Topology Discussion

In this project, an isolated DC-DC converter will be designed with the specifications as can be seen from Table 1.

|  |  |
| --- | --- |
| Vin,min | 12V |
| Vin,max | 18V |
| Vout | 48V |
| Pout | 48W |
| Vout,pp Ripple | 3% |
| Line Regulation | 3% |
| Load Regulation | 3% |

Table 1. Specifications of the Project

There are 5 candidates for this isolated DC-DC converter which are as follows:

* Flyback Converter
* Forward Converter
* Push-Pull Converter
* Half-Bridge Converter
* Full-Bridge Converter

The final decision on the topology used on this project is decided by discussing the advantages and disadvantages of each of these topologies. After careful examination, using the flyback converter topology is decided. Flyback is the easiest to control and the smallest sized converter in these five topologies. Less number of switches in the flyback converter also means smaller switching losses, which was another factor in selecting this selection process. Although there are certain advantages of other topologies, the control of switches is deemed problematic as turning on both switches at the same time for push-pull, half-bridge and full-bridge converters may blow up the converter. On the other hand, the forward converter is avoided mainly because of the limitation it brings to the maximum duty cycle.

|  |  |  |
| --- | --- | --- |
| Topology Name | Advantages | Disadvantages |
| Flyback Converter | * Only one switch is needed, so it is easier to control. * Comparatively smaller in size because no additional inductor is used. * Only one switch, so smaller switching losses. | * The peak current and voltage through the switch are high. * High output current ripple. |
| Forward Converter | * Power is transferred immediately. * Low output current ripple. * If a third winding topology is used, the energy is transferred back to the supply. * Only one switch, so smaller switching losses. | * RCD snubber circuit or a third winding on the transformer is necessary. This causes heat or worse fill factor. * One inductor is used, slightly bigger size. * Maximum duty cycle is limited to , otherwise core will saturate. |
| Push-Pull Converter | * Better use of core, 2 quadrant operation (1st and 3rd Quadrants). | * Two switches need to work together, hard to control. * Center tapped transformer will mean worse fill factor in the transformer. * One inductor, two diodes, two switches cause bigger size and switching losses. |
| Half-Bridge Converter | * Small output current ripple. | * One inductor, two diodes, two switches cause bigger size. * Small variances in the capacitances in the primary may cause unbalanced voltage division among them. |
| Full-Bridge Converter | * Small output current ripple. * Higher gain with the same turns ratio and duty cycle. | * 4 switches working synchronously, worse switching losses. |

Table 2. Advantages and disadvantages of each topology

The specifications in Table 1 suggests that the converter will need to take input between 12V and 18V. Considering the gain formula for the flyback converter is , the maximum duty cycle is selected as 0.5 and turns ratio N1:N2 is selected as 1:4. This selection is valid when the input is 12V. When the input is 18V, the duty cycle becomes 0.4 and this is the minimum value. Hence, the converter should be able to operate at a duty cycle range of 0.4 to 0.5.

Component Selection

In the flyback converter there are three component selections. These components are diode, capacitor, and switch (MOSFET). While choosing the switch, there are two considerations which are the peak switch current and peak switch voltage.

Output capacitor is found to be 220uF from the simulations and it needs to be able to withstand to Volts.