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Photovoltaic Power Control Module for Maximum Power Point Operation

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***Abstract*: According to [1] the DC-DC converters are largely used in regulated switched DC power supplies. The input of these converters is not regulated DC voltage, which is obtained by a photovoltaic arrangement and therefore fluctuate due to changes in the Radiation and temperature Renewable energy is growing rapidly and is becoming significant our world today and the future to come. Photovoltaic (PV) is one of the most important in the area of renewable energy and this has attracted much research. In recent years, P V Power generation systems have attracted attention due to the energy crisis and the environment Pollution systems Photovoltaic power generation can effectively mitigate environmental problems such as the greenhouse effect and pollution [2]. A main problem with the photovoltaic module is that the electrical output power depends on the climatic condition that is; the output is changing with a change in the weather conditions that Photovoltaic module Non-linear power supply. Due for the climatic condition mentioned above and others factors listed below in [2] the maximum power point of the photovoltaic module as described below. It will move away from the maximum operating point of the module. Based on this result is a maximum power point tracker (MPPT) Using the DC-DC converter is developed and used to maintain the maximum power point (MPP) of the modules.**

Keywords: photovoltaic, maximum power point

I. Introduction

The photovoltaic cell, also known as solar cell, is used to convert energy from the sun directly into electrical energy without any form of rotational parts. Photovoltaic cells represent the basic unit of energy conversion of the photovoltaic system. These cells are made of semiconductors and, like any other solid-state electronic device, for example, diodes, transistors and integrated circuits, they have a similar behavior. Photovoltaic cells are usually organized into modules and matrix when applied practically [6]. There are different types of photovoltaic cells available on the market and yet other different types of cells are in development, Nand-crystalline cells sensitized by dyes. The reason for the different types of photovoltaic cells, materials and structure is to extract the maximum energy from the cell and keep the cost to a minimum. According to [6], efficiency above 30% was achieved in the laboratory and the efficiency of the practical application is generally less than half that value. Crystalline silicon technology is well established and its cell is more expensive, but still controls much of the photovoltaic market, with efficiency close to 18%. Other types of photovoltaic cells, such as amorphous thin films, are less expensive, but with a low efficiency drawback. There are several factors that affect the electrical performance of a photovoltaic module operating at the ideal operating point. These factors are:

1) Intensity / irradiation of sunlight
2) Cell temperature
3) Load resistance
4) Shading and use of photovoltaic and

MPPT panels to reduce these challenges are developing rapidly.

II. Boost Converter

The DC to DC boost converters are used to convert the unregulated DC input voltage into the desired controlled DC output voltage [19]. The main purpose of this converter is to perform the conversion process by applying a DC voltage across an inductor or transformer for a time period, which causes current to flow through it. It is generally lies in range of 20 kHz to 5 MHz approximately. Then this energy is stored magnetically. By switching this voltage off and causing the stored energy to be transferred to the output voltage in a controlled manner. Now this output voltage is regulated by adjusting the ratio of on & off time i.e. Duty Cycle. This is achieved by using switched mode or chopper, the main advantage of this circuit is that it dissipates negligible power loss. The Pulse Width Modulation (PWM) scheme allows to control & regulates the total output voltage. It is main part of power supply, which directly affects the overall performance of the power supply system. The ideal converter exhibits 100% efficiency (approx.), but in practice it is quite efficient of 70-95% are typically obtained. The boost converter is capable of producing a dc output voltage greater in magnitude than the dc input voltage. The circuit topology for a boost converter is a shown in Fig. 1. The mode of operation for boost converter is shown below,

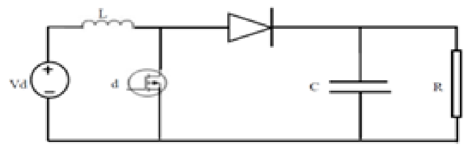

Fig. 1. Schematic Diagram Boost Converter

Mode-1: when the IGBT switch is in ON state (Closed), the equivalent circuit will be divided into two groups one is at the input side and another is on output side [20-21]. The closed loop towards at input consisting of inductor/transformer, which gets charged by the current flowing through the loop during this period. This current results to increase in linear nature till the time, switch is in closed condition.

On the same time interval, inductor voltage is also high as it is not delivered to any load but itself. Diode is off during this

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mode. The equivalent circuit representation of Mode 1 is shown in Fig. 2.

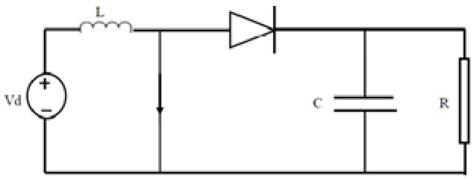

Fig. 2. Mode 1 (Circuit when switch is closed)

Mode 2: When switch is open i.e. OFF state, there will be a closed loop which contains power source, inductor & RC Load combination. The energy which is stored during ON state is now discharged through the RC circuit from diodes. Hence, the inductor current reduces linearly. It charges the capacitor at the load side. The equivalent circuit for Mode 2 operation is shown in Fig. 3.

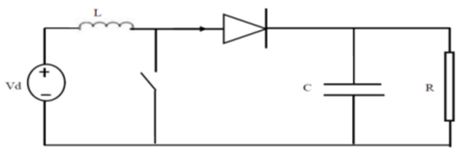

Fig. 3. Mode 2 (Circuit when switch is open)

So for closed switch time inductor gets charged and capacitor is delivering the required power to the load, and for the opened switch time inductor will discharge supplying the full power to load and charging capacitor simultaneously. The steady state response of inductor current and voltage waveform is shown in Fig. 4.

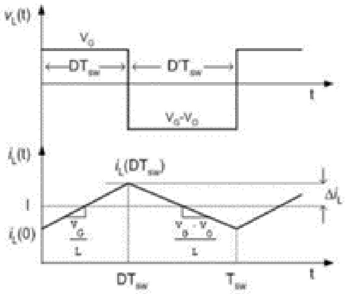

Fig. 4. Steady state response of inductive current and voltage

The rate of change of inductor current is a constant, indicating a linearly increasing inductor current. The preceding equation can be expressed as,

$$V_L = V_d = L\frac{di}{dt} \quad (1)$$

Duty Cycle:
The duty cycle can be found using the following relation,

$$D = 1 - \frac{V_i}{V_o} \quad (2)$$

Inductor value:
The value of inductor is determined using the following relation,

$$L_{\min} = \frac{D(1-D)^2 \times R}{2 \times F_S} \quad (3)$$

Capacitor value:
The value of capacitor is determined from the following equation,

$$C = \frac{D}{F_S \times R \times V_r} \quad (4)$$

Where,
C is the minimum value of capacitance,
D is duty cycle,
R is output resistance,
F_s is switching frequency, and
V_r is output voltage ripple factor.

III. Design and Simulation

The Simulink model used for the implementation of the required solar cell and boost converter system is as shown. This is for the incremental conductance method.

Here the solar cell is represented by a block named ‘Photovoltaic cell’. The MPPT and gating signal generator are shown in a single unit called ‘MPPT with Gating Signal’. The ‘Ilg Generator’ is basically the photo-generated current that is given as input to the single diode model of the cell.

Other elements of the model constitute the boost converter, which consists of a 0.2 mH inductor and a 1 mF capacitor. This boost converter is used to step up the voltage to the required value. The gating signal to the boost converter is generated by comparing the signal generated by the MPPT algorithm to a repeating sequence operating at a high frequency. The load is a 10 ohm resistance. The Model for MPPT Parameter calculation is shown in Fig. 5.

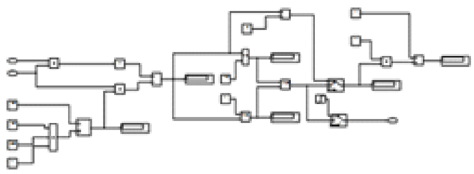

Fig. 5. PV Simulink diagram

IV. Simulation Results of the Converter Model

The simulations were carried out in Simulink and the various voltages, currents and power plots were obtained.

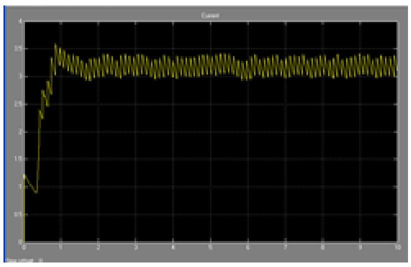

Fig. 6. Converter output current waveform

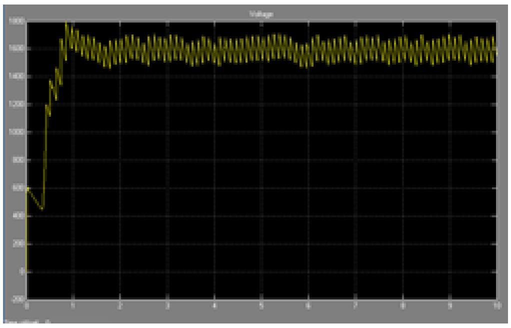

Fig. 7. Converter output voltage waveform

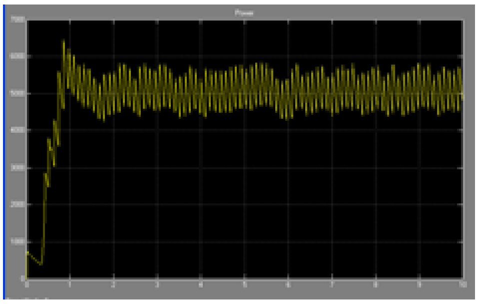

Fig. 8. Power output converter waveform

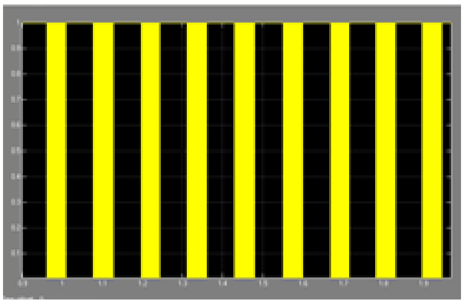

Fig. 9. Gate pulse for IGBT

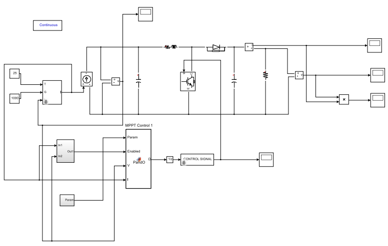

Fig. 10. Simulink diagram of proposed system

V. CONCLUSION

The objective of the work is to design a DC reinforcement converter and a maximum power point scanner for Optimize efficiency at all times. This has been done through a careful examination of the photovoltaic module data sheet to achieve the most desirable result, particularly with maximum power. The design was made for the first time through careful care system design schemes. Design DC-DC pulse converter, pulse generator (PWM) for the project it was successfully concluded, but the automated maximum power point scanner was not reached successfully and will be looking towards separately. The practical test of implementation explains the behavior of the module during different irradiation and also to observe MPPT control.

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