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Reactive power compensation on grid with connected solar pv system

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Abstract— *The grid connected solar PV system reactive power compensation using the control scheme. In this use the inverter controls scheme and STATCOM. The inverter control scheme use park transformation technique and PLL and PWM through inverter control. In inverter control scheme we control the active and reactive power and when we connect the PV system to grid. The grid systems in disturbances are occurring harmonic and reactive problem are faces so this problem we control the using STATCOM. The grid connected solar PV system requires a proper voltage control by controller. In this project reactive power compensate solar PV system using of inverter control scheme and a control strategy using dq0 transformation. In this inverter control strategy to balance the power flow from PV panel to the grid and STATCOM through reactive power compensates.*

Keywords—*MATLAB, STATCOM, PV System, Inverter, MPPT*

I. INTRODUCTION

The uses of renewable energy sources are give us economical and technical advantages. Solar energy is recently the most use of the renewable source. For the customers personal distribution generations increased in irregular electricity market. The use of solar generation at distribution side is increasing fast and it expected to rise more in future.

India confirmed that it completed its solar farm in Longyangxia Dam solar park, in China it is taking the title of the world's largest solar power plant with a capacity of 850mw significantly more than the previous largest solar farm, the Kamuthi solar power project Tamilnadu in India with a capacity of 648mw and the topaz solar farm in California with a capacity of 550mw. [11]

The increase growth of renewable leads to study at about the PV system technologies and problem face. The most common problem the solar energy systems are voltage variations, flicker, transient, harmonics, active power, reactive power.

Solar PV system for connected to grid reactive power problem associated. It is solved by the use of FACTS devices like STATCOM provides reactive power support and the using park transformation controller.

II. CONTROL METHODOLOGY

PROPOSED SCHEME OF PV TO GRID CONNECTED

PV to grid connected system block diagram describe the which component are mentioned in reactive power compensation and PV to grid power flow.

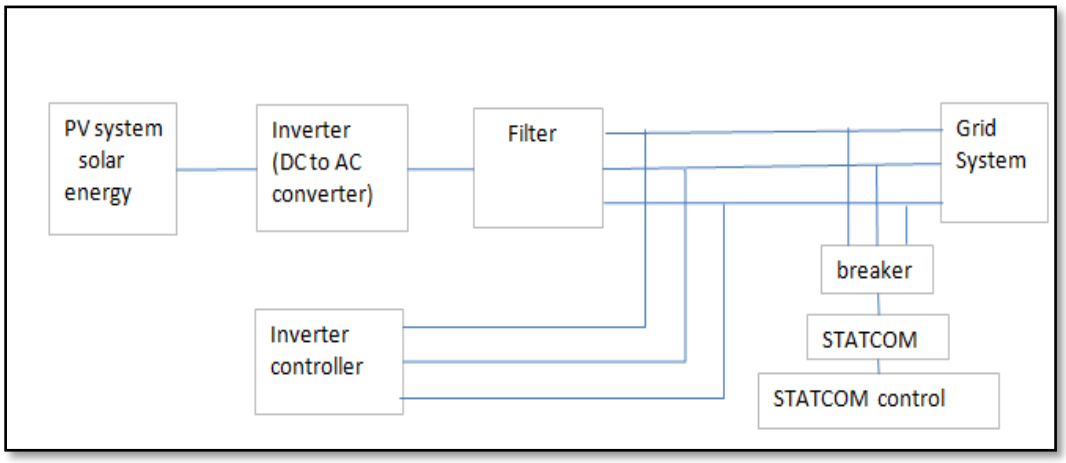

Figure1. Block diagram of proposed work

PV system

Photovoltaic model in solar cell is basically a p-n junction semiconductor device which is fabricated in thin wafer. Sunlight is a form of electromagnetic radiation, according to Einstein law. The sunlight of electromagnetic radiation can be directly converted into direct electricity, by the effect of photovoltaic. Irradiation is the velocity of flow of solar

intensity per unit area. When the sunlight will be exposed to the PV system, the produced photons include energy which is larger than the band gap energy (0.5 – 0.7v) of the semiconductors is wrapped up and some electron hole pairs are produced i.e. proportional to the occurrence solar irradiation. Photovoltaic system is relative to the solar spectrum / insolation. In PV system IV and PV characteristics are nonlinear, because of deviation of solar irradiance intensity and temperature of cell. Solar cell is p-n junction semiconductor device. Solar module of cells can be connected in series and parallel to give raise solar module. In solar array solar modules are connected in series and parallel to include the solar array according the demands.

PV system produces DC output voltage and current, its output use directly or can be stored in battery as it is a DC source. PV system is of two types i.e. standing alone system or grid connected system. For the grid associated system the DC voltage find the PV panel will be connected to the converters i.e. buck converter, boost converter, buck-boost converter, then the output of the converters connected to the inverter that can be single phase inverter or three phase inverter for the optimized results.

Perturb and Observe (P&O) MPPT Algorithm

A perturb and observe algorithm is to maximizing the output power of PV system. By unstable the duty cycle with small amount we can obtain the maximum power output. The planned P&O algorithms use adaptive perturbation step sizes and adaptive observation periods. A proposed algorithm is shown in figure. Generated switching signal is fed to the inverter and maximum power output is removed.

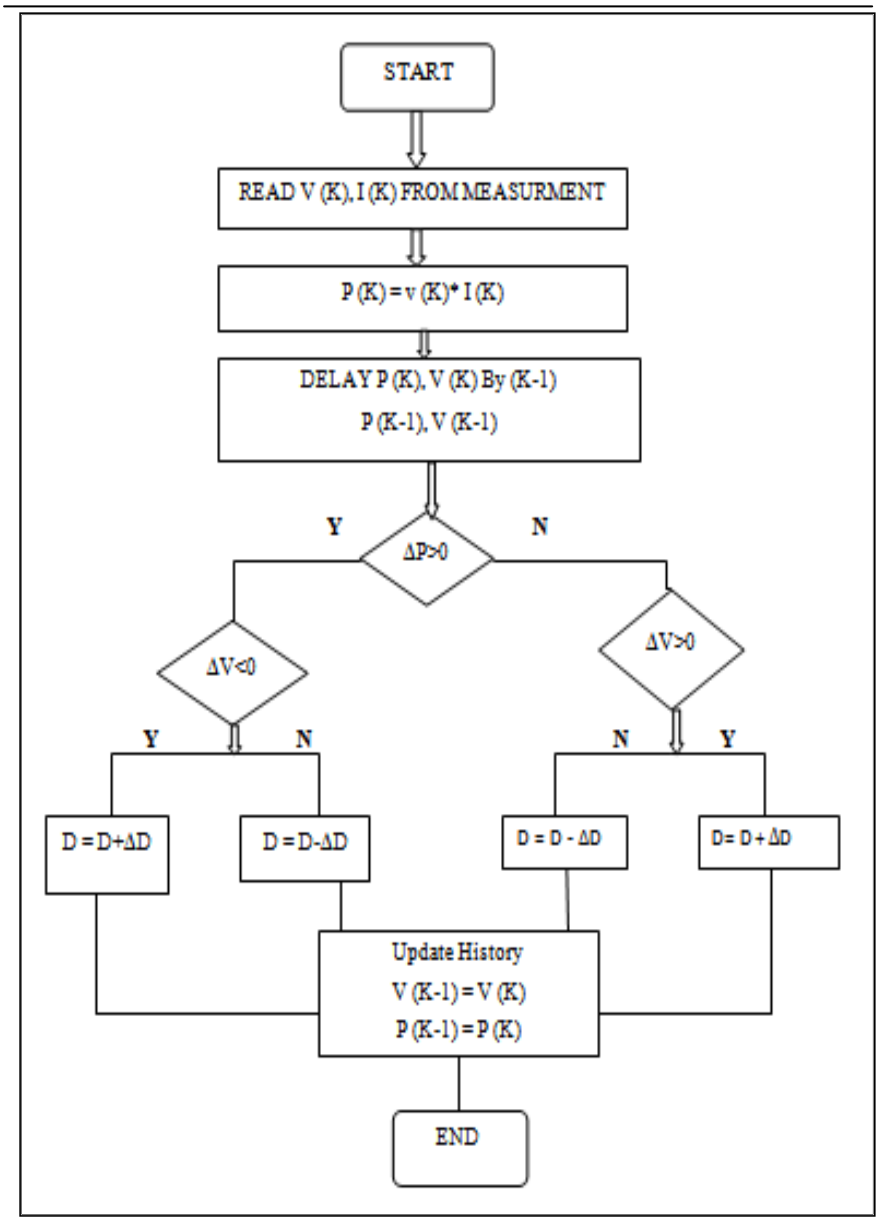

Figure2. Flowchart of P&O method

Inverter control and Control Scheme

The output voltage we obtained from the PV system in DC voltage, which is given to the inverter controller in inverter controller MPPT, PLL, dq0 transformation and PWM technique are used. Three Phase inverter circuit of obtain output AC voltage for our application. The inverters are modulated PWM technique.

MPPT Perturb and observe (P&O) Algorithm

A perturb and observe algorithm technique is used to maximizing the output power of PV system. This controller is used to approximation the maximum power point as a reference for it to track that point and force the PV system to operate in this point. Maximum power point tracking are used to incorporate with photovoltaic power systems so that the photovoltaic arrays are able to deliver the maximum power available. In general, PV produces megawatt power. In distribution system, these produced powers are transmitted through grid to load. If the load increased, the source side power demands take places. In order to continue the power be constant in both grid and load side, insert the additional power to grid by using PV module.

Phase Lock Loop (PLL)

In PLL device that provides tracking of one signal by another one. As a result of this tracking, the output signal is corresponding with the input reference signal in phase and frequency. It is used to compare between two frequencies and results the input frequency is equal to the output frequency. It is used to supply rotational frequency at direct and quadrature components. Using low pass filter eliminates high frequency and PLL using synchronizes the signal. Output signal generates Phase locked Loop control system whose phase is equal to the input signal. For grid connected system method in grid synchronization plays an important task. Using different transformation PLL is used to synchronize the phase sequence and the frequency of the grid with the inverter. PLL is used to reduce the error between the output current and the reference current obtains from the controller. Phase Locked Loop is a response signal which locks the two input signal with same frequency and shifted in a single phase. It is used to compare two frequencies and results the input frequency is equal to the output frequency. Also it is used to provide rotational frequency at direct and quadrature components. At the point of common coupling (PCC) the abc components are transforming into dq component and then force the q component to zero which is used to minimize the error. Here the filter used is a low pass filter to eliminate high frequency. It is possible by using an integrator circuit. By integrating the phase angle θ of the PI controller which is a low passed filter a constant frequency is maintained. By using the PLL the phase difference between the inverter and grid is reduced to zero which results = 0 and gives magnitude of the grid voltage. [14]

Dq0 Transformation

The park transformation in abc to dq0 performs in a rotating reference frame. The dq0 to abc performs is called an inverse park transformation. Park transformation is used to convert a three phase reference frame to a two phase reference frame which is rotating at synchronous speed.

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PWM (Pulse Width Modulation)

In the PWM technique the square wave from pulse generator will be converted to triangular wave by changing the frequency of the pulse generator and this triangular wave form is compared with the sine wave, in PWM the carrier frequency is compared with modulated frequency to get desired pulse for the system.

STATCOM (Static Synchronous Compensator)

When PV system connects to grid in this reactive power problem take place so the STATCOM using harmonic eliminates and reactive power compensation. A STATCOM is a controlled reactive-power source. It provides the desired reactive power generation and absorption entirely by means of electronic processing of the voltage and current waveforms in a calculation method. The control scheme is calculation control type. In shunt active power filter (STATCOM) a connected parallel in grid system. In this grid supplied by a three phase source to a non linear load an active power filter is connected in parallel to this system for the compensation of reactive power. Using technique is PI controller, hysteresis controller, and inverter.

III. SIMULATION AND RESULTS

Following figure 5.1 is a simulation of PV to grid connected system. This simulation is designed in MATLAB platform. The simulation is reactive power compensation strategy. This Simulation designed purpose for active and reactive power control and reactive power compensation in grid system. Power generation by PV system and connect to the grid system.

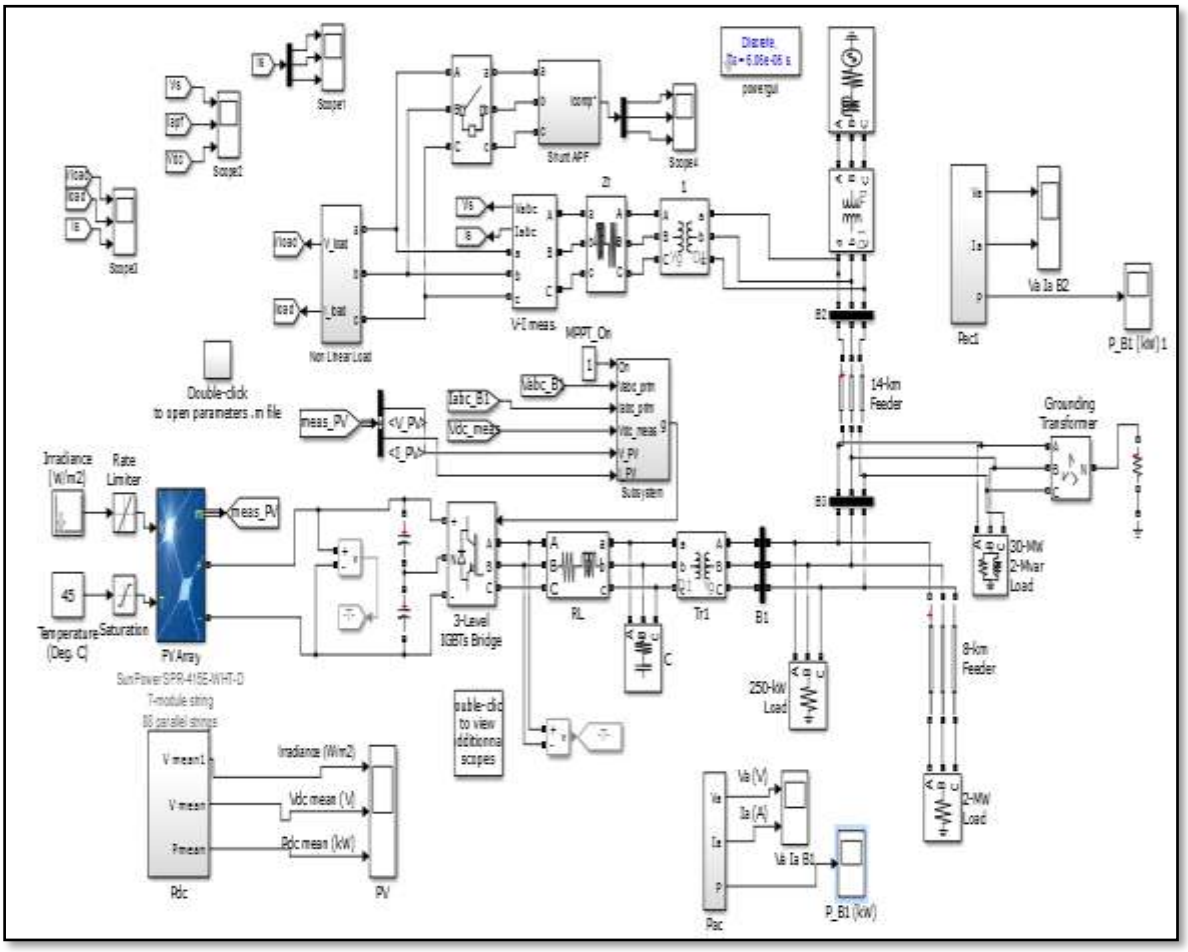


Figure3.Simulation of PV to grid connected

Inverter control technique simulation is shown in figure. This controlling system through us control active power and reactive power. In this method used the MPPT, PLL, dq0, current voltage regulator and PWM technique.

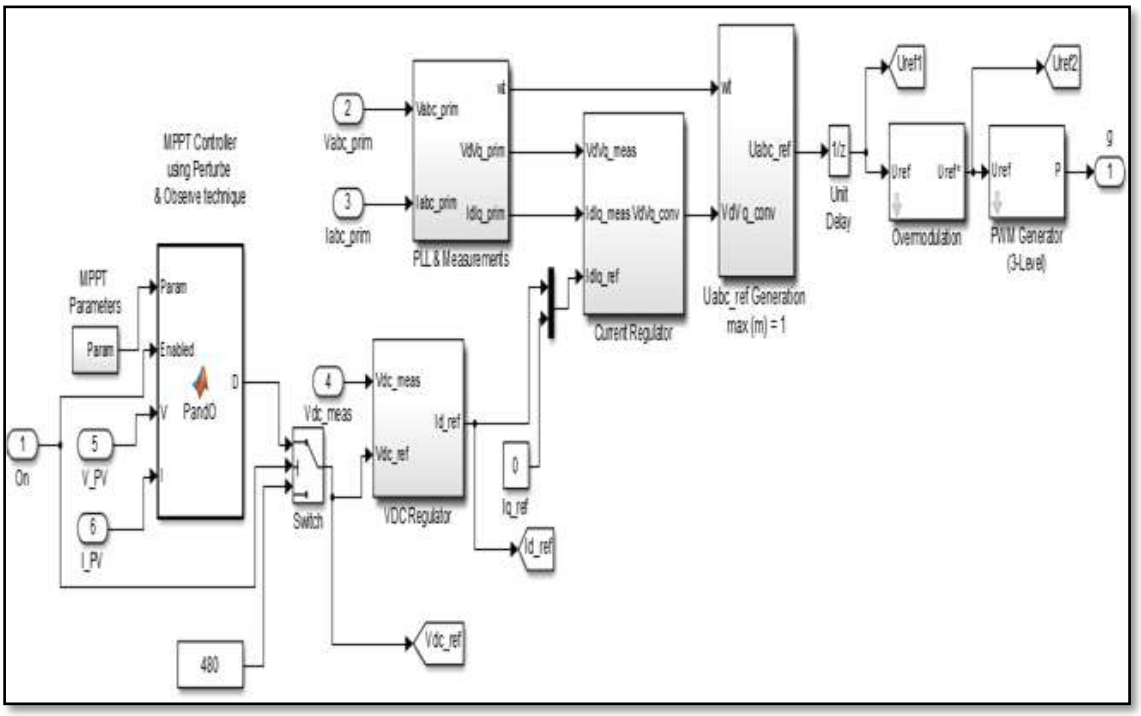


Figure4. Inverter control scheme

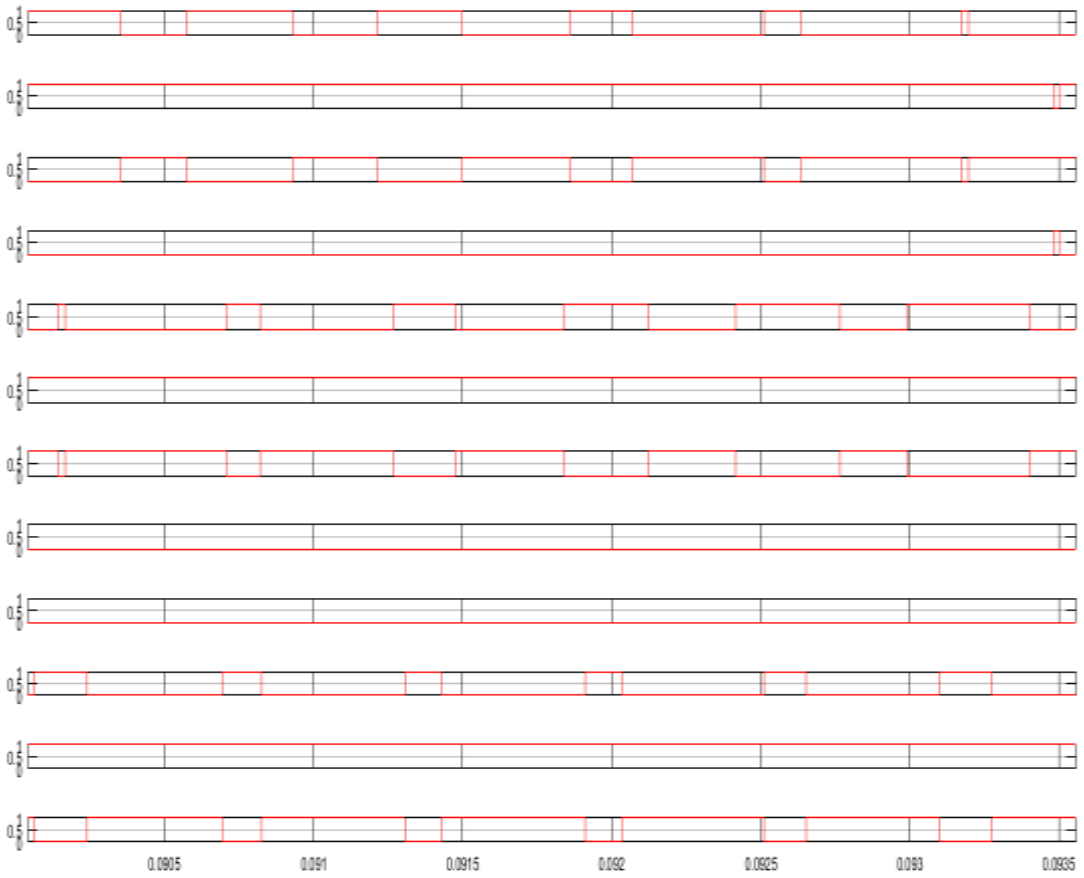


Figure5. Switching pulse of inverter

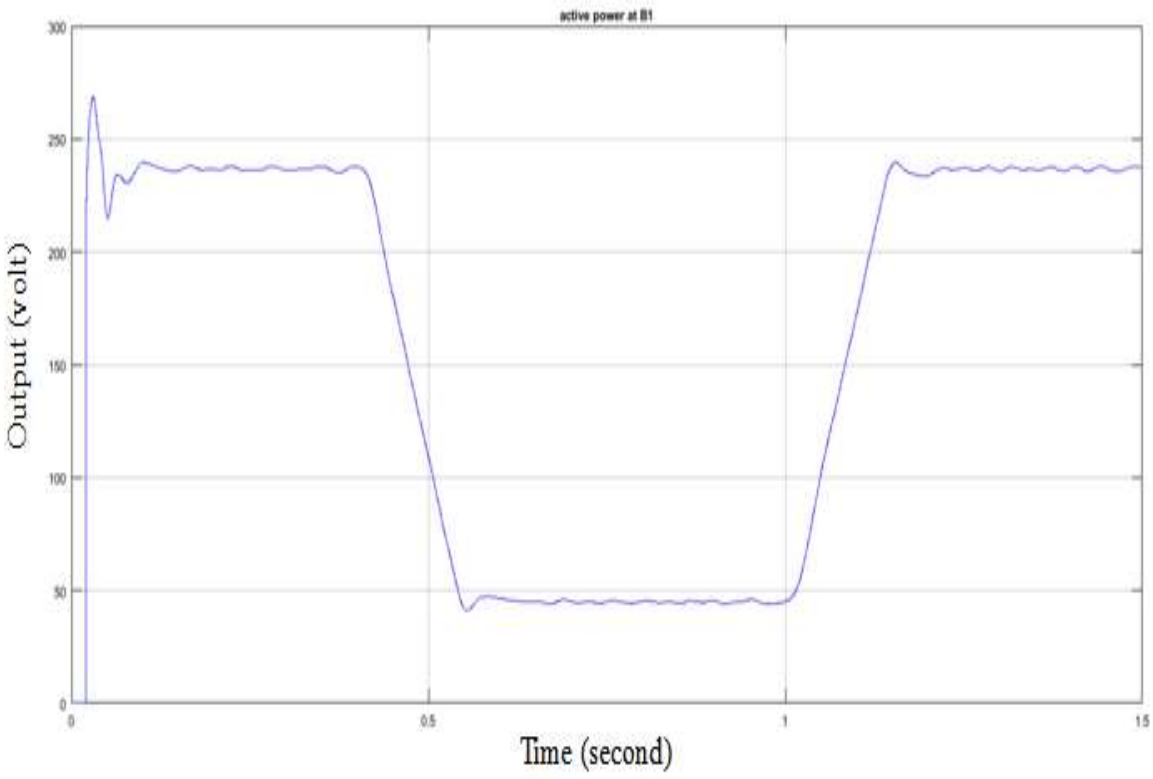


Figure6. Active power inverter controls

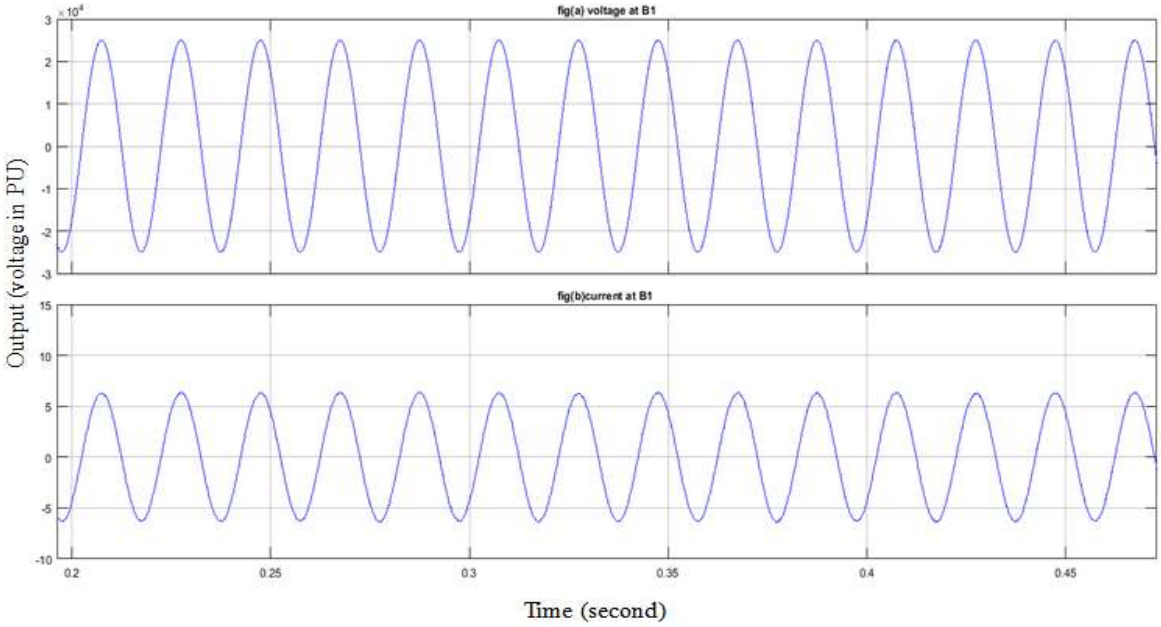


Figure7. Voltage and current phase system at inverter control

STATCOM

In shunt active power filter (STATCOM) a connected parallel in grid system. In this grid supplied by a three phase source to a non linear load an active power filter is connected in parallel to this system for the compensation of reactive power.

STATCOM simulation is shown in figure 8. STATCOM in us used the calculation technique. In this pi controller, hysteresis controller, PQ &I compensation, inverter used.

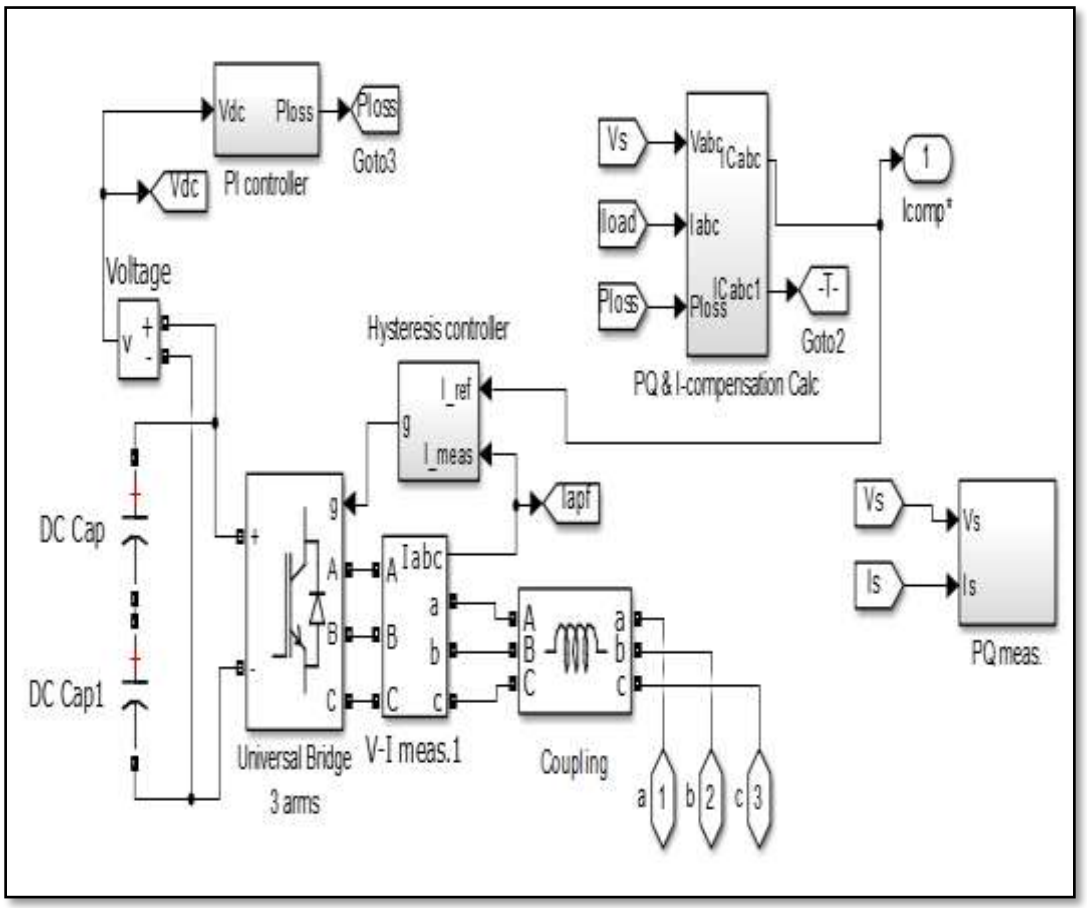


Figure8. STATCOM (shunt active power filter)

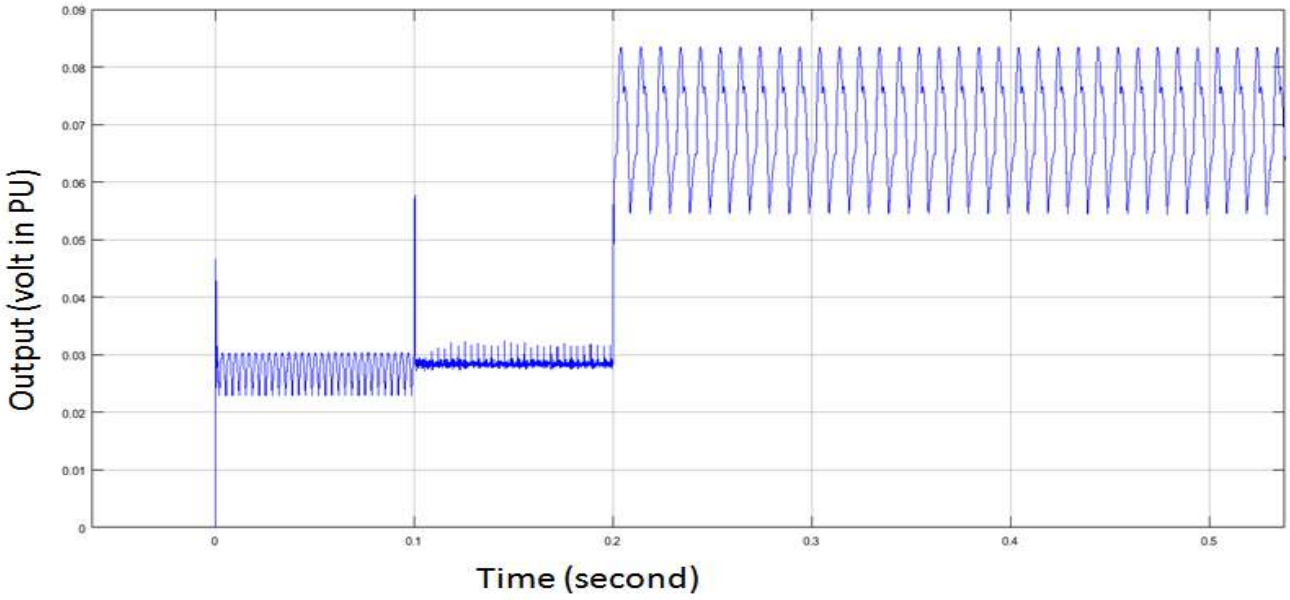


Figure9. Result active power STATCOM

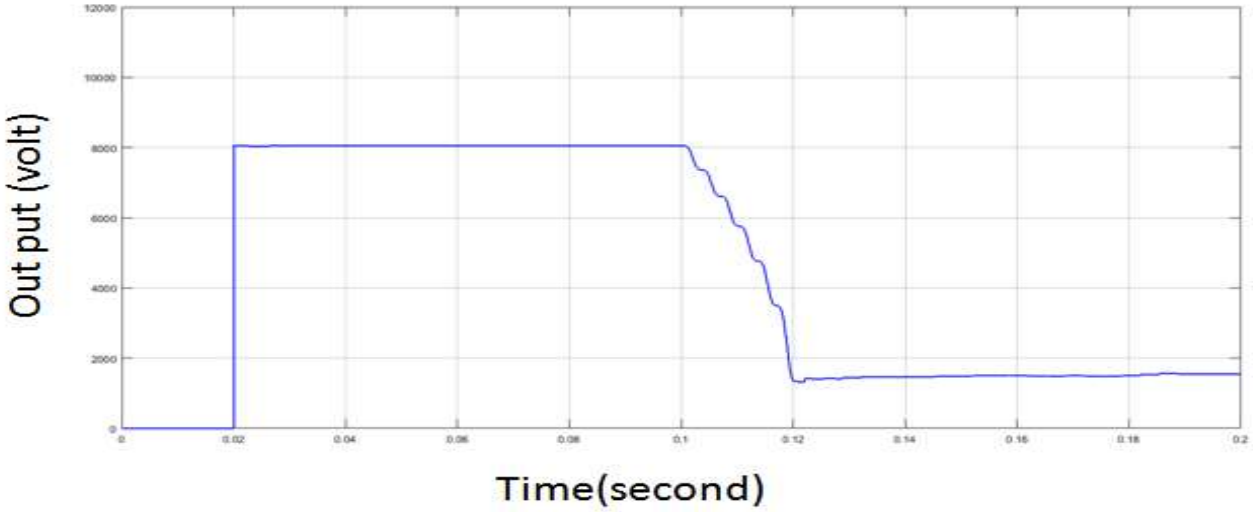
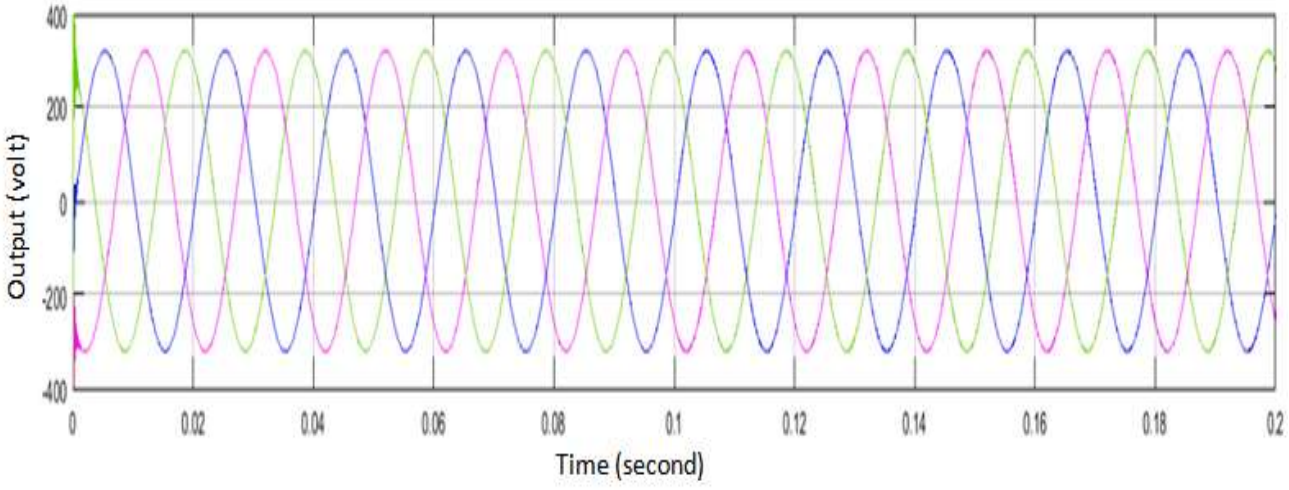


Figure10. Result reactive power STATCOM



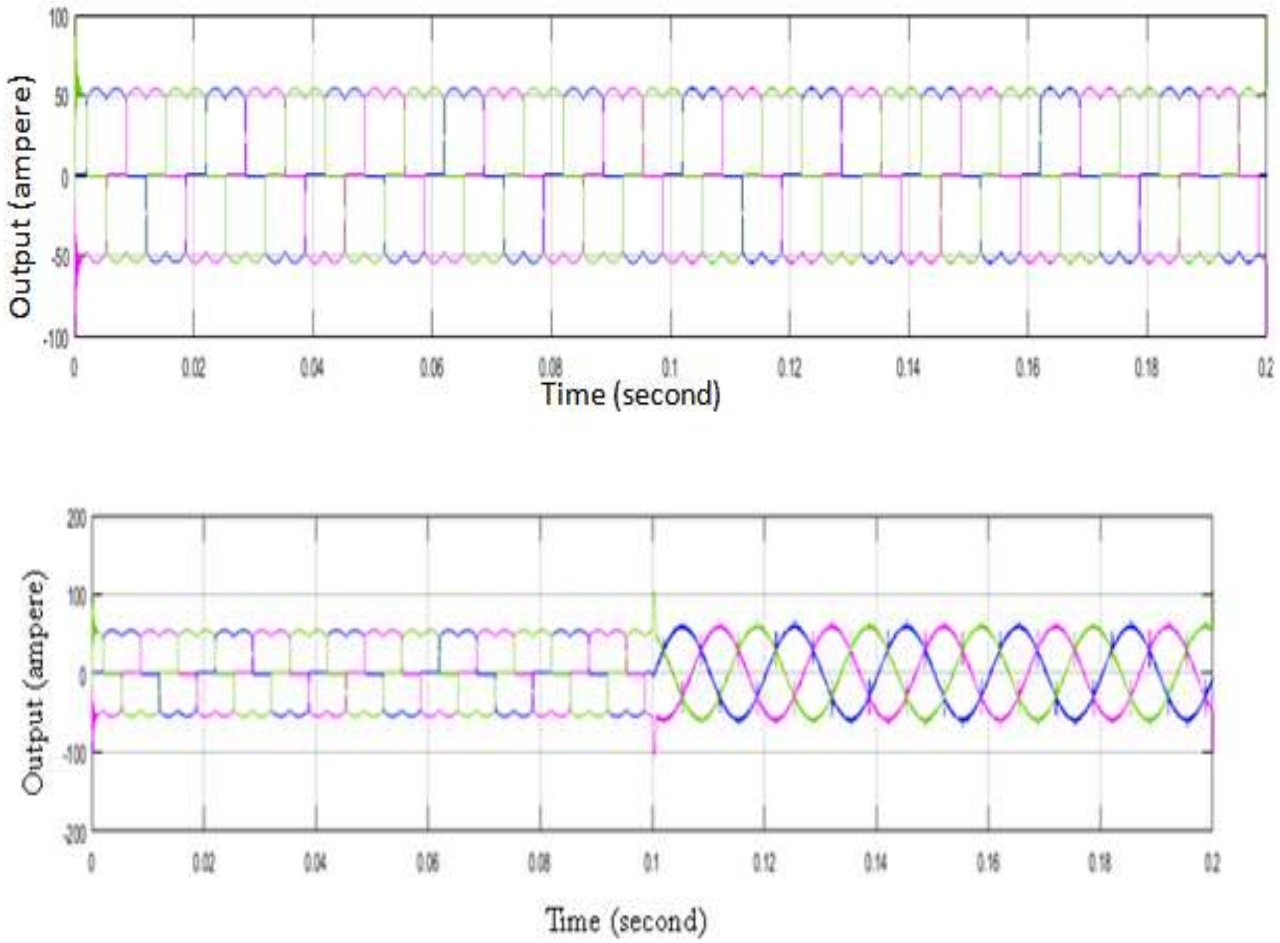


Figure11.
a) Voltage of STATCOM (b) current of STATCOM and (c) current source

CONCLUSION

The paper has presented reactive power compensation for grid connected solar PV system in this the modeling inverter control and STATCOM and the control strategy using dq0 transformation of three phase PWM inverter to be employed in a grid connected photovoltaic generation system and PWM inverter control system to using control active and reactive power. In inverter control strategy using PLL, PWM, and dq0 transformation technique and when synchronize the three phase inverter output and grid system the grid system in required reactive power the STATCOM absorb and generate reactive power requirement of grid system. Using STATCOM compensate reactive power and eliminates harmonic.

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