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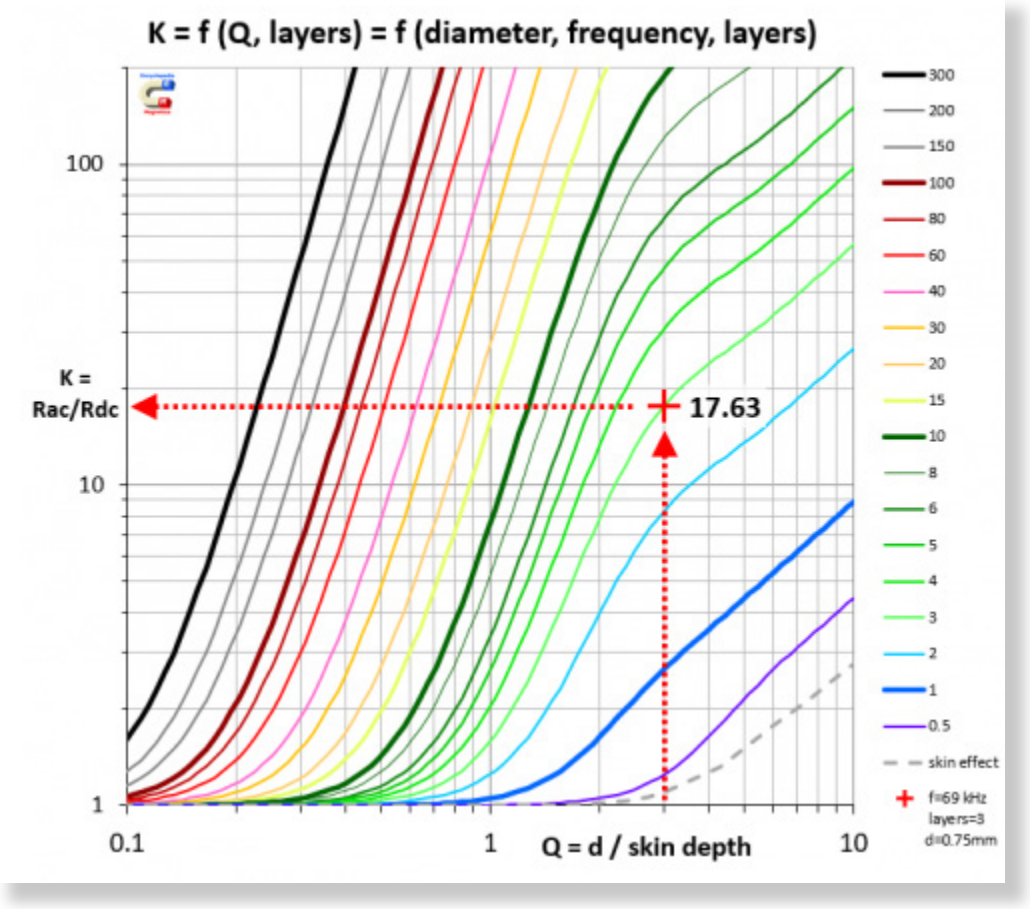
OPTIMIZING WINDING LOSSES

Via Dowell's Equations

Standex Electronics

TOP TIPS

Optimizing Winding Losses



S. Zurek (2021), *Proximity Factor Example* [Image]. Encyclopedia Magnetica, https://www.e-magnetica.pl/

Design Tips for Optimizing Winding Losses via Dowell's Equations

In a transformer or inductor, the magnetomotive force (MMF) is the force that generates the magnetic flux in the core and the windings. The MMF is proportional to the number of turns in the winding and the current flowing through it. The higher the MMF, the greater the magnetization of the core, and the more power losses due to hysteresis and eddy currents. Interleaving is needed to reduce the peak MMF in between conductive layers. Using Dowell's equations can help realize the Rac/Rdc at each winding or layer.

The Dowell method is a commonly used technique for calculating the losses in magnetic materials, particularly in inductors and transformers. The method is based on the idea of modeling the magnetic field in the material as a series of harmonic fields, each with a different frequency and amplitude.

1. Calculate Q via skin depth.

To calculate the AC resistance, you will need to calculate Q and m at each layer. Q is calculated via the thickness of the conductor divided by the skin depth. Also, keep in mind that the skin depth can change with temperature, conductor material and most importantly frequency. This method is effective for round conductors or rectangular conductor cross sections.

2. Find Fr or k using Dowell's curves.

You will then need Dowell's curves to find the relative Rac/Rdc based on Q and m. The value of m is determined by the total number of layers in the analyzed winding section. A section is determined when the flux crosses the zero point on the MMF diagram.

3. Add all layers together.

Calculating the Rac can be done by taking the "Fr" or "k" factor and multiplying by the DC resistance at each layer. The summation of all layers made up of each individual winding will yield the AC resistance. Several instances with differing conductor thicknesses will need to be compared to produce the lowest possible AC resistance for each winding.

4. Get expert advise.

Standex Electronics can provide expert guidance to ensure each design is tailored to meet the specific performance targets of our customers.

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