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Real and Reactive Power Control of Three Phase Grid Connected Solar Plant

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ABSTRACT: This paper presents a strategy for the management of active and reactive power feeding to the utility and therefore the load through a 3 phase grid connected photovoltaic power plant. A 2 stage management strategy has been accustomed give a good and simplified management to extract most power from the PV array further on management the reactive power. This paper focuses on simplifying the management topology by exploitation proportional resonant controller and reducing the amount of control variables. The time domain simulation exploitation Matlab/Simulink has been done to analyse the performance of the controller and justify the strength at totally different operational conditions.

KEYWORDS: Grid connected PV system, maximum power point tracking, proportional integral controller, real and reactive power control, three phase photovoltaic.

I.INTRODUCTION

For over a decade, distributed generators (DG) arefor the most partused for power generation at low voltage in standalone and grid connected mode, relying upon the kind of the load [1], since they're economic and atmosphere friendly [2]. solar powerbased mostlydg systems connected to single phase or 3phase network of the grid, ar being put in at giant scale in several countries [3]. Photovoltaic (PV) power plants, with capability in MWs, arsometimes connected at the sub-transmission voltage level whereas upper side PV installations of few KWs capabilityarput in at the distribution level. Grid connected photovoltaic systems inject processed power into the utility [4 and 5]. Several kinds ofcontrol theories areplanned to inject active and reactive power into the onephase grid through PV power plant [6]-[9]. In synchronous system theory there's a cross coupling between control variables [6]. Conjointly this managementneeds the phase of the grid voltage. Aside from this, Clarke's transformation has been employed by introducing an additionalnotional 'q' axis to the onephase grid connected invertercontrol that will increase the complexness of the system [7].

Single phase grid connected electrical convertercan even be controlled victimizationphysical phenomenon controller, that is enforced by changethe powerelectronics switches however it introduces chattering within the current [8]. K. De. et. al. have planneda controlalgorithmic ruleemploying aKalmanfigurerbased mostly filter howeverhaven't commented on its accuracy once utilizing it in single section grid connected dg [9]. In this paper, a 2 stage management strategy is planned for a PV system connected to a fewsection grids. The plannedmanagement strategy regulates the provision of active and reactive power to the load and therefore the utility, as outlined by the system regulator. To cut back the complexness of the feedback loop, proportional resonant (PR) controller is employedthatar effective for dominantsinusoidal signals. The effectiveness of the plannedmanagement strategy and its hardiness against the changes in operational conditions arincontestable through time-domain simulations.

In this paper, Section II describes regardingthe entire PV system connected to the load and therefore the utility. The careful description of the electrical phenomenon array modelling and methodologywont to extract most power from the array is given in Section III. In Section IV, twin stage convertorstyle is explained at the side of used management. Simulation results aranalysed in Section V and conclusion is drawn in Section VI

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II. SYSTEM MODELING

The circuit diagram for photovoltaic system connected to single part grid at the purpose of common coupling (PCC) is shown within the Fig. 1. The mostelements of the system square measurephotovoltaic array, dual-stage convertor comprising of DCDC convertor and voltage supplyinverter (VSI), native load and therefore the grid. The electrical phenomenon array is connected to DC-DC convertor through a capacitor (CPV) that helps in dominant PV array voltage thereby extracting most power from it victimisationmostwall plugtrailing (MPPT) rule. The DC-DC convertor is connected to VSI via DC link electrical condenser (C). The voltage across C is maintained constant, through the outer voltage controller loop of VSI, to facilitate complete active power transfer to the AC facet of the VSI. The VSI is controlled victimisationcurved pulse dimension modulation strategy to feed active (P) and reactive power (Q) to the native load and therefore the utility. The system is loaded with each static and dynamic load. The grid with voltage Vgrid is connected at the PCC and is assumed to be capable of fascinating active and reactive power generated from the icon voltaic.

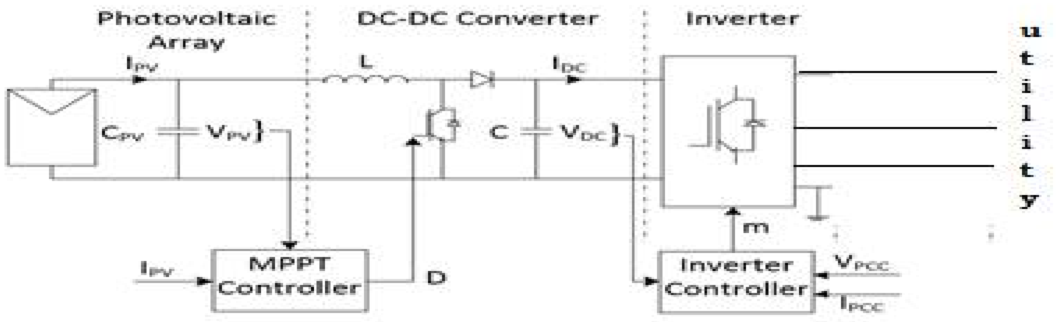

Figure 1. PV system and its control

III. MODELING OF PV PANEL

The equivalent circuit of a PV panel with a load. The current output of the PV panel is modelled by the following three equations. All the parameters are shown in Table:

$$I_{pv} = n_p I_{ph} - n_p I_{sat} * [\exp\left(\left(\frac{q}{AKT}\right)\left(\frac{V_{pv}}{n_s} + I_{pv}R_s\right)\right) - 1] \quad (1)$$

$$I_{pv} = \left(I_{sso} + K_i(T - T_r)\right) * \frac{S}{1000} (2)$$

$$I_{sat} = I_{rr}\left(\frac{T}{T_r}\right)^3 \exp\left(\left(\frac{qE_{gap}}{KA}\right)\left(\frac{1}{T_r} - \frac{1}{T}\right)\right)(3)$$

IV. MPPT ALGORITHM

A PV array beneath constant uniform irradiance contains a current–voltage (I–V) characteristic like that shown in Figure one. there'sa singularpurpose on the curve, referred to asthe utmostwall plug (MPP), at that the array operates with mostpotency and produces most output power. once a PV array is directly connected to a load (a questionable ‘direct-coupled’ system), the system’s operationalpurposeare going to be at the intersection of the I–V curve of the PV array and cargo line shown in Figure a pair of. In general, this operationalpurposeisn't at the PVarray’s MPP, which might be clearly seen in Figure a pair of.

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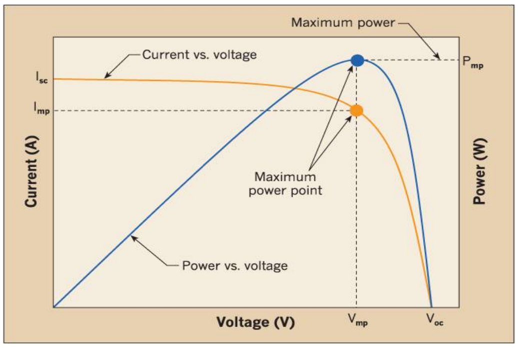

Fig 2: Typical current–voltage curve for a PV array

INCREMENTAL CONDUCTANCE (INC)

Incremental conductance considers the actual fact that the slope of the power-voltage curve is zero at the utmostelectrical outlet, positive at the left of the MPP, and negative at the correct of the MPP. The MPP is found by comparison the fastelectrical phenomenon (I/V) to the progressiveconductance (ΔI/ΔV). Once you have got the MPP, the system maintains this power point unless aamendment in V or I happens (caused by an external event). If this happens, the rulecannotice the new MPP.

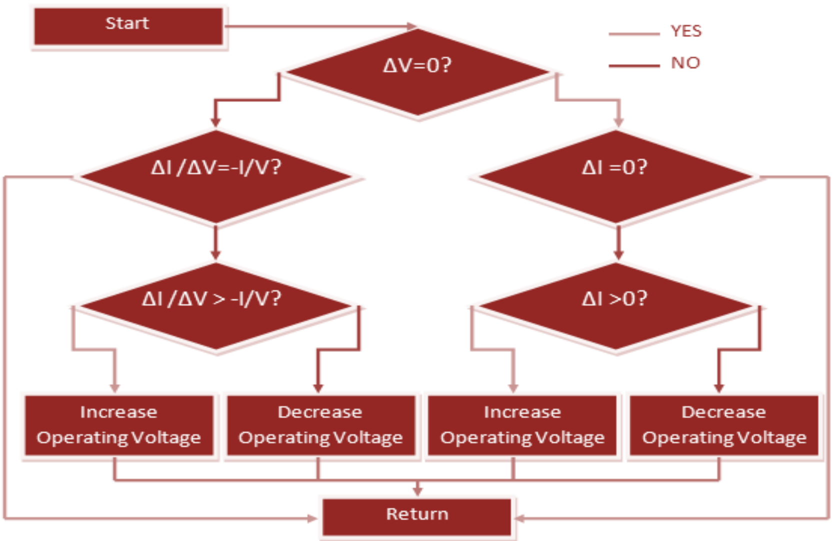

Fig 3: Incremental conductance algorithm flowchart

V. DUAL STAGE CONVERTER

Dual Stage convertor} includes of 2 parts: DC-DC converter that extracts the most power from the PV array and performs voltage amplification. The DC-DC device is connected to DC link of a VSI thattakes care of with grid current management thereby provides P and q at the PCC. cdcare often calculated by (4) ,

$$C \geq \frac{P_{PV}}{2\omega_{GRID} V_{DC} \Delta V_{DC}} \ldots \ldots \ldots \ldots (4)$$

where PPV representso-called power of PV array, cogridrepresent the grid voltage frequency, V_{DC} represents indicatevoltage across the capacitor and ΔV_{DC} represents theamplitude of the ripple.

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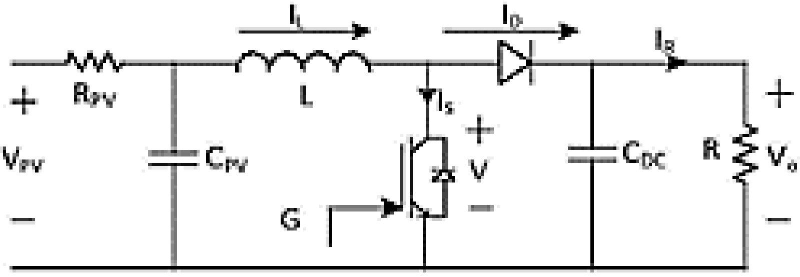
DC-DC CONVERTER AND ITS CONTROL

To extract the most power from the array, pulse dimension modulation controlled, boost kind DC-DC convertoris employeddue tothe advantages as follows: boost convertor has sensible switch utilization issue [13] however the characteristics of switchcomponent, harmonic level and operative temperature of the parts majorly decide the performance and stability of the convertor [14]. Boost convertor have continuous input current that eliminates the need of input filter [15]. Conjointly the output voltage of the boost convertoris usuallybigger than the input voltage thatreduces the need of connecting sizable amount of modules serial. Equivalent circuit of the boost convertor is shown



within the Fig. 4.

Figure 4 ; Equivalent circuit of Boost converter

VOLTAGE SOURCE INVERTER (VSI) AND ITS CONTROL

VSI could be a device that converts DC signals into AC signals. during this paper, VSI is controlled to produce system outlined active and reactive power to the nativemassesand also the utility. to attain this, it's controlled in such the simplest way that it performs the subsequent functions:

1. Synchronizing the inverter with the grid and provide reactive power.
2. Maintain the input DC voltage at a continuingworthto maximisethe facility transfer.

Grid facet DC-AC converters artypically controlled exploitation2 cascaded loops i.e. internal current loop and external voltage loop [18]. Current loop regulates the grid feeding current and voltage loop balances the facility flow within the system. DC link controller is employedto take care ofinverter input DC voltage at a continuingworthemploying a PI controller; and desired worth of reactive power is maintained exploitation an another PI controller (Q controller). Fig. 8 shows the entireinvertermanagement diagrams with totally different controllers employed in it. The PI controllers track the reference worthto scale back the error signal, ex and ey, to zero so generates two quantities, Ex and Ey, thatareaccustomed generate this reference

The plannedmanagement methodology adds to many advantages:

1. because thecontrol variables arcurving, these may be controlled exploitation the PR controller that is capable of eliminating the steady state error between the controlled signal and reference because it attains a awfully high gain at the resonant frequency [19]. so it overcomes the disadvantage of a PI controller whichfailsto get rid of the steady state error with curving reference.
2. The complexness of feedback circuit is reduced as just onemanagement variable is to be controlled in inner current loop.
3. conjointly the PR controller may be used for compensating the upper order harmonics [18].

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VI. SIMULATION RESULTS

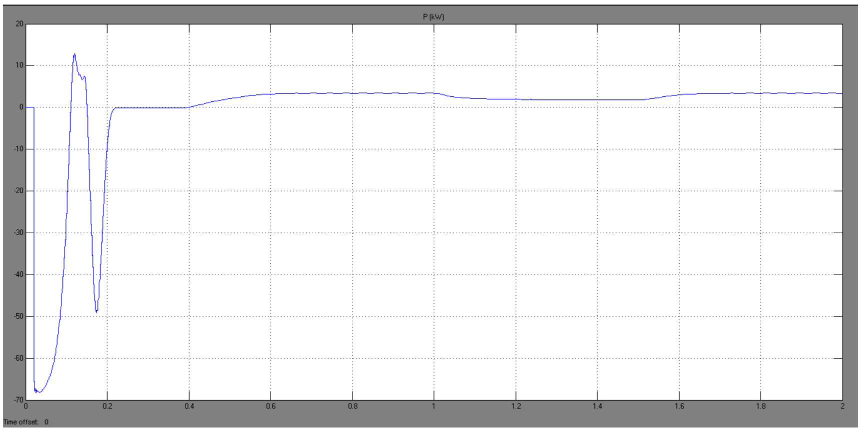

Fig. 5: Input power(PV power)

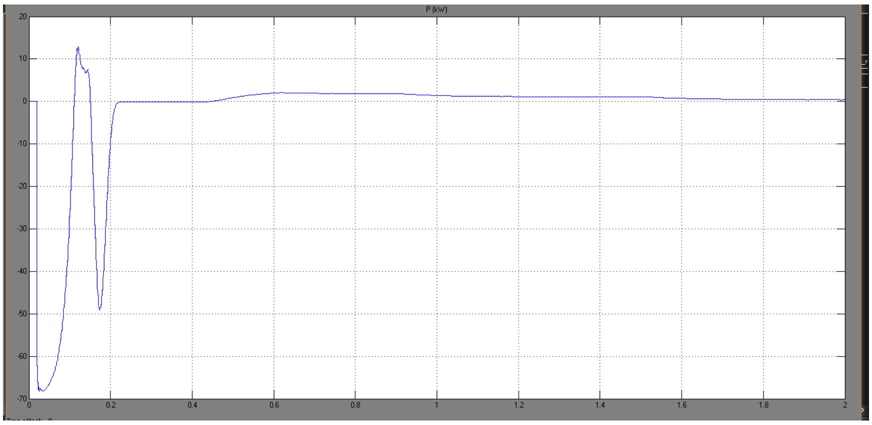

Fig. 6: Inverter output power

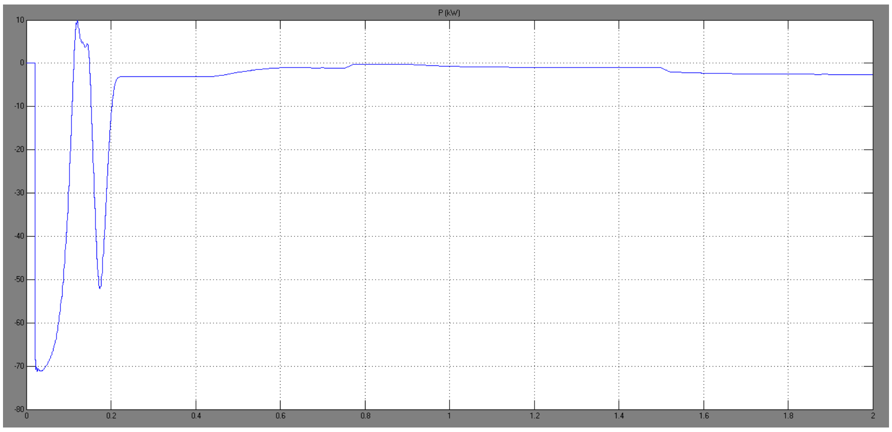

Fig. 7: Grid power

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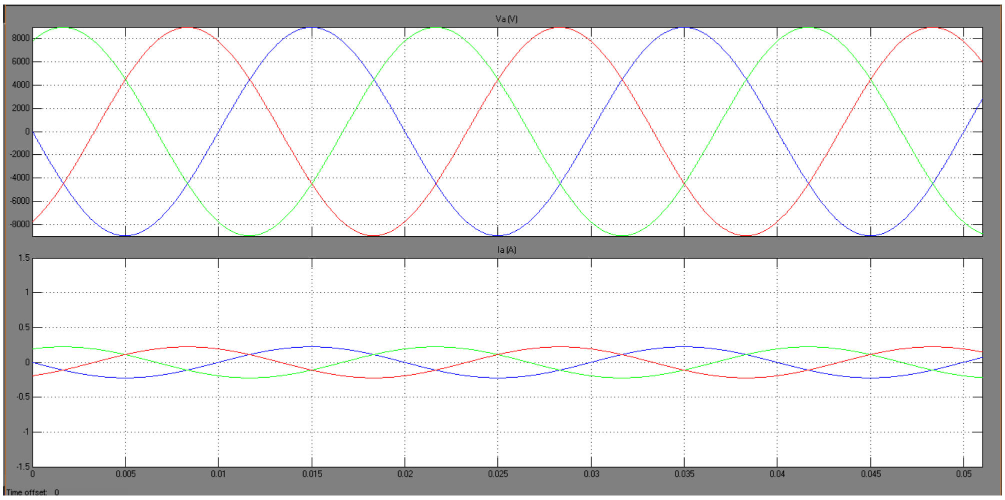

Fig. 8: load side voltages and currents

VI.CONCLUSION

In this paper, the power output of a grid connected threephase photovoltaic system has been controlled using areference frame based control methodology. In the proposedcontrol mechanism, a PR controller along with an outervoltage regulating loop is used to regulate the output currentof the system. MPP control is used to extract the maximumpower from the PV system. The proposed controller is ableto deliver the specified real and reactive powers into thesingle phase grid. Even though control performance issatisfactory, the controller parameters need to be tunedfurther in order to attain responses with reduced ripples.

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