14.2 A step-by-step procedure

The following quantities are specified, using the units noted:

Wire resistivity	ρ	(Ω-cm)
Peak winding current	I_{max}	(A)
Inductance	L	(H)
Winding resistance	R	(Ω)
Winding fill factor	K_u	
Core maximum flux density	B_{max}	(T)

The core dimensions are expressed in cm:

Core cross-sectional area	A_c	(cm^2)
Core window area	W_A	(cm^2)
Mean length per turn	MLT	(cm)

The use of centimeters rather than meters requires that appropriate factors be added to the design equations.

Determine core size

$$K_g \geq \frac{\rho L^2 I_{max}^2}{B_{max}^2 R K_u} 10^8 \qquad (\text{cm}^5)$$

Choose a core which is large enough to satisfy this inequality (*see Appendix D for magnetics design tables*).

Note the values of A_c, W_A, and MLT for this core.

Determine air gap length

$$\ell_g = \frac{\mu_0 L I_{max}^2}{B_{max}^2 A_c} 10^4 \qquad \text{(m)}$$

with A_c expressed in cm^2. $\mu_0 = 4\pi 10^{-7}$ H/m.

The air gap length is given in meters.

The value expressed above is approximate, and neglects fringing flux and other nonidealities.

A_L

Core manufacturers sell gapped cores. Rather than specifying the air gap length, the equivalent quantity A_L is used.

A_L is equal to the inductance, in mH, obtained with a winding of 1000 turns.

When A_L is specified, it is the core manufacturer's responsibility to obtain the correct gap length.

The required A_L is given by:

$$A_L = \frac{10 B_{max}^2 A_c^2}{L I_{max}^2} \qquad \text{(mH/1000 turns)}$$

Units:
A_c cm^2,
L Henries,
B_{max} Tesla.

$$L = A_L n^2 10^{-9} \qquad \text{(Henries)}$$

Determine number of turns n

$$n = \frac{LI_{max}}{B_{max}A_c}\ 10^4$$

Evaluate wire size

$$A_W \le \frac{K_u W_A}{n} \quad (\mathrm{cm}^2)$$

Select wire with bare copper area A_W less than or equal to this value. An American Wire Gauge table is included in Appendix D.

As a check, the winding resistance can be computed:

$$R = \frac{\rho n\ (MLT)}{A_w} \quad (\Omega)$$