# DESIGN AND IMPLEMENTATION OF CONVERTERS USING MPPT IN AN ECO VECHCLE

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**Abstract -** *The photovoltaic (PV) systems are found to be the best source employing conventional source of energy from the sun. However these photovoltaic arrays do not deliver a maximum power automatically and shows a non linear behavior and hence it produces a non linear I-V curve due to sunlight radiance and temperature. In order to overcome this drawback a SEPIC converter which regulates the linear output is employed and we track the maximum power point obtained by using perturb and observe (P&O) algorithms to obtain maximum power. To control the converter topologies, fuzzy logic control is used. For storing the obtained voltage from the photo voltaic system we use a 48V battery. Thus the overall efficiency and performance of the solar eco vehicle has been improved.*

***Key Words*: Photovoltaic system, Maximum power point tracking, SEPIC converter, Fuzzy logic controller.**

## 1. INTRODUCTION

The rapid depletion of non renewable energy resources is the major problem nowadays. In addition to this, the population is increasing at a greater extent which increases the demand of electricity. Hence we use renewable energy resources which are found as an effective alternative for the conventional energy resources. One such example of such a replacement is the solar eco vehicle. This vehicle uses photovoltaic systems which absorbs the sunlight and converts this to Direct Current (DC). This DC produces non linear I-V characteristics due to sun radiance and temperature which varies due to time. As the irradiance of the sun is more the temperature of the photovoltaic system increases which reduces the overall efficiency of the solar panel. If the irradiance of the sun reduces maximum power cannot be obtained. This also reduces the efficiency of the panel. Hence the panel efficiency has to be improved. This drawback can be overcome by designing and employing certain power electronic devices such as converter and controlling circuits. The non linear power that is obtained as output from the photovoltaic system, which is due to irradiance of the sun and temperature changes is being corrected by using a suitable converter. In case of a photovoltaic system, the output varies with time. Hence the output from the solar panel should be boosted or reduced in order to obtain the desired output. If the desired output voltage has to be increased, we use a buck converter and if the desired output voltage has to be reduced we use a boost converter. But the output voltage of a solar panel has to be increased or reduced comparing the desired output voltage with the present output voltage. For this reason we cannot use a buck converter or a boost converter. Hence we require a buck- boost converter with increases or reduces the output voltage according to the desired voltage but this buck boost converter has certain disadvantages. Hence a SEPIC converter is being used for this operation. Thus a variable fluctuating DC is being converted into stiff DC by using converters. But still the I-V characteristics is non linear and hence we use Maximum power point tracking technique, where the maximum power is being tracked and set as reference power which is being compared with the present power and accordingly adjusted to produce a smooth I-V characteristics. This maximum power point tracking (MPPT) technique is done with the help of perturb and observe algorithm. To obtain maximum power the firing pulses of the converter has to be controlled using a controller circuit. Here, fuzzy logic controller is being employed. Hence the output voltage of the converter is being controlled with great accuracy by controlling the firing pulses of the converter. Thus the efficiency of the photovoltaic (PV) systems has been increased due to the design of converters and controllers. Finally, the obtained DC voltage is being stored in a battery for later use of energy.

## 2. BLOCK DIAGRAM OF PROPOSED AREA

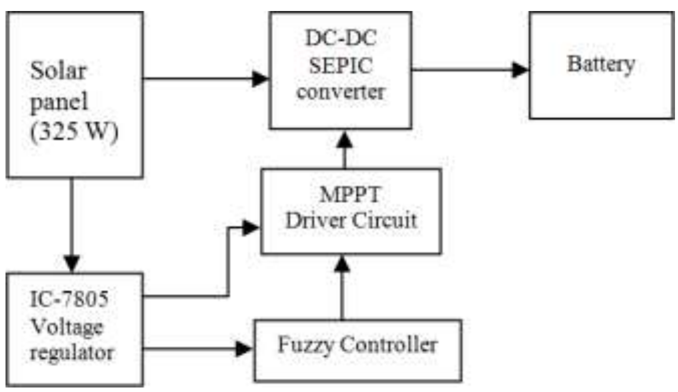


**Fig -1**: Block Diagram

## 3. ENERGY ABSORPTION AND CONVERSION WORKING OF SEPIC CONVERTER

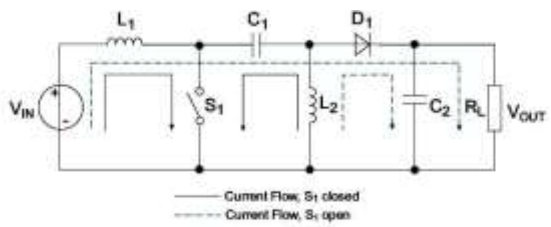


**Fig – 2:** Working of SEPIC Converter

To increase the overall efficiency of the photovoltaic (PV) system we employ a SEPIC converter, because the output voltage from the solar panel is fluctuating and variable DC which cannot be stored in a battery. Hence this fluctuating DC has to be converted into stiff DC with the help of a DC-DC converter. If the output voltage has to be increased, we use a boost converter else we require buck converter. In the case of a photovoltaic system we sometimes need to increase or reduce the output voltage, hence a buck boost converter can be used. But buck boost converter has certain disadvantages such as poor transient response, need of a filter in the input side, high peak current etc. Thus we use a SEPIC converter which can increase or lessen the output voltage of the photovoltaic system. The block diagram of a SEPIC converter shows that it employs two inductors L1 and L2, three capacitors Cin, C1 and C2, a switch S1, a diode D and a resistive load R which are connected in series and parallel. The capacitor Cin is used as a filter capacitor, C1 as coupling capacitor and C2 as decoupling capacitor.

### 3.1 CASE 1: WHEN SWITCH S1 IS OPEN

When the switch S1 is open, input voltage flows through inductors L1 and L2, capacitances Cin, C1 andC2, Diode D1 and load R. The capacitances and inductances charges at this case. Voltage flows through inductor L1, capacitor C1, inductor L2, diode D1, capacitor C2 and load RL. This is the voltage path when the switch S1 is open. This switch can be of any switching device, but in this case we use a MOSFET . The main aim of using this SEPIC converter is to increase or reduce the output voltage to achieve the desired output. This is done by adjusting the pulse width modulation signals which is applied to the switching device that is MOSFET. The output voltage of the SEPIC converter is boosted by increasing the ON time of the PWM signals fed to the converter. And the output voltage of this converter can be reduced by reducing the ON time and increasing the OFF time.

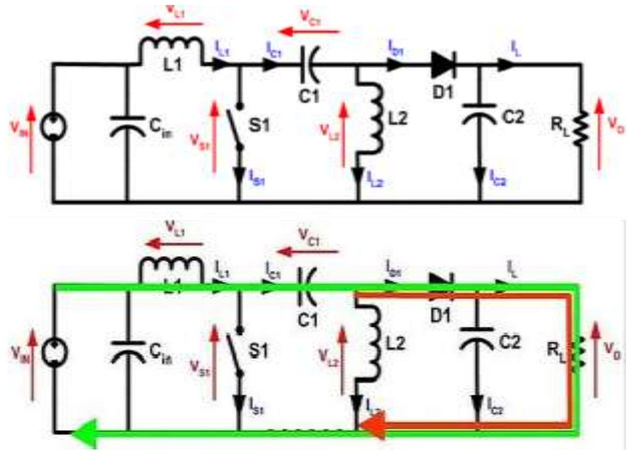


**Fig – 3:** Circuit Diagram when switch S1 is open

### 3.1 CASE 2: WHEN SWITCH S1 IS CLOSED

In this case, when the switch S1 is closed there exists two loops of operation, because the current flows through the low impedance path and hence it passes through loop1 which is indicated in green lines in the figure. Only the leakage current flows through the loop2 that is through capacitor C1, inductor L2, capacitor C2, diode D1 and load RL which is indicated in red lines. Only very less voltage passes through the load .Thus the operation of a SEPIC converter is being discussed.

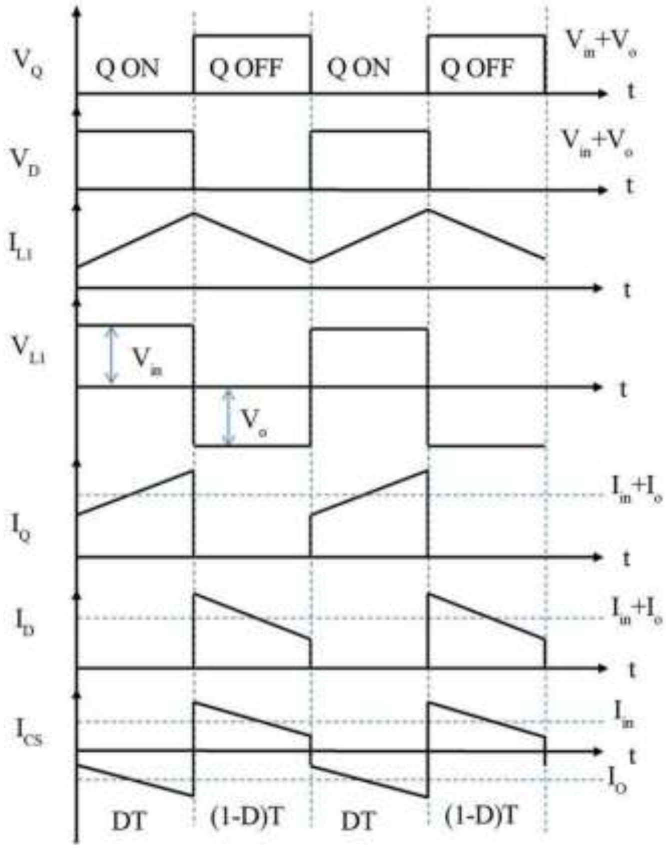


**Fig - 4:** Waveform of SEPIC Converter

The above graph shows the waveform of SEPIC converter when the pulses are being applied. The voltage and current characteristics with respect to time are being plotted accordingly. Hence using SEPIC converter, the desired output is being brought by varying its firing pulses. Thus the output which is obtained can be increased or decreased according to the output from the photovoltaic module. This SEPIC converter is fed with PWM signals by a controller.

## 4. MAXIMUM POWER POINT TRACKING TECHNIQUE

The general output power-voltage (P-V) waveform of the photovoltaic system is being shown below. From the graph we can infer that, the P-V characteristic is not linear due to solar radiance and temperature. general the output current of PV module is mainly depends on irradiation level, whereas, the output voltage of PV module depends on temperature level. However the power variation at different temperature is very small, so only the irradiation variation is the main factor of output power of PV array. In order to overcome this we use a maximum power point tracking technique. This technique employs perturb and observe (P&O) algorithm for tracking the maximum power point of the panel.

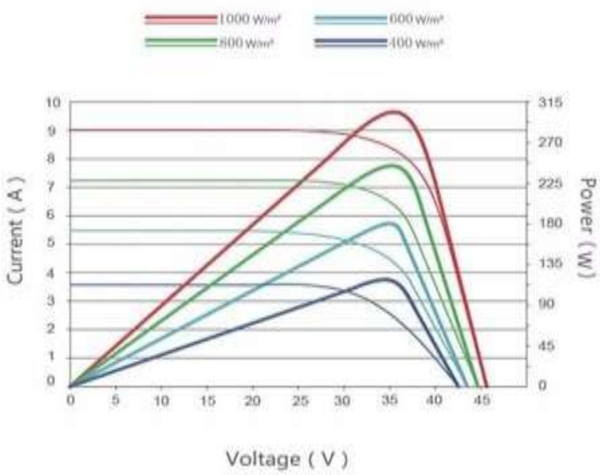


**Fig – 5:** General P-V Characteristics of PV panel

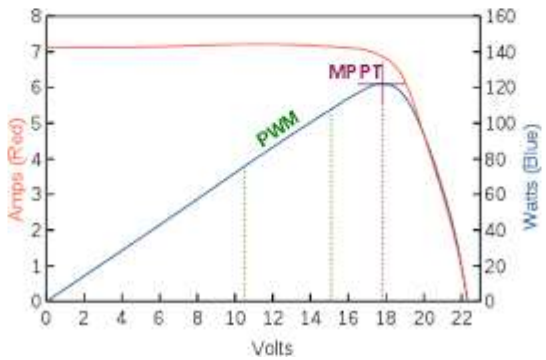


**Fig - 6**: P-V Characteristics of PV panel after implementing MPPT technique

Thus using P&O algorithm, the maximum power point is set as reference and the present power is being compared with the reference and accordingly the reference voltage is being adjusted. The flowchart of Perturb and Observe algorithm is sketched as follows.

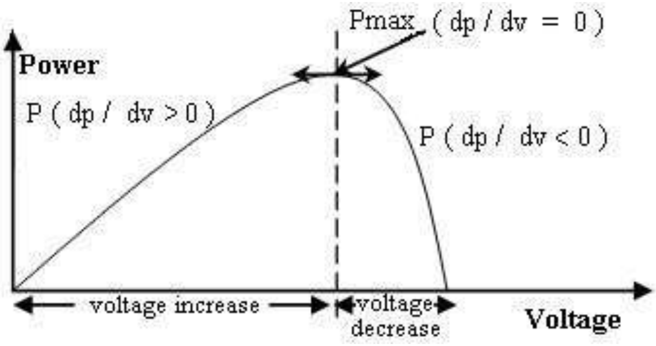


**Fig - 7:** P-V characteristics after employing MPPT Technique in SEPIC converter topology

Thus by using perturb and absorb algorithm, we could obtain the maximum power point tracking, which produces a linear P-V output characteristic curve at all operating conditions.

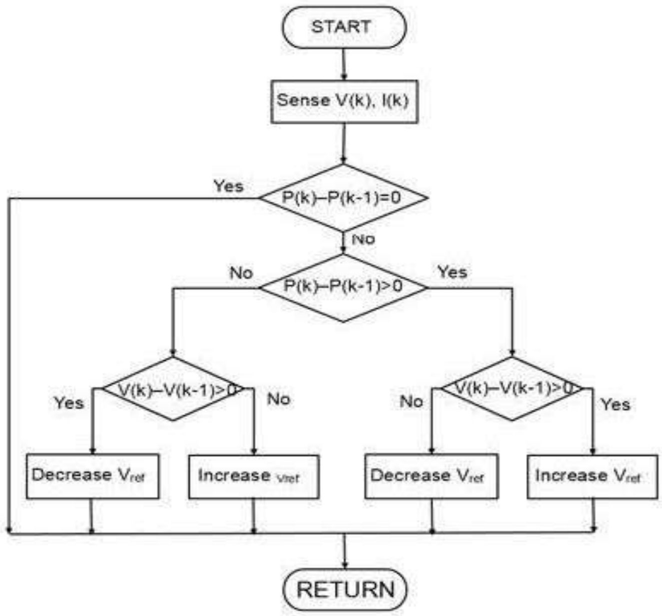


**Fig – 8:** Flowchart of Perturb and Observe algorithm

## 5. FUZZY LOGIC CONTROLLER

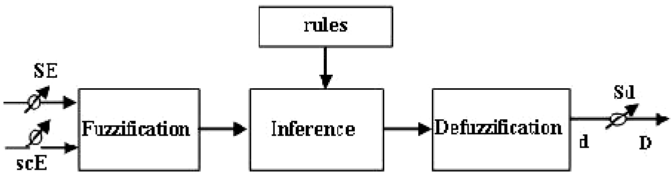


**Fig – 9:** Block diagram of fuzzy logic controller

Fuzzy logic controller is used to provide the Pulse width modulated (PWM) signals to the SEPIC converter. If the ON time of the PWM signal is increased, the output voltage can be boosted. The fuzzy logic controller can have multiple inputs multiple outputs, Whereas P, PI or PID controllers have only single input and single output. Hence for this reason fuzzy logic converters are being used in the place of conventional converter circuits. This controller can provide more accurate control than other converters. The first process to be done is fuzzification. Conversion of crisp inputs into fuzzy inputs is called as fuzzification. This inputs are being compared with the rules which are being set accordingly. Now the output obtained is being defuzzified, as the output is to be converted again to crisp form. This output thus produced is being compared with the reference carrier signal. This reference carrier signal is fixed whereas the output waveform varies with time. The amplitudes at the point of interfering of the reference wave and output are being compared and the required PWM signals are being obtained, which is used to provided to the SEPIC converter to obtain the linear desired output. This PWM signal can have more ON time or less ON time after comparing the two waveforms. If the ON time of the PWM signals is more, the output voltage boosts up and if ON time is less and OFF time of the PWM signal is more, then the output is reduced compared it the input to the SEPIC converter. Thus the firing pulses of the SEPIC converter are being varied to control its output voltage

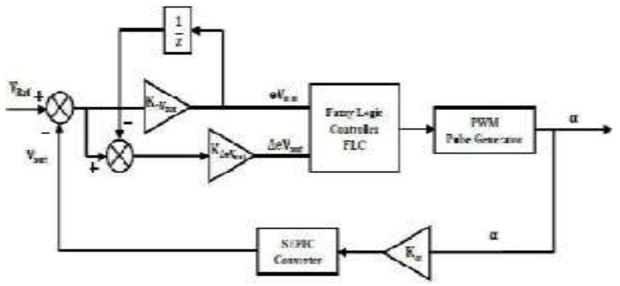


**Fig – 10:** Block diagram of fuzzy logic controller for SEPIC converter

The membership function conversion and the rules that are to be formed by programming it in Embedded C during hardware implementation of this project, whereas the rules and membership function can directly set in the MATLAB software during the software implementation. Hence fuzzy logic controller proves to be a more efficient and accurate way of controlling the SEPIC converter to obtain a overall linear P-V characteristic curve from the output of the photovoltaic module employed in the solar eco vehicle.

## 6. CONCLUSION

We have designed a more efficient SEPIC converter employing maximum power point tracking (MPPT) algorithm to obtain linear P-V characteristics of the photovoltaic module and a fuzzy controller to generate the required pulse with modulation (PWM) signals which is more efficient and accurate is fed to the converter for varying its firing pulses and the DC output from the converter is stored in a 48V battery.

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