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Self Tuning Buck Converter

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Abstract

Switch-mode power supplies are commonly used in a wide variety of consumer and professional appliances to transform DC voltages with high efficiency. One such switch-mode supply is the buck converter, which steps down a DC voltage. The design of a buck converter is based around its tolerated inductor ripple, and will require specific components to design the output filter. These components can be difficult to purchase or accurately manufacture. This project will implement a control system to actively control with inductor ripple by modulating the switching frequency. This will allow engineers to design the converter directly for the inductor ripple, eliminating the need to design the output filter.

Contents

Chapter 1

Introduction

This chapter gives an introduction to the project report.
In Chapter 3 we explain how to use this document, and the `vuwproject` style. In Chapter 2 we say some things about LaTeX, and in Chapter 4 we identify key future work.

Chapter 2

Background

Talk about the lack of published research on this topic, mention the search terms and the search engines used for the search. Then outline what this background section will cover.

2.1 Buck Converters

- Talk about the use and purpose of buck converters, as well as their basic design factors.
- Talk about the different buck converter topologies, and why it is that we have chosen to implement this design on a non-synchronous converter.
- Talk about the buck converter design equations, and specify which equations are relevant to my design.

2.2 PWM Generation

- Discuss what PWM is, and how it is used in the context of a buck converter.
- Discuss the different methods of PWM generation.
  - Analogue
  - Digital (Microcontroller & FPGA)
- Discuss how PWM is used in the context of the project. Quickly overview how in this project it will be important to modulate both the PWM frequency, and the PWM duty cycle.

2.3 Control Systems

Possibly not needed in this report as I have not designed any control systems yet for this project?

- Discuss in very general terms what a control system is what what it seeks to do in a system.
- Discuss what the control system will be doing in the case of this project. Talk about how a controller will be used to control both the output voltage of the converter, and the inductor ripple of the converter.

Chapter 3

Work Completed

3.1 System Architecture & Design

- Give an overview of the entire system architecture. This means a high level block diagram of what different inputs and outputs are, and what the different signals in the system are. This can be done with the help of a diagram that I will create.

3.2 Defining & Justifying System Specifications

- Discuss the requirements that were laid out in the project proposal for the evaluation of the system.
- Discuss how these system requirements needed to be translated into a set of quantitative system requirements that can be used to define and design the system.
- Discuss the system requirements that are required to effectively design the system (PWM frequency & duty cycle step size), and then outline how they were calculated.
- Discuss how these requirements will affect the design of the system

3.3 PWM Generation Design

- Discuss the different PWM generation methods outlined in chapter 2. Talk about each of their specific design implication, their advantages, and their disadvantages. This will be included in three different sections, analogue, microcontroller, FPGA.
- Discuss why I have selected a microcontroller for the PWM generation. And discuss how the design of this implementation affected the microcontroller selection.
- Discuss how the final design of the PWM generation was implemented, and what it's capabilities are. Show some images of it functioning, and attach the esp32 code in the appendix.

Chapter 4

Future Plan

4.1 Work to be Completed

- Discuss what work I still have to do before beginning the evaluation of the system.
  - Select sensors to measure peak-to-peak ripple current
  - finalise the circuit design for the project, this includes selection all other components needed for it's operation.
  - Create a final PCB for the design
  - Design the controller that will control both output voltage and inductor ripple

4.2 System Evaluation

- Discuss how the system will be evaluated, reference the project proposal as this will not have changed significantly.

4.3 Project Timeline

- Create another Gant chart that now more accurately breaks down the required tasks into the remaining time. Discuss this chart and why it is set out the way that it is.

Feedback

This could highlight any difficulties currently faced, and make specific requests for guidance from the examination committee. For example, a student may be unsure how best to evaluate their artefact, and would appreciate suggestions for alternative methods.

Bibliography