



## Allowing Eq 145-8 to be tested-missing Icon-2P\_other definition

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# Terms

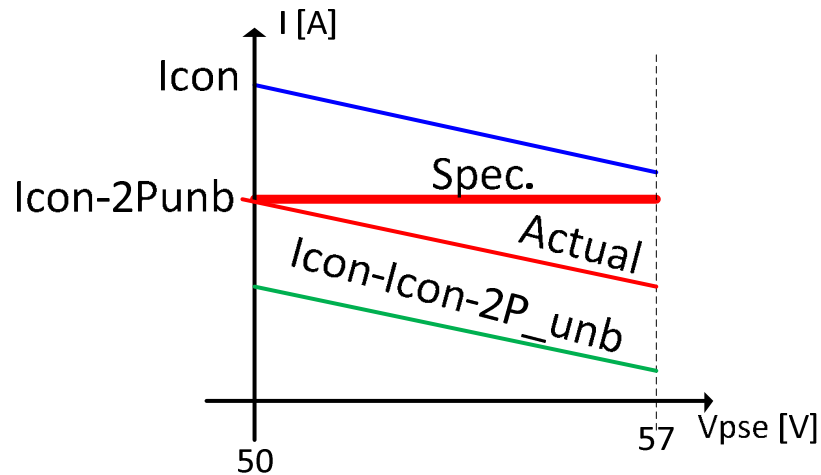
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- Runb is used in this presentation for the End to End pair-to-pair effective resistance unbalances as specified in D2.5

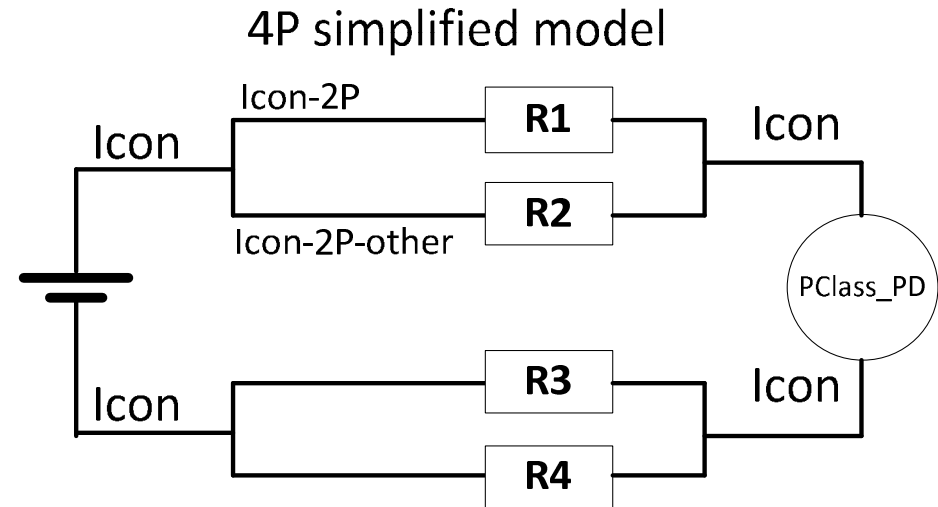
# Background

- D2.5 requires that “PSEs shall be able to source ***ICon-2P***, the current the PSE supports on each powered pairset, as defined in Equation (145–8).”
- ICon-2P\_unb is:
  - A fixed value (For Class 6, PClass=60W it is 0.682A).
  - Defined under PSE minimum voltage (50V for class 6) **only** and under worst case resistance unbalance conditions of PSE, PD and Channel.
- If Pclass is set and Vpse\_max=57V, ICon falls from ICon=Pclass/50V=1.022A to ICon=Pclass/57V=0.896A.
- ***As a result, ICon-2P\_unb\_actual falls from 0.682A to ~0.598A<sup>1,2</sup>***
- ***Two questions:***
  - (a) Does the test vendor will need to increase PClass\_PD in order to increase ICon-2P\_unb\_actual from 0.598A to 0.682A to verify that PSE is able to support 0.682A? If test vendor will do this it will violate PClass<sup>3</sup>
  - (b) What is ICon-2P-other value
- ***The answer for (a) is NO.*** Pclass will not be violated due the fact that Equation 145-8 fix this for us since it requires that PSE will be able to support ***ICon-2P = min{ICon-Iport\_other, ICon-2P\_unb} = {0.896A-(0.896A-0.598A), 0.682A} = 0.598A which is < 0.682A .***
- ***The answer for (b) is: This information is missing from the spec.***
  - Note 1:  $0.598A \approx 0.682A \cdot 50V / 57V$  (approximation and also confirmed by simulations. See Annex A1, A2)
  - Note 2: The missing info in the spec is how to calculate ICon-2P\_unb-actual (**worst comment for D3.0**)
  - Note 3:  $0.682A \cdot 50V + (1.022 - 0.682) \cdot 50V > 60W$

# Background Cont.



Icon-2P-unb vs Icon-2P\_unb\_actual



- $I_{con} = P_{Class} / V_{pse}$
- $I_{con} = I_{con-2P} + I_{con-2P-other}$
- $I_{con-2P\_unb\_actual} = V_{pse\_min} * I_{con} * (1 + R_{unb}) / (2 * V_{pse})$   
for the range 50V to 57V.
- $R_{unb} = (R1 - R2) / (R1 + R2)$ ,
- If  $R2 > R1$ ,  $I_{con-2P} = I_{con-2P\_unb\_actual}$
- If  $R1 > R2$ ,  $I_{con-2P-other} = I_{con-2P\_unb\_actual}$
- $I_{con-2P\_unb} = I_{con-2P\_unb\_actual} = 0.682A$  for Class 6  
at 50V and worst case  $P_{Runb}$ .

# Background – Answering question A

					Table 145-16		Eq 145-8				Test	
Vpse	Rchan	PClass_PD	Pclass	Icon	Icon-2P_unb	Icon-2P_unb_actual	Icon-2P=	Icon-2P-other	Pmax	Pmin	Pclass=	Runb
						$=Icon(1+Runb)/2$	$\min\{Icon-Icon-2P\_other, Icon-2P\_unb\}$				$Pmin+Pmax$	
50	0.1	51	60	1.022	0.682	0.682	0.682	0.340	34.100	17.004	51.104	0.335
57	0.1	51	60	0.896	0.682	0.598	0.598	0.298	34.084	16.996	51.080	0.335
52	6.25	71.3	90	1.732	0.932	0.932	0.932	0.800	48.464	41.574	90.038	0.077
57	6.25	71.3	90	1.496	0.932	0.805	0.805	0.691	45.911	39.384	85.295	0.077

-We can see that Pclass\_PD is kept.

-Runb is used as a constant although in reality it will be a bit higher by ~2% at 57V since Runb is increased when current is decreased due to the diodes nonlinearity in the PD) however Icon will be lower by 13.32% and Icon-2P\_unb\_actual will be lower by 11.82% (sim results).

***-The only problem is question (B): in order to use Equation 145-8, we need the knowledge of Icon-2P\_other that is missing in the spec. I have calculated it and verify it by simulations however the knowledge to do it is not exists in the spec. while not all the equation parts are specified.***

# Summary

- The criteria to meet unbalance requirements is to be below  $I_{con-2P\_unb}$
- Meeting Equation 145-15 ( $R_{pse\_min/max}$ ) guarantees meeting  $I_{con-2P\_unb}$  when PSE is connected to the test model shown in Figure 145-22 and with the components described in Table 145-17.
- ***PSEs need to support  $I_{con-2P}$ .***
- ***$I_{con-2P}$  may reach  $I_{con-2P\_unb}$  (Table 145-16) at  $V_{pse\_min}$  and worst case  $R_{unb}$  as a result, **PSE has to be designed to  $I_{con-2P\_unb}$  when  $V_{pse\_min}=50V$  and PSE PI  $R_{unb}$  is at worst case.*****
- When  $V_{pse} > V_{pse\_min}$ ,  $I_{con}$  and as a result,  $I_{con-2P}$ ,  $I_{con-2P\_other}$  and  $I_{con-2P\_unb\_actual}$  adjust themselves per the physics so  $P_{Class\_PD}$  is kept within spec and as a result,  $P_{Class}$  too.
- In addition, PSE can be designed to support  $I_{con-2P} < I_{con-2P\_unb}$  for voltages  $> 50V$ . The problem is that it can't be done now since the spec doesn't specify what is  $I_{con-2P\_other}$  in this conditions.
- In addition, it will be beneficial to the user to know that  $I_{con-2P\_unb\_actual} = I_{con} * (1 + R_{unb}) / 2$ .
- **Equation 145-8 is behavioral equation type and insufficient as a design tool.**



# Recommendations

- For the question investigated:
  - (A) Does PSE has to be designed to support Icon-2P? **YES.**
  - Does it means that it has to support Icon-2P\_unb? **YES at Vpse=Vpse\_min:**  
**Eq. 145-8: Icon-2P=min {Icon-Icon-2P-other, 0.682A}**  
**= min{1.022A-(1.022A-0.682A), 0.682A}=0.682A=Icon-2P\_unb**
  - No need for spec changes for this topic.
- In order to use Equation 145-8 **e.g. in Class 6:**  
Icon-2P=min {Icon-Icon-2P-other, 0.682A) for other values of Vpse, we need to know Icon and Icon-2P-other.
  - We know that have Icon=Pclass/Vpse.
  - **We don't know Icon-2P\_other however we can add it to the spec:**  
Icon-2P\_other=Icon-2P\_unb\_actual=Icon-2P\_unb\*Vpse\_min/Vpse so in case of Vpse=Vpse\_min we will get the current result of Icon-2P=0.682A.

# Discussion

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# Thank You

## Annex A1 – Icon, Icon-2P\_unb vs. Vpse, Class 5

		Vpse[V]		Ratio	Icon		Ratio
Simulation	simplified model	50.3	57.000	13.32%	50.3	57.000	
I(R41)	R1	547.065	490.135	11.62%	797.818	703.536	13.40%
I(R42)	R2	250.753	213.401	17.50%			
I(R20)	R3	510.425	454.614	12.28%	797.818	703.535	13.40%
I(R19)	R4	287.393	248.921	15.46%			

- Runb at 50V is 37.14% and at 57V is 39.33% which is ~2% increase which means that the resistant unbalance is about constant at 50V-57V voltage range.
- Icon is proportional to voltage ratio which is obvious (13.32% vs 13.4%)
- Icon-2P\_unb is reduced by 11.62% when Vpse is increased by 13.32%
- These means that we can use the following approximation:

$\text{Icon-2P\_unb}/\text{Icon-2P\_unb\_actual} = \text{Vpse}/\text{Vpse\_min} \rightarrow$

$\text{Icon-2P\_other} = \text{Icon-2P\_unb\_actual} = \text{Icon-2P\_unb} * \text{Vpse\_min}/\text{Vpse}$

## Annex A2 – Icon, Icon-2P\_unb vs. Vpse, Class 6

		Vpse[V]		Ratio	Icon		Ratio
Simulation	simplified model	50.3	57.000	13.32%	50.3	57.000	
I(R41)	R1	678.651	606.891	11.82%	1018.171	897.654	13.43%
I(R42)	R2	339.52	290.763	16.77%			
I(R20)	R3	640.227	569.326	12.45%	1018.171	897.654	13.43%
I(R19)	R4	377.944	328.328	15.11%			

- Runb at 50V is 33.3% and at 57V is 35.2% which is ~2% increase which means that the resistant unbalance is about constant at 50V-57V voltage range.
- Icon is proportional to voltage ratio which is obvious (13.32% vs 13.4%)
- Icon-2P\_unb is reduced by 11.82% when Vpse is increased by 13.32%
- These means that we can use the following approximation:

$\text{Icon-2P\_unb}/\text{Icon-2P\_unb\_actual} = \text{Vpse}/\text{Vpse\_min} \rightarrow$

$\text{Icon-2P\_other} = \text{Icon-2P\_unb\_actual} = \text{Icon-2P\_unb} * \text{Vpse\_min}/\text{Vpse}$

For class 7-8 we will get same conclusions.

