QuadraMAX PPS Test Guide

How to Run PPS Tests
8/14/2024

Introduction

This document is a guide to determining when SPT PPS tests are required and how to run them with the QuadraMAX tester. SPT PPS tests include SPT.6 Voltage Step Test and SPT.7 Current Limit Test from the USB Type-C and PD Source Power Requirements Test Specification.

The test procedure incorporates a Total Phase PD Analyzer to capture PD messaging and to visualize the overall Vbus and CC electrical signature for test analysis. Alternatively a GRL-USB-PD-A1-EPR may be used if a Total Phase PD Analyzer is not available.

Applicability

SPT PPS tests are applicable and required when the VIF for the Port Under Test contains an APDO. These tests also apply to Shared Capacity devices with special test conditions laid out in this document.

Procedure

1) Setup Hardware:
   QuadraMAX ⇔ Total Phase PD Analyzer ⇔ Cable ⇔ PUT
   Test Operator Computer ⇔QuadraMAX
   Test Operator Computer ⇔ Total Phase PD Analyzer
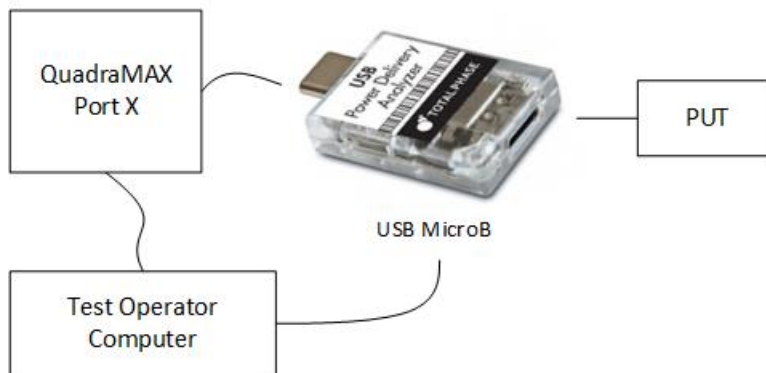   Shorter cables are better because they introduce less Cable IR Drop.

Figure 1: Total Phase PD Analyzer in QuadraMAX PPS Test Setup

2) Setup Software:
   a. Open QuadDraw
   b. Verify Real-Time graphs working (this signifies QuadDraw has a good handle on QuadraMAX device)
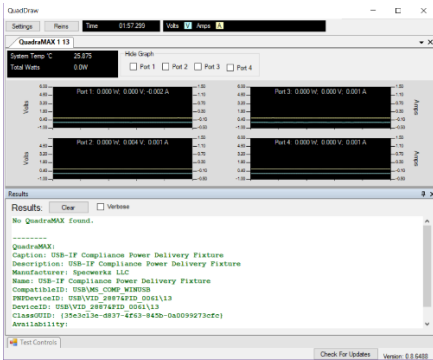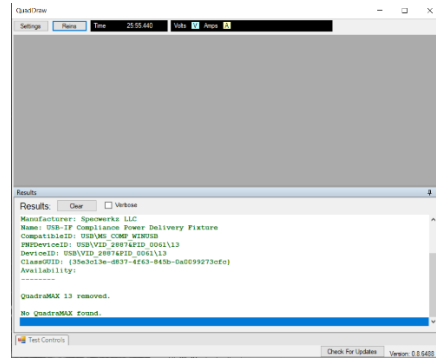

Figure 2: Real-Time Graph Working

Figure 3: Real-Time Graph Not Working

   c. In the Test Control window, enter Cable IR Drop info for PUT
   d. Check SPT.6 Voltage Step Test and SPT.7 Current Limit Test

   e. Open Total Phase Data Center software
      https://www.totalphase.com/products/data-center/
   f. Click the "Connect to Analyzer" button and connect to PD Analyzer (this signifies Data Center has a good handle on the PD Analyzer device)
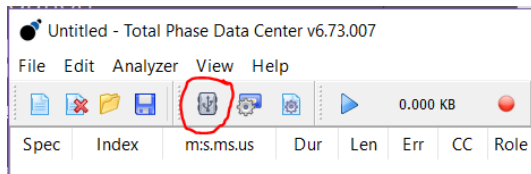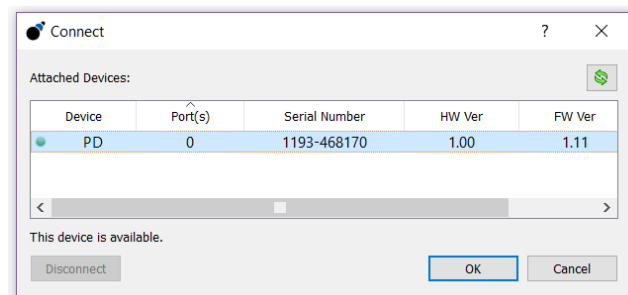

Figure 4: Select "Connect" button

Figure 5: Select PD Analyzer Device and then Select "OK"

3) Start Test:
   a. In QuadDraw Test Control window, hit "Run"
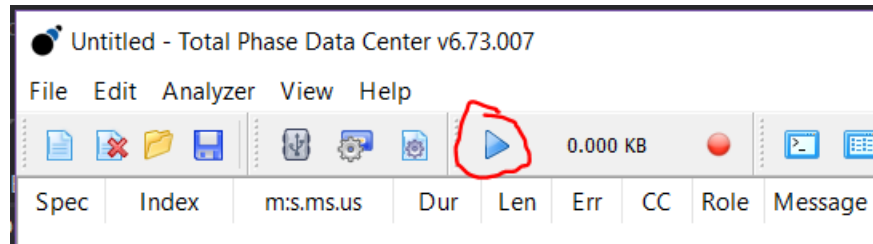   b. In Total Phase Data Center, hit "Start Capture"

Figure 6: Start Capture

c. Watch for a flatline in the software graphs. If the PD analyzer graph has flatline for 30 seconds, something is messed up and tests need manual intervention.
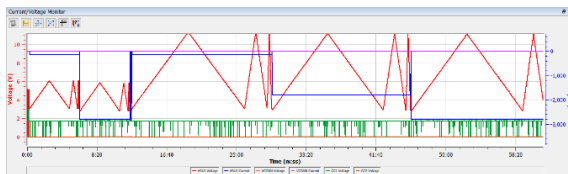

Figure 7: SPT.6 Voltage Step Test Signature
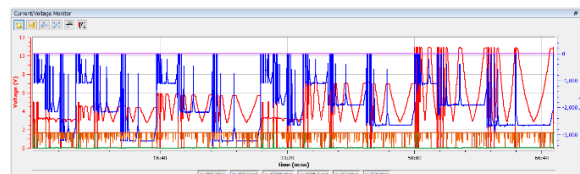
Figure 8: SPT.7 Current Limit Test Signature
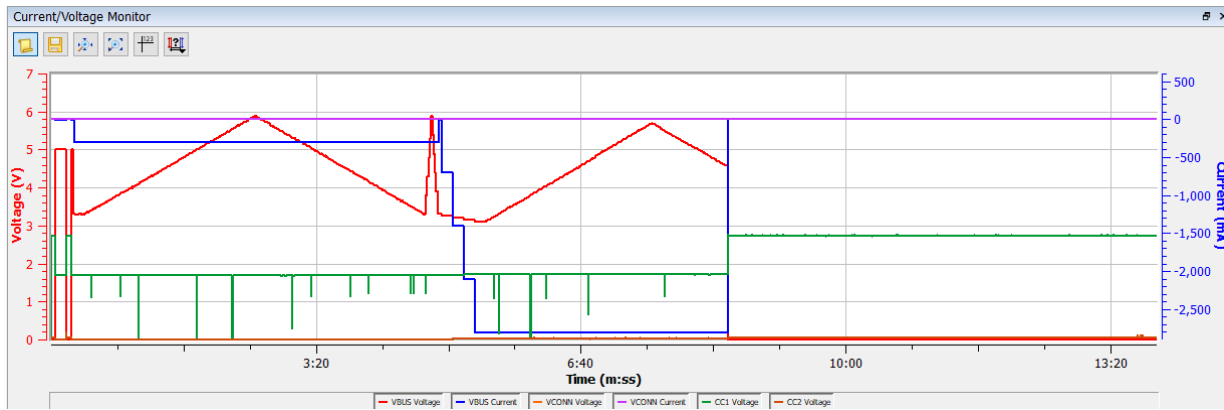
Figure 9: Example "Flatline" Graph Indicating Tests Require Manual Intervention. Test appears to cut out around the 8:30 mark.

d. When the test run is complete in QuadraMAX, stop capture in Total Phase Data Center and save trace results so we can cross reference later during analysis.

Figure 10: Stop Capture

e. **Save Results!** Save Total Phase PD Analyzer trace results.
   Example directory and file naming scheme: Replace "CompanyX" below with vendor company name or moniker.

Procedure for Multi-Port PPS solutions

Currently the QuadraMAX is only able to test one PPS port at a time, so multiport solutions require a special setup, as follows.
Note: This is only concerning SPT 6 and SPT 7. SPT 1-5 still need to be run as applicable.
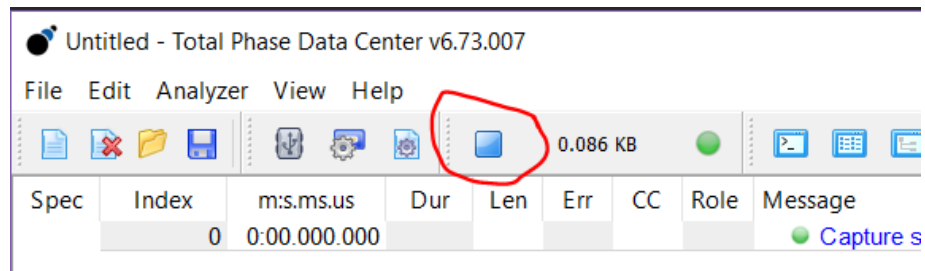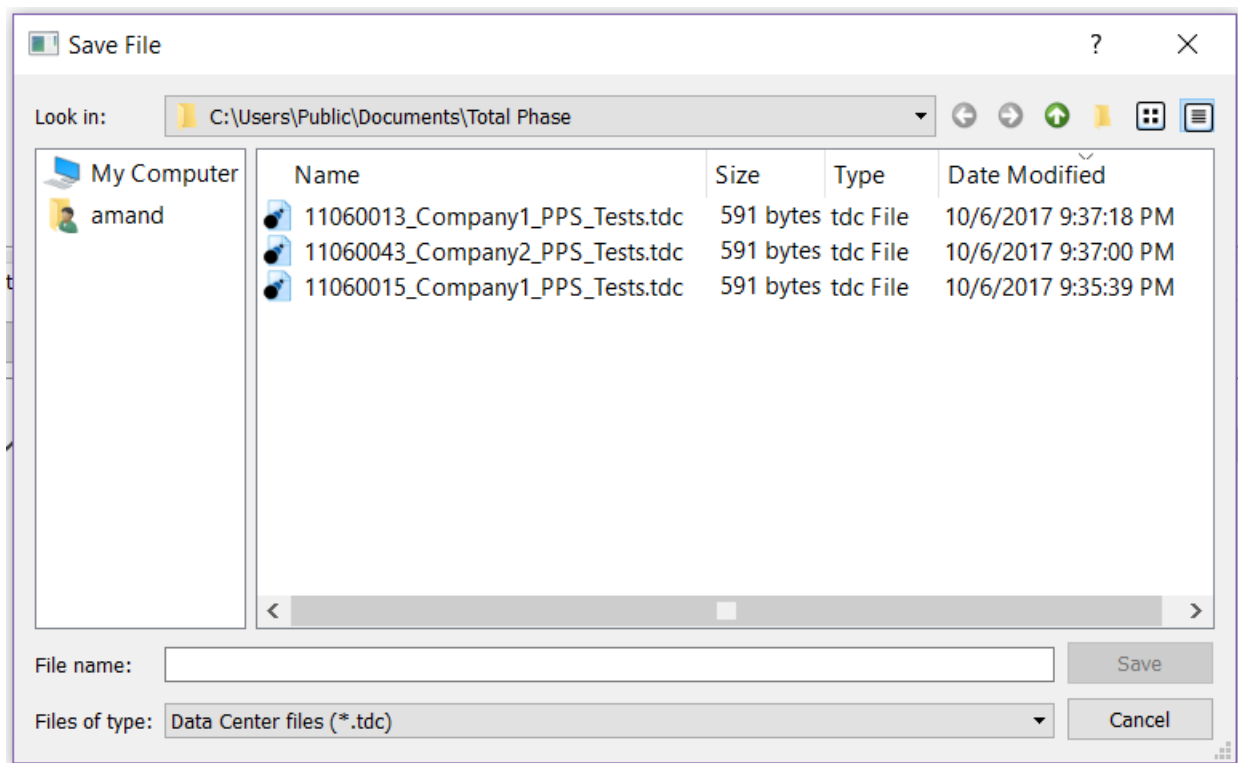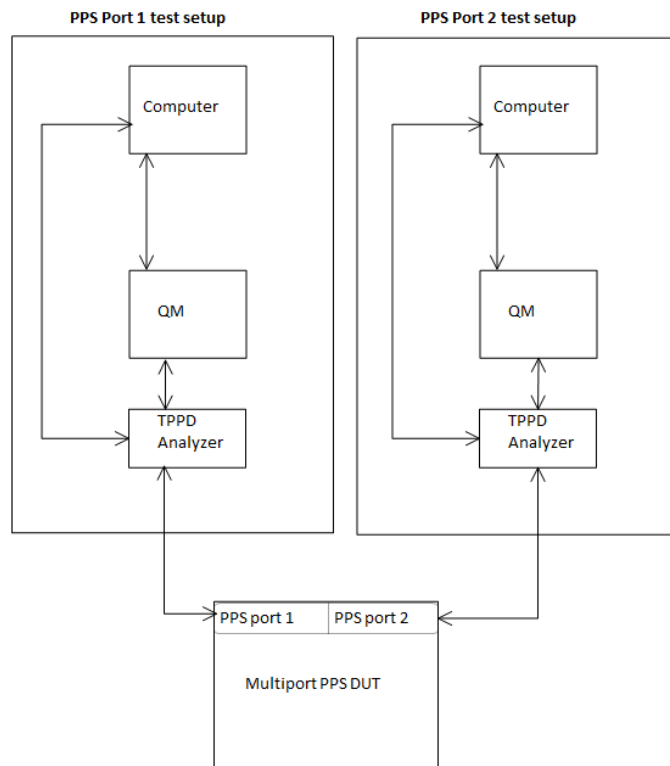*Note: This method is currently in development and may change over time.*
*Note: **Shared Capacity** DUTs require special test setup, see section "Shared Capacity PPS Test Conditions"*

Each PPS port will have to be plugged into a separate and complete QuadraMAX PPS testing setup. For example, here is a two PPS port DUT hooked up for testing:

In general for testing compliance, each port on a multiport PPS DUT must have a test condition where (1) its PPS capabilities are tested while all other ports are disconnected, (2) where all other ports are at "Max Static Load", and (3) where all ports' PPS capabilities are tested at once (5 minute interval between each port's test start).

Multiport PPS Test cases:
"Max Static Load": maintain a constant load at the maximum power available on the port at a time. This is the PDP for PD capable ports, or in the case of a Type-A port it's the highest current the port is capable of (e.g. BC 1.2 ports should be loaded to 1.5A).
"PPS Test": normal PPS testing, i.e. SPT.6 and SPT.7
"disconnected": port is physically disconnected from the QuadraMAX.

All "disconnected" and "Max Static Load" ports should be set up to the definition of those test states prior to the start of the test condition run.

"Max Static Load" can be automatically setup in QuadDraw versions 0.8.7326 and later. To do this, go to *Settings → Source Test Options(group) → PPS Multiport (tab)* and enable the checkbox "**Pre-Connected Ports: Maximize Static Load**". Then before running each test, open the Reigns window and "Connect Port" on every port that needs to be run with the maximum static load. This will log which ports are connected prior to the test, and after the test starts QuadDraw will load them properly. PD ports will request the highest fixed PDO available and load to its max current. Type-C Only ports will use the highest encoded current, and Type-A ports will load to what their respective "Debug Type-A Load" options are set to which shall be their maximum capability (e.g. BC 1.2 ports shall be set to use 1.5A).

In multi-QuadraMAX situations it may be necessary to maximize the static load manually. To do this, simply select a port and in the *Reigns → Set Load (group)* click the "**Maximize Load**" button:

If a test condition includes more than one port running "PPS Tests", each port running "PPS Tests" during that test condition shall stagger-start each port's test, with 5 minute intervals between the port test start. For example, a two PPS port DUT running Test Condition 5 from **Example Table 1** will start port 1's PPS Test, and then 5 minutes later start port 2's PPS Test.

Any results from each test run should be grouped together by test condition #.

Example Table 1: DUT with 2 PPS ports:

Test Condition #	PPS Port 1	PPS port 2
1	**PPS Test**	*disconnected*
2	*disconnected*	**PPS Test**
3	**PPS Test**	Max Static Load
4	Max Static Load	**PPS Test**
5	**PPS Test**	**PPS Test**

Example Table 2: DUT with 4 PPS ports:

Test Condition #	PPS Port 1	PPS port 2	PPS Port 3	PPS Port 4
1	**PPS Test**	*disconnected*	*disconnected*	*disconnected*
2	*disconnected*	**PPS Test**	*disconnected*	*disconnected*
3	*disconnected*	*disconnected*	**PPS Test**	*disconnected*
4	*disconnected*	*disconnected*	*disconnected*	**PPS Test**
5	**PPS Test**	Max Static Load	Max Static Load	Max Static Load
6	Max Static Load	**PPS Test**	Max Static Load	Max Static Load
7	Max Static Load	Max Static Load	**PPS Test**	Max Static Load
8	Max Static Load	Max Static Load	Max Static Load	**PPS Test**
9	**PPS Test**	**PPS Test**	**PPS Test**	**PPS Test**

For shared capacity products without PPS, run the SPT.1-SPT.5 tests as normal.

If the device is shared capacity *and* PPS, then there are special steps to complete multiport PPS tests, particularly for "Max Static Load" ports and for the last all-ports-PPS condition (e.g. condition 5 in two port products).

"Max Static Load" ports:
The settings option "Pre-Connected Ports: Maximize static load" should be used as before (connect "Max" ports before starting test), but now if it's a shared capacity device the test will pause and wait for you to *manually* set the loads of the "Max Static Load" scheduled ports.

Determining "Max" port load:
To determine the load set point for these ports, look at the VIF and determine the gang power remaining after the highest power the PPS port(s) takes. Then split that budget among all the "Max" ports of the same gang (if there are multiple). These calculations should be done using the maximum power of the fixed PDOs instead of a lower power request from the same PDO (e.g. a 5V 3A fixed PDO counts as and should be loaded to 15W, no partial loading of a fixed PDOs capability).
If there is not enough remaining power budget, then step down the PPS port's APDO to the next lower power APDO with the Settings -> PPS -> "Single APDO" setting.
If there is not enough remaining power budget even on the lowest power APDO, then target the lowest APDO and try a lower power request & loading on the "Static Load" ports (this is the one exception to the "no partial loading" rule above). This may not work and in this case the "Max Static Load" conditions may not be possible to be run (please check in with us if this is the case).

Do these calculations for each gang separately if there are multiple gangs.

If there are also assured ports, load these with the "Maximize Load" button. This loads the port to the standard "Max Static Load" level.

Example 1:
A two port shared capacity PPS DUT with the VIF values below.
Product_Total_Source_Power_mW = 54W
Port_Source_Power_Gang_Max_Power = 54W
PPS port PDP = 45W
Source Capabilities:
1. Fixed - 5V 3A - 15W
2. Fixed - 9V 3A - 27W
3. Fixed - 15V 3A - 45W
4. Fixed - 20V 2.25A - 45W
5. PPS - 5-11V 3A - 33W
6. PPS - 5-16V 2.8A - 44.8W
7. PPS - 5-21V 2.1A - 44.1W

The remaining power budget using all APDOs for the PPS PUT will leave 54-45= 9W, but this doesn't leave enough power budget for the lowest 15W fixed PDO on the "Max Static" port. So we have to select the next highest power APDO that will leave at least a 15W power budget, in this case APDO 5-11V 3A - 33W.
This leaves 54-33= 21W. This is not enough for the 2nd fixed PDO (27W) but plenty for the 1st(15W).

So in this example for condition 3 & 4: one port will run only the first APDO, and the "Max Static Load" port will need to be manually set to 15W on the first fixed PDO.

To run this example test:
1. Select targeted APDO (1st one, 33W)

2. Select "Maximize static load" option

3. Using Reins, Connect the port which is scheduled as "Max Static Load" in the conditions.

3	**PPS Test**	Max Static Load
4	Max Static Load	**PPS Test**

7. Run the PPS test, and the test will pause to allow for manual loading

8. Using Reins, Connect to the "Max Static Load" port, Request the fixed PDO determined in the above calculation (PDO1 15W), and load to maximum current 3A. In general load all ports scheduled for "Max Static Load" at this time including any assured ports.
9. Click "Ok" to continue the test.

Concurrent PPS Test Conditions (Condition 5 in two port products):
These conditions are similar but with multiple concurrent PPS tests involved.
1. Add up all PPS PUTs' maximum powers.
2. If the total is larger than the total gang power then use settings to target a set of APDOs which do not exceed the maximum gang power.

3. Run the test as laid out above, but with the staggard start for all the PPS PUTs as laid out in the QuadraMAX PPS Test Manual.

If there is no set of APDOs which do not exceed the total gang power, then these conditions should be noted as "Not Applicable" since it's not able to be tested.

Example 2:
Consider the same device as in Example 1. There is no combination of APDOs which do not exceed 54W. The lowest available APDO combination would be 33W + 33W = 66W.
This device should be marked "Not Applicable" for these conditions (in this case condition 5).

Example 3:
A two port shared capacity PPS DUT with the VIF values below.
Product_Total_Source_Power_mW = 120W
Port_Source_Power_Gang_Max_Power = 120W
PPS port PDP = 100W
Source Capabilities:
1. Fixed - 5V 5A - 25W
2. Fixed - 9V 5A - 45W
3. Fixed - 15V 5A - 75W
4. Fixed - 20V 5A - 100W
5. PPS - 3.3-11V 5A - 55W
6. PPS - 3.3-16V 5A - 80W
7. PPS - 3.3-21V 5A - 105W

Test condition 5 should target APDO 1 (source capability #5) for both ports (55W + 55W = 110W < 120W). APDO 2 & 3 would both exceed max gang power of 120W.

Handling Non-PPS and Type-A ports:

Unlike PPS ports, Type-A and Type-C Only ports do not need to be separated into their own dedicated QuadraMAX setups. They can be plugged into a QuadraMAX that is also running a PPS port. Only PPS ports need to be separated into different QuadraMAX setups.

Example: 2 PPS ports and 1 Type-A port – requires only two full QuadraMAX setups:
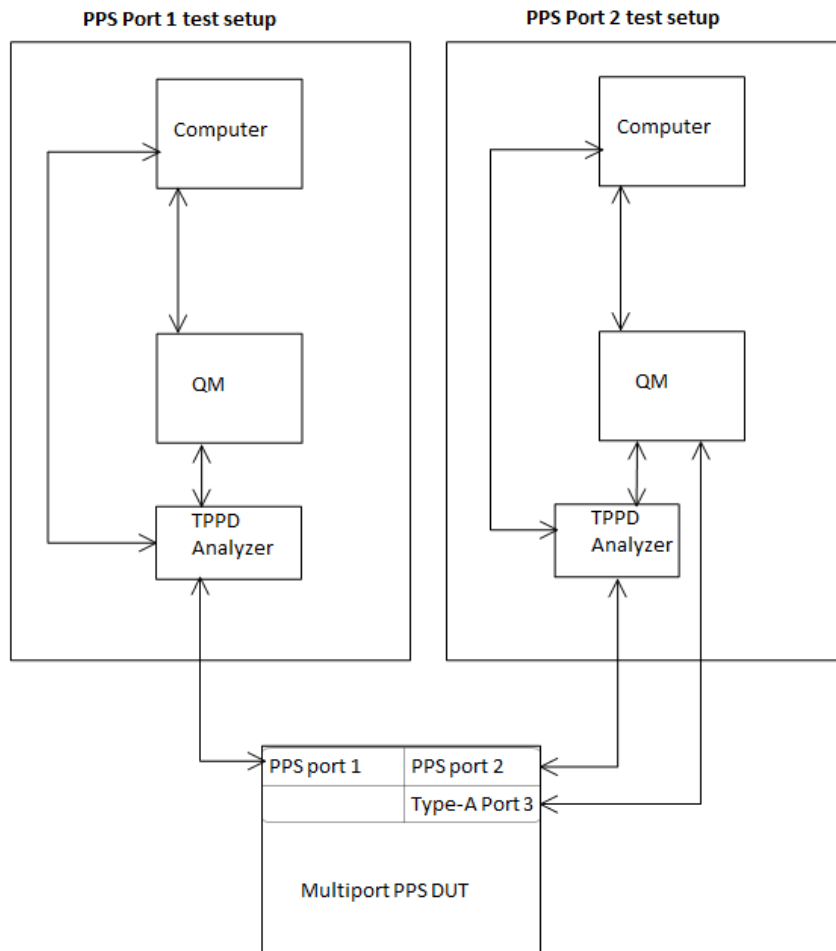
If a DUT has non-PPS ports (e.g. Type-C only or Type-A) it is still considered a multiport PPS device. These devices will be tested similarly to above. The last all-PPS condition extrapolates into two conditions, one with the non-PPS ports loaded to "Max Static Load" and one where the non-PPS ports are "disconnected".

Example Table 3: DUT with 1 PPS port and one Type-A port:

Test Condition #	PPS Port 1	Type-A port 2
1	**PPS Test**	*disconnected*
2	**PPS Test**	Max Static Load

Example Table 4: DUT with Two PPS ports, a Type-A Port, and a Type-C Only port:

Test Condition #	PPS Port 1	PPS port 2	Type-A Port 3	Type-C Only Port 4
1	**PPS Test**	*disconnected*	*disconnected*	*disconnected*
2	*disconnected*	**PPS Test**	*disconnected*	*disconnected*
3	**PPS Test**	Max Static Load	Max Static Load	Max Static Load
4	Max Static Load	**PPS Test**	Max Static Load	Max Static Load
5	**PPS Test**	**PPS Test**	*disconnected*	*disconnected*
6	**PPS Test**	**PPS Test**	Max Static Load	Max Static Load

*Special Considerations for Type-A and Type-C Only ports:*

Ground Isolation:

Some DUT implementations require their Type-A and Type-C Only ports use an isolated ground. When using a shared ground between multiple ports, sometimes more current can be drawn out of a single port than is intended or other symptoms.

In order to test these devices, the QuadraMAX's ground isolation feature on port 1 must be utilized (note: only port 1 can isolate its ground from the other ports). To setup, connect the non-PD ports to the QuadraMAX's Port 1, for example a DUT with two PPS ports and one Type-A port can be setup to test as below. Note that all ports (including non-PPS ports) need to have a TP PD Analyzer trace:
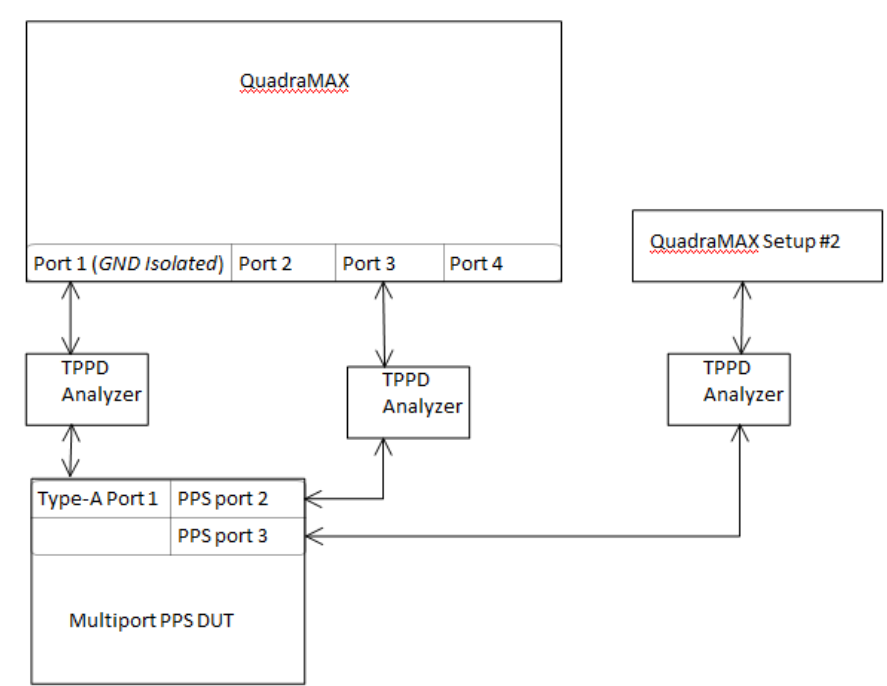
To enable the ground isolation on port 1, in the QuadDraw software go to *Settings → Source Test Options (group) → Common (tab)*, and check "Isolate Port 1 Gnd".
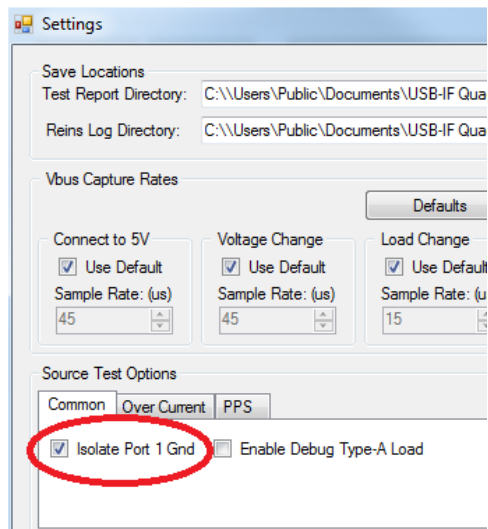
This will enable Port 1's ground isolation from the rest of the three ports for all applicable SPTs.

Note: In some cases this option can interfere with communication with the QuadraMAX's Port 1 PD controller, so it isn't advised to use a PD port on port 1 while this option is enabled.

Note: Because there is only one port on the QuadraMAX that can be isolated in this way, multiple ports needing this isolation may have to use several different QuadraMAXes.

Type-A port load levels:

All Type-A ports will need their maximum current manually set (the QuadraMAX lacks the capability to determine this value). To enable this option, go to *Settings → Source Test Options (group) → Common (tab)* and check the "**Enable Debug Type-A Load**" option. This will display a "Type-A Custom Load" group in the Test Controls window that must be set for each port on each QuadraMAX used. Changing the "QuadraMAX Serial #" dropdown switches between which QuadraMAX's port-group is displaying.