A Single Phase Inverter for the Solar Applications

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***Abstract*- Solar energy is available for every living being since life came into existence and it has been used vigorously. It is one of the eternal source of energy that anyone can use free of cost. People have started taking more interest in renewable non-conventional energy sources. Now a day's solar energy is used to generate electricity and has grown in use. Solar panel does this job of converting solar energy into electrical but this power is in DC. so for the use of this power for AC appliances, it need to be converted into AC. Inverter converts that DC power into AC.**

In this paper solar inverter with P&O MPPT algorithm is discussed. The results are first taken from simulation and verified by hardware of the inverter circuit with controller circuit having DSPIC33EP256MC202 model of single phase inverter for solar applications.

***Index Terms*- MPPT, P&O algorithm, Inverter, solar Photovoltaic, micro-controller**

I.INTRODUCTION

The huge amount of solar energy reaches to the earth everyday and it is tracked and converted into electricity. solar panel has no of solar cells are connected in series or parallel to get desired electricity generation. Though there are some losses occur in this system but solar energy still has lot of benefits solar energy is used in various sectors at various platforms, from industries to domestic purpose, even solar panels has grown use in irrigation as well.

The need of running AC Loads on solar energy leads us to the design of Solar Power Inverter.. Since the majority of modern conveniences all run on 220 volts AC, the Power Inverter will be the heart of the Solar Energy System. It converts the low voltage 12 volts DC to the 220 volts AC that runs most appliances but also Sun radiates 180 billion MW of energy over Earth. Just one hour of this energy could meet power needs of entire planet for a year. India receives 5000 Trillion kWh of energy from Sun per annum. This energy is clean, pollution free and inexhaustible [2].

In this paper we have designed an efficient MPPT solar inverter. Purpose of investment in solar power project is to enter in development of green energy technology, which is the only ultimate source of energy for future generations. Here DSPIC33EP256MC202 is used as micro-controller IC which is dumped with P&O (perturbation and observation) algorithm. P&O MPPT algorithm allows to extract the maximum power from the PV panel which increases the operating efficiency of solar PV panel. The hardware implementation of single phase inverter using P&O algorithm has given prominent result, which are verified with the help of MATLAB Simulink model.

Proposed scheme

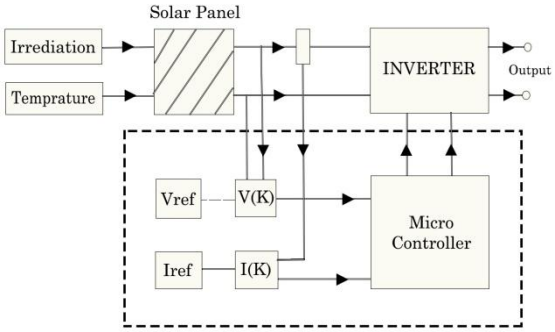

Fig. 1. Proposed diagram for single phase inverter using MPPT.

As per the proposed scheme the PV module generates the electricity which is DC in nature and that needs to be in AC so that power is given to the MPPT controller where it tracks the maximum power point and gets the maximum power and then its is fed to the Gate Driver circuit. The gate driver circuit Generates the Gating pulses to trigger the IGBTs of the inverter circuit. After that the inverter circuit converts that power into AC power.

1. PV Module

The photovoltaic module in this system consists of the solar cells which are connected in series and parallel. To get the maximum output from the solar panel it is made to operate at the Maximum Power Point.

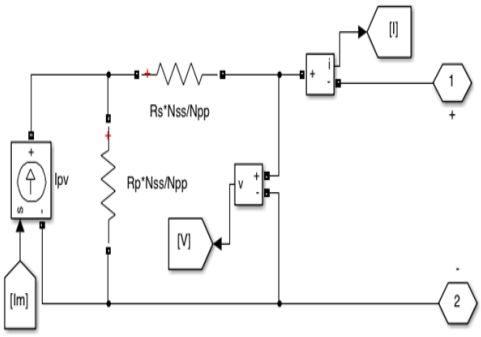

Fig 2 Solar Cell Model

Simple construction of the solar cell is as given in below figure(2)

The annual average output power of the solar panel can be calculated by the below equation,

$E = A \times r \times H \times PR$

Where,

E = Energy (kWh)

A = Total solar panel Area (m2)

r = solar panel yield or efficiency (%)

H = Annual average solar radiation on tilted panels (shadings not included)

PR = Performance ratio, coefficient for losses (range between 0.5 and 0.9, default value = 0.75)

1.MPPT Controller

The Maximum Power Point Tracking (MPPT) Controller Consists of an algorithm that track the point of maximum power and makes the power to operate at that point which helps in increasing the efficiency of the solar panel.

In this paper Perturb and Observe (P&O) method of MPPT is used.

P&O MPPT Algorithm

This method builds a simple regulation in closed-loop incorporating only a few controlled parameters. The P&O algorithm compares the previously delivered power with the one after disturbance by perturbing the voltage of the panel with a minuscule incremental step to reduce the oscillation around the Maximum Power Point or the desired step [3]. This algorithm has a wide

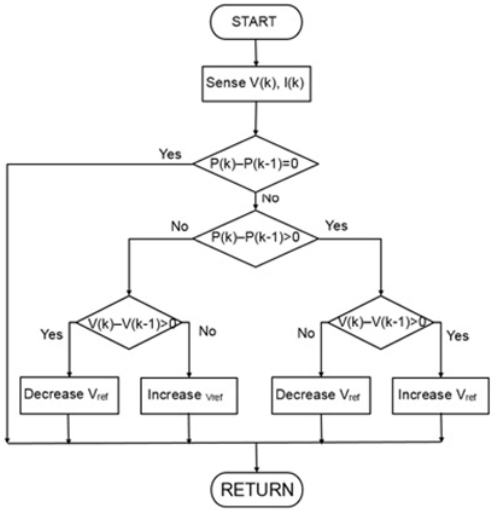

Fig 3 Flowchart of P&O algorithm

application in commercial systems due to its simplicity and involvement of few measured parameters . The principle of this method is described by flowchart is given in Fig 3.

Modeling of P&O

The detailed Matlab/Simulink model is shown in Fig 4. The photovoltaic voltage (Vpv) and current (Ipv) are taken as the perturbation

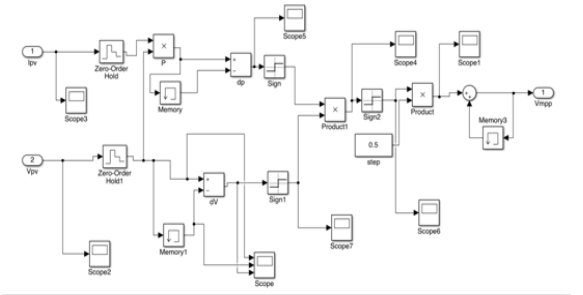

Fig 4 Modelling of P&O technique

inputs from solar photovoltaic array module to MPPT unit [3]. The duty cycle D is obtained as output.

Simulation

Simulation of the P&O MPPT in the MATLAB Simulink gives very prominent result as that of the controller circuit when Solar panel is connected to the system. The output power of the solar photovoltaic panel depends upon the irradiation of the sunlight and the temperature [2]. The below figure shows the Simulink model of the solar

photovoltaic system incorporating the Maximum Power Point Tracking algorithm to track the maximum power . The simulation of this model has been done by taking different values of irradiance and temperature.

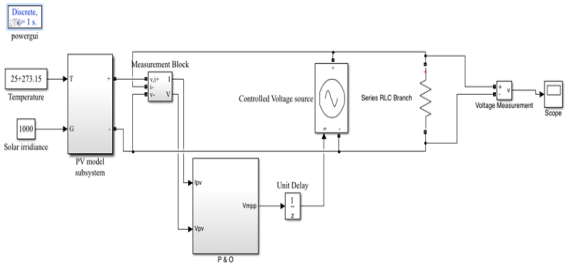

Fig 5 Simulink model of the Solar photovoltaic System

Result of the simulation

The simulation result verifies the output of the controller circuit and gives the fixed step sized wave. The below given result is taken at the irradiance of 1000 W/m2 and temperature of 25 0C. Initially the MPPT algorithm tracks the maximum power and after the 50 cycles the output wave comes to steady state and gives desirable output as shown in below fig 6.

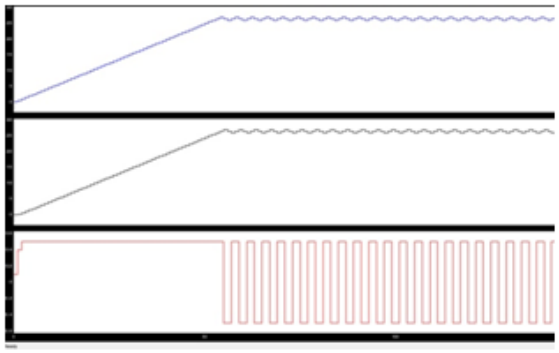

Fig 6 Output Waveform of Simulation

Construction and working of the Hardware

The proposed Single phase inverter is designed and fabricated using DSPIC33EP256MC202 micro controller. the complete Hardware consists of three main circuits

1. Inverter Circuit
2. MPPT Controller Circuit
3. Gate Driver Circuit

1. Inverter circuit

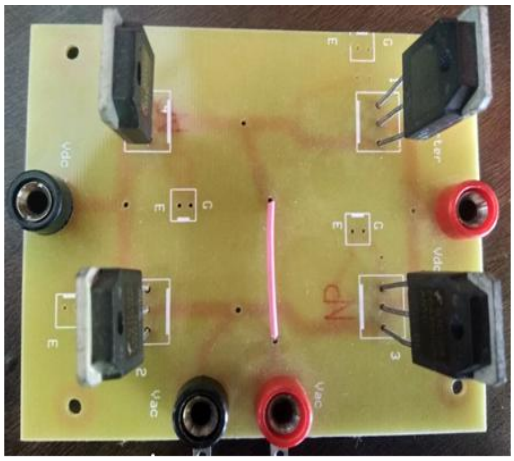

Fig 7 Inverter Hardware Circuit

The full bridge PWM inverter circuit consists of four IGBTs which are operated by the gating pulse. Gate pulse is needed for triggering of the IGBT and these triggering pulses are taken from the Gate driver circuit.

The circuit diagram of single phase full bridge inverter is as shown in the fig 6.

2. MPPT Controller Circuit

An MPPT Controller circuit consists of a DSPIC33EP256MC202 which is digital signal processor integrated circuit. It is in the family of embedded processor in which the MPPT algorithm program is dumped with the help of MPLAB. It generates the output that helps the gate driver circuit to generate triggering pulses. It takes the input of a 3.3 volts for normal running of micro-controller IC.

3. Gate driver circuit

Gate driver circuit produces the triggering signal for firing of IGBTs in inverter circuit.

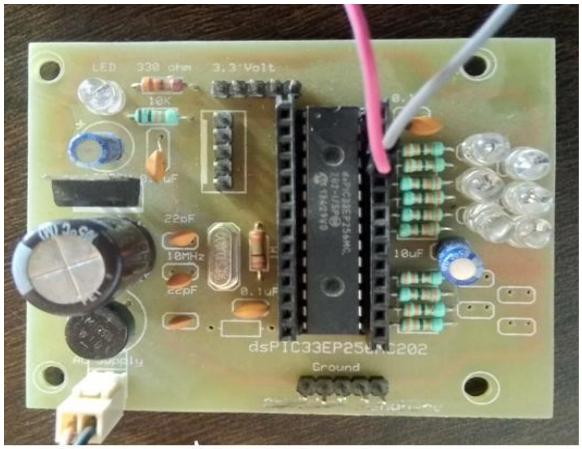

Fig 8 MPPT controller circuit

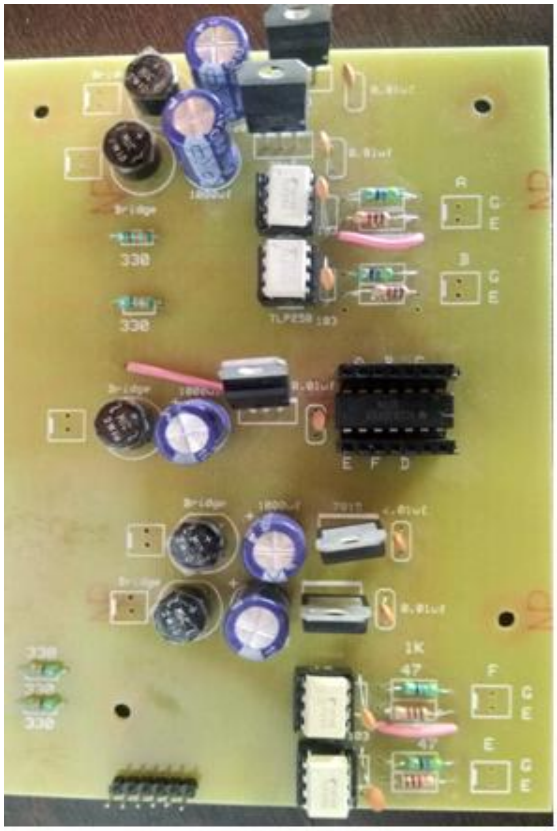

Fig 9 Gate Driver Circuit

Output waveforms of the Hardware

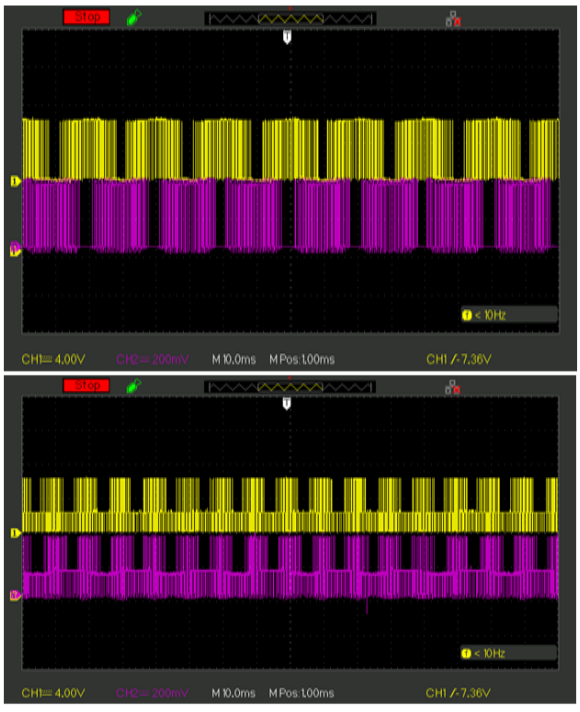

Fig 10. Gate pulse waveforms

These are the pulses that are obtained from the MPPT controller hardware circuit which will give signals to the gate driver circuit to produce the triggering signal for firing of IGBTs.

CONCLUSION

This paper firstly serves to establish a proposed simulation model along with P&O MPPT technique for maximum power point tracking. The results are verified with Matlab/Simulink as well as hardware model, and the need of inverter for solar applications has been discussed.

The motive of this paper is to develop the single phase inverter for solar applications and its systems in efficient and optimized way has been achieved. There are, many countries in the world which are located in the tropical and temperature belt with ample amount of sunlight where the intensity of the sunlight may reach up to 1000 W/m2 [3]. The effect of the environmental parameters i.e., temperature and irradiance variation could also be simulated and observed.

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