

UNIVERSITI TEKNOLOGI MARA

**DEVELOPMENT OF A HALF-BRIDGE
LLC DC-DC LOADED RESONANT
CONVERTER FOR LOW POWER
APPLICATION**

MAZLIZA BINTI ABDUL HALIM

Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science
(Electrical Power)

Faculty of Electrical Engineering

June 2018

CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 12 December 2017 to conduct the final examination of Mazliza Abdul Halim in her **Master of Science** thesis entitled “Development of A Half-Bridge LLC DC-DC Loaded Resonant Converter For Low Power Application” in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiner recommends that the student be awarded the relevant degree. The Panel of Examiners was as follows:

Aman Ihsan Mamat, PhD
Associate Professor
Institute of Graduate Studies (IGS)
Universiti Teknologi MARA
(Chairman)

Ahmad Maliki Omar, PhD
Associate Professor
Faculty of Electrical Engineering
Universiti Teknologi MARA
(Internal Examiner)

Nor Zaihar Yahaya, PhD
Faculty of Electrical Engineering
Universiti Teknologi Petronas
(External Examiner)

**PROF SR DR HAJI ABDUL HADI
HAJI NAWAWI**
Dean
Institute of Graduates Studies
Universiti Teknologi MARA
Date: 28 June 2018

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student : Mazlia Binti Abdul Halim
Student I.D. No. : 2010138427
Programme : Master of Science (Electrical Power)- EE780
Faculty : Electrical Engineering
Thesis Title : Development of A Half-Bridge LLC DC-DC Loaded
Resonant Converter For Low Power Application

Signature of Student : 

Date : June 2018

ABSTRACT

An LLC DC-DC loaded resonant converter is gaining more attention in power-supply designs due to its potential to achieve high efficiency and power density. Due to complex resonant circuit behaviour, the design method of LLC converter becomes complicated and difficult. In the past, there are many studies have presented the design methods of LLC converter to facilitate the design work. However, those studies only applied LLC converter for medium power application and never been applied for low power application. Besides that, LLC converter has been designed with small magnetising inductance value (μH) which led the converter to high conduction loss. Therefore, this study presents details LLC converter design method with large magnetising inductance (mH) which applies for low power application. The FHA method is used to analyse and design the converter while MATLAB/Simulink software is utilised to verify the converter design. The prototype circuit of half bridge LLC DC-DC loaded resonant converter with 30mW/3V output is then fabricated and tested. The results at switching, resonant tank, rectifier and load stages successfully verified with theoretical, simulation and experimental works and converter also successfully achieved lowest switching loss.

TABLE OF CONTENTS

| | Page |
|--|-------------|
| CONFIRMATION BY PANEL OF EXAMINERS | ii |
| AUTHOR'S DECLARATION | iii |
| ABSTRACT | iv |
| ACKNOWLEDGEMENT | v |
| TABLE OF CONTENTS | vi |
| LIST OF TABLES | viii |
| LIST OF FIGURES | ix |
| LIST OF SYMBOLS | xi |
| LIST OF ABBREVIATION | xii |
| | |
| CHAPTER ONE: INTRODUCTION | 1 |
| 1.1 Background of Study | 1 |
| 1.2 Problem Statement | 2 |
| 1.3 Objectives of Study | 3 |
| 1.4 Scopes and Limitations of Study | 3 |
| 1.5 Significance of Study | 4 |
| | |
| CHAPTER TWO: LITERATURE REVIEW | 5 |
| 2.1 Introduction | 5 |
| 2.2 Quality Factor | 6 |
| 2.3 DC-DC Loaded Resonant Converter | 8 |
| 2.3.1 Series Resonant Converter (SRC) | 9 |
| 2.3.2 Parallel Resonant Converter (PRC) | 11 |
| 2.3.3 Series Parallel Resonant Converter (LCC) | 14 |
| 2.3.4 Series-Parallel Resonant Converter (LLC) | 17 |
| 2.4 Circuit Operation of LLC Converter. | 20 |
| 2.5 Modeling Circuit of LLC Converter | 25 |