
**FACULTY OF ELECTRICAL ENGINEERING**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**FINAL YEAR PROJECT REPORT**

# DUAL MAXIMUM POWER POINT TRACKING; FOCUS ON DYNAMIC MPPT

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"I hereby declare that I have read through this report entitle "*Dual Maximum Power Point Tracking (MPPT); focus on Dynamic MPPT*" and in my opinion this thesis is sufficient in terms of scope and quality for awarding the degree of *Bachelor of Electrical Engineering (Power Electronic & Drive)*"

| | | |
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# DUAL MAXIMUM POWER POINT TRACKING; FOCUS ON DYNAMIC MPPT

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**A report submitted in partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering (Power Electronic & Drive)**

**Faculty of Electrical Engineering**

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Signature : ……

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I lovingly dedicate this thesis to my beloved parents.

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## ABSTRACT

Dynamic MPPT is mainly control the axis of solar panel to establish the maximum potential power absorbs from sunlight which is the solar panel has to place perpendicular with sunlight. Based on pilot sensor which is sense the optimum light, solar panel is always attached to the most of sunlight. Movement of solar panel was actuated by DC motor. Then, for electrical MPPT are based on closed-loop voltage reference of boost DC-DC converter. The output voltage of boost DC-DC converter obtained based of consideration on Pulse-width Modulation (PWM) by percentage of duty cycle. Therefore, the combination of both MPPT has become Dual MPPT.

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# ABSTRAK

Projek ini adalah untuk mengawal paksi panel solar bagi memperolehi kuasa yang maksimum dari cahaya matahari. Kedudukan panel solar disepadankan dalam keadaan serenjang dengan cahaya matahari yang dikesan oleh pengesan cahaya. Panel solar ini digerakkan menggunakan motor arus terus. Seluruh sistem ini dikawal oleh mikrokawalan jenis PIC16F877A. Projek ini membentuk *"Dynamic Maximum Power Point Tracking (MPPT)".* Kemudian, hasil dapatan projek ini digabungkan pula dengan MPPT yang menggunakan "*DC-DC Boost Converter*" melalui kaedah rujukan voltan gelung tertutup. Hasil gadingan kedua-dua MPPT ini membentuk dwi MPPT.

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## LIST OF ABREVIATIONS

| | |
|---|---|
| ADC | Analog-to-Digital Converter |
| DC | Direct Current |
| MPPT | Maximum Power Point Tracking |
| PWM | Pulse-width Modulation |
| PV | Photovoltaic |
| PIC | Peripheral Interface Controller |
| PVC | Polyvinyl Chloride |
| LDR | Light Dependent Resistor |
| LCD | Liquid Crystal Display |
| LED | Light Emitting Diode |

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# CHAPTER 1

# INTRODUCTION

## 1.1 Project Introductory

This project called “Dual Maximum Power Point Tracking (MPPT) for Solar System” which is implemented of combination between dynamic (mechanical) MPPT and electrical MPPT. Generally, the MPPT solar system has been widely studied and concerned among researchers and become interest due to applicable of green energy where it is renewable power source applied.

In this project, dynamic MPPT represent as mechanical MPPT is use to control the axis of solar panel to establish the maximum potential power absorb from sunlight which is the solar panel has to place perpendicular with sunlight. Based on pilot sensor which is sense the optimum light, solar panel motion will be move by DC motor where follow by pilot sensor.

Meanwhile the electrical MPPT are based on closed-loop voltage reference by DC-DC boost converter. DC-DC boost converter will be remaining output voltage which is consideration of the percentage of duty cycle. Both MPPT methods controlled by single chip microcontroller which is PIC 16F877A. Besides, the conversion from DC supply into AC supply will be use Pulse Width Modulation (PWM) inverter.

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PWM inverter where selected harmonics are evict with the smallest number of switching and improvement of the system adeptness by decrease switching losses and providing ease of filtering at the inverter output. Therefore, the combination of this Dual MPPT will gradually improve the efficiency of the solar system instead of current produce and power absorption. In this project, it highly focused on dynamic MPPT.

## 1.2 Problem Statement

Nowadays, in recent years, our lives based on economic development and achieve an impressive lead us towards a more sophisticated standard of living and modern. Therefore, indirectly impact on the use of energy sources that are not renewable. Due to the use of the long dependence on the rate of energy sources that cannot be renewed and the sources from time to time reduced by usage and high of demand. On the initiative of this global issue, a strong emphasis on the use of renewable energy sources in turn leads towards applications and greater ability to reduce the use of non-renewable energy. Thus, solar energy is one of renewable energy that becomes interested for researcher and these studies.

In order to achieve the high performance of MPPT for solar system, focus to the dynamic; there are few issue could be face up. Firstly, since the PV panel is moveable and positioning automated, the stability and efficiency of PV panel movement from point to another point need to be consider. The distances of PV panel movement in degrees need to be precise and accurate after point been tracked. Thus, the tracking error and parasitic losses are reduced.

Not only the moving distance, while beginning and ending point of PV panel movement, vibration on its panel could occur. Therefore, characteristics and fundamental of control system for DC motor as actuator to the PV panel must be design as well and produce result in good performance. Furthermore, when weather in cloudiness, pilot sensor plays as an important for sensing the optimal sunlight for PV panel absorption.

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The pilot sensor must be performing properly as guidance to PV panel. The mechanism of dynamic MPPT which is the whole project structures must be solid and robustness. This is because when it is not strong enough, it may expose for having an accident and this could occurs more problems instead of design, development and definitely, time. So that, all of this point matter need to stress at high attention and consideration.

## 1.3 Objectives

In every project, there are objectives as guidance to the entire important thing in the project to achieve the project goal. The objectives are defined step by step to ensure the project is complete through the planning, suggestion and expected result. At the end of the project is succeed when the project accomplish the entire objectives listed. In this project, there are four objectives as follow below:-

1. To study the behavior and potential of solar application in Malaysia.
2. To design and develop of dynamic MPPT.
3. To analyze dynamic MPPT performance and compare it to electrical MPPT.

## 1.4 Project Scopes

Scope is important to avoid the project progress go beyond its limit. The scope is to ensure that the project is achievable and realistic. In this project, the scopes covered with implementation of small scale applications which is build a dynamic MPPT of solar system with single axis of moveable solar panel. The movement of PV panel is actuated by DC motor. Controller of dynamic MPPT shall be based on a chip of microcontroller and a sensor as drive the PV panel; called pilot sensor.

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# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Solar Energy

Solar energy is one of the most frequently used renewable powers and it plays a significant role for the sustainable development in the world. There are few renewable energy sources that may be used to generate electricity such as from solar, geothermal, biomass, water and wind. Indeed, solar energy is a clean, almost free of maintenance and is an abundant source of energy. This is why it has become interested among researchers and the cost of solar system does not expensive with compare to others.

Furthermore, the generated power by the performance of solar energy is more effectiveness. Solar energy by equip of photovoltaic (PV), is the one of the inexhaustible renewable energy resources today. It forms of silicon or some characteristic of certain crystal which use to convert sunlight into electrical energy directly. The board used for the conversion is named photovoltaic panels or solar cells [1,2].

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## 2.2 Photovoltaic

Photovoltaic (PV) is an equipment that convert from solar energy into electrical energy by absorb the solar irradiance or sunlight. PV is mainly made from semiconductor material which is silicon. [2-7]

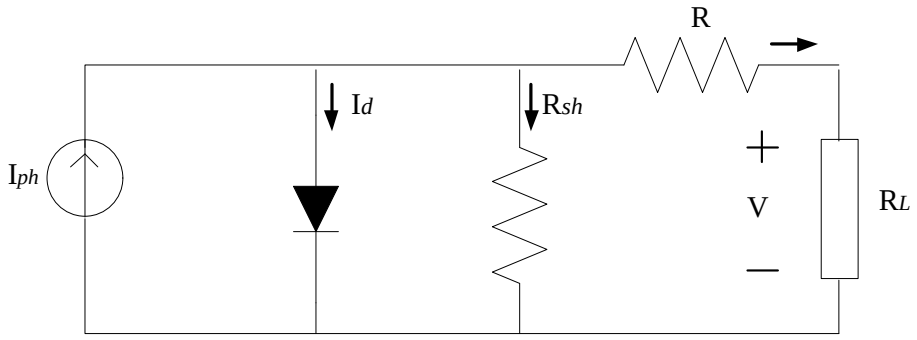


Figure 2.0: PV panel equivalent circuit

Figure 2.0 above represent as an equivalent circuit of PV. The parameters of PV that could be measure are voltage (V), current (I). The equation following to the figure above, the output current of an short circuit is equal to difference short circuit (Isc) and diode current (Id) can be written as

$$I = Iph - Id = Iph - Io\ (e^{\frac{q.V}{k.Tc}} - 1) \qquad (2.0)$$

where,

$Iph$ = cell current (A)
$Id$ = average current (A)
$k$ = $1.38 \times 10^{-23}(j/K)$, Boltzmann gas constant
$K$ = absolute temperature of SC [K]
$q$ = $1.6 \times 10^{-19}$C, electron charge
V = voltage across the cell

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Meanwhile, if the output of PV panel assumed as zero, it considered as open circuit. Open circuit voltage (Voc) can be written as

$$Voc = \frac{k.Tc}{q} ln \frac{Iph+Io}{Io} \approx \frac{k.Tc}{q} ln \frac{Iph}{Io} \quad (2.1)$$

## 2.3 Types of Photovoltaic

In general, PV material is categorized as either crystalline or thin film which is consideration on two basic criteria; efficiency and economics. Crystalline is divided to two which is mono-crystalline and poly-crystalline. Both are based on silica material that has been melted and crystallized. The thin film cells are made by depositing a liquidized semiconductor material directly onto glass, plastic or stainless steel substrate. Amorphous silicon cells (a-Si) are one of type of thin film cell technology. These three type of PV cell; mono-crystalline, poly-crystalline and amorphous are commonly been used. [10]

Figure 2.1: Mono-crystalline PV panel

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Figure 2.2 Poly-crystalline PV panel

Figure 2.3: Amorphous PV panel

The difference type of PV panel may provide difference amount of energy produced. It is because the PV panel producing energy depends not only on available solar energy but also on how suit and well the PV panel converts sunlight to useful electrical energy.

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The efficiency of PV panel is defined as the amount of electricity produced and divided its sunlight energy striking the PV panel. The conversion efficiency can be obtained as written below:- [1, 10]

$$\eta = P\max/(Irradiance * Area) * 100 \quad (2.2)$$

where,

Pmax = the maximum output power (kW)
Irradiance = is the solar radiation intensity (kW/m²)
Area = total area of PV cell (m²)

Table 2.0 Efficiency and cost for various type of PV panel. [12]

| Types of PV | Typical Efficiency | Cost (USD/Watt) |
|---|---|---|
| Mono-crystalline | 12 – 18 % | 5.5 – 6 |
| Poly-crystalline | 11 – 14% | 4.5 |
| Amorphous silicon | 6 – 7% | 3 |

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