

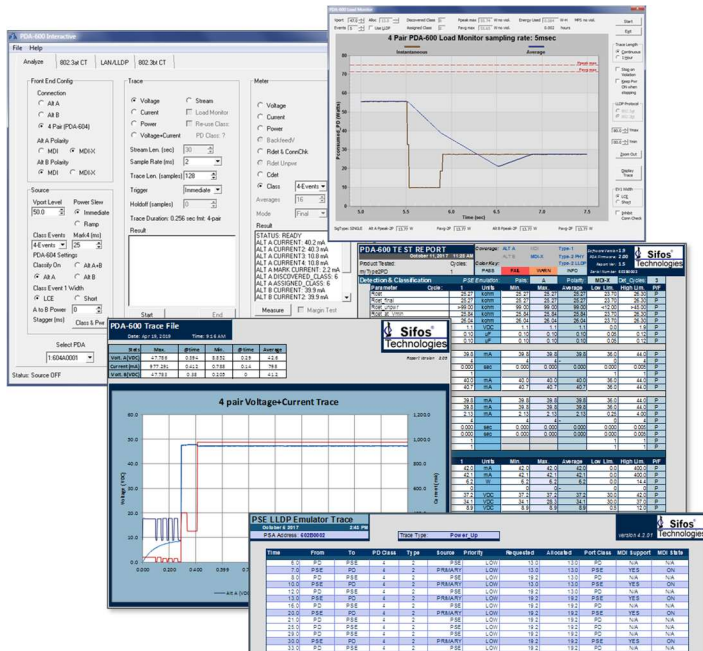


PDA-604A

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
- ❑ Fully Configurable Classification and 802.3bt / 802.3at Power Grants
- ❑ Continuous PD Powering to >82 Watts at All PD Input Voltages
- ❑ Comprehensive Analysis of 802.3bt / 802.3at PD Performance Parameters
- ❑ Automated IEEE 802.3at* Powered Device Conformance Testing
- ❑ 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 ($\leq 13W$) PD's
- Type-2 ($\leq 25.5W$) PD's
- Type-3 ($\leq 51W$) PD's
- Type-4 ($\leq 71.3W$) PD's
- 802.3at & 802.3bt LLDP capable PD's

Assure Full Interoperability

- Emulate 4-Pair and 2-Pair Powering
- Emulate Type-1, 2, 3, and 4 Power Grants to All PD's
- Real-Time Load Monitoring
- Automatic Static and Transient Load Limit Violation Analysis
- Automated 802.3at* PD Conformance Testing including LLDP
- Configurable Waveform Traces Including Class, Source, Transient Triggering
- LLDP Power Negotiation & Protocol Verification

Versatile Applications

- Evaluation & Design
- Quality Assurance
- Manufacturing Test
- 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, many parameters critical to 802.3at and 802.3bt interoperability can be accurately assessed relative to specification requirements, thus fully avoiding the need for and the severe limitations associated with 802.3at/802.3bt PSE's.

Fully Integrated, One-Box Solution

The PDA-604A removes the need for specialized instrumentation setups requiring DC power supplies, precision meters, custom test fixtures, protocol analyzers, a variety of PSE's, and custom software. The PDA-604A can be used with PDA Interactive software to perform specification compliance analyses of new PD designs and to troubleshoot PD specification compliance problems. The PDA-604A can facilitate remote configuration of PD states over the LAN while simultaneously assessing power demand and LLDP processing from a PD. Different PSE behaviors can readily be 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-over-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 200 μ sec. The PDA-604A test port can link 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 Testing of 802.3at PD's

The PDA-604A offers an optional 802.3at PD Conformance Test Suite* and associated reporting that may be further optioned for Type-1 or Type-1 & 2 PD testing, including PoE LLDP protocol testing. This "one-button" test suite produces over 50 limit-checked PD parameters. The test suite is accessible from the PDA Interactive (GUI), from the PowerShell PD scripting environment, or from any programming language interfacing Windows DLL's. Test results are produced as colorful Microsoft Excel spreadsheets to annotate problem areas and provide multi-cycle statistics.

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.

* Future PDA-604A options will include 802.3bt Conformance Test

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 some 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.

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 **802.3at PD’s** with PSE emulations that include both **802.3at** and **802.3bt PSE’s**.

Table 2 depicts licensed feature options 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.

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

Feature Option	Description	Features Included		Required Features
		Load Monitor (2-Pair & 4-Pair)	Class 5-8, Class 4-5D	
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 Feature Options and Combinations. * Future Product Feature.

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



Figure 1: 3-Event Classification

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 new PSE's will 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 802.3at (Type-1/Type-2) 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.

The **Type-3/4** feature option 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 are restricted to draw less than 25.5 watts given 2-Event or 3-Event classification and less than 13 watts given 1-Event classification.

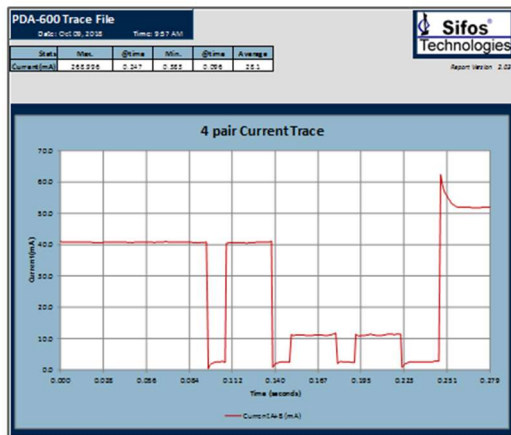


Figure 3: 4-Event Classification of a Class 6 PD

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 option.

Figure 2 shows a 4-Event classification signature measurement for a Class 6 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.

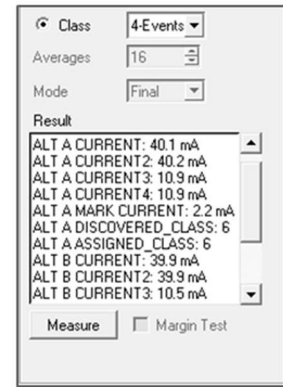


Figure 2: 4-Event Class Meter Measurement

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 option.

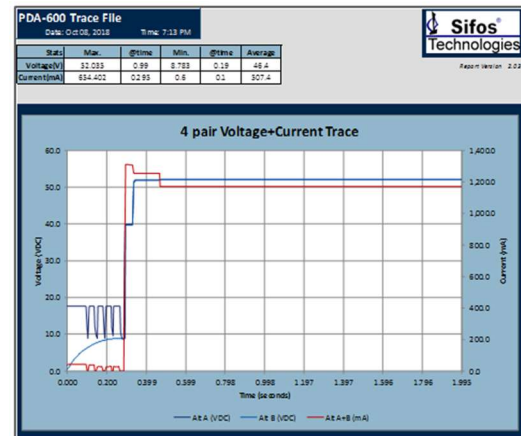


Figure 4: Class 8 PD Power-Up V+I Waveform

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 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. PD manufacturers seeking to perform **1st party** testing may utilize the **EA Cert Mode** available with the PD Conformance Test Suite to run fully automated testing that produces specialized EA test reports required to obtain and update PoE logo certifications for their powered devices.



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.

The CT-AT option 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 802.3at 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.

PDA-600 TEST REPORT									
Product Tested:		Cycles:		Coverage: ALT A MDI Type-1		Software Version 1.15		Sifos Technologies	
m:ClassID		2		Color Key: ALT B MDI-A Type-2 PHY		PDA Firmware: 2.05		Report Number: 1.7	
m:ClassID		2		Color Key: PASS FAIL WARN INFO		Serial Number: 10000000		PDA Firmware: 2.05	
Detection & Classification									
Parameter	Cycle: 1	2	Units	Min	Max	Average	Low Lim	High Lim	P.F
Rdnt	26.14	26.16	kohm	26.14	26.16	26.15	23.70	26.30	P
Rdnt_fini	26.09	26.14	kohm	26.09	26.14	26.11	23.70	26.30	P
Rdnt_LinVr	>=99.00	>=99.00	kohm	25.51	25.61	25.61	<=12.00	>=45.00	P
Rdnt_at_Vmin	25.92	26.03	kohm	25.92	26.03	25.97	23.70	26.30	P
Rdnt_at_Vmax	26.01	25.91	kohm	25.91	26.01	25.96	23.70	26.30	P
Rdnt_Vorbat	0.6	0.6	VDC	0.6	0.6	0.6	0.0	1.9	P
Cdnt	0.09	0.09	uF	0.09	0.09	0.09	0.05	0.12	P
Cdnt_fini	0.09	0.09	uF	0.09	0.09	0.09	0.05	0.12	P
1 Event Classification									
lclass	40.0	40.0	mA	40.0	40.0	40.0	36.0	44.0	P
ClassNum	4	4		4	4	4	4	4	P
Tclass	0.0005	0.0005	sec	0.0005	0.0005	0.0005	0.0005	0.0050	P
ClassStability	1	1		1	1	1	1	1	P
lclass_at_Vmin	39.7	39.7	mA	39.7	39.7	39.7	36.0	44.0	P
lclass_at_Vmax	39.9	40.1	mA	39.9	40.1	40.0	36.0	44.0	P
2 Event Classification									
lclass_event1	40.0	40.0	mA	40.0	40.0	40.0	36.0	44.0	P
lclass_event2	40.0	40.0	mA	40.0	40.0	40.0	36.0	44.0	P
Mark1	1.01	1.00	mA	1.00	1.01	1.00	0.25	4.00	P
ClassNum2	4	4		4	4	4	4	4	P
Tclass_event1	0.0005	0.0005	sec	0.0005	0.0005	0.0005	0.0005	0.0050	P
Tclass_event2	0.0005	0.0005	sec	0.0005	0.0005	0.0005	0.0005	0.0050	P
ClassStability_event1	1	1		1	1	1	1	1	P
ClassStability_event2	1	1		1	1	1	1	1	P
Power Up / Down									
Parameter	Cycle: 1	2	Units	Min	Max	Average	Low Lim	High Lim	P.F
Inrush_1	41.6	41.6	mA	41.6	41.6	41.6	0.0	400.0	P
Inrush_2	240.5	230.5	mA	230.5	240.5	235.5	0.0	400.0	P
Pmax_Totlay	1.5	1.5	W	1.51	1.51	1.51	0.0	14.4	P
Inrush_observed	0	0		0	0	0	0	0	P
Von	38.0	37.9	VDC	37.9	38.0	37.9	30.0	42.0	P
Voff	33.6	34.9	VDC	33.6	34.9	34.2	30.0	42.0	P
Vhyst	4.4	3.0	VDC	3.0	4.4	3.7	0.5	12.0	P
BackRecovery	0.0	0.1	VDC	0.0	0.1	0.1	0.0	2.0	P
ClassRecover	0	0		0	0	0	0	0	P
SignRecoveryTime	0.0	0.0	sec	0.0	0.0	0.0	0.0	30.0	P
MDI Powered Type-1									
Parameter	Cycle: 1	2	Units	Min	Max	Average	Low Lim	High Lim	P.F
Mint_1	40.4	40.4	mA	40.4	40.4	40.4	0.0	350.0	P
Mmax_1	41.1	41.1	mA	41.1	41.1	41.1	10.0	390.0	P
Vport_1	36.9	36.9	VDC	36.9	36.9	36.9	37.0	57.0	INFO
Ppeak_1	1.52	1.52	W	1.52	1.52	1.52	0.0	14.4	P
Pavg_1	1.51	1.51	W	1.51	1.51	1.51	0.0	13.0	P
MPSViolation_1	0	0		0	0	0	0	0	P
TcutrWindowViolation_1	0	0		0	0	0	0	0	P
DutyCycleViolation_1	0	0		0	0	0	0	0	P
MDI Powered Type-2 PHY									
Parameter	Cycle: 1	2	Units	Min	Max	Average	Low Lim	High Lim	P.F
Mint_2	53.8	53.7	mA	53.7	53.8	53.8	0.0	670.0	P
Mmax_2	221.2	220.8	mA	220.8	221.2	221.0	10.0	670.0	P
Vport_2	42.1	42.2	VDC	42.1	42.2	42.2	42.5	57.0	INFO
Ppeak_2	9.32	9.31	W	9.31	9.32	9.32	0.0	28.3	P
Pavg_2	8.82	8.81	W	8.81	8.82	8.82	0.0	25.5	P
MPSViolation_2	0	0		0	0	0	0	0	P
TcutrWindowViolation_2	0	0		0	0	0	0	0	P
DutyCycleViolation_2	0	0		0	0	0	0	0	P
MDI Powered Type-2 LLDP									
Parameter	Cycle: 1	2	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: PD Conformance Test Report

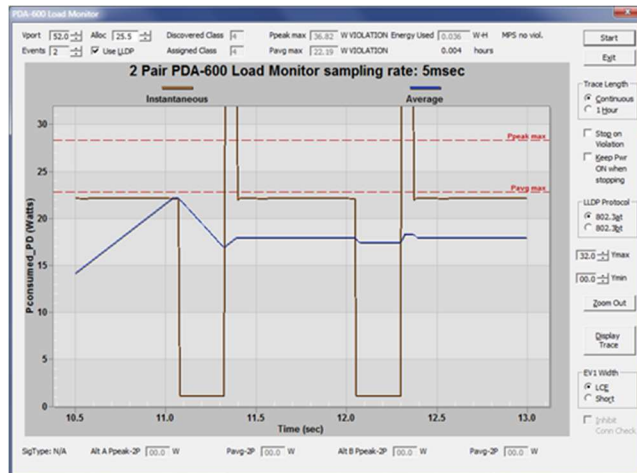


Figure 6: PDA-604A Load Monitor

A third feature of the CT-AT option is the ability to **stream long traces** of instantaneous and average power consumption into spreadsheet reports (see *Figure 7*) and data files for subsequent analysis. Streaming traces can collect power consumption samples with sample granularity 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.

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. As with the PD Conformance Test Suite, the Load Monitor can be extended to utilize PoE LLDP (for 802.3at) to acquire and set limits in accordance with PD LLDP power requests and PSE power allocations, given the LLDP feature option.

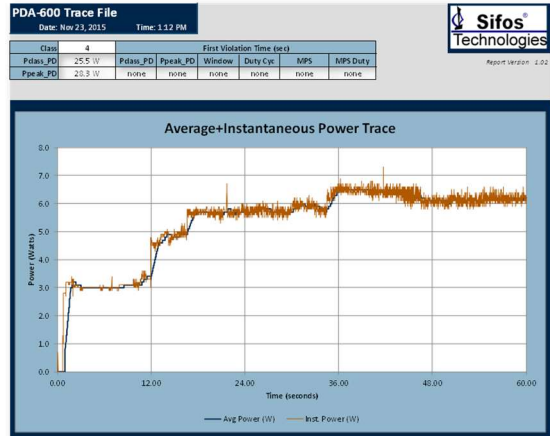


Figure 7: PDA-602 Streaming Trace

Combining the Type-3/4 Feature with the CT-AT Feature

Because the **CT-AT** feature enables the **Load Monitor** and **Streaming Traces**, in combination with the **Type-3/4** feature option, the 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.

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.

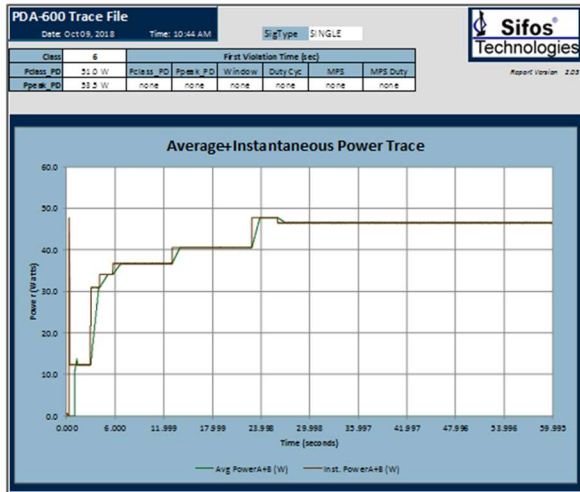


Figure 8: Streaming Power Trace from Class 6 PD

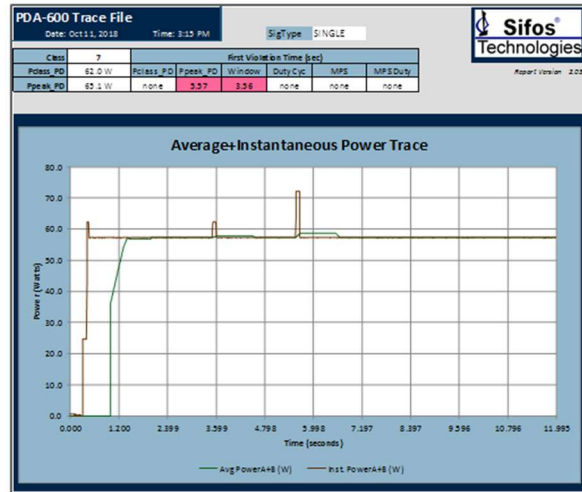


Figure 9: Streaming Power Trace from Class 7 PD

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. PSE's that provide Type-2, Type-3, or Type-4 power levels have the option to utilize LLDP in order to grant power levels higher than 13 watts to any PD. In fact, many Type-2 PSE's conforming to the 802.3at specification work exactly this way so that their budgeting of power to many PSE ports can be managed with a granularity of 0.1 watts.

The PoE LLDP requirement places at least two burdens on a 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.

PSE LLDP Emulator Trace
November 24 2015 11:45 AM
PSA Address: 60MAENG9 Trace Type: Power-Up version 4.1.01 Sifos Technologies

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 10: LLDP Power-Up Protocol Trace Report

The PDA-604A provides two feature options to enable testing of the PD conformance to each of these 802.3 requirements. First, the **LLDP-AT** feature option enables flexible emulation of Type-2 PSE's that use LLDP to grant power levels between 13 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 10**.

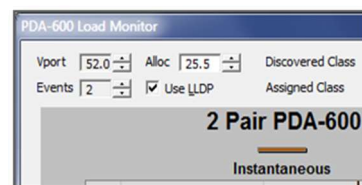


Figure 12: Link Monitor - LLDP Power Consumption Validation

MDI Powered Type-2 LLDP Parameters Table

Parameter	1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
Power	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Max Power	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Avg Power	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0

Figure 13: 802.3at Test Suite with LLDP

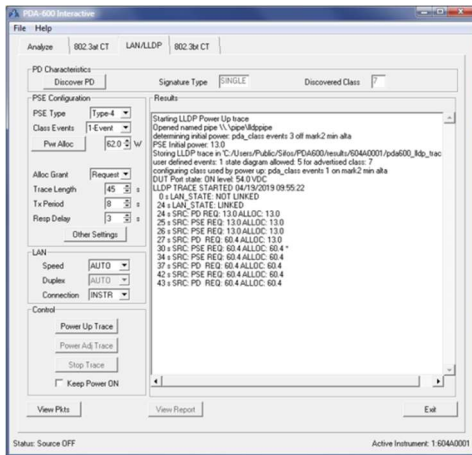


Figure 14: 802.3bt LLDP Power-Up Trace

The **LLDP-BT** feature option offers flexible emulation of Type-3 and Type-4 PSE's that deploy an extended 802.3bt PoE LLDP protocol in support of 4-pair powering. Under PDA version 1.15 software*, the PDA-604A can perform basic analysis of PD LLDP protocol associated with power-up negotiations and PSE-induced power adjustments. In **Figure 14**, a negotiated Class 7 power-up is analyzed. Control of PSE granting logic, message timing, and request update timing is provided during this emulation.

The **LLDP-BT** feature option when combined with the **CT-AT** option and the **Type-3/4** option 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

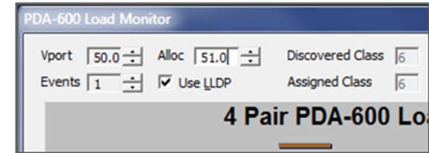


Figure 15: Link Monitor – 802.3bt Power Consumption Validation

communication with and network management of a PD-under-test while LLDP protocols run between the PDA-604A and that same PD-under-test.

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.

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.

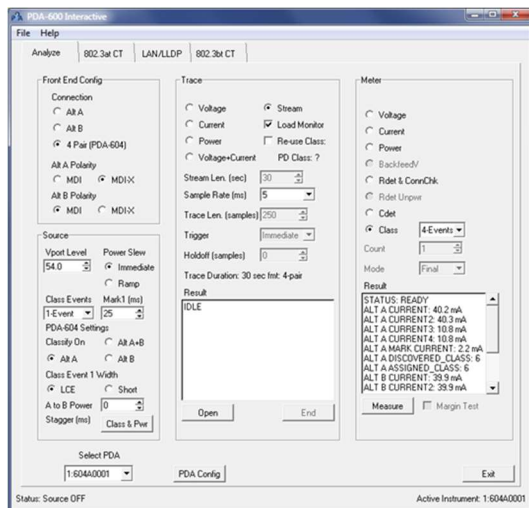


Figure 16: Analyze Menu Class Measurement

PDA Interactive provides four tabbed menus:

Analyze: The Analyze menu (see **Figure 16**) supports interactive powering, metering, and waveform trace captures. With the **CT-AT** feature option, it adds access to the Load Monitor and Stream Tracing features of the PDA-604A. The **Type-3/4** feature option further enhances this menu by allowing 4-Event / 5-Event power-ups and PD Class measurements (see **Figure 15**). In general, the Analyze menu enables intuitive methods of manually testing and analyzing many essential characteristics of a PD.

802.3at CT: The 802.3at Test Suite menu shown in **Figure 17** is available to instruments with the **CT-AT** feature option. This menu

provides for configuration and control of the **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, and **Type-2 LLDP** if the **LLDP-AT** feature option is enabled.

LLDP: This menu (see **Figures 14 and 18**) accesses the PSE LLDP emulation and LLDP protocol tracing features of a PDA-604A

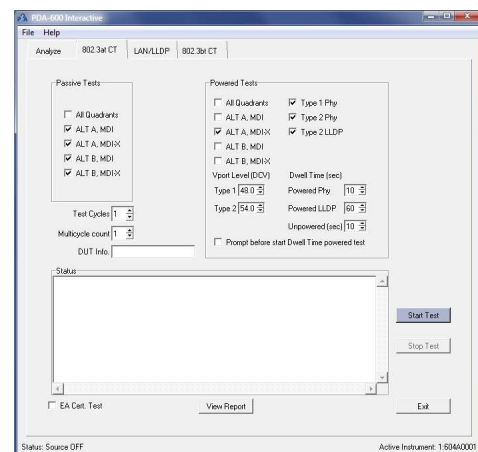


Figure 17: PDA Interactive Test Suite Menu

* Version 1.15 software supports LLDP and Load Monitor for testing 802.3bt single signature PD's. Spreadsheet protocol trace reports are provided for 802.3at (Type-2) protocol analysis and will be added for 802.3bt in a future software release.

discussed above. 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.

A fourth tab menu, **802.3bt CT**, is for managing the 802.3bt PD Conformance Test given the **CT-BT** feature option that is not yet available under the current PDA version 1.15 software release.

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.

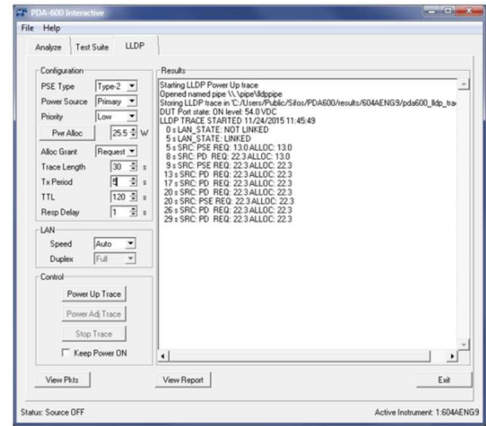


Figure 18: PDA Interactive LLDP Menu

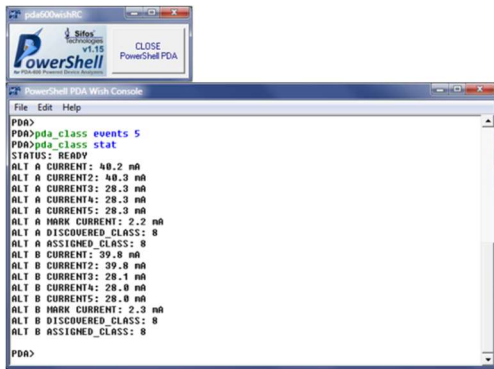


Figure 19: PowerShell PDA Wish Console

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 18 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.

The PowerShell PDA Tcl Console in Figure

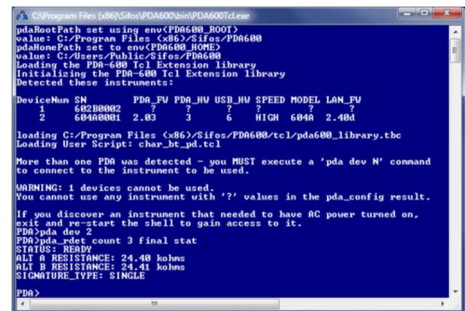


Figure 20: PowerShell PDA Tcl Console

19 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.

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)	\pm (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
PD Detection Resistance	Method	$\Delta V / \Delta I$
	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, \leq 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 K Ω to 50 K Ω
	Accuracy (19 K Ω to 26.5 K Ω , Probing 4.4-8.8V)	\pm 1%
	Accuracy (Full Range, Probing 4.4-8.8V)	\pm 2.5%
Connection Check	Outcomes	SINGLE or DUAL or INVALID PD
	Expected PD Signature for VALID result	21 K Ω to 28 K Ω on each pairset
Detection Capacitance (per pairset)	Range	50nF-10 μ F
	Accuracy (0.05..2 μ F)	\pm (2.5% + 6 nF)
	Accuracy (2.1..10 μ F)	\pm (10% + 6 nF)
Classification (per pairset)	Classification Range	0 mA to 50 mA
	Classification Accuracy (1..15 mA @ ~17.5V)	\pm (2.5% + 600 μ A)
	Classification Accuracy (16..50 mA @ ~17.5V)	\pm (1.5% + 400 μ A)
	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	\pm (2% + 100 μ A)
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	\pm (2.0% + 0.1 W) per pairset, \pm (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)	\pm (2.0% + 600 μ A) per pairset, \pm (2.0% + 1.2mA) 4-Pair
	Accuracy (16..50 mA)	\pm (1.85% + 600 μ A) per pairset, \pm (1.85% + 1.2mA) 4-Pair
	Accuracy (51..100 mA)	\pm (1.0% + 500 μ A) per pairset, \pm (1.0% + 1.0mA) 4-Pair
	Accuracy (101..1000 mA)	\pm (0.75% + 800 μ A) per pairset, \pm (0.75% + 1.6mA) 4-Pair
Port Voltage, Backfeed Voltage with 2-Pair Powering	Range	0 VDC to 57 VDC
	Resolution	0.1 V
	Accuracy	\pm (0.75% + 100 mV) per pairset, \pm (0.75% + 200 mV) 4-Pair
Backfeed Voltage with 3-Pair Powering	Range	TBD
	Resolution	TBD
	Accuracy	TBD
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

Measurement Specifications		
Measurement	Parameter	Specification
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 Switched (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.
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	Specification
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 (Industrial, Scientific Equipment RF emissions, Europe)
	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)
	CE Marking Directive (93/68/EEC)
Patents	U.S. Patent 10,060,965

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-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*	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	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-PDA	Carrying Case for PDA-600 Instruments (see below)

* Feature license not yet available

Accessories Included with PDA-604A:

- PDA-604 Reference Manual
- PDA-600 Software (CD)
- USB Cable
- Power Cord



Carrying Case for PDA-600



Rack Mount Kit for PDA-600

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Verification, Simplified.