Power Matters

Microsemi

IEEE802.3bt 4-Pair Power over Ethernet Task Force
4P PoE with Typical Y cable Construction Use Case Analysis
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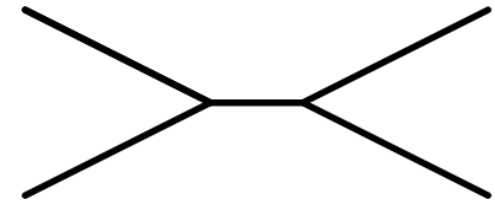- Steinke, Stephan / Molex

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Objectives

- Address typical symmetrical Y cable (or X cable) installations used worldwide with 2P PoE.

- Analyzing operating of existing installations when connected to 4P PoE systems.

Background   -1

- **The most common Y cable installations are *symmetrical on both ends*. This is also known as X cable construction.**

Hi level system illustration of symmetrical Y cable (X cable)   Symbol

- **The Y cable is sometimes confused with one of the components used to construct it.**

+   **=** Symmetrical Ycable (Xcable)
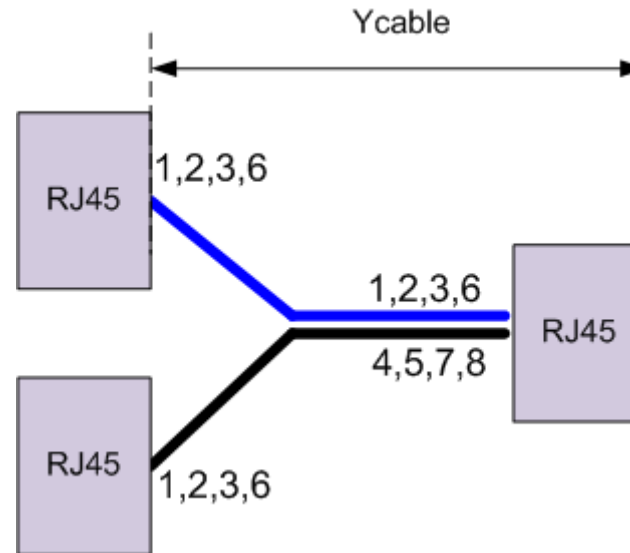

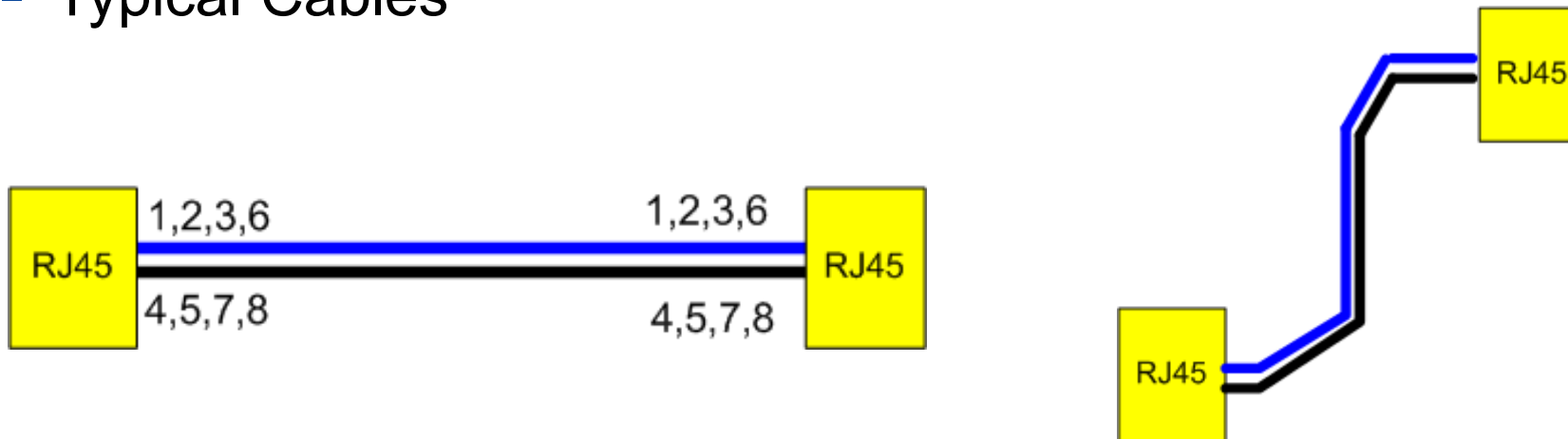Ycable (combiner side)   Ycable (splitter side)

- Incentive for using Y cables
  - Allows driving two separate PDs or DTEs or Mix of these from two different Switch ports through a single cable
  - Saves cables in 100BaseT applications
- It works
  - Point to Point Connected
  - Fully IEEE802.3-2012 compliant for Type 1 and 2 PoE sys.
    - Supports detection, classification, and power of a PD.
- It is widely used

Key/Terms and abbreviations
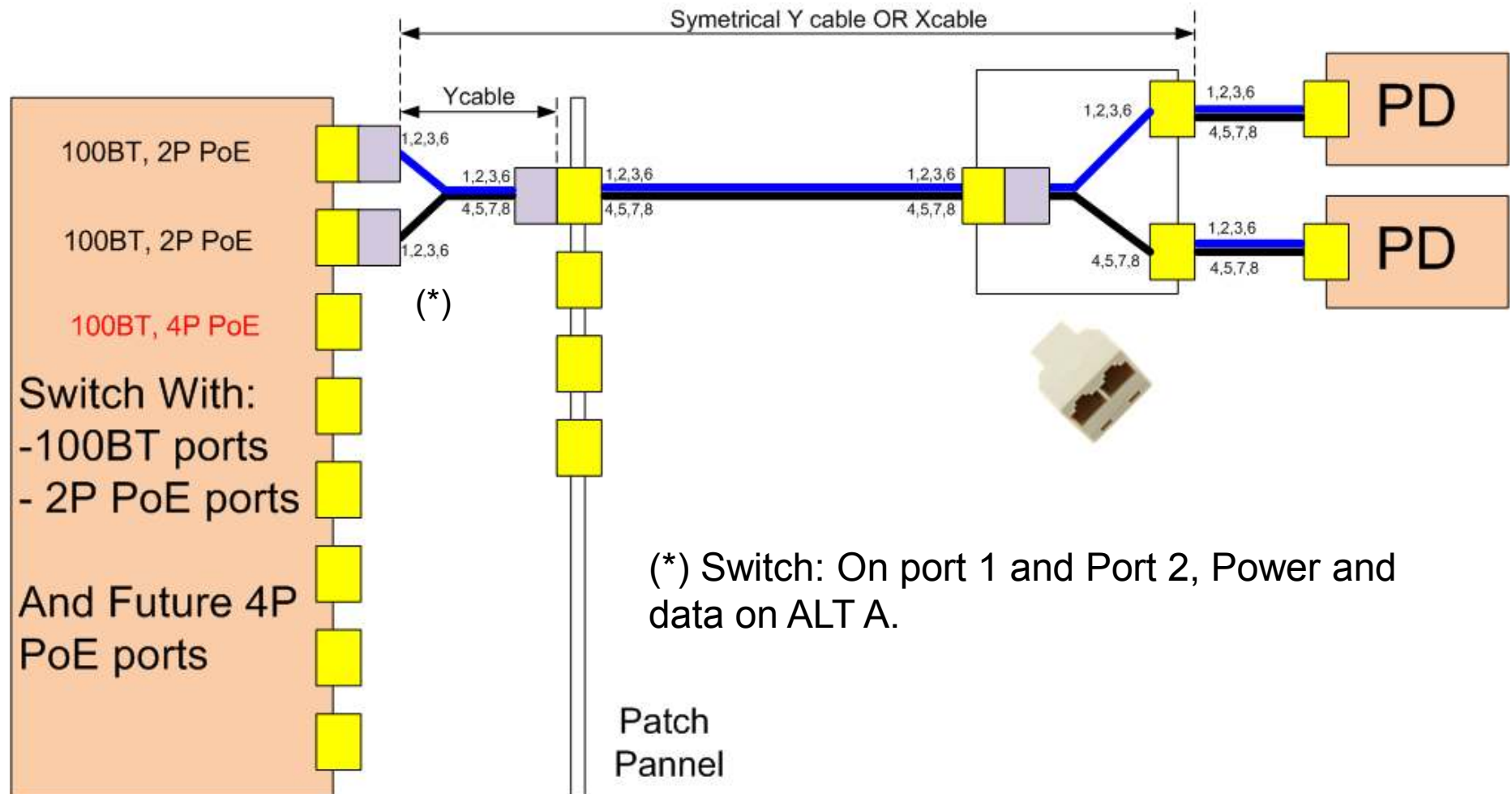
- ## Y cable
  - Combiners or splitters

Ycable

1,2,3,6
RJ45

1,2,3,6
RJ45

4,5,7,8

RJ45
1,2,3,6

- ## Typical Cables

RJ45   1,2,3,6   1,2,3,6   RJ45
       4,5,7,8   4,5,7,8

RJ45

RJ45

Example of Typical System   1

(*) Switch: On port 1 and Port 2, Power and data on ALT A.
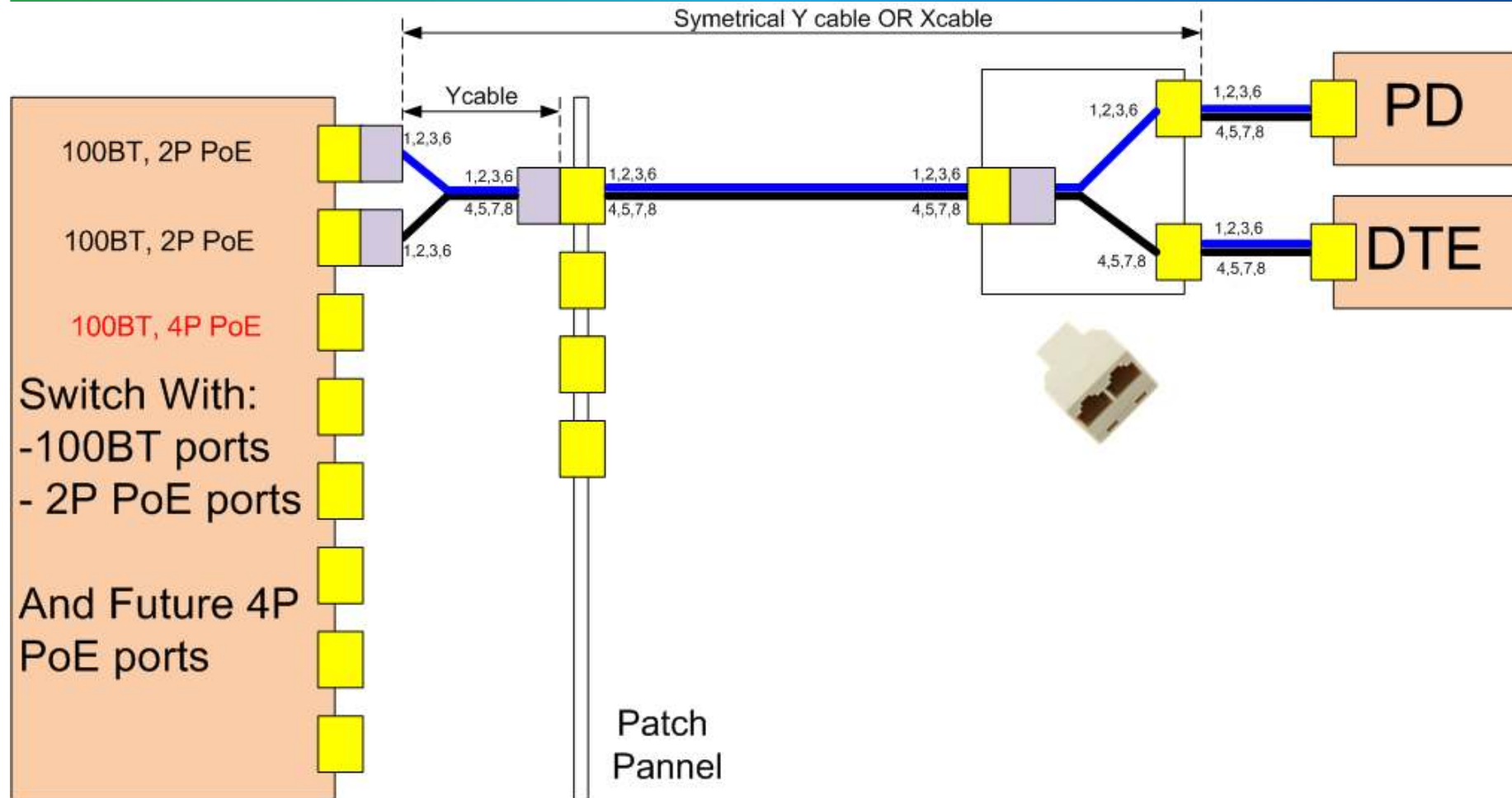
- Both PDs will work as planned
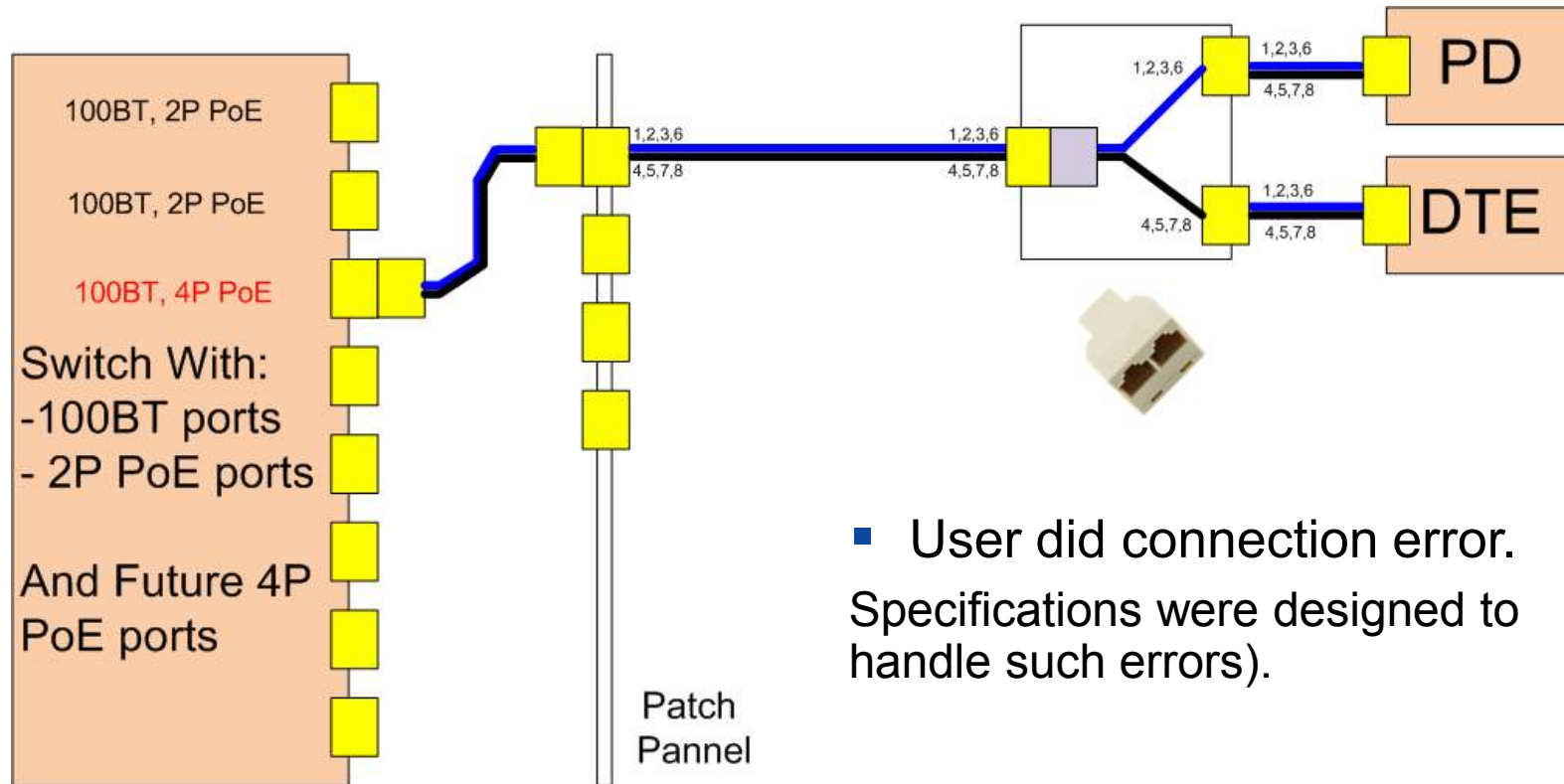
- **PD** will be powered. **DTE will not** since it is not compliant PD
- System working as planned.

Example of User connection error

- User did connection error.

Specifications were designed to handle such errors).

- Pairs 1,2,3,6 is being detected and will be powered due to compliant PD at its end.
- If Pairs 4,5,7,8 are detected as well, separately from pairs 1,2,3,6, DTE will not be powered and will not be exposed to potential damaged as required.(See: http://www.ieee802.org/3/af/objectives.pdf objective 3)
- If pairs 4,5,7,8 are not detected for valid signature separately from pairs 1,2,3,6, the DTE may be damaged due to powering 4,5,7,8 regardless of a presence of invalid signature. Please see more details on Annex A1 – A3 and C for details.

Conclusions

- In order to
  - Meet our objectives
  - Meet 5C
  - Keep the same reliability of 802.3af/at
- We need to keep the Detection function requirement as it is today without any change per IEEE802.3 clause 33.2.5:

  - In any operational state, the PSE shall not apply operating power to the PI until the PSE has successfully detected a PD requesting power.

  - The PSE shall turn on power only on the same pairs as those used for detection.

Summary

- In the new 4P PoE specification

- To enable 4 pair powering, a valid detection must be performed on both Pairs 4,5 and 7,8 (ALTERNATIVE B) and pairs 1,2 and 3,6 (ALTERNATIVE A) in order to ensure that that a DTE (or any non-PD connected to the system) will not be powered.

- The above goal is achievable with the existing text and is required toady by IEEE802.3-2012 clause 33.1 and 33.2.5.

Thank You

Annex A1

- **Some examples for reasons why DTEs may be damaged if not detected first prior applying power.**

- Example 1: DTEs such NIC cards contains terminations. Most of the popular terminations concept in DTEs (prior PoE era) was using 75 ohms from each center tap, connect it together and then connect this summation point to a single capacitor to the chassis. In this way you save the extra capacitors of the other 3 terminations. The result of it is 150 ohms between center tap to center tap which when 50V PoE voltage is applied to it, it will be damaged/on fire etc. since its power rating is $<<50V^2/150\Omega$.

  - If the terminations are R+C separate for each connection, than there is no issue from terminations point of view. *However PHYs may be damaged upon hot connection.*

- Example 2: In addition, there are other applications of pre-standard PDs that works at 5V, 24V etc. so when 50V is applied the DC/DC of the PD will be damaged since those PDs are without signature detection etc. so they will surely damage.

Annex A2

- **4P PoE with two MOSFETS connected to any combinations of straight or Y cables:**
  - PD will be powered, DTE will not.
  - No damage.
  - Full interoperability and compatibility to current standard.

- **4P PoE with single MOSFETS connected to any combinations of straight or Y cables:**
- PD on port #1. DTE with front end #1 on port #2: will not be powered at all due to very low resistance ➔ invalid signature. Just interoperability issues. No damage issues.
  - During Hot connection, DTE will be damaged since we have already voltage on port 2.

- PD only on port #1. Power is on due to valid detection. Now you have live voltage on second port. DTE with front end #1 is being connected now to port #2. DTE will be damaged.

- PD on port #1and DTE with front end #2 on port #2: PD will be powered. DTE will receive power too. DTE will not be damaged (each resistor has capacitor in series that blocks the DC)
  - During Hot connection, PHYs may be damaged during hot connection of DTE due to voltage transients up on connection to alive voltage seen at the PHY side due to asymmetry operation of the transformer that is receiving voltage not at the same time (connector pins are not connected at the same time (e.g. pin 1 and 2 or 3 and 6 etc.) resulting with >0 common mode voltage at the time of connection).

- PD on port #1 and non-compliant PD on port #2. PD will be powered. The 2nd port will be powered too if It has high impedance during detection and may be damaged if it is pre standard PoE designed for 24V, 5V operation etc. that can't handle 50V.

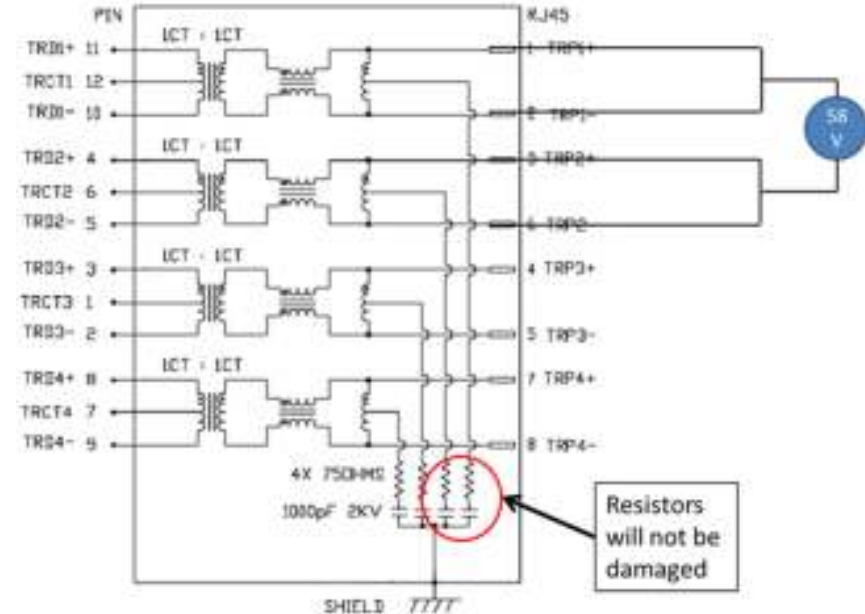# A3 - DTE – different terminations concept

■ DTE interface #1

(common terminations with no DC isolation)

If power applied to the pairs w/o detection first on
each pair separately as done with 2P PoE:
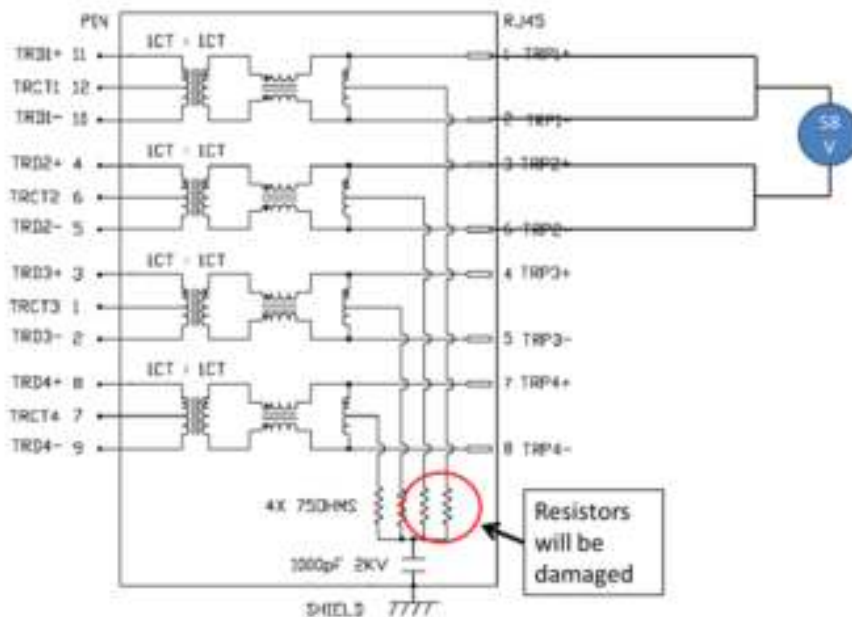
DTE Interface #2

(Separate terminations)

Annex B – IEEE802.3-2012 detection requirements

- **33.2.5 PSE detection of PDs**

- **In any operational state, the PSE shall not apply operating power to the PI until the PSE has successfully detected a PD requesting power.**

- The PSE probes the link section in order to detect a valid PD detection signature. The PSE PI is connected to a PD through a link segment. In the following subclauses, the link is not called out to preserve clarity.

- The PSE is not required to continuously probe to detect a PD signature. The period of time when a PSE is not attempting to detect a PD signature is implementation dependent. Also, a PSE may successfully detect a PD but then opt not to power the detected PD.

- **The PSE shall turn on power only on the same pairs as those used for detection.**

References

- IEEE802.3-2012: Clause 33.1 and 33.3.5
- http://www.ieee802.org/3/bt/public/mar14/balasubramanian_01_0314.pdf (Detection and interoperability issues).
- http://www.ieee802.org/3/bt/public/mar14/darshan_02_0314.pdf (interoperability issues)
- http://www.ieee802.org/3/bt/public/mar14/darshan_01_0314.pdf (Potential damage issues)
- Leading manufacturer(s): The use of X-construction cabling is very common. The most common is a combination of the Y-splitter and Y-combiner cables connected by a single Permanent Link.

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Annex C: From 802.3af Objectives

http://www.ieee802.org/3/af/objectives.pdf   Objective #3.

(3) Not cause damage and interoperate with compliant RJ- 45 MDI Ethernet

devices including:

a. Switch- to- switch connections (both supplying power)

b. Cross- over cables

c. Common mode termination implémentations

d. Shorted conductors, pairs or loop- back plug

- The above is done by the detection function per 33.2.5