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# Modelling and Control of Grid Integrated Photovoltaic System

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***Abstract —This paper focuses on pv array, dc-dc boost converter to boost up the voltage, dc-ac inverter. This paper also focuses on grid connected pv system, maximum power point tracking algorithm, synchronization of inverter to grid using dqo transformation and phase locking loop.***

***Keywords- Photovoltaic array, dc-dc boost converter, dc-ac inverter, maximum power point tracking, dqo transformation, phase locking loop control.***

## I. INTRODUCTION

In the present scenario, the non renewable sources like coal petroleum etc. are getting exhausted due to increase in population, urbanization, industrialization. So there is a need to find some alternative for this. Renewable energy sources like solar, wind, geothermal, biogas etc. can be used as the alternative. Solar energy is very much attracted now-a-days as it is pollution free, no maintenance needed as it has no moving parts, no noise and it is freely available. Apart from stand alone photovoltaic system, grid connected MW class photovoltaic plants are being installed with very high capacity. Maximum power point tracking technique is applied for complete modelling of photovoltaic system. Maximum power point tracking technique is applied to dc-dc boost converter. Photovoltaic system and dc link are connected to input and output of boost converter.

There are some issues which should be concerned when PV source is connected to grid. Firstly, the power qualities of fluctuating PV power. Secondly, during grid faults a voltage dip occurs at the point of connection of PV source, which causes an increase in current at grid which can disconnect electrical appliances from each other. The impacts of PV systems on the grid are becoming increasingly apparent in the rapid development. They bring serious challenges to the stable operation of the grid. Apart from stand-alone PV systems, grid connected megawatt class PV plants are being installed.

## II. Modelling of PV System under study

### A. PV plant modelling

PV systems are manufactured to withstand the most rugged conditions. Modules are designed to endure extreme temperatures, at any elevation, in high winds, and with any degree of moisture or salt in the atmosphere. Systems can be designed with storage capabilities to provide consistent, high-quality power even when the sun isn't shining.

As we can show in fig 2, that PV array is getting irradiation 1000w/m2 and 25 degree temperature.output of PV array is connected to boost converter which increases voltage from 366 to 440 v.

| Parameters | Value |
|---|---|
| Short circuit current | 8.5 A |
| Open circuit voltage | 45.5V |
| PV panel | Trina solar TSM-300PD14.08 |
| Irradiation | 1000 w/m$^2$ |
| Number of cells | 72 |
| Boost converter(input voltage) | 266.7 V |
| Boost converter(output voltage) | 440v |
| Transformer | 20 MVA |
| Three phase source(grid) | 66KV |
| Grid frequency | 50 hz |
| Switching frequency | 20khz |

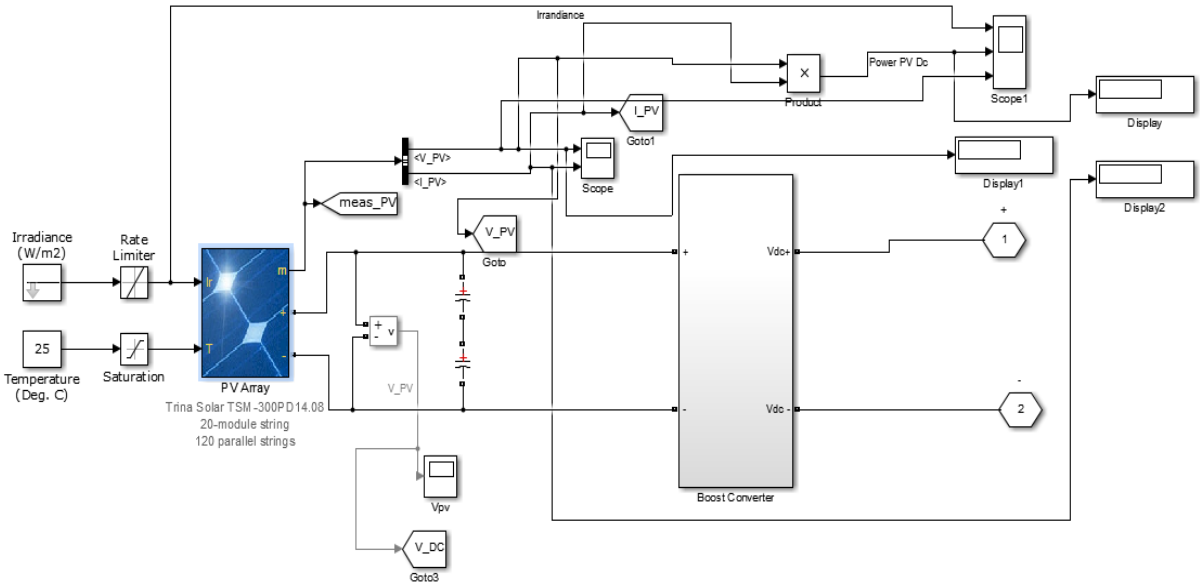


*Figure 1 PV connected to boost converter*

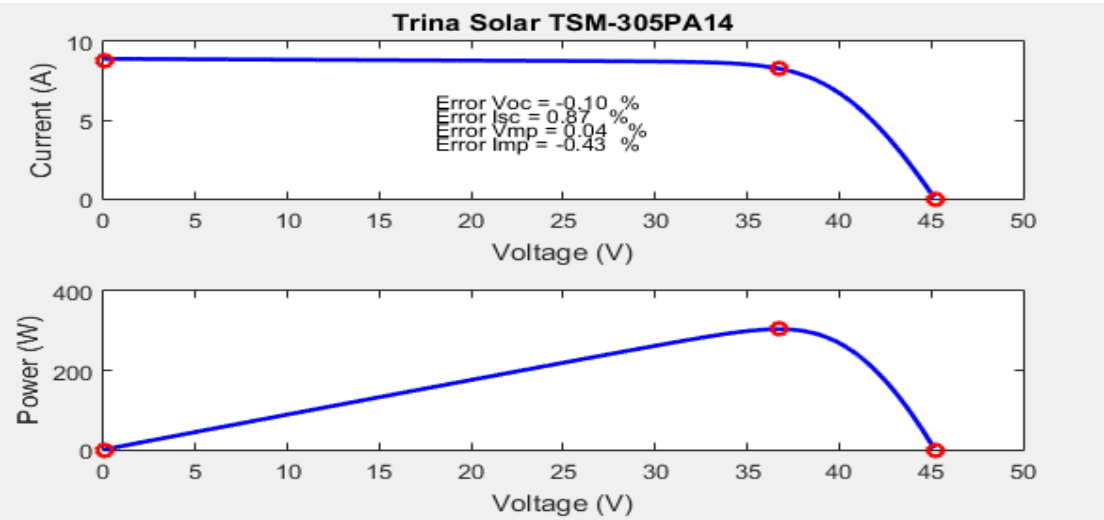


*Figure 2 IV and PV characteristics of PV array*

### *B. Modelling of DC-DC Boost Converter*

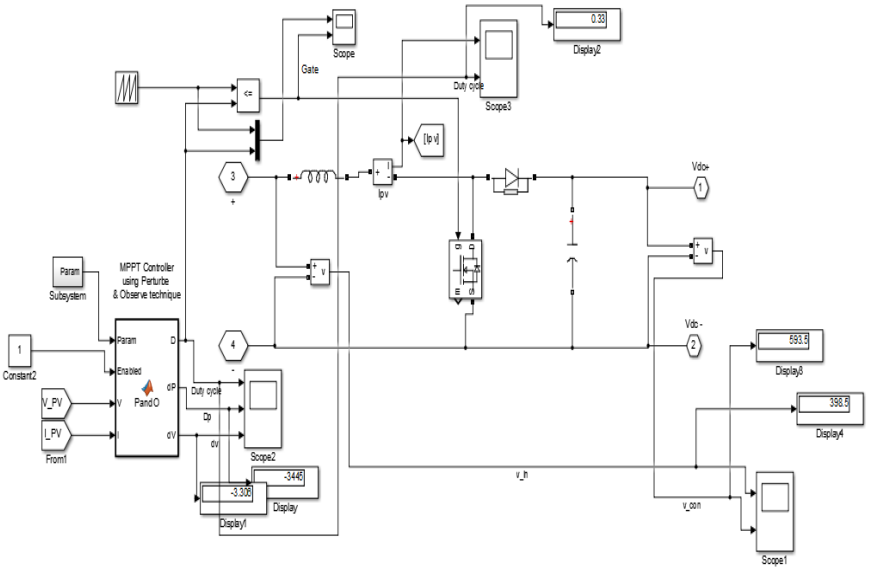


*Figure 3 dc-dc boost converter with mppt control*

Boost converter is a DC-DC power converter that steps up voltage (while stepping down current) from its input to its output. It is a class of switched-mode power supply containing at two semiconductors capacitor and inductors which smooths and filters output taken from inverter. Boost converter is placed between inverter and PV array. Here, we given duty cycle from MPPT control to switch used in boost converter.

There are so many techniques are used for MPPT control which gives the maximum output from PV array. We have used Perturb &Observation MPPT technique forr boost converter. Because it is easily implemented and less complicated from other techniques. We used duty cycle generated from this MPPT technique given to DC-DC boost converter and it converts to AC at inverter next to it.

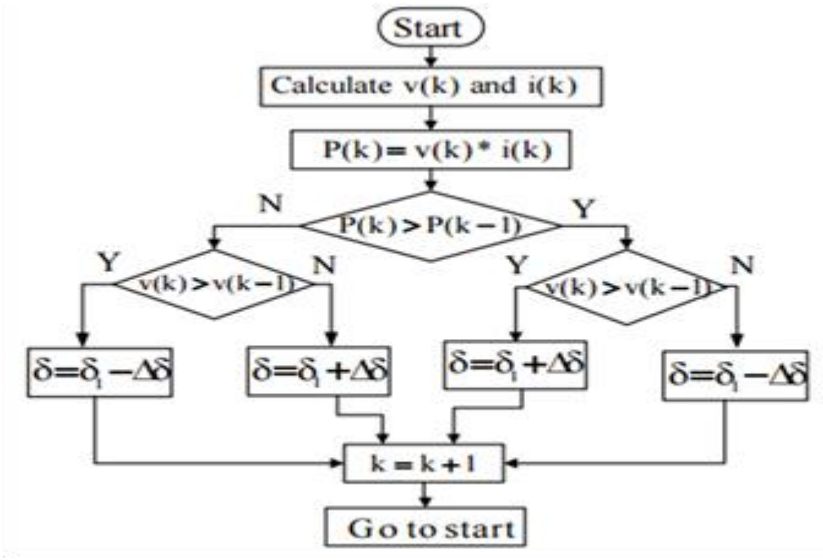


*Figure 4 P and O algorithm*

### C. Modelling of DC-AC Inverter

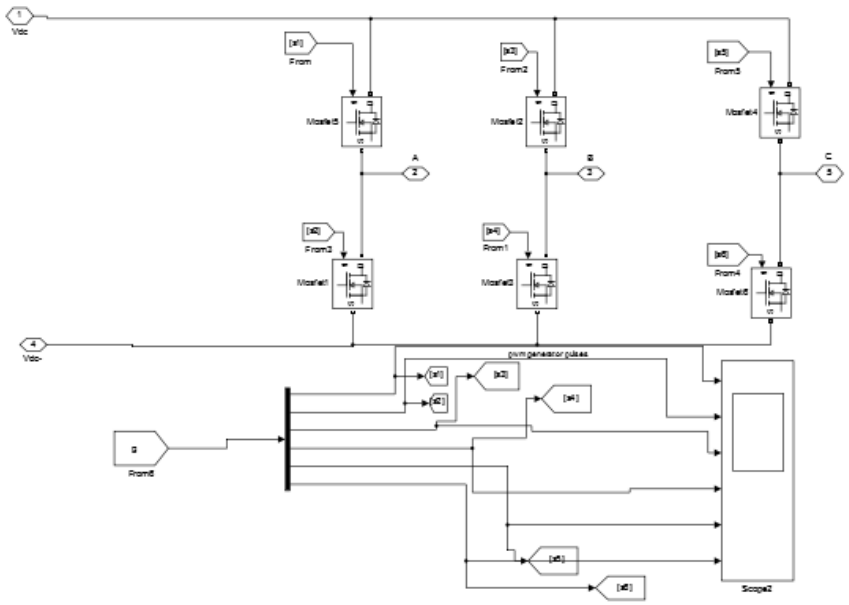

*Figure 5 dc-ac inverter*

### D. Controlling of Inverter from grid

**Here we have a simple way of modelling and the control strategy using *dq0* transformation of a three-phase PWM inverter to be employed in a grid-connected photovoltaic generation system. The inverter used in this work is a three-phase bidirectional DC-AC converter with PWM modulation using six power switches.**

**The simplified diagram of the inverter is shown in Fig. 5. The inverter modelling is quit simple and is accomplished through *dq0* transformation which gives id,vd,iq and vq. The modelling for the inverter control is obtained considering the AC output.**

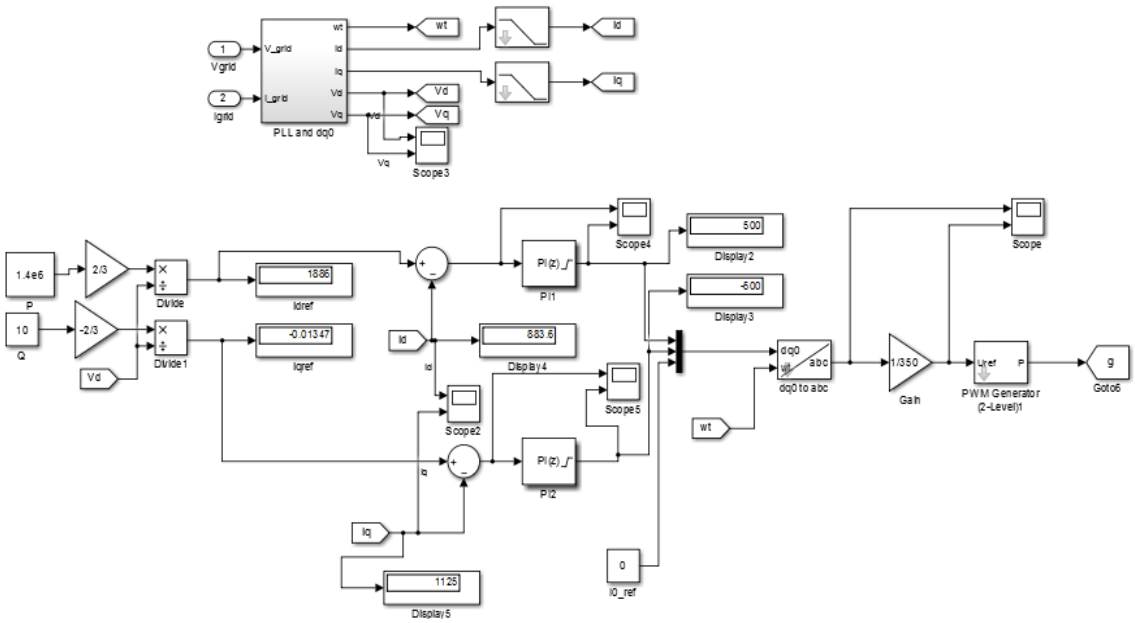

*Figure 6 dqo transformation and PLL loop for inverter controlling*

### E. Grid Connected PV System

Fig. 7 represents the schematic diagram of 4.6 MW pv plant connected to 66 KV. PV plant is followed by the DC/DC boost converter and then a DC/AC inverter is employed to dispatch the AC power to the grid. The inverter is capable of maintaining constant 350V DC voltage at the DC link. Finally a 350V/ 66kV transformer (delta-way) is employed to integrate the generated PV power to the grid.

Figure 3 represents the responses of the PV power, input irradiance and voltage measured at the PV terminal, and duty cycle applied to boost converter with MPPT control . It is seen that when the irradiance level is 1000 w/m2, the PV plant delivers 4.6 MW power to the grid. However, when the irradiance level goes down to 250 w/m2, it is capable of generating about 3.4 MW power. Duty cycle is varied by the MPPT technique to extract maximum power at different irradiance level. MPPT forces the PV plant to operate different voltage level at different irradiance.

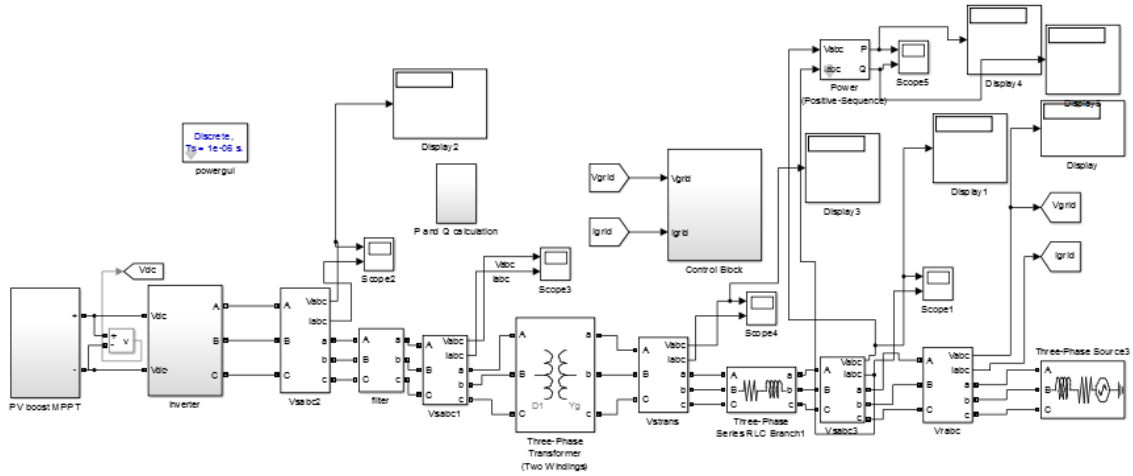


*Figure 7 grid connected pv system.*

## III. CONCLUSION

In this paper modelling of dc-dc boost converter is shown to increase the voltage . Modelling of dc-ac inverter is done for conversion of dc voltage to 3 phase ac voltage. LC filter is used after dc-ac inverter to filter out the harmonics .Maximum power point tracking is done using P and O algorithm. Phase locking loop control and dqo transformation is used for controlling of inverter and to synchronise the inverter to grid. The complete modelling is done in MATLAB/SIMULINK

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