IEEE802.3at Task Force

Flexible PD implementation driven Architecture

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Rev 001

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PowerDsine

Purpose of this presentation

- Target
- Allows Broad PDs Market
  - Flexible PD implementations as long as technically and economically feasible
  - Ensuring interoperability
  - Functional reliability
  - Safety
  - Keep Heat Dissipation Low
- Resulting with More ports in PDs market
- More PSE/Ethernet port

Terms and Abbreviations

- MP = Medium Power
- HP= High Power = 2x MP
- P=Power [W]
- O = Need to be met by objectives
- 5C= Need to be met by 5 Criteria

Assuming the following

- Supporting the following PD types
  - 802.3af, 802.3at 2P, 802.3at 4P single load
  - 802.3at 4P dual load
  - 802.3at 4P with and without current sharing
  - 802.3at 4P = 2 x 802.3af/at channels with single load

Possible PD implementations in the market

#	PSE Port	PD type	PD load	Cable	Requires Current Sharing
1	802.3af	-802.3af (O,5C)	single	2P or 4P	NO
2	802.3at 2PMP	-802.3af (O,5C) -802.3at 2PMP	single	2P or 4P	
3	802.3at 4PHP	-802.3af (O,5C)	single	2P	
		-802.3at 2PMP		2P or 4P	
4	802.3at 4PHP (Same port, box, Ground and Voltage Diff <TBD= ENV A)	-802.3at 4PHP	single	4P	**YES,** if TBD<P<MP **NO,** if P<TBD **or** functional isolation at the primary side of the PD.
5			Dual independent		**NO**, if each channel is functionally isolated at the PD side. It is the same PD hence works with layer 2.

Notes

1. Current sharing is not required only if **|I1-I2|<Idiff<Icut** otherwise overload condition will happen. **Idiff** is function of **pair (I1) to pair (I2)** channel imbalance model.

2. If current sharing is located in PD then no special signature required for case 4 and 5.

3. If in **case 5** the loads are different i.e. **P1 and P2** then **dual class signature** is required if we need to know who gets what **(due to additional info received from layer 2)** and not only the total power. In addition it helps PSE to decide if turn off all channels in case 4 or not in case 5 for mission critical applications which use redundant hardware in PD

Possible PD implementations in the market

#	PSE Port	PD type	PD load	Cable	Requires Current Sharing
6	802.3at 4PHP (Same Box, Port and Ground. Voltage Diff<TBD)=ENV A **Layer 2 issues**	2 x 802.3af 2 x 802.3at 2P MP Splitted TOs	Dual independent	4P	NO. Each channel is functionally isolated
7	2 x 802.3at 2PMP **OR** 2 x 802.3at 4PHP **Different boxes	2 x 802.3af 2 x 802.3at 2P MP Splitted TOs	Dual independent	4P	NO
8	2 x 802.3at 2PMP (or 2x802.3af) **Different boxes	802.3at 4P HP	single	4P	YES for any P. ** -Requires ENV B isolation. -Reduced available power -Increase power dissipation -Increased cost. -No issue if in PD and is not precluded by the standard
9	2 x 802.3at 2PMP (or 2x802.3af) **Different boxes	802.3at 4P HP	Dual independent	4P	NO

Possible non operational conditions

#	PSE Port	PD type	PD load	Cable	Comments
9	802.3af	802.3at 2PMP	single	2P or 4P	-May not work. -PD indication is issued. (O)
		802.3at 4PHP	Single or Dual	2P or 4P	-May not work. -PD indication is issued. (O) -Do we need separate indication for 4P?
10	802.3at 2PMP	802.3at 4PHP	Single	4P	
11	802.3at 2PMP	802.3at 4PHP	dual	4P	-May work

What is the common denominator …

- PDs can be implemented in many ways according to application
- Complexity is implementation dependent and not specification issue, over time implementations will be converged to the simplest, lowest cost and market driven needs.
- Current Sharing in 4P is not always needed. It depends on Power level. The breaking point should be specified according to the channel pair to pair imbalance model
- PD vendors know according to power needs (current level) which Current Sharing implementation to use (Active, Passive, None)
- Hence current sharing function is best to be in the PD. Otherwise, it will be needed in PSE regardless of PD type in 4P PSE and we will narrow the type of PD usage, applications and implementations and unnecessary added cost for the PSE.

Single vs Dual Classification Signature

- Adding additional class signature to the 2nd 2P is not significantly increase the cost of the PD (<<0.3%).
- Allows unique distinction between
  - 4P PD single load and 4P dual independent load
    - Different power allocation results and turn OFF after OVLD behavior
  - Dual independent load that requires different 2P class code for each 2pair
    - P1 for pair #1 P2 for pair #2.
    - Different shut down after overload behavior according to application (mission critical or not etc.)

Proposal Concept

- To define requirements at the PD RJ45 (PI) in terms of voltage, current, current difference, timing etc SO ANY PD implementation will have to meet it.
- Current Sharing proposed to be in the PD. Current sharing operating range should be defined based on the Over Load (Icut) region and pair to pair imbalance model.
- Detection and classification signatures on each 2P
- Classification table support 2P MP PD classes and 4P HP PD classes.
  - Allowing to uniquely distinguish between af, at 2P, at 4P and Splitted TO configuration
- Modifying the concept of the Back Off function in order to distinguish between splitted or single load 802.3af/802.3at 2P PDs connected to 4P 802.3at PSE (may not be required if splitted TOs are excluded from the standard)
- Limit turn ON time between pairs only if 4P PD is detected which will simplify even more the PD 4P design.

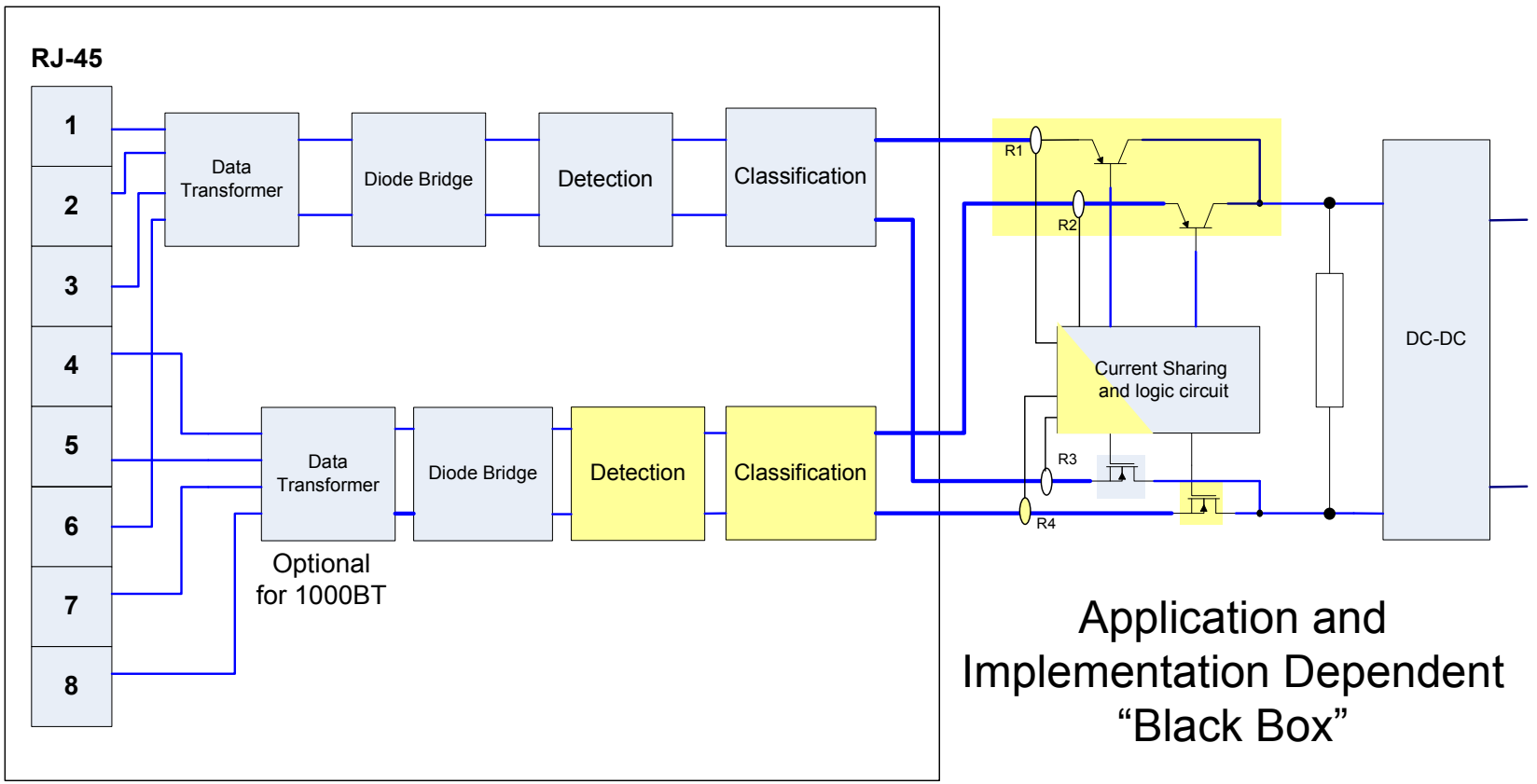
Classification Table - Example

Class code #	PD type	2P MP	4P HP	PD Power[W]	Notes
0	802.3af	802.3at 2P		0.44 – 12.95	
1	802.3af	802.3at 2P		3.84	
2	802.3af	802.3at 2P		6.49	
3	802.3af	802.3at 2P		12.95	
4		802.3at 2P		2	
5		802.3at 2P		9	
6		802.3at 2P		15	
7		802.3at 2P		20	
8		802.3at 2P		25	
9		802.3at 2P		30	
10		802.3at 2P		Reserved	
11		802.3at 2P		Reserved	
12			802.3at 4P	20	Do we want to support lower value for overlapping in order to increased efficiency and utilization?
13			802.3at 4P	25	
14			802.3at 4P	30	
15			802.3at 4P	35	
16			802.3at 4P	40	
17			802.3at 4P	45	
18			802.3at 4P	50	
19			802.3at 4P	60	
20			802.3at 4P	Reserved	

Implementation independent parameters set at the PI (RJ45)

- Voltage
- Current
- Current difference
- Max time delay between each 2P Power ON voltage
- Status and indications per 2P
- Power Class info per 2P. Separate codes for 2P and 4P
- Modified Back Off function
- Isolation requirements are the same as 802.3af.
  - No need for changes. Functional isolation may required however it is implementation issue and not always required.

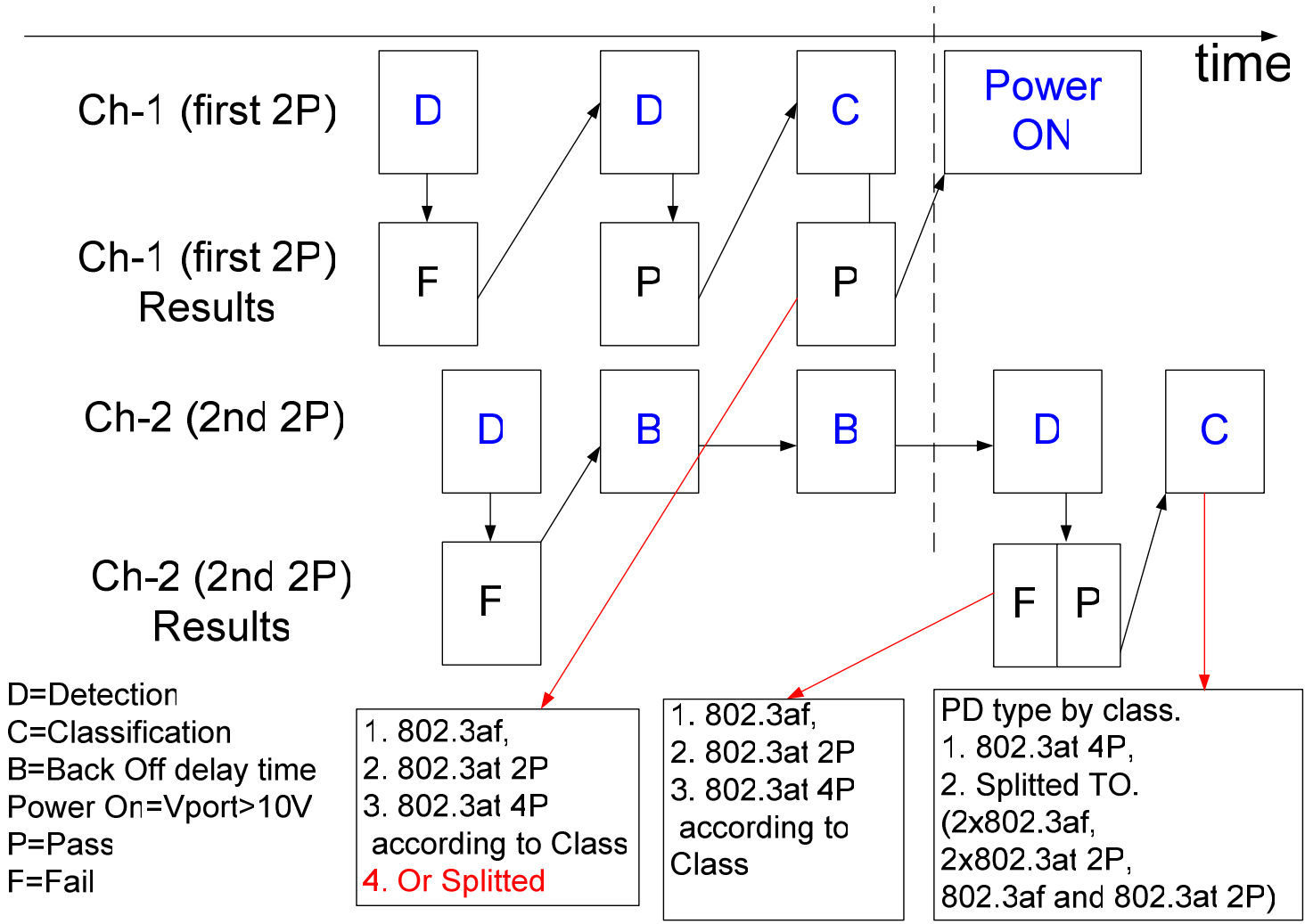
Scope of work



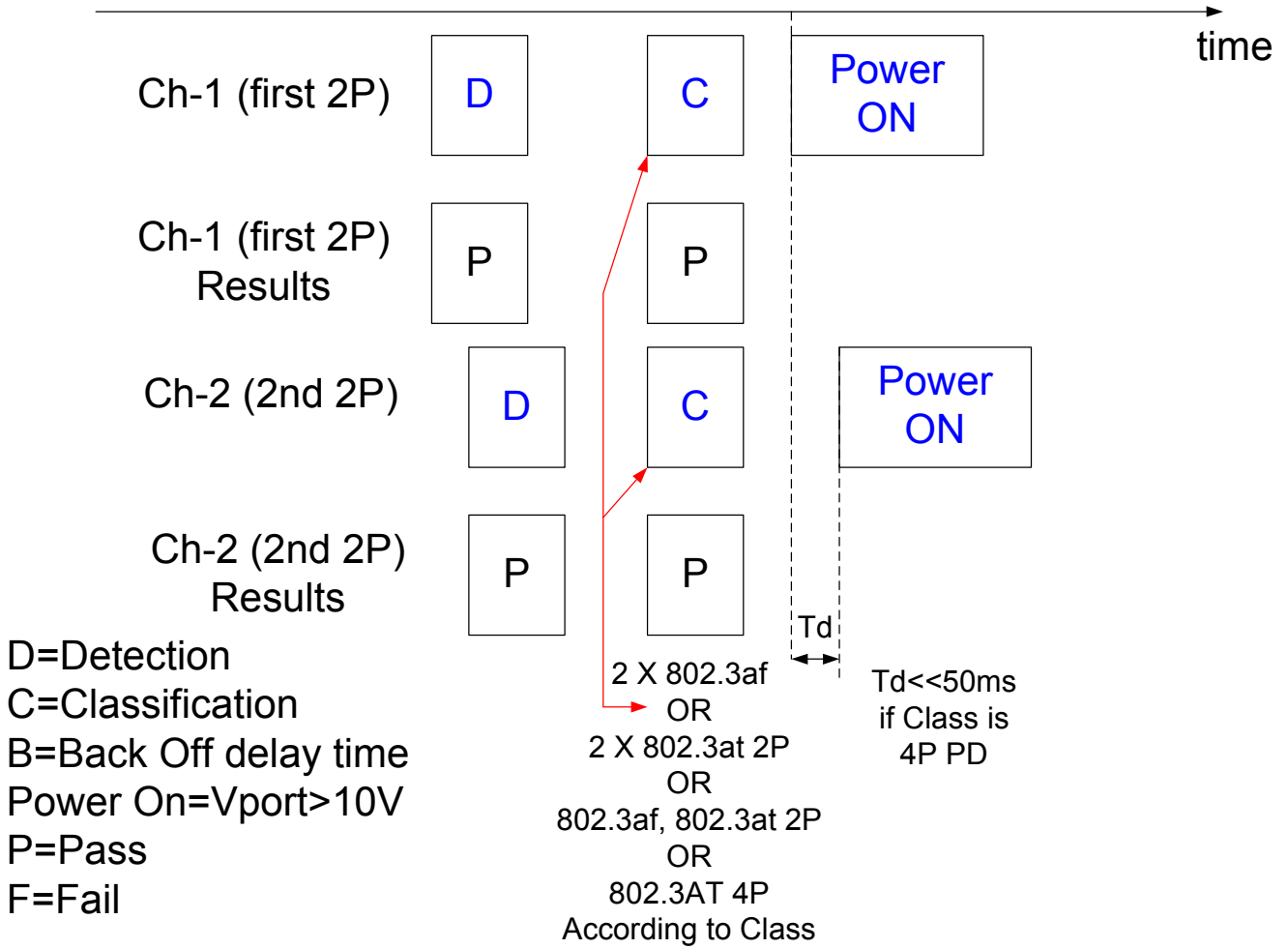
Application and Implementation Dependent "Black Box"

To be defined by the specification to have implementation independent case

How to get unique distinction objective - 1



How to get unique distinction objective - 2



How to get unique distinction objective - 3

- We can draw the algorithm Flow Chart and see (I hope..) that almost or all relevant cases are covered by knowing the following:
  - IF detection Pass on both channels or not.
  - If Detection on 2nd pair passed while power on 1st pair is ON (Vport >10V)
  - What is the class: 802.3af, 802.3at 2P, 802.3at 4P?

Example – 4P PD, Different implementations

Class code #	PD type	2P MP	4P HP	PD Power[W]	Notes
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5		802.3at 2P		9	
6		802.3at 2P		15	
7		802.3at 2P		20	
8		802.3at 2P		25	
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16			802.3at 4P	40	
17			802.3at 4P	45	
18			802.3at 4P	50	
19			802.3at 4P	60	
20			802.3at 4P	Reserved	

Suggested PD specification

- See Attached PD specification in separate document for implementation independent PDs

Summary

- PDs implementation is a function of the application and market needs. Needs is an unknown variable.
- We may need to try to support all as long as it is technically and economically feasible
- Current Sharing in 4P is not always needed and is application and implementation issue.
  - PD vendors know according to power needs (current level) which implementation to use (Active, Passive, None)
  - The breaking point should be specified according to the channel pair to pair imbalance model
- Hence current sharing function is best to be in the PD and not in PSE
- 802.3at 2P PD interface is similar to 802.3af interface
- 802.3at 4P PD interface requires detection and Classification Signature for each 2P.
- Different class codes for 2P and 4P PDs enhance unique PD types distinction
- Modified Back Off algorithm for 4P PSE allows distinction between separate PD loads over 4P cable and 4P single PD (May not required for some system configuration. To be decided later)
- No need for new isolation requirements
- Need to define pair to pair turn on delay time only if 4P is detected
- No significant effects on Detection, Classification and power on timings per 2P
- Max 1sec between detection end to power on is OK however we can keep the 400ms if working in parallel

Open Questions

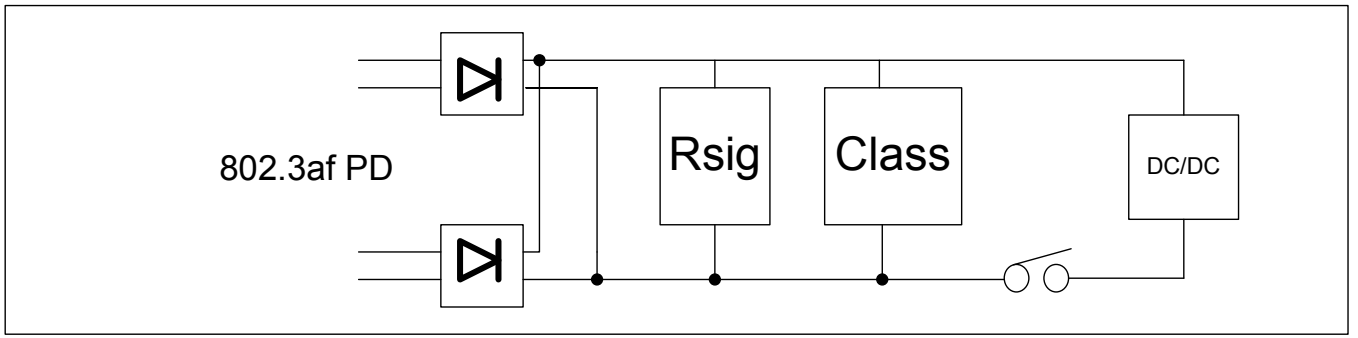
- Which system configurations we want to support
- What is the extent of 2p/4p class overlapping?
  - A function of efficiency, power supply utilization and number of classes we wish to support
- What is the point in which current sharing is not required
  - A function of pair to pair imbalance model

Annex

802.3af PDs – PD side

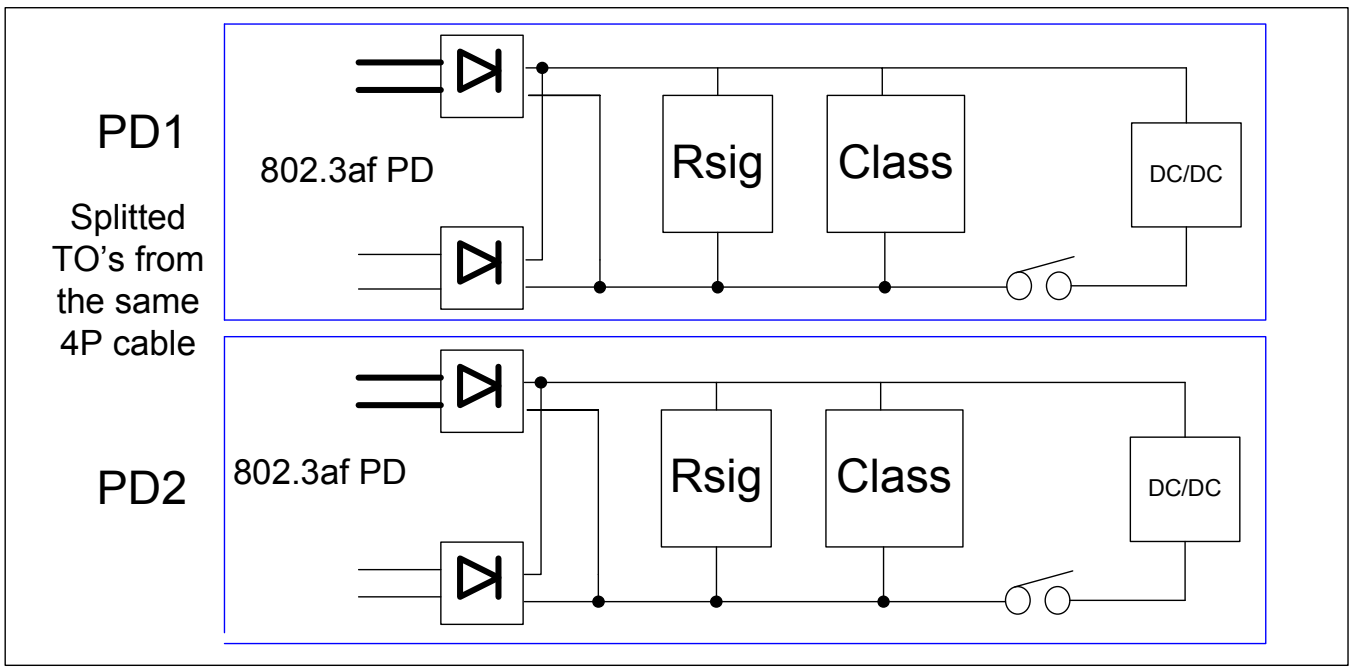
-Single Signature

-Need to be supported by objectives

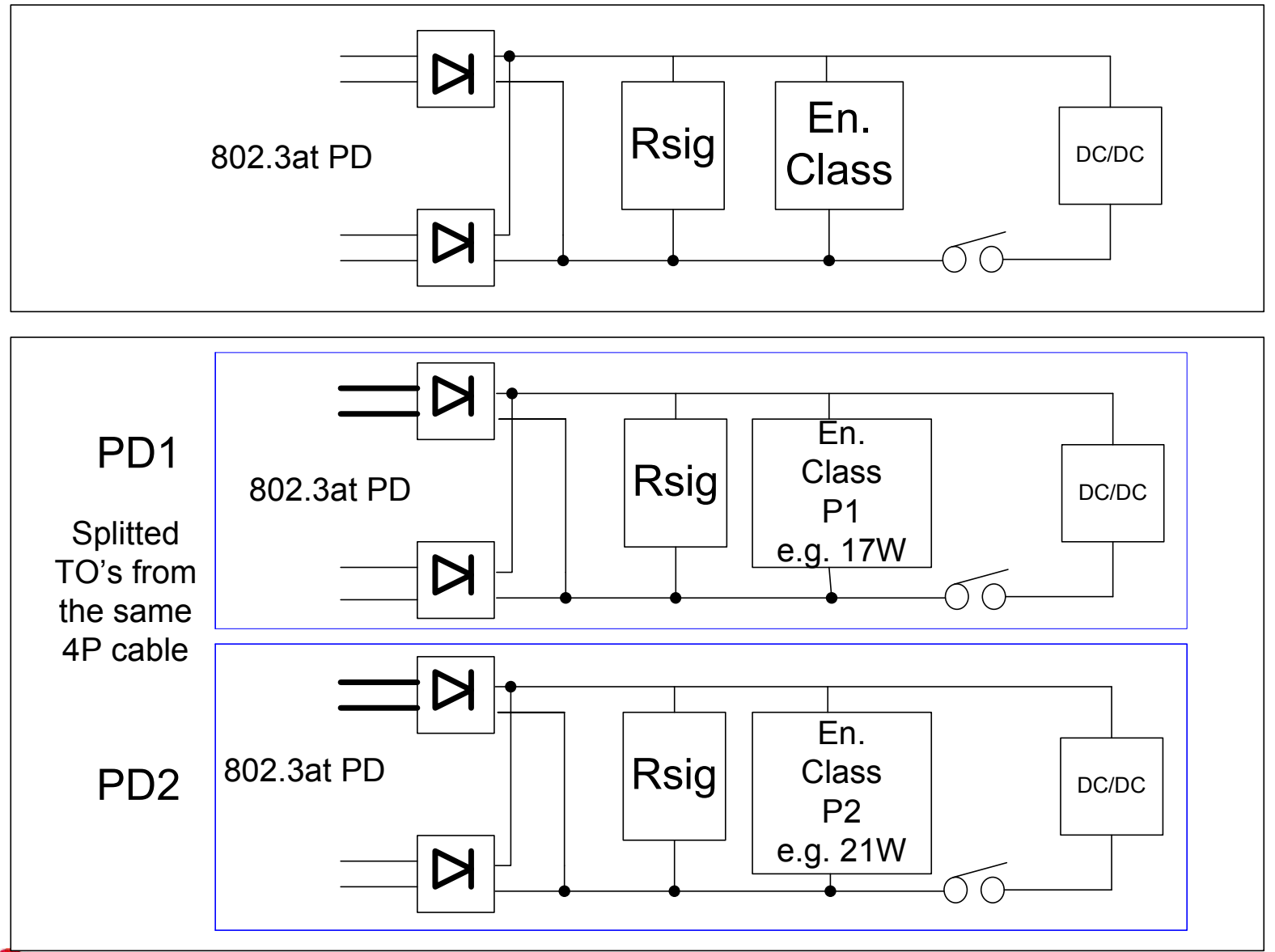


-Single Signature

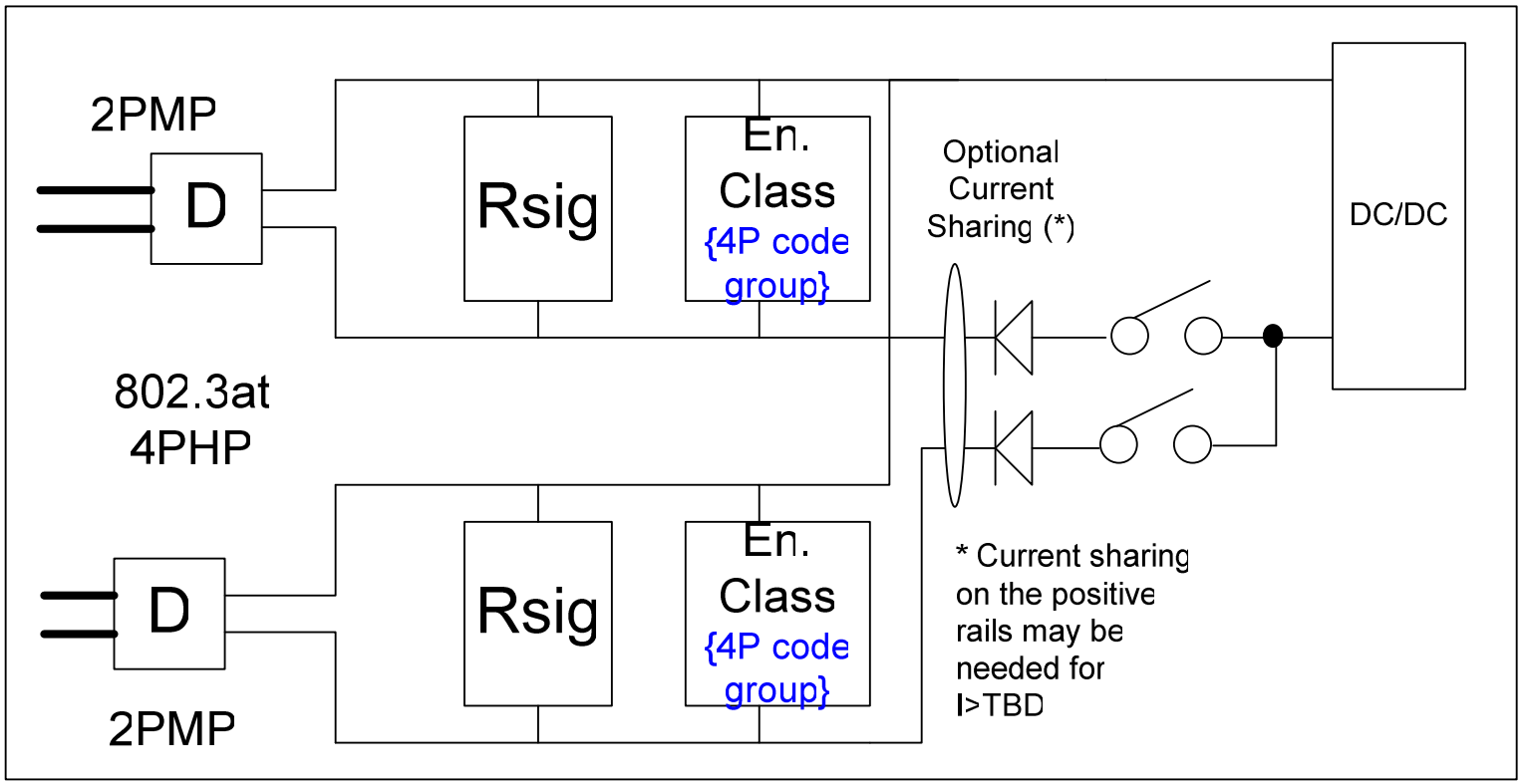
-Need to be discussed



802.3at 2P MP PDs – PD side



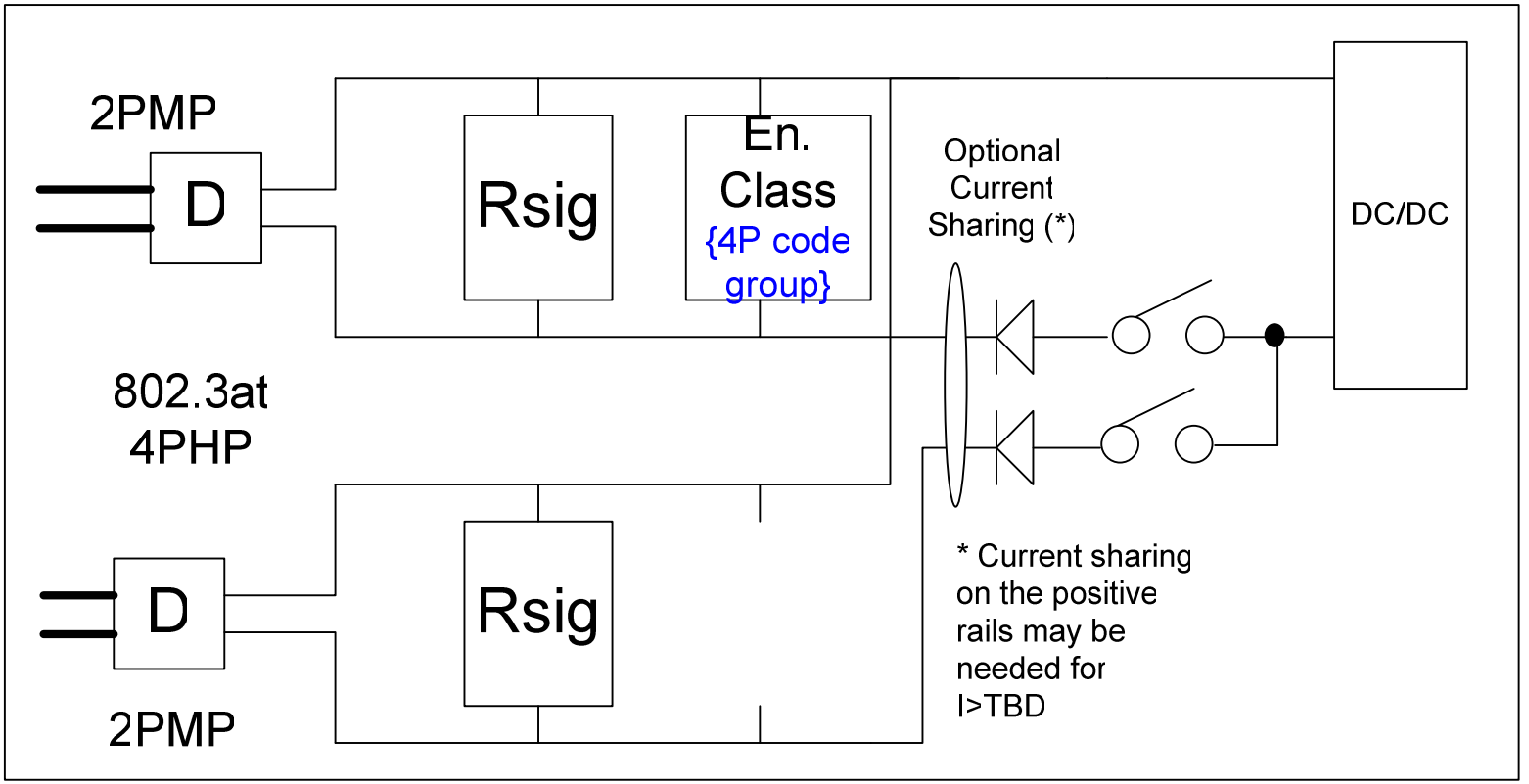
802.3at 4P HP PDs – PD side, dual class sig.



In this example each 2P advertise a 4P class on each pair. e.g for 60W PD, each 2P advertise Class 60W which is detected as 30W per each 2P.

Unique identification between single load 4P PD and 4P PD with dual independent loads

802.3at 4P HP PDs – PD side, single class sig.



In this example single class is used to identify 60W single load PD.

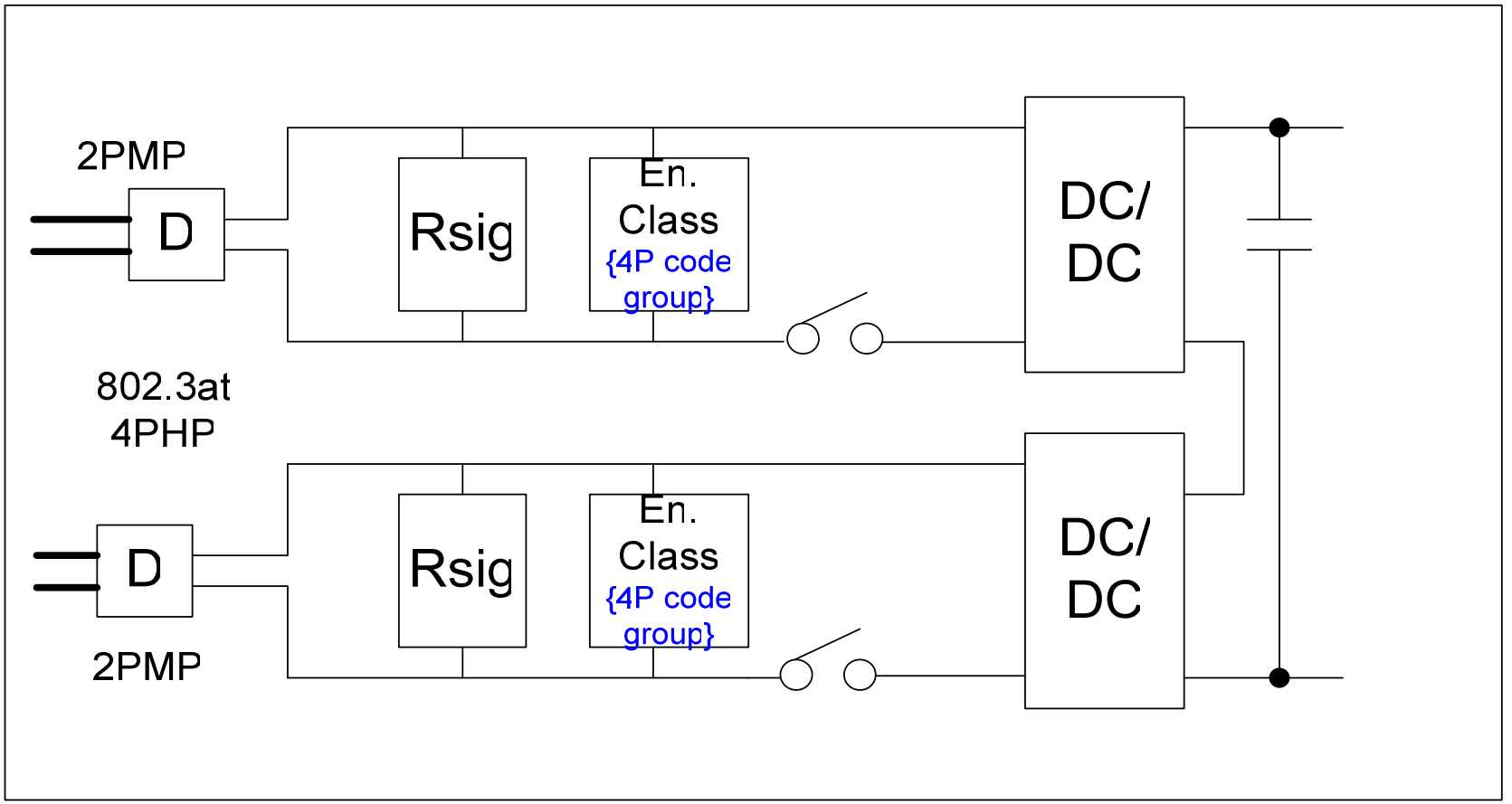
Problem: If current sharing in PSE, overload problems or excessive heat in PSE when 4P PD with independent loads is used.

Possible Solution:

-Current sharing is located in 4P PD and not in PSE.

- If 2P cable is used, class may be not red (cross cable or ALT B configuration) hence unique identification will not be achieved (af vs at..) hence dual class code may solve this issue.

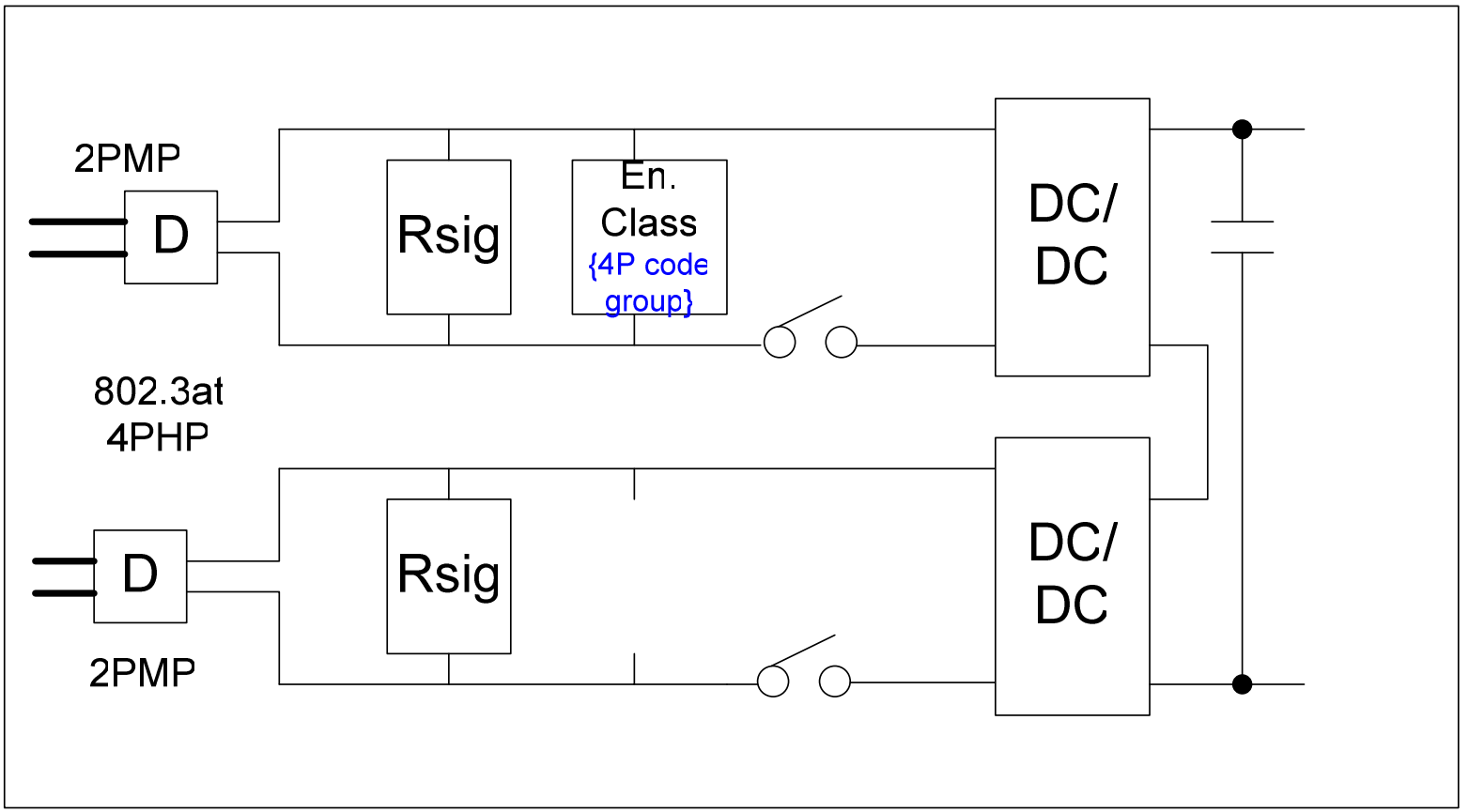
802.3at 4P HP PDs – PD side , dual class sig.



Simplified 4P PD without the need for Active Current Sharing in most high power applications

In this example each 2P has DC/DC however they operate as a single 4P PD (Single load) uniquely identified by special 4P class code.

802.3at 4P HP PDs – PD side , single class sig.



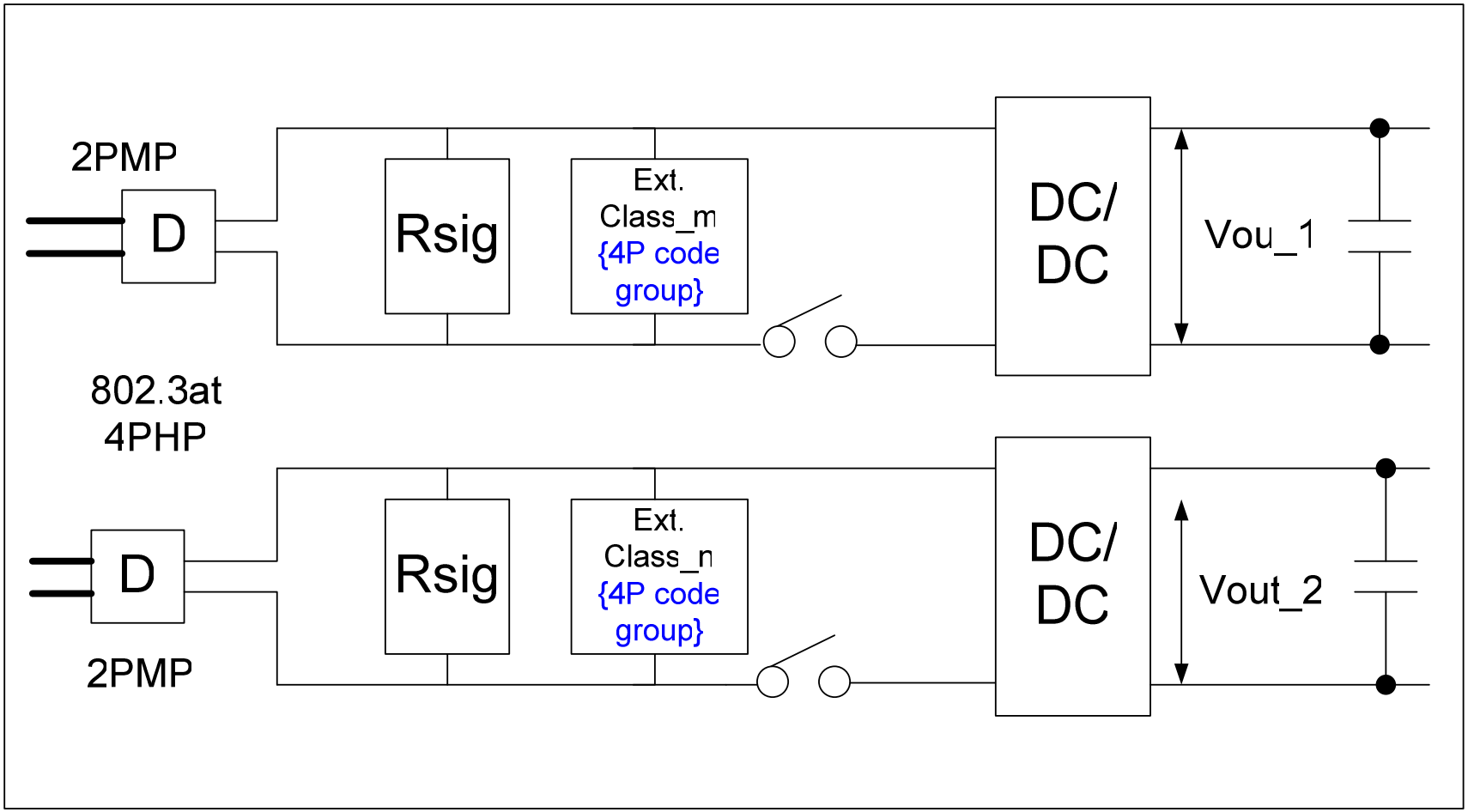
Simplified 4P PD without the need for Active Current Sharing in most high power applications

In this example each 2P has DC/DC however they operate as a single 4P PD (Single load) .

Problem: how to distinguish between single load 4P PD and dual load 4P PD? It may affect PSE power off after OVLD behavior (to turn off both channels or only one in mission critical applications?)

Solution: to use dual load. 4P class code (e.g. 60W) on each pair for single load. 2P class code (e.g. 30W or P1,P2) on each pair for dual independent load.

802.3at 4P HP PDs – PD side , dual class sig.

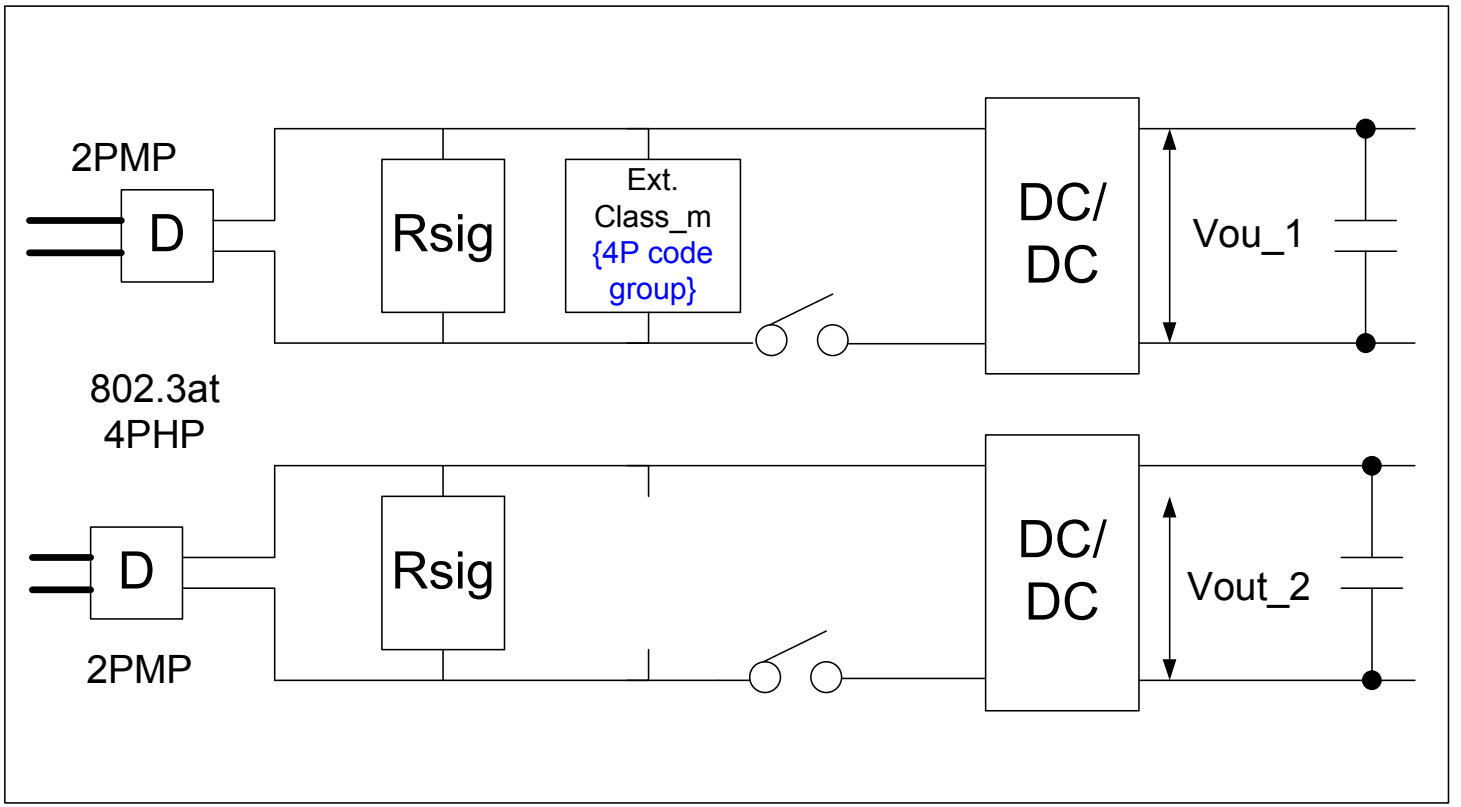


Simplified 4P PD without the need for Active Current Sharing in most cases

-In this example each 2P has DC/DC supporting independent loads however they operate as a single 4P PD uniquely identified by special 4P class.

-Other alternative in this PD is to use 2P class code on each pair if splitted TOs case is ruled out from the standard.

802.3at 4P HP PDs – PD side, single class sig.



Simplified 4P PD without the need for Active Current Sharing in most cases

In this example each 2P has DC/DC supporting independent loads however they operate as a single 4P PD uniquely identified by special 4P class.

Problems:

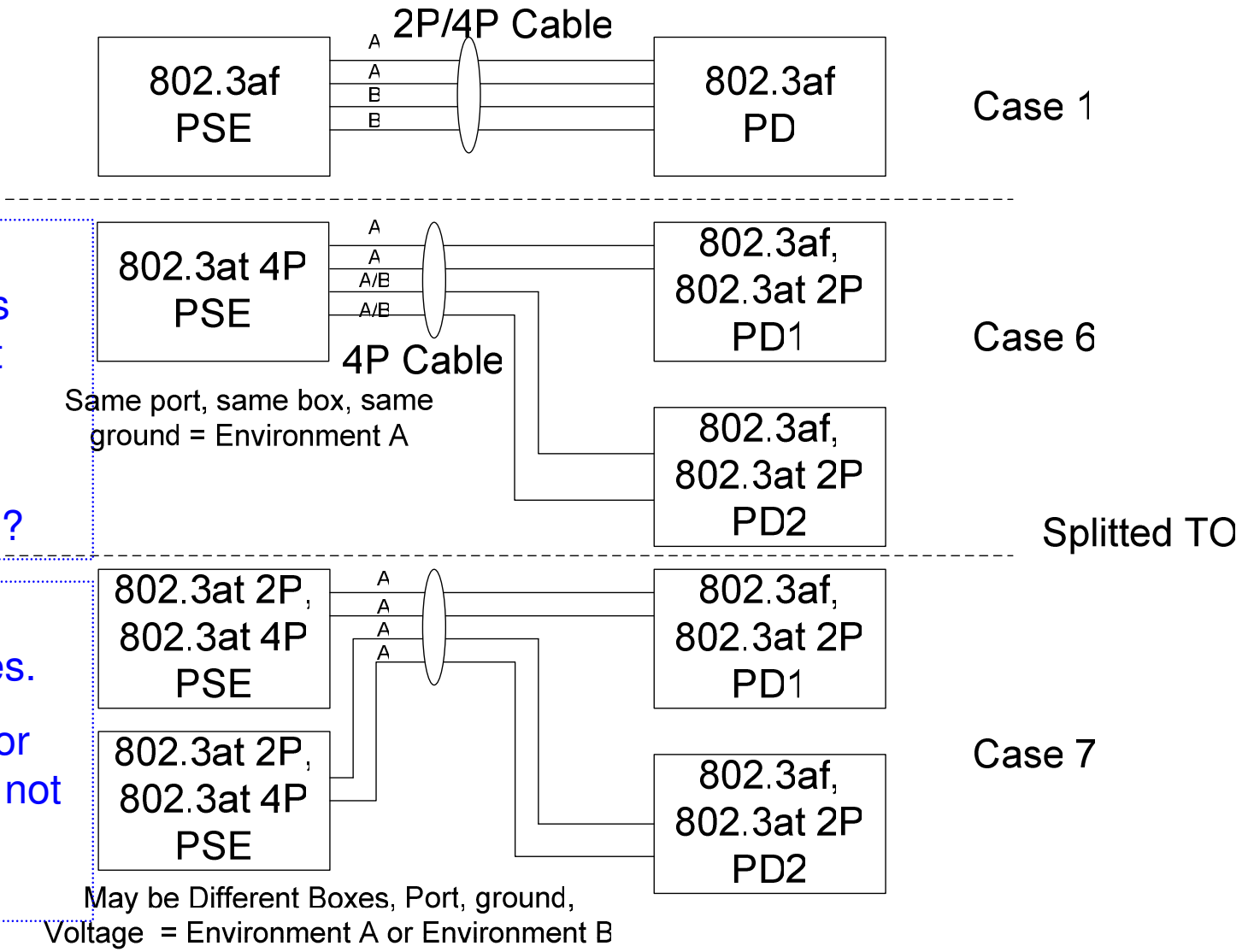
-With single signature how we know how much power to allocate for each 2P?

-Is it single load 4P PD (60W, current share) or splitted TO (P1,P2 for each 2P w/o current sharing)

-or is it dual load 4P PD? It may affects shut down policy after OVLD.

-Do we need all these information?

802.3af, 802.3at 2P MP PDs – System Description



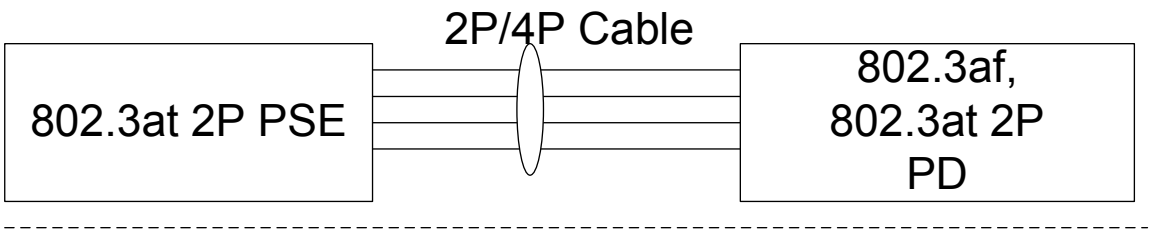
-Need to be discussed if it is "legal" Ethernet configuration in 10/100 or 1G ?

-Layer 2 issues?

-No known technical issues.

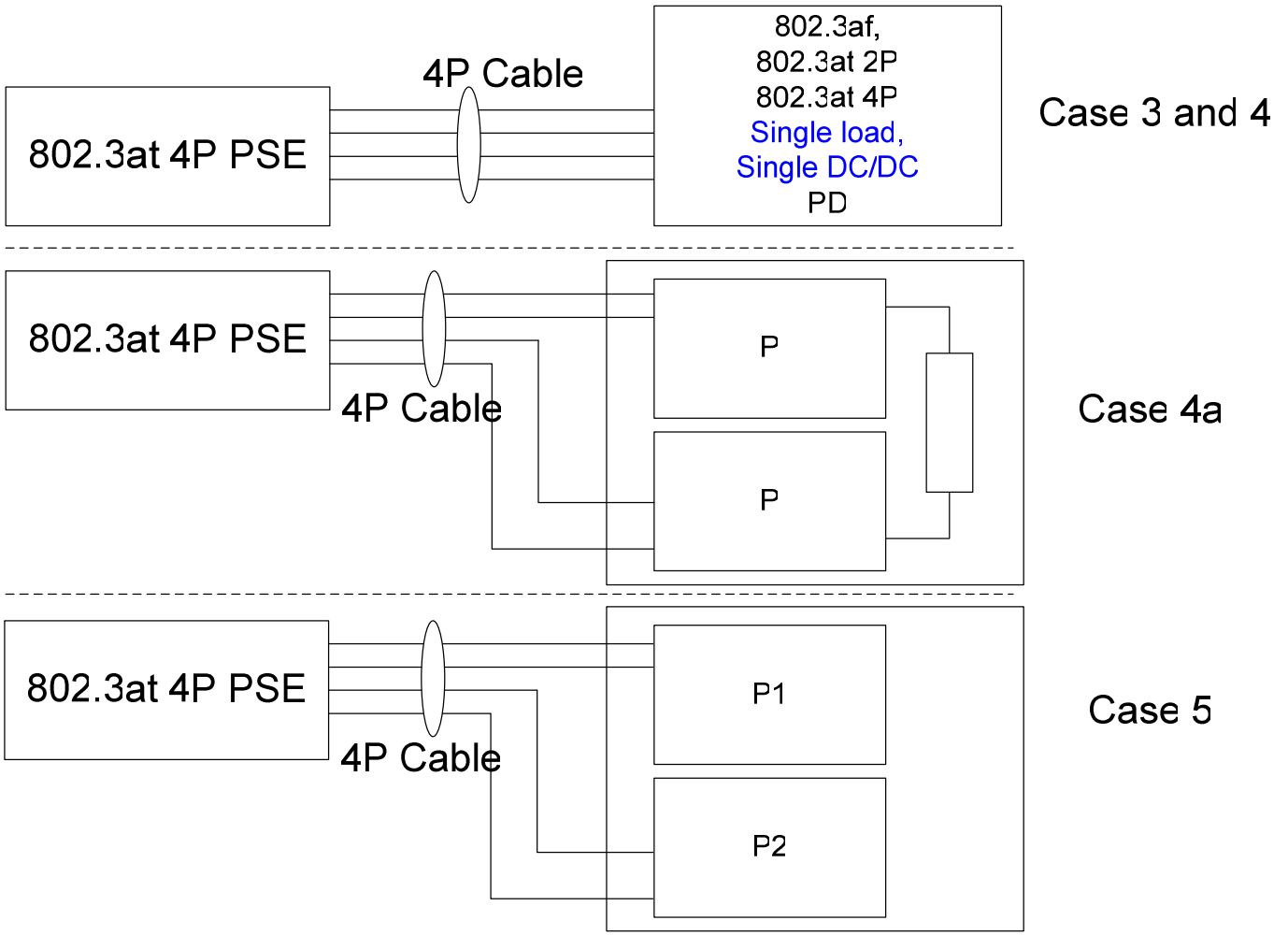
-Exists today for 802.3af and is not precluded by 802.3af

802.3at 2P MP PDs – System Description

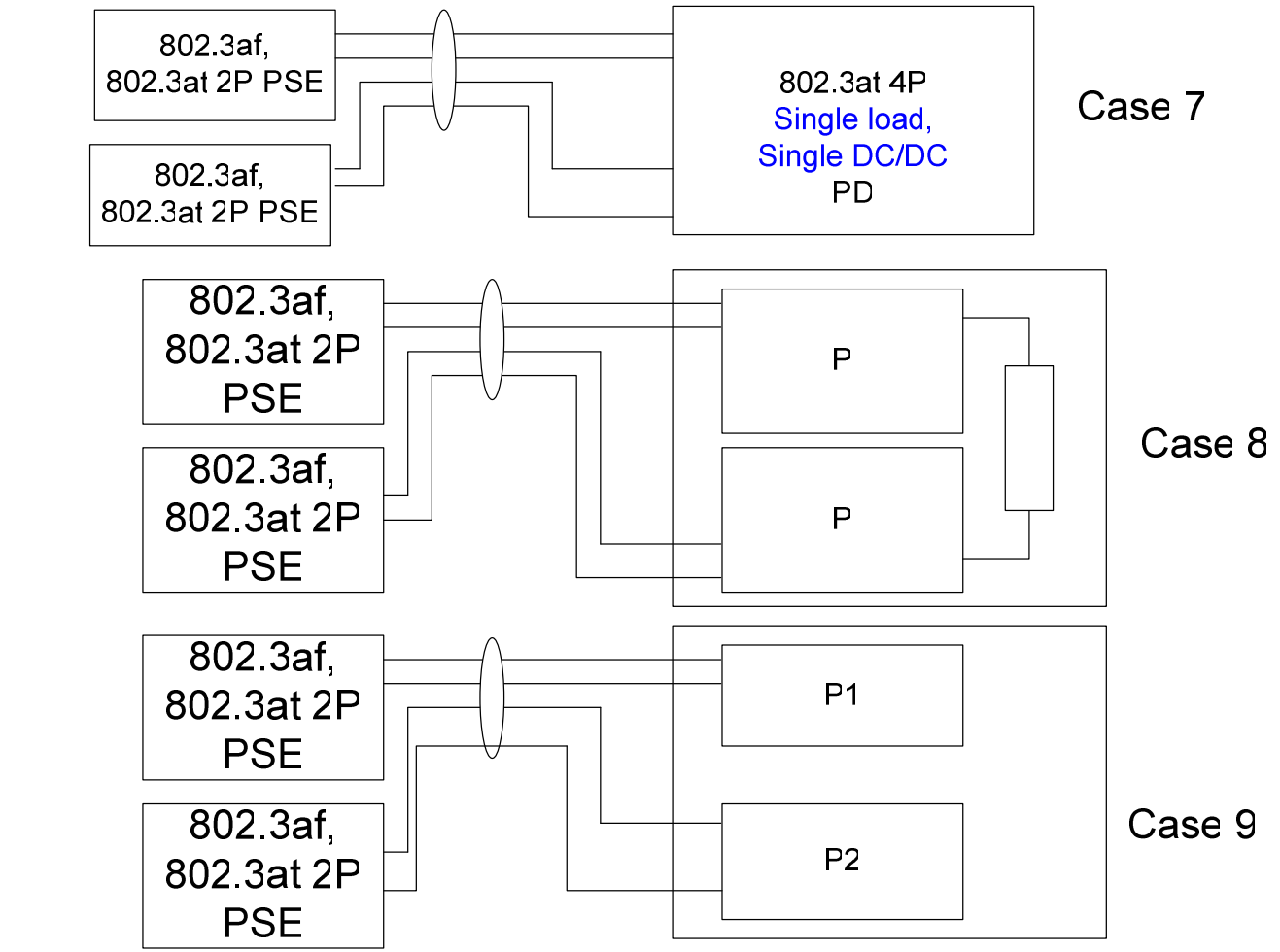


Case 2

802.3at 4P HP PDs – System Description

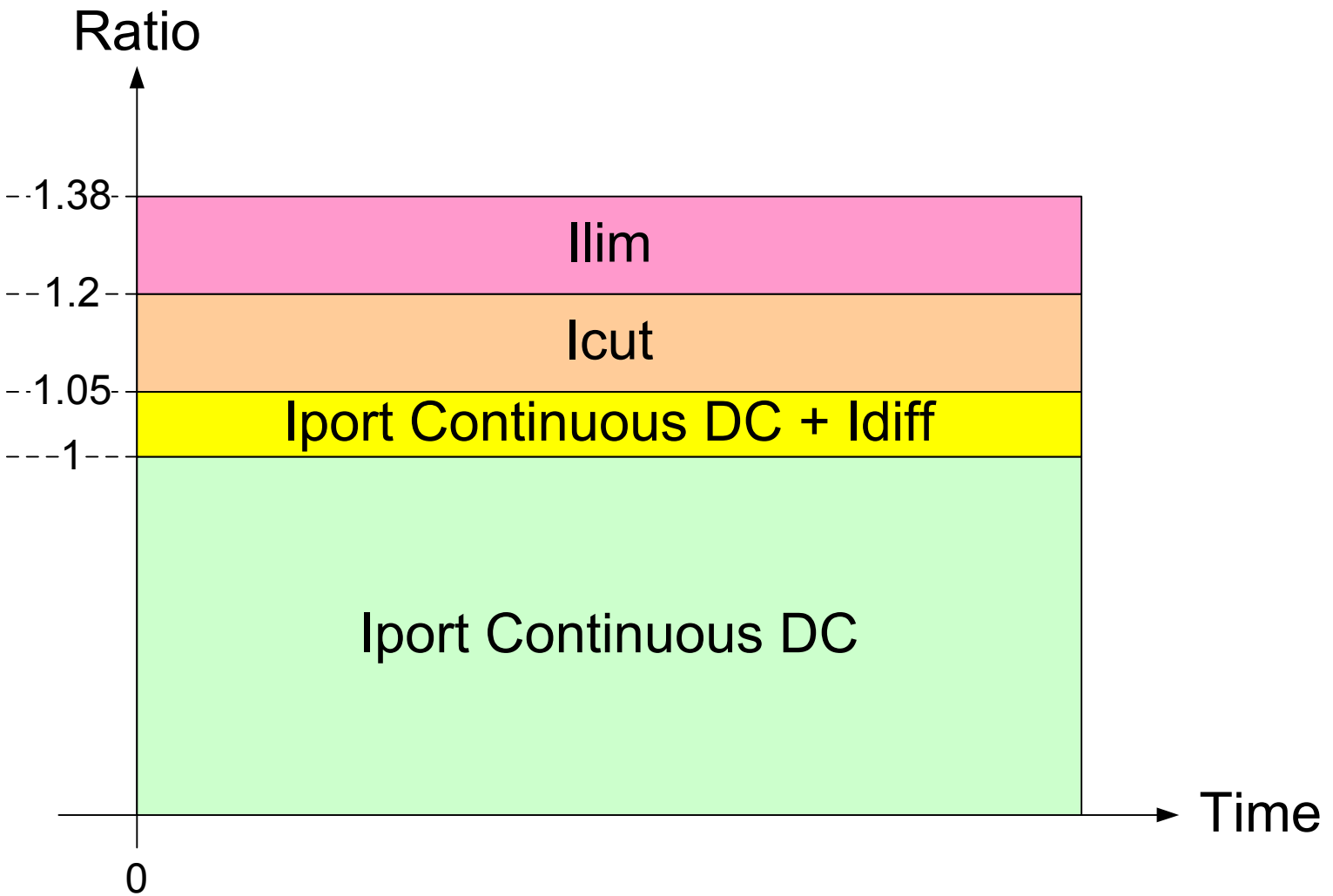


802.3at 4P HP PDs – System Description

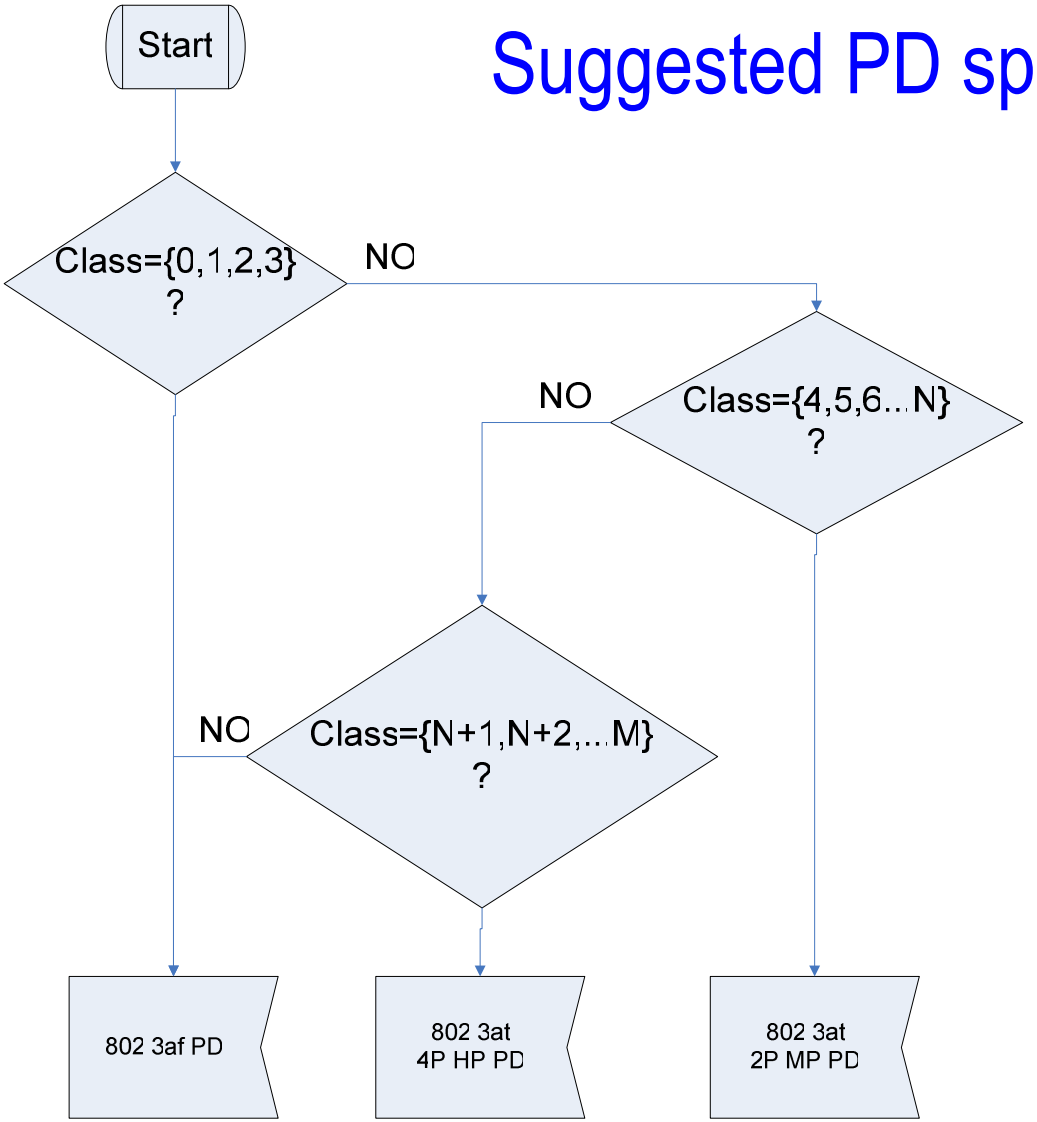


Different Boxes, Port, ground, Voltage = Environment B

Suggested PD specification

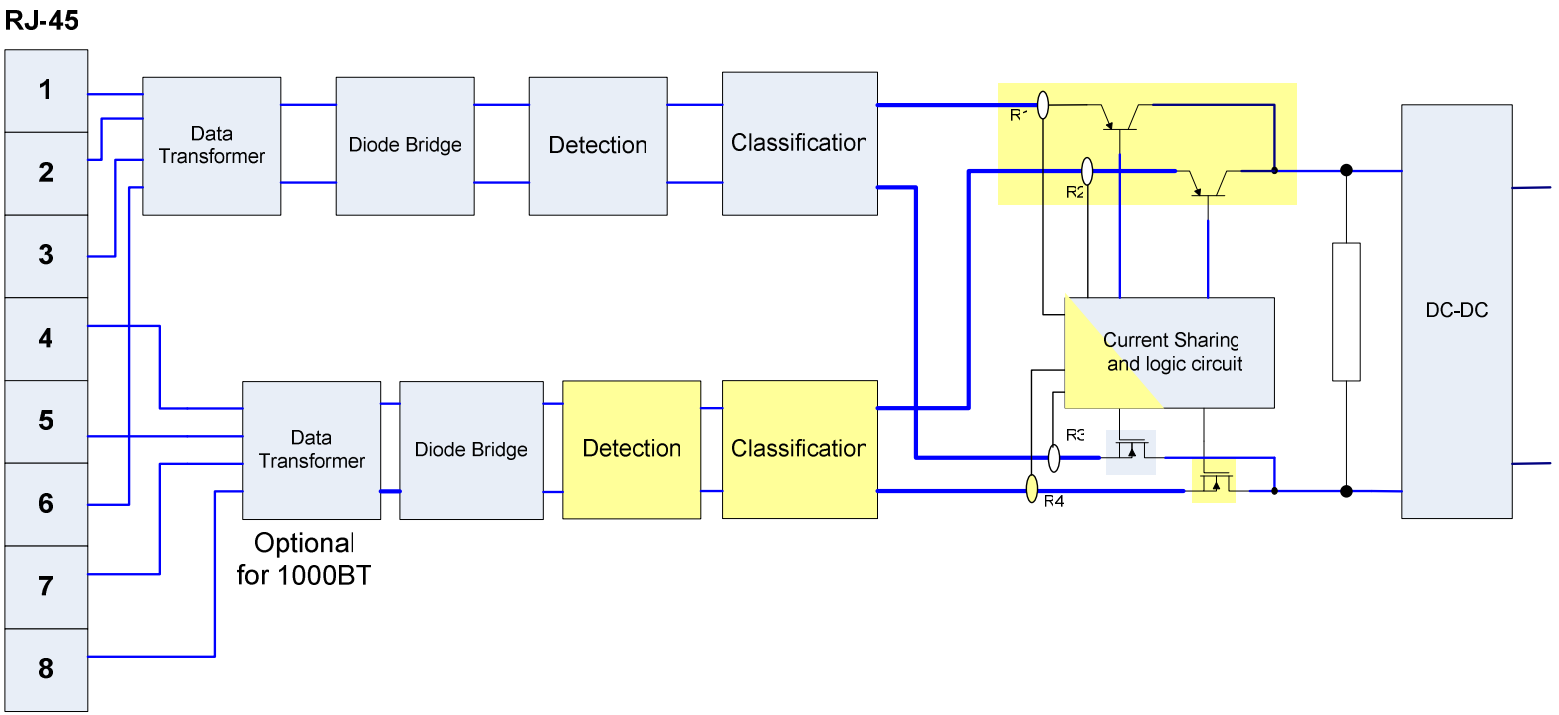


Suggested PD specification



Detection if PD is 2P or 4P Architecture Type

802.3at 4P HP PDs – PD side - details



802.3at 4P HP PDs – PD side - details