$$R_e = \left(\frac{n_1}{n_2}\right)^2 \frac{8}{\pi^2} R_L$$

$$B(t) = \frac{1}{n_1 \mathrm{A}_e} \int u_1(t)\, dt$$

$$\Delta B = 2B^{\max} = \frac{U_1\, t_{on}}{n_1 \mathrm{A}_e} \qquad n_1 = \frac{U_1\, t_{on}}{2B^{\max} \mathrm{A}_e} \qquad L_m = \frac{n_1{}^2 \mathrm{A}_e \mu_0 \mu_r}{l_e}$$

$$\frac{\Delta B}{2} \rightarrow \textit{Steinmetz equation} \rightarrow \textit{power losses} \rightarrow B^{\max}$$

$$\mathrm{A}_{p1} = \mathrm{A}_w \mathrm{A}_e = \frac{L\, I_{pk}\, I_{rms}}{B_{pk}\, J\, k_f}; \qquad k_f \approx 0.5$$

$$J_1 \approx 4.5\,\mathrm{A\,mm^{-2}}$$

$$\mathrm{A}_{p2} = \mathrm{A}_w \mathrm{A}_e = \frac{L\, \Delta I\, I_{rms}}{\Delta B\, J\, k_f}; \qquad J_2 \approx 1.0\,\mathrm{A\,mm^{-2}} \quad (I_{2rms} \approx 1000\,\mathrm{A})$$

$$\mathrm{A}_e = \frac{1}{n_1} \frac{U_1}{4 f_{sw}\, \Delta B} \qquad \mathrm{A}_p = \mathrm{A}_w \mathrm{A}_e = 2 I_{1rms} \frac{U_1\, d_{on}}{f_{sw}\, \Delta B\, J\, k_f};$$

$$\mathrm{A}_w = \frac{w_{\mathrm{A}_1} \cdot n_1 + w_{\mathrm{A}_2} \cdot n_2}{k_f}$$

$$\mathrm{A}_p = I_{1rms} \frac{U_1}{2 f_{sw}\, \Delta B\, J\, k_f}; \quad (d_{on} = 1/4)$$

$$R_{dc} = \rho \frac{l}{s}$$

$$w_{\mathrm{A}_1} = \frac{I_{1rms}}{J_1} \qquad \rho = 0.0175\,\Omega\, \mathrm{mm^2/m}$$

$$w_{\mathrm{A}_2} = \frac{I_{1rms}}{J_2} \qquad h = 5.5 \frac{\mathrm{W}}{\mathrm{K\,m^2}}$$

Transformer Design

$$B_{pk} = \frac{L\, I_{pk}}{n\, \mathrm{A}_e}$$

$$\Delta B = \frac{L\, \Delta I}{n\, \mathrm{A}_e}$$

$$L = \frac{\mu_{eff} \mu_0 n^2 \mathrm{A}_e}{l_e}$$

$$\mu_{eff} = \frac{1}{\frac{1}{\mu_r} + \frac{1}{l_e/g}}$$

$$\mu_{eff} \approx \frac{l_e}{g}$$

$$\frac{1}{2} L\left(\hat{i}\right)^2 = \frac{1}{2} \frac{A_e l_e}{\mu_{eff} \mu_0} B_{\max}^2$$

Inductor Design
airgap and energy stored

$$\omega_0 = \frac{1}{\sqrt{L_r C_r}}$$

$$Q_s = \frac{\omega_0 L_r}{R_e}$$

$$m = \frac{L_m}{L_r}$$

$$\delta[mm] = \frac{72}{\sqrt{f[Hz]}}$$

$$d = Q \cdot \delta \rightarrow 0.25 \cdot \delta$$

$$Q = \frac{d}{\delta} \qquad R_{ac} = R_{dc}\left(1 + \frac{\left(r_0/\delta\right)^4}{48 + 0.8\left(r_0/\delta\right)^4}\right)$$

$$\frac{Q_1}{Q_2} = 4 \rightarrow \frac{R_{dc1}}{R_{dc2}} \approx 16 \rightarrow \frac{R_{ac1}/R_{dc1}}{R_{ac2}/R_{dc2}} \approx 60$$

$$\frac{R_{dc1}}{R_{dc2}} = \left(\frac{d_2}{d_1}\right)^2$$

Windind Design
Proximity and skin effects