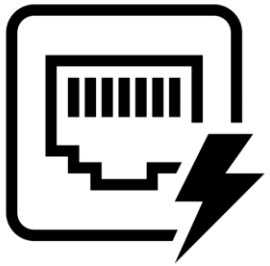
Waarborgen van PoE interoperability

Gerard Fianen - INDES IDS BV



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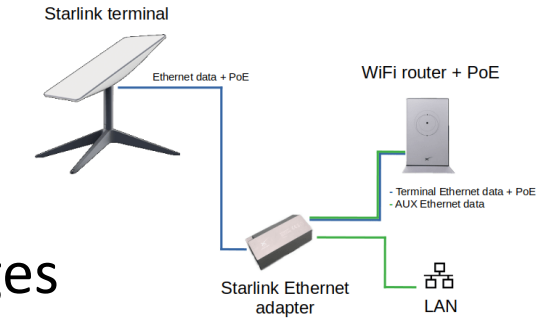
PoE is everywhere !

connected lighting

- VoIP phones
- Security camera’s
- WAN / Wifi Access points

- Office lighting & Wifi / Smart building
- Hospitality & Healthcare
- Audio, Video, Lighting networking for stages



- Settop boxes
- TV’s
- Active Phased Array antennas for Satellite internet

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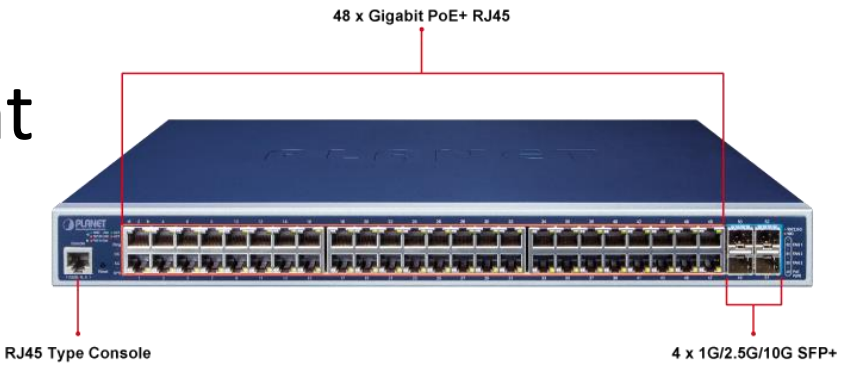
PoE Systems and the IEEE PoE standard

PSE = Power Sourcing Equipment

- Router / Switch
- Injector
- Security camera recorder

PD = Powered Device



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Propriety PoE and Passive PoE

Polycom, 3Com, Lucent, Nortel : Power-over-LAN
Cisco : PoE with Cisco Discovery Protocol (CDP) and later UPOE
Lineair Technology : LTPOE++

Passive PoE

- Propriety, not standardized.
- Polarity and voltages differ (9V to 48V)
- DC is ‘always-on’ !!
- No signaling or Power negotiation
- Confusing. Offered as PoE by brands like TP-link, MikroTik and Ubiquity

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PoE - the IEEE Standard

- 802.3af PoE Sourcing to 15 Watt (2 wire-pairs)
- 802.3at PoE+ Sourcing to 30 Watt (2 wire-pairs)
- 802.3bt PoE++ Sourcing to 100 Watt (4 wire-pairs)
- Signaling & negotiation
- Backward compatible

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PoE - the IEEE Standard

	PoE	PoE+	PoE++	PoE++
IEEE Standard	IEEE 802.3af	IEEE 802.3at	IEEE 802.3bt	IEEE 802.3bt
PoE Type Designation	Type 1	Type 2	Type 3	Type 4
Switch Port Power				
Max Port Power	15.4W	30W	60W	100W
Port Voltage Range	44–57V	50–57V	50–57V	52–57V
Cables				
Supported cables	Cat3/ Cat5 (or better)	Cat5 (or better)	Cat5 (or better)	Cat5 (or better)
Twisted Pairs Used	2-pair	2-pair	2-pair or 4-pair	4-pair
Powered Device Power				
Max Power to Device	12.95W	25.5W	51W	71W
Voltage Range to Device	37–57V	42.5–57V	42.5–57V	41.1–57V
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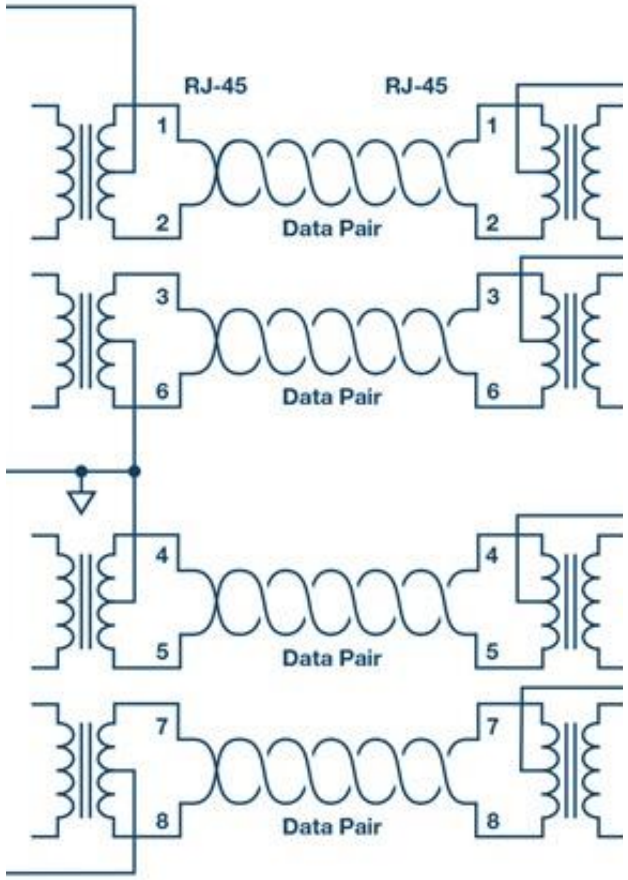
Ethernet interface & cable



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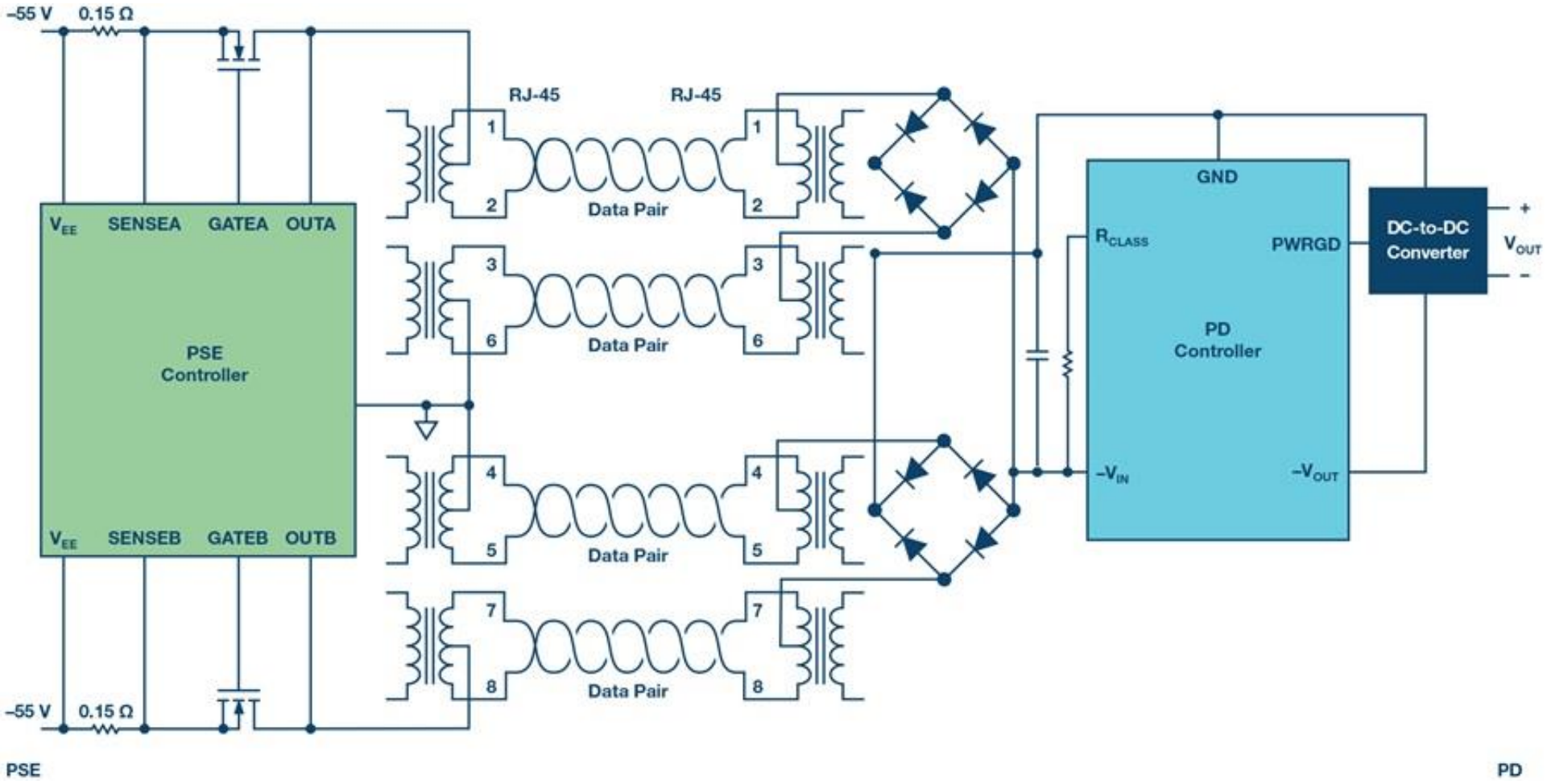
2 wire and 4 wire PoE



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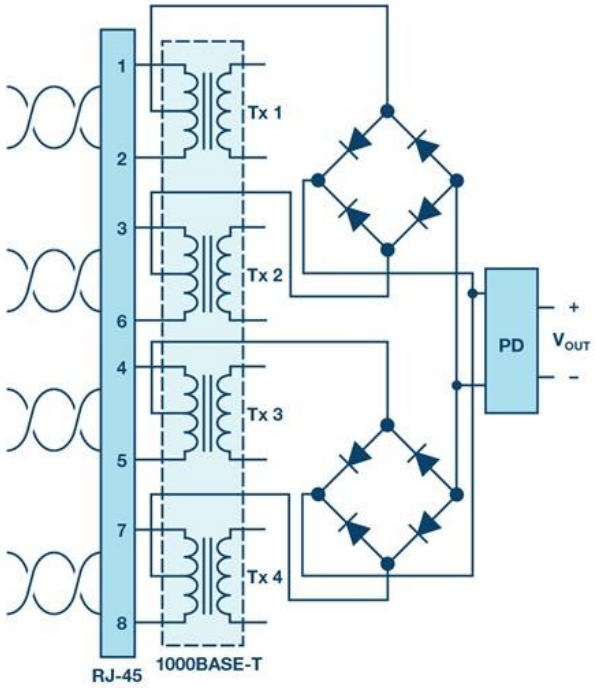
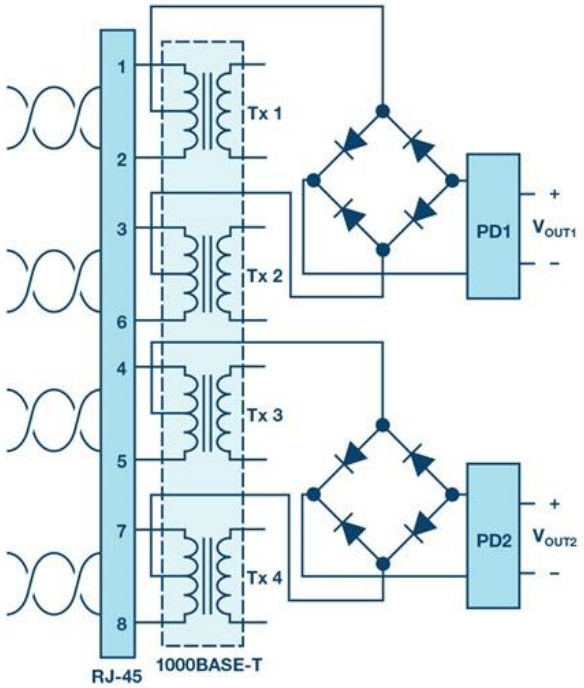
PoE - Single signature vs Dual signature





Single-Signature PDs		Dual-Signature PDs	
Class	PD Power Available (W)	Class	Pairset PD Power Available (W)
0	13		
1	3.84	1	3.84
2	6.49	2	6.49
3	13	3	13
4	25.5	4	25.5
5	40	5	40
6	51		
7	62		
8	71		

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PoE - more than just ‘put DC on ethernet wires’

- No DC sourcing until after a verification
- Signaling / Power budget allocation by classification

Just imagine 24 port switches. (24 x 100W = 2.400W!!)

PD Classification :

- Pulses
- LLDP (Layer 2 Link Layer Discovery Protocol

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Power is entirely managed by PSE's :

- Discriminating Powered Devices from other devices that might be damaged if PoE voltages were applied
- Assessing the basic power requirements of a newly connected PD
- Supporting surge (or inrush) power required to start up a PD
- Conducting PoE link-layer (LLDP) mutual discovery and power negotiation
- Supporting spurious peak power demands from a PD
- Reacting to PD's that are drawing more power than they should
- Supporting surge power demands from a PD when PSE power sources are replaced by back-up power sources
- Supporting unbalanced load currents between pairsets when powering 4-pair to single signature PD's
- Limiting maximum possible current in the event of short circuit in order to protect the PSE power supply and to limit cable heating or sparking
- Reacting to PD's that have been disconnected by removing power before another device can be plugged into the PSE port.

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PSE - Detection, classification and management

Detection there is a PD on the other side :

802.3at and 802.3bt specify that compliant PDs will present a load resistance between 23.7K and 26.3K (measured at PSE between 19 K and 26.5 K).

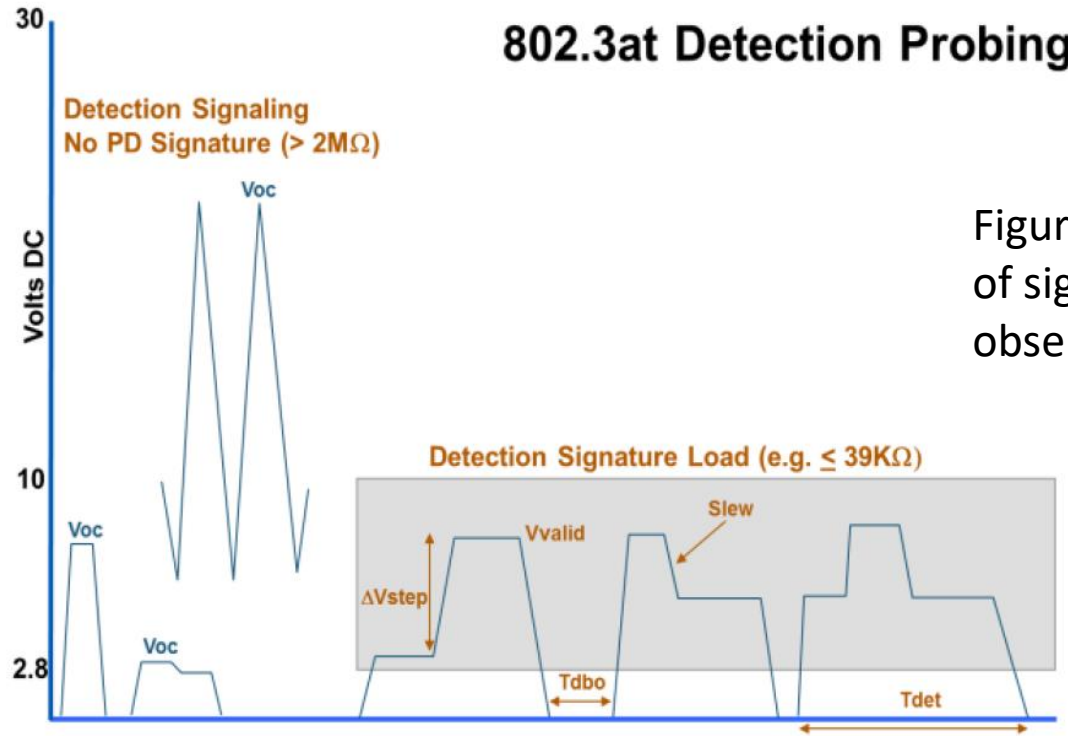

Figure 2.4 802.3 PoE Detection

Figure 2.4 demonstrates some of the range of signaling characteristics that might be observed from 802.3at and 802.3bt PSE's.

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PSE - Detection, classification and management

Type 1 classification:

Type-1 (class 0-3) and Type-2 (class-4) classes :

PSE Type	Classification	Guaranteed Power at PSE Output	Minimum Power at PSE Output	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	~ 15.4	

Note:
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 and allocate 15W to it.

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	PD Type
0	5	mA	Class 0	Type-1
8	13	mA	Class 1	Type-1
16	21	mA	Class 2	Type-1
25	31	mA	Class 3	Type-1
35	45	mA	Class 4	Type-2

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Type 2 classification

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 may return to zero or may hold its value (or anything in between) following completion of classification.
The “2-event” classification involves 2 successive classification current measurements separated by a “mark” region.

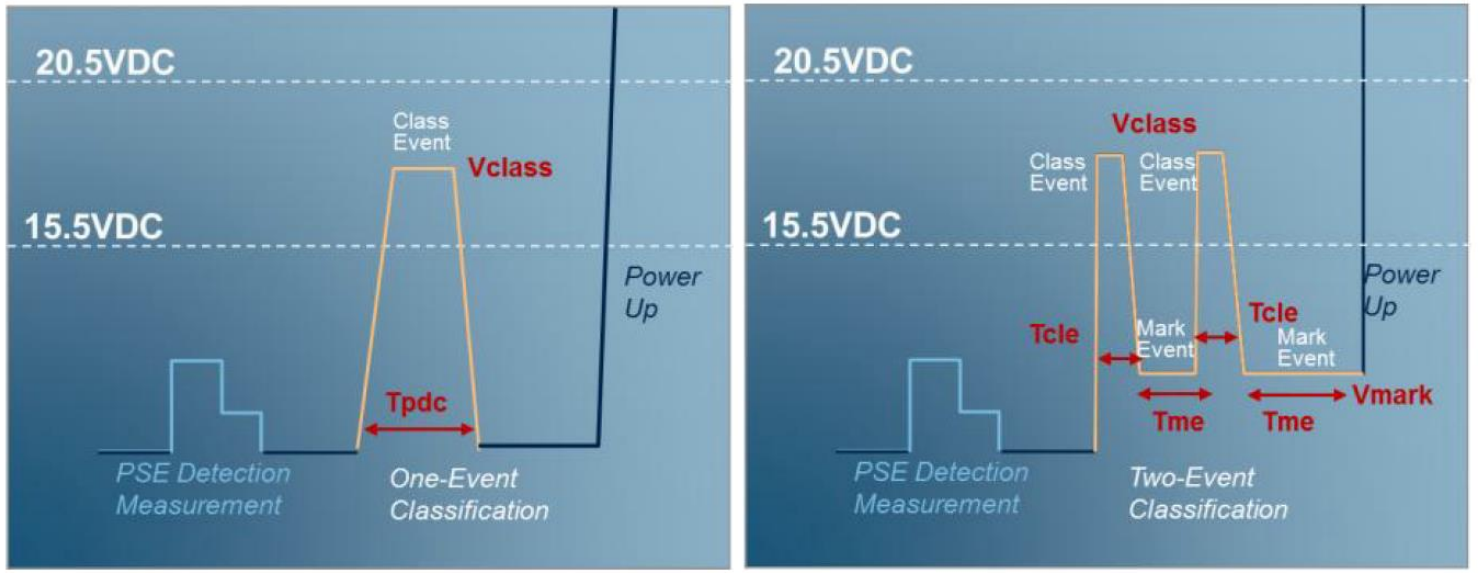

Figure 2.6 PD Classification under the **802.3at** Specification

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PD Classification - IEEE 802.3bt

The 802.3bt specification significantly extended the model of 2-Event classification so that PSE's and PD's could signal new classification bands that relate to power levels above Type-2 (Class 4).

The following table describes the 13 possible PD classifications described in the 802.3bt specification.

PD Signature Type	Classification	PSE Output Power*	PD Input Power	Units
Single	Class 1	4.0	3.94	Watts Total on 2-Pairs or 4-Pairs
	Class 2	7.0	6.5	
	Class 3	15.4	13.0	
	Class 4	30.0	25.5	
	Class 5	45.0	40.0	Watts Total on 4-Pairs
	Class 6	60.0	51.0	
	Class 7	75.0	62.0	
	Class 8	90.0	71.3	
Dual	Class 1 (D)	4.0	3.94	Watts per Pairset
	Class 2 (D)	7.0	6.5	
	Class 3 (D)	15.4	13.0	
	Class 4 (D)	30.0	25.5	
	Class 5 (D)	45.0	35.6	

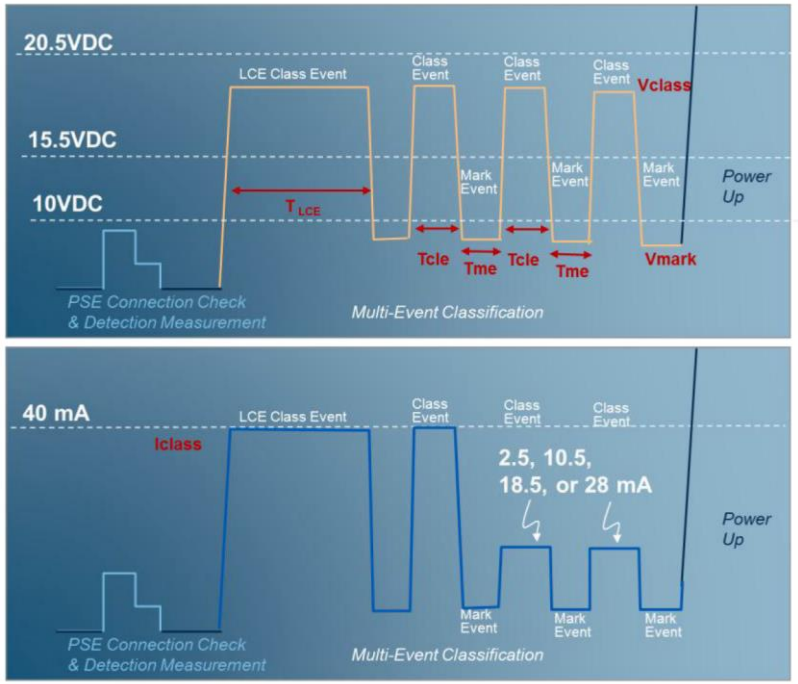

Figure 2.7 PD Classification under the 802.3bt Specification

Further reading in the Technical reference manuals at www.sifos.com/knowledge-center/

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Link Layer Discovery Protocol” (LLDP)

After a PSE powers up a PD, it may utilize a link layer discovery protocol (LLDP) to better understand the PD’s power needs. LLDP protocols only exist between two physical link partners and are not visible anywhere else on a network.

All PSE’s are allowed but not required to deploy PoE LLDP. All Type-2, Type-3, and Type-4 PD’s are required by 802.3at and 802.3bt to support PoE LLDP protocols.

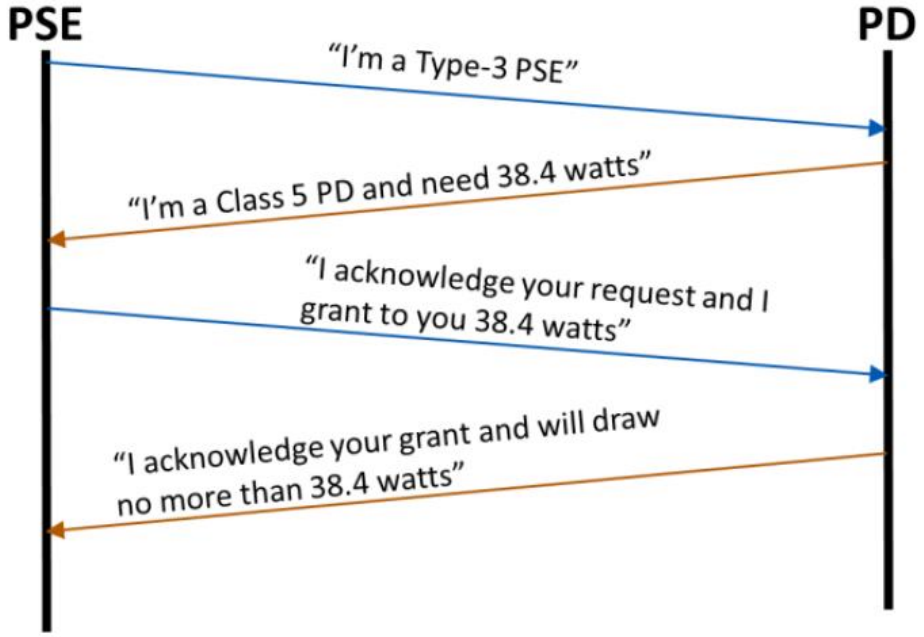

Figure 2.10 PoE LLDP Dialog/Negotiation

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Ensuring PoE interoperability

- Prevent Finger pointing
  - PSE
  - PD
  - Cable

- Many PoE Devices are low costs / high volume

- Not all potential issues can be fixed via OTA software

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Ensuring PoE interoperability

- Measure against the standard.
- Keep some margin

PDA-600 AT TEST REPORT

november 17, 2021 10:24 AM

Product Tested: UNDEFINED | Cycles: 1

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

Color Key: PASS | FAIL | WARN | INFO

Software Version: 2.2.0.1
PDA Firmware: 1,09
Report Ver: 1,11
Serial Number 602A0013

Sifos Technologies

Detection & Classification — PSE Emulation: | Pairs: A | Polarity: MDI | Det_Cycles: 3

Parameter	Cycle: 1	Units	Min.	Max.	Average	Low Lim.	High Lim.	P/F
Rdet	25,49	kohm	25,49	25,49	25,49	23,70	26,30	P
Rdet final	25,44	kohm	25,44	25,44	25,44	23,70	26,30	P
Rdet unpwr	>99.00	kohm	99,00	99,00	99,00	<12.00	>45.00	P
Cdet	0,12	uF	0,12	0,12	0,12	0,05	0,12	P
Cdet final	0,13	uF	0,13	0,13	0,13	0,05	0,12	F
1 Event Classification								
Iclass	1,1	mA	1,1	1,1	1,1	0,0	4,0	P
ClassNum	0		0	0	-	0	4	P
Tclass	0,0005	sec	0,0005	0,0005	0,0005	0,0005	0,0050	P
ClassStability	1					1	1	P
2 Event Classification								
Iclass event1	1,1	mA	1,1	1,1	1,1	0,0	4,0	P

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PoE : Certification / Logo certification

EA PoE certification :

- Certified Test labs

- Self certification using certified instruments

- Run tests and submit to EA for logo certification

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PoE Conformance Test Suite

PSE Conformance Test Suite

november 17, 2021 11:06

Port Count..... 1

Loop Count..... 1

PSE Tested: **Unspecified Type-4**

Sifos Technologies

802.3bt 4Pr Conformance Report

version 5.2.67

PSE Type: **4 MDI-X+MDI-X** *report version 5.2.20*

Safety Index*: **100%** Interop Index*: **100%**

Error Log: C:/Users/Public/Sifos/PSA3000/Results/192.168.221.105/psa_error_log

Chassis ID: 192.168.221.105 TestLoop: 1	PSA-3000 Ports 1-1	UNITS	Min	Max	Average	Low Limit	P/F	High Limit	P/F
Test: det v									
Open Circuit Voc A=	14,9	volts	14,9	14,9	14,9	0	Pass	30	Pass
Open Circuit Voc B=	14,9	volts	14,9	14,9	14,9	0	Pass	30	Pass
Backoff Voltage A=	1,1	volts	1,1	1,1	1,1	0	Pass	2,8	Pass
Backoff Voltage B=	1,2	volts	1,2	1,2	1,2	0	Pass	2,8	Pass
Backoff Voltage Ss=	1,3	volts	1,3	1,3	1,3	0	Pass	2,8	Pass
Max Det Step V A=	8,05	volts	8,05	8,05	8,05	3,8	Pass	10	Pass
Max Det Step V B=	8,06	volts	8,06	8,06	8,06	3,8	Pass	10	Pass
Min Det Step V A=	4,44	volts	4,44	4,44	4,44	2,8	Pass	9	Pass
Min Det Step V B=	4,47	volts	4,47	4,47	4,47	2,8	Pass	9	Pass
Det Step Changes A=	3	****	3	3	3	1	Pass	9	Pass
Det Step Changes B=	3	****	3	3	3	1	Pass	9	Pass
Min Step DV A=	1,73	volts	1,73	1,73	1,73	1	Pass	7,2	Pass
Min Step DV B=	1,73	volts	1,73	1,73	1,73	1	Pass	7,2	Pass
Pre-Det CC Step V A=	5,32	volts	5,32	5,32	5,32	0	Pass	10	Pass
Pre-Det CC Step V B=	1,89	volts	1,89	1,89	1,89	0	Pass	10	Pass
Test: det cc									
Presumed CC DET SEQ=	1	****	1	1	1	0	Pass	3	Pass
Conn Chk SS V A=	6,32	volts	6,32	6,32	6,32	2,8	Pass	10	Pass
Conn Chk SS V B=	6,42	volts	6,42	6,42	6,42	2,8	Pass	10	Pass
Conn Chk DS V A=	5,3	volts	5,3	5,3	5,3	2,8	Pass	10	Pass
Conn Chk DS V B=	5,41	volts	5,41	5,41	5,41	2,8	Pass	10	Pass
High Signature CC A=	1	****	1	1	1	1	Pass	1	Pass
High Signature CC B=	1	****	1	1	1	1	Pass	1	Pass
4Pair Start Fail=	0	****	0	0	0	0	Pass	0	Pass
Test: det i									
Isc Init A=	0,36	mA	0,36	0,36	0,36	0	Pass	5	Pass
Isc Init B=	0,29	mA	0,29	0,29	0,29	0	Pass	5	Pass
Isc Det A=	0,36	mA	0,36	0,36	0,36	0	Pass	5	Pass
Isc Det B=	0,27	mA	0,27	0,27	0,27	0	Pass	5	Pass
Det Slew A=	0,0072	V/usec	0,0072	0,0072	0,0072	0	Pass	0,1	Pass
Det Slew B=	0,0054	V/usec	0,0054	0,0054	0,0054	0	Pass	0,1	Pass
Test: det range									
Rgood Max Single=	29	Kohm	29	29	29	27	Pass	32	Pass
Rgood Min Single=	16	Kohm	16	16	16	16	Pass	19	Pass
Cgood Max Single=	0,1	uF	0,1	0,1	0,1	0	Pass	10	Pass
Rgood Max Dual A=	29	Kohm	29	29	29	27	Pass	32	Pass

Special Notes	802.3bt Coverage		
	802.3 Parm.	PIC	802.3bt Clause
	VOC	PSE6	145.2.5.1
	VOC	PSE10	145.2.6.1
Measured as a minimum voltage in the IDLE region when Dual detection signature is set to 37K Ω	Voff, VReset	PSE12	145.2.6.2
		PSE15	
		PSE16	
Assess the IDLE Backoff voltage a Single Signature PD would see downstream of the full wave bridge with detection signature of 37K Ω. The 802.3bt standard requires PSE to pass through IDLE and separately requires IDLE voltage ≤ 2.8V. The parameter is treated as a Warning (Info mark) only because it is not clear that PSE-PD detection interoperability could be practically be affected by detection signaling that does not drop below 2.8V as a result of invalid detection backoff.		PSE21	145.2.7
		PSD75	145.2.10.11
		PSE76	

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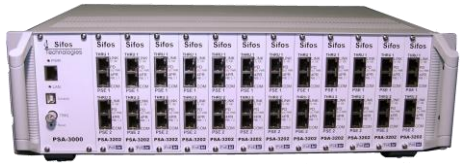


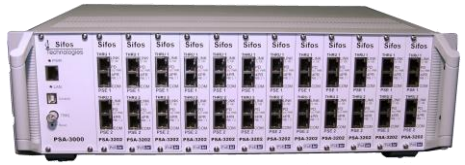
PD Tester

EA Certified 2.0™

Sifos® Technologies

www.sifos.com

Ethernet PHY (L1) testers



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