

# Microcontroller Based MPPT Buck-Boost Converter

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## Abstract

The demand of solar energy has increased rapidly in this decade. This is due to the advantages of the energy compared to other form of sources. The solar energy conversion system is very interesting alternative on supplement the electric system generation, due to the persistent cost reduction of the overall system and cleaner power generation. To obtain a stable voltage from an input supply (PV cells) that is higher and lower than the output, a high efficiency and minimum ripple DC-DC converter required in the system for residential power. Buck-boost converters make it possible to efficiently convert a DC voltage to either a lower or higher voltage. Buck-boost converters are especially useful for PV maximum power tracking purposes, where the objective is to draw maximum possible power from solar panels at all times, regardless of the load.

**Keywords-** MPPT, Solar tracking, Microcontroller, Timer 555, DC-DC converter

## I. INTRODUCTION

Solar energy is getting more important now a day due to various advantages such as

- 1) Everlasting and renewable source of energy
- 2) Large source
- 3) Clean source
- 4) Easily available to all

Good quality, reliable solar radiation data is becoming increasingly important in the field of renewable energy, with regard to both photovoltaic (PV) and thermal systems. It helps well-founded decision making on activities such as research and development, production quality control, determination of optimum locations, monitoring the efficiency of installed systems and predicting the system output under various sky conditions. Especially with larger solar power plants, errors of a few percent can significantly impact upon the return on investment.

## II. MAXIMUM POWER POINT TRACKING

Maximum power point tracking, frequently referred to as MPPT, is an electronic system that operates the Photovoltaic (PV) modules in a manner that allows the modules to produce all the power they are capable of. MPPT is not a mechanical tracking system that “physically moves” the modules to make them point more directly at the sun. MPPT is a fully electronic system that varies the electrical operating point of the modules so that the modules are able to deliver maximum available power. Additional power harvested from the modules is then made available as increased battery charge current. MPPT can be used in conjunction with a mechanical tracking system, but the two systems are completely different.

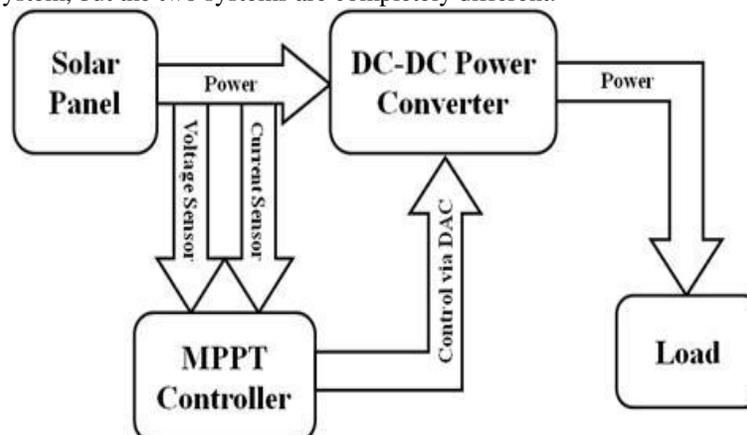


Fig. 1: Block diagram of MPPT system

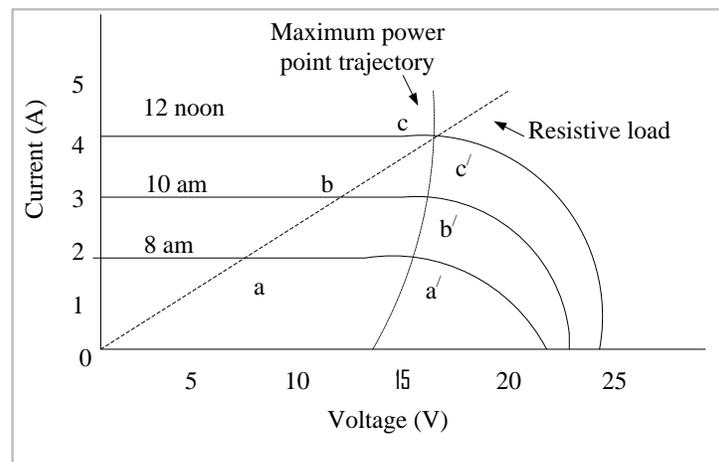


Fig. 2: I-V curve

### III. VARIOUS MPPT METHODS

Controllers usually follow one of following types of strategies to optimize the power output of an array. Maximum power point trackers may implement different algorithms and switch between them based on the operating conditions of the array.

#### A. Perturb and Observation Method

In this method the current pulled from the (PV) panel is perturbed and the resulting power is observed. This is an iterative method which perturbs the operation point of the (PV) panel to find the direction of change for maximizing the power output. The main disadvantage of this method is that the operating point is oscillating around the MPP and its slow response in a rapped change of radiation. An improve MPPT algorithm for rapid irradiation changes which is called as optimized dP- P and O can slightly improve the traditional methods.

#### B. Incremental Conductance Method

In the incremental conductance method, the controller measures incremental changes in array current and voltage to predict the effect of a voltage change. This method requires more computation in the controller, but can track changing conditions more rapidly than the perturb and observe method (P&O). Like the P&O algorithm, it can produce oscillations in power output. This method utilizes the incremental conductance ( $dI/dV$ ) of the photovoltaic array to compute the sign of the change in power with respect to voltage ( $dP/dV$ ).

The incremental conductance method computes the maximum power point by comparison of the incremental conductance ( $\Delta I/\Delta V$ ) to the array conductance ( $I/V$ ). When the incremental conductance is zero, the output voltage is the MPP voltage. The controller maintains this voltage until the irradiation changes and the process is repeated.

#### C. Current Sweep Method

The current sweep method uses a sweep waveform for the PV array current such that the I-V characteristic of the PV array is obtained and updated at fixed time intervals. The maximum power point voltage can then be computed from the characteristic curve at the same intervals.

#### D. Constant Voltage Method

In the constant voltage method, the power delivered to the load is momentarily interrupted and the open-circuit voltage with zero current is measured. The controller then resumes operation with the voltage controlled at a fixed ratio, such as 0.76, of the open-circuit voltage, which has empirically been determined as the estimated maximum power point. The operating point of the PV array is kept near the MPP by regulating the array voltage and matching it to a fixed reference voltage  $V_{ref}$ . The  $V_{ref}$  value is set equal to the maximum power point voltage of the characteristic PV module or to another calculated best fixed voltage.

#### IV. HARDWARE OF BUCK-BOOST CONVERTER

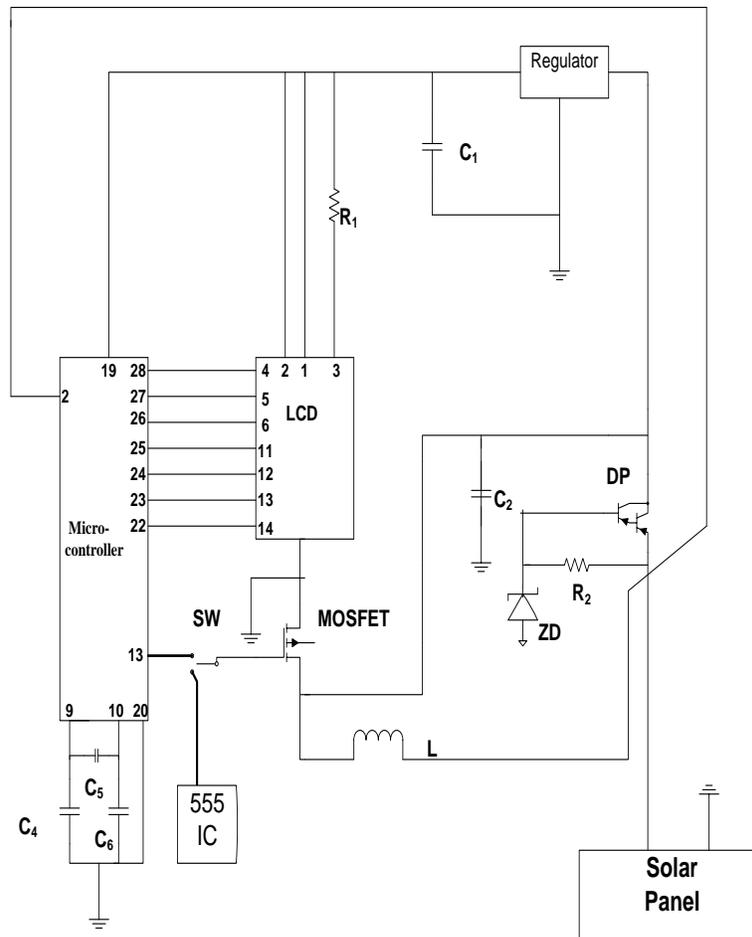


Fig. 3: Block diagram of hardware

The solar panel will generate energy when solar radiations will fall on it. The panel used here is of 6volts. A relay is connected to the panel so as to control the buck and boost action. This relay is controlled by the microcontroller. This supply from panel is then given to Darlington pair and to pin 2 of the microcontroller. The Darlington pair will increase the current gain of the supply which means it will increase the current. The output of panel given to the pin 2 of microcontroller will use this voltage for comparison as panel voltage. Then the output of Darlington pair is given to the regulator. The regulator will regulate the voltage and keep it constant to 5 volts always. These 5 volts is required by the microcontroller as  $V_{cc}$  and also by LCD. The capacitor used with regulator is used for filtering. The resistance  $R_1$  used with LCD is used for brightness, more resistive means more bright. The LCD can be used in 4-bit mode and in 8-bit mode. Here it is used in 4-bit mode.

The terminals 7, 8, 9, 10 are not used. Hence in 4-bit mode first LSB are send and then MSB are send. In 4-bit mode we are using only 4 pins so remaining 4 pins can be used for some other work and hence it is advantageous. The microcontroller used is PIC 18 (L) F25/45K22. It is a 28 pin IC. It is advantageous than 8051 as in 8051 machine cycle required are 4 where as in PIC only 1 machine cycle is required for same instruction. And other advantage is that in PIC we can perform many functions at a time where as in 8051 only one function can be performed at same time. In this PIC we are getting output to LCD from pin 22 to 28. From pin 13 triggering pulses are given to the MOSFET. At terminals 2, 10, and 20 crystal oscillator is connected. The function of crystal oscillator is to create electrical signals of precise frequency. This frequency is used to keep track of time. It is needed as we are using the inbuilt timer of the microcontroller.

The MOSFET can be triggered using 2 ways, by using microcontroller and using 555 IC. The MOSFET used is IRFZ44N. The gate terminal is connected to the pin 13 of microcontroller or to 555 IC. The drain terminal is grounded and source is connected to inductor.

A diode is connected to MOSFET which avoids the back flow of current and hence supply charge to the panel through battery during night. The inductor of 2 mH is used which is connected to source of MOSFET as it avoids its damage by reducing instantaneous change in current supplied to it. The battery which is being charged id connected across the capacitor  $C_2$ .

If the output of the panel increases above 6V it may damage the circuit hence Zener diode is connected it will ground the excessive voltage and will help to maintain constant voltage.

## V. FLOWCHART

In the buck- boost converter we are going to check the battery voltage which is connected at output and then depending on its voltage operate the converter in buck or boost mode. This is the basic advantage of using buck- boost instead of buck converter or boost converter.

The flowchart shown below is explaining the programming used. Here initially we are going to check or scan the panel and the battery voltage. Once we know these voltages then we are going to compare these voltages. If the panel voltage is greater than the battery voltage, then we will increase the PWM so as to increase the charging and if the battery voltage is good then we will have to reduce PWM so as to reduce charging. Once this PWM is controlled then we will again scan the voltages of panel and battery.

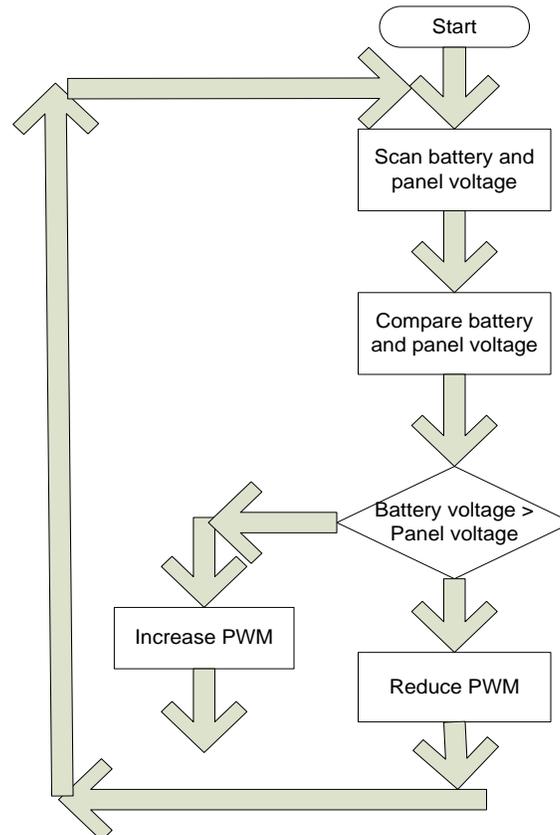


Fig. 4: Flowchart

## VI. PROGRAM

### A. Introduction to Program

It is main folder or file named ADC. We are including it so as to reduce the length of program. From instruction 2-7 information about LCD are given. In second instruction the data pin of LCD is connected to pin 4 of port B of the microcontroller. The enable pin is connected to pin 2 of microcontroller and at pin3 the reset pin is connected. Then we are interfacing LCD in 4-bit mode and two lines of LCD are used. The type of LCD is alphanumeric which means we can display alphabets and numbers both. The delay of 100millisecond is given. The LCD requires 90millisecond and 10millisecond extra time is given. The Cls instruction will clear the screen of LCD. The symbol RL for relay is given to pin 0 of port B. It is used as output relay.

Then the dimension is given to the input and output that are going to be displayed. The dimension of input from panel is taken as word (2 bytes). The dimension of output to battery is also taken as word. Then the dimension of pulse and count is also taken as word. Pull ups for port B are ON as we are connecting all the pin to port B. If there is no input to any of the pins then this instruction will set it as high.

### B. Main Program

“While” loop is started which is continuous as the condition is 1 should be equal to 1. This condition will always be satisfied. If it is true then OP (output) will be given to channel 2 of ADC and IP (input) will be given to channel 1 of ADC. Then we are starting a If... Else condition. If output is less than 9 then the relay (RL) will be turned ON. As the relay will be turned ON the 555 IC will

get connected to the MOSFET and start boosting the voltage. The next instruction is used for printing, as the voltage is less print on second line from first letter "BATTERY LOW"

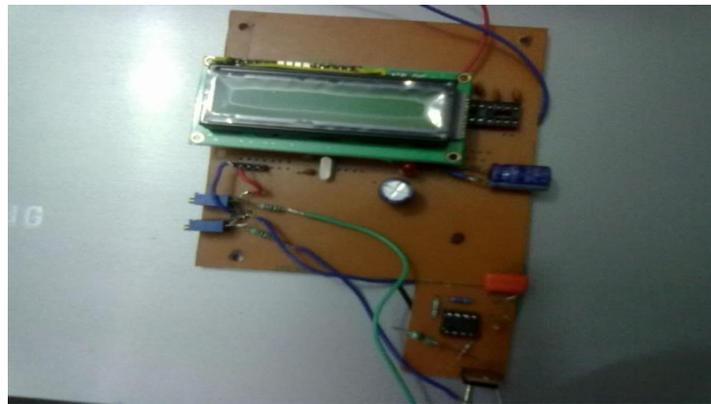
Now the else condition is if the battery voltage is more than 9 volts the relay will be turned OFF and will print on second line from first word that "BATTERY OK". Now end the if – else condition.

Say PULSE= IP which means pulse is equal to input which we are receiving from panel and we have given it to channel 1 of ADC. In the next instruction the value of pulse is changed to analog and given as PWM pulses to the gate of MOSFET.

Then we are printing in first line from first word the value of input and output in volts that was given to ADC on channel 1 and 2.

Then delay of 1 second or 1000 millisecond is given. After this delay the while loop ends and will again start from first condition and will check if  $I = 1$ . As this condition is true always this procedure will be followed again. Hence this continuous cycle will keep on going continuously.

## VII. HARDWARE



## VIII. CONCLUSION

The buck- boost converter was designed and implemented. The output obtained was boosted depending on intensity of solar radiation.

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