

**HARMONIC STUDY OF CYCLCONVERTER: SINGLE PHASE AND THREE
PHASE COMPARISON**

**Thesis presented in partial fulfilment for the award of the
Bachelor of Engineering (Hons) Electrical
UNIVERSITI TEKNOLOGI MARA**



JACK ANAK DAKIT

**Faculty of Electrical Engineering
UNIVERSITI TEKNOLOGI MARA
40450 SHAH ALAM, MALAYSIA
JULY 2013**

ACKNOWLEDGEMENT

Firstly, I would like to say thanks to my supervisor, Ir. Amir Mohd. Saad for giving me advice and guide during this project. I really appreciate his helps and I believe I have improved a lot as a person through his guidance and advices.

Besides, I like to say thanks to my parents for their unwavering confidence that I can achieve whatever I set my mind to. Without their support, I will be nothing. For all my friends, I would like to say thank you for their support. Lastly, to all the people that help me directly or indirectly, thank you very much.

ABSTRACT

Harmonics is a sinusoidal components of a periodic wave or quantity having a frequency that is an integer multiple of the fundamental frequency. Harmonics are caused by non-linear loads, which are loads that draw a non-sinusoidal current from a sinusoidal voltage source. Some examples of harmonic producing loads are electric arc furnaces, static VAR compensators, inverters, DC converters, switch-mode power supplies, and AC or DC motor drives. High levels of harmonic distortion can cause such effects as increased electrical equipment heat such as transformer, and thus shorter the device's life span. It is important to study on the harmonic that occurs caused by the non-linear loads such as cycloconverters. Cycloconverters are commonly used as AC to AC converter, which is more on converts an AC waveform, such as the mains supply, to another AC waveform of a different frequency. Due to fast switching during the operation, the cycloconverters can produce harmonics. This thesis shows the simulation of cycloconverters in different pulse. There are four cycloconverter used which are two single phase cycloconverter (2pulse), three phase cycloconverter (3pulse), and lastly three phase cycloconverter (6pulse). The method of controlling the gate pulse generator is phase control or delay angle control method. This multi-pulse cycloconverters is design and simulated using engineering software, Matlab and Simulink and one single phase cycloconverter is constructed at lab. The advantage of study different pulse of cycloconverter is to find a good and reliable cycloconverter with fewer harmonics.

Table of Contents

Chapter	Contents	Page
	Acknowledgement	iii
	Abstract	iv
	List of Figure	vii
	List of Table	ix
1.	Introduction	1
	1.1 Background of Study	1
	1.2 Problem Statement	2
	1.3 Objective	3
	1.4 Scope of Work	3
	1.5 Significance of Research	4
	1.5 Thesis Organization	5
2.	Literature Review	6
	2.1 Introduction	6
	2.2 Harmonic Background	6
	2.2.1 Definition of Harmonic	6
	2.2.2 Cause of Harmonic	7
	2.2.3 Effects of Harmonic	8
	2.3 Cycloconverter	9
	2.3.1 Definition of Cycloconverter	9
	2.3.2 Applications of Cycloconverter	9
	2.3.3 Operation of Cycloconverter	10
	2.3.3.1 Single Phase Cycloconverter	10
	2.3.3.2 Three Phase Cycloconverter	12
	2.4 Thyristor Background	16
	2.4.1 Definition of Thyristor	16
	2.4.2 Operation of Thyristor	16
	2.4.3 Turn-On by Gate Triggering Method	18
	2.4.4 Type of Thyristor	18
	2.5 Cosine Wave-Crossing Technique	20
3.	Methodology	21
	3.1 Introduction	21
	3.2 Cycloconverter Part	21

3.2.1	Single Phase Cycloconverter	22
3.2.2	Three Phase Cycloconverter	24
3.3	Switch Contol Operation Part	29
3.4	Total Harmonic Distortion (THD) Part	30
3.4.1	Definition of Total Harmonic Distortion (THD)	30
3.4.2	Equation of Total Harmonic Distortion (THD)	30
3.4.3	Detection of Total Harmonic Distortion (THD)	31
3.4.4	Important of Total Harmonic Distortion (THD)	31
4.	Results and Discussions	32
4.1	Introduction	32
4.2	Data And Readings	33
4.2.1	Waveform for Single Phase Cycloconverter (2 Pulse) Simulation	33
4.2.2	Waveform for Single Phase Cycloconverter (2 Pulse) Experiment	34
4.2.3	Waveform for Three Phase Cycloconverter (3 Pulse) Simulation	36
4.2.4	Waveform for Three Phase Cycloconverter (6 Pulse) Simulation	37
4.2.5	Harmonics Spectrum for Single Phase Cycloconverter (2 Pulse) Simulation	39
4.2.6	Harmonics Spectrum for Single Phase Cycloconverter (2 Pulse) Experiment	41
4.2.7	Harmonics Spectrum for Three Phase Cycloconverter (3 Pulse) Simulation	43
4.2.8	Harmonics Spectrum for Three Phase Cycloconverter (6 Pulse) Simulation	45
4.3	Analysis of the Results	47
5.	Conclusions	50
6.	Recommendation for Future Works	53
7.	References	54
8.	Appendices	56