Magnetic Design Formulas

Inductance of Wound Core

The inductance of a wound core at a given number of turns is calculated using the following formula.

$$L = \frac{0.4\pi\mu N^2 A \times 10^{-2}}{\ell}$$

$$L_N = A_L \times N^2 \times 10^{-3}$$

- L = inductance (μH)
- μ = core permeability
- N = number of turns
- A = core cross section (cm^2)
- ℓ = mean magnetic path length (cm)
- L_N = Inductance for n turns (μH)
- A_L = nominal Inductance (nH/N^2)

Permeability - Flux Density - Magnetizing Force

Ampere's law and Faraday's law show the relations of permeability, flux density and magnetizing force of wound core.

$$H = \frac{0.4\pi NI}{\ell} \quad \text{----- Ampere's Law}$$

$$B_{max} = \frac{E_{rms} \times 10^8}{4.44fAN} \quad \text{----- Faraday's Law}$$

$$\mu = \frac{B}{H}$$

- H = magnetizing force (oersteds)
- N = number of turns
- I = peak magnetizing current (amperes)
- ℓ = mean magnetic path length (cm)
- B_{max} = maximum flux density (gausses)
- E_{rms} = voltage across coil (volts)
- f = frequency (hertz)

Inductance calculation by Permeability vs DC Bias Curves

Inductor specification
- Core : CM270125
- Number of Winding : 22Turns
- Current : DC 10Amperes

solution

a) Formula to calculate L at 0Ampere

$L_N = A_L \times N^2 \times 10^3$

The Nominal inductance table on page 7 shows the A_L value of CM270125 to be 157.

Therefore, L (@0A) = $157 \times 22^2 \times 0.001 = 76$ (μH)

b) Determine DC magnetizing force (H) by using Ampere's law to achieve the roll off.

$H = 0.4\pi NI / l$

$H = 0.4 \times 3.14 \times 22 \times 10 / 6.35 = 43.5$(Oe)

The magnetizing force(dc bias) is 43.5 oersteds, yielding 59% of inital permeability.

The inductance at 10Ampere will decrease by 59% compared with 0Ampere.

Therefore, L(@10A) = 76×0.59

= 44.8 (μH)

※ Inductance calculation by A_L vs NI Curve is also available on 21page.