

APPLICATION NOTE

ANP138 | Custom Rated Current Calculator

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1. INTRODUCTION

The definition of rated current continues to vary between passive component manufacturers in the power electronics industry, despite the adoption of IEC standard 62024-2 which specifically describes how rated current should be measured. Because of this, misconceptions can still arise about what this parameter actually represents and how design engineers can use it. Is it an absolute parameter? Are rated current values from different manufacturers directly comparable? The answer to these questions is no. As a result of this, it is possible that parts from some manufacturers appear better at first glance than others. However, design and component engineers should always endeavor to fully understand how a manufacturer is measuring their components for reporting rated current parameters and not accept the parameters at face value.

With this in mind, Würth Elektronik has developed a thermal model which calculates the rated current of power inductors given specific trace dimension on a PCB. This will give design and component engineers the ability to explore how the rated current of parts is affected by different conductor dimensions used on the PCB.

2. HOW DO PCB DIMENSIONS EFFECT RATED CURRENT?

An explanation of the thermal behavior of power inductors can be found in [ANP096 – What do rated current values mean?](#) How the PCB trace dimensions have an influence on the inductor temperature rise are described and summarized in the referenced application note. To summarize, wider traces and increased copper thickness will reduce the thermal conduction resistance, increasing the flow of conducted heat from the inductor. As the surface area of the conductor increases, the thermal convection and radiation resistance is reduced increasing convection and radiation transfer to the ambient environment. In this scenario of increasing dimensions, more heat is transferred to the environment, lowering the operating temperature of the inductor. This also means that a higher current can now feasibly be applied to the part to reach the same temperature as when a PCB with smaller conductor dimensions is used. Now we can see how

PCB conductor dimensions used on the PCB affect the reported value of rated current in datasheets. Again, test measurement PCBs with large conductor dimensions or thicknesses may be used to enhance rated current values. This information may not be specified in datasheets, leaving room for misinterpretation by design and component engineers. This was demonstrated in [ANP096](#).

3. RATED CURRENT CALCULATOR

In order to define the rated current for components when measured on different sized PCB conductor traces, Würth Elektronik now has online Rated Current Calculator available through **REDEXPERT** which allows the user to input the desired copper conductor dimensions (Figure 1).

The screenshot displays the 'Custom Rated Current Calculator' interface. At the top, there's a title bar with a back arrow and the title. Below it is a 'PARAMETERS' section. A 3D diagram of a PCB trace is shown with labels for Length (L), Width (W), and Thickness (H). The 'Temperature' section has two input fields: 'Ambient Temperature' set to 20°C and 'Max. temperature rise' set to 40 K. Below this is a red circular icon with a target symbol and the text 'CALCULATE RATED CURRENT'. Underneath are three input fields: 'Length (L)' set to 8 cm, 'Width (W)' set to 4 cm, and 'Copper Thickness (H)' set to 105 µm. At the bottom is a large red button labeled 'CALCULATE CURRENT'.

Figure 1: User interface of Rated Current Calculator with IEC62024-2 Class A 5 mm dimensions entered.

After the dimensions have been entered by the user, a Custom IR column is added to the parameter table (Figure 2)

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in addition to the temperature rise chart being updated to reflect the new conductor dimensions (Figure 3).

I_R	Custom I_R
4.45 A	2.98 A

Figure 2: Datasheet Rated Current (left) and Custom Rated Current value (right) based upon dimensions entered in the user interface. Note how this value is different from that found in the datasheet. Therefore the PCB conductor is too narrow.

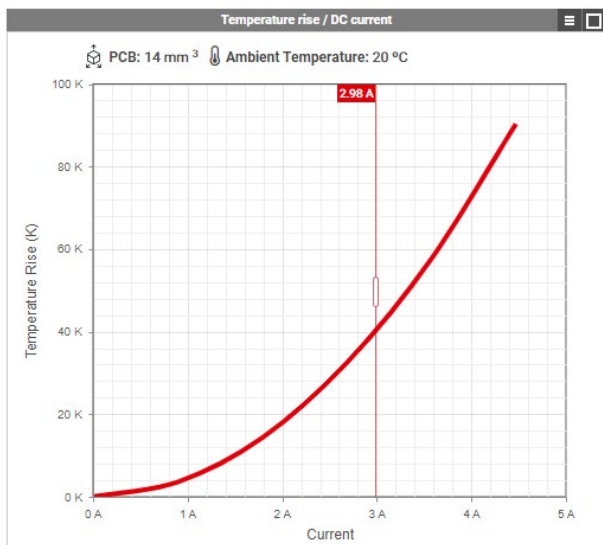


Figure 3: Temperature rise chart based upon dimensions entered into user interface.

These calculations use a numerical model which is based on and verified by measurements of components using different sized PCB traces. In this way the user can now view the rated current for Würth Elektronik power inductors on different sizes of copper conductor. The results can be used for comparisons

with other power inductors or to estimate the rated current of a part when soldered to the application PCB. It should be noted that when used to estimate the rated current in the target application, it should be remembered that other components will contribute to the heat distribution in the PCB. These components such as ICs and capacitors could increase the temperature of the PCB or in the case of heat sinks lower the temperature of the PCB.

Consider the inductor WE-LHMI (74437346068) which has a performance rated current of 4.45 A (Figure 4). This is measured on an IEC 62024-2 I_{Class C} PCB (Appendix). The graph displays the temperature rise as a result of the DC current for this component on the I_{Class A} 5 mm, I_{Class C}, and I_{Class D} PCB. In addition the chart displays the output from the Rated Current Calculator in the **REDEXPERT** user interface available online as the data points. As can be seen, the calculated values are comparable to those gathered from component measurements.

This comparison demonstrates how the Rated Current Calculator determines the current with relative accuracy when compared to rated current measurements. It also demonstrates how the rated current of a part is highly reliant on the PCB conductor dimensions with the inductor being able to be operated at even higher currents than the rated current on the datasheet. Additionally, the comparison demonstrates that rated current are values to compare and guide in the selection of inductors before prototyping. It should be remembered that these are basic parameters, considering only DC currents with no additional heat generating parts on the PCB. In real conditions, AC losses and

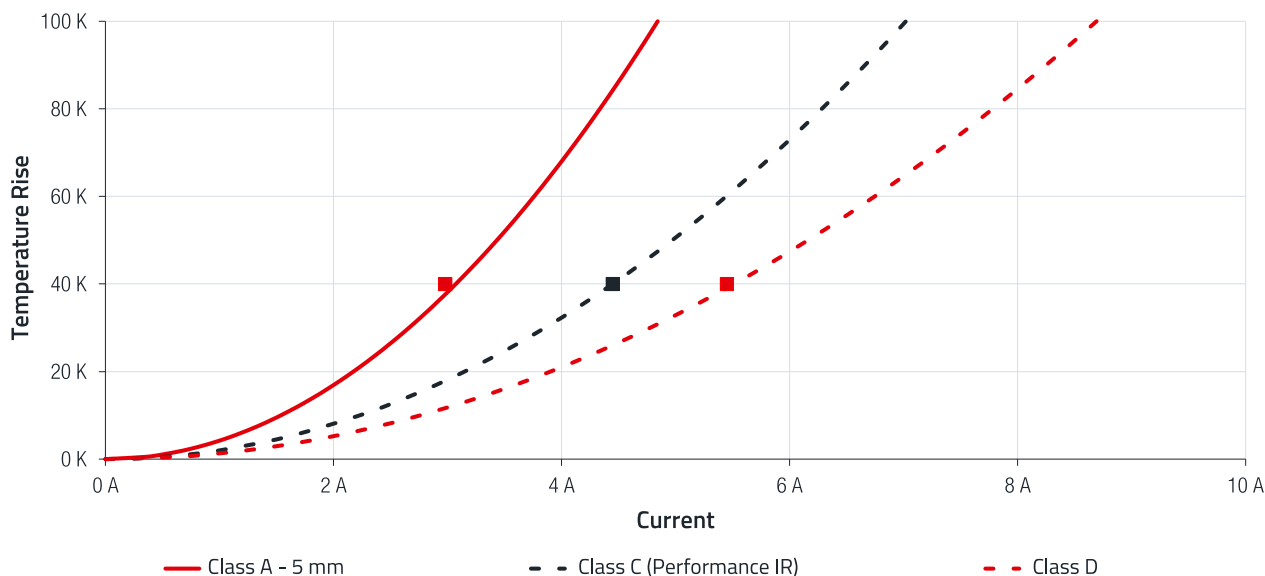


Figure 4: Self heating comparison of WE-LHMI 744 373 460 68 on different IEC 62024-2 PCBs and the calculated current for a 40K temperature rise using the Rated Current Calculator (data points).

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the thermal effects of surrounding components would also have to be considered, which account for most of the losses at higher switching frequencies. The actual temperature rises seen in the end applications will vary considerably dependent on the conditions.

4. CONCLUSION

Rated current values found on datasheets serve as a guide for the selection of power inductors. However, the temperature rise in power inductors can be influenced by the PCB conductor dimensions on which they are tested. These are not always comparable between all manufacturers giving a false sense of what the rated current values actually represent.

Comparing similar parts from different manufactures on the same PCBs reveals that the thermal performance is almost analogous. To this end, Würth Elektronik has devised an online Rated Current Calculator which can determine the rated current of Würth Elektronik power inductors on a PCB using traces of the user's choosing. This allows a rated current value to be estimated for the users end application or to compare the rated current values of inductors from other manufactures when the test PCB conductor dimensions are stated in the datasheet.

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A. Appendix

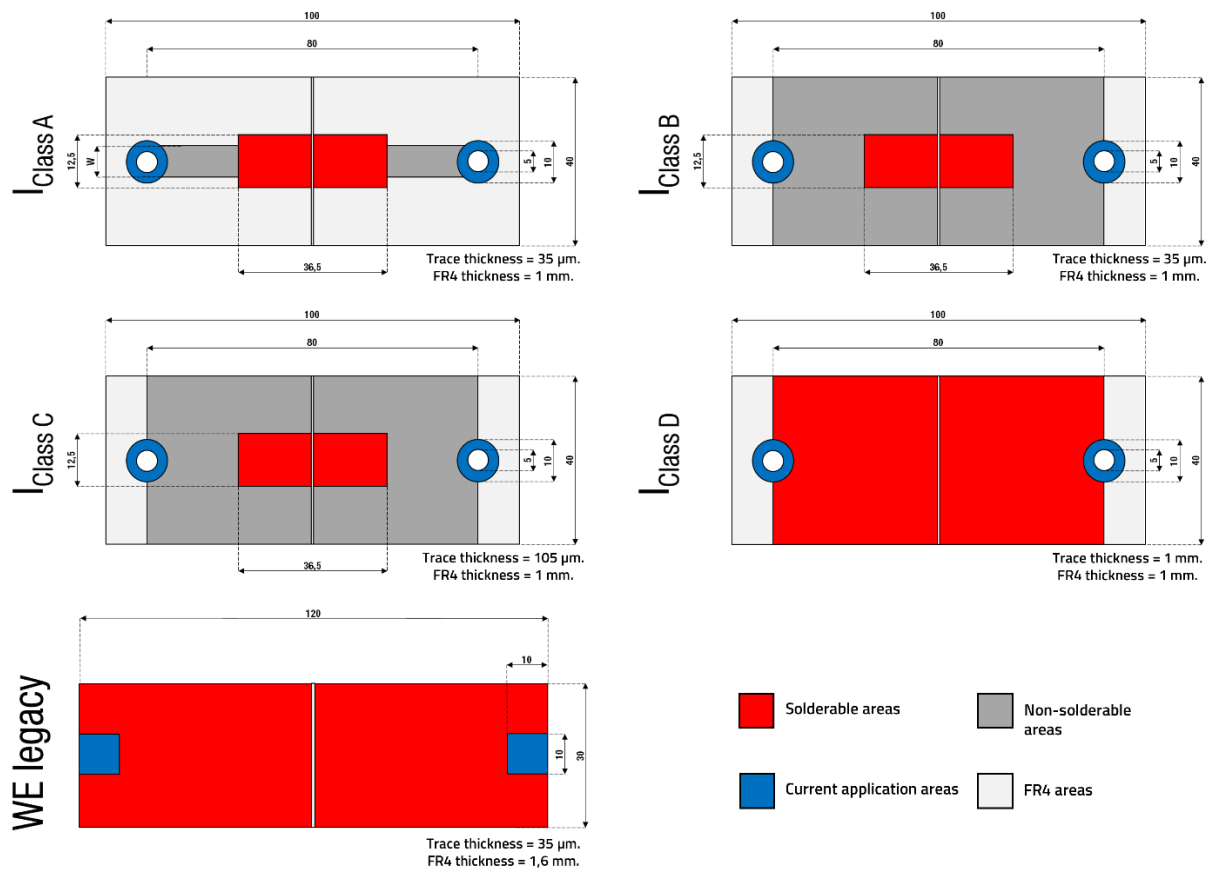


Figure 5: Diagram of PCBs used for rated current measurements in the IEC 62024-2

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