ECE4055 Electrical Energy – Power Electronic Applications
Semester 2 – 2014

Simulation Laboratory Assignment Part 2 – Investigation of the Full-Bridge Power Switching Converter

Introduction

In this experiment, the behaviour of the full-bridge power switching converter will be studied, using the Simplorer simulation software. The performance will be investigated for the full range of allowable duty ratio, and the detailed behaviour of the output rectifier stage will be investigated using different rectifier configurations.

Getting Started

(i) In this session, you will build a working simulation model for the full-bridge switching converter that we have studied in lectures. As a starting point, use the full-bridge converter topology as given in your *SMPS Topologies* document.

(ii) The Simplorer V15.0 Getting Started Guide (*SimplorerGSG.pdf*) will be a valuable tool in getting going with this task.

(iii) Start the Simplorer V15.0 software.

(iv) There are various ways for getting started in constructing your circuit model. You could for example:

- Select the "Open an Existing Simulation Model" option, and open one of the existing "example" models (for example, the buck converter), and then use this as a starting template for building your own model for this task. However, while this may seem to be a quick way to get up and running, you may also end up with unintended glitches when you start adapting to your full-bridge modelling task.
- You could also start from scratch using, as a guide, the procedures for constructing a simulation as outlined in the *Simplorer V15.0 Getting Started Guide,* starting on page 15 of the guide (Chapter 2: Creating a New Project). This is the preferred approach.

(v) Start building your model, using components from the Simplorer library.

(vi) It is suggested that for the transformer, you should use the "Ideal Two-winding Transformer". This will help you to get your simulation up and running initially.

(vii) For your first simulation, start with the four-diode output rectifier configuration.

(viii) For the other component values, the following values will be useful as a starting point:

L = 50uH
C = 22uF
f_s = 50 kHz
R_{LOAD} = 2 Ohm
D = 0.2
DC supply = 24 Volt DC

Start with a total simulation interval of 0.4 msec, minimum step time 0.1 usec, and maximum step time 0.5 usec.

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(ix) Control can be achieved using the "PWM" control block. One way of doing this is to use two PWM blocks set to the same duty ratio, but with 180º phase shift applied to the second PWM block.

(x) It is suggested that you build up your circuit incrementally, and carry out testing as you add each section. This will make it easier to find problems as you go along, rather than trying to find faults in a complete model all at once.

(xi) Don't forget to place a ground connection in each section of the circuit, otherwise the simulation will come up with errors.

(xii) Using the Simplorer simulation software allows for the display of many circuit waveform quantities simultaneously. In order to make the display clear and non-confusing, apply offsets to the various waveforms in the output display, so as to avoid having the waveforms directly on top of each other (if you don't do this, it can be very difficult to properly distinguish the various waveforms from each other). Make sure you capture waveforms showing the behaviour of different circuit variations and parameter variations for collation at the conclusion of your work.

(xiii) Explore the behaviour of your full-bridge converter through the allowable range of duty ratio (what is this allowable range)? In particular, study the current waveforms in each of the circuit elements and confirm that your observations are consistent in different parts of the circuit.

(xiv) Change the output rectifier configuration to the *two-diode* rectifier arrangement. What are the advantages in doing this? How does the behaviour of the converter change when adopting this configuration?

Completion and Report

- The report for this work is to be a compilation of your simulation *models* and *waveform results* for this session (Week 4) as well as the results from the first simulation laboratory session (Week 3). It should also include your answers to questions asked in the laboratory sheets.
- Only one report is required per group of two students.
- The due date for submission is *at the beginning* of your scheduled laboratory class time in Week 5. Please submit as a hard-copy report, (to be handed in to your demonstrator at the laboratory).