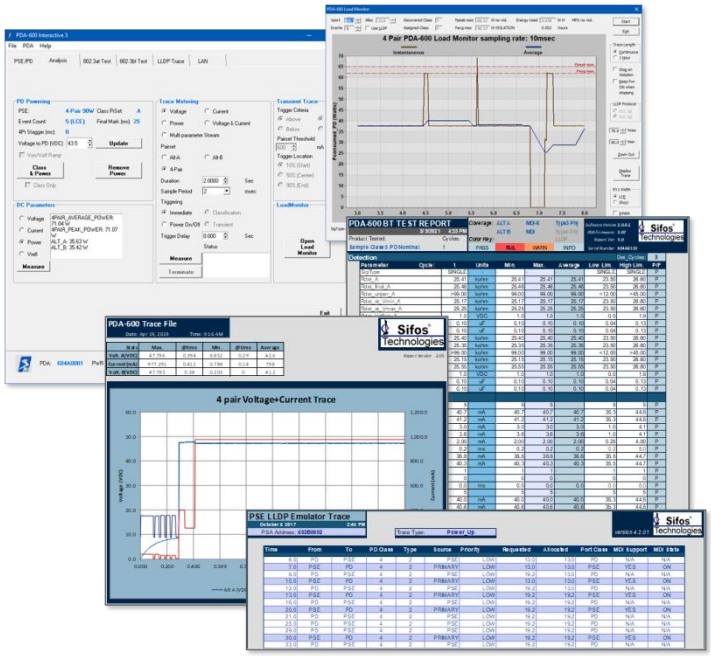
PDA-604A

PoE Powered Device Analyzer

IEEE 802.3bt & 802.3at Power-over-Ethernet



Product Overview

Patented Technology from Sifos

Key Features

- ❑ **4-Pair and 2-Pair Powering and Analysis of All 802.3bt / 802.3at PD's**
- ❑ **Automated IEEE 802.3bt / 802.3at Powered Device Conformance Testing**
- ❑ **Fully Configurable Classification and 802.3bt / 802.3at Power Grants**
- ❑ **Continuous PD Powering up to 2 Amps at All PD Input Voltages**
- ❑ **Comprehensive Analysis of 802.3bt / 802.3at PD Performance Parameters**
- ❑ **Flexible 802.3bt / 802.3at LLDP Emulation and LLDP Protocol Analysis**
- ❑ **Powerful Metering: Voltage, Current, & Power Sampling at the PD Interface**
- ❑ **Intuitive Graphical User Interface for Rapid Analysis and Testing**
- ❑ **Powerful Script Automation and Binary API Library for Microsoft Windows**
- ❑ **Informative Pop-Up Spreadsheet Reports and Statistics**
- ❑ **Plug'n Play USB Interface to Windows PC's**
- ❑ **LAN Port for External PD Configuration and Control During Testing**

Verification, Simplified.

One Box Solution

- **Replaces PSE's, DC Supplies, Fixtures, Scopes, Meters, & Protocol Analyzers**
- **Just Plug and Test**

IEEE 802.3bt & 802.3at PD's

- **Type-1 (≤ 13W) PD's**
- **Type-2 (≤ 25.5W) PD's**
- **Type-3 (≤ 51W) PD's**
- **Type-4 (≤ 71.3W) PD's**
- **All LLDP capable PD's**
- **802.3bt Dual Signature PD's**

Assure Maximum Interoperability

- **Emulate 4-Pair and 2-Pair Powering with Type-1, 2, 3, and 4 Multi-Event and LLDP Power Grants**
- **Automated 802.3bt / 802.3at PD Conformance Testing including LLDP**
- **Real-Time Load Monitoring**
- **Automatic Static and Transient Load Limit Violation Analysis**
- **Configurable Waveform Traces with Class, Source, Transient Triggering**
- **LLDP Protocol Verification**

Versatile Applications

- **Evaluation & Design**
- **Quality Assurance**
- **Manufacturing Test**
- **EA Certification Testing**
- **Field Service**
- **Energy Standard Rating**

Verification, Simplified.

Overview

The PDA-604A Powered Device Analyzer is a single-box comprehensive solution for testing **IEEE 802.3bt** and **802.3at** PoE Powered Devices (PD's). It offers one-button, fully automated test sequences and limit checking for critical Powered Device PoE characteristics. With measurements performed at the Powered Device network interface, parameters critical to 802.3at and 802.3bt interoperation are accurately assessed relative to specification requirements, thus avoiding the severe deficiencies associated with using 802.3at/802.3bt PSE's for PD testing.

Fully Integrated, One-Box Solution

The PDA-604A removes the need for specialized setups requiring DC power supplies, precision meters, test fixtures, protocol analyzers, a variety of PSE's, and custom software. The PDA-604A is used with PDA Interactive software to perform specification compliance analyses of new PD designs and to troubleshoot PD specification compliance problems. The PDA-604A facilitates remote configuration of PD states over the LAN while simultaneously assessing power demand and LLDP processing from a PD. Different PSE behaviors are readily mimicked including detection cycling, single and multi-event classification with and without elongated first class events, class-to-power timing, and LLDP acknowledgement timing. The PDA-604A includes robust automation development facilities including Tcl/Tk scripting and binary API libraries. This versatility allows users to apply the PDA-604A over the full lifecycle of any Powered Device including newer, Type-3/4, IEEE 802.3bt compliant PD's.

Superior Defect Coverage

The PDA-604A provides defect coverage far beyond what a commercial PSE or instrument grade DC power supply might offer. It provides power and performs measurements in all possible 2-pair and 4-pair connection and polarity configurations. Measurements including DC load versus voltage, classification validity, power on-off thresholds, MPS validity, and detection characteristics are readily performed and compared to applicable specification limits. Load currents up to 1A per pairset, or 2A total, can be sourced and sensed with PD input voltages ranging from 28 to 57VDC. Sporadic transient loads can be captured with sampling resolution as granular as 200µsec. The PDA-604A test port links to any PD at 10Base-T, 100Base-Tx, or 1000Base-T and it can optionally relay multi-gig links up to 10GBase-T between a PD and an external network device.

Flexible Automated Test of 802.3bt and 802.3at PD's

The PDA-604A offers optional **802.3at** and **802.3bt PD Conformance Test Suites** that support fully automated, "one-click", comprehensive evaluation and verification of PD's that classify anywhere from class 0 to class 8 including dual signature class 1 to class 5. In combination with other feature licenses, 802.3at and 802.3bt LLDP emulations and test coverage can be added to the automated testing. The test suites are accessible from PDA Interactive (GUI) and from command line consoles. Test reports consist of colorful Microsoft Excel spreadsheets to annotate problem areas and provide multi-cycle statistics. Both the 802.3at and 802.3bt PD Conformance Test Suites are approved for performing comprehensive **EA Gen1** and **EA Gen2** PoE Logo Certification testing respectively in-house.

EA Certified 2.0™

Powerful Real-Time Load Monitor and Compliance Analysis

Under PDA Interactive software, the PDA-604A offers powerful real time tools for analysis of PD power draw over arbitrary periods of time under constraints of user-specified PD power grants, including both class-based and LLDP grants. Real time limit checking of average, peak, transient, and MPS power is performed.

Desktop Ready Design

The PDA-604A is at home on any desktop or lab bench with USB to host PC connectivity and a cooling fan that only runs when powering PD's.

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PDA-604A Versus a Commercial PSE

With the ready availability of commercial Power Sourcing Ethernet Switches (PSE), including low cost PSE injectors, a strong temptation exists to utilize these products to test Powered Devices. Coupled with a long spool of cable, a PSE provides a "real world" interface to a PD.

As an "interop" test strategy, this approach overlooks the wide-ranging design flexibility allowed to IEEE **802.3bt** and **802.3at** PSE's. This attribute of the PoE standard has translated into a vast proliferation of PSE designs and configurations with widely varying tolerances of many critical PD traits. *PD's that interoperate with one or a few PSE's may fail to properly interoperate with hundreds of other specification compliant PSE's and cabling networks*.

The reality is that PSE's are not test instruments. A PSE cannot test critical characteristics of a PD that are vital to interoperability over all PoE networks. Even the most sophisticated PSE's that offer management reporting of PD classification and power draw offer no insight regarding how the PSE produces those parameters or what they might really mean.

Table 1 illustrates a variety of PD performance parameters that are critical to the broad interoperability of a PD and the respective test coverage that can be expected from a commercial PSE relative to a PDA-604A.

PD Behavior	PDA-604 Test Coverage	Commercial PSE Coverage
PD Power-Ups to Minimum / Maximum Voltages	✓	✗
Ethernet LAN Link-Up / Auto-Neg / Rate Control	✓	?
ALT-A, ALT-B, & 4-Pair Powering	✓	✗
MDI & MDI-X Powering Permutations	✓	✗
Detection Resistance – Single & Multi- Cycle	✓	?
Detection Resistance vs Voltage*	✓	✗
Detection Capacitance – Single & Multi-Cycle	✓	✗
Connection Check/Signature Validation	✓	?
Classification Signature (per Pairset)	✓	?
Classification Signature Per Class Event	✓	✗
Classification Signature vs Voltage*	✓	✗
Mark Loading	✓	✗
Inrush Loading (per PSE Type-1, 2, 3, and 4)	✓	✗
Inrush Limiting (per PSE Type-1, 2, 3, and 4)	✓	✗
Type-2/3/4 Power Delay	✓	✗
Turn-On Voltage	✓	✗
Turn-Off Voltage	✓	✗
Average Power Consumption (per Class Grant)	✓	✗
Instantaneous Peak Power Load (per Class Grant)	✓	✗
Windowed Peak Power Load (per Class Grant)	✓	✗
Classification Integrity	✓	✗
MPS – Level (per PSE Type 1, 2, 3, and 4)	✓	?
MPS – Duty Cycle (per PSE Type 1, 2, 3, and 4)	✓	?
Load Power over Voltage	✓	✗
LLDP Message Formatting	✓	?
LLDP Allocation Response Time	✓	✗
LLDP Requested Power Integrity	✓	✗

Table 1: PDA-604A versus Commercial PSE Coverage

PDA-604A Feature Scalability

The PDA-604A is a scalable instrument for testing IEEE 802.3bt and 802.3at PD's. This allows users to choose the best configuration at the lowest possible cost to suit their needs.

The base configuration of the PDA-604A enables both 2-Pair and 4-Pair PD powering, power-ups and metering that provide between zero and three classification events, detection measurements that include 802.3bt connection check, and highly programmable waveform captures of voltage, current, and power in 2-Pair or 4-Pair modes. This configuration supports testing of **Class 0 – 4** PD's with PSE emulations that include both **802.3at** and **802.3bt PSE's**.

Table 2 depicts optional feature licenses for testing high power PD's, automated test suites, and LLDP emulation and analysis. These are further described in the sections that follow Table 2.

Feature License	Description	Features Included: Load Monitor (2-Pair & 4-Pair)	Features Included: Class 5-8, Class 4-5D	Required Features
TYPE-3/4	**Type-3/4 4-Event and 5-Event** Power-Ups to support Class 5-8 and Dual Class 4-5 PD's		✓	
CT-AT	**802.3at Type-1/2** PD Automated Test Suite, Load Monitor & Streaming Traces for up to Type-4 PD's	✓		**Type-3/4** *for Load Mon>Type-2*
LLDP-AT	**Type-1 LLDP** & **Type-2 LLDP** PSE Emulation & Protocol Analysis			
CT-AT + **LLDP-AT**	**Type-1**, **Type-2 2-Event**, & **Type-2 LLDP** PD Automated Test Suite, Load Monitor with "at" LLDP	✓		
CT-BT	**802.3bt Type-3/4** PD Automated Test Suite	✓	✓	**Type-3/4, CT-AT**
LLDP-BT	**802.3bt Type-3/4 LLDP** PSE Emulation & Protocol Analysis		✓	**Type-3/4, LLDP-AT**
CT-BT + **LLDP-BT**	**Type-3**, **Type-4 Multi-Event**, & **Type-3/4 LLDP** PD Automated Test Suite, Load Monitor with "bt" LLDP	✓	✓	**Type-3/4, CT-AT, LLDP-AT**

Table 2: PDA-604A Optional Feature Licenses and Option Combinations.

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Type-3/4 PD Testing with the PDA-604A

The base configuration of the PDA-604A supports 2-Pair and 4-Pair powering and discrete measurements. With the advent of the IEEE 802.3bt standard, many newer PSE's apply 4-Pair powering whether they are powering 802.3at (Type-1/Type-2) PD's or newer 802.3bt Type-3/Type-4 PD's. The PDA-604A base configuration can simulate the detection, classification, and powering characteristics of both 802.3at and 802.3bt PSE's as they interact with Class 0 – Class 4 PD's. PD classification can be configured to 0, 1, 2, or 3-Events (*see Figure 1*) meaning Type-2 PD's can be granted full 25.5 watt power levels via 2-Event or 3-Event classification. Additionally, the first class event may be specified to use the 802.3bt elongated (LCE) class pulse or the "normal" 802.3at compliant class pulse.

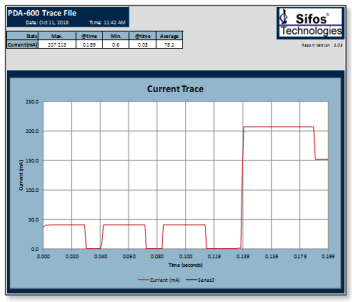


Figure 1: 3-Event Classification

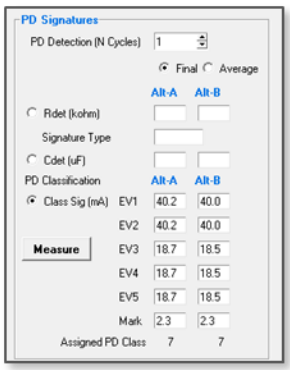


Figure 2: 5-Event Class Meter Measurement

The optional **Type-3/4** license extends the classification capability of the PDA-604A to include 4-Event and 5-Event classification required to grant power levels beyond 25.5 watts to 802.3bt compliant PD's. Under the 802.3bt standard, PD's that operate at more than 25.5 watts normally must draw less than 25.5 watts given 2-Event or 3-Event classification and less than 13 watts given 1-Event classification.

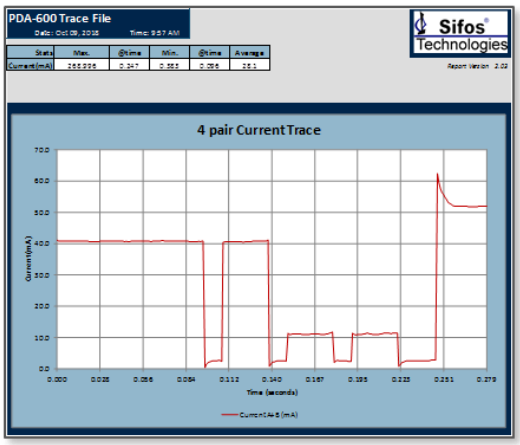


Figure 3: 4-Event Classification of a Class 6 PD

Figure 2 shows a 5-Event classification signature measurement for a Class 7 PD and Figure 3 is a current waveform depicting a 4-Event classification sequence to a Class 6 PD. Measuring 802.3at and 802.3bt PD performance under conditions of "power demotion", that is with various classification event counts, is an essential form of interoperability testing for all Class 4 and higher PD's.

Figure 4 is a 4-Pair power-up trace of voltage and current to a Class 8 PD drawing just under 1.2 amps of load current. This particular trace, triggered on the start of PD classification, is made possible by the Type-3/4 feature license.

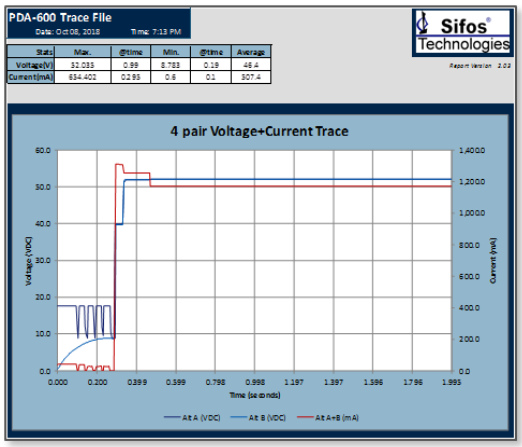


Figure 4: Class 8 PD Power-Up V+I Waveform

The 802.3at PD Conformance Test Suite & Load Monitor (CT-AT)

The **802.3at PD Conformance Test Suite** is a fully automated 802.3at specification compliance test suite for a PD. The test suite performs many measurements of PD interface parameters that are critical to interoperability with the full range of compliant 802.3at PSE's and connection environments. Testing can optionally be configured to run on a single quadrant (e.g. Alt-A, MDI) or on up to 4 quadrants (Alt-A and B, MDI and MDI-X). Measurements are organized into passive pre-powered parameters and powered state parameters. The test suite automatically produces color-coded Microsoft Excel spreadsheets that are organized by quadrant and test category (*see Figure 5*).

Test coverage is provided for Type-1 (13W) PD's and Type-2 (25.5W) PD's. Test coverage can be expanded to include Type-2 PD's responding to PoE **LLDP protocols** and PSE power grants with the addition of the **LLDP-AT** Emulation and Analysis feature described below.

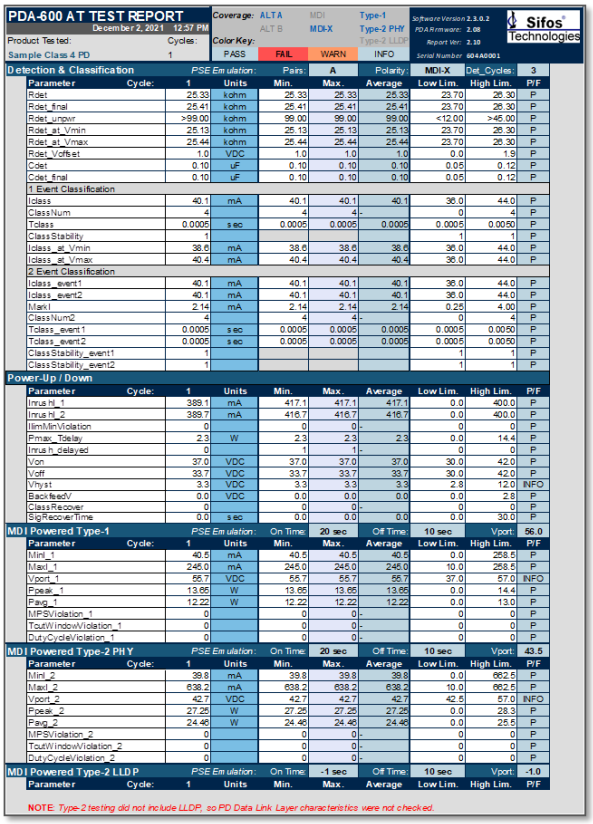
Certified for 1st Party Gen1 EA Logo Testing

The 802.3at PD Conformance Test Suite is certified to support **1st party**, or **in-house**, Ethernet Alliance (EA) PoE logo testing under the EA Gen 1 program. The EA PoE Logo mark assures end customers that PD's will interoperate safely and effectively with any certified, specification compliant PSE in all possible cable and connection environments. In-house testing allows PD developers to push their designs into all possible operational states and loading conditions while running the tests.

EA Certified™

Load Monitor & Stream Traces

One of the most critical operating parameters of a powered device is the load power consumed as the device operates in a number of states and under a number of varying conditions. In many instances, the maximum and minimum power consumption levels of a PD cannot be ascertained without over-the-network interactions. Common examples include wireless access points that consume power based on numbers and proximities of wireless users, IP cameras consuming transient power when panned or zoomed in harsh weather conditions, and IP telephones altering power consumption based on server enabling, video display states, and even network interface speed.



PDA-600 AT TEST REPORT

December 2, 2021 12:57 PM

Product Tested:

Sample Class 4 PD

Cycles: 1

Coverage: ALT A, ALT B, MDI, MDI-X, Type-1, Type-2 PHY, Type-2 LLDP

Color Key: PASS, FAIL, WARN, INFO

Sifos Technologies

Software Version 2.3.0.2 PDA Firmware: 2.08 Report Ver: 2.10 Serial Number 604A0001

Detection & Classification	PSE Emulation:		Pairs:	A	Polarity:	MDI-X	Det_Cycles:	3
Parameter	Cycle: 1	Units	Min.	Max.	Average	Low Lim.	High Lim.	P/F
Rdet	25.33	kohm	25.33	25.33	25.33	23.70	26.30	P
Rdet_final	25.41	kohm	25.41	25.41	25.41	23.70	26.30	P
Rdet_unpwr	>99.00	kohm	99.00	99.00	99.00	<12.00	>45.00	P
Rdet_at_Vmin	25.13	kohm	25.13	25.13	25.13	23.70	26.30	P
Rdet_at_Vmax	25.44	kohm	25.44	25.44	25.44	23.70	26.30	P
Rdet_Voffset	1.0	VDC	1.0	1.0	1.0	0.0	1.9	P
Cdet	0.10	uF	0.10	0.10	0.10	0.05	0.12	P
Cdet_final	0.10	uF	0.10	0.10	0.10	0.05	0.12	P
1 Event Classification								
Iclass	40.1	mA	40.1	40.1	40.1	36.0	44.0	P
ClassNum	4		4	4		0	4	P
Tclass	0.0005	sec	0.0005	0.0005	0.0005	0.0005	0.0050	P
ClassStability	1					1	1	P
Iclass_at_Vmin	38.6	mA	38.6	38.6	38.6	36.0	44.0	P
Iclass_at_Vmax	40.4	mA	40.4	40.4	40.4	36.0	44.0	P
2 Event Classification								
Iclass_event1	40.1	mA	40.1	40.1	40.1	36.0	44.0	P
Iclass_event2	40.1	mA	40.1	40.1	40.1	36.0	44.0	P
MarkI	2.14	mA	2.14	2.14	2.14	0.25	4.00	P
ClassNum2	4		4	4		0	4	P
Tclass_event1	0.0005	sec	0.0005	0.0005	0.0005	0.0005	0.0050	P
Tclass_event2	0.0005	sec	0.0005	0.0005	0.0005	0.0005	0.0050	P
ClassStability_event1	1					1	1	P
ClassStability_event2	1					1	1	P
Power-Up / Down								
Parameter	Cycle: 1	Units	Min.	Max.	Average	Low Lim.	High Lim.	P/F
Inrus hl_1	389.1	mA	417.1	417.1	417.1	0.0	400.0	P
Inrus hl_2	389.7	mA	416.7	416.7	416.7	0.0	400.0	P
IlimMinViolation	0		0	0		0	0	P
Pmax_Tdelay	2.3	W	2.3	2.3	2.3	0.0	14.4	P
Inrus h_delayed	0		1	1		0	0	P
Von	37.0	VDC	37.0	37.0	37.0	30.0	42.0	P
Voff	33.7	VDC	33.7	33.7	33.7	30.0	42.0	P
Vhyst	3.3	VDC	3.3	3.3	3.3	2.8	12.0	INFO
Backfeed V	0.0	VDC	0.0	0.0	0.0	0.0	2.8	P
ClassRecover	0		0	0		0	0	P
SigRecoverTime	0.0	sec	0.0	0.0	0.0	0.0	30.0	P
MDI Powered Type-1	PSE Emulation:		On Time:	20 sec	Off Time:	10 sec	Vport:	56.0
Parameter	Cycle: 1	Units	Min.	Max.	Average	Low Lim.	High Lim.	P/F
Minl_1	40.5	mA	40.5	40.5	40.5	0.0	258.5	P
Maxl_1	245.0	mA	245.0	245.0	245.0	10.0	258.5	P
Vport_1	56.7	VDC	56.7	56.7	56.7	57.0	INFO	
Ppeak_1	13.65	W	13.65	13.65	13.65	0.0	14.4	P
Pavg_1	12.22	W	12.22	12.22	12.22	0.0	13.0	P
MPSViolation_1	0		0	0		0	0	P
TcutWindowViolation_1	0		0	0		0	0	P
DutyCycleViolation_1	0		0	0		0	0	P
MDI Powered Type-2 PHY	PSE Emulation:		On Time:	20 sec	Off Time:	10 sec	Vport:	43.5
Parameter	Cycle: 1	Units	Min.	Max.	Average	Low Lim.	High Lim.	P/F
Minl_2	39.8	mA	39.8	39.8	39.8	0.0	662.5	P
Maxl_2	638.2	mA	638.2	638.2	638.2	10.0	662.5	P
Vport_2	42.7	VDC	42.7	42.7	42.7	42.5	57.0	INFO
Ppeak_2	27.25	W	27.25	27.25	27.25	0.0	28.3	P
Pavg_2	24.46	W	24.46	24.46	24.46	0.0	25.5	P
MPSViolation_2	0		0	0		0	0	P
TcutWindowViolation_2	0		0	0		0	0	P
DutyCycleViolation_2	0		0	0		0	0	P
MDI Powered Type-2 LLDP	PSE Emulation:		On Time:	-1 sec	Off Time:	10 sec	Vport:	-1.0
Parameter	Cycle: 1	Units	Min.	Max.	Average	Low Lim.	High Lim.	P/F

NOTE: Type-2 testing did not include LLDP, so PD Data Link Layer characteristics were not checked.

Figure 5: 802.3at PD Conformance Test Report

The optional **CT-AT** license enables a powerful **Load Monitor** (*see Figure 6*) offering the capability to continuously monitor instantaneous and average power consumption of a PD over long periods of time while operating conditions of the PD are manipulated. The Load Monitor is accessed from PDA Interactive software. It includes the intelligence to evaluate both static and transient power excursions that may violate 802.3 limits and ultimately cause PSE's to remove power from a PD unexpectedly. Static load power is evaluated to PD advertised physical layer classification or optionally to PD LLDP power request levels. Transient load power is automatically evaluated to peak instantaneous loading limits and to windowed transient limits that are enforced by PSE's. These parameters are also derived from PD advertised classification and any LLDP power requests.

The **Load Monitor** is the natural tool for developing assurance that the PD classification (and any PD LLDP power request level) is compliant with actual PD behavior under all operating conditions and for troubleshooting PD's that experience unexpected shutdowns while in service.

Figure 6: PDA-604A Load Monitor

As with the PD Conformance Test Suite, the Load Monitor can be extended to utilize PoE LLDP to acquire and set limits in accordance with PD LLDP power requests and PSE power allocations, given the **LLDP** feature option.

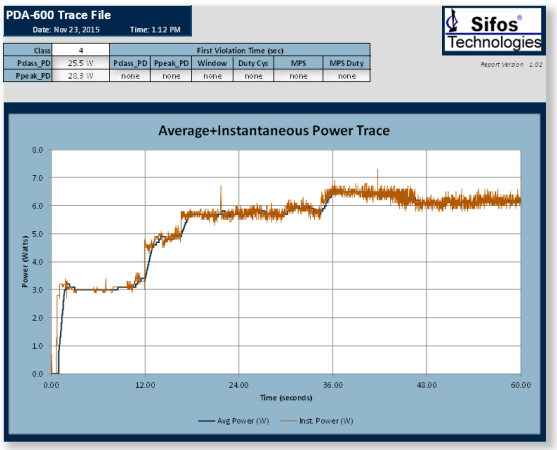


Figure 7: PDA-602 Streaming Trace

A third feature of the CT-AT option is the ability to **stream long traces** of instantaneous and average power consumption into spreadsheet reports and data files for subsequent analysis (*see Figure 7*). Streaming traces can collect power consumption samples with sample timing as small as 5msec over many hours. As with the real-time Load Monitor, the streaming trace report can identify and localize power violations and also report DC MPS (low current) violations.

Combining the Type-3/4 and CT-AT Features

Because the **CT-AT** license enables the **Load Monitor** and **Streaming Traces**, when combined with the **Type-3/4** license, both the Load Monitor and Streaming Trace resources become available for analyzing 802.3bt Type-3 and Type-4 PD's including those drawing power to 71 watts or higher. That means that limit checking for PD average, peak, transient window, and MPS violations is available when evaluating **802.3bt Class 5-8** PD's.

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In Figure 8, a 60 second duration streaming trace is captured from a Class 6 PD drawing just under 50 watts following various start-up transients. No power violations are flagged during this trace. In Figure 9, a 12 second streaming trace from a Class 7 PD is captured indicating both a peak power and a transient power window violation.

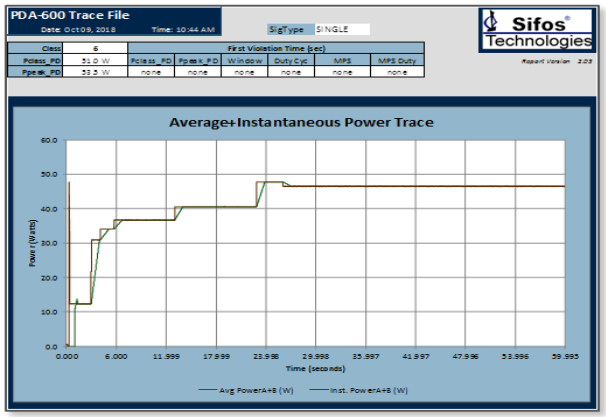


Figure 8: Streaming Power Trace from Class 6 PD

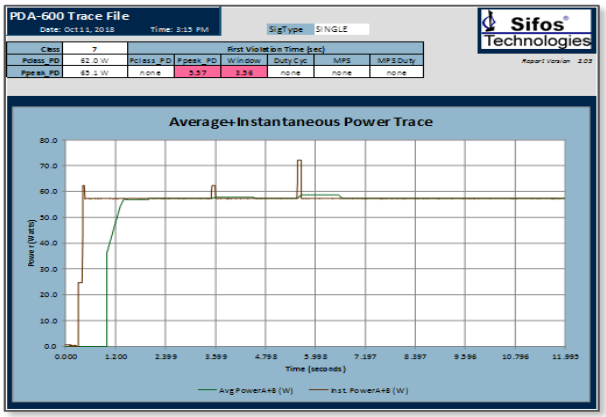


Figure 9: Streaming Power Trace from Class 7 PD

The 802.3bt PD Conformance Test Suite (CT-BT)

A fully automated test suite for 802.3bt PD's, including single signature PD's that classify as **Class 5-8** and dual signature PD's that classify as **Class 1-5** per pairset, may be added to any PDA-604A that is already licensed for 802.3at PD Conformance Test (CT-AT). As an automated test suite, the 802.3bt PD Conformance Test Suite includes all of the features of the 802.3at test suite and many **more features** including:

- 4-pair powering with 4-quadrant polarity combinations
- Multi-event classification measurements
- Support for Type-3, Type-4 single & dual signature PD's
- Power-demotion testing (Type-1, Type-2, Type-3 PSE's)
- Class reset response
- Autoclass signature and response
- Inrush energy and timing analysis
- 802.3bt analysis of PSE MPS properties
- Differing PD input voltages per powered test case
- 802.3bt LLDP protocol and power negotiation integrity
- LLDP backward compatibility

The 802.3bt PD Conformance Test Suite includes a test report (*see Figure 10*) that incorporates the many additional test parameters necessitated by the 802.3bt standard. Limit checking is predicated upon pre-test discovery of PD signature type (single or dual), PD classification (1-8 or dual 1-5), and user-declared autoclass support.

Like the 802.3at PD Conformance Test Suite, users are given control over test coverage by quadrant for both passive and powered tests. Users may also specify multiple test cycles to get repeatability metrics on all test parameters. The powered test configurations automatically probe PD performance at specified PD input voltage extremes.

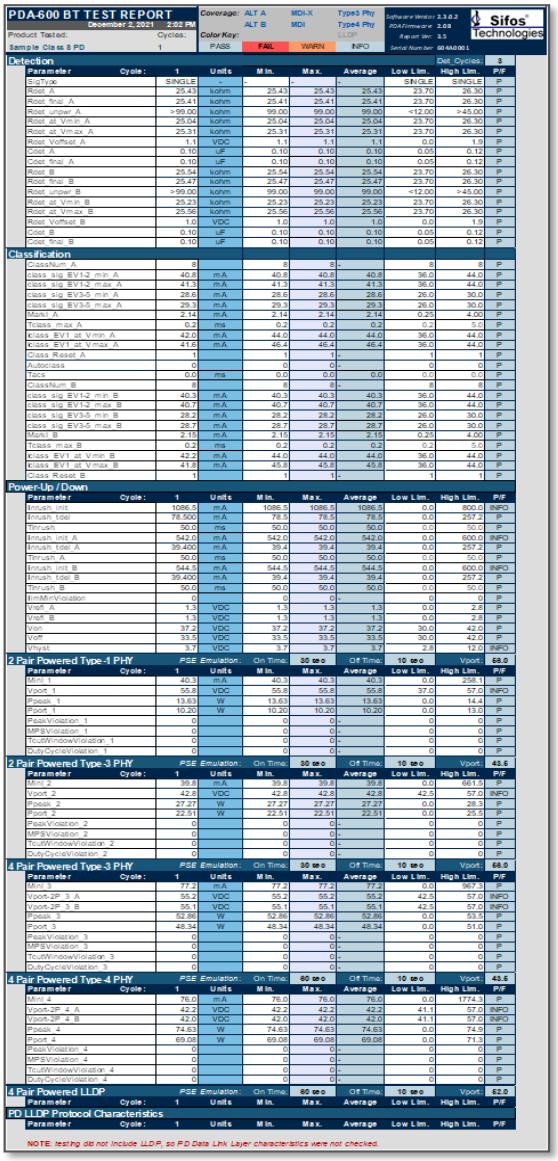


Figure 10: 802.3bt PD Conformance Test Report

Certified for 1st Party Gen2 EA Logo Testing

The 802.3bt PD Conformance Test Suite is certified to support **1st party**, or **in-house**, Ethernet Alliance (EA) PoE logo testing under the EA Gen 2 program. The EA PoE

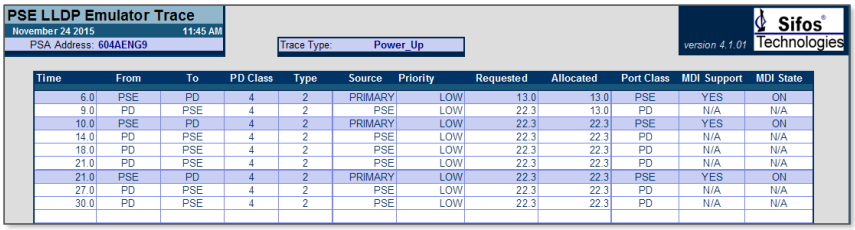
Logo mark assures end customers that PD's will interoperate safely and effectively with any certified, specification compliant PSE in all possible cable and connection environments. In-house testing allows PD developers to push their designs into all possible operational states and loading conditions while running the tests.

PoE LLDP Emulation and Analysis with the PDA-604A (LLDP-AT, LLDP-BT)

A mandatory requirement of all PD's that draw more than 13 watts under IEEE **802.3** specifications is that they support 802.3 PoE extensions to LLDP (link layer discovery) protocol. Many Type-2 (802.3at) conforming PSE's require PD LLDP support in order to furnish power levels exceeding 13 watts (Type-1). While many Type-3 and Type-4 (802.3bt) PSE's may grant their maximum available power using multi-event classification, these PSE's may still rely on PD LLDP support in order to rationally and efficiently manage power allocations after PD's are powered.

Summarizing both 802.3at and 802.3bt standards, the PoE LLDP requirement places at least two burdens on a class 4 or higher PD:

1. To have an operating state that draws 13 watts or less.
2. To support PoE link layer (layer 2) discovery protocol as defined under IEEE 802.3.



Time	From	To	PD Class	Type	Source	Priority	Requested	Allocated	Port Class	MDI Support	MDI State
6.0	PSE	PD	4	2	PRIMARY	LOW	13.0	13.0	PSE	YES	ON
9.0	PD	PSE	4	2	PSE	LOW	22.3	13.0	PD	N/A	N/A
10.0	PSE	PD	4	2	PRIMARY	LOW	22.3	22.3	PSE	YES	ON
14.0	PD	PSE	4	2	PSE	LOW	22.3	22.3	PD	N/A	N/A
18.0	PD	PSE	4	2	PSE	LOW	22.3	22.3	PD	N/A	N/A
21.0	PD	PSE	4	2	PSE	LOW	22.3	22.3	PD	N/A	N/A
21.0	PSE	PD	4	2	PRIMARY	LOW	22.3	22.3	PSE	YES	ON
27.0	PD	PSE	4	2	PSE	LOW	22.3	22.3	PD	N/A	N/A
30.0	PD	PSE	4	2	PSE	LOW	22.3	22.3	PD	N/A	N/A

Figure 11: 802.3at LLDP Power-Up Protocol Trace

The PDA-604A offers two optional feature licenses that enable testing of the PD conformance to each of these 802.3 requirements. First, the optional **LLDP-AT** license enables flexible emulation of Type-2 PSE's that use 802.3at LLDP to grant power levels between13 watts and 25.5 watts to Type-2 PD's. The LLDP-AT option also offers in depth **802.3at** LLDP protocol analysis including testing of protocol fields and message timing as shown in Figure 11. Further, with the combination of the **CT-AT** license and the **LLDP-AT** license, PD conformance testing involving both the Load Monitor (*see Figure 12*) and the PD Conformance Test Suite (*see Figure 13*) are extended to support PSE LLDP power granting emulations.

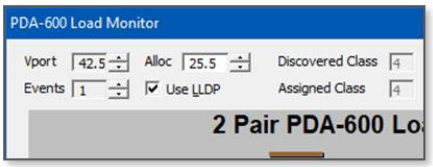


Figure 12: Load Monitor – 2-Pair LLDP Power Draw Validation

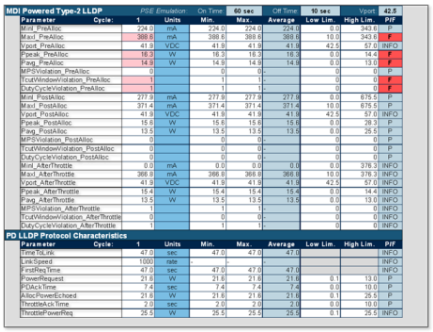
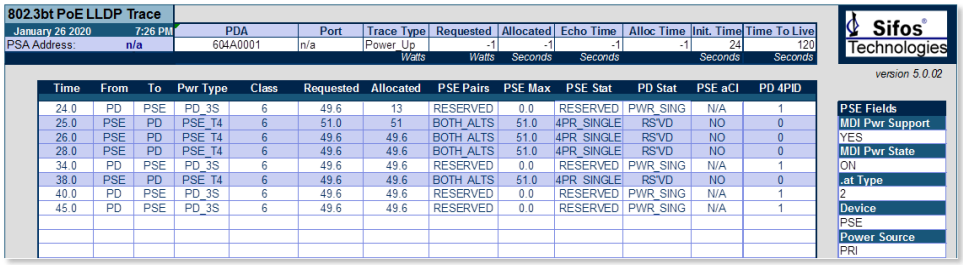


Figure 13: 802.3at Test Suite with LLDP

The optional **LLDP-BT** license offers flexible emulation of Type-3 and Type-4 PSE's that deploy the extended 802.3bt PoE LLDP protocol in support of 4-pair powering. The PDA-604A performs basic analysis of PD LLDP protocol associated with power-up negotiations and PSE-induced power adjustments. In Figure 14, an LLDP negotiated Class 6 power-up is analyzed. Users control PSE granting logic, message timing, and request update with these traces.



PDA	Port	Trace Type	Requested	Allocated	Echo Time	Alloc Time	Init. Time	Time To Live
604A0001	n/a	Power_Up	-1	-1	-1	-1	24	120
			Watts	Watts	Seconds	Seconds	Seconds	Seconds

Time	From	To	Pwr Type	Class	Requested	Allocated	PSE Pairs	PSE Max	PSE Stat	PD Stat	PSE aCl	PD 4PID
24.0	PD	PSE	PD_3S	6	49.6	13	RESERVED	0.0	RESERVED	PWR_SING	N/A	1
25.0	PSE	PD	PSE_T4	6	51.0	51	BOTH_ALTS	51.0	4PR_SINGLE	RSVD	NO	0
26.0	PSE	PD	PSE_T4	6	49.6	49.6	BOTH_ALTS	51.0	4PR_SINGLE	RSVD	NO	0
28.0	PSE	PD	PSE_T4	6	49.6	49.6	BOTH_ALTS	51.0	4PR_SINGLE	RSVD	NO	0
34.0	PD	PSE	PD_3S	6	49.6	49.6	RESERVED	0.0	RESERVED	PWR_SING	N/A	1
38.0	PSE	PD	PSE_T4	6	49.6	49.6	BOTH_ALTS	51.0	4PR_SINGLE	RSVD	NO	0
40.0	PD	PSE	PD_3S	6	49.6	49.6	RESERVED	0.0	RESERVED	PWR_SING	N/A	1
45.0	PD	PSE	PD_3S	6	49.6	49.6	RESERVED	0.0	RESERVED	PWR_SING	N/A	1

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

Figure 14: 802.3bt LLDP Power-Up Protocol Trace

The **LLDP-BT** license, when combined with the **CT-AT** license and the **Type-3/4** license, further enhances the Load Monitor to work with LLDP power granting scenarios while also assessing the integrity of PD power requests (*see Figure 15*). Further, the PDA-604A allows for external communication with and network management of a PD-under-test while LLDP protocols run between the PDA-604A and that same PD-under-test.

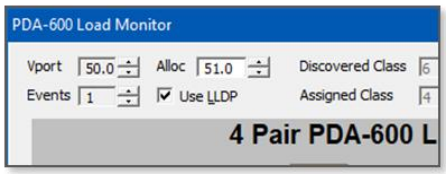


Figure 15: Load Monitor – 4-Pair LLDP Power Draw Validation

While 802.3 PoE LLDP requirements do impose a non-trivial design burden on many PD's, the power and flexibility of the PDA-604A to emulate a wide range of PSE's that conduct PoE LLDP negotiation and associated power policing readily facilitates the testing of these mandatory PD features in any Type-2, Type-3, or Type-4 PD.

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PDA Interactive Software

The PDA-604A is a software-managed instrument. The user interface to the instrument is host-based software running on a Windows PC. **PDA Interactive**, a component of PDA-600 software, is an intuitive graphical user interface that can access all of the key features and capabilities of the PDA-604A.

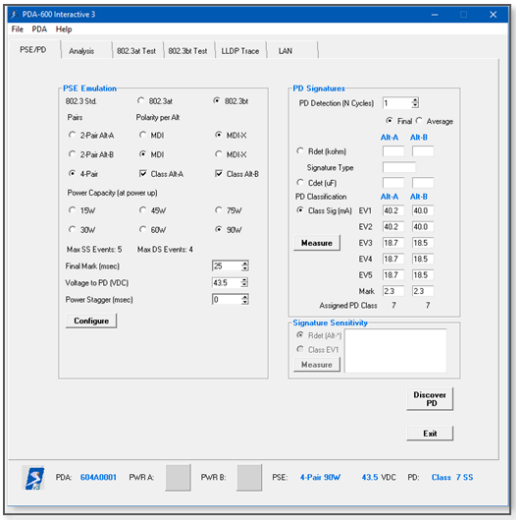

Figure 16: PDA Interactive PSE/PD Menu

PDA Interactive provides several file-tabbed menus:

PSE/PD (*Figure 16*): This menu serves three purposes:

1. Describe characteristics (and limitations) of a "test PSE" that will power and perform measurements on the PD-under-test. Characteristics include powered pairset(s), polarity, emulated PSE power capacity (15W, 30W, 45W, 60W, 75W, or 90W), and input voltage to the PD when powered.
2. Discover characteristics, namely PD signature type (single vs dual) and PD classification, of the connected PD-under-test.
3. Perform PD detection and classification signature parametric measurements.

In general, the emulated "test PSE" and the basic PD characteristics must be established in advance of any manual testing and troubleshooting supported by other tab menus.

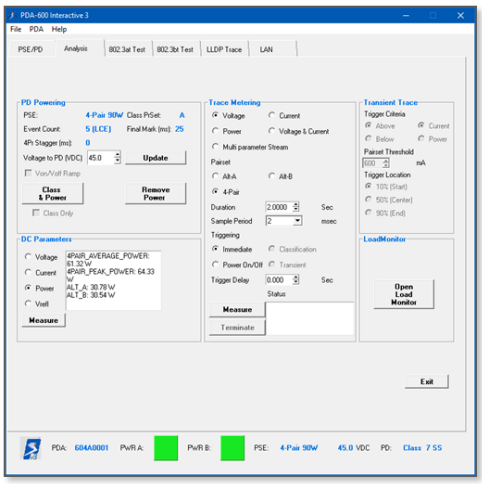

Figure 17: PDA Interactive Analysis Menu

Analysis (*Figure 17*): The Analysis tab menu supports manual application and removal of power to the PD, powered DC parameter measurements, (waveform) trace metering measurements, and access to the Load Monitor.

Manual PD powering always involves a PD classification as required to communicate any power draw grants or limitations to the PD imposed by the emulated PSE. PD input voltage can be configured anywhere between 28V and 57V and may be revised after powering. A special Von/Voff ramp powering mode enables analyses of PD turn-on and turn-off voltage levels.

DC Parameters are simple one-click meter measurements of voltage, current draw, average/peak power draw, and reflected voltage. Measurements are performed on powered the pairset(s).

A powerful set of trace metering resources enables flexible capture and analysis of waveforms depicting PD input voltage, PD current draw, PD power draw, and combined voltage and current. Sample resolution (period) and trace durations are highly configurable. Traces may be immediate triggered, triggered at start of PD classification, at PD power-up, or at PD power-down. A special meter mode of transient triggering offers flexible scanning for load impulses (power or current) meeting user defined transient threshold criteria.

Finally, the PDA-600 Load Monitor application is accessed from the Analysis tab menu.

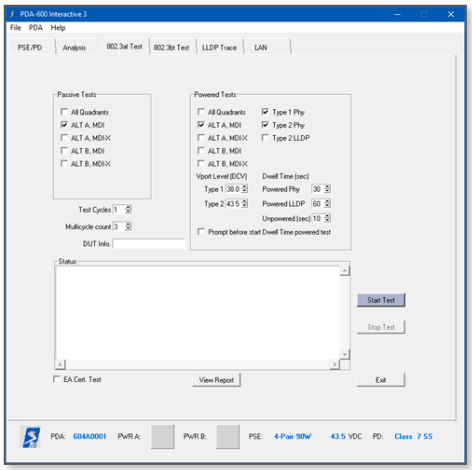

Figure 18: 802.3at Conf. Test Suite Menu

802.3at Test (*Figure 18*): The 802.3at Test menu s is available to instruments with the optional **CT-AT** license. This menu provides for configuration and control of the IEEE **802.3at** PD Conformance Test Suite. Users can select quadrants (Alt-A,B and MDI,MDI-X) for both unpowered and powered state testing, source voltage levels by PD type, and test coverage options. Test coverage options include **Type-1 Phy** PD, **Type-2 Phy** PD if the **Type-2** feature is licensed, and **Type-2 LLDP** if the **Type-2** and **LLDP** features are licensed.

802.3bt Test (*Figure 19*): The 802.3bt Test menu is available to instruments with the **CT-BT** license. This menu enables configuration and control of the fully automated conformance test suite for 802.3bt PD's. Users can select quadrants (e.g. Alt-A MDI-X + Alt-B MDI) for both unpowered and powered state testing, source voltage levels by PD type, and test coverage options.

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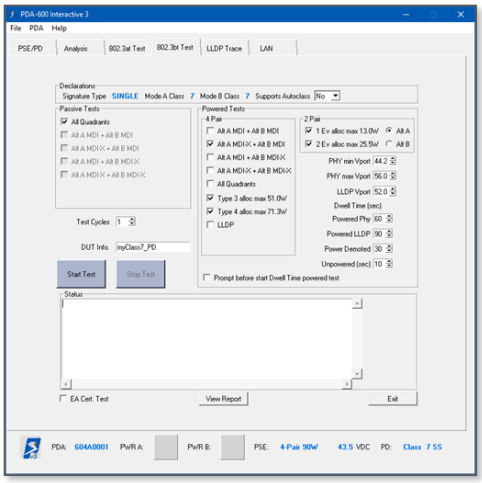

Figure 19: 802.3bt Conf. Test Suite Menu

When testing 802.3bt PD's, there are numerous power demotion scenarios, each of which can be configured as part of the automated testing. These include **2-Pair Type-1** and **2-Pair Type-2** PSE emulations as well as **Type-3** PSE emulations that demote Type-4 PD's. Control of power-on dwell times and PD input voltages are also provided.

LLDP Trace (*Figure 20*): This menu accesses the PSE LLDP emulation and LLDP protocol tracing features of a PDA-604A instrument configured with the **LLDP-AT** and optionally, the **LLDP-BT** license. PSE LLDP emulations allow configuration of PSE-controlled message fields, power (available) allocation, power grant logic, transmit period, and response delay between new PD power request values and PSE acknowledgement of those updated values. LLDP trace types include **Power Up Trace** for evaluation of initial PD LLDP negotiation and **Power Adjust Trace** for evaluating PD responses to revised PSE power allocations after power-up. PSE emulation, as described in the PSE/PD tab menu, determines PoE LLDP protocol version, that is 802.3bt (29 octet) when 4-Pair powering and 802.3at (12 octet) when 2-Pair powering.

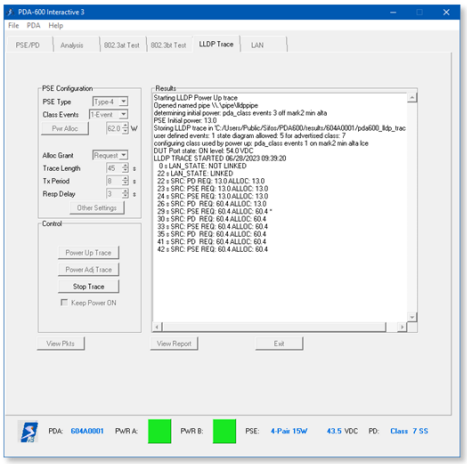

Figure 20: LLDP Trace Menu

LAN (not shown): This tab menu allows the LAN port that facilitates communication between the PD-under-test and an outside network connection to configure for either 10/100/1000Base-T auto-neg or for a fixed link rate and duplex mode. Alternatively, the LAN port may be passively configured to a THRU mode that allows multi-gig links to form between the PD-under-test and the remote network connection.

PowerShell PDA Software

PDA-600 software provides a robust, Tcl/Tk-based script development environment consisting of intuitive commands for configuring PDA-604A resources, performing measurements, running PD Conformance Tests, Load Monitor streams, and LLDP protocol traces. PowerShell PDA supports interpreted, immediate execute commands and queries from a command shell with the ability to build automated test scripts using both PDA commands and the wealth of programming commands available with Tcl/Tk. Scripting and debugging dedicated, customized test scripts for volume QA or manufacturing is a very natural application for PowerShell PDA.

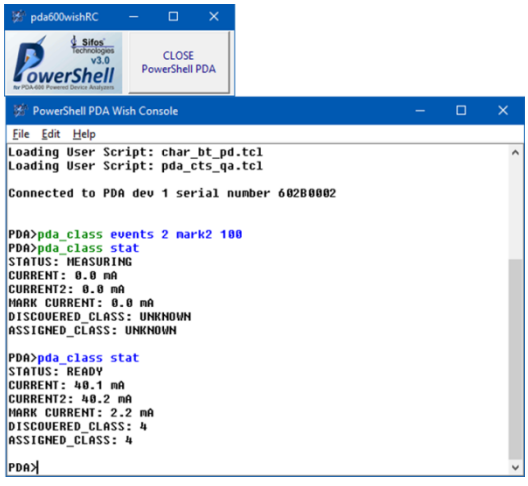

Figure 21: PowerShell PDA Wish Console

When PDA-600 software is installed, two forms of interactive command consoles are offered with corresponding desktop icons. The PowerShell PDA Wish Console in Figure 21 offers a Windows-like command shell supporting typical Windows editing operations. It also enables Tk graphical user interface commands along with Tcl and PDA-600 commands.

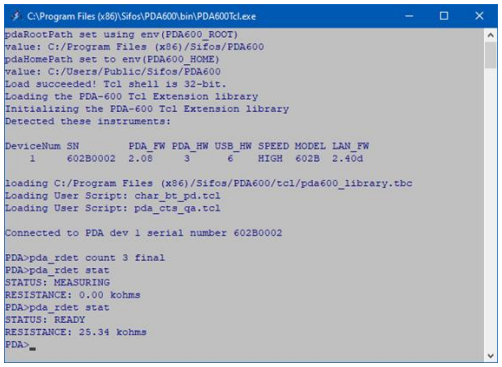

Figure 22: PowerShell PDA Tcl Console

The PowerShell PDA Tcl Console in Figure 22 is the Windows command prompt shell environment extended with Tcl commands and PDA-600 commands.

User written automated test scripts can run in either console, though if those scripts utilize Tk graphical user interface utilities such as message boxes, the Wish console must be used. Multiple PDA-604A instruments can be managed by scripts and commands executed in either PowerShell PDA console.

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Every PDA command includes a standard convention to get help with command arguments, that is, valid argument forms and value ranges. A sampling of PowerShell PDA commands is presented in Table 3 below.

Resource Configuration	Meter Commands	Utility Commands	Application Commands
pda_alt	pda_rdet	pda_wait_meas	pda_stream
pda_polarity	pda_cdet	pda_stop_meas	pda_conformance
pda_source	pda_class	pda_manage_trace	pda_lldp
pda_link	pda_ptrace	pda_update_fw	pda_selftest

Table 3: Sampling of PowerShell PDA Commands

PDA-600 Application Programming Interface

PDA-600 software, including PowerShell PDA and PDA Interactive, are built on top of a binary API library that can be accessed from any programming language able to link Windows DLL's and call Win32 functions. In many cases, there is a one-to-one relationship between PowerShell PDA commands such as those in Table 3 and underlying API function calls accessible to other programming languages such as Microsoft Visual Basic, National Instruments LabView, or Python scripting language.

The binary API library is documented in **the PDA-600 API Library Reference Manual** furnished with the PDA-604A.

PDA-604A Technical Specifications

Input / Output		
Interface	Parameter	Specification
PD Port	Connections	RJ45
	PoE Signaling and Supply Modes: 2-Pair Operation	MODE A MDI, MODE A MDI-X, MODE B MDI, MODE B MDI-X
	PoE Signaling and Supply Modes: 4-Pair Operation	MODE A MDI+ MODE B MDI, MODE A MDI-X+ MODE B MDI, MODE A MDI+ MODE B MDI-X, MODE A MDI-X+ MODE B MDI-X
	Data Rates and Signaling	10/100/1000Base-T
	Impedance	100 Ω, Balanced
LAN Port	Connections	RJ45
	Modes	Active Switched (*for LLDP to PD*) or Passive Thru
	Data Rates and Signaling (Active Switched Mode)	10/100/1000Base-T
	Data Rates and Signaling (Passive Thru Mode)	10/100/1000/2.5G/5G/10GBase-T
	Impedance	100 Ω, Balanced
USB Port	Connections	USB Standard-B
User Interface	Type	USB 2.0 High Speed
	LED's	**USB**: Connected, host is furnishing 5VDC **LLDP**: Blinks on to indicate LLDPDU received **COM**: Blinks when I/O from host occurs **ALT A**: DC Power Applied to Alt A pairs **ALT B**: DC Power Applied to Alt B pairs

Source Specifications		
Source	**Parameter**	**Specification**
DC Supply	Output Voltage Range	28 VDC to 57 VDC
	Voltage Accuracy (50mA load)	± (0.75% + 60 mV)
	Voltage Resolution	0.1 Volt
	Source Resistance (typical)	1.6 Ω
	Maximum Continuous Source Current	1000 mA per Pairset, 2000mA total

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Source Specifications

Source	Parameter	Specification
PD Detection Resistance	Method	ΔV / ΔI
	Probing Voltage (typical)	4.4 V – 8.8 V
	Probing Range (Margin Test)	2.7 V - 10.1 V
PD Detection Capacitance	Method	Slew Time
	Probing Voltage (typical)	~4 V – 8 V
PD Classification	Modes: Standard PDA-604	1-Event, 2-Event, and 3-Event Classification
	Modes: PDA-604 with **PDA-604-TYPE34**	1-Event, 2-Event, 3-Event, 4-Event, 5-Event Classification
	First Event Duration	Selectable: T_{LCE} 100 msec or T_{CEV} 30 msec
	Classification Probing Voltage (typical)	~17.5 V
	Classification Probing Voltage (margin test)	14.5 V, 20.5 V
	Classification Probing Event Duration (typical)	30 msec
	Mark Region Voltage (typical, ≤ 6mA load)	7- 9 V
	Mark Region Duration (typical)	Mark 1 through 2, 3, or 4: 10 msec each Final Mark: Selectable, 25 to 375 msec

Measurement Specifications

Measurement	Parameter	Specification
Detection Resistance (*per pairset*)	Range	3 KΩ to 50 KΩ
	Accuracy (19 KΩ to 26.5 KΩ, Probing 4.4-8.8V)	± 1%
	Accuracy (Full Range, Probing 4.4-8.8V)	± 2.5%
Connection Check	Outcomes	SINGLE or DUAL or INVALID PD
	Expected PD Signature for VALID result	21 KΩ to 28 KΩ on each pairset
Detection Capacitance (*per pairset*)	Range	50nF-10μF
	Accuracy (0.05..2 μF)	± (2.5% + 6 nF)
	Accuracy (2.1..10 μF)	± (10% + 6 nF)
Classification (*per pairset*)	Classification Range	0 mA to 50 mA
	Classification Accuracy (1..15 mA @ ~17.5V)	± (2.5% + 600 μA)
	Classification Accuracy (16..50 mA @ ~17.5V)	± (1.5% + 400 μA)
	Events Measured	Selectable, 1 to 2 (standard), 3-5 with Type-3/4 license
	Mark Region Range	0.5 to 5 mA
	Mark Region Accuracy	± (2% + 100 μA)
Power	Range	0 to 56 Watts per pairset, 0 to 112 Watts 4-Pair
	Resolution	0.01 W per pairset, 0.02 W 4-Pair
	Accuracy	± (2.0% + 0.1 W) per pairset, ± (2.0% + 0.2 W) 4-Pair
Load Current	Range	0 to 1000 mA per pairset, 0 to 2000 mA 4-Pair
	Resolution	0.1 mA, 0.2mA 4-Pair
	Accuracy (1..15 mA)	± (2.0% + 600 μA) per pairset, ± (2.0% + 1.2mA) 4-Pair
	Accuracy (16..50 mA)	± (1.85% + 600 μA) per pairset, ± (1.85% + 1.2mA) 4-Pair
	Accuracy (51..100 mA)	± (1.0% + 500 μA) per pairset, ± (1.0% + 1.0mA) 4-Pair
	Accuracy (101..1000 mA)	± (0.75% + 800 μA) per pairset, ± (0.75% + 1.6mA) 4-Pair
Port Voltage, Unpowered Pairset Backfeed or Reflected Voltage (2-Pair PSE)	Range	0 VDC to 57 VDC
	Resolution	0.1 V
	Accuracy (Pairset Voltage)	± (0.75% + 100 mV) per pairset, ± (0.75% + 200 mV) 4-pair
Unpowered Pairset Reflected Voltage (4-Pair PSE)	Range	0 VDC to > 5VDC
	Resolution	0.1 V

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Measurement Specifications

Measurement	Parameter	Specification
Trace	Types	Voltage, Current, Power, Voltage & Current (V+I)
	Trigger Modes	**Immediate**, **Class** (leading edge of first event), **Source** (ON or OFF transition), **Transient** (Current or Power) with Selectable (2-Pair) Threshold and Selectable Pre-Trigger Sample Count
	Sample Rate – 2-Pair Traces (Immediate, Class, Source triggered traces)	0.05 – 20 msec / sample (1-2-5 pattern) Voltage, Current also support 0.025 msec/sample
	Sample Rate – 4-Pair Traces (Immediate, Class, Source triggered traces)	2 – 20 msec / sample (1-2-5 pattern)
	Trace Length (Voltage, Current) – 2-Pair Traces	Selectable up to 5120 points
	Trace Length (Voltage, Current) – 4-Pair Traces	Selectable up to 2560 points
	Trace Length (Power, V+I) – 2-Pair Traces	Selectable up to 2560 points
	Trace Length (Power, V+I) – 4-Pair Traces	Selectable up to 1280 points
	Sample Rate – 2-Pair & 4-Pair Transient Triggered Traces	2 – 20 msec / sample (1-2-5 pattern)
	Trace Length – Transient triggered traces	Indefinite – Runs until specified **2-Pair** current or power condition occurs. In 4-Pair mode, both pairsets are monitored for the 2-Pair current or power condition.
	Trace Trigger Hold-off: Supported Triggers	Class, Source
	Trace Trigger Hold-off – 2-Pair Traces	0 to 65535 samples
	Trace Trigger Hold-off – 4-Pair Traces	0 to 32768 samples
Streaming Trace (2-Pair & 4-Pair modes)	Parameters Included	Voltage, Current, Instantaneous Power, Avg. Power
	Sample Rate	5 msec or 10 msec
	Trace Length (5 msec period)	≤ 1048400 samples (≤ 5242 seconds)

LLDP (802.3at and 802.3bt TLV's)

Interface	Parameter	Specification
PD Port (with **PDA-LLDP-AT** feature license)	Receive	In-board Ethernet switch is configured to filter for LLDPDUs. Normally parsed to extract the IEEE **802.3at** conformant Power-via-MDI TLV; entire raw frame is available for analysis.
	Transmit	LLDPDU containing an IEEE **802.3at** conformant Power-via-MDI TLV with programmatically controlled alloc value.
	Trace	Continuous (once started by the user), stores and optionally displays **802.3at** Power-via-MDI TLV content.
PD Port (with **PDA-LLDP-BT** feature license)	Receive	In-board Ethernet switch is configured to filter for LLDPDUs. Normally parsed to extract the IEEE **802.3bt** conformant (extended) Power-via-MDI TLV; entire raw frame is available for analysis.
	Transmit	LLDPDU containing an IEEE **802.3bt** conformant (extended) Power-via-MDI TLV with programmatically controlled alloc value.
	Trace	Continuous (once started by the user), stores and optionally displays **802.3bt** Power-via-MDI TLV content.
LAN Port	No LLDP support on LAN Port. LAN and PD Ports must be in Active Swiitched (10/100/1000) Mode.	

Physical and Environment

Measurement	Parameter	Specification
Physical	Width	7.5"
	Height	3.0"
	Depth	10.0"
	Weight	3.2 lbs
	Power	100VAC – 240VAC, 50-60 Hz, 1.3A Max.

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Physical and Environment		
Measurement	**Parameter**	**Specification**
Environmental	Operating Temperature	0°C to 40°C
	Storage Temperature	-20°C to 85°C
	Operating Humidity	5% to 95% RH, Non-Condensing
	Altitude	2000 Meters
	Pollution Degree	2

Certifications		
Category	**North America**	**Europe & International**
Safety	CSA Listed (CSA22.2 No. 61010)	EN61010-1 (Test & Measurement Equipment Safety Standard)
Emissions	FCC Part 15, Class A (Industrial Equipment emissions, USA)	EN55011:2016 (Industrial, Scientific Equipment RF emissions, Europe)
		EN 61326-1:2013 (Immunity)
		VCCI (Information Technology Equipment emissions, Japan)
		AS/NZS 3548 (Information Technology Equipment emissions, Australia/N.Z.)
European Commission		Low Voltage Directive (2014/35/EU)
		Electromagnetic Compatibility Directive (2014/30/EU)
		ROHS Compliance Directive (2011/65/EU)
		CE Marking Directive (93/68/EEC)
Patents	U.S. Patent 10,060,965	

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Ordering Information

PDA-604A	PDA-604A Instrument for 2-Pair Type-1 & Type-2 PD Analysis Including PDA-600 Software
PDA-604-CT-AT	License for Automated **802.3at** PD Conformance Test Suite and Load Monitor applicable to Type-1 (up to 13W) and Type-2 (up to 25.5W) PD's
PDA-LLDP-AT	License for 802.3at (Type-2) PD Powering and Analysis Using 802.3at LLDP.
PDA-604-Type3/4	License for 802.3bt Type-3 (51W) and Type-4 (71.3W) PD Powering and Analysis Using 4-Event and 5-Event Classification
PDA-604-CT-BT[1]	License for Automated **802.3bt** PD Conformance Test Suite and Load Monitor applicable to Type-3 (up to 51W) and Type-4 (up to 71.3W) PD's
PDA-LLDP-BT[1]	License for 802.3bt (Type-3/4) PD Powering and Analysis Using 802.3bt LLDP.
RACKKIT-PDA	Rack Mount Kit for PDA-600 Instruments (see below)
CASE-PSA-PDA	Carrying Case for PDA-600 Instruments (see below)
HCopy-Manual	Hardcopy of PDA-604 Technical Reference Manual

[1] See Table 2 (page 3) for prerequisite feature requirements.

Accessories Included with PDA-604A:

- PDA-600 Software (CD, USB Stick)
- PSA Installation Guide (Hardcopy, CD, USB Stick)
- PDA-604 Technical Reference Manual (Softcopy, CD and USB Stick)
- Power Cord
- USB 2.0 Cable
- Cat 5e Patch Cable

Optional Carrying Case for PDA-600

Optional Rack Mount Kit for PDA-600

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Verification, Simplified.

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