Two-Switch Forward Design

The selected topology for the term project is the two-switch forward converter, chosen for its advantageous characteristics tailored to meet specific application requirements. Primarily, the topology ensures that voltage stress on the primary side remains constrained to the maximum supply voltage, anticipated to be approximately 40 volts, coinciding with the maximum input voltage. Consequently, the necessity for any snubber circuitry is obviated, and the conduction of the MOSFET body diode is rendered unnecessary.

diyagram, çizgi, teknik çizim, plan içeren bir resim

Açıklama otomatik olarak oluşturuldu

Figure 1. Two-Side Switching Forward Converter Topology

However, it is acknowledged that the adoption of this topology may entail certain trade-offs. Foremost among these is the likelihood of increased switching and conduction losses across the MOSFETs and diodes compared to alternative topologies. Additionally, the management of the two switches presents a notable challenge within the scope of this project. Moreover, the design of the requisite output inductor is anticipated to incur supplementary costs and operational complexities.

In summary, while the two-switch forward converter offers distinct advantages aligned with the project's objectives, its adoption necessitates careful consideration of associated drawbacks, notably heightened losses and control complexities, alongside the requisite additional investment in output inductor design.

Desired topology’s simulation results and some measurement will be evaluated with LTSpice.

SYSTEM SPECIFICATION

|  |  |  |
| --- | --- | --- |
| Vin-max | Maximum Input Voltage | 40 V |
| Vin-min | Minimum Input Voltage | 20 V |
| Iout | Output Current | 5 A |
| Vout | Output Voltage | 12 V |
| Pout | Continuous Output Power | 60 W |
| Vout-pp | Output Voltage Ripple | 3% |
|  | Line Regulation | 3% |
| л | Desired Efficiency | 80% |
| Dmax | Maximum Duty Cycle | 0.5 |

Component selection, transformer and inductor design will be done with these specifications.

Operating Modes Of The Converter

Operation of the converter has same idea with one-switch forward converter. However, to use third winding, two switches and 2 diodes are used. Third winding normally used for the dissipate the energy which is stored in magnetizing inductance in the transformer. With using this topology, this energy dissipates on the diode way when MOSFET’s are opened. It has 2 operating modes.

Switches are ON

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Figure 2. ON Period of the Topology

When the switches are on state, current flows through the primary side winding and current enter the primary winding from dot on primary side. This situation produces magnetic flux in the core. Then, this magnetic flux occurs at secondary side with the same way. Current is flow from secondary winding to the load. Df will be on and Dfw will be off states. Then inductor on the secondary side will be charged. Moreover, magnetizing inductance at the primary side will be charged at this period. Diodes at the primary side will be off at this period. Load is fed by current on secondary winding.

Switches are OFF

diyagram, plan, çizgi, teknik çizim içeren bir resim

Açıklama otomatik olarak oluşturuldu

Figure 3. OFF Period of the Topology

When the switches are off state, current flows through the magnetizing inductor to input supply and current enter the primary winding from dot on primary side. With this operation, magnetic flux in the core will be disappeared. Current flows on the diodes at the primary side. When the load side is examined, load is fed by the inductor at the secondary side. Current flows on the Dfw and Df will be reverse biased.

At these operation modes, critical design parameter is maximum duty cycle. According to observation of the operating modes, required maximum duty cycle will be 0.5. Because charging period of the magnetizing inductance should be less or equal to discharging period. This is the requirement for his topology because if this situation is not provided, stored energy in the magnetizing inductance will go to very high values and it causes to saturation on the core. This situation affects the inductance value of the core and efficiency of the system. So, with these information, simulations are done.