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GRID CONNECTED PV SYSTEM USING MPPT

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ABSTRACT

In this paper presents analysis of grid connected PV system with maximum power point tracking (MPPT) control.Grid interconnection of photovoltaic (PV) power generation systems has the advantage of effective utilization of generated power because there are no storage losses involved.Grid-connected photovoltaic system simulates in MATLAB/Simulink.The key technology of a PV system includes PV cell modeling, maximum power point tracking (MPPT) algorithm, DC/DC converter and grid-connected DC/AC inverter.MPPT is used for extracting the maximum power from the PV cell and transferring that power to the load.A DC/DC converter acts as an interface between the load and the PV cell. It used for transferring maximum power from the solar PV cellto load. The DC/AC Inverter is used to regulate the output voltage of DC/DC converter and connects the PV cell with DC/DC converter to the grid. The output voltage is required to be sinusoidal and in phase with the grid voltage.

Keywords—photovoltaic system, MPPT, grid-connected

INTRODUCTION

Among a variety of renewable energy sources, solar energy is predicted to become the largest contributors to world energy for its clean and no supply limitations characteristic. Over the past decade, PV technology has shown the potential by robust and continuous growth even during times of financial crisis. Grid interconnection of photovoltaic (PV) power generation system has the advantage of more effective utilization of generatedpower.

As day by day the demand of electricity is increased and that much demand cannot be meeting up by the conventional power plant. And also these power plants create pollution. If
we look at the nature of load demand curve it is found that demand is increased from morning for different causes like opening the shops, markets, schools, colleges, offices etcand that increases demand remains up to around 5 PM, and fromthestudyofthePVsystemitisfound that, it is very much ideal to meet that increased energy demand by using grid connected PV. That’s why we go for grid connected topology.

Grid interconnected photovoltaic system is accomplished through the inverter, which convert DC power generated from PV modules to AC power used for ordinary power supply for electrical equipment. Inverter system is therefore very important for grid connected PV system. It is also required to generate high quality power to AC utility system with reasonable cost. By mean of high frequency switching of semiconductor device with PWM (Pulse width modulation) technologies, high power factor and low harmonic distortion power can be generated.

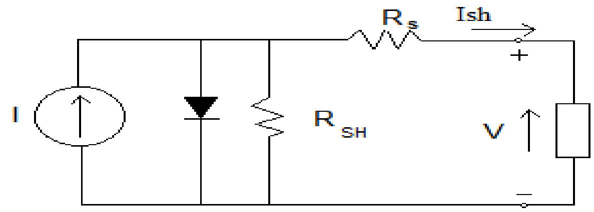
The key technology of a PV system includes PV cell modeling, maximum power point tracking (MPPT) algorithm, DC/DC converter and grid-connected DC/AC inverter.

MODELING OF PHOTOVOLTAIC CELL

(I)- Ideal PV Cell

Photovoltaic (PV) cell is a semiconductor device that absorbs and converts the energy of light into electricity by photovoltaic effect.

Figure1- Equivalent circuit of ideal PV cell



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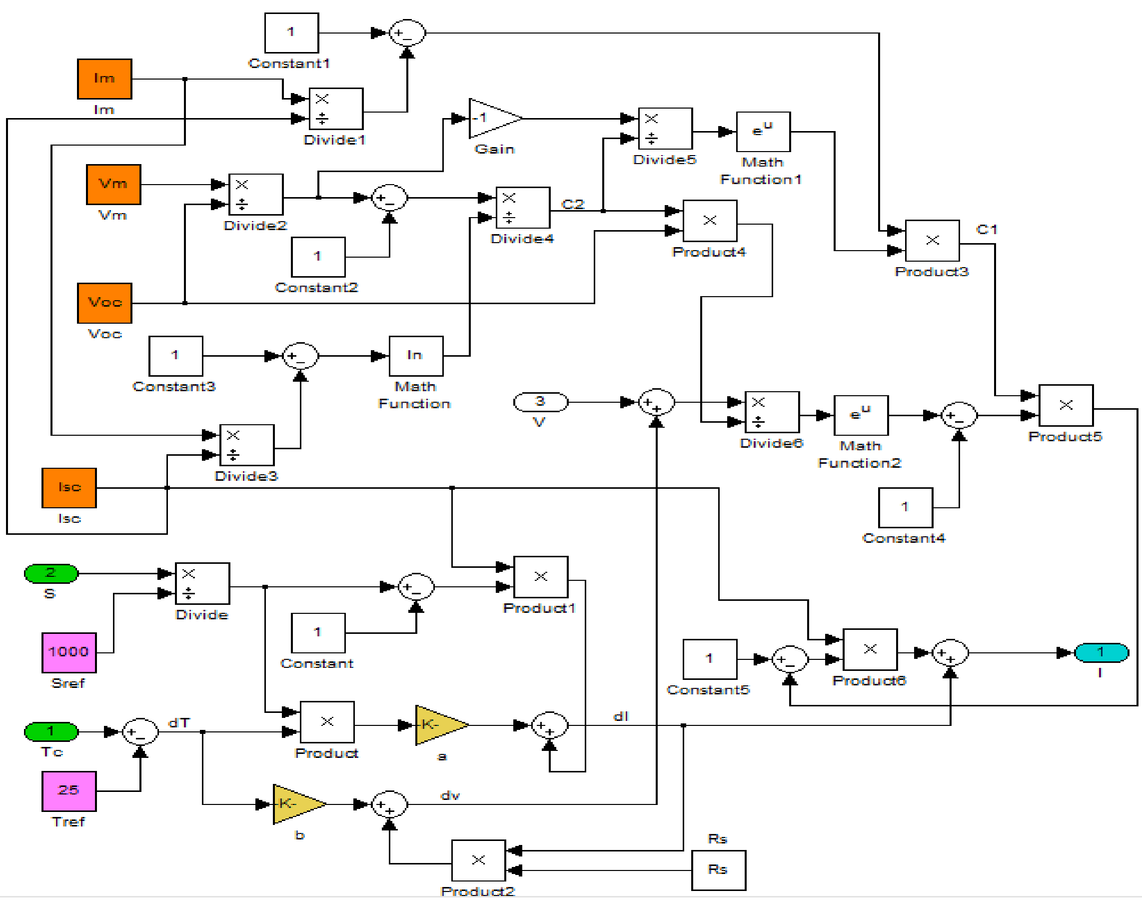
The voltage-current characteristic equation of a solar cell is given as **(1)**
$I=I_{eh} - [\exp((+I_s)/q) - 1] - (+I_s)/sh$ (1)
Where,Ish is a light-generated current or photocurrentI is the cell saturation of dark current,q (= 1.6 ×10−19 C) is an electron charge,k (= 1.38 ×10−23J/K) is a Boltzmann'sconstant,Tc is the cell's working temperature,A is anideal factor,Rsh is a Shunt resistance, and Rs is a series resistance of solar cell.The photocurrent mainly depends on the solar insolation and cell's working temperature,which is described as**(2)**
$I_{eh} = [Is + (-ref)]\, H$ (2)
Where $I_s$is the cells short-circuit current at a 25°C and 1kW/m2,Ki is the cell's short-circuit current temperaturecoefficient,T_{ref} is the cell's referencetemperature,And H is the solar insolation in kW/m2.
On the other hand, the cell's saturation current varies with the cell temperature, which is described as
$I_s= I_{rs}(/ref)^3\exp[(qg(-ref)/ref](3)$
Where, I_{rs} is the cell's reverse saturation current at a reference temperature and standardsolar radiation.

Figure 2.Simulation structure of PV module



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Characteristic data of PV module

Characteristics	Specification
Peak Power PMP	60 W
Voltage at Peak Power (VMP)	14.16 V
Current at Peak Power(IMP)	2.25A
ShortCircuit Current(ISC)	2..55 A
Open Circuit Voltage(VOC)	17.1 V
Temperature Co-efficient OfShort CircuitCurrent(K)	0.0017 A/°C

MPPT CONTROL ALGORITHM

On the I-V curve, there is a point where the PV cell generates the maximum power, this point always locates at the knee of the curve, and is called maximum power point (MPP). Since the output power of PV cell is related with many parameters such as solar radiation, temperature and load, theoutput characteristic is nonlinear. It is necessary for the PV system to work at the maximum power point under changing external environment to achieve best performance.

A MPPT is used for extractingthe maximum power from the PV cell and transferring that power to the load **(6)-(7).**

Perturb& Observe algorithm

The Perturb & Observe algorithm states that when the operating voltage of the PV panel isperturbed by a small increment, if the resulting change in power P is positive, then we aregoing in the direction of MPP and we keep on perturbing in the same direction. If P is negative, we are going away from the direction of MPP and the sign of perturbation supplied has to be changed**.(3)- (4)**

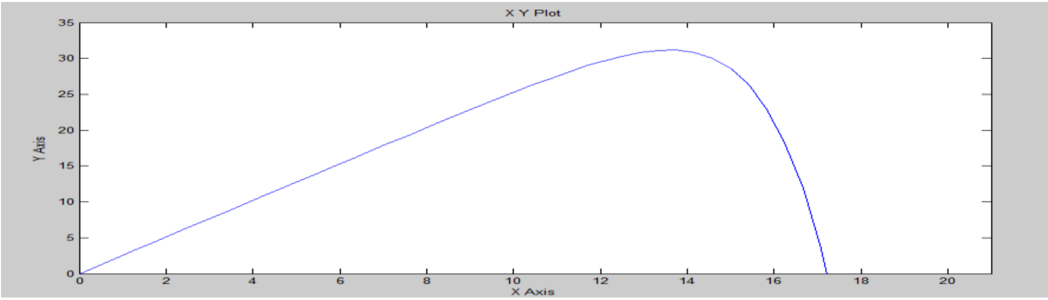

Figure3. Power graph of P&O algorithm

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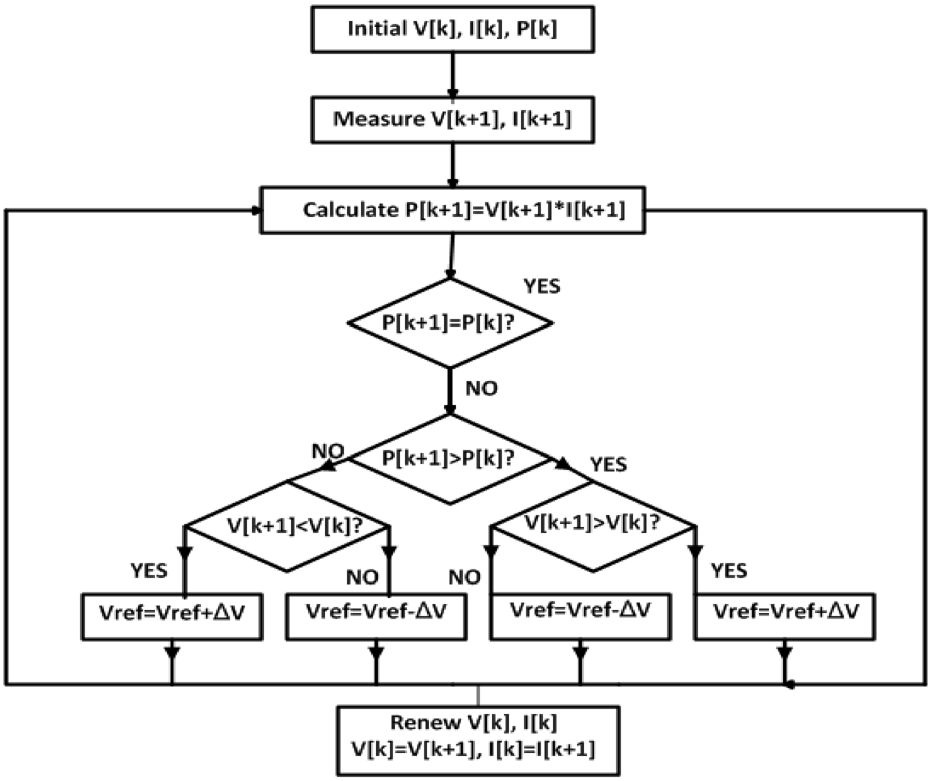

Figure 4. Flowchart of P&O Method

BOOST CONVERTER

A. Reason for Choosing Boost Converter

We chose the classical boost converter to implement the A DC/DC converter serves the purpose of transferring maximum power from the solar PV cell to the load. A DC/DC converter acts as an interface between the load and the PV cell. By changing the duty cycle, the load impedance is varied and matched at the point of the peak power with the source, so as to transfer the maximum power.

B. Operating Principle of Boost Converter

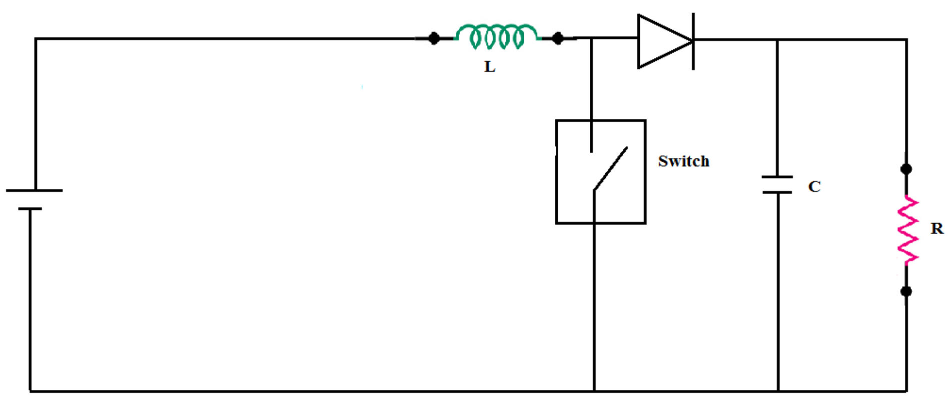

Figure.5 Circuit diagram of boost converter

Figure5 shows the topology of Boost converter. For this converter, power flow is controlled by means of the on/off duty cycle of the switching transistor. When the switch is On T_{on} for seconds, current flows through the

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inductor in clockwise, and energy Vi I_1T_{off} is stored

DC/DC CONVERTER

A DC/DC converter serves the purpose of transferring maximum power from the solar PV cell to the load. A DC/DC converter acts as an interface between the load and the PV cell. By changing the duty cycle, the load impedance is varied and matched at the point of the peak power with the source, so as to transfer the maximum power. When the switch is Off T_{off} for seconds, current will be reduced for increasingimpedance the only path of the inductor current is through diode D to the capacitor C and load R. The polarity of inductor will change. And the energy accumulated in the inductor during the On-State will be released,

$(V_c\text{-}V_i)I_1t_{off}.$

$$V_i I_1 t_{on}=(V_c-V_i)I_1t_{off}$$

we have

$$V_c = \frac{t_{off}}{t_{on}+t_{off}} V_i = \frac{T}{t_{off}} V_i = \frac{T}{t_{off}} \geq 1$$

Where D is the duty cycle. It represents the fraction of the commutation period T during which the switch is On. Since, the output voltage is always higher than the sourcevoltage.

C. Simulation of DC/DC Converter with MPPT algorithm inMATLAB/Simulink

TABLEII PARAMETERS OF THE DC/DC CONVERTER

Parameter	**Value**
Inductor L	0.01 H
Capacitor C1	2*10-3 F
Capacitor C	2*10-3 F
Resistor R	2*10-3 F

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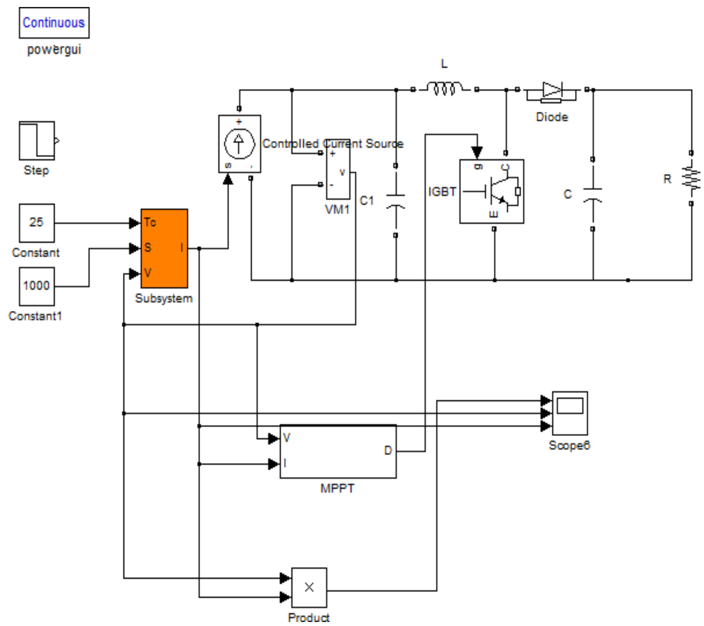

Figure6.Simulation Model for DC/DC converter

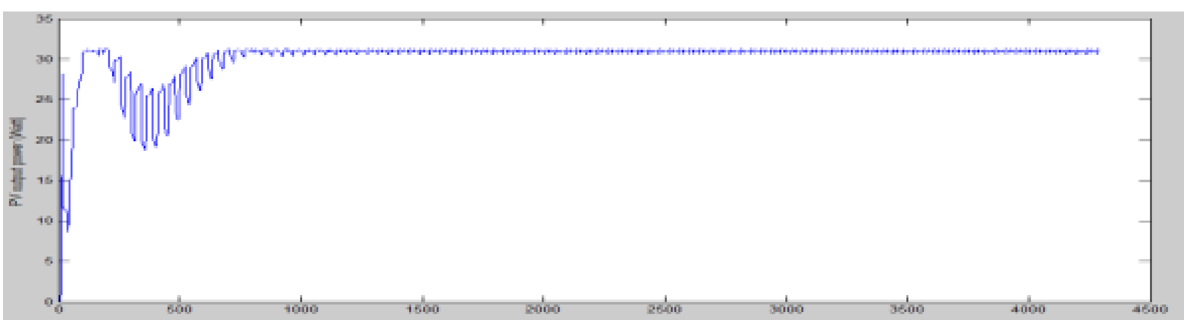

Figure7.Output power of PV module

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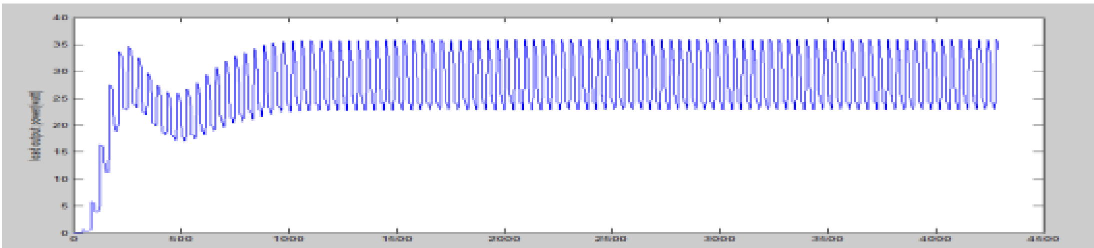


r radiation. Output voltage of DC/DC converter and connects the PV cell with DC/DC converter to the grid. The output voltage is required to be sinusoidal and in phase with the grid voltage. Figure11 shows the whole PV grid- connected system. The PWM signal can be usedtocontrol switches of DC/AC inverter. The frequency of PWM waveform is set as 5 kHz, which can reduce the switching noise, simplify the system design and improve the dynamic performance.

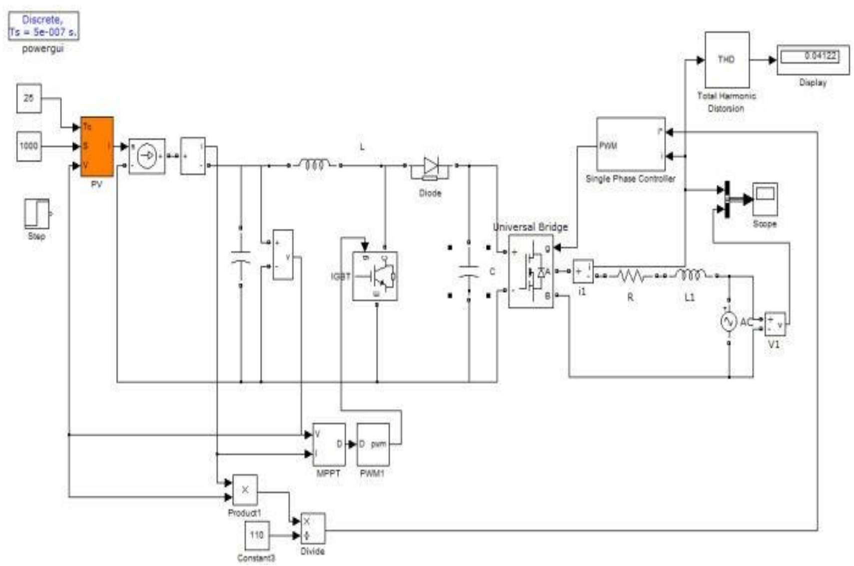
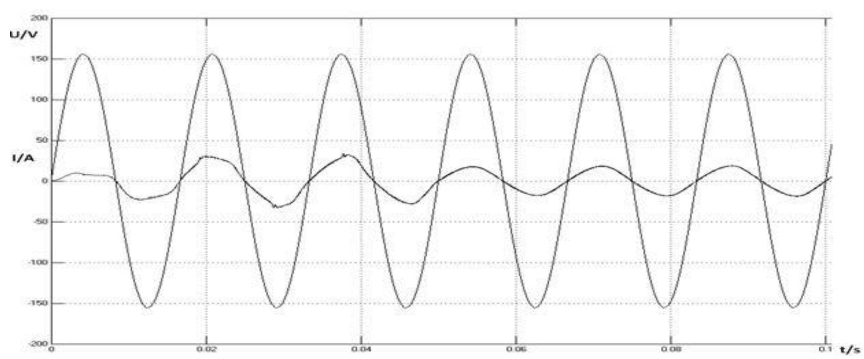


Figure9. Whole PV Grid-Connected System



Simulation result when temperature and solar radiation keeps unchanged, T=25 ℃S=1000 w/m^2.

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CONCLUSION

Grid connected PV system with MPPT system, it can be concluded that, this model can work well under sudden change of environment temperature or solar radiation. The maximum power of the PV cell is tracked with an adjusted P&O MPPTalgorithm based on Boost DC/DC converter. A DC/AC inverter has been used to connect the PV cell to the grid and regulate theoutput voltage of DC/DC converter. The whole pv grid connected system issimulated in MATLAB/Simulink. Special situations such as sudden change of temperature and solar radiation have been simulated andanalyzed

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