https://www.mouser.com/pdfdocs/2-8.pdf

We decided to have a turn ratio of 4 so $N_P/N_S = 1/4$ and have switching freq around 50 kHz.

$$V_{DSMax} = V_{INMax} + V_{Reflected} + V_{DSMax} * 0.3\ (due\ to\ leakage\ ringing)$$
$$0.7V_{DSMax} = 18 + (48 + 0.7) * 1/4 \text{ So } V_{DSMax} \approx 45\ V$$

$$D_{Max} = \frac{V_R}{V_R + V_{INmin}} = 0.505$$

$$P_{INMax} = P_{OUTMax}/eff\ (assuming\ \%85\ efficiency) = 48/0.85 \approx 56.5\ W$$

$$I_P = \frac{2*P_{INMax}}{V_{INMin}*D_{Max}} = \frac{2*56.5}{12*0.505} \approx 18.65\ A$$

$$L_{PriMax} = \frac{V_{INMin}*D_{Max}}{I_P*f_{SW}} = \frac{12*0.505}{18.65*50000} = 6.5 * 10^{-6}\ H = 6.5\ \mu H$$

https://www.digikey.com/en/products/detail/ferroxcube/CPV-RM12-I-1S-12PD-TZ/7034242
https://www.ferroxcube.com/upload/media/product/file/Pr_ds/RM12_ILP.pdf
For the core we will use a ferrite core assuming its BSat = 0.24 T. And we found a core which has 125 mm2 Ae. Bsat values can be in the range of 0.2 - 0.34 as we researched about it.

$$N_P = \frac{L_{PriMax}*I_P}{B_{Sat}*A_e} = \frac{6.5*10^{-6}*18.65}{0.24*0.000125} \approx 4\ Turns\ so\ we\ would\ have\ 16\ turns\ at\ secondary$$

$$I_{PRMS} = I_P * \sqrt{D_{Max}/3} = 18.65 * \sqrt{0.505/3} = 7.65\ A$$

$$I_{Secpk} = I_P * 1/4 = 4.67\ A \qquad I_{SecRMS} = 4.67 * \sqrt{\frac{1-0.505}{3}} = 1.9\ A$$

https://tr.farnell.com/awg-donusturme-hesaplayicisi

According to the table above we should choose AWG 23 for 50 kHZ operation

But it has a 0.729 A max current capacity, so we should parallel the cables.

For primary 7.65/0.729 = 11 Cable so 4*11=44 cable in total

For Secondary 1.9/0.729 = 3 Cable so 16*3=48 cable in total

AWG 23 has 0.258 mm2 area so we will have total of (44+48)*0.258 = 24 mm2 winding area. But since we will parallel it it will probably be higher let's assume 30 mm2.

Winding area of the coil former is 75mm2 so 30/75 = 0.4 fill factor is reasonable.

Winding data for RM12/I coil former (DIL)

NUMBER OF SECTIONS	AVERAGE LENGTH OF TURN (mm)	WINDING AREA (mm^2)	WINDING WIDTH (mm)	TYPE NUMBER
1	61	75.0	14.3	CPV-RM12/I-1S-12PD

$$V_{RVDiode} = V_{Out} + V_{INMax} * Ns/Np = 48 + 18 * 4 = 120\,V$$

According to the design guides we should choose VRRM at least 30% higher than VRVdiode and IF (average forward current) is at least 50% higher than the IsecRMS.

So VRRM should be around 156 V and IF should be around 2.9 A

$$C_{OutMin} = \frac{I_{OutMax} * N_{CP}}{f_{SW} * V_{Ripple}}$$

Ncp is the number of internal clock cycles needed by the control loop to reduce the duty cycle from maximum to minimum value. This usually takes around 10-20 switching periods.

With %3 Vo ripple 48*0.03=1.44

So $C_{OutMin} = \frac{1*15}{50000*1.44} = 208.3 * 10^{-6} F \;\; 208.3\,\mu F = 0.21\,mF$

$$I_{CapRMS(min)} = \sqrt{I_{SecRMS}^{2} - I_{Out}^{2}} = 1.62\,A$$

$$ESR_{Max} < \frac{\Delta V_{Out}}{I_{Secpk}} = 1.44/1.9 = 0.76$$

THIS IS OKAY EXCEPT CAP VALUE IS PROBABLY TOO HIGH IT HAS VERY LOW RIPPLE (LOWER THAN %3) WE MAY DECREASE IT.