

Sifos Technologies

PowerSync® Service Analyzer

PSA100-SA



Technical Reference Manual

Version 3.4

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Safety Precautions

To prevent electric shock, do not remove the cover of the PSA-100-SA. No user serviceable parts are inside. Service should be referred to qualified personnel.

The PSA-100-SA is for connection only to the isolated intra-corporate or private Ethernet networks.

The PSA should be powered via the supplied AC Power Adapter, which includes an Earthing Conductor. The ground terminal of the plug should not be modified, since this could result in a product that is not properly earthed. When placing the equipment in its final configuration, the equipment should be placed such that it is easy to access the power cord; this will allow the cord to be pulled out of the unit in the event that it is necessary to remove power. THE PSA-100-SA SHOULD ONLY BE OPERATED WITH THE POWER SUPPLY THAT WAS PROVIDED WITH THAT PRODUCT.

Note! The PSA-100-SA may be powered from 5V battery modules. **This power configuration has not been tested for CSA certifications.** The PSA-100_SA is CSA certified when powered from the AC Power Adapter.

THERE ARE VENTILATION HOLES ON THE SIDES AND TOP OF THE PSA-100. THESE SHOULD NOT BE BLOCKED OR OTHERWISE OBSTRUCTED.

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1. Introduction

The PSA-100-SA is a special adaptation of the PowerSync Analyzer (PSA), the network industry's most popular instrument for Power-Over-Ethernet (PoE) design validation and Power Sourcing Equipment (PSE) systems testing. The PSA-100-SA leverages the PSA Compact hardware platform and adds a specialized application aimed at comprehensive qualification of PoE Service at the Powered Device (PD) interface. The PSA-100-SA connects in place of a PD to *automatically* analyze and report on all critical parameters of the PoE service including power capacity, power management, and numerous interoperability parameters.

This manual provides a detailed overview of the PSA-100-SA and is organized as follows:

Section 2 will introduce basic PoE technology, PSE product characteristics, and the capabilities of the PowerSync Analyzer.

Section 3 will cover the PSA-100-SA Service Analyzer automated test suite including Basic Service tests, Parametric Interoperability tests, Classification Service tests, Line Monitoring tests, and signal viewing capabilities.

Section 4 will describe fundamental configurations and hook-up options for the PSA-100-SA Service Analyzer.

Section 5 will cover the PSA Interactive user interface for the PSA-100-SA.

Section 6 will introduce PowerShell and automated scripting capabilities available with the PSA-100-SA.

The PowerSync Analyzer family from Sifos Technologies also includes the following products:

- **PSA-1200:** Chassis-based analyzer with capacity to test up to 24 PSE ports. The PSA-1200 fully supports optional modules including the **PSE Conformance Test Suite** and the **PSE Multi-Port Test Suite**.
- **PSA-2400:** The PSA-2400 "RackPack" bundles 48 test ports in 2 chassis' with equivalent options and capabilities as the PSA-1200.
- **PSA-100:** The PSA-100 Compact is a 2-port, portable versions of the PSA-1200 optionally offering full support of the PSE Conformance Test Suite. The PSA-100 is fully software compatible with the PSA-1200 and PSA-2400 chassis-based platforms.
- **PSA-PL:** The PSA-PL (Programmable Load) is a low cost per-port version of the PSA-1200 aimed at PoE testing in a production environment. The PSA-PL supports a portion of the automated Multi-Port (System) Test Suite for the PSA-1200 and also supports upward compatible automation scripting with the PSA family.
- **PDA-100:** The PDA-100 is a stand-alone analyzer for assessing Powered Devices (PD) and their expected interoperability with a broad range of PSE's. It is also useful for PD design analysis and parametric reporting.

2. PoE and the PowerSync Analyzer

2.1. IEEE 802.3af / 802.3at Overview

The 802.3af specification was designed to create an environment whereby Powered Devices (PD's) from numerous different manufacturers could be interconnected to Power Sourcing inter-networking equipment (PSE) including switches, routers, and hubs produced by many different networking equipment manufacturers. It is envisioned that such interoperability will lead to lower cost and higher proliferation among both the sourcing equipment and the networked PD's. The ongoing emergence of VoIP telephony combined with ramp-up in TCP-IP networked devices show that this is a fast growing market. There are numerous new PD functions such as security, inventory management, environmental management, and other applications.

The basic features of 802.3af PoE are:

- 48V DC Supply to PD's
- Guaranteed 15.4 Watts of Power Consumption per network connection (PD and cabling)
- Power Sourcing from both "End-Point" switches/routers as well as "Mid-Span" power "adder" devices.
- Safety "interlocks" to prevent powering when no PD's are connected and to assure prompt power removal when PD's are disconnected as well as to limit DC current flow at all voltage levels.
- Physical layer mechanism for PSE's to characterize power demands of individual PD's and thus manage power delivered per port.

The 802.3at specification will expand upon 802.3af in several key areas:

- Guaranteed up to 30 Watts of Power Consumption per network connection (PD and cabling)
- Optional LLDP (MAC Layer) based protocol for negotiating power demands with a PD with granularity of 0.1 watts.
- PoE End-Point and Mid-Span PSE's with full gigabit Ethernet support

2.1.1. The Power Connection

Under the 802.3af specification, DC power must be carried on 2 of the 4 pairs of a LAN (e.g. category 5) cable. Either +48V or -48V DC is carried on one pair (common mode) and reference (zero volts) is carried on a second pair. ALT A (alternative A) refers to the case where power is sourced on Pairs 2 and 3 (referring to EIA/TIA 568B), the data transmission pairs for 10/100BaseT. ALT B refers to the case where power is carried on Pairs 1 and 4 which are otherwise unused in 10/100BaseT. Mid-Span PSE's MUST apply power on the "ALT B" pairs while End-Point PSE's may use either, though typically will use ALT A. This allows both End-Point and Mid-Span PSE's to coexist on the same cable.

Power may be applied by the PSE in either an MDI or MDI-X (crossover) port configuration. This means that from the PD's point of view, the incoming voltage may look either like +48 VDC (MDI) or -48 VDC (MDI-X) since in the latter configuration, pairs 2 and 3 (as well as 1 and 4) are crossed. PD's are required to be completely insensitive to whether power is furnished on the ALT A or ALT B pairs and whether power is positive polarity or negative polarity.

Each PSE port is responsible for managing 4 basic aspects (or phases) of PoE:

1. PD Detection
2. PD Classification
3. Power-Up
4. Power-Removal

802.3at compliant PSE's will source at least 50 VDC and will readily differentiate between PD's that are high power (802.3at) versus normal power (802.3af) type PD's. PSE's, including Mid-Spans, can furnish power on any pair (ALT A or ALT B) and an option *may* exist to allow powering of all 4 pairs under 802.3at.

2.1.2. PD Detection

A PoE enabled PSE port provides a low power signaling mechanism that constantly monitors for an 802.3af Powered Device to appear at the end of the LAN cable. If a non-powered network device is connected, the PSE port can function just as would a non-PoE port and link to the networked device. However, if an 802.3af PD is connected, the PSE port will quickly recognize this and begin the process of powering up the PD.

The primary means of detection is a measurement of PD port electrical resistance performed by the PSE port. 802.3af specifies that compliant PDs will present a load resistance at the PSE between 19 KΩ and 26.5 KΩ given an input voltage under 10 VDC. It further specifies that the method of resistance measurement shall allow for an unknown voltage drop up to 2.8 volts associated with one or more diode junctions in series with this load resistance. This implies that the resistance must be determined from a $[\Delta V / \Delta I]$ measurement performed at 2 (or more) voltage levels and that the minimum detection voltage must be at least 2.8 VDC.

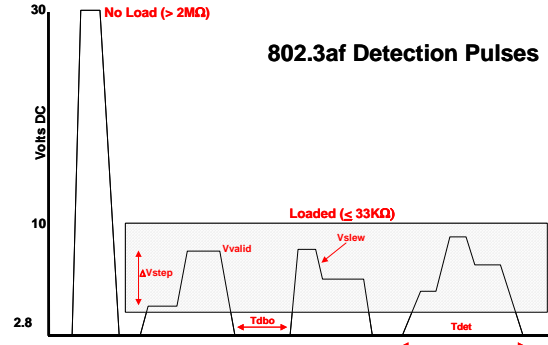


Figure 2.1 802.3af Detection

Some of the relevant specifications affecting the detection process are:

Characteristic	Minimum	Maximum	Units
Unterminated (Open Circuit) Detection Voltage		30	VDC
Terminated Detection Voltages	2.8	10	VDC
Detection Current Limit (compliance)		5	mA
$[\Delta V / \Delta I]$ Voltage Step	1	7.2	VDC
Maximum Acceptable Load Resistance	26.5	33	KΩ
Minimum Acceptable Load Resistance	15	19	KΩ
Maximum Acceptable Load Capacitance	0.15	10	μF
Slew Rate of Voltage Step		0.1	V / μsec
Detection Duration		500	mSec
Detection Backoff (following unsuccessful detection) (does not apply to End-Point PSE's)	2		Sec

It should be noted that despite the various requirements described for PD Detection signaling in the 802.3 specification, that there is considerable room for design variation and that in practice, detection pulses and detection measurement schemes do vary significantly across PSE interface technologies. The 802.3af and 802.3at standards do *not* prohibit the use of complementary schemes that might improve detection accuracy and speed while also reducing risk of possible damage to non-PoE capable end station equipment.

2.1.3. PD Classification

802.3af allows for PD's to communicate their power demands to a PSE port via a "Classification" process. From the perspective of a PSE port, PD's can be classified as follows:

Type (802.3at)	Classification	Guaranteed Power	Minimum Power	Units
Type-1	Class 0	15.4	~ 0.5	Watts
	Class 1	4.0	~ 0.5	
	Class 2	7.0	~ 4.0	
	Class 3	15.4	~ 7.0	
Type-2	Class 4	30.0 (802.3at)	~ 15.4	

A Type-1 PSE has the option not to classify the PD in which case the PD must be assumed to require Class 0 power.

Classification is performed by applying a voltage in the band from 15.5V to 20.5V and measuring the fixed DC current load presented by the PD. The magnitude of measured current is then translated into a classification as follows:

Minimum Current	Maximum Current	Units	Classification
0	5	mA	Class 0
8	13	mA	Class 1
16	21	mA	Class 2
25	31	mA	Class 3
35	45	mA	Class 4

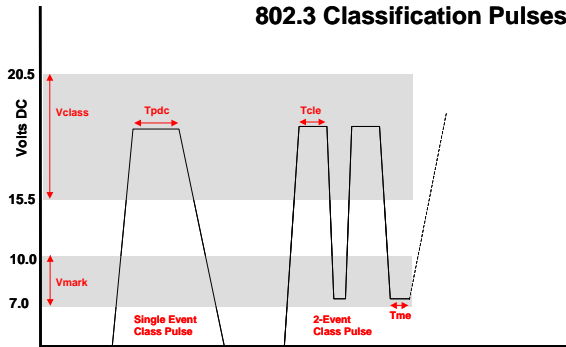


Figure 2.2 802.3af & 802.3at Classification

The PSE is free to make decisions regarding current measurements that fall between the above bands. Classification must be completed in 75 mSec, so typically classification involves a short duration pulse with amplitude between 15.5 and 20.5 Volts. A “single-event” class pulse (see Figure 2.2) may return to zero or may hold its value (or anything in between) following completion of classification.

The 802.3at specification requires that all compliant PSE’s perform classification and it adds an expanded classification measurement option that allows PSE’s to “signal” their 802.3at high power capability to a powered device while reading the power demand of the powered device. The “2-event” classification (see Figure 2.2) involves 2 successive

classification current measurements separated by a “mark” region. The 802.3at PD must be capable of discharging the class voltage in order to “see” this mark region and thereby detect the presence of an 802.3at capable PSE. The 2-event classification cannot ever drop below 2.8V, or the PD will reset and forget that the PSE is 802.3at capable.

802.3at PSE’s may use either single-event or 2-event PD classification. Those that use single event method are required to us MAC layer LLDP protocol to negotiate power with an 802.3at PD following initial PD power-up.

2.1.4. Power-Up

Following classification, assuming the PSE performs this step, the PSE will apply power (voltage and current) to the PD. A PSE is required to furnish between 44 V (50 V for Type-2 PSE’s) and 57 V to at the PSE interface. There are two timing criteria of interest: Time from end-of-detection until power-up is complete and the rise time of the PoE voltage. The first parameter includes classification time and must be under 400 mSec. The power-on rise time is required to be longer than 15 μ sec.

Other parameters of interest during the power-on event are the initial (in-rush) current and the peak-to-peak ripple and noise amplitude. PSE’s are required to clamp in-rush current to 450 mA regardless of the transient load provided by a PD. AC ripple (including AC MPS signals) under 500 Hz in frequency should not exceed 500 mVpp. AC noise in the region below 150 KHz should not exceed 200 mVpp.

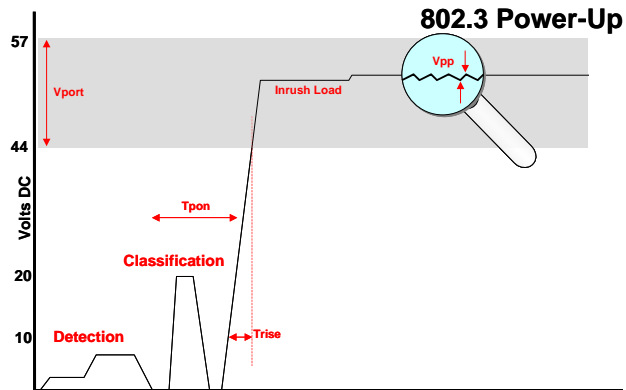


Figure 2.3 802.3af Power-Up

While the PSE is furnishing power to the PD, the PSE is responsible for regulating total power delivered to the PD. 802.3af compliant PSE ports must have capability of furnishing a minimum of 15.4 watts given connection to a “Class 0” PD. High Power 802.3at compliant PSE ports must have capability to furnish at least 30 watts given connection to a “Class 4” PD. The maximum power capacity of a PSE port is limited by a current ceiling defined as I_{cut} in the 802.3 specification. Given the ceilings specified, an 802.3af compliant PSE might theoretically furnish a maximum of 22.7 watts while a 2-pair, high power, 802.3at compliant PSE might theoretically supply up to 38.9 watts continuous power. Practically speaking, typical port power capacity will be relatively close to the minimum required values.

2.1.5. Power Removal

802.3 compliant PSE’s offer one of two means to determine that a Powered Device has been disconnected, and therefore DC power should be removed. By implication, the two different mechanisms are mutually exclusive, though the specification allows for what effectively would be an impractical combination of both methods.

The AC MPS method involves the superposition of a low level, relatively low frequency signal on the DC power rail. The AC signal is sourced from a high output impedance such that when exposed to a nominal load resistance of 25 KΩ, the amplitude of the signal is attenuated to well below 500 mVp-p. Typically it will be well below 200 mVp-p. When the 25 KΩ signature load is removed, the AC signal amplitude increases and can be detected on the PSE output. The PSE must then wait for an interval of at least 300 mSec, but not longer than 400 mSec to remove power. The main advantage of the AC MPS method over the DC MPS method is the ability to tolerate well below 10mA of load current indefinitely so long as the AC MPS load impedance of 25 KΩ is detected.

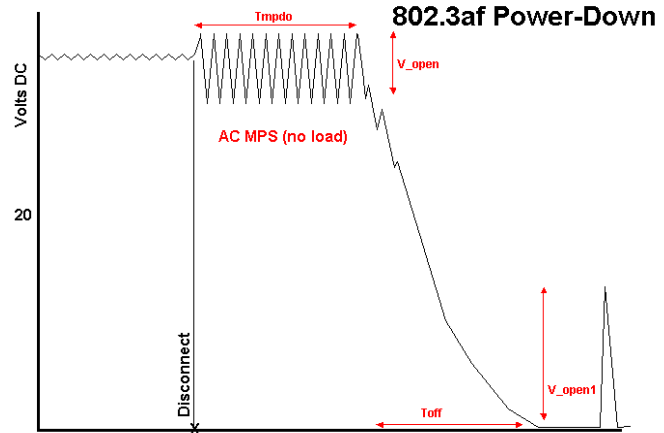


Figure 2.4 802.3af Power-Down

The DC MPS method relies on a continuous measurement of DC load current. When the DC load current drops below 10 mA, the PSE has the “right” to remove DC power. When the DC load current drops below 5 mA, the PSE must remove DC power. As with AC MPS, the timing of the low-load current is such that the PSE must tolerate 300 mSec of low load, but not longer than 400 mSec of this condition. Additionally, the specification makes allowance for the DC MPS signature to be intermittent so long as it is present for a continuous 60 msec out of every 360 msec interval. The main advantage of DC MPS is that it does not add any noise onto the power rail.

2.2. Power Sourcing Equipment Characteristics

The 802.3af specification leaves considerable room for implementation dependent behaviors. Additionally, many vendors of Power Sourcing Equipment (PSE) will choose to go outside the 802.3 specification in ways that will not affect the ability to power and maintain pure 802.3 Power Devices (PD). This high degree of variation will add a number of challenges to the generation and performance of PSE specification conformance tests.

2.2.1. Signaling Variations

One area of implementation variation relates to the signaling utilized prior and during power-up. The following table describes some of the possible variations in the area of signaling.

Signal Type	Variants
Open Circuit Detection	Amplitude: 2 – 30 VDC Course Detection Range: Any Detection Signature > 33 KΩ Course Detection Method: Not strictly specified – may use 802.3af ΔV/ΔI Steps Measurement Timing: No firm requirements, just recommendations
Connected Detection Signature	Amplitude: 2.8 – 10 VDC (given valid PD signature from 19 to 26.5 KΩ) Pulse Duration: 20 – 500 mSec ΔV/ΔI Steps: 1 or more Step Edge: Rising, Falling, Both Step Magnitude: 1 – 7.2 V Pulse End: RZ or NRZ
Classification	Amplitude: 15.5 – 20.5 VDC Classification Pulse Count: ≥ 1 Pulse Separation: ≥0 (≥2 Midspan) sec Duration: 15 to 70 mSec Pulse End: RZ or NRZ
AC MPS Signal	Waveform: CW or Pulsed Removal: Before, During, After Frequency: 20 to 500 Hz Power-Down (or Never ?)
Power-Down	AC MPS Threshold: 27 KΩ to 1.98 MΩ DC MPS Threshold: 5 – 10 mA Dissipation: PD Load, PSE Shunt, or Active PSE Discharge

2.2.2. Connection Alternatives

PSE's will generally be configured to source power on EITHER the data pairs (10/100BaseT) OR the unused pairs. For any given PSE port implementation, this should be a design constant. Within the 802.3af specification, Mid-Span PSE's MUST utilize the unused 10/100BaseT pairs. The 802.3at specification allows for Mid-Span PSE's that power either pair and support 1000BaseT where all 4 pairs are used for data transmission.

PSEs can provide EITHER polarity (+48V or -48V) to which PDs must be insensitive. Some PSE's may offer programmability in configuring their ports for MDI or MDI-X which in turn may affect voltage polarity.

2.2.3. MPS Behaviors

Generally, a PSE will be designed to utilize either the AC or DC MPS method for determining a PD disconnect. Hence, this is one fundamental characterization of each PSE port that affects both the types of tests and the method of controlling a PSE port through PD emulation. Those ports supporting DC MPS need to see a low current condition (below 10 mA) in order to remove power. Those ports supporting AC MPS need to see an effective load impedance in excess of 1.98 MΩ in order to remove power, with a PSE-dependent load threshold ranging from 27 KΩ to 1.98 MΩ! These PSE's will tolerate a PD operating at less than 0.1 watt indefinitely since a DC load current of 2 mA (assuming port voltage of 48 VDC) translates to effective 24KΩ resistive load.

2.2.4. Legacy Modes and Proprietary Detection Schemes

Prior to 802.3af, a considerable amount of "legacy" PoE equipment including first-generation VoIP phones utilized proprietary technology to generate and manage power over LAN. Typical legacy powered devices include a low frequency coupling circuit between data transmission pairs and/or the existence of a large capacitance seen by common mode measurements across either data or spare pairs. These features could be sensed by the power sourcing equipment using proprietary techniques. Protocols for determining power requirements of the PD were also proprietary and conducted at the MAC layer.

With the volume of legacy PD's in the marketplace, many new generation PSE's seek to utilize BOTH 802.3 signaling and legacy detection methods simultaneously so that either type of PD can be recognized and powered. This "hybrid" detection behavior may violate 802.3 specifications when detection signaling is compliant with relevant 802.3af criteria including signal levels, source impedance, and slew rates. However, assuming this hybrid behavior does not damage 802.3 compliant PD's, it is desirable to customers who want maximum flexibility in their PSE.

Hybrid detection schemes may also include coarse measurements to assess possible PD connections prior to performing more refined 802.3 detection.

These proprietary techniques may help to prevent damage to ordinary Ethernet interfaces (non-PD) or they may be beneficial in determining possible legacy PD connections. On the other hand, the added complexity complicates testing by adding ambiguity as to exactly how a PSE is detecting either an 802.3 or other type of PD.

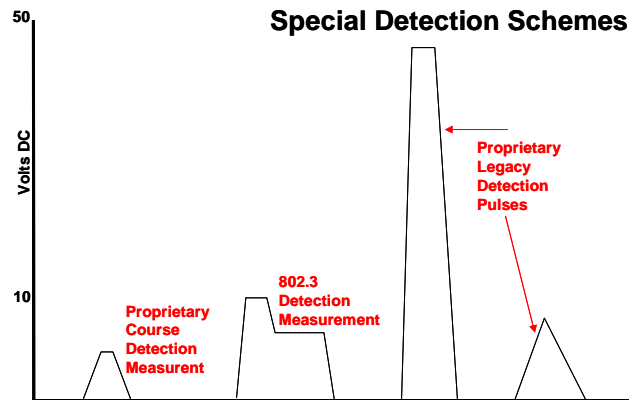
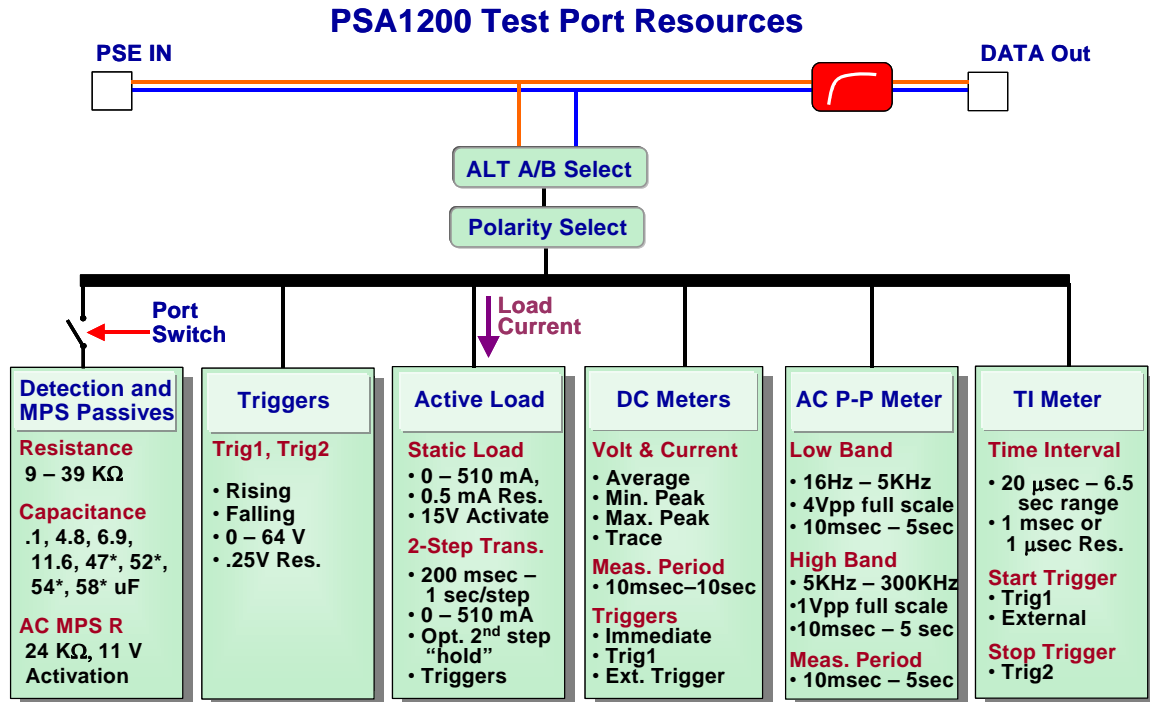


Figure 2.5 Hybrid Proprietary Detection Methods

2.3. System Hardware Overview

The diagram below shows a block diagram of a single PowerSync Analyzer (PSA) test port. Each PSA test blade (or PSA100 instrument) contains two of these measurement circuits, which are electrically isolated from each other and from the chassis control circuitry.



* "Type 2" or "Type 3" PSA Test Blades Only

Figure 2.6 PSA Test Port Resources

The PSE input connector is connected to a PSE device under test. The DC power and related common mode control and classification signals are tapped off and fed to the measurement subsystems. The DC voltage and very low frequency, common mode PoE signals are not visible at the output port. The data signal is passed directly to the output connector, and can be used for data-related measurements with other test equipment.

At the front end of the test port, there are two sets of switches. These are implemented with electro-mechanical relays. The ALT-A/B switch selects which wire pair is connected to the PSA test resources. The Polarity switch selects the polarity of the power supplied by the device under test. ALT-A/B and Polarity settings will depend upon the characteristics of the equipment being tested. Incorrect settings of either switch will not damage the instrument.

The paragraphs that follow will cover each test subsystem in greater detail.

2.3.1. Port Switch and Detection Subsystem

The Port Switch and Detection Passives subsystem provides the detection loading required for a PSE under test to recognize a Powered Device (PD) "signature" so that it can turn on and supply power. It also provides an AC Maintain Power Signature (MPS) resistive loading that is visible to a powered-up PSE. This load value is at the top of the range where PSE's must interpret a valid load signature.

The Port switch is used to connect the passive detection loads to the PSE under test. On initial power-up of the PSA-1200, this switch is typically in the open (or "isolated") position. This switch closes and opens under software control, and within all PowerSync Analyzers *excluding* the PSA-PL, may be used as a triggering event for many single-shot measurements of detection and MPS behaviors.

The Detection Passives are affected by an internal disconnect feature that is dependent only upon the PSE voltage level. When the PSE voltage reaches approximately 11 volts, the passive R-C Detection signature is removed and the MPS signature R-C circuit is inserted thus presenting a valid AC MPS signature following PSE power-up for as long as the Port Switch is closed (or connected).

The Detection resistance and capacitance ranges in the Detection subsystem are 9 K Ω -39 K Ω Ohms, and nominally 0, 5, 7, and 11 μ F respectively. Newer “Type 2” or “Type 3” PSE Test Blades add capacitance values of 47, 52, 54, and 58 μ F to aid with legacy PD emulation needs. The AC MPS signature consists of 24 K Ω in parallel with 0.1 μ F that becomes visible above 11 volts – the same level where Detection Signature passives are removed and become invisible. Because of the 11 volt activation floor, the effective DC resistance of the AC MPS signature is significantly greater than 24 K Ω until the port voltage significantly exceeds 11V. This means that neither the Detection Signature nor the AC MPS signature will produce any measurable error to Classification Signature loads created by the Active Load module.

There are 2 forward-biased diodes that the signal must pass through before entering the Detection and MPS passives circuitry. These model typical PD bridge characteristics and are commensurate with recommended circuitry as described in the 802.3 PoE standard.

2.3.2. Triggers

The PowerSync Analyzer has extensive triggering capabilities, which are divided into 2 categories: *internal (or waveform)* and *external (or event)*. The instrument also has the ability to perform non-triggered measurements. The triggering types are depicted in Figures 2.7 and 2.8. Also depicted in Figure 2.7 are trigger applications including the DC meters, time-interval measurement, and load current transient, each of which can be initiated with those triggers.

Internal (or waveform) triggering is derived from the common mode voltage levels received from the PSE under test. For most measurements, this triggering is based upon the trigger levels and directions (rising or falling) set for **Trigger 1**. A second trigger, **Trigger 2** is used exclusively for terminating time interval measurements. Trigger 2 offers identical programmability as Trigger 1 (levels and edge polarities).

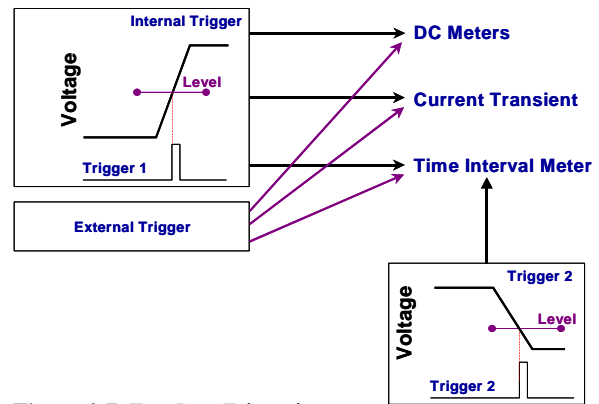


Figure 2.7 Test Port Triggering

External (or Event) triggering is also used to initiate measurements or actions, and is initiated by either a user command, an action that is programmed to send out an external trigger, or through an external event that appears on the trigger bus.

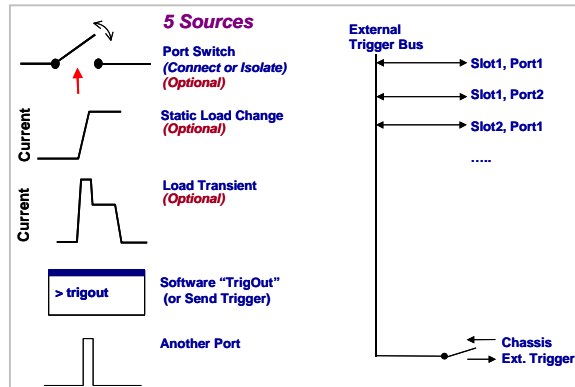


Figure 2.8 PSA Test Port Trigger Sources

The trigger bus is a trigger signal connection that is shared by all ports within a system, and by the Trig Out BNC connector on each PowerSync Analyzer. Figure 2.8 shows the sources used to generate External (or event) triggers on the left, and shows the external bus configuration on the right.

Any External trigger in the system will appear on this bus, and will trigger any port which is waiting for an external trigger event. This enables cross-triggering across ports and triggering via externally generated signals. It also enables the user to use the trigger output for other purposes, such as monitoring data throughput during PSE powering or load transients.

Any External trigger in the system will appear on this bus, and will trigger any port which is waiting for an

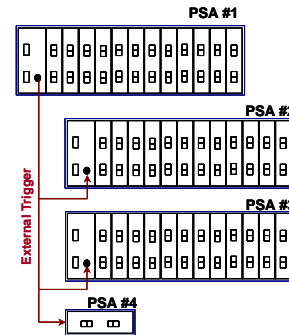


Figure 2.9 External Trigger Bus

The BNC trigger connector on the Chassis Controller front panel can be configured as an output or an input. As an output, it directly mirrors the External trigger bus. Output triggers will appear as a 3.3V, 10 mSec pulse. When set as an input, it can drive the external trigger bus inside the PSA chassis. This enables triggering across multiple instruments, which may be desirable when testing equipment with more than 24 ports.

For example, the Figure 2.9 shows cross triggering across instruments. The trigger direction on PSA #1 is set as an **output**, and the other PSA's are set as inputs. This set-up can be used to perform measurements, or initiate a load current change across 96 or more PoE ports simultaneously.

2.3.3. Loads and Load Transients

The load and load transients subsystem uses an active programmable current load. This current load is activated for port voltages in excess of 15V from the PSE under test. Similarly, the load is deactivated when the port voltage drops below 15VDC. The current load has a programmable range from 0 through 511 mA, in 0.5 mA steps. The PowerSync Analyzer's active load may also be configured to produce a programmable 2-step transient current load, where both current level and load step durations can be set. The durations are programmable from 200 μ Secs to 1 second per step. The second step can optionally be held indefinitely thus becoming the new static DC load. The load transient can be triggered via either Trigger 1 (waveform) or Externally (event), and it is also capable of *generating* an Event Trigger at the beginning of the transient. The load circuitry is automatically switched out of the circuit for input voltages lower than 15V.

2.3.4. DC Meters

The DC Meter subsystem is capable of measuring PSE voltages and sensing actual load currents. Measurement capabilities include average, maximum peak, minimum peak, and trace capture of either voltage or current. Each of these measurements uses configurable measurement periods from 10 mSecs to 10 seconds. The sampling rates scale with measurement period, and range from 40 μ s to 40 mSecs for 10 mSec and 10 second measurement periods respectively.

All DC Meter measurements can be user initiated, triggered with a designated voltage transition and level, or triggered via an external event (*see Section 2.3.2*). Only one DC measurement can be performed at a time on a each test port. Triggered measurements across multiple test ports may be configured to run simultaneously however using either port-specific waveform triggering or shared external triggering.

2.3.5. AC Meter

The AC Meter is used to measure ripple voltage on the DC signal supplied by the PSE under test. This measurement is always initiated upon receipt of the AC measurement command.

The AC Meter is capable of measuring ripple in either a 16 Hz – 5K Hz band, or in a 5K – 300K Hz band (3dB BW). This measurement is a peak-to-peak voltage measurement, based upon a sample rate of approximately 20K-samples per second. Since this is a peak-to-peak measurement of ripple on a steady state voltage, there are no triggers associated with this measurement. Integration period can be programmed from 10msec to 5 seconds in 1,2,5 scale increments.

2.3.6. Time Interval Meter

The time interval meter measures time duration between a Trigger 1 edge transition or an External Trigger event, and a Trigger 2 edge transition. This measurement is configured either to 1 mSec or 1 μ Sec resolution scale, and can be used for measurements of reaction times, rise times, pulse widths, and other time-critical events.

If the timing measurement exceeds the maximum capacity of the counters, an "overflow" condition will be returned. The maximum measurable time intervals are 52.4 mSecs and 6.7 seconds for the 1 μ Sec and 1 mSec scales respectively. The resolution for the mSec range is 0.1 mSec and the resolution for the μ Sec range is 1 μ Sec. The minimum measurable time interval is 20 μ Sec.

2.3.7. LAN Test "Data OUT" Ports

Each test port provides a passively de-coupled "output" to enable the testing of LAN packet throughput either with or without PoE loads applied. Testing under conditions of PoE load can be used to resolve any significant contribution of PoE voltage and current toward packet transmission impairment. Such testing can be performed using 10BaseT (Ethernet), 100BaseT (Fast Ethernet), and 1000BaseT (Gigabit Ethernet) signals. Packet transmission latency through a PSA Test Port will be negligible owing to the simple passive coupling.

Because the primary purpose of the instrument is to accurately resolve numerous Power-over-Ethernet behaviors, the LAN pass-thru channel is not optimized for LAN transmission per applicable IEEE 802.3 and ANSI/EIA/TIA standards. Users should expect that the PSA test port will add a small degree of impairment, particularly affecting low frequency response of the LAN channel. This impairment *may* lead to very low levels of packet loss depending upon characteristics of connected LAN PHY's. Such characteristics may either worsen or help overcome effects of baseline wander and low frequency response. Sifos does not specify any particular level of performance for the Data OUT port because performance is strongly influenced by physical layer design characteristics of LAN ports (e.g. packet data testers, PSE ports) that are connected to the PSA Test Ports.

Also, because many LAN terminations include various methods of EMI suppression (e.g. “Bob Smith termination”), Sifos recommends that the OUT port **not** be connected to a LAN analyzer or other Ethernet device when running precision PoE signaling measurements including the optional **PSE Conformance Test Suite** available for PSA-1200 platforms since these can devices can present unpredictable AC loads and impairments that will negatively affect those PoE signals.

2.4. System Software Overview

PowerSync Analyzers require externally hosted software in order to operate. PSA software is primarily designed for the Microsoft Windows operating environment. A version is also available for Linux and Unix based hosts. PSA software consists of several distinct subsystems:

PSA Interactive: A graphical user interface designed to promote interactive use of the PSA1200 or PSA-PL instrument.

PowerShell: A scripting and application program development environment for creating and executing automated test sequences. The PowerShell script development environment is built upon the Tcl/Tk scripting language.

PSE Conformance Test Suite: A series of applications developed specifically for conformance testing PSE ports to the 802.3 PoE specification given an PSA-1200 platform.

PSE Multi-Port Test Suite: A series of applications developed specifically for system performance testing PSE power management, capacity, and multi-port decision behaviors.

PoE Service Analyzer: A set of applications and tools for in-depth analysis of PoE Service characteristics at the PD interface available for the PSA-1200 platform.

PowerShell includes a robust set of commands added into Tcl/Tk that create the Application Programming Interface (API) for the PowerSync Analyzer family of instruments. Both **PSA Interactive** and each of the **test suites** fully utilize the PowerShell API to control and monitor the PSA. This assures complete uniformity of behaviors when the instrument is configured from either the PowerShell interface or from PSA Interactive.

2.4.1. PSA Interactive

PSA Interactive is a Tcl/Tk based graphical user interface (GUI) constructed on top of the PowerShell API. It offers robust control of most PowerSync Analyzer functions. It is intended for users who intermittently or regularly use the PowerSync Analyzer for PD emulation and PSE measurements as well as for PSE Conformance (PSA-1200) and PSE Multi-Port (PSA-1200 and PSA-PL) testing.

2.4.2. PowerShell Scripting Environment

PowerShell provides command level access to the PowerSync Analyzer. It consists of the full Tcl/Tk programming shells (Tcl and Wish) combined with numerous extensions specific to the PowerSync Analyzer.

Tcl/Tk offers two shell programs for interactive command / query execution and scripting development. The “classic” Tcl shell is an interpretive development environment for Tcl command and script execution. In Windows, the Tcl shell is typically the Windows command shell with the full range of Tcl libraries (command set) packaged in. Many operating system (e.g. “MS DOS”, Linux “Bash”) commands also execute in this shell.

The Wish shell enables Tk extensions useful for developing graphical user interfaces. As a shell program, Wish is more “Windows-like” in its support of a mouse controlled cursor as well as its cut and paste editing capabilities. It does impose certain limitations in the handling of “standard input” (interactive user prompting) however.

For the most part, PowerShell commands and scripts run equivalently in either the Tcl Shell or the Wish Shell, so users are generally free to use the shell that best suits their needs. When PSA software is installed, certain configuration files will be placed such that opening either the Tcl Shell or the Wish Shell will automatically integrate all of the PowerShell resources.

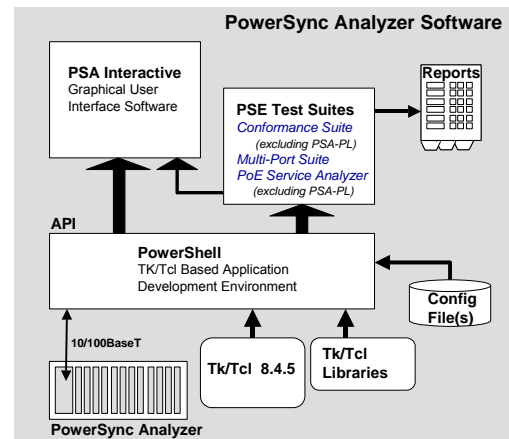


Figure 2.10 PSA Host Software Architecture

Many test engineers will want to integrate PowerShell API into pre-existing script environments to support test automation involving several instruments including DUT control interaction. The final chapter of this manual addresses PowerShell features designed to enable this possibility.

2.4.3. PSE Automated Test Suites

The **PSE Conformance Test Suite** is an optional feature of the PSA-1200 (including PSA-100, PSA-2400) consisting of 23 tests and associated utilities that run in PowerShell and can be accessed and sequenced from either PowerShell or from PSA Interactive. These tests are designed to assess 802.3af and 802.3at compliance of one or more PSE ports. The tests cover detection, classification, power-up, power management, MPS, and power-down behaviors of PSE ports. The tests have been constructed to work as generally as possible given the wide range of signaling and other PSE characteristics described above in Section 2.2. Each test returns one or more specification parameters relating to the 802.3 PoE specification.

The **PSE Multi-Port Test Suite** is an optional feature of the PSA-1200 (including PSA-2400) and PSA-PL consisting of 16 tests that automatically analyze PSE system powering characteristics including bulk power-on, power-down, and overload processing characteristics as well as power management, power capacity, and stress test behaviors. Each test returns a variety of multi-port statistics and offers the capability to generate detailed logs of PSE port interactions and timing behaviors.

The **PoE Service Analyzer** is aimed at qualifying PoE service delivered to a PD at the PD interface point. It evaluates basic service capabilities, many interoperability parameters, and classification or power management behaviors of the PoE service. This feature is available on all PSA-1200, PSA-100, and PSA-2400 platforms.

Each test suite includes a test sequencer and several report generation options including automatic Microsoft Excel spreadsheet that reports test results, test statistics, test limits, and pass/fail results on one or more cycles of testing.

2.4.4. PowerSync Analyzer Configuration Files

PowerSync Analyzer software utilizes two local configuration files that can be adapted for a number of characteristics that are “local” to a user’s setup and testing requirements. These files are located as follows:

Operating System	Config Directory Location
Windows NT – Windows XP	\Program Files\Sifos\PSA1200\Config\
Windows Vista & Windows 7	\Users\Public\Sifos\PSA1200\Config\
Linux & Unix	\$HOME/Sifos/PSA1200/Config/

The **PSA Environment** local configuration file is named **psa_env.txt**. This file is found in the subdirectory **\env** (or **/env/** for Linux) beneath the above mentioned **Config** directory location. Only one instance of this configuration can exist in the host computer. It contains system environment related parameters as described in the following table:

Parameter Type	Parameter Values
Default_PSA_Address:	<current PSA IP address>
PSA_Addresses:	{<Tcl List of known PSA IP addresses>}
Default_Conf_Test_List_AF:	{<Tcl List PSE Conformance Tests>}
Default_Conf_Test_List_AT:	{<Tcl List PSE Conformance Tests>}
Default_Test_Results_Path:	{<Tcl string of default path location for all test result files>}
Excel_Path_Location:	{<Tcl string of path route to MS Excel> “N/A”}
Emulation_Mode:	ON or OFF
I/O_Routing:	psa

Default_PSA_Address: The PSA chassis to initially be controlled by the PowerShell and PSA Interactive when those applications open up. This chassis will be automatically “inventoried” upon application initialization and initial PSA connection. The address will be updated in this file whenever **Select Chassis** is performed via PSA Interactive or when the **psa** command is executed in PowerShell *assuming that the new address is valid and present*.

PSA_Addresses: A (Tcl) list of “known” PSA Chassis addresses on the network. A Tcl list is enclosed in braces and uses spaces to separate different elements (e.g. IP addresses). This list will evolve as new chassis are connected and selected by either PSA Interactive or PowerShell.

Default_Conf_Test_List_AF: A (Tcl) list of available standard tests within the Version 3.4 PSE Conformance Test Suite for 802.3af and pre-802.3at standard high power PSE’s.

Default_Conf_Test_List_AT: A (Tcl) list of available standard tests within the Version 4.0 PSE Conformance Test Suite for 802.3at compliant PSE’s. **Note:** *These tests are only available for the PSA-3000 platform.*

Default_Test_Results_Path: Path to where test results from the sequencer will be stored. This has the default value of “c:/Program Files/Sifos/PSA1200/Results/<chassis IP Address>” when PSA software is initially installed. Note that PSE-specific local configuration files may override this default (see below).

Excel_Path_Location: Path where Microsoft Excel application is stored. This is formed during installation.

Emulation_Mode: A control that allows software operation in the absence of a PowerSync Analyzer instrument. It is also referred to as “Demo Mode”. This control should be normally set to “OFF”.

I/O_Routing: A control that should be normally set to “psa”.

A second type of configuration file is the **Local PSE Configuration File** for specific PSEs. These files generally (though not necessarily) reside in the **Config** directory location described above. They must have **.txt** file extensions. There may be more than one local configuration file, for example there may be one Local PSE Configuration File for each type of PSE that a user plans to test.

The PSE Local Configuration file consists of the following settings:

Parameter Type	Parameter Values	Status
Default_PSE_Class:	EndSpan or MidSpan	Required
Default_PSE_MPS_Type:	AC or DC	Required
Default_ALT_Setting:	A or B	Required
Default_POL_Setting:	MDI or MDI-X	Required
PSE_High_Pwr_Grant:	NONE or PHY or LLDP	
PSE_Test_Results_Path:	{<TCL string of path location for results files>}	Optional
PSE_Conf_Test_Report:	{<Non-standard Conformance Report template file>}	Optional
PSE_MP_Test_Report:	{<Non-standard Multi-Port Report template file>}	Optional

Default_PSE_Class: Specifies whether the PSE is **EndSpan** or **MidSpan** equipment. This setting will be affected by the **PSE Type** declaration in the PSE Conformance Test menus in PSA Interactive software and may also be configured in PowerShell using the **psaPseClass** global variable. The PSE Class or Type is used to limit certain other PSE descriptors (e.g. “LLDP” High Power Grant) and is fed to the PSE Conformance Standard Report for test limit processing.

Default_PSE_MPS_Type: Specifies whether PSE utilizes **AC** or **DC** MPS method to remove power from a PD. This setting will be affected by the “DC MPS” vs “AC MPS” PSE Description controls in the PSA Interactive PSE Conformance Test menus and Multi-Port Test Menus (see Section 3.3).

Default_ALT_Setting: Specifies how to initialize all ports within the PowerSync Programmable Load for ALT pair selection. Initialization is performed ONLY when the local configuration file is loaded via the **[File] [Load]** operation in PSA interactive or via the **psa_pse** (= **psa_getConfig**) command in PowerShell. The **[File] [Save]** operation in PSA Interactive or the **psa_saveConfig** command in PowerShell will store these settings using current PSA port configuration. Initialization will automatically include all PSA chassis’ that make up a PSA-2400 RackPack PSA.

Default_POL_Setting: Specifies how to initialize all ports within the PowerSync Analyzer for PoE polarity (MDI vs MDI-X). Initialization is performed ONLY when the local configuration file is loaded via the **[File] [Load]** operation in PSA interactive or via the **psa_pse** (= **psa_getConfig**) command in PowerShell. The **[File] [Save]** operation in PSA Interactive or the **psa_saveConfig** command in PowerShell will save these settings using current PSA port configuration. Initialization will automatically include all PSA chassis’ that make up a PSA-2400 RackPack PSA.

PSE_High_Pwr_Grant: Specifies the method used by a Type-2 PSE (as defined in IEEE 802.3at) to grant full power to a Type-2 PD. Type-1, or 802.3af generation PSE’s must therefore specify **NONE** for this parameter since they are not capable of delivering 30 Watts of power. Some PSE’s, such as Type-2 MidSpans, will specify **PHY** to indicate that they use 2-event classification in response to a PD Class 4 signature to grant access to full power. Many Type-2 EndSpan PSE’s may use Link Layer Discovery Protocol (LLDP) defined under 802.3at to grant access to full power – those PSE’s will therefore use the **LLDP** setting. This setting is available under the PSE Conformance Test Menus in PSA Interactive and may also be configured in PowerShell using the global **psaPseHpGrant**. As a setting it is used to gate access to high power tests using Type-2 PD emulation, it is used to make decisions inside automated tests, and it is used by the Conformance Test Standard Report in configuring test limits.

PSE_Test_Results_Path: This parameter, if provided, will override the default test reporting path found in the **psa_env.txt** environment file and guide all test results and reports to the specified directory path that can be PSE type or model specific. **NOTE: This setting can only be changed by editing the PSE local configuration file directly – the setting is retained whenever a local configuration file is “loaded”, then “saved” by PSA Interactive or PowerShell.**

PSE_Conf_Test_Report: Specifies a non-standard PSE Conformance Test template (spreadsheet) file for use by the PSE Conformance Test Suite running on a **PSA-1200** (or PSA-100, PSA-2400). An example might be a re-named copy of **psa_report.xls** that has modified test limits for a particular PSE type. **NOTE: This setting can only be changed by editing the configuration file directly – the setting is retained whenever a local configuration file is “saved” by PSA Interactive or PowerShell. See Section 5.10 of the PSA-1200 manual for further information.**

PSE_MP_Test_Report: Specifies a non-standard PSE Multi-Port Test template (spreadsheet) file. An example might be a re-named copy of **mp_report.xls** that has modified test limits for a particular PSE type. **NOTE: This setting can only be changed by editing the configuration file directly – the setting is retained whenever a local configuration file is “saved” by PSA Interactive or PowerShell. See Section 6.11 for further information.**

Note that changes to PSE Local Configuration Files required to make existing files compatible with PSA 3.4 Version software will occur automatically after software is updated and those PSE Local Configuration Files are loaded or saved.

2.4.5. Directory and File Organization – Microsoft Windows

When PowerSync Analyzer software is installed to a Microsoft Windows® PC, files will be populated to particular directories as described in the following table.

Directory Path	Directory	Files
C: \Program Files\Sifos\PSA1200		PowerShell Script Library PowerShell Wish and PowerShell Tcl Executables PSA Initialization Script PowerShell Wish and PowerShell Tcl resource files
	\documentation\	Various PSA reference documents
	\PSA Interactive\	PSA Interactive Script Library and various library sub-directories to support PSA Interactive functions (plotchart, tkprint1.1, tbcload14, etc.). PSA Interactive Executable PSA Interactive resource file
Windows NT – Windows XP C: \Program Files\Sifos\PSA1200 Windows Vista – Windows 7 C:\Users\Public\Sifos\PSA1200	\Config\	PSA (local) Configuration Files including \Config\env environment file sub-directory.
	\Results\	PSA Test Report Files Including psa_report.xls , mp_report.xls , and service_report.xls template report spreadsheets and the psa_trace.xls trace display spreadsheet. Chassis-specific subdirectories under \Results will automatically be created as needed by PowerSync Analyzer software.
	\Emul\	Files only used when PSA software is placed in “Demo Mode” (also called Emulation Mode).
	\Contrib\	Tcl scripts stored in this directory will automatically source into PowerShell. This directory includes various sample scripts at installation.

Version information concerning individual PowerSync Analyzer software libraries is available from PSA Interactive under the [Help] menu as well as from PowerShell using the **psa_version** command.

2.4.6. Directory and File Organization – Linux and Unix

PSA Software installs into Linux and Unix in a manner that separates and organizes files into 3 categories:

Category	File Locations
Compiled Software and Libraries	/usr/local/Sifos/PSA1200
Configuration and User Data	<User’s Home Directory>/ Sifos/PSA1200
Shell Scripts (Program Launchers)	<User’s Home Directory>/bin

This organization allows various users in a shared computing or NFS type of environment to maintain local user information independent from other users and independent of the actual shared software modules and libraries.

Installation of PSA Software requires that the user have full permissions to add the application into the **/usr/local/** directory path while the installation takes place. After installation, those permissions may be removed.

The following table provides greater detail regarding files and file locations after PSA software installation is completed.

Directory Path	Directory	Files
/usr/local/Sifos/PSA1200		PowerShell Application Programs & Script Libraries PowerShell Wish and PowerShell Tcl resource files (<i>unused copies</i>)
	/PSA Interactive/	PSA Interactive Application Programs & Script Libraries Shared Library Directories with binaries and scripts used by PowerShell and PSA Interactive Copy of PSA Interactive initialization resource file
<User Home Path>/Sifos/PSA1200		PowerShell Wish and PowerShell Tcl resource files (<i>used by shell scripts to initialize PSA software</i>)
	/Config/	PSE (local) Configuration Files including /Config/env environment file sub-directory.
	/Results/	PSA Test Report Files Including psa_report.xls , mp_report.xls , and service_report.xls template report spreadsheets and the psa_trace.xls trace display spreadsheet. Chassis-specific subdirectories under \Results will automatically be created as needed by PowerSync Analyzer software.
	/documentation/	Various PSA reference documents
	/Emul/	Files only used when PSA software is placed in “Demo Mode” (also called Emulation Mode).
	/Contrib/	Tcl scripts stored in this directory will automatically source into PowerShell. This directory includes various sample scripts at installation.
<User Home Path>/bin		Shell scripts to launch: PowerShell TCL (PowerShell_TCL.sh), PowerShell Wish (PowerShell_Wish.sh) PSA Interactive PL (PSA_Interactive.sh). PSA Software Installer and Removal Scripts.

Version information concerning individual PowerSync Analyzer software libraries is available from PSA Interactive PL under the **Help** menu as well as from PowerShell using the **psa_version** command.

2.4.7. TK/TCL Requirements & Resources

PowerSync Analyzer software was developed utilizing Tcl/Tk version 8.4.5. Generally, there should not be a problem with using newer versions of Tcl/Tk. PSA software is distributed with an installer for Tcl/Tk 8.4.5 on Microsoft Windows platforms. If Tcl/Tk is not present on the host PC system or if a version older than 8.4.5 is found, PSA installation software will install version 8.4.5 Tcl. If a newer version (e.g. ActiveState Tcl 8.4.9) is already on the host system, PSA software will utilize that version. (**Note:** This does not apply to Linux systems where the user is responsible for pre-installing a satisfactory version of Tcl/Tk.)

While there are no requirements as to where the user installs Tcl/Tk, it is recommended that the install be done in the **c:\Program Files\tcl** directory on Microsoft Windows systems and in **/usr/local/** on Linux systems. Users should beware that older or specially modified versions of Tcl present from installations of various LAN analyzer software tools and applications could interfere with PSA software behavior.

PowerShell software includes four “resource” files: **tclshrc.tcl**, **tclshrc_psapi.tcl**, **wishrc.tcl** and **wishrc_psapi.tcl**. These files are utilized by PowerShell during initialization and should remain in the directories where they are initially installed. Sections 8.3 and 8.4 of this manual provide further information regarding PowerShell API integration into native TCL shells as well as the use of these files to enable remote access to PowerShell.

There are a number of valuable resources to help programmers and test engineers get acquainted with Tcl. First, the **help software** that comes with Tcl/Tk is very robust and easy to work with. Also, there are several books available including “Practical Programming in Tcl and Tk” by Brent B. Welch. On the Web, there are numerous “notes” sites with correspondence on Tcl and Tk programming owing to Tcl’s popularity in academic and commercial enterprises.

2.5. (Section Omitted)

2.6. (Section Omitted)

2.7. Technical Specifications

2.7.1. Port Configuration

Input/Output	Ports 1 & 2	RJ45, 10/100/1000BaseT	100Ω Balanced
Pair Connectivity	Ports 1 & 2	Alt. A or Alt. B	
Polarity	Ports 1 & 2	MDI or MDI-X	
Detection Resistance	Ports 1 & 2	Range Resolution Accuracy	8 to 39 KΩ 1 KΩ 1%
Detection Capacitance	Ports 1 & 2	Range Accuracy	0.14, 5.14, 7.14, 11.14, 47, 52, 54, and 58 μF 5%
Load Current	Ports 1 & 2	Range Resolution Error Activation Voltage	0 to 511 mA 0.5 mA ±1.8% ±1.1 mA 15.5V
Configurable Load Transient	Ports 1 & 2	Load Steps Range Resolution	2 200μs to 1sec 100μs

2.7.2. Measurements

DC Voltage	Pair-to-Pair	Type Range Resolution Error Peak Types Trace Length Triggers	Peak, Average, or Trace 0 to 60V 64 mV ±1.2% ±13 mV Max or Min 256 Samples Immediate, Internal, External
DC Current	Powered Pair	Type Range Resolution Error Peak Types Trace Length Triggers	Peak, Average, or Trace 0 to 511 mA 0.5 mA ± 1.2% ± .25mA Max or Min 256 Samples Immediate, Internal, External
Voltage Ripple 16Hz - 5kHz	Pair-to-Pair	Range Resolution Error	0 to 2Vpp 4mV TBD%

Voltage Ripple 5kHz - 300kHz	Pair-to-Pair	Range Resolution Error	0 to 0.5Vpp 1mV <u>TBD%</u>
Time Interval	Pair-to-Pair	Start Trigger Edge Start Trigger Range Stop Trigger Edge Stop Trigger Range Time Range Time Resolution	Rising or Falling 0 to 60V Rising or Falling 0 to 60V 20–52400 μ s or 0-6700 ms 1 usec or 1 msec

2.7.3. Triggering

Internal (Trigger 1)	Ports 1 & 2	Range Resolution Error Routing	0 to 60V 250 mV \pm 250mV DCV and DCI Measurements, External Trigger Bus
Optional Trigger Events	Ports 1 & 2	Port Connection Current Load Software Routing	Connect, Disconnect Change Current Load or Start Current Transient Trigout Command DCV and DCI Measurements, External Trigger Bus

2.7.4. Programming and Control

Interface:	Ethernet 10/100BaseT
Host Requirements:	PC or Lap-Top, Windows NT, 98, 2000, or XP
Control Environment:	Sifos PowerShell or PSA-Interactive
Network Latency:	< 5 msec

2.7.5. Physical and Environmental

Width:	19 "
Height:	5.25" (3 Rack Unit)
Depth:	12"
Weight:	17.25 lbs. (Fully Populated)
Power:	100VAC – 240VAC, 50-60Hz, 600 mA Max.
Operating Temperature:	50°C at 20W Max per Port, linearly de-rated from 30°C at 30W per port (Figure 2.11) Note: 30W is the heat dissipation rating, not the power loading capability of each PSA Test Port.

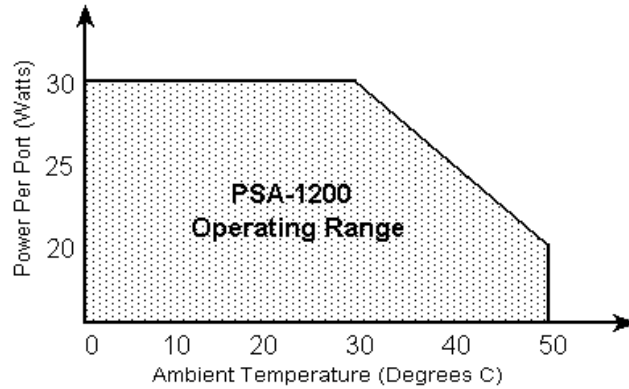


Figure 2.11: Heat Dissipation Capability of Each PSA Test Port

Storage Temperature: -20°C to 85°C
 Operating Humidity: 5% to 95% RH, Non-Condensing.

2.7.6. Certifications

Emissions: FCC Part 15, Class A
 Meets EN55022, VCCI, AS/NZS 3548

Safety: CSA Listed (CSA22.2 No. 61010)
 Meets EN61010-1

European Commission: Low Voltage Directive (73/23/EEC)
 Electromagnetic Compatibility Directive (89/336/EEC)
 CE Marking Directive (93/68/EEC)

FCC Statement:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.

3. PoE Service Analyzer Tests

The **PoE Service Analyzer** combines Sifos PowerSync™ Analyzer test ports with specialized application software to enable the most comprehensive and fully automated testing available for PoE analysis and qualification at a Powered Device service access point. The tests available go well beyond standard power-up and line voltage measurements found in low cost, hand-held analyzers. The PoE Service Analyzer will fully assess **interoperability risks, safety hazards,** and **PoE performance limitations** at the connection to any Powered Device.

The Sifos PoE Service Analyzer offers three categories of PoE Service Testing at the Powered Device connection:

1. **PoE Service Test Suite:** A fully automated suite of standardized tests for **PoE Service Qualification** including proof of interoperability.
2. **PoE Monitor:** A **PoE Monitoring Test** to assess or characterize intermittent PoE Service problems.
3. **PoE Scope Trace:** A visual measurement of critical PoE signals at any live PoE service connection.

3.1. PoE Service Test Suite

The **PoE Service Test Suite** provides fully automated testing in 3 categories:

3.1.1. Basic Service Tests

Basic Service Tests evaluate the basic Power-over-Ethernet connection, reporting connection information such as powered pairs (including multiple PoE sources), power polarity, and the ability of the PoE service to power up typical (and nominal) Class 0, Class 1, Class 2, and Class 3 Powered Devices*.

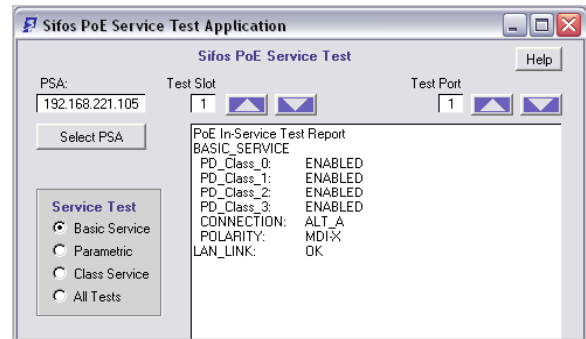


Figure 3.1: Basic Service Tests

Parameter	Description	Range of Outcomes
PD_Class_0:	Ability of service to power typical Class 0 PD	ENABLED / DISABLED
PD_Class_1:	Ability of service to power typical Class 1 PD	ENABLED / DISABLED
PD_Class_2:	Ability of service to power typical Class 2 PD	ENABLED / DISABLED
PD_Class_3:	Ability of service to power typical Class 3 PD	ENABLED / DISABLED
CONNECTION:	Powered Cable Pairs (number of services)	ALT A, ALT B, ALT A+B (redundant)
POLARITY:	Power Polarity (per Powered Pair)	MDI(positive) / MDI-X(negative)

* Note: By the IEEE 802.3af standard, PD’s are classified by power utilization according to the table below. PD’s are responsible for “signaling” this classification prior to receiving power from the PoE enabled network connection.

Classification	PD Maximum Power Requirement
0	0.44 to 12.95 Watts
1	0.44 to 3.84 Watts
2	0.44 to 6.49 Watts
3	6.49 to 12.95 Watts

3.1.2. Parametric (Interoperability) Tests

Parametric Tests report a number of parameters of the PoE service that are relevant to interoperability of all PD's at the PoE service outlet. Additionally, certain safety related behaviors of the PoE service are analyzed. Information collected includes line voltages (DC and AC) at power extremes, detection signature range verification, rejection signature range verification, inrush and overload tolerance of the PoE connection, disconnect timing, and overload timing response of the PoE connection. In performing these tests, the PowerSync® Analyzer is utilized to emulate a wide range of IEEE 802.3af compliant steady state and transient Powered Device behaviors.

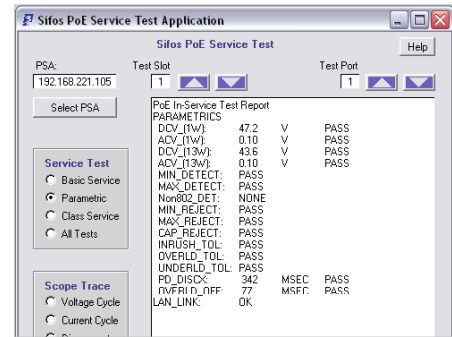


Figure 3.2: Parametric Tests

Parameter	Description	Range of Outcomes
DCV_(1W) :	PoE Line Voltage to Low Power PD <i>to assure valid line voltage to low power PD (36 to 57 VDC)</i>	0 – 60 VDC PASS / FAIL
ACV_(1W) :	PoE Line Noise to Low Power PD <i>to assure “clean” DC line voltage to low power PD (< 0.5 Vpp)</i>	0 – 5 VAC PASS / FAIL
DCV_(13W) :	PoE Line Voltage to High Power PD <i>to assure valid line voltage to high power PD (36 to 57 VDC)</i>	0 – 60 VDC PASS / FAIL
ACV_(13W) :	PoE Line Noise to High Power PD <i>to assure “clean” DC line voltage to high power PD (< 0.5 Vpp)</i>	0 – 5 VAC PASS / FAIL
MIN_DETECT :	Power Applied to Valid Low-End PD Signature <i>to assure all Valid PD’s are detected properly (24 Kohm)</i>	PASS / FAIL
MAX_DETECT :	Power Applied to Valid High-End PD Signature <i>to assure all Valid PD’s are detected properly (26 Kohm)</i>	PASS / FAIL
Non802_DET :	Power Applied to Capacitive Load, Invalid 802.3af PD <i>to note capability of PSE to power many “legacy” PD’s</i>	NONE / Non802-Detect
MIN_REJECT :	Rejection of Invalid Low-End PD Signature <i>to assure that non-PoE devices do not get powered (15 Kohm)</i>	PASS / FAIL
MAX_REJECT :	Rejection of Invalid High-End PD Signature <i>to assure that non-PoE devices do not get powered (33 Kohm)</i>	PASS / FAIL
CAP_REJECT :	Rejection of Highly Capacitive PD Signature <i>to assure that non-PoE devices do not get powered</i>	PASS / FAIL
INRUSH_TOL :	Tolerance of Service to Worst Case Allowable Startup Load <i>to assure proper startup of all compliant PD’s (400 mA, 45 msec)</i>	PASS / FAIL
OVERLD_TOL :	Tolerance of Service to Maximum Transient Overload <i>to assure power maintained to compliant PD’s (400 mA, 45 msec)</i>	PASS / FAIL
PD_DISCX :	Power Removal Timing on PD Disconnect <i>to assure PoE service will not damage non-PD’s (300 – 400 msec)</i>	0 to 1500 msec PASS / FAIL
OVERLD_OFF :	Power Removal Timing on PD Overload Shutdown <i>to assure PoE Service will not damage cables and connections (50 – 75 msec)</i>	0 to 1500 msec PASS / FAIL

3.1.3. Classification Service and Interoperability Tests

Classification Service Tests report the behavior of the PoE service connection to each PD classification (0, 1, 2, or 3). Information reported includes maximum power capacity available by PD classification as well as the ability of the PoE connection to deliver the appropriate power capacity to PD classification signatures that are borderline for each PD classification.

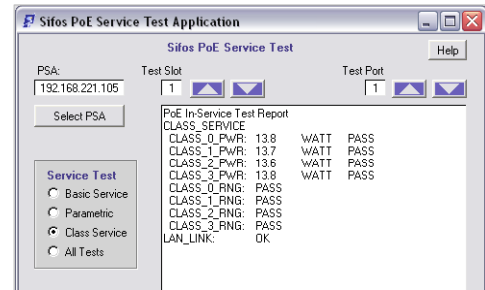


Figure 3.3: Classification Service Tests

Parameter	Description	Range of Outcomes
CLASS_0_PWR:	Power Available to a nominal PD Classifying as Class 0 <i>to assure a minimum of 12.95 watts is available to PD</i>	0 to 20 Watts PASS / FAIL
CLASS_1_PWR:	Power Available to a nominal PD Classifying as Class 0 <i>to assure a minimum of 3.84 watts is available to PD</i>	0 to 20 Watts PASS / FAIL
CLASS_2_PWR:	Power Available to a nominal PD Classifying as Class 0 <i>to assure a minimum of 6.49 watts is available to PD</i>	0 to 20 Watts PASS / FAIL
CLASS_3_PWR:	Power Available to a nominal PD Classifying as Class 0 <i>to assure a minimum of 12.95 watts is available to PD</i>	0 to 20 Watts PASS / FAIL
CLASS_0_RNG:	Power Available to PD with Borderline Class 0 Signatures <i>to assure all Class 0 PD's receive the same power allocation</i>	PASS / FAIL
CLASS_1_RNG:	Power Available to PD with Borderline Class 1 Signatures <i>to assure all Class 0 PD's receive the same power allocation</i>	PASS / FAIL
CLASS_2_RNG:	Power Available to PD with Borderline Class 2 Signatures <i>to assure all Class 0 PD's receive the same power allocation</i>	PASS / FAIL
CLASS_3_RNG:	Power Available to PD with Borderline Class 3 Signatures <i>to assure all Class 0 PD's receive the same power allocation</i>	PASS / FAIL

3.1.4. PoE Service Test Suite Reporting

The Sifos **PoE Service Analyzer** includes a colorful **Microsoft Excel** Test Report (see Figures 3.4, 3.6) that can be automatically produced upon completion of the full set of PoE Service Access Tests. The report performs **limit checking** and **color formatting** of each test outcome. It also presents a graphical depiction both required and available power to each PD Class, PoE line voltage and line noise across PD power levels, and transient (burst) power performance of the PoE service.



Figure 3.4 PoE Service Spreadsheet Report Showing Fully Compliant Service

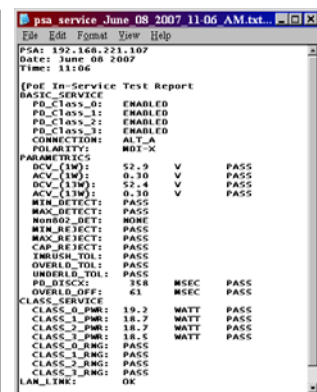


Figure 3.5 PoE Service Text File Report

The Microsoft Excel spreadsheet report includes time and date of testing, as well as notation of the test instrument (IP Address and Test Port) utilized. Users may enter test site or outlet information into the report header.

Additionally, if an **In-Band** test configuration is utilized (see Section 4) and the Ethernet LAN link is found to drop and return as PoE power is applied or removed, a link delay parameter will be provided to note the time delay that might occur between a PD power-up and actual link communications.

Text reports (see Figure 3.5) may also be produced when running all or a subset of the PoE Service Access Tests. These reports are also time-date stamped and carry much of the same information included in the spreadsheet report.

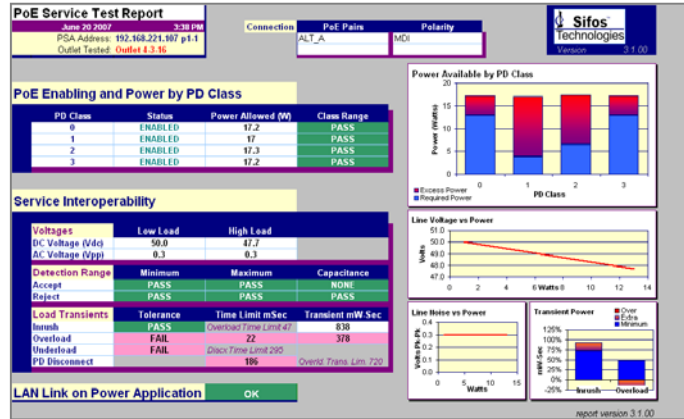


Figure 3.6 PoE Service Spreadsheet Report, Non-Compliant Service

3.2. PoE Monitoring Test

The **PoE Service Analyzer** also includes an automated **Line Monitor** designed to capture intermittent service drop-outs. This test may be configured to run with PD Class 1, Class 2, or Class 3 emulation where Class 3 would be the most strenuous in terms of power consumption. Users select between a **30 minute** test and a **12 hour** test, though in either case, user's have the option to terminate monitoring at any time and recover results.

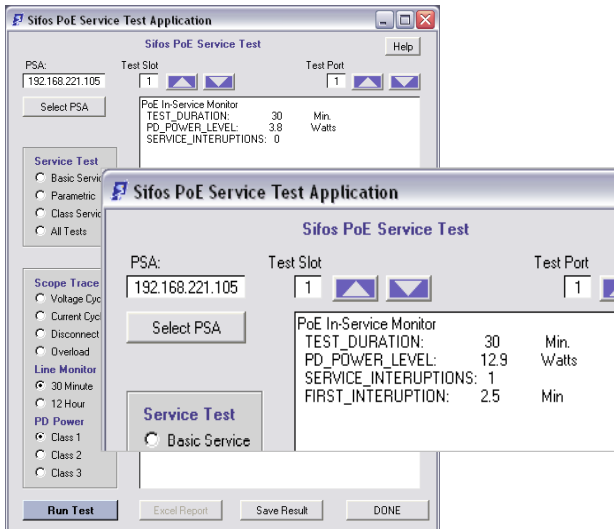


Figure 3.7: PoE Monitor Test

Intermittent Service Detection is sensitive to power drops that are either instantaneous or of longer durations. The test will report a count of observed drops as well as the elapsed time until the first observed service drop-out.

Testing for intermittent PoE service at any test site or outlet may can be beneficial both for assessing intermittent connections and for capturing PSE behaviors at a particular outlet when power demands or other intermittent transitions are exceeding total output power capacity across a range of PoE served devices. Line Monitor Test Reports can be saved to a time-date stamped text file (see Figure 3.8) upon test completion.

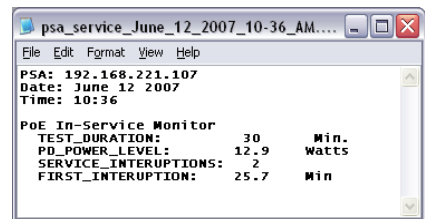


Figure 3.8 PoE Line Monitor Report

3.3. PoE Scope Trace

Another unique feature of the Sifos **PoE Service Analyzer** is the ability to produce **graphical waveforms** of controlled PoE events. These waveforms can be useful for observing problem behaviors.

Two **Power-Cycle** waveforms are included to observe the full cycle of an ordinary PoE power-up and PD disconnect power-down captured over a 5 second time interval. One waveform looks at line voltage (see *Figure 3.9*) while the other records electrical current flow (see *Figure 3.10*). Both can be configured to run with **PD Class 1, Class 2, or Class 3** emulation. Users with very moderate understanding of PoE technology can observe and analyze **detection signaling, classification signaling, the powered line state, and PSE response to a PD disconnect**.

Two additional waveforms available are **Disconnect Shutdown** (see *Figure 3.11*) and **Overload Shutdown** (see *Figure 3.12*). These waveforms may utilized to visualize the PD service outlet response to either a PD disconnect or a PD transient overload condition. Both conditions should result in power removal in order to prevent damage to network devices when plugged into the service outlet. The disconnect shutdown should occur in approximately a half second while the overload shutdown should occur in less than one tenth of a second, regardless of PD Classification selected.



Figure 3.9: Power Up/Down Voltage Cycle



Figure 3.10: Power Up/Down Current Cycle

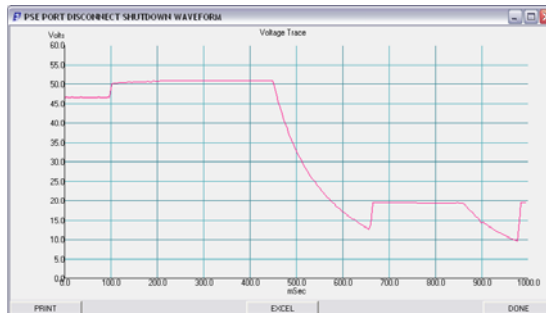


Figure 3.11: Overload Shutdown Voltage



Figure 3.12: Disconnect Shutdown Voltage

Following waveform capture, waveforms may be printed or imported to Microsoft Excel for further analysis as shown in *Figure 3.13*.

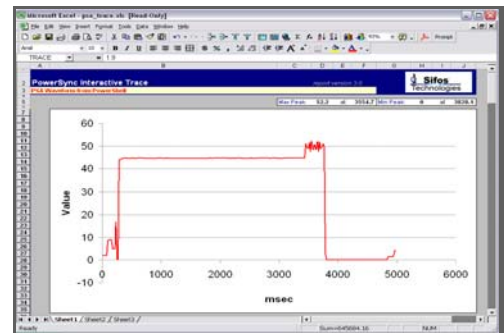


Figure 3.13 Voltage Cycle Waveform - Excel

4. PoE Service Test Configurations

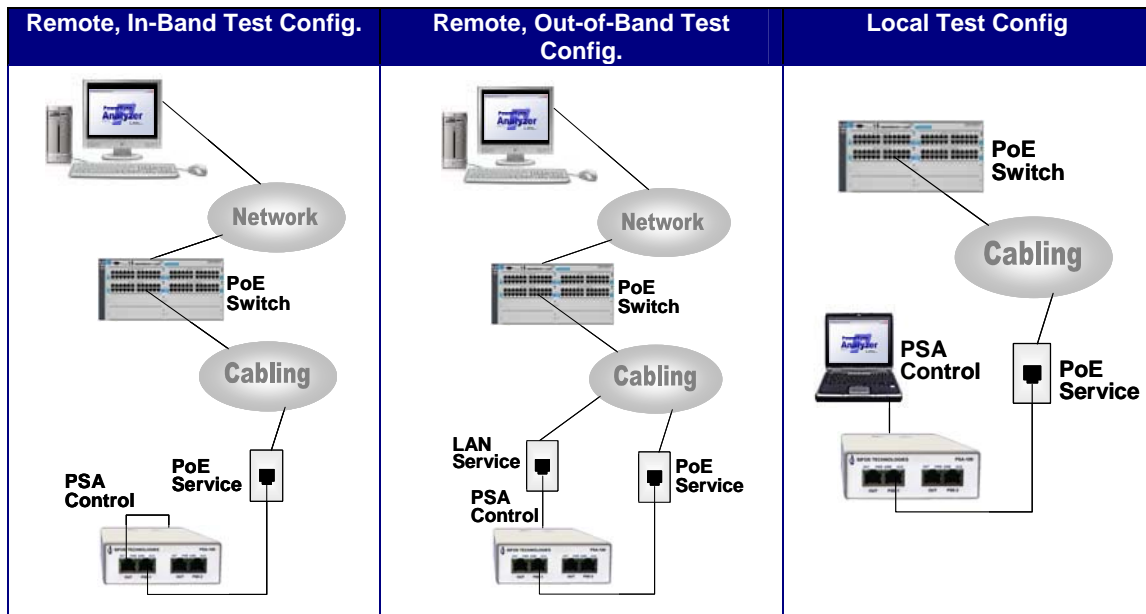


Figure 4.1 PoE Service Analyzer Test Configurations

The **PoE Service Analyzer** can be configured in any of several ways to enable testing of PoE Service. In common to all configurations, the PSA test port is connected wherever the PD is to be connected.

Remote In-Band Configuration: In this configuration, the PowerSync Analyzer is controlled over the network using the same connection that carries the PoE service to be tested. PoE Service Test software is designed to tolerate temporary LAN communications drop-outs that may occur as the power service is initiated or removed over the course of PoE Service testing. The software host may be a Microsoft Windows PC or Linux Workstation collocated on the same network. The network must be configured to allow Telnet protocols.

Note! When testing PoE Service with the In-Band configuration and where the PSE inhibits packet transmission following power application and removal, the time to complete a full PoE Service Compliance Test will be lengthened significantly. The test will report the maximum LAN inhibition durations.

Remote Out-of-Band Configuration: In this configuration, the PowerSync Analyzer is controlled over the network using a different connection from that carrying the PoE Service to be tested. This configuration will overcome any time delays or other uncertainties that might develop with PoE LAN service as it is subjected to various test conditions. Some PoE enabled switches, for example, will suspend LAN communications for 30 seconds or more with each application and removal of PoE power.

Local Test Configuration: In this configuration, the PowerSync Analyzer is controlled directly from a laptop or PC in the same locality as the PoE service being tested. This configuration is convenient for moving the instrument around and testing a number of remote service points in succession.

5. PSA Interactive for the PoE Service Analyzer

PSA Interactive will open the PoE Service Analyzer to a PSA Selection Dialog (see Figure 5.1). This dialog may be used to select from one of several known analyzers, to add or delete known analyzers to/from the list of known analyzer addresses, and then to make connection to an available Service Analyzer.

Once connected, the PoE Service Test menu (see Figure 5.2) presents controls to select and connect to another PowerSync Analyzer (**Select PSA**), and to further select the Test Slot and Test Port. **Select PSA** will open the PSA Selection Dialog box (Figure 5.1) described above. The **Test Slot** will always be “1” for the PSA-100-SA (PSA Compact). The **Test Port** may be selected as “1” or “2” since there are 2 identical and independent test ports available on each PSA-100-SA instrument.

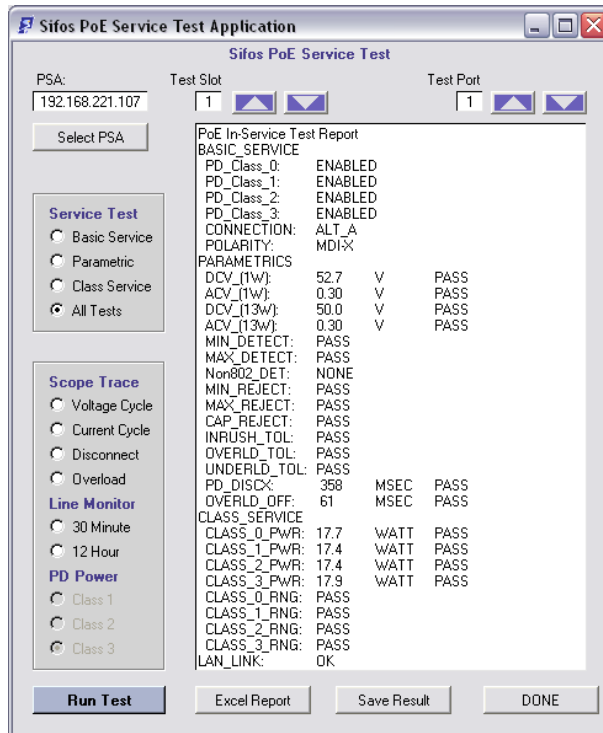


Figure 5.2 Sifos PoE Service Analyzer Menu, Results

the event **Stop Test** is pressed, the accumulated results captured will be presented in the results window.

The **Excel Report** button is only available upon completion of *All Service Tests*. This button will open the PoE Service Spreadsheet Report described earlier.

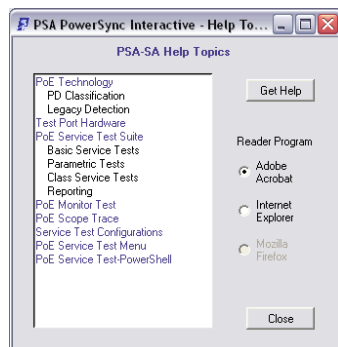


Figure 5.4 Help Menu

Test results may be optionally saved to a textual report file by selecting the **Save Results** button. This will open a brief dialog to state the time-date stamped name and location of the saved report file.

The **Help** button opens a new dialog (see Figure 5.4) to bring up selected topics from this reference manual to an Adobe Acrobat reader. This function requires installation of Adobe Acrobat Reader version 6.0 or later.

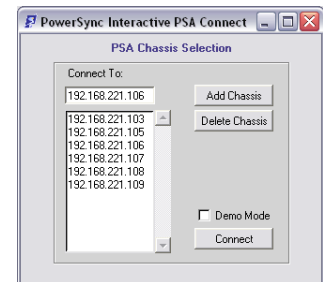


Figure 5.1 PSA Selection Dialog

Simple radio button controls allow the selection of a specific test group or the optional selection of **All Tests**. Each of the test groups are described in Section 3 previously.

Visual waveforms are selected using one of the **Scope Trace** radio buttons. Each of the four traces was described in Section 3.

The **Line Monitor** offers **30 Minute** and a **12 Hour** intermittency testing options. **Scope Traces** and **Line Monitor** measurements require the selection of a **PD Power**, or load, to emulate as these measurements are run. A **Class 1** PD represents a 3.8 Watt device, a **Class 2** PD represents a 6.5 Watt device, and a **Class 3** PD emulates a 13 Watt device. Note that the PD classification selections are disabled for the **PoE Service Tests** since those tests cycle through all PD classes during the course of testing.

Run Test initiates the **PoE Service Test**, **Scope Trace**, or **Line Monitor** selected. As the test runs, test status information will be presented (see Figure 5.3). PoE Service Tests and the Line Monitor may be terminated mid-test by the **Done** button which becomes the **Stop Test** button as those tests and measurements execute. In



Figure 5.3 Service Test Status

6. Accessing the PoE Service Analyzer from PowerShell

The automated tests for PoE Service and Service Monitoring may also be accessed using commands from PowerShell TCL or PowerShell Wish. These tests do not require any kind of pre-configuration of the PSA test port to the type of PSE servicing the PoE interface. The tests will automatically scan for powered pairs and power polarity.

Utilizing PowerShell can be a significant automation advantage when the PoE Service or Service Monitoring tests are to be automatically run in succession across one or more service outlets without user intervention.

Command	Command Parameters
psa_poe_service	<p><i><slot,port> <basic parm class all <-s>> <-f> <-v></i></p> <p><i>Executes the PoE Service Test application according to user configuration. This test will automatically deliver a spreadsheet report if “all” tests are specified along with the appropriate reporting option.</i></p> <p><i><slot,port></i> Specifies the PSA test port. Default is current slot and port.</p> <p>basic Run only the Basic PoE Service Tests described in Section 9.1 above.</p> <p>parm Run only the Parametric PoE Service Tests described in Section 9.1 above.</p> <p>class Run only the Classification Integrity PoE Service Tests described in Section 9.1.</p> <p>all Run all (basic, parametric, and classification integrity) Tests described in Section 9.1. This is the default mode and must be utilized to generate the spreadsheet report described in Section 9.2 above.</p> <p>-s Control to produce spreadsheet report shown in Section 9.2.</p> <p>-f Control to produce a time-date named text file test report. This can be specified whether running all Service Tests or only a subset of Service Tests.</p> <p>-v Control to run the PoE Service Test in a “verbose” diagnostic mode.</p>
psa_poe_monitor	<p><i><slot,port> <1 2 3> <short long> <-f></i></p> <p><i>Executes the PoE Service Monitor to capture and report on intermittent PoE Service drops.</i></p> <p><i><slot,port></i> Specifies the PSA test port. Default is current slot and port.</p> <p>1 Runs the Service Monitor using a Class 1 PD and associated power load.</p> <p>2 Runs the Service Monitor using a Class 2 PD and associated power load.</p> <p>3 Runs the Service Monitor using a Class 3 PD and associated power load.</p> <p>short Specifies to run the Service Monitor over a 30 minute period. This is the default.</p> <p>long Specifies to run the Service Monitor over a 12 hour period.</p> <p>-f Control to request a time-date named text file report be generated upon completion of the testing.</p>