☐	Inspection	4.5.4
MACA19	Does the Micro-A plug have a valid TID?	Yes ☐ No ☐	Vendor Declaration	

MACA20	Does the UUT have a Micro-AB receptacle on its OTG port?	Yes ☐ No ☐	Inspection	6.1
MACA21	Does the Micro-AB receptacle have a valid TID?		Vendor Declaration	
MACA22	Does the UUT Charger Port have a Micro-B receptacle, a captive cable terminated with a Standard-A plug, or a captive cable terminated with a Charger?	Micro-B ☐ Standard-A ☐ Charger ☐ No ☐	Inspection	6.2.1
MACA23	If the Charger Port has a Micro-B receptacle or a Standard-A plug, does this have a valid TID?	Yes ☐ No ☐ N/A ☐	Vendor Declaration	
MACA24	Does the UUT charger port draw less than I_{SUSP} when anything other than a charging port is attached to it? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.3, 12.4, 12.5	6.2.6
MACA25	Does the UUT charger port draw less than I_{SUSP} when a charging port is attached to it, and nothing is attached to the OTG port or accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.6	6.2.6
MACA26	Is the resistance between the V_{BUS_CHG} and V_{BUS_OTG} pins of the UUT, $R_{ACA\_CHG\_OTG}$ when the charger switch is closed, and the voltage on V_{BUS_CHG} is V_{ACA_OPR}? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.6	6.2.6
MACA27	Is the resistance between the V_{BUS_CHG} and V_{BUS_ACC} pins of the UUT, $R_{ACA\_CHG\_ACC}$ when the accessory switch is closed, and the voltage on V_{BUS_CHG} is V_{ACA_OPR}? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.8	6.2.6
MACA28	Is the resistance between the V_{BUS_OTG} and V_{BUS_ACC} pins of the UUT, $R_{ACA\_OTG\_ACC}$ when the accessory switch is closed, and the voltage on V_{BUS_OTG} is V_{ACA_OPR}?	Yes ☐ No ☐	12.8	6.2.6
MACA29	Is the resistance between the internal ground of the UUT and the ground pin of the Micro-AB receptacle attached to the OTG port of the UUT, $R_{OTG\_ACA\_GND}$?	Yes ☐ No ☐	Vendor Declaration	6.2.6

MACA30	Does the UUT output V_{DP_SRC} on DP_CHG when it detects V_{BUS_CHG}? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.8	6.2.6
MACA31	Does the UUT close its charger switch when it detects DN_CHG greater than V_{DAT_REF} and V_{BUS_CHG} remains above $V_{OTG\_SESS\_VLD}$? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.8	6.2.6
Questions specific to Micro-ACAs with Combined Charger				
MACC1	Is the output voltage of the UUT less than V_{CHG_OVRSHT} max for any step change in load current, and also when powering on or off? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4.1.1
MACC2	Is the output current of the UUT prevented from exceeding I_{CDP} max under any condition? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐	Vendor Declaration	4.1.2
MACC3	Has it has been shown, using schematics or by some other explanation, that in the case of a single failure in the UUT, the output voltage on V_{BUS} will not exceed V_{CHG_FAIL}? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐	Vendor Declaration	4.1.5
MACC4	Is the output voltage of the UUT OTG port greater than V_{CHG_UNDSHT} min for any step change in load current where current is less than I_{CDP} min? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4.5.2
MACC5	Is the output voltage of the UUT Accessory port greater than V_{CHG_UNDSHT} min for any step change in load current where current is less than I_{CFG_MAX}? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4.5.2

MACC6	Does the UUT output a voltage of V_{CHG} (averaged over T_{VBUS_AVG}) for all currents less than I_{CDP} min on its OTG port? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4
MACC7	Does the UUT output a voltage of V_{CHG} (averaged over T_{VBUS_AVG}) allowing for a drop across $R_{ACA\_OTG\_ACC}$ for all currents less than 500mA on its ACC port? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4
MACC8	If the UUT goes into shutdown during a current overload condition, does it recover and output a voltage of V_{CHG} within a time of T_{SHTDWN_REC} when the current overload condition has been removed.	Yes ☐ No ☐	Vendor Declaration	4.2.2

12.2 PET Cable Calibration

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	This is the first procedure in the Micro-ACA Test Suite.
Purpose	To calibrate the Test Cables, and to prepare the Micro-ACA for the following tests.
Description	The test operator is instructed to connect the test cables in turn, and these are calibrated. The test operator is then instructed to connect up the Micro-ACA in preparation for the tests.

12.2.1 Test procedure

1. Instruct test operator to plug Special Cable C into PET D-type connector, and the Micro-B plug of the Special Cable C into the PET Micro-AB receptacle, and then click on 'OK'.

2. PET passes a current of 500mA through the VBUS conductor of the cable, and measures and records the voltage drop.

3. Instruct test operator to unplug the Micro-B plug of the Special Cable C from the PET Micro-AB receptacle, and then click on 'OK'.

4. If 'Captive Cable' checkbox is checked, skip to step 8.

5. Instruct test operator to plug Special Cable B into the Standard-A receptacle of Special Cable C, and the Micro-B plug of the Special Cable B into the PET Micro-AB receptacle, and then click on 'OK'.

6. PET passes a current of 1500mA through the VBUS conductor of the cable, and measures and records the voltage drop.

7. PET passes a current of 2000mA through the VBUS conductor of the cable, and measures and records the voltage drop.

8. Instruct test operator to unplug the Micro-B plug of the Special Cable B from the PET Micro-AB receptacle, and then click on 'OK'.

9. Instruct test operator to plug the Micro-B plug of Special Cable C into the Accessory Port of the Micro-ACA under test, and then click on 'OK'.

10. Instruct test operator to plug the Micro-B plug of the captive OTG cable of the Micro-ACA under test into the PET Micro-AB receptacle, and then click on 'OK'.

11. **With Captive Charger Cable**
    Instruct test operator to plug the Standard-A plug of the captive Charger cable of the Micro-ACA under test into the Standard-A receptacle of Special Cable C, and then click on 'OK'.

    With No Captive Charger Cable
    Instruct test operator to plug the Micro-B plug of Special Cable B into the Charger port of the Micro-ACA under test, and then click on 'OK'.

Check that cables are connected:

12. Connect 10kΩ pull-down resistor to OTG port V_{BUS}.
13. Apply 5V to V_{BUS} on charger port.
14. Connect together D+ and D- on charger port via 200R.
15. Apply ground to ID pin on accessory port.
16. Check that we can sense 5V on V_{BUS} on OTG port.
17. Check that we can sense 5V on V_{BUS} on accessory port.
18. Remove 5V from V_{BUS} on charger port.
19. Disconnect D+ from D- on charger port.
20. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.
21. Remove ground from ID pin on accessory port.
22. If test fails report ‘Either cables not correctly connected or accessory port ID pin not functioning’.

End of Test

12.3 SDP attached to Charger Port, Nothing attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with SDP attached to the Charger Port and Nothing attached to accessory port
Description	The PET simulates an SDP being attached to the Charger Port of the UUT, and nothing to the Accessory Port of the UUT. Check whether VBUS comes from the OTG port or the Accessory Port. Check the resistance to ground of ID pin on OTG port. Check the current drawn by the Charger Port. Check correct functioning of the Indicator.
Parameters	R_{ID_FLOAT}, I_{SUSP}
Checklist	MACA3, MACA12, MACA24
Pass Criteria	Step 3. VBUS is not coming from the Accessory port. Step 4. VBUS is not coming from the OTG port. Step 5. Resistance to ground of ID pin on OTG port is R_{ID_FLOAT}. Step 7. Indicator is off. Step 8. UUT is drawing less than I_{SUSP} from the charger port

12.3.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No V_{BUS} voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port V_{BUS}.

2. Apply 5V to V_{BUS} on charger port.

3. Check that V_{BUS} is not coming from the Accessory port. i.e. Check that Accessory port V_{BUS} is less than $V_{OTG\_VBUS\_LKG}$ (0.7V)

4. Check that V_{BUS} is not coming from the OTG port. i.e. Check that OTG port V_{BUS} is less than $V_{OTG\_VBUS\_LKG}$ (0.7V)

Check R_{ID_FLOAT}

5. Check that resistance to ground of ID pin on OTG port is R_{ID_FLOAT} (> 220 kΩ). [MACA12]

Check Indicator

6. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

7. Wait for response, if ‘Yes’, test fails. If ‘No’ it passes. [MACA3]

Check Current Drawn by UUT Charger Port

8. Check that the UUT is drawing less than I_{SUSP} (2.5mA) from the charger port. [MACA24]

9. Remove 5V from V_{BUS} on charger port.

10. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

End of Test

12.4 SDP attached to Charger Port, A-device attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with SDP attached to the Charger Port and A-device attached to accessory port
Description	The PET simulates an SDP being attached to the Charger Port of the UUT, and an A-device to the Accessory Port of the UUT. Check whether VBUS comes from the OTG. Check the resistance to ground of ID pin on OTG port. Check the resistance between VBUS on the OTG Port, and on the Accessory Port. Check the current drawn by the Charger Port. Check correct functioning of the Indicator.
Parameters	RID_ FLOAT, ISUSP
Checklist	MACA3, MACA9, MACA10, MACA24
Pass Criteria	Step 5. VBUS is coming from the OTG port. Step 8. Indicator is off. Step 9. Resistance to ground of ID pin on OTG port is RID_FLOAT. Step 12. Resistance to ground of ID pin on OTG port is RID_FLOAT. Step 14. Voltage is less than 100mV Step 19. UUT is drawing less than ISUSP from the charger port

12.4.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port VBUS.
2. Connect 5V to VBUS on charger port.
3. Connect 0V to VBUS on accessory port.
4. Check that voltage on VBUS from OTG is less than VOTG_VBUS_LKG (0.7V)
5. Connect 5V to VBUS on accessory port.
6. Check that voltage on VBUS from OTG port is >= 4.75V.

Check Indicator

7. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.
8. Wait for response, if ‘Yes’, test fails. If ‘No’ it passes. [MACA3]

Check RID_FLOAT

9. Connect 0V to V_{BUS} on accessory port.

10. Check that resistance to ground of ID pin on OTG port is R_{ID_FLOAT} (> 220 kΩ). [MACA9]

11. Connect 5V to V_{BUS} on accessory port.

12. Check that resistance to ground of ID pin on OTG port is R_{ID_FLOAT} (> 220 kΩ). [MACA10]

For now skip to step 16 (See note at start of Section 12)

Check $R_{ACA\_OTG\_ACC}$

13. Set OTG Port V_{BUS} current load to 500mA.

14. Check that voltage on Accessory Port V_{BUS} minus OTG V_{BUS} is less than 100mV, allowing for the voltage drop in the test cables. This confirms $R_{ACA\_OTG\_ACC}$ (200mΩ).

15. Set OTG Port V_{BUS} current load to 0mA.

Check Current Drawn by UUT Charger Port

16. Set OTG Port V_{BUS} current load to 10mA.

17. Measure current drawn from V_{BUS} generator.

18. Disconnect V_{BUS} from Charger Port.

19. Check that current drops by less than I_{SUSP} (2.5mA) [MACA24]

20. Remove 5V from V_{BUS} on OTG port.

21. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

22. Set OTG Port V_{BUS} current load to 0mA.

End of Test

12.5 SDP attached to Charger Port, B-device attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with SDP attached to the Charger Port and B-device attached to accessory port
Description	The PET simulates an SDP being attached to the Charger Port of the UUT, and a B-device to the Accessory Port of the UUT. Check whether VBUS comes from the OTG port or the Accessory Port. Check the resistance to ground of the ID pin on OTG port. Check the current drawn by the Charger Port. Check correct functioning of the Indicator.
Parameters	RID_GND, RACA_OTG_ACC, ISUSP
Checklist	MACA3, MACA6, MACA24, MACA28
Pass Criteria	Step 4. VBUS is not coming from the Accessory port. Step 5. VBUS is not coming from the OTG port. Step 6. Resistance to ground of ID pin on OTG port is RID_GND. Step 8. Indicator is off. Step 11. Voltage is less than 100mV Step 16. UUT is drawing less than ISUSP from the charger port

12.5.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port VBUS.
2. Apply 5V to VBUS on charger port.
3. Apply ground to ID pin on accessory port.
4. Check that VBUS is not coming from the Accessory port. i.e. Check that Accessory port VBUS is less than VOTG_VBUS_LKG (0.7V).
5. Check that VBUS is not coming from the OTG port. i.e. Check that OTG port VBUS is less than VOTG_VBUS_LKG (0.7V)

Check RID_GND

6. Check that resistance to ground of ID pin on OTG port is RID_GND (< 1kΩ). [MACA6]

Check Indicator

7. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.
8. Wait for response, if ‘Yes’, test fails. If ‘No’ it passes. [MACA3]

For now skip to step 13 (See note at start of Section 12)

Check $R_{ACA\_OTG\_ACC}$

9. Apply V_{BUS} to OTG port

10. Connect 10Ω load to Accessory Port V_{BUS} line

11. Check that voltage on OTG V_{BUS} minus Accessory Port V_{BUS} is less than 100mV, allowing for the voltage drop in the test cables. This confirms $R_{ACA\_OTG\_ACC}$ (200mΩ). [MACA28]

12. Remove 10Ω load from accessory port V_{BUS} line

Check Current Drawn by UUT Charger Port

13. Connect 625Ω load to Accessory Port V_{BUS} line.

14. Measure current drawn from V_{BUS} generator.

15. Disconnect V_{BUS} from Charger Port.

16. Check that current drops by less than I_{SUSP} (2.5mA) [MACA24]

17. Remove 5V from V_{BUS} on OTG port.

18. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

19. Disconnect 625Ω load from Accessory Port V_{BUS} line.

20. Disconnect ground from ID pin on accessory port.

End of Test

12.6 DCP or CDP attached to Charger Port, Nothing attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Charger attached to the Charger Port and Nothing attached to accessory port
Description	The PET simulates a DCP or CDP being attached to the Charger Port of the UUT, and nothing to the Accessory Port of the UUT. Check whether V_{BUS} comes from the OTG Port or the Accessory Port. Check the resistance to ground of the ID pin on OTG Port. Check the resistance between V_{BUS} on the Charger Port, and on the OTG Port. Check correct functioning of the Indicator. Check UUT outputs V_{DP_SRC} on Charger Port D+.
Parameters	R_{ID_B}, $R_{ACA\_CHG\_OTG}$, V_{DP_SRC}
Checklist	MACA3, MACA8, MACA24, MACA26
Pass Criteria	Step 4. V_{BUS} is not coming from the Accessory port. Step 5. V_{BUS} is coming from the OTG port. Step 6. Less than 2.5mA is being drawn by the charger port. Step 8. Voltage is less than 300mV Step 10. Resistance to ground of ID pin on OTG port is R_{ID_B}. Step 12. Indicator is on. Step 13. Voltage is 0.5V-0.7V.

12.6.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No V_{BUS} voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port V_{BUS}.
2. Apply 5V to V_{BUS} on charger port.
3. Connect together D+ and D- on charger port via 200R.
4. Check that V_{BUS} is not coming from the Accessory port. i.e. Check that Accessory port V_{BUS} is less than $V_{OTG\_VBUS\_LKG}$ (0.7V)
5. Check that V_{BUS} is coming from the OTG port. i.e. Check that OTG port V_{BUS} is greater than 4.75V.
6. Check that less than I_{SUSP} max (2.5mA) is being drawn by charger port. [MACA24]

Check $R_{ACA\_CHG\_OTG}$

7. Set OTG Port V_{BUS} current load to 1500mA.

8. Check that voltage on Charger V_{BUS} minus OTG Port V_{BUS} is less than 300mV, allowing for the voltage drop in the test cables. This confirms $R_{ACA\_CHG\_OTG}$ (200mΩ). [MACA26]

9. Set OTG Port V_{BUS} current load to 0mA.

Check R_{ID_B}

10. Check that resistance to ground of ID pin on OTG port is R_{ID_B} (67-69 kΩ). [MACA8]

Check Indicator

11. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

12. Wait for response, if ‘Yes’, test passes. If ‘No’ it fails. [MACA3]

Check V_{DP_SRC}

13. Check that voltage on D+ of charger port is V_{DP_SRC} (0.5V-0.7V).

14. Remove 5V from V_{BUS} on charger port.

15. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

16. Disconnect D+ from D- on charger port.

End of Test

12.7 DCP or CDP attached to Charger Port, A-device attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with DCP or CDP attached to the Charger Port and A-device attached to accessory port
Description	The PET simulates a DCP or CDP being attached to the Charger Port of the UUT, and an A-device to the Accessory Port of the UUT. Check whether VBUS comes from the OTG. Check the resistance to ground of ID pin on OTG Port. Check correct functioning of the Indicator. Check UUT outputs V_{DP_SRC} on Charger Port D+.
Parameters	R_{ID_C}, I_{SUSP}, V_{DP_SRC}
Checklist	MACA3, MACA9, MACA10
Pass Criteria	Step 5. V_{BUS} is coming from the OTG port. Step 6. Resistance to ground of ID pin on OTG port is R_{ID_B}. Step 8. Resistance to ground of ID pin on OTG port is R_{ID_C}. Step 10. Indicator is on. Step 15. Current is < 2.5mA Step 17. Voltage is 0.5V-0.7V.

12.7.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No V_{BUS} voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port V_{BUS}.
2. Apply 0V to V_{BUS} on Accessory Port.
3. Apply 5V to V_{BUS} on Charger Port.
4. Connect together D+ and D- on charger port via 200Ω.
5. Check that V_{BUS} is coming from the OTG port. i.e. Check that OTG port V_{BUS} is greater than 4.75V.

Check R_{ID_B} and R_{ID_C}

6. Check that resistance to ground of ID pin on OTG port is R_{ID_B} (67-69 kΩ). [MACA9]
7. Apply 5V to V_{BUS} on Accessory Port.
8. Check that resistance to ground of ID pin on OTG port is R_{ID_C} (36-37 kΩ). [MACA10]

Check Indicator

9. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.

10. Wait for response, if 'Yes', test passes. If 'No' it fails. [MACA3]

Check Current From Accessory Port

11. Set OTG Port V_{BUS} current load to 10 mA.

12. Measure current from V_{BUS} generator.

13. Disconnect V_{BUS} from Accessory Port.

14. Measure current from V_{BUS} generator and subtract from previous measurement.

15. Check that difference is less than I_{SUSP} (2.5mA).

16. Set OTG Port V_{BUS} current load to zero.

Check V_{DP_SRC}

17. Check that voltage on D+ of charger port is V_{DP_SRC} (0.5V-0.7V).

18. Remove 5V from V_{BUS} on Charger Port.

19. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

20. Disconnect D+ from D- on charger port.

End of Test

12.8 DCP or CDP attached to Charger Port, B-device attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with DCP or CDP attached to the Charger Port and B-device attached to accessory port
Description	The PET simulates a DCP or CDP being attached to the Charger Port of the UUT, and a B-device to the Accessory Port of the UUT. Check whether V_{BUS} comes from the OTG Port or the Accessory Port. Check the resistance to ground of ID pin on OTG Port. Check the resistance between V_{BUS} on the Charger Port, and on the OTG Port. Check the resistance between V_{BUS} on the Charger Port, and on the Accessory Port. Check correct functioning of the Indicator. Check UUT outputs V_{DP_SRC} on Charger Port D+.
Parameters	R_{ID_A}, V_{ACA_OPR}, V_{ACA_DIS}, $R_{ACA\_CHG\_ACC}$, $R_{ACA\_CHG\_OTG}$, V_{DP_SRC}
Checklist	MACA3, MACA7, MACA26, MACA27, MACA30
Pass Criteria	Step 6. V_{BUS} is coming from the Accessory port. Step 7. V_{BUS} is coming from the OTG port. Step 8. Resistance to ground of ID pin on OTG port is R_{ID_A}. Steo 10. V_{BUS} is coming from the Accessory port. Step 11. V_{BUS} is coming from the OTG port. Step 15. Voltage is less than 500mV Step 17. Voltage is less than 300mV Step 20. Indicator is on. Step 21. Voltage is 0.5V-0.7V.

12.8.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No V_{BUS} voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port V_{BUS}.
2. Connect Accessory Port ID pin to ground.
3. Apply 5V to V_{BUS} on charger port.
4. Connect together D+ and D- on charger port via 200R.
5. Connect 625Ω load on Accessory Port V_{BUS}
6. Check that V_{BUS} is coming from the Accessory port. i.e. Check that Accessory port V_{BUS} is greater than 4.75V.

7. Check that V_{BUS} is coming from the OTG port. i.e. Check that OTG port V_{BUS} is greater than 4.75V.

Check R_{ID_A}

8. Check that resistance to ground of ID pin on OTG port is R_{ID_A} (122-126 kΩ). [MACA7]

Check V_{ACA_OPR}

9. Change V_{BUS} generator voltage to V_{ACA_OPR} min (4.1V).

10. Check that V_{BUS} is coming from the Accessory port. i.e. Check that Accessory port V_{BUS} is greater than 3.85V.

11. Check that V_{BUS} is coming from the OTG port. i.e. Check that OTG port V_{BUS} is greater than 3.85V. [MACA27]

Check $R_{ACA\_CHG\_ACC}$

12. Disconnect 625Ω load from Accessory Port V_{BUS}

13. Set OTG Port V_{BUS} current load to 1500mA.

14. Connect 10Ω load to Accessory Port V_{BUS} line.

15. Check that voltage on Charger V_{BUS} minus Accessory Port V_{BUS} is less than 500mV, allowing for the voltage drop in the test cables. This confirms $R_{ACA\_CHG\_ACC}$ (400mΩ). [MACA27]

Note: The 500mV comprises 400mV across the Charger Switch (2A x 200mΩ), plus 100mV across the Accessory Switch (0.5A x 200mΩ).

Check $R_{ACA\_CHG\_OTG}$

16. Disconnect 10Ω load from Accessory Port V_{BUS} line.

17. Check that voltage on Charger V_{BUS} minus OTG Port V_{BUS} is less than 300mV, allowing for the voltage drop in the test cables. This confirms $R_{ACA\_CHG\_OTG}$ (200mΩ). [MACA26]

18. Set OTG Port V_{BUS} current load to 0mA.

Check Indicator

19. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

20. Wait for response, if ‘Yes’, test passes. If ‘No’ it fails. [MACA3]

Check V_{DP_SRC}

21. Check that voltage on D+ of charger port is V_{DP_SRC} (0.5V-0.7V). [MACA30]

22. Remove 5V from V_{BUS} on charger port.

23. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

24. Disconnect Accessory Port ID pin from ground.

25. Disconnect D+ from D- on charger port.

End of Test

12.9 Nothing attached to Charger Port, Nothing attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Nothing attached to the Charger Port and an A-device attached to accessory port
Description	The PET simulates nothing being attached to the Charger Port of the UUT, and nothing to the Accessory Port of the UUT. Check the resistance to ground of ID pin on OTG Port. Check the resistance between VBUS on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.
Parameters	RID_FLOAT
Checklist	MACA3, MACA11
Pass Criteria	Step 3. Voltage is less than 20mV. (Not mandatory) Step 6. Resistance to ground of ID pin on OTG port is RID_FLOAT. Step 8. Indicator is off.

12.9.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

For now skip to step 4 (See note at start of Section 12)

Check RACA_OTG_ACC

1. Apply 0.75V to VBUS on OTG Port.

Note: Accessory port has 100kΩ to ground on VBUS.

2. Check that voltage on OTG VBUS minus Accessory Port VBUS is less than 20mV. This confirms ability to transmit ADP probes.

NOTE: Transmission of ADP probes is a desirable feature but it is not the intention of the BC Specification that this be mandatory.

3. Disconnect VBUS from OTG port.

Check RID_FLOAT

4. Check that resistance to ground of ID pin on OTG port is RID_FLOAT (> 220 kΩ). [MACA11]

Check Indicator

5. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.

6. Wait for response, if 'No', test passes. If 'Yes' it fails. [MACA3]

End of Test

12.10 Nothing attached to Charger Port, A-device attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Nothing attached to the Charger Port and A-device attached to accessory port
Description	The PET simulates nothing being attached to the Charger Port of the UUT, and an A-device to the Accessory Port of the UUT. Check the resistance to ground of ID pin on OTG Port. Check the resistance between VBUS on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.
Parameters	RID_FLOAT, RACA_OTG_ACC
Checklist	MACA3, MACA14, MACA15
Pass Criteria	Step 2. Resistance to ground of ID pin on OTG port is RID_FLOAT. Step 5. Voltage is less than 100mV. Step 8. Indicator is not on.

12.10.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check RID_ FLOAT

1. Connect 10kΩ pull-down resistor to OTG port VBUS.
2. Check that resistance to ground of ID pin on OTG port is RID_ FLOAT (> 220kΩ). [MACA14]
3. Connect 5V VBUS to Accessory port.
4. Check that resistance to ground of ID pin on OTG port is RID_ FLOAT (> 220kΩ). [MACA15]

For now skip to step 8 (See note at start of Section 12)

Check RACA_OTG_ACC

5. Set OTG Port current load to 500mA.
6. Check that voltage on Accessory VBUS minus OTG Port VBUS is less than 100mV, allowing for the voltage drop in the test cables. This confirms RACA_OTG_ACC (200mΩ)
7. Set OTG Port current load to 0mA.

Check Indicator

8. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

9. Wait for response, if ‘No’, test passes. If ‘Yes’ it fails. [MACA3]

10. Disconnect V_{BUS} from Accessory port.

11. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

End of Test

12.11 Nothing attached to Charger Port, B-device attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Nothing attached to the Charger Port and a B-device attached to accessory port
Description	The PET simulates nothing being attached to the Charger Port of the UUT, and a B-device to the Accessory Port of the UUT. Check the resistance to ground of ID pin on OTG Port. Check the resistance between V_{BUS} on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.
Parameters	R_{ID_GND}, $R_{ACA\_OTG\_ACC}$
Checklist	MACA3, MACA5
Pass Criteria	Step 2. Resistance to ground of ID pin on OTG port is R_{ID_GND}. Step 5. Voltage is less than 100mV Step 8. Indicator is off.

12.11.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No V_{BUS} voltage applied to any port. Switch between D+ and D- to charger port is open.

Check R_{ID_GND}

1. Apply ground to ID pin on accessory port.
2. Check that resistance to ground of ID pin on OTG port is R_{ID_GND} (< 1kΩ). [MACA5]

For now skip to step 7 (See note at start of Section 12)

Check $R_{ACA\_OTG\_ACC}$

3. Connect 5V V_{BUS} to OTG port.
4. Connect Accessory Port 10Ω load.
5. Check that voltage on OTG V_{BUS} minus Accessory Port V_{BUS} is less than 100mV, allowing for the voltage drop in the test cables. This confirms $R_{ACA\_OTG\_ACC}$ (200mΩ)
6. Disconnect Accessory Port 10Ω load.

Check Indicator

7. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.
8. Wait for response, if ‘No’, test passes. If ‘Yes’ it fails. [MACA3]
9. Disconnect V_{BUS} from OTG port.
10. Disconnect ground from ID pin on accessory port.

End of Test

12.12 Bypass Capacitance

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check presence and values of bypass capacitors C_{MACA_VBUS}. **Note:** If the ACA is capable of passing ADP probes from the OTG port to the accessory port when not powered, the capacitance at the OTG port will be seen as a combined capacitance. Therefore the range of capacitance at the OTG port is valid if it lies between 1 μF and 4 μF (2 x C_{MACA_VBUS} max).
Description	The PET simulates necessary conditions for measuring the bypass capacitors on the OTG port and the Accessory port.
Parameters	C_{MACA_VBUS}
Checklist	MACA1, MACA2
Pass Criteria	Step 6. Capacitance is 1-2 μF Step 10. Capacitance is 1-4 μF

12.12.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No V_{BUS} voltage applied to any port. Switch between D+ and D- to charger port is open.

For now skip this test (See note at start of Section 12)

Check Accessory Port Bypass Capacitance:

1. Apply 5V to V_{BUS} on charger port.
2. Connect together D+ and D- on charger port via 200Ω.
3. Check that Accessory port V_{BUS} is less than 0.25V
4. Connect 625R resistor from Accessory port V_{BUS} to ground.
5. Connect 5V to V_{BUS} on Accessory port.
6. Disconnect it and measure fall time as it discharges through the 625R pull-down resistor.
7. Evaluate capacitance from fall time and check it lies within C_{MACA_VBUS} (1 – 2 μF). [MACA2]
8. Disconnect 5V from V_{BUS} on charger port.
9. Disconnect 625R resistor from Accessory port V_{BUS} to ground.
10. Disconnect D+ from D- on charger port.

Check OTG Port Bypass Capacitance:

11. Use ADP circuit components in PET to evaluate OTG port capacitance.

12. Check that this capacitance lies within C_{MACA_VBUS} min and 2 x C_{MACA_VBUS} max (1 – 4 μF). [MACA1]

End of Test

13 Micro-ACA Compliance, Combined Charger

Note: There are some discrepancies in the BC 1.2 Specification with regard to the Micro-ACA. Essentially, these relate to the requirement in Table 6-2 of that document that the Accessory switch be closed, in rows 1-3 (i.e. have a resistance of less than 200mΩ) at a time when there is no power available to the Micro-ACA. The presence and/or required value of C_{MACA_VBUS} capacitor(s) is also related to this. As some further work will be required to resolve this issue, it was decided to release this Compliance Plan with the appropriate parts of the Micro-ACA tests left out, with the intention of adding them as soon as a resolution is found.

This situation has no effect on the Standard-ACA tests.

13.1 Submission Materials

13.1.1 Device Specific Information

Table 13-1 Device Specific Information for Micro-ACAs with Combined Charger

Item	Function	Value/ Support
1	Schematics or other proof that UUT output current cannot exceed 5.0 amperes	
2	The USB-IF TID for the UUT micro-AB receptacle used for the accessory port	
3	The USB-IF TID for the UUT micro-A plug used for the OTG port captive cable	
4	Schematics or other proof that a single UUT failure will not cause the output voltage on V_{BUS} to exceed V_{CHG_FAIL}?	

13.1.2 Checklists

See previous section for Checklist

13.2 PET Cable Calibration

Test Setup	Test Setup 7b. UUT is a Micro-ACA, with combined charger, PET simulates devices on the two ports.
Pre-conditions	This is the first procedure in the Micro-ACA, Combined Charger Test Suite.
Purpose	To calibrate the Test Cables, and to prepare the Micro-ACA for the following tests.
Description	The test operator is instructed to connect the test cables in turn, and these are calibrated. The test operator is then instructed to connect up the Micro-ACA in preparation for the tests.

13.2.1 Test procedure

1. Instruct test operator to plug Special Cable C into PET D-type connector, and the Micro-B plug of the Special Cable C into the PET Micro-AB receptacle, and then click on ‘OK’.

2. PET passes a current of 500mA through the VBUS conductor of the cable, and measures and records the voltage drop.

3. Instruct test operator to unplug the Micro-B plug of the Special Cable C from the PET Micro-AB receptacle, and then click on ‘OK’.

4. Instruct test operator to plug the Micro-B plug of Special Cable C into the Accessory Port of the Micro-ACA under test, and then click on ‘OK’.

5. Instruct test operator to plug the Micro-B plug of the captive OTG cable of the Micro-ACA under test into the PET Micro-AB receptacle, and then click on ‘OK’.

Check that cables are connected:

6. Connect 10kΩ pull-down resistor to OTG port VBUS.

7. Instruct test operator to power up the Micro-ACA under test, and then click on ‘OK’.

8. Apply ground to ID pin on accessory port.

9. Check that we can sense 5V on VBUS on OTG port.

10. Check that we can sense 5V on VBUS on accessory port.

11. Disconnect 10kΩ pull-down resistor from OTG port VBUS.

12. Remove ground from ID pin on accessory port.

13. If test fails report ‘Either cables not correctly connected or UUT is not functioning’.

14. Instruct test operator to perform steps required to bring the Micro-ACA from a powered state to an un-powered one.

15. Wait for operator to click ‘OK’.

End of Test

13.3 Micro-ACA Voltage, Current and Transient Test

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	PET Cable Calibration test has been run.
Purpose	To verify the Micro-ACA meets voltage, current, voltage overshoot and undershoot specifications, for any specified step change in load.
Description	This test measures the V_{BUS} voltage at extremes of load current. It also changes the V_{BUS} current abruptly, and measures the resulting voltage overshoot and undershoot levels.
Parameters	$V_{CHG\_OVERSHT}$, V_{CHG_UNDSHT}, V_{CHG}
Checklist	MACC1, MACC4, MACC5, MACC6, MACC7
Pass Criteria	Step 8 – Latch not triggered Step 10 – Voltage in range Step 14 – Latches not triggered Step 17 – Voltage in range Step 18 – Latches not triggered Step 26 – Latch not triggered Step 28 – Voltage in range Step 32 – Latches not triggered Step 35 – Voltage in range Step 36 – Latches not triggered

13.3.1 Test procedure

Initial State: No load applied.

OTG Port

1. Ensure that Micro-ACA is in an un-powered state.
2. Wait for Micro-ACA OTG port V_{BUS} to fall below V_{BUS_LKG} max (0.7V), in case it has just been switched off. (Speed up fall using 100mA current load.)
3. Connect accessory port ID pin to ground.
4. Set up voltage watch-block ready to capture overshoot of V_{CHG_OVRSHT} (6.0V) on OTG port V_{BUS}.
5. Instruct test operator to perform steps required to bring the Micro-ACA from an un-powered state to a powered one.
6. Wait for operator to click ‘OK’.
7. Wait for Micro-ACA OTG port V_{BUS} to rise above V_{CHG} min (4.75V).
8. Check watch-block overshoot detector latch was not triggered. [MACC1]

9. Set up voltage watch-block ready to capture undershoot of V_{CHG_UNDSHT} (4.1V), or overshoot of V_{CHG_OVRSHT} (6.0V) on Micro-ACA OTG port V_{BUS}.

10. With no current load applied, check that Micro-ACA OTG port V_{BUS} is within appropriate range V_{CHG} (4.75V to 5.25V). [MACC6]

Load Testing OTG port

11. Apply load of I_{CDP} min (1.5A) to Micro-ACA OTG port V_{BUS}.

12. Wait 10ms.

13. Check that Micro-ACA OTG port V_{BUS}, at Micro-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V).

14. Check watch-block overshoot and undershoot detector latches were not triggered. [MACC1] [MACC4]

15. Remove Current Load.

16. Wait 10ms

17. Check that V_{BUS} voltage from Micro-ACA accessory port V_{BUS}, at Micro-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V). [MACC6]

18. Check watch-block overshoot and undershoot detector latches were not triggered. [MACC1] [MACC4]

19. Instruct test operator to perform steps required to bring the Micro-ACA from a powered state to an un-powered one.

20. Wait for operator to click ‘OK’.

Accessory Port

21. Wait for Micro-ACA accessory port V_{BUS} to fall below V_{BUS_LKG} max (0.7V). (Speed up fall using 10R resistive load.)

22. Set up voltage watch-block ready to capture overshoot of V_{CHG_OVRSHT} (6.0V) on accessory port V_{BUS}.

23. Instruct test operator to perform steps required to bring the Micro-ACA from an un-powered state to a powered one.

24. Wait for operator to click ‘OK’.

25. Wait for Micro-ACA OTG port V_{BUS} to rise above V_{CHG} min (4.75V).

26. Check watch-block overshoot detector latch was not triggered. [MACC1]

27. Set up voltage watch-block ready to capture undershoot of V_{CHG_UNDSHT} (4.1V), or overshoot of V_{CHG_OVRSHT} (6.0V) on Micro-ACA accessory port V_{BUS}, allowing for voltage drop in cable.

28. With no current load applied, check that Micro-ACA accessory port V_{BUS} is within appropriate range V_{CHG} (4.75V to 5.25V). [MACC7]

Load Testing Accessory port

29. Apply load of I_{CFG_MAX} (500mA) to Micro-ACA accessory port V_{BUS}.

30. Wait 10ms.

31. Check that Micro-ACA accessory port V_{BUS}, at Micro-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable.

32. Check watch-block overshoot and undershoot detector latches were not triggered. [MACC1] [MACC5]

33. Remove Current Load.

34. Wait 10ms

35. Check that V_{BUS} voltage from Micro-ACA accessory port V_{BUS}, at Micro-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range $V_{CHG} - R_{ACA\_OTG\_ACC} \times I_{CFG\_MAX}$ (4.65V to 5.25V). [MACC7]

36. Check watch-block overshoot and undershoot detector latches were not triggered. [MACC1] [MACC5]

37. Instruct test operator to perform steps required to bring the Micro-ACA from a powered state to an un-powered one.

38. Wait for operator to click ‘OK’.

End of Test

13.4 Micro-ACA Not Powered, Nothing attached to Accessory Port

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA not powered and nothing attached to accessory port
Description	The PET simulates nothing being attached to the Accessory Port of the UUT. Checks the resistance to ground of ID pin on OTG Port. Checks the resistance between VBUS on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.
Parameters	RID_FLOAT
Checklist	MACA3, MACA11
Pass Criteria	Step 3. Voltage is less than 20mV. (Not mandatory) Step 6. Resistance to ground of ID pin on OTG port is RID_FLOAT. Step 8. Indicator is off.

13.4.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to any port. ACA is not powered. Accessory port ID pin is floating.

1. Ensure that Micro-ACA is in an un-powered state.

For now skip to step 5 (See note at start of Section 13)

Check RACA_OTG_ACC

2. Apply 0.75V to VBUS on OTG Port.

Note: Accessory port has 100kΩ to ground on VBUS.

3. Check that voltage on OTG VBUS minus Accessory Port VBUS is less than 20mV. This confirms ability to transmit ADP probes.

NOTE: Transmission of ADP probes is a desirable feature but it is not the intention of the BC Specification that this be mandatory.

4. Disconnect VBUS from OTG port.

Check RID_FLOAT

5. Check that resistance to ground of ID pin on OTG port is RID_FLOAT (> 220 kΩ). [MACA11]

Check Indicator

6. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

7. Wait for response, if ‘No’, test passes. If ‘Yes’ it fails. [MACA3]

End of Test

13.5 Micro-ACA Not Powered, A-device attached to Accessory Port

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA not powered and A-device attached to accessory port
Description	The PET simulates an A-device being attached to the Accessory Port of the UUT. Checks the resistance to ground of ID pin on OTG Port. Checks the resistance between V_{BUS} on the OTG Port, and on the Accessory Port. Checks correct functioning of the Indicator.
Parameters	R_{ID_FLOAT}, $R_{ACA\_OTG\_ACC}$
Checklist	MACA3, MACA13, MACA14
Pass Criteria	Step 3. Resistance to ground of ID pin on OTG port is R_{ID_FLOAT}. Step 7. Voltage is less than 100mV. Step 10. Indicator is not on.

13.5.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No V_{BUS} voltage applied to any port. ACA is not powered. Accessory port ID pin is floating.

1. Ensure that Micro-ACA is in an un-powered state.

Check R_{ID_FLOAT}

2. Connect 10kΩ pull-down resistor to OTG port V_{BUS}.
3. Check that resistance to ground of ID pin on OTG port is R_{ID_FLOAT} (> 220kΩ). [MACA13]
4. Connect 5V V_{BUS} to Accessory port.
5. Check that resistance to ground of ID pin on OTG port is R_{ID_FLOAT} (> 220kΩ). [MACA14]

For now skip to step 9 (See note at start of Section 13)

Check $R_{ACA\_OTG\_ACC}$

6. Set OTG Port current load to 500mA.
7. Check that voltage on Accessory V_{BUS} minus OTG Port V_{BUS} is less than 100mV, allowing for the voltage drop in the test cables. This confirms $R_{ACA\_OTG\_ACC}$ (200mΩ)
8. Set OTG Port current load to 0mA.

Check Indicator

9. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

10. Wait for response, if ‘No’, test passes. If ‘Yes’ it fails. [MACA3]

11. Disconnect VBUS from Accessory port.

12. Disconnect 10kΩ pull-down resistor from OTG port VBUS.

End of Test

13.6 Micro-ACA Not Powered, B-device attached to Accessory Port

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA not powered and a B-device attached to accessory port
Description	The PET simulates a B-device being attached to the Accessory Port of the UUT. Checks the resistance to ground of ID pin on OTG Port. Checks the resistance between VBUS on the OTG Port, and on the Accessory Port. Checks correct functioning of the Indicator.
Parameters	RID_GND, RACA_OTG_ACC
Checklist	MACA3, MACA5, MACA28
Pass Criteria	Step 2. Resistance to ground of ID pin on OTG port is RID_ GND. Step 5. Voltage is less than 100mV Step 8. Indicator is off.

13.6.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to any port. ACA is not powered. Accessory port ID pin is floating.

1. Ensure that Micro-ACA is in an un-powered state.

Check RID_GND

2. Apply ground to ID pin on accessory port.

3. Check that resistance to ground of ID pin on OTG port is RID_GND (< 1kΩ). [MACA5]

For now skip to step 8 (See note at start of Section 13)

Check RACA_OTG_ACC

4. Connect 5V VBUS to OTG port.

5. Connect Accessory Port 10Ω load.

6. Check that voltage on OTG VBUS minus Accessory Port VBUS is less than 100mV, allowing for the voltage drop in the test cables. This confirms RACA_OTG_ACC (200mΩ). [MACA28]

7. Disconnect Accessory Port 10Ω load.

Check Indicator

8. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

9. Wait for response, if ‘No’, test passes. If ‘Yes’ it fails. [MACA3]

10. Disconnect V_{BUS} from OTG port.

11. Disconnect ground from ID pin on accessory port.

End of Test

13.7 Micro-ACA Powered Up, Nothing attached to Accessory Port

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA powered and Nothing attached to accessory port
Description	The PET simulates nothing being attached to the Accessory Port of the UUT. Checks whether VBUS comes from the OTG Port or the Accessory Port. Checks the resistance to ground of ID pin on OTG Port. Checks correct functioning of the Indicator.
Parameters	RID_B, RACA_CHG_OTG
Checklist	MACA3, MACA8
Pass Criteria	Step. VBUS is not coming from the Accessory port. Step. VBUS is coming from the OTG port. Step. Less than 2.5mA is being drawn by the charger port. Step. Voltage is less than 300mV Step. Resistance to ground of ID pin on OTG port is RID_B. Step. Indicator is on. Step. Voltage is 0.5V-0.7V.

13.7.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to any port. ACA is not powered. Accessory port ID pin is floating.

1. Instruct test operator to perform steps required to bring the Micro-ACA from an un-powered state to a powered one.
2. Wait for operator to click ‘OK’.
3. Ensure that Micro-ACA is in a powered state.

Check Switching Functionality:

4. Connect 10kΩ pull-down resistor to OTG port VBUS.
5. Check that VBUS is not coming from the accessory port. i.e. Check that accessory port VBUS is less than VOTG_VBUS_LKG (0.7V)
6. Check that VBUS is coming from the OTG port. i.e. Check that OTG port VBUS is greater than 4.75V.

Check RID_B

7. Check that resistance to ground of ID pin on OTG port is RID_B (67-69 kΩ). [MACA8]

Check Indicator

8. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

9. Wait for response, if ‘Yes’, test passes. If ‘No’ it fails. [MACA3]

10. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

End of Test

13.8 Micro-ACA Powered Up, A-device attached to Accessory Port

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA powered and A-device attached to accessory port
Description	The PET simulates an A-device being attached to the Accessory Port of the UUT. Checks whether V_{BUS} comes from the OTG port. Checks the resistance to ground of ID pin on OTG Port. Checks correct functioning of the Indicator.
Parameters	R_{ID_C}, I_{SUSP}
Checklist	MACA3, MACA9, MACA10
Pass Criteria	Step. V_{BUS} is coming from the OTG port. Step. Resistance to ground of ID pin on OTG port is R_{ID_B}. Step. Resistance to ground of ID pin on OTG port is R_{ID_C}. Step. Indicator is on. Step. Current is < 2.5mA Step. Voltage is 0.5V-0.7V.

13.8.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No V_{BUS} voltage applied to any port. ACA is powered. Accessory port ID pin is floating.

1. Ensure that Micro-ACA is in a powered state.

Check Switching Functionality:

2. Connect 10kΩ pull-down resistor to OTG port V_{BUS}.

3. Apply 0V to V_{BUS} on Accessory Port.

4. Check that V_{BUS} is coming from the OTG port. i.e. Check that OTG port V_{BUS} is greater than 4.75V.

Check R_{ID_B} and R_{ID_C}

5. Check that resistance to ground of ID pin on OTG port is R_{ID_B} (67-69 kΩ). [MACA9]

6. Apply 5V to V_{BUS} on Accessory Port.

7. Check that resistance to ground of ID pin on OTG port is R_{ID_C} (36-37 kΩ). [MACA10]

Check Indicator

8. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

9. Wait for response, if ‘Yes’, test passes. If ‘No’ it fails. [MACA3]

Check Current From Accessory Port

10. Set OTG Port V_{BUS} current load to 10 mA.
11. Measure current from V_{BUS} generator.
12. Disconnect V_{BUS} from Accessory Port.
13. Measure current from V_{BUS} generator and subtract from previous measurement.
14. Check that difference is less than I_{SUSP} (2.5mA).
15. Set OTG Port V_{BUS} current load to zero.
16. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

End of Test

13.9 Micro-ACA Powered Up, B-device attached to Accessory Port

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA powered and B-device attached to accessory port
Description	The PET simulates a B-device being attached to the Accessory Port of the UUT. Checks whether VBUS comes from the OTG Port or the Accessory Port. Checks the resistance to ground of ID pin on OTG Port. Checks correct functioning of the Indicator.
Parameters	RID_A, VACA_OPR, VACA_DIS, RACA_CHG_ACC, RACA_CHG_OTG
Checklist	MACA3, MACA7
Pass Criteria	Step 5. VBUS is coming from the Accessory port. Step 6. VBUS is coming from the OTG port. Step 7. Resistance to ground of ID pin on OTG port is RID_A. Step 9. Indicator is on.

13.9.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to any port. ACA is powered. Accessory port ID pin is floating.

1. Ensure that Micro-ACA is in a powered state.

Check Switching Functionality:

2. Connect 10kΩ pull-down resistor to OTG port VBUS.
3. Connect Accessory Port ID pin to ground.
4. Connect 625Ω load on Accessory Port VBUS
5. Check that VBUS is coming from the Accessory port. i.e. Check that Accessory port VBUS is greater than 4.75V.
6. Check that VBUS is coming from the OTG port. i.e. Check that OTG port VBUS is greater than 4.75V.

Check RID_A

7. Check that resistance to ground of ID pin on OTG port is RID_A (122-126 kΩ). [MACA7]

Check Indicator

8. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.
9. Wait for response, if ‘Yes’, test passes. If ‘No’ it fails. [MACA3]
10. Disconnect 10kΩ pull-down resistor from OTG port VBUS.

11. Disconnect Accessory Port ID pin from ground.

End of Test

13.10 Bypass Capacitance

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Checks presence and values of bypass capacitors C_{MACA_VBUS}. **Note:** If the ACA is capable of passing ADP probes from the OTG port to the accessory port when not powered, the capacitance at the OTG port will be seen as a combined capacitance. Therefore the range of capacitance at the OTG port is valid if it lies between 1 μF and 4 μF (2 x C_{MACA_VBUS} max).
Description	The PET simulates necessary conditions for measuring the bypass capacitors on the OTG port and the Accessory port.
Parameters	C_{MACA_VBUS}
Checklist	MACA1, MACA2
Pass Criteria	Step 6. Capacitance is 1-2 μF Step 10. Capacitance is 1-4 μF

13.10.1 Test procedure

For now skip this test (See note at start of Section 13)

Initial State: The PET is connected to both ports of ACA. No V_{BUS} voltage applied to any port. ACA is powered. Accessory port ID pin is floating.

1. Ensure that Micro-ACA is in a powered state.

Check Accessory Port Bypass Capacitance:

2. Check that Accessory port VBUS is less than 0.25V
3. Connect 625R resistor from Accessory port VBUS to ground.
4. Connect 5V to V_{BUS} on Accessory port.
5. Disconnect it and measure fall time as it discharges through the 625R pull-down resistor.
6. Evaluate capacitance from fall time and check it lies within C_{MACA_VBUS} (1 – 2 μF). [MACA2]
7. Disconnect 625R resistor from Accessory port V_{BUS} to ground.

Check OTG Port Bypass Capacitance:

8. Instruct test operator to perform steps required to bring the Micro-ACA from a powered state to an un-powered one.
9. Wait for operator to click ‘OK’.

10. Use ADP circuit components in PET to evaluate OTG port capacitance.

11. Check that this capacitance lies within C_{MACA_VBUS} min and 2 x C_{MACA_VBUS} max (1 – 4 μF). [MACA1]

End of Test

14 Standard-ACA Compliance, Separate Charger

14.1 Submission Materials

14.1.1 Device Specific Information

Table 14-1 Device Specific Information for Standard-ACAs with Separate Charger

Item	Function	Value/ Support
1	The USB-IF TID for the UUT standard-A receptacle used for the accessory port	
2	The USB-IF TID for the UUT micro-A plug used for the OTG port captive cable	
3	The USB-IF TID for the UUT standard-A plug or micro-B receptacle used for the charger port	

14.1.2 Checklists

Table 14-2 Checklist for Standard-ACAs

Question		Response	Test Number	BC 1.2 Section Number
Questions relating to all Standard-ACAs				
SACA1	Does the UUT have a capacitance from V_{BUS} to ground of C_{MACA_VBUS} on its OTG or accessory port?	Yes ☐ No ☐	12.12	6.2.6
SACA2	Does the ACA have an indicator showing when the charger port is able to supply power to the other ports?	Yes ☐ No ☐	12.3 - 012.11	6.1
SACA3	Is the Charger Port on the UUT clearly labeled 'Charger Only'? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	Inspection	6.1
SACA4	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_GND} when nothing is connected to its charger port, and a B-device is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_GND} when the unit is not connected to a power source and a B-device is connected to its accessory port?	Yes ☐ No ☐	012.11	4.5.3

SACA5	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_GND} when an SDP is connected to its charger port, and a B-device is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.5	4.5.3
SACA6	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_A} when a DCP or a CDP is connected to its charger port, and a B-device is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_A} when the unit is connected to a power source, and a B-device is connected to its accessory port?	Yes ☐ No ☐	12.8	4.5.3
SACA7	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_A} when a DCP or a CDP is connected to its charger port, and nothing is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_A} when the unit is connected to a power source, and nothing is connected to its accessory port?	Yes ☐ No ☐	12.6	4.5.3
SACA8	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_GND} when nothing is connected to its charger port, and nothing is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_GND} when the unit is not connected to a power source, and nothing is connected to its accessory port?	Yes ☐ No ☐	12.9	4.5.3

SACA9	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_GND} when an SDP is connected to its charger port, and nothing is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.3	4.5.3
SACA10	Does the UUT directly connect the data pins of the OTG port directly to the data pins of the accessory port?	Yes ☐ No ☐	Vendor Declaration	4.5.3
SACA11	Does the UUT directly connect V_{BUS} of the OTG port directly to V_{BUS} of the accessory port?	Yes ☐ No ☐	Vendor Declaration	6.3.3
SACA12	Does the UUT have a captive cable terminated with a Micro-A plug on its OTG port?	Yes ☐ No ☐	Inspection	4.5.4
SACA13	Does the Micro-A plug have a valid TID?	Yes ☐ No ☐	Vendor Declaration	
SACA14	Does the UUT have a Standard-A receptacle on its accessory port?	Yes ☐ No ☐	Inspection	6.1
SACA15	Does the Standard-A receptacle have a valid TID?		Vendor Declaration	
SACA16	Does the UUT Charger Port have a Micro-B receptacle, a captive cable terminated with a Standard-A plug, or a captive cable terminated with a Charger (or combined Charger)?	Micro-B ☐ Standard-A ☐ Charger ☐ No ☐	Inspection	6.2.1
SACA17	If the Charger Port has a Micro-B receptacle or a Standard-A plug, does this have a valid TID? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	Vendor Declaration	
SACA18	Does the UUT charger port draw less than I_{SUSP} when anything other than a charging port is attached to it? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.3, 12.4, 12.5	6.2.6

SACA19	Does the UUT charger port draw less than I_{SUSP} when a charging port is attached to it, and nothing is attached to the OTG port or accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.6	6.2.6
SACA20	Is the resistance between VBUS_CHG and either VBUS_OTG pins or VBUS_ACC of the UUT, $R_{ACA\_CHG\_OTG}$ when the charger switch is closed, and the voltage on V_{BUS_CHG} is V_{ACA_OPR} ? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.6	6.2.6
SACA21	Is the resistance between the internal ground of the UUT and the ground pin of the Micro-AB receptacle attached to the OTG port of the UUT, $R_{OTG\_ACA\_GND}$?	Yes ☐ No ☐	Vendor Declaration	6.2.6
SACA22	Does the UUT output V_{DP_SRC} on DP_CHG when it detects VBUS_CHG? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.8	6.2.6
SACA23	Does the UUT close its charger switch when it detects DN_CHG greater than V_{DAT_REF} and VBUS_CHG remains above $V_{OTG\_SESS\_VLD}$? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.8	6.2.6
Questions specific to Standard-ACAs with Combined Charger				
SACC1	Is the output voltage of the UUT less than V_{CHG_OVRSHT} max for any step change in load current, and also when powering on or off? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4.1.1
SACC2	Is the output current of the UUT prevented from exceeding I_{CDP} max under any condition? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐	Vendor Declaration	4.1.2

SACC3	Has it has been shown, using schematics or by some other explanation, that in the case of a single failure in the UUT, the output voltage on V_{BUS} will not exceed V_{CHG_FAIL}? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐	Vendor Declaration	4.1.5
SACC4	Is the output voltage of the UUT OTG port greater than V_{CHG_UNDSHT} min for any step change in load current where current is less than I_{CDP} min? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4.5.2
SACC5	Is the output voltage of the UUT Accessory port greater than V_{CHG_UNDSHT} min for any step change in load current where current is less than I_{CFG_MAX}? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4.5.2
SACC6	Does the UUT output a voltage of VCHG (averaged over T_{VBUS_AVG}) for all currents less than I_{CDP} min on its OTG port? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4
SACC7	Does the UUT output a voltage of VCHG (averaged over T_{VBUS_AVG}) allowing for a drop across $R_{ACA\_OTG\_ACC}$ for all currents less than 500mA on its ACC port? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4
SACC8	If the UUT goes into shutdown during a current overload condition, does it recover and output a voltage of V_{CHG} within a time of T_{SHTDWN_REC} when the current overload condition has been removed.	Yes ☐ No ☐	Vendor Declaration	4.2.2

14.2 PET Cable Calibration

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	This is the first procedure in the Standard-ACA Test Suite.
Purpose	To calibrate the Test Cables, and to prepare the Standard-ACA for the following tests.
Description	The test operator is instructed to connect the test cables in turn, and these are calibrated. The test operator is then instructed to connect up the Standard-ACA in preparation for the tests.

14.2.1 Test procedure

1. Instruct test operator to plug Special Cable D into PET D-type connector, and the Standard-A plug of the Special Cable D into the Standard-A receptacle of the Special Cable D, and then click on ‘OK’.

2. PET passes a current of 500mA through the VBUS conductor of the cable, and measures and records the voltage drop.

3. Instruct test operator to unplug Standard-A plug of the Special Cable D from the Standard-A receptacle of the Special Cable D, and then click on ‘OK’.

4. If ‘Captive Cable’ checkbox is checked, skip to step 9.

5. Instruct test operator to plug Special Cable B into the Standard-A receptacle of Special Cable D, and the Micro-B plug of the Special Cable B into the PET Micro-AB receptacle, and then click on ‘OK’.

6. PET passes a current of 500mA through the VBUS conductor of the cable, and measures and records the voltage drop.

7. PET passes a current of 1500mA through the VBUS conductor of the cable, and measures and records the voltage drop.

8. Instruct test operator to unplug the Micro-B plug of the Special Cable B from the PET Micro-AB receptacle, and then click on ‘OK’.

9. Instruct test operator to plug the Standard-A plug of Special Cable D into the Accessory Port of the Standard-ACA under test, and then click on ‘OK’.

10. Instruct test operator to plug the Micro-B plug of the captive OTG cable of the Standard-ACA under test into the PET Micro-AB receptacle, and then click on ‘OK’.

11. **With Captive Charger Cable**
    Instruct test operator to plug the Standard-A plug of the captive Charger cable of the Standard-ACA under test into the Standard-A receptacle of Special Cable D, and then click on ‘OK’.

    With No Captive Charger Cable
    Instruct test operator to plug the Micro-B plug of Special Cable B into the Charger port of the Standard-ACA under test, and then click on ‘OK’.

Check that cables are connected:

12. Connect 10kΩ pull-down resistor to OTG port V_{BUS}.
13. Apply 5V to V_{BUS} on charger port.
14. Connect together D+ and D- on charger port via 200R.
15. Check that we can sense 5V on V_{BUS} on OTG port.
16. Check that we can sense 5V on V_{BUS} on accessory port.
17. Remove 5V from V_{BUS} on charger port.
18. Disconnect D+ from D- on charger port.
19. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.
20. If test fails report 'Either cables not correctly connected or accessory port ID pin not functioning'.

End of Test

14.3 SDP attached to Charger Port, Nothing attached to Accessory Port

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with SDP attached to the Charger Port and Nothing attached to accessory port
Description	The PET simulates an SDP being attached to the Charger Port of the UUT, and nothing to the Accessory Port of the UUT. Check whether V_{BUS} comes from the OTG port or the Accessory Port. Check the resistance to ground of ID pin on OTG port. Check the current drawn by the Charger Port. Check correct functioning of the Indicator.
Parameters	R_{ID_GND}, I_{SUSP}
Checklist	SACA2, SACA9, SACA18
Pass Criteria	Step 3. V_{BUS} is not coming from the Accessory port. Step 4. V_{BUS} is not coming from the OTG port. Step 5. Resistance to ground of ID pin on OTG port is R_{ID_GND}. Step 7. Indicator is off. Step 8. UUT is drawing less than I_{SUSP} from the charger port

14.3.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No V_{BUS} voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port V_{BUS}.
2. Apply 5V to V_{BUS} on charger port.
3. Check that V_{BUS} is not coming from the Accessory port. i.e. Check that Accessory port V_{BUS} is less than $V_{OTG\_VBUS\_LKG}$ (0.7V)
4. Check that V_{BUS} is not coming from the OTG port. i.e. Check that OTG port V_{BUS} is less than $V_{OTG\_VBUS\_LKG}$ (0.7V)

Check R_{ID_GND}

5. Check that resistance to ground of ID pin on OTG port is R_{ID_GND} (< 1 kΩ). [SACA9]

Check Indicator

6. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.
7. Wait for response, if 'Yes', test fails. If 'No' it passes. [SACA2]

Check Current Drawn by UUT Charger Port

8. Check that the UUT is drawing less than I_{SUSP} (2.5mA) from the charger port. [SACA18]

9. Remove 5V from V_{BUS} on charger port.

10. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

End of Test

14.4 SDP attached to Charger Port, B-device attached to Accessory Port

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with SDP attached to the Charger Port and B-device attached to accessory port
Description	The PET simulates an SDP being attached to the Charger Port of the UUT, and a B-device to the Accessory Port of the UUT. Check whether V_{BUS} comes from the OTG port or the Accessory Port. Check the resistance to ground of ID pin on OTG port. Check the current drawn by the Charger Port. Check correct functioning of the Indicator.
Parameters	R_{ID_GND}, I_{SUSP}
Checklist	SACA2, SACA5
Pass Criteria	Step 4. V_{BUS} is not coming from the Accessory port. Step 5. V_{BUS} is not coming from the OTG port. Step 6. Resistance to ground of ID pin on OTG port is R_{ID_GND}. Step 8. Indicator is off. Step 11. Voltage is less than 100mV Step 16. UUT is drawing less than I_{SUSP} from the charger port

14.4.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No V_{BUS} voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port V_{BUS}.
2. Apply 5V to V_{BUS} on charger port.
3. Check that V_{BUS} is not coming from the Accessory port. i.e. Check that Accessory port V_{BUS} is less than $V_{OTG\_VBUS\_LKG}$ (0.7V).
4. Check that V_{BUS} is not coming from the OTG port. i.e. Check that OTG port V_{BUS} is less than $V_{OTG\_VBUS\_LKG}$ (0.7V)

Check R_{ID_GND}

5. Check that resistance to ground of ID pin on OTG port is R_{ID_GND} (< 1kΩ). [SACA5]

Check Indicator

6. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.
7. Wait for response, if ‘Yes’, test fails. If ‘No’ it passes. [SACA2]

Check $R_{ACA\_OTG\_ACC}$

8. Apply 5V V_{BUS} to OTG port

9. Connect 10Ω load to Accessory port V_{BUS} line

10. Check that voltage on OTG V_{BUS} minus Accessory port V_{BUS} is less than 100mV, allowing for the voltage drop in the test cables. This confirms that a VBUS path exists from OTG port to Accessory port.

11. Remove 10Ω load from accessory port V_{BUS} line.

Check Current Drawn by UUT Charger Port

12. Connect 625Ω load to Accessory Port V_{BUS} line.

13. Measure current drawn from V_{BUS} generator.

14. Disconnect V_{BUS} from Charger Port.

15. Check that current drops by less than I_{SUSP} (2.5mA)

16. Remove 5V from V_{BUS} on OTG port.

17. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

18. Disconnect 625Ω load from Accessory Port V_{BUS} line.

End of Test

14.5 DCP or CDP attached to Charger Port, Nothing attached to Accessory Port

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Charger attached to the Charger Port and Nothing attached to accessory port
Description	The PET simulates a Charger being attached to the Charger Port of the UUT, and nothing to the Accessory Port of the UUT. Check whether V_{BUS} comes from the OTG Port or the Accessory Port. Check the resistance to ground of ID pin on OTG Port. Check the resistance between VBUS on the Charger Port, and on the OTG Port. Check correct functioning of the Indicator. Check UUT outputs V_{DP_SRC} on Charger Port D+.
Parameters	R_{ID_A}, $R_{ACA\_CHG\_OTG}$, V_{DP_SRC}
Checklist	SACA2, SACA7, SACA19, SACA20, SACA22, SACA23
Pass Criteria	Step 4. V_{BUS} is coming from the Accessory port. Step 5. V_{BUS} is coming from the OTG port. Step 6. Less than 2.5mA is being drawn by the charger port. Step 8. Voltage is less than 300mV Step 10. Resistance to ground of ID pin on OTG port is R_{ID_A}. Step 12. Indicator is on. Step 13. Voltage is 0.5V-0.7V.

14.5.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No V_{BUS} voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port V_{BUS}.
2. Apply 5V to V_{BUS} on charger port.
3. Connect together D+ and D- on charger port via 200R.
4. Check that V_{BUS} is coming from the Accessory port. i.e. Check that Accessory port V_{BUS} is greater than 4.75V.
5. Check that V_{BUS} is coming from the OTG port. i.e. Check that OTG port V_{BUS} is greater than 4.75V. [SACA23]
6. Check that less than I_{SUSP} max (2.5mA) is being drawn by charger port. [SACA19]

Check $R_{ACA\_CHG\_OTG}$

7. Set OTG Port V_{BUS} current load to 1500mA.

8. Check that voltage on Charger V_{BUS} minus OTG Port V_{BUS} is less than 300mV, allowing for the voltage drop in the test cables. This confirms $R_{ACA\_CHG\_OTG}$ (200mΩ). [SACA20]

9. Set OTG Port V_{BUS} current load to 0mA.

Check R_{ID_A}

10. Check that resistance to ground of ID pin on OTG port is R_{ID_A} (122-126 kΩ). [SACA7]

Check Indicator

11. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

12. Wait for response, if ‘Yes’, test passes. If ‘No’ it fails. [SACA2]

Check V_{DP_SRC}

13. Check that voltage on D+ of charger port is V_{DP_SRC} (0.5V-0.7V). [SACA22]

14. Remove 5V from V_{BUS} on charger port.

15. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

16. Disconnect D+ from D- on charger port.

End of Test

14.6 DCP or CDP attached to Charger Port, B-device attached to Accessory Port

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Charger attached to the Charger Port and B-device attached to accessory port
Description	The PET simulates a Charger being attached to the Charger Port of the UUT, and a B-device to the Accessory Port of the UUT. Check whether V_{BUS} comes from the OTG Port or the Accessory Port. Check the resistance to ground of ID pin on OTG Port. Check the resistance between V_{BUS} on the Charger Port, and on the OTG Port. Check the resistance between V_{BUS} on the Charger Port, and on the Accessory Port. Check correct functioning of the Indicator. Check UUT outputs V_{DP_SRC} on Charger Port D+.
Parameters	R_{ID_A}, V_{ACA_OPR}, V_{ACA_DIS}, $R_{ACA\_CHG\_ACC}$, $R_{ACA\_CHG\_OTG}$, V_{DP_SRC}
Checklist	SACA2, SACA6
Pass Criteria	Step 5. V_{BUS} is coming from the Accessory port. Step 6. V_{BUS} is coming from the OTG port. Step 7. Resistance to ground of ID pin on OTG port is R_{ID_A}. Steo 9. V_{BUS} is coming from the Accessory port. Step 10. V_{BUS} is coming from the OTG port. Step 13. Voltage is less than 100mV Step 16. Indicator is on. Step 17. Voltage is > 0.5V-0.7V.

14.6.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No V_{BUS} voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port V_{BUS}.

2. Apply 5V to V_{BUS} on charger port.

3. Connect together D+ and D- on charger port via 200R.

4. Connect 625Ω load on Accessory Port V_{BUS}

5. Check that V_{BUS} is coming from the Accessory port. i.e. Check that Accessory port V_{BUS} is greater than 4.75V.

6. Check that V_{BUS} is coming from the OTG port. i.e. Check that OTG port V_{BUS} is greater than 4.75V.

Check R_{ID_A}

7. Check that resistance to ground of ID pin on OTG port is R_{ID_A} (122-126 kΩ). [SACA6]

Check V_{ACA_OPR}

8. Change V_{BUS} generator voltage to V_{ACA_OPR} min (4.1V).

9. Check that V_{BUS} is coming from the Accessory port. i.e. Check that Accessory port V_{BUS} is greater than 3.85V.

10. Check that V_{BUS} is coming from the OTG port. i.e. Check that OTG port V_{BUS} is greater than 3.85V.

Check $R_{ACA\_CHG\_ACC}$

11. Disconnect 625Ω load from Accessory Port V_{BUS}

12. Connect 10Ω load to Accessory Port V_{BUS} line.

13. Check that voltage on Charger V_{BUS} minus Accessory Port V_{BUS} is less than 100mV, allowing for the voltage drop in the test cables. This confirms $R_{ACA\_CHG\_ACC}$ (200mΩ).

14. Disconnect 10Ω load from Accessory Port V_{BUS} line.

Check Indicator

15. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated. [SACA2]

16. Wait for response, if 'Yes', test passes. If 'No' it fails.

Check V_{DP_SRC}

17. Check that voltage on D+ of charger port is V_{DP_SRC} (0.5V-0.7V).

18. Remove 5V from V_{BUS} on charger port.

19. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

20. Disconnect D+ from D- on charger port.

End of Test

14.7 Nothing attached to Charger Port, Nothing attached to Accessory Port

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Nothing attached to the Charger Port and an nothing attached to accessory port
Description	The PET simulates nothing being attached to the Charger Port of the UUT, and nothing to the Accessory Port of the UUT. Check the resistance to ground of ID pin on OTG Port. Check the resistance between VBUS on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.
Parameters	R_{ID_GND}
Checklist	SACA2, SACA8
Pass Criteria	Step 2. Voltage is less than 20mV. Step 4. Resistance to ground of ID pin on OTG port is R_{ID_GND}. Step 6. Indicator is off.

14.7.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No V_{BUS} voltage applied to any port. Switch between D+ and D- to charger port is open.

Check $R_{ACA\_OTG\_ACC}$

1. Apply 0.75V to V_{BUS} on OTG Port.

Note: Accessory port has 100kΩ to ground on V_{BUS}.

2. Check that voltage on OTG V_{BUS} minus Accessory Port V_{BUS} is less than 20mV. This confirms ability to transmit ADP probes.

3. Disconnect VBUS from OTG port.

Check R_{ID_GND}

4. Check that resistance to ground of ID pin on OTG port is R_{ID_GND} (< 1kΩ). [SACA8]

Check Indicator

5. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

6. Wait for response, if ‘No’, test passes. If ‘Yes’ it fails. [SACA2]

End of Test

14.8 Nothing attached to Charger Port, B-device attached to Accessory Port

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Nothing attached to the Charger Port and a B-device attached to accessory port
Description	The PET simulates nothing being attached to the Charger Port of the UUT, and a B-device to the Accessory Port of the UUT. Check the resistance to ground of ID pin on OTG Port. Check the resistance between VBUS on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.
Parameters	RID_GND
Checklist	SACA2, SACA4
Pass Criteria	Step 1. Resistance to ground of ID pin on OTG port is RID_ GND. Step 4. Voltage is less than 100mV Step 7. Indicator is off.

14.8.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check RID_GND

1. Check that resistance to ground of ID pin on OTG port is RID_GND (< 1kΩ). [SACA4]

Check RACA_OTG_ACC

2. Connect 5V VBUS to OTG port.

3. Connect Accessory Port 10Ω load.

4. Check that voltage on OTG VBUS minus Accessory Port VBUS is less than 100mV, allowing for the voltage drop in the test cables. This confirms that a VBUS path exists from OTG port to Accessory port.

5. Disconnect Accessory Port 10Ω load.

Check Indicator

6. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

7. Wait for response, if ‘No’, test passes. If ‘Yes’ it fails. [SACA2]

8. Disconnect VBUS from OTG port.

End of Test

14.9 Bypass Capacitance

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check presence and values of bypass capacitor C_{SACA_VBUS}.
Description	The PET simulates necessary conditions for measuring the bypass capacitor on the OTG / Accessory port.
Parameters	C_{SACA_VBUS}
Checklist	SACA1
Pass Criteria	Step 4. Capacitance is 10-100nF

14.9.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No V_{BUS} voltage applied to any port. Switch between D+ and D- to charger port is open.

Check OTG Port Bypass Capacitance:

1. Use ADP circuit components in PET to evaluate capacitance on OTG port V_{BUS}.
2. Check that this capacitance lies within C_{SACA_VBUS} min and C_{SACA_VBUS} max (10 – 100 nF). [SACA1]

End of Test

15 Standard-ACA Compliance, Combined Charger

15.1 Submission Materials

15.1.1 Device Specific Information

Table 15-1 Device Specific Information for Standard-ACAs with Combined Charger

Item	Function	Value/ Support
1	Schematics or other proof that UUT output current cannot exceed 5.0 amperes	
2	The USB-IF TID for the UUT standard-A receptacle used for the accessory port	
3	The USB-IF TID for the UUT micro-A plug used for the OTG port captive cable	
4	Schematics or other proof that a single UUT failure will not cause the output voltage on V_{BUS} to exceed V_{CHG_FAIL}?	

15.1.2 Checklists

See previous section for submission Materials.

15.2 PET Cable Calibration

Test Setup	Test Setup 8b. UUT is a Standard-ACA, with combined charger, PET simulates devices on the two ports.
Pre-conditions	This is the first procedure in the Standard-ACA, Combined Charger Test Suite.
Purpose	To calibrate the Test Cables, and to prepare the Standard-ACA for the following tests.
Description	The test operator is instructed to connect the test cables in turn, and these are calibrated. The test operator is then instructed to connect up the Standard-ACA in preparation for the tests.

15.2.1 Test procedure

1. Instruct test operator to plug Special Cable D into PET D-type connector, and the Standard-A plug of the Special Cable D into the Standard-A receptacle of the Special Cable D, and then click on 'OK'.
2. PET passes a current of 500mA through the VBUS conductor of the cable, and measures and records the voltage drop.
3. Instruct test operator to unplug Standard-A plug of the Special Cable D from the Standard-A receptacle of the Special Cable D, and then click on 'OK'.
4. Instruct test operator to plug the Standard-A plug of Special Cable D into the Accessory Port of the Standard-ACA under test, and then click on 'OK'.
5. Instruct test operator to plug the Micro-B plug of the captive OTG cable of the Standard-ACA under test into the PET Micro-AB receptacle, and then click on 'OK'.

Check that cables are connected:

6. Connect 10kΩ pull-down resistor to OTG port VBUS.
7. Instruct test operator to power up the Standard-ACA under test, and then click on 'OK'.
8. Check that we can sense 5V on VBUS on OTG port.
9. Check that we can sense 5V on VBUS on accessory port.
10. Disconnect 10kΩ pull-down resistor from OTG port VBUS.
11. If test fails report 'Either cables not correctly connected or UUT is not functioning'.
12. Instruct test operator to perform steps required to bring the Standard-ACA from a powered state to an un-powered one.
13. Wait for operator to click 'OK'.

End of Test

15.3 Standard-ACA Voltage, Current and Transient Test

Test Setup	Test Setup 8b. UUT is a Standard-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	PET Cable Calibration test has been run.
Purpose	To verify the Standard-ACA meets voltage, current, voltage overshoot and undershoot specifications, for any specified step change in load.
Description	This test measures the V_{BUS} voltage at extremes of load current. It also changes the V_{BUS} current abruptly, and measures the resulting voltage overshoot and undershoot levels.
Parameters	$V_{CHG\_OVERSHT}$, V_{CHG_UNDSHT}, V_{CHG}
Checklist	SACC1, SACC4, SACC5, SACC6, SACC7
Pass Criteria	Step 7 – Latch not triggered Step 9 – Voltage in range Step 13 – Latches not triggered Step 16 – Voltage in range Step 17 – Latches not triggered Step 25 – Latch not triggered Step 27 – Voltage in range Step 31 – Latches not triggered Step 35 – Latches not triggered

15.3.1 Test procedure

Initial State: No load applied.

OTG Port

1. Ensure that Standard-ACA is in an un-powered state.
2. Wait for Standard-ACA OTG port V_{BUS} to fall below V_{BUS_LKG} max (0.7V), in case it has just been switched off. (Speed up fall using 100mA current load.)
3. Set up voltage watch-block ready to capture overshoot of V_{CHG_OVRSHT} (6.0V) on OTG port V_{BUS}.
4. Instruct test operator to perform steps required to bring the Standard-ACA from an un-powered state to a powered one.
5. Wait for operator to click ‘OK’.
6. Wait for Standard-ACA OTG port V_{BUS} to rise above V_{CHG} min (4.75V).
7. Check watch-block overshoot detector latch was not triggered. [SACC1]
8. Set up voltage watch-block ready to capture undershoot of V_{CHG_UNDSHT} (4.1V), or overshoot of V_{CHG_OVRSHT} (6.0V) on Standard-ACA OTG port V_{BUS}.

9. With no current load applied, check that Standard-ACA OTG port V_{BUS} is within appropriate range V_{CHG} (4.75V to 5.25V). [SACC6]

Load Testing OTG port

10. Apply load of I_{CDP} min (1.5A) to Standard-ACA OTG port V_{BUS}.

11. Wait 10ms.

12. Check that Standard-ACA OTG port V_{BUS}, at Standard-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V).

13. Check watch-block overshoot and undershoot detector latches were not triggered. [SACC1] [SACC4]

14. Remove Current Load.

15. Wait 10ms

16. Check that V_{BUS} voltage from Standard-ACA OTG port V_{BUS}, at Standard-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V). [SACC6]

17. Check watch-block overshoot and undershoot detector latches were not triggered. [SACC1] [SACC4]

18. Instruct test operator to perform steps required to bring the Standard-ACA from a powered state to an un-powered one.

19. Wait for operator to click 'OK'.

Accessory Port

20. Wait for Standard-ACA accessory port V_{BUS} to fall below V_{BUS_LKG} max (0.7V). (Speed up fall using 10R resistive load.)

21. Set up voltage watch-block ready to capture overshoot of V_{CHG_OVRSHT} (6.0V) on accessory port V_{BUS}.

22. Instruct test operator to perform steps required to bring the Standard-ACA from an un-powered state to a powered one.

23. Wait for operator to click 'OK'.

24. Wait for Standard-ACA accessory port V_{BUS} to rise above V_{CHG} min (4.75V).

25. Check watch-block overshoot detector latch was not triggered. [SACC1]

26. Set up voltage watch-block ready to capture undershoot of V_{CHG_UNDSHT} (4.1V), or overshoot of V_{CHG_OVRSHT} (6.0V) on Standard-ACA accessory port V_{BUS}, allowing for voltage drop in cable.

27. With no current load applied, check that Standard-ACA accessory port V_{BUS} is within appropriate range V_{CHG} (4.75V to 5.25V). [SACC7]

Load Testing Accessory port

28. Apply load of I_{CFG_MAX} (500mA) to Standard-ACA accessory port V_{BUS}.

29. Wait 10ms.

30. Check that Standard-ACA accessory port V_{BUS}, at Standard-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable.

31. Check watch-block overshoot and undershoot detector latches were not triggered. [SACC1] [SACC5]

32. Remove Current Load.

33. Wait 10ms

34. Check that V_{BUS} voltage from Standard-ACA accessory port V_{BUS}, at Standard-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range $V_{CHG} - R_{ACA\_OTG\_ACC} \times I_{CFG\_MAX}$ (4.65V to 5.25V). [SACC7]

35. Check watch-block overshoot and undershoot detector latches were not triggered. [SACC1] [SACC5]

36. Instruct test operator to perform steps required to bring the Standard-ACA from a powered state to an un-powered one.

37. Wait for operator to click ‘OK’.

End of Test

15.4 Standard-ACA Not Powered, Nothing or B-device attached to Accessory Port

Test Setup	Test Setup 8b. UUT is a Standard-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA not powered and nothing or a B-device attached to accessory port
Description	The PET simulates nothing being attached to the Accessory Port of the UUT. Checks the resistance to ground of ID pin on OTG Port. Checks the resistance between VBUS on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.
Parameters	RID_FLOAT
Checklist	SACA2, SACA4, SACA8
Pass Criteria	Step 4. Voltage is less than 125mV. Step 7. Resistance to ground of ID pin on OTG port is RID_GND. Step 9. Indicator is off.

15.4.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to either port. ACA is not powered. Accessory port ID pin is floating.

1. Ensure that Standard-ACA is in an un-powered state.

Check VBUS Continuity

2. Apply 5V to VBUS on OTG Port.
3. Connect 10R load on accessory port VBUS.
4. Check that voltage on OTG VBUS minus Accessory Port VBUS is less than 125mV. (This value matches the drop allowed by OTG 2.0 in a detachable cable).
5. Disconnect 10R load from accessory port VBUS.
6. Disconnect VBUS from OTG port.

Check RID_GND

7. Check that resistance to ground of ID pin on OTG port is RID_GND (< 1 kΩ). [SACA4] [SACA8]

Check Indicator

8. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.
9. Wait for response, if ‘No’, test passes. If ‘Yes’ it fails. [SACA2]

End of Test

15.5 Standard-ACA Powered Up, Nothing or B-device attached to Accessory Port

Test Setup	Test Setup 8b. UUT is a Standard-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA powered and Nothing or a B-device attached to accessory port
Description	The PET simulates nothing being attached to the Accessory Port of the UUT. Checks whether VBUS comes from the OTG Port or the Accessory Port. Checks the resistance to ground of ID pin on OTG Port. Checks correct functioning of the Indicator.
Parameters	RID_A
Checklist	SACA2, SACA6, SACA7
Pass Criteria	Step 5. VBUS is coming from the Accessory port. Step 6. VBUS is coming from the OTG port. Step 7. Resistance to ground of ID pin on OTG port is RID_A. Step 9. Indicator is on.

15.5.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to either port. ACA is not powered. Accessory port ID pin is floating.

1. Instruct test operator to perform steps required to bring the Standard-ACA from an un-powered state to a powered one.

2. Wait for operator to click ‘OK’.

3. Ensure that Standard-ACA is in a powered state.

Check Switching Functionality:

4. Connect 10kΩ pull-down resistor to OTG port VBUS.

5. Check that VBUS is coming from the accessory port. i.e. Check that accessory port VBUS is greater than 4.75V.

6. Check that VBUS is coming from the OTG port. i.e. Check that OTG port VBUS is greater than 4.75V.

Check RID_A

7. Check that resistance to ground of ID pin on OTG port is R_{ID_A} (122-126 kΩ). [SACA6] [SACA7]

Check Indicator

8. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

9. Wait for response, if ‘Yes’, test passes. If ‘No’ it fails. [SACA2]

10. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

End of Test

15.6 Bypass Capacitance

Test Setup	Test Setup 8b. UUT is a Standard-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check presence and values of bypass capacitor C_{SACA_VBUS}.
Description	The PET simulates necessary conditions for measuring the bypass capacitor on the OTG / Accessory port.
Parameters	C_{SACA_VBUS}
Checklist	SACA1
Pass Criteria	Step 4. Capacitance is 10-100nF

15.6.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No V_{BUS} voltage applied to either port.

Check OTG Port Bypass Capacitance:

1. Ensure that Standard-ACA is in an un-powered state.

2. Use ADP circuit components in PET to evaluate capacitance on OTG port V_{BUS}.

3. Check that this capacitance lies within C_{SACA_VBUS} min and C_{SACA_VBUS} max (10 – 100 nF). [SACA1]

16 ACA-Dock Compliance

Note: USB2.0 tests are to be run separately, using appropriate equipment.

16.1 Submission Materials

16.1.1 Device Specific Information

Table 16-1 Device Specific Information for ACA-Docks

Item	Function	Value/ Support
1	Schematics or other proof that UUT output current cannot exceed 5.0 amperes	
2	The USB-IF TID for the UUT micro-A plug used for connecting the PD	
3	Schematics or other proof that a single UUT failure will not cause the output voltage on V_{BUS} to exceed V_{CHG_FAIL}?	
4	If it is not possible to plug the ACA-Dock into the PET Micr0-AB receptacle, a means of achieving this	

16.1.2 Checklists

Table 16-2 Checklist for ACA-Docks

ID and Question		Response	Test Number	BC 1.2 Section Number
ACAD1	Is the output voltage of the UUT less than V_{CHG_OVRSHT} max for any step change in load current, and also when powering on of off?	Yes ☐ No ☐	16.2	4.1.1
ACAD2	Is the output current of the UUT prevented from exceeding I_{CDP} max under any condition?	Yes ☐ No ☐	Vendor Declaration	4.1.2
ACAD3	Has it has been shown, using schematics or by some other explanation, that in the case of a single failure in the UUT, the output voltage on V_{BUS} will not exceed V_{CHG_FAIL}?	Yes ☐ No ☐	Vendor Declaration	4.1.5
ACAD4	As per provided UUT description: if the UUT provides multiple USB Charging Ports, the active UUT USB Charging Port does not affect operation of any other Charging Port.	Yes ☐ No ☐	Vendor Declaration	4.1.6
ACAD5	Does the UUT output a voltage of V_{CHG} (averaged over T_{VBUS_AVG}) for all currents less than I_{CDP} min?	Yes ☐ No ☐	16.3	4.3.1

ACAD6	Is the output voltage of the UUT greater than V_{CHG_UNDSHT} min for any step change in load current where current is less than I_{CDP} min?	Yes ☐ No ☐	16.2	4.3.2
ACAD7	Does the UUT enable V_{DM_SRC} within $T_{CP\_VDM\_EN}$ if D+/- are at idle, and disable V_{DM_SRC} within $T_{CP\_VDM\_DIS}$ of any USB activity on D+/-?	Yes ☐ No ☐	16.3	4.3.3
ACAD8	Does the UUT pull the ID pin to ground through a resistance of RID_A, whenever the connected PD is allowed to act as host and to draw current, and through R_{ID_FLOAT} at all other times?	Yes ☐ No ☐	16.3	4.3.3
ACAD9	Does the UUT have a captive cable with a Micro-A plug?	Yes ☐ No ☐	Inspection	4.3.4
ACAD10	Does the Micro-A plug have a valid TID?	Yes ☐ No ☐	Vendor Declaration	
ACAD11	Does the UUT have a captive (non-removable) USB hub?	Yes ☐ No ☐	Vendor Declaration	
ACAD12	If the hub has exposed downstream-facing ports, are they exposed via Standard-A receptacle(s) with valid TID(s)?	Yes ☐ No ☐ N/A ☐	Vendor Declaration	
ACAD13	Does the hub silicon have a valid TID?	Yes ☐ No ☐	Vendor Declaration	
ACAD14	Does the UUT have an indicator showing when it is able to supply power to the OTG port?	Yes ☐ No ☐	16.3, 16.4	
ACAD15	If the UUT goes into shutdown during a current overload condition, does it recover and output a voltage of V_{CHG} within a time of T_{SHTDWN_REC} when the current overload condition has been removed.	Yes ☐ No ☐	Vendor Declaration	4.2.2

16.2 ACA-Dock Overshoot and Undershoot Voltage Test

Test Setup	Test Setup 9. UUT is an ACA-Dock, PET simulates a PD.
Pre-conditions	This must be performed as the first test in the ACA-Dock suite.
Purpose	To verify the ACA-Dock meets overshoot and undershoot voltage specifications, for any specified step change in load.
Description	This test changes the VBUS current abruptly, and measures the resulting voltage overshoot and undershoot levels.
Parameters	VCHG_OVERSHT, VCHG_UNDSHT
Checklist	ACAD1, ACAD6
Pass Criteria	Step 4 – Maximum voltage during overshoot is less than 6.0V. Step 6 – VBUS is in range 4.75V to 5.25V Step 9 – VBUS is in range 4.75V to 5.25V Step 10 – Minimum voltage during undershoot is above 4.1V. Step 10 – Maximum voltage during overshoot is less than 6.0V. Step 13 – VBUS is in range 4.75V to 5.25V Step 14 – Minimum voltage during undershoot is above 4.1V. Step 14 – Maximum voltage during overshoot is less than 6.0V.

16.2.1 Test procedure

Initial State: No VBUS voltage applied. ACA-Dock is not powered.

1. Instruct test operator to plug captive cable of the ACA-Dock into the Micro-AB receptacle of the PET, and then click on 'OK'.

Note: If this is not physically possible, then make use of the alternative arrangement provided by the vendor.

2. Ask test operator to ensure that power is disconnected from the ACA-Dock, and then click on 'OK'. Check that VBUS is off.

3. Set up voltage watch-block ready to capture overshoot of VCHG_OVRSHT (6.0V) on VBUS.

4. Instruct test operator to perform steps required to bring the ACA-Dock from an un-powered state to a powered one.

5. Wait for operator to click 'OK'.

6. Wait for ACA-Dock OTG port VBUS to rise above VCHG min (4.75V).

7. Check watch-block overshoot detector latch was not triggered. [ACAD1]

8. Set up voltage watch-block ready to capture undershoot of VCHG_UNDSHT (4.1V), or overshoot of VCHG_OVRSHT (6.0V) on VBUS, allowing for voltage drop in cable.

9. With an applied current load of 0mA, check that V_{BUS} is within appropriate range V_{CHG} (4.75V to 5.25V).

10. Apply load of I_{CDP} min (1.5A) to V_{BUS}.

11. Wait 10ms.

12. Check that V_{BUS} voltage from ACA-Dock, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V).

13. Check watch-block overshoot and undershoot detector latches were not triggered. [ACAD1] [ACAD6]

14. Remove Current Load.

15. Wait 10ms

16. Check that V_{BUS} voltage from ACA-Dock, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V). [ACAD1] [ACAD6]

17. Check watch-block overshoot and undershoot detector latches were not triggered.

End of Test

16.3 ACA-Dock Voltage, Current, and R_{ID_A} Test

Test Setup	Test Setup 9. UUT is an ACA-Dock, PET simulates a PD.
Pre-conditions	ACA-Dock Overshoot and Undershoot Voltage Test has been run, and ACA-Dock is now switched on.
Purpose	To verify that the V_{BUS} voltage / current load characteristic meets the specified requirements.
Description	This test measures the voltage at various current loads, in order to confirm correct behavior.
Parameters	V_{CHG}, R_{ID_A}, V_{DM_SRC}
Checklist	ACAD5, ACAD7, ACAD8, ACAD14
Pass Criteria	Step1 - V_{BUS} voltage is in correct range. Step 4 - V_{BUS} voltage is in correct range. Step 7 - Voltage on ID pin is in correct range. Step 9 – Response was 'Yes'. Step 10 - V_{DM_SRC} is in correct range.

16.3.1 Test procedure

Initial State: The captive cable of the ACA-Dock is connected to the Micro-AB receptacle of the PET. No V_{BUS} voltage applied. ACA-Dock is powered.

Check Voltage under load

1. Confirm that power has been connected to ACA-Dock, asking test operator to connect it, if not.

2. Check that V_{BUS} voltage, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), from ACA-Dock is within V_{CHG} (4.75 – 5.25V). [ACAD5]

3. Apply load of I_{CDP} min (1.5A) to V_{BUS}.

4. Wait 1 sec to avoid possible overshoot period (overshoot and undershoot are measured separately).

5. Check that V_{BUS} voltage from ACA-Dock, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within V_{CHG} (4.75 – 5.25V). [ACAD5]

6. Disconnect the current load.

Check ID pin

7. Connect voltage source (3.3V) via 82k resistor to ID pin.

8. Check voltage on ID pin is in the range 1.970V – 2.002V. [ACAD8]

Note: This shows that the RID_A value from the ACA-Dock lies in the range 122k – 126k.

Check Indicator

9. Ask test operator to confirm ‘Yes’ or ‘No’ whether indicator lamp on UUT is illuminated.

10. Wait for response, if ‘Yes’, test passes. If ‘No’ it fails. [ACAD14]

Check V_{DM_SRC}

11. Check that voltage on D- is in range V_{DM_SRC} (0.5 to 0.7V). [ACAD7]

End of Test

16.4 ACA-Dock not Powered

Test Setup	Test Setup 9. UUT is an ACA-Dock, PET simulates a PD.
Pre-conditions	ACA-Dock Overshoot and Undershoot Voltage Test has been run, and ACA-Dock is now switched on.
Purpose	To verify that the ID pin and the indicator meets the specified requirements under no power conditions.
Description	This test measures the ID pin, and checks the indicator, after the power has been removed.
Parameters	R_{ID_FLOAT}
Checklist	ACAD8, ACAD14
Pass Criteria	Step 3 - Voltage on ID pin is 2.40V or above. Step 5 – Response was 'No'.

16.4.1 Test procedure

Initial State: ACA-Dock Micro-A plug is connected to Micro-AB receptacle on PET. No V_{BUS} voltage applied. ACA-Dock is powered.

Check ID pin

1. Ask test operator to disconnect power from ACA-Dock, and then to confirm that this has been done.
2. Connect voltage source (3.3V) via 82k resistor to ID pin.
3. Check voltage on ID pin is 2.40V or above. [ACAD8]

Note: This shows that the R_{ID_FLOAT} value from the ACA-Dock lies above 220k.

Check Indicator

4. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.
5. Wait for response, if 'No', test passes. If 'Yes' it fails. [ACAD14]

End of Test