Sifos Technologies

PowerSync Analyzer

PSA-3000, PSA-3x02, PSA-3x48

Technical Reference Manual

Version 5.3

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Disclaimer

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1. Introduction

1.1. PowerSync Analyzer Introduction

The PowerSync Analyzer (PSA-3000) is designed to enable comprehensive analysis and testing of IEEE 802.3at and 802.3bt Power-over-Ethernet (PoE) Power Sourcing Equipment (PSE). The PSA-3000 exists in several different configurations:

PSA-3402 (PSA-3202 blade) **PSA-3002** (PSA-3102 blade)	• Compact PSA Instrument (single "slot") with PSA-3202 Test Blade (PSA-3402) or PSA-3102 Test Blade (PSA-3002) including 2 PSE Test Ports • PowerSync Analyzer Software (Version 5.0 or later) for a host PC including PSA Interactive graphical user interface and PowerShell PSA interactive scripting console. • Optional PSE Conformance Test Suite • Optional PoE LLDP (PSE and PD) Emulation
PSA-3000	• One PowerSync Analyzer Chassis and PSA Controller Card (Slot 0) • One to twelve PSA-3202 or PSA-3102 Dual Port PSE (Power Sourcing Equipment) Test Blades with capability to test from 2 to 24 PSE ports. • PowerSync Analyzer Software (Version 5.0 or later) for a host PC including PSA Interactive graphical user interface and PowerShell PSA interactive scripting console. • Optional PSE Conformance Test Suite • Optional PSE Multi-Port Suite: Live PD Emulation and the PSE Multi-Port Test Suite • Optional PoE LLDP (PSE and PD) Emulation
PSA-3248 (PSA-3202 blades) **PSA-3048** (PSA-3102 blades)	• Two or more PSA-3000 Chassis' and PSA Controller Cards (Slot 0) • 24 PSA-3202 or PSA-3102 Dual Port PSE (Power Sourcing Equipment) Test Blades with capability to test 48 PSE ports. • PowerSync Analyzer Software (Version 5.0 or later) for a host PC including PowerShell PSA interactive scripting console. • Optional PSE Conformance Test Suite • Optional PSE Multi-Port Suite: Live PD Emulation and the PSE Multi-Port Test Suite • Optional PoE LLDP (PSE and PD) Emulation • Optional PSA Interactive GUI

Each PSA-3000 test port includes an input to receive both power and data from a PSE and an output where Ethernet packets may be forwarded to a LAN Analyzer or other data transmission interface. The PowerSync Analyzer test ports are designed to forward 10/100/1000Base-T and multi-gig signals while terminating the DC power from a PSE. PSA-3000 test ports also offer capability to terminate Ethernet links with an ability to emulate PoE Link Layer Discovery Protocol (**LLDP**) messaging from an LLDP-capable Powered Device or PSE.

The PowerSync Analyzer is designed to be controlled from a PC over a TCP/IP network connection (10/100BaseT). Multiple PowerSync Analyzer instruments of varying configuration may be controlled from a single controller. Each test port works in conjunction with host software to provide various Powered Device (PD) load emulation functions along with an assortment of PSE measurement and analysis functions.

1.2. Reference Manual Organization

Section 1 of this manual provides an overview of PoE technology and the applicable IEEE 802.3 standards, including many of the important behaviors of Power Sourcing Equipment (PSE's) and Powered Devices (PD's). Instrument users will first need to have at least a basic grasp of PoE technology in order to best understand the capabilities and usage of the PowerSync Analyzer and related products.

Section 3 will introduce PowerSync Analyzer instrument capabilities and basic hardware resources. Additionally, Section 3 will provide an overview of the PowerSync Analyzer's software organization. An understanding of these resources will support more intuitive usage of PSA software applications and development environments.

Section 4 will detail the features and usage of **PSA Interactive** graphical user interface software for the PowerSync Analyzer and Programmable Load instruments. PSA Interactive has been designed to allow robust access to instrument resources combined with rapid means by which to "move around" among multiple ports and between various instrument chassis'. It can be used for occasional measurements, PSE analysis and troubleshooting, as well as for test script prototyping. Examples will be provided to demonstrate various tasks that PSA Interactive will support.

Section 5 will describe the **PowerShell PSA** scripting and automation environment for the PowerSync Analyzer. PowerShell PSA is a powerful, interpretive, and fast executing programming environment. This section will introduce the various commands and command syntax that form the "API" (application programming interface) for the PSA-3000. Users who wish to fully automate certain test sequences or to optimize test throughput can readily use PowerShell PSA to build test scripts and associated applications. PowerShell PSA is built on the widespread Tcl/Tk script language and will enable test script integration with various Packet Transmission tests previously developed within Tcl/Tk.

Section 6 provides an overview of the PowerSync Analyzer's **PSE Conformance Test Suites** for **802.3at** (clause 33.2) and **802.3bt** (clause 145.2) PSE's. The PSE Conformance Test Suites consist of a libraries of fully automated tests that measure and report upon many of the PSE parameters specified in the IEEE 802.3 standards. These tests have been designed to adapt to a wide array of PSE design implementations and device technologies including certain equipment that simultaneously supports "legacy" or other proprietary, complimentary modes of powered device detection. PSE Conformance Tests can be automatically sequenced across many PSE ports to automatically produce comprehensive statistics and pass/fail analysis.

The **2-Pair PSE Conformance Test Suite** and the **4-Pair PSE Conformance Test Suite** may each be purchased as licenses for each PSA instrument. They are accompanied by a **Tracking Service** support plans that enable users to remain current with the rapid evolution of PSE designs and integrated PSE controllers.

Section 7 provides an overview of the **802.3at PSE Multi-Port Suite** including the PowerSync Analyzer's unique **PSE Multi-Port Test Suite** and **Multi-Port Live PD Emulation**. All PSA-3000 Multi-Port features are designed to support simultaneous and sequential Powered Device emulations across up to eight PSA-3000 chassis' and up to 192 802.3at compliant PSE ports. **Multi-Port Live PD Emulation** enables PSA-3000 test ports to behave as user-defined Powered Devices with full support of the IEEE 802.3at standard, including Type-2 devices with PoE LLDP (see Section 8). Multi-Port Live PD Emulation enables interactive PSE system testing of power management , administrative actions, and system policies in mid to high port count PSE's.

The second generation **Multi-Port Test Suite** performs fully automated system testing of 802.3at Type-1 and Type-2, including PoE LLDP capable Type-2, PSE's. This powerful testing capability automatically sequences through different "classes" and "types" of PD emulation evaluating:

- PSE powering and power granting decisions and stability
- Static power management behaviors and policies
- Transient reserve power under full and partial static loads
- Power capacity uncertainty and variation to each powered PD
- Power-Up, LLDP response, disconnect shutdown, and group overload timing behaviors and responses.
- Port group subset powering and granting behaviors
- Multi-Port stress-over-time responses

The **PSE Multi-Port Suite** is purchased as a feature option or an upgrade for each PSA instrument.

Section 8 will overview PSA-3000 **PoE LLDP Emulation and Testing** Capabilities available from PSA software. The PSA-3000 offers capability to flexibly emulate powered device (PD) LLDP transmissions and to recover PSE originated LLDP transmissions for analysis of message contents and message timing. Fully automated protocol "tracing" is available with standardized spreadsheet reporting and protocol parameter analysis. These capabilities are supported with full compliance to IEEE 802.3 Clauses 33 and 79 as ratified by the IEEE in 2009. Coupled with PSE Multi-Port Suite features, Powered Device LLDP emulations may be defined to run continuously to many PSE ports. **PSE LLDP Emulation and Protocol Tracing** is also supported with this feature.

PoE LLDP Emulation and Testing is purchased as a feature option or an upgrade for each PSA instrument.

Section 9 will tie together other sections of this manual to address certain specialized challenges such as test throughput **optimization**, intra-port PSE testing, actuating PowerShell PSA from **remote programs** or TCL shells, and blending PoE tests with existing or new packet transmission test libraries and scripts.

Finally, **Section 10** introduces the **802.3at PoE Service Analyzer** application. This application provides fully automated testing of PoE service at the PD interface point. The PoE Service Analyzer combined with any PSA instrument (PSA-3x02, PSA-3000, PSA-3x48) offers the most comprehensive analysis available for assessing integrity and interoperability of PoE service to a PD connection point.

1.3. Related Sifos Products

The following Sifos products share certain hardware and software features with the PSA-3000 product family. Reference to these products may be made elsewhere in this manual.

1.3.1. PVA-3000 PhyView Analyzer

The PhyView Analyzer (PVA) is designed to perform direct physical layer testing and analysis of 10/100/1000BaseT LAN ports. Similar to the PSA-3000, the PhyView Analyzer is packaged as two-port test blades that may be installed within a PSA-3000 chassis side-by-side with PSA-3x02 or PSL-3x02 test blades. PVA test ports can be controlled using the same script automation software, PowerShell PSA, as are PSA-3x02 and PSL-3102 test ports. However, the graphical user interface for the PVA, PVA Interactive, is a distinct and separate software package from the PSA Interactive graphical user interface that is used for the PSA-3000 family of products.

When PSA Software is installed to a host computer, any attempts to utilize PVA software commands or to run the PVA Interactive GUI will be rejected unless PVA hardware is found within the connected instrument configuration.

The PVA-3000 may be combined with the PSA-3000 to automatically characterize DC Unbalance Tolerance of PSE ports. This powerful and unique capability is described in the Sifos application note **DC Unbalance Tolerance in PSE's**.

1.3.2. PSA-3002-SA Service Analyzer

The PSA-3002-SA is a specially configured version of the PSA-3002 Compact PowerSync Analyzer designed specifically for characterizing PoE performance and interoperability at any service outlet. It is managed by the same host software (PowerShell PSA, PSA Interactive) that controls the PSA-3000 family of products.

Using either PSA Interactive or PowerShell PSA, any PSA-3000 can mimic the full functionality of the PSA-3000-SA service analyzer. This topic is covered in Section 10 of this manual.

2. IEEE 802.3 PoE Technology Overview

The **802.3af** specification was originally conceived to create an environment whereby **Powered Devices** (**PD**'s) from numerous different manufacturers could be interconnected to **Power Sourcing** (inter-networking) **Equipment** (**PSE**) including switches, routers, and hubs produced by many different networking equipment manufacturers. Such devices included IP telephones, wireless access points, and digital security cameras that could operate with 13 watts or less power. The interoperability created by 802.3af led to lower cost and higher proliferation among both the sourcing equipment and the networked PD's. PD's no longer required DC power supplies and could be installed in a variety of locations without the need for running an electrical service.

The basic features of IEEE 802.3af (802.3 clause 33, 2004) PoE were:

- 48V DC Supply to PD's
- Guaranteed 13 Watts of Power Consumption per network connection (PD and cabling)
- Power Sourcing from both "End-Point" switches/routers as well as "Mid-Span" power "adder" devices.
- Safety "interlocks" to prevent powering when no PD's are connected and to assure prompt power removal when PD's are disconnected as well as to limit DC current flow at all voltage levels.
- Physical layer mechanism for PSE's to characterize power demands of individual PD's and thus manage power delivered per port.

2.1. IEEE 802.3at Enhancements

The **802.3at** specification (ratified in 2009, 802.3 clause 33) both replaced and expanded upon 802.3af in several key areas:

- Enabled higher power **Type-2** PD's such as wireless access points, panning security cameras, video phones, and audio appliances requiring continuous power to 25.5 watts at distances up to 100M from the PSE. **Type-2** PSE's furnish at least 30.0 Watts at the PSE output.
- Provided full backward compatibility and interoperability to existing **Type-1** 802.3af compliant PSE's and PD's.
- Enabled all PSE's, including midspan injectors, and all PD's to support 1000BaseT data links.
- Minimized cost increases for PSE ports and PD equipment so that services requiring more than 13 watts were economically viable.
- Improved potential power management granularity through a datalink protocol (LLDP) allowing Type-2 PSE's to more effectively distribute a shared DC power supply.
- Resolved well known issues of specification clarity inherent in the 802.3af specification.

802.3at defined all PSE's as either **Type-1** or **Type-2**. Any PSE developed strictly to the original IEEE 802.3af specification was a **Type-1** PSE. PSE's that deliver at least 30 Watts per port must be **Type-2** PSE's. Many of the 802.3at specifications were divided according to Type-1 versus Type-2 PSE's. However, 802.3at allowed Type-1 PSE's to evolve in ways that gained many of the IEEE 802.3at feature enhancements described above even if they continue to limit minimum output power to the 15.4 watt range.

2.2. IEEE 802.3bt Enhancements

The **802.3bt** specification (ratified in 2018 as 802.3 clause 145) is a new and separate specification from IEEE 802.3at.

IEEE 802.3at (and 802.3af before it), restricted the delivery of PoE power to just two of the four wire pairs found in a Category 5 or 6 LAN cable. However, prior to the release of the 802.3at standard, cabling standards bodies (EIA/TIA, ISO) had determined that Cat 5 and 6 LAN cable could safely support up to 600mA of continuous current flow on the unused wire pairs (or pairsets) in a LAN cable meaning that if all four wire pairs were used for power delivery, PD's could safely draw up to 51 watts instead of 25.5 watts.

Why did 802.3at not take advantage of this option? Going back to 802.3af, PD's were required to operate from a two wire pair power source in order to accommodate older wiring systems that only provided two wire pairs for data. Further, those PD's had to be designed to accept the power on the 10/100Base-T data pairs (**pairset A**) or the 10/100Base-T spare pairs (**pairset B**), and to accept the power in either polarity so that crossover patch cabling or system wiring did not disturb the delivery of PoE power. To retain backward compatibility, 802.3at retained the same requirement at the PD interface. PD's therefore implemented full-wave bridging circuits to accept power from either pairset A or pairset B in either positive or negative polarity.

This typical design of a PD created significant complications if power were to suddenly appear on all four wire pairs, that is both **pairset A** and **pairset B**. Fundamentally, there was no way to assure that the DC current would ever split evenly between the two pairsets as there was nothing in the PoE system that would regulate that behavior. For this reason, 4-pair powering was abandoned during the development of the 802.3at standard.

Besides the delivery of more power, a second key advantage of 4-pair PoE is the reduced power lost in cabling. Using four wire pairs rather than two wire pairs reduces total end-to-end electrical resistance by a factor of two meaning the I^2R loss is also reduced by at least a factor of two. So if 13W or 25.5W PD's could operate from 4-pair power, total system power consumption is reduced.

IEEE 802.3bt tackled the whole issue of 4-Pair powering through a combination of new requirements for 802.3bt compliant PSE's, 802.3bt PD's that draw more than 25.5 watts, and LAN cabling systems. 802.3bt allowed for twice as much power delivery as was available under 802.3at given no impact to installed cabling plants. PSE's and PD's that support up to 51 watts at the PD are referred to as **Type-3** devices.

Further, 802.3bt enabled even higher power services whereby PD's could receive up to 71.3 watts from PSE's that furnish 90 watts on their outputs. PSE's that support 90W and PD's that draw more than 51W are referred to as **Type-4** devices. Implementation of PoE systems using Type-4 equipment requires certain constraints that must be applied to cabling plants. These constraints involve the type of LAN cable used (e.g. electrical insulation properties) and limitations on the way cables are bundled when running through ceilings and walls. In North America, installations of Type-4 systems may require compliance to new electrical codes (NEC) and associated inspections.

The key features of the 802.3bt specification are:

- 4-Pair Powering up to 71.3W at the PD and 90W at the PSE. (Actually, the standard allows for systems where PD's could, under controlled circumstances, draw up to 90W).
- Full backward compatibility with 802.3at, and therefore, with 802.3af equipment, both PSE's and PD's.
- Full range of PD classifications including 3.8W (class 1), 6.5W (class 2), 13W (class 3), 25.5W (class 4), 40W (class 5), 51W (class 6), 62W (class 7) and 71.3W (class 8).
- Full range of PSE powering capability including 2-Pair powering from 4W up to 30W and 4-Pair powering from 4W up to 90W.
- Extensions to the PoE datalink (LLDP) protocol to enable more refined power management by system PSE's.
- Implementation of a very low power "sleep mode" where PD's can remain powered while drawing negligible power from a PSE. This is a key feature to LED lighting systems that operate from PoE power.
- An alternative "dual signature" PD front-end architecture where in essence, a PD can be operated as two PD's, one powered by each pairset.
- An alternative PD power classification scheme, "autoclass", that also allows very refined power management by a system PSE without relying on datalink protocols. This also is a feature aimed at LED lighting systems.
- Support of 2.5GBase-T, 5GBase-T, and 10GBase-T data links carrying PoE power.

802.3bt opened the doors to many future applications of Power-over-Ethernet, most notably lighting systems, large panel displays, wireless microcells, higher power wireless LAN access points and controllers, and IOT components.

2.3. The Power Connection

Balanced wire pairs in LAN cables carry high speed differential electrical signals used by 10/100/1000/MG-Base-T communications links. From their inception, Ethernet interfaces have been designed to work over distances of up to 100 meters.

In order to assure electrical isolation between equipment and also from electrical disturbances appearing on long cabling runs, Ethernet ports include isolation transformers on each wire pair. This enables the insertion of DC voltage and current in common mode to each wire pair meaning that both conductors of the wire pair experience the exact same DC voltage and share 50% of the DC current. Insertion of voltages and extraction of currents is performed using the primary coil center taps of the Ethernet transformers. So long as the center taps are truly "centered", the addition of the DC power has no impact to the integrity of the high speed LAN signaling.

Figure 2.1 depicts a typical PSE interface. A 2-Pair (e.g. 802.3at) PSE would be represented by the top half of this figure. A 4-Pair PSE would encompass the entire

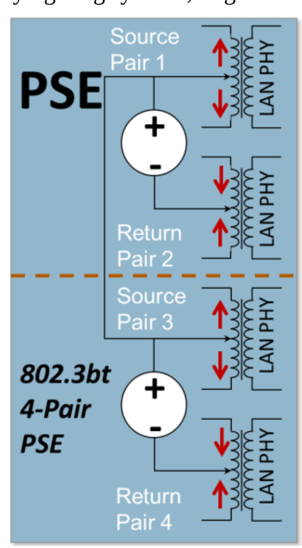


Figure 2.1 PSE Connection

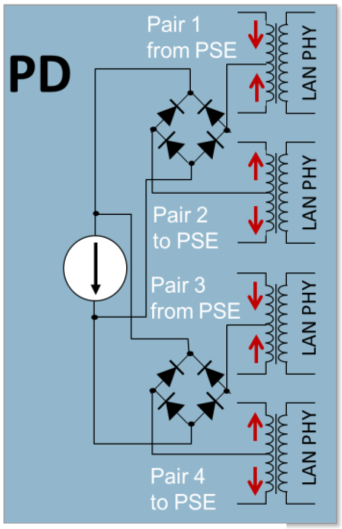


Figure 2.2 PD Connection

figure. The diagram includes two voltage sources in the 4-Pair PSE because typically, 4-Pair PSE's can independently connect each voltage source to each pairset and also, typically, the "switched" side of the voltage source is the negative, or low side.

Unlike PSE's, PD's are always "4-Pair" devices because going back to the 802.3af specification, PD's needed to receive power on either pairset in either polarity. **Figure 2.2** demonstrates a typical PD physical interface (PI) whereby all four wire pairs are combined through full wave diode bridges to serve the PD power load. In 802.3bt terms, this PI represents a **single signature** PD because the bridge outputs are combined and do not serve separate, independent loads. 802.3bt also describes **dual signature** PD's where the diode bridges are not combined but rather are wired to separate, independent loads much as if the PD was really two PD's, one connected to each pairset. Dual signature PD's are generally not common.

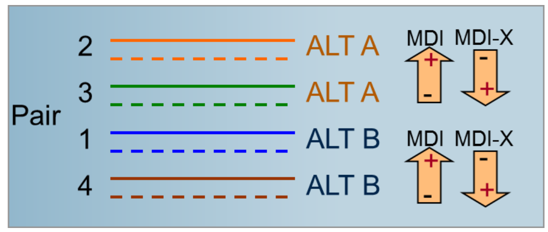


Figure 2.3 PSE Pairsets

2.4. Pairset Terminology & Polarity

A pairset consists of one wire pair that sources current from the PSE to the PD and one wire pair that returns current from a PD to the PSE. On the PSE side of the link, pairsets are referred to as Alternative A (**Alt-A**) and Alternative B (**Alt-B**). A 2-Pair 802.3at or 802.3bt PSE will source power on just one pairset, Alt-A or Alt-B. A 4-Pair 802.3bt PSE will source power on both pairsets Alt-A and Alt-B.

The **Alt-A** pairset refers to the same two wire pairs used to transmit data in 10/100Base-T links. The **Alt-B** pairset refers to the wire pairs not used in 10/100Base-T links. 2-Pair PSE's compliant to 802.3at and 802.3bt may source power on either pairset. In terms of TIA-568 wire pairs, Alt-A consists of wire pairs 2 (orange) and 3 (green) while Alt-B consists of wire pairs 1 (blue) and 4 (brown).

On the PD side of the link, pairsets are referred to as **Mode A** and **Mode B**. These are each identical to Alt-A and Alt-B on the PSE side of the link.

Each pairset provides voltage and current to the PD in either a positive polarity or a negative polarity, thus necessitating the full wave bridges in the PD PI (*see **Figure 2.2***). The Alt-A pairset is said to be in an **MDI** polarity when the positive voltage is on wire pair 2 and the negative voltage is on wire pair 3 (*see **Figure 2.3***). Conversely, Alt-A is in an **MDI-X** polarity when the positive voltage is on pair 3 and the negative voltage is on pair 2. The same applies for the Alt-B pairset where **MDI** means positive voltage on pair 1 and negative voltage on pair 2 while **MDI-X** means positive voltage on pair 4 and negative voltage on pair 1.

In practice, many 2-Pair PSE's are configured to **Alt-A**, **MDI-X** and many 4-Pair PSE's are configured to **Alt-A, MDI-X** combined with **Alt-B**, **MDI**.

802.3bt requires **Type-4** PSE's to be configured as Alt-A, MDI-X and Alt-B, MDI. Older 802.3af mid-span PSE's were required to power on **Alt-B** with **MDI** only, however, that restriction was lifted under the 802.3at standard when midspan PSE's needed to support 1000Base-T (4-pair LAN) connections.;

2.5. Basic PoE Processes

PoE power is entirely managed by PSE's. PSE's are responsible for:

- Discriminating Powered Devices from other devices that might be damaged if PoE voltages were applied
- Assessing the basic power requirements of a newly connected PD
- Supporting surge (or inrush) power required to start up a PD
- Conducting PoE link-layer (LLDP) mutual discovery and power negotiation
- Supporting spurious peak power demands from a PD
- Reacting to PD's that are drawing more power than they should
- Supporting surge power demands from a PD when PSE power sources are replaced by back-up power sources

- Supporting unbalanced load currents between pairsets when powering 4-pair to single signature PD's
- Limiting maximum possible current in the event of short circuit in order to protect the PSE power supply and to limit cable heating or sparking
- Reacting to PD's that have been disconnected by removing power before another device can be plugged into the PSE port.

The following sections will address these PoE behaviors with associated responsibilities of the PSE and the PD.

2.6. PD Detection Processes: Discriminating PD's from non PD's

A PoE enabled PSE port provides a low power signaling mechanism that constantly monitors for an 802.3 Powered Device (PD) to appear at the end of the LAN cable. If a non-powered network device is connected, the PSE port can function just as would a non-PoE port and link to the networked device. However, if an 802.3 PD is connected, the PSE port will quickly recognize this and begin the process of powering up the PD.

The primary means of detection is a measurement of PD PI electrical resistance performed by the PSE port. 802.3at and 802.3bt specify that compliant PDs will present a load resistance between 23.7KΩ and 26.3KΩ that when measured at the PSE is between 19 KΩ and 26.5 KΩ given an input voltage under 10 VDC. They further specify that the method of resistance measurement shall allow for an unknown voltage drop up to 2.8 volts associated with one or more diode junctions in series with this load resistance. This implies that "AC" resistance must be determined from a [ΔV / ΔI] measurement performed at 2 (or more) voltage levels and that the minimum detection voltage must be at least 2.8 VDC.

Some of the relevant specifications affecting the detection process are:

Characteristic	Minimum	Maximum	Units
Unterminated (Open Circuit) Detection Voltage		30	VDC
Terminated Detection Voltages given Valid Signatures	2.8	10	VDC
Detection Current Limit (compliance)		5	mA
[ΔV / ΔI] Voltage Step	1	7.2	VDC
Maximum Acceptable Load Resistance	26.5	33	KΩ
Minimum Acceptable Load Resistance	15	19	KΩ
Maximum Acceptable Load Capacitance	0.15	10	μF
Slew Rate of Voltage Step		0.1	V / μsec
Detection Duration		500	mSec
Detection Backoff (following unsuccessful detection) (does not apply to End-Span PSE's)	2		Sec

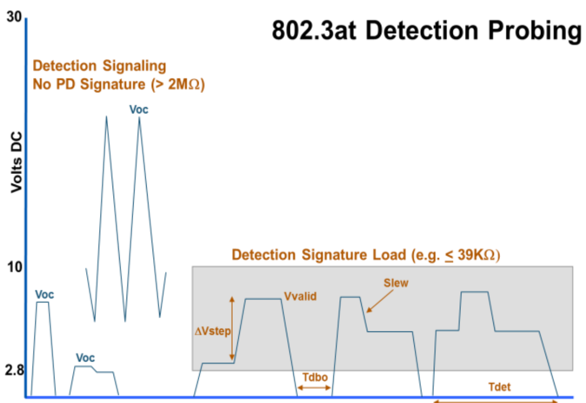


Figure 2.4 802.3 PoE Detection

It should be noted that despite the various requirements described for PD Detection signaling in the 802.3 specification, there is considerable room for design variation and that in practice, detection pulses and detection measurement schemes do vary significantly across PSE interface technologies. The 802.3 PoE standards do *not* prohibit the use of complementary schemes that might improve detection accuracy and speed while also reducing risk of possible damage to non-PoE capable end station equipment.

Figure 2.4 demonstrates some of the range of signaling characteristics that might be observed from 802.3at and 802.3bt PSE's. In truth, the range of options including number of detection current-voltage steps, use of voltage versus current sourcing, and use of low voltage pre-detection scheme is really unlimited with the one exception that detection must complete in 500msec and that a subsequent decision to apply power must be completed in 400msec or less.

The 802.3bt standard adds a separate phase of PD qualification and characterization referred to a **connection check**. The sole function of this PSE "measurement" is to allow a 4-Pair PSE to determine if the PD is a **single signature** or a **dual signature** PD, or neither. 4-Pair PSE's manage single signature PD's differently from dual signature PD's so this is an essential part of the detection process. In developing the 802.3bt standard, participants deliberately decided to only put a vague description to the connection check process stating that it must function in the same voltage range as

PD detection and that, like PD detection, it must be completed within 400 msec of a decision to apply power. This essentially allows vendors of integrated PSE controllers to do their own thing regarding connection check.

Figure 2.5 depicts the basic concept of 802.3bt PD connection check where during the process, signaling is applied simultaneously to both pairsets and some form of measurement is done to determine if the presence of a single signature PD is causing an interference of some sort between the respective pairset signals.

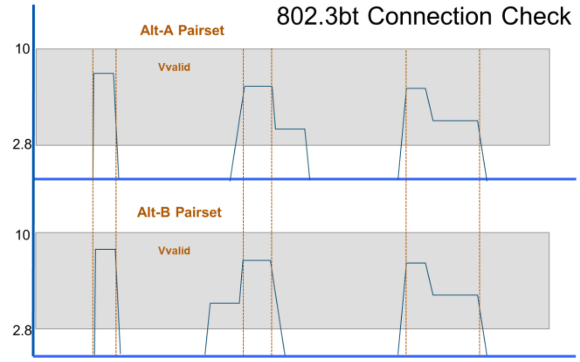


Figure 2.5 802.3bt Connection Check

As an example, if both pairsets inject an equal current source to a single signature PD, the voltage appearing will be a function of the combined currents and the ~25KΩ PD detection resistance. Conversely, if this same source is applied to a dual signature PD, the voltage appearing on each pairset will be approximately half because each current source experiences its own ~25KΩ load. This is the basic concept of connection check.

2.7. PD Classification – 802.3at

802.3at specification allows for PD's to communicate their power demands to a PSE port via a **classification** process. From the perspective of a PSE port, PD's can be classified as follows:

PSE Type	Classification	Guaranteed Power at PSE Output	Minimum Power at PSE Output	Units
Type-1	Class 0	15.4	~ 0.5	Watts
	Class 1	4.0	~ 0.5	
	Class 2	7.0	~ 4.0	
	Class 3	15.4	~ 7.0	
Type-2	Class 4	30.0	~ 15.4	

A **Type-1** PSE has the option not to classify the PD in which case the PD must be assumed to require **Class 0** power.

Classification is performed by applying a voltage in the band from 15.5V to 20.5V and measuring the fixed DC current load presented by the PD. The magnitude of measured current is then translated into a classification as follows:

Minimum Current	Maximum Current	Units	Classification	PD Type
0	5	mA	Class 0	Type-1
8	13	mA	Class 1	Type-1
16	21	mA	Class 2	Type-1
25	31	mA	Class 3	Type-1
35	45	mA	Class 4	Type-2

The PSE is free to make decisions regarding current measurements that fall between the above bands. Classification must be completed in 75 mSec, so typically classification involves a short duration pulse with amplitude between 15.5 and 20.5 Volts. A "single-event" class pulse (*see* ***Figure 2.6***) may return to zero or may hold its value (or anything in between) following completion of classification.

The 802.3at specification requires that all compliant PSE's perform classification and it adds an expanded classification measurement option that allows PSE's to "signal" their 82.3at Type-2 power capability to a powered device while reading the power demand of the powered

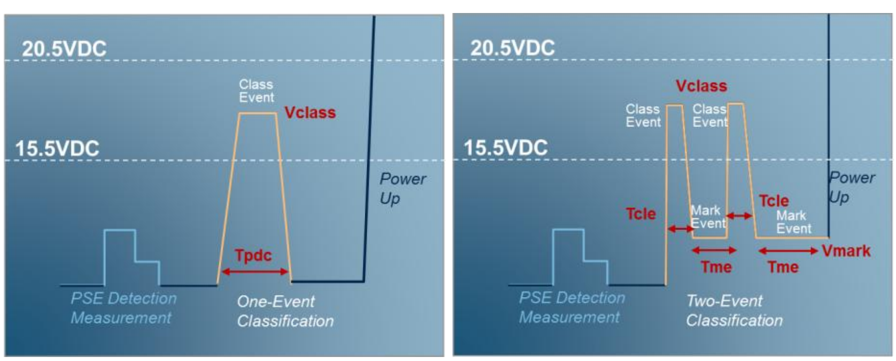


Figure 2.6 PD Classification under the **802.3at** Specification

device. The "2-event" classification (*see **Figure 2.6***) involves 2 successive classification current measurements separated by a "mark" region. The 802.3at Type-2 PD must be capable of discharging the class voltage in order to "see" this mark region and thereby detect the presence of an 802.3at capable PSE. The 2-event classification cannot ever drop below 2.8V, or the PD will reset and forget that the PSE is Type-2 power capable.

Type-2 PSE's may use either single-event or 2-event PD classification. Those that use single event method are required to us MAC layer LLDP protocol to negotiate power with a Type-2 PD following initial PD power-up. See Section 2.10 below for more information concerning LLDP PD power classification.

2.8. PD Classification – 802.3bt

The 802.3bt specification significantly extended the model of 2-Event classification so that PSE's and PD's could signal new classification bands that relate to power levels above Type-2 (Class 4). As with 802.3at, classification is a process that follows PD detection and precedes PSE powering of the PD.

802.3bt introduced nine new PD classifications, four that pertain to single signature PD's and five that pertain to dual signature PD's. 802.3bt also retained 803.2at PD classifications 1-4. As with 2-Event classification in 802.3bt, the count of classification pulses represents the method by which a PSE authorizes power levels to a PD.

The following table describes the 13 possible PD classifications described in the 802.3bt specification.

PD Signature Type	Classification	PSE Output Power*	PD Input Power	Units
Single	Class 1	4.0	3.94	Watts Total on 2-Pairs or 4-Pairs
	Class 2	7.0	6.5	
	Class 3	15.4	13.0	
	Class 4	30.0	25.5	
	Class 5	45.0	40.0	Watts Total on 4-Pairs
	Class 6	60.0	51.0	
	Class 7	75.0	62.0	
	Class 8	90.0	71.3	
Dual	Class 1 (D)	4.0	3.94	Watts per Pairset
	Class 2 (D)	7.0	6.5	
	Class 3 (D)	15.4	13.0	
	Class 4 (D)	30.0	25.5	
	Class 5 (D)	45.0	35.6	

Unlike 802.3at, 802.3bt requires that classification currents drawn by the newer classes of PD's change after the first two events are completed. The change in class current then encodes information regarding the power the PD demands. This difference enables 802.3bt PSE's to differentiate between 802.3at PD's where the classification signature never changes after the second class event and 802.3bt PD's where that signature always changes. Figure 2.7 diagrams the relationship between PSE voltage and PD current draw during a 4-Event classification sequence.

* PSE output power is actually dependent on PSE output voltage. Higher voltage PSE's can deliver the same power to the PD with PSE output power less than shown in the table. Table values are based on PSE's with minimum output voltage.

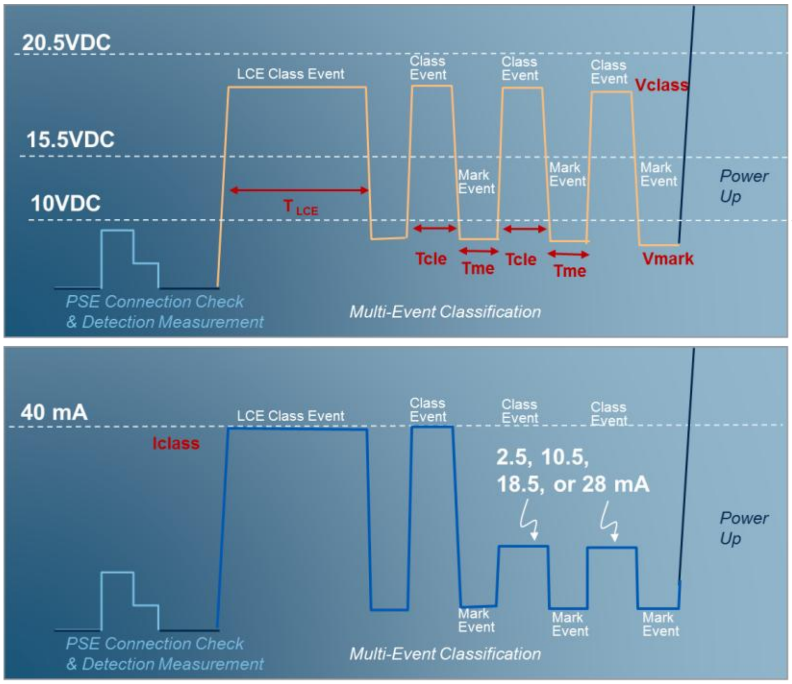


Figure 2.7 PD Classification under the 802.3bt Specification

As with PD detection, a single signature PD can be probed on either the Alt-A or Alt-B pairset and will produce the same classification signature. A dual signature PD must be probed on both pairsets, Alt-A and Alt-B, independently and may possibly produce different signatures on each pairset.

As stated above, the classification current sequence across three to five classification events, or pulses, encodes the power demand of the single signature PD and also the power demand of a single pairset of a dual signature PD. Conversely, the count of classification events, or pulses, from the PSE encodes the power grant, that is authorized power level to the 802.3bt PD. While much more complex than the 802.3at classification scheme, the 802.3bt classification scheme was designed to be fully backward compatible with 802.3at PSE's and PD's.

The following table describes 802.3bt classification signatures. Note that 802.3at **Class 0** is not included in 802.3bt, however a Class 0 PD will typically be managed as if it was a Class 3 PD drawing up to 13 watts maximum.

PD Class	Events 1 & 2	Events 3-5	Power Request at the PD	Units
Class 1	10.5 mA	10.5 mA	3.84	Watts Total on 2-Pairs or 4-Pairs
Class 2	18.5 mA	18.5 mA	6.5	
Class 3	28.0 mA	28.0 mA	13.0	
Class 4	40.0 mA	40.0 mA	25.5	
Class 5	40.0 mA	2.5 mA	40.0	Watts Total on 4-Pairs
Class 6	40.0 mA	10.5 mA	51.0	
Class 7	40.0 mA	18.5 mA	62.0	
Class 8	40.0 mA	28.0 mA	71.3	
Class 1 (Dual)	10.5 mA	2.5 mA	3.94	Watts per Pairset
Class 2 (Dual)	18.5 mA	2.5 mA	6.5	
Class 3 (Dual)	28.0 mA	2.5 mA	13.0	
Class 4 (Dual)	40.0 mA	2.5 mA	25.5	
Class 5 (Dual)	40.0 mA	28.0 mA	35.6	

The following table describes PSE power authorizations, also referred to as "assigned class" in the standard.

PD Signature Type	Total Events (= Class Pulses before power-up)	PD Class	Authorized Power Draw at the PD	Units	Assigned Class
Single	1	Class 1	3.84	Watts Total	Class 1
		Class 2	6.5		Class 2
		Class 3-8	13.0		Class 3
	2	All Classes	25.5		Class 4
	3	All Classes	25.5		
	4	Class 5	40.0		Class 5
		Class 6	51.0		Class 6
	5	Class 7	62.0		Class 7
		Class 8	71.3		Class 8
Dual	1	Class 1 (Dual)	3.84	Watts per Pairset	Class 1 (Dual)
		Class 2 (Dual)	6.5		Class 2 (Dual)
		Class 3-5 (Dual)	13.0		Class 3 (Dual)
	2	All Classes	25.5		Class 4 (Dual)
	3	All Classes	25.5		
	4	Class 5 (Dual)	35.6		Class 5 (Dual)

As with the 802.3at specification, classification probing is done with class pulses providing between 15.5V and 20.5V at the PSE output and between 14.5V and 20.5V at the PD input (*see **Figure 2.7***). Multiple event classification requires that each class pulse, or class event, be separated by mark regions where the PSE voltage drops to between 7V and 10V for a period of at least 6 msec. The mark voltage provides a "battery" voltage enabling the PD to count and store the number of classification events so the PD is aware of the power authorization, or **assigned class**, prior to power-up.

Another unique feature of 802.3bt is that the first class event must be between 88msec and 105msec duration (*see **Figure 2.7***). This is considerably longer than 802.3at class pulses and much longer than class pulses following the first event. This elongated (**LCE**) class pulse signals to an 802.3bt PD that the PSE is 802.3bt compliant and operates according to 802.3bt PSE rules and requirements. An 802.3at PSE would never exceed 72 msec during a class event.

Finally, one other feature of 802.3bt classification is referred to as **Autoclass**. Autoclass allows a PD to demonstrate to a PSE, soon after the application of operating voltage, the maximum level of power draw that PD will ever produce. A PSE that supports the optional autoclass feature can then measure that power level and use it in the management of total power budgets across multiple PSE ports. This is especially useful because the measured power draw takes into account the power loss in the cabling between the PSE and the PD.

An 802.3bt single signature PD communicates that it will support an autoclass power measurement by altering the current in the first (elongated) class event after 88msec to a value in the range 1 to 4 mA (e.g. 2.5mA). The PSE that supports autoclass will implement an LCE (first event) class pulse that exceeds 88msec so that it can capture the load current change from 40mA to ~2.5mA. The PD that supports autoclass will always draw maximum power in a time interval between 1.5 seconds and 3.3 seconds following the application of operating voltage.

In practice, autoclass is limited in application because many PD's will not have the ability to provide a maximum load condition in this time interval (1.35 to 3.65 seconds) following power-up. Many PD's are early in their boot process during this time interval. One important target application for autoclass would be LED lighting systems.

2.9. Power-Up

Following detection and classification, the PSE will apply power (voltage and current) to the PD. The DC voltage while powered at the output of a PSE port is defined for each PSE type as follows.

PSE Type	Minimum Output Voltage	Maximum Output Voltage
1	44 VDC	57 VDC
2 or 3	50 VDC	
4	52 VDC	

Figure 2.8 depicts the typical sequence of events after a PD connects to a PSE. This diagram pertains to a single pairset, Alt-A or Alt-B, but similar action could occur on both pairsets of a 4-pair PSE.

On the PSE side, there are three timing criteria of interest. The first parameter, **Tpon**, measures time from end of detection until power-up is completed. This includes classification time and must be under 400 mSec. **Tpon** exists to minimize the chance that a PSE powers a non-PD in the event a valid PD is briefly connected, then quickly replaced by the non-PD.

The power-on rise time is required to be longer than 15 μsec. This limitation minimizes possible RF emissions when PSE ports activate power to PD's.

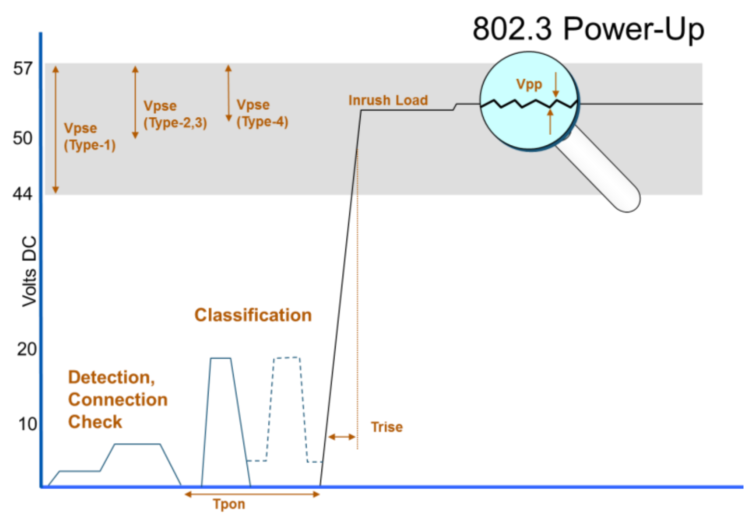


Figure 2.8 802.3 Power-Up

Once the PD is powered, it will typically draw an initial inrush (or charging) current (*see **Figure 2.9***). The PSE is designed to expect this sudden load and to tolerate it for a period of time referred to as **Tinrush**. During this period and depending upon the PSE type, the PSE may restrict current output on a pairset to a band between 200mA and 450mA.

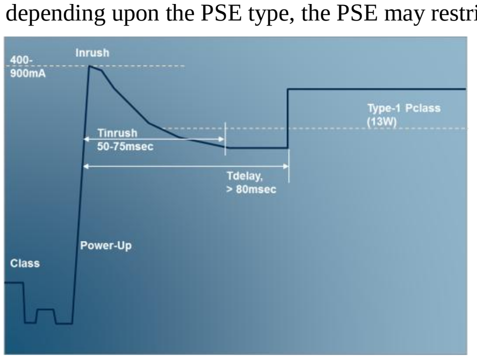


Figure 2.9 PD Inrush and Power Delay

Given a 4-pair power-up, this amounts to between 400mA and 900mA total current, again depending up on the PSE type. Given a two pair power-up, the band will be 400mA to 450mA.

The PD is obligated to assure that it can complete its surge load in 50msec or less given the lowest allowed current limiting (e.g. 400mA) by the PSE. Further, the PD is obligated to operate at a power level less than 13W, or more specifically a Type-1 peak power level less than 14.4W for a period of 30msec following the completion of inrush, in other words, for a period of 80msec following power-up (*see **Figure 2.9***).
PD's may be implemented with their own internal current limiting such that charging periods are extended without overdrawing current

from the PSE. PD's with large surge demands and/or delayed surge loads will reduce risk of PSE inrush shutdown by internally limiting current draw during startup.

While the PSE is furnishing operating power to the PD, 802.3 specifications include restrictions on the amount of AC ripple and noise that appears on the DC supply voltage. In a 2-pair (e.g. 802.3at) powering context, this would be AC peak-peak voltage across a pairset (Alt-A or Alt-B) and in a 4-pair powering scenario, would be the AC peak-peak voltage appearing across both pairsets. The AC peak-peak voltage is split into frequency bands with lower limits for higher frequency bands up to 1MHz. Restricting peak-peak DC voltage reduces the possibility that common mode AC ripple and noise could be converted into differential noise that might interfere with LAN signaling. It is worth noting that as a practical matter, PSE's have output capacitance on the order of 0.1μF to 0.5μF and PD's have input capacitance on the order of 5μF or higher while powered. These levels of capacitance will typically limit the AC peak-peak noise that can develop across the pairsets.

2.10. PoE LLDP Dialog / Power Negotiation

After a PSE powers up a PD, it may utilize a link layer discovery protocol (LLDP) to better understand the PD's power needs. LLDP protocols only exist between two physical link partners and are not visible anywhere else on a network.

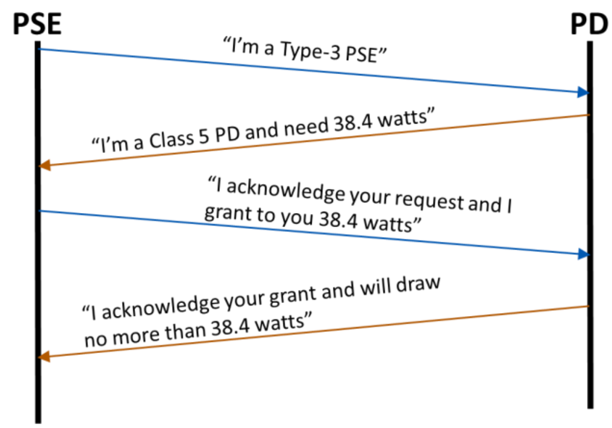


Figure 2.10 PoE LLDP Dialog/Negotiation

All PSE's are allowed but not required to deploy PoE LLDP. All Type-2, Type-3, and Type-4 PD's are required by 802.3at and 802.3bt to support PoE LLDP protocols.

LLDP is particularly useful to large system PSE's with 24 or more ports where power allocations to each PD are more challenging. Under PoE LLDP, a PD communicates its maximum power demand with a granularity of 0.1 watt. This in turn enables the PSE to allocate power more precisely across many PSE ports. In sections 2.7 and 2.8 above, it was seen that physical layer classification typically provides granularity of about 15 watts.

While there are many details to the PoE LLDP protocol, **Figure 2.10** shows in simple form what the essence of such dialog accomplishes. While historically LLDP protocols are stateless an generally used so that link partners just advertise information about themselves, the PoE rendition of LLDP is a more stateful, handshaking dialog.

As a practical matter, since the advent of 802.3at and Type-2 PD's, a large segment of the industry has avoided implementing LLDP support in PD's as a cost saving strategy, thus causing considerable interop problems. Many PD manufacturers offer low cost Type-2 midspan PoE injectors to help customers overcome the non-compliance of their PD's. While time will tell, the same issues may persist as 802.3bt PD's deploy into the world.

2.11. PSE Load Regulation and Overload Management

While the PSE is furnishing power to the PD, the PSE is responsible for regulating total power delivered to the PD. On the PSE side, there are three essential parameters governing the ongoing power the PSE is obligated to provide to a PD.

1. **Pclass**: The steady-state continuous or average power required by the PD translated to the PSE interface
2. **Ppeak**: The sporadic and transient (< 50msec) peak power required by a PD also translated to the PSE interface
3. **Ilim_min**: The maximum current a PSE should tolerate over a short transient (< 10msec) interval

As most PD's are constant power loads, the power output at the PSE must account both for the PD power load and the power that will be lost in LAN cabling. The power lost in LAN cabling is a function of the distance between PSE and PD, the resistivity characteristic of the LAN conductors, and the DC current flowing to satisfy the power demand of the PD. The DC current required is a function of the PSE output voltage – higher voltage means less required current. As an example, a Class 4 PD requiring the maximum allowed 25.5 watts and connected across 100meters of Cat5e cabling to a PSE will require the PSE to furnish 30 watts IF the PSE output voltage is the minimum of 50 VDC for a Type-2 PSE. In this case, there will be 600mA of DC current in the wires. If the Type-2 PSE implemented a 56 VDC output, then the PSE would need to support just 28.8 watts at its output and the current flowing in the wires would be 514mA.

The following table provides requirements for Pclass, Ppeak, and Ilim_min output requirements at the PSE assuming the PSE is operating at its minimum allowable (Vpse) output voltage.

PSE Type	Max Class	Voltage	Pclass	Ppeak	Ilim_min
1	1	44 VDC	4.0 watts	5.3 watts	400 mA
	2	44 VDC	7.0 watts	9.2 watts	400 mA
	0, 3	44 VDC	15.4 watts	17.6 watts	400 mA
2	4	50 VDC	30.0 watts	34.1 watts	684 mA
3	5	50 VDC	45.0 watts	47.7 watts	580 mA / pairset
	6	50 VDC	60.0 watts	63.7 watts	720 mA / pairset
	1 Dual Sig.	50 VDC	3.9 watts / pairset	5.1 watts / pairset	400 mA / pairset
	2 Dual Sig.	50 VDC	6.6 watts / pairset	8.5 watts / pairset	400 mA / pairset
	3 Dual Sig.	50 VDC	13.5 watts / pairset	15.0 watts / pairset	400 mA / pairset
	4 Dual Sig.	50 VDC	30.0 watts / pairset	34.1 watts / pairset	684 mA / pairset
4	7	52 VDC	75.0 watts	79.8 watts	850 mA / pairset
	8	52 VDC	90.0 watts	96.3 watts	1005 mA / pairset
	5 Dual Sig.	52 VDC	45.0 watts / pairset	48.1 watts / pairset	990 mA / pairset

On the PD side, there are two essential power load parameters:

1. **Pclass_pd**: The steady-state continuous or average power required by the PD
2. **Ppeak_pd**: The sporadic and transient (< 50msec) peak power required by a PD

These values are:

PD Type	PD Class	Pclass_pd	Ppeak_pd	Minimum Input Voltage
1	1	3.84 watts	5.0 watts	42.8
	2	6.49 watts	8.36 watts	42.0
	0, 3	13.0 watts	14.4 watts	39.9
2	4	25.5 watts	28.3 watts	42.5
3	5	40.0 watts	42.0 watts	44.3
	6	51.0 watts	53.5 watts	42.5
	1 Dual Sig.	3.84 watts / pairset	5.0 watts / pairset	42.8
	2 Dual Sig.	6.49 watts / pairset	8.36 watts / pairset	42.0
	3 Dual Sig.	13.0 watts / pairset	14.4 watts / pairset	39.9
	4 Dual Sig.	25.5 watts / pairset	28.3 watts / pairset	42.5
4	7	62.0 watts	65.1 watts	42.9
	8	71.3 watts	74.9 watts	41.1
	5 Dual Sig.	35.6 watts / pairset	37.4 watts / pairset	41.1

Figure 2.11 describes some of these requirements in a graphical manner that includes time intervals associated with Ppeak and Ilim_min load transients. A PD that exceeds **Pclass_pd** for longer than 50 msec may have power removed by a PSE. A PD that exceeds **Ppeak_pd** for any amount of time may also experience PSE power removal. All of this is very dependent upon PSE configuration and cabling lengths. For example, a Type-2 PSE operating at 50VDC must allow up to 30W power output but may choose to allow 34W power output allowing some headroom for marginal PD's or extra cabling loss.

Finally, the PoE LLDP protocol may be used to refine the value of **Pclass_pd** and **Ppeak_pd**. Once Pclass_pd is "negotiated" to 0.1 watt granularity using LLDP, the PSE is free to police the power draw at the PSE (**Pclass**, **Ppeak**) based on that power negotiation.

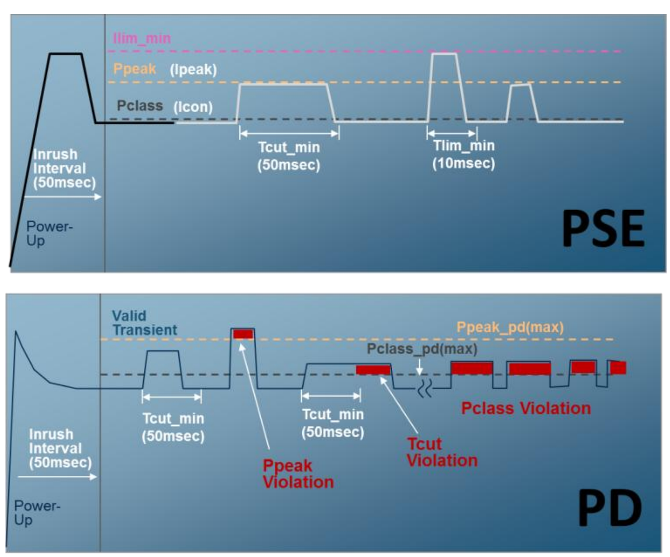


Figure 2.11 Power Regulation and PD Overloads

2.12. Pair to Pair Unbalance with 4-Pair, Single Signature Powering

One of the greatest challenges addressed by the 802.3bt specification was the matter of pair-to-pair current unbalance that will naturally occur when a 4-pair PSE is powering a single signature PD. This is a critical problem because the vast majority of PD's are single signature PD's.

The dilemma of pair-to-pair current unbalance occurs because in prior specifications, there was no explicit regulation of pairset-to-pairset resistances in the output of the PSE port, the LAN cabling, or the PD input. This is complicated by the fact that determinants of pairset-to-pairset DC resistance will involve components such as FET switches in the PSE and PD and diode bridges in the PD. Additionally, EIA/TIA and ISO specifications for LAN cabling systems did not regulate pairset-to-pairset DC resistance.

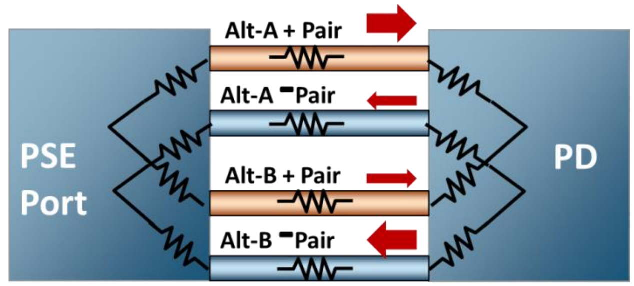


Figure 2.11 Pair-to-Pair Current Unbalance

Figure 2.11 depicts this problem where the current required to power the PD does not split evenly between either the positive or negative rails of the Alt-A and Alt-B pairsets.

Considerable work was done in the 802.3bt standard to model what worst case pair-to-pair unbalances might be present in PSE interfaces, cabling, and PD interfaces. In conjunction with this, the cabling industry published guidelines for pair-to-pair DC resistance unbalance LAN cabling systems. The 802.3bt standard includes some testing procedures to assess that PSE and PD interfaces to not exceed the worst case models used by the specification.

The PSE powering 4-pairs to Class 0 – Class 8 PD's is required to tolerate appreciable levels of current unbalance between the two pairsets.

PD Class	Maximum Pairset Current	% Maximum 4-Pair Current
1	78 mA	100% (= 2-pair powering)
2	132 mA	100% (= 2-pair powering)
3	269 mA	100% (= 2-pair powering)
4	548 mA	100% (= 2-pair powering)
5	560 mA	62.1%
6	692 mA	57.7%
7	794 mA	55.1%
8	948 mA	54.8 %

PSE's must be designed to accept higher pairset current without any notion of which polarities of which pairsets will draw more or less current. Only time will tell if the modeling done within the standard fully accounts for all of the real-world contributions to pair-to-pair current unbalance.

2.13. Power Removal

PSE ports are required to remove DC power very soon after a PD becomes disconnected. This is an essential behavior to protect non-PD devices from damage should they be plugged in immediately after a PD was disconnected from the same PSE port.

Across the 802.3af, 802.3at, and 802.3bt standards, there are two different methods, **DC MPS** and **AC MPS**, by which a PSE detects a disconnected PD. Generally, a PSE deploys one method or the other but not both.

Both methods, described below, require that once a PSE detects the disconnection of a PD, power should be removed within a time band (**Tmpdo**) between 300msec (320msec in 802.3bt) and 400msec (*see **Figure 2.12***). This assures that replacing a PD with a non-PD very quickly would generally be safe.

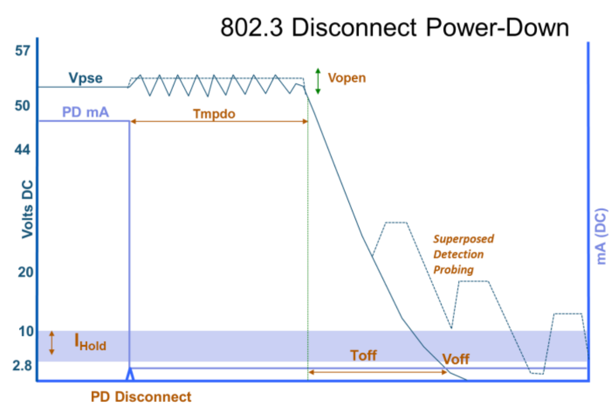


Figure 2.12 802.3 PoE Disconnect Power-Down

Once the PSE removes operating voltage, the PSE is expected to discharge to **Voff**, or 2.8V, in a period of

500msec (**Toff**). Some PSE's may start detection probing as the output voltage discharges resulting in superposed signaling on the discharging output. This could interfere with the **Toff** requirement.

PSE's powering single signature PD's with 4-Pair power have the option to remove power on one pairset immediately at PD disconnect but must keep the other pairset powered over the duration of **Tmdpo** (320 – 400 msec) to be sure the PD disconnect is a real event and not a sudden spurious drop in PD load current.

The **DC MPS** (DC maintain power signature) method for detecting a PD disconnect was allowed in all three specifications (802.3af, 802.3at, and 802.3bt) and relies on a continuous measurement of DC load current to assess PD disconnects. The DC MPS method is the only technique allowed by the more recent **802.3bt** specification. Under this method, a small band of current (**I_{HOLD}**) is defined where a PSE has the option to deem the PD as connected or disconnected. Above this band, the PSE must assume the PD is present. Below this band, the PSE must assume the PD is disconnected. The **I_{HOLD}** current band differs between 802.3at and 802.3bt but has been designed so that 802.3at PD's will interoperate with 802.3bt PSE's and vice versa.

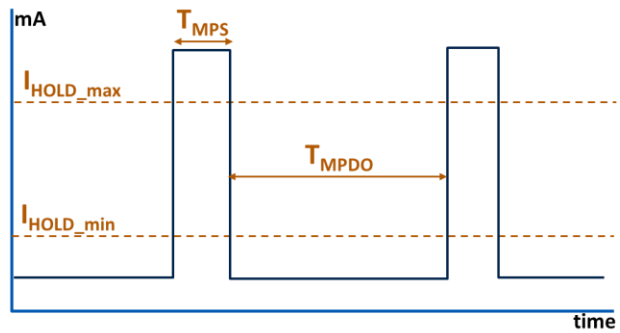


Figure 2.13 DC MPS Minimum Power State

Under 802.3at, the maximum **I_{HOLD}** current was 10mA meaning that a PD needing to stay powered would draw typically 0.5 watts or more continuously. For a PD operating in a "sleeping" state, this was a considerable amount of power and depending on the design of the PD, the quiescent power of 0.5 watt might steal from the power available when the PD was fully operating.

To address this, both 802.3at and 802.3bt allow that the DC MPS signature current, **I_{HOLD}**, need not be present continuously. In Figure 2.13, the PD load current is show to exceed the maximum **I_{HOLD}** level for a period of **T_{MPS}**. Between **T_{MPS}** intervals, the PD load current can drop all the way to 0mA for a maximum period of **T_{MPDO}** (min). This produces a duty cycle of **T_{MPS}** / (**T_{MPS}** + **T_{MPDO}** (min)). A PD meeting or exceeding this duty cycle must be deemed connected by a PSE that uses the DC MPS method.

The following table provides values for **I_{HOLD}**, **T_{MPS}**, and **T_{MPDO}** from 802.3at and 802.3bt.

PSE Type	Powered Pairs	PD Class	I_{HOLD} (Pairset)	I_{HOLD} (4-Pair)	T_{MPS}	T_{MPDO}(min)	T_{MPDO}(max)
1 and 2	2	All	5 to 10 mA	N/A	60 msec	300 msec	400 msec
3	2	1 - 4	4 to 9 mA	N/A	6 msec	320 msec	400 msec
3 and 4	4	1 - 4	2 to 5 mA	4 to 9 mA			
3 and 4	4	5 - 8	2 to 7 mA	4 to 14 mA			
3 and 4	4	1 dual – 5 dual	2 to 7 mA				

From this table, it is evident that any PD connected to an 802.3at PD must draw 10mA with a duty cycle of more than 17% in order to maintain power. However, PD's connected to an 802.3bt (Type-3 or Type-4) PSE can operate at much lower duty cycles on the order of 2.5% and maintain power. This "low power MPS" feature will allow very low power sleep modes in PD's such as lighting systems.

The **AC MPS** method involves the superposition of a low level, relatively low frequency AC resistance probing signal on the DC power rail. The AC MPS probing signal is sourced through high impedance such that when exposed to a nominal load resistance of 25 KΩ, the amplitude of the signal is attenuated to well below 500 mVp-p. Typically it will be far below 200 mVp-p. When the 25 KΩ signature load is removed as a result of PD disconnect, the AC signal amplitude increases and can be detected on the PSE output (*see **Figure 2.12***). **Vopen** specifies maximum allowed AC voltage during this time interval to be 10% of **Vpse**. The PSE must then wait for an interval of at least 300 mSec, but not longer than 400 mSec to remove power.

PD's can present a ~25KΩ or smaller resistive load to assure PSE's using the AC MPS method will keep them powered. This amounts to a continuous power consumption of approximately 0.1 watt. PD's that continuously draw even just two milliamps will also meet this load requirement (50V / .002A = 25KΩ). The key drawback to AC MPS is that it requires additional hardware in the PSE and it may increase power rail ripple by a small amount. AC MPS was not included in the **802.3bt** specification because PSE silicon manufacturers all accepted that DC MPS was a more cost effective solution to PD disconnect detections.

3. The PowerSync Analyzer

3.1. System Hardware Overview

The diagram below is a block diagram of a single PowerSync Analyzer (PSA-3000) test port. Each PSA test blade (or PSA3002 instrument) contains two of these measurement circuits, which are electrically isolated from each other and from the chassis control circuitry.

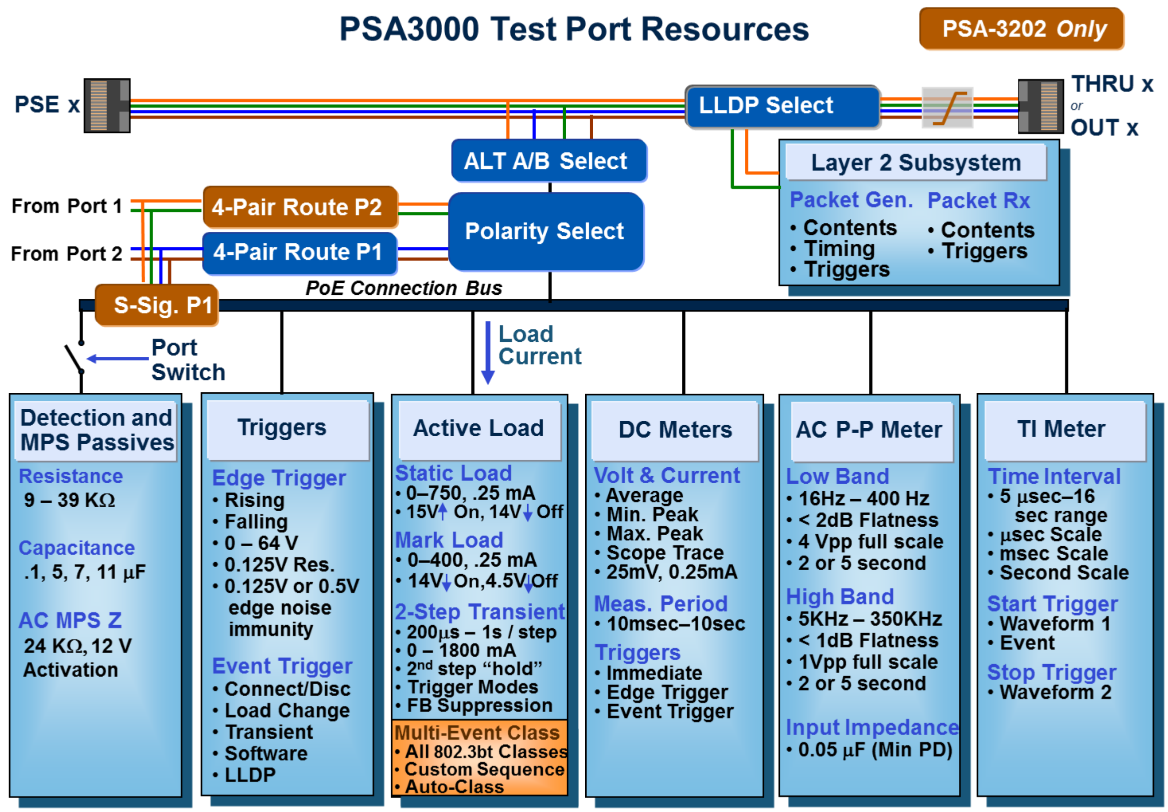


Figure 3.1 PSA-3000 Test Port Diagram

The PSE input connector (**PSE x** where **x** is **1** or **2**) is connected to a PSE device under test. The DC power and related common mode control and classification signals are tapped off and fed to the measurement subsystems. The DC voltage and low frequency, common mode PoE signals are not visible at the output port (**THRU x** or **OUT x**).

LAN transmission pairs 1 and 4 (blue and brown) are routed from the **PSE x** directly to the **OUT x** (or **THRU x** on PSA-3202) port with passive DC isolation. LAN transmission pairs 2 and 3 (orange and green) are routed to an **LLDP Select** switch that is used to select port pass-through mode for packet testing or LLDP PD emulation mode whereby these pairs are terminated in a 10/100BaseT interface inside the **Layer 2 Subsystem** of the PSA Test Port.

At the PoE front end of the test port, there are three sets of switches. These are implemented with electro-mechanical relays. The **ALT-A/B Select** switch selects which wire pair is connected to the PSA test resources. The **Polarity Select** switch selects the polarity (MDI or MDI-X) of the power supplied by the PSE under test. A **4-Pair Route P1** switch allows the ALT B pairs to route from Port 2 to the PoE connection bus of Port 1 so that 4-Pair PSE's can be tested from Port 2. **PSA-3202** test blades also include a **4-Pair Route P2** select switch to allow the ALT A pairs to route from Port 1 to the PoE connection bus of Port 2 so that 4-Pair PSE's can be tested from Port 1 also.

ALT-A/B and Polarity settings will depend upon the characteristics of the PSE being tested. Incorrect settings of either switch will not damage the instrument and should not affect PSE either, but will prohibit PoE testing.

The paragraphs that follow will cover each test subsystem in greater detail.

3.1.1. Port Switch and Detection Subsystem

The **Port Switch** and **Detection Passives** subsystem provides the detection loading required for a PSE under test to recognize a Powered Device (PD) "signature" so that it can turn on and supply power. It also provides an AC Maintain

Power Signature (MPS) resistive loading that is visible to a powered-up PSE. This load value is at the top of the range where AC MPS PSE's must interpret a valid load signature.

The **Port Switch** is used to connect the passive detection loads to the PSE under test. On initial power-up of the PSA-3000, this switch is in the open (or "isolated") position. This switch closes and opens under software control and may be used as a triggering event for many single-shot measurements of detection and MPS behaviors.

The **Detection Passives** are affected by an internal disconnect feature that is dependent only upon the PSE voltage level. When the PSE voltage reaches approximately 12 volts, the passive R-C Detection signature is removed and the MPS signature R-C circuit is inserted thus presenting a valid AC MPS signature following PSE power-up for as long as the **Port Switch** is closed (or connected).

The resistance and capacitance ranges in the **Detection Passives** subsystem are 9 KΩ -39 KΩ Ohms, and nominally 0, 5, 7, and 11µF respectively. The AC MPS signature consists of 24 KΩ in parallel with 0.1 µF that becomes visible above 12 volts DC – the same level where Detection Signature passives are removed and become invisible. Because of the 12 volt activation floor, the effective DC resistance of the AC MPS signature is significantly greater than 24 KΩ until the port voltage significantly exceeds 12V. This means that neither the Detection Signature nor the AC MPS signature will produce any measurable error to Classification Signature loads created by the Active Load module.

There are 2 forward-biased diodes that the signal must pass through before entering the **Detection and MPS Passives** circuitry. These model typical PD bridge characteristics and are commensurate with recommended circuitry as described in the 802.3 PoE standard.

PSA-3202 test blades (and the PSA-3402 Compact PSA) add a **Single Signature** (**S-Sig. P1**) switch that enables the Port 1 Detection and MPS Passives to be applied to both Port 1 and Port 2 inputs. This effectively creates a 4-Pair, Single Signature PD as described in the IEEE 802.3bt standard. *This capability is not available in PSA-3102's nor in PSA-3002's where only **Dual Signatures** can be emulated given a 4-Pair PSE connection.*

3.1.2. Triggers

The PowerSync Analyzer has extensive triggering capabilities, which are divided into 2 categories: **Edge** (or waveform) and **Event** (or external). The instrument also has the ability to perform non-triggered measurements. The triggering types are depicted in **Figures 3.2** and **3.3**. Also depicted in **Figure 3.2** are trigger applications including the DC meters, time-interval measurement, and load current transient, each of which can be initiated with those triggers.

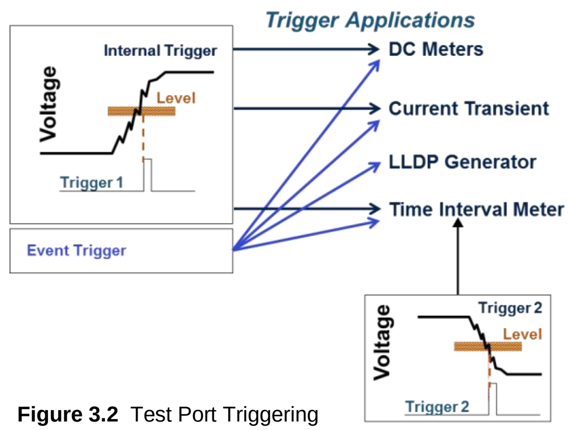


Figure 3.2 Test Port Triggering

Edge (or waveform) triggering is derived from the common mode voltage levels received from the PSE under test. For most measurements, this triggering is based upon the trigger levels and polarities (rising or falling) set for **Trigger 1**. A second trigger, **Trigger 2** is used exclusively for terminating time interval measurements. Trigger 2 offers identical features as Trigger 1 (levels and edge polarities). PSA-3000 trigger levels may be specified with 0.125V resolution from 0.25 to 59.5 VDC.

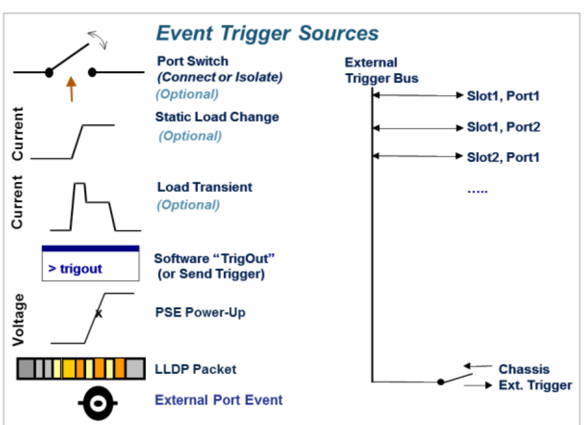


Figure 3.3 PSA Test Port Event Trigger Sources

PSA-3000 Test Ports offer an edge noise immunity feature and control to improve trigger edge reliability in the presence of electrical noise. This is especially important when working with many of the high impedance signaling modes found in PoE. Noise immunity may be selected for either 0.125V (**Normal**) or for 0.5V (**Noisy**) levels of edge noise.

Event triggering is also used to initiate measurements or actions, and is initiated by either a user command, an action that is programmed to send out an event trigger, or through an external event that appears on the trigger bus. While most triggers precede measurements, the PSE **Power-Up** event trigger is used exclusively as a post-trigger to voltage and current waveform measurements.

The trigger bus is a trigger signal connection that is shared by all ports within a system, and by the **Trig Out** BNC connector on each PowerSync Analyzer. **Figure 3.3** shows the sources used to generate **Event** triggers on the left, and shows the external bus configuration on the right. Any **Event Trigger** in the system will appear on this bus, and will trigger any port that is waiting for an event trigger. This enables cross-triggering across test ports and triggering via remotely generated signals. It also enables the user to use the trigger output for other purposes, such as synchronizing a LAN packet to PSE powering or load transients.

The BNC trigger connector on the Chassis Controller front panel can be configured as an output or an input. As an output, it directly mirrors the External Trigger bus. Output triggers will appear as a 3.3V, 10 mSec pulse. When set as an input, it can drive the external trigger bus inside the PSA chassis. This enables triggering across multiple instruments, which may be desirable when testing equipment with more than 24 ports.

For example, **Figure 3.4** depicts triggering across instruments. The trigger direction on PSA #1 is set as an output, and the other PSA's are set as inputs. This set-up can be used to perform measurements, or initiate a load current change across 96 or more PoE ports simultaneously.

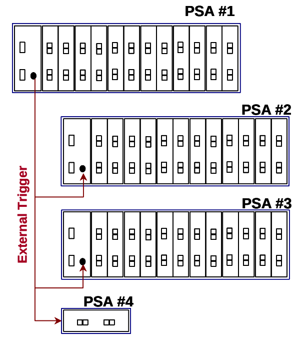


Figure 3.4 External Trigger Bus

3.1.3. Static DC and Transient Loads

The **Active Load** subsystem includes a flexible programmable current load. This current load is activated when port voltage exceeds 15 VDC from the PSE under test. The programmable load enters a transition (or **Mark**) band when the port voltage drops below 14 VDC, then completely shuts off when port voltage drops below 6 VDC (or 4.5V on PSA-3202's). This state machine behavior is depicted in **Figure 3.5**.

The **Static Load** has a programmable range from 0 through 950 mA (*750mA in PSA-3102's*), in 0.25 mA steps. In the transition region, the programmable range is 0 to 400mA, also in 0.25 mA steps. The transition region is useful for replicating PD **Mark** loads during classification and for assessing various PSE current limiting behaviors.

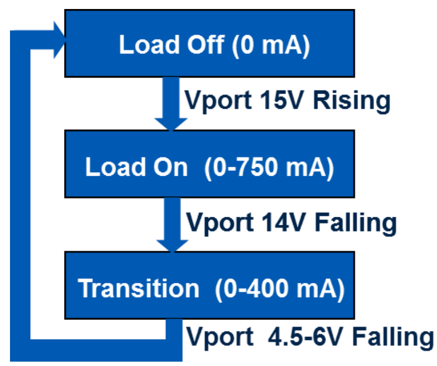


Figure 3.5 Active Load State Behavior

The PowerSync Analyzer's active load can be configured to produce a programmable 2-step **Transient** current load, where both current level and load step durations can be configured. Load transient **Step 1** may be programmed from 0 to 1023 mA with a step duration of 200µsec to 1000 msec, or may be programmed from 1024 to 1800 mA with a maximum step duration of 80msec. Load transient **Step 2** may be programmed from 0 to 950 mA (*750mA in PSA-3102's*) with a step duration of 200µsec to 1000 msec. Load **Step 2** may also be configured to become the new static load current and therefore persist indefinitely. See **Figure 3.6** for a graphical depiction of the load transient capabilities.

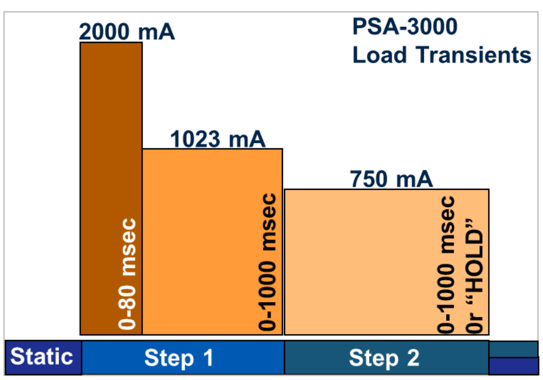


Figure 3.6 Active Load Transients

Load transients can be triggered immediately or via either the Edge Trigger or Event Trigger, and are also capable of *generating* an Event Trigger at the beginning of the transient. They may also be repeated up to 5 cycles producing sequences of transients up to 10 seconds long.

The PSA-3000 introduces a unique feature, **Foldback Suppression**, to help with evaluation of PSE's during severe current overloads that place PSE's into a current limiting state. For example, PSE's are required to limit maximum output current to between 400mA and 450mA when initially powering a PD. When any power supply limits current, output voltage will drop to a level dependent upon effective resistance of the loading device. This voltage drop causes power to be absorbed in the PSE active switch with potential of overheating and damaging that component. PSE's will often sense low voltage outputs and restrict current flow to well below 400mA in order to protect the active switch.

Foldback Suppression is an option that may be invoked for the full duration of a load transient that will significantly reduce PSE active switch voltage drop when the PSE is in a current limiting mode. By inhibiting the possibility of a voltage-controlled foldback on the part of the PSE, current limiting behaviors of PSE ports can more thoroughly be analyzed.

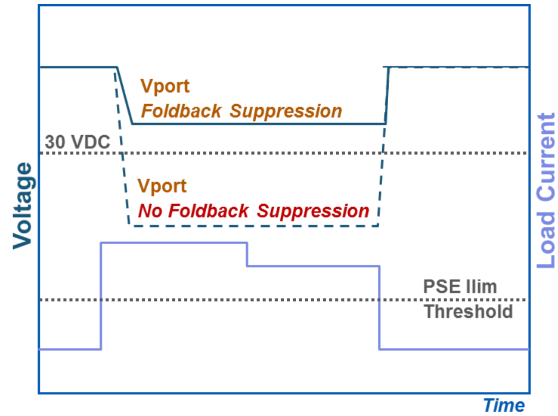


Figure 3.7 Load Transient Foldback Suppression

3.1.4. 802.3bt Multi-Event Class Signatures

PSA-3202 test ports include a special ability to sequence **Multi-Event Class** signatures required to emulate Type-3 and Type-4 PD's described by the IEEE 802.3bt specification. These sequences of programmable classification load currents and Mark region currents can be activated with emulated 4-Pair PD connections and are automatically reset when voltage drops below 4.5V. The Multi-Event sequencing "engine" in the **Active Load** subsystem will automatically debounce short voltage glitches and noise in order to reliably produce the programmed signature sequences including 802.3bt PD Classes 5-8 and 802.3bt Dual Signature PD Classes 1-5.

3.1.5. DC Meters

The **DC Meter** subsystem is capable of measuring PSE voltages and sensing actual load currents. Measurement capabilities include average, maximum peak, minimum peak, and sampled trace capture of either voltage or current. Each of these measurements uses configurable measurement periods from 10 mSecs to 10 seconds. Each of these measurements are derived from 256 voltage or current samples meaning that the sampling rates scale with measurement period, and range from 40us to 40 mSecs for 10 mSec and 10 second measurement periods respectively.

Sampled waveform measurements of voltage and current additionally offer several 1024 sample length traces covering 200msec, 2 seconds, 4 seconds, 8 seconds and 20 seconds.

The DC Voltage Meter ranges from 0 to 60 Volts with 0.025V resolution. The DC Load Current Meter ranges from 0 to 1800 mA with 0.25 mA resolution.

All DC Meter measurements can be user initiated, triggered with a designated voltage transition and level, or triggered via an event (*see Section 3.1.2*). Only one DC measurement can be performed at a time on each test port. Triggered measurements across multiple test ports may be configured to run simultaneously however using either port-specific edge triggering or shared event (or external) triggering.

3.1.6. AC Meter

The AC Peak Meter is used to measure ripple and noise voltages on the DC power supplied by the PSE under test. The meter is capable of measuring ripple in either a 16 Hz – 400 Hz band, or noise in a 5K – 350K Hz band (1dB BW). Full scale voltage for the AC meter is 2 Vpp with 1mV resolution.

The AC Peak Meter presents the smallest (or worst case) Powered Device input load of 0.05µF when making ripple and noise measurements so that measurements reflect AC voltages actually visible to a Powered Device.

AC Meter measurements are immediate triggered with integration periods selectable as 2 or 5 seconds.

3.1.7. Time Interval Meter

The time interval meter measures time duration between an Edge Trigger (#1) or an Event Trigger, and a second Edge Trigger (#2). This measurement is configured to one of 3 time scales: µSec, mSec, or Sec. Time interval measurements can be used for measurements of reaction times, rise times, slew rates, pulse widths, and other time-critical events.

In the µSec scale, time intervals from 4 µSec to 26000 µSec can be measured with Edge Trigger noise immunity (*see Section 3.1.2*) applied to any initiating edges. In the mSec scale, time intervals from 2 to 6500 msec may be measured with Edge Trigger noise immunity applied to both initiating and terminating trigger edges. In the Sec scale, time intervals from 0.1 to 16 seconds may be measured with Edge Trigger noise immunity applied to both initiating and terminating trigger edges.

All time interval measurements by necessity are triggered and thus must resolve to a TIMEOUT condition if the initiating trigger fails to occur or an OVERFLOW condition if the terminating trigger fails to occur.

3.1.8. Layer 2 (LLDP Emulation) Subsystem

The **Layer 2 Subsystem** offers the ability for each test port to flexibly emulate LLDP protocol exchanges with a PSE. Under the IEEE 802.3at standard, many PSE's only deliver higher power levels (> 15.4 watts) after sufficient LLDP exchanges have occurred between PSE and PD. IEEE 802.3bt extends the PoE LLDP protocol to address higher power levels and dual signature PD's and, depending upon PSE implementation, LLDP may be required for PD's to obtain their requested power draw.

PSA software provides software tools and resources that can be used for flexible and robust PD LLDP emulation and PSE LLDP analysis (*see Section 8)*. This capability is available only if the PSA-3000 instrument is licensed for LLDP. Instruments not licensed for LLDP can be upgraded with an LLDP feature license that is purchased from Sifos.

3.1.9. LAN Test THRU*n (or* OUT*n*) Ports

Each test port provides a passively de-coupled **THRU***n* (or **OUT***n* on PSA-3102) interface that can be connected to a LAN analyzer in support of packet traffic generation/capture or other forms of LAN analysis***** in the presence of PoE loading induced by the PSA test port. Links between the PSE port-under-test and a test instrument connected to the **THRU***n* interface will support 10BaseT, 100Base-T, and 1000Base-T signaling with negligible impairment. Because the **THRU**n interface is passively coupled to the **TEST***n* interface, there is no latency in packet flow.

When the **Layer 2 Subsystem** is activated (*see section 3.1.8*), LAN Data Pairs 2 and 3 will not connect through to the **THRU***n* ports. Therefore, LAN testing from the **THRU***n* interface can only be performed while the Layer 2 subsystem is inactive. Typically, LLDP emulation can be discontinued, thereby enabling use of the **THRU***n* interface, *after* a power negotiation with a PSE is completed.

The LAN pass-thru channel is not optimized for LAN transmission per applicable IEEE 802.3 and ANSI/EIA/TIA standards. Users should expect that the PSA test port will add a very small degree of electrical impairment to transmitted LAN signals, especially above 1000Base-T (e.g. 5GBase-T and 10GBase-T). This impairment should not materially impact packet loss or other measurements*****.

Also, because many LAN terminations include various methods of EMI suppression (e.g. "Bob Smith termination"), Sifos recommends that the **THRU***n* port **not** be connected to a LAN analyzer or other Ethernet device when running precision PoE signaling measurements including the **PSE Conformance Test Suite** available for PSA-3000 platforms since these can terminations can present subtle and unpredictable AC loads and impedance paths that will negatively affect those PoE measurements.

***** **Note:** Sifos Technologies offers an efficient and practical alternative to packet transmission measurements when evaluating impact of PoE loading on Ethernet Magnetics. Explore the **PhyView Analyzer** and the **PHY Performance Test Suite,** including automated **DC Unbalance Tolerance Testing,** at **www.sifos.com.**

3.2. System Software Overview

PowerSync Analyzers require externally hosted software in order to operate. PSA software is primarily designed for the Microsoft Windows operating environment. A version is also available for Linux and Unix based hosts. PSA software consists of several distinct subsystems:

PSA Interactive: A graphical user interface designed to promote interactive use of the PSA-3000 or PSL-3000 instrument. *See section 3.2.1 below*.

PowerShell PSA: A scripting and application program development environment for creating and executing automated test sequences. The PowerShell script development environment is built upon the Tcl/Tk scripting language. *See section 3.2.2 below*.

2-Pair PSE Conformance Test Suite: A series of applications developed specifically for conformance testing 2-Pair PSE ports to the 802.3at/802.3bt PoE specification.

4-Pair PSE Conformance Test Suite: A series of applications developed specifically for conformance testing 4-Pair PSE ports to the 802.3bt PoE specification.

PSE Multi-Port Test Suite: A series of applications developed specifically for system performance testing PSE power management, capacity, and multi-port decision behaviors in 2-Pair, 802.3at PSE's.

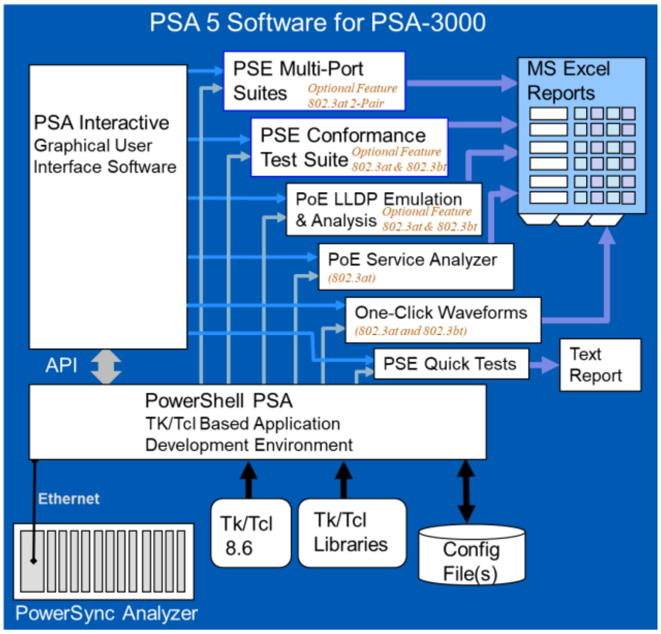


Figure 3.8 PSA Host Software Architecture

One-Click Waveforms: Integrated functions accessible to PowerShell PSA and PSA Interactive that stimulate and capture a wide range of PSE behaviors given flexible emulation of 802.3at and 802.3bt PD's. These functions are accessed from a single PowerShell PSA command or from a button click in PSA Interactive.

PoE Service Analyzer: A set of applications and tools for in-depth analysis of **802.3at** PoE Service characteristics at the PD interface available for the PSA-3000 platform.

PoE LLDP Emulation & Analysis: A set of applications and tools that enable PoE LLDP level communications with an LLDP-capable PSE (or PD) and analyze PSE LLDP conformance to 802.3 and 802.1 protocol rules including extensions for the 802.3bt standard.

PowerShell PSA includes a robust set of commands added into Tcl/Tk that create the Application Programming Interface (API) for the PowerSync Analyzer family of instruments. Both **PSA Interactive** and each of the **test suites** fully utilize the PowerShell API to control and monitor the PSA. This assures complete uniformity of behaviors when the instrument is configured from either the PowerShell interface or from PSA Interactive.

3.2.1. PSA Interactive

PSA Interactive is a Tcl/Tk based graphical user interface (GUI) constructed on top of the PowerShell PSA API. It offers robust control of most PowerSync Analyzer functions. It is intended for users who intermittently or regularly use the PowerSync Analyzer for PD emulation (*including LLDP*) and PSE measurements as well as for PSE Conformance (PSA-3000) and PSE Multi-Port (PSA-3000 and PSL-3000) testing. PSA Interactive works interchangeably with current generation PSA-3202/PSL-3202 hardware and older generation PSA-3102/PSL-3102 hardware. PSA Interactive seamlessly manages testing resources as required to address both 2-Pair (e.g. 802.3at) and 4-Pair (e.g. 802.3bt) PSE's.

3.2.2. PowerShell PSA Scripting Environment

PowerShell PSA provides command level access to the PowerSync Analyzer. It consists of the full Tcl/Tk programming shells (Tcl and Wish) combined with numerous extensions specific to the PowerSync Analyzer. Tcl/Tk offers two shell programs for interactive command / query execution and scripting development. The "classic" Tcl shell is an interpretive development environment for Tcl command and script execution. In Windows, the Tcl shell is typically the Windows command shell with the full range of Tcl libraries (command set) packaged in. Many operating system (e.g. "MS DOS", Linux "Bash") commands also execute in this shell.

The Wish shell enables Tk extensions useful for graphical user interfaces, including PSA trace displays (*see Section 5.1.1*) As a shell program, Wish is more "Windows-like" in its support of a mouse controlled cursor as well as its cut-and-paste editing capabilities. It is "knowledgeable" of TCL and PowerShell PSA command syntax and uses colored fonts to distinguish them. Wish does impose certain limitations in the handling of "standard input" (interactive user prompting) however.

For the most part, PowerShell PSA commands and scripts run equivalently in either the Tcl or the Wish Shell, so users are generally free to use the shell that best suits their needs. When PSA software is installed, certain configuration files will be placed so that opening either PowerShell PSA program will automatically integrate all of PowerShell PSA's resources.

Test automation developers may want to integrate PowerShell API into pre-existing script environments to support test automation involving several instruments including DUT control interaction. Section 9 addresses PowerShell features designed to enable this possibility.

3.2.3. PSE Automated Test Suites

The **2-Pair** and **4-Pair PSE Conformance Test Suites** are optional licenses for the PSA-3000 (including PSA-3x02, PSA-3x48) consisting of many tests and associated utilities that run in PowerShell PSA and can be accessed and sequenced from either PowerShell PSA or from PSA Interactive. These tests are designed to assess 802.3at and 802.3bt (Type-, Type-2, Type-3, Type-4) compliance of one or more PSE ports. The test suites cover detection, classification, LLDP negotiation, power-up, power management, MPS, and power-down behaviors of PSE ports. The tests have been constructed to work as generally as possible given the wide range of signaling and other PSE characteristics described above in section 2. Each test returns between 1 and 10 specification parameters relating to the 802.3at PoE specification.

The **802.3at PSE Multi-Port Suite** (including **Multi-Port Live PD Emulation** and **PSE Multi-Port Test Suite**) is an optional feature of the PSA-3000 (including PSA-3x48) and PSL-3000 (including PSL-3x24) that enables powerful and flexible multi-port PD simulations and PSE system analyses across as many as 192 PSE ports. These analyses take advantage of the ability of PSA/PSL test instruments to concurrently emulate as many as 192 Type-1 and Type-2 PD's, including PoE LLDP interactions and negotiations. The 802.3at PSE Multi-Port Test Suite consists of a series of sequenced tests and powerful reporting to automatically characterize system-wide powering behaviors and policies of any 802.3at PSE.

The **PoE Service Analyzer** is the aimed at qualifying PoE service delivered to an **802.3at** PD at the PD interface point. It evaluates basic service capabilities, many interoperability parameters, and classification or power management behaviors of the PoE service. This feature is available on all PSA-3000, PSA-3x02, and PSA-3x48 platforms.

Each test suite includes a test sequencer and several report generation options including automatic production of Microsoft Excel spreadsheets that add test statistics, test limits, and pass/fail results on one or more cycles of testing.

3.2.4. PowerSync Analyzer Configuration Files

PowerSync Analyzer software utilizes two local configuration files that can be adapted for a number of characteristics that are specific to a user's setup and testing requirements. These files are located as follows:

Operating System	Config Directory Location
Windows XP	\Program Files\Sifos\PSA3000\Config\
Windows Vista, 7, 8, or 10	\Users\Public\Sifos\PSA3000\Config\
Linux & Unix	$HOME/Sifos/PSA3000/Config/

The **PSA Environment** local configuration file is a single file titled **psa_env.txt**. This file is found in the subdirectory **\env** (or **/env/** for Linux) beneath the above **Config** directory location and it specifies the following parameters:

Parameter Type	Parameter Values
Default_PSA_Address:	<current PSA IP address>
PSA_Addresses:	{<TCL List of known PSA IP addresses>}
Default_Test_Results_Path:	{<TCL string of default path location for all test result files>}
Excel_Path_Location:	{<TCL string of path to MS Excel>} | "**N/A**"
Emulation_Mode:	**ON** or **OFF**
I/O_Routing:	**psa**

Default_PSA_Address: The PSA chassis to initially be controlled by the PowerShell and PSA Interactive when those applications open up. This chassis will be automatically "inventoried" upon application initialization and initial PSA connection. The address will be updated in this file whenever Select Chassis is performed via PSA Interactive or when the psa command is executed in PowerShell assuming that the new address is valid and present.

PSA_Addresses: A (Tcl) list of "known" PSA Chassis addresses on the network. A Tcl list is enclosed in braces and uses spaces to separate different elements (e.g. IP addresses). This list will evolve as new chassis are connected and selected by either PSA Interactive or PowerShell.

Default_Test_Results_Path: Path to where test results from the sequencer will be stored. This has the default value of "c:/Program Files/Sifos/PSA3000/Results/<chassis IP Address>" when PSA software is initially installed. Note that PSE Attribute Files may override this default (see below).

Excel_Path_Location: Path where Microsoft Excel application is stored. This is formed during installation.

Emulation_Mode: A control that allows software operation in the absence of a PowerSync Analyzer instrument. It is also referred to as "Demo Mode". This control should be normally set to "OFF".

I/O_Routing: A control that should be normally set to "psa".

A second type of configuration file is the **PSE Attributes File** for specific PSEs. These files generally (though not necessarily) reside in the **Config** directory location described above. They must have **.txt** file extensions. There may be more than one PSE attributes file, for example there may be one PSE Attributes File for each type of PSE that a user plans to test. PSE Attribute Files are used to produce both hardware and software configurations when applied using [**File**] [**Load Config**] in PSA Interactive or the **psa_pse** command in PowerShell PSA.

The PSE Attributes file consists of the following settings:

Parameter Type	Parameter Values	Status
Default_PSE_Class:	**AT** or **BT**	Required
Default_PSE_MPS_Type:	**AC** or **DC**	Required
Default_ALT_Setting: *(2 Pair PSE)* Default_ALT_Setting: *(4 Pair PSE)*	**A** or **B** **4Pr**	Required
Default_POL_Setting: *(2-Pair PSE)* Default_POL_Setting: *(4-Pair PSE)*	**MDI** or **MDI-X** **MDI+MDI** or **MDI-X+MDI** or **MDI+MDI-X** or **MDI-X+MDI-X**	Required
PSE_4Pair_Type:	**NONE** or **NONE_ac** or **Type-3** or **Type-4** or **Type-3ac** or **Type-4ac**	Required
PSE_Min_4Pair_Class:	**NONE** or **1** or **2** or **3** or **4** or **5**	Required
PSE_High_Pwr_Grant:	**NONE** or **PHY** or **LLDP** or **PHY+LLDP**	Required
PSE_Test_Results_Path:	{<TCL string of path location for results files>}	Optional
PSE_Conf_Test_Report:	{<Non-standard Conformance Report template file>}	Optional
PSE_MP_Test_Report:	{<Non-standard Multi-Port Report template file>}	Optional

Default_PSE_Class: Specifies whether the PSE is designed to comply to 802.3at (**AT**) or 802.3bt (**BT**) standards. 802.3at PSE's power 2 pairs while 802.3bt PSE's can power 2 pairs or 4 pairs. Certain 4-Pair proprietary (non-802.3bt compliant) PSE's may be described as **BT** under PSA 5.0 and later software. This attribute must be manually declared for each PSE when using **Auto Discover** or **psa_auto_port** to determine PSE attributes.

Default_PSE_MPS_Type: Specifies whether PSE utilizes **AC** or **DC** MPS method to remove power from a PD. This setting can be altered by the "DC MPS" vs. "AC MPS" PSE Description controls in the PSA Interactive PSE Conformance Test menus and Multi-Port Test Menus. All 802.3bt PSE's are required to use **DC** MPS. This attribute will be automatically learned and configured by **Auto Discover** in PSA Interactive and by the **psa_auto_port** command in PowerShell PSA.

Default_ALT_Setting: Specifies how to initialize all test ports/blades within the PSA Instrument for ALT pair selection. **A** and **B** settings will disengage any 4-pair connections and set all test ports uniformly to Alt-A or Alt-B respectively. **4Pr** setting will engage 4-pair connections in all test blades, setting Port 1's to Alt-B and Port 2's to Alt-A. This parameter is used in the 802.3at PSE Conformance Test Suite limit processing. This attribute will be automatically learned and configured by **Auto Discover** in PSA Interactive and by the **psa_auto_port** command in PowerShell PSA.

Default_POL_Setting: Specifies how to initialize all ports/blades within the PSA Instrument for PoE polarity (MDI vs. MDI-X). PSE's with Default_ALT_Setting= **A** or **B** must be either **MDI** or **MDI-X**. PSE's with Default_ALT_Setting= **4Pr** must specify the polarity for Alt-A followed by the polarity for Alt-B, for example **MDI-X+MDI**. This attribute will be automatically learned and configured by **Auto Discover** in PSA Interactive and by the **psa_auto_port** command in PowerShell PSA.

PSE_4Pair_Type: Specifies the type of 802.3bt PSE or specifies **NONE** for 802.3at and **NONE** or **NONE_ac** for 2-Pair 802.3bt PSE's. All 4-Pair 802.3bt PSE's are specified as **Type-3** or **Type-3_ac** or **Type-4** or **Type-4_ac**. 802.3bt Type-3 PSE's that power only 2 pairs are referred to as **NONE** and their Default_ALT_Setting will indicate **A** or **B**. The **_ac** extension is a manual declaration of an 802.3bt PSE that supports autoclass capability. When the PSE_Class is specified as **BT**, the Type-3 vs Type-4 attribute will be automatically discovered and configured by **Auto Discover** in PSA Interactive and by the **psa_auto_port** command in PowerShell PSA. Any **_ac** extension must then be added either with manual file edit or by selecting **Autoclass** in the PSA Interactive **PSE** tab menu (*see Section 4.2*) and then saving the attribute file.

PSE_High_Pwr_Grant: Specifies the method used by a PSE to grant the maximum power the PSE is capable of to a PD that requests that amount of Power. A Type-1 (15.4W) PSE cannot grant high power and therefore has the setting **NONE**. A Type-2 PSE can grant 25.5W from either 2-event classification (**PHY** setting) or using PoE LLDP (**LLDP** setting). A Type-3 or Type-4 PSE can grant the maximum available power through classification events (**PHY** setting) or through LLDP (**LLDP** setting). A PSE that grants maximum available power through classification events (PHY) but also uses PoE LLDP for refined power management may be declared **PHY+LLDP**. This setting is used to make critical decisions in various automated test suites.

PSE_Min_4Pair_Class: This parameter specifies the lowest PD classification whereby a 4-pair capable (802.3bt Type-3 or Type-4) PSE will power using all four pairs. PSE's that power only with 2 pairs will have the value **NONE**. A PSE that always powers 4-pairs to all PD's will have the value **1** meaning the PSE powers Class 1 and above with 4-pairs. A PSE that powers 4-pairs to PD Class 5 and above will have the value **5**. This parameter will have application in automated 802.3bt PSE Conformance and Multi-Port testing.

The PSE_Min_4Pair_Class is normally irrelevant to the 2-Pair PSE Conformance Test Suite. However, it can serve a special purpose to permit the 2-Pair **class_lldp** test to run with a Type-1 (15W capable) PSE. To affect that, the PSE attribute file would need to be manually edited to indicate **LLDP** for this parameter while the PSE_High_Pwr_Grant method would be **NONE**.

PSE_Test_Results_Path: This parameter, if provided, will override the default test reporting path found in the **psa_env.txt** environment file and guide all test results and reports to the specified directory path that can be PSE type or model specific. It may be manually edited in a PSE Local Config File or can be specified in the PSA Interactive **PSE** tab menu**.** Sequencing commands such as **sequence**, **mp_sequence**, and **pva_sequence** can optionally further specify a sequence-specific reporting directory by placing a short extension on this setting (*see sections 5.18 and 5.23.4*).

PSE_Conf_Test_Report: Specifies a non-standard PSE Conformance Test template (spreadsheet) file for use by the PSE Conformance Test Suite running on a **PSA-3000** (or PSA-3x02, PSA-3x48). An example might be a re-named copy of **psa_report.xlsm** that has modified test limits for a particular PSE type. ***NOTE: This setting can only be changed by editing the configuration file directly – the setting is retained whenever a PSE Attributes File is "saved" by PSA Interactive or PowerShell.***

PSE_MP_Test_Report: Specifies a non-standard PSE Multi-Port Test template (spreadsheet) file. An example might be a re-named copy of **mp_report_30.xlsm** that has modified test limits for a particular PSE type. ***NOTE: This setting can only be changed by editing the configuration file directly – the setting is retained whenever a PSE Attributes File is "saved" by PSA Interactive or PowerShell.***

3.2.5. Directory and File Organization – Microsoft Windows

When PowerSync Analyzer software is installed to a Microsoft Windows® PC, files will be populated to particular directories as described in the following table.

Directory Path	Directory	Files
C: \Program Files\Sifos\PSA3000 **Note**: *On 64 Bit Windows,* C:\Program Files *will become* C:\Program Files (x86) **Note**: *International versions of Windows may choose a different name for* "Program Files"		PowerShell PSA Library *(as compiled script containers)* PowerShell Wish and PowerShell Tcl Binary Executables PSA Initialization Script PowerShell Wish and PowerShell Tcl resource files
	\documentation\	Various PSA reference documents
	\PSA Interactive\	PSA Interactive Library *(as compiled script containers)* Library sub-directories to support PSA Interactive functions (plotchart, tkprint1.1). Sub-directories to support PowerShell binary libraries (tbcload, etc.) PSA Interactive Binary Executable PSA Interactive resource file
	\PVA Interactive\	*(Used by PVA-3000 instruments only)*
Windows Vista, 7, 8, 10 or 11 C:\Users\Public\Sifos\PSA3000 **Windows XP** C: \Program Files\Sifos\PSA3000	\Config\	PSA (local) Configuration Files including \Config\env environment file sub-directory.
	\Results\	PSA Test Report Files Including spreadsheet report templates utilized by the PSA-3000 family of instruments**.** Chassis-specific subdirectories and user-specified directories under **\Results** will automatically be created as needed by PowerSync Analyzer software.
	\Emul\	Files only used when PSAsoftware is placed in "Demo Mode" (also called Emulation Mode).
	\Contrib\	Tcl scripts stored in this directory will automatically source into PowerShell. This directory includes various sample scripts at installation.

Version information concerning individual PowerSync Analyzer software libraries is available from PSA Interactive under the [**Help**] menu as well as from PowerShell PSA using the **psa_version** command.

3.2.6. Directory and File Organization – Linux and Unix

PSA Software installs into Linux and Unix in a manner that separates and organizes files into 3 categories:

Category	File Locations
Compiled Software and Libraries	/usr/local/Sifos/PSA3000
Configuration and User Data	$HOME/ Sifos/PSA3000
Shell Scripts (Program Launchers)	$HOME /bin

This organization allows various users in a shared computing or NFS type of environment to maintain local user information independent from other users and independent of the actual shared software modules and libraries.

Installation of PSA Software requires that the user have full permissions to add the application into the **/usr/local/** directory path while the installation takes place. After installation, those permissions may be removed.

The following table provides greater detail regarding files and file locations after PSA software is installed.

Directory Path	Directory	Files
/usr/local/Sifos/PSA3000		PowerShell PSA Application Programs & Script Libraries *(as compiled script containers)* PowerShell Wish and PowerShell Tcl resource files (*copies*)
	/PSA Interactive/	PSA Interactive Library *(as compiled script containers)* Library sub-directories to support PSA Interactive functions (plotchart, tkprint1.1). Sub-directories to support PowerShell binary libraries (tbcload, etc.) PSA Interactive Binary Executable PSA Interactive resource file *(copy)*
$HOME/Sifos/PSA3000		PowerShell Wish and PowerShell Tcl resource files (*used by shell scripts to initialize PSA software*)
	/Config/	PSE (local) Configuration Files including **/Config/env** environment file sub-directory.
	/Results/	PSA Test Report Files Including spreadsheet report templates utilized by the PSA-3000 family of instruments**.** Chassis-specific subdirectories and user-specified directories under **\Results** will automatically be created as needed by PowerSync Analyzer software.
	/documentation/	Various PSA reference documents
	/Emul/	Files only used when PSA software is placed in “Demo Mode” (also called Emulation Mode).
	/Contrib/	Tcl scripts stored in this directory will automatically source into PowerShell. This directory includes various sample scripts at installation.
$HOME/bin		Shell scripts to launch: PowerShell Tcl (**PowerShell_Tcl.sh**), PowerShell Wish (**PowerShell_Wish.sh**) PSA Interactive PL (**PSA_Interactive.sh**). PSA Software Installer and Removal Scripts.

Version information concerning individual PowerSync Analyzer software libraries is available from PSA Interactive under the **Help** menu as well as from PowerShell PSA using the **psa_version** command.

3.2.7. Tcl/Tk Requirements & Resources

PowerSync Analyzer software was developed utilizing Tcl/Tk version 8.4.5. Generally, there should not be a problem with using newer versions of Tcl/Tk. PSA software is distributed with an installer for Tcl/Tk 8.4.20 on Microsoft Windows platforms. If Tcl/Tk is not present on the host PC system or if a version older than 8.4.5 is found, PSA installation software will install version 8.4.20 Tcl. If a newer version (e.g. ActiveState Tcl 8.4.9) is already on the host system, PSA software will utilize that version, though it should be noted that PowerShell PSA has not been validated with versions of Tcl more recent than 8.4.20. (**Note**: This does not apply to Linux systems where the user is responsible for pre-installing a satisfactory version of Tcl/Tk.)

While there are no requirements as to where the user installs Tcl/Tk, it is recommended that the install be done in the **c:\Program Files\Tcl** directory on Microsoft 32-bit Windows, **c:\Program Files (x86)\Tcl** on Microsoft 64-bit Windows, and in **/usr/local/** on Linux systems. Users should be aware that older or specially modified versions of Tcl present from installations of various LAN analyzer software tools and applications could interfere with PSA software behavior. Ideally, older versions of Tcl should be removed if possible.

PowerShell PSA software includes four “resource” files: **tclshrc.tcl**, **tclshrc_psapi.tcl**, **wishrc.tcl** and **wishrc_psapi.tcl**. These files are utilized by PowerShell during initialization and should remain in the directories where they are initially installed. Sections 9.3 and 9.4 of this manual provide further information regarding PowerShell API integration into native TCL shells as well as the use of these files to enable remote access to PowerShell.

There are a number of valuable resources to help programmers and test engineers get acquainted with Tcl. First, the **help software** that comes with Tcl/Tk is very robust and easy to work with. Also, there are several books available including “Practical Programming in Tcl and Tk” by Brent B. Welch. On the Web, there are numerous “notes” sites with correspondence on Tcl and Tk programming owing to Tcl’s popularity in academic and commercial enterprises.

3.3. Network Latency, Host Software, and Host Firewall Considerations

Certain aspects of the PowerSync Analyzer and its host-based software (PowerShell PSA, PSA Interactive) rely on a **low latency network connection** and **uninterrupted run-time execution** in a host computer. Applications such as the PSE Conformance Test Suite, the PSE Multi-Port Test Suite, and LLDP Protocol Trace Analysis can be impacted in subtle but detrimental ways given very long (and typically very intermittent) network connection latencies or process preemption delays. Network connection latency between the application host and the PSA should be minimized and should **never exceed 15 msec** with a target range of **0 to 5 msec desirable**. The same applies to process preemption delays. This will best enable the full flexibility and features of the PowerSync Analyzer across all testing applications.

Statistical assessment of network connection latency and run-time execution integrity is readily available using the **psa_latency_test** utility. (*See section 5.7 for further information on the* **psa_latency_test** *utility.*) Typical causes of excessive connection latency include congested network paths between host and instrument, network paths with wireless links, use of VLAN connections, and host software (or malware) that seeks exclusive use of computer resources. Host computers running PSA software should *never* be configured to run multiple "virtual" PC's nor should they concurrently run resource consuming file and web server processes alongside of PSA automated test software.

The PSA uses a Telnet protocol so any host firewall or router path between the host computer and the PSA *must enable* Telnet protocol (standard TCP port #23). Since the PSA uses a low level binary communication within the Telnet protocol, users should **never** attempt to configure or control the PSA with a Telnet session. The ***only*** command line interface to the PSA-3000 is PowerShell PSA.

3.4. Special PSA-3248, PSA-3048 Configuration Requirements

Important! *Beginning with the PSA 5.2.05 software release, this section is no longer applicable. Individual chassis' making up a PSA-3x48 RackPack are handled no differently than two independent PSA-3000 instruments.*

The multi-chassis (RackPack) PSA-3x48 (either PSA-3248 or PSA-3048) adds several unique configuration requirements that must be met in order for the instrument to operate properly under control of PSA software.

1. There must be two or more chassis' making up a PSA-3x48 available and operating on the ***same subnet*** in order for interaction with one chassis to be successful.
2. Each of the two or more PSA-3x48 chassis' must each contain 12 dual-PSE test blades for a total test port capacity of 24 ports per chassis.
3. PowerSync Analyzer software must initially "discover" the PSA-3x48 configuration. This one-time operation occurs after initial installation of PowerSync Analyzer host software and consists of the user being prompted by PowerShell TCL for the IP addresses of PSA-3x48 chassis'.

If the different chassis' associated with the PSA-3x48 are separated to different users on different networks, attempts to link to each individual chassis as a stand-alone element on the subnet will be rejected. This may occur on regular basis or an intermittent basis depending upon the conditions preceding chassis separation. This behavior is quite intentional since the PSA-3x48 is designed to function as a single instrument entity.

For new PSA-3x48 installations, the user is advised to execute the following initialization procedure:

1. Install PSA Software (Version 5.0 or newer)
2. Utilize the Serial Console interface to establish IP addresses for each PSA-3x48 chassis
3. Connect all PSA-3x48 chassis' to the host subnet and power them on
4. Open **PowerShell PSA TCL** from the host
5. Execute "psa <IpAddress>" to one of the PSA-3x48 chassis'
6. Execute "psa <IpAddress> to second PSA-3x48 chassis when prompted

This will complete the initialization of the PSA-3x048.

3.5. PSA-3000 Technical Specifications

3.5.1. LAN Interface Specifications

Operating Mode	Signal Path	Parameter	Specification
Data Through Mode	PSE-# to OUT-#	Connections	RJ45
		Data Rates and Signaling	10/100/1000BaseT/2.5GBaseT *5GBase-T, 10GBase-T with minor impairment*
		Latency	None - Passively Coupled
		Impedance	100Ω, Balanced
		Pair-Pair Isolation	≥ 36dB @ 100MHz
		Insertion Loss	≤ 2dB, 0.1MHz to 100 MHz
		Insertion Loss Variation	≤ 0.75dB, 0.1MHz to 100 MHz
		Return Loss (OUT pairs terminated into 100Ω)	≤ -24dB, 1MHz to 100MHz
Data Connect (LLDP Emulation) Mode	PSE-# to Blade Transceiver	Connection	RJ45
		Data Rate and Signaling	10/100Base-T
		Orientation	MDI End Point
		Protocol	802.1ab, 802.3bc, 802.3at
		Impedance	100Ω, Balanced
		Return Loss	≤-20dB, 1MHz to 100MHz

3.5.2. PoE Port Connections

Operating Mode	Dependency	Parameter	Selections
2-Pair Power	Port 1 and Port 2 operate independently	Powered Pair	ALT-A or ALT-B
		Polarity	MDI or MDI-X
4-Pair Power: ***PSA-3202***	Connect to Port 1 (Port 2 disabled) or Connect to Port 2 (Port 1 disabled)	ALT-A Polarity (Port 2)	MDI or MDI-X
		ALT-B Polarity (Port 1)	MDI or MDI-X
		Detection Signature Type	Single (Port 1) or Dual (Port 1 and Port 2)
4-Pair Power: ***PSA-3102***	Connect to Port 2 (Port 1 disabled)	ALT-A Polarity (Port 2)	MDI or MDI-X
		ALT-B Polarity (Port 1)	MDI or MDI-X
		Detection Signature Type	Dual (Port 1 and Port 2)
All	Any Conductor referenced to Any Other Conductor	Maximum Input Voltage	±60 VDC
	Any Conductor referenced RJ-45 Shield	Maximum Input Voltage	±60 VDC

3.5.3. Detection and AC MPS Specifications

Description	Conditions	Parameter	Specification
Detection Resistance	Vport = 2.5VDC - 12VDC, Port Connected, Transition Current Load = 0	Range	9 KΩ to 39 KΩ
		Resolution	1 KΩ
		Accuracy vs Setting $\Delta V / \Delta I$ at 4.5 Volt Spacing	±1.75% + 300Ω
Detection Capacitance	Vport = 2.5VDC - 12VDC, Port Connected, Transition Current Load = 0	Range	0.14, 5, 7, 11μF
		Accuracy	±15%
Detection Signature Cut-Off Threshold	Port Connected	Vport	12V ± 2%
AC MPS Signature	Vport = 12VDC - 60VDC, Port Connected	AC Impedance	24KΩ || (0.1μF + 330Ω)
		Resistance Accuracy $\Delta V / \Delta I$ at 2 Volt Spacing	22.8KΩ ± 250Ω
	Port Isolated	AC Impedance (≤ 500 Hz) AC Impedance (≤ 120 Hz)	≥ 1.1 MΩ ≥ 3.0 MΩ

3.5.4. Current Load Specifications

Description	Conditions	Parameter	Specification
Load Current	Per Powered (*or classifying*) Pair	Range	PSA-3202: 0 to 950 mA PSA-3102: 0 to 750 mA
		Resolution	0.25 mA
		Accuracy	± (0.5% setting + 0.25mA)
		Slew Rates	> 4mA / µsec
		Activation Voltage	15V, Rising Vport
		De-Activation Voltage	14V, Falling Vport
Transition (Mark Region) Current	Load Current Active, Per Powered Pair	Range	0 to 400 mA
		Resolution	0.25 mA
		Accuracy	± (1.0% setting + 0.5mA)
		Slew Rates	> 4mA / µsec
		Activation Voltage	14V, Falling Vport
		De-Activation Voltage	PSA-3202: 4.5V, Falling Vport PSA-3102: 6V, Falling Vport
Multi-Event Classification ***PSA-3202 Only***	Multi-Event Activated	802.3bt Signatures Emulated	Single Signature Class 5 - 8 Dual Signature Class 1 - 5
		Non-Standard Signatures	Class Current per Event
		802.3bt Auto-Class	2mA @ 80msec of LCE1
		Multi-Event Activation	**psa_connect** or **mclass**
		Multi-Event Deactivation	**psa_disconnect** or **mclass**
		Multi-Event Timeout	100 msec @ > 15V
		Event Start Glitch Debounce	150µsec
		Mark and Idle Transition Glitch Debounce	500µsec
		Event Reset Condition	4.5V for > 500µsec
Configurable Load Transient	Vport > 15VDC	Sequential Load Steps	2
		Transient Sequence Repeats	0 to 4
		Load Step 1 Range	0 to 1800 mA
		Load Step 2 Range	PSA-3202: 0 to 950 mA PSA-3102: 0 to 750 mA
		Resolution (0 – 950 mA) Resolution (> 950 mA)	0.25 mA 0.50 mA
		Accuracy (0 – 25 mA) Accuracy (> 25 mA)	± (2% setting + 0.5mA) ± (1% setting + 1mA)
		Slew Rate	< 10mA / µsec
		Step 1 Duration ≤ 950 mA	200 µsec to 1 sec
		Step 1 Duration > 950 mA	200 µsec to 80 msec
		Step 2 Duration Load Step 1 ≤ 950 mA Load Step 1 > 950 mA	 200 µsec to 1 sec (or persist) 1 sec
		Step Resolution	100 µs
		Trigger Modes: ≤ 950 mA > 950 mA	Immediate, Edge, Event Immediate
		Active Load Resistance	37 Ω
		Foldback Suppression Min. Port Voltage (@ 400mA)	30 VDC
		Foldback Suppression Duration	Step 1 + Step 2 Duration

3.5.5. DC Metering Specifications

Description	Conditions	Parameter	Specification
Voltage Meter	Average, Max-Peak, Min-Peak, Scope Trace	Voltage Range	0 - 60V
		Aperture or Trace Length	256 Samples (10ms, 20ms, 50ms…10s)
		Extended Trace Length[3]	1024 Samples (200ms, 2s, 4s, 8s, 20s)
		Sample Rates	39.1 µsec - 39.1 msec (1,2,5 steps)
		Resolution	16 mV
		Displayed Resolution	Avg & Peak: 2 decimal places O-scope Traces: 25 mV
		Accuracy[1]	> 30VDC: ± (1.5% reading + 16mV) < 30VDC: ± (2.0% reading + 16 mV)
		Measurement Triggers	Immediate, Edge, Event, Power-Up (*traces only*)
Current Meter	Average, Max-Peak, Min-Peak, Scope Trace	Current Range	0 – 2000 mA
		Aperture or Trace Length	256 Samples (10ms, 20ms, 50ms…10s)
		Extended Trace Length[3]	1024 Samples (200ms, 2s, 4s, 8s, 20s)
		Sample Rates	39.1 µsec - 39.1 msec (1,2,5 steps)
		Resolution (0– 1023 mA)	0.25mA
		Resolution (1024–2000 mA)	0.5mA
		Accuracy[2]	± (0.5% reading + 0.5mA)
		Triggers	Immediate, Edge, Event, Power-Up (*traces only*)

1. Does not include Voltage drop due to cable losses and 0.45Ω maximum test port input resistance.
2. Does not include MPS current present in Port Switch Connected state that adds approximately (Vport - 12V)/24kΩ.
3. Scope Traces only - require PSA controller firmware 3.10 or newer and test port firmware 3.14 or newer.

3.5.6. AC Metering Specifications

Description	Conditions	Parameter	Specification
AC Peak-Peak Meter	Low Band, VDC= 40-57V	Accuracy, 25Hz – 325Hz Accuracy, 50Hz – 300Hz	-15%, +11% -7.5%, +11%
	High Band, VDC= 40-57V	Accuracy, 2.5KHz – 250KHz Accuracy, 20KHz – 250KHz	-15%, +7% -6%, +7%
	Full Band, VDC= 40-57V	Accuracy, 50Hz – 250KHz	-7.5%, +8.5%
	All Bands, VDC= 40-57V	Resolution	1mV
		Range	2Vp-p
		Input Impedance	0.05µF[1]

1. Input impedance models the lowest possible PD input capacitance – measurements are therefore affected by the effective source impedance of the PSE, including any frequency specific variations in that source impedance.

3.5.7. Triggering Specifications

Description	Conditions	Parameter	Specification
Edge & Event Triggers	All Modes	Range	0.25V - 59.5V
		Resolution	0.125 mV
		Accuracy (relative to DC Meter readings)	± 0.0625 mV
		Trig1 to Meter or Transient Latency	~ 50 µsecs
		Event Trigger Latency	< 500 µsecs
	Trigger Noise Immunity	Pre-Trigger Qualification Time (Voltage below Rising threshold or above Falling threshold)	1.5 msec
		Normal Mode Edge Noise Rejection	125 mV
		Noisy Mode Edge Noise Rejection	500 mV

3.5.8. Time Interval Metering Specifications

Description	Conditions	Parameter	Specification
Time Interval Meter	Microsecond scale	Time Range	4 – 26200 µs
		Time Resolution	1 µsec
		Time Accuracy	± 2 µsecs
		Min. Resolvable Time Interval	~ 4 µsecs
	Millisecond scale	Time Range	2-6550 msec
		Time Resolution	0.1 msec
		Time Accuracy	± 1 msec
		Min. Resolvable Time Interval	2 msec
	Second Scale	Time Range	0.1 – 16.1 sec
		Time Resolution	0.1 sec
		Time Accuracy	± 50 msec
		Min. Resolvable Time Interval	0.1 sec
	Triggering & Noise Immunity	Start Trigger	Edge or Event
		Stop Trigger	Edge
		Normal Mode Edge Noise Rejection	125 mV
		Noisy Mode Edge Noise Rejection	500 mV

3.5.9. Front Panel PSA-3202 LED Indicators

LED Label	Parameter	Description
LINK	LLDP Link Status & Activity	**GREEN**: Linked at 100Base-Tx for LLDP, Blink with Activity **AMBER**: Linked at 10Base-T for LLDP, Blink with Activity **OFF**: Unlinked (or Disconnected)
PD	PoE Power Status	**GREEN**: PSE powered with Vport > 36 VDC **AMBER**: Valid 802.3 Detection Signature Connected (No PSE Power) **OFF**: PSE not powered & PD signature not connected
4PR	Test Port Mode	**GREEN**: Test port configured for 4-Pair powering **AMBER**: Opposite test port configured for 4-Pair powering **OFF**: Test port configured for 2-Pair powering
COM	Communications	**ON**: Indicates active communications with test port

3.5.10. Front Panel PSA-3102 LED Indicators

LED Label	Parameter	Description
DET	Detection Signature & LLDP Link Status	**ON:** Valid 802.3 Detection Signature Connected Normally Off **BLINKING**: LLDP connected but NOT LINKED Normally On **BLINKING**: LLDP connected and LINKED **OFF**: Detection Signature & LLDP link removed
PWR	PSE Power On	**ON**: PSE powered with Vport > 36 VDC **OFF**: PSE not powered - Vport < 36 VDC
ARM	Trigger ARM	**ON:** Edge Trigger 1 in the ARMED State **OFF:** Edge Trigger 1 NOT in the ARMED State
AUX	Communications	**ON**: Indicates active communications to test port

3.5.11. Programming and Control

Description	Specification
Interface	Ethernet 10/100BaseT (*Telnet Port 23 protocols*) **NOTE**: *The **Console** interface is for IP Address config only.*
Host Requirements	PC running Microsoft Windows XP, Vista, 7, 8, 10, or Linux PC (Fedora, SUSE, Debian)
Host Software Environment	Sifos PowerShell PSA or PSA-Interactive
Recommended Network/Run-Time Latency:	< 5 msec (*See Section 3.3*)

3.5.12. Physical and Environmental

Description	Specification
Dimensions	19”W x 5.25”H x 12”L (3U Rack Mount)
Weight	20.4 lbs. (Fully Populated with PSA-3x02 Cards)
Power	100VAC-240VAC, 50-60 Hz, 1.35A Max.
Ambient Operating Temperature	0°C to 40°C (≤ 100 Watt combined loading per PSA-3202 or PSA-3102 blade or PSA-3402 compact PSA, and ≤ 75W combined loading per PSA-3002 Compact PSA)
Storage Temperature	-20°C to 85°C
Operating Humidity	5% to 95% RH, Non-Condensing.

3.5.13. Certifications

Description	North America	Europe & International
Safety	**CSA Listed** (CSA22.2 No. 61010)	EN61010-1 (Test & Measurement Equipment)
Emissions	FCC Part 15, Class A	EN55011 (Class A Radiated Emissions) EN61326-1 (Immunity) VCCI, AS/NZS 3548, ICES-001
European Commission		Low Voltage Directive (2014/35/EU) Electromagnetic Compatibility Directive (2014/30/EU) RoHS 2 Directive (2011/65/EU) **CE Marking** Directive (93/68/EEC)
	FCC Statement: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.	

4. PSA Interactive

PowerSync Interactive is the graphical user interface for PowerSync Analyzers and Programmable Loads. It is a Tcl/Tk application that is built from a number of Tcl/Tk scripts. It fully uses the PowerShell PSA API for all instrument interactions as well as a number of other library functions that are useful to PowerShell PSA scripts.

When PSA Interactive is opened, the user will be prompted to select a PSA chassis to which PSA Interactive will initially connect *(see **Figure 4.1**)*. The default selection will be the *most recently* connected PSA chassis. This brief dialog assures that various users on a common network sharing multiple PowerSync Analyzers can connect to an instrument without interference to other instruments that might be in use by other host computers. It also assures that any *selected* PSA to be utilized is powered up and connected to the local network. The **PSA Chassis Selection** dialog (see ***Figure 4.1***) verifies the presence of any selected or entered PSA address, inventories the selected PSA chassis for available test ports, and allows users to add any new instruments that may have been connected to the network.

Note: If the Chassis Selection dialog ***fails to find a connected and available PSA instrument***, it will ultimately open PSA Interactive in **Demo Mode**. **Important!** *Demo Mode operations are only partially supported by PSA software*.

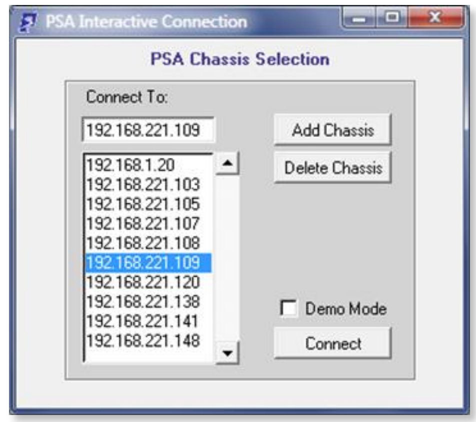


Figure 4.1 PSA Connection Dialog

4.1. The PSA Interactive Slot-Port Selection Panel

When PSA Interactive initially opens, two windows appear:

- The Tab Menu Window (*see **Figure 4.6***)
- The Slot-Port Selection Panel (*see **Figure 4.2***)

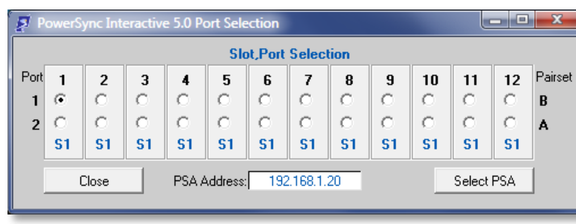


Figure 4.2 PSA Interactive Slot-Port Panel

The Slot-Port Selection panel is utilized in conjunction with many of the tab dialog menus to select a test port that will be configured or utilized for measurements of a PSE port. The panel always presents the maximum twelve possible PSA/PSL slots and disables all slots that are not populated with PSA-3000/PSL-3000 test blades.

The Slot-Port Selection panel indicates the instrument type (PSA or PSL) and the IP address of the presently connected test instrument. The **Select PSA** button is used to access the PSA Chassis Selection dialog introduced in **Figure 4.1**. This allows navigation to different PSA/PSL instruments. The **Close** button is used to quit PSA Interactive software and is generally activated at all times.

As described earlier in section 3.1, each test slot can be configured for 2-Pair or 4-Pair PSE interfacing. When in a 2-Pair configuration, the slot offers two fully independent test ports, 1 and 2, that may be connected to two PSE ports. When in a 4-Pair configuration, each test slot offers one test port that may be connected to one 4-Pair PSE port.

Pair State Key:

Mode	Connected Port	Hardware	PairState
2-Pair	1 & 2	PSx-3202	2Pr
2-Pair	1 & 2	PSx-3102	2Pr
4Pr Single	1	PSx-3202	S1
4Pr Single	2	PSx-3202	S2
4Pr Dual	1	PSx-3202	D1
4Pr Dual	2	PSx-3202	D2
4Pr Dual	2	PSx-3102	D2

Figure 4.3 Slot-Port Pair States

The **Pair State** of each PSA/PSL test slot is indicated underneath the Port 2 radio button in each test slot. This value tracks the true configuration of its corresponding test slot as test port configurations are performed and as PSE testing utilities are executed.

The Pair State informs of the hardware vintage (PSx-**3202** versus PSx-**3102**), and the pair configuration (2-Pair, 4-Pair Single Signature, or 4-Pair Dual Signature) according to **Figure 4.3**. PSx-3202 test slots support 4-Pair Single Signature and 4-Pair Dual Signature configurations on either test port 1 or 2. PSx-3102 test slots only support 4-Pair Dual Signature configurations on test port 2.

PSA Interactive software supports mixed configurations of PSx-**3202** and PSx-**3102** hardware (*see **Figure 4.4***). Also supported are **PSA**-3000 and **PSL**-3000 test instruments.

Important! Combinations of **PSA**-3x02 (PowerSync Analyzer) and **PSL**-3x02 (PowerSync Programmable Load) blades in the same PSA-3000 are not recommended.

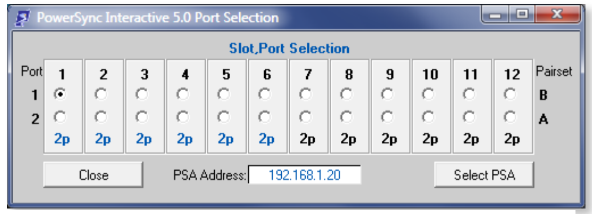


Figure 4.4 Hybrid Configuration PSA Instrument

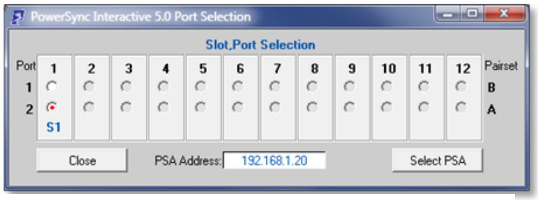


Figure 4.5 Selecting Disconnected 4-Pair Port

While PSx-**3102** test blades do support a 4-Pair Dual Signature connection on test port 2, they are *not* capable of working with most 4-Pair **802.3bt** PSE's. Only PSx-**3202** hardware (with **blue** Pair State notations) will support testing of 4-Pair 802.3bt PSE's.

The Slot-Port Panel provides an indication when a DISCONNECTED 4-pair port is selected. In **Figure 4.5**, test port 1,1 (slot 1, port 1) is configured to 4-pair Single Signature when test port 1,2 (slot 1, port 2) is selected. The radio button annotates this by turning red. Several of the tab menus to be addressed in the upcoming sections can then alter the state of slot 1 such that test port 1,2 becomes a connected 2-pair or 4-pair test port whereupon the radio button will return to black. Several other tab menus that have no ability to manipulate pair states in a test slot will become disabled when a disconnected 4-pair port is selected.

4.2. The PSE Tab Menu

Many of the testing and analysis functions available in PSA Interactive software depend on or benefit from knowing some basic facts about the PSE to be evaluated. With the introduction of the IEEE 802.3bt standard, PSE ports now appear in many "flavors" and the means by which those ports are evaluated is very dependent on these facts, or **PSE Attributes**. This is why the **PSE** tab menu is the first menu to appear when PSA Interactive opens (see ***Figure 4.6***).

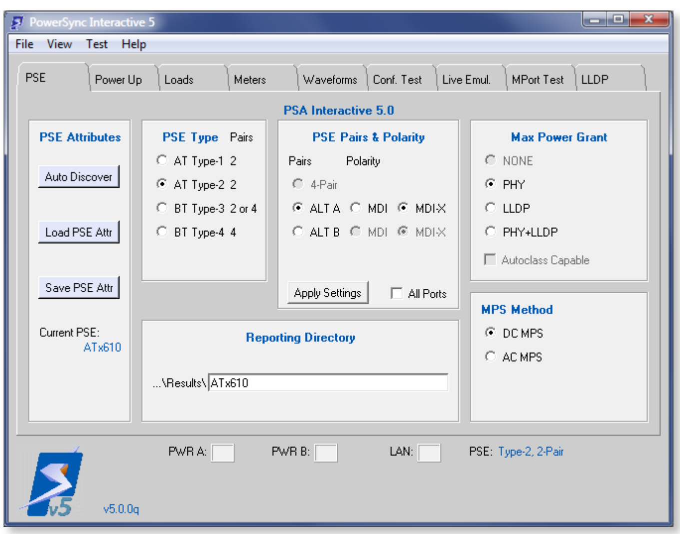


Figure 4.6 PSE Tab Menu

PSE attributes were introduced earlier in section 3.2.4. The PSE tab menu offers users the opportunity to manually describe PSE attributes or alternatively, to automatically discover these critical attributes. PSE attributes may be saved and retained, then later recalled so that users need only keep track of the PSE product (e.g. model number) that is to be tested.

Important! Two very significant PSE attributes, the PSE Type and powered pairs, are always displayed in blue on the bottom right of the tab menu window. Several of the tab menus configure capabilities based upon these attributes of the PSE to be analyzed.

4.2.1. Manually Describing the PSE Attributes

The PSE tab menu offers five categories of attribute description. First, the PSE Type is used to differentiate PSE's that are designed to the 802.3at (IEEE 802.3 clause 33) standard as opposed to PSE's designed to the 802.3bt (IEEE 802.3 clause 145) standard. The **AT Type-1** PSE is an 802.3at PSE designed to furnish up to 13 watts at the PD. The **AT Type-2** PSE is an 802.3at PSE designed to furnish up to 25.5 watts at the PD. The **BT Type-3** PSE is an 802.3bt PSE designed to operate either with two powered pairs or four powered pairs where it can furnish up to 51 watts at the PD. And the **BT Type-4** PSE is an 802.3bt PSE powering four pairs and furnishing up to 71.3 watts at the PD.

Important! Users *must* properly declare if the PSE is **AT** or **BT**, even if they have no other information about PSE attributes. Auto-Discovery (*see section 4.2.2*) can resolve all of the other attributes.

When the PSE Type is AT (Type-1 or Type-2), **4-Pair** powering is prohibited so the user declares if the PSE is powering using the **ALT A** or **ALT B** pairset (*see section 2.4*). Further, once the pairset is selected, the power polarity **MDI** (positive voltage) or **MDI-X** (negative voltage) for the associated pairset must be specified.

When the PSE Type is BT (Type-3 or Type-4), the **4-Pair** attribute can be used to specify a 4-pair powering PSE. The **BT Type-3** selection allows for 2-pair powering on **ALT A** or **ALT B** and for **4-Pair** powering on both pairsets. When **BT Type-4** is selected, then **4-Pair** powering is the only valid option and is automatically selected. When **4-Pair** is selected, then the polarity for *both* pairsets, **ALT A** and **ALT B**, must be specified as **MDI** or **MDI-X**.

Once **PSE Pairs and Polarity** selections are made, the **Apply Settings** button will configure the presently selected test port in the Slot-Port Panel for the specified PSE **Pairs & Polarity** attributes. The **Apply Settings** button will generally be aware of changes relative to present test port configuration and will annunciate that with a red **Apply Settings** button label. Once the settings are applied to the selected test port, the button will return to black lettering.

The **All Ports** selection will cause all test slots to configure identically using the selected PSE attributes when the **Apply Settings** button is pressed..

Another important PSE attribute for Type-2, Type-3, and Type-4 PSE's is the method by which the PSE allows more than Type-1 power, that is, more than 13 watts to a PD. This is established in the **Max Power Grant** menu frame. An **AT Type-1** PSE Type will force this selection to **NONE** because a Type-1 PSE is restricted to 13 watt PD powering.

AT Type-2 and **BT** PSE's must have some method for allowing higher powers than 13 watts, so when those selections are made, the **NONE** option is removed. The **PHY** selection indicates that the PSE exclusively utilizes PD classification to communicate the maximum power the PSE can provide to the PD (*see sections 2.7 and 2.8*). The **LLDP** selection indicates that the PSE uses exclusively LLDP to grant the maximum power the PSE is capable of to a PD (*see section 2.10*). Some PSE's may allow maximum available power to a PD through PD classification, but then use LLDP later to refine the PD power allocation to 0.1 watt granularity. This type of PSE would be **PHY+LLDP**.

The **MPS Method** describes the means by which a PSE recognizes that a PD has been disconnected. **DC MPS** indicates that the PSE uses the DC MPS method described in both the 802.3at and 802.3bt specifications and **AC MPS** indicates that the PSE uses the AC MPS method described in the 802.3at specification (*see section 2.13*). When the PSE Type is **BT Type-3** or **BT Type-4**, **DC MPS** is automatically selected as it is the only method allowed to 802.3bt PSE's.

The final PSE-specific attribute that can be provided is a **Reporting Directory** that might be unique to the PSE product that is to be tested. The standard or default reporting directory for all test reports is described in sections 3.2.5 and 3.2.6. Users can then extend this so that reports are automatically routed to a specific directory path for specific PSE's.

4.2.2. Auto-Discovery of PSE Attributes

PSA Interactive can automatically determine **PSE Pairs and Polarity**, **Max Power Grant** method, and where applicable, **MPS Method**. It can also automatically determine if a BT PSE is **Type-3** or **Type-4**.

To begin this process the user must first select the PSE Type as either **AT** or **BT**, then press the **Auto Discover** button to open the Auto Discover Dialog menu (*see* ***Figure 4.7***).

Important! **Auto-Discover** cannot determine that a PSE is 802.3at or 802.3bt compliant. A user must provide this one input.

The Auto Discover Dialog shows the selected PSE Type to be **AT** or **BT**. Assuming is the correct selection, the **Start** button will initiate the process. The port evaluated will be the port presently selected in the Slot-Port Panel.

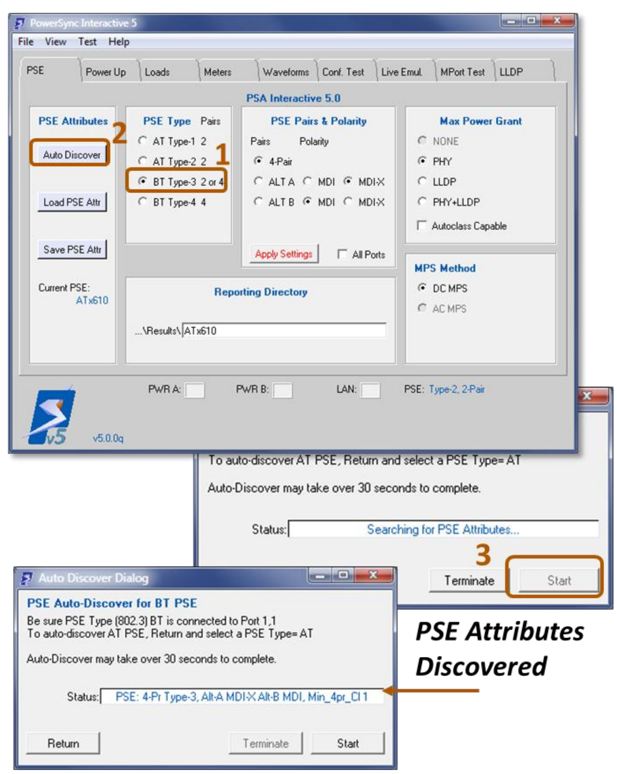


Figure 4.7 PSE Attributes Auto-Discovery

The auto-discovery process takes between15 seconds and 60 seconds to resolve PSE attributes where 802.3bt PSE's generally require more time. When completed, the PSE attributes will be shown in the Status box and all of the slots and test ports in the PSA instrument will be configured according to the powered pairset(s) (2-pair or 4-pair), and the proper polarity (MDI or MDI-X per pairset). Pressing the **Terminate** button will abort an auto-discovery immediately.

The MPS Method will be properly selected and in certain cases, so will the Max Power Grant method. If the PSE Type specified was BT Type-4 and the PSE is discovered to limit power at 51 watts, then the PSE Type will be re-selected to Type-3. Conversely, if Type-3 is selected but the PSE is actually Type-4, that too will cause a re-selection.

Pressing the **Return** button closes the Auto Discover Dialog and re-activates the tab menu window.

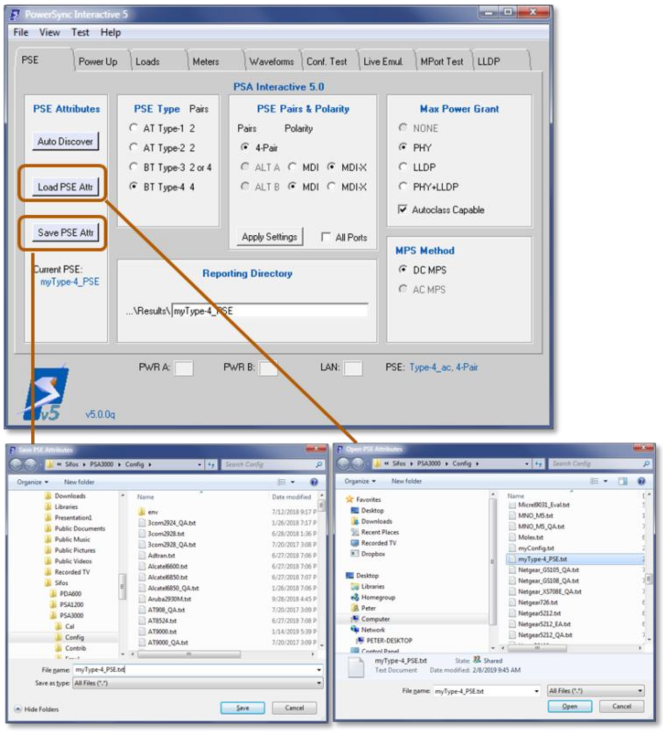


Figure 4.8 Saving and Loading PSE Attributes

4.2.3. Saving and Loading PSE Attributes

PSE Attributes, once entered and/or discovered, can be stored for retrieval at any later time. The PSE Attributes file contains the information described in section 3.2.4.

The **Save PSE Attr** button (*see **Figure 4.8***) opens a file navigation dialog offering ability to specify the location and name of the PSE Attributes file. The directory location should generally not be altered and will default to the location described in sections 3.2.5 and 3.2.6. The file name should be unique to the PSE such as the PSE model number.

The **Load PSE Attr** button (*see **Figure 4.8***) will then allow a user to navigate to and select the PSE Attribute file pertaining to the PSE to be tested.

Important! When the PSE Attribute file is loaded, the PSE tab menu is updated to the PSE attributes and all of the slots and ports in the presently connected instrument are automatically updated to the pair configuration and polarity settings that go with the selected PSE.

4.3. The Power-Up Tab Menu

The Power-Up tab menu (*see **Figure 4.9***) provides the ability to rapidly define a PD that will be emulated, then to connect that PD to the presently selected test port. There are generally four key characteristics involved in emulating any PD:

1. PD Type
2. PD Classification
3. Power Load (after power-up)
4. LLDP Usage and Power Request

4.3.1. Selecting the PD Type and Class

The tab menu supports four PD Types. **Type-1/2/3** would apply to all PD's that can be successfully powered and operated from a 2-pair PSE, that is, from a Type-1 or Type-2 PSE, or from a Type-3 2-pair PSE. A Type-1/2/3 PSE would therefore need to be one of **Class 0**, **Class 1**, **Class 2**, **Class 3**, or **Class 4** because the maximum power a PD can draw from a 2-pair PSE is 25.5 watts (*see section 2.7*). **Figure 4.10** shows the **PD Class** options presented when **Type-1/2/3** is the selected PD type.

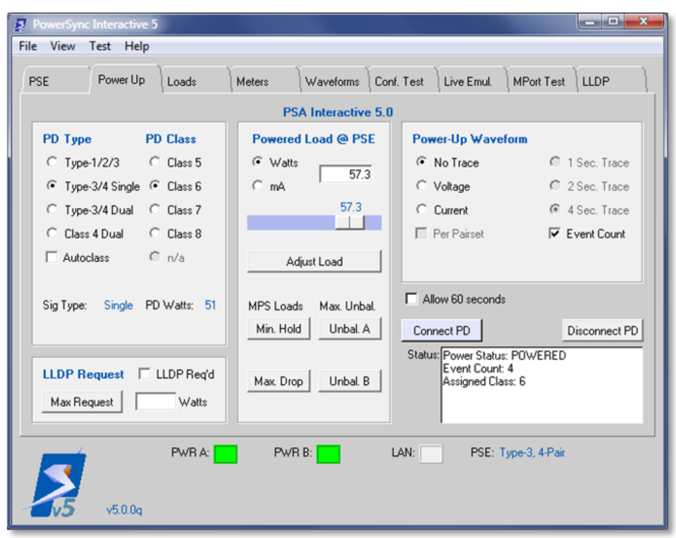


Figure 4.9 The Power-Up Tab Menu: Class 6 PD Emulation

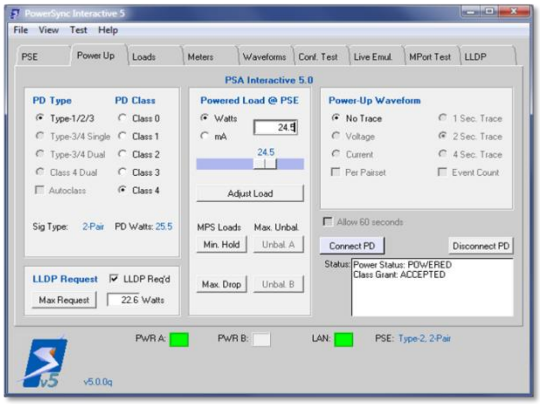


Figure 4.10 2-Pair Power-Up of Class 4 PSE

Type-3/4 Single refers to **802.3bt** PD's that require 4-pair powering, that is, they draw more than 25.5 watts, and they present a single signature (*see section 2.3*) to the PSE during detection. As seen in **Figure 4.9**, there are four possible PD classifications: **Class 5**, **Class 6**, **Class 7**, and **Class 8**. These were described earlier in section 2.8.

Type-3/4 Dual refers to **802.3bt** PD's that require 4-pair powering because they need to power each pairset individually much as if they act like two separate PD's. While the 802.3bt standard supports many possible combinations of Dual Signature classifications per pairset, the Power-Up tab menu offers five possible emulated PD's where the classification on both pairsets, Alt-A and Alt-B, are identical (*see **Figure 4.11***). The available PD classifications are **Class 1D** (PD Class 1 on both pairsets), **Class 2D** (PD Class 2 on both pairsets), **Class 3D** (PD Class 3 on both pairsets), **Class 4D** (PD Class 4 on both pairsets), and **Class 5D** (PD Class 5 on both pairsets). These are all further explained in section 2.8. PD emulations involving dissimilar classifications per pairset can be accomplished in PowerShell PSA using the **power_bt** command (*see section 5.11*).

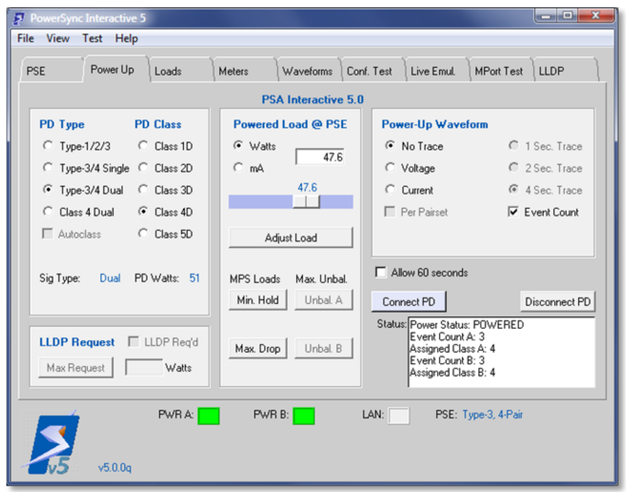


Figure 4.11 Power-Up of 802.3bt Dual (Class 4) Signature PD

The final PD Type is **Class 4 Dual** (*see **Figure 4.12***). This represents a pre-802.3bt (or "proprietary" PD that requires 4-pair powering because it draws more than 25.5 watts. The PD emulation consists of a dual signature PD but unlike 802.3bt PD's, the Class 4 Dual does not alter its class signature between the second and third event of classification as all 802.3bt dual signature PD's must do. Instead, it presents only a Class 4 signature regardless of how many classification events are present. Hence, as seen in **Figure 4.12**, the only PD Class choice is **Class 4**.

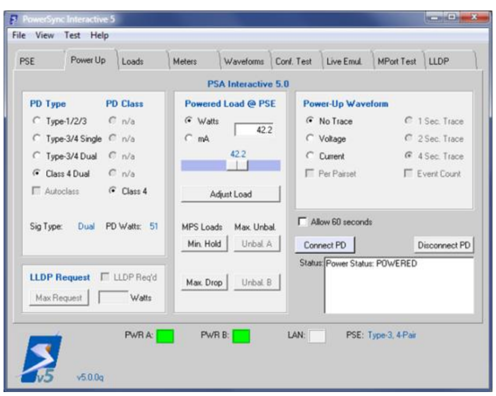


Figure 4.12 Power-Up of Pre-Standard 4-Pair PD

Certain conditions govern which **PD Types** are available at any given time as explained in the following table.

PSE: (in Main menu)	Test Port Hardware	Available PD Types	Expected PSE Powering
Type-1 2-Pair or **Type-2 2-Pair**	Any PSA-3000, PSL-3000, PSA-3402, PSA-3002	**Type-1/2/3**	2-Pairs only
Type-3 4-Pair or **Type-4 4-Pair**	PSA-3202, PSL-3202, PSA-3402 test port	**Type-1/2/3**	4-Pairs or 2-Pairs
		Type-3/4 Single	4-Pairs
		Type-3/4 Dual	4-Pairs
		Class 4 Dual	4-Pairs
	PSA-3102, PSL-3102, PSA-3002 test port #2	**Class 4 Dual**	4-Pairs
	PSA-3102, PSL-3102, PSA-3002 test port #1	NONE	N/A

4.3.2. Connecting and Disconnecting the Emulated PD

In the Power-Up tab menu, emulated PD connections are achieved by pressing the **Connect PD** button. If and when the PSE powers the emulated PD, the tab menu window indicators **PWR A** and **PWR B** will turn on (green) depending on the pairsets powered, Alt-A and Alt-B respectively (*see **Figures 4.10** and **4.11***). The Status window will then indicate the powering status, namely “POWERED” or “DOWN” (unpowered). With 4-pair PD emulations, that is **Type-3/4 Single**, **Type-3/4 Dual**, and **Class 4 Dual**, the powering status could also indicate 2-pair powering with “PWRD A” or “PWRD B”.

When emulating 802.3bt **Type-3/4 Single** and **Type-3/4 Dual** PD’s, the option exists to report both the **Event Count** observed during power-up and the resulting **Assigned Classification** provided by the PSE. **Figures 4.9** and **4.11** show this outcome for both the single signature and dual signature PD emulations.

Pressing the **Disconnect PD** button then emulates a PD disconnect that should cause the PSE to remove power. With that, the tab menu window indicators **PWR A** and **PWR B** should turn off.

4.3.3. Emulated LLDP Power-Ups and Negotiations

The Power-Up tab menu supports emulated LLDP power-ups for both 802.3at (2-pair) and 802.3bt (4-pair) PD’s. This feature requires that the PSA-3000 instrument be licensed for **LLDP Emulation and Analysis Feature**. **Figure 4.13** describes an emulated Class 4 LLDP power-up with a Type-2 PSE that uses PoE LLDP to grant power levels above 13 watts to the PD. In this example, the PSE is Type-2, 2-Pair and the PD is described as a **Class 4** PD that will request a refined power draw of up to 22.6 watts. The **LLDP Req’d** check button is used to control the PD emulation so that the PD will not draw more than Type-1 power (13 watts) until the LLDP negotiation is completed. The requested power level is then entered with granularity of 0.1 watts.

The **Max Request** button will automatically enter the maximum power request allowed given the present **PD Class** selection. For example, if **Class 4** is selected, the **Max Request** button would insert a power request of 25.5 watts.

When emulating 802.3at PD’s powered from Type-2 PSE’s, the 802.3at PoE protocol will be utilized. When emulating 802.3bt single or dual signature PD’s that require 4-pair powering, the 802.3bt extended PoE LLDP protocol will automatically be deployed. The emulated PD will form an initial power request based on the assigned PD class at power-up, and will then, depending on PSE capabilities communicated via LLDP, transmit the requested power level to seek authorization from the PSE to draw that power. See sections 2.10 and 8 for further information regarding PoE LLDP.

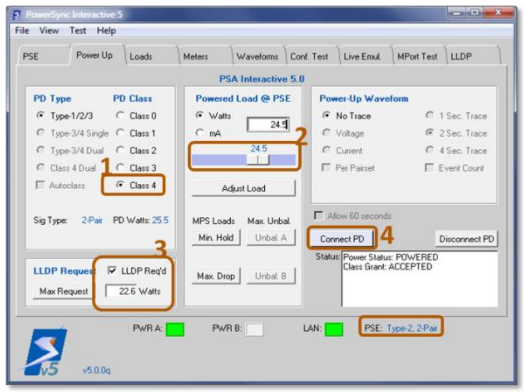


Figure 4.13 LLDP Power-Up of Emulated Class 4 PD

4.3.4. Power-Up Tab General Features and Conditional Restrictions

Before describing other features of the **Power-Up** tab menu, it is useful to review the conditional features of this menu and the associated dependencies.

Feature	Instrument Type	Selected PD Type	License Option
802.3at **LLDP Power-Ups**	PSA-3000, PSL-3000	Type-1/2/3	LLDP Emulation and Analysis
802.3bt **LLDP Power-Ups**	PSA-3000, PSL-3000 with PSx-3202 test blades or PSA-3402	Type-3/4 Single Type-3/4 Dual	
Power-Up Waveforms (Voltage, Current)	PSA-3000 with PSA-3202 test blades	Type-3/4 Single Type-3/4 Dual Class 4 Dual	(none)
Event Count and Assigned Class determination		Type-3/4 Single Type-3/4 Dual	(none)
Autoclass Emulation	PSA-3000, PSL-3000 with PSx-3202 test blades or PSA-3402	Type-3/4 Single	(none)
Max Unbalance Emulations	PSA-3000, PSL-3000 with PSx-3202 test blades or PSA-3402	Type-3/4 Single	(none)
Allow 60 second wait for power-up	PSA-3000, PSL-3000 with PSx-3202 test blades or PSA-3402	Type-3/4 Single Type-3/4 Dual Class 4 Dual	(none)

802.3at and **802.3bt** LLDP Power-Ups were discussed above in section 4.3.3. These are available for 802.3at Type-1 and Type-2 PD emulations and also, given PSx-3202 hardware, for 802.3bt single and dual signature PD emulations.

Power-Up Waveforms are voltage and current traces optionally produced upon connecting an emulated PD. They are available only when using **PSA-3202** or **PSA-3402** hardware and when capturing power-ups from any **Type-3 4-Pair** or **Type-4 4-Pair** PSE. (**Note**! This does not mean all power-ups from these PSE types are 4-pair power-ups. Note also that certain non-802.3bt 4-pair capable PSE's are treated as **Type-3 4-Pair** or **Type-4 4-Pair** PSE's by PSA Interactive.)

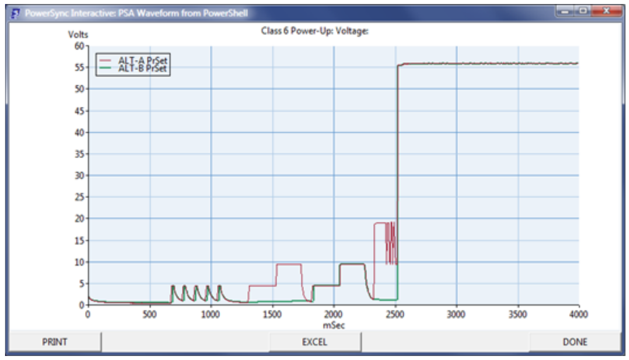


Figure 4.14 Voltage Waveform from Class 6 Power-Up

Waveforms always start exactly at the PD connection and terminate after 1 second, 2 seconds or 4 seconds according to the selected waveform duration of **1 Sec. Trace**, **2 Sec Trace**, or **4 Sec. Trace** respectively. One second traces are normal resolution (256 samples) while two and four second traces provide high resolution (1024 samples).

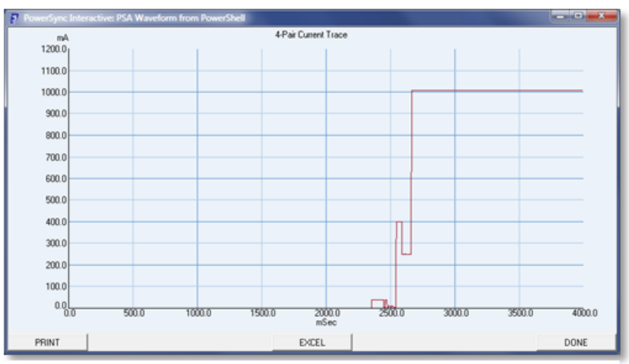
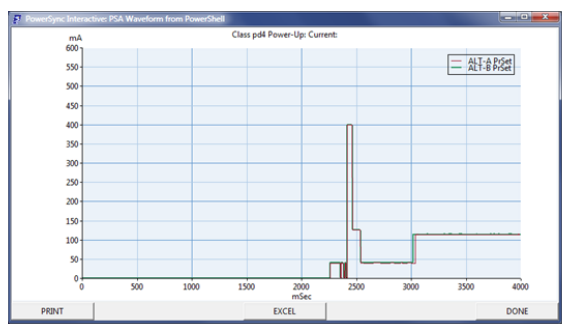


Figure 4.15 4-Pair Current Waveform from Class 6 Power-Up

Voltage waveforms (see **Figure 4.14**) always include two separate traces, an Alt-A voltage trace and an Alt-B voltage trace. **Current** waveforms may be presented either as combined 4-pair current (*see **Figure 4.15***) or as two separate traces of pairset current on Alt-A and Alt-B (*see **Figure 4.16***). This latter option is effected by the selection of the **Per Pairset** check button that activates when the **Current** trace is selected.

Per Pairset is automatically selected for dual signature (**Type-3/4 Dual** and **Class 4 Dual**) PD Types as a default setting. **Per Pairset** current may be selected or de-selected for any of the supported **PD Type** emulations prior to connecting the PD.

Waveform traces may be exported to a Microsoft Excel spreadsheet view simply by pressing the EXCEL button in each waveform trace. **Figure 4.16** depicts the 4-pair current waveform of **Figure 4.15** exported to Excel. From the Excel spreadsheet, all of the time and voltage or current sample values are available for more detailed analysis.



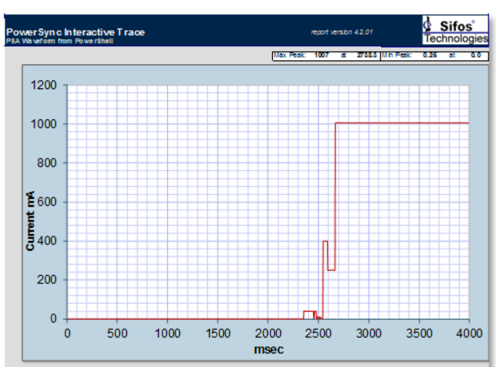


Figure 4.17 Figure 4.15 Exported to Excel

Another feature supported with **Type-3/4 Single** and **Type-3/4 Dual PD** emulations is the option to report the classification event counts and assigned class provided by the PSE during power-up (*see **Figure 4.11***). As explained in section 2.8, event counts communicate an initial power grant by the PSE to a Type-3 or Type-4 PD. An 802.3bt PD then derives the assigned classification based upon the PD's requested class and the event count observed. Selecting the **Event Count** check button will enable this feature.

Autoclass is another feature available given **Type-3/4 Single** PD emulated power-ups (*see section 2.8*). Within the 802.3bt standard, PSE's and single signature PD's may optionally support an autoclass protocol whereby three events occur during the power-up process:

1. PD alters class signature from ~40mA to ~2.5mA during the final ~15 msec of class event #1 (LCE)
2. PD draws its maximum possible load power in the time band of 1.4 to 3.7 seconds after power is applied
3. PSE measures the PD load power during this same time band

Normally, emulated PD power-ups performed in the Power-Up tab menu will not assure that a target PD power level is achieved in any particular time frame following the application of operating voltage. However, when the Autoclass check button is selected, the power-up emulation will accelerate the application of target power load (*see section 4.3.5*) so that this load power is present approximately 1.4 seconds following the power up.

Important! To perform **Autoclass** emulated power-ups and meet the timing requirements, waveforms collection must be deactivated by selecting **No Trace**. This is because the collection of a waveform trace always delays application of target PD power draw.

Another feature available only during **Type-3/4 Single** PD emulations is the ability to unbalance pairset currents. This is discussed in section 4.3.6 below.

One other conditional feature is the option to extend the wait time for a 4-pair capable PSE to provide power to the emulated PD. Normally, this wait time is up to 12 seconds following PD connection. However, when **PD Type** is **Type-3/4 Single**, **Type-3/4 Dual**, or **Class 4 Dual**, the selection of the **Allow 60 seconds** check button will cause the PD signatures, including multi-event classification signature, to remain active over a period of up to 60 seconds before the power-up is abandoned. This will allow for PSE's that may have PoE powering temporarily inhibited to cycle detection and classification many times before applying power.

4.3.5. Setting the PD Power Load

One final important aspect of all PD power-up emulations is the steady-state load power consumed by the emulated PD after power-up is completed. This is configured in the **Powered Load @ PSE** menu frame. The value programmed is always the power load presented to the PSE interface so, from the perspective of the PSE, may include power consumed by the combination of the emulated PD and the cable connections.

The load may be expressed in power by selecting **Watts** or in current by selecting **mA**. The default load power (or current) is adjusted when **PD Class** selections are made and is always a valid power load just below the minimum power load the PSE would be expected to support if the PSE assigns the requested PD classification. The range of valid power and current loads is also adjusted according to **PD Class**, ranging from 0.2 watts to a maximum load that will typically constitute an overload for the emulated **PD Class**. Load power (in watts) or current (mA) may be set using the slider control or typed into the entry box.

The time-to-application of the steady-state powered load will vary depending on waveforms that are collected, instrument type (PSA vs PSL), and other factors such as staggered 4-pair power-ups. The **Autoclass** option for **Type-3/4 Single** emulated power-ups can accelerate this time (*see section 4.3.4*).

After the PSE is applying power, the steady-state load can be modified at any time using the **Adjust Load** button.

It should also be noted that when **PSA-3x02** instruments perform emulated PD power-ups, they will typically produce brief start-up transient (or **inrush**) loads appropriate to the selected PD Class. These will appear in any collected current waveforms. In no case are the inrush transients of sufficient time duration or magnitude that a PSE should fail to provide operating power.

4.3.6. Configuring Special Load Conditions for DC MPS and Pairset Unbalance

After a PD is powered and drawing a steady-state load, either or both of the **PWR A:** and **PWR B:** indicators will be active (green). This condition will persist until either the **Disconnect PD** button is pressed or a load condition causing the PSE to remove power is introduced.

The DC MPS method of detecting PD disconnects was reviewed in section 2.13. Two boundary condition DC MPS loads can be applied each with the press of a button. The first is the **Min. Hold** load condition (*see **Figure 4.18***). This is the minimum load current, either 2-pair current given 2-pair powering or 4-pair current given 4-pair powering, that the PD must draw to assure the PSE maintains power. The actual current value depends upon PD Type and powered pairsets. In **Figure 4.18**, a **Class 6** PD emulation utilizes 14mA as the minimum DC MPS "valid signature" current.

The expectation given this load is that the PSE maintains power as depicted by the power indicators **PWR A** and **PWR B**.

The second boundary condition is the **Max. Drop** load current (*see **Figure 4.19***). This is the maximum PD load current that the PSE is required to interpret as an "invalid signature" current meaning that the PSE must remove power on the assumption that the PD is disconnected. In **Figure 4.19**, a **Class 6** PD emulation applies 4mA load current that the PSE interprets as a disconnected PD. The power indicators **PWR A** and **PWR B** show the removal of PSE power from the emulated PD.

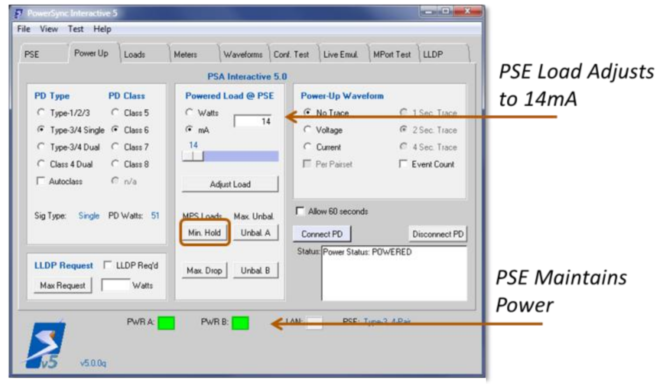


Figure 4.18 Maximum Hold Current Load

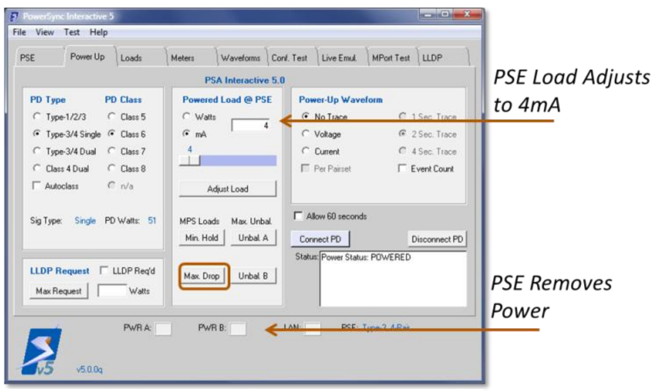


Figure 4.19 Minimum Drop Current Load

Both of these boundary condition "tests" apply to steady state loading only. DC MPS also allows for intermittent valid signature loading. This type of testing will be addressed under the **Waveforms** tab menu.

The topic of pair-to-pair current unbalance was addressed earlier in section 2.12. When **Type-3/4 Single** (PD **Class 5**, **Class 6**, **Class 7**, or **Class 8**) are emulated, the **Max Unbal** pushbutton loads become available. The **Unbal. A** button (*see **Figure 4.20***) alters the 4-pair current load to a total load just below the 802.3bt **Icon** (or **Pclass**) limit given the present **PD Class** emulation, then splits the load between the Alt-A pairset and the Alt-B pairset so that the maximum possible pair-to-pair unbalance current appears on the Alt-A pairset. In **Figure 4.20**, a PD Class 5 emulated power-up was done, then pressing the **Unbal. A** button caused the 4-pair load to adjust to 706mA and the pairset load on Alt-A to adjust to 560mA. Given a **Class 5** PD emulation, the PSE is required to tolerate this amount of pairset load unbalance without removing power.

The actual load current on the Alt-A pairset can be inspected using the **Meters** tab menu.

The Alt-B pairset can also be subjected to the exact same condition using the **Unbal. B** button. In **Figure 4.22**, an emulated Class 6 PD draws a 4-pair current of 948mA and the Alt-B pairset draws 692mA when the **Unbal. B** button is pressed.

Again, the PSE should tolerate both the 4-pair load because it is below **Pclass** and the current unbalance. The Alt-B current here can be inspected using the **Meters** tab menu.

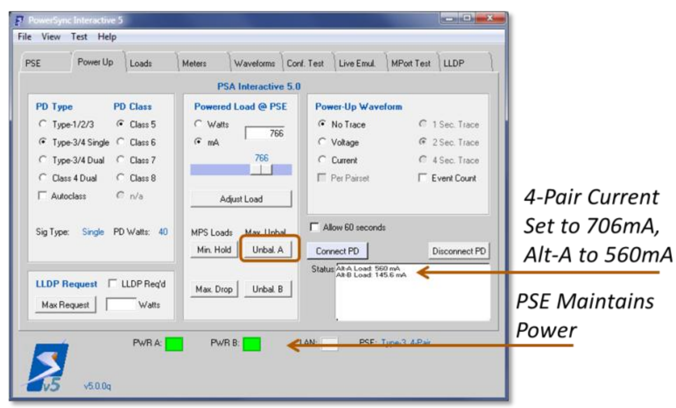


Figure 4.20 Alt A Maximum Unbalance

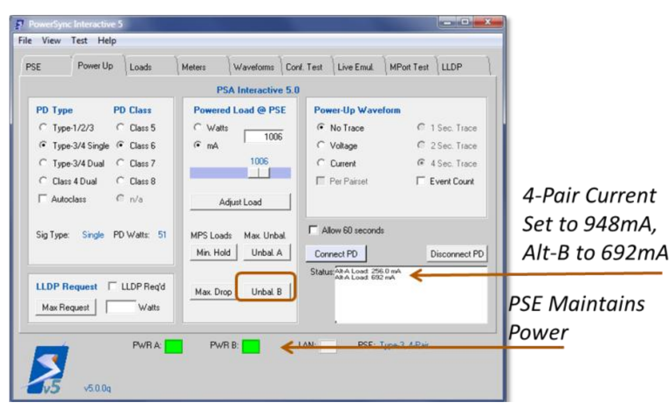


Figure 4.22 Alt B Maximum Unbalance Current

4.4. The Loads Tab Menu

The Loads tab menu (*see **Figure 4.23***) provides access to several elemental test port resources:

- Detection Signature Configuration and Actuation
- Static Current Load Configuration
- Transient Current Load configuration

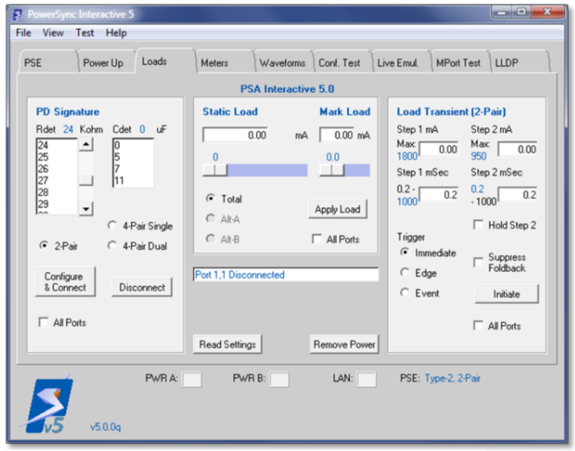


Figure 4.23 The Loads Tab Menu

While the **Power Up** tab menu provides flexible, general purpose abilities to emulate PD's, the **Loads** tab menu provides means to manipulate signatures and loads that are not manageable in the **Power Up** tab menu.

The Loads tab menu offers a **Read Settings** button that will update all of the tab menu settings from the presently selected port in the Slot-Port Panel.

Important! When working with test slots that are configured into a 4-pair configuration (e.g. **S1**, **S2**, **D1**, **D2**), the selection of a DISCONNECTED 4-pair port in the Slot-Port Panel will disable the **Loads** tab menu. This is because the **Loads** tab menu works with elemental resources that must always be addressed to the CONNECTED 4-pair port of the test slot. The **Loads** tab menu will re-enable when a CONNECTED 4-pair port is selected or when the DISCONNECTED 4-pair port is re-configured to be a CONNECTED 4-pair port. Operations in the **PSE** tab menu, the **Power Up** tab menu, and the **Waveforms** tab menu can alter CONNECTED 4-pair port within a test slot.

4.4.1. Configuring PD Detection Signatures

The emulated PD detection signature consists of three components:

1. Signature Type
2. Detection Resistance
3. Detection Capacitance

The PD signature type can be configured to **2-Pair**, **4-Pair Single**, or **4-Pair Dual**. The signature type is altered by selecting the desired radio button and pressing the **Configure and Connect** button. When the signature type is altered, the pair state for the present test slot will be updated on the Slot-Port Panel (*see **Figure 4.3***).

When the Loads tab menu is selected, the default signature type will be **2-Pair** when the PSE is Type-1, 2-Pair or Type-2, 2-Pair and will be **4-Pair Single** when the PSE is Type-3, 4-Pair or Type-4, 4-Pair.

The signature type is only relevant when testing 4-pair powering (e.g. 802.3bt) PSE's because 2-pair (i.e. all 802.3at) PSE's can only observe one pairset, Alt-A or Alt-B, of a PD. Put another way, all PD signature types to a 2-pair powering PSE look like **2-Pair**. When working with 2-pair PSE's, generally the **2-Pair** signature configuration should be used so that both test ports of the test slot are available for PSE connections and analysis.

The signature type is constrained when the selected slot-port is a PSx-3102 test blade. The **4-Pair Single** signature type is not available to the **PSx-3102** and the **4-Pair Dual** signature type may only be selected when the test port is **Port 2** of the **PSx-3102** blade.

The detection signature resistance is selected from the **Rdet** list box (*see **Figure 4.23***) where the present selection is shown above the scrolled list box. This resistance ranges from 9KΩ to 39KΩ in 1KΩ steps. Most PSE's are looking for detection signatures in the band of ~18KΩ to ~29KΩ in order to apply power.

The detection signature capacitance is selected from the **Cdet** list box (*see **Figure 4.23***) where the present selection is shown above the list box. This capacitance can be 0μF, 5μF, 7μF, or 11μF. Generally, most PSE's will reject any capacitance larger than the 0μF value unless they power legacy capacitive signatures in older, pre-802.3 PD's.

The detection resistance and capacitance signatures, once selected, are applied when the **Configure & Connect** button is pressed. At that point the status box will update to indicate Port x,y Connected (*see **Figure 4.24***). The **Disconnect** button will remove the detection signature and present what looks like high impedance to the PSE.

The **All Ports** check button enables the application of a selected detection signature (type, **Rdet**, **Cdet**) to all test ports or test slots in the presently connected instrument when **Configure & Connect** is pressed. This option is inhibited when all slots are not in a uniform pair state (*see **Figure 4.3***) configuration to begin with.

4.4.2. Configuring and Applying Static Current Load

Another elemental resource that is configured by the **Loads** tab menu is the static current load. The **Static Load** (*see **Figure 4.24***) is the current that the PSE will experience when the PSE output voltage exceeds 15VDC.

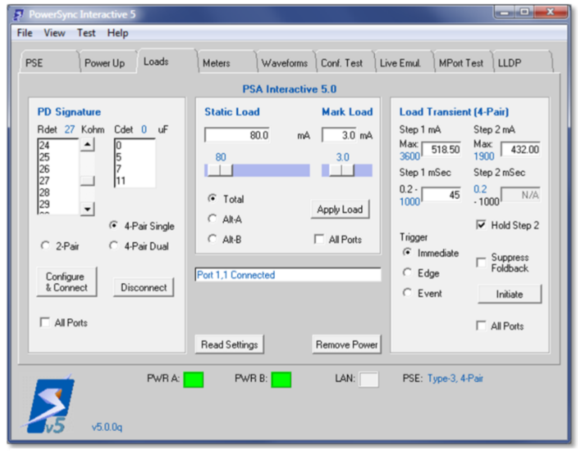


Figure 4.24 Class 4 Power-Up, 27KΩ Single Signature

The **Static Load** can be configured to a single pairset, as it always is when the signature type is **2-Pair**, or to both pairsets combined when in a **4-Pair Single or 4-Pair Dual** signature type configuration.

The **Static Load** current is configured or altered by pressing the **Apply Load** button. When the signature type is **2-Pair**, as it generally should be when evaluating Type-1, 2-Pair and Type-2, 2-Pair PSE's, the load shown is the 2-pair current meaning it is always the **Total** current.

When the signature type is **4-Pair Single or 4-Pair Dual**, as it generally should be when evaluating Type-3, 4-Pair and Type-4, 4-Pair PSE's, the **Total** radio button causes the combined 4-pair current to be configured or altered while the Alt-A and Alt-B radio buttons cause the respective individual pairset currents to be configured or altered.

This static load current can range from 0mA to a maximum current governed by the signature type, the type of test blade, and the **Static Load** target as follows.

Test Blade	Signature Type	Load Target	Max. Current
PSx-3202 (PSA-3402)	2-Pair	Total	950 mA
	4-Pair Single or 4-Pair Dual	Total	1900 mA
	4-Pair Single or 4-Pair Dual	Alt-A or Alt-B	950 mA
PSx-3102 (PSA-3002)	2-Pair	Total	750 mA
	4-Pair Dual	Total	1900 mA
	4-Pair Dual	Alt-A or Alt-B	950 mA

Important! When configured to a **4-Pair** mode (signature type) with the **Total** setting, the 4-pair **Static Load** current is split evenly between the Alt-A pairset and the Alt-B pairset. For example, the load is configured to 80mA as in **Figure 4.24**, then there is a 40mA current on Alt-A and a 40mA current on Alt-B. This means that if the PSE is powering (or classifying) on just one pairset, Alt-A or Alt-B, it will experience exactly half of this load current.

The **Mark Load** is the current experienced by the PSE when the voltage drops below 14V during classification sequences, that is, on the trailing edge of class events (*see sections 2.7 and 2.8*). This current mimics what PD's must do in order to recognize the end of a class pulse. It can be configured between 0 and 10mA and is configured to *both* pairsets, Alt-A *and* Alt-B. Like the **Static Load**, it is applied when the **Apply Load** button is pressed.

The **Static Load** and **Mark Load** may be applied to every test port (or 4-pair test slot) in the presently connected test instrument by selecting the **All Ports** check button before pressing **Apply Load**.

4.4.3. Powering an Emulated PD from the Loads Tab Menu

There are some important considerations when using the **Loads** tab menu to connect and potentially power emulated PD's from a PSE. For example, when testing PSE response to a variety of PD detection signatures, the **Static Load** must be set up so that a PSE experiencing a valid detection will apply and maintain power.

When the **Configure & Connect** button is pressed, the selected PD Signature is applied. Many Type-1 and all Type-2, Type-3, and Type-4 PSE's that deem the signature to be a valid PD will then attempt to classify the emulated PD. The **Static Load** configures the current that the PSE will experience during classification. Many Type-1 and all Type-2, Type-3, and Type-4 PSE's must measure a class signature between 0mA and 50mA in order to apply power.

Assuming the **Static Load** is configured to a valid classification signature current, the PSE will apply power. If the PSE uses DC MPS method of PD disconnect detection, the static load current will then need to remain above 10mA for

Type-1 and Type-2 PSE's and above 14mA for Type-3 and Type-4 PSE's in order to assure the PSE maintains power. (PSE's using the AC MPS method do not require this.)

Finally, when powering a 4-pair PSE and emulating a **4-Pair Single** or **4-Pair Dual** signature type, the **Static Load** set up for **Total** (4-pair) current will split that total current between pairsets Alt-A and Alt-B. This means that the class signature experienced by the PSE will be half of the programmed current.

When working with 2-Pair PSE's to get a power-up, the **Static Load** should be set to a valid class signature for Class 1, 2, 3, or 4 and Apply Load should be pressed BEFORE pressing **Connect & Configure**. Associated class currents would be 10mA, 18mA, 28mA, or 40mA respectively. This will assure DC MPS PSE's maintain power.

When working with 4-Pair PSE's to get a power-up, the **Static Load** should generally be set to produce a 40mA class signature ON EACH PAIRSET. This means it should be configured to 80mA (**Total**) as shown in **Figure 4.24** thus emulating a Type-2, Class 4 PD to the 4-pair (802.3bt) PSE. The 40mA per pairset load current will assure that Type-3 and Type-4 PSE's see a valid class signature and maintain power.

Finally, if the sole intent of using the **Loads** tab menu is to adjust static loads or initiate load transients to already powered PSE ports, it will be advantageous to use the **Power Up** tab menu to produce the emulated PD power-up, then switch over to the **Loads** tab menu once the emulated PD is powered.

4.4.4. Configuring and Launching Load Transients

Load transients are temporary transitions in load current that are described by two distinct current loads in sequence, each load of programmable time duration (*see section 3.1.3*). The **Loads** tab menu offers the capability to describe and then initiate a load transient.

Load transients are only meaningful when the PSE port is powering an emulated PD. This is because the load transient is utilizing the same active load hardware as the Static Load that requires 15VDC to activate.

The **Load Transient** menu in the Loads tab (*see **Figure 4.25***) indicates in the frame header the present mode of the load transient, either **2-Pair** or **4-Pair** current. This is dictated by the signature type used during power-up. The ranges of load transient current are generally doubled for **4-Pair** mode relative to **2-Pair** mode.

The menu includes four numeric entries:

1. **Step 1** Load Current (**mA**)
2. **Step 1** Transient Duration (**msec**)
3. **Step 2** Load Current (**mA**)
4. **Step 2** Transient Duration (**msec**)

The absolute current ranges and time durations for **Step 1** and **Step 2** of the load transient are governed by a number of factors that PSA Interactive will automatically take into account. **Step 1 mA** and **Step 2 mA** current ranges are described in the following table.

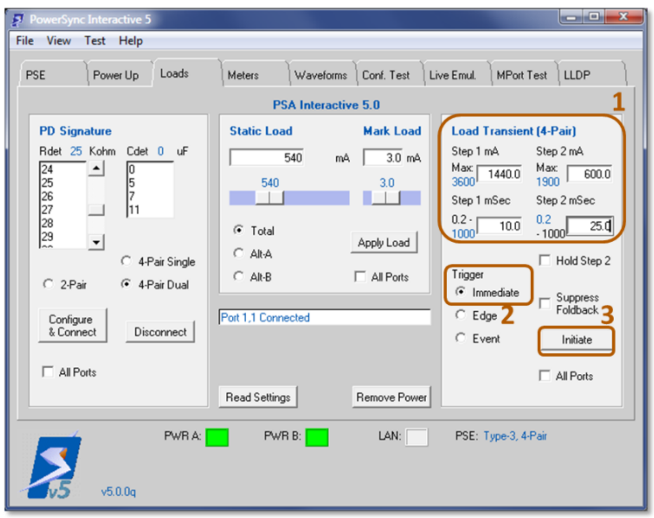


Figure 4.25 Producing Class 6 Ilim_min Transient

Parameter	Pair Mode	Test Port Type	Minimum (mA)	Maximum (mA)
Step 1 Current	2-Pair	Any	0	1800
	4-Pair	Any	0	3600
Step 2 Current	2-Pair	PSA-3202, PSA-3402	0	950
		PSA-3102, PSA-3002	0	750
	4-Pair	Any	0	1900

The durations **Step 1 mSec** and **Step 2 mSec** are dependent upon the value of the **Step 1 mA** load current. These ranges are explained in the following table.

Pair Mode	Step 1 mA	Parameter	Minimum (msec)	Maximum (msec)
2-Pair	0-950	Step 1 Duration	0.2	1000
		Step 2 Duration	0.2	1000
	951-1900	Step 1 Duration	0.2	80
		Step 2 Duration	1000	1000
4-Pair	0-1900	Step 1 Duration	0.2	1000
		Step 2 Duration	0.2	1000
	1900-3600	Step 1 Duration	0.2	80
		Step 2 Duration	1000	1000

The **Step 2 mSec** duration can be overridden with the **Hold Step 2** control whenever the minimum **Step 2 mSec** duration is set to 0.2 msec. Selecting **Hold Step 2** means that at the end of **Step 1** of the load transient, the **Step 2** current will become the steady state static load current indefinitely. This option only exists when the **Step 1 mA** load is 950mA or less in **2-Pair** mode and 1900mA or less in **4-Pair** mode.

There are three triggering options for the load transient (*see **Figure 4.25***).

1. **Immediate**: Transient starts when **Initiate** is pressed
2. **Edge**: Transient arms when **Initiate** is pressed, then fires when a particular voltage edge transition occurs
3. **Event**: Transient arms when **Initiate** is pressed, then fires when a particular event occurs

While **Immediate** trigger is straight forward, the **Edge** and **Event** trigger modes of the load transient are intertwined with settings in the **Meters** tab menu and will be addressed in sections 4.5.3 and 4.5.4 below. The basic concept of **Edge** and **Event** triggering is to allow captures of voltage or current traces coincident with the load transients.

In **Figure 4.25**, the load transient is utilized to generate an **Ilim_min_2p** impulse load from an emulated Class 6 PD. **Ilim_min_2p** for Class 6 is 720mA (per pairset) and **Tlim_min** for Class 6 is 10msec. So a 4-Pair load of (2 x 720mA=) 1440 mA is programmed to **Step 1 mA** with a **Step 1 mSec** duration of 10 msec. The **Step 2 mA** current used here is not particularly important so long as it is within the allowable power band for the Class 6 PD. The **Step 2 mSec** duration is also of no consequence in this test case. In this example, 600mA and 25 msec are programmed.

One final setting under **Load Transients** is the **Suppress Foldback** check button. This feature is designed to help sustain higher PSE output voltages when the PSE enters a current limiting state during **Step 1 mSec**, the duration of the first load transient step. The primary goal of foldback suppression is to assure that a PSE limiting current to 400mA on a pairset experiences 30VDC or higher during that time period. Generally, Suppress Foldback should be selected when:

1. The user knows the Step 1 mA load transient may put the PSE output into a current limiting (foldback) mode
2. The **Step 1 mA** load is > 950 mA in **2-Pair** mode
3. The **Step 1 mA** load is > 1900 mA in **4-Pair** mode

As with the **Static Load** menu, the **Load Transients** menu offers the option to program and initiate load transients on all test ports in the presently connected PSA instrument using the **All Ports** option. Also, as with the PD Signature and Static Load All Ports check buttons, this feature is only enabled when all of the test slots are identically configured to the same pair state (*see **Figure 4.3***).

4.5. The Meters Tab Menu

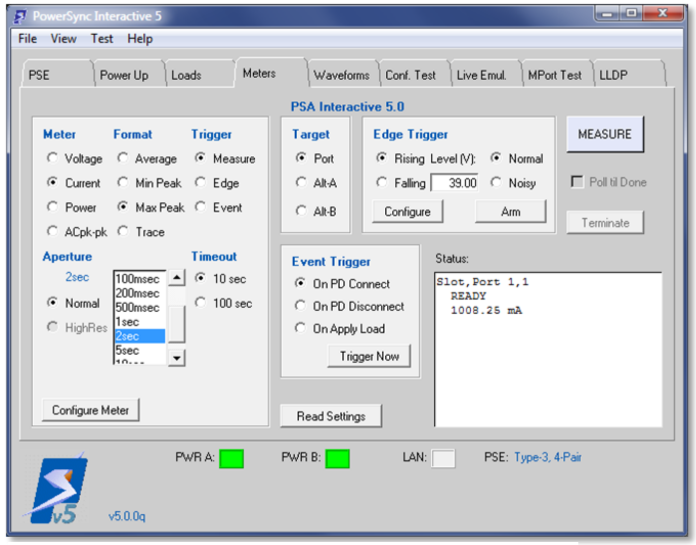


Figure 4.26 The Meters Tab Menu

The **Meters** tab menu (*see **Figure 4.26***), like the **Loads** tab menu, provides access to test port elemental resources used in measurements and triggering. Specifically, these include:

1. DC Meters
2. AC Meter
3. Edge Trigger Configuration
4. Event Trigger Configuration

Like the **Loads** tab menu, the **Meter**s tab menu includes **a Read Settings** button that will update all settings from the presently selected slot-port for the presently selected meter and for the edge trigger.

Important! When working with test slots that are configured into a 4-pair configuration (e.g. **S1**, **S2**, **D1**, **D2**), the selection of a DISCONNECTED 4-pair port in the Slot-Port Panel will disable the **Meters** tab menu. This is because the **Meters** tab menu works with elemental resources that must always be addressed to the CONNECTED 4-pair port of the test slot. The **Meters** tab menu will re-enable when a CONNECTED 4-pair port is selected or when the DISCONNECTED 4-pair port is re-configured to be a CONNECTED 4-pair port. Operations in the **PSE** tab menu, the **Power Up** tab menu, and the **Waveforms** tab menu can alter CONNECTED 4-pair port within a test slot.

4.5.1. Meter Selection and Configuration

Referring to **Figure 4.26**, there are four meter types that can be selected:

1. DC **Voltage**
2. DC **Current**
3. DC **Power**
4. **AC** Peak-Peak

Depending of the meter selection, there are a variety of meter configurations available. The following table summarizes the various abilities for each meter type.

Meter	Formats	Trigger Modes	Timeouts	Apertures
Voltage and **Current**	**Average** **Min**imum **Peak** **Max**imum **Peak**	Immediate (**Measure**) **Edge** **Event**	 **10 sec** **100 sec**	10msec to 10sec in 2-5-10 steps
	Trace (Waveform)	Immediate (**Measure**) **Edge** **Event**	 **10 sec** **100 sec**	**Normal** Resolution: 10msec to 10sec in 2-5-10 steps **High Res**olution: 200msec, 2 sec, 4 sec, 8 sec, 20 sec
Power	**Average**	Immediate (**Measure**)		10msec to 10sec in 2-5-10 steps
Meter	**Formats**	**Trigger Modes**	**Bands**	**Apertures**
AC Pk-Pk	**Average**	Immediate (**Measure**)	**Ripple** (low freq.) **Noise** (high freq.)	2 sec, 5 sec

Average, peak, and trace meters all evaluate samples over a specified time period or **Aperture**. The DC meters (*see also section 3.1.5*), for example, typically evaluate 256 samples and then produce an **Average** or a **Peak** (minimum or maximum) or a waveform **Trace** using those samples. Stated another way, the **Aperture** determines the averaging period for **Average** measurements and the peak sampling period for **Peak** measurements. It also determines the time length of a waveform **Trace**.

In **Figure 4.26**, a maximum peak current measurement is performed over a period of 2 seconds. The value shown is the highest of 256 evenly spaced samples collected during the 2 second aperture.

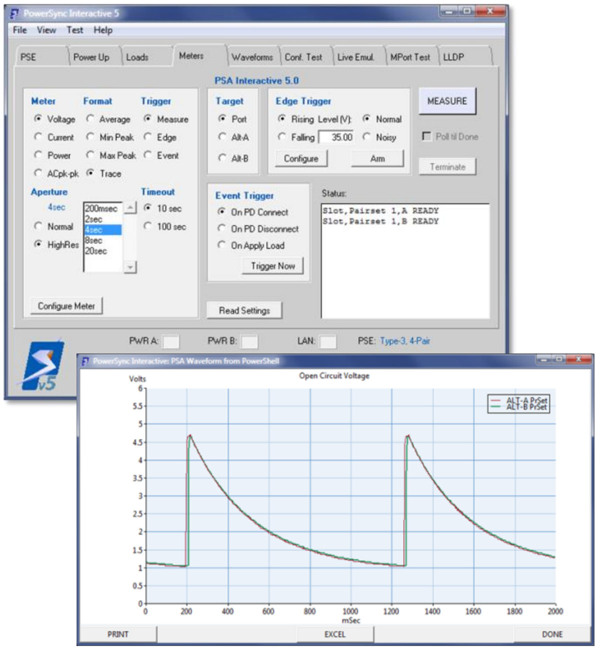


Figure 4.27 Voltage Trace Measurement

The **Trace** meter offers several **High Res** apertures that collect 1024 samples over the specified **Aperture**. These are available for apertures of 200msec, 2 seconds, 4 seconds, 8 seconds, and 20 seconds. **High Res** apertures are especially useful for evaluating PSE activity over the durations encompassing PD detection and classification.

In **Figure 4.27**, a high resolution **Voltage Trace** measurement is configured and performed and, because the test port is configured as a 4-pair port, traces for both Alt-A and Alt-B pairsets are presented. The standard waveform display window offers the option to load the trace into an Excel trace template where all of the sample data is available.

The DC meters will automatically determine if the measurements performed are 2-pair or 4-pair based on the pair state (*see **Figure 4.3***) configuration of the presently selected slot-port. When a test port is in a 4-pair mode, the measurement **Target** can be selected as **Port** (4-pair measurement), **Alt-A**, or **Alt-B** (pairset measurement). Selecting **Alt-A** or **Alt-B** will then return a 2-pair measurement from a 4-Pair configured port.

The **AC Pk-Pk** meter (*see also section 3.1.6*) always produces an "average" value though in reality, it produces the difference between a minimum voltage peak and a maximum voltage peak over the specified aperture of 2 seconds or 5 seconds. This meter can be configured to evaluate **Ripple** or **Noise**. **Ripple** consists peak-to-peak voltages measured in a low-pass filtered frequency band of roughly 25Hz to 325Hz. **Noise** consists of peak-to-peak voltages measured in a high-pass filtered frequency band ranging from about 20KHz to 250KHz. The AC Pk-Pk meter includes an input capacitance of 0.05µF to mimic the lowest possible capacitance that a PD would introduce when connected to a PSE.

In **Figure 4.28**, an **ACpk-pk Ripple** measurement is performed over an aperture of 2 seconds. Generally, **ACpk-pk** measurements are only meaningful when a PSE is providing power.

The **ACpk-pk** meter will automatically determine if the measurements performed are 2-pair or 4-pair based on the pair state (*see **Figure 4.3***) configuration of the presently selected slot-port. In a 4-pair mode, the **Target** setting **Alt-A** or **Alt-B** can be used to return a 2-pair measurement on the selected pairset.

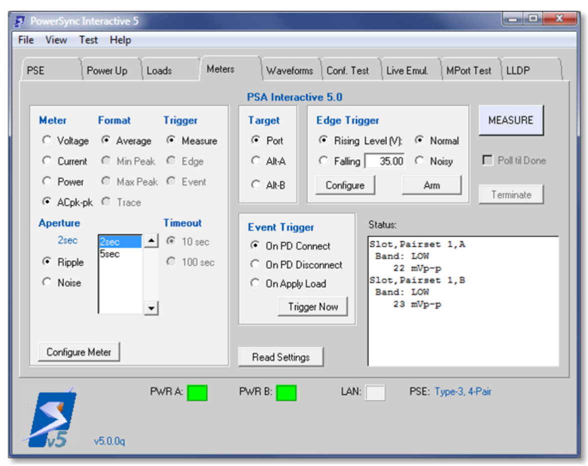


Figure 4.28 AC Peak-Peak Measurement

The meter type frame also includes a **Configure Meter** button. This can be used to apply all of the presently selected settings to the presently selected meter type (**Voltage**, **Current**, **Power**, or **ACpk-pk**) without performing any measurements. After a meter is configured, pressing the **Read Settings** button should read back that same meter configuration.

4.5.2. Immediate Triggered Measurements

All of the meter types support immediate triggered measurements. When the trigger mode **Measure** is selected, then the meter measurement commences when the **MEASURE** button is pressed. At this point, all menu controls will disable until the result is produced and posted in the **Status** display.

Important! The **MEASURE** button will perform the operation of configuring the presently selected meter type to the presently selected settings meaning there is no need to press the **Configure Meter** button when settings are altered prior to a measurement being performed.

Figures 4.26, **4.27**, and **4.28** all demonstrate immediate triggered measurements.

4.5.3. Edge Triggers and Edge Triggered Measurements

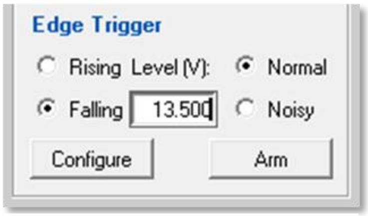


Figure 4.29 Trigger Configuration

The concept of edge triggering was introduced earlier in section 3.1.2. Edge triggering specifically refers to acting on voltage edge transitions of a specified polarity (**Rising** or **Falling**) and at a specified voltage.

The DC Voltage and Current meters can be edge triggered (*see section 3.1.5*) to produce average, peak, and trace measurements. The **Edge Trigger** frame (*see **Figure 4.29***) offers radio buttons to select the edge polarity, **Rising** or **Falling**. The voltage level desired is typed into the **Level(V)** entry box. This voltage can range from 0.75V to 57V.

The **Normal** and **Noisy** controls govern the amount of hysteresis utilized in the edge triggering process. **Normal** is useful for most edges such as class pulses and power-ups. **Noisy** increases the hysteresis to 0.75V so that false triggers on noisy edges are rejected. This is typically useful for triggering on detection pulses where noisy edges are common.

The **Configure** button is used to apply the trigger settings to the presently selected slot-port. If the test port is in a 4-pair configuration and the **Target** is **Port**, both pairsets Alt-A and Alt-B will be set up with the same edge trigger settings. If the **Target** is **Alt-A** or **Alt-B**, then only that pairset will be configured to the selected settings.

The **Arm** control allows the trigger configuration to be ARMED for the specified edge condition. One example of where this would be useful is to arm a **Load Transient** that is configured for **Edge** triggering (*see section 4.4.4*).

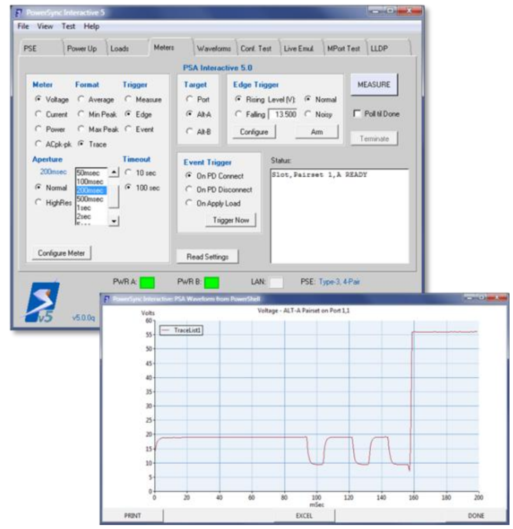


Figure 4.30 Edge Triggered Voltage Trace on Alt-A

In **Figure 4.30**, an **Edge** triggered voltage trace is captured.
In this example, the intent was to trigger on the leading edge of classification using a trigger threshold of 13.5V Rising. The PSE is a Type-3, 4-Pair PSE and the slot-port is configured to a 4-pair pair state. The **Target** is set to observe classification on the **Alt-A** pairset only.

To perform the measurement, the meter type **Voltage**, format **Trace**, and trigger mode **Edge** are selected along with a **200msec** aperture. The timeout is set to **100 sec** to allow time to effect the emulated PD connection from the **Loads** tab menu.

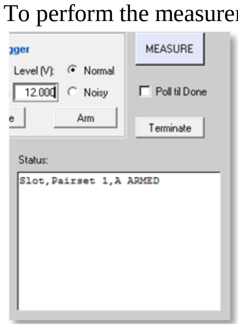


Figure 4.31 Meter ARM

When the **MEASURE** button is pressed, the meter moves into an ARMED state (*see **Figure 4.31***). At this point, the measurement will initiate when the first 13.5V rising edge occurs on the Alt-A pairset. The **Loads** tab menu can then be used to apply a class signature, for example 40mA on each pairset (*see section 4.4.3*), then **Connect & Configure** a valid detection signature. This will cause the PSE to detect, classify, and apply power. The PSE in this example is known to classify on the Alt-A pairset.

To complete the measurement, the **MEASURE** button is pressed again in the Meters tab. So long as the expected voltage edge occurred, the meter will enter the READY state and the trace of **Figure 4.30** will be displayed. For longer aperture measurements, the **MEASURE** button may return a MEASURING state until the aperture time interval is completed at which point the measured result is produced.

4.5.4. Event Triggers and Event Triggered Measurements

Event triggers were introduced earlier in section 3.1.2. The DC **Voltage** and **Current** meters have the ability to trigger on four event types:

1. Button Press (**Trigger Now**)
2. Connection of an Emulated PD (**On PD Connect**)
3. Disconnection of an Emulated PD (**On PD Disconnect**)
4. Static Load (Current) Change (**On Apply Load**)

When the **Voltage** or **Current** meter is configured for trigger mode **Event**, pressing the **MEASURE** button will cause the measurement to ARM until the specified event occurs or until the meter times out (*see section 3.1.5*).

Working with PSA Interactive, events are instigated by the user. The following table describes events and the means to effect those events.

Event Type	User Action(s)
Trigger Immediately	Press **Trigger Now** button
On PD Connect	**Loads** tab: **Configure & Connect** button
On PD Disconnect	**Loads** tab: **Disconnect** button
	Loads tab: **Remove Power** button
On Apply Load	**Loads** tab: **Apply Load** button

Figure 4.32 depicts an event triggered current trace that is coincident with an event triggered load transient. In this example, the load transient is designed to present a Class 6 **Ilim_min_2p** transient of 720mA on each pairset, or 1440mA combined. The duration of the transient is **Tlim_min** for Class 6, or 10msec.

This whole process is completed in 7 steps as shown in **Figure 4.32**:

1. Configure **Current** meter as **Trace**, **Event** triggered with aperture **100msec**.
2. Press **MEASURE** button
3. Open **Loads** tab and configure load transient **Step 1 mA** for 1440, **Step 1 mSec** for 10, **Step 2 mA** for 600 (arbitrary), **Step 2 mSec** for 25 (also arbitrary)
4. Select **Event** trigger for load transient
5. Press **Initiate** to arm the load transient for the event trigger
6. Open **Meters** tab and press **Trigger Now**
7. Press **MEASURE**

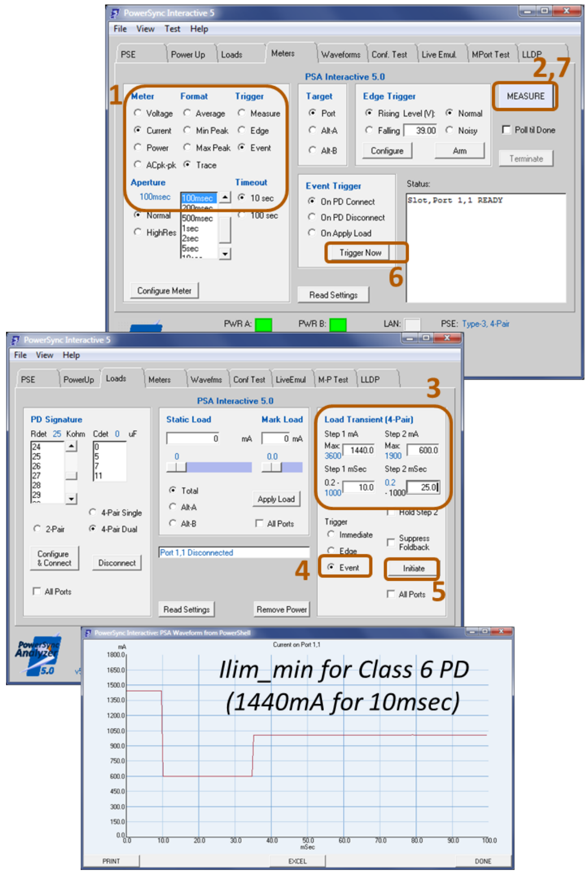


Figure 4.32 Ilim_min Measured Using Event Trigger

4.5.5. Terminating and Polling for Triggered Measurements

Edge and **Event** triggered **Voltage** and **Current** measurements must always resolve to a READY state or a TIMEOUT state (*see section 3.1.5*). Depending on the selection of timeout (**10 sec** or **100 sec**), timeout may take well over 100 seconds to occur. However, triggered measurements can be immediately aborted and terminated by pressing the **Terminate** button while the measurement is in the ARMED state. The **Terminate** button will only be active when a triggered Voltage or Current measurement is ARMED or MEASURING.

In each of the above examples, the final result of a triggered meter measurement was obtained by pressing the **MEASURE** button first to initiate the measurement, then later to obtain the result. The **MEASURE** button serves the purpose of querying a meter to return a status. That status may be ARMED (waiting for trigger), MEASURING (trigger received but aperture not completed), TIMEOUT (no trigger in 10 or 100 seconds), and READY (measurement completed).

When an **Edge** or **Event** triggered meter measurement is selected, the **Poll til Done** check button will activate. Selecting the **Poll til Done** check button causes PSA Interactive to query the meter status periodically without pressing the **MEASURE** button. When the measurement resolves to the READY (or TIMEOUT) state, the result is automatically presented.

4.6. The Waveforms Tab Menu

The **Waveforms** tab menu offers extensive stimulus-response analysis of PSE behaviors through the combination of:

- Flexible PD Emulations
- **One-Click Waveform** Generation

PD Emulations are performed by selecting a **PD Type** and **PD Class** in a manner that is identical to the Power Up tab menu. All of the options and behaviors of the PD Type/PD Class frame are overlapped with the **Power Up** tab so that selections performed in either tab, **Power Up** or **Waveforms,** are retained when moving to the other tab menu.

The rules and behaviors for working with the **PD Type** and **PD Class** selection frame (*see **Figure 4.35***) are described in 4.3.1 above.

The one difference between the **Waveforms** tab menu and the **Power Up** tab menu is that LLDP emulations performed in the **Waveforms** tab menu are always done seeking the maximum power grant, much like pressing the **Max Request** button would do in the **Power Up** tab menu. This is because the subset of one-click waveforms that require power-ups to class-based power grants are seeking PSE responses when the power grant is maximized for the PD classification.

The **Waveforms** tab provides the **Waveforms** selection frame where the one-click waveforms of interest are selected and then produced using the **Produce Waveform** button. Waveforms are separated into two basic categories:

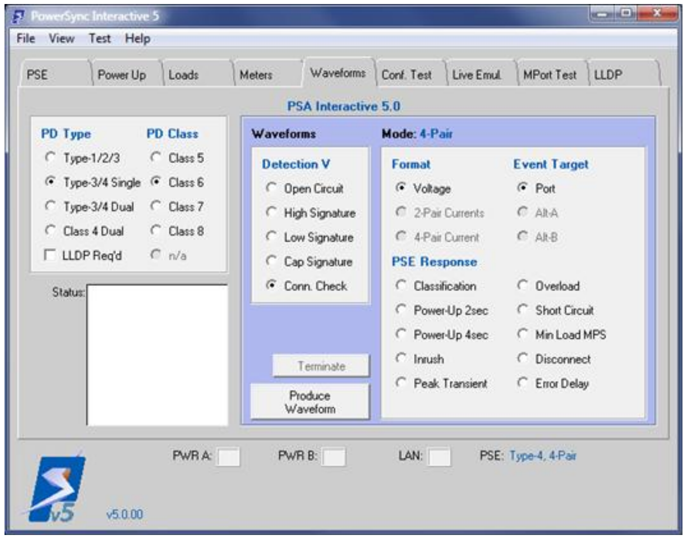


Figure 4.35 Waveforms Tab Menu

1. Detection Voltage waveforms
2. Voltage & Current Stimulus-Response Waveforms

The waveform **Mode** is either **2-Pair** for testing 2-Pair PSE's or **4-Pair** for testing 4-Pair PSE's. This mode is governed by presently configured PSE attributes (**PSE Pairs** configuration in the **PSE** tab menu).

Important! Beginning with PSA 5.1 software, certain 4-Pair waveforms will be combined on a single graph depicting both pairsets when PSA software is running on Tcl/Tk 8.6. With Tcl/Tk 8.4, those waveforms will appear as 2 separate graphs. *See Figures 4.37 and 4.38 below for examples of combined waveform graphs.*

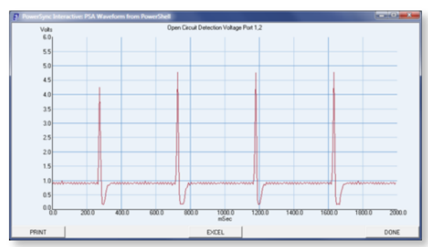


Figure 4.36 Open Circuit Signaling

Waveforms that are in process may be terminated immediately at any time using the **Terminate** button.

4.6.1. Detection Voltage Waveforms

The detection waveforms are always voltage traces. During PD detection, a PSE necessarily uses high impedance sources to limit currents that non-PD's could otherwise be damaged by. Hence, current flow during detection is always approximately 0 mA.

The following table explains the availability and purpose of each detection waveform.

Detection V Waveform	Purpose	Emulated Signature	See Figure	Mode(s)
Open Circuit	Evaluate signaling all PD's and non-PD's experience	~ 3 MΩ	**4.36**	2-Pair or 4-Pair
High Signature	Evaluate PSE signaling to invalid high signature Resolve Voltage vs Current sourcing, backoff timing	39KΩ, 0μF	**4.37**	
Low Signature	Evaluate PSE signaling to invalid low signature Resolve Voltage vs Current sourcing	11KΩ, 0μF		

Detection V Waveform	Purpose	Emulated Signature	See Figure	Mode(s)
Cap Signature	Evaluate PSE signaling to invalid large capacitive signature Estimate current limiting during detection	39KΩ, 11μF	**4.38**	
Conn. Check	Evaluate PSE method for sorting Single Signature from Dual Signature PD's	25KΩ, 0μF	**4.39**	4-Pair

Generally, the detection waveform collection process is designed to automatically size trace apertures to capture waveform edges and typically several waveform edges for **Open Circuit**, **High Signature** (*see **Figure 4.37***), **Low Signature**, and **Conn. Check** (*see **Figure 4.39***) waveforms. The **Capacitive** signature waveform (*see **Figure 4.38***), seeks to capture at least one rising edge.

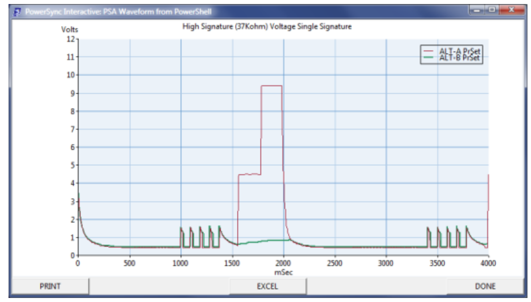


Figure 4.37 High Signature Signaling – 4-Pair PSE

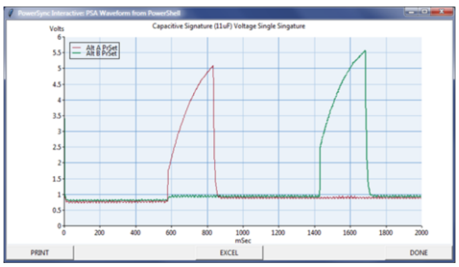


Figure 4.38 Capacitive Signature Signaling

The only **Detection V** waveform that would cause a PSE to apply power is the **Conn. Check** waveform (*see **Figure 4.39***). However, this waveform is specially post-processed to retain just those detection level signals, that is between 2.8 and 10 volts, that appear simultaneously between the Alt-A and Alt-B pairsets.

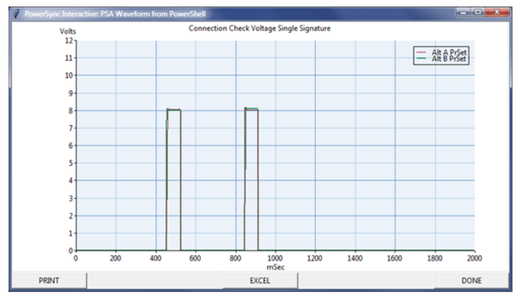


Figure 4.39 4-Pair Connection Check Waveform

4.6.2. Voltage & Current Stimulus-Response Waveforms

All of the remaining one-click waveforms can be produced as **Voltage** or **Current** traces. Depending upon the nature of the stimulus, there are cases where only one of these two trace types provides practical information.

More specifically, the available **Format** options are:

Mode	Formats	Traces Produced
2-Pair	**Voltage**	1 trace
	Current	1 trace
4-Pair	**Voltage**	1 or 2 traces
	2-Pair Currents	2 traces
	4-Pair Current	1 trace

Certain waveforms involve the application of a specific load scenario such as an overload or a disconnect (zero) load. These "events" are configured by the **Event Target**. In **2-Pair** mode, the only Event Target is **Port**. In **4-Pair** mode, the Event Target can be **Port** for 4-Pair stimulus or **Alt-A** and **Alt-B** for a pairset specific stimulus.

4.6.3. Classification Waveform

The **Classification** waveform (*see **Figure 4.40***) is designed to evaluate the classification signaling that occurs prior to a power-up. Both voltage and current views of classification can be meaningful. The waveform automatically filters out all voltages or currents not related to the PD classification process.

In a 4-Pair mode, there are some special considerations. Given a **Type-3/4 Single**, **Class 5** – **Class 8** emulation, the waveform must deal with the fact that the pairset classifying the emulated PD is completely unpredictable and so it attempts to replicate what the PD experiences on the far side of the rectifying bridge (*see section 2.3*). To do this, the following processing is performed to form a **4-Pair Current**:

Format	Type-3/4 Single Processing
Voltage	One Trace that is maximum of Alt-A and Alt-B voltage on a sample-by-sample basis
Current	One trace that is the sum of Alt-A and Alt-B voltage on a sample-by-sample basis

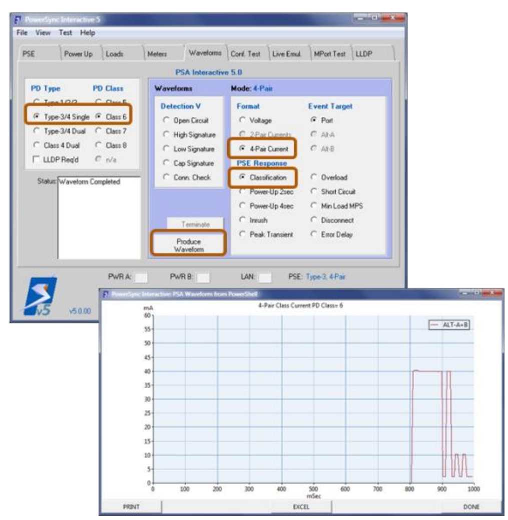


Figure 4.40 Class 6 Classification Current

Given dual signature **Class-3/4 Dual** or **Class 4 Dual** emulations, the only current option is **2-Pair Currents** because with dual signature PD's, each pairset is an independent entity during classification. Voltage traces are also produced separately per pairset given these emulations.

4.6.4. Power-Up Waveform

The **Power-Up** Waveform is very similar to what is produced when a trace is specified in the Power-Up tab menu. The underlying mechanisms to produce the 4-pair power-ups are identical.

One difference between the **Power-Up** tab and the **Waveforms** tab menu is that **Power-Up** waveforms are available for **Type-1/2/3** (2-pair) PD emulations in the **Waveforms** tab.

Power-Up waveforms come with two different apertures:

1. **Power-Up 2sec**: Captures 2 seconds from PD connection
7. **Power-Up 4sec**: Captures 4 seconds from PD connection

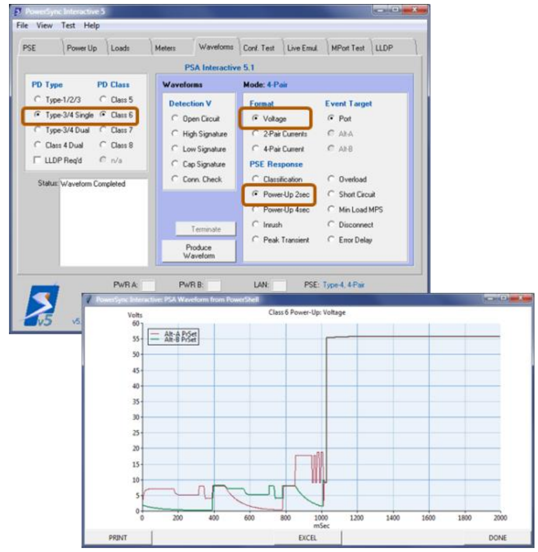


Figure 4.41 Emulated Class 4D Power-Up Voltage

While **Power-Up 2sec** will capture everything including the power-up for most 2-pair PSE's, 4-pair PSE's may take longer than 2 seconds to apply power. In general, many power-managed PSE's that rely on system firmware to authorize power-ups may take longer than one or two seconds to apply power to a PD.

In **Figure 4.41**, a **Type-3/4 Dual** signature PD with **Class 4** on each pairset is emulated while connected to a Type-4, 4-Pair PSE. The two second aperture is sufficient to capture both power-ups with this 802.3bt PSE.

4.6.5. Inrush Waveform

The **Inrush** waveform is utilized to evaluate PSE response to inrush overload currents. Generally, PSE's are required to furnish a minimum current between 400mA and 800mA, depending upon PD class, to support PD start-up (*see section 2.9*). This load current is expected to be tolerated for a minimum of 50 msec so long as the PSE output voltage remains above 30V.

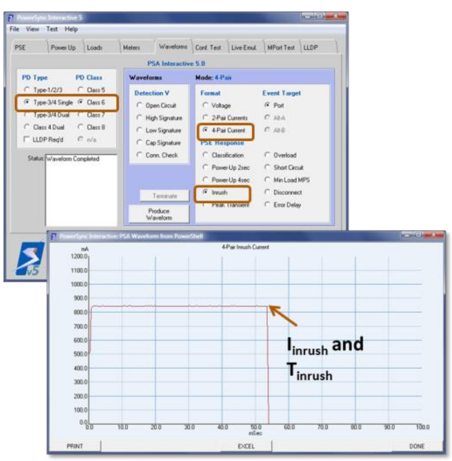


Figure 4.42 Inrush Current Waveform

PSE's are also expected to limit the maximum current flow during PD start-up. Depending upon PD class, the current should not exceed either 450mA or 900mA and the current limiting interval should not exceed 75 msec.

The **Inrush** waveform produces sufficient inrush overload current to force the PSE into a current limiting state. In a 2-Pair mode, a 500mA current is drawn and the PSE should limit between 400mA and 450mA. In a 4-Pair mode, a 1000mA current is drawn and the PSE should limit as follows.

PD Class	Max 4-Pair Current	Max 2-Pair Current
0 - 4	450mA	450mA
5 - 8	900mA	600mA
1D – 5 D		450mA

Generally, the Inrush waveform should be configured for **Current** rather than **Voltage** since current tolerance and current limiting are two of the important properties of interest. Inrush timing can be evaluated with either format. In 4-Pair mode with **Type-3/4 Single** emulation, both **4-Pair Current** and **2-Pair Currents** will be of interest. With dual signature PD emulations, only the **2-Pair Currents** format will be meaningful.

Figure 4.42 is an emulated **Class 6**, **4-Pair Current** waveform. In this waveform the 4-pair PSE allows over 800mA and limits current just below 850mA for a time duration of about 54msec.

4.6.6. Peak Transient Waveform

Once a PSE is powering a PD, the 802.3at and 802.3bt standards describe a minimum overload transient load that a PSE is expected to tolerate for a minimum time duration. This overload is referred to as **I_{LIM_min}** in 802.3at and **$I_{LIM\_min\_2p}$** in 802.3bt (*see section 2.11*).

I_{LIM}_min may be thought of as the lowest possible current level where a PSE will restrict, or limit current output to comply with the standard. When powering 4-pairs, both pairsets Alt-A and Alt-B are expected to support this level of load transient under all conditions.

The **Peak Transient** waveform produces the **I_{LIM}_min** (or **I_{LIM}_min_2p**) load transient and captures the PSE response to this transient. **Figure 4.43** is an emulated **Class 6** instance of the **Peak Transient** waveform using the **2-Pair Currents** format so that **I_{LIM}_min_2p** is evaluated.

When powering in 4-Pair mode, the **Peak Transient** is one of several waveforms that may be applied uniformly to both pairsets or alternatively, targeted to a specific pairset, **Alt-A** or **Alt-B**. The **Event Target** radio buttons define where the transient is applied.

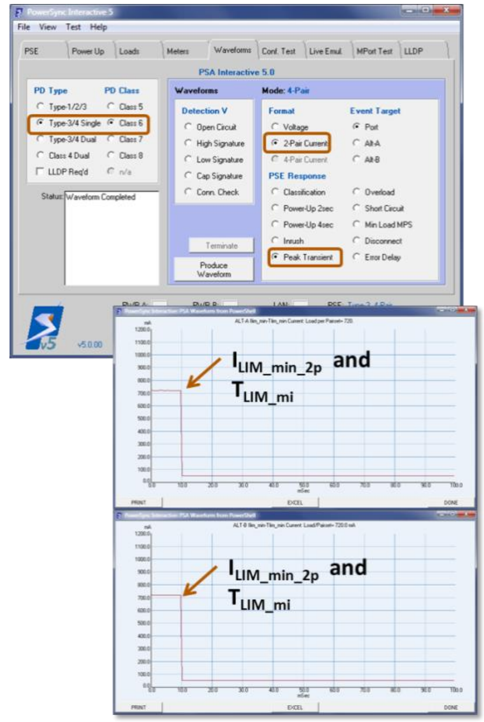


Figure 4.43 $I_{LIM\_min\_2p}$ Current Waveform

4.6.7. Overload Waveform

The **Overload** waveform (*see **Figure 4.44***) seeks to discover a current threshold where the PSE removes power in a time band between 50msec and 75msec. This waveform would normally be viewed as current rather than voltage.

Overload shutdowns were covered in section 2.11. The **Overload** waveform scans over a range governed by the selected **PD Type** and **PD Class**. The waveform applies load transients that are 150 msec in duration with the expectation that an **Icut** overload shutdown should occur before 75 msec (**Tcut_max**). When the shutdown occurs, the current should drop to 0mA when the PSE removes voltage from the emulated PD.

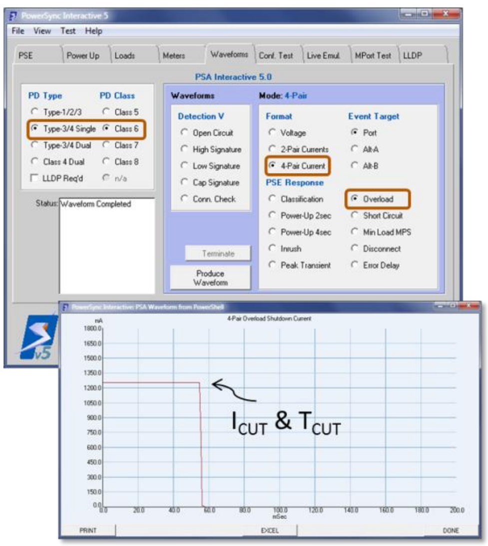


Figure 4.44 Overload Current Waveform

In a 4-Pair mode, the **Overload** waveform may be viewed either as **4-Pair Current** or **2-Pair Currents** (Alt-A and Alt-B separately). Generally, when emulating **Type-3/4 Single** PD's, the **4-Pair Current** is more meaningful unless the overload is targeted to a single pairset. When evaluating dual signature PD emulations, **2-Pair Currents** are more meaningful. **Figure 4.44** demonstrates a 4-pair overload shutdown while emulating a **Type-3/4 Single**, **Class 6** PD.

Like the **Peak Transient** waveform the overload condition may be targeted to both pairsets as a 4-pair current, or to a specific pairset, **Alt-A** or **Alt-B**, as a 2-pair current using the **Event Target** radio buttons.

4.6.8. Short Circuit Waveform

The Short Circuit waveform (*see **Figure 4.45***) is a special case of an overload shutdown that probes the PSE port for an upper limit to output current.

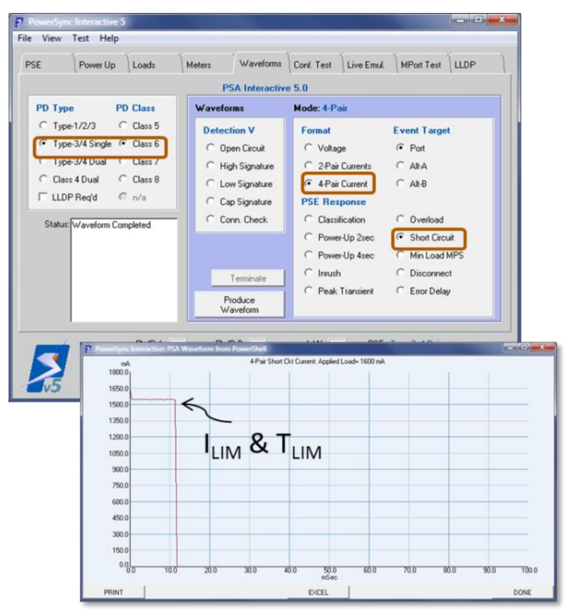


Figure 4.45 Short Circuit Current Waveform

Similar to inrush behavior discussed earlier in section 4.6.5, a PSE will enter a current limiting behavior when the load current from a PD exceeds some threshold (I_{LIM}) that is often **PD Type** and **PD Class** specific. The purpose of the waveform is to expose that threshold and to assess the shutdown timing. As with the **Overload** waveform, generally the most meaningful format for **Short Circuit** is a **Current** waveform.

Section 2.11 above reviewed PSE overload and short circuit behaviors. Type-1 PSE's are generally expected to support a current limiting phase for 50msec or longer, Type-2 and Type-3 PSE's for 10msec or longer, and Type-4 PSE's for 6msec or longer. PSE's should not remain in current limit for longer than 75msec, or **Tcut_max**.

The **Short Circuit** waveform uses brief load transients whose duration is PD Class dependent, and specifically seeks conditions where the PSE restricts current output to a level lower than that of the applied load transient.

In a 4-Pair mode, the **Short Circuit** waveform may be viewed either as **4-Pair Current** or **2-Pair Currents** (Alt-A and Alt-B separately). Generally, when emulating **Type-3/4 Single** PD's, the **4-Pair Current** is more meaningful unless the overload is targeted to a single pairset. When evaluating dual signature PD emulations, **2-Pair Currents** are more meaningful. **Figure 4.45** demonstrates a 4-pair overload shutdown while emulating a **Type-3/4 Single**, **Class 6** PD.

Like the **Peak Transient** and **Overload** waveforms the short circuit condition may be targeted to both pairsets as a 4-pair current, or to a specific pairset, **Alt-A** or **Alt-B**, as a 2-pair current using the **Event Target** radio buttons.

4.6.9. Min Load MPS Waveform

The subject of PSE power removal upon PD disconnect was addressed earlier in section 2.13. The **Min Load MPS** waveform (*see **Figure 4.46***) creates a scenario to test the **Tmps** processing of the PSE.

The **Tmps** and **Tmpdo** parameters in 802.3at and 802.3bt create a minimum valid DC MPS signature duty cycle whereby a value of I_{HOLD} current appearing at this duty cycle should cause the PD to maintain powering to the PD. This allows a connected PD to draw a small fraction of a watt and maintain power from the PSE.

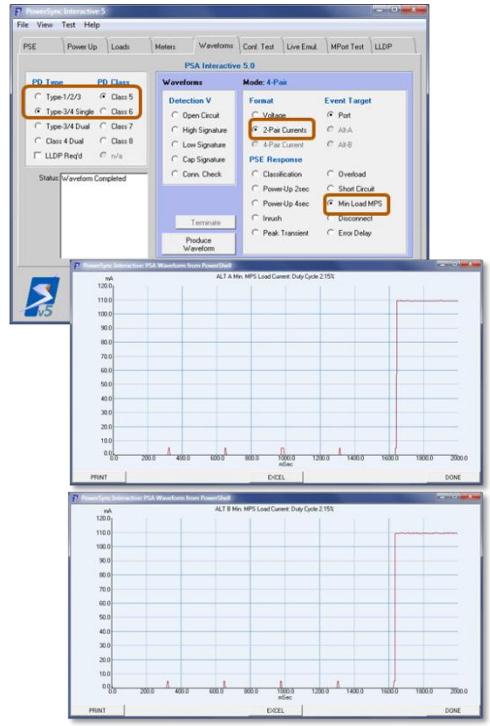


Figure 4.46 Min Load MPS Current Waveform

The values for **Tmps**, **Tmpdo**, and I_{HOLD} vary according to **PD Type**. The **Min Load MPS** waveform automatically configures the scenario of a minimum possible DC MPS "signature" for the emulated PD and cycles that across 5 successive **Tmpdo** time durations so that PSE response to the low DC MPS duty cycle can be evaluated. PSE's should remain powered over the duration of the trace.

If viewed using a **Current** trace, the five **Tmps** duration current pulses of magnitude **I_{HOLD}_2p** are visible before a steady state load current is returned indicating the PSE has maintained power. The **Voltage** trace view should just indicate the presence of PSE output voltage over the duration of the trace.

When in 4-Pair mode, the only current trace option is **2-Pair Currents**. This allows viewing of the individual pairset currents used during the waveform. When emulating a **Type-3/4 Single PD**, the pairset load currents are 8mA for a combined 4-pair load of 16mA. These values are just slightly above the absolute limit for **I_{HOLD}_min**, allowing for load tolerance error in the PSA instrument.

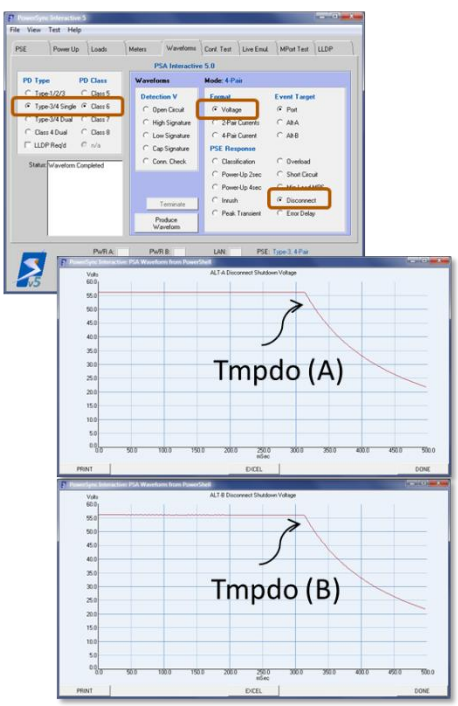


Figure 4.47 PD Disconnect Voltage Waveform

4.6.10. Disconnect Waveform

The **Disconnect** waveform (*see **Figure 4.47***) allows observation of PSE response to a PD disconnect event. Generally, since there is no current flow upon PD disconnect, only the Voltage format of this waveform is of use.

PSE's are expected to remove operating voltage to the PD in the **Tmpdo** time frame that is greater than 300msec but less than 400msec (*see section 2.13*). Also of interest is the voltage activity following power removal where voltage should drop to below 30V and remain there.

In a 4-Pair mode, disconnects may be applied coincidentally to both pairsets (or to the **Port**), or alternatively, to an individual pairset, **Alt-A** or **Alt-B**. Generally, a Type-3/4 Single PSE should not remove power to either pairset if just one is disconnected while PSE's *may* treat dual signature PD pairsets independently and power down only the disconnected pairset.

Figure 4.47 shows a Type-3/4 Single, Class 6 emulated PD disconnect shutdown.

4.6.11. Error Delay Waveform

The **Error Delay** waveform (*see **Figure 4.46***) captures PSE (voltage) activity following removal of power for an "error condition" such as an overload or short circuit overload. In such cases, PSE's are required to hold off re-powering the PD for at least 750 msec. Many PSE's will inhibit powering for considerably longer.

The **Error Delay** waveform is only practical when viewed as **Voltage** rather than **Current**. This waveform captures PSE activity for a period of 5 seconds after inducing a high overload shutdown, typically an $\mathbf{I_{LIM}}$ shutdown (*see section 2.11*). The expectation is that the PSE should not perform a PD detection that leads into a power-up in less than the specified 750msec.

In a 4-Pair mode, the overload condition used may be targeted at both pairsets concurrently (**Port**) or to an individual pairset **Alt-A** or **Alt-B**. Pairset testing is primarily useful in evaluating PSE's given dual signature PD emulations.

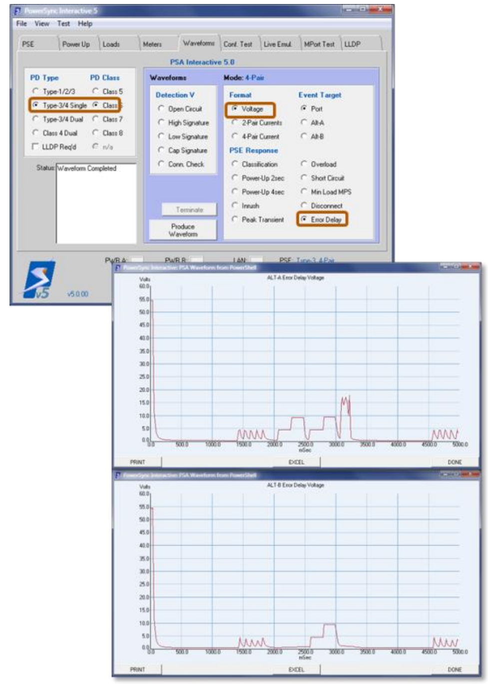


Figure 4.48 Error Delay Voltage Waveform

4.7. PSA Interactive Menu Bar

Before addressing the feature-specific tab menus, the drop-down menus available from the PSA Interactive menu bar will be reviewed. There are four drop-down menu items:

1. File
2. View
3. Test
4. Help

4.7.1. File Drop-Down Menu

The **File** menu (*see **Figure 4.50***) offers four menu items. **Load Config** and **Save Config** perform the exact same functions as the **PSE** tab menu **Load PSE Attr** and **Save PSE Attr** buttons described earlier in section 4.2.3. The **Exit** option closes PSA Interactive.

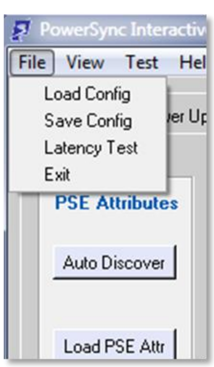


Figure 4.50 File Menu

The **Latency Test** option opens the **Latency Evaluation** menu (*see **Figure 4.51***) that is used to assess LAN communication performance between the host PC and the PSA instrument. This capability is most important to users that frequently run the **PSE Conformance Test Suite** (*see section 3.3*). The intent of the latency test utility is to determine if network connection latencies or host PC applications that interfere with host I/O could possibly disrupt time sensitive measurements in the Conformance Test Suite.

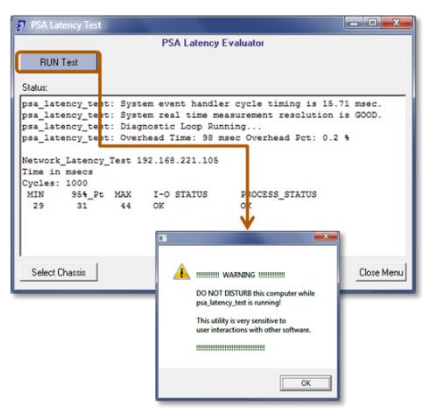


Figure 4.51 Latency Test

4.7.2. View Drop-Down Menu

To options are available under the View drop-down menu (*see **Figure 4.52***).

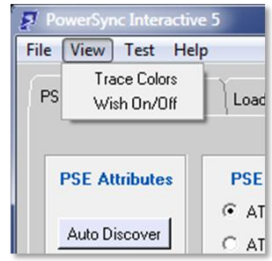


Figure 4.52 View Menu

1. Trace Colors
8. Wish On/Off

Figure 4.53 Trace Colors

The **Trace Colors** option opens the **Select Color Scheme** menu (*see **Figure 4.53***) that offers six options for the standard waveform trace windows that pop up when traces are collected either in the **Power-Up**, **Meters**, or **Waveforms** tab menus.

The **Wish On/Off** option acts as a toggle switch to either open or close a PowerShell Wish console (*see **Figure 4.54***) that enables command and query capability using PowerShell PSA commands (*see section 5*). This can be a convenient tool to effect configurations or measurements that may not be fully supported in the PSA Interactive menus.

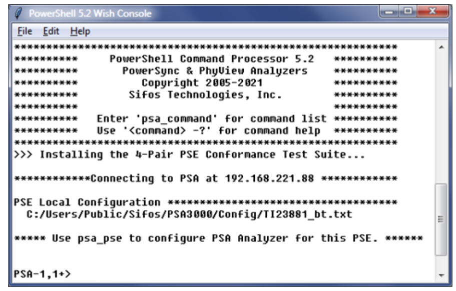


Figure 4.54 Wish Console

4.7.3. Help Drop-Down Menu

The Help drop-down menu (*see **Figure 4.55***) provides three options:

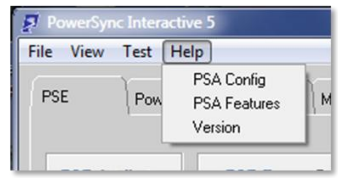


Figure 4.55 Help Menu

1. PSA Config
2. PSA Features
3. Version

The **PSA Config** option queries the presently connected instrument configuration, then opens a window show display the configuration (*see **Figure 4.56***). Configuration information from the instrument includes instrument hardware type, hardware version, and firmware version for all populated test slots. (PSA-3402 and PSA-3002 instruments are considered to populate slot #1.)

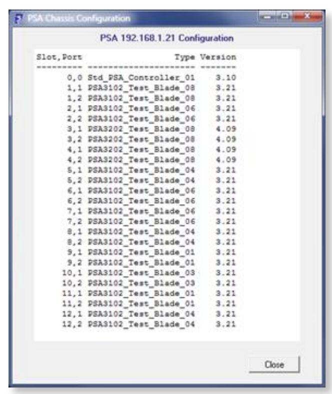


Figure 4.56 PSA Config

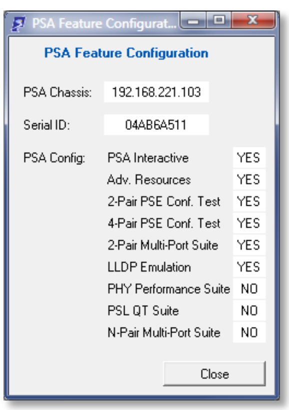


Figure 4.57 PSA Features

The **PSA Features** option queries the presently connected instrument license features, then displays those in the **PSA Feature Configuration** window (*see **Figure 4.57***). Configurations include:

Feature	Description
PSA Interactive	(*always* "YES")
Advanced Resources	PSA-3xxx Instrument vs PSL-3xxx Instrument
PSE 2Pr Conformance Suite	Instrument licensed for the 2-Pair Conf. Test Suite
PSE 4Pr Conformance Suite	Instrument licensed for the 4-Pair Conf. Test Suite
PSE 2Pr Multi-Port Suite	Instrument Licensed for the 2-Pair Multi-Port Suite
LLDP Emulation	Instrument Licensed for LLDP Emulation and Analysis
PHY Performance Suite	(*Pertinent to PVA-3000 instruments only*)
PSL QT Suite	*(Pertinent to PSL-3424 instruments only)*
PSE NPr Multi-Port Suite	*(Pertinent to PSL-3424 instruments only)*

The **Version** option opens the **PSA Interactive Version** window (*see **Figure 4.58***) to show software version including the module versions for all of major components of PowerShell PSA and PSA Interactive software.

Figure 4.58 Version

4.7.4. Test Drop-Down Menu

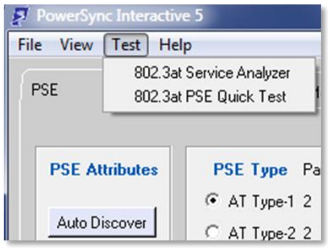


Figure 4.59 Test Menu

The **Test** drop-down menu (*see **Figure 4.59***) provides access to two automatic testing applications that are not otherwise available through the tab menus in PSA Interactive.

The first application is the **802.3at Service Analyzer** (*see **Figure 4.60***). This application is designed for qualifying 802.3at-based PoE service at any service outlet where an PD would connect. The **PoE Service Test** application is the topic of section 10.

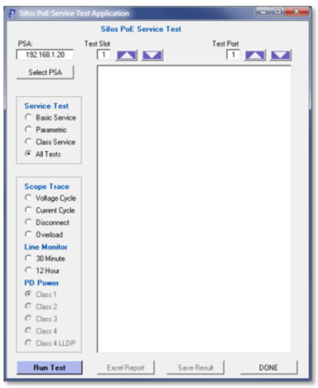


Figure 4.60 Service Analyzer

The **802.3at PSE Quick Test** is an automated test designed to rapidly test between four and eight PSE ports at a time. It is applicable to multi-port, 802.3at compliant PSE's.

The **PSE Quick Test** menu (*see **Figure 4.61***) accesses the PSA Quick Test automated test utility. This fully automated PSE test allows for rapid "go-no/go" testing of between 4 and 8 PSE ports per test cycle. The PSA Quick Test program (*see section 5.14*) analyzes up to 9 critical PSE behaviors is as little as 8 seconds per PSE port tested. Those parameters include:

Parameter	Description
Detect_Accept	Verify that each PSE port will power 19KΩ and 26KΩ PD signatures
Detect_Reject	Verify that each PSE port will not power 15KΩ and 33KΩ PD signatures
Vport_Low_Load	Maximum PSE continuous port voltage by PSE port
Vport_High_Load	Minimum PSE continuous port voltage by PSE port
Load_Capacity	Maximum load current tolerated per PSE port
Power_Capacity	Maximum continuous output power per PSE port
Disconnects	Verify that each PSE port removes power within 500msec of PD disconnects
Overloads	Verify that each PSE port removes power within 100msec of PD overloads
LLDP_Allocations	Verify PoE LLDP protocol response (*LLDP PSE's only*)

While primarily intended to be run from PowerShell PSA as a manufacturing or high volume QA application, PSA Quick Test may also be configured and run from PSA Interactive using the **PSE Quick Test** menu (see ***Figure 4.61***). The menu will allow a selection of up to 8 test ports. If fewer than 4 ports are selected, a warning message will appear indicating that at least 4 ports must be tested.

The only other configuration is **PSE Type** that must be declared as **Type-1**, **Type-2 PHY** meaning a Type-2 PSE that uses 2-Event classification to grant 25.5W to each PD, and **Type-2 LLDP** meaning a Type-2 PSE that uses PoE LLDP to grant any power level above 13W to Type-2 PD's. Once the ports are selected and PSE Type is declared, then **RUN TEST** will initiate PSE Quick Test.

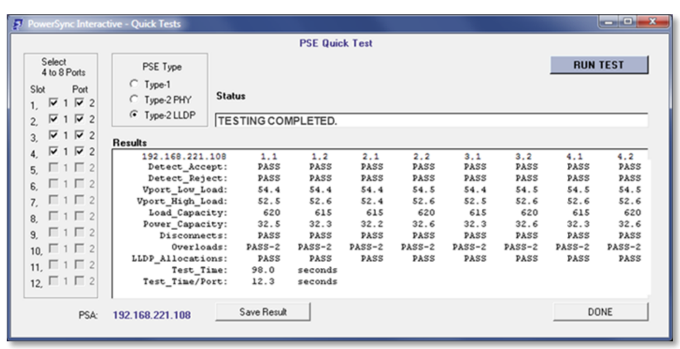


Figure 4.61 PSA Quick Test Menu

The **psa_quick_test** script for PowerShell PSA is provided as source code that users may modify (*see section 5.14*). The file is located in the …\Contrib\ directory path (*see section 3.2.5*). Users should be aware that modifications to that program may affect how it will behave when run from the PSE Quick Test menu in PSA Interactive.

4.8. PSE Conformance Test Menu

The Conf. Test tab menu is used to perform automated PSE conformance testing of both **2-Pair** (802.3at/802.3bt) and **4-Pair** (802.3bt) PSE's. The behavior of this menu is totally dependent on three basic factors:

1. PSA-3000 license* for the **2-Pair** PSE Conformance Test Suite (PSA-CT2P).
2. PSA-3000 licence* for the **4-Pair** PSE Conformance Test Suite (PSA-CT4P).
3. PSE attributes as declared or determined in the PSE tab menu.

As the 2-Pair and 4-Pair PSE Conformance Test Suites are separate and autonomous feature licences, the menu must respond to the PSE attributes established in the PSE tab menu in order to determine if testing is licensed and then to further determine what PD Loading and which PSE conformance tests should be made available.

If an instrument is licensed* for neither the 2-Pair nor the 4-Pair PSE Conformance Test Suite, the **Conf. Tab** menu will be fully disabled and not accessible. If an instrument is licensed for one of the two test suites, then the menu will only be functional when the described PSE (2-Pair or 4-Pair) matches the licensed test suite.

4.8.1. 2-Pair PSE Conformance Testing

When testing 2-Pair PSE's, the Conf. Test tab menu (*see **Figure 4.63***) opens indicating that the **2-Pair** test suite (with its associated version code) is the active test suite. PSE attributes including PSE Type, powered pairs, maximum power grant method, and MPS method are displayed. These attributes will determine which tests are available to the PSE and will further restrict PD Loading conditions. **PD Emulations** describes the type of PD emulation that is performed during PSE conformance testing. The PD Emulations utilized during testing are automatically selected according to the PSE Type: A 15W capable PSE (e.g. 802.3at **Type-1**) will have a Max Grant value of **NONE** and the only PD emulation applied will the Type-1, 15.4W. A 30W capable PSE (e.g. 802.3at **Type-2** or 802.3bt **Type-3**) will have a Max Grant value of **PHY**, **LLDP**, or **PHY+LLDP** and the PD emulations applied during testing will include *both* Type-1 PD's and Type-2 PD's.

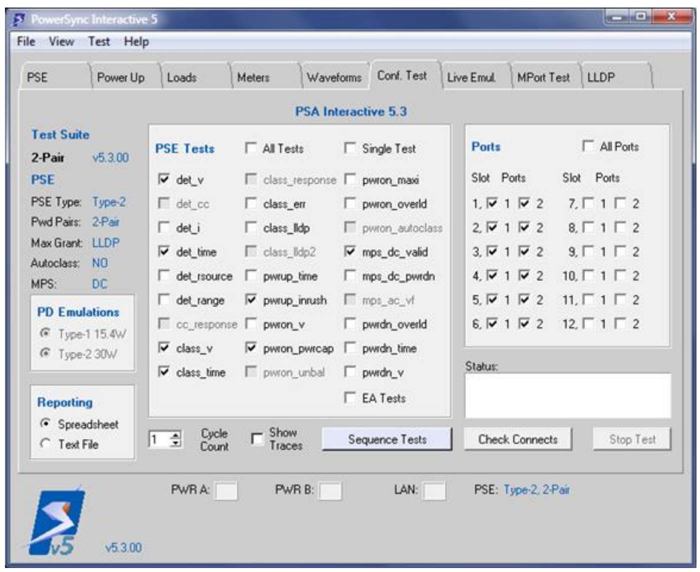


Figure 4.63 PSE Conformance Test Menu: 2-Pair PSE Testing

When sequencing tests automatically, users may use the **PSE Tests** menu to select individual tests to include in the sequence or may simply select **All Tests** to run every applicable test given the PSE attributes and **PD Loading**. Tests that are not applicable to the test suite or to the declared PSE attributes will be disabled and therefore not selectable.

The menu also supports a mode where a **Single Test** can be run on a selected test port. When **Single Test** is selected, the PSE Tests menu will permit selection of just one test and the test will be run on the selected port in the Slot-Port Selection Panel (*see section 4.1*). The **Sequence Tests** button will be renamed to **Run Test**. Upon completion, the results are displayed in a pop-up window (*see **Figure 4.64***).

The **Ports** sub-menu allows selection of slots and ports where sequences will be run. Slot-Port checkbuttons will be enabled wherever there is a PSA-3102 or PSA-32x2 test port located in the presently connected PSA instrument. Selecting **All Ports** will automatically cause test sequencing to occur on all available test ports.

4.8.2. General Test Sequencing Features

Whether running **2-Pair** or **4-Pair** PSE conformance test sequences, there are two available **Reporting** options. The default option is a pop-up (Microsoft Excel) **Spreadsheet** report where all of the parameter limit checking and associated statisitics are performed. This is the standard PSE Conformance Test report *(see sections 4.8.4 and 4.8.5*).

* If PSA software is updated and the associated **2-Pair** or **4-Pair** conformance test **Product Key** is not provided during software installation, then the PSA-3000 instrument license for that test suite will be deactivated. The license can be re-activated by re-installing the PSA software update with the required Product Key(s).

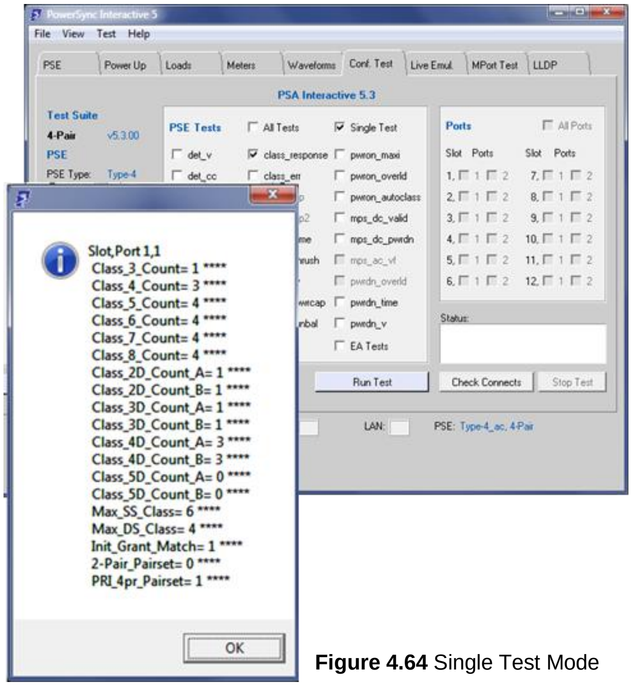


Figure 4.64 Single Test Mode

Alternatively, test sequence reporting can be routed to a **Text File** (.txt) that will have a name derived from time and date of testing. This mode is provided primarily for situations where Microsoft Excel is not available.

When sequencing tests, users have the option to repeat the test sequence of all selected tests on all selected ports over multiple cycles using the **Cycle Count** control. This allows up to 16 repeat cycles of testing. Repeat cycles are useful when peforming exhaustive QA of a PSE or when studying intermittent behaviors of a PSE.

The **Show Traces** control instructs each test that collects and processes waveform traces to display those traces as they are collected and analyzed. This can be useful for observing PSE behaviors while tests are running or when they complete.

The **Check Connects** button runs a utility that verifies PSE physical connectivity to all selected test ports in the **Ports** menu. This should generally be done before sequencing tests. The results of the connection check are posted to the **Status** display.

The **Sequence Tests** button initiates a test sequence covering the selected tests, test ports, and cycle count. As testing proceeds, the **Status** display will update indicating currently running test and test port. Once testing as commenced, the **Stop Test** button will activate. The test sequence can be stopped nearly immediately by pressing this button.

4.8.3. 4-Pair PSE Conformance Testing

When testing 4-Pair PSE's, the Conf. Test tab menu (*see **Figure 4.65***) opens indicating the **4-Pair** test suite (with its associated version code) is the active test suite. PSE attributes including PSE Type, powered pairs, maximum power grant method, Autoclass support, and MPS method are displayed.

The **PD Emulations** sub-menu is altered and enabled to include **Full Conformance** and **Exclude Dual Sig. Full Conformance** should be selected if performing complete PSE Conformance Testing on a Type-3 or Type-4 4-Pair PSE. **Exclude Dual Sig.** will cause the test suite to bypass dual signature PD emulations in some of the long duration tests including **det_range**, **class_v**, **class_time**, **pwron_pwrcap**, **pwron_maxi**, **pwron_overld**, and **mps_dc_valid**. This will save considerable time because fewer parameters are measured.

In the 4-Pair test suite, the only tests conditioned on PSE attributes are the LLDP tests **(class_lldp, class_lldp2)** and **pwron_autoclass**. The **mps_ac_vf** test is never available in the 4-Pair suite because 802.3bt does not support AC MPS.

The **Ports** menu is restricted to PSA-32x2 test ports only. PSA-3102 test ports will be excluded when the **4-Pair** test suite is active. All other behaviors of the **Conf. Test** tab menu when the 4-Pair test suite is active are identical to the behaviors described under 2-Pair PSE Conformance Testing (*see section 4.8.1*).

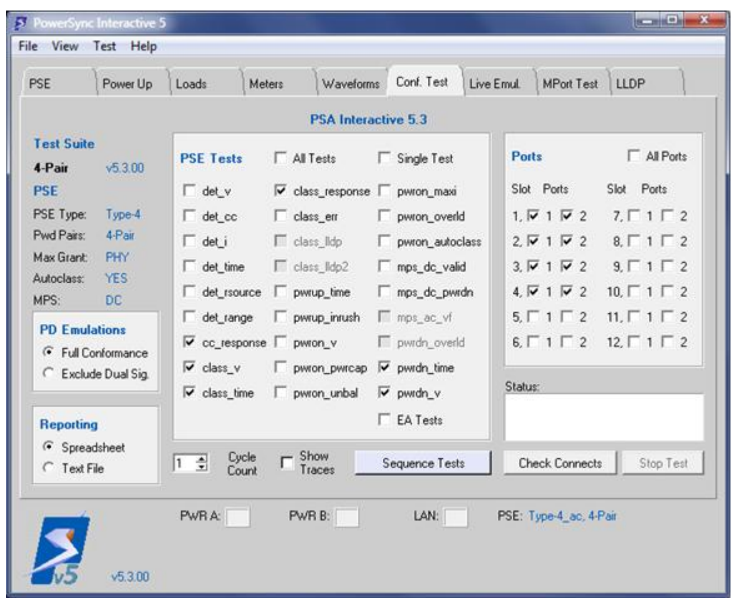


Figure 4.65 PSE Conformance Test Menu: 4-Pair PSE Testing

4.8.4. PSE Conformance Test Reporting: 2-Pair 802.3at and 802.3bt PSE's

There are two types of reports available from the Test Sequencer. The first is an automatic Excel Spreadsheet Report (*see **Figure 4.67***), **psa_report.xlsm** (in the "…\Results\" directory and each subdirectory below this level – *see sections 3.2.5 and 3.2.6*). This is the report that performs IEEE 802.3 limit checking to 802.3at and to 2-Pair 802.3bt PSE's.

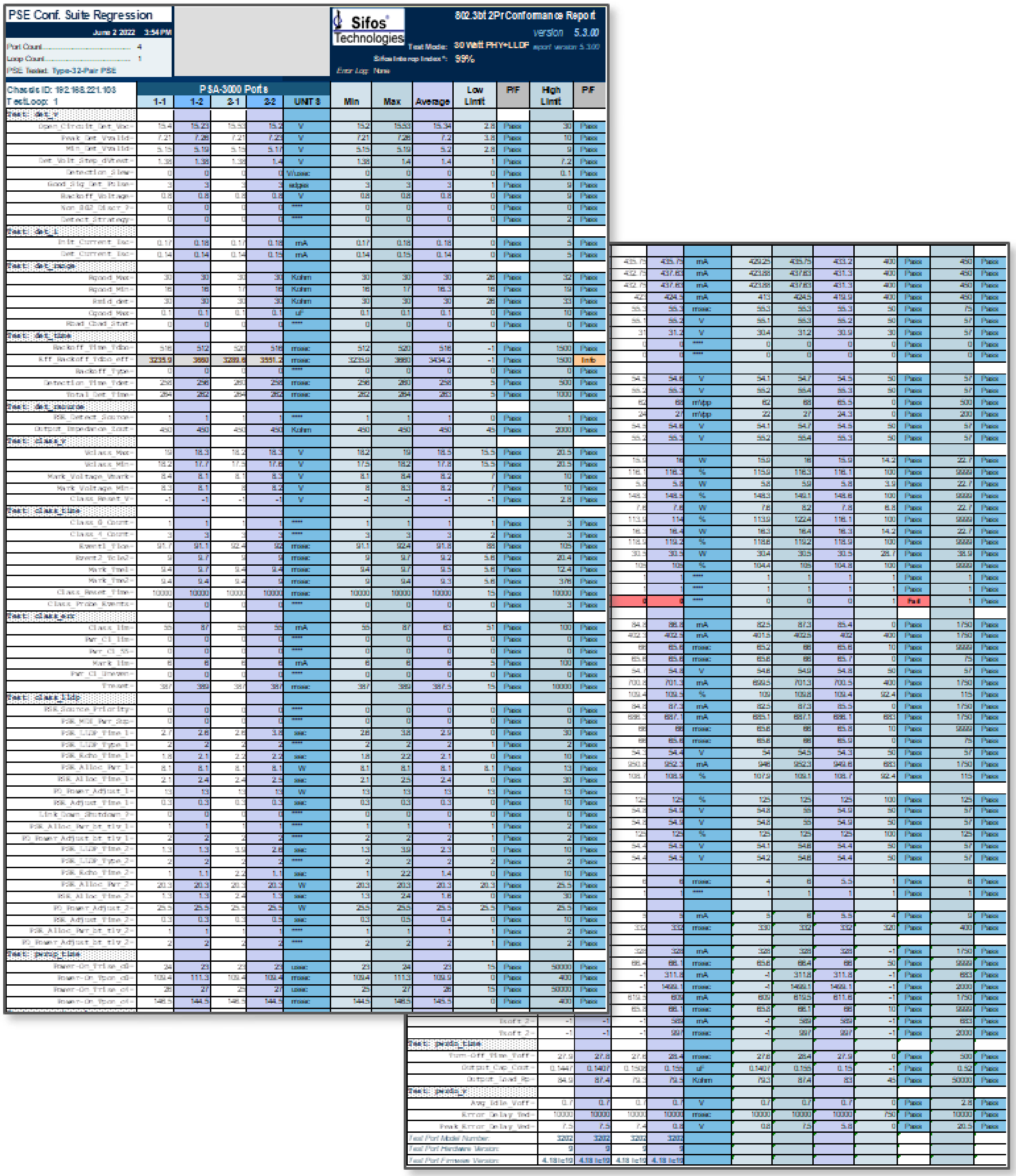


Figure 4.67 PSE Conformance Test Pop-Up Spreadsheet Report (2-Pair Type-2 PSE)

Note: *Microsoft Excel 2007(or newer) must be separately installed and configured to low macro security for this report to function properly.*

This spreadsheet automatically executes a macro sequence to form around the dimensions of data collected (tests, slot-ports, test cycles) and produce test data, test statistics by test cycle, and test limit checking against 802.3 PSE specification parameters. The Test Sequencer uses a file called psa_report_data.csv as an intermediate to capture data prior to loading that data in to **psa_report.xlsm**. Upon completion of the test sequence, **psa_report.xlsm** will automatically open and present the test data. As the file opens, the macro will be removed so that the file becomes

psa_report.xlsx. Users may then save this (.xlsx) file using MS Excel's standard menu to a directory and file name that they choose. The report includes the time and date that the sequence of tests was initiated.

Important! PSE specification performance is assessed by observing the two "**PF**" (Pass/Fail) columns in this report. Any occurrence of a **FAIL** indication means the PSE is not compliant to one or more features described by the IEEE 802.3 specification. PSE specification compliance is established if all applicable tests are sequenced and there are no occurances of a **FAIL** indication. Any occurance of an INFO indication means that a tested parameter is either impossible to fully resolve without internal design knowledge or that a parameter is specification compliant but is not a "recommended" configuration according to IEEE 802.3.

Note: *PSA Software will automatically create chassis-specific subdirectories under the \Results\ path for storage of PSE Conformance test reports. These default reporting locations (i.e. directories) may optionally be overridden by entries in the PSE Attributes Files described earlier in sections 3.2.4 and 4.2.*

The standard 2-Pair PSE Conformance Spreadsheet Report also includes a spreadsheet page for the 802.3 PSE Conformance Test **Limits** and a **Notes 5.x.x** page describing the various PSE Conformance Tests and all measured parameters and IEEE 802.3 PICS coverage. Finally, it offers a "Sifos Interop Index" (*see **Figure 4.68***) page that provides an **802.3at** interoperability "index" and information describing its calculation. The Interoperability Index is a bulk indication of interoperability risk with 100% representing a minimal chance of interoperability problems when powering compliant PD's on compliant cabling links. The Sifos Interop Index is tabulated only when a high percentage of the PSE Conformance Test Suite is run on one or more PSE ports.

802.3at Conformance Report

June 13 2022 10:52 PM

Port Count.................................... 4
Loop Count.................................... 1
PSE Tested:

Sifos PSE Interop Index*: **93%**

Tests Run: 19
Total Parameters: 105

version 5.3.0a
report version 5.3.0a

Sifos Technologiess

Interoperability Test Items	UNITS	Min	Max	Average	Low Limit	P/F	High Limit	P/F	Deduct Points
Rgood_Min=	Kohm	11	18	14.5	16	Fail	19	Pass	1.5%
Rmid_det=	Kohm	11	11	11	26	Fail	33	Pass	0.9%
Cgood_Max=	uF	7.1	11.1	9.1	0	Pass	10	Fail	0.9%
Rbad_Cbad_Stat=	****	1	1	1	0	Pass	0	Fail	0.9%
Backoff_Type=	****	3	3	3	0	Pass	0	Info	0.3%
Output_Impedance_Zout=	Kohm	35	40.1	37.5	45	Info	2000	Pass	0.3%
Inrush_Strategy_c4=	****	3	3	3	0	Pass	1	Info	0.3%
Vport_5%DC_2=	V	0.5	0.6	0.6	50	Fail	57	Pass	1.5%

Figure 4.68 PSE Conformance Test Spreadsheet Report – Sifos 2-Pair Interop Index Page

Note: *It is important to note that the Interoperability Index is **NOT** a measure of PSE Conformance to 802.3at.* PSE Conformance to IEEE 802.3 is established only by the absence of **FAIL** indications in the test report. See section 6.10 for further information regarding the PSE Conformance Test Report.

Test data from the **Test Sequencer** may alternatively be captured in a flat **Text File Report** (*see **Figure 4.69***) presenting test results in the exact order that testing is performed. This file may be copy-pasted into a spreadsheet if desired. It does not include any information beyond that generated directly by the various individual conformance tests that are sequenced. As with the **Spreadsheet Report**, the **Text File Report** will include a time-date header. The **Text File Report** will be unique to each test sequence as it embeds a time-date stamp within the file name, assuming that the **Standard Time-Date File** control is selected. Optionally, users may choose to specify a file name (**User Specified File**) and enter that name in the **Enter File Name** field. When this is done, the file name should include just a file name, not a directory path nor a file extension. The standard extension for all **Text File Reports** will be ".txt".

During the **Sequence Tests** execution, the sequence **Status** will display the test cycle, the current test, and the current slot-port.

```
PSA-3000 TEST RESULTS

Port Count: 2
Loop Count: 1
Time-Date: June 20, 2022 16:34
PSE: ATx610 Type-2 30W
Power: Type-2
Type-2_Grant: PHY

 TEST LOOP 1

Port: 1,1
det_v: Detection Voltages
   Open_Circuit_Det_Voc=         10.48             V
        Peak_Det_Vvalid=         7.95              V
         Min_Det_Vvalid=         3.99              V
   Det_Volt_Step_dVtest=         3.29              V
         Detection_Slew=         0.000             V/usec
     Good_Sig_Det_Pulse=         3                 edges
        Backoff_Voltage=         0.6               V
        Non_802_Discr_?=         0                 ****
        Detect_Strategy=         0                 ****
det_i: Detection Compliance
       Init_Current_Isc=           0.14            mA
        Det_Current_Isc=           0.10            mA
det_range: Detection Range
              Rgood_Max=         29                Kohm
              Rgood_Min=         17                Kohm
               Rmid_det=         29                Kohm
              Cgood_Max=          0.1              uF
         Rbad_Cbad_Stat=         0                 ****
det_time: Detection Time
      Backoff_Time_Tdbo=         133.0             msec
   Eff_Backoff_Tdbo_eff=         133.0             msec
           Backoff_Type=             0             ****
    Detection_Time_Tdet=         313.0             msec
         Total_Det_Time=         314.0             msec

Port: 1,2
```

Figure 4.69 PSE Conformance Test Text File Report

4.8.5. PSE Conformance Test Reporting : 4-Pair 802.3bt PSE's

The 4-Pair PSE Conformance Test Report (*see **Figure 4.70***) has many features that are similar to the 2-Pair PSE Conformance Test Report (*see Section 4.8.4*). However, the 4-Pair test report is considerably larger as it must produce at least twice as many parameters as the 2-Pair test report.

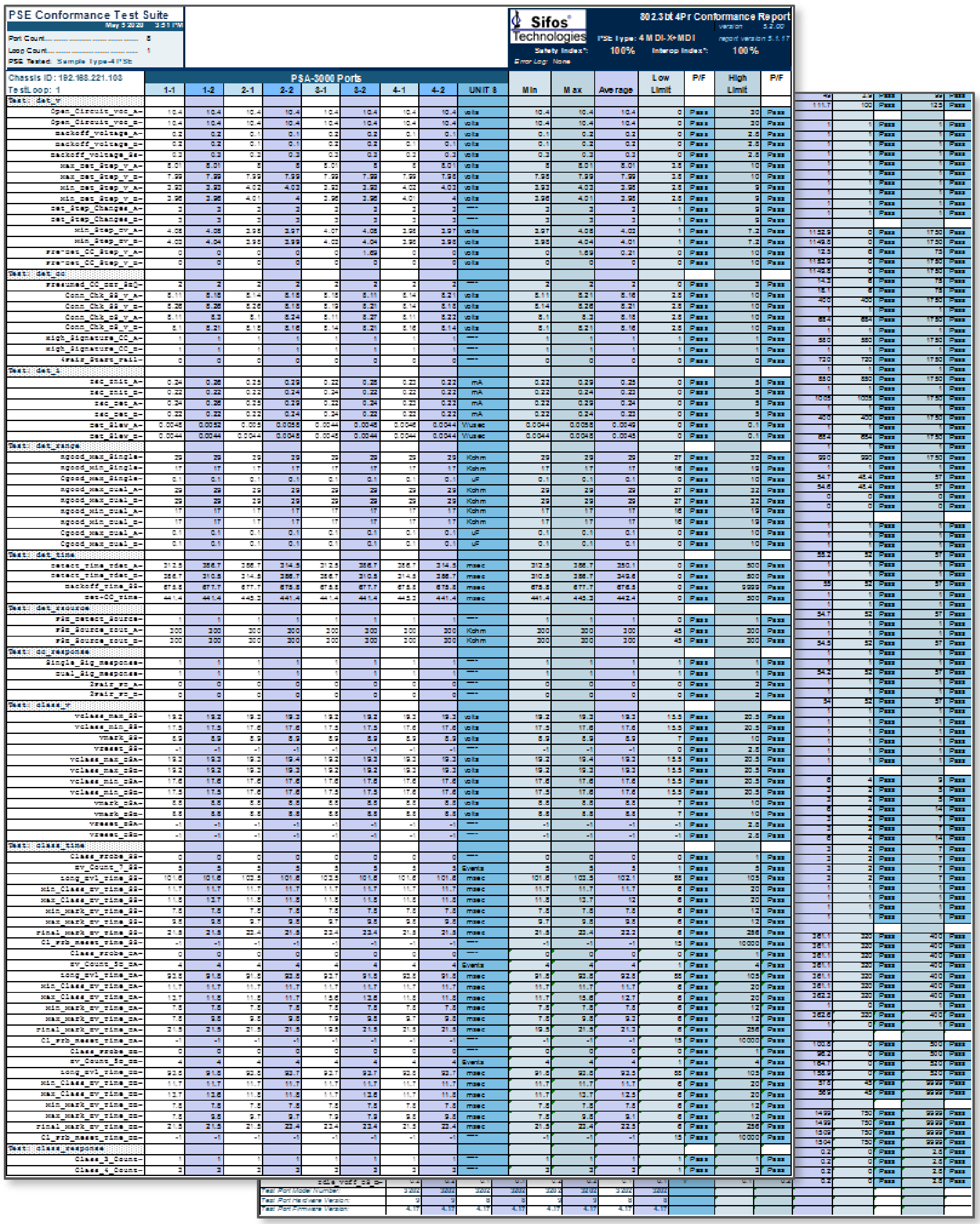


Figure 4.70 PSE Conformance Test Pop-Up Spreadsheet Report (4-Pair Type-4 PSE)

Important! The 4-Pair PSE Conformance Test Report produces two summary scores: A Sifos **Interop** index and a Sifos **Safety** index. As with the 2-Pair test report, these are somewhat arbitrary analyses of specific test parameters in specific tests performed in order to score overall performance. PSE 802.3bt Conformance should not be judged by these scores. Instead, a PSE is IEEE 802.3bt specification conformant if there are no **FAIL** marks in the test report.

The 4-Pair PSE Conformance Test Report includes a **Notes 5.x.x** tab page (*see **Figure 4.71***) with a very detailed explanation of all test parameters including special considerations associated with many of those parameters. All test parameters are mapped to 802.3bt clause, 802.3bt parameter name, and PSE / DLL PICS. This page serves to document PSE and DLL PICS coverage of the test suite.

4-Pair PSE Conformance Test Suite 5.x.x Tests and Parameters

Parameter	Description	Special Notes	802.3bt Coverage		
Test: det_v			**802.3 Parm.**	**PIC**	**802.3bt Clause**
Open_Circuit_Voc_A=	Peak Open Circuit Detection Voltage on Alt-A Pairset		VOC	PSE6	145.2.5.1
Open_Circuit_Voc_B=	Peak Open Circuit Detection Voltage on Alt-B Pairset		VOC	PSE10	145.2.6.1
Backoff_Voltage_A=	IDLE State voltage during detection backoff on the Alt-A Pairset	*Measured as a minimum voltage in the IDLE region when Dual detection signature is set to 37K Ω*	Voff, VReset	PSE12	145.2.6.2
Backoff_Voltage_B=	IDLE State voltage during detection backoff on the Alt-A Pairset			PSE15	
Backoff_Voltage_Ss=	IDLE State voltage during Single Signature detection backoff across both Pairsets	*Assess the IDLE Backoff voltage a Single Signature PD would see downstream of the full wave bridge with detection signature of 37K Ω. The 802.3bt standard requires PSE to pass through IDLE and separately requires IDLE voltage ≤ 2.8V. The parameter is treated as a Warning (Info mark) only because it is not clear that PSE-PD detection interoperability could be practically be affected by detection signaling that does not drop below 2.8V as a result of invalid detection backoff.*		PSE16 PSE21 PSD75 PSE76	 145.2.7 145.2.10.11
Max_Det_Step_V_A=	Maximum Detection Voltage with Valid Detection Signature - Alt-A Pairset	*Measured with (valid) 26K Ω signature*	Vvalid		
Max_Det_Step_V_B=	Maximum Detection Voltage with Valid Detection Signature - Alt-B Pairset				
Min_Det_Step_V_A=	Minimum Valid Step Voltage with Valid Detection Signature - Alt-A Pairset	*Measured with (valid) 19K Ω signature*			
Min_Det_Step_V_B=	Minimum Valid Step Voltage with Valid Detection Signature - Alt-B Pairset				
Det_Step_Changes_A=	Count of Detection Step Transitions on the Alt-A Pairset	*Measured with (valid) 26K Ω signature*			
Det_Step_Changes_B=	Count of Detection Step Transitions on the Alt-B Pairset				
Min_Step_DV_A=	Detection Step Magnitude from Max Voltage to Min Voltage - Alt-A Pairset	*Measured with (valid) 19K Ω signature*	ΔVtest		
Min_Step_DV_B=	Detection Step Magnitude from Max Voltage to Min Voltage - Alt-A Pairset				
Pre-Det_CC_Step_V_A=	Magnitude of any non-802 pre-detection signaling on the Alt-A Pairset	*Set to 0V if no predetection discovered. Predetection would generally include non-stepped signals that appear on just one pairset at any time.*			
Pre-Det_CC_Step_V_B=	Magnitude of any non-802 pre-detection signaling on the Alt-A Pairset				
Test: det_cc			**802.3 Parm.**	**PIC**	**802.3bt Clause**
Presumed_CC_DET_SEQ=	CC_DET_SEQ as described by the 802.3bt PSE State Machine.	*Based upon observations and analysis of PSE detection and connection check signaling relative to PSE state machine described sequences. Knowledge of this parameter is essential to the evaluation of detection timing behaviors.*	CC_DET_SEQ	PSE2 PSE3 PSE4 PSE7	145.2.4 145.2.5 145.2.5.1
Conn_Chk_SS_V_A=	Peak connection check voltage on the Alt-A Pairset with Single Signature	*These voltages must fall into the valid detection voltage band: 2.8V to 10V.*	Vvalid	PSE20	145.2.7
Conn_Chk_SS_V_B=	Peak connection check voltage on the Alt-B Pairset with Single Signature			PSE22	
Conn_Chk_DS_V_A=	Peak connection check voltage on the Alt-A Pairset with Dual Signature				
Conn_Chk_DS_V_B=	Peak connection check voltage on the Alt-B Pairset with Dual Signature				
High_Signature_CC_A=	Flag indication compliance to PSE state machine on the Alt-A Pairset. 1 is a PASS, 0 is a FAIL.	*The performance of Connection check is insensitive to PD detection signature validity if CC_DET_SEQ = 0, 2, or 3. If CC_DET_SEQ=1, then there should be no Connection Check given an invalid PD signature.*			
High_Signature_CC_B=	Flag indication compliance to PSE state machine on the Alt-B Pairset. 1 is a PASS, 0 is a FAIL.				
4Pair_Start_Fail=	Flag indication that the 4-Pair PSE failed to produce any signaling on at least one Pairset when a valid PD signature was connected.	*This is a serious problem if the PSE is designed to do 4-pair powering.*			
Test: det_i			**802.3 Parm.**	**PIC**	**802.3bt Clause**
Isc_Init_A=	Peak detection current @ >1.5V on the Alt-A Pairset	*PSE's are required to restrict detection current to 5mA or less in order to protect non-PD's. Testing is performed with a large capacitive load and peak current in each voltage band is assess as the derivative of current versus time. The PSA test port signature is visable above ~1.3V.*	Isc	PSE12	145.2.6.2
Isc_Init_B=	Peak detection current @ >1.5V on the Alt-B Pairset			PSE17	
Isc_Det_A=	Peak detection current @ >2.2V on the Alt-A Pairset			PSE21	145.2.7
Isc_Det_B=	Peak detection current @ >2.2V on the Alt-B Pairset				
Det_Slew_A=	Maximum expected detection voltage slew rate on the Alt-A Pairset	*This parameter is derived based upon the peak current and the voltage effect it would have given the minimum PD input capacitance of 0.05 μF on a pairset.*	Vslew		
Det_Slew_B=	Maximum expected detection voltage slew rate on the Alt-B Pairset				

Figure 4.71 PSE Conformance Test Report **Notes 5.x.x** Page

The report also includes tab pages used to compute the Sifos **Interop** and Sifos **Safety** scores (*see **Figure 4.72***). The weightings that govern how each test parameter influences the Interop and Safety scores are provided along with all test limits in the **Limits** tab page of the standard report.

4-Pair PSE Conformance Report

May 23 2020 4:23 AM
Port Count.................................. 8
Loop Count.................................. 1
PSE Tested: Sample Type-3 PSE PHY+LLDP

Sifos PSE Interop Index*: **95%**
Tests Run: 24
Total Parameters: 288

version 5.2.12
report version 5.2.00

Interoperability Test Items	UNITS	Min	Max	Average	Low Limit	P/F	High Limit	P/F	Deduct Points
Conn_Chk_DS_V_B=	volts	2.11	2.27	2.21	2.8	Fail	10	Pass	0.5%
Tinrush_minPr_Class_7=	msec	31.45	49.81	41.2	50	Fail	75	Pass	0.8%
Tinrush_maxPr_Class_7=	msec	31.45	49.81	41.2	50	Fail	75	Pass	0.8%
45ms_Pwr_Stat_Class_7=	****	0	1	0	1	Fail	1	Pass	0.5%
pseP2pUnbal_c8A=	****	0	0	0	1	Fail	1	Pass	0.5%
pseP2pUnbal_c8B=	****	0	0	0	1	Fail	1	Pass	0.5%
pseP2pUnbal_c7A=	****	0	0	0	1	Fail	1	Pass	0.5%

4-Pair PSE Conformance Report

May 23 2020 4:23 AM
Port Count.................................. 8
Loop Count.................................. 1
PSE Tested: Sample Type-3 PSE PHY+LLDP

Sifos Safety Index*: **95%**
Tests Run: 24
Total Parameters: 288

version 5.2.12
report version 5.2.00

Safety Test Items	UNITS	Min	Max	Average	Low Limit	P/F	High Limit	P/F	Deduct Points
Iinrush_4P_max2_Class_5=	mA	857.3	902.6	871.7	0	Pass	900	Fail	2.3%
Iinrush_4P_max2_Class_7=	mA	855.1	903.9	872.1	0	Pass	900	Fail	2.3%

Figure 4.72 4-Pair PSE Conformance Test Report Interop and Safety Score Pages

4.8.6. EA PoE Logo Certification for Gen1 (802.3at) and Gen2 (802.3bt)

Important! See EA PoE Registry for PSA software releases that are authorized for PoE Logo Certification testing.

The Ethernet Alliance (EA) introduced an industry program in 2017 to certify PSE's and powered devices (PD's) so that interoperability and safety factors associated with PoE network equipment could be better ensured across the industry. The certification program includes a PoE Logo, or mark, that is applied to certified equipment and to associated literature. The Gen2 PoE Logo Certification program covering 4-Pair capable 802.3bt PSE's and Class 1-8 PD's was introduced in 2020. Certified PSE's and PD's are listed in a public registry maintained by the EA.

EA Certified 2.0™

Manufacturers of PSE's and PD's have two options for obtaining the required testing necessary to receive the Ethernet Alliance PoE logo certifications.

3rd PARTY TESTING: One option is to work with a certified 3rd party laboratory where products are submitted and testing is conducted by an outside party approved by the Ethernet Alliance. This approach makes the most sense when only a few products are to be certified and need for re-certifications due to product updates or product variants are rare.

1st PARTY TESTING: The second option is to perform the testing in-house using Ethernet Alliance approved test equipment. In this scenario, testing is performed by the manufacturer or product developer and test reports are submitted to the Ethernet Alliance PoE Logo Certification program auditor, UNH-IOL.

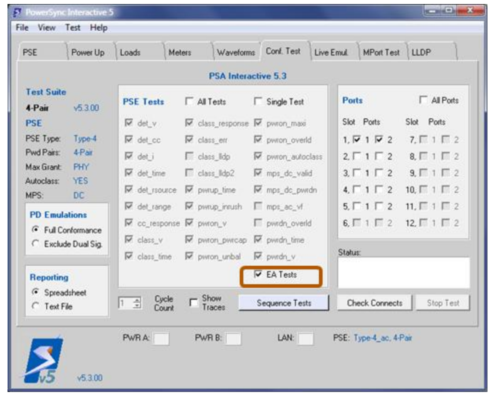


Figure 4.73 Selecting the (Gen2) EA Test Mode

For producers of PoE equipment, the **1st Party** alternative may offer *significant* benefits.

- **Lower external costs** to obtain and maintain EA logo certifications across a range of products
- **Reduced engineering effort** as fully automated testing normally performed to verify designs and design changes can also support the certification
- **Faster turn-around** time to obtain and update EA logo certifications
- **Flexibility** to routinely update products and to demonstrate certification compliance with minimal incremental effort
- **Avoid effort** and **information disclosures** required to justify multiple product versions (also referred to as "derivative product")
- **Overcome technical limitations** of a 3rd Party lab where "worst case" test conditions may be difficult or impossible to produce (e.g. PD's operating a maximum power draw)

Both the 2-Pair and 4-Pair **PSE Conformance Test Suites** have been designated certified test equipment for performing **Gen1** and **Gen2** PSE certification testing respectively. The Ethernet Alliance, working with their contracted "auditor", UNH-IOL, maintains a separate online registry of certified test systems and equipment.

To run the EA certification testing, simply check the **EA Tests** checkbox (*see **Figure 4.73***) and **Sequence** tests.

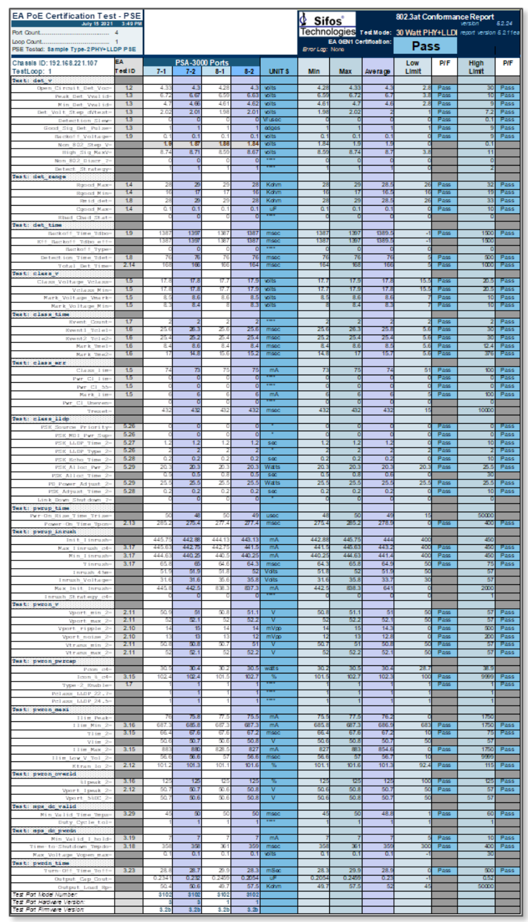

EA PoE Certification Test - PSE
Sifos Technologies
802.3at Conformance Report
Pass
PSA-3000 Ports

Figure 4.74 EA Approved (Gen1) Test Report

EA Gen1 (*see **Figure 4.74***) and Gen2 test reports are produced as **.xlsx** files but unlike the standard PSE Conformance Test Reports, will not allow any editing or manipulation of test data or test limits.

4.9. Live PD Emulation Tab Menu

The **Live Emul.** tab menu (*see **Figure 4.75***) has been temporarily constructed to access the original **Live PD Emulation** menu from the PSA 4.2 version of PSA Interactive. Live PD Emulation is a subset of the **Multi-Port Suite** that is available under the IEEE **802.3at** Multi-Port Suite license option for a PSA-3000. The tab menu is disabled if that license is not present on the presently connected PSA instrument.

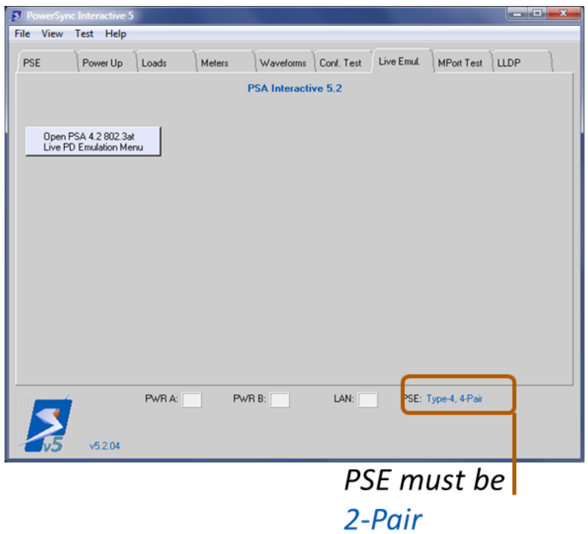


Figure 4.75 Live PD Emulation Tab Menu

Because the only test suite supported by PSA Interactive at this point in time is the **802.3at** Multi-Port Suite, access to the Live PD Emulation menu is conditioned upon the PSE Type being either Type-1, 2-Pair or Type-2, 2-Pair. It is also conditioned on the PSA instrument being licensed for the 802.3at PSE Multi-Port Suite.

The 802.3at Live PD Emulation menu is accessed simply by pressing the one button in the tab menu. If the present PSE Type is Type-3 or Type-4, then a message box will alert the user to:

"Use **PSE** tab menu to specify a Type-1 or Type-2 PSE before opening this menu."

Once the traditional Live PD Emulation menu opens, the PSA Interactive tab menu and Slot Port Panel will temporarily disappear while the PSA 4.2 version PSA Interactive menu is active.

4.9.1. Multi-Port Live PD Emulation Menu

The Live PD Emulation menu is utilized to configure, start, stop, and evaluate status of Multi-Port Live PD Emulation. **Live PD Emulation** is a specialized state of one or more PSA test ports whereby ports will truly and continuously mimic an actual, user-described IEEE 802.3at Powered Device. That means if each PSA test port is connected to a PSE port, it will always present a detection signature and a user-defined classification signature. When PSE power is applied, it will draw a user-defined amount of power (watts) with option to emulate cable loss as well as PD load power. If a PSE disables PoE service, then restores that service on a particular port or group of ports, those ports will behave just as if actual user-defined PD's were connected. (*Note: PSA Interactive supports a uniform PD definition that is applied to all PSE ports during Live PD Emulation. Users desiring to emulate a variety of PD's using Live PD Emulation may do so with PowerShell PSA and the **psa_emulate_pd** command discussed in section 5.23.1*)

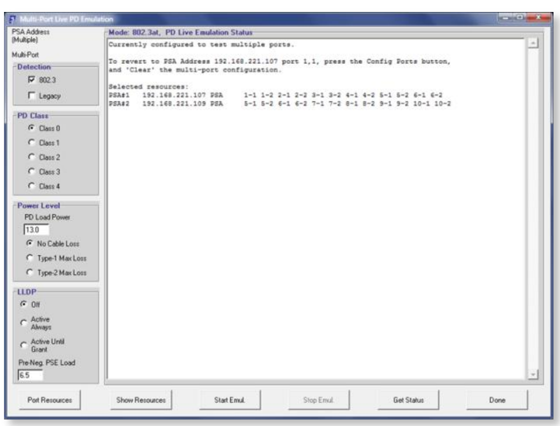


Figure 4.76 Multi-Port Live PD Emulation Menu

On PSA-3000's that support LLDP (*see section 8*), Live PD Emulation can include LLDP negotiated power-ups and PSE initiated LLDP power throttling. This enables full emulation of Type-2 PD's that must negotiate (and Type-1 PD's that may negotiate) for power draw with an LLDP-capable PSE. Users can specify a **Pre-Negotiated PSE Load** level that is applied until higher power allocations are granted by the PSE. This same level is applied after power throttling is performed by the PSE to reduce PD power load.

User-specified **PD Load Power** can be set to exceed maximum valid levels for compliant PD's so that PSE responses to over-loading PD's can be assessed.

When PSA Interactive is started and the Live PD Emulation menu is initially entered, the default "Resource Configuration" for emulating PD's is simply the current PSA address and current *slot,port* selection as established in the Slot-Port Panel. This "single port" configuration will be displayed in the upper left corner of the menu. Live PD Emulation can readily be extended to multiple (up to 192) PSA ports using the **Port Resources** button to access the **Multi-Port Resource Configuration** menu. That menu is described below in section 4.9.2. **Figure 4.79** depicts a multi-port configuration that includes 12 ports from a first PSA and 12 additional ports from a second PSA.

For every PD emulation, users specify PD **Detection**, **Class**, **PD Load Power**, and **Cable Loss** (*see **Figure 4.76***). **PD Detection** can be either **802.3at** or **Legacy**. The default **802.3at** selection indicates that PD emulation should be 802.3

compliant while the **Legacy** selection will cause test ports to use a capacitive (11µF) detection signature in place of the standard 802.3at compliant PD signature. (Note: **PD Class** *is restricted to* **Class 0** *given a* **Legacy** *type PD*.)

PD **Class** models any PD from **Class 0** to **Class 4**. **PD Load Power** is the power drawn by a virtual PD once it is fully powered up, and in the case of LLDP emulations, after it has been allocated its requested power by the PSE. Depending upon **PD Class** selection, **PD Load Power** will accept values from 0.5 watts up to a maximum level that is about 12% above maximum continuous power allowed by the 802.3at standard for PD's of the emulated classification.

Users can further influence the total load experienced by each PSE port by specifying a Cable Loss value. With **No Cable Loss**, the PSE directly experiences the **PD Load Power**. If **PD Class** is between **Class 0** and **Class 3**, users may increase that power draw by the total power dissipated in a maximum length TIA/EIA Category 3 cable with the **Type-1 Max Loss** control, or given and **PD Class** selection, increase power draw by the total power dissipated in a maximum length TIA/EIA Category 5 cable with the **Type-2 Max Loss** control . For example, PD **Class 0** and **Class 3** will add up to an additional 2.4 watts for **Max Type-1 Loss** and PD **Class 4** will add up to 4.5 watts for **Max Type-2 Loss**. The applied cable loss is a function of the **PD Load Power**. PSE's must always account for the worst case cable loss on top of the PD power loading when budgeting power to PD's.

The **Start Emul** button is used to actuate Live PD Emulation on the currently defined PSA port (or field of ports and chassis'). When Live PD Emulation is started, it will run indefinitely until it is stopped using the **Stop Emul** button. For each PSA chassis in the Resource Configuration, Live PD Emulation will be initiated almost simultaneously on all specified test ports inside that Resource Configuration.. When **Stop Emul** is pressed, Live PD Emulation will terminate simultaneously across all PSA test ports on a PSA chassis-by-chassis basis.

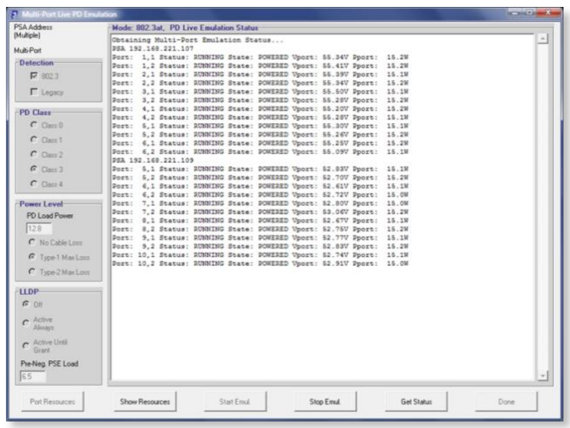


Figure 4.77 Multi-Port Live PD Emulation Status

The **Show Resources** button will replace the current **Status** display with the Resource Configuration at any time the Live PD Emulation has stopped. A powerful feature of Live PD Emulation is the ability to rapidly survey the states of all PSA test ports in the Resource Configuration during (or after) emulation. The **Get Status** button initiates a survey of all test ports and reports emulation status, power status, port voltage, and PSE port power loading (*see* ***Figure 4.77***). This status can be updated repeatedly as the emulation runs across the full Resource Configuration.

The **LLDP** setting should always be **Off** when evaluating non-LLDP capable PSE's. PD LLDP emulation can be part of the Live PD Emulation when testing LLDP-capable PSE's so long as all of the PSA's in the Resource Configuration are enabled for the PoE LLDP emulation feature license. Live PD Emulation with LLDP is activated by selecting either the **Active Always** or **Active Until Grant** radio buttons. **Active Always** configures the LLDP protocol portion of Live PD Emulation to run continuously whenever power is applied by the PSE to the virtual PD(s). As is true of all Live PD Emulation features, this behavior is fully autonomous by test port. If a PSE decides to use LLDP to throttle a Type-2 PD back down to Type-1 PD power levels, the PD Emulation will respond via LLDP and reduce power to a user-specified **Pre_Neg**otiated **PSE Load** level.

If **Active Until Grant** is selected, each emulated PD on each test port will utilize LLDP to negotiate for the **PD Load Power** level and then, upon receiving that power grant and setting up that power load, will discontinue LLDP protocol and connect the OUTn port (*see section 3.1.9*) so that packet traffic may be run to and from the PSE port. This means the PD emulation will not respond to any spontaneous requests from a PSE to throttle back power. Again, this action is fully autonomous for every test port in the Resource Configuration that is actively emulating a PD.

LLDP controls in the LLDP sub-menu will only be activated if *all* PSA chassis' within a Resource Configuration support the LLDP emulation feature. Otherwise, LLDP will be set to **Off** and other controls will be disabled.

The following table conveys the maximum accepted **PD Load Power** levels by **PD Class** and the maximum possible per-port PSE power loads given selection of the worst case cable loss condition. Live PD Emulation allows users to create power load conditions in excess of the maximum allowed by the IEEE 802.3at standard. **PD Load Power** entries exceeding the maximum will be automatically adjusted to the maximum **PD Load Power** shown in the table.

PD Class	Max. PD Load Power	Max. Cable Loss	Max. Per-Port PSE Load
Class 0, Class 3	14.6 Watts	Type-1 Max Loss	17.7 Watts
Class 1	4.3 Watts	Type-1 Max Loss	4.6 Watts
Class 2	7.2 Watts	Type-1 Max Loss	8.0 Watts
Class 4	28.6 Watts	Type-2 Max Loss	34.3 Watts

Maximum **Pre-Negotiated PSE Load** for **LLDP** power-ups is 15.5 watts and is not affected by the cable loss selection. To be 802.3at specification compliant, a Type-2 PD may not present more than 15.4 watts load power *at the PSE interface* prior to having an LLDP allocation for full power load.

4.9.2. PSE Multi-Port Resource Configuration Menu

The **PSE Multi-Port Resource Configuration** menu *(see **Figure 4.79**)* provides a method to configure test resources for the Multi-Port Live PD Emulation and the PSE Multi-Port Test Suite. **Multi-Port Live PD Emulation** is described in section 7.1 and the **PSE Multi-Port Test Suite** is the subject of sections 7.2 to 7.7.

Unlike PSE Conformance Testing where testing is conducted on a single test port within a single PSA chassis at any one time, Multi-Port PSE Testing involves simultaneous and synchronized usage of many PSA-3000/PSL-3000 test ports across one or more PSA-3000/PSL-3000 chassis'. As such, a special configuration menu is provided to establish the PSA-3000/PSL-3000 chassis and test port resources to be assigned for Multi-Port testing and analyses.

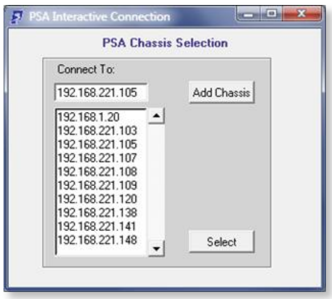


Figure 4.78 Multi-Port Chassis Select

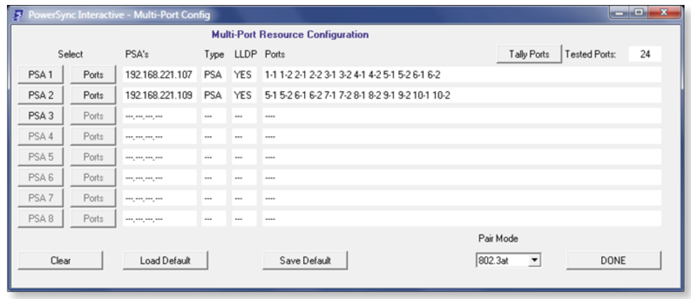


Figure 4.79 Multi-Port Test Field Configuration Menu

The **Multi-Port Resource Configuration** menu is accessed from the **Port Resources** (or **Config Resources**) button found in each PSE Multi-Port menu, that is, **Live PD Emulation**, **PSE Tests**, and **Sequencer**. This menu allows up to 8 PSA/PSL chassis', each with up to 24 test ports to be assigned to a Multi-Port test session. This means that the maximum number of test ports allowed for Multi-Port testing is 192.

Within the **Multi-Port Resource Configuration** menu, the **Clear** button may be used to clear out any previous configurations prior to creating a new resource configuration. PSA/PSL resources must be configured starting with PSA 1 and working upwards until all required test ports are assigned.

To add a PSA or PSL chassis to the test resource field, each **PSA N** button opens a menu *(see **Figure 4.78**)* identical to the **Chassis Selection** menu seen in **Figure 4.1**. PSA Addresses may be entered, selected from the current list of known PSA's, or added to the list of known PSA's. Many of the same rules apply here as would apply with the **Chassis Selection** menu. PSA addresses that are entered or selected MUST be available on the local network, or otherwise they will be rejected. Additionally, each PSA added to the **PSA's** column must be unique – there can be no duplication of addresses from row to row. If a duplicate PSA address is entered, it will not be added to the test resource field.

Once a valid PSA address has been assigned to the Multi-Port test resource field, an associated **Ports** button activates to enable the assignment of test ports from that PSA chassis. The **Port Selection** sub-menu *(see **Figure 4.80**)* allows selection of one or more test ports or, in the event where all PSA test ports are utilized, the **ALL PORTS** option may be selected. This menu will only be enabled for the available test ports within the associated PSA chassis. If fewer than 24 test ports (12 test blades) are installed, then **ALL PORTS** will only include those test ports that exist within the associated PSA chassis.

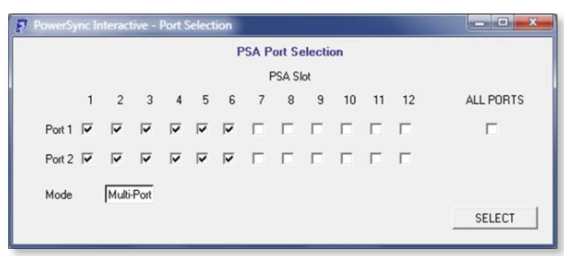


Figure 4.80 Multi-Port Port Select Dialog

The Multi-Port Test Resources includes the **Type** of PSA/PSL instrument. PSL-3000's are referred to as **PL** in this field. If one or more PSL-3000 instruments are included, then all test resources are restricted to PSL-3000 limitations.

At any time, as resources are configured, the **Tally Ports** button may be used to validate and summarize all test port resources currently assigned for Multi-Port testing. The **Save Default** button will store a non-volatile Multi-Port Resources configuration according to whatever is currently configured in the menu. The **Load Default** will load a previously saved Multi-Port Resource configuration into the menu. When resource configuration is completed, the **DONE** button will validate all test port resources specified and then close the menu whereupon the new resource configuration is made available to each Multi-Port menu.

4.10. MPort Test Tab Menu

The **MPort Test** tab menu (*see **Figure 4.85***) has been temporarily constructed to access the original **Multi-Port Test Sequencer** menu from the PSA 4.2 version of PSA Interactive. The Multi-Port Test Suite is a subset of the **Multi-Port Suite** that is available under the IEEE **802.3at** Multi-Port Suite license option for a PSA-3000. The tab menu is disabled if that license is not present on the presently connected PSA instrument.

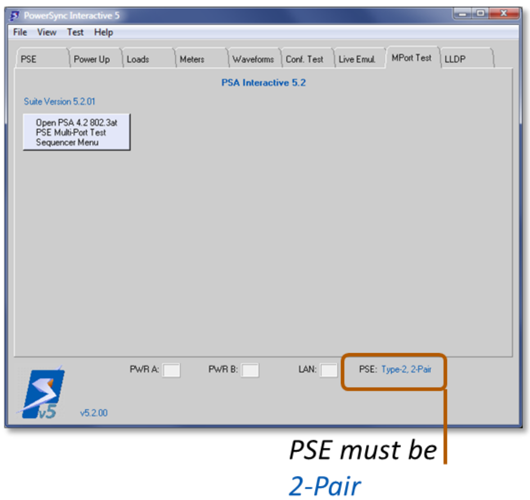


Figure 4.85 Multi-Port Test Suite Tb Menu

Because the only test suite supported by PSA Interactive at this point in time is the **802.3at** Multi-Port Suite, access to the Multi-Port Sequencer menu is conditioned upon the PSE Type being either Type-1, 2-Pair or Type-2, 2-Pair. It is also conditioned on the PSA instrument being licensed for the 802.3at PSE Multi-Port Suite.

The Multi-Port Test Sequencer menu is accessed simply by pressing the one button in the tab menu. If the present PSE Type is Type-3 or Type-4, then a message box will alert the user to:

“Use **PSE** tab menu to specify a Type-1 or Type-2 PSE before opening this menu.”

Once the traditional Multi-Port Test Sequencer menu opens, the PSA Interactive tab menu and Slot Port Panel will temporarily disappear while the PSA 4.2 version PSA Interactive menu is active.

4.10.1. Multi-Port Test Sequencer Menu and Multi-Port Test Suite Reporting

PSA 5.2 software includes a second generation, fully automated Multi-Port Test Suite. Much like the PSE Conformance Test Suite, this test suite can be accessed through a sequencer menu for automatically sequencing one or more tests to a standard report format. In order for the Multi-Port Test Suite to be available, the test resources specified (*see Section 4.9.2*) must include exclusively PSA-3000 (and/or PSL-3000) test ports that are enabled (or licensed) for the Multi-Port Suite feature.

The second generation Multi-Port Test Suite is discussed in greater detail in section 7.2. Additional information regarding this test suite is available in video format on the Sifos website and in the Multi-Port Test Suite datasheet. This section will focus on how to use the Multi-Port Test Suite from PSA Interactive software.

The **Multi-Port Test Sequencer** menu *(see **Figure 4.86**)* is analogous to the PSE Conformance Sequencer menu. This menu enables the automated sequencing of selected or all Multi-Port tests and automated generation of a standard Microsoft Excel spreadsheet or text file report.

The Multi-Port Test Suite uses the exact same mechanism as Live PD Emulation in order to configure **Test Resources**. This mechanism is accessed by the **Config Resources** button and is explained above in section 4.9.2. Test Resources may include up to 8 PSA/PSL instruments, each with up to 24 test port.

Unlike Live PD Emulation, the Multi-Port Test Suite *requires* that a Test Resources configuration be established prior to running the test suite.

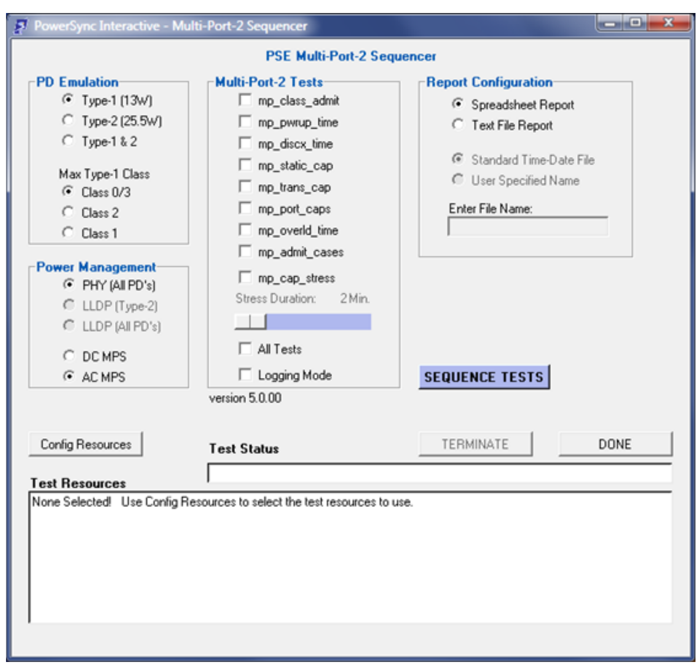


Figure 4.86 Multi-Port Test Sequencer Menu

Prior to running the Multi-Port Test Suite, there are two categories of configuration that must be established: **PD Emulation** and **Power Management** scheme. PD Emulation offers three options:

- **Type-1**: Select this when testing 802.3at Type-1 (max 15.4W or 802.3af) PSE's, or if testing just the Type-1 behaviors of a Type-2 PSE.
- **Type-2**: Select this when testing 802.3at Type-2 (max 30W) PSE's and more specifically testing just the Type-2 behaviors of that PSE.
- **Type-1 & 2**: This would be the typical selection when testing Type-2 PSE's so that behavior of those PSE's is analyzed using both Type-1 and Type-2 PD emulations.

The test suite also allows that there are Type-1 PSE's that will not power either Class 0 or Class 3 PD's, but may power Class 2 (max 7W) and/or Class 1 (max 4W) PD's. When Type-1 PD Emulation is selected, the **Max Type-1** Class options are enabled where either **Class 2** or **Class 1** may be specified rather than the default **Class 0/3**. Normally, the vast majority of 802.3at Type-1 (and 802.3af) PSE's should be tested at **Class 0/3** as the maximum power class.

Power Management also offers three options:

- **PHY**: Select this when testing a PSE that does *not* utilize PoE LLDP for mutual identification and power granting.
- **LLDP**: Select this when testing a PSE that *does* utilize PoE LLDP for mutual identification and power granting. In this mode, LLDP will be used when powering all PD classes 0 – 4.
- **LLDP2**: Select this when testing a PSE that *does* utilize PoE LLDP for mutual identification and power granting. In this mode, LLDP will be *only* when powering all PD class 4, that is, emulating **Type-2** PD's. This would be the more practical Power Management scheme for testing most Type-2, LLDP capable PSE's.

The **Multi-Port-2 Tests** frame allows the selection of one or more specific tests or **All Tests**. While a sequence may include just one or two tests, because of sequencing interdependencies, prerequisite tests may automatically be executed in order to produce a report of just the selected tests. In other words, if the selected tests require one or more prerequisite tests, the results from those prerequisite tests will not be reported unless they are selected as part of the test sequence.

The **mp_cap_stress** test includes a control for configuring the time duration of that particular test. The default time duration is 2 minutes, however this may be extended to much longer durations. *Note that selecting a long period of time for the* **mp_cap_stress** *test will have significant impact on the overall duration of the test sequence*.

A **Logging Mode** checkbox enables or disables the automatic production of text format data logs that are specific to each Multi-Port test. The data logs include significant details gathered as a Multi-Port test executes and may be of value in troubleshooting PSE behaviors as well as testing problems. The log files are named for each Multi-Port test (e.g. mp_class_admit_log.txt) and will be found in the current **Results**\ directory path (*see sections 3.2.5 and 3.2.6*).

Also analogous to the PSE Conformance Test Sequencer menu, there is a **Report Configuration** sub-menu enabling the reporting to be automatically directed to the standard PSE Spreadsheet report for the Multi-Port-2 test suite (*see* ***Figure 4.87***), or to a text file. Text report files may take on a Time-Date Stamp (default) file name or may be placed in a file name specified by the user.

The **SEQUENCE TESTS** button begins the sequence of Multi-Port tests. **Test Status** will be reported as the tests sequence. The **TERMINATE** button will abort PSE Multi-Port Testing nearly immediately. Partial test reports should be available within the appropriate **…\Results** subdirectory after testing is aborted. If default spreadsheet reporting is specified, those results will be found in a file named **mp_report_data.csv** file.

4.10.2. Multi-Port Test Suite Reporting

The standard Multi-Port spreadsheet report is a Microsoft Excel template file, **mp_report_30.xlsm**, that will be found in the same /Results/ directory path where any data logging is saved (*see sections 3.2.5 and 3.2.6*) as well as in any subdirectories established below that for storing PSE test reports. The Multi-Port Test Sequencer develops an intermediate **mp_report_data.csv** file that is then utilized by macros within **mp_report_30.xlsm** to automatically process Multi-Port test data upon completion of the test sequence.

Figure 4.87 Multi-Port Standard Pop-Up Spreadsheet Report

The standard Multi-Port spreadsheet report in **Figure 4.87** includes header sections that convey both the testing and the port resources configurations. Because Multi-Port system testing of a PSE is not strictly guided by industry specifications and because most PSE's make design trade-offs between cost, size, and weight, the reporting includes two categories for parameter limit checking: "Non-Ideal Feature / Design Limitation" and "802.3at Specification Violation". Report parameters highlighted in tan are of the fall into the first of these categories and parameters highlighted in light red fall into the second, more severe category. A test limits table is accessible within the report. See sections 7.2 - 7.7 for further information concerning the Multi-Port Test Suite and associated reporting.

Note: *Microsoft Excel 2007 or later must be separately installed and configured to low macro security for this report to function properly.*

4.11. LLDP Tab Menu

The **LLDP** tab menu (*see **Figure 4.92***) provides access to test port LLDP emulation and analysis features when the connected PSA-3000 (or PSL-3000) instrument is licensed for the LLDP feature. The tab menu is disabled if that license is not present on the presently connected PSA instrument.

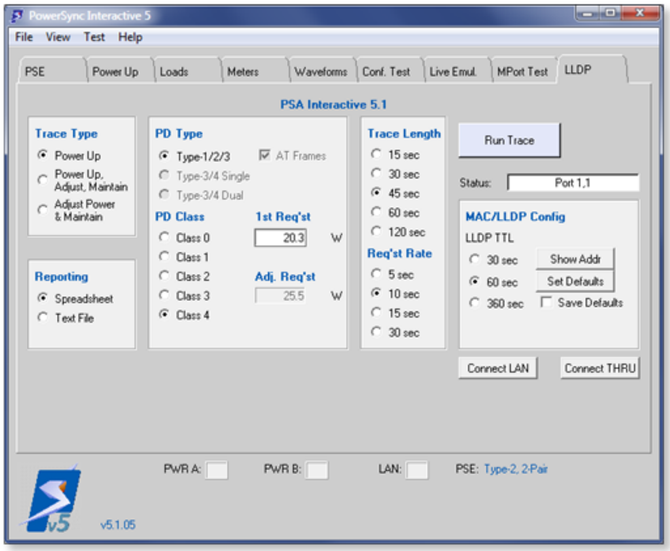


Figure 4.92 LLDP Tab Menu

LLDP emulation and analysis involves flexible emulation of any PD that supports the 802.3 PoE LLDP protocols and capture of protocol sequences, or "traces", for the purpose of observing the 2-way PoE LLDP protocol including associated protocol timing. Protocol trace reports are automatically produced to standard Excel spreadsheet analyzers or to text files.

The LLDP tab menu supports both 802.3at and 802.3bt PoE protocols. 802.3at protocol is invoked when testing **Type-1** or **Type-2** (2-Pair) PSE's. By default, 802.3bt protocol is invoked when testing **Type-3** (2-Pair or 4-Pair) and **Type-4** (4-Pair) PSE's. As such, the PSE tab menu (*see Section 4.2*) is essential to properly describing the PSE to be analyzed prior to running protocol traces.

The PSE: indicator in the lower right corner of the PSA Interactive background menu always indicates the currently declared (or configured) PSE type. This indicator affects the range of PD Type's and PD Classes that can be emulated and it affects the 802.3 PoE protocol version that may be utilized. The following table describes this relationship.

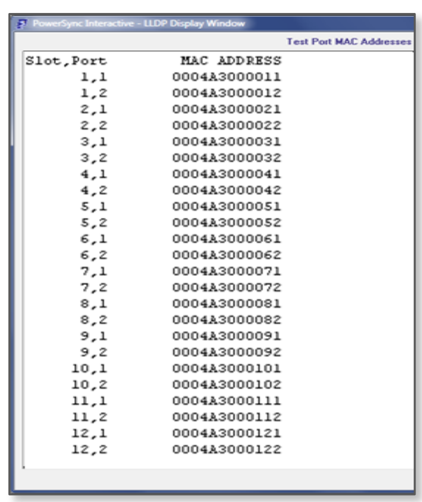
PSE: Indicator	PD Type Options	PD Class Options	PoE LLDP Protocol
Type-1, 2-Pair or Type-2, 2-Pair	Type-1/2/3	Class 0, Class 1, Class 2, Class 3, Class 4	802.3at (12 octet)
Type-3, 2-Pair or Type-3, 4-Pair or Type-4, 4-Pair	Type-1/2/3	Class 0, Class 1, Class 2, Class 3, Class 4	Default: 802.3bt (29 octet) Optional: 802.3at (12 octet)
Type-3, 4-Pair or Type-4, 4-Pair	Type-3/4 Single	Class 5, Class 6, Class 7, Class 8	802.3bt (29 octet)
	Type-3/4 Dual	Class 1D, Class 2D, Class 3D, Class 4D, Class 5D	

4.11.1. Configuring MAC Layer Settings

The **LLDP** tab menu may be utilized to observe and configure low level LLDP protocol components of **TTL** (time-to-live) and the emulated **MAC Address**. The selected **TTL** value will be included in all outgoing PD Request packets during a trace.

The **Show Addr** button will open up a display window (*see **Figure 4.93***) showing the MAC Addresses assigned to each test port. These addresses can be manipulated in PowerShell PSA if needed. The **Set Defaults** button will automatically program a unique MAC addresses to each available PSA test port using a common "root" value combined with a 3-digit value derived from Slot and Port. If **Save Defaults** is checked, those default LLDP MAC settings will be retained in each test port in a non-volatile manner.

Important! If test blades are added or rotated within the PSA-3000 instrument, it may be desirable to re-program these default MAC addresses.


PowerSync Interactive - LLDP Display Window

Test Port MAC Addresses

Slot,Port	MAC ADDRESS
1,1	0004A3000011
1,2	0004A3000012
2,1	0004A3000021
2,2	0004A3000022
3,1	0004A3000031
3,2	0004A3000032
4,1	0004A3000041
4,2	0004A3000042
5,1	0004A3000051
5,2	0004A3000052
6,1	0004A3000061
6,2	0004A3000062
7,1	0004A3000071
7,2	0004A3000072
8,1	0004A3000081
8,2	0004A3000082
9,1	0004A3000091
9,2	0004A3000092
10,1	0004A3000101
10,2	0004A3000102
11,1	0004A3000111
11,2	0004A3000112
12,1	0004A3000121
12,2	0004A3000122

Figure 4.93 Default PSA Test Port MAC Addresses

4.11.2. LLDP Protocol Trace Types and Configuration

Regardless of the PSE type (802.3 PoE LLDP protocol), the LLDP tab menu supports three protocol trace types.

A **Power Up** trace captures the LLDP behavior that occurs when a PSE initially powers a PD and enters a power negotiation process. The **Power Up** trace will generally wait for a first LLDP message from the PSE so that it can time the duration between power application and first frame. It will then capture a sequence of PD Request and PSE Allocation messages. The **Power Up** trace will negotiate for the power demand entered in the **1st Req'st** field (watts) in this menu. When the trace is completed, the emulated PD will disconnect and the PSE should remove power.

A **Power Up, Adjust, and Maintain** trace is designed to capture the LLDP behavior when an emulated PD is initially connected, requests an initial power value, then subsequently negotiates for a second power draw. The trace starts by negotiating for the power draw specified in **1st Req'st**, and then captures all LLDP protocol between that starting point and the negotiation of the power draw specified in **Adj. Req'st** (watts). When the trace completes, the emulated PD will not be disconnected and power should be maintained by the PSE.

The **Adjust Power & Maintain** trace can be used following the **Power Up, Adjust, and Maintain** trace to negotiate subsequent power draw requests made by the emulated PD. When this trace type is selected, the only entry field available will be the **Adj. Req'st** field where the new power demand is entered. The protocol trace starts with this new PD request message and when the trace completes, the emulated PD will remain connected and the PSE should maintain power.

The time duration of an LLDP protocol trace may be set using **Trace Length** options. The settings range from 15 seconds to 120 seconds. Generally, most power negotiations will occur in fewer than 15 seconds.

The rate at which the emulated PD transmits power request messages can also be set using the **Req'st Rate** options. This then affects the "density" of PD frames within the protocol trace report. The settings include **5 sec**, **10 sec**, **15 sec**, or **30 sec**. This timing does not affect the emulated PD response to new PSE power allocations – those messages will be more immediate.

The reporting may be directed to a standard (Microsoft Exce) **Spreadsheet** or to a **Text File**. The standard **Spreadsheet** report is required in order to evaluate and limit check all aspects of PoE LLDP protocol including parameter values and message timing. This feature requires that Microsoft Excel (2007 or later) be installed on the host computer. Depending upon the PD emulation performed, **802.3at**, **802.3bt Single Signature**, or **802.3bt Dual Signature**, the spreadsheet report invoked will be unique for that protocol case.

4.11.3. 802.3at LLDP Emulation and Protocol Tracing

When the PSE Type has been declared as Type-1, 2-Pair or Type-2, 2-Pair in the PSE tab menu, then the LLDP menu will automatically be configured to work with **802.3at** (12 octet) LLDP protocol and any trace reports generated will test according to the 802.3at protocol.

In **Figure 4.92** above, the LLDP tab menu is configured for a Power Up trace emulating a Class 4 PD requesting 20.3 watts. Trace duration is set to 45 seconds with a 10 second periodicity of PD request messages. When the **Run Trace** button is pressed, the emulated PD will connect, get powered, and enter a PoE LLDP power negotiation protocol. A live display of this opens to show protocol messages as they occur (*see **Figure 4.94***).

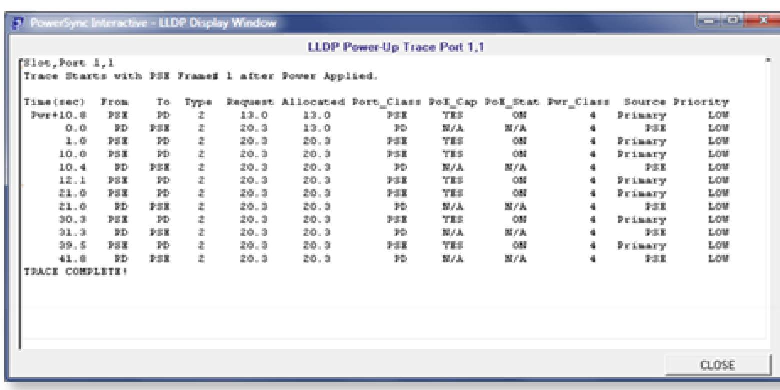


Figure 4.94 Real Time Trace Window

Once the trace duration (45 seconds) is exceeded, the protocol trace terminates and the 802.3at LLDP spreadsheet report pops up (*see **Figure 4.95***). Spreadsheet reports may be retained permanently by simply saving the spreadsheet to any desired location.

The spreadsheet report delineates message direction (light blue versus white shading), provides message contents, message timing, and flags any problem areas (light read) such as a slow response time by the PSE to a new PD power request. It is a very efficient tool for assessing the integrity of protocol transactions from a PSE port.

PSA-3000 LLDP Trace
June 4, 2020 2:43 PM
PSA Address: 192.168.221.141

PSE	Port	Trace Type	Requested	Allocated	Echo Time	Alloc Time	Init. Time	Time To Live
HP5120	1-1	Power-Up	20.3	20.3	3	3	3.2	80
			Watts	Watts	Seconds	Seconds	Seconds	Seconds

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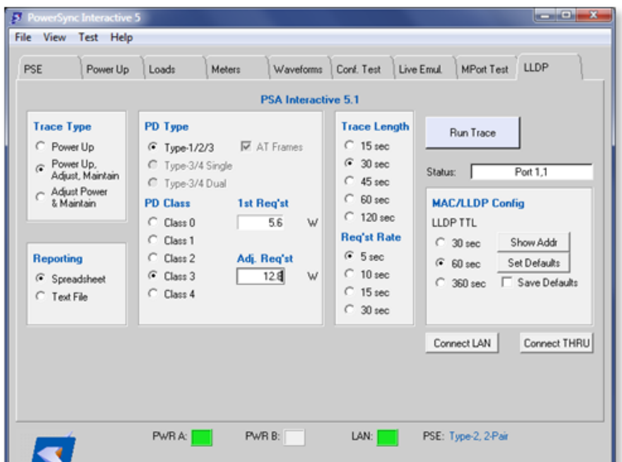
version 5.1.01

Time	From	To	Type	Requested	Allocated	Port Class	MDI Capability	MDI Status	Power Class	Source	Priority
PWR+3.2	PSE	PD	2	13.0	13.0	PSE	YES	ON	4	PRIMARY	LOW
0.0	PD	PSE	2	13.0	13.0	PD	N/A	N/A	4	PSE	LOW
0.1	PSE	PD	2	13.0	13.0	PSE	YES	ON	4	PRIMARY	LOW
2.3	PD	PSE	2	20.3	13.0	PD	N/A	N/A	4	PSE	LOW
3.0	PSE	PD	2	20.3	20.3	PSE	YES	ON	4	PRIMARY	LOW
5.3	PD	PSE	2	20.3	20.3	PD	N/A	N/A	4	PSE	LOW
15.5	PD	PSE	2	20.3	20.3	PD	N/A	N/A	4	PSE	LOW
22.6	PSE	PD	2	20.3	20.3	PSE	YES	ON	4	PRIMARY	LOW
25.8	PD	PSE	2	20.3	20.3	PD	N/A	N/A	4	PSE	LOW
36.0	PD	PSE	2	20.3	20.3	PD	N/A	N/A	4	PSE	LOW
42.7	PSE	PD	2	20.3	20.3	PSE	YES	ON	4	PRIMARY	LOW

Figure 4.95 Pop-Up Spreadsheet Report of 20.3W Class 4 Power-Up

An example of an 802.3at **Power-Up, Adjust, and Maintain** trace for a **Class 3** PD initially seeking **5.6 watts**, then seeking an adjustment to **12.8 watts** is shown in **Figure 4.96**.



PSA-3000 LLDP Trace
June 4, 2020 2:49 PM
PSA Address: 192.168.221.141

PSE	Port	Trace Type	Requested	Allocated	Echo Time	Alloc Time	Init. Time	Time To Live
HP5120	1-1	Pwr_Change	12.8	12.8	0.1	0.1	-1	80
			Watts	Watts	Seconds	Seconds	Seconds	Seconds

Sifos Technologies
version 5.1.01

Time	From	To	Type	Requested	Allocated	Port Class	MDI Capability	MDI Status	Power Class	Source	Priority
PWR+11	PSE	PD	2	5.6	5.6	PSE	YES	ON	3	PRIMARY	LOW
0.0	PD	PSE	1	12.8	5.6	PD	N/A	N/A	3	PSE	LOW
0.1	PSE	PD	2	12.8	12.8	PSE	YES	ON	3	PRIMARY	LOW
1.8	PD	PSE	1	12.8	12.8	PD	N/A	N/A	3	PSE	LOW
6.9	PD	PSE	1	12.8	12.8	PD	N/A	N/A	3	PSE	LOW
12.2	PD	PSE	1	12.8	12.8	PD	N/A	N/A	3	PSE	LOW
16.1	PSE	PD	2	12.8	12.8	PSE	YES	ON	3	PRIMARY	LOW
17.5	PD	PSE	1	12.8	12.8	PD	N/A	N/A	3	PSE	LOW
22.8	PD	PSE	1	12.8	12.8	PD	N/A	N/A	3	PSE	LOW
28.1	PD	PSE	1	12.8	12.8	PD	N/A	N/A	3	PSE	LOW

Figure 4.96 Class 3 Power-Up to 5.6W and Adjust to 12.8W

4.11.4. 802.3bt LLDP Emulation and Protocol Tracing

When the PSE Type has been declared as **Type-3, 2-Pair**, **Type-3, 4-Pair**, or **Type-4, 4-Pair** in the PSE tab menu, then the LLDP menu will automatically be configured to work with **802.3bt** (29 octet) LLDP protocol and any trace reports generated will test according to the 802.3bt protocol. Further, the exact format of that protocol will depend upon whether a Single Signature (**Type-1/2/3** or **Type-3/4 Single**) PD is emulated or a Dual Signature (**Type-3/4 Dual**) PD is emulated.

In **Figure 4.97**, a **Type-3, 4-Pair** PSE is tested using a **Class 6** PD emulation. The PD is requesting an allocation of 44.4 watts from the PSE. The real time protocol trace display shown in **Figure 4.98** opens when the **Run Trace** button is pressed. This is a very wide panel necessitated by all of the elements (or TLV's) included in the 802.3bt PoE LLDP protocol.

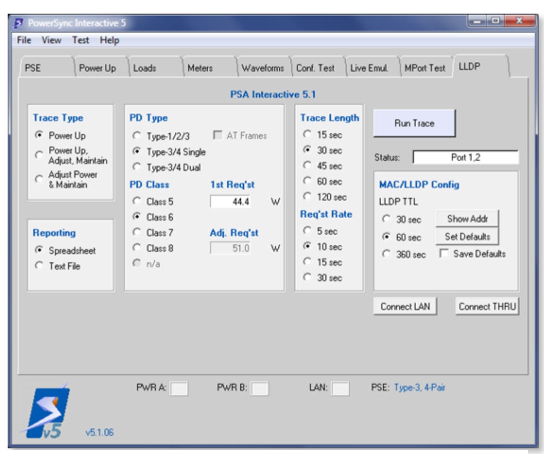


Figure 4.97 Class 6 Power-Up to 44.4 watts

PowerSync Interactive - LLDP Display Window

LLDP Power-Up Trace Port 1,1

```
Slot,Port 1,1
Trace Starts with PSE Frame# 1 after Power Applied.

Time_sec From  To Typ ssReq Alloc Dev PoE? Stat atCl S'rce Pr'ty dsRqA dsRqB dsAlcA dsAlcB 4PID PsePwrStat PdPwrStat PsePwrPrs dsClA dsClB  ssCl PwrTyp PDload MaxPwr PSEaCl aClDone aClReq ShutRq OffTime

 Pwr+2.6  PSE  PD   2  13.0  13.0 PSE  YES   ON    3  Pri   LOW   0.0   0.0   0.0   0.0   0 4pr_Single     Rs'vd Both_Alts  ssPD  ssPD   3 PSE_T3 NoIsol  51.0   NO  Idle  Idle  None  0
     0.0   PD PSE   2  13.0  13.0  PD  N/A  N/A    4  PSE   LOW   0.0   0.0   0.0   0.0   1   Reserved  Pwr_Sing  Reserved  ssPD  ssPD   6  PD_3S NoIsol   N/A  N/A   N/A  Idle  None  0
     2.5  PSE  PD   2  13.0  13.0 PSE  YES   ON    3  Pri   LOW   0.0   0.0   0.0   0.0   0 4pr_Single     Rs'vd Both_Alts  ssPD  ssPD   3 PSE_T3 NoIsol  51.0   NO  Idle  Idle  None  0
     4.3   PD PSE   2  44.4  13.0  PD  N/A  N/A    4  PSE   LOW   0.0   0.0   0.0   0.0   1   Reserved  Pwr_Sing  Reserved  ssPD  ssPD   6  PD_3S NoIsol   N/A  N/A   N/A  Idle  None  0
     5.1  PSE  PD   2  13.0  13.0 PSE  YES   ON    3  Pri   LOW   0.0   0.0   0.0   0.0   0 4pr_Single     Rs'vd Both_Alts  ssPD  ssPD   3 PSE_T3 NoIsol  51.0   NO  Idle  Idle  None  0
     8.4  PSE  PD   2  44.4  44.4 PSE  YES   ON    4  Pri   LOW   0.0   0.0   0.0   0.0   0 4pr_Single     Rs'vd Both_Alts  ssPD  ssPD   6 PSE_T3 NoIsol  51.0   NO  Idle  Idle  None  0
    10.2   PD PSE   2  44.4  44.4  PD  N/A  N/A    4  PSE   LOW   0.0   0.0   0.0   0.0   1   Reserved  Pwr_Sing  Reserved  ssPD  ssPD   6  PD_3S NoIsol   N/A  N/A   N/A  Idle  None  0
    20.2   PD PSE   2  44.4  44.4  PD  N/A  N/A    4  PSE   LOW   0.0   0.0   0.0   0.0   1   Reserved  Pwr_Sing  Reserved  ssPD  ssPD   6  PD_3S NoIsol   N/A  N/A   N/A  Idle  None  0
    30.4   PD PSE   2  44.4  44.4  PD  N/A  N/A    4  PSE   LOW   0.0   0.0   0.0   0.0   1   Reserved  Pwr_Sing  Reserved  ssPD  ssPD   6  PD_3S NoIsol   N/A  N/A   N/A  Idle  None  0
    38.4  PSE  PD   2  44.4  44.4 PSE  YES   ON    4  Pri   LOW   0.0   0.0   0.0   0.0   0 4pr_Single     Rs'vd Both_Alts  ssPD  ssPD   6 PSE_T3 NoIsol  51.0   NO  Idle  Idle  None  0
    40.7   PD PSE   2  44.4  44.4  PD  N/A  N/A    4  PSE   LOW   0.0   0.0   0.0   0.0   1   Reserved  Pwr_Sing  Reserved  ssPD  ssPD   6  PD_3S NoIsol   N/A  N/A   N/A  Idle  None  0
    50.5  PSE  PD   2  44.4  44.4 PSE  YES   ON    4  Pri   LOW   0.0   0.0   0.0   0.0   0 4pr_Single     Rs'vd Both_Alts  ssPD  ssPD   6 PSE_T3 NoIsol  51.0   NO  Idle  Idle  None  0
    51.0   PD PSE   2  44.4  44.4  PD  N/A  N/A    4  PSE   LOW   0.0   0.0   0.0   0.0   1   Reserved  Pwr_Sing  Reserved  ssPD  ssPD   6  PD_3S NoIsol   N/A  N/A   N/A  Idle  None  0
    56.5  PSE  PD   2  44.4  44.4 PSE  YES   ON    4  Pri   LOW   0.0   0.0   0.0   0.0   0 4pr_Single     Rs'vd Both_Alts  ssPD  ssPD   6 PSE_T3 NoIsol  51.0   NO  Idle  Idle  None  0
TRACE COMPLETE!
```

Figure 4.98 Trace Display - Class 6 Power-Up to 44.4 watts

Upon completion of the trace as determined by Trace Length, the pop-up Excel spreadsheet report will open as shown in **Figure 4.99**. This report differs significantly from the 802.3at protocol trace report as there are many more fields, more complex limit checking, and a column of PSE and PD fixed value fields to the right. As with the 802.3at report, if any fields or parameters are found to be in violation of 802.3bt LLDP protocol, they will be shaded **light red**.

802.3bt PoE LLDP Trace

June 4, 2020	3:07 PM	PSE	Port	Trace Type	Requested	Allocated	Echo Time	Alloc Time	Init. Time	Time To Live
PSA Address:	192.168.221.141	Aruba2930M	1-1	Power-Up	44.4	44.4	8.4	8.4	2.6	120
					Watts	Watts	Seconds	Seconds	Seconds	Seconds

Sifos Technologies

version 5.1.03

Time	From	To	Pwr Type	Class	Requested	Allocated	PSE Pairs	PSE Max	PSE Stat	PD Stat	PSE aCl	PD 4PID
PWR+2.6	PSE	PD	PSE_T3	3	13.0	13	BOTH_ALTS	51.0	4PR_SINGLE	RSVD	NO	0
0.0	PD	PSE	PD_3S	6	13.0	13	RESERVED	N/A	RESERVED	PWR_SING	N/A	1
2.5	PSE	PD	PSE_T3	3	13.0	13	BOTH_ALTS	51.0	4PR_SINGLE	RSVD	NO	0
4.3	PD	PSE	PD_3S	6	44.4	13	RESERVED	N/A	RESERVED	PWR_SING	N/A	1
5.1	PSE	PD	PSE_T3	3	13.0	13	BOTH_ALTS	51.0	4PR_SINGLE	RSVD	NO	0
8.4	PSE	PD	PSE_T3	6	44.4	44.4	BOTH_ALTS	51.0	4PR_SINGLE	RSVD	NO	0
10.2	PD	PSE	PD_3S	6	44.4	44.4	RESERVED	N/A	RESERVED	PWR_SING	N/A	1
20.2	PD	PSE	PD_3S	6	44.4	44.4	RESERVED	N/A	RESERVED	PWR_SING	N/A	1
30.4	PD	PSE	PD_3S	6	44.4	44.4	RESERVED	N/A	RESERVED	PWR_SING	N/A	1
38.4	PSE	PD	PSE_T3	6	44.4	44.4	BOTH_ALTS	51.0	4PR_SINGLE	RSVD	NO	0
40.7	PD	PSE	PD_3S	6	44.4	44.4	RESERVED	N/A	RESERVED	PWR_SING	N/A	1
50.5	PSE	PD	PSE_T3	6	44.4	44.4	BOTH_ALTS	51.0	4PR_SINGLE	RSVD	NO	0
51.0	PD	PSE	PD_3S	6	44.4	44.4	RESERVED	N/A	RESERVED	PWR_SING	N/A	1
56.5	PSE	PD	PSE_T3	6	44.4	44.4	BOTH_ALTS	51.0	4PR_SINGLE	RSVD	NO	0

PSE Fields
MDI Pwr Support
YES
MDI Pwr State
ON
.at Type
2
Device
PSE
Power Source
PRI
Priority
LOW
aCl Done
IDLE

Figure 4.99 Spreadsheet Report: Single Signature Class 6 Power-Up Trace

In Figure 4.100, a **Dual Class 4** PD emulation is defined to a **Power-Up, Ajdust, Maintain** protocol trace. Each pairset of the emulated PD will initially request 9.5 watts, then once granted, will adjust the power demand to 25.5 watts on each pairset A and B.

Important! Note that there is no ability in this menu to have differing power requests by pairset. If there is a need for that, then the PowerShell PSA utility **trace_lldp_pwrup** or **trace_lldp_change** must be used (*see Section 8.9.4*).

The trace is configured for 45 seconds with 5 second PD message periodicity. After the trace completes, the Dual Signature 802.3bt report opens as shown in **Figure 4.101**.

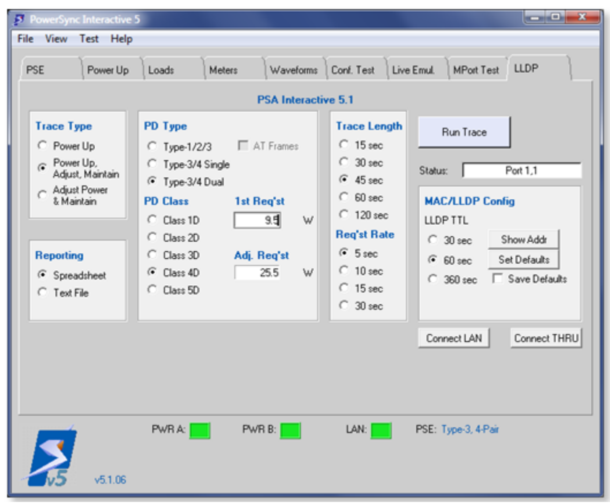


Figure 4.100 Dual Class 4 Power-Up, Adjust, Maintain Trace

802.3bt Dual Sig PoE LLDP Trace

June 4, 2020	03:59 PM	PSE	Port	Trace Type	Req A	Req B	Alloc A	Alloc B	Echo Time	Alloc Time	Init. Time	TTL
PSA Address:	192.168.221.141	Aruba2930M	1-1	Pwr_Change	25.5	25.5	25.5	25.5	2.1	2.1	-1	120
					Watts	Watts	Watts	Watts	Seconds	Seconds	Seconds	Seconds

Sifos Technologies

version 5.1.01

Time	From	To	Pwr Type	Class A	Class B	Req A	Req B	Alloc A	Alloc B	PSE Pairs	PSE Max	PSE Stat	PD Stat	PSE aCl	PD 4PID
PWR+24	PSE	PD	PSE_T3	3	3	9.5	9.5	9.5	9.5	BOTH_ALTS	51.0	4PR_DUAL	RSVD	NO	0
0.0	PD	PSE	PD_3D	4	4	25.5	25.5	9.5	9.5	RESERVED	N/A	RESERVED	4PR_DUAL	N/A	1
2.1	PSE	PD	PSE_T3	4	4	25.5	25.5	25.5	25.5	BOTH_ALTS	51.0	4PR_DUAL	RSVD	NO	0
3.8	PD	PSE	PD_3D	4	4	25.5	25.5	25.5	25.5	RESERVED	N/A	RESERVED	4PR_DUAL	N/A	1
9.2	PD	PSE	PD_3D	4	4	25.5	25.5	25.5	25.5	RESERVED	N/A	RESERVED	4PR_DUAL	N/A	1
14.8	PD	PSE	PD_3D	4	4	25.5	25.5	25.5	25.5	RESERVED	N/A	RESERVED	4PR_DUAL	N/A	1
20.3	PD	PSE	PD_3D	4	4	25.5	25.5	25.5	25.5	RESERVED	N/A	RESERVED	4PR_DUAL	N/A	1
25.9	PD	PSE	PD_3D	4	4	25.5	25.5	25.5	25.5	RESERVED	N/A	RESERVED	4PR_DUAL	N/A	1
31.4	PD	PSE	PD_3D	4	4	25.5	25.5	25.5	25.5	RESERVED	N/A	RESERVED	4PR_DUAL	N/A	1
32.3	PSE	PD	PSE_T3	4	4	25.5	25.5	25.5	25.5	BOTH_ALTS	51.0	4PR_DUAL	RSVD	NO	0
37.0	PD	PSE	PD_3D	4	4	25.5	25.5	25.5	25.5	RESERVED	N/A	RESERVED	4PR_DUAL	N/A	1
42.6	PD	PSE	PD_3D	4	4	25.5	25.5	25.5	25.5	RESERVED	N/A	RESERVED	4PR_DUAL	N/A	1

PSE Fields
MDI Pwr Support
YES
MDI Pwr State
ON
.at Type
2
Device
PSE
Power Source
PRI
Priority
LOW

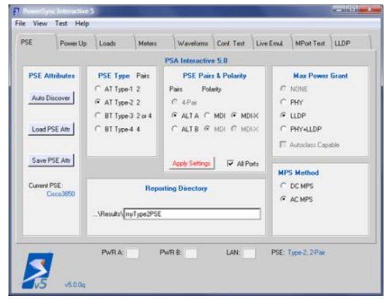
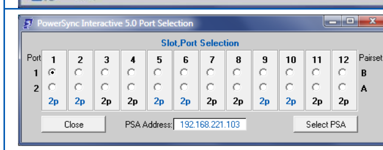
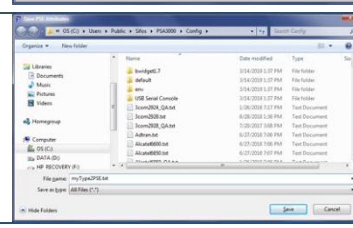
Figure 4.101 Dual Class 4 Power-Up, Adjust, Maintain Trace Report

4.12. PSA Interactive Exercises

The following paragraphs will demonstrate various operations that PSA Interactive will perform. These may be used to gain hands on familiarity with the PSA instrument and PSA Interactive software.

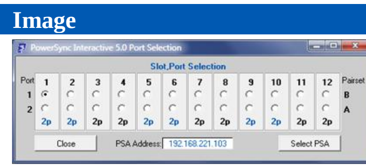
4.12.1. Configure Ports to Test an 802.3at Type-2 PSE that is Alt-A, MDI-X

The PSE is known to be Type-2 (30W), powering Alt-A pairset with negative (MDI-X) polarity. Additionally, the PSE is known to use 2-Event classification to grant Type-2 power to a PD and the PSE is known to use the DC MPS method for disconnect detection. Save the PSE configuration to “myType2PSE.txt” PSE attributes file.

Menu	Step	Task	Image
PSE	1	Select **AT Type-2**, Select **Alt-A** and **MDI-X**	
	2	**Apply Settings** *This sets up the test blade for 2-pair PSE testing* Select **PHY** and **DC MPS** *This declares other PSE attributes that will be used by automated tests*	 
	3	Press **Save PSE Attr** Enter **myType2PSE.txt**	

4.12.2. Auto-Discover an 802.3bt PSE

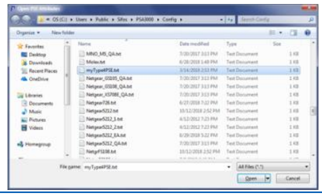
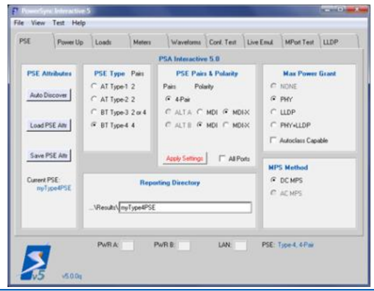
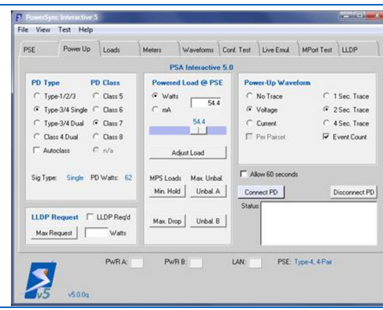
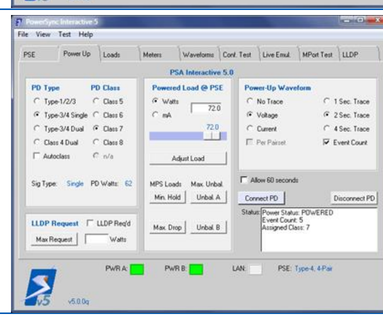
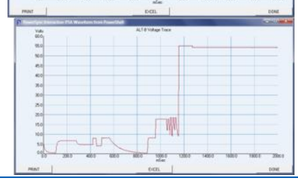
The PSE is known to be 802.3bt compliant but all other characteristics need to be discovered. Configure all slots accordingly in a PSA instrument that is a blend of PSA-3202 and PSA-3102 test blades.

Menu	Step	Task	Image
PSE		*All test ports are initially configured for 2-Pair PSE testing.* *Note that thisPSA-3000 has a blend of PSA-3202 and PSA-3102 test blades.*	

	1	Enter **BT Type-4** Press **Auto Discover**	
Auto-Discover	2	"Auto-Discover for BT PSE" Press **Start** (*PSE discovered as:* Type-4, 4-Pair, MDI-X on Alt-A, MDI on Alt-B)	
PSE	3	Press **Return** *PSE also discovered as:* Max Power Grant = PHY (Multi-Event) MPS Method = DC MPS	
		All test ports now configured for 4-Pair connections. PSA-3202 test blades configured to Single Signature on Port 1, PSA-3101 test blades to Dual Signature on Port 2. *Because this is a Type-4 802.3bt PSE, only the PSA-3202 ports will be able to test it.*	

4.12.3. Observe a 4-Pair Power-Up from Type-4 PSE Emulating a Class 7 PD

Load the configuration of a known 802.3bt Type-4 PSE at slot 1, port 1. Then configure for Class 7 PD emulation and capture a voltage waveform over a 2 second interval starting with PD connection. Also determine the PSE event count and PD assigned classification.

Menu	Step	Task	Image
PSE	1	Press **Load PSE Attr** Select myType4PSE and press **Open**	
		PSE Type is **BT Type-4** Alt A is **MDI-X**, Alt B is **MDI** High Power Grant is **PHY** MPS Method is **DC MPS**	
Slot Port	2	*All test slots are configured for 4-Pair modes.* Select **Slot 1 Port 1** (*Note this is presently a DISCONNECTED 4-Pair port*)	
Power Up	4	Select **Type-3/4 Single** Select **Class 7** Select **Voltage** and **2 Sec Trace** Select **Event Count**	
	5	Press **Connect PD** When PSE applies power, PWR A and PWR B indicators activate Event Count reported as 5 Assigned Class reported as 7 Voltage waveforms for Alt-A and Alt-B produced	
			 

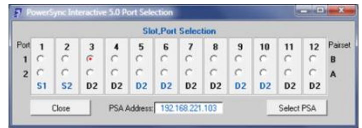
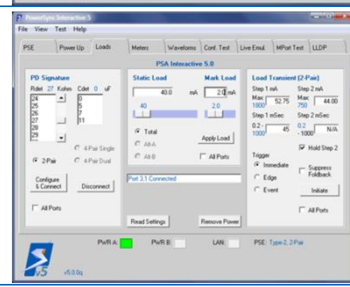
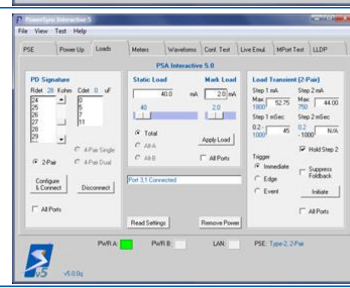
4.12.4. Perform an Emulated Class 6 LLDP Power-Up

Emulate a Class 6 PD that will use LLDP following a power-up to request 46.8 watts from a PSE that supports 802.3bt LLDP-based power management using test port 2,2. At the PSE interface, the power output will be 49.5 watts. Record the Event Count and Assigned Class at power-up.

Menu	Step	Task	Image
Slot-Port	1	Select Slot 2, Port 2	
Power Up	2	Select **Type-3/4 Single** Select **Class 6** Select **Event Count** Select **LLDP Req'd** Enter LLDP Request= 46.8 Enter Power Load @ PSE = 49.5	
	3	Press **Connect PD** *PWR A and PWR B indicators activate along with LAN indicator* *Status = POWERED and ACCCEPTED meaning PSE powered up and negotiated the 46.8 watt request successfully* *Event Count and Assigned Class at initial power-up shown as 1-Event, Class 3*	

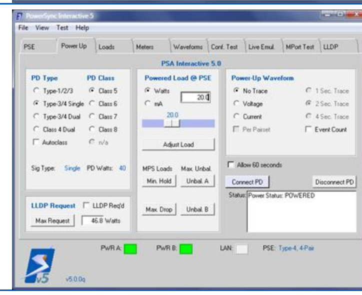
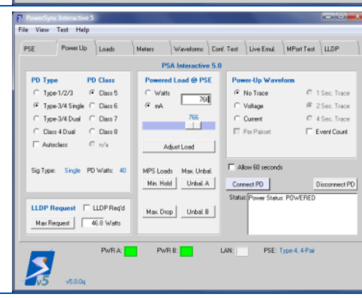
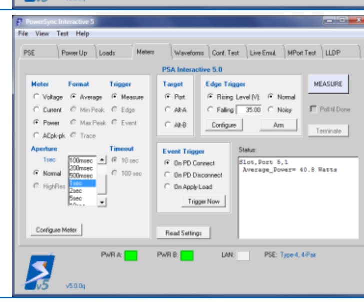
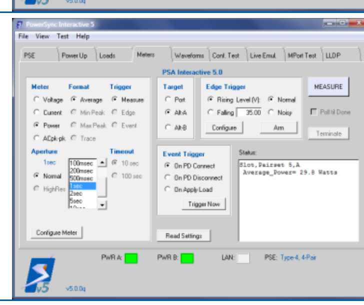
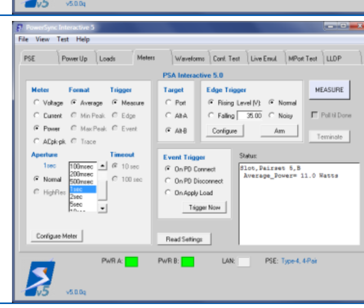
4.12.5. Determine the Maximum Signature Resistance a Type-2 (802.3at) PSE will power

This exercise involves configuring port 3,1 for an 802.3at Type-2 PSE (Alt A, MDI-X), then using the **Loads** menu to attempt power-ups at various detection signatures starting at 27KΩ.

Menu	Step	Task	Image
Slot-Port	1	Select slot 3, port 1	
PSE	2	Select **AT Type-2** Select **Alt-A** and **MDI-X** Press **Apply Settings** *Note that* PSE: Type-2, 2-Pair *in lower right of tab menu window*	
Loads	3	Enter **Static Load** = 40mA Press **Apply Load** (sets up Class 4 signature) Select **Rdet= 27**, **Cdet= 0** Press **Configure & Connect** **PWR A** indicates PSE accepted 27KΩ and applied power	
	4	Press **Remove Power** Enter **Static Load** = 40mA Press **Apply Load** (sets up Class 4 signature) Select **Rdet= 28**, **Cdet= 0** Press **Configure & Connect** **PWR A** indicates PSE accepted 28KΩ and applied power	
	5	Press **Remove Power** Enter **Static Load** = 40mA Press **Apply Load** (sets up Class 4 signature) Select **Rdet= 29**, **Cdet= 0** Press **Configure & Connect** **PWR A** indicates PSE accepted 29KΩ and applied power	
	6	Press **Remove Power** Enter **Static Load** = 40mA Press **Apply Load** (sets up Class 4 signature) Select **Rdet= 30**, **Cdet= 0** Press **Configure & Connect** **PWR A** indicates PSE rejected 30KΩ and did not power up	

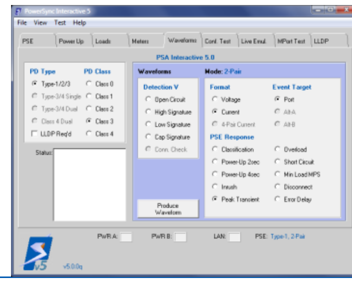
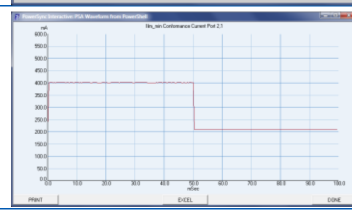
4.12.6. Measure Total and Pairset Powers of Emulated Class 5 PD after unbalancing the load to Alt-A

An emulated Class 5 PD is powered on port 5,1 to 20 watts. The worst allowed pair-to-pair unbalance load is then created with higher load on Alt-A. The DC power draw is measured on the port as well as the individual pairsets.

Menu	Step	Task	Image
Slot-Port	1	Select Slot 5, Port 1 *PSE previously entered as 4-Pair (Type-4) so Port 1,1 already in S1 state*	
Power Up	2	Select **Type-3/4 Single** Select **Class 5** Press **Connect PD** *When PSE applies power, PWR A and PWR B indicators activate*	
	3	Select **mA** Press **Unbal A** *Total current load adjusts to 766 mA*	
Meters	4	Select **Power** (*Format will automatically select* ***Average*** *and Trigger will automatically select* ***Measure***) Select **1sec** (Aperture) Select **Port** (Target) Press **MEASURE** *Meter measures 40.8 watts total*	
	5	Select **Alt-A** (Target) Press **MEASURE** *Meter measures 29.8 watts on Alt-A pairset*	
	6	Select **Alt-B** (Target) Press **MEASURE** *Meter measures 11.0 watts on Alt-B pairset*	

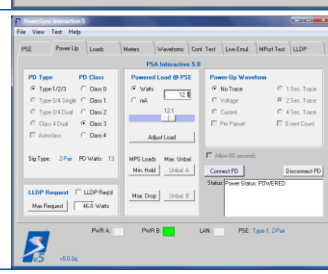
4.12.7. Assess PSE Tolerance of Type-1 Ilim_min Transient using Peak Transient waveform

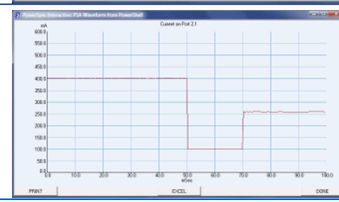
A Type-1 PSE is evaluated for tolerance of Ilim_min transient to an emulated Class 3 PD using test port 2,1. This analysis is done by simply using a standard 1-click waveform.

Menu	Step	Task	Image
Slot-Port	1	Select Slot 2, Port 1	
Waveforms	2	Select **Type-1/2/3** Select **Class 3** Select **Current** Select **Peak Transient** Press **Produce Waveform**	
		Waveform indicates a 400mA load applied for 50msec – the PSE maintains power as it should	

4.12.8. Assess PSE Tolerance of Type-1 Ilim_min Transient using Load Transient and Meters

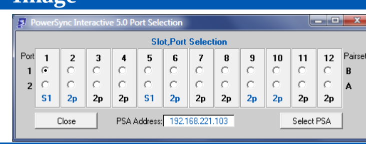
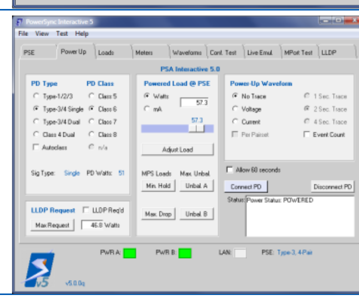
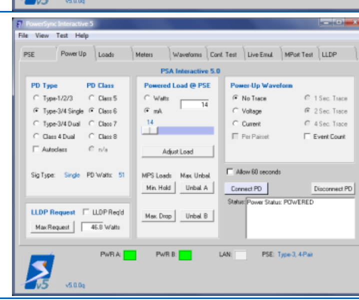
Similar to the previous exercise, a Type-1 PSE is evaluated for tolerance of Ilim_min transient to an emulated Class 3 PD using test port 2,1. However, in this exercise, the process is carried out "manually" using the Power Up, Loads, and Meters tab menus.

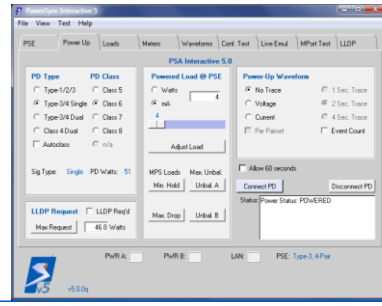
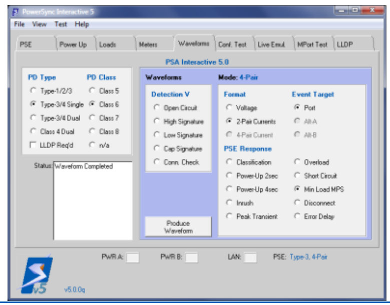
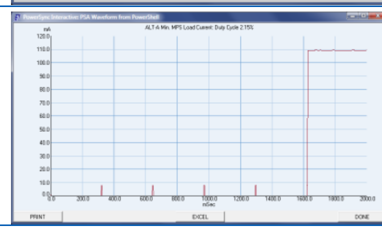
Menu	Step	Task	Image
Slot-Port	1	Select Slot 2, Port 1	
Power Up	2	Select **Type-1/2/3** Select **Class 3** Press **Connect PD** *When this PSE applies power, PWR B indicators activate*	
Loads	3	Enter **Step1 mA**= 400 Enter **Step1 mSec** = 50 Enter **Step2 mA** = 100 Enter **Step2 mSec** = 20 *Note: Step2 parameters are arbitrary here* Select **Event** (trigger) Press **Initiate**	

Menu	Step	Task	Image
Meters	4	Select **Current** Select **Trace** Select **Event** Select **100msec** (aperture) Press **MEASURE** *Current trace meter and load transient are now armed and waiting for an event trigger*	
	5	Press **Trigger Now** *Meter and transient both triggered* Press **MEASURE** *This will return the measurement now*	
		Waveform indicates a 400mA load applied for 50msec – the PSE maintains power as it should	

4.12.9. Assess that a Type-3 PSE satisfies DC MPS requirements

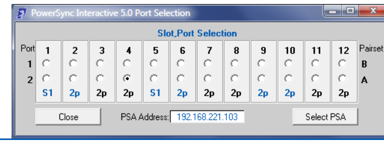
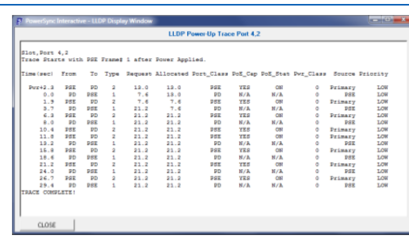
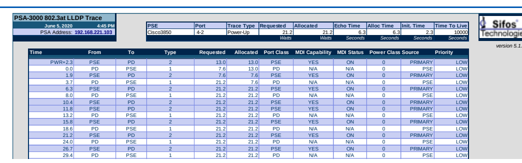
A Type-3 PSE is powered using a Class 6 PD emulation on test port 1,1. The PSE is evaluated for maintaining power with a 14 mA total load, removing power with a 4 mA total load, and maintaining power with a series of 6msec pulses of valid DC MPS signature current at 2.5% duty cycle.

Menu	Step	Task	Image
Slot-Port	1	Select Slot 1, Port 1 *This PSE was previously declared as a Type-3, 4-Pair PSE*	
Power Up	2	Select **Type-3/4 Single** Select **Class 6** Press **Connect PD** *When PSE applies power, PWR A and PWR B indicators activate, Status = POWERED.*	
	3	Select **mA** (*in* **Powered Load***)* Press **Min. Hold** *4-Pair Load Current adjusted to 14mA* *PWR A and PWR B indicators show PSE maintains power as it should*	

Menu	Step	Task	Image
	4	Press **Max. Drop** *4-Pair Load Current adjusted to 4mA* *PWR A and PWR B indicators show PSE removed power as it should*	
Waveforms	5	Select **Type-3/4 Single** Select **Class 6** Select **Min Load MPS** Select **2-Pair Currents** Press Produce **Waveform**	
		ALT-A pairset shows series of load current pulses *Each pulse is 8mA and 6msec duration* *PSE maintains power at end of trace as it should*	
		ALT-B pairset shows series of load current pulses *Each pulse is 8mA and 6msec duration* *PSE maintains power at end of trace as it should*	

4.12.10. Evaluate the LLDP Protocol from a Type-2 PSE powering a Class 4 PD

Capture a protocol trace of an Type-2 LLDP PSE powering an emulated Class 4 PD on test port 4,2 where the PD is requesting 21.2 watts of power. Evaluate over 30 seconds of time.

Menu	Step	Task	Image
Slot-Port	1	Select Slot 4, Port 2	
LLDP	2	Select **PSE** tab to describe PSE as **Alt-A**, **MDI-X**, Type-2 **Apply Settings** PSE: Type-2, 2-Pair	
	3	Select **LLDP** tab Select **Power-Up** Select **Type-1/2/3** Select **Class 4** Enter **1st Req'st**= 21.2 watts Select **30 sec** Select **5 sec** (Req'st Rate) Press **RUN TRACE**	
		PSE powers, trace starts running in live trace window	
		When trace is completed 30 seconds after first PSE frame, the standard LLDP trace report is produced	

5. PowerShell PSA Scripting Environment

PowerShell PSA is a script development and interactive command execution shell built upon the Tcl/Tk scripting language (version 8.4.5 or later). Tcl/Tk is an open source, portable, and easily extendable programming language developed for Unix (Linux) and subsequently extended to Windows and MAC operating systems. Compiled versions of Tcl/Tk are available (at no charge) from the ActiveState Web-Site (www.activestate.com).

Tcl (Tools Command Language) is a scripting language consisting entirely of commands for developing programs that run on and utilize command line interfaces. Tk is a significant extension to Tcl to enable Graphical User Interface (GUI) applications that are (for the most part) platform-independent.

5.1. TCL and Wish Shells

PowerShell PSA is provided with access to both a Tcl shell and a Wish shell. Shells are interactive command consoles just like the traditional DOS command shell that accompanies Windows or a "terminal" shell in Linux. In fact, when a **Tcl** or **Wish shell** is opened on a Windows-based system, traditional DOS commands such as "dir" are fully available.

Both Tcl and Wish shells support interpretive command execution, meaning commands may be typed and executed immediately when the [Enter] key is pressed. There is no compilation or linking required for Tcl/Tk commands. This feature makes Tcl/Tk an attractive solution for instrument control. Tcl is also quite powerful at managing and analyzing arbitrary data structures through its "list processing" capabilities. There is a considerable body of information regarding Tcl and Tk that is freely available over the Internet. Additionally there are some commonly used reference books including "Practical Programming in Tcl and Tk" by Brent Welch. The remainder of this manual will assume that the reader has some familiarity with Tcl – familiarity with the Tk extensions to Tcl is not necessary.

The **Tcl Shell** (*see **Figure 5.1***) is purely a command entry and program execution shell that does not support GUI application development. It supports keyboard entry, mouse operations, and shell configuration in a manner consistent with the host command shell (e.g. Windows "cmd" shell or Linux "terminal" shell). It supports interactive user prompting (via "standard input") from a script. The Tcl Shell will not support Tk graphical interface extensions.

The **Wish Shell** (*see **Figure 5.4***) is a newer shell designed to enable GUI application development. PowerShell Wish uses the top-level window created by the **Wish Shell** to present a "Close PowerShell" button since the console window opened by **Wish** is subsidiary to the top-level window. As with the **Tcl Shell**, the **Wish Shell** may be used either for script execution or interpretive command execution. PowerShell Wish must be used by any applications or command sequences that produce O-Scope traces since these require the Tk resources available under Wish.

5.1.1. Tcl Versus Wish in the PC Windows Environment

On Microsoft Windows systems, when a **Tcl Shell** is opened, users may right-click on the title bar to set properties for the console shell. Generally, PC users will benefit from configuring the shell properties to support "QuickEdit" and "Insert" modes. Text may be copied using the mouse to select the text and pressing [Enter] on the keyboard. Text may be pasted by using the mouse or cursor keys to position the cursor and then right-clicking the mouse. One handy feature of the Tcl shell is ability to select and copy columns of text or data. A second benefit is that the screen buffer length can also be configured to very large sizes as part of the console settings.

Wish is more "Windows-like" in that users may use typical methods of selecting, inserting, deleting, and copy-paste as are used in other Windows applications. Also, Wish is both Tcl and PowerShell PSA command-knowledgeable and will color code all known commands as they are typed into the shell. Wish supports Tk graphics and offers easy access to graphical user interface commands and tools such as message boxes. PowerShell Wish enables the display of PSA-3000 O-Scope traces using a single command from the shell. One limitation with the **Wish Shell** under Windows is that any applications utilizing command-line prompts to the user will not function properly since Wish is will not take "standard input" from the command shell. Also, the screen buffer length is limited and fixed.

5.2. PSA Connection Dialog

When either PowerShell Tcl (*see **Figure 5.1***) or PowerShell Wish (*see **Figure 5.3***) is opened, the user will be prompted via a command prompt (Tcl) or via the PSA Chassis Select window (Wish) to select a PSA address to connect. The dialog will validate that the desired PSA is available on the local network and then connect to that PSA. If the PSA is not available or is not powered, the dialog will refuse that connection. If all known PSA's are found to not be available, PowerShell PSA will open up in Demo

Figure 5.1 PowerShell TCL Connection Dialog

Mode (*see **Figure 5.2***) meaning that all instrument control becomes "virtual" – that is to a fictitious PSA. The PowerShell TCL prompt will time out if given no response in just under 10 seconds, at which time it will attempt to re-connect to the last successfully connected PSA address. (*See section 9.3.1 for information on how to configure this timeout characteristic*.)

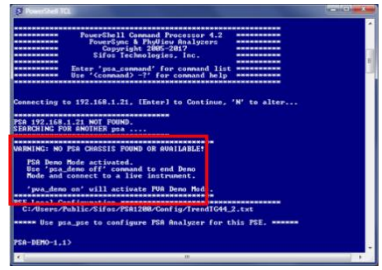


Figure 5.2 Demo Mode Warning

When opening PowerShell Wish, the user may force PowerShell to open to Demo Mode by simply selecting the **Demo Mode** checkbox prior to pressing **Connect**. With Demo Mode, users are given a choice of which type of PSA platform they would like to emulate when PowerShell opens. Once PowerShell is opened (either Tcl or Wish), the **psa_demo** command may be used to enter or exit **Demo Mode** as well as to reconfigure characteristics of the PSA platform being emulated.

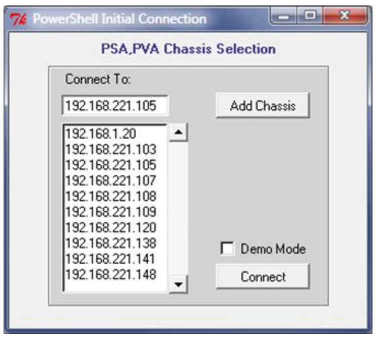


Figure 5.3 PowerShell Wish Connection Dialog

As PowerShell PSA is opened, the connected PSA will be inventoried for available test ports. Attempts to address commands to non-available test ports will be rejected. Changing PSA connection to a different PSA via the **psa** command (see below) will always update this inventory.

PowerShell PSA is a Tcl or Wish shell extended by a number of commands, utilities, and test scripts dedicated to the PowerSync Analyzer. All of the standard Tcl (and Tk in the case of Wish) commands are available to programs running in PowerShell. The remainder of this chapter will introduce the PowerShell PSA extensions to Tcl/Tk.

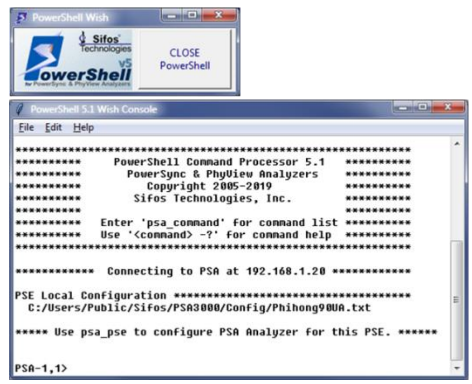


Figure 5.4 PowerShell Wish

5.3. PowerShell PSA Command Documentation Conventions

In presenting the PowerShell PSA API over the next few sections, certain conventions will be commonly utilized. These are described in the following table.

Convention	Definition
keyword *(command)*	An API command that will typically be followed by one or more command arguments. The minimum required text to execute the command on the command line is highlighted in purple. (Scripts must utilize the full name of the command.)
-?	A universal argument that responds with information on how to use the command including all command arguments. If a command is given no arguments, the Help menu often will appear.
?	A universal query argument to obtain the configuration state of the associated entity or function.
<**parameter**>	The "<" and ">" brackets indicate that a particular argument or argument set are optional.
literal *(sub-command)*	A literal argument associated with a command. Literal arguments may be followed by associated parameters but seldom have "nested" literal arguments.
parameter	A numeric or alpha-numeric argument accompanying a command or literal argument. Absence of an optional command parameter results in no change to the associated configuration value.
<*slot*,*port*> *Structured as* *slot*,1 or *slot*,2 *4-Pair Option:* *slot*,*pairset*	The presently addressed test port formatted as '*slot,port*' (*Example:* **3,2** is slot 3 port 2). Most Powershell PSA commands and queries may specify a test port in which case the default address is updated to that newly specified test port. Commands and queries that do not include the *slot*, *port* argument will automatically be addressed to the default address. The PowerShell PSA command prompt always indicates the default test port address. In 4-pair modes, *slot*,*port* must have the value of a presently CONNECTED test port. See the **psa_4pair** command in Section 5.8. Commands and queries that do not include the *slot*,*port* argument will automatically be addressed to the most recent CONNECTED test port specified. *See Section 9.1.1 for description of* **99,99**, **99,y**, *and* **x,99** *broadcast configuration ports*.
"|"	Indicates logical "OR"
stat	A special optional query available to many commands to report Operational State and in some cases, to return a measurement result.

5.3.1. PowerShell PSA Help Capabilities

PowerShell provides interactive help capability at the PowerShell PSA command line. First, an alphabetical listing and short description of all PowerShell API commands is available by entering the following command:

```
PSA-1,1> psa_command
```

Each PowerShell PSA command may then be further explained by typing the specific command followed by the "**-?**" keyword. An example would be:

```
PSA-1,1> vdcaverage -?
```

Tcl/Tk help is available from "Help" applications that are provided with Tcl/Tk.

5.4. The PowerShell PSA Prompt

In PSA 5.x version software, the PowerShell PSA prompt always conveys the following information:

Test Blade Config	Prompt Information	Examples
2-Pair (4-Pair DISABLED)	Presently addressed (2-pair) slot and port.	PSA-1,1> PSA-8,2>
4-Pair Single Signature (*PSx-3202 Only*)	Presently CONNECTED 4-pair slot and port and test blade Single Signature configuration. Single signature configuration is indicated by the single "+" symbol.	PSA-1,1+> PSA-6,2+>
4-Pair Dual Signature	Presently CONNECTED 4-pair slot and port and test blade Dual Signature configuration. Dual signature configuration is indicated by the double "++" symbol. *On PSx-3102 test blades, only Port 2 of each blade may be 4-pair CONNECTED.*	PSA-1,2++> PSA-2,1++> PSA-11,2++>

In 4-pair configurations involving **PSx-3202** test blades (and the PSA-3402 Compact), PowerShell PSA commands and queries MUST always be addressed to the CONNECTED 4-Pair port. At any one time, either Port 1 or Port 2 of the PSx-3202 test blade can be CONNECTED to a 4-Pair capable PSE.

In 4-pair configurations involving **PSx-3102** test blades, the only signature option is Dual Signature and only Port 2 of the PSx-3102 test blade can be configured to connect to a 4-pair PSE. However, in general, PSx-3102 test blades will not be effective for testing 4-Pair **802.3bt** PSE's.

Configuration of the 4-Pair connection on any test blade is directly performed using the **psa_4pair** command. See section 5.8.

5.5. PowerShell PSA Important Global Settings

PowerShell PSA incorporates many global settings (or global variables), some of which will be of interest to test script developers and other system users. In particular, those settings associated with PSE attributes will affect decisions made within automated test suites such as the PSE Conformance Test Suites (*see section 6*) and the PSE Multi-Port Test Suite (*see section 7*). These settings and their associated global variable names are described in the following table. See section 3.2.4 for further information about PSE attributes.

Setting	Global Variable	Value Range	Configuration Commands
Current Test Port	port	**1,1** – **12,2**	Any command or query with a non-broadcast *slot,port* specified will alter port
PSE Category	psaPseClass	**AT**, **BT**, or **PROP4**	**psa_pse**, **psa_auto_port**
PSE ALT (Powered Pair) Configuration	psaDefaultAlt	**A**, **B**, or **4Pr**	**alt**, **psa_pse**, and **psa_auto_port** can configure this setting.
PSE Polarity Configuration	psaDefaultPol	**MDI**, **MDI-X**, **MDI+MDI-X**, **MDI-X+MDI**, **MDI+MDI**, **MDI-X+MDIX**	**polarity**, **psa_pse**, and **psa_auto_port** can configure this setting.
PSE MPS (Disconnect) Method	psaPseMps	**AC** or **DC**	**psa_pse** and **psa_auto_port** can configure this setting.
PSE 4-Pair Type	psaPse4prType	**NONE**, **Type-3**,**Type-4**, **Type-3ac, Type-4_ac**	**psa_pse** and **psa_auto_port** can configure this setting.
Type-2 PSE High Power Grant Method	psaPseHpGrant	**NONE**, **PHY**, **LLDP**, **PHY+LLDP**	**psa_pse** and **psa_auto_port** can configure this setting.
Populated Test Slots	slotRange	**{1 2 3** … **12}**	

Test Port Pair State	psaPairState	**2Pr**, **4PrS1**, **4PrS2**, **4PrD1**, **4PrD2**	**psa** and **psa_config** will update this list based on currently connected PSA. **psa_4pair** will alter the value of psaPairState. Each of these globals are arrays indexed by Test Ports (e.g. psaTestBladeType(1,1))
Test Blade Type	psaTestBladeType		
Test Port Firmware Version	psaPortVersion	Array of **n.nn** formatted values per test port	
Test Port Hardware Version	psaTestBladeHW ver	Array of interger version numbers per test port	

5.6. Script Writing with Notepad ++ *(for Microsoft Windows)*

PowerShell PSA scripts may be created and edited in the freely available **Notepad++** source code editor that is readily available on the web (e.g. https://notepad-plus-plus.org). This powerful editor is knowledgeable of Tcl/Tk and PowerShell PSA commands, global variables, and other common syntactical constructs such as braces and brackets, math operators, etc. It provides many powerful capabilities that support authoring and troubleshooting bug-free scripts.

To configure Notepad++ for PowerShell PSA, first install Notepad++, then use the **Language** drop-down menu to **Define Your Language**…, then select the **Import** control and import the file **PowerShell_PSA.xml** from the installed directory for PSA software. This will typically be **c:\Program Files (x86)\Sifos\PSA3000** on a Windows computer.

5.7. PowerShell PSA Connection and Configuration Commands

PowerShell PSA configuration commands are specific to a PowerShell (console) window. The commands only affect that window and will have no immediate impact to any other PowerShell windows. Settings for "psa" (most recent IP Address) and the most recently accessed PSE Attributes File will be remembered when a new shell is opened.

<table>
<tr><th>Command</th><th>Command Parameters</th><th>Query</th><th>Returned Parameters</th></tr>
<tr><td>psa</td><td>ipAddress
Selects the instrument to which subsequent commands and queries will be directed.
ipAddress An n.n.n.n format IP address. This address will apply until re-established by another psa command and is persistent if the shell is closed and re-opened.</td><td>?</td><td>Current Chassis IP Address</td></tr>
<tr><td>psa_demo</td><td><ON <PSA | PL | SA> |OFF> slots <i>num_blades</i>
This command enables or disables the Demo Mode and selects the type of platform to emulate in Demo Mode. In Demo Mode, most commands may be executed just as when connected to a live instrument. Default emulation will be PSA-3000 with 12 populated test slots.
ON Enable Demo (Emulation) Mode
OFF Disable Demo (Emulation) Mode – must be connected to an instrument.
PSA Emulate PowerSync Analyzer
PL Emulate PowerSync Programmable Load
SA Emulate PowerSync Service Analyzer
<i>numblades</i> The number of populated test slots (1-12)\</td><td></td><td></td></tr>
</table>

Command	Command Parameters	Query	Returned Parameters
psa_pse (or **psa_ getConfig**)	<*filename*> <**-alt A** | **B** | **4Pr**> <**-pol mdi** | **mdix** | **mdi+mdi** | **mdix+mdi** | **mdi+mdix** | **mdix+mdix**> <**-spec at** | **bt** | **prop4**> <**-mps dc** | **ac**> <**-grant type-1** | **phy** | **lldp** | **phy+lldp**> <**-4prtype** *4prType* <**-min4prclass** <**NONE** | **1** | **2**| **3** | **4** | **5**>> <**-nosetup**> Configure and/or load (from a file) the PSE attributes. Command is used to declare PSE attributes so that PSA test ports are properly configured for Powered Pairs, Alt, and Polarity and so automated test suites can evaluate expected PSE behaviors. Use **psa_auto_port** to automatically discover attributes from a connected PSE port. *See section 3.2.4 for further information on PSE Attributes Files.* *filename* The specific file name, EXCLUDING path and extension, that will be installed. If no file name is specified, **psa_pse** will maintain existing PSE attributes unless specified in other arguments to **psa_pse**. If file is provided, any settings in that file will be overridded byany attributes specified with the **psa_pse** command. Then all pair state, alt, and polarity settings will be propagated to all PSA test ports. **-alt A** | **B**: Override 2-Pair PSE powered pairs attribute with alt **A** or alt **B**. 2-Pair connections with this powered pair will be propagated to all PSA test ports. **-alt 4pr**: Override powered pairs attribute to indicate that both pairsets are powered. 4-Pair connections will be propagated to all test ports. **-pol mdi** | **mdix**: Override 2-pair polarity attribute to specify mdi (positive) or mdix (negative) polarity. Attribute will be propagated to all PSA test ports. ALT attribute must be “A” or “B”. **-pol mdi+mdi** | **mdix+mdi** | **mdi+mdix** | **mdix+mdix**: Override polarity settings for both pairsets in a 4-pair configuration where value is ‘**Alt-A** Polarity’**+**’**Alt-B** Polarity’. Attribute will be propagated to all PSA test ports. ALT attribute must be “4pr”. **-spec at** | **bt** | **prop4**: Override declared PSE category. Declare PSE as 802.3**at**, 802.3**bt**, or **Prop**rietary 4-Pair. ALT attribute must be “4pr” for **prop4**. **-mps dc** | **ac**: Override declared PSE MPS method to **DC** MPS or **AC** MPS. If PSE category is **bt** or **prop4**, this setting must be “dc”. **-grant type-1**: Override PSE High Power Grant setting with ‘NONE’ for a Type-1 PSE. **-grant phy**: Override PSE High Power Grant setting with ‘PHY’ for a Multi-Event classification, Type-2/3/4 PSE. This is method used by PSE to grant the highest power level it is capable of. **-grant lldp**: Override PSE High Power Grant setting with ‘LLDP’ for a LLDP capable, Type-2 PSE. This is method used by PSE to grant the highest power level it is capable of. **-grant phy+lldp**: Override PSE High Power Grant setting with ‘PHY’ for a Multi-Event classification, Type-2/3/4 PSE. PSE also utilizes LLDP only to reduce power allocated. **-4prtype** Override PSE 4-Pair Type attribute *4prType* **NONE** (802.3at PSE), **Type-3** | **Type-4** (802.3bt PSE including 2-Pair Type-3), **PSE1** | **PSE2** | **UPoE** | **UPoE2** | **LT++** (Proprietary 4-Pair PSE . These are not supported in PSA 5.0 or newer version software. See *Sifos application note*: **4-Pair PSE Testing with the PSA-3000 & PSL-3000.pdf**) **-min4prclass** Use to specify the minimum PD class that will get 4-Pair powered by the PSE. Specify **NONE** if 2-Pair PSE. **Note:** Use **psa_saveConfig** to permanently update any settings overrides for a particular PSE.	**?**	**AT** | **BT** | **PROP4** (Alt) **A** | **B** | **4Pr** Polarity MPS (**AC** | **DC**) HP Grant 4-Pair Type Min. 4-Pair Class

Command	Command Parameters	Query	Returned Parameters
psa_saveConfig	<*filename*> Saves a PSE Attributes File to the standard configuration directory "\Config". *filename*: The specific file name, EXCLUDING path and extension, that will be installed. If no file name is specified, psa_saveConfig will save to the last PSE attributes file loaded.		
psa_version	Outputs current version of PowerShell PSA software components.		Module Version List
psa_exists	*ipaddress* Returns "1" if PSA is found on network and "0" if PSA is not found on the network. *ipaddress*: The IP address of a PSA chassis.		1 =PSA found 0 =No PSA found
psa_show_ trace	**ON** | **OFF** Enables or disables automated display of any acquired waveform traces during PSE Conformance Testing. **ON** Enable display of waveform traces **OFF** Disable display of waveform traces **NOTE!** *Command is only functional in PowerShell Wish.*		
qpsa_config	*ipAddr#1* <*ipAddr#2 ipAddr#3… ipAddr#8* > Preconfigures up to 8 PSA / PSL / PVA chassis' for rapid switching between chassis connections using **qpsa** command. Must be executed before qpsa can be used. *ipAddr#1* First of up to 8 PSA/PSL chassis addresses *ipAddr#2* Second of up to 8 PSA/PSL chassis addresses *ipAddr#N* Last of up to 8 PSA/PSL chassis addresses		
qpsa	*ipAddr* Switches from current PSA / PSL / PVA chassis to a different PSA / PSL / PVA chassis in a small fraction of a second. Chassis address specified must have been included in a prior **qpsa_config** command. *ipAddr* PSA / PSL / PVA address to switch to.		
psa_latency_ test	<*ipAddr*> <*ioCount*> <**-v**> Utility to statistically analyze network connection latency between host computer and PSA instrument and process preemption delays within the host computer. *See Sections 3.3 for further information*. *ipAddr* IP address of PSA Instrument to which latency is being studied – default is currently connected PSA. *ioCount* Count of latency measurements to run. Range is 100 to 2000 measurements. Default value is 2000. Higher counts will catch more intermittent problems. **-v** Produce diagnostic details from the **psa_latency_test** utility. Default is no diagnostic details.	PSA Address, Measurement Count, Minimum Latency (msec), Maximum Latency (msec), 95^{th} Percentile Latency (msec), I-O Status: **OK** | **WARNING** | **PROBLEM!** PROCESS_STATUS: **OK** | **WARNING** | **PROBLEM!**	

5.8. Test Blade Configuration Commands

PSx-3x02 test blades (or slots) can be configured for testing 2 fundamental categories of PSE's:

- 2-Pair PSE's (e.g. all 802.3at PSE's, 2-Pair 802.3bt PSE's)
- 4-Pair PSE's (e.g. 802.3bt Type-3/4 PSE's and various Proprietary 4-Pair PSE's). 802.3bt Type-3/4 4-Pair PSE's require the PSx-3202 test blade (or PSA-3402 instrument) to perform comprehensive testing.

Within the 4-Pair realm, there are two additional categories of PD types that 4-Pair PSE's will encounter:

- Single Signature PD's (Most 802.3at PD's and 802.3bt PD's)
- Dual Signature PD's (Some 802.3bt PD's and most Proprietary 4-Pair PD's)

Each **PSx-3x02** can be configured for testing 2-Pair PSE's and certain 4-Pair PSE's. **PSx-3202** test blades can be configured to emulate both Single Signature and Dual Signature PD's from EITHER test port 1 or test port 2, but not both at the same time. When port 1 is configured to a 4-Pair mode, then port 1 becomes the CONNECTED 4-Pair port while port 2 of that slot is physically disconnected. Similarly, when port 2 is configured to a 4-Pair mode, then port 2 becomes the CONNECTED 4-Pair port.

PSx-3102 test blades can be configured to emulate Dual Signature PD's using only port 2, however, the PSx-3102 will not fully emulate **802.3bt** Dual Signature PD's.

The **psa_4pair** command is the means to directly configure a test blade for 2-Pair and 4-Pair testing modes. Other commands, for example **psa_pse**, **power_bt**, and **psa_auto_port** embed the **psa_4pair** command to manage blade configurations.

Command	Addr	Command Parameters	Query	Returned Parameters
psa_4pair	<*port*>	<**dual**> | <**single**> | <**disable**> Controls the PSA 4-pair switch that in turn causes both Port 1 and Port 2 test port resources in a single test blade (or PSA compact instrument) to be shared to one physical 4-pair test port. A 4-Pair PSE can be connected to Port 2's of PSA/PSL-3102's and to either port of PSA/PSL-3202's. (**802.3bt** 4-Pair PSE's will generally require PSA/PSL-3202 blades or the PSA-3402 Compact PSA.) **dual** Connects specified *slot,port* to a DUAL signature configuration with ALT-A pairset connected to Port 2 and ALT-B pairset connected to Port 1. Specified port argument must be *slot*,**2** given PSA/PSL-3102 test blades. **single** Connects specified slot,port to a SINGLE signature configuration with ALT-A pairset connected to Port 2 and ALT-B pairset connected to Port 1. *Only available with **PSA/PSL-3202** test blades.* **disable** Isolates Port 1 from Port 2 so they work independently as 2-pair test ports. This is the power-on default position. NOTE: **psa_4pair single** and **psa_4pair dual** will automatically configure Alt settings so **port 1** is **Alt B** and **port 2** is **Alt A**.	**?**	DUAL | SINGLE | DISABLED | DISCONNECTED (SINGLE and DISCONNECTED applicable to PSA/PSL-3202 only)
psa_3pair	<*port*>	**connect** | **isolate** *Applicable to **PSA-3202 version 9** or newer hardware only.* Controls the connection of a 33KΩ resistance between the low (or negative side) of Port 1 (or Pairset B) and the low (or negative) side of Port 2 (or Pairset A). Utilized for measurements of PSE parameter $\mathbf{I_{Rev}}$ when a PSE is providing 3-Pair powering to a 4-pair, Single Signature PD. Addressed port may be "**x,1**" or "**x,2**". **connect** Connects the Pairset A and Pairset B negative buses with 33KΩ given that port is in a 4-Pair, Single Signature configuration. **isolate** Disconnects the Pairset A and Pairset B negative buses so that they are fully isolated.	**?**	CONNECTED | ISOLATED

5.9. Test Port Configuration Commands

The following commands are directed to specific test ports and generally used for static configuration of test resources at that port. Whenever the *port* parameter is provided, the default *slot*,*port* for that and all subsequent commands will be updated as will the command prompt. Configuration operations support multicast *port* values **99**,**99** and **99**,*y* and *x*,**99** though **99**,**99** is not available in 4-Pair configurations and **99**,*y* requires identical test blade 4-pair configurations throughout the instrument. When test blades are in 4-Pair mode, single pairset operations can be performed by addressing *slot*,*pairset* where *pairset* can be the Alt-A (*slot*,**A**) or Alt-B pairset (*slot*,**B**).

<table>
<tr><th>Command</th><th>Addr</th><th>Command Parameters</th><th>Query</th><th>Returned Parameters</th></tr>
<tr><td rowspan="2">alt</td><td>2-Pair
<<i>port</i>>

or
4-Pair
<i>slot</i>,A
<i>slot</i>,B</td><td>a | b | toggle

Configures Port Mux for powered pairs given 2-Pair test blade configuration. Port will default to Alt A when PSA chassis is first powered on.

A Select ALT A pairs
b Select ALT B pairs
toggle Select ALT pair opposite to current setting</td><td rowspan="2">?</td><td rowspan="2">A | B | 4PR</td></tr>
<tr><td>4-pair
Con-
nected
<<i>port</i>></td><td><i>(Not applicable)</i>

For test blades (or compact instruments) in 4-Pair configuration, the alt command is unnecessary because the psa_4pair command must force ports 1’s to Alt B and port 2’s to Alt A.</td></tr>
<tr><td rowspan="2">polarity</td><td>2-Pair
<<i>port</i>>
or
4-Pair
<i>slot</i>,A
<i>slot</i>,B</td><td>pos | neg | mdi | mdix

Configures test port bus switch for power polarity. Test blades will default every port to negative polarity (MDI-X) when PSA chassis is first powered on.
pos or mdi sets to PoE Positive Polarity (MDI)
neg or mdix sets to PoE Negative Polarity (MDI-X)</td><td>?</td><td>POS | NEG</td></tr>
<tr><td>4-pair
Con-
nected
<<i>port</i>></td><td>pos+pos | neg+pos | pos+neg | neg+neg | mdi+mdi | mdix+mdi | mdi+mdix | mdix+mdix

Configures test blade bus switches for pairset polarities. Test blades will default every pairset to negative polarity (MDI-X) when PSA chassis is first powered on.

pos+pos or mdi+mdi sets Alt-A and Alt-B to positive (MDI) polarity
neg+pos or mdix+mdi sets Alt-A to negative (MDI-X) and Alt-B to positive (MDI) polarity
pos+neg or mdi+mdix sets Alt-A to positive (MDI) and Alt-B to negative (MDI-X) polarity
neg+neg or mdix+mdix sets Alt-A and Alt-B to negative (MDI-X) polarity</td><td>?</td><td>POS+POS |
NEG+POS |
NEG+NEG |
POS+POS</td></tr>
<tr><td rowspan="2">port</td><td>2-Pair
<<i>port</i>>

or
4-Pair
<i>slot</i>,A
<i>slot</i>,B</td><td>connect <trigout> | isolate <trigout>

Connects or disconnects 2-pair detection signature and AC MPS signature. Port will default to isolated when PSA chassis is first powered on.

connect connects the detection and AC MPS signature
isolate disconnects the detection and AC MPS signature
trigout Generate event trigger on command execution</td><td rowspan="2">?</td><td rowspan="2">Connected |
Isolated</td></tr>
<tr><td>4-pair
Con-
nected
<<i>port</i>></td><td>connect <trigout> | isolate <trigout>

Connects or disconnects 4-pair detection and AC MPS signature, either Single or Dual Signature. Pairsets will default to isolated when PSA chassis is first powered on.

connect connects 4-pair single signature if blade is in Single Signature mode or connects 4-Pair dual signature if blade is in Dual Signature mode.
isolate disconnects 4-pair single signature if blade is in Single Signature mode or connects 4-Pair dual signature if blade is in Dual Signature mode.
trigout Generate event trigger on command execution</td></tr>
</table>

Command	Addr	Command Parameters	Query	Returned Parameters
passive	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	<**r** *resistance*> <**c** *capacitance*> Configures passive detection signature. Port will default to resistance = 24 KΩ, capacitance = .1 µ F (“0”) when PSA chassis is first powered on. **R** specifies a 2-pair or pairset resistance setting *resistance* is integer resistance value in KΩ from 9 to 39 **c** specifies a 2-pair or pairset capacitance setting *capacitance* is capacitance value in µF = 0, 5, 7, or 11	**?**	Resistance Value Capacitance Value
	4-pair Con-nected <*port*>	<**r** *resistance*> <**c** *capacitance*> Configures passive detection signature. If Dual Signature configuration, both signatures are configured uniformly. **R** specifies 4-pair single signature resistance setting or each dual signature resistance setting. *resistance* is integer resistance value in KΩ from 9 to 39 **c** specifies 4-pair single signature capacitance setting or each dual signature capacitance setting. *capacitance* is capacitance value in µF = 0, 5, 7, or 11	**?**	*SINGLE SIG*: Resistance Value Capacitance Value *DUAL SIG*: Resistance Value on Alt A Capacitance Value on Alt A Resistance Value on Alt B Capacitance Value on Alt B
iload	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	<**i** *load_current* > <**t** *mark_current* > <**trigout**> Configures active load to a steady state current load and also specifies load current in the Mark voltage region. Option provided to generate an event trigger when active load is adjusted. **I** *load_current* is 2-pair or pairset current load in units of mA. Current load has range of 0 to 950 mA (*750mA on PSA-3102*) with 0.25 mA resolution. **t** *mark_current* is transition load in units of mA. Transition load has range of 0 to 400 mA with 0.25 mA resolution. **trigout** Generate hardware (event) trigger coincident with static load change.	**?**	Load Current Value Transition (mark) Current
	4-pair Con-nected <*port*>	<**i** *load_current* > <**t** *mark_current* > <**trigout**> Configures active load to a steady state current load and also specifies load current in the Mark voltage region. Option provided to generate an event trigger when active load is adjusted. **I** *load_current* is 4-pair load in units of mA. Current load has range of 0 to 1900 mA (*1500mA on PSA-3102*) with 0.25 mA resolution. **t** *mark_current* is transition load *on each pairset* in units of mA. Transition load has range of 0 to 400 mA with 0.25 mA resolution. **trigout** Generate hardware (event) trigger coincident with static load change.	**?**	4-Pair Load Current Value Alt-A Transition (mark) Current Alt-B Transition (mark) Current

Command	Addr	Command Parameters	Query	Returned Parameters
class	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	*class_value* <**mark2**> | *me_class* *This is a utility command that MAY revise any prior settings performed by* **iload**. Command establishes a PD classification signature. *class_value* A fixed 802.3at 2-pair (or pairset) signature load. Range is **0**, **1**, **2**, **3**, or **4** corresponding to 2.5, 10.5, 18.5, 28, and 40 mA respectively *applied to addressed 2-pair port or pairset*. Class **4** applies 2mA mark load current by default. This can be modified by the **iload** command. **mark2** Applies Mark Region ccurrent of 2mA for classes < 4. *APPLICABLE TO **PSA/PSL-3202** IN 4-PAIR SINGLE SIGNATURE OR 2-PAIR CONFIGURATIONS ONLY*: *me_class* A multi-event 802.3bt signature load to configure. Range is **5**, **6**, **7**, **8** where **5-8** are single signature class 5 to 8 multi-event loads applied to addressed 2-pair port or pairset. (*Normally, these are only used in 4-Pair Single Signature configuration*.) Class **5-8** applies 2mA mark load current by default. This can be modified by the **iload** command. *APPLICABLE TO **PSA/PSL-3202** IN 4-PAIR DUAL SIGNATURE CONFIGURATIONS ONLY*: *me_class* A multi-event 802.3bt signature load to configure. Range is **1d**, **2d**, **3d**, **4d**, or **5d** where **1d-5d** are class 1 to 5 dual signature multi-event loads applied to addressed 2-pair port or pairset. Class **1d-5d** applies 2mA mark load current by default. This can be modified by the **iload** command. Multi-Event classification will be disabled when *me_class* is specified. Multi-event classification must subsequently be ARMED using **mclass_start**, **psa_connect mevent**, or **psa_triggered_connect mevent**.	**?**	PD Class Mark Load Multi-Event Class (PD Class = Multi-Event Class when Multi-Event is ARMED on specified pairset. Otherwise, PD Class derived from present **iload** setting.)
	4-pair Con-nected <*port*>	*class_value* <**mark2**> | *me_class* *This is a utility command that MAY revise any prior settings performed by* **iload**. Command establishes a PD classification signature. *class_value* A fixed 802.3at 2-pair (or pairset) signature load. Range is **0**, **1**, **2**, **3**, or **4** corresponding to 2.5, 10.5, 18.5, 28, and 40 mA respectively *applied to both pairsets*. This can be modified by the **iload** command. **mark2** Applies Mark Region ccurrent of 2mA for classes < 4. *APPLICABLE TO **PSA/PSL-3202** IN 4-PAIR SINGLE SIGNATURE CONFIGURATIONS ONLY*: *me_class* A multi-event 802.3bt signature load to configure. Range is **5**, **6**, **7**, **8** where **5-8** are single signature class 5 to 8 multi-event loads applied to both pairsets Alt-A and Alt-B. Class **5-8** applies 2mA mark load current by default. This can be modified by the **iload** command. *APPLICABLE TO **PSA/PSL-3202** IN 4-PAIR DUAL SIGNATURE CONFIGURATIONS ONLY*: *me_class* A multi-event 802.3bt signature load to configure. Range is **1d**, **2d**, **3d**, **4d**, or **5d** where **1d-5d** are class 1 to 5 dual signature multi-event loads applied to both pairsets Alt-A and Alt-B. Class **1d-5d** applies 2mA mark load current by default. This can be modified by the **iload** command. Multi-Event classification will be disabled when *me_class* is specified and multi-event classification must subsequently be ARMED using **mclass_start**, **psa_connect mevent**, or **psa_triggered_connect mevent**.	**?**	*Alt-A Pairset:* PD Class Mark Load Multi-Event Class *Alt-B Pairset:* PD Class Mark Load Multi-Event Class (PD Class = Multi-Event Class when Multi-Event is ARMED. Otherwise, PD Class derived from present **iload** setting.)

Command	Addr	Command Parameters	Query	Returned Parameters
mclass	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	**event** *N* **i** *current* <**start** <**autoclass**>> | <**stop**>	?	Class_Sig Event_Currents
		Enables "editing" of standardized multi-event signatures to produce non-nominal load currents and illegal signatures on a specified test port or pairset. May be used to initiate or terminate multi-event class signatures. Queries **?** and **stat** only available to **PSx-3202** test ports. **event** specifies an event where load current will be specified *N* the event number to be configured. Range is **2** or **3** for PSA-3102's and **2**, **3**, **4**, or **5** for PSA/PSL-3202's. **i** specifies that a load current for Event *N* will be specified *current* the actual load current to apply during Event *N* **start** resets and arms (or activates) the configured multi-event signature. **stop** disarms the multi-event signature *APPLICABLE TO **PSA/PSL-3202** ONLY*: **autoclass** (see **psa_connect** to simulate 802.3bt autoclass.) **psa_connect** and **psa_triggered_connect** *may be utilized to start (or activate) the multi-event signature.* *APPLICABLE TO **PSA-3102** ONLY*: **mclass** *is utilized exclusively to produce uneven 2*-event and LT++ 3-event signatures. It is not supported by the PSL-3102. **start** *or* **stop** *must be included with the* **mclass** *command given a PSA-3102 test port. For this reason, it should only be applied after a PD detection signature is connected to the PSE port to prevent false-triggering on open circuit signaling.*	**stat**	State (enabled or disabled) Autoclass (enabled or disabled) Event Count (most recent count) Event_1 (LCE, NOT_LCE, N/A)
	4-pair Con-nected <*port*>	**event** *N* **i** *current* <**start** <**autoclass**>> | <**stop**> Enables "editing" of standardized multi-event signatures to produce non-nominal load currents and illegal signatures on both Alt-A and Alt-B pairsets. May be used to initiate or terminate multi-event class signatures. Queries **?** and **stat** only available to PSx-3202 test ports.	?	*Alt-A Pairset:* Class_Sig Event_Currents *Alt-B Pairset:* Class_Sig Event_Currents
		All settings and usage rules are identical to the 2-Pair application described above.	**stat**	*Alt-A Pairset:* State (enabled or disabled) Autoclass (enabled or disabled) Event Count (most recent count) Event_1 (LCE, NOT_LCE, N/A) *Alt-B Pairset:* State (enabled or disabled) Autoclass (enabled or disabled) Event Count (most recent count) Event_1 (LCE, NOT_LCE, N/A)

Command	Addr	Command Parameters	Query	Returned Parameters
itrans	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	<**i1** *current1*> <**t1** *duration1*> <**i2** *current2*> <**t2** *duration2*> < **go** | **trig1** | **ext**> <**sfb** <**step1**>> <**repeat** *cycles*> **trigout** Configures and launches 2-pair or pairset load transients consisting of up to 6 cycles of a two step load current sequence with specified durations. Optionally produces trigger out. Test ports do not retain settings of **trigger mode**, **foldback suppression**, or **step1 load > 950mA** – these must be specified on each instance of initiating a transient. **i1**, **i2** specify 2-pair or pairset current for step 1 and 2 respectively. **t1**, **t2** specify duration entry for step 1 and 2 respectively. *current1* is 1st transient step 2-pair or pairset current value in units of mA (0 to 1800 mA, 0.25mA steps). For *current1* values **> 950 mA**, transients must be immediate triggered with **go** argument and foldback suppression will be automatically invoked. *duration1* is time duration of 1st step with *current1*. For *current1* values **≤ 950 mA**, this duration ranges from 200u to 1000u (µSec) or 1m to 1000m (mSec). For *current1* values **> 950 mA**, *duration1* must be specified from 200u to 1000u (µSec) or 1m to 80m (mSec), or it will default to 80msec. *current2* is 2nd transient step 2-pair or pairset current value in units of mA. Range is 0 to 950 mA (*750mA on PSA-3102*) with resolution of 0.25mA. *duration2* is time duration of 2nd step with *current2*. The duration ranges from 200u to 1000u (µSec) or 1m to 1000m (mSec). *duration2* also takes the value "hold" causing the static current load to remain indefinitely at the *current2* value instead of returning to the original static load. For *current1* values **> 1023 mA**, *duration2* must be 1000m. **sfb** suppress foldback on *next transient* for duration of load transient. Must be specified with **go**, **trig1**, or **ext** arguments. **go** launch load current transient immediately **trig1** start load current transient on next edge trigger (on test port or in 4-pair mode, on pairset) **ext** start load current transient on next event trigger **trigout** generate event trigger on command execution **repeat** cycle the specified load transient more than once. If not provided with **go** | **trig1** | **ext**, the transient will cycle only once. *cycles* Number of load transient repeats. Range is 1 to 6. Default is no repeats.	**?**	Step 1 Current Step 1 Duration Step 2 Current Step 2 Duration
	4-pair Con-nected <*port*>	**i1** *current1*> <**t1** *duration1*> <**i2** *current2*> <**t2** *duration2*> < **go** | **trig1** | **ext**> <**sfb** <**step1**>> <**repeat** *cycles*> **trigout** Configures and launches 4-pair load transients consisting of up to 6 cycles of a two step load current sequence with specified durations. Optionally produces trigger out. Test ports do not retain settings of **trigger mode**, **foldback suppression**, or **step1 load > 1900mA** – these must be specified on each instance of initiating a transient. **i1**, **i2** specify 2-pair or pairset current for step 1 and 2 respectively. **t1**, **t2** specify duration entry for step 1 and 2 respectively. *current1* is 1st transient step 4-pair current value in units of mA (0 to 3600 mA, 0.5mA steps). For *current1* values **> 1900 mA**, transients must be immediate triggered with **go** argument and foldback suppression will be automatically invoked. *current2* is 2nd transient step 4-pair current value in units of mA. Range is 0 to 950 mA (*750mA on PSA-3102*) with resolution of 0.5mA. *All other settings are identical to the 2-Pair application described above.*	**?**	Step 1 Current *(4-Pair)* Step 1 Duration Step 2 Current *(4-Pair)* Step 2 Duration

<table>
<tr><th>Command</th><th>Addr</th><th>Command Parameters</th><th>Query</th><th>Returned Parameters</th></tr>
<tr><td rowspan="4">trig1</td><td rowspan="2">2-Pair
<<i>port</i>>

or

4-Pair
<i>slot</i>,A
<i>slot</i>,B</td><td rowspan="2"><rising | falling> <level <i>trigLevel</i>> <arm | clear> <normal | noisy>

Configures and/or arms the edge trigger for operation on a 2-pair configured port or on a pairset. trig1 is also used as a start event in time interval measurements.

rising sets trigger to respond to rising edge on PoE bus.
falling sets trigger to respond to falling edge on PoE bus.
level specifies trigger level setting to follow
<i>trigLevel</i> trigger level in voltage with range of 0.25 to 59.5 VDC in with resolution of 0.125 V.
arm enables start trigger to trigger once when input conditions are satisfied. Trigger will then reset.
clear disables start trigger until arm re-enables it.
normal configures edge trigger for 0.125V noise immunity.
noisy configures edge trigger for 0.5V noise immunity. Minimum trigger level = 0.75V for noisy mode.</td><td>?</td><td>RISING | FALLING
Voltage Level
NORMAL | NOISY</td></tr>
<tr><td>stat</td><td>ARMED | TRIGGERED</td></tr>
<tr><td rowspan="2">4-pair Con-nected
<<i>port</i>></td><td rowspan="2"><rising | falling> <level <i>trigLevel</i>> <arm | clear> <normal | noisy>

Configures and/or arms the edge trigger for operation on both pairsets of a 4-pair configured port.

<i>All settings are identical to the 2-Pair application described above.</i></td><td>?</td><td><i>Alt-A Pairset:</i>
RISING | FALLING
Voltage Level
NORMAL | NOISY
<i>Alt-B Pairset:</i>
RISING | FALLING
Voltage Level
NORMAL | NOISY</td></tr>
<tr><td>stat</td><td>Alt-A Pairset:
ARMED | TRIGGERED
Alt-B Pairset:
ARMED | TRIGGERED</td></tr>
<tr><td rowspan="4">trig2</td><td rowspan="2">2-Pair
<<i>port</i>>

or

4-Pair
<i>slot</i>,A
<i>slot</i>,B</td><td rowspan="2"><rising | falling> <level <i>trigLevel</i>> <normal | noisy>

trig2 configures end (voltage edge) criteria to complete time interval measurements on a 2-pair configured port or on a pairset.

rising sets trigger to respond to rising edge on PoE bus.
falling sets trigger to respond to falling edge on PoE bus.
level specifies trigger level setting to follow
<i>trigLevel</i> trigger level in voltage with range of 0.25 to 59.5 VDC in with resolution of 0.125 V.
normal configures edge trigger for 0.125V noise immunity.
noisy configures edge trigger for 0.5V noise immunity. Minimum trigger level = 0.75V for noisy mode.</td><td>?</td><td>RISING | FALLING
Voltage Level
NORMAL | NOISY</td></tr>
<tr><td>stat</td><td>ARMED | TRIGGERED</td></tr>
<tr><td rowspan="2">4-pair Con-nected
<<i>port</i>></td><td rowspan="2"><rising | falling> <level <i>trigLevel</i>> <normal | noisy>
trig2 configures end (voltage edge) criteria to complete time interval measurements on both pairsets of a 4-pair configured port.

<i>All settings are identical to the 2-Pair application described above.</i></td><td>?</td><td><i>Alt-A Pairset:</i>
RISING | FALLING
Voltage Level
NORMAL | NOISY
<i>Alt-B Pairset:</i>
RISING | FALLING
Voltage Level
NORMAL | NOISY</td></tr>
<tr><td>stat</td><td>Alt-A Pairset:
ARMED | TRIGGERED
Alt-B Pairset:
ARMED | TRIGGERED</td></tr>
</table>

Command	Addr	Command Parameters	Query	Returned Parameters
trigout	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	Generate immediate event trigger from the present or user-specified port. All test ports in the PSA-3000, including the originating test port, will see this trigger at the exact same time. Event triggers may be generated from Port "0,0", the Controller Blade as well.		
	4-pair Con-nected <*port*>	Generate immediate event trigger from Port "0,0", the PSA Controller Blade. This assures that the event trigger arrives at each pairset at the exact same time.		
psa_ connect	2-Pair <*port*> Or 4-Pair *slot*,**A** *slot*,**B**	<**i** *current*> <**rising** | **falling**> <**level** *trigLevel*> <**trigout**> <**mevent** <**autoclass**>> *This is a utility command that MAY revise any prior settings performed by* **port**, **class**, **iload**, and **trig1**. Combines the **port connect** operation with static **2-pair** or **pairset** DC load current and edge trigger configuration settings so that all settings can occur *coincidently* with the detection signature connection. For example, a PD classification signature can be applied coincidently with the PD detection signature. **i** *load_current* is 2-pair or pairset current load in units of mA. Current load has range of 0 to 950 mA (*750mA on PSA-3102*) with 0.25 mA resolution. **rising** sets trigger to respond to rising edge on PoE bus. **falling** sets trigger to respond to falling edge on PoE bus. **level** specifies trigger level setting to follow *trigLevel* trigger level in voltage with range of 0.25 to 59.5 VDC in with resolution of 0.125 V. Should be set to $\geq$ 0.75V if **trig1** is configured with NOISY mode triggering. **trigout** Generate hardware (event) trigger coincident with the port (detection signature) connection. *APPLICABLE TO* ***PSA/PSL-3202*** *ONLY*: **mevent** Reset and activate (or arm) Multi-Event classification with the port connection. **autoclass** Provide autoclass variant of Event #1 signature as part of multi-event signature. **NOTE**! A PSx-3202 test blade configured for **Single Signature** will not accept *slot*,**A** or *slot*,**B** pairset connection because in Single Signature configurations, either both pairsets are connected or neither pairset is connected.		
	4-pair Con-nected <*port*>	<**i** *current*> <**rising** | **falling**> <**level** *trigLevel*> <**trigout**> <**mevent** <**autoclass**>> *This is a utility command that MAY revise any prior settings performed by* **port**, **class**, **iload**, and **trig1**. Combines the **port connect** operation with static **4-pair** DC load current and edge trigger configuration settings so that all settings can occur *coincidently* with the detection signature connection. For example, a PD classification signature can be applied coincidently with the PD detection signature. PD detection signature will be governed by the 4-Pair state, that is, Single or Dual Signature. **i** *load_current* is 4-pair current load in units of mA. Current load has range of 0 to 1900 mA (*1500mA on PSA-3102*) with 0.5 mA resolution. If applying a static classification signature on both pairsets, *load_current* must be double the signature current that appears on each pairset. *All other settingsand rules are identical to the 2-Pair application described above.*		

<table>
<tr><th>Command</th><th>Addr</th><th>Command Parameters</th><th>Query</th><th>Returned Parameters</th></tr>
<tr><td rowspan="2">**psa_ disconnect**</td><td>2-Pair
<*port*>

Or

4-Pair
slot,**A**
slot,**B**</td><td><**trigout**>

This is a utility command that MAY revise any prior settings performed by **port**, **class**, **iload** and **psa_lan**.

Forces PSE port to power-down by emulating PD disconnects. Opens port switch to remove AC MPS and detection signatures and sets 2-pair or pairset load current to 0 mA. Performs brief discharge of PSE voltage, discontinues frame transmission and disconnects the LAN link used with LLDP (if available).

trigout: Generates an event trigger during the PD disconnect.

PSA/PSL-3202 *ONLY*: Terminates any Multi-Event classification.</td><td></td><td rowspan="2"></td></tr>
<tr><td>4-pair
Con-
nected
<*port*></td><td><**trigout**>

This is a utility command that MAY revise any prior settings performed by **port**, **class**, **iload** and **psa_lan**.

Forces PSE port to power-down by emulating PD disconnects. Opens port switch to remove AC MPS and detection signatures and sets 4-pair load current to 0 mA. Performs brief discharge of PSE voltage on both pairsets, discontinues frame transmission and disconnects the LAN link used with LLDP (if available).

trigout: Generates an event trigger during the PD disconnect.

PSA/PSL-3202 *ONLY*: Terminates any Multi-Event classification.</td><td></td></tr>
<tr><td rowspan="2">**psa_ triggered_ connect**</td><td>2-Pair
<*port*>

Or

4-Pair
slot,**A**
slot,**B**</td><td><**i** *current*> <**rising** \| **falling**> <**level** *trigLevel*> <**trigout**> <**mevent autoclass**>>

This is a utility command that MAY revise any prior settings performed by **port**, **class**, **iload** and **trig1**.

Simulate a 2-pair PD connection in a manner that is synchronized to PSE open circuit signaling. Port switch connection will occur upon next occurrence of a voltage transition matching **trig1** configuration ***PRIOR*** to execution of this command. Command will arm **trig1** and will return a status of either **CONNECTED** or **TIMEOUT**. Operation will time out in ~ 5 seconds if PSE signaling is not present or **trig1** is not configured for PSE open circuit signaling.

See **psa_connect** for argument specifications and rules.

NOTE! A PSx-3202 test blade configured for **Single Signature** will not accept *slot*,**A** or *slot*,**B** pairset connection because in Single Signature configurations, either both pairsets are connected or neither pairset is connected.</td><td></td><td>CONNECTED \|
TIMEOUT</td></tr>
<tr><td>4-pair
Con-
nected
<*port*></td><td>**trigpr A** \| **B** <**i** *current*> <**rising** \| **falling**> <**level** *trigLevel*> <**trigout**> <**mevent autoclass**>>

This is a utility command that MAY revise any prior settings performed by **port**, **class**, **iload** and **trig1**.

Simulate a 4-pair Single or Dual Signature PD connection in a manner that is synchronized to PSE open circuit signaling. Port switch connection will occur upon next occurrence of a voltage transition matching **trig1** configuration ***PRIOR*** to execution of this command. Command will arm **trig1** and will return a status of either **CONNECTED** or **TIMEOUT**. Operation will time out in ~ 5 seconds if PSE signaling is not present or **trig1** is not configured for PSE open circuit signaling.

trigpr A Trigger the PD connection from the Alt-A pairset voltage
trigpr B Trigger the PD connection from the Alt-B pairset voltage

See **psa_connect** for other argument specifications and rules.</td><td></td><td>CONNECTED \|
TIMEOUT</td></tr>
</table>

Command	Addr	Command Parameters	Query	Returned Parameters
psa_lan	<*port*> or 4-pair Con-nected <*port*>	<**connect** | **through**> <**duplex auto** | **full** | **half**> Controls the PSA port LAN switch. **through** Connects incoming LAN to the PSA test port OUT interface to enable packet transmission testing. This is the power-on default position. *APPLICABLE TO PSA/PSL's WITH **LLDP** FEATURE ENABLED* **connect** Connects incoming LAN to the PSA LLDP emulation interface to enable LLDP emulation. *APPLICABLE TO HARDWARE **VERSION 8** OR LATER PSx-3x02's INCLUDING ALL PSA-3202's, PSL-3202's, PSA-3402's, and PSA-3248's WITH **LLDP** FEATURE ENABLED* **duplex auto**: Auto-negotiate for link rate and link duplex mode (Default). Rate options are 10Base-T and 100Base-Tx. **duplex full**: Force auto-negotiated link to 10Base-T, full duplex **duplex half**: Force auto-negotiated link to 10Base-T, half duplex	**?**	THROUGH | CONNECT
			stat	*Status Information regarding the LAN controller Link State.*

5.10. Test Port Measurement Commands

The following commands are also directed to a particular test port and are utilized to configure and perform various measurements covering DC voltage, DC current, AC voltage, and time interval. Whenever the *port* parameter is provided, the default *slot,port* for that and all subsequent commands will be set as will the command prompt. Meter configuration operations support multicast **Port** values 99,99 and 99,y and x,99 though 99,99 is not avaible in 4-Pair configurations and 99,y requires uniform test blade 4-pair configurations throughout the instrument.

When test blades are in 4-Pair mode, single pairset measurements are performed by addressing *slot*,*pairset* where *pairset* can be the Alt-A (*slot*,A) or Alt-B pairset (*slot*,B).

Command	Addr	Command Parameters	Query	Returned Parameters
pstatus	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	Returns PSE power status on specified test port (2-pair mode) or pairset (4-pair mode). This is a query only and must include the **stat** (query) argument.	**stat**	PSE power status, "**ON**" or "**OFF**"
	4-pair Con-nected <*port*>	Returns PSE 4-pair power status on from connected 4-pair port. This is a query only and must include the **stat** (query) argument.		*Alt-A Pairset:* "**ON**" or "**OFF**" *Alt-B Pairset:* "**ON**" or "**OFF**"

<table>
<tr><th>Command</th><th>Addr</th><th>Command Parameters</th><th>Query</th><th>Returned Parameters</th></tr>
<tr><td rowspan="6">vdcaverage</td><td rowspan="2">2-Pair
<<i>port</i>></td><td><trig off | on | ext> <period <i>interval</i>> <timeout 10 | 100></td><td>stat</td><td>READY | ARMED | MEASURING | TIMEOUT
Average DC Volts</td></tr>
<tr><td>Configures and/or performs an Average DC Voltage measurement on the PoE connection (see Figure 3.1). Meter configurations are retained persistently in each test port.

trig off enables immediate execute of DC measurement when stat query is issued.
trig on specifies that the measurement will be performed when the trigger condition specified on trig1 occurs. trig1 will be armed automatically when stat query is issued.
trig ext specifies that the measurement will be performed when the external (event) trigger is asserted.
period specifies that an averaging period will be defined.
interval specifies the sampling period as “Nm” where N is 10, 20, 50, 100, 200, 500 mSec or “Ns” where N is 1, 2, 5, or 10 seconds. Default value is most recent configuration.
timeout 10 specifies that a hardware triggered measurement should time out if no trigger is found within ~13 seconds following trigger arm.
timeout 100 specifies that a hardware triggered measurement should time out if no trigger is found within 100 seconds following trigger arm.</td><td>?</td><td>TRIG OFF | ON | EXT
Averaging Period
Timeout 10 | 100</td></tr>
<tr><td rowspan="2">4-pair Con-nected
<<i>port</i>></td><td><trig off | on | ext> <period <i>interval</i>> <timeout 10 | 100>
Configures and/or performs a 4-pair (Alt-A and Alt-B) Average DC Voltage measurement on both Alt-A and Alt-B pairsets. Meter configurations are retained persistently for each pairset.</td><td>stat</td><td><i>Alt-A Pairset:</i>
READY | ARMED | MEASURING | TIMEOUT
Average DC Volts
<i>Alt-BPairset:</i>
READY | ARMED | MEASURING | TIMEOUT
Average DC Volts</td></tr>
<tr><td>trig on specifies that the Alt-A and Alt-B measurements will be initiated when the trigger condition specified on trig1 for each respective pairset occurs. trig1 will be armed automatically when stat query is issued. Note that it is possible Alt-A and Alt-B meters may not trigger simultaneously meaning meter states between Alt-A and Alt-B may not be in phase.

All other settingsand rules are identical to the 2-Pair application described above.</td><td>?</td><td>TRIG OFF | ON | EXT
Averaging Period
Timeout 10 | 100</td></tr>
<tr><td rowspan="2">4-Pair
slot,A
slot,B</td><td>Performs an Average DC Voltage measurement on the addressed pairset (Alt-A or Alt-B).</td><td>stat</td><td>READY | MEASURING | TIMEOUT
Average DC Volts</td></tr>
<tr><td>NOTE: Configuration parameters are not valid when addressing pairsets because the meters for Alt-A and Alt-B pairsets must be identically configured at all times and therefore cannot be configured individually.</td><td>?</td><td>TRIG OFF | ON | EXT
Averaging Period
Timeout 10 | 100</td></tr>
</table>

Command	Addr	Command Parameters	Query	Returned Parameters
vdcpeak	2-Pair <*port*>	<**trig off** | **on** | **ext**> <**min** | **max**> <**period** *interval*> <**timeout** 10 | 100> Configures and/or performs a Peak DC Voltage measurement on the PoE connection (*see **Figure 3.1***). Meter configurations are retained persistently in each test port. **trig off** enables immediate execute of DC measurement when **stat** query is issued. **trig on** specifies that the measurement will be performed when the trigger condition specified on **trig1** occurs. **trig1** will be armed automatically when **stat** query is issued. **trig ext** specifies that the measurement will be performed when the external (event) trigger is asserted. **max** specifies that the peak should be the highest value sampled over the measurement period. **min** specifies that the peak should be the lowest value sampled over the measurement period. **period** specifies that an sampling period will be defined. *interval* specifies the sampling period as "*N***m**" where *N* is **10**, **20**, **50**, **100**, **200**, **500** mSec or "*N***s**" where *N* is **1**, **2**, **5**, or **10** seconds. Default value is most recent configuration. **timeout 10** specifies that a hardware triggered measurement should time out if no trigger is found within ~13 seconds following trigger arm. **timeout 100** specifies that a hardware triggered measurement should time out if no trigger is found within 100 seconds following trigger arm.	**stat**	READY | ARMED | MEASURING | TIMEOUT Peak DC Volts
			?	TRIG OFF | ON | EXT MAX | MIN Sampling Period Timeout 10 | 100
	4-pair Con-nected <*port*>	<**trig off** | **on** | **ext**> <**min** | **max**> <**period** *interval*> <**timeout** 10 | 100> Configures and/or performs a 4-pair (Alt-A and Alt-B) Peak DC Voltage measurement on both Alt-A and Alt-B pairsets. Meter configurations are retained persistently for each pairset. **trig on** specifies that the Alt-A and Alt-B measurements will be initiated when the trigger condition specified on **trig1** for each respective pairset occurs. **trig1** will be armed automatically when **stat** query is issued. Note that it is possible Alt-A and Alt-B meters may not trigger simultaneously meaning meter states between Alt-A and Alt-B may not be in phase. *All other settingsand rules are identical to the 2-Pair application described above.*	**stat**	*Alt-A Pairset:* READY | ARMED | MEASURING | TIMEOUT Peak DC Volts *Alt-BPairset:* READY | ARMED | MEASURING | TIMEOUT Peak DC Volts
			?	TRIG OFF | ON | EXT MAX | MIN Sampling Period Timeout 10 | 100
	4-Pair *slot*,**A** *slot*,**B**	Performs a Peak DC Voltage measurement on the addressed pairset (Alt-A or Alt-B). **NOTE**: Configuration parameters are not valid when addressing pairsets because the meters for Alt-A and Alt-B pairsets must be identically configured at all times and therefore cannot be configured individually.	**stat**	READY | ARMED | MEASURING | TIMEOUT Peak DC Volts
			?	TRIG OFF | ON | EXT MAX | MIN Sampling Period Timeout 10 | 100

Command	Addr	Command Parameters	Query	Returned Parameters
vdctrace	2-Pair <*port*>	<**trig off** | **on** | **ext**> <**period** *interval*> <**timeout 10** | 100> Configures and collects a DC Voltage Trace of 256 or 1024 samples on the PoE connection (*see **Figure 3.1***). Meter configurations are retained persistently in each test port. **trig off** enables immediate execute of DC measurement when "stat" query is issued. **trig on** specifies that the measurement will be performed when the trigger condition specified on **trig1** occurs. **trig1** will be armed automatically when **stat** query is issued. **trig ext** specifies that the measurement will be performed when the external (event) trigger is asserted. **period** specifies that an sampling period will be defined. *interval* specifies the sampling period as *N*m or *N*s for 256 sample traces and *N*mx or *N*sx for 1024 sample traces where 'm' is milliseconds and 's' is seconds. Range is **10m**, **20m**, **50m**, **100m**, **200m**, **500m**, **1s**, **2s**, **5s**, and **10s** for 256 sample traces and **200mx**, **2sx**, **4sx**, **8sx**, and **20sx** for 1024 sample traces. Default value is most recent configuration. **NOTE!** *1024 sample traces cannot be configured or utilized while performing any LLDP operations in a test port.* **timeout 10** specifies that a hardware triggered measurement should time out if no trigger is found within ~13 seconds following trigger arm. **timeout 100** specifies that a hardware triggered measurement should time out if no trigger is found within 100 seconds following trigger arm.	**stat**	READY | ARMED | MEASURING | TIMEOUT List of 256 or 1024 time and voltage values
			?	TRIG OFF | ON | EXT Sampling Period Timeout 10 | 100 Trace Length 1x | 4x
	4-pair Con-nected <*port*>	<**trig off** | **on** | **ext**> <**period** *interval*> <**timeout 10** | 100> Configures and collects a 4-pair (Alt-A plus Alt-B) DC Voltage Trace of 256 or 1024 samples from both the Alt-A and Alt-B pairsets. Meter configurations are retained persistently in each test port. **trig on** specifies that the Alt-A and Alt-B measurements will be initiated when the trigger condition specified on **trig1** for each respective pairset occurs. **trig1** will be armed automatically when **stat** query is issued. Note that it is possible Alt-A and Alt-B meters may not trigger simultaneously meaning meter states between Alt-A and Alt-B may not be in phase. *All other settingsand rules are identical to the 2-Pair application described above.*	**stat**	*Alt-A Pairset:* READY | ARMED | MEASURING | TIMEOUT List of 256 or 1024 time and voltage values *Alt-B Pairset:* READY | ARMED | MEASURING | TIMEOUT List of 256 or 1024 time and voltage values
			?	OFF | ON | EXT Sampling Period Timeout 10 | 100 Trace Length 1x | 4x
	4-Pair *slot*,**A** *slot*,**B**	Collects a Voltage trace on the addressed pairset (Alt-A or Alt-B). **NOTE**: Configuration parameters are not valid when addressing pairsets because the meters for Alt-A and Alt-B pairsets must be identically configured at all times and therefore cannot be configured individually.	**stat**	READY | ARMED | MEASURING | TIMEOUT List of 256 or 1024 time and voltage values
			?	TRIG OFF | ON | EXT Sampling Period Timeout 10 | 100 Trace Length 1x | 4x

Command	Addr	Command Parameters	Query	Returned Parameters
idcaverage	2-Pair <*port*>	<**trig off** | **on** | **ext**> <**period** *interval*> <**timeout** 10 | 100> Configures and/or performs an Average DC Current measurement. Meter configurations are retained persistently in each test port. **trig off** enables immediate execute of DC measurement when **stat** query is issued. **trig on** specifies that the measurement will be performed when the trigger condition specified on **trig1** occurs. **trig1** will be armed automatically when **stat** query is issued. **trig ext** specifies that the measurement will be performed when the external (event) trigger is asserted. **period** specifies that an averaging period will be defined. *interval* specifies the sampling period as "*N***m**" where *N* is **10**, **20**, **50**, **100**, **200**, **500** mSec or "*N***s**" where *N* is **1**, **2**, **5**, or **10** seconds. Default value is most recent configuration. **timeout 10** specifies that a hardware triggered measurement should time out if no trigger is found within ~13 seconds following trigger arm. **timeout 100** specifies that a hardware triggered measurement should time out if no trigger is found within 100 seconds following trigger arm.	**stat**	READY | ARMED | MEASURING | TIMEOUT Average DC Current
			?	TRIG OFF | ON | EXT Averaging Period Timeout 10 | 100
	4-pair Con-nected <*port*>	<**trig off** | **on** | **ext**> <**period** *interval*> <**timeout** 10 | 100> Configures and/or performs a 4-pair (Alt-A plus Alt-B) Average DC Current measurement on both Alt-A and Alt-B pairsets combined. Meter configurations are retained persistently for each pairset. **trig on** specifies that the Alt-A and Alt-B measurements will be initiated when the trigger condition specified on **trig1** for each respective pairset occurs. **trig1** will be armed automatically when **stat** query is issued. Note that it is possible Alt-A and Alt-B meters may not trigger simultaneously meaning meter states between Alt-A and Alt-B may not be in phase. *All other settingsand rules are identical to the 2-Pair application described above.*	**stat**	*Alt-A Pairset:* READY | ARMED | MEASURING | TIMEOUT Average DC Current *Alt-BPairset:* READY | ARMED | MEASURING | TIMEOUT Average DC Current
			?	TRIG OFF | ON | EXT Averaging Period Timeout 10 | 100
	4-Pair *slot*,**A** *slot*,**B**	Performs an Average DC Current measurement on the addressed pairset (Alt-A or Alt-B). **NOTE**: Configuration parameters are not valid when addressing pairsets because the meters for Alt-A and Alt-B pairsets must be identically configured at all times and therefore cannot be configured individually.	**stat**	READY | ARMED | MEASURING | TIMEOUT Average DC Current
			?	TRIG OFF | ON | EXT Averaging Period Timeout 10 | 100

Command	Addr	Command Parameters	Query	Returned Parameters
idcpeak	2-Pair <*port*>	<**trig off** | **on** | **ext**> <**min** | **max**> <**period** *interval*> <**timeout** 10 | 100> Configures and/or performs a Peak DC Current measurement. Meter configurations are retained persistently in each test port. **trig off** enables immediate execute of DC measurement when **stat** query is issued. **trig on** specifies that the measurement will be performed when the trigger condition specified on **trig1** occurs. **trig1** will be armed automatically when **stat** query is issued. **trig ext** specifies that the measurement will be performed when the external (event) trigger is asserted. **max** specifies that the peak should be the highest value sampled over the measurement period. **min** specifies that the peak should be the lowest value sampled over the measurement period. **period** specifies that an sampling period will be defined. *interval* specifies the sampling period as "*N***m**" where *N* is **10**, **20**, **50**, **100**, **200**, **500** mSec or "*N***s**" where *N* is **1**, **2**, **5**, or **10** seconds. Default value is most recent configuration. **timeout 10** specifies that a hardware triggered measurement should time out if no trigger is found within ~13 seconds following trigger arm. **timeout 100** specifies that a hardware triggered measurement should time out if no trigger is found within 100 seconds following trigger arm.	**stat**	READY | ARMED | MEASURING | TIMEOUT Peak DC Current
			?	TRIG OFF | ON | EXT MAX | MIN Sampling Period Timeout 10 | 100
	4-pair Con-nected <*port*>	<**trig off** | **on** | **ext**> <**min** | **max**> <**period** *interval*> <**timeout** 10 | 100> Configures and/or performs a 4-pair (Alt-A plus Alt-B) Peak DC Current measurement on both Alt-A and Alt-B pairsets combined. Meter configurations are retained persistently for each pairset. **trig on** specifies that the Alt-A and Alt-B measurements will be initiated when the trigger condition specified on **trig1** for each respective pairset occurs. **trig1** will be armed automatically when **stat** query is issued. Note that it is possible Alt-A and Alt-B meters may not trigger simultaneously meaning meter states between Alt-A and Alt-B may not be in phase. *All other settingsand rules are identical to the 2-Pair application described above.*	**stat**	*Alt-A Pairset:* READY | ARMED | MEASURING | TIMEOUT Average DC Volts *Alt-BPairset:* READY | ARMED | MEASURING | TIMEOUT Peak DC Current
			?	TRIG OFF | ON | EXT MAX | MIN Sampling Period Timeout 10 | 100
	4-Pair *slot*,**A** *slot*,**B**	Performs a Peak DC Current measurement on the addressed pairset (Alt-A or Alt-B). **NOTE**: Configuration parameters are not valid when addressing pairsets because the meters for Alt-A and Alt-B pairsets must be identically configured at all times and therefore cannot be configured individually.	**stat**	READY | ARMED | MEASURING | TIMEOUT Peak DC Current
			?	TRIG OFF | ON | EXT MAX | MIN Sampling Period Timeout 10 | 100

<table>
<tr><th>Command</th><th>Addr</th><th>Command Parameters</th><th>Query</th><th>Returned Parameters</th></tr>
<tr><td rowspan="6">idctrace</td><td rowspan="2">2-Pair
<<i>port</i>></td><td rowspan="2"><trig off | on | ext> <period <i>interval</i>> <timeout 10 | 100>
Configures and collects a DC Current Trace of 256 or 1024 samples. Meter configurations are retained persistently in each test port.

trig off enables immediate execute of DC measurement when “stat” query is issued.
trig on specifies that the measurement will be performed when the trigger condition specified on trig1 occurs. trig1 will be armed automatically when stat query is issued.
trig ext specifies that the measurement will be performed when the external (event) trigger is asserted.
period specifies that an sampling period will be defined.
<i>interval</i> specifies the sampling period as <i>N</i>m or <i>N</i>s for 256 sample traces and <i>N</i>mx or <i>N</i>sx for 1024 sample traces where ‘m’ is milliseconds and ‘s’ is seconds. Range is 10m, 20m, 50m, 100m, 200m, 500m, 1s, 2s, 5s, and 10s for 256 sample traces and 200mx, 2sx, 4sx, 8sx, and 20sx for 1024 sample traces. Default value is most recent configuration. NOTE! <i>1024 sample traces cannot be configured or utilized while performing any LLDP operations in a test port.</i>
timeout 10 specifies that a hardware triggered measurement should time out if no trigger is found within ~13 seconds following trigger arm.
timeout 100 specifies that a hardware triggered measurement should time out if no trigger is found within 100 seconds following trigger arm.</td><td>stat</td><td>READY | ARMED | MEASURING | TIMEOUT
List of 256 or 1024 time and voltage values</td></tr>
<tr><td>?</td><td>TRIG OFF | ON | EXT
Sampling Period
Timeout 10 | 100
Trace Length 1x | 4x</td></tr>
<tr><td rowspan="2">4-pair Con-nected
<<i>port</i>></td><td rowspan="2"><trig off | on | ext> <period <i>interval</i>> <timeout 10 | 100>
Configures and collects a 4-pair (Alt-A plus Alt-B) DC Current Trace of 256 or 1024 samples from both the Alt-A and Alt-B pairsets combined. Meter configurations are retained persistently in each test port.

trig on specifies that the Alt-A and Alt-B measurements will be initiated when the trigger condition specified on trig1 for each respective pairset occurs. trig1 will be armed automatically when stat query is issued. Note that it is possible Alt-A and Alt-B meters may not trigger simultaneously meaning meter states between Alt-A and Alt-B may not be in phase.

<i>All other settingsand rules are identical to the 2-Pair application described above.</i></td><td>stat</td><td><i>Alt-A Pairset:</i>
READY | ARMED | MEASURING | TIMEOUT
List of 256 or 1024 time and voltage values
<i>Alt-B Pairset:</i>
READY | ARMED | MEASURING | TIMEOUT
List of 256 or 1024 time and voltage values</td></tr>
<tr><td>?</td><td>OFF | ON | EXT
Sampling Period
Timeout 10 | 100
Trace Length 1x | 4x</td></tr>
<tr><td rowspan="2">4-Pair
slot,A
slot,B</td><td rowspan="2">
Collects a Current trace on the addressed pairset (Alt-A or Alt-B).

NOTE: Configuration parameters are not valid when addressing pairsets because the meters for Alt-A and Alt-B pairsets must be identically configured at all times and therefore cannot be configured individually.</td><td>stat</td><td>READY | ARMED | MEASURING | TIMEOUT
List of 256 or 1024 time and voltage values</td></tr>
<tr><td>?</td><td>TRIG OFF | ON | EXT
Sampling Period
Timeout 10 | 100
Trace Length 1x | 4x</td></tr>
</table>

<table>
<tr><th>Command</th><th>Addr</th><th>Command Parameters</th><th>Query</th><th>Returned Parameters</th></tr>
<tr><td rowspan="3">pwruptrace</td><td rowspan="3">2-Pair
<port>

or

4-Pair
slot,A
slot,B</td><td>v | i <period interval> <timeout maxTime>
<stat connect></td><td rowspan="2">stat</td><td>READY | TIMEOUT</td></tr>
<tr><td rowspan="2">Configures and performs voltage or current traces of 256 or 1024 samples preceding a PSE power-up event on the PoE connection (or addressed pairset if in 4-pair mode). This meter is only immediate triggered and will timeout if a PSE power-up event fails to occur within user specified time. Meter configurations (interval and maxTime for v and i versions) are retained persistently in each test port.

v Specify that meter will return voltage samples
i Specifies that meter will return load current samples. Either v or i must be specified with all configurations and queries.
period Specifies that an sampling period will be defined.
interval Specifies the sampling period as Nm or Ns for 256 sample traces and Nmx or Nsx for 1024 sample traces where ‘m’ is milliseconds and ‘s’ is seconds. Range is 10m, 20m, 50m, 100m, 200m, 500m, 1s, 2s, 5s, and 10s for 256 sample traces and 200mx, 2sx, 4sx, 8sx, and 20sx for 1024 sample traces. Default value is most recent configuration to v or i rendition of the meter. NOTE! 1024 sample traces cannot be configured or utilized while performing any LLDP operations in a test port.
timeout Specify a timeout for measurement
maxTime Time, in seconds, to wait from command execution until PSE power-up before declaring a TIMEOUT condition. Range is 1 to 15 seconds. Default is most recent configuration.
connect Perform a port (PD) connection at the start of the trace process. This allows capture of power-up traces from PSE’s that rapidly get to power-up following PD connection. Must be combined with a stat query, (Requires firmware 3.25 in PSA-3102 and 4.0e or newer in PSA-3202.)

Usage Example: Capture 200msec preceding a power-up on slot,port $port:
pwruptrace $port period 200m timeout 10
psa_connect $port
set trace [lindex [pwruptrace $port stat] 4]</td><td>List of 256 or 1024 time and current values</td></tr>
<tr><td>v ?
i ?</td><td>Trace Type (V or I)
Sampling Period
Timeout
Trace Length 1x | 4x</td></tr>
<tr><td></td><td rowspan="2">4-pair Con-nected
<port></td><td>v | i <period interval> <timeout maxTime></td><td rowspan="2">v ?
i ?</td><td rowspan="2">Alt-A Pairset:
Trace Type (V or I)
Sampling Period
Timeout
Trace Length 1x | 4x
Alt-B Pairset:
Trace Type (V or I)
Sampling Period
Timeout
Trace Length 1x | 4x</td></tr>
<tr><td></td><td>Configures voltage or current traces of 256 or 1024 samples preceding a PSE power-up event on both pairsets Alt-A and Alt-B.

NOTE: The pwruptrace meter is not a 4-Pair meter and therefore does not support measurements from the connected 4-pair port. In a 4-pair mode, both Alt-A and Alt-B pairset meters will be identically configured when the 4-pair connected port is addressed. Configuration query to the connected 4-pair port will return Alt-A and Alt-B configurations.

Also, in a 4-pair mode, Alt-A or Alt-B PAIRSET meters may be queried – see above.

All configuration settings are identical to the 2-Pair application described above.</td></tr>
</table>

Command	Addr	Command Parameters	Query	Returned Parameters
acvolts	-Pair <*port*>	<**high** | **low | full**> <**period** *interval*>	**stat**	AC Pk-Pk Voltage
		Configures and performs a peak-peak AC voltage measurement on the PoE connection (*see **Figure 3.1***) in a specified frequency band. Default band is Low. **high** specifies that measurement should be in 5 KHz to 350 KHz band. **low** specifies that measurement should be in 16 Hz to 500 Hz band. **full** specifies that measurement should be wideband from 16 Hz to 350 KHz. **period** specifies that a sampling period will be defined. *interval* specifies the sampling period as “Nm” where N is 2, or 5 seconds.	**?**	Sampling Period, Frequency Band (low | high)
	4-pair Con-nected <*port*>	<**high** | **low | full**> <**period** *interval*>	**stat**	*Alt-A Pairset:* AC Pk-Pk Voltage *Alt-B Pairset:* AC Pk-Pk Voltage
		Configures and performs peak-peak AC voltage measurements on both pairsets (Alt-A and Alt-B) in a specified frequency band. Default band is Low. *All configuration settings and rules are identical to the 2-Pair application described above.*	**?**	Sampling Period, Frequency Band (low | high)
	4-Pair *slot*,**A** *slot*,**B**		**stat**	AC Pk-Pk Voltage
		Performs a peak-peak AC voltage measurement on the addressed pairset (Alt-A or Alt-B). **NOTE**: Configuration parameters are not valid when addressing pairsets because the meters for Alt-A and Alt-B pairsets must be identically configured at all times and therefore cannot be configured individually.	**?**	Sampling Period, Frequency Band (low | high)

<table>
<tr><th>Command</th><th>Addr</th><th>Command Parameters</th><th>Query</th><th>Returned Parameters</th></tr>
<tr><td rowspan="3">timint</td><td rowspan="2">2-Pair
<port>

or

4-Pair
slot,A
slot,B</td><td><start rising | falling | ext level trigLevel> <stop rising | falling level trigLevel> <usec | msec | sec> <timeout 10 | 100> <normal | noisy></td><td>stat</td><td>READY | ARMED | COUNTING | TIMEOUT | OVERFLOW
Measured Time Interval (and associated units)</td></tr>
<tr><td>Configures and initiates a time interval measurement on the PoE connection (or the addressed pairset in 4-pair mode).

start indicates that the following trigger parameters are for trigger 1, the start trigger. Trigger 1 will be armed upon execution of the “stat” query in the command and will not re-arm until it reaches the “READY” state.
stop indicates that the following trigger parameters are for trigger 2, the stop trigger.
rising sets trigger to respond to rising edge on PoE bus.
falling sets trigger to respond to falling edge on PoE bus.
ext specifies Start Trigger on External Trigger bus.
level specifies trigger level setting to follow.
trigLevel trigger level in voltage with range of 0 to 64 VDC in with resolution of 0.25 V.
usec specifies to report time interval in units of microseconds (1 µSec resolution) up to 26,200 µsec.
msec specifies to report time interval in units of milliseconds (.1 mSec resolution) up to 6,550 mSec.
sec specifies to report time interval in units of microseconds (1 µSec resolution) up to 16.1 sec.
normal configures edge triggers for 0.125V noise immunity.
noisy configures edge triggers for 0.5V noise immunity.
timeout 10 specifies that a hardware triggered measurement should time out if no trigger is found within ~13 seconds following trigger arm.
timeout 100 specifies that a hardware triggered measurement should time out if no trigger is found within 100 seconds following trigger arm.</td><td>?</td><td>Start Trigger Polarity
Start Trigger Voltage Level
Stop Trigger Polarity
Stop Trigger Voltage Level
Units mSec | µSec | sec
Timeout 10 | 100
NORMAL | NOISY</td></tr>
<tr><td>4-pair Con-nected
<port></td><td><start rising | falling | ext level trigLevel> <stop rising | falling level trigLevel> <usec | msec | sec> <timeout 10 | 100> <normal | noisy>

Configures a time interval measurement on both pairsets (Alt-A and Alt-B) identically.

NOTE: The timint meter is not a 4-Pair meter and therefore does not support measurements from the connected 4-pair port. In a 4-pair mode, both Alt-A and Alt-B pairset meters will be identically configured when the 4-pair connected port is addressed. Configuration query to the connected 4-pair port will return Alt-A and Alt-B configurations.

Also in a 4-pair mode, Alt-A or Alt-B PAIRSET meters may be queried – see above.

All configuration settings are identical to the 2-Pair application described above.</td><td>?</td><td>Alt-A Pairset:
Start Trigger Polarity
Start Trigger Voltage Level
Stop Trigger Polarity
Stop Trigger Voltage Level
Units mSec | µSec | sec
Timeout 10 | 100
NORMAL | NOISY
Alt-B Pairset:
Start Trigger Polarity
Start Trigger Voltage Level
Stop Trigger Polarity
Stop Trigger Voltage Level
Units mSec | µSec | sec
Timeout 10 | 100
NORMAL | NOISY</td></tr>
</table>

Command	Addr	Command Parameters	Query	Returned Parameters
paverage	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	<**period** *interval*> *This is a utility command that MAY revise any prior settings performed by* **vdcaverage** and **idcaverage**. Performs an immediate average power measurement and returns power in watts from the PoE connection (or the addressed pairset in 4-pair mode). Because it is a utility command, it does not support a configuration query **?**. Use **vdcaverage** or **idcaverage** to determine configuration. **period** specifies that a integration period will be defined. *interval* specifies the sampling period as "*N***m**" where *N* is 10, 20, 50, 100, 200, 500 mSec or "*N***s**" where *N* is 1, 2, or 5 seconds. Default is to use prior settings of **vdcaverage** and **idcaverage**.	**stat**	Average (2-pair or pairset) Power Delivered (Watts)
	4-pair Con-nected <*port*>	<**period** *interval*> *This is a utility command that MAY revise any prior settings performed by* **vdcaverage** and **idcaverage**. Performs an immediate average 4-pair power measurement and returns power in watts that is the combined Alt-A and Alt-B pairset power levels. *All configuration settings and rules are identical to the 2-Pair application described above.*	**stat**	Average 4-Pair Power Delivered (Watts)
psa_wait	2-Pair <*port*> or 4-pair Con-nected <*port*> or 4-Pair *slot*,**A** *slot*,**B**	*measurement_type* <*timeout*> Returns the final result of any edge or event triggered measurement upon completion of that measurement. Automatically polls the test port until measurement state reaches **READY**, **TIMEOUT**, or **OVERFLOW** *(***timint** ***only***). *measurement_type* is the type of triggered measurement to be "polled". Options are **vdcaverage**, **vdcpeak**, **vdctrace**, **idcaverage**, **idcpeak**, **idctrace**, or **timint**. *timeout* is the desired timeout of the triggered measurement. Range is 1 to 100 seconds. Note: Use with **timint** will not support a 4-pair Connected Port address because **timint** is not a 4-pair meter.		*See corresponding meter* **stat** *query result*
psa_expire	2-Pair <*port*> or 4-pair Con-nected <*port*> or 4-Pair *slot*,**A** *slot*,**B**	*measurement_function* Forces a triggered measurement in the ARMed or MEASURING state to terminate without completing. *measurement_function* **vdcaverage**, **vdcpeak**, **vdctrace**, **idcaverage**, **idcpeak**, **idctrace**, **timint**.		

5.11. PowerShell PSA Test Support Utilities

PowerShell PSA includes a number of utilities and higher-level commands that perform test support functions on a port level. Unlike most test port Configuration and Measurement commands that interact directly with the PSA test instrument, utilities perform their tasks by combining PowerShell PSA configuration and measurement commands into integrated PowersShell PSA programs. They generally do not support configuration or status queries and they are typically addressed to a single *slot*,*port* or in 4-Pair modes, to a connected *slot*,*port* or alternatively, with some commands, to a *slot*,*pairset*. They generally do *not* support multi-cast port addresses such as 99,99 or 99,2 or 2,99.

Command	Addr	Command Parameters	Returned Parameters
psa_auto_port	<*port*>	**AT** <**-nomps**> <**-hpgrant**> | **BT** <**-no4prtype**> | **PROP4** <**-save**>	
		Given a PSE category declaration (e.g. **802.3at** or **802.3bt**) and a test port (e.g. **3,1**), this utility automatically characterizes important PSE attributes so that other test software can correctly interact with the PSE and also so that PSE attributes can be saved in a file for recall at any time. Once connection settings (e.g. ALT pair, polarity) are determined, **psa_auto_port** will propagate those settings to other test ports in the PSA instrument. See Section 3.2.4 for further information on PSE attributes and associated configuration files. Also see Section 5.5 for further information on PowerShell PSA system global settings. *port* The slot and port number (e.g. **1,1**) where the PSE to characterize is connected. This can be any test port in a PSA instrument, however, if the PSE category is **802.3bt** and the PSE is known support 4-Pair power, the test port SHOULD be a PSA/PSL-**3202** test port. (A PSA/PSL-3102 may determine connection settings for a 4-pair 802.3bt PSE but cannot perform meaningful testing with that type of PSE.) **AT** This is a user declaration that the PSE to be characterized is designed to the 802.3at, 2-pair powering standard. Furnishing this argument will place test ports into 2-pair mode. **BT** This is a user declaration that the PSE to be characterized is designed to the 802.3bt, 4-pair or 2-pair powering standard. Furnishing this argument will place test ports into either 4-pair mode or 2-pair mode depending upon PSE powered pairs. **PROP4** This is a user declaration that the PSE to be characterized is a proprietary 4-pair design. **NOTE**! **PSA 5.2** software does not presently support this user declaration. This type of PSE must be tested with **PSA 4.2** software. **-nomps** Optional control to suppress discovery of PSE MPS method if only ALT and Polarity are of interest. Only valid for **AT** PSE declarations because **BT** PSE's are universally DC MPS. **-hpgrant** Optional control to automatically discover at Type-2 PSE's method of granting PD's greater than 13W power. Only valid for **AT** PSE declarations (with **BT** PSE's, this is always characterized). **-no4prtype** Optional control to bypass determination that an 802.bt PSE is either Type-3 or Type-4. **-save** Optional control to prompt user to save the PSE settings in a PSE Attributes File (*see Section 3.2.4*).	ALT, Polarity Configuration, PSE 4-Pair Type, MPS, and High Power Grant Attributes
psa_conn_ check		<*qList*> <**threshold** *value*>	Returns "ALL CONNECTIONS VERIFIED!" or a list of disconnected test ports.
		Verify that a 2-Pair PSE is properly connected to a specified list of test ports. Utility by default looks for open circuit detection signaling that is higher than 2.8V on each specified test port. In 4-Pair configurations, slot,port must be addressed to 4-Pair **connected** ports. **psa_conn_check_4p** is recommended for 4-Pair PSE connection verification. *qList* A list of test ports or *slot*,*pairsets* as follows: **2-Pair Configured Test Blades**: Specify either or both test ports in the list (e.g. 1,1 1,2 2,1 2,2 ….) **4-Pair Configured Test Blades**: Specify either 4-Pair Connected Test Ports (e.g. 1,1 2,1 3,1 …) or specify slot,pairsets (e.g. 1,A 1,B 2,A 2,B, 3,A 3,B….) *value:* Non-default voltage for discriminating open circuit detection. Default is 2.8V - this should work correctly for virtually all PSE's.	

Command	Addr	Command Parameters	Returned Parameters
psa_conn_ check_4p		<*qList*> <**threshold** *value*>	
		Verify that a 4-Pair PSE is properly connected to a specified list of test ports. Utility by default looks for open circuit detection signaling that is higher than 2.8V on each specified test port. The slot,port list may include ports that are **not** presently **connected** 4-pair ports. *qList* A list of test ports as follows: Specify either or both test ports on any available slot. (e.g. 1,1 1,2 2,1 2,2 ….). Test ports do not need to be in a 4-pair connected configuration. *value:* Non-default voltage for discriminating open circuit detection. Default is 2.8V - this should work correctly for virtually all PSE's.	
power_check	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**		Power State - See
		Returns 2-pair (or pairset) powering state of the specified test port or 4-pair pairset. This is an alternative to **pstatus** in that it utilizes DC metering to assess power status and is therefore less susceptible to instantaneous power-ups or shutdowns. **POWERED**: Indicates PSE port or specified slot,pairset is powered up. **DOWN**: Indicates PSE port or specified slot,pairset is not powered.	
	4-pair Con- nected <*port*>		
		Returns 4-pair powering state of a 4-pair capable PSE port. This is an alternative to **pstatus** in that it utilizes DC metering to assess power status and is therefore less susceptible to instantaneous power-ups or shutdowns. **POWERED**: Indicates PSE port is powered up on 4-pairs. **DOWN**: Indicates PSE port is not powered on either pairset. **PWRD_A**: Indicates the PSE port is powered only on Alt-A pairset but not on the Alt-B pairset. **PWRD_B**: Indicates the PSE port is powered only on Alt-B pairset but not on the Alt-A pairset.	
psa_det_sync	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	<**standard** | **legacy**> <*edge*> <**level** *trigLev*> <**normal** | **noisy**>	1 (= Sync'd) 0 (= No Sync)
		This measurement utility is used to synchronize an application script to a particular edge transition on a 2-pair connection or single pairset of a 4-pair connection. The command will return within 80 mSec of the actual specified edge transition occurring. One example usage would be to time a PD signature connection relative to PSE open circuit signaling. Another example would be to time a measurement window (or aperture) to a preceding edge transition such as a end-of-detection. **standard**: Sets a default PoE voltage detection threshold of 2.75 VDC. **legacy**: Sets a default PoE voltage detection threshold of 35 VDC. *edge:* Specifies "rising" or "falling" edge for event detection. Default is "rising" edge. **level**: Indicates that the voltage threshold is to be specified. *trigLev:*Voltage threshold for edge detection (0.625 to 57 V) **normal** configures edge trigger for 0.125V noise immunity. **noisy** configures edge trigger for 0.5V noise immunity.	
	4-pair Con- nected <*port*>	*This utility is a 2-pair or pairset function and is not valid when addressed to a 4-pair (connected) slot,port*	

<table>
<tr><th>Command</th><th>Addr</th><th>Command Parameters</th><th>Returned Parameters</th></tr>
<tr><td rowspan="3">power_port</td><td rowspan="3">2-Pair <<i>port</i>></td><td><<c <i>class</i> | ci <i>class_current</i>> <p <i>power</i>>> | <i <i>load</i>> <dr <i>resistance</i>> <dc <i>capacitance</i>> <abort <i>pwrTime</i>>
<lldp <ad | force> <<i>req_pwr</i>> <timeout <i>maxwait</i>>></td><td>POWERED | DOWN</td></tr>
<tr><td rowspan="2">This command is restricted to testing 2-Pair 802.3at and 2-Pair 802.3bt Type-3 PSE's only. It is only valid when used with test ports configured for 2-Pair powering mode.

Simulates a PD connection to a 2-pair (802.3at) PSE port to bring power up to a user-specified condition. If no command parameters are specified, the default power-up condition is a static load of 20 mA. Status of port is returned upon completion of command. class or class_current may be combined with post-power-up power level, otherwise default power-up levels will be applied given PD classification. (See section 8.9.5 for further information regarding 802.3at LLDP emulation.)

p indicates that power draw of port will be specified.
power is the power in watts that the port will power-up to. Default classification will be a nominal "Class 0" PD. PD class or class_current may be specified along with target power level. Range is .2 to 15.4 Watts.
i indicates that current draw of port will be specified.
current is the current draw in mA that the port will power-up with. Regardless of current specified, classification will detect a "Class 0" PD. Range is 0 to 350 mA.
c indicates that classification of port will be specified.
class is the port classification. Range is 0 to 4. Load currents implemented by classification are:
<table>
<tr><th>Class</th><th>Class Current</th><th>Default Powered Load Current</th></tr>
<tr><td>0</td><td>2 mA</td><td>140 mA</td></tr>
<tr><td>1</td><td>10 mA</td><td>44 mA</td></tr>
<tr><td>2</td><td>18 mA</td><td>108 mA</td></tr>
<tr><td>3</td><td>28 mA</td><td>202 mA</td></tr>
<tr><td>4</td><td>40 mA</td><td>320 mA</td></tr>
</table>
Target port power level may be specified in combination with class in which case port will be powered to target power draw.
ci indicates that the classification current to be applied will be specified.
class_current is the classification current to apply during classification. Range is 0 to 45 mA. Power-up current will be determined according the class-band of the specified classification current. Target port power level may be specified in combination with class_current in which case port will be powered to target power draw.
dr indicates that a non-default detection resistance should be used.
resistance is the detection load resistance to use for the power-up. Range is 11 to 39KΩ.
dc indicates that a non-default detection capacitance should be used.
capacitance is the detection load resistance to use for the power-up. Range is 0, 5, 7, or 11 μF.
abort indicates that a non-default power application timer will be applied. Default wait-for-power application time is 16 seconds.
pwrTime is the maximum time in seconds to wait for PSE to apply power. Range is 4 to 30 seconds.

See Section 8.9.5 for LLDP command arguments.</td><td>Measured Port Voltage</td></tr>
<tr><td>Target Port Current</td></tr>
</table>

Command	Addr	Command Parameters	Returned Parameters
power_bt ***(PSA-3202, PSA-3402 only)***	4-pair Con-nected <*port*>	**c** *pdClass* | **ca** *pdClass* **cb** *pdClass* <**autoclass**> <**p** *power* | **i** *load*> <**dr** *rDet*> <**dc** *cDet*> <**abort** *pwrTime*> <**trace v** <**1s** | **2s** | **4s**> | **i** <**1s** | **2s** | **4s**> <**clip**>> <**evcount**> <**lldp** *…see Section 8.9.5 for LLDP arguments*> Simulates a PD connection to a **4-Pair 802.3bt** PSE port to bring power to a user-specified condition. May be addressed to either port 1 or 2 of **PSA/PSL-3202** test blade whereupon it will configure the 4-pair connection to the user-specified test port. (*Not supported by PSA/PSL-3102 test blades*.) Command must contain a *pdClass* argument. Returns port status. **c** Select PD class signature for both pairsets. Use when emulating Single Signature PD's (e.g. Class **0-8**) or Dual Signature PD's with equivalent pairset class signatures (e.g. Class **1D-5D**, **PD4**). **ca** Select PD class signature for Alt-A pairset. Use when emulating Dual Siganture PD's (e.g. Class **1D-5D**, **PD4**). **cb** Select PD class signature for Alt-B pairset. Use when emulating Dual Siganture PD's (e.g. Class **1D-5D**, **PD4**). *pdClass* IEEE 802.3bt PD classification. Range is **0**, **1**, **2**, **3**, **4**, **5**, **6**, **7**, **8**, **1D**, **2D**, **3D**, **4D**, **5D**, **PD4**, or **NONE**. pdClass **0-8** will emulate Single Signature PD's while pdClass **1D-5D** emulate 802.3bt Dual Signature PD's. **PD4** represents a Dual Class 4 (non-standard 4-Pair) PD and **NONE** represents a 0mA signature and may only be specified with **ca** or **cb** but not both **ca** and **cb**. **autoclass** Emulated PD signature to indicate autoclass capable (*Emulated PD will be in full power state when PSE performs autoclass assessment so long as no waveform trace is specified*.) **p** Specify load power. Default is *pdClass* specific. *power* 4-Pair load power after power-up. Minimum 0.2 W and maximum is 99W. Default is 13W for classes 3-8, 2D-5D, 6.6W for classes 2, 1D, and 3.8W for class 1. **i** Specify Current Load. Default is governed by power target (see above). Cannot use with **autoclass** – instead use **p** to specify *power*. *load* 4-Pair load current to draw from PSE after power-up. Range is 20mA to 1900mA. **dr** Specify detection resistance. Default is 24 Kohm. *rDet* Detection signature value. Range is 9 to 39 Kohm. Will be single signature with class 1-8, dual signature with class 1D-5D. **dc** Specify detection capacitance. Default is 0 uF. *cDet* Detection signature value. Range is 0, 5, 7, or 11 uF. Will be single signature with class 1-8, dual signature with class 1D-5D. **abort** Specify time to wait for power-up. Default is 12 seconds. *pwrTime* Time to wait for power-up in seconds. Range is 4 to 30 sec. **trace** Capture and display trace of the 4-pair power-up sequence. Default trace is 1 second duration from PD connect with 4msec sample resolution. Either **v** or **i** must be specified. **NOTE**: If **autoclass** is specified, autoclass power assessment timing will not be achieved if a trace is captured. **v** Present voltage traces from both Alt-A and Alt-B pairsets. **i** Present 4-pair combined current trace including both Alt-A and Alt-B. **1s** Capture 1 second duration trace with 4 msec sample resolution. **2s** Capture 2 second duration (extended) trace with 2 msec sample resolution. This is the default waveform aperture. **4s** Capture 4 second duration (extended) trace with 4 msec sample resolution. **evcount** Return the maximum event count observed on Alt-A and Alt-B pairsets. **NOTE**: If PSE divides classification between Alt-A and Alt-B pairsets to a single signature PD, then this count will not be a valid representation of the PSE event count and associated power grant. **clip** Present any captured waveform with all samples of power-up zero'd out so that detection and classification levels govern the full scale of the waveform graph. *See Section 8.9.5 for LLDP command arguments.*	POWERED | PWRD_A | PWRD_B | DOWN | DROPPED Measured Voltages and Currents on Alt-A and Alt-B *Optional:* Class Event Count Wavefor Trace(s) of Voltage or Current

<table>
<tr><th>Command</th><th>Addr</th><th>Command Parameters</th><th>Returned Parameters</th></tr>
<tr><td>power_prop4

<i>(PSA-3102, PSA-3002 only)</i></td><td></td><td>ci <i>Iclass</i> <p <i>power</i> | i <i>load</i>> <dr <i>rDet</i>> <dc <i>cDet</i>> <abort <i>pwrupTime</i>> <trace v <1s | 2s | 4s> | i<2> <1s | 2s | 4s> <clip> <rtn_trace>

<i>This command is supports testing of Proprietary 4-Pair PSE's using Port 2 of a PSA-3102 test blade or PSA-3002 instrument.</i>
Emulates a dual signature, proprietary PD presenting <u>fixed class signature on each pairset</u>. See power_bt for explanation of all arguments except those presented below.
ci indicates that the classification current to be applied will be specified. Default current is 40mA on each pairset.
<i>class_current</i> is the classification current to apply during classification. Range is 0 to 45 mA.</td><td></td></tr>
<tr><td rowspan="2">psa_set_load</td><td>2-Pair
<<i>port</i>>

or

4-Pair
<i>slot</i>,A
<i>slot</i>,B</td><td>p <i>new_power</i> <dcv <i>vport</i> <trigout>| interate <i>counts</i>>

Adjusts 2-pair (or pairset) load power to a target level with option to either measure voltage and converge load current or to accept user-furnished voltage to avoid any measurements that might disturb other user measurements in process. Must be addressed to single <i>port</i> (or <i>slot</i>,<i>pairset</i> in 4-pair mode) unless dcv argument is provided. May be multi-cast (e.g. 99,99 or 99,A) if PSE output voltage dcv is specified.

<i>new_power</i> DC power target. Range is 0.5 to 37.5 watts for 2-pair mode and 0.5 to 49.4 watts for pairset <i>slot</i>,A or <i>slot</i>,B in 4-pair mode. Must be furnished with command.
dcv <i>vport</i> Override any port voltage measurements and configure <i>new_power</i> utilizing the voltage provided, <i>vport.</i> This option allows any previously configured measurements to continue without disruption. Range for <i>vport</i> is 44 to 57 volts.
interate <i>counts</i> Specify the number of cycles of voltage measurements and load computation in order to converge power load to <i>new_power</i>. Range is 1 to 5. Default is 1. If dcv is not specified, at least one voltage measurement will be conducted and will disturb any user measurements that might be armed.
trigout Generates an event trigger out during the first load adjust iteration. This may be used to trigger a previously armed meter. Only valid when dcv is specified.</td><td></td></tr>
<tr><td>4-pair Con-nected
<<i>port</i>></td><td>p <i>new_power</i> <dcv <i>vport</i> <trigout>| interate <i>counts</i>>

Adjusts 4-pair load power to a target level with option to either measure voltage and converge load current or to accept user-furnished voltage to avoid any measurements that might disturb other user measurements in process. Must be addressed to single connected 4-pair <i>port</i> unless dcv argument is provided. May be multi-cast (e.g. 99,1 or 99,2) if PSE output voltage dcv is specified.

<i>new_power</i> DC power target. Range is 0.5 to 98.8 watts. Must be furnished with command.

<i>All other arguments are identical to 2-pair version of utility above.</i></td><td></td></tr>
<tr><td rowspan="2">psa_edge_ count</td><td>2-Pair
<<i>port</i>>

or

4-Pair
<i>slot</i>,A
<i>slot</i>,B</td><td><level <i>threshold</i>> <period <i>interval</i>>

This measurement utility can be used to tally the number of edge transitions counted over a specified period of time on the PoE connection or specified pairset of a 4-pair connection. This may be used to determine approximate detection (and 802.3bt connection check) pulses occurring in any given time interval.

level: Specify non-default threshold voltage.
<i>threshold:</i> Voltage to detect edges with. Default is 5V. Range 0.5 to 59 V.
period<i>:</i> Specify non-default measurement iterval.
<i>interval</i> : Time (in seconds) over which to count edges. Default is 5 seconds. Range is 1 to 30 seconds.</td><td>Count of Eds</td></tr>
<tr><td>4-pair Con-nected
<<i>port</i>></td><td><i>This utility is a 2-pair or pairset function and is not valid when addressed to a 4-pair (connected) slot,port.</i></td><td></td></tr>
</table>

<table>
<tr><th>Command</th><th>Addr</th><th>Command Parameters</th><th>Returned Parameters</th></tr>
<tr><td>replicate_ ports</td><td>2-Pair <<i>port</i>>

Or

4-pair Con-nected <<i>port</i>></td><td><i>config_type</i> {<i>target_ports</i>}

Replicate configuration of resources from one port to one or more other ports in a PSA-3000 or PSA-3x48. Command will initially replicate the pair state (2-pair or 4-pair) configuration of the addressed <i>port</i> to the <i>target_ports</i> before copying the user specified <i>config_type</i>. So if the pair state of <i>port</i> is 2-pair, then all <i>target_ports</i> will be 2-pair. If the pair state of <i>port</i> is 4-pair Single Signature, then the <i>target_ports</i> will all be connected 4-pair Single Signature configurations.

If replicating from a 4-pair connected port, the <i>target_ports</i> must also be a list of 4-pair connected ports meaning if copying from <i>x</i>,1, all <i>target_ports</i> must be <i>x</i>,1 and if copying from <i>x</i>,2, all <i>target_ports</i> must be <i>x</i>,2.

<i>This utility should be used cautiously in systems that may have mixed configurations of PSx-3202 and PSx-3102 as well as mixed configurations of 4-pair and 2-pair configured blades.</i>

<i>config_type</i>: The type of configuration to be replicated from <i>port</i> to {<i>target_ports</i>}. Options are: port | trig | load | vdca | vdcp | vdct | idca | idcp | idct | acv | time | all. “all” will fully replicate all subsystem configurations.

<i>target_ports</i>: A list of ports (<i>slot</i>,<i>port</i> format) to which the configuration is to be copied. Use “allports” to copy configuration to all ports in PSA-3000 or PSA-3x48.</td><td></td></tr>
<tr><td>psa_test_load</td><td><<i>port</i>></td><td><slow | fast | sharp> <c <i>class</i>< -force>> <t <i>duration</i>>

<i>This utility is only supported for testing 802.3at (2-pair) PSE’s at this time.</i>

Utility generates a configurable loading sequence to a powered 2-pair PSE port that runs for a user specified duration. This can be used in conjunction with data transmission tests performed by other test equipment. Supports LLDP power-up for PD Class 4 if global $psaPseHpGrant = “LLDP“ and PSA is enabled for LLDP.
slow: A slowly varying (~ .5 Hz), approximately sinusoidal loading waveform ranging from .5 watts to a power level just below the maximum classification power level. This is the default waveform.
fast: A rapidly varying (4 Hz) series of step transitions between low power and a power just below the maximum classification power level.
sharp: Approximately 5 very short duration load transients per second ranging from low power to the maximum classification power level.
c: Specify a PD Classification. Default is Class 0.
<i>class</i>: User specified PD Classification. Test loads vary over the following ranges according to selected classification:
<table>
<tr><th>Class</th><th>Min Load</th><th>Max Load</th></tr>
<tr><td>0</td><td>0.5 Watts</td><td>15.3 Watts</td></tr>
<tr><td>1</td><td>0.5 Watts</td><td>3.9 Watts</td></tr>
<tr><td>2</td><td>0.5 Watts</td><td>6.9 Watts</td></tr>
<tr><td>3</td><td>7.1 Watts</td><td>15.3 Watts</td></tr>
<tr><td>4</td><td>15.5 Watts</td><td>29.8 Watts</td></tr>
</table>
-force: Recycle power to PSE port using PD Classification Emulation for the desired class level entered to assure proper classification.
-t: Specify a time duration for the load sequence.
duration: Time duration in seconds. Range is 5 to 240 seconds. Default is 10 seconds.</td><td>Peak Power Utilized</td></tr>
</table>

5.11.1. Proprietary 4-Pair PSE Testing Utilities

PSA software offers limited support for proprietary 4-Pair PSE testing utilities under PSA 5.2 software. See the **Class 4 Dual** PD Type option under PSA Interactive (*see Sections 4.3, 4.6*) and the **PD4** signature option in **power_bt** (*see Section 5.11 above*). Also see the **power_prop4** command above.

5.12. PowerShell PSA Trace Display and Analysis Commands

PowerShell PSA offers several commands that are useful for working with voltage and current traces gathered from the respective trace meters.

Command	Command Parameters	Returned Parameters
psa_trace	**v** | **i** *PSA_Trace_Data* <**-raw**> <**-title** *frame_title*> This utility will create a waveform trace (*see sections 4.5 and 4.6*) given a captured trace from a **PowerShell Wish** command or script. **v**: Waveform is a voltage trace. **i**: Waveform is a current trace. *PSA_Trace_Data*: The TCL list of 256 or 1024 time-value data returned from a **vdctrace stat**, **idctrace stat** , or **pwruptrace** measurement. **-raw**: Disable LSB trace smoothing in O-Scope display. *frame_title*: Text to place in waveform window frame **Note!** *This command will only operate in PowerShell* ***Wish***.	
psa_trace **(Additional arguments for Tcl/Tk 8.5, 8.6 only)**	**v** | **i** *PSA_Trace_Data_A PSA_Trace_Data_B* <**-raw**> <**-title** *frame_title*> <**-label1** *legend_A*> <**-label2** *legend_B*> This utility will create a dual waveform trace generally used to depict waveforms from both Alt-A and Alt-B pairsets together. *PSA_Trace_Data_A*: The TCL list of 256 or 1024 time-value data returned from a **vdctrace stat** or **idctrace stat** measurement on the Alt-A pairset. *PSA_Trace_Data_B*: The TCL list of 256 or 1024 time-value data returned from a **vdctrace stat** or **idctrace stat** measurement on the Alt-B pairset. *legend_A*: A graph legend label for the Alt-A trace *legend_B*: A graph legend label for the Alt-A trace	
psa_edge_search	*trace_list* (**rising** | **falling**) *threshold* <**-start** *start_sample*> <**forward** | **backward**> <**-qual** *count*>	1 (=Edge Found) 0 (=No Edge Found)
	This utility operates on an already acquired trace (trace list of time-value sampled data) to locate a user-specified edge within that trace and to report the trace list sample index (1 – 511) where the edge is found. Note: Trace Lists consist of time and sample items with time (msec) at all even number indices and sample value at all odd numbered indices. *trace_list*: A valid trace list returned from vdctrace or idctrace queries. **rising**: Specifies that a rising edge is sought. **falling**: Specifies that a falling edge is sought. *threshold*: Specifies the sample level (voltage in V or current in mA) for the desired edge transition. Range is 0.5 to 1023.5, however with voltage traces, useful range is limited to 59.5 V and with non-combined current traces, useful range is limited to 511.5 mA. **-start:** Specifies that edge search should begin at some sample index after the start of the trace. Range is 1 to 511 (odd). *start_sample*: The non-default start sample index. **forward:** Specifies that search should proceed in the direction from start until end of trace (forward time). **backward:** Specifies that search should proceed in reverse direction from start_sample (reverse time). **-qual:** Indicates that non-default edge recognition will be applied. Default is 0 which is most susceptible to noise (false edge). *count*: Non-default edge recognition criteria specifying count of samples on both sides of threshold required in order to accept the edge transition. Higher values overcome noise. Default is 0 additional samples on either side of threshold. Range is 0 to 4	Edge Sample Index (=511 if no edge found)

<table>
<tr><th>Command</th><th>Command Parameters</th><th>Returned Parameters</th></tr>
<tr><td rowspan="2">psa_pulse_remove</td><td><i>traceList</i> < -max <i>maxAmplitude</i> > < -min <i>minAmplitude</i> > <-t <i>maxPulseWidth</i> ></td><td>Count of Pulse Removed</td></tr>
<tr><td>This utility operates on a trace to remove an unwanted pulse that might interfere with other subsequent trace analysis. It is also useful for recognizing the presence of user-specified pulses in a trace capture.
trace_list: A valid trace list returned from vdctrace or idctrace query.
maxAmplitude: Maximum pulse amplitude of pulse to be removed from trace. Default = 59 (V or mA). Range is 1-60.
minAmplitude: Minimum pulse amplitude of pulse to be removed from trace. Default = 35 (V or mA). Range is 1-60.
maxPulseWidth: Maximum duration of pulse that will meet criterial for removal. All pulses shorter that this duration will be removed. Default is 60 msec. Range is 2 msec to 75% of trace duration.</td><td>Modified Trace List (256 time and value samples)</td></tr>
<tr><td rowspan="2">psa_subsample</td><td>#samples PSA_Trace_Data</td><td rowspan="2">{List of subsample voltage or current value s}</td></tr>
<tr><td>This utility returns a subset of a collected voltage or current trace with evenly time-spaced sub-samples.
#samples: The number of evenly separated trace samples to return.
PSA_Trace_Data: The TCL list of 256 time-value data returned from a vdctrace stat or idctrace stat measurement.</td></tr>
</table>

5.13. PowerShell PSA System & Chassis Commands

System commands are utilized to control and configure at the PowerSync Analyzer chassis level. The **psa** command described in Section 5.7 above will define the chassis on which each of these commands will operate.

<table>
<tr><th>Command</th><th>Command Parameters</th><th>Returned Parameters</th></tr>
<tr><td rowspan="2">psa_config</td><td><-d <-sernum> | -s> <-pva> <-alc></td><td rowspan="2">{Port + Type + Version}</td></tr>
<tr><td>Inventories and reports status of available system resources (blades, ports, firmware & hardware version). Inventory is performed upon currently selected PSA chassis. Default output is Tcl List of inventory.
-d Causes inventory to be displayed in tabular form.
-sernum Adds test blade serial numbers to configuration table
-s Returns a list of populated slots
-pva Returns only PVA-3000 blade configuration
The following applies to PSA/PSL-3202 only:
-alc Returns ALC (auto load control) firmware version</td></tr>
<tr><td rowspan="2">trig_port</td><td>< in | out ></td><td rowspan="2">{INPUT | OUTPUT}</td></tr>
<tr><td>Configures the TRIG port on the PSA chassis controller to either transmit or receive external (event) trigger signals. Default (wake-up) mode is output. See section 3.1.2.
in: Config TRIG port on PSA Controller to an input
out: Config TRIG port on PSA Controller to an output</td></tr>
<tr><td rowspan="2">psa_setipaddress</td><td><i>ipaddress</i> <mask <i>mask</i>> <gateway <i>gateway</i>></td><td rowspan="2">Current IP Address, Mask, and Gateway Address.</td></tr>
<tr><td>Installs a new fixed IP address to be utilized by the Chassis Controller. This command completes in approximately 15 seconds but does not require rebooting of the PSA chassis for the new address to take affect.
ipaddress is the new IP address that will be utilized by the Chassis Controller in the format of nnn.nnn.nnn.nnn.
mask keyword indicating that next item is IP address mask.
mask is the IP mask to be utilized for Internet communications. Format is nnn.nnn.nnn.nnn. Default is 255.255.255.0. Must comply with IP rules for valid mask values.
gateway keyword indicating that next item is IP gateway address.
gateway is a gateway address to be utilized for Internet Protocol. Format is nnn.nnn.nnn.nnn. Default is 000.000.000.000.</td></tr>
</table>

Command	Command Parameters	Returned Parameters
psa_flash load	**type AT** | **BT** | **AF file** *"filename"* This command is used for downloading new PSA **test blad**e (PSA-3x02) firmware images from a host computer to chassis flash memory. **type AT**: Indicates that a firmware image to be downloaded to the PSA is targeted for a PSA-3102 or PSL-3102 blade. **type BT**: Indicates that a firmware image to be downloaded to the PSA is targeted for a PSA-3202 or PSL-3202 blade. **type AF**: Indicates that a firmware image to be downloaded to the PSA is targeted for a PSA-1200 or PSA-1200-PL blade in a PSA-3000. *filename* local path & file name to be downloaded to the chassis flash memory. The file may be for PSA-3000, PSL-3000, or older PSA-1200 blade. Use forward slashes for directory level delimiters in *filename*. Enclose in quotes if there are spaces in *filename.* **Important!** Must be entered with proper case from file name.	
psa_flash update	<**recover**> *slot*,*port* | **all** **type** <**AT** | **BT** | **AF**> This command is used for updating PSA-3000 **test blades** (PSA-3x02) with new firmware images previously installed to chassis flash memory. **recover**: Option to load firmware image to a test port that fails to appear in PSA chassis inventory. *Not required for normal updating*. *slot*,*port* Single test port to be updated with new firmware. **all**: Update all test ports that match the specified type in currently connected instrument with new firmware. **type AT**: Indicates that a firmware image is to be installed from chassis flash memory to a PSA-3102 or PSL-3102 blade. **type BT**: Indicates that a firmware image is to be installed from chassis flash memory to a PSA-3202 or PSL-3202 blade. **type AF**: Indicates that a firmware image is to be installed from chassis flash memory to a PSA-1200 or PSA-1200-PL blade.	
psa_flash dir	Returns the stored firmware file versions in the PSA-3000 controller	Firmware Files
psa_speed	**fast** | **slow** | **?** Sets a non-default backplane datacom speed to PSA/PSL instrument. Default is **fast** (57Kbaud) if PSA/PSL instrument has controller firmware version 3.18 or newer. Otherwise it is **slow** (9.6Kbaud). Use **?** to query	FAST | SLOW
psa_update_fw	*slot*,*port* **file** *"filename"* <**-y**> This command is used to download and install new firmware images to a PSA-3000 **controller blade** or to PSA-3x02 test blades installed in older PSA-1200 chassis'. Note: *This command will take several minutes to complete per port.* *slot*,*port* Test port to be updated with new firmware. Use 0,0 for updating PSA-3000 controller blade firmware. Use N,N for updating PSA-3000 test blade firmware in a PSA-1200 chassis. **file**: Indicates following string represents path and file name of firmware image to download and install. *filename* local path & file name to be downloaded to the chassis flash memory. The file may be for PSA-3000, PSL-3000, or older PSA-1200 blade. Use forward slashes for directory level delimiters in *filename*. Enclose in quotes if there are spaces in *filename*. **-y** Bypass user prompts and download immediately to selected port. (*Useful for automated updating to more than one port*.)\	
psa_enable	**?** | *feature_code* <**enable** | **disable**> Command is used for querying Serial Number and Features from a PSA Controller. Also used to enable and disable features given a proper code. NOTE: This command will run from either PowerShell Wish or PowerShell Tcl and requires PSA Software Version 2.0 or later. **?** Returns current feature settings for connected PSA. *feature_code*: A unique alpha-numeric code provided when new features are purchased from Sifos for a specific PSA chassis or instrument. **enable**: Enable feature associated with the provided feature code. (Default action). **disable**: Disable feature associated with the provided feature code.	Serial Number Feature Info (*see Section 4.7.3*)

5.14. Multi-Port PSE Automated Test Script for 802.3at PSE's (psa_quick_test)

PSA Software includes a sample test script for the PSA-3000 and PSA-3x48 (PSA-3248 or PSA-3048) instruments to support high throughput PSE testing using methods described both in this section and later in section 8.1. This script is provided as source code so that it may be modified or used as a template for PSE test automation, particularly in high volume QA and manufacturing test environments. The psa_quick_test script will test IEEE 802.3at Type-1, Type-2 (2-event), and Type-2 (LLDP) PSE's with an average test time ranging from 8 to 14 seconds per port.

The script file, **psa_quick_test.tcl** is located in the **…\PSA3000\Contrib** directory (*see section 3.2*).

Note: Users must properly configure ALT and Polarity within each test port prior to running **psa_quick_test**. See the **psa_auto_port** command in section 5.11 and/or the **psa_pse** command in section 5.7.

<table>
<tr><th>Command</th><th>Command Parameters</th><th>Returned Parameters</th></tr>
<tr><td rowspan="2">psa_quick_test</td><td><<i>PSA Address</i>> <i>port1 port2 port3 port4</i> <<i>port 5</i> <<i>port 6</i> <<i>port 7</i> <<i>port 8</i>>>>> <type-1 | type-2 <lldp>> <-v></td><td rowspan="2">Detection
Acceptance
Detection Reject
Vport_Low_Load
Vport_High_Load
Load_Capacity
Power_Capacity
Disconnect_
Shutdown
(<i>including timing</i>)
Overloads
LLDP_Allocations
(<i>optional</i>)</td></tr>
<tr><td>Executes psa_quick_test on between 4 and 8 PSE ports as specified by command arguments. Command may be iterated to cover beyond 8 ports. Test covers Detection Signature Range, Port Voltage vs Load, Load and Power Capacity, Disconnect and Overload Shutdowns, and where applicable, LLDP power allocations.

PSA Address: Address of PSA instrument on which to run the test script.
port1 port2 port3 port 4…port 8: List of PSA test ports to utilize for testing. Must provide a minimum of 4 test ports and a maximum of 8 test ports, all of which are available in specified PSA Address.
type-1: Indicates that PSE is a Type-1 (15.4W) PSE. (Default value.)
type-2: Indicates that PSE is a Type-2 (30W) PSE. Type-2 PSE is assumed to use 2-event classification unless otherwise specified using the 'lldp' argument.
lldp: Indicates that PSE uses 802.3at LLDP to grant full power to Type-2 PD's. Requires PSA to be enabled for LLDP features.</td></tr>
</table>

5.15. PowerShell PSA Scripting Examples: 2-Pair 802.3at PSE Analysis

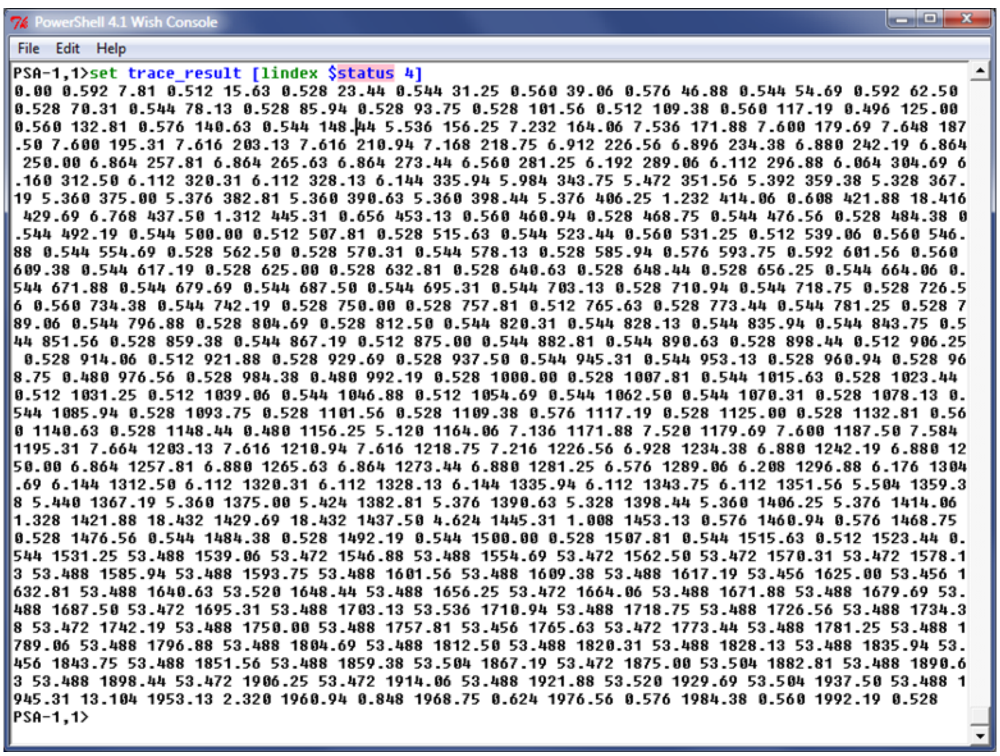
Several examples of short PowerShell PSE testing scripts are provided below.

5.15.1. Capturing a 2-Pair 802.3at Power-Up Trace to a Class 1 PD on Port 3,2

The following short script will capture a power-up trace and place the trace data (256 time-value) points into the Tcl list variable trace_result.

If the above code is executed in a Wish Shell, the value of `$trace_result` would be as shown below:

```
# Enable the port for detection, power-down port if it powered
#   Leave the port disconnected.   PSE is ALT A, MDI-X.
alt 3,2 a
polarity 3,2 neg
psa_disconnect 3,2
passive 3,2  r 23 c 0

# Setup the load and load transient to emulate Class 1 power-up.  Trigger
#   set up to launch the current transient when PoE voltage is 35 V.
class 3,2 1
itrans 3,2 i1 70 t1 50m i2 44 t2 hold trig1
trig1 3,2 rising level 35 normal arm

# Configure the measurement, then initiate the power-up sequence by
#   connecting the port.  Use port connection to trigger the voltage trace.
vdctrace 3,2 trig ext period 2s timeout 10 stat
port 3,2 connect trigout
set status [psa_wait vdctrace]
set trace_result [lindex $status 4]
```



PowerShell 4.1 Wish Console
File Edit Help

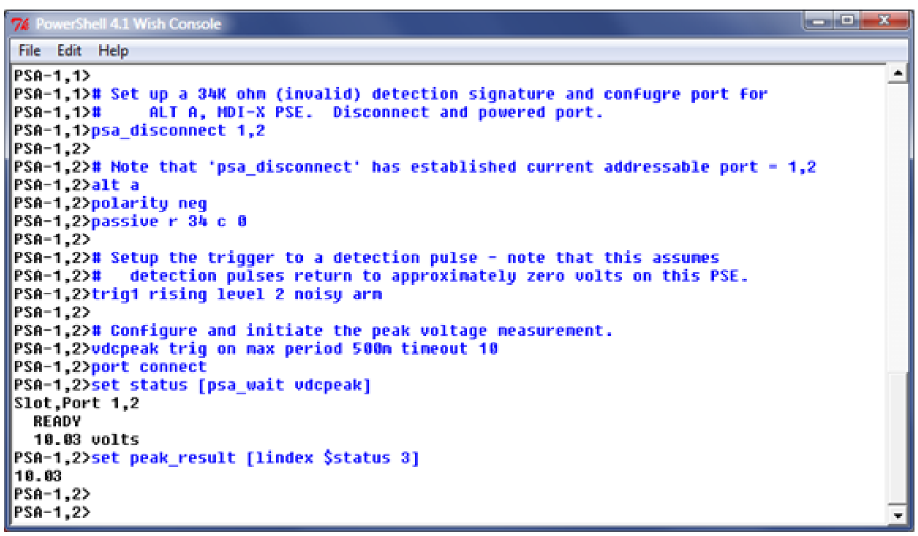
```
PSA-1,1>set trace_result [lindex $status 4]
0.00 0.592 7.81 0.512 15.63 0.528 23.44 0.544 31.25 0.560 39.06 0.576 46.88 0.544 54.69 0.592 62.50
0.528 70.31 0.544 78.13 0.528 85.94 0.528 93.75 0.528 101.56 0.512 109.38 0.560 117.19 0.496 125.00
0.560 132.81 0.576 140.63 0.544 148.44 5.536 156.25 7.232 164.06 7.536 171.88 7.600 179.69 7.648 187
.50 7.600 195.31 7.616 203.13 7.616 210.94 7.168 218.75 6.912 226.56 6.896 234.38 6.880 242.19 6.864
 250.00 6.864 257.81 6.864 265.63 6.864 273.44 6.560 281.25 6.192 289.06 6.112 296.88 6.064 304.69 6
.160 312.50 6.112 320.31 6.112 328.13 6.144 335.94 5.984 343.75 5.472 351.56 5.392 359.38 5.328 367.
19 5.360 375.00 5.376 382.81 5.360 390.63 5.360 398.44 5.376 406.25 1.232 414.06 0.608 421.88 18.416
 429.69 6.768 437.50 1.312 445.31 0.656 453.13 0.560 460.94 0.528 468.75 0.544 476.56 0.528 484.38 0
.544 492.19 0.544 500.00 0.512 507.81 0.528 515.63 0.544 523.44 0.560 531.25 0.512 539.06 0.560 546.
88 0.544 554.69 0.528 562.50 0.528 570.31 0.544 578.13 0.528 585.94 0.576 593.75 0.592 601.56 0.560
609.38 0.544 617.19 0.528 625.00 0.528 632.81 0.528 640.63 0.528 648.44 0.528 656.25 0.544 664.06 0.
544 671.88 0.544 679.69 0.544 687.50 0.544 695.31 0.544 703.13 0.528 710.94 0.544 718.75 0.528 726.5
6 0.560 734.38 0.544 742.19 0.528 750.00 0.528 757.81 0.512 765.63 0.528 773.44 0.544 781.25 0.528 7
89.06 0.544 796.88 0.528 804.69 0.528 812.50 0.544 820.31 0.544 828.13 0.544 835.94 0.544 843.75 0.5
44 851.56 0.528 859.38 0.544 867.19 0.512 875.00 0.544 882.81 0.544 890.63 0.528 898.44 0.512 906.25
 0.528 914.06 0.512 921.88 0.528 929.69 0.528 937.50 0.544 945.31 0.544 953.13 0.528 960.94 0.528 96
8.75 0.480 976.56 0.528 984.38 0.480 992.19 0.528 1000.00 0.528 1007.81 0.544 1015.63 0.528 1023.44
0.512 1031.25 0.512 1039.06 0.544 1046.88 0.512 1054.69 0.544 1062.50 0.544 1070.31 0.528 1078.13 0.
544 1085.94 0.528 1093.75 0.528 1101.56 0.528 1109.38 0.576 1117.19 0.528 1125.00 0.528 1132.81 0.56
0 1140.63 0.528 1148.44 0.480 1156.25 5.120 1164.06 7.136 1171.88 7.520 1179.69 7.600 1187.50 7.584
1195.31 7.664 1203.13 7.616 1210.94 7.616 1218.75 7.216 1226.56 6.928 1234.38 6.880 1242.19 6.880 12
50.00 6.864 1257.81 6.880 1265.63 6.864 1273.44 6.880 1281.25 6.576 1289.06 6.208 1296.88 6.176 1304
.69 6.144 1312.50 6.112 1320.31 6.112 1328.13 6.144 1335.94 6.112 1343.75 6.112 1351.56 5.504 1359.3
8 5.440 1367.19 5.360 1375.00 5.424 1382.81 5.376 1390.63 5.328 1398.44 5.360 1406.25 5.376 1414.06
1.328 1421.88 18.432 1429.69 18.432 1437.50 4.624 1445.31 1.008 1453.13 0.576 1460.94 0.576 1468.75
0.528 1476.56 0.544 1484.38 0.528 1492.19 0.544 1500.00 0.528 1507.81 0.544 1515.63 0.512 1523.44 0.
544 1531.25 53.488 1539.06 53.472 1546.88 53.488 1554.69 53.472 1562.50 53.472 1570.31 53.472 1578.1
3 53.488 1585.94 53.488 1593.75 53.488 1601.56 53.488 1609.38 53.488 1617.19 53.456 1625.00 53.456 1
632.81 53.488 1640.63 53.520 1648.44 53.488 1656.25 53.472 1664.06 53.488 1671.88 53.488 1679.69 53.
488 1687.50 53.472 1695.31 53.488 1703.13 53.536 1710.94 53.488 1718.75 53.488 1726.56 53.488 1734.3
8 53.472 1742.19 53.488 1750.00 53.488 1757.81 53.456 1765.63 53.472 1773.44 53.488 1781.25 53.488 1
789.06 53.488 1796.88 53.488 1804.69 53.488 1812.50 53.488 1820.31 53.488 1828.13 53.488 1835.94 53.
456 1843.75 53.488 1851.56 53.488 1859.38 53.504 1867.19 53.472 1875.00 53.504 1882.81 53.488 1890.6
3 53.488 1898.44 53.472 1906.25 53.472 1914.06 53.488 1921.88 53.520 1929.69 53.504 1937.50 53.488 1
945.31 13.104 1953.13 2.320 1960.94 0.848 1968.75 0.624 1976.56 0.576 1984.38 0.560 1992.19 0.528
PSA-1,1>
```

5.15.2. Measure Peak Detection Voltage on Port 1,2 Given Out-Of-Band Signature

This script will capture the peak detection voltage measured while the detection signature is invalid.

```
# Set up a 34K ohm (out-of-range) detection signature and configure port for
#     ALT A, MDI-X PSE.  Disconnect any power.
alt 1,2 a
polarity neg
psa_disconnect
passive r 34 c 0

# Setup the triggering to a detection pulse - note that this assumes
#   detection pulses return to approximately zero volts.
trig1 rising level 2 noisy arm

# Configure and initiate the peak voltage measurement.
vdcpeak trig on max period 500m timeout 10
port connect
set status [psa_wait vdcpeak]
       set peak result [lindex $status 3]
```

If these commands are sequentially executed in a Wish Shell, it will appear as follows:

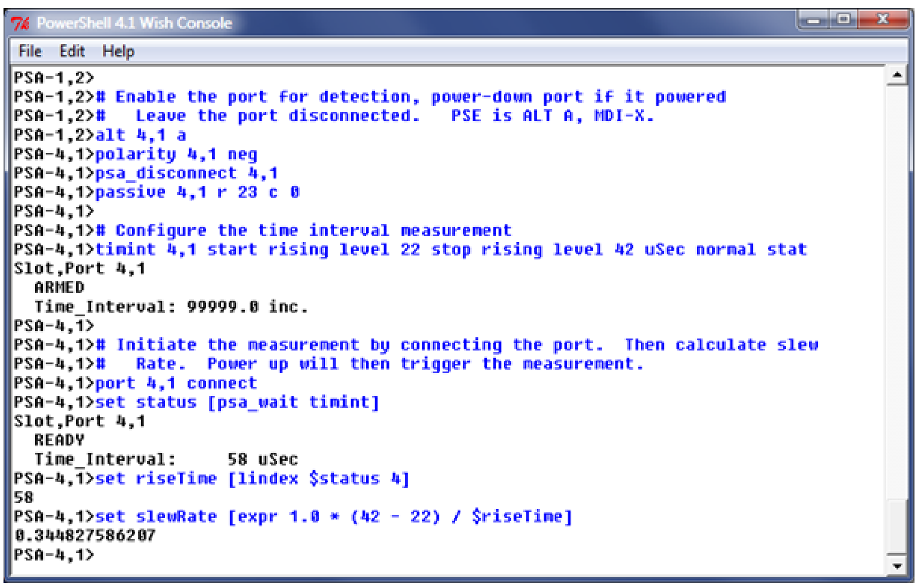


5.15.3. Power-Up Slew Rate Command Sequence

In this example, a short command sequence will measure the slew rate of a Power-Up event. Triggering thresholds between 22 and 42 VDC will be use to avoid false triggering by detection and classification signals.

```
# Enable the port for detection, power-down port if it powered
#   Leave the port disconnected.   PSE is ALT A, MDI-X.
alt 5,1 a
polarity 5,1 neg
psa_disconnect 5,1
passive 5,1 r 23 c 0

# Configure the time interval measurement
timint 5,1 start rising level 22 stop rising level 42 uSec normal stat

# Initiate the measurement by connecting the port.  Then calculate slew
#   Rate.  Power up will then trigger the measurement.
port 5,1 connect
set status [psa_wait timint]
set riseTime [lindex $status 4]
set slewRate [expr 1.0 * (42 - 22) / $riseTime]
```

The script is executed in the PowerShell PSA (Wish) window below.



```
PowerShell 4.1 Wish Console
File  Edit  Help
PSA-1,2>
PSA-1,2># Enable the port for detection, power-down port if it powered
PSA-1,2>#   Leave the port disconnected.   PSE is ALT A, MDI-X.
PSA-1,2>alt 4,1 a
PSA-4,1>polarity 4,1 neg
PSA-4,1>psa_disconnect 4,1
PSA-4,1>passive 4,1 r 23 c 0
PSA-4,1>
PSA-4,1># Configure the time interval measurement
PSA-4,1>timint 4,1 start rising level 22 stop rising level 42 uSec normal stat
Slot,Port 4,1
  ARMED
  Time_Interval: 99999.0 inc.
PSA-4,1>
PSA-4,1># Initiate the measurement by connecting the port.  Then calculate slew
PSA-4,1>#   Rate.  Power up will then trigger the measurement.
PSA-4,1>port 4,1 connect
PSA-4,1>set status [psa_wait timint]
Slot,Port 4,1
  READY
  Time_Interval:     58 uSec
PSA-4,1>set riseTime [lindex $status 4]
58
PSA-4,1>set slewRate [expr 1.0 * (42 - 22) / $riseTime]
0.344827586207
PSA-4,1>
```

5.15.4. Measure Class 3 Power-Up Current Inrush

The inrush current during a Class 3 power-up will be measured using the peak current meter triggered on the power-up edge at 35 V. A current transient will launch a 500 mA load during power-up to determine the peak current sourced by the PSE during this event.

In this example, a Tcl script will be generated and stored as "c:\inrush.tcl". When the script is "sourced" to Tcl/Wish, it can be executed as if it were a new command as titled by the "proc" command in Tcl.

```
proc inrush  {args} {

  # Default Port To Test
  global port

  # Prococess Port If Given As Input
  if { [string first "," $args] > -1 } {
    set port $args
  }

  # Enable the port for detection, power-down port if it powered
  #   Leave the port disconnected.   PSE is ALT B, MDI.
  alt $port b
  polarity $port pos
  psa_disconnect $port
  passive $port r 23 c 0

  # Setup the load and load transient to emulate class 3 power-up.  Trigger
  #   set up to launch the current transient when PoE voltage is 35 V.
  #   Use foldback suppression to deal with PSE current limiting.
  class $port 3
  itrans $port i1 500 t1 10m i2 202 t2 hold sfb trig1
  trig1 $port rising level 35 arm

  # Configure the peak current measurement for 20 mSec sampling interval
  idcpeak $port trig on max period 20m timeout 10 stat

  # Initiate the measurement by connecting the port.  Then calculate slew
  #   Rate.  Power up will then trigger the measurement.
  port $port connect
  set status [psa_wait $port idcpeak]
  set Iinrush [lindex $status 3]
  return $Iinrush
}
```

5.16. PowerShell PSA Scripting Examples: 4-Pair 802.3bt PSE Analysis

Several examples of short PowerShell PSE testing scripts are provided below.

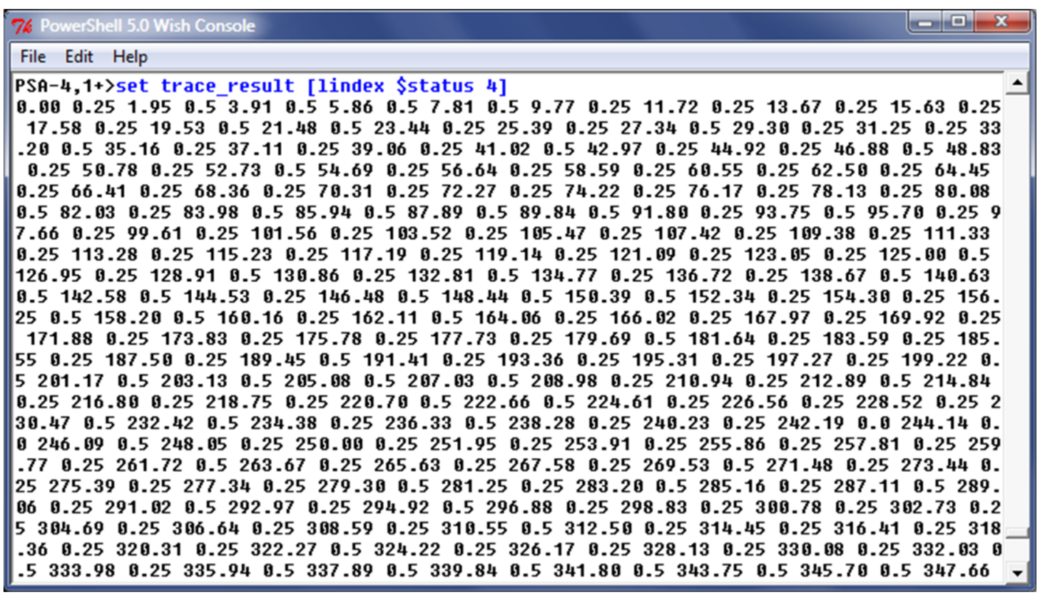
5.16.1. Capturing a Power-Up Current (Extended) Trace on Connection of Class 6 (Single Signature) PD

The following short script will capture a power-up (extended) 2 second current trace and place the trace data (10246 time-value) points into the Tcl list variable trace_result. Test port will be slot 4, port 1. PSE is Alt-A MDI-X and Alt-B MDI. (Note: This same process can be done using just the **power_bt** command.)

If the above code is executed in a Wish Shell, the value of `$trace_result` would be as shown below:

```
# Estatblish 4-Pair Single Signature Connection (PD emulation)
psa_4pair 4,1 single

# Establish proper polarities & detection signatures for pairsets
polarity 4,1 mdi+mdix
passive 4,1 r 25 c 0

# Establish Class Signture
#  Multi-Event signatures are not applied until Class Event #1
#  Class 6 will by default set 2mA mark load
class 4,1 6

# Configure the Current Trace to 2 second high resolution aperture
#  Arm the meter for an event trigger
idctrace 4,1 trig ext period 2sx stat

# Configure a Load Transient to simulate Inrush load and Steady State load (850mA)
#   Trigger transient on 39V at power-up
itrans 4,1 i1 400 t1 80m i2 850 t2 hold trig1
trig1 4,1 rising level 39 arm

# Connect the port, arm multi-event class, and trigger the meter
psa_connect 4,1 mevent trigout

# Collect the current trace when completed
set status [psa_wait 4,1 idctrace]
set trace_result [lindex $status 4]
```

The final command in this script loads the captured current trace, a list of time-value tuplets, into the variable trace_result:



5.16.2. Measure Peak Detection Voltages on Port 4,2 Given High Detect Signature with Dual Sig. PD

This script will capture the peak detection voltages measured while the detection signature is invalid on slot 4, port 2. PSE is Alt-A MDI, Alt-B MDI.

```
# Estatblish 4-Pair Dual Signature Connection (PD emulation)
psa_4pair 4,2 dual

# Establish proper polarities & invalid high detection signatures on both
pairsets
polarity 4,2 mdi+mdi
passive 4,2 r 37 c 0

# Connnect the port and capture peak voltages
port 4,2 connect
set status [vdcpeak 4,2 trig off max period 2s stat]
set vpeakA [lindex $status 3]
set vpeakB [lindex $status 9]
```

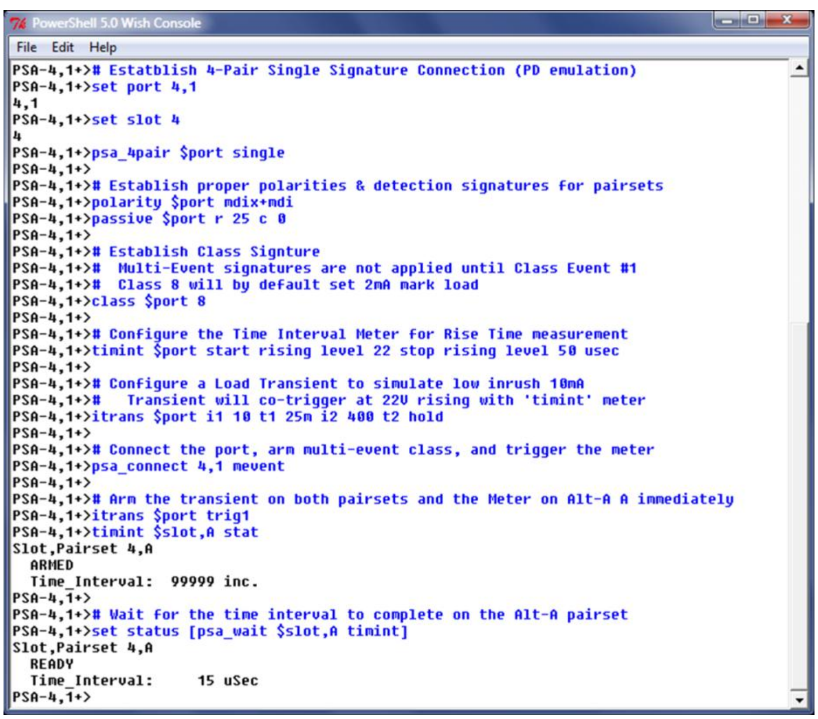
If these commands are sequentially executed in a Wish Shell, it will appear as follows:

```
PowerShell 5.0 Wish Console
File  Edit  Help
PSA-4,1+>psa_4pair 4,2 dual
PSA-4,2++>
PSA-4,2++># Establish proper polarities & invalid detection signatures on both pairsets
PSA-4,2++>polarity 4,2 mdi+mdi
PSA-4,2++>passive 4,2 r 37 c 0
PSA-4,2++>
PSA-4,2++># Connnect the port and capture peak voltages
PSA-4,2++>port 4,2 connect
PSA-4,2++>set status [vdcpeak 4,2 trig off max period 2s stat]
Slot,Pairset 4,A
  READY
  10.93 volts
Slot,Pairset 4,B
  READY
  10.90 volts
PSA-4,2++>set vpeakA [lindex $status 3]
10.93
PSA-4,2++>set vpeakB [lindex $status 9]
volts
PSA-4,2++>
```

5.16.3. Measure Power-Up Slew Rate on Alt-A Pairset Emulating Class 8 PD With Delayed Inrush

In this example, the rise time/slew rate of the power-up edge is measured on the Alt-A pairset while emulating a class 8 PD that presents low current load until after power-up. The PSE is Alt-A MDI, Alt-B MDI-X. Test Port is slot 4, port 1. Note that the time interval meter is configured to the 4-pair connected port but the measurement must be on a pairset, either 4,A or 4,B in this example.

```
# Estatblish 4-Pair Single Signature Connection (PD emulation)
set port 4,1
set slot 4
psa_4pair $port single

# Establish proper polarities & detection signatures for pairsets
polarity $port mdix+mdi
passive $port r 25 c 0

# Establish Class Signture
#  Multi-Event signatures are not applied until Class Event #1
#  Class 8 will by default set 2mA mark load
class $port 8

# Configure the Time Interval Meter for Rise Time measurement
timint $port start rising level 22 stop rising level 50 usec

# Configure a Load Transient to simulate low inrush 10mA
#   Transient will co-trigger at 22V rising with 'timint' meter
itrans $port i1 10 t1 25m i2 400 t2 hold

# Connect the port and arm multi-event classification
psa_connect $port mevent

# Arm the transient on both pairsets and the Meter on Alt-A A immediately
itrans $port trig1
timint $slot,A stat

# Wait for the time interval to complete on the Alt-A pairset
set status [psa_wait $slot,A timint]
```



```
PSA-4,1+># Estatblish 4-Pair Single Signature Connection (PD emulation)
PSA-4,1+>set port 4,1
4,1
PSA-4,1+>set slot 4
4
PSA-4,1+>psa_4pair $port single
PSA-4,1+>
PSA-4,1+># Establish proper polarities & detection signatures for pairsets
PSA-4,1+>polarity $port mdix+mdi
PSA-4,1+>passive $port r 25 c 0
PSA-4,1+>
PSA-4,1+># Establish Class Signture
PSA-4,1+>#  Multi-Event signatures are not applied until Class Event #1
PSA-4,1+>#  Class 8 will by default set 2mA mark load
PSA-4,1+>class $port 8
PSA-4,1+>
PSA-4,1+># Configure the Time Interval Meter for Rise Time measurement
PSA-4,1+>timint $port start rising level 22 stop rising level 50 usec
PSA-4,1+>
PSA-4,1+># Configure a Load Transient to simulate low inrush 10mA
PSA-4,1+>#   Transient will co-trigger at 22V rising with 'timint' meter
PSA-4,1+>itrans $port i1 10 t1 25m i2 400 t2 hold
PSA-4,1+>
PSA-4,1+># Connect the port, arm multi-event class, and trigger the meter
PSA-4,1+>psa_connect 4,1 mevent
PSA-4,1+>
PSA-4,1+># Arm the transient on both pairsets and the Meter on Alt-A A immediately
PSA-4,1+>itrans $port trig1
PSA-4,1+>timint $slot,A stat
Slot,Pairset 4,A
  ARMED
  Time_Interval:  99999 inc.
PSA-4,1+>
PSA-4,1+># Wait for the time interval to complete on the Alt-A pairset
PSA-4,1+>set status [psa_wait $slot,A timint]
Slot,Pairset 4,A
  READY
  Time_Interval:     15 uSec
PSA-4,1+>
```

5.16.4. Measure Class 7 Power-Up 4-Pair Inrush Current Limiting with Foldback Suppression

The inrush current during a Class 7 power-up will be measured using the average current meter triggered on the power-up edge at 39V. A current transient will launch a 1000 mA load during power-up to place the PSE into inrush current limiting. Foldback suppression will be applied with the power-up load transient to maintain pairset voltages above 30V during the current limiting phase. PSE is Alt-A MDI, Alt-B MDI.

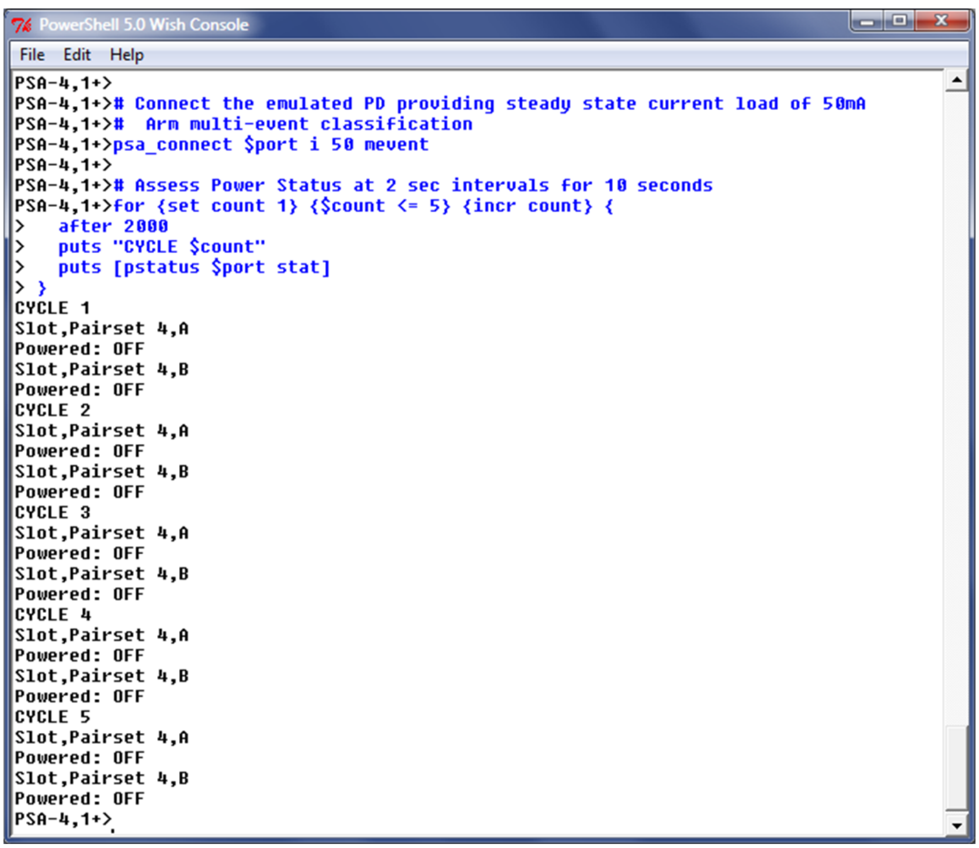
In this example, a Tcl script will be generated and stored as “c:\inrush.tcl”. When the script is “sourced” to Tcl/Wish, it can be executed as if it were a new command as titled by the “proc” command in Tcl. The test port is then passed as an argument to this command.

```
proc inrush7  {args} {

  # Default Test Port
  global port

  # Did user specify the Test Port ?
  if { [string first "," $args] > -1 } {
    set port $args
  }

  # Estatblish 4-Pair Single Signature Connection (PD emulation)
  #  and polarities and detection signature
  psa_4pair $port single
  polarity $port mdi+mdi
  passive $port r 25 c 0

  # Configure the peak current measurement for 50 mSec sampling interval
  idcaverage $port trig on period 50m timeout 10

  # Establish class signature and configure power-up inrush current
  class $port 7
  trig1 $port rising level 39 arm
  itrans $port i1 1000 t1 50m i2 100 t2 hold sfb trig1

  # Connect the emulated PD, activate multi-event class, measure avg inrush
  psa_connect $port mevent
  set status [psa_wait $port idcaverage]

  # Remove the PD Connection
  psa_disconnect $port

  return $status
}

source c:/inrush7.tcl
inrush7 4,2
```

5.16.5. Analyze PSE Response to Invalid Classification Sequence

A classification signature of 40mA – 18mA – 18mA – 18mA – 18mA is created and furnished to the PSE during classification. The PSE should reject this as an illegal PD classification and refuse to power. The mclass command is used to "edit" the classification signature and the pstatus query is used to assess power status. The PSE is Alt-A MDI-X, Alt-B MDI.

```
# Estatblish 4-Pair Single Signature Connection (PD emulation)
set port 4,1
psa_4pair $port single

# Establish proper polarities & detection signatures for pairsets
polarity $port mdix+mdi
passive $port r 25 c 0

# Establish Class Signture
#  Class 7 sets up 40-40-18-18-18 mA sequence
class $port 7

# Edit the 2nd event to invalid signature 40-18-18-18-18
mclass $port event 2 i 18

# Connect the emulated PD providing steady state current load of 50mA
#  Arm multi-event classification when PD connected
psa_connect $port i 50 mevent

# Assess Power Status at 2 sec intervals for 10 seconds
for {set count 1} {$count <= 5} {incr count} {
  after 2000
  puts "CYCLE $count"
  puts [pstatus $port stat]
}
```



5.16.6. Assess Response of Class 6 PSE to Worst Case Pair-Pair Current Unbalance

A PSE powering a Class 6 PD must, according to 802.3bt, support at least 692mA on either the Alt-A or Alt-B pairsets without removing power. This script will perform an emulated Class 6 power-up, setting each pairset to 692mA while the other pairset is adjusted to 300mA. Power status of the PSE will then be recorded.

In this example, a PSE attributes file will be used to set up pairset polarities properly for the PSE under test.

```
# Set up test port for a PSE using PSE Attributes File 'myBtPSE'
#   This will configure polarities properly for this PSE
psa_pse myBtPse
set port 1,2
set slot 1

# Emulate Class 6 power-up to 950 mA
power_bt $port c 6 i 950

# Unbalance with Alt-A high
iload $slot,B i 350
iload $slot,A i 692
after 500

# Check Powering Status after 500msec
set status [pstatus $port stat]
if { "[lindex $status 3] [lindex $status 7]" == "ON ON" } {
  puts "PSE myBtPSE PROPERLY TOLERATES MAXIMUM PAIR-PAIR UNBALANCE ON ALT-A"
} else {
  puts "PSE myBtPSE FAILED TO TOLERATE MAXIMUM PAIR-PAIR UNBALANCE ON ALT-A"

  # Re-cycle Power to the PSE port as it shut down
  power_bt $port c 6 i 950
}

# Unbalance with Alt-B high
iload $slot,A i 350
iload $slot,B i 692
after 500

# Check Powering Status after 500msec
set status [pstatus $port stat]
if { "[lindex $status 3] [lindex $status 7]" == "ON ON" } {
  puts "PSE myBtPSE PROPERLY TOLERATES MAXIMUM PAIR-PAIR UNBALANCE ON ALT-B"
} else {
  puts "PSE myBtPSE FAILED TO TOLERATE MAXIMUM PAIR-PAIR UNBALANCE ON ALT-B"
}

# Remove PD
psa_disconnect $port
```

In the example here, the PSE fails to tolerate the minimum required pair-pair unbalance load:

```
PowerShell 5.0 Wish Console
File  Edit  Help
PSA-1,2++># Emulate Class 6 power-up to 950 mA
PSA-1,2++>power_bt $port c 6 i 950
POWERED Alt-A: 55.35 V 474.50 mA Alt-B: 55.40 V 474.25 mA
PSA-1,2+>
PSA-1,2+># Unbalance with Alt-A high
PSA-1,2+>iload $slot,B i 350
PSA-1,2+>iload $slot,A i 692
PSA-1,2+>after 500
PSA-1,2+>
PSA-1,2+># Check Powering Status after 500msec
PSA-1,2+>set status [pstatus $port stat]
Slot,Pairset 1,A
Powered: OFF
Slot,Pairset 1,B
Powered: OFF
PSA-1,2+>if { "[lindex $status 3] [lindex $status 7]" == "ON ON" } {
>    puts "PSE myBtPSE PROPERLY TOLERATES MAXIMUM PAIR-PAIR UNBALANCE ON ALT-A"
> } else {
>    puts "PSE myBtPSE FAILED TO TOLERATE MAXIMUM PAIR-PAIR UNBALANCE ON ALT-A"
>
>    # Re-cycle Power to the PSE port as it shut down
>    power_bt $port c 6 i 950
> }
PSE myBtPSE FAILED TO TOLERATE MAXIMUM PAIR-PAIR UNBALANCE ON ALT-A
POWERED Alt-A: 55.35 V 474.50 mA Alt-B: 55.40 V 474.25 mA
PSA-1,2+>
PSA-1,2+># Unbalance with Alt-B high
PSA-1,2+>iload $slot,A i 350
PSA-1,2+>iload $slot,B i 692
PSA-1,2+>after 500
PSA-1,2+>
PSA-1,2+># Check Powering Status after 500msec
PSA-1,2+>set status [pstatus $port stat]
Slot,Pairset 1,A
Powered: OFF
Slot,Pairset 1,B
Powered: OFF
PSA-1,2+>if { "[lindex $status 3] [lindex $status 7]" == "ON ON" } {
>    puts "PSE myBtPSE PROPERLY TOLERATES MAXIMUM PAIR-PAIR UNBALANCE ON ALT-B"
> } else {
>    puts "PSE myBtPSE FAILED TO TOLERATE MAXIMUM PAIR-PAIR UNBALANCE ON ALT-B"
> }
PSE myBtPSE FAILED TO TOLERATE MAXIMUM PAIR-PAIR UNBALANCE ON ALT-B
PSA-1,2+>
PSA-1,2+># Remove PD
PSA-1,2+>psa_disconnect $port
PSA-1,2+>
```

5.17. PowerShell PSA: 2-Pair PSE Conformance Test Support Utilities

PowerShell PSA offers high level PSE characterization and analysis utility for those systems that are selectively enabled for PSE Conformance Test Suite. This are described below.

Command	Slot	Command Parameters	Returned Parameters
psa_det_char	<*port*>	This utility performs a detailed analysis of PSE detection signaling behaviors and is used by PSE Conformance Tests to adapt to the variety of PSE technologies available. Characterizations is done for both open circuit signaling and invalid signature response signaling. Parameters returned are: **syncMode**: Open Circuit Signaling Type **syncTrig**: Optimal level for open circuit synchronization trigger **ocDutyCycle**: Duty cycle of open circuit signaling above syncTrig **idleMode**: Idle State back-off type **idleLevel**: Idle State floor voltage **idleBackoff**: Minimum timing between Idle state pulses **idleRdet**: Optimal detection signature for Idle State analysis **TdetTot**: Duration of a full detection measurement	*See Parameters…*

5.18. PowerShell PSA: 2-Pair PSE Conformance Test Commands

Note*: The following commands are only available when connected to PSA chassis' that are licensed for the* ***2-Pair PSE Conformance Test Suite*** (PSA-CT2P).

The 2-Pair PSE Conformance Test Suite is addressed in section 6.1 and was introduced previously in section 3.2.3. Each PSE Conformance Test is readily executable from PowerShell PSA utilizing exactly the same test name as it appears in the PSE (Conformance) Tests menu as well as in the PSE Conformance Sequencer menu.

All PSE Conformance Tests accept the following (optional) command arguments:

- **-?** Help on command usage and arguments
- **-v** Verbose diagnostic output as the test executes
- **-csv** Output to PowerShell PSA will be formatted for copy-paste to a spreadsheet

Important! Many of the 2-Pair PSE Conformance Tests rely upon proper configuration of PSE attributes including **powered pair** (Alt-A or Alt-B), **power polarity** (MDI vs MDI-X), and the **High Power Grant Method**. PSE attributes are configured on the **PSE** tab menu in PSA Interactive or by the **psa_pse** command in PowerShell PSA (*see section 5.7*). The High Power Grant Method attribute is set to **NONE** for 15.4W capable PSE's and to one of **PHY**, **LLDP**, or **PHY+LLDP** for 30W capable PSE's. For further information see section 3.2.4.

PowerShell PSE Conformance Test (Ver 5.x.x) commands are:

Command	Command Parameters
det_v	<*port*> <**r** *resistance*> <**c** *capacitance*> <**valid**>
	Runs **det_v** test. Optional input Arguments: **r** Specify non-default valid detection signature resistance *resistance* Configure Detection Resistance for V_{valid} RANGE: 9 to 39 DEFAULT: 23 UNIT: KΩ **c** Specify non-default valid detection signature capacitance *capacitance* Configure Detection Capacitance for V_{valid}. RANGE: 0, 5, 7, or 11 DEFAULT: 0 UNIT: µF **valid** Return just V_{valid}(Max) and V_{valid}(Min) values.
det_i	<*port*>
	Runs **det_i** test.
det_time	<*port*> <*det_R*>
	Runs **det_time** test. Optional input Arguments: *det_R* Detection Signature (Kohm) for **tdet** and **detpulse** measurements (Default = '25' KΩ)
det_range	<*port*> <*max_time*>
	Runs **det_range** test. Optional input Arguments: *max_time* Maximum Time to Wait for a Power-Up. Default is ~15 seconds. Range 2 to 30 seconds.
det_rsource	<*port*>
	Runs **det_rsource** test.
class_v	<*port*> <**i** *current* | **c** *pdClass*> <**m** *mark_load*>
	Runs **class_v** test. Optional input Arguments: **i** Select Non-Default Class Current Load for Vclass_Max measurement *current* Classification current load. RANGE: **0** to **50** mA DEFAULT: **1** mA **c** Specify Non-Default PD Class to emulate for Vclass_Max measurement *pdClass* PD Class as **0**, **1**, **2**, **3**, or **4**. DEFAULT: Class **0** with 1mA. **m** Specify non-default mark region current *mark_load* Mark region current. RANGE: 0 to 5 UNIT: mA. DEFAULT: 4 mA. Vclass_Min always tested with 43mA. For PSE Conformance, test should be run without 'i' or 'c' arguments.

Command	Command Parameters
class_time	<*port*> <**i** *current* | **c** *pdClass*> <**m** *mark_load*>
	Runs **class_time** test. Optional input Arguments: **i** Report timing with just one class signature current. *current* Non-Default classification current load. RANGE: 0 to 45 mA DEFAULT: **2.5** mA AND **40** mA **c** Report timing with just one class signature. *pdClass* PD Class as **0**, **1**, **2**, **3**, or **4**. DEFAULT: Class **0** AND Class **4**. **m** Specify non-default mark region current *mark_load* Mark region current. RANGE: **0** to **5** mA. DEFAULT: **2** mA. For PSE Conformance, test should be run without 'i' or 'c' arguments. This will collect classification events and timing using BOTH 2.5mA AND 40mA signatures.
class_err	<*port*> <**c** *pd_class*>
	Runs **class_err** test. Optional input Arguments: c Specify emulated PD Class. *pd_class* PD Classification to emulate. RANGE: 0 to 4 DEFAULT: Determined from PSE Attribute **High Power Grant Method**. Class **0** if **NONE**, Class **4** if **PHY**, **LLDP**, or **PHY+LLDP**.
class_lldp	<*port*> <c *pd_class*> < req *init_req_pwr*>
	Runs **class_lldp** test. Optional input Arguments **c** Specify non-default PD Class to emulate *pdClass* Emulated PD Class. Range 3 or 4. DEFAULT: Determined from PSE Attribute **High Power Grant Method**. Class **3** if **NONE**, Class **4** if **LLDP** or **PHY+LLDP**. **req** Overrride default initial power request. *init_req_pwr* Initial power request. Range is 1 - 25.5. UNITS: Watts. DEFAULT: 8.1W for Class 3, 20.3W for Class 4.
pwrup_time	<*port*> <**c** *pd_class* | **ci** *current*>
	Runs **pwrup_time** test. Optional input Arguments: **ci** Report timing with specified class signature current. *current* Class current to emulate. RANGE: 0 to 45 mA. DEFAULT: Determined from PSE Attribute **High Power Grant Method**. 2.5mA if **NONE**. 2.5mA AND 40mA if **PHY**, **LLDP**, or **PHY+LLDP**. **c** Report timing with specified class signature. *pdClass* PD classification to emulate. RANGE: 0 to 4. DEFAULT: Determined from PSE Attribute **High Power Grant Method**. Class **0** if **NONE**. Class **0** AND Class **4** if **PHY**, **LLDP**, or **PHY+LLDP**.
pwrup_inrush	<*port*> <**c** *pd_class* >
	Runs **pwrup_inrush** test. Optional input Arguments: **c** Test inrush with specified class signature. *pdClass* PD classification to emulate. RANGE: 0 to 4. DEFAULT: Determined from PSE Attribute **High Power Grant Method**. Class **0** if **NONE**. Class **0** AND Class **4** if **PHY**, **LLDP**, or **PHY+LLDP**.
pwron_v	<*port*> <**c** *pd_class* > <**xlldp**>
	Runs **pwron_v** test. Optional input Arguments: **c** Specify non-default PD class to emulate *pd_class* PD Class to emulate. RANGE 0, 1, 2, 3, or 4. DEFAULT: Determined from PSE Attribute **High Power Grant Method**. Class **0** if **NONE,** Class **4** if **PHY**, **LLDP**, or **PHY+LLDP**. **xlldp** Skip LLDP for Type-2, LLDP High Power Grant PSE's. Note: LLDP used only for Type-2, LLDP granting PSE's.

Command	Command Parameters
pwron_pwrcap	<*port*> <**c** *pd_class* | **ci** *load current*> <**xlldp**>
	Runs **pwron_pwrcap** test. Optional input Arguments: **c** Specify PD Class to emulate *pd_class* Emulated PD class. RANGE: 0, 1, 2, 3, or 4. If 0, 1, 2, or 3 specified, all four classes 0, 1, 2, and 3 will be tested. If class 4 specified, only Class 4 will be tested. If PSE does not power class 0 or class 3, class 2 should be specified. If PSE does not power class 2, class 1 should be specified. DEFAULT: All PD classes (0-4) are emulated and tested. **ci** Specify just one emulated PD class signature current. Test will emulate only this one classification. *class_current* PD classification current load during power-up. Range 0 to 45 mA. **xlldp** Bypass LLDP power negotiation for Type-2, **LLDP** High Power Grant PSE's.
pwron_maxi	<*port*> <**c** *pd_class* > <**xlldp**>
	Runs **pwron_maxi** test. Optional input Arguments: **c** Specify non-default PD class to emulate. *pdClass* PD classification to emulate. RANGE: 0 to 4. DEFAULT: Determined from PSE Attribute **High Power Grant Method**. Class **0** if **NONE**. Class **0** AND Class **4** if **PHY**, **LLDP**, or **PHY+LLDP**. **xlldp** Bypass LLDP power negotiation for Type-2, LLDP High Power Grant PSE's.
pwron_overld	<*port*> <c *pd_class* > <**xlldp**>
	Runs **pwron_overld** test. Optional input Arguments: **c** Specify non-default PD class to emulate. *pdClass* PD classification to emulate. RANGE: 0 to 4. DEFAULT: Determined from PSE Attribute **High Power Grant Method**. Class **0** if **NONE**. Class **0** AND Class **4** if **PHY**, **LLDP**, or **PHY+LLDP**. **xlldp** Bypass LLDP power negotiation for Type-2, LLDP High Power Grant PSE's.
pwron_autoclass	<*port*> <c *pd_class* > <**xlldp**>
	Runs **pwron_autoclass** test (*Type-3 PSE's only*). Optional input Arguments: **c** Specify non-default PD class to emulate. *pdClass* PD classification to emulate. RANGE: 0 to 4. DEFAULT: Determined from PSE Attribute **High Power Grant Method**. Class **3** if **NONE**. Class **3** AND Class **4** if **PHY**, **LLDP**, or **PHY+LLDP**.
mps_ac_vf	<*port*> <**c** *pd_class* >
	Runs **mps_ac_vf** test. Optional input Arguments: **c** Specify non-default PD classification *pd_class* PD Classification to emulate. RANGE: 0 to 4. DEFAULT: 0
mps_ac_voff	<*port*> <**c** *pd_class* >
	Runs **mps_ac_voff** test. Optional input Arguments: **c** Specify non-default PD classification *pd_class* PD Classification to emulate. RANGE: 0 to 4. DEFAULT: 0
mps_ac_pwrdn	<*port*> <**c** *pd_class* >
	Runs **mps_ac_pwrdn** test. Optional input Arguments: **c** Specify non-default PD classification *pd_class* PD Classification to emulate. RANGE: 0 to 4. DEFAULT: 0
mps_dc_valid	<*port*> <**c** *pd_class* > <**-bt**>
	Runs **mps_dc_valid** test. Optional input Arguments: **c** Specify non-default PD classification *pd_class* PD Class to emulate. RANGE: 0 to 4. DEFAULT: Class 0 **-bt** Evaluate **Tmps** over the range of 16 msec declining to 4 msec This will automatically occur if PSE is Type-3 (802.3bt).

Command	Command Parameters
mps_dc_pwrdn	<*port*> <**c** *pdClass*> <**ihold**>
	Runs **mps_dc_pwrdn** test. Optional input Arguments: **c** Specify non-default PD classification *pd_class* PD Classification to emulate. RANGE: 0 to 4. DEFAULT: Class 0 **ihold** Report only the I_hold value
pwrdn_overld	<*port*> <**c** *pd_class* > <**xlldp**>
	Runs **pwrdn_overld** test. Optional input Arguments: **c** Specify non-default PD class to emulate. *pdClass* PD classification to emulate. RANGE: 0 to 4. DEFAULT: Determined from PSE Attribute **High Power Grant Method**. Class **0** if **NONE**. Class **0** AND Class **4** if **PHY**, **LLDP**, or **PHY+LLDP**. **xlldp** Bypass LLDP power negotiation for Type-2, LLDP High Power Grant PSE's
pwrdn_time	<*port*> <**c** *pd_class* >
	Runs **pwrdn_time** test. Optional input Arguments: **c** Specify non-default PD classification *pd_class* PD Classification to emulate. RANGE: 0 to 4. DEFAULT: Class 0
pwrdn_v	<*port*> <c *pd_class* > <xlldp>
	Runs **pwrdn_v test**. Optional input Arguments: **c** Specify non-default PD class to emulate. *pdClass* PD classification to emulate. RANGE: 0 to 4. DEFAULT: Determined from PSE Attribute **High Power Grant Method**. Class **0** if **NONE,** Class **4** if **PHY**, **LLDP**, or **PHY+LLDP**. **xlldp** Bypass LLDP power negotiation for Type-2, LLDP High Power Grant PSE's.

5.19. PowerShell PSA: 4-Pair PSE Conformance Test Commands

All 4-Pair PSE tests accept the **-v** argument for producing diagnostic text to the screen and the **-csv** argument for formatting results to go into a spreadsheet report.

Important! Many of the 4-Pair PSE Conformance Tests rely upon proper configuration of PSE attributes including pairset polarities (MDI vs MDI-X) and the **High Power Grant Method** in order to test PSE ports correctly. PSE attributes are configured on the **PSE** tab menu in PSA Interactive or by the **psa_pse** command in PowerShell PSA (*see section 5.7*). The High Power Grant Method attribute is set to **NONE** for 15.4W capable PSE's and to one of **PHY**, **LLDP**, or **PHY+LLDP** for all higher power PSE's (e.g. 90W, 60W, 30W). For further information see section 3.2.4.

Command	Command Parameters
det_v	<*port*> <**-v**> <**-csv**>
	Runs Detection Voltages test on a 4-Pair PSE.
det_cc	<*port*> <**-v**> <**-csv**> <**cc_det**>
	Runs Connection Check Voltages test on a 4-Pair PSE. **cc_det** Return just the CC_DET_SEQ attribute of the PSE port
det_i	<*port*> <**-v**> <**-csv**>
	Runs Detection Current Limit test on a 4-Pair PSE.
det_time	<*port*> <**-v**> <**-csv**>
	Runs Detection Timing test on a 4-Pair PSE.
det_range	<*port*> <**-v**> <**-csv**> <**ssds** | **ss** | **ds**>
	Runs Detection Range test on 4-Pair PSE. Optional arguments are: **ssds** Run both Single and Dual Signature test cases (Default). **ss** Run only Single Signature test cases. **ds** Run only Dual Signature test cases.
det_rsource	<*port*>
	Runs Detection Source Impedance test on a 4-Pair PSE.

Command	Command Parameters
cc_response	<*port*> <**-v**> <**-csv**>
	Runs Connection Check Response test on a 4-Pair PSE.
class_v	<*port*> <**-v**> <**-csv**> <**ssds** | **ss** | **ds**>
	Runs Classification Voltages test on a 4-Pair PSE. Optional arguments are: **ssds** Run both Single and Dual Signature PD emulations (Default). **ss** Run only Single Signature PD emulations. **ds** Run only Dual Signature PD emulations.
class_time	<*port*> <**-v**> <**-csv**> <**ssds** | **ss** | **ds**>
	Runs Classification Timing test on a 4-Pair PSE. Optional arguments are: **ssds** Run both Single and Dual Signature PD emulations (Default). **ss** Run only Single Signature PD emulations. **ds** Run only Dual Signature PD emulations.
class_err	<*port*> <**-v**> <**-csv**>
	Runs the Classification Current Limit and Invalid Signature Test on a 4-Pair PSE.
class_response	<*port*> <**-v**> <**-csv**>
	Runs the PD Classification Signature Response Test on a 4-Pair PSE.
class_lldp	<*port*> <**-v**> <**-csv**> <**-lv**>
	Runs the Single Signature LLDP Verification test on a 4-Pair PSE. **-lv** Include LLDP utility calls in -v diagnostic output.
class_lldp2	<*port*> <**-v**> <**-csv**> <**-lv**>
	Runs the Dual Signature LLDP Verification test on a 4-Pair PSE. **-lv** Include LLDP utility calls in -v diagnostic output.
pwrup_time	<*port*> <**-v**> <**-csv**>
	Runs the Power-Up Timing test on a 4-Pair PSE.
pwrup_inrush	<*port*> <**-v**> <**-csv**>
	Runs the Power-Up Inrush Response test on a 4-Pair PSE.
pwron_v	<*port*> <**-v**> <**-csv**>
	Runs the Power-On PSE Voltages test on a 4-Pair PSE.
pwron_pwrcap	<*port*> <**-v**> <**-csv**> <**ss** | **ds**>
	Runs the Power-On Power Capacity test on a 4-Pair PSE. **ss** Run only Single Signature PD emulations. **ds** Run only Dual Signature PD emulations. Default is to run BOTH Single and Dual Signature PD emulations.
pwron_unbal	<*port*> <**-v**> <**-csv**>
	Runs the Power-On Pair-to-Pair Unbalance Test on a 4-Pair PSE.
pwron_maxi	<*port*> <**-v**> <**-csv**> <**ss** | **ds**>
	Runs the Power-On Short Circuit test on a 4-Pair PSE. **ss** Run only Single Signature PD emulations. **ds** Run only Dual Signature PD emulations. Default is to run BOTH Single and Dual Signature PD emulations.
pwron_overld	<*port*> <**-v**> <**-csv**> <**ss** | **ds**>
	Runs the Power-On Overload Tolerance test on a 4-Pair PSE. **ss** Run only Single Signature PD emulations. **ds** Run only Dual Signature PD emulations. Default is to run BOTH Single and Dual Signature PD emulations.
pwron_autoclass	<*port*> <**-v**> <**-csv**>
	Runs the Autoclass test on a 4-Pair PSE.
mps_dc_valid	<*port*> <**-v**> <**-csv**> <**ss** | **ds**>
	Runs the MPS Valid Signature test on a 4-Pair PSE. **ss** Run only Single Signature PD emulations. **ds** Run only Dual Signature PD emulations. Default is to run BOTH Single and Dual Signature PD emulations.

Command	Command Parameters
mps_dc_pwrdn	<*port*> <**-v**> <**-csv**>
	Runs the MPS Invalid Signature test on a 4-Pair PSE.
pwrdn_time	<*port*> <**-v**> <**-csv**>
	Runs the Shutdown Timing test on a 4-Pair PSE.
pwrdn_v	<*port*> <**-v**> <**-csv**>
	Runs the Error Delay test on a 4-Pair PSE.

5.20. PSE 2-Pair and 4-Pair Conformance Test Utilities

In section 4.8, the capability of PSA software to sequence standard PSE Conformance Tests was described. Sequencing can also be performed at the Tcl or Wish command line using the **sequence** utility. This command works similarly for both the **2-Pair** and the **4-Pair** PSE Conformance Test Suites.

Command	Command Parameters
sequence	<**-v**> <*loopCount*> <**-p** *portList*> <**-t** *testList*> <**-c** | **-s** | **-f** <**-n** *file_name*>> <**-dir** *pathExt*> <**-noreset**> <**-break**> <**-ea**> <**-type 1** <**-class** *pdclass*>| **-type 2**>
	Performs standard conformance test sequencing over designated test list and selected ports with options for reporting to spreadsheet or to a asci text file as designated by user. **IMPORTANT!** PSE attributes including powered pairs, polarities, MPS method, and High Power Grant method must be properly established prior to sequening tests. See **psa_pse** command in section 5.7. *Arguments common to 2-Pair and 4-Pair Test Suites* **-v** Verbose mode – this is useful for tracking the test steps within each conformance test. *loopCount* The number of test cycles to execute where one test cycle is all specified tests on all specified ports. Range is 1 to 99. Default is 1. **-p** Sub-command indicating that a user specified list of slot-ports will be provided. Default is ALL available test ports in PSA-3000 instrument. *portList* A space delimited TCL list of slot-port identifiers. Example would be {**1,1 1,2 2,1 2,2**}. Must be in braces (or quotes) if more than one port is specified. List may be used to repeat test ports (e.g "**1,1 1,2 1,1 1,2 1,1 1,2**") so they appear on single page of test report. **-t** Sub-command indicating that a user specified list of tests will be provided. Default is ALL available tests for the PSE Type (AC MPS or DC MPS). *testList* A space delimited TCL list of test identifiers. Example would be {**det_v det_i det_time**}. Must be in braces (or quotes) if more than one port is specified. **-c** or **-s** Sub-command to route test results to the psa_report.xlsm spreadsheet. **-f** Sub-command to route test results to an ASCII file where the default file will be a date and time-stamped file name placed in the \Results subdirectory. **-n** Sub-command to specify a file name & path that is different than the default for and ASCII report file *file_name* The absolute path and file name (excluding ".txt" extension) of ASCII formatted report. Use forward slashes in path input. **-dir** Add extension '_ *pathExt* ' to default Results path allowing report routing to unique directories. *pathExt* Alpha-numeric extension to add to Results path name. 1-6 characters of letters and/or numbers. **-noreset** Prevent power-downs to other Test Ports in PSA instrument. Default is to power down all Test Ports prior to sequencing. **-break** Configure sequencer to terminate sequencing and produce a partial test report if and when any Conformance Test first generates an error. Example would be a PSE port failing to power-up. **-ea** Run EA test sequence to EA **Gen1** (2-Pair) or **Gen2** (4-Pair) certification report template. Any Test list and report mode entries will be overriden. *loopCount* will be forced to 1. This command option is equivalent to selecting the **EA Tests** option in PSA Interactive (*see Section 4.8.6*) *Arguments specific to the 2-Pair Test Suite* **-type 1** Run any tests that accept PD class arguments with (default) Class 0. See individual tests for impact of specifying PD class emulation. **-type 2** Run any tests that accept PD class arguments with (default) Class 4. See individual tests for impact of specifying PD class emulation. **-class** Override default Class 0 for Type-1 emulations (requires **-type 1** argument). *pdClass* Type-1 override Class. Range= '0' to '3'. **IMPORTANT!** As if PSA 5.3 and later version software, the **-type** argument should be avoided because each test automatically DEFAULTS to the required PD emulations for the declared PSE attributes. *Arguments specific to the 4-Pair Test Suite* **-ss** Restricts certain long duration tests such as **pwron_pwrcap** and **pwron_maxi** from running Dual Siganture test cases. Should not be used for full conformance testing. Default is to run full comformance testing including Dual Signature test cases.

An example of the **sequence** command (**2-Pair** conformance test suite) would be:

```
PSA-3,1> sequence 2 -p {3,1 3,2 5,1 5,2} -t {det_v det_i det_range class_v
         pwrup_time} -c
```

This will sequence the 5 tests in the test list across the 4 ports in the port list a total of 2 cycles or iterations and send the results to the **psa_report.xlsm** spreadsheet.

To cover all ports with all available tests,

```
PSA-3,1> sequence 1  -f  -n  c:/Temp/myfile
```

will sequence all available tests to all populated ports and place the results in an ASCII file (myfile.txt) in the c:\Temp directory.

PowerShell PSA also provides a PSE Conformance Test **diagnostic troubleshooter command** designed to trap information from intermittent test failures and unexpected test results including those. The utility will cycle a selected PSE conformance test until a pre-described condition occurs whereupon cycling stops with diagnostics and waveforms presented. Note that certain arguments pertain only to either the 2-Pair Conformance Test Suite or the 4-Pair test suite.

Command	Command Parameters
psa_trapper	*test_name* <*slot,port slot,port slot,port* ….> <*loopCount*> **row** *parmNum1* <*parnNum2* <*parNum3..*>>> **min** *minVal1* <*minVal2* <*minVal3*..>>> **max** *maxVal1* <*maxVal2* <*maxVal3*..>>> <**p** *preReqTest*> <**-notrace**> <**c** *pdClass*>
	Cycles a selected PSE Conformance Test in PowerShell WISH over a user specified test ports and count of test cycles, searching for an occurrence where a test parameter falls into a user specified value band. This utility by default produces verbose diagnostics and waveforms, and will terminate when the user specified condition is discovered or when the cycle count is completed. Users may then inspect the waveforms and the diagnostics to better understand the test results. *Arguments common to 2-Pair and 4-Pair Test Suites* *testName* The name of a PSE Conformance Test to be cycled. Must be provided in command. *slot,port* The test port(s) to be included in the anomalous parameter result search. Default is current test port. Range is all available PSA test ports in the PSA instrument. *loopCount* The number of test cycles to execute over the specified test ports. Range is 1 to 250. Default values is 1. **-notrace** An optional control to inhibit waveform generation. This control will affect how certain tests make measurements. Some tests will use Time Interval measurements to measure parameters such as **Tcut** or **Tmpdo** if the waveform production is inhibited. However if waveforms are active, these measurements will be performed by evaluating capture traces. *Arguments specific to the 2-Pair Test Suite* **row** *parmNum1* The row number of the parameter of interest as presented in the test report. Range for *parmNum* is 1 to 12. This is a required argument. **min** *minVal1* The minimum parameter value of the selected parameter that will cause the utility to terminate so that waveforms and diagnostics can be evaluated. **max** *maxVal1* The maximum parameter value of the selected parameter that will cause the utility to terminate so that waveforms and diagnostics can be evaluated. **c** *pdClass* Run any tests that accept PD class arguments with specified PD class emulation. Range is 0, 1, 2, 3, or 4. Default is let *testName* automatically determine required PD emulations.. **IMPORTANT!** Avoid the **c** *pdClass* argument if goal is to run tests so they behave exactly as they would during ordinary sequencing. *Arguments specific to the 4-Pair Test Suite* **row** *parmNum1* <*parnNum2* <*parNum3..*>>> The row number(s) of one or more parameter(s) of interest as presented in the test report. Range for *parmNum* is 1 to 30. This is a required argument. **min** *minVal1* <*minVal2* <*minVal3*..>>> The minimum parameter value(s) associated with the provided row number(s) that would cause the cycling to terminate so that waveforms and diagnostics can be evaluated. Must be one *minValN* foreach *parmNumN* provided. This is a required argument. **max** *maxVal1* <*maxVal2* <*maxVal3*..>>> The maximum parameter value(s) associated with the provided row number(s) that would cause the cycling to terminate so that waveforms and diagnostics can be evaluated. Must be one *maxValN* foreach *parmNumN* provided. This is a required argument **p** *preReqTest* Specifies that PSE conformance *test preReqTest s*hould be run before running specified *test_name* in each cycle.

5.21. PowerShell PSA: 802.3at (2-Pair) Standard Waveforms

PowerShell PSA 5.x offers a series of standard waveforms that are used by PSA Interactive when testing 2-Pair PSE's. These are not documented at this time, but they are available with **-?** Help options in PowerShell Wish. The commands to obtain these waveforms are:

Command	Description
psa_2pr_det_wfm	Produces detection waveforms (Open Circuit, High Signature, Low Signature, Capacitive Signture)
psa_2pr_class_wfm	Produces classification waveform
psa_2pr_pwrup_wfm	Produces a power-up waveform
psa_2pr_inrush_wfm	Produces an inrush overload waveform
psa_2pr_minilim_wfm	Produces PSE response to an **Ilim_min** for **Tlim_min** load transient
psa_2pr_overld_wfm	Produces an **Icut/Tcut** overload waveform
psa_2pr_shckt_wfm	Produces an **Ilim** (current limiting) overload shutdown waveform
psa_2pr_discx_wfm	Produces a disconnect shutdown waveform
psa_2pr_errdel_wfm	Produces an error delay waveform

Many of these waveforms have 4-pair equivalents that are explained in detail in the following section.

5.22. PowerShell PSA: 802.3bt (4-Pair) Standard Waveforms

PowerShell PSA offers command access to the standardized waveforms in the PSA Interactive version 5.2. The following waveform generation commands are briefly introduced. These utilities must all be addressed to a single, connected 4-Pair port. The commands will return waveforms as time-value lists. To observe these waveforms using PowerShell Wish, use the **psa_show_trace ON** configuration prior to executing waveform commands.

Command	Addr	Command Parameters
psa_detect_wfm	<*port*>	**open** | **high** | **low** | **cap** | **conn_chk** <**c** *pdClass*>
		Produces a standardized PSE detection waveform in PowerShell Wish. **open** Produce Open Circuit voltage waveforms for both Alt-A and Alt-B pairsets. **high** Produce High (invalid) detection signature voltage waveforms for both Alt-A and Alt-B pairsets. **low** Produce Low (invalid) detection signature voltage waveforms for both Alt-A and Alt-B pairsets. **cap** Produce Capacitive (invalid, 11uF) detection signature voltage waveforms for both Alt-A and Alt-B pairsets. **conn_chk** Produce Connection Check voltage waveforms for both Alt-A and Alt-B pairsets. **c** *pdClass* Emulated PD Class used for signature type. Specify 0,1,2,3,4,5,6,7, or 8 for Single Signature and specify 1D,2D,3D,4D,5D, or PD4 for Dual Signature
psa_class_wfm	<*port*>	**c** *pdClass* <**v** | **i**> <**autoclass**>
		Produces waveforms of PSE classification sequences. Waveforms begin at start of Class Event #1. Voltage waveforms from Alt-A and Alt-B pairsets will not necessarily be time-aligned. **c** *pdClass* Emulated PD Class used for signature type. Specify 0,1,2,3,4,5,6,7, or 8 for Single Signature and specify 1D,2D,3D,4D,5D, or PD4 for Dual Signature **v** Specify a voltage trace from both pairsets (A and B) . This is the default. **i** Specify a current trace from the classifying pairset (A or B) given a single signature classification or from both pairsets (A and B) given a dual signature classification **autoclass** Produce an autoclass signature on LCE Event #1 as part of the emulation
psa_pwrup_wfm	<*port*>	**c** *pdClass* <**v** | **i** | **i2**> <**autoclass**> <**long**> <**clip**>
		Produces waveforms of the emulated PD connection and power-up sequence. Waveforms are started at the PD connection event. Voltage and dual-current waveforms on each pairset are time-aligned. **c** *pdClass* Emulated PD Class used for signature type. Specify 0,1,2,3,4,5,6,7, or 8 for Single Signature and specify 1D,2D,3D,4D,5D, or PD4 for Dual Signature **v** Specify a voltage trace from both pairsets (A and B). This is the default. **i** Specify a 4-pair current trace that is the combination of Alt-A and Alt-B currents. **i2** Specify individual pairset current traces. **autoclass** Produce an autoclass signature on LCE Event #1 as part of the emulation. This utility will NOT adjust to maximum PD power draw within the PSE measurement window. To get that behavior, see **power_bt**. **long** Instead of default 2 second waveform, collect a 4 second waveform. Waveform will in either case consist of 1024 samples of time-voltage tuplets. **clip** Capture the power-up waveform with the actual power-up voltage / current removed from the trace so that only detection and classification are presented.

Command	Addr	Command Parameters
psa_inrush_wfm	<*port*>	**c** *pdClass* <**v** | **i** | **i2**>
		Produces waveform(s) of PSE response to high inrush overloads. Inrush loads are somewhat specific to PD class that is specified. Waveforms are started at the power-up event and are synchronous between pairsets. **c** *pdClass* Emulated PD Class used for signature type. Specify 0,1,2,3,4,5,6,7, or 8 for Single Signature and specify 1D,2D,3D,4D,5D, or PD4 for Dual Signature **v** Specify a voltage trace from both pairsets (A and B). **i** Specify a 4-pair current trace that is the combination of Alt-A and Alt-B currents. This is the default waveform type given single signature PD emulation. **i2** Specify individual pairset current traces from Alt-A and Alt-B. This is the default waveform type given dual signature PD emulation.
psa_minilim_wfm	<*port*>	**c** *pdClass* <**v** | **i2**> <**4pr** | **2prA** | **2prB**> <**lldp** <**force** *pwrReq*>>
		Produces waveforms of PSE response to an **Ilim_min_2p** load transient applied on each pairset for the duration of **Tlim_min**. PSE's are required to support this level of load transient without removing power. The only option for current is **i2** because the specification is a pairset requirement. **c** *pdClass* Emulated PD Class used for signature type. Specify 0,1,2,3,4,5,6,7, or 8 for Single Signature and specify 1D,2D,3D,4D,5D, or PD4 for Dual Signature **v** Specify a voltage trace from both pairsets (A and B). **i2** Specify individual pairset current traces from Alt-A and Alt-B. This is the default waveform type given dual signature PD emulation. **4pr** Apply **Ilim_min_2p** to both pairsets simultaneously **2prA** Apply **Ilim_min_2p** to the Alt-A pairset only **2prB** Apply **Ilim_min_2p** to the Alt-B pairset only **lldp** *pwrReq* Emulated PD will use 802.3bt PoE LLDP protocol to negotiate for pwrReq watts before the **Ilim_min** transient is applied. Valid for Single Signature emulations (Class 0-8) and 802.3bt Dual Signature emulations (Class 1D-5D). **force** *pwrReq*: A non-default LLDP power request. Default request is max for *pdClass*.
psa_overld_wfm	<*port*>	**c** *pdClass* <**v** | **i** | **i2**> <**4pr** | **2prA** | **2prB**> <**lldp** <**force** *pwrReq*>>
		Utility scans for a load current overload shutdown threshold on both pairsets or on a user-specified single pairset (A or B). It then applies this overload current in a manner the captures both the overload, or Icut current magnitude and the Tcut shutdown timing. Waveforms are started at the application of overload and are synchronous between pairsets. **c** *pdClass* Emulated PD Class used for signature type. Specify 0,1,2,3,4,5,6,7, or 8 for Single Signature and specify 1D,2D,3D,4D,5D, or PD4 for Dual Signature **v** Specify a voltage trace from both pairsets (A and B). **i** Specify a 4-pair current trace that is the combination of Alt-A and Alt-B currents. This is the default waveform type given single signature PD emulation. **i2** Specify individual pairset current traces from Alt-A and Alt-B. This is the default waveform type given dual signature PD emulation. **4pr** Determine 4-pair **Icut** value, then apply this current to capture waveform. **2prA** Determine 2-pair **Icut** value on the Alt-A pairset, then apply this pairset current to capture waveforms from both pairsets. **2prB** Specify Determine 2-pair **Icut** value on the Alt-B pairset, then apply this pairset current to capture waveforms from both pairsets. **lldp** *pwrReq* Emulated PD will use 802.3bt PoE LLDP protocol to negotiate for pwrReq watts before the **Ilim_min** transient is applied. Valid for Single Signature emulations (Class 0-8) and 802.3bt Dual Signature emulations (Class 1D-5D). **force** *pwrReq*: A non-default LLDP power request. Default request is max for *pdClass*.

Command	Addr	Command Parameters
psa_shckt_wfm	<*port*>	**c** *pdClass* <**v** | **i** | **i2**> <**4pr** | **2prA** | **2prB**> <**lldp** <**force** *pwrReq*>> Utility scans for a load current short circuit, or current limiting threshold on both pairsets or on a user-specified single pairset (A or B). Foldback suppression is applied to attempt to keep PSE output voltage as high as possible. It then applies this high overload current in a manner the captures both the short circuit overload, or Ilim current magnitude and the Tlim shutdown timing. Waveforms are started at the application of overload and are synchronous between pairsets. **c** *pdClass* Emulated PD Class used for signature type. Specify 0,1,2,3,4,5,6,7, or 8 for Single Signature and specify 1D,2D,3D,4D,5D, or PD4 for Dual Signature **v** Specify a voltage trace from both pairsets (A and B). **i** Specify a 4-pair current trace that is the combination of Alt-A and Alt-B currents. This is the default waveform type given single signature PD emulation. **i2** Specify individual pairset current traces from Alt-A and Alt-B. This is the default waveform type given dual signature PD emulation. **4pr** Determine 4-pair **Ilim** value, then apply this current to capture waveform. **2prA** Determine 2-pair **Ilim** value on the Alt-A pairset, then apply this pairset current to capture waveforms from both pairsets. **2prB** Specify Determine 2-pair **Ilim** value on the Alt-B pairset, then apply this pairset current to capture waveforms from both pairsets. **lldp** *pwrReq* Emulated PD will use 802.3bt PoE LLDP protocol to negotiate for pwrReq watts before the **Ilim_min** transient is applied. Valid for Single Signature emulations (Class 0-8) and 802.3bt Dual Signature emulations (Class 1D-5D). **force** *pwrReq*: A non-default LLDP power request. Default request is max for *pdClass*.
psa_tmps_wfm	<*port*>	**c** *pdClass* <**v** | **i2**> <**lldp** <**force** *pwrReq*>> Utility will apply the minimum possible valid DC MPS load and determine that the PSE maintains power. The minimum load requires that load current per pairset is **Ihold_2p**(max) for **Tmps** with a duty cycle of **Tmps**/(**Tmps**+**Tmpdo**). Five cycles of the minimum power load pulses will be applied. The only valid current option is **i2** because the analysis is perfomed per pairset. Waveform returned will cover 2 seconds. **c** *pdClass* Emulated PD Class used for signature type. Specify 0,1,2,3,4,5,6,7, or 8 for Single Signature and specify 1D,2D,3D,4D,5D, or PD4 for Dual Signature **v** Specify a voltage trace from both pairsets (A and B). **i2** Specify individual pairset current traces from Alt-A and Alt-B. This is the default waveform type given dual signature PD emulation. **lldp** *pwrReq* Emulated PD will use 802.3bt PoE LLDP protocol to negotiate for pwrReq watts before the **Ilim_min** transient is applied. Valid for Single Signature emulations (Class 0-8) and 802.3bt Dual Signature emulations (Class 1D-5D). **force** *pwrReq*: A non-default LLDP power request. Default request is max for *pdClass*.
psa_discx_wfm	<*port*>	**c** *pdClass* <**v** | **i** | **i2**> <*I_disc*> <**4pr** | **2prA** | **2prB**> Utility powers the PSE to the desired class, then performs an emulated PD disconnect in order to allow evaluation of PSE power removal behavior. Waveforms are initiated with the PD disconnect event and are synchronous between pairsets. **c** *pdClass* Emulated PD Class used for signature type. Specify 0,1,2,3,4,5,6,7, or 8 for Single Signature and specify 1D,2D,3D,4D,5D, or PD4 for Dual Signature **v** Specify a voltage trace from both pairsets (A and B). This is default waveform. **i** Specify a 4-pair current trace that is the combination of Alt-A and Alt-B currents. **i2** Specify individual pairset current traces from Alt-A and Alt-B. *I_disc* DC Current to indicate disconnect. Default is 0mA, range is 0-10mA. **4pr** Apply disconnect condition to both pairsets simultaneously. This is default. **2prA** Apply disconnect condition only to the Alt-A pairset. **2prB** Apply disconnect condition only to the Alt-B pairset.

Command	Addr	Command Parameters
psa_errdel_wfm	<*port*>	**c** *pdClass* <**v** | **i** | **i2**> <**4pr** | **2prA** | **2prB**> <**lldp** <**force** *pwrReq*>>
		Utility powers the PSE to the desired class, then performs a severe overload shutdown to assess PSE error delay between the shutdown and any ensuing detection prior to a power-up. Test port will revert to valid signatures immediately after the shutdown. Waveform returned will then capture the next 5 seconds after power removal. Overloads used are 765mA per pairset (950mA per pairse for Classes 7, 8, and 5D). **c** *pdClass* Emulated PD Class used for signature type. Specify 0,1,2,3,4,5,6,7, or 8 for Single Signature and specify 1D,2D,3D,4D,5D, or PD4 for Dual Signature **v** Specify a voltage trace from both pairsets (A and B). **i** Specify a 4-pair current trace that is the combination of Alt-A and Alt-B currents. This is the default waveform type given single signature PD emulation. **i2** Specify individual pairset current traces from Alt-A and Alt-B. This is the default waveform type given dual signature PD emulation. **4pr** Apply the overload current to both pairsets. **2prA** Apply the overload current to just the Alt-A pairset. **2prB** Apply the overload current to just the Alt-B pairset. **lldp** *pwrReq* Emulated PD will use 802.3bt PoE LLDP protocol to negotiate for pwrReq watts before the **Ilim_min** transient is applied. Valid for Single Signature emulations (Class 0-8) and 802.3bt Dual Signature emulations (Class 1D-5D). **force** *pwrReq*: A non-default LLDP power request. Default request is max for *pdClass*.

5.23. PSE Multi-Port Suite for 2-Pair (802.3at/802.3bt) PSE's

Note: *Commands covered in this section are only available when connected to PSA or PSA-PL chassis' that are licensed for PSE Multi-Port Suite. The Multi-Port Suite is only applicable to **2-Pair** PSE analysis and testing.*

5.23.1. Live 802.3at PD Emulation – Single Port or Single Chassis

PowerShell PSA can be used to place one or more PSA test ports into a state of "live" PD emulation. In this state, the test port(s) will behave as an actual user-defined **802.3at** Powered Device (PD) when PSE connections are made or PoE service is removed, then restored by a PSE. This PSA test port mode is particularly useful for PSE system testing functions.

While in the Live PD Emulation state, test ports cannot accept any commands other than the status query "stat" that will return the emulation status (RUNNING vs IDLE), PSE port power state, and current PSE port power output.

Command	Slot	Command Parameters	Query	Returned Parameters
psa_emulate_pd	<*port*>	**start** | **stop** <**-noshut**> <**c** *class* | **ci** *class_sig*> <**p** *pd_power*> <**o** *cable_loss*> <**alt A** | **B**> <**pol POS** | **NEG**> <**dr** *Rdet*> <**dc** *Cdet*> <**lldp off** | **connect** | **through**> <**init** *initpwr*> <**period** *intvl*> This command configures a test port to emulate a PD indefinitely, with no intervention from PowerShell required. Once the emulator has been started, the port will respond autonomously when a PSE is connected and disconnected, functioning just as a PD would. This command accepts the broadcast *port* argument **99,99** to initiate Live PD Emulation on all test ports in a single PSA chassis. *See* Section 8.9.6 *for LLDP specific parameter descriptions.* **start** Enable the PD Emulation mode (RUNNING). Any non-default final, offset, or init powers and any LLDP settings must be accompanied by this argument. **stop** Disable the PD Emulation mode (IDLE). **-noshut** Use with **stop** to leave port in powered state. **-allports** used with **stat** query to report status for all PSx ports in chassis. *Configuration Arguments that retain most recently specified settings*: *class* PD Classification: 0 - 4. Default class is 0. *class_sig* Range is 0 - 60 mA. Default is 2 mA. **alt A** PSE to power Alternative A pairs. **alt B** PSE to power Alternative B pairs. Default will be pre-existing port ALT configuration. **pol POS** PSE power polarity is MDI, or Positive. **pol NEG** PSE power polarity is MDI-X, or Negative. Default will be pre-existing port Polarity configuration. *Configuration Arguments that should be accompanied by the **start** argument: If **start** is specified without these, default values for each of these will apply.* *pd_power* PD Power Load: Range is 0.5 to 25.5 (watts). See below for actual allowed MAX power levels. Default load is 8 watts for Class 0, 3, & 4. ForClass 1 it is 2 watts, for Class 2 it is 3.5 watts. *cable_loss* Cable power loss: Range is 0 - 9.0 watts. This is added load that PSE will experience on top of specified PD power load. Default is 0 watts. Maximum combined *power* and *offsetpwr* is: **Class 0,3**: 17.7 watt **Class 1**: 4.6 watt **Class 2**: 8 watt **Class 4**: 34.5 watt *Rdet* Resistive detection signature to apply. Default will be 23 KΩ. Range is 9 to 39 KΩ. *Cdet* Capacitive detection signature to apply. Default will be 0 μF. Range is 0, 5, 7, and 11 μF.	**?**	PD Class PD Power Initial Power* (= ½ PD Power) OffsetPower: *Cable Loss* LLDP status ALT Bus_Polarity ** Initial power only has significance for LLDP power-ups – see Section 8.9.6*
			stat <**-allports**>	Status: **IDLE | RUNNING** Vport(setting) *used for load setup* Power (setting) *PSE output power* State: **UNPOWERED | POWERED** Vport (meas) *final measured V* Iport (meas) *final measured I* Pload *measured PSE power* This query does not disrupt the running emulation.

5.23.2. Multi-Port Resource Configurations and Associated Command Arguments

Many of the PSE Multi-Port Suite commands will require the specification of a **Multi-Port Resource Configuration** consisting of one or more PSA chassis' and selected test ports with each of those chassis addresses. The **st_config** command creates a Multi-Port Resource Configuration from Resource Configuration arguments. Those same arguments may be provided to Multi-Port *Test Suite* commands directly as an alternative to executing the **st_config** command. Conversely, **st_config** must be executed to form the Multi-Port Resource Configuration prior to initiating **Multi-Port Live PD Emulation** described in section 5.23.3 as well as utility commands in section 5.23.5 below.

Once the resource configuration is established, the command **st_psa** may be used to rapidly switch between different PSA chassis addresses. If PSE ports are connected to test ports within PSA chassis' that make up the Multi-Port Resource Configuration but not to test ports actually within that Resource Configuration, then those PSE ports will be unaffected by any Multi-Port testing or Live PD Emulations.

<table>
<tr><th>Command</th><th>Command Parameters</th></tr>
<tr><td>st_config</td><td><<i>PSA_ipAddr1</i> <allports | slots <i>slotRange</i> | ports <i>portList</i>>>
<<i>PSA_ipAddr2</i> <allports | slots <i>slotRange</i> | ports <i>portList</i>>> …
<<i>PSA_ipAddr8</i> <allports | slots <i>slotRange</i> | ports <i>portList</i>>></td></tr>
<tr><td>Arguments may be embedded within
all mp_***_*** test commands including mp_sequence</td><td>Establishes a Multi-Port Resource Configuration that is a user-specified collection of test ports that may span as many as 8 PSA chassis'. This command is a prerequisite to executing the st_psa, mp_emulate_pd (Section 5.23.3 and many of the Multi-Port Test Suite utility commands in Section 5.23.5 st_config functionality can be embedded in any of the Multi-Port Test Suite test and sequencer commands by providing the exact same arguments to those commands.

PSA_ipAddrN IP address of one PSA to be utilized in a multi-PSA test setup. Up to 8 PSA addresses allowed, each to be followed by test port selection parameters.
allports Setup to include all available PSA test ports associated with PSA. This is the default value if no port parameters are entered for each PSA address.
slots Specify a range of blade slots to provide test ports for a particular PSA chassis.
slotRange Range of slots to be used in format M-N where M≤N, M and N are integers between 1 and 12. Example: 1- 6 configures 12 test ports in slots 1, 2, 3, 4, 5, and 6.
ports Specify a range of test ports to be a test configuration for a particular PSA chassis.
portList List of test ports (slot,port format) to be included for a PSA.
Example is: 1,1 1,2 2,1 2,2

Example Resource Configuration: All test ports in two PSA's
st_config 192.168.221.105 allports 192.168.221.106 allports

Example Resource Configuration As Part Of Any M-P Test Command:
Slots 1-6 in PSA #1 and 4 assorted test ports from PSA #2
mp_***_*** 192.168.221.105 slots 1-6 192.168.221.106 ports 1,1 3,1 5,1 7,1

Example Resource Configuration:
All test ports in PSA #1 and PSA #2, the first 12 test ports from PSA #3 and PSA #4
st_config 192.168.221.105 allports 192.168.221.106 allports 192.168.221.107 slots 1- 6 192.168.221.108 slots 1- 6</td></tr>
<tr><td>st_psa</td><td>psa_ID | psa_address</td></tr>
<tr><td></td><td>Switches PSA chassis connection in PowerShell PSA. Equivalent to psa command except execution is instantaneous. Requires st_config to have been already executed.

psa_ID Integer identification of PSA/PSL chassis' to connect. Range is 1 to 8. Associated PSA is order of PSA addresses utilized in the st_config command (see above).
psa_address IP address of one of the PSA/PSL chassis' to connect. Address must be a part of previously established multi-port configuration formed using st_config command (see above).</td></tr>
</table>

5.23.3. Multi-Port Live PD Emulation on a Multi-Port Resource Configuration

The Live PD Emulation command is readily extended to a Multi-Port Resource Configuration (up to 192 test ports) using the **mp_emulate_pd** command described below. This command is only functional after a valid Multi-Port resource configuration has been developed using the **st_config** command.

<table>
<tr><th>Command</th><th>Command Parameters</th><th>Query</th><th>Returned Parameters</th></tr>
<tr><td rowspan="2">mp_emulate_pd</td><td><c <i>class</i>> <p <i>pd_power</i>> <o <i>cable_loss</i>> <dr <i>Rdet</i> > <dc <i>Cdet</i> > <limit <i>maxports</i>> <lldp connect | through <init <i>initpwr</i>>> | suspend | stat</td><td rowspan="2">stat</td><td rowspan="2">Live PD Emulation Status for all Chassis' and Test Ports in the Resource Configuration.</td></tr>
<tr><td>This command is used to initiate or query status on a Multi-Port Live PD Emulation utilizing the Multi-Port Resource Configuration model used throughout the PSE Multi-Port suite. Resource Configurations may include up to 8 PSA chassis' and up to 192 total test ports. Resource Configurations are established using the st_config command.

See section 8.9.6 for LLDP specific parameter descriptions.
pd_power PD Power Load: Range is 0.5 to 25.5 (watts). See below for actual allowed MAX power levels. A pd_power parameter must be specified when initiating Multi-Port Live PD Emulation..
cable_loss Cable power loss: Range is 0 - 9.0 watts. This is added load that PSE will experience on top of specified PD power load. Default is 0 watts. Maximum combined power and offsetpwr is:<table><tr><td>Class 0,3: 17.7 watt</td><td>Class 1: 4.6 watt</td></tr><tr><td>Class 2: 8 watt</td><td>Class 4: 34.3 watt</td></tr></table>Rdet Resistive detection signature to apply. Default will be 23 KΩ. Range is 9 to 39 KΩ.
Cdet Capacitive detection signature to apply. Default will be 0 μF. Range is 0, 5, 7, and 11 μF.
Maxports Maximum port count to include when initiating Live PD Emulations. Default is all ports included in the prior st_config generated Resource Configuration. This parameter can be used to restrict total ports emulated to a subset of that Resource Configuration.
suspend Control to discontinue Live PD Emulation but leave all test ports in current state, for example, with PSE ports powered on. Note: To terminate Multi-Port Live PD Emulation, use the mp_shutdown command</td></tr>
</table>

5.23.4. Multi-Port Test Suite Commands

The (second generation) **PSE Multi-Port Test Suite** for IEEE 802.3at PSE's was introduced earlier under **PSA Interactive** and is explained in detail in section 7.2. Each PSE Multi-Port Test is readily executable from PowerShell PSA using exactly the same test names that appear in the **PSE** (Multi-Port) **Tests** menu as well as in the PSE (Multi-Port) **Sequencer** menu.

With just one exception in the **mp_cap_stress** command, all individual test commands share the exact same set of command arguments.

Command	Command Parameters
mp_class_admit	*Multi-Port_Resource_Configuration* | -cfgok <**-type 1** <**limit 1** | **2**> | **-type 2** | **-type 1+2**> <**-pm phy** | **lldp** | **lldp2**> <**-log**> <**-v**>
	Execute the **mp_class_admit** test on newly defined or previously specified resource configuration. This test will not execute any prerequisite tests. *Multi-Port Resource Configuration* Same arguments provided to st_config (*see Section 5.23.2).* Either *Multi-Port Resource Configuration* or -cfgok must be provided. **-cfgok** Utilize Multi-Port Resource Configuration established previously from an st_config command or from running earlier Multi-Port tests. **-type 1** Testing performed with emulated Class 0, 1, 2, and/or 3 PD's. (Default emulation.) Typically used for testing Type-1 PSE's. **limit 1** Restrict maximum Type-1 PD Class to Class 1. **limit 2** Restrict maximum Type-1 PD Class to Class 2. **-type 2** Testing performed with emulated Class 4 PD's. **-type 1+2** Testing performed with Class 0, 1, 2, 3, and 4 PD's. Typically used for testing Type-2 PSE's. **-pm phy** PD emulation done with class signatures only. (Default emulation.) Typically used for testing Type-1 PSE's and Type-2 PSE's that provide 2-Event classification. **-pm lldp** PD emulation done with LLDP for all PD classes only. **-pm lldp2** PD emulation done with LLDP for Class 4 only. Typically used for testing Type-2 PSE's that require LLDP to negotiate Type-2 power levels. **-log** Retain diagnostic data, including *verbose* messages, log per test in a text log file. **-v** Output verbose diagnostics as tests execute.
mp_pwrup_time	*(See **mp_class_admit** command arguments)*
	Execute the **mp_pwrup_time** test on newly defined or previously specified resource configuration. This test will automatically execute the **mp_class_admit** test unless it is given a **-cfgok** argument and the required parameters from **mp_class_admit** are available. (See **mp_class_admit** command arguments)
mp_discx_time	*(See **mp_class_admit** command arguments)*
	Execute the **mp_discx_time** test on newly defined or previously specified resource configuration. This test will not execute any prerequisite tests. (See **mp_class_admit** command arguments)
mp_static_cap	*(See **mp_class_admit** command arguments)*
	Execute the **mp_static_cap** test on newly defined or previously specified resource configuration. This test will automatically execute the **mp_class_admit** test unless it is given a **-cfgok** argument and the required parameters from **mp_class_admit** are available. (See **mp_class_admit** command arguments)
mp_trans_cap	*(See **mp_class_admit** command arguments)*
	Execute the **mp_trans_cap** test on newly defined or previously specified resource configuration. This test will automatically execute the **mp_static_cap** test unless it is given a **-cfgok** argument and the required parameters from **mp_static_cap** are available. (See **mp_class_admit** command arguments)
mp_port_caps	*(See **mp_class_admit** command arguments)*
	Execute the **mp_port_caps** test on newly defined or previously specified resource configuration. This test will automatically execute the **mp_static_cap** test unless it is given a **-cfgok** argument and the required parameters from **mp_static_cap** are available. (See **mp_class_admit** command arguments)

Command	Command Parameters
mp_overld_time	*(See **mp_class_admit** command arguments)*
	Execute the **mp_overld_time** test on newly defined or previously specified resource configuration. This test will not execute any prerequisite tests. This test will automatically execute the **mp_port_caps** test unless it is given a **-cfgok** argument and the required parameters from **mp_port_caps** are available. (See **mp_class_admit** command arguments)
mp_admit_cases	*(See **mp_class_admit** command arguments)*
	Execute the **mp_admit_cases** test on newly defined or previously specified resource configuration. This test will automatically execute the **mp_class_admit** test unless it is given a **-cfgok** argument and the required parameters from **mp_class_admit** are available. (See **mp_class_admit** command arguments)
mp_cap_stress	*(See **mp_class_admit** command arguments)* <**-dur** *minutes*>
	Execute the **mp_cap_stress** test on newly defined or previously specified resource configuration. This test will automatically execute the **mp_static_cap** test unless it is given a **-cfgok** argument and the required parameters from **mp_static_cap** are available. (See **mp_class_admit** command arguments) **-dur** *minutes* Specify the time duration in minutes of the Multi-Port Stress Test. Range is 1 to 1500 minutes. Default is 2 minutes.

The Multi-Port Test Suite sequencer command also takes the commonly used test resource specification argument utilized by the individual Multi-Port tests and by the **st_config** command. Alternatively, the sequencer can run with a previously established Multi-Port Resource Configuration with the specification of the **–cfgok** argument.

Command	Command Parameters
mp_sequence	*Multi-Port_Resource_Configuration* | **-cfgok** <**-type 1** <**limit 1** | **2**> | **-type 2** | **-type 1+2**> <**-pm phy** | **lldp** | **lldp2**> <**-log**> <**-v**> <**-t {***testList***}** | **-e {***excludeList***}**> <**-s** | **-f** <**-n** *fileName*>> <**-dir** *ext*> <**-pse** *pseName*> <**-dur** *minutes*>
	Executes a sequence of Multi-Port Tests on a defined or previously established Multi-Port Resource Configuration. Tests will automatically sequence to meet requirements for pre-requisite test data to each test. Test results can be routed to the standard spreadsheet test report for the Multi-Port 2 test suite or to text file. Diagnostic data logging can be specified to produce log files for each test sequenced. (See **mp_class_admit** command arguments for **-type**, **-pm**, **-log**, and **-v**) **-t** *testList* Specify a list of tests to sequence within braces or quotes. Any prerequisite tests not specified will automatically be sequenced to produce prerequisite test data but not to reporting. Default is all nine tests. **-e** *excludeList* Specify a list of tests to exclude from the sequence – list must be within braces or quotes. Any prerequisite tests not within resulting test sequence will automatically be sequenced to produce prerequisite test data but not to reporting. **-s** Product standard Multi-Port 2 spreadsheet report. Default reporting is just to PowerShell window. **-f** Route results to a text file in current results directory with time-date stamp file name. **-n** *fileName* Route results to a user named text file *fileName* in current results directory (*exclude file extension as* '.txt' *will be automatically appended*.) **-dir** Specify a directory name path extension for the present default reporting directory *ext* Alpha-numeric extension to be appended to the present default reporting directory for test results so that each sequence executed can route results to a unique reporting directory. *ext* may include from 1 to 6 alpha-numeric characteris and will be appended to the results directory with two underscores. Example: Default results path= c:\Users\Public\Sifos\Results\myPSE\ and *ext*= **seq1**. Current sequence results will be saved in c:\Users\Public\Sifos\Results\myPSE__seq1\. **-pse** *pseName* Specify the name/model number of PSE-under-test for report header. **-dur** *minutes* Specify the time duration in minutes of the Multi-Port Stress Test, mp_cap_stress. Range is 1 to 1500 minutes. Default is 2 minutes.

An example of a simple Multi-Port sequencing command using all available (e.g. 24) test ports on one PSA to test a Type-2, LLDP PSE would be as follows:

```
PSA-1,1> mp_sequence 192.168.221.105 allports –type 1+2 –pm LLDP2 –s –dur 5
```

The above command also routes results to the standard spreadsheet report and it runs the stress test for 5 minutes.

An example of a simple Multi-Port sequencing command using all test ports from one PSA, 12 test ports from a second PSA to test an 802.3at Type-2, 2-Event PSE would be:

```
PSA-1,1> mp_sequence 192.168.221.105 allports 192.168.221.106 slots 1-6 -type 1+2 -pm phy -s -dur 20
```

The above command also routes results to the standard spreadsheet report and it runs the stress test for 20 minutes.

In one more example, the Multi-Port Resources are pre-configured with st_config, then the Multi-Port Sequencer is used just to run the mp_class_admit test with output to PowerShell window:

```
PSA-1,1> st_config 192.168.221.105 allports 192.168.221.106 allports
PSA-1,1> mp_sequence -cfgok -t {mp_class_admit} -type 1+2 -pm phy
```

The (second generation) **PSE Multi-Port Test Suite** will only be available to a Multi-Port Resource Configuration that includes exclusively PSA-3xxx test ports. (*Any PSA chassis' with older PSA-1200 test blades will be rejected*.)

5.23.5. PowerShell PSA: Multi-Port Utility Commands

Several specialized support commands are provided in PowerShell PSA to pre-configure PowerShell for Multi-Port testing as well as to facilitate unique Multi-Port operations. Certain commands are generally used only by Multi-Port test scripts and/or the Multi-Port sequencer script, however, they may have potential use in other applications such as high speed multi-chassis PSE testing. These are described below.

Command	Command Parameters
st_wait	*wait_time*
	Command to cause program pauses in increments of seconds. Command will allow updates to the PowerShell window during the delay period and should be used in place of Tcl after command for long program delays. *wait_time* Time to wait in seconds.
mp_calc_cable_loss	*powerLevel* <**PSE** | **PD**> <**-type 1** | **2**>
	Utility accepts a power level (watts) and determines the maximum possible power lost in the cable. Power is specified either at the PSE or PD interface. *powerLevel* Power in watts that either the PD is consuming or the PSE is sourcing. Range is 0.5 to 34.5 watts. **PSE** Specify that *powerLevel* provided is at the PSE output (Default). **PD** Specify that *powerLevel* provided is at the PD input. **-type 1** Cabling system is a Type-1 (20Ω) round-trip pair resistance. **-type 2** Cabling system is a Type-2 (12.5Ω) round-trip pair resistance. Default cabling system is determined by the PowerShell global psaPseHpGrant *(see Section 5.4)*
mp_power_port	<**c** *class*> <**lldp** <**-req** *pwrRequest*>> <**timeout** *maxTime*> <**-maintain**>
	Attempts to bring all ports within a previously established **Multi-Port Resource Configuration** (*see Section 5.23.2*) to a powered state at specified class and, if applicable, LLDP power demand, while drawing minimal power of approximately 1 watt per powered port. Utilizes Multi-Port Live PD Emulation (*see Section 5.23.3* to perform this task. Returns status information including: **Count of Powered Ports, List of Intermittent Ports, List of Unpowered Ports, and List of <u>Powered</u> Un-Granted Ports.** *class* PD Classification to emulate on all test ports. Range is 0 to 4. Default is Class 0. **lldp** Conduct LLDP negotiations following power-up on each port. Command will not return until all negotiations on all ports are completed timeout occurs. *pwrRequest* Given LLDP power-up, request a user-specified power demand on every powered port. Range is 0.5 to 25.5 watts. Default is the maximum PD power request for the specified (or default) PD *class*. (NOTE: *Actual load power will remain at approximately 1 watt regardless of PD request.*) *maxTime* Maximum time to wait for all ports to power, and if using LLDP, to grant requested power levels across all ports in the Multi-Port Resource Configuration. Range is 15 to 120 seconds. Default is 35 seconds. **-maintain** Continue Multi-Port Live PD Emulation indefinitely after the command returns. Default is to discontinue Live PD Emulation on all test ports, leaving those ports in a powered state with LLDP protocol, if specified, still active.

Command	Command Parameters
mp_load_pse	<**c** *class*> **p** *totPwr* <**max** *portCount*> <**lldp** <**-req** *pwrRequest*>> <**timeout** *maxTime*> <**-maintain**>
	Attempts to bring ports within a previously established **Multi-Port Resource Configuration** (*see Section 5.23.2* to a powered state at specified class and, if applicable, LLDP power demand, while drawing a user-specified total power load spread across the powered ports. Utilizes Multi-Port Live PD Emulation (*see 5.23.3*) to perform this task. Returns status information including: **Count of Powered Ports, Total PSE Power, Power-Up Attempts, Powered (& Granted if LLDP) Chassis-Port List**. *This command differs from* **mp_power_port** *because it can operate on a subset of the Multi-Port Resource Configuration and it powers up to a user-specified total power target rather than 1watt per port.* *class* PD Classification to emulate on all test ports. Range is 0 to 4. Default is Class 0. *totPwr* Total power to draw from PSE. This is a required argument. Maximum allowed power load is 34.5 watts x Number of Ports (in M-P Resource Configuration or *portCount*). Example: Powering a 24 Port PSE to 18 watts per port: 24 x 18 = 432 watts. *portCount* A non-default count of ports to power. By default, command will attempt to power all ports in a Multi-Port Resource Configuration. If *portCount* is specified, it will attempt to power just the first *portCount* ports within that configuration to *totPwr* load. **lldp** Conduct LLDP negotiations following power-up and prior to target load application on each port. Command will not return until all negotiations on all ports are completed timeout occurs. *pwrRequest* Given LLDP power-up, request a user-specified power demand on every powered port. Range is 0.5 to 25.5 watts. Default is the maximum PD power request for the specified (or default) PD *class*. (NOTE: *Actual load power will remain at approximately 1 watt regardless of PD request.*) *maxTime* Maximum time to wait for all ports to power, and if using LLDP, to grant requested power levels across all ports in the Multi-Port Resource Configuration. Range is 15 to 120 seconds. Default is 35 seconds. **-maintain** Continue Multi-Port Live PD Emulation indefinitely after the command returns. Default is to discontinue Live PD Emulation on all test ports, leaving those ports in a powered state with LLDP protocol, if specified, still active.
mp_shutdown	<**-discharge**>
	Disconnects and powers down all test ports within a previously established **Multi-Port Resource Configuration** (*see 5.23.2*). My be used to terminate Multi-Port Live PD Emulation running on a Multi-Port Resource Configuration from the **mp_emulate_pd** command. Command will have no impact to any ports that are outside the Multi-Port Resource Configuration. (Command is aliased to the **st_disconnect** command for backwards compatibility.) **-discharge** Actively discharge voltage from all PSE ports that have power removed.
mp_disconnect	
	Removes PD detection signatures from all test ports within a previously established **Multi-Port Resource Configuration** (*see 5.23.2*). This assures that when any of these ports remove power, for example, given an overload shutdown, they will not attempt to power-up again.
mp_scan_state	<*Resource_List*>
	Utility uses Multi-Port Live PD Emulation to scan the powering states of a set of ports and reports all ports that are not in a powered state. By default, the command surveys all ports in a previously established **Multi-Port Resource Configuration** (*see 5.23.2*). Command returns with **Count of Unpowered Ports** and **List of Unpowered Ports**. *Resource_List* A list of chassis addresses and test ports to survey instead of the default case where every port in Multi-Port Resource Configuration is surveyed. Example: “192.168.221.105 {1,1 1,2 2,1 2,2} 192.168.221.106 {1,1 1,2 2,1 2,2}”.
trig_port _check	
	Evaluates inter-PSA chassis trigger port connections in a Multi-Port Resource Configuration that is using PowerSync Analyzers. Inter-chassis triggering is required for the **mp_trans_cap** test and for timing measurements performed during **mp_discx_time** and **mp_overld_time** tests. *Not applicable when using PSL-3000's.*

6. PSE Conformance Test Suites (2-Pair, 4-Pair PSE's)

The PSA-3000 supports an optional 2-Pair PSE Conformance Test Suite for 802.3at Type-1 and Type-2 PSE's. This test suite requires one or more PSA-3102 test blades, PSA-3202 test blades, PSA-3002 Compact PSA, or the PSA-3402 Compact PSA.

Separately, the PSA-3000 supports an optional 4-Pair PSE Conformance Test Suite for 802.3bt Type-3 and Type-4, 4-Pair powering PSE's. This test suite requires one or more PSA-3202 test blades or the PSA-3402 Compact PSA.

The two test suites are provided under two independent license options meaning that one or both test suites may be enabled within a PSA-3000 instrument.

6.1. 2-Pair PSE Conformance Test Suite Overview

The 2-Pair PSE Conformance Test Suite for the PowerSync Analyzer comprises a set of **802.3at** (IEEE 802.3 clause 33.2) specification conformance tests that are designed to evaluate specific characteristics of conforming 802.3at power sourcing equipment (PSE). The suite also supports conformance testing of **802.3bt**, **Type-3**, **2-Pair** PSE's. The test suite runs over the PowerShell PSA System API for the PowerSync Analyzer. The test suite may also be accessed from PSA Interactive graphical user interface software for the PowerSync Analyzer.

The **5.x.xx** 2-Pair PSE Conformance Test Suite is Sifos' second generation automated test suite for PSE specification compliance testing and should be applied to any and all PSE's that claim IEEE **802.3at** or **802.3bt** (2-Pair) conformance.

6.1.1. PSE Types Covered by the 2-Pair PSE Conformance Suite

The **5.x.xx** 2-Pair PSE Conformance Test Suite is designed to fully test any of the following PSE types described in the IEEE 802.3at specification:

- Any Type-1 (15.4W) 802.3at compliant PSE with or without PoE LLDP mutual identification
- Any Type-2 (30W) 802.3at compliant PSE with 2-Event (PHY) Classification
- Any Type-2 (30W) 802.3at compliant PSE with PoE LLDP mutual identification
- Any Type-3 (15.4W) 802.3bt compliant PSE with or without LLDP mutual identification
- Any Type-3 (30W) 802.3bt compliant PSE with 2-Event or 3-Event (PHY) Classification
- Any Type-3 (30W) 802.3bt compliant PSE with PoE LLDP Classification

As of **PSA 5.3** and later versions of PSA software, all **Type-1**, **Type-2**, and **Type-3** (2-Pair) PSE's can be fully tested in a single pass of the 802.3at PSE Conformance Test Suite with all test results produced to a single test report.

Important! The 2-Pair PSE Conformance Test Suite relies on proper configuration of certain critical PSE attributes. These include:

- Powered pairset (**Alt-A** or **Alt-B**)
- Powering polarity (**MDI** or **MDI-X**)
- High Power Grant Method (**NONE** for 15W PSE's and **PHY**, **LLDP**, or **PHY+LLDP** for 30W PSE's)
- MPS Method (**DC** or **AC**)

PSE attributes are configured in the **PSE** tab menu of PSA Interactive (*see Section 4.2*) where they may be stored and later retrieved from PSE attribute files (*see Section 3.2.4*). Many PSE attributes, including powered pairset, polarity, and MPS method can be automatically discovered using **Auto Discover** in PSA Interactive (*see Section 4.2.2*) or the **psa_auto_port** command in PowerShell PSA software (*see Section 5.11*). In PowerShell PSA software, the **psa_pse** command (*see Section 5.7*) is used to configure and retrieve previously stored PSE attributes.

See also Sifos application note **Before You Run PSE Conformance Test.pdf** for a general overview of PSE attributes essential to PSE conformance testing.

6.1.2. 2-Pair PSE Conformance Suite Adaptability

The PSE Conformance Test Suite has been engineered to accommodate the generality included within the 802.3 Power over Ethernet specification. 802.3at and 802.3bt provide guidelines and ranges for various signaling amplitudes and timing. However, it does not strictly describe all signals utilized in detecting, classifying, and connection-checking thus placing burden on test methods to adapt to vendor-specific implementations of the specification. PSE variants covered by the **PSE Conformance Test Suite** include various forms of pre-detection (pre-qualification), zero back-off / rapid back-off detection, and integrated (interlaced) 802.3 - legacy (or capacitive) detection schemes.

The conformance tests that comprise the test suite may be sequenced in arbitrary order on arbitrary groups of PSE ports using the sequencing facilities described above in sections 4.8 and 5.16. The API command **psa_tests** will return a list and brief description of PSE Conformance Tests available in PowerShell PSA.

6.2. 4-Pair PSE Conformance Test Suite Overview

The 4-Pair PSE Conformance Test Suite for the PowerSync Analyzer comprises a set of **802.3bt** (IEEE 802.3 clause 145.2) specification conformance tests that are designed to evaluate specific characteristics of conforming 802.3bt power sourcing equipment (PSE). The test suite runs over the PowerShell PSA System API for the PowerSync Analyzer. The test suite may also be accessed from PSA Interactive graphical user interface software for the PowerSync Analyzer.

The **5.x.xx** 4-Pair PSE Conformance Test Suite is Sifos' first generation automated test suite for 4-Pair PSE specification compliance testing and should be applied to any and all PSE's that claim IEEE **802.3bt** (4-Pair) conformance. The test suite is considerably larger and more complicated than the 2-Pair test suite owing to the vastly expanded behavioral characteristics of 4-Pair PSE's under the 802.3bt specification. To put this in perspective, the PSE state machine for a 2-Pair PSE is 1½ pages and the PSE state machine for a 4-Pair PSE fills 15 pages!

6.2.1. PSE Types Covered by the 4-Pair PSE Conformance Suite

The **5.x.xx** 4-Pair PSE Conformance Test Suite is designed to fully test any of the following PSE types described in the IEEE 802.3at specification:

- Any Type-3 (45W or 60W) 802.3bt compliant PSE that uses Multi-Event (PHY) Classification to allocate full power to a PD at power-up
- Any Type-3 (45W or 60W) 802.3bt compliant PSE that uses PoE LLDP mutual identification to allocate full power to a PD after power-up
- Any Type-4 (75W or 90W) 802.3bt compliant PSE that uses Multi-Event (PHY) Classification to allocate full power to a PD at power-up
- Any Type-4 (75W or 90W) 802.3bt compliant PSE that uses PoE LLDP mutual identification to allocate full power to a PD after power-up

The 4-Pair PSE Conformance Test Suite automatically assesses the maximum power grant a PSE is capable of and automatically conditions all of the tests to work within the PSE capabilities. Hence, all conformance testing is completed in a single sequence of tesing.

Important! The 4-Pair PSE Conformance Test Suite relies on proper configuration of certain critical PSE attributes. These include:

- Powering polarity on each pairset (**MDI** or **MDI-X**)
- High Power Grant Method (**NONE** for 15W PSE's and **PHY**, **LLDP**, or **PHY+LLDP** for PSE's that support 30W or higher powering)
- Minimum 4-Pair Class (the minimum PD class, 1, 2, 3, 4, or 5, that gets 4-Pair powered)

PSE attributes are configured in the **PSE** tab menu of PSA Interactive (*see Section 4.2*) where they may be stored and later retrieved from PSE attribute files (*see Section 3.2.4*). Many PSE attributes, including pairset polarity and minimum 4-pair class, can be automatically discovered using **Auto Discover** in PSA Interactive (*see Section 4.2.2*) or the **psa_auto_port** command in PowerShell PSA software (*see Section 5.11*). In PowerShell PSA software, the **psa_pse** command (*see Section 5.7*) is used to configure and retrieve previously stored PSE attributes.

See also Sifos application note **Before You Run PSE Conformance Test.pdf** for a general overview of PSE attributes essential to PSE conformance testing.

6.2.2. 4-Pair PSE Conformance Suite Adaptability

The 4-Pair PSE Conformance Test Suite must adapt to the wide range of PSE behaviors allowed under the 802.3bt specification. This includes variations in the means by which PSE's deem that PD's can receive 4-pair power (4-pair ID) and variations in PD classification behaviors. The standard also allows that 4-pair PD's can utilize 2-pair powering to 802.3at (Class 0-4) PD's and further, that 4-Pair PSE's might move into and out of 4-pair powered states while powering those PD's.

Further, some parameters within 802.3bt are only pertinent to PSE's that exhibit certain optional behaviors. The 4-Pair PSE Conformance Test Suite is designed to recognize these situations automatically, then measure and report those parameters accordingly.

Unlike the 2-Pair PSE Conformance Test Suite, the 4-pair suite does benefit from specification limitations in 802.3bt that did not exist in 802.3at. These include the fact that all PSE's must classify PD's in 802.3bt and that the only method for PD disconnect processing is DC MPS. Practically speaking, PSE controllers developed for 802.3bt are less likely to deploy and inter-mix proprietary detection schemes for older pre-802.3 PD types.

6.3. Operating Conditions and Requirements

The PSE Conformance Test Suites rely on real-time LAN connection performance between a host (PC) computer and the PowerSync Analyzer chassis. See section 3.3 for further information regarding this critical requirement.

It is strongly recommended that any devices connected to PSA Test Port "**THRU**" (or "**OUT**") ports be removed before performing PSE Conformance Tests. Certain PSE Conformance Test parameters can be affected by interactions between PSE port signaling and EMI terminations found on many LAN ports that were not designed for PoE compatibility. Generally, Sifos Technologies does not recommend performing PSE Conformance Tests simultaneously with LAN data traffic because PSE Conformance Testing requires many PoE power cycles that can disrupt that LAN data traffic severely.

Finally, by default, PSE Conformance Testing is performed on just one PSE port at a time. The IEEE 802.3 PoE standards do not define PSE behaviors beyond a single-port PSE meaning that PSE conformance issues that arise only the presence of powering activities on adjacent PSE ports are not clearly resolvable as problems under the specification. Users may use the **sequence** command in PowerShell (*see Section 5.20*) to override this restriction, though it is generally recommended that testing be performed one port at a time.

6.4. Global PSE Description Parameters

PSE Conformance Test Suites rely upon several "global" parameters (or declarations) that describe each PSE port. These "global" declarations, or settings, were introduced earlier in sections 3.2.4 and 5.5. Using this information, a test suite automatically adapts and optimizes testing for accuracy and coverage.

Test Suite	Property	Powershell PSA Global Parameter	Definition	Value Range
2-Pair	Powered Pairsets	**psaDefaultAlt**	Defines whether PSE uses Alt-A or Alt-B pairs for power. Used in test limit processing.	A or B
2-Pair 4-Pair	Powering Polarity	**psaDefaultPol**	Defines whether PSE is powering each pairset with negative or positive polarity. Type-4 PSE's are required to apply MDI-X on Alt-A and MDI on Alt-B (MDI-X+MDI).	MDI+MDI or MDI-X+MDI or MDI-X+MDI-X or MDI+MDI-X
2-Pair	PSE MPS Method	**psaPseMps**	Defines whether the PSE port utilizes the AC or DC method of "Maintain Power Signature" – the disconnection detection method. This must be defined to enable the proper test suite and power-down methods.	AC or DC
2-Pair 4-Pair	Maximum Power Grant Method	**psaPseHpGrant**	Defines how a PSE port allocates it's maximum power capacity. Many PSE's use Multi-Event Classification to do this prior to power-up. Some PSE's only grant low power at power-up, then use LLDP to negotiate to maximum available power with the PD. Further, some PSE's use Multi-Event at power-up to grant full power, but then utilize LLDP after power-up to refine the PD demand to something less than was initially allocated at power-up. **Important!** It is essential that users properly declare this PSE attribute.	NONE or PHY or LLDP or PHY+LLDP
4-Pair	PSE 4-Pair Type	**psaPse4prType**	This declaration affects some limit processing and other specific test decisions within the 4-Pair test suite. The 4-Pair test suite expects the declaration to be Type-3, Type-4, Type-3_ac, or Type-4_ac. Type-n_ac is used to declare that a PSE is autoclass capable. (**Note**: *If this parameter is not properly declared, the test suite will try to automatically correct that.*)	NONE or NONE_ac Type-3 or Type-4 or Type-3_ac or Type-4_ac
4-Pair	Minimum PD Class that gets 4-pair Power	**psaPseMin4prClass**	This declaration indicates the minimum PD class that will get 4-pair powering. 4-Pair PSE's have the option to power Class 0-4 PD's using either 2-Pair or 4-Pair power. This parameter also affects certain test decisions and limit processing. (**Note**: *If this parameter is not properly declared, the test suite will try to automatically correct that.*)	1 or 2 or 3 or 4 or 5

Two PSE characteristics that require PSA-3000 test port configuration prior to running PSE Conformance Tests are:

- **Powered Pairsets**: The PowerSync Analyzer must be pre-configured to the proper powered pairs by the user prior to executing the PSE Conformance Test Suite. For 2-Pair PSE's, this means configured to **Alt-A** or **Alt-B** with the test port 4-Pair connection **disabled**. For 4-Pair PSE's, this means to **enable** the 4-Pair connection.

- **Powering Polarity**(s): The PowerSync Analyzer must be pre-configured to the proper polarity (positive **MDI**, or negative **MDI-X**) by the user prior to executing the PSE Conformance Test Suite. In a 4-Pair test port configuration, there is a polarity setting for each pairset, Alt-A and Alt-B. A setting of **MDI-X+MDI** means MDI-X on the Alt-A pairset and MDI on the Alt-B pairset.

These two settings are associated with a particular PSE and can be automatically configured to all ports in a PowerSync Analyzer chassis through the creation and loading of **PSE Attribute Files** described previously in section 3.2.4 and 4.2. The ALT and Polarity settings as well as the MPS Method can be automatically "discovered" using the **Auto-Discover** (or **MPS Find**) facility described previously in sections 4.2.2 and 5.11.

6.5. The 2-Pair PSE Conformance Suite Tests

6.5.1. Documentation Conventions

Each of the tables in the following section will specify the test name, test parameters, control, and test processing for each of the version **5.x.xx** 2-Pair PSE Conformance Tests that comprise the test suite. Parameters in **dark blue** are 802.3 parameters produced for all PSE's. Parameters in **teal** are produced for all Type-2 and Type-3 (30W capable) PSE's. Parameters in **light brown** are produced for only Type-3 (802.3bt) PSE's. Parameters in **grey** are informational parameters that either cannot be reliably tested or are outside the 802.3 specification and therefore cannot cause conformance failures.

The standard **psa_report.xlsm** spreadsheet report for the PSE Conformance Test Suite will process well-specified 802.3at (and 802.3bt 2-Pair) parameters as **Pass/Fail**. This report will apply a **Pass/Info** criteria to tests that assess behaviors that are vaguely specified in 802.3 or that are indeterminate in terms of specification compliance without internal knowledge of the PSE design. The following tables will shade Pass/Info Acceptance Criteria in grey.

6.5.2. 2-Pair PSE Conformance Tests – Detection Processes

Detection tests will automatically adapt to PSE detection signaling characteristics as well as non-802.3 proprietary signaling that may be present. When detection tests are sequenced, the first test executed on a given PSE port will perform a complex set of measurements to enable subsequent adaptive logic decisions made by all detection and classification tests to address unique PSE signaling and detection / classification response behaviors.

Detection tests other than **det_range** are insensitive to whether PSE's are Type-1 (15.4W), Type-2 (30W) or Type-3 (802.3bt 2-Pair). They are all insensitive to PSE methods of granting Type-2 high power and to PSE disconnect detection (MPS) method.

det_v	**Detection Pulse Waveform Parameters**	**Pwr Type** Ignored	**30W Grant** Ignored	**MPS** Ignored
	Parameter	**Definition**		**Acceptance Range**
Measurements	**Open_Circuit_Voc**	Peak open circuit (disconnected) detection voltage		< 30 VDC
	Peak_Det_Vvalid	Maximum Detection Step Level with Valid Signature		≤ 10 VDC
	Min_Det_Vvalid	Minimum Detection Step Level with Valid Signature		≥ 2.8 VDC
	Det_Volt_Step_dVtest	Detection Step Magnitude		≥ 1 V
	Detection Slew	Detection step slew rate		≤ 0.1 V/µsec
	Good_Sig_Det_Pulse	Number of Detection Signal transitions		≥ 1
	Backoff_Voltage	Minimum Voltage during detection (ALT B) backoff		< 2.8 V
	Non802_Discr?	Dependence upon Non-802 detection for validity. PSE's that use non-802.3 detection measurements to resolve a valid signature band will report "1".		= 0
	Detect Strategy	Reports PSE Detection as one of five known strategies including 802.3at standard, proprietary pre-detection, etc.		0, 1, or 2
PowerShell Control Options	**Det. Resistance KΩ**	**Det. Capacitance µF**	**Controls**	
	9 to 39	**0, 5, 7, or 11**	**valid**	
Description	This test captures and analyzes PSE detection signaling voltages with both valid and slightly non-valid detection signatures. It uses PSE Conformance Test adaptive methods analyze detection signaling and to tightly resolve detection steps, transitions between steps, as well as presence of signals (and PSE measurements) that are outside the 802.3at specification. **det_v** will adapt to a wide variety of proprietary pre-detection and hybrid 802.3+legacy detection schemes.			
Waveform Display	Valid Signature and High Signature traces are captured and retained during this test.			
Approximate Time	45 – 80 seconds per port (includes PSE pre-characterization)			

det_i	**Detection Current Limiting**		**Pwr Type** Ignored	**30W Grant** Ignored	**MPS** Ignored
	Parameter	**Definition**		**Acceptance Range**	
Measurements	**Init_Current_Isc=**	Max detection current at minimum detection voltage (I_{sc})		< 5 mA	
	Det_Current_Isc=	Max detection current during detection (I_{sc})		< 5 mA	
Description	Test performs a low voltage slew rate measurement on the leading edge of the first detection pulse following the attachment of fully discharged detection passives. Detection passives consist of a relatively large capacitance and the maximum out-of-band resistance. The test must assume that detection waveform will vary above 2.8 Volts and must work around non-802.3at measurement pulses that might be present on the PoE connection. Care must be taken to assure zero charge on the detection capacitance prior to each slew rate measurement and to compensate out any load resistance.				
Waveform Display	Two or more voltage traces of detection pulses with capacitive signature loading are captured and retained.				
Approximate Time	18 – 22 seconds per port				

det_range	**Detection Passive Acceptance Range**		**Pwr Type** PD Class	**30W Grant** Ignored	**MPS** Ignored
	Parameter	**Definition**		**Acceptance**	
Measurements	**Rgood_Max**	Maximum accepted detection resistance signature. (R_{good_max})		≤ 32 KΩ	
	Rgood_Min	Minimum accepted detection resistance signature. (R_{good_min})		≥ 16 KΩ	
	Rmid_det	MAX (or MIN) detection resistance producing successful detection when detection signatures are connected midway in a detection cycle.		16 KΩ to 32 KΩ	
	Cgood_Max	Maximum accepted detection capacitance signature. Signatures applied are 11.1, 7.1, 5.1, and 0.1 µF. (C_{good_max}, C_{bad_min})		0.1 µF to 7.1 µF	
	Rbad_Cbad_Stat	Power-Up status given a 35Kohm (marginally high) resistive signature with the lowest Capacitive signature *rejected* by the PSE. Determines if capacitance can trick the detection measurement.		=0 (1 means the PSE applied power)	
PowerShell Control Options	**PD Class**	**Max. Wait Time**			
	0 - 4	**2 to 30 seconds**			
Description	The det_range test seeks to determine the threshold resistance levels leading to successful detection. It uses a resistance hunting algorithm to rapidly converge on the threshold resistances while allowing (by default) up to 15 seconds per signature to resolve unsuccessful detections. The Max_Wait_Time parameter can be used to set the time duration used to assess a failed detection – reducing this will reduce test time. Measurements are designed to ignore any pre-detection or legacy pulses and will work with both AC MPS and DC MPS type PSE ports.				
Waveform Display	NONE				
Approximate Time	131 – 152 seconds per port				

det_time	**Detection Timing**		**Pwr Type** Ignored	**30W Grant** Ignored	**MPS** Ignored
	Parameter	**Definition**		**Acceptance**	
Measurements	**Backoff_Time_Tdbo**	Measured backoff time during IDLE condition with invalid detection signature. Max allowed is 16 seconds only because other tests are won't tolerate >16 second backoff between detections. (T_{dbo})		> 2 seconds for ALT B PSE's	
	Eff_Backoff_Tdbo_eff	Effective backoff time measured as time from end of a rejected signature until start of detection signature preceding a power-up given application of a valid signature. (T_{dbo})		> 2 seconds for ALT B PSE's	
	Detection_Time_Tdet	802.3at detection time duration (T_{det})		5 to 500 msec	
	Total_Det_Time	Total detection time including pre-detection measurements		5 to 1000 msec	
	Backoff_Type	0= **Standard**: No legacy or capacitive detections 1= **Non802_Pulses**: Legacy or proprietary low voltage detection found. 2= **50V_Pulses**: Legacy or proprietary high voltage detection found. 3= **PoH** Double-Detection Scheme		=0	
PowerShell Control Options	**det_R (KΩ)**				
	11 - 39				
Description	The test first analyzes detection backoff and must accommodate backoff behaviors ranging from 0 msec (or zero-backoff) out to over 12 seconds (e.g. long legacy detections). The test uses PSE Conformance Test adaptive methods to determine backoff and also for resource configuration and synchronization required to measure Tdet parameters. Tdet is measured through complex trace analysis. Detection resistance may be specified for Tdet measurement. The test needs to work around any non-802.3at signaling discovered on the test port.				
Waveform Display	One or more traces to analyze Tdet are captured and retained.				
Approximate Time	6 to 12 seconds per port				

det_rsource	**PSE Output Resistance during Detection**		**Pwr Type** Ignored	**30W Grant** Ignored	**MPS** Ignored
	Parameter	**Definition**		**Acceptance Range**	
Measurements	PSE_Detect_Source	Flag indicating if PSE uses current or voltage detection probe		0 or 1	
	Output_Impedance_Zout	Current probe output impedance during detection (Z_{source})		≥ 45 KΩ	
Description	The test measures PSE Detection Step magnitude response to various PD detection signatures (resistive loads) to assess effective source impedance of the PSE during detection. PSE's that utilize current sources or high impedance voltage sources for detection signature measurements should enable an effective source impedance measurement that is typically above 45KΩ. PSE's that use regulated voltage steps will be reported as such and will produce a very low Zout. The test limit is >45KΩ or <12KΩ to accommodate both types of PSE's. The test limit is applied as a soft (informational) limit because all PSE's may include a series blocking diode in their output which in turn allows for any Zout value. The Zout measurement alone cannot detect the presence of such a diode though the Rp measurement in the pwrdn_time test coupled with the Zout measurement may be able to infer the presence of absence of this diode.				
Waveform Display	Detection Voltages in response to Varying Detection Signatures will be captured and retained.				
Approximate Time	25 – 30 seconds per port				

6.5.3. 2-Pair PSE Conformance Tests – Classification & Mutual Discovery Processes

Classification tests can be sensitive to whether 802.3 PSE's are Type-1, Type-2, or Type-3 and may also get varying results depending upon whether PD emulation is Class 0-3 or Class 4. **class_v**, **class_time**, and **class_err** also pay attention to the specified **30W Grant** method (PHY vs LLDP) and **class_lldp** will only run with LLDP-capable PSE's.

Default sequences will utilize PD Class 0 emulation for Type-1 PSE's and both Class 0 and Class 4 for Type-2/3 PSE's.

class_v	**Classification Voltages**		**Pwr Type** I_class	**30W Grant** PHY | ! PHY	**MPS** Ignored
	Parameter	**Definition**		**Acceptance Range**	
Measurements	**Vclass_Max**	Class Pulse Average Voltage with 1 mA (default) class signature		15.5 to 20.5 Volts	
	Vclass_Min	Class Pulse Average Voltage with 43 mA class signature		15.5 to 20.5 Volts	
	Mark_Voltage_Vmark	Mark Region Voltage with 4 mA mark signature load		7 to 10 Volts	
	Mark_Voltage_Min	Minimum Port Voltage measured over both MARK regions		7 to 10 Volts	
	Class_Reset_V	Class Probe Reset Voltage (*if class probe present*)		-1 to 2.8 Volts	
PowerShell Control Options	**Vclass_Max current**	**Mark Current (mA)**			
	0 – 45	**0 - 5**			
Description	This test uses PSE Conformance Test adaptive methods to accurately synchronize to and capture the final classification pulse that precedes a power-up. The test automatically decides if PSE is using Single Event or Multi-Event classification, and measures Classification Voltage level and Mark Voltage level if the PSE uses Multi-Event classification. Measurements depend upon PSE ability to apply power given valid detection and class signatures.				
Waveform Display	One or more traces to isolate and process the final classification pulse(s) preceding power-ups are retained.				
Approximate Time	12 – 35 seconds per port, Type-2/3 PSE's take longer				

class_time	**Classification Timing**		**Pwr Type** I_class	**30W Grant** PHY | ! PHY	**MPS** Ignored
	Parameter	**Definition**		**Acceptance Range**	
Measurements	**Class_0_Count**	Count of class pulses to a Class 0 PD		Type-1 PSE 0 to 2	
	Class_4_Count	Count of class pulses to a Class 4 PD		Type-2 PSE 1 to 2 Type-3 PSE 1 to 3	
	Class_Time_Tpdc	Duration of class pulse given Single-Event 802.3at Classification		6 to 75 msec	
	Event1_Tcle1	Duration of first class pulse given 802.3at Multi-Event Classification		6 to 30 msec	
	Event1_Tlce	Duration of first (elongated) class pulse		88 to 105 msec	
	Event2_Tcle2	Duration of second* class pulse given Multi-Event Classification		6 to 30 msec	
	Mark_Tme1	Duration of first mark interval given Multi-Event Classification		6 to 12 msec	
	Mark_Tme2	Duration of final mark interval given Multi-Event Classification		6 to 376 msec	
	Class_Reset_Time	Duration of IDLE time after class probe (*if class probe present*)		≥ 15 msec	
	Class_Probe_Events	Type-3 PSE"s only: If PSE performs an 802.3bt class probe, this is the event count of the class probe. Otherwise reports -1.		0 to 3	
PowerShell Control Options	**Class Current (mA)**	**Mark Current (mA)**			
	0 – 45	**0 - 5**			
Description	This test uses PSE Conformance Test adaptive methods to accurately synchronize to and capture the final classification pulse that precedes a power-up. The test automatically decides if PSE is using Single Event or Multi-Event classification, and measures Classification Pulse Time(s) and Mark Region Times if the PSE uses Multi-Event classification. Measurements depend upon PSE ability to apply power given valid detection and class signatures.				
Waveform Display	One or more traces to isolate and process the final classification pulse(s) preceding power-ups are retained.				
Approximate Time	12 – 35 seconds per port, Type-2/3 PSE's take longer				

class_err	**Classification Current Limiting**		**Pwr Type** / **PD Class**	**30W Grant** / **PHY | !PHY**	**MPS** / **Ignored**
	Parameter	**Definition**		**Acceptance Range**	
Measurements	**Class_lim**	Maximum Class Current before PSE starts to limit Class Current. (I_{class_LIM})		51 to 100 mA.	
	Pwr_Cl_lim	PSE Power-Up Response to Class Signature= Class_lim. 0= No Power-Up, 1= Power-Up.		Type-1 PSE 0 or 1 Type-2 PSE 0	
	Pwr_Cl_55	PSE Power-Up Response to Class Signature= 55mA. 0= No Power-Up, 1= Power-Up.		Type-1 PSE 0 or 1 Type-2 PSE 0	
	Mark_Lim	Minimum Mark Current Supported during 2-event Mark Region. Tested at 5.5 mA and 105 mA given 2-Event Classification. (I_{mark_LIM})		5 to 100 mA.	
	Pwr_cl_Uneven	Power-Up Response to 2-level classification of 40 mA on event 1 and 18.5 mA on event 2 given several cycles of 2-Event Classification. 0= No Power-Up, 1= Power-Up.		Type-1 PSE 0 or 1 Type-2 PSE 0	
	Treset	Duration of IDLE region (< 2.8V) following classification given the uneven class signature given 2-Event Classification. (T_{Reset})		> 15 msec	
PowerShell Control Options	**PD Class** **0 – 4**				
Description	The class_err test assesses what, if any, limits a PSE places on Classification current and in the event of 2-event classification, on Mark region current. The test also evaluates the port powering (or state machine) response when invalid levels of Classification load current are applied including an asymmetrical load current on a 2-event classification pulse. The three 2-event classification measurements are only performed on PSE's with 30W Grant type= PHY.				
Waveform Display	Two or more load current traces to assess PSE classification current levels given various loads are captured and retained. Current limited states will show up as low current and current oscillations in traces.				
Approximate Time	29 - 50 seconds per port, Type-2/3 PSE's take longer				

class_lldp	**LLDP Protocol and Mutual Discovery Analysis**		**Pwr Type** / **PD Class**	**30W Grant** / **LLDP | ! LLDP**	**MPS** / **Ignored**
	Parameter	**Definition**		**Acceptance Range**	
Measurements	**PSE_Source_Priority**	Bit Field for PSE Source, Priority, Reserved		= 0	
	PSE_MDI_Pwr_Sup	Bit Field from legacy TLV for Port Class, MDI Power Support, MDI Power State, Pair Selection, and Reserved		= 0	
	PSE_LLDP_Time_1	Time from Power-On to first PoE LLDP frame from PSE to Type-1 PD		≤ 30 seconds	
	PSE_LLDP_Type_1	PSE Type advertised by a PSE given Class 0-3 PD signature		1 or 2	
	PSE_Echo_Time_1	Time for PSE to echo back the PD Requested Power level		≤ 10 seconds	
	PSE_Alloc_Pwr_1	Allocated Power in response to 8.1 W PD Request from a Class 0–3 PD		8.1 to 13 W	
	PSE_Alloc_Time_1	Time to respond To 8.1 W PD Request with Power Allocated		≤ 30 seconds	
	PD_Power_Adjust_1	Allocated Power in response to a Change Request from 8.1W to 13W		= 13 W	
	PSE_Adjust_Time_1	Time to echo a PD 13 watt PD Change Request		≤ 10 seconds	
	PSE_LLDP_Time_2	Time from Power-On to first PoE LLDP frame from PSE to Type-2 PD		≤ 10 seconds	
	PSE_LLDP_Type_2	PSE Type advertised by PSE given Class 4 PD signature		= 2	
	PSE_Echo_Time_2	Time for PSE to echo back the PD Requested Power level		≤ 10 seconds	
	PSE_Alloc_Pwr_2	Allocated Power in response to 20.3W PD Request from a Class 4 PD		20.3 to 25.5 W	
	PSE_Alloc_Time_2	Time to respond To 20.3 W PD Request with Power Allocated		≤ 30 seconds	
	PD_Power_Adjust_2	Allocated Power in response to Change Request from 20.3W to 25.5W		= 25.5 W	
	PSE_Adjust_Time_2	Time to echo a PD 25.5 watt PD Change Request		≤ 10 seconds	
	Link_Down_Shutdown_?	Indicates if power removed on Link Drop after LLDP negotiation		= 0	
	PSE_Alloc_Pwr_bt_tlv_1	PSE ability to allocate using 802.3bt TLV's with Class 3 PD		1 or 2	
	PD_Power_Adjust_bt_tlv_1	PSE ability to adjust power using 802.3bt TLV's with Class 3 PD		1 or 2	
	PSE_Alloc_Pwr_bt_tlv_2	PSE ability to allocate using 802.3bt TLV's with Class 4 PD		1 or 2	
	PD_Power_Adjust_bt_tlv_2	Bit Field for PSE Source, Priority, Reserved		1 or 2	
PowerShell Control Options	**PD Class** **0 – 4**	**Initial Request Power** **1 – 25.5**			
Description	The class_lldp test first assesses the first PSE LLDP transmitted packet following a power-up using the specified (or default) PD Classification, measuring control fields and packet timing. The test then uses the High Power Grant Method declaration (**NONE** or **LLDP**) to emulate LLDP Power-Ups for Type-1 and, if **LLDP**, Type-2 PD's requesting 8.1 watts for Type-1 and 20.3 watts for Type-2. LLDP tracing is used to capture and time PSE responses to the initial PD requests. Finally, if requested power is allocated, the test causes the PD side to issue a Power Change Request to move to 13 watts for Type-1 and, if **LLDP** grant, 25.5 watts for Type-2, then captures and times PSE LLDP responses to the new request. With **802.3bt Type-3** PSE's tested by **PSA-32x2** ports, test further checks PSE response and ability to work with 802.3bt TLV's rather than 802.3at TLV's.				
Trace Analysis	In PowerShell verbose diagnostic mode, LLDP packets are traced.				
Approximate Time	105 – 115 seconds per port assuming Type-2/3 PSE				

6.5.4. 2-Pair PSE Conformance Tests – Power-Up Processes

Two tests provide coverage of PSE “POWER UP” behaviors: pwrup_time and pwrup_inrush. POWER-UP refers to the transition between when a PSE decides to apply power to a PD and when power has reached a steady state condition. Default sequences will utilize PD Class 0 emulation for Type-1 PSE’s and both Class 0 and Class 4 for Type-2/3 PSE’s.

pwrup_time	**Power-Up Timing Parameters**			**Pwr Type** / **PD Class**	**30W Grant** / **Ignored**	**MPS** / **Ignored**
	Parameter	**Definition**			**Acceptance Range**	
Measurements	Power-On_Trise_c0	Rise Time from 10% to 90% of Vport to a Class 0 PD			≥ 15 mSec	
	Power-On_Tpon_c0	Time from end of detection until POWER_ON state (power-up + 50 msec) given a Class 0 PD			≤ 400 msec	
	Power-On_Trise_c4	Rise Time from 10% to 90% of Vport to a Class 4 PD			≥ 15 mSec	
	Power-On_Tpon_c4	Time from end of detection until POWER_ON state (power-up + 50 msec) given a Class 4 PD			≤ 400 msec	
PowerShell Control Options	**PD Class**					
	0 – 4					
Description	The pwrup_time test emulates by default a Class 0 PD (for Type-1, 15.4W) and a Class 4 PD (for Type-2, 30W) when performing power-ups for measuring Trise and Tpon. The Class 0 default for Type-1 emulation may be overridden with Class 1-3. Rise time is measured from a voltage just above the classification pulse magnitude up to 0.9 Vport using the time interval meter in ‘usec’ scale. This measurement is then extrapolated down to 0.1Vport to get Trise. Metering supports actual measurements as low as 6 usec in the PSA-3000. Tpon is analyzed from a power-up voltage trace with adaptive processing to assess timing back from a power-up to the end of the last complete detection pulse preceding the power-up.					
Waveform Display	One or more voltage traces used for Tpon analysis are captured and retained.					
Approximate Test Time	18 – 32 seconds per port, Type-2/3 PSE’s take longer					

*** For further information concerning the relationship between* $\mathbf{T_{rise}}$ *measurements and PSA-3120 test port hardware versions, see Sifos application note “***Power-Up Rise Time Measurements with the PSA-3000.pdf***”.*

pwrup_inrush	**Assess PSE Current Limiting Behaviors during Power-Up**			**Pwr Type** / **PD Class**	**30W Grant** / **Ignored**	**MPS** / **Ignored**
	Parameter	**Definition**			**Acceptance Range**	
Measurements	**Init_Inrush**	Maximum output current immediately after 1 msec of a severe inrush overload			< 450 mA	
	Max_Inrush_c0	Maximum output current in time interval from 1 to 75 msec given Class 0-3 PD			< 450 mA	
	Max_Inrush_c4	Maximum output current in time interval from 1 to 75 msec given Class 4 PD			< 450 mA	
	Min_Inrush	Minimum output current while current limiting in time interval from 1 to 50 msec given 30V or higher port voltage			> 400 mA	
	Tinrush	Duration of current limiting until PSE removes power			50 to 75 msec.	
	Inrush_45m	Port voltage after 50msec following 45 msec current limiting inrush overload			Type-1: > 44 Volts Type-2: > 50 Volts	
	Inrush_Voltage	Average Port Voltage - PSE current limiting, PSA foldback suppression applied			30 to 57 Volts	
	Inrush_Strategy_c0	Indicator if PSE uses “legacy_powerup” exception (and consequences thereof) categorized into one of five possible outcomes given a Class 0 PD			30 to 57 Volts	
	Inrush_Strategy_c4	Indicator if PSE uses “legacy_powerup” exception and consequences thereof categorized into one of five possible outcomes given a Class 4 PD			0 to 1 if 802.3at =0 if Type-3	
PowerShell Control Options	**PD Class**					
	0 – 4					
Description	The test uses a series of edge triggered transients and traces to analyze both load current and voltage responses associated with a current-limiting overload induced during power-up. The test applies PSA-3000 foldback suppression to assure Vport stays above 30V during the current limiting transients. Maximum and Minimum load currents are assessed from traces while the PSE is load-limiting. Inrush shutdown timing and PSE response to a sub-Tinrush_Min (45 msec) inrush overload are also recovered from trace captures. The test also assesses if the PSE limits inrush current when the inrush load is delayed (e.g. 25 msec) from the power-up in order to determine if the PSE uses Tinrush or Vport to mark the end of the Power-Up state. *Type-2 PSE’s that use Vport (legacy_powerup) may never limit PD inrush to 450mA or less when inrush load is delayed.*					
Waveform Display	Both load current and voltage traces are captured and retained for Iinrush, Tinrush, and Voltage measurements					
Approximate Time	65 -75 seconds per port, Type-2/3 PSE’s take longer					

6.5.5. 2-Pair PSE Conformance Tests: Power-On Processes

The “POWER ON” group of tests assess PSE behaviors when operating in a steady state mode of powering a PD. All of these tests by default will use Type-1 PD emulations with Type-1 PSE’s and both Type-1 PD and Classs 4 emulations with Type-2/3 PSE’s. Tests cover DC and AC voltages, power capacity, and transient load responses. When testing Type-2 LLDP-capable PSE’s in 30W mode (Type-2 PD emulation), LLDP emulation will be automatically be used for all power-ups, though this feature may be overridden in PowerShell.

pwron_v	**Powered Port Voltage, Ripple, and Noise**		**Pwr Type** **PD Class**	**30W Grant** **LLDP | ! LLDP**	**MPS** **Ignored**
	Parameter	**Definition**			**Acceptance Range**
Measurements	**Vport_min**	Minimum Port voltage with 95% of maximum supported current load			Type-1: 44 to 57 VDC Type-2: 50 to 57 VDC
	Vport_max	Maximum Port voltage with low power (0.5 Watt) load			Type-1: 44 to 57 VDC Type-2: 50 to 57 VDC
	Vport_ripple	Peak AC Ripple with 0.5 Watt and 95% of maximum supported current load			0 to 500 mVpp
	Vport_noise	Peak AC Noise with 0.5 Watt and 95% of maximum supported current load			0 to 200 mVpp
	Vtrans_min	Minimum Port Voltage measured during a 5msec load transient from 12mA to Pclass (max supported power) and back			< 57 VDC
	Vtrans_max	Maximum Port Voltage measured during a 5msec load transient from 12mA to Pclass (max supported power) and back			Type-1: > 44 VDC Type-2: > 50 VDC
PowerShell Control Options	**PD Class** **0 – 4**	**LLDP Power Bypass** **xlldp**			
Description	This test measures port voltage characteristics under loading extremes of low load and near-maximum steady-state load. Steady state DC voltage is measured with minimum and maximum values retained. Vpp_ripple is a measurement of AC voltage in the frequency range of 20 to 500 Hz while Vpp_noise measures AC voltage in the frequency range of 1.5KHz to 300KHz. Both AC measurements are performed under conditions of a .05uF capacitive load to emulate the lowest possible PD input capacitance. Vtrans measures port voltage response to a short load transient from low power to Pport and back (15.4 watts for Type-1 and 30 watts for Type-2).				
Waveform Display	NONE				
Approximate Time	80 - 130 seconds per port, LLDP granting PSE's may take longer				

pwron_pwrcap	**PSE Port Power Capacity**		**Pwr Type** **PD Class**	**30W Grant** **LLDP | ! LLDP**	**MPS** **Ignored**
	Parameter	**Definition**			**Acceptance Range**
Measurements	**Pcon_c0=**	Maximum output power from PSE Port given Class 0 PD			14.2 to 22.7 watts
	Icon_%_c0=	Maximum static output current relative to 802.3at Icon(Pclass_0)			> 100%
	Pcon_c1=	Maximum output power from PSE Port given Class 1 PD			3.9 to 22.7 watts
	Icon_%_c1=	Maximum static output current relative to 802.3at Icon(Pclass_1)			> 100%
	Pcon_c2=	Maximum output power from PSE Port given Class 2 PD			6.8 to 22.7 watts
	Icon_%_c2=	Maximum static output current relative to 802.3at Icon(Pclass_2)			> 100%
	Pcon_c3=	Maximum output power from PSE Port given Class 3 PD			14.2 to 22.7 watts
	Icon_%_c3=	Maximum static output current relative to 802.3at Icon(Pclass_3)			> 100%
	Pcon_c4=	Maximum output power from PSE Port given Class 4 PD			28.7 to 38.9 watts
	Icon_%_c4=	Maximum static output current relative to 802.3at Icon(Pclass_4)			> 100%
	Type-2_Enable	Verifies > 450 mA continuously available at 80 msec following 2-event power-up for 2-event, Type-2 PSE's *or* verifies >450 mA is not available for LLDP capable Type-2 PSE's prior to negotiation			=1 for PHY and PHY+LLDP Grants, =0 for LLDP Grants
	Pclass_LLDP_22.7	Indicator of PSE ability to deliver Pclass (Icon) given 22.7W power grant			1 *(-1 for non-LLDP PSE)*
	Pclass_LLDP_24.5	Indicator of PSE ability to deliver Pclass (Icon) given 24.5W power grant			1 *(-1 for non-LLDP PSE)*
PowerShell Control Options	**PD Class** **0 – 4**				
Description	The test determines from PD Class whether to run in Type-1 mode or Type-2 mode. In Type-1 mode, pwron_pwrcap will emulate each of PD Class 0, 1, 2, and 3, and measure maximum tolerated steady-state power and load current as a percentage of 802.3at Icon for each PD classification. In Type-2 mode, it will perform these measurements given a Class 4 PD, using LLDP to negotiate maximum 25.5 watt power from LLDP-capable PSE's. Finally, given Type-2 emulation, the test assesses power available at 80 msec following power-up and returns Type-2_Enable which should be 1 for 2-event grants and 0 for **LLDP** PSE's.				
Waveform Display	A waveform trace is used in the Type-2_Enable measurement.				
Approximate Time	182 -325 seconds per port, Type-2 and LLDP granting PSE's take longer				

pwron_maxi	PSE Response to Maximum Overloads	Pwr Type PD Class	30W Grant LLDP | ! LLDP	MPS Ignored
	Parameter	**Definition**		**Acceptance Range**
Measurements	**Ilim_Peak_1**	Maximum current PSE outputs in response to 1.95A load after 8 msec to a Class 0 PD		≤ 1750 mA
	Ilim_min_1	Minimum output current up to 50 msec with 402mA load pulse and foldback suppression applied to assure > 30VDC (Type-1 PD emulation)		≥ 400 mA
	Tlim_1 or **Tlim_min_1**	Time to port shutdown in response to 400 mA overload given Type-1 PD		Type-1: ≥ 50 msec Type-2/3: ≥ 10 msec
	Tlim_max_1	Time to port shutdown in response to 850 mA overload given Type-1 PD		≤ 75 msec
	Vlim_1	Average port voltage coincident with Tlim_1 measurement		Type-1: 44 to 57 V Type-2/3: 50 to 57 V
	Ilim_Max_1	Maximum output current from 1 to 75 msec given 700mA load pulse and foldback suppression active given a Type-1 PD		400 to 1750 mA
	Ilim_Peak_2	Maximum current PSE outputs in response to 1.95A load after 8 msec to a Class 4 PD		≤ 1750 mA
	Ilim_Min_2	Minimum output current up to 50 msec with 686mA load pulse and foldback suppression applied to assure > 30VDC given Type-2 PD emulation		≥ 683 mA
	Tlim_2 or **Tlim_min_2**	Time to port shutdown in response to 684 mA overload given Type-2 PD		10 to 75 msec
	Tlim_max_2	Time to port shutdown in response to 850 mA overload given Type-2 PD		≤ 75 msec
	Vlim_2	Average port voltage coincident with Tlim_2 measurement		50 to 57V
	Ilim_Max_2	Maximum output current from 1 to 75 msec given 860mA load pulse and foldback suppression active given a Type-1 PD		683 to 1750 mA
	Ktran_lo	% excursion below 50V given 250usec (fast) overload transient (684 mA) given a Class 4 PD		≥ 92.4% of **V_{Port_PSE}** (Min) (=50V)
PowerShell Control Options	**PD Class** 0 – 4	**LLDP Power Bypass** xlldp		
Description	The pwron_maxi test evaluates PSE characteristics with respect to the POWER_ON state PI operating current templates in Figure 33-14 of the 802.3at specification. The test assures that the PSE Upper-Bound template is satisfied with measurement parameters Ilim_Peak and Tlim_2 while assuring that the PSE Lower-Bound template is satisfied using measurement parameters Ilim_Min_1, Tlim_1, and Vlim_1 for Type-1 PSE's and Ilim_Min_2, Tlim_1, and Vlim_2 for Type-2 PSE's. Additionally, the test assures that Type-2 PSE's properly regulate port voltage in the presence of fast load transients with the Ktran_lo measurement. The test measures Ilim_Max_1 and Ilim_Max_2 to assess PSE current source behavior in the region between Lower and Upper-Bound templates.			
Waveform Display	Both load current and voltage traces are captured and retained for Ipeak, Ilim, Tlim, and Vlim measurements.			
Approximate Time	48 - 150 seconds per port, Type-2 and LLDP granting PSE's take longer			

pwron_overld	PSE Response to Maximum PD Power Transients	Pwr Type PD Class	30W Grant LLDP | ! LLDP	MPS Ignored
	Parameter	**Definition**		**Acceptance Range**
Measurements	**%Ipeak_1**	Percent of required **Ipeak** current that is supported over 50msec duration where **Ipeak** (Eq. 33-4 in 802.3at) tested up to 125% with Class 0 PD		≥ 100%
	Vport_Ipeak_1	Minimum Port Voltage at **Ipeak** transient pulse given a Class 0 PD		Type-1: ≥ 44 Volts Type-2: ≥ 50 Volts
	Vport_5%DC_1	Minimum Port Voltage over 5 seconds with a quantity of 50 msec **Ipeak** pulse transients separated by 1 second (5% duty cycle) given a Class 0 PD		Type-1: ≥ 44 Volts Type-2: ≥ 50 Volts
	%Ipeak_2	Percent of required **Ipeak** current that is supported over 50msec duration where **Ipeak** (Eq. 33-4 in 802.3at) tested up to 125% with Class 4 PD		≥ 50 Volts
	Vport_Ipeak_2	Minimum Port Voltage at **Ipeak** transient pulse given a Class 4 PD		≥ 50 Volts
	Vport_5%DC_2	Minimum Port Voltage over 5 seconds with a quantity of 50 msec **Ipeak** pulse transients separated by 1 second (5% duty cycle) given a Class 4 PD		≥ 50 Volts
PowerShell Control Options	**PD Class** **0 – 4**	**LLDP Power Bypass** **xlldp**		
Description	The pwron_overld test assesses powered PSE port behaviors with respect to Ipeak, the maximum power overload allowed to a PD as defined in Equation 33-4 of the 802.3at standard. The test assures that Ipeak related power can be delivered and that port voltage is maintained. It also assures that Ipeak can be delivered with a 5% duty cycle to a PD.			
Waveform Display	NONE			
Approximate Time	35 – 85 seconds per port, Type-2 and LLDP granting PSE's take longer			

pwron_autoclass	**PSE Response to PD with Autoclass Ability**		**Pwr Type** / **PD Class**	**30W Grant** / **!LLDP**	**MPS** / **Ignored**
	Parameter	**Definition**			**Acceptance Range**
Measurements	Autoclass_shutdown	Flag indicating if PSE adjusts power capacity in response to a Type-3 autoclass signature and power measurement. 1= Autoclass capable, 0= No apparent autoclass capability.			0 or 1
	Pac_margin_C3_low **Pac_margin_C3_high** **Pac_margin_C4_low** **Pac_margin_C4_high**	Flag indicating that an Autoclass capable PSE allows minimum required power to PD max power demand. 1= power supported, 0= under-powered to PD demand. If Autoclass_shutdown is 0, 99 will be reported. Tested at low Class 3, high Class 3, low Class 4, and high Class 4 power demands.			1 or -1
	Autoclass_4W	Flag (0, 1, or 99) indicating that an autoclass signature of less than 4W is ignored whereupon PSE furnishes assigned class from classification.			1 or 99
PowerShell Control Options	**PD Class** **0 – 4**				
Description	The pwron_autoclass test checks the autoclass response of a Type-3 (802.3bt) autoclass capable PSE to assure that it does properly respond to the autoclass PD signature and that it further correctly assesses maximum PD power demand and then supports a **Pclass** (continuous power output) that adds the required autoclass power margin to the measured autoclass power demand.				
Waveform Display	NONE				
Approximate Time	(TBD)				

6.5.6. 2-Pair PSE Conformance Tests – MPS Processes

MPS (Maintain Power Signature) tests assess PSE thresholds for and responses to potential disconnects of a powered device (PD). 802.3at allows for two distinct methods of detecting a PD disconnect: DC MPS which monitors load current continuously and AC MPS which monitors port impedance continuously. Because the methods are quite distinct and are separately defined in the 802.3at standard, the PSE Conformance Test Suite applies different tests for DC MPS vs AC MPS capable PSE's. The PSE declaration of AC versus DC MPS dictates which tests are executed. 30W Grant method is not relevant to these tests because all power-ups (including PD Class 4) are maintained below 15.4 watt loading throughout these tests. The AC MPS method is not allowed to Type-3 (802.3bt 2-Pair) PSE's.

mps_ac_pwrdn	**Examines the Power-Down Timing and Load Current Impact**		**Pwr Type** / **PD Class**	**30W Grant** / **Ignored**	**MPS** / **DC | AC**
	Parameter	**Definition**			**Acceptance Range**
Measurements	**Power_Down_Time_Tmpdo**	Disconnect power-down timing from start of invalid signature (T_{mpdo})			300 to 400 mA
	DC_Max_Load_Imin1	Maximum DC Load Current allowed prior to AC MPS Disconnect Shutdown ($Z_{ac\ 1}$)			< 1 mA
PowerShell Control Options	**PD Class** **0 – 4**				
Description	The mps_ac_pwrdn test measures the timing between PD disconnect and power removal from the port. The test also determines if power is removed with a small DC load current, something that should never happen given the high (> 24 KΩ) impedance threshold required to determine a disconnect. (Note: A 1 mA load current on a 50V port would appear as a much lower effective impedance than 24 KΩ.) The test must adapt to PSE's that discharge extremely slowly or superpose detection signaling when power is removed.				
Waveform Display	NONE				
Approximate Time	25 seconds per port				

mps_ac_vf	**Examines AC MPS Signaling Characteristics**		**Pwr Type** / **PD Class**	**30W Grant** / **Ignored**	**MPS** / **DC | AC**
	Parameter	**Definition**			**Acceptance Range**
Measurements	**AC_MPS_V_open**	Peak-Peak AC probing voltage following PD Disconnect. (**V_open**)			1.9 to 5.7 Vpp
	AC_MPS_V_open%	Peak-Peak AC probing voltage following PD Disconnect expressed as a % Vport_pse. (**V_open**)			3.3 to 10% (Vport_pse)
	AC_MPS_Frequency	AC probing signal frequency following PD Disconnect. (**F_p**)			5 to 500 Hz
	Slew_Rate	AC probing signal slew rate (**SR**)			< 0.1 V/msec
	Source_Current_Isac	Signal current sourced by AC MPS signal generation resource. (**I_sac**)			< 5 mA
PowerShell Control Options	**PD Class**				
	0 – 4				
Description	The msp_ac_vf test performs analysis on the AC Probing signal that appears on the PSE output superposed with Vport_pse once the load current and resistance presented by a PD is removed. The signal is present for between 300 msec and 400 msec nominally. Voltage waveforms are analyzed to assess peak-to-peak voltage, frequency, and slewrate. A separate voltage waveform is captured coincident with very low load current transient steps to assess a ΔV/ΔI response for purposes of estimating Isac.				
Waveform Display	Voltage waveforms are captured and retained for all measurements in this test.				
Approximate Time	25 seconds per port				

mps_ac_voff	**Analyzes Port Voltages During AC Disconnect and After Power Removal**		**Pwr Type** / **PD Class**	**30W Grant** / **Ignored**	**MPS** / **DC | AC**
	Parameter	**Definition**			**Acceptance Range**
Measurements	**Peak_AC_MPS_V_open1**	Peak port voltage found after AC disconnect power removal. (V_open1)			≤ 30 Volts
	Peak_Disconnect_Vport	Peak port voltage found af er the disconnect event over a period of one second.			< 60 Volts
PowerShell Control Options	**PD Class**				
	0 – 4				
Description	This test examines potential adverse impact of an AC MPS signal generator both before and after power removal. The test assures peak voltages remain below 60 volts for at least one second after the disconnect event and that post-shutdown voltages remain within the allowable open circuit detection range of 0 to 30 Volts. The test uses adaptive logic to resolve the shutdown point and to assess post-shutdown peak voltages.				
Waveform Display	Voltage traces are captured and retained for Vopen analysis.				
Approximate Time	20 seconds per port				

mps_dc_valid	**Examines the Power-Down Timing and Load Current Impact**		**Pwr Type** / **PD Class**	**30W Grant** / **Ignored**	**MPS** / **DC | AC**
	Parameter	**Definition**			**Acceptance Range**
Measurements	**Min_Valid_Time_Tmps**	Minimum valid signature ACTIVE time required for DC MPS validity. The test scans down from 110msec to 10msec looking for the smallest duration of valid signature current that will cause a "reset" to the PSE Port Tmpdo timing. (T_{mps})			< 60 msec
	Duty_Cycle_tol	Verify PSE is still powered after at least 5 cycles of load VALID for 60msec, load OFF for 300msec.			> 0
PowerShell Control Options	**PD Class**	**802.3bt (6msec) Tmps Mode**			
	0 – 4	**-bt**			
Description	The mps_dc_valid test evaluates Tmps by scanning "valid signature" currents (e.g. 25mA) from 110msec duration to 10msec duration seeking for the smallest duration of valid signature current that will cause a "reset" to the PSE Port Tmpdo timing. The test then measures Duty_Cycle_tol by cycling a 2 step load transient consisting of 16% duty cycle valid signature current (e.g. 25mA) over a period of 5 seconds and determining port power status, reported as: 1= POWERED, 0= OFF. If '-bt' input provided, Tmps is scanned from 16msec down to 4msec in order to qualify 802.3bt limit of 6msec Tmps.				
Waveform Display	The test will produce and retain load current traces demonstrating Tmps and Duty_Cycle_tol.				
Approximate Time	24 - 35 seconds per port				

mps_dc_pwrdn	Examines AC MPS Signaling Characteristics		Pwr Type / PD Class	30W Grant / Ignored	MPS / DC | AC
	Parameter	**Definition**			**Acceptance Range**
Measurements	**Min_Valid_I_hold**	DC MPS Valid/Non-Valid Load Current Threshold. Scan down using steady state load for best load current accuracy. (I_{Hold})			5 to 10 mA.
	Time-to-Shutdown _Tmpdo	Disconnect power-down timing from start of invalid signature. Use 0 mA signature. (T_{mpdo})			300 to 400 msec
PowerShell Control Options	**PD Class** 0 – 4				
Description	The mps_dc_pwrdn test rotates between a valid DC MPS load current and a progressively smaller DC Load looking for a threshold current that causes power removal – then assigns the lowest value that did not cause power removal to I_hold. If the power removal occurs in < Tmpdo(MAX), Tmpdo is also recorded, otherwise, a second shutdown using a load current = (I_hold – 3mA) is used to time Tmpdo. The test records peak voltage over 1 second following the disconnect event to obtain Vopen_pk.				
Waveform Display	Voltage waveforms can be captured and retained to show Tmpdo and Vopen_pk.				
Approximate Time	32 seconds per port				

6.5.7. 2-Pair PSE Conformance Tests – Power-Down Characteristics

Three power-down tests are provided to evaluate PSE "simple" overload responses, disconnect shutdown timing with PSE output characteristics, and error delay behavior following overload shutdown. These tests accept PD Class input (PD emulation) and in one case, pwrdn_overld, must respond to 30W Grant type to support Type-1 vs Type-2 power-ups. MPS method is not relevant to these tests.

pwrdn_overld	Analyzes PSE Overload Shutdown Behaviors		Pwr Type / PD Class	30W Grant / LLDP | ! LLDP	MPS / Ignored
	Parameter	**Definition**			**Acceptance Range**
Measurements	**Icut_1**	Required current to produce a Tcut (< 75msec) shutdown to a Class 0 PD			-1 to 1750 mA
	Tcut_1	Time from initiation of Icut_1 load until power removal			50 to 9999 msec
	Isoft_1	Required current to produce a 2 second shutdown to a Class 0 PD if less than Icut_1			Type-1: -1 to 399 mA Type-2: -1 to 683 mA
	Tsoft_1	Time from initiation of Isoft_1 load until power removal			≤ 2000 msec
	Icut_2	Required current to produce a Tcut (< 75msec) shutdown to a Class 4 PD			-1 to 1750 mA
	Tcut_2	Time from initiation of Icut_2 load until power removal			10 to 9999 msec
	Isoft_2	Required current to produce a 2 second shutdown to a Class 4 PD if less than Icut_2			-1 to 683 mA
	Tsoft_2	Time from initiation of Isoft_2 load until power removal			≤ 2000 msec
PowerShell Control Options	**PD Class** 0 – 4	**LLDP Power Bypass** xlldp			
Description	With 802.3at, "simple", non-current limited overload shutdowns became an optional behavior of a PSE and the processing of these overloads into a shutdown was described in vague terms to permit wider design flexibility in overload shutdown processing. Overload shutdown processing involves load-current-over-time processing below the I_{LIM_min} threshold in 802.3at figure 33-14 and above the PSE lowerbound template. The standard allows the PSE to "accumulate" samples over a "sliding window" and then remove power if an accumulation of load samples exceeding I_{cut} for T_{cut} elapsed duration is discovered. The test also seeks to find any lower load threshold, Isoft, wherein power is removed after a longer than $T_{cut\ max}$ elapsed duration of up to 2 seconds.				
Waveform Display	Load current trace is produced and retained for the Isoft_N, Tsoft_N measurement.				
Approximate Time	82 to 380 seconds per port depending on PSE Type, LLDP, and Overload Processing logic				

pwrdn_time	**Evaluates Disconnect Shutdown Time and PSE Ouput Characteristics**		**Pwr Type** **PD Class**	**30W Grant** **Ignored**	**MPS** **Ignored**
	Parameter	**Definition**			**Acceptance Range**
Measurements	**Turn-Off_Time_Toff**	Power discharge time with hypothetical 320KΩ load. (**T_{off}**)			< 500 msec
	Output_Cap_Cout	PSE output capacitance during power discharge (**C_{out}**)			< 0.52 mF
	Output_Load_Rp	PSE shunt output resistance during power discharge (**R_rev**)			> 45 KΩ
PowerShell Control Options	**PD Class** 0 – 4				
Description	This test evaluates the time for the power-down transition to occur. The test models a 320 KΩ load resistance to all PSE port types (AC MPS, DC MPS) during the power-down transition. This is done mathematically by combining timing of shutdowns with high impedance and fixed current loads. Power down slew rate given the small DC load current is also utilized to assess PSE port capacitance Cout. Cout is then used to assess Rp from the voltage decay characteristics of the PSE port during shutdown with high impedance. Known characteristics of the PSA test port are factored into the various calculations for Toff, Cout, and Rp. Test must adapt to PSE's that resume detection immediately on power removal. Test must also adapt to PSE's that actively remove charge during a disconnect shutdown by reporting Cout = -1 since Cout and Rp cannot be measured in these cases.				
Waveform Display	Various voltage traces produced and retained to assess passive discharge time and a load current trace is produced to support Cout calculation.				
Approximate Time	48 seconds per port				

pwrdn_v	**Evaluates Overload Shutdown IDLE & Error Delay**		**Pwr Type** **PD Class**	**30W Grant** **NONE | ! NONE**	**MPS** **Ignored**
	Parameter	**Definition**			**Acceptance Range**
Measurements	**Avg_Idle_Voff**	IDLE state voltage between detections after overload shutdown. (V_{off})			< 2.8V
	Error_Delay_Ted	Time from overload condition shutdown until a detection leading to a successful power-up. (T_{ed})			> 750 mSec
	Peak_Error_Delay_Ved	Peak voltage over the Ted interval.			< 20.5V
PowerShell Control Options	**PD Class** 0 – 4				
Description	The pwrdn_v test assesses PSE port behaviors immediately following an overload shutdown. Voff determines that port voltage drops into an IDLE state (< 2.8V) for some period of time. Ted reports the time from shutdown until the first detection measurement that precedes a power-up. Ved reports the peak voltage found during the Ted time interval. This should be no more than maximum allowed class pulse levels.				
Waveform Display	Voltage waveforms can be captured and retained to show Tmpdo and Vopen_pk.				
Approximate Time	18 -41 seconds per port depending on PSE Type, LLDP, and Overload Processing logic				

6.6. The 2-Pair PSE Conformance Standard Spreadsheet Report

The 2-Pair PSE Conformance Test Suite report is produced using the **Conf Test** menu in PSA Interactive or the **sequence** command in PowerShell PSA. Both methods allow flexible specification of tests and ports, as well as cycles of testing per port.

The standard 2-Pair report, **psa_report.xlsm**, is a "smart" Microsoft Excel spreadsheet that automatically processes results from the test sequencer into colorful, easily read reports that add port statistics and pass-fail criteria. These reports will allow PSA users to quickly locate and characterize real or potential conformance issues as well as to rapidly identify port-specific defects. The unprocessed **psa_report.xlsm** file includes four spreadsheet pages (or tabs):

- **Sheet1**: Test Cycle #1 Test data and statistics – becomes **Loop1** after report processing
- **Limits**: Test Limit Type and Test Limit Data
- **Notes 5.x.x**: Information describing all 2-Pair PSE test parameters with special comments regarding Pass/Info test parameters for the 2-Pair PSE Conformance Test Suite and 802.3 PICS coverage
- **Interop**: Interop index calculation page with summarized score deductions

If multiple test cycles are specified, additional report pages will be created for each test loop prior to the Test Limit page.

Test parameters that fall outside of **Pass/Fail** type limit criteria will be marked as **FAIL** in the summary column and will be flagged in a **pale red** shading on each failing port. Test parameters that fall outside of **Pass/Info** type limit ranges will be annunciated as **Info** in the summary column and will flagged in the report by boldface, brown text.

The PSE Conformance Test Limits may be found on the **Limits** tab of the standard test report. The **Notes 5.x.x** tab provides information concerning all of the PSE Conformance Test parameters and limit processing details.

Finally, the **Interop** tab uses all of the test results to create a **Sifos Interop Index** score based upon test limit excursions of selected parameters in selected tests. The score is based upon weighted impact values for the various PSE Conformance parameters. It will only be produced if a sufficient number (large majority) of tests are sequenced. The Interop score is not a measure of specification conformance.

Important! The only measure of 2-Pair PSE (802.3at, 802.3bt) specification conformance is the number of (or absence of) **FAIL** indications on the test report pages. Full conformance is a achieved when there are no **FAIL** indications in the report.

Occasionally, a test malfunction may occur, for example when a PSE port unexpectedly fails to power-up or a measurement is disrupted by some unexpected event. This will result in an aborted test and a **See Log!** indicator in the parameter result field. This means that an error log has formed in the current active results directory. That log file can be opened simply by clicking on the Error Log *hyperlink* in the upper right hand corner of the PSE Conformance Test report.

The standard PSE Conformance Report file **psa_report.xlsm** is always installed as a read-only file and any specific reports generated following a test sequence should ALWAYS be saved to another name. When reports open, the macro essentially self-deletes rendering the report file as a **.xlsx** Excel file. Hence, when reports are saved, they are saved as non-macro enabled Excel files.

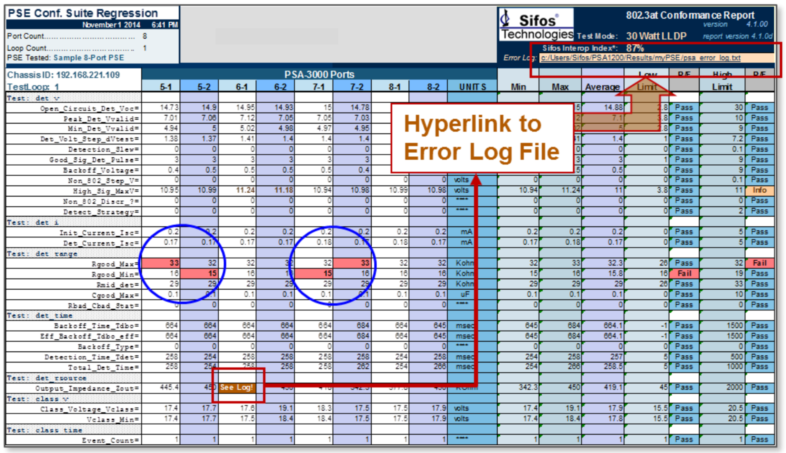


Figure 6.1 Sample 2-Pair Conformance Test Report – Test Loop1 Tab

A second file, **psa_report.bak**, is a backup copy of **psa_report.xlsm** provided in the event that **psa_report.xlsm** is lost or corrupted. See Section 3.2.5 for the directory location of these report template files.

Special versions of **psa_report.xlsm** may be created and utilized for purposes of adjusting test limits or adding statistics that go beyond the standard template report. These versions can be associated with a PSE Attributes File (*see section 3.2.4)* such that when that PSE attributes file is loaded to PSA Interactive or PowerShell PSA, the custom-modified report template will be used in place of the standard **psa_report.xlsm** template for that particular PSE type.

To create a modified template, the following steps should be taken:

1. Copy **Users\Public\PSA3000\Results\psa_report.xlsm** to a newly named template such as **…\Results\ my_psa_report.xlsm** (saved into that same directory path).
2. Remove Read-Only permissions from **…\Results\ my_psa_report.xlsm**
3. Edit **…\Results\ my_psa_report.xlsm** as required and save it.
4. Restore Read-Only permissions to **…\Results\ my_psa_report.xlsm**
5. Open (or create) PSE Attribute File (e.g. **my_PSE.txt**) in the **Users\Public\PSA3000\Config** directory.
6. Add the following line to **…\PSA3000\Config\ my_PSE.txt** :

```
PSE_Conf_Test_Report:  my_psa_report.xlsm
```

Loading the PSE Attributes File **my_PSE** will now cause the PSE Conformance Test Sequencer to utilize this modified template file in place of the standard **psa_report.xlsm**. Sections 4.2.3 and 5.7 provide further information on loading PSE Attributes Files.

Important! Never make modifications to **psa_report.xlsm**.

6.7. The 4-Pair PSE Conformance Suite Tests

6.7.1. Documentation Conventions

The 4-Pair (802.3bt) PSE test suite consists of 24 tests covering the features of PSE Detection/Connection Check, PSE Classification and LLDP, PSE Power-Up, PSE Powered On state, MPS Disconnect behaviors, and PSE Shutdown behaviors. In the tables that follow, each test is described in terms of tested parameters, associated test limtis, and 802.3bt coverage elements including 802.3bt parameter names, PSE/DLL PICS, and 802.3bt associated clauses. In total, the test suite has the ability to assess over 230 parameters on each PSE port.

The standard **psa_report_4p.xlsm** spreadsheet report (*see Section 4.8.5*) for the 4-Pair PSE Conformance Test Suite will process well-specified 802.3bt parameters as **PASS/FAIL**. Parameters that are vaguely specified, and parameters that require additional internal design knowledge of the PSE in order to fully assess, may be processed as **PASS/INFO**. This is notated under the Limits column in each table.

6.7.2. 4-Pair PSE Conformance Tests – Detection / Connection Check Processes

Detection and Connection Check (4-Pair ID) tests evaluate the PSE features that determine the presence of a valid 802.3 PD and then further, evaluate the suitability of that PD for powering on both pairsets (Alt-A and Alt-B) simultaneously. For further information on detection and connection check, see section 2.6.

The 802.3bt PSE state machine describes four fundamental categories of PSE behavior encompassing detection and connection check. These tests will automatically assess and then adapt to the PSE state processing and will also adapt to certain non-802.3 proprietary signaling that may also be present.

Test: det_v *(Detection Voltages)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Open_Circuit_Voc_A	Peak Open Circuit Detection Voltage on Alt-A Pairset	≤ 30V	VOC	PSE6 PSE10 PSE12 PSE15 PSE16 PSE21 PSD75 PSE76	145.2.5.1 145.2.6.1 145.2.6.2
Open_Circuit_Voc_B	Peak Open Circuit Detection Voltage on Alt-B Pairset	PASS/FAIL			
Backoff_Voltage_A	IDLE State voltage during detection backoff on the Alt-A Pairset	≤ 2.8V	Voff, VReset		145.2.7 145.2.10.11
Backoff_Voltage_B	IDLE State voltage during detection backoff on the Alt-A Pairset	PASS/FAIL			
Backoff_Voltage_Ss	IDLE State voltage during Single Signature detection backoff across both Pairsets (as a single signature PD would detect it)	≤ 2.8V PASS/INFO			
Max_Det_Step_V_A	Maximum Detection Voltage with Valid Detection Signature - Alt-A Pairset	3.8V to 10V	Vvalid		
Max_Det_Step_V_B	Maximum Detection Voltage with Valid Detection Signature - Alt-B Pairset	PASS/FAIL			
Min_Det_Step_V_A	Minimum Valid Step Voltage with Valid Detection Signature - Alt-A Pairset	2.8V to 9V			
Min_Det_Step_V_B	Minimum Valid Step Voltage with Valid Detection Signature - Alt-B Pairset	PASS/FAIL			
Det_Step_Changes_A	Count of Detection Step Transitions on the Alt-A Pairset	≥ 1			
Det_Step_Changes_B	Count of Detection Step Transitions on the Alt-B Pairset	PASS/FAIL			
Min_Step_DV_A	Detection Step Magnitude from Max Voltage to Min Voltage - Alt-A Pairset	1V to 7.2V	ΔVtest		
Min_Step_DV_B	Detection Step Magnitude from Max Voltage to Min Voltage - Alt-A Pairset	PASS/FAIL			
Pre-Det_CC_Step_V_A	Magnitude of any non-802 pre-detection signaling on the Alt-A Pairset	0V to 10V		**Approx.Test Time**	
Pre-Det_CC_Step_V_B	Magnitude of any non-802 pre-detection signaling on the Alt-A Pairset	PASS/FAIL		**41 seconds**	

Test: det_cc *(Connection Check & 4 Pair ID)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Presumed_CC_DET_SEQ	CC_DET_SEQ as described by the 802.3bt PSE State Machine.	= 1 to 4 PASS/FAIL	CC_DET_SEQ	PSE2 PSE3 PSE4 PSE7 PSE15 PSE20 PSE22	145.2.4 145.2.5 145.2.5.1 145.2.7
Conn_Chk_SS_V_A	Peak connection check voltage on the Alt-A Pairset with Single Signature	2.8V to 10V PASS/FAIL	Vvalid		
Conn_Chk_SS_V_B	Peak connection check voltage on the Alt-B Pairset with Single Signature				
Conn_Chk_DS_V_A	Peak connection check voltage on the Alt-A Pairset with Dual Signature	2.8V to 10V PASS/FAIL			
Conn_Chk_DS_V_B	Peak connection check voltage on the Alt-B Pairset with Dual Signature				
High_Signature_CC_A	Flag indicating invalid signature compliance to PSE state machine on the Alt-A Pairset. 1 is a PASS, 0 is a FAIL.	= 1 PASS/FAIL			
High_Signature_CC_B	Flag indicating invalid signature compliance to PSE state machine on the Alt-B Pairset. 1 is a PASS, 0 is a FAIL	= 1 PASS/FAIL		**Approx.Test Time**	
4Pair_Start_Fail	Flag indication that the 4-Pair PSE failed to produce any signaling on at least one Pairset when a valid PD signature was connected.	= 0 PASS/FAIL		**31 seconds**	

Test: det_i *(Detection Current & Slew)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Isc_Init_A	Peak detection current @ >1.5V on the Alt-A Pairset	≤ 5mA PASS/FAIL	Isc	PSE12 PSE17 PSE21	145.2.6.2 145.2.7
Isc_Init_B	Peak detection current @ >1.5V on the Alt-B Pairset				
Isc_Det_A	Peak detection current @ >2.2V on the Alt-A Pairset				
Isc_Det_B	Peak detection current @ >2.2V on the Alt-B Pairset				
Det_Slew_A	Maximum expected detection voltage slew rate on the Alt-A Pairset	≤ 0.1 V/µsec PASS/FAIL	Vslew	**Approx.Test Time**	
Det_Slew_B	Maximum expected detection voltage slew rate on the Alt-B Pairset			**18-39 seconds**	

Test: det_time *(Detection-Connection Check Timing)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Detect_Time_Tdet_A	Time from start of detection until end of detection on the Alt-A Pairset	≤ 500 msec PASS/FAIL	Tdet	PSE4 PSE5 PSE7 PSE57 *As drafted, PICS are not complete*	145.2.5 145.2.5.1 145.2.10
Detect_Time_Tdet_B	Time from start of detection until end of detection on the Alt-A Pairset				
Backoff_Time_SS	(IDLE state) Time from end of a detection sequence until start of a new detection sequence given an invalid Single Signature	≥ 15 msec PASS/INFO (EA Tests: PASS/FAIL)	Tdbo		
Backoff_Time_DS	(IDLE state) Time from end of a detection sequence until start of a new detection sequence given invalid signature on the Alt-A pairset.				
Det2Det_Time	CC_DET_SEQ 0, 1, and 3 ONLY: The time duration between the end of detection on the PRI Pairset and the start of detection on the SEC pairset.	≤ 400msec PASS/FAIL	Tdet2det		
Det+CC_Time	CC_DET_SEQ 2 ONLY: The total time duration of Detection on both pairsets and Connection Check.	≤ 500 msec PASS/FAIL	Tdet	**Approx.Test Time**	

Test: det_time *(Detection-Connection Check Timing)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
CC2Det_Time	CC_DET_SEQ 0, 3 ONLY: The time from end of Connection Check until start of the first Pairset Detection.	≤ 400msec PASS/FAIL	Tcc2det	**35 seconds**	

Test: det_rsource *(Detection Source Impedance)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
PSE_Detect_Source	PSE Detection Scheme. 0= Voltage probing, 1= Current probing.	0 or 1 PASS/INFO		PSE11	145.2.6.1
PSE_Source_Zout_A	The source impedance of the Detection probing on the Alt-A Pairset. A pure voltage source will report as 0 Ω.	0 or ≥ 45KΩ PASS/FAIL	Zsource	**Approx.Test Time**	
PSE_Source_Zout_B	The source impedance of the Detection probing on the Alt-B Pairset. A pure voltage source will report as 0 Ω.			**23 seconds**	

Test: det_range *(Detection Accept/Reject Ranges)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Rgood_Max_Single	Maximum Detection signature resistance that gets powered given a Single Signature PD	27 KΩ to 32KΩ PASS/FAIL	Rgood, Rbad	PSE9 PSE18 PSE19 PSE56	145.2.6 145.2.6.3 145.2.6.4 145.2.9
Rgood_Min_Single	Minimum Detection signature resistance that gets powered given a Single Signature PD	16 KΩ to 19 KΩ PASS/FAIL			
Cgood_Max_Single	Maximum Capacitive signature that gets powered given a Single Signature PD	< 10µF PASS/FAIL	Cgood, Cbad		
Rgood_Max_Dual_A	Maximum Detection signature resistance that gets powered on the Alt-A Pairset given a Dual Signature PD	27 KΩ to 32KΩ PASS/FAIL	Rgood, Rbad		
Rgood_Max_Dual_B	Maximum Detection signature resistance that gets powered on the Alt-B Pairset given a Dual Signature PD				
Rgood_Min_Dual_A	Minimum Detection signature resistance that gets powered on the Alt-A Pairset given a Dual Signature PD	16 KΩ to 19 KΩ PASS/FAIL			
Rgood_Min_Dual_B	Minimum Detection signature resistance that gets powered on the Alt-B Pairset given a Dual Signature PD				
Cgood_Max_Dual_A	Maximum Capacitive signature that gets powered on the Alt-A Pairset given a Dual Signature PD	< 10µF PASS/FAIL	Cgood, Cbad	**Approx.Test Time**	
Cgood_Max_Dual_B	Maximum Capacitive signature that gets powered on the Alt-B Pairset given a Dual Signature PD			**172-195 seconds**	

Test: cc_response *(Connection Check Validity)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Single_Sig_Response	Flag indicating that the PSE properly characterized a Single Signature PD prior to powering. 1= Success, 0= Failure.	= 1		PSE4 PSE56	145.2.5 145.2.9
Dual_Sig_Response	Flag indicating that the PSE properly characterized a Dual Signature PD prior to powering. 1= Success, 0= Failure.	= 1			

Test: cc_response *(Connection Check Validity)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
2Pair_PD_A	Flag indicating the count of Pairsets powered when a valid PD signature is connected only on the Alt-A Pairset. 0= No Pairsets powered, 1= Alt-A Pairset powered, 2= both pairsets powered.	< 2		**Approx.Test Time**	
2Pair_PD_B	Flag indicating the count of Pairsets powered when a valid PD signature is connected only on the Alt-B Pairset. 0= No Pairsets powered, 1= Alt-A Pairset powered, 2= both pairsets powered.	< 2		**75-115 seconds**	

6.7.3. 4-Pair PSE Conformance Tests – Classification and LLDP Processes

The 802.3bt specification significantly extended the complexity of PD classification used as a means for the PSE and the PD to mutually understand the PD's power requirements and to agree on what power level the PSE can support (*see Section 2.8*). As a consequence of this, the testing burden around classification is significantly increased.

As with the 802.3at specification, the 802.3bt specification requires that all PD's seeking more than 13W power levels support PoE LLDP so that when powered by PSE's that support PoE LLDP, power demand can be negotiated to much higher granularity. 802.3bt extended the PoE LLDP protocol significantly in support of both single and dual signature PD's (*see Section 2.10*).

This section describes tests and parameters used to qualify PSE classification and where applicable, PSE LLDP behaviors.

Test: class_v *(Classification Voltages)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Vclass_max_SS	Maximum Class Event Voltage measured as the peak of both pairsets given a Single Signature PD emulation	15.5V to 20.5V	Vclass	PSE30 PSE31 PSE38 PSE40 PSE42 PSE44 PSE49 PSE50 PSE52 PSE53	145.2.8 145.2.8.1
Vclass_min_SS	Minimum Class Event Voltage measured as the peak of both pairsets given a Single Signature PD emulation	PASS/FAIL			
Vmark_SS	Median Mark region voltage from the peak of both pairsets given a Single Signature PD emulation	7V to 10V PASS/FAIL	Vmark		
Vreset_SS	If the PSE utilizes a Class Probe given Single Signature PD connection, this is the maximum voltage following the completion of the class probe until the start of Event 1 Classification. Reports -1 if there is no class reset.	≤ 2.8V PASS/FAIL	Vreset		
Vclass_max_DSA	Maximum Class Event Voltage on the Alt-A Pairset given a Dual Signature PD emulation	15.5V to 20.5V	Vclass		
Vclass_max_DSB	Maximum Class Event Voltage on the Alt-B Pairset given a Dual Signature PD emulation				
Vclass_min_DSA	Minimum Class Event Voltage on the Alt-A Pairset given a Dual Signature PD emulation	PASS/FAIL			
Vclass_min_DSB	Minimum Class Event Voltage on the Alt-B Pairset given a Dual Signature PD emulation				
Vmark_DSA	Median Mark region voltage on the Alt-A Pairset given a Dual Signature PD emulation	7V to 10V	Vmark		
Vmark_DSB	Median Mark region voltage on the Alt-B Pairset given a Dual Signature PD emulation	PASS/FAIL			
Vreset_DSA	If the PSE utilizes a Class Probe given Dual Signature PD connection, this is the min. voltage following the completion of the class probe until the start of Event 1 Classification on the Alt-A Pairset. Reports -1 if there is no class reset.	≤ 2.8V PASS/FAIL	Vreset	**Approx.Test Time**	
Vreset_DSB	If the PSE utilizes a Class Probe given Dual Signature PD connection, this is the min. voltage following the completion of the class probe until the start of Event 1 Classification on the Alt-**A** Pairset. Reports -1 if there is no class reset.			**203 seconds**	

Test: class_time *(Classification Timing)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Class_Probe_SS	Flag indicating if a Class Probe is discovered given a Single Signature PD. 1= Class Probe Discovered, 0= No Class Probe.	0 to 1 PASS/INFO		PSE27 PSE28 PSE30 PSE31 PSE32 PSE33 PSE34 PSE35 PSE38 PSE40 PSE41 PSE43 PSE45 PSE50 PSE51 PSE52 PSE53	145.2.8 145.2.8.1
EV_Count_7_SS	Class Event Count in response to Class 7 (Single Signature) PD on either the Alt-A or Alt-B pairset.	1 to 5 PASS/FAIL			
Long_EV1_Time_SS	Duration of Event #1 (LCE) Class Pulse prior to power-up given a Single Signature PD connection.	88 msec to 105 msec PASS/FAIL	Tlce		
Min_Class_EV_Time_SS	Minimum duration of any non-LCE Class Event prior to power-up given a Single Signature PD.	6 msec to 20 msec PASS/FAIL	Tcev		
Max_Class_EV_Time_SS	Maximum duration of any non-LCE Class Event prior to power-up given a Single Signature PD.				
Min_Mark_EV_Time_SS	Minimum duration of any non-final Mark Event prior to power-up given a Single Signature PD.	6 msec to 12 msec PASS/FAIL	Tme1		
Max_Mark_EV_Time_SS	Maximum duration of any non-final Mark Event prior to power-up given a Single Signature PD.				
Final_Mark_EV_Time_SS	Duration of the final Mark Event leading into Power-Up given a Single Signature PD.	6 msec to 256 msec PASS/FAIL	Tme2		
Cl_Prb_Reset_Time_SS	If the PSE utilizes a Class Probe given Single Signature PD connection, this is the time duration from end-of-Class-Probe until start of Event #1. Set to -1 if no class probing.	≥ 15msec or -1 PASS/FAIL	Treset		
Class_Probe_DA	Flag indicating if a Class Probe is discovered on the Alt-A Pairset given a Dual Signature PD. 1= Class Probe Discovered, 0= No Class Probe.	0 to 1 PASS/INFO			
EV_Count_5D_DA	Class Event Count on the Alt-A Pairset in response to a Dual Class 5 PD	1 to 4 PASS/FAIL			
Long_EV1_Time_DA	Duration of Event #1 (LCE) Class Pulse prior to power-up on the Alt-A Pairset given a Dual Signature PD connection.	88 msec to 105 msec PASS/FAIL	Tlce		
Min_Class_EV_Time_DA	Minimum duration of any non-LCE Class Event on the Alt-A Pairset prior to power-up given a Dual Signature PD.	6 msec to 20 msec PASS/FAIL	Tcev		
Max_Class_EV_Time_DA	Maximum duration of any non-LCE Class Event on the Alt-A Pairset prior to power-up given a Dual Signature PD.				
Min_Mark_EV_Time_DA	Minimum duration of any non-final Mark Event on the Alt-A Pairset prior to power-up given a Dual Signature PD.	6 msec to 12 msec PASS/FAIL	Tme1		
Max_Mark_EV_Time_DA	Maximum duration of any non-final Mark Event on the Alt-A Pairset prior to power-up given a Dual Signature PD.				
Final_Mark_EV_Time_DA	Duration of the final Mark Event on the Alt-A Pairset leading into Power-Up given a Dual Signature PD.	6 msec to 256 msec PASS/FAIL	Tme2		
Cl_Prb_Reset_Time_DA	If the PSE utilizes a Class Probe on the Alt-A Pairset given a Dual Signature PD connection, this is the time duration from end-of-Class-Probe until start of Event #1. Set to -1 if no class probing.	≥ 15msec or -1 PASS/FAIL	Treset		
Class_Probe_DB	Flag indicating if a Class Probe is discovered on the Alt-B Pairset given a Dual Signature PD. 1= Class Probe Discovered, 0= No Class Probe.	0 to 1 PASS/INFO			
EV_Count_5D_DB	Class Event Count on the Alt-B Pairset in	1 to 4			

Test: class_time *(Classification Timing)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
	response to a Dual Class 5 PD	PASS/FAIL			
Long_EV1_Time_DB	Duration of Event #1 (LCE) Class Pulse prior to power-up on the Alt-B Pairset given a Dual Signature PD connection.	88 msec to 105 msec PASS/FAIL	Tlce		
Min_Class_EV_Time_DB	Minimum duration of any non-LCE Class Event on the Alt-B Pairset prior to power-up given a Dual Signature PD.	6 msec to 20 msec PASS/FAIL	Tcev		
Max_Class_EV_Time_DB	Maximum duration of any non-LCE Class Event on the Alt-B Pairset prior to power-up given a Dual Signature PD.				
Min_Mark_EV_Time_DB	Minimum duration of any non-final Mark Event on the Alt-B Pairset prior to power-up given a Dual Signature PD.	6 msec to 12 msec PASS/FAIL	Tme1		
Max_Mark_EV_Time_DB	Maximum duration of any non-final Mark Event on the Alt-B Pairset prior to power-up given a Dual Signature PD.				
Final_Mark_EV_Time_DB	Duration of the final Mark Event on the Alt-B Pairset leading into Power-Up given a Dual Signature PD.	6 msec to 256 msec PASS/FAIL	Tme2	**Approx.Test Time**	
Cl_Prb_Reset_Time_DB	If the PSE utilizes a Class Probe on the Alt-B Pairset given a Dual Signature PD connection, this is the time duration from end-of-Class-Probe until start of Event #1. Set to -1 if no class probe.	≥ 15msec or -1 PASS/FAIL	Treset	**82 - 110 seconds**	

Test: class_response *(Class response to all PD types)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Class_3_Count	Class Event count in response to Class 3 (Single Signature) PD	= 1 PASS/FAIL		PSE2 PSE4	145.2.4 145.2.5
Class_4_Count	Class Event count in response to Class 4 (Single Signature) PD	1 to 3 PASS/FAIL		PSE8 PSE27	145.2.5.1 145.2.5.4
Class_5_Count	Class Event count in response to Class 5 (Single Signature) PD	1 to 4 PASS/FAIL		PSE28 PSE29	145.2.8
Class_6_Count	Class Event count in response to Class 6 (Single Signature) PD	1 to 4 PASS/FAIL		PSE32 PSE33	
Class_7_Count	Class Event count in response to Class 7 (Single Signature) PD	1 to 5 PASS/FAIL		PSE34 PSE35	145.2.8.1
Class_8_Count	Class Event count in response to Class 8 (Single Signature) PD	1 to 5 PASS/FAIL		PSE36 PSE37	
Class_2D_Count_A	Class Event count on the Alt-A Pairset in response to a Dual Class 2 PD	1 to 3 PASS/FAIL		PSE51	
Class_2D_Count_B	Class Event count on the Alt-B Pairset in response to a Dual Class 2 PD				
Class_3D_Count_A	Class Event count on the Alt-A Pairset in response to a Dual Class 3 PD	1 to 3 PASS/FAIL			
Class_3D_Count_B	Class Event count on the Alt-B Pairset in response to a Dual Class 3 PD				
Class_4D_Count_A	Class Event count on the Alt-A Pairset in response to a Dual Class 4 PD	1 to 3 PASS/FAIL			
Class_4D_Count_B	Class Event count on the Alt-B Pairset in response to a Dual Class 4 PD				
Class_5D_Count_A	Class Event count on the Alt-A Pairset in response to a Dual Class 5 PD	1 to 4 PASS/FAIL			
Class_5D_Count_B	Class Event count on the Alt-B Pairset in response to a Dual Class 5 PD				
Max_SS_Class	Maximum Single Signature PD Class that the PSE will assign at power-up	2 to 8 PASS/FAIL			

Test: class_response *(Class response to all PD types)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Max_DS_Class	Maximum Dual Signature PD Class that both Alt-A and Alt-B Pairsets will assign at power-up	1 to 5 PASS/FAIL			
Init_Grant_Match	Flag indicating that the maximum power granted to Dual Signature PD's corresponds to the maximum power granted to Single Signature PD's. 1= Correspondance, 0 = Inconsistent	= 1 PASS/FAIL			
2-Pair_Pairset	Flag indicating which Pairset gets 2-Pair powered if and when the PSE performs 2-Pair powering. Set to 0 if PSE always 4-Pair powers, 1 if Alt-A Pairset powered, 2 if Alt-B Pairset powered.	0 to 2 PASS/INFO		**Approx.Test Time**	
PRI_4pr_Pairset	Primary (PRI) Pairset where Classification occurs given Single Signature PD connection. 1= Alt-A Pairset, 2= Alt-B Pairset, 12= Either Pairset.	1, 2, 12 PASS/INFO		**224 seconds**	

Test: class_err *(Processing of deviant class signatures)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Class_Ilim_A	Classification Event current limit on the Alt-A Pairset.	51 mA to 100 mA PASS/FAIL	Iclass_lim	PSE4 PSE30 PSE31 PSE46 PSE47 PSE48 PSE51 *As drafted, PICS are not complete*	145.2.5 145.2.8.1
Class_Ilim_B	Classification Event current limit on the Alt-B Pairset.				
Pwr_Cl_52_SS	Flag indicating if PSE powers a 52mA Class signature given a Single Signature PD. 0= No Power. 1= Power Applied.	= 0 PASS/FAIL			
Pwr_Cl_52_DSA	Flag indicating if PSE powers the Alt-A Pairset a 52mA Class signature given a Dual Signature PD. 0= No Power. 1= Power Applied.	= 0 PASS/FAIL			
Pwr_Cl_52_DSB	Flag indicating if PSE powers the Alt-B Pairset a 52mA Class signature given a Dual Signature PD. 0= No Power. 1= Power Applied.				
Class_Reset_SS	Flag indicating if PSE produces at least 15msec of IDLE time and voltage on both pairsets following an aborted classification sequence. Tested using 55mA class signature with single signature emulation.	= 1 PASS/FAIL	Treset		
Class_Reset_DS	Flag indicating if PSE produces at least 15msec of IDLE time and voltage on each pairset following an aborted classification sequences. Tested using 55mA class signature on each pairset with dual signature emulation.	= 1 PASS/FAIL			
Mark_Ilim_A	Mark Event current limit on the Alt-A Pairset.	6 mA to 100 mA PASS/FAIL	Imark_lim		
Mark_Ilim_B	Mark Event current limit on the Alt-B Pairset.				
Inval_Sig_EV2_SS	Flag indicating if the PSE powers an uneven 2-Event classification given a Single Signature PD where Event 1 is 40mA, Event 2 is 18 mA. 0 = No Power, 1= PSE dropped back to 1-event, 2= PSE Powered.	= 0 PASS/FAIL			
Inval_Sig_EV4_SS	Flag indicating if the PSE powers an uneven 4-Event classification given a Single Signature PD where Event #4 differs from Event #3. 0 = No Power, 1= PSE dropped back to 1-3 events, 2= PSE Powered.	= 0 PASS/FAIL			
Inval_Sig_EV5_SS	Flag indicating if the PSE powers an uneven 5-Event classification given a Single Signature PD where Event #5 differs from Event #4. 0 = No Power, 1= PSE dropped back to 1-4 events, 2= PSE Powered.	= 0 PASS/FAIL			
Inval_Sig_EV2_DSA	Flag indicating if the PSE powers the Alt-A Pairset following an uneven 2-Event classification given a Dual Signature PD. 0 = No Power, 1= PSE dropped back to 1-event, 2= PSE Powered.	= 0 PASS/FAIL			
Inval_Sig_EV2_DSB	Flag indicating if the PSE powers the Alt-B Pairset following an uneven 2-Event classification given a Dual Signature PD. 0 = No Power, 1= PSE dropped back to 1-event, 2= PSE Powered.				

Test: class_err *(Processing of deviant class signatures)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Inval_Sig_EV4_DSA	Flag indicating if the PSE powers the Alt-A Pairset following an uneven 4-Event classification where Event #4 differs from Event #3 given a Dual Signature PD. 0 = No Power, 1= PSE dropped back to 1 -3 events, 2= PSE Powered.	= 0 PASS/FAIL		**Approx.Test Time**	
Inval_Sig_EV4_DSB	Flag indicating if the PSE powers the Alt-B Pairset following an uneven 4-Event classification where Event #4 differs from Event #3 given a Dual Signature PD. 0 = No Power, 1= PSE dropped back to 1 -3 events, 2= PSE Powered.			**110 - 225 seconds**	

Test: class_lldp *(LLDP protocol & negotiation – Single Sig.)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
PSE_LLDP_Time_SS	Time from Power On to 1st LLDP Frame. -1 = No Frame Received < 45 seconds	0 to 10 sec PASS/FAIL		DLL1 DLL2 DLL3 DLL4 DLL5 DLL7 DLL9 DLL12 PVT3 PVT5 - PVT8 PVT9 - PVT10 PVT11 PVT12 - PVT14 PVT17 PVT18 PVT19 PVT22 PVT25 PVT26 PVT30 PVT38 PVT40 - PVT44	145.5.1 145.5.2 145.5.3 145.5.4 79.3.2 79.3.2.1 79.3.2.2 79.3.2.3 79.3.2.4
LLDP_Length	TLV Length Field. 29 for 802.3bt	= 29 PASS/FAIL			
PSE_Pwr_Pair	MDI Legacy Powered Pair. Confirm the value of either 1 or 2. All other values fail. Value = 1 means the Signal Pairs are in use. Value = 2 means the Spare Pairs are in use.	1 to 2 PASS/FAIL			
PSE_MDI_Pwr_Sup	MDI Power Support Field. 4 bit value where bits 0-2 are set and bit 3 is don't care.	= 7 PASS/FAIL			
PSE_Pwr_Class	MDI 802.3at PSE Class Support. Class 4 and above will specify 4	3 to 4 PASS/FAIL			
PSE_Source_Priority	MDI 802.3at Type-Source-Priority field. If PSE is Type-3 and Type-4 it will specify Type-2	= 0 PASS/FAIL			
PSE_Ext_Type	Extended PSE Type. Either Type-3 or Type-4	3 or 4 PASS/FAIL			
PSE_Ext_Status_SS	Powering Status of PSE. =41 if set to Both_Alts and 4pr_Pwr_Single. =21 if et to Alt_A or Alt_B and 2pr_Pwr. Otherwise set to 0.	= 41 PASS/FAIL			
PSE_Ext_Class_SS	Assigned Class available from the PSE. =41 if Class between 1 and 8 and 4pr_Pwr_Single. =21 if Class between 1 and 4 and 2pr_Pwr. Otherwise set to 0	= 41 PASS/FAIL			
PSE_Max_Pwr_SS	Reported PSE maximum available port power. There are no restrictions on this value.	0.1W to 99.9W PASS/FAIL			
PSE_Class_6_Ext_Pwr	Flag indicating that PSE allows extended power allocations to a Class 6 PD. If PSE_Max_Pwr_SS reports > 51.0 watts, a class 6 LLDP power request exceeding 51.0 watts is performed. 0 = Power Allocation limited to 51.0 watts and 1= Power Allocation exceeded 51.0 watts.	= 0			

Test: class_lldp *(LLDP protocol & negotiation – Single Sig.)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
PSE_Pwr_Class_DS	Value of the Dual-sig Extended Class for Alt-A and Alt-B. Set to 1 if both TLVs are set to Single Signature otherwise set to 0.	= 1 PASS/FAIL			
PSE_Echo_Time_1SS	Time from a PD request for an initial power until the frame containing the Echo of that request is received	0 to 10 sec PASS/FAIL			
PSE_Alloc_Time_1SS	Time from a PD request for an initial power until the frame containing the Allocation of that request is received	0 to 30 sec PASS/INFO			
PSE_Alloc_LowPwr_1SS	Power Allocated by the PSE when requesting an initial power	8.1W to 71.3W PASS/FAIL			
PSE_Echo_Time_2SS	Time from a PD request for a change to the max power available until the frame containing the Echo of that request is received	0 to 10 sec PASS/FAIL			
PSE_Alloc_Time_2SS	Time from a PD request for a change to the max power available until the frame containing the Allocation of that request is received	0 to 30 sec PASS/INFO			
PSE_Alloc_MaxPwr_2SS	Indicates Power was Allocated by the PSE when requesting a change to the max power available. =1 if Allocated, =0 if Not Allocated	= 1 PASS/FAIL			
PSE_Alloc_MaxPwr_2SS	Indicates Power was Allocated by the PSE when requesting a change to the max power available.	= 1 PASS/INFO			
PSE_AT_Pwr_Neg	Indicates the PSE can successfully negotiate power using the 802.3at LLDP Protocol.	= 1 PASS/INFO		**Approx.Test Time**	
Link_Down_Shutdown	Disconnect the LAN. Set to 1 if Power NOT removed. 0 if Power removed	= 1 PASS/FAIL		**165 -190 seconds**	

Test: class_lldp2 *(LLDP protocol & negotiation – Dual Sig.)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
PSE_LLDP_Time_DS	Time from Power On to 1st LLDP Frame. -1 = No Frame Received < 45 seconds	0 to 10 sec PASS/FAIL		DLL1 DLL2 DLL3 DLL4 DLL5 DLL7 DLL9 DLL12 PVT3 PVT5 - PVT8 PVT9 - PVT10 PVT11 PVT12 - PVT14 PVT17 PVT20 PVT21 PVT25 PVT26 PVT31 PVT34 PVT35 PVT39 PVT40	145.5.1 145.5.2 145.5.3 145.5.4 79.3.2 79.3.2.1 79.3.2.2 79.3.2.3 79.3.2.4
PSE_Ext_Status_DS	Powering Status of PSE. =42 if set to Both_Alts and 4pr_Pwr_Dual =21 if et to Alt_A or Alt_B and 2pr_Pwr. Otherwise set to 0.	= 42 PASS/FAIL			
PSE_Ext_Class_DSA	Assigned Class available from the PSE on Alt-A. =42 if Class between 1 and 5 and 4pr_Pwr_Dual. =21 if Class between 1 and 4 and 2pr_Pwr. Otherwise set to 0	= 42 PASS/FAIL			
PSE_Ext_Class_DSB	Assigned Class available from the PSE on Alt-B. =42 if Class between 1 and 5 and 4pr_Pwr_Dual. =21 if Class between 1 and 4 and 2pr_Pwr. Otherwise set to 0	= 42 PASS/FAIL			
PSE_Max_Pwr_DS	Reported PSE maximum available port power. There are no restrictions on this value. Value is the sum of both pairsets.	0.1W to 99.3W PASS/FAIL			
PSE_Pwr_Class_SS	Value of the Single-sig Extended Class for Alt-A and Alt-B. Set to 1 if TLV is set to Single Signature otherwise set to 0.	= 1 PASS/FAIL			
PSE_Echo_Time_1DS	Time from a PD request for a change to a low power until the frame containing the Echo of that request is received	0 to 10 sec PASS/FAIL			
PSE_Alloc_Time_1DS	Time from a PD request for a change to a low power until the frame containing the Allocation of that request is received	0 to 30 sec PASS/INFO			

Test: class_lldp2 *(LLDP protocol & negotiation – Dual Sig.)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
PSE_Alloc_LowPwr_1DSA	Power Allocated on Alt-A by the PSE when requesting a change to a low power	8.1W to 71.3W PASS/INFO		PVT41	
PSE_Alloc_LowPwr_1DSB	Power Allocated on Alt-B by the PSE when requesting a change to a low power				
PSE_Echo_Time_2DS	Time from a PD request for a change to the max power available until the frame containing the Echo of that request is received	0 to 10 sec PASS/FAIL			
PSE_Alloc_Time_2DS	Time from a PD request for a change to the max power available until the frame containing the Allocation of that request is received	0 to 30 sec PASS/INFO			
PSE_Alloc_MaxPwr_2DSA	Indicates Power was Allocated on Alt-A by the PSE when requesting a change to the max power available. =1 if Allocated, =0 if Not Allocated	= 1 PASS/FAIL			
PSE_Alloc_MaxPwr_2DSB	Indicates Power was Allocated on Alt-B by the PSE when requesting a change to the max power available. =1 if Allocated, =0 if Not Allocated			**Approx.Test Time**	
PSE_Alloc_Limit_DS	Flag indicating if PSE will over-allocate to a Class 3 D power-up. 1 = max allocation consistent with assigned pairset classe. 0= allocation exceeded pairset assigned classes.	= 1 PASS/FAIL		**153 seconds**	

6.7.4. 4-Pair PSE Conformance Tests – Power-Up Processes

Power-Up processes pertain to the PSE operating in the POWER_UP state following classification (*see Section 2.9*). Two tests cover timing related parameters and inrush current handling.

As with classification testing, there are a wider field of PD emulations required in order to assess timing and inrush characteristics. Specifically regarding the inrush tests, PSE's are required to behave in accordance with the Assigned PD Class that is the combination of the PD advertised class and the PSE powering capability. This adds considerable complexity beyond the 802.3at requirements covered in the 2-Pair test suite. Additionally, the test must deal with PSE's that power either with 2-pairs or 4-pairs given PD classes 1-4.

Test: pwrup_time *(Power-Up Timing Behavior)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Pwr_On_Time_Tpon_SS	Time duration from the end of Detection and Connection Check until the end of the POWER_UP state given a Single Signature PD.	≤ 400msec PASS/FAIL	Tpon	PSE4 PSE7 PSE57 PSE60 PSE80 PSE81 *As drafted, PICS are not complete*	145.2.5 145.2.10.14
Pwr_On_Time_Tpon_DSA	Time duration from the end of Detection and Connection Check until the end of the POWER_UP state on the Alt-A Pairset given a Dual Signature PD.	≤ 400msec PASS/FAIL			
Pwr_On_Time_Tpon_DSB	Time duration from the end of Detection and Connection Check until the end of the POWER_UP state on the Alt-B Pairset given a Dual Signature PD.				
Pwrup_Rise_Time_A	Estimated time (μsec) for the Alt-A Pairset to transit from 10% of Vpse to 90% of Vpse while applying power.	≥ 15 μsec PASS/FAIL	Trise		
Pwrup_Rise_Time_B	Estimated time (μsec) for the Alt-B Pairset to transit from 10% of Vpse to 90% of Vpse while applying power.				
Pwr_Stagger_Time_SS4	Time duration between primary (PRI) Pairset power-up and secondary (SEC) pairset power-up given Single Signature Class 4. Set to 0 for simultaneous power-ups and to -1 for 2-pair power-ups.	≤ 75 msec or -1 PASS/FAIL			

Test: pwrup_time *(Power-Up Timing Behavior)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Pwr_Stagger_Time_SS5	Time duration between primary (PRI) Pairset power-up and secondary (SEC) pairset power-up given Single Signature Class 5. Set to 0 for simultaneous power-ups and to -1 for 2-pair power-ups.	≤ 75 msec PASS/FAIL		**Approx.Test Time**	
Pwr_Stagger_Time_DS	Time duration between primary (PRI) Pairset power-up and secondary (SEC) pairset power-up given Dual Signature PD. Set to 0 for simultaneous power-ups and to -1 for 2-pair power-ups.	≤ 1000 msec PASS/INFO		**155-186 seconds**	

Test: pwrup_inrush *(Power-Up Inrush Behavior)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Iinrush_min_Class_3	Minimum 4-Pair Inrush current from power-up until 50msec after power-up given Single Signature Class 3 PD	≥ 400mA PASS/FAIL	Iinrush	PSE4 PSE57 PSE68 PSE69 PSE70	145.2.5 145.2.10.7
Iinrush_min_Class_5	Minimum 4-Pair Inrush current from power-up until 50msec after power-up given Single Signature Class 5 PD	≥ 400mA PASS/FAIL			
Iinrush_min_Class_7	Minimum 4-Pair Inrush current from power-up until 50msec after power-up given Single Signature Class 7 PD	Type-4: ≥ 800mA Type-3: ≥ 400mA PASS/FAIL			
Iinrush_min_Class_1D_A	Minimum Alt-A Pairset Inrush current from power-up until 50msec after power-up given Dual Signature Class PD	≥ 400mA PASS/FAIL	Iinrush_2p		
Iinrush_min_Class_1D_B	Minimum Alt-B Pairset Inrush current from power-up until 50msec after power-up given Dual Signature Class PD				
Iinrush_4P_max_Class_3	Maximum 4-Pair Inrush current from 1msec after power-up until shutdown given a Single Signature Class 3 PD	≤ 450mA PASS/FAIL	Iinrush		
Iinrush_4P_max1_Class_5	Maximum 4-Pair Inrush current from 1msec after power-up until shutdown given a Single Signature Class 5 PD and given a PSE that grants a maximum of Class 4 power.	≤ 450mA PASS/FAIL			
Iinrush_4P_max2_Class_5	Maximum 4-Pair Inrush current from 1msec after power-up until shutdown given a Single Signature Class 5 PD and given a PSE that grants greater than Class 4 power.	≤ 900mA PASS/FAIL			
Iinrush_4P_max1_Class_7	Maximum 4-Pair Inrush current from 1msec after power-up until shutdown given a Single Signature Class 7 PD and given a PSE that grants a maximum of Class 4 power.	≤ 450mA PASS/FAIL			
Iinrush_4P_max2_Class_7	Maximum 4-Pair Inrush current from 1msec after power-up until shutdown given a Single Signature Class 7 PD and given a PSE that grants greater than Class 4 power.	≤ 900mA PASS/FAIL			
Iinrush_2P_max_Class_3	Maximum 2-Pair Inrush current from 1msec after power-up until shutdown given a Single Signature Class 3 PD.	≤ 450mA PASS/FAIL	Iinrush_2p		
Iinrush_2P_max1_Class_7	Maximum 2-Pair Inrush current from 1msec after power-up until shutdown given a Single Signature Class 7 PD and given a PSE that grants a maximum of Class 4 power.	≤ 450mA PASS/FAIL			
Iinrush_2P_max2_Class_7	Maximum 2-Pair Inrush current from 1msec after power-up until shutdown given a Single Signature Class 7 PD and given a PSE that grants greater than Class 4 power.	≤ 600mA PASS/FAIL			

Test: pwrup_inrush *(Power-Up Inrush Behavior)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Iinrush_2p_max_Cl_1D_A	Maximum 2-Pair Inrush current on the Alt-A Pairset from 1msec after power-up until shutdown given a Dual Signature Class 1 PD.	≤ 450mA PASS/FAIL			
Iinrush_2p_max_Cl_1D_B	Maximum 2-Pair Inrush current on the Alt-B Pairset from 1msec after power-up until shutdown given a Dual Signature Class 1 PD.				
Tinrush_minPr_Class_3	Inrush Shutdown Time measured from power-up until power removal given Single Signature Class 3 PD - minimum of the Alt-A and Alt-B Pairsets	50msec to 75 msec PASS/FAIL	Tinrush		
Tinrush_maxPr_Class_3	Inrush Shutdown Time measured from power-up until power removal given Single Signature Class 3 PD - maximum of the Alt-A and Alt-B Pairsets				
Tinrush_minPr_Class_7	Inrush Shutdown Time measured from power-up until power removal given Single Signature Class 7 PD - minimum of the Alt-A and Alt-B Pairsets	50msec to 75 msec PASS/FAIL			
Tinrush_maxPr_Class_7	Inrush Shutdown Time measured from power-up until power removal given Single Signature Class 7 PD - maximum of the Alt-A and Alt-B Pairsets				
Tinrush_Class_1D_A	Inrush Shutdown Time measured from power-up until power removal on the Alt-A Pairset given Dual Signature Class 1 PD	50msec to 75 msec PASS/FAIL			
Tinrush_Class_1D_B	Inrush Shutdown Time measured from power-up until power removal on the Alt-B Pairset given Dual Signature Class 1 PD				
Delay_Inrush_Class_7	Inrush Shutdown Time measured from power-up until power removal on both Pairsets given a Single Signture Class 7 PD and an inrush overload that is delayed by 25msec from power-up	50msec to 75 msec PASS/FAIL			
Delay_Inrush_Class_2D_A	Inrush Shutdown Time measured on the Alt-A Pairset from power-up until power removal given a Dual Signture Class 1 PD and an inrush overload that is delayed by 25msec from power-up of the Alt-A Pairset	50msec to 75 msec PASS/FAIL			
Delay_Inrush_Class_2D_B	Inrush Shutdown Time measured on the Alt-B Pairset from power-up until power removal given a Dual Signture Class 1 PD and an inrush overload that is delayed by 25msec from power-up of the Alt-B Pairset				
45ms_Pwr_Stat_Class_7	Flag indicating if PSE maintained power when a 45msec Inrush current overload is applied given a Single Signature Class 7 PD. 1= Power Maintained, 0= Power Removed.	= 1 PASS/FAIL			
45ms_Pwr_Stat_Class_2D_A	Flag indicating if PSE maintained power on the Alt-A Pairset when a 45msec Inrush current overload is applied given a Dual Signature Class 2 PD. 1= Power Maintained, 0= Power Removed.	= 1 PASS/FAIL			
45ms_Pwr_Stat_Class_2D_B	Flag indicating if PSE maintained power on the Alt-B Pairset when a 45msec Inrush current overload is applied given a Dual Signature Class 2 PD. 1= Power Maintained, 0= Power Removed.	= 1 PASS/FAIL			
Vinrush_Class_2D_A	Inrush voltage on the Alt-A Pairset while the PSE is in current limit.	30V to 60V PASS/FAIL			
Vinrush_Class_2D_B	Inrush voltage on the Alt-B Pairset while the PSE is in current limit.				
Iinrush_16V_DS3A	Minimum inrush current following foldback to ~16V on the Alt-A pairset with Class 3D emulation. Measured over 10msec interval.	≥ 60 mA	Iinrush_2p	**Approx.Test Time**	
Iinrush_16V_DS3B	Minimum inrush current following foldback to ~16V on the Alt-B pairset with Class 3D emulation. Measured over 10msec interval.			**194-230 seconds**	

6.7.5. 4-Pair PSE Conformance Tests – Power-On State

The tests in this section cover the POWER_ON state of a 4-Pair 802.3bt PSE. These tests must address a very demanding set of requirements covering PSE behaviors when powering a representative set of all possible 802.3at and 802.3bt PD's. Under the 802.3bt standard, a total of 8 Single Signature and 5 Dual Signature PD classes are described and all PSE's must be able to work with any of these 13 PD "flavors" including appropriate power demotion cases (see Sections 2.11 and 2.12). This compares with 2 PD types under 802.3at.

The Power-On state testing assesses PSE voltages, steady state power capacity, and transient overload behaviors. In addition, a new category of test for pair-to-pair unbalance is added to address PSE responses to asymmetrical power delivery between pairsets (Alt-A and Alt-B) as Single Signature PD's are powered. For PSE's that support 802.3bt autoclass, a test is added to assess that PSE records and responds to autoclass signatures properly.

In certain tests within this group, some parameters associated with PD classes above the maximum assigned class a PSE grants will not be tested and/or reported. In particular, this affects certain "short circuit" (**pwron_maxi**) and peak transient (**pwron_overld**) parameters where the testing of power demotion cases is of marginal value.

Test: pwron_v *(Powered Pairset Voltages)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Vpse_Max_Alt_A	PSE output voltage on the Alt-A Pairset when PSE is powered and lightly loaded (~1W).	Type-3: 50V to 57V Type-4: 52V to 57V PASS/FAIL	Vport_pse_2p	PSE57 PSE58 PSE61 PSE64	145.2.10 145.2.10.1 145.2.10.3 145.2.10.5
Vpse_Max_Alt_B	PSE output voltage on the Alt-B Pairset when PSE is powered and lightly loaded (~1W).				
Vpse_Min_Alt_A	PSE output voltage on the Alt-A Pairset when PSE is powered and heavily loaded (~95% of Pclass).				
Vpse_Min_Alt_B	PSE output voltage on the Alt-B Pairset when PSE is powered and heavily loaded (~95% of Pclass).				
Vport_PSE_diff=	Difference between Alt-A and Alt-B output voltages when PSE is 4-pair powered and has zero mA load.	≤ 65mV PASS/FAIL	Vport_pse_diff		
V_ripple_A	Low frequency (20Hz-150Hz) ripple measured on the Alt-A Pairset when the PSE is powered. Measurement made at both low and high power load with maximum of the two reported.	≤ 500mVpp PASS/FAIL	Vnoise		
V_ripple_B	Low frequency (20Hz-150Hz) ripple measured on the Alt-B Pairset when the PSE is powered. Measurement made at both low and high power load with maximum of the two reported.				
V_noise_A	High frequency (50KHz-300KHz) noise measured on the Alt-A Pairset when the PSE is powered. Measurement made at both low and high power load with maximum of the two reported.	≤ 200mVpp PASS/FAIL			
V_noise_B	High frequency (50KHz-300KHz) noise measured on the Alt-B Pairset when the PSE is powered. Measurement made at both low and high power load with maximum of the two reported.				
V_trans_A	Minimum voltage mesured on the Alt-A Pairset during a load transition from ~0.5W to ~Pclass and back over a short (< 5msec) duration.	Type-3: 50V to 57V Type-4: 52V to 57V PASS/FAIL	Vtran_2p	**Approx.Test Time**	
V_trans_B	Minimum voltage mesured on the Alt-B Pairset during a load transition from ~0.5W to ~Pclass and back over a short (< 5msec) duration.			**150 seconds** **175 seconds (lldp)**	

Test: pwron_pwrcap *(Continous Power Capacity)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Max_Asgn_Class_SS	The maximum classification a PSE will assign to a Single Signature PD through either event counts or LLDP.	1 to 8 PASS/FAIL		PSE25 PSE29 PSE60 PSE65 PSE68 PSE82	145.2.8 145.2.10.1 145.2.10.6 145.2.11
Pcon_c1	Maximum sustainded power (in watts) to a Class 1 PD	3.9 to 99 PASS/FAIL	Icon		
Icon_%_c1	Maximum sustained load current as a % of **Icon** for a	≥ 100%			

Test: pwron_pwrcap *(Continous Power Capacity)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
	Class 1 PD, the minimum required load current associated with **Pclass**. To pass, this should be ≥ 100%.	PASS/FAIL		*As drafted, PICS are not complete*	
Pcon_c2	Maximum sustainded power (in watts) to a Class 2 PD	3.9 to 99 PASS/FAIL			
Icon_%_c2	Maximum sustained load current as a % of **Icon** for a Class 2 PD, the minimum required load current associated with **Pclass**. To pass, this should be ≥ 100%.	≥ 100% PASS/FAIL			
Pcon_c3	Maximum sustainded power (in watts) to a Class 3 PD	3.9 to 99 PASS/FAIL			
Icon_%_c3	Maximum sustained load current as a % of **Icon** for a Class 3 PD, the minimum required load current associated with **Pclass**. To pass, this should be ≥ 100%.	≥ 100% PASS/FAIL			
Pcon_c4	Maximum sustainded power (in watts) to a Class 4 PD	3.9 to 99 PASS/FAIL			
Icon_%_c4	Maximum sustained load current as a % of **Icon** for a Class 4 PD, the minimum required load current associated with **Pclass**. To pass, this should be ≥ 100%.	≥ 100% PASS/FAIL			
Pcon_c5	Maximum sustainded power (in watts) to a Class 5 PD	3.9 to 99 PASS/FAIL			
Icon_%_c5	Maximum sustained load current as a % of **Icon** for a Class 5 PD, the minimum required load current associated with **Pclass**. To pass, this should be ≥ 100%.	≥ 100% PASS/FAIL			
Pcon_c6	Maximum sustainded power (in watts) to a Class 6 PD	3.9 to 99 PASS/FAIL			
Icon_%_c6	Maximum sustained load current as a % of **Icon** for a Class 6 PD, the minimum required load current associated with **Pclass**. To pass, this should be ≥ 100%.	≥ 100% PASS/FAIL			
Pcon_c7	Maximum sustainded power (in watts) to a Class 7 PD	3.9 to 99 PASS/FAIL			
Icon_%_c7	Maximum sustained load current as a % of **Icon** for a Class 7 PD, the minimum required load current associated with **Pclass**. To pass, this should be ≥ 100%.	≥ 100% PASS/FAIL			
Pcon_c8	Maximum sustainded power (in watts) to a Class 8 PD	3.9 to 99 PASS/FAIL			
Icon_%_c8	Maximum sustained load current as a % of **Icon** for a Class 8 PD, the minimum required load current associated with **Pclass**. To pass, this should be ≥ 100%.	≥ 100% PASS/FAIL			
Type_N_Enable	Powering status when a load of ~ 90% **Pclass** (Icon) is applied at 80 msec following power-up.	= 1 PASS/FAIL	Tdelay (PD)		
Pclass_2p_c5	If PSE supports class 5 or higher and PSE maintains 2-pair powering after a 2-pair overload shutdown, verify that remaining pairset supports at least 28W (Class 4 power capacity). -1 = both pairsets shut down.	= 1 or -1			
Pclass_LLDP_95%	LLDP Granting PSE's Only: Power status when a negotiation for 95% of the maximum available PSE port power is negotiated, then the corresponding PD load with maximum cable loss is applied.	= 1 PASS/FAIL	Pclass		
Pclass_LLDP_75%	LLDP Granting PSE's Only: Power status when a negotiation for 75% of the maximum available PSE port power is negotiated, then the corresponding PD load with maximum cable loss is applied.	= 1 PASS/FAIL			

Test: pwron_pwrcap *(Continous Power Capacity)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Max_Asgn_Class _DS	The maximum classifications a PSE will assign to a Dual Signature PD (on both pairsets) through either event counts or LLDP.	1 to 5 PASS/FAIL			
Pcon_c1DA	Maximum sustainded power on the Alt-A pairset (in watts) to a Dual Class 1 PD	3.9 to 99 PASS/FAIL	Icon_2p		
Icon_%_c1DA	Given a Dual Class 1 PD, the maximum sustained Alt-A load current as a % of **Icon_2p**, the minimum required load current associated with **Pclass_2p**. To pass, this should be ≥ 100%.	≥ 100% PASS/FAIL			
Pcon_c2DB	Maximum sustainded power on the Alt-B pairset (in watts) to a Dual Class 2 PD	3.9 to 99 PASS/FAIL			
Icon_%_c2DB	Given a Dual Class 2 PD, the maximum sustained Alt-B load current as a % of **Icon_2p**, the minimum required load current associated with **Pclass_2p**. To pass, this should be ≥ 100%.	≥ 100% PASS/FAIL			
Pcon_c3DA	Maximum sustainded power on the Alt-A pairset (in watts) to a Dual Class 3 PD	3.9 to 99 PASS/FAIL			
Icon_%_c3DA	Given a Dual Class 3 PD, the maximum sustained Alt-A load current as a % of **Icon_2p**, the minimum required load current associated with **Pclass_2p**. To pass, this should be ≥ 100%.	≥ 100% PASS/FAIL			
Pcon_c4DB	Maximum sustainded power on the Alt-B pairset (in watts) to a Dual Class 4 PD	3.9 to 99 PASS/FAIL			
Icon_%_c4DB	Given a Dual Class 4 PD, the maximum sustained Alt-B load current as a % of **Icon_2p**, the minimum required load current associated with **Pclass_2p**. To pass, this should be ≥ 100%.	≥ 100% PASS/FAIL			
Pcon_c5DA	Maximum sustainded power on the Alt-A pairset (in watts) to a Dual Class 4 PD	3.9 to 99 PASS/FAIL		**Approx.Test Time**	
Icon_%_c5DA	Given a Dual Class 4 PD, the maximum sustained Alt-A load current as a % of **Icon_2p**, the minimum required load current associated with **Pclass_2p**. To pass, this should be ≥ 100%.	≥ 100% PASS/FAIL		**410 seconds** **1000 seconds (lldp)**	

Test: pwron_unbal *(Pair-2-Pair Unbalance Tolerance)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
pseP2pUnbal_c4A	If a PSE powers Class 4 with 4-Pairs: The powering status when a total load of ~90% Icon is shifted to the Alt-A pairset and the load current on Alt-B pairset is 0 mA. 0= Unpowered, 1= Powered.	=1 PASS/FAIL	Icon_2p _unb	PSE57 PSE65 PSE66	145.2.10 145.2.10.6 145.2.10.6.1
pseP2pUnbal_c4B	If a PSE powers Class 4 with 4-Pairs: The powering status when a total load of ~90% Icon is shifted onto the Alt-B pairset and the load current on the Alt-A pairset is zero mA. 0= Unpowered, 1= Powered.	=1 PASS/FAIL			
pseP2pUnbal_c5A pseP2pUnbal_c6A pseP2pUnbal_c7A pseP2pUnbal_c8A	The powering status when a total load of ~90% **Icon** is split such that the Alt-A pairset gets **Icon_2p_unb** and the Alt-B pairset gets the remaining load current (90% * **Icon** - **Icon_2p_unb**). **Icon_2p_unb** = 560mA for assigned class 5, 692mA for assigned class 6, 794mA for assigned class 7, and 948mA for assigned class 8. 0= Unpowered, 1= Powered.	=1 PASS/FAIL			
pseP2pUnbal_c5B pseP2pUnbal_c6B pseP2pUnbal_c7B pseP2pUnbal_c8B	The powering status when a total load of ~90% **Icon** is split such that the Alt-B pairset gets **Icon_2p_unb** and the Alt-A pairset gets the remaining load current (90% * **Icon** - **Icon_2p_unb**). **Icon_2p_unb** = 560mA for assigned class 5, 692mA for assigned class 6, 794mA for assigned class 7, and 948mA for assigned class 8. 0= Unpowered, 1= Powered.	=1 PASS/FAIL			

Test: **pwron_unbal** *(Pair-2-Pair Unbalance Tolerance)*			802.3bt Coverage		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
pseP2pPkUnbal_A pseP2pPkUnbal_B	The powering status following an **Ipeak_2p_unb** (= **Ilim_2p** - 2mA) transient load of duration **Tcut_min** (50msec) applied to the pairset (Alt-A or Alt-B) that is carrying the higher unbalanced load at PSE maximum supported class.	=1 PASS/FAIL		**Approx.Test Time** **130 seconds** **218 seconds (lldp)**	

Test: **pwron_maxi** *(Powered Pairset Current Limiting)*			802.3bt Coverage		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Ilim_2p_max_SSA Ilim_2p_max_SSB	Maximum pairset current measured during “short circuit” overload from the maximum single signature class PD that the PSE will grant full power to. Assessed on both the Alt-A and Alt-B pairsets.	≤ 1.75A PASS/FAIL	Ilim_2p	PSE57 PSE61 PSE71 PSE72 PSE73 PSE79	145.2.10.3 145.2.10.9 145.2.10.13
Tlim_SS	Time from short circuit overload assertion until first pairset shutdown. The low side of this parameter is not enforceable because the standard allows that when PSE output voltage drops below **Vport_pse_2p**(Min), the PSE may remove power without regard to Tlim. A PSE that is limiting output current would almost certainly drop output voltage below **Vport_pse_2p**(min).	Type-3 PSE: 10 to 75msec Type-4 PSE: 6 to 75msec PASS/INFO	Tlim		
Ilim_2p_max_DSA Ilim_2p_max_DSB	Maximum pairset current measured during “short circuit” overload from the maximum dual signature class PD that the PSE will grant full power to. Assessed on both the Alt-A and Alt-B pairsets.	≤ 1.75A PASS/FAIL	Ilim_2p		
Tlim_DSA	Time from short circuit overload assertion until Alt-A pairset shutdown. See Tlim_SS above.	Type-3 PSE: 10 to 75msec Type-4 PSE: 6 to 75msec PASS/INFO	Tlim		
Tlim_DSB	Time from short circuit overload assertion until Alt-B pairset shutdown. See Tlim_SS above.				
Ilim_min_cAB3	Minimum current sustained with **Ilim_min_2p** (400mA) applied to Alt-A, then to Alt-B pairsets for **Tlim_min**. Reports the minimum of both pairsets.	≥ 400mA PASS/FAIL	Ilim_2p Tlim		
Max_trans_c3	PSE Powering status 100msec after class 3 **Ilim_min_2p** transient was applied for **Tlim_min** on each pairset. 1= PSE did not remove power. 0= Power was removed.	= 1 PASS/FAIL			
Ilim_min_cAB4	Minimum current sustained with **Ilim_min_2p** (684mA) applied to Alt-A, then to Alt-B pairsets for **Tlim_min**. Reports the minimum of both pairsets.	≥ 684mA PASS/FAIL			
Max_trans_c4	PSE Powering status 100msec after class 4 **Ilim_min_2p** transient was applied for **Tlim_min** on each pairset. 1= PSE did not remove power. 0= Power was removed.	= 1 PASS/FAIL	Ilim_2p Tlim		
Ilim_min_cAB5	Minimum current sustained with **Ilim_min_2p** (580mA) applied simultaneously to Alt-A and Alt-B pairsets for **Tlim_min**. Reports MIN of both pairsets.	≥ 580mA PASS/FAIL			
Max_trans_c5	PSE Powering status 100msec after class 5 **Ilim_min_2p** transient was applied for **Tlim_min** on both pairsets. 1= PSE did not remove power. 0= Power was removed.	= 1 PASS/FAIL			
Ilim_min_cAB6	Minimum current sustained with **Ilim_min_2p** (720mA) applied Alt-A and Alt-B pairsets for **Tlim_min**. Reports the minimum of both pairsets.	≥ 720mA PASS/FAIL			
Max_trans_c6	PSE Powering status 100msec after class 6 **Ilim_min_2p** transient was applied for **Tlim_min** on both pairsets. 1= PSE did not remove power. 0= Power was removed.	= 1 PASS/FAIL			
Ilim_min_cAB7	Minimum current sustained with **Ilim_min_2p** (850mA) applied Alt-A and Alt-B pairsets for **Tlim_min**. Reports the minimum of both pairsets.	≥ 850mA PASS/FAIL			

Test: pwron_maxi *(Powered Pairset Current Limiting)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Max_trans_c7	PSE Powering status 100msec after class 7 **Ilim_min_2p** transient was applied for **Tlim_min** on both pairsets. 1= PSE did not remove power. 0= Power was removed.	= 1 PASS/FAIL			
Ilim_min_cAB8	Minimum current sustained with **Ilim_min_2p** (1005mA) applied Alt-A and Alt-B pairsets for **Tlim_min**. Reports the minimum of both pairsets.	≥ 1005mA PASS/FAIL			
Max_trans_c8	PSE Powering status 100msec after class 8 **Ilim_min_2p** transient was applied for **Tlim_min** on both pairsets. 1= PSE did not remove power. 0= Power was removed.	= 1 PASS/FAIL			
Ilim_min_cAB3D	Minimum current sustained with **Ilim_min_2p** (400mA) applied Alt-A and Alt-B pairsets for **Tlim_min**. Reports the minimum of both pairsets.	≥ 400mA PASS/FAIL			
Max_trans_c3D	PSE Powering status 100msec after dual class 3 **Ilim_min_2p** transient was applied for **Tlim_min** on both pairsets. 1= PSE powered. 0= Power removed.	= 1 PASS/FAIL			
Ilim_min_cAB4D	Minimum current sustained with **Ilim_min_2p** (684mA) applied Alt-A and Alt-B pairsets for **Tlim_min**. Reports the minimum of both pairsets.	≥ 684mA PASS/FAIL			
Max_trans_c4D	PSE Powering status 100msec after dual class 4 **Ilim_min_2p** transient was applied for **Tlim_min** on both pairsets. 1= PSE did not remove power. 0= Power was removed.	= 1 PASS/FAIL			
Ilim_min_cAB5D	Minimum current sustained with **Ilim_min_2p** (990mA) applied Alt-A and Alt-B pairsets for **Tlim_min**. Reports the minimum of both pairsets.	≥ 990mA PASS/FAIL			
Max_trans_c5D	PSE Powering status 100msec after dual class 5 **Ilim_min_2p** transient was applied for **Tlim_min** on both pairsets. 1= PSE did not remove power. 0= Power was removed.	= 1 PASS/FAIL			
Vtrans_2p_A	Minimum Alt-A voltage in response to a maximum transient overload (**Ilim_min**) of 250usec duration from the max. class PD a PSE grants full power to.	Type-3 PSE: ≥ 45.3V Type-4 PSE: ≥ 48.4V PASS/FAIL	Vtran_2p		
Vtrans_2p_B	Minimum Alt-B voltage in response to a maximum transient overload (**Ilim_min**) of 250usec duration from the max. class PD a PSE grants full power to.				
Iport_max_type3	Flag indicating power removed from both pairsets of Type-3 PSE with 852mA per pairset for > 75 msec. 0= Power removed, 1= 1 pairset powered, 2= both pairsets powered.	= 0 PASS/FAIL	Iport_2p		
Iport_max_type4	Flag indicating power removed from both pairsets of Type-4 PSE with 1302mA per pairset for > 75 msec. 0= Power removed, 1= 1 pairset powered, 2= both pairsets powered.	= 0 PASS/FAIL		**Approx.Test Time**	
Ilps_type4	Flag indicating power removed from both pairsets of Type-4 PSE with Maximum LPS current per pairset for > 4 sec. Maximum LPS current is the current that restricts PSE to <100 Watt output. 0= Power removed, 1= Powered after 4 sec.	= 0 PASS/FAIL	Ilps_2p	**410 seconds** **460 seconds (lldp)**	

Test: pwron_overld *(Powered Pairset Peak Transients)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Ipeak_c1	Flag indicating if the PSE maintains power following an **Ipeak** current transient of duration **Tcut_min** (50msec) to a Class 1 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL	Ipeak	PSE57 PSE62 PSE66 PSE82	145.2.10.3 145.2.10.6 145.2.11
Ipeak_c2	Flag indicating if the PSE maintains power following an **Ipeak** current transient of duration **Tcut_min** (50msec) to a Class 2 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL	Ipeak		

Test: pwron_overld *(Powered Pairset Peak Transients)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Ipeak_c3	Flag indicating if the PSE maintains power following an **Ipeak** current transient of duration **Tcut_min** (50msec) to a Class 3 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL	Ipeak	*As drafted, PICS are not complete*	
Vport_Ipeak_c3	Minimum voltage during **Ipeak** Class 3 transient.	Type-3 PSE: ≥ 50V Type-4 PSE: ≥ 52V	Vport_pse		
Ipeak_5%DC_c3	Flag indicating if PSE maintains powwer following a 5% duty cylcle transient load of **Ipeak** to a Class 3 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL			
Ipeak_c4	Flag indicating if the PSE maintains power following an **Ipeak** current transient of duration **Tcut_min** (50msec) to a Class 4 PD	= 1 PASS/FAIL	Ipeak		
Vport_Ipeak_c4	Minimum voltage during **Ipeak** Class 4 transient	Type-3 PSE: ≥ 50V Type-4 PSE: ≥ 52V	Vport_pse		
Ipeak_5%DC_c4	Flag indicating if PSE maintains powwer following a 5% duty cylcle transient load of **Ipeak** to a Class 4 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL			
Ipeak_c5	Flag indicating if the PSE maintains power following an **Ipeak** current transient of duration **Tcut_min** (50msec) to a Class 4 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL	Ipeak		
Vport_Ipeak_c5	Minimum voltage during **Ipeak** Class 5 transient	Type-3 PSE: ≥ 50V Type-4 PSE: ≥ 52V	Vport_pse		
Ipeak_5%DC_c5	Flag indicating if PSE maintains powwer following a 5% duty cylcle transient load of **Ipeak** to a Class 4 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL			
Ipeak_c6	Flag indicating if the PSE maintains power following an **Ipeak** current transient of duration **Tcut_min** (50msec) to a Class 6 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL	Ipeak		
Vport_Ipeak_c6	Minimum voltage during **Ipeak** Class 6 transient	Type-3 PSE: ≥ 50V Type-4 PSE: ≥ 52V	Vport_pse		
Ipeak_5%DC_c6	Flag indicating if PSE maintains powwer following a 5% duty cylcle transient load of **Ipeak** to a Class 6 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL			
Ipeak_c7	Flag indicating if the PSE maintains power following an **Ipeak** current transient of duration **Tcut_min** (50msec) to a Class 7 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL	Ipeak		
Vport_Ipeak_c7	Minimum voltage during **Ipeak** Class 7 transient	Type-3 PSE: ≥ 50V Type-4 PSE: ≥ 52V	Vport_pse		
Ipeak_5%DC_c7	Flag indicating if PSE maintains powwer following a 5% duty cylcle transient load of **Ipeak** to a Class 7 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL			

Test: pwron_overld *(Powered Pairset Peak Transients)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Ipeak_c8	Flag indicating if the PSE maintains power following an **Ipeak** current transient of duration **Tcut_min** (50msec) to a Class 8 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL	Ipeak		
Vport_Ipeak_c8	Minimum voltage during **Ipeak** Class 8 transient	Type-3 PSE: ≥ 50V Type-4 PSE: ≥ 52V	Vport_pse		
Ipeak_5%DC_c8	Flag indicating if PSE maintains powwer following a 5% duty cylcle transient load of **Ipeak** to a Class 8 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL			
Ipeak_c1D	Flag indicating if the PSE maintains power following **Ipeak_2p** current transients of duration **Tcut_min** (50msec) applied to both pairsets of a Dual Class 1 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL	Ipeak_2p		
Ipeak_c2D	Flag indicating if the PSE maintains power following **Ipeak_2p** current transients of duration **Tcut_min** (50msec) applied to both pairsets of a Dual Class 2 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL			
Ipeak_c3D	Flag indicating if the PSE maintains power following **Ipeak_2p** current transients of duration **Tcut_min** (50msec) applied to both pairsets of a Dual Class 3 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL			
Ipeak_c4D	Flag indicating if the PSE maintains power following **Ipeak_2p** current transients of duration **Tcut_min** (50msec) applied to both pairsets of a Dual Class 4 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL		**Approx.Test Time**	
Ipeak_c5D	Flag indicating if the PSE maintains power following **Ipeak_2p** current transients of duration **Tcut_min** (50msec) applied to both pairsets of a Dual Class 5 PD. 1= Powered, 0= Not powered.	= 1 PASS/FAIL		**280 seconds**	

Test: pwron_autoclass *(Autoclass Power Capacity)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Autoclass_Shutdown	PSE load is set to 95% of **Pclass** (based on assigned class) to determine if PSE removes power following an auto class signature. 0= no autoclass support, 1= apparent autoclass support.	0 or 1	Autoclass	PSE24 PSE24a PSE39 PSE54 PSE55	145.2.8 145.2.8.1 145.2.8.2
Pac_margin_C3_low	Flag indicating that given class 3 PD autoclass load of 3W, PSE supports Pclass of 3.5W or higher (0.5W margin). Set to -1 if PSE Autoclass_Shutdown= 0.	1 or -1	Pac_margin		
Pac_margin_C3_high	Flag indicating that given class 3 PD autoclass load of 9W, PSE supports Pclass of 9.5W or higher (0.5W margin). Set to -1 if PSE Autoclass_Shutdown= 0.				
Pac_margin_C5_low	Flag indicating that given class 5 PD autoclass load of 3W, PSE supports Pclass of 3.75W or higher (0.75W margin). Set to -1 if PSE Autoclass_Shutdown= 0.				
Pac_margin_C5_high	Flag indicating that given class 5 PD autoclass load of 34W, PSE supports Pclass of 34.75W or higher (0.75W margin). Set to -1 if PSE Autoclass_Shutdown= 0.				
Pac_margin_C7_low	Flag indicating that given class 7 PD autoclass load of 3W, PSE supports Pclass of 4.5W or higher (1.5W margin). Set to -1 if PSE Autoclass_Shutdown= 0.				
Pac_margin_C7_high	Flag indicating that given class 7 PD autoclass load of 55W, PSE supports Pclass of 56.5W or higher (1.5W margin). Set to -1 if PSE Autoclass_Shutdown= 0.			**Approx.Test Time**	
Autoclass_4W	Flag indicating that an autoclass signature of less than			**TBD seconds**	

Test: pwron_autoclass *(Autoclass Power Capacity)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
	4W is ignored - PSE furnishes assigned class from classification. Set to -1 if PSE Autoclass_Shutdown= 0.				

6.7.6. 4-Pair PSE Conformance Tests – MPS Disconnect Processes

PD Disconnect shutdown behaviors are reviewed in Section 2.13. The 802.3bt standard eliminated the AC MPS option available in the 802.3at standard and settled on use of the DC MPS method for sensing PD disconnects. Further, in the interest of saving power while a PD drops into a "sleep" mode, DC MPS was revised relative to 802.3at to reduce the minimum power draw required to keep a PD powered by as much as 90%. This places new burdens on 802.3bt PSE's to carefully discriminate between valid and invalid MPS signatures when deciding to maintain or withdraw power.
DC MPS behaviors at the PSE are influenced by:

1. Single vs Dual Signature PD
2. 2-Pair vs 4-Pair Powering to Class0-4 PD's
3. PD classification

Further complicating the matter is that a PSE that might be 4-pair powering a Class 0-4 PD is allowed, under the standard, to withdraw power from one pairset. Some PSE's will do this to divert very low power loads onto just a single pairset for DC MPS monitoring.

As with many of the POWER_ON state tests, some parameters that are associated with PD classes above the maximum assigned class a PSE grants will not be tested or reported.

Test: mps_dc_valid *(Valid MPS Signature Discrimination)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Ihold_c3	Minimum 4-pair load current, split evenly between pairsets, that will maintain power to a Class 3 PD. Report -1 if PSE only does 2-Pair power with Class 3.	4mA to 9mA or -1 PASS/FAIL	Ihold PASS/FAIL	PSE57 PSE83 PSE84 PSE85 PSE87 PSE88 PSE91 PSE93 PSE96	145.2.10 145.2.12
Ihold_2p_c3A	Minimum 2-pair load current on Alt-A pairset that will maintain power to a Class 3 PD. If PSE powers with 4-pairs, the Alt-B pairset will be drawing 1.5 mA during the scan. Set to -1 for any unpowered pairset.	4-Pr Power: 2 mA to 5mA 2-Pr Power: 4mA to 9mA or -1 PASS/FAIL	Ihold_2p PASS/FAIL		
Ihold_2p_c3B	Minimum 2-pair load current on Alt-B pairset that will maintain power to a Class 3 PD. If PSE powers with 4-pairs, the Alt-A pairset will be drawing 1.5 mA during the scan.				
Ihold_c5	Minimum 4-pair load current, split evenly between pairsets, that will maintain power to a Class 5 PD	4mA to 14mA PASS/FAIL	Ihold PASS/FAIL		
Ihold_2p_c5A	Minimum 2-pair load current on Alt-A pairset that will maintain power to a Class 5 PD when the Alt-B pairset is drawing 1.5 mA	2mA to 7mA PASS/FAIL	Ihold_2p PASS/FAIL		
Ihold_2p_c5B	Minimum 2-pair load current on Alt-B pairset that will maintain power to a Class 5 PD when the Alt-A pairset is drawing 1.5 mA				
Ihold_c7	Minimum 4-pair load current, split evenly between pairsets, that will maintain power to a Class 7 PD	4mA to 14mA PASS/FAIL	Ihold PASS/FAIL		
Ihold_2p_c7A	Minimum 2-pair load current on Alt-A pairset that will maintain power to a Class 7 PD when the Alt-B pairset is drawing 1.5 mA	2mA to 7mA PASS/FAIL	Ihold_2p PASS/FAIL		
Ihold_2p_c7B	Minimum 2-pair load current on Alt-B pairset that will maintain power to a Class 7 PD when the Alt-A pairset is drawing 1.5 mA				
Ihold_2p_c2DA	Minimum Alt-A load current to maintain power on the Alt-A pairset given a dual signature PD and 80mA load on the Alt-B pairset.	2mA to 7mA PASS/FAIL	Ihold_2p PASS/FAIL		
Ihold_2p_c2DB	Minimum Alt-B load current to maintain power on the Alt-B pairset given a dual signature PD and 80mA load				

Test: mps_dc_valid *(Valid MPS Signature Discrimination)*			802.3bt Coverage		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
	on the Alt-A pairset.				
LP_MPS_Tol_c3	Flag indicating if 2-Pair or 4-Pair power is maitained following a succession of low power MPS impulses providing valid current for Tmps with 2.15% duty cycle given a Class 3 PD. 1= Powered, 0= Power removed.	=1 PASS/FAIL	Tmps, Tmpdo (min), Ihold (max) PASS/FAIL		
LP_MPS_Tol_c5	Flag indicating if 4-Pair power is maitained following a succession of low power MPS impulses providing valid current for Tmps with 2.15% duty cycle given a Class 5 PD. 1= Powered, 0= Power removed.	=1 PASS/FAIL			
LP_MPS_Tol_c7	Flag indicating if 4-Pair power is maitained following a succession of low power MPS impulses providing valid current for Tmps with 2.15% duty cycle given a Class 7 PD. 1= Powered, 0= Power removed.	=1 PASS/FAIL		**Approx.Test Time**	
LP_MPS_Tol_c2D	Flag indicating if power is maitained on both pairsets following a succession of low power MPS impulses providing valid current for Tmps with 2.15% duty cycle given a Class 2D PD. 1= Powered, 0= Power removed.	=1 PASS/FAIL		**345-410 seconds**	

Test: mps_dc_pwrdn *(Disconnect Shutdown Timing)*			802.3bt Coverage		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Tmpdo_c3A	Time from PD disconnect until power removal on Alt-A pairset given a Class 3 PD. Tested using a load current of **Ihold_min** - 1 mA. Set to -1 if PSE only powers the Alt-B pairset.	320msec to 400msec or = -1 PASS/FAIL	Tmpdo Ihold (min) Ihold_2p (min)	PSE57 PSE83 PSE85 PSE86 PSE89 PSE90 PSE92 PSE94 PSE95	145.2.12
Tmpdo_c3B	Time from PD disconnect until power removal on Alt-B pairset given a Class 3 PD. Tested using a load current of **Ihold_min** - 1 mA. Set to -1 if PSE only powers the Alt-A pairset.				
Tmpdo_c5A	Time from PD disconnect until power removal on Alt-A pairset given a Class 5 PD. Tested using a load current of **Ihold_min** - 1 mA.	320msec to 400msec PASS/FAIL			
Tmpdo_c5B	Time from PD disconnect until power removal on Alt-B pairset given a Class 5 PD. Tested using a load current of **Ihold_min** - 1 mA.				
Tmpdo_c7A	Time from PD disconnect until power removal on Alt-A pairset given a Class 7 PD. Tested using a load current of **Ihold_min** - 1 mA.	320msec to 400msec PASS/FAIL			
Tmpdo_c7B	Time from PD disconnect until power removal on Alt-B pairset given a Class 7 PD. Tested using a load current of **Ihold_min** - 1 mA.				
Tmpdo_c2DA	Time from Alt-A pairset disconnect until power removal on the Alt-A pairset given a dual Class 2 PD. Tested using load current of **Ihold_2p_min** - 1 mA.	320msec to 400msec PASS/FAIL			
4pr_Stat_c2DA	Flag indicating if PSE removes power on one pairset or both pairsets when the Alt-A pairset is disconnected. 0= No power, 1= Alt-B powered, 2= Alt-A powered.	= 0 or 1 PASS/FAIL			
Tmpdo_c2D	Time from Alt-B pairset disconnect until power removal on the Alt-B pairset given a dual Class 2 PD. Tested using load current of **Ihold_2p_min** - 1 mA.	320msec to 400msec PASS/FAIL		**Approx.Test Time**	
4pr_Stat_c2DB	Flag indicating if PSE removes power on one pairset or both pairsets when the Alt-B pairset is disconnected.	= 0 or 1 PASS/FAIL		**85-110 seconds**	

6.7.7. 4-Pair PSE Conformance Tests – Shutdown Behaviors

The final category of testing involves PSE behaviors immediately following the removal of PoE power. If power is removed because of a PD disconnect, then a requirement exists to discharge the PSE output voltage to a safe level before the potential connection of a non-PD device to that same PSE port. If power is removed because of an overload condition, then voltage discharge should be immediate however the PSE must allow time (ERROR_DELAY) for active powering components to cool before restoring power to a PD.

Test: pwrdn_time *(Discharge Time and Output Capacitance)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Turnoff_time_Toff_A	PSE shutdown time on the Alt-A pairset following a PD Disconnect. The measurement is performed with a hypothetical 320KΩ load appllied across the pairset. Measured Cout_A and Output_Rp_A values enable the decay time modeling used to produce Toff.	≤ 500msec PASS/FAIL	Toff	PSE14 PSE51 PSE57 PSE74 PSE75	145.2.6.1 145.2.10.10 145.2.10.11
Turnoff_time_Toff_B	PSE shutdown time on the Alt-B pairset following a PD Disconnect. The measurement is performed with a hypothetical 320KΩ load appllied across the pairset. Measured Cout_B and Output_Rp_B values enable the decay time modeling used to produce Toff.				
Cout_A	PSE output capacitance on the Alt-A pairset as measured immediately after disconnect shutdown.	≤ 520µF PASS/FAIL	Cout		
Cout_B	PSE output capacitance on the Alt-B pairset as measured immediately after disconnect shutdown.				
Output_Rp_A	Effective PSE discharge resistance on the Alt-A pairset as measured immediately after disconnect shutdown.	≥ 45KΩ PASS/INFO			
Output_Rp_B	Effective PSE discharge resistance on the Alt-B pairset as measured immediately after disconnect shutdown.			**Approx.Test Time**	
Idle_time_SS	Duration following a 4-pair disconnect shutdown over which IDLE voltage is maintained prior to new detection cycles.	≥ 15 msec	Treset	**75 seconds**	

Test: pwrdn_v *(Error Delay Timing)*			**802.3bt Coverage**		
Parameter	**Parameter Description**	**Limits**	**802.3 Parm.**	**PIC**	**802.3bt Clause**
Error_Delay_SS_A	Time between overload shutdown and attempted new detection of a single signature PD on the Alt-A pairset.	≥ 750 msec	Ted	PSE4 PSE57 PSE75 PSE76	145.2.5 145.2.10 145.2.10.11
Error_Delay_SS_B	Time between overload shutdown and attempted new detection of a single signature PD on the Alt-B pairset.				
Error_Delay_DS_A	Time between overload shutdown and attempted new detection of a dual signature PD on the Alt-A pairset.				
Error_Delay_DS_B	Time between overload shutdown and attempted new detection of a dual signature PD on the Alt-B pairset.				
Idle_Voff_SS_A	Average voltage during the error delay period on the Alt-A pairset given a single signature PD	≤ 2.8V	Voff		
Idle_Voff_SS_B	Average voltage during the error delay period on the Alt-B pairset given a single signature PD				
Idle_Voff_DS_A	Average voltage during the error delay period on the Alt-A pairset given a dual signature PD			**Approx.Test Time**	
Idle_Voff_DS_B	Average voltage during the error delay period on the Alt-B pairset given a dual signature PD			**58 seconds**	

6.8. The 4-Pair PSE Conformance Standard Spreadsheet Report

The 4-Pair PSE Conformance Test Suite report is produced using the **Conf Test** menu in PSA Interactive or the **sequence** command in PowerShell PSA. Both methods allow flexible specification of tests and ports, as well as cycles of testing per port.

The standard 4-Pair report, **psa_report_4p.xlsm**, is a "smart" Microsoft Excel spreadsheet that automatically processes results from the test sequencer into colorful, easily read reports that add port statistics and pass-fail criteria. These reports will allow PSA users to quickly locate and characterize real or potential 802.3bt conformance issues as well as to rapidly identify port-specific defects. The unprocessed **psa_report_4p.xlsm** file includes five spreadsheet pages (or tabs):

- **Sheet1**: Test Cycle #1 Test data and statistics – becomes **Loop1** after report processing
- **Limits**: Test Limit Type and Test Limit Data
- **Notes 5.x.x**: Information describing all 4-Pair PSE test parameters with special comments regarding Pass/Info test parameters for the 4-Pair PSE Conformance Test Suite
- **Interop**: PSE **Interop** index calculation page with summarized score deductions
- **Safety**: PSE **Safety** index calculation page with summarized score deductions

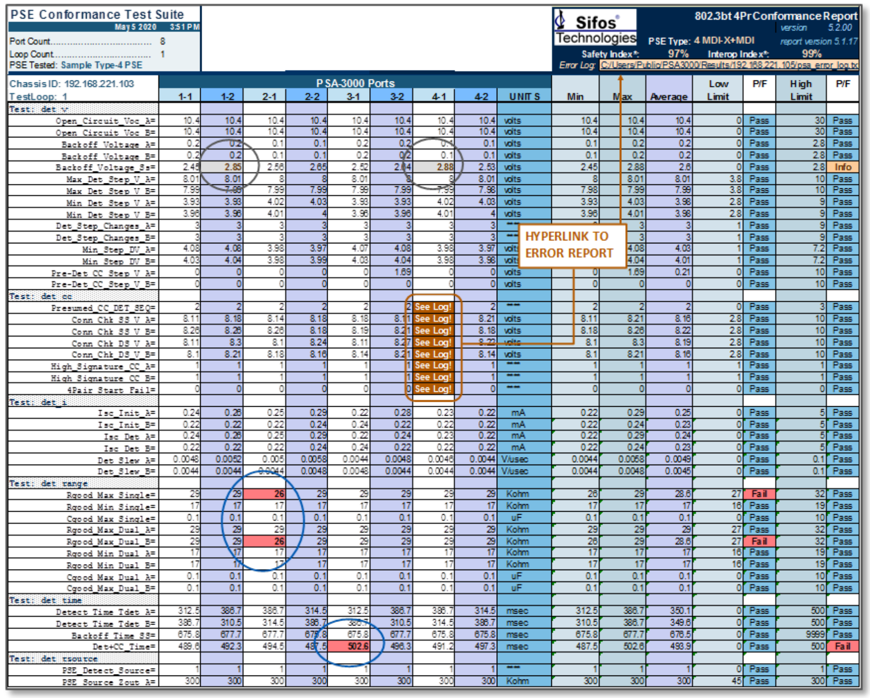


Figure 6.2 Sample 4-Pair Conformance Test Report – Test Loop1 Tab

If multiple test cycles are specified, additional report pages will be created for each test loop prior to the Test Limit page.

Test parameters that fall outside of **Pass/Fail** type limit criteria will be marked as **FAIL** in the summary column and will be flagged in a **pale red** shading on each failing port. Test parameters that fall outside of **Pass/Info** type limit ranges will be annunciated as **Info** in the summary column and will flagged in the report by brown text with gray shading.

The PSE Conformance Test Limits may be found on the **Limits** tab of the standard test report. The **Notes 5.x.x** tab provides information concerning all of the PSE Conformance Test parameters and limit processing details.

The **Interop** tab uses all of the test results to create a **Sifos Interop Index** score based upon test limit excursions of selected parameters in selected tests.
The **Safety** tab uses all of the test results to create a **Sifos Safety Index** score also based upon test limit excursions of selected parameters in selected tests.

The scores are based upon weighted impact values for the various PSE Conformance parameters. They will only be produced if a sufficient number (large majority) of tests are sequenced.

Important! Neither the Interop Index nor the Safety Index are a measure of specification conformance. **The only measure of 802.3bt specification conformance** is the number of (or absence of) **FAIL** indications on the test report pages. Full conformance is achieved when there are no **FAIL** indications in the report.

Occasionally, a test malfunction may occur, for example when a PSE port unexpectedly fails to power-up or a measurement is disrupted by some unexpected event. This will result in an aborted test and a **See Log!** indicator in the parameter result field. This means that an error log has formed in the current active results directory. That log file can be opened simply by clicking on the Error Log *hyperlink* in the upper right hand corner of the PSE Conformance Test report.

The standard PSE Conformance Report file **psa_report_4p.xlsm** is always installed as a read-only file and any specific reports generated following a test sequence should ALWAYS be saved to another name. A second file, **psa_report_4p.bak**, is a backup copy of **psa_report_4p.xlsm** provided in the event that **psa_report_4p.xlsm** is lost or corrupted. See Section 3.2.5 for the directory location of these report template files.

6.9. Enabling the PSE Conformance Test Suite

The **standard** PSA-3000, PSA-3x02, and PSA-3x48 PowerSync Analyzers are not licensed for either the 2-Pair or the 4-Pair PSE Conformance Test Suites. Attempts to execute any of the PSE Conformance Tests either directly or via the sequencer will yield “Invalid Command” responses to PowerShell PSA. The **Conf Test** tab menu will be disabled in PSA Interactive when connected to a PSA chassis that is not licensed for either test suite.

PowerSync Analyzer customers may elect to upgrade their instrument with separate licences for either or both the 2-Pair PSE Conformance Test Suite and the 4-Pair PSE Conformance Test Suite. This is done simply by procuring the desired license(s) from Sifos Technologies. Licenses for both test suites are keyed to a PSA-3000 instrument so when the license is purchased, Sifos will need to be provided with the serial ID for that instrument.

Contact Sifos Technologies for further information on performing this upgrade to your PowerSync Analyzer.

6.10. PSE Conformance Test Suites: 802.3 PICS Coverage

Both IEEE 802.3 clause 33 (802.3at) and clause 145 (802.3bt) include sections describing protocol implementation conformance statement, or PICS. These are tables of line items that are derived from mandatory specification requirements in each respective clause.

PICS coverage for both the 2-Pair PSE Conformance Test Suite and the 4-Pair PSE Conformance Test Suite is documented in the **Notes 5.x.x** tab of the respective Excel spreadsheet reports (*see Figure 6.3*).

PICS coverage for the 4-Pair 802.3bt PSE Conformance Test Suite is also described within the tables throughout Section 6.7.

Both test suites offer in excess of 90% coverage of PSE and DLL PICS items.

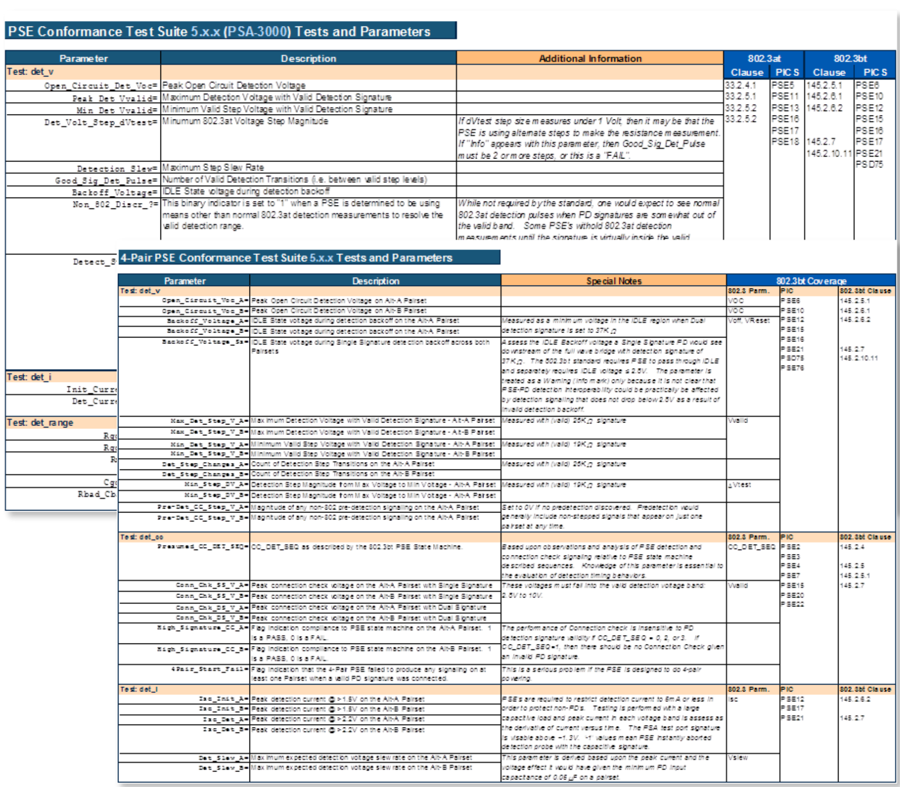


Figure 6.3 Notes 5.x.x Tabs from 2-Pair and 4-Pair Test Reports

7. PSE Multi-Port Suite for 802.3at PSE's

The PSE Multi-Port Suite consists of two fundamental components that are both applicable to PSE system and power management testing:

- Multi-Port Live PD Emulation
- PSE Multi-Port Test Suite (*Second Generation for 802.3at PSE's*)

The PSE Multi-Port Suite introduces the concept of a **Resource Configuration**, that is, a collection of test ports that may come from as many as eight different PSA chassis'. A Resource Configuration can therefore consist of 1 to 192 test ports testing that same number of PSE ports utilizing a single button press in PSA Interactive or a single command in PowerShell PSA. The Multi-Port Suite also relies heavily on the concept of flexible Powered Device (PD) emulation so that PSE ports can be evaluated as a system of power sources feeding a user-defined set of power loads.

Multi-Port Live PD Emulation is the topic of section 7.1 below and the PSE Multi-Port Test Suite will be covered beginning in section 7.2.

7.1. Multi-Port Live PD Emulation

Multi-Port Live PD Emulation was introduced earlier in section 4.9 and section 5.23. Those sections describe how to access and utilize Multi-Port Live PD Emulation from PSA Interactive and from PowerShell PSA software.

Unlike a test suite, Multi-Port Live PD Emulation does not perform specific tests and generate reports with limit checking. Instead, it presents a powerful tool for PSE system developers and system testers in that it allows one or more PSA tests ports to replicate the behavior of a user-defined Powered Device (PD) for an indefinite period of time. When PSA test ports are in the Live PD Emulation mode, they automatically respond to physical disconnects and PSE initiated service shutdowns by shifting into a pre-power state and preparing for the next power-up. If testing an LLDP-capable PSE, PSA test ports will conduct power-up negotiations on each application of PSE power and will respond to PSE initiated power throttle-backs. It should be noted that Live PD Emulation is an exclusive mode or state of any test port. Any test port configurations or queries, excluding the Live PD Emulation status query, will immediately terminate the Live PD Emulation mode.

Users may query the *status* of Live PD Emulation at any time on any test port or receive a summary status from all test ports in a Resource Configuration regardless of the emulation state (RUNNING or IDLE). Live PD Emulation *configuration* may also be queried in a similar manner when the emulations are IDLE (or inactive).

When operated from either PSA Interactive or PowerShell PSA, a *uniform* Live PD Emulation configuration may be defined and applied to a Resource Configuration with a single button press or command. Non-uniform PD Emulations can also be created from PowerShell PSA using the **psa_emulate_pd** command described earlier in section 5.23.1.

7.1.1. Live PD Emulation Configurations

The following table summarizes the attributes and the allowable ranges for configuring Live PD Emulation on one or more test ports. The ranges have been designed to allow for 802.3at compliant and non-compliant PD's to be emulated.

Emulation Attribute	Description	Minimum Value	Maximum Value
PD Detection	Type of Detection Signature	802.3at (*default*)	Legacy (*override*)
PD Class	PD Classification during Power-Up	0	4
PD Power Load	PD Normal Operating Power Draw	0.5 watts	*see below*
Cable Power Loss	Additional Power Furnished by PSE to PD when drawing PD Power Load	0	*see below*
LLDP Mode	LLDP Usage Option (Off, Connected indefinitely, or Connected until Power Grant)		
Initial Power	Startup Power – Primarily for LLDP usage, this is Type-1 power level PD draws during initial negotiation or after PSE induced power throttle-back.	0.5 watts	15.5 watts

The normal operating power load (or post-negotiated LLDP power load) supported by Live PD Emulation is a function of the PD Classification used in the emulation. The upper limits are applied to the *combination* of PD Power Load and Cable Power Loss so that they are in terms of power load experienced at the PSE port. These upper load limits are:

PD Classification	Maximum PSE Power Modeled
0, 3	17.7 watts
1	4.6 watts
2	8.0 watts
4	34.5 watts

Beyond the Multi-Port Resource Configuration, Live PD Emulation configurations established within the Live PD Emulation menu (*see section 4.9.1*) and Live PD Emulation commands (*see section 5.23.1*) are fully independent of any configurations specified for the Multi-Port Test Suite discussed starting in section 7.2.

7.2. PSE Multi-Port Test Suite Overview

The second generation PSE Multi-Port Test Suite is a fully automated group of tests and reporting that takes the PowerSync Analyzer and it's proven PSE Conformance Testing Capabilities into the realm of fully automated PSE System Power Management and Multi-Port Behavior testing.

Whereas PSE Conformance Testing assesses compliance of each stand-alone PSE port to 802.3at specifications, Multi-Port Testing assesses system-wide behaviors only observable when many PD's are powered by a PSE. The PSE Multi-Port Test Suite will acquire and distill information regarding key behaviors of a PSE including class-based power administration, multi-port LLDP granting, power-up and LLDP grant timing, static power capacity, transient reserve capacity, power down timing, power-per-port uniformity and uncertainty, and power stress test analyses.

The Multi-Port Test Suite is easily configured to cover all required PD emulations such that system testing of Type-2 and Type-1 PSE's is performed in a just a single sequence, with up to 38 limit-checked parameters produced on a single, graphic-rich Microsoft Excel report.

The standard report generated by the Multi-Port Test Suite organizes all parameters by Multi-Port Test and by PD emulation (e.g. Class 4, Type-1, etc.) with colorful annotations for parameters that represent non-ideal or design-constrained behaviors and, for certain parameters, IEEE 802.3at specification violations.

7.3. Multi-Port Testing: Coverage and Rationale

PSE Multi-Port (System) Testing addresses that combination of software and hardware functionality within a PSE that manages access to a finite power resource by each connected Powered Device (PD). This mode of testing requires that multiple PD's, or virtual PD's, be connected to the PSE-under-test, ideally at every PoE-capable port of the PSE.

Multi-Port Testing contrasts with PSE Conformance Testing where only one PSE port is tested at any one time. Referring to **Figure 7.1**, PSE Conformance Testing primarily addresses characteristics of the Local PSE Power Control subsystems and all associated connections through the Ethernet MDI. Consistent with IEEE 802.3 specifications in general, clause 33 of 802.3 describes a PSE as a single-port entity and therefore provides no specific guidance on dealing with systems of multiple ports.

Most PSE ports in existence, however, are part of a larger system of ports with a shared power resource. The shared power resource may typically have ample power to enable PSE power sourcing that conforms to 802.3 clause 33 requirements at any one port, however for practical and economic reasons, that power resource cannot possibly meet maximum potential PD load requirements on all PSE ports. This places a burden on the PSE to flexibly and efficiently allocate the power resource to PD's.

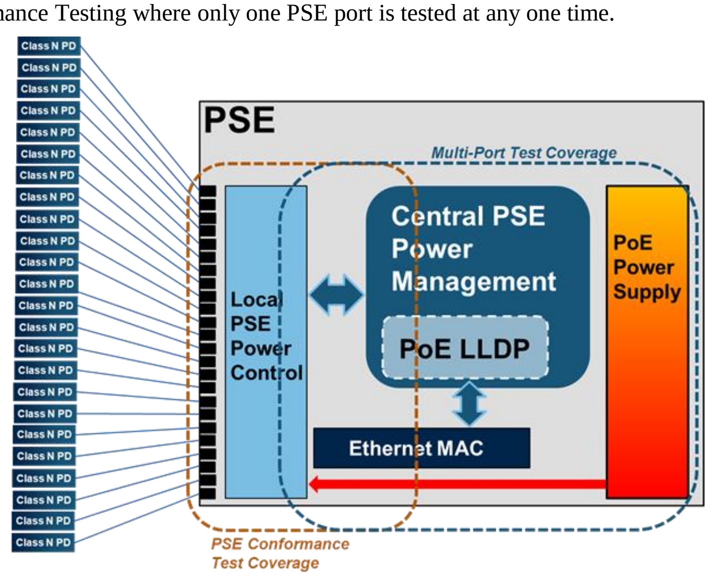


Figure 7.1 Sample Spreadsheet Report – Test Loop1 Tab

PD's typically have the ability to "announce" their power demand, initially through the power-up classification process, and then, in select cases, using Link Layer Discovery Protocol (LLDP) following the application of power. PSE's have full flexibility to respond to these declarations as they choose, as well as to consider other factors in the allocation of power including user-established PSE port priorities, user-established powering restrictions, actual measured power demand, and targeted reserve power for unexpected PD load transients. PSE's have the right to deny power to any PD on any port, and for PSE's that utilize PoE LLDP, they have the right to deny requested power allocations to PD's operating in quiescent low power states.

Because PD's can come and go at any time on any port, Central PSE Power Management (*see **Figure 7.1***) must have ability to process many possible events in real time including new connections and classifications, PD disconnects, overload shutdowns, processing of LLDP power requests, and any ongoing, per-port monitoring of power loads. In many PSE's, this is an extremely challenging development task!

The development task is made even more difficult because of the challenge of *testing* system behaviors. The Multi-Port Test Suite radically simplifies this testing task.

7.4. The Multi-Port Test Suite Components and Sequencing

PSE Multi-Port Test Suite consists of nine distinct automated tests that may be automatically sequenced with a single "push button" or from a single command. The tests are designed to follow a logical progression so that a sequence of tests can intelligently adapt to the many possible unique characteristics of the PSE-under-test.

Each of the Multi-Port Tests, including the automated test sequencer, share an identical set of configuration parameters so that configuration is both simple and intuitive. Whether testing a low port-count Type-1 PSE or a complex 48 Type-2 PSE that deploys PoE LLDP, all testing is completed in a single test sequence and summarized on a one-page spreadsheet test report.

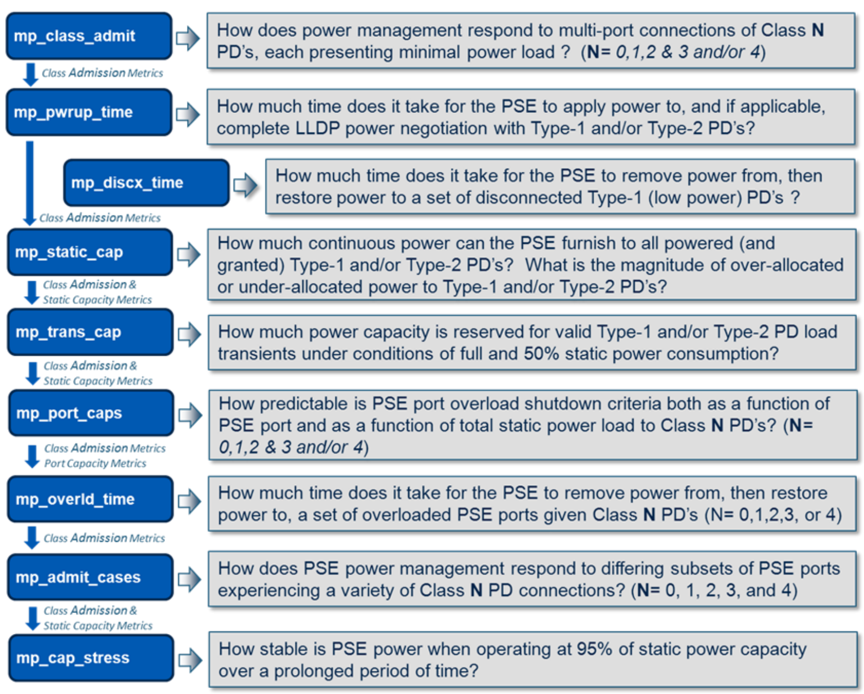


Figure 7.2 Multi-Port Test Suite: Tests, Coverages, and Sequencing

Figure 7.2 presents these tests in their "natural" sequence, including a very brief description of the fundamental questions answered by each test.

Starting with the **mp_class_admit** test, many of the tests perform Multi-Port, or near simultaneous, PD connections while modeling PD's of certain classifications (e.g. Class 0 or Class 4), and where PoE LLDP negotiations are conducted, modeling maximum PD class-specific power requests. Actual power draw from the modeled (or virtual) PD's is typically kept very low so that PSE power management decisions are based purely upon PD classifications and LLDP power requests. PSE's that do not make power management decisions based up on PD classification (or LLDP requests) are readily identified and distinguished from PSE's that use PD classification and/or LLDP mutual identification in power management decisions. Following **mp_class_admit**, many subsequent tests including **mp_pwrup_time**, **mp_static_cap**, and **mp_admit_cases** are necessarily constrained by classification-specific and LLDP grant-specific powering decisions of the PSE-under-test. Similarly, other tests including **mp_trans_cap**, **mp_port_caps**, **mp_overld_time**, and **mp_cap_stress** are constrained by not only these "admittance" decisions, but also by total static power capacity as determined in **mp_static_cap** on a class-specific and/or LLDP grant-specific basis.

Figure 7.3 depicts all the adaptive test sequencing dependencies. Each Multi-Port Test is designed to be aware of dependent information, and if that information is missing, to automatically invoke the pre-requisite test sequence as part of ordinary test execution.

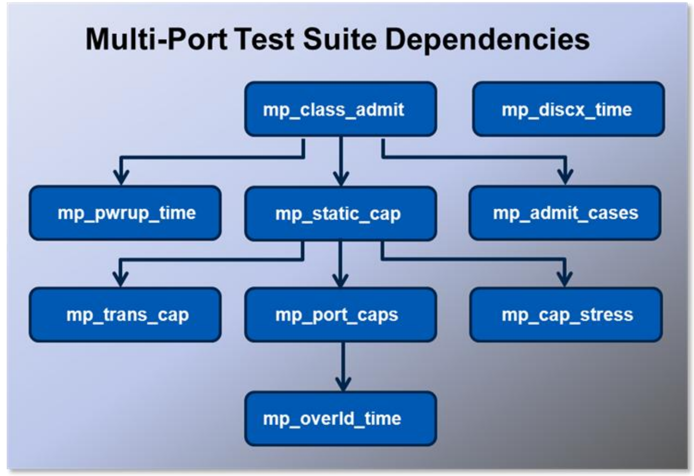


Figure 7.3 Multi-Port Test Order Dependencies

7.5. Configuring the Multi-Port Test Suite

The second generation Multi-Port Test Suite for IEEE 802.3at has been designed to be easy to configure and run for any given PSE type. All testing, regardless of PSE category, is completed in a single sequence and summarized on a single standard report.

Fundamentally, each test or test sequence requires just three configuration items:

- The Multi-Port (Test Port) Resource Configuration
- One of three possible PD Emulations
- One of three possible PSE Power Management Modes

The Multi-Port Resource Configuration is simply a grouping of up to 8 PSA-3000 instruments, or up to 4 PSA-3x48 (PSA-3248 or PSA-3048) Rack Pack instruments, along with specification of the test ports to be utilized within each test instrument. Each instrument chassis, if fully populated with 12 test blades, will supply up to 24 test ports for Multi-Port testing. The Multi-Port Test Suite is architected such that individual tests and test sequences need only to specify a resource configuration once. This feature allows tests that have dependencies to other tests, as shown in **Figure 7.3**, to optionally avoid invoking those other tests if dependent test data associated with a current Multi-Port Resource Configuration has previously been collected.

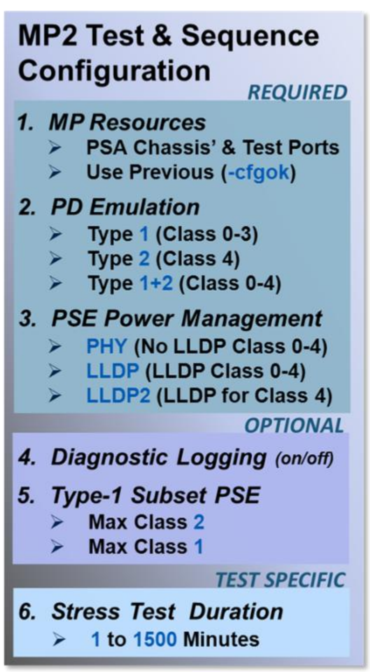


Figure 7.4 Multi-Port Test Suite - Test and Sequence Configuration

Referring to **Figure 7.4**, Multi-Port PD Emulation can be Type **1**, Type **2**, or Type **1+2**. Type **1** PD Emulation includes PD Classes 0-3 and is appropriate for testing Type-1 (15.4W) PSE's. Type **1+2** PD Emulation encompasses PD Classes 0-4 and is appropriate for testing Type-2 PSE's. Type **2** PD Emulation may be used to restrict all testing to just PD Class 4 given a Type-2 PSE.

PSE Power Management can be **PHY**, **LLDP**, or **LLDP2**. For PSE's that never use 802.3at PoE LLDP for mutual discovery and power negotiation, only **PHY** should be specified. For Type-2 PSE's that do use 802.3at PoE LLDP to grant power levels greater than 13 watts to PD's, **LLDP2** would be the recommended Power Management mode as it will use LLDP only for PD Class 4 power-ups, but not for PD Class 0 – 3 (Type-1) power-ups.

Optionally, for PSE's that deploy 802.3at PoE LLDP, all power-ups for PD Class 0 – 4 may include LLDP power negotiations if **LLDP** is specified as the Power Management mode. In this case, all negotiations are conducted to the maximum allowed PD power load per PD classification.

Each time a Multi-Port test or test sequence is run, users have the option to request that diagnostic log files be produced. These files provide deep insight into the events that transpired during each test and the decisions that are made in response to those events. An excerpt of one such file is shown in **Figure 7.5**.

```
mp_trans_cap TEST LOG Recorded August 12, 2014 1:19:23 AM

mp_trans_cap: st_admit_phy(0)= 15 st_static_cap(1)= 172.6, st_alloc_port_power(0)= 11.5  st_pclass(0)= 14.4 53.2
mp_trans_cap: st_admit_lldp(4)= 15 st_static_cap(2)= 171.6, st_alloc_port_power(4)= 11.4 st_pclass(4)= 29.3 53.1
mp_trans_cap: Assuring availability of all PSE ports and removing power...

mp_trans_cap: PD CLASS 0 TESTING at Full CAPACITY...
mp_trans_cap: Powering PSE to 90% of 172.6 W = 155.3 W total power...
mp_trans_cap: PSE powered 15 of 15 ports to measured power 158.6 W for transient reserve at Full power.
mp_trans_cap: At Full power, Multi-Port power-up measured typical Vport= 53.2 V, Iport= 198.7 mA.
mp_trans_cap: 802.3at Ipeak for class 0 computes to 305.8 mA for this PSE.
mp_trans_cap: 45msec, 305.8 mA Load Transients will be applied to PSE ports. This is the IEEE 802.3at 'Ipeak' value.
 . . . . .
```

Figure 7.5 Diagnostic Log File (excerpt) for the **mp_trans_cap** Test

Another supported option relates to the testing of Type-1 PSE's that only offer support for PD's that classify as Class **1** (4 watt loading per PSE port) and/or Class **2** (7 watt loading per PSE port). With this specification, tests and test sequences are restricted to Type-1 PD Emulation and will generally bypass Class 0 and Class 3 cases.

One final configuration applies to just the Multi-Port Stress Test (**mp_cap_stress**). This configuration simply specifies the length of time over which the PSE will furnish 95% of static power capacity while being monitored for unexpected shutdowns and power restores.

7.6. Standard Multi-Port System Test Report

PSE Multi-Port Test Suite provides a standard Microsoft Excel spreadsheet report* that is automatically produced upon the completion of any sequence of Multi-Port tests. The report offers both tabular and graphical presentations of many key parameters with extensive "behind the scenes" limit checking logic to draw attention to any potential problem areas. A sample report is shown in **Figure 7.6**.

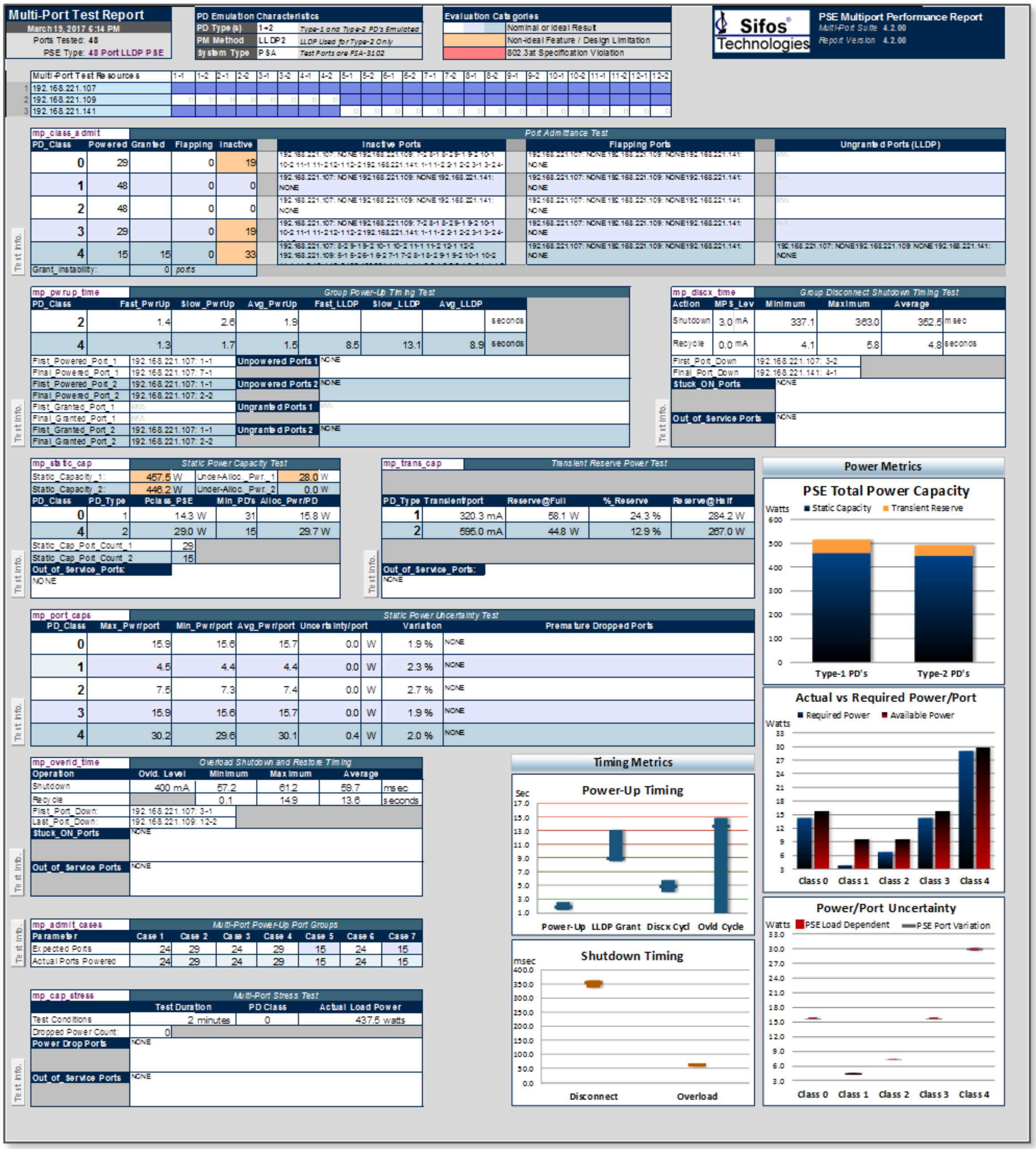


Figure 7.6 Multi-Port Test Suite Standard Spreadsheet Report: 48-Port, Type-2, LLDP Granting PSE

The report includes header information describing the test configuration including Multi-Port Test Resources (chassis addresses and utilized test ports), chassis type (**PSA** vs **PSL**), PD Emulation (Type **1**, **2**, or **1+2**), and Power Management Mode (**PHY**, **LLDP**, or **LLDP2**). Also included is time-date information and PSE-under-test description including the number of PSE ports tested.

** The standard spreadsheet report requires Microsoft Office 2007 or later with macro processing enabled.*

Test data is organized by Multi-Port test following the ordinary sequence of testing. Many tabular parameters are evaluated against low and/or high test limits and if a value falls outside those limits, the parameter field is colored to reflect the category of limit exception. Two categories are provided as shown in **Figure 7.7**. The first category is a **Non-Ideal Feature / Design Limitation**. Parameters marked with this color should *not* be interpreted as failures to some particular standard. The IEEE 802.3 clause 33 standard governing PSE's does not address behaviors of PSE's beyond just a single port. With about 10 exceptions, the parameters produced by the Multi-Port Test Suite are not linked to any published standards.

Evaluation Catagories	
	Nominal or Ideal Result
	Non-Ideal Feature / Design Limitation
	802.3at Specification Violation

Figure 7.7 Color Annotations

A simple example of this is the **Static Power Capacity** measured in the **mp_static_cap** test. A 24 Port Type-2 PSE would need a 720 watt power supply to furnish 30 watts to 24 Type-2 PD's all demanding their maximum allowed power. For most applications, this amount of power is excessive and expensive. If static power capacity of this PSE is measured as 350 watts while the PSE still powers all 24 ports, then the static power capacity is a less-than-ideal design constraint that can lead to unexpected powering limitations and PD powering instability depending upon the combined demand of all PD's connected. This behavior will render the **Static Capacity** as Non-Ideal Feature / Design Limitation and will also affect at least one other parameter, **Alloc_Pwr/PD** similarly. Another example of a Non-Ideal behavior is the **Grant Stability** metric measured in **mp_class_admit**. If a Type-2, LLDP-capable PSE does not produce a repeatable number of LLDP (25.5 watt) power grants during a succession of Multi-Port power-ups, then it is likely that PSE power management will run into trouble with over-allocated power and/or instability in setting up overload shutdown criteria across all granted ports. This behavior is not governed by any standard, yet it could be detrimental to the success of the PSE in managing many PD's.

Conversely, there are about 10 parameters across several Multi-Port tests that have direct connections to single-port behavior that is described by IEEE 802.3 clause 33. One example would be the **Maximum**, **Minimum**, and **Average Shutdown Times** measured in **mp_discx_time**. These times are specified such that disconnect shutdowns, regardless of how many are performed simultaneously, should occur between 300msec and 400msec after virtual PD disconnect. A **Minimum Shutdown** time less than 300 msec or a **Maximum Shutdown** time greater than 400 msec will be colored to reflect an 802.3at Specification Violation.

The standard spreadsheet test report includes several graphs that represent various tabular parameters. The PSE Total Power Capacity graph in **Figure 7.8** plots both **Static Capacity** (blue) and **Transient Reserve Capacity** (gold) for Type-1 and Type-2 PD Emulations. **Transient Reserve Capacity** is power that the PSE reserves for brief load transients caused by one or more PD's. Ideally, PSE's that don't have excess **Static Capacity** should retain, depending on output voltage, between 12.5% and 14.3% power in reserve for load transients.

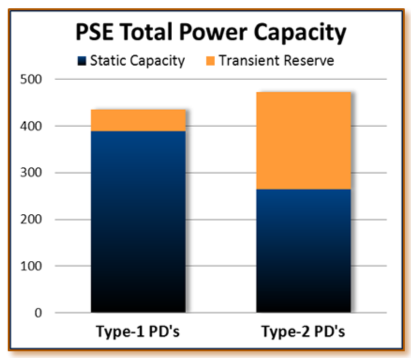


Figure 7.8 Total Power Capacity

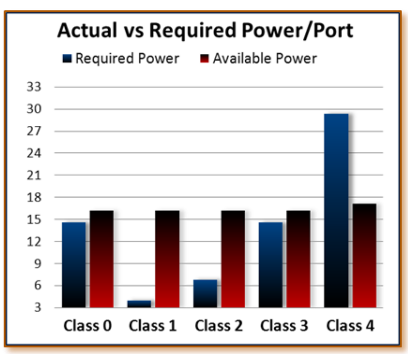


Figure 7.9 Actual vs Required Power per Port

Figure 7.9 is the graph of per-port power capacity as compared to that power level ideally required to power any PD at each PD classification.

Where red bars are higher than blue bars in this graph, the PSE does have adequate power capacity per PD to keep any PD powered. Otherwise, the PSE is over-allocated to that PD class if the blue bar is taller than the red bar and some PD's of that particular class will run into power stability problems.

In **Figure 7.10**, **Power/Port Uncertainty** is plotted. This parameter is determined in the **mp_port_caps** test and represents the power capacity uncertainty a PD of each class will experience when plugged into any arbitrary port of the PSE in any arbitrary application. The two factors that guide uncertainty are first, the power allocated out to all other PD's on all other PSE ports and second, the inherent variation of cutoff current (**I_{cut}**) thresholds from PSE port to PSE port.

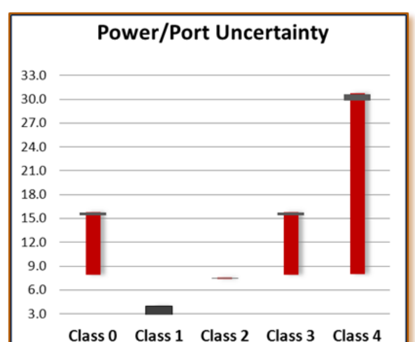


Figure 7.10 Power/Port Uncertainty

Two other graphs are provided to show timing ranges across all PSE ports. The Power-Up Timing graph depicts time to power all ports with both Type-1 and Type-2 PD classification signatures and for PSE's that perform LLDP negotiation, the time to grant requested power to all ports with Type 2 (and/or Type-1) PD Emulation. The Shutdown Timing graph shows time ranges to remove power given PD disconnects (MPS shutdowns) and given group PD overloads ($\mathbf{I_{cut}}$ shutdowns).

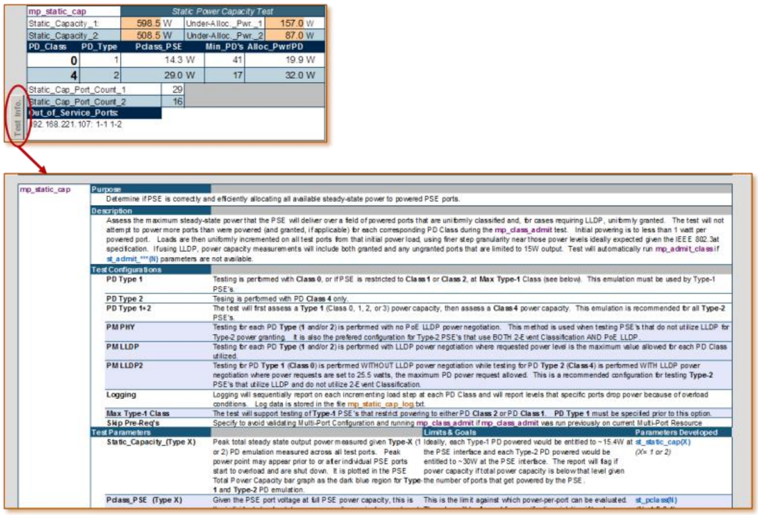


Figure 7.11 Multi-Port Report-Embedded Test Information

Another feature of the standard Multi-Port spreadsheet report is the Test Info button (*see **Figure 7.11***) that appears adjacent to the tabular summaries for each Multi-Port test. When this button control is pressed, it will open the workbook to a full write-up describing the purpose of that test, the test strategy, implications of various test configurations, and detailed write-up of each test parameter. Included for each test parameter is a description of what constitutes an ideal outcome and what value might get flagged with a notation when it is out of limit.

This test write-up will also describe any limitations of that test when using the PSL-3000 Programmable Load as opposed to the PSA-3000 PowerSync Analyzer.

One additional feature of the standard spreadsheet report becomes evident if any test encounters an error condition during sequencing. In this event, there will be no test data produced by that particular test, however, the report will embed a hyperlink (*see **Figure 7.12***) that will automatically open an error log file describing the error condition that developed during that test. Severely abhorrent behaviors of a PSE such as "crashing" all PSE service will in certain instances lead to test error conditions.

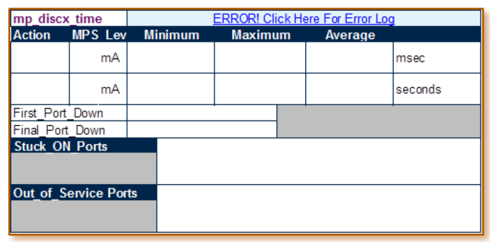


Figure 7.12 Test Error Hyperlink

7.7. Multi-Port Tests and Parameters

The following tables introduce each Multi-Port test, describing the basic purpose of each test and the parameters that are measured by each test. Parameters that are accompanied by ***Class N*** are collected per PD Class, that is, Class 0 – Class 4. Parameters that are accompanied by ***Type X*** are collected per PD Type, that is, Type-1 and/or Type-2. Any limitations imposed on each test by the PSL-3000 Programmable Load are also described. This same information is available from the **Notes** page of the standard spreadsheet report.

mp_class_admit	**Understand PSE power management powering and power granting strategy as it relates to each PD classification and to LLDP-based power requests. Provide other Multi-Port tests with expectations regarding how many ports will power to each PD classification and how many ports will grant maximum power requests via LLDP.**

Test Parameters		**Limits & Goals**
Powered Count *(Class N)*	Count of ports that remain powered after multi-port power-up by PD Class.	Ideally, this would be equivalent to the total number of PSE ports tested. Flagged conditions are: PSE does not power Class 1 to PSE port count, PSE powers more Class 2 ports than Class 1 ports, PSE powers more Class 0 and/or Class 3 ports than Class 1 and/or Class 2 ports.
Granted Count *(Class N)*	Count of ports that receive LLDP power grants for requested power level by PD Class. If Class 4 multi-port LLDP granting behavior is not repeatable (see Grant Stability below), this figure will be determined by sequencing single-port LLDP power-ups with 25.5W power requests.	Ideally, this would be equivalent to the total number of PSE ports powered.
Flapping Count *(Class N)*	Count of ports that intermittently shut down during the multi-port power-up process by PD Class.	Ideally this should be zero so that PD's are not powering, then shutting down as other PD's power.
Inactive Count *(Class N)*	Count of ports that remain unpowered after multi-port power-up by PD Class.	Ideally this would be zero, though power management decisions that budget a limited power supply may necessitate that some ports remain unpowered.

Test Parameters		Limits & Goals
Inactive Ports *(Class N)*	List of PSA chassis' and test ports that remain unpowered by PD Class.	Ideally, this list is empty, though if power management is restricting power-ups by PD Class, then ports with lower powering priorities should appear on this list.
Flapping Ports *(Class N)*	List of PSA chassis' and test ports that intermittently shut down during multi-port power-up by PD Class.	Ideally, this list is empty, though if power management is restricting power-ups by PD Class, then ports with lower powering priorities may appear on this list.
Ungranted Ports *(Class N)*	List of PSA chassis' and test ports that do not receive LLDP power grants by PD Class.	Ideally, this list is empty. If populated, it should be no more than one port because two or more ungranted (13W) ports indicates sufficient power capacity to power and grant at least one additional Class 4 PD.
Grant Instability	Range of ports that provide 25.5W LLDP power grants given PD Class 4 across 4 cycles of powering. Ideally, this range should be zero if multi-port powering with LLDP behavior is repeatable.	Ideally, this value is zero. Instability in Class 4 LLDP power granting will often lead to other power management issues affecting tests subsequent to mp_class_admit.
PSL-3000 Limitations	NONE	

mp_pwrup_time

Gain insight into the efficiency of PSE power management when processing multiple demands for power and LLDP power allocations. Expose scenarios where PD's may be unacceptably delayed in receiving power and/or LLDP allocations. Assess any vulnerability in per-port PoE service to PD group-connect events.

Test Parameters		Limits & Goals
Fast Power-Up, **Slow Power-Up**, and **Average Power-Up** *(Type X)*	Time in seconds between emulated PD connection and application of power to emulated PD. Reported as minimum (or Fast) time, maximum (or Slow) time, and average time across all ports.	The IEEE 802.3at standard imposes no requirements concerning time for PSE to power PD's. Lengthy power-ups are a possible problem to users however. The Multi-Port standard report imposes arbitrary time limits ranging from 10 to 24 seconds depending on PSE port count. These limits may be modified in the Limits tab.
First Port Powered *(Type X)*	Chassis address and test port that first received power.	
Final Port Powered *(Type X)*	Chassis address and test port that was the last to receive power.	
Fast LLDP, **Slow LLDP**, and **Average LLDP** *(Type X)*	Time in seconds between emulated PD connection and granting of a power request to a emulated PD. Reported as minimum (or Fast) time, maximum (or Slow) time, and average time across all ports.	The IEEE 802.3at standard imposes no requirements concerning time for PSE to grant power requests to PD's. Lengthy power grants may be a problem to users however. The standard report imposes arbitrary time limits ranging from 16 to 48 seconds depending on PSE port count. These limits may be modified in the Limits tab.
First Port Granted *(Type X)*	Chassis address and test port that first received LLDP power grant.	
Final Port Granted *(Type X)*	Chassis address and test port that was the last to receive LLDP power grant.	
Unpowered Ports *(Type X)*	List of PSA chassis addresses and test ports that failed to apply power.	Ideally, this list is empty because the test will only attempt to power the number of ports that were initially admitted per PD Class utilized in the mp_class_admit test.
Ungranted Ports *(Type X)*	List of PSA chassis addresses and test ports that failed to receive LLDP power grant.	Ideally, this list is empty because the test will only attempt to power the number of ports that were initially granted LLDP power request per PD Class utilized in the mp_class_admit test.
PSL-3000 Limitations	NONE	

mp_discx_time — **Determine that PSE ports are uniformly responding to valid PD disconnect signatures and then autonomously (independently) managing disconnect shutdown timing. Separately, determine if a group-disconnect shutdown event is in any way detrimental to subsequent per-port PoE service under control of PSE power management.**

Test Parameters		Limits & Goals
Minimum, **Maximum**, and **Average Shutdown Times**	Time in milliseconds between emulated PD disconnect and power removal by PSE port. Reported as minimum time, maximum time, and average time across all ports.	The IEEE 802.3at standard requires that PSE ports remove power between 300 msec and 400 msec (= T_{mpdo}) following each PD disconnect event. The report will flag any shutdowns that require more than 500 msec and, if using PSA-3000, any ports that remove power in less than 300 msec.
First Port Down	Chassis address and test port that first removed power. *(PSA-3000 only)*	
Last Port Down	Chassis address and test port that was the last to remove power. *(PSA-3000 only)*	
Minimum, **Maximum**, and **Average Power Re-Cycle Time**	Time in seconds between emulated PD disconnect followed by a shutdown and immediate PD re-connect until power is restored by the PSE port.	The IEEE 802.3at standard imposes no requirements concerning time for PSE to power PD's. The report will flag if maximum recycle time exceeds the same time limit used in mp_pwrup_time by more than 3 seconds.
Stuck On Ports	Ports that fail to remove power given PD disconnects.	If many ports fail to remove power, it may be that an AC MPS PSE is specified as DC MPS or that a DC MPS PSE has too low an I_{Hold} disconnect current threshold.
Out-of-Service Ports	Ports that initially powered for the disconnect shutdown timing measurements but then fail to recycle power.	The test will allow up to 90 seconds for all initially powered ports to recycle power after the disconnect shutdown and emulated PD re-connection.
PSL-3000 Limitations	Because the PSL-3000 (Programmable Load) does not support programmable load transients, time interval measurements, and cross-chassis triggering, shutdown and power recycle timing is assessed with low resolution ranges. Shutdown states are sampled after 500msec following all port disconnects and then again at 3 seconds. If any ports have removed power at 500msec, then Minimum Range is '500msec'. If all ports remove power at 500msec or at 3 seconds, than that range is reported as the Maximum Range. Recycle power states are assessed at 15 seconds, then again at 35 seconds following the group disconnect shutdown.	

mp_static_cap — **Determine if PSE is correctly and efficiently allocating all available steady-state power to powered PSE ports.**

Test Parameters		Limits & Goals
Static_Capacity *(Type X)*	Peak total steady state output power measured given **Type-X** (1 or 2) PD emulation measured across all test ports. Peak power point may appear prior to or after individual PSE ports start to overload and are shut down. It is plotted in the PSE Total Power Capacity bar graph as the dark blue region for **Type-1** and **Type-2** PD emulation.	Ideally, each Type-1 PD powered would be entitled to ~15.4W at the PSE interface and each Type-2 PD powered would be entitled to ~30W at the PSE interface. The report will flag if power capacity if total power capacity is below that level given the number of ports that get powered by the PSE.
Pclass_PSE *(Class N)*	Given the PSE port voltage at full PSE power capacity, this is the individual steady-state power capacity required on each port in order to meet IEEE 802.3at power capacity requirements.	This is the limit against which power-per-port can be evaluated. The value will be flagged for specification violation if too low (insufficient power for all PD's of Class N) or too high (PSE is under-voltage at full power).
Min_PD's *(Type X)*	This is the number of PD's that could receive maximum allowed power given PD classification, PSE static power capacity, and PSE port voltage. For **Class 0**, that power would be 13 watts at the PD interface, or $\mathbf{P_{class}(0)}$ at the PSE interface, and for **Class 4**, that power is 25.5W at the PD interface, or $\mathbf{P_{class}(4)}$ at the PSE interface.	This parameter is not limit checked. It is used in determining potential under-allocation of total PSE power to PD's.
Alloc_Power/PD *(Class N)*	Given the number of powered ports, this is essentially the total static power capacity spread to each of those ports. In the case of LLDP power grants, this figure is the total static power available to just those ports that were granted their requested power level (e.g. 25.5 watts).	If **Static_Capacity_(Type X)** is flagged by the report for being too low, then it is likely that **Alloc_Power/PD (Type X)** is below $\mathbf{P_{class}}$ **(Type X)** and this parameter will also be flagged. This then means that powered PD's will not all be able to draw maximum allowed power under maximum cable loss.
Under-Alloc._Pwr._1	This is excess power available for powering additional Type-1 PD's based on PSE capacity, $\mathbf{P_{class}}$ **(Type-1)**, and also considering any differences in capacity between Type-2 powering and Type-1 powering.	This will be flagged if there is excess capacity $\mathbf{P_{class}}$ **(Type 1)** to power at least one more Type-1 PD.
Under-Alloc._Pwr._2	This is excess power available for powering additional Type-2 PD's based on PSE capacity, $\mathbf{P_{class}}$**(Type-2)**, and also considering any differences in capacity between Type-1 powering and Type-2 powering.	This will be flagged if there is excess capacity $\mathbf{P_{class}}$ **(Type 2)** to power at least one more Type-2 PD.

Test Parameters		Limits & Goals
Static_Cap_Port_Count *(Type X)*	This is the count of powered ports when the peak static power capacity **(Static_Capacity_(Type-X))** is measured. This may be the same or less than the number of ports orginally powered with Type-X emulation.	The only reason for this value NOT to be the original number of powered ports is that some PSE ports are dropping power at levels well below other PSE ports, that is, that I_{cut} is not very uniform across PSE ports. If more than 2 ports have dropped before peak is found, this parameter will be flagged.
Out-of-Service Ports	This is a list of chassis addresses and test ports that refuse to power up to PD Class 1 emulation following completion of the static power capacity measurements.	Ideally, this list should be empty ("NONE"). Otherwise, it is possible that the power overloads created by the static power measurement has caused the PSE to either temporarily or permanently remove PoE service from these ports.
PSL-3000 Limitations	NONE	

mp_trans_cap **Determine if PSE is keeping power in reserve to meet IEEE 802.3at allowed PD transient loads (e.g. Ipeak). If PSE allocates all available power to static (steady state) loads, there is the risk that one or more PD load transients will cause one or more PSE ports to remove power, including ports that do not experience the load transient. A common example of a PD load transient would be the panning motor on a pan-tilt-zoom camera.**

Test Parameters		Limits & Goals
Transient/port *(Type X)*	This is the actual applied transient load current that is applied for 45 msec given **Type-1** emulation and either 45 msec or 9.5 msec given **Type-2** emulation. It will not be lower than IEEE 802.3at I_{peak}(PD Class= N) and will not be higher than I_{lim_min} (PD Type 1 or 2). It is computed based on **st_pclass(N)** and **st_alloc_port_power(N)**.	
Reserve@Full *(Type X)*	This is the total power reserve in watts available to support load transients for **Type-1** and/or **Type-2** PD emulation given a PSE operating at its maximum static power capacity. It is plotted in the PSE Total Power Capacity bar graph as gold-colored region above the dark blue static power capacity for **Type-1** and **Type-2** PD emulation. While it is measured starting at 90% total static power capacity, it is computed by removing the remaining 10% from the measured transient load power in order to assess just the transient reserve ABOVE 100% static load capacity.	This value is set to zero if there is negative reserve power because the PSE port does not meet static capacity requirements, namely P_{class}**(N)** per powered port. If it reports **-1**, then it was not measured because the PSE failed to power (and grant, if using LLDP) the expected number of ports observed during **mp_class_admit** testing.
%_Reserve *(Type X)*	This is the percentage of power ABOVE static power capacity requirement **(P_{class}(N))** available to support short load transients of at least I_{peak}**(N)** on all powered (and granted, if using LLDP) ports. Both P_{class}**(N)** and I_{peak}**(N)** are computed using the PSE output voltage measured at full power capacity. This parameter may range negative on PSE's that have no reserve because they cannot furnish required static power capacity, P_{class}**(N)**.	For **Type-1** PD emulation, **minimum %_Reserve** should range between 12.5% and 15.3% depending on PSE port voltage at full load in the range of 57 VDC to 44 VDC respectively. For **Type-2** PD emulation, **minimum %_Reserve** should range between 12.8% and 13.7% depending on PSE port voltage at full load in the range of 57 VDC to 50 VDC respectively.
Reserve@Half *(Type X)*	This is the total power reserve in watts available to support load transients for **Type-1** and/or **Type-2** PD emulation given a PSE operating at one half of its maximum static power capacity.	This value is set to zero if there is negative reserve power because the PSE port does not support 50% of the static capacity requirements, namely 0.5*P_{class}**(N)** per powered port. If it reports **-1**, then it was not measured because the PSE failed to power (and grant, if using LLDP) the expected number of ports observed during **mp_class_admit** testing.
Out-of-Service Ports	This is a list of chassis addresses and test ports that refuse to power up to PD Class 1 emulation prior to assessment of Transient Reserve power. The test requires that all but one of the expected ports MUST power up and if using LLDP, grant the power request.	Ideally, this list should be empty ("NONE"). Otherwise, if more than one port that was expected to power does not power, it is likely the PSE has either temporarily or permanently discontinued PoE service on those ports.
PSL-3000 Limitations	Because this test requires programmable Load Transients, it is only available to PSA-3000 test ports and is not available to PSL-3000's.	

mp_port_caps From a PD's perspective, total power uncertainty is the range of possible power levels available to any PD powering at a particular classification. It is dependent on PSE power allocation to other PD's and on individual overload tolerance variation by PSE port. This test produces figures for total power undertainty by PD class and PSE port variation in that figure.

Test Parameters		Limits & Goals
Max_Pwr/port *(Class N)*	The maximum power allowed before port shutdown on all sampled ports at each PD class.	
Min_Pwr/port *(Class N)*	The minimum power allowed before port shutdown on all sampled ports at each PD class.	The minimum power each port will ideally deliver is **P_{class} (Class N)**. This value is a function of system type (1 or 2) and PSE output voltage. It is determined during **mp_static_cap** test and may be found in the Limits table as the minimum entry for **Min Power/Port Class N PD's**.
Average_Pwr/port *(Class N)*	The average power allowed before port shutdown across all sampled ports at each PD class.	
Uncertainty/port *(Class N)*	The total uncertainty range of power available to any Class N PD connecting to any port of the PSE.	This parameter is not important if both the **Alloc_Power/PD (Class N)** and the **Average_Pwr/port (Class N)** both exceed **P_{class} (Class N)** because it does not matter what the uncertainty if each PD is guaranteed its maximum allowable power. For cases where ports do not furnish **P_{class} (Class N)**, by default, the report will flag if the power capacity Uncertainty to a PD exceeds 10% of **P_{class} (Class N)**. This is an arbitrary threshold reflecting variations in **I_{cut}** (per-port overload) thresholds across all PSE ports.
Variation *(Class N)*	The percentage variation in power available to any Class N PD. This variation is purely a function of Icut overload threshold variation across PSE ports.	
Premature Dropped Ports *(Class N)*	List of chassis addresses and test ports where power capacity was substantially lower than expected given the coarse **Icut** capacity measurements initially performed at each PD class.	This list should ideally be empty (NONE). Ports that remove power unexpectedly, or at significantly lower than expected individual port power capacity thresholds, will be noted in this list.
PSL-3000 Limitations	NONE	

mp_overld_time Determine that PSE ports are uniformly responding to overload conditions and then autonomously (or independently) managing overload shutdown timing. Separately, determine if a group-overload event is in any way detrimental to subsequent per-port PoE service under control of PSE power management.

Test Parameters		Limits & Goals
Minimum, **Maximum**, and **Average Shutdown Time**	Time in milliseconds between emulated PD overload and power removal by PSE port. Reported as minimum time, maximum time, and average time across all ports.	The IEEE 802.3at standard requires that PSE ports remove power between 50 msec and 75 msec following each PD overload event. If overload required to assure shutdowns exceeds I_{lim_min} for PD **Class 4** (683mA), this range is extended to 10 msec and 75 msec to allow for **Type-2** PSE's that don't implement "normal" (sub-current limit) overload processing. The report will flag any shutdowns that require more than 75 msec and, if using PSA-3000, any ports that remove power in less than 50 (or if **Icut** > 683 mA, 10) msec.
First Port Down	Chassis address and test port that first removed power. *(PSA-3000 only)*	
Last Port Down	Chassis address and test port that was the last to remove power. *(PSA-3000 only)*	
Minimum, **Maximum**, and **Average Power Re-Cycle Time**	Time in seconds between emulated PD overload followed by a shutdown and immediate PD re-connect until power is restored by the PSE port.	The IEEE 802.3at standard imposes no requirements concerning time for PSE to power PD's. The report will flag if maximum recycle time exceeds the same time limit used in **mp_pwrup_time** by more than 10 seconds.
Stuck On Ports	Ports that fail to remove power given PD overloads.	This list should be empty because the overload level applied exceeds the maximum individual powered port Icut level assessed across many PSE ports. If not empty, port is either in a "stuck on" condition or likely has defective overload shutdown processing.

Test Parameters		Limits & Goals
Out-of-Service Ports	Ports that initially powered for the disconnect shutdown timing measurements but then fail to recycle power.	The test will allow up to 90 seconds for all initially powered ports to recycle power after the overload shutdown and emulated PD re-connection, this this list should ideally be empty. If not, it likely means the PSE has either temporarily or permanently shut down PoE service on these ports.
PSL-3000 Limitations	Because the PSL-3000 (Programmable Load) does not support programmable load transients, time interval measurements, and cross-chassis triggering, shutdown and power recycle timing is assessed with low resolution ranges. Shutdown states are sampled after 500msec following all port overloads and then again at 3 seconds. If any ports have removed power at 500msec, then Minimum Range is '500msec'. If all ports remove power at 500msec or at 3 seconds, than that range is reported as the Maximum Range. Recycle power states are assessed at 15 seconds, then again at 35 seconds following the group overload shutdown.	

mp_admit_cases

Ultimately, the purpose of this test is to determine if PSE power management treats all PSE ports, regardless of location, equally and independently when making (class based) power-up decisions and LLDP power grants. Ideally, all ports should be treated independently regardless of physical location on the PSE.
CASE 1: PD Class 1 connected to every ODD port (1st, 3rd, 5th, 7th…) in the Resource Configuration
CASE 2: PD Class 0 on uppermost st_admit_*(0) ports in the Resource Configuration**
CASE 3: PD Class 2 on every EVEN port (2nd, 4th, 6th…) in the Resource Configuration
CASE 4: PD Class 3 on a middle set of st_admit_*(3) ports iin the Resource Configuration**
CASE 5: PD Class 4 on uppermost st_admit_*(4) ports in the Resource Configuration**
CASE 6: PD Class 3 on every ODD port (1st, 3rd, 5th, 7th…) in the Resource Configuration
CASE 7: PD Class 4 on every EVEN port (2nd, 4th, 6th…) in the Resource Configuration

Test Parameters		Limits & Goals
Expected Ports *(Case M)*	Count of ports that are expected to power up (and, if applicable, provide LLDP grant) given the class-specific power-up (and, if applicable, LLDP grant) counts (**st_admit_***(N)**) orginally determined in **mp_class_admit**.	
Actual Ports Powered *(Case M)*	Count of ports that actually powered up (and, if applicable, provided LLDP grant).	This should be identical to the Expected Ports for each case. If not, then the value will be flagged. It will never exceed the Expected Ports because only the Expected Ports count of emulated PD's is connected in each case.
PSL-3000 Limitations	None	

mp_cap_stress

Demonstrate that the PSE withstands a high static power load over a long duration of time without causing ports to drop out or drop PoE service.

Test Parameters		Limits & Goals
Actual Load Power	This is the actual total PSE power established while trying to attain 95% of previously measured static power capacity.	Ideally 95% of the larger of **st_static_cap(1)** and **st_static_cap(2)**. If some ports fail to power (or grant) this figure will be lower than 95% and will be flagged if lower than 92%.
Dropped Power Count	The count of events where a port removed power over the course of testing. Each shutdown on each port is deemed a power removal event.	This value should be zero or it will be flagged. Once the PSE has initially made decsions to power (and, if applicable, LLDP grant) various ports, it ideally should adhere to those decisions. Port shutdowns may be thermal issues or severely delayed power management decisions.
Power Drop Ports	The list of ports that experienced one or more power drops during the course of testing. Use the log file to get further details concering how many times each port dropped power and when those drop-outs occurred.	Ideally, this list should be empty (NONE).
Out-of-Service Ports	Since the test is only powering the number of ports expected to power based on **st_admit_***(N)**, this is a list of ports that were expected to power up initially, but failed to power or provide expected LLDP power grant.	Ideally, this list should be empty (NONE).
PSL-3000 Limitations	None	

7.8. Enabling the PSE Multi-Port Suite in the PowerSync Analyzer

The **standard** PSA-3000, PSA-3x02, PSA-3x48, PSL-3000, and PSL-3x24 PowerSync Analyzers and Programmable Loads do not enable the PSE Multi-Port Test Suite. Attempts to execute any of the PSE Multi-Port Suite commands, either directly or via the sequencer, will yield "Invalid Command" responses to PowerShell PSA. All PSE Multi-Port Suite Menus will be disabled in PSA Interactive when connected to a PSA chassis that does not have PSE Multi-Port Suite support.

PowerSync Analyzer and PowerSync PL customers may elect to upgrade their analyzer to support the PSE Multi-Port Test Suite. This is done simply by procuring a unique key code from Sifos Technologies. Contact Sifos Technologies for further information on performing this upgrade to your PowerSync Analyzer.

8. Link Layer Discovery Protocol (LLDP) Emulation

8.1. PoE LLDP Overview

Each of the two test ports on the PSA-3x02 test blade are equipped with an Ethernet Controller, the purpose of which is to support transmitting and receiving LLDP packets. This capability has been added for the express purpose of allowing a PSA-3x02 test port to emulate powered device (PD's) that can negotiate power demand with an LLDP-capable, end-span PSE. Under **802.3at**, all Type-2 PD's must have this capability in order to assure full power-up while Type-1 PD's may have this capability, though not as a prerequisite to achieving full power. Under **802.3bt**, all Type-3 PDs that draw more than 13 watts and all Type-4 PD's must have this capability to support granular power management behaviors in PSE's that support PoE LLDP.

IEEE 802.3 specifies Power-over-Ethernet (PoE) LLDP behaviors and protocols Clauses 33 (802.3at), 145 (802.3bt), and Clause 79. Clause 79 aggregates input from both 802.1 and from 802.3 specifications concerning PoE LLDP information types (or type-length-values, TLV's) that reside in industry standard LLDP frame structures as well as SNMP management objects. Clauses 33 and 145 specify rules governing PSE and PD usage of LLDP to negotiate power levels including timing requirements and "state-like behaviors" for LLDP messaging.

8.2. PSA-3000 LLDP Connection

As explained in section 3.1 of this manual, the default state of a Test Port is to connect the PSE (input) port to the OUT port with passive coupling. The PSE input ("data" pairs only) can alternatively be connected to the test port's internal Ethernet controller. These connections are mutually exclusive (see ***Figure 8.1***) – when the Ethernet controller is connected, the OUT port "data" pairs are isolated, and when the OUT port is connected, the Ethernet controller is fully disconnected and shut down. Note that the "spare" pairs (wire pairs 1 and 4) are not switched. When the Ethernet controller is connected, the **DET LED** on the test port front panel indicates:

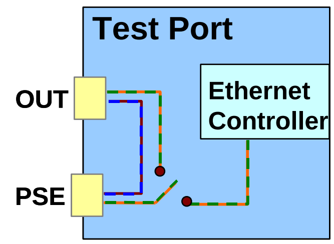


Figure 8.1: Test Port LAN Connections

- Long ("on") Duty Cycle Blinking: LAN LINKED
- Very Short ("on") Duty Cycle Blinking: LINK DOWN

The PSx-3202 and version 8 PSx-3102 test blades support 10/100 half and full duplex LAN links. The PSx-3202 will indicate in **green** for 100Base-Tx and **amber** for 10Base-T links. Older PSx-3102 version 1-6 test blades only support 10Base-T links. Auto-MDI is not supported on the PSA/PSL LLDP interface.

Generally, there should be no problem if Ethernet equipment (e.g. LAN test instruments) are connected to the OUT port when the test port is performing LLDP Emulations because Ethernet links cannot develop via the "spare pairs". However, as cautioned under PSE Conformance Tests, it is generally not advisable to have the OUT port connected to external equipment when PSE Conformance Tests are run owing to the subtle effects of some EMI terminations on PSE measurements.

8.3. Enabling LLDP Features

The LLDP functions are not enabled in the standard PSA-3000 (or related products PSA-3x48, PSA-3x02, PSL-3000, or PSL-3x24). A unique, instrument-specific license code is required to enable this capability. The **psa_enable ?** command in PowerShell PSA or the **Help-Features** menu in PSA Interactive can be used to determine whether or not LLDP is enabled on a specific instrument.

If the LLDP feature is not enabled, any attempt to execute one of the functions related to this feature will return an error, for example:

```
pse_frame: This command is not available to this instrument
```

LLDP Emulation can be enabled in a PSA-3000 (or PSA-1200 with PSA-3x02 test blades) by purchasing an instrument-specific license code from Sifos Technologies.

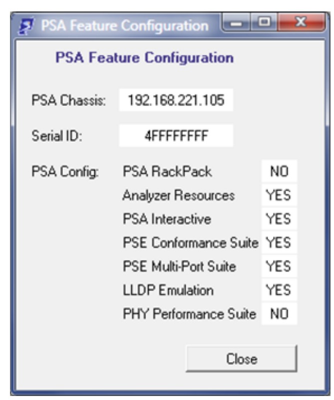


Figure 8.2: Help Features menu

8.4. PD LLDP Emulation and Testing with PSA Interactive 5

PSA Interactive offers capabilities to emulate **802.at** and **802.3bt** LLDP Power-Ups and to run LLDP Trace Sequences. LLDP Power-Up Emulation is available via the **Power Up** tab menu (*see section 4.3*) and is also utilized within the **Waveforms** tab menu (*see section 4.6*). LLDP Protocol Traces are available from the **LLDP** tab menu (*see section 4.11*).

8.5. PoE LLDP Diagnostic Protocol Traces for 802.3at and 802.3bt

Two robust diagnostic protocol trace applications are available to PSA Interactive and PowerShell PSA. These may be used for emulating PD behaviors or for troubleshooting and observing LLDP protocol problems on a single PSE port.

8.5.1. LLDP Power-Up Protocol Trace with 802.3at (Type-1/Type-2 PD) TLV's

The **802.3at** Power-Up Trace always starts from a power-down state and emulates the connection, PD classification, and LLDP post-power-up negotiation while emulating a Type-1 (class 0-3) or Type-2 (class 4) PD. Users can specify the **PD Class** signature, the **PD Requested Power** level, the trace **duration**, and the **periodicity** of PD transmitted Power Request packets. During the course of the trace, all packet contents and timing are captured in both directions until the trace completes. Information is displayed in real time and may optionally be routed to a pre-formatted pop-up Excel spreadsheet for protocol value and timing analysis.

If PD Class is specified to the trace without a PD Request Power, PD Power Requests will be PD Class dependent with values of 8.6W, 3.2W, 6.1W, 11.4W, and 22.2W for PD Classes 0, 1, 2, 3, and 4 respectively. If PD Request Power is specified to the trace without PD Class, then PD Class will be automatically selected to match the requested power level (e.g. Class 4 if greater than 13W).

Actual power draw will approximate the PD Requested Power level up to a maximum of 12.8 watts. The trace utility will never adjust actual power load following the negotiation to the PD Requested Power level because the *intent* of the trace is to observe the negotiation that would *precede* the PD power adjustment. Power draw is maintained below 13W for Type-2 (Class 4) PD's so that the PSE will not remove power for an un-negotiated power draw.

Upon completion of the LLDP Power-Up Trace, power is always removed. Section 4.11 explains how to access LLDP traces from PSA Interactive software and provides a sample of a Power-Up Trace report.

8.5.2. LLDP Power-Up Protocol Trace with 802.3bt (Type-3/Type-4 PD) TLV's

Like the 802.3at Power-Up Trace, the 802.3bt Power-Up Trace starts from a power-down state and emulates the connection, PD classification, and LLDP post-power-up negotiation while emulating a Type-3 (class 1-6 or class 1D-4D) or a Type-4 (class 7-8 or class 5D) PD. Users can specify the **PD Class** signature(s), the **PD Requested Power** level(s), the trace **duration**, and the **periodicity** of PD transmitted Power Request packets. During the course of the trace, all packet contents and timing are captured in both directions until the trace completes. Information is displayed in real time and may optionally be routed to a pre-formatted pop-up Excel spreadsheet that will display and analyze only the protocol fields utilized for single signature PD power negotiation.

If PD Class is specified to the trace without a PD Request Power, PD Power Requests will be PD Class dependent and will be set to a default value that is lower than the maximum power grant level. Generally, the PD Request Power should be specified to assure the proper LLDP protocol is used. Different pairset PD classes and power requests may be specified for Dual Signature cases.

Actual power draw will approximate the PD Requested Power level up to a maximum of 12.8 watts. The trace utility will never adjust actual power load following the negotiation to the PD Requested Power level because the *intent* of the trace is to observe the negotiation that would *precede* the PD power adjustment. Power draw is maintained below 13W for Type-2 (Class 4) PD's so that the PSE will not remove power for an un-negotiated power draw.

Upon completion of the 802.3bt LLDP Power-Up Trace, power is always removed.

8.5.3. LLDP Power-Change Protocol Trace with 802.3at (Type-1/Type-2 PD) TLV's

The Power-Change Protocol Trace can start either from a power-down state or an already-powered state. This trace tracks the protocol sequencing associated with a PD initiated Power Change Request. These requests can work in either direction – adjusting power up or down.

When starting from a power-down state, the user specifies PD Class (0 - 4) and both an initial request power level, then a power change request level (in watts). The power-up will involve a fully emulated LLDP power-up to the Initial Power Request with an actual power-draw to match the request.

When starting from an already-powered state, the user just specifies the new power request level. In the case of power increases, the actual power draw is increased upon the completion of the protocol trace. In the case of power reductions, the actual power draw is reduced to the new request level prior to executing the protocol trace.
In all cases, the trace begins with the new (or final) power request transmission. During the course of the trace, all packet contents and timing are captured in both directions until the trace completes. Information is displayed in real time and may optionally be routed to a pre-formatted pop-up Excel spreadsheet that will display and analyze only the protocol fields utilized for single signature PD power negotiation.

Upon completion of the Power Change Trace, power is always maintained. Section 4.11 explains how to access LLDP traces from PSA Interactive software and provides a sample of a Power-Change Trace report.

8.5.4. 9.1.1LLDP Power-Change Protocol Trace with 802.3bt (Type-3/Type-4 PD) TLV's

Like the 802.3at Power-Change Trace, the 802.3bt Power-Change Trace can start either from a power-down state or an already-powered state. This trace tracks the protocol sequencing associated with a PD initiated Power Change Request. These requests can work in either direction – adjusting power up or down.

When starting from a power-down state, the user specifies PD Class (1 – 8 or 1D – 5D) and both an initial request power level, then a power change request level (in watts). The power-up will involve a fully emulated LLDP power-up to the Initial Power Request with an actual power-draw to match the request. Different pairset PD classes and power requests may be specified for Dual Signature cases.

When starting from an already-powered state, the user just specifies the new power request level(s). In the case of power increases, the actual power draw is increased upon the completion of the protocol trace. In the case of power reductions, the actual power draw is reduced to the new request level prior to executing the protocol trace.

In all cases, the trace begins with the new (or final) power request transmission. During the course of the trace, all packet contents and timing are captured in both directions until the trace completes. Information is displayed in real time and may optionally be routed to a pre-formatted pop-up Excel spreadsheet for protocol value and timing analysis.

Upon completion of the Power Change Trace, power is always maintained.

8.6. PD LLDP Emulation and Testing with PowerShell PSA

Flexible **802.3at** and **802.3bt** PD LLDP emulation is readily available using PSA Interactive or PowerShell PSA (Wish or Tcl). In PowerShell PSA, the command set for LLDP emulation includes the following elements:

- Primitive commands for constructing and capturing LLDP traffic
- Utility commands for managing LLDP emulations
- Application commands for assessing LLDP protocol
- Extensions to other PowerShell PSA commands for LLDP emulation

The PowerShell PSA LLDP software hierarchy is depicted in **Figure 8.3**.

The "primitive" commands interact directly with test ports to support resource configuration, configuration query, and/or status query. The **psa_lan** command is utilized to connect or disconnect the Ethernet controller as described in section 8.2 above. The **pd_req**, **pd_frame**, and **pd_lldp** commands are used to construct all aspects of a PD LLDP PoE message including LLDP headers and PoE TLV's. In addition, transmitted LLDP frame counts, periodicity, and transmission trigger modes may be configured. Much like PSA-3000 DC metering, LLDP frame transmissions can be armed and synchronized to trigger generating events.

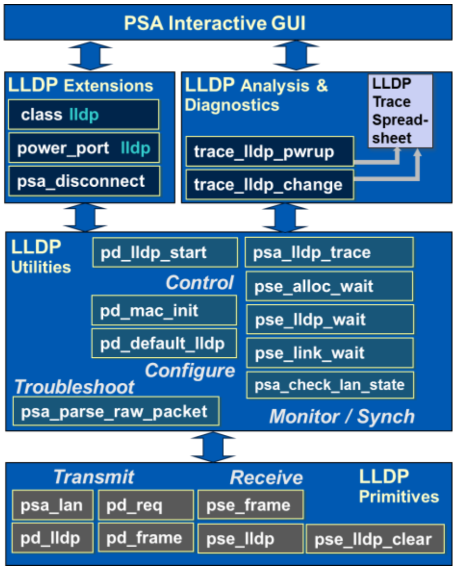


Figure 8.3 PSA Software LLDP hierarchy

Each transmit primitive supports broadcast ports "**99,***" and "***,99**" (*see section 9.1.1*). In 4-Pair test port configurations, commands must be addressed to the CONNECTED 4-pair port and there is no support of *slot*,*pairset* addressing because the LAN interface is not truly a PoE entity.

The **pse_frame** and **pse_lldp** commands are used for capturing, counting, and evaluating LLDP frames transmitted by a PSE. They also can generate "frame receive" or "event" triggers when a frame is received. The **pse_frame** can also be used to recover PD-generated LLDP messages when emulating PSE LLDP functions.

Utilities simplify the task of performing routine configuration, control, and monitoring operations related to LLDP PD emulation. They make use of the LLDP primitives as "drivers" and abstract commonly performed tasks including real-time bidirectional protocol traces.

Finally, existing PowerShell PSA commands used for PD emulation, namely **power_port**, **power_bt**, and **psa_disconnect** will selectively utilize LLDP resources whenever LLDP features are enabled on the PSA-3000 chassis. For example, **power_port** can perform a full LLDP granted high power power-up to any classification and power-request level acceptable to an LLDP-capable PSE in a single command. The following sections will detail PowerShell PSA commands and arguments for LLDP PD Emulation in the PSA-3000.

8.7. Review of PowerShell PSA Syntax Conventions

The following table summarizes conventions for describing PowerShel1 PSA commands and arguments.

Convention	Definition
keyword *(command)*	An API command that will typically be followed by one or more subcommands and/or command parameters. The minimum required text to execute the command on the command line is highlighted in purple. (Scripts must utilize the full name of the command.)
-?	A universal argument that responds with information on how to use the command including all command arguments. If a command is given no arguments, the Help menu often will appear.
?	A universal query argument that generates a reply of the configuration state of the associated test resource.
<**parameter**>	The "<" and ">" brackets indicate that a particular argument or argument set are optional.
keyword *(sub-command)*	A subcommand associated with a command. Sub-commands may be followed by associated parameters but seldom have "nested" sub-commands. Minimum required command line characters are shown in purple. Absence of an optional sub-command following any command will cause the associated configuration to remain unchanged.
parameter	A numeric or alpha-numeric value that accompanies a particular command or sub-command. It generally follows the command or sub-command to which it is associated. Absence of an optional command parameter results in no change to the associated configuration value.
<*port*>	An optional route parameter for all blade-port specific commands. If omitted, the most recent command specifying a port (command destination) will govern routing of subsequent commands. *port* = <*slot*,*portId*> Example: "3,2" = slot 3, port 2. Slot and Port will default to lowest available slot, Port 1 upon connecting to a PSA. **The current value of** *port* **is always displayed in the PowerShell command prompt**. The command line will reject values of port that are not available in the current selected PSA chassis. *See Section 9.1.1 for description of* **99,99***,* **99,1***, and* **99,2** *broadcast configuration ports*.
"|"	Indicates logical "OR"
"+"	Indicates logical "AND"
stat	A special optional query available to many commands to report Operational State and in some cases, to return a measurement result.
PARAMETER	A default configuration parameter.

8.8. LLDP Primitive Command Set

LLDP Primitive Commands work directly with PSA test port(s) to effect connection, data, transmission, and reception configurations for LLDP. Configurations are generally stored in each test port and retained until altered by command execution or power is re-cycled to the PSA instrument. These commands are used extensively by LLDP utilities and applications. In 4-Pair configurations, addressed port must be the CONNECTED 4-pair port and *slot*,*pairset* addressing is prohibited.

Command	Port	Command Parameters	Query	Returned Parameters
psa_lan	<*port*>	(See Section 5.7)		
pd_req	<*port*>	<**pwr** *pd_req_pwr* | **sspwr** *pd_req_pwr* | **dspwra** *pd_req_pwr_ds* **dspwrb** *pd_req_pwr_ds*> <**class** *cnum* | **dsclsa** *cnum _ds* **dsclsb** *cnum _ds*> <**period** *pd_req_interval*> <**count** *pd_req_count*> <**trig off** | **trig1** | **ext** | **rx**> <**init**> <**stop** | **stat** <**raw**>> <**autocl now** | **end**> <**pwrdn dis** | *D_time*> <**2pr**> <**ds1Load**>	**?**	Requested_Power PD Class Transmit_Interval Transmit_Count Echo_Alloc_Pwr Trigger_Mode TLV_Version *If 802.3bt TLV asserted, additional fields are provided:* Dual_Sig_Req_Pwr (Alt A & B) Dual_Sig_Alloc_Pwr (Alt A & B) Dual_Sig_PD_Class (Alt A & B) PD_Pwr_Status Extended_Pwr_Type PD_Load PD4PID Autoclass_Req Pwr_Down_Req Pwr_Down_Time
		Defines the requested PD power, rate of packet transmission, and number of packets to be sent as well as triggering mode. Any reconfiguration of **pd_req** will automatically terminate message transmission until a **stat** query is issued to begin transmission. For 2-pair test port configurations supporting **802.3at** emulations, <*port*> may be any **PSx-3x02** test port and broadcast ports “99,99”, “x,99”, and “99,x” may be specified. For 4-pair test port configurations supporting **802.3bt** emulations, <*port*> must be a 4-Pair CONNECTED **PSx-3202** (or PSA-3402) test port and the multi-cast address “99,x” is only supported if all test slots are configured identically. Test ports must be running ver 4.0f or later firmware. **pwr** Specify a requested **802.3at** power level. Asserts 802.3at TLV usage. *pd_req_pwr* PD power request in watts. Default: 13.0 watts. Range 0.5 to 99.9 Watts. Resolution: 0.1 Watt. **class** Specify a requested (single signature) PD LLDP classification. *cnum* Specifies 802.3at PD Class 0, 1, 2, 3, or 4. Default: 3. Class 0 asserts 802.3at TLV usage. **period** Specify a transmission interval value. *pd_req_interval* LLDP transmission interval in Seconds. Default: 30 seconds. Range 1 to 90 seconds. **count** Specify a transmitted packet count value. *pd_req_count* Count of LLDP packets to transmit after 'start' event. Default: 0 (unlimited). Range 0 to 64 messages. **trig off** Specifies immediate startup of LLDP on first stat query. **trig trig1** Startup of LLDP transmission on waveform trigger **trig1** following a **pd_req stat** query. **trig ext** Startup of LLDP transmission on the **event** trigger following a **pd_req stat** query. **trig rx** Startup of LLDP transmission on **receipt-of-frame** trigger following a **pd_req stat** query.. **init** Control to reset PSE Allocated Power to PD Requested Power. This should be used when emulating power-ups. **stop** Literal argument to halt LLDP transmission immediately. (Note: Reconfigurations will also halt LLDP transmission.) **stat raw** Return hexadecimal version of the presently configured PD PoE LLDP message. This will not start LLDP transmission. *continued…*	**stat**	LAN_NOT_ CONNECTED | LINK_DOWN | RUNNING (*The* **stat** *query will either start transmission or will report link error condition.*)

Command	Port	Command Parameters	Query	Returned Parameters
pd_req *(extensions for **802.3bt** only)*	<*port*>	*Supported only by **PSx-3202** for **802.3bt** emulations:* **sspwr** Specify a requested **802.3bt** single signature power level to be negotiated. Asserts 802.3bt TLV usage. *cnum* Specifies 802.3bt Single Signature Class 1, 2, 3, 4, 5, 6, 7, or 8. Class 5-8 asserts 802.3bt TLV usage. **dspwra** Specify a requested **802.3bt** dual signature power level to be negotiated on Alt-A. Asserts 802.3bt TLV usage. **dspwrb** Specify a requested **802.3bt** dual signature power level to be negotiated on Alt-B. Asserts 802.3bt TLV usage. *pd_req_pwr_ds* PD pairset power request in watts. Range 0.5 to 49.9 Watt. **dsclsa** Specify a requested dual signature classification for the Alt-A pairset. **dsclsb** Specify a requested dual signature classification for the Alt-B pairset. *cnum _ds* Specifies 802.3bt PD dual signature class 1 (or 1D) to 5 (or 5D). **autocl now** Request a PSE to autoclass the PD **autocl end** Terminate request for PSE to autoclass the PD **pwrnd dis** Do not seek PSE shutdown *D_time* Specify time (seconds) that power should be removed. Range is 0 for indefinite shutdown or 1-262143 seconds. **2pr** Force dual signature powered status to “2-Pair_Powered” **ds1Load** Specify a dual signature PD with shared load		
pd_frame	<*port*>	<**mac** *nn.nn.nn.nn.nn.nn* | *nnnnnnnnnnnn* <**store**>> <**type 1** | **2**> <**source pse** | **local** | **both** | **unknown**> <**priority low** | **high** | **critical** | **unknown**> <**pwr_alloc echo** | *pse_alloc_pwr*> <**alloc_dspwra echo** | *pse_alloc_pwr*> <**alloc_dspwrb echo** | *pse_alloc_pwr*> Assign MAC address temporarily or permanently to a port. Specify other “basic” PoE LLDP PD attributes that are included in LLDP messages from a PD. For 2-pair test port configurations supporting **802.3at** emulations, <*port*> may be any **PSx-3x02** test port and broadcast ports “99,99”, “x,99”, and “99,x” may be specified. For 4-pair test port configurations supporting **802.3bt** emulations, <*port*> must be a 4-Pair CONNECTED **PSx-3202** (or PSA-3402) test port and the multi-cast address “99,x” is only supported if all test slots are configured identically. *nn.nn.nn.nn.nn.nn* | *nnnnnn nnnnnn* MAC address to assign formatted with or without period separators. See also the **pd_mac_init** utilty. **store** Retain MAC address in non-volatile test port memory. **type 1** Specify that PD is Type-1 **type 2** Specify that PD is Type-2 **source** Specify that PD is using “pse”, “local”, “both” , or “unknown” power source. **priority** Specify that PD is “low”, “high”, “critical”, or “unknown” priority for receiving power. Default is “low”. **pwr_alloc echo** Specify that PD should echo any allocated power values received from PSE. (Default setup) Use **alloc_dspwra** and **alloc_dspwrb** to configure 802.3bt Dual Signature pairset behavior. *pse_alloc_pwr* Fixed power value to be placed in the echo’d PSE power allocation field. Specifying a value overrides the default “echo” behavior. Range is 0 to 99.9 Watts or 0 to 49.9Watts for dual signature pairsets.	**?**	MAC Addr, PD Type Power_Source Priority PSE_Alloc_Pwr (*2-Pair or 4-Pair Single Signature*) PSE_Alloc_A PSE_Alloc_B (*4-Pair Dual Signature*)

Command	Port	Command Parameters	Query	Returned Parameters
pd_lldp	<*port*>	<**lldpaddr** *lldp_addr*> <**ch_id 4** *ch_id_value*> <**port_id 3** *port_id_val*> <**ttl** *time_to_live*> <**vlan enable** | **disable** <**pcp** *pcp_val* **cfi** *cfi_val* **vid** *vid_val*>> Configures general LLDP framing fields to be used in 'PD' LLDP PoE messages transmitted by an emulated PD. Most of these fields should seldom or never be adjusted from default values. These fields should not be modified when the **pd_req** status is **ARMED** or **RUNNING**. For 4-pair test port configurations supporting **802.3bt** emulations, <*port*> must be a 4-Pair CONNECTED **PSx-3202** (or PSA-3402) test port. **lldpaddr** Specify (override) LLDP multicast address. *lldp_addr* Well known LLDP multicast address. Power-On Default: 0x 0180C200000E **ch_id 4** Specify Channel ID Type and Value. Type is "4" for "MAC_Address". *ch_id_value* 12 char. MAC Address. Default= "UNDEFINED" **port_id 3** Specify Port ID Type and Value. Type is "3" for "MAC_Address". *port_id_value* 12 char. MAC Address. Default= "UNDEFINED" **ttl** Specify non-default Time-To-Live in seconds for PoE information transmitted to PSE. *time_to_live* Seconds to retain PoE information at receiving end. (0= Delete now, Range 1 to 65535 seconds). PSA power-on default: 120 seconds. **vlan enable** | **disable**: Enable or disable VLAN tags on transmitted LLDP frames from 'PD'. Default is disable. **pcp** *pcp_val* 802.1Q Priority. Range is 1(low)-7(high). **cfi** *cfi_val* 802.1Q MAC address Canonical Format Indicator – 0 (yes) is default for ethernet switch. Range 0-1. **vid** *vid_val* 802.1Q VLAN identifier. Range 0-4094. Default=0	**?**	LLDP_Address ChassisID_Type ChassisID_Value PortID_Type PortID_Value Time-To-Live VLAN_tag PCP CFI VID
pse_lldp	<*port*>	Reports status of PSE message capture, count of <u>all</u> received LLDP messages since message capture was enabled by the **pse_frame start** command, and reports most recent captured LLDP frame parameters. Count of LLDP messages, both PoE and non-PoE will be resent to zero when **pse_frame start** is issued. For 4-pair test port configurations supporting **802.3bt** emulations, <*port*> must be a 4-Pair CONNECTED **PSx-3202** (or PSA-3402) test port.	**stat**	**LAN_NOT_ CONNECTED |** **LINK_DOWN** | IDLE | RUNNING LLDP Rx_Count <LLDP_Address> <Ethernet_Type> <Chassis_ID_Type> <Chassis_ID_Val.> <Port_ID_Type> <Port_ID_Value> <Time-To_Live> <VLAN_State> <VLAN_PCP> <VLAN_CFI> <VLAN_VID>

Command	Port	Command Parameters	Query	Returned Parameters
pse_frame	<*port*>	<**start** | **stop**> <**rxtrig**> <**trigout**> <**stat raw**>	**stat**	**LAN_NOT_ CONNECTED | LINK_DOWN** | IDLE | RUNNING PoE LLDP Rx Count <Allocated_Power> <PD Class (0-4)> <Power_Type> <Power_Source> <Priority> <Echoed_Request> <Source_MAC> <MDI_Power_Support> <PSE_Power_Pair> *If 802.3bt TLV present, additional fields are provided:* <Dual_Sig_Req_Pwr> (Alt A & B) <Dual_Sig_Alloc_Pwr> (Alt A & B) <PSE_Pwr_Status> <PD_Pwr_Status> <Dual_Sig_PD_Class> (Alt A & B) <PD_Class (1-8)> <PSE_Pwr_Pairs> <Extended_Pwr_Type> <PD_Load> <PSE_Max_Power> <Autoclass_Support> <Autoclass_Done> <Autoclass_Req> <PD4PID> <Power_Down>
		Enables or terminates LLDP message capture and PoE LLDP message counting from a PSE. Reports LLDP link status and most recently captured PoE TLV data while capture is active. For 4-pair test port configurations supporting **802.3bt** emulations, <*port*> must be a 4-Pair CONNECTED **PSx-3202** (or PSA-3402) test port. Given an 802.3bt (extended) LLDP message from a PSE, additional fields will be reported with the **stat** query. **start** Initiate LLDP message capture and PoE LLDP message counting and reset PoE LLDP message counter. **stop** Terminate LLDP message capture and PoE LLDP message counting. **rxtrig** Generate an Rx Frame trigger on first received LLDP frame from PSE following next “start” of capture. **trigout** Generate a broadcast Event trigger on first received **LLDP** frame from PSE following next “start” of capture. **raw** In conjunction with **stat** query, returns the contents of a recovered LLDP frame in hexadecimal format. Frame does not need to be PoE LLDP compliant.		
pse_lldp_ clear	<*port*>			
		Resets PSE Frame (Rx) Count to zero and clears the LLDP receive frame buffer. For 4-pair test port configurations supporting **802.3bt** emulations, <*port*> must be a 4-Pair CONNECTED **PSx-3202** (or PSA-3402) test port.		

8.9. LLDP Utility & Application Command Set

8.9.1. LLDP Port Configuration Utilities

LLDP port configuration utilities may be addressed to one or more PSA test ports.

Command	Port	Command Parameters	Query	Returned Parameters
pd_default_lldp	<*port*>	Restores default LLDP framing parameters to one or all PSA test ports. For 2-pair test port configurations supporting **802.3at** emulations, <*port*> may be any **PSx-3x02** test port and broadcast ports “99,99”, “x,99”, and “99,x” may be specified. For 4-pair test port configurations supporting **802.3bt** emulations, <*port*> must be a 4-Pair CONNECTED **PSx-3202** (or PSA-3402) test port and the multi-cast address “99,x” is only supported if all test slots are configured identically. LLDP Broadcast Address: 0180c200000E LLDP Chassis ID Type: 4 (MAC Address) LLDP Chassis ID Value: <*test_port_MAC_address*> LLDP Port ID Type: 3 (MAC Address) LLDP Port ID Value: <*test_port_MAC_address*> TIME-TO-LIVE: 120 (seconds) VLAN_State: Disable VLAN PCP: 0 VLAN CFI: 0 VLAN VID: 0		
pd_mac_init	<*port*>	<**root** *addr_root*> <**store**> Configures one or all MAC addresses to a common 9-character “root” with final 3 characters representing the PSA slot/port ID. Optionally writes values to non-volatile memory. Broadcast port “99,99” is accepted for any PSA with one or more PSA-3000 test blades. This includes PSA slots configured in 4-Pair modes so that every test port can be configured with a MAC address at any time. **getall** query will return all PSA-3000 test port MAC addresses. **root** Specify a 9 hex-character root MAC address that will be used to form 12 character MAC addresses with the final 3 characters encoding slot and port. *addr_root* 9 hex-character formatted with or without dot delimiters (*nnnnnnnnn* or *nn.nn.nn.nn.n*) **store** Store MAC address(es) in non-volatile memory.	**getall**	*List of all MAC Addresses in all PSA-3000 test ports*

8.9.2. LLDP Emulation Control Utilities

LLDP Emulation Control utilities must be addressed to a single PSA test port as they generally involve queries. For test slots configured in a 4-pair mode, these utilities must be addressed to the 4-Pair CONNECTED test port and *slot*,*pairset* addressing is prohibited.

Command	Port	Command Parameters	Returned Parameters
pd_lldp_start	<*port*>	<**timeout** *wait_time*> Command-Query will attempt to link to PSE, then if link is successful, it will start pre-configured LLDP message transmission (to PSE). It will always return status of the link. **timeout** Specify a non-default waiting period to get link and start transmission. Default is 10 seconds. *wait_time* Maximum time, in seconds, to wait for successful link and start of frame transmission.	**RUNNING |** **LINK DOWN**

8.9.3. LLDP Monitoring Utilities

LLDP Monitoring utilities must be addressed to a single PSA test port as they perform queries to test ports. For test slots configured in a 4-pair mode, these commands must be addressed to the 4-Pair CONNECTED test port and *slot*,*pairset* addressing is prohibited.

Command	Port	Command Parameters	Returned Parameters
psa_check_lan_state	<*port*>	<**connected**> Query returns LLDP subsystem state and returns if LAN is either not connected, not linked, or linked. **connected**: Bypass check of LAN switch connection – assume LAN is physically connected. Produces faster link state check.	**UP | DOWN |** **NOT_CONNECTED**
pse_link_wait	<*port*>	<**timeout** *wait_time*> Query will verify LLDP subsystem connection and seek to get a linked state within specified time period. **timeout** Specify a non-default waiting period for link to become operational. Default is 10 seconds. *wait_time* Maximum time, in seconds, to wait for LAN link-up. Default: 10 seconds. Range 1 – 60 seconds.	**LINK_UP |** **LINK_DOWN |** **DISCONNECTED**
pse_lldp_clear	<*port*>	Resets PSE Frame (Rx) Count to zero and clears the LLDP receive frame buffer.	
pse_lldp_wait	<*port*>	<**at** | **bt**> <**timeout** *wait_time*> <**rxtrig**> <**frame1**> Query will verify LLDP subsystem connection and seek to get at least one PoE LLDP packet from PSE within specified time period. Responds to PoE LLDP packets regardless of 802.3at versus 802.3bt TLV content. **at** Wait for an 802.3at TLV LLDP frame. Default is to wait for any 802.3 PoE LLDP frame. **bt** Wait for an 802.3bt TLV (extended) LLDP frame. **timeout** Specify a non-default waiting period for LLDP message to arrive from PSE. *wait_time* Maximum time, in seconds, to wait for PoE LLDP message from PSE. Default: 30 seconds. Range 1 – 120 seconds. **rxtrig** Generate Rx Trigger when first PSE PoE packet is received. **frame1** Accept any existing PoE LLDP frames in capture buffer as indication of PoE LLDP packet received. Generally used only after clearing Rx buffer with **pse_lldp_clear**. This overcomes possible race condition capturing a first LLDP message from PSE following LAN connection.	**UPDATED |** **TIMEOUT |** **LINK_DOWN |** **DISCONNECTED**

Command	Port	Command Parameters	Returned Parameters
pse_alloc_wait	<*port*>	**min** | **max** *req_pwr* | **mina** req_pwrA **minb** req_pwrB <**timeout** *wait_time*> <**ack**> <**rxtrig**> Query will verify LLDP subsystem connection and seek to get at least one PoE LLDP packet from PSE containing an 802.3at or 802.3bt (single or dual signature) power grant of a specified range within specified time period. Command may be optionally used to seek just an echo of the emulated 802.3at or 802.3bt power request. It will return status and Allocated PSE Power value. **min** Wait for a PSE LLDP power grant that is ≥ *req_pwr* to 802.3at or 802.3bt Single Signature PD. **max** Wait for a PSE LLDP power grant that is equal to *req_pwr*. (Use for power reduction testing.) *req_pwr* Max/Min allocated power level sought from PSE. **mina, minb** Wait for a PSE LLDP power grant that is ≥ *req_pwrA and req_pwrB* to an 802.3bt Dual Signature PD. **maxa, maxb** Wait for a PSE LLDP power grant that is equal to *req_pwrA* and *req_pwrB* to a Dual Signature PD. *req_pwrA, req_pwrB* Max/Min allocated power level sought. **wait** Specify a non-default timeout. *wait_time* Maximum time, in seconds, to wait for power allocation from PSE. Default: 30 seconds. Range 1–120 sec. **ack** Wait only for PSE to Echo Power Request whether power request is Allocated or not. When the echo'd request occurs, status will be ACKNOWLEDGED. **rxtrig** Generate Rx Trigger when first PSE PoE packet is received whether it includes power allocation or not.	**ALLOCATED | ACKNOWLEDGED | TIMEOUT | LINK_DOWN | DISCONNECTED** **Allocated PSE Power**
psa_lldp_trace	<*port*>	<**period** *pd_req_intvl*> <**duration** *trace_duration*> <**onSync** *newReq* | **onSyncA** *newReqA* **onSyncB** *newReqB*> <**-e**> <**space 1** | **2**> <**file** *path*> <**-csv**> <**-v**> Utility will produce a real-time protocol trace of PoE LLDP transactions from both PSE and PD. Trace will display in in PowerShell and may be stored a selected file when completed. PD Request Transmissions will terminate upon end of the trace. The trace will automatically respond to usage of 802.3at versus 802.3bt TLV's. **NOTE**: *To view 802.3bt TLV's in the PowerShell console window, the window will need to be widened to the full width of the monitor*. **period** Specify non-default transmission interval for the transmitted PD frames. *pd_req_intvl* Periodicity, in seconds, of PD frames during the protocol trace. Default is 10 sec. Range is 2 to 60 sec. **duration** Specify non-default time length, or duration, of the protocol trace. Default is 1 minute. *trace_duration* Duration, in minutes, of the protocol trace capture. Default is 1 minute. Range is 0.25 to 120 minutes. **onSync**, **onSyncA**, **onSyncB** Enter a new power request value(s) once PSE echos present power request value(s). Use **onSync** for 802.3at and 802.3bt single signature. Use **onSyncA** and **onSyncB** for 802.3bt dual signature traces. *newReq* , *(newReqA, newReqB)* New power request(s), in watts, to assert when LLDP synchronization is present. **-e** Include "basic" PoE LLDP framing parameters in trace **space 1** Single space the protocol trace in PowerShell **space 2** Double space the protocol trace in PowerShell **file** Save the trace as a text file. Default is no file save. *path* Full path and file name, with forward slashes for directory delimiters, to store protocol trace. Example: c:/temp/my_trace_file.txt. **-v** Run "verbose" mode – adds various PoE TLV notification fields to the protocol trace. **-csv** Create a .csv file of the protocol trace.	*Protocol Trace Includes*: Time (sec) Packet Source Packet Destination Requested Power Allocated Power *-e option adds*: Port_Class PoE_Capability PoE_Status Power_Class Power_Source Priority *If 802.3bt TLV present, additional fields are:* Dual_Sig_Req_Pwr (Alt A & B) Dual_Sig_Alloc_Pwr (Alt A & B) PSE_Pwr_Status PD_Pwr_Status Dual_Sig_PD_Class> (Alt A & B) PD_Class (1-8) PSE_Pwr_Pairs Extended_Pwr_Type PD_Load PSE_Max_Power Autoclass_Support Autoclass_Done Autoclass_Req PD4PID Power_Down

8.9.4. LLDP Testing and Analysis Applications

LLDP Protocol Traces provide in-depth live viewing of LLDP protocol transactions between the PSE and the PD. Packet transmissions in both directions are captured and parsed in real time. An optional pop-up spreadsheet report can be automatically produced that analyzes the LLDP protocol for specific content or timing problems. For test slots configured in a 4-pair mode, these commands must be addressed to the 4-Pair CONNECTED test port and *slot*,*pairset* addressing is prohibited.

Command	Port	Command Parameters	Returned Parameters
trace_lldp_pwrup	<*port*>	<**c** *pdClass* | **ca** *pdClassDS* **cb** *pdClassDS*> <**pwr | sspwr** *pwr_request* | **dspwra** *pwr_request* **dspwrb** *pwr_request*> <**period** *pd_req_intvl*> <**duration** *trace_duration*> <**-s**> Application will emulate an **802.3at** or **802.3bt** PD and produce a protocol trace of all PoE LLDP transactions from both PSE and PD following a new PD connection and power-up. Trace will display in real time in PowerShell and may also generate a pop-up spreadsheet report with analysis of the protocol sequence. Power will be removed upon trace completion. **NOTE**: *To view 802.3bt TLV's in the PowerShell console window, the window will need to be widened to the full width of the monitor*. **c** Specify a non-default PD Class. Default is 4. *pdClass* PD Class to emulate. Range is **0** – **8** and **1D** to **5D**. The choice of 802.3at vs 802.3bt TLV's is governed by the power request argument (**pwr**, **sspwr**, **dspwr**). *pdClass* argument must be consistent with the power request argument (e.g. **sspwr** for *pdClass* 5, 6, 7, or 8). **pwr** Specify a non-default **802.3at** power request. Default is 8.6W (Class 0), 3.2W (Class 1), 6.1W (Class 2), 11.4W (Class 3), 22.2W (Class 4). This will assert 802.3at TLV's. **sspwr** Specify a non-default **802.3bt** Single Signature power request. Default is 3.2W (Class 1), 6.1W (Class 2), 11.4W (Class 3), 22.2W (Class 4), 34.8W (Class 5), 44.4W (Class 6), 53.9W (Class 7), 62W (Class 8). This will assert 802.3bt TLV's. **dspwra** and **dspwrb** Specify non-default **802.3bt** Dual Signature power requests for the Alt-A and Alt-B pairsets. Default is 1.6W (Class 1D), 3.1W (Class 2D), 11.1W (Class 3D), 22.2W (Class 4D), 31.0W (Class 5D). This will assert 802.3bt TLV's. *pwr_request* Power (in watts) to request. Range is 1 to 99.9W. **period** Specify non-default transmission interval for the transmitted PD frames. *pd_req_intvl* Time interval, in seconds, for transmitting PD frames during the protocol trace. Default is 10 sec. Range is 2 to 60 sec. **duration** Specify non-default time length, or duration, of the protocol trace. Default is 45 seconds. *trace_duration* Trace duration (seconds) from first LLDP message transmitted. Range is 15 to 120 seconds. **-s** Produce a pop-up spreadsheet report of the captured LLDP power-up trace upon completion. Spreadsheet will contain 802.3at TLV contents and a limited subset of 802.3bt TLV contents applicable to Single Signature power negotiation.	*Protocol Trace Includes*: Time from Power Applied to first PSE LLDP packet. Time (sec) Packet Source Packet Destination Requested Power Allocated Power Port_Class PoE_Capability PoE_Status Power_Class Power_Source Priority *If 802.3bt TLV present, additional fields are:* Dual_Sig_Req_Pwr (Alt A & B) Dual_Sig_Alloc_Pwr (Alt A & B) PSE_Pwr_Status PD_Pwr_Status Dual_Sig_PD_Class> (Alt A & B) PD_Class (1-8) PSE_Pwr_Pairs Extended_Pwr_Type PD_Load PSE_Max_Power Autoclass_Support Autoclass_Done Autoclass_Req PD4PID Power_Down

Command	Port	Command Parameters	Returned Parameters
trace_lldp_change	<*port*>	<**c** *pdClass*> <**pwr1** *init_pwr*| **sspwr1** *init_pwr* | **dspwra1** *init_pwr* **dspwrb1** *init_pwr*> <**pwr2** *final_pwr* | **sspwr2** *final_pwr* | **dspwra2** *final_pwr* **dspwrb2** *final_pwr* > <**period** *pd_req_intvl*> <**duration** *trace_duration*> <**-s**> Application will emulate an **802.3at** or **802.3bt** PD and produce a protocol trace of all PoE LLDP transactions from both PSE and PD associated with PD initiated power request changes. Trace will display in real time in PowerShell and may also generate a pop-up spreadsheet report with analysis of the protocol sequence. Power will be maintained upon trace completion. **NOTE**: *To view 802.3bt TLV's in the PowerShell console window, the window will need to be widened to the full width of the monitor*. **c** Specify a non-default PD Class. Default is 4. *pdClass* PD Class to emulate. Range is **0** – **8** and **1D** to **5D**. The choice of 802.3at vs 802.3bt TLV's is governed by the power request argument (**pwr**, **sspwr**, **dspwr**). *pdClass* argument must be consistent with the power request argument (e.g. **sspwr** for *pdClass* 5, 6, 7, or 8). **pwr1** Specify a non-default **802.3at** initial power request to use during PD power-up. Default is 8.6W (Class 0), 3.2W (Class 1), 6.1W (Class 2), 11.4W (Class 3), 22.2W (Class 4). This will assert 802.3at TLV's. **sspwr1** Specify a non-default **802.3bt** Single Signature power request to use during PD power-up. This will assert 802.3bt TLV's. **dspwra1** and **dspwrb1** Specify non-default **802.3bt** Dual Signature initial power requests for the Alt-A and Alt-B pairsets. This will assert 802.3bt TLV's. *init_pwr* Power (in watts) to request at power-up. Range is "bypass" or 1 to 99.9W. Use **bypass** if PSE port is already powered to a negotiated level. **pwr2** Specify a non-default **802.3at** adjusted power request to use after initial negotiation completes. Default is 13W (Class 0), 3.4W (Class 1), 6.5W (Class 2), 13W (Class 3), 25.5W (Class 4). **sspwr2** Specify a non-default **802.3bt** Single Signature power request to use after initial negotiation completes. Default is 3.4W (Class 1), 6.5W (Class 2), 13W (Class 3), 25.5W (Class 4), 40W (Class 5), 51W (Class 6), 62W (Class 7), 71.3W (Class 8). **dspwra1** and **dspwrb1** Specify non-default **802.3bt** Dual Signature power requests for the Alt-A and Alt-B pairsets that will be used after each pairset negotiation to the initial power level completes. Default is 3.9W (Class 1D), 6.5W (Class 2D), 13W (Class 3D), 25.5W (Class 4D), 35.6W (Class 5D). *final_pwr* New power (in watts) to request from PSE. Range is 1 to 99.9W. **period** Specify non-default transmission interval for the transmitted PD frames. *pd_req_intvl* Time interval, in seconds, for transmitting PD frames during the protocol trace. Default is 10 sec. Range is 2 to 60 sec. **duration** Specify non-default time length, or duration, of the protocol trace. Default is 30 seconds. *trace_duration* Trace duration (seconds) from first LLDP message transmitted. Range is 15 to 120 seconds. **-s** Produce a pop-up spreadsheet report of the captured LLDP power modification trace upon completion.	*Protocol Trace Includes*: Time (sec) Packet Source Packet Destination Requested Power Allocated Power Port_Class PoE_Capability PoE_Status Power_Class Power_Source Priority *If 802.3bt TLV present, additional fields are:* Dual_Sig_Req_Pwr (Alt A & B) Dual_Sig_Alloc_Pwr (Alt A & B) PSE_Pwr_Status PD_Pwr_Status Dual_Sig_PD_Class> (Alt A & B) PD_Class (1-8) PSE_Pwr_Pairs Extended_Pwr_Type PD_Load PSE_Max_Power Autoclass_Support Autoclass_Done Autoclass_Req PD4PID Power_Down

8.9.5. LLDP Extensions to Standard PowerShell Commands

Two standard PowerShell commands will accept LLDP arguments when LLDP is enabled to a PSA-3000. Those are **power_port** and **power_bt**. Also, the **psa_disconnect** command will automatically disconnect and shutdown the LLDP subsystem if it was used during power-up to negotiate power level with the PSE via LLDP.

The **power_port** command performs all LLDP emulated power-ups using exclusively the **802.3at** LLDP TLV's.

Command	Port	Command Parameters	Add'l Returned Parameters
power_port	<*port*>	<<**c** *class* | **ci** *class_current*> <**p** *power*>> | <**i** *load*> <**dr** *resistance*> <**dc** *capacitance*> <**lldp** <**ad** | **force**> <*req_pwr*> <**timeout** *wait_time*>> Simulates a PD connected to a PSE port to bring power up to a user-specified condition. *See Section 5.11 for non-LLDP arguments*. *Command must be addressed to a test port configured for 2-Pair powering*. The LLDP option allows automatic emulation of an LLDP-capable PD during power-up. LLDP power-ups can be configured to complete either when the PD starts to advertise requested power or when the PSE allocates PD requested power. PD power request packets are pre-configured to initialize Echoed Allocated Power to Requested Power until a PSE frame is captured. **Note**! **power_port** *with no LLDP arguments disconnects the LLDP subsystem*. **lldp** Specify that PD LLDP emulation will be performed during a power-up. **power_port** will manage LLDP connection and convey the Requested Power level to advertise. Note: Use other LLDP primitives and/or utilities to define all other properties of the PD's LLDP messages. **ad** After power application by the PSE, the emulation will advertise a PD Requested Power level and the command will return prior to determining that the PSE grants that power level. The PD advertised request will be restricted to PSE power capability. PD power draw will be governed by defaults for each classification level. Command will return "ADVERTISING" status. **force** After power application by the PSE, the emulation will advertise a PD Requested Power level and the command will wait for some period of time for the PSE to authorize (or grant) that power level. Actual power will then be adjusted to the *req_pwr* level unless the 'p *power*' argument was provided in which case it will be adjusted to *power*. *req_pwr* PD Requested Power level. Range is 0.5 to 30 W, default is 13 W. This is the PD Power Request that will be transmitted to the PSE for authorization. It is the power level the PSE port will be delivering to the PSA test port if the **force** option is used with **lldp**. **timeout** Specify a time duration in which PSE is expected to produce LLDP response. Default is 35 seconds. *wait_time* Time duration, in seconds, to wait for PSE to apply power and either advertise (**ad**) or produce power grant (**force**). Range is 2 to 120 seconds.	*LLDP Status*: ADVERTISING =PSE applied power, emulated PD transmitting request | ACCEPTED =PSE powered to LLDP Requested power | STANDBY =PSE powered but denied LLDP requested power | STANDBY-BAD_TLV =PSE powered but LLDP Messaging Is Defective

The **power_bt** command performs all LLDP emulated power-ups using the **802.3bt** LLDP TLV's by default and is restricted to Single Signature PD emulation as of the present PSA 5.x software release. An override to utilize the 802.3at TLV's is available.

Command	Port	Command Parameters	Add'l Returned Parameters
power_bt ***(PSA-32x2, PSA-3402 only)***	4-pair Con-nected <*port*>	*(See standard arguments in section 5.11)* <**lldp** <**ad** *req_pwr* **|** **ada** *req_pwrA* **adb** *req_pwrA* | **force** <*req_pwr*> | **forca** <*req_pwrA*> **forcb** <*req_pwrB*> <**timeout** *maxwait*> <**noalloc**> <**at_tlv**>> Simulates a PD connection to a **4-Pair 802.3bt** PSE port to bring power to a user-specified condition. May be addressed to either port 1 or 2 of **PSA/PSL-3202** test blade whereupon it will configure the 4-pair connection to the user-specified test port. (*Not supported by PSA/PSL-3102 test blades*.) *See Section 5.11 for non-LLDP arguments*. The **lldp** option allows automatic emulation of an LLDP-capable PD's during power-up. LLDP power-ups can be configured to complete either when the PD starts to advertise requested power or when the PSE allocates PD requested power. Initial PD power requests and echo'd power allocations are limited by PSE physical layer (class event based) power grant at power-up. **Note**! **power_bt** *with no LLDP arguments disconnects the LLDP subsystem*. LLDP power-ups must specify single signature Class 1 to 8 or dual signature class 1D to 5D whereupon port will be configured for the specified signature type. **lldp** Specify that PD LLDP emulation will be performed during a power-up using (by default) the **802.3bt** TLV's. **power_bt** will manage LLDP connection and convey the Requested Power level to advertise. *Note*: Use other LLDP primitives and/or utilities to define all other properties of the PD's LLDP messages. **ad** Complete the emulated power-up process when LLDP frame is received from PSE and requested power is advertised to PSE. Command will return "ADVERTISING" status. **force** Complete the emulated power-up process when the requested power level, *req_pwr*. In this case, command will return with "ACCEPTED" status. If *req_pwr* is not allocated by PSE, command will return with "STANDBY" status. *req_pwr* Single signature PD Requested Power level. Range is 0.5 to 99 W. This is the PD Power Request that will be transmitted to the PSE for authorization. Once allocated, the emulated PD will draw the power specified in the **p** or **i** argument (see section 5.11). If neither **p** nor **i** specified, then the emulated PD will draw *req_pwr*. **ada**, **adb** Dual signature equivalent of **ad**. See above **forca**, **forcb** Dual signature equivalent of **force**. See above *req_pwrA*, *req_pwrB* Dual signature equivalent of *req_pwr*. These are power requests for the Alt-A and Alt-B pairs respectively. **timeout** Specify a time duration in which PSE is expected to produce LLDP response. Default is 35 seconds. *wait_time* Time duration, in seconds, to wait for PSE to apply power and either advertise (**ad**) or produce power grant (**force**). Range is 2 to 120 seconds. **noalloc** Allows actual power load to adjust to specified *power* regardless of whether PSE allocates requested power or not. Default behavior is to remain at a Type-1 power load if requested power allocation is not received. **at_tlv** Utlitize the 802.3at LLDP TLV's. This option allows **power_bt** to be utilized with an LLDP capable 802.3at PSE that will perform 2-pair powering up to PD class 4.	*LLDP Status*: ADVERTISING =PSE applied power, emulated PD transmitting request | ACCEPTED =PSE powered to LLDP Requested power | STANDBY =PSE powered but denied LLDP requested power | STANDBY-BAD_TLV =PSE powered but LLDP Messaging Is Defective

8.9.6. LLDP Extensions to the 802.3at PSE Multi-Port Suite Commands

The Multi-Port Live PD Emulation commands also accept optional LDLP configuration arguments. These commands are described in sections 5.23.1 and 5.23.3. They are pertinent only to testing of **802.3at** PSE ports.

Command	Port	Command Parameters	Returned Parameters
psa_emulate_pd	<*port*>	<**c** *pd_class*> <**p** *pd_power*> <**o** *cable_loss*> <**alt A** | **B**> <**pol POS** | **NEG**> <**start** | **stop**> <**lldp off** | **connect** | **through** <**i** *initpwr*> <**period** *intvl*>> This command configures a test port to emulate a PD indefinitely, with no intervention from PowerShell required. Once the emulator has been started, the port will respond autonomously when a PSE is connected and disconnected, functioning just as a PD would. This command accepts the broadcast *port* argument 99,99 to initiate emulation on all test ports in a PSA chassis. **lldp** Specifiy the LLDP relevance of the final power negotiation. If not specified, LLDP will not be used for power negotiation. **off** LLDP not utilized power negotiation or power management. **connect** LLDP will be utilized for power negotiation and power management for as long as the Live PD Emulation stays active. **through** LLDP will be utilized for each start-up power negotiation and, upon receipt of requested power allocation, will disconnect the LLDP LAN termination and connect the PSE*n* port to the OUT*n* port to support packet transmission testing. **i** Specify a non-default initial, or start-up power to be applied. Default initial power is 50% of pd_power. *initpwr* The "Type-1" power load presented by the emulated PD until normal operating power is granted by LLDP. This will also be the fall-back power draw if the PSE uses LLDP to throttle back PD power. Range is 0.5 to 15.5 watts. NOTE! This power draw is not affected by the *cable_loss* configured. *intvl* The desired transmit period for LLDP frames. Default is 4 seconds. Range is 1 to 90 seconds.	**?** *(IDLE state only)* PD Class PD Power Initial Power OffsetPower: LLDP mode ALT Bus_Polarity **stat** **IDLE | RUNNING** Vport(setting) *used for load setup* Power (setting) *PSE output power* State: **UNPOWERED |** **NEGOTIATING |** **POWERED** Vport (meas) *final measured V* Iport (meas) *final measured I* Pload *measured* *PSE power*
mp_emulate_pd		**Multi-Port Resource Configuration** (*see Section 5.23.1*) <**c** *pd_class*> <**p** *pd_power*> <**o** *cable_loss*> <**alt A** | **B**> <**pol POS** | **NEG**> <**start** | **stop**> <**lldp off** | **connect** | **through** <**i** *initpwr*>> This command extends the psa_emulate_pd command to work with a **Multi-Port Resource Configuration** model used throughout the PSE Multi-Port suite. Resource Configurations may include up to 8 PSA chassis' and up to 192 total test ports. Multi-Port **Resource Configuration** is described in Section 5.23.2. Non-LLDP arguments are described earlier in Section 5.23.3. LLDP arguments are described above under **psa_emulate_pd** command below.	**?** Live PD Emulation Configurations for all Chassis' and Test Ports in the Resource Configuration. **stat** Live PD Emulation Status for all Chassis' and Test Ports.

8.10. LLDP Programming Examples

Some examples of LLDP configuration, control, monitoring, and emulation modes will be presented below. These will cover the full range of PowerShell PSA primitive and utility functions. While most of the examples were generated for an 802.3at (Alt-A powering) PSE, they would be functionally similar working any 802.3at or 802.3bt PSE.

8.10.1. Configuring MAC Addresses to One or More PSA Test Ports

Since LLDP is a link (or MAC) layer protocol, a necessary prerequisite is the assignment of MAC addresses, and presumably unique MAC addresses, to each of the PSA test ports that will emulate LLDP capable and/or Type-2 PD's.

PSA software offers several means to establish one or more MAC addresses as well as to assure unique MAC addresses per test port. The **pd_frame** command can program a single MAC address to one or more test ports. The **pd_mac_init** is a simple way to work with multiple test ports.

```
PSA-1,1># Program Slot 1, Port 1 MAC Address - dot delimited address
PSA-1,1>pd_frame 1,1 mac 00.4a.30.00.00.11
PSA-1,1>
PSA-1,1># Program Slot 1, Port 2 MAC Address - 12 digit address
PSA-1,1>pd_frame 1,2 mac 004a30000011
PSA-1,2>
PSA-1,2># Program All Ports to One MAC Address
PSA-1,2>pd_frame 99,99 mac 00.4a.30.00.99.99
PSA-1,2>
PSA-1,2># Assign Unique MAC Address to All Test Ports
PSA-1,2>pd_mac_init 99,99 root 00.4a.30.00.0
Slot,Port  1,1 004A30000011
Slot,Port  1,2 004A30000012
Slot,Port  2,1 004A30000021
Slot,Port  2,2 004A30000022
Slot,Port  3,1 004A30000031
Slot,Port  3,2 004A30000032
Slot,Port  4,1 004A30000041
Slot,Port  4,2 004A30000042
Slot,Port  5,1 004A30000051
Slot,Port  5,2 004A30000052
Slot,Port  6,1 004A30000061
Slot,Port  6,2 004A30000062

PSA-1,2>
PSA-1,2># Query Slot 1, Port 1 MAC Address
PSA-1,2>pd_frame 1,1 ?
Slot,Port 1,1
  Source_Address 004a30000011
  Type Type2_PD
  TTL 120 seconds
  Power_Source PSE
  Priority LOW
  PSE_Alloc_Pwr ECHO
PSA-1,1>
PSA-1,1># Query All MAC Address in All Test Ports
PSA-1,1>pd_mac_init getall
Slot,Port  1,1 004a30000011
Slot,Port  1,2 004a30000012
Slot,Port  2,1 004a30000021
Slot,Port  2,2 004a30000022
Slot,Port  3,1 004a30000031
Slot,Port  3,2 004a30000032
Slot,Port  4,1 004a30000041
Slot,Port  4,2 004a30000042
Slot,Port  5,1 004a30000051
Slot,Port  5,2 004a30000052
Slot,Port  6,1 004a30000061
Slot,Port  6,2 004a30000062

PSA-1,1>
```

8.10.2. PD Emulation with psa_lan, pd_lldp, pd_frame, and pd_req Primitives

The following command sequence will set up an LLDP PD Emulation of an 802.3at Class 4 PD requiring 22.2 watts of power with an LLDP messaging interval of 15 seconds.   Various queries are added for illustrative purposes.

```
PSA-1,1># Connect the LLDP Subsystem
PSA-1,1>psa_lan 1,1 connect
PSA-1,1>
PSA-1,1># Program LLDP Packet Parameters - Mostly Power-Up Defaults
PSA-1,1>pd_lldp 1,1 lldpaddr 01.80.C2.00.00.0E ch_id 4 004a30000011 port_id 3
004a30000011
PSA-1,1>pd_lldp 1,1 ttl 120 vlan disable
PSA-1,1>
PSA-1,1># Query LLDP Packet Parameters
PSA-1,1>pd_lldp 1,1 ?
Slot,Port 1,1
  Dest_Address 0180c200000e
  ChassisID_subtype MAC_address ChassisID 004a30000011
  PortID_subtype MAC_address PortID 004a30000011
  TTL 120 seconds
  VLAN_tag disabled
  PCP 0
  CFI 0
  VID 0
PSA-1,1>
PSA-1,1># Program PD MAC and PoE TLV Parameters
PSA-1,1>pd_frame 1,1 mac 00.4a.30.00.00.11
PSA-1,1>pd_frame 1,1 type 2 source pse priority high pwr_alloc echo
PSA-1,1>
PSA-1,1># Query LLDP PoE Configuration
PSA-1,1>pd_frame 1,1 ?
Slot,Port 1,1
  Source_Address 004a30000011
  Type Type2_PD
  TTL 120 seconds
  Power_Source PSE
  Priority HIGH
  PSE_Alloc_Pwr ECHO
  PSE_alloc_A ECHO
  PSE_alloc_B ECHO
PSA-1,1>
PSA-1,1># Program 802.3at PD Power Request and Message Transmission Parameters
PSA-1,1>pd_req 1,1 pwr 22.2 class 4 period 15 count 0 trig off init
PSA-1,1>
PSA-1,1># Query PD LLDP Transmission Parameters
PSA-1,1>pd_req 1,1 ?
Slot,Port 1,1
  Requested_Power 22.2 Watts
  Class 4
  Transmit_Interval 15 Seconds
  Transmit_Count 0 Frames
  Echo_Alloc_Pwr 22.2 Watts
  Trigger_Mode OFF
  Power-via-MDI_TLV_version 802.3at
PSA-1,1>
PSA-1,1># Start PD LLDP Transmission
PSA-1,1>pd_req 1,1 stat
Slot,Port 1,1
  RUNNING
PSA-1,1>
PSA-1,1># Query PD LLDP Status
PSA-1,1>pd_req 1,1 stat
Slot,Port 1,1
  RUNNING
PSA-1,1>
```

8.10.3. PD Emulation with LLDP Utilities

The following command sequence will set up all test ports with unique MAC addresses and default LLDP packet parameters, then emulate **802.3bt** PD LLDP packets from a class 5 PD on four test ports: 1,1 1,2 2,1 and 2,2. The sequence will then discontinue transmission on these test ports.

```
PSA-2,1+># Program Default LLDP Packet Parameters to ALL Test Ports
PSA-2,1+>pd_default_lldp 99,99
PSA-2,1+>
PSA-2,1+># Program Unique MAC Addresses to ALL Test Ports with specified 9-digit ROOT
PSA-2,1+># Store these in non-volatile memory in each test port
PSA-2,1+>pd_mac_init 99,99 root 00.4a.30.00.0 store
Slot,Port  1,1 004A30000011
Slot,Port  1,2 004A30000012
Slot,Port  2,1 004A30000021
…
Slot,Port  9,2 004A30000092
Slot,Port 10,1 004A30000101
Slot,Port 10,2 004A30000102
PSA-2,1+>
PSA-2,1+># Connect the LLDP Subsystem on all ports
PSA-2,1+>psa_lan 99,99 connect
PSA-2,1+>
PSA-2,1+># Give the PSE Some Time to Link with PSA Test Ports
PSA-2,1+>after 2000
PSA-2,1+>
PSA-2,1+># Program 802.3bt PD Power Request & Message Transmission Parameters to ALL Ports
PSA-2,1+>pd_req 99,99 sspwr 36.2 class 5 period 12 count 0 trig off init
PSA-2,1+># Query the PD request configuration on port 2
PSA-2,1+>pd_req p2 ?
Slot,Port 1,1
  Requested_Power 36.2 Watts
  Class 5
  Transmit_Interval 12 Seconds
  Transmit_Count 0 Frames
  Echo_Alloc_Pwr 36.2 Watts
  Trigger_Mode OFF
  AT_Class 4
  DS_Req_PowerA 0.0 Watts
  DS_Req_PowerB 0.0 Watts
  DS_Alloc_AltA 0.0 Watts
  DS_Alloc_AltB 0.0 Watts
  DS_ClassA Single_Sig_PD_2pr_PSE
  DS_ClassB Single_Sig_PD_2pr_PSE
  PD_Pwr_status Pwr_Single
  Power_type_ext TYPE_3_Single_PD
  PD_Load Single_or_Dual_NOT_isol
  PD4PID Pwr_Both_Modes
  Power-via-MDI_TLV_version 802.3bt
  Autoclass_Request Idle
  Power_down No_Request
  Pwrdn_Time 0 sec
PSA-2,1+># Start PD LLDP Transmission on Desired Test Ports
PSA-2,1+>pd_req 1,1 stat
Slot,Port 1,1
  RUNNING
PSA-1,1+>pd_req 1,2 stat
Slot,Port 1,2
  RUNNING
PSA-1,2>pd_req 2,1 stat
Slot,Port 2,1
  RUNNING
PSA-2,1+>pd_req 2,2 stat
Slot,Port 2,2
  RUNNING
PSA-2,2>
PSA-2,2># Query LLDP status on Port 2,1
PSA-2,2>pd_req 2,1 stat
Slot,Port 2,1
  RUNNING
PSA-2,1+># Discontinue PD Packet Transmission on ALL Test Ports
PSA-2,1+>pd_req 99,99 stop
PSA-2.1+>
```

8.10.4. Recover and Analyze PSE LLDP Frames

This example will connect to an 802.3at PSE, power up the test port, then read PoE LLDP messages from the PSE prior to transmitting any PD LLDP messages from and emulated PD.

```
PSA-1,1># Power Up to Class 0 power
PSA-1,1>power_port 1,1 c 0
POWERED 52.58 140
PSA-1,1>
PSA-1,1># Connect the LLDP Subsystem - NOTE: power_port will initially disconnect it
PSA-1,1>psa_lan 1,1 connect
PSA-1,1>
PSA-1,1># Wait up to 5 seconds for linkup
PSA-1,1>pse_link_wait 1,1 timeout 5
LINK_UP
PSA-1,1>
PSA-1,1># Start capturing frames (assuming LINK UP)
PSA-1,1>pse_frame 1,1 start
PSA-1,1>
PSA-1,1># Wait up to 30 seconds for a PSE LLDP Message
PSA-1,1>pse_lldp_wait 1,1 timeout 30
UPDATED
PSA-1,1>
PSA-1,1># Read PoE Values from Most Recent PSE LLDP Message
PSA-1,1>pse_frame 1,1 stat
Slot,Port 1,1
  Rx_Status RUNNING
  Rx_Count 1
  Allocated_Power 7.3 Watts
  Class 0
  Power_Type Type_2_PSE
  Power_Source Primary_source
  Priority low
  Echoed_Request 0.0 Watts
  Source_MAC 00c08f220613
  MDI_Power_Support 0x7
  PSE_Power_Pair 0x1
PSA-1,1>
PSA-1,1>
PSA-1,1># Read LLDP Frame Value from Most Recent PSE LLDP Message
PSA-1,1>pse_lldp 1,1 stat
Slot,Port 1,1
  Rx_Status RUNNING
  Rx_Count 2
  LLDP_Addr 0180c200000e
  Ethernet_Type 0x88cc(LLDP)
  Chassis_ID MAC_address 00c08f220613000000000000
  Port_ID MAC_address 00c08f220613000000000000
  TTL 120 seconds
  VLAN_tagged no
PSA-1,1>
```

8.10.5. (section omitted)

8.10.6. PD Emulation with power_port, and psa_disconnect Commands

The following example utilizes the **power_port** utility to emulate connection and powering of an 802.3at Class 4 PD that requests 24.3 watts. **power_port** will wait up to 45 seconds to receive a power grant for the requested power, then draw 24 watts. It then removes the PD (to power down the port) and verifies no link or connection thereafter.

```
PSA-1,1># Power-Up to 24 Watts - Return when power is granted and established
PSA-1,1>power_port 1,1 c 4 p 24 lldp force 24.3 timeout 45
POWERED 51.85 462 ACCEPTED
PSA-1,1>
PSA-1,1># Measure the Power to the PD
PSA-1,1>paverage 1,1 period 500m stat
Slot,Port 1,1
 Average_Power= 24.0 Watts
PSA-1,1>
PSA-1,1># Remove Power from the PSE Port and disconnect LLDP
PSA-1,1>psa_disconnect 1,1
PSA-1,1>
PSA-1,1># Verify LAN and LINK Status
PSA-1,1>psa_check_lan_state 1,1
NOT_CONNECTED
PSA-1,1>
```

8.10.7. LLDP Protocol Traces

In this example, a real-time trace of messages between the PSE and PD is displayed as the PSE powers-up, grants PD power, then goes into steady state thereafter. The same 24.3 Watt PD is used again for this example. Note that PSE LLDP interval is around 30 seconds compared to the programmed PD interval of 8 seconds.

```
PSA-1,2># Configure PD
PSA-1,2>passive 1,2 r 25 c 0
PSA-1,2>class 1,2 4
PSA-1,2>
PSA-1,2># Connect the port - it will draw 40mA (class 4 signature) at power-up
PSA-1,2>port 1,2 connect
PSA-1,2>psa_lan 1,2 connect
PSA-1,2>
PSA-1,2># Wait for Link and Start a 2 minute Trace
PSA-1,2>pse_link_wait 1,2 timeout 15
LINK_UP
PSA-1,2># Configure the LLDP power request
PSA-1,2>pd_req 1,2 class 4 pwr 24.3
PSA-1,2>
PSA-1,2># Start a 2 minute Trace
PSA-1,2>psa_lldp_trace 1,2 period 8 duration 2
Starting LLDP Trace: Period 8 Seconds  Duration 2 Minutes...
Trace Buffering off

Slot,Port 1,2
Time(sec)  From    To  Type  Request Allocated
      0.0    PD   PSE    2     24.3      24.3
      1.0   PSE    PD    2     13.0      13.0
      8.0    PD   PSE    2     24.3      13.0
     10.0   PSE    PD    2     24.3      24.3
     16.0    PD   PSE    2     24.3      24.3
     17.0   PSE    PD    2     24.3      24.3
     24.0    PD   PSE    2     24.3      24.3
     27.0   PSE    PD    2     24.3      24.3
     32.0    PD   PSE    2     24.3      24.3
     36.0   PSE    PD    2     24.3      24.3
.....
     73.0    PD   PSE    2     24.3      24.3
     81.0    PD   PSE    2     24.3      24.3
     81.0   PSE    PD    2     24.3      24.3
     89.0    PD   PSE    2     24.3      24.3
     91.0   PSE    PD    2     24.3      24.3
     97.0    PD   PSE    2     24.3      24.3
    101.0   PSE    PD    2     24.3      24.3
    105.0    PD   PSE    2     24.3      24.3
    109.0   PSE    PD    2     24.3      24.3
    113.0    PD   PSE    2     24.3      24.3
    118.0   PSE    PD    2     24.3      24.3
DONE
PSA-1,2>
```

9. Specialized Scripting with the PSA3000

The PowerSync Analyzer has a number of features that are beneficial in scripting specialized PSE tests for use in engineering, QA, and manufacturing. Section 9 will specifically address 5 topics of interest test automation:

- Optimizing **Test Speed** for **High Volume**, **High Coverage** Testing
- **Intra-Port** Interaction Testing
- Integrating the PowerShell API into **Native Tcl Shells**
- Launching or Managing PowerShell from **External Applications** Including TCL
- Integrated Power-over-Ethernet and **Packet Transmission Testing**

High speed testing is of interest to manufacturing and large QA environments where considerable test data is generated and the time to generate that data needs to be minimized. Intra-Port interaction testing is perhaps more of interest in a QA and design verification setting where the PoE actions of one or more ports could possibly have negative impact on other PoE ports. Some test engineers desire to run test automation from host applications outside PowerShell and can take advantage of PowerShell facilities to support such development. Finally, integrated power and transmission testing is of general relevance to all aspects of testing PSE's since PSE's must simultaneously deliver power and data with the two functions operating largely independent of each other.

9.1. Optimizing Test Speed for High Volume, High Coverage Testing

Four specific strategies for optimizing (or minimizing) test time will be discussed in this section. These are:

- Rapid Port Replication
- Customizing Test Methods to Specific PSE Behaviors (*802.3at PSE's only*)
- Time-Interlacing of Tests Across Ports
- Multi-Chassis Testing in Parallel

9.1.1. Rapid Port Replication

PowerShell PSA offers several "broadcast" port designations so that **configuration** parameters can be established in more than a single test port using just a single configuration command.

Important! Under PowerShell 5.0 and later versions, it will be necessary to have *uniform pair states* in all test slots before using broadcast port addressing. For example, all ports in a chassis configured as 2-Pair or all slots configured as 4-Pair Single on Port 1's.

The slot-port **99,99** will broadcast a configuration to every test port in a PSA chassis. Similarly the slot-port **99,1** will configure all Port 1's and **99,2** will configure all Port 2's in current chassis to the specified configuration. Additionally, the slot-port **N,99** will configure both test ports of slot **N** within a PSA chassis. When all slots are in an identical 4-pair configuration, **99,A** and **99,B** may be used to configure resources to all Alt-A or Alt-B pairsets respectively and 99,1 or 99,2 may be addressed to CONNECTED 4-pair ports in all test slots. Broadcast port designations should ***only*** be used with test port ***configuration commands*** – they are not supported by configuration and status queries, nor by PowerShell utilities and system commands. Some examples are:

`port 99,99 isolate`	Opens port switch on all test ports in chassis
`alt 99,99 A`	In 2-Pair mode, sets all test ports to Alternative A
`passive 3,99 r 23`	In 2-Pair mode, sets detection resistance to 23 KΩ in Ports 3,1 and 3,2
`alt 99,1 B`	In 2-Pair mode, sets all PSE1 test ports to Alternative B
`iload 99,a i 560`	In 4-Pair Mode, sets Alt-A pairset loads on all slots to 560mA
`polarity 99,1 neg+pos`	In 4-Pair mode, sets all slots to Alt-A, MDI-X and Alt-B, MDI

Typically, in multi-port or system testing, there will be the need to uniformly configure many ports. This method will enable that much quicker than a software loop issuing repetitious commands to individual test ports. *Note that this method does not span more than a single chassis within a **PSA-3x48** system.*

Some commonly used commands supporting broadcast slot-port parameters are:

alt	**trig1**	idcaverage *(config only)*	**psa_connect**
polarity	**trig2**	**idcpeak** *(config only)*	**psa_lan**
port	**itrans**	**idctrace** *(config only)*	**pd_req** *(excluding* **stat***)*
passive	**vdcaverage** *(config only)*	**acvolts** *(config only)*	**pd_lldp**
iload	vdcpeak *(config only)*	**timint** *(config only)*	**pd_frame**
class	**vdctrace** *(config only)*	**paverage** *(config only)*	**psa_emulate_pd** *(config only)*

9.1.2. Customizing Test Methods to Specific 802.3at PSE Behaviors

Because the **802.3** PSE specifications leave much room for design flexibility, PSE's can vary tremendously in their methods for performing detection, classification, and power maintenance. The PSE Conformance Test Suites discussed in section 6 must automatically adjust or "adapt" to these variations and the penalty for such adaptation is time (and complexity). This is typical of a more general principle in the field of engineering where "generality" commonly represents a trade off against "efficiency".

Test script developers can take advantage of this principle to derive test data from a particular PSE product much faster than the PSE Conformance Test Suite would produce the same data on a large number of ports. Some important PSE characteristics that affect test method refinement are:

- PSE Open Circuit Signaling Voltages (Min, Max)
- PSE Open Circuit Signaling Rate (Back-off behavior and timing)
- Detection Signal Waveform Characteristics with Valid Detection Signatures
- Detection Signature Range Design Objectives
- Classification Signal Waveform
- MPS Method and Signal Characteristics
- Multi-Port Power Management Features of the PSE
- Maximum Port Power Capacity

Conveniently, script developers can utilize PowerSync Interactive to capture useful waveforms that will address a number of these parameters. Results from PSE Conformance Testing will address a number of other parameters.

Starting with detection signaling, there is often a need in PSE port testing to capture and characterize single shot events such as the behavior of the ***first*** detection pulse following a PD connection (or in PowerSync Analyzer terms, a port switch connection). This typically involves a requirement to synchronize the port switch connection in a manner that it will occur ***between*** detection pulses. It may also involve the need to set a trigger level and polarity at an optimal point for triggering a measurement of interest such as a peak classification voltage measurement. Timing apertures (or "windows") for measurement periods also may need to be optimized to the duration of the pulse being characterized.

Let's now look at an example of a script that will attempt to capture the peak detection voltage, **Vvalid(Max)**, and power-on timing, **Tpon**, from the first detection pulse following a simulated PD connection. Further details on any of the commands utilized in this section may be found in section 5, PowerShell Scripting. For reference, we will use PowerSync Interactive to capture both **Open Circuit Detection** and **Power-Up Sequence** waveforms from the PSE.

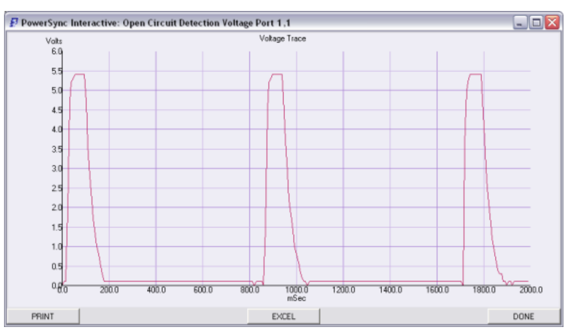


Figure 9.1 Open Circuit Detection Signaling

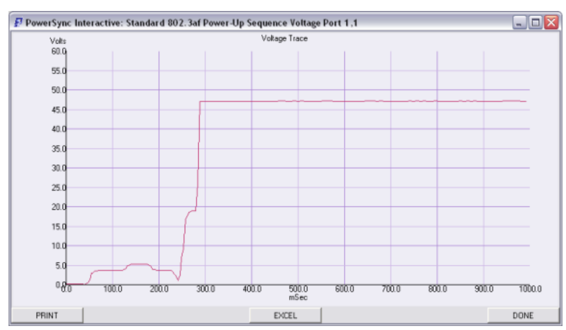


Figure 9.2 Power-Up Sequence

From the **Open Circuit Detection** waveform in **Figure 9.1**, it is determined that open-circuit detection signal triggering could be set at 2.5 Volts and that the 700 msec back-off (time separation) should allow ample time for several PSA commands to execute prior to the next detection pulse. From the Power-Up Sequence in **Figure 9.2**, it is determined that 2 Volts would be a good trigger threshold for the first valid detection pulse and that 200 msec would be an adequate time aperture or measurement period in which to seek the peak detection voltage. For the **Tpon** measurement, it is also determined that the Detection Pulse does return to zero and that a time interval measurement initiating at 2 volts on the trailing edge of this pulse and terminating at 40 volts on the power-up edge should provide an adequate value.

Here's a short script to perform this test:

```
# Configure test port for valid signature
passive 1,1  r 26 c 0

# Configure Vpeak  Measurement
vdcpeak 1,1 trig on max period 200m timeout 10

# Sync to trailing edge of pre-detection pulse (uses Trigger 1 !)
psa_det_sync 1,1 falling level 2.5

# Setup trigger for Vvalid(Max) measurement
trig1 1,1  rising

# Connect the detection resistance by connecting the port switch
port 1,1 connect

#  Recover the peak voltage of the detection pulse
set status [psa_wait 1,1 vdcpeak]
set VvalidMax [lindex $status 3]

# Force a power-down by opening port switch, setting load to zero
psa_disconnect 1,1

# Configure the Time Interval Measurement
#   Trigger level and polarity of falling at level 2 also used for sync
timint 1,1 start falling level 2 stop rising level 40 msec noisy

# Synchronize to the end of pre-detection pulse
psa_det_sync 1,1 falling level 2 noisy

# Connect the detection resistance by connecting the port switch
port 1,1 connect

#  Recover the time from end of detection until power-up
set status [psa_wait 1,1 timint]
set Tpon [lindex $status 4]

puts "Vvalid_Max = $VvalidMax volts, Tpon = $Tpon msec"
```

While not yet fully optimized for multi-port testing, this script provides an example of tailoring various configuration parameters to the characteristics of the PSE being tested.   The importance of pre-characterizing the behavior of the PSE is vital to the "hard-coding" of trigger and synchronization configurations.   This fact is further highlighted by observing detection signals from the same PSE now with 4 other ports in the powered-up state.

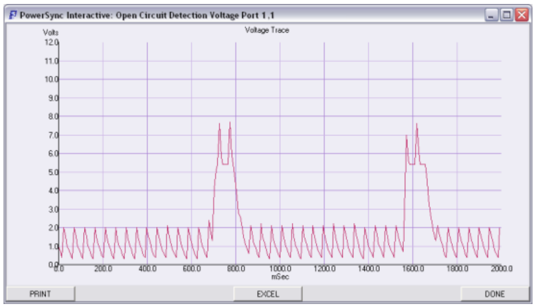


Figure 9.3 Pre-Detection Signaling – 4 ports powered

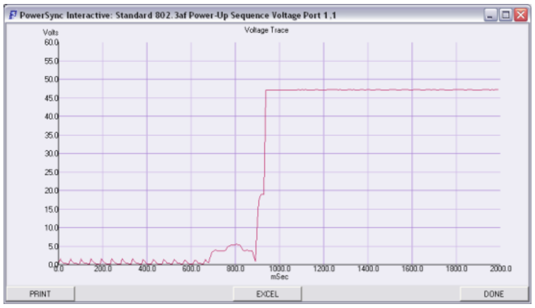


Figure 9.4 Power-Up Sequence – 4 ports powered

As can be seen, selection of ideal trigger levels and synchronization levels must not only take into account the ***type*** of PSE, but perhaps even the ***state*** of the PSE, as is the case in this example.

Two other examples where known characteristics of a PSE can be utilized to save test time are detection signature band and port power capacity.   The following excerpt from a PSE Conformance Test report provides useful information in the design of this test script for a particular PSE.

PSE Conf. Suite Regression
November 1 2014 6:41 PM
Port Count........................ 8
Loop Count........................ 1
PSE Tested: Sample 8-Port PSE - Failures

Sifos Technologies — 802.3at Conformance Report, version 4.1.00
Test Mode: 30 Watt LLDP — report version 4.1.0d
Sifos Interop Index*: 95%
Error Log: None

Chassis ID: 192.168.221.109	PSA-3000 Ports															
TestLoop: 1	5-1	5-2	6-1	6-2	7-1	7-2	8-1	8-2	UNITS	Min	Max	Average	Low Limit	P/F	High Limit	P/F
Test: det range																
Rgood_Max=	29	29	29	29	29	29	29	29	Kohm	29	29	29	26	Pass	32	Pass
Rgood_Min=	17	17	17	17	16	17	17	17	Kohm	16	17	16.9	16	Pass	19	Pass
Rmid_det=	29	29	29	29	29	29	29	29	Kohm	29	29	29	26	Pass	33	Pass
Cgood_Max=	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	uF	0.1	0.1	0.1	0	Pass	10	Pass
Rbad_Cbad_Stat=	0	0	0	0	0	0	0	0	---	0	0	0	0	Pass	0	Pass
Test: det_time																
Backoff_Time_Tdbo=	664	664	664	664	664	684	664	645	msec	645	684	664.1	-1	Pass	1500	Pass
Eff_Backoff_Tdbo_eff=	664	664	664	664	664	684	664	645	msec	645	684	664.1	-1	Pass	1500	Pass
Backoff_Type=	0	0	0	0	0	0	0	0	---	0	0	0	0	Pass	0	Pass
Detection_Time_Tdet=	258	254	258	258	258	258	254	258	msec	254	258	257	5	Pass	500	Pass
Total_Det_Time=	258	254	258	258	258	262	254	266	msec	254	266	258.5	5	Pass	1000	Pass
Test: pwron_pwrcap																
Pcon_c4=	30.1	29.5	30	29.6	30.3	29.4	29.3	30.1	watts	29.3	30.3	29.8	28.7	Pass	38.9	Pass
Icon_%_c4=	100.6	99.8	100.2	99.8	101	99.7	99.6	101.5	%	99.6	101.5	100.3	100	Fail	9999	Pass
Type-2_Enable=	0	0	0	0	0	0	0	0	---	0	0	0	0	Pass	0	Pass

Figure 9.5 (Partial) PSE Conformance Test Report

Testing for PSE response to a particular detection signature resistance can be time consuming as some PSE's may take up to 10 or more seconds to "decide" that a particular signature is valid. To speed testing, we will start with a value that is generally "known" to be valid (29 KΩ and 17 KΩ from the **det_range** **Rgood_Max** and **Rgood_Min** results), then if power-up fails to occur after some period of time, attempt a power up at another value near the edge of the absolute required range of 19 KΩ to 26.5 KΩ. Starting with values that should lead to a successful power-up, less time will be spent determining the validity of the signature resistance to the PSE port. The maximum wait time we will allow here will 5 detection/class cycles * **Tdbo_eff**, the effective back-off time from an invalid detection signature (~ 4 seconds).

```
# Establish detection resistance scan values
set rangeList(hi) "29 28 27 26"
set rangeList(lo) "16 17 18 19"
set maxR "<26"
set minR ">19"
psa_disconnect 1,1

foreach range "hi lo" {

  foreach resistance $rangeList($range) {

    # Set the passive load & connect the port
    passive 1,1 r $resistance c 0
    port 1,1 connect

    # Examine port status over the next ~4 seconds, allow 200 mSec for power_check
    set timer 0
    set state UNDETECTED
    while { $timer < 5 && $state == "UNDETECTED" } {
      incr timer
      set state [power_check 1,1]
      after 800
    }

    # If port powered up, exit the loop with maxR or minR
    if { $state == "POWERED" } {
      if { $range == "hi" } {
        set maxR $resistance
      } else {
        set minR $resistance
      }

      # Force a power-down and exit the resistance loop
      psa_disconnect 1,1
      break
    }
  }
}
puts "Detection Thresholds= $maxR and $minR Kohm"
```

Port power capacity can also be time consuming depending upon the granularity of measurement desired since at least 100 msec must be allowed for each port to decide about each power level. We know from the PSE Conformance Test data above that the PSE here delivers ~30 Watts at each port. Since this is the 802.3at minimum specified performance (30W = 50 V * 600 mA), a test is designed to verify this threshold.

```
# Initialize port to 28 Watts power
set Vport [lindex [power_port 1,1 c 4 p 28] 1]
if { $Vport < 49 } {
  puts "Port Power Capacity is below 28 Watts"
}
set pMax ">30"

foreach power "28.5 29 29.5 30" {

  # Calculate target current level
  set current [expr round(1000.0 * $power / $Vport)]

  # Establish the power level by increasing the current
  iload 1,1 i $current

  # Wait .5 seconds and assess port status, use pstatus command for speed
  after 500
  set status [lindex [pstatus 1,1 stat] 3]

  # If power is off, exit loop with pMax = previous power tested
  if { $status == "OFF" } {
    set pMax [expr $power - .5]
    break
  }
}

puts "Power_Capacity= $pMax Watts"
```

9.1.3. Time-Interlacing of Tests Across Ports

Test scripts written for the PowerSync Analyzer can readily take advantage of the measurement "state machine" behavior of each test port as described earlier in section 3.1.5 (Triggered Measurements). Two factors that routinely affect measurement times during testing on a specific test port are:

- Time for PSE to produce the signal or behavior of interest
- Measurement time (or aperture) for the measurement to complete

The concept of time-interlacing tests across ports essentially means that while one or more ports are waiting for triggering events and/or completing measurements, other ports can be configured for similar or different measurements.

There are numerous ways to apply this concept in the development of a high speed test script, so this section will provide just a couple of examples to demonstrate the concept and quantify the test speed improvements. Note that the examples in this section will also take advantage of the concepts of rapid port replication and customizing test methods described in the previous sections.

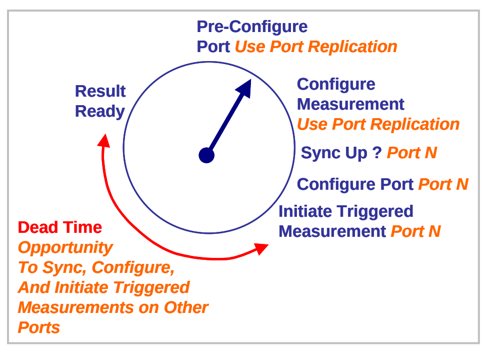


Figure 9.6 Multi-Port Command Interlacing

In the first example, a script is developed to recover three parameters from each of six test ports. These parameters are:

- **Vvalid(Max)** Peak detection voltage
- **Vport** Powered-up port voltage
- **Rgood(Max)** Validate a maximum signature threshold

One power-up per test port (or PSE port) is all that is required to recover all three parameters. Our test script, **psa_take_six** will accept six user-supplied test ports to be tested. The Vvalid(Max) measurement will be configured and initiated on each port before it is completed on any ports. Vport will then be measured immediately following the port power up given the detection load of Rgood(Max). If Vport shows the port not to be powered (i.e. < 44 V), then Rgood(Max) will be inferred to be below the target value (28 KΩ) used in the test script.

```
proc psa_take_six {args} {
  global port
  #   Inputs:  List of 6 test ports in list format
  # DUT Assumptions
  #   Detection Signal:  No pre-detection, NRZ, 3 steps, 2 edges, > 600 mSec backoff
  #   Classification Signal:  NRZ
  #   MPS Method: AC

  # Process the Test Port List
  set portList $args
  if { [llength $portList] != 6 } {
    return -code error "Must Specify 6 Ports in Slot,Port format"
  }

  # Initialize result parameters
  foreach portId $portList {
    set Vport($portId) 0
    set RgoodMax($portId) "<26_K"
  }
  # Pre-Configuration - All Ports
  # Power Down all Ports
  iload 99,99 i 0
  port 99,99 isolate

  # Establish Passives for Vvalid Max Test - use 27K ohm for det range validation
  passive 99,99 r 27 c 0

  # Configure Vpeak measurement for Vvalid_Max measurement - all ports
  #   Configure for duration of the detection pulse peak = 50 mSec
  vdcpeak 99,99 trig on max period 200m timeout 10

  # Configure Average VDC measurement for Vport measurement
  vdcaverage 99,99 trig off period 100m

  # For each port, initiate VvalidMax measurement then given R = RgoodMax
  foreach port $portList {

    # Sync to trailing edge of pre-detection pulse, then modify trigger point
    set syncDetect [psa_det_sync $port falling level 2.5]
    trig1 $port rising
    if { $syncDetect == 0 } {
      return -code error "Port $port has no detection pulse!"
    }

    # Initiate Triggered Measurement on this port and connect the port switch
    vdcpeak $port stat
    port $port connect
  }

  # For each port, complete VvalidMax measurement then Vport if port powered
  foreach port $portList {

    # Recover the peak detection voltage - shouldn't have to wait long!
    set status [psa_wait $port vdcpeak 10]
    if { [lindex $status 2] == "READY" } {
      set Vvalid($port) [lindex $status 3]
    } else {
      return -code error "Detection Signal Measurement Timed Out !"
    }

    # Now verify that PSE powered up and recover Vport
    set VportMaxR [lindex [vdcaverage $port stat] 3]

    # Disconnect port so it powers down for next test
    if { $VportMaxR >= 44 } {
      set Vport($port) $VportMaxR
      set RgoodMax($port) ">=27_K"
    }
  }
  parray Vvalid
  parray Vport
  parray RgoodMax
  return
}
```

The total execution time for the above test script on a sample PSE measures 8.1 seconds and produces the following results:

```
Vvalid(1,1)  = 5.6
Vvalid(1,2)  = 6.1
Vvalid(2,1)  = 6.1
Vvalid(2,2)  = 6.1
Vvalid(3,1)  = 6.2
Vvalid(3,2)  = 6.1
Vport(1,1)  = 47.8
Vport(1,2)  = 47.8
Vport(2,1)  = 47.6
Vport(2,2)  = 47.9
Vport(3,1)  = 47.9
Vport(3,2)  = 47.9
RgoodMax(1,1)  = >=27_K
RgoodMax(1,2)  = >=27_K
RgoodMax(2,1)  = >=27_K
RgoodMax(2,2)  = >=27_K
RgoodMax(3,1)  = >=27_K
RgoodMax(3,2)  = >=27_K
```

If the same measurements were to be run on just a single port, the total test time measures 2.1 seconds. Thus, the net time savings from interlacing across 6 ports would be:

Time Savings = (6 * 2.1 seconds) – 8.1 seconds = 4.5 seconds

For reference, to get these three parameters from the PSE Conformance Test Suite requires running the **det_v**, **det_range**, and **poweron_v** tests. The total time for those 3 tests on the same PSE measures 125 seconds per port! (Of course, those tests produce considerably more information as well.)

A second example of time interlacing of tests will recover port voltage and port power capacity across 6 user-selected ports. Again, this script will take advantage of port interlacing to recover Vport measurements as well as to assess power capacity.

```
proc psa_six_pack {args} {
  global port
  #   Inputs:  List of 6 test ports in list format

  # DUT Assumptions
  #   Detection Signal:  No pre-detection, NRZ, 3 steps, 2 edges, > 600 msec backoff
  #   Classification Signal:  NRZ
  #   MPS Method: AC

  # Initiate Test Time
  set t0 [clock clicks -milliseconds]

  # Process the Test Port List
  set portList $args
  if { [llength $portList] != 6 } {
    return -code error "Must Specify 6 Ports in Slot,Port format"
  }

  # Power down all ports and set up valid detection
  port 99,99 isolate
  iload 99,99 i 0
  passive 99,99 r 23 c 0

  # Set up measurements to recover port voltages
  vdcaverage 99,99 trig on period 200m timeout 10

  # Set up triggering for Vport measurement
  trig1 99,99 rising level 45

  # Initiate voltage measurements on all ports
  foreach port $portList {
    vdcaverage $port stat
    port $port connect
  }
  # Continued…
```

```
  # Recover voltage measurements and set port power to 15.1 Watts on all ports
  foreach port $portList {
    set status [psa_wait $port vdcaverage]
    if { [lindex $status 2] == "READY" } {
      set Vport($port) [lindex $status 3]
    } else {
      return -code error "Port $port Did Not Power Up."
    }

    # Load Port to 15 Watts
    set current($port) [format "%4.0f" [expr 1000.0 * (15.1 / $Vport($port))]]
    iload $port i $current($port)

    # Initialize trigger status
    set stat($port) "ARMED"

  }

  # Configure trigger to capture power down events on all ports
  trig1 99,99 falling level 20 arm

  # Recover the port capacity by increasing current
  set oneOrMore "ARMED"
  set poweredList $portList
  while { $oneOrMore == "ARMED" } {
    foreach port $portList {
      if { $stat($port) == "ARMED" } {
        set stat($port) [lindex [trig1 $port stat] 3]
        if { $stat($port) == "ARMED" } {
          set PportCap($port) [lindex [paverage $port period 50m stat] 3]
          set current($port) [expr $current($port) + 6]
          iload $port i $current($port)
        } else {
          set Icut($port) $current($port)
          set stat($port) "TRIGGERED"
          set idx [lsearch $poweredList $port]
          set poweredList [lreplace $poweredList $idx $idx]
          if { [llength $poweredList] == 0 } {
            set oneOrMore "NOT ARMED"
          }
        }
      } ; # If port still powered
    } ; # Foreach Port
  }

  # Power Down All Ports
  port 99,99 isolate
  iload 99,99 i 0

  # Print Results
  parray Vport
  parray PportCap

  return
}
```

This script produces the following result in 22.6 seconds:

```
Vport(1,1)  = 47.8
Vport(1,2)  = 47.8
Vport(2,1)  = 47.6
Vport(2,2)  = 47.9
Vport(3,1)  = 47.9
Vport(3,2)  = 47.9
PportCap(1,1)  = 15.2
PportCap(1,2)  = 15.5
PportCap(2,1)  = 15.2
PportCap(2,2)  = 15.5
PportCap(3,1)  = 15.5
PportCap(3,2)  = 15.5
```

When the test is run on a single port, the test time is 5.6 seconds, so the time savings by interlacing across 6 ports is:

```
Time Savings = (6 * 5.6 seconds) - 22.6 seconds = 11.0 seconds
```

9.1.4. psa_quick_test: Fully Automated PSE Test Script Template for 802.3at Multi-Port PSE's

PSA Software includes a fully automated, multi-port PSE test script designed for high throughput and high defect coverage of PSE ports. This script, **psa_quick_test**, is provided as source code and is found in the **…\Contrib** directory (*see section 3.2.5)*.

psa_quick_test is capable of testing 802.3at Type-1 PSE's, Type-2 (2-event) PSE's, and Type-2 (LLDP* capable) PSE's. (*See section 5.14 for command usage information*.) Important features of the **psa_quick_test** are:

- Source Code Provided: May be used as is, may be modified, or may be used as template script
- Scans 4 to 8 PSE ports per test cycle
- Tests Type-1, Type-2 (2-event), and Type-2 (LLDP*) PSE's
- Validates PoE Detection Acceptance and Rejection Ranges
- Measures PSE Port Voltage at minimum and maximum load conditions
- Determines Power Capacity in Watts and mA
- Assesses Disconnect Power Removal response and timing
- Assesses Overload Power Removal and Power-Type Threshold
- Assesses LLDP Power Allocations* and associated timing

Typical test types will range from 8 to 15 seconds per port tested, even when testing Type-2 LLDP capable PSE's.

192.168.221.106	1,1	1,2	2,1	2,2	3,1	3,2	4,1	4,2
Detect_Accept:	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
Detect_Reject:	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
Vport_Low_Load:	51.4	51.5	51.5	51.4	51.5	51.4	51.4	51.5
Vport_High_Load:	50.2	50.1	50.2	50.2	50.2	50.1	50.2	50.2
Load_Capacity:	599	595	599	595	599	595	595	599
Power_Capacity:	30.1	29.5	30.1	29.6	30.3	29.4	29.3	30.1
Disconnects:	N/A	PASS	PASS	PASS	PASS	PASS	PASS	PASS
Overloads:	PASS-2	PASS-2	PASS-2	PASS-2	PASS-2	PASS-2	PASS-2	PASS-2
LLDP_Allocations:	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
Test_Time:122.0seconds								
Test_Time/Port:15.3seconds								

Figure 9.7 psa_quick_test Report (8 ports tested, Type-2 LLDP capable PSE)

* LLDP Capable PSE Testing requires PSA-3000 to be enabled for LLDP Features.

9.1.5. Multi-Chassis Testing in Parallel

One other technique that can be utilized to speed up testing with the PowerSync Analyzer is parallel execution of test scripts on multiple chassis'. For example, with two PSA chassis', the PSE Conformance Test sequencer may be executed concurrently from a single host computer controlling two different PSA chassis. This "brute force" method of reducing test time may be applied to any test script executing in conjunction with any PSA chassis.

Since PSA Software limits the user to **two instances** of PowerShell and **one instance** of PowerSync Interactive, test sequences may actually be executed with up to three PowerSync Analyzers in parallel with no effective loss of test time to any of the shells meaning whatever is accomplished in one shell across N ports of the PSE can be effectively halved if two PSA chassis' are available.

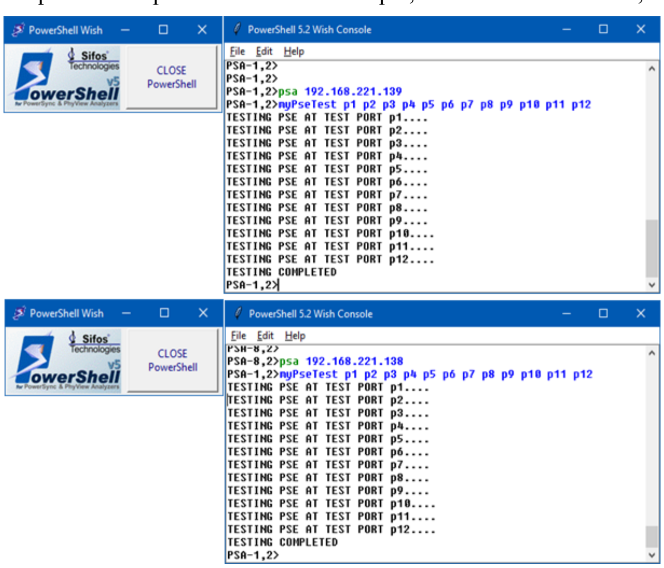


Figure 9.7 Executing Scripts Concurrently From 2 PowerShell's

9.2. Intra-Port Interaction Testing

The PowerSync Analyzer has been developed to readily support measurements that span across multiple PSE ports, even if those ports are connected through multiple PSA chassis'. The two features that enable such testing are:

- External (Event) Triggering (*see section 3.1.2*)
- The TRIG Out BNC Port on the PSA Controller Blade

External Triggering provides a mechanism where events that occur on one port may be visible to all ports across all chassis'. External Triggers can be generated by user selected events, such as the initiation of a current load transient, and they can be used to trigger measurements, such as a minimum peak voltage measurement over a user-defined time interval.

Additionally, external triggers can be utilized to initiate current load transients. This feature allows the current transient resource within each test port to act as a mechanism for internal trigger (or waveform transition events) to be transferred to external trigger events.

An example of intra-port interaction testing would be to examine the effect on PoE line voltage on one or more ports caused by a sudden load transient occurring on one or more other ports. In this test case, external triggering will be used to:

- Launch load transients concurrently on M ports
- Launch Vpeak measurements concurrently on N ports

Intra-Port Interaction Tests can be configured and carried out from both PowerSync Interactive as well as PowerShell where specialized scripts can be developed. The example below provides some PowerShell command sequences that would be relevant to an interaction test where effects of load current transients are to be analyzed.

```
# Assign load ports
set loadPorts "1,1 1,2 2,1 2,2"
set testPorts "3,1 3,2 4,1 4,2 5,1 5,2"

# Power all the ports that will experience load transients to 4 Watts
# Configure the load transients for 350 mA over 45 mSec
foreach port $loadPorts {
  power_port $port p 4.0
  itrans $port i1 350 t1 45m i2 40 t2 55m ext
}

# Power all the ports that will be measured to 7 Watts
# Configure the peak voltage meter to capture a voltage transient
foreach port $testPorts {
  power_port $port p 7.0
  vdcpeak $port trig ext period 100m min timeout 10
}

# Initiate the triggered voltage measurements
foreach port $testPorts {
  vdcpeak $port stat
}

# Launch the current transients and trigger the peak voltage measurements
trigout 1,1
after 100

# Recover the peak voltage measurements
foreach port $testPorts {
  set MinV($port) [lindex [vdcpeak $port stat] 3]
}

# Present the results
parray MinV
```

This example script would produce and output as follows:

```
MinV(3,1) = 47.0
MinV(3,2) = 46.9
MinV(4,1) = 46.8
MinV(4,2) = 47.0
MinV(5,1) = 47.1
MinV(5,2) = 46.9
```

The next example extends this testing into two chassis' and returns a Min-Max-Delta voltage effect on the tested ports. To extend beyond the chassis, the chassis at 192.168.221.105 will be the trigger generator and the chassis at 192.168.221.106 will receive the trigger as an input. Four ports in each chassis will generate transients and 6 ports will be measured from each chassis. At the PSE, this represents 8 ports of stimulus and 12 ports measured.

```
proc psa_intra_port {args} {
 # Assign load ports
 set chassisList "192.168.221.105 192.168.221.106"
 set loadPorts "1,1 1,2 2,1 2,2"
 set testPorts "3,1 3,2 4,1 4,2 5,1 5,2"
 # Configure Trigger I/O on each controller
 psa 192.168.221.105
 trig_port out
 psa 192.168.221.106
 trig_port in
 # Power all the ports that will experience load transients to 4 Watts
 foreach chassis $chassisList {
   psa $chassis
   foreach port $loadPorts {
     power_port $port p 4.0
   }
   # Power all the ports that will be measured to 7 Watts
   foreach port $testPorts {
     power_port $port p 7.0
     vdcpeak $port trig ext period 100m timeout 100
   }
   # Initiate the triggered voltage measurements
   foreach port $testPorts {
     vdcpeak $port stat
   }
 }
 # Run both a MIN and a MAX peak voltage case
 foreach level "min max" {
   foreach chassis $chassisList {
     psa $chassis
     # Configure the load transients for 350 mA over 45 mSec, then 0 mA over 55 mSec
     foreach port $loadPorts {
       itrans $port i1 350 t1 45m i2 0 t2 55m ext
     }
     # Configure the peak voltage meter to capture a voltage transient
     foreach port $testPorts {
       vdcpeak $port trig ext $level period 100m timeout 100 stat
     }
   }
   # Return to generating chassis
   psa 192.168.221.105
   # Launch the current transients and trigger the peak voltage measurements
   trigout 1,1
   after 100
   # Recover the peak voltage measurements from each tested port of each chassis
   foreach chassis $chassisList {
     psa $chassis
     foreach port $testPorts {
       if { $level == "min" } {
         set minV($chassis.$port) [lindex [vdcpeak $port stat] 3]
       } else {
         set maxV($chassis.$port) [lindex [vdcpeak $port stat] 3]
       }
       if { $level == "max" } {
         set deltaV($chassis.$port) [expr $maxV($chassis.$port) - \
                    $minV($chassis.$port)]
       }
     }
   }
 }
 # Continued…
```

```
  # Present the results
  parray minV
  parray maxV
  parray deltaV

  return
}
```

This script produces the following results:

```
minV(192.168.221.105.3,1) = 46.9
minV(192.168.221.105.3,2) = 46.8
minV(192.168.221.105.4,1) = 46.8
minV(192.168.221.105.4,2) = 46.9
minV(192.168.221.105.5,1) = 47.0
minV(192.168.221.105.5,2) = 46.8
minV(192.168.221.106.3,1) = 47.2
minV(192.168.221.106.3,2) = 47.0
minV(192.168.221.106.4,1) = 46.8
minV(192.168.221.106.4,2) = 46.8
minV(192.168.221.106.5,1) = 47.1
minV(192.168.221.106.5,2) = 47.0
maxV(192.168.221.105.3,1) = 47.1
maxV(192.168.221.105.3,2) = 47.0
maxV(192.168.221.105.4,1) = 47.0
maxV(192.168.221.105.4,2) = 47.0
maxV(192.168.221.105.5,1) = 47.2
maxV(192.168.221.105.5,2) = 47.0
maxV(192.168.221.106.3,1) = 47.3
maxV(192.168.221.106.3,2) = 47.2
maxV(192.168.221.106.4,1) = 47.0
maxV(192.168.221.106.4,2) = 47.0
maxV(192.168.221.106.5,1) = 47.2
maxV(192.168.221.106.5,2) = 47.2
deltaV(192.168.221.105.3,1) = 0.2
deltaV(192.168.221.105.3,2) = 0.2
deltaV(192.168.221.105.4,1) = 0.2
deltaV(192.168.221.105.4,2) = 0.1
deltaV(192.168.221.105.5,1) = 0.2
deltaV(192.168.221.105.5,2) = 0.2
deltaV(192.168.221.106.3,1) = 0.1
deltaV(192.168.221.106.3,2) = 0.2
deltaV(192.168.221.106.4,1) = 0.2
deltaV(192.168.221.106.4,2) = 0.2
deltaV(192.168.221.106.5,1) = 0.1
deltaV(192.168.221.106.5,2) = 0.2
```

The deltaV reported in each of the test ports (3,1 – 5,2) indicates that the effect on line voltage of the 8-port transient load is between 100 and 200 mV.

Within the above script, note the uses of the "psa" command to steer commands to particular chassis' and the "trig_port" command to set the directionality of the external trigger port.

Finally, an example of the "itrans" command used to convert internal triggers to external triggers is presented in the following sequence of PowerShell instructions.

```
# Setup internal or waveform trigger criteria
trig1 1,1 rising level 35 normal

# Configure load to 60 mA
iload 1,1 i 60

# Configure transient to fire on trig1, generate external trigger out, but not
# affect load current
itrans 1,1 i1 60 t1 10m i2 60 t2 10m trig1 trigout

# Arm the trigger – next edge at 35V rising will produce an external trigger
trig1 1,1 arm
```

9.3. Merging the PowerShell API into TCL and Wish Shells

PSA Software includes **resource scripts** that may be used to merge the PowerShell API into a native Tcl or Wish Shell for use with other applications and API's.

Users should be aware that in merging PowerShell with other applications, there is always the risk of a **command** or **global variable** overlap where two or more applications use identical commands or global variables. Many PowerShell commands and global variables begin with the characters "**psa**" or "**psa_**". The likelihood of a conflict with these commands and globals is minimal.

The following table presents certain PowerShell commands and global variables that should be considered before merging applications into a common shell.

PowerShell Commands	PowerShell Commands
`port`	`pstatus`
`polarity`	`vdcaverage`
`alt`	`idcaverage`
`class`	`paverage`
`passive`	`replicate_ports`
`trig1` *(n/a for PSL-3000)*	
`trig2` *(n/a for PSL-3000)*	**PowerShell Globals**
`trigout` *(n/a for PSL-3000)*	`port`
`trig_port` *(n/a for PSL-3000)*	`port_available`
`iload`	`channel_available`
`itrans` *(n/a for PSL-3000)*	`slotRange`
`pstatus`	`portRange`
`power_port`	`emulationMode`
`power_check`	`emulationPath`

PowerShell is provided with four Tcl source-code initialization files in the directory path:

- c:\Program Files\Sifos\PSA3000\ *(Microsoft Windows platforms)*
- <User Home Directory>/Sifos/PSA3000/ *(Linux/Unix platforms)*

These files may be used to import PowerShell PSA into Tcl and Wish with the following features:

File	Purpose
tclshrc.tcl	Sourcing this file will configure a **Tcl shell** for PowerShell PSA including command-line prompt that embeds present slot,port connection.
wishrc.tcl	Sourcing this file will configure a **Wish shell** for PowerShell PSA including command-line prompt that embeds present slot,port connection.
tclshrc_psapi.tcl	Sourcing this file will layer (or add) the PowerShell PSA API into a **Tcl shell** without modifying the standard "%" prompt.
wishrc_psapi.tcl	Sourcing this file will layer (or add) the PowerShell PSA API into a **Wish shell** without modifying the standard "%" prompt.

To merge the PowerShell PSA API into a Tcl shell, execute the following command from Tcl:

```
source "c:/Program Files/Sifos/PSA3000/tclshrc_psapi.tcl"    (Windows PC)

source "$env(HOME)/Sifos/PSA3000/tclshrc_psapi.tcl"          (Linux/Unix WS)
```

To merge the PowerShell PSA API into a Wish shell, execute the following command from Wish:

```
source "c:/Program Files/Sifos/PSA3000/wishrc_psapi.tcl"    (Windows PC)

source "$env(HOME)/Sifos/PSA3000/wishrc_psapi.tcl"          (Linux/Unix WS)
```

PowerShell Tcl and Wish may be sourced into Tcl and Wish respectively at "Level 0" or below, meaning that the sourcing may be done by a Tcl script.

9.3.1. Initial Connection Dialog Control – PowerShell Tcl

Whenever **PowerShell Tcl** is initiated, the user is presented with a command prompt to either re-connect to the most recently connected PSA or to enter a new PSA address and establish a different connection. By default, this command prompt will time out after about 8 seconds and PowerShell will then attempt to connect to the most recently connected PSA address or subsequently to any other known PSA addresses.

Users may elect to either bypass this dialog entirely or to configure the time delay associated with the connection prompt prior to connecting to a default (most recent or other known) address. This is done by setting the appropriate value to the global variable **psaConnectPause** near the beginning of the **tclshrc.tcl** and/or **tclsrhc_psapi.tcl** PowerShell Tcl initialization files. Normally, this global will be set to 8 seconds. If set to zero, the initial connection prompt will be entirely bypassed and PowerShell Tcl will attempt to open a connection to the most recently connected PSA address. The delay associated with the connection prompt may be set between 2 and 60 seconds.

9.3.2. Initial Connection Dialog Control – PowerShell Wish (and PSA Interactive)

Whenever **PowerShell Wish** (or **PSA Interactive**) is initiated, the user is presented with a PSA Connection dialog that must, by default, be completed before the application will fully start.

Users may elect to either bypass this dialog entirely by setting the value of the global variable **psaConnectPause** found near the beginning of **wishrc.tcl** and **wishrc_psapi.tcl**. If the value is set to 1 (default), the initial PSA connection dialog will always occur and wait indefinitely for a user selection. If the value is set to 0, the connection dialog will be bypassed and the application will automatically attempt to connect to the most recently connected PSA address.

Important! It is generally not a good idea to bypass the initial connection dialog if multiple (2 or more) PSAs exist on a common LAN and are shared by multiple users. Bypassing the initial connection dialog increases the risk that 2 users will attempt to control the same PSA at the same time.

9.3.3. Tcl Version Compatibility

PowerShell PSA is developed and tested on platforms running Tcl version 8.4.5 through 8.4.12. PowerShell PSA is distributed in compiled bytecode format, along with a bytecode loader implemented in a binary library compatible with the installation platform: a Dynamic Link Library (.dll) for Microsoft Windows, or a Shared Object Library (.so) for Linux or Sun Solaris.

The Tcl bytecode loader extension package (tbcload) that is furnished with PowerShell PSA is `tbcload14`. Sifos does not warrant that PowerShell PSA will load properly with other versions of this extension package.

PowerShell PSA has not been tested with Tcl versions 8.5 or later, and is not supported for use with newer Tcl versions.

9.4. Managing PowerShell from External Applications

There are various methods that can be used to work with PowerShell PSA from an external application context. In all cases, it is recommended that the native PowerShell PSA scripting environment be used to develop and debug the commands or scripts that perform the desired actions with the instrument, and then transition those commands to the automation technique appropriate for the external application context the user needs to use.

PowerShell PSA can be accessed from external applications using the following methods:

- **Application Programming Interface (API) Library** (accessible to any programming environment that can call functions in either a Windows .dll or Linux .so library). Used primarily for compiled language support.
- **Socket Interface** (accessible to any programming environment that can read and write a TCP/IP socket).
- **Mailbox File** (available to any environment that is capable of creating files, and polling for the presence of files).
- **Batch Mode** (available to any environment that is capable of launching an executable with command line arguments).

9.4.1. API Library

The PowerShell PSA API Library* provides functions that allow many of the basic capabilities available within the Sifos PSA-3000 family of instruments to be configured or queried. Each of these functions accepts specific arguments and returns values to specific parameters. The library includes a general purpose function that will allow any valid Tcl command string (including PowerShell PSA commands) to be submitted for execution, with the Tcl list response returned as delimited text.

* **Important!** The Sifos API Library is informally supported by Sifos and will not always track changes and enhancements included in fully supported PSA software releases.

The API Library provides a very robust means of performing specific actions with the PSA/PSL-3000 instrument, where each function defines exactly what it needs for input (input parameters), and exactly what will be returned (output parameters, for any function that returns values). Each function returns the status of its execution. If that status indicates that an error occurred, an API library function that furnishes a related error message text can be called. This is the recommended technique for remote control for application environments that are capable of calling library functions.

The PowerShell PSA API Library is furnished in binary form, along with language specific definition files for various languages including C, Visual Basic, C#, and National Instruments LabView. PowerShell PSA and a supported version of Tcl must be installed on the system where the API library will be used.

The **PowerShell API Library Reference Manual** (*PowerShell API Library Ref Manual.pdf*) provides information regarding the functions provided in the library, and usage with selected programming languages.

9.4.2. TCP Socket Server Method

PowerShell PSA can be operated as a TCP Socket Server with ability to receive commands, process commands, and transmit responses to a TCP socket client operating on the same host computer or perhaps elsewhere on the network. Any external application capable of input/output via TCP sockets can take advantage of this inter-process communication capability. A key benefit of the Socket Server is that all PSA commands and queries available to PowerShell PSA become available to any external application that can output lines (ASCII strings) to a socket connection and read lines back from that same socket connection.

In order to maintain robustness, client applications are required to pair a socket read operation with every socket write operation, even if PowerShell PSA is not returning any information. This provides a command-by-command handshake to assure remotely furnished commands were properly processed.

PSA software versions 5.0 and later include an embedded command to initiate the TCP Socket Server and a separate command to terminate that server. The TCP Socket Server may run either in PowerShell Tcl or PowerShell Wish.

Command	Port	Command Parameters	Returned Parameters
psa_socket_server	< *tcp_port*> <**-space** | **-semicolon** | **-grave** | **-caret** >		**COMMAND_OK** | **RESPONSE** + delimited ascii string | **PowerShell_ERROR** + delimited ascii string
	This command puts PowerShell PSA into a TCP Socket Server mode where it will automatically receive, process, and respond to PSA commands and queries from a remote client application, either on same host or elsewhere on the network. Query and utility results are passed back through the socket I/O as single lines with user-specified delimiters between elements. Commands will respond with either **COMMAND_OK** or with **PowerShell_ERROR** *Error Message*". Queries will respond with either **RESPONSE** *data* or with PowerShell error message. Special client command quit will terminate PowerShell, **psa_server_off** will prevent new server connections, show port will return current slot,port value, **show psa** will return currently connected PSA address, and **show error** will return the most recent error message from PowerShell. *tcp_port* TCP port to be assigned to socket server. Default value is 6900. Range is 1024 to 9999. **-space** Specifies that all response data elements will be separated by a space. Line will terminate with a line feed. This is the default mode. **-semicolon** Specifies that all response data elements will be separated by a semicolon (;). Lines will terminate with a semicolon, then a line feed. **-grave** Specifies that all response data elements will be separated by a grave accent (`).Lines will terminate with a grave accent, then a line feed. **-caret** Specifies that all response data elements will be separated by a caret (^).Lines will terminate with a caret, then a line feed.		
psa_server_off	Discontinues PowerShell PSA command server such that it will not accept any new connections.		**SERVER_STOPPED**

The TCP Socket Interface method, including an example, is discussed in greater detail in the Sifos Technologies application note **PowerShell PSA - Remote Access Methods** (*PowerShell PSA - Remote Access Methods.pdf*). Additionally, application notes with specific examples of the TCP Socket Interface are available for the following application environments:

- Microsoft Visual Basic 6 (PowerShell Socket Client - Visual Basic 6 Application.pdf)
- National Instruments LabView (PowerShell Socket Client - LabView Application.pdf)

9.4.3. Mailbox File Method

PowerShell PSA can be operated in a mode where it will poll the file system, checking for the existence of the file **psa_command.txt**, and will execute the commands contained within that file when it is detected.

The command file is created on-the-fly by the external controlling environment. The file contains a series of one or more valid PowerShell PSA commands that are executed in the order they are listed in the file, from top to bottom.

The PowerShell PSA execution environment communicates that it has completed execution by creating the file **psa_response.txt**. This file does not contain any command result text – its sole purpose is to act as a handshake to the caller.

The Mailbox File technique is substantially less robust than the Socket Interface method because there is no path by which results developed as a consequence of PowerShell commands are automatically conveyed back to the external application. This means that commands or scripts passed into PowerShell must have internal capability to retain those results and feed them back, via data files or other means, to the external application.

The Mailbox File technique is useful in cases where very defined actions need to be performed, such as running a standard test suite sequence, which by design will store the results to the disk. This technique is not recommended where a varied set of commands needs to be executed, and where different results are required to make decisions.

The Mailbox File technique, including an example, is discussed in detail in the Sifos Technologies application note **PowerShell PSA - Remote Access Methods** (*PowerShell PSA - Remote Access Methods.pdf*).

9.4.4. Batch Mode Methods

PowerShell Tcl (or Wish) consoles can be invoked from any environment where a batch file (Windows) or shell script (Linux) can be executed. Furthermore, there are several methods by which a user-specified script can automatically run once the PowerShell console opens. These methods are:

1. PSA Software **Contrib** Directory
9. Script Call from PowerShell Initialization File
10. PowerShell Launch Program Command Arguments (*Windows only*)

A PowerShell PSA console is opened (or installed) in Windows using the **PowerShell TCL.exe** (or **PowerShell Wish.exe**) executable and in Linux with the **PowerShell_TCL.sh** or **PowerShell_WISH.sh** shell scripts. Batch mode method #1 takes advantage of the fact that any ***.tcl** file located in the PSA Software Contrib directory will automatically get sourced into PowerShell. Batch mode #2 involves editing the PowerShell Initialization File to execute a user-specified command (or command sequence) when PowerShell opens. And Batch mode #3 capitalizes on a feature of the Windows PowerShell launch executable where a script name file can be attached as an argument to the PowerShell launch command thus causing that file to source into PowerShell when PowerShell opens.

The Batch Mode technique is generally less robust than the Socket Interface method because there is no path by which results developed as a consequence of PowerShell script execution are automatically conveyed back to the external application. This means that commands or scripts passed into PowerShell must have internal capability to retain those results and feed them back, via data files or other means, to the external application. Batch mode #3 (Windows only) does enable the remote application to specify an standard output channel to PowerShell such that all command results could be routed to a user-specified data file.

The Batch Mode technique, including an example, is discussed in detail in the Sifos Technologies application note **PowerShell PSA - Remote Access Methods** (*PowerShell PSA - Remote Access Methods.pdf*).

9.5. Integrated Power-over-Ethernet and Packet Transmission Testing

Popular Ethernet transmission test and load instruments are equipped with TCL-based programming and interactive control capabilities. Since PowerShell utilizes TCL, the opportunity exists to combine libraries under a single console and execute test scripts written to control both PowerSync Analyzers and Ethernet test equipment.

This capability gives script developers the option to generate efficient tests that can:

- Evaluate impact of Powered-Device emulations on transmission integrity*
- Evaluate impact of data transmission on PoE voltages and power draw
- Simultaneously test PoE and Data Transmission characteristics in the interest of minimizing total test time.

Powered-Device emulations may take the form of various load changes and rapid load transient conditions. These are readily controlled utilizing PowerShell commands discussed earlier in section 5. During a packet transmission and capture sequence, a test script could run various scenarios of load transients and transitions, then evaluate any negative consequences to packet transmission. The standard test script, **psa_test_load** described in section 5.11 provides a flexible means to generate active load sequences that can operate concurrently with a data transmission test.

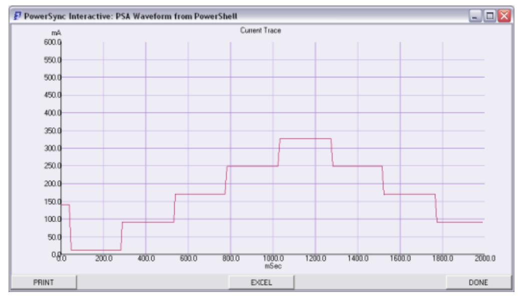


Figure 9.8 Load Sequencing from **psa_test_load**

The impact of data transmission on PoE supplied voltage and power is readily observed using DC and AC metering within the PSA test port.

Spirent's SmartBits products are an example of a Ethernet performance tester offering a TCL API for automated script development. The following sequence of commands may be used in a PowerShell console to integrate in the SmartLib TCL API to PowerShell.

```
set smartPath "c:/Program Files/SmartBits/SmartLib"
set smartTcl "Tcl/TclFiles"
set smartComm "Commlib"


# Determine that Smart Lib is installed in the typical place
if { [file exists "$smartPath/$smartTcl/smartlib.tcl"] == 0 } {
  return -code error "CANNOT FIND SmartLib @ /PROGRAM
  FILES/SmartBits/SmartLib..."
}

# Place the Tcl DLL's into the Comm Library if they are not already there
file copy -force "$smartPath/$smartTcl/tclet100.dll" "$smartPath/$smartComm"
file copy -force "$smartPath/$smartTcl/tclstruc.dll" "$smartPath/$smartComm"

cd "$smartPath/$smartComm"
set smartVer [source "$smartPath/$smartTcl/smartlib.tcl"]
```

A "contributed" script is available for the PowerSync Analyzer that will automatically load from the ..\Contrib directory offering a single command to integrate SmartLib into PowerShell. When the script "**psa_smartlib.tcl**" is placed into the …\Contrib directory, simply combine environments as follows:

```
PSA-1,1>psa_smartlib
************ SmartLib TCL Enabled ! ******************
SmartBits Programming Library 5.00-85

PSA-1,1>
```

*** Note**: Sifos Technologies offers a more productive and comprehensive alternative to packet transmission measurements when evaluating impact of PoE loading on Ethernet Magnetics. Explore the **PhyView Analyzer** and the **PHY Performance Test Suite**, including automated **DC Unbalance Tolerance Testing**, at **www.sifos.com**.

10. 802.3at PoE Service Analyzer Application

The PowerSync Analyzer includes a fully automated test application for assessing **802.3at**-based (i.e. Type-1 or Type-2) PoE Service to a PD. This software application allows each PSA test port to function as a highly sophisticated service analyzer at the *PD interface* (or service outlet).

This type of testing is quite different from PSE Conformance Testing addressed in section 6 because it is specific to service at the PD interface, not the PSE interface. The level of analysis performed by the PoE Service Analyzer application is far more comprehensive than PoE service measurements typically performed by commercially available hand-held service analyzers.

The **PoE Service Analyzer** application is accessible through either PSA Interactive or PowerShell. It is also provided in the dedicated PSA-3002-SA service analyzer instrument. This section will introduce the types of testing performed by the PoE Service Analyzer and the associated reporting available.

10.1. PoE Service Access Tests

The **PoE Service Analyzer** combines PowerSync Analyzer test ports with specialized application software to enable the most comprehensive and fully automated testing available for PoE analysis and qualification at a Powered Device service access point. The tests available go well beyond standard power-up and line voltage measurements found in hand-held analyzers. The PoE Service Analyzer will fully assess **interoperability risks**, **safety hazards**, and PoE **performance limitations** at the connection to any Powered Device.

The PoE Service Analyzer provides fully automated testing in 3 categories:

Basic Service Tests evaluate the basic Power-over-Ethernet connection, reporting connection information such as powered pairs (including multiple PoE sources), power polarity, PD disconnect detection method, and service category.

Parameter	Outcome	Explanation
Service Pairs & Polarity	CONNECTION: ALT-A: MDI, MDI-X, NONE CONNECTION: ALT-B: MDI, MDI-X, NONE	PoE service is active on ALT-A and/or ALT-B pairset with polarity MDI or MDI-X.
	CONNECTION: NONE	PoE service is not available
Disconnect Detection	MPS: DC	PSE removes power when DC current below 5 mA.
	MPS: AC	PSE removes power when PD 25KΩ signature is removed.
Service Category	TYPE-1	PoE service up to 13W
	SUB_TYPE-1	PoE service between 4W & 7W
	TYPE-2_PHY	PoE service up to 25.5W to any Class 4 PD
	TYPE-2_LLDP	PoE service up to 25.5W provided Class 4 PD supports PoE LLDP
	TYPE-2_OTHER	PoE service up to 25.5W to any PD
	DISABLED	No PoE service available

Parametric Tests report a number of parameters of the PoE service that are relevant to interoperability of all PD's at the PoE service outlet. Additionally, certain safety related behaviors of the PoE service are analyzed. Information collected includes line voltages (DC and AC) at power extremes, detection signature range verification, rejection signature range verification, inrush and overload tolerance of the PoE connection, disconnect timing, and overload timing response of the PoE connection. In performing these tests, the PowerSync® Analyzer is utilized to emulate a wide range of IEEE 802.3af compliant steady state and transient Powered Device behaviors.

Parameter	Description	Range of Outcomes
MIN_DETECT:	Power Applied to Valid Low-End PD Signature *to assure all Valid PD's are detected properly (24 KΩ)*	PASS / FAIL
MID_DETECT	Power Applied to Nominal IEEE 802.3 Signature *to assure nominal 802.3at PD's are detected properly (25 KΩ)*	IEEE_Service / No_IEEE_Service
MAX_DETECT:	Power Applied to Valid High-End PD Signature *to assure all Valid PD's are detected properly (26 KΩ)*	PASS / FAIL
Non802_DET:	Power Applied to Capacitive Load, Invalid 802.3at PD *to note capability of PSE to power many "legacy" PD's*	Legacy_Det / No_Legacy_Det
Full_Pwr_Time:	Time from PD Connection until PD Can Draw Full Power	0 – 60 seconds

Parameter	Description	Range of Outcomes
LLDP_Allocation:	Power Allocation from a Type-2, LLDP PSE	X.Y Watts / N/A
DCV_Min_Load:	PoE Line Voltage to Very Low Power PD *to assure valid line voltage to low power PD* *(Type-1 PSE: 37 to 57 VDC, Type-2 PSE: 42.5 to 57 VDC)*	0 – 60 VDC PASS / FAIL
ACV_Min_Load:	PoE Line Noise to Very Low Power PD *to assure "clean" DC line voltage to low power PD (≤ 0.5 Vpp)*	0 – 1 Vpkpk PASS / FAIL
DCV_Max_Load:	PoE Line Voltage to High Power PD *to assure valid line voltage to high power PD* *(Type-1 PSE: 37 to 57 VDC, Type-2 PSE: 42.5 to 57 VDC)*	0 – 60 VDC PASS / FAIL
ACV_Max_Load:	PoE Line Noise to High Power PD *to assure "clean" DC line voltage to high power PD (≤0.5 Vpp)*	0 – 1 Vpkpk PASS / FAIL
Overload_Tolerance:	Tolerance of Service to Maximum Transient Overload *to assure power maintained to compliant PD's (Type-1 PD: ≥400mA for ≥45msec, Type-2 PD: ≥684mA for ≥45 msec)*	PASS / FAIL
PD_Disconnect:	Power Removal Timing on PD Disconnect *to assure PoE service will not damage non-PD's (≤500 msec)*	0 to 1500 msec PASS / FAIL
Inrush_Tolerance:	Tolerance of Service to Worst Case Allowable Startup Load *to assure proper startup of all compliant PD's* *(≥450 mA for ≥45 msec)*	PASS / FAIL / N/A
Overload_Shutdown:	Power Removal Timing on PD Overload Shutdown *to assure PoE Service will tolerate short duration power peaks and not damage cables and connections (50 – 75 msec with Type-1 PSE: ≥402 mA, Type-2 PSE: ≥684 mA)*	0 to 1500 msec PASS / FAIL / N/A
Min_Reject:	Rejection of Invalid Low-End PD Signature *to assure that non-PoE devices do not get powered (≤15 KΩ)*	PASS / FAIL / N/A
Max_Reject:	Rejection of Invalid High-End PD Signature *to assure that non-PoE devices do not get powered (≥33 KΩ)*	PASS / FAIL / N/A
Cap_Reject:	Rejection of Highly Capacitive PD Signature *to assure that non-PoE devices do not get powered*	PASS / FAIL / N/A

Classification Service Tests report the behavior of the PoE service connection to each PD classification (0, 1, 2, or 3). Information reported includes maximum power capacity available by PD classification as well as the ability of the PoE connection to deliver the appropriate power capacity to PD classification signatures that are borderline for each PD classification.

Parameter	Description	Range of Outcomes
Class_0_Capacity:	Power Available to a nominal PD Classifying as Class 0 *to assure a minimum of 13 watts is available to PD*	1 to 15 Watts PASS / FAIL
Class_1_Capacity:	Power Available to a nominal PD Classifying as Class 1 *to assure a minimum of 3.84 watts is available to PD*	1 to 15 Watts PASS / FAIL
Class_2_Capacity:	Power Available to a nominal PD Classifying as Class 2 *to assure a minimum of 6.49 watts is available to PD*	1 to 15 Watts PASS / FAIL
Class_3_Capacity:	Power Available to a nominal PD Classifying as Class 3 *to assure a minimum of 13 watts is available to PD*	1 to 15 Watts PASS / FAIL
Class_4_Capacity:	Power Available to a nominal PD Classifying as Class 4 *to assure a minimum of 25.5 watts is available to PD*	12 to 37 Watts PASS / FAIL
Class_0_Interop:	Power Available to PD with Borderline Class 0 Signatures *to assure all Class 0 PD's receive the same power allocation*	PASS / FAIL
Class_1_Interop:	Power Available to PD with Borderline Class 1 Signatures *to assure all Class 1 PD's receive the same power allocation*	PASS / FAIL
Class_2_Interop:	Power Available to PD with Borderline Class 2 Signatures *to assure all Class 2 PD's receive the same power allocation*	PASS / FAIL
Class_3_Interop:	Power Available to PD with Borderline Class 3 Signatures *to assure all Class 3 PD's receive the same power allocation*	PASS / FAIL
Class_4_Interop:	Power Available to PD with Borderline Class 4 Signatures *to assure all Class 4 PD's receive the same power allocation*	PASS / FAIL

By the IEEE 802.3at standard, PD's are classified by power utilization according to the table below. PD's are responsible for "signaling" this classification prior to receiving power from the PoE enabled network connection.

Classification	PD Maximum Power Requirement
0	0.44 to 13.0 Watts
1	0.44 to 3.84 Watts
2	0.44 to 6.49 Watts
3	6.49 to 13.0 Watts
4	13.0 to 25.5 Watts

10.2. Running the PoE Service Analyzer

In PSA Interactive software, the PoE Service Analyzer is accessed from the **Test** drop down menu (*see **Figure 10.1***).

When the PoE Service Test menu opens (*see **Figure 10.2***), the presently connected PSA IP address is displayed along with **Test Slot** and **Test Port** controls. In a PSA-3002-SA, there is just one **Test Slot** and on all instruments there are two **Test Ports** that can be selected.

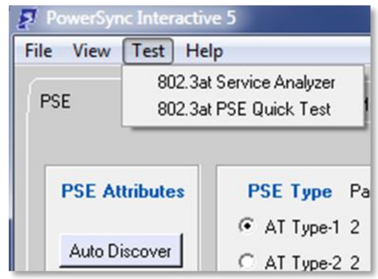


Figure 10.1 PoE Service Test Access

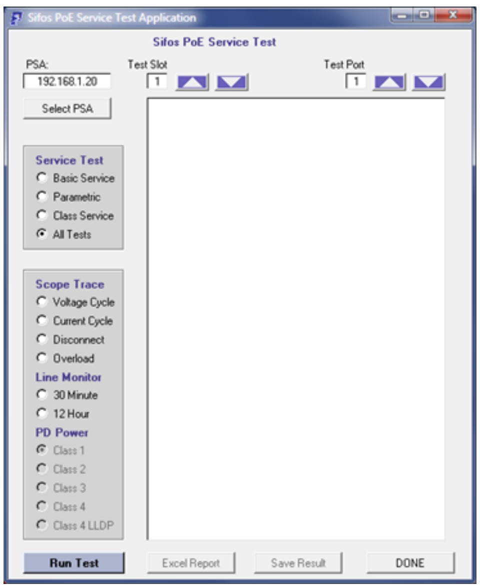


Figure 10.2 PoE Service Test Menu

The PoE Service Test application consists of the three categories described earlier in section 10.1: **Basic Service**, **Parametric** tests, and **Class Service** analysis. Selecting **All Tests** causes all three categories to run. This setting is a requirement to produce the standard spreadsheet report described in section 10.3 below.

Once the Service Test is configured, pressing the Run Test button will cause the testing to start. As testing proceeds, parameters are posted to the results display. Upon completion of the testing, menu controls are re-enabled and all results are displayed (*see **Figure 10.3***). If **All Tests** was selected, the **Excel Report** button will be enabled and may be used to produce the standard test report shown in section 10.3.

Test results may also be stored in an Ascii text file that will be named for according to time and date by pressing the **Save Result** button. This feature is available if any portion of the **Service Test** is run.

The PoE Service Test menu also provides for two other types of analysis of PoE service. The **Line Monitor** and **Scope Trace** features are described in sections 10.4 and 10.5 below.

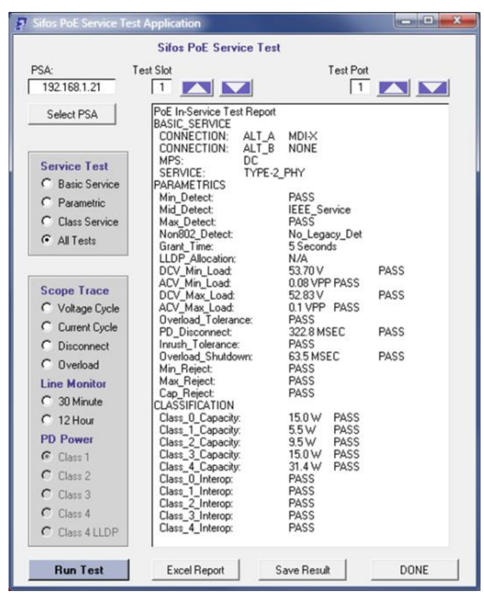
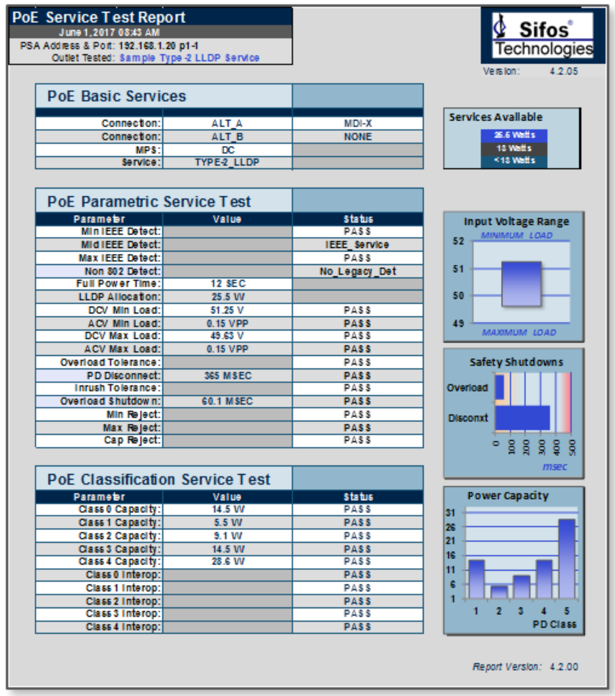


Figure 10.3 Completed Service Test

10.3. PoE Service Test Reporting

The Sifos **PoE Service Analyzer** includes a colorful **Microsoft Excel** Test Report* (*see* ***Figure 10.4***) that can be automatically produced upon completion of the full set of PoE Service Access Tests. In order to produce this report, the full sequence of Service Tests must be completed.


PoE Service Test Report
June 1, 2017 08:43 AM
PSA Address & Port: 192.168.1.20 p1-1
Outlet Tested: Sample Type-2 LLDP Service
Sifos Technologies
Version: 4.2.05

PoE Basic Services

Connection:	ALT_A	MDI-X
Connection:	ALT_B	NONE
MPS:	DC	
Service:	TYPE-2_LLDP	

PoE Parametric Service Test

Parameter	Value	Status
Min IEEE Detect:		PASS
Mid IEEE Detect:		IEEE_Service
Max IEEE Detect:		PASS
Non 802 Detect:		No_Legacy_Det
Full Power Time:	12 SEC	
LLDP Allocation:	25.5 W	
DCV Min Load:	51.25 V	PASS
ACV Min Load:	0.15 VPP	PASS
DCV Max Load:	49.63 V	PASS
ACV Max Load:	0.15 VPP	PASS
Overload Tolerance:		PASS
PD Disconnect:	365 MSEC	PASS
Inrush Tolerance:		PASS
Overload Shutdown:	60.1 MSEC	PASS
Min Reject:		PASS
Max Reject:		PASS
Cap Reject:		PASS

PoE Classification Service Test

Parameter	Value	Status
Class 0 Capacity:	14.5 W	PASS
Class 1 Capacity:	5.5 W	PASS
Class 2 Capacity:	9.1 W	PASS
Class 3 Capacity:	14.5 W	PASS
Class 4 Capacity:	28.6 W	PASS
Class 0 Interop:		PASS
Class 1 Interop:		PASS
Class 2 Interop:		PASS
Class 3 Interop:		PASS
Class 4 Interop:		PASS

Figure 10.4 PoE Service Spreadsheet Report Depicting a Fully Interoperable Class 4 PoE Service

The report header provides the time and date of the testing performed and enables user entry of the test site or outlet location.

The report provides three tabular tables that include results from **PoE Basic Services**, **PoE Parameteric Service** testing, and **PoE Classification Service** analysis. Parameters that should comply to the IEEE 802.3at PoE system specification are notated with **PASS**/**FAIL** indications in these tables.

The **Services Available** graphic indicates the level of PoE service available, that is, 25.5W (Class 4), 13W (Class 3), or <13W (Class 1 or 2). This is based upon PSE capability.

A second graph, **Input Voltage Range**, depicts the PD supply voltage range as a function of PD load power. PD's should receive a minimum of 37V if PSE provides Class 0-3 service and 42.5V if the PSE provides Class 4 service.

The **Safety Shutdowns** graph shows the timing of power removal both in response to a PD disconnect and to a PD power surge or overload. Service should be removed between 300msec and 400msec when a PD is disconnected and between 50msec and 75msec when an overload event occurs.

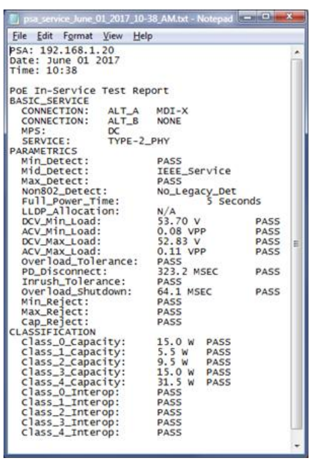
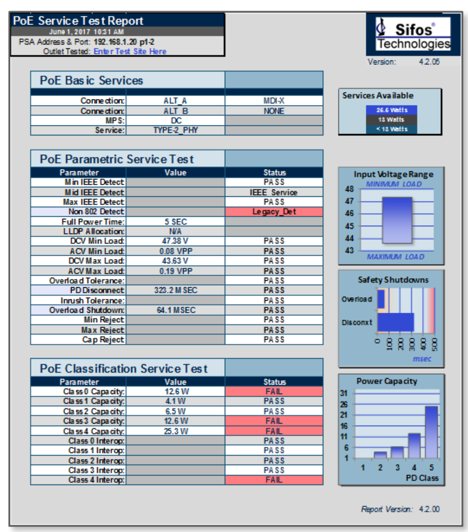

```
psa_service_June_01_2017_10-38_AM.txt - Notepad
File  Edit  Format  View  Help
PSA: 192.168.1.20
Date: June 01 2017
Time: 10:38

PoE In-Service Test Report
BASIC_SERVICE
   CONNECTION:    ALT_A   MDI-X
   CONNECTION:    ALT_B   NONE
   MPS:           DC
   SERVICE:       TYPE-2_PHY
PARAMETRICS
   Min_Detect:            PASS
   Mid_Detect:            IEEE_Service
   Max_Detect:            PASS
   Non802_Detect:         No_Legacy_Det
   Full_Power_Time:               5 Seconds
   LLDP_Allocation:       N/A
   DCV_Min_Load:          53.70 V         PASS
   ACV_Min_Load:          0.08 VPP        PASS
   DCV_Max_Load:          52.83 V         PASS
   ACV_Max_Load:          0.11 VPP        PASS
   Overload_Tolerance:    PASS
   PD_Disconnect:         323.2 MSEC      PASS
   Inrush_Tolerance:      PASS
   Overload_Shutdown:     64.1 MSEC       PASS
   Min_Reject:            PASS
   Max_Reject:            PASS
   Cap_Reject:            PASS
CLASSIFICATION
   Class_0_Capacity:      15.0 W  PASS
   Class_1_Capacity:      5.5 W   PASS
   Class_2_Capacity:      9.5 W   PASS
   Class_3_Capacity:      15.0 W  PASS
   Class_4_Capacity:      31.5 W  PASS
   Class_0_Interop:       PASS
   Class_1_Interop:       PASS
   Class_2_Interop:       PASS
   Class_3_Interop:       PASS
   Class_4_Interop:       PASS
```

Figure 10.5 PoE Service Text File Report

The **Power Capacity** graph charts the power avaible to various PD classifications. The PD Maximum Power Requirements are provided in the table above in section 10.1.

Text reports (*see* ***Figure 10.5***) may also be produced when running all or any subset of the PoE Service Access Tests. These reports are also time-date stamped and carry much of the same information included in the spreadsheet report.

Actual test data and test reports are retained in a Results directory on the host PC. Typically, the directory path will include **\Results\<IP Address>** and is located under **\Users\Public\Sifos\PSA1200** on Windows 10, 8, 7, and Vista computers. On Windows XP computers, the directory path is **\Program Files\Sifos\PSA1200**. See section 3.2.5 for further information on file directory locations.


PoE Service Test Report
June 1, 2017 10:31 AM
PSA Address & Port: 192.168.1.20 p1-2
Outlet Tested: Enter Test Site Here
Sifos Technologies
Version: 4.2.05

PoE Basic Services

Connection:	ALT_A	MDI-X
Connection:	ALT_B	NONE
MPS:	DC	
Service:	TYPE-2_PHY	

PoE Parametric Service Test

Parameter	Value	Status
Min IEEE Detect		PASS
Mid IEEE Detect		IEEE_Service
Max IEEE Detect		PASS
Non 802 Detect		Legacy_Det
Full Power Time:	5 SEC	
LLDP Allocation:	N/A	
DCV Min Load:	47.38 V	PASS
ACV Min Load:	0.08 VPP	PASS
DCV Max Load:	43.63 V	PASS
ACV Max Load:	0.19 VPP	PASS
Overload Tolerance:		PASS
PD Disconnect:	323.2 MSEC	PASS
Inrush Tolerance:		PASS
Overload Shutdown:	64.1 MSEC	PASS
Min Reject		PASS
Max Reject		PASS
Cap Reject		PASS

PoE Classification Service Test

Parameter	Value	Status
Class 0 Capacity:	12.6 W	FAIL
Class 1 Capacity:	4.1 W	PASS
Class 2 Capacity:	6.5 W	PASS
Class 3 Capacity:	12.6 W	FAIL
Class 4 Capacity:	25.3 W	FAIL
Class 0 Interop:		PASS
Class 1 Interop:		PASS
Class 2 Interop:		PASS
Class 3 Interop:		PASS
Class 4 Interop:		FAIL

Figure 10.6 PoE Service Spreadsheet Report, Non-Compliant Service

Figure 10.6 depicts a non-compliant, or marginally interoperable PoE service. This service indicates support for non-802.3at PD types, a feature that might possibly damange non-PD equipment. Additionally, the report indicates a power deficiency for Class 0, 3, and 4 PD's along with an inconsistent classification process with all possible Class 4 signatures. These characteristics may not interfere with the operation of many PD's so the consequence is therefore somewhat unpredictable, that is, it is very dependent on the device that is connected to the service.

* Requires Microsoft Excel 2007 or newer. Reports require the macro security in Excel be disabled for the Service Report (**service_report.xlsm**) template file.

10.4. PoE Intermittent Service Detection

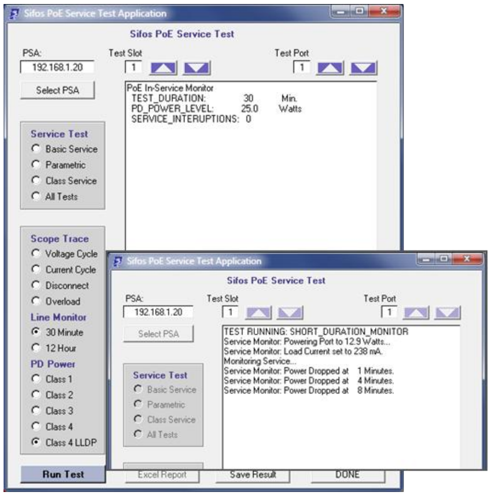
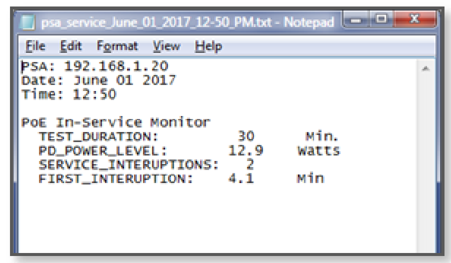


Figure 10.7 PoE Service Line Monitor

The **PoE Service Analyzer** also includes an automated **Line Monitor** designed to capture intermittent service drop-outs. This test may be configured to run with PD **Class 1**, **Class 2**, **Class 3**, or **Class 4** emulation, including **Class 4** with **LLDP**. Users select between a **30 minute** test and a **12 hour** test, though in either case, users have the option to terminate monitoring at any time and recover results. In **Figure 10.7**, the Line Monitor is run for 30 minutes on a **Class 4 LLDP** service with no interruptions to a 25W load, then run again on a different **Class 3** service using a 12.9W load with several interruptions recorded as it runs.

Intermittent Service Detection is sensitive to power drops that are either instantaneous or of longer durations. The test will report a count of observed drops as well as the elapsed time until the first observed service drop-out.

Testing for intermittent PoE service at any test site or outlet can be beneficial both for assessing intermittent connections and for capturing PSE behaviors at a particular outlet when power demands or other intermittent transitions are exceeding total output power capacity across a range of PoE served devices. Line Monitor Test Reports can be saved to a time-date stamped text file (*see **Figure 10.8***) upon test completion.



psa_service_June_01_2017_12-50_PM.txt - Notepad

File Edit Format View Help

```
PSA: 192.168.1.20
Date: June 01 2017
Time: 12:50

PoE In-Service Monitor
  TEST_DURATION:          30     Min.
  PD_POWER_LEVEL:        12.9    Watts
  SERVICE_INTERUPTIONS:   2
  FIRST_INTERUPTION:     4.1     Min
```

Figure 10.8 PoE Line Monitor Report

10.5. Visual PoE Analysis

Another unique feature of the Sifos **PoE Service Analyzer** is the ability to produce **graphical waveforms** of controlled PoE events. These waveforms can be useful for troubleshooting problem behaviors.

Two **Power-Cycle** waveforms (*see **Figure 10.9***) are included to observe the full cycle of an ordinary PoE power-up and PD disconnect power-down captured over a 5 second time interval. One waveform looks at line voltage while the other records electrical current flow. Both can be configured to run with PD **Class 1**, **Class 2**, **Class 3**, or **Class 4** emulation, including **Class 4** with **LLDP**. Users with a moderate understanding of PoE technology can observe and analyze **detection signaling**, **classification signaling**, the **powered line state**, and PSE response to a **PD disconnect**.

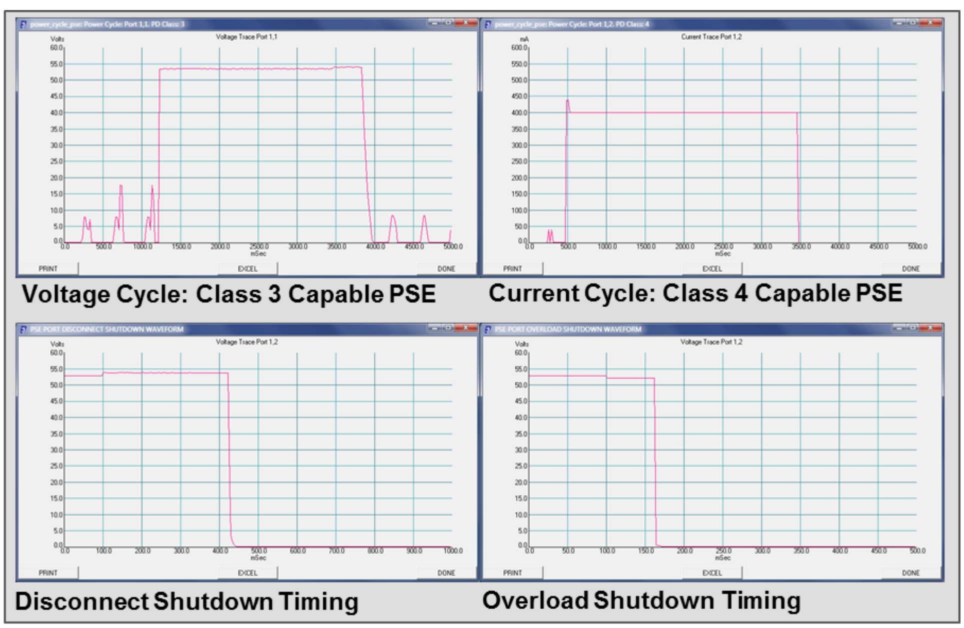


Figure 10.9 PoE Service Analyzer Waveforms

Two additional waveforms available are **Disconnect Shutdown** and **Overload Shutdown** (*see **Figure 10.9***). These waveforms may utilized to visualize the PD service outlet response to either a PD disconnect or a PD transient overload condition. Both conditions should result in power removal in order to prevent damage to network devices when plugged into the service outlet. The disconnect shutdown should occur in approximately a half second while the overload shutdown should occur in less than one tenth of a second, regardless of PD Classification selected.

Following waveform capture, waveforms may be printed or imported to Microsoft Excel for further analysis as shown in **Figure 10.10**.

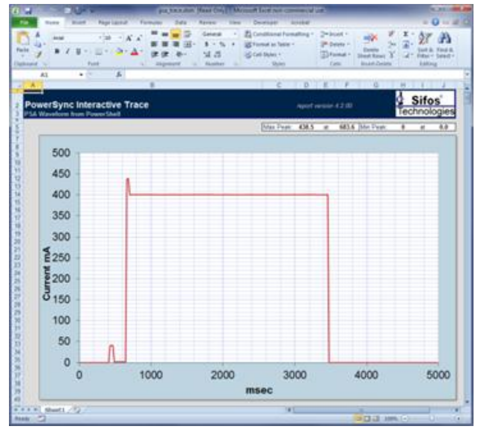


Figure 10.10 Voltage Cycle Waveform - Excel

10.6. Accessing the PoE Service Analyzer from PowerShell

The automated tests for PoE Service and Service Monitoring may also be accessed using commands from PowerShell TCL or PowerShell Wish. These tests do not require any kind of pre-configuration of the PSA test port to the type of PSE servicing the PoE interface. The tests will automatically scan for powered pairs and power polarity.

Utilizing PowerShell can be a significant automation advantage when the PoE Service or Service Monitoring tests are to be automatically run in succession across one or more service outlets without user intervention.

<table>
<tr><th>Command</th><th>Command Parameters</th></tr>
<tr><td rowspan="2">psa_poe_service</td><td><<i>slot,port</i>> <basic | parm | class | all <-s>> <-f> <-v></td></tr>
<tr><td><i>Executes the PoE Service Test application according to user configuration. This test will automatically deliver a spreadsheet report if “all” tests are specified along with the appropriate reporting option.</i>

<<i>slot,port</i>> Specifies the PSA test port. Default is current slot and port.
basic Run only the Basic PoE Service Tests described in Section 10.1 above.
parm Run only the Parametric PoE Service Tests described in Section 10.1 above.
class Run only the Classification Integrity PoE Service Tests described in Section 10.1.
all Run all (basic, parametric, and classification integrity) Tests described in Section 10.1. This is the default mode and must be utilized to generate the spreadsheet report described in Section 10.3 above.
-s Control to produce spreadsheet report shown in Section 10.3.
-f Control to produce a time-date named text file test report. This can be specified whether running all Service Tests or only a subset of Service Tests.
-v Control to run the PoE Service Test in a “verbose” diagnostic mode.</td></tr>
<tr><td rowspan="2">psa_poe_monitor</td><td><<i>slot,port</i>> <1 | 2 | 3> <short | long> <-f></td></tr>
<tr><td><i>Executes the PoE Service Monitor to capture and report on intermittent PoE Service drops.</i>

<<i>slot,port</i>> Specifies the PSA test port. Default is current slot and port.
1 Runs the Service Monitor using a Class 1 PD and associated power load.
2 Runs the Service Monitor using a Class 2 PD and associated power load.
3 Runs the Service Monitor using a Class 3 PD and associated power load.
4 Runs the Service Monitor using a Class 4 PD and associated power load.
lldp Runs the Service Monitor when PoE Class 4 service requires PoE LLDP.
short Specifies to run the Service Monitor over a 30 minute period. This is the default.
long Specifies to run the Service Monitor over a 12 hour period.
-f Control to request a time-date named text file report be generated upon completion of the testing.</td></tr>
</table>