PEP01-5841
Power over Ethernet protection

Web training

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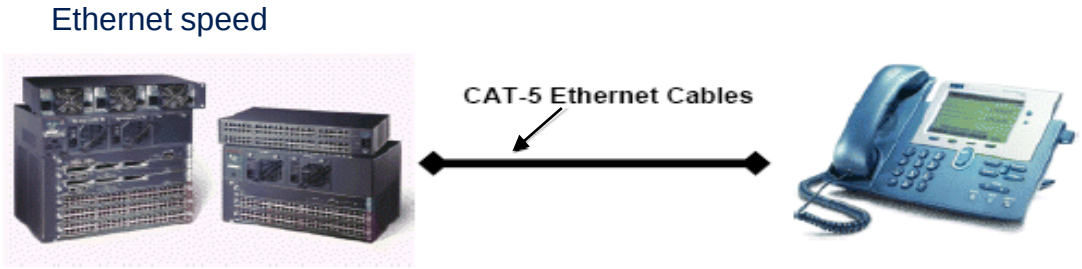
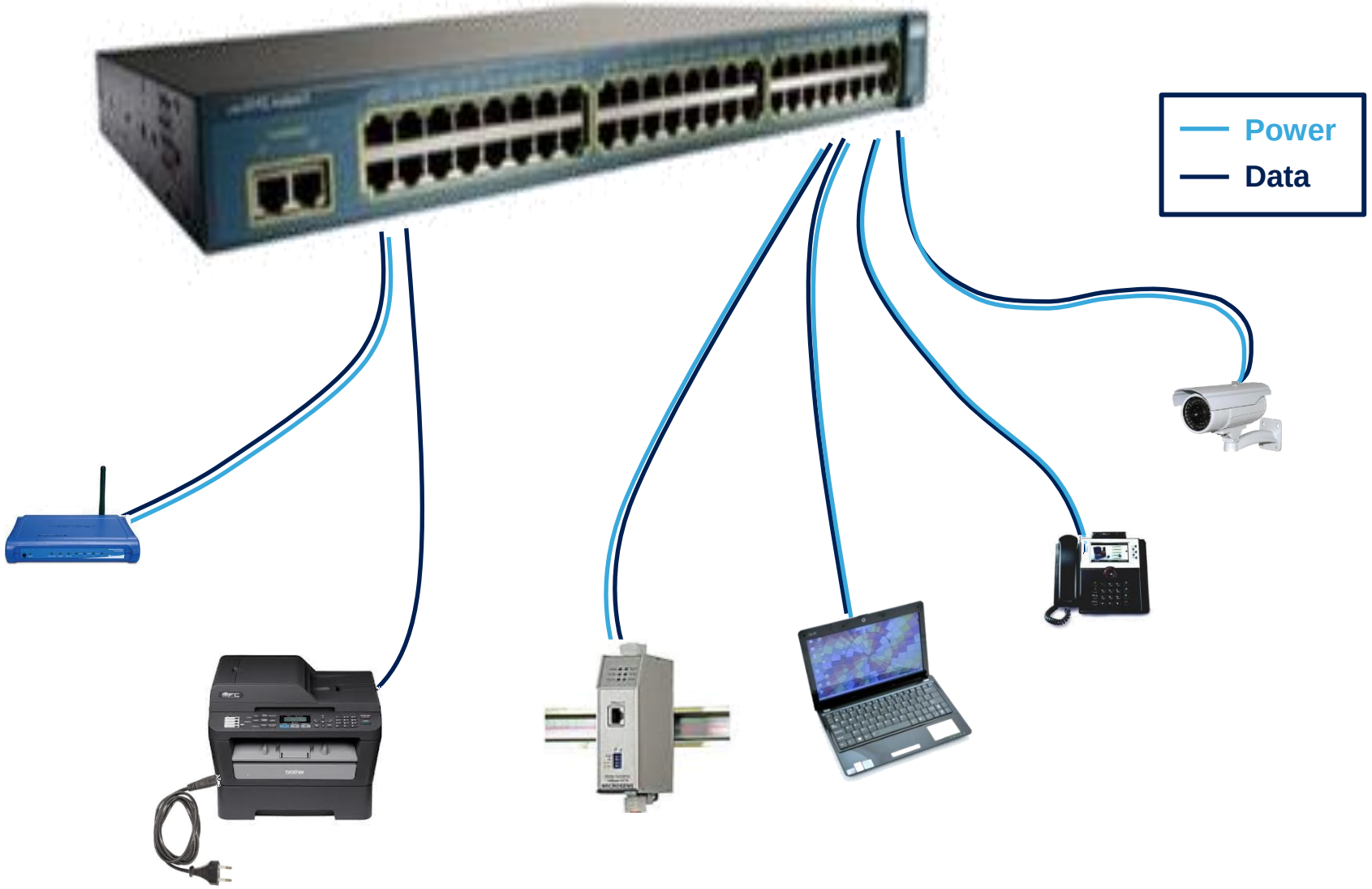
Power over Ethernet



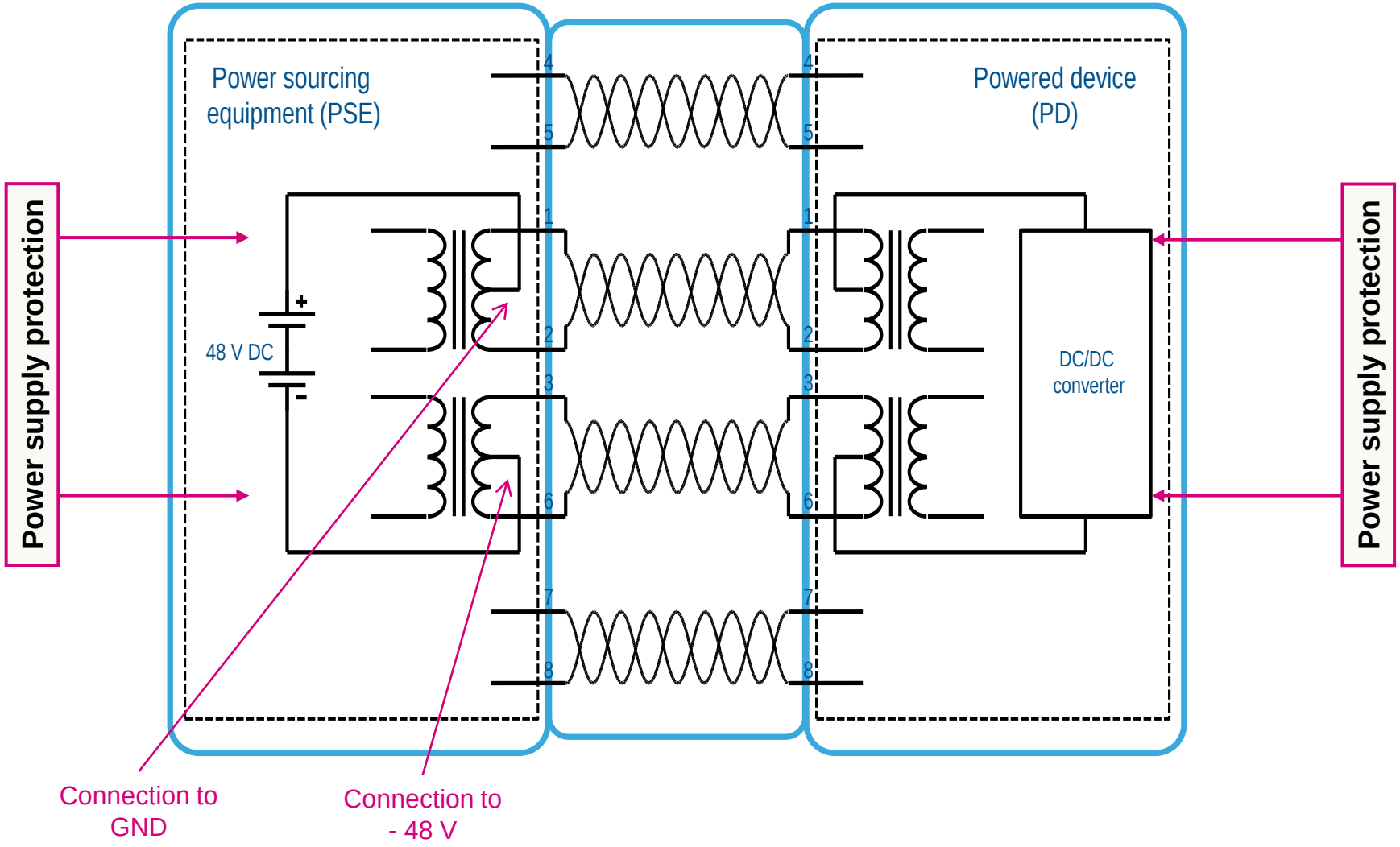
- PoE targets :
  - Remove AC adapters
  - Compatible with non PoE devices
  - Giga Ethernet capabilities

- Two versions
  - POE : Power capability 48 V – 13 W – 350 mA on the source (IEEE 802.3af)
  - POE+ : Power capability 48 V – 30 W – 800 mA on the source (IEEE 802.3at)

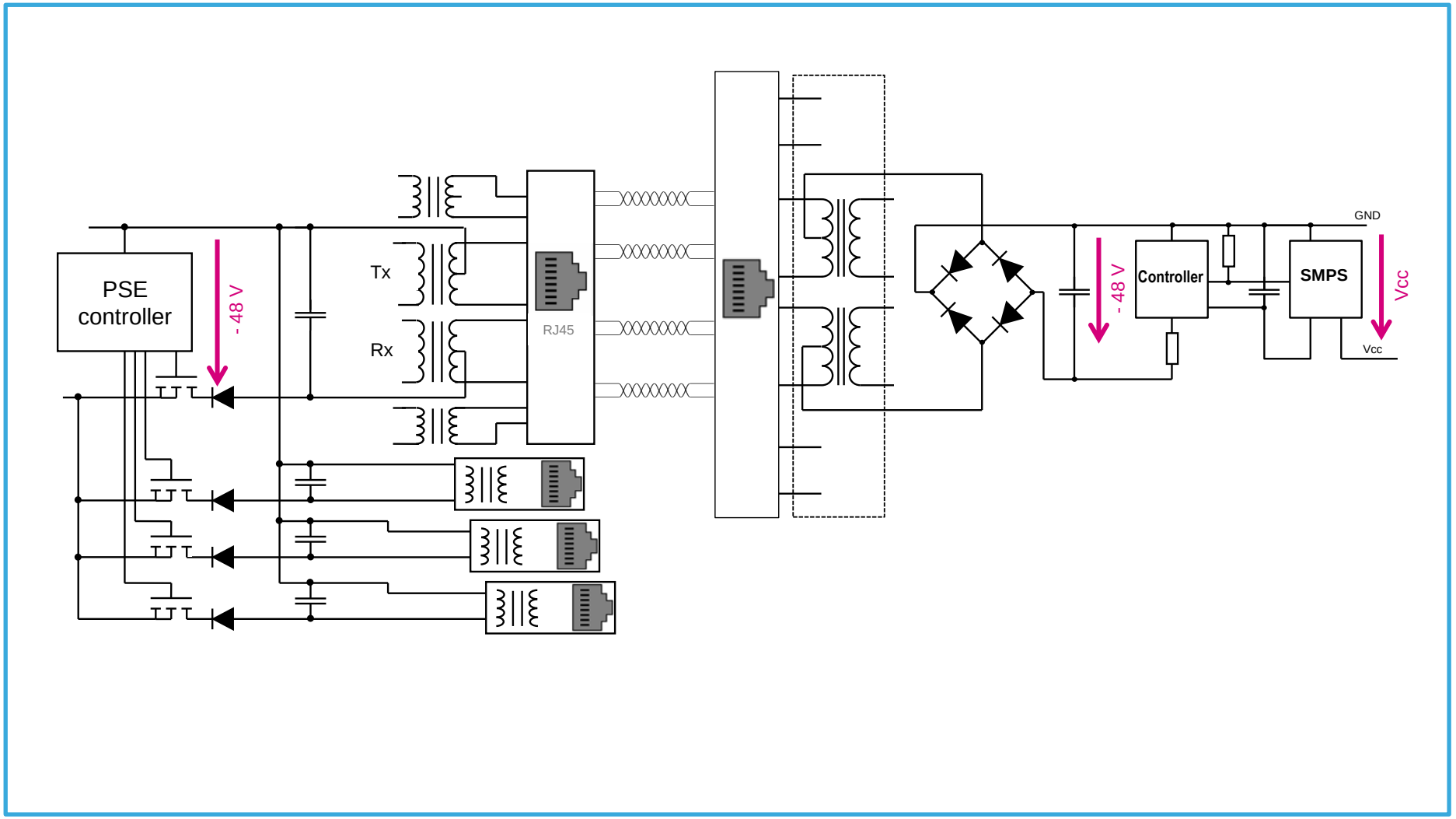
PoE topology and applications



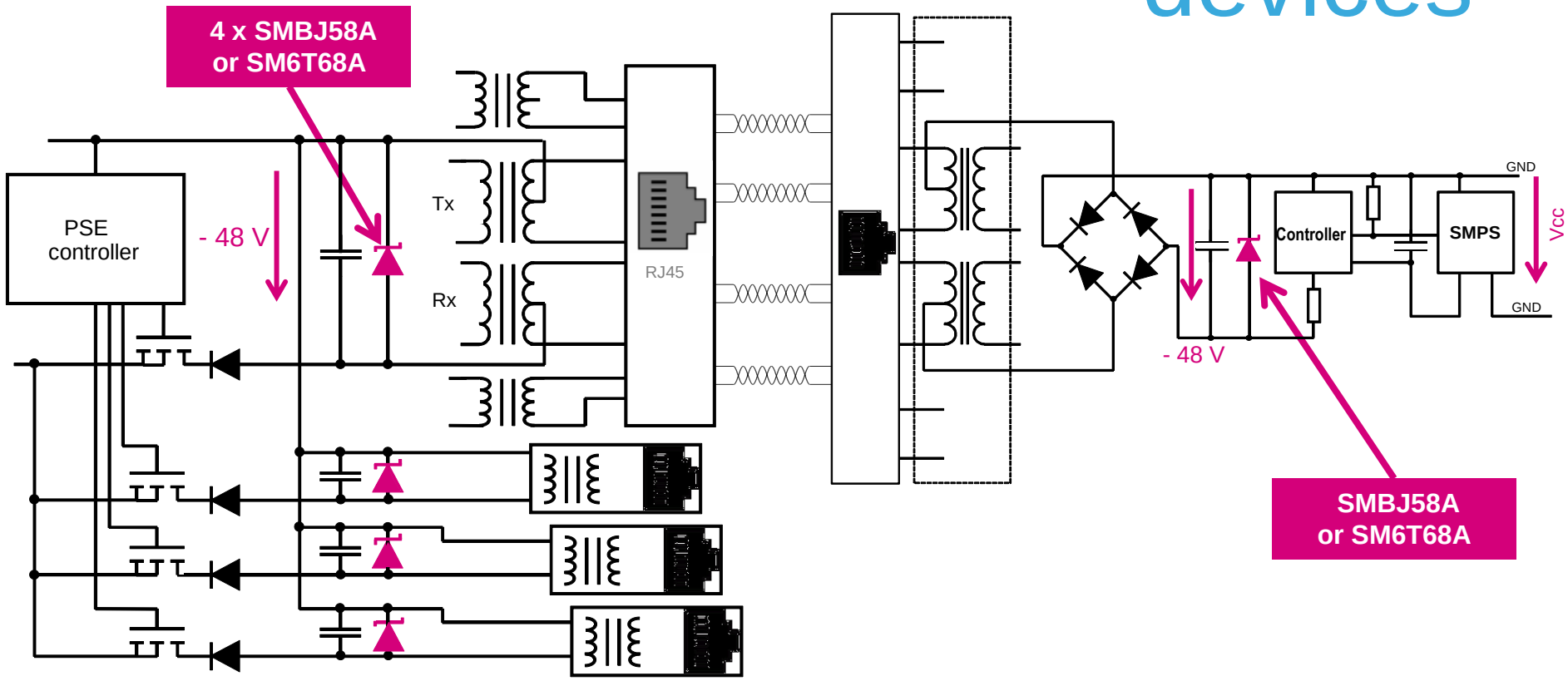
PoE: how does it work?



PoE circuit details



PoE circuit details with protection devices



- Protection devices are necessary because Ethernet equipment are subjected to surge standards
- Let's focus on IEC 61000-4-5 standard which is the main standard for Ethernet

IEC 61000-4-5: definition & environment

Lines are subjected to:

- Power system switching transients due to switching or short circuits, or arcing faults
- Lightning transients

Selection of generators and test levels

The selection of the test levels should be based on the installation conditions. Unless otherwise specified in product or product-family standards, Table A.1 should be used, together with information given in Clause B.3 where:

Class 0:	Well-protected electrical environment, often within a special room.
Class 1:	Partly protected electrical environment.
Class 2:	Electrical environment where the cables are well-separated, even at short runs.
Class 3:	Electrical environment where cables run in parallel.
Class 4:	Electrical environment where the interconnections run as outdoor cables along with power cables, and cables are used for both electronic and electric circuits.
Class 5:	Electrical environment for electronic equipment connected to communication cables and overhead power lines in a non-densely populated area.
Class x:	Special conditions specified in the product specification.

extract from IEC 61000-4-5 available at www.iec.ch

IEC 61000-4-5: class and voltage

B.3 Installation classification

Class 1 Partly protected electrical environment

All incoming cables to the room are provided with overvoltage (primary) protection.

The units of the equipment are well-interconnected by a ground connection network, which is not significantly influenced by the power installation or lightning.

The electronic equipment has its power supply completely separated from the other equipment.

Switching operations can generate interference voltages within the room.

Surge voltage may not exceed 500 V.

Class 2 Electrical environment where the cables are well-separated, even at short runs.

The installation is grounded via a separate connection to the grounding system of the power installation which can be subjected to interference voltages generated by the installation itself or by lightning. The power supply to the electronic equipment is separated from other circuits, usually by a dedicated transformer for the mains power supply.

Non-protected circuits are present in the installation, but well-separated and in restricted numbers.

Surge voltages may not exceed 1 kV.

extract from IEC 61000-4-5 available at *www.iec.ch*

Test voltages:

Level	Open circuit test voltage (kV)
1	0.5
2	1
3	2
4	4
X	Special

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IEC 61000-4-5: impedance and current

B.1 Different source Impedance

The selection of the source impedance of the generator depends on:

- the kind of cable/conductor/line (a.c. power supply, d.c. power supply, interconnection, etc.);
- the length of the cables/lines;
- indoor/outdoor conditions;
- application of the test voltage (line-to-line or lines-to-ground).

The impedance of 2 Ω represents the source impedance of the low-voltage power supply network. The generator with its effective output impedance of 2 Ω is used.

The impedance of 12 Ω (10 Ω + 2 Ω) represents the source impedance of the low-voltage power supply network and ground. The generator with an additional resistor of 10 Ω in series is used.

The effective impedance of 42 Ω (40 Ω + 2 Ω) represents the source impedance between all other lines and ground. The generator with an additional resistor of 40 Ω in series is used.

extract from IEC 61000-4-5 available at www.iec.ch

Voltage 1.2/50 µs	Class 0 25 V	**Class 1** **500 V**	**Class 2** **1 kV**	Class 3 2 kV	Class 4 4 kV
8/20µs current (short circuit)	< 1 A	12 A	24 A	48 A	96 A

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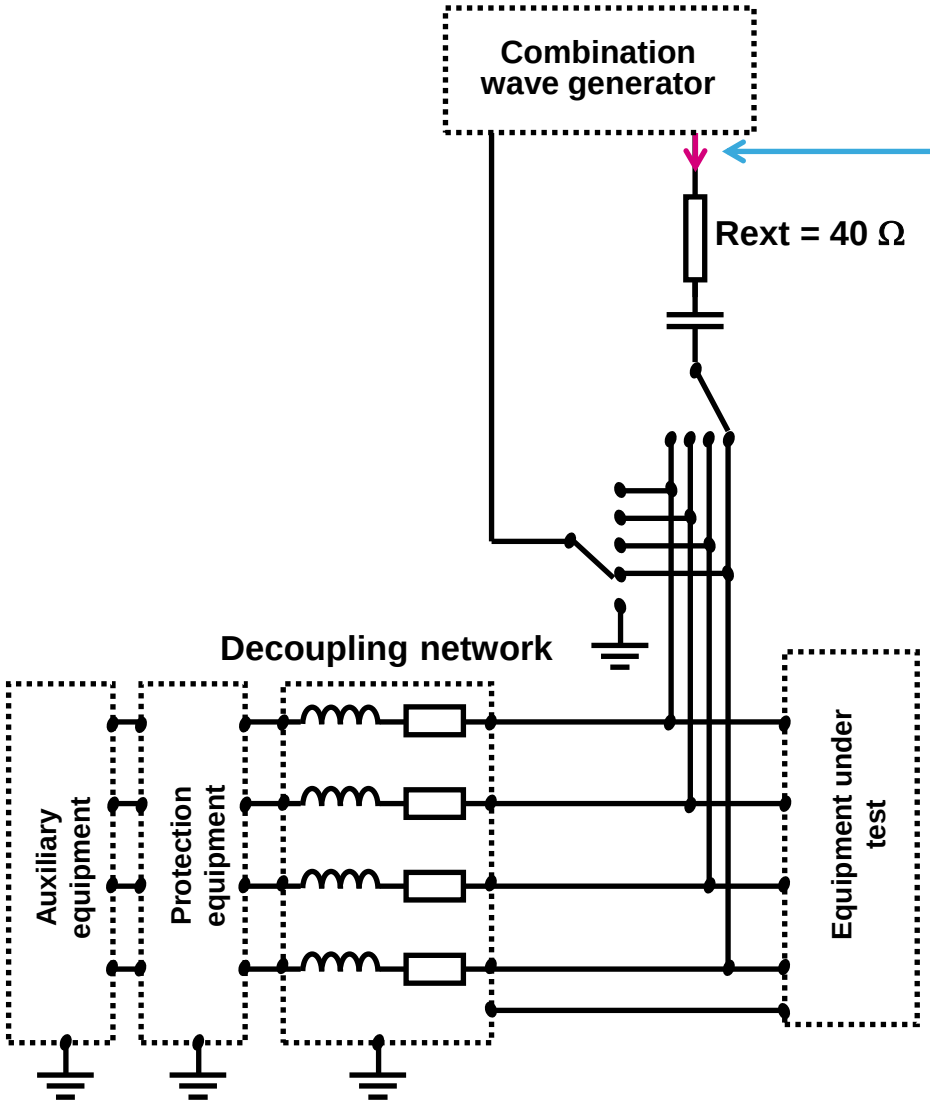
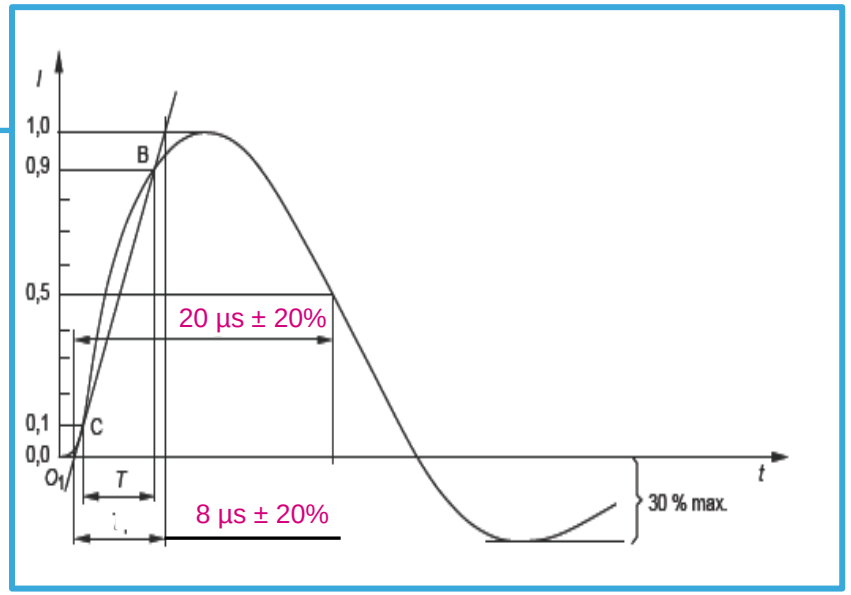
IEC 61000-4-5: test set-up





Required surge is 8/20 µs and NOT 10/1000 µs

General purpose protection devices are not suitable

extract from IEC 61000-4-5 available at www.iec.ch

Applications

Multiple of
4 or 6 lines

Industrial switches *Switches* *Residential gateway* *Routers*

PEP01-5841: ST's new PoE protection

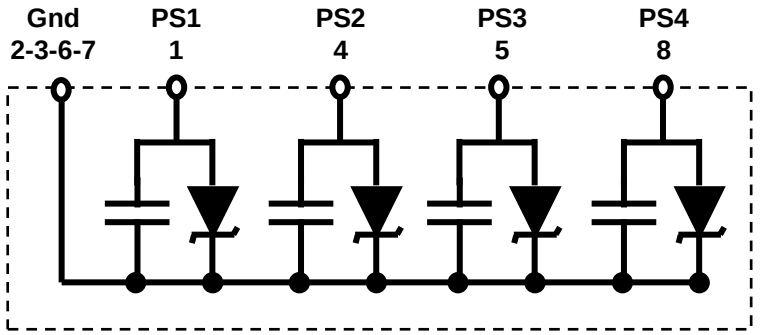
Current

Current protection solution is made of 4 x SMA or SMB packages

New

New : SO-8 package with 4 protection Transil™ and 4 capacitors

(function : clamping AND filtering)



Surge capability compliant with IEC 61000-4-5 Class 2 (1 kV) – 24 A

Maximum V_{CL} compatible with PSE* controller technology (100 V)

Power Source Equipment

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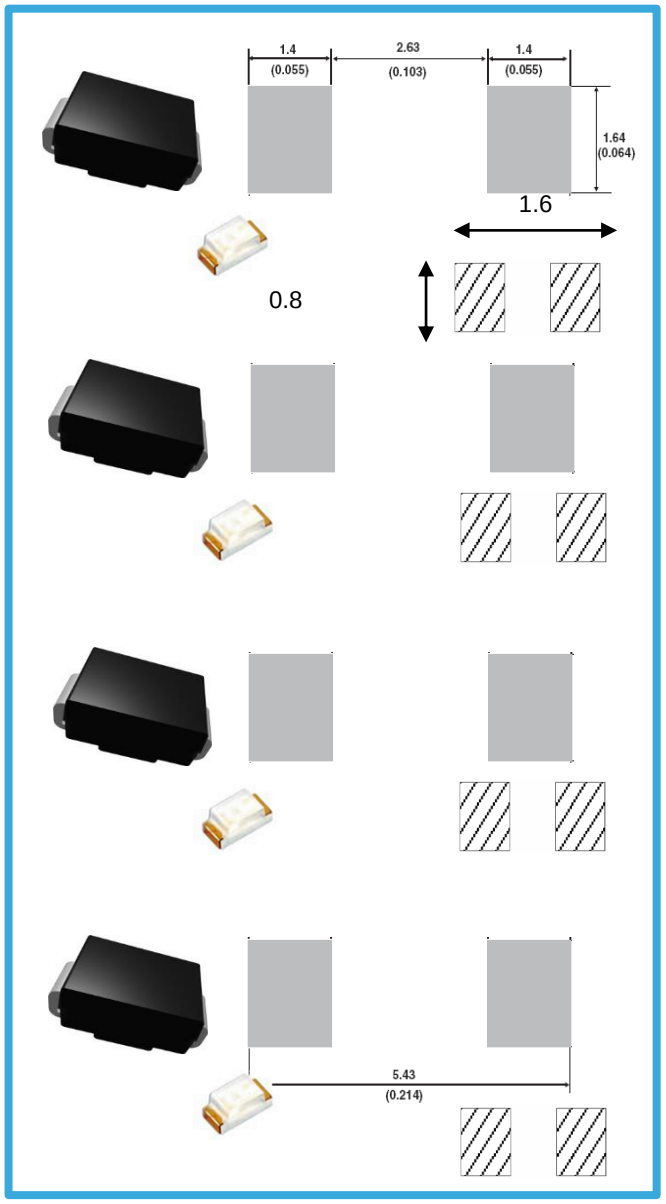
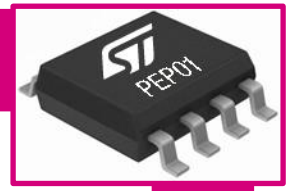
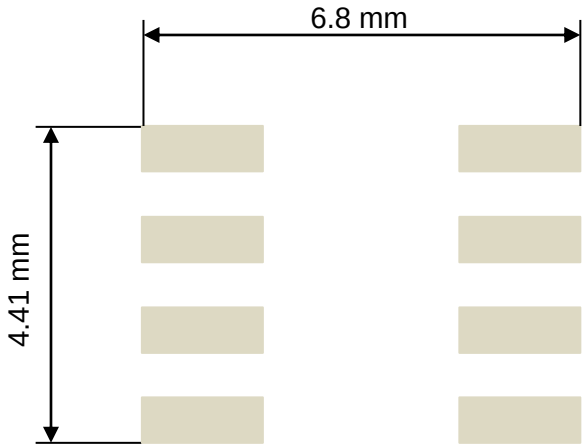
Space saving

0306 capacitors	4 x 1.6 x 0.8 = 4.65 mm²	
SMBJ58A	4 x 3.6 x 5.35 = 77 mm²	=> 82 mm²





30 mm²



Space saving : 74 %

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SMBJ58A / PEP01-5841 comparison

Competition

Device Type Modified "J" Bend Lead	Device Marking Code UNI	Device Marking Code BI	Breakdown Voltage $V_{(BR)}$ at I_T (1) (V) Min	Breakdown Voltage $V_{(BR)}$ at I_T (1) (V) Max	Test Current I_T (mA)	Stand-off Voltage V_{WM} (V)	Maximum Reverse Leakage at V_{WM} I_D (µA) (3)	Maximum Peak Pulse Surge Current I_{PPM} (A)(2)	Maximum Clamping Voltage at I_{PPM} V_C (V)
+SMBJ58	NF	NF	64.4	78.7	1.0	58	1.0	5.8	103
+SMBJ58A	NG	NG	64.4	71.2	1.0	58	1.0	6.4	93.6

Source : competitor datasheet

2 V_{BR} tolerances due to yield reasons ?

No 85 °C specification

No IEC 61000-4-5 specification only 10/1000 µs (not tested with 8/20 µs surges)

Source : PEP01-5841 datasheet available www.ST.com

	I_{RM} max @ V_{RM}			V_{BR} @I_R (1)				8/20 µs V_{CL} @I_{PP}		8/20 µs R_D(2)	C	αT(3)
	25 °C	85 °C		min.	typ.	max.		max.			typ.	max.
	µA	µA	V	V			mA	V	A	Ω	pF	10^{-4} °C
PEP01-5841	0.2	1	58	64.4	67.8	71.2	1	100	24	1.2	55	10.4

αT can be used to recalculate $V_{CL} = f(T_j)$

Low leakage current

Specified at 85 °C according to telecom temperature range

V_{CL} max compatible with PoE controller IC and PMOS

IEC 61000-4-5 1 kV - 24 A compliant

R_D can be used to recalculate $V_{CL} = f(I_{PP})$

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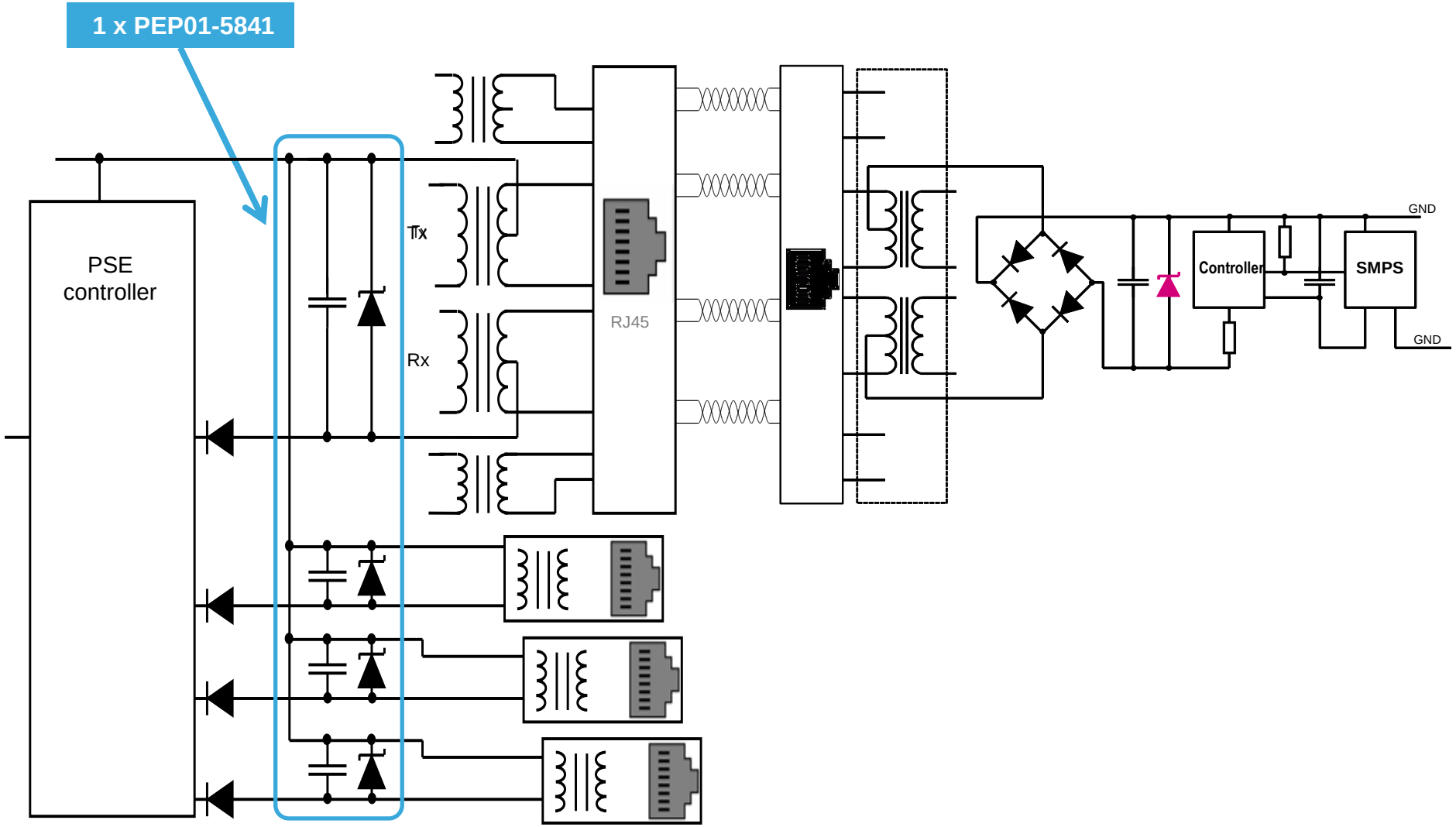
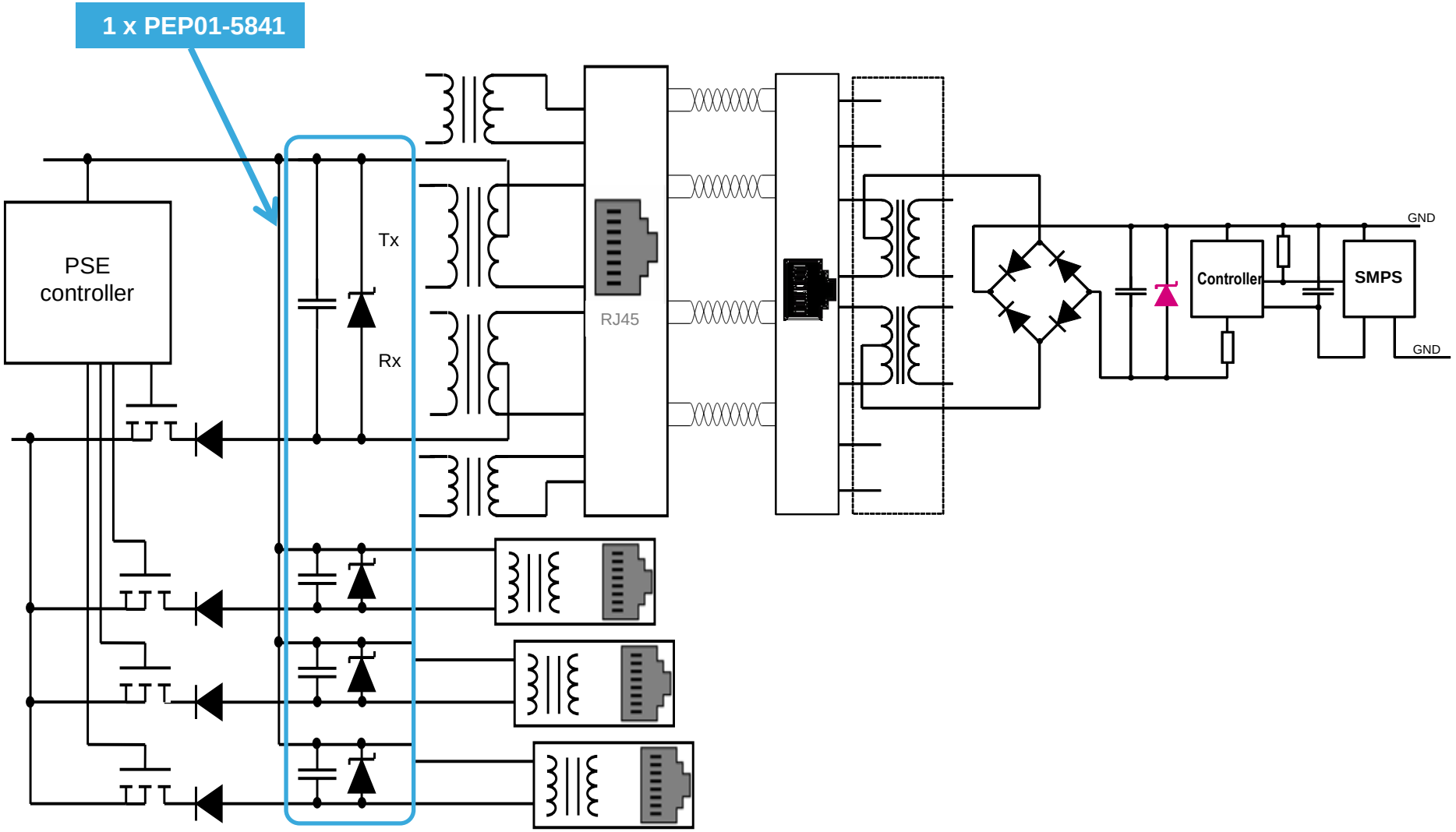
PoE circuit with integrated MOSFETS

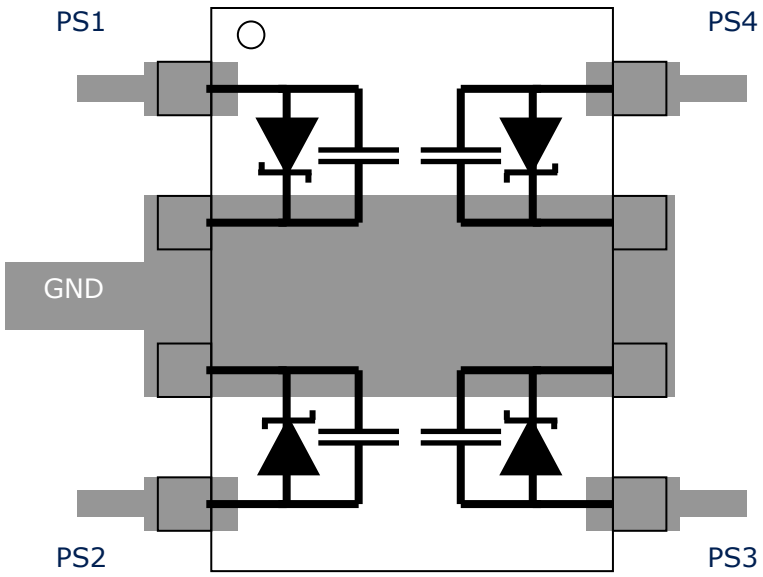


PoE circuit with external MOSFETS

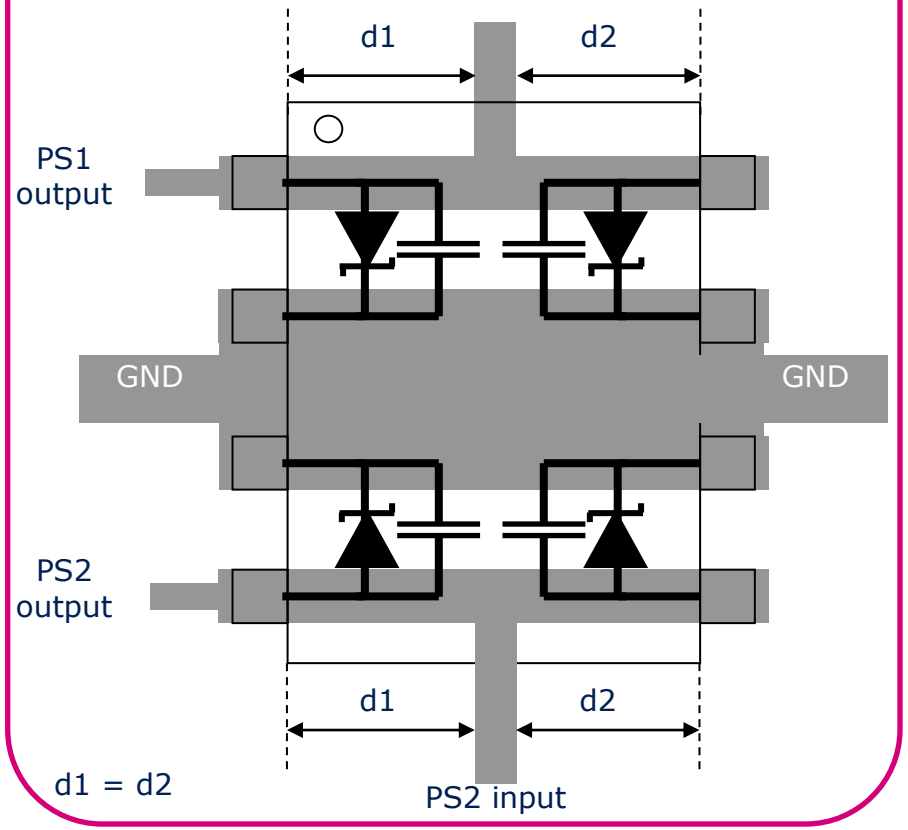


24 A and 48 A surge protection

Protection of 4 power supplies
(1 kV 1.2/50 µs – 42 Ω)



Protection of 2 power supplies (2 kV 1.2/50 µs – 42 Ω)



One SO-8 package for two power supplies
compliant with IEC 61000-4-5 (2 kV – 48 A)

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PEP01-5841: benefits and added values

Benefits…	...thanks to…
More ports per board for compact application	More than 50% PCB thanks to integrated protection Embeds 4 protection devices and 4 capacitances
Equipment compliance with IEC 61000-4-5	500 V – 12 A surge compliant 1 kV – 24 A surge compliant 2 kV – 48 A surge compliant
PoE controller and/or Pmos protected by design	Clamping voltage (V_{CL}) limited to 100 V
Compatible with telecommunication temperature range	Rated at 85 °C
Compliant to IEEE 802.3af/at	Dedicated design
Increase your margin	By reducing PCB area By getting the right product at the first shot By getting a cost effective product

Thank you

www.st.com/pep01-epres