Transformer Design

As introductory, a trade-off rises between the core efficiency and core size. A moderate frequency is selected to keep these two parameters reasonable, which is 62500 Hz. ΔIlm is chosen as 6A. Therefore, at 75% duty cycle, primary side inductance should be:

, which yields Lm=24 µH.

To select the proper core, it is necessary to investigate the some properties of the core types:

1. Saturation flux density
2. Inductance Factor and
   1. Gap
   2. Dimensions
   3. Equivalent permeability
3. Window area

ETD 39 core with N87 material and 2mm gap can show desired performance. Its corresponding inductance factor is 115 nH[reference of ETD core] :

To check the saturation of the material,

Its saturation flux density is 0.32 T. From the formula

Maximum current carrying capability of the transformer can be calculated. Take B=Bmax=0.32 T. Ae=125 mm2, ℜ=1/AL=8695652, N=14

Imax=24.8 A, which is above current range of magnetizing inductance.

, which is in the current capability range of the transformer.

If the core saturated, either gap would be increased and turn number would be increased by the ratio of square root of gap increase, the size of the core would be increased or frequency is increased. In the first case, the limiting factor is window area. As turn number increases, it gets harder to fit in window area and temperature rise becomes more critical for central layers of cables wound on coil former. Moreover, while we keep magnetizing inductance constant through this operation, leakage inductance increases as turns number increases.

To calculate the N2,

is used. N2 is about 19 turns in ideal case. However, to compensate the voltage drop on switching MOSFET, output diode and copper resistances, turns ratio is increased to 28 in practice.