## Comment

To update **33.2.8.4.1 and** Annex B per the remedy and guidelines in darshan_04_0316.pdf.

**Background**

The following were the guidelines for wording 33.2.8.4.1 and Annex B text.
a) When reading 33.2.8.4.1 (PSE P2PRunb) that links to Annex B, to make sure that reader knows that Annex B is normative and contain shalls.
b) To verify that we need all shalls in Annex B.
c) To verify that the shalls are not similar.
d) To update the test to cover high resistance channel.
e) Add clarifications to the text whenever is needed. Seethe following marked text.

## Proposed Remedy

### 33.2.8.4.1 PSE PI pair-to-pair resistance and current unbalance

[Page 108, Lines 5-8.]

The values of $R_{PSE\_max}$ and $R_{PSE\_min}$ are implementation specific and need to satisfy Equation (33–12). $R_{PSE\_max}$, $R_{PSE\_min}$ and Icon-2P_unb shall be measured according to the tests ~~setup and test conditions shown~~ described in the normative Annex 33 B.

## Annex 33B

(normative)

## PSE PI pair-to-pair resistance/current unbalance

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 met with $R_{load\_max}$ and $R_{load\_min}$ as specified by Table 33B-1. The details for derivation of $R_{load\_max}$ and $R_{load\_min}$, which are composed of compliant channel and PD effective resistances, can be found in Annex 33D.

A compliant unbalanced load, Rload consists of the channel (cables and connectors) and the PD effective resistances.

Equation (33–12) is described in 33.2.8.4.1, specified for the PSE, assures that E2EP2PRunb will be met in a compliant 4-pair powered system. Figure 33B-1 illustrates the relationship between PSE PI Equation (33–12) and $R_{load\_min}$ and $R_{load\_max}$ as specified in Table 33B-1.

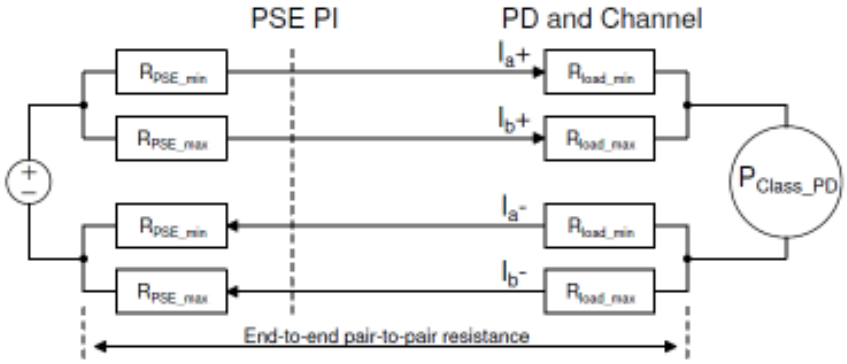



**Figure 33B–1—PSE PI unbalance specification and E2EP2PRunb**

Table 33B-1—Rload_max and Rload_min requirements

| PSE Class | Rload_min, [Ω] | Rload_max, [Ω] | Additional Information |
|---|---|---|---|
| 5 | 0.723 | 1.628 | Rload is at low channel resistance conditions |
| 6 | 0.623 | 1.289 | |
| 7 | 0.590 | 1.090 | |
| 8 | 0.544 | 0.975 | |
| 5 | 5.920 | 7.190 | Rload is at high channel resistance conditions |
| 6 | 5.780 | 7.000 | |
| 7 | 5.710 | 6.870 | |
| 8 | 5.650 | 6.790 | |

**Editor Note: Rload_min/max requirements for class 5-8 may be simplified by using the same Rload_min/max for class 5-8 but it requires further work to validate it.**

Equation (33–12) specifies the PSE effective resistances required to meet E2EP2PRunb in the presence of all compliant, unbalanced loads attached to the PSE PI. There are three alternate test methods for $R_{PSE\_max}$ and $R_{PSE\_min}$ and determining conformance to Equation (33–12) and to Icon-2P_unb.

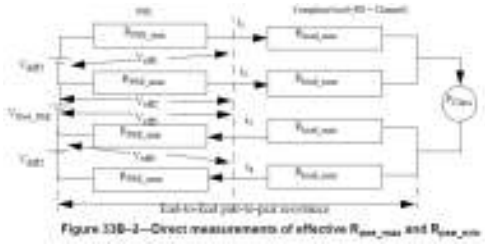
Measurement methods to determine $R_{PSE\_max}$ and $R_{PSE\_min}$ and Icon-2P_unb are defined in 33B.1, 33B.2, and 33B.3.

## 33B.1 Direct $R_{PSE}$ measurement

If there is access to internal circuits, effective resistance may be determined by sourcing current in each path corresponding to maximum $P_{Class}$ 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 $V_{eff}$, divided by the current through the path e.g. the effective value of $R_{PSE\_min}$ for i1 is $R_{PSE\_min} = V_{eff1}/i1$ as shown in Figure33B-2.

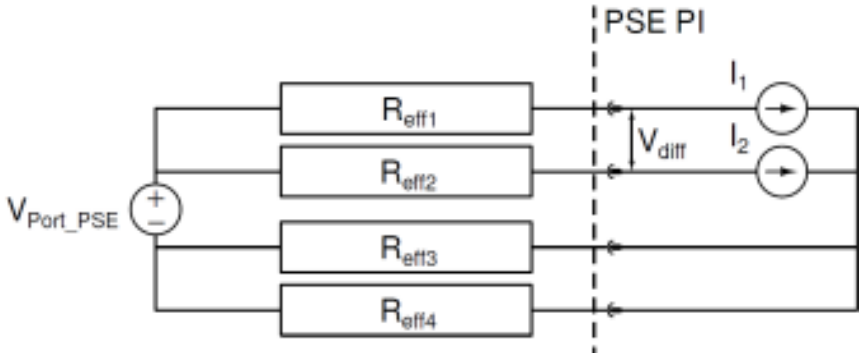
The following text is redundant. It is described already in page 222 lines

~~The two sections that follow, 33B.2 and 33B.3 illustrate two other possible measurements of PSE effective resistances for $R_{pse\_max}$ and $R_{pse\_min}$ Equation (33–12) verification, if the internal circuits are not accessible.~~



## 33B.2 Effective resistance Rpse measurement

Figure 33B-3 shows a possible test circuit for effective resistance measurements on a PSE port for evaluating conformance to Equation (33–12) if the internal circuits are not accessible. In Figure 33B-3, the positive pairs of the same polarity are shown as an example. The same concept applies to the negative pairs.




The Effective Resistance Test 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 voltage difference $V_{diff}$ across $V_1$, $V_2$ ($V_{diff}=V_1-V_2$).
3) Reduce $I_1$ by 20% ($=I_1'$). Ensure $I_2$ remains unchanged.
4) Measure $V_{diff}'$ across $V_1$, $V_2$.
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 (33–12). Evaluate compliance of $R_{eff3}$ and $R_{eff4}$ with Equation (33–12).

The effective resistance test 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 33B.3 shall be used.

## 33B.3 Current unbalance ~~RPSE~~ measurement

-The title of 33B.3 and some of its text is not accurate. The tested parameter is only Icon-2P_unb which actually tests for actual current unbalance and not Rpse.
- In D1.4 and D1.5 we change Rpair to Rpse and some of it was not implemented in D1.6 correctly.

The following method may be used if the internal PSE circuits are not accessible. Current unbalance requirement shall be met for any pairs of the same polarity ~~to pair resistances ($R_{Pair\_max}$ and $R_{Pair\_min}$) meeting Equation 33–12~~ and with the load resistances per Table 33B-1. Selected resistance values for ~~$R_{Pair\_max}$ and $R_{Pair\_min}$~~ $R_{PSE\_max}$ and $R_{PSE\_min}$ which provide adequate verification to Equation 33-12 or control Icon-2P_unb value are dependent upon PSE circuit implementation and as such are left to the designer. Figure 33B-4 shows a test circuit for the current unbalance requirements measurement.

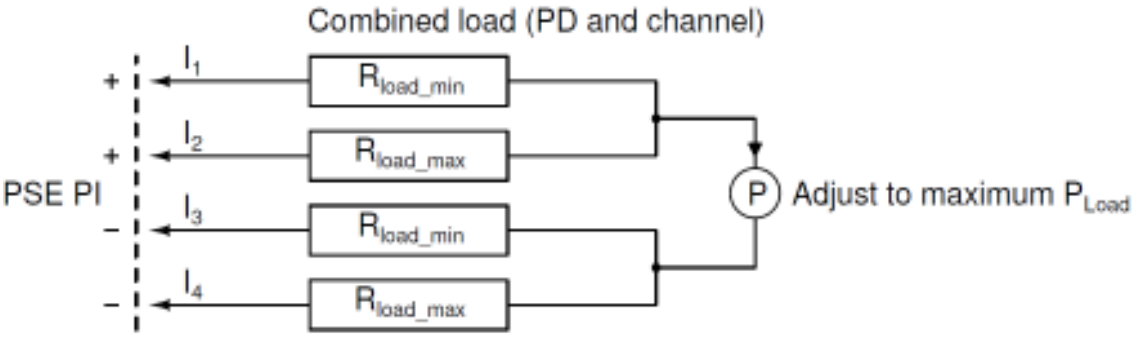



**Figure 33B-4--Current unbalance test circuit**

The current unbalance test method is described below:

1) Use $R_{load\_min}$ and $R_{load\_max}$ from Table 1 for Rload at low channel resistance conditions.
2) With the PSE powered on, adjust the load for maximum power at the PSE.
3) Measure $I_1$, $I_2$.
4) Swap $R_{load\_max}$, $R_{load\_min}$, repeat steps 1 and 2.
5) Repeat for $I_3$, $I_4$.
6) Verify that the current ~~unbalance~~ in each case does not exceed $I_{con\text{-}2P\_unb}$ minimum in Table 33–17 item 4a.
7) Repeat steps 1-6 for $R_{load\_min}$ and $R_{load\_max}$ from Table 1 for for Rload at high channel resistance conditions.

Verification of $I_{con\text{-}2P\_unb}$ in step 6 and 7 confirms PSE Rpse_max and Rpse_min are in conformance to ~~Equation (33–12)~~ this specifications.

## 33B.4 Channel resistance with less than 0.1Ω

$I_{con\_2P\_unb}$ max and Equation 33-12 are specified for total channel common mode pair resistance from 0.1Ω to 12.5Ω and worst case unbalance contribution by a PD. When the PSE is tested for channel common mode resistance less than 0.1 Ω, i.e. 0 Ω < $R_{ch\_x}$ < 0.1 Ω, the PSE shall be tested with ($R_{load\_min}$ - $R_{ch\_x}$) and ($R_{load\_max}$ - $R_{ch\_x}$) to meet $I_{con\_2P\_unb}$ requirements and Rpse_min and Rpse_max conformance to Equation (33–12).

*Editor's Note: To consider the value of adding informative section to present $R_{load\_max}$ and $R_{load\_min}$ equation derivation and values.*

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The following is NOT part of the baseline text.

## Annex A – Derivation of Rload_min/max for the case with 100m channel

| | Ppd=40W<br>Vpse=50.3V<br>2.65m cable | Ppd=51W<br>Vpse=50.3V<br>100m cable | Ppd=62W<br>Vpse=52.31V<br>100m cable | Ppd=71W<br>Vpse=52.31V<br>100m cable | Units |
|---|---|---|---|---|---|
| Veqv1 | 2.8905 | 3.7322 | 4.4116 | 5.182 | V |
| Veqv2 | 2.8812 | 3.7228 | 4.4021 | 5.1723 | V |
| Veqv3 | -2.962 | -3.83 | -4.5307 | -5.3251 | V |
| Veqv4 | -2.9741 | -3.8418 | -4.5421 | -5.3363 | V |
| I1 | 488.198 | 645.618 | 772.901 | 917.381 | mA |
| I2 | 400.843 | 533.346 | 640.499 | 762.143 | mA |
| I3 | -473.735 | -627.014 | -750.95 | -891.632 | mA |
| I4 | -415.306 | -551.95 | -662.449 | -787.892 | mA |
| **Lowest Rload_min/max (pairs of the same polarity with lowest resistances)** | | | | | |
| Rload_min | 5.921 | 5.781 | 5.708 | 5.649 | ohms |
| Rload_max | 7.188 | 6.980 | 6.873 | 6.787 | ohms |

Note 1: Rload_min/max requirements for class 5-8 may be simplified by using the same Rload_min/max for class 5-8 but it requires further work to validate it.

Note 2: Simulations conditions:
For 100m channel length: cordage and cable with a resistance of 0.121 ohm per meter with 4 connectors each with 0.05 ohm max for getting common mode resistance max of 6.25 ohm at 100m.
For 2.65m channel length: cordage resistance: 0.0926 ohm per meter for 10% of the channel length. Cable resistance: 0.074 ohm per meter for 90% of the channel length. No connectors.