

Flyback Transformer Design

- 0.條件: a.輸入電壓:10.5V~13.8V
 b.輸出電壓:142V
 c.輸出 Power:360W
 d.操作頻率:50KHZ
 e.Dmax:0.5

1.計算 Ton(max):

$$T_{on(max)} = \frac{1}{f} \cdot D_{max} = \frac{1}{50 \text{ K}} \cdot 0.5 = 10 \mu\text{S}$$

2.計算初級側最大峰值電流:

$$I_p = \frac{2 \cdot P_o}{\eta \cdot f \cdot V_{in(min)} \cdot T_{on(max)}} = \frac{2 \cdot 360}{0.8 \cdot 50 \text{ K} \cdot 9.5 \cdot 10^{-6}} = 190 \text{ A}$$

3.計算初級側最大 rms 值電流:

$$I_{rms} = I_p \cdot \sqrt{\frac{D_{max}}{3}} = 190 \cdot \sqrt{\frac{0.5}{3}} = 77.6 \text{ A}$$

4.計算初級側電感:

$$L_p = \frac{V_{in(min)} \cdot T_{on(max)}}{I_p} = \frac{9.5 \cdot 10^{-6}}{190} = 500 \text{ nH}$$

5.計算鐵心的 Area Product 值及鐵心選用:

$$AP = \left(\frac{L_p \cdot I_p \cdot I_{rms} \cdot 10^4}{450 \cdot K \cdot B_{max}} \right)^{1.143} = \left(\frac{500 \text{ n} \cdot 190 \cdot 77.6 \cdot 10^4}{450 \cdot 0.2 \cdot 0.25} \right)^{1.143} = 3.88 \text{ cm}^4$$

鐵心選用 EE42X20: $A_e=2.36$ $A_w=1.974$ $AP_c=4.66$

6.計算電感儲存 Energy:

$$\Delta W = \frac{1}{2} \cdot L_p \cdot I_p^2 = \frac{1}{2} \cdot 500 \text{ n} \cdot 190^2 = 9.025 \text{ mJ}$$

7.計算初級側的 Amp-Turn:

$$Hl_g = \frac{2 \cdot \Delta W}{B_{max} \cdot A_e} \cdot 10^4 = \frac{2 \cdot 9.025 \text{ m}}{0.25 \cdot 2.36} \cdot 10^4 = 306 \text{ AT}$$

8.計算 Gap:

$$l_g = \frac{AT}{\frac{4 \cdot \pi \cdot 10^{-7}}{0.2}} \cdot 10^3 = \frac{306}{\frac{4 \cdot \pi \cdot 10^{-7}}{0.2}} \cdot 10^3 = 1.92 \text{ mm}$$

9.計算初級側的圈數:

$$N_p = \frac{Hl_g}{I_p} = \frac{306}{190} = 1.61$$

初級側的圈數選用 2T

10.計算圈數比:

$$n = \frac{N_p}{N_s} = \frac{V_{in(min)} \cdot D_{max}}{V_s \cdot (1 - D_{max})} = \frac{9.5 \cdot 0.5}{142 \cdot 0.5} = 0.0669$$

11. 計算次級側的圈數:

$$N_s = \frac{N_p}{n} = \frac{2}{0.0669} = 30 \text{ T}$$

12. 計算電流密度:

$$J = 450 \cdot AP^{-0.125} = 450 \cdot 4.66^{-0.125} = 371$$

13. 計算輸出電流, 輸出峰電流, 輸出 rms 電流:

$$I_o = \frac{P_o}{V_o} = \frac{360}{142} = 2.54 \text{ A}$$

$$I_{sp} = \frac{2 \cdot I_o}{1 - D_{max}} = \frac{2 \cdot 2.54}{1 - 0.5} = 10.14 \text{ A}$$

$$I_{sr} = I_{sp} \cdot \sqrt{\frac{1 - D_{max}}{3}} = 10.14 \cdot \sqrt{\frac{1 - 0.5}{3}} = 4.14 \text{ A}$$

14. 計算銅的截面積:

$$A_p = \frac{I_{rms}}{J} = \frac{77.6}{371} = 0.21 \text{ cm}^2$$

$$A_s = \frac{I_{sr}}{J} = \frac{4.14}{371} = 0.01116 \text{ cm}^2$$