Electromagnetic Relationships and Formulas

Impedance (for an inductor) $|Z| = R + jX_L$ $|Z| = \sqrt{R^2 + X^2}$

Core Constant $C_1 = \Sigma \frac{\ell_e}{A_e}$; for a toroid (Ht in cm) $C_1 = \frac{2\pi}{Ht \times \ln(OD/ID)}$

Inductance L $\frac{N\varphi}{I} = \frac{\text{\# Flux linkages}}{\text{current that produces flux}}$

Attenuation $(dB) = 20 \text{ Log}_{10} \left[\frac{Z_s + Z_L + Z_{SD}}{Z_s + Z_L} \right]$

	For Toroids (SI Units)
Magnetic Field Intensity (H) (Amperes/meter)	$H = \frac{NI}{2\pi r}$
Magnetic Flux Density (B) (Webers/meter^2)	$B = \frac{\mu NI}{2\pi r}$
Inductance (L) (Henries)	$L = \frac{4\pi\mu_e N^2}{C_1} \times 10^{-9}$
Quality Factor (Q)	$Q = \frac{\omega L_s}{R_s} = \frac{R_p}{\omega L_p}$
Effective Permeability (μ_e)	$\mu_e = \frac{\ell_e}{\ell_e / \mu_i + \ell_g}$ where $\ell_g << \ell_e$

Equation Variables

$\mu = \mu_r \mu_0$

μ_r = relative permeability of the core

μ_o = permeability of free space = $4\pi \times 10^{-7}$ Henries/meter

μ_e = effective permeability of the core

$\omega = 2\pi fL$

ℓ_e = effective path length

ℓ_g = length of gap

r = mean core radius

f = frequency

A_e = effective cross-sectional area

Ht = height of core

I = current in amperes

ID = inside diameter of core

OD = outside diameter of core

N = number of turns

R_s = series resistance

jX_L = imaginary component of inductive reactance

$X_L = 2\pi fL$

Z_S = source impedance

Z_L = load impedance

Z_{SD} = shielding device impedance

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