

$$k := 10^3 \quad m := 10^{-3} \quad u := 10^{-6}$$

$$u0 := 4\pi \cdot 10^{-7}$$

$$ur := 2500$$

$$Vinmin := 7 \quad Vinmax := 55$$

$$Vo1 := 5 \quad Io1 := 0.1 \quad Vd := 0.3$$

$$Vo2 := 5 \quad Io2 := 0.1 \quad fsw := 250k$$

$$Vo3 := 5 \quad Io3 := 0.5 \quad Iocp := 2$$

Topology fly-buckboost with ER11 transformer

ER11

070-6058 Bobbin Area

$$Ae := 11 \cdot 10^{-6}$$

$$Width := 2.01 \cdot 10^{-3}$$

$$le := 14.7 \cdot 10^{-3}$$

$$Build := 1.6 \cdot 10^{-3}$$

$$Ae_min := 10.3 \cdot 10^{-6}$$

$$Perimeter := 16.69 \cdot 10^{-3}$$

$$Bmax := 0.3$$

$$Vo_pri := 5$$

$$D(Vin) := \frac{Vo_pri}{Vo_pri + Vin}$$

匝比

$$n1 := \frac{Vo1 + 0.3}{Vo_pri}$$

Turn ratio between Primary and Vo1

$$n1 = 1.06$$

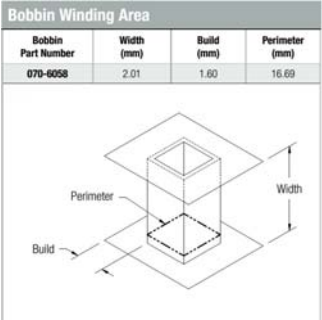
$$n2 := \frac{Vo2 + 0.3}{Vo_pri}$$

Turn ratio between Primary and Vo2

$$n2 = 1.06$$

$$n3 := \frac{Vo2 + 0.3}{Vo_pri}$$

Turn ratio between Primary and Vo2



Bobbin Winding Area			
Bobbin Part Number	Width (mm)	Build (mm)	Perimeter (mm)
070-6058	2.01	1.60	16.69

$$n3 = 1.06$$

原边电感量

$$Io_total := Io1 \cdot n1 + Io2 \cdot n2 + Io3 \cdot n3$$

$$Io_total = 0.742$$

$$Iinmax := \frac{Io_total \cdot Vo_pri}{0.84 \cdot Vinmin}$$

$$Iinmax = 0.631$$

$$ILmax := Iinmax + Io_total$$

$$\Delta ILmax := (1.6 - Iinmax - Io_total) \cdot 2$$

$$\Delta ILmax = 0.454$$

$$Lmin := \frac{Vo_pri \cdot (1 - D(Vinmin))}{fsw \cdot \Delta ILmax}$$

$$Lmin = 2.569 \times 10^{-5}$$

$$Ltr := 22u$$

变压器各绕组匝数

$$Npri := \frac{Ltr \cdot Iocp}{Ae \cdot Bmax}$$

$$Npri = 13.333$$

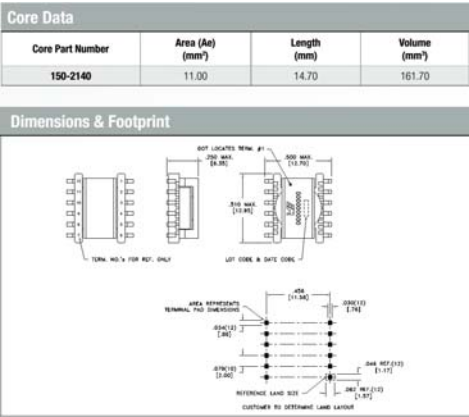
$$Npri := 14$$

$$N1 := Npri \cdot n1 \qquad N1 = 14.84$$

$$N1 = 14.84$$

$$N1 := 15$$

$$N2 := 15$$



$$N3 := 15$$

计算磁芯气隙长度

$$AL := \frac{L_{tr}}{N_{pri}^2}$$

$$lg := \mu_0 \cdot \left(\frac{A_e}{AL} - \frac{l_e}{\mu_0 \cdot \mu_r} \right)$$

$$lg = 1.173 \times 10^{-4}$$

集肤深度

$$\delta_{depth} := \frac{7.6}{\sqrt{f_{sw}}}$$

$$\delta_{depth} = 0.015 \quad \text{cm(radius)}$$

按照集肤深度计算, 需要选择AWG28以下的线径

$$J := 800 \cdot 10^4 \quad \text{Amp per m}^2$$

$$W_{cu_{Lp}} := \frac{IL_{max}}{J}$$

$$W_{cu_{Lp}} = 1.716 \times 10^{-7} \quad \text{平方米}$$

按照8A/cm², 需要选择的铜线截面积在0.1716mm²以上

原边线径计算

Choose AWG28

Primary Wire selected:

Wire size

$$AWG_{Lp} := 28$$

Bare area (copper plus single insulation)

$$W_{a_{Lp}} := 0.1 \cdot 10^{-4}$$

Copper area:

$$W_{cu_{Lp}} := 0.0806 \cdot 10^{-4}$$

Diameter(copper plus single insulation)

$$D_{cu_{Lp}} := 0.3556 \text{mm}$$

Number of strands(原边并绕的匝数):

$$N_{st_{Lp}} := 2$$

原边每层能放下的匝数(Ntl):

$$N_{tl_{Lp}} := \frac{\text{Width}}{D_{cu_{Lp}}}$$

$$N_{tl_{Lp}} = 5.652$$

$$N_{tl_{Lp}} := 5$$

原边一共需要的层数(Nly)

$$N_{ly_{Lp}} := \frac{N_{pri} \cdot N_{st_{Lp}}}{N_{tl_{Lp}}}$$

$$N_{ly_{Lp}} = 5.6$$

$$N_{ly_{Lp}} := 6$$

副边1&2线径计算

$$J := 800 \cdot 10^4$$

$$W_{cu_{S1}} := \frac{I_{o1} \cdot \sqrt{2}}{J}$$

$$W_{cu_{S1}} = 1.768 \times 10^{-8}$$

电流有限制估算为 $I_o \cdot 1.414$

按照 $8A/cm^2$, 需要选择的铜线截面积在 $0.0125mm^2$ 以上

Choose AWG34

Wire size

$$AWG_{Ls1} := 34$$

Bare area (copper plus single insulation)

$$W_{a_{Ls1}} := 0.0265 \cdot 10^{-4}$$

Copper area:

$$W_{cu_{Ls1}} := 0.0176 \cdot 10^{-4}$$

Diameter(copper plus single insulation)

$$D_{cu_{Ls1}} := 0.18415m$$

副边1&2每层能放下的匝数(Ntl):

$$N_{tl_{Ls1}} := \frac{\text{Width}}{D_{cu_{Ls1}}}$$

$$N_{tl_{Ls1}} = 10.915$$

$$N_{tLs1} := 11$$

副边1&2一共需要的层数(Nly)

$$N_{lyLs12} := \frac{N1 + N2}{N_{tLs1}} \quad N_{lyLs12} = 2.727$$

$$N_{lyLs12} := 3$$

副边3线径计算

$$J := 800 \cdot 10^4$$

$$W_{cuLs3} := \frac{I_{o3} \cdot \sqrt{2}}{J} \quad W_{cuLs3} = 8.839 \times 10^{-8}$$

按照8A/cm², 需要选择的铜线截面积在0.088mm²以上

Choose AWG29

Secondary3 Wire selected:

Wire size

$$AWG_{Ls3} := 29$$

Bare area (copper plus single insulation)

$$W_{aLs3} := 0.0804 \cdot 10^{-4}$$

Copper area:

$$W_{cuLs3} := 0.0649 \cdot 10^{-4}$$

Diameter(copper plus single insulation)

$$D_{cuLs3} := 0.32m$$

副边3每层能放下的匝数(Ntl):

$$N_{tLs3} := \frac{\text{Width}}{D_{cuLs3}} \quad N_{tLs3} = 6.281$$

副边3一共需要的层数(Nly)

$$N_{lyLs3} := \frac{N1}{N_{tLs3}} \quad N_{lyLs3} = 2.388$$

$$Nly_{Ls3} := 3$$

$$D_{insulation} := 0.25m$$

$$Build1 := Nly_{Ls3} \cdot Dcu_{Ls3} + Nly_{Ls12} \cdot Dcu_{Ls1} + Ntl_{Lp} \cdot Dcu_{Lp}$$

$$Build1 = 3.29 \times 10^{-3}$$

$$Build = 1.6 \times 10^{-3}$$

AP法验证

$$k_{1w} := 0.2 \qquad J := 800$$

$$K1 := J \cdot k_{1w} \cdot 10^{-4}$$

$$K1 = 0.016$$

$$Kt := \frac{0.00025}{1.97} \cdot 10^3$$

$$AP := \left(\frac{Ltr \cdot Iocp}{Bmax} \cdot \frac{ILmax \cdot 1.2}{K1} \right)^{\frac{4}{3}} \cdot 10^{-8} \qquad cm^4$$

$$AP1 := \frac{Io_total \cdot Vo_pri}{Kt \cdot Bmax \cdot fsw \cdot J}$$

$$AP = 3.733 \times 10^{-11}$$

$$AP1 = 4.872 \times 10^{-7}$$

$$AP_{ER11} := Ae \cdot Build \cdot Width$$

$$A_{\text{P}_{\text{ER11}}} = 3.538 \times 10^{-11}$$