Comment

D2.3 (#111, #131, #181, #322, #214, #333, #369).

1. The case when channel resistance is less then 0.2 ohm is addressed in 145.2.8.5.1. Therfore, the text that link this use case to Annex 145A.1 was deleted.
2. Some text is missing from the approved baselines darshan_01_0117_Rev007 and darshan_05_0116Rev005.pdf. This text is marked by YELOW marker and inserted back.
3. The whole Annex 33A.5 with the changes made by the approved remedy darshan_05_0116Rev005.pdf is missing.
4. We need to keep the following concept for th eunbalance variable names to keep consistency:
   Rpse_min/max is PSE PI effective resistance.
   RPD_min/max is the PD PI effective resistance (Currently it is Rpair_pd_min/max).
   Nominal PI resistances will be: Rpair_PSE_min/max and Rpair_PD_min/max.
   (Rpd is not used anywhere. We have only Rpd_d in detection section.)

Suggested Remedy:

Baseline starts here

~~**Modify the text per the proposed baseline:**~~

1. ***Editor please note: Some text is missing from the approved baselines darshan_01_0117_Rev007 and darshan_05_0116Rev005.pdf. This text is marked by YELOW marker and inserted back.***
2. **Modify the text per the proposed baseline:**

145.2.8.5.1 PSE PI pair-to-pair effective resistance and current unbalance

PSEs that operate over 4-pairs are subject to unbalance requirements. The contribution of PSE PI pair-to-pair effective resistance unbalance to the system end to end effective resistance unbalance, is specified by PSE maximum (RPSE_max) and minimum (RPSE_min) common mode effective resistance in the powered pairs of same polarity. See Figure 145-22.
Effective resistances of RPSE_min and RPSE_max include the effects of VPort_PSE_diff as specified in Table 145-16 and the PSE PI resistive elements. See definition and measurements in Annex 145A.

The PSE PI pair-to-pair effective resistance unbalance determined by RPSE_max and RPSE_min ensures that along with any other parts of the system, i.e. channel (cables and connectors) and the PD, the pairset with the highest current including unbalance does not exceed ICon-2P-unb as defined in Table 145–16 during normal operating conditions. ICon-2P-unb is the current in the pairset with the highest current in the case of maximum unbalance and will be higher than ICon/2. ICon-2P-unb applies for total channel common mode pair resistance from 0.2 Ω to RCh, as defined in 145.1.3. ~~For channels with common mode pair resistance lower than 0.2Ω, see 145A.1.~~

This is not part of the baseline
The following text "The sum of RCh_unb_min and RCh_unb_max is RChan-2P as described in Figure 145–22 …" was moved to after Table 145-17

~~The sum of RCh_unb_min and RCh_unb_max is RChan-2P as described in Figure 145–22 and as defined by the pair-to-pair channel resistance unbalance requirement for 4-pair operation in 33A.4 .~~

RPSE_max and RPSE_min are specified and measured under maximum PClass_PD load conditions, measured at the PD PI, over the VPort_PSE-2P operating range. ~~Conformance with Equation (145–15) shall be met for RPSE_max and RPSE_min.~~ RPSE_max and RPSE_min for the positive pairs are not necessarily the same values as for the negative pairs.

PSEs that meet ~~The relation between~~ RPSE_max and RPSE_min, as defined by equation 145-15 meet ~~makes the PSE meet its~~ the unbalance requirements under worst case conditions of channel pair to pair unbalance and PD PI pair to pair unbalance. PSEs that comply with Equation (145–15) intrinsically meet unbalance requirements.

$$0 < R_{PSE\_max} \le \begin{Bmatrix} 2.182 \times R_{PSE\_min} - 0.040 & for & Class & 5 \\ 1.999 \times R_{PSE\_min} - 0.040 & for & Class & 6 \\ 1.904 \times R_{PSE\_min} - 0.030 & for & Class & 7 \\ 1.832 \times R_{PSE\_min} - 0.030 & for & Class & 8 \end{Bmatrix} \qquad 145\text{-}15$$

where

RPSE_max is, given RPSE_min, the highest allowable common mode effective resistance in the powered pairs of the same polarity.

RPSE_min is the lower PSE common mode effective resistance in the powered pairs of the same polarity.

> **This is not part of the baseline**
>
> The addition "components on each conductor" means the resistors in series to this conductors. Any better wording?

R_{PSE} max or R_{PSE} min ~~C~~common mode effective resistance is the resistance of the two ~~wires~~ conductors (including ~~and~~ their components on each conductor) in a powered pair of the same polarity connected in parallel.

> **This is not part of the baseline**
>
> 1- Some lines moved up for correct order of topics.
> 2- The link to Annex 145X (was Annex 33A.5 that was not implemented per darshan_05_0116Rev005.pdf) is missing and restored. It is marked with YELOW marker.

Figure 145-22 illustrates the relationship between RPSE_max and RPSE_min effective resistances at the PSE PI as specified by Equation 145-15 and the rest of the end to end pair to pair effective resistance components.

~~PSEs that comply with Equation (145–15) intrinsically meet unbalance requirements.~~ ***[This text was moved up]***

~~Figure 145-22 illustrates the relationship between RPSE_max and RPSE_min effective resistances at the PSE PI as specified by Equation 145-15 and the rest of the end to end pair to pair effective resistance components.~~

A PSE shall not source more than Icon-2P_unb min on any pair when connected to a load as shown in Figure 145-42, using values of Rload_min and Rload_max as specified in ~~Table 145-17~~Equation 145-16 and Equation 145-17.

Table 145-17—Rload_max and Rload_min requirements

PSE Class	Rch_unb_min, (Ω)	Rch_unb_max, (Ω)	~~RPair_PD_min~~ RPD_min, (Ω)	~~RPair_PD_max~~ RPD_max, (Ω)	~~Rload_min, (Ω)~~	~~Rload_max, (Ω)~~	Additional Information
5	0.087	0.101	0.641	1.524	~~0.728~~	~~1.624~~	~~Rload is at l~~Low channel resistance conditions. All resistances within ±1% range.
6			0.541	1.187	~~0.628~~	~~1.288~~	
7			0.486	1.020	~~0.573~~	~~1.121~~	
8			0.441	0.896	~~0.529~~	~~0.996~~	
5	5.405	6.250	0.708	1.031	~~6.113~~	~~7.281~~	~~Rload is at h~~High channel resistance conditions. All resistances within ±1% range.
6			0.567	0.826	~~5.972~~	~~7.076~~	
7			0.494	0.720	~~5.898~~	~~6.970~~	
8			0.432	0.630	~~5.837~~	~~6.882~~	

Rload_min and Rload_max, defined in Equation 16 and Equation 17~~Table 145–17~~, are respectively the minimum and maximum common mode effective load resistances in the powered pairs of the same polarity.

~~RPair_PD_min~~ RPD_min and ~~RPair_PD_max~~ RPD_max are respectively the minimum and maximum common mode effective PD PI resistances. They account for the effective resistance of resitive elements combined with PD pair to pair voltage difference and the effect of system end to end pair to pair resistance unbalance. See Annex 145X.

Rch_unb_min ~~Rchunb_min~~ and Rch_unb_max ~~Rchunb_max~~ are respectively the minimum and maximum common mode channel resistances in the powered pairs of the same polarity from PSE PI to PD PI per the model described in Figure 145A-2.

This is not part of the baseline
The text "The sum of RCh_unb_min and RCh_unb_max is RChan-2P as ...." was in D2.2 and moved to this location and modified to be accurate.

The sum of RCh_unb_min from the positive pairs and RCh_unb_max from the negative pairs is RChan-2P as described in Figure 145–22 and as defined by the pair-to-pair channel resistance unbalance requirement for 4-pair operation in ~~33A.4~~ 145A.4.

~~Table 145-17 specifies the values of Rload_min and Rload_max components according to Equations 145-16 and Equation 145-17.~~

[This text was moved below Equations 145-16 and 145-17] ~~The values of RPair_PD_min and RPair_PD_max are given to allow calculations and measurement of PClass_PD at the PD PI.~~

Rload_min = ~~RPair_PD_min~~RPD_min+~~Rchunb_min~~ Rch_unb_max (145-16)

Rload_max = ~~RPair_PD_max~~RPD_max+~~Rchunb_max~~ Rch_unb_max (145-17)

The values of ~~RPair_PD_min~~RPD_min and ~~RPair_PD_max~~RPD_max are given to allow calculations and measurement of PClass_PD at the PD PI.

Figure 145–22 shows a verification circuit for the current unbalance requirements measurement. Other methods for measuring RPSE_min and RPSE_max are described in Annex 145-A.

ICon-2P-unb and Equation (145–15) are specified for total channel common mode pair resistance RChan-2P from 0.2 Ω to 12.5 Ω and worst case unbalance contribution by a PD. PSEs that support channel common mode resistance less than 0.2 Ω, or if RChan is less than 0.1 Ω, the PSE should meet ICon-2P-unb requirements when connected to (Rload_min – 0.5 × RChan-2P) and (Rload_max – 0.5 × RChan-2P). This can be achieved by using a lower RPSE_max or higher RPSE_min than required by Equation (145–15). Lower RPSE _max values may be obtained by using smaller constant α or higher RPSE_min in Equation (145–15) in the form of ~~RPSE_ max~~ RPSE_max = α × RPSE_min + β.

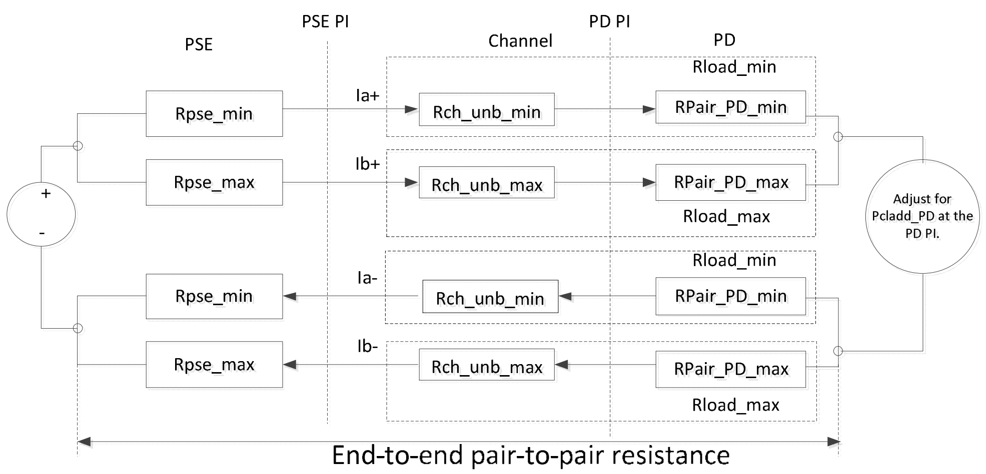


Figure 145-22—PSE PI unbalance specification and E2EP2PRunb

The evaluation method is as follows:

a) Use Rload_min and Rload_max from Table 145–17 for ~~Rload at~~ low channel resistance conditions.

b) With the PSE powered on, adjust the load to PClass_PD.
c) Measure Ia+, Ib+, Ia-, and Ib-.
d) Exchange Rload_max and Rload_min. Repeat steps b) and c).
e) Verify that the current in any pair does not exceed ICon-2P-unb, as defined in Table 145–16.
f) Repeat steps b) through e) for Rload_min and Rload_max from Table 145–17 ~~for Rload~~ at high channel resistance conditions.

145A.3 Intra pair resistance unbalance

Operation for all PSE and PD Types requires that the resistance unbalance be 3% or less. Resistance unbalance is a measure of the difference between the two conductors of a twisted pair in the 100 Ω balanced cabling system. Resistance unbalance is defined as in Equation (145A–1):

$$\textbf{Runb}=\left\{\frac{(R\max - R\min)}{(R\max + R\min)}\times 100\right\}_{\%} \qquad (145A–1)$$

where

Rmax is the resistance of the pair conductor with the highest resistance
Rmin is the resistance of the pair conductor with the lowest resistance.

145A.4 Pair-to-pair channel resistance unbalance requirement for 4-pair operation

Operation using 4-pair requires the specification of resistance unbalance between each two pairs of the channel, not greater than 100 milliohm or resistance unbalance of 7% whichever is a greater unbalance. Resistance unbalance between the channel pairs is a measure of the difference of resistance of the common mode pairs of conductors used for power delivery. Channel pair-to-pair resistance unbalance is defined by Equation (145A–2).

$$\textbf{Rch\_unb}=\left\{\frac{(Rch\_unb\_\max - Rch\_unb\_\min)}{(Rch\_unb\_\max + Rch\_unb\_\min)}\times 100\right\}_{\%}$$

(145A-2)

Channel pair-to-pair resistance difference is defined by Equation (145A–3):

$$\textbf{Rdiff}=\{Rch\_unb\_\max - Rch\_unb\_\min\}$$

(145A-3)

where

Rch_unb_max is the sum of channel pair components with highest common mode resistance from PSE PI to PD PI.
Rch_unb_min is the sum of channel pair components with lowest common mode resistance from PSE PI to PD PI.

Channel ~~C~~common mode resistance is the resistance of the two conductors ~~wires in a pair~~ (including connectors) in a pair, connected in parallel.

The resistance of the common mode pairs of conductors and connectors Rch_unb_min and Rch_unb_max are described by Figure 145A-2.

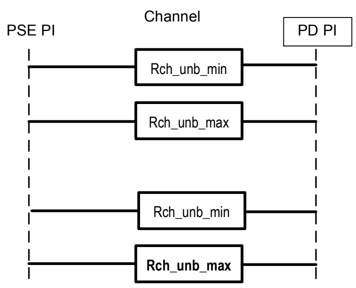


Figure 145A-2 – Common mode Pair-to-pair channel resistance unbalance

Note: Each conductor in Figure 145A-2 is the equivalent of two conductors in parallel.

Annex 145A

(Informative)

PSE PI pair-to-pair resistance/current unbalance

145A.1 Introduction

End to end pair-to-pair resistance/current unbalance (E2EP2PRunb) refers to current differences in powered pairs of the same polarity. Current unbalance can occur in positive and negative powered pairs when a PSE uses all four pairs to deliver power to a PD.

Current unbalance requirements (RPSE_min, RPSE_max and Icon-2P_unb) of a PSE ~~shall be~~is met with Rload_max and Rload_min as specified in Table 145-17.

A compliant unbalanced load, Rload_min and Rload_max consists of the channel (cables and connectors), and PD effective resistances, including the effects *(or influence)* of PSE PI effective resistance as a function of the system end-to-end unbalance.

Equation (145–15) is described in 145.2.8.5.1, specified for the PSE, assures that E2EP2PRunb will be met in the presence of all compliant, unbalanced loads (Rload_min and Rload_max) attached to the PSE PI. Figure 145-22 illustrates the relationship between effective resistances at the PSE PI as specified by Equation (145–15) and Rload_min and Rload_max as specified in Table 145-17.

There are two alternate verification methods for RPSE_max and RPSE_min and determining conformance to Equation (145–15) and to Icon-2P_unb.

Measurement methods to determine RPSE_max and RPSE_min and Icon-2P_unb are defined in 145A.2 and 145A.3.

145A.2 Direct RPSE measurement

If there is access to internal circuits, effective resistance may be determined by sourcing current in each path corresponding to maximum PClass operation, and measuring the voltage across all components that contribute to the effective resistance, including circuit board traces and all components passing current to the PSE PI output connection. The effective resistance is the measured voltage Veff, divided by the current through the path e.g. the effective value of RPSE_min for i1 is RPSE_min =Veff1/i1 as shown in Figure 145A-1. RPSE_min and RPSE_max values respectively may be diferent than Rpair_pse_min and Rpair_pse_max values.

Update Figure 145A-1as follows:

Change Rpair_min to Rpair_pse_min

Change Rpair_max to Rpair_pse_max

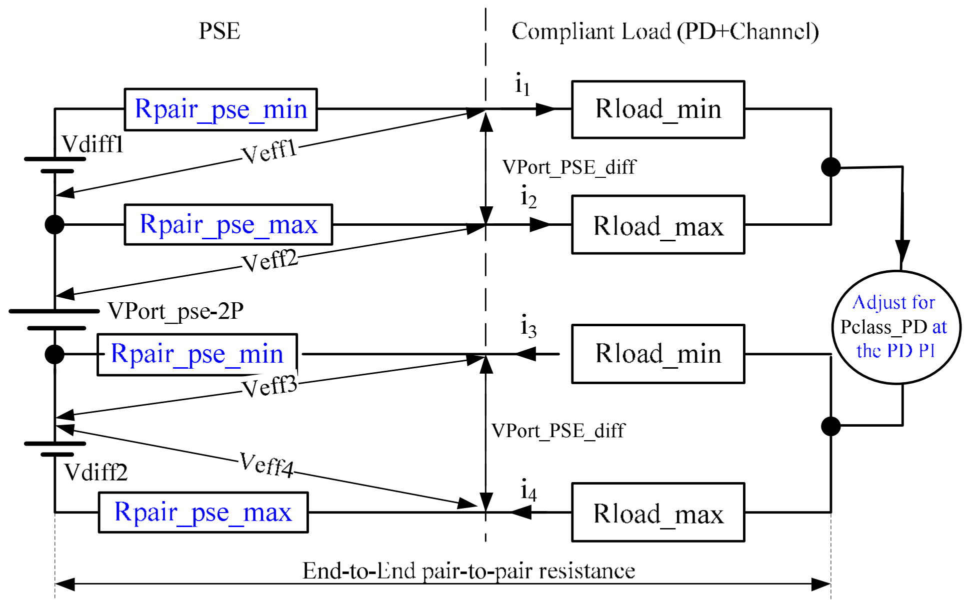


Figure 145A-1—Direct measurements of effective RPSE_max and RPSE_min

145A.3 Effective resistance Rpse measurement

Figure 145A-2 shows a possible verification circuit for effective resistance measurements on a PSE port for evaluating conformance to Equation (145–15) if the internal circuits are not accessible. In Figure 145A-2, the positive pairs of the same polarity are shown as an example. The same concept applies to the negative pairs.

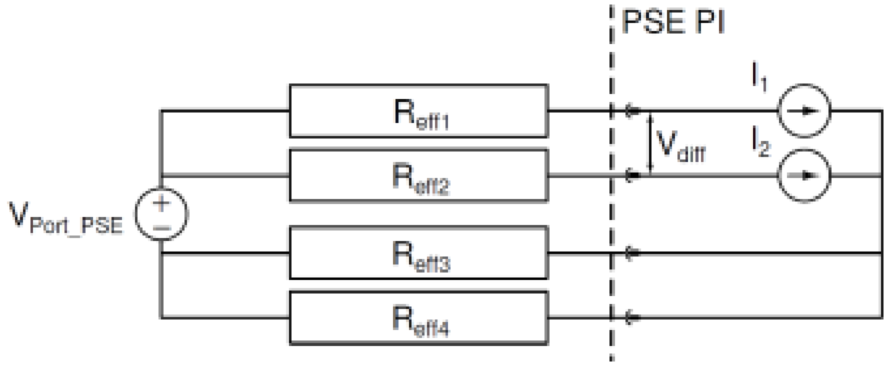


Figure 145-A2 – Effective resistance verification circuit

The Effective Resistance verification Procedure is described below:

1) With the PSE powered on, set the following current values
   a. 10 mA < I_2 < 50 mA
   b. $I_1 = 0.5 \times (P_{max}/V_{port}) - I_2$
2) Measure V_{diff}.
3) Reduce I_1 by 20% (=I_1'). Ensure I_2 remains unchanged.
4) Measure V_{diff}' in the same mannar as V_{diff}..
5) Calculate R_{eff1}: $R_{eff1} = [(V_{diff}) - (V_{diff}')] / (I_1 - I_1')$
7) Repeat procedure for R_{eff2}, with I_1, I_2 values swapped.
8) Repeat procedure for R_{eff3}, R_{eff4}.
9) Evaluate compliance of R_{eff1} and R_{eff2} with Equation (145–15). Evaluate compliance of R_{eff3} and R_{eff4} with Equation (145–15).

The effective resistance verification method applies to the general case. If pair-to-pair balance is actively controlled in a manner that changes effective resistance to achieve balance, then the current unbalance measurement method described in 145.2.8.5.1 ~~shall be~~ is recommended method to verify unbalance~~used~~.

PD Section

This is not part of the baseline
-In the following text, referenced will be made to Annex 145X which was Annex 33A.5 in D2.2 and was not implemented as approved by darshan_05_0116Rev005.pdf and is missing from D2.2. Annex 145X is added later in this document. -The parts that are marked with YELOW marker are parts that was approved in darshan_05_0116Rev005.pdf and was not implemented.

145.3.8.10 PD pair-to-pair current unbalance

This section describes unbalance requirements for PDs that operate over 4-pair. The contribution of PD PI pair-to-pair effective resistance unbalance to the effective system end to end resistance unbalance, is determined by PD maximum (~~RPair_PD_max~~RPD_max) and minimum (~~RPair_PD_min~~RPD_min) common mode effective resistance in the powered pairs of same polarity. ~~See Figure 33A-2~~ See Figure 145X-1.
Effective resistances of ~~RPair_PD_min~~RPD_min and ~~RPair_PD_max~~RPD_max include the effects of PD pair to pair voltage difference and the PD PI resistive elements. See definition and measurements in Annex 145X.

RPD_max ~~RPair_PD_max is given RPair_PD_min~~, defined in Equation (145–31) for a given RPD_min, is the highest allowable common mode effective resistance in the powered pairs of the same polarity. PDs that meet Equation (145–31) intrinsically meet unbalance requirements.

Change:

-Rpair_PD_max and Rpair_PD_min to RPD_max and RPD_min in Equation 145-31.

$$0 < R_{PD\_max} \le \begin{Bmatrix} 2.17 \times R_{PD\_min} + 0.125 & \text{for PD Type } 3, \text{ Class } 5 \\ 1.988 \times R_{PD\_min} + 0.105 & \text{for PD Type } 3, \text{ Class } 6 \\ 1.734 \times R_{PD\_min} + 0.08 & \text{for PD Type } 4, \text{ Class } 7 \\ 1.727 \times R_{PD\_min} + 0.074 & \text{for PD Type } 4, \text{ Class } 8 \end{Bmatrix}_{\Omega} \qquad (145\text{-}31)$$

where

~~RPair_PD_max~~RPD_max is, given ~~RPair_PD_min~~RPD_min, the highest allowable common mode effective resistance in the powered pairs of the same polarity.

~~RPair_PD_min~~RPD_min is the lower PSE common mode effective resistance in the powered pairs of the same polarity .

Rpd ~~C~~common mode effective resistance is the ~~effective~~ resistance of the two conductors ~~wires~~ (including their components on each conductor) ~~and their components~~ in a powered pair of the same polarity connected in parallel.

Smaller constants α and β in the equation RPD_max = α × RPD_min + β ensure that ICon-2P-unb is not exceeded for PD power consumption above the values in Table 145–26.

Figure 145X-1 illustrates the relationship between RPD_max and RPD_min effective resistances at the PD PI as specified by Equation 145-31 and the rest of the end to end pair to pair effective resistance components.

Under all operating states, single-signature PDs assigned to Class 5 or higher shall not exceed ICon-2P-unb for longer than TCUT-2P min as defined in Table 145–16 on any pair when PD PI pairs of the same polarity are connected to all possible common source voltages in the range of VPort_PSE-2P through two common mode resistances, Rsource_min and Rsource_max, as defined by Equation (145-32) and shown in Figure 145-34.

Under all operating states, dual-signature PDs shall not exceed ICon-2P as defined in Equation (145–8) for longer than TCUT-2P min as defined in Table 145–16 on any pair when PD PI pairs of the same polarity are connected to all possible common source voltage in the range of VPort_PSE-2P through two common mode resistances, Rsource_min and Rsource_max, as defined in Equation (145–32) and shown in Figure 145–34.

$$R_{source\_max} = \left\{ (-0.03 \times R_{source\_min} + 1.324) \times R_{source\_min} \text{ for } (0.145\Omega \le R_{source\_min} \le 5.47\Omega) \right\}_{\Omega} \quad (145\text{–}32)$$

Rsource_min and Rsource_max represent the Vin source common mode effective resistance that consists of the PSE PI components (RPSE_min and RPSE_max as specified in 145.2.8.5.1, VPort_PSE_diff as specified in Table 145–16, the channel resistance, and influence of ~~RPair_PD_min~~ RPD_min and ~~RPair_PD_max~~ RPD_max as function of system end-to-end unbalance). Common mode effective resistance is the resistance of two con-ductors of the same pair and their other components, which form Rsource, connected in parallel including the effect of the total system (PSE and PD) pair to pair voltage~~-~~difference. IA and IB are the pair currents of pairs with the same polarity.

~~RPair_PD_min~~ RPD_min ~~RPair_PD_max~~ RPD_max ensures that along with any other parts of the system, i.e. channel (cables and connectors) and the PSE, the maximum pair current including unbalance does not exceed ICon-2P-unb as defined in Table 145–16 during normal operating conditions.~~-~~See Annex 145X .

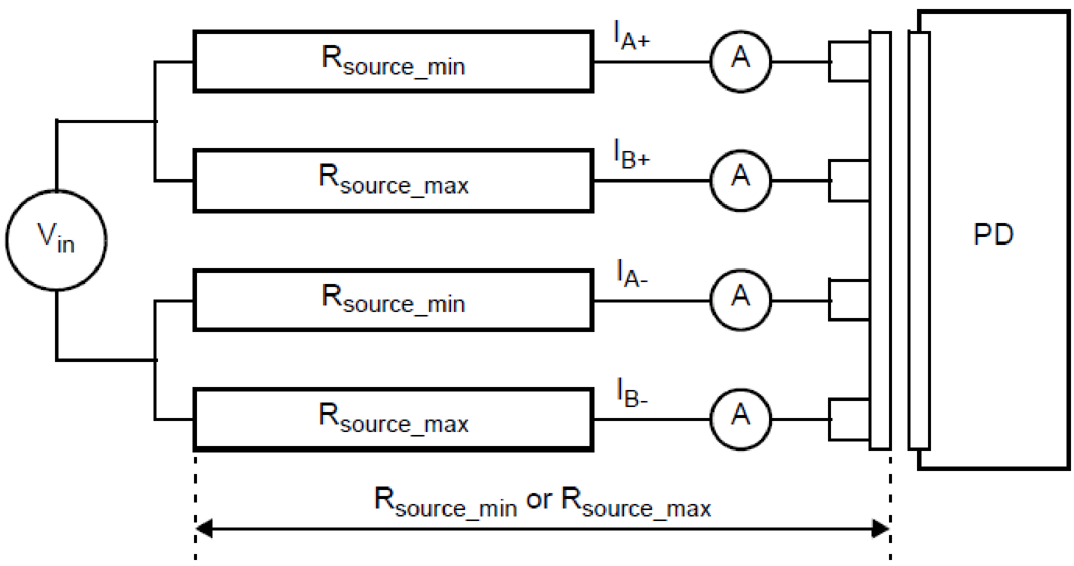


Figure 145–34—$I_{Con\text{-}2P}$ and $I_{Con\text{-}2P\text{-}unb}$ evaluation model

[Note 1 was changed to address comment #322. Note 2 cannot be changed]

NOTE 1—Rsource in Figure 145-34 includes the connecting hardware resistance ~~resistance Rcon~~of the evaluation model to the PD which~~-~~its ~~is the connection resistance at the PD. The~~ maximum recommended value is ~~Rcon value~~ is 0.02 Ω.

NOTE 2—The pairset current limits should also be met when Rsource_max and Rsource_min are swapped between pairs of the same polarity.

This is not part of the baseline

-Annex 145A.5 (which was Annex 33A.5 in D2.2) is missing from D2.3 and need to be inserted in the next draft per the approved changes made to it by darshan_05_0116Rev005.pdf from January 2017.

-The following is darshan_05_0116Rev005.pdf with new updates for D2.3 regarding using RPD_min/max instead of Rpair_PD_min/max in the text and in the drawings.

-Copy the following text and drawing into Annex 145X (used to be Annex 33A.5 in D2.2).

-Approved Changes in Figure 145X-1 from D2.2 to D2.3 are marked with RED color.

-New Changes in Figure 145X-1 from D2.3 to next draft are marked with BLUE color.

Annex 145X

(Informative)

PD PI pair-to-pair current unbalance requirements

RPD_max and RPD_min represent PD common mode input effective resistance of pairs of the same polarity. Common mode effective resistance is the resistance of two conductors of the same pair and their other components connected in parallel including the effect of PD pair-to-pair voltage difference of pairs with the same polarity (e.g. Vf1-Vf3). The common mode effective resistance Rn is the measured voltage Veff_pd_n, divided by the current through the path as described below and as shown in the example in Figure145X-1, where *n* is the pair number.

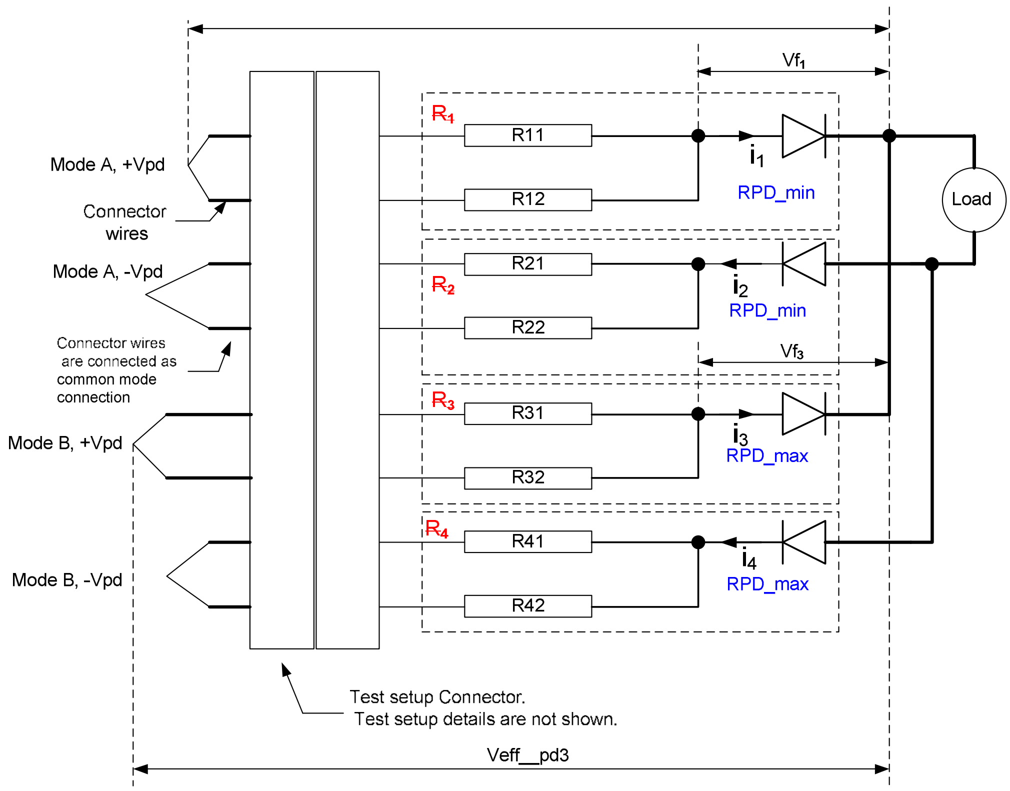


Figure 145X-1—PD resistance unbalance elements overview

Positive pairs:

RPD_min =Veff_pd1 / i1

RPD_max =Veff_pd3 / i3

Negative pairs:

RPD_min =Veff_pd2 / i2

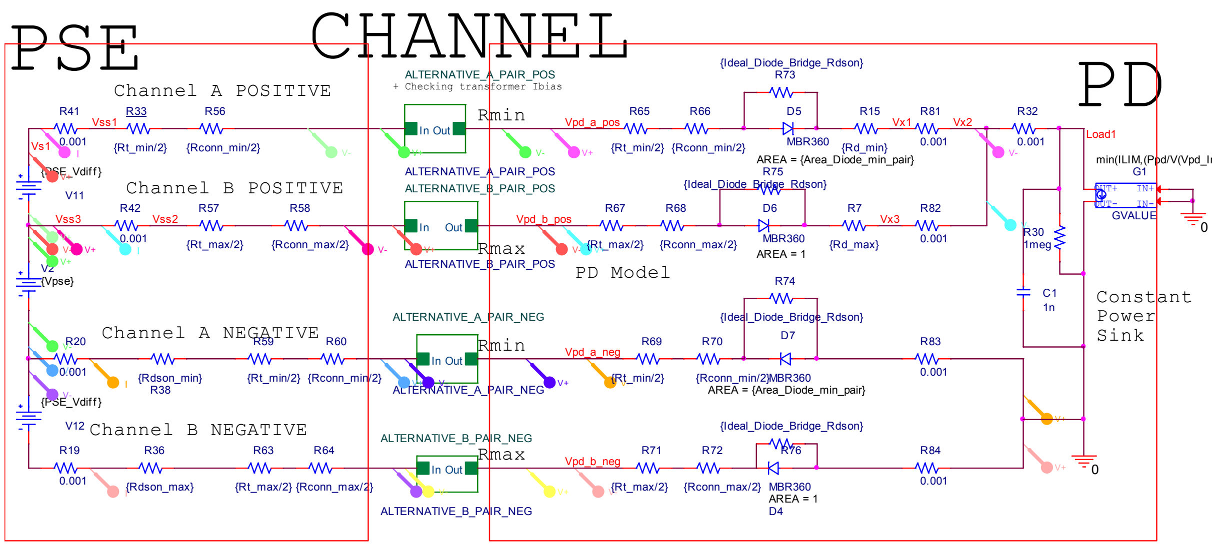
RPD_max =Veff_pd4 / i4

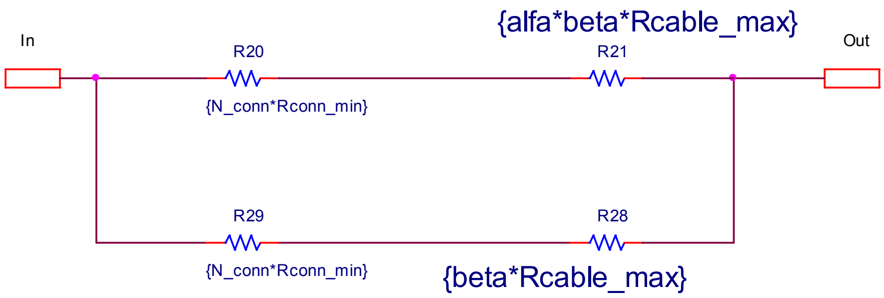
End Of proposed baseline

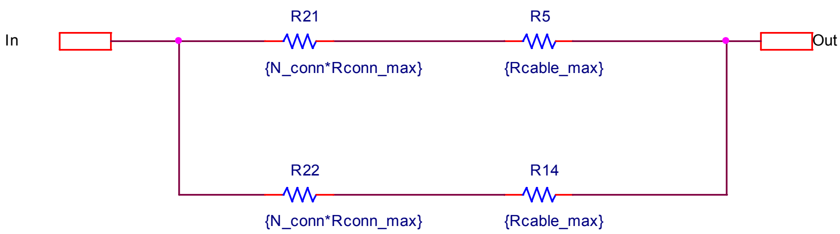
Annex A: 4-pairs spice simulation model parameters used to specify IEEE802.3bt D2.2 and D2.3 requirements.

The following values of the 4-pair model where used to set the specification requirements of the PSE PI and the PD PI unbalance requiremenrs as a function of the total system end to end pair to pair effective resistance/current unbalance.

#	Parameter	Units	Class 5-6		Class 7-8		Notes
			Min	Max	Min	Max	
1	Vpse	Vdc	50.31	----	52.31	----	PSE voltage source, no load voltage
2	Ppd	W	40, 51	----		----	PD input power measured at the PD PI
3	Ppd extended power	W	59.7	----	89.4	----	PD input power measured at the PD PI
4	Lcable	m	2.65	100	2.65	100	Cable and cordage legth.
5	Diode AREA2	-	10		10		Diode simulation parameter. Set the PD Vdiff compare to the diode in the pair with minimum resistance that is set to AREA=1. As a result, PD Vdiff is set to Vdiff=(n*K*T/q)*LN(Is2/Is1) while Is2=Is1 (same diodes only AREA parameter is changed) . As a result, AREA2/AREA1 sets PD Vdiff. For AREA2=10 we will get PD Vdiff =60mV measured at IF=10mA (PD Vdiff is the pair to pair PD voltage difference casued by the forward voltage difference between two diodes on pairs of the same polarity. PD Vdiff is determined at low current (few mA range). When current increase the effect of PD Vdiff on the PD contribution to its PI unbalance and to the total system unbalance is reduced. The use of diodes with higher Vdiff, will increase the PD unbalance at high currents. Therefore a limit of 60mV for PD Vdiff was set at 10mA.
	Diode AREA1	-	1	----	1		Diode simulation parameter set to AREA 1. This diode is located at the pair with maximum resistance.
	Cordage Resistivity	Ω/m	0.0926	----	0.0926	----	Used for short channel length with Lacble =2.65m simulations
	Cable resistivity	Ω/m	0.074	----	0.074	----	Used for short channel length with Lacble =2.65m simulations
	Nuber of connectors	-	0	----	0	----	Used for short channel length with Lacble =2.65m simulations
	Cordage Resistivity	Ω/m	0.123	Ω	0.123	----	Used for long channel length with Lacble =100m simulations
	Cable resistivity	Ω/m	0.123	Ω	0.123	----	Used for long channel length with Lacble =100m simulations
	Nuber of connectors	-	4	----	4	----	Used for long channel length with Lacble =100m simulations
	Minimum Channel Resistance wire 1	Ω	=α*β*Lcable*(0.1*cordage_resistivity+0.9*cable_resistivity)+N*Rconn_min				1st wire of the pair withminimum resistance α=(1-pair_Runb)/(1+pair_Runb)=0.96. Pair_Runb=0.02. β=(1-pair2p_Runb)/(1+pair2p_Runb)=0.9. Pair2p_Runb=0.05 for IEEE802.3bt D2.1 and was changed to β=(1-pair2p_Runb)/(1+pair2p_Runb)=0.8867. Pair2p_Runb=0.06 to ensure total channel pair to pair resistance unbalance of 7% per Annex 145A.4. Wire length is measured from PSE PI to PD PI (not round loop). Each pair of the same polarity has two wires (wire 1 and wire 2) are connected in parallel and form common mode resistance of that pair. In the positive pairs, we have two pairs with the same voltage polarity, the 1st pair is set to minum resistance and the 2nd pair is set to maximum resistance. The same applies to the negative pairs.
	Minimum Channel Resistance wire 2	Ω	=β*Lcable*(0.1*cordage_resistivity+0.9*cable_resistivity))+N*Rconn_min				
	Maximum Channel Resistance wire 1 and wire 2		Lcable*(0.1*cordage_resistivity+0.9*cable_resistivity)				
	PSE Vdiff	mV	10	----	10	----	
	Rt	Ω	0.12	0.13	0.12	0.13	Transformer winding resistance
	Rconn	Ω	0.03	0.05	0.03	0.05	Connector resistance
	Rdson	Ω	0.07	0.1	0.07	0.1	
	Rsense	Ω	0.0225	0.25	0.0225	0.25	







Simulation results on the positive pairs Done for IEEE802.3bt D2.2 and D2.3 for reference.

Cable Length (m)	2.65m	100m	Spec in D2.2	Notes
Channel max common mode resistance resistance (Ω)	0.2	12.5		It is the value of two conductors in parallel from PSE PI to PD PI and back.
Number of connectors	0	4		
PSE Vdiff (mV)	10	10		
PD Vdiff (mV)	60	60		
Pair with maximum current (mA) on (I(R41))	Imax,	Imax,	Imax=Icont_2P_unb	Positive pairs
Class 5	547.07	483.86	550(*)	Maximum current is at short cable length.
Class 6	678.65	638.83	682(*)	Maximum current is at short cable length.
Class 7	780.85	764.43	781(**)	Maximum current is at short cable length.Different from D2.1 results (maximum current was at long cable) due to different model parameters values that was updated at D2.1 meeting.
Class 8	911.62	911.61(*)	931(***)	Maximum current is at long cable length.

(*) Spec was not changed in D2.2 for class 5 and 6 in order to finish first the significant digits issues.
(**) (Spec was changed in D2.2 for class 7 to update per the updated sim results.
(**) Spec was changed in D2.2 for class 8 to allow PD margin for Extended Class 8 use case. D2.1 spec was 925mA.