JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Decoupled Control of Three Phase Grid Connected Solar PV System

Mr.P. Jithendar[1] , L. Sandeep Kumar[2], T. Praveen[3], Yash Varma [4], A. Kalyan[5]Guide[1],Student[2,3,4,5].
Department of Electrical and Electronics EngineeringMLR
Institute of Technology
Dundigal, Hyderabad, India

Abstract: Solar photovoltaic is a promising renewable energy resource that converts solar energy into electrical energy while being environmentally friendly. It is inefficient and incurs high relative costs. To overcome these constraints, a grid-connected PV system should be required to meet the load demand. Because the vast majority of PV systems are grid-connected, a dependable power electronic connectivity between the grid and the Photovoltaic system is required. The Boost converter and inverter are critical electrical components in grid- connected photovoltaic systems that must be managed in order to synchronizing a grid voltages and frequencies. The simulation run in the MATLAB, and a 31.5 kW Photovoltaic system is modelled to produce 30 kilowatts of power under Standard Test Conditions using MPPT (STC). Each and every power factor value for both 0.85 lagging and 0.9 leading can be achieved by adjusting the reference q current in this inverter control method. Thissimulation results show that changing the reactive power has no effect on the active power values of the system, demonstrating efficacy of inverter's decoupled control method.

Index terms: PV System; Decoupled Power Factor; InC Based MPPT; Boost Converter; Grid Synchronization.

I. Introduction

Solar energy is widely regarded as one of the most capable renewable energy sources on the planet. The global demand for electric energy had already steadily increased over the last few decades. In today's society, energy and the environment have become major problems. Because most PV systems are connected to the grid, a reliablepower among the grid and PV system is necessary. A solar PV system consists of PV panels, MPPT controllers, DC-DC converters, inverters, and the grid. The Boost converters are fitted between the PV panel and the inverterto stepup the PV output voltage. To get the highest power, the LG350Q1C PV model is used to represent the PV array, and an incremental conductance based MPPT controller by means of a DC-DC converter is constructed. The sync block measures a grid and current voltage to synchronize the converter. PLL is a famous synchronization mechanism for acquiring the grid's phase angle in order to provide the reference signal for the inverter. To regulate inverter outputs and produce a controllable power factor, the dq axis manage approach are frequently employed in conjunction with Pulse Width Modulation technology. To accomplish trailing, leading, and unity power factors, this system uses a control method that decouples active power (P) and reactive power (Q). As a result, in order to achieve the desired power factor, a grid-connected Photovoltaic system and inverter- controlled technique relies on decoupling P and Q.

II. Literature Survey:

K. Khatua, Institute of Power Engineering, Department of Electrical Power Engineering, University TenagaNasional, Malaysia.
k. Ramachandaramurt, Institute of Power Engineering, Department of Electrical Power Engineering, UniversityTenaga Nasional, Malaysia.
Jia Ying Yong, Institute of Power Engineering, Department of Electrical Power Engineering, University TenagaNasional, Malaysia

III. DESCRIPTION OF THE SYSTEM

Figure 1 shows a model schematic of a three-phase grid-connected PV system. Direct current (DC) and alternatecurrent (AC) are the two sections of the model (AC). The DC component includes Photovoltaic panels, Maximum power point tracking controller, and Boost Converter, In contrast, the Alternating Current component consists ofan inverter, transformer, loads, dq transformation, PLL, decoupling circuit, and pulse width modulation. By controlling gate signals of the Boost converter, MPPT optimizes solar energy in proportion to the temperatures and irradiance. While inverter transforms Direct Current power from the converter output to Alternating Current. To keep the voltage at the same level as the grid and to provide galvanic isolation (a design method that separateselectrical circuits to avoid stray currents), a step-up transformer is utilized. The phase and frequency of this system's PLL will be locked to synchronise the inverter with the grid, as well as provide the proper angle for dq change. The grid variation's circular frames (d and q) are provided and related to measured value in the decoupled circuit by decoupling P and Q. Switching between leading and trailing power factors is done with the switch in diagram 1. The output of the decoupled circuit is converted reverse to 3 phase machinery, which are then supplied into the inverter via PWM to generate the necessary pulses

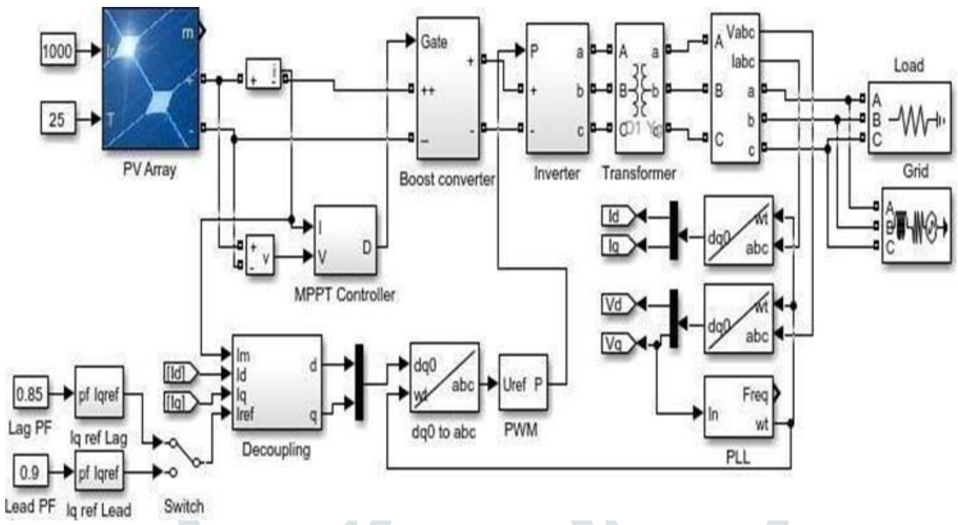


Fig.1: Illustrates a grid connected Photovoltaic system & control architecture

IV. PV SYSTEM IMPLEMENTATION

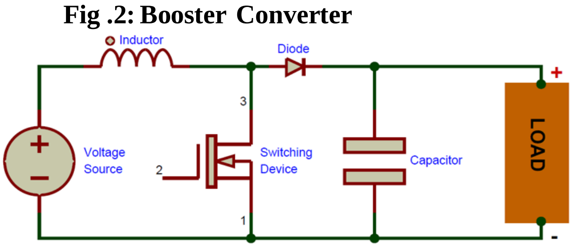
1. PV Array:

A photovoltaic array (PV array) is a power-generating system made up of any number of PV modules and panels. The maximum DC power output (watts) of PV modules is under Standard Test Conditions is commonly used to assess their efficiency(STC).

2. Boost Converter:

A boost converter is a DC-DC converter with a higher output voltage than the input voltage. Because it "steps up" the source voltage, a boost converter is also known as a step-up converter. As a result, the output current is small than the source current. The DC-DC converter, likewise known as a boost converter, has two modes of operation, they are continuous conduction for effective power conversion and discontinuous conduction for low power or standby. However, it raises the input voltage to the desired level and provides excellent operating efficiency, while the input current remains constant, which is ideal for PV or battery sources. Solar power systems, automobile applications, battery power systems, consumer electronics, and communication applications all employ boost converters.

Fig .2: Booster Converter



3. Three Phase Inverter

The inverter converts a Direct Current signal to an Alternating Current signal. It comprises six higher- frequencyswitches and a lower-pass filter in essence. As shown in Figure 3.3, this system converts three-phase AC using six MOSFETs and an LC filter. PWM signals are used to regulate the MOSFETs. To get smooth sinusoidal signals, the filter's L and C values are appropriately adjusted, depending on the frequency of filter termination.

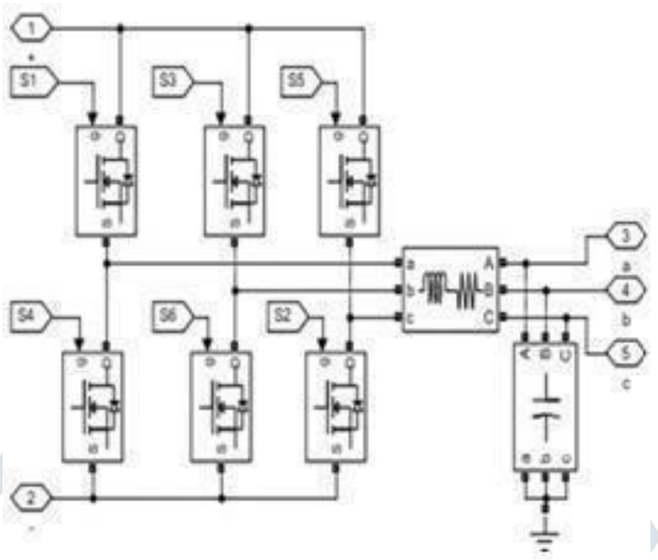


Fig.3: **Three-phase inverter with LC filter**

V. HOW TO MAKE A CONTROL PLAN5.1: MPPT

Controller:

Because the electricity provided by PV system is dependent on external variables, such as variations in isolation and temperature, the PV system has poor efficiency. An MPPT controller based on InC has been developed. The flowsheet of the InC algorithm used in this PV solar system is shown in Figure 5.1. The duty cycle (D) algorithmis integrated with the network company's triangular signal to form the DC-DC converter MOSFET converter, which provides 30 KW Photovoltaic power to the STC.

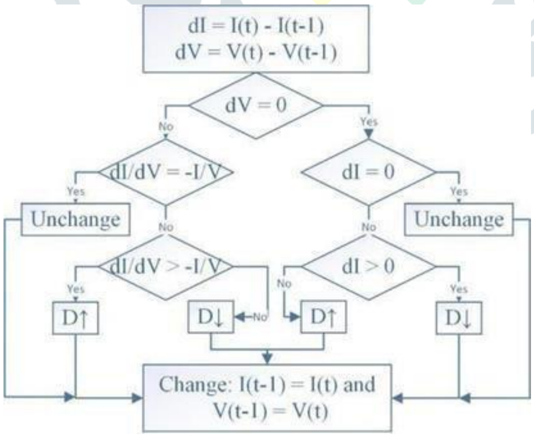


Fig. 5.1 InC algorithm flowchart

5.2 : Grid Synchronization:

The initial stage of the inverter controller is grid synchronization, which is done in two parts. In the first step, theparts of the abc references frames work are converted into a straight quadrature frame work

[□
□] = 2 /3 [sin □ sin (□ − 2□/ 3) sin (□ + 2□ /3)
cos □ cos (□ − 2□/ 3) cos (□ + 2□ /3)] [a,b,c] (1)

The PLL implementation is the second step in grid synchronization, in which angle required for calculation.It is predictable that transformation will occur. PLLis depicted in fig 5.2 as a diagram.

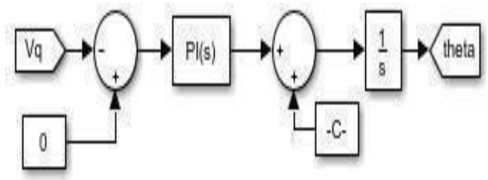


Fig .5.2: PLL algorithm

Error signal is generated by comparing the quadrature voltage to zero and passing it through a PI controller to generate angular frequency (). To obtain immediate phase angle, this is multiplied by the fundamental angular frequency(f = 2*50) and sent through an integrator.

5.3 : Termination of Active power and Reactive Power.

For decoupling P & Q, the network circuits of 3-phase inverter is reduced to a 1-phase inverter circuit inFigure 5.3.

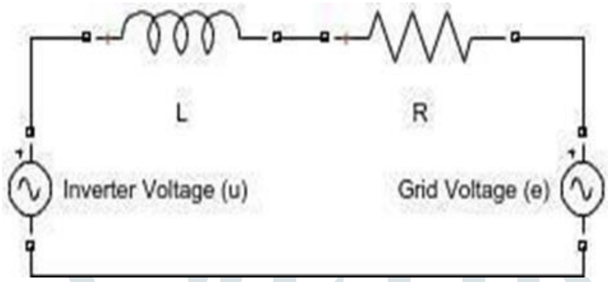


Fig. 4.3 single phase inverter circuit

The inductance (L) in Figure 4.3 is sum of this filters and grid inductances, and R is the total resistancesamong the inverter & the grid. In the preceding circuit, the Kirchhoff Voltage Law (KVL) is used.

$$L\, di/\, dt + Ri = \Delta V \ (2)$$

In a 3-phase circuit, I is changed by iabc, and V is changed by Vabc. The resulting equations are found:

$$ud = ed + Rid + L\, did/\, dt - \omega Liq \ (3)$$

$$uq = eq + Riq + L\, diq\, dt + \omega Lid \ (4)$$

ud must only depends on d element for manipulating P and Q separately, while uq should only depend on q components. The voltage loss caused by grid inverter impedance can be adjusted by using a PI controller,as shown in (5). (6).

$$ud = ed + (KP + KI/\, S\,)\,(Id,ref - Id) - \omega Liq(5)$$

$$uq = eq + (KP + KI/\, S\,)\,(Iq,ref - Iq) + \omega Lid(6)$$

The P and Q in synchronous reference frame are

$$P = 3/\, 2\, (udid + uqiq) \ (7)$$

$$Q = 3\,/2\, (udiq - uqid) \ (8)$$

To divide P & Q, d-axis is linked to the voltage through establishing uq = 0. this PV system, P reliesexclusively on the id, whereas Q relies exclusively on the iq

VI. SIMULATION ANALYSIS AND RESULT

Figure 5.1-5.4 depicts the results of the simulation using the SIMULINK tool. To obtain the needed power factor, the worth of P is altered while the rate of Q is modified. To reach the simulation results,the reference quadrature current is altered

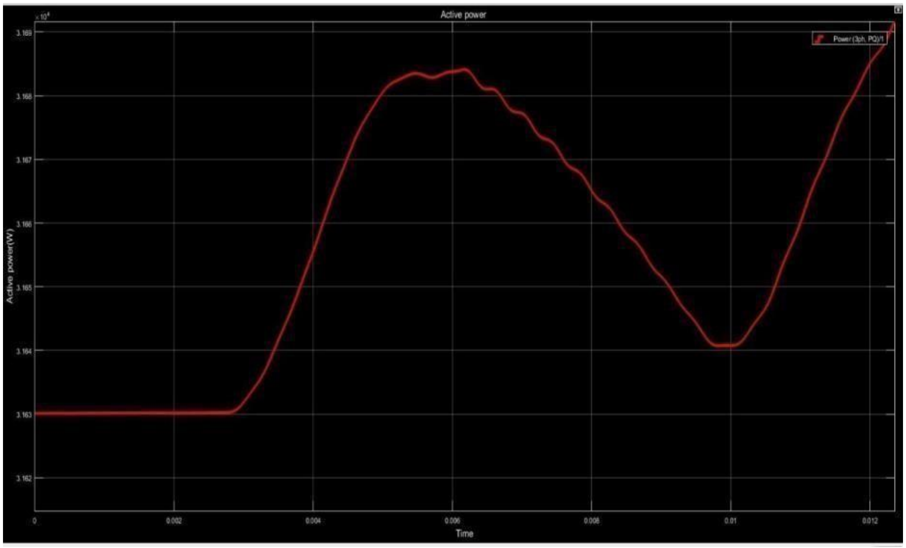


Fig. 6.1 Active Power factor (0.85Lagging)

The above fig shows variation of active power by changing the reference quadraturecurrent at 0.85lagging power factor

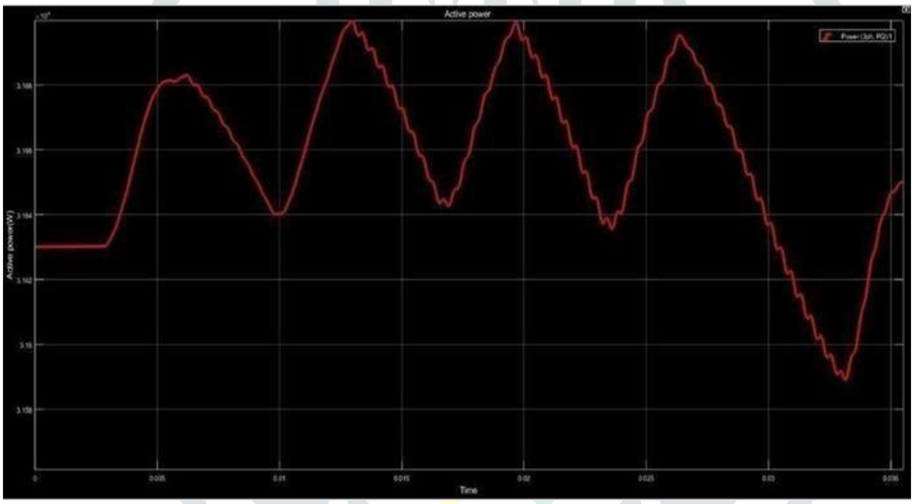


Fig. 6.2 Active Power factor (0.9 Leading)

The above fig. shows the variation of active power by changing the reference quadraturecurrent at 0.9 leading power factor

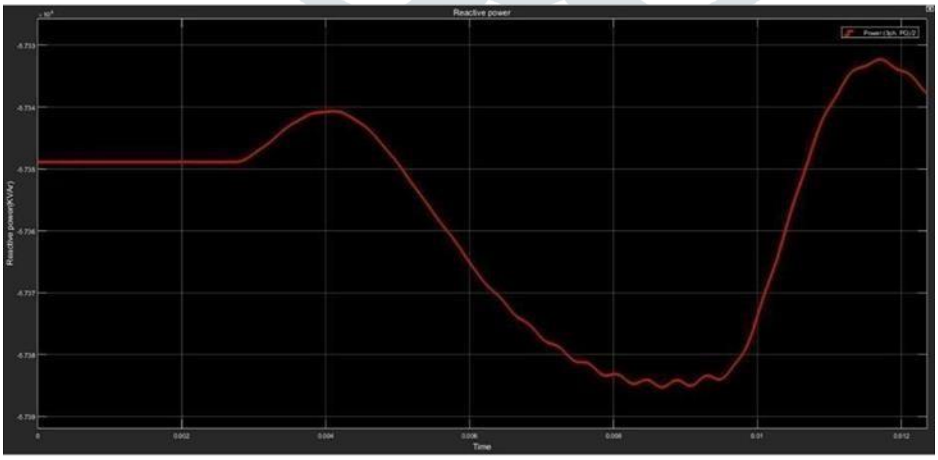


Fig. 6.3 Reactive Power factor (Lagging)

The above fig. shows variation of reactive power by changing the reference quadraturecurrent at 0.85lagging power factor.

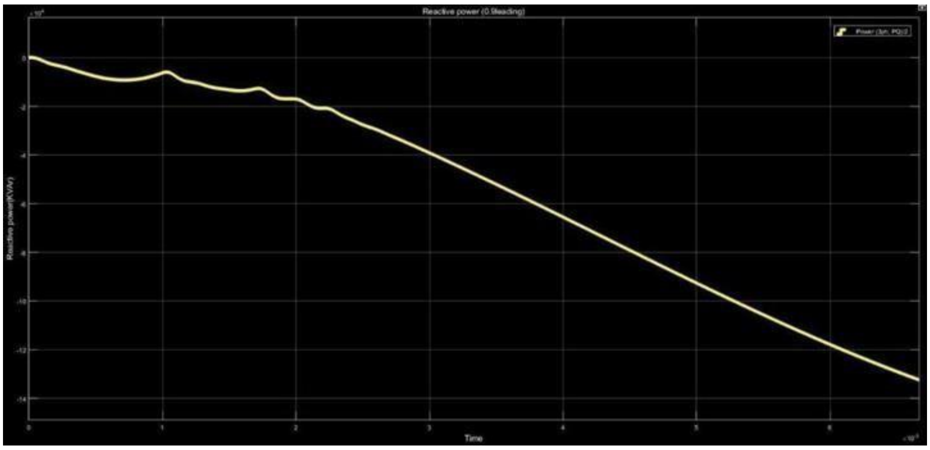


Fig 6.4 Factor of reactive power (leading)

The above fig. shows the variation of reactive power by changing the reference quadrature current at 0.9 leadingpower factor.

Table.1 for a given power factor, theoretic and simulation values of the Q

Power Factor	Q (Theoretic Values)(KVAR)	Q (Simulation Values)(KVAR)
0.85 (Lag)	18.5	16.7
1	0	-0.5
0.9 (Lead)	-14.5	-13.9

VII. CONCLUSION

To achieve the specified power factor, a decoupled control technique for a 3-phase grid-connected PV systemwas successfully developed. 30KW of power is generated from a 31.5kw PV panel. To synchronize the low grid voltage PLL is used and the grid frame variation is compared to the reference variable in the partition circuit. The current d reference in this system is set to 30 KW of active power, while current q reference is instep to change the active powers in accordance with essential power factors(pf). The result displayed, that control method works well with power factors ranging from 0.85 to 0.9.

REFERENCES

1. A. H. M. Nordin, A. M. Omar and H. Zainuddin, "Modelling and Simulation of Grid Inverter in Grid- Connected PhotovoltaicSystem", International Journal of Renewable Energy Research, vol.4, no. 4, pp.949-957, 2014.
2. K. Padmanathan, U. Govindarajan, V. K. Ramachandaramurthy, S.O.
T. Selvi and B. Jeevarathinam, "Integrating solar photovoltaic energy conversion systems into industrial and commercial electricalenergy utilization-A survey",Journal of Industrial Information Integration, vol.10, pp. 39-54, 2018.
3. T. Esram and P. L. Chapman, "Comparison of Photovoltaic Array Maximum Power Point Tracking Techniques",IEEE Transactions on EnergyConversion, Vol. 22, no. 2, pp. 439-449, 2007.
4. N. Karami, N. Moubayed and R. Outbib, "General review and classification of different MPPT Techniques",Renewable and Sustainable EnergyReviews, vol. 68, no. 1, pp. 1-18, 2017.
5. H. Islam, S. Mekhilef, N. B. M. Shah, T. K. Soon, M. Seyedmahmousian, B. Horan and A. Stojcevski, "Performance Evaluation of Maximum Power Point Tracking Approaches and Photovoltaic Systems", Energies, vol. 11, no. 2, pp. 1-24, 2018.
6. S. S. Mohammed and D. Devaraj, "Simulation of Incremental Conductance MPPT based Two phase Interleaved Boost Converter using MATLAB/Simulink"IEEE International Conference on Electrical, Computer and Communication Technologies, Coimbatore, India, 2015, doi:10.1109/ICECCT.2015.7225987