Inductor Current Ratings - the Role of Temperature Rise

An inductor's Current Rating is derived from a mathematical calculation based on the self-heating rise of the coil while current is applied under controlled conditions.[1]

Power Dissipation (heat generation) is influenced by:

- Winding wire diameter
- Wire thickness
- Amount of turns
- Length of winding
- Winding style
- Core material
- External surface area
- Body material

[1] Test is performed by the temperature rise method as referred to in MIL-PRF documents such as 15305, 83446, 39010, or 27.

Current Rating Formula

$$I = \sqrt{\frac{P = G_t\,(\text{Temp Rise})}{R_{25°C}[1+(0.00385)(T_{max} - 25°C)]}}$$

I = Current Rating

P = Power (watts)

G_t = Thermal conductance of coil (mW°C)

Temp Rise = Difference between ambient and maximum

R = Coil DC Resistance at (25°C in this example)

0.00385 = Temperature coefficient of copper wire

Impact of Temperature Rise Values

$$I = \sqrt{\frac{P = G_t\,(\text{Temp Rise})}{R_{25°C}[1+(0.00385)(T_{max} - 25°C)]}}$$

- For a given inductor design, where all variables are constant in the formula above except for the temperature rise value being utilized, the calculated current rating can vary considerably. See example below.
- The impact of different temperature rise values makes it very difficult to compare inductors expressly based on current ratings provided in vendor specification sheets.
- The temperature rise values need to be the same for valid comparison.

Comparison of 35°C temperature rise vs. 100°C temperature rise for a given inductor[2]

$$I = \sqrt{\frac{P = G_t\,(\text{Temp Rise})}{R_{25°C}[1+(0.00385)(T_{max} - 25°C)]}}$$

$$I = \sqrt{\frac{P = 0.0026(35)}{0.87[1+(0.00385)(125 - 25)]}}$$

$$I = \sqrt{\frac{0.091}{1.20495}}$$

I = **275 mA**

Current Rating based on:
35°C temperature rise from 90°C ambient.

$T_{max} = 90 + 35 = 125$

$$I = \sqrt{\frac{P = G_t\,(\text{Temp Rise})}{R_{25°C}[1+(0.00385)(T_{max} - 25°C)]}}$$

$$I = \sqrt{\frac{P = 0.0026\,(100)}{0.87[1+(0.00385)(125 - 25)]}}$$

$$I = \sqrt{\frac{0.26}{1.20495}}$$

I = **465 mA**

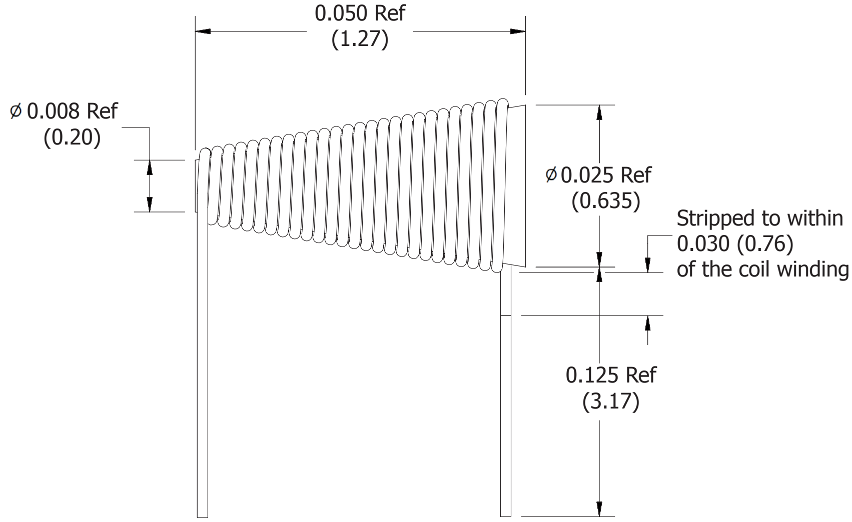
Current Rating based on:
100°C temperature rise from 25°C ambient.

$T_{max} = 90 + 35 = 125$

[2]Refer to page 2

Inductor Design Utilized in Example

Gowanda Conical Coil:
C050FL2947G6



SPECIFICATION SHEET:

- Current Rating: 275 mA
- Based on a 35°C temperature rise from 90°C ambient
- Terminals are gold plated over nickel, base material is copper
- Wire turns: 29
- Wire size: 47 AWG
- DC Resistance: 0.87 Ohms

IN CONCLUSION

Be careful when comparing current rating information provided by inductor manufacturers. The role of the temperature rise value in the mathematical calculation of current rating is significant. Using similar temperature rise values to calculate current ratings will provide better comparisons.

If you have any questions about this Technical Tip, suggestions for future Technical Tips, or need assistance with our standard or custom products, please contact us.

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