Sifos Technologies

PowerSync Programmable Load

PSL-3000, PSL-3x24

Technical Reference Manual

Version 5.3

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Sifos® Technologies

Sifos Technologies, Inc.
(978) 640-4900 Phone
(978) 640-4990 FAX

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1. Introduction

1.1. PowerSync PL Introduction

The PowerSync Programmable Load (PSL-3000) is designed to enable basic testing and stressing of IEEE 802.3at and 802.3bt Power-over-Ethernet (PoE) Power Sourcing Equipment (PSE). The PSL-3000 exists in 2 different configurations:

PSL-3000

- One PowerSync Programmable Load Chassis and PSL Controller Card (Slot 0)
- One to twelve PSL-3202 or PSL-3102 Dual Port PSE (Power Sourcing Equipment) Load Modules with capability to test from 2 to 24 PSE ports.
- PowerSync Programmable Load Software (Version 5.0 or later) for a host PC including PSA Interactive graphical user interface and PowerShell PSA interactive scripting console.
- Optional PSE Multi-Port Suite: Live PD Emulation and the PSE Multi-Port Test Suite
- Optional PoE LLDP (PSE and PD) Emulation

PSL-3224
(PSL-3202 blades)

PSL-3024
(PSL-3102 blades)

- One PowerSync Programmable Load Chassis and PSL Controller Card (Slot 0)
- 12 PSL-3202 or PSL-3102 Dual Port PSE (Power Sourcing Equipment) Test Modules with capability to test 24 PSE ports.
- PowerSync Programmable Load Software (Version 5.0 or later) for a host PC including PowerShell PSA interactive scripting console.
- Optional PSE Multi-Port Suite: Live PD Emulation and the PSE Multi-Port Test Suite
- Optional PoE LLDP (PSE and PD) Emulation

Each PSL-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. PSL-3000 test ports also offer capability to terminate Ethernet links with an ability to emulate Link Layer Discovery Protocol (**LLDP**) messaging from an LLDP-capable Powered Device.

The PowerSync Programmable Load is controlled from a PC over a TCP/IP network connection (10/100BaseT). Multiple PSL-3000 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 basic PSE measurement functions.

The PSL-3000 and PSL-3024 represent the entry level to a family of PowerSync Analyzers from Sifos Technologies. The PowerSync Analyzer 3000 (PSA-3000) extends the testing and analysis capabilities of the PSL-3000 with many features useful for fully and automatically qualifying PSE ports to the 802.3at standard and troubleshooting PSE ports that fall short of the 802.3at standard.

1.2. Reference Manual Organization

Section 2 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 Programmable Load instrument capabilities and basic hardware resources. Additionally, Section 3 will provide an overview of the PSL-3000's software organization. An understanding of these resources will support more intuitive usage of PSL-3000 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 and Programmable Load instruments. 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 PSL-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 (*Omitted for PSL-3000*)

Section 7 provides an overview of the **802.3at PSE Multi-Port Suite** including the PSL-3000's unique **PSE Multi-Port Test Suite** and **Multi-Port Live PD Emulation**. All PSL-3000 Multi-Port features are designed to support simultaneous and sequential Powered Device emulations across up to eight PSL-3000 chassis' and up to 192 802.3at compliant PSE ports. **Multi-Port Live PD Emulation** enables PSL-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
- 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 PSL-3000 **PoE LLDP Emulation and Testing** Capabilities available from PSA software. The PSL-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.

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 can combine with the PSL-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.

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.

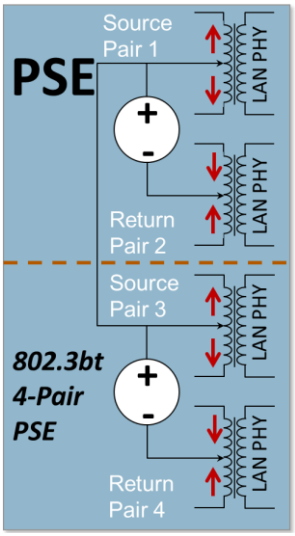


Figure 2.1 PSE Connection

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

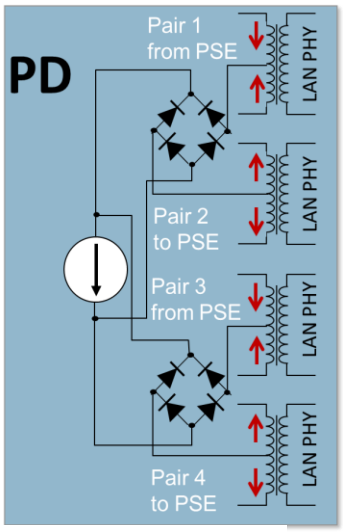


Figure 2.2 PD Connection

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.

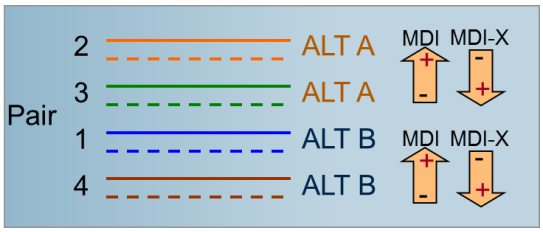


Figure 2.3 PSE Pairsets

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

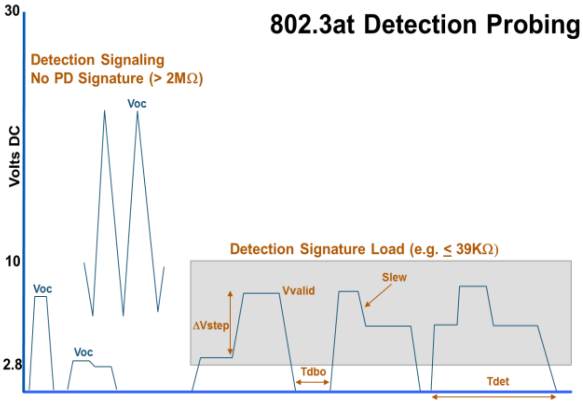


Figure 2.4 802.3 PoE Detection

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.

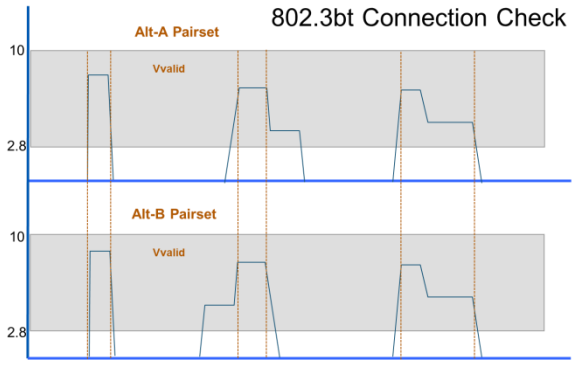


Figure 2.5 802.3bt Connection Check

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.

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

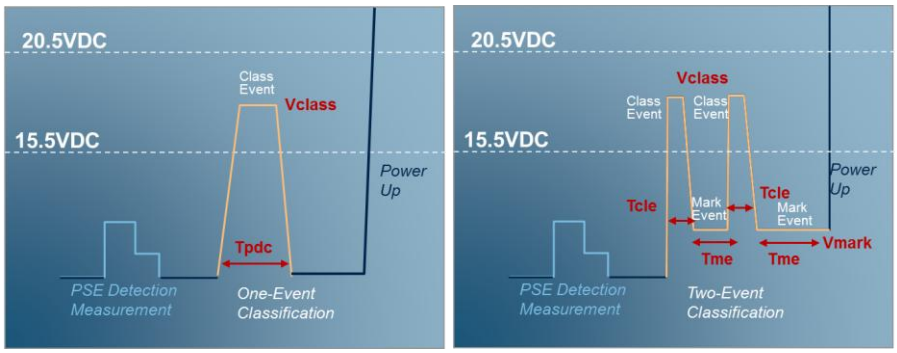


Figure 2.6 PD Classification under the **802.3at** Specification

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.

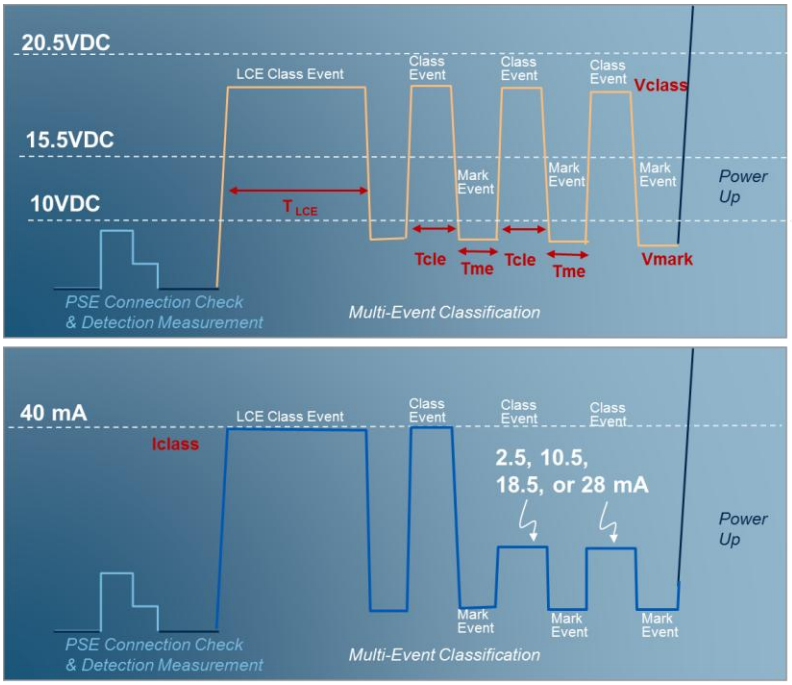


Figure 2.7 PD Classification under the 802.3bt Specification

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.

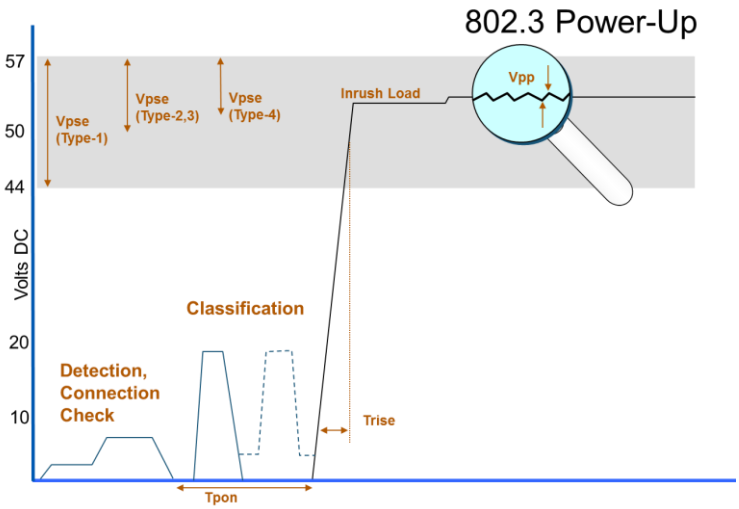


Figure 2.8 802.3 Power-Up

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. 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.

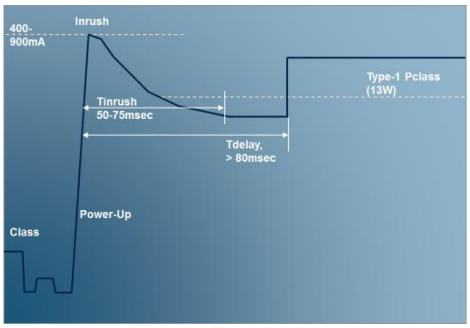


Figure 2.9 PD Inrush and Power Delay

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.

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.

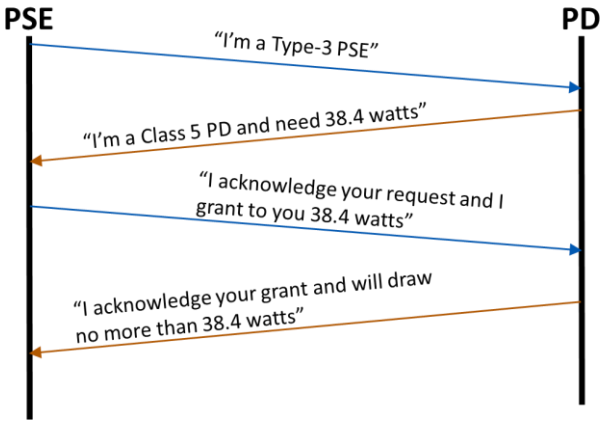


Figure 2.10 PoE LLDP Dialog/Negotiation

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:

[4]

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.

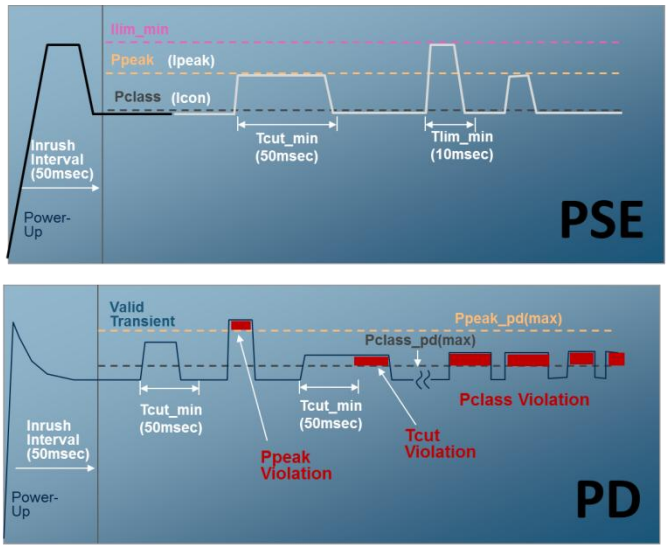


Figure 2.11 Power Regulation and PD Overloads

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.

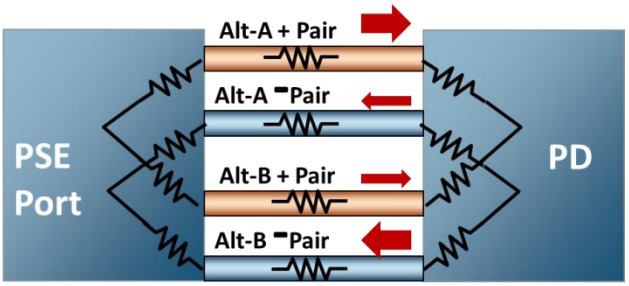


Figure 2.11 Pair-to-Pair Current Unbalance

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.

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

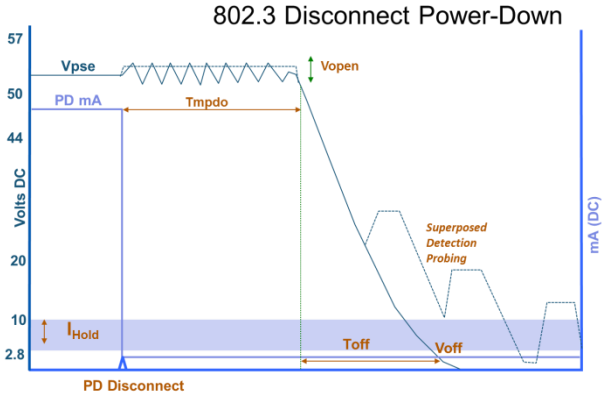


Figure 2.12 802.3 PoE Disconnect Power-Down

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 ($\mathbf{I_{HOLD}}$) 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 $\mathbf{I_{HOLD}}$ 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.

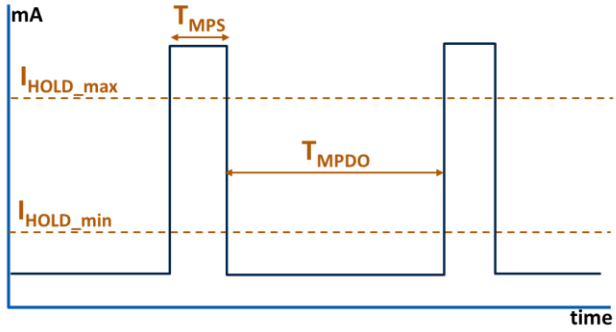


Figure 2.13 DC MPS Minimum Power State

Under 802.3at, the maximum $\mathbf{I_{HOLD}}$ 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, $\mathbf{I_{HOLD}}$, need not be present continuously. In **Figure 2.13**, the PD load current is show to exceed the maximum $\mathbf{I_{HOLD}}$ level for a period of $\mathbf{T_{MPS}}$. Between $\mathbf{T_{MPS}}$ intervals, the PD load current can drop all the way to 0mA for a maximum period of $\mathbf{T_{MPDO}}$ (min). This produces a duty cycle of $\mathbf{T_{MPS}}$ / ($\mathbf{T_{MPS}}$ + $\mathbf{T_{MPDO}}$ (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 $\mathbf{I_{HOLD}}$, $\mathbf{T_{MPS}}$, and $\mathbf{T_{MPDO}}$ 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 Programmable Load

3.1. System Hardware Overview

Figure 3.1 shows a block diagram of a single PowerSync Programmable Load test port. Each PSL-3x02 card contains two of these measurement circuits, which are electrically isolated from each other and from the chassis control circuitry.

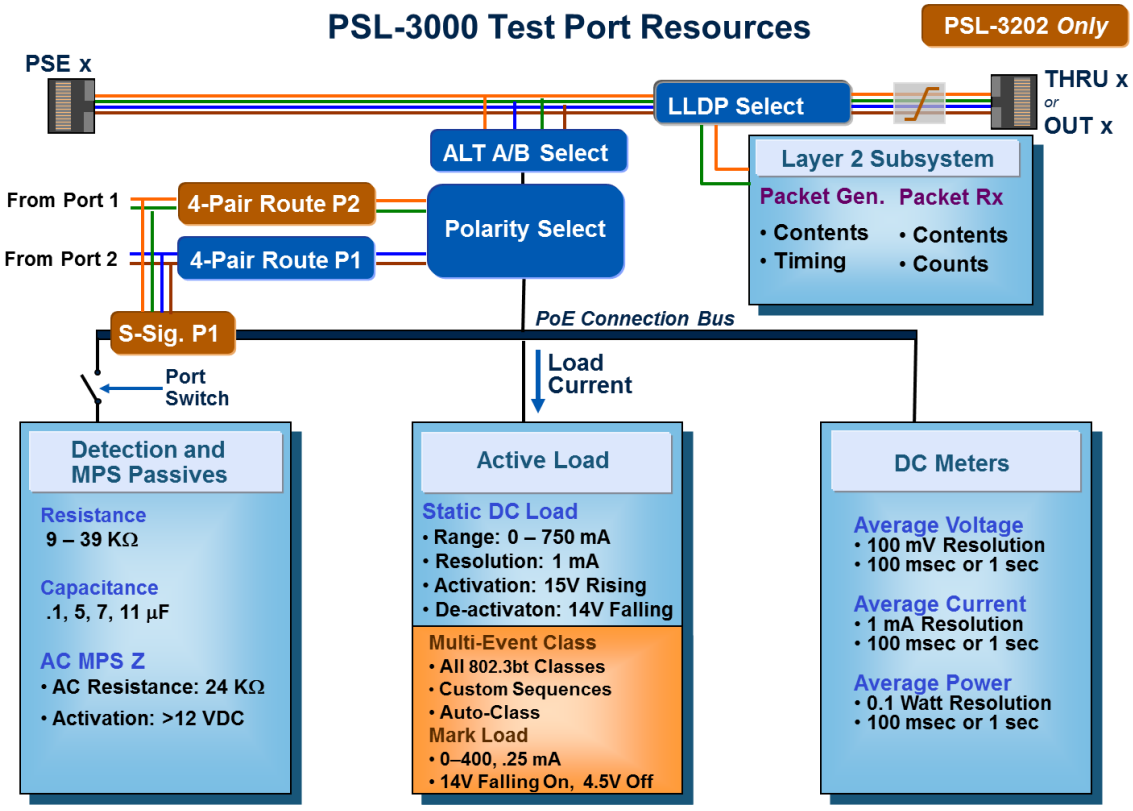


Figure 3.1 PSL-3000 Load Port Resources

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. **PSL-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 equipment being tested. Incorrect settings of either switch will not damage the instrument.

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

3.1.1. Port Switch and Detection Section

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 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 PSL-3000, this switch is typically in the open (or "isolated") position. This switch closes and opens under software control. 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.

PSL-3202 load blades 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 PSL-3102's where only **Dual Signatures** can be emulated given a 4-Pair PSE connection.*

3.1.2. (Omitted for PSL-3000)

3.1.3. Active Load

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.

In PSL-3202's, 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 4.5 VDC. This state machine behavior is depicted in **Figure 3.2**. *PSL-**3102** load blades do not include the transition band, and therefore they transition from Load On state to Load Off state given the 14V Falling voltage edge.*

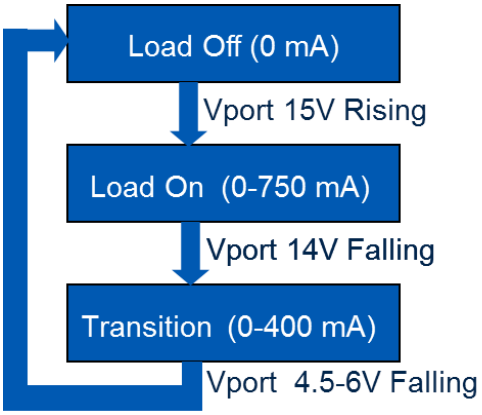


Figure 3.2 PSL-3202 Active Load State Behavior

The active load is used for both classification and power-up states of PSE ports. The **Static DC Load** has a programmable range from 0 through 950 mA (*750mA in PSL-3102's*), in 1.0 mA steps.

There is no limit on the number of ports or total load programmed in every port of the PSL-3000. From a heating perspective, the PSL-3000 is designed to withstand up to 50 watts of continuous loading on up to 24 test ports in a single chassis.

The active DC load can be rapidly adjusted by software script commands at a rate approximating 10 or more changes per second. Simple scripting commands also enable loads to be adjusted in a similar manner across all test ports in a chassis at essentially the same time.

3.1.4. 802.3bt Multi-Event Class Signatures

PSL-3202 load 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 de-bounce 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** functions are capable of measuring average PSE port voltage and sensing actual DC load currents. Both voltage and current measurement may be done with selectable averaging period of 100 msec or 1 second. The DC Metering also can report DC average power.

Voltage measurements may be made over the range of 0 to 60 Volts with 0.1 Volt resolution. Current measurements can be made over the range of 0 to 1000 mA with 1.0 mA resolution.

Measurements are made on one port at a time, though with simple scripting loops, all ports can be scanned relatively rapidly (approximately 4 measurements per second at the 100 msec averaging period).

3.1.6. (Omitted for PSL-3000)

3.1.7. (Omitted for PSL-3000)

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 PSL-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*****.

***** **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 PSL-3000 instrument.

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.

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.

PoE LLDP Emulation & Analysis: A set of applications and tools that enable LLDP level communications with an LLDP-capable PSE and analyze PSE LLDP conformance to 802.3 and 802.1 protocol rules.

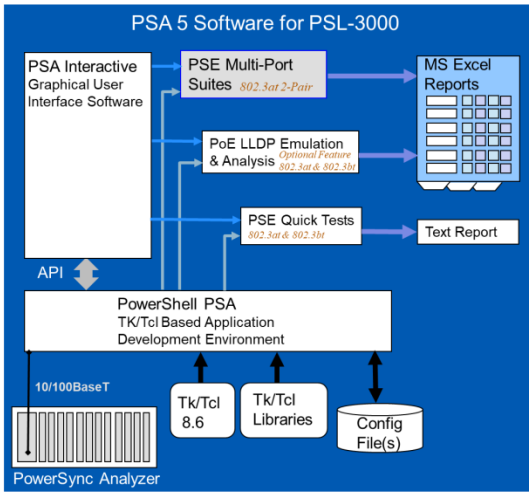


Figure 3.3 PSA Host Software Architecture

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 Programmable Load functions. It is intended for users who intermittently or regularly use the PowerSync Programmable Load for PD emulation (*including LLDP*), PSE measurements, and PSE Multi-Port testing.

3.2.2. PowerShell PSA Scripting Environment

PowerShell PSA provides command level access to the PowerSync Programmable Load. It consists of the full Tcl/Tk programming shells (Tcl and Wish) combined with numerous extensions specific to the PowerSync Programmable Load 3000.

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. 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/Tk and PowerShell command words 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 program will automatically integrate all of PowerShell's resources.

Many test engineers will want to integrate PowerShell API into pre-existing script environments to support test automation involving several instruments including DUT control interaction. Sections 9.3 - 9.4 of this manual addresses PowerShell features designed to enable this possibility.

3.2.3. PSE Multi-Port Suite

The **PSE Multi-Port Suite** (including **Multi-Port Live PD Emulation** and **PSE Multi-Port Test Suite**) is an optional feature of the PSL-3000 (including PSL-3x24) that enables powerful and flexible PD simulations and PSE system analysis across as many as 192 PSE ports. The PSE Multi-Port Test Suite consists of 16 tests (9 tests in the PSL-3000) that automatically analyze PSE system powering characteristics including bulk power-on, power-down, and overload processing characteristics as well as power management, power capacity, and stress test behaviors. Each test returns a

variety of multi-port statistics and offers the capability to generate detailed logs of PSE port interactions and timing behaviors.

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 "local" 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** or **PROP4**	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_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 Multi-Port testing.

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_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 **mp_sequence** can optionally further specify a sequence-specific reporting directory by placing a short extension on this setting (*see section 5.20.4*).

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 detail regarding files and file locations after PSA software installation is completed.

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)*

Directory Path	Directory	Files
$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 and 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 Programmable Load 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 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 50 msec** with a target range of **0 to 20 msec desirable**. The same applies to process preemption delays. This will best enable the full flexibility and features of the PowerSync Programmable Load 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. (Section Omitted)

3.5. 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: ***PSL-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: ***PSL-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 to RJ-45 Shield	Maximum Input Voltage	±60 VDC

3.5.3. Detection and AC MPS Specifications

Description	Conditions	Parameter	Specification
Detection Resistance	Vport = 2.5 VDC – 12 VDC, Port Connected	Range	9 KΩ to 39 KΩ
		Resolution	1 KΩ
		Accuracy vs Setting ΔV / ΔI at 4.5 Volt Spacing	±1.75% + 300Ω
Detection Capacitance	Vport = 2.5 VDC – 12 VDC, Port Connected	Range	0.14, 5, 7, 11μF
		Accuracy	±15%
Detection Signature Cut-Off Threshold	Port Connected	Vport	12V ± 2%
AC MPS Signature	Vport = 12 VDC – 60 VDC, Port Connected	AC Impedance	24KΩ ‖ (0.1μF + 330Ω)
		Resistance Accuracy ΔV / ΔI 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	PSL-3202: 0 to 950 mA PSL-3102: 0 to 750 mA
		Resolution	1.00 mA
		Accuracy	± (0.5% setting + 1.0mA)
		Slew Rates	> 4mA / µsec
		Activation Voltage	15V, Rising Vport
		De-Activation Voltage	14V, Falling Vport
Transition (Mark Region) Current ***PSL-3202 Only***	Load Current Active, Per Powered Pair	Range	0 to 400 mA
		Resolution	0.25 mA
		Accuracy	± (0.5% setting + 0.25mA)
		Slew Rates	> 4mA / µsec
		Activation Voltage	14V, Falling Vport
		De-Activation Voltage	4.5V, Falling Vport
Multi-Event Classification ***PSL-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 (*Event N changes to static load*)	100 msec @ > 15V
		Event Start Glitch De-bounce	150msec
		Mark and Idle Transition Glitch De-bounce	500msec
		Event Reset Condition	4.5V for > 500msec

3.5.5. DC Metering Specifications

Description	Conditions	Parameter	Specification
Voltage Meter	Average	Voltage Range	0 - 60V
		Sample Averaging	256 Samples
		Sample Rate (100 msec Period) Sample Rate (1 sec Period)	390 msec 3.9 msec
		Resolution	100 mV
		Accuracy[1]	± (2% reading +100mV)
Current Meter	Average	Current Range	0 – 1000 mA / pairset
		Sample Averaging	256 Samples
		Sample Rate (100 msec Period) Sample Rate (1 sec Period)	390 msec 3.9 msec
		Resolution	1.00 mA
		Accuracy[2]	± (2% reading + 1.0mA)

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.

3.5.6. 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

3.5.7. Front Panel PSL-3102 LED Indicators

LED Label	Parameter	Description
DET	Detection Enabled	**ON:** Valid Detection Signature Connected (R= 19 to 26 KΩ, C= 0μF) AND Port Switch Connected with LLDP Disconnected Normally Off **BLINKING:** LLDP connected but NOT LINKED Normally On **BLINKING:** LLDP connected and LINKED **OFF**: (Port Switch Open OR Invalid PD Signature) AND LLDP Disconnected
PWR	PSE Power On	**ON**: Indicates Power-Up with Vport > 36 VDC **OFF**: Vport < 36 VDC
ARM	*(LED Not Utilized)*	**OFF:**
AUX	Communications	**ON** or **BLINKING:** Indicates Communications to PSA Test Port

3.5.8. Programming and Control

Description	Specification
Interface	Ethernet 10/100BaseT
Host Requirements	PC running Microsoft Windows XP, Vista, 7, 8, 10, or Linux PC (Fedora, SUSE, Debian)
Control Environment	Sifos PowerShell PSA or PSA Interactive-PL
Network/Run-Time Latency:	< 20 msec (*See Section 3.3*)

3.5.9. 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 PSL-3x02 Cards)
Power	100VAC-240VAC, 50-60 Hz, 1.35A Max.
Ambient Operating Temperature	0°C to 40°C (≤ 100W combined PoE loading per test blade or 50W per test port)
Storage Temperature	-20°C to 85°C
Operating Humidity	5% to 95% RH, Non-Condensing.

3.5.10. 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.

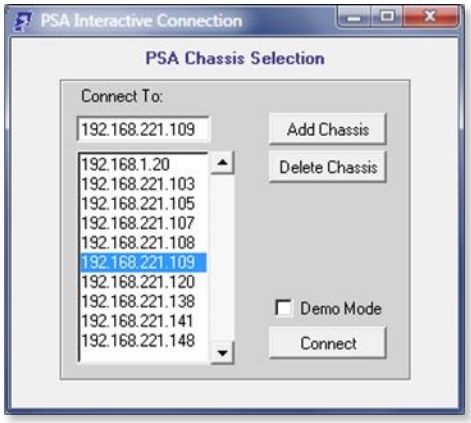


Figure 4.1 PSA Connection Dialog

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*.

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***)

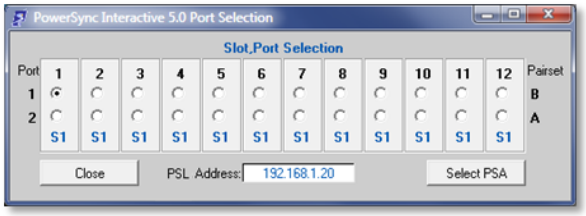


Figure 4.2 PSA Interactive Slot-Port Panel

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.

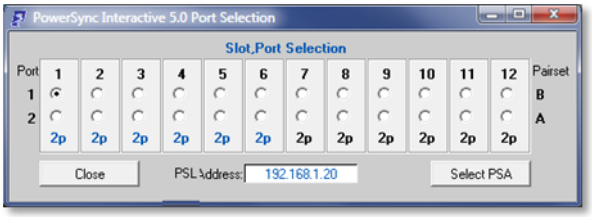


Figure 4.4 Hybrid Configuration PSA Instrument

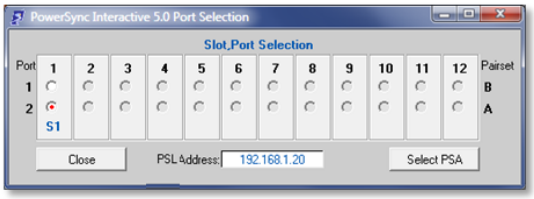


Figure 4.5 Selecting Disconnected 4-Pair Port

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***).

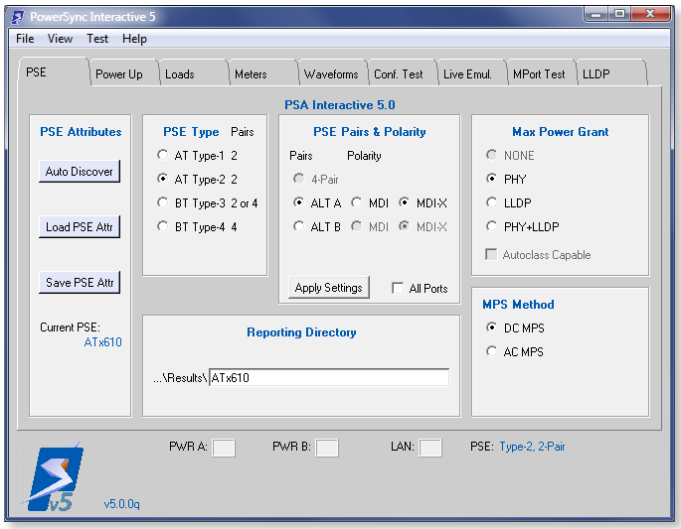


Figure 4.6 PSE Tab Menu

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.

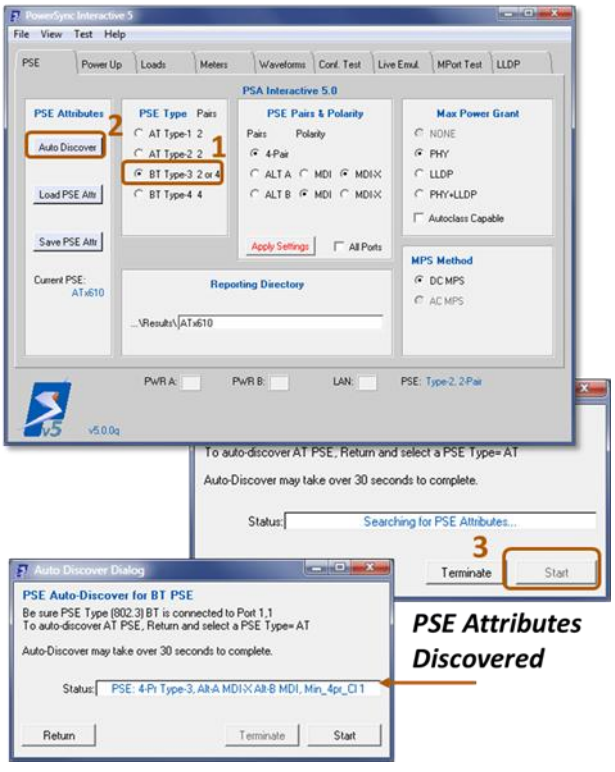


Figure 4.7 PSE Attributes Auto-Discovery

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 would cause a re-selection.

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

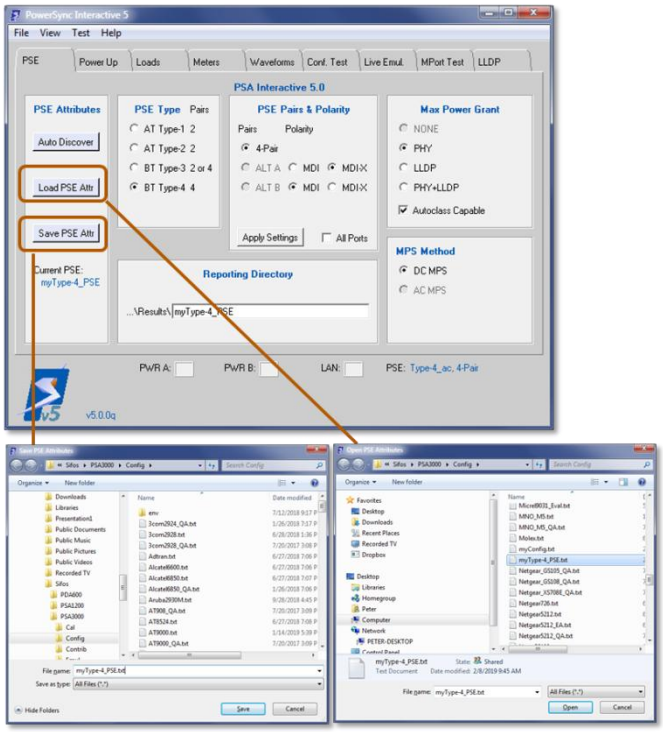


Figure 4.8 Saving and Loading PSE Attributes

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.

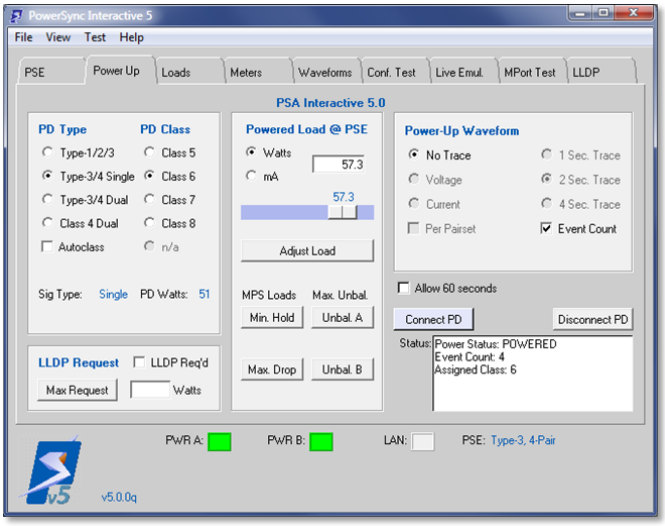


Figure 4.9 The Power-Up Tab Menu: Class 6 PD Emulation

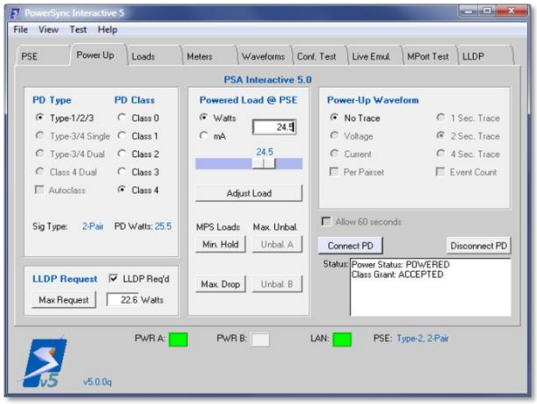


Figure 4.10 2-Pair Power-Up of Class 4 PSE

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*).

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**.

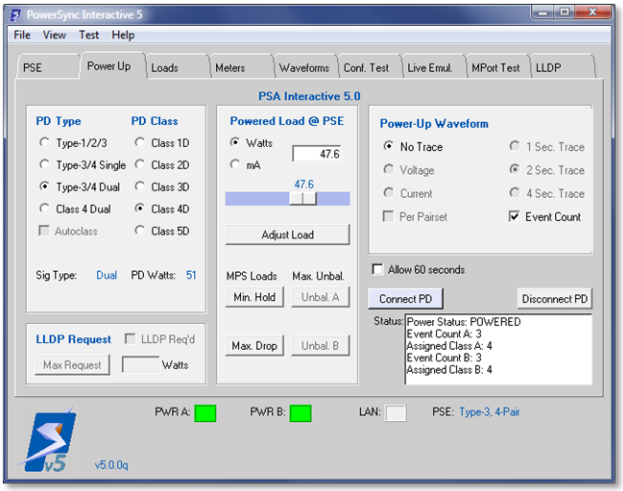


Figure 4.11 Power-Up of 802.3bt Dual (Class 4) Signature PD

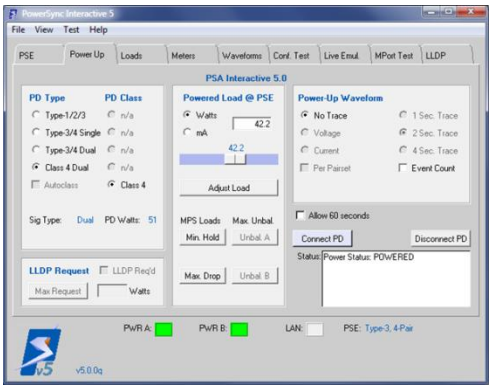


Figure 4.12 Power-Up of Pre-Standard 4-Pair PD

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.

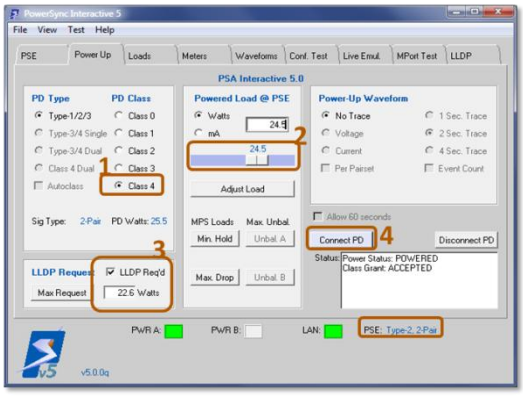


Figure 4.13 LLDP Power-Up of Emulated Class 4 PD

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.

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 (*Not available to PSL-3000 instruments*)	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.

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.

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.

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.

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.

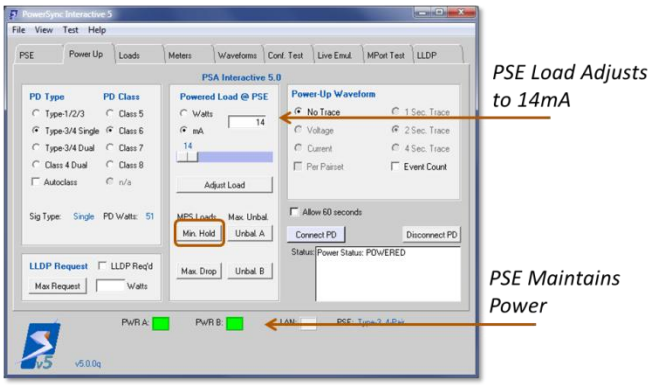


Figure 4.18 Maximum Hold Current Load

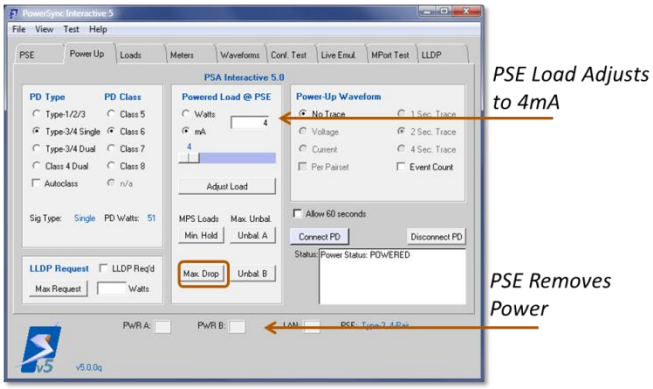


Figure 4.19 Minimum Drop Current Load

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.

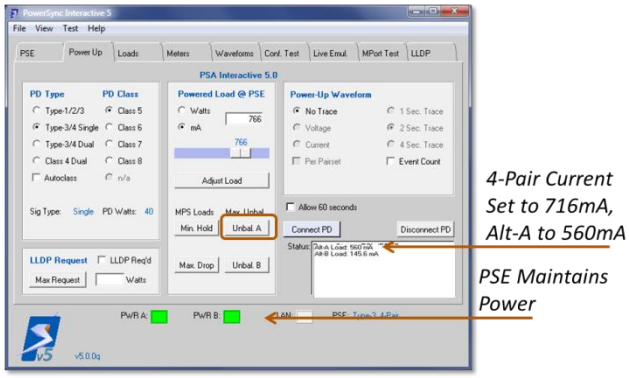


Figure 4.20 Alt A Maximum Unbalance Current

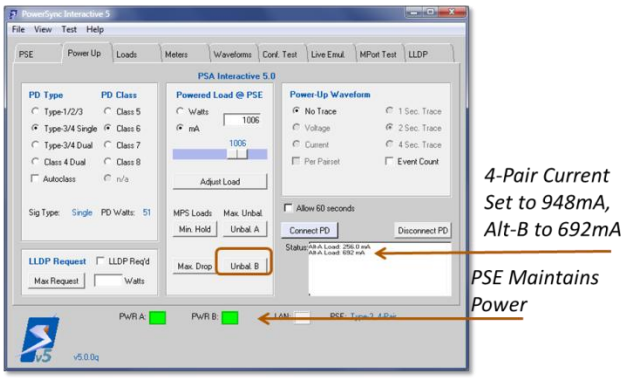


Figure 4.22 Alt B Maximum Unbalance Current

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 (*Not available with PSL-3000 instruments.*)

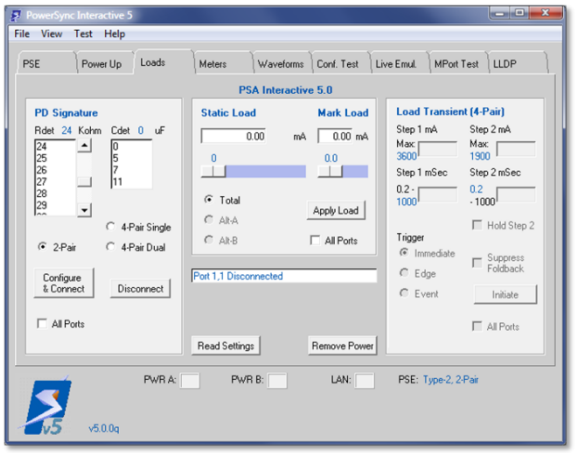


Figure 4.23 The Loads Tab Menu

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.

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.

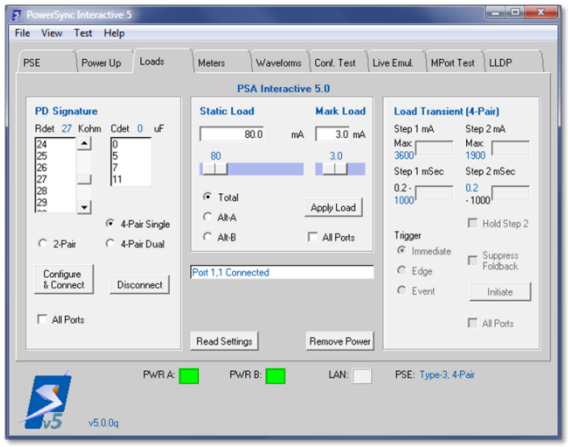


Figure 4.24 Class 4 Power-Up, 27KΩ Single Signature

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, 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.

4.5. 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. For the PSL-3000 instrument, the only metering resources supported are the DC Voltage, Current, and Power meters.

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.

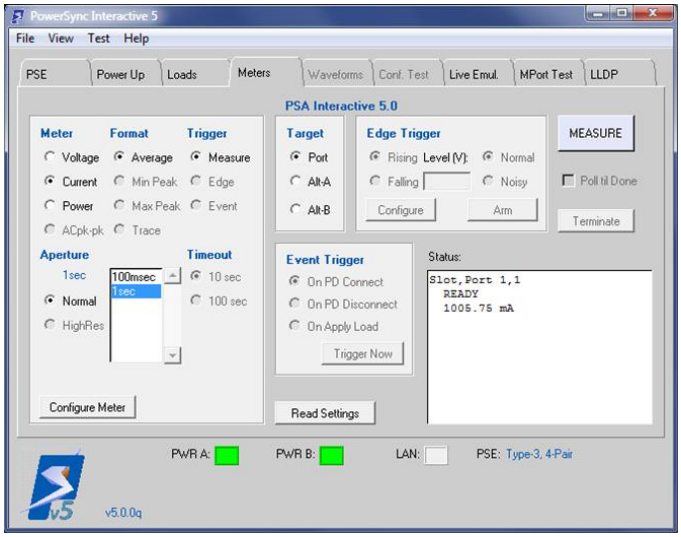


Figure 4.26 The Meters Tab Menu

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 three meter types that can be selected:

1. DC Voltage
2. DC Current
3. DC Power

With **PSL-3000** instruments, the only **Format** available for each meter is **Average** and the only **Trigger** option available is **Measure**, that is, immediate triggering when the **MEASURE** button is pressed. All three meters offer two **Aperture**, or averaging time options: **100msec** or **1sec**.

The meter type frame also includes a **Configure Meter** button. This can be used to apply the presently selected **Aperture** setting to the presently selected meter type (**Voltage**, **Current**, or **Power**) 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

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 Aperture setting meaning there is no need to press the **Configure Meter** button when the Aperture is altered prior to a measurement being performed.

4.5.3. (Omitted for PSL-3000)

4.5.4. (Omitted for PSL-3000)

4.5.5. (Omitted for PSL-3000)

4.6. The Waveforms Tab Menu

The **Waveforms** tab menu is not available to PSL-3000 instruments and will be disabled.

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.

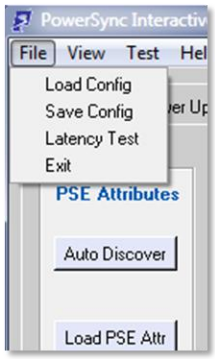


Figure 4.50 File Menu

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. While of greater importance to PSA-3000 instruments, severe LAN latency issues could possibly interfere with PSE Multi-Port testing performed by PSL-3000 instruments (*see section 3.3*).

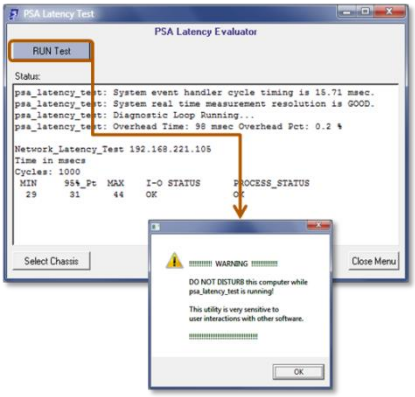


Figure 4.51 Latency Test

4.7.2. View Drop-Down Menu

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

1. Trace Colors
2. Wish On/Off

Figure 4.52 View Menu

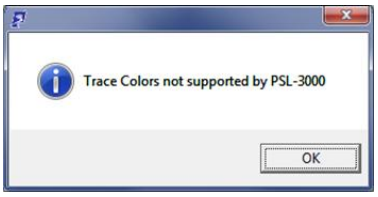


Figure 4.53 Trace Colors

The **Trace Colors** option pertains only to PSA-3000 instruments and will produce a message to this effect when connected to a PSL-3000 (*see **Figure 4.53***).

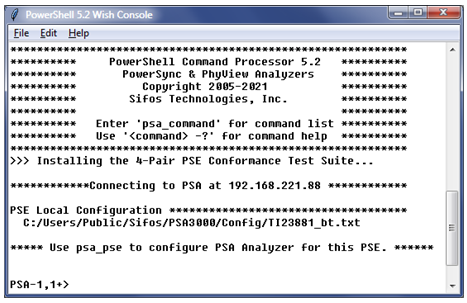


Figure 4.54 Wish Console

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.

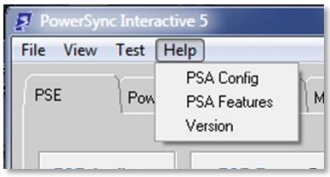


Figure 4.55 Help Menu

4.7.3. Help Drop-Down Menu

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

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.)

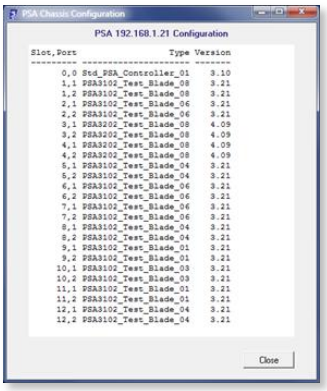


Figure 4.56 PSA Config

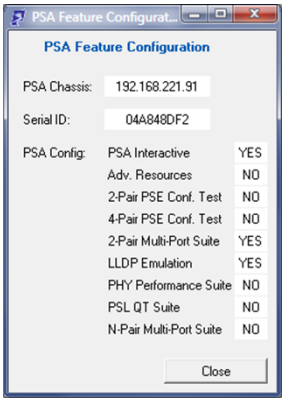


Figure 4.57 PSA Features

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	(*Pertinent to PSA-3000 instruments only*)
PSE 4Pr Conformance Suite	(*Pertinent to PSA-3000 instruments only*)
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.

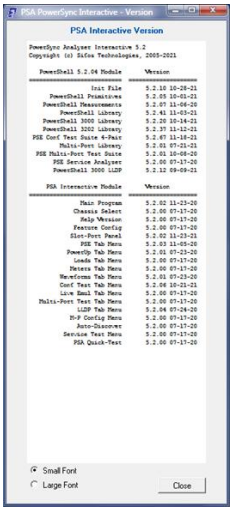


Figure 4.58 Version

4.7.4. Test Drop-Down Menu

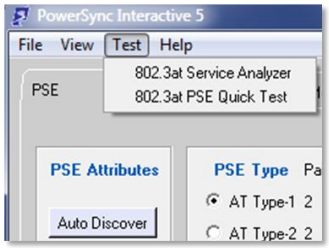


Figure 4.59 Test Menu

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.

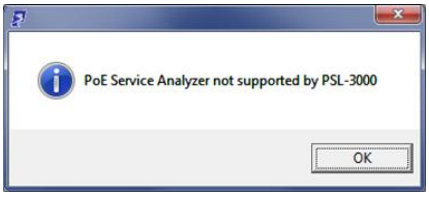


Figure 4.60 Service Analyzer

The first application, the **802.3at Service Analyzer**, is only available to PSA-3000 instruments so a message to this effect will be produced (*see **Figure 4.60***).

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 **802.3at PSE Quick Test** menu (*see **Figure 4.61***) accesses the PSL 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 PSL 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 given PD disconnects
Overloads	Verify that each PSE port removes power given 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, PSL 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.

The **psl_quick_test** script for PowerShell PSA is provided as source code that users may modify (*see section 5.14*). The file is located

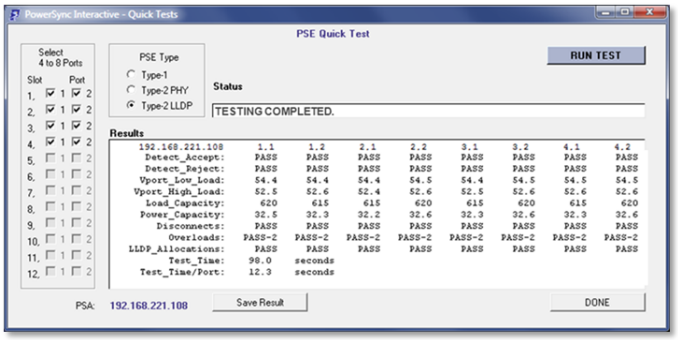


Figure 4.61 PSA Quick Test Menu

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. 802.3at PSE Conformance Test Menu

The **Conf Test** tab menu is not available to PSL-3000 instruments and will be disabled.

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.

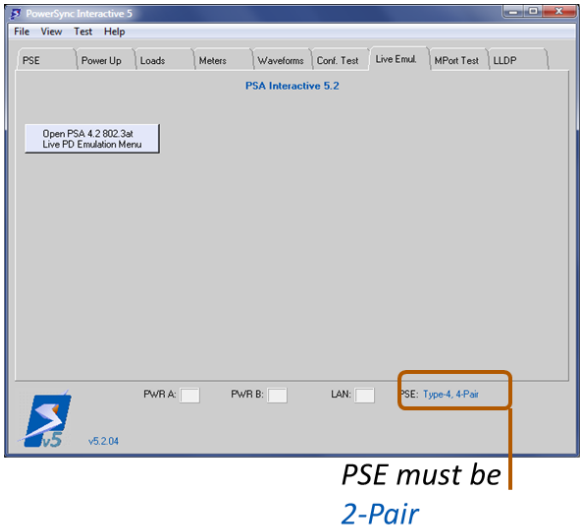


Figure 4.75 Live PD Emulation Tab Menu

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 5.20.1*)

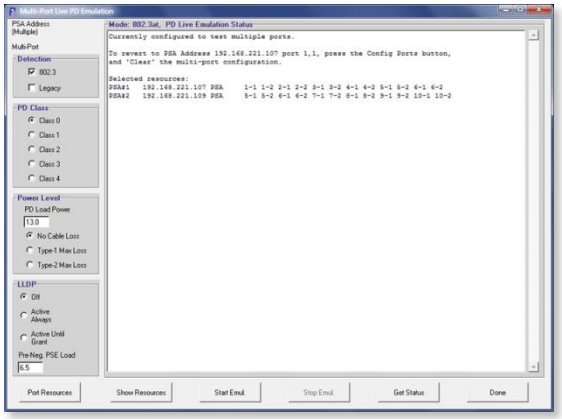


Figure 4.76 Multi-Port Live PD Emulation Menu

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 8 ports from a first PSL-3000 and 8 additional ports from a second PSL-3000.

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.

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.

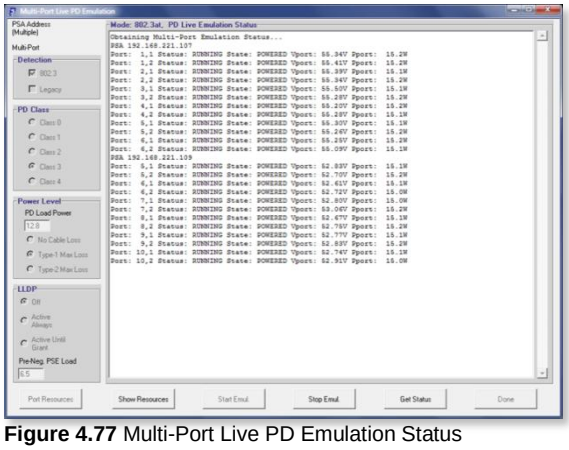


Figure 4.77 Multi-Port Live PD Emulation Status

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 4.78**)* 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 0 to 7.6.

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.

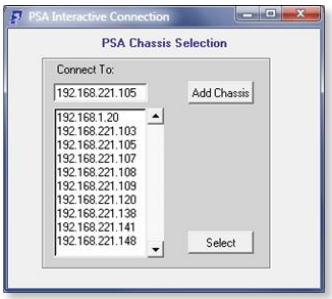


Figure 4.78 Multi-Port Chassis Select

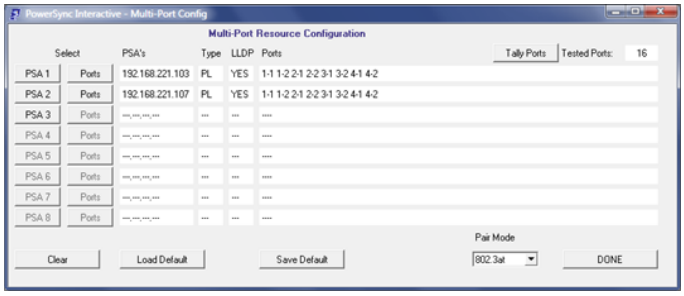


Figure 4.79 Multi-Porzt Test Field Configuration Menu

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 4.79**)* 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.

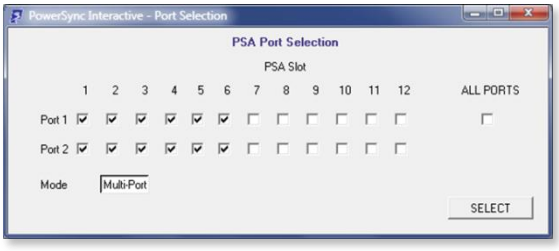


Figure 4.80 Multi-Port Port Select Dialog

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.

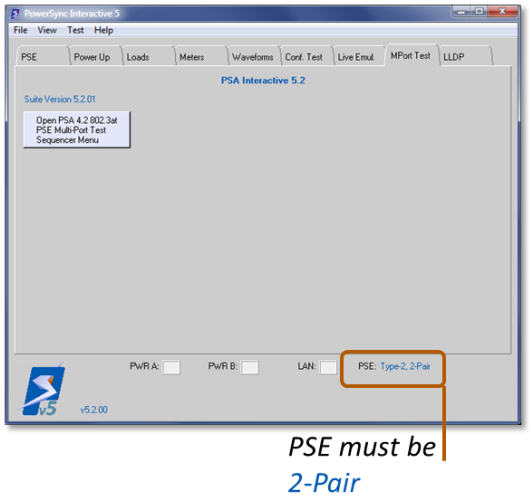


Figure 4.85 Live PD Emulation Tab Menu

Because the only test suite supported by PSA Interactive at this point in time is the **802.3at** Multi-Port Suite, access to the 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. 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 PSL-3000 (and/or PSA-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**)* enables the automated sequencing of selected or all Multi-Port tests and automated generation of a standard Microsoft Excel spreadsheet or text file report.

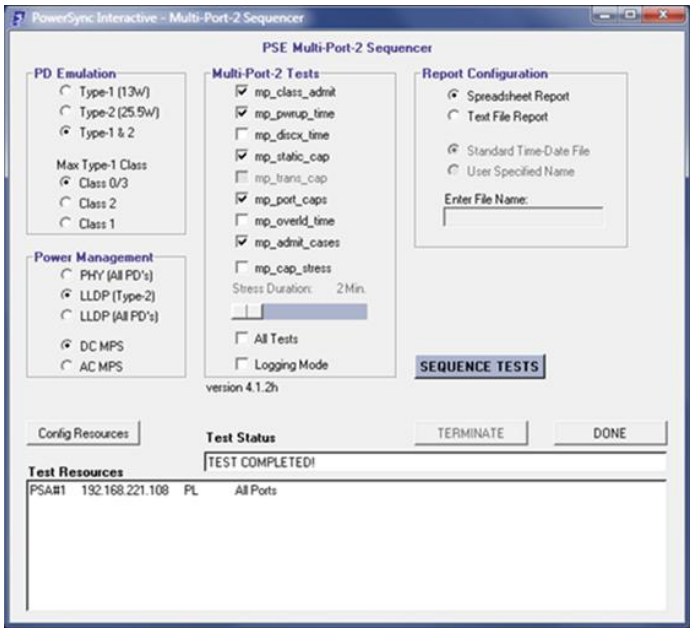


Figure 4.86 Multi-Port Test Sequencer Menu

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-3000/PSL-3000 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.

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_trans_cap** test is supported only by the PSA-3000 and is not available for the PSL-3000.

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.

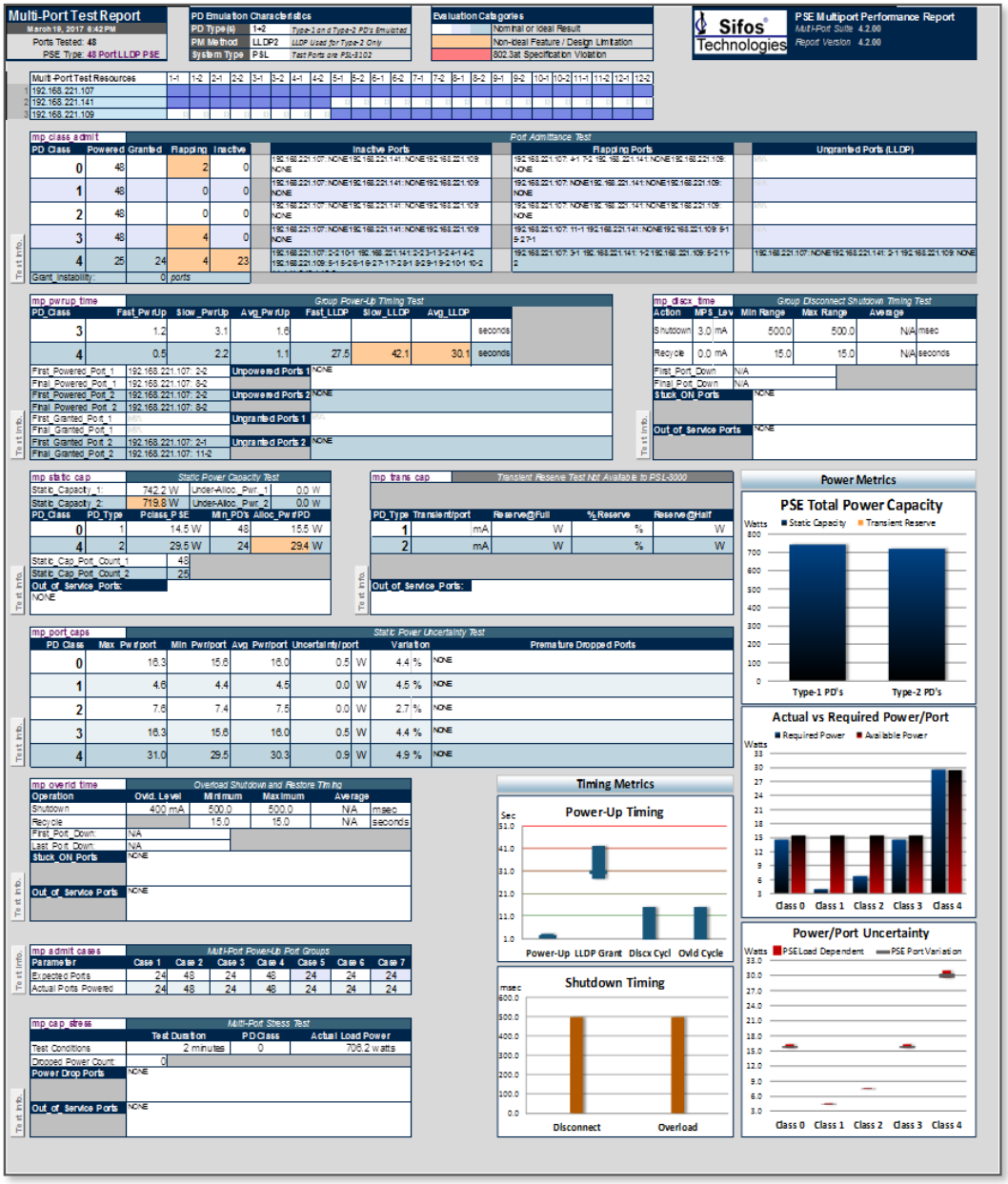


Figure 4.87 Multi-Port Standard Pop-Up Spreadsheet Report

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 0 - 7.6 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.

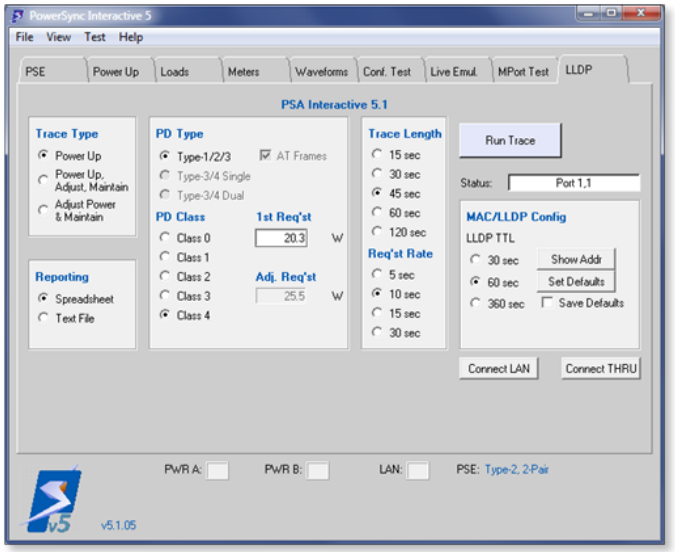


Figure 4.92 LLDP Tab Menu

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. 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 will 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.

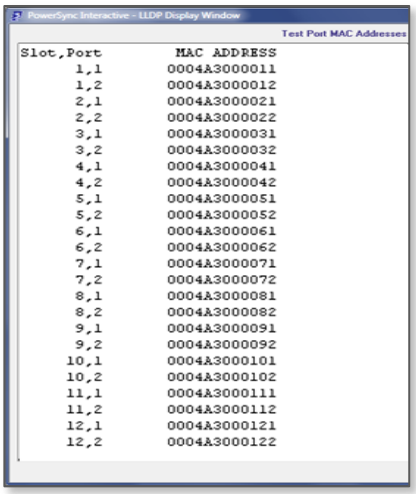


Figure 4.93 Default PSA Test Port MAC Addresses

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***).

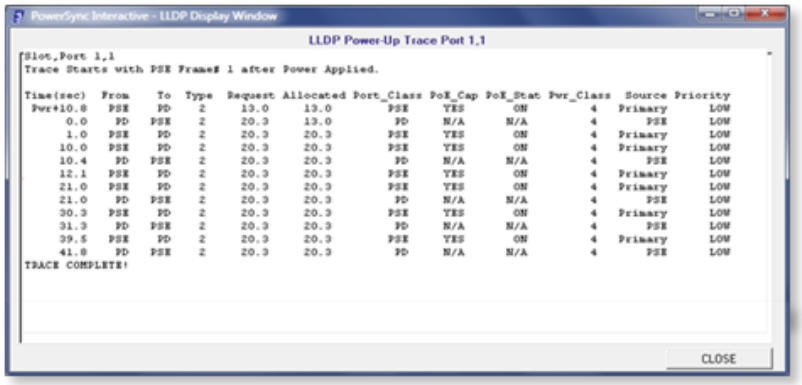
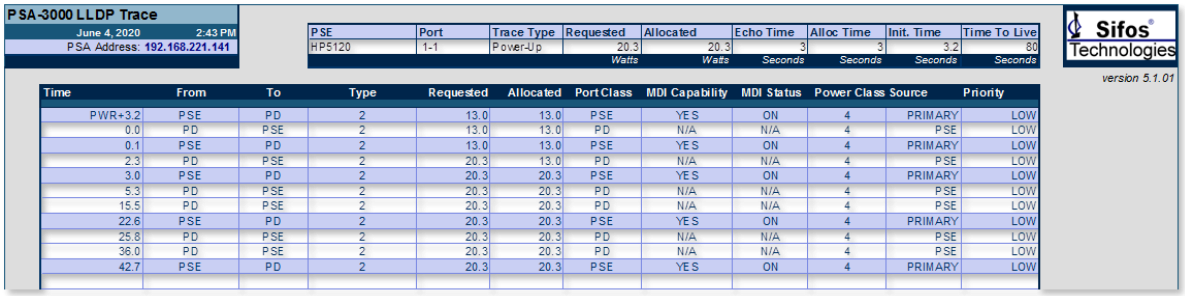


Figure 4.94 Real Time Trace Window

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.

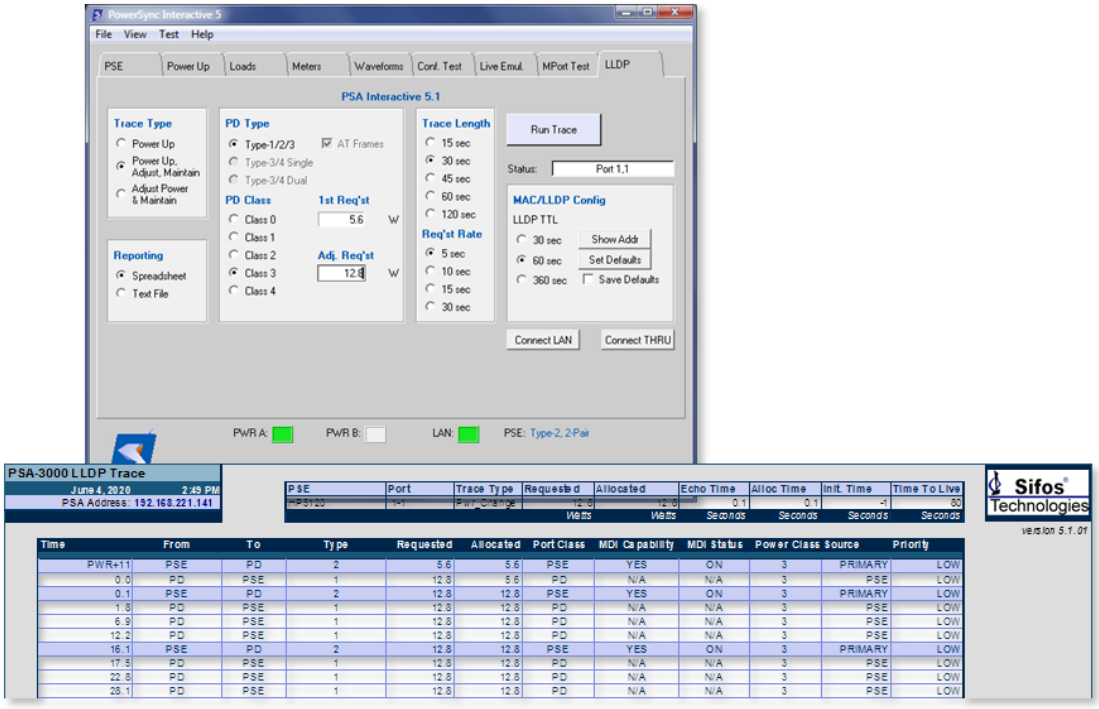


PSE	Port	Trace Type	Requested	Allocated	Echo Time	Alloc Time	Init. Time	Time To Live
HP5120	1-1	Power-Up	20.3 Watts	20.3 Watts	3 Seconds	3 Seconds	3.2 Seconds	80 Seconds

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**.



PSE	Port	Trace Type	Requested	Allocated	Echo Time	Alloc Time	Init. Time	Time To Live
HP5120	1-1	Pwr_Change	12.8 Watts	12.8 Watts	0.1 Seconds	0.1 Seconds	4 Seconds	80 Seconds

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.

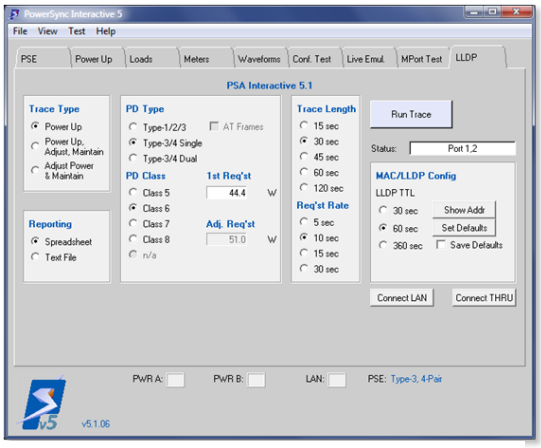


Figure 4.97 Class 6 Power-Up to 44.4 watts

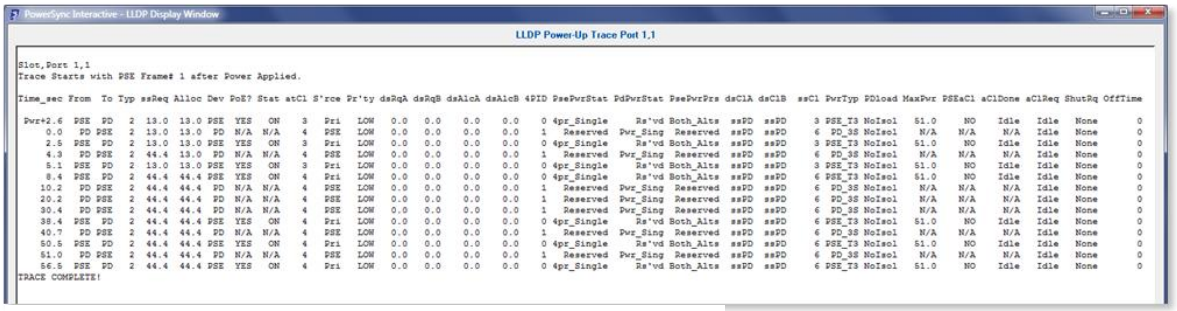


Figure 4.98 Trace Display - Class 6 Power-Up to 44.4 watts

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**.

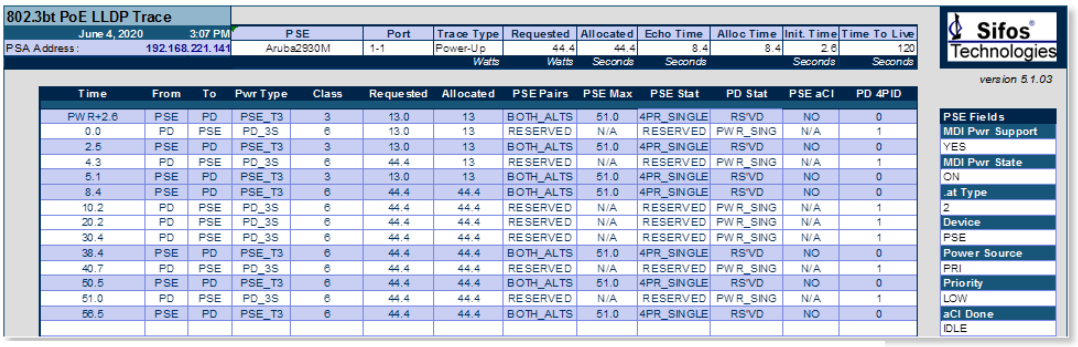


Figure 4.99 Spreadsheet Report: Single Signature Class 6 Power-Up Trace

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 8.5*).

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**.

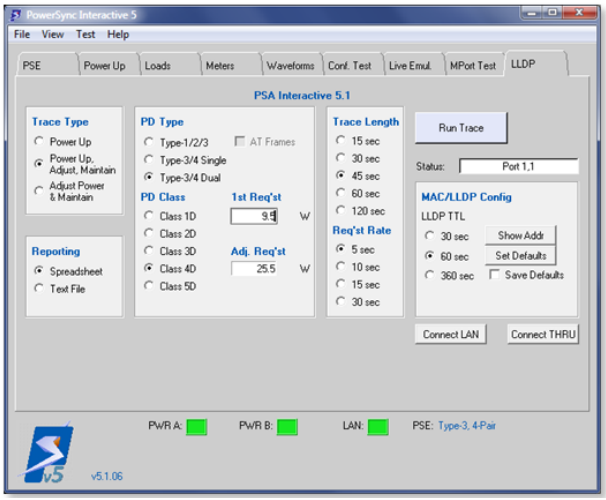


Figure 4.100 Dual Class 4 Power-Up, Adjust, Maintain Trace

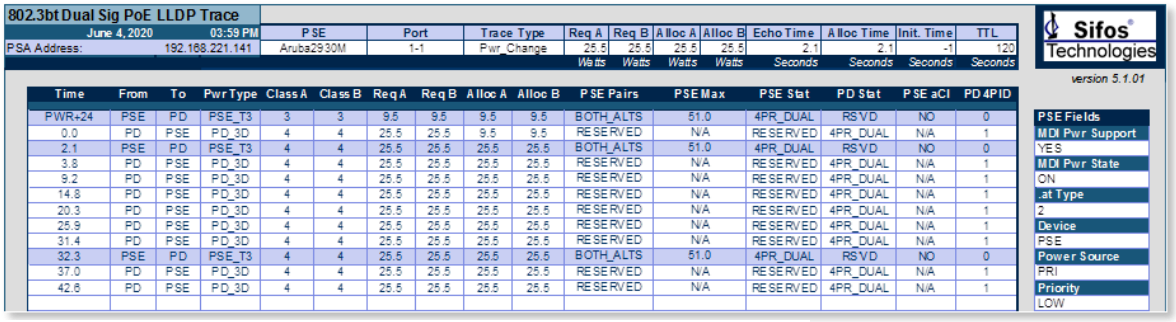


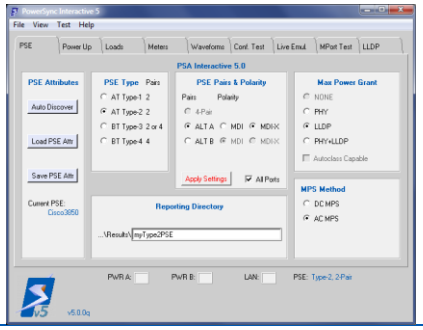
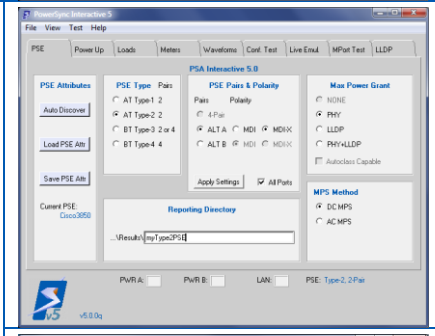
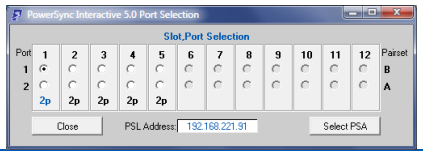
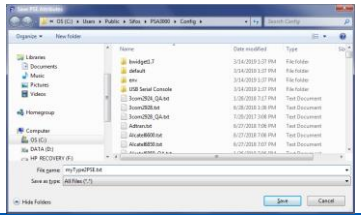
Figure 4.101 Dual Class 4 Power-Up, Adjust, Maintain Trace Report

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.

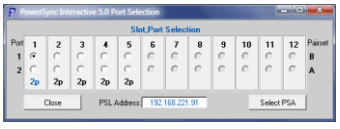
4.12.1. Configure Ports to Test an 802.3at Type-2 PSE that is Alt-A, MDI-X

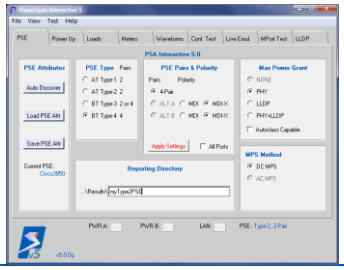
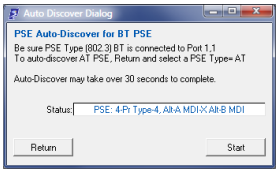
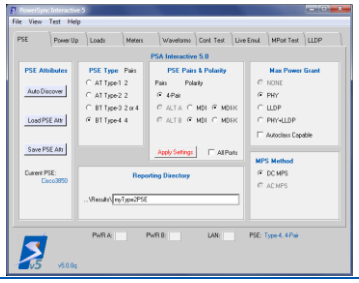
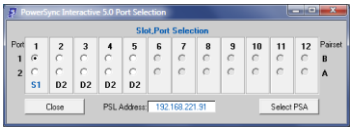
The PSE is known to be Type-2 (30W), powering Alt-A pairset with negative (MDI-X) polarity. Additionally, the PSE is known to use 2-Event classification to grant Type-2 power to a PD and the PSE is known to use the DC MPS method for disconnect detection. Save the PSE configuration to "myType2PSE.txt"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

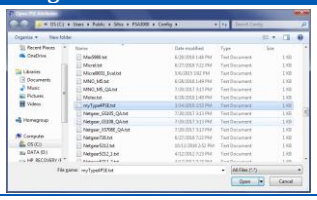
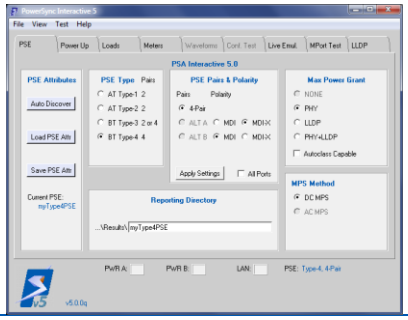
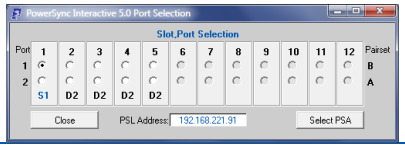
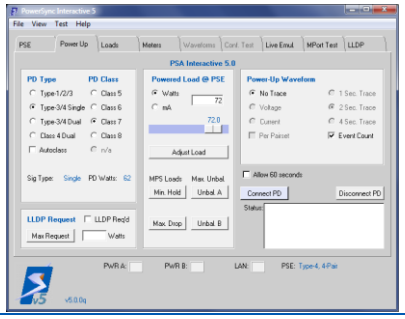
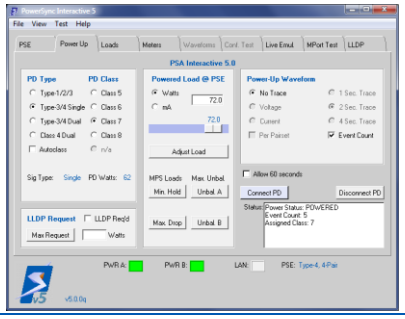
The PSE is known to be 802.3bt compliant but all other characteristics need to be discovered. Configure all slots accordingly in a PSA instrument that is a blend of PSA-3202 and PSA-3102 test blades.

Menu	Step	Task	Image
PSE	1	*All test ports are initially configured for 2-Pair PSE testing.* *Note that thisPSL-3000 has a blend of PSL-3202 and PSL-3102 test blades.*	

	2	Enter **BT Type-4** Press **Auto Discover**	
	3	"Auto-Discover for BT PSE" Press **Start** (*PSE discovered as:* Type-4, 4-Pair, MDI-X on Alt-A, MDI on Alt-B)	
	4	Press **Return** *PSE also discovered as:* Max Power Grant = PHY (Multi-Event) MPS Method = DC MPS	
	5	*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 PSL-3202 ports will be able to test it.*	

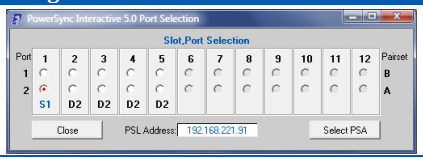
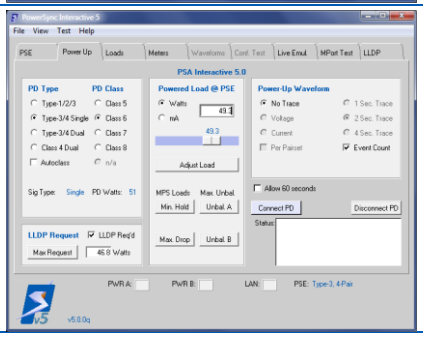
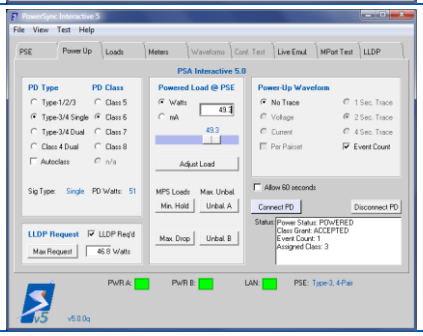
4.12.3. Perform a 4-Pair Power-Up from Type-4 PSE Emulating a Class 7 PD

Load the configuration of a known 802.3bt Type-4 PSE at slot 1, port 1. Then configure for Class 7 PD emulation and determine the PSE event count and PD assigned classification.

Menu	Step	Task	Image
PSE	1	Press **Load PSE Attr** Select myType4PSE and press **Open**	
	2	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	3	*All test slots are configured for 4-Pair modes.* Select **Slot 1 Port 1**	
Power Up	4	Select **Type-3/4 Single** Select **Class 7** 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*	

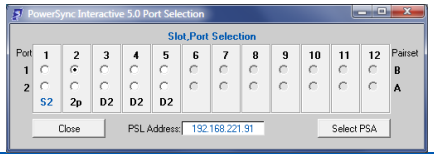
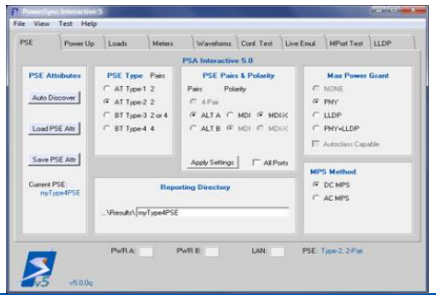
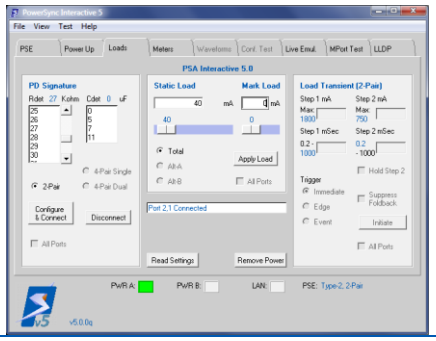
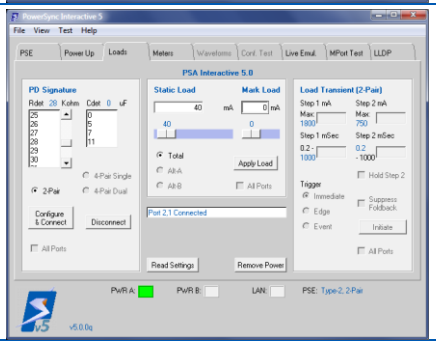
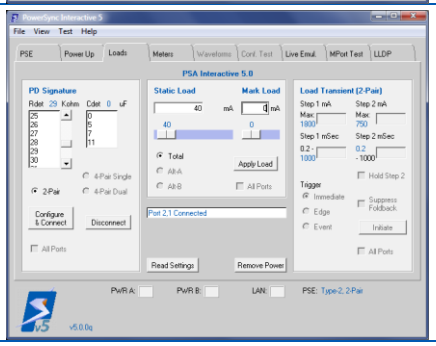
4.12.4. Perform an Emulated Class 6 LLDP Power-Up

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 1,2. 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 1, Port 2 *Note that this is presently a DISCONNECTED 4-Pair port. Also, the PSL-3000 has a mix of PSL-3202 and PSL-3102 blades.*	
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*	

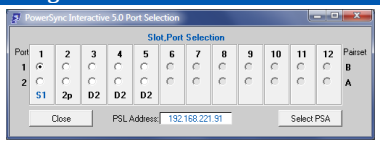
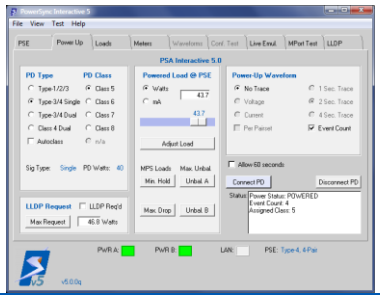
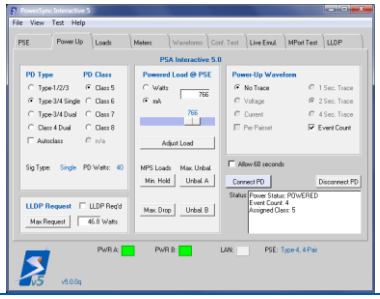
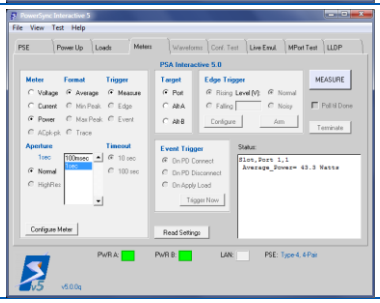
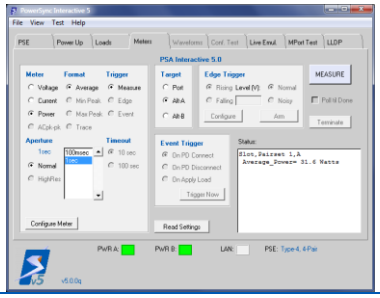
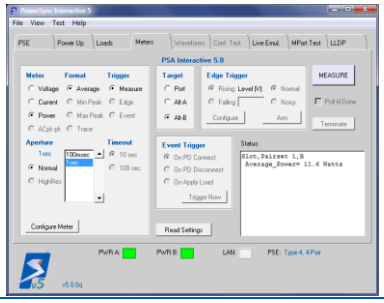
4.12.5. Determine the Maximum Signature Resistance a Type-2 (802.3at) PSE will power

This exercise involves configuring port 2,1 for an 802.3at Type-2 PSE, 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 2, 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 rejected 29KΩ and did not power up	

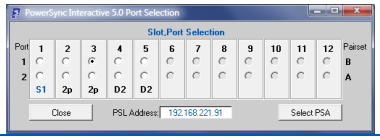
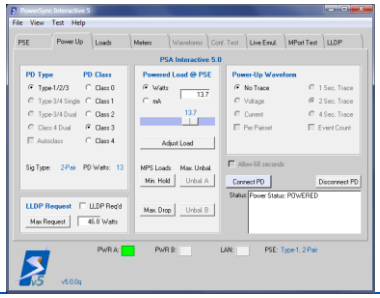
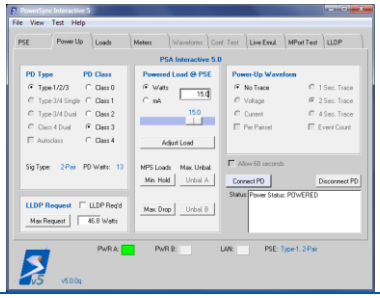
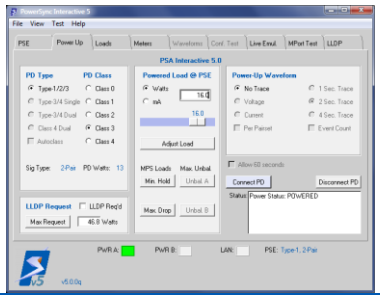
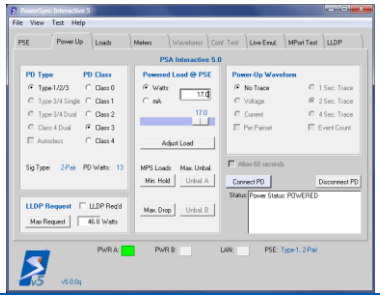
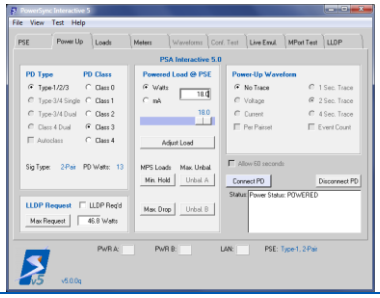
4.12.6. Measure Total and Pairset Powers of Emulated Class 5 PD after unbalancing the load to Alt-A

An emulated Class 5 PD is powered on port 1,1 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 1, 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, Status = POWERED*	
	3	Select **mA** Press **Unbal A** *Total current load adjusts to 766 mA*	
Meters	4	Select **Power** Select **1sec** (Aperture) Select **Port** (Target) Press **MEASURE** *Meter measures 43.3 watts total*	
	5	Select **Alt-A** (Target) Press **MEASURE** *Meter measures 31.6 watts on Alt-A pairset*	
	6	Select **Alt-B** (Target) Press **MEASURE** *Meter measures 11.6 watts on Alt-B pairset*	

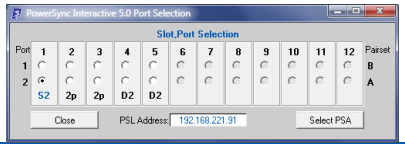
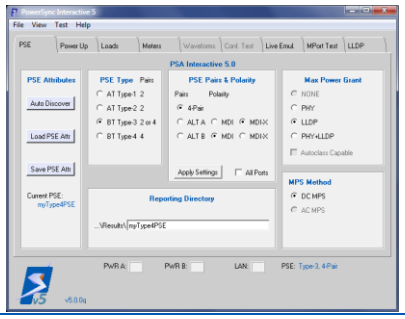
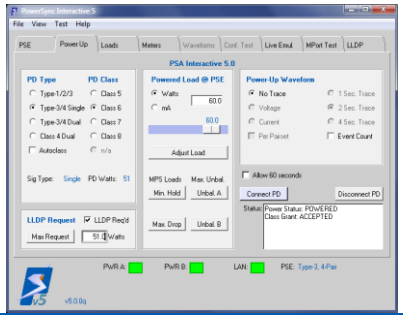
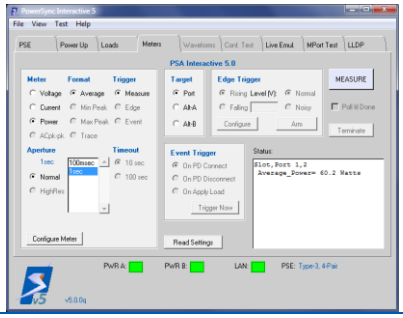
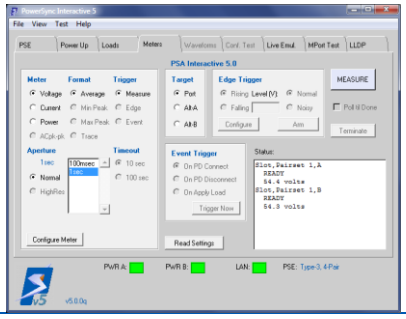
4.12.7. Assess Output Power Capacity of a Type-1 PSE port

A Type-1 PSE port is connected to test port 3,1, the port is powered with Class 3 PD emulation, and power is stepped up until a shutdown is observed.

Menu	Step	Task	Image
Slot-Port	1	Select Slot 3, Port 1 *PSE was already declared as Type-1, 2-Pair. This is a PSL-3102 test port.*	
Power Up	2	Select **Type-1/2/3** Select **Class 3** Press **Connect PD** *PWR A indicates PSE powered Alt-A pairset. Status = POWERED.* *Starting load is 13.7 watts*	
	3	Enter or adjust Powered Load to 15.0W Press **Apply Load** *PWR A indicates Alt-A pairset is still powered so PSE will provide 15W to a Class 3 PD*	
	4	Enter or adjust Powered Load to 16.0W Press **Apply Load** *PWR A indicates Alt-A pairset is still powered so PSE will provide 16W to a Class 3 PD*	
	5	Enter or adjust Powered Load to 17.0W Press **Apply Load** *PWR A indicates Alt-A pairset is still powered so PSE will provide 17W to a Class 3 PD*	
	6	Enter or adjust Powered Load to 18.0W Press **Apply Load** *PWR A indicates Alt-A pairset removed power meaning the PSE will not tolerate an 18W load from a Class 3 PD.*	

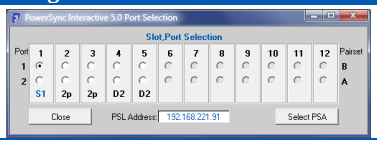
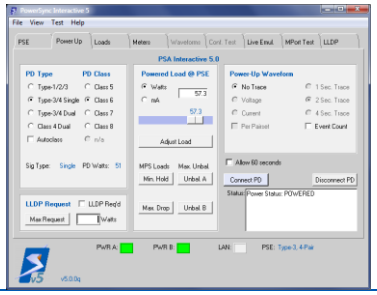
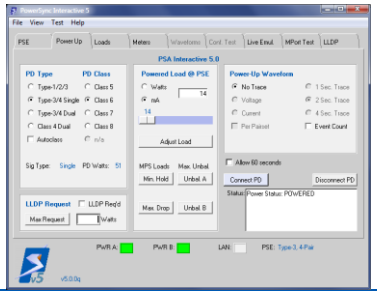
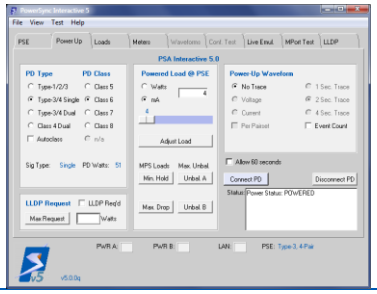
4.12.8. Assess Type-3, LLDP PSE Output Voltage at 60W loading

A Type-3, LLDP capable PSE is powered using test port 1,2 to 60 watts given a PD request for 51 watts. Output power is verified, then voltages are measured on both pairsets.

Menu	Step	Task	Image
Slot-Port	1	Select Slot 1, Port 2	
PSE	2	Select **BT Type-3** Select **4-Pair** Press **Apply Settings** *PSE declaration (bottom of window) is* Type-3, 4-Pair	
Power Up	3	Select **Type-3/4 Single** Select **Class 6** Select **LLDP Req'd** Press **Max Request** Enter **Powered Load** = 60 watts Press **Connect PD** *When PSE applies power, PWR A and PWR B indicators activate, Status = POWERED, ACCEPTED meaning negotiation for 51.0W was successful*	
Meters	4	Select **Power** Select **1sec** (aperture) Select **Port** (target) Press **MEASURE** *PSE output power verified at 60 watts*	
	6	Select **Voltage** Press **MEASURE** Output voltages are 54.4V on Alt-A and 54.3V on Alt-B	

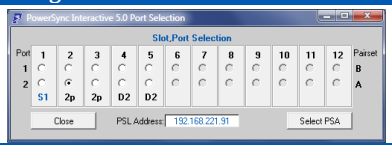
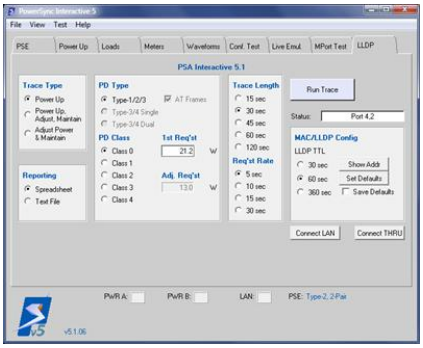
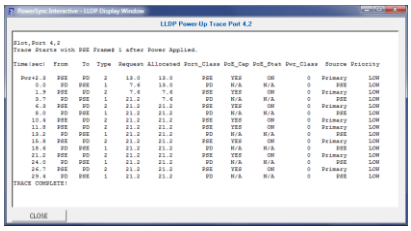
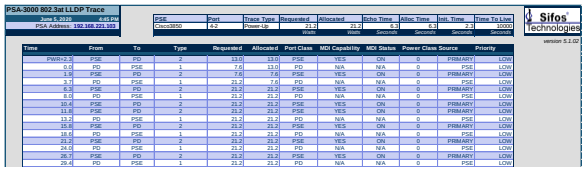
4.12.9. Assess that a Type-3 PSE satisfies DC MPS requirements

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 and removing power with a 4 mA total load.

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*	
	4	Press **Max. Drop** *4-Pair Load Current adjusted to 4mA* *PWR A and PWR B indicators show PSE removed power 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 2,2 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 2, Port 2	
PSE	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**	
	5	*PSE powers, trace starts running in live trace window*	
	6	*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 Tcl and PowerShell 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. 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 PSL-3000 (*also referred to as "**PSA**" in this section*) 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 be unavailable, PowerShell will open up in Demo Mode (*see **Figure 5.2***) meaning that all instrument control becomes "virtual" – that is to a

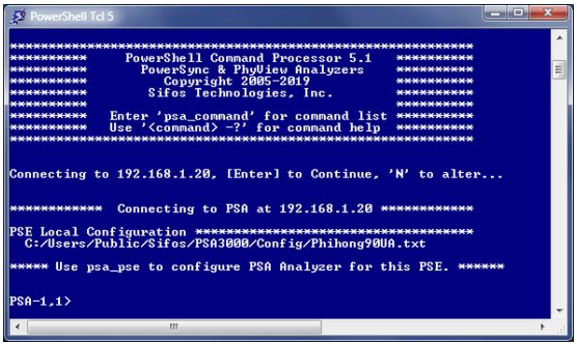


Figure 5.1 PowerShell TCL Connection Dialog

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. (*This delay can be altered in the **tclshrc.tcl** resource file*.)

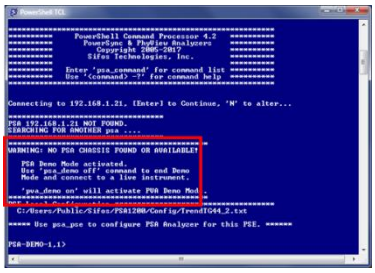


Figure 5.2 Demo Mode Warning

When opening PowerShell Wish, the user may force PowerShell PSA 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.

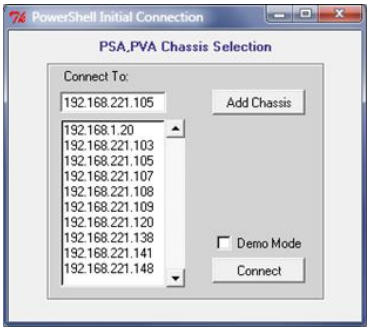


Figure 5.3 PowerShell Wish Connection Dialog

As PowerShell 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 Programmable Load. 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.

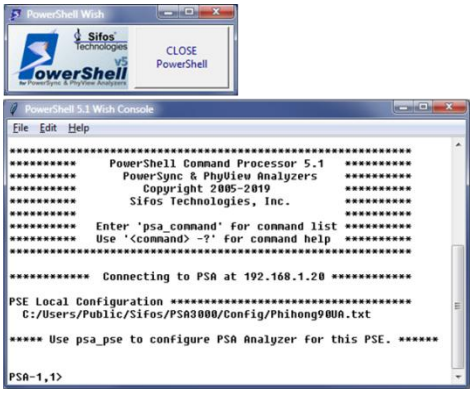


Figure 5.4 PowerShell Wish

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 0. 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 **Error! Reference source not found.** for description of* **99,99**, **99,y**, *and* **x,99** *roadcast 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 PSA provides interactive help capability at the PowerShell 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 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 characteristics will affect decisions made within automated test suites such as the PSE Multi-Port Test Suite (*see section 7.2*). These settings and their associated global variable names are described in the following table.

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}**	

Setting	Global Variable	Value Range	Configuration Commands
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	psaTestBladeHWver	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 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.

Command	Command Parameters	Query	Returned Parameters
psa	*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.	**?**	Current Chassis IP Address
psa_demo	<**ON** <**PSA** | **PL** | **SA**> |**OFF**> **slots** *num_blades* 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 *numblades* The number of populated test slots (1-12)		

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**>	**?**	**AT** | **BT** | **PROP4** (Alt) **A** | **B** | **4Pr** Polarity MPS (**AC** | **DC**) HP Grant 4-Pair Type Min. 4-Pair Class
	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 overridden 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.		

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.		
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	
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. The command will report Minimum, Maximum, and 95th Percentile values for I-O response time for specified interactions with a specified PSA address. It will also categorize I-O response time and internal process execution integrity. *See Section 3.3 for further information about Network Connection Latency*. *ipAddr* IP address of PSA Instrument to which connection latency is being studied. Default address is currently connected PSA instrument. *ioCount* Count of latency measurements to be performed. Range is 100 to 2000 measurements. . Default value is 100 measurements. 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), 95th 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)

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**).

Command	Addr	Command Parameters	Query	Returned Parameters
alt	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	**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	**?**	A | B | 4PR
	4-pair Con-nected <*port*>	*(Not applicable)* 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.		
polarity	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	**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)	**?**	POS | NEG
	4-pair Con-nected <*port*>	**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	**?**	POS+POS | NEG+POS | NEG+NEG | POS+POS
port	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	**connect** | **isolate** 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	**?**	Connected | Isolated
	4-pair Con-nected <*port*>	**connect** | **isolate** 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.		

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*> 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.	**?**	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.	**?**	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 a*pplied 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**> *APPLICABLE TO* ***PSA/PSL-3202*** *ONLY* 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 **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.*	? **stat**	Class_Sig Event_Currents 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**> *APPLICABLE TO* ***PSA/PSL-3202*** *ONLY* 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. *All settings and usage rules are identical to the 2-Pair application described above.*	? **stat**	*Alt-A Pairset:* Class_Sig Event_Currents *Alt-B Pairset:* Class_Sig Event_Currents *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
psa_ connect	2-Pair <*port*> Or 4-Pair *slot*,**A** *slot*,**B**	<**i** *current*> <**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. *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*> <**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.*		

Command	Addr	Command Parameters	Query	Returned Parameters
psa_ disconnect	2-Pair <*port*> Or 4-Pair *slot*,**A** *slot*,**B**	*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). ***PSA/PSL-3202*** *ONLY*: Terminates any Multi-Event classification.		
	4-pair Con-nected <*port*>	*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). ***PSA/PSL-3202*** *ONLY*: Terminates any Multi-Event classification.		
		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.		
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 and DC current. 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**		**stat**	PSE power status, "**ON**" or "**OFF**"
		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.		
	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**"
vdcaverage	2-Pair <*port*>	<**period 100m** | **1s**>	**stat**	READY Average DC Volts
		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. **period** specifies that an averaging period will be defined. **100m** Sets measurement integration time to 100msec **1s** Sets measurement integration time to 1second	**?**	Averaging Period 100m | 1s
	4-pair Con-nected <*port*>	<**period 100m** | **1s**>	**stat**	*Alt-A Pairset:* READY Average DC Volts *Alt-BPairset:* READY Average DC Volts
		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. *All settings and rules are identical to the 2-Pair application described above.*	**?**	Averaging Period 100m | 1s
	4-Pair *slot*,**A** *slot*,**B**		**stat**	READY Average DC Volts
		Performs an Average 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.	**?**	Averaging Period 100m | 1s

Command	Addr	Command Parameters	Query	Returned Parameters
idcaverage	2-Pair <*port*>	<**period 100m** | **1s**>	**stat**	READY Average DC Volts
		Configures and/or performs an Average DC Current measurement. Meter configurations are retained persistently in each test port. **period** specifies that an averaging period will be defined. **100m** Sets measurement integration time to 100msec **1s** Sets measurement integration time to 1second	**?**	Averaging Period 100m | 1s
	4-pair Con-nected <*port*>	<**period 100m** | **1s**>	**stat**	*Alt-A Pairset:* READY Average DC Volts *Alt-BPairset:* READY Average DC Volts
		Configures and/or performs a 4-pair (Alt-A and Alt-B) Average DC Current measurement on both Alt-A and Alt-B pairsets. Meter configurations are retained persistently for each pairset. *All settings and rules are identical to the 2-Pair application described above.*	**?**	Averaging Period 100m | 1s
	4-Pair *slot*,**A** *slot*,**B**		**stat**	READY Average DC Volts
		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.	**?**	Averaging Period 100m | 1s
		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.*		

Command	Addr	Command Parameters	Query	Returned Parameters
paverage	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	<**period** **100m** | **1s**> *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 an averaging period will be defined. **100m** Sets measurement integration time to 100msec **1s** Sets measurement integration time to 1second	**stat**	Average (2-pair or pairset) Power Delivered (Watts)
	4-pair Con-nected <*port*>	<**period** **100m** | **1s**> *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)

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(s)) 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 support 802.3bt testing.) **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 older **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. This option adds significant execution time. Only valid for **AT** PSE declarations because 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 0.2VDC - 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 0.2VDC - 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.	⇦

<table>
<tr><th>Command</th><th>Addr</th><th>Command Parameters</th><th>Returned Parameters</th></tr>
<tr><td rowspan="2">power_port</td><td rowspan="2">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>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 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

Target Port Current</td></tr>
</table>

Command	Addr	Command Parameters	Returned Parameters
power_bt ***(PSL-3202*, *PSL-3224* only)**	4-pair Con-nected <*port*>	**c** *pdClass* | **ca** *pdClass* **cb** *pdClass* <**autoclass**> <**p** *power* | **i** *load*> <**dr** *rDet*> <**dc** *cDet*> <**abort** *pwrTime*> <**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. (*Not supported by PSA/PSL-3102 test blades*.) Must contain a class argument. No support for LLDP in this version. 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. **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. *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
power_prop4 ***(PSL-3102*, *PSL-3024* only)**		**ci** *Iclass* **<p** *power* **| i** *load***> <dr** *rDet***> <dc** *cDet***> <abort** *pwrupTime***>** *This command is supports testing of **Proprietary 4-Pair** PSE's using Port 2 of a PSL-3102 test blade or Port 2's in a PSL-3024.* Emulates a dual signature, proprietary PD presenting fixed class signature on each pairset. 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. *class_current* is the classification current to apply during classification. Range is 0 to 45 mA.	

Command	Addr	Command Parameters	Returned Parameters
psa_set_load	2-Pair <*port*> or 4-Pair *slot*,**A** *slot*,**B**	**p** *new_power* <**dcv** *vport* | **interate** *counts*> 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 *port* (or *slot*,*pairset* 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. *new_power* DC power target. Range is 0.5 to 37.5 watts for 2-pair mode and 0.5 to 49.4 watts for pairset *slot*,**A** or *slot*,**B** in 4-pair mode. Must be furnished with command. **dcv** *vport* Override any port voltage measurements and configure *new_power* utilizing the voltage provided, *vport.* This option allows any previously configured measurements to continue without disruption. Range for *vport* is 44 to 57 volts. **interate** *counts* Specify the number of cycles of voltage measurements and load computation in order to converge power load to *new_power*. 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.	
	4-pair Con-nected <*port*>	**p** *new_power* <**dcv** *vport* | **interate** *counts*> 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 *port* unless **dcv** argument is provided. May be multi-cast (e.g. 99,1 or 99,2) if PSE output voltage **dcv** is specified. *new_power* DC power target. Range is 0.5 to 98.8 watts. Must be furnished with command. *All other arguments are identical to 2-pair version of utility above.*	
replicate_ ports	2-Pair <*port*> Or 4-pair Con-nected <*port*>	*config_type* {*target_ports*} 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 *port* to the *target_ports* before copying the user specified *config_type*. So if the pair state of *port i*s 2-pair, then all *target_ports* will be 2-pair. If the pair state of *port* is 4-pair Single Signature, then the *target_ports* will all be connected 4-pair Single Signature configurations. If replicating from a **4-pair** connected port, the *target_ports* must also be a list of 4-pair connected ports meaning if copying from *x*,**1**, all *target_ports* must be *x*,**1** and if copying from *x*,**2**, all *target_ports* must be *x*,**2**. *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.* *config_type*: The type of configuration to be replicated from *port* to {*target_ports*}. Options are: **port** | **load** | **vdca** | **idca** | **all**. "**all**" will fully replicate all subsystem configurations. *target_ports*: A list of ports (*slot*,*port* format) to which the configuration is to be copied. Use "allports" to copy configuration to all ports in PSA-3000 or PSA-3x48.	

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 Section 4.3*) and the **PD4** signature option in **power_bt** (*see Section **Error! Reference source not found.** above*). Also see the **power_prop4** utility above.

5.12. (*Section Omitted*)

5.13. PowerShell PSA Chassis System 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.

Command	Command Parameters	Returned Parameters
psa_config	<-**d** <-**sernum**> | -**s**> <-**pva**> <-**alc**> 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	{Port + Type + Version}
psa_setipaddress	*ipaddress* <**m**ask *mask*> <**g**ateway *gateway*> Installs a new fixed IP address to be utilized by the Chassis Controller. This command takes about 15 seconds to execute 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. **m**ask 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 (Class C). Must comply with IP rules for valid mask values. **g**ateway 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.	Current IP Address, Mask, and Gateway Address.
psa_flash load	**type AT** | **BT** | **AF file** *"filename"* This command is used for downloading new PSL **test blade** (PSL-3x02) firmware images from a host computer to PSA-3000 / PSL-3000 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** | **AF**> This command is used for updating PSL-3000 **test blades** (PSL-3x02) with new firmware images previously downloaded into 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 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 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

Command	Command Parameters	Returned Parameters
psa_update_fw	*slot*,*port* **file** *"filename"* <-y> This command is used to download and install new firmware images to a PSL-3000 **controller blade** or to PSL-3102 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 PSL-3000 controller blade firmware. Use N,N for updating PSL-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. feature_code: A unique code provided when new features are purchased 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 (psl_quick_test)

PSA Software includes a sample test script for the PSL-3000 and PSL-3024 instruments to support high throughput PSE testing using methods described both in this section and later in section 9.1. 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 **ps1_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 16 to 30 seconds per port.

The script file, **psl_quick_test.tcl** is located in the …**PSA3000\Contrib** directory (*see section 3.2.5*).

Note: Users must properly configure ALT and Polarity within each test port prior to running **psl_quick_test**. See the **psa_auto_port** command in section 5.11 and/or the **psa_pse** command in section 5.7.

Command	Command Parameters	Returned Parameters
psl_quick_test	<*PSA Address*> *port1 port2 port3 port4* <*port 5* <*port 6* <*port 7* <*port 8*>>>> <**type-1** | **type-2** <**lldp**>> <**-v**> Executes **psl_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.	Detection Acceptance Detection Reject Vport_Low_Load Vport_High_Load Load_Capacity Power_Capacity Disconnect_ Shutdown Overloads LLDP_Allocations (*optional*)

5.15. PowerShell PSA Scripting Examples: 2-Pair 802.3at PSE Analysis

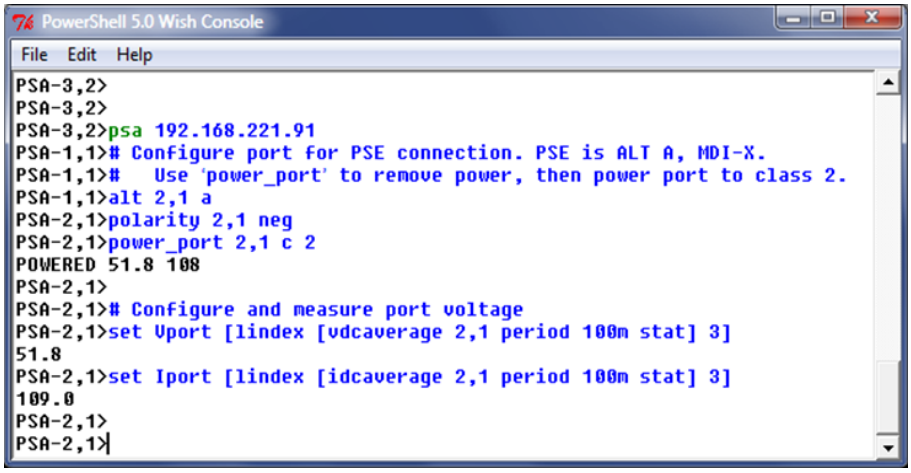
Several examples of short PowerShell PSA scripts to analyze 802.3at PSE's are provided below.

5.15.1. Measure Vport and Iport on a port powered up to Class 2.

The following script will power-up port 2,1 emulating Class 2 PD and report Vport & Iport for ALT A, MDI-X PSE.

```
# Configure port for PSE connection. PSE is ALT A, MDI-X.
#   Use 'power_port' to remove power, then power port to class 2.
alt 2,1 a
polarity 2,1 neg
power_port 2,1 c 2

# Configure and measure port voltage
set Vport [lindex [vdcaverage 2,1 period 100m stat] 3]
set Iport [lindex [idcaverage 2,1 period 100m stat] 3]
```

Actual execution:

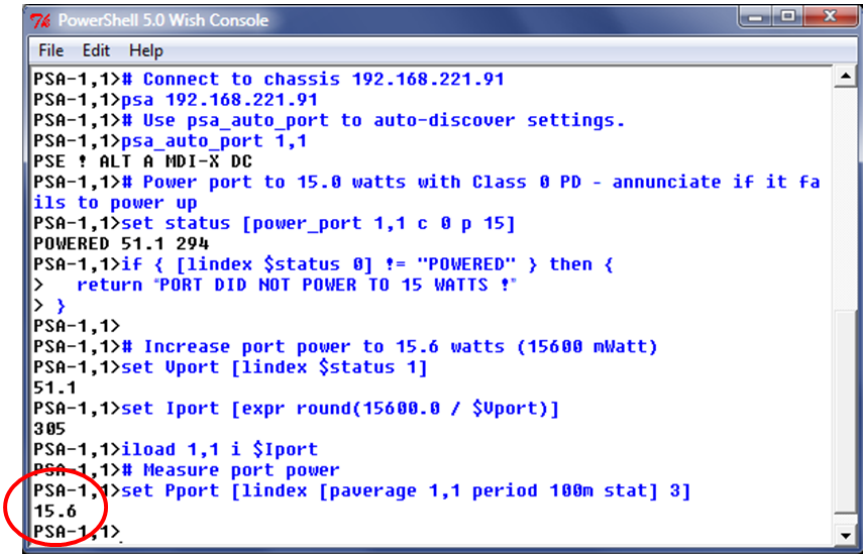


5.15.2. Test a PSE Port to provide at least 15.4 Watts to a Class 0 PD on Port 1,1 of PSA 192.168.221.106

Determine if PSE Port with unknown ALT and Polarity setup can power at least 15.4 Watts given a Class 0 PD.

```
# Connect to chassis 192.168.221.106
psa 192.16 8.221.106
# Use psa_auto_port to auto-discover settings.
psa_auto_port 1,1
# Power port to 15.0 watts with Class 0 PD - annunciate if it fails to
power up
set status [power_port 1,1 c 0 p 15]
if { [lindex $status 0] != "POWERED" } then {
  return "PORT DID NOT POWER TO 15 WATTS !"
}

# Increase port power to 15.6 watts (15600 mWatt)
set Vport [lindex $status 1]
set Iport [expr round(15600.0 / $Vport)]
iload 1,1 i $Iport
# Measure port power
set Pport [lindex [paverage 1,1 period 100m stat] 3]
```

Actual execution:
PSE succeeded in providing at least 15.4 Watts !

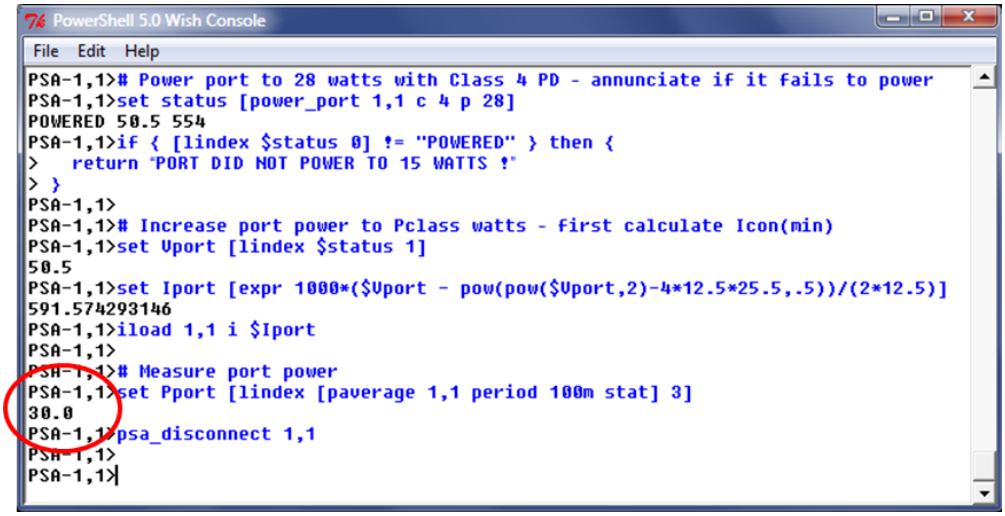


5.15.3. Test a PSE Port to provide at least Pclass (~30W) to a Class 4 PD on the same PSE as 5.15.2 above

Determine if PSE Port with unknown ALT and Polarity setup can power at least 30 Watts given a Class 4 PD. Then power down the port.

```
# Power port to 28 watts with Class 4 PD - annunciate if it fails to power
set status [power_port 1,1 c 4 p 28]
if { [lindex $status 0] != "POWERED" } then {
  return "PORT DID NOT POWER TO 2 WATTS !"
}

# Increase port power to Pclass watts - first calculate Icon(min)
#  Pclass calculation from 802.3at specification
set Vport [lindex $status 1]
set Iport [expr 1000*($Vport - pow(pow($Vport,2)-4*12.5*25.5,.5))/(2*12.5)]
iload 1,1 i $Iport

# Measure port power
set Pport [lindex [paverage 1,1 period 100m stat] 3]
psa_disconnect 1,1
```

Actual execution:



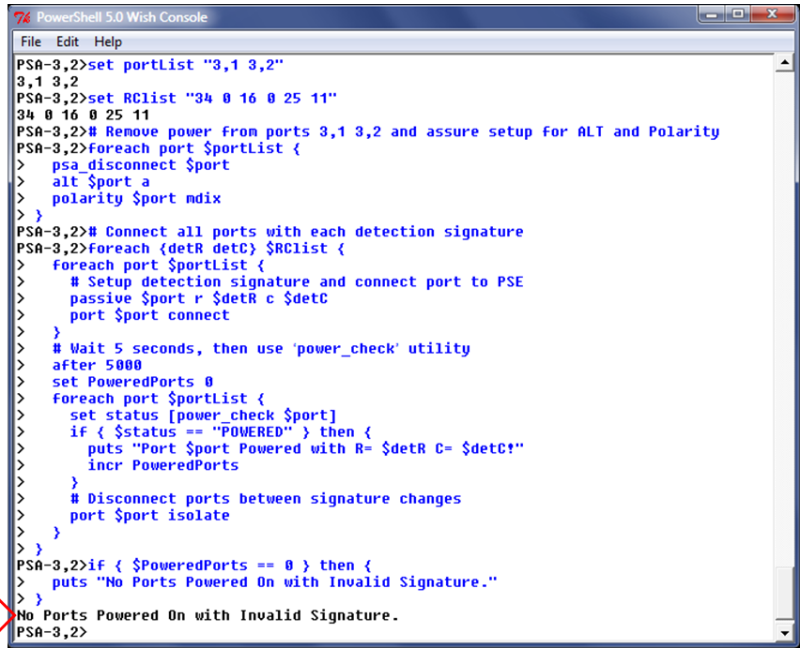
PSE succeeded in providing at least Pclass to a Class 4 PD !

5.15.4. Apply Invalid Detection signatures to ALT A, MDI-XPSE on Port 3,1 - 3,2 and verify no power-ups

Verify that a PSE fails to apply power when presented with several invalid detection signatures on 2 ports.

```
# Specify ports and detection signatures
#  Invalid Signatures: 34Kohm, 16Kohm, 11uF
set portList "3,1 3,2"
set RClist "34 0 16 0 25 11"
# Remove power from ports 3,1 3,2 and assure setup for ALT and Polarity
foreach port $portList {
  psa_disconnect $port
  alt $port a
  polarity $port mdix
}
# Connect all ports with each detection signature
foreach {detR detC} $RClist {
  foreach port $portList {
    # Setup detection signature and connect port to PSE
    passive $port r $detR c $detC
    port $port connect
  }
  # Wait 5 seconds, then use 'power_check' utility
  after 5000
  set PoweredPorts 0
  foreach port $portList {
    set status [power_check $port]
    if { $status == "POWERED" } then {
      puts "Port $port Powered with R= $detR C= $detC!"
      incr PoweredPorts
    }
    # Disconnect ports between signature changes
    port $port isolate
  }
}
if { $PoweredPorts == 0 } then {
  puts "No Ports Powered On with Invalid Signature."
}
```

Actual execution:

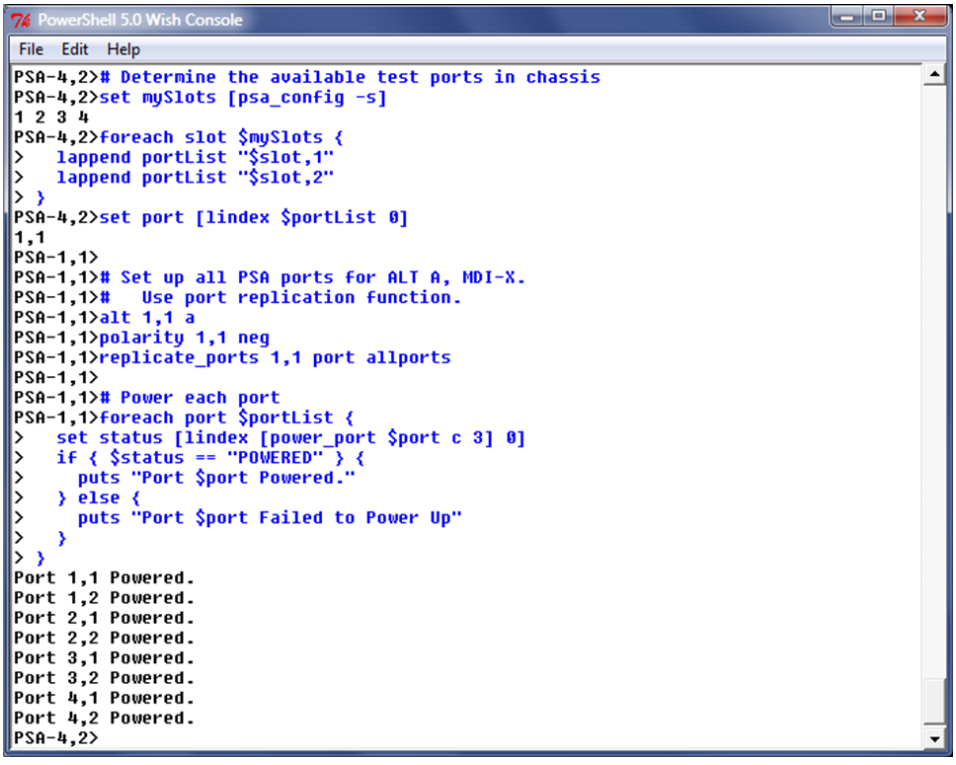


Success: PSE did not power invalid signatures

5.15.5. Attempt to power up all ports in PSA chassis with Class 3 PD loads

```
# Determine the available test ports in chassis
set mySlots [psa_config -s]
foreach slot $mySlots {
  lappend portList "$slot,1"
  lappend portList "$slot,2"
}
set port [lindex $portList 0]

# Set up all PSA ports for ALT A, MDI-X.
#   Use port replication function.
alt 1,1 a
polarity 1,1 neg
replicate_ports 1,1 port allports

# Power each port
foreach port $portList {
  set status [lindex [power_port $port c 3] 0]
  if { $status == "POWERED" } {
    puts "Port $port Powered."
  } else {
    puts "Port $port Failed to Power Up"
  }
}
```

Actual execution:



PSE succeeded in powering up 8 out of 8 ports to Class 3 PD's.

5.16. PowerShell PSA Scripting Examples: 4-Pair 802.3bt PSE Analysis

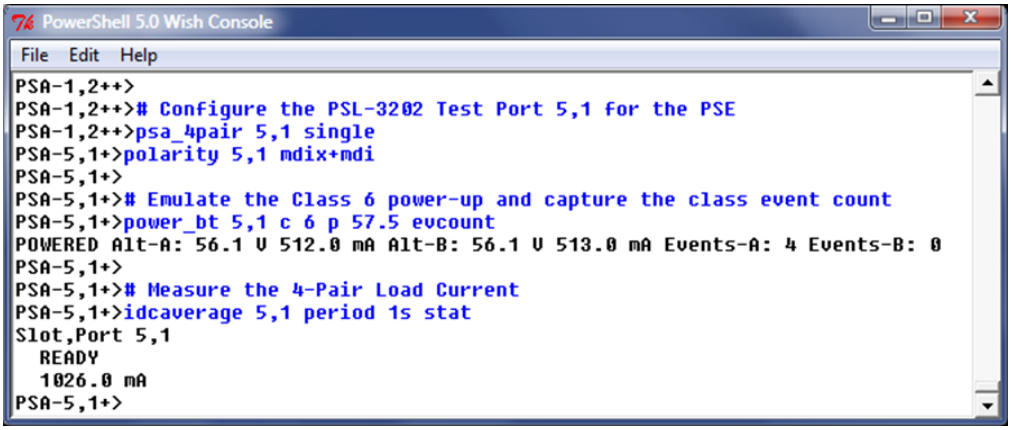
Several examples of short PowerShell PSA scripts to analyze 4-pair capable 802.3bt PSE's are provided below.

5.16.1. Perform a Class 6 emulated power-up to 57.5W and report PSE class events and 4-Pair load current

Here, a 4-Pair 802.3bt PSE that is configured as Alt-A, MDI-X and Alt-B, MDI will be connected to an emulated Class 6 PD that draws 57.5W from the PSE. The script will capture the class events issued by the PSE and then measure the 4-Pair load current.

```
# Configure the PSL-3202 Test Port 5,1 for the PSE
psa_4pair 5,1 single
polarity 5,1 mdix+mdi

# Emulate the Class 6 power-up and capture the class event count
power_bt 5,1 c 6 p 57.5 evcount

# Measure the 4-Pair Load Current
idcaverage 5,1 period 1s stat
```

Actual execution:
PSE successfully powers the Class 6 PD providing 4 class events on the Alt-A pairset. The 57.5 watt load then leads to a load current of 1.026A.



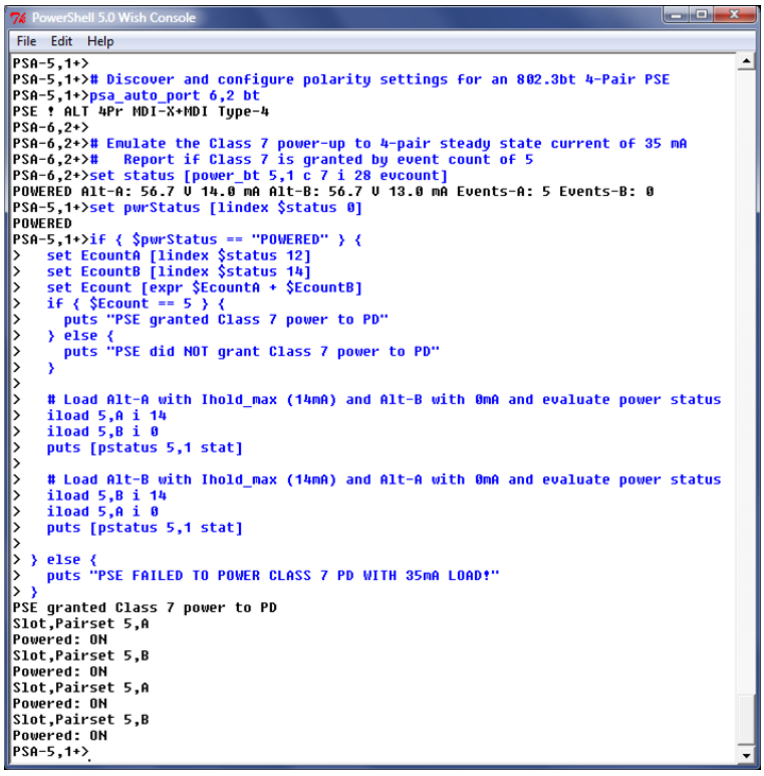
5.16.2. Automatically discover PSE attributes, then evaluate MPS Behavior of a Class 7 PD

Verify that a 4-Pair capable PSE maintains power to a Class 7 PD when Alt-A pairset draws 14mA and Alt-B pairset draws 0 mA. Verify that reversing current such that Alt-B is 14mA and Alt-A is 0mA also keeps the PD powered. PSE is connected to PSL-3000 slot 6, port 2.

```
# Discover and configure polarity settings for an 802.3bt 4-Pair PSE
psa_auto_port 6,2 bt

# Emulate the Class 7 power-up to 4-pair steady state current of 35 mA
#   Report if Class 7 is granted by event count of 5
set status [power_bt 5,1 c 7 i 28 evcount]
set pwrStatus [lindex $status 0]

# PSE Applied Power ?
if { $pwrStatus == "POWERED" } {
  set EcountA [lindex $status 12]
  set EcountB [lindex $status 14]
  set Ecount [expr EcountA + EcountB]
  if { $Ecount == 5 } {
    puts "PSE granted Class 7 power to PD"
  } else {
    puts "PSE did NOT grant Class 7 power to PD"
  }

  # Load Alt-A with Ihold_max (14mA), Alt-B with 0mA, evaluate power status
  iload 5,A i 14
  iload 5,B i 0
  puts [pstatus 5,1 stat]

  # Load Alt-B with Ihold_max (14mA), Alt-A with 0mA, evaluate power status
  iload 5,B i 14
  iload 5,A i 0
  puts [pstatus 5,1 stat]

# PSE Failed to Power PD
} else {
  puts "PSE FAILED TO POWER CLASS 7 PD WITH 28mA LOAD!"
}
```

Actual execution:

The PSE properly tolerates combinations of 14mA on one pairset and 0mA on the other pairset when powering a Single Signature (Class 7 in this example) PD.

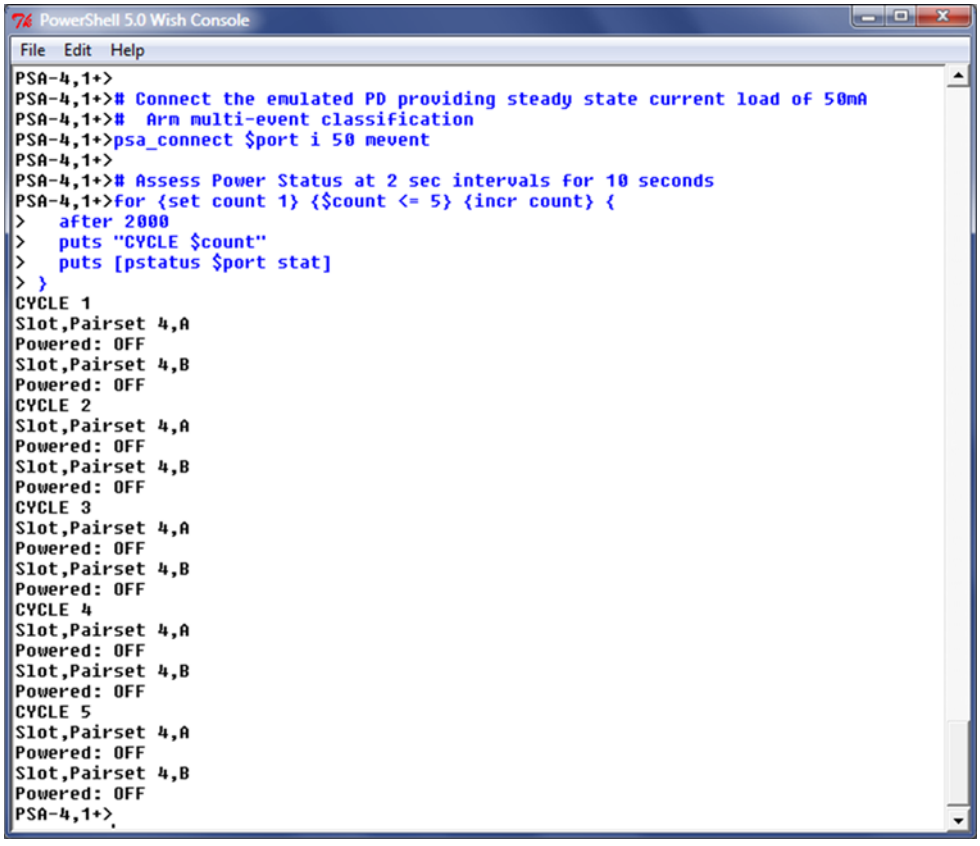


5.16.3. Analyze PSE Response to Invalid Classification Sequence

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" a valid Class 7 signature to produce the invalid class signature. The PSE is Alt-A, MDI-X and Alt-B, MDI.

```
# Establish 4-Pair Single Signature Connection (PD emulation)
set port 5,1
psa_4pair $port single

# Establish proper polarities & detection signatures for pairsets
polarity $port mdix+mdi
passive $port r 25 c 0

# Establish Class Signature
#  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]
}
```

Actual execution:



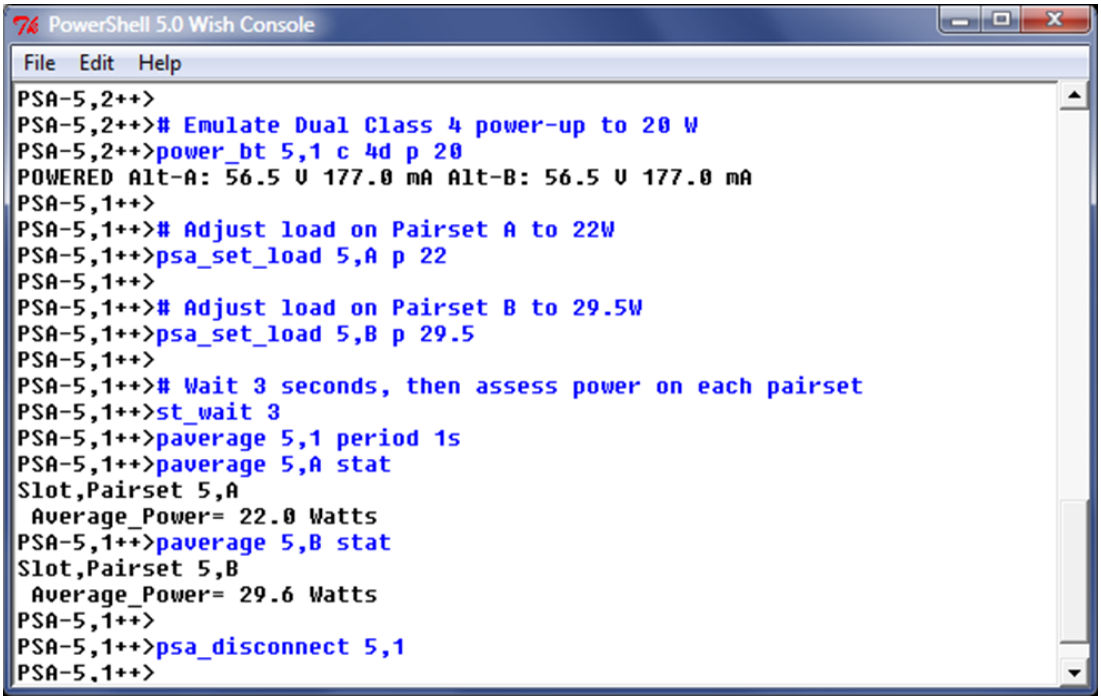
5.16.4. Emulate dual Class 4 signature PD drawing 22W on the Alt-A pairs, 29.5W on the Alt-B pairset

In this example, a PSE Attributes file will be loaded to establish the 4-pair and proper polarity connections for a Type-4 PSE. An emulated Dual (Class 5) Signature PD will be connected with power draw of 22W on one pairset and 29.5W on the other pairset. Power will then be measured on both pairsets to confirm the emulation is successful and the PSE is supporting this PD. Remove PD connection once measurement is completed.

```
# Load the PSE Attributes from a PSE Attributes file myBtPse
#   This will configure polarities properly for this PSE
psa_pse myBtPSE

# Emulate Dual Class 4 power-up to 20 W
power_bt 5,1 c 4d p 20

# Adjust load on Pairset A to 22W
psa_set_load 5,A p 22

# Adjust load on Pairset B to 29.5W
psa_set_load 5,B p 29.5

# Wait 3 seconds, then assess power on each pairset
st_wait 3
paverage 5,1 period 1s
paverage 5,A stat
paverage 5,B stat

psa_disconnect 5,1
```

Actual execution:

The PSE powers the dual Class 4 signature PD successfully and furnishes the two different loads on each pairset.

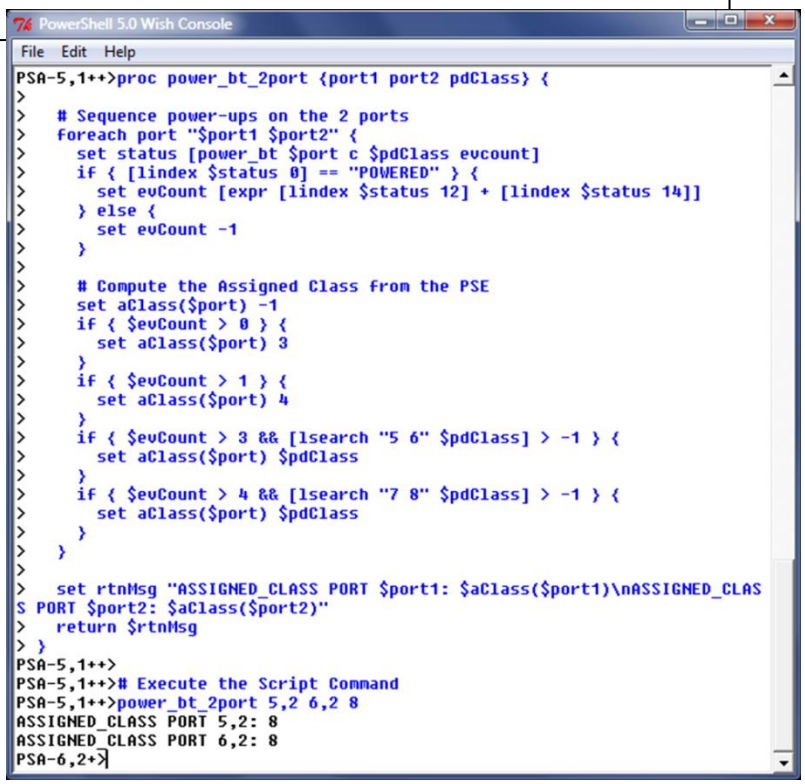


5.16.5. Power two specified ports to a user specified PD Class and return the Assigned Classes

The script will be designed to receive two test ports and a PD class, power both ports to the furnished PD class, record event counts, then return assigned class from both ports.

```
# PROC TO POWER 2 PORTS TO SPECIFIED CLASS, THEN RETURN ASSIGNED CLASS
proc power_bt_2port {port1 port2 pdClass} {

  # Sequence power-ups on the 2 ports
  foreach port "$port1 $port2" {
    set status [power_bt $port c $pdClass evcount]
    if { [lindex $status 0] == "POWERED" } {
      set evCount [expr [lindex $status 12] + [lindex $status 14]]
    } else {
      set evCount -1
    }

    # Compute the Assigned Class from the PSE
    set aClass($port) -1
    if { $evCount > 0 } {
      set aClass($port) 3
    }
    if { $evCount > 1 } {
      set aClass($port) 4
    }
    if { $evCount > 3 && [lsearch "5 6" $pdClass] > -1 } {
      set aClass($port) $pdClass
    }
    if { $evCount > 4 && [lsearch "7 8" $pdClass] > -1 } {
      set aClass($port) $pdClass
    }
  }

  set rtnMsg "ASSIGNED_CLASS PORT $port1: $aClass($port1)\nASSIGNED_CLASS
PORT $port2: $aClass($port2)"
  return $rtnMsg
}

# Execute the Script Command
power bt 2port 5,2 6,2 8
```

Actual execution:
The PSE powers both ports together and grants Class 8 power to both emulated PD's.



5.17. (Section Omitted)

5.18. (*Section Omitted*)

5.19. (*Section Omitted*)

5.20. PowerShell PSA: PSE Multi-Port Suite for 802.3at PSE's

Note: *Commands covered in section 5.20 are only available when connected to PSA or PSA-PL chassis' that are licensed for PSE Multi-Port Suite.*

5.20.1. Live 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 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.

<table>
<tr><th>Command</th><th>Slot</th><th>Command Parameters</th><th>Query</th><th>Returned Parameters</th></tr>
<tr><td rowspan="2">psa_emulate_pd</td><td rowspan="2"><port></td><td>start | stop <-noshut> <c <i>class</i> | ci <i>class_sig</i>>
<p <i>pd_power</i>> <o <i>cable_loss</i>> <alt A | B>
<pol POS | NEG> <dr <i>Rdet</i>> <dc <i>Cdet</i>>
<lldp off | connect | through> <init <i>initpwr</i>></td><td>?</td><td>PD Power
Initial Power* <i>(= ½ PD Power)</i>
OffsetPower: <i>Cable Loss</i>
LLDP status
ALT
Bus_Polarity

* <i>Intial power only has significance for LLDP power-ups.</i></td></tr>
<tr><td>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:
<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: 34.5 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.</td><td>stat <-allports></td><td>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.</td></tr>
</table>

5.20.2. 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 (or PSL) 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 7.1 as well as utility commands in Section 5.20.5 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.

Command	Command Parameters
st_config	<*PSA_ipAddr1* <**allports** | **slots** *slotRange* | **ports** *portList*>> <*PSA_ipAddr2* <**allports** | **slots** *slotRange* | **ports** *portList*>> … <*PSA_ipAddr8* <**allports** | **slots** *slotRange* | **ports** *portList*>>
Arguments may be embedded within all **mp_***_***** *test commands including* mp_sequence	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 5.20.3*) and many of the Multi-Port Test Suite utility commands in section 5.20.5. **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**
st_psa	*psa_ID*
	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 to connect. Range is 1 to 8. Associated PSA is order of PSA addresses utilized in the **st_config** command (see above).

5.20.3. 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>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

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.

<i>See section 8.9.6 for LLDP specific parameter descriptions.</i>

<i>pd_power</i> PD Power Load: Range is 0.5 to 25.5 (watts). See below for actual allowed MAX power levels. A <i>pd_power</i> parameter must be specified when initiating Multi-Port Live PD Emulation..
<i>cable_loss</i> 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 <i>power</i> and <i>offsetpwr</i> 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>
<td>stat</td>
<td>Live PD Emulation Status for all Chassis' and Test Ports in the Resource Configuration.</td>
</tr>
</table>

5.20.4. 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. The transient reserve capacity test, **mp_trans_cap**, is only available to PSA-3000 PowerSync Analyzers and is not available to PSL-3xxx Programmable Loads.

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 5.20.2).* 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 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	***(This test is not available to PSL-3000 instruments)***
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 **-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/PSL-3xxx test ports. (*Any PSA chassis' with older PSA-1200 test blades will be rejected*.)

5.20.5. 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 5.5)*
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 5.20.2* 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 5.20.3)* to perform this task. Returns status information including: **Count of Powered Ports, List of Intermittent Ports, List of Unpowered Ports, and List of Powered 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 5.20.2*) 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 section 5.20.3*) 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 section 5.20.2*). 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 section 5.20.2*). 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 section 5.20.2*). 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	***(This test is not available to PSL-3000 instruments)***

6. (Section Omitted)

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 5.20. 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 PL 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 5.20.1.

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*) and Live PD Emulation commands (*see section 5.20.1*) are fully independent of any configurations specified for the Multi-Port Test Suite discussed starting in section 7.2.

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, 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 36 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.

7.2. 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 (as performed by the PSA-3000 PSE Conformance Test Suite) 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.

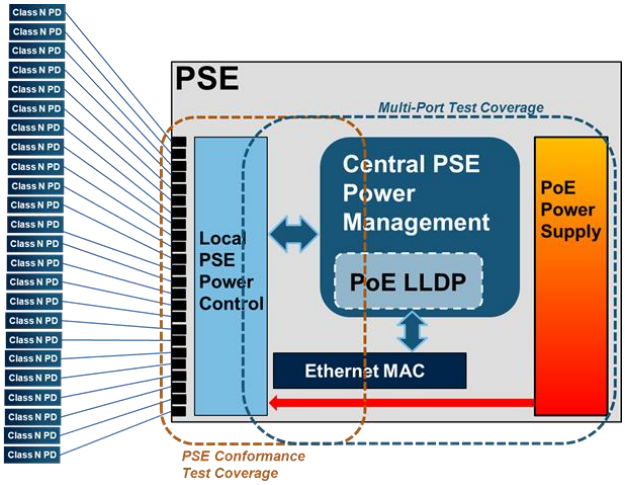


Figure 7.1 Sample Spreadsheet Report – Test Loop1 Tab

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.

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.

7.3. 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.

NOTE! *The PSL-3000 Programmable Load platform supports eight of the nine available tests within this test suite and imposes restrictions on on parameter resolutions in two of the eight supported tests. All Multi-Port tests are available to the PSA-3000 PowerSync Analyzer platform with no parameter restrictions.*

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_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.

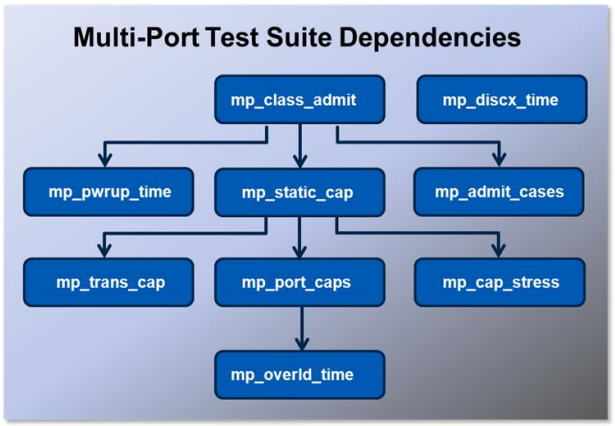


Figure 7.3 Multi-Port Test Order Dependencies

7.4. 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 PSL-3000 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.

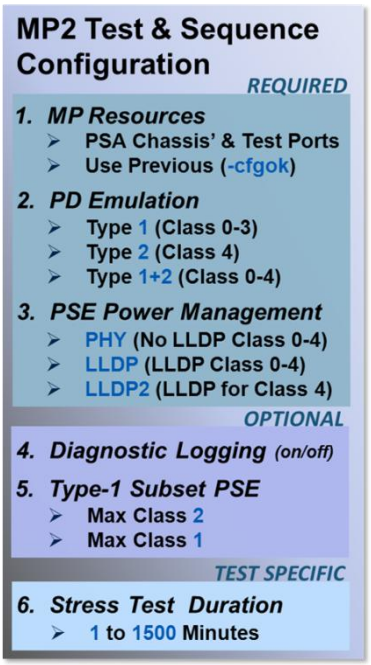


Figure 7.4 Multi-Port Test Suite - Test and Sequence Configuration

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.

7.5. Standard Multi-Port System Test Report

The 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 **Min_Pwr/port** measured in **mp_cap_ports**. This parameter captures the static power capacity of individual PSE ports while all other PSE ports are furnishing minimal output power and records the minimum value measured. This value ideally will be at least **Pclass** as defined for a PSE in IEEE 802.3at. If the measured capacity is below **Pclass**, the minimum value 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 **Static Capacity** (blue) for Type-1 and/or Type-2 PD emulations. **Transient Reserve Capacity** (gold) is not plotted because the PSL-3000 does not support the **mp_trans_cap** test in the Multi-Port Test Suite. (*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*.)

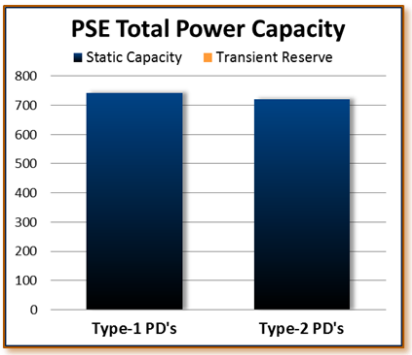


Figure 7.8 Total Power Capacity

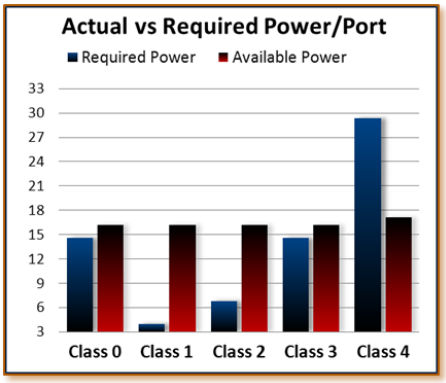


Figure 7.9 Actual vs Required Power/Port

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 ($\mathbf{I_{cut}}$) thresholds from PSE port to PSE port.

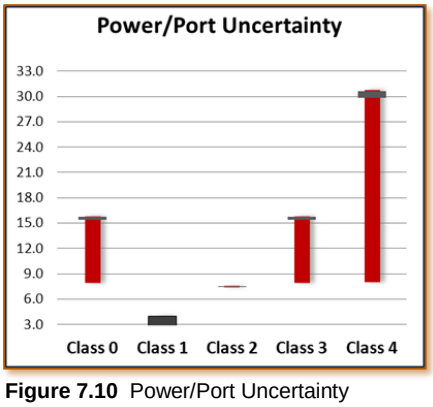


Figure 7.10 Power/Port Uncertainty

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). (**Important!** *Shutdown timing measured by the PSL-3000 is restricted to low granularity time windows, as compared to equivalent parameters measured with the PSA-3000 PowerSync Analyzer*.)

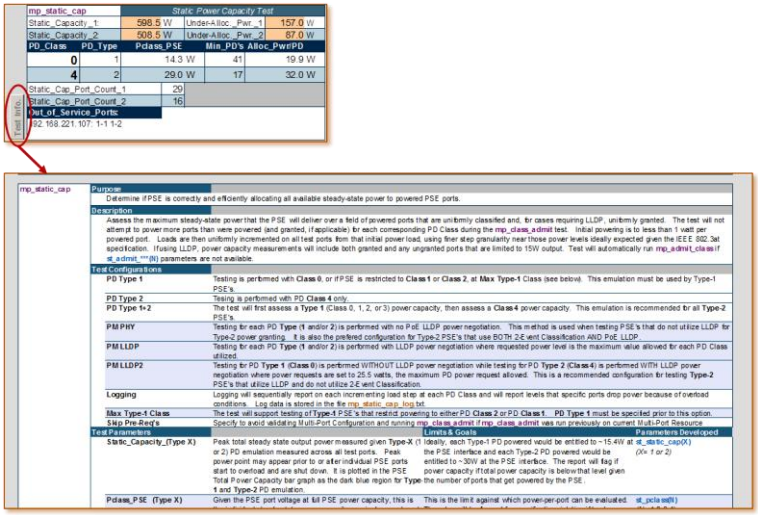


Figure 7.11 Multi-Port Report-Embedded Test Information

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.

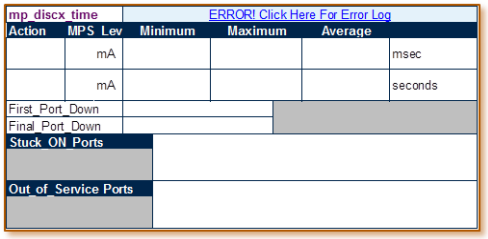


Figure 7.12 Test Error Hyperlink

7.6. 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.

Test Parameters		Limits & Goals
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.
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 $\mathbf{I_{peak}}$(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 $\mathbf{P_{class}(N)}$ 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 $\mathbf{(P_{class}(N))}$ available to support short load transients of at least $\mathbf{I_{peak}(N)}$ on all powered (and granted, if using LLDP) ports. Both $\mathbf{P_{class}(N)}$ and $\mathbf{I_{peak}(N)}$ 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, $\mathbf{P_{class}(N)}$.	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 $\mathbf{0.5*P_{class}(N)}$ 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	

7.7. Enabling the PSE Multi-Port Suite in the PowerSync Programmable Load

The **standard** PSL-3000 PowerSync Programmable Load does not enable the PSE Multi-Port Suite. Attempts to execute any of the Live PD Emulation commands or PSE Multi-Port Tests either directly or via the sequencer will yield "Invalid Command" responses to PowerShell. All PSE Multi-Port Suite Menus will be disabled in PSA Interactive when connected to a PSL-3000 chassis that does not have PSE Multi-Port Suite support.

PowerSync Programmable Load customers may elect to upgrade their instrument to support the PSE Multi-Port 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. PSL-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:

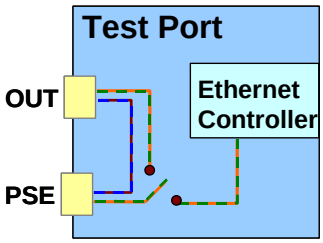


Figure 8.1: Test Port LAN Connections

- 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.

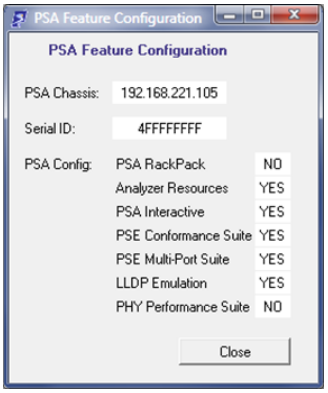


Figure 8.2: Help Features menu

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 (*not available in PSL-3000**Error! Reference source not found.***). LLDP Protocol Traces are available from the **LLDP** tab menu (*see section 4.11**Error! Reference source not found.***).

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. LLDP 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.

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.

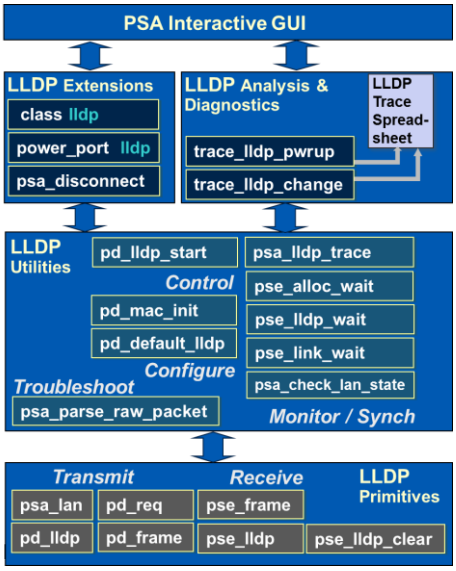


Figure 8.3 PSA Software LLDP hierarchy

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 PSL 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 PSL 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*> <**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. **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* | *nnnnnnnnnnn* <**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 all 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**> <**stat** <**raw**>> 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. **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.	**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>
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 PSL 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**>	**getall**	*List of all MAC Addresses in all PSA-3000 test ports*
		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.		

8.9.2. LLDP Emulation Control Utilities

LLDP Emulation Control utilities must be addressed to a single PSL 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 PSL 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*> <**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. **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**> 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.	**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**>	*Protocol Trace Includes*:
		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.	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 ***(PSL-3202 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 8.9.5 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 5.20.1 and 5.20.3. 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*>>	**?** *(IDLE state only)* PD Class PD Power Initial Power OffsetPower: LLDP mode ALT Bus_Polarity
		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.	**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 Section5.20.1*) <**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 5.20.2. Non-LLDP arguments are described earlier in Section 5.20.3. 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 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>
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 PSL-3000

The PowerSync Programmable Load has several features that are beneficial in testing multi-port PSE devices in an automated testing environment. Section 9 will specifically address several topics of interest in multi-port PSE testing:

- Optimizing Test Speed for High Volume Testing
- Integrating the PowerShell PSA API into Native Tcl Shells
- Launching or Managing PowerShell PSA 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. 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 Testing

Three specific strategies for optimizing (or minimizing) test time will be discussed in this section. These are:

- Rapid Port Replication
- Time Optimized Test Methods
- 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
`class 99,B 4D`	In 4-Pair Mode, configures all Alt-B pairsets to Class 4D
`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.

Some commonly used commands supporting the special **99,*x*** slot-port parameter are:

`alt`	`iload`	`vdcaverage` (*config only*)	`pd_req` (*excluding* `stat`)
`polarity`	`iload_2`	`idcaverage` (*config only*)	`pd_lldp`
`port`	`class`	`paverage` (*config only*)	`pd_frame`
`passive`	`psa_connect`	`psa_lan`	`psa_emulate_pd` (*config only*)

9.1.2. Time Optimized Test Methods

Certain higher level utilities available in PowerShell PSA such as **psa_disconnect** and **power_port** are designed to be robust at the tradeoff of execution speed. Multi-port testing can be sped up by avoiding use of general purpose utilities, especially where characteristics of a PSE are already known. Instead, lower level resource commands, coupled with rapid port replication, will combine to effect faster testing.

The following script powers up PSE ports connected to every test port in the PSL-3000 instrument using a Class 3 PD emulation. A current load of 202 mA is applied and the power draw of the first port in the instrument is measured.

```
# Determine first available slot,port in PSA chassis
set port1 "[lindex [psa_config -s] 0],1"

# Assure all ports are powered down
port 99,99 isolate
iload 99,99 i 0
after 500

# Set up all PSA ports for ALT A, MDI-X and a valid detection signature.
#   Set up classification load for Class 3.
alt 99,99 a
polarity 99,99 neg
passive 99,99 r 23 c 0
class 99,99 3

# Connect all ports simultaneously, alter port load to 202 mA after first
#   known port powers up.  Allow up to several seconds for the power-up.
set count 0
set status "OFF"
port 99,99 connect
while { $status == "OFF" && $count < 30 } {
  set status [lindex [pstatus $port1 stat] 3]
  incr count
  after 100
}
iload 99,99 i 202
set Pport [lindex [paverage $port1 period 100m stat] 3]
puts "Port $port1 Powered to $Pport Watts."
puts "All Ports Should Be Powered To Class 3."
```

Actual execution:

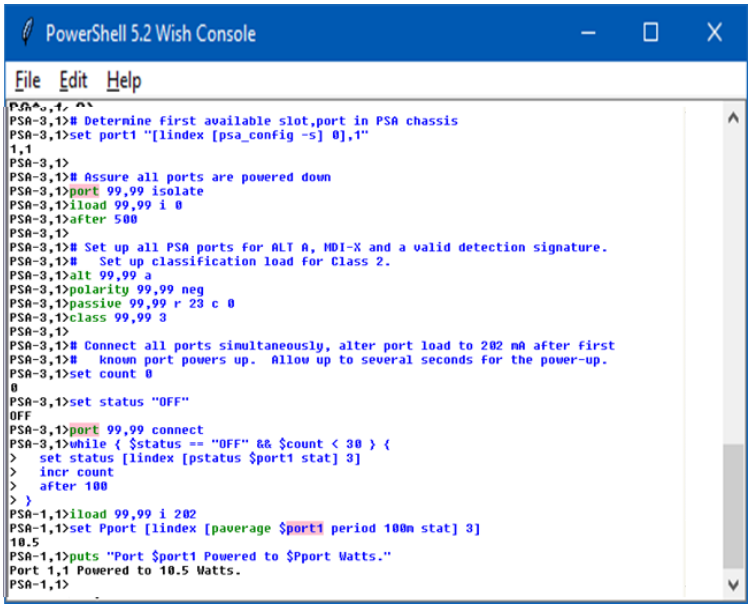


Figure 9.1 Multi-Port Power-Up to 10.5 watts

9.1.3. psl_quick_test: Fully Automated Test Script Template for 802.3at Multi-Port PSE's

PSL-3000 software includes a fully automated, multi-port PSE test script designed for high throughput and high defect coverage of PSE ports. This script, **psl_quick_test**, is provided as source code and is found in the …\Contrib\ directory (*see sections 3.2.5 and 3.2.6*).

psl_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 **psl_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
- Assesses Overload Power Removal and Power-Type Threshold
- Assesses LLDP Power Allocations*

Typical test types will range from 18 to 35 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:	55.6	55.7	55.6	55.8	55.6	55.6	56.0	55.8
Vport_High_Load:	54.8	54.9	54.9	55.0	54.7	54.8	55.1	55.0
Load_Capacity:	650	650	645	645	650	650	645	655
Power_Capacity:	35.6	35.7	35.4	35.5	35.6	35.6	35.6	36.1
Disconnects:	PASS	PASS	N/A	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:	193.0	seconds						
Test_Time/Port:	24.1	seconds						

Figure 9.2 psl_quick_test Report (8 ports tested, Type-2 LLDP capable PSE)

* LLDP Capable PSE Testing requires PSL-3000 to be enabled for LLDP Features.

9.1.4. Multi-Chassis Testing in Parallel

One other technique that can be utilized to speed up testing with the PowerSync Programmable Load is parallel execution of test scripts on multiple PSL-3000 chassis'. For example, with two chassis', two independent PowerShell PSA sessions can be opened and linked to each individual PSA chassis. Scripts may be simultaneously run in each window whereby effective execution time across all test ports (e.g. 48 ports, 24 per PSA chassis) will be halved.

PSA Software allows up to two instances of PowerShell PSA to be running at any given time. Additionally, one instance of PSA Interactive may also be running on the host computer.

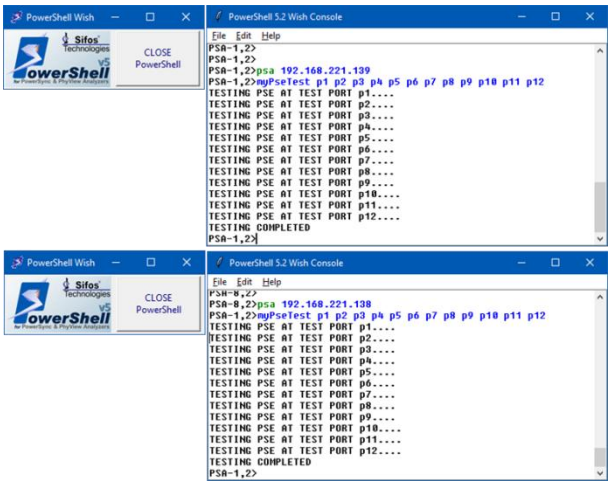


Figure 9.3 Tests Executing Simultaneously in 2 PowerShell's

9.2. (Section Omitted)

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/Tk versions 8.5 or later, and is not supported with those 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

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 includes 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** >	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.	**COMMAND_OK** | **RESPONSE** + delimited ascii string | **PowerShell_ERROR** + delimited ascii string
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
5. Script Call from PowerShell Initialization File
6. 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 signals on PoE voltages
- 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 as packets are transmitted. These are readily controlled utilizing PowerShell commands discussed earlier in section 54.12.7. During a packet transmission and capture sequence, a test script could run various scenarios of load transitions while evaluating any negative consequences to packet transmission. Similarly, any impact from data transmissions into PSE supply voltage is readily analyzed.

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**.