SOLAR PANEL BASED MAXIMUM POWER POINT TRACKING USING SEPIC CONVERTER FOR AGRICULTURE PUMPING

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Abstract:

The main aim of the project is to track the maximum power point of a solar panel under varying meteorological conditions and also over coming the disadvantages of buck boost convertor over non inverted voltage. Every PV panel has an optimum operating point which varies depending on cell temperature, the isolation level and array voltage. So, in order to maximize the PV output power, a maximum power point tracker should be used in PV system. SEPIC converter is one of the buck-boost converters which maintain the output voltage as constant irrespective of the solar isolation level and the output is stored in battery and further used for agriculture pumping.

Keywords: Battery power supply, PIC Microcontroller, Solar panel, SEPIC converter, Voltage Sensor, LCD display.

1. Introduction:

Solar power is a renewable energy source that might replace fossil fuel dependent energy sources. However, for that to happen, solar power cost per kilowatt-hour has to be competitive with fossil fuel energy sources. Currently, solar panels are not very efficient it has 12-20% efficiency to convert sunlight to electrical power. The efficiency can drop further due to other factors such as solar panel temperature and load conditions. In order to maximize the power derived from the solar panel, it is important to operate the panel at its optimal power point. To achieve this, a type of charge controller called a Maximum Power Point Tracker will be designed and implemented. This paper presents a PIC Microcontroller based pulse width modulated (PWM) DC-DC circuit is used to extract maximum power from solar PV panel. I-V characteristic curve of photovoltaic (PV) generators based on various DC-DC converters was proposed and concluded that SEPIC converter is the best alternative to track maximum power from PV panel.

A DC-DC converter with simpler structure and higher efficiency has been an active research topic in the power electronics. A SEPIC is similar to a traditional buck-boost converter, but has advantages of having non-inverted output ,superior current purity and higher frequency. It also operates at lower switching losses ,low output voltage losses, higher efficiency, and allows high frequency operation Non-inverting buck-boost topologies require more active components. SEPICs are useful in applications in which a battery voltage can be above and below that of the regulator's intended output. In this proposed system, a prototype SEPIC converter is designed to Charge the battery from the solar panel. A Maximum Power Point Tracking algorithm is required to increase the efficiency of the solar panel. MPPT is a method that compensates for that changing voltage and current characteristic of solar panel and maximum utilization of solar energy from panel. MPPT is point where power is drawn from solar panel maximum, then efficiency of solar cell will be increase. Many maximum power point tracking algorithm are developed.

2. Literature Review:

Abd kadir Mahammad, et al. has compared conventional Proportional Integral Derivative (PID) and Fuzzy Logic(FL) under four different conditions which are : constant irradiation and temperature, constant irradiation and variable temperature, constant temperature and variable irradiation. After simulation results PID controller has shown better performance than FL controller under partially shaded conditions. PID controller has greater maximum power and average power compared to FL controller. A.Bouilouta, et al.[17] has introduced a new method to track the global maximum power point (GMPP) under partially shaded condition for standalone PV systems. Advantages are that PV systems have fast response and good stabilization at the real MPP, efficiency is high. The disadvantage is that under rapid changes in isolation (or under dynamic loads) it takes small amount of time to reach MPP and has small overshoots. Further work is being conducted on the overall system design and experimental implementation.

Nicola Femia, et al. has shown that negative effects of drawbacks of P&O can be limited by customizing P&O MPPT parameters to the dynamic behavior of the specific converter adopted. Also, theoretical analysis has been provided. Hiren Patel and Vivek Aggarwal [26] has presented a MATLABbased modeling and simulation scheme suitable for studying the I-V and P-V characteristics of a PV array under partial shading, also , it can be used for developing new MPPT techniques. It can also be used as a tool to study the effects of shading patterns on PV panels with different configurations.

K. Punitha et al. has proposed a neural network (NN) based modified IC algorithm for MPPT in PV system. IC algorithm comes under the category of model-free algorithm. The idea behind the IC method is to increase or decrease Vref value based on the comparison of instantaneous conductance to incremental conductance. The advantage of this method is that it offers an effective solution under rapidly changing atmospheric condition. Under the variation in atmospheric condition this algorithm tracks the MPP by applying increments or decrements to Vref. The disadvantage of IC algorithm is that size of increment or decrement value is crucial. If the size is large, the algorithm finds MPP quickly but results in oscillation around the MPP. If size is small, the oscillation around the MPP is reduced but the convergence will decrease. Future scope of this algorithm is that it provides higher percentage of maximum power with less response time.

3. Implementation:

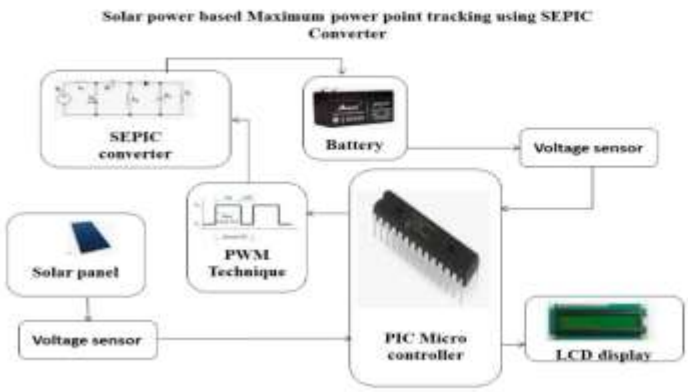

Fig1: Block Diagram

The solar power which can be obtained from solar cell cannot be utilized directly. It is usually stored in the battery and inverter circuit and further it can be used as AC. But the output voltage as well as power from the solar cell depends upon the illumination and intensity of the light. If the light intensity is very low it may produce very low output voltage. The lower output voltage from the solar cell may not charge the battery and the power is wasted. Here an intermediate stage of converter called SEPIC is used to boost the lower output voltage from the solar cell and also buck the voltage if the light intensity is high

In this project Micro controller gives the Pulses to the MOSFET's of the SEPIC converter using PWM technique. Based on the triggering from controller section SEPIC converter can Boost/Buck from Low/High voltages from the solar panel. So that SEPIC converter maintains constant output

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voltage irrespective of the solar isolation level. LCD is interfaced to the controller section, which can display the voltage levels of the whole system.

4.COMPONENTS

The brief introduction of different modules used in this project is discussed below:

4.1 Solar:

A solar cell or photovoltaic cell is a device that converts solar energy into electricity by the photovoltaic effect.

Fig2: 12v,10watt monocrystal line solar panel

1. Photons in sunlight hit the solar panel and are absorbed by semi conducting materials, such as silicon.
2. Electrons (negatively charged) are knocked loose from their atoms, allowing them to flow through the material to produce electricity. Due to the special composition of solar cells, only allow the electrons to move in a single direction.

The complementary positive charges that are also created (like bubbles) are called holes and flow in the direction opposite of the electrons in a silicon solar panel.

3. An array of solar panels converts solar energy into a usable amount of direct current (DC) electricity.

4.2 SEPIC converter:

Single-ended primary inductor converter (SEPIC) is a type of DC-DC converter, that allows the voltage at its output to be more than, less than, or equal to that at its input. The output voltage of the SEPIC is controlled by the duty cycle of the MOSFET. A SEPIC is similar to a traditional buck-boost converter, but has advantages of having non-inverted output, by means of coupling energy from the input to the output is via a series capacitor. When the switch is turned off output voltage drops to 0 V. SEPIC is useful in applications like battery charging where voltage can be above and below that of the regulator output.

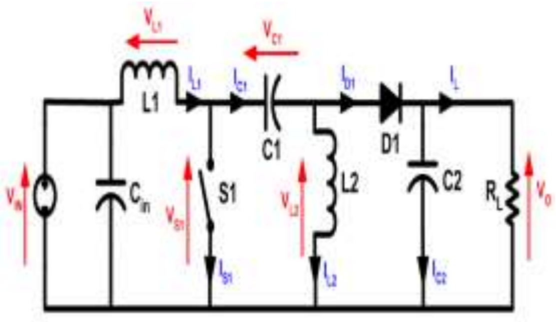

Fig3: SEPIC converter

DC-DC converter used in maximum power point tracking system to interface load and PV system SEPIC (Single Ended Primary Inductance Converter) is modelled, output voltage of SEPIC converter can be step-up or step-down then input voltage. In MPPT SEPIC converter work in continuous conduction mode. PWM controlled with switching frequency of 50KHz. Power flow of circuit controlled by using ON/OFF duty ratio threw switching MOSFET.

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4.3 MPPT:

The optimal ratio of Current (I) to Voltage (V) in the power curve of a PV panel to generate most power is known as MPPT i.e. Maximum Power Point. MPPT curve varies based on irradiation conditions.

MPPT offers indirect connection between PV panel and battery. It functions as DC to DC voltage converter. It is suitable when battery voltage is less than the PV panel array output. MPPT utilizes extra PV voltage of solar array to generate extra current at low voltage without loss of power. This increases efficiency of the solar system.

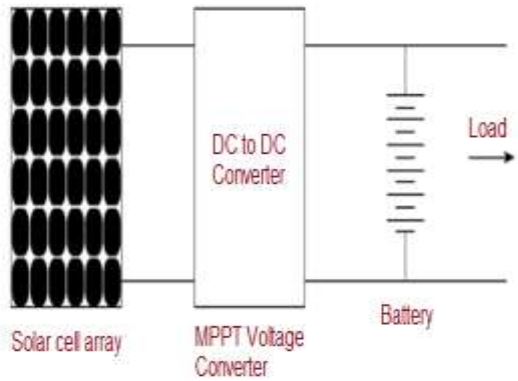


Fig4: MPPT

Advantages of MPPT:

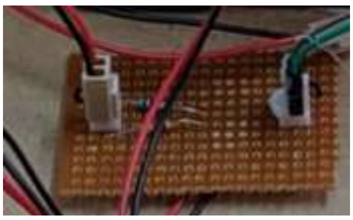
- It is more efficient compare to PWM solar charge controller.
- It can optimize voltage differences and offers DC load optimization.
- It is ideal for larger systems where solar panel output is substantially greater than battery voltage.
- It offers more output and hence more capacity (Amp).

4.4 Rechargeable battery:

Fig5: Rechargeable battery

In this project we are using 12v rechargeable battery to store the solar energy and this battery power will give to the h-bridge inverter.

4.5 Voltage sensor:



The Voltage sensor 10:1 contains a 90 kΩ resistor and a 10 kΩ resistor. Both resistors have a ratio tolerance of ±0.02%.

The maximum input voltage into the voltage sensor10:1 should not exceed ±50 V. Increased input settling time may be necessary to accommodate the relatively high resistance of the voltage divider.

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4.6 LCD display:
LCD (LIQUID CRYSTAL DISPLAY):

One of the most common devices attached to a micro controller is an 16x2 LCD display. This means 16 characters per line by 2 lines respectively. The status of the project will display on LCD.

4.7 PIC Microcontroller:

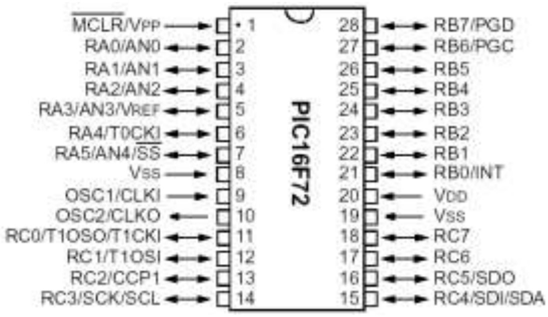

Fig6: PIC Microcontroller

The PIC16F72 CMOS FLASH-based 8-bit microcontroller is upward compatible with PIC16C72/72A and PIC16F872devices. It features 200 ns instruction execution, self-programming, an ICD, 2 Comparators, 5 channels of 8-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, a synchronous serial port that can be configured as either 3-wire SPI or 2-wire I2C bus, a USART, and a Parallel Slave Port. PIC Microcontroller is used for switching the MOSFETs.

6. RESULTS

Table1:Ambient temperatures in April(from 21 to 30) 2023

Date	Temperature (^{O}C)													Output Power (w)
	6 (AM)	7 (AM)	8 (AM)	9 (AM)	10 (AM)	11 (AM)	12 (PM)	01 (PM)	02 (PM)	03 (PM)	04 (PM)	05 (PM)	06 (PM)	
21	26	27	29	29	29.5	30	31	32	33	32	32	30	28	12
22	28	29	29	30	31	33	36	38	35	34	30	28	26	12
23	26	27	28	30	32	34	38	40	37	35	33	30	27	12
24	27	28	29	30	31	32	34	39	38	35	34	33	28	12
25	25	26	27	28	32	33	34	38	37	36	33	31	26	12

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26	**26**	**28**	**28**	**29**	**33**	**33**	**35**	**37**	**36**	**37**	**32**	**32**	**25**	**12**
27	**26**	**27**	**28**	**28**	**31**	**32**	**33.3**	**35**	**36**	**35**	**32**	**30**	**27**	**12**
28	**24**	**25**	**27**	**29**	**32**	**33**	**34**	**36**	**34**	**35**	**33**	**32**	**28**	**12**
29	**27**	**29**	**29**	**29**	**32**	**33**	**34.5**	**37**	**38**	**37**	**32**	**33**	**27**	**12**
30	**25**	**27**	**28**	**30**	**30**	**31**	**32**	**38**	**36**	**36**	**35**	**33**	**26**	**12**

4. CONCLUSION:

A novel technique using a SEPIC converter to efficiently track the maximum power point of a solar panel has been presented. The technique is simple and elegant and does not require complicated mathematical computation. The tracking capability of the proposed technique has been verified experimentally with a 12V, 2A converter with input voltages.
SEPIC converter and MPPT used to obtain the maximum power point operation of PV module. A PIC microcontroller was used to generate the pulses for driving the switch of the SEPIC converter.

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