Magnetic Losses

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Core losses

$$B_{\max} = \frac{V_{IN}}{4 f_S A_e N}$$

$B_{\max}$	peak flux density for a 50% duty cycle square wave in Teslas
V_{IN}	peak input voltage in Volts
f_S	switching frequency in Hertz
A_e	effective cross-sectional area in m^2
N	number of turns in winding

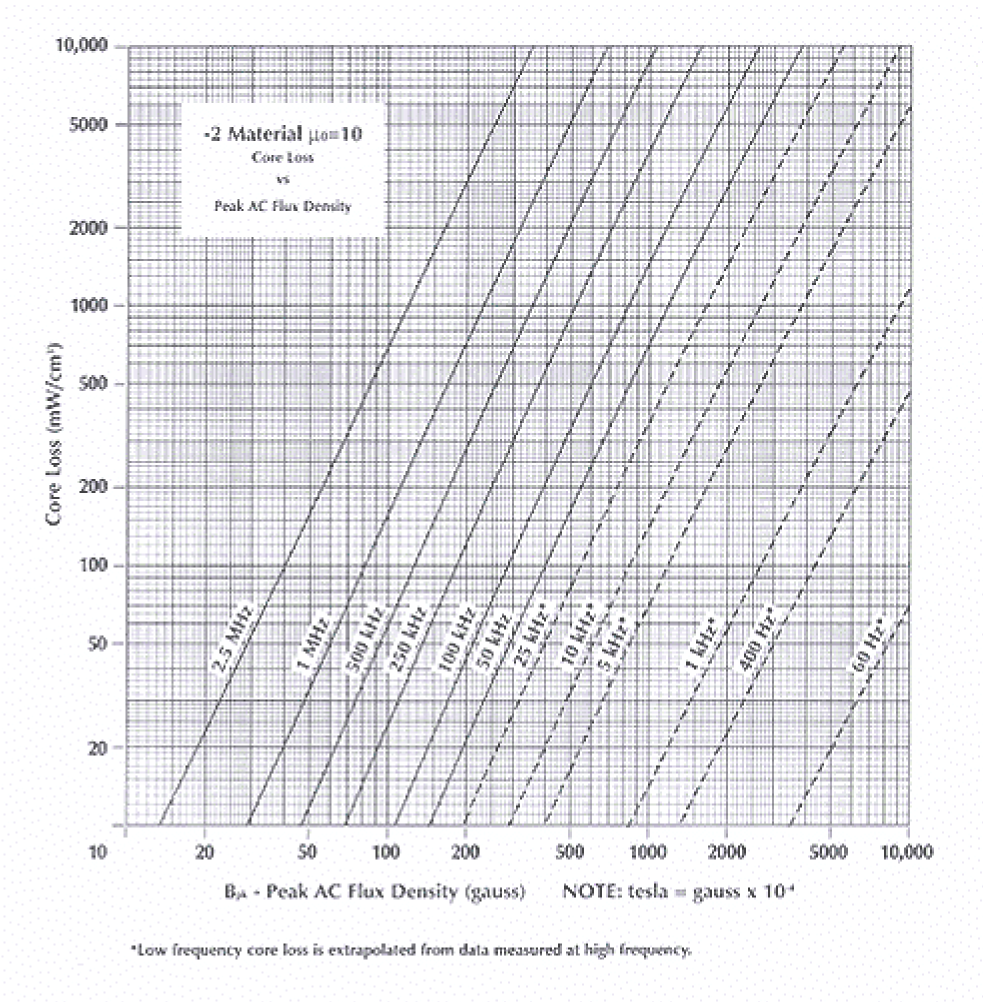
Look at the core loss table for the magnetic material in question and find the loss per unit volume for the given f_S and $B_{\max}$ then multiply this value by the effective core volume V_e for the net core loss.

Note that this loss is temperature dependent. Also, the loss curves assume a *sinusoid*, so add 50% to the calculated core loss for a safety margin.

General guideline:

Make $B_{\max}$ as high as the core losses allow. This will help minimize problems associated with more winding turns.

Below is an example core loss table for Micrometals type –2 material:



This data is for the fundamental only. To account for a square wave allow an extra 50%.

Copper losses

$$D_{PEN} = (0.24mm)\left(\frac{100kHz}{f_S}\right)^{1/2}$$

D_{PEN}	conductor penetration depth versus frequency
f_S	switching frequency

$$t = 0.83d\left(\frac{d}{s}\right)^{1/2}$$

t	effective layer thickness
d	wire diameter (copper only)
s	center-to-center spacing of wires *within* the layer

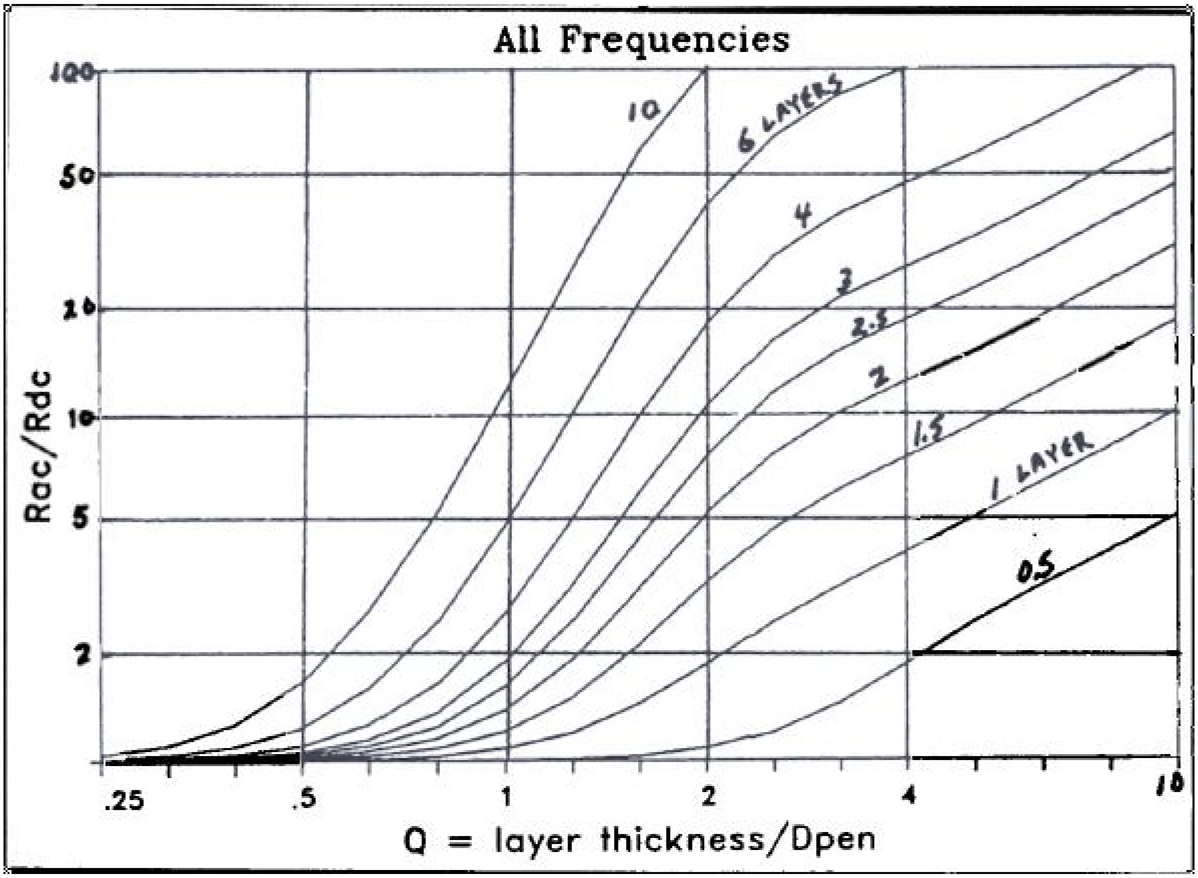
$$F_R = \frac{R_{ac}}{R_{dc}}$$

A good design goal is to set F_R = 1.5. Above this the losses are excessive, below this is the point of diminishing returns.

$$Q = \frac{t}{D_{PEN}}$$

An F_R of 1.5 corresponds to a Q of 1.6 with a single-layer winding.

Below are Dowell's curves for ac versus dc losses:



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