Sifos® Technologies

LLDP Emulation & Analysis
for the **PSA-3000 / PSL-3000**
IEEE 802.3at Power over Ethernet

Product Overview

Key Features

- ❑ **Integrated PoE LLDP and Load Emulation in a Single Instrument**
- ❑ **IEEE 802.3 Clause 33 and Clause 79 Compliance**
- ❑ **Independent, Per-Port LLDP Emulations**
- ❑ **Flexible PD LLDP Modeling and Configuration**
- ❑ **One-Button LLDP Protocol Capture and Analysis**
- ❑ **LLDP Testing with PSA Interactive Graphical User Interface**
- ❑ **Pop-Up Excel Spreadsheet Reports**
- ❑ **Enables 802.3at PSE Conformance Test Suite with LLDP PSE's**
- ❑ **Enables 802.3at PSE Multi-Port Suite with LLDP PSE's**
- ❑ **Available for PSA-3000 and PSL-3000 Platforms**
- ❑ **Supports Cisco 4-Pair UPoE LLDP PD Emulation**

Verification, Simplified.

One-Button Testing: 802.3at LLDP

One-Button Protocol Traces

Power-Up PD Emulation

Power Adjust PD Emulation

Flexible PSE LLDP Emulation Support

Flexible 802.3at PD Emulation

PD Classification

PD Pre-Negotiated Power Load

PD Post-Negotiated Power Load

LLDP Parameters

LLDP Message Timing

Troubleshoot LLDP Issues

Protocol Sequencing

Protocol Timing

Protocol Content

Enable 802.3at Test Suites

PSE Conformance Test

PSE Multi-Port Test

Live PD Emulation

Overview

With the 802.3at standard, PoE augmented layer 1 Powered Device (PD) classification with a MAC (or Link) Layer PD classification that offers significantly improved power management accuracy and enables dynamic negotiation of power levels between PSE and PD.

The link layer scheme uses a PoE-specific Link Layer Discovery Protocol (LLDP) as specified in Clause 79 of IEEE 802.3 with additional protocol rules defined in Clause 33 (IEEE 802.3at).   LLDP is a point-to-point MAC protocol historically used to allow switches and routers to automatically "discover" connected equipment and to populate and maintain a MIB that can be used for viewing and managing a network topology.   Under IEEE 802.3at, LLDP is extended to perform a link configuration function related to power negotiation between a PSE and a PD.

PSA-3000 Family: LLDP Emulation and Analysis

PSA-3000 and PSL-3000 platforms each offer a feature upgrade that enables flexible emulation and analysis for 802.3at LLDP.   The upgrade is available in the form of an instrument-specific license code that may be purchased from Sifos Technologies.

LLDP Emulation involves modeling numerous characteristics of a PD as it uses LLDP to request and agree upon power allocations from a PSE. Normally, such transactions are performed immediately after powering the PD, though they may be ongoing with subsequent power adjustments induced by either the PD or the PSE.   Characteristics that may be modeled are **PD Power Request**, **PSE Power Allocation** (echo), **periodicity** of packet transmission, **timing** of responses to value changes, LLDP **time-to-live**, and various TLV fields that communicate **device status** and **information**.

LLDP Analysis involves capturing and analyzing bi-directional PoE-specific LLDP packets and associated packet timing during PD power-ups and during ongoing (post power-up) power adjustments.

The PSA-3000 and PSL-3000 platforms support **flexible LLDP Emulation** and **robust LLDP Analysis** capabilities that are accessible from both PSA Interactive (GUI) and PowerShell PSA. LLDP power-up emulations to target power requests are performed in a single "button-click" in PSA Interactive or a single command in PowerShell PSA. LLDP Protocol Traces offer fully automated capture, display, and analysis of LLDP protocol sequences between a PSE port and a user-defined PD.   Analysis is performed in colorful pop-up Excel spreadsheets that highlight protocol non-conformances or timing defects.

Beyond 802.3at, robust emulation of **Cisco UPoE** compatible 4-Pair PD's is also supported under the LLDP feature option for the PSA/PSL-3000.

LLDP Enabling for PSE Conformance and Multi-Port Suites

Flexible LLDP emulation and analysis is a mandatory component in any **PSE Conformance Test** for end-span PSE's that use LLDP for power management. With the LLDP emulation feature, the PSA-3000 is uniquely positioned to fulfill this requirement.

LLDP emulation also facilitates both **Multi-Port Live PD Emulation** and the **Multi-Port Test Suite** in combination with LLDP capable end-span PSE's.   This testing enables robust PSE system administrative and power management analyses without the need of any Powered Devices.

Verification, Simplified.

One-Button LLDP Protocol Traces

The LLDP Protocol trace is a simple way to describe a PD, then sequence a complete LLDP-negotiated power-up or power change where messsage exchanges are viewed both in real time and in a post-processed pop-up Excel spreadsheet with colorful highlighting of protocol violations, message direction, and timing issues.

LLDP Protocol Traces can be easily accessed from the LLDP Traces control in the PSA Interactive Waveforms & Traces menu or directly from the main menu in PSA Interactive PL. LLDP Protocol traces can also be configured and monitored from PowerShell PSA using a single command.

LLDP Protocol traces on each individual port may be captured while other PSE ports are statically loaded with user selected power levels.

The LLDP Power-Up Trace

The LLDP Power-Up Trace always starts from a power-down state and emulates the connection, PD classification, and LLDP post-power-up negotiation.   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.
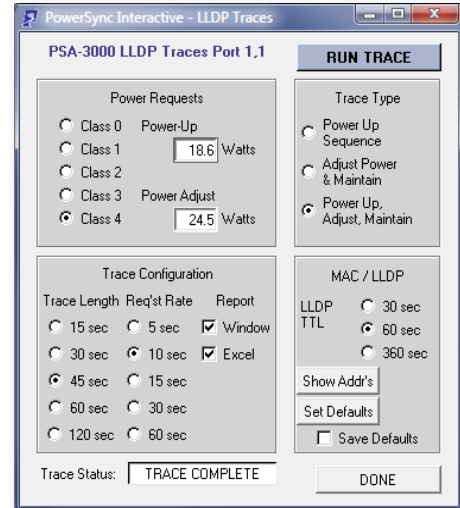
LLDP Traces Menu in PSA Interactive

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 will never adjust power following the negotiation to the PD Requested Power level because the purpose 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 load.

PSA-3000 LLDP Trace			PSE	Port	Trace Type	Requested	Allocated	Echo Time	Alloc Time	Init. Time	Time To Live		
June 15 2017	4:12 PM		Sample Type-2 PSE	2-1	Power-Up	22.3	22.3	17.5	17.5	38.3	80		
PSA Address: 192.168.221.103						*Watts*	*Watts*	*Seconds*	*Seconds*	*Seconds*	*Seconds*		version 4.2.00

Time	From	To	Type	Requested	Allocated	Port Class	MDI Capability	MDI Status	Power Class	Source	Priority
PWR+38.3	PSE	PD	2	0.0	13.0	PSE	YES	ON	3	PRIMARY	LOW
0.0	PD	PSE	2	22.3	13.0	PD	N/A	N/A	4	PSE	LOW
5.4	PD	PSE	2	22.3	13.0	PD	N/A	N/A	4	PSE	LOW
11.1	PD	PSE	2	22.3	13.0	PD	N/A	N/A	4	PSE	LOW
16.7	PD	PSE	2	22.3	13.0	PD	N/A	N/A	4	PSE	LOW
17.5	PSE	PD	2	22.3	22.3	PSE	YES	ON	3	PRIMARY	LOW
22.3	PD	PSE	2	22.3	22.3	PD	N/A	N/A	4	PSE	LOW
27.9	PD	PSE	2	22.3	22.3	PD	N/A	N/A	4	PSE	LOW
33.6	PD	PSE	2	22.3	22.3	PD	N/A	N/A	4	PSE	LOW
37.6	PSE	PD	2	22.3	22.3	PSE	YES	ON	3	PRIMARY	LOW
39.2	PD	PSE	2	22.3	22.3	PD	N/A	N/A	4	PSE	LOW
44.8	PD	PSE	2	22.3	22.3	PD	N/A	N/A	4	PSE	LOW

LLDP 22.3 Watt Power-Up Trace Report

Upon completion of the LLDP Power-Up Trace, power is always removed.

LLDP Power-Adjust Protocol Trace

The Power-Adjust Protocol Trace can start from either an 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 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 load 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 *after* 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.


PSA-3000 LLDP Trace

		PSE	Port	Trace Type	Requested	Allocated	Echo Time	Alloc Time	Init. Time	Time To Live
June 15 2017	5:16 PM	Sample Type-2 PSE	5-1	Pwr_Change	24.2	24.2	0.6	0.6	0	120
PSA Address: 192.168.221.84					*Watts*	*Watts*	*Seconds*	*Seconds*	*Seconds*	*Seconds*

Time	From	To	Type	Requested	Allocated	Port Class	MDI Capability	MDI Status	Power Class	Source	Priority
PWR+19	PSE	PD	2	14.6	14.6	PSE	YES	ON	4	PRIMARY	LOW
0.0	PD	PSE	2	24.2	14.6	PD	N/A	N/A	4	PSE	LOW
0.6	PSE	PD	2	24.2	24.2	PSE	YES	ON	4	PRIMARY	LOW
5.4	PD	PSE	2	24.2	24.2	PD	N/A	N/A	4	PSE	LOW
11.0	PD	PSE	2	24.2	24.2	PD	N/A	N/A	4	PSE	LOW
16.7	PD	PSE	2	24.2	24.2	PD	N/A	N/A	4	PSE	LOW
22.5	PD	PSE	2	24.2	24.2	PD	N/A	N/A	4	PSE	LOW
28.1	PD	PSE	2	24.2	24.2	PD	N/A	N/A	4	PSE	LOW

LLDP 14.6 Watt Power-Up Followed By 24.2 Watt Power Change Report

Upon completion of the Power Change Trace, power is always maintained at the newly requested level.
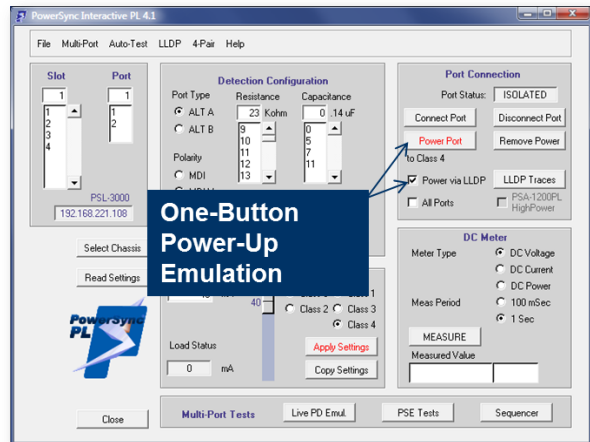
One-Button Emulated LLDP Power-Ups

Emulated LLDP PD Power-Ups become available in PSA Interactive when the LLDP feature is enabled.
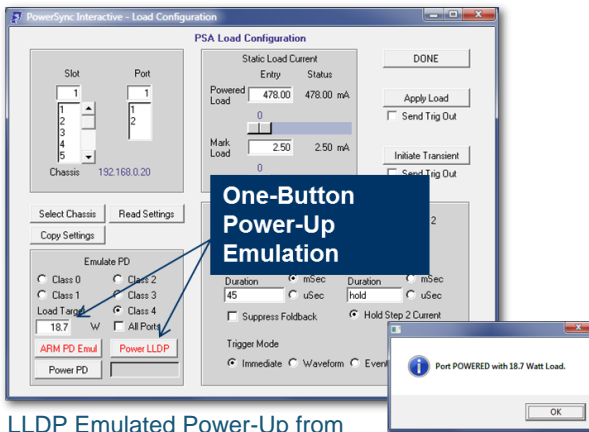

LLDP Emulated Power-Up from

In PSA Interactive, this capability is found in the **Load Configuration** menu where a user can specify a **PD Class** and a **Load Target** (in watts), then power up one port at a time emulating both actual power-draw and LLDP emulation. Each emulated LLDP power-up will be followed with a status notification message box.

LLDP Emulated Power-Up from PSA Interactive PL

In PSA Interactive PL, this feature is available on the main menu. Users may select a **PD Class**, and the target load will be automatically selected based upon PD classification. The emulated LLDP power up is then effected by selecting the **Power via LLDP** check box and pressing **Power Port**. The **LLDP Traces** (LLDP Power-Change Protocol Trace) can then be used to negotiate and adjust the final loading after the initial LLDP power-up completes.

## LLDP & Multi-Port Live PD Emulation

LLDP Emulation enables the **Multi-Port Test Suite** to support LLDP and LLDP2 modes of power management as required to test PoE[+] PSE's that use LLDP for power management. LLDP Emulation also enables **Multi-Port Live PD Emulation** to simultaneously emulate up to 192 LLDP-capable PD's. For further information, see Sifos datasheet, **Multi-Port Live PD Emulation Overview**.
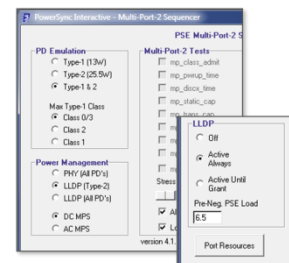
LLDP Enabling in PSE Multi-Port Suite

PSE Conformance Testing with LLDP-Capable PSE's

The **PSE Conformance Test Suite** for 802.3at* is designed to test PSE's using either Type-1 or Type-2 PD Emulation. Type-2 (30 Watt) PSE's should generally be tested with both emulations. When testing Type-2 PSE's that use LLDP to grant high power (> 13W) to PD's, LLDP power-up emulations must be used in any tests that require power-up beyond 15.4 watts at the PSE. The LLDP Emulation and Analysis feature must be enabled in a PowerSync Analyzer that performs this mode of testing.

LLDP Enabling in PSE
Conformance Test Suite
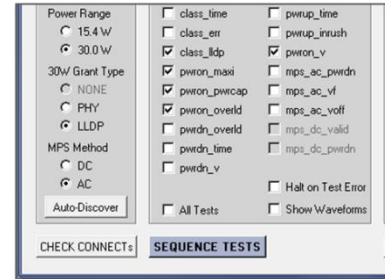
Additionally, the PSE Conformance Test Suite for 802.3at adds a conformance test directly aimed at assessing LLDP protocol function and performance. The **class_lldp** test will emulate either Type-2 (PD Class 4) or Type-1 (PD Class 3) PD's and will produce the following measurements:

| Test Parameter	Description
PSE_Source_Priority	Binary indication of Valid (=0) or Invalid (=1) PoE+ Source/Priority Field
PSE_MDI_Pwr_Sup	Binary indication of Valid (=0) or Invalid (=1) MDI Capabilities Field
PSE_LLDP_Time_n	Time from Power-Up until Receipt of First PoE LLDP Packet from PSE given Type "n" (1 or 2) mode PD Emulation
PSE_LLDP_Type_n	PSE Type Communicated in PoE+ Source/Priority Field given Type "n" (1 or 2) mode PD Emulation.
PSE_Echo_Time_n	Time for PSE to Echo PD Power Request given Type "n" (1 or 2) mode PD Emulation.
PSE_Alloc_Pwr_n	Power Allocated to PD at Startup given Type "n" (1 or 2) mode PD Emulation.
PSE_Alloc_Time_n	Time for PSE to Allocate PD Power Request given Type "n" (1 or 2) mode PD Emulation.
PD_Power_Adjust_n	Power Allocated to PD following a Power Adjustment Request to Maximum Power Allowed given Type "n" (1 or 2) mode PD Emulation.
PSE_Adjust_Time_n	Time for PSE to Echo PD Power (Adjustment) Request given Type "n" (1 or 2) mode PD Emulation.

*For further information, see Sifos datasheet **PSE Conformance Test Product Overview**.

In-Depth LLDP Emulation Control from PowerShell PSA

Using PowerShell PSA, even greater control of LLDP emulations and associated LLDP testing is made possible through a full set of PowerShell API commands. Received PSE packets may be analyzed for "**raw**" LLDP content. PD Request packets may be configured for various content including MAC address, TTL, and all PoE Plus fields including invalid power requests. PD Request packet timing relative to incoming PSE packets can be precisely controlled. *PSE LLDP* packets may be emulated as might be useful for script development or testing PD's.

PowerShell PSA LLDP commands are organized into primitives, utilities, LLDP command extensions, and LLDP trace diagnostics. The **primitives** provide test port level configurations and queries of LLDP resources on each test port. This includes link connection, emulated PD LLDP framing characteristics, PoE TLV values, packet transmission characteristics, PSE frame capture and buffer, TLV parsing, raw frame display, and frame counting. The **utilities** use primitives to perform higher level configurations or queries such as assigning default MAC addresses, waiting for link, waiting for Power Request echo, and waiting for Power Request allocation.

The command **extensions** involve LLDP conditional modifications to other PowerShell PSA commands such as **power_port** for PD LLDP power-up emulation. The LLDP **trace diagnostics** are the application layer commands that configure, capture, display in real time, and report LLDP protocol traces.
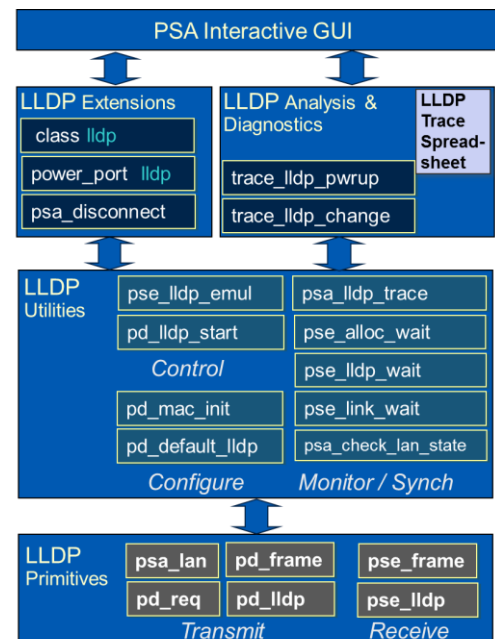
PSA LLDP Software Hierarchy

Technical Data: LLDP Emulation and Analysis

PD LLDP Emulation

Parameter	Value
LLDP Support	PSA-3202 and PSA-3102 Test Blades PSL-3202 and PSL-3102 Load Blades
Test Port Connections	"**through**" to THRU *n* port or "**connect**" to LLDP Resources
PHY Layer: PSA/PSL-3102 Hardware Ver. 1-6 PSA/PSL-3202, PSA/PSL-3102 Ver. 8	10BaseT Half-Duplex, MDI (no Auto-Neg.) 10/100BaseTx Full-Duplex, Auto-MDI
PD LLDP Framing Control per Test Port	**MAC Address** (any 12-character Hex String) **LLDP Channel ID Type and Value**: 4, MAC Address **LLDP Port ID Type and Value**: 3, MAC Address **LLDP Time-To-Live**: 1 – 65535 seconds **VLAN Tagging**: Enable / Disable, PCP (1-7), CFI (0-1), VID(0-4094)
PD PoE TLV per Test Port	MDI Capability **Port Class**: = PD MDI Capability **PSE Power Support**: = 0 MDI Capability **Power State**: = 0 MDI Capability **Pair Control**: = 0 MDI Capability **Reserved**: = 0 **PoE Plus Type**: 1, 2, PSE Type 1, PSE Type 2 **PoE Plus Source**: PSE, Local, Both, Unknown **PoE Plus Priority**: Low, High, Critical, Unknown **PoE Plus Power Allocation Field**: Echo PSE or Fixed Value
PD Request Transmission per Test Port	**Requested Power**: 1 – 30 Watts **Transmit Period**: 1 – 90 seconds **Transmit Count**: 0= transmit indefinitely, 1 – 64 packets PoE Plus **Power Allocation Init**: Initialize to Power Request MDI **Power Class**: 0 – 4 **Trigger Mode** (*PSA-3102 only*): Immediate, Event, Rx Frame

PSE LLDP Frame Acquisition

Parameter	Value
Capture State	LAN_NOT_CONNECTED, LINK_DOWN, IDLE, RUNNING
PoE LLDP Receive Parameters *Most Recent Message Only*	**Buffer Depth**: 1 packet **Receive Packet Count** (since last 'clear') **Allocated Power** **Power Type** **Power Source** **Priority** **Echoed Power Request** **Source MAC Address** MDI **Power (PD) Class** MDI **Power Support Field** MDI **PSE Powered Pair Field**
LLDP Frame Parameters	**LLDP Destination Address** **Ethernet Type** **Chassis ID Type and Value** **Port ID Type and Value** **Time-To-Live** VLAN State, PCP, CFI, VID values *if VLAN enabled*

Ordering Information

PSA-LLDP, LLDP Emulation and Analysis for one **PSA** Controller (PSA-300x, PSA-3x48*****, PSA-1200+3102 blades)

PSL-LLDP, LLDP Emulation and Analysis for one **PSL** Controller (PSL-3000, PSL-3x24, PSL-1200+3102 blades)

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* The PSA-3x48 RackPack requires one PSA-LLDP
per chassis.

Verification, Simplified.