

# **POWER OVER ETHERNET**

**Power Sourcing Equipment  
Parametric Test Suite  
Version 1.8**

*Technical Document*



*Last Updated: September 9, 2004 1:00PM*

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## **MODIFICATION RECORD**

January 10, 2003	-Version 1.0 Jeff Lapak
March 3, 2003	-Version 1.1 Veena Venugopal
April 16, 2003	-Version 1.2 Veena Venugopal
July 23, 2003	-Version 1.3 Veena Venugopal
July 31, 2003	-Version 1.4 Veena Venugopal
August 14, 2003	-Version 1.5 Veena Venugopal
August 26, 2003	-Version 1.6 Veena Venugopal
October 6, 2003	-Version 1.7 Veena Venugopal
September 9, 2004	-Version 1.8 David Schwarzenberg

## **ACKNOWLEDGEMENTS**

**The University of New Hampshire would like to acknowledge the efforts of the following individuals in the development of this test suite.**

Nathan Bourgoine	University of New Hampshire
Zachary Clifton	University of New Hampshire
Jeremy Kent	University of New Hampshire
Jeff Lapak	University of New Hampshire
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Veena Venugopal	University of New Hampshire

## **INTRODUCTION**

### **Overview**

The University of New Hampshire's InterOperability Laboratory (IOL) is an institution designed to improve the interoperability of standards based products by providing an environment where a product can be tested against other implementations of a standard. This suite of tests has been developed to help implementers identify problems related to the functional and electrical characteristics of the Power Sourcing Equipment for use with the physical that IEEE p802.3af D4.1 devices may have in establishing link and exchanging packets with each other. The tests do not determine if a product conforms to the IEEE p802.3af D4.0 standard. Rather, they provide one method to verify that the two devices can exchange packets within the bit error ratio specifications established by the IEEE p802.3af D4.1 standard when operating over a worst-case compliant channel. The interoperability test suite focuses on two areas of functionality to simulate a real-world environment: the exchange of packets to produce a packet error ratio that is low enough to meet a desired bit error ratio while power is being supplied over the link channel, and the ability to detect and establish a link at the optimal speed between two devices that make up a link segment while power is being supplied over the link channel. A third area covers specific cable testing.

**Note: Successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other compliant devices. However, combined with satisfactory operation in the IOL's interoperability test bed, these tests provide a reasonable level of confidence that the Device Under Test (DUT) will function well in most environments.**

### **Cable Plants**

The intent of interoperability testing is to ensure that the DUT will perform as expected in a real world network. Testing in a real world network is often variable. Each technology has a standard, which defines the allowable cable characteristics for that technology. To account for all of the possible cable plant scenarios in the real world, a "worst case cable plant" which is very close to the limit of the TIA/EIA cable standards is used. The cable plants are tuned to be between 1-5% above the margins specified in ANSI-TIA-EIA-568-B-2001 or other applicable specifications. A shorter patch cable is also included in testing to insure that short links between devices are also viable.

### **Organization of Tests**

The tests contained in this document are organized to simplify the identification of information related to a test and to facilitate in the actual testing process. Each test contains an identification section that describes the test and provides cross-reference information. The discussion section covers background information and specifies why the test is to be performed. Tests are grouped in order to reduce setup time in the lab environment. Each test contains the following information:

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**Test Number**

The Test Number associated with each test follows a simple grouping structure. Listed first is the Test Group Number followed by the test's number within the group. This allows for the addition of future tests to the appropriate groups of the test suite without requiring the renumbering of the subsequent tests.

**Purpose**

The purpose is a brief statement outlining what the test attempts to achieve. The test is written at the functional level.

**References**

The references section lists cross-references to the IEEE p802.3af D4.1 standard and other documentation that might be helpful in understanding and evaluating the test and results.

**Resource Requirements**

The requirements section specifies the hardware, and test equipment that will be needed to perform the test. The items contained in this section are special test devices or other facilities, which may not be available on all devices.

**Last Modification**

This specifies the date of the last modification to this test.

**Discussion**

The discussion covers the assumptions made in the design or implementation of the test as well as known limitations. Other items specific to the test are covered here.

**Test Setup**

The setup section describes the configuration of the test environment. Small changes in the configuration should be included in the test procedure.

**Procedure**

The procedure section of the test description contains the step-by-step instructions for carrying out the test. It provides a cookbook approach to testing, and may be interspersed with observable results.

**Observable Results**

The observable results section lists specific items that can be examined by the tester to verify that the DUT is operating properly. When multiple values are possible for an observable result, this section provides a short discussion on how to interpret them. The determination of a pass or fail for a certain test is often based on the successful (or unsuccessful) detection of a certain observable result.

**Possible Problems**

This section contains a description of known issues with the test procedure, which may affect test results in certain situations.

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## **Test Suites Related to PSE Parametric Testing**

**Scope:** The following parametric tests are specific to Power Sourcing Equipment that supports 10BASE-T, 100BASE-TX, and 1000BASE-T devices.

**Overview:** These tests are designed to identify problems with IEEE p802.3af-2003 compliant devices. Specifically, the problems related to the functional and electrical characteristics of Power Sourcing Equipment. The tests should be used in conjunction with the physical layer information defined in clauses 14, 25 and 40 of the IEEE p802.3-2002 standard.

### **33.1.1: Open Circuit Voltage**

**Purpose:** To verify that the open circuit voltage at the PI of the PSE during detection mode is below the conformance limit.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.5 and Table 33-2.

**Resource Requirements:**

- Oscilloscope

**Last Modification:** September 22, 2003

**Discussion:** The PSE should detect that a valid PD has been connected. During the detection mode, the open circuit voltage ( $V_{oc}$ ) of the PSE should not exceed 30V.

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

1. Measure the open circuit voltage at the PI of the DUT using a high impedance probe.

**Observable Results:**

- a. The open circuit voltage ( $V_{oc}$ ) should not exceed 30 Volts.

**Possible Problems:** None



### 33.1.2: Detection Circuit

**Purpose:** To verify the Thevenin equivalent detection circuit of the PSE detection source.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.5, Figures 33-8, 33-9

**Resource Requirements:**

- 45k $\Omega$  test load
- Current Source
- Current Meter
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** The PSE should detect the PD via the PSE PI. The PSE's detection circuit can have a Thevenin equivalent circuit consistent with Figure 33-8 or 33-9, in all detection states. This is intended to prevent a PSE to PSE connection from detecting a valid PD signature.

**Test Setup:** The PSE is connected to the PD simulator with a 1m length of Category 5 cable. A current source and current meter is connected to the PI of the PD simulator.

**PSE Detection Source (Figure 33-8):** The PSE is connected to the PD simulator with a 1m length of Category 5 cable. An oscilloscope is connected across the PI of the PD simulator. A 45k $\Omega$  load is attached to the PD's PI.

**Alternative PSE Detection Source (Figure 33-9):** The PSE is connected to the PD simulator with a 1m length of Category 5 cable. A current meter is connected to the PI of the PD simulator. A current source is connected to the PI of the PD simulator to inject current to the  $V_{\text{detect}+}$  port.

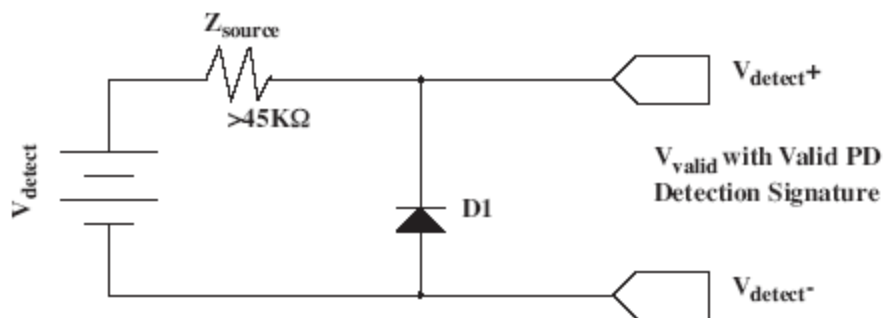


Figure 33-8—PSE detection source

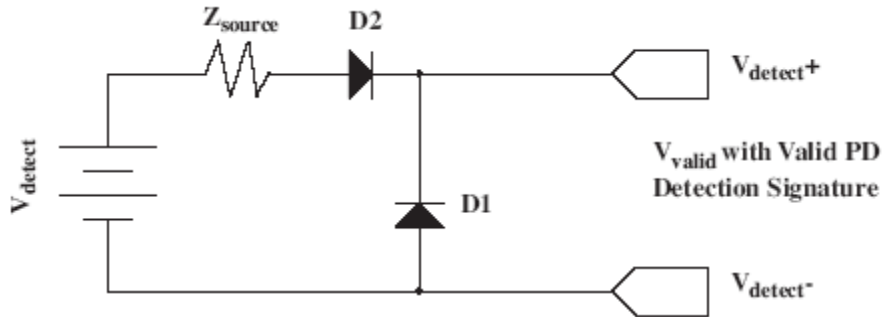


Figure 33-9—Alternative PSE detection source

**Procedure:**

1. Connect the current source to the PI
2. Measure the current flowing into the  $V_{\text{detect}+}$  port of the PSE
3. If current was not accepted in step 2, measure the maximum output voltage of the open circuit PI. Otherwise, the test is complete.
4. Disconnect the current source
5. Connect the 45k $\Omega$  test load to the PI
6. Measure the maximum output voltage of the loaded PI

**Observable Results:**

- a. If the DUT does not accept current into the  $V_{\text{detect}+}$  port, the DUT follows Figure 33-9. Otherwise, the DUT should accept current into the  $V_{\text{detect}+}$  port and the DUT should show a loaded PI voltage of less than half of the open circuit PI voltage, according to Figure 33-8.

**Possible Problems:** None

### **33.1.3: Backdrive Current**

**Purpose:** To verify the detection circuit of the PSE can withstand maximum backdrive current over the range of  $V_{Port}$ .

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.5, Table 33-5

**Resource Requirements:**

- PD Simulator
- Current Source

**Last Modification:** September 23, 2003

**Discussion:** The PSE must be able to handle a PSE to PSE connection. The standard specifies this as the DUT receiving a backdrive current of 5mA at a voltage corresponding to  $V_{Port}$ . After the maximum backdrive current has been applied, the DUT should still be capable of detecting an attached PD.

**Test Setup:** The PSE is connected to the PD simulator with a 1m length of Category 5 cable. A current meter is connected to the PI of the PD simulator.

**Procedure:**

1. Using the 5mA source, inject a current into the PSEs  $V_{detect+}$  port for 10 seconds.
2. Disconnect the current source from the PSE and attach a valid PD signature
3. Observe if the PSE correctly detects the PD and supplies power
4. Disconnect the valid PD
5. Re-connect the current source and inject current into the PSEs  $V_{detect-}$ .
6. Disconnect the current source
7. Re-connect the PSE to a valid PD
8. Observe if the PSE correctly detects the PD and supplies power

**Observable Results:**

- a. The DUT should not be affected by the backdrive current.

**Possible Problems:** None.

#### **33.1.4: Detector Circuit Output Current**

**Purpose:** To verify that the short circuit output current of the PSE during PD detection is within the conformance limits.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.5, Table 33-2

**Resource Requirements:**

- PD Simulator
- Oscilloscope
- Current meter

**Last Modification:** September 23, 2003

**Discussion:** The PSE should limit its output current during detection such that in the event of a short circuit condition, the PSE will not be damaged. The output current for the PSE detection circuit should not exceed 5mA. This value assures the PSE and any attached media will not be damaged.

**Test Setup:** The DUT is connected to the PD simulator, configured as a short circuit.

**Procedure:**

1. Using the current probe, measure the short circuit current at the PI.
2. Repeat step 1 for all probe voltages sourced by the DUT.

**Observable Results:**

- a. In step 1, the short circuit current should not exceed 5 mA.

**Possible Problems:** None

### **33.1.5: Detector Circuit Output Voltage**

**Purpose:** To verify that the test voltages of the PSE detection circuit conform to the specifications defined in Table 33-2.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.5.1, Table 33-2

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** June 30, 2004

**Discussion:** While the PSE is probing the link segment for a valid PD detection signature, the detection voltage  $V_{\text{detect}}$  at the PSE PI should be within the  $V_{\text{valid}}$  voltage range of 2.8 to 10 Volts. The loaded circuit values are measured with a valid PD signature attached to the PSE. The PSE should make at least 2 measurements with  $V_{\text{detect}}$  values that create at least a  $\Delta V_{\text{test}}$  difference of 1 Volt.

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI. Confirm that the DUT is operating in PD detection mode and transmitting probe voltages.

**Procedure:**

1. Supply a valid signature using the PD simulator board at the PI of the DUT
2. Measure the probe voltages at the PI of the DUT.
3. Measure the slew rate of the probe voltages.

**Observable Results:**

- a. In step 2, the loaded PI output detection voltages should be between 2.8 and 10 volts.
- b. In step 2, the voltage difference between consecutive detection probe voltages should be at least 1 volt.
- c. In step 3, the slew rate of the probe voltages should be less than 0.1 V/ $\mu$ s

**Possible Problems:** None

### **33.1.6: PD Detection Timing**

**Purpose:** To verify that the PSE probes its PI with valid detection pulses and completes an entire detection sequence within the proper time period.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.5, Table 33-2, Table 33-5.

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** While the PSE is probing the link segment for a valid PD detection signature, the PSE is required to make at least 2 measurements within  $V_{\text{detect}}$  values. During these measurements, the time between any two valid test points must be at least 2ms ( $T_{BP}$ ), while the total time taken for the PSE to complete detection should not be greater than 500ms ( $T_{\text{det}}$ ).

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI. Confirm that the DUT is in PD detection mode and transmitting probe voltages.

**Procedure:**

1. Measure the pulse width of the entire detection sequence.
2. Measure the time between any two valid detection voltages.

**Observable Results:**

- a. In step 1, the total pulse width of the detection pulse should not be greater than 500ms.
- b. In step 2, the time between any two valid detection pulses should be at least 2 ms.

**Possible Problems:** None

### **33.1.7: Turn On Rise Time**

**Purpose:** To verify that when the PSE applies power, the response times of the PSE are within the conformance limits.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.8, Table 33-5.

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** September 26, 2003

**Discussion:** The PSE may turn on power when it detects a valid signature at its PI. Signal rise is defined as a transition from the baseline voltage to  $V_{Port}$ . This signal rise time ( $T_{Rise}$ ) is defined to be the time difference between the point where the signal transition crosses 10% and 90% of  $V_{Port}$  of the PSE. All measured rise times should be greater than 15  $\mu s$  as specified in Table 33-5. This implies that the slew rate during powering on should not exceed 3.04V/ $\mu s$ .

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

1. Provide a valid signature at the PI of the PSE.
2. Confirm that the PSE probes the link section with valid detection pulses before it powers on.
3. Measure the  $V_{Port}$ .
4. Measure the slew rate when the DUT is powering on the PD simulator.

**Observable Results:**

- a. In step 4, all measured slew rates should not exceed 3.04V/ $\mu s$ .

**Possible Problems:** None

### 33.1.8: PD Signature Detection Limits

**Purpose:** To verify that the DUT will properly detect a PD's signature impedance.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.6; Table 33-2

**Resource Requirements:**

- PD Simulator
- Voltmeter

**Last Modification:** September 23, 2003

**Discussion:** The PSE should be able to detect the signature impedance of an attached PD. This detection is accomplished by probing the PD via the PI. From this signature, the PSE should determine whether or not to supply power to the attached PD. The PSE should only provide power if the PD presents a signature which is compliant with Table 33-2 which is partially printed here for convenience.

Item	Parameter	Minimum	Maximum
7	$R_{good}$ (K $\Omega$ )	19	26.5
8	$R_{bad}$ (K $\Omega$ )	15	33
10	$C_{good}$ (nF)		150
11	$C_{bad}$ ( $\mu$ F)	10	

**Table 33-2**

**Test Setup:** The DUT is connected to the PD Simulator with a 1m length of Category 5 cable.

**Procedure:**

*Part a: Input Resistance Minimums*

1. Adjust the PD simulator to have a valid input signature capacitance (0.1 $\mu$ F)
2. Increase the signature resistance from  $R_{badmin}$  until the DUT supplies power to the PD
3. Record the value at which the PSE accepts the PD signature resistance.
4. Decrease the signature resistance below  $R_{goodmin}$  until the DUT does not supply power to the PD
5. Record the value at which the PSE rejects the PD signature resistance.

*Part b: Input Resistance Maximums*

6. Increase the signature resistance above  $R_{goodmax}$  until the DUT does not supply power to the PD
7. Record the value at which the PSE rejects the PD signature resistance.
8. Decrease the signature resistance from  $R_{badmax}$  until the DUT supplies power to the PD.



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9. Record the value at which the PSE accepts the PD signature resistance.

*Part c: Input Capacitance “Must Accept”*

10. Set the PD signature model to have a resistance between  $R_{goodmin}$  and  $R_{goodmax}$  ( $22k\Omega$ ).
11. Set the PD signature model to have a capacitance of  $C_{sigmax}$  less than  $150nF$
12. Connect the PD signature model to the PI of the DUT and observe the voltage at the PI.

*Part d: Input Capacitance “Must Reject”*

13. Set the PD signature model to have a capacitance of greater than  $C_{badmin}$  ( $10\ \mu F$ )
14. Connect the PD signature model to the PI of the DUT and observe the voltage at the PI.

**Observable Results:**

- a. In step 3 and 5, the resistance ( $R_{accept(min)}$ ) should be between  $15k\Omega$  and  $19k\Omega$
- b. In step 7 and 9, the resistance ( $R_{accept(max)}$ ) should be between  $26.5k\Omega$  and  $33k\Omega$
- c. In step 12, the DUT should accept the PD signature and may provide power
- d. In step 14, the DUT should reject the PD signature and not provide power

**Possible Problems:** None.

### 33.1.9: PD Classification

**Purpose:** To verify a PSE supporting classification properly performs PD class detection.

**Reference:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.7.1,33.2.7.2, Table 33-3, Table 33-4.

**Resource Requirements:**

- PD simulator
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** The PSE may attempt to classify the PD. Also, the PD may provide information to allow features such as load management to be implemented. The PSE should probe the PD with a voltage between 15.5 and 20.5 volts limited to 100 mA. The PSE should measure  $I_{Class}$  and classify the PD based on the observed current as dictated by Table 33-4, which is printed here for convenience.

Measure $I_{class}$	Classification
0mA to 5mA	Class 0
>5mA and <8mA	May be Class 0 or 1
8mA to 13mA	Class 1
>13mA and <16mA	May be Class 0,1 or 2
16mA to 21mA	Class 2
>21mA and <25mA	May be Class 0,2 or 3
25mA to 31mA	Class 3
>31mA and <35mA	May be Class 0,3 or 4
35mA to 45mA	Class 4
>45mA and <51mA	May be Class 0 or 4

**Table 33-4**

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

1. Set the load resistance to the minimum.
2. Measure  $V_{Class}$  using an oscilloscope before 75 ms ( $T_{pdc}$ ).
3. Measure the  $I_{Class}$ .
4. Vary the resistance stepwise to draw the different levels of current.
5. After the classification time ( $T_{pdc}$ ), measure the voltage ( $V_{Port}$ ) across the PD model.

**Observable Results:**

- a. In step 2, the DUT should supply voltage between 15.5-20.5 Volts.
- b. In step 3, the DUT should accurately classify the PD.

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- c. In step 3, if the  $I_{\text{Class}}$  is greater than or equal to 51mA the DUT should classify the PD as Class 0.
- d. In step 4, the DUT should supply current less than 100 mA.

**Possible Problems:** If the DUT does not perform classification, then the DUT should assign the PD to Class 0.

### **33.1.10: Classification Timing**

**Purpose:** To verify that a PSE capable of classifying a PD completes the classification within  $T_{PDC}$  after successfully completing the detection of a PD.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.8, Table 33-5

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** After successful detection of a PD, a PSE supporting classification must complete classification within the time frame of 10 to 75ms ( $T_{pdc}$ ). The classification should occur anytime within the time frame of 400 ms ( $T_{pon}$ ). If the PSE fails to power the PD within  $T_{pon}$ , it must reinitiate the detection and optional classification sequence.

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

1. Measure the width of the classification. Classification width is the time that the DUT initiates classification to the time that it has completed one classification cycle.

**Observable Results:**

- a. In step 1, the width of the class pulse should be between 10 and 75ms.

**Possible Problems:** This test does not apply to a DUT that does not perform PD classification.

### **33.1.11: PD MPS Dropout Current Limits ( $I_{\min}$ measurement)**

**Purpose:** To verify that the PSE correctly monitors the PD Maintain Power Signature.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.10.1.2, Table 33-5

**Resource Requirements:**

- PD Simulator
- Multimeter

**Last Modification:** September 23, 2003

**Discussion:** The PSE must monitor the link segment for the PD's Maintain Power Signature, and remove power if it detects that the PD is disconnected. The PSE may monitor the AC MPS component, the DC MPS component, or both signature components. If the PSE monitors the DC MPS component, the DUT should remove power from the PI if the current drawn by the PD drops below 5mA ( $I_{\min 1 (\max)}$ ) for more than 400 ms ( $T_{\text{MPDO}}$ ). The PSE may remove power if the current drawn by the PD is between 5mA and 10mA ( $I_{\min 2 (\max)}$ ) for greater than 400ms ( $T_{\text{MPDO}}$ ).

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The multimeter is connected to the PD simulator at the PI to measure current.

**Procedure:**

1. Set the PD Simulator to draw 10mA of current from the DUT
2. Decrease the current draw of the PD simulator from 10mA to less than 5mA for 400ms, in steps of 1mA.
3. Observe the output voltage at the PI of the DUT during each step.
4. Record the current draw at which the PSE removes power.

**Observable Results:**

- a. In Step 4, if the current drawn by the PD simulator is between 5mA and 10mA, the DUT may disconnect power from the PI.
- b. In Step 4, if the current drawn by the PD simulator is less than 5mA, the DUT must disconnect power from the PI.

**Possible Problems:** This test does not apply if the DUT performs only MPS AC disconnect.

### **33.1.12: Range of TMPDO Timer**

**Purpose:** To verify that the PSE correctly monitors the PD Maintain Power Signature.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.10.1.2, Table 33-5, Figure 33-6, Figure 33-7.

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** Once a PSE has entered the 'POWER\_ON' state, it must receive an 'mr\_mps\_valid' from the link partner within a specified amount of time. If this message is not received, it will enter the 'IDLE\_MPS' state and remove power from the link segment before attempting a new detection sequence. This time is defined by the device's 'tmpdo\_timer' and is required to be between 300ms and 400ms. This test is designed to verify that the device under test enters the 'IDLE\_MPS' state from the 'POWER\_ON' state when an mr\_mps\_valid message is not received from its link partner in the acceptable range of time.

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

*Part 1: DC disconnect*

1. Attach a valid signature to the PI of the DUT such that the DUT enters the 'POWER\_ON' state.
2. Reduce the current drawn by the PD to 2mA for  $t \leq 300\text{ms}$ .
3. Observe whether the DUT entered the 'IDLE\_MPS' state.
4. Repeat steps 1-3 varying  $t$  until the DUT enters the 'IDLE\_MPS' state.
5. Find the  $t$  for which the PSE removes power.

*Part 2: AC disconnect*

6. Attach a valid signature to the PI of the DUT such that the DUT enters the 'POWER\_ON' state.
7. Disconnect the PD from the PI of the DUT.
8. Measure the time taken by the DUT to remove power.

**Observable Results:**

*Part 1:*

- a. In step 5, verify that  $300\text{ms} \leq \text{TMPDO} \leq 400\text{ms}$ .

*Part 2:*

- a. In step 8, verify that  $300\text{ms} \leq \text{TMPDO} \leq 400\text{ms}$ .

**Possible Problems:** None.

### 33.1.13: Power Feed Ripple and Noise

**Purpose:** To verify the power feeding ripple and noise are within the conformance limits.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.8.3, Table 33-5

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** The PSE should source power at all rated levels with noise and ripple that are below the levels specified in item 3 of Table 33-5 (printed here for convenience). Excessive noise may cause attached PDs to behave abnormally.

Item	Parameter	Min	Max
3	Power feeding Ripple and noise (Vpp)		
	$f < 500\text{Hz}$		0.5
	$500\text{Hz} \leq f < 150\text{KHz}$		0.2
	$150\text{KHz} \leq f < 500\text{KHz}$		0.15
	$500\text{KHz} \leq f < 1\text{ MHz}$		0.1

**Table 33-5**

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

1. Adjust the PD to sink .44 watts.
2. Measure the amount of pair-to-pair ripple and noise voltage at the PI of the PSE.
3. Measure the amount of common-mode ripple and noise voltage at the PI of the PSE.
4. Adjust the PD to sink 15.4 watts.
5. Repeat steps 3 and 4.

**Observable Results:**

- a. The ripple and noise peak-to-peak voltages, pair-to-pair and common-mode, in the band 0-500Hz will be less than .5 volts
- b. The ripple and noise peak-to-peak voltages, pair-to-pair and common-mode, in the band 500Hz-150kHz will be less than .2 volts
- c. The ripple and noise peak-to-peak voltages, pair-to-pair and common-mode, in the band 150kHz-500kHz will be less than .15 volts
- d. The ripple and noise peak-to-peak voltages, pair-to-pair and common-mode, in the band 500kHz-1MHz will be less than .1 volts

**Possible Problems:** None.

### **33.1.14: Load Regulation**

**Purpose:** To verify that the PSE performs load regulation while supplying power on its PI.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.8.2, Table 33-5

**Resource Requirements:**

- PD Simulator
- Multimeter

**Last Modification:** September 23, 2003

**Discussion:** The PSE should perform voltage regulation while supplying power to a PD over the PI. The output voltage of the PSE must stay between 44 and 57 volts if the load changes at a maximum rate of 35mA/ $\mu$ s. The PSE must not produce any transients greater than 3.5V/ $\mu$ s. These requirements prevent the voltage supply from exceeding the operating range of a PD.

**Test Setup:** Connect the DUT to the PD Simulator with a 1m length of Category 5 cable. Connect the multimeter to the PI of the PD simulator to measure voltage and current.

**Procedure:**

1. Connect the PSE to the PD simulator with a valid signature and the load set to draw 10mA.
2. Adjust the current draw of the PD from 10mA to 350mA in less than 9.7 $\mu$ s.
3. Observe the voltage transients and output voltage of the PSE at the PI.

**Observable Results:**

- a. In Step 3, the voltage transients seen should not exceed 3.5V/ $\mu$ s.
- b. In Step 3, the DUT output voltage at the PI should be within the range of 44 to 57 volts.

**Possible Problems:** None.



### **33.1.15: Power Turn On Timing**

**Purpose:** To verify that the PSE starts applying power within  $T_{pon}$  after it has successfully detected the PD.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.8.13, Table 33-5

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** The PSE must power on the PD after detection and optional classification within  $T_{pon}$ . If the PSE supports classification then it must successfully complete classification within the time frame of 10 to 75ms ( $T_{pdc}$ ). If the PSE fails to power the PD within 400ms ( $T_{pon}$ ), it must reinitiate the detection and optional classification sequence.

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

1. Confirm that the detection of the PD has been successfully completed.
2. Measure the time delay between the end of detection and when the PSE starts applying power.

**Observable results:**

- a. In step 2, the time delay ( $T_{pon}$ ) should not be greater than 400ms.

**Possible Problems:** None.

### **33.1.16: Apply Power**

**Purpose:** To verify that the PSE applies power on the same pairs as those used for detection after completing a valid detection.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.4, 33.2.5.

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** A PSE detects the PD by probing it via the PSE's PI. A PSE should apply power only after it has completed the detection of a PD. The power should be supplied on the same pairs as those used for detection.

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

1. Supply a valid signature at the DUT's PI for a time approximately equal to  $T_{det}$  of the DUT.
2. Confirm that the DUT performs valid detection sequence before powering the PD simulator.
3. Check the pairs on which DUT supplies power.

**Observable Results:**

- a. In step 3, the DUT must power the PD simulator only after a proper detection sequence.
- b. In step 4, the DUT should supply power on the same pairs as that it performed detection for the PD simulator.

**Possible Problems:** None

### 33.1.17: Overload Current Detection Range

**Purpose:** To verify that the PSE removes power if the  $I_{Port}$  exceeds the specified limits.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.8.6, 33.2.8.7, Table 33-5, Figure 33C.6

**Resource Requirements:**

- PD Simulator
- Oscilloscope
- Current probe

**Last Modification:** September 9, 2004

**Discussion:** The PSE monitors the current ( $I_{Port}$ ) drawn by the PD. If  $I_{Port}$  exceeds the overload current detection range  $I_{CUT}$  ( $P_{class} / 44V$  to 400mA) for greater than 75ms ( $T_{Ovld}$ ), the PSE should remove power from its PI. If the PSE does not implement classification then  $I_{CUT}$  should lie within the range of  $(15.4/V_{Port})$  to 400mA. Figure 33C.6 that depicts the relationships between overload detection and timing is printed here for convenience.

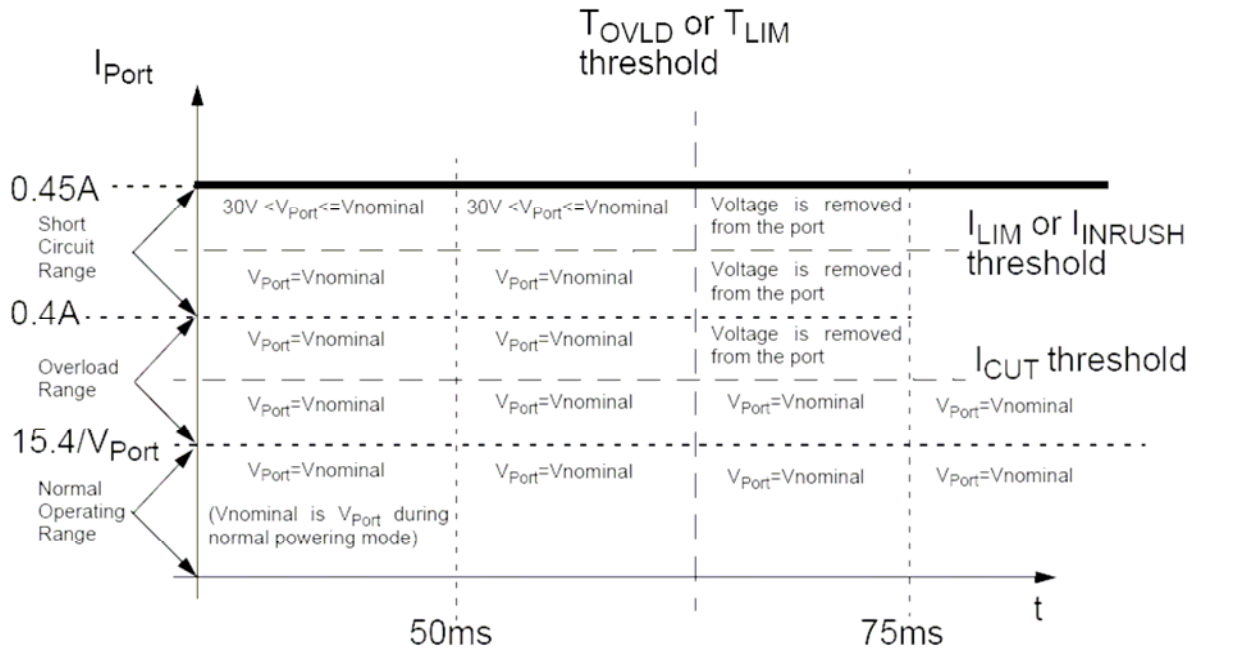


Figure 33C.6

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the current probe. The current probe is connected to the PD simulator at the PI.

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**Procedure:**

1. Verify that the PD is drawing current greater than or equal to  $I_{Min}$  from the DUT.
2. Measure the  $V_{Port}$  at the PI of the PSE.
3. If  $44V \leq V_{Port} \leq 57V$  then connect the load to the DUT.
4. Decrease the load resistance gradually until the DUT removes power from its PI.
5. Measure the current ( $I_{CUT}$ ) at which the DUT stops supplying power

**Observable Results:**

- a. In step 5, if the DUT supports classification, the value of  $I_{CUT}$  should lie between  $P_{class}/44$  to 400mA; otherwise  $I_{CUT}$  should be between  $15.4/V_{port}$  and 400mA(inclusive).

**Possible Problems:** None

### 33.1.18: Overload Time Limit

**Purpose:** To verify that the PSE removes power if  $I_{PORT}$  exceeds 400mA for a time greater than the overload time interval.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.8.6, 33.2.8.7, Table 33-5, Figure 33C.6

**Resource Requirements:**

- PD Simulator
- Oscilloscope
- Current probe

**Last Modification:** September 23, 2003

**Discussion:** The PSE monitors the current ( $I_{Port}$ ) drawn by the PD. If  $I_{Port}$  exceeds the overload current detection range  $I_{CUT}$  ( $P_{class} / 44V$  to 400mA) for greater than 75ms ( $T_{Ovld}$ ), the PSE should remove power from its PI. If the PSE does not implement classification then  $I_{CUT}$  should lie within the range of  $(15.4/V_{Port})$  to 400mA. Figure 33C.6 that depicts the relationships between overload detection and timing. It is printed here for convenience.

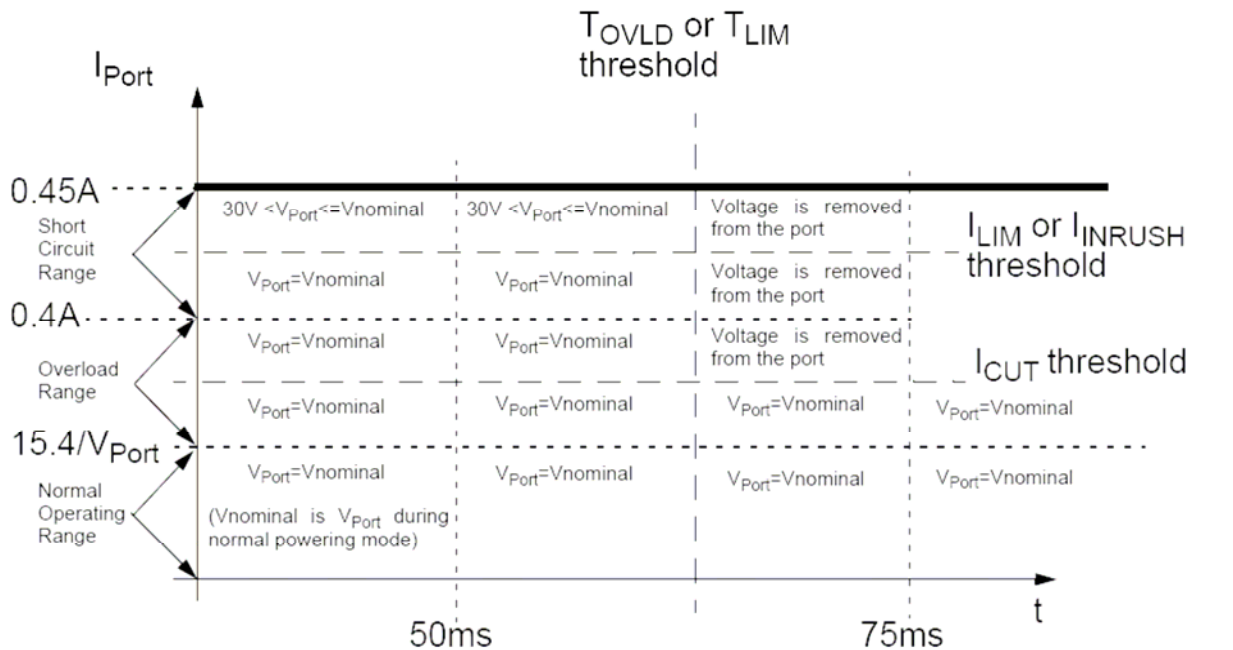


Table 33C.6

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

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**Procedure:**

1. Connect the PD to the DUT with the load set to maximum.
2. Vary the load until the  $I_{Port} \geq I_{CUT}$ .
3. Disconnect the load
4. Set the trigger on the PD simulator to connect the load to the DUT for a period of 50ms.
5. Increase the time in steps of 5 ms till 75ms.
6. Measure the current at which the DUT stops supplying power.
7. Record the time interval when the DUT removes power.

**Observable Results:**

- a. In step 7, the time interval ( $T_{ovld}$ ) should be between 50ms and 75ms(inclusive).

**Possible Problems:** None

### 33.1.19: Inrush Current

**Purpose:** To verify that the inrush current during startup conforms to the specified values. Also, to ensure the PSE removes power within the conformant time limit when it detects a short circuit condition.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.8.5, Table 33-5, Figure 33C.6, 33C.4, Annex 33C1.4

**Resource Requirements:**

- PD Simulator
- Oscilloscope
- Current probe

**Last Modification:** September 23, 2003

**Discussion:** The PSE monitors the current ( $I_{Port}$ ) drawn by the PD. If the PD detects a short circuit condition, it must start removing power within 50 to 75ms ( $T_{LIM}$ ) and must be done by 500ms ( $T_{Off}$ ). The minimum inrush current applies for duration of  $T_{LIM}$ . During startup, for PI voltages greater than 30 V the inrush current must be between 400mA and 450mA. For PI voltages between 10V and 30V, the inrush current must be at least 60mA. Figure 33C.4, which defines the  $I_{Port}$  current, timing limits during startup and short-circuit conditions, is printed here for convenience. Figure 33C.6, which depicts the limits of the Inrush current and short circuit time limit, is also printed below.

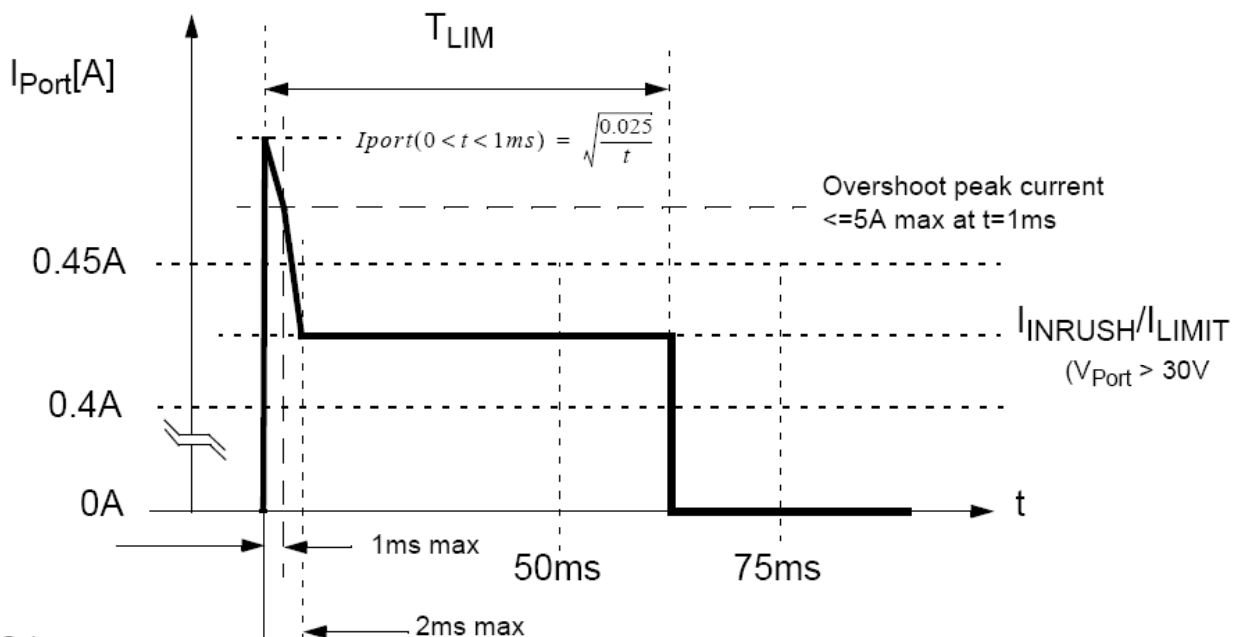


Figure 33C.4

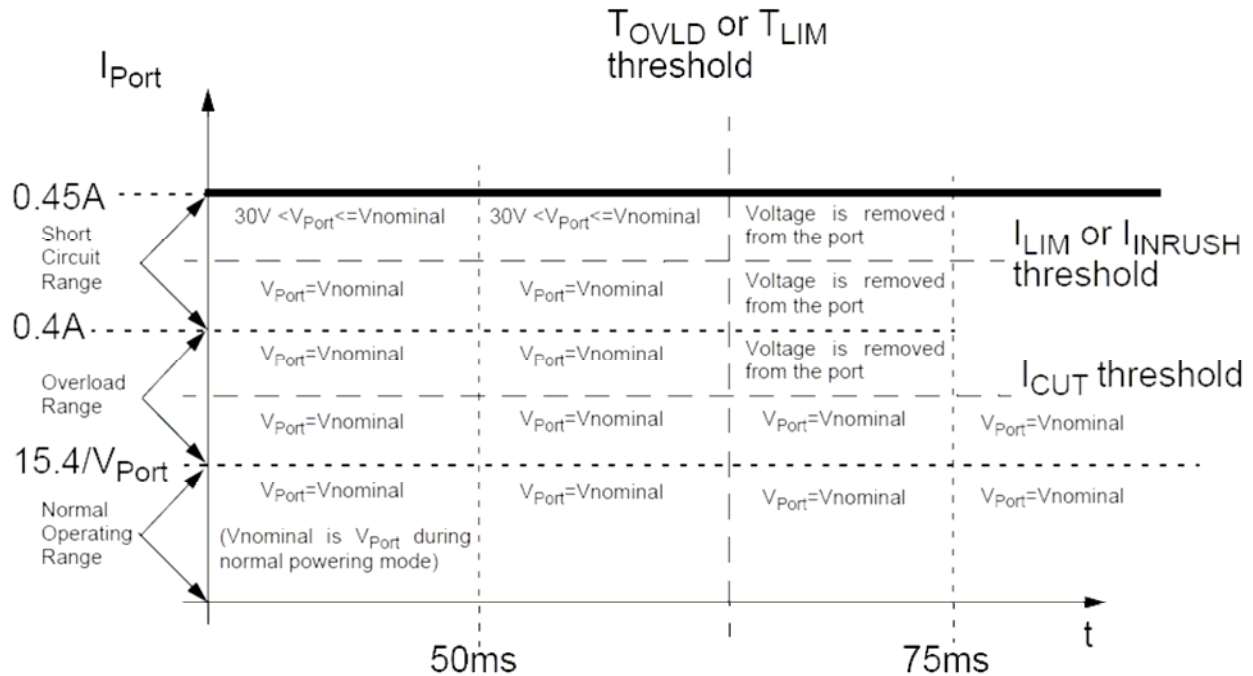


Figure 33C.6

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the current probe. The current probe is connected to the PD simulator at the PI.

**Procedure:**

1. Connect the 30 Volt Zener Diode using a fast switching circuit. This will establish a short circuit condition for more than 75ms.
2. Measure  $I_{Port}$  at the PI of the DUT.
3. Attach the 10 to 30 Volt short circuit simulator.
4. Measure  $I_{Port}$  at the PI of the DUT.

**Observable Results:**

- a. In step 2, the inrush current at the PI of the DUT must be between 400 to 450mA (inclusive).
- b. In step 4, verify that the inrush current at the PI of the DUT is at least 60mA.

**Possible Problems:** None



### 33.1.20: Short Circuit Time Limit

**Purpose:** To verify that the PSE starts removing power from the PI, within  $T_{LIM}$ , when it detects a short circuit condition.

**References:**

[2] IEEE Std 802.3af-2003: Subclause 33.2.8.9, Table 33-5, Figure 33C.6, 33C.4, Annex 33C1.4

**Resource Requirements:**

- PD Simulator
- Oscilloscope
- Current probe

**Last Modification:** September 23, 2003

**Discussion:** The PSE monitors the current ( $I_{Port}$ ) drawn by the PD. If the PD detects a short circuit condition, it must start removing power within 50 to 75ms ( $T_{LIM}$ ). The minimum inrush current applies for a duration of  $T_{LIM}$ . Figure 33C.4 defines the  $I_{Port}$  current and timing limits during startup and short-circuit conditions. It is printed here for convenience. Figure 33C.6, which depicts the limits of the Inrush current and short circuit time limit, is also printed below.

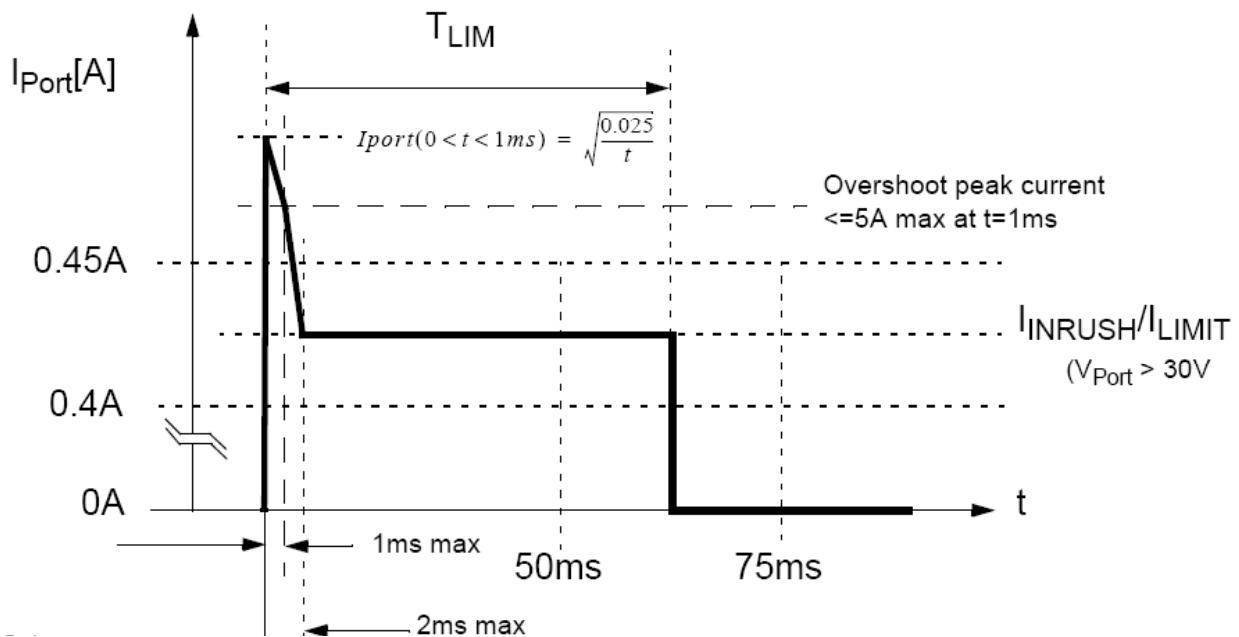


Figure 33C.4

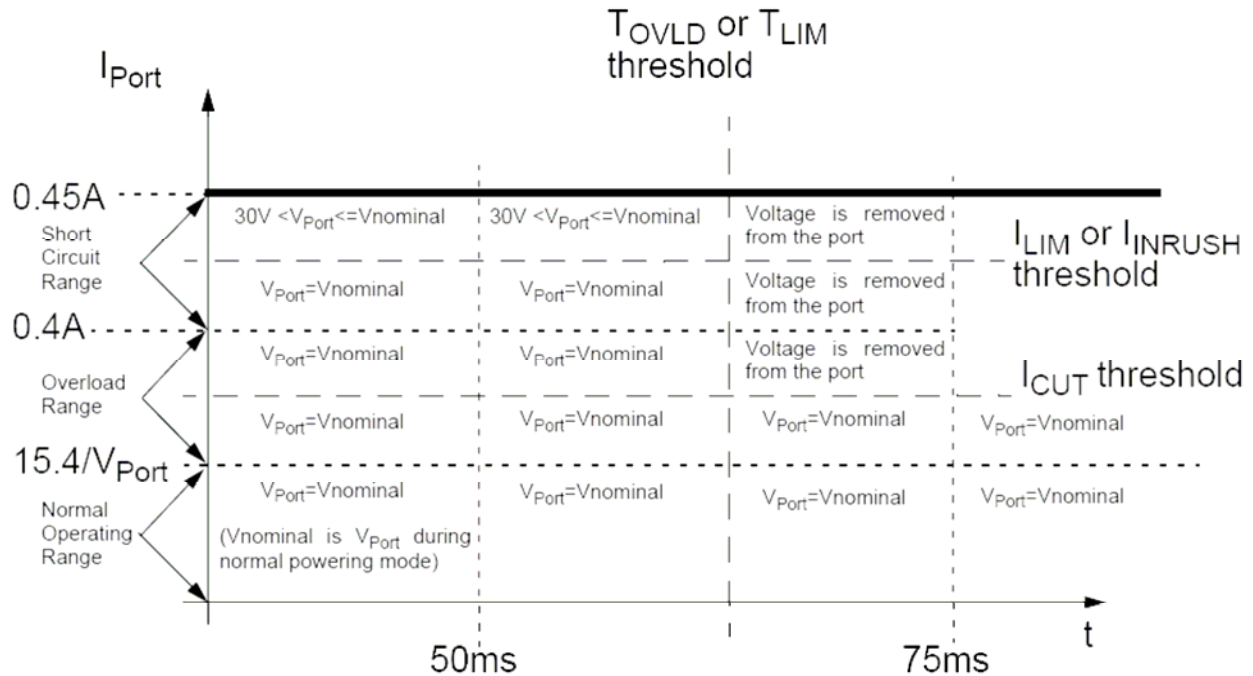


Figure 33C.6

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the current probe. The current probe is connected to the PD simulator at the PI.

**Procedure:**

1. Connect the large capacitive load using a fast switching circuit. This will emulate a short circuit condition for more than 75ms.
2. Measure  $V_{Port}$  at the PI of the DUT.

**Observable Results:**

- a. Verify that the DUT starts removing power within  $T_{LIM}$  after the switch S1 is closed.

**Possible Problems:** None.

### **33.1.21: PD MPS Time for Validity**

**Purpose:** To verify that the PSE waits for at least the minimum MPS validity time when it monitors the DC MPS component.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.10, 3.2.10.1.2, Table 33-5, Figure 33-7

**Resource Requirements:**

- PD Simulator
- Oscilloscope
- Current probe

**Last Modification:** September 23, 2003

**Discussion:** The PSE can monitor either the DC or AC MPS component to verify if the PD is still drawing the minimum current ( $I_{MIN2}$ ) that is required by the PSE. A PSE that monitors the DC MPS component of the signature will remove power from its PI if it detects that the PD is drawing current less than its  $I_{MIN1}$  (5mA) for greater than 400ms. In order to maintain a valid MPS signature, the PD can draw less than the  $I_{MIN1}$  (5mA) for 300ms and then draw more than its  $I_{MIN2}$  max (10mA) for the next 60ms or more. This improves the power efficiency of the PSE.

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the current probe. The current probe is connected to the PD simulator at the PI.

**Procedure:**

1. Verify that the DUT is supplying power to the PD simulator.
2. Confirm that the PD simulator is drawing more than 10 mA.
3. Set the PD simulator to draw less than 5 mA for 300ms.
4. Set the PD simulator to draw more than 10 mA for a period of 65ms and then drop the current back to less than 5 mA for the next 300ms.
5. Repeat step 3 and 4.
6. Measure the  $V_{Port}$  at the PI of the DUT.

**Observable Results:**

- a.  $T_{MPS} \geq 60\mu s$

**Possible Problems:** If the DUT does not support DC MPS, then this test does not apply.

### 33.1.22: AC MPS Signal Parameters

**Purpose:** To verify that the PI AC probing signals fall within the conformance limits.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.10.1.1, Table 33-6, Figure 33C.15.

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** Once power has been applied to the link section, the PSE must monitor the link segment for the PD’s Maintain Power Signature, and remove power if it detects that the PD has been disconnected. The PSE may monitor the AC MPS component, the DC MPS component, or both signature components. This test has been designed to verify that a PSE that monitors the AC MPS component meets the AC signal parameters as specified in Item 1 of Table 33-6, which has been printed here for convenience. These parameters can be measured as depicted in Figure 33C.15, which is also printed here for convenience.

Item	Parameter		Min	Max
	AC Signal Parameters			
1a	PI probing AC Voltage	V <sub>open</sub> (Vpp)	1.9	10% of the average value of V <sub>Port</sub> . (44V < V <sub>Port</sub> < 60V)
		V <sub>open1</sub> (Vp)		30V, V <sub>Port</sub> ≤ 44V
1b	AC Probing Signal Frequency	Fp (Hz)		500
1c	AC Probing Signal Slew Rate	SR (V/μs)		0.1 (Positive or negative)

**Table 33-6**

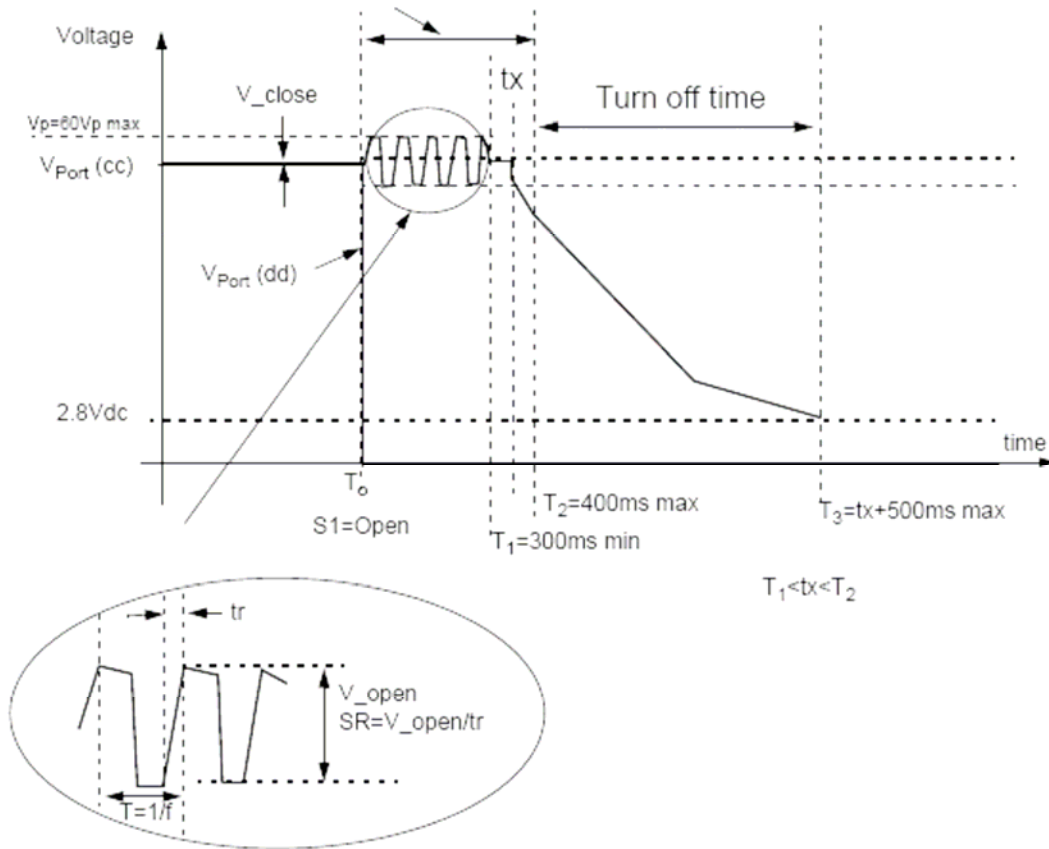


Figure 33C.15

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

1. Attach a valid signature (less than or equal to  $27K\Omega$ ) to the PI of the DUT.
2. Verify that the DUT is supplying power to the PD simulator.
3. Disconnect the signature from the PI of the DUT.
4. Verify that the DUT removes power from its PI within 400ms.
5. Measure the PI probing AC voltage ( $V_{open}$ ).
6. Measure the PI probing signal frequency.
7. Compute the AC probing signal slew rate (SR).

**Observable Results:**

- a.  $1.9V \leq V_{open} \leq 10\%$  of average value of  $V_{port}$  ( $44V < V_{Port} < 57V$ ).
- b. The PI probing frequency should not be greater than 500Hz.
- c. The slew rate should not be greater than  $0.1V/\mu s$ .

**Possible Problems:** If the DUT does not support the AC MPS component, then this test does not apply.

### 33.1.23: AC Disconnect Detection Voltages

**Purpose:** To verify that the PI probing AC voltages during AC disconnect detection fall within the conformance limits.

**References:**

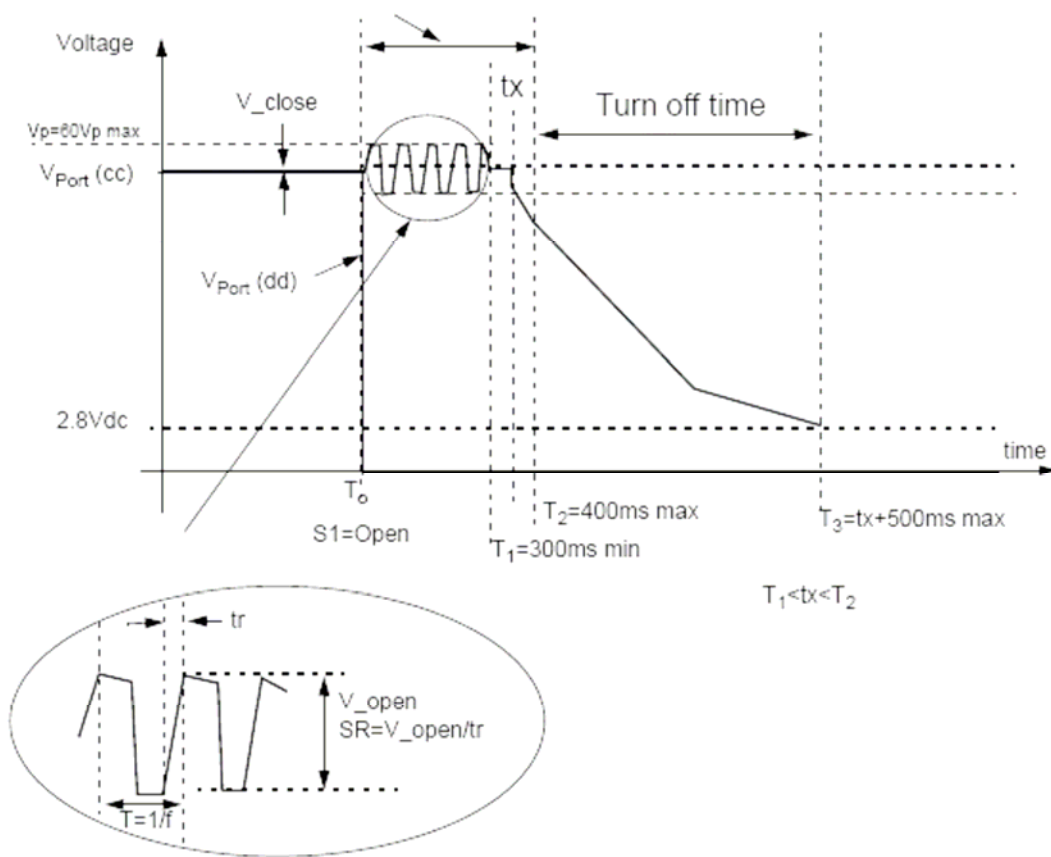
[1] IEEE Std 802.3af-2003: Subclause 33.2.10.1.1, Table 33-6, Figure 33C.15.

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** Once power has been applied to the link segment, the PSE must monitor this segment for the PD's Maintain Power Signature, and remove power if it detects that the PD has been disconnected. To perform this detection, the PSE may monitor the AC MPS component, the DC MPS component, or both signature components. This test is designed to verify that a PSE that monitors the AC MPS component meets the disconnect detection timing and PI voltages as specified in Item 3 of Table 33-6, which is printed here for convenience. These parameters can be measured as depicted in Figure 33C.15, which is also printed here for convenience.



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**Figure 33C.15**

Item	Parameter		Min	Max
	AC Signal Parameters			
1a	PI probing AC Voltage	V <sub>open</sub> (Vpp)	1.9	10% of the average value of V <sub>Port</sub> . (44V<V <sub>Port</sub> <57V)
		V <sub>open1</sub> (Vp)		30V, V <sub>Port</sub> ≤44V
1b	AC Probing Signal Frequency	Fp (Hz)		500
1c	AC Probing Signal Slew Rate	SR (V/μs)		0.1(Positive or negative)

**Table 33-6**

**Test Setup:** The DUT is connected to the PD Simulator with a 1m length of Category 5 cable.

**Procedure:**

1. Attach a valid signature (less than or equal to 27KΩ) to the PI of the DUT.
2. While the DUT is supplying power to the link section, measure the peak to peak ripple voltage.
3. Disconnect the signature.
4. Measure the peak voltage while the PD is disconnected.

**Observable Results:**

- a. In step 3, the AC ripple voltage should be less than 0.5Vpp.
- b. In step 5, the measured V<sub>P</sub> should not exceed 60V.

**Possible Problems:** If the DUT does not support the AC MPS component, then this test does not apply.

### 33.1.24: AC MPS Signature

**Purpose:** To verify that the PSE that implements AC MPS component correctly monitors the PD Maintain Power Signature.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.10.1.1 and Table 33-5, Table 33-6, Figure 33-10, Figure 33-11.

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** The PSE must monitor the link segment for the PD’s Maintain Power Signature, and remove power if it detects that the PD is disconnected. The PSE may monitor the AC MPS component, the DC MPS component, or both signature components. A PSE that monitors AC MPS component will remove power if it detects an AC impedance at the PI equal to or greater than 1980 K $\Omega$  ( $|Z_{ac2}|$ ) as defined in Table 33-6, which is printed below for convenience. It may or may not remove power if it detects an AC impedance between 27K $\Omega$  ( $|Z_{ac1}|$ ) and  $|Z_{ac2}|$ . The PSE will maintain power if it detects an impedance less than or equal to  $|Z_{ac1}|$ . The PSE will remove power from its PI if the AC MPS signature is absent for more than 400ms ( $T_{MPDO}$ ).

Item	Parameter		Min	Max
	AC Signal Parameters			
1a	PI probing AC Voltage	V <sub>open</sub> (V <sub>pp</sub> )	1.9	10% of the average value of V <sub>Port</sub> . (44V < V <sub>Port</sub> < 60V)
		V <sub>open1</sub> (V <sub>p</sub> )		30V, V <sub>Port</sub> ≤ 44V
1b	AC Probing Signal Frequency	F <sub>p</sub> (Hz)		500
1c	AC Probing Signal Slew Rate	SR (V/ $\mu$ s)		0.1 (Positive or negative)

**Table 33-6**

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

1. Attach a valid signature (less than or equal to 27K $\Omega$ ) to the PI of the DUT.
2. Confirm that the DUT is supplying power at its PI.
3. Increase the impedance connected to the PI of the DUT from 27K $\Omega$  to 2M $\Omega$ .
4. Measure the V<sub>port</sub> after 400msec.
5. If 44V ≤ V<sub>port</sub> ≤ 60V, repeat step 3.
6. Record the value of impedance (Z) at which the DUT removes power from its PI.



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**Observable Results:**

- a. In Step 2, the DUT should supply power onto its PI.
- b. In Step 6, the impedance ( $Z$ ) should be between  $27\text{K}\Omega$  and  $1980\text{K}\Omega$  (inclusive).

**Possible Problems:** If the DUT does not implement AC MPS disconnect, then this test does not apply.

### **33.1.25: New Detection Cycle**

**Purpose:** To verify that if the PSE is unable to supply power within  $T_{pon}$  then, it initiates and successfully completes a new detection cycle before powering on.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.3.1, Table 33-5.

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** The PSE may apply power after a valid sequence of detection and optional classification. However if the PSE is unable to supply power within a time interval of 400ms ( $t_{pon\_timer}$ ), then it must initiate a new valid detection cycle before applying power. The ‘ $t_{pon\_timer}$ ’ timer is used to limit the time for power turn-on, which is referred to as  $T_{pon}$  in Table 33-5.

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

1. Supply a valid signature at the DUT’s PI for a time approximately lesser than the  $T_{pon}$  of the DUT. (Refer to Test # 33.1.7 for the value of turn on time for the DUT.)
2. Connect an invalid signature at the DUT’s PI for at least 2sec.
3. Reconnect the valid signature at the DUT’s PI.
4. Observe the waveform on the oscilloscope.
5. Measure the detection time.
6. Measure the  $T_{pon}$ .

**Observable Results:**

- a. The DUT completes a full detection cycle before applying power to the PD simulator.

**Possible Problems:** None

### **33.1.26: Alternative B Backoff Cycle**

**Purpose:** To verify that if a PSE that implements Alternative B fails to detect a valid detection signature at its PI, it will back off for no less than  $T_{dbo}$  and apply a voltage less than 2.8VDC during the backoff.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.3.1, Table 33-5.

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** A PSE that implements Alternative B will start the 'tdbo\_timer' if it fails to detect a valid signature at its PI. The 'tdbo\_timer' is used to regulate backoff upon detection of an invalid signature as is referred to as  $T_{dbo}$  in Table 33-5. During this backoff period, the PSE must not apply a voltage greater than 2.8Vdc to the PI. A PSE that implements Alternative B detection must not resume detection mode until at least one backoff cycle has elapsed.

**Test Setup:** The PSE is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

1. Connect an invalid signature at the DUT's PI.
2. Measure the DC voltage between the consecutive valid detection sequences.
3. Measure the time between consecutive valid detection sequences.

**Observable Results:**

- a. In step 2, the DUT must not apply a voltage greater than 2.8 Vdc at its PI.
- b. In step 3,  $T_{dbo} > 2$  sec.

**Possible Problems:** This test does not apply to a PSE that implements Alternative A.

### **33.1.27: Current Unbalance**

**Purpose:** To verify that the current unbalance between the two conductors of the power pairs of the PSE over the current load range is within the permissible range.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.8.12, Table 33-5.

**Resource Requirements:**

- PD Simulator
- Oscilloscope
- Multimeter

**Last Modification:** June 30, 2004

**Discussion:** A PSE supplies power via its PI to the PD using either Alternative A or Alternative B pinout. Ideally the current flowing on both the conductors per power pair should be the same, however due to practical limitations this is not possible. Thus, the current output unbalance between the two conductors per power pair should not exceed 3% of the  $I_{Port}$  of the PSE.

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. Attach a current probe to each wire of the TX pair and allow the DUT to power the PD simulator.

**Procedure:**

1. Verify that the DUT is supplying power to the PD simulator.
2. Connect a resistive load to the DUT.
3. Set the PD simulator to draw at least 10mA.
4. Measure the current on both the twisted pairs at the PI of the DUT.
5. Vary the load so that the PD simulator draws the maximum current that the DUT can supply (at least 350mA).
6. Measure the current on both conductors per power pairs at the PI of the DUT.

**Observable Results:**

- a. In step 4 and step 6, the current unbalance between the two conductors per power pair should not be greater than 10mA.

**Possible Problems:** None

### 33.1.28: Error Delay Timing

**Purpose:** To verify that the PSE waits for at least the minimum conformant time before attempting subsequent detection after it removes power due to the detection of the error condition.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.3.5, Table 33-5, Figure 33-6.

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** September 23, 2003

**Discussion:** If the PSE detects an error condition during its normal operation when the PSE is supplying power to the PD, it must remove power from its PI. The error condition can be a short circuit or an overload condition. The PSE must wait for at least 750ms ( $T_{ed}$ ) before it commences with valid detection sequence after power removal.

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

*Part a: Short circuit condition*

1. Verify that the DUT is supplying power to the PD simulator.
2. Create a short circuit condition at the PD simulator for at least 75ms.
3. Measure the time at which the DUT removes power from its PI.
4. Observe the time at which the DUT attempts subsequent detection.
5. Compute the difference between the time recorded in step 3 and 4.

*Part b: Overload Condition:*

6. Verify that the DUT is supplying power to the PD simulator.
7. Create an overload condition by increasing the current draw greater than 400mA for time greater than  $T_{ovld}$ .
8. Repeat steps 3 to 5.

**Observable Results:**

- a. In step 5,  $T_{ed} \geq 750\text{ms}$ .
- b. In step 8,  $T_{ed} \geq 750\text{ms}$ .

**Possible Problems:** None

### **33.1.29: Turn Off Time Limits**

**Purpose:** To verify that the PSE disconnects power within  $T_{\text{Off}}$  through a test resistor.

**References:**

[1] IEEE Std 802.3af-2003: Subclause 33.2.8.10, Table 33-5

**Resource Requirements:**

- PD Simulator
- Oscilloscope

**Last Modification:** July 14, 2004

**Discussion:** When the DUT is disconnected from a valid maintain power signature it shall remove power within  $T_{\text{Off}}$  through a test resistor of  $320\text{k}\Omega$  attached to the PI.  $T_{\text{Off}}$  is defined as the discharge time from  $V_{\text{Port}}$  to  $2.8\text{Vdc}$ .

**Test Setup:** The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

**Procedure:**

1. Verify that the DUT is supplying power to the PD simulator.
2. Disconnect DUT with a  $320\text{k}\Omega$  test resistor attached to the PI.
3. Measure the time at which the DUT removes power from its PI.

**Observable Results:**

- a. In step 3,  $T_{\text{Off}} \leq 500\text{ms}$ .

**Possible Problems:** For AC MPS the DUT can observe the test resistor as a valid MPS and will remain in powering mode.

### **33.1.30: PSE Isolation**

**Purpose:** To verify that the power supply of the PSE is isolated.

**Reference:**

[1] IEEE Std 802.3af-2003: Subclause 33.4.1

**Resource Requirements:**

- PD Simulator
- Multimeter

**Last Modification:** July 14, 2004

**Discussion:** The PSE detects and supplies power to the PD via the PI. The power supply of the PSE should be completely isolated from any extraneous connections to the positive or negative PI terminals. Thus no current should flow through a connection to the ground reference on either PI terminal.

**Test Setup:** Connect the DUT to the PD Simulator with a 1 m length of Category 5 cable. Attach the multimeter between the PI and earth ground to measure current.

**Procedure:**

1. Allow the PSE to detect and supply power to the PD Simulator.
2. Attach the positive PI pin to the ground reference through a 10k $\Omega$  resistor.
3. Record the current through the resistor.
4. Repeat for the negative PI pin.

**Observable Results:**

- a. In step 3, the current draw is below 5 $\mu$ A for positive pin.
- b. In step 3, the current draw is below 5 $\mu$ A for negative pin.

**Possible Problems:** None