IPeak-2P-unb v100

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Introduction

This presentation deals with the specification of $I_{Peak\text{-}2P\text{-}unb}$. There are two important parameters that deal with unbalance: $I_{Con\text{-}2P\text{-}unb}$ and $I_{Peak\text{-}2P\text{-}unb}$. This parameter is used both for PD and PSE specifications, and is used in different context.

- **$I_{Con\text{-}2P\text{-}unb}$**

  PSE The **minimum** amount of unbalance current on a pairset the PSE must be able to deliver continuously. Also, the **maximum** amount of current the PSE may cause to flow when exposed to the worst-case unbalance channel+PD combination.

  PD The **maximum** amount of current a PD may cause to flow on a pair when connected to a worst case PSE+channel combination.

- **$I_{Peak\text{-}2P\text{-}unb}$**

  PSE See $I_{Con\text{-}2P\text{-}unb}$, but for peak current up to $T_{CUT\text{-}2P}$ min.

  PD See $I_{Con\text{-}2P\text{-}unb}$, but for peak current up to $T_{CUT\text{-}2P}$ min.

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$I_{Con\text{-}2P\text{-}unb}$

$I_{Con\text{-}2P\text{-}unb}$ depends on P_{Class_PD}, the assigned Class by the PSE. Other than that it is a fixed number, determined by a worst-case unbalance model.

5	Pairset current including unbalance effect per the assigned Class, when powering single-signature PDs						
	Class 0 to 4	$I_{Con\text{-}2P\text{-}unb}$	A	I_{Con}[a]		3, 4	See 145.2.8.5 and 145.2.8.5.1.
	Class 5			0.55		3, 4	
	Class 6			0.682		3, 4	
	Class 7			0.781		4	
	Class 8			0.932		4	

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$I_{Peak\text{-}2P\text{-}unb}$

$I_{Peak\text{-}2P\text{-}unb}$ on the other hand depends on V_{PSE}, P_{Class_PD}, I_{Peak}, R_{Chan}, and a curve fit parameter $K_{I_{Peak}}$, which in turn depends on P_{Class_PD} and $R_{Chan\text{-}2P}$.

I_{Peak}, defined in Equation (145–11), is the total current of the powered pairs with the same polarity that a PSE supports, when powering a PD over 2-pairs or powering a single-signature PD over 4-pairs.

$$I_{Peak} = \left\{ \frac{V_{PSE} - \sqrt{V_{PSE}^2 - 4 \times R_{Chan} \times P_{Peak\_PD}}}{2 \times R_{Chan}} \right\}_A \quad (145\text{–}11)$$

where

V_{PSE}	is the voltage at the PSE PI as defined in 145.1.3
R_{Chan}	is the channel loop resistance as defined in 145.1.3
P_{Peak_PD}	is the total peak power a PD may draw for its Class; see Table 145–28

$I_{Peak\text{-}2P\text{-}unb}$, defined in Equation (145–12), is the minimum current due to unbalance effects that a PSE supports on a pairset when powering a single-signature PD over 4-pairs.

$$I_{Peak\text{-}2P\_unb} = \left\{ (1 + K_{IPeak}) \times \frac{I_{Peak}}{2} \right\}_A \quad (145\text{–}12)$$

where

K_{IPeak}	The value of K_{IPeak}, defined in Equation (145–13), is based on a curve fit and is dimensionless
I_{Peak}	is the total peak current a PSE supports per Equation (145–11)

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$I_{Peak\text{-}2P\text{-}unb}$ (more)

$$K_{Ipeak} = \begin{cases} 1 & \text{for Class 0 to 4} \\ \min(0.214 \times (R_{chan\text{-}2P})^{-0.363}, 0.331) & \text{for Class 5} \\ \min(0.199 \times (R_{chan\text{-}2P})^{-0.35}, 0.304) & \text{for Class 6} \\ \min(0.18 \times (R_{chan\text{-}2P})^{-0.335}, 0.27) & \text{for Class 7} \\ \min(0.176 \times (R_{chan\text{-}2P})^{-0.347}, 0.26) & \text{for Class 8} \end{cases} \quad (145\text{–}13)$$

where

$R_{Chan\text{-}2P}$ is the channel DC loop resistance per pairset, as defined in 145.1.3. $R_{Chan\text{-}2P}$ has a minimum value of 0.2 Ω when used in Equation (145–13).

Alternatively, an over-margined value of $I_{Peak\text{-}2P\text{-}unb}$, $I_{Peak\text{-}2P\text{-}unb\_max}$, defined in Equation (145–14) may be used.

$$I_{Peak\text{-}2P\_unb\_max} = \{I_{LIM\text{-}2P} - 0.002\}_A \quad (145\text{–}14)$$

where

$I_{LIM\text{-}2P}$ is the $I_{LIM\text{-}2P}$ min value per pairset for the PSE, as defined in Table 145–16

$I_{Peak\text{-}2P\text{-}unb\_max}$ is a shorthand to derive the worst case $I_{Peak\text{-}2P\text{-}unb}$ from $I_{LIM\text{-}2P}$.

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Importance of $I_{Con\text{-}2P\text{-}unb}$ and $I_{Peak\text{-}2P\text{-}unb}$

Apart from their importance is specification parameter, these two numbers determine for large part implementation cost as well. All current carrying components will need to remain fully operational under $I_{Con\text{-}2P\text{-}unb}$ continuously, and for a duty cycle of 5% under $I_{Peak\text{-}2P\text{-}unb}$ as well.

These unbalance parameters do not impact power budgeting, which is determined solely by the total power levels I_{Con} and I_{Peak}.

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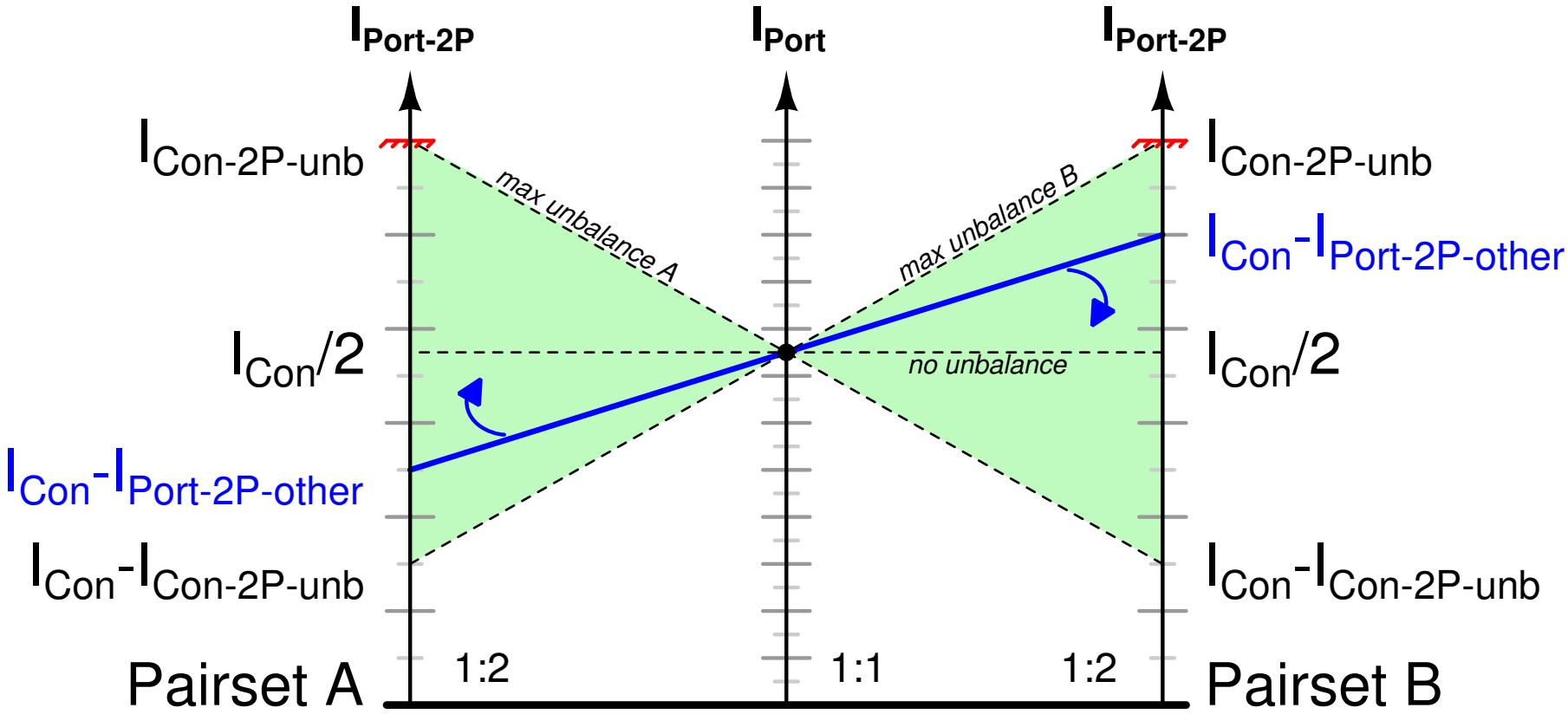
Unbalance & power budgeting



As can be seen, the unbalance parameter does not have influence on power budgeting.

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The issue

The determination of $I_{Peak\text{-}2P\text{-}unb}$ is very complex and depends in a highly non-linear fashion on R_{Chan} and V_{PSE}. This may allow optimization, however:

1. Due to complexity there is a high risk of bad implementation/confusion leading to interoperability issues
2. As the next slides will show, $I_{Peak\text{-}2P\text{-}unb}$ can be **lower** than $I_{Con\text{-}2P\text{-}unb}$. Obviously then $I_{Con\text{-}2P\text{-}unb}$ 'clips' the value of $I_{Peak\text{-}2P\text{-}unb}$.
3. As we now will use $I_{Peak\text{-}2P\text{-}unb}$ as a PD requirement, we face the issue that the PD cannot know the value of $I_{Peak\text{-}2P\text{-}unb}$ if it depends on V_{PSE} and R_{Chan}.

The next slides show plots of $I_{Peak\text{-}2P\text{-}unb}$ versus V_{PSE} and R_{Chan}.

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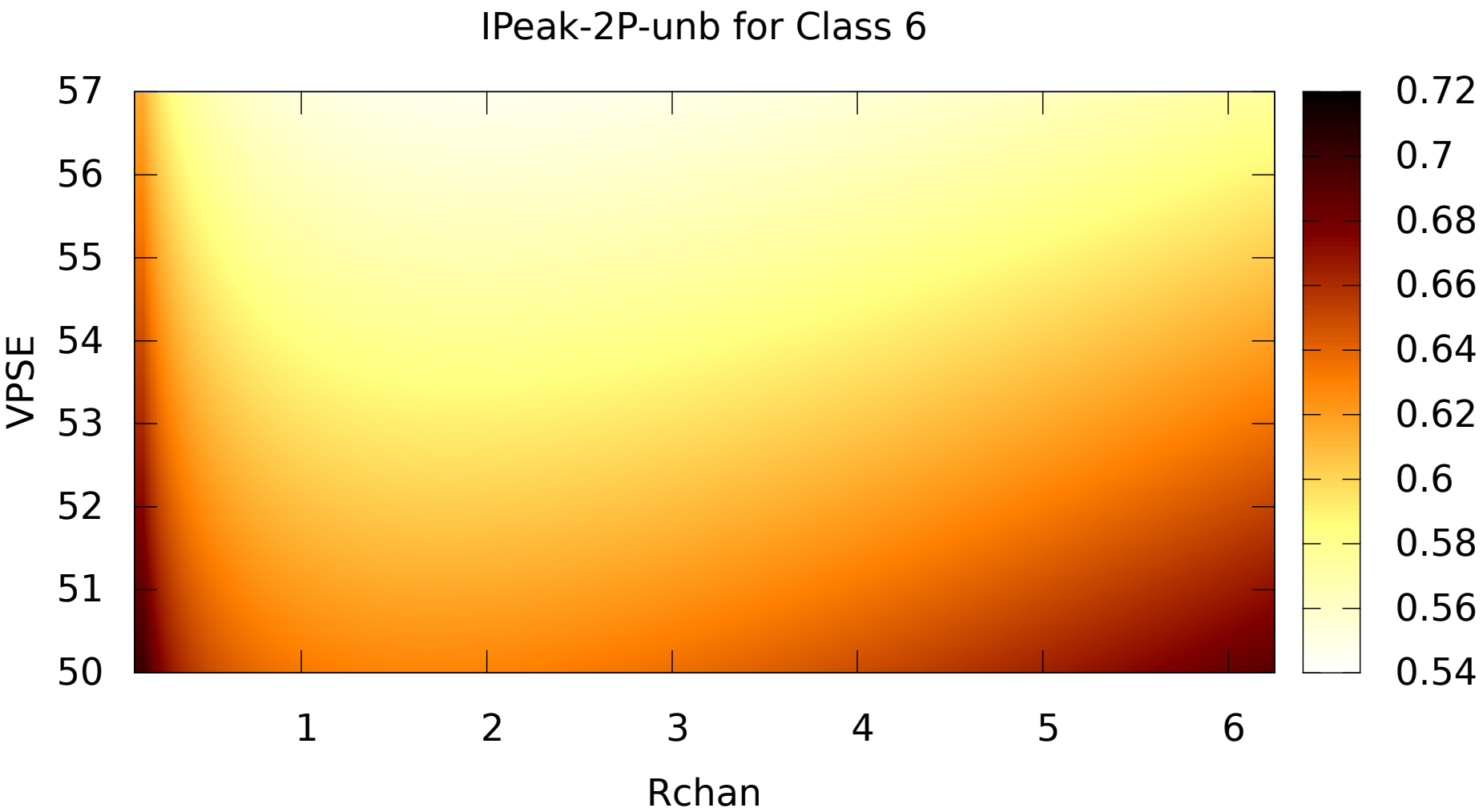
Class 6



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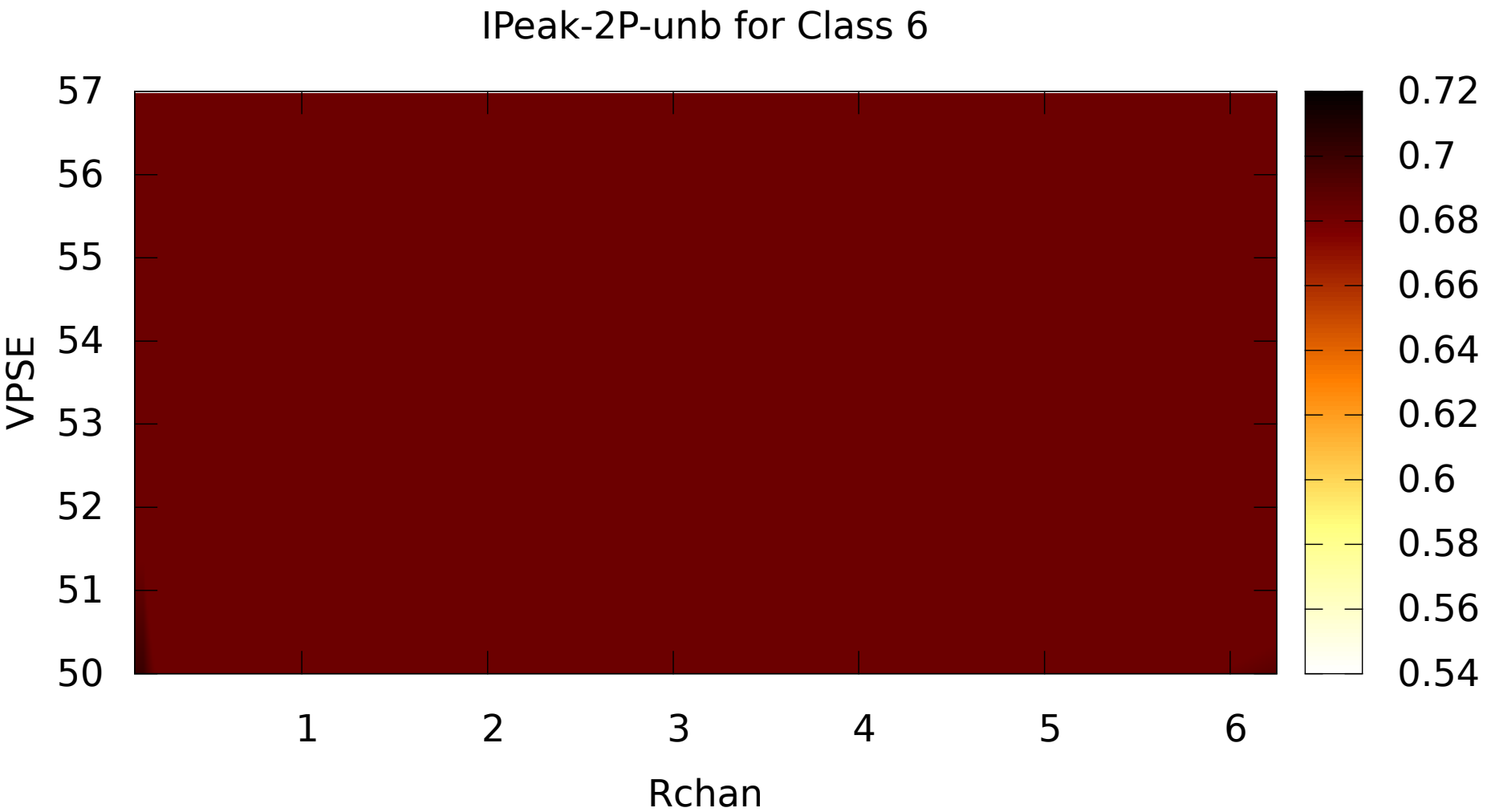
Class 6, taking $I_{Con\text{-}2P\text{-}unb}$ into account



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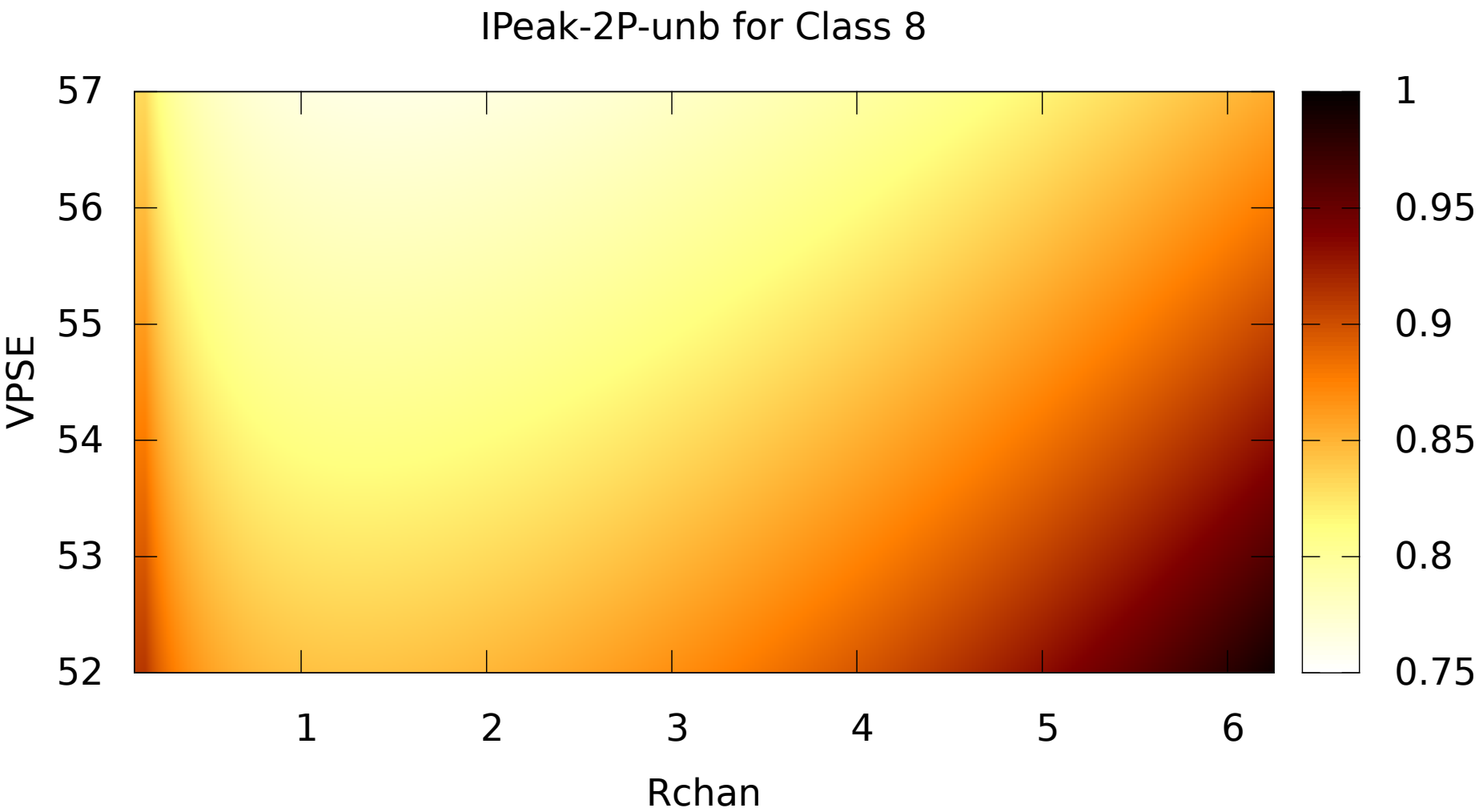
Class 8



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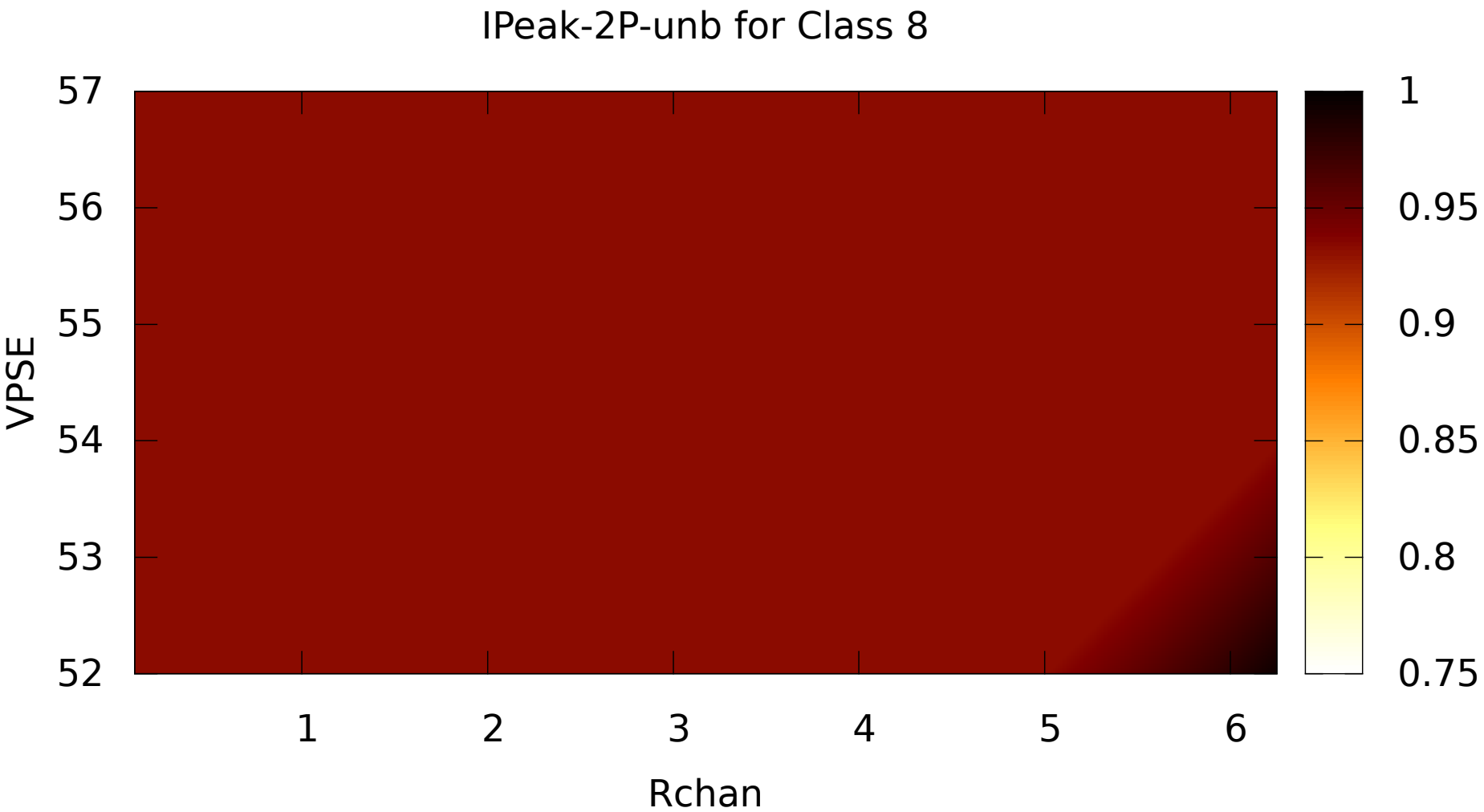
Class 8, taking $I_{Con\text{-}2P\text{-}unb}$ into account



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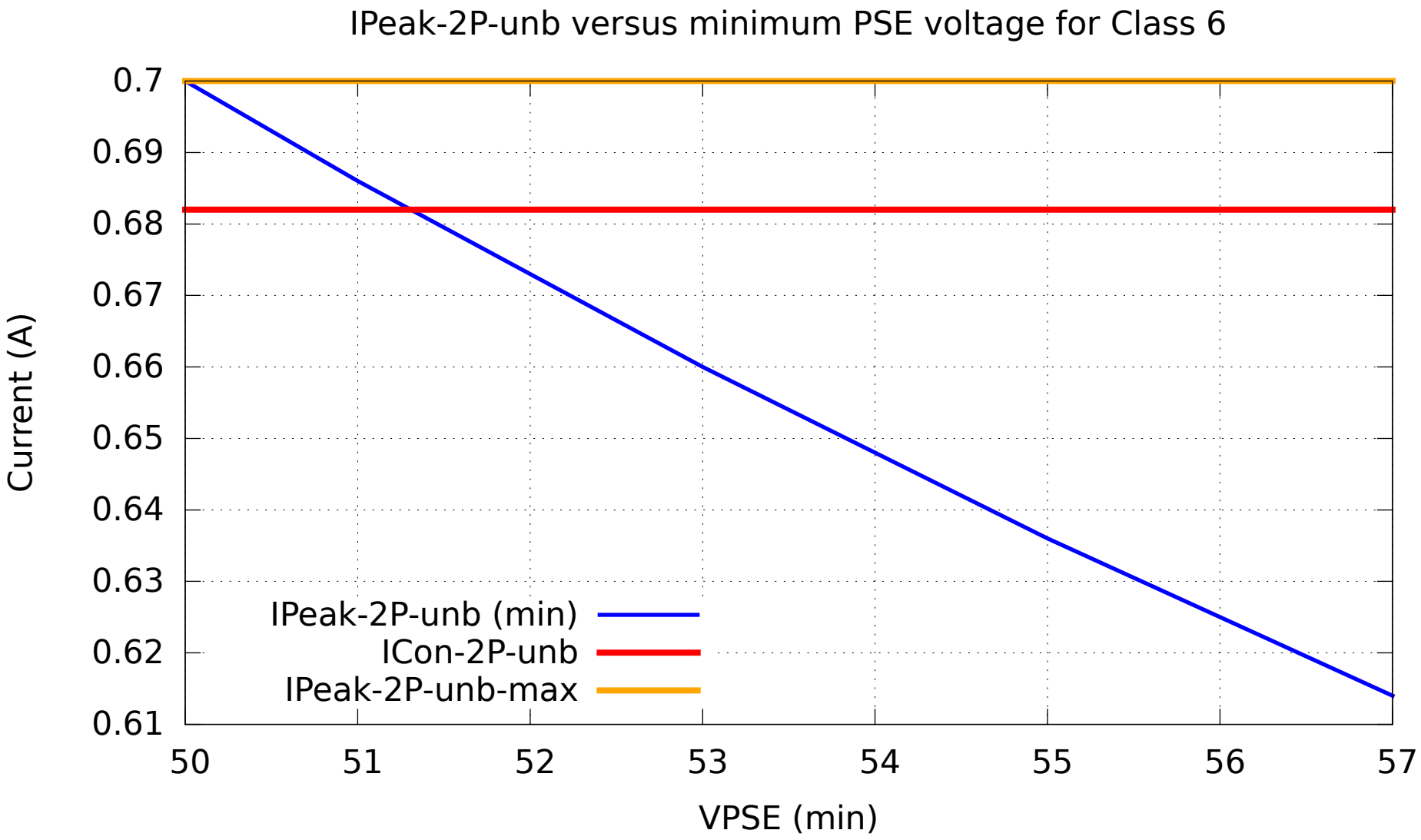
Class 6, V_{PSE} only



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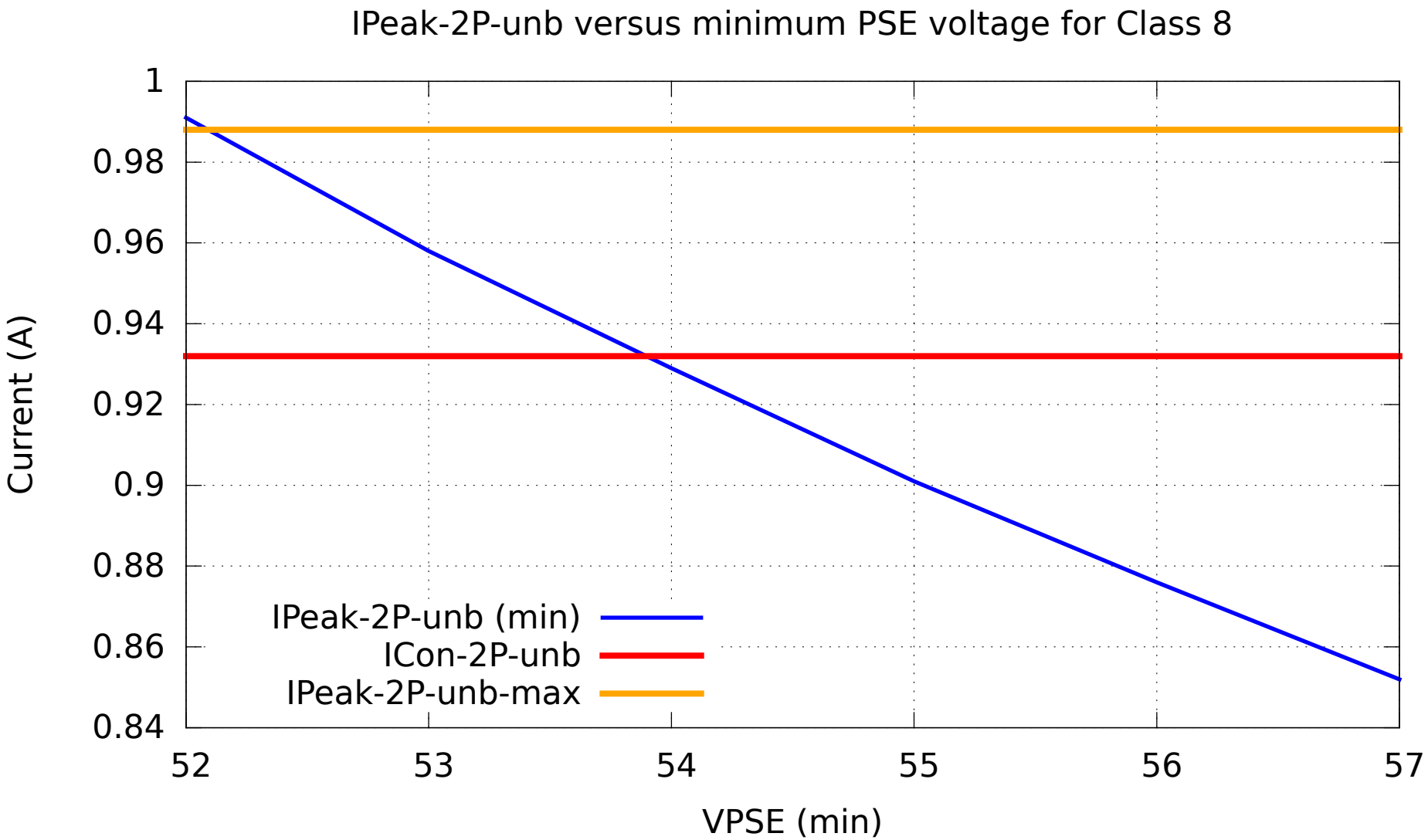
Class 8, V_{PSE} only



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Summary

The maximum effective possible gain achievable by using the set of equations is modest:

Class	Max gain	$V_{Port\_PSE\text{-}2P}$ min
Class 5	10 mA	51 V
Class 6	18 mA	51.5 V
Class 7	50 mA	54 V
Class 8	60 mA	54 V

Max gain is the largest achievable difference between $I_{Peak\text{-}2P\text{-}unb}$ and $I_{Peak\text{-}2P\text{-}unb\_max}$.

$I_{Peak\text{-}2P\text{-}unb}$ in its current state is unusable for PD requirements. The possible gain of using the optimized version versus the worst case version ($I_{LIM\text{-}2P} - 2mA$) is small.

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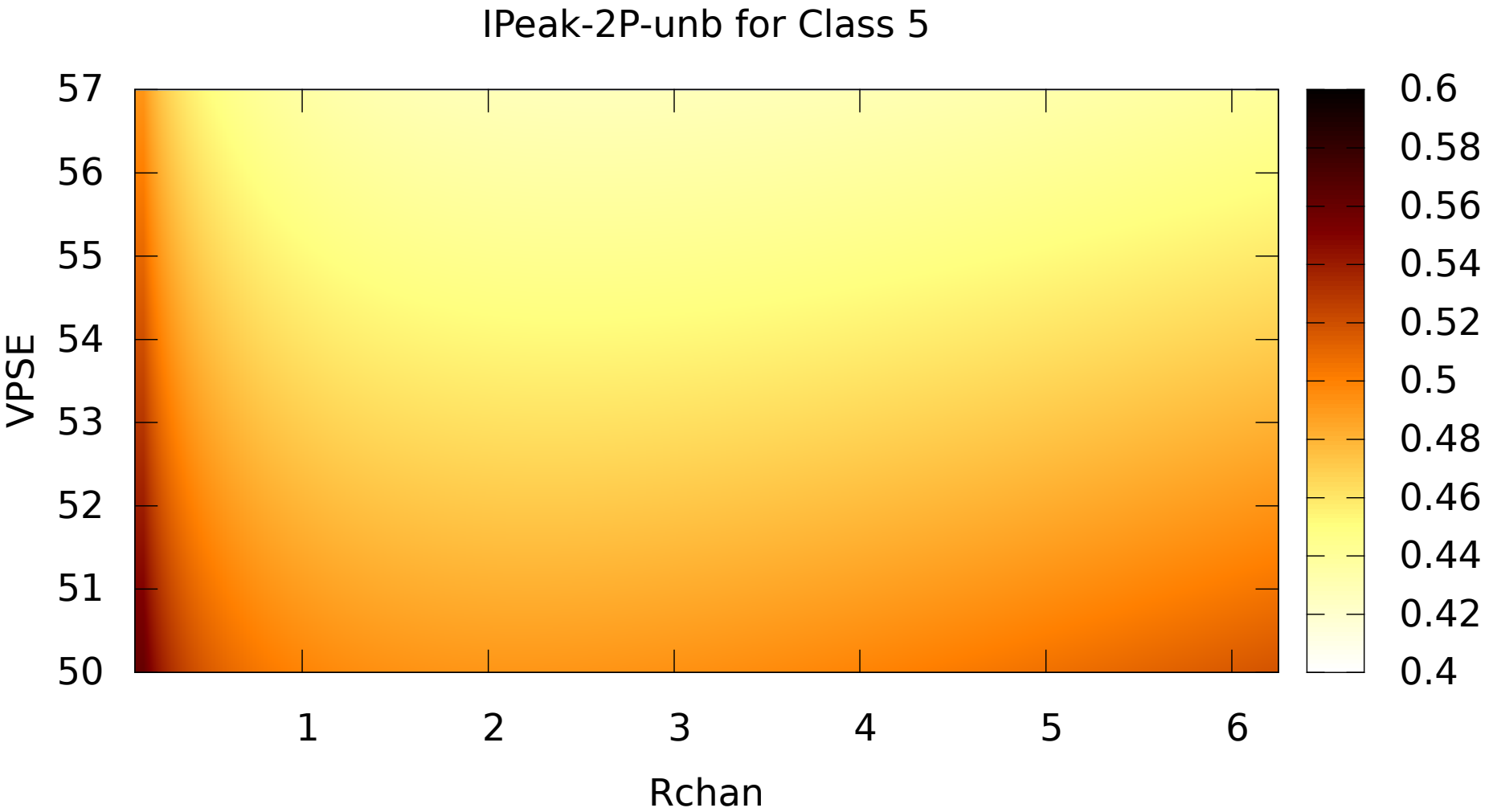
Class 5



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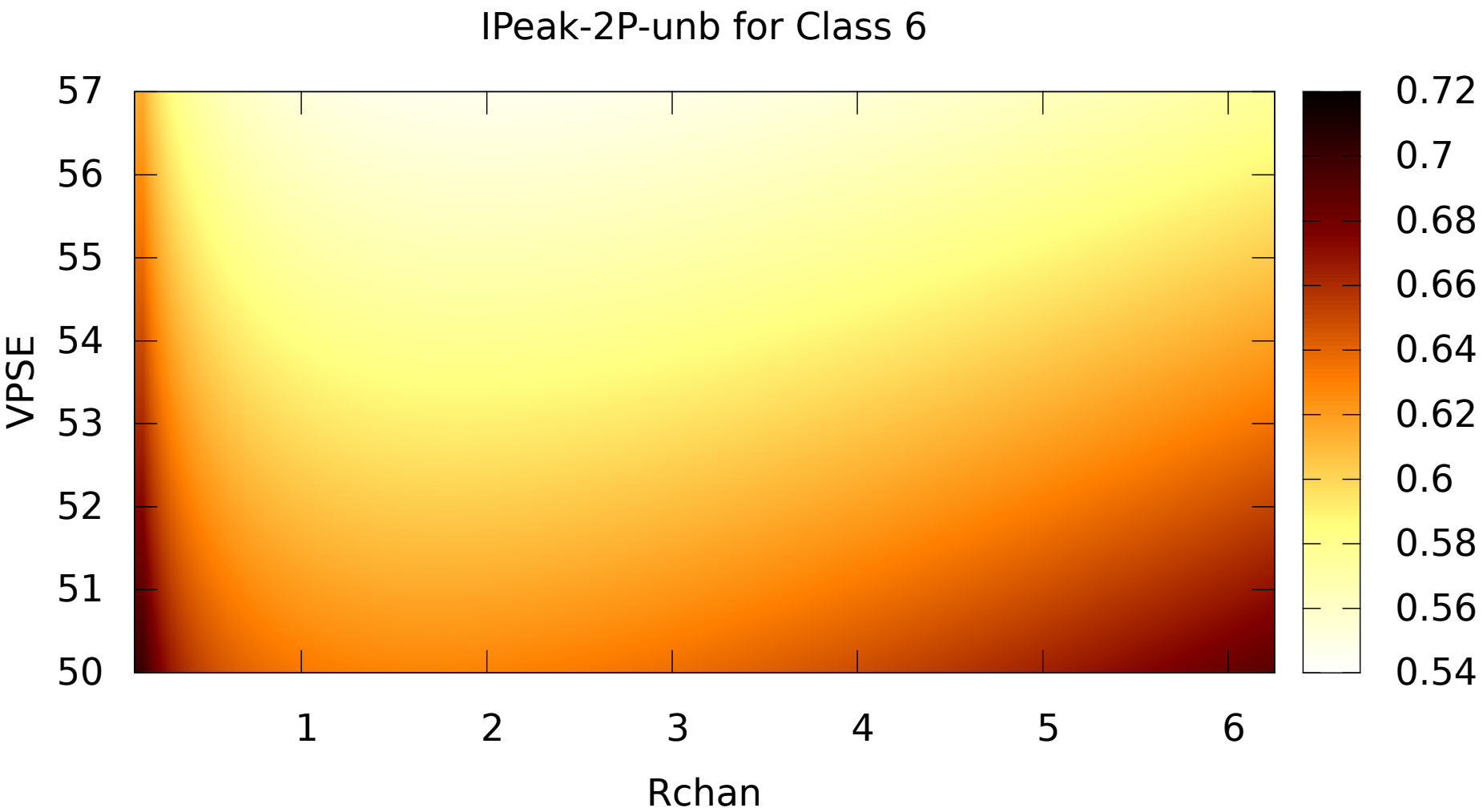
Class 6



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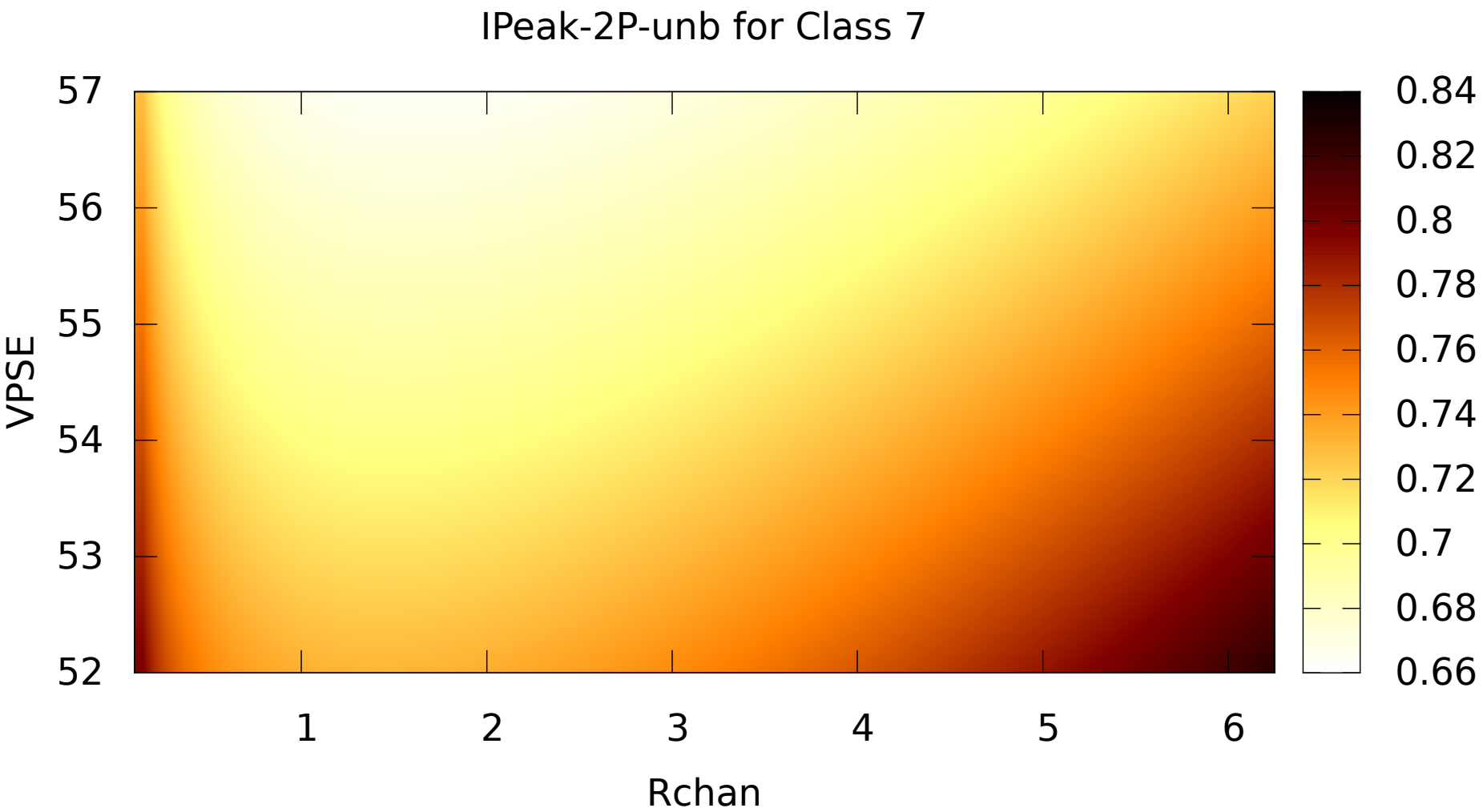
Class 7



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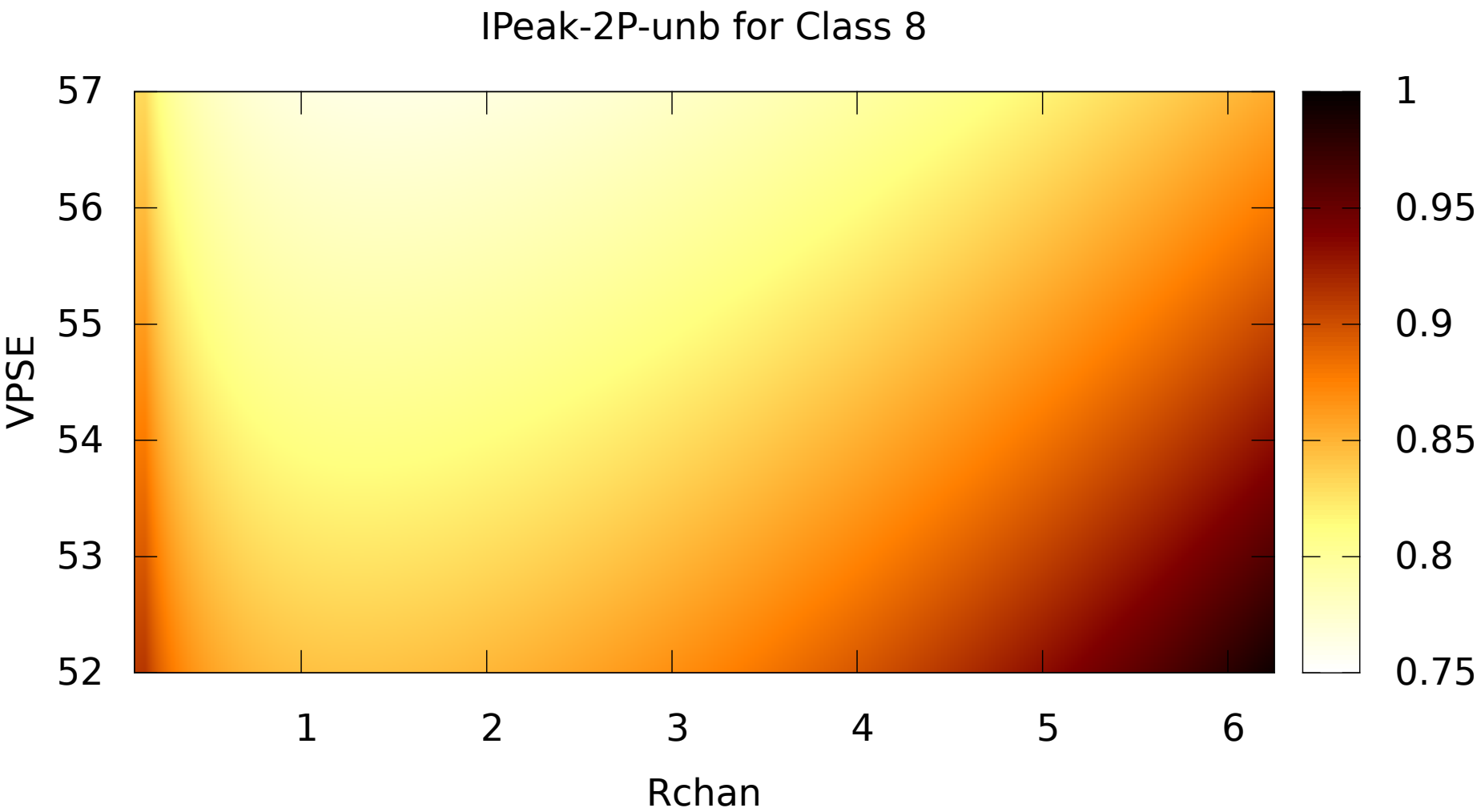
Class 8



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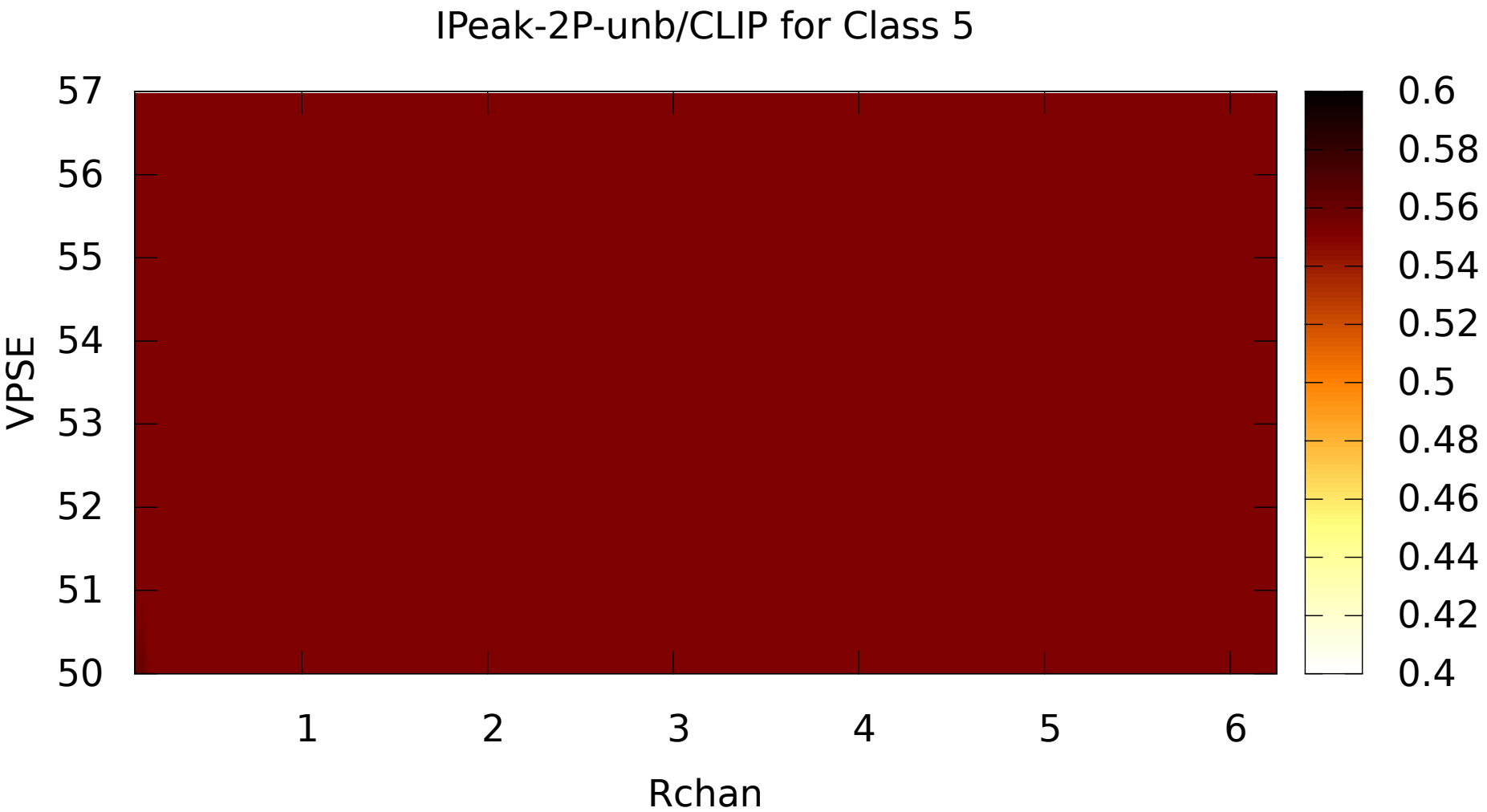
Class 5, taking $I_{Con\text{-}2P\text{-}unb}$ into account



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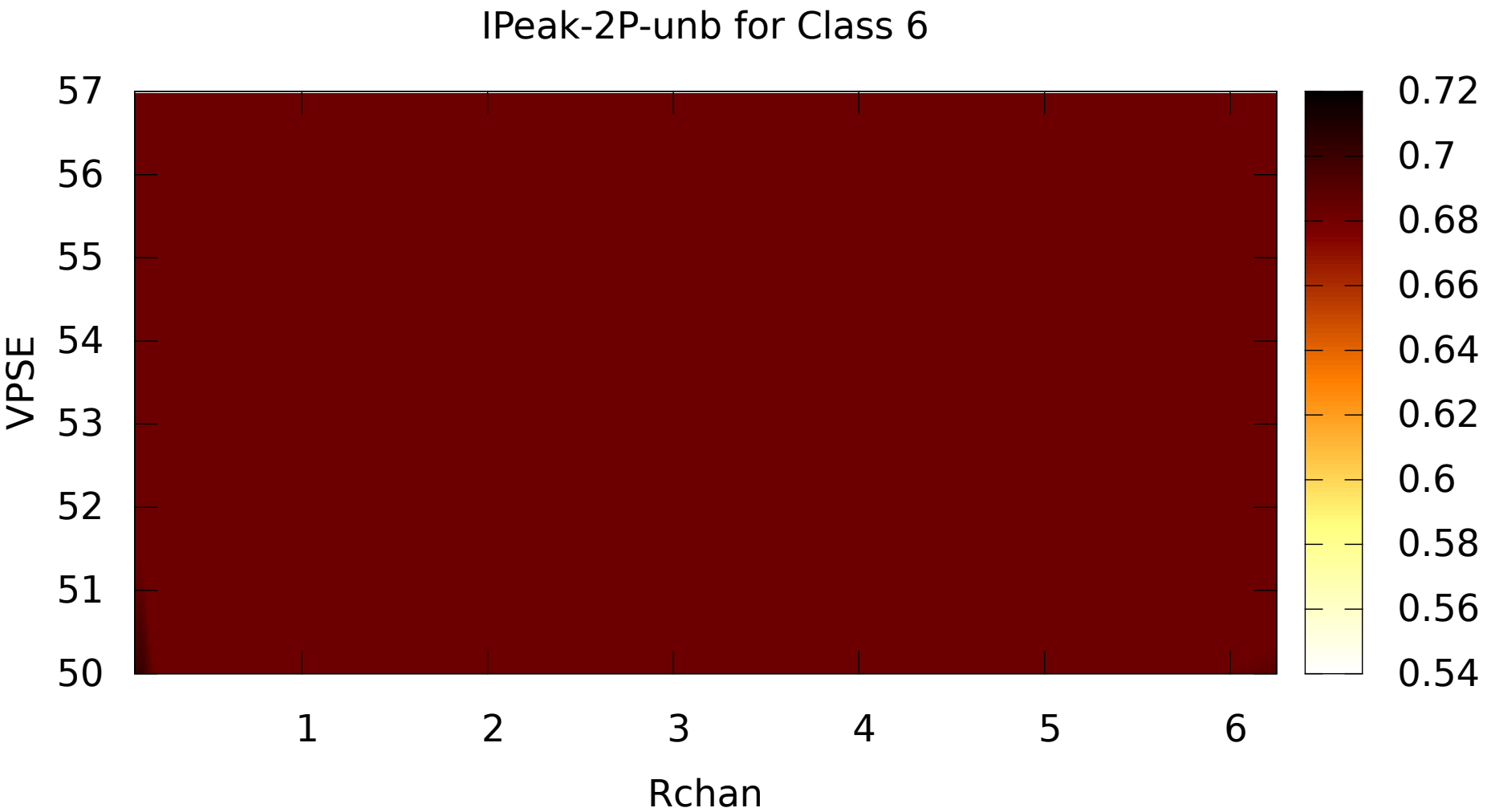
Class 6, taking $I_{Con\text{-}2P\text{-}unb}$ into account



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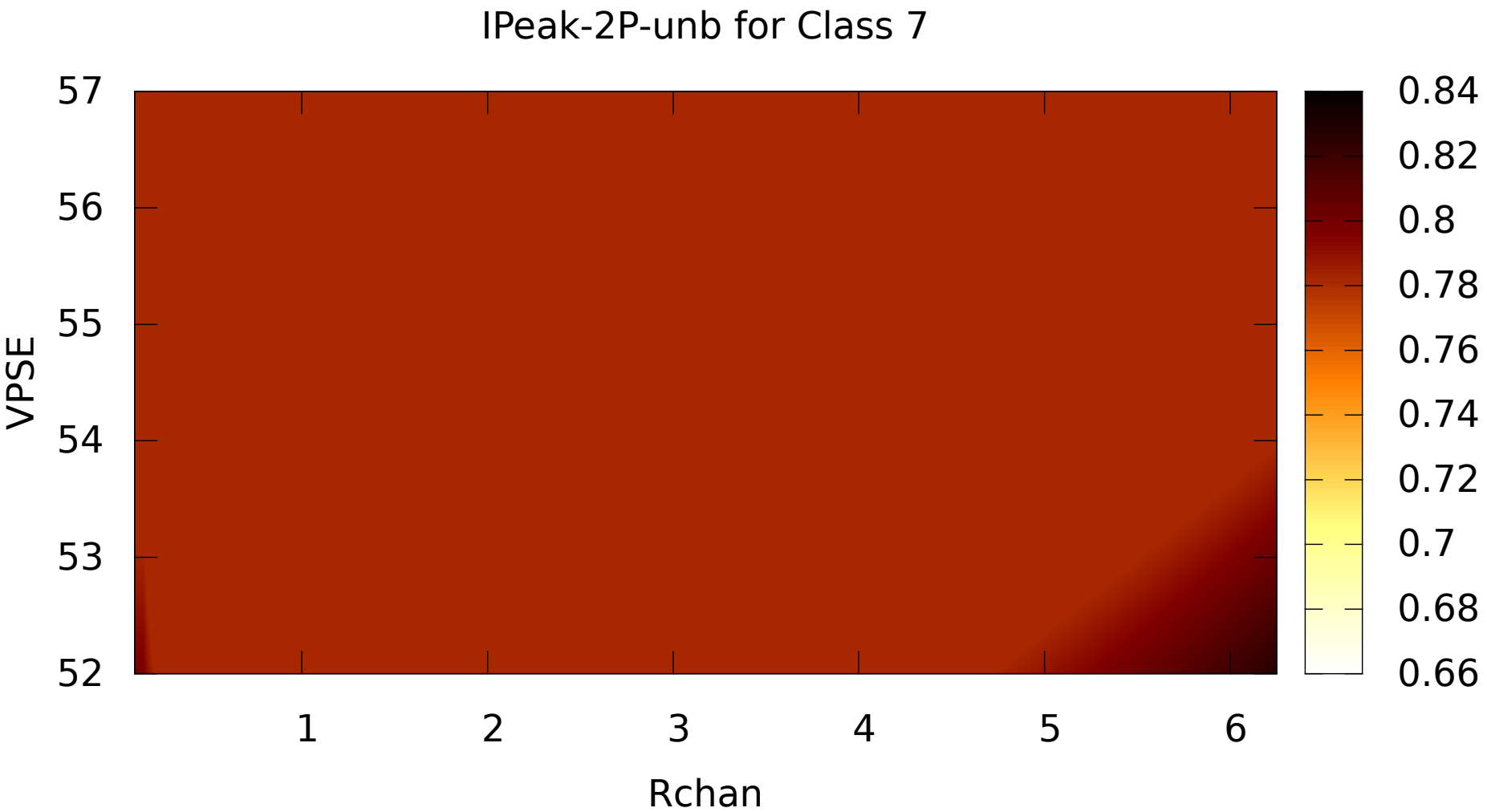
Class 7, taking $I_{Con\text{-}2P\text{-}unb}$ into account



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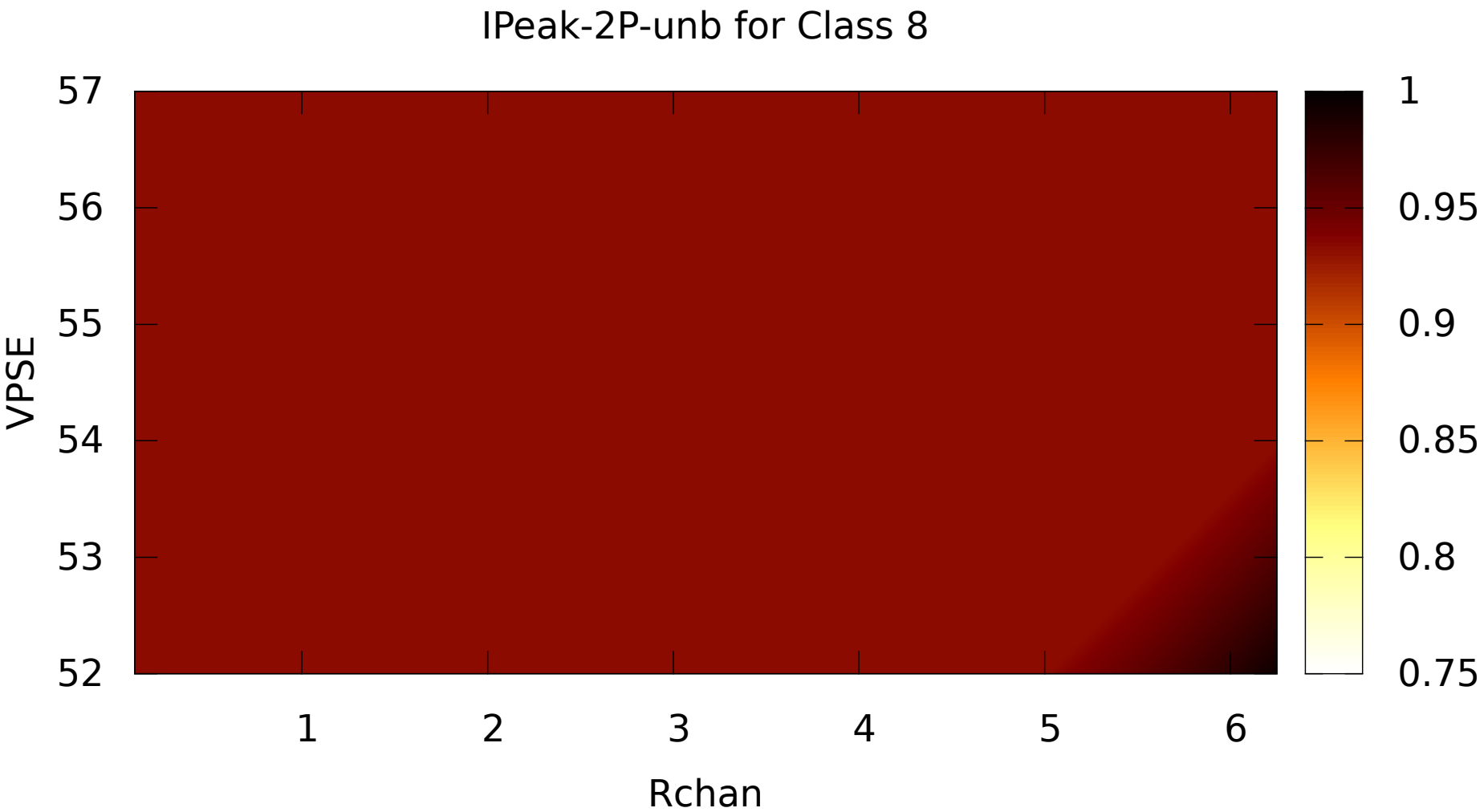
Class 8, taking $I_{Con\text{-}2P\text{-}unb}$ into account



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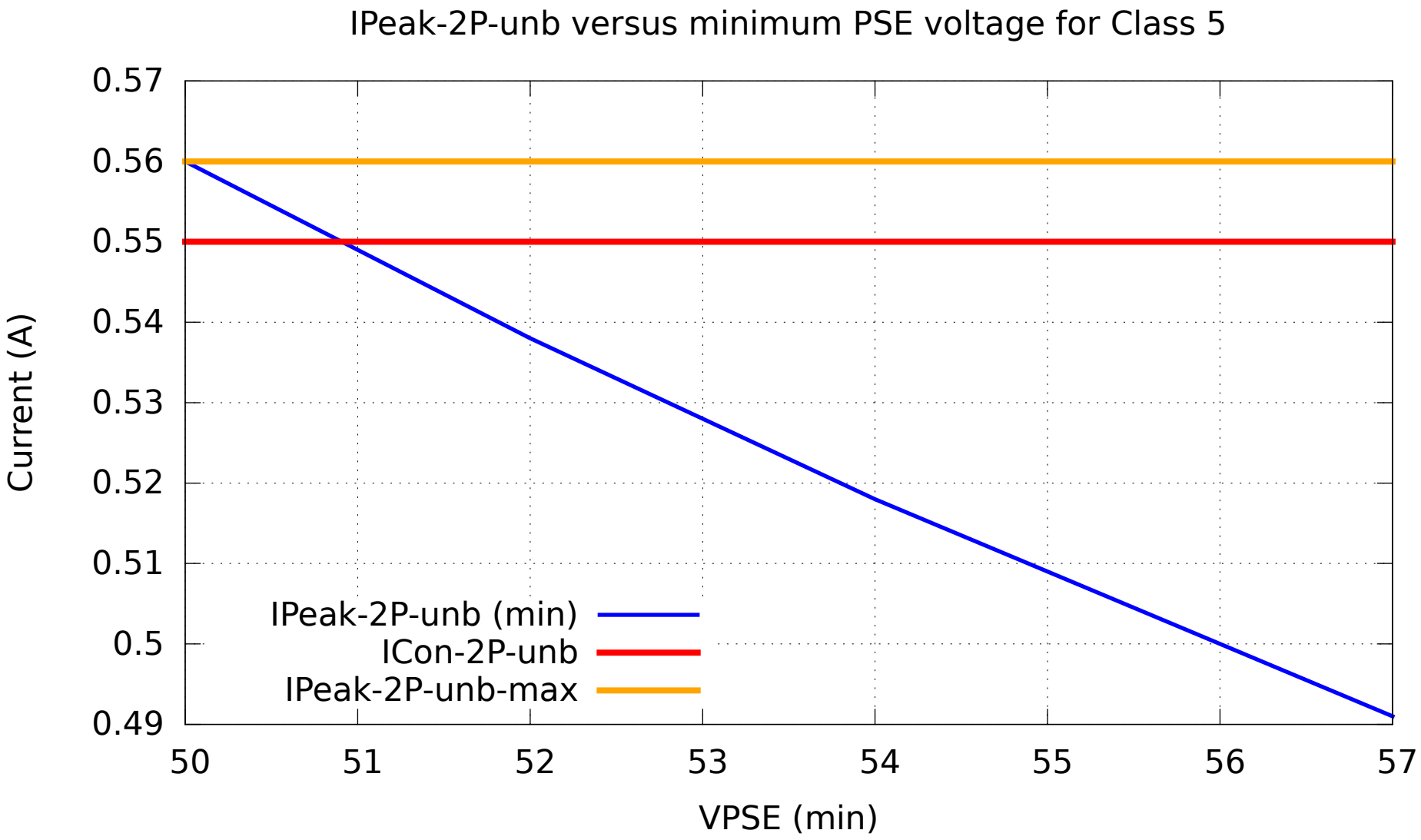
Class 5, V_{PSE} only



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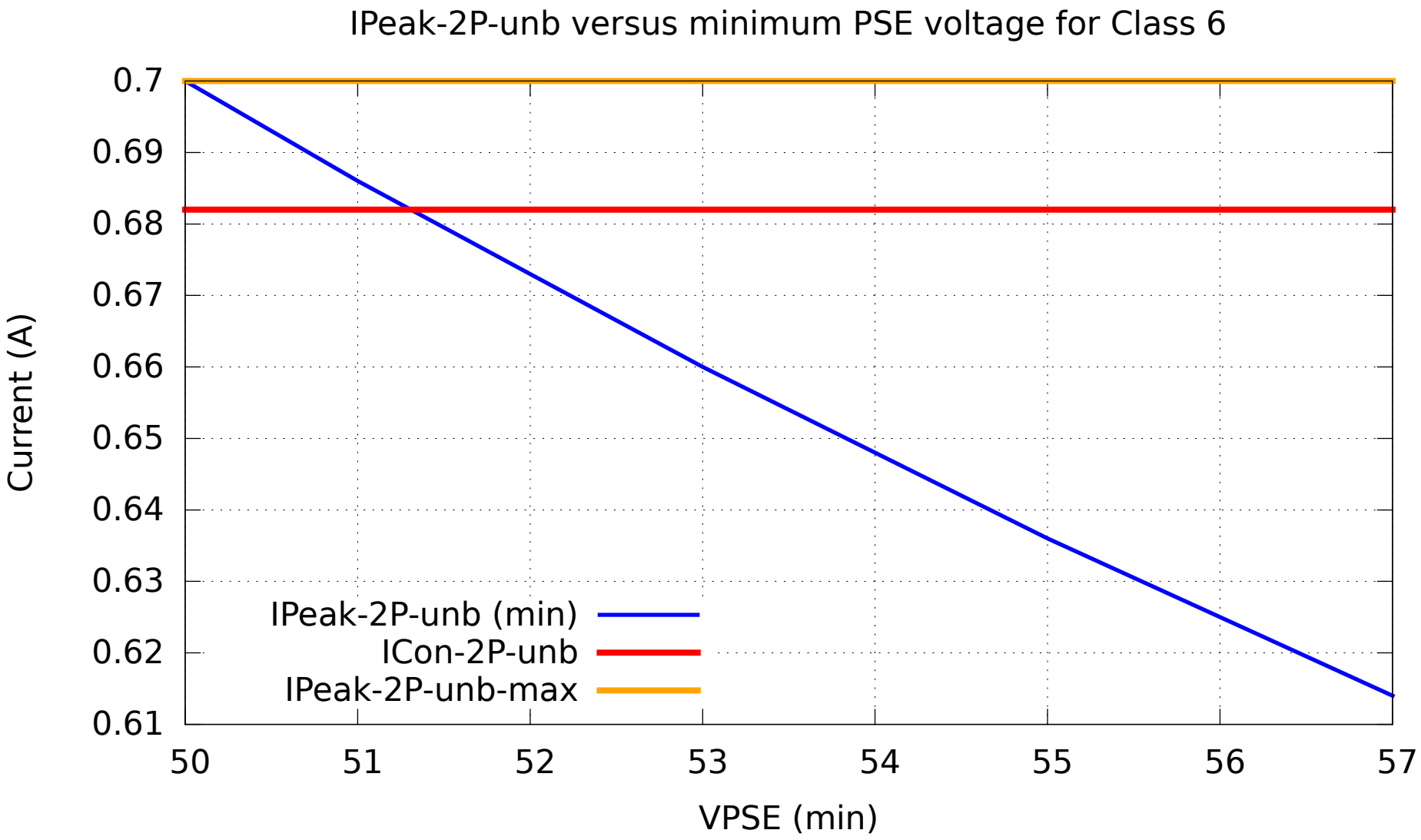
Class 6, V_{PSE} only



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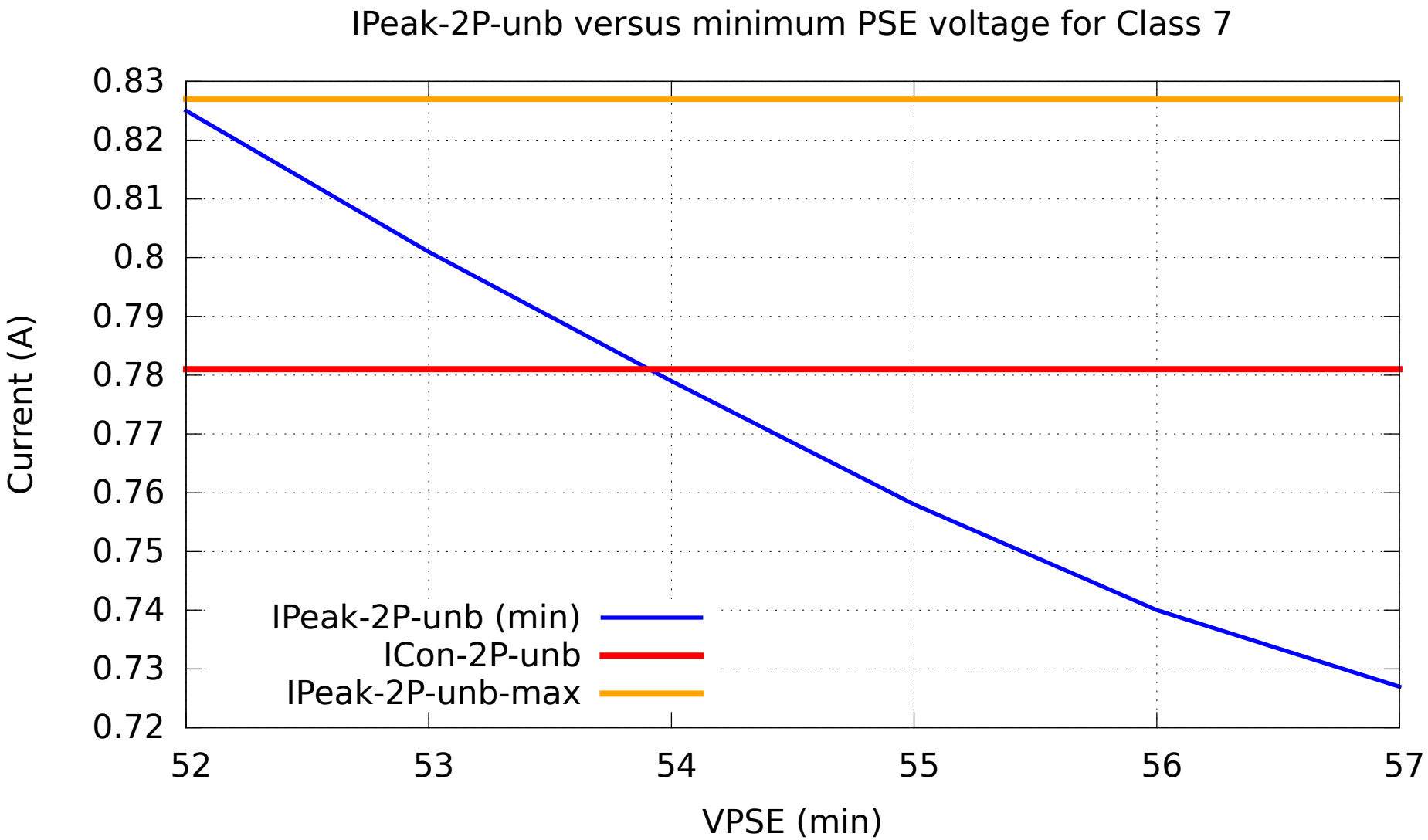
Class 7, V_{PSE} only



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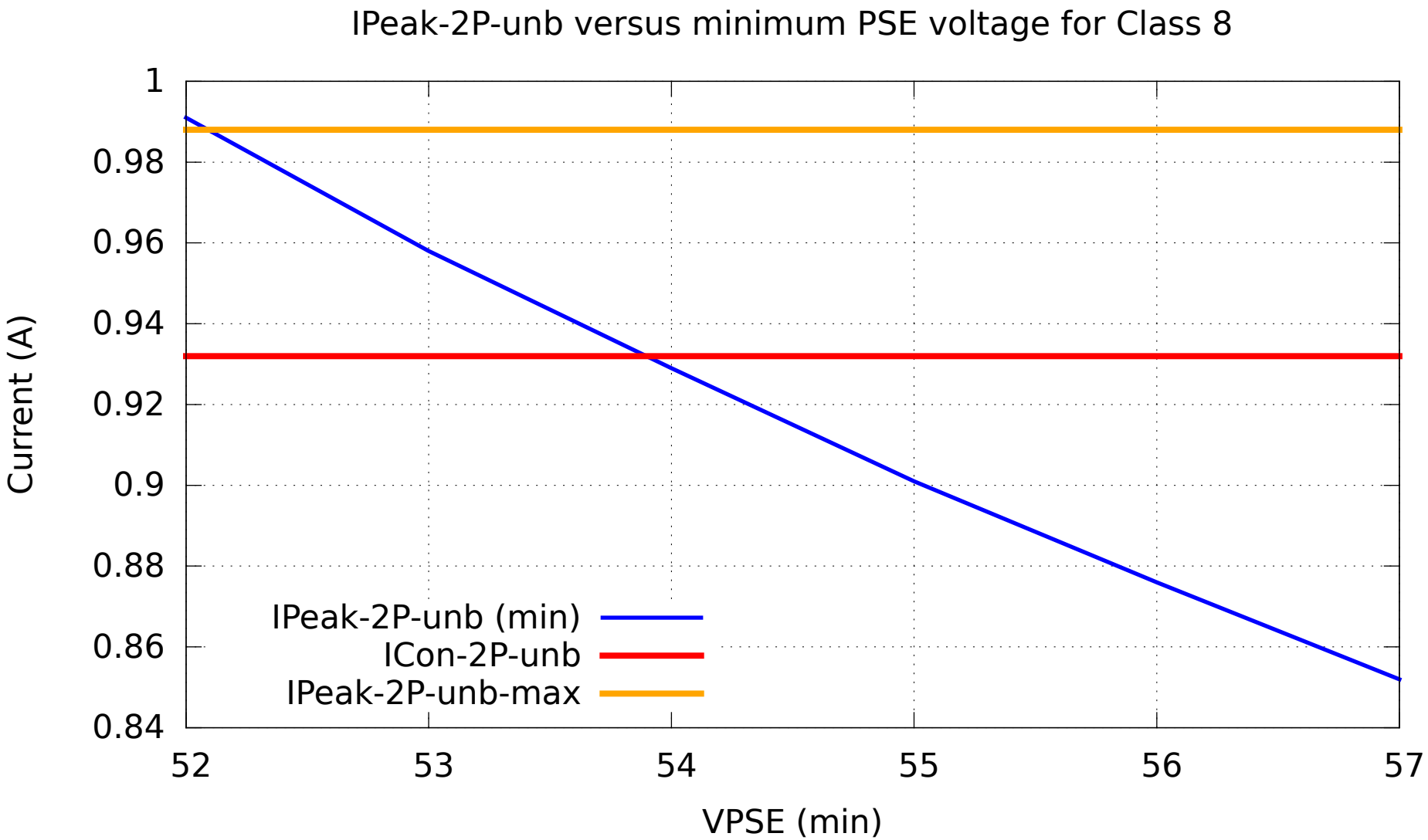
Class 8, V_{PSE} only



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