

**TO DESIGN AND DEVELOP ISLANDING DETECTION INTERFACE
SYSTEM FOR PV CONNECTED MICROGRID**

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Bachelor of Electrical Engineering (Industrial Power)

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“I admit that I have read this report with the title “To design & develop islanding detection interface system for PV connected Microgrid” and found that it has meet the partial fulfilment for awarding the degree Bachelor of Electrical Engineering (Industrial Power).

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**TO DESIGN AND DEVELOP ISLANDING DETECTION INTERFACE SYSTEM
FOR PV CONNECTED MICROGRID**

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**A report submitted in partial fulfilment of the requirements for the degree
Of Electrical Engineering
(Industrial Power)
Faculty of Electrical Engineering**

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2013

I declare that this report qualify “To design & develop islanding detection interface system for PV connected Microgrid” is the result of my own case study and research except as cited in the references. This report is not receive by any degree and is not simultaneously submitted by other candidates from other degree.

Signature: _____

Name: Eliakim Bin Che Yaacob

Date: May 27th 2013

To My Mother and My Father

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ABSTRACT

Solar energy has a great possibility to be used as a source of renewable energy to be used as a source of electricity generation and the role of smart grids in the future. Micro grid is power generation, utilization and grid connection while built upon the generation, control and utility connections. This system serves to protect the sensitive and critical loads during abnormal grid conditions. Despite the many advantages that can be obtained using this system, but many lack in the building process of micro grid had been observed including the appropriate ways and aspects must be considered to detect when there is no grid connection. Common way is to take voltage readings at the point of common coupling. This method uses the 9th harmonic injection as a disturbance to make the system disconnected from the grid and using different loads on the inverter after LCL filter as an emergency load. This method should also qualify for the current situation there is no power grid available in the IEEE 929-2000, IEEE 1547. The time required for this situation should also be observed for less than what was required.

ABSTRAK

Tenaga solar mempunyai kemungkinan yang besar untuk dijadikan sebagai salah satu sumber tenaga yang boleh diperbaharui untuk digunakan sebagai sumber penjanaan elektrik dan memainkan peranan sebagai grid pintar pada masa hadapan. Mikrogrid adalah penjanaan tenaga elektrik, penggunaan dan grid sambungan sementara yang dibina berasaskan penjanaan, kawalan dan sambungan utiliti. Sistem ini bertindak untuk melindungi beban yang sensitif dan kritikal semasa keadaan grid yang tidak normal. Walaupun banyak kelebihan yang boleh didapati menggunakan sistem Mikrogrid ini namun banyak kekurangan dalam proses pembinaannya termasuklah cara dan aspek yang sesuai untuk mengesan keadaan semasa tiada sambungan grid. Cara yang biasa digunakan adalah dengan mengambil bacaan voltan di titik isyarat maklum balas. Kaedah ini menggunakan suntikan harmonik ke-9 sebagai gangguan untuk membuat beban menjalani keadaan terputus bekalan grid pada masa yang disuntik harmonik dan menggunakan beban yang berbeza pada penyongsang selepas penapis LCL. Kaedah ini juga perlu memenuhi syarat untuk situasi semasa tiada bekalan grid yang terdapat dalam IEEE 929-2000, IEEE 1547. Masa yang diperlukan untuk situasi ini juga perlu diperhatikan untuk mendapatkan masa kurang daripada yang telah ditetapkan. Pelaksanaan kaedah yang dicadangkan telah disimulasikan dengan menggunakan MATLAB simulink.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	ACKNOWLEDGEMENT	ii
	ABSTRACT	iii
	ABSTRAK	iv
	TABLE OF CONTENT	v
	LIST OF TABLES	ix
	LIST OF FIGURES	x
	LIST OF ABBREVIATIONS	xiii
	LIST OF APPENDICES	xiv
1	INTRODUCTION	1
	1.1 Project Background	1
	1.2 Problem Statement	2
	1.3 Objectives	2
	1.4 Scopes	2
	1.5 Project Methodology	3
	1.6 Thesis Outline	4

CHAPTER	TITLE	PAGE
2	LITERATURE REVIEW	5
2.1	Introduction	5
2.2	Microgrid	5
	2.2.1 The main concerns with islanded system	6
2.3	Islanding condition	7
2.4	Summary of IEEE Std. 929-2000	8
2.5	Simulink	9
2.6	The PV model	10
2.7	Maximum power point tracking	11
2.8	Islanding Detection Method	11
2.9	Harmonic Component Injection	13
2.10	Management of dc link voltage	15
2.11	Boost converter	16
2.12	Inverter	18
2.13	Small systems (10kW)	21
2.14	Phase-Locked Loop (PLL)	21
2.15	Pulse Width Modulation, PWM	22
	2.15.1 Principle PWM	22
2.16	Circuit Breaker	23
2.17	LCL filter	23
3	METHODOLOGY	25
3.1	Introduction	25
	3.1.1 Literature review finding	25
	3.1.2 Find and Design the reference circuit	26
	3.1.3 Make some modification on reference circuit	27
	3.1.4 Analyse result based on parameter used	28
3.2	Flowchart of Methodology	29

CHAPTER	TITLE	PAGE
3.3	Maximum power point tracking	33
3.4	Pulse Width Modulation (PWM) Generator	34
3.5	Phase-Locked Loop (PLL)	35
3.6	LCL filter	36
3.7	Inverter	37
4	RESULT, ANALYSIS AND DISCUSSION	38
4.1	Introduction	38
4.2	Battery system performance	38
4.3	Calculation for N-point Discrete Fourier Transform	40
4.4	Analysis condition with battery supply	41
4.5	Different number of harmonic inject at load 500W	42
4.5.1	9 th harmonic injection to the system	43
4.5.2	7 th harmonic injection to the system	43
4.5.3	5 th harmonic injection to the system	44
4.5.4	3 rd harmonic injection to the system	45
4.6	Calculation on harmonic injected	46
4.7	Different Load Power inserted to the system	51
4.7.1	36W inserted to the system	52
4.7.2	500W inserted to the system	52
4.7.3	1.1kW inserted to the system	53
4.7.4	2.5kW inserted to the system	54
4.7.5	400W inserted to the system	54
4.7.6	300W inserted to the system	55
4.7.7	200W inserted to the system	55
4.7.8	100W inserted to the system	56
4.8	Calculation and analysis on different load inserted to system	57
4.9	Load calculation	58
4.9.1	Normal condition	58
4.9.2	Islanding condition	59

CHAPTER	TITLE	PAGE
4.10	Discussion	60
4.10.1	Harmonic injection method	60
4.10.2	Load insertion	60
4.10.3	Different Load Power inserted to the system	61
4.10.4	Harmonic level and percentage inserted to the system	62
5	CONCLUSION AND RECOMMENDATION	66
5.1	Conclusion	66
5.2	Recommendation	67
	REFERENCES	68
	APPENDICES	70

LIST OF TABLES

TABLE	TITLE	PAGE
2.1	Distortion limits as recommended in IEEE Std. 519-1992	8
2.2	Abnormal voltages response	9
2.3	A difference characteristic between the techniques in local method	12
3.1	System specification for reference circuit	27
3.2	Table for switching state of PWM	35
4.1	Bin frequency and f_{int}	46
4.2	Magnitude, y [N] and phase of f_{int} , θ	48
4.3	Simulation result base on different number of harmonic injection on 500W load.	48
4.4	List of the load (watt) by refer range of load	51
4.5	Difference between load current under normal and islanding condition	57
4.6	Calculation result for load	59
4.7	9 th harmonic used as constant	61
4.8	7 th harmonic used as constant	61

LIST OF FIGURES

FIGURE	TITLE	PAGE
2.1	An islanding condition in a grid connected PV	6
2.2	Grid-connected PV system configuration	8
2.3	Overview of MATLAB & Simulink toolbox	10
2.4	Circuit of solar cell	10
2.5	PV sources connection with grid	13
2.6	Voltage harmonic injection principle	14
2.7	Boost converter	16
2.8	‘On’-state and ‘Off’-state in boost converter	16
2.9	Single phase full -bridge inverter	18
2.10	Inverter switching modes	19
2.11	Switching gate signal	19
2.12	Pulse Width Modulation	22
2.13	Two possible place for load connected to inverter	24
3.1	Islanding Detection Method	25
3.2	Control block diagram of the reference circuit	26
3.3	Modification made on the reference model	28
3.4	Flowchart of Methodology	29
3.5	Design circuit for PV solar source	31

3.6	Result from solar source	32
3.7	MPPT controller design	33
3.8	Reference and modulation signal	34
3.10	One-phase PLL	35
3.11	LCL filter	36
3.12	Universal bridge as a inverter in simulink	37
4.1	Battery block and parameter in Simulink	38
4.2	Result of battery voltage	39
4.3	Waveform from the reference circuit	39
4.4	Normal condition with battery supplied	41
4.5	Islanding condition with battery supply 120V	41
4.6	Islanding condition without battery supply	42
4.7	9 th harmonic injection on 500W	43
4.8	7 th harmonic injection on 500W	43
4.9	Voltage result for 5 th harmonic injection	44
4.10	Time detection for 5 th harmonic injection	44
4.11	Voltage result for 3 rd harmonic injection	45
4.12	Time detection for 3 rd harmonic injection	45
4.13	Waveform for 36W load inserted	52
4.14	Waveform for 500W load inserted	52
4.15	Waveform for 1.1kW load inserted	53
4.16	Waveform for 2.5kW load inserted	54
4.17	Waveform for 400W load inserted	54

4.18	Waveform for 300W load inserted	55
4.19	Waveform for 200W load inserted	56
4.20	Waveform for 100W load inserted	56
4.21	9 th harmonic with 0.1% of it amplitude inserted	62
4.22	7 th harmonic with 0.1% of it amplitude at t=0.5s	63
4.23	9 th harmonic with 0.1% of it amplitude at t=0.5s.	63
4.24	9 th harmonic with 0.05% of it amplitude at t=0.5s	64
	using transport delay	

LIST OF ABBREVIATIONS

NDZ	-	Non-Detection zone
AIM	-	anti-islanding method
PV	-	Photovoltaic
DG	-	Distributed Generation
PCC	-	Point of Common Coupling
PLL	-	Phase-Locked Loop
PWM	-	Pulse Width Modulation
CB	-	Circuit Breaker
DC	-	Direct Current
AC	-	Alternating Current
DFT	-	Discrete Fourier Transform
IEEE	-	Institute of Electrical and Electronics Engineers
MPPT	-	Maximum power point tracking
PCS	-	Power conditioning system

LIST OF APPENDICES

APPENDICES	TITLE	PAGE
A	Islanding mode and Active Technique	70
B	Advantages and disadvantages local techniques	71

CHAPTER 1

INTRODUCTION

Introduction is about the briefing about the study and includes objective, scope and the problem statement of this project.

1.1 Project Background

This study about an islanding detection interface system for PV connected system by referred IEEE Std. 1547 as well IEEE Std. 929- 2000. Islanding refer to condition when distribution generator continue to power a place although supply that come from grid is disconnect. Micro grid is a system with a generators, load and battery in a small system (<10 kW). Point of Common Coupling (PCC) is a point where a supply from grid, local load and other loads is connected and disconnected. There are two methods in islanding method which is passive and active. Passive method is good in detection for islanding and power quality, but it has had big non-detection zone (NDZ). Compared with active methods, it has smaller non-detected zone and also has good time detection. This study plans on an anti-islanding technique in grid-connected with photovoltaic (PV) supply based on active method. This method use harmonic component injection as a disturbance to make the local load undergoes islanding condition at a time the harmonic injected and use different load connected to inverter after the LCL filter. Then, the voltage and time detection can be observed from that condition. Matlab is used to simulate the designed circuit and observe the waveform of voltage at point of common coupling and trip time at load and grid.

1.2 Problem Statement

There are many issues related to islanding detection techniques that have been introduced by pioneer. The effect of the unsynchronized voltage and frequency are an electrical devices and equipment will be damage if DG had often out of voltage and frequency [1]. Islanding techniques may give worst effect to the power system due to grid unsynchronized.

Non detected zone (NDZ) is the problem that need to be concerned when involve in islanding because it cause anti islanding detection failure. This problem needed to be concerned because it will take a time and high cost for repair the equipment if it had breakdown. Many people will get involve in repairing and blamed because of this problem. NDZ is a weakness in the islanding, so it should prevent from occur. This is to maintain power quality and prevent damage to the system. It can make the system constantly supply energy to the system without any blackout otherwise, unintentional islanding occurs like a lightning, fall of tree on the transmission line and other. Due to small detected zone and fast detected time, active method is suggested in this project [2].

1.3 Objectives

The aim of the project is listed down below:

1. To detect islanding condition in the PV connected micro grid system.
2. To isolate an area of the DG connected if islanding condition had been occurs.
3. To measure the voltage at Point of common coupling (PCC) in micro grid.

1.4 Scope

This research project focused on:

1. A technique to control V_{pcc} and observe the time detection when a specified method had been applied to the circuit with condition referred in IEEE std. 929- 2000.

2. Harmonic component is injected into the grid and islanding is detected from the waveform produced at point of common coupling.
3. Sources and circuit model :
 - a. Solar energy as an alternative source. The references model used based on IEEE std. 929- 2000 model.
 - b. Battery is used as PV solar source.
4. Islanding detection must less than 2 second.
5. The method use:
 - a. Local method
 - i. Active technique
6. Software :
 - a. MATLAB software
7. Observation:
 - a. Voltage, time detection limit.

Project Methodology

Project methodology is a description how the processes of this project. It is the one of most important step in a project because it requires careful planning to carry out a project.

Literature review can be finding from the journals, books and internet resources. Literature review is the first procedures to look as a first step in making the finding.

The process of finding the method for islanding detection is carried out after find the suitable journal to make as a reference circuit. Then the reference circuit is designed by using MATLAB software.

The modification for the reference circuit must be done if the circuit can be running by using MATLAB Simulink. If not, it will be modified and also if the result is not achieved the circuit also must be modified.

The parameter used in this work is based on load change and different odd number of harmonic injection effect to the system. The islanding detection time must be jotted down to make comparison based on the changing.

1.5 Thesis outline

In this report consist of 5 chapters. All chapters are summarized below:

Chapter 1 is introduction, this chapter covers several aspects that need to be made in ensuring the smooth running of projects. This chapter include the project background, problem statement, project objective, scope and project methodology and thesis outline.

Chapter 2 is literature review, in this chapter will overview the theory and research to give more understand about the project and it also can help in represent the best case study.

Chapter 3 is a methodology, this chapter guides us to follow the steps to be undertaken to achieve the objectives of the project.

Chapter 4 is an analysis, result and discussion after conducting simulations and calculations, all data will be recorded. Problems that occur while simulation and construction of circuit will be discussed in this topic.

Chapter 5 is conclusion and recommendation, this chapter summarizes the results that have been obtained from the project and what happened during the investigation included in this topic. Suggestions and recommendations are also put in this part.

CHAPTER 2

LITERATURE REVIEW

In this topic explained about the process to find the information regarding to the sources such as people, internet, journal and book.

2.1 Introduction

Photovoltaic system use solar energy to convert sunlight to electricity. So, the photovoltaic is most recommend in Malaysia as an alternative source in distributed generation (DG) [2]. The capability of islanding detection in the connection of photovoltaic (PV) system is an important requirement in this method [3]. Micro grid is a system with a generators, load and battery in a small area. It also can be defined as a low voltage supplied to small generation systems. It also an ability to connect load to the grid from photovoltaic sources [3]. This system carry power from the grid and controls the active and reactive power when disconnected from grid.

2.2 Microgrid

An inverter exists in micro grid change their control depend on connection status of micro grid to the grid. If grid is connected to the system, inverter injected current in same level with voltage at the point of common coupling, PCC. Micro grid is isolated because inverter controls the main system control in micro grid and act as voltage supply. Islanding process give an impact formation of micro grid due to chaos [1]. This condition occurs when facility is disconnected from DG and load demand continues supplied by another power supply refer to Figure 2.1. It occurs when voltage is disconnected, short circuit incident or appliances breakdown. Micro grid is a system that consist of local load and

another load can be connected with small power [4]. Between the switching processes from the supply from the grid to the supply from PV sources, the frequency and voltage must be stable to prove that the method that applied is safe. In this conversion time also need to identify that there is no voltage drop or current overshoot at the point of common coupling to avoid islanding condition from occur continuously. Inverter control the system will only supply output power lower than grid connected power. In islanding condition, inverter supply the load while the grid is disconnected [4].

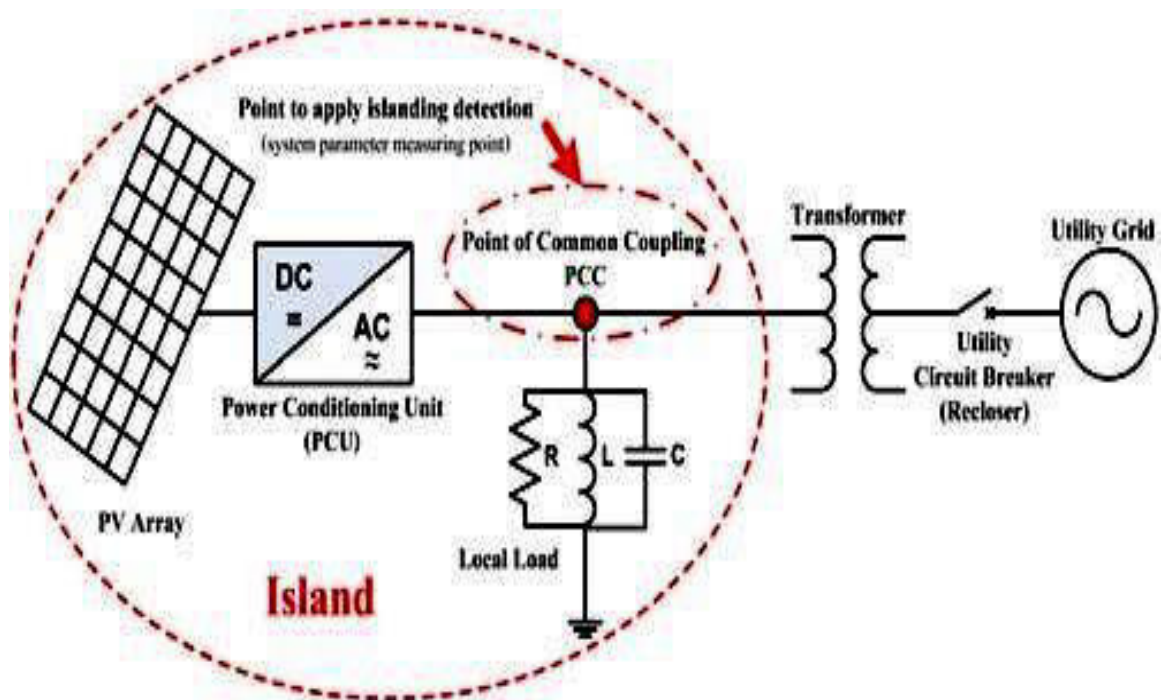


Figure 2.1: An islanding condition in a grid connected PV [2]

2.2.1 The main concerns with islanded system [2]:

Customer is provided with a different voltage and frequency in islanding condition if the distribution system not controls this parameter.

- Islanding condition may create hazard for the electrical worker cause line is still had a supply.
- The DG in islanding mode will be break down when island that out of phase reconnected by Electrical Power System.
- Islanding condition may be interfaced either in manual or automatic control for nearby load.