# Extended Detection Protocol for 4P PSE

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# Overview

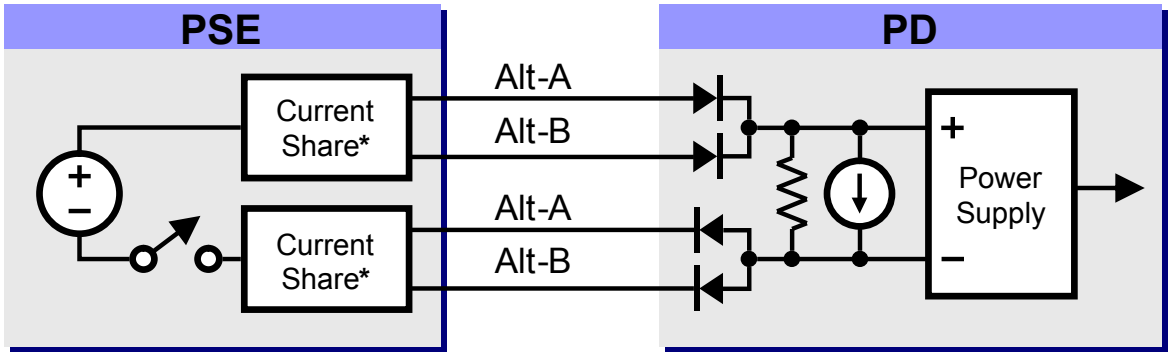
- If a 4P PSE uses a single power source, then there is a potential for putting too much current on some of the wires.
- This paper explains the problem and offers a possible solution, based on a minor extension of the detection protocol.
- This is intended to provide just one piece in the 4P puzzle, and is not in any way a total solution.
- A complete comparison of single-source vs. dual-source topologies is outside the scope of this presentation.

# Quick Review of 4P Topologies

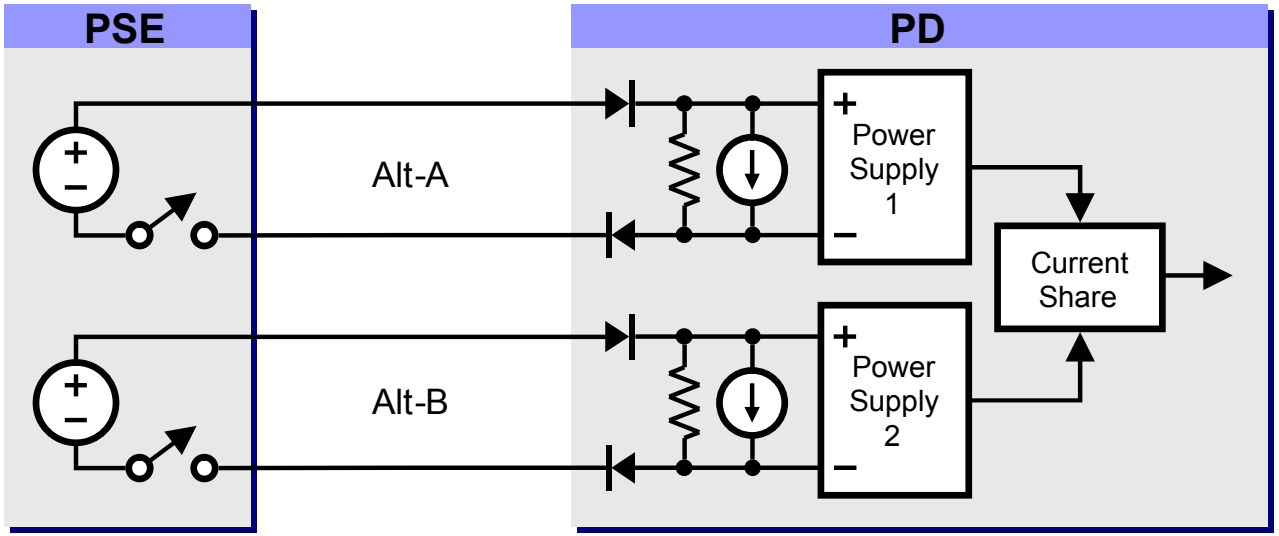
## The Two Major Topology Categories

### Single-Source Topology

*Could be active or passive.




### Dual-Source Topology




**Symbol Legend**

= Class Signature

= Detection Signature

# One Key Difference

- In the case where the PD requires very high power, a Single-Source 4P PSE might put too much current on the wiring, possibly causing overheating.
  - A midspan could block 2 pairs.
  - Some cables might have only 2 pairs.
  - The pairs could be split between two PDs.
- A Dual-Source 4P PSE wouldn't overheat the wiring.
  - Each source would be current-limited to a level that 2P can reliably carry.
  - If only 2 pairs are present in the wiring, then only one supply sources current.

# Fixes For Single-Source

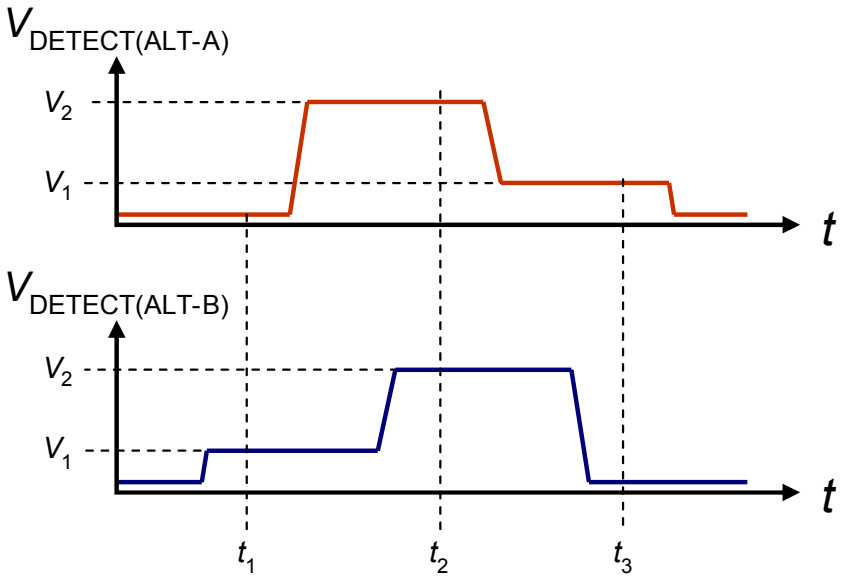
## To Eliminate a Key Advantage of Dual-Source

- One possible solution could be to use the current-sharing circuits as sensors.
  - If a severe imbalance occurs on both top and bottom circuits during classification, then only 2 pairs are present in the wiring.
  - But this method wouldn't tell you if the 4 pairs have been split between two PDs.
- A better solution is to sense the wiring during detection.
  - Several schemes are possible.
  - To show technical feasibility, one scheme is detailed on the next 4 slides. (This is for example only; I'm not suggesting that the standard should define any specific waveforms.)

# Extended Detection Protocol

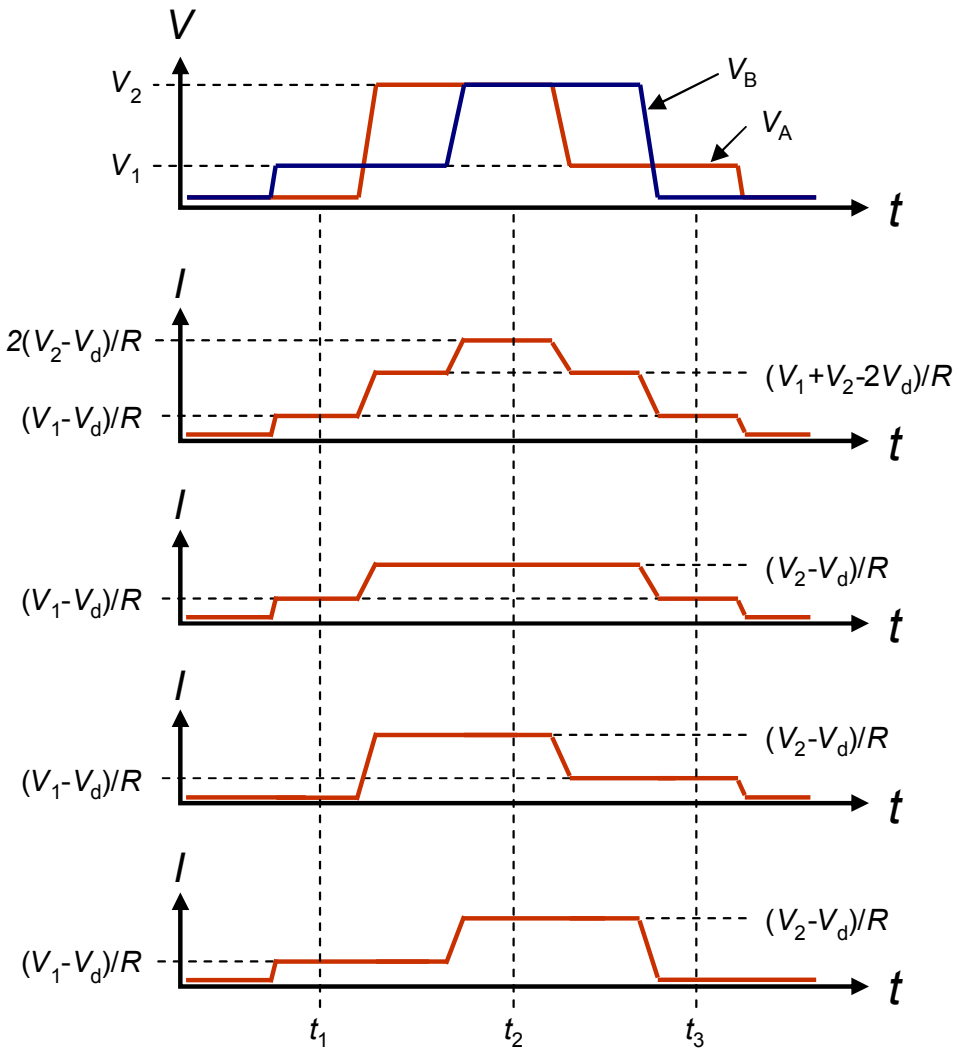
## One Possible Implementation

- A 2P PSE would still follow the original 802.3af protocol.
- But a single-source 4P PSE must look for detection signatures on both Alt-A and Alt-B.
- This example scheme probes Alt-A and Alt-B concurrently, but with one waveform reversed and shifted.
- By looking at the combined return current at only 3 points, all possible scenarios are determined.

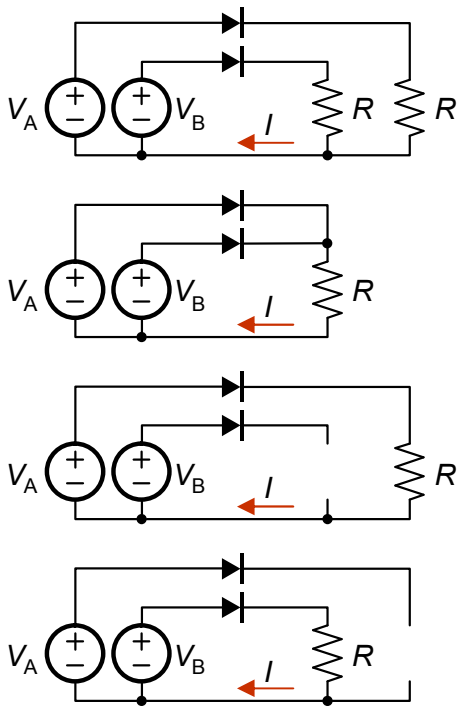


# Extended Detection Protocol

## Example Waveforms




*I* = The total combined current through both sources.




**CASE 1**
**Two separate PDs**
(Don't turn on)

**CASE 2**
**PD on all 4 pairs**
(Turn on, allow full power)

**CASE 3**
**PD on Alt-A only**
(Turn on, allow half power)

**CASE 4**
**PD on Alt-B only**
(Turn on, allow half power)

# Extended Detection Protocol

## Error Analysis

- The worst-case analysis for cases 2 thru 4 from the previous slide is unchanged from 802.3af.
- But can case 1 be mistaken for case 2? *No.*
  - The PSE sees

$$R_{MEASURED} = \frac{R(V_2 - V_1)}{2(V_2 - V_d) - (V_1 - V_d)}$$

  - The worst-case is when $R_{MEASURED}$ is maximized

$$R_{MEASURED} = \frac{26.25k(10 - 2.8)}{2(10 - 2) - (2.8 - 2)} = 12.43k$$

  - The minimum threshold in the PSE is 15k, so it will reject this signature.

# Extended Detection Protocol

## Calculations and Logic

- Resistance range tests
  - Measurements: Let $i_1=I(t_1)$, $i_2=I(t_2)$, $i_3=I(t_3)$
  - Constants: Let $\Delta I_{MIN}=(V_2-V_1)/R_{MAX}$ and $\Delta I_{MAX}=(V_2-V_1)/R_{MIN}$
  - Calculations:
    - Let ***A*** be true if $\{\Delta I_{MIN} < i_2-i_3 < \Delta I_{MAX}\}$ and false otherwise
    - Let ***B*** be true if $\{\Delta I_{MIN} < i_2-i_1 < \Delta I_{MAX}\}$ and false otherwise
- Interpreting the results

| ***A*** | ***B*** | **PD Detected** | **Proceed to Classification** | **Classification may Grant PD Power Requests up to:** |
|---|---|---|---|---|
| F | F | Two 2P or none | No | N/A |
| F | T | 2P on Alt-B | Yes | Half power |
| T | F | 2P on Alt-A | Yes | Half power |
| T | T | Single 4P | Yes | Full power |

# Summary

- If a Single-Source topology is used for 4P, then it must be able to sense the wiring in order to avoid potential overheating.
- The maximum power request that can be granted must be a function of how many conductors are actually present.
- The example detection protocol presented here would allow a 4P single-source PSE to:
  - Determine if the wiring has 4 pairs or just 2.
  - Verify all 4 pairs go to the same PD.
- Impact on system cost and complexity is minimal:
  - 2P PSE and PDs are not affected at all.
  - 4P PSE must be able to probe both Alt-A and Alt-B (but that was inevitable).
  - Only 3 data points per detection cycle.
  - None of the timing or voltage parameters in 802.3af need to change.
- This extended protocol would link Detection and Classification.