Magnetic Design Formulas

Flux Density (Peak)

$$B = \frac{E\ 10^8}{4.44 f N A_e}$$

Note: use 4.0 for square wave

Magnetizing Force (Peak)

$$H = \frac{.4\pi N I_P}{l_e}$$

Where:

E = RMS sine wave voltage
f = Frequency (Hz)
A_e = Effective area (cm^2)
l_e = Magnetic path length (cm)
I_P = Peak current (A)
N = Number of turns

Attenuation

$$20 \log_{10} \frac{Z_S + Z_L + Z_{SD}}{Z_S + Z_L} \text{ dB}$$

Where:

Z_S = Source Impedance
Z_L = Load Impedance
Z_{SD} = Shielding device Impedance

Quality Factor

$$Q = \frac{2\pi f L_S}{R_S} = \frac{R_P}{2\pi f L_P}$$

$$L_S = \frac{L_P Q^2}{1 + Q^2} \qquad R_S = \frac{R_P}{1 + Q^2} \qquad X_S = \frac{X_P Q^2}{1 + Q^2}$$

$$L_P = L_S\left(1 + \frac{1}{Q^2}\right) \qquad Rp = R_S(1 + Q^2) \qquad X_P = X_S\left(1 + \frac{1}{Q^2}\right)$$

Air Core Inductance

$$Lo = 2Ht.\ Ln\left(\frac{OD}{ID}\right)(N^2 \times 10^{-9}\ H) \text{ Using cm (x 2.54 Using in.)}$$

Initial Permeability

$$\mu i = \frac{L / N^2}{Lo} = \frac{L / Lo\ N^2}{\text{(if } N^2 \text{ not in Lo)}} = \frac{L / Lo}{\text{(if } N^2 \text{ is in Lo)}}$$

Inductance Index

$$AL = \mu Lo\ \ (nH / N^2)$$

Magnetic Path Length

$$l_e = \frac{2\pi \text{ Ln OD/ID}}{\frac{1}{IR} - \frac{1}{OR}} \text{ (cm)} = \frac{\pi \text{Ln(OD/ID)}}{\frac{1}{ID} - \frac{1}{OD}} \text{ (cm)}$$ (x 2.54 when using in.)

Magnetic Cross Section

$$A_e = \frac{\text{Ht Ln}^2 \text{ OD/ID}}{\frac{1}{IR} - \frac{1}{OR}} \text{ (cm}^2\text{)} = \frac{.5\text{HtLn}^2\text{(OD/ID)}}{\frac{1}{ID} - \frac{1}{OD}} \text{ (cm}^2\text{)}$$ (x 2.54^2 when using in.)

Loss Factor

$$\tan \delta/\mu = \frac{R}{\mu\, 2\pi fL} = \frac{Lo\, N^2\, R}{2\pi fL^2} = \frac{1}{\mu\, 2\pi f\, C_P R_P} = \frac{Lo\, R_S}{2\pi f (L^2)}$$

ET Constant

$$ET = \frac{(B\, A_e\, N)}{10^8} \text{ (V/uS)}$$ (@2200 Gauss)

Resistance

$$R_S = \frac{(\tan \delta/\mu_{(max)}\, 2\pi f\, (L_{S\ min})^{2)}}{L_o\, N^2} \text{ (ohms)}$$

Impedance

$$Z = \text{SQRT}\,[(2\,\pi\, f\, L)^2 + R^{2]}$$