HIGHER TECHNICAL INSTITUTE

ELECTRICAL ENGINEERING DEPARTMENT

DIPLOMA PROJECT

AC TO DC CONVERTERS: EXPERIMENTS AND ANALYSIS

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Introduction

Power electronics deals with the control and conversion of electrical power, by power semiconductor devices such as diodes, thyristors, triacs, power mosfets, power junction transistors etc. In this project we deal with the application of diodes and thyristors in power electronics circuits using a technique called the "Switching Function Technique".

The diode is the simplest electronic device with two terminals, the anode and the cathode. The main operation characteristic of the diode is that it conducts current in one direction (forward biased) and it does not in the other (reverse biased). A forward biased diode has the positive terminal of the supply at its anode and a reverse biased diode has the negative terminal of the supply at its anode.

The thyristor is a three terminal device with three terminals, the anode, the cathode and the gate. In the thyristor, conduction can be controlled and this takes place in the forward biased condition. The important difference of the thyristor when compared to a diode is that the conduction will not take place unless the third terminal, the gate, is fired. Fired means that a sufficient current is supplied to the gate for a minimum period of time. A train of pulses is used in order to ensure conduction.

There are many methods used to analyse a circuit in order to derive the equations describing the behaviour of that particular circuit. The conventional method, and also the most known one up to today, is the use of Laplace Transforms and differential equations. But in this project a rather new approach is followed, which is called the "Switching Function Technique". This technique provides an effective and easy way for analysing the equations describing the behaviour of a particular application by using simple mathematical formulas from Fourrier Series and simple trigonometry. It also provides an alternative to the already known methods of analysis. This makes the "Switching Function Technique" an exciting new upgrade to be used by every engineer.

The main task of power electronics is to control and convert electrical power from one form to another. The four main forms of conversion are:

- AC-to-DC conversion (also called rectification),
- DC-to-AC conversion,

- DC-to DC conversion and
- AC-to-AC conversion.

This project deals with the AC to DC conversion, both in single and in three phase applications.

Rectifiers can be classified as uncontrolled and phase controlled rectifiers. Uncontrolled rectifier circuits are built with diodes, and phase controlled rectifier circuits are built with thyristors.

There are several important points to notice in power electronics, the most important one among them being the extensive use of inductors and capacitors. Most of the power electronics applications deal with inductive loads. Capacitors are also used for filtering the output. An important point to notice is the use of a diode connected in parallel with the load, known as a "freewheeling diode", in the case of inductive loads, which protects the circuit from the trapped energy released by the presence of inductors in the circuit.

The study of power electronics provides an exciting and challenging experience. Furthermore, power electronics applications can be divided into the following categories:

- Residential, Refrigeration and Freezers, Air Conditioning, Cooking, Washing Machines, etc.
- Commercial
- Industrial
- Transportation
- Utility systems
- Aerospace
- Telecommunications

This project is divided into four chapters. All the background information and relevant data can be found in the Appendices at the back of this book and on the cd-rom labeled Appendices VI, VII, VIII, IX, X.

Every chapter begins with an introduction of what is presented in it. Then, every case is analyzed individually by starting with the operation of the circuit, followed by the circuit diagram and its modes, the waveforms, the analysis and some overall comments and conclusions.

Chapter 1 presents the single phase half wave and full wave rectifiers with both diodes and thyristors.

Chapter 2 presents the three phase half wave and full wave rectifiers with both diodes and thyristors.

Chapter 3 presents the experimental results and waveforms taken at the Higher Technical Institute and it also includes a comparison with the theoretical results and waveforms taken from Mathcad.

Finally, the conclusions for this project are given at the end of this book, followed by the Appendices, which provide some background information and theory.

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