Detecting PDs Over All 4 Pairs in Parallel: An Analysis

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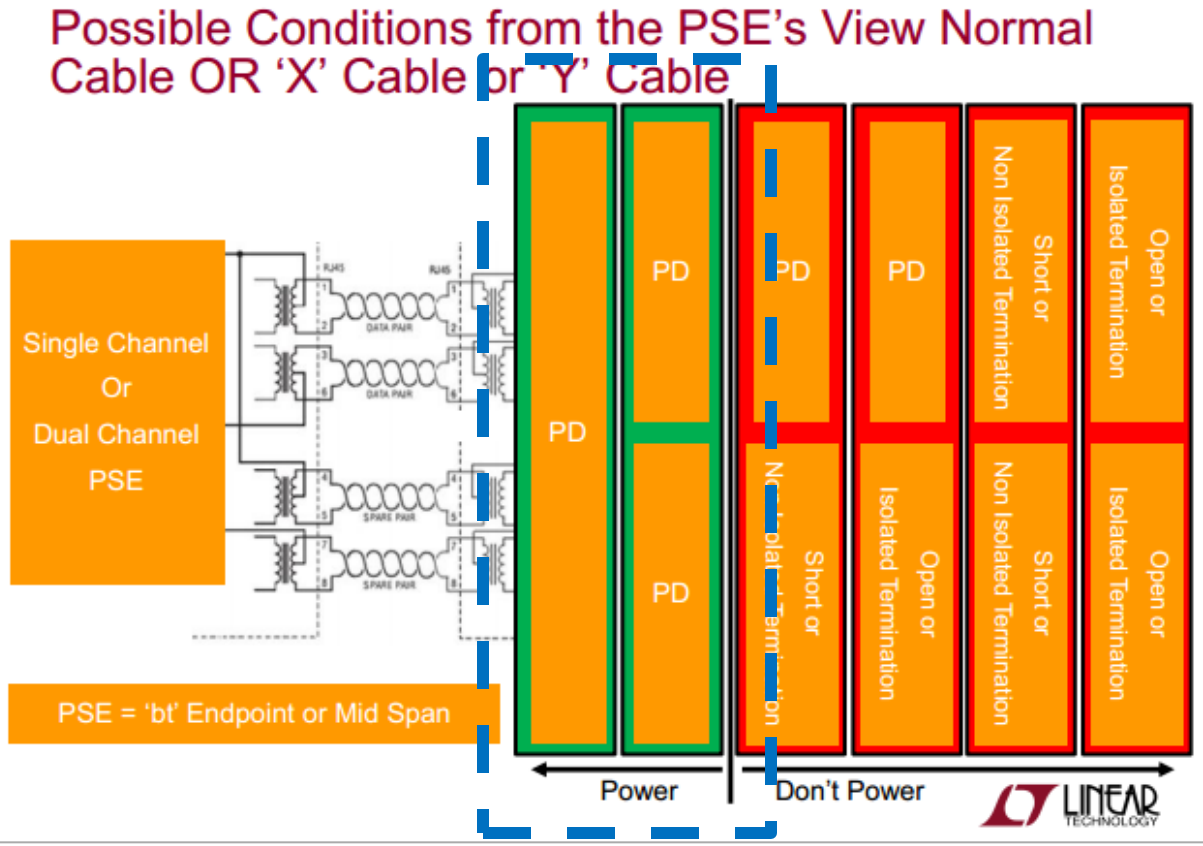
What Should Get Powered?

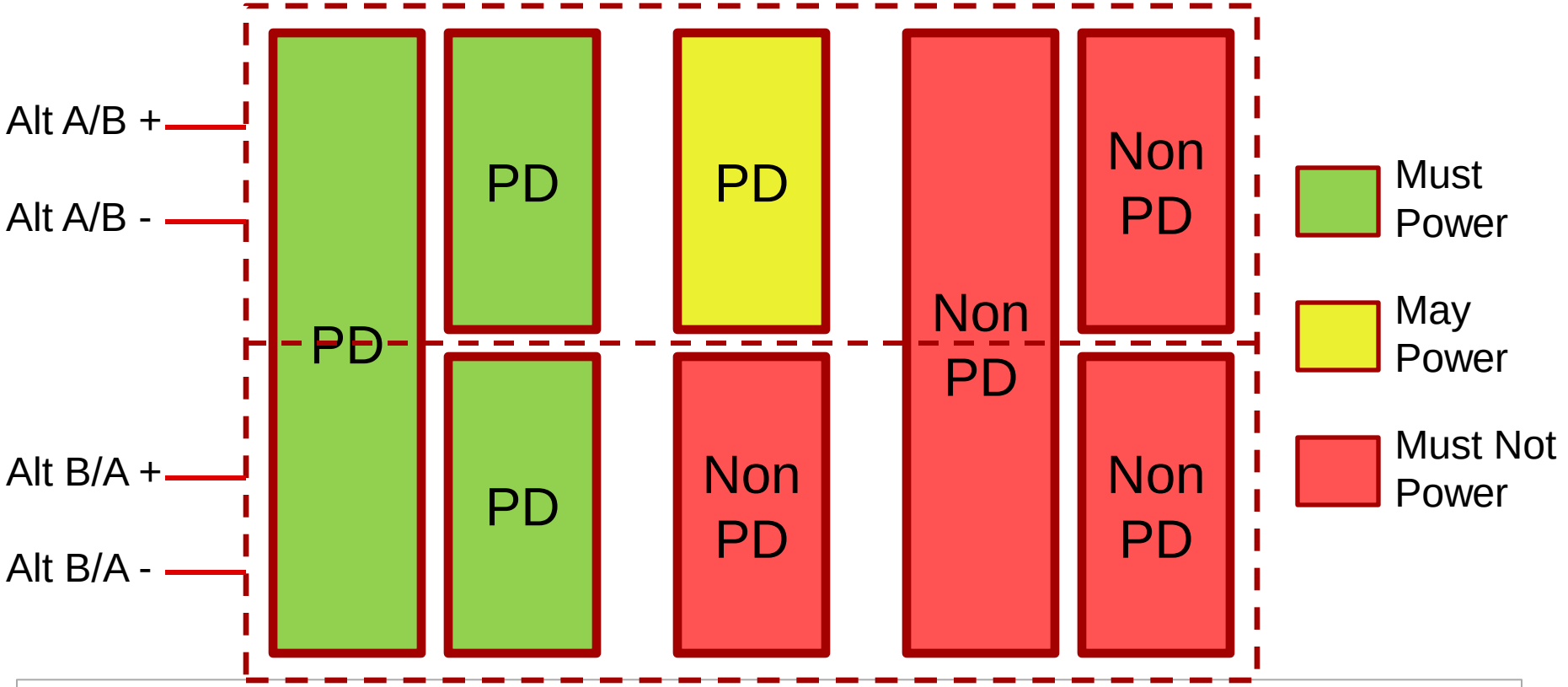
- There has been consensus on applying power when the PSE detects a single PD load or a dual PD load.
  - Dual PD can be either a single PD with two internal loads or two PDs connected by a Y-cable (PSE cannot tell the difference between the two).
  - Existing PDs can appear in this way.



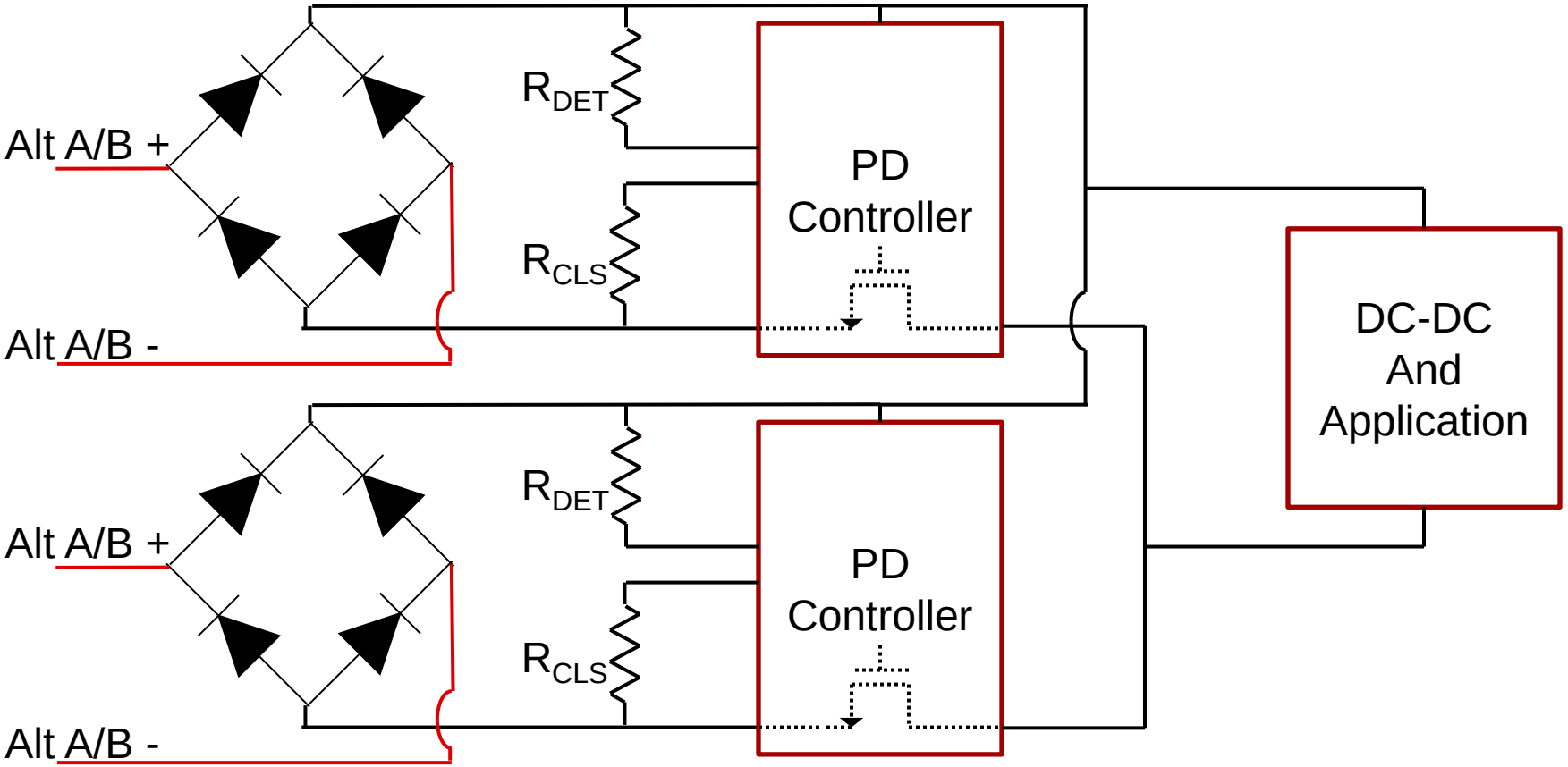
Picture taken from heath_1_0514.pdf

What Should Get Powered?

- Links with valid PDs on both alternatives need to be powered.
  - Existing Type 1/2 PDs can be built that appear as individual PDs on each pair set.
- Links with a valid PD on one alternative may be powered (system decision).
- Any alternative showing an invalid PD must not be powered.



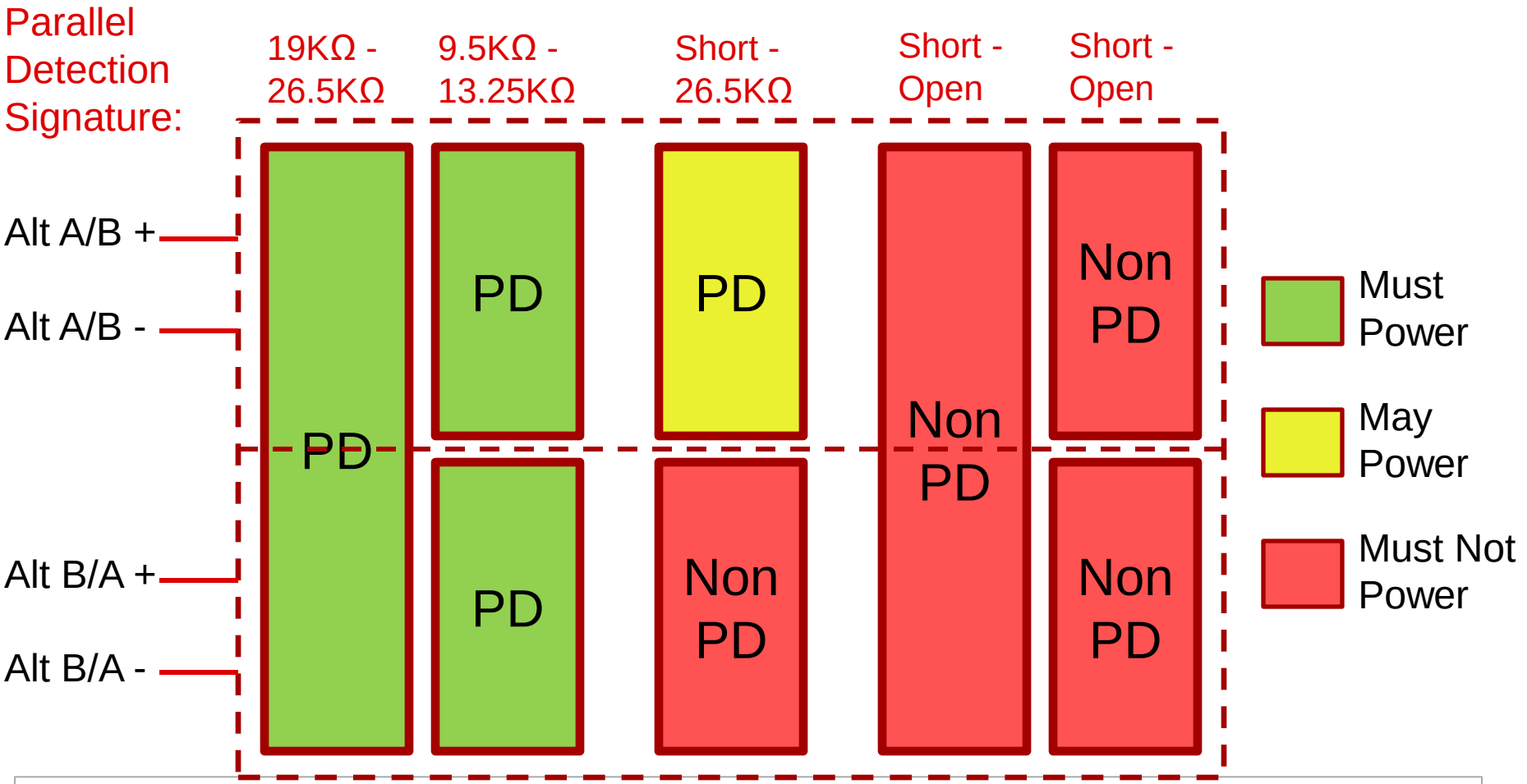
Possible Existing Implementation of a PD



- PD presents 25KΩ on each alternative.
  - Once one alternative is powered, the other alternative shows an invalid detection signature.

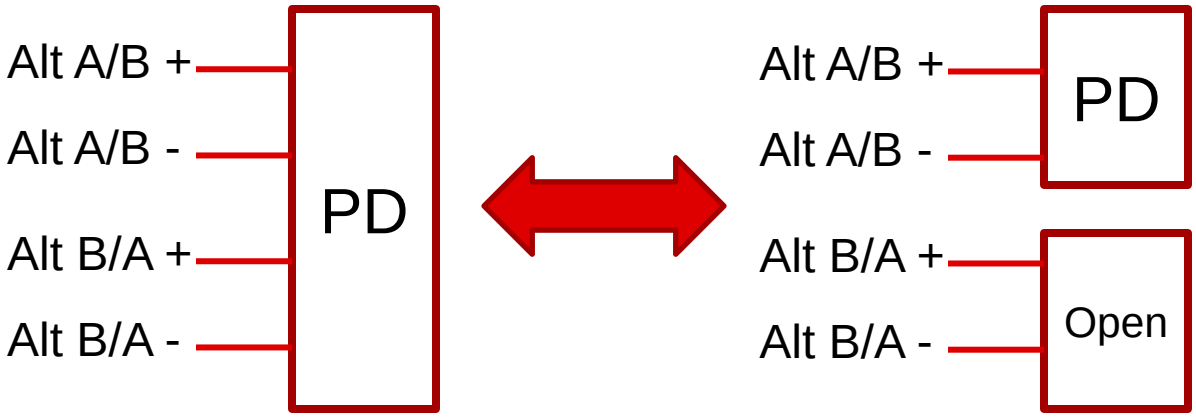
Detecting both Alternatives in Parallel

- Detecting both alternatives in parallel means that:
  - You cannot tell column 1 from column 3 if the Non-PD is a high impedance
  - You must accept detection signatures around 12.5KΩ



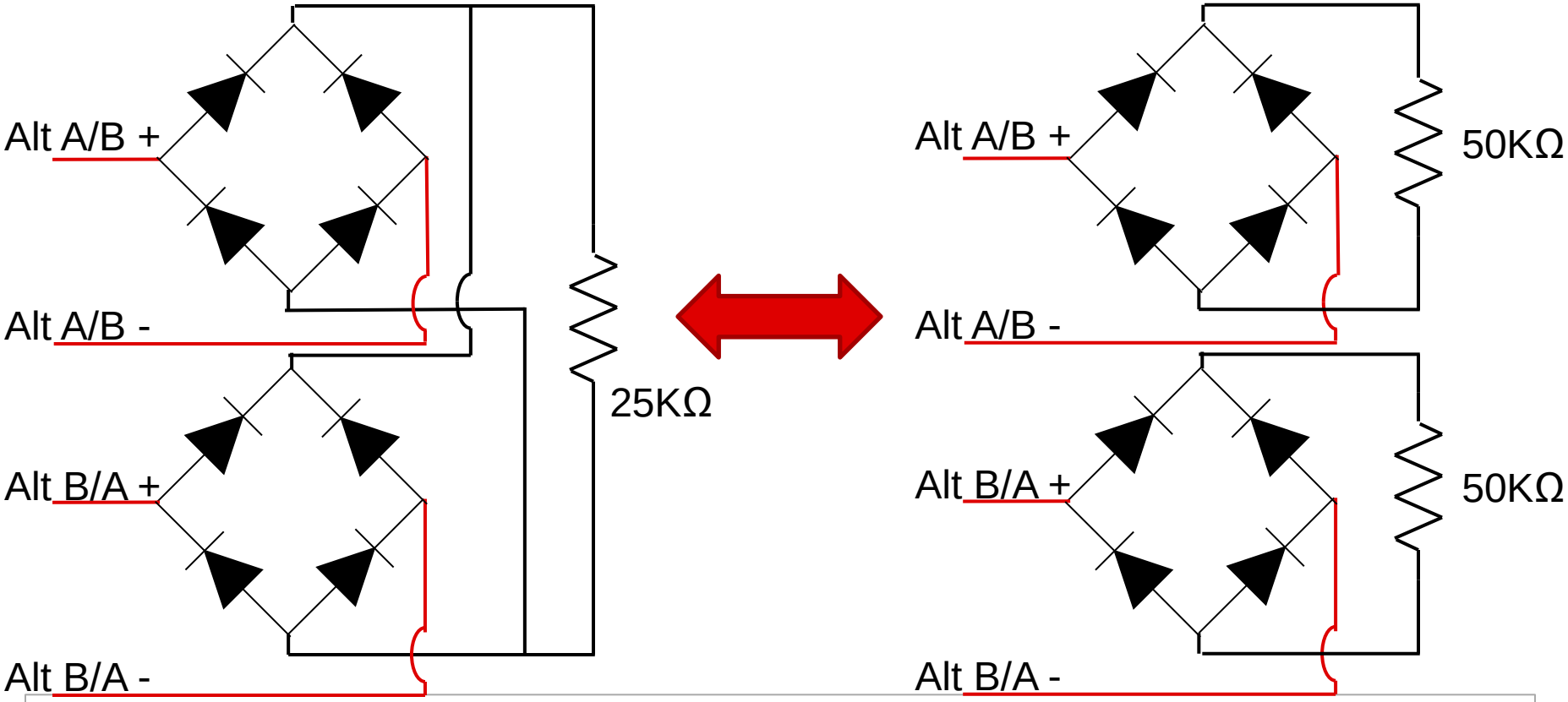
The Open Alternative Problem

- When detecting both alternatives in parallel, it is very difficult to tell the difference between:
  - A single PD interface connected to both alternatives through a bridge
  - A PD connected to one alternative and an open circuit on the other alternative.
- Both scenarios result in a valid PD detection signature.
- The result is that the PSE will power open circuits and isolated termination resistors when a valid PD is connected to only one alternative.



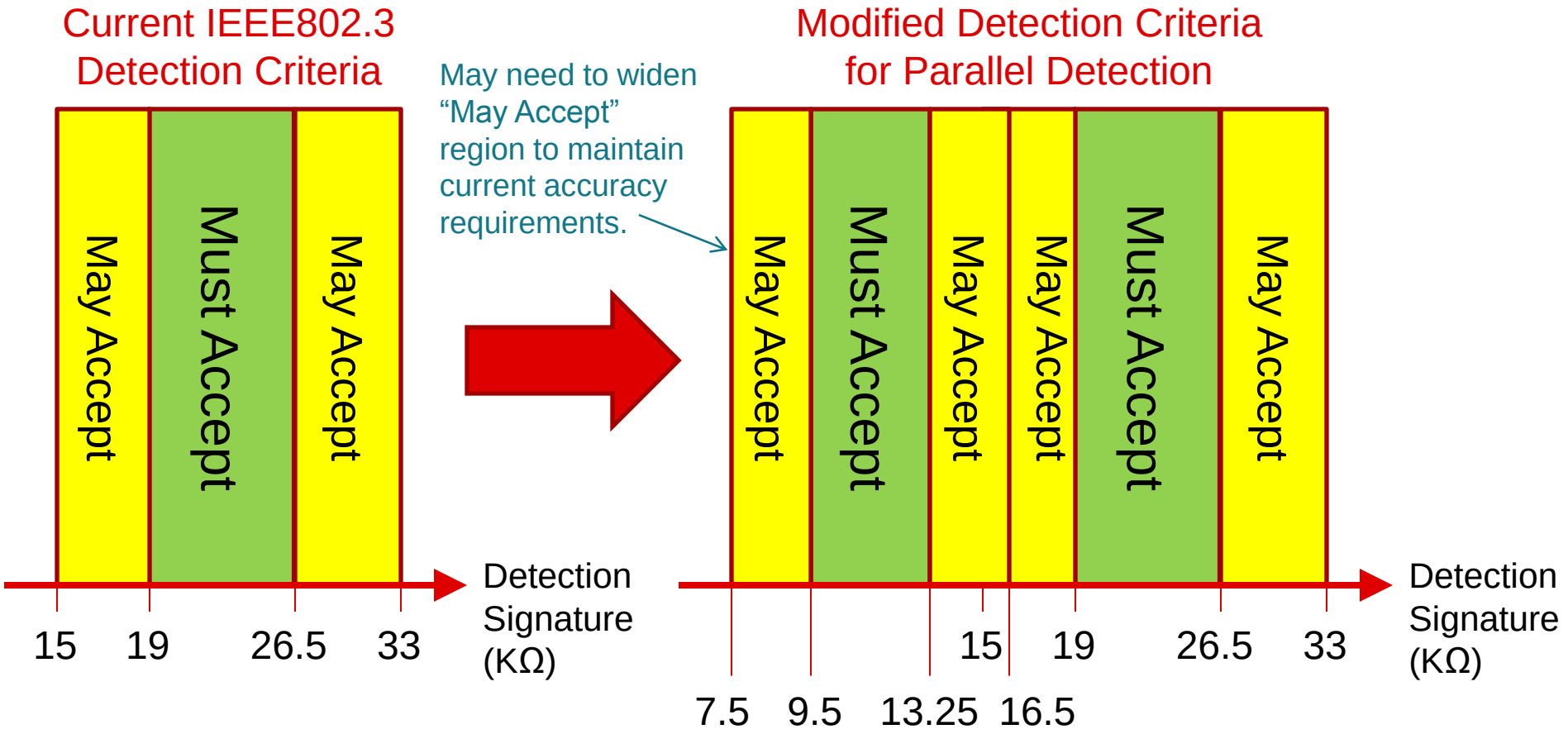
Invalid Signature Combinations

- Combinations of invalid signatures can appear in the valid detection range if detection is done on both alternatives in parallel.
  - Both PSEs and PDs in the mark state are allowed to have signatures greater than 45KΩ.
- Additional combinations of invalid signatures may produce a valid detection if the detection criteria is altered to accept 12.5KΩ (see following slides).
  - For example: Invalid signatures of 33KΩ and 15KΩ in parallel produce a 10.3KΩ signature which falls within the new acceptance range.



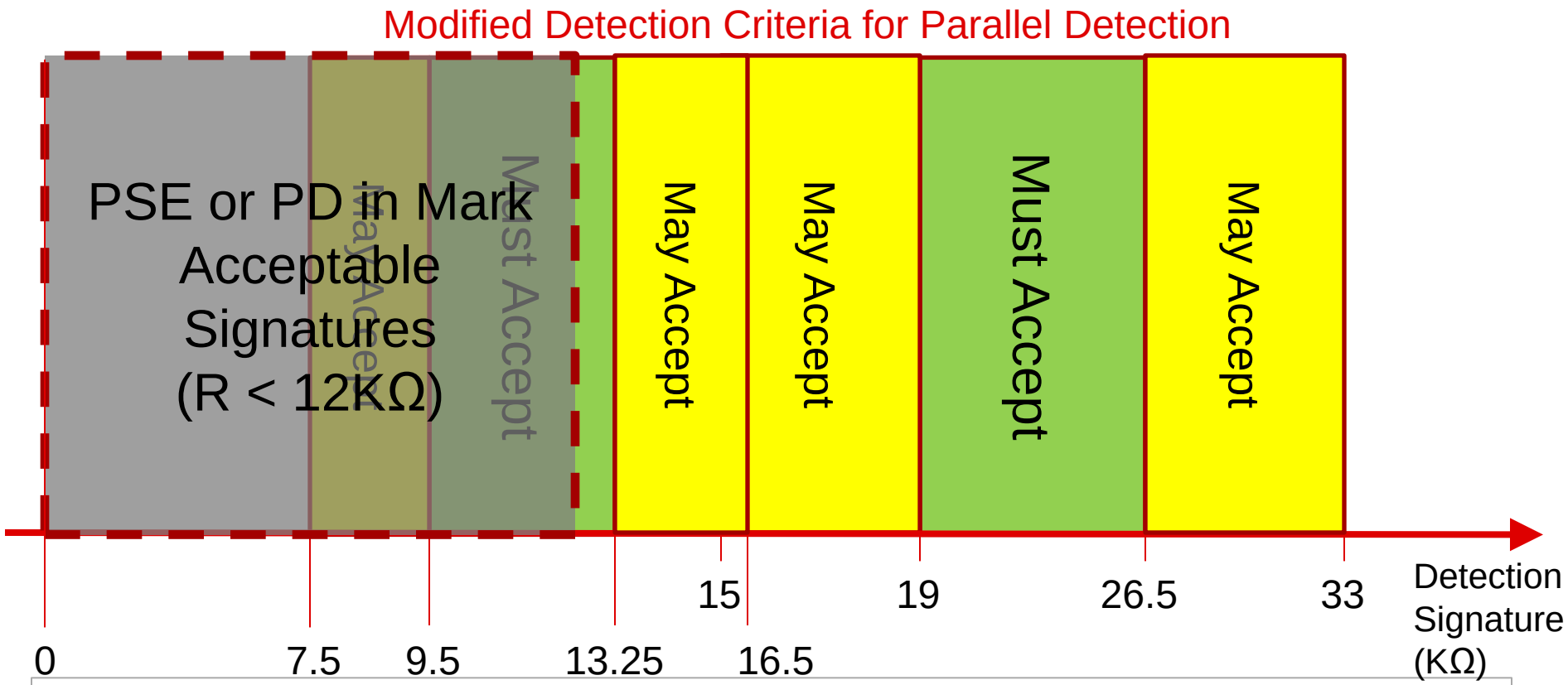
Accepting 12.5KΩ Detection Signatures

- When detection is done on both alternatives in parallel, half of the normal detection signature may be read depending on the implementation of the PD.



Problems Arising from Accepting 12.5KΩ

- According to IEEE Std 802.3-2012, PSEs may present a signature below 12KΩ or above 45KΩ.
- According to IEEE Std 802.3-2012, PDs may present a signature below 12KΩ or above 45KΩ when in the mark state.
- Parallel combinations of 2 invalid signatures can now result in a valid detection.



IEEE Std 802.3-2012: The 12KΩ Range

- Existing PSEs and PDs in the mark state can exhibit a detection signature as high as 12KΩ.

33.2.5.1 PSE detection validation circuit

The PSE shall detect the PD by probing via the PSE PI. The PSE shall present a non-valid PD detection signature as defined in Table 33–15 when probed in either polarity by another PSE. An illustrative embodiment of a detection circuit is shown in Figure 33–11.

33.3.5.2.1 Mark Event behavior

When the PD is presenting a mark event signature as shown in the state diagram of Figure 33–16, the PD shall draw I_{Mark} as defined in Table 33–17 and present a non-valid detection signature as defined in Table 33–15.

Table 33–15—Non-valid PD detection signature characteristics, measured at PD input connector

Parameter	Conditions	Range of values	Unit
R_{detect}	V < 10.1 V	Either greater than 45.0 or less than 12.0	kΩ
Input capacitance	V < 10.1 V	Greater than 10.0	μF

A non-valid detection signature shall have one or both of the characteristics in Table 33–15.

Powering PSEs

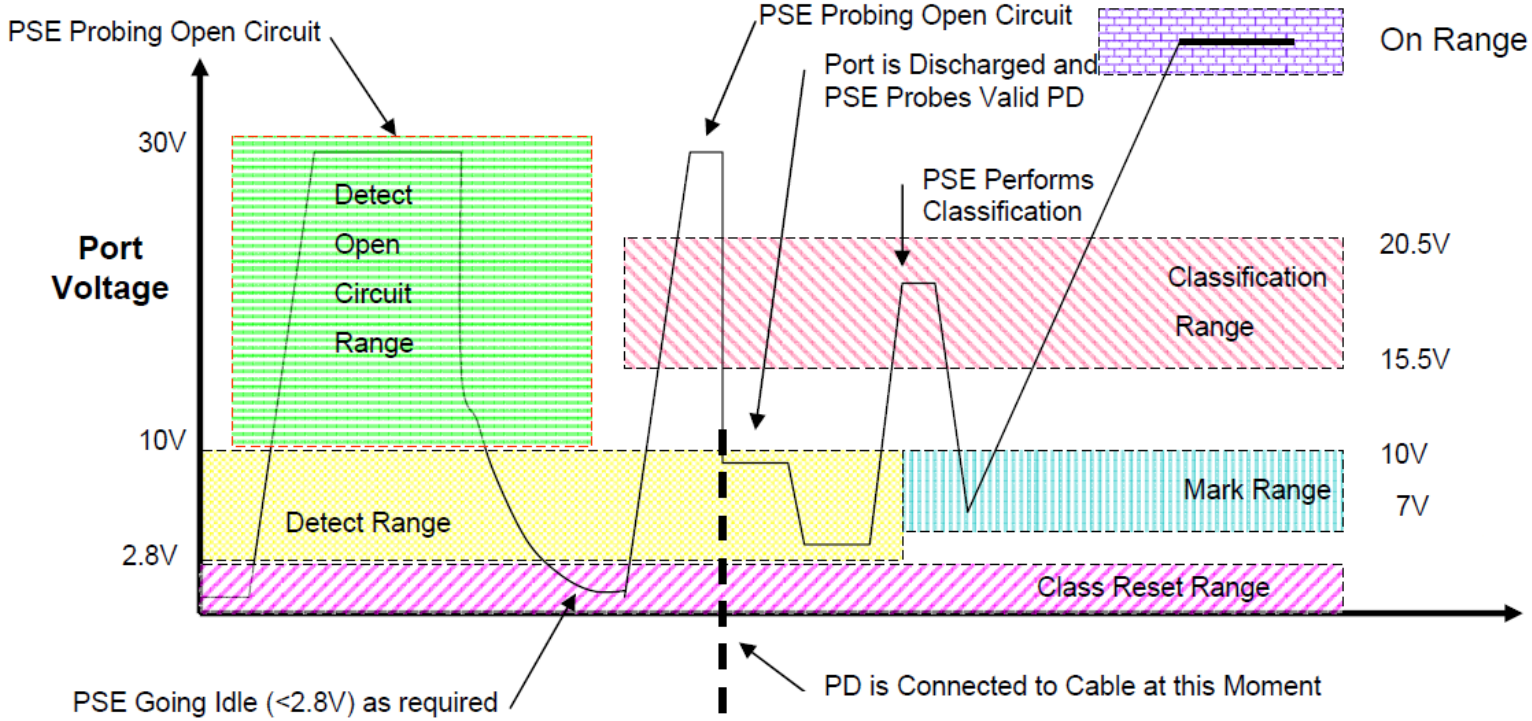
- PSEs are currently required to be able to withstand 5mA of backdriven current.
  - This corresponds to the maximum short circuit current during detection.
  - PSEs are not expected to be able to withstand higher backdriven current because they should never be powered when a PSE-to-PSE connection occurs.

The open circuit voltage and short circuit current shall meet the specifications in Table 33–4. The PSE shall not be damaged by up to 5 mA backdriven current over the range of V_{oc} as specified in Table 33–4. Output capacitance shall be as specified in Table 33–11.

Item	Parameter	Symbol	Unit	Min	Max	Additional information
1	Open circuit voltage	V_{oc}	V		30.0	In detection state only
2	Short circuit current	I_{sc}	A		0.005	In detection state only

PDs in the Mark State: Wrong Mutual ID

- If a PD in mark state is interpreted as a valid detection signature, the mutual Identification protocol will be thrown off.
  - PD can interpret the transition from an open-circuit voltage to the mark/detect range as a first class finger.
  - The PD will believe it has received an additional finger than the PSE has sent causing it to believe the PSE can supply more power than it may be capable of.



Picture from:
http://grouper.ieee.org/groups/802/3/at/public/2007/09/stanford_0907.pdf

Conclusions

- Detecting both alternatives in parallel is not sufficient to apply power safely:
  - It will allow invalid loads that produce a valid signature when in parallel to be powered.
  - It will allow powering of open circuits and isolated terminations.
  - It requires the addition of a 12.5KΩ valid detection range to maintain backwards compatibility.

- We should not change the detection criteria (accept/reject ranges) for 802.3bt. Specifically, 12.5KΩ should remain an invalid detection signature. Otherwise:
  - PSEs will be powered, and most likely damaged, as they can exhibit a 12KΩ signature.
  - Mutual identification will produce the wrong results because PDs in the mark state can have signatures as high as 12KΩ.
  - Invalid loads may produce valid signatures in the new detection range and will be powered on.