Applied Science & Engineering Journal for Advanced Research
ISSN (Online): 2583-2468
Volume-1 Issue-3 || May 2022 || PP. 28-33 DOI: 10.54741/asejar.1.3.5

MPPT Algorithm based DC Converter for Dual Voltage Automotive Systems

Abhinav Ram PS
Assistant Professor, Department of EEE, Sri Krishna College of Engineering & Technology, India

Corresponding Author: abhinavrps@rerdiffmail.com

Received: 16-04-2022	Revised: 30-04-2022	Accepted: 19-05-2022

ABSTRACT
Perturb and Observe (PO) is an algorithm for tracking the maximum power point (MPPT) in a photovoltaic system. Sunlight and temperature affect the performance of solar cells in a nonlinear fashion. The voltage and current have a non-linear effect on its power. A maximum power point (MPP) exists only at a single voltage and current for a given set of meteorological circumstances. The MPPT is used to monitor the MPP. A detailed description of how to model a solar panel, design a DC-DC boost converter, and design a PO MPPT is provided. Under various environmental conditions, the solar panel are simulated. It is used to control the duty cycle of a DC-DC converter so that the PV generator can operate at its maximum power point and ensure that the solar panels can operate at their optimum efficiency (MPP). Using a Perturb and Observe (P&O) approach, the algorithm under consideration was analysed. When the DC-side capacitor voltage fluctuates, this is designed to improve MPP tracking (interface between the DC-DC and the DC-AC stage). Using SIMULINK simulations under two different conditions—rapid changes in irradiance and a second order distortion in the voltage at the DC-side capacitor—we can compare the performance of MPPT techniques. When comparing the sensors, the number of sensors, their rise time and their efficiency are taken into consideration.

Keywords: *photo voltaic system, mppt, dc converter*

I. INTRODUCTION

In today's power sector, one of the most pressing issues is that demand for power is increasing at an ever-increasing rate, but conventional energy sources are insufficient to meet this demand. Renewable energy sources must be used in conjunction with conventional sources of power generation to meet the needs of the future. One renewable method for resolving today's energy crisis is the so-called Solar Energy method, which draws power from the incoming solar radiation for no cost to anyone on the planet. Solar energy is abundantly available on Earth's surface and in space, allowing us to harvest it, convert it to a form we can use, and put it to good use. It is possible to connect a solar power generation system to the grid or use it as a stand-alone power generation system, depending on the utility, the load area, and the proximity of a power grid. As a result, solar power can be used in areas where grid connections are difficult or expensive. The two most important advantages of solar power are that its fuel costs are zero and that it does not emit any greenhouse gases during its operation. For those who need a portable source of small-scale electricity, the use of solar power can be an excellent option. During the last few years, the size of solar power conversion mechanisms has significantly decreased. Power electronics and material science advancements have made it possible for engineers to develop a system that is small but powerful and capable of supplying the high demand for electricity. Every country's power density demand is rising on a daily basis. Setting the system up for multiple input converter units allows solar power generation to handle voltage fluctuation very effectively. However, as a primary renewable energy source, solar power generation systems are unable to compete in competitive power markets due to their high installation costs and low efficiency of the solar cells. Solar cell manufacturing technology is constantly being improved by scientists in order to increase efficiency. Such an approach would certainly help to make the use of solar power as the primary renewable source of electrical power more widespread than is currently the case. Maximum Power Point Tracking, more commonly known as MPPT, is a new power control mechanism being used in solar power generation systems that has guided an increase in the efficiency of power generation from solar cells. As a result, MPPT is critical when it comes to the use of renewable energy sources.

II. THE SOLAR CUBICLE

A solar cell is an microelectronic device that uses the photovoltaic effect to directly convert light energy into electricity without the need for any moving parts. A Photovoltaic (PV) cell is another name for a Solar cell. Semiconductor materials, such as silicon, are used to create this solid-state electronic device. Using a solar cell, light energy is converted directly into AC current (DC). Electricity is generated in a solar cell without the use of light's heat. Many factors influence the efficiency of solar cells, including shading on cells, irradiance, temperature, and so on.

N-type semiconductors and P-type semiconductors are used in the production of solar cells, which generate electricity. A pair of electrons (-) and holes (+) is created when light strikes a semiconductor. There is no way for electron and hole to be rejoined when they reach the joint surface of two different semiconductors, because the joint surface does not allow for both ways of traffic between these two semiconductors. An electromotive force (emf) is generated in electrodes when electrons are restricted by an N-type semiconductor and pigpens are enclosed by a P-type semiconductor. Electrons flow toward the O-type semiconductor and pigpens flow toward the N-type semiconductor when these electrodes are associated by a conductor.

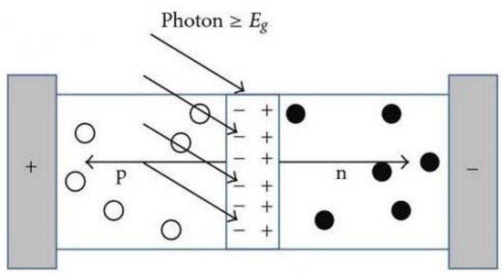

Figure 1: P-N Junction illustration of PV cell

In solar power generation system number of solar cells is compulsory to create high power so they attached in form of solar panel and for higher capability as shown in figure 2.

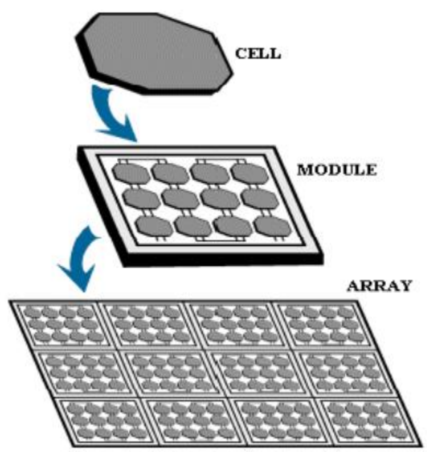

Figure 2: Formation of Solar module and Solar PV array

In order to generate more power, solar arrays consist of a number of photovoltaic squares or sections that are electrically connected and mounted on a sturdy framework. Designing a stand-alone power generation system for a small load like a hilly house or any other small load not connected to the grid network is the primary objective of this project. This type of load requires a system that takes the power generated by a PV arrangement, converts it to alternating current (AC), and then supplies the load in parallel.

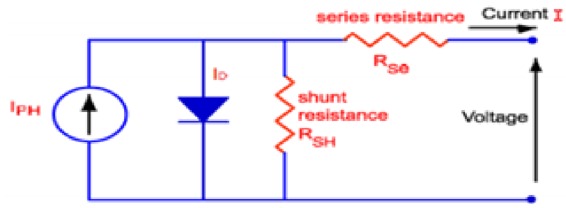

Figure 3: Equivalent circuits of Solar cell

III. DC CONVERTER

A filter circuit and a load make up a basic DC converter. Classes for DC converters include isolated DC onverters and non-isolated DC converters. Isolated DC converters are the most common. A transformer separates the output and input of an isolated DC converter type. When compared to a non-isolated DC converter, it is larger, takes up more space, and is more expensive. Converters with element connections such as Buck, Boost, Buck-Boost, and SEPIC can be distinguished from non-isolated DC converters. In order to convert an unregulated DC input into a regulated DC output, a DC converter is commonly used. The heart of any MPPT hardware implementation is a DC-DC converter. When the solar input voltage is regulated and impedance is matched for maximum power transfer, the MPPT uses one of these converters. The simplest and most basic converter is the Buck or Boost converter, which uses fewer components and is a simple circuit. This paper uses a Boost converter because it is a DC converter that boosts the input voltage and provides the output with the same voltage as the input. When you use a boost converter, you temporarily store the energy from the input and then release it at a higher voltage to the output. In the event that the switching device fails, the load is still connected to the power source.

3.1 Enhancement Converter

The output voltage of a boost converter or regulator is higher than the input voltage of the converter circuit, which is why it is referred to as a "BOOST" regulator. There is an inductor, a diode (for a load), a capacitor, and a switching device like a MOSFET or BJT in the circuit. Figure 4 shows a enhancement converter circuit diagram.

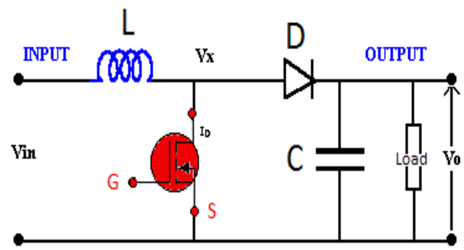

Figure 4: Enhancement Converter

IV. MPPT SYSTEM SIMULATION

4.1 Modeling of Photovoltaic Panel

Photovoltaic cell's equivalent circuit is shown schematically in Figure 5. PV compartments are congregated into larger units called PV panels, which are then connected in a parallel-series configuration to form PV arrays. Cell model parameters are multiplied by the number of cells in order to simulate the array.

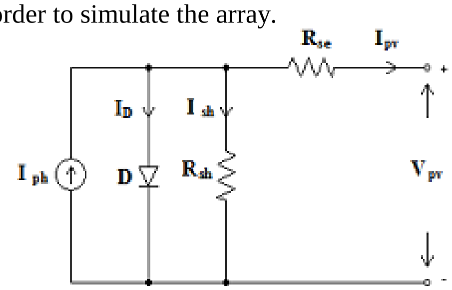

Figure 5: Equivalent circuits of Solar cell

The model equations are given from (1) to (4).

$$I_{PV} = I_{ph}(G,T) - I_D - \frac{V_d}{R_{sh}} \quad (1)$$

$$I_D = I_R(e^{\frac{V_d}{V_T}} - 1) \quad (2)$$

$$V_T = nKT / q \quad (3)$$

$$V_d = V_{PV} + I_{PV} R_{se} \quad (4)$$

The current voltage and power of voltage is individualities at STC [G=1002 W/m2, T=250C] are showing in below figure, which is achieved by feigning the equations (1) to (4) .

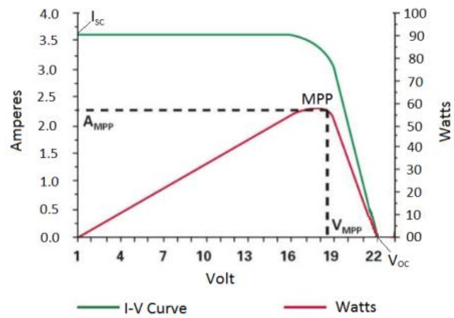

Figure 6: Characteristic of Solar Panel

4.2 Simulation of MPPT Algorithm

MPP tracking is done using the Perturb and Observe algorithm. There are few measured parameters in the perturb and observe algorithm. An array terminal voltage adjustment is made periodically and compared to the previous perturbation cycle to see if the output power is higher or lower. An increase (decrease) in array power is followed by a similar (opposite) change of direction for a subsequent perturbation. As a result, the peak power tracker is able to locate the optimal power level on a regular basis. As a result, the MPPT can take a long time to track the MPP in rapidly changing atmospheric conditions. Figure 7 depicts the Perturb and Observe Algorithm's flow diagram.

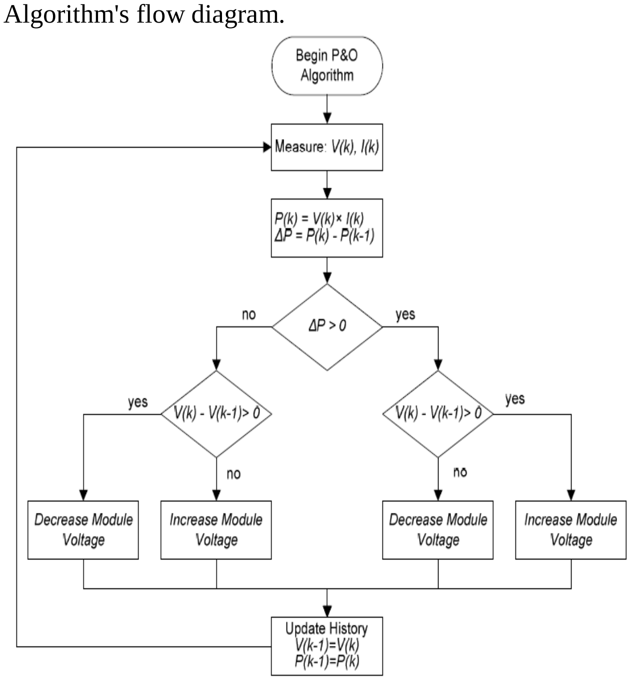

Figure 7: Flow Chart for Perturb and Observe Algorithm

Applied Science & Engineering Journal for Advanced Research
ISSN (Online): 2583-2468
Volume-1 Issue-3 || May 2022 || PP. 28-33 DOI: 10.54741/asejar.1.3.5

4.3 Simulation Results

The single-ended primary inductance converter [10] charger system is examined in this paper using renewable sources. Buck-boost feature of SEPIC widens applicable PV voltage and thus increases the adopted PV module flexibility. In MATLAB SIMULINK, the simulation was performed. The simulation has been run under the same conditions as the actual test. The following are the parameters for the simulation. Irradiation has been set at 1000 W/m2 and the temperature is set at 25oC. The voltage and current from the solar panel are taken independently and nurtured to the boost converter. The boosted productivity voltage and modern meet the demand of the load. Although the boost converter typically has a higher efficiency than the SEPIC, it can only be used when the battery voltage is higher than the voltage of the PV module. The solar panel and boost converter output current-voltage graph is shown below.

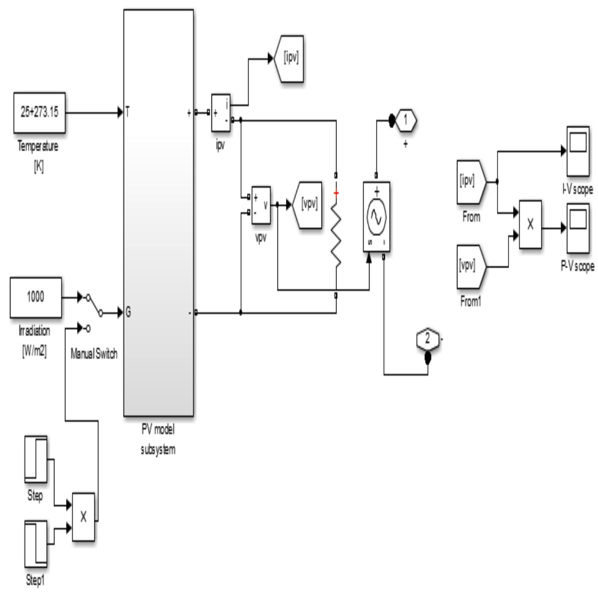

Figure 8: Solar Panel in Simulink diagram

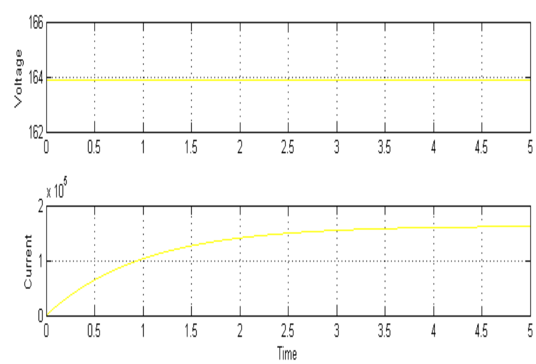

Figure 9: Output VI from the Panel

V. RESULT AND DISCUSSION

The proposed MPPT controller's tracking performance was verified through simulation. Output current maximisation was largely responsible for this. For simulation purposes, a new hybrid PV model was introduced. Finally, the algorithm's validity was confirmed through simulations. Increasing the efficiency of solar photovoltaic (PV) modules has been a focus of research for the last several decades. Tracking the maximum voltage and current points on the IV curve of a solar PV module is necessary because the IV curve is non-linear (MPP). Consequently, MPPT approaches were widely used in this endeavour. With the proposed MPPT method, the MPP could be tracked more reliably and with less oscillation when the irradiance changed frequently. A change in irradiance led to a significant improvement in achieving the MPP, which was confirmed through simulations in MATLAB/SIMULNK. Additionally, the dynamic models, frequency characteristics, and component costs of various dc/dc converter technologies, all of which were required for the design, were compared. As a result of this comparison, we've received praise. In this paper, a boost converter-based MPPT strategy is proposed, which provides the necessary voltage for high-power applications.

VI. CONCULSION

Simulink is used to model a solar panel, and its nonlinear properties are examined in this paper. PV and IV physiognomies of solar panels are tested and simulated in a variety of radiation and hotness environments. Relationship between power, temperature and radiation has been established. Short circuit current, Open circuit voltage and MPP are measured as a result of temperature and radiation changes. Simulating the Discompose and Discern MPPT in MATLAB/Simulink is a great way to practise.

MPPT uses a DC-DC boost converter. Voltage, current, and power measurements show that step changes in radiation have an effect. For hardware implementation, PO MPPT is simpler and faster than other approaches. Designing and implementing advanced control strategies, comparing results with conventional MPPT techniques like PO, and proposing a modified MPPT algorithm will be the focus of the next phase of work.

REFERENCES

1. T. Bhattacharya, V. S. Giri, K. Mathew, & L. Umanand. (2009). Multiphase bidirectional flyback converter topology for hybrid electric vehicles. *IEEE Trans. Ind. Electron., 56*(1), pp. 78–84.
2. Z. Amjadi, & S. S. Williamson. 92010). A novel control technique for a switched-capacitor-converter-based hybrid electric vehicle energy storage system. *IEEE Trans. Ind. Electron., 57*(3), pp. 926–934.
3. F. Z. Peng, F. Zhang, & Z. Qian. (2003). A magnetic-less DC–DC converter fordual-voltage automotive systems. *IEEE Trans. Ind. Appl., 39*(2), pp. 511–518.
4. L. A. Flores, O. Garcia, J. A. Oliver, & J. A. Cobos. (2006). High-frequency bi-directional DC/DC converter using two inductor rectifier. In: *IEEE IECON Conf.*, pp. 2793–2798.
5. M. A. Abusara, J. M. Guerrero, & S. M. Sharkh. (2014). Line-interactive UPS for microgrids. *IEEE Trans. Ind. Electron., 61*(3), pp. 1292–1300.
6. G. Chen, Y. S. Lee, S. Y. Hui, D. Xu, & Y. Wang. 92000). Actively clamped bidirectional flyback converter. *IEEE Trans. Ind. Electron., 47*(4), pp. 770–779.