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HUAWEI ENTERPRISE A BETTER WAY

Thinking on 4-pair PD Architectures

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Background

1. Why would we focus on PD first?

According to 5.5 section in 802.3bt PAR：

5.5 Need for the Project: Since the publication of IEEE Std 802.3at-2009, significant market demand has emerged for more efficient power delivery and for applications with power levels greater than those defined in the standard. Example applications include thin clients, multi-radio wireless access points, pan / tilt / zoom cameras, digital signage, building automation, industrial sensors / actuators etc.

The increased market demands and power requirements of next generation PDs has driven us to form the 802.3bt task group.

Hence, the 4-Pair PD design should be taken as the start point of 4-Pair PoE work.

2.Ahead of our discussion, we'd like to emphasize the rules of 5C that we shall insist on:

➢ ***Distinct Identity***

a) Substantially different from other IEEE 802 standards.
b) One unique solution per problem (not two solutions to a problem).
c) Easy for the document reader to select the relevant specification.
d) Substantially different from other IEEE 802.3 specifications/solutions.

A unique 4-Pair PD architecture for all 4-Pair PDs to draw power from PSEs.

➢ ***Technical Feasibility***

a) Demonstrated system feasibility.
b) Proven technology, reasonable testing.
c) Confidence in reliability.

The 4-Pair PD solution should be feasible under the PoE technical principle.

➢ ***Economic Feasibilitv***

a) Known cost factors, reliable data.
b) Reasonable cost for performance.
c) Consideration of installation costs.

The 4-Pair PD solution should be cost-efficient.

Outlines

- Review of AF/AT PD Architecture
- Potential 4-pair PD Architecture
- Analysis of 4-pair PD Architecture
- Summary

Overview of AF/AT PD Architecture

1.What's AF/AT PoE Architectures ?

According to 802.3 at Page21：

A power system, consisting of a single PSE, link segment, and a single PD,

One-by-One

AF/AT PoE itself is a one PD architecture.

2.What's the requirement of AF/AT PD Power interface ?

According to 802.3 at 33.3.1：

33.3.1 PD PI

The PD shall be capable of accepting power on either of two sets of PI conductors. The two conductor sets are named Mode A and Mode B. In each four-wire connection, the two wires associated with a pair are at the same nominal average voltage. Figure 33–8 in conjunction with Table 33–13 illustrates the two power modes.

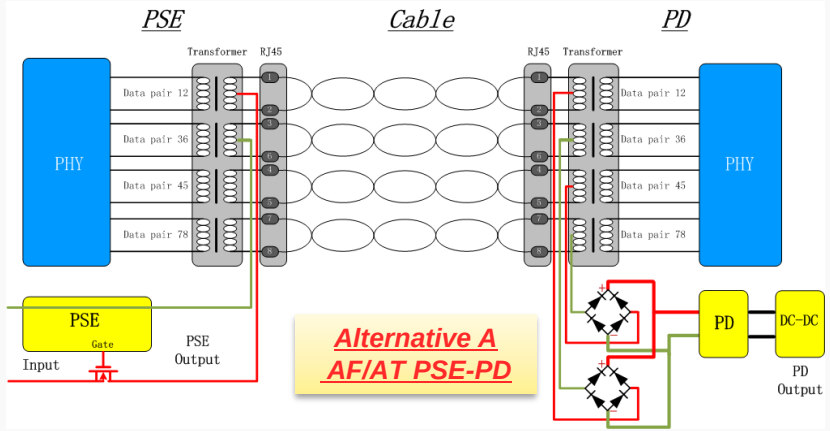
Table 33–13—PD pinout

Conductor	Mode A	Mode B
1	Positive V_{PD}, Negative V_{PD}	
2	Positive V_{P}, Negative V_{PD}	
3	Negative V_{PD}, Positive V_{PD}	
4		Positive V_{PD}, Negative V_{PD}
5		Positive V_{PD}, Negative V_{PD}
6	Negative V_{PD}, Positive V_{PD}	
7		Negative V_{PD}, Positive V_{PD}
8		Negative V_{PD}, Positive V_{PD}

The PD shall be implemented to be insensitive to the polarity of the power supply and shall be able to operate per the PD Mode A column and the PD Mode B column in Table 33–13.

NOTE—PDs that implement only Mode A or Mode B are specifically not allowed by this standard. PDs that simultaneously require power from both Mode A and Mode B are specifically not allowed by this standard.

e.g.



AF/AT PD shall be able to receive power from either 2-pair. That is, the 1PD architecture of AT/AF is capable of receiving power over 4 pairs.

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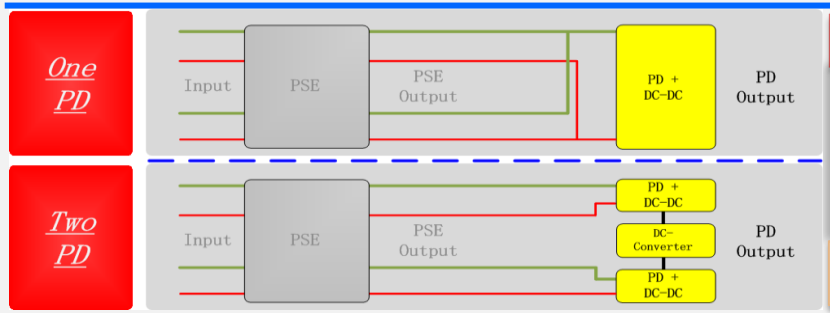
Overview of Potential 4-Pair PD Architectures



4-Pair PD Architecture

There are two architectures for 4-pair PD:

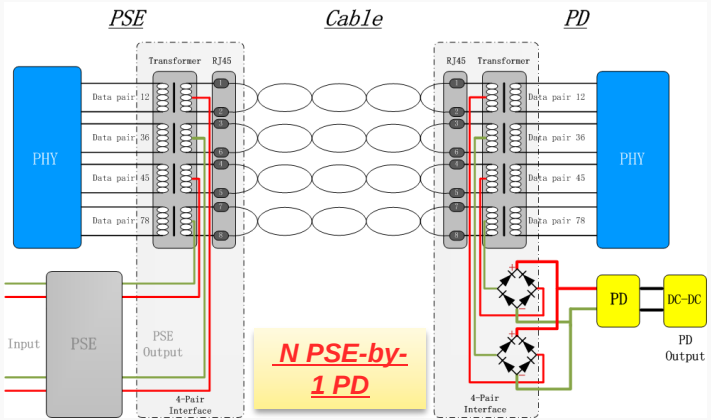
N PSE-by-One PD Architecture or N PSE-by-Two PD Architecture

Note: we focus on the architecture of PD, but not go for a particular PSE choice.

4-Pair PD architecture may use one PD or two PDs.

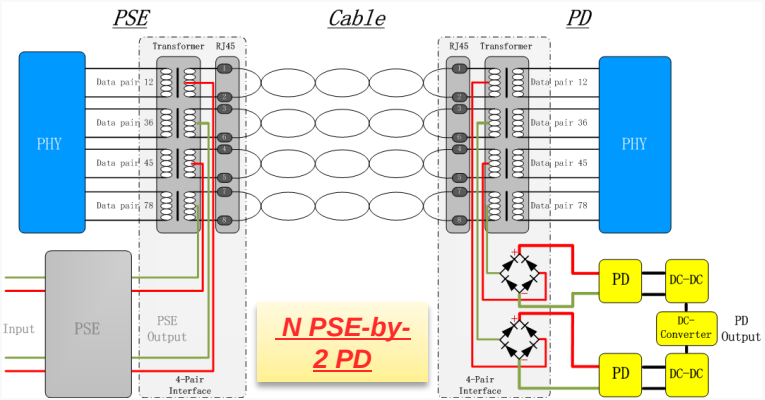
N PSE-by-One PD Architecture

1. The N-by-one architecture uses **N PSE and 1 PD**.
2. **The design of 4-pair one PD architecture is the same as that of 2-pair PD in AT/AF standard.**



N PSE-by-Two PD Architecture

1. The N-by-Two architecture uses **N PSE and 2 PD**.
2. The design of 4-pair two PD uses **two sets of AF/AT 2-pair PD and additionally a DC-DC converter for current combination.**



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How we study 4-pair PD architectures

We could study 4-pair PD architectures from three aspects:
technical gaps with AT/AF PD, compatibility and estimated costs.

- ***Technical Gap analysis of 4-pair PD architectures***

1. According to different PoE status, the whole PoE procedure can be divided into 6 processes:
Idle, Detect, Class, Power up, Power on and Disconnect.

2. So, based on the previous potential 4-pair PD architectures, we'll study:
How these 4-Pair PDs follow the current 802.3at/af standard, and point out technical gaps to be filled.

- ***Compatibility of 4-pair PD architectures***

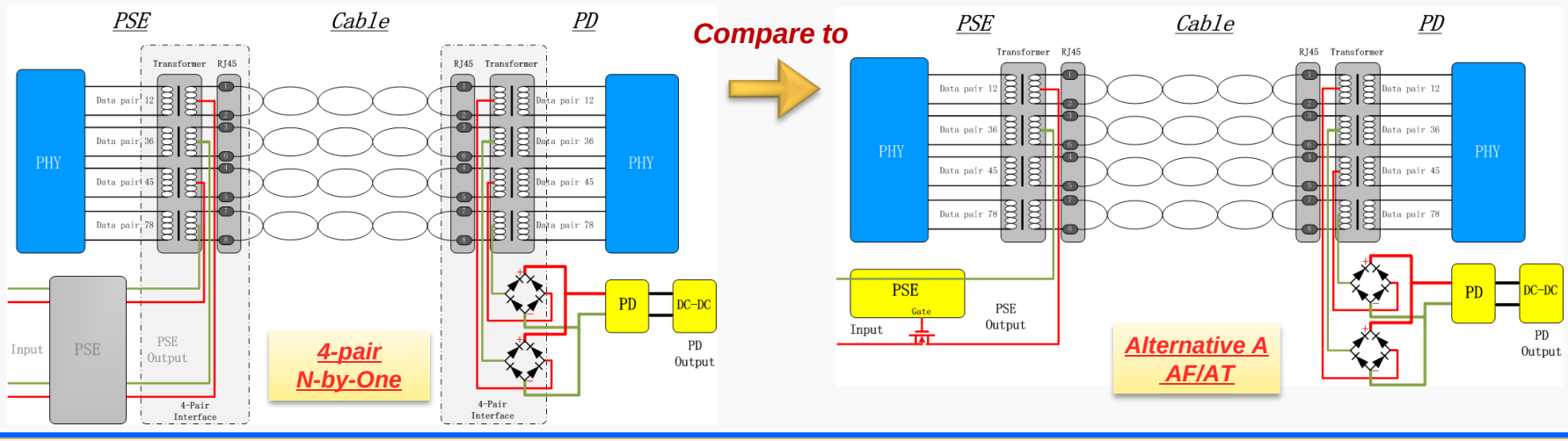
We'll study how these 4-pair PDs work with PSEs.

- ***Estimated Costs of 4-pair PD architectures***

Relative to AT PD, we'll give out estimated costs of these 4-pair PDs.

Gap analysis of one PD architecture

According to the previous architecture overview, we can see **the design of 4-pair one PD in N-by-one architecture is the same as 2-pair PD in AT/AF standard.**



➢ **Reuse of the existing standard:**

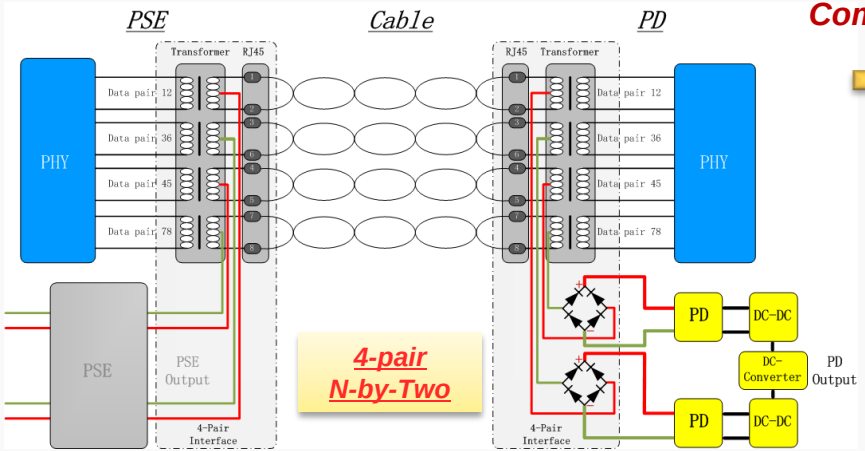
The 4-pair one PD in N-by-1 architecture works the same as AT/AF 2-pair PD in the processes of detection, classification, power up, power on and disconnection.

➢ **Gaps between 4-pair N-by-one PD and 2-pair AT/AF PD:**

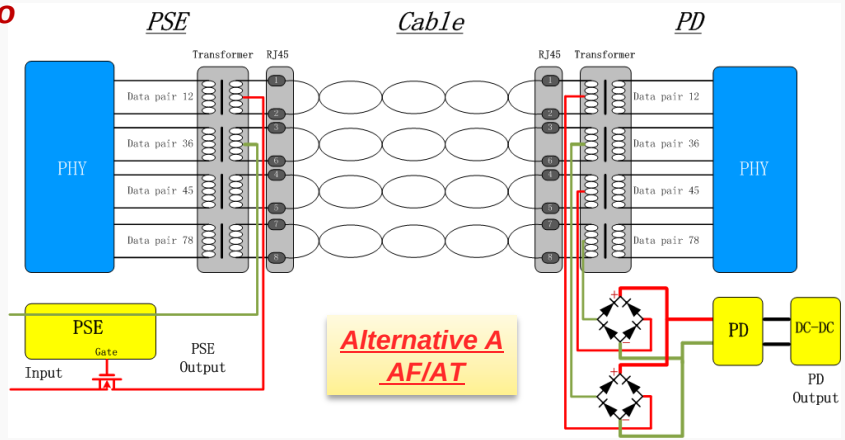
1. **Class**: new class levels should be added to provide higher power level;

Gap analysis of two PD architecture

According to the previous architecture overview, we have **the design of 4-pair two PD design** uses **two sets of AF/AT architectures.**



Compare to



➢ **Gaps between 4-pair N-by-two PD and AT/AF PD:**

1. **Class**: new class levels should be added to provide higher power level;
2. **PD management**: management of the two PD sets, 2 DC-DC units, as well as a DC Converter.
3. When a 4 Pair PD connects to a AF/AT PSE, **only one PD works, while the other PD must be idle.**

Compatibility of 4-Pair One PD architecture

One PD design is capable of requesting and receiving low, medium and high power from **legacy PSE, 4P 1PSE and 4P 2PSE**. With no big changes on PD side, a one PD design is as easy to operate as an AF/AT PD design.

PSE Type	4-Pair One PD		
	<12.95w	12.95w<P<25.5w	25.5w<P<TBDw
Type1 PSE	Works[note1#]	Power up as type1 or notify underpowered	Power up as type1 or notify underpowered
Type2 PSE	Works[note1#]	Works[note1#]	Power up as type2 or notify underpowered
4P 1 PSE	Works[note1#]	Works[note1#]	Works[note2#]
4P 2 PSE	Works[note1#]	Works[note1#]	Works[note2#]

Notes:

1. note1#: work as AT/AF does.
2. note2#: works only apply to >25.5W.

Compatibility of 4-Pair Two PD architecture

Two PDs is able to support requesting and receiving low, medium and high power from **legacy PSEs and 4-pair 2PSE, but need a new design to support 4-pair 1PSE.**

PSE Type	4-pair Two PD		
	<12.95w	**12.95w<P<25.5w**	**25.5w<P<TBDw**
Type1 PSE	Works[note1#]	Power up as type1or notify underpowered	Power up as type1or notify underpowered
Type2 PSE	Works[note1#]	Works[note1#]	Power up as type1or notify underpowered
4P 1 PSE	New[note2#]	New[note2#]	New[note2#]
4P 2 PSE	Works[note3#]	Works[note3#]	Work[note3#]

Notes:

1. note1#: work only on two-pair, while the other **two-pair must be idle**.
2. note2#: new design is needed, since **a 4-pair 1 PSE must detect two parallel PDs, hence, new detection should be added as well as new classification, power-up, power-on and disconnection.**
3. note3#: works, but with two sets of AF/AT system, **the standby power consumption is doubled.**

Estimated 4-Pair PD Costs

Relative to costs of 802.3at PoE components, we'll show the estimated costs of 4-pair PDs expressed in multiple forms of AT PDs :

- 4-Pair two PD architecture: Costs of PD chips will be around twice as AT, in addition, a DC converter is needed.
- 4-Pair one PD architecture: there will be a limited increase in PD cost since the 1PD design is consistent with 802.3at standard, no additional components needed.

Mode		PD		
		Chip	DC-DC	DC converter
802.3 at PoE		1	1	0
4-Pair PoE	1 PD	1.X note1#	1.X note1#	0
	2 PD	2 note2#	2 note2#	1 note3#

Notes:

1. note1#: 1 PD needs to operate redefined current.
2. note2#: 2 PD uses 2 sets of AT PD, which doubles the PD cost.
3. note3#: 2 PD needs 1 added DC converter to combine 2 PD channels.

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Summary

From previous analysis on aspects of technical gaps, compatibility, and estimated cost about 4-pair PD architectures, we can see：

- 4-pair one PD architecture :

1. **Consistent with AT/AF PD designs** and can reuse operations of legacy standard;

2. Supports **requesting and receiving power from 4-pair N PSE, as well as type1 and type2 PSE;**

3. A **limited increase in cost** compared with AF/AT PDs.

- 4-pair two PD architecture :

1. Not only has **two sets of AT PDs, but also adds a DC-converter**;

2. **Needs new designs for** detection, classification, power-up, power-on and disconnection to work with 4-pair 1PSE.

3. Costs **twice as much as AT PD and should add a DC converter.**

So, one PD architecture is a better choice for 4-pair PD design in distinct Identity, technical feasibility, compatibility and economic feasibility.

Thank you!