International Journal of Recent Advances in Multidisciplinary Topics
Volume 3, Issue 5, May 2022
https://www.ijramt.com | ISSN (Online): 2582-7839

Development of Solar MPPT System Using Boost Converter with Microcontroller

Utkarsha Adhikrao Chavan[1*], Pranav Guruprasad Kulkarni[2], Suyash Shivaji Kadam[3], Pratik Adinath Dhabu[4], Ajinkya B. Parit[5]
[1,2,3,4]*UG Student, Department of Electrical Engineering, Annasaheb Dange College of Engineering and Technology, Ashta, India*
[5]*Assistant Professor, Department of Electrical Engineering, Annasaheb Dange College of Engineering and Technology, Ashta, India*

***Abstract*: The material that can be used to generate power is depleting on a daily basis, the demand for renewable energy sources is increasing, owing to the current global energy crisis. In recent news, it has been reported that India is running out of coal, forcing us to switch to renewable energy sources such as solar and wind. In this project, we look at a design for extracting the highest amount of solar electricity possible utilizing MPPT techniques (Maximum power point tracker). We will convert and introduce the boost converter in this project, such as the boost converter, which enhances the voltage. The boost converter's premise is that the output voltage is higher than the input voltage, i.e. (V_{out}>V_{in}). Our boost converter is designed to convert the solar panel's 12-volt output to 24 volts, which is then applied to the battery. The output of the solar panel is regulated by a microcontroller unit that employs the voltage feedback approach. To safeguard the microcontroller from damage, voltage feedback is utilized to transform the 12 volts to a range of 0-5 volt.**

We can continuously monitor and measure the boost converter output and pass it to the microcontroller to generate the pulse width modulation (PWM) signal. This can affect the boost converter's duty cycle, therefore MPPT is a technology that tracks and monitors the solar panel's maximum power before delivering it to the load.

***Keywords*: Solar MPPT system, DC-DC converter, Microcontroller, Battery.**

1. Introduction

As we all know, pollution in our world is getting worse by the day, so it's critical to employ renewable energy sources like solar and wind power. Also, solar and wind generation are used in a variety of applications, such as battery charging. As we all know, as electric vehicles become more common, there will always be a need to charge the batteries in those vehicles. This need can be met by solar generation, in which we can use our solar system generation. Solar generation is more popular because it produces less pollution and has no moving parts.

Our project is needed in industries, and we may utilize it in some locations where migrant workers and sugarcane workers do not stay in one place all of the time. As a result, they are confronted with numerous issues, one of which is the lack of electricity. Sugarcane workers live in tents, which are generally in open areas such as farms or outside areas with little access to electricity. So, we can assist them by utilizing this project concept and explaining how our project works, its importance, and the ease with which they may install it in your location.

2. Objectives

- As we know sun is an ultimate source of energy but we are lagging to complete or convert the great source in to application. To fulfill low-cost energy MPPT is very efficient option.
- This project further developed to include both buck & boost converter functionalities to get different levels of voltage as per our requirement.
- Also, modification can be made to adjust the system for applications where multiple panels are used.
- A circuit was designed to monitor the power output of solar panels and adjust the operating conditions based on the control system in order to maximize the power output.

3. Block Diagram

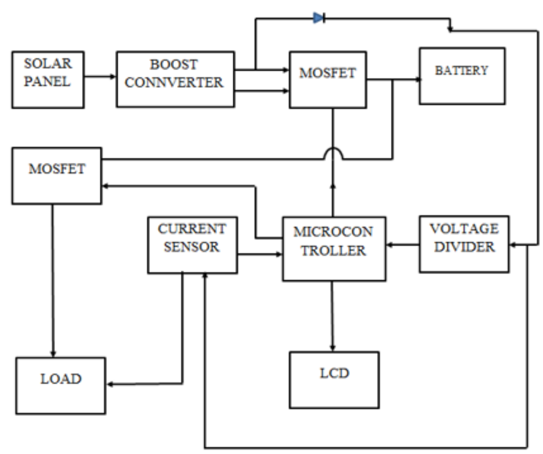

Fig. 1. Block diagram of proposed work

4. Proposed Method

We all know that irradiance and temperature have an impact on solar energy generation. We know there are three types of converters: boost, buck, and buck-boost, and they're all dc to dc. A boost converter was used to convert the output of a 12-volt solar panel to a 24-volt battery in our project. Because 24-

*Corresponding author: utkarshachavan655@gmail.com

volt batteries are not currently available on the market, we are using a lithium-ion battery and connecting two 12-volt batteries in series. Because we all know that solar panels have a low efficiency, we use a boost converter to boost their efficiency.

Moving to the MPPT (maximum power point tracker), which tracks the maximum power of the solar panels and distributes it to the load. We could also look into different approaches, such as constructing a voltage feedback control algorithm with a microcontroller. Set the duty cycle of a pulse width modulation (PWM) signal as the boost converter's output signal. As the output voltage changes, the duty cycle will fluctuate. Our project's main goal is to use a solar MPPT system with a boost converter to produce an output voltage that is higher than the input voltage. Keeps an eye on the maximum power setting when it's at its highest? We could make a simulation of our project diagram, watch it, evaluate it, and then take measurements. The findings on the LCD can also be compared to simulated results.

A. MPPT

MPPT (Maximum Power Point Tracker) is used for extracting maximum available power from PV module under certain conditions. The voltage at which PV module can produce maximum power is called “Maximum Power Point”. Maximum power varies with solar radiation, ambient temperature and solar cell temperature. There are various techniques and many projects Perturbation and Observation (P&O) method which is most preferred. In this project we have using Beta algorithm.

1) Beta Algorithm

Traditional algorithms, such as Perturb and Observe (P&O), Incremental Conductance (IC), Beta and others, have commonly been used to perform the maximum power point tracking (MPPT) in photovoltaic (PV) system.

This technique is proposed to enhance the response speed. It includes two stages such as:

1. Computing stage and
2. Regulating stage

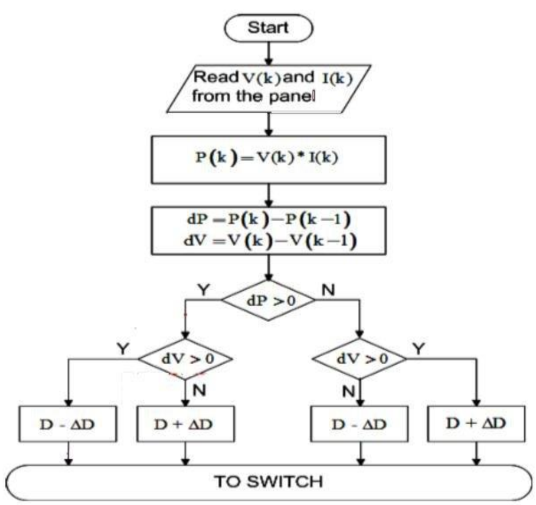

Fig. 2. Flow chart

The coarse and fine positioning operations are included in the computing stage. In the computing stage, an initial value for the duty cycle is generated based on the DC-DC converter's characteristics and the V-I curve's characteristics. The DC-DC converters duty cycle is regulated with a small step size in the regulating stage, which improves tracking efficiency.

This MPPT technique produces a response that is 4.6 times faster than the InC technique. In comparison to other methods, the Beta algorithm is superior. As a result, we chose the Beta algorithm for our project. This technique is similar to the P&O algorithm, except that in the P&O algorithm, the duty cycle oscillates at steady state, resulting in power losses, which are overcome by using the beta algorithm.

5. Description of Major Components

A. Solar Panel

Solar panels generate DC electricity by using sunlight as an energy source. Photovoltaic modules employ the photovoltaic effect to create electricity from light energy (photons) from the sun. To get the desired voltage, the cells are linked in series and then in parallel to boost current. The steps are as follows: When the sun's rays impact the panel's surface, electrons flow and generate DC electricity. This DC electricity is stored in a battery, then converted to AC electricity via an inverter, and then distributed to various applications. For solar panels, the most common material utilized for cells is Si. With photovoltaic cells, it is impossible to capture 100% of the sunshine.

Fig. 3. Solar panel

B. Boost Converter

Boost converter is a DC-to-DC converter which steps up the voltage from supply to load i.e., 12V DC of solar panel output converted into 24V DC which is applied to 24V battery. In this project for designing boost converter we have used MOSFET transistor. Boost converter output voltage is always greater than input voltage i.e., Power P=VI must be conserved; the output current is lower than the source current. The output of boost Converter is connected to battery through MOSFET switching circuit. High voltage side output current can be controlled by controlling the duty cycle of the switch.

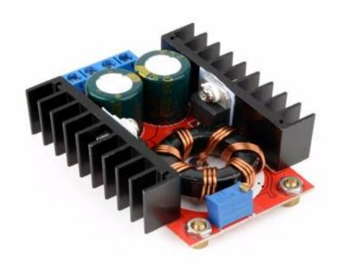

Fig. 4. Boost converter

C. *MOSFET (IRF3205)*

A voltage controller is a MOSFET. Although the MOSFET transistor is bidirectional, current can only flow across the source-drain (S-D) terminal if the source voltage exceeds the drain voltage. The IRF3205 is a high-current N-channel MOSFET with a switching current of 110A and a voltage of 55V. We used two MOSFETs in this project, one for the boost switching circuit and the other for the load circuit. The load switching kit has a MOSFET that supplies GND to the load.

Fig. 5. MOSFET IRF3205

D. *Microcontroller*

In this project ATmega328P-Pu microcontroller is used. The ATmega328 is an Advanced Virtual RISC processor (AVR). It can process data in 8 bits. It's most commonly found in Embedded System. It features a 1KB EEPROM memory, which means that even if the microcontroller's electric supply is turned off, it can still store data and produce results if the power is restored.

Fig. 6. ATmega328P-Pu

E. *Lithium Ion Battery*

Here in this project, we have used two Lithium-Ion Batteries. Each battery is having 12V, 9Ah and which is connected in series because we got 24V output from boost converter. This 24V battery is connected to load through load switching circuit. This battery stored energy up to 216W.

- Nominal Voltage of this battery is 25.6V
- Back-up of this battery is 10-11 hours, $\frac{216W}{20W}$ =10.8Wh
- When battery is fully charged then for 20W load back-up hours are minimum 6 hours. As per the company standard the maximum charging current is 2.2A

Here, in this project the charging current of battery is 0.5A. Battery is connected to 20W load so battery is discharged by 20W. We can use 25% of total battery,

$$24*\frac{25}{100} = 18V$$

In this, 24V battery of minimum cut-off is 22V and maximum charging cut-off is 27.50 V.

Fig. 7. Lithium-ion battery

6. Calculations

A. *For Duty Cycle*

$$D = 1- \frac{V_{in\,min.} * \eta}{V_{out}}$$

$$= 1- \frac{(9*1)}{24}$$

$$= 0.33 \text{ duty cycle}$$

B. *Inductor Selection*

$$L = \frac{V_{in}*(V_{out}-V_{in})}{\Delta I_L * F_s * V_{out}}$$

$$\Delta I_L = 0.4*Iout_{max}*\frac{V_{out}}{V_{in}}$$

$$= 0.4*10*\frac{24}{9}$$

$$=10.64\text{Amp}$$

$$L = \frac{9*(24-9)}{10.64*10^3*24}$$

$$= \frac{135}{2553600}$$

$$= 52.8\mu H$$

7. Proposed Work

Our project is divided into two parts, the first of which is the simulation and the second of which is the hardware. We used the MATLAB simulator to simulate the software part. So, according to MATLAB, we are getting 24 volts from the solar panel's 12-volt output.

As a result, the voltage is converted from 12 V to 24V using a boost converter. For the tracking system in the MPPT program, we use the Beta algorithm. As a result, it's used to track the maximum power delivered from the source to the load. We obtain the PV curve and the maximum power track at 80W from the input to the load after running the program.

Our project goal is to achieve a constant voltage of 24V using a boost converter with a duty cycle controlled by a microcontroller Beta algorithm program.

Inductor, capacitor, resistors and a switch are used in the boost converter design. The voltage measurement block is used to measure the boost converter's output voltage. The boost converter's MOSFET is controlled by the pulse generator's pulse signal. Resistors, inductors, and capacitor values are set accordingly.

8. Hardware Result

Fig. 8. Hardware Setup

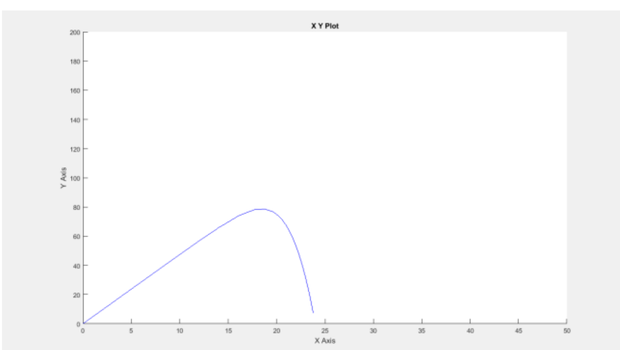

Fig. 9. MPPT PV curve

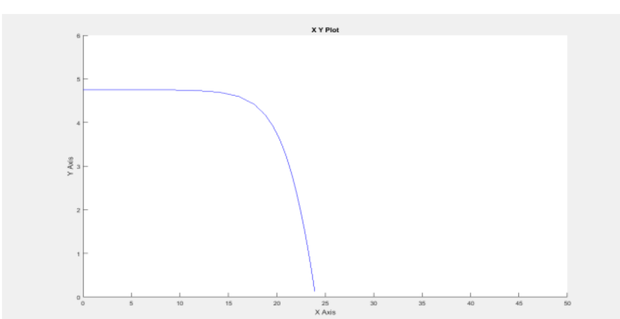

Fig. 10. I-V curve

Table 1
Result and discussion

Type	Actual Value	Observed Value
Battery Charging Current	0.5A	0.5A
Battery Charging Voltage	24V	24.65V

From above results it is clear that the actual output value is similar to observed output value which is displayed on LCD. Also, real time inductor value and solar efficiency is displayed on LCD. Some minor change in voltage because solar voltage variations or load variations.

9. Conclusion

In this project we have designed the solar MPPT system using boost converter. We have studied all MPPT techniques, compared them and selected most efficient technique for our project. According to comparative study we have chosen the beta algorithm for our project. Furthermore, this system aids in better resource allocation for all consumers. This controller's algorithm is more efficient than others. This will improve the efficiency of the system. The battery is charging faster, according to the performance analysis. Also, at the maximum point, extract maximum power. As per result analysis we have got approximate 24 V output voltages and this output voltage is converted from solar output of 12 V by using boost converter.

References

[1] S. Z. Hassan, H. Li, T. Kamal, J. Ahmad, M. H. Riaz and M. A. Khan, "Performance of Different MPPT Control Techniques for Photovoltaic Systems," 2018 International Conference on Electrical Engineering (ICEE), 2018, pp. 1-6.

[2] Fernando Lessa Tofoli, Dênis de Castro Pereira, Wesley Josias de Paula, "Comparative Study of Maximum Power Point Tracking Techniques for Photovoltaic Systems", International Journal of Photoenergy, vol. 2015, Article ID 812582, 10 pages, 2015.

[3] B. M. Hasaneen and A. A. Elbaset Mohammed, "Design and simulation of DC/DC boost converter," 2008 12th International Middle-East Power System Conference, 2008, pp. 335-340.

[4] Vikas R. Gurav, Sunil S. Patil, Akshay S. Salokhen and P. V. Kothawale, "Implementation of MPPT Charge Controller Based Buck-Boost Converter," International Research Journal of Engineering & Technology, vol. 4, no. 3, March 2017.

[5] Nilesh V. Memane and V. S. Ponkshe, "Design & Simulation of DC-DC Boost Type PWM based Solar Charge Controller for Constant Output Power Under Partial Shading Conditions," International Journal of Science and Research, vol. 6, no. 2, Feb. 2017.

[6] Tolentino, L.K., Abacco, D.F., & Siquihod, M.J. (2019). Efficiency Improvement of Commercially Available MPPT Controllers Using Boost Converter. EngRN: Embedded System (Topic).

[7] Asmita S. Mane, and V. A. Mane, "Incremental Conductance Maximum Power Point Tracking Algorithm for Photovoltaic System," International Research Journal of Engineering and Technology, vol. 7, no. 9, Sept. 2020.

[8] T. Sridhar, and Anish Kumar J., "Development of solar MPPT System Using Boost Converter with Microcontroller," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 1, no. 4, October 2012.

[9] M. F. F. ROSDIN and F. Mustafa, "Study of Battery Charging Methods for Solar Renewable Storage Energy System", Progress in Engineering Applications and Technology, vol. 2, no. 2, pp. 508–518, Dec. 2021.

[10] Marhaposan Situmorang et al., "Solar Charge Controller using Maximum Power Point Tracking Techniques," IOP Conf. Series: Journal of Physics: Conf. Series 1230 (2019) 012090.

[11] V.C. Kotak, and Preti Tyagi, "DC To DC Converter in Maximum Power Point Tracker," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 2, no. 12, December 2013.