



System Unbalance Examples

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Issue

- The PSE contribution to system unbalance calculated using the values and methods from Draft 2.1 33B-4 is not in conformance with Icon-2p-unb from Table 33-19
- This presentation simply shows that the system is inoperable as defined
- The 33B-4 method for testing the PSE contribution to unbalance is well thought out
- The model shown in Figure 33B-1 and 33B-4 needs a small adjustment for the calculation to work

Class 6 Low Channel Resistance Example

Let:

$$R_{pse_min} = 0.1\Omega$$

$$V_{supply} = 50.14V$$

$$R_{pse_max} = 2.010 * 0.1 - 0.04 = 0.161\Omega$$

$$R_a = R_{pse_min} + R_{load_min} = 0.723\Omega$$

$$R_b = R_{pse_max} + R_{load_max} = 1.450\Omega$$

$$R_{e2e} = R_a || R_b = 0.482\Omega$$

$$I_{con} = 1038mA$$

$$I_a / I_b = R_b / R_a = 2.005$$

$$I_a = 692.5mA \quad \leftarrow \text{Violates } I_{con-2p-unb} (682mA)$$

$$I_b = 345.3mA$$

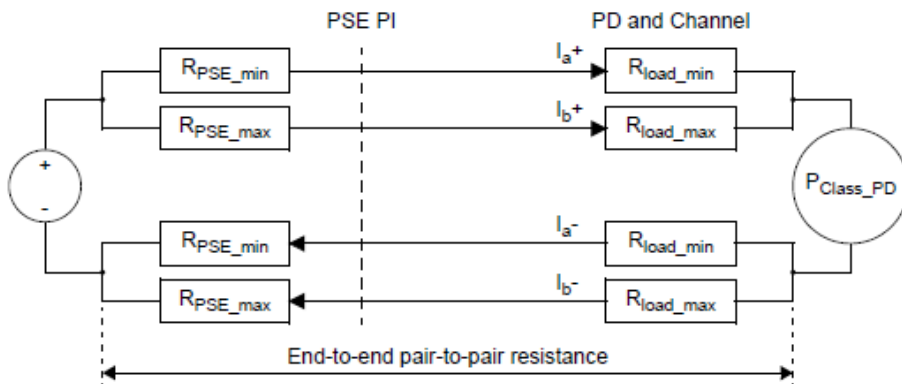


Figure 33B-1—PSE PI unbalance specification and E2EP2PRunb

$$R_{PSE_max} = \left. \begin{array}{ll} 2.200 \times R_{PSE_min} - 0.040 & \text{for Class 5} \\ 2.010 \times R_{PSE_min} - 0.040 & \text{for Class 6} \\ 1.800 \times R_{PSE_min} - 0.030 & \text{for Class 7} \\ 1.750 \times R_{PSE_min} - 0.030 & \text{for Class 8} \end{array} \right\} \Omega$$

Table 33B-1— R_{load_max} and R_{load_min} requirements

PSE Class	R_{load_min} (Ω)	R_{load_max} (Ω)	Additional information
5	0.723	1.628	R_{load} 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	R_{load} is at high channel resistance conditions
6	5.780	7.000	
7	5.710	6.870	
8	5.650	6.790	

Measurement methods to determine R_{PSE_max} and R_{PSE_min} and $I_{Con-2P-unb}$ are defined in 33B.2, 33B.3, and 33B.4.

Class 6 Low Channel Resistance Icon Calculation

Let:

$$R_{e2e} = 0.482\Omega$$

$$V_{supply} = 50.14V$$

$$R_{thev} = 2 * R_{e2e} \text{ (factor of 2 for source and return paths)}$$

$$P_{pd} = 51W$$

$$V_{pd} = [-1 * V_{supply} - \sqrt{V_{supply}^2 - 4 * P_{pd} * R_{thev}}] / 2$$

$$V_{pd} = 49.13V$$

$$I_{con} = (V_{supply} - V_{pd}) / R_{thev} = 1038mA$$

Source of Error

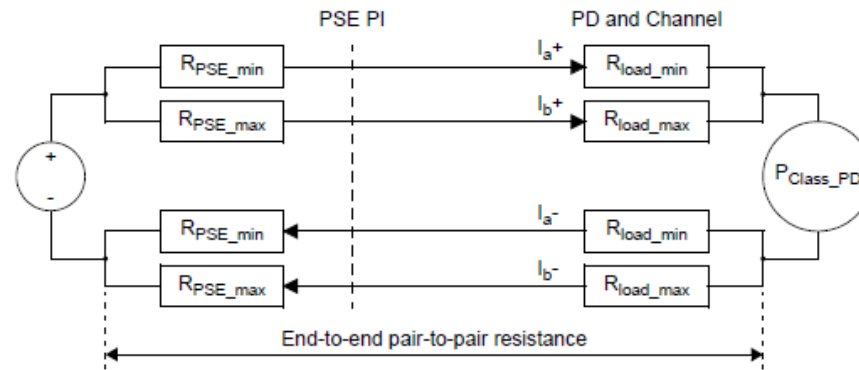
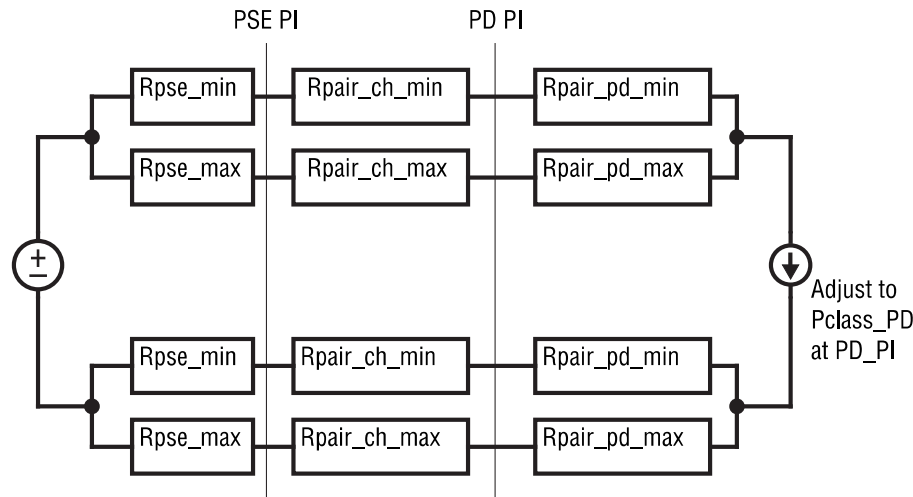


Figure 33B-1—PSE PI unbalance specification and E2EP2PRunb

- Rload_min and Rload_max are the lumped sum of the PD and Channel Effective Resistances
- This causes an error in the calculation of Pclass_pd
- I suggest we use a slightly more complicated model so that it is clear where the power calculation should be made.



Update Model Values

- Update Table 33B-1 so that Rload_max and Rload_min are broken into Channel and PD Components

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	

Measurement methods to determine R_{PSE_max} and R_{PSE_min} and I_{Con-2P-imb} are defined in 33B.2, 33B.3, and 33B.4.

PSE Class	Rpair_pd_min	Rpair_pd_max	Rpair_ch_min	Rpair_ch_max
5	0.623	1.518	0.1	0.11
6	0.523	1.179		
7	0.490	0.980		
8	0.444	0.875		
5	0.623	1.518	5.9375	6.25
6	0.523	1.179		
7	0.490	0.980		
8	0.444	0.875		

Updated Class 6 Low Channel Resistance Example

Let:

$$R_{pse_min} = 0.1\Omega$$

$$V_{supply} = 50.14V$$

$$R_{pse_max} = 2.010 * 0.1 - 0.04 = 0.161\Omega$$

$$R_a = R_{pse_min} + R_{chan_min} + R_{pd_min} = 0.723\Omega$$

$$R_b = R_{pse_max} + R_{chan_max} + R_{pd_max} = 1.450\Omega$$

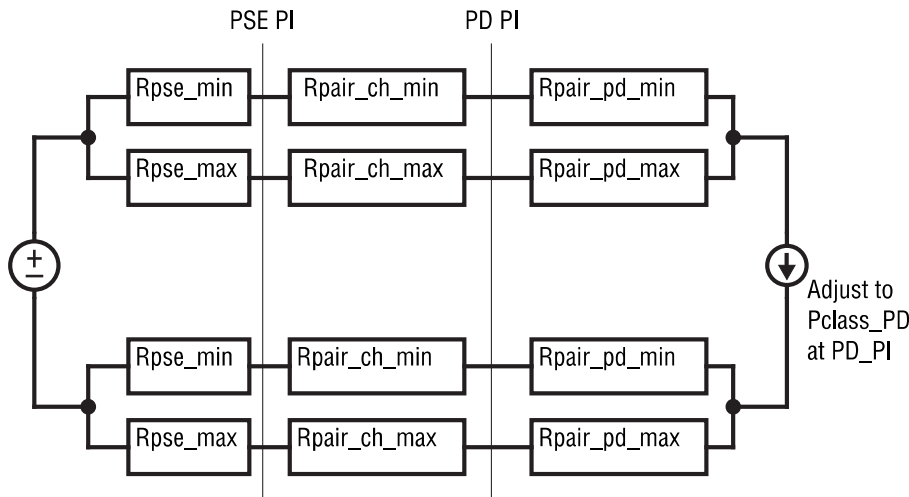
$$R_{e2e} = R_a \parallel R_b = 0.482\Omega$$

$$I_{con} = 1022mA$$

$$I_a / I_b = R_b / R_a = 2.005$$

$$I_a = 682mA \quad \leftarrow \text{This is in spec now (682mA)}$$

$$I_b = 340mA$$



$$R_{pse_max} = \begin{cases} 2.200 \times R_{pse_min} - 0.040 & \text{for Class 5} \\ 2.010 \times R_{pse_min} - 0.040 & \text{for Class 6} \\ 1.800 \times R_{pse_min} - 0.030 & \text{for Class 7} \\ 1.750 \times R_{pse_min} - 0.030 & \text{for Class 8} \end{cases} \Omega$$

PSE Class	Rpair_pd min	Rpair_pd max	Rpair_ch min	Rpair_ch max
5	0.623	1.518	0.1	0.11
6	0.523	1.179		
7	0.490	0.980		
8	0.444	0.875		
5	0.623	1.518	5.9375	6.25
6	0.523	1.179		
7	0.490	0.980		
8	0.444	0.875		

Updated Class 6 Low Channel Resistance Icon Calculation

Let:

$$R_{e2e} = 0.482\Omega$$

$$V_{supply} = 50.14V$$

$$R_{thcv} = 2 * R_{e2e} \text{ (factor of 2 for source and return paths)}$$

$$P_{pd} = 51W$$

Assume 683mA into R_{pd} Min

$$683mA^2 * 0.523\Omega = 244mW$$

$$336mA^2 * 1.179\Omega = 133mW$$

$$R_{pd} \text{ Power loss} = 2 * (244mW + 133mW) = 754mW$$

$$P_{adj} = 51W - 0.754W$$

$$V_{pd} = [-1 * V_{supply} - \sqrt{V_{supply}^2 - 4 * P_{adj} * R_{thcv}}] / 2$$

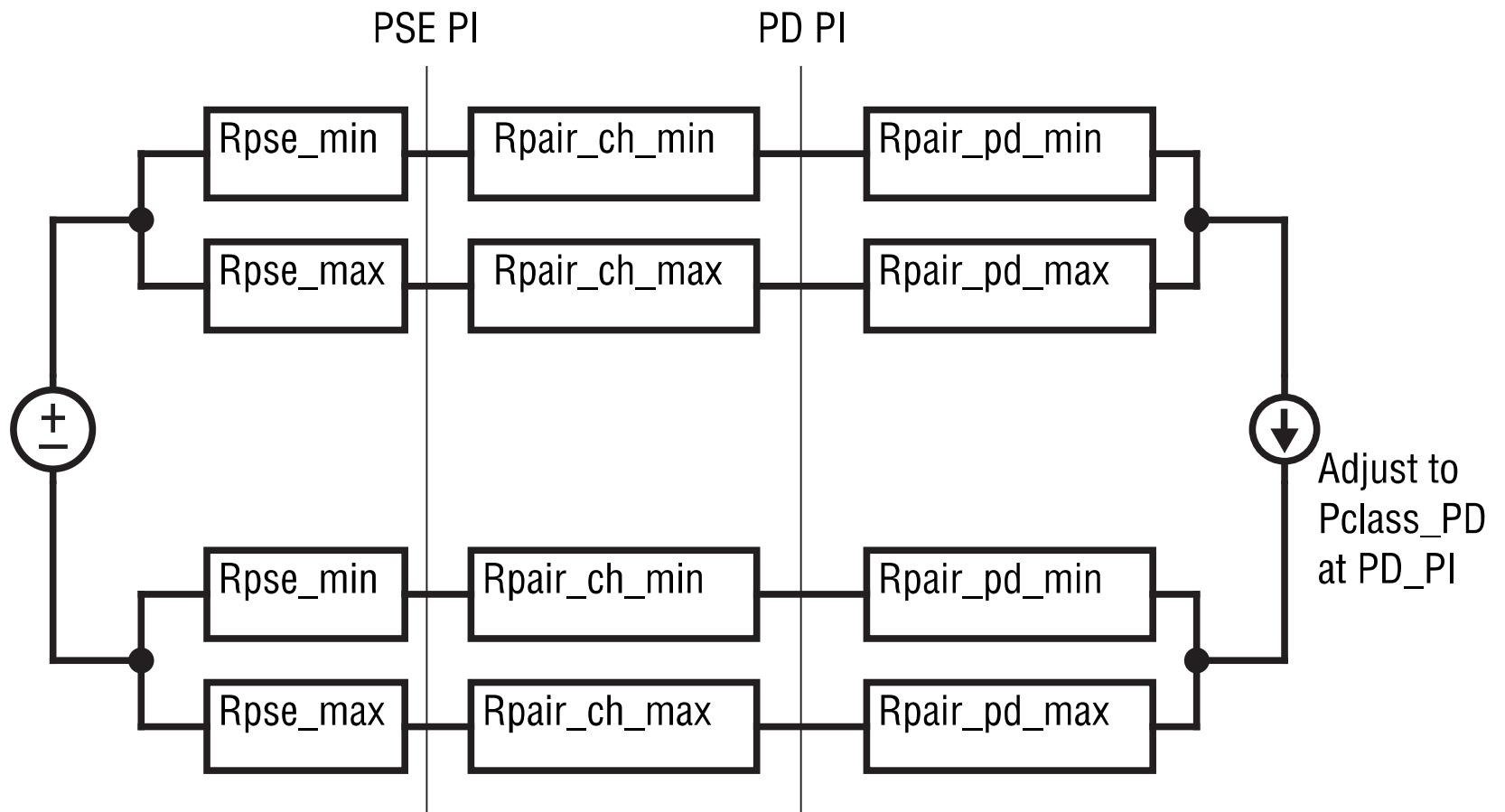
$$V_{pd} = 49.153V$$

$$I_{con} = (V_{supply} - V_{pd}) / R_{thcv} = 1022mA$$

Conclusion

- The PSE contribution to system unbalance calculated using the values and methods from Draft 2.1 33B-4 is not in conformance with Icon-2p-unb from Table 33-19
- The system model in figure 33B-1 should define Pclass_PD at the PD PI
- Breaking the Rload resistances into Rpd and Rchan resistances and calculating Pclass_PD at the PD PI brings the unbalance calculations back into conformance

Replace Figure 33B-1



Replace Table 33B-1

PSE Class	Rpair_pd min	Rpair_pd max	Rpair_ch min	Rpair_ch max
5	0.623	1.518	0.1	0.11
6	0.523	1.179		
7	0.490	0.980		
8	0.444	0.875		
5	0.623	1.518	5.9375	6.25
6	0.523	1.179		
7	0.490	0.980		
8	0.444	0.875		

Replace Figure 33B-4

