

ELE613 – SWITCH MODE POWER SUPPLIES HOMEWORK 2

The topology to be analyzed and simulated in this homework is a flyback converter with the following specifications:

- $V_d = 310 \text{ Vdc}$
- $L_m = 40 \mu\text{H}, \frac{N_1}{N_2} = 12$
- $C = 200 \mu\text{F}$
- $R_{load} = 2 \Omega$
- $f_s = 100 \text{ kHz}$
- $D = 0.4$

For simulations, Simulink environment is preferred and the simulation model is shown in Figure 1, below. It is observed that the circuit operates in discontinuous mode when load resistance is 2Ω . As increasing load resistance in Q5 would also not change this and we would not be able to see the differences between two operation modes, load resistance it is chosen as 0.1Ω for Q1-4 and 2Ω for Q5.

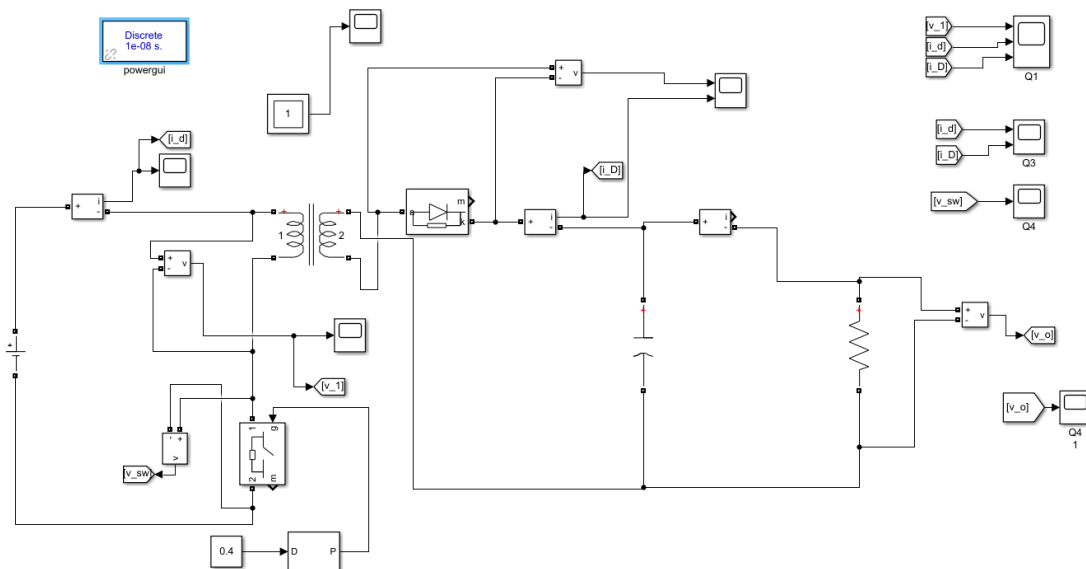


Figure 1: Simulation Model of the Flyback Converter

Q1) Primary voltage and current waveforms and diode current waveform are provided in Figure 2.

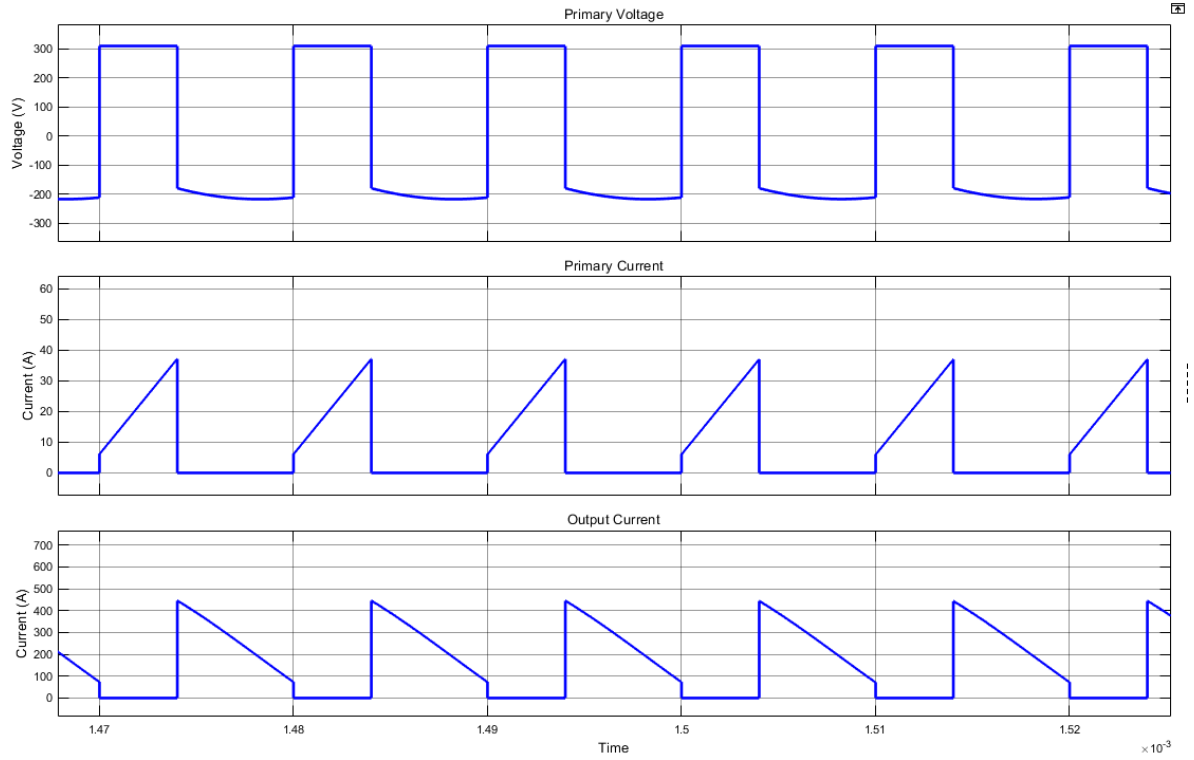


Figure 2: Primary Voltage, Primary Current and Output Current

Q2) Primary voltage, switch current and diode current waveforms during a switch transition are provided in Figure 3.

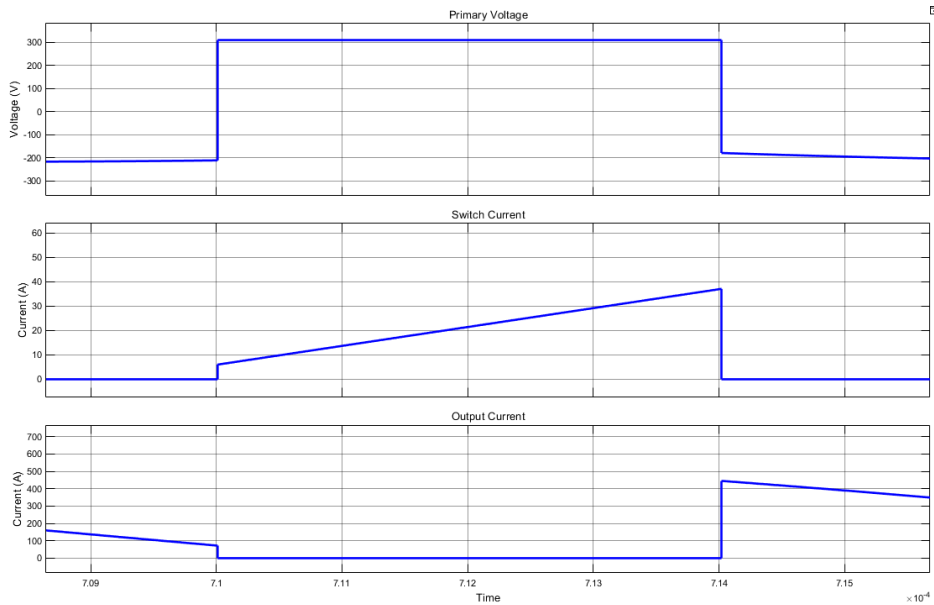


Figure 3: Primary Voltage, Switch Current and Output Current in a Switch Transition

Q3) Average values of primary side current, output voltage and output current are shown in Figure 4, below.

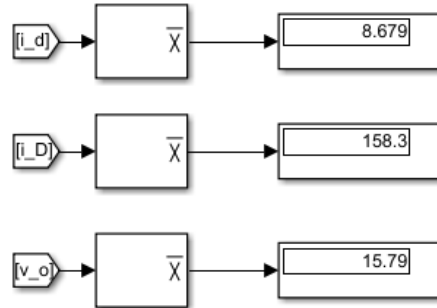


Figure 4: Average Primary Current, Output Current and Output Voltage Values.

Verification: $V_d = 310 \text{ V}$

$$\frac{V_d I_d}{V_o I_o} = \frac{8.68 * 310}{15.8 * 158} = 1.07$$

Q4) Switch voltage waveform is shown in Figure 5, below. It can be easily seen that its peak value is $v_{sw} = \frac{V_d}{1-D} = \frac{310}{0.6} = 517 \text{ V}$.

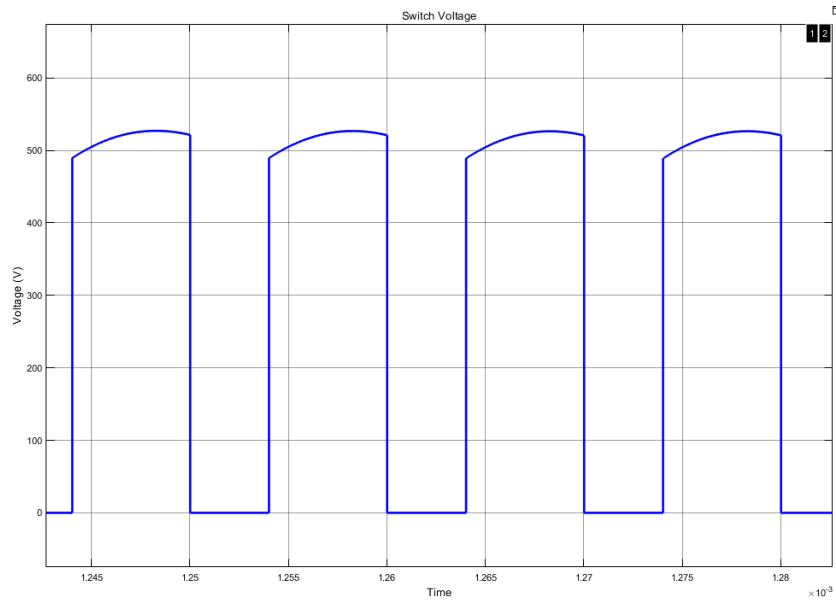


Figure 5: Switch Voltage

Q4) Discontinuous mode operation of the converter can be observed in this part where load resistance is 2Ω . Primary voltage and current waveforms and diode current waveform are provided in Figure 6 and switch transition waveforms are shown in Figure 7.

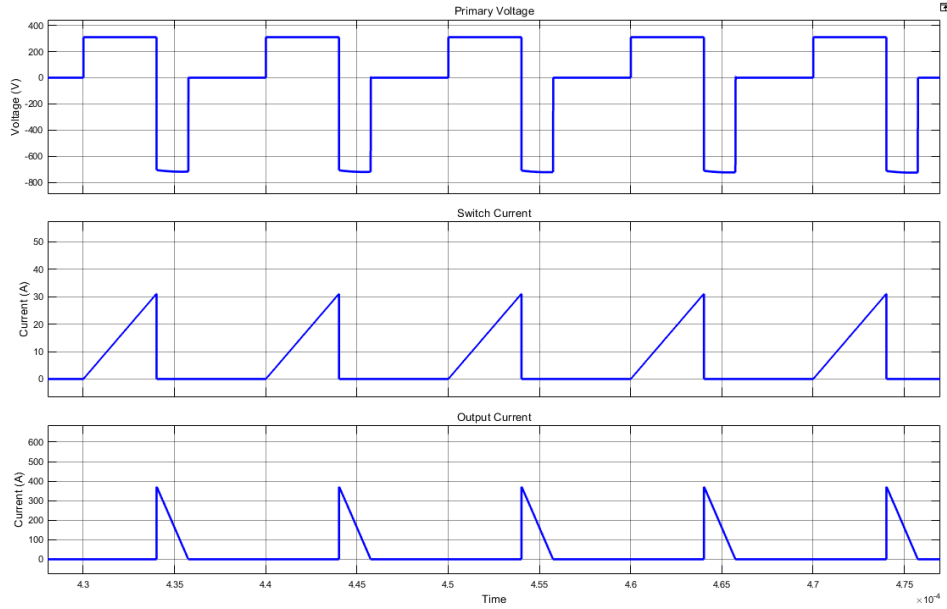


Figure 6: Primary Voltage, Primary Current and Output Current in DCM

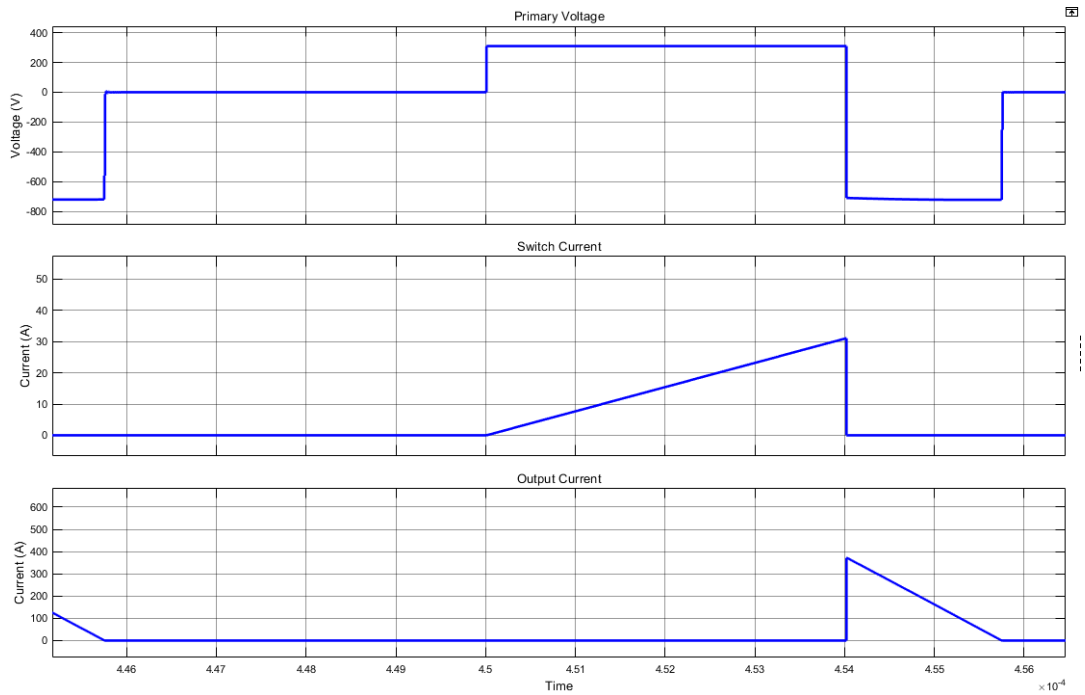


Figure 7: Primary Voltage, Switch Current and Output Current in a Switch Transition in DCM