Buck Converter

Project File

*b*uck.sqproj

Introduction

The step-down dc-dc converter is known as buck converter. Its main applications are in regulated dc power supplies and the dc motor speed control. The average output is always lesser than the dc input voltage. The output voltage is controlled by controlling the switch-duty cycle. When the switch is on, the diode is reverse biased, the inductor and the output get the energy from the supply, the inductor also stores the energy during this moode. During "switch off" state, the diode becomes forward biased and the output stage receives the energy from the inductor and the input remains isolated. Thus the net energy transfered to the output from input is always lesser in a given switching cycle. The ratio of output voltage to input voltage is given by

$$\frac{V_o}{V_{in}} = D = \frac{I_{in}}{1_o} \tag{1}$$

Where, V_o and V_{in} are the output and input voltages, respectively. The term I_o and I_{in} are the output and input currents, respectively. The term D is the duty ratio and defined as the ratio of the on time of the switch to the total switching period.

Simulation Example

The simulation example consists of a simple buck converter as shown in Figure 1. In the present example, the input voltage is kept at 50V. The Load resistance is kept at 50Ω. The output filter capacitor is chosen as 100μF. The switch is controlled by a signal "gce clock". The output can be controlled by changing the *d*uty cycle parameter for the clock. The switch and diode are ideal switch and diode, respectively.

Sample Plots

The sample simulation plots are shown in Fig. 2. Here, the first upper plot shows the gate driver pulse. The second plot shows input and output voiltages. At 60% duty-cyxle the
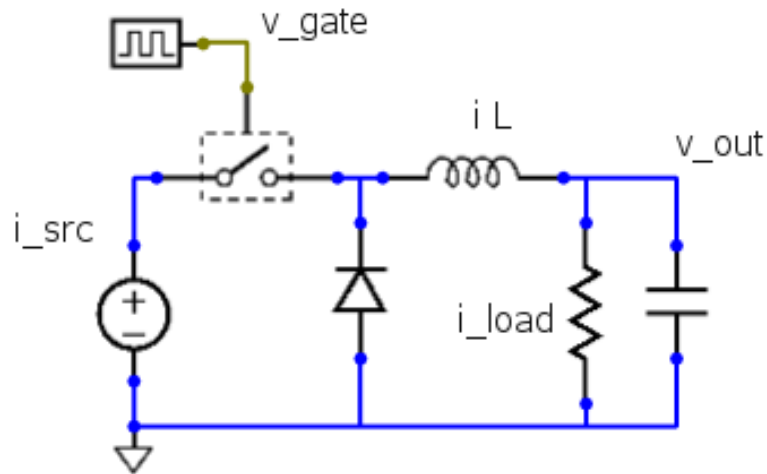
Figure 1: The Schematic circuit for the buck converter

output voltage is 30V with 50V input. The third plot shows the diode current the source current and the load current.

Few sample exercises are given here to get the complete understanding of the topic.

Exercises

1. Change the duty cycle, re-run the simulation and verify the output voltage

2. Create a condition of discontinuose current conduction and observe its effect on output voltage. Study which parameters influnce this condition and find the boundary conditions and verfy it by simulation with appropriate parameter values.

3. See the effect of change in the frequency

4. See the effect of change in inductor on the boundary conditions for discontinuose current conduction.

5. See the effect of change in output filter capacitance value.

References

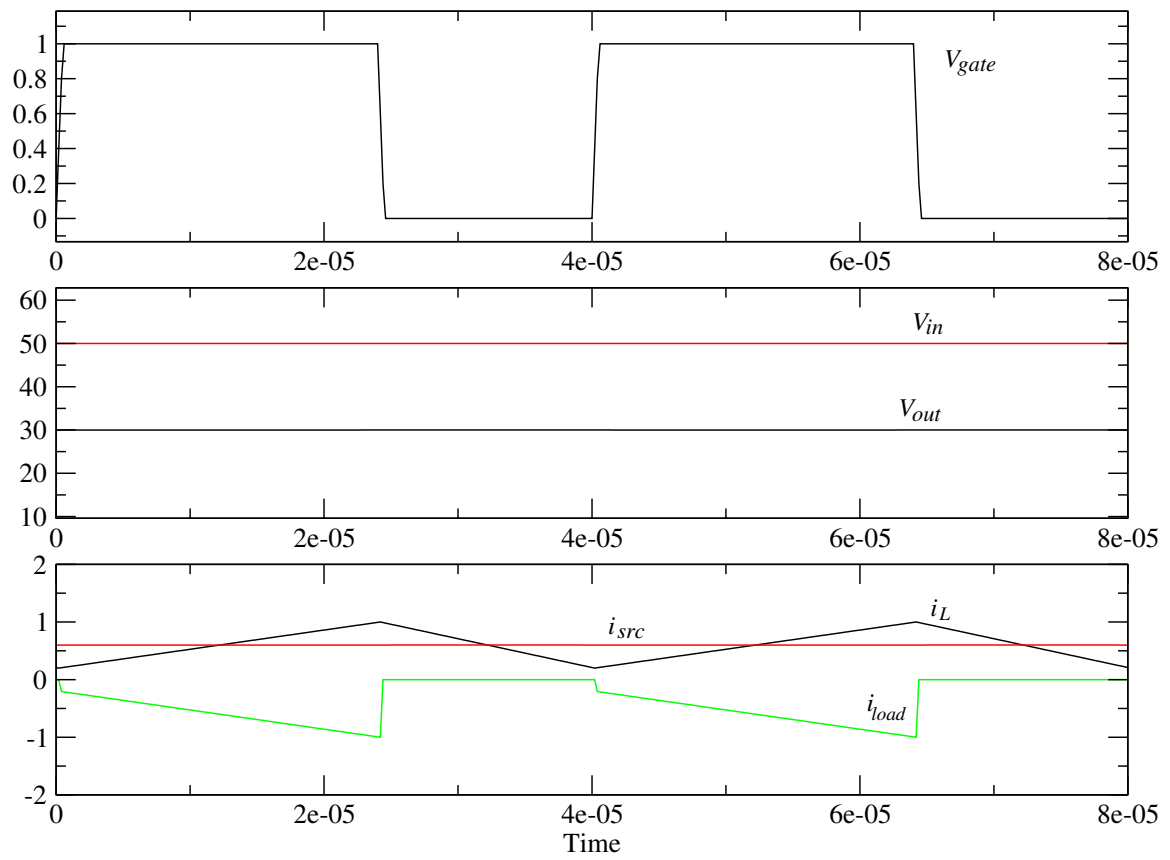[1] Ned Mohan, T.M.Undeland and W.P. Robbins, *Power Electronics: Converter, Applications and Devices*, Second Edition, John Wiley and Sons, 1995

Figure 2: Simulation Plots for boost converter