**Transformer Design**

To design a proper transformer for our application, we firstly determined the wire size for safe operation. As we have seen in the lectures, we have limited current density to 4-5 A/mm2. In the input side of the converter, 48W/24V= 2A is carried by the wires and 0.5mm2 cross sectional area is required if the converter is 100% efficient. Since the efficiency will be lower, input power will be higher. By checking the AWG wire sizes, we decided that AWG#19 (0.653 mm2) is suitable for primary windings of the transformer. For this wire, recommended maximum frequency is 21kHz [1]. Output current of the converter is 48W/10V=4.8A. Hence, cross section area of the secondary winding must be 1.2 mm2 for 4 A/mm2 current density. However, increasing wire area decreases the recommended maximum frequency. To overcome this problem, we decided to use 2 parallel AWG#19 (0.653 mm2) wires for secondary winding, and we have selected 20kHz switching frequency which is appropriate for selected wire type.

For a forward converter, input-output relationship is given by equation (1). By choosing N1=N3(reset), we limited the maximum duty ratio to 50% in order to reset the reset the transformer.

(1)

Vi=24V is the limiting input voltage since increases in Vi can be overcome by lowering duty ratio. We need Vo=10V at the output of the converter. However, since equation (1) is derived for ideal components, we set Vo=11-12V by considering the voltage drops on output inductor and diode. Therefore, we chose . If voltage drops on the output components become lower than expected, decreasing D solves the problem.

We used formula (2) to find minimum number of primary winding not to saturate the core.

(2)

In equation (2), ,, and , , for our core selection which is 0P44022EC. For given parameters 16, and we decided that . As we mentioned in the previous parts, and selected wire has 0.653 mm2 cross sectional area. The total area of conductors is 52.24 mm2. Then, we have calculated the fill-factor of the transformer by equation (3) to check if the conductors fit in the window area of the selected core.

(2)

Although resulting fill-factor is lower than limits, we decided that it would be best choice from available cores.

To find magnetizing inductance of the transformer, we used inductance factor (AL) given in the datasheet of the core. From equation (3), calculated that Lm=2.4mH.

(2)