**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
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.
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 message 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.

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.

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.

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.

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.

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.
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.

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:

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

*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 capture, configure, display in real time, and report LLDP protocol traces.
## Technical Data: LLDP Emulation and Analysis

### PD LLDP Emulation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LLDP Support</td>
<td>PSA-3202 and PSA-3102 Test Blades; PSL-3202 and PSL-3102 Load Blades</td>
</tr>
<tr>
<td>Test Port Connections</td>
<td>&quot;through&quot; to THRU n port or &quot;connect&quot; to LLDP Resources</td>
</tr>
<tr>
<td>PHY Layer: PSA/PSL-3102 Hardware Ver. 1-6 PSA/PSL-3202, PSA/PSL-3102 Ver. 8</td>
<td>10BaseT Half-Duplex, MDI (no Auto-Neg.) 10/100BaseTx Full-Duplex, Auto-MDI</td>
</tr>
<tr>
<td>PD LLDP Framing Control per Test Port</td>
<td>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)</td>
</tr>
<tr>
<td>PD PoE TLV per Test Port</td>
<td>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</td>
</tr>
<tr>
<td>PD Request Transmission per Test Port</td>
<td>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</td>
</tr>
</tbody>
</table>

### PSE LLDP Frame Acquisition

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capture State</td>
<td>LAN_NOT_CONNECTED, LINK_DOWN, IDLE, RUNNING</td>
</tr>
<tr>
<td>PoE LLDP Receive Parameters Most Recent Message Only</td>
<td>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</td>
</tr>
<tr>
<td>LLDP Frame Parameters</td>
<td>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</td>
</tr>
</tbody>
</table>

### 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)  

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