

DESIGN AND IMPLEMENTAION OF DC-DC BOOST CONVERTER USING OUTPUT VOLTAGE SENSOR BASED ALGORITHM

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Abstract - An algorithm based MPPT has been used for extracting maximum possible power from PV module. The algorithm used for controlling MPPT is Output voltage sensor based algorithm. The solar module characteristics (I-V and P-V) have been simulated in MATLAB. The simulation results for various parameters of boost converter have been obtained. The algorithm used in this is based on the output voltage sensor based algorithm that helps us calculating voltages from the solar panel. The solar panel is interfaced with PIC Microcontroller and the input is given to the boost converter which steps up the voltage. It is important to operate PV energy conversion system near the maximum power point to increase the output efficiency of PV array. The PV system with the help of algorithm used will be able to optimally track the maximum power points with minimum possible oscillation around maximum power points. Consequently the light energy to electrical energy conversion efficiency can be improved significantly.

Key Words: Boost Converter, Maximum power point Tracking, output voltage sensor based MPPT algorithm.

1. INTRODUCTION

Utilization of renewable energy resources is the demand of today and the necessity of tomorrow. Due to the electric power crisis globally, it is to be thought about the optimized utilization of these resources. The efficiency of the SPV system may be substantially increased by using Maximum Power Point Tracker (MPPT). MPPT is a power electronic system which tracks the maximum power point on the characteristic curve of PV module throughout the day in varying solar insolation. Basically MPPT is a highly efficient DC-DC converter which is controlled by using a power electronic switch operated by an algorithm. The design of MPPT may be based upon Buck converter, Boost converter, Buck-boost converter etc. Due to the more flexibility and better performance, the boost converter has been used. In the case of buck converter the current is not constantly flowing but in the case of boost converter, the constant flow of current may be achieved. This is one more advantage of boost converter over buck converter. Many types of algorithms are available to control the operation of switch of boost converter like Perturb & Observe (P&O) algorithm,

Incremental Conductance (INC) algorithm, Parasitic Capacitance method etc. Solar cell can act as constant current source. The MPPT is responsible for extracting maximum power from the photovoltaic cell and fed it to the load via buck boost converter with step up the voltage to required level. Buck boost converter can act as impedance matching circuit. The maximum power is transferred to the load when load impedance is equal to source impedance.

2. Prototype Description

It Consist of Boost Converter, Micro Controller, Solar panel, Gate Driver Circuit and Voltage Divider Circuit. Boost Converter consist of inductor, Capacitor, MOSFET and diode. Gate Driver Circuit Consist of TLP 250. The Controller consist of Voltage Regulator and rectifier.

2.1. MOSFET

In this project we used, IRF840 Metal oxide semiconductor Field effect transistor. MOSFET stands for metal oxide semiconductor field effect transistor. It is most commonly fetched by controlled oxidation of silicon. It has an insulated gate, whose voltage determine the conductivity of device. The output voltage is adjustable based on the duty cycle of switching transistor. MOSFET is a semiconductor device is widely used for switching in buck boost converter. The MOSFET is a four terminal device with source(S), Gate(G), Drain(D), and Body(B) terminal.

2.2 Solar Panel

Photovoltaic solar panels absorb sunlight as a source of energy to generate electricity.

A Photovoltaic (PV) module may be prepacked connected assembly of usually 6x10 electrical phenomenon solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. The Output of solar panel is given as input to DC-DC converter. Solar Short circuit current is 0.68A. The Dimension panel open circuit voltage is 21.6V. Solar panel of solar panel is 351*291*17mm. Maximum Power is obtained at Knee

point of I-V Characteristic of solar panel. Maximum power of solar panel is 10W.

2.3 DC-DC Converter

In this project we used Boost converter. Boost Converter is mainly used for impedance matching. When load resistance is equal to source resistance, the maximum power get transferred from source side to load side. Impedance of Boost converter is mainly depend on gate pulse of mosfet.

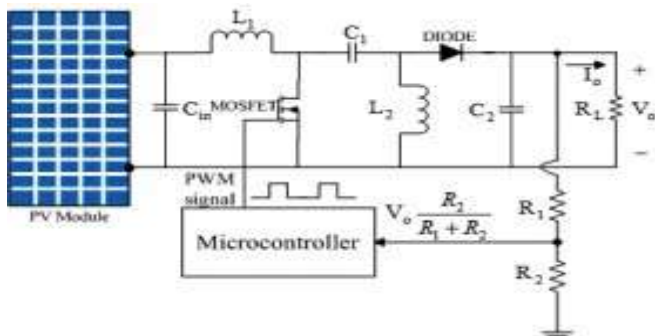


Fig1 Maximum power point tracking

Boost Converter increase the input voltage. The Input of Boost converter is 12V. Boost Converter consist of inductor, capacitor and diode. A DC-DC Converter is an electronic circuit that converts a source of direct current from one voltage level to another. Power levels range from very low (small batteries) to very high (high-voltage power transmission).

2.3 Gate Driver Circuit

Gate Driver Circuit consist of TLP 250. TLP 250 is otherwise called as optocoupler. It isolate from low level voltage to high level voltage. The output of microcontroller is given as input to TLP250 which is in the range of 5v. It consist of rectifier and capacitor. Rectifier is used to convert from alternating current to direct current. The supply of TLP 250 is given by capacitor. The output of TLP250 is given as input to gate of mosfet.

2.4 Microcontroller

The output of voltage divider circuit is given as input to microcontroller which is in the range of 3.5V to 5V. PIC 30F 2010 is a 16 bit microcontroller. It consist of 28 pins. PIC 30F 2010 controller consist of rectifier, voltage regulator. PIC 30F 2010 convert from analog signal to digital signal. The maximum operating range for PIC microcontroller is 5v. It consist of 8 output pins. Rectifier converts from 230 Vrms to 16V. The output of rectifier is given as input to voltage regulator. It converts from 16V to 5V.

2.5 Voltage Divider Circuit

Voltage divider circuit is connected at output of DC-DC converter. Voltage divider circuit also act as voltage sensor. This voltage sensor senses the output of DC-DC converter. It consist of two resistor are connected in series. The resistance values are 1K and 10K.. The output of voltage sensor is given as input to ds PIC 30F 2010. Output voltage sensor based MPPT algorithm is encoded in PIC microcontroller.

3. BOOST CONVERTER DESIGN

A boost converter is a Dc-Dc power converter that steps up voltage (while stepping down current) from its input (supply) to its output (load). It is a class of SMPS containing at least two semiconductors (a diode and a transistor) and at least one energy storage element : a capacitor, inductor or the two in combination. To reduce voltage ripples, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter).

In this project inductance value is 5mH, capacitance value is 47 micro farad and 25v.

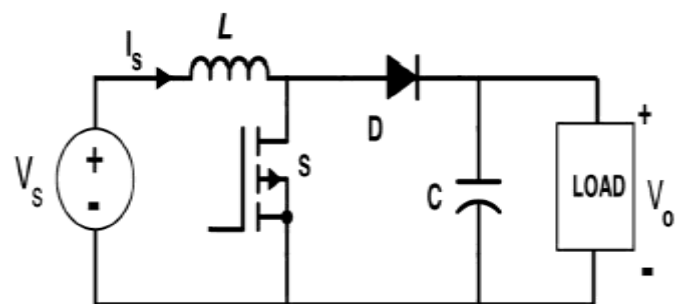


Fig 2 Boost converter circuit

4. MPPT Algorithm

Output voltage sensor based MPPT is used in this project. This MPPT algorithm is mainly depend on output voltage and Duty cycle. Maximum power is available at the knee point of (Vo - D) characteristic. By using this MPPT algorithm we get maximum power at all time in load side.

$$dV_o / dD = 0 \text{ (at MPP)}$$

$$dV_o / dD > 0 \text{ (left side of MPP)}$$

$$dV_o / dD < 0 \text{ (right side of MPP)}$$

Thus the maximum power from the PV module can be tracked by evaluating dV_o / dD by sensing only the output voltage. The Duty cycle can be incremented or decremented by ΔD depending on the sign of voltage.

$$V(K) = \text{present value of output voltage}$$

$V(K-1)$ = past value of output voltage

dV = Difference in past and present value of output voltage

$D(K)$ = present value of Duty cycle

$D(K-1)$ =past value of Duty cycle

dD =Difference in past and present value of Duty cycle

$V(K+1)$ =future value of output voltage

$D(K+1)$ =future value of Duty cycle

Output voltage sensor based MPPT is encoded in PIC 30F 2010. The maximum power is available at $dV_o / dD=0$. When $dV_o / dD>0$, we should increase the Duty cycle. When $dV_o / dD<0$, we should decrease the duty cycle. Finally we update the value of output voltage and duty cycle.

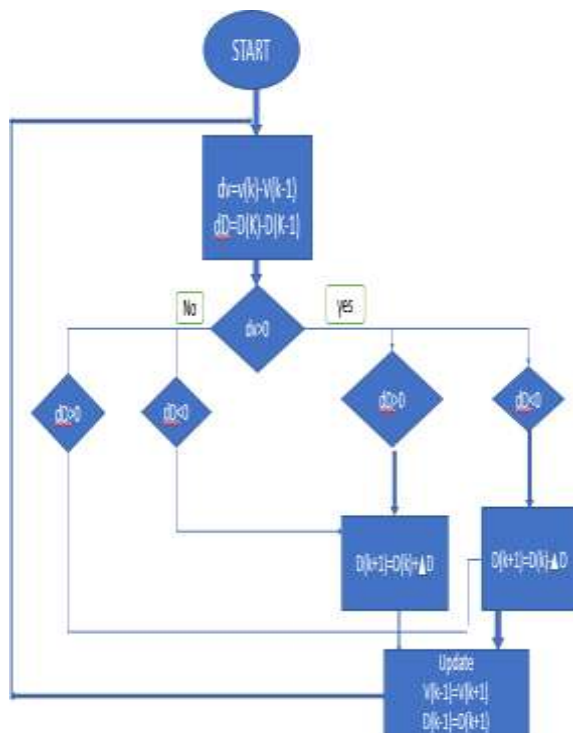


Fig 3: MPPT Algorithm

5. BLOCK DIAGRAM OF MPPT

The output of solar panel is directly given as input to Boost converter. Boost converter can act as impedance matching circuit. Impedance of

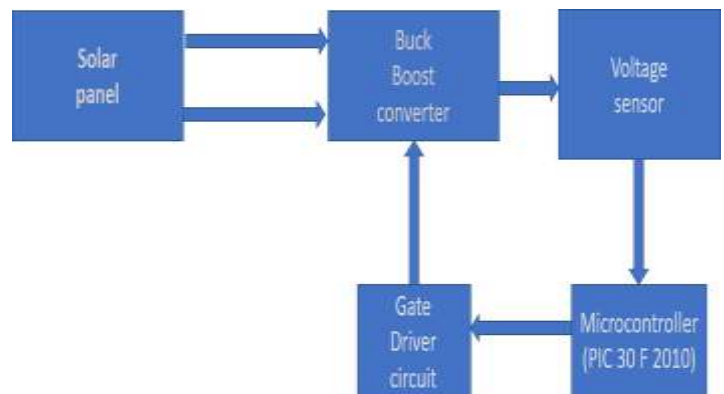


Fig 4 : Block Diagram of MPPT

Boost converter is controlled by gating signal of MOSFET. Voltage divider circuit act as a voltage sensor. The output voltage of Boost converter is sensed by voltage divider circuit. The output of voltage sensor is given as input to PIC microcontroller. Output voltage sensor based MPPT algorithm is encoded in microcontroller. The output of PIC microcontroller is in the range of 5V. The output of PIC microcontroller is given as input to Gate driver circuit. The output of gate driver circuit is given as input to gate of MOSFET. Zener diode is connected in voltage divider circuit. The output of Zener diode is 5V. In this microcontroller we used rectifier and voltage divider circuit. The output of step down transformer is given as input to rectifier circuit. The output of rectifier circuit is connected by voltage regulator. The output of voltage regulator is given as supply to microcontroller. In this voltage divider circuit we used 1K and 10K resistor. 10K resistor is connected at upper side of voltage divider circuit. 1K resistor is connected at bottom of voltage divider circuit. Gate driver consist of rectifier and filter. The output of rectifier is given as input to filter circuit. Filter circuit converts from pulsating signal to D.C signal. TLP 250 is one type of optocoupler. It is otherwise called as Electronic isolator. It isolates the high voltage and low voltage signal. The output of microcontroller is given as input to gate driver circuit. The output of gate driver circuit is given as input to gate of the MOSFET. TLP 250 is suitable for gate driver circuit of IGBT or MOSFET.

6. Methodology

Output voltage sensor based MPPT algorithm is encoded in DSPIC 30F 2010. By using this MPPT algorithm we get maximum power in load at all time. We give the pulse to MOSFET through tlp 250. The output of PIC microcontroller is given as input to tlp 250. This MPPT is based on output voltage and Duty cycle. MPPT algorithm is encoded in PIC 30F 2010 using MPLAB IDE. Due to variation of irradiance and temperature we cannot get maximum power. Voltage sensor senses the output voltage and give the input to pic microcontroller. Based on MPPT algorithm, microcontroller gives the pulse width modulation. Based on pulse width modulation, it tracks the maximum point.

7. Conclusion

The main aim of our project is to design a DC-DC Converter with MPPT Output voltage sensor based Algorithm to optimize its efficiency all time. A Renewable energy system like the one implemented here, is suitable for residential and/or industrial application. Utilization of renewable energy resources is the demand of today and the necessity of tomorrow. Due to the electric power crisis globally, it is to be thought about the optimized utilization of these resources. The efficiency of the SPV system may be substantially increased by using Maximum Power Point Tracker (MPPT). The simulation MPPT Output voltage sensor based algorithm is successfully completed and hardware implementation of boost converter is done. The simulation output explains the PV curve and VI curve of the MPPT algorithm technique and how the boost converter along with the MPPT reduces constant output voltage by stepping the input voltage. Output voltage sensor based algorithm is used because it is very easy for implementation over other algorithms and it doesn't response to any environmental variations. It also provides efficiency of 84% when voltage and current values are fixed. Output voltage sensor based is a standard MPPT algorithm technique that is generally used in DC-DC converter.

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