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Solar Powered Boost Converter using MPPT control

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Abstract - *Photovoltaic (PV) is a technical name in which light (photon) energy observed from the sun is converted into direct current (DC) Electrical Energy. PV power output will be low, continuous efforts are taken to develop the PV converter and controller for maximum power extracting efficiency and reduce the cost factor. The maximum power point tracking (MPPT) is a process which tracks one maximum power point from solar panel or PV module, varying the ratio between the voltage and current delivered to get the maximum power it can. A number of algorithms have been developed for extracting maximum power and efficiency. Here, in our project this effective MPPT(Perturb and Observe) algorithm is implemented in a DC-DC boost converter by modifying the switching PWM signal. Hence, our project is about the study of Perturb & Observe MPPT algorithm. And it can be experimentally verified by modeling the PV system with MPPT algorithm in MATLAB simulations.*

Key Words: **MPPT algorithm, Solar Panel, Boost converter, Arduino Uno, Voltage sensing, PWM signal.**

1. INTRODUCTION

Over the past two decades renewable energy sources have gained more attention is contributing to power production due to the increase of power demand in the world. Especially as there is much concern with the worlds energy crisis, oil shortage and environmental problems caused by conventional power generation sources such as fossil (example: oil, natural gas, coal).Renewable energy sources such as wind energy, wave energy and solar energy may be right solution for these problem. Solar energy is a very attractive energy renewable energy source amongst all the aforementioned renewable source due to the relative small system size, free and sustainable generation source or fuel, noise free operation due to absence of moving parts, the possibility to put it close to the user ease of installation and system require relatively little regular maintenance. It is clean and important source of producing electricity. It has a huge energy potential compared to other sources.

However efficiency of solar panel is not very high. their ability to transfer sunlight to electrical power is relatively inefficient with conversion efficiency typically in the range 12-20 %.The range of efficiency can drop further varying solar irradiation, panel temperature and load conditions. Therefore if the load directly to the PV array, the PV array must usually be over sized to supply the required power to the load. This leads to an over sized expensive system.

The overall system cost can be reduced and operation is possible at increase efficiency. If the solar panel is constantly used to extract as much as possible. During the daylight hours by ensuring the panel is always operating under optimal power delivery conditions, rather like impedance matching allows maximum power to be extracted from a voltage source with internal resistance.

2. PROPOSED SYSTEM

There are numerous techniques available in the industry for delivering the constant and maximum obtainable power form the solar panel or PV module. But, in our project we have chosen the Perturb and Observe algorithm for the maximum power point tracking. We have chosen this technique just because of its easier hardware installation and cost effective. Here, the voltage and current are sensed from the solar panel using the sensors. According to the sensed voltage and current, the controller will run the coded algorithm. The controller, by modifying the duty cycle of the boost converter, can adjust the output power to the maximum. This adjustment will take place continuously until it reach the maximum power. The algorithm actually compares the voltage and power of the previously sensed values to the currently sensed values. By this continuous comparison and modification of duty cycle, we can achieve a continuous tracking of maximum power.

In this method the controller adjust the voltage to small amount from the array and measures power, if the power increases further adjustments in the direction are tried until power longer increases. This is called perturb and observe method and most common, although this method can result in oscillations of power output. Perturb and observe method is most commonly used in MPPT method due to ease of implementation of perturb and observe method may result in top level efficiency, provided that a proper predictive and adaptive hill climbing strategy is adapted.

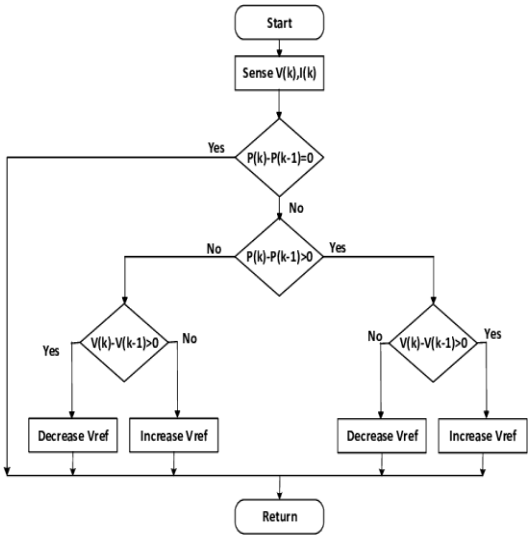

Fig -1: MPPT(P&O) algorithm

2.1 Block diagram

This block diagram shows the main operating blocks of the system. The supply for the block diagram is taken from the solar panel. From the solar panel, voltage and current sensors are connected. They will update the values to the Arduino for modifying the duty cycle. The PWM signal to the switch of the boost converter is generated by the controller. This signal is generated as directed by the MPPT algorithm. The output of the converter is given to a constant load. The DC load can get a supply with constant maximum power.

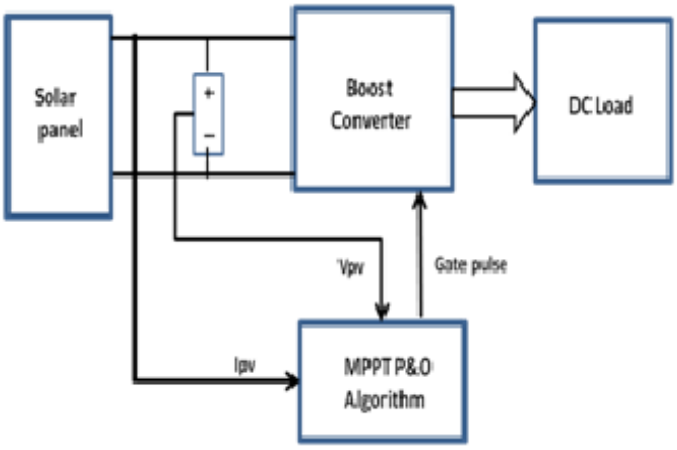

Fig -2: Block diagram

2.2 Description

The description of the entire system will be explained in the following.

2.2.1 VI characteristics of solar module

The VI characteristics of solar PV module is shown in fig 3. In this curve, power can be calculated at a point by taking the current and voltage at that point. The current(Isc) will be maximum when the solar panel is short circuited and the voltage will be zero. On the other side the voltage(Voc) will be maximum when the panel is open circuited and the current will be minimum. At these two conditions we cannot get maximum power. The maximum power will be obtained at a particular combination of current and voltage, which is called maximum power point(MPP).

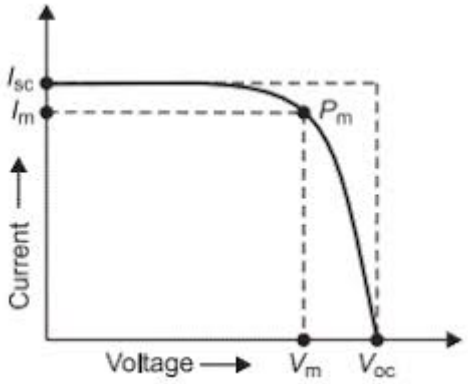

Fig -3: VI characteristics of solar module

2.2.2 Circuit diagram of Boost converter

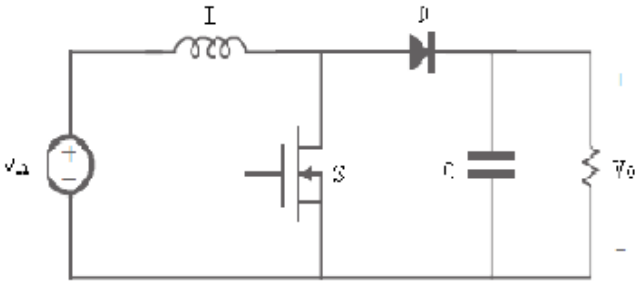

Fig -4: Circuit diagram of boost converter

Fig -5: Hardware of boost converter

2.2.3 Sensing unit and Control unit

The sensing of the voltage and the current form the solar panel have to be done for directing the controller to obtain the maximum power point. The voltage sensing can be done by designing a voltage divider circuit that will sense the voltage from the panel. Two resistors are which are connected in series can divide the voltage. Likewise the

resistors with values 10.5K ohm and 1.5K ohm are connected in series. These values are chosen in order to divide the voltage into 7:1 ratio taking the maximum voltage as 40V.The voltage drop across the resistor 1.5K ohm can be given to the Arduino as analog input which has a maximum voltage limit of 5V. The controller can calculate actual solar voltage. The current sensing have been done by the current sensor ACS712ELC-30A. The sensed values of the voltage and current will be given to the controller. The controller will calculate the power for the sensed voltage and current at a time and compares the power of the previous power. If the present power is greater than the previous power the duty cycle of the gate pulse will be decreased. If the present value of power is less than the previous power the duty cycle will be increased. This event will run continuously according the switching frequency. Here it is calculated as 7KHz. The duty cycle of each signal will be modified in order to obtain a constant maximum frequency.

Fig -6: Arduino Uno board

2.2.4 Simulation and result

Simulation of the entire MPPT control have been done using MATLAB IDE. MATLAB consists of numerous functionalities for creating a function and defining its flow of control. One of the major reason for taking this IDE is the availability of the PV panel in its library. MATLAB have been known for its libraries. The following image shows the simulation diagram of the system.

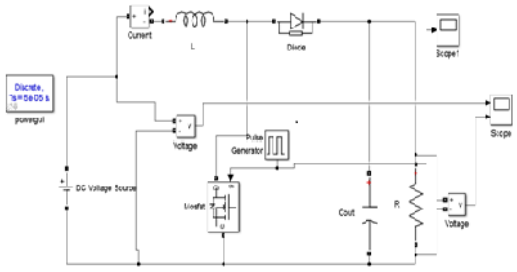

Fig -5: Simulation diagram

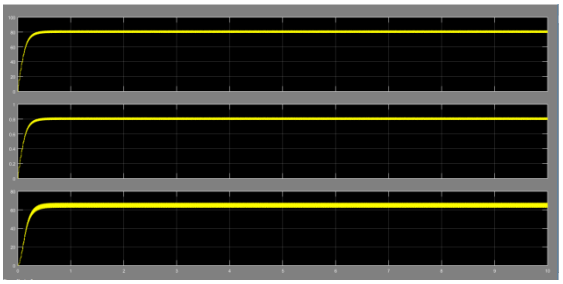

Fig -7: Simulation output of output current, voltage and power

2.2.5 Duty cycle output

Duty cycle is increased when the input voltage is decreased. According to the program

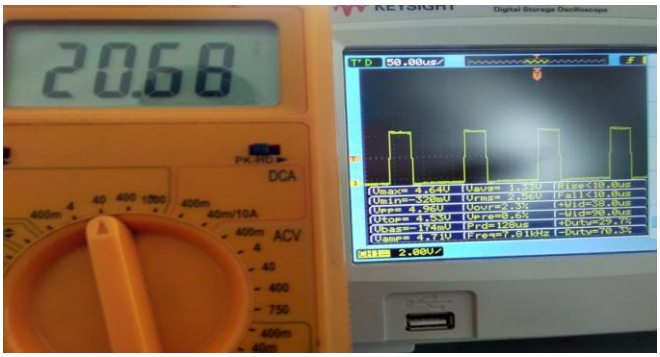

Fig -8: Duty cycle1

According to the program, duty cycle is 16%when there is maximum input voltage

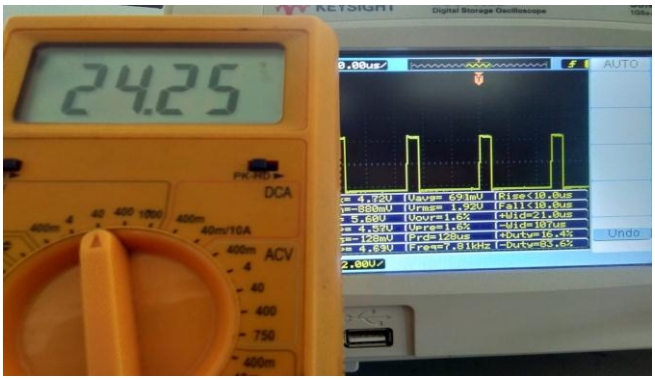

Fig -9: Duty cycle2

3. CONCLUSION

In this project a low cost high performance DC-DC boost converter has been designed for extracting maximum power we have implemented using perturb and observe algorithm by using this algorithm we can track maximum power. The complete system has designed and simulated in MATLAB and implemented with the help of Arduino. A laboratory prototype has been implemented and tested.

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