EE682
Fuel Cell Energy Processing Systems
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Class Notes: Overvoltage Snubber Design

Fuel Cells

DC/DC Converters

Inverters

Mechatronics Laboratory

Department of Electrical Engineering

The Ohio State University

CHAPTER 8 Overvoltage Snubber Design Using Simulink

8.1 Introduction

Simple snubber circuit is necessary for your power switches and free wheeling diodes to protect them from overvoltage during switching operations. Figure 8-1 shows turn-on and turn-off transients of a power diode. Overvoltage can be observed at turn-on time. Figure 8-2 shows turn-on and turn-off transients of a power transistor. Overvoltage can be observed at turn-off time. If an R-C branch is used across the diode or transistor, the voltage can be clamped by the capacitor and overvoltage can be avoided.

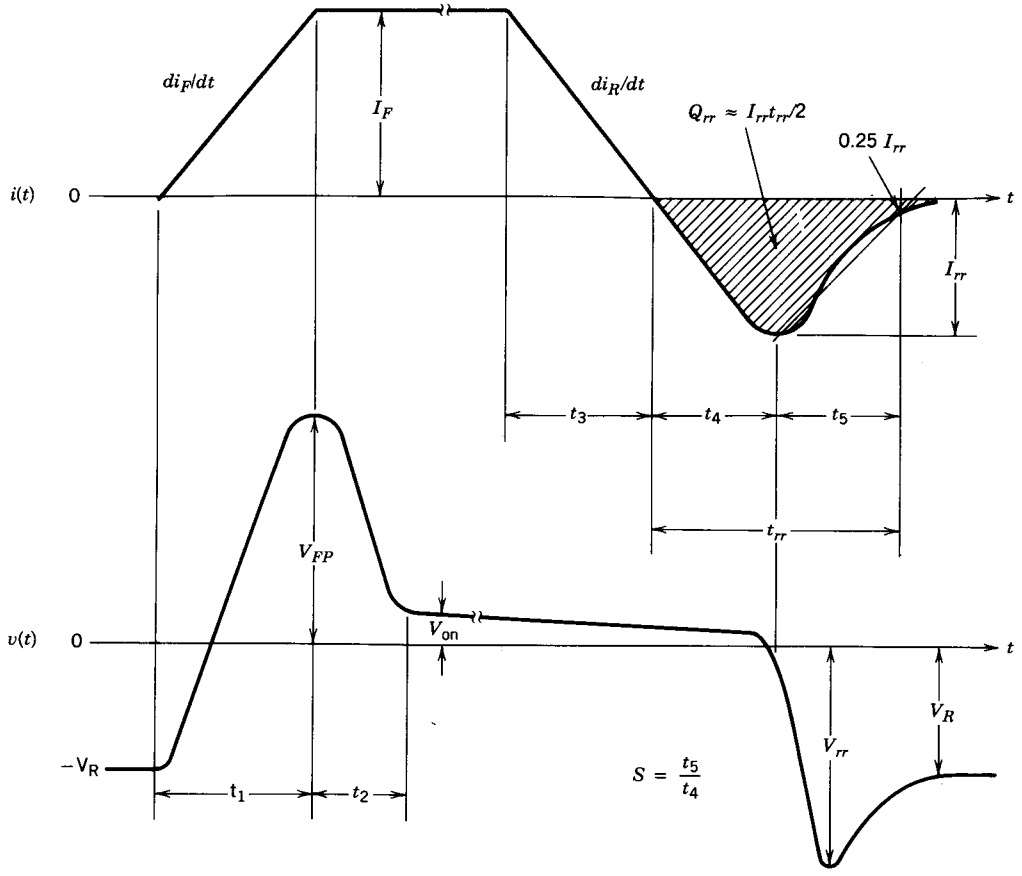

Figure 8-1 Voltage and current waveforms for a power diode driven by currents with a specified rate of rise during turn-on ad a specified rate of fall during turn-off

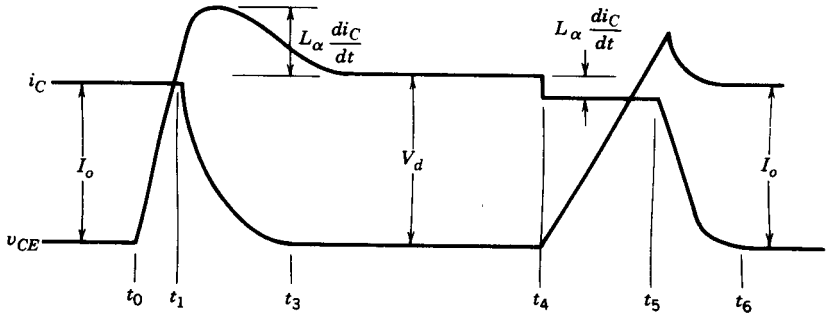

Figure 8-2 Voltage and current waveforms of a power transistor during turn-off and turn-on

R-C overvoltage snubber circuits for a diode and a MOSFET are shown as follows.

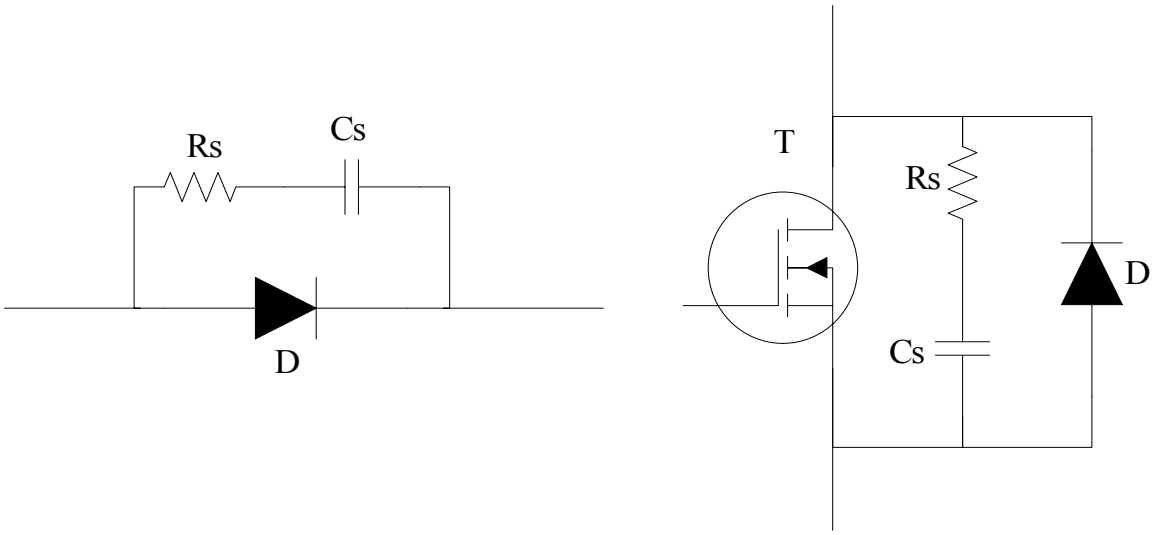

Figure 8-3 R-C snubber circuits for a diode and a MOSFET

8.2 Design Using Simulink

An R-C series branch can be used as an overvoltage snubber if it is connected across drain and source (for MOSFET) or anode and cathode (for diode). The R-C snubber circuit can be designed using Simulink simulation:

Observe the voltage and current of the device you would like to protect when you do the simulation. The R-C snubber parameters are already embedded in the device property in Simulink SimPowerSystem Blockset and can be set by user through the clickable dialogue box associated with the device. If the R-C values are not correct,

overvoltage across the device can be observed. Here, overvoltage means high transient voltage (much greater than the steady state value). Before you adjust the R-C values in the dialogue box, make sure the other parameters used match the parts you will use in your design. The default R-C values given by Simulink are R=100 ohm and C=0.01 uF. R=100 is usually too large. You can reduce it to R=1 ohm temperarily and adjust C first. In some case C=0.01 uF is good, but sometimes it is too small. You can try C values in a wide range from 0.001 uF to 10 uF and find a smallest possible value which does not cause overvoltage. Once you have found a good C value, it is time to readjust R. Sometimes R=1 ohm is good but sometimes R=1 ohm is too small and will cause too much current through the device. If so, increase R value till the current decrease to the rated range of the device.

Simulations with poor and good snubbers are shown in Figure 8-4 and Figure 8-5:

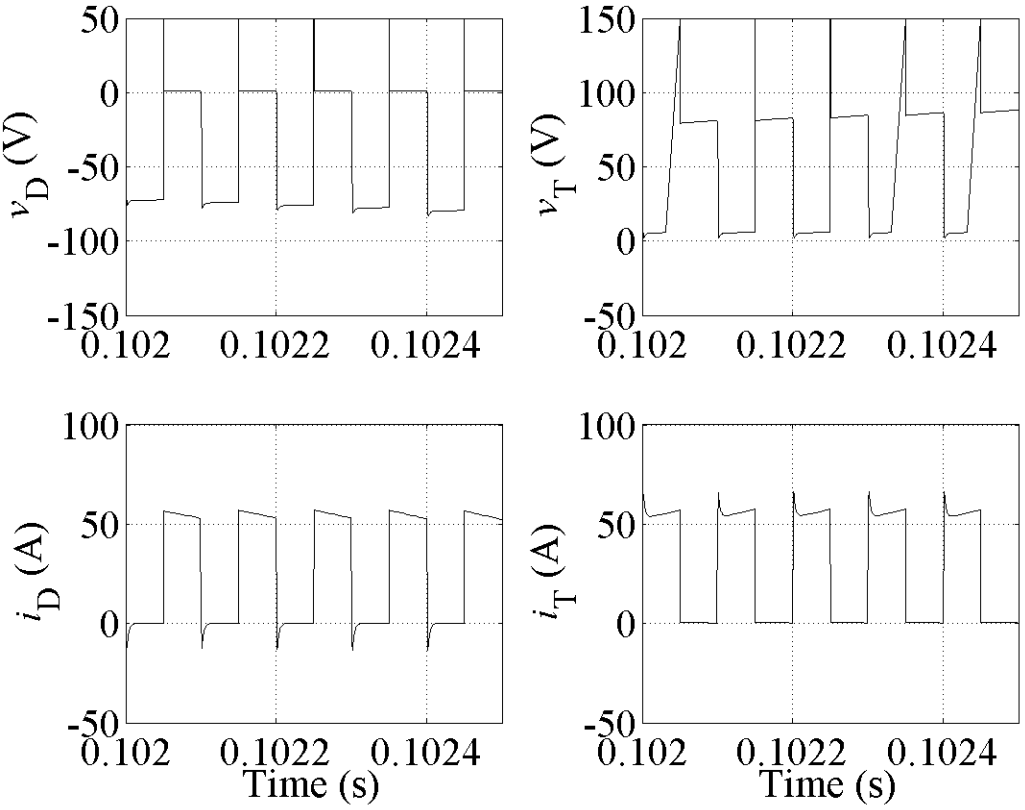

Figure 8-4 DC/DC boost converter diode and MOSFET voltage and current waveforms with poor snubber parameters

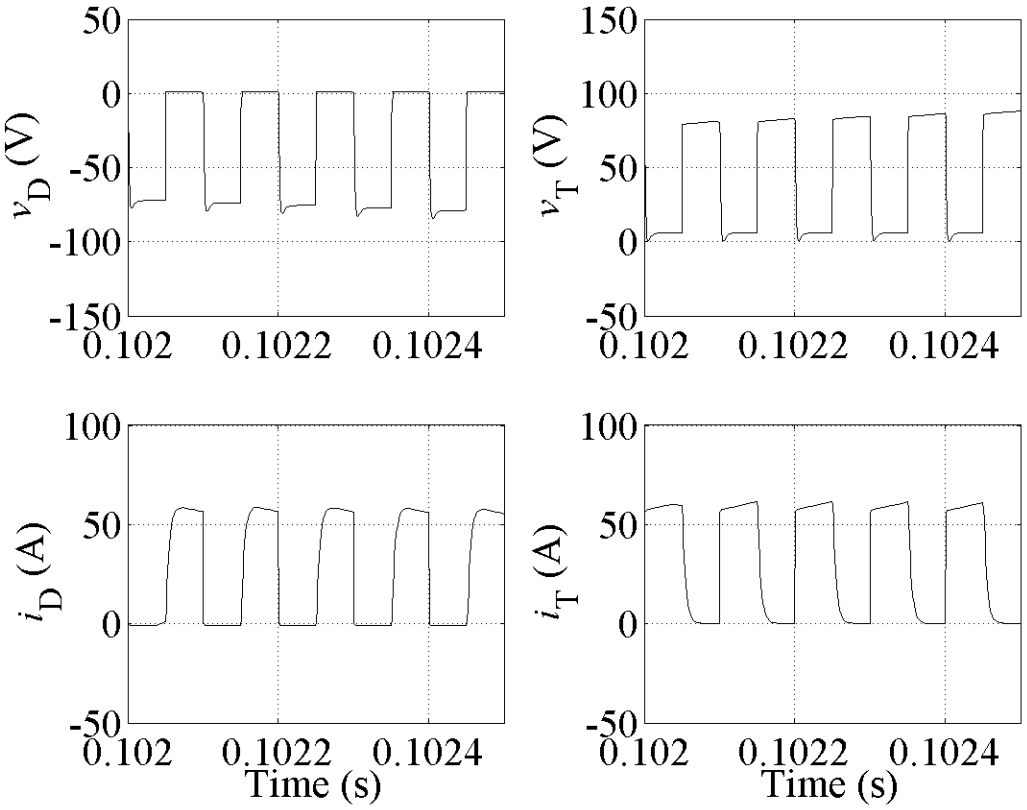

Figure 8-5 DC/DC boost converter diode and MOSFET voltage and current waveforms with good snubber parameters

8.3 Implementation Issue

Please follow the above methodology when you use Simulink to design your snubber circuits for all your MOSFETs and free wheeling diodes. You should include Simulink plots in your progress report to show the effectiveness of your snubber circuits. You need to buy these R_s and C_s if you have not done so. Making your order together with other groups may save you some money. Or you may be able to find them from a Radioshack store.

8.4 Bibliography

1. N. Mohan, W. P. Robbin, and T. Undeland, Power Electronics: Converters, Applications, and Design, 2nd Edition.