Sifos Technologies

PowerSync Programmable Load

PSL-3424

Technical Reference Manual

Version 5.3

Revised August 8, 2022

Sifos® Technologies

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

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1. Introduction

1.1. PSL-3424 Introduction

The PowerSync Programmable Load (PSL-3424) 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-3424 is part of the PSA-3000 family of PowerSync® Analyzers and Programmable Loads produced by Sifos Technologies. As such, the terms "PSA" and "PSA Software" will appear frequently throughout this manual as reference to that family of products that all share the same host software environments.

The PSL-3424 platform consists of two model numbers: The **PSL-3424A** and the **PSL-3424L**. The PSL-3424L is configured to emulate and analyze PoE LLDP on all test ports while the PSL-3424A does not include that particular feature. Otherwise, the two model numbers have identical features and will typically be referred to as the PSL-3424 instrument throughout this manual.

The PSL-3424 includes 24 test ports capable of drawing power from either two or four wire pairs. Each PSL-3424 test port functions as an autonomous entity to emulate PD connections and loading behaviors for the purpose of testing PSE ports. Within each test port is a collection of resources that are managed externally using **PSA software**.

The PSL-3424 is the first member of the PSA-3000 family with ability to simultaneously load up to 24 4-Pair capable PSE ports, offering the ability to draw up to 2400 watts of power continuously. This capability opens the door to sophisticated and automated tools to perform system power management testing of 802.3bt PSE's.

A standard feature of each test port is the ability to connect Ethernet (LAN) data to an adjacent test port. Each odd numbered test port (1, 3, 5… 23) has the ability to transfer 10/100/1000Base-T and Multi-Gig packet traffic to an adjacent even numbered test port (2, 4, 6…24). This configuration supports the traditional "snaked data" testing of PoE switches where all PSE ports are powered with user-configured loads and passing traffic throughout the switch fabric.

An standard feature of each PSL-3424L test port is the ability to emulate and test PoE LLDP protocol and power negotiations with LLDP-capable PSE's. In this configuration, test ports can emulate the Layer 2 LLDP negotiation behaviors of any conceivable **802.3bt** or **802.3at** PD while analyzing the LLDP behaviors of PSE ports. In the LLDP configuration, links are configured to 10/100Base-T.

The PowerSync Programmable Load is controlled from a PC (Windows or Linux) over a TCP/IP network connection (10/100BaseT). Multiple instruments of varying configuration belonging to the PSA-3000 family may be controlled from a single host PC under a common software environment. Each PSL-3424 test port works in conjunction with host software to provide various Powered Device (PD) load emulation functions along with basic PSE measurement functions.

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 PSL-3424 instrument capabilities and basic hardware resources. Additionally, Section 3 will provide an overview of the PSL-3424's software organization. An understanding of these resources will support more intuitive usage of PSL-3424 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 and efficient access to instrument resources combined with rapid means by which to "move around" among multiple ports and between various instruments. Automated PSE testing and LLDP protocol analysis is accessible using PSA Interactive. Examples are 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-3424. 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 upon the widespread and highly extendible Tcl/Tk scripting language commonly used by other Ethernet test platforms.

Section 6 (*Omitted for PSL-3424*)

Section 7 (*Omitted for PSL-3424*)

Section 8 will overview PSL-3424L **PoE LLDP Emulation and Testing** Capabilities available from PSA software. The PSL-3424L 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, 79, and 145 as ratified by the IEEE in 2019.

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. PSA-3000 PowerSync Analyzer

The PSA-3000 is the industry standard for comprehensive PoE conformance testing of any 802.3at or 802.3bt PSE. It offers a variety of feature license options including LLDP Emulation and Analysis, the 2-Pair PSE Conformance Test Suite for fully automated 802.3at PSE specification conformance testing, the 4-Pair PSE Conformance Test Suite for fully automated 802.3bt PSE specification conformance testing, and the Multi-Port Suite for 802.3at PSE system power management testing and analysis. The PSA-3000 may be flexibly configured from 2 to 24 test ports, each capable of sequencing 2-Pair and 4-Pair PSE conformance tests. The PSA-3402 is a compact, 2-Port fixed configuration of the PSA-3000 offering the conformance test suite and LLDP licensing features.

1.3.2. PVA-3000 PhyView Analyzer

The PhyView Analyzer (PVA) is designed to perform direct physical layer testing and analysis of 10/100/1000BaseT LAN ports. 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-3424 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**.

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.

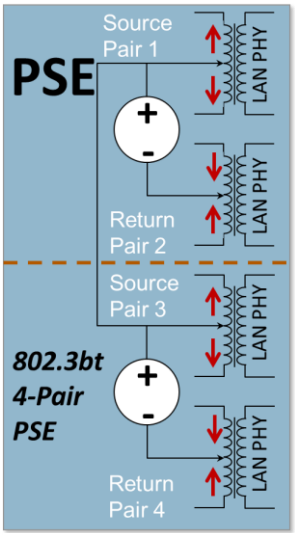


Figure 2.1 PSE Connection

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

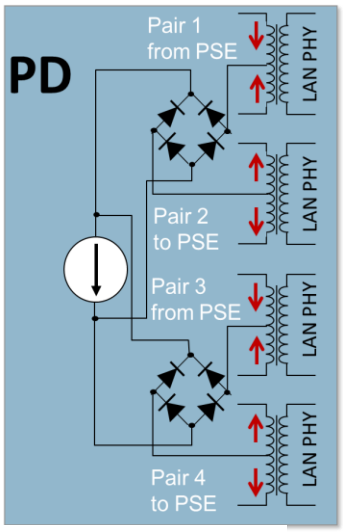


Figure 2.2 PD Connection

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.

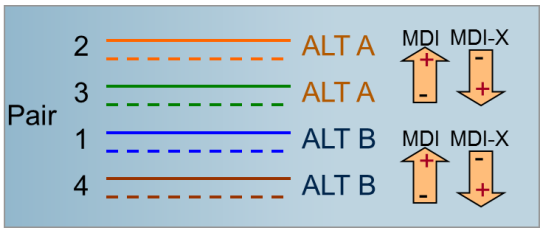


Figure 2.3 PSE Pairsets

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

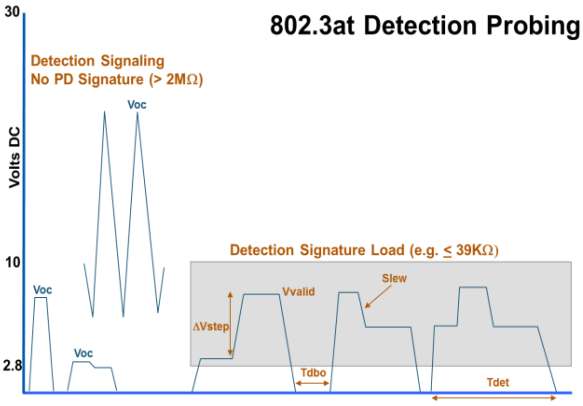


Figure 2.4 802.3 PoE Detection

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.

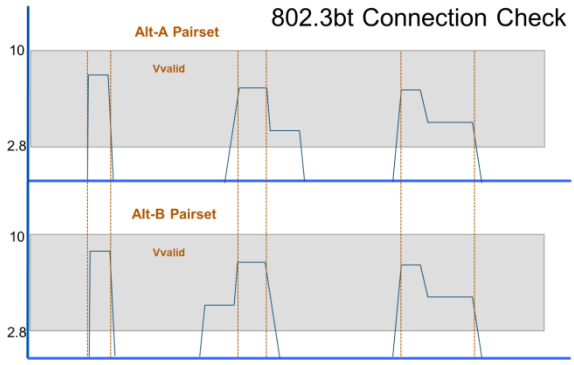


Figure 2.5 802.3bt Connection Check

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

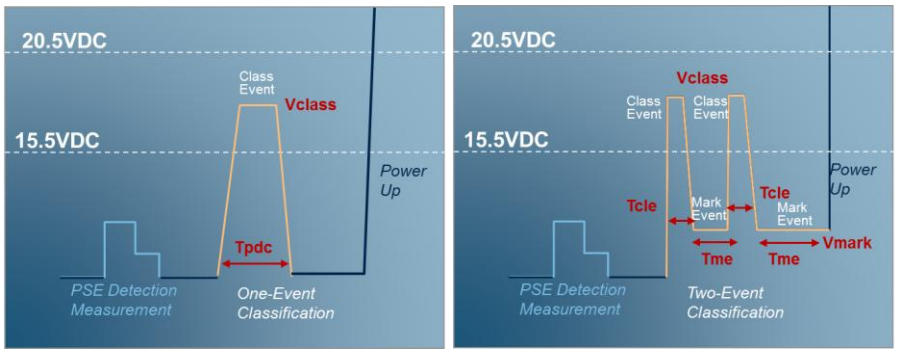


Figure 2.6 PD Classification under the **802.3at** Specification

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.

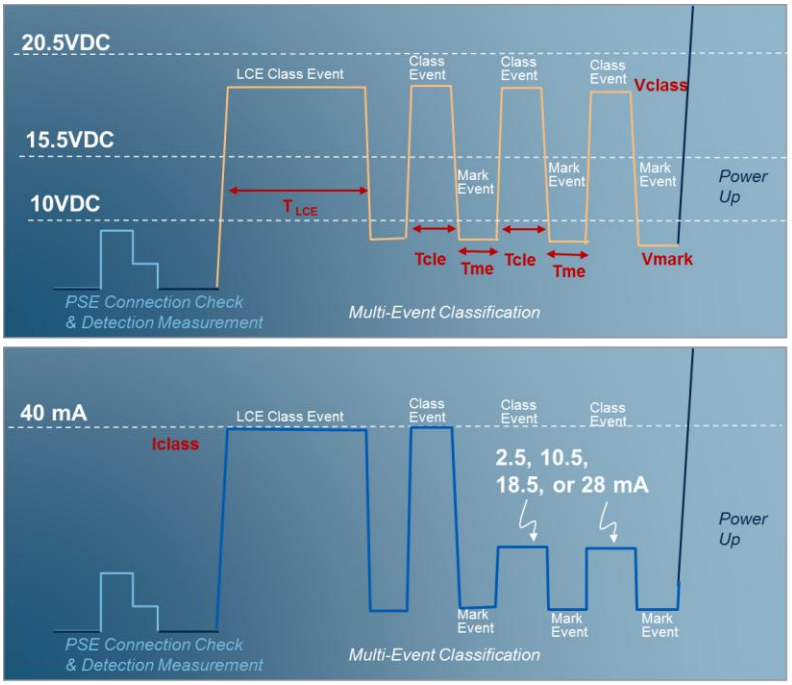


Figure 2.7 PD Classification under the 802.3bt Specification

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.

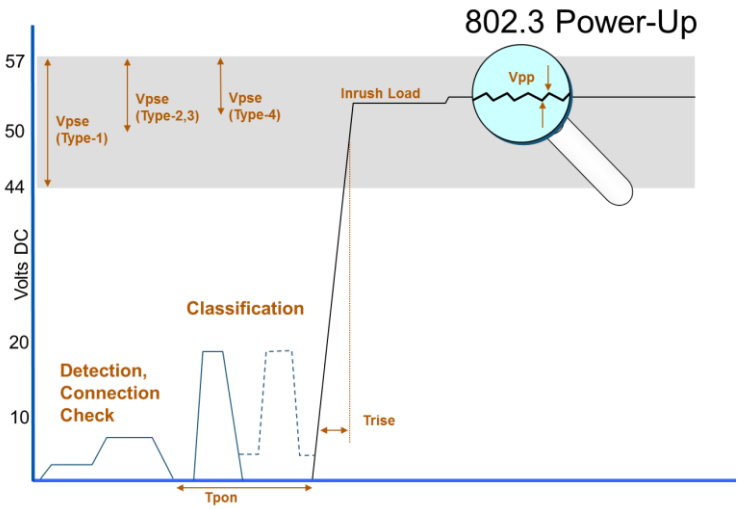


Figure 2.8 802.3 Power-Up

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.

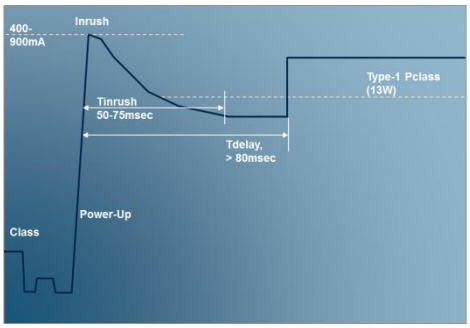


Figure 2.9 PD Inrush and Power Delay

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.

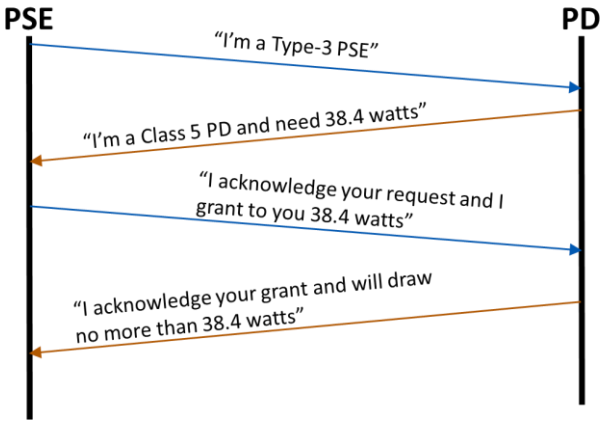


Figure 2.10 PoE LLDP Dialog/Negotiation

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:

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.

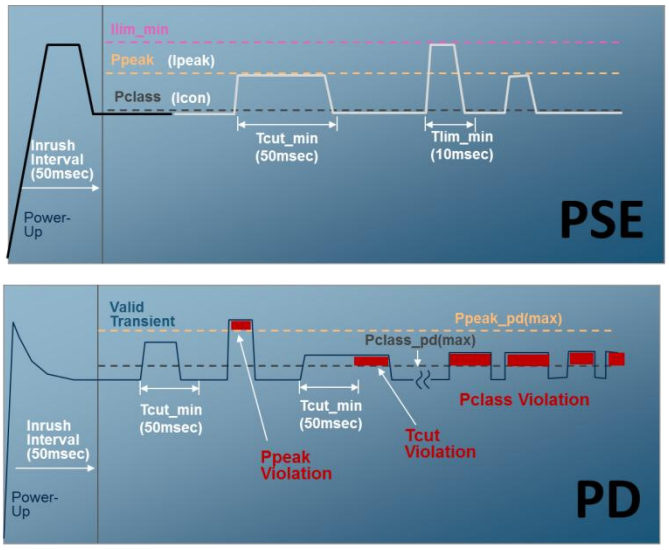


Figure 2.11 Power Regulation and PD Overloads

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.

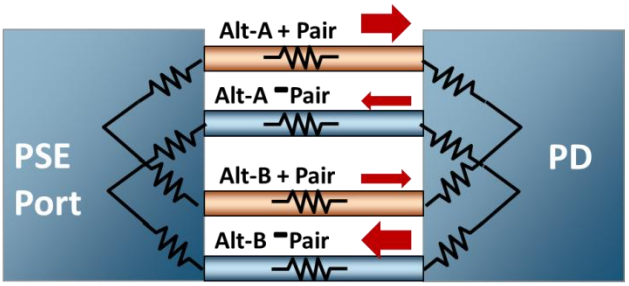


Figure 2.11 Pair-to-Pair Current Unbalance

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

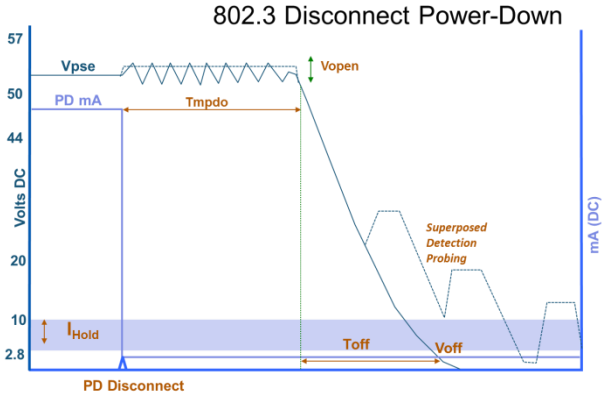


Figure 2.12 802.3 PoE Disconnect Power-Down

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.

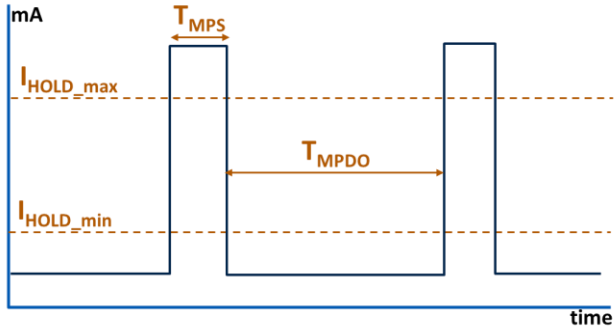


Figure 2.13 DC MPS Minimum Power State

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 PSL-3424 test port. Each test port in the PSL-3424 is electrically isolated from every other test port.

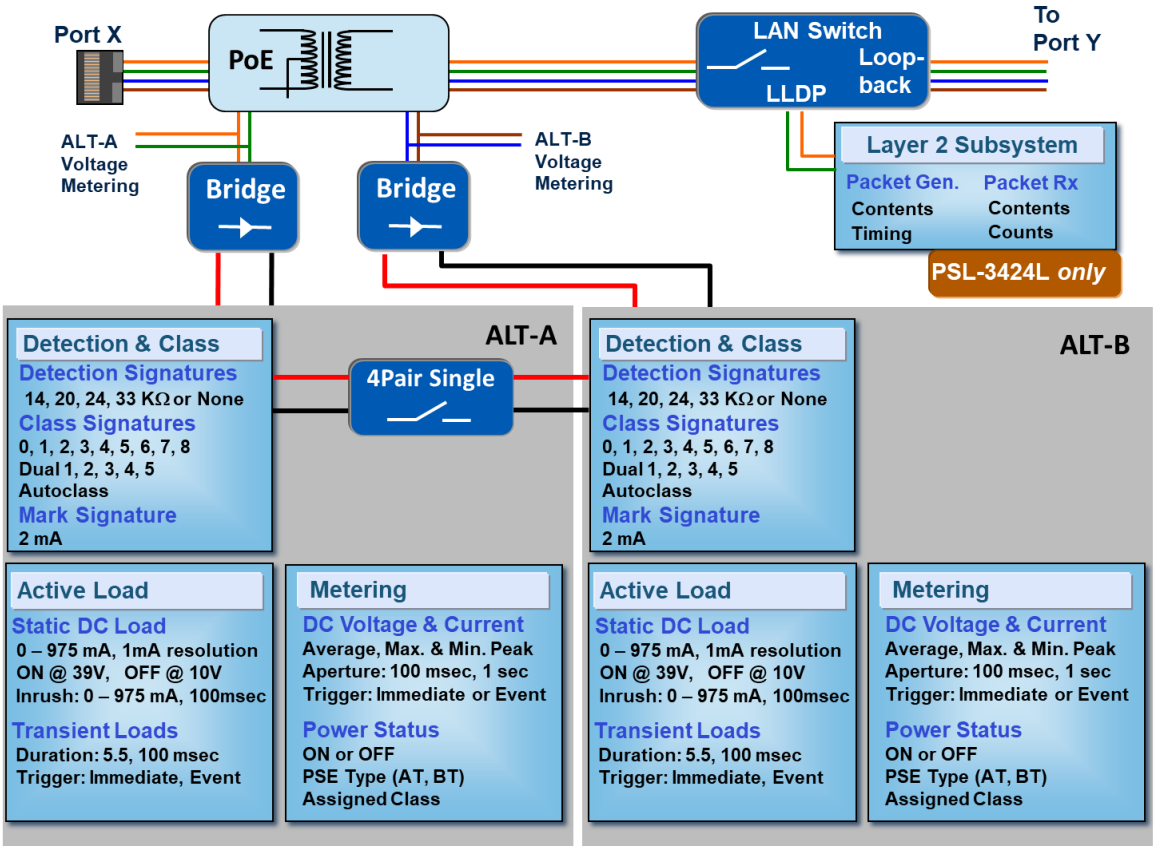


Figure 3.1 PSL-3424 Test Port Resources

From a PoE perspective, PSL-3424 test ports segregate the **Alt-A** and **Alt-B** pairsets so that PoE signatures and loading are configured independently for each pairset. When powering 2-Pair (e.g. 802.3at) PSE's, only one of the two pairsets is utilized, namely the pairset Alt-A or Alt-B, that is powered by the PSE. When powering 4-Pair (e.g. 802.3bt) PSE's, both pairsets are configured and utilized in tandem. In the special case of 4-Pair Single Signature emulation, the test port activates connections that enable the PSE to detect the single signature PD emulation where a detection signature is shared between the two pairsets.

PSA software hides much of the detail involved in managing test port resources to support powering of 2-Pair Alt-A PSE's, 2-Pair Alt-B PSE's, 4-Pair PSE's powering Single Signature PD's, and 4-Pair PSE's powering Dual Signature PD's. Once a test port is configured for one of these scenarios, software automatically adapts to control resources and measurements in a manner appropriate to the configuration.

The PSE input connector, **Port X**, is connected to a PSE device under test. The DC power and related common mode detection and classification signals are tapped off and fed to the Alt-A and Alt-B subsystems through full wave bridges that rectify voltages in either polarity on both pairsets.

After extraction of PoE, the LAN signaling pairs route to a physical switch that configures in one of three ways:

1. Unterminated: LAN signaling is isolated
2. Loop-Back: LAN signaling is coupled between odd numbered ports and even numbered ports
3. LLDP: (*PSL-3424L only*) LAN signaling is coupled to 10/100Base-T LLDP interface for emulating and testing LLDP protocols

The Alt-A and Alt-B pairsets are each routed to three categories of test port resources:

1. Detection & Classification Subsystem
2. Active Load Subsystem
3. Meters Subsystem

The paragraphs that follow will cover each of the test port subsystems in greater detail.

3.1.1. Detection/Classification Subsystem

The Detection & Classification Subsystem implements the PD detection and classification signatures that are utilized by a PSE in determining if to provide power and what the PD power demand will be (*see Section 2.6)*. These resources are available to each PoE pairset, Alt-A and Alt-B. The detection signature can be configured in the following ways:

1) Not Connected (high impedance)
2) Valid PD (20KΩ or 24KΩ)
3) Invalid PD (14KΩ or 33KΩ)

Generally, an 802.3 complaint PSE port is required to provide PoE power if the detection signature is present (connected) and in the range of 19KΩ to 26KΩ. A compliant PSE port should always reject (i.e. not power) the 14KΩ and the 33KΩ detection signatures when those are connected.

The test port can be configured to emulate both Single and Dual Signature PD's to a 4-Pair (802.3bt) powering PSE. In the **Dual Signature** configuration, each detection signature is distinct and isolated from the opposite pairset, much as if it were a separate PD. In the **Single Signature** configuration, a common detection signature is shared by both the Alt-A and Alt-B pairsets so that the PSE assesses that pairset power draw is combined inside the two full wave bridges.

When utilizing the four detection signatures to assess PSE response to valid and invalid signatures, it is *recommended* that such testing be done either in a 2-Pair configuration for 2-Pair 802.3at PSE's or in a Dual Signature configuration for 4-Pair 802.3bt PSE's. This will assure that the signatures are accurate across voltage band of 2.5V to 12V.

While detection signatures are assessed by a PSE in the band of 2.8V to 10V, classification signatures are assessed in the voltage band from 14.5V to 20.5V (*see Sections 2.7 and 2.8*). Each pairset of each test port can be flexibly configured to emulate 802.3at PD classes 0 – 4 and 802.3bt Classes 1 – 8, 802.3bt Dual Signature Classes 1 – 5, and proprietary 4-pair PD (dual) class 4. As explained in Section 2, class emulations involve sequences of one or more class events often followed by one or more mark events where voltage drops to the 7V to 10V band. Class/mark emulations performed within each pairset are designed to de-bounce signaling transition glitches that might occur so that the test port can accurately and reliably resolve the class event counts provided by the PSE in response to any particular class signature.

Each test port also offers capability to emulate 802.3bt autoclass (*see Section 2.8*) signatures when emulating single signature 802.3bt PD's.

In all test port configurations, including the 4-Pair Single Signature configuration, class signatures are implemented autonomously by the Alt-A and Alt-B pairsets. This means that detection signatures presented prior to PD classification automatically "disappear" while classification is performed by the PSE.

3.1.2. Active Load Subsystem

The **Active Load** subsystem includes a programmable current load dedicated to each pairset, Alt-A and Alt-B. This current load is activated when a pairset voltage exceeds 39 VDC from the PSE under test and it shuts off when the pairset voltage drops below 10VDC (*see Figure 3.2*).

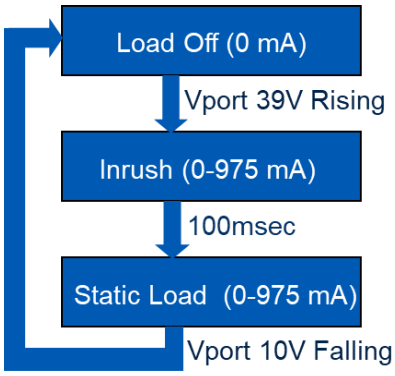


Figure 3.2 PSL-3424 Active Load State Behavior

The active load can be configured to draw between 0mA and 975mA on each pairset meaning a 4-Pair powering PSE could experience a total load current between 0mA and 1950mA. Loads are configured with resolution of 1mA per pairset.

The active load can be configured to present an initial inrush current that is different from the steady state current. The inrush current will persist for 100msec following power-up. The inrush current can be configured over the same range as the active load stead-state current. When powering to high loads, i.e. larger than 400mA per pairset, it is generally good practice to set the inrush below the steady-state load to prevent PSE's from entering a current limiting state at power-up. Conversely, PSE response to inrush overloads can be assessed by setting high inrush levels.

Because the active load is managed on a pairset basis, it is always possible to adjust pairset load levels differently when PSE's are providing 4-pair power. This capability is essential in evaluating PSE pair-to-pair unbalance tolerance and responses when emulating single signature PD's.

The active load is also capable of generating short-duration current bursts that can be used to assess PSE response to overload conditions. Short duration, 5.5msec overloads bursts may be configured to assess PSE tolerance of Ilim_min levels of current (*see Section 2.11*). Long duration, 100msec overload bursts may be used to assess PSE response to Icut/Tcut overload conditions. Transient currents are configured over the same range as steady-state currents, that is 0 to 975mA per pairset.

When testing 4-Pair capable PSE's, transient loads between the two pairsets, Alt-A and Alt-B, are fully synchronized. A transient load can be initiated either immediately (i.e. software command), or it can be "armed" so that it is initiated by a system hardware trigger called and **Event Trigger**. Event triggers (*see Figure 3.3*) originate from the PSL-3424 instrument controller and are broadcast to all of the test ports. The event trigger may be used to synchronize load transients originating from two or more test ports and also to synchronize meter measurements with the start of a load transient (*see Section **Error! Reference source not found.** below*).

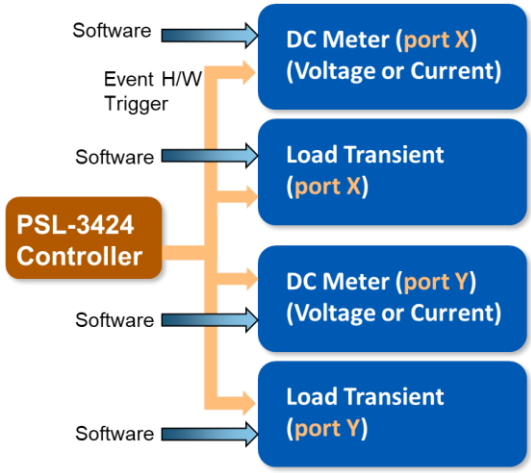


Figure 3.3 PSL-3424 Triggering

3.1.3. Meters Subsystem

Each test port offers metering of DC voltage, current, and power. As with the active load subsystem, all metering is done on a per-pairset basis.

When a PSE is powering 4-pairs (both pairsets), current metering will default to measuring 4-pair total current but may be addressed to present current on each pairset as well. Voltage measurements are always aligned to pairsets. Both 4-pair voltage and current measurements are synchronized between the two powered pairsets, that is, they are coincident.

Both the voltage and current meters can report measurements in one of three forms:

1. Average
2. Maximum Peak
3. Minimum Peak

Current metering is primarily valuable in dealing with cases where the programmed load current in the active load might not agree with the actual current provided to a pairset by the PSE. One reason for this would be a PSE that removes power meaning the active load shuts off and would measure 0mA. Another reason would be a PSE that enters a current limiting condition during an overload.

DC power metering simply involves producing the product of voltage and current measurements. In producing power measurements, voltage and current are interleaved in time, that is, they are not simultaneous.

The time window, or aperture, over which all DC metering is performed is programmable to either 100 msec or 1 second. Voltage measurements resolve to 0.1VDC, current measurements resolve to 1mA, and power measurements to 0.1 Watt.

As with active load transients (*see Section 3.1.2*), voltage and current measurements may be triggered immediately by software commands or may be triggered using the **Event Trigger** hardware system trigger (*see Figure 3.3*). The event trigger option allows multiple measurements across different test ports to be synchronized and it also allows meter measurements to be synchronized with load transients. This is a powerful capability for analyzing certain PSE responses to sudden load changes and overload conditions.

One other metering resource is the Power Status indicator. This measurement reports the powering state of a PSE port, including both pairsets when 4-pair powered. Following a PSE power-up, the measurement also reports the PSE type as either 'AT' or 'BT' and the assigned class provided to the emulated PD. This is critically important information in determining how a PSE should be tested while powered.

3.1.4. Layer 2 (LLDP Emulation) Subsystem

The **Layer 2 Subsystem** is available to PSL-3424L instruments only.

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 0).*

3.2. System Software Overview

The PSL-3424 requires externally hosted **PSA software** in order to operate. PSA software is primarily designed for the Microsoft Windows operating environment. A version is also available for Linux based hosts. PSA software consists of several distinct subsystems:

PSA Interactive: A graphical user interface designed to promote interactive use of the PSL-3424 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: (*Future feature*)

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.

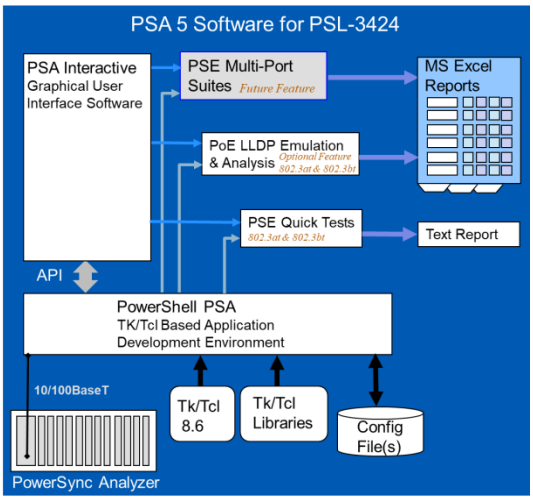


Figure 3.4 PSA Host Software Architecture

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 PSL-3424.

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.

Some 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

(Future feature.)

3.2.4. PSA Software Configuration Files

PSA 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

Parameter Type	Parameter Values	Status
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 **psl_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 PSE tab menu of PSA Interactive. All 802.3bt PSE's are required to use **DC** MPS and a majority of 802.3at PSE's use DC MPS. This attribute will be automatically learned and configured by **Auto Discover** in PSA Interactive and by the **psl_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. Initialization will automatically include all PSA chassis' that make up a PSA-3x48 RackPack PSA. 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**. Initialization will automatically include all PSA chassis' that make up a PSA-3x48 RackPack PSA. 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 0*) 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**.**

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 PSL-3424 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. Network connection latency should **never exceed 50 msec** with a goal of **0 to 20 msec** desirable. The same applies to **host process preemption** delays.

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 instrument is PowerShell PSA.

3.4. Technical Specifications

3.4.1. LAN Interface Specifications

Operating Mode	Signal Path	Parameter	Specification
Isolated	No Connection		
Data Loopback Mode	Odd Port to Even Port (e.g. Port 1 to Port 2, Port 3 to Port 4, Port 5 to Port 6, …Port 23 to Port 24)	Connections	RJ45
		Data Rates and Signaling	10/100/1000Base-T/ 2.5GBase-T/5GBase-T/ 10GBase-T
		Latency	None - Passively Coupled
		Impedance	100Ω, Balanced
		Pair-Pair Isolation	≥ 30dB @ 100MHz
		Insertion Loss	≤ 2.5dB, 1MHz to 100 MHz
		Insertion Loss Variation	≤ 1dB, 1MHz to 100 MHz
		Return Loss (OUT pairs terminated into 100Ω)	≤ -16dB, 1MHz to 100MHz
LLDP Mode	Terminate in Test Port	Data Rate and Signaling	10/100Base-T
		Protocol	802.1ab, 802.3bc, 802.3at, 802.3bt
		Impedance	100Ω, Balanced
		Return Loss	≤ -16dB, 1MHz to 100MHz

3.4.2. PoE Port Connections

Operating Mode	Dependency	Parameter	Selections
2-Pair PSE Loading	Any Port 1-24	ALT-A	Polarity MDI or MDI-X
		ALT-B	Polarity MDI or MDI-X
4-Pair PSE Loading	Any Port 1-24	Single Signature	ALT-A, MDI or MDI-X and ALT-B, MDI or MDI-X
		Dual Signature	
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

3.4.3. Detection Specifications

Description	Conditions	Parameter	Specification
Detection Resistance	2-Pair and 4-Pair Dual Signature Vport = 2.5VDC - 10VDC ΔV / ΔI at 4.5 Volt Spacing below 9.25V Port "Connected"	Valid Signatures	20 KΩ, 24 KΩ
		Invalid Signatures	≤ 14 KΩ, ≥ 33KΩ
		Valid Signature Accuracy (20KΩ)	20.6KΩ ±200Ω (*Reduce by 600Ω for Single Sig.*)
		Valid Signature Accuracy (24KΩ)	24.8KΩ ±200Ω (*Reduce by 1KΩ for Single Sig.*)
		Cut-Out Voltage	13V ± 4%
Detection Capacitance	Vport = 2.5VDC – 57VDC	Pairset Capacitance	0.05μF
		Accuracy	±20%

3.4.4. Classification Specifications

Description	Conditions	Parameter	Specification
Classification Signatures	PSE Voltage Vport = 13 – 22.5 VDC	2-Pair Classes	0, 1, 2, 3, or 4
		4-Pair Single Signature Classes	1, 2, 3, 4, 5, 6, 7,or 8
		4-Pair Dual Signature Classes	1, 2, 3, 4, 5
		4-Pair Proprietary Classes	4 (each pairset)
Class Events	PSE Voltage Vport = 13 – 22.5 VDC	Class 0 current	2.5 ± 0.4mA
		Class 1 current	10.8 ± 0.4mA
		Class 2 current	18.5 ± 0.4mA
		Class 3 current	28 ± 0.7mA
		Class 4 current	40 ± 0.8mA
		Class Stability Timing	≤ 1 msec
		Event 1 Autoclass Current	2.5 ± 1.5mA
		Event 1 Autoclass Transition Time	81.5 ± 5 msec
Mark Event Load	PSE Voltage Vport = 4 – 12VDC Following Class Events	Resistance per Pairset	10KΩ ± 2.5KΩ
Class Reset		Reset Threshold	4 VDC
		Minimum Time Duration	< 1 msec

3.4.5. Current Load Specifications

Description	Conditions	Parameter	Specification
Static Load Current	2-Pair PSE Loading	Range	0 to 975 mA
		Resolution	1.00 mA
	4-Pair PSE Loading	Range	0 to 1950 mA
		Resolution	2.00 mA
		Pairset Configuration	Autonomous, Fully Isolated
		Pairset Resolution (ALT-A, ALT-B)	1.00 mA
	2-Pair or 4-Pair PSE Loading	Slew Rates	> 2.5mA / μsec
		Activation Voltage	39V, Rising Vport
		De-Activation Voltage	10V, Falling Vport
		Default Inrush Current at Power-Up	40 mA per Pairset (80mA 4-Pair)
		Inrush Duration at Power-Up	100msec ± 1msec
		Inrush Current Range	0 to 975 mA per Pairset
Transient Load Current	2-Pair PSE Loading	Range	0 to 975 mA
		Resolution	1.00 mA
	4-Pair PSE Loading	Range	0 to 1950 mA
		Resolution	2.00 mA
	2-Pair or 4-Pair PSE Loading	Trigger Mode	**Immediate** or **Event Trigger**[1]
		Duration = "Short"	5.5 msec
		Duration = "Long"	100 msec
		Duration = "Hold"	Indefinite

1 **Event Trigger** is used to synchronize transient loads across test ports and also with meter measurements

3.4.6. DC Metering Specifications

Description	Conditions	Parameter	Specification
Voltage Meter	Average, Max. Peak, or Min. Peak each Pairset	Voltage Range	0 - 58V
		Measurement Apertures	100 msec, 1 sec
		Sample Rate (100 msec aperture)	390 μsec
		Sample Rate (1 sec aperture)	3.9 msec
		Resolution	30 mV
		Accuracy: ≥ 2 VDC[1]	± (2% reading + 0.3 V)
		Accuracy: < 2 VDC	+0.75V, -0.3V
		Trigger Mode	**Immediate** or **Event Trigger**[2]
Current Meter	2-Pair or Pairset Average, Max. Peak, or Min. Peak	Current Range	0 – 1000 mA
		Resolution	0.1 mA

Description	Conditions	Parameter	Specification
	4-Pair Average, Max. Peak, or Min. Peak	Current Range	0 – 2000 mA
		Resolution	0.2 mA
	Average, Max. Peak, or Min. Peak 2-Pair or 4-Pair	Measurement Apertures	100 msec, 1 sec
		Sample Rate (100 msec aperture)	390 µsec
		Sample Rate (1 sec aperture)	3.9 msec
		Accuracy	± (1% reading + 2.5 mA)
		Trigger Modes	**Immediate** or **Event Trigger**[2]
Power Meter	2-Pair Average	Range	0 – 57W
		Resolution	0.1 W
	4-Pair Average	Range	0 – 114W
		Resolution	0.2 W
Power Meter	2-Pair or 4-Pair Average	Measurement Apertures	100 msec, 1 sec
		Sample Rate (100 msec aperture)	390 µsec
		Sample Rate (1 sec aperture)	3.9 msec
		Accuracy	± (4% reading + 0.2W)
		Trigger Mode	**Immediate**

1 Does not include Voltage drop due to cable losses and 0.3Ω maximum test port input resistance.
2 **Event Trigger** is used to synchronize meter measurements across test ports and also with transient loads

3.4.7. Front Panel PSA-3202 LED Indicators

LED Label	Parameter	Description
Top LED	ALT-A Power & Activity	**GREEN**: ALT-A Pairset Powered **OFF**: ALT-A Pairset Not Powered **AMBER** (Blink): Test port command/query activity
Bottom LED	ALT-B Power & LAN	**GREEN**: ALT-B Pairset Powered **OFF**: ALT-B Pairset Not Powered **AMBER** (Blink Fast): Test port configured for LLDP **AMBER** (Blink Slow): Test port configured for Loop Back (snaked data)

3.4.8. Programming and Control

Description	Specification
Interface	Ethernet 10/100BaseT **NOTE**: The **Console** interface is for IP Address config only.
Host Requirements	PC running Microsoft Windows XP, Vista, 7, 8, 10, or Linux PC (Fedora, SUSE, Debian)
Control Environment	Sifos PowerShell PSA or PSA Interactive PL
Recommended Network Latency:	< 50 msec

3.4.9. Physical and Environmental

Description	Specification
Dimensions	19"W x 5.25"H x 12"L (3U Rack Mount)
Weight	24.8 lbs.
Power	100VAC-240VAC, 50-60 Hz, 1.35A Max.
Ambient Operating Temperature	0°C to 40°C (≤ 100W per test port)
Max Fan Air Flow	~300[1] CFM
Storage Temperature	-20°C to 85°C
Operating Humidity	5% to 95% RH, Non-Condensing.

1 Relative to Reach Technology PoE5, maximum Fan Noise is 14.8dB quieter wideband and 18dB quieter above 1KHz

3.4.10. Certifications

Description	North America	Europe & International
Safety	**CSA Listed** (CSA22.2 No. 61010)	EN61010-2 (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 family instrument to which PSA Interactive will initially connect *(see **Figure 4.1**)*. The default selection will be the *most recently* connected PSA instrument.

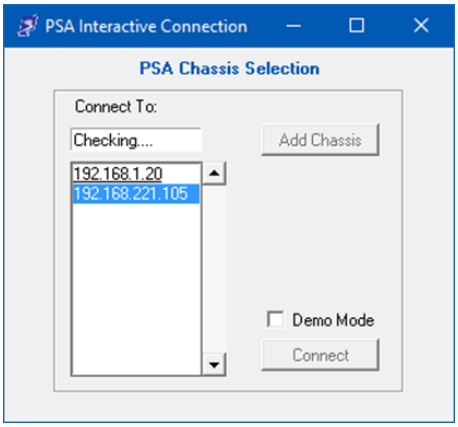


Figure 4.1 PSA Connection Dialog

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* instrument 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 recently connected to the network.

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

4.1. The PSL-3424 Interactive Port Selection Panel

When PSA Interactive initially opens, two windows appear:

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

The PSL-3424 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 stimulus/ measurements on a PSE port. When connecting to other instruments in the PSA-3000 family, this panel will alter to fit the structure and characteristics of that instrument.

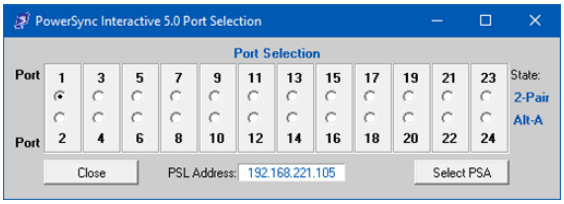


Figure 4.2 PSA Interactive Slot-Port Panel

The PSL-3424 Port Selection panel indicates the instrument type (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 port can be configured for 2-Pair or 4-Pair PSE interfacing. When a selected test port is in a 2-Pair configuration, the port **State** is indicated as 2-Pair Alt-A (*see **Figure 4.2***) or 2-Pair Alt-B. See Section 0 below for information regarding the configuration of a test port **State**. If different test ports are in different states, then this indicator will update as ports are selected.

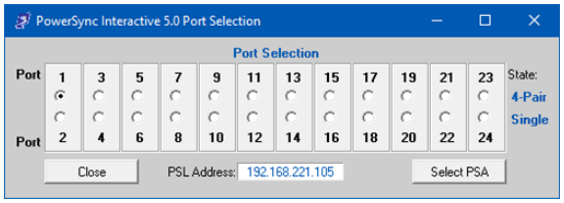


Figure 4.3 Selected Test Port in 4-Pair Single Config.

When a test port is configured for 4-Pair PSE interfacing, it will either be in a 4-Pair Single signature or 4-Pair Dual signature configuration. These two states are depicted respectively in **Figure 4.3** and **Figure 4.4**.

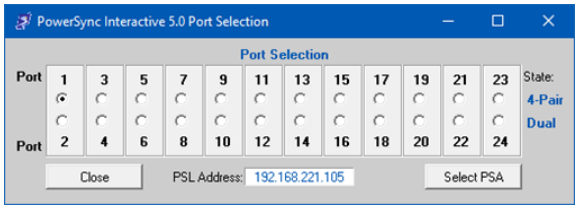


Figure 4.4 Selected Test Port in 4-Pair Dual Config.

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***).

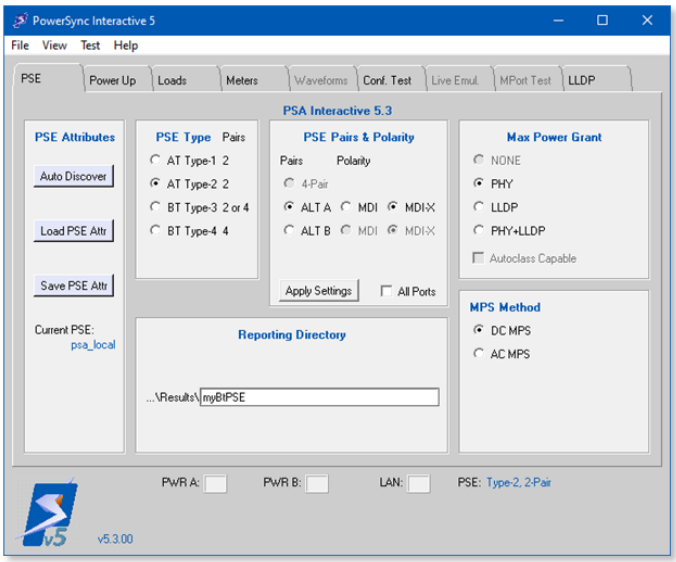


Figure 4.6 PSE Tab Menu

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 must declare 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 PSL-3424 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 ports 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** (Type-3 and Type-4) 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 declared as **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

When working with a PSL-3424, PSA Interactive can automatically discover all relevant PSE attributes and then automatically configure all test ports accordingly. These attributes include **PSE Type** (AT Type-1, AT Type-2, BT Type-3, or BT Type-4), **Powered Pairs** (ALT A, ALT B, or 4-Pair), **Max Power Grant** (NONE, PHY, or LLDP), and **MPS Method** (DC or AC).

Important! **LLDP** granting PSE's can only be discerned by the PSL-3424L. The PSL-3424A auto-discover will not fully resolve Max Power Grant unless the PSE is a PHY granting PSE.

The polarity configuration of the powered pairs, MDI vs MDI-X, is not determined by the PSL-3424 auto-discovery process nor is this PSE attribute relevant to PSL-3424 test ports because those ports are polarity neutral (*see **Figure 3.1***).

To begin the auto-discovery process, the user simply presses the **Auto Discover** button to open the Auto Discover Dialog menu (*see **Figure 4.7***). Pressing the Start button then initiates the discovery on the currently selected test port in the PSL-3424 Port Selection panel.

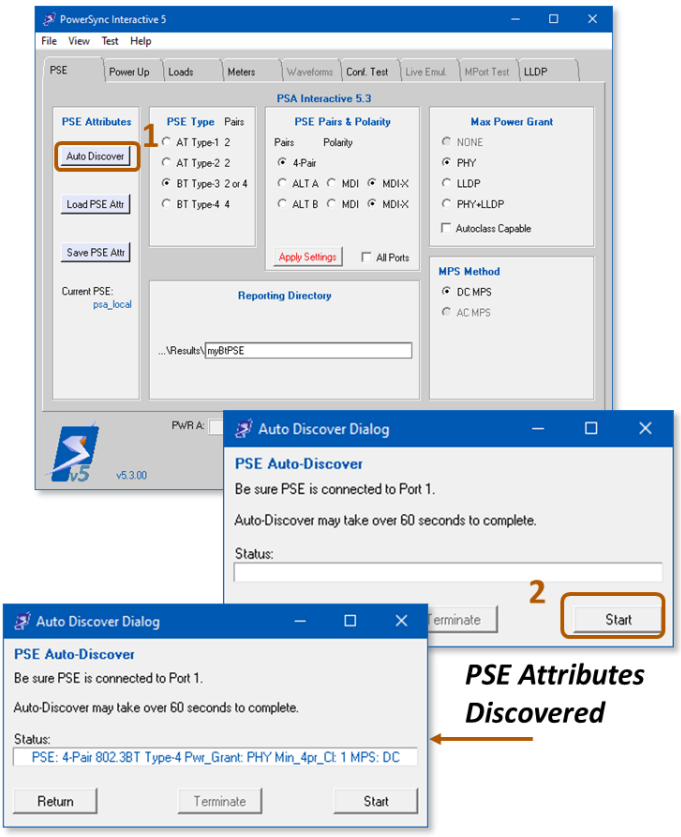


Figure 4.7 PSE Attributes Auto-Discovery

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 (*see **Figure 4.7***) and all of the slots and test ports in the PSA instrument will be configured according to the powered pairset(s) (2-pair Alt-A, 2-Pair Alt-B, or 4-Pair). Pressing the **Terminate** button will abort an auto-discovery immediately.

Pressing the **Return** button closes the Auto Discover Dialog and re-activates the PSE tab menu window. The PSE Type and Powered Pairs displayed in the lower right corner of the main PSA Interactive window (*see **Figures 4.6** and **4.8***) will update automatically to the discovered PSE attributes.

4.2.3. Saving and Loading PSE Attributes

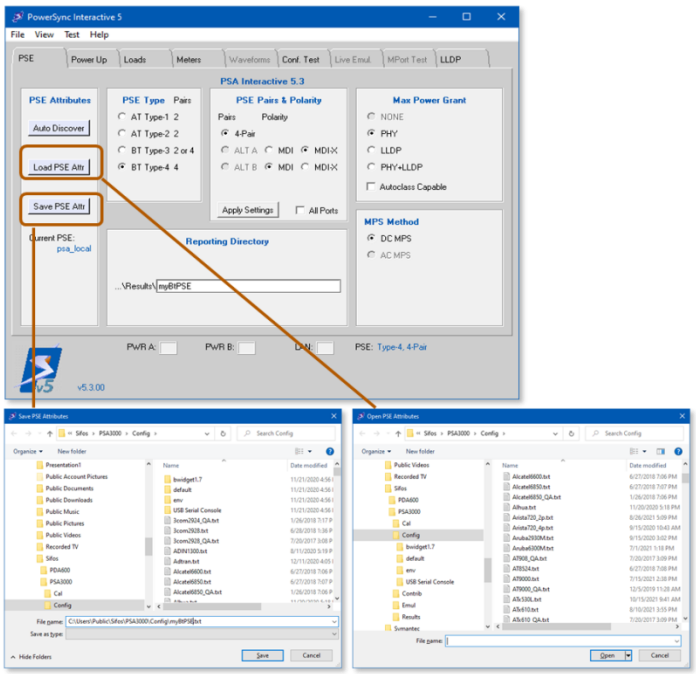


Figure 4.8 Saving and Loading PSE Attributes

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 test ports in the presently connected instrument are automatically updated to the powered pairs configuration 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
5.

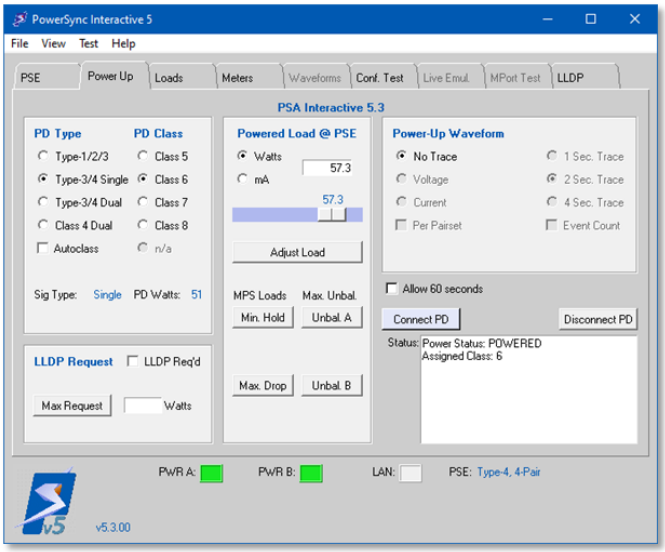


Figure 4.9 The Power-Up Tab Menu: Class 6 PD Emulation

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.

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.

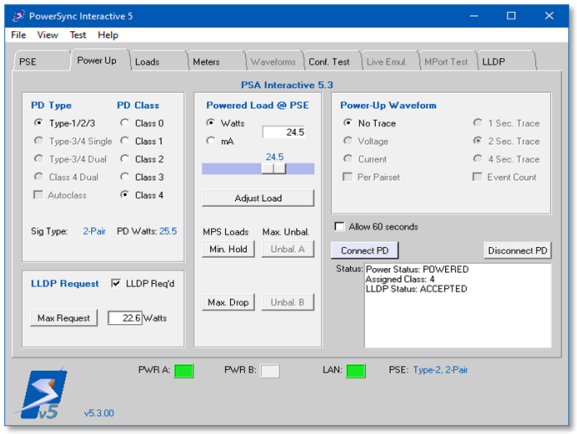


Figure 4.10 2-Pair Power-Up of Class 4 PSE

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**.

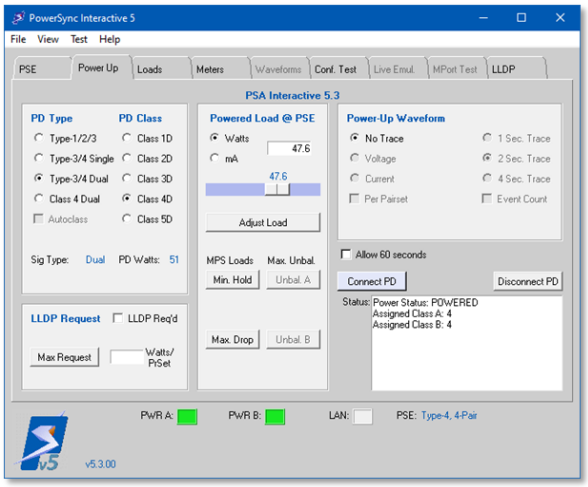


Figure 4.11 Power-Up 802.3bt Dual (Class 4) Signature PD

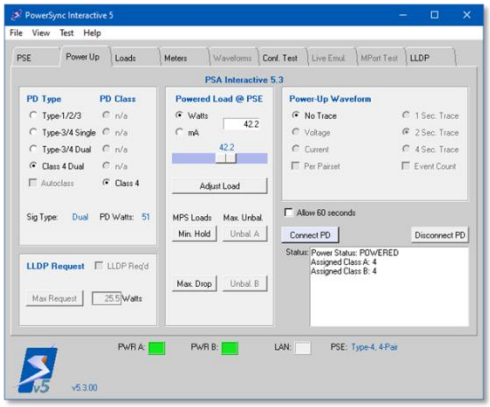


Figure 4.12 Power-Up of Pre-Standard 4-Pair PD

In general, the available **PD Types** (and associated PD Classes) are always governed by PSE attributes established using the **PSE** tab menu. Given a Type-1 or Type-2 PSE, the only PD Type available will be **Type 1/2/3**. Given a Type-3 or Type-4 PSE, the other PD Types, **Type-3/4 Single**, **Type-3/4 Dual**, and **Class 4 Dual** will be available.

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 the PSE applies power to the emulated PD, the **Status** will also describe the assigned class to the PD at power-up (*see Section 2.8*). The assigned class indicates what power level the PSE can furnish to the emulated PD.

The PSL-3424 does not support **Power Up Waveforms** so those controls are always disabled. The **Event Count** control is also disabled because the PSL-3424 directly reports the assigned class with every power-up status.

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 (*PSL-3424L only*)

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.

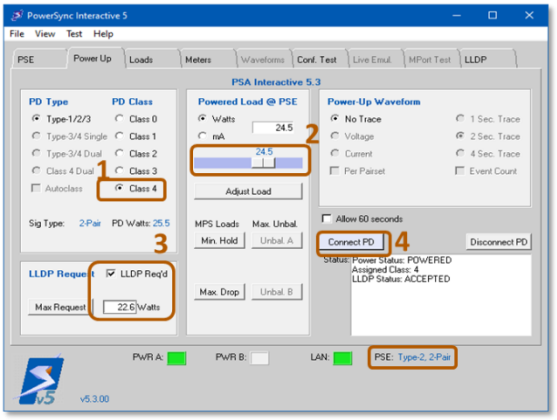


Figure 4.13 LLDP Power-Up of Emulated Class 4 PD

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 0 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
802.3at **LLDP Power-Ups**	PSL-3424L	Type-1/2/3
802.3bt **LLDP Power-Ups**	PSL-3424L	Type-3/4 Single Type-3/4 Dual
Autoclass Emulation	PSL-3424A, PSL-3424L	Type-3/4 Single
Max Unbalance Emulations	PSL-3424A, PSL-3424L	Type-3/4 Single
Allow 60 second wait for power-up	PSL-3424A, PSL-3424L	Any

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.

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 selectable 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. 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 selected or entered power load will be applied 100msec after the PSE applies power. During the first 100msec, a "default" start-up current restricted to 40mA per pairset will be applied. 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**.

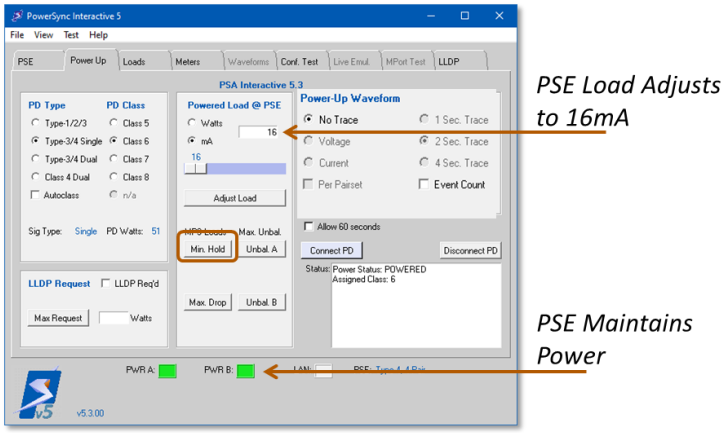


Figure 4.18 Maximum Hold Current Load

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

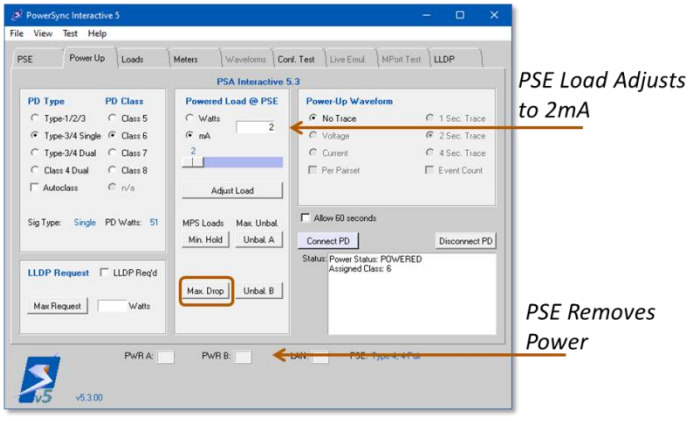


Figure 4.19 Minimum Drop Current Load

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

The topic of pair-to-pair current unbalance was addressed earlier in section 2.12. When **Type-3/4 Single** (PD **Class 5**, **Class 6**, **Class 7**, or **Class 8**) are emulated, the **Max Unbal** pushbutton loads become available. The **Unbal. A** button (*see **Figure 4.20***) alters the 4-pair current load to a total load just below the 802.3bt **Icon** (or **Pclass**) limit given the present **PD Class** emulation, then splits the load between the Alt-A pairset and the Alt-B pairset so that the maximum possible pair-to-pair unbalance current appears on the Alt-A pairset. In **Figure 4.20**, a PD Class 5 emulated power-up was done, then pressing the **Unbal. A** button caused the 4-pair load to adjust to 766mA 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.

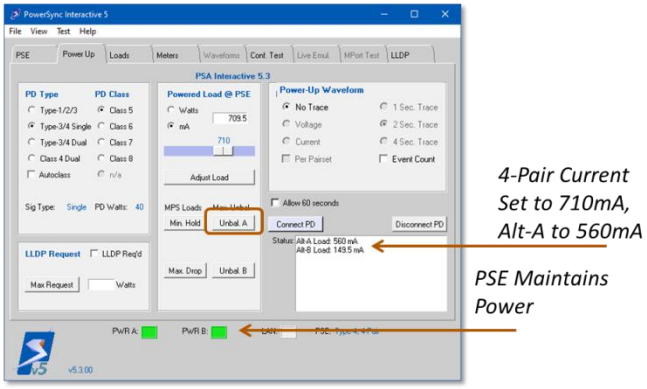


Figure 4.20 Alt A Maximum Unbalance Current

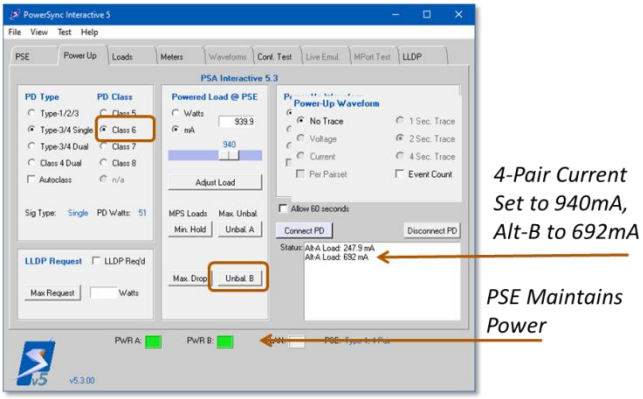


Figure 4.21 Alt B Maximum Unbalance Current

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 4.21**, an emulated Class 6 PD draws a 4-pair current of 1006mA 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.

4.4. The Loads Tab Menu

The **Loads** tab menu (*see **Figure 4.22***) provides access to several elemental test port resources:

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

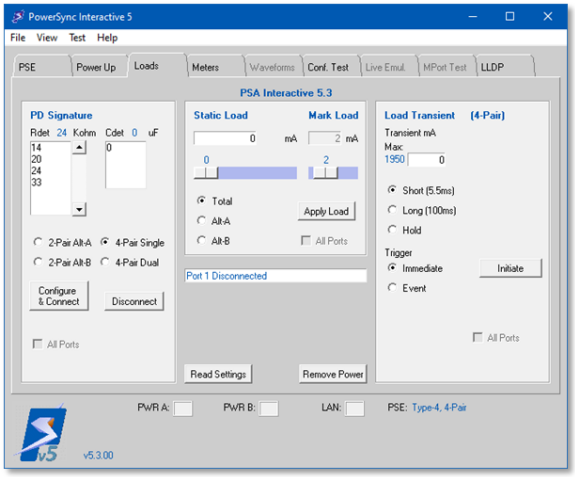


Figure 4.22 The Loads Tab Menu

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 Port Selection Panel.

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 Alt-A**, **2-Pair Alt-B**, **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 port will be updated on the PSL-3424 Port Panel (*see **Figure 4.3***).

When the **Loads** tab menu is first selected, the default signature type will be either **2-Pair Alt-A** or **2-Pair Alt-B** 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. PSE attribute settings in the **PSE** tab menu will determine this but will not constrain alterations to the PD signature type that are subsequently performed.

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 options include 14KΩ, 20KΩ, 24KΩ, and 33KΩ. Generally, the 14KΩ and 33KΩ are invalid signatures that should inhibit PSE powering while 20Ω and 24KΩ are valid signatures that should enable PSE powering. **Important!** It is recommended that detection signature stimulus-response testing of a PSE be done with PD signature types **2-Pair Alt-A**, **2-Pair Alt-B**, or **4-Pair Dual** as certain PSE technologies might respond abnormally to the 20K Ω or the 33K Ω detection resistance when in **4-Pair Single** mode.

In the PSL-3424, detection capacitance is fixed at .05μF, shown as "**0**" in the menu.

The detection resistance, once selected, is applied when the **Configure & Connect** button is pressed. At that point the status box will update to indicate Port x,y Connected (*see **Figure 4.23***). 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 and **Rdet**) to all test ports or test slots in the presently connected instrument when **Configure & Connect** is pressed. This option is inhibited when all ports are not already in a uniform pair state.

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 4.23***) is the current that the PSE will experience when the PSE output voltage exceeds 39VDC.

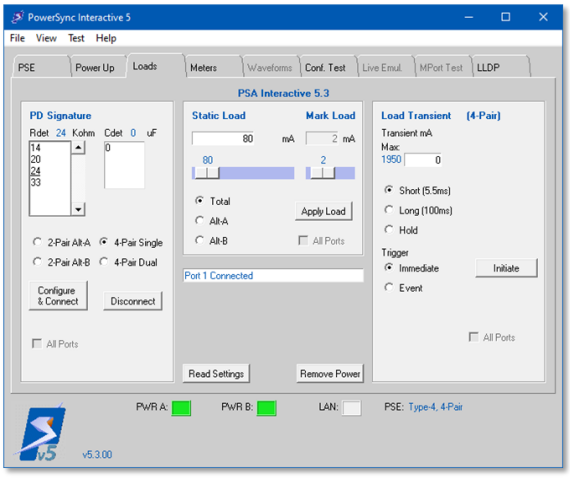


Figure 4.23 Class 4 Power-Up, 24KΩ Single Signature

The **Static Load** can be configured to a single pairset, as it always is when the signature type is **2-Pair Alt-A** or **2-Pair Alt B**, 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 Alt-A** or **2-Pair Alt-B**, as it generally should be when evaluating Type-1, 2-Pair and Type-2, 2-Pair PSE's, the load shown is the 2-pair current meaning it is always the **Total** current.

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

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

Signature Type	Load Target	Max. Current
2-Pair Alt-A or 2-Pair Alt-B	Total	975 mA
4-Pair Single or 4-Pair Dual	Total	1950 mA
4-Pair Single or 4-Pair Dual	Alt-A or Alt-B	975 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 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 11V 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. With the PSL-3424, it is a fixed value of approximately 2mA.

The **Static Load** may be applied to every test port in the presently connected test instrument by selecting the **All Ports** check button before pressing **Apply Load**. As with detection signatures, this option is only available when all test ports are configured with the same signature type (e.g. 4-Pair Single).

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 class signature that will be utilized during that power-up will be *the most recent classification configured for the selected test port*, for example, in using the **Power Up** tab menu or the **LLDP** tab menu. Generally, the presently configured class signature won't impact the PSE's decision to apply power but it will affect the magnitude of load current that the PSE will accept once powered.

Proir to connecting the virtual PD, the **Static Load** should generally be set to at or above the minimum DC MPS valid load (*see Section 2.13*) current if the objective is for a PSE port to stay powered. For example 16 mA or higher should do this for most all PSE's.

Important! Finally, if the sole intent of using the **Loads** tab menu is to adjust static load current or apply transient 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.

4.4.4. Configuring and Applying Load Transients

Load transients are limited duration load current alterations. Using the Loads tab menu, transient currents can be configured and applied in order to create a meaningful stimulus to the PSE port while the PSE port is powered. Examples would be peak currents that the PSE should tolerate and peak currents that the PSE should cause the PSE to remove power.

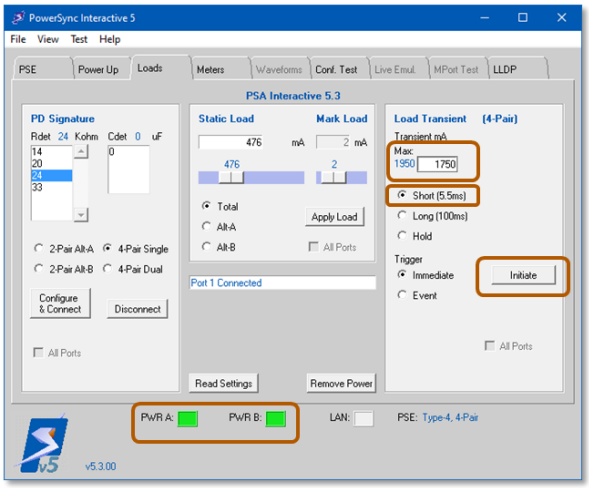


Figure 4.24 Short Duration 1750mA Transient

A load transient configuration (*see* ***Figure 4.24***) includes three components:

1. Transient Current level (mA)
2. Transient Duration
3. Trigger Method

The **Load Transient** current, like the **Static Load** level, ranges from 0mA to a maximum of 975mA for 2-Pair powering and 1950mA for 4-Pair powering. The value of the load transient current is totally independent of the static load current.

A **Short** duration transient is applied for 5.5msec. This is an appropriate duration for testing PSE responses to 802.3 parameters such as **Ipeak** and **Ilim_min** (*see Section 2.11*) where PSE's are required to maintain power.

A **Long** duration transient (see **Figure 4.25**) is applied for 100msec. This is an appropriate duration for assessing PSE responses to **Icut**/**Tcut** and **Ilim** overload shutdowns (*again see Section 2.11*).

A third "duration" option is **Hold**. With this selection, the transient simply causes the static load current to adjust to the **Transient mA** value indefinitely. This feature can be used with the **Event** triggering option described below to synchronize load changes on many test ports.

When the **Trigger** selected is **Immediate**, the load transient will be applied when the **Initiate** button is pressed.

A second triggering option is **Event**. When **Event** is selected and **Initiate** is pressed, the load transient configured will be ARMED but will not get applied until the **Trigger Now** button in the **Meters** tab menu is pressed (*see Section 0*). This method of triggering allows load transients to be simultaneously initiated on multiple test ports. It also allows meter measurements such as peak voltage or peak current to be performed coincident with the applied load transient.

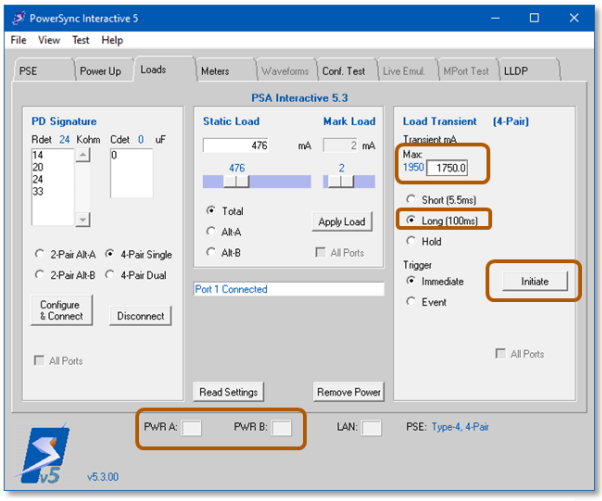


Figure 4.25 Long Duration 1750mA Transient

In Figure 4.24, a 5.5msec, 4-Pair load transient of 1.75A is applied to the currently selected test port and the response of the PSE port is to maintain power. In Figure 4.25, a 100msec duration load transient of the same current magnitude is applied and the response of the PSE port is to remove power.

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 the meter settings from the presently selected port in the Port Selection Panel.

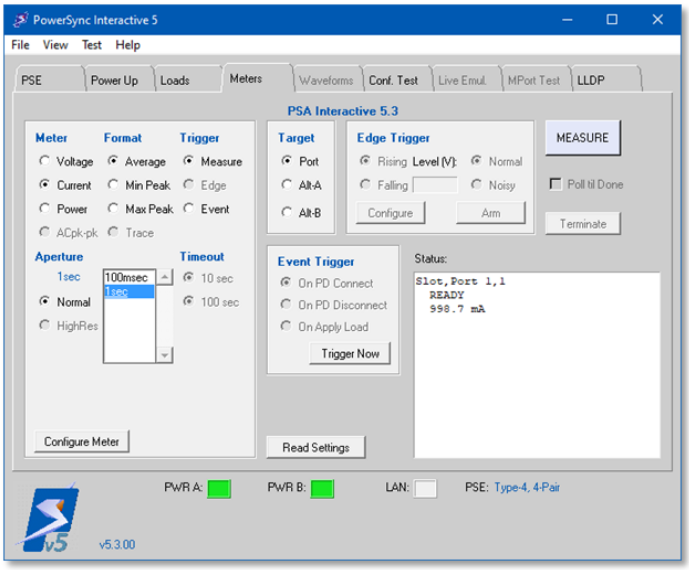


Figure 4.26 The Meters Tab Menu

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-3424** instruments, there are three **Format** options available to the **Voltage** and **Current** meters; **Average**, **Minimum Peak**, and **Maximum Peak**. Additionally, there are two **Trigger** options available to these meters; **Measure** and **Event**.

Selecting the **Measure** trigger option means the measurement is performed and reported when the **MEASURE** button is pressed. **Important!** The **MEASURE** button will perform the operation of configuring the presently selected meter type to the presently selected **Aperture** and **Trigger** setting meaning there is no need to press the **Configure Meter** button when the **Aperture** or **Trigger** setting is altered prior to a measurement being performed.

The **Event** trigger option means that the measurement is ARMED when the **MEASURE** button is pressed and will initiate at some later time when the **Trigger Now** button is pressed. This feature allows measurements to be "cued up" on multiple test ports, then all initiated at the same time using the event trigger mechanism (*see Section 3.1.3*). Further, it allows a **Min Peak** or **Max Peak** measurement to be synchronized to a Load Transient (*see Section 3.1.2*). When **Event** triggering is utilized, the selected meter will remain in the ARMED state for approximately 10 – 15 seconds whereupon it will enter a TIMEOUT state if the **Trigger Now** button is not pressed.

The **Power** meter offers only the **Average** format and the **Measure** trigger. All three meters offer two **Aperture**, or measurement duration options: **100msec** or **1sec**.

The meter type frame also includes a **Configure Meter** button. This can be used to apply the presently selected **Aperture** and **Trigger** 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.

4.6. The Waveforms Tab Menu

The **Waveforms** tab menu is not available to PSL-3424 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 0. The **Exit** option closes PSA Interactive.

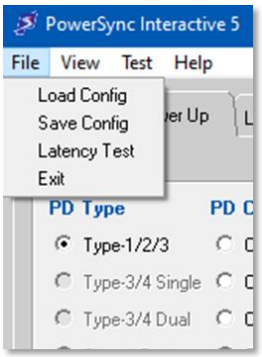


Figure 4.50 File Menu

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*).

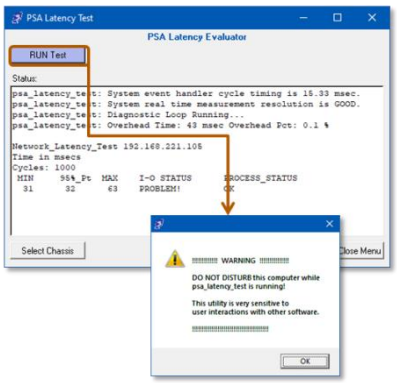


Figure 4.51 Latency Test

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

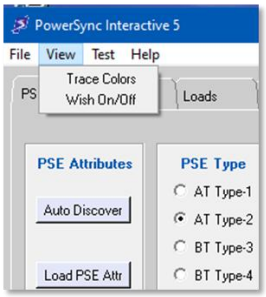


Figure 4.52 View Menu

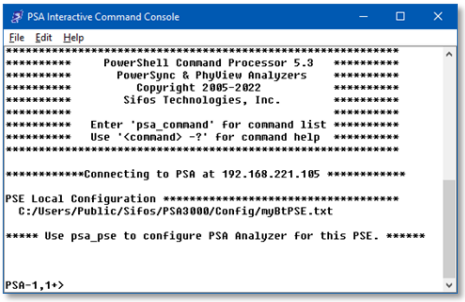


Figure 4.54 Wish Console

The **Trace Colors** option pertains only to PSA-3000 instruments.

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 0*). This can be a convenient tool to effect configurations or measurements that may not be fully supported in the PSA Interactive menus.

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

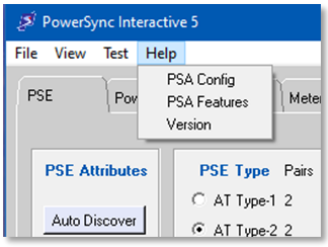


Figure 4.55 Help Menu

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

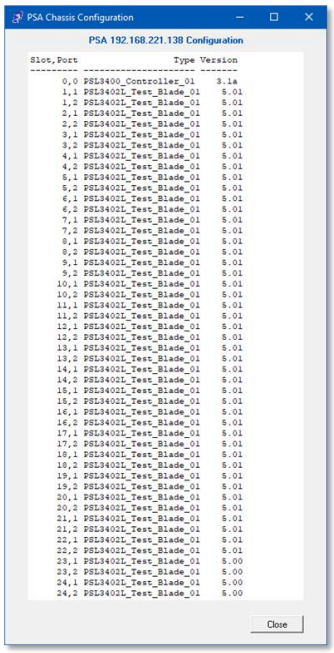


Figure 4.56 PSA Config

and PSA-3002 instruments are considered to populate slot #1.)

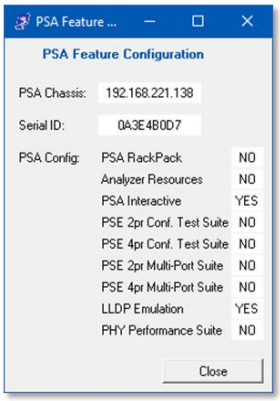


Figure 4.57 PSA Features

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
RackPack	***Repurpose to PSL-3424-QT OPTION?***
Advanced Resources	PSA-3xxx Instrument vs PSL-3xxx Instrument
PSA Interactive	(*always* "YES")
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	(*Pertinent to PSA/PSL-3000 instruments only*)
PSE NPr Multi-Port Suite	*(Future License Option)*
LLDP Emulation	PD PoE LLDP Emulation and Analysis
PHY Performance Suite	(*Pertinent to PVA-3000 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.

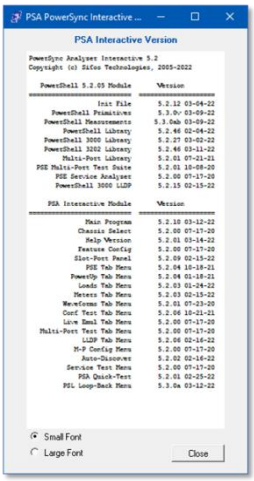


Figure 4.58 Version

4.7.4. Test Drop-Down Menu

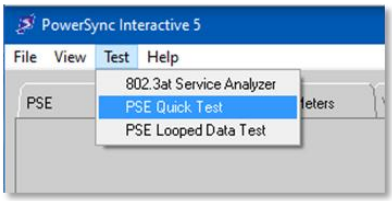


Figure 4.59 Test Menu

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

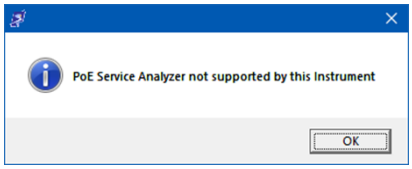


Figure 4.60 Service Analyzer

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***).

4.7.5. PSE Quick Inspection Test Application

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

The **PSE Quick Inspection Test** menu (*see **Figure 4.61***) accesses the **psl34_quick_test** automated test utility. This fully automated PSE test allows for rapid "go-no/go" testing of between 2 and 8 PSE ports per test cycle. The PSL Quick Test program (*see Section 5.14*) analyzes up to 11 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 20KΩ and 24KΩ PD signatures
Detect_Reject	Verify that each PSE port will not power 14KΩ and 33KΩ PD signatures
Vport_Low_Load	Maximum PSE continuous port voltage by PSE port powering valid MPS load
Vport_High_Load	Minimum PSE continuous port voltage by PSE port powering Pclass load
PSE Type	PSE Type as “AT” (802.3at) or “BT” (802.3bt)
Max Class Grant	Maximum PD Class that will be granted full requested power
Pclass	PSE Required Power Capacity given PSE output voltage
Disconnects	Verify that each PSE port removes power given PD disconnects
Overloads	Verify that each PSE port removes power in <100msec given PD overloads
LLDP Protocol	(*PSL-3424L only*) Verify 802.3at/802.3bt PoE LLDP protocol responses
LLDP_Allocations	(*PSL-3424L only*) Verify PoE LLDP power allocation to emulated PD

The PSE Inspection Quick Test will automatically respond to PSE attributes established in the PSE tab menu of PSA Interactive. Of critical importance is the specification of PSE Type and Powered Pairs. MPS must also be correctly declared.

If testing a PSE that requires LLDP for maximum power granting, the PSE Quick Test menu offers the **LLDP Req’d** option that will tell the test application to determine PSE maximum power capacity using LLDP and to also test LLDP protocol behaviors. This option is available to a PSL-3424L instrument.

Once the desired test ports are selected, **RUN TEST** will initiate PSE Quick Test. Upon completion, the **Save Result** button will store the test results into a text file in the current \Results\ path directory.

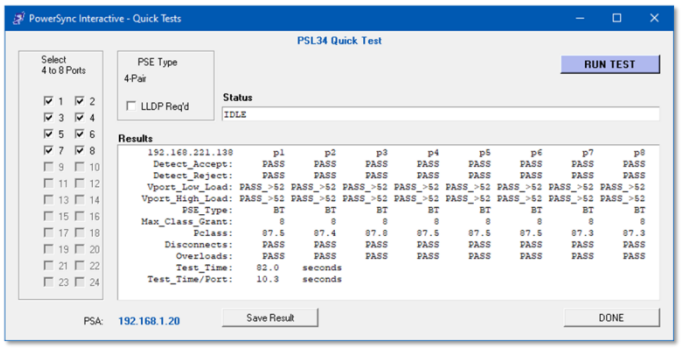


Figure 4.61 PSA Quick Test Menu

The **psl34_quick_test** application is also accessible from PowerShell PSA (*see Section 5.14*).

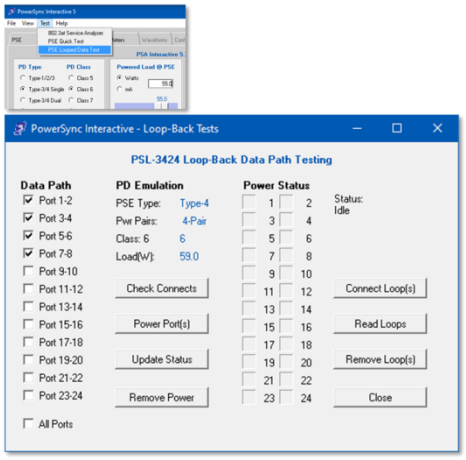


Figure 4.63 Looped Data Path Test Menu

4.7.6. Loop-Back Data Path Testing

Each PSL-3424 test port can be configured with its vertically adjacent port to pass Ethernet data bi-directionally (*see Section 3.1*). This configuration supports the concept of “snaked data path” testing of a multi-port PSE switch or router. More specifically, this means routing a single stream of Ethernet traffic through up to 24 PSE ports while each of those ports is providing user-specified levels of DC power to emulated PD’s. Ethernet traffic may be formatted to any speed from 10Base-T to Multi-Gig rates (2.5G, 5G, or 10GBase-T).

The Looped Data Path test menu (*see **Figure 4.63***) facilitates this method of PSE testing requiring just a few mouse clicks to configure and verify test setups so that traffic testing can be executed.

Prior to accessing this screen from the Test drop-down menu, users should properly describe PSE attributes in the PSE tab menu, then select the PD Type, PD Class, and PD Loading (power or current) in the Power Up tab menu. The Looped Data Path Test menu will then display those PSE/PD attributes under **PD Emulation** when it opens.

Once the menu is opened, the desired loop-back paths are selected under the **Data Path** set of checkboxes. In **Figure 4.63**, data is snaked through a 16 port, 4-Pair capable PSE using PSL-3424 test ports 1-8. The emulated PD’s will be Class 6 each with 55W power draw at the PSE port.

Configuring a 24-Port snaked data path can require at least 24 patch cable connections with commensurate opportunity for one or more impaired physical connections. The **Check Connects** button will run the

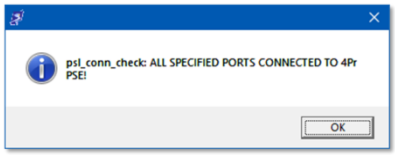


Figure 4.64 Connection Check Result

psl_conn_check utility across all of the selected Data Path test ports to assure that PSE connections to PSL-3424 test ports are all intact (*see **Figure 4.64***). If one or more ports has a defective connection, the displayed result will indicate the problem connections.

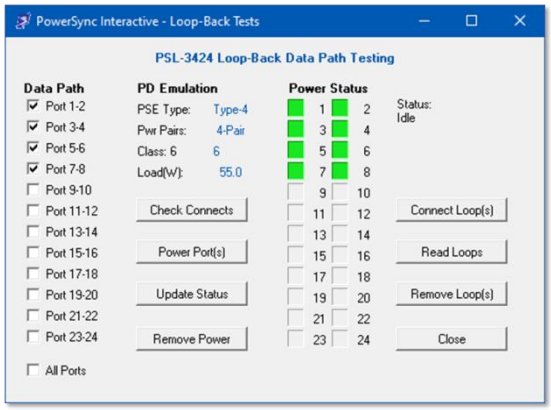


Figure 4.65 8-Port, Class 6 Loop-Back Setup

Once all physical connections are verified, the **Power Port(s)** button is pressed to connect the emulated PD's to the specified test ports. The Power Status indicators will display the ports as they get powered. 2-Pair PSE ports that apply power and sustain the specified load and 4-Pair PSE ports that apply 4-pair power and sustain the specified load will indicate with **green** indicators. 4-Pair PSE ports that power-up with 2-pairs and sustain the specified load will indicate with **amber** indicators. Port powering is done one port at a time to deal with PSE power management behaviors that might interfere with simultaneous PD connections.

At any time, the **Update Status** button will retrieve the powering status of every test port and update the **Power Status** indicators. Once testing is completed, the **Remove Power** button will create emulated PD disconnects on all test ports to get the PSE to remove power.

After all desired ports are applying power, the test port loop-back connections are effected by pressing the **Connect Loop(s)** button. This applies the port-pair loop-back connection to all selected port-pairs under the **Data Path** selections. The **Read Loops** button will survey all test ports and update the checked port-pairs according to which port pairs are actually configured for loop-back. The **Remove Loop(s)** button will then disconnect all port-pair loop-back paths. Pressing **Close** removes the menu and returns the PSA Interactive tab menu and Port Select panel.

The menu supports the concept of working with more than one PSL-3424 instrument. After a looped data path setup is created, the menu may be closed and then re-opened after connecting to a second PSL-3424 instrument. Use of the **Update Status** and **Read Loops** controls will help verify the conditions of the snaked data path with the presently connected instrument.

4.8. 802.3at PSE Conformance Test Menu

The **Conf Test** tab menu is not available to PSL-3424 instruments and will be disabled.

4.9. Live PD Emulation Tab Menu

The **Conf Test** tab menu is not yet available to PSL-3424 instruments and will be disabled.

4.10. MPort Test Tab Menu

The **Conf Test** tab menu is not yet available to PSL-3424 instruments and will be disabled.

4.11. LLDP Tab Menu

Important! The LLDP tab menu will only be available when connected to a PSL-3424L instrument. It is not available to the PSL-3424A instrument.

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, PSL-3424L) instrument supports the LLDP feature. The tab menu is disabled if that license is not present on the presently connected PSA instrument.

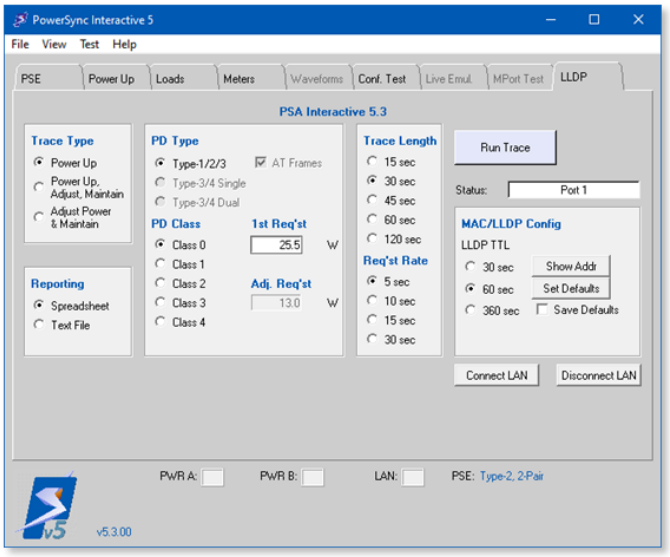


Figure 4.92 LLDP Tab Menu

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 0*) 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 each test port number. 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 PSL-3424 instrument, it may be desirable to re-program these default MAC addresses.

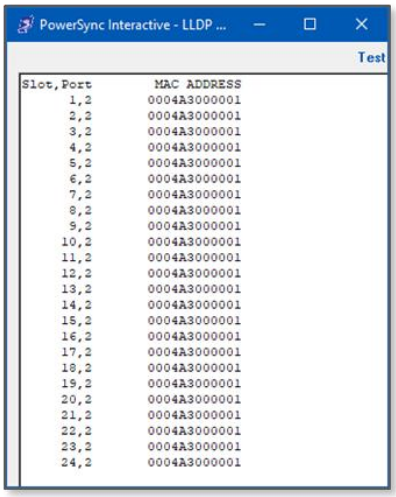


Figure 4.93 Default PSA Test Port MAC Addresses

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 25.5 watts. Trace duration is set to 30 seconds with a 5 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***).

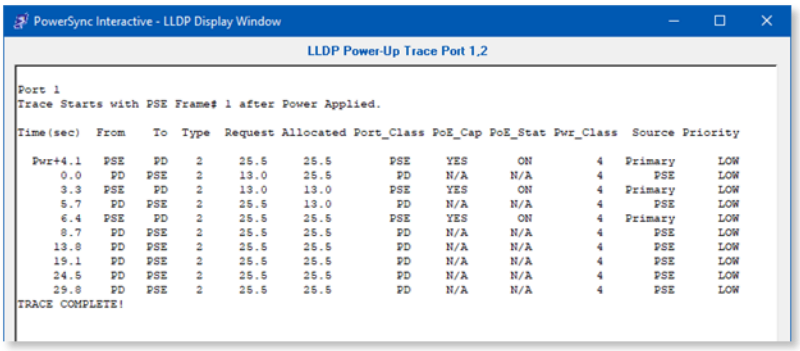
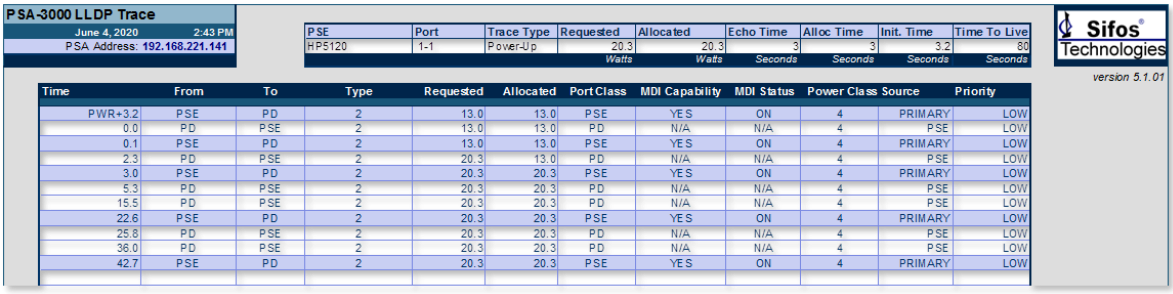


Figure 4.94 Real Time Trace Window

Once the trace duration (30 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
HPS120	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 4** PD initially seeking **12.6 watts**, then seeking an adjustment to **24.3 watts** is shown in **Figure 4.96**.

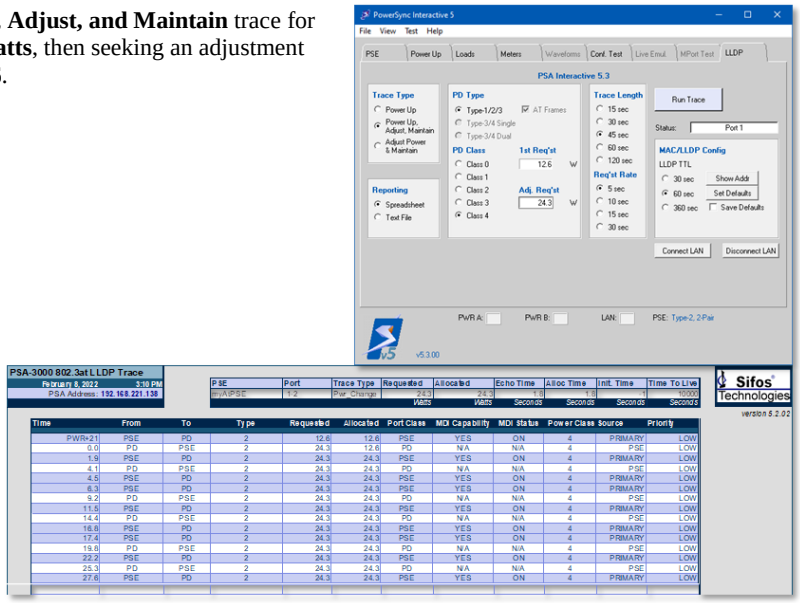


Figure 4.96 Class 4 Power-Up to 12.6W and Adjust to 24.3W

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 5** PD emulation. The PD is requesting an allocation of 38.4 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.

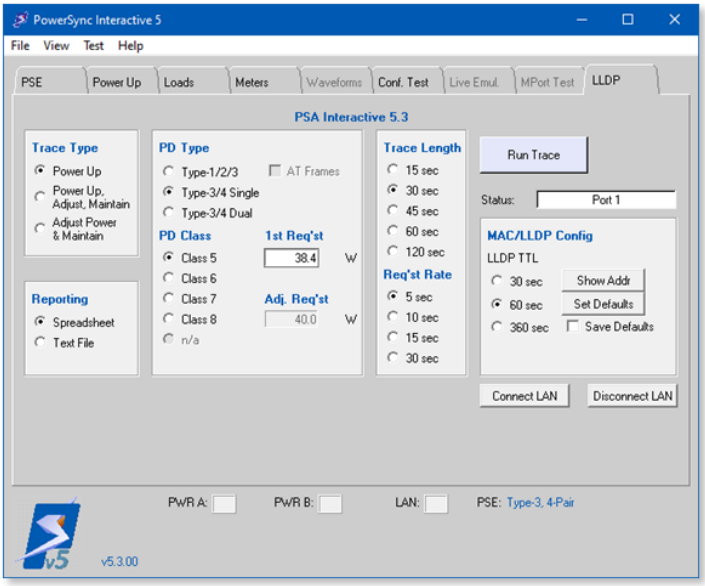


Figure 4.97 Class 5 Power-Up to 38.4 watts

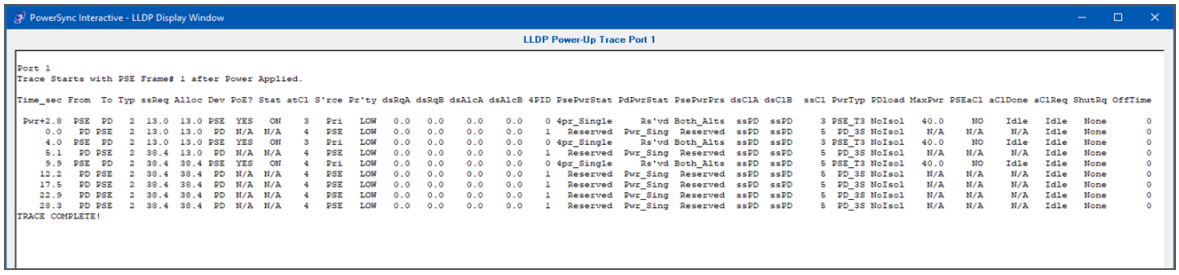


Figure 4.98 Trace Display - Class 6 Power-Up to 44.4 watts

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**.

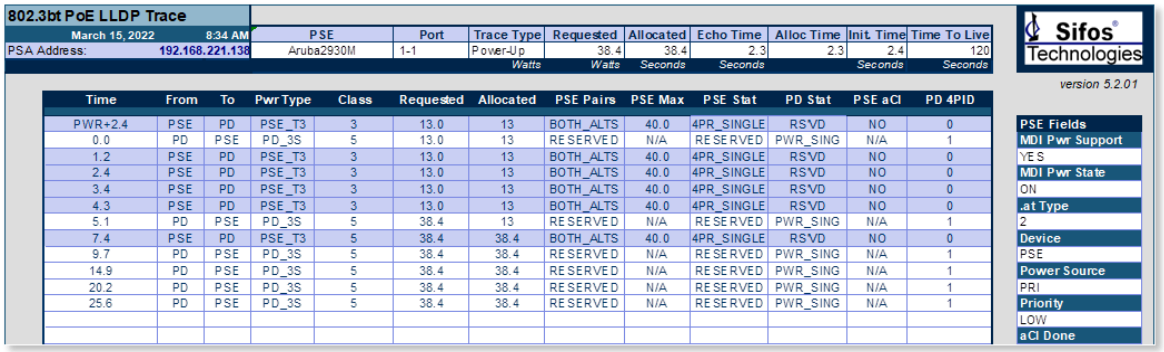


Figure 4.99 Spreadsheet Report: Single Signature Class 5 Power-Up Trace

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 14.6 watts, then once granted, will adjust the power demand to 21.3 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 30 seconds with 5 second PD message periodicity. After the trace completes, the Dual Signature 802.3bt report opens as shown in **Figure 4.101**.

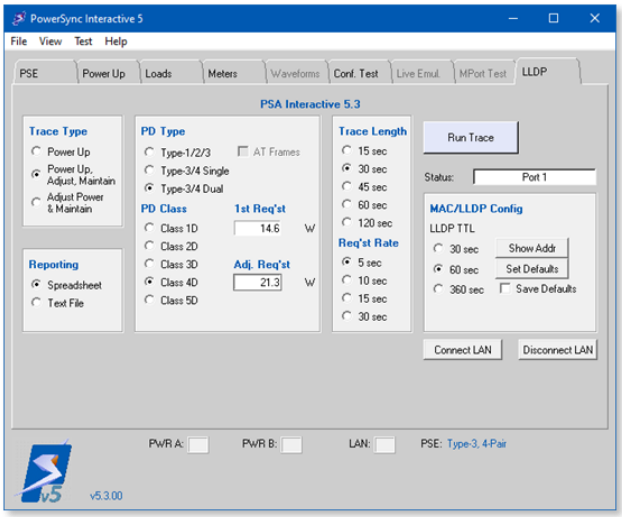


Figure 4.100 Dual Class 4 Power-Up, Adjust, Maintain Trace

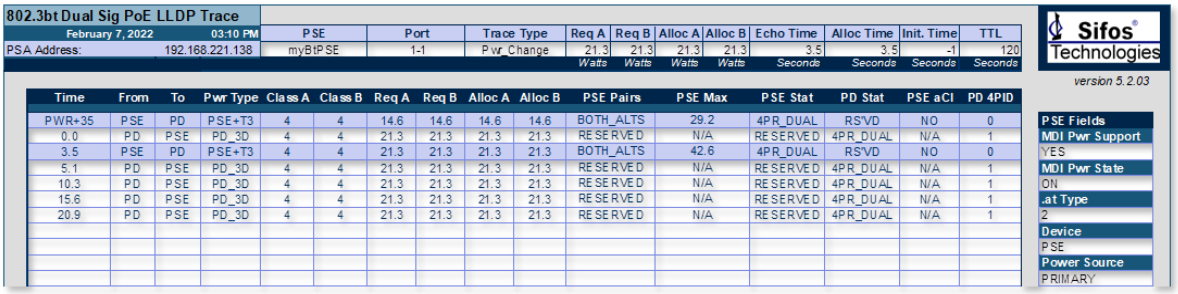


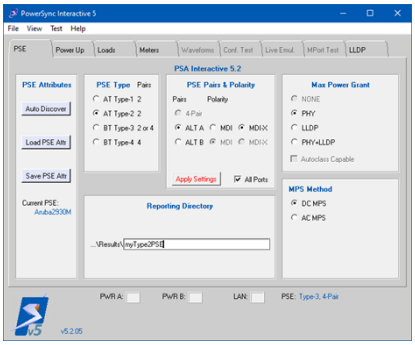
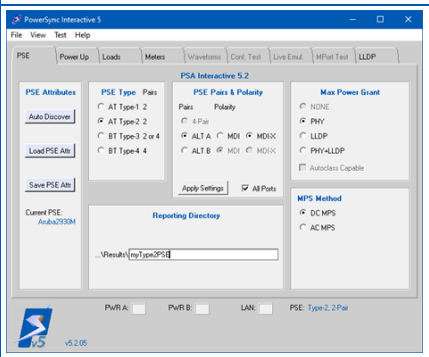
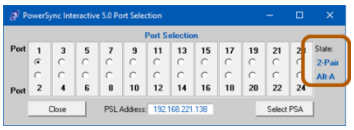
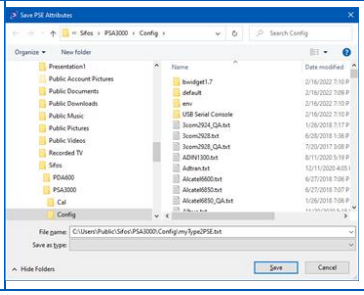
Figure 4.101 Dual Class 4 Power-Up, Adjust, Maintain Trace Report

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 PSL-3424 instrument and PSA Interactive software.

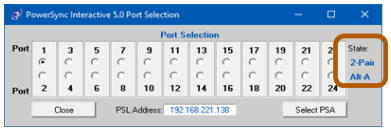
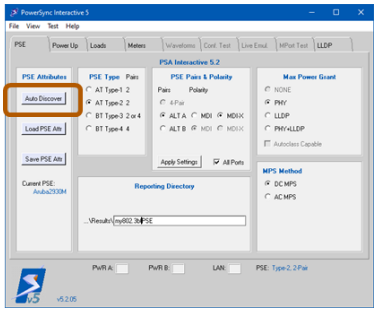
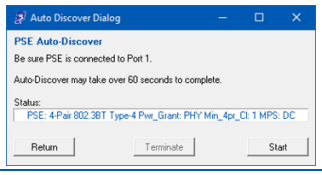
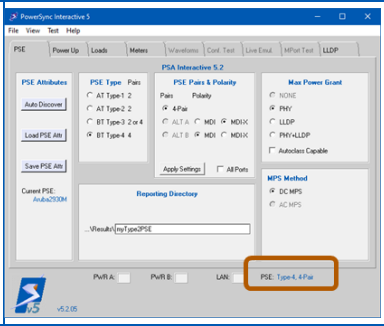
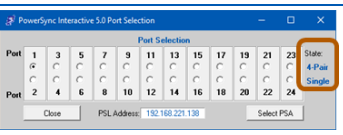
4.12.1. Configure All Ports to Type-2, PHY Granting PSE Powering Alt-A Pairset and Save PSE Attributes

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** *The PSL-3424 does not require the Polarity configuration but other PSA-3000 instruments do, so it is beneficial to include this in the PSE Attributes file that will be created below.*	
	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**	

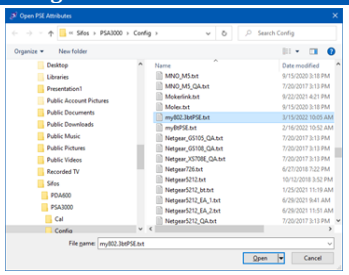
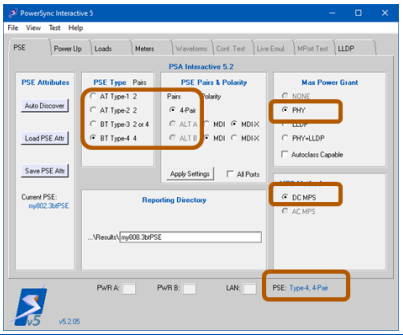
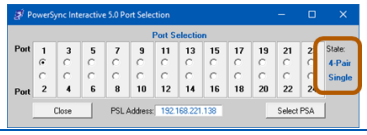
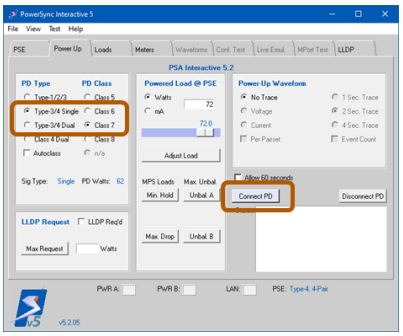
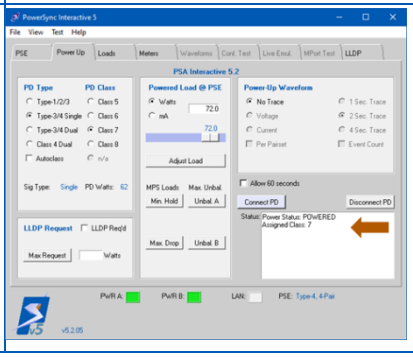
4.12.2. Auto-Discover an 802.3bt PSE

The PSE is known to be 802.3bt compliant but all other characteristics are unknown. Automatically discover other PSE attributes and configure the PSL-3424 test ports accordingly.

Menu	Step	Task	Image
Port Select	1	*Current test port is configured for 2-Pair Alt-A PSE powering.*	
PSE	2	Press **Auto Discover**	
	3	PSE Auto-Discover Press **Start** (*PSE discovered as:* **4-Pair Type-4**, Max Power Grant **PHY**, Min 4-Pair Class= **1**, **DC** MPS)	
	4	Press **Return** *Menu settings and PSE Type and Powered Pairs indicator updated*	
Port Select	5	*All test ports now configured for 4-Pair Single Signature connections.*	

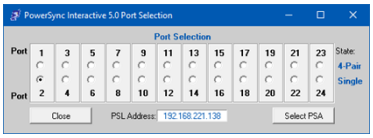
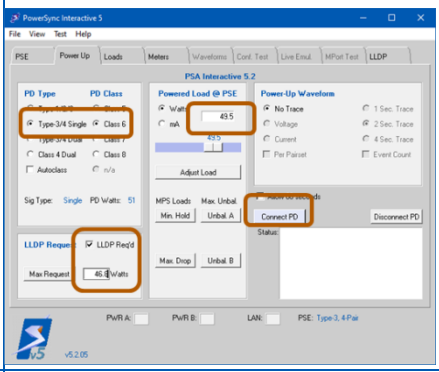
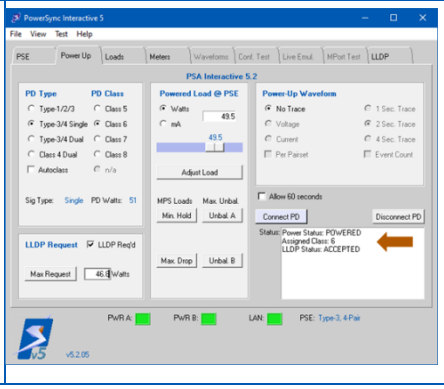
4.12.3. Perform a 4-Pair Power-Up from Type-4 PSE Emulating a Class 7 PD

Load the PSE attributes of a known 802.3bt PSE presently connected to Port 1. Then configure the Power Up tab menu for Class 7 PD emulation and determine the PD assigned classification at power-up.

Menu	Step	Task	Image
PSE	1	Press **Load PSE Attr** Select my802.3btPSE and press **Open**	
	2	PSE Type is **BT Type-4** High Power Grant is **PHY** MPS Method is **DC MPS** Alt A is **MDI-X**, Alt B is **MDI** *(not pertinent to PSL-3424)*	
Port Select	3	*All test slots are configured for 4-Pair Single Signature mode.* Select **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* *Assigned Class reported as 7 meaning the PSE is truly able to grant Type-4 power using multi-event classification*	

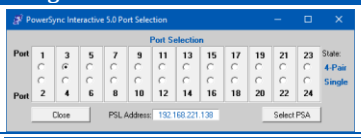
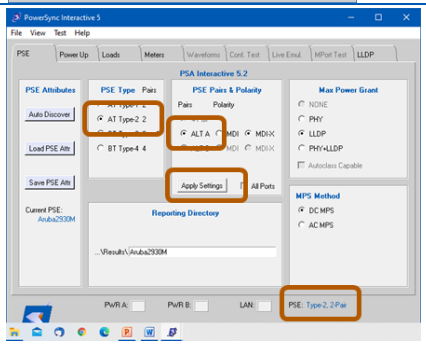
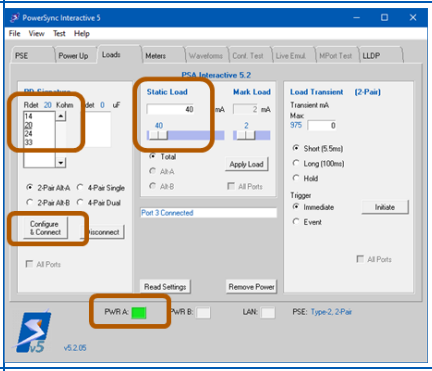
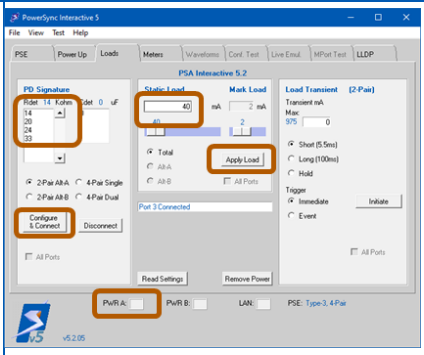
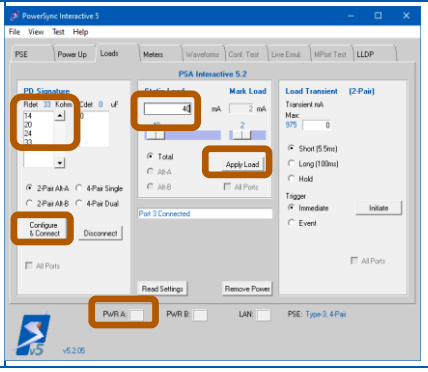
4.12.4. Perform an Emulated Class 6 LLDP Power-Up with PSL-3424L

Emulate a Class 6 PD that will use LLDP following a power-up to request 46.8 watts from a PSE that supports 802.3bt LLDP-based power management using test port 2. At the PSE interface, the power output will be 49.5 watts. Verify the assigned class is Class 6 after power-up and LLDP negotiation and that the requested power is granted.

Menu	Step	Task	Image
Port Select	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* *Assigned class is Class 6.*	

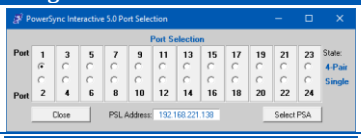
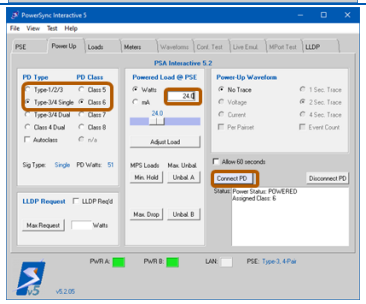
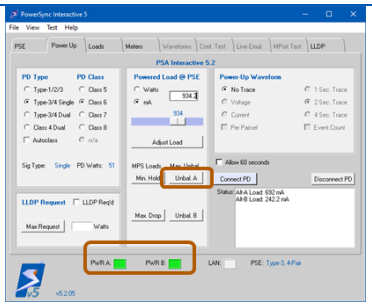
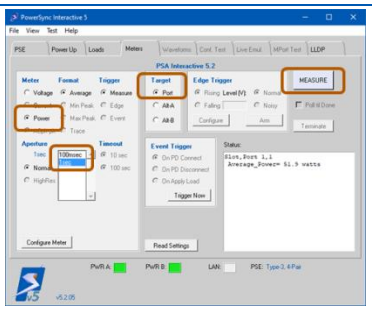
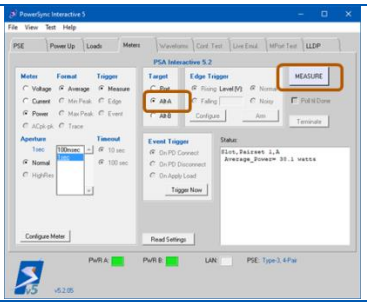
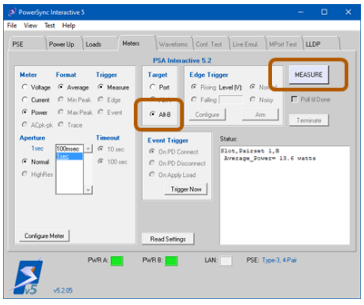
4.12.5. Determine the Maximum Signature Resistance a Type-2 (802.3at) PSE will power

This exercise involves configuring port 3 for an 802.3at Type-2 PSE, then using the Loads menu to assess PSE response to marginally invalid and valid PD signatures.

Menu	Step	Task	Image
Port Select	1	Select Port 3	
PSE	2	Select **AT Type-2** Select **Alt-A** 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** *(assures PSE maintains power)* Select **Rdet= 20** Press **Configure & Connect** **PWR A** indicates PSE accepted 20KΩ and applied power	
	4	Press **Remove Power** Enter **Static Load** = 40mA Press **Apply Load** *(assures PSE maintains power)* Select **Rdet= 14** Press **Configure & Connect** **PWR A** indicates PSE rejected 14KΩ and did not power up	
	5	Press **Remove Power** Enter **Static Load** = 40mA Press **Apply Load** *(assures PSE maintains power)* Select **Rdet= 33** Press **Configure & Connect** **PWR A** indicates PSE rejected 33KΩ and did not power up	

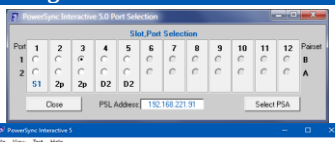
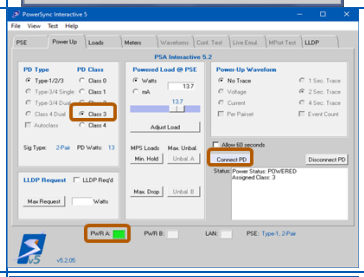
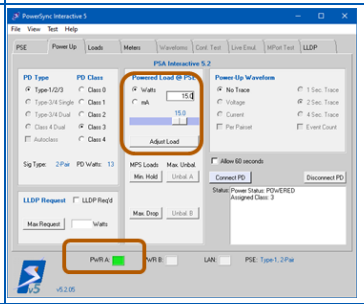
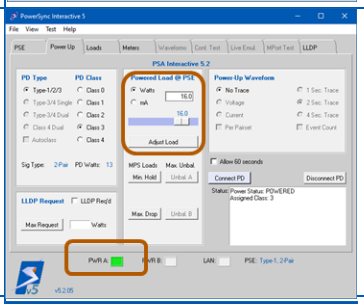
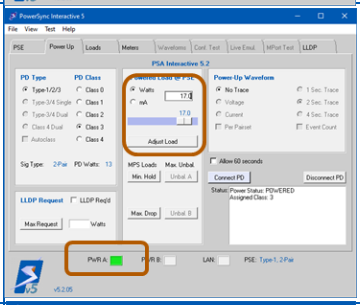
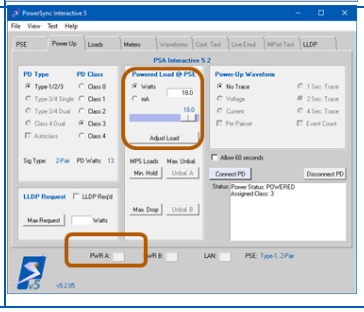
4.12.6. Measure Total and Pairset Powers of Emulated Class 6 PD After Unbalancing the Load to Alt-A

An emulated Class 6 PD is powered on port 1 to 24 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
Port Select	1	Select Port 1 *PSE previously entered as 4-Pair (Type-4) so Port 1 already in 4-Pair Single state*	
Power Up	2	Select **Type-3/4 Single** Select **Class 6** Enter load power of **24 W** 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 934mA* *Alt-A load current applied is 692mA* *(=Class 6 Icon_unb_2p)* *The PSE maintains power as it should*	
Meters	4	Select **Power** Select **1sec** (Aperture) Select **Port** (Target) Press **MEASURE** *Meter measures 51.9 watts total*	
	5	Select **Alt-A** (Target) Press **MEASURE** *Meter measures 38.1 watts on Alt-A pairset*	
	6	Select **Alt-B** (Target) Press **MEASURE** *Meter measures 13.6 watts on Alt-B pairset*	

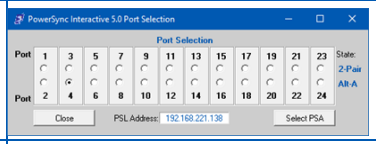
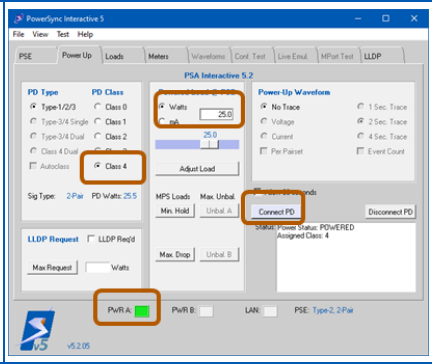
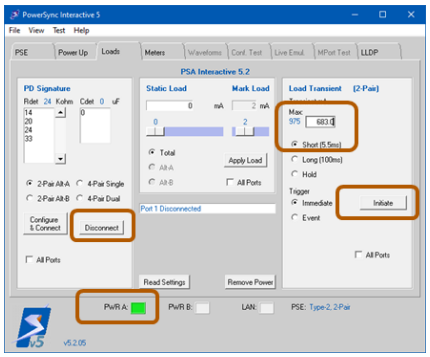
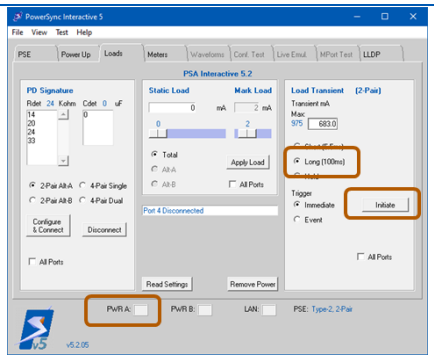
4.12.7. Assess Output Power Capacity of a Type-1 PSE port

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

Menu	Step	Task	Image
Port Select	1	Select Port 3 *PSE was already declared as Type-1, 2-Pair.*	
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 **Adjust 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.*	

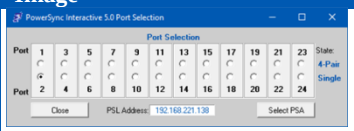
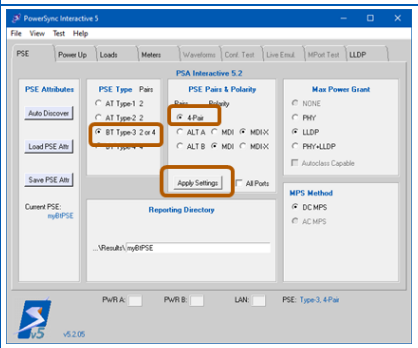
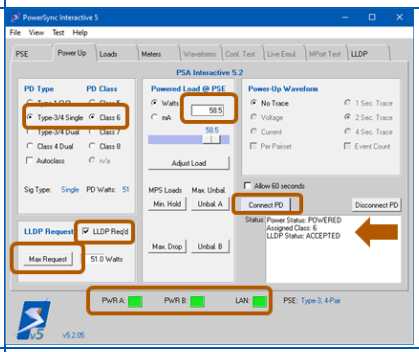
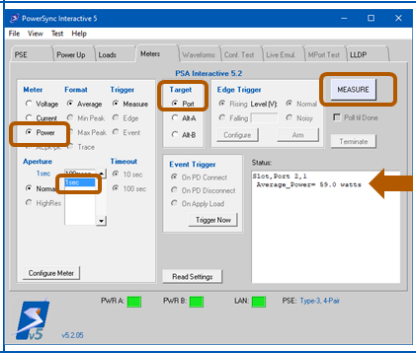
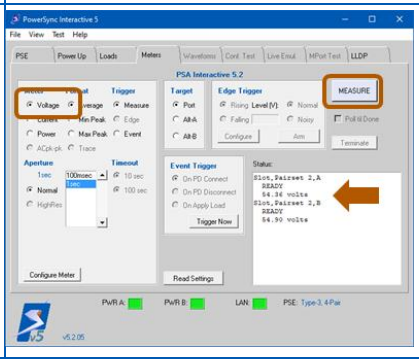
4.12.8. Evaluate Type-2 PSE Response to Ilim_min Load Transients

Emulate a Class 4 power-up to a Type 2 PSE on port 4 to 25W. Then use the Loads tab menu to apply a Short duration (5.5 msec) load transient of 683mA (Ilim_min) and verify that power is maintained. Then re-apply the same load transient with Long duration (100msec) and verify that power is removed.

Menu	Step	Task	Image
Port Select	1	Select Port 4 *PSE was already declared as Type-2, 2-Pair.*	
Power Up	2	Select **Class 4**, enter **25**W load, and press **Connect PD** *PWR A indicates Alt-A pairset is powered with the 25 W load*	
Loads	3	Press **Disconnect** so that detection signature is removed and PSE will remain shut down after it removes power Enter Load Transient = **683**mA (Ilim_min for Class 4), select **Short** duration, and then press **Initiate** *PWR A indicates Alt-A pairset is still powered meaning the 5.5msec duration transient of 683mA did not produce an overload shutdown. This is a compliant behavior.*	
		Select **Long** duration, and then press **Initiate** *PWR A indicates Alt-A pairset has removed power in response to a 100msec duration overload of 683mA. This is a compliant behavior.*	

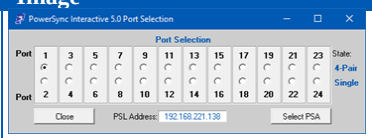
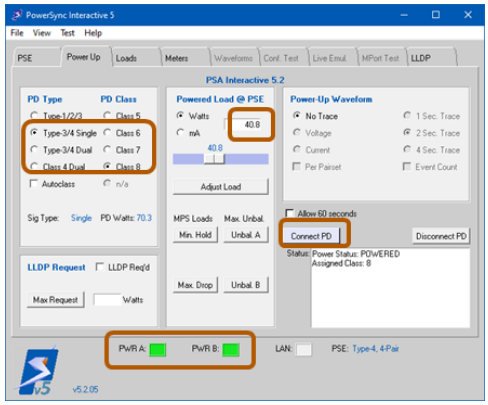
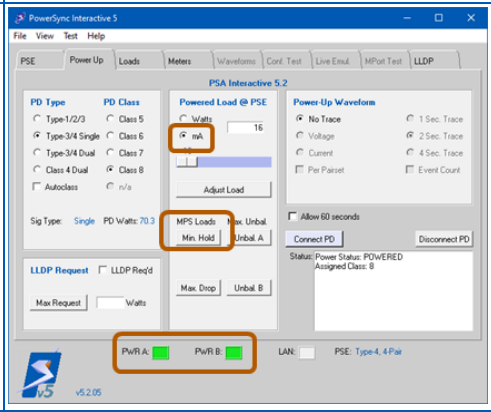
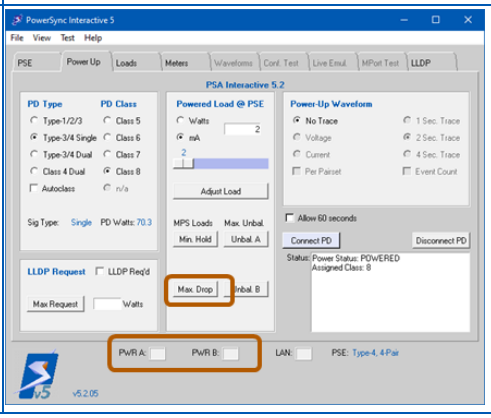
4.12.9. Assess Type-3, LLDP PSE Output Voltage at 60W Loading with PSL-3424L

A Type-3, LLDP capable PSE is powered using test port 2 to 58.5 watts given a PD request for 51 watts. Output power is verified, then voltages are measured on both pairsets.

Menu	Step	Task	Image
Port Select	1	Select 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** = 58.5 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 59 watts*	
	6	Select **Voltage** Press **MEASURE** Output voltages are 54.4V on Alt-A and 54.9V on Alt-B	

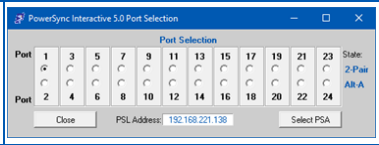
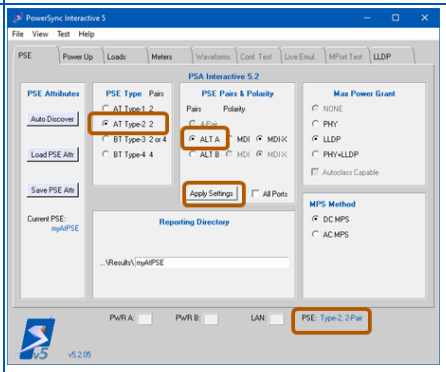
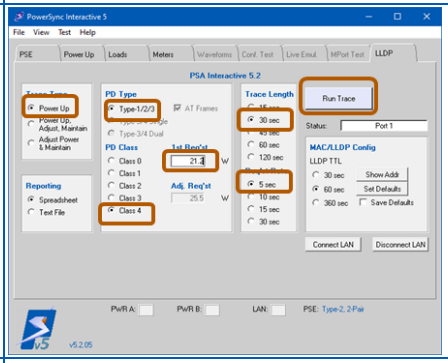
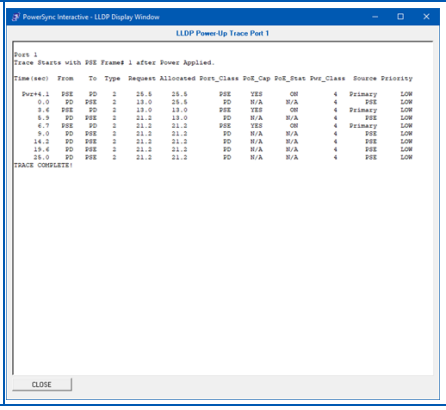
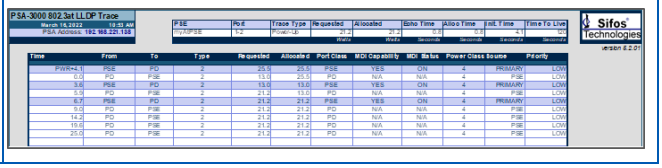
4.12.10. Assess that a Type-4 PSE satisfies DC MPS requirements

A Type-4 PSE is powered to approximately 40W using a Class 8 PD emulation on test port 1. The PSE is evaluated for maintaining power with a 16 mA total load and removing power with a 2 mA total load.

Menu	Step	Task	Image
Port Select	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 8** 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 16mA* *PWR A and PWR B indicators show PSE maintains power as it should*	
	4	Press **Max. Drop** *4-Pair Load Current adjusted to 2mA* *PWR A and PWR B indicators show PSE removed power as it should*	

4.12.11. 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 1 where the PD is requesting 21.2 watts of power. Evaluate over 30 seconds of time.

Menu	Step	Task	Image
Port Select	1	Select Port 1	
PSE	2	Select **PSE** tab to describe PSE as **AT Type-2** powering **Alt-A** pairs **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 8.6 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 (PSA-3000) waveform 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 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 an instrument address to connect. The dialog will validate that the desired PSA/PSL instrument (henceforth referred to as "PSA" in this section) 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 fictitious PSA. The PowerShell Tcl prompt will time out if given no response in

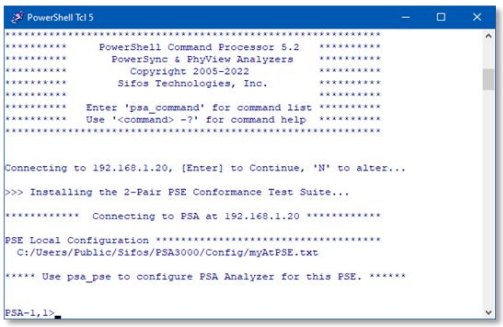


Figure 5.1 PowerShell TCL Connection

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*.)

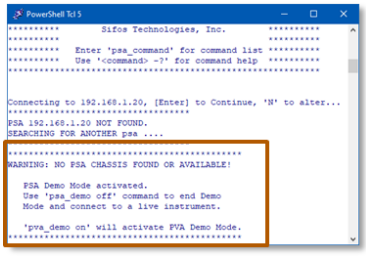


Figure 5.2 Demo Mode Warning

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.

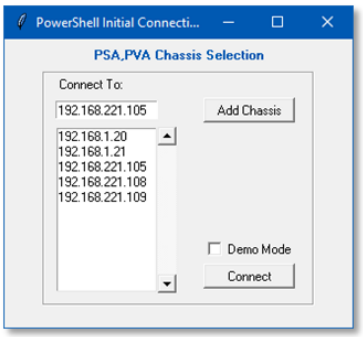


Figure 5.3 PowerShell Wish Connection Dialog

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.

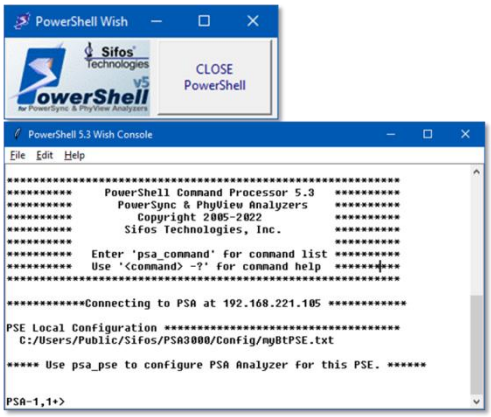


Figure 5.4 PowerShell Wish

5.3. PowerShell PSA Command Documentation Conventions

In presenting the PowerShell PSA API over the next few sections, certain conventions will be commonly utilized.

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.
<**p***Port*> *4-Pair Option:* **p***Port*,*Pairset*	**PSL-3424** test port addresses may be expressed as a literal "**p**" followed by the integer test port number (1, 2, 3, … 24). This notation is an alternative to the standard *slot*,*port* notation utilized with all other PSA-3000 instruments. PSL-3424 commands will also accept *slot*,*port* addressing following rules that are specific to the PSL-3424 (*see below*). The most recently addressed port is presented using *slot*,*port* format in the command prompt. In a 4-Pair configuration, specific pairsets (Alt-A or Alt-B) can be addressed using **p***Port*,**A** or **p***Port*,**B** notation. *See section 9.1.1 for description of* **p99** *broadcast configuration ports*.
<*slot*,*port*> *Structured as* *slot*,1 or *slot*,2 *4-Pair Option:* *slot*,*pairset*	Within the PSL-3424, each test port may be considered a "virtual" *slot* with a sub-entity *port* that relates to a pairset, that is, to Alt-A or Alt-B. *This notation is quite different from all other PSA-3000 family instruments*. When configured in a **2-Pair** mode for working with 2-Pair PSE's, *slot* is the integer number of the test port and *port* has the value of **1** for Alt-B PSE's and **2** for Alt-A PSE's. When configured in a **4-Pair** mode, either Single or Dual Signature, *slot* is the integer number of the test port and *port* always has the value **1**. Specific pairsets (Alt-A or Alt-B) can be addressed using *slot*,**A** or *slot*,**B** notation. Using the **p***Port* notation described above is a simple way to avoid this complexity. *See section 9.1.1 for description of* **99,x** *broadcast configuration ports*.
"**|**"	Indicates logical "OR"
stat	An query available to many commands, including all meter 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 when connected to a PSL-3424 instrument:

Test Port Config	Prompt Information	Examples
2-Pair Alt-A	Presently addressed test port and pairset (=**2** for Alt-A)	PSA-1,2> PSA-8,2>
2-Pair Alt-B	Presently addressed test port and pairset (=**1** for Alt-B)	PSA-6,1> PSA-14,1>
4-Pair Single Signature	Presently addressed test port with pairset fixed at **1**. Single signature configuration is indicated by the single "**+**" symbol.	PSA-2,1+> PSA-6,1+>
4-Pair Dual Signature	Presently addressed test port with pairset fixed at **1**. Dual signature configuration is indicated by the double "**++**" symbol.	PSA-3,1++> PSA-11,1++>

Important! The PowerShell PSA prompt embedded address has a subtly different meaning when connected to a PSL-3424 versus other members of the PSA-3000 family.

In 2-pair configurations utilized with a PSE powering the Alt-A pairset, all commands and queries must be addressed to an address *portNumber*,**2**. In 2-pair configurations utilized with a PSE powering the Alt-B pairset, all commands and queries must be addressed to *portNumber*,**1**. In 4-pair Single and Dual signature configurations, all commands and queries must be addressed to *portNumber*,**1**. The prompt will always display the legitimate current address.

Important! Using the **p***Port* notation for port addressing will work universally regardless of test port configuration.

Test port (2-pair and 4-pair) configurations are directly performed using the **psl_setup** command. See Section 5.8.

5.5. PowerShell PSA Important Global Settings

PowerShell PSA incorporates many global settings (or global variables), some of which will be of interest to test script developers and other system users. In particular, those settings associated with PSE attributes will affect decisions made within automated test suites and analysis utilities. 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** or **BT**	**psa_pse**, **psl_auto_port**
PSE ALT (Powered Pair) Configuration	psaDefaultAlt	**A**, **B**, or **4Pr**	**alt**, **psa_pse**, and **psl_auto_port** can configure this setting.
PSE Polarity Configuration	psaDefaultPol	**MDI**, **MDI-X**, **MDI+MDI-X**, **MDI-X+MDI**, **MDI+MDI**, **MDI-X+MDIX**	*Not relevant to PSL-3424 as test ports are polarity insensitive*
PSE MPS (Disconnect) Method	psaPseMps	**AC** or **DC**	**psa_pse** and **psl_auto_port** can configure this setting.
PSE 4-Pair Type	psaPse4prType	**NONE**, **Type-3**,**Type-4**, **Type-3ac**, **Type-4_ac**	**psa_pse** and **psl_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 Ports	slotRange	**{1 2 3 … 24}**	**psa** and **psa_config** will update this
Test Port Pair State	psaPairState	**2Pr**, **X**, **4PrS1**, **4PrD1**	

Setting	Global Variable	Value Range	Configuration Commands
Test Blade Type	psaTestBladeType		list based on currently connected PSA. **psl_setup** will alter the value of psaPairState. Each of these globals are arrays indexed by Test Ports (e.g. psaTestBladeType(1,1))
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	

Important! The Global Variable *port* has special significance throughout PowerShell PSA and must always store the currently addressed test port in the *slot*,*port* format. When PSL-3424 port addressing is done using the **p***N* format, as is commonly recommended throughout this section, those addresses should NOT be stored in the global variable *port*. The variable name *port* may be used for **p***N* formatted addresses only if that script does not connect to the global variable *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** | **PSL** | **PSL3400** | **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 (PSA-3000) **PSL** Emulate PowerSync Programmable Load (PSL-3000) **PSL3400** Emulate PSL-3424 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 **psl_auto_port** to automatically discover attributes from a connected PSE port. *See Section 3.2.4 for further information on PSE Attributes Files.* *filename* The specific file name, EXCLUDING path and extension, that will be installed. If no file name is specified, **psa_pse** will maintain existing PSE attributes unless specified in other arguments to **psa_pse**. If file is provided, any settings in that file will be overridded byany attributes specified with the **psa_pse** command. Then all pair state, alt, and polarity settings will be propagated to all PSA test ports. **-alt A** | **B**: Override 2-Pair PSE powered pairs attribute with alt **A** or alt **B**. 2-Pair connections with this powered pair will be propagated to all PSA test ports. **-alt 4pr**: Override powered pairs attribute to indicate that both pairsets are powered. 4-Pair connections will be propagated to all test ports. **-pol mdi** | **mdix**: Override 2-pair polarity attribute to specify mdi (positive) or mdix (negative) polarity. Attribute will be propagated to all PSA test ports. ALT attribute must be “A” or “B”. **-pol mdi+mdi** | **mdix+mdi** | **mdi+mdix** | **mdix+mdix**: Override polarity settings for both pairsets in a 4-pair configuration where value is ‘**Alt-A** Polarity’**+**’**Alt-B** Polarity’. Attribute will be propagated to all PSA test ports. ALT attribute must be “4pr”. **-spec at** | **bt** | **prop4**: Override declared PSE category. Declare PSE as 802.3**at**, 802.3**bt**, or **Prop**rietary 4-Pair. ALT attribute must be “4pr” for **prop4**. **-mps dc** | **ac**: Override declared PSE MPS method to **DC** MPS or **AC** MPS. If PSE category is **bt** or **prop4**, this setting must be “dc”. **-grant type-1**: Override PSE High Power Grant setting with ‘NONE’ for a Type-1 PSE. **-grant phy**: Override PSE High Power Grant setting with ‘PHY’ for a Multi-Event classification, Type-2/3/4 PSE. This is method used by PSE to grant the highest power level it is capable of. **-grant lldp**: Override PSE High Power Grant setting with ‘LLDP’ for a LLDP capable, Type-2 PSE. This is method used by PSE to grant the highest power level it is capable of. **-grant phy+lldp**: Override PSE High Power Grant setting with ‘PHY’ for a Multi-Event classification, Type-2/3/4 PSE. PSE also utilizes LLDP only to reduce power allocated. **-4prtype** Override PSE 4-Pair Type attribute *4prType* **NONE** (802.3at PSE), **Type-3** | **Type-4** (802.3bt PSE including 2-Pair Type-3), **PSE1** | **PSE2** | **UPoE** | **UPoE2** | **LT++** (Proprietary 4-Pair PSE . These are not supported in PSA 5.0 or newer version software. See *Sifos application note*: **4-Pair PSE Testing with the PSA-3000 & PSL-3000.pdf**) **-min4prclass** Use to specify the minimum PD class that will get 4-Pair powered by the PSE. Specify **NONE** if 2-Pair PSE. **Note:** Use **psa_saveConfig** to permanently update any settings overrides for a particular PSE.		

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

PSL-3424 test ports each independently support four possible configurations:

Test Port Configuration	PSE Powering Capability	PD Emulation
2-Pair Alt-A	2-Pair Powering the Alt-A Pairset	2-Pair Mode A Connection
2-Pair Alt-B	2-Pair Powering the Alt-B Pairset	2-Pair Mode B Connection
4-Pair Single Signature	4-Pair Powering both Pairsets	Single Signature PD
4-Pair Dual Signature	4-Pair Powering both Pairsets	Dual Signature PD

PSA software automatically adapts to each of these configurations. For example, if configuring a load current on a test port, PSA software determines based upon the test port configuration whether that load should be applied to one pairset (2-Pair powering) or both pairsets (4-Pair powering). Similarly, if performing a measurement, PSA software utilizes the test port configuration to determine how to report that measurement. So it is vital to configure test ports to properly match the **PSE Powering Capability** and desired **PD Emulation** as shown in the table above.

PowerShell PSA (and PSA Interactive) always keep track of each test port's present configuration. So command and query test port addressing determines the behavior of each command. **Important!** When using multi-cast addressing (port **p99**) to simultaneously configure all test ports, it is essential that all test ports be in the exact same Test Port Configuration. Otherwise, those commands will be rejected by PowerShell PSA.

Test Port Configuration is established by a relatively short group of commands. A the most basic (or "primitive") level, the **psl_setup** command establishes a Test Port Configuration. Above that level, the following utility commands can alter the Test Port Configuration:

Command	Test Ports Affected
psa_pse (*see Section 5.7*)	All Test Ports
power_pse (*see Section 5.11*)	One (addressed) Test Port
psl_auto_port (*see Section 5.11*)	All Test Ports
LLDP Trace Commands (*see Section 8.5*)	One (addressed) Test Port

Command	Addr	Command Parameters	Query	Returned Parameters
psl_setup	<p*Port*>	**2pA** | **2pB** | **single** | **dual** Configures the test port *N* to one of four Test Port Configurations depending upon PSE powering capability and desired PD emulation. Multicast Support: **p99** **2pA** Establishes a 2-Pair configuration for testing 2-Pair PSE's that power the Alt-A pairset. 2-Pair PSE's could be 802.3at or 802.3bt compliant. **2pB** Establishes a 2-Pair configuration for testing 2-Pair PSE's that power the Alt-B pairset. **2pA** 2-Pair PSE's could be 802.3at or 802.3bt compliant. **single** Establishes a 4-Pair configuration for testing 4-Pair (802.3bt) PSE's emulating a Single Signature PD configuration. **dual** Establishes a 4-Pair configuration for testing 4-Pair (802.3bt and certain proprietary 4-Pair) PSE's emulating a Dual Signature PD configuration. **Note**: Unlike other instruments in the PSA-3000 family, the PSL-3424 is not sensitive to pairset polarities as pairsets are full-wave rectified in the front end of each test port (*see Section 3.1*). So no polarity configuration is ever required.	**?**	Connected Signature **2-Pair** | **Single** | **Dual** Connected Pairset **A** | **B** | **A+B**

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 test port. Whenever the **p***Port* parameter is provided, the default test port for that and all subsequent commands will be updated as will the command prompt showing the port address in *slot*,*port* format (*see Section 5.4*). Configuration operations generally support the multicast address **p99**, however, the multicast address will only be accepted when all test ports in the PSL-3424 are in the same Test Port Configuration (*see Section 5.8*). When a test port is in a 4-Pair configuration (**single** or **dual**), individual pairsets may be addressed using the notation **p***Port*,**A** or **p***Port*,**B** for Alt-A and Alt-B pairsets respectively. Similarly, when in a 4-Pair configuration, multicast pairset addressing can be performed using the notation **p99**,**A** or **p99**,**B**.

<table>
<tr><th>Command</th><th>Addr</th><th>Command Parameters</th><th>Query</th><th>Returned Parameters</th></tr>
<tr><td>passive</td><td><p<i>Port</i>>

4-Pair pairset
p<i>Port</i>,A
p<i>Port</i>,B</td><td>r 14 | 20 | 24 | 33

Configures detection signature. Applicable to all Test Port Configurations. See technical data in Section 3.4.3 for further information on detection signatures.
Multicast Support General: p99
Multicast Support 4-Pair Dual: p99,A | p99,B
<i>(Pairset addressing available to Dual Signature only.)</i>

r 14: Configure detection signature to 14KΩ
r 20: Configure detection signature to 20KΩ
r 24: Configure detection signature to 24KΩ
r 33: Configure detection signature to 33KΩ</td><td>?</td><td>Resistance Value (Kohm)

(<i>Per pairset if in 4-Pair Dual configuration</i>)</td></tr>
<tr><td>port</td><td><p<i>Port</i>>

4-Pair pairset
p<i>Port</i>,A
p<i>Port</i>,B</td><td>connect | isolate

Connects or disconnects an emulated PD detection signature. When disconnected, test port will appear as high impedance.
Multicast Support General: p99
Multicast Support 4-Pair Dual: p99,A | p99,B
<i>(Pairset addressing available to Dual Signature only.)</i>

connect: Connect the detection signature configured by passive command
isolate: Remove the detection signature</td><td>?</td><td>CONNECTED | ISOLATED

(<i>Per pairset if in 4-Pair Dual configuration</i>)</td></tr>
<tr><td>class</td><td><p<i>Port</i>>

4-Pair pairset
p<i>Port</i>,A
p<i>Port</i>,B</td><td><i>pdClass</i> <autoclass>

Configures an emulated PD Classification signature that is constrained by Test Port Configuration.
Multicast Support General: p99
Multicast Support 4-Pair Dual: p99,A | p99,B
<i>(Pairset addressing available to Dual Signature only.)</i>

<i>pdClass</i>: PD Class to emulate. Options are:
<table><tr><th>Test Port Configuration</th><th>Valid Classifications</th></tr><tr><td>2-Pair (Alt-A or Alt-B)</td><td>0 | 1 | 2 | 3 | 4</td></tr><tr><td>4-Pair Single</td><td>0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8</td></tr><tr><td>4-Pair Dual</td><td>1D | 2D | 3D | 4D | 5D | PD4</td></tr></table>Class 1D-5D refer to dual class 1 – dual class 5 respectively. PD class PD4 is a proprietary 4-pair dual signature class 4 signature.

autoclass Emulate an 802.3bt autoclass signature. This option is available when PD class specified is 1 – 8.</td><td>?</td><td>PD Class (0-8, 1D-5D)

Autoclass state (DISABLED | ENABLED)

(<i>Per pairset if in 4-Pair Dual configuration</i>)</td></tr>
</table>

Command	Addr	Command Parameters	Query	Returned Parameters
iload	<p*Port*> 4-Pair pairset p*Port*,**A** p*Port*,**B**	<**i** *loadCurrent*> <**s** *inrushCurrent*> Configures total static load current and inrush current that appear when a PSE applies power to one or both pairsets (Alt-A, Alt-B). If test port is configured to a 2-Pair mode, current will be applied to just one pairset. If test port is configured to a 4-Pair mode, current will be split between both pairsets. In 4-Pair modes (single or dual), current may be programmed to each pairset independently using pairset addressing. Multicast Support General: **p99** Multicast Support 4-Pair: **p99**,**A** | **p99**,**B** **i**: Specify static load current that appears 100msec after PSE power is applied *loadCurrent*: Static load current in mA. Range is 0 to 975mA when addressed test port is configured for 2-Pair and 0 to 1950mA when addressed test port is configured for 4-Pair. When addressing a 4-pair pairset, range is 0 to 975mA. Granularity is 1mA for 2-Pair (or pairset) and 2mA for 4-Pair loads. **s**: Specify a non-default start-up load current that appears during first 100msec after PSE power is applied. If not specified, the start-up current will be fixed at 40mA per pairset after command is executed. *InrushCurrent*: Start-up load current in mA. Range is 0 to 975mA when addressed test port is configured for 2-Pair and 0 to 1950mA when addressed test port is configured for 4-Pair. When addressing a 4-pair pairset, range is 0 to 975mA. Granularity is 1mA for 2-Pair (or pairset) and 2mA for 4-Pair loads.	**?**	Static Load Current (mA) Inrush Load Current (mA) (*Per pairset if pairset address is queried in a 4-Pair configuration*)
ptrans	<p*Port*> 4-Pair pairset p*Port*,**A** p*Port*,**B**	<**i** *load_current* > <**short** | **long** | **hold** > <**go** | **arm**> Configures a transient load current and a transient duration option. Load transients can be initiated on command or can be **Event Triggered** to synchronize with other test ports or with meter measurements (*see Section 3.1.2*). If test port is configured to a 2-Pair mode, current will be applied to just one pairset. If test port is configured to a 4-Pair mode, current will be split between both pairsets. In 4-Pair modes (single or dual), current may be programmed to each pairset independently using pairset addressing. Multicast Support General: **p99** Multicast Support 4-Pair: **p99**,**A** | **p99**,**B** **i**: Specify transient load current that is applied immediately with the command or upon an Event Trigger *loadCurrent*: Transient load current in mA. Range is 0 to 975mA when addressed test port is configured for 2-Pair and 0 to 1950mA when addressed test port is configured for 4-Pair. When addressing a 4-pair pairset, range is 0 to 975mA. Granularity is 1mA for 2-Pair (or pairset) and 2mA for 4-Pair loads. **short**: Specify transient time duration of **5.5msec**. Useful for evaluation **Ilim_min** responses of the PSE. **long**: Specify transient time duration of **100msec**. Useful for evaluation **Tcut_max** responses of the PSE. **hold**: Specify permanent load change to *loadCurrent* upon execution of the command or upon an Event Trigger. **go**: Initiate the load transient immediately upon execution of the command. This is default behavior unless **arm** is specified. **arm**: Initiate the load transient when the next Event Trigger occurs (*see Sections 3.1.2 and 3.1.3*). This option enables load transients to be synchronized on multiple test ports and also to be synchronized to meter measurements.	**?**	Transient Current (mA) Transient Duration (**Short** | **Long** | **Hold**) (*Per pairset if pairset address is queried in a 4-Pair configuration*)

Command	Addr	Command Parameters	Query	Returned Parameters
trigout	<**p0**>			
		Initiates an Event Trigger that is broadcast to all test ports in the PSL-3424. The Event Trigger is a hardware trigger that originates in the instrument controller and therefore, the only valid command address is **p0**. Any armed load transients and meter measurements will then commence when the Event Trigger is received.		
psa_ disconnect	<**p***Port*> 4-Pair pairset **p***Port*,**A** **p***Port*,**B**	<**trigout**>		
		This is a utility command that MAY revise any prior settings performed by **port**, **iload**, *and* **psa_lan**. Emulates a PD disconnect. Detection signature is removed and load current is set to 0mA. Any LLDP LAN connection (*PSL-3424L only*) is removed. Multicast Support General: **p99** Multicast Support 4-Pair: **p99**,**A** | **p99**,**B** **trigout**: Produces an event trigger as the load current is set to 0mA.		
psa_lan	<**p***Port*>	**isolate** | **loop** | **lldp** <**auto** | **10full** | **10half**> <**stat**> <**reset**>	**?**	**ISOLATED** | **LOOP_BACK** | **LLDP**
		Configures the LAN data connection within the test port. In the **PSL-3424A**, LAN pairs may either be unterminated (e.g. disconnected) or may be configured to wrap around to the vertically adjacent test port (loop-back). In the **PSL-3424L**, LAN pairs may also be configured to terminate with an LLDP emulating transceiver supporting 10/100Base-T link-ups and emulated PoE LLDP protocols. Multicast Support General: **p99** **isolate**: Disconnect the LAN pairs so they are unterminated **loop**: Connect the LAN pairs to the vertically adjacent test port. If addressed to any odd numbered port, the vertically adjacent even numbered port will also be connected into the loop-back. If addressed to any even numbered port, the vertically adjacent odd numbered port will also be connected into the loop-back. Use for snaked data testing setups. *PSL-3424L Only*: **lldp**: Connect the LAN pairs (2 and 3) to a 10/1000Base-T transceiver to emulate PoE LLDP protocols from an LLDP capable PD. Both 802.3at and 802.3bt protocols are supported (*see Section 2.10*). **auto**: Configure the LLDP transceiver for auto-negotiation to link either 100Base-Tx or 10Base-T. **10full**: Force the LLDP transceiver into a 10Base-T, full duplex configuration. **10half**: Force the LLDP transceiver into a 10Base-T, half duplex configuration as would happen in the absence of auto-negotiation. **reset**: Reset the LLDP transceiver to recover from and error condition.	**stat**	*Status Information regarding the LLDP transceiver Link State.*
trig_port	<**p0**>	**in** | **out**	**?**	
		Configures the BNC Trigger port on the PSL-3424 to be either a transmitter (to transmit Event Triggers) or a receiver (to receive hardware triggers from other PSA/PSL instruments). **in**: Configure as a receiver to receive hardware triggers and broadcast those triggers internally as Event Triggers. **out**: Configure as a transmitter to transmit a hardware trigger when an Event Trigger is generated internally.		

5.10. Test Port Measurement Commands

The following commands are directed to specific test ports and generally used for static configuration of test resources at that test port. Whenever the **p***Port* parameter is provided, the default test port for that and all subsequent commands will be updated as will the command prompt showing the port address in *slot*,*port* format (*see Section 5.4*). Meter configuration operations generally support the multicast address **p99**, however, the multicast address will only be accepted when all test ports in the PSL-3424 are in the same Test Port Configuration (*see Section 5.8*).

When a test port is in a 4-Pair configuration (**single** or **dual**), individual pairsets may be *queried* using the notation **p***Port*,**A** or **p***Port*,**B** for Alt-A and Alt-B pairsets respectively. Individual pairsets can never be *configured* however as meter configurations to each pairset must always be identical.

Command	Addr	Command Parameters	Query	Returned Parameters
pstatus	<**p***Port*> 4-Pair pairset **p***Port*,**A** **p***Port*,**B**	Queries PSE power status, **ON** or **OFF**, from specified test port, including each pairset when in 4-Pair (single or dual) mode. Also returns the PSE Type (**AT** or **BT**) and the **Assigned Class** when PSE power is in the ON state. Assigned Class is provided per pairset when in 4-Pair dual signature configuration. This is a query only and must include the **stat** (query) argument.	**stat**	PSE power status, **ON** or **OFF** (per pairset in 4-Pair Mode) PSE Type (**AT** or **BT**) Assigned Class (**0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8**)
vdcaverage	<**p***Port*> 4-Pair pairset query **p***Port*,**A** **p***Port*,**B**	<**trig off** | **ext**> <**period 100m** | **1s**> Configures and/or performs an Average DC Voltage measurement at the PoE connection (*see **Figure 3.1***). Meter configurations are retained persistently in each test port and may be combined with measurements (**stat** queries). Multicast Configuration Support: **p99** **trig off**: Meter measurement is initiated immediately upon command execution and will return a result **trig ext**: Meter measurement is armed will wait up to at least 10 seconds for an Event Trigger to start the measurement. **stat** query will return meter status as ARMED, READY, or TIMEOUT. **period 100m**: Configures the meter sampling integration time to 100 msec **period 1s**: Configures measurement sampling integration time to 1 second	**stat**	**READY** | **ARMED** | **TIMEOUT** If **READY**: Average DC Volts (*per pairset* in 4-Pair modes)
			?	Trigger Mode **IMMEDIATE** or **EVENT** Averaging Period **100m** | **1s**
idcaverage	<**p***Port*> 4-Pair pairset query **p***Port*,**A** **p***Port*,**B**	<**trig off** | **ext**> <**period 100m** | **1s**> Configures and/or performs an Average DC Current measurement. Meter configurations are retained persistently in each test port and may be combined with measurements (**stat** queries). Multicast Configuration Support: **p99** **trig off**: Meter measurement is initiated immediately upon command execution and will return a result **trig ext**: Meter measurement is armed will wait up to at least 10 seconds for an Event Trigger to start the measurement. **stat** query will return meter status as ARMED, READY, or TIMEOUT. **period 100m**: Configures the meter sampling integration time to 100 msec **period 1s**: Configures measurement sampling integration time to 1 second	**stat**	**READY** | **ARMED** | **TIMEOUT** If **READY**: Total 2-Pair or 4-Pair current in mA or if 4-Pair pairset is queried, Pairset Current in mA.
			?	Trigger Mode **IMMEDIATE** or **EVENT** Averaging Period **100m** | **1s**

Command	Addr	Command Parameters	Query	Returned Parameters
vdcpeak	<p*Port*> 4-Pair pairset query p*Port*,A p*Port*,B	<**trig off** | **ext**> <**max** | **min**> <**period 100m** | **1s**> Configures and/or performs a Peak Voltage measurement at the PoE connection (*see* ***Figure 3.1***). Meter configurations are retained persistently in each test port and may be combined with measurements (**stat** queries). Multicast Configuration Support: **p99** **trig off**: Meter measurement is initiated immediately upon command execution and will return a result **trig ext**: Meter measurement is armed will wait up to at least 10 seconds for an Event Trigger to start the measurement. **stat** query will return meter status as ARMED, READY, or TIMEOUT. **max**: Report the maximum peak voltage over the sampling time **min**: Report the minimum peak voltage over the sampling time **period 100m**: Configures the meter sampling time to 100 msec during which 256 samples are analyzed **period 1s**: Configures measurement sampling integration time to 1 second during which 256 samples are analyzed	**stat**	**READY** | **ARMED** | **TIMEOUT** If **READY**: Peak Volts (*per pairset* in 4-Pair modes)
			?	Trigger Mode **IMMEDIATE** or **EVENT** Peak Type **MIN** or **MAX** Averaging Period **100m** | **1s**
idcpeak	<p*Port*> 4-Pair pairset query p*Port*,A p*Port*,B	<**trig off** | **ext**> <**max** | **min**> <**period 100m** | **1s**> Configures and/or performs a Peak Current measurement. Meter configurations are retained persistently in each test port and may be combined with measurements (**stat** queries). Multicast Configuration Support: **p99** **trig off**: Meter measurement is initiated immediately upon command execution and will return a result **trig ext**: Meter measurement is armed will wait up to at least 10 seconds for an Event Trigger to start the measurement. **stat** query will return meter status as ARMED, READY, or TIMEOUT. **max**: Report the maximum peak voltage over the sampling time **min**: Report the minimum peak voltage over the sampling time **period 100m**: Configures the meter sampling time to 100 msec during which 256 samples are analyzed **period 1s**: Configures measurement sampling integration time to 1 second during which 256 samples are analyzed	**stat**	**READY** | **ARMED** | **TIMEOUT** If **READY**: Total 2-Pair or 4-Pair peak current in mA or if 4-Pair pairset is queried, Pairset Current in mA.
			?	Trigger Mode **IMMEDIATE** or **EVENT** Peak Type **MIN** or **MAX** Averaging Period **100m** | **1s**
paverage	<p*Port*> 4-Pair pairset query p*Port*,A p*Port*,B	<**period 100m** | **1s**> *This is a utility command that MAY revise any prior settings performed by* **vdcaverage** and **idcaverage**. Configures and/or performs an average power measurement utilizing average voltage and current metering (*see above*). Measurements are always immediate triggered and may be performed per pairset when in a 4-pair mode. **period 100m**: Configures the meter sampling integration time to 100 msec **period 1s**: Configures measurement sampling integration time to 1 second	**stat**	Total 2-Pair or 4-Pair Average DC Power in W If 4-Pair pairset is queried, Pairset power in W

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 PSL-3424 test instrument, utilities perform their tasks by combining PowerShell PSA configuration and measurement commands into integrated PowersShell PSA programs. As such, many of the commands in Sections 5.9 and 5.10 may have their associated configurations altered by test support utilities described here. Generally, there is no concept of broadcast port addresses (e.g. **p99**) or pairset addressing (e.g. **p*N*,A**) with these commands.

Command	Addr	Command Parameters	Returned Parameters
psl_auto_port	<**p***Port*>	<**lldp**> <**-save** *PSE_Name*>	
		Automatically discovers critical PSE attributes from a connected PSE at address **p***Port* or on the currently addressed port. Attributes discovered generally include **PSE Class** (AT or BT), **MPS Type** (DC or AC) powered pairs (Alt-A, Alt-B, or 4-Pair), **maximum power grant method** (PHY or LLDP* or PHY+LLDP*) , **PSE Type** (Type-1, Type-2, Type-3, or Type-4) and **Minimum 4-Pair Powered Class** (NONE, 1, 2, 3, 4, 5). 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. **-save**: Control to store the learned PSE attributes to a PSE Attributes file for later retrieval and automatic instrument configuration. *PSE_Name*: Unique name (e.g. model number) of PSE to save PSE attributes to. Attribute file will be a text (.txt) file stored in the \Config\ Directory path (*see Section 3.2.5*). ***** *PSL-3424L Only:* **lldp**: Utilize an LLDP negotiation to see if that alters the assigned class to the maximum the PSE will support. This can then affect both the maximum power grant method and the PSE Type discovery with certain LLDP capable PSE's. **Note**! The command will report PSE powered pair polarities (MDI or MDI-X), but those are not discovered by **psl_auto_port** and are not utilized by the PSL-3424. As such, they may not be valid for other PSA-3000 family instruments.	PSE Class, MPS Type, Powered Pairs, Max Power Grant method, PSE Type, Minimum 4-Pair Powered Class
psl_conn_ check		<**4pr** | **2pA** | **2pB**> <**p***Na* <**p***Nb* <**p***Nc*. ... >>>	Returns "ALL CONNECTIONS VERIFIED!" or a list of disconnected test ports.
		Verify that PSE ports are properly connected as expected to one or more PSL-3424 test ports. If Test Port Configuration (4pr, 2pA, or 2pB) is not specified, command will utilized the present Test Port Configuration of the first port in the list of ports. If no ports are provided, then all ports in the instrument will be checked for PSE connections. **4pr**: Force all test ports to a 4-Pair configuration for checking 4-Pair capable PSE port connections. **2pA**: Force all test ports to a 2-Pair Alt-A configuration for checking 2-Pair Alt-A powering PSE port connections. **2pB**: Force all test ports to a 2-Pair Alt-B configuration for checking 2-Pair Alt-A powering PSE port connections. **p***Na*: First port to check connections on **p***Nb*: Second port to check connections on. Up to 24 ports may be included in the list.	

<table>
<tr><th>Command</th><th>Addr</th><th>Command Parameters</th><th>Returned Parameters</th></tr>
<tr><td rowspan="2">power_pse</td><td rowspan="2"><p<i>Port</i>></td><td>c <i>pdClass</i> <autoclass> | ca <i>pdClass</i> cb <i>pdClass</i> <p <i>power</i> | i <i>load</i>> <dr <i>rDet</i>> <start <i>inrush</i>> <abort <i>pwrupTime</i>> <trigout>
<i>PSL-3424L Only:</i>
<lldp_at <ad | force> <i>req_pwr</i> <timeout <i>maxwait</i>>> |
<lldp_bt <ad | force> <i>req_pwr</i> <timeout <i>maxwait</i>>> |
<lldp_bt <ada | forca> <i>req_pwr</i> <adb | forcb> <i>req_pwr</i>
<timeout <i>maxwait</i>>></td><td></td></tr>
<tr><td>Emulate a PD connection and monitor/report for PSE response to that PD connection and associated PD attributes. The utility will alter the Test Port Configuration if needed to support the PD Class specified as follows:
<table>
<tr><th>Initial Config.</th><th>PD Class pdClass</th><th>Final Config.</th></tr>
<tr><td rowspan="3">2-Pair A or 2-Pair B</td><td>0 - 4</td><td>Unchanged</td></tr>
<tr><td>5-8</td><td>4-Pair Single</td></tr>
<tr><td>1D – 5D, PD4</td><td>4-Pair Dual</td></tr>
<tr><td rowspan="2">4-Pair Single</td><td>0-8</td><td>Unchanged</td></tr>
<tr><td>1D – 5D, PD4</td><td>4-Pair Dual</td></tr>
<tr><td rowspan="2">4-Pair Dual</td><td>0-8</td><td>4-Pair Single</td></tr>
<tr><td>1D – 5D, PD4</td><td>Unchanged</td></tr>
</table>
The utility returns the following states:
<table>
<tr><th>Final Config.</th><th>State</th><th>Definition</th></tr>
<tr><td rowspan="3">Any</td><td>POWERED</td><td>PSE powered successfully</td></tr>
<tr><td>DOWN</td><td>PSE failed to apply power</td></tr>
<tr><td>DROPPED</td><td>PSE powered initially but dropped power after final load was applied</td></tr>
<tr><td rowspan="2">4-Pair Single or 4-Pair Dual</td><td>PWRD_A</td><td>4-Pair PSE powered only the Alt-A pairset</td></tr>
<tr><td>PWRD_B</td><td>4-Pair PSE powered only the Alt-B pairset</td></tr>
</table>
c: pdClass: (Requried parameter) PD class to emulate. pdClass may be:
• 2-Pair or 4-Pair Single Signature classes 0, 1, 2, 3, or 4
• 4-Pair Single Signature classes 5, 6, 7, or 8
• 4-Pair Dual Signature classes 1D, 2D, 3D, 4D, 5D, or PD4.
If a dual signature class is specified with the c argument, it will be applied to both pairsets. PD4 is a class 4 signature applied to both pairsets in a dual signature PD emulation (e.g. proprietary 4-Pair).
ca: pdClass: (Requried parameter if c not provided) Dual signature class to emulate on the Alt-A pairset. pdClass may be: 1D, 2D, 3D, 4D, or 5D.
cb: pdClass: (Requried parameter if c not provided) Dual signature class to emulate on the Alt-B pairset. pdClass may be: 1D, 2D, 3D, 4D, or 5D.
p: Specify a non-default static power load to be applied after PSE is powered. Default power load will be ~50% of maximum pdClass power if load current (i load) is not specified.
power: Load power applied after PSE is powered. For 2-pair configurations (Alt-A or Alt-B), range is 0.5 to 42.5 watts. For 4-pair configurations (Single or Dual), range is 0.5 to 97.5 watts.
i: Specify a static current load to be applied after PSE is powered.
load: Load current applied after PSE is powered. For 2-pair configurations (Alt-A or Alt-B), range is 10 to 975 mA. For 4-pair configurations (Single or Dual), range is 10 to 1950mA.
dr: Specify a non-default detection signature to use. Default is 24KΩ.
rDet: Detection signature. Options are 14KΩ, 20KΩ, 24KΩ, and 33KΩ.</td><td>Power State (POWERED | DOWN | PWRD_A | PWRD_B | DROPPED</td></tr>
</table>

Command	Addr	Command Parameters	Returned Parameters
power_pse *(continued)*		**start**: Specify a non-default inrush current to apply during first 100msec of power-up. Default inrush current is 40mA per pairset powered. *inrush*: Inrush current. Range is 0 to 975mA for all PD classes. **abort** Specify a non-default time duration to wait for PSE to apply power. Default is 12 seconds. *pwrupTime*: Maximum time to wait for PSE power-up. Range is 4 to 60 seconds. **trigout**: Produce an Event Trigger coincident with the PD signature connection. *PSL-3424L Only:* **lldp_at**: Negotiate an LLDP power request after PSE applies power using 802.3at LLDP protocol. **lldp_bt**: Negotiate an LLDP power request after PSE applies power using 802.3bt LLDP protocol. **force**: Instructs command to wait until PSE provides a power grant to the requested PD power (*req_pwr*) or until the LLDP negotiation times out. **forca**: Dual signature equivalent of **force** for Alt-A pairset. **forcb**: Dual signature equivalent of **force** for Alt-B pairset. **ad**: Instructs command to simply start the LLDP negotiation advertising PD power request but not to wait for power allocation. **ada**: Dual signature equivalent of **ad** for Alt-A pairset. **adb**: Dual signature equivalent of **ad** for Alt-B pairset. *req_pwr*: (*Required parameter for LLDP emulations*) PD power request (watts) to deliver using LLDP protocol to the PSE. With dual signature emulations, this is provided for each pairset. Range is 0.5 to 25.5 watts if 802.3at protocol is specified and 0.5 to 99.9 watts if 802.3bt protocol is specified. **timeout** Specify a non-default time duration to wait for PSE to allocate requested power. Default is 35 seconds. *maxwait*: Maximum time to wait for PSE to allocate the requested power. Range is 10 to 90 seconds.	
psl_power_wait	<**p***Port*>	<**timeout** *wait_time*> <**2Pr**> <**pace** *loopRate*> Utility monitors for PSE to apply power. Utilized by **power_pse**. **timeout**: Specify non-default wait time for power to be applied. Default wait time is 12 seconds. *wait_time*: Time to wait for PSE to apply power. Range is 6 to 60 seconds. **2Pr**: Instructs command to return immediately if PSE powers 2-Pairs (Alt-A or Alt-B) **pace**: Specify non-default sampling period for assessing power state of the PSE. Default is 250msec. *loopRate*: Sampling period for assessing PSE power state. Range is 25 to 500 msec.	Power State (POWERED | DOWN | PWRD_A | PWRD_B Power Mode (2-Pair | 4-Pair) Assigned Class (0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8) *Assigned Class returned per pairset in Dual Signature configuration*
psl_set_load	2-Pair <**p***Port*> 4-Pair pairset **p***Port*,**A** **p***Port*,**B**	**p** *power* <*interations*> <**trigout**> Utility adjusts power draw in watts on a specified port or on a 4-Pair powered pairset (Alt-A or Alt-B). **p** *power*: (*Required parameter*) Power load, in watts, to apply to addressed test port (or 4-pair pairset). Pairset addressing may be utilized when emulating single and dual signature PD's. *interations*: Specify non-default count of measure voltage – set current cycles. Default is 2 cycles. Range is 1 to 5 cycles. **trigout**: Produce an Event Trigger coincident with the first load adjust.	

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**> 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	{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 PL file** *"filename"* This command is used for downloading new PSL **test port** firmware images from a host computer to PSL-3424 chassis flash memory. **type PL:** Indicates that a firmware image to be downloaded to the PSA is targeted for a PSL-3402 (PSL-3424) test blade. This parameter differs for various members of the PSA-3000 family. *filename* local path & file name to be downloaded to the chassis flash memory. 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**> **p***N* | **all type PL** This command is used for updating PSL-3402 **test ports** (PSL-3424) 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*. **p***N*: Single test port *N* to be updated with new firmware. **all:** Update all test ports in currently connected instrument with new firmware. **type PL:** Indicates that a firmware image is to be installed from chassis flash memory to a PSL-3402 (PSL-3424) test port type. **Important!** In the PSL-3424, there are two microcontrollers per Test Port, so both will be updated for each port **p***N* specified. This command will take on the order of minutes per test port updated.	
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	**0,0 file** *"filename"* <-y> This command is used to download and install new firmware images to a PSL-3424 **controller blade**. **0,0**: Address for the update must be '0,0', the controller blade. **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. 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 License 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

5.14. Multi-Port PSE Automated Test Script 802.3at and 802.3bt PSE's

Note! *The following feature is available with the PSL-3424-QT feature license.*

PSA Software optionally provides a fully automated test for rapidly inspecting several critical functions of a multi-port PSE whereby from two to eight ports are tested at a time from a single command. The PSE Quick Inspection Test performs the following:

- Validates PoE Detection Acceptance and Rejection Ranges
- Measures PSE Port Voltage at both minimum (DC MPS) and maximum (Pclass) load conditions
- Reports PSE type (AT vs BT), maximum assigned class capability, and expected Pclass power capacity
- Assesses Disconnect Power Removal response (< 1 second on each port)
- Assesses Overload Power Removal response (< 100msec on each port)
- Assesses LLDP Power Protocol and Allocations*

The PSE Quick Inspection test can complete testing in 8 to 15 seconds per port depending upon PSE port features and also upon any requirement for LLDP negotiations*. The test is available from PSA Interactive (*see Section 4.7.5*) and using the following command in PowerShell PSA.

Command	Command Parameters	Returned Parameters
psl34_quick_test	<*PSA Address*> **p***N* **p***N* < **p***N* < **p***N* < **p***N* < **p***N* < **p***N* >>>>>> <**lldp**> Runs the automated PSE Quick Inspection test on a selected set of from two to eight PSE ports. The test will automatically determine PSE type and powered pairs and test it accordingly. Results are presented in PowerShell and may be captured for reporting or further analyis by any application that executes this command. *PSA Address*: Address of PSA instrument on which to run the test script. **p***N*: PSL-3424 ports (N) that will be utilized in testing. A minimum of two ports and maximum of eight ports should be provided. *PSL-3424L Only*: **lldp**: Indicates that testing should include LLDP power-up negotiations to obtain full power grants and/or to assess LLDP protocol.	Detection Acceptance Detection Reject Vport_Low_Load Vport_High_Load PSE Type PSE Max Class Expected Pclass Disconnect Shutdown Time Overload Shutdown Time LLDP Protocol* LLDP Allocation*

* LLDP testing features of the PSE Quick Inspection Test are only available to the PSL-3424L.

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

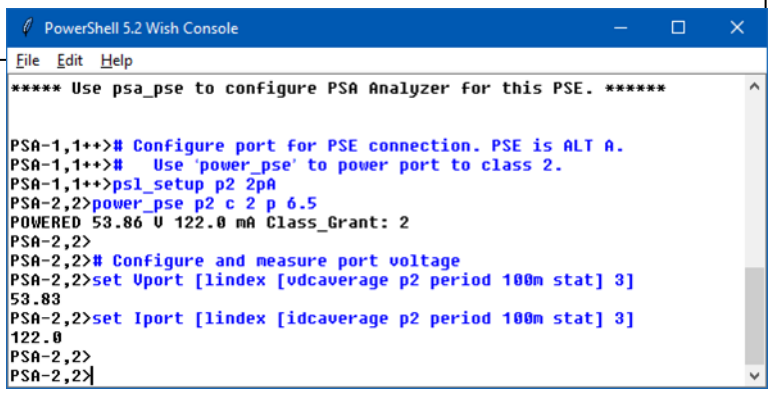
Several examples of short PowerShell PSA scripts to analyze 802.3at PSE's are provided below.

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

The following script will power-up port 2, emulating Class 2 PD drawing 6.5 watts and report Vport & Iport for an Alt-A PSE.

```
# Configure port for PSE connection. PSE is ALT A.
#   Use 'power_pse' to power port to class 2.
psl_setup p2 2pA
power_pse p2 c 2 p 6.5

# Configure and measure port voltage
set Vport [lindex [vdcaverage p2 period 100m stat] 3]
set Iport [lindex [idcaverage p2 period 100m stat] 3]
```

Actual execution:

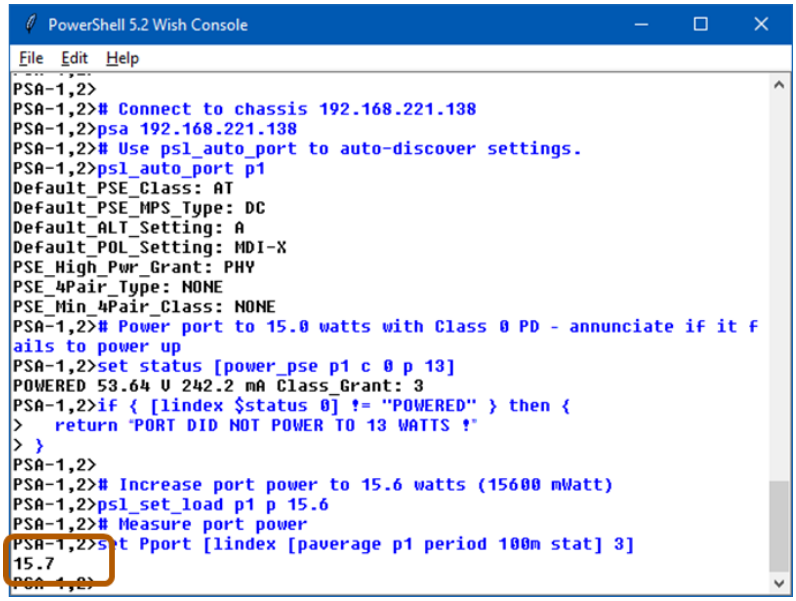


5.15.2. Test a PSE Port to provide at least 15.6 Watts to a Class 0 PD on Port 1 of PSA 192.168.221.138

Determine if PSE Port with unknown powered pairset (Alt) can power at least 15.4 Watts given a Class 0 PD.

```
# Connect to chassis 192.168.221.138
psa 192.168.221.138
# Use psl_auto_port to auto-discover settings.
psl_auto_port p1
# Power port to 15.0 watts with Class 0 PD - annunciate if it fails to
power up
set status [power_pse p1 c 0 p 13]
if { [lindex $status 0] != "POWERED" } then {
  return "PORT DID NOT POWER TO 13 WATTS !"
}

# Increase port power to 15.6 watts (15600 mWatt)
psl_set_load p1 p 15.6
# Measure port power
set Pport [lindex [paverage p1 period 100m stat] 3]
```

Actual execution:
PSE succeeded in providing at least 15.6 Watts !



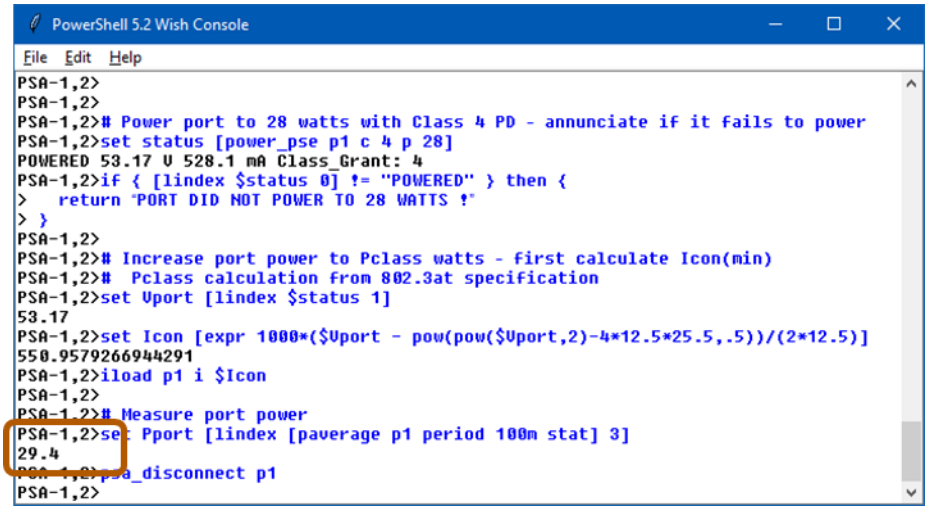
5.15.3. Test a PSE Port to provide at least Pclass (~30W) to a Class 4 PD on the same PSE as 5.15.2 above

Determine if PSE Port with unknown powered pairset (Alt) 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_pse p1 c 4 p 28]
if { [lindex $status 0] != "POWERED" } then {
  return "PORT DID NOT POWER TO 28 WATTS !"
}

# Increase port power to Pclass watts - first calculate Icon(min)
#  Pclass calculation from 802.3at specification
set Vport [lindex $status 1]
set Icon [expr 1000*($Vport - pow(pow($Vport,2)-4*12.5*25.5,.5))/(2*12.5)]
iload p1 i $Icon

# Measure port power
set Pport [lindex [paverage p1 period 100m stat] 3]
psa_disconnect p1
```

Actual execution:

PSE succeeded in providing at least Pclass(29.4W to a Class 4 PD !

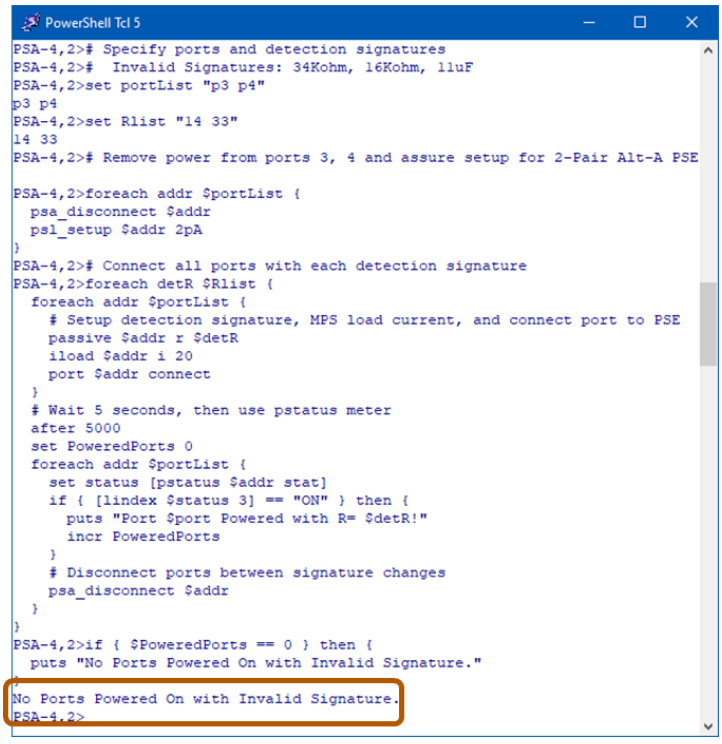


5.15.4. Apply Invalid Detection signatures to ALT A PSE on Ports 3 and 4, then verify no power-ups

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 "p3 p4"
set Rlist "14 33"
# Remove power from ports 3, 4 and assure setup for 2-Pair Alt-A PSE
foreach addr $portList {
  psa_disconnect $addr
  psl_setup $addr 2pA
}
# Connect all ports with each detection signature
foreach detR $Rlist {
  foreach addr $portList {
    # Setup detection signature, MPS load current, and connect port to PSE
    passive $addr r $detR
    iload $addr i 20
    port $addr connect
  }
  # Wait 5 seconds, then use pstatus meter
  after 5000
  set PoweredPorts 0
  foreach addr $portList {
    set status [pstatus $addr stat]
    if { [lindex $status 3] == "ON" } then {
      puts "Port $port Powered with R= $detR!"
      incr PoweredPorts
    }
    # Disconnect ports between signature changes
    psa_disconnect $addr
  }
}
if { $PoweredPorts == 0 } then {
  puts "No Ports Powered On with Invalid Signature."
}
```

Actual execution:



Success: PSE did not power invalid signatures

5.15.5. Power up 8 PSE (Alt-A) ports with Class 3 emulated PD's drawing 11.5 watts each.

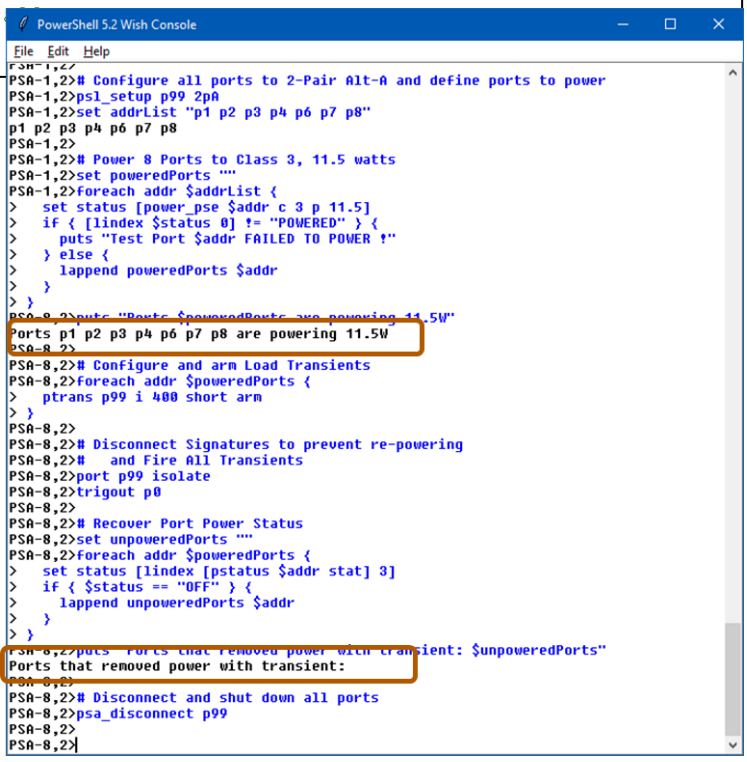
Assess response to short duratio, 400mA load transients simultaneously applied to all 8 ports.

```
# Configure all ports to 2-Pair Alt-A and define ports to power
psl_setup p99 2pA
set addrList "p1 p2 p3 p4 p6 p7 p8"

# Power 8 Ports to Class 3, 11.5 watts
set poweredPorts ""
foreach addr $addrList {
  set status [power_pse $addr c 3 p 11.5]
  if { [lindex $status 0] != "POWERED" } {
    puts "Test Port $addr FAILED TO POWER !"
  } else {
    lappend poweredPorts $addr
  }
}
puts "Ports $poweredPorts are powering 11.5W"

# Configure and arm Load Transients
foreach addr $poweredPorts {
  ptrans p99 i 400 short arm
}
# Disconnect Signatures to prevent re-powering
#   and Fire All Transients
port p99 isolate
trigout p0

# Recover Port Power Status
set unpoweredPorts ""
foreach addr $poweredPorts {
  set status [lindex [pstatus $addr stat] 3]
  if { $status == "OFF" } {
    lappend unpoweredPorts $addr
  }
}
puts "Ports that removed power with transient: $unpoweredPorts"
# Disconnect and shut down
psa_disconnect p99
```

Actual execution:

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

All 8 ports tolerated the 5.5msec, 400mA load transients



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.

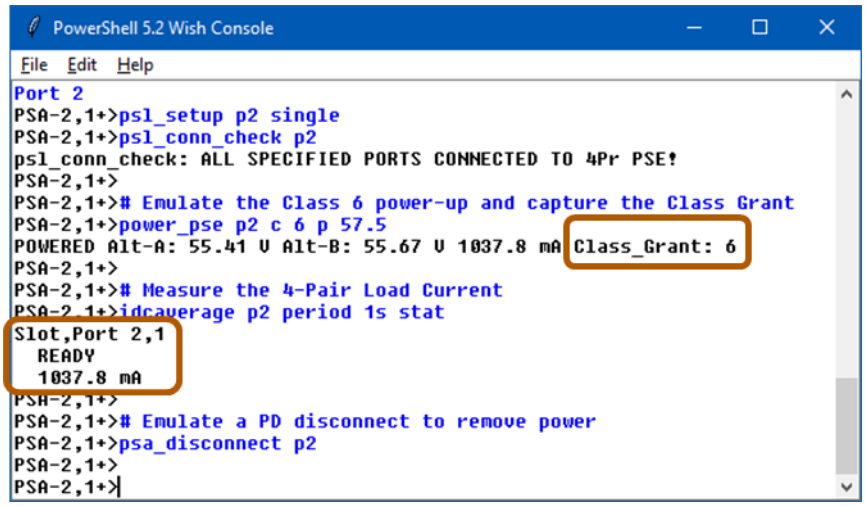
5.16.1. Verify PSE connection on Port 2, then perform a Class 6 emulated power-up to 57.5W to obtain the assigned class, measure 4-Pair load current, and remove Power

Here, a 4-Pair 802.3bt PSE will be connected to an emulated Class 6 PD that draws 57.5W from the PSE. The script will capture the PSE Type and Assigned Class issued by the PSE and then measure the 4-Pair load current. It will then emulate a PD disconnect.

```
# Configure Test Port for 4-Pair to verify PSE Connection on Port 2
psl_setup p2 single
psl_conn_check p2

# Emulate the Class 6 power-up and capture the Class Grant
power_pse p2 c 6 p 57.5

# Measure the 4-Pair Load Current
idcaverage p2 period 1s stat

# Emulate a PD disconnect to remove power
psa_disconnect p2
```

Actual execution:

PSE successfully powers the Class 6 PD providing 4 class events(Class 6 Grant). The 57.5 watt load then leads to a load current of 1037.8mA.



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

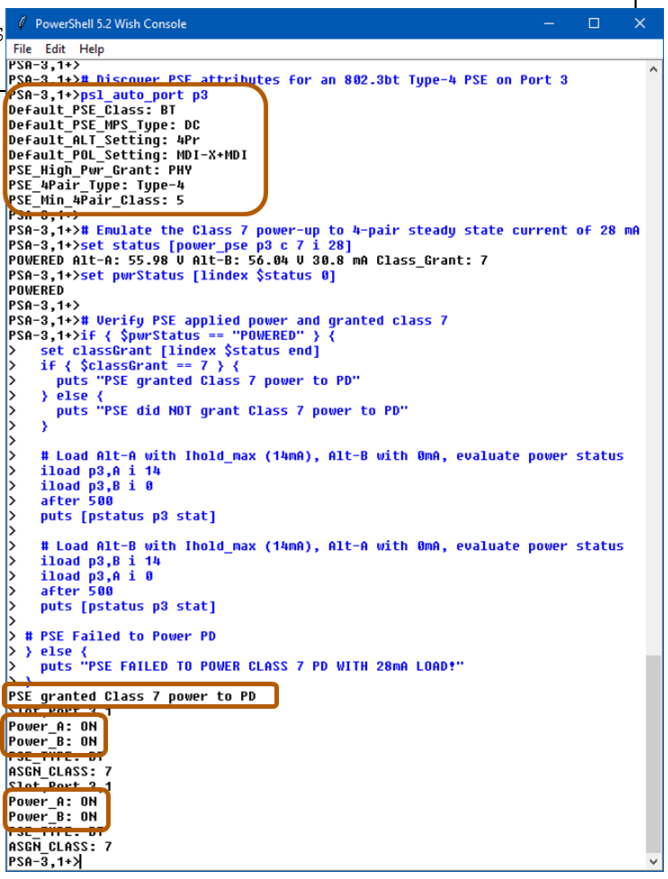
Verify that a 4-Pair capable PSE maintains power to a Class 7 PD when Alt-A pairset draws 14mA and Alt-B pairset draws 0 mA. Verify that reversing current such that Alt-B is 14mA and Alt-A is 0mA also keeps the PD powered. PSE is connected to PSL-3424 port 3.

```
# Discover PSE attributes for an 802.3bt Type-4 PSE on Port 3
psl_auto_port p3

# Emulate the Class 7 power-up to 4-pair steady state current of 28 mA
set status [power_pse p3 c 7 i 28]
set pwrStatus [lindex $status 0]

# Verify PSE applied power and granted class 7
if { $pwrStatus == "POWERED" } {
  set classGrant [lindex $status end]
  if { $classGrant == 7 } {
    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 p3,A i 14
  iload p3,B i 0
  after 500
  puts [pstatus p3 stat]

  # Load Alt-B with Ihold_max (14mA), Alt-A with 0mA, evaluate power status
  iload p3,B i 14
  iload p3,A i 0
  after 500
  puts [pstatus p3 stat]

# PSE Failed to Power PD
} else {
  puts "PSE FAILED TO POWER CLASS
}
```

Actual execution:

The PSE is discovered to support Type-4 (Class 7 and 8) PD's.

The PSE grants the Class 7 power at power-up and then 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 Ilim_min and 850mA Load Transients from a Class 6 PD

On Port 4, emulate a Class 6 PD power-up to 42 watts. Then apply a Class 6 **Ilim_min** (1140mA) load transient for 5.5 msec (Short duration) and determine that PSE maintains power. Follow that with an 1700mA load transient of 100 msec (Long duration) to determine that the PSE removes power.

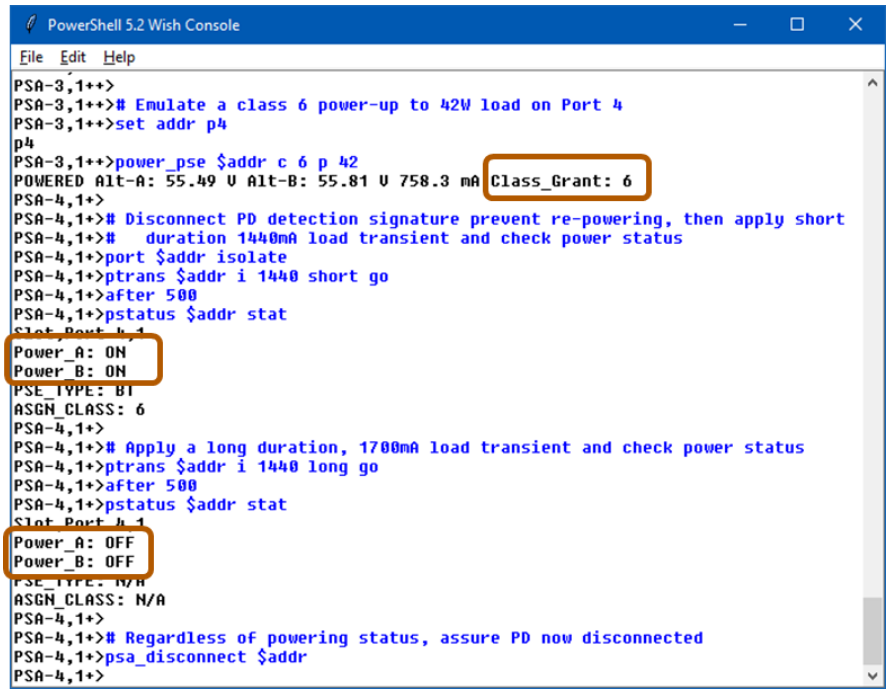
```
# Emulate a class 6 power-up to 42W load on Port 4
set addr p4
power_pse $addr c 6 p 42

# Disconnect PD detection signature prevent re-powering, then apply short
#   duration 1440mA load transient and check power status
port $addr isolate
ptrans $addr i 1440 short go
after 500
pstatus $addr stat

# Apply a long duration, 1700mA load transient and check power status
ptrans $addr i 1440 long go
after 500
pstatus $addr stat

# Regardless of powering status, assure PD now disconnected
psa_disconnect $addr
```

Actual execution:

PSE powers and grants Class 6 power.

***Ilim_min** transient of 1440mA for 5.5 msec was properly tolerated by the PSE without removing power.*

Overload transient of 1700mA for 100msec was properly handled by PSE removal of power.



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

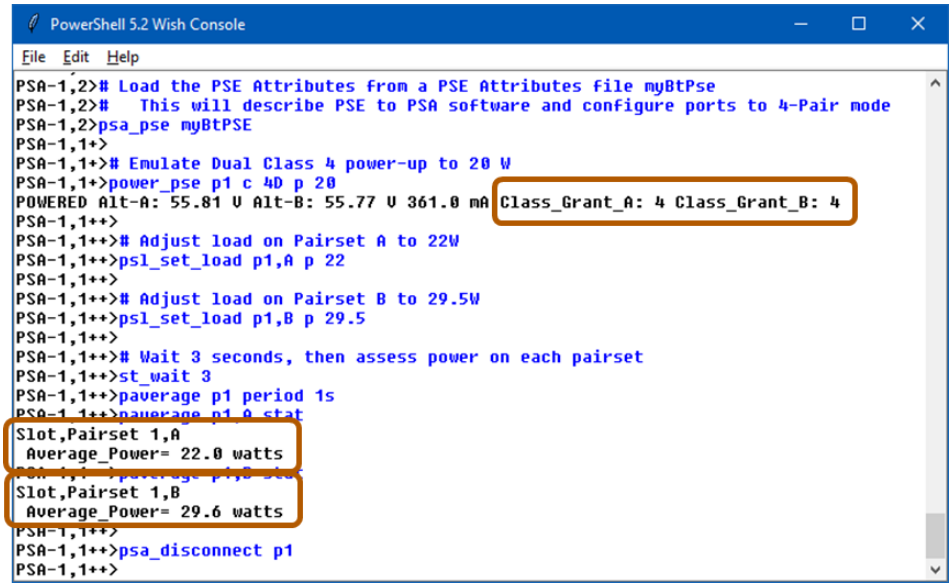
In this example, a PSE Attributes file will be loaded to establish the 4-pair and proper polarity connections for a Type-3 PSE. Using Port 1, an emulated Dual (Class 4) Signature PD will be connected with power draw of 22W on one pairset and 29.5W on the other pairset. Power will then be measured on 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 describe PSE to PSA software and configure ports to 4-Pair mode
psa_pse myBtPSE

# Emulate Dual Class 4 power-up to 20 W
power_pse p1 c 4D p 20

# Adjust load on Pairset A to 22W
psl_set_load p1,A p 22

# Adjust load on Pairset B to 29.5W
psl_set_load p1,B p 29.5

# Wait 3 seconds, then assess power on each pairset
st_wait 3
paverage p1 period 1s
paverage p1,A stat
paverage p1,B stat

psa_disconnect p1
```

Actual execution:

The PSE powers the dual Class 4 signature PD successfully granting Class 4 to each pairset.

Power meter measurements confirm the load power levels that were configured to the Alt-A and Alt-B pairsets.



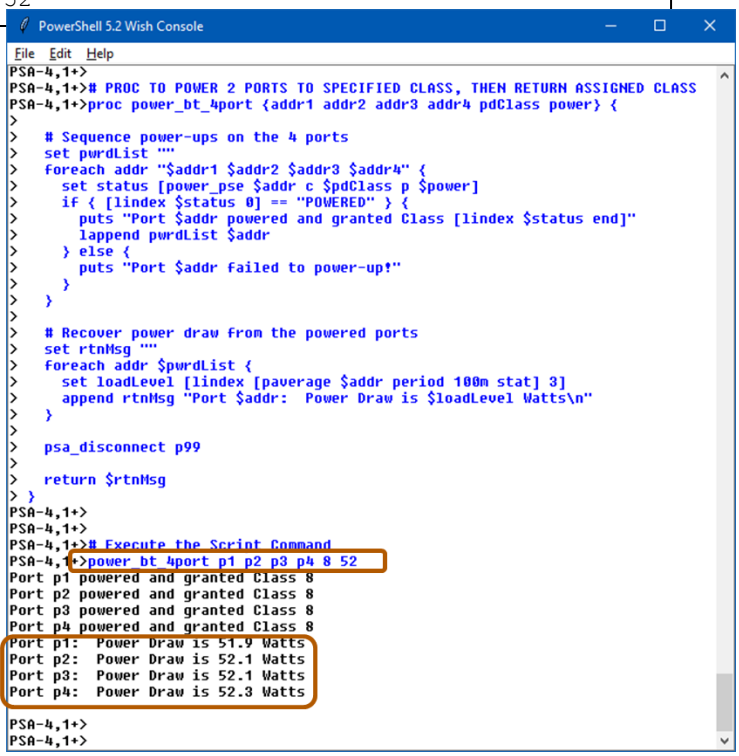
5.16.5. Power four PSE ports to Class 8 PD's each drawing 52 watts. Verify that all PD's are assigned Class 8.

A script, **power_bt_4port**, will be created to process four test ports, a PD class, and a target power load. It will then sequence powering each port and report final load status, then remove power from all ports.

```
# PROC TO POWER 2 PORTS TO SPECIFIED CLASS, THEN RETURN ASSIGNED CLASS
proc power_bt_4port {addr1 addr2 addr3 addr4 pdClass power} {

  # Sequence power-ups on the 4 ports
  set pwrdList ""
  foreach addr "$addr1 $addr2 $addr3 $addr4" {
    set status [power_pse $addr c $pdClass p $power]
    if { [lindex $status 0] == "POWERED" } {
      puts "Port $addr powered and granted Class [lindex $status end]"
      lappend pwrdList $addr
    } else {
      puts "Port $addr failed to power-up!"
    }
  }

  # Recover power draw from the powered ports
  set rtnMsg ""
  foreach addr $pwrdList {
    set loadLevel [lindex [paverage $addr period 100m stat] 3]
    append rtnMsg "Port $addr:  Power Draw is $loadLevel Watts\n"
  }

  psa_disconnect p99

  return $rtnMsg
}
# Execute the Script Command
power_bt_4port p1 p2 p3 p4 8 52
```

Actual execution:
The PSE powers all 4 ports with Class 8 power grants.

Measured power demonstrates that all 4 ports each delivered 52 watts.



6. Section 6 Omitted

7. Section 7 Future

8. Link Layer Discovery Protocol (LLDP) Emulation

Note: Section 8 is only applicable to the **PSL-3424L** instrument.

8.1. PoE LLDP Overview

Each test port in a PSL-3424L is 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 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.

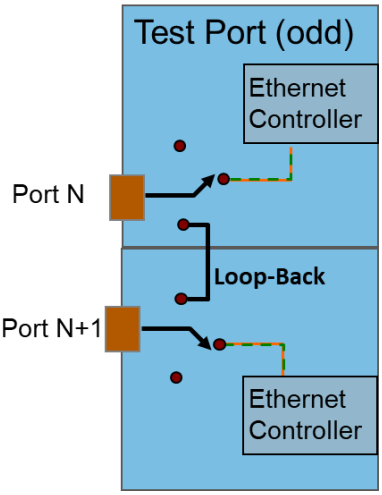


Figure 8.1: Test Port LAN Connections

8.2. PSL-3000 LLDP Connection

Each test port within the PSL-3424L offers three connection options for handling of the LAN signaling. The first option is to leave those signals unterminated (*see Sections 3.1 and 5.9*). A second option, also available to PSL-3424A test ports, is to loop the LAN data back through the vertically adjacent test port. The third option (*see **Figure 8.1***), available only to the PSL-3424L, is to route the LAN connection to a test port hosted Ethernet controller for purposes of receiving and emulating PoE LLDP messaging.

In the isolated, or unterminated state, all four wire pairs are left unconnected. In the Loop-Back configuration, all four wire pairs route between the two test ports and will conduct traffic comprised of 10/100/1000Base-T and Multi-Gigabit (2.5G, 5G, 10G) signaling. In the LLDP configuration, the "spare pairs" (LAN pairs 1 and 4) are unterminated and the "data pairs" (LAN pairs 2 and 3) are connected to a 10/100Base-T transceiver.

Important! LLDP emulation by a test port is restricted to auto-negotiated **10/100Base-T Ethernet**. The test port transceiver only supports **MDI polarity** and therefore requires that the PSE interface support auto-MDI or MDI-X connectivity.

When a test port is configured to the LLDP connection mode, one of the LED's on that test port will flash amber at a steady rate. If the PSE is providing power on the Alt-B pairset, that LED will flash between green and amber.

8.3. Verifying LLDP Features

The PSL-3424L will indicate support for the LLDP connections and emulations through the Help Features menu in PSA Interactive (*see **Figure 8.2***) and also through the psa_enable ? query in PowerShell (*see Section 5.13*). The PSL-3424A instrument will no LLDP support.

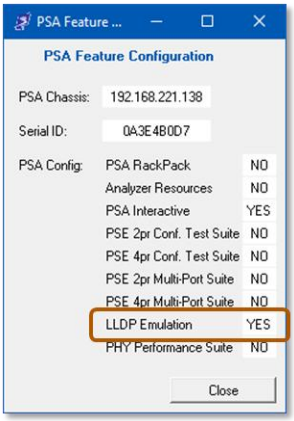


Figure 8.2: Help Features

8.4. PD LLDP Emulation and Testing with PSA Interactive 5

PSA Interactive offers capabilities to emulate **802.at** and **802.3bt** LLDP Power-Ups and to run LLDP Trace Sequences. LLDP Power-Up Emulation is available via the **Power Up** tab menu (*see Section 4.3*) and is also utilized within the **Waveforms** tab menu (*see Section **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 0* 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 0 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 the broadcast port "**p99**" (*see section 9.1.1*).

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.

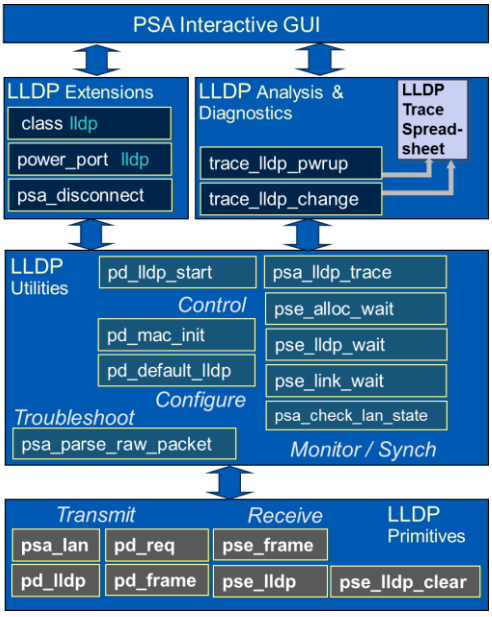


Figure 8.3 PSA Software LLDP hierarchy

Finally, existing PowerShell PSA commands used for PD emulation, namely **power_pse**, **psl_auto_port**, and **psa_disconnect** will selectively utilize LLDP resources whenever LLDP features are enabled with the PSL-3424 instrument. For example, **power_pse** 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 PSL-3424L.

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 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.
<**p***Port*> *4-Pair Option:* **p***Port*,*Pairset*	**PSL-3424** test port addresses may be expressed as a literal "**p**" followed by the integer test port number (1, 2, 3, … 24). This notation is an alternative to the standard *slot*,*port* notation utilized with all other PSA-3000 instruments. PSL-3424 commands will also accept *slot*,*port* addressing following rules that are specific to the PSL-3424 (*see below*). The most recently addressed port is presented using *slot*,*port* format in the command prompt. In a 4-Pair configuration, specific pairsets (Alt-A or Alt-B) can be addressed using **p***Port*,**A** or **p***Port*,**B** notation. *See section 9.1.1 for description of* **p99** *broadcast configuration ports*.
<*slot*,*port*> *Structured as* *slot*,1 or *slot*,2 *4-Pair Option:* *slot*,*pairset*	Within the PSL-3424, each test port may be considered a "virtual" *slot* with a sub-entity *port* that relates to a pairset, that is, to Alt-A or Alt-B. *This notation is quite different from all other PSA-3000 family instruments*. When configured in a **2-Pair** mode for working with 2-Pair PSE's, *slot* is the integer number of the test port and *port* has the value of **1** for Alt-B PSE's and **2** for Alt-A PSE's. When configured in a **4-Pair** mode, either Single or Dual Signature, *slot* is the integer number of the test port and *port* always has the value **1**. Specific pairsets (Alt-A or Alt-B) can be addressed using *slot*,**A** or *slot*,**B** notation. Using the **p***Port* notation described above is a simple way to avoid this complexity. *See section 9.1.1 for description of* **99,x** *broadcast configuration ports*.
"|"	Indicates logical "OR"
stat	An query available to many commands, including all meter commands, to report Operational State and in some cases, to return a measurement result.

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	<p*Port*>	(See Section 5.7)		
pd_req	<p*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)*	<p*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	<p*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	<p*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	<p*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	<p*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	<p*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	<p*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	<p*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	<**p***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	<**p***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	<**p***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	<**p***Port*>	 Resets PSE Frame (Rx) Count to zero and clears the LLDP receive frame buffer.	
pse_lldp_wait	<**p***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	<p*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	<p*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	<**p***Port*>	<**c** *pdClass* | **ca** *pdClassDS* **cb** *pdClassDS*> <**pwr | sspwr** *pwr_request* | **dspwra** *pwr_request* **dspwrb** *pwr_request*> <**period** *pd_req_intvl*> <**duration** *trace_duration*> <**-s**> Application will emulate an **802.3at** or **802.3bt** PD and produce a protocol trace of all PoE LLDP transactions from both PSE and PD following a new PD connection and power-up. Trace will display in real time in PowerShell and may also generate a pop-up spreadsheet report with analysis of the protocol sequence. Power will be removed upon trace completion. **NOTE**: *To view 802.3bt TLV's in the PowerShell console window, the window will need to be widened to the full width of the monitor*. **c** Specify a non-default PD Class. Default is 4. *pdClass* PD Class to emulate. Range is **0** – **8** and **1D** to **5D**. The choice of 802.3at vs 802.3bt TLV's is governed by the power request argument (**pwr**, **sspwr**, **dspwr**). *pdClass* argument must be consistent with the power request argument (e.g. **sspwr** for *pdClass* 5, 6, 7, or 8). **pwr** Specify a non-default **802.3at** power request. Default is 8.6W (Class 0), 3.2W (Class 1), 6.1W (Class 2), 11.4W (Class 3), 22.2W (Class 4). This will assert 802.3at TLV's. **sspwr** Specify a non-default **802.3bt** Single Signature power request. Default is 3.2W (Class 1), 6.1W (Class 2), 11.4W (Class 3), 22.2W (Class 4), 34.8W (Class 5), 44.4W (Class 6), 53.9W (Class 7), 62W (Class 8). This will assert 802.3bt TLV's. **dspwra** and **dspwrb** Specify non-default **802.3bt** Dual Signature power requests for the Alt-A and Alt-B pairsets. Default is 1.6W (Class 1D), 3.1W (Class 2D), 11.1W (Class 3D), 22.2W (Class 4D), 31.0W (Class 5D). This will assert 802.3bt TLV's. *pwr_request* Power (in watts) to request. Range is 1 to 99.9W. **period** Specify non-default transmission interval for the transmitted PD frames. *pd_req_intvl* Time interval, in seconds, for transmitting PD frames during the protocol trace. Default is 10 sec. Range is 2 to 60 sec. **duration** Specify non-default time length, or duration, of the protocol trace. Default is 45 seconds. *trace_duration* Trace duration (seconds) from first LLDP message transmitted. Range is 15 to 120 seconds. **-s** Produce a pop-up spreadsheet report of the captured LLDP power-up trace upon completion. Spreadsheet will contain 802.3at TLV contents and a limited subset of 802.3bt TLV contents applicable to Single Signature power negotiation.	*Protocol Trace Includes*: Time from Power Applied to first PSE LLDP packet. Time (sec) Packet Source Packet Destination Requested Power Allocated Power Port_Class PoE_Capability PoE_Status Power_Class Power_Source Priority *If 802.3bt TLV present, additional fields are:* Dual_Sig_Req_Pwr (Alt A & B) Dual_Sig_Alloc_Pwr (Alt A & B) PSE_Pwr_Status PD_Pwr_Status Dual_Sig_PD_Class> (Alt A & B) PD_Class (1-8) PSE_Pwr_Pairs Extended_Pwr_Type PD_Load PSE_Max_Power Autoclass_Support Autoclass_Done Autoclass_Req PD4PID Power_Down

Command	Port	Command Parameters	Returned Parameters
trace_lldp_change	<**p***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 **bypas**s 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. Section Omitted

8.9.6. Section Omitted

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-1,2># Program Port 1 MAC Address - dot delimited address
PSA-1,2>pd_frame p1 mac 00.4a.30.00.00.11
PSA-1,2>
PSA-1,2># Program Port 2 MAC Address - 12 digit address
PSA-1,2>pd_frame p2 mac 004a30000011
PSA-1,2>
PSA-1,2># Program All Ports to One MAC Address
PSA-1,2>pd_frame p99 mac 00.4a.30.00.99.99
PSA-1,2>
PSA-1,2># Assign Unique MAC Address to All Test Ports
PSA-1,2># Final 3 characters of each address are <Test Port>2
PSA-1,2>pd_mac_init p99 root 00.4a.30.00.0
Slot,Port  1,2 004A30000012
Slot,Port  2,2 004A30000022
Slot,Port  3,2 004A30000032
Slot,Port  4,2 004A30000042
Slot,Port  5,2 004A30000052
…….
Slot,Port 17,2 004A30000172
Slot,Port 18,2 004A30000182
Slot,Port 19,2 004A30000192
Slot,Port 20,2 004A30000202
Slot,Port 21,2 004A30000212
Slot,Port 22,2 004A30000222
Slot,Port 23,2 004A30000232
Slot,Port 24,2 004A30000242
PSA-1,2>
PSA-1,2># Query Port 1 MAC Address
PSA-1,2>pd_frame p1 ?
Slot,Port 1,2
  Source_Address 004a30000012
  Type Type2_PD
  Power_Source PSE
  Priority LOW
  PSE_Alloc_Pwr ECHO
  PSE_alloc_A ECHO
  PSE_alloc_B ECHO
PSA-1,2>
PSA-1,2># Query All MAC Address in All Test Ports
PSA-1,2>pd_mac_init getall
Slot,Port  1,2 004A30000012
Slot,Port  2,2 004A30000022
Slot,Port  3,2 004A30000032
Slot,Port  4,2 004A30000042
Slot,Port  5,2 004A30000052
…….
Slot,Port 17,2 004A30000172
Slot,Port 18,2 004A30000182
Slot,Port 19,2 004A30000192
Slot,Port 20,2 004A30000202
Slot,Port 21,2 004A30000212
Slot,Port 22,2 004A30000222
Slot,Port 23,2 004A30000232
Slot,Port 24,2 004A30000242

PSA-1,2>
```

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.

When configuring LLDP functions in a PSL-3424L test port, the *slot*,*port* notation for all LLDP resources will be presented as Port,**2**. This is because the LLDP controller in each test port is managed under the Alt-A pairset microcontroller. Command and query addressing to test port **p***N* format hides this detail (*see Section 8.7*).

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-1,2># Connect the LLDP Subsystem
PSA-1,2>psa_lan p1 lldp
PSA-1,2>
PSA-1,2># Program LLDP Packet Parameters - Mostly Power-Up Defaults
PSA-1,2>pd_lldp p1 lldpaddr 01.80.C2.00.00.0E ch_id 4 004a30000012 port_id 3
004a30000011
PSA-1,2>pd_lldp p1 ttl 120 vlan disable
PSA-1,2>
PSA-1,2># Query LLDP Packet Parameters
PSA-1,2>pd_lldp p1 ?
Slot,Port 1,2
  Dest_Address 0180c200000e
  ChassisID_subtype MAC_address ChassisID 004a30000012
  PortID_subtype MAC_address PortID 004a30000012
  TTL 120 seconds
  VLAN_tag disabled
  PCP 0
  CFI 0
  VID 0
PSA-1,2>
PSA-1,2># Program PD MAC and PoE TLV Parameters
PSA-1,2>pd_frame p1 mac 00.4a.30.00.00.12
PSA-1,2>pd_frame p1 type 2 source pse priority high pwr_alloc echo
PSA-1,2>
PSA-1,2># Query LLDP PoE Configuration
PSA-1,2>pd_frame p1 ?
Slot,Port 1,2
  Source_Address 004a30000012
  Type Type2_PD
  TTL 120 seconds
  Power_Source PSE
  Priority HIGH
  PSE_Alloc_Pwr ECHO
  PSE_alloc_A ECHO
  PSE_alloc_B ECHO
PSA-1,2
PSA-1,2># Program 802.3at PD Power Request and Message Transmission Parameters
PSA-1,2>pd_req p1 pwr 22.2 class 4 period 15 count 0 trig off init
PSA-1,2>
PSA-1,2># Query PD LLDP Transmission Parameters
PSA-1,2>pd_req p1 ?
Slot,Port 1,2
  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-1,2>
PSA-1,2># Start PD LLDP Transmission
PSA-1,2>pd_req p1 stat
Slot,Port 1,2
  RUNNING
PSA-1,2>
PSA-1,2># Query PD LLDP Status
PSA-1,2>pd_req p1 stat
Slot,Port 1,2
  RUNNING
PSA-1,2>
```

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, 2, 3, and 4. 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 p99 root 00.4a.30.00.0 store
Slot,Port  1,2 004A30000012
Slot,Port  2,2 004A30000022
Slot,Port  3,2 004A30000032
…….
Slot,Port 21,2 004A30000212
Slot,Port 22,2 004A30000222
Slot,Port 23,2 004A30000232
Slot,Port 24,2 004A30000242
PSA-2,1+>
PSA-2,1+># Connect the LLDP Subsystem on all ports
PSA-2,1+>psa_lan p99 lldp
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 p99 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 p1 stat
Slot,Port 1,2
  RUNNING
PSA-1,1+>pd_req p2 stat
Slot,Port 2,2
  RUNNING
PSA-2,1+>pd_req p3 stat
Slot,Port 3,2
  RUNNING
PSA-3,1+>pd_req p4 stat
Slot,Port 4,2
  RUNNING
PSA-4,1+>
PSA-4,1+># Query LLDP Status on Port 2
PSA-4,1+>pd_req p2 stat
Slot,Port 2,2
  RUNNING
PSA-2,1+># Discontinue PD Packet Transmission on ALL Test Ports
PSA-2,1+>pd_req p99 stop
```

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 3 power
PSA-1,1>power_pse p1 c 3
POWERED 54.29 V 121.0 mA Class_Grant: 3
PSA-1,1>
PSA-1,1># Connect the LLDP Subsystem - NOTE: power_pse will initially disconnect it
PSA-1,1>psa_lan p1 lldp
PSA-1,1>
PSA-1,1># Wait up to 5 seconds for linkup
PSA-1,1>pse_link_wait p1 timeout 5
LINK_UP
PSA-1,1>
PSA-1,1># Start capturing frames (assuming LINK UP)
PSA-1,1>pse_frame p1 start
PSA-1,1>
PSA-1,1># Wait up to 30 seconds for a PSE LLDP Message
PSA-1,1>pse_lldp_wait p1 timeout 30
UPDATED
PSA-1,1>
PSA-1,1># Read PoE Values from Most Recent PSE LLDP Message
PSA-1,1>pse_frame p1 stat
Slot,Port 1,2
  Rx_Status RUNNING
  Rx_Count 4
  Allocated_Power 13.0 Watts
  Class 0
  Power_Type Type_2_PSE
  Power_Source Primary_source
  Priority low
  Echoed_Request 13.0 Watts
  Source_MAC 3810f0f76bcf
  MDI_Power_Support 0x07
  PSE_Power_Pair 0x02
PSA-1,1>
PSA-1,1>
PSA-1,1># Read LLDP Frame Value from Most Recent PSE LLDP Message
PSA-1,1>pse_lldp p1 stat
Slot,Port 1,2
  Rx_Status RUNNING
  Rx_Count 2
  LLDP_Addr 0180c200000e
  Ethernet_Type 0x88cc(LLDP)
  Chassis_ID MAC_address 00c08f220613000000000000
  Port_ID MAC_address 00c08f22061300000000000
  TTL 120 seconds
  VLAN_tagged no
PSA-1,1>
```

8.10.5. (section omitted)

8.10.6. PD Emulation with power_pse, and psa_disconnect Commands

The following example utilizes the **power_pse** utility to emulate connection and powering of an 802.3at Class 4 PD that requests 24.3 watts. **power_pse** 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-1,2># Power-Up to 24 Watts - Return when power is granted and established
PSA-1,2>power_pse p1 c 4 p 24 lldp_at force 24.3 timeout 45
POWERED 53.48 V 450.8 mA Class_Grant: 4 ACCEPTED
PSA-1,2>
PSA-1,2># Measure the Power to the PD
PSA-1,2>paverage p1 period 1s stat
Slot,Port 1,2
 Average_Power= 24.1 Watts
PSA-1,2>
PSA-1,2># Remove Power from the PSE Port and disconnect LLDP
PSA-1,2>psa_disconnect p1
PSA-1,2>
PSA-1,2># Verify LAN and LINK Status
PSA-1,2>psa_check_lan_state p1
NOT_CONNECTED
PSA-1,2>
```

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 so it will advertise class 4 and draw 50 mA at power-up
PSA-1,2>passive p1 r 24
PSA-1,2>class p1 4
PSA-1,2>iload p1 i 50
PSA-1,2>
PSA-1,2># Connect the port
PSA-1,2>port p1 connect
PSA-1,2>psa_lan p1 lldp
PSA-1,2>
PSA-1,2># Wait for Link and Start a 2 minute Trace
PSA-1,2>pse_link_wait p1 timeout 15
LINK_UP
PSA-1,2># Configure the LLDP power request
PSA-1,2>pd_req p1 class 4 pwr 24.3
PSA-1,2>
PSA-1,2>psa_lldp_trace p1 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-3424

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. Further information on this topic appears in Section 4.7.6.

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 a broadcast port designation so that **configuration** parameters can be established in more than a single test port using just a single configuration command. This saves both on programming and execution time.

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 Alt-A or 4-Pair Single Signature. The only exception to this is the **psl_setup** command that actually performs test port configuration.

The address **p99** will broadcast a configuration to every test port in a PSA chassis regardless of test port configuration (2-Pair or 4-Pair). When all slots are in an identical 4-pair configuration, **p99,A** and **p99,B** may be used to configure resources to all Alt-A or Alt-B pairsets respectively. 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:

`psl_setup p99 2pA`	Configures all test ports to 2-Pair, Alt-A configuration.
`port p99 isolate`	Removes detection signature on all test ports
`passive p99 r 24`	Sets all detection signatures in all test ports to 24KΩ
`class p99 7`	Configures a Class 7 classification signature in all test ports
`iload p99,A i 560`	In 4-Pair Mode, sets Alt-A pairset loads on all ports to 560mA
`ptrans p99 i 400 short`	Configures load transients in all ports to 400mA, 5.5msec duration

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 **p99** address are:

`psl_setup`	`ptrans`	`vdcaverage` (*config only*)	*PSL-3424L Only*
`passive`	`psa_lan`	`idcaverage` (*config only*)	`pd_req` (*excluding* `stat`)
`port`	`psa_disconnect`	`vdcpeak` (*config only*)	`pd_lldp`
`class`		`idcpeak` (*config only*)	`pd_frame`
`iload`		`paverage` (*config only*)	`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_pse** 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 broadcast configurations, will combine to effect faster testing.

The following script will power-up 8 PSE ports to with emulated Class 3 PD's each drawing 12.6 watts.

```
# Specify test ports to use and configure to Alt-A, 2-Pair
set startTime [clock seconds]
set addrList "p1 p2 p3 p4 p5 p6 p7 p8"
psl_setup p99 2pA

# Assure all ports are powered down
port p99 isolate
iload p99 i 0
after 500

# Configure emulated PD signatures and set initial load
passive p99 r 24
class p99 3
iload p99 i 50

# Configure metering
paverage p99 period 100m

# Connect all ports simultaneously and wait up to 30 seconds to power
port p99 connect
set t0 [clock seconds]
set timer 0
set unPwrdList $addrList
while {$timer < 30 && $unPwrdList != "" } {
  foreach addr $unPwrdList {
    set status [lindex [pstatus $addr stat] 3]
    if { $status == "ON" } {
      set idx [lsearch $unPwrdList $addr]
      set unPwrdList [lreplace $unPwrdList $idx $idx]

      # Adjust power load to 12.6 watts on powered port
      psl_set_load $addr p 12.6 1
    }
    after 500
    set timer [expr [clock seconds] - $t0]
  }
}

# Measure actual power draws and report
foreach addr $addrList {
  puts "Test Port $addr: Power = [paverage $addr stat]"
}
puts "Execution Time: [expr [clock seconds] - $startTime] seconds"
```

Actual execution:

In this example, all 8 PSE ports are powered and delivering 12.6 watts in less than 20 seconds.

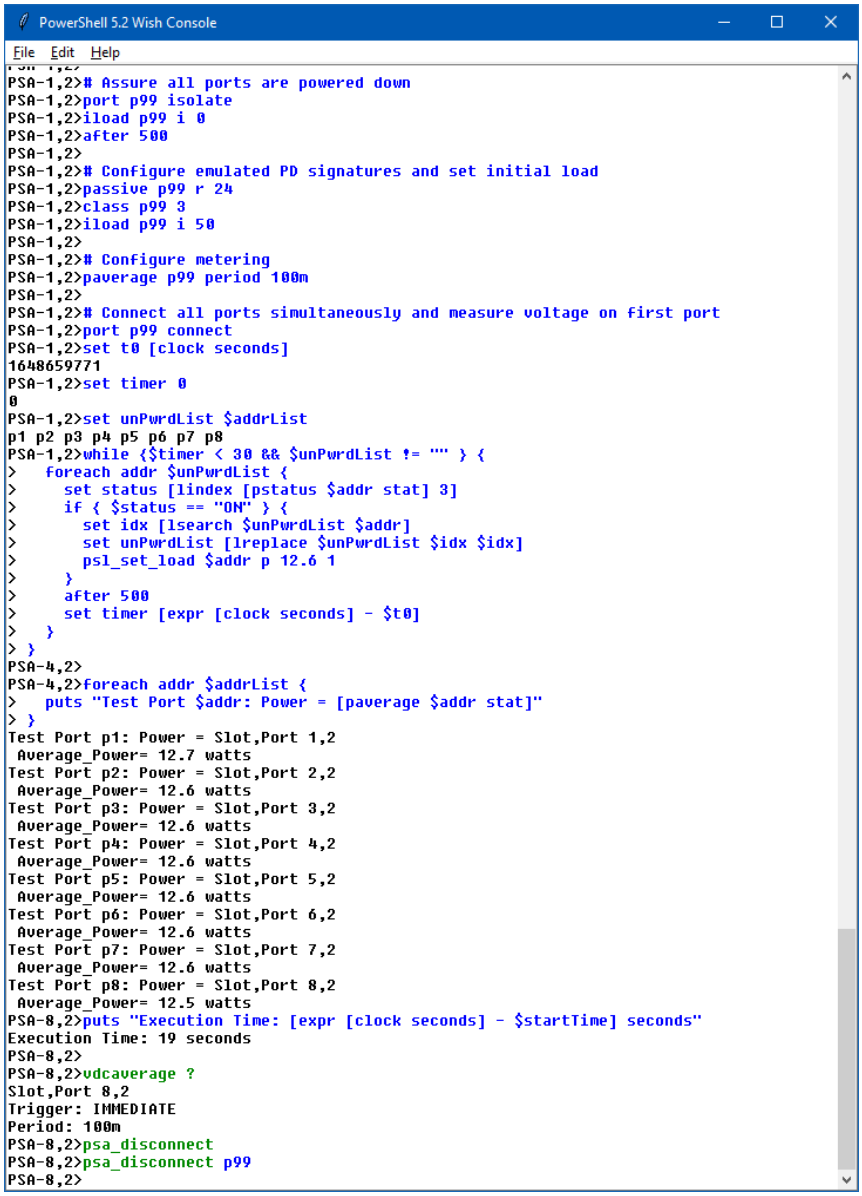


Figure 9.1 8-Port Power-Up to 12.6Watts in Less Than 20 Seconds

9.1.3. psl34_quick_test: Fully Automated Test Script for Multi-Port PSE's

PSL-3424 software includes a fully automated, multi-port PSE test script designed for high throughput and high defect coverage of PSE ports (*see also Section 4.7.5*). This test utility is accessed from PowerShell with the command **psl34_quick_test** (*see Section 5.14*). Typical test types will range from 8 to 15 seconds per port tested. In this report, an LLDP capable PSE is tested with a PSL-3424L.

```
    192.168.221.138       p1       p2       p3       p4       p5       p6       p7       p8
     Detect_Accept:     PASS     PASS     PASS     PASS     PASS     PASS     PASS     PASS
     Detect_Reject:     PASS     PASS     PASS     PASS     PASS     PASS     PASS     PASS
    Vport_Low_Load: PASS_>50 PASS_>50 PASS_>50 PASS_>50 PASS_>50 PASS_>50 PASS_>50 PASS_>50
   Vport_High_Load: PASS_>50 PASS_>50 PASS_>50 PASS_>50 PASS_>50 PASS_>50 PASS_>50 PASS_>50
         PSE_Type:       AT       AT       AT       AT       AT       AT       AT       AT
  Max_Class_Grant:        4        4        4        4        4        4        4        4
           Pclass:     29.2     29.3     29.2     29.3     29.2     29.2     29.2     29.2
      Disconnects:     PASS     PASS     PASS     PASS     PASS     PASS     PASS     PASS
        Overloads:     PASS     PASS     PASS     PASS     PASS     PASS     PASS     PASS
    LLDP_Protocol:  PASS_AT  PASS_AT  PASS_AT  PASS_AT  PASS_AT  PASS_AT  PASS_AT  PASS_AT
  LLDP_Allocations:  PASS_AT  PASS_AT  PASS_AT  PASS_AT  PASS_AT  PASS_AT  PASS_AT  PASS_AT
         Test_Time:   69.0    seconds
    Test_Time/Port:    8.6    seconds
           Version:    5.3.0c
```

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

9.1.4. Multi-Chassis Testing in Parallel

One other technique that can be utilized to speed up testing with the PSL-3424 is parallel execution of test scripts on multiple PSL-3424 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.

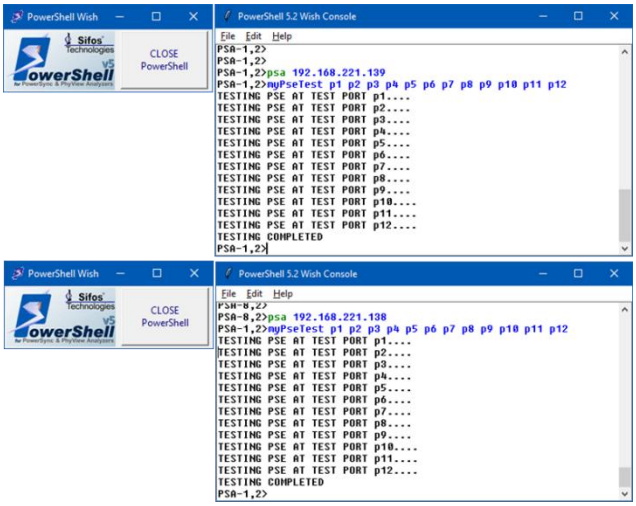


Figure 9.3 Tests Executing Simultaneously in 2 PowerShell's

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 lack the prefix "psa" and should be considered before merging applications into a common shell.

PowerShell Commands	
port	vdcpeak
class	idcpeak
passive	paverage
iload	**PowerShell Globals**
ptrans	port
trigout	slotRange
trig_port	portRange
pstatus	channel available
vdcaverage	emulationMode
idcaverage	commandOut

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.

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

* **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.

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
4. Script Call from PowerShell Initialization File
5. 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 PSA 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 PSA 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**.