

# USB Power Delivery Compliance Test Specification

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## Version 1.0 Revision History

Revision	Release Date	Description
1.0	September 15, 2019	Initial release
1.0	November 22, 2019	Adds missing cover page, copyright notice and table of contents. No change to the compliance tests.

# 1 Introduction

This document specifies USB-IF compliance tests for a USB PD3.0 device. This test specification covers USB-IF testing for compliance with the requirements in Chapters 5-8 and 10 in the USB PD2.0 and PD3.0 Specifications.

The following documents as well as any other tests mandated by the USB-IF may be applicable to a USB PD3.0 device:

- USB Type-C Functional Test Specification
- USB Type-C and PD Source Power Test Specification
- USB Command Verifier Compliance Test Specification
- USB 2.0 Electrical Test Specification

This document is organized as followed:

- Chapter 2 describes the common test procedures and checks that would be repeated in the tests described in the subsequent chapters.
- Chapter 3 describes tests that primarily cover Chapter 5 requirements in the USB PD2.0 and PD3.0 Specifications.
- Chapter 4 describes tests that primarily cover Chapters 6, 8 and 10 requirements in the USB PD2.0 and PD3.0 Specifications.
- Chapter 5 describes tests that primarily cover Chapter 7 requirements in the USB PD2.0 and PD3.0 Specifications.

## 1.1 Overview

The Tester runs tests applicable to the UUT in Chapter 3-5. The UUT applicability is determined by the VIF fields and it is provided at the beginning of each subsection e.g. “The tests in this subsection are applicable to UUT with VIF field VIF\_Product\_Type set to Port”.

The Tester runs the common checks and procedures as described in Chapter 2 for all tests.

The applicability of common check for a given PD message is provided in Check Applicability e.g. Message Header check (COMMON.CHECK.PD.2) is applicable to “all PD messages except GoodCRC”.

The applicability of common procedure is provided in Procedure Applicability e.g. unless otherwise specified, the Tester runs this procedure (COMMON.PROC.PD.2) whenever receiving Get\_Source\_Cap message from the UUT. The exceptions are provided either in the test steps or Test Specific Tester Behavior.

The Tester runs all the steps as described in the test (in Chapter 3-5) and the common procedure (in Section 2.3) unless the condition for “the test stops here” is satisfied. The test does not stop when a check fails.

In summary:

- Bring-up Procedures in Section 2.2 are used to start the tests in Chapter 3-5
- Common Checks in Section 2.1 are used in all the tests depending on the Check Applicability

- Common Procedures in Section 2.3 are used in all the tests depending on the Procedure Applicability and exceptions provided in the test.
- The test does not stop until the last step or the condition for “the test stops here” is satisfied

## 1.2 Terms and Abbreviations

Tester is the instrument used for running the test procedures and checks.

Unit Under Test (UUT) is the product undergoing the test procedures and checks.

## 1.3 Keywords

### 1.3.1 Check

Check is a keyword used to indicate requiring the Tester to determine whether the UUT has failed to comply the mandatory requirement in the base specification.

### 1.3.2 PD2 mode

The test is running in PD2 mode if the Tester as a Sink sends the first Request message with Message Header Bits 7...6 (Specification Revision) set to 01b.

The test is running in PD2 mode if the Tester as a Source sends the Source Capabilities and Discover Identity messages with Message Header Bits 7...6 (Specification Revision) set to 01b.

### 1.3.1 PD3 mode

The test is running in PD3 mode if the Tester as a Sink sends the first Request message with Message Header Bits 7...6 (Specification Revision) set to 10b.

The test is running in PD3 mode if the Tester as a Source sends the Source Capabilities and Discover Identity messages with Message Header Bits 7...6 (Specification Revision) set to 10b.

## 2 Common Procedures and Checks

This chapter describes the common test procedures and checks that would be repeated in the tests described in the subsequent chapters.

### 2.1 Common Checks

#### 2.1.1 PD2 and PD3 Modes

The common procedures in this subsection are applicable when the test is running in PD2 and PD3 modes.

##### *COMMON.CHECK.PD.1 Check Preamble*

Description: The Tester performs the physical layer checks on the Preamble sent by the UUT.



Check Applicability: All PD messages

The Tester performs the following checks on the Preamble of all PD messages

**[COMMON.CHECK.PD.1#1]**

- The check fails if the Preamble is not a 64-bit sequence of alternating '0's and '1's. (In practice the last 60 bits are checked as there is some uncertainty about detecting the initial bits.)
- The check fails if the Preamble does not end with a single “one”.

*COMMON.CHECK.PD.2 Check Message Header*

Description: The Tester performs the protocol checks on the Message Header sent by the UUT.

Check Applicability: All PD messages except GoodCRC

The Tester performs the following checks on the Message Header of all PD messages except GoodCRC and Returned BIST Counters: **[COMMON.CHECK.PD.2#1]**

1. For Source Capabilities and Discover Identity messages before the first response from the Tester after detach, Hard Reset or Error Recovery
  - a. Bit 15 (Extended for PD3). The check fails if this field is not set to 0b
  - b. Bit 7...6 (Specification Revision). The check fails if this field is not set to 10b
  - c. Bit 4...0 (Message Type). The check fails if the Message Type is not valid
2. Other messages
  - a. Bit 15 (Extended for PD3 and Reserved for PD2). The check fails if this bit is not set to 0b when the test is running in PD2 mode
  - b. Bits 7...6 (Specification Revision). The check fails if this field is not set to 01b when the test is running in PD2 mode
  - c. Bits 7...6 (Specification Revision). The check fails if this field is not set to 10b when the test is running in PD3 mode
  - d. In PD2 mode
    - i. Bit 4 (Reserved). The check fails if this field is not is set to 0b
    - ii. Bit 3...0. The check fails if the Message Type is not valid.
  - e. In PD3 mode
    - i. Bit 4...0. The check fails if the Message Type is not valid
3. Bits 14...12: Number of Data Objects
  - a. When the Extended field is set to zero, the check fails if Number of Data Objects field does not match the number of 32-bit Data Objects that follow the Message Header
  - b. When the Extended bit (in the Message Header) is set to 1b and Chunked bit (in the Extended Message Header) is set to 1b, the check fails if the size in bytes of the payload following the Message Header is not 4 times the Number of Data Objects
  - c. When the Extended bit (in the Message Header) is set to 1b and Chunked bit (in the Extended Message Header) is set to 0b, the check fails if Number of Data Objects field is not set to 000b
4. Bits 11...9: MessageID. The check fails if the value is not 000b under the following conditions:
  - a. The first message after a Hard Reset was sent or received

- b. The message is a Soft\_Reset
  - c. The first message after receiving Soft\_Reset
  - d. The first message after a successful Power Role Swap
  - e. The first message to the Cable Plug using SOP' or SOP'' packet
  - f. The first message after a Cable Reset (only for communication involving a Cable Plug using SOP' or SOP'' packet)
- 5. Bits 11...9: MessageID. Except for conditions as mentioned above, the check fails if MessageID is incremented by three comparing to the previously received message
- 6. Bits 11...9: MessageID. The check fails if MessageID is incremented for a valid retry scenario as described in the test procedures
- 7. Bit 8: Port Power Role (SOP packet type only)
  - a. The check fails if Port Power Role does not represent the UUT port power role
  - b. For a Ping or GotoMin message, the check fails if Port Power Role is not Source
  - c. For a Request, the check fails if Port Power Role is not Sink
  - d. The check fails if the Port Power Role is not Sink for the first PS\_RDY during a Power Role Swap
  - e. The check fails if the Port Power Role is not Source for the second PS\_RDY during a Power Role Swap
- 8. Bit 5: Port Data Role (SOP packet type only). The check fails if Port Data Role does not represent the UUT port data role
- 9. Bit 5: Port Data Role (SOP' and SOP'' packet types). The check fails if Port Data Role is not set to zero

#### *COMMON.CHECK.PD.3 Check GoodCRC*

Description: The Tester performs the protocol checks on the GoodCRC message received by the Tester.

Check Applicability: All GoodCRC messages

The Tester performs the following checks on the reception of GoodCRC message:

1. The check fails if the GoodCRC is received before tInterFrameGap min or after tTransmit max has expired. The delay is measured between the last bit of the EOP of Tester sent message and the first bit of the Preamble of the UUT sent GoodCRC Message. [COMMON.CHECK.PD.3#1]
2. Perform the following checks on the Message Header of GoodCRC message: [COMMON.CHECK.PD.3#2]
  - a. Bit 15 (Reserved for PD2, Extended for PD3). The check fails if this field is not set to 0b
  - b. Bits 11...9: MessageID. The check fails if MessageID is not the same as the value in the preceding message sent by the Tester
  - c. Bit 8: Port Power Role (SOP packet type only). The check fails if Port Power Role does not represent the UUT port power role
  - d. Bits 7...6 (Specification Revision). The check fails if this field is not set to 01b when the test is running in PD2 mode
  - e. Bits 7...6 (Specification Revision). The check fails if this field is not set to either 00b, 01b or 10b when the test is running in PD3 mode

- f. Bit 5: Port Data Role (SOP packet type only). The check fails if Port Data Role does not represent the UUT port data role
- g. Bit 5: Port Data Role (SOP' and SOP'' packet types). The check fails if Port Data Role is not set to zero
- h. Bits 4...0 (Message Type) is set to 0001b

#### *COMMON.CHECK.PD.4 Check Atomic Message Sequence*

Description: The Tester performs additional protocol checks on response messages as part of the Atomic Message Sequence (AMS).

Check Applicability: All PD response messages when an AMS has started

The Tester performs the following check when an AMS has started:

1. As part of an AMS, the check fails if the UUT does not **respond to a message** (sent by the Tester) within tSenderResponse max from the last bit of the EOP of the GoodCRC message sent [COMMON.CHECK.PD.4#1]. The following are the exceptions:
  - a. PS\_RDY message as part of Power Negotiation AMS
  - b. PS\_RDY message as part of Power Role Swap AMS
  - c. PS\_RDY message as part of VCONN Swap AMS
  - d. Security\_Response message as part of Security AMS

#### *COMMON.CHECK.PD.5 Check Unexpected Messages and Signals*

Description: The Tester performs additional protocol checks on unexpected messages sent by the UUT.

Check Applicability: All PD messages

Unless specifically mentioned, the check fails if Soft\_Reset message (using SOP packet) is sent by the UUT during a test [COMMON.CHECK.PD.5#1].

Unless specifically mentioned, the check fails if the UUT sends a Hard Reset or a Cable Reset signal [COMMON.CHECK.PD.5#2].

Unless specifically mentioned, the check fails if GotoMin message is sent by the UUT [COMMON.CHECK.PD.5#3]. The Tester does not set the GiveBack flag during a test.

The following messages sent by the UUT are unexpected during a test when the Tester is in *PE\_SRC\_Ready*, *PE\_SNK\_Ready* or *PE\_CBL\_Ready* state (Policy Engine States as described in the base specification), and the check fails [COMMON.CHECK.PD.5#4]:

- GoodCRC
- BIST
- Sink\_Capabilities
- Accept
- Reject
- Wait

- PS\_RDY
- Structured VDM response (ACK, NAK, BUSY)
- Ping (when the UUT is not in *PE\_SRC\_Ready*)

#### *COMMON.CHECK.PD.6 Check Control Message*

Description: The Tester performs additional protocol checks on all Control messages sent by the UUT.

Check Applicability: Control messages including GoodCRC, GoToMin, Accept, Reject, Ping, PS\_RDY, Get\_Source\_Cap, Get\_Sink\_Cap, Protocol Error, DR\_Swap, PR\_Swap, VCONN\_Swap, Wait, Soft\_Reset.

The Tester performs the following additional check on all Control messages [COMMON.CHECK.PD.6#1]:

1. The check fails if the Number of Data Object field in the Header is not zero
2. The check fails if the number of bytes of the payload following the header is not zero

#### *COMMON.CHECK.PD.7 Check Source Capabilities Message*

Description: The Tester performs additional protocol checks on all Source Capabilities messages sent by the UUT.

Check Applicability: Source Capabilities message

Perform the following checks on all Source Capabilities messages (if VIF field Port\_Source\_Power\_Type = Assured): [COMMON.CHECK.PD.7#1]

1. Without receiving a SOP' Discover Identity Request message from the UUT, the check fails if VIF field Captive\_Cable = No and the UUT sends Source Capabilities offering currents greater than 3A and/or voltages greater than 20V
2. The check fails if the Number of Data Objects field in the Message Header is not equal to VIF field Num\_Src\_PDOs
3. For the first PDO, the Tester check the consistency
  - a. B31...30 (Fixed Supply) set to 00b
  - b. B29 (Dual-Role Power) set to 1b if any of the following VIF fields is YES:
    - i. Accepts\_PR\_Swap\_As\_Src
    - ii. Accepts\_PR\_Swap\_As\_Snk
    - iii. Requests\_PR\_Swap\_As\_Src
    - iv. Requests\_PR\_Swap\_As\_Snk
  - c. B28 (USB Suspend Supported) set to 1b if VIF field USB\_Suspend\_May\_Be\_Cleared = NO
  - d. B27 (Unconstrained Power) matches VIF field Unconstrained\_Power
  - e. B26 (USB Communications Capable) matches VIF field USB\_Comms\_Capable
  - f. B25 (Dual-Role Data) set to 1b if VIF field DR\_Swap\_To\_UFP\_Supported or DR\_Swap\_To\_DFP\_Supported = YES
  - g. For Source Capabilities message before the first response from the Tester
    - i. Bit 24 (Unchunked Extended Messages Supported) matches VIF field Unchunked\_Extended\_Messages\_Supported
    - ii. Bits 23...22 (Reserved) set to 00b

- h. For Source Capabilities message after the Tester has sent Request message
    - i. Bit 24 (Unchunked Extended Messages Supported) matches VIF field Unchunked\_Extended\_Messages\_Supported if the test is running in PD3 mode
    - ii. Bits 23...22 (Reserved) set to 00b if the test is running in PD3 mode
    - iii. Bits 24...22 (Reserved) set to 000b if the test is running in PD2 mode
  - i. B21...20 (Peak Current) matches VIF field Src\_PDO\_Peak\_Current1
  - j. B19...10 (Voltage) set to 5V
  - k. B9...0 (Maximum Current) matches VIF field Src\_PDO\_Max\_Current1
4. If it is not the first Fixed Supply PDO, check that B29...22 are set to zero
  5. If it is a Programmable Power Supply APDO, check that B26...25, B16 and B7 are set to zero
  6. The Tester compares all PDOs to VIF field PD\_Power\_as\_Source and check that they meet the requirements of the Power Rules.
  7. For each PDO, the Tester checks consistency of:
    - a. Src\_PDO\_Supply\_TypeN
    - b. If Fixed Supply PDO:
      - i. Src\_PDO\_VoltageN
      - ii. Src\_PDO\_Peak\_CurrentN
      - iii. Src\_PDO\_Max\_CurrentN
    - c. If Variable Supply PDO:
      - i. Src\_PDO\_MinVoltageN
      - ii. Src\_PDO\_MaxVoltageN
      - iii. Src\_PDO\_Max\_CurrentN
    - d. If Battery Supply PDO:
      - i. Src\_PDO\_MinVoltageN
      - ii. Src\_PDO\_MaxVoltageN
      - iii. Src\_PDO\_Max\_PowerN
    - e. If Programmable Power Supply PDO:
      - i. Src\_PDO\_MinVoltageN
      - ii. Src\_PDO\_MaxVoltageN
      - iii. Src\_PDO\_Max\_CurrentN
  8. The Tester checks PDOs following the first one, are in the correct order: Fixed PDOs in increasing Voltage sequence, Battery PDOs in increasing Minimum Voltage sequence, Variable PDOs in increasing Minimum Voltage sequence, and finally Programmable Power Supply APDOs in increasing Maximum Voltage sequence.
  9. The Tester checks that no Fixed PDO has the same voltage as any other
  10. The Tester checks that no Variable PDO has the same voltage range as any other
  11. The Tester checks that no Battery PDO has the same voltage range as any other

Perform the following checks on all Source Capabilities messages (if VIF field Port\_Source\_Power\_Type = Assured): [\[COMMON.CHECK.PD.7#2\]](#)

1. The check fails if the Number of Data Objects field in the Message Header is not equal to VIF field Num\_Src\_PDOs
2. For the first PDO, the Tester checks consistency

- a. B31...30 (Fixed Supply) set to 00b
  - b. B29 (Dual-Role Power) set to 1b if any of the following VIF fields is YES:
    - i. Accepts\_PR\_Swap\_As\_Src
    - ii. Accepts\_PR\_Swap\_As\_Snk
    - iii. Requests\_PR\_Swap\_As\_Src
    - iv. Requests\_PR\_Swap\_As\_Snk
  - c. B28 (USB Suspend Supported) set to 1b if VIF field USB\_Suspend\_May\_Be\_Cleared = NO
  - d. B27 (Unconstrained Power) matches VIF field Unconstrained\_Power
  - e. B26 (USB Communications Capable) matches VIF field USB\_Comms\_Capable
  - f. B25 (Dual-Role Data) set to 1b if VIF field DR\_Swap\_To\_UFP\_Supported or DR\_Swap\_To\_DFP\_Supported = YES
  - g. For Source Capabilities message before the first response from the Tester
    - i. Bit 24 (Unchunked Extended Messages Supported) matches VIF field Unchunked\_Extended\_Messages\_Supported
    - ii. Bits 23...22 (Reserved) set to 00b
  - h. For Source Capabilities message after the Tester has sent Request message
    - i. Bit 24 (Unchunked Extended Messages Supported) matches VIF field Unchunked\_Extended\_Messages\_Supported if the test is running in PD3 mode
    - ii. Bits 23...22 (Reserved) set to 00b if the test is running in PD3 mode
    - iii. Bits 24...22 (Reserved) set to 000b if the test is running in PD2 mode
  - i. B21...20 (Peak Current) matches VIF field Src\_PDO\_Peak\_Current1
  - j. B19...10 (Voltage) set to 5V
  - k. B9...0 (Maximum Current) matches VIF field Src\_PDO\_Max\_Current1
3. If it is not the first Fixed Supply PDO, check that B29...22 are set to zero
  4. If it is a Programmable Power Supply APDO, check that B26...25, B16 and B7 are set to zero
  5. The Tester check that all PDOs meet the requirements of the Power Rules.
  6. The Tester checks PDOs following the first one, are in the correct order: Fixed PDOs in increasing Voltage sequence, Battery PDOs in increasing Minimum Voltage sequence, Variable PDOs in increasing Minimum Voltage sequence, and finally Programmable Power Supply APDOs in increasing Maximum Voltage sequence.
  7. The Tester checks that no Fixed PDO has the same voltage as any other
  8. The Tester checks that no Variable PDO has the same voltage range as any other
  9. The Tester checks that no Battery PDO has the same voltage range as any other

#### *COMMON.CHECK.PD.8 Check Request Message*

**Description:** The Tester performs additional protocol checks to all Request messages sent by the UUT.

**Check Applicability:** Request message

The Tester performs the following additional checks on all Request messages:

#### **[COMMON.CHECK.PD.8#1]**

1. The Number of Data Objects field in the Message Header is exactly 1
2. Field check for all types of Request Data Object
  - a. B31 (Reserved) set to 0b

- b. B30...28 (Object Position) is not 000b, and the value is not greater than the number of PDOs in the last Source Capabilities message
  - c. B25 (USB Communications Capable), matches VIF field USB\_Comms\_Capable
  - d. B24 (No USB Suspend), matches VIF field No\_USB\_Suspend\_May\_Be\_Set
  - e. Bit 23 (Unchunked Extended Messages Supported) matches VIF field Unchunked\_Extended\_Messages\_Supported if the test is running in PD3 mode
  - f. Bits 22...20 (Reserved) set to 000b if the test is running in PD3 mode
  - g. Bits 23...20 (Reserved) set to 0000b if the test is running in PD2 mode
- 3. Fixed and Variable Request Data Object
  - a. B19...10 (Operating Current) does not exceed the current offered by the referenced PDO
  - b. If B27 (GiveBack flag) = 0b
    - i. If B9...0 (Maximum Operating Current) is less than or equal to the current offered by the referenced PDO, then B26 (Capability Mismatch) is set to zero
    - ii. B19...10 (Operating Current) does not exceed B9...0 (Maximum Operating Current)
  - c. If B27 (GiveBack flag) = 1b
    - i. B9...0 (Minimum Operating Current) does not exceed B19...10 (Operating Current)
- 4. Battery Request Data Object
  - a. B19...10 (Operating Power) does not exceed the power offered by the referenced PDO
  - b. If B27 (GiveBack flag) = 0b
    - i. If B9...0 (Maximum Operating Power) is less than or equal to the power offered by the referenced PDO, then B26 (Capability Mismatch) is set to zero
    - ii. B19...10 (Operating Power) does not exceed B9...0 (Maximum Operating Power)
  - c. If B27 (GiveBack flag) = 1b
    - i. B9...0 (Minimum Operating Power) does not exceed B19...10 (Operating Power)
- 5. Programmable Power Supply Request
  - a. If B6...0 (Maximum Operating Power) is less than or equal to the power offered by the referenced PDO, then B26 (Capability Mismatch) is set to zero
  - b. Bit 23 (Unchunked Extended Messages Supported) matches VIF field Unchunked\_Extended\_Messages\_Supported
  - c. B22...20 (Reserved) set to zero
  - d. B8...7 (Reserved) set to zero
  - e. Bits 27 (Reserved) set to 0b
  - f. Bits 31 (Reserved) set to 0b

#### *COMMON.CHECK.PD.9 Check Structured VDM Message*

Description: The Tester performs the protocol checks on the Structured VDM Message sent by the UUT.

Check Applicability: All Structured VDM messages

The Tester performs the following checks on the Structured VDM Message Header (the first Data Object): [\[COMMON.CHECK.PD.9#1\]](#)

1. Bits 31...16 (SVID)

- a. This field shall be set to 0xFF00 (PD SID) if Command (Bits 4...0) is a Discover Identity or Discover SVIDs
  - b. This field shall not be set to 0xFF00 if Command (Bits 4...0) is 16-31 (SVID specific)
2. Bit 14...13 (Structured VDM Version) are set to 00b (when the test is running in PD2 mode)
3. Bit 14...13 (Structured VDM Version) are set to 01b (when the test is running in PD3 mode)
4. Bits 12...11 (reserved):
  - a. Set to 00b if Command = 0...15
5. Bits 10...8 (Object Position):
  - a. Set to 001b...111b if Command = Exit Mode
  - b. Set to 001b...110b if Command = (Enter Mode or Attention)
  - c. Set to 000b if Command = (Discover Identity, Discover SVIDs or Discover Modes)
6. Bit 5 (reserved) is set to 0b
7. Bits 4...0 (Command) shall be 1-6 or 16-31

#### *COMMON.CHECK.PD.10 Check Extended Message Header*

**Description:** The Tester performs the protocol checks on the Message Header and Extended Message Header sent by the UUT.

**Check Applicability:** All PD messages except GoodCRC

The Tester performs the following checks on the Message Header and Extended Message Header of all Extended Messages: [\[COMMON.CHECK.PD.10#1\]](#)

1. If both the Tester and UUT support Unchunked Extended Message (i.e. Unchunked Extended Messages Supported field set to 1b in the Tester sent Request or Source Capabilities message, and Unchunked Extended Messages Supported bit set to 1b (in UUT sent Request or Source Capabilities message)):
  - a. Bit 15 Chunked bit (in Extended Message Header) = 0
2. If either the Tester or the UUT supports Chunked Extended Message (i.e. either Unchunked Extended Messages Supported field set to 0b in the Tester sent Request or Source Capabilities message, or Unchunked Extended Messages Supported bit set to 0b (in UUT sent Request or Source Capabilities message)):
  - a. Bit 15 Chunked bit (in Extended Message Header) = 1
  - b. The payload is padded to the next 4-byte Data Object boundary with zeros
3. Additional checks for Extended Message Header
  - a. Bits 14...11 Chunk Number = 0 if Chunked flag is also set to zero
  - b. Bit 9 Reserved = 0
  - c. Bits 8...0 Data Size
    - i. Source Capabilities Extended = 24
    - ii. Status = 6
    - iii. Get\_Battery\_Status = 1
    - iv. Battery\_Capabilities = 9
    - v. Manufacturer\_Info
      1. Valid Get\_Manufacturer\_Info = 5 + vendor defined string (0...21)



2. Invalid Get\_Manufacturer\_Info = 18 = (PID + VID + “Not Supported” + null)

#### *COMMON.CHECK.PD.11 Check Source Capabilities Extended Message*

Description: The Tester performs additional protocol checks on all Source Capabilities Extended messages sent by the UUT.

Check Applicability: Source Capabilities Extended message

Perform the following checks on all Source Capabilities Extended:

1. For the SCEDB [COMMON.CHECK.PD.11#1]
  - a. Voltage Regulation field: Bits 0..1 (Load Step) = 00b or 01b
  - b. Voltage Regulation field: Bits 3..7 (Reserved) are 0
  - c. Compliance field: Bits 3..7 (Reserved) are 0
  - d. Touch Current field: Bits 3..7 (Reserved) are 0
  - e. Touch Temp field is 0, 1 or 2
  - f. Source Inputs field: If Bit 0 is 0, Bit 1 is 0
  - g. Source Inputs field: Bits 3..7 (Reserved) are 0
  - h. Batteries/Battery Slots field:
    - i. Upper nibble (Number of Hot Swappable Battery Slots) <= 4 and matches VIF field Num\_Swappable\_Battery\_Slots
    - ii. Lower nibble (Number of Fixed Batteries) <= 4 and matches VIF field Num\_Fixed\_Batteries
  - i. Source PDP field
    - i. Bits 0..6 (Source’s rated PDP) is the floor of the VIF field PD\_Power\_as\_Source
    - ii. Bit 7 (Reserved) is 0

## 2.2 Bring-up Procedures

### 2.2.1 PD2 and PD3 Modes

The common checks in this subsection are applicable when the test is running in PD2 and PD3 modes.

#### *COMMON.PROC.BU.1 Bring-up Source UUT*

1. The test starts in a disconnected state.
2. If VIF field Captive\_Cable = YES, the Tester applies Rd. Otherwise (VIF field Captive\_Cable = No), the Tester applies Rd and Ra.
3. The check fails if the first bit of a Source Capabilities message is not received from the UUT within tFirstSourceCap max after VBUS present (vSafe5V). [COMMON.PROC.BU.1#1]
4. The Tester responds with a Request message for 5V at 100mA.
  - a. B30 (Object Position) = 001b
  - b. B27 (GiveBack Flag) = 0b

- c. B26 (Capability Mismatch) = 0b
  - d. B25 (USB Communication Capable) = 0b
  - e. B24 (No USB Suspend) = 1b
  - f. B23 (PD3, Unchunked Extended Messages Supported) = 0b
  - g. B19...10 (Operating Current) = 100mA
  - h. B9...0 (Maximum Operating Current) = 100mA
5. The check fails if the UUT does not respond with an Accept message. [COMMON.PROC.BU.1#2]
  6. The check fails if PS\_RDY message is not received within tPSTransition max from the last bit of the EOP of Accept message. [COMMON.PROC.BU.1#3]
  7. An explicit contract is now established.
  8. The Tester waits 500ms to respond to messages from the UUT.

#### *COMMON.PROC.BU.2 Bring-up Sink UUT*

1. The test starts in a disconnected state.
2. The tester applies Rp.
3. If the UUT attachment is detected, the Tester applies VCONN (if Ra is detected) and vSafe5V on VBUS.
4. The Tester waits for 50 ms.
5. The Tester transmits Source Capabilities message with single PDO:
  - a. B31...30 (Fixed Supply) set to 00b
  - b. B29 (Dual-Role Power) set to 0b if Tester is a Source only; set to 1b if Tester is a Dual-Role Power
  - c. B28 (USB Suspend Supported) set to 0b
  - d. B27 (Unconstrained Power) set to 1b
  - e. B26 (USB Communications Capable) set to 0b
  - f. B25 (Dual-Role Data) set to 0b
  - g. B24 (PD3, Unchunked Extended Messages Supported) set to 0b
  - h. B21...20 (Peak Current) set to 00b
  - i. B19...10 (Voltage) set to 5V
  - j. B9...0 (Maximum Current) set to 100mA
6. Repeat Step-5 if the Tester does not receive a GoodCRC from the UUT in response to Source Capabilities message. This requires a delay of tTypeCSendSourceCap (100 ms to 200 ms). This sequence is repeated at least 50 times.
9. The check fails if the UUT does not respond with a Request message. [COMMON.PROC.BU.2#1]

10. The Tester responds with an Accept message to the Request message.
11. If the VBUS voltage is stable within the target voltage, the Tester sends a PS\_RDY message at the limit of tPSTransition max after the reception of Accept message.
12. An explicit contract is now established.
13. The Tester presents SinkTxOK if the test is in PD3 mode. The Tester waits 500ms to respond to messages from the UUT.

#### *COMMON.PROC.BU.3 Bring-up Cable Plug UUT*

1. The test starts in a disconnected state.
2. The Tester applies Rp and Rd to one cable end.
3. If the UUT attachment is detected (detected Ra), the Tester applies VCONN and vSafe5V on VBUS.
4. The Tester waits for tvCONNStable max.

#### Note:

1. Cable Plug tests need to be run 4 times, on both ends with VCONN voltage set to 2.75V, and 5.75V.
2. The Tester uses SOP' message in Cable Plug tests.

#### *COMMON.PROC.BU.4 Bring-up Source UUT for PPS Test*

1. The test starts in a disconnected state.
2. The Tester applies Rd.
3. The check fails if the first bit of a Source Capabilities message is not received from the UUT within tFirstSourceCap max after VBUS present (vSafe5V). [\[COMMON.PROC.BU.4#1\]](#)
4. If there is no PPS APDO in the Source\_Capabilities, the test stops here.
5. The Tester responds with a Request message for Programmable Power Supply APDO 4V 1A.
  - a. B26 (Capability Mismatch) = 0b
  - b. B25 (USB Communication Capable) = 0b
  - c. B24 (No USB Suspend) = 1b
  - d. B23 (PD3, Unchunked Extended Messages Supported) = 0b
  - e. B19...9 (Output Voltage) = 4V
  - f. B6...0 (Operating Current) = 1A
6. The check fails if an Accept message is not received. [\[COMMON.PROC.BU.4#2\]](#)

7. The check fails if PS\_RDY message is not received within tPSTransition max from the last bit of the EOP of Accept message. [COMMON.PROC.BU.4#3]
8. An explicit contract is now established.
9. The Tester waits 500ms to respond to messages from the UUT.

#### *COMMON.PROC.BU.5 Bring-up Sink UUT for PPS Test*

1. The test starts in a disconnected state.
2. The tester applies Rp.
3. If the UUT attachment is detected, the Tester applies VCONN (if Ra is detected) and vSafe5V on VBUS.
4. The Tester transmits Source Capabilities message with two PDOs:
  - a. Fixed Supply PDO
    - i. B31...30 (Fixed Supply) set to 00b
    - ii. B29 (Dual-Role Power) set to 0b if Tester is a Source only; set to 1b if Tester is a Dual-Role Power
    - iii. B28 (USB Suspend Supported) set to 0b
    - iv. B27 (Unconstrained Power) set to 1b
    - v. B26 (USB Communications Capable) set to 0b
    - vi. B25 (Dual-Role Data) set to 0b
    - vii. B24 (PD3, Unchunked Extended Messages Supported) set to 0b
    - viii. B21...20 (Peak Current) set to 00b
    - ix. B19...10 (Voltage) set to 5V
    - x. B9...0 (Maximum Current) set to 3A
  - b. APDO PPS
    - i. B31...30 (Augmented PDO) set to 11b
    - ii. B29...28 00b – Programmable Power Supply
    - iii. B27 (PPS Power Limited) set to 0b
    - iv. B24...17 (Maximum Voltage) set to 5.9V
    - v. B15...8 (Minimum Voltage) set to 3.3V
    - vi. B6...0 (Maximum Current) set to 3A
5. Repeat Step-4 if the Tester does not receive a GoodCRC from the UUT in response to Source Capabilities message. This requires a delay of tTypeCSendSourceCap (100 ms to 200 ms). This sequence is repeated at least 50 times.
6. The check fails if a Request message is not received. [COMMON.PROC.BU.5#1]
7. The Tester responds with an Accept message to the Request message.
8. When the VBUS voltage is stable within the target voltage, the Tester sends a PS\_RDY message at the limit of tPSTransition max after the reception of Accept message.
9. An explicit contract is now established.
10. The Tester presents SinkTxOK.

11. If the Sink doesn't request the PPS APDO in 5s from the time Tester presented SinkTxOK, the test stops here. If the Request message is received, the Tester responds with an Accept message.
12. When the VBUS voltage is stable within the target voltage, the Tester sends a PS\_RDY message at the limit of tPSTransition max after the reception of Accept message.
13. The Tester presents SinkTxOK. The Tester waits 500ms to respond to messages from the UUT.

## 2.3 Common Procedures

### 2.3.1 PD2 and PD3 Modes

The common procedures in this subsection are applicable when the test is running in PD2 and PD3 modes.

#### *COMMON.PROC.PD.1 Tester Sends GoodCRC*

**Procedure Applicability:** Unless otherwise specified, the Tester replies with a GoodCRC whenever receiving any PD message from the UUT.

1. The Tester sends a GoodCRC message to acknowledge messages received from the UUT. The Tester starts the preamble of GoodCRC message after tInterframeGap min of the last bit of the previously received message.

#### *COMMON.PROC.PD.2 UUT Sent Get\_Source\_Cap*

**Procedure Applicability:** Unless otherwise specified, the Tester runs this procedure whenever receiving Get\_Source\_Cap message from the UUT.

1. The Tester receives a Get\_Source\_Cap message from the UUT. This message is valid except the following conditions: [COMMON.PROC.PD.2#1]
  - a. The check fails if the UUT sends this message before the Tester has established an Explicit Contract
  - b. The check fails if the UUT sends this message within a non-interruptible AMS
  - c. The check fails if the VIF field PD\_Port\_Type = Provider Only
2. There are three scenarios:
  - a. The Tester is a Source
    - i. The Tester responds with Source Capabilities message that contains single PDO
      1. B31...30 (Fixed Supply) set to 00b
      2. B29 (Dual-Role Power) set to 0b if Tester is a Source only; set to 1b if Tester is a Dual-Role Power
      3. B28 (USB Suspend Supported) set to 0b

4. B27 (Unconstrained Power) set to 1b
  5. B26 (USB Communications Capable) set to 0b
  6. B25 (Dual-Role Data) set to 0b
  7. B24...22 (Reserved) set to 00b
  8. B21...20 (Peak Current) set to 00b
  9. B19...10 (Voltage) set to 5V
  10. B9...0 (Maximum Current) set to 100mA
- ii. The check fails if the UUT does not respond with a Request message.  
[COMMON.PROC.PD.2#2]
  - iii. The Tester responds with an Accept message to the Request message.
  - iv. If the VBUS voltage is stable within the target voltage, the Tester sends a PS\_RDY message at the limit of tPSTransition min after the reception of Accept message.
- b. The Tester is a Sink only
    - i. The Tester responds with a Reject message.
  - c. The Tester is a Sink with Dual-Role Power
    - i. The Tester responds with a Source Capabilities message for best condition for the PR\_Swap to be accepted:
      1. For the first PDO:
        - a. B31...30 (Fixed Supply) set to 00b
        - b. B29 (Dual-Role Power) set to 1b
        - c. B28 (USB Suspend Supported) set to 0b
        - d. B27 (Unconstrained Power) set to 1b
        - e. B26 (USB Communications Capable) matches VIF field USB\_Comms\_Capable
        - f. B25 (Dual-Role Data) matches VIF field DR\_Swap\_To\_UFP\_Supported
        - g. B24...22 (Reserved) set to 00b
        - h. B21...20 (Peak Current) set to 00b
        - i. B19...10 (Voltage) set to 5V
        - j. B9...0 (Maximum Current) set to VIF field Snk\_PDO\_Max\_Current1
      2. Create the subsequent PDOs using Sink PDO values in the VIF:
        - a. If Snk\_PDO\_Supply\_TypeN = Fixed
          - i. B31...30 (Fixed Supply) set to 00b
          - ii. B19...10 (Voltage) set to VIF field Snk\_PDO\_VoltageN

- iii. B9...0 (Maximum Current) set to VIF field Snk\_PDO\_Op\_CurrentN
- b. If Snk\_PDO\_Supply\_TypeN = Variable
  - i. B31...30 (Variable Supply) set to 10b
  - ii. B29...20 (Maximum Voltage) set to VIF field Snk\_PDO\_MaxVoltageN
  - iii. B19...10 (Minimum Voltage) set to VIF field Snk\_PDO\_MinVoltageN
  - iv. B9...0 (Maximum Current) set to VIF field Snk\_PDO\_Op\_CurrentN
- c. If Snk\_PDO\_Supply\_TypeN = Battery
  - i. B31...30 (Battery Supply) set to 01b
  - ii. B29...20 (Maximum Voltage) set to VIF field Snk\_PDO\_MaxVoltageN
  - iii. B19...10 (Minimum Voltage) set to VIF field Snk\_PDO\_MinVoltageN
  - iv. B9...0 (Maximum Power) set to VIF field Snk\_PDO\_Op\_PowerN

#### *COMMON.PROC.PD.3 UUT Sent Get\_Sink\_Cap*

**Procedure Applicability:** Unless otherwise specified, the Tester runs this procedure whenever receiving Get\_Sink\_Cap message from the UUT.

1. The Tester receives Get\_Sink\_Cap message from the UUT. This message is valid except the following conditions: **[COMMON.PROC.PD.3#1]**
  - a. The check fails if the UUT sends this message before the Tester has established an Explicit Contract
  - b. The check fails if the UUT sends this message within a non-interruptible AMS
  - c. The check fails if the VIF field PD\_Port\_Type = Consumer only
2. There are three scenarios:
  - a. The Tester is a Source only
    - i. The Tester responds with a Reject message
  - b. The Tester is a Source with Dual Role Power
    - i. The Tester responds the following Sink Capabilities message with single PDO:
      1. B31...30 (Fixed Supply) set to 00b
      2. B29 (Dual-Role Power) set to 1b
      3. B28 (Higher Capability) set to 0b
      4. B27 (Unconstrained Power) set to 1b
      5. B26 (USB Communications Capable) set to 0b

6. B25 (Dual-Role Data) set to 0b
7. B24...20 (Reserved) set to 00000b
8. B19...10 (Voltage) set to 5V
9. B9...0 (Maximum Current) set to 100mA

c. The Tester is a Sink

- i. The Tester responds the following Sink Capabilities message with single PDO:
  1. B31...30 (Fixed Supply) set to 00b
  2. B29 (Dual-Role Power) set to 0b if Tester is a Sink only; set to 1b if Tester is a Dual-Role Power
  3. B28 (Higher Capability) set to 0b
  4. B27 (Unconstrained Power) set to 1b
  5. B26 (USB Communications Capable) set to 0b
  6. B25 (Dual-Role Data) set to 0b
  7. B24...23 (Fast Role Swap required USB Type-C Current) set to 00b (Fast Swap not supported)
  8. B22...20 (Reserved) set to 000b
  9. B19...10 (Voltage) set to 5V
  10. B9...0 (Maximum Current) set to 100mA

#### *COMMON.PROC.PD.4 UUT Sent Ping*

**Procedure Applicability:** Unless otherwise specified, the Tester runs this procedure whenever receiving Ping message from the UUT.

1. The Tester receives Ping message from the UUT and ignores it. This message is valid except the following conditions: **[COMMON.PROC.PD.4#1]**
  - a. The check fails if the UUT sends this message before the Tester has established an Explicit Contract
  - b. The check fails if the UUT sends this message within a non-interruptible AMS
  - c. The check fails if the UUT sends this message and the UUT is a Sink

#### *COMMON.PROC.PD.5 UUT Sent PR\_Swap*

**Procedure Applicability:** Unless otherwise specified, the Tester runs this procedure whenever receiving PR\_Swap message from the UUT.

1. The Tester receives PR\_Swap message from the UUT. This message is valid except the following conditions: **[COMMON.PROC.PD.5#1]**
  - a. The check fails if the UUT sends this message before the Tester has established an Explicit Contract



- b. The check fails if the UUT sends this message within a non-interruptible AMS
- 2. The following are the scenarios (for rejecting a PR\_Swap).
  - a. The Tester is a Sink, the Tester responds with a Reject message. The check fails if the VIF field Requests\_PR\_Swap\_As\_Src = No. [COMMON.PROC.PD.5#2]
  - b. The Tester is a Source, the Tester responds with a Reject message. The check fails if the VIF field Requests\_PR\_Swap\_As\_Snk = No. [COMMON.PROC.PD.5#3]

#### *COMMON.PROC.PD.6 UUT Sent VCONN\_Swap*

**Procedure Applicability:** Unless otherwise specified, the Tester runs this procedure whenever receiving VCONN\_Swap message from the UUT.

- 1. The Tester receives VCONN\_Swap message from the UUT. This message is valid except the following conditions: [COMMON.PROC.PD.6#1]
  - a. The check fails if the UUT sends this message before the Tester has established an Explicit Contract
  - b. The check fails if the UUT sends this message within a non-interruptible AMS
- 2. There are two scenarios:
  - a. The Tester is the initial Vconn Source, and the Tester runs the following procedures
    - i. If the VIF field VCONN\_Swap\_To\_On\_Supported = Yes and the UUT sends a VCONN\_Swap message, the Tester responds with an Accept message. Otherwise (the VIF field VCONN\_Swap\_To\_On\_Supported = No and the UUT sends a VCONN\_Swap message), the check fails and the test stops here. [COMMON.PROC.PDU.6#2]
    - ii. The check fails if the UUT does not respond with PS\_RDY message within tVCONNSourceOn max from the last bit of the EOP of GoodCRC message corresponding to the Accept Message sent. [COMMON.PROC.PD.6#3]
    - iii. The Tester stops sourcing VCONN
  - b. The UUT is the initial VCONN Source, and the Tester runs the following procedures
    - i. If the VIF field VCONN\_Swap\_To\_Off\_Supported = Yes and the UUT sends a VCONN\_Swap message, the Tester responds with an Accept message. Otherwise (VIF field VCONN\_Swap\_To\_Off\_Supported = No and the UUT sends a VCONN\_Swap message), the check fails and the test stops here. [COMMON.PROC.PD.6#4]
    - ii. The Tester applies VCONN and sends PS\_RDY message.

#### *COMMON.PROC.PD.7 UUT Sent Discover Identity Request*

**Procedure Applicability:** Unless otherwise specified, the Tester runs this procedure whenever receiving Discover Identity Request message from the UUT.

1. The Tester receives Discover Identity Request message from the UUT. This message is valid except the following conditions: [\[COMMON.PROC.PD.7#1\]](#)
  - a. If the test is running in PD2 mode, the check fails if the UUT is a UFP or a Cable Plug
  - b. If the test is running in PD3 mode, the check fails if the UUT is a Cable Plug
  - c. The check fails if the VIF field Attempts\_Discov\_SOP = NO
  - d. The check fails if the UUT sends this message using SOP'' packet
  - e. The check fails if the UUT sends this message within a non-interruptible AMS
  - f. The check fails if the UUT sends this message using SOP packet before the Tester has established an Explicit Contract
2. The Tester performs the following checks on the Structured VDM Message Header: [\[COMMON.PROC.PD.7#2\]](#)
  - a. Bits 7...6 (Command Type) is set to 00b
  - b. Bits 4...0b (Command) is set to 1 (Discover Identity)
3. The Tester response depends on the SOP\* Communication:
  - a. If a SOP' Discover Identity Request message is received from the UUT, the Tester responds with a "Responder ACK" advertising Passive Cable with Vbus Current Handling Capability set to 5A and Maximum Vbus Voltage set to 20V.
  - b. If a SOP Discover Identity Request message is received from the UUT, the Tester responds with a "Responder NAK".
4. The Tester check the response: [\[COMMON.PROC.PD.7#3\]](#)
  - a. The check fails if the VIF field Captive\_Cable = No and the UUT has sent Discover Identity Request message using SOP'.
  - b. The check fails if a message is received from the UUT before the Tester has sent "Responder ACK" or "Responder NAK".

#### *COMMON.PROC.PD.8 UUT Sent Discover SVIDs Request*

**Procedure Applicability:** Unless otherwise specified, the Tester runs this procedure whenever receiving Discover SVIDs Request message from the UUT.

1. The Tester receives Discover SVIDs Request message from the UUT. This message is valid except the following conditions: [\[COMMON.PROC.PD.8#1\]](#)

- a. If the test is running in PD2 mode, the check fails if the UUT is a UFP or a Cable Plug
  - b. If the test is running in PD3 mode, the check fails if the UUT is a Cable Plug
  - c. The check fails if the VIF field Attempts\_Discov\_SOP = NO
  - d. The check fails if the UUT sends this message using SOP'' packet
  - e. The check fails if the UUT sends this message within a non-interruptible AMS
  - f. The check fails if the UUT sends this message before the Tester has established an Explicit Contract
2. The Tester performs the following checks on the Structured VDM Message Header:  
[COMMON.PROC.PD.8#2]
    - a. Bits 7...6 (Command Type) is set to 00b
    - b. Bits 4...0 (Command) is set to 2 (Discover SVIDs)
  3. The Tester responds with a "Responder NAK". The check fails if a message is received from the UUT before the Tester has sent "Responder NAK". [COMMON.PROC.PD.8#3]

#### *COMMON.PROC.PD.9 UUT Sent Attention*

**Procedure Applicability:** Unless otherwise specified, the Tester runs this procedure whenever receiving Attention Request message from the UUT.

1. The Tester receives Attention Request message from the UUT. This message is valid except the following conditions: [COMMON.PROC.PD.9#1]
  - a. In PD2, the check fails if the UUT is a DFP or a Cable Plug
  - b. In PD2, the check fails if the UUT is a Cable Plug
  - c. The check fails if VIF field Modal\_Operation\_Supported\_SOP = NO
  - d. The check fails if the UUT sends this message using SOP' or SOP'' packet
  - e. The check fails if the UUT sends this message within a non-interruptible AMS
  - f. The check fails if the UUT sends this message before the Tester has established an Explicit Contract
2. The Tester perform the following checks on the Structured VDM Message Header:  
[COMMON.PROC.PD.9#2]
  - a. Bits 7...6 (Command Type) is set to 00b
  - b. Bits 4...0b (Command) is set to 6 (Attention)
3. The Tester ignores the Attention Request message and does not send a response.

#### *COMMON.PROC.PD.10 UUT Sent Request*

**Procedure Applicability:** Unless otherwise specified, the Tester runs this procedure whenever receiving Request message from the UUT.

1. The Tester receives Request message from the UUT. This message is valid except the following conditions: [COMMON.PROC.PD.10#1]
  - a. The check fails if the UUT sends this message without the Tester sending any Source Capabilities message
  - b. The check fails if the UUT sends this message within a non-interruptible AMS
  - c. The check fails if the UUT is a Source
2. The Tester responds with an Accept message to the Request message.
3. If the VBUS voltage is stable within the target voltage, the Tester sends a PS\_RDY message at the limit of tPSTransition max after the reception of Accept message.

#### *COMMON.PROC.PD.11 UUT Sent Source Capabilities*

**Procedure Applicability:** Unless otherwise specified, the Tester runs this procedure whenever receiving Source Capabilities message from the UUT.

1. The Tester receives Source Capabilities message from the UUT. This message is valid except the following conditions: [COMMON.PROC.PD.11#1]
  - a. The check fails if the UUT sends this message within a non-interruptible AMS
  - b. The check fails if the UUT is a Sink
2. The Tester sends a Request message for 5V at 100mA.
  - a. B30 (Object Position) = 001b
  - b. B27 (GiveBack Flag) = 0b
  - c. B26 (Capability Mismatch) = 1b
  - d. B25 (USB Communication Capable) = 0b
  - e. B24 (No USB Suspend) = 1b
  - f. B19...10 (Operating Current) = 100mA
  - g. B9...0 (Maximum Operating Current) = 100mA
3. The check fails if an Accept message is not received. [COMMON.PROC.PD.11#2]
4. The check fails if PS\_RDY message is not received within tPSTransition max from the last bit of the EOP of Accept message. [COMMON.PROC.PD.11#3]

#### *COMMON.PROC.PD.12 UUT Sent DR\_Swap*

**Procedure Applicability:** Unless otherwise specified, the Tester runs this procedure whenever receiving DR\_Swap message from the UUT.

1. The Tester receives DR\_Swap message from the UUT. This message is valid except the following conditions: [\[COMMON.PROC.PD.12#1\]](#)
  - a. The check fails if the UUT sends this message before the Tester has established an Explicit Contract
  - b. The check fails if the UUT sends this message within a non-interruptible AMS
  - c. The check fails if the UUT is a UFP and the VIF field DR\_Swap\_To\_DFP\_Supported = No
  - d. The check fails if the UUT is a DFP and the VIF field DR\_Swap\_To\_UFP\_Supported = No

#### 2.3.2 PD3 Mode

The common procedures in this subsection are applicable only when the test is running in PD3.

##### *COMMON.PROC.PD3.1 Sink Start an AMS*

**Procedure Applicability:** Unless otherwise specified, the Tester runs this procedure whenever it needs to start an AMS.

1. The Tester as a Sink monitors the Rp value to start an AMS:
  - a. If the UUT presents SinkTxOK, the Sink proceeds to send message (and start an AMS) as described in the test.
  - b. If the UUT presents SinkTxNG and it does not send any message for 1s, then the check fails. [\[COMMON.PROC.PD3.1#1\]](#)

### 3 Physical Layer Specific Tests

This chapter describes tests that primary cover Chapters 6 and 8 requirements in the USB PD specifications.

**Receiver Test Signaling Table**

	TX_NORMAL	TX_GROUP_1	TX_GROUP_2	TX_GROUP_3
High Level (nom)	1100 mV	1200 mV	790 mV	1290 mV
Low Level (nom)	25mV	0 mV	-250mV	250mV
Bit Rate	300 kb/s	270 kb/s	330 kb/s	330 kb/s
Rise/Fall Time	735 ns	735 ns	735 ns	735 ns

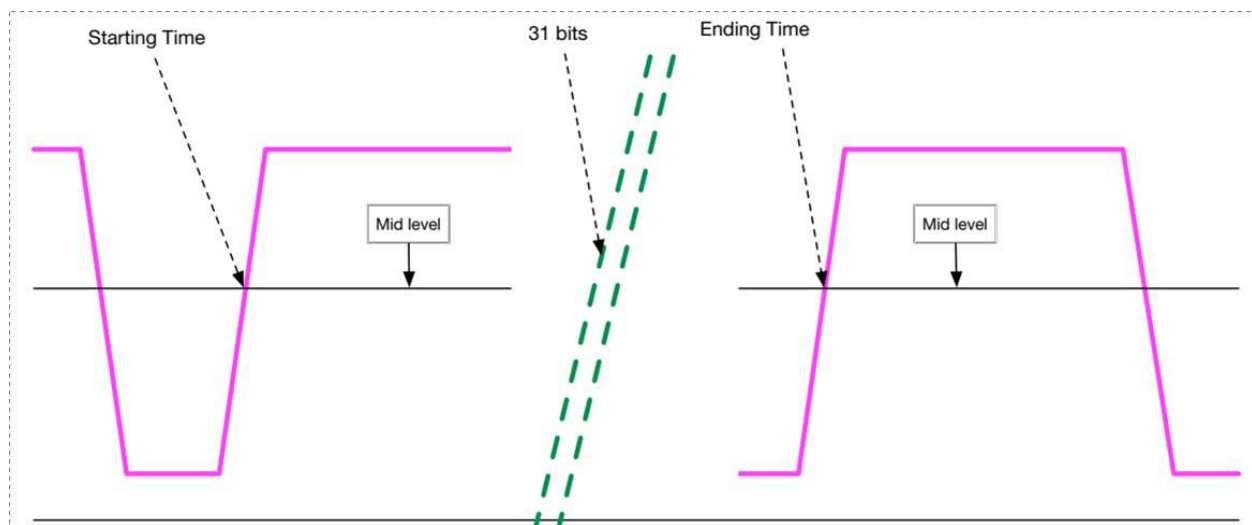


Figure 1: using mid-level to find the reference unit interval

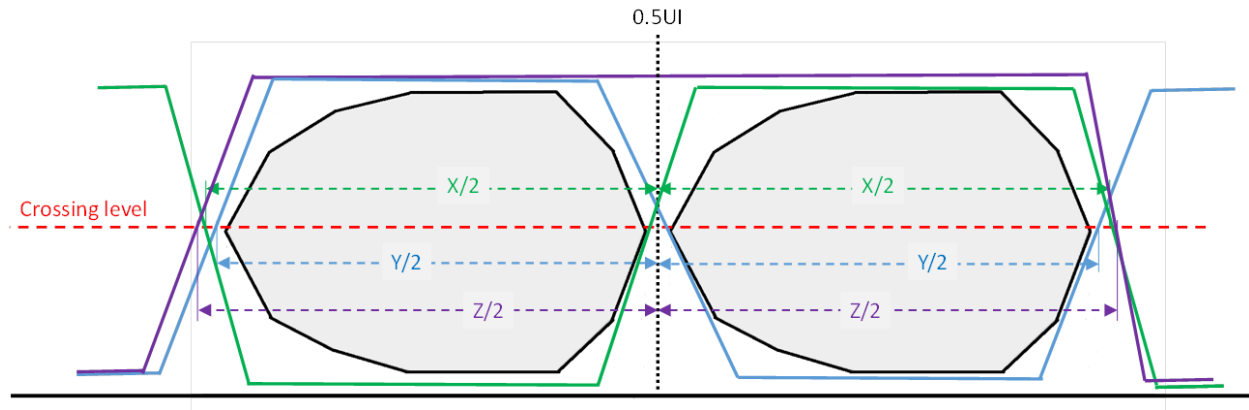


Figure 2: Example of producing eye diagram

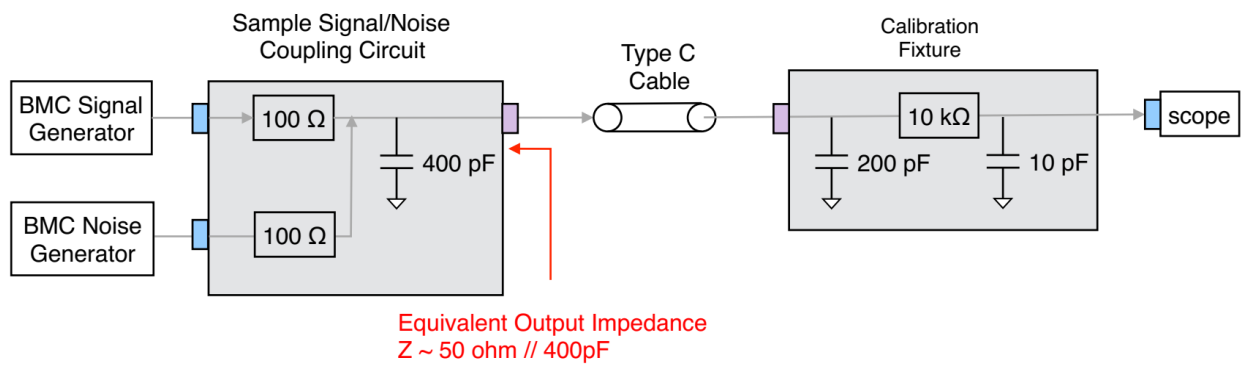


Figure 3: Noise injection generator and calibration fixture setup

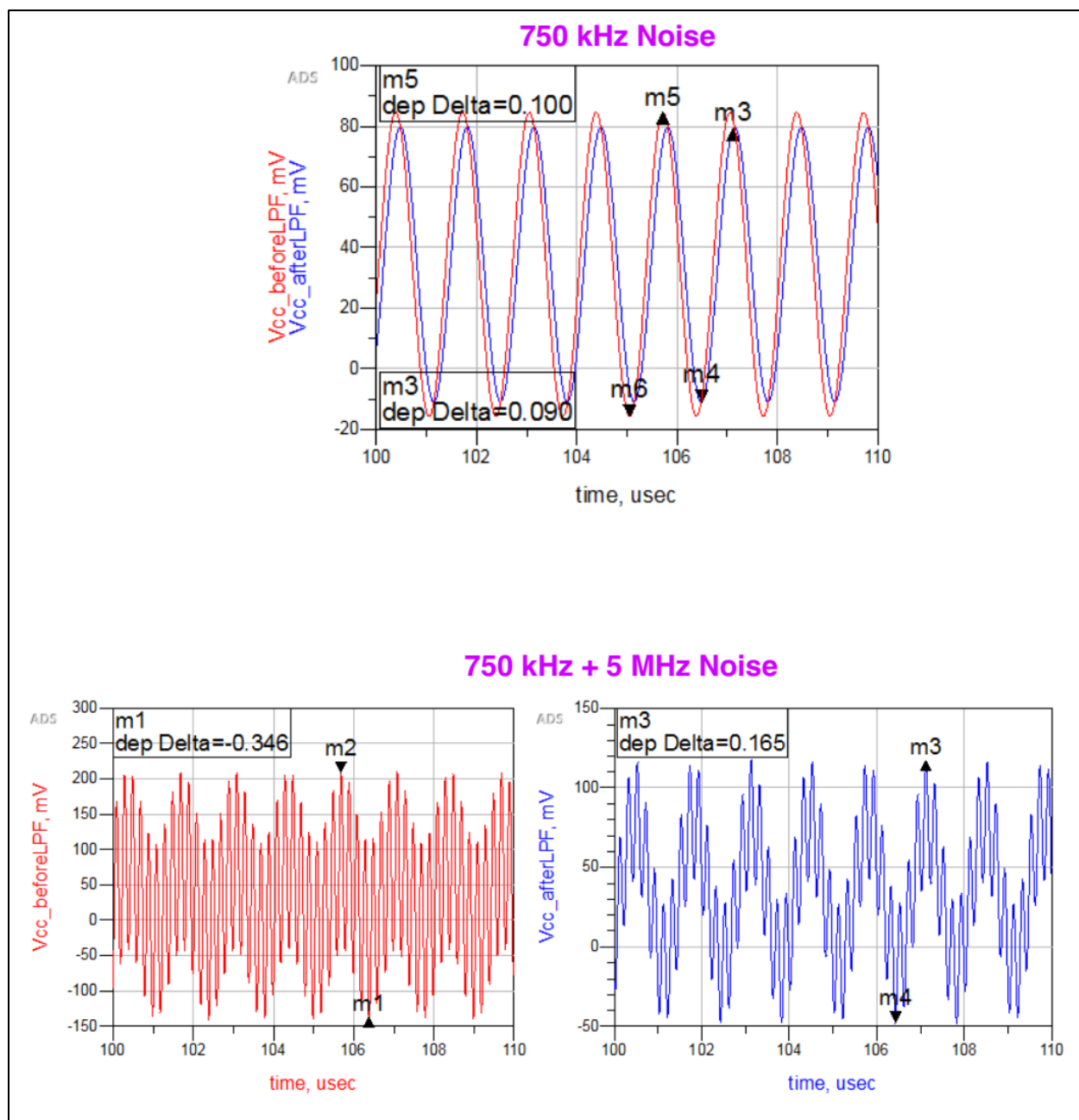


Figure 4: Two-tone noise calibration



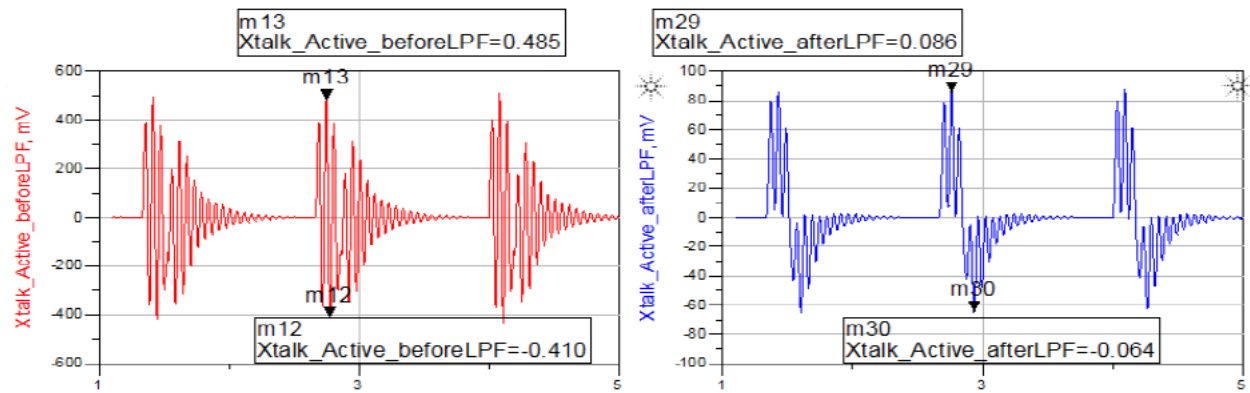


Figure 5: AWG measurement waveforms

### 3.1 Test Procedures for All UUTs

#### 3.1.1 PD3 Mode

The tests in this subsection are run only in PD3 mode.

The tests in this subsection are applicable to all UUTs.

Unless a Test Specific Tester Behavior is specified, this section uses the following behavior:

- The Tester always replies with an Accept message to a DR\_Swap message
- The Tester always rejects PR\_Swap COMMON.PROC.PD.5
- The Tester always accepts VCONN\_Swap COMMON.PROC.PD.6
- The Tester always provides a NAK response for Discover Identity COMMON.PROC.PD.7
- The Tester always provides a NAK response for Discover SVIDs COMMON.PROC.PD.8

#### *TEST.PD.PHY.ALL.1 Transmit Bit Rate and the Drift*

Description: The Tester checks that the UUT transmitted data meets the bit rate requirements and it correctly implements BIST Carrier Mode 2.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a BIST request to the UUT, specifying "BIST Carrier Mode 2".
3. The Tester creates a histogram with at least 100 bins of the total voltage swing for the bit stream collected from the BIST request. For example 100 bins, the voltage absolute max is 1.1V and absolute min is 0V; then the top bin is count of voltages between 1.089V and 1.1V; bottom bin is count of voltages between 0V and 0.011V
4. The Tester searches for the bin with highest count between Y5TX (0.5625V) and the maximum; and the middle voltage of the bin is "high level"
5. The Tester searches for the bin with highest count between Y5TX (0.5625V) and the minimum; and the middle voltage of the bin is "low level"
6. The average between "high level" and "low level" is the mid-level
7. The Tester uses the mid-level to find fBitRateRef (refer to [Figure 1](#))
  - a. Locate the first rising edge of a "0" bit.
  - b. Count 32 bits.
  - c. Locate the rising edge of a "0" bit, this is the **start** of the measured time.

- d. Count 32 bits
  - e. Locate the rising edge of a “0” bit, this is the **end** of the measured time.
  - f. The reference bit length fBitRateRef equals 32 divided by the measured time
8. The Tester finds a rising edge of a “0” bit and then it locates a 1024 bits long packet, where the first bit is identified as B0 and the last bit is identified as B1023. The Tester repeats the following 256 times with `_num = 0` (the first run starts from B0 through B32, the second runs starts from B4 through B36 etc.)
  - a. Locate the rising edge of B(`_num`) (a “0” bit), this is the **start** of the measured time.
  - b. Locate the rising edge of B(`_num + 32`) (a “0” bit), this is the **end** of the measured time.
  - c. Calculate fBitRateMeas as 32 divided by the measured time
  - d. The Tester checks fBitRateMeas: [\[TEST.PD.PHY.ALL.1#1\]](#)
    - i. The check fails if fBitRateMeas is less than or equal to fBitRate min
    - ii. The check fails if fBitRateMeas is more than or equal to fBitRate max
  - e. Compute  $pBitRateMax = (fBitRateMeas - fBitRateRef) / fBitRateRef$ .
  - f. The Tester checks that pBitRateMax is less than 0.25% [\[TEST.PD.PHY.ALL.1#2\]](#)
  - g. Compute  $pBitRateMin = (fBitRateRef - fBitRateMeas) / fBitRateRef$ .
  - h. The Tester checks that pBitRateMin is less than 0.25% [\[TEST.PD.PHY.ALL.1#3\]](#)
  - i. Set `_num = _num + 4`
9. The Tester checks that the bit stream collected meets tBISTContMode limits. [\[TEST.PD.PHY.ALL.1#4\]](#)
10. If it is a Cable Plug UUT, repeat the test on the other end of the cable.

#### *TEST.PD.PHY.ALL.2 Transmitter Eye Diagram*

Description: The Tester checks that the UUT transmitted data meets the eye diagram mask requirements.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a BIST request to the UUT, specifying “BIST Carrier Mode 2”.
3. The Tester creates a histogram with at least 100 bins of the total voltage swing for the bit stream collected from the BIST request. For example 100 bins, the voltage absolute max is 1.1V and absolute min is 0V; then the top bin is count of voltages between 1.089V and 1.1V; bottom bin is count of voltages between 0V and 0.011V

4. The Tester searches for the bin with highest count between Y5TX (0.5625V) and the maximum; and the middle voltage of the bin is "high level"
5. The Tester searches for the bin with highest count between Y5TX (0.5625V) and the minimum; and the middle voltage of the bin is "low level"
6. The average between "high level" and "low level" is the mid-level
7. Use the mid-level to find 1 UI (refer to [Figure 1](#))
  - a. Locate the rising edge of a "0" bit. This is the start of the measured time.
  - b. Count 32 bits.
  - c. Locate the rising edge of a "0" bit. This is the end of the measured time.
  - d. The reference bit length 1 UI equals the measured time divided by 32
8. The Tester uses the mid-level as the initial crossing level of the Eye Diagram, refer to [Figure 2](#).
9. Produce an Eye Diagram and verify that the parameters meet the requirements of Figures 5-22 and 5-23 of the USB PD2.0 specification.
  - a. The Eye Diagram shall use 2640 bits placed on the TX-Mask.
  - b. 1UI and crossing level is used for plotting the Eye Diagram. For each bit, the first and last crossings are separated equally from 0.5UI. Refer to [Figure 2](#).
  - c. The Eye Diagram verification fails if the signals violate the TX-Mask.
10. If the Eye Diagram verification fails in the previous step, the crossing level is shifted as follows and the Eye Diagram is re-verified for each sub-step below. For example, a given bit may shift left or right when the crossing level is adjusted.
  - a. Initial crossing level set to the mid-level, run Step-9
  - b. Add 10mv to the initial crossing level, run Step-9
  - c. Subtract 10mv from the initial crossing level, run Step-9
  - d. Add 20mv to the initial crossing level, run Step-9
  - e. Subtract 20mv from the initial crossing level, run Step-9
  - f. Add 30mv to the initial crossing level, run Step-9
  - g. Subtract 30mv from the initial crossing level, run Step-9
  - h. Add 40mv to the initial crossing level, run Step-9
  - i. Subtract 40mv from the initial crossing level, run Step-9
  - j. Add 50mv to the initial crossing level, run Step-9
  - k. Subtract 50mv from the initial crossing level, run Step-9
11. The check fails if the Eye Diagram verification fails in Steps 9 and 10. [\[TEST.PD.PHY.ALL.2#1\]](#)
12. Cable Plug tests need to be run 6 times, on both ends with VCONN voltage set to 2.75V, 4.25V and 5.75V.

#### [TEST.PD.PHY.ALL.3 Collision Avoidance](#)

Description: The Tester checks that the UUT properly implements collision avoidance requirements.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:

- a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a BIST request to the UUT, specifying "BIST Test Data".
3. Exactly 17us after the end of the previous packet, the Tester transmits a bit stream sequence (alternating 0s and 1s simulating a preamble) for a duration of 200 us. *Editorial note: it takes 2 UI (3.7us tUnitInterval max) to generate 3 transitions (nTransitionCount). So that is 25us (tInterFrameGap) minus 7.4us.*
4. The Tester waits for 10ms and the check fails if the UUT sends a GoodCRC.  
[TEST.PD.PHY.ALL.3#1]
5. The Tester sends a BIST request to the UUT, specifying "BIST Test Data".
6. Immediately after the end of the previous packet, the Tester transmit a continuous stream of 0s for a duration of 195us.
7. The Tester waits for 10ms and the check fails if the UUT sends a GoodCRC.  
[TEST.PD.PHY.ALL.3#1]
8. If it is a Cable Plug UUT, repeat the test on the other end of the cable.

#### TEST.PD.PHY.ALL.4 Bus Idle Detection

Description: The Tester checks that the expected levels of noise on the CC line do not prevent the UUT from detecting a bus idle condition.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a BIST request to the UUT, specifying "BIST Test Data".
3. Immediately after the end of the previous packet, the Tester either transmits simulated noise waveforms using an Arbitrary Waveform Generator (AWG) or transmits the two-tone noise waveforms for 438us.
4. The check fails if the UUT does not respond with a GoodCRC within tReceive.  
[TEST.PD.PHY.ALL.4#1]

5. If it is a Cable Plug UUT, repeat the test on the other end of the cable.

The two-tone sinusoidal noise waveform is generated as followed:

1. The noise calibration setup is as shown in [Figure 3](#):
  - a. The equivalent impedance of the Tester BMC transmitter and the noise generator is 50 Ohm +/- 10% and 400pF +/-15%
  - b. The calibration fixture consists of a bandwidth limiting filter as shown in [Figure 3](#). The probe capacitance loading effect shall be considered.
2. The noise generator provides a superimposed two-tone sinusoidal waveform. One at  $750 \pm 50$  kHz and another at  $5 \pm 0.5$  MHz.
3. The noise magnitude is calibrated using a scope connected to the calibration fixture (refer to [Figure 4](#)):
  - a. First, inject 750 kHz sinusoidal waveform and adjust the magnitude until the scope (attached to the calibration fixture) measures 90mV peak-to-peak.
  - b. Next, superimpose 5 MHz sinusoidal waveform on the 750 kHz waveform, adjust the magnitude of the 5 MHz sinusoidal waveform until the scope measures 300mV peak-to-peak.

The Arbitrary Waveform Generator (AWG) waveform is generated as followed:

1. The noise calibration setup is as shown in [Figure 3](#):
  - a. The equivalent impedance of the Tester BMC transmitter and the noise generator is 50 Ohm +/- 10% and 400pF +/-15%
  - b. The calibration fixture consists of a bandwidth limiting filter as shown in [Figure 3](#). The probe capacitance loading effect shall be considered.
2. Program the AWG to output the simulated noise using the generated waveform file. This should be summed with the CC signal during the transmission of a BIST Tester Data message.
3. In [Figure 5](#), the left-hand waveform m13 is both the content of the AWG-waveform data file, and exactly what should appear on the CC line of the test cable. The waveform data file is not what should be applied to the noise insertion point in [Figure 3](#). This point requires a pre-emphasized version of the waveform data file, which compensates for the filtering effect of the noise insertion circuit comprising the two 100Ω resistors, the 400pF and 200pF capacitors and the nominal capacitance of the cable type used by the test equipment.

#### [TEST.PD.PHY.ALL.5 Receiver Interference Rejection](#)

**Description:** The Tester checks that the UUT correctly receives signals under boundary conditions.

**Test Specific Tester Behavior:** N/A

#### **Test Procedures:**

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).

- b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
    - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
  2. The Tester sends a BIST request to the UUT, specifying “BIST Test Data”.
  3. The Tester waits 15ms.
  4. Using TX\_GROUP\_1 parameters in the **Receiver Test Signaling Table**, the Tester sends “BIST Test Data” message (without incrementing MessageID) for 13362 times. The noise generator transmits two-tone noise or AWG waveforms when the Tester sends the BIST Test Data message, and the two-tone noise or AWG waveforms are not transmitted when the Tester stops sending BIST Test Data message. The check fails if UUT does not respond with a GoodCRC for each of the “BIST Test Data” message. [TEST.PD.PHY.ALL.5#1]
  5. The Tester runs the following procedures depending on the power role:
    - a. If it is a Sink UUT, using TX\_GROUP\_2 parameters in the **Receiver Test Signaling Table**, the Tester sends “BIST Test Data” message (without incrementing MessageID) for 13362 times. The check fails if UUT does not respond with a GoodCRC for each of the “BIST Test Data” message. [TEST.PD.PHY.ALL.5#2]
    - b. If it is a Source UUT, using TX\_GROUP\_3 parameters in the **Receiver Test Signaling Table**, the Tester sends “BIST Test Data” message (without incrementing MessageID) for 13362 times. The check fails if UUT does not respond with a GoodCRC for each of the “BIST Test Data” message. [TEST.PD.PHY.ALL.5#3]
    - c. If it is a Cable Plug UUT, the Tester performs the following checks [TEST.PD.PHY.ALL.5#4]:
      - i. Using TX\_GROUP\_2 parameters in the **Receiver Test Signaling Table**, the Tester sends “BIST Test Data” message (without incrementing MessageID) for 13362 times. The check fails if UUT does not respond with a GoodCRC for each of the “BIST Test Data” message.
      - ii. Using TX\_GROUP\_3 parameters in the **Receiver Test Signaling Table**, the Tester sends “BIST Test Data” message (without incrementing MessageID) for 13362 times. The check fails if UUT does not respond with a GoodCRC for each of the “BIST Test Data” message.
  6. If UUT is a Dual-Role Power device (and it has been running this test first time as a Sink), repeat the test with the UUT as a Source. If it is a Cable Plug UUT, repeat the test on the other end of the cable.

The two-tone sinusoidal noise waveform is generated as followed:

1. The noise calibration setup is as shown in [Figure 3](#):
  - a. The equivalent impedance of the Tester BMC transmitter and the noise generator is 50 Ohm +/- 10% and 400pF +/-15%
  - b. The calibration fixture consists of a bandwidth limiting filter as shown in [Figure 3](#). The probe capacitance loading effect shall be considered.
2. The noise generator provides a superimposed two-tone sinusoidal waveform. One at  $750 \pm 50$  kHz and another at  $5 \pm 0.5$  MHz.

3. The noise magnitude is calibrated using a scope connected to the calibration fixture (refer to [Figure 4](#)):
  - a. First, inject 750 kHz sinusoidal waveform and adjust the magnitude until the scope (attached to the calibration fixture) measures 90mV peak-to-peak. The offset is at 0V.
  - b. Next, superimpose 5 MHz sinusoidal waveform on the 750 kHz waveform, adjust the magnitude of the 5 MHz sinusoidal waveform until the scope measures 165mV peak-to-peak. The offset is at 0V.

The Arbitrary Waveform Generator (AWG) waveform is generated as followed:

1. The noise calibration setup is as shown in [Figure 3](#):
  - a. The equivalent impedance of the Tester BMC transmitter and the noise generator is 50 Ohm +/- 10% and 400pF +/-15%
  - b. The calibration fixture consists of a bandwidth limiting filter as shown in [Figure 3](#). The probe capacitance loading effect shall be considered.
2. Program the AWG to output the simulated noise using the generated waveform file. This should be summed with the CC signal during the transmission of a BIST Tester Data message.
3. In [Figure 5](#), the left-hand waveform m13 is both the content of the AWG-waveform data file, and exactly what should appear on the CC line of the test cable. The waveform data file is not what should be applied to the noise insertion point in [Figure 3](#). This point requires a pre-emphasized version of the waveform data file, which compensates for the filtering effect of the noise insertion circuit comprising the two 100Ω resistors, the 400pF and 200pF capacitors and the nominal capacitance of the cable type used by the test equipment.

#### [TEST.PD.PHY.ALL.6 Invalid SOP\\*](#)

Description: The Tester checks that the UUT responds correctly to invalid SOP\*.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a BIST request to the UUT, specifying "BIST Test Data".
3. The Tester waits 15ms to respond to messages from the UUT.
4. Transmit a BIST message with BIST Test Data object using SOP packet
5. Transmit 10 BIST Test Data messages flipping Bit 0 of the first two symbols (number 1&2) of the SOP. The check fails if the UUT responds with a GoodCRC. [\[TEST.PD.PHY.ALL.6#1\]](#)



6. Repeat Step-5 with all combinations of flipping Bit 0 of two symbols of the SOP (number 1&3, 1&4, 2&3, 2&4, 3&4).
7. Additionally, for Cable Plug and DFP UUT, repeat the test using SOP' packet (if SOP\_P\_Capable = Yes) and SOP'' packet (if SOP\_PP\_Capable = Yes).

#### *TEST.PD.PHY.ALL.7 Valid SOP\**

Description: The Tester checks that the UUT responds correctly to valid SOP\*.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a BIST request to the UUT, specifying "BIST Test Data".
3. The Tester waits 15ms to respond to messages from the UUT.
4. Transmit a BIST message with BIST Test Data object using SOP packet
5. Transmit 10 BIST Test Data messages using SOP.
  - a. The check fails if the Cable Plug UUT respond with a GoodCRC [TEST.PD.PHY.ALL.7#1]
6. Transmit 10 BIST Test Data messages using SOP'.
  - a. The check fails if VIF field SOP\_P\_Capable = No and the DFP UUT responds with a GoodCRC [TEST.PD.PHY.ALL.7#2]
  - b. The check fails if the UFP UUT responds with a GoodCRC [TEST.PD.PHY.ALL.7#3]
  - c. The check fails if the Cable Plug UUT does not respond with a GoodCRC [TEST.PD.PHY.ALL.7#4]
7. Transmit 10 BIST Test Data messages using SOP''.
  - a. The check fails if VIF field SOP\_PP\_Capable = No and the DFP UUT responds with a GoodCRC [TEST.PD.PHY.ALL.7#5]
  - b. The check fails if the UFP UUT responds with a GoodCRC [TEST.PD.PHY.ALL.7#6]
  - c. The check fails if VIF field SOP\_PP\_Capable = Yes and the Cable Plug UUT does not respond with a GoodCRC. Similarly, the check fails if VIF field SOP\_PP\_Capable = No and the Cable Plug UUT responds with a GoodCRC. [TEST.PD.PHY.ALL.7#7]
8. Transmit 10 BIST Test Data messages using SOP'\_Debug.
  - a. The check fails if VIF field SOP\_P\_Debug\_Capable = No and the UUT responds with a GoodCRC [TEST.PD.PHY.ALL.7#8]
9. Transmit 10 BIST Test Data messages using SOP''\_Debug.
  - a. The check fails if VIF field SOP\_PP\_Debug\_Capable = No and the UUT responds with a GoodCRC [TEST.PD.PHY.ALL.7#9]

#### *TEST.PD.PHY.ALL.8 Incorrect CRC*

Description: The Tester checks that the UUT does not provides a GoodCRC to an intentionally corrupted message.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a message depending on the UUT type/role (note that this test is first run sending uncorrupted message followed by corrupted messages):
  - a. If the UUT is a Cable Plug, the Tester sends a Discover Identity Request message.
  - b. If the UUT is a Source or Sink, the Tester sends a Get\_Sink\_Cap message.
3. The Tester checks the response message depending on the UUT type/role:
  - a. The UUT is a Cable Plug: [TEST.PD.PHY.ALL.8#1]
    - i. If the Tester has sent an uncorrupted message, the check fails if the UUT does not send a Discover Identity ACK message.
    - ii. If the Tester has sent a corrupted message, the check fails if the UUT responds with a GoodCRC or a Discover Identity ACK message.
  - b. The UUT is a Sink: [TEST.PD.PHY.ALL.8#2]
    - i. If the Tester has sent an uncorrupted message, the check fails if the UUT does not send a Sink Capabilities message.
    - ii. If the Tester has sent a corrupted message, the check fails if the UUT responds with a GoodCRC or a Sink Capabilities message.
  - c. The UUT is a Source: [TEST.PD.PHY.ALL.8#3]
    - i. If the Tester has sent an uncorrupted message, the check fails if the UUT does not send Sink Capabilities, Not Supported or Reject message.
    - ii. If the Tester has sent a corrupted message, the check fails if the UUT responds with a GoodCRC or Sink Capabilities, Not Supported or Reject message.
4. The Tester repeats Step-2 and Step-3 but implements modifications to the messages in Step-2 as followed:
  - a. Flip Bit 0 in the CRC before 4b5b encoding
  - b. Flip Bit 0 in the CRC after 4b5b encoding
  - c. After generating the CRC, flip Bit 0 of the packet payload before 4b5b encoding
  - d. After generating the CRC and the 4b5b encoding, flip Bit 0 of the packet payload

- e. After the 4b5b encoding, replace the third 5b symbol of the Message Header with 11111b (a reserved 5b symbol).

## 3.2 Test Procedures for Source and Sink Capable UUTs

### 3.2.1 PD3 Mode

The tests in this subsection are run only in PD3 mode.

The tests in this subsection are applicable to UUT with VIF field VIF\_Product\_Type set to Port.

Unless a Test Specific Tester Behavior is specified, this section uses the following behavior:

- The Tester always replies with an Accept message to a DR\_Swap message
- The Tester always rejects PR\_Swap COMMON.PROC.PD.5
- The Tester always accepts VCONN\_Swap COMMON.PROC.PD.6
- The Tester always provides a NAK response for Discover Identity COMMON.PROC.PD.7
- The Tester always provides a NAK response for Discover SVIDs COMMON.PROC.PD.8

#### *TEST.PD.PHY.PORT.1 Invalid Reset Signals*

Description: The Tester checks that the UUT responds correctly to invalid reset signals.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 2 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends a BIST request to the UUT, specifying "BIST Test Data".
3. The Tester waits 15ms to respond to messages from the UUT.
4. The Tester sends a Cable Reset signal.
5. The Tester waits 1.5 second, and the check fails if the UUT does send any message or removing VBUS. [TEST.PD.PHY.PORT.1#1]
6. The Tester transmits Hard Reset flipping Bit 0 of the first two symbols (number 1&2).
7. The Tester waits 1.5 second and checks that the UUT does not send any message or removing VBUS.
8. The Tester sends a Get\_Sink\_Cap message to the UUT.
9. The check fails if the Tester does not receive a Sink Capabilities message (or a Reject message if it is a Source UUT).
10. The Tester repeats Step-6 through Step-9 and uses all combinations of flipping Bit 0 of two symbols (number 1&3, 1&4, 2&3, 2&4, 3&4) in Step-6.

## 4 Protocol Specific Tests

This chapter describes tests that primary cover Chapters 6 and 8 requirements in the USB PD2 specifications.

### 4.1 Test Procedures for All UUTs

#### 4.1.1 PD2 and PD3 Modes

The tests in this subsection are run firstly in PD2 mode and secondly in PD3 mode.

The tests in this subsection are applicable to all UUTs.

Unless a Test Specific Tester Behavior is specified, this section uses the following behavior:

- The Tester always replies with an Accept message to a DR\_Swap message
- The Tester always rejects PR\_Swap COMMON.PROC.PD.5
- The Tester always accepts VCONN\_Swap COMMON.PROC.PD.6
- The Tester always provides a NAK response for Discover Identity COMMON.PROC.PD.7
- The Tester always provides a NAK response for Discover SVIDs COMMON.PROC.PD.8

#### *TEST.PD.PROT.ALL.1 Corrupted GoodCRC*

Description: The Tester checks that the UUT retransmits the PD message if it does not receive a correct GoodCRC.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a message depending on the UUT type/role (first time):
  - a. If the UUT is a Cable Plug, the Tester sends a Discover Identity Request message.
  - b. If the UUT is a Source or Sink, the Tester sends a Get\_Sink\_Cap message.
3. The Tester checks the response message depending on the UUT type/role:
  - a. If the UUT is a Cable Plug, the check fails if the UUT does not send a Discover Identity ACK message. [TEST.PD.PROT.ALL.1#1]
  - b. If the UUT is a Sink, the check fails if the UUT does not send a Sink Capabilities message. [TEST.PD.PROT.ALL.1#2]
  - c. If the UUT is a Source, the check fails if the UUT does not send Sink Capabilities, Not Supported or Reject message. [TEST.PD.PROT.ALL.1#3]
4. The Tester sends a GoodCRC with an incorrect CRC (flip bit 0 of the CRC before 4b5b encoding).
5. The Tester checks the behavior:

- a. For Cable Plug UUT, the check fails if the UUT retransmits [TEST.PD.PROT.ALL.1#4]
  - b. For Sink or Source UUT, the check fails if the UUT does not retransmit (Sink Capabilities, Not Supported or Reject message) with the same MessageID (within tRetry of the CRCReceiveTimer expiring), and the Tester responds a valid GoodCRC. [TEST.PD.PROT.ALL.1#5]
6. The Tester sends a message depending on the UUT type/role (second time):
  - a. If the UUT is a Cable Plug, the Tester sends a Discover Identity Request message.
  - b. If the UUT is a Source or Sink, the Tester sends a Get\_Sink\_Cap message.
7. The Tester checks the response message depending on the UUT type/role:
  - a. If the UUT is a Cable Plug, the check fails if the UUT does not send a Discover Identity ACK message. [TEST.PD.PROT.ALL.1#6]
  - b. If the UUT is a Sink, the check fails if the UUT does not send a Sink Capabilities message. [TEST.PD.PROT.ALL.1#7]
  - c. If the UUT is a Source, the check fails if the UUT does not send Sink Capabilities, Not Supported or Reject message. [TEST.PD.PROT.ALL.1#8]
8. The Tester sends a GoodCRC with an incorrect MessageID (increment by one to the received message).
9. The Tester checks the behavior:
  - a. For Cable Plug UUT, the check fails if the UUT retransmits [TEST.PD.PROT.ALL.1#9]
  - b. For Sink or Source UUT, the check fails if the UUT does not retransmits (Sink Capabilities, Not Supported or Reject message) with the same MessageID (within tRetry of the CRCReceiveTimer expiring) for nRetryCount times. [TEST.PD.PROT.ALL.1#10]

#### *TEST.PD.PROT.ALL.2 Retransmission*

Description: The Tester checks that the UUT uses Soft Reset and Hard Reset correctly.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a message depending on the UUT type/role (first time):
  - a. If the UUT is a Cable Plug, the Tester sends a Discover Identity Request message.
  - b. If the UUT is a Source or Sink, the Tester sends a Get\_Sink\_Cap message.
3. The Tester checks the response message depending on the UUT type/role:
  - a. If the UUT is a Cable Plug, the check fails if the UUT does not send a Discover Identity ACK message. [TEST.PD.PROT.ALL.2#1]

- b. If the UUT is a Sink, the check fails if the UUT does not send a Sink Capabilities message. [\[TEST.PD.PROT.ALL.2#2\]](#)
  - c. If the UUT is a Source, the check fails if the UUT does not send Sink Capabilities, Not Supported or Reject message. [\[TEST.PD.PROT.ALL.2#3\]](#)
- 4. The Tester does not send a GoodCRC.
- 5. The Tester checks the response message depending on the UUT type/role:
  - a. For Cable Plug UUT, the check fails if the UUT retransmits [\[TEST.PD.PROT.ALL.2#4\]](#)
  - b. For Sink or Source UUT, the check fails if the UUT does not retransmit (Sink Capabilities, Not Supported or Reject message) with the same MessageID (within tRetry of the CRCReceiveTimer expiring) for nRetryCount times. [\[TEST.PD.PROT.ALL.2#5\]](#)
- 6. The Tester checks the behavior depending on the UUT type/role:
  - a. If the UUT is a Cable Plug, the check fails if the UUT sends a Soft\_Reset message or a Hard Reset signal. [\[TEST.PD.PROT.ALL.2#6\]](#)
  - b. If the UUT is a Sink
    - i. The check fails if the UUT does not transmit a Soft\_Reset message. [\[TEST.PD.PROT.ALL.2#7\]](#) The Tester responds with a valid GoodCRC.
    - ii. The Tester sends an Accept message.
    - iii. The Tester transmits Source Capabilities message with single PDO (5V @ 100mA, Source only). The check fails if the UUT does not send a Request message. [\[TEST.PD.PROT.ALL.2#8\]](#) The Tester establishes a PD contract using common procedure COMMON.PROC.PD.10.
  - c. If the UUT is a Source
    - i. The check fails if the UUT does not transmit a Soft\_Reset message. [\[TEST.PD.PROT.ALL.2#9\]](#) The Tester responds with a valid GoodCRC.
    - ii. The Tester sends an Accept message.
    - iii. The check fails if the UUT does not send a Source Capabilities message. [\[TEST.PD.PROT.ALL.2#10\]](#) The Tester establishes a PD contract using common procedure COMMON.PROC.PD.11.
- 7. The Tester sends a message depending on the UUT type/role (second time):
  - a. If the UUT is a Cable Plug, the Tester sends a Discover Identity Request message.
  - b. If the UUT is a Source or Sink, the Tester sends a Get\_Sink\_Cap message.
- 8. The Tester checks the behavior depending on the UUT type/role:
  - a. For Cable Plug UUT: the check fails if the UUT does not send a Discover Identity ACK message. [\[TEST.PD.PROT.ALL.2#11\]](#)
  - b. For Sink UUT: the check fails if the UUT does not send a Sink Capabilities message. [\[TEST.PD.PROT.ALL.2#12\]](#)
  - c. For Source UUT: the check fails if the UUT does not send Sink Capabilities, Not Supported or Reject message. [\[TEST.PD.PROT.ALL.2#13\]](#)
- 9. The Tester does not send a GoodCRC.
- 10. The Tester checks the response message depending on the UUT type/role:
  - a. For Cable Plug UUT, the check fails if the UUT retransmits [\[TEST.PD.PROT.ALL.2#14\]](#)
  - b. For Sink or Source UUT, the check fails if the UUT does not retransmit (Sink Capabilities, Not Supported or Reject message) with the same MessageID (within tRetry of the CRCReceiveTimer expiring) for nRetryCount times. [\[TEST.PD.PROT.ALL.2#15\]](#)

11. The Tester checks the behavior depending on the UUT type/role:
  - a. If the UUT is a Cable Plug, check that the UUT does not send a Soft\_Reset message or a Hard Reset signal [TEST.PD.PROT.ALL.2#16]
  - b. If the UUT is a Sink or Source
    - i. The check fails if the UUT does not transmit a Soft\_Reset message [TEST.PD.PROT.ALL.2#17]
    - ii. The Tester does not send a GoodCRC to the Soft\_Reset message.
    - iii. The check fails if the UUT does not retransmit (Soft\_Reset message) with the same MessageID (within tRetry of the CRCReceiveTimer expiring) for nRetryCount times [TEST.PD.PROT.ALL.2#18].
    - iv. The check fails if the UUT does not transmit a Hard Reset [TEST.PD.PROT.ALL.2#19].

### *TEST.PD.PROT.ALL.3 Soft Reset Response*

Description: The Tester checks that the UUT responds correctly to Soft Reset message.

Test Specific Tester Behavior: N/A

### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a message depending on the UUT type/role (using an incremented MessageID):
  - a. If the UUT is a Cable Plug, the Tester sends a Discover Identity Request message.
  - b. If the UUT is a Source or Sink, the Tester sends a Get\_Sink\_Cap message.
3. The Tester checks the response message (with an incremented MessageID) based on the UUT type/role:
  - a. If the UUT is a Cable Plug, the check fails if the UUT does not send a Discover Identity ACK message. [TEST.PD.PROT.ALL.3#1]
  - b. If the UUT is a Sink, the check fails if the UUT does not send a Sink Capabilities message. [TEST.PD.PROT.ALL.3#2]
  - c. If the UUT is a Source, the check fails if the UUT does not send Sink Capabilities, Not Supported or Reject message. [TEST.PD.PROT.ALL.3#3]
4. If MessageID in the last sent message is not 000b, the Tester repeats the previous 2 steps (i.e. sending Discover Identity REQ or Get\_Sink\_cap and receiving response) until the MessageID in the last sent message is 000b.



5. Immediately after sending GoodCRC (to the Discover ID ACK, Sink Capabilities or Reject), the Tester sends a Soft Reset message after tInterframeGap. The check fails if the UUT does not resend an Accept message with MessageID 000b. [TEST.PD.PROT.ALL.3#4]
6. The Tester checks the response message depending on the UUT type/role:
  - a. For Sink UUT, the Tester transmits Source Capabilities message with single PDO (5V @ 100mA, Source only). The check fails if the UUT does not send a Request message. [TEST.PD.PROT.ALL.3#5] The Tester establishes a PD using common procedure COMMON.PROC.PD.10.
  - b. For Source UUT, the check fails if the UUT does not send a Source Capabilities. [TEST.PD.PROT.ALL.3#6] Once the Tester receives Source Capabilities message, the Tester establishes a PD contract using common procedure COMMON.PROC.PD.11.
7. The Tester sends a message depending on the UUT type/role:
  - a. If the UUT is a Cable Plug, the Tester sends a Discover Identity Request message.
  - b. If the UUT is a Source or Sink, the Tester sends a Get\_Sink\_Cap message.
8. The Tester checks the response message depending on the UUT type/role:
  - a. For Cable Plug UUT: the check fails if the UUT does not send a Discover Identity ACK message. [TEST.PD.PROT.ALL.3#7]
  - b. For Sink UUT: the check fails if the UUT does not send a Sink Capabilities message. [TEST.PD.PROT.ALL.3#8]
  - c. For Source UUT: the check fails if the UUT does not send Sink Capabilities, Not Supported or Reject message. [TEST.PD.PROT.ALL.3#9]

#### *TEST.PD.PROT.ALL.4 Reset Signals and MessageID*

Description: The Tester checks that the UUT responds correctly to Hard Reset and Cable Reset signals.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a message depending on the UUT type/role (using an incremented MessageID):
  - a. If the UUT is a Cable Plug, the Tester sends a Discover Identity Request message.
  - b. If the UUT is a Source or Sink, the Tester sends a Get\_Sink\_Cap message.
3. The Tester checks the response message (with an incremented MessageID) based on the UUT type/role:



- a. If the UUT is a Cable Plug, check that the UUT sends a Discover Identity ACK message.  
[TEST.PD.PROT.ALL.4#1]
  - b. If the UUT is a Sink, check that the UUT sends a Sink Capabilities message.  
[TEST.PD.PROT.ALL.4#2]
  - c. If the UUT is a Source, check that the UUT sends a Sink Capabilities or Reject message.  
[TEST.PD.PROT.ALL.4#3]
4. If MessageID in the last sent message is not 000b, the Tester repeats the previous 2 steps (i.e. sending Discover Identity REQ or Get\_Sink\_cap and receiving response) until the MessageID in the last sent message is 000b.
5. Immediately after sending GoodCRC (to the Discover ID ACK, Sink Capabilities or Reject), the Tester sends a Hard Reset signal after tInterframeGap (note that the second run through is a Cable Reset signal for a Cable Plug UUT).
6. The test proceeds depending on the UUT type/role:
  - a. If the UUT is a Sink, the Tester drives VBUS to vSafe0V and then restores VBUS to vSafe5V. The Tester transmits Source Capabilities message with single PDO (5V @ 100mA, Source only) between tTypeCSinkWaitCap min and max. The Tester checks that the UUT sends a Request message. [TEST.PD.PROT.ALL.4#4] Once it receives a Request message, it proceeds using common procedure COMMON.PROC.PD.10.
  - b. If the UUT is a Source:
    - i. The Tester checks that the UUT drives VBUS to vSafe0V and then restores VBUS to vSafe5V. [TEST.PD.PROT.ALL.4#5]
    - ii. The check fails if Source Capabilities is not sent by the UUT within tNoResponse. [TEST.PD.PROT.ALL.4#6] Once the Tester receives Source Capabilities message, the Tester establishes a PD contract using common procedure COMMON.PROC.PD.11.
  - c. If the UUT is a Cable Plug, the Tester checks the responds depending on the UUT type.  
[TEST.PD.PROT.ALL.4#7]
    - i. If the Tester has sent a Hard Reset (first run), the Tester drives VBUS to vSafe0V and then restores VBUS to vSafe5V. The Tester transmits Discover Identity REQ every tDiscoverIdentity until either nDiscoverIdentityCount has expired or it receives a GoodCRC followed by a Discover Identity ACK. The check fails nDiscoverIdentityCount has expired.
    - ii. If the Tester has sent a Cable Reset (second run), the Tester transmits Discover Identity REQ every tDiscoverIdentity. The check fails if the UUT does not sends a GoodCRC followed by a Discover Identity ACK.
7. The Tester sends a message depending on the UUT type/role (using an incremented MessageID):
  - a. If the UUT is a Cable Plug, the Tester sends a Discover Identity Request message.
  - b. If the UUT is a Source or Sink, the Tester sends a Get\_Sink\_Cap message.
8. The Tester checks the response message (with an incremented MessageID) based on the UUT type/role:
  - a. If the UUT is a Cable Plug, check that the UUT sends a Discover Identity ACK message.  
[TEST.PD.PROT.ALL.4#8]

- b. If the UUT is a Sink, check that the UUT sends a Sink Capabilities message.  
[TEST.PD.PROT.ALL.4#9]
  - c. If the UUT is a Source, check that the UUT sends a Sink Capabilities or Reject message.  
[TEST.PD.PROT.ALL.4#10]
- 9. The Tester repeats Step-7 with the same MessageID.
- 10. The check fails if the UUT has sent a response message (either Discover Identity ACK, NAK or BUSY, or Sink Capabilities or Reject) when the MessageID has been repeated.  
[TEST.PD.PROT.ALL.4#11]
- 11. The Tester sends a message depending on the UUT type/role (using an incremented MessageID):
  - a. If the UUT is a Cable Plug, the Tester sends a Discover Identity Request message.
  - b. If the UUT is a Source or Sink, the Tester sends a Get\_Sink\_Cap message.
- 12. The Tester checks the response message (with an incremented MessageID) based on the UUT type/role:
  - a. For Cable Plug UUT: the check fails if the UUT does not send a Discover Identity ACK message. [TEST.PD.PROT.ALL.4#12]
  - b. For Sink UUT: the check fails if the UUT does not send a Sink Capabilities message.  
[TEST.PD.PROT.ALL.4#13]
  - c. For Source UUT: the check fails if the UUT does not send Sink Capabilities, Not Supported or Reject message. [TEST.PD.PROT.ALL.4#14]
- 13. If the UUT is a Cable Plug, the Tester repeats the test using Cable Reset (in lieu of Hard Reset).

#### *TEST.PD.PROT.ALL.5 Unrecognized Message*

Description: The Tester checks that the UUT responds correctly to unrecognized message.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends the following message, depending on the UUT type/role:
  - a. If the UUT is a Cable Plug, the Tester sends an Extended Message:
    - i. Chunked bit = 1
    - ii. Data Size field set to 26
    - iii. Message Type set to 11111b
    - iv. Bytes 0 to 25 of data block contain incrementing values starting at 0x00

- b. If the UUT is a Source or Sink, the Tester sends a Control Message with Message Type field set to 1110b (Reserved, in PD2 mode) or 01110b (Reserved, in PD3 mode).
3. The Tester checks the response message (with an incremented MessageID) based on the UUT type/role:
  - a. For Cable Plug UUT, the check fails if the UUT does not ignore the message i.e. message is received within tChunkReceiverRequest max. [TEST.PD.PROT.ALL.5#1]
  - b. For Source or Sink UUT, the check fails if the UUT does not send Reject message if in PD2 mode and Not\_Supported message if in PD3 mode. [TEST.PD.PROT.ALL.5#2]

#### 4.1.2 PD3 Mode

The tests in this subsection are run only in PD3 mode.

The tests in this subsection are applicable to all UUTs.

Unless a Test Specific Tester Behavior is specified, this section uses the following behavior:

- The Tester always replies with an Accept message to a DR\_Swap message
- The Tester always rejects PR\_Swap COMMON.PROC.PD.5
- The Tester always accepts VCONN\_Swap COMMON.PROC.PD.6
- The Tester always provides a NAK response for Discover Identity COMMON.PROC.PD.7
- The Tester always provides a NAK response for Discover SVIDs COMMON.PROC.PD.8

#### *TEST.PD.PROT.ALL3.1 Get\_Status Response*

Description: The Tester verifies that the Source UUT responds correctly to Get\_Status message.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a Get\_Status message to the UUT.
3. The Tester checks the response message depending on the UUT type/role:
  - a. If the UUT is a Cable Plug, the check fails if the UUT does not respond with either Ignore or Status message [TEST.PD.PROT.ALL3.1#1]
  - b. If the UUT is a Source or Sink, the check fails if the UUT does not respond with either Not\_Supported or Status message. [TEST.PD.PROT.ALL3.1#2]

4. The Tester runs additional check for the Status message: [TEST.PD.PROT.ALL3.1#3]
  - a. For the SDB
    - i. Present Input field: Bit 0 = 0
    - ii. Present Input field: Bits 5...7 (Reserved) are 0
    - iii. If Bit 3 (Internal Power from Battery) is 0 in Present Input field, then Present Battery Input field shall be 0
    - iv. Event Flags field: Bit 0 and Bits 5...7 (Reserved) are 0
    - v. Event Flags field: Bit 3 OVT Event = 0
    - vi. Temperature Status field: Bit 0, Bits 3...7 (Reserved) are 0
    - vii. Power Status field: Bit 0, Bits 6...7 (Reserved) are 0
    - viii. If Bit 2 (OTP event) is 1 in Event Flags field, then Temperature Status field shall be set to 11b (Over Temperature)
5. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

#### *TEST.PD.PROT.ALL3.2 Get\_Manufacturer\_Info Response*

Description: The Tester verifies that the Source UUT responds correctly to Get\_Manufacturer\_Info message.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a Get\_Manufacturer\_Info message with Manufacturer Info Target set to 0.
3. The Tester checks the response message depending on the UUT type/role:
  - a. If the UUT is a Cable Plug, the check fails if the UUT does not respond with either Ignore or Manufacturer\_Info message [TEST.PD.PROT.ALL3.2#1]
  - b. If the UUT is a Source or Sink, the check fails if the UUT does not respond with either Not\_Supported or Manufacturer\_Info message. [TEST.PD.PROT.ALL3.2#2]
4. The Tester runs the following VIF field checks for Manufacturer\_Info message: [TEST.PD.PROT.ALL3.2#3]
  - a. Manufacturer\_Info\_VID(\_SOP)
  - b. Manufacturer\_Info\_PID(\_SOP)
5. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

#### *TEST.PD.PROT.ALL3.3 Invalid Manufacturer Info Target*

Description: The Tester sends a Get\_Manufacturer message with an invalid target and verifies correct field values in the response message.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a Get\_Manufacturer\_Info message with Manufacturer Info Target set to 2 and Manufacturer Info Ref set to 0.
3. The Tester checks the response message depending on the UUT type/role:
  - a. If the UUT is a Cable Plug, the check fails if the UUT does not respond with either Ignore or Manufacturer\_Info message [TEST.PD.PROT.ALL3.3#1]
  - b. If the UUT is a Source or Sink, the check fails if the UUT does not respond with either Not\_Supported or Manufacturer\_Info message. [TEST.PD.PROT.ALL3.3#2]
4. The Tester verifies Manufacturer\_Info message: the check fails if Manufacturer String in Manufacturer Info Data Block is not null terminated ASCII text string "Not Supported" [TEST.PD.PROT.ALL3.3#3]
5. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

#### *TEST.PD.PROT.ALL3.4 Invalid Manufacturer Info Ref*

Description: The Tester sends a Get\_Manufacturer message with an invalid reference and verifies correct field values in the response message.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).

- b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a Get\_Manufacturer\_Info message with Manufacturer Info Target set to 1 and Manufacturer Info Ref set to 8.
3. The Tester checks the response message depending on the UUT type/role:
  - a. If the UUT is a Cable Plug, the check fails if the UUT does not respond with either Ignore or Manufacturer\_Info message. [TEST.PD.PROT.ALL3.4#1]
  - b. If the UUT is a Source or Sink, the check fails if the UUT does not respond with either Not\_Supported or Manufacturer\_Info message. [TEST.PD.PROT.ALL3.4#2]
4. The Tester verifies Manufacturer\_Info message: the check fails if Manufacturer String in Manufacturer Info Data Block is not null terminated ASCII text string "Not Supported" [TEST.PD.PROT.ALL3.4#3]
5. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

#### *TEST.PD.PROT.ALL3.5 Chunked Extended Message Response*

Description: The Tester verifies that the UUT receives a chunked extended message correctly by sending messages to request chunks.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends the first chunk of a chunked extended message to the UUT
  - a. Chunked bit = 1
  - b. Data Size field set to 260
  - c. Message Type set to 11111b
  - d. Bytes 0 to 259 of data block contain incrementing values (mod 256) starting at 0x00
3. The tester checks the response
  - a. If the UUT is a Cable Plug, the check fails if the UUT does not respond with either Ignore or a request for a Chunk of Data Block message. [TEST.PD.PROT.ALL3.5#1]
  - b. If the UUT is a Source or Sink, the Tester check the response: [TEST.PD.PROT.ALL3.5#2]

- i. The check fails if Sink or Source UUT does not respond with either Not\_Supported or a request for a Chunk of Data Block message.
  - ii. The check fails if a Not\_Supported message is received, and it is not received between tChunkingNotSupported min and tChunkingNotSupported max
  - iii. The check fails if a request for a Chunk of a Data Block is received, and it is not received within tChunkReceiverRequest max.
- c. Upon receipt of the response from the UUT, the Tester sends the requested chunk to the UUT. This step is repeated until the Tester has sent all 10 chunk messages. The Tester runs the following additional checks the request chunk message:

[TEST.PD.PROT.ALL3.5#3]

- i. For Message Header
  - 1. Number of Data Objects = 1
  - 2. Message Type = 11111b
- ii. For Extended Message Header
  - 1. Bits 14...11 Chunk Number = next chunk in the series
  - 2. Bit 10 Request Chunk = 1
  - 3. Bits 8...0 Data Size = 0

#### *TEST.PD.PROT.ALL3.6 ChunkSenderResponseTimer Timeout*

Description: The Tester verifies that the UUT recovers correctly after the Tester stops sending chunked messages in the middle.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 3 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
  - c. The UUT has VIF field VIF\_Product\_Type set to Cable. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends the first chunk of a chunked extended message to the UUT
  - a. Chunked bit = 1
  - b. Data Size field set to 260
  - c. Message Type set to 11111b
  - d. Bytes 0 to 259 of data block contain incrementing values (mod 256) starting at 0x00
3. The tester checks the response
  - a. If the UUT is a Cable Plug, the check fails if the UUT does not respond with either Ignore or a request for a Chunk of Data Block message. [TEST.PD.PROT.ALL3.6#1]
  - b. If the UUT is a Source or Sink, the Tester checks response: [TEST.PD.PROT.ALL3.6#2]

- i. The check fails if Sink or Source UUT does not respond with either Not\_Supported or a request for a Chunk of Data Block message.
    - ii. The check fails if a Not\_Supported message received, and it is not received between tChunkingNotSupported min and tChunkingNotSupported max
    - iii. The check fails if a request for a Chunk of a Data Block is received, and it is not received within tChunkReceiverRequest max.
  - c. Upon receipt of the response from the UUT, the Tester sends the requested chunk to the UUT. This step is repeated until the Tester has sent 4 chunk messages and it intentionally does not send the 5<sup>th</sup> chunk message to the UUT.
  - d. The Tester runs the following additional checks the request chunk message:
    - [TEST.PD.PROT.ALL3.6#3]
    - i. For Message Header
      - 1. Number of Data Objects = 1
      - 2. Message Type = 11111b
    - ii. For Extended Message Header
      - 1. Bits 14...11 Chunk Number = next chunk in the series
      - 2. Bit 10 Request Chunk = 1
      - 3. Bits 8...0 Data Size = 0
- 4. The Tester waits for tChunkSenderResponse max + 5 ms and then it sends the first chunk message to the UUT.
- 5. The tester checks the response
  - a. If the UUT is a Cable Plug, the check fails if the UUT does not respond with either Ignore or a request for a Chunk of Data Block message. [TEST.PD.PROT.ALL3.6#1]
  - b. If the UUT is a Source or Sink, the Tester checks the response [TEST.PD.PROT.ALL3.6#2]
    - i. The check fails if Sink or Source UUT does not respond with either Not\_Supported or a request for a Chunk of Data Block message.
    - ii. The check fails if a Not\_Supported message received, it is not received between tChunkingNotSupported min and tChunkingNotSupported max
    - iii. The check fails if a request for a Chunk of a Data Block is received, it is not received within tChunkReceiverRequest max.
  - c. Upon receipt of the response from the UUT, the Tester sends the requested chunk to the UUT.
  - d. The Tester runs the following additional checks on the request chunk message:
    - [TEST.PD.PROT.ALL3.6#10]
    - i. For Message Header
      - 1. Number of Data Objects = 1
      - 2. Message Type = 11111b
    - ii. For Extended Message Header
      - 1. Bits 14...11 Chunk Number = next chunk in the series
      - 2. Bit 10 Request Chunk = 1
      - 3. Bits 8...0 Data Size = 0



## 4.2 Test Procedures for Source and Sink Capable UUTs

### 4.2.1 PD2 and PD3 Modes

None

### 4.2.2 PD3 Mode

The tests in this subsection are run only in PD3 mode.

The tests in this subsection are applicable to UUT with VIF field VIF\_Product\_Type set to Port.

Unless a Test Specific Tester Behavior is specified, this section uses the following behavior:

- The Tester always replies with an Accept message to a DR\_Swap message
- The Tester always rejects PR\_Swap COMMON.PROC.PD.5
- The Tester always accepts VCONN\_Swap COMMON.PROC.PD.6
- The Tester always provides a NAK response for Discover Identity COMMON.PROC.PD.7
- The Tester always provides a NAK response for Discover SVIDs COMMON.PROC.PD.8

#### *TEST.PD.PROT.PORT3.1 Get\_Battery\_Status Response*

Description: The Tester verifies that the Source UUT responds correctly to Get\_Battery\_Status message

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 2 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends a Get\_Source\_Cap\_Extended message to the UUT.
3. The check fails if the UUT does not send either Not\_Supported or Source\_Capabilities\_Extended message. [TEST.PD.PROT.PORT3.1#1]
4. The Tester sends a Get\_Battery\_Status message to the UUT, with Battery Status Ref field set to 0.
5. The check fails if the UUT does not send either Not\_Supported or Battery\_Status message. [TEST.PD.PROT.PORT3.1#2]
6. If the UUT has sent Not\_Supported as a response to Get\_Battery\_Status, the Tester checks the response: [TEST.PD.PROT.PORT3.1#3]
  - a. The check fails if the UUT has sent Source\_Capabilities\_Extended message as a response to Get\_Source\_Cap\_Extended and the Number of Batteries/Battery Slots field in the message has non-zero value
  - b. The check fails if the UUT has sent Not\_Supported message as a response to Get\_Source\_Cap\_Extended and the values of VIF fields Num\_Fixed\_Batteries and Num\_Swappable\_Battery\_Slots are non-zero.

7. The Tester runs the following additional field checks for Battery\_Status message:  
[TEST.PD.PROT.PORT3.1#4]
  - a. Bits 7..0 of the BSDO are 0
  - b. Battery Info field:
    - i. Bits 7..4 (Reserved) are 0
    - ii. Check that Bit 0 (Invalid Battery Reference field) matches:
      1. If Source\_Capabilities\_Extended is received as a response to Get\_Source\_Cap\_Extended, check against Number of Batteries/Battery Slots field in the message
      2. If Not\_Supported message is received as a response to Get\_Source\_Cap\_Extended, check against VIF fields Num\_Fixed\_Batteries and Num\_Swappable\_Battery\_Slots
    - iii. If Bit 0 (Invalid Battery Reference bit) is 0b and Battery Status Ref field (in the Get\_Battery\_Status Message) has a value between 0 and 3, then check that the Bit 1 (Battery is Present bit) is set to 1b
    - iv. If Bit 0 (Invalid Battery Reference bit) is 1b, then check that the Bit 1 (Battery is Present bit) is set to 0b
    - v. If Bit 1 (Battery is Present bit) is set to 1b, then check that Bits 3...2 (Battery Charging Status field) is not 11b
    - vi. If Bit 1 (Battery is Present bit) is set to 0b, then check that Bits 3...2 (Battery Charging Status field) is 00b
8. Rerun steps 6 and 7 with Battery Status Ref (in the Get\_Battery\_Status message) set to 1 – 7

#### *TEST.PD.PROT.PORT3.2 Invalid Battery Status Reference*

**Description:** The Tester sends a Get\_Battery\_Status message with an invalid battery reference to the UUT and verifies correct field values in the response message.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

1. There are 2 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends a Get\_Source\_Cap\_Extended message to the UUT.
3. The check fails if the UUT does not send either Not\_Supported or Source\_Capabilities\_Extended message. [TEST.PD.PROT.PORT3.2#1]
4. The Tester sends a Get\_Battery\_Status message with Battery Status Ref field set to 8.
5. The check fails if the UUT does not send either Not\_Supported or Battery\_Status message. [TEST.PD.PROT.PORT3.2#2]

6. If the UUT has sent Not\_Supported as a response to Get\_Battery\_Status, the Tester check the response: [TEST.PD.PROT.PORT3.2#3]
  - a. The check fails if the UUT has sent Source\_Capabilities\_Extended message as a response to Get\_Source\_Cap\_Extended and the Number of Batteries/Battery Slots field in the message has non-zero value
  - b. The check fails if the UUT has sent Not\_Supported message as a response to Get\_Source\_Cap\_Extended and the values of VIF fields Num\_Fixed\_Batteries and Num\_Swappable\_Battery\_Slots are non-zero.
7. The Tester runs the following additional field checks for Battery\_Status message: [TEST.PD.PROT.PORT3.2#4]
  - a. Bits 7..0 of the BSDO are 0
  - b. Battery Info field:
    - i. Check that Bit 0 (Invalid Battery Reference field) is 1b
    - ii. Check that Bits 7..1 are 0

#### *TEST.PD.PROT.PORT3.3 Get\_Battery\_Cap Response*

Description: The Tester verifies that the Source UUT responds correctly to Get\_Battery\_Cap message

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. There are 2 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends a Get\_Source\_Cap\_Extended message to the UUT.
3. The check fails if the UUT does not send either Not\_Supported or Source\_Capabilities\_Extended message. [TEST.PD.PROT.PORT3.3#1]
4. The Tester sends a Get\_Battery\_Cap message to the UUT, with Battery Cap Ref field set to 0.
5. The check fails if the UUT does not send either Not\_Supported or Battery\_Capabilities message. [TEST.PD.PROT.PORT3.3#2]
6. The Tester runs the following additional field checks for Battery\_Capabilities message: [TEST.PD.PROT.PORT3.3#3]
  - a. Battery Type field:
    - i. Check that Bit 0 (Invalid Battery Reference field) matches:
      1. If Source\_Capabilities\_Extended is received as a response to Get\_Source\_Cap\_Extended, check against Number of Batteries/Battery Slots field in the message
      2. If Not\_Supported message is received as a response to Get\_Source\_Cap\_Extended, check against VIF fields Num\_Fixed\_Batteries and Num\_Swappable\_Battery\_Slots

- ii. Check that Bits 1...7 are 0
- 7. Rerun steps 6 and 7 with Battery Cap Ref (in the Get\_Battery\_Capabilities message) set to 1 – 7
- 8. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

#### *TEST.PD.PROT.PORT3.4 Invalid Battery Capabilities Reference*

**Description:** The Tester sends a Get\_Battery\_Capabilities message with an invalid battery reference to the UUT and verifies correct field values in the response message.

**Test Specific Tester Behavior:** N/A

#### **Test Procedures:**

1. There are 2 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends a Get\_Source\_Cap\_Extended message to the UUT.
3. The check fails if the UUT does not send either Not\_Supported or Source\_Capabilities\_Extended message. [TEST.PD.PROT.PORT3.4#1]
4. The Tester sends a Get\_Battery\_Cap message to the UUT, with Battery Cap Ref field set to 8.
5. The check fails if the UUT does not send either Not\_Supported or Battery\_Capabilities message. [TEST.PD.PROT.PORT3.4#2]
6. The Tester runs the following additional field checks for Battery\_Capabilities message: [TEST.PD.PROT.PORT3.4#3]
  - a. Battery Type field:
    - i. Check that Bit 0 (Invalid Battery Reference field) is 1b
    - ii. Check that Bits 1...7 are 0
7. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

#### *TEST.PD.PROT.PORT3.5 Get\_Country\_Codes Response*

**Description:** The Tester verifies that the Source UUT responds correctly to Get\_Country\_Codes message.

**Test Specific Tester Behavior:** N/A

#### **Test Procedures:**

1. There are 2 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).

- b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends a Get\_Country\_Codes message to the UUT.
3. The check fails if the UUT does not send either Not\_Supported or Country\_Codes message. [TEST.PD.PROT.PORT3.5#1]
4. If the Country\_Codes message received is chunked, the Tester requests for the next chunk message until the UUT has sent the last chunk message. The Tester runs the following additional field checks for CCDB: [TEST.PD.PROT.PORT3.5#2]
  - a. Length = (Data Size) / 2 - 1
  - b. All other bytes are ascii codes of capital letters (65 - 90 inclusive)
5. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

#### *TEST.PD.PROT.PORT3.6 Get\_Country\_Info Response*

**Description:** The Tester verifies that the Source UUT responds correctly to Get\_Country\_Info message.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

1. There are 2 possible bring-up procedures:
  - a. The UUT has VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider or DRP. The Tester behaves as a Source only and it runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
  - b. The UUT has VIF field PD\_Port\_Type set to Provider Only or Provider/Consumer. The Tester behaves as a Sink only and it runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends a Get\_Country\_Codes message to the UUT.
3. The check fails if the UUT does not send either Not\_Supported or Country\_Codes message. [TEST.PD.PROT.PORT3.6#1]
4. If a Not\_Supported message is received, the test stops here. Otherwise, the Tester sends a Get\_Country\_Info message to the UUT.
5. The check fails if the UUT does not send Country\_Info message. [TEST.PD.PROT.PORT3.6#2]
6. If the Country\_Codes message received is chunked, the Tester requests for the next chunk message until the UUT has sent the last chunk message. The Tester runs the following additional field checks for CIDB: [TEST.PD.PROT.PORT3.6#3]
  - a. Country Code field (Byte 0 and Byte 1) is the same as that in the Get\_Country\_Info message sent by the Tester
  - b. Byte 2 and Byte 3 (Reserved) are 0
7. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

## 4.3 Test Procedures for Source Capable UUT

### 4.3.1 PD2 and PD3 Modes

The tests in this subsection are run firstly in PD2 mode and secondly in PD3 mode.

The tests in this subsection are applicable to UUT with VIF field PD\_Port\_Type set to Provider Only, Provider/Consumer and DRP.

Unless a Test Specific Tester Behavior is specified, this section uses the following behavior:

- The Tester is a Sink
- The Tester always replies with an Accept message to a DR\_Swap message
- The Tester always rejects PR\_Swap COMMON.PROC.PD.5
- The Tester always accepts VCONN\_Swap COMMON.PROC.PD.6
- The Tester always provides a NAK response for Discover Identity COMMON.PROC.PD.7
- The Tester always provides a NAK response for Discover SVIDs COMMON.PROC.PD.8

#### *TEST.PD.PROT.SRC.1 Get\_Source\_Cap Response*

Description: The Tester verifies that the Source UUT responds correctly to Get\_Source\_Cap message.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends a Get\_Source\_Cap message to the UUT.
3. The check fails if the Tester does not receive Source Capabilities message.  
[TEST.PD.PROT.SRC.1#1]
4. Once the Tester receives Source Capabilities message, the Tester establishes a PD contract using common procedure COMMON.PROC.PD.11.

#### *TEST.PD.PROT.SRC.2 Get\_Source\_Cap No Request*

Description: The Tester sends a Get\_Source\_Cap message to the UUT. After receiving a Source\_Capabilities message, the Tester intentionally does not send the Request message to force a SenderResponseTimer timeout on the Source UUT. The Tester verifies correct implementation of this timer.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends a Get\_Source\_Cap message to the UUT.

3. The check fails if the Tester does not receive Source Capabilities message.  
[TEST.PD.PROT.SRC.2#1]
4. The Tester does not send a Request message after receiving Source Capabilities message.
5. The check fails if the UUT does not issue a Hard Reset after tSenderResponse max expires, where this delay is from the last bit of the EOP of Source Capabilities message.  
[TEST.PD.PROT.SRC.2#2]

#### *TEST.PD.PROT.SRC.3 SenderResponseTimer Deadline*

Description: As a Sink, the Tester checks that the UUT accepts a Request message sent at the deadline limit of tSenderResponse min in reply to a Source Capabilities message.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The test starts in a disconnected state.
2. The Tester applies Rd and it waits for VBUS for tNoResponse max.
3. The check fails if the first bit of a Source Capabilities message is not received from the UUT within tFirstSourceCap max after VBUS present. [TEST.PD.PROT.SRC.3#1]
4. The Tester responds with a Request message at the deadline limit of tSenderResponse min after the GoodCRC message.
5. The check fails if a Hard Reset is detected after tProtErrSoftReset max from the time the EOP of the GoodCRC sent in response to the Accept message has been sent. [TEST.PD.PROT.SRC.3#2]

#### *TEST.PD.PROT.SRC.4 Reject Request*

Description: As a Sink, the Tester requests 200% of the offered current or power under the terms of each PDO on the UUT, and verifies the request is rejected by the UUT.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The test starts in a disconnected state.
2. The Tester applies Rd and it waits for VBUS for tNoResponse max.
3. The check fails if the first bit of a Source Capabilities message is not received from the UUT within tFirstSourceCap max after VBUS present. [TEST.PD.PROT.SRC.4#1]
4. The Tester sends a Request (starting from the first PDO), requesting 200% of the current or power offered.
5. The check fails if a Reject message is not received. [TEST.PD.PROT.SRC.4#2]

- Restart the test from Step 1 by sending Request to the next PDO.

#### *TEST.PD.PROT.SRC.5 Reject Request Invalid Object Position*

**Description:** As a Sink, the Tester sends a Request with an invalid object position, and verifies the request is rejected by the UUT.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

- The test starts in a disconnected state.
- The Tester applies Rd and it waits for VBUS present.
- The check fails if the first bit of a Source Capabilities message is not received from the UUT within tFirstSourceCap max after VBUS present. [TEST.PD.PROT.SRC.5#1]
- The Tester sends a Request message using the VIF field Num\_Src\_PDOs:
  - If Num\_Src\_PDOs = 7, then set Object Position field to 0
  - Otherwise, set Object Position field to 1 + Num\_Src\_PDOs
- The check fails if the UUT does not respond with a Reject message. [TEST.PD.PROT.SRC.5#2]

#### *TEST.PD.PROT.SRC.6 Atomic Message Sequence – Request*

**Description:** As a Sink, the Tester sends a Get\_Sink\_Cap message instead of a Request message and verifies that the UUT correctly sends a Soft Reset to recover from this error.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

- The test starts in a disconnected state.
- The Tester applies Rd and it waits for VBUS present.
- The check fails if the first bit of a Source Capabilities message is not received from the UUT within tFirstSourceCap max after VBUS present. [TEST.PD.PROT.SRC.6#1]
- The Tester sends a Get\_Sink\_Cap message instead of a Request message.
- The check fails if a Soft\_Reset message is not received within tSoftReset max. [TEST.PD.PROT.SRC.6#2]
- The Tester sends an Accept message to the UUT (as a response to Soft\_Reset message).
- The check fails if a Source Capabilities message with a MessageID = 1 is not received within tTypeCSinkWaitCap max from the last bit of the EOP of the GoodCRC message. [TEST.PD.PROT.SRC.6#3]



#### *TEST.PD.PROT.SRC.7 DR\_Swap*

Description: As a Sink, the Tester sends a DR\_Swap message, and verifies that the UUT responds correctly.

#### Test Specific Tester Behavior:

- The Tester always replies with a Reject message to a DR\_Swap message

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1. The Tester instead sends Request message with B25 (USB Communication Capable) set to 1b.
2. The Tester sends a DR\_Swap message.
3. The Tester checks the response. [TEST.PD.PROT.SRC.7#1]
  - a. If the UUT responds with a Wait message and the Tester resends DR\_Swap every tDRSwapWait + 15ms for 10 times. The check fails and the test ends here if the Tester has resent DR\_Swap for 10 times.
  - b. The check fails and the test ends here if the UUT responds with a Reject message and the VIF field DR\_Swap\_To\_UFP\_Supported = Yes.
  - c. The check fails if the UUT responds with an Accept message and the VIF field DR\_Swap\_To\_UFP\_Supported = No.
4. The Tester requests a further DR\_Swap.
5. The Tester checks the response. [TEST.PD.PROT.SRC.7#2]
  - a. If the UUT responds with a Wait message and the Tester resends DR\_Swap every tDRSwapWait + 15ms for 10 times. The check fails and the test ends here if the Tester has resent DR\_Swap for 10 times.
  - b. The check fails and the test ends here if the UUT responds with a Reject message and the VIF field DR\_Swap\_To\_DFP\_Supported = Yes.
  - c. The check fails if the UUT responds with an Accept message and the VIF field DR\_Swap\_To\_DFP\_Supported = No.

#### *TEST.PD.PROT.SRC.8 VCONN\_Swap Response*

Description: As a Sink, the Tester sends a VCONN\_Swap message, and verifies that the UUT responds correctly.

#### Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. If VIF field Captive\_Cable = No, the Tester presents Ra to the non-CC line (of the UUT). If a SOP' Discover Identity message is received from the UUT, the Tester replies as Passive Cable with Vbus Current Handling Capability set to 5A and Maximum Vbus Voltage set to 50V.
3. The Tester sends a VCONN\_Swap message.
4. The Tester checks the response. [TEST.PD.PROT.SRC.8#1]

- a. If the UUT responds with a Wait message and the Tester resends VCONN\_Swap every  $tVCONN\text{SwapWait} + 15\text{ms}$  for 10 times. The check fails and the test ends here if the Tester has resent VCONN\_Swap for 10 times.
  - b. In PD2 mode, the check fails and the test ends here if the UUT does not respond with an Accept message.
  - c. In PD3 mode, the check fails and the test ends here if the UUT does not respond with Accept or Not\_Supported message.
5. The Tester sends a PS\_RDY message.
6. The Tester checks that the UUT does not present VCONN at the non-CC line within  $tVCONN\text{SourceOff}$ . [TEST.PD.PROT.SRC.8#2]
7. The Tester sends another VCONN\_Swap.
8. The Tester checks the response. [TEST.PD.PROT.SRC.8#3]
  - a. If the UUT responds with a Wait message and the Tester resends VCONN\_Swap every  $tVCONN\text{SwapWait} + 15\text{ms}$  for 10 times. The check fails and the test ends here if the Tester has resent VCONN\_Swap for 10 times.
  - b. The check fails if the UUT responds with Reject or Not\_Supported (PD3 mode only) message and the VIF field VCONN\_Swap\_To\_On\_Supported = Yes. The test ends here.
  - c. The check fails if the UUT responds with an Accept message and the VIF field VCONN\_Swap\_To\_On\_Supported = No.
9. The Tester checks that the UUT sends a PS\_RDY message. [TEST.PD.PROT.SRC.8#4]
10. The Tester checks that VCONN is present at the non-CC line. [TEST.PD.PROT.SRC.8#5]

#### *TEST.PD.PROT.SRC.9 PR\_Swap Response*

Description: The Tester verifies that the initial Source UUT responds correctly to the PR\_Swap message.

#### Test Specific Tester Behavior:

- The Tester is a Dual-Role Power, initially a Sink
- The Tester sends Sink Capabilities setting B27 (Unconstrained Power) to 0b COMMON.PROC.PD.3

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.BU.PD.1.
2. The Tester sends a PR\_Swap message.
3. The Tester checks the response. [TEST.PD.PROT.SRC.9#1]
  - a. If the UUT responds with a Wait message and the Tester resends PR\_Swap every  $tPR\text{SwapWait} + 15\text{ms}$  for 10 times. Once the Tester has resent PR\_Swap for 10 times, the check fails and the test ends here.
  - b. The check fails and the test ends here if the UUT responds with a Reject message and the VIF field PD\_Port\_Type is not set to "Provider Only".
  - c. The check fails if the UUT responds with an Accept message and the VIF field PD\_Port\_Type is not set to either "Provider/Consumer" or "DRP".
4. The Tester draws no more than  $i\text{SwapStandby}$  within  $t\text{SrcTransition min}$  after it has sent the last GoodCRC.

5. The Tester checks that the UUT sends a PS\_RDY message after the UUT driving VBUS voltage to vSafe0V. [TEST.PD.PROT.SRC.9#2]
6. The Tester checks that the UUT sends PS\_RDY within tSrcTransition max plus tSrcSwapStdby max after the last bit of GoodCRC was sent in response to the received Accept.  
[TEST.PD.PROT.SRC.9#3]
7. The Tester presents vSafe5V on VBUS and then it sends a PS\_RDY message, both within tNewSRC max of the last GoodCRC sent by the UUT.
8. The Tester transmits Source Capabilities message with single PDO (5V @ 100mA, B29 Dual-Role Power set to 1b). The Tester checks that the UUT sends a Request message.  
[TEST.PD.PROT.SRC.9#4] The Tester uses the common procedure COMMON.PROC.PD.10 to establish a PD contract.
9. The UUT is now a Sink and the Tester is a Source.
10. The Tester sends a PR\_Swap message.
11. The Tester checks the response. [TEST.PD.PROT.SRC.9#5]
  - a. If the UUT responds with a Wait message and the Tester resends PR\_Swap every tPRSwapWait + 15ms for 10 times. Once the Tester has resent PR\_Swap for 10 times, the check fails and the test ends here.
  - b. The check fails if the UUT responds with a Reject message and that the VIF field Accept\_PR\_Swap\_As\_Snk = Yes.
  - c. The check fails if the UUT responds with an Accept message and that the VIF field Accept\_PR\_Swap\_As\_Snk = No.
12. At tSinkTransition max (this delay is from the last bit of GoodCRC sent in response to the Accept), the Tester drives the VBUS voltage to vSafe0V within tSrcSwapStdby max.
13. The Tester sends a PS\_RDY at the deadline limit of tPSSourceOff min, the delay is from the time the last bit of the EOP of the GoodCRC corresponding to the Accept message.
14. The Tester checks that the UUT sends PS\_RDY only after the UUT has applied vSafe5V.  
[TEST.PD.PROT.SRC.9#6]
15. The Tester checks that the PS\_RDY from the UUT is within tNewSrc max.  
[TEST.PD.PROT.SRC.9#7] This delay is from the GoodCRC sent by the UUT in response to the PS\_RDY sent by the Tester.
16. The Tester checks that the UUT sends a Source Capabilities message within tFirstSourceCap max.  
[TEST.PD.PROT.SRC.9#8]

#### *TEST.PD.PROT.SRC.10 PR\_Swap – PSSourceOnTimer Timeout*

**Description:** As a new Source, the Tester intentionally does not send a PS\_RDY message after a PR\_Swap in order to force a PSSourceOnTimer timeout on the UUT and verifies it is correctly implemented.

#### Test Specific Tester Behavior:

- The Tester is a Dual-Role Power, initially a Sink
- The Tester sends Sink Capabilities setting B27 (Unconstrained Power) to 0b  
COMMON.PROC.PD.3

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.BU.PD.1.
2. The Tester sends a PR\_Swap message.
3. The Tester checks the response. [TEST.PD.PROT.SRC.10#1]
  - a. The UUT responds with a Wait message and the Tester has resent PR\_Swap every tPRSwapWait + 15ms for 10 times
  - b. The UUT responds with a Reject message and the VIF field PD\_Port\_Type is not set to "Provider Only".
  - c. The UUT responds with an Accept message and the VIF field PD\_Port\_Type is not set to either "Provider/Consumer" or "DRP".
4. The test ends here if the UUT does not respond with an Accept message.
5. The Tester draws no more than iSwapStandby within tSrcTransition min after it has sent the last GoodCRC.
6. The Tester checks the response: [TEST.PD.PROT.SRC.10#2]
  - a. The check fails if the UUT does not send a PS\_RDY message after the UUT driving VBUS voltage to vSafe0V
  - b. The check fails if the UUT does not send PS\_RDY within tSrcTransition max plus tSrcSwapStdby max after the last bit of GoodCRC was sent in response to the received Accept.
7. The Tester presents vSafe5V on VBUS but does not send a PS\_RDY message, in order to force a PSSourceOnTimer timeout on the UUT.
8. A Hard Reset is expected from the UUT. The Tester checks the response: [TEST.PD.PROT.SRC.10#3]
  - a. The check fails if a Hard Reset is detected after tPSSourceOn max after the time the last bit of the EOP of the GoodCRC Message corresponding to the received PS\_RDY message.
  - b. The check fails if a Hard Reset is not detected within tPSSourceOn min after the last bit of the EOP of the GoodCRC Message corresponding to the received PS\_RDY message.

#### *TEST.PD.PROT.SRC.11 Cable Type Detection*

Description: As a Sink, the Tester verifies that the UUT does cable detection if it offers currents in excess of 3A, voltages in excess of 20V or both.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The test starts in a disconnected state.
2. If VIF field Captive\_Cable = Yes, the test stops here. Otherwise (VIF field Captive\_Cable = No), the Tester applies Rd and Ra, and it waits for VBUS present.
3. The Tester checks the response:
  - a. If a SOP<sup>1</sup> Discover Identity message is received from the UUT, the Tester replies as Passive Cable with Vbus Current Handling Capability set to 5A and Maximum Vbus Voltage set to 50V.

- b. Without receiving a SOP' Discover Identity message from the UUT, the check fails if the UUT sends Source Capabilities offering currents in excess of 3A and/or voltages in excess of 20V. [TEST.PD.PROT.SRC.11#1]
4. The Tester removes all terminations and simulates a disconnection
5. The Tester applies Rd and Ra, and it waits for VBUS present.
6. The Tester checks the response:
  - a. If a SOP' Discover Identity message is received, the Tester replies as Passive Cable with Vbus Current Handling Capability set to 3A and Maximum Vbus Voltage set to 20V.
  - b. The check fails if the UUT sends Source Capabilities offering currents in excess of 3A and/or voltages in excess of 20V. [TEST.PD.PROT.SRC.11#2]
7. The Tester removes all terminations and simulates a disconnection
8. The Tester applies Rd but does not present Ra, and it waits for VBUS present.
9. The Tester checks the response. [TEST.PD.PROT.SRC.11#3]
  - a. The check fails if SOP' Discover Identity message is received.
  - b. The check fails if the UUT sends Source Capabilities offering currents in excess of 3A and/or voltages in excess of 20V

#### *TEST.PD.PROT.SRC.12 Unexpected Message Received in Ready State*

**Description:** As a Sink, the Tester sends an unexpected message to the UUT after setting up a contract with the UUT and verifies the UUT does Soft Reset.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends an Accept message to the UUT.
3. The check fails if a Soft Reset message is not received within tProtErrSoftReset max. [TEST.PD.PROT.SRC.12#1] This delay is measured from the EOP of the GoodCRC corresponding to the Accept message has been received to the time the EOP the Soft Reset message has been received.

#### *TEST.PD.PROT.SRC.13 Get\_Sink\_Cap Response*

**Description:** The Tester verifies that the Source UUT responds correctly to Get\_Sink\_Cap message.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.

2. The Tester sends a Get\_Sink\_Cap message to the UUT.
3. The Tester checks the response. [TEST.PD.PROT.SRC.13#1]
  - a. The check fails if VIF field PD\_Port\_Type = Provider Only and a Reject message is not received. The test stops here.
  - b. The check fails if VIF field PD\_Port\_Type = Provider Only and a Sink Capabilities message is not received.
4. The Tester runs the following additional field checks on the Sink Capabilities message: [TEST.PD.PROT.SRC.13#2]
  - a. The Number of Data Objects field in the Message Header matches VIF field Num\_Snk\_PDOs
  - b. For the first PDO, the Tester checks consistency of:
    - i. B31...30 (Fixed Supply) set to 00b
    - ii. B29 (Dual-Role Power) set to 1b
    - iii. B26 (USB Communications Capable) matches VIF field USB\_Comms\_Capable
    - iv. B25 (Dual-Role Data) set to 1b if VIF field DR\_Swap\_To\_UFP\_Supported or DR\_Swap\_To\_DFP\_Supported = YES
    - v. B24...23 (Fast Role Swap required USB Type-C Current) matches VIF field FR\_Swap\_Reqd\_Type\_C\_Current\_As\_Initial\_Source
    - vi. B22...20 (Reserved) set to 00b
    - vii. B19...10 (Voltage) set to 5V
    - viii. B9...0 (Maximum Current) matches VIF field Snk\_PDO\_Max\_Current1
  - c. For each PDO, the Tester checks consistency of:
    - i. Snk\_PDO\_Supply\_TypeN
    - ii. If Fixed Supply PDO:
      1. Snk\_PDO\_VoltageN
      2. Snk\_PDO\_Op\_CurrentN
    - iii. If Variable Supply PDO:
      1. Snk\_PDO\_Max\_VoltageN
      2. Snk\_PDO\_Min\_VoltageN
      3. Snk\_PDO\_Op\_CurrentN
    - iv. If Battery Supply PDO:
      1. Snk\_PDO\_Max\_VoltageN
      2. Snk\_PDO\_Min\_VoltageN
      3. Snk\_PDO\_Op\_PowerN
    - v. If Programmable Power Supply APDO:
      1. Snk\_PDO\_Max\_VoltageN
      2. Snk\_PDO\_Min\_VoltageN
      3. Snk\_PDO\_Max\_CurrentN
  - d. The Tester compares all PDOs to VIF field PD\_Power\_as\_Sink and check that they meet the requirements of the Power Rules.
  - e. The Tester checks PDOs following the first one, are in the correct order: Fixed PDOs in increasing voltage sequence, Battery PDOs in increasing minimum voltage sequence and finally Variable PDOs in increasing minimum voltage sequence
  - f. The Tester checks that no Fixed PDO has the same voltage as any other

- g. The Tester checks that no Variable PDO has the same voltage range as any other
- h. The Tester checks that no Battery PDO has the same voltage range as any other

#### 4.3.2 PD3 Mode

The tests in this subsection are run only in PD3 mode.

The tests in this subsection are applicable to Source capable UUT with VIF field PD\_Port\_Type set to Provider Only, Provider/Consumer and DRP.

Unless a Test Specific Tester Behavior is specified, this section uses the following behavior:

- The Tester is a Sink only
- The Tester always replies with an Accept message to a DR\_Swap message
- The Tester always rejects PR\_Swap COMMON.PROC.PD.5
- The Tester always accepts VCONN\_Swap COMMON.PROC.PD.6
- The Tester always provides a NAK response for Discover Identity COMMON.PROC.PD.7
- The Tester always provides a NAK response for Discover SVIDs COMMON.PROC.PD.8

##### *TEST.PD.PROT.SRC3.1 SourceCapabilityTimer Timeout*

Description: The Tester waits for a Source Capabilities message from the Source UUT. The Tester intentionally does not reply with a GoodCRC in order to force a SourceCapabilityTimer timeout, then verifies it is correctly implemented.

Test Specific Tester Behavior: N/A

##### Test Procedures:

1. The test starts in a disconnected state.
2. The Tester applies Rd and it waits for VBUS present.
3. The check fails if the first bit of a Source Capabilities message is not received from the UUT within tFirstSourceCap max after VBUS present. [TEST.PD.PROT.SRC3.1#1]
4. Upon receipt of the first Source Capabilities message from the Source UUT, the Tester intentionally does not reply with a GoodCRC message and waits for the next Source Capabilities message. **The Tester does not reply with a GoodCRC message for the duration of this test.**
5. The tester sets the value of a variable *tTESTSourceCapabilityTimer* to 0.
6. Upon receipt of the Source Capabilities message (the Tester does not reply with a GoodCRC) the Tester measures the delay from the last bit of the last Source Capabilities message EOP to the first bit of the preamble of the Source Capabilities message received just now. If the delay is larger than *tTESTSourceCapabilityTimer*, sets the value of *tTESTSourceCapabilityTimer* to the delay.

7. Repeat Step-6 until the Tester has received the fifth Source Capabilities message.
8. The Tester checks the values of **tTESTSourceCapabilityTimer** [TEST.PD.PROT.SRC3.1#2]
  - a. The check fails if the value of **tTESTSourceCapabilityTimer** is larger than 201.1 ms (tTypeCSendSourceCap max + tReceive max)
  - b. The check fails if the value of **tTESTSourceCapabilityTimer** is smaller than 100.9 ms (tTypeCSendSourceCap min + tReceive min)

#### *TEST.PD.PROT.SRC3.2 SenderResponseTimer Timeout*

**Description:** As a Sink, the Tester intentionally does not send the Request message to force a SenderResponseTimer timeout on the Source UUT. The Tester verifies correct implementation of this timer.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

1. The test starts in a disconnected state.
2. The Tester applies Rd and it waits for VBUS for tNoResponse max.
3. The check fails if the first bit of a Source Capabilities message is not received from the UUT within tFirstSourceCap max after VBUS present. [TEST.PD.PROT.SRC3.2#1]
4. The Tester intentionally does not send a Request message and waits for a Hard Reset.
5. The Tester checks the response: [TEST.PD.PROT.SRC3.2#2]
  - a. The check fails if a Hard Reset is detected before tSenderResponse min from the time the last bit of the GoodCRC message EOP has been sent.
  - b. The check fails if a Hard Reset is detected after tSenderResponse max + 5ms from the time the last bit of the GoodCRC message EOP has been sent.

#### *TEST.PD.PROT.SRC3.3 Get\_Source\_Cap\_Extended Response*

**Description:** As a Sink, the Tester verifies that the Source UUT responds correctly to Get\_Source\_Cap\_Extended message.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends a Get\_Source\_Cap\_Extended message to the UUT.
3. The check fails if the UUT does not send either Not\_Supported or Source\_Capabilities\_Extended message. [TEST.PD.PROT.SRC3.3#1]



4. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

#### *TEST.PD.PROT.SRC3.4 Alert Response Source Input Change*

Description: As a Sink, the Tester sends Alert message indicating Source Input Change and verifies the response messages.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends an Alert message to the UUT with Type of Alert field = Source Input Change Event (Bit 5).
3. The test stops here when one of the following conditions happens:
  - a. A Not\_Supported message is received as a response to the last Alert message.
  - b. A Get\_Status message is not received within 500 ms after the last Alert message was sent
4. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

#### *TEST.PD.PROT.SRC3.5 Alert Response Battery Status Change*

Description: As a Sink, the Tester sends Alert message indicating Battery Status Change and verifies the response messages.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends an Alert message to the UUT
  - a. Type of Alert field = Battery Status Change Event (Bit 1)
  - b. Fixed Batteries = Battery 0 (B20)
3. Upon receiving the Get\_Battery\_Status message, the Tester verifies Battery Status Ref = 0.  
[TEST.PD.PROT.SRC3.5#1]
4. The test stops here when one of the following conditions happens:
  - a. A Not\_Supported message is received as a response to the last Alert message.
  - b. A Get\_Battery\_Status message is not received within 500 ms after the last Alert message was sent
5. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

#### *TEST.PD.PROT.SRC3.6 Soft\_Reset Sent Regardless of Rp Value*

Description: As a Sink, the Tester forces the UUT to send Soft\_Reset and verifies Soft\_Reset is sent regardless of the Rp value is SinkTxOK or SinkTxNG.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends a Get\_Source\_Cap message to the UUT.
3. Upon receipt of the Source\_Capabilities Message, the Tester doesn't reply with GoodCRC.
4. The check fails if a Soft\_Reset message is not sent by the UUT within tReceive max + tSoftReset max, the delay is measured from the time the last bit of the last retransmitted Source\_Capabilities Message EOP has been received to the time the last bit of the Soft\_Reset message EOP has been received. [TEST.PD.PROT.SRC3.6#1]

#### *TEST.PD.PROT.SRC3.7 Get\_PPS\_Status Response*

Description: The Tester verifies that the Source UUT responds correctly to Get\_PPS\_Status message.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source for PPS test COMMON.PROC.BU.4.
2. The Tester sends a Get\_PPS\_Status message to the UUT.
3. The check fails if the Tester does not receive PPS\_Status message. [TEST.PD.PROT.SRC3.7#1]
4. The Tester runs the following additional field checks for the PPSSDB: [TEST.PD.PROT.SRC3.7#2]
  - a. Output Voltage field shall be within  $\pm 3\%$  of the actual output voltage rounded to the nearest 20mV or 0xFFFF
  - b. Output Current field shall be 0x00 to 0x03(inclusive) or 0xFF
  - c. For Real Time Flags field
  - d. Bit 0 shall be 0
  - e. PTF shall be 0x00 (Not Supported) or 0x01 (Normal)
  - f. OMF shall be 0 (Constant Voltage mode)
  - g. Bits 4..7 shall be 0
5. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

#### *TEST.PD.PROT.SRC3.8 SourcePPSCmmTimer Deadline*

**Description:** As a Sink, the Tester sends the second Request message after tPPSRequest max, verifies SourcePPSCmmTimer is not timeout at the UUT and the timer is correctly reinitialized.

**Test Specific Tester Behavior:** N/A

#### **Test Procedures:**

1. The Tester runs bring-up procedure with the UUT as a Source for PPS test COMMON.PROC.BU.4.
2. The check fails if a Hard Reset is received within tPPSRequest max. [TEST.PD.PROT.SRC3.8#1]  
The delay is measured from the time the last bit of the EOP of the GoodCRC Message sent by the UUT in response to the previous Request message to the time the first bit of the Hard Reset is received.
3. The Tester sends the second Request message to request the Programmable Power Supply APDO at 4V 1A, tPPSRequest max after the previous Request message. The check fails if the Tester cannot send the second Request message at tPPSRequest max because the UUT has presented SinkTxNG. [TEST.PD.PROT.SRC3.8#2]
4. The check fails if the UUT does not respond with an Accept message and then a PS\_RDY message. [TEST.PD.PROT.SRC3.8#3]
5. The check fails if a Hard Reset is received within tPPSRequest max. [TEST.PD.PROT.SRC3.8#4]  
The delay is measured from the time the last bit of the EOP of the GoodCRC Message sent by the UUT in response to the second Request Message to the time the first bit of the Hard Reset is received.

#### *TEST.PD.PROT.SRC3.9 SourcePPSCmmTimer Timeout*

**Description:** As a Sink, the Tester intentionally does not send the second Request message, in order to force a SourcePPSCmmTimer timeout on the UUT and verifies it is correctly implemented.

**Test Specific Tester Behavior:** N/A

#### **Test Procedures:**

1. The Tester runs bring-up procedure with the UUT as a Source for PPS test COMMON.PROC.BU.4.
2. The Tester intentionally does not send the second Request Message.
3. The check fails if a Hard Reset is received before tPPSTimeout min, or not received within tPPSTimeout max. [TEST.PD.PROT.SRC3.9#1] The delay is measured from the time the last bit of the EOP of the GoodCRC Message sent by the UUT in response to the previous Request Message to the time the first bit of the Hard Reset is received.

#### *TEST.PD.PROT.SRC3.10 SourcePPSCmmTimer Stopped*

**Description:** As a Sink, the Tester request a PPS APDO first and then request a fixed PDO, verifies SourcePPSCmmTimer is stopped at the UUT.

**Test Specific Tester Behavior:** N/A

#### **Test Procedures:**

1. The Tester runs bring-up procedure with the UUT as a Source for PPS test COMMON.PROC.BU.4.
2. The check fails if a Hard Reset is received within tPPSRequest max. [TEST.PD.PROT.SRC3.10#1]  
The delay is measured from the time the last bit of the EOP of the GoodCRC message sent by the UUT in response to the previous Request message to the time the first bit of the Hard Reset is received.
3. The Tester sends the second Request message to request the Fixed Supply PDO at 5V 0.1A, tPPSRequest max after the previous Request message. The check fails if the Tester cannot send the second Request message at tPPSRequest max because the UUT has presented SinkTxNG. [TEST.PD.PROT.SRC3.10#2]
4. The check fails if the UUT does not respond with an Accept message and then a PS\_RDY message. [TEST.PD.PROT.SRC3.10#3]
5. The check fails if a Hard Reset is received within tPPSTimeout max + 15ms. [TEST.PD.PROT.SRC3.10#4]  
The delay is measured from the time the last bit of the EOP of the GoodCRC message sent by the UUT in response to the second Request message to the time the first bit of the Hard Reset is received.

#### *TEST.PD.PROT.SRC3.11 GoodCRC Specification Revision Compatibility*

Description: As a Sink, the Tester verifies the UUT accepts GoodCRC with Specification Revision set to 00b, 01b, or 10b.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The test starts in a disconnected state.
2. The Tester applies Rd and it waits for VBUS for tNoResponse max.
3. The check fails if the first bit of a Source Capabilities message is not received from the UUT within tFirstSourceCap max after VBUS present. [TEST.PD.PROT.SRC3.11#1]
4. The Tester sends a GoodCRC (acknowledging the Source Capabilities message) with Specification Revision set to 00b. The check fails if the UUT retransmits the Source Capabilities message. [TEST.PD.PROT.SRC3.11#2]
5. Repeat the test with Specification Revision in GoodCRC set to 01b and 10b.

## 4.4 Test Procedures for Sink Capable UUT

### 4.4.1 PD2 and PD3 Modes

The tests in this subsection are run firstly in PD2 mode and secondly in PD3 mode.

The tests in this subsection are applicable to UUT with VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider and DRP.

Unless a Test Specific Tester Behavior is specified, this section uses the following behavior:

- The Tester is a Source only
- The Tester always replies with an Accept message to a DR\_Swap message
- The Tester always rejects PR\_Swap COMMON.PROC.PD.5
- The Tester always accepts VCONN\_Swap COMMON.PROC.PD.6
- The Tester always provides a NAK response for Discover Identity COMMON.PROC.PD.7
- The Tester always provides a NAK response for Discover SVIDs COMMON.PROC.PD.8

#### *TEST.PD.PROT.SNK.1 Get\_Sink\_Cap Response*

Description: The Tester verifies that the Sink UUT responds correctly to the Get\_Sink\_Cap message.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b)
2. The Tester sends a Get\_Sink\_Cap message to the UUT. The Tester continues to present SinkTxNG while waiting for a response if the test is running in PD3 mode.
3. The check fails if the UUT does not send Sink Capabilities message. [TEST.PD.PROT.SNK.1#1]
4. The Tester runs the following additional field checks on the Sink Capabilities message: [TEST.PD.PROT.SNK.1#2]
  - a. The Number of Data Objects field in the Message Header is at least 1 and it matches VIF field Num\_Snk\_PDO
  - b. For the first PDO, the Tester checks consistency of:
    - i. B31...30 (Fixed Supply) set to 00b
    - ii. B29 (Dual-Role Power) set to 1b if any of the following VIF fields is YES:
      1. Accepts\_PR\_Swap\_As\_Snk
      2. Accepts\_PR\_Swap\_As\_Src
      3. Requests\_PR\_Swap\_As\_Snk
      4. Requests\_PR\_Swap\_As\_Src
    - iii. B26 (USB Communications Capable) matches VIF field USB\_Comms\_Capable
    - iv. B25 (Dual-Role Data) set to 1b if VIF field DR\_Swap\_To\_UFP\_Supported or DR\_Swap\_To\_DFP\_Supported = YES
    - v. B24...23 (Fast Role Swap required USB Type-C Current) matches VIF field FR\_Swap\_Reqd\_Type\_C\_Current\_As\_Initial\_Source
    - vi. B22...20 (Reserved) set to 00b
    - vii. B19...10 (Voltage) set to 5V
    - viii. B9...0 (Maximum Current) matches VIF field Snk\_PDO\_Max\_Current1
  - c. For each PDO, the Tester checks consistency of:
    - i. Snk\_PDO\_Supply\_TypeN
    - ii. If Fixed Supply PDO:
      1. Snk\_PDO\_VoltageN
      2. Snk\_PDO\_Op\_CurrentN

- iii. If Variable Supply PDO:
  - 1. Snk\_PDO\_Max\_VoltageN
  - 2. Snk\_PDO\_Min\_VoltageN
  - 3. Snk\_PDO\_Op\_CurrentN
- iv. If Battery Supply PDO:
  - 1. Snk\_PDO\_Max\_VoltageN
  - 2. Snk\_PDO\_Min\_VoltageN
  - 3. Snk\_PDO\_Op\_PowerN
- v. If Programmable Power Supply APDO:
  - 1. Snk\_PDO\_Max\_VoltageN
  - 2. Snk\_PDO\_Min\_VoltageN
  - 3. Snk\_PDO\_Max\_CurrentN
- d. The Tester compares all PDOs to VIF field PD\_Power\_as\_Sink and check that they meet the requirements of the Power Rules.
- e. The Tester checks PDOs following the first one, are in the correct order: Fixed PDOs in increasing voltage sequence, Battery PDOs in increasing minimum voltage sequence and finally Variable PDOs in increasing minimum voltage sequence
- f. The Tester checks that no Fixed PDO has the same voltage as any other
- g. The Tester checks that no Variable PDO has the same voltage range as any other
- h. The Tester checks that no Battery PDO has the same voltage range as any other

#### *TEST.PD.PROT.SNK.2 Get\_Source\_Cap Response*

Description: The Tester verifies that the Sink UUT responds correctly to the Get\_Source\_Cap message.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b)
2. The Tester sends a Get\_Source\_Cap message to the UUT. The Tester continues to present SinkTxNG while waiting for a response if the test is running in PD3 mode.
3. The Tester checks the response. [TEST.PD.PROT.SNK.2#1]
  - a. The check fails if VIF field PD\_Port\_Type = Consumer Only and the UUT does not send a Reject message
  - b. The check fails if VIF field PD\_Port\_Type != Consumer Only and the UUT does not send a Source Capabilities message

#### *TEST.PD.PROT.SNK.3 SinkWaitCapTimer Deadline*

Description: The Tester verifies that the UUT provides a Request to a Source Capabilities message sent at the deadline limit of tTypeCSinkWaitCap max after a Hard Reset.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
2. The Tester sends a Hard Reset. It drives VBUS to vSafe0V and then restores VBUS to vSafe5V.
3. The Tester transmits Source Capabilities message with single PDO at the limit of tTypeCSinkWaitCap max (the delay is from the time VBUS present vSafe5V min to the last bit of Source Capabilities message EOP):
  - a. B31...30 (Fixed Supply) set to 00b
  - b. B29 (Dual-Role Power) set to 0b if Tester is a Source only; set to 1b if Tester is a Dual-Role Power
  - c. B28 (USB Suspend Supported) set to 0b
  - d. B26 (USB Communications Capable) set to 0b
  - e. B25 (Dual-Role Data) set to 0b
  - f. B24...22 (Reserved) set to 00b
  - g. B21...20 (Peak Current) set to 00b
  - h. B19...10 (Voltage) set to 5V
  - i. B9...0 (Maximum Current) set to 100mA
4. The Tester continues to present SinkTxNG while waiting for a response if the test is running in PD3 mode. The Tester checks that the UUT responds with a Request message.  
[TEST.PD.PROT.SNK.3#1]

#### *TEST.PD.PROT.SNK.4 SinkWaitCapTimer Timeout*

**Description:** The Tester does not send Source Capabilities message after cycling VBUS to force a SinkWaitCapTimer timeout on the UUT, then verifies it is correctly implemented.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
2. The Tester sends a Hard Reset. It drives VBUS to vSafe0V and then restores VBUS to vSafe5V.
3. The Tester does not send a Source Capabilities message after cycling the VBUS to force a SinkWaitCapTimer timeout on the UUT.
4. The check fails if the UUT does not send a Hard Reset between tTypeCSinkWaitCap min and max. [TEST.PD.PROT.SNK.4#1] The delay is between the VBUS present vSafe5V min and the time of the first bit of Preamble of the Hard Reset sent by the UUT.

#### *TEST.PD.PROT.SNK.5 SenderResponseTimer Deadline*

**Description:** The Tester verifies that the UUT accepts an Accept message sent at the deadline limit of tSenderResponse min.

Test Specific Tester Behavior: N/A

Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b)
2. The Tester transmits Source Capabilities message with single PDO between tTypeCSinkWaitCap min and max:
  - a. B31...30 (Fixed Supply) set to 00b
  - b. B29 (Dual-Role Power) set to 0b if Tester is a Source only; set to 1b if Tester is a Dual-Role Power
  - c. B28 (USB Suspend Supported) set to 0b
  - d. B26 (USB Communications Capable) set to 0b
  - e. B25 (Dual-Role Data) set to 0b
  - f. B24...22 (Reserved) set to 00b
  - g. B21...20 (Peak Current) set to 00b
  - h. B19...10 (Voltage) set to 5V
  - i. B9...0 (Maximum Current) set to 100mA
3. The Tester continues to present SinkTxNG while waiting for a response if the test is running in PD3 mode. The check fails if the UUT does not respond with a Request message.
4. The Tester sends an Accept message at the deadline limit of tSenderResponse min after the GoodCRC message. This delay is measured from the time the last bit of the GoodCRC message has been transmitted to the time the last bit of the Accept message has been transmitted.
5. The check fails if a Hard Reset is detected after tProtErrSoftReset max from the time the EOP of the GoodCRC sent in response to the Accept message has been sent. [TEST.PD.PROT.SNK.5#1]

*TEST.PD.PROT.SNK.6 SenderResponseTimer Timeout*

Description: The Tester does not respond to the Request message from the UUT, in order to force a SenderResponseTimer timeout on the UUT and verifies it is correctly implemented.

Test Specific Tester Behavior: N/A

Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b)
2. The Tester transmits Source Capabilities message with single PDO between tTypeCSinkWaitCap min and max:
  - a. B31...30 (Fixed Supply) set to 00b
  - b. B29 (Dual-Role Power) set to 0b if Tester is a Source only; set to 1b if Tester is a Dual-Role Power
  - c. B28 (USB Suspend Supported) set to 0b
  - d. B26 (USB Communications Capable) set to 0b
  - e. B25 (Dual-Role Data) set to 0b
  - f. B24...22 (Reserved) set to 00b
  - g. B21...20 (Peak Current) set to 00b



- h. B19...10 (Voltage) set to 5V
  - i. B9...0 (Maximum Current) set to 100mA
- 3. The Tester continues to present SinkTxNG while waiting for a response if the test is running in PD3 mode. The check fails if a Request message is not received from the UUT.
- 4. The Tester does not send an Accept (as a response to the Request message) in order to force a SenderResponseTimer timeout on the UUT.
- 5. The Tester checks the response: **[TEST.PD.PROT.SNK.6#1]**
  - a. The check fails if a Hard Reset is detected before tSenderResponse min from the time the last bit of the GoodCRC message EOP has been sent.
  - b. The check fails if a Hard Reset is detected after tSenderResponse max + 5ms from the time the last bit of the GoodCRC message EOP has been sent.

#### *TEST.PD.PROT.SNK.7 PStransitionTimer Timeout*

**Description:** The Tester does not send the PS\_RDY message after the Accept message is sent to the UUT, in order to force a PStransitionTimer timeout on the UUT and verifies it is correctly implemented.

**Test Specific Tester Behavior:** N/A

#### **Test Procedures:**

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
2. The Tester sends a Hard Reset.
3. The Tester drives VBUS to vSafe0V and then restores VBUS to vSafe5V. The Tester transmits Source Capabilities message with single PDO (5V @ 100mA, Source only) between tTypeCSinkWaitCap min and max.
4. The Tester continues to present SinkTxNG while waiting for a response if the test is running in PD3 mode. The check fails if a Request message is not received from the UUT.  
**[TEST.PD.PROT.SNK.7#1]**
5. The Tester responds with an Accept message to the Request message.
6. The Tester does not send a PS\_RDY message.
7. The check fails if a Hard Reset is not detected between tPSTransition min and max.  
**[TEST.PD.PROT.SNK.7#2]** The delay is between the last bit of the GoodCRC message EOP and the first bit of Preamble of the Hard Reset sent by the UUT.

#### *TEST.PD.PROT.SNK.8 Atomic Message Sequence – Accept*

**Description:** The Tester sends a GetSinkCap message in place of Accept message and verifies the UUT will send a SoftReset and recover from the error.

**Test Specific Tester Behavior:** N/A

#### **Test Procedures:**

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
2. The Tester sends a Hard Reset. It drives VBUS to vSafe0V and then restores VBUS to vSafe5V.

3. The Tester transmits Source Capabilities message with single PDO between tTypeCSinkWaitCap min and max:
  - a. B31...30 (Fixed Supply) set to 00b
  - b. B29 (Dual-Role Power) set to 0b if Tester is a Source only; set to 1b if Tester is a Dual-Role Power
  - c. B28 (USB Suspend Supported) set to 0b
  - d. B26 (USB Communications Capable) set to 0b
  - e. B25 (Dual-Role Data) set to 0b
  - f. B24...22 (Reserved) set to 00b
  - g. B21...20 (Peak Current) set to 00b
  - h. B19...10 (Voltage) set to 5V
  - i. B9...0 (Maximum Current) set to 100mA
4. The Tester continues to present SinkTxNG while waiting for a response if the test is running in PD3 mode. The check fails if the UUT does not respond with a Request message.  
[TEST.PD.PROT.SNK.8#1]
5. The Tester sends a Get\_Sink\_Cap message at the limit of tReceiverResponse min after the reception of Request message.
6. The check fails if a Soft\_Reset message is not received within tSoftReset max.  
[TEST.PD.PROT.SNK.8#2]
7. The Tester responds with an Accept message to the Soft\_Reset message.
8. The Tester sends Source Capabilities message to the UUT repeatedly until nCapsCount is reached or a GoodCRC is received. The check fails if nCapsCount is reached.
9. The check fails if the UUT does not respond with a Request message. [TEST.PD.PROT.SNK.8#2]

#### *TEST.PD.PROT.SNK.9 Atomic Message Sequence – PS\_RDY*

Description: The Tester sends a GetSinkCap message in place of PS\_RDY message and verifies the UUT will send a Hard Reset.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
2. The Tester sends a Hard Reset.
3. The Tester drives VBUS to vSafe0V and then restores VBUS to vSafe5V. The Tester transmits Source Capabilities message with single PDO (5V @ 100mA, Source only) between tTypeCSinkWaitCap min and max.
4. The Tester checks that the UUT sends a Request message within tNoResponse.  
[TEST.PD.PROT.SNK.9#1] Once it receives a Request message, it proceeds using common procedure COMMON.PROC.PD.10.

5. The Tester continues to present SinkTxNG while waiting for a response if the test is running in PD3 mode. The check fails if a Request message is not received from the UUT.  
[TEST.PD.PROT.SNK.9#2]
6. The Tester responds with an Accept message to the Request message.
7. The Tester sends a Get\_Sink\_Cap message at tPSTransition min after the last bit of the EOP of the GoodCRC message received.
8. The check fails if a Hard Reset is not received within 15ms after the Get\_Sink\_Cap message EOP was sent. [TEST.PD.PROT.SNK.9#3]

#### *TEST.PD.PROT.SNK.10 DR\_Swap Request*

Description: As a Sink, the Tester sends a DR\_Swap message, and verifies that the UUT responds correctly.

#### Test Specific Tester Behavior:

- The Tester always replies with a Reject message to a DR\_Swap message

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
2. The Tester requests a DR\_Swap. The Tester continues to present SinkTxNG while waiting for a response if the test is running in PD3 mode.
3. The Tester checks the response. [TEST.PD.PROT.SNK.10#1]
  - a. If the UUT responds with a Wait message, the Tester resends DR\_Swap every tDRSwapWait + 15ms for 10 times. The check fails if the Tester has resent DR\_Swap for 10 times and the test ends here.
  - b. The check fails if the UUT responds with a Reject message and the VIF field DR\_Swap\_To\_DFP\_Supported = Yes. The test ends here.
  - c. The check fails if the UUT responds with an Accept message and the VIF field DR\_Swap\_To\_DFP\_Supported = No.
4. The Tester requests a further DR\_Swap.
5. The Tester checks the response. [TEST.PD.PROT.SNK.10#2]
  - a. If the UUT responds with a Wait message, the Tester resends DR\_Swap every tDRSwapWait + 15ms for 10 times. The check fails if the Tester has resent DR\_Swap for 10 times.
  - b. The UUT responds with a Reject message and the VIF field DR\_Swap\_To\_UFP\_Supported = Yes.
  - c. The UUT responds with an Accept message and the VIF field DR\_Swap\_To\_UFP\_Supported = No.

#### *TEST.PD.PROT.SNK.11 VCONN\_Swap Request*

**Description:** As a Source, the Tester sends a VCONN\_Swap message, and verifies that the UUT responds correctly.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
2. The Tester presents Ra to the non-CC line (of the UUT). The Tester checks that VCONN is not present at the non-CC line.
3. The Tester requests a VCONN\_Swap. The Tester continues to present SinkTxNG while waiting for a response if the test is running in PD3 mode.
4. The Tester checks the response. [TEST.PD.PROT.SNK.11#1]
  - a. If the UUT responds with a Wait message and the Tester resends VCONN\_Swap every tVCONNSwapWait + 15ms for 10 times. The check fails and the test ends here if the Tester has resent VCONN\_Swap for 10 times.
  - b. The check fails and the test ends here if the UUT responds with a Reject message and the VIF field VCONN\_Swap\_To\_On\_Supported = Yes
  - c. The check fails if the UUT responds with an Accept message and the VIF field VCONN\_Swap\_To\_On\_Supported = No
5. The Tester checks that the UUT sends a PS\_RDY message. [TEST.PD.PROT.SNK.11#2]
6. The Tester checks that VCONN is present at the non-CC line. [TEST.PD.PROT.SNK.11#3]
7. The Tester requests a further VCONN\_Swap.
8. If the UUT's response is a Wait, the Tester waits tVCONNSwapWait + 15ms seconds to resend VCONN\_Swap. The Tester sends VCONN\_Swap up to 10 times, and the check fails if the UUT does not respond with an Accept message. [TEST.PD.PROT.SNK.11#4] If the UUT responds with a Reject message, (the checks fails and) the test ends here.
9. The Tester sends a PS\_RDY message.
10. The Tester checks that the UUT does not present VCONN at the non-CC line within tVCONNSourceOff. [TEST.PD.PROT.SNK.11#5]

#### *TEST.PD.PROT.SNK.12 GoodCRC Specification Revision Compatibility*

**Description:** As a Source, the Tester verifies the UUT accepts GoodCRC with Specification Revision set to 00b, 01b, or 10b.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

1. The test starts in a disconnected state.
2. The tester applies Rp.

3. If the UUT attachment is detected, the Tester applies VCONN (if Ra is detected) and vSafe5V on VBUS.
4. The Tester waits for 50 ms.
5. The Tester transmits Source Capabilities message with single PDO:
  - a. B31...30 (Fixed Supply) set to 00b
  - b. B29 (Dual-Role Power) set to 0b
  - c. B28 (USB Suspend Supported) set to 0b
  - d. B27 (Unconstrained Power) set to 1b
  - e. B26 (USB Communications Capable) set to 0b
  - f. B25 (Dual-Role Data) set to 0b
  - g. B24...22 (Reserved) set to 00b
  - h. B21...20 (Peak Current) set to 00b
  - i. B19...10 (Voltage) set to 5V
  - j. B9...0 (Maximum Current) set to 100mA
6. Repeat Step-5 if the Tester does not receive a GoodCRC from the UUT in response to Source Capabilities message. This requires a delay of tTypeCSendSourceCap (100 ms to 200 ms). This sequence is repeated at least nCapsCount times.
7. The check fails if the UUT does not respond with a Request message. [TEST.PD.PROT.SNK.12#1]
8. The Tester sends a GoodCRC (acknowledging the Request message) with Specification Revision set to 00b. The check fails if the UUT retransmits the Request message.  
[TEST.PD.PROT.SNK.12#2]
9. Repeat the test:
  - a. GoodCRC response is sent with Specification Revision set to 10b if the test is running in PD2 mode
  - b. GoodCRC response is sent with Specification Revision set to 01b if the test is running in PD3 mode

#### *TEST.PD.PROT.SNK.13 PR\_Swap – PSSourceOffTimer Timeout*

Description: As a new Sink, the Tester intentionally does not send a PS\_RDY message after a PR\_Swap in order to force a PSSourceOffTimer timeout on the UUT and verifies it is correctly implemented.

#### Test Specific Tester Behavior:

- The Tester is a Dual-Role Power, initially a Source
- The Tester sends Sink Capabilities setting B27 (Unconstrained Power) to 0b  
COMMON.PROC.PD.3

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 1b).
2. The Tester sends a PR\_Swap message. The Tester continues to present SinkTxNG while waiting for a response if the test is running in PD3 mode.
3. The Tester checks the response. [TEST.PD.PROT.SNK.13#1]
  - a. If the UUT responds with a Wait message, the Tester resends PR\_Swap every tPRSwapWait + 15ms for 10 times. The check fails and the test ends here if the PR\_Swap has been resent for 10 times.
  - b. The check fails and the test stops here if the UUT responds with a Reject message or Not Supported (PD3 only) and the VIF field PD\_Port\_Type is not set to "Consumer Only"
  - c. The check fails if the UUT responds with an Accept message and the VIF field PD\_Port\_Type is not set to either "Consumer/Provider" or "DRP".
4. At tSinkTransition max (this delay is from the last bit of GoodCRC sent in response to the Accept), the Tester drives the VBUS voltage to vSafe0V within tSrcSwapStdbby max.
5. The Tester does not send a PS\_RDY message, in order to force a PSSourceOffTimer timeout on the UUT.
6. A Hard Reset is expected from the UUT. The Tester checks the response: [TEST.PD.PROT.SNK.13#2]
  - a. The check fails if a Hard Reset is not detected after tPSSourceOff max after the time the last bit of the EOP of the GoodCRC Message corresponding to the received Accept message.
  - b. The check fails if a Hard Reset is detected within tPSSourceOff min after the last bit of the EOP of the GoodCRC Message corresponding to the received Accept message.

#### *TEST.PD.PROT.SNK.14 PR\_Swap – Request SenderResponseTimer Timeout*

**Description:** As a new Sink, the Tester intentionally does not send a PS\_RDY message after a PR\_Swap in order to force a PSSourceOffTimer timeout on the UUT and verifies it is correctly implemented.

#### Test Specific Tester Behavior:

- The Tester is a Dual-Role Power, initially a Source
- The Tester sends Sink Capabilities setting B27 (Unconstrained Power) to 0b COMMON.PROC.PD.3

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 1b).
2. The Tester sends a PR\_Swap message. The Tester continues to present SinkTxNG while waiting for a response if the test is running in PD3 mode.
3. The Tester checks the response. [TEST.PD.PROT.SNK.14#1]
  - a. If the UUT responds with a Wait message, the Tester resends PR\_Swap every tPRSwapWait + 15ms for 10 times. The check fails and the test ends here if the Tester has resent PR\_Swap for 10 times.

- b. The check fails and the test ends here if the UUT responds with a Reject message or Not Supported (PD3 only) and the VIF field PD\_Port\_Type is not set to “Consumer Only”
  - c. The check fails if the UUT responds with an Accept message and the VIF field PD\_Port\_Type is not set to either “Consumer/Provider” or “DRP”.
- 4. At tSinkTransition max (this delay is from the last bit of GoodCRC sent in response to the Accept), the Tester drives the VBUS voltage to vSafe0V within tSrcSwapStdbY max.
- 5. The Tester sends a PS\_RDY at the deadline limit of tPSSourceOff min, the delay is from the time the last bit of the EOP of the GoodCRC corresponding to the Accept message.
- 6. The Tester checks that the UUT sends PS\_RDY only after the UUT has applied vSafe5V.  
[TEST.PD.PROT.SNK.14#2]
- 7. The check fails if the PS\_RDY from the UUT is not sent within tNewSrc max.  
[TEST.PD.PROT.SNK.14#3] This delay is from the GoodCRC sent by the UUT in response to the PS\_RDY sent by the Tester.
- 8. The Tester checks that the UUT sends a Source Capabilities message within tFirstSourceCap max.  
[TEST.PD.PROT.SNK.14#4]
- 9. Once the Tester receives Source Capabilities message, the Tester establishes a PD contract using common procedure COMMON.PROC.PD.11.
- 10. The Tester waits 500ms to respond to messages from the UUT.
- 11. The Tester sends a Get\_Source\_Cap message to the UUT.
- 12. The check fails if the Tester does not receive Source Capabilities message.  
[TEST.PD.PROT.SNK.14#5]
- 13. The Tester intentionally does not send a Request message and waits for a Hard Reset.
- 14. The Tester checks the response: [TEST.PD.PROT.SNK.14#8]
  - a. The check fails if a Hard Reset is detected before tSenderResponse min from the time the last bit of the GoodCRC message EOP has been sent.
  - b. The check fails if a Hard Reset is detected after tSenderResponse max + 5ms from the time the last bit of the GoodCRC message EOP has been sent.

#### 4.4.2 PD3 Mode

The tests in this subsection are run only in PD3 mode.

The tests in this subsection are applicable to UUT with VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider and DRP.

Unless a Test Specific Tester Behavior is specified, this section uses the following behavior:

- The Tester is a Source only
- The Tester always replies with an Accept message to a DR\_Swap message
- The Tester always rejects PR\_Swap COMMON.PROC.PD.5
- The Tester always accepts VCONN\_Swap COMMON.PROC.PD.6
- The Tester always provides a NAK response for Discover Identity COMMON.PROC.PD.7
- The Tester always provides a NAK response for Discover SVIDs COMMON.PROC.PD.8

#### *TEST.PD.PROT.SNK3.1 Get\_Source\_Cap\_Extended*

**Description:** The Tester verifies that the Sink UUT responds correctly to Get\_Source\_Cap\_Extended message.

**Test Specific Tester Behavior:** N/A

#### **Test Procedures:**

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b)
2. The Tester sends a Get\_Source\_Cap\_Extended message to the UUT and continues to present SinkTxNG while waiting for a response.
3. The check fails if the UUT does not send either Not\_Supported or Source\_Capabilities\_Extended message. [TEST.PD.PROT.SNK3.1#1]
4. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Source Capabilities message.

#### *TEST.PD.PROT.SNK3.2 Alert Response Source Input Change*

**Description:** As a Source, the Tester sends Alert message indicating OTP event and verifies that the response messages.

**Test Specific Tester Behavior:** N/A

#### **Test Procedures:**

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b)
2. The Tester sends an Alert message to the UUT with Type of Alert field = OTP event (Bit 3).
3. The Tester presents SinkTxOK.
4. The test stops here when one of the following conditions happens:
  - a. A Not\_Supported message is received as a response to the last Alert message
  - b. A Get\_Status message is not received within 500 ms after the last Alert message was sent
5. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

#### *TEST.PD.PROT.SNK3.3 Alert Response Battery Status Change*

**Description:** As a Source, the Tester sends Alert message indicating Battery Status Change and verifies that the response messages.

**Test Specific Tester Behavior:** N/A

#### **Test Procedures:**

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b)



2. The Tester sends an Alert message to the UUT
  - a. Type of Alert field = Battery Status Change Event (Bit 1)
  - b. Fixed Batteries = Battery 0 (B20)
3. The Tester presents SinkTxOK.
4. Upon receiving the Get\_Battery\_Status message, the Tester verifies Battery Status Ref = 0.  
[TEST.PD.PROT.SNK3.3#1]
5. The test stops here when one of the following conditions happens:
  - a. A Not\_Supported message is received as a response to the last Alert message
  - b. A Get\_Battery\_Status message is not received within 500 ms after the last Alert message was sent
6. Rerun the test, with Unchunked Extended Messages Supported field set to 1b in the Tester sent Request message.

#### *TEST.PD.PROT.SNK3.4 Soft\_Reset Sent Regardless of Rp Value*

Description: The Tester verifies that the Sink UUT responds correctly to the Get\_Sink\_Cap message.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b)
2. The Tester sends a Get\_Sink\_Cap message to the UUT and continues to present SinkTxNG while waiting for a response.
3. Upon receipt of the Sink\_Capabilities Message, the Tester doesn't reply with GoodCRC.
4. The check fails if a Soft\_Reset message is not sent by the UUT within tReceive max + tSoftReset max. [TEST.PD.PROT.SNK3.4#1] The delay is measured from the time the last bit of the last retransmitted Sink\_Capabilities Message EOP has been received to the time the last bit of the Soft\_Reset message EOP has been received.

#### *TEST.PD.PROT.SNK3.5 Sink PPS Normal Operation*

Description: The Tester verifies that the Sink UUT verifies the UUT periodically re-request the PPS APDO.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.5 (Dual-Role Power bit B29 in the first PDO is set to 0b)
2. The Tester presents SinkTxOk.
3. The check fails if a Request message is not received within tPPSRequest max.  
[TEST.PD.PROT.SNK3.5#1] The delay is measured from the time the last bit of the EOP of the GoodCRC Message sent by the Tester in response to the previous Request Message to the time the first bit of the Preamble of the new Request Message is received.

4. The Tester runs the following additional field checks on the Request Data Object:  
[TEST.PD.PROT.SNK3.5#2]
  - a. Object Position field is 2.
  - b. The Operating Current is less than or equal to the maximum current offered in the Source\_Capabilities Message.
  - c. The Output Voltage field:
    - i. Greater than or equal to the Minimum Voltage field in the PPS APDO.
    - ii. Less than or equal to the Maximum Voltage field in the PPS APDO.
  - d. Bit 31 = 0b (Reserved)
  - e. Bit 27 = 0b (Reserved)
  - f. Bits 22..20 = 000b (Reserved)
  - g. Bits 8..7 = 00b (Reserved)

#### *TEST.PD.PROT.SNK3.6 Collision Avoidance after PR\_Swap*

Description: The Tester verifies that the Sink UUT verifies the UUT periodically re-request the PPS APDO.

#### Test Specific Tester Behavior:

- The Tester is a Dual-Role Power, initially a Source
- The Tester sends Sink Capabilities setting B27 (Unconstrained Power) to 0b  
COMMON.PROC.PD.3

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.5 (Dual-Role Power bit B29 in the first PDO is set to 1b)
2. The Tester sends a PR\_Swap to the UUT and continues to present SinkTxNG while waiting for a response.
3. If the UUT's response is a Wait, the Tester waits 5 seconds to resend PR\_SWAP. The Tester sends PR\_SWAP up to 3 times, and the check fails if the UUT does not respond with Not\_Supported, Reject or Accept. [TEST.PD.PROT.SNK3.6#1]
4. If the UUT's response is a Reject or Not\_Supported, the test stops here.
5. If the UUT's response is an Accept then the Tester proceeds to complete the Power Role Swap.
6. During the 10 second period after Power Role Swap has completed, the Tester monitors the Rp value. The check fails if the UUT does not present SinkTxOK if it doesn't send any message for 1 second. [TEST.PD.PROT.SNK3.6#2] During this time period, the Tester replies any message sent from the UUT with a proper response.

#### *TEST.PD.PROT.SNK3.7 Revision Number Test*

Description: As a Source, the Tester sends Source Capabilities message with the Message Header containing a higher revision number than that supported and the UUT responds using the highest supported revision number.

#### Test Specific Tester Behavior: N/A

### Test Procedures:

1. The test starts in a disconnected state.
2. The tester applies Rp.
3. If the UUT attachment is detected, the Tester applies VCONN (if Ra is detected) and vSafe5V on VBUS.
4. The Tester waits for 50 ms.
5. The Tester sets the Specification Revision (in the Message Header) to 11b and transmits Source Capabilities message with single PDO:
  - a. B31...30 (Fixed Supply) set to 00b
  - b. B29 (Dual-Role Power) set to 0b
  - c. B28 (USB Suspend Supported) set to 0b
  - d. B27 (Unconstrained Power) set to 1b
  - e. B26 (USB Communications Capable) set to 0b
  - f. B25 (Dual-Role Data) set to 0b
  - g. B24...22 (Reserved) set to 00b
  - h. B21...20 (Peak Current) set to 00b
  - i. B19...10 (Voltage) set to 5V
  - j. B9...0 (Maximum Current) set to 100mA
6. Repeat Step-5 if the Tester does not receive a GoodCRC from the UUT in response to Source Capabilities message. This requires a delay of tTypeCSendSourceCap (100 ms to 200 ms). This sequence is repeated at least nCapsCount times.
7. The check fails if a Request message is not received from the UUT. [\[TEST.PD.PROT.SNK3.7#1\]](#)

## 4.5 Structured VDM Test Procedures for Source Capable UUT

### 4.5.1 PD2 and PD3 Modes

The tests in this subsection are run firstly in PD2 mode and secondly in PD3 mode.

The tests in this subsection are applicable to UUT with VIF field PD\_Port\_Type set to Provider Only, Provider/Consumer and DRP.

Unless a Test Specific Tester Behavior is specified, this section uses the following behavior:

- The Tester is a Sink
- The Tester always replies with a Reject message to a DR\_Swap message
- The Tester always rejects PR\_Swap COMMON.PROC.PD.5
- The Tester always accepts VCONN\_Swap COMMON.PROC.PD.6
- The Tester always provides a NAK response for Discover Identity COMMON.PROC.PD.7
- The Tester always provides a NAK response for Discover SVIDs COMMON.PROC.PD.8

#### *TEST.PD.VDM.SRC.1 Discovery Process and Enter Mode*

**Description:** The Tester verifies that the UUT responds appropriately to VDM messages.

**Test Specific Tester Behavior:** N/A

#### **Test Procedures:**

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1. The Tester instead sends Request message with B25 (USB Communication Capable) set to 1b.
2. The Tester sends a Discover Identity Request to the UUT, using SOP. The Tester checks the response:
  - a. In PD2 mode, the Tester checks the response as follow: **[TEST.PD.VDM.SRC.1#1]**
    - i. The check fails if the UUT does not respond with anything but “Responder NAK” or Ignore response.
    - ii. The check fails if the VIF fields Responds\_To\_Discov\_SOP\_DFP = NO and Responds\_To\_Discov\_SOP\_UFP = YES, and the UUT does not respond with “Responder NAK”.
    - iii. The check fails if the VIF fields Responds\_To\_Discov\_SOP\_DFP = NO and Responds\_To\_Discov\_SOP\_UFP = NO, and the UUT does not respond with Ignore.
  - b. In PD3 mode, the Tester checks the response as follow: **[TEST.PD.VDM.SRC.1#2]**
    - i. The check fails if the UUT responds with anything but a Discover ID Response message or Not\_Supported, and the Tester has resent Discover ID Request tVDMBusy min after it is in PE\_SRC\_RDY for 10 times.
    - ii. The check fails if the UUT responds with a “Responder BUSY” message, and the Tester has resent Discover ID Request for 10 times every tVDMBusy min
    - iii. The check fails if the UUT responds with a “Responder ACK” message and VIF field Responds\_To\_Discov\_SOP\_DFP = No.
    - iv. The check fails if the VIF fields Responds\_To\_Discov\_SOP\_DFP = NO and Responds\_To\_Discov\_SOP\_UFP = YES, and the UUT does not respond with “Responder NAK”.
    - v. The check fails if the VIF fields Responds\_To\_Discov\_SOP\_DFP = NO and Responds\_To\_Discov\_SOP\_UFP = NO, and the UUT does not respond with Not\_Supported.
  - c. The Tester performs the following check on the “Responder ACK” message: **[TEST.PD.VDM.SRC.1#3]**
    - i. If VIF field Product\_Type\_UFP\_SOP = AMA, the check fails if the Number of Data Objects is not 5. Otherwise (i.e. VIF field Product\_Type\_UFP\_SOP != AMA), the check fails if the Number of Data Objects is not 4.
    - ii. ID Header VDO:
      1. The check fails if B31 does not match VIF field Data\_Capable\_as\_USB\_Host\_SOP
      2. The check fails if B30 does not match VIF field Data\_Capable\_as\_USB\_Device\_SOP
      3. The check fails if B29...27 does not match VIF field Product\_Type\_UFP\_SOP

4. The check fails if B26 does not match VIF field  
Modal\_Operation\_Supported\_SOP
    5. In PD3, the check fails if B25...23 does not match VIF field  
Product\_Type\_DFP\_SOP
    6. In PD3, the check fails if B22...16 is not set to zero
    7. In PD2, the check fails if B25...16 is not set to zero
    8. The check fails if B15...0 does not match VIF field USB\_VID\_SOP
  - iii. The check fails if Cert Stat VDO does not match VIF field XID\_SOP
  - iv. The check fails if Product VDO does not match VIF fields PID\_SOP and  
bcdDevice\_SOP
  - v. If VIF field Product\_Type\_UFP\_SOP = AMA, the check fails if AMA VDO does not  
match the following VIF fields:
    1. AMA\_HW\_Vers
    2. AMA\_FW\_Vers
    3. AMA\_VCONN\_power
    4. AMA\_VCONN\_reqd
    5. AMA\_VBUS\_reqd
    6. AMA\_Superspeed\_Support
3. The Tester sends a Discover SVIDs Request to the UUT, using SOP. The Tester checks the  
response:
- a. In PD2 mode, the Tester checks the response as follow [TEST.PD.VDM.SRC.1#4]
    - i. The check fails if the UUT does not respond with anything but “Responder NAK”  
or Ignore response.
    - ii. The check fails if the VIF fields Responds\_To\_Discov\_SOP\_DFP = NO and  
Responds\_To\_Discov\_SOP\_UFP = YES, and the UUT does not respond with  
“Responder NAK”.
    - iii. The check fails if the VIF fields Responds\_To\_Discov\_SOP\_DFP = NO and  
Responds\_To\_Discov\_SOP\_UFP = NO, and the UUT does not respond with  
Ignore.
  - b. In PD3 mode, the Tester checks the response as follow [TEST.PD.VDM.SRC.1#5]
    - i. The check fails if the UUT responds with anything but a Discover SVIDs Response  
message or Not\_Supported, and the Tester has resent Discover SVID Request  
tVDMBusy min after it is in PE\_SRC\_RDY for 10 times.
    - ii. The check fails if the UUT responds with a “Responder BUSY” message, and the  
Tester has resent Discover SVID Request for 10 times every tVDMBusy min
    - iii. The check fails if the UUT responds with a “Responder ACK” message and VIF  
field either Responds\_To\_Discov\_SOP\_DFP = NO or  
Modal\_Operation\_Supported\_SOP = NO.
    - iv. The check fails if the VIF fields Responds\_To\_Discov\_SOP\_DFP = NO and  
Responds\_To\_Discov\_SOP\_UFP = YES, and the UUT does not respond with  
“Responder NAK”.
    - v. The check fails if the VIF fields Responds\_To\_Discov\_SOP\_DFP = NO and  
Responds\_To\_Discov\_SOP\_UFP = NO, and the UUT does not respond with  
Not\_Supported.

4. The Tester evaluates the number of SVIDs in the Discover SVIDs ACK message and checks against VIF fields SVID<X>\_SOP, Num\_SVIDs\_max\_SOP and Num\_SVIDs\_min\_SOP.  
[TEST.PD.VDM.SRC.1#6]
  - a. For each VDO, the Tester checks if B15...0 (SVID n+1) are set to zeros, this marks the last VDO.
  - b. For each VDO, the Tester checks if B31...16 (SVID n) are set to zeros, then B15...0 shall also be zeros and this marks the last VDO.
  - c. If the Discover SVIDs ACK message has 6 VDOs, and B15...0 in VDO 6 is non-zero, then repeat Step-3 until the Tester finds the last VDO.
5. For each SVID:
  - a. The Tester sends a Discover Modes Request to the UUT, using SOP.
  - b. The Tester checks the response: [TEST.PD.VDM.SRC.1#7]
    - i. The check fails if VIF fields Responds\_To\_Discov\_SOP\_DFP = NO and Responds\_To\_Discov\_SOP\_UFP = YES, and the UUT does not respond with "Responder NAK.
    - ii. The check fails if VIF fields Responds\_To\_Discov\_SOP\_DFP = NO and Responds\_To\_Discov\_SOP\_UFP = NO, and the UUT does not respond with Not\_Supported.
    - iii. The check fails if the UUT responds with anything but a Discover Modes Response message or Not\_Supported, and the Tester has resent Discover SVID Request tVDMBusy min after it is in PE\_SRC\_RDY for 10 times.
    - iv. The check fails if the UUT responds with a "Responder BUSY" message, and the Tester has resent Discover SVID Request for 10 times every tVDMBusy min
    - v. The check fails if the UUT responds with a "Responder ACK" message, and VIF field either Responds\_To\_Discov\_SOP\_DFP = NO or Modal\_Operation\_Supported\_SOP = NO.
    - vi. The check fails if there is any consistency mismatch between the values in the Discover Modes ACK message and VIF fields: SVID<X>\_SOP, SVID<X>\_num\_modes\_min\_SOP, and SVID<X>\_num\_modes\_max\_SOP
6. The Tester sends Enter Mode Request to the UUT pointing to the first SVID and Mode 1, using SOP. The check fails if the UUT responds with anything but "Responder NAK".  
[TEST.PD.VDM.SRC.1#8]

#### *TEST.PD.VDM.SRC.2 tVDMSenderResponse Deadline – Discover Identity*

**Description:** The Tester verifies that the UUT accepts a Discover Identity ACK sent at the deadline limit of tVDMSenderResponse min.

**Test Specific Tester Behavior:** N/A

#### **Test Procedures:**

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1. The Tester instead sends Request message with B25 (USB Communication Capable) set to 1b.
2. The Tester checks for Discover Identity Request message: [TEST.PD.VDM.SRC.2#1]

- a. The check fails if VIF field Attempts\_Discov\_SOP = Yes and the UUT does not send Discover Identity Request message after 10 second
  - b. The check fails if VIF field Attempts\_Discov\_SOP = No and the UUT sends Discover Identity Request message.
3. The test stops here if VIF field Attempts\_Discov\_SOP = No and the UUT does not send Discover Identity Request message after 500ms second.
4. The Tester sends a Discover Identity ACK at tVDMSenderResponse min time period. The delay is between the last bit of the GoodCRC and the last bit of the Discover Identity ACK.
5. The check fails if a message is received from the UUT between the Discover Identity Request and the Discover Identity ACK. [TEST.PD.VDM.SRC.2#2]
6. The check fails if a Discover SVIDs command is not received within 100 ms. [TEST.PD.VDM.SRC.2#3]

#### *TEST.PD.VDM.SRC.3 tVDMSenderResponse Timeout – Discover Identity*

Description: The Tester verifies that the UUT accepts a Discover Identity ACK sent at the deadline limit of tVDMSenderResponse min.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1. The Tester instead sends Request message with B25 (USB Communication Capable) set to 1b.
2. The Tester checks for Discover Identity Request message: [TEST.PD.VDM.SRC.3#1]
  - a. The check fails if VIF field Attempts\_Discov\_SOP = Yes and the UUT does not send Discover Identity Request message after 10 second
  - b. The check fails if VIF field Attempts\_Discov\_SOP = No and the UUT sends Discover Identity Request message.
3. The test stops here if VIF field Attempts\_Discov\_SOP = No and the UUT does not send Discover Identity Request message after 500ms second.
4. If the UUT sends Discover Identity Request message, the Tester sends a Discover Identity ACK at tVDMSenderResponse max plus 1ms time period. The delay is between the last bit of the GoodCRC and the last bit of the Discover Identity ACK.
5. The Tester checks the response: [TEST.PD.VDM.SRC.3#2]
  - a. The check fails if a message is received from the UUT between the Discover Identity Request and the Discover Identity ACK.
  - b. The check fails if the UUT does not respond with a GoodCRC for the Discover Identity ACK message.
6. The check fails if a Discover SVIDs command is not received within 100 ms. [TEST.PD.VDM.SRC.3#3]

#### *TEST.PD.VDM.SRC.4 Invalid Fields – Discover Identity*

**Description:** The Tester verifies that the UUT responds correctly to a Discover Identity ACK sent with invalid fields.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1. The Tester instead sends Request message with B25 (USB Communication Capable) set to 1b.
2. The Tester checks for Discover Identity Request message: [TEST.PD.VDM.SRC.4#1]
  - a. The check fails if VIF field Attempts\_Discov\_SOP = Yes and the UUT does not send Discover Identity Request message after 10 second
  - b. The check fails if VIF field Attempts\_Discov\_SOP = No and the UUT sends Discover Identity Request message.
3. The test stops here if VIF field Attempts\_Discov\_SOP = No and the UUT does not send Discover Identity Request message after 500ms second.
7. If the UUT sends Discover Identity Request message, the Tester sends an invalid Structured VDM message at tVDMSenderResponse min time period. The delay is between the last bit of the GoodCRC and the last bit of the invalid Structured VDM message. The Tester checks the response: [TEST.PD.VDM.SRC.4#2]
  - a. The check fails if a message is received from the UUT between the Discover Identity Request and the invalid Structured VDM message
  - b. The check fails if the UUT does not respond with a GoodCRC for the invalid Structured VDM message
4. The Tester performs the following check on invalid Structured VDM message: [TEST.PD.VDM.SRC.4#3]
  - a. Structured VDM Header
    - i. SVID = 0xEEEE
    - ii. Structured VDM Version = 3
    - iii. Command Type = Initiator
    - iv. Command = Discover Modes
    - v. Object Position = 7
  - b. ID Header VDO
    - i. Product Type = 6 (Reserved)
  - c. No other VDOs
5. The check fails if a Discover SVIDs command is received within 100 ms. [TEST.PD.VDM.SRC.4#4]

## 4.6 Structured VDM Test Procedures for Sink Capable UUT

### 4.6.1 PD2 and PD3 Modes

The tests in this subsection are run firstly in PD2 mode and secondly in PD3 mode.

The tests in this subsection are applicable to UUT with VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider and DRP.



Unless a Test Specific Tester Behavior is specified, this section uses the following behavior:

- The Tester is a Source only
- The Tester always replies with a Reject message to a DR\_Swap message
- The Tester always rejects PR\_Swap COMMON.PROC.PD.5
- The Tester always accepts VCONN\_Swap COMMON.PROC.PD.6
- The Tester always provides a NAK response for Discover Identity COMMON.PROC.PD.7
- The Tester always provides a NAK response for Discover SVIDs COMMON.PROC.PD.8

#### *TEST.PD.VDM.SNK.1 Discovery Process and Enter Mode*

Description: The Tester verifies that the UUT responds correctly to the Discovery Process and the Enter Mode message.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (in the single PDO, Dual-Role Power B29 is set to 0b and USB Communications Capable B26 is set to 1b).
2. The Tester sends a Discover Identity Request to the UUT, using SOP. The Tester checks the response. [TEST.PD.VDM.SNK.1#1]
  - a. The check fails if VIF fields Responds\_To\_Discov\_SOP\_UFP = NO and Responds\_To\_Discov\_SOP\_DFP = YES, and the UUT does not respond with “Responder NAK.
  - b. The check fails if VIF fields Responds\_To\_Discov\_SOP\_UFP = NO and Responds\_To\_Discov\_SOP\_DFP = NO, and the UUT does not respond with either Not\_Supported (in PD3 mode) or Ignore (in PD2 mode).
  - c. The check fails if the UUT responds with anything but a Discover SVIDs Response message or Not\_Supported and the Tester has resent Discover ID Request tVDMBusy min after it is in PE\_SNK\_RDY for 10 times.
  - d. The check fails if the UUT responds with a “Responder BUSY” message and the Tester has resent Discover ID Request for 10 times every tVDMBusy min.
  - e. The check fails if the UUT responds with a “Responder ACK” message and VIF field Responds\_To\_Discov\_SOP\_DFP = No.
3. Perform the following check on “Responder ACK” message: [TEST.PD.VDM.SNK.1#2]
  - a. If VIF field Product\_Type\_UFP\_SOP = AMA, the check fails if the Number of Data Objects is not 5. Otherwise (i.e. VIF field Product\_Type\_UFP\_SOP != AMA), the check fails if the Number of Data Objects is not 4.
  - b. ID Header VDO:
    - i. The check fails if B31 does not match VIF field Data\_Capable\_as\_USB\_Host\_SOP
    - ii. The check fails if B30 does not match VIF field Data\_Capable\_as\_USB\_Device\_SOP
    - iii. The check fails if B29...27 does not match VIF field Product\_Type\_UFP\_SOP
    - iv. The check fails if B26 does not match VIF field Modal\_Operation\_Supported\_SOP

- v. In PD3 mode, the check fails if B25...23 does not match VIF field Product\_Type\_DFP\_SOP
    - vi. In PD3 mode, the check fails if B22...16 is not set to zero
    - vii. In PD2 mode, the check fails if B25...16 is not set to zero
    - viii. The check fails if B15...0 does not match VIF field USB\_VID\_SOP
  - c. The check fails if Cert Stat VDO does not match VIF field XID\_SOP
  - d. The check fails if Product VDO does not match VIF fields PID\_SOP and bcdDevice\_SOP
  - e. If VIF field Product\_Type\_UFP\_SOP = AMA, the check fails if AMA VDO does not match the following VIF fields:
    - i. AMA\_HW\_Vers
    - ii. AMA\_FW\_Vers
    - iii. AMA\_VCONN\_power
    - iv. AMA\_VCONN\_reqd
    - v. AMA\_VBUS\_reqd
    - vi. AMA\_Superspeed\_Support
4. The Tester sends a Discover SVIDs Request to the UUT, using SOP. The Tester checks the response. [\[TEST.PD.VDM.SNK.1#3\]](#)
- a. If VIF fields Responds\_To\_Discov\_SOP\_UFP = NO and Responds\_To\_Discov\_SOP\_DFP = YES, then the check fails if the UUT does not respond with “Responder NAK”. The test stops here.
  - b. If VIF fields Responds\_To\_Discov\_SOP\_UFP = NO and Responds\_To\_Discov\_SOP\_DFP = NO, then the check fails if the UUT does not respond with either Not\_Supported (in PD3 mode) or Ignore (in PD2 mode). The test stops here.
  - c. If the UUT responds anything but a Discover SVIDs Response message or Not\_Supported, the Tester resends Discover SVIDs Request tVDMBusy min after it is in PE\_SNK\_RDY for 10 times. Once the Tester has repeated Discover ID for 10 times, the check fails and the test stops here.
  - d. If the UUT responds a “Responder BUSY” message, the Tester resends Discover SVIDs Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover SVIDs for 10 times, the check fails and test stops here.
  - e. If the UUT responds with a “Responder ACK” message, the check fails if VIF field either Responds\_To\_Discov\_SOP\_DFP = NO or Modal\_Operation\_Supported\_SOP = NO.
5. The Tester evaluates the number of SVIDs in the Discover SVIDs ACK message and checks against VIF fields SVID<X>\_SOP, Num\_SVIDs\_max\_SOP and Num\_SVIDs\_min\_SOP. [\[TEST.PD.VDM.SNK.1#4\]](#)
- a. For each VDO, the Tester checks if B15...0 (SVID n+1) are set to zeros, this marks the last VDO.
  - b. For each VDO, the Tester checks if B31...16 (SVID n) are set to zeros, then B15...0 shall also be zeros and this marks the last VDO.
  - c. If the Discover SVIDs ACK message has 6 VDOs, and B15...0 in VDO 6 is non-zero, then repeat Step-3 until the Tester finds the last VDO.
6. For each SVID:
- a. The Tester sends a Discover Modes Request to the UUT, using SOP.
  - b. The Tester checks the response: [\[TEST.PD.VDM.SNK.1#5\]](#)

- i. If VIF fields Responds\_To\_Discov\_SOP\_DFP = NO and Responds\_To\_Discov\_SOP\_UFP = YES, then the check fails if the UUT does not respond with "Responder NAK.
  - ii. If VIF fields Responds\_To\_Discov\_SOP\_DFP = NO and Responds\_To\_Discov\_SOP\_UFP = YES, then the check fails if the UUT does not respond with Not\_Supported.
  - iii. If the UUT responds anything but a Discover Modes Response message or Not\_Supported, the Tester resends Discover Modes Request tVDMBusy min after it is in PE\_SNK\_RDY for 10 times. Once the Tester has repeated Discover ID for 10 times, the check fails and test stops here.
  - iv. If the UUT responds a "Responder BUSY" message, the Tester resends Discover Modes Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover SVIDs for 10 times, the check fails and test stops here.
  - v. If the UUT responds with a "Responder ACK" message, the check fails if VIF field either Responds\_To\_Discov\_SOP\_DFP = NO or Modal\_Operation\_Supported\_SOP = NO.
  - vi. If the UUT responds with a Discover Modes ACK message, check the consistency against VIF fields: SVID<X>\_SOP, SVID<X>\_num\_modes\_min\_SOP, and SVID<X>\_num\_modes\_max\_SOP.
- 7. For every Mode in each SVID:
  - a. The Tester sends Enter Mode to the UUT, using SOP.
  - b. The Tester checks the response. [TEST.PD.VDM.SNK.1#7]
    - i. UUT responds with "Responder BUSY", the check fails.
    - ii. The check fails if the UUT responds with "Responder NAK" to the corresponding SVID<X>\_mode<Y>\_enter\_SOP = Yes.
    - iii. If the UUT responds with "Responder ACK" to Enter Mode, the Tester then sends an Exit Mode Request to the UUT using SOP. The check fails if the UUT does not respond with "Responder ACK" to Exit Mode.

#### *TEST.PD.VDM.SNK.2 Exit Mode without Entering*

Description: The Tester verifies that the UUT responds with a correctly formed message to an Exit Mode command from the Tester.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (in the single PDO, Dual-Role Power B29 is set to 0b and USB Communications Capable B26 is set to 1b).
2. The Tester sends a Discover SVIDs Request to the UUT, using SOP.
3. The Tester checks the responds: [TEST.PD.VDM.SNK.2#1]
  - c. The check fails if a response message (ACK, NAK or BUSY) is not sent after tInterFrameGap min but before tVDMReceiverResponse max. This delay is from the last bit of the EOP of the GoodCRC.

- d. If the UUT responds with a BUSY message, the Tester resends Discover SVIDs Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover SVIDs Request for 10 times, the check fails.
  - e. If VIF field Modal\_Operation\_Supported\_SOP = No, the Tester checks that the UUT responds with a Discover SVIDs NAK message using SOP.
  - a. If VIF field Modal\_Operation\_Supported\_SOP = Yes, the Tester checks that the UUT responds with a Discover SVIDs ACK message using SOP.
4. The Tester sends Exit Mode to the UUT using SOP, set to the first SVID and the first Mode.
5. The Tester checks that Exit Mode NAK is sent after tInterFrameGap min but before tVDMReceiverResponse max. [TEST.PD.VDM.SNK.2#2] This delay is from the last bit of the EOP of the GoodCRC.

### *TEST.PD.VDM.SNK.3 Interruption by PD Message*

**Description:** The Tester verifies that the UUT correctly supports PD message interruption during VDM exchanges.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (in the single PDO, Dual-Role Power B29 is set to 0b and USB Communications Capable B26 is set to 1b).
2. The Tester sends a Discover ID Request to the UUT, using SOP.
3. The Tester sends a Get\_Sink\_Cap using SOP packet immediately after tInterFrameGap has expired, the delay is from the last bit of the EOP of the UUT sent GoodCRC.
4. The check fails if the UUT does not send a Sink Capabilities message. [TEST.PD.VDM.SNK.3#1]
5. The Tester runs the following additional field checks on the Sink Capabilities message: the Number of Data Objects field in the Message Header is at least 1 and it matches VIF field Num\_Snk\_PDO. [TEST.PD.VDM.SNK.3#2]
6. The Tester sends a Discover SVIDs Request to the UUT, using SOP.
7. The Tester sends a Get\_Sink\_Cap using SOP packet immediately after tInterFrameGap has expired, the delay is from the last bit of the EOP of the UUT sent GoodCRC.
8. The check fails if the UUT does not send a Sink Capabilities message. [TEST.PD.VDM.SNK.3#3]
9. The Tester runs the following additional field checks on the Sink Capabilities message: the Number of Data Objects field in the Message Header is at least 1 and it matches VIF field Num\_Snk\_PDO. [TEST.PD.VDM.SNK.3#4]
10. For each SVID:
  - a. The Tester sends a Discover Modes Request to the UUT, using SOP.
  - b. The Tester sends a Get\_Sink\_Cap using SOP packet immediately after tInterFrameGap has expired, the delay is from the last bit of the EOP of the UUT sent GoodCRC.
  - c. The check fails if the UUT does not send a Sink Capabilities message. [TEST.PD.VDM.SNK.3#5]
  - d. The Tester runs the following additional field checks on the Sink Capabilities message: the Number of Data Objects field in the Message Header is at least 1 and it matches VIF field Num\_Snk\_PDO. [TEST.PD.VDM.SNK.3#6]

11. For each of these Modes:

- a. The Tester sends Enter Mode to the UUT, using SOP.
- b. The Tester sends a Get\_Sink\_Cap using SOP packet immediately after tInterFrameGap has expired, the delay is from the last bit of the EOP of the UUT sent GoodCRC.
- c. The check fails if the UUT does not send a Sink Capabilities message.  
[TEST.PD.VDM.SNK.3#7]
- d. The Tester runs the following additional field checks on the Sink Capabilities message: the Number of Data Objects field in the Message Header is at least 1 and it matches VIF field Num\_Snk\_PDO. [TEST.PD.VDM.SNK.3#8]

#### *TEST.PD.VDM.SNK.4 Interruption by VDM Message*

Description: The Tester verifies that the UUT correctly aborts an ongoing VDM exchange if it is interrupted by other VDM command.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (in the single PDO, Dual-Role Power B29 is set to 0b and USB Communications Capable B26 is set to 1b).
2. The Tester sends a Discover ID Request to the UUT, using SOP.
3. The Tester sends a Discover SVIDs Request using SOP packet immediately after tInterFrameGap has expired, the delay is from the last bit of the EOP of the UUT sent GoodCRC.
4. The Tester checks the response: [TEST.PD.VDM.SNK.4#1]
  - a. The check fails if the UUT does not send a response message (ACK, NAK or BUSY) is not sent after tInterFrameGap min but before tVDMReceiverResponse max. This delay is from the last bit of the EOP of the GoodCRC.
  - b. If the UUT responds with a BUSY message, the Tester resends Discover SVIDs Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover SVIDs Request for 10 times, the check fails.
  - c. If VIF field Modal\_Operation\_Supported\_SOP = No, the Tester checks that the UUT responds with a Discover SVIDs NAK message using SOP.
  - d. If VIF field Modal\_Operation\_Supported\_SOP = Yes, the Tester checks that the UUT responds with a Discover ID ACK message using SOP.
5. The Tester evaluates the number of SVIDs in the Discover SVIDs ACK message:  
[TEST.PD.VDM.SNK.4#2]
  - a. For each VDO, the Tester checks if B15...0 (SVID n+1) are set to zeros, this marks the last VDO.
  - b. For each VDO, the Tester checks if B31...16 (SVID n) are set to zeros, then B15...0 shall also be zeros and this marks the last VDO.
6. For each SVID (if there isn't any SVID, then send Discover Mode Request with SVID = 0xFF00):
  - a. The Tester sends a Discover Modes Request to the UUT, using SOP.
  - b. The Tester sends a Discover SVIDs Request using SOP packet immediately after tInterFrameGap has expired, the delay is from the last bit of the EOP of the UUT sent GoodCRC.

- c. The Tester checks the response: [TEST.PD.VDM.SNK.4#3]
  - i. The check fails if the UUT does not send a response message (ACK, NAK or BUSY) after tInterFrameGap min but before tVDMReceiverResponse max. This delay is from the last bit of the EOP of the GoodCRC.
  - ii. If the UUT responds with a BUSY message, the Tester resends Discover SVIDs Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover SVIDs Request for 10 times, the check fails.
  - iii. If VIF field Modal\_Operation\_Supported\_SOP = No, the Tester checks that the UUT responds with a Discover SVIDs NAK message using SOP.
  - iv. If VIF field Modal\_Operation\_Supported\_SOP = Yes, the Tester checks that the UUT responds with a Discover SVIDs ACK message using SOP.
- 7. For each SVID (if there isn't any SVID, then send Discover Mode Request with SVID = 0xFF00):
  - a. The Tester sends a Discover Modes Request to the UUT, using SOP.
  - b. The Tester checks the response: [TEST.PD.VDM.SNK.4#4]
    - i. The check fails if the UUT does not send a response message (ACK, NAK or BUSY) after tInterFrameGap min but before tVDMReceiverResponse max. This delay is from the last bit of the EOP of the GoodCRC.
    - ii. If the UUT responds with a BUSY message, the Tester resends Discover Modes Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover Modes Request for 10 times, the check fails.
    - iii. The check fails if the UUT does not respond with a Discover Modes ACK message using SOP.
- 8. For Modes 1...6 in each SVID (if there isn't any SVID, then send Enter Mode Request with SVID = 0xFF00):
  - a. The Tester sends Enter Mode to the UUT, using SOP.
  - b. The Tester sends a Discover SVIDs Request using SOP packet immediately after tInterFrameGap has expired, the delay is from the last bit of the EOP of the UUT sent GoodCRC.
  - c. The Tester checks the response: [TEST.PD.VDM.SNK.4#4]
    - i. The check fails if the UUT does not send a response message (ACK, NAK or BUSY) after tInterFrameGap min but before tVDMReceiverResponse max. This delay is from the last bit of the EOP of the GoodCRC.
    - ii. If the UUT responds with a BUSY message, the Tester resends Discover SVIDs Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover SVIDs Request for 10 times, the check fails.
    - iii. If VIF field Modal\_Operation\_Supported\_SOP = No, the Tester checks that the UUT responds with a Discover SVIDs NAK message using SOP.
    - iv. If VIF field Modal\_Operation\_Supported\_SOP = Yes, the Tester checks that the UUT responds with a Discover SVIDs ACK message using SOP.
- 9. For Modes 1...6 in each SVID (if there isn't any SVID, then send Discover Mode Request with SVID = 0xFF00):
  - a. The Tester sends Exit Mode to the UUT, using SOP.

- b. The Tester sends a Discover SVIDs Request using SOP packet immediately after tInterFrameGap has expired, the delay is from the last bit of the EOP of the UUT sent GoodCRC.
- c. The Tester checks the response: [TEST.PD.VDM.SNK.4#5]
  - i. The check fails if the UUT does not send a response message (ACK, NAK or BUSY) after tInterFrameGap min but before tVDMReceiverResponse max. This delay is from the last bit of the EOP of the GoodCRC.
  - ii. If the UUT responds with a BUSY message, the Tester resends Discover SVIDs Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover SVIDs Request for 10 times, the check fails.
  - iii. If VIF field Modal\_Operation\_Supported\_SOP = No, the Tester checks that the UUT responds with a Discover SVIDs NAK message using SOP.
  - iv. If VIF field Modal\_Operation\_Supported\_SOP = Yes, the Tester checks that the UUT responds with a Discover SVIDs ACK message using SOP.

#### *TEST.PD.VDM.SNK.5 DR Swap in Modal Operation*

Description: The Tester verifies that the UUT issues a Hard Reset within tDRSwapHardReset if DR\_Swap is sent by during a modal operation.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (in the single PDO, Dual-Role Power B29 is set to 0b and USB Communications Capable B26 is set to 0b).
6. The Tester sends a Discover SVIDs Request to the UUT, using SOP.
7. The Tester checks the responds: [TEST.PD.VDM.SNK.5#1]
  - f. The check fails if a response message (ACK, NAK or BUSY) is not sent after tInterFrameGap min but before tVDMReceiverResponse max. This delay is from the last bit of the EOP of the GoodCRC.
  - g. If the UUT responds with a BUSY message, the Tester resends Discover SVIDs Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover SVIDs Request for 10 times, the check fails.
  - h. If VIF field Modal\_Operation\_Supported\_SOP = No, the Tester checks that the UUT responds with a Discover SVIDs NAK message using SOP.
  - a. If VIF field Modal\_Operation\_Supported\_SOP = Yes, the Tester checks that the UUT responds with a Discover SVIDs ACK message using SOP.
2. For each SVID
  - a. The Tester sends a Discover Modes Request to the UUT, using SOP.
  - b. The Tester checks the responds: [TEST.PD.VDM.SNK.5#2]
    - i. The check fails if a response message (ACK, NAK or BUSY) is not sent after tInterFrameGap min but before tVDMReceiverResponse max. This delay is from the last bit of the EOP of the GoodCRC.



- ii. If the UUT responds with a BUSY message, the Tester resends Discover Modes Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover Modes Request for 10 times, the check fails.
  - iii. The check fails if the UUT does not responds with a Discover Modes ACK message using SOP.
- 3. For every Mode in each SVID:
  - a. The Tester sends Enter Mode to the UUT, using SOP.
  - b. The Tester checks the responds: [TEST.PD.VDM.SNK.5#3]
    - i. The check fails if a response message (ACK, NAK or BUSY) is not sent after tInterFrameGap min but before tVDMReceiverResponse max. This delay is from the last bit of the EOP of the GoodCRC.
    - ii. If the UUT responds with a BUSY message, the Tester resends Enter Mode Request for 10 times every tVDMBusy min. Once the Tester has repeated Enter Mode Request for 10 times, the check fails.
    - iii. If the UUT responds with an Enter Mode NAK, the Tester proceeds to the next Mode.
  - c. If the UUT responds with an Enter Mode ACK, the Tester sends a DR\_Swap using SOP packet. The check fails if Hard Reset is not received within tDRSwapHardReset. [TEST.PD.VDM.SNK.5#4]

#### *TEST.PD.VDM.SNK.6 Structured VDM Revision Number Test*

**Description:** The Tester verifies that the UUT correctly handles Structured VDM Version higher than supported.

**Test Specific Tester Behavior:** N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (in the single PDO, Dual-Role Power B29 is set to 0b and USB Communications Capable B26 is set to 0b).
2. The Tester sends a Discover ID Request to the UUT, using SOP. The Structured VDM Version field in the VDM Header is set to 3.
3. The Tester checks that a response message (ACK, NAK or BUSY) is sent after tInterFrameGap min but before tVDMReceiverResponse max, this delay is from the last bit of the EOP of the GoodCRC. [TEST.PD.VDM.SNK.6#1]
4. The Tester checks that the response contains Structured VDM Version 1.0 (B14...13 = 00b). [TEST.PD.VDM.SNK.6#2]

#### *TEST.PD.VDM.SNK.7 Unrecognized VID in Unstructured VDM*

**Description:** As a DFP, the Tester verifies that the UUT responds a Not\_Supported message to an unstructured VDM message with an unrecognized VID.

**Test Specific Tester Behavior:** N/A



#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (in the single PDO, Dual-Role Power B29 is set to 0b and USB Communications Capable B26 is set to 0b).
2. The Tester sends an unstructured VMD message to the UUT, in which VID in the Unstructured VDM Header is set to the Tester manufacture's VID.
3. If the UUT does not respond with a Not\_Supported message, the check fails.  
[TEST.PD.VDM.SNK.7#1]

### 4.7 Structured VDM Test Procedures for Cable Plug UUT

#### 4.7.1 PD2 and PD3 Modes

The tests in this subsection are run firstly in PD2 mode and secondly in PD3 mode.

The tests in this subsection are applicable to UUT with VIF field VIF\_Product\_Type set to Cable.

#### *TEST.PD.VDM.CBL.1 Discovery Process and Enter Mode*

**Description:** The Tester verifies that the UUT responds correctly to the Discovery Process and the Enter Mode message.

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sends a Discover ID Request to the UUT, using SOP'.
3. The Tester checks the response message: [TEST.PD.VDM.CBL.1#1]
  - a. The check fails if the UUT responds anything but a Discover SVIDs Response message.
  - b. If the UUT responds with "Responder BUSY" message, the Tester resends Discover ID Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover ID for 10 times, the check fails.
  - c. If the UUT responds with a "Responder NAK", the check fails.
  - d. Check the "Responder ACK" message:
    - i. If VIF field Product\_Type = Passive Cable, the check fails if the Number of Data Objects is not 5. If VIF field Product\_Type = Active Cable, the check fails if the Number of Data Objects is not 6.
    - ii. ID Header VDO:
      1. The check fails if B31 does not match VIF field Data\_Capable\_as\_USB\_Host
      2. The check fails if B30 does not match VIF field Data\_Capable\_as\_USB\_Device
      3. The check fails if B29...27 does not match VIF field Product\_Type
      4. The check fails if B26 does not match VIF field Modal\_Operation\_Supported
      5. The check fails if B25...16 is not set to zero
      6. The check fails if B15...0 does not match VIF field USB\_VID
    - iii. The check fails if Cert Stat VDO does not match VIF field XID
    - iv. The check fails if Product VDO does not match VIF fields PID and bcdDevice

- v. Cable VDO consistency:
  1. Cable\_HW\_Vers
  2. Cable\_FW\_Vers
  3. Type\_C\_to\_Type\_A\_B\_C
  4. Type\_C\_to\_Plug\_Receptacle
  5. Cable\_Latency
  6. Cable\_Termination\_Type
  7. Cable\_SSTX1\_Dir\_Support
  8. Cable\_SSTX2\_Dir\_Support
  9. Cable\_SSRX1\_Dir\_Support
  10. Cable\_SSRX2\_Dir\_Support
  11. Cable\_VBUS\_Current
  12. VBUS\_through\_cable
  13. Cable\_SOP''\_controller
  14. Cable\_Superspeed\_Support
4. The Tester sends a Discover SVIDs Request to the UUT, using SOP'. The Tester checks the response message: [\[TEST.PD.VDM.CBL.1#2\]](#)
  - a. The check fails if the UUT responds anything but a Discover SVIDs Response message.
  - b. If the UUT responds with "Responder BUSY" message, the Tester resends Discover ID Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover ID for 10 times, the check fails and the test ends here.
  - c. If the UUT responds with a "Responder NAK" message, the check fails if VIF field Modal\_Operation\_Supported\_SOP = YES and the test ends here.
  - d. If the UUT responds with a "Responder ACK" message, the check fails if VIF field Modal\_Operation\_Supported\_SOP = NO.
5. The Tester evaluates the number of SVIDs in the Discover SVIDs ACK message and checks against VIF fields SVID<X>, Num\_SVIDs\_max and Num\_SVIDs\_min. [\[TEST.PD.VDM.CBL.1#3\]](#)
  - a. For each VDO, the Tester checks if B15...0 (SVID n+1) are set to zeros, this marks the last VDO.
  - b. For each VDO, the Tester checks if B31...16 (SVID n) are set to zeros, then B15...0 shall also be zeros and this marks the last VDO.
  - c. If the Discover SVIDs ACK message has 6 VDOs, and B15...0 in VDO 6 is non-zero, then repeat Step-4 until the Tester finds the last VDO.
6. For each SVID:
  - a. The Tester sends a Discover Modes Request to the UUT, using SOP'.
  - b. The Tester checks the response: [\[TEST.PD.VDM.CBL.1#4\]](#)
    - i. The check fails if the UUT responds anything but a Discover Modes Response message.
    - ii. If the UUT responds with "Responder BUSY" message, the Tester resends Discover ID Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover ID for 10 times, the check fails and the test ends here.
    - iii. If the UUT responds with a "Responder ACK" message, the check fails if VIF field Modal\_Operation\_Supported\_SOP = NO.

- iv. The check fails if there is any consistency mismatch between the values in the Discover Modes ACK message and VIF fields: SVID<X>\_SOP, SVID<X>\_num\_modes\_min\_SOP, and SVID<X>\_num\_modes\_max\_SOP.
- 7. For every Mode in each SVID:
  - a. The Tester sends Enter Mode to the UUT, using SOP'.
  - b. The Tester checks the response: [TEST.PD.VDM.CBL.1#5]
    - i. If the UUT responds with "Responder BUSY", the check fails.
    - ii. The check fails if the UUT responds with "Responder NAK" to the corresponding SVID<X>\_mode<Y>\_enter = Yes. If the UUT responds with "Responder ACK" to Enter Mode, the Tester then sends an Exit Mode Request to the UUT using SOP. The check fails if the UUT does not respond with "Responder ACK" to Exit Mode.

#### 4.7.2 PD3 Mode

The tests in this subsection are run only in PD3 mode.

The tests in this subsection are applicable to UUT with VIF field VIF\_Product\_Type set to Cable.

##### *TEST.PD.VDM.CBL3.1 Revision Number Test*

**Description:** As a Source, the Tester sends Discover ID REQ message with the Message Header containing a higher revision number than that supported and the UUT responds using the highest supported revision number.

##### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Cable Plug COMMON.PROC.BU.3
2. The Tester sets the Specification Revision (in the Message Header) to 11b and transmits a Discover ID Request to the UUT, using SOP'.
3. The Tester checks the response: [TEST.PD.VDM.CBL3.1#1]
  - a. The check fails if a response message (ACK, NAK or BUSY) is not sent after tInterFrameGap min but before tVDMReceiverResponse max. This delay is from the last bit of the EOP of the GoodCRC.
  - b. The Tester checks that the Specification Revision (in the Message Header) is set consistent with VIF field PD\_Specification\_Revision.
  - c. If the UUT responds with a BUSY message, the Tester resends Discover ID Request for 10 times every tVDMBusy min. Once the Tester has repeated Discover ID for 10 times, the check fails.
  - d. If VIF field Responds\_To\_Discov\_SOP\_UFP = No, the check fails if the UUT does not respond with a Discover ID NAK message using SOP.
  - e. If VIF field Responds\_To\_Discov\_SOP\_UFP = Yes, the check fails if the UUT does not respond with a Discover ID ACK message using SOP.

## 5 Power Supply Specific Tests

**PDO Sequence Table**

Number of PDOs	1	2	3	4	5	6	7
Sequence #1	1 to 1	1 to 2	1 to 2	1 to 2	1 to 2	1 to 2	1 to 2
Sequence #2		2 to 1	2 to 1	2 to 1	2 to 1	2 to 1	2 to 1
Sequence #3			1 to 3	1 to 3	1 to 3	1 to 3	1 to 3
Sequence #4			3 to 2	3 to 2	3 to 2	3 to 2	3 to 2
Sequence #5			2 to 3	2 to 3	2 to 3	2 to 3	2 to 3
Sequence #6			3 to 1	3 to 1	3 to 1	3 to 1	3 to 1
Sequence #7				1 to 4	1 to 4	1 to 4	1 to 4
Sequence #8				4 to 3	4 to 3	4 to 3	4 to 3
Sequence #9				3 to 4	3 to 4	3 to 4	3 to 4
Sequence #10				4 to 2	4 to 2	4 to 2	4 to 2
Sequence #11				2 to 4	2 to 4	2 to 4	2 to 4
Sequence #12				4 to 1	4 to 1	4 to 1	4 to 1
Sequence #13					1 to 5	1 to 5	1 to 5
Sequence #14					5 to 4	5 to 4	5 to 4
Sequence #15					4 to 5	4 to 5	4 to 5
Sequence #16					5 to 3	5 to 3	5 to 3
Sequence #17					3 to 5	3 to 5	3 to 5
Sequence #18					5 to 2	5 to 2	5 to 2
Sequence #19					2 to 5	2 to 5	2 to 5
Sequence #20					5 to 1	5 to 1	5 to 1
Sequence #21						1 to 6	1 to 6
Sequence #22						6 to 5	6 to 5
Sequence #23						5 to 6	5 to 6
Sequence #24						6 to 4	6 to 4
Sequence #25						4 to 6	4 to 6
Sequence #26						6 to 3	6 to 3
Sequence #27						3 to 6	3 to 6
Sequence #28						6 to 2	6 to 2
Sequence #29						2 to 6	2 to 6
Sequence #30						6 to 1	6 to 1
Sequence #31							1 to 7
Sequence #32							7 to 6
Sequence #33							6 to 7
Sequence #34							7 to 5
Sequence #35							5 to 7
Sequence #36							7 to 4
Sequence #37							4 to 7
Sequence #38							7 to 3
Sequence #39							3 to 7
Sequence #40							7 to 2
Sequence #41							2 to 7
Sequence #42							7 to 1

## 5.1 Test Procedures for Source Capable UUT

### 5.1.1 PD2 and PD3 Modes

The tests in this subsection are run firstly in PD2 mode and secondly in PD3 mode.

The tests in this subsection are applicable to UUT with VIF field PD\_Port\_Type set to Provider Only, Provider/Consumer and DRP.

Unless a Test Specific Tester Behavior is specified, this section uses the following behavior:

- The Tester is a Sink
- The Tester always replies with an Accept message to a DR\_Swap message
- The Tester always rejects PR\_Swap COMMON.PROC.PD.5
- The Tester always accepts VCONN\_Swap COMMON.PROC.PD.6
- The Tester always provides a NAK response for Discover Identity COMMON.PROC.PD.7
- The Tester always provides a NAK response for Discover SVIDs COMMON.PROC.PD.8

#### *TEST.PD.PS.SRC.1 Multiple Request Messages*

Description: As a Sink only, the Tester verifies that the Source UUT responds correctly to various Request messages.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.BU.PD.1.
2. The Tester repeats the following steps for each of the PDOs (in the Source Capabilities message), starting with the first PDO:
  - a. The Tester sends a Request message:
    - i. B27 (GiveBack Flag) = 0b
    - ii. B26 (Capability Mismatch) = 0b
    - iii. B25 (USB Communication Capable) = 0b
    - iv. B24 (No USB Suspend) = 1b
    - v. **B19...10 (Operating Current / Power) = 0mA / 0mW**
    - vi. B9...0 (Maximum Operating Current / Power) = Maximum Current / Power in the Source PDO.
  - b. The check fails if an Accept message is not received.
  - c. The check fails if PS\_RDY message is not received within tPSTransition max from the last bit of the EOP of Accept message.
  - d. The Tester performs the following checks:
    - i. If the transition involves a current decrease, the Tester decreases current to the new value within tSinkTransition min of the last bit of the GoodCRC sent in

response to the Accept message. The Tester draws the requested Operating Current / Power with a current transition slew rate of 100mA per  $\mu$ s. The Tester monitors VBUS voltage and the check fails if VBUS voltage is not within the limits of vSrcNew. [TEST.PD.PS.SRC.1#1]

- ii. If the transition involves a current increase, the Tester increase current to the new value after the last bit of the GoodCRC sent in response to the PS\_RDY message. The Tester draws the requested Operating Current / Power with a current transition slew rate of 100mA per  $\mu$ s. The Tester monitors VBUS voltage and the check fails if VBUS voltage is not within the limits of vSrcNew. [TEST.PD.PS.SRC.1#2]
- iii. If the transition involves a VBUS voltage change, decrease the power drawn by the Tester to less than pSnkStdbY within tSinkTransition min of the last bit of the GoodCRC sent in response to the Accept message. The Tester performs the following checks:
  - 1. The Tester checks the VBUS is within vSrcNew of the starting voltage within tSrcTransition min after the end of the GoodCRC sent in response to the Accept message. [TEST.PD.PS.SRC.1#3]
  - 2. The Tester checks that the VBUS transition meets vSrcSlewPos and vSrcSlewNeg. [TEST.PD.PS.SRC.1#4]
  - 3. The Tester checks that the VBUS voltage is within vSrcNew limits between tSrcSettle max and 100ms after tSrcSettle max. [TEST.PD.PS.SRC.1#5]
  - 4. For positive voltage transition, the Tester checks that the VBUS voltage is within vSrcValid limits upon crossing vSrcValid min. [TEST.PD.PS.SRC.1#6]
  - 5. For negative voltage transition, the Tester checks that the VBUS voltage is within vSrcValid limits upon crossing vSrcValid max. [TEST.PD.PS.SRC.1#7]
  - 6. The Tester checks that the UUT does not send PS\_RDY before the VBUS is within vSrcNew. [TEST.PD.PS.SRC.1#8]
- e. The Tester repeats Step-2a and Step-2d, **replacing B19...10 (Operating Current / Power in the Request message)** with the following values. The Tester sends 9 separate Request messages for each PDO.
  - i. 25% of Maximum Current / Power in the Source PDO
  - ii. 50% of Maximum Current / Power in the Source PDO
  - iii. 75% of Maximum Current / Power in the Source PDO
  - iv. 100% of Maximum Current / Power in the Source PDO

- v. 75% of Maximum Current / Power in the Source PDO
- vi. 50% of Maximum Current / Power in the Source PDO
- vii. 25% of Maximum Current / Power in the Source PDO
- viii. 0mA / 0mW

#### *TEST.PD.PS.SRC.2 PDO Transition*

Description: As a Sink only, the Tester enumerates all possible transitions among the PDOs of the UUT and verifies the UUT performs PDO transitions correctly.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.BU.PD.1.
2. The Tester repeats the following steps using the PDO as provided in the **PDO Sequence Table**:
  - a. The Tester sends a Request message:
    - i. B27 (GiveBack Flag) = 0b
    - ii. B26 (Capability Mismatch) = 0b
    - iii. B25 (USB Communication Capable) = 0b
    - iv. B24 (No USB Suspend) = 1b
    - v. **B19...10 (Operating Current / Power) = 500mA / 2.5W (or less if less is offered in the PDO)**
    - vi. B9...0 (Maximum Operating Current / Power) = Maximum Current / Power in the Source PDO.
  - b. The check fails if an Accept message is not received. [TEST.PD.PS.SRC.2#1]
  - c. The check fails if PS\_RDY message is not received within tPSTransition max from the last bit of the EOP of Accept message. [TEST.PD.PS.SRC.2#2]
  - d. The Tester performs the following checks:
    - i. If the transition involves a current decrease, the Tester decreases current to the new value within tSinkTransition min of the last bit of the GoodCRC sent in response to the Accept message. The Tester draws the requested Operating Current / Power with a current transition slew rate of 100mA per  $\mu$ s. The Tester monitors that VBUS voltage and the check fails if VBUS is not within the limits of vSrcNew. [TEST.PD.PS.SRC.2#2]
    - ii. If the transition involves a current increase, the Tester increase current to the new value after the last bit of the GoodCRC sent in response to the PS\_RDY message. The Tester draws the requested Operating Current / Power with a

current transition slew rate of 100mA per  $\mu$ s. The Tester monitors that VBUS voltage and the check fails if VBUS is not within the limits of vSrcNew.

[TEST.PD.PS.SRC.2#3]

- iii. If the transition involves a VBUS voltage change, decrease the power drawn by the Tester to less than pSnkStdby within tSinkTransition min of the last bit of the GoodCRC sent in response to the Accept message. The Tester performs the following checks:
  1. The Tester checks the VBUS is within vSrcNew of the starting voltage within tSrcTransition min after the end of the GoodCRC sent in response to the Accept message. [TEST.PD.PS.SRC.2#4]
  2. The Tester checks that the VBUS transition meets vSrcSlewPos and vSrcSlewNeg. [TEST.PD.PS.SRC.2#5]
  3. The Tester checks that the VBUS voltage is within vSrcNew limits between tSrcSettle max and 100ms after tSrcSettle max. [TEST.PD.PS.SRC.2#6]
  4. For positive voltage transition, the Tester checks that the VBUS voltage is within vSrcValid limits upon crossing vSrcValid min. [TEST.PD.PS.SRC.2#7]
  5. For negative voltage transition, the Tester checks that the VBUS voltage is within vSrcValid limits upon crossing vSrcValid max. [TEST.PD.PS.SRC.2#8]
  6. The Tester checks that the UUT does not send PS\_RDY before the VBUS is within vSrcNew. [TEST.PD.PS.SRC.2#9]
3. The Tester repeats Step-2, **replacing B19...10 (Operating Current / Power in the Request message)** with Maximum Current / Power in the Source PDO.



### *TEST.PD.PS.SRC.3 Initial Source PDO Transition*

**Description:** The Tester verifies that the new Sink UUT responds correctly to a new Source Capabilities messages

#### Test Specific Tester Behavior:

- The Tester is a Dual-Role Power, initially a Sink
- The Tester sends Sink Capabilities setting B27 (Unconstrained Power) to 0b COMMON.PROC.PD.3

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Source COMMON.PROC.BU.1.
2. The Tester sends a PR\_Swap message.
3. The Tester checks the response. [TEST.PD.PS.SRC.3#1]
  - a. If the UUT responds with a Wait message and the Tester resends PR\_Swap every tPRSwapWait + 15ms for 10 times. Once the Tester has resent PR\_Swap for 10 times, the check fails and the test ends here.
  - b. The check fails and the test ends here if the UUT responds with a Reject message and the VIF field PD\_Port\_Type is not set to "Provider Only".
  - c. The check fails if the UUT responds with an Accept message and the VIF field PD\_Port\_Type is not set to either "Provider/Consumer" or "DRP".
4. The Tester draws no more than iSwapStandby within tSrcTransition min after it has sent the last GoodCRC.
5. The Tester checks that the UUT sends a PS\_RDY message after the UUT driving VBUS voltage to vSafe0V. [TEST.PD.PS.SRC.3#2]
6. The Tester checks that the UUT sends PS\_RDY within tSrcTransition max plus tSrcSwapStdby max after the last bit of GoodCRC was sent in response to the received Accept. [TEST.PD.PS.SRC.3#3]
7. The Tester presents vSafe5V on VBUS and then it sends a PS\_RDY message, both within tNewSRC max of the last GoodCRC sent by the UUT.
8. The Tester transmits Source Capabilities message with single PDO (5V @ 100mA, B29 Dual-Role Power set to 1b). The Tester checks that the UUT sends a Request message. [TEST.PD.PS.SRC.3#4]
9. The Tester uses the common procedure COMMON.PROC.PD.10 to establish a PD contract. The Tester checks that the UUT draws no more than pSnkSusp max until the Tester sends the Accept message. [TEST.PD.PS.SRC.3#5]
10. The UUT is now a Sink and the Tester is a Source.
11. The Tester presents SinkTxOK if the test is in PD3 mode. The Tester waits 500ms to respond to messages from the UUT.
12. The Tester sends a Get\_Sink\_Cap message to the UUT.
13. The Tester sends a new Source Capabilities message with up to two PDOs
  - a. The first PDO:
    - i. B31...30 (Fixed Supply) set to 00b
    - ii. B29 (Dual-Role Power) set to 0b
    - iii. B28 (USB Suspend Supported) set to 0b

- iv. B26 (USB Communications Capable) set to 0b
    - v. B25 (Dual-Role Data) set to 0b
    - vi. B24...22 (Reserved) set to 00b
    - vii. B21...20 (Peak Current) set to 00b
    - viii. B19...10 (Voltage) set to 5V
    - ix. B9...0 (Maximum Current) set to the full requested current as provided in the 1<sup>st</sup> PDO of the Sink Capabilities from the UUT
  - b. The second PDO provides full requested current or power as provided in the 2<sup>nd</sup> PDO of the Sink Capabilities. If the Sink Capabilities consists of only one PDO, the Tester provides only 1 PDO in the Source Capabilities.
14. The Tester checks that it receives a Request message. [TEST.PD.PS.SRC.3#6]
15. The Tester sends an Accept message.
- a. If the Tester needs to change the VBUS:
    - i. After a total of tSrcTransition min, check that power drawn by the UUT does not exceed pSnkStdbby max. [TEST.PD.PS.SRC.3#7]
    - ii. Wait a nominal tSrcTransition from the GoodCRC message, and then change VBUS voltage requested to the new value and/or be prepared to supply more or less current within tSrcTransition max plus tSrcReady max as appropriate.
    - iii. As soon as the voltage on VBUS has stopped changing, check that power drawn by the UUT does not exceed pSnkStdbby max. [TEST.PD.PS.SRC.3#8]
    - iv. The Tester sends a PS\_RDY message to the UUT
  - b. Otherwise,
    - i. After 315ms time period, (tSrcTransition max + tSrcReady max) check that the current drawn from VBUS does not exceed the previously contracted current (100mA). [TEST.PD.PS.SRC.3#9]
    - ii. The Tester sends a PS\_RDY message to the UUT.
16. The Tester checks that the current drawn by the UUT does not exceed the level specified in the current PDO over the next 5 seconds. [TEST.PD.PS.SRC.3#10]
17. The Tester sends a new Source Capabilities message with up to two PDOs
- a. The first PDO:
    - i. B31...30 (Fixed Supply) set to 00b
    - ii. B29 (Dual-Role Power) set to 0b
    - iii. B28 (USB Suspend Supported) set to 0b
    - iv. B26 (USB Communications Capable) set to 0b
    - v. B25 (Dual-Role Data) set to 0b
    - vi. B24...22 (Reserved) set to 00b
    - vii. B21...20 (Peak Current) set to 00b
    - viii. B19...10 (Voltage) set to 5V
    - ix. B9...0 (Maximum Current) set to 0mA
  - b. The second PDO matches the 2<sup>nd</sup> PDO of the Sink Capabilities but with 0mA or 0mW. If the Sink Capabilities consists of only one PDO, the Tester provides only 1 PDO in the Source Capabilities.
18. The Tester checks that it receives a Request message. [TEST.PD.PS.SRC.3#11]
19. The Tester sends another new Source Capabilities message with single PDO

- a. The first PDO:
  - i. B31...30 (Fixed Supply) set to 00b
  - ii. B29 (Dual-Role Power) set to 0b
  - iii. B28 (USB Suspend Supported) set to 0b
  - iv. B26 (USB Communications Capable) set to 0b
  - v. B25 (Dual-Role Data) set to 0b
  - vi. B24...22 (Reserved) set to 00b
  - vii. B21...20 (Peak Current) set to 00b
  - viii. B19...10 (Voltage) set to 5V
  - ix. B9...0 (Maximum Current) set to 0mA
20. The Tester checks that it receives a Request message with the Object Position (in the RDO) = 1.  
[TEST.PD.PS.SRC.3#12]
21. The Tester sends an Accept message.
  - a. If the Tester needs to change the VBUS:
    - i. After a total of tSrcTransition min, check that power drawn by the UUT does not exceed pSnkStdbY max. [TEST.PD.PS.SRC.3#13]
    - ii. Wait a nominal tSrcTransition from the GoodCRC message, and then change VBUS voltage requested to the new value and/or be prepared to supply more or less current within tSrcTransition max plus tSrcReady max as appropriate.
    - iii. As soon as the voltage on VBUS has stopped changing, check that power drawn by the UUT does not exceed pSnkStdbY max. [TEST.PD.PS.SRC.3#14]
    - iv. The Tester sends a PS\_RDY message to the UUT
  - b. Otherwise,
    - i. After 315ms time period, (tSrcTransition max + tSrcReady max) check that the current drawn from VBUS does not exceed the previously contracted current (100mA). [TEST.PD.PS.SRC.3#15]
    - ii. The Tester sends a PS\_RDY message to the UUT.
22. After sending PS\_RDY message, the Tester checks that the UUT VBUS power does not exceed pSnkSusp max. [TEST.PD.PS.SRC.3#16]

## 5.2 Test Procedures for Sink Capable UUT

### 5.2.1 PD2 and PD3 Modes

The tests in this subsection are run firstly in PD2 mode and secondly in PD3 mode.

The tests in this subsection are applicable only to UUT with VIF field PD\_Port\_Type set to Consumer Only, Consumer/Provider and DRP.

Unless a Test Specific Tester Behavior is specified, this section uses the following behavior:

- The Tester is a Source only
- The Tester always replies with an Accept message to a DR\_Swap message
- The Tester always rejects PR\_Swap COMMON.PROC.PD.5
- The Tester always accepts VCONN\_Swap COMMON.PROC.PD.6
- The Tester always provides a NAK response for Discover Identity COMMON.PROC.PD.7

- The Tester always provides a NAK response for Discover SVIDs COMMON.PROC.PD.8

#### *TEST.PD.PS.SNK.1 PDO Transition*

Description: The Tester verifies that the UUT responds correctly to a new Source Capabilities messages.

Test Specific Tester Behavior: N/A

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 0b).
2. The Tester sends a Get\_Sink\_Cap message to the UUT.
3. The check fails if the UUT does not send Sink Capabilities message. [TEST.PD.PS.SNK.1#1]
4. The Tester sends a new Source Capabilities message with up to two PDOs
  - a. The first PDO:
    - i. B31...30 (Fixed Supply) set to 00b
    - ii. B29 (Dual-Role Power) set to 0b
    - iii. B28 (USB Suspend Supported) set to 0b
    - iv. B26 (USB Communications Capable) set to 0b
    - v. B25 (Dual-Role Data) set to 0b
    - vi. B24...22 (Reserved) set to 00b
    - vii. B21...20 (Peak Current) set to 00b
    - viii. B19...10 (Voltage) set to 5V
    - ix. B9...0 (Maximum Current) set to the full requested current as provided in the 1<sup>st</sup> PDO of the Sink Capabilities from the UUT
  - b. The second PDO provides full requested current or power as provided in the 2<sup>nd</sup> PDO of the Sink Capabilities. If the Sink Capabilities consists of only one PDO, the Tester provides only 1 PDO in the Source Capabilities.
5. The check fails if the UUT does not responds with a Request message. [TEST.PD.PS.SNK.1#2]
6. The Tester sends an Accept message.
  - a. If the Tester needs to change the VBUS change:
    - i. After a total of tSrcTransition min, check that power drawn by the UUT does not exceed pSnkStdbby max. [TEST.PD.PS.SNK.1#3]
    - ii. Wait a nominal tSrcTransition from the GoodCRC message, and then change VBUS voltage requested to the new value and/or be prepared to supply more or less current within tSrcTransition max plus tSrcReady max as appropriate.
    - iii. As soon as the voltage on VBUS has stopped changing, check that power drawn by the UUT does not exceed pSnkStdbby max. [TEST.PD.PS.SNK.1#4]
    - iv. The Tester sends a PS\_RDY message to the UUT
  - b. Otherwise,
    - i. After 315ms time period, (tSrcTransition max + tSrcReady max) check that the current drawn from VBUS does not exceed the previously contracted current (100mA). [TEST.PD.PS.SNK.1#5]
    - ii. The Tester sends a PS\_RDY message to the UUT.
7. The Tester checks that the current drawn by the UUT does not exceed the level specified in the current PDO over the next 5 seconds. [TEST.PD.PS.SNK.1#6]

8. The Tester sends another new Source Capabilities message with single PDO
  - a. The first PDO:
    - i. B31...30 (Fixed Supply) set to 00b
    - ii. B29 (Dual-Role Power) set to 0b
    - iii. B28 (USB Suspend Supported) set to 0b
    - iv. B26 (USB Communications Capable) set to 0b
    - v. B25 (Dual-Role Data) set to 0b
    - vi. B24...22 (Reserved) set to 00b
    - vii. B21...20 (Peak Current) set to 00b
    - viii. B19...10 (Voltage) set to 5V
    - ix. B9...0 (Maximum Current) set to 0mA
9. The Tester checks that it receives a Request message with the Object Position (in the RDO) = 1.  
[TEST.PD.PS.SNK.1#7]
10. The Tester sends an Accept message.
  - a. If the Tester needs to change the VBUS:
    - i. After a total of tSrcTransition min, check that power drawn by the UUT does not exceed pSnkStdbY max. [TEST.PD.PS.SNK.1#8]
    - ii. Wait a nominal tSrcTransition from the GoodCRC message, and then change VBUS voltage requested to the new value and/or be prepared to supply more or less current within tSrcTransition max plus tSrcReady max as appropriate.
    - iii. As soon as the voltage on VBUS has stopped changing, check that power drawn by the UUT does not exceed pSnkStdbY max. [TEST.PD.PS.SNK.1#9]
    - iv. The Tester sends a PS\_RDY message to the UUT
  - b. Otherwise,
    - i. After 315ms time period, (tSrcTransition max + tSrcReady max) check that the current drawn from VBUS does not exceed the previously contracted current (100mA). [TEST.PD.PS.SNK.1#10]
    - ii. The Tester sends a PS\_RDY message to the UUT.
11. After sending PS\_RDY message, the Tester checks that the UUT VBUS power does not exceed pSnkSusp max. [TEST.PD.PS.SNK.1#11]

#### *TEST.PD.PS.SNK.2 Initial Sink PDO Transition*

Description: The Tester verifies that the new Source UUT performs PDO transitions correctly.

#### Test Specific Tester Behavior:

- The Tester is a Dual-Role Power, initially a Source
- The Tester sends Sink Capabilities setting B27 (Unconstrained Power) to 0b  
COMMON.PROC.PD.3

#### Test Procedures:

1. The Tester runs bring-up procedure with the UUT as a Sink COMMON.PROC.BU.2 (Dual-Role Power bit B29 in the single PDO is set to 1b).
2. The Tester sends a PR\_Swap message.

3. The Tester checks the response: [TEST.PD.PS.SNK.2#1]
  - a. If the UUT responds with a Reject message, the Tester checks that the VIF field PD\_Port\_Type is set to "Consumer Only" and the test ends here.
  - b. If the UUT responds with a Wait message, the Tester resends PR\_Swap every tPRSwapWait + 15ms for 10 times. Once the Tester has repeated for 10 times, the check fails and the test ends here.
  - c. If the UUT responds with an Accept message, the Tester checks that the VIF field PD\_Port\_Type is set to either "Consumer/Provider" or "DRP".
4. At tSinkTransition max (this delay is from the last bit of GoodCRC sent in response to the Accept), the Tester drives the VBUS voltage to vSafe0V within tSrcSwapStdby max.
5. The Tester sends a PS\_RDY at the deadline limit of tPSSourceOff min, the delay is from the time the last bit of the EOP of the GoodCRC corresponding to the Accept message.
6. The Tester checks that the UUT sends PS\_RDY only after the UUT has applied vSafe5V. [TEST.PD.PS.SNK.2#2]
7. The Tester checks that the PS\_RDY from the UUT is within tNewSrc max, this delay is from the GoodCRC sent by the UUT in response to the PS\_RDY sent by the Tester. [TEST.PD.PS.SNK.2#2]
8. Once the Tester receives Source Capabilities message, the Tester establishes a PD contract using common procedure COMMON.PROC.PD.11.
9. The Tester repeats the following steps using the PDO as provided in the **PDO Sequence Table**:
  - a. The Tester sends a Request message:
    - i. B27 (GiveBack Flag) = 0b
    - ii. B26 (Capability Mismatch) = 0b
    - iii. B25 (USB Communication Capable) = 0b
    - iv. B24 (No USB Suspend) = 1b
    - v. **B19...10 (Operating Current / Power) = Maximum Current / Power in the Source PDO**
    - vi. B9...0 (Maximum Operating Current / Power) = Maximum Current / Power in the Source PDO.
  - b. The check fails if the UUT does not respond with an Accept message. [TEST.PD.PS.SNK.2#3]
  - c. The check fails if PS\_RDY message is not received within tPSTransition max from the last bit of the EOP of Accept message. [TEST.PD.PS.SNK.2#4]
  - d. The Tester performs the following checks:
    - i. If the transition involves a current decrease, the Tester decreases current to the new value within tSinkTransition min of the last bit of the GoodCRC sent in response to the Accept message. The Tester draws the requested Operating Current / Power with a current transition slew rate of 100mA per  $\mu$ s. The Tester

monitors that VBUS voltage and the check fails if VBUS is not within the limits of vSrcNew. [TEST.PD.PS.SNK.2#5]

- ii. If the transition involves a current increase, the Tester increase current to the new value after the last bit of the GoodCRC sent in response to the PS\_RDY message. The Tester draws the requested Operating Current / Power with a current transition slew rate of 100mA per  $\mu$ s. The Tester monitors that VBUS voltage and the check fails if VBUS is not within the limits of vSrcNew. [TEST.PD.PS.SNK.2#6]
- iii. If the transition involves a VBUS voltage change, decrease the power drawn by the Tester to less than pSnkStdby within tSinkTransition min of the last bit of the GoodCRC sent in response to the Accept message. The Tester performs the following checks:
  1. The Tester checks the VBUS is within vSrcNew of the starting voltage within tSrcTransition min after the end of the GoodCRC sent in response to the Accept message. [TEST.PD.PS.SNK.2#7]
  2. The Tester checks that the VBUS transition meets vSrcSlewPos and vSrcSlewNeg. [TEST.PD.PS.SNK.2#8]
  3. The Tester checks that the VBUS voltage is within vSrcNew limits between tSrcSettle max and 100ms after tSrcSettle max. [TEST.PD.PS.SNK.2#9]
  4. For positive voltage transition, the Tester checks that the VBUS voltage is within vSrcValid limits upon crossing vSrcValid min. [TEST.PD.PS.SNK.2#10]
  5. For negative voltage transition, the Tester checks that the VBUS voltage is within vSrcValid limits upon crossing vSrcValid max. [TEST.PD.PS.SNK.2#11]
  6. The Tester checks that the UUT does not send PS\_RDY before the VBUS is within vSrcNew. [TEST.PD.PS.SNK.2#12]

## Appendix A: Requirements for Compliance Test Results

The Compliance Test results **Shall** be output in XML format, compliant with the official USB-IF schema.

- A component element **Shall** be created to reflect the VIF component tested
  - Under the *testRun* node:
    - The following values **Shall** be set within the *spec* element:
      - *title*: [Name of document]
      - *version*: [Version number of document]
    - A *test* element **Shall** be created for each Common Check, Common Procedure, and Test
      - The *tcID* attribute **Shall** match the test number
      - A *step* element **Shall** be created for every check identifier (the green text)  
e.g. **COMMON.CHECK.PD.1#1** and **TEST.PD.PROT.SRC.1#1**.
        - If the check fails, the *score* element **Shall** be set to fail.
        - A *comment* element **Shall** be used to provide detail on the nature of each failure. The format in which this is done may be determined by the test vendor.
        - In Common Checks and Procedures, the *comment* element **Shall** indicate both the number of failures and total number of time the check was performed. The format in which this is done may be determined by the test vendor.