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IMPROVED MPPT CONTROL BASED GRID CONNECTED PV SYSTEM

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Abstract- The aim of this work is to design and optimize the solar charger which increases its capacity of solar energy using SEPIC converter. The SEPIC converter allows and maintain the constant dc output voltage. This system is analysed by using a PID controller for the optimization of power and improve its power capacity. This paper proposes Maximum Power Point Tracking (MPPT) control strategy for grid-connected solar systems based on Incremental conductance. An improved Maximum Power Point Tracking (MPPT) control system for a grid-connected Photovoltaic (PV) system enhance the efficiency, reliability, and performance of the system. The purpose of the suggested method is to create as much power as feasible from a PV system during environmental changes, then transfer it to the power grid. To accomplish this, a hybrid combination of incremental conductance and optimization are proposed to locate maximum power followed by model predictive control to track maximum power and control the SEPIC converter to achieve high performance regardless of parameter variations. The proposed system is simulated and evaluated in a variety of dynamic conditions using Matlab/Simulink.
Key terms: MPPT, SEPIC converter, PID controller, Photo Voltaic System.

INTRODUCTION

The converter plays a major role for power transmission and saving power. Renewable energy like solar wind etc., can is used for power generation for a specific application. In general charging applications can utilize the solar energy for better performance. Input control of the converter is found to crucial for designing an energy-based converter is depicted in. SEPIC converter analysis is made in detail with. Converters like SEPIC, BUCK, BUCK BOOST, KY boost, and LUO converter can be used for solar power generation. Comparing to the operation of the entire converters SEPIC converter provides us the better performance for charging application. Different controllers can be adopted with converters for stable operation of the application. Soft computing techniques like fuzzy controller, neural controller place a major role in stability of the operation. Charging applications like mobile charging and laptop charging with solar energy is essential. Requirement for charging a mobile is 5V and for laptop it is less than 25V. In these days at the beginning of the 21st century, energy demand is increasing day by day. However, in order to meet this energy need, it is thought that choosing renewable energy sources (RES) instead of fossil-based fuels, which have very harmful effects on the environment such as greenhouse gas emissions and pollution, will minimize these effects. The use of RES is no longer a matter of preference for societies that think of the future and becomes a necessity.

Solar energy is one of the most important and sustainable RES. Photovoltaic (PV) panels are widely used in recent years to take advantage of the infinite energy of the Sun. This energy, which reaches the Earth from the Sun by traveling a long way, varies depending on atmospheric events . There are many applications in the literature where the energy obtained from PV panels is used directly. However, this way of use reduces efficiency considerably. In addition, in applications where PV panels are not used efficiently, it may be necessary to use more panels to generate the demanded energy. This means both an increase in costs and the carbon footprint against the intended use of RES. For such reasons, it is very important to continuously monitor the energy obtained from PV panels and to try to obtain maximum efficiency. In line with this purpose, applications that perform maximum power point tracking (MPPT) increase efficiency by providing maximum power from PV panels continuously. When these applications are examined, it is seen that PI or PID controllers are used for reasons, such as being easier to understand and applicable. However, when the relevant literature is examined, it is seen that the parameters of these controllers, which have a simple structure, are determined by trial and error. This method used in parameter determination also prolongs and complicates the system design process. In addition, the system parameters need to be rearranged in case of any change that may occur in the system to be controlled (changing the system scale, adding a different energy element, etc.). On the other hand, when it comes to complex structured nonlinear systems, these controllers are insufficient.

In PV panel applications, system parameters are constantly changing due to its nature. Using adaptive controllers like Fuzzy Logic Controller that can quickly respond to variable system parameters may be appropriate to overcome such constraints. Considering all these cases, fuzzy logic controllers are preferred in applications where MPPT is desired, despite the need to develop more complex algorithms and apply more effective coding techniques due to their relatively more complex mathematical calculations. Indeed, this market knows a remarkable growth, because it provides electricity from an inexhaustible and clean energy source. This makes the return on investment of a photovoltaic installation more and more interesting. However, a photovoltaic system can be exposed, during its operation, to external influences leading to a decrease in its performance. These consequences will obviously reduce the productivity of the installation, and therefore reduce its profit. A PV system is composed by PV modules, electronic converters, battery, battery charge controller, inverter, MPPT controller and some components of the low-voltage switchgear. The output characteristics of PV modules depend on the environmental conditions especially solar irradiance and external temperature. In order to extract and exploit the maximum power generated by a photovoltaic module, Maximum Power Point Trackers (MPPT) are employed using different algorithms. MPPT techniques differ in terms of response time, stability and reliability. A combination of MPPT methods can be proposed to find a compromise between these criteria. Several MPPT techniques have been developed in the literature based on different topologies and with diverse complexity, cost and overall efficiency. In this paper, we present an overview of the most stated MPPT methods and we classify them into three major categories:indirect MPPT, direct MPPT and artificial intelligence based MPPT. Comparison of these techniques is provided based on the literature results. Besides, the implementation of two MPPT methods is carried out in Matlab/Simulink environment and the simulation results are discussed.

SYSTEM ANALYSIS

EXISTING SYSTEM

A DC-DC converter nothing but step-up converter is a power converter with an output dc voltage greater than its input dc voltage, Battery powered systems often stack batteries in series to achieve higher voltage. However, stacking batteries is not possible in many high voltage applications due to lack of space. Boost converters can increase the voltage and reduce the number of cells. Two battery-powered applications that use boost converters lighting systems.

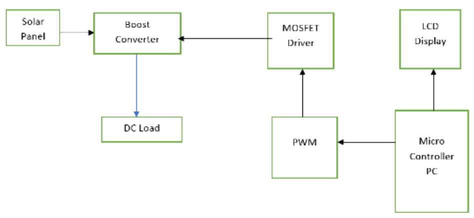


Fig: |Block Diagram of Existing System

EXISTING SYSTEM DRAWBACK

- They are physically larger for the same capacitance and working voltage as other types.
- They have a higher leakage current than most other types.
- They are not very good for low frequency applications.
- They can only be mounted vertically because of the liquid electrolyte inside.

PROPOSED SYSTEM

The Buck Boost converter is the most widely used converter for a wide range of renewable energy sources. Even though the theoretical gain of the ideal Boost converter can reach up to infinite value with the increase in the operating duty cycle, but the presence of the parasitic makes it really difficult to reach up to a voltage gain. At the same time, the efficiency of the power conversion also drops down with the increase of the voltage gain. Hence, for the voltage Boosting application, if we go for cascading of the converters, then the overall system efficiency will drop down in geometric progression.

The production of electricity is one of the largest blessings that were given by the science to mankind. It has also become a component of the present life and one cannot imagine a world without it. The need for electricity to work with electronic gadgets and electrical appliances for our day-to-day life

increases drastically. To reduce the utilization of energy from electricity board, solar power is used

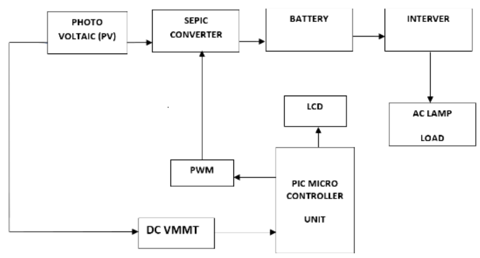


Fig: Block diagram of Proposed System

MAXIMUM POWER POINT TRACKING

The output characteristics of solar modules depend, in particular, on solar irradiation and temperature. Under all environmental conditions, there is only one operating point that correspond to the maximum power generated by the PV module called Maximum Power Point (MPP). In order to ensure that the photovoltaic cell is generating the maximum power that it can provide, a Maximum Power Point Tracker (MPPT) should be employed. The MPPT algorithm is implemented in a DC-DC converter to adapt the impedance of the electric charge to the maximum power. A block diagram of Maximum Power Point Tracking process is illustrated. A classification based on the most stated MPPT techniques can be given into three major categories that are presented below. A Indirect Maximum Power Point Tracking Fractional Open Circuit Voltage. The fractional open circuit voltage (FOCV) method is based on a linear relationship between the voltage at the MPP (Vmpp) and the open circuit voltage (Voc) as described. The constant of proportionality, k, depends on the environmental conditions (irradiance and temperature) and the PV technology. For crystalline silicon, the literature reports a value between 0.7-0.8. In order to estimate the Vmpp, the Voc should be measured every time the metrological conditions change. This is achieved by disconnecting the PV module from the load instantaneously, which leads to a loss in the generated power. Besides, the constant k is only approximate, then the FOCV technique does not give the accurate Vmpp but only a near value. In FOCV based MPPT was proposed with a short sampling time providing a low-cost circuit which is appropriate for low power photovoltaic applications. The proposed technique was experimented and has proven good performance. It combined the FOCV technique with the conventional P&O method. The results of this work showed a robust MPPT under variable irradiance. The proposed method tracks the MPP with less oscillations compared to the conventional P&O. An optimization of the conventional FOCV was carried out. The measurement of the Voc was performed on only one PV pilot cell on the edge of the PV panel. During the measurement, only the pilot cell is detached from the panel and the other cells continue their performance. The proposed method suits the small PV systems and provides better efficiency than the conventional FOCV method. The PV panel model block has two inputs that represent temperature and irradiance values. The temperature input is set to be 25ºC, which is the ideal temperature at which catalogue data were obtained. Irradiation input values are entered according to the amount of radiation that differs during the day. Thus, it is possible to monitor the response of the system to varying irradiance values. This block also outputs the maximum power that can be obtained from the PV panel. This enables the results obtained from the developed fuzzy logic-based MPPT algorithm to be compared with the values they should have, thus evaluating the performance of the developed algorithm. A resistor is used to represent the loads to be connected to the system. In addition, the current and voltage values at the output of the PV panel and on the load, which are very important for the developed algorithm, were determined using the relevant sensors. The DSP environment has also been simulated so that the microcontroller embedded codes can be automatically generated. In order to process the measured analog values by DSP, an analog to digital converter (ADC) block, to generate DC-DC boost converter switching signals according to the determined duty ratio value a pulse width modulation (PWM) block, and to write the developed algorithm in C language a Simplified C block was used.

PERTURB AND OBSERVE (P&O)

The P&O algorithm is based on the fact that the PV power as a function of PV voltage. The principle of this algorithm is to apply a perturbation to the PV array voltage, current or duty cycle. This implies an increase or a decrease in power. If the increase in voltage involves an increase in power, therefore the operating point is on the left of the MPP, and then the perturbation continues in the same direction. Otherwise, if the increase of voltage generates a decrease of power, thus the operating point is on the right of the MPP and the perturbation is occurred in the opposite direction. The MPP is reached after a number of iterations. Thanks to its simplicity and ease of implementation, the P&O technique is one of the widest applied MPPT methods in practice and it is widely studied in research. The literature states satisfactory results for this method even with itsconventional algorithm.For instance, in the P&O technique was implemented with a Boost converter using Matlab/ Simulink environment. The results of this work revealed a good tracking of the MPP. The authors of another work carried out an implementation of P&O algorithm with CUK converter and concluded an efficient performance of the algorithm. In the authors compared the reference voltage perturbation based P&O technique to the P&O technique based on direct duty ratio perturbation for standalone PV pumping system application. The results showed that the response to the changes of irradiance and temperature is faster for the reference voltage perturbation technique. As for stability, it is degraded for the reference voltage perturbation under high rate of perturbation or when low-pass feedback filters are utilized. Besides, the energy utilization is better for the duty ratio perturbation technique.

COMPARISON OF MPPT TECHNIQUES

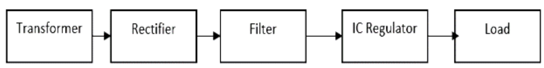
The literature has shown that The FVOC algorithm is based on only an approximation of Vmpp and the fact of disconnecting the load each time the Voc should be measured, leads to a loss in power. As an improvement of this method the pilot cell was used. The conventional P&O algorithm is easy to implement however, it is difficult to get the accurate MPP due to the permanent oscillations at steady state. For this reason, some modifications were proposed to improve the basic P&O algorithm using variable step size. The Inc. algorithm, unlike P&O, does not have oscillations and it can track MPP even under the sudden change in atmospheric conditions. The disadvantage of Inc. method is its relatively complex implementation. The Artificial Intelligence (AI) methods have proven good performance and efficient tracking of MPP under different conditions and they converge to the MPP without oscillations.

OVERALL CIRCUIT DIAGRA1E47M DESCRIPTION

POWER SUPPLY

BLOCK DIAGRAM

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.



Fig|Block diagram (Power supply)

WORKING PRINCIPLE

TRANSFORMER

The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op–amp. The advantages of using precision rectifier are it will give peak voltage output as DC, rest of the circuits will give only RMS output.

BRIDGE RECTIFIER

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners.

Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

The path for current flow is from point B through D1, up through RL, through D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction. In flowing through RL this current develops a voltage corresponding to that shown waveform (5). Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

This may be shown by assigning values to some of the components shown in views A and B. assume that the same transformer is used in both circuits. The peak voltage developed between points X and y is 1000 volts in both circuits. In the conventional full-wave circuit shown—in view A, the peak voltage from the center tap to either X or Y is 500 volts. Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts.

The maximum voltage that appears across the load resistor is nearly-but never exceeds-500 v0lts, as result of the small voltage drop across the diode. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage, which is 1000 volts. Therefore, the peak output voltage across the load resistor is nearly 1000 volts. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage than the conventional full-wave rectifier circuit.

IC VOLTAGE REGULATORS

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground.

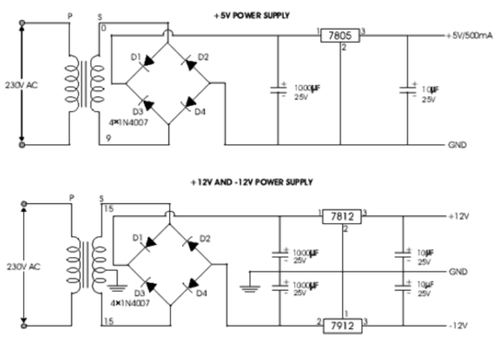


Fig Circuit diagram for Regulators

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

- For ICs, microcontroller, LCD - 5 volts
- For alarm circuit, op-amp, relay circuits - 12 volts

VOLTAGE DIVIDER:

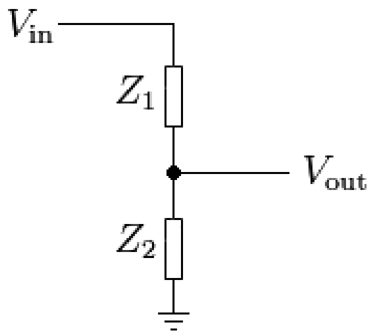


Fig Voltage divider

In electronics, a **voltage divider** (also known as a **potential divider**) is a simple linear circuit that produces an output voltage (V_{out}) that is a fraction of its input voltage (V_{in}). **Voltage division** refers to the partitioning of a voltage among the components of the divider.The formula governing a voltage divider is similar to that for a current divider, but the ratio describing voltage division places the selected impedance in the numerator, unlike current division where it is the unselected components that enter the numerator.A simple example of a voltage divider consists of two resistors in series or a potentiometer. It is commonly used to create a reference voltage, and may also be used as a signal attenuator at low frequencies.

SIMULATION

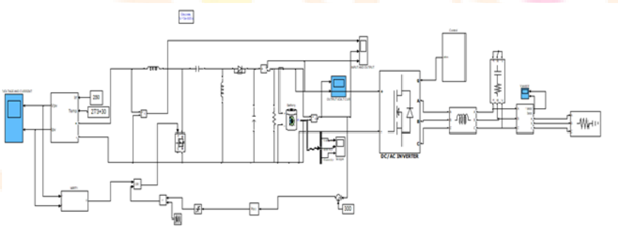


Fig: Simulation Diagram

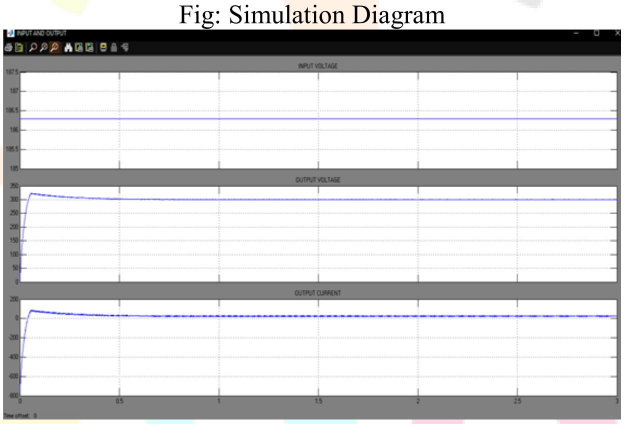


Fig Solar Input and Output Waveform

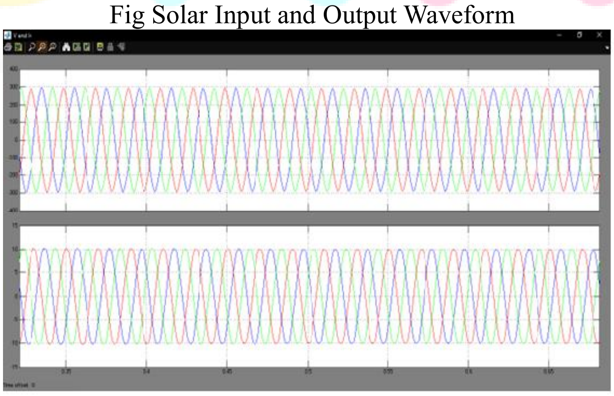


Fig: Inverter Volage and Current Output

CONCLUSION

The dc-dc conversion is mostly used to maintain full operation in battery operated circuits. SEPIC converters are used for that purpose which assesta the price of the extra inductor and capacitor to maintain the stable operation. Simulation results for the physical potentiometer-controlled SEPIC converter provide 90% efficiency which is helpful to maintain the voltage throughout the process. Additionally, an optimization technique can be implemented to increase the peak efficiency with durable cost.

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