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Power Quality Conditioner Functionality by Using a Single Phase Voltage Controlled Grid Connected Photovoltaic System

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Abstract— **The voltage sags are minimized by using voltage controlled converter, this voltage converter acts as a shunt controller. The voltage quality is improved by using the shunt controller for the small voltage droops for nonlinear loads. For the improvement of voltage profile and un -fluctuating voltage in the power system by using the static var generator, this is nothing but shunt controller, and to minimizing current harmonics and unbalanced load currents. In existing method a single phase PV system that provides voltage support to the grid and minimization of harmonic distortion by using repetitive controller. The PV inverter not only producing the power but also manages the voltage profile by the PV panels in the presence of repetitive controller. Here, the harmonics of current and voltage are selected and minimize by using the repetitive controller. The PV system contributes voltage support to grid at fundamental frequency and compensation of harmonic distortion. By using MPPT algorithm based on incremental conduction method the voltage generated by the PV modules and takes high amount of voltage from the panels .The simulation results validate by using MATLAB software.**
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Keywords— MPPT Algorithms, shunt controller, single phase inverter.

I. INTRODUCTION

In present days there are lots of problems occurring on power quality because of unbalanced loads at the consumer ends. For these power quality problems we have to eliminate by using different techniques. The power quality problems are voltage sag, voltage swell. To compensate these power quality problems we are using shunt and series controllers. The voltage controllers are almost acts as shunt controller for improving the voltage quality when voltage droops are occurs for non linear loads. Here, voltage sag minimization for small loads are very easy to eliminate but for the large type of loads the voltage sags are minimize by using heavy voltage controllers. For this we are using repetitive controller and MPPT algorithm. Compensation of current harmonics and unbalanced load currents by using shunt controller and it improves the voltage profile in power system. In future the small PV power plants are connecting to the low power distribution system. The research has been focusing on integration of real power filtering the PV inverter operation.

Distribution networks are less capable of performing without failure than transmission network and their reliability, because of radial configuration. For this reason PV systems are connecting to grid which has the capability of low voltage. Moreover, in distribution network the lines have resistive in nature because of low voltage distribution, when DPGS is connected to grid which has low voltage, the grid voltage and frequency cannot control independently by adjusting the real and reactive power and improve the voltage profile and compensate the current harmonics and unbalanced load currents in the power system network.

A. POWER QUALITY PROBLEMS

The power quality problems are occurring in distribution of voltage and current waveforms of amplitude. These are occurred because of harmonics in current and voltage.

a .Voltage fluctuation

The most savior cause to fail the equipments like computers and televisions for the power fluctuations .these power fluctuations are occurred in power system network because of loose and corroded connections at home or power lines and we noticed flickering of light for these problems.

b. Voltage surges/spikes

The power will rise in lines within a short period and damage the equipments. The voltage spikes are generally 10% to 35% higher than the normal voltage; it is 15ms to several minutes.

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c. Voltage dips and under voltage

Voltage sag is a short duration reduction in RMS voltage which can form by short circuit or over load and starting of the motors, when the RMS voltage is decrease from 10% to 90% of the normal voltage. This is known as voltage sag for the on half cycle.

II. VOLTAGE AND FREQUENCY SUPPORT

The DPGS is connected between two section of the transmission line from the grid in a short model and complex phasors as shown in figure1. When the DPGS was connected to the grid, the line has mainly inductive in nature i.e. X>>R, R may neglected if the power angle δ is very small then, then $\sin\delta \cong \delta$ and $\cos\delta \cong 1$,

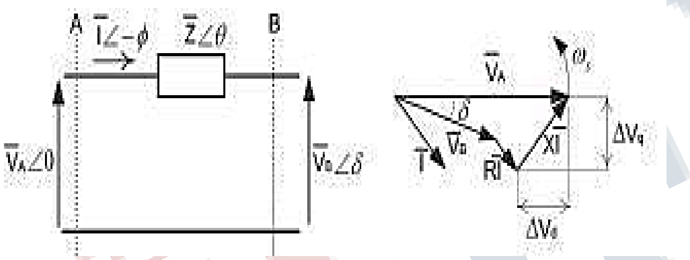

Fig. 1 power flow from V_A to V_B and phasor diagram

$$\delta \cong \frac{XP_A}{V_A V_B} \qquad (1)$$

$$V_A - V_B \cong \frac{XP_A}{V_A} \qquad (2)$$

When V_A, P_A, Q_A, denotes respectively voltage, active power and reactive power in V_A to V_B

For X>>R , power angle is very small and the difference of V_A-V_B shows that the power angle predominantly lean on the real power and the voltage difference V_A-V_B predominantly depends on reactive power and voltage. Here, the angle can control by regulate the real power whereas inverter voltage V_A is controlled through the reactive power. By adjusting the real and reactive power independently determine the frequency and amplitude of the grid In this paper the relation (1) was adopted to optimize the power extraction from PV modules by using MPPT.

III. SHUNT CONTROLLERS FOR VOLTAGE DIP MITIGATION

Variable impedance type static var generators consists of large energy storage inductors and capacitors to meet var demand switched mode converters are used to provide instantaneous VAR control. Alternating current can control by the converter with in magnitude and relationship with AC voltage leading lagging and UPF can be achieved. The DC source can implement by a small capacitor for energy storage the converter average power is zero. The fundamental voltage can control ability at certain points in depends on impedance of the grid power factor of the load. By injection of current in to the line for minimizing the voltage sag is difficult to achieve because of low grid impedance and current injection could be very high because of injecting the voltage of the load. The current and voltage are controlling by shunt controllers.

Here, the shunt converter is a current controlled device it can represent as the grid feeding device, this supports voltage by adjusting the real power to the grid when shunt converter is a voltage controlled device it is a grid supporting device the device will control the output voltage

However, the shunt controller has the vector diagram provides real power

a) The phasor represents the current controlling converter in normal condition

b) The phasor representation for the compensation of voltage sag of 0.15 pu

$$\bar{I}_g + \bar{I}_C = \bar{I}_{load} \qquad (3)$$

$$\bar{I}_g = \frac{\bar{V}_{L_g}}{j\omega L_g} \qquad (4)$$

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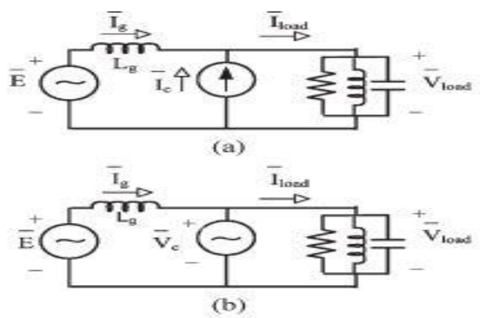

Fig.2. (a)

a) ***Current controlled shunt converter***

b) ***Voltage controlled shunt converter***

$$\bar{V}_{load} = \bar{E} + \bar{V}_{L_g} \quad (5)$$

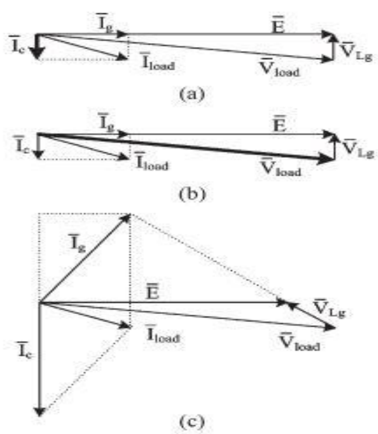

Fig.3. (a) current controlled converter in normal conditions;
(b) Voltage controlled converter in normal condition;
(c) Vector diagram for compensation of a voltage dip of 0.15 pu.

IV. PV SYSTEM WITH SHUNT-CONNECTED MULTIFUNCTIONAL CONVERTER

For low power applications the main advantage is use of converter and that parallel connected to grid for compensating .The reactive power and harmonics are compensated in this paper by using the PV system converter.

The improvement of voltage with shunt controller is very difficult and works for other simultaneous controller for output voltage and current. To minimize the voltage sag in power system a large rated converter is needed. In proposed model the PV system worked based on shunt controller and it will connect to load through LC filter and to grid through an additional inductance of 0.1pu as shown in figure

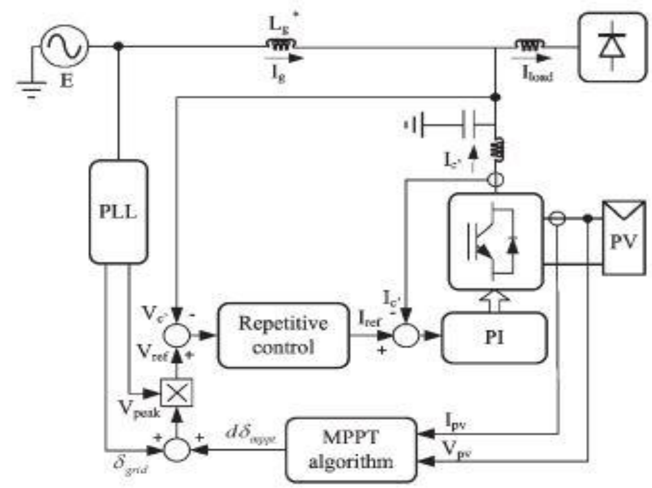

Fig.5
Shunt controller functionality for Grid connected PV system

Actually in case of low power applications the model is connected to distribution system which has the capability very low and the impedance of the system is resistive in nature .The voltage limitation is mainly affected by the voltage drop on inductance L_g^* .When the grid is operating normal condition but the voltage drop limiting is very difficult, this is main drawback of the system

A. Control of Converter

In the converter scheme the major two converting strategies are applied.

1. Repetitive Controller
2. MPPT Algorithm.

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The MPPT algorithm is based on incremental conductance method .The MPPT algorithm changing the phase displacement of the grid voltage and source voltage produced by the converter .The phase displacement is changing by injecting the maximum power in the given condition. Hence, The injection of current is controlled indirectly, The peak amplitude of current majorly depends on the difference of voltage to grid and voltage at the ac capacitors V'_c. The phase displacement of voltages is determined by using the real power injection it is decided by the MPPT algorithm. The real power of pv system ratings and it leads to limiting the maximum displacement angle $d\delta_{mppt}$. Moreover, the inverter has protection for inner side is PI based current loop, over current protection.

A phase lock loop (PLL) detects the amplitudeV_{peak} and phase of grid voltage $d\delta_{grid}$ then the displacement of phages $d\delta_{mppt}$ is provided by the MPPT algorithm repetitive controller, the error of voltages between $V_{ref}\, and\, V_c'$was processed by repetitive controller which is used to compensate the third and fifth harmonics by generating the signals of fundamental components.

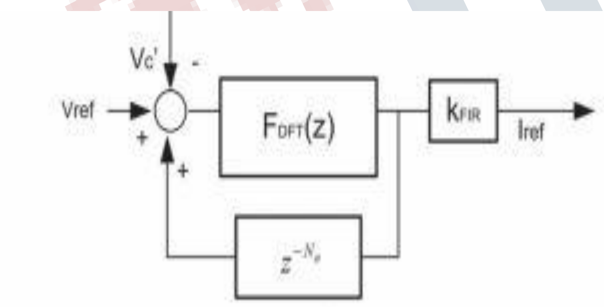

Fig.6 repetitive-based controller

$$F_{DFT}(z) = \frac{2}{N}\sum_{i=0}^{N}\left(\sum_{h\epsilon N_h} \cos\left[\frac{2\pi}{N}h(i + N_a)\right]\right).z^{-i} \qquad (6)$$

The proposed repetitive controller, where N is the for one fundamental period the number of samples N_h is determining the number of leading steps to exactly track. The selected harmonics are tracked by using repetitive controller this is the précised method for tracking the harmonics The PI controller improving the stability of the system it is based on low pass filter function. The PI controller G_C is designed for the low frequency poles damping factor of this is 0.707

$$G_C(s) = k_p + \frac{k_i}{s} \qquad (7)$$

In order to maintain for the natural operations mode of the shunt connecting converter injecting the real power for the utility grid and it is controlling the harmonics of the load voltage at low irradiation the PV inverter acts as not only shunt controller but also eliminating the harmonics and controlling the voltage sag compensation was improved by the PV converter.

B. MPPT Algorithm

MPPT(maximum power point tracking) the name itself that extracting maximum power available by using the charge controller from the PV modules. The maximum voltage and power provided by MPPT is called maximum power point tracking or peak voltage power. The MPPT checks the output of the PV modules it could produce to change the battery and the best voltage to get maximum current into battery by using PV converter. The system operates in the area of MPP the ripples on PV side minimized The MPP can track by comparing the instant conductance toincremental conductance. The MPP observes the power and voltage characteristics of the system. Moreover, operating in the area right side of MPP has to increase and it will indicates +1

V.RESULTS

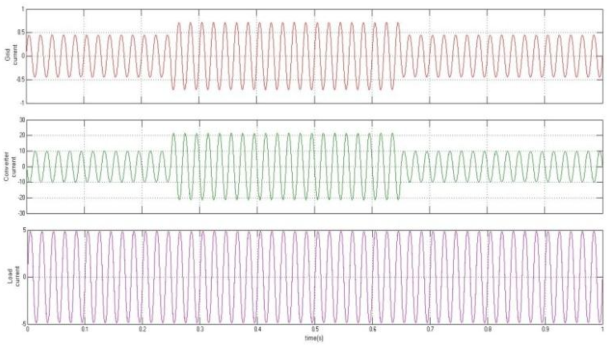

Fig.7. Controlling of currents from the grid, converter and to the load

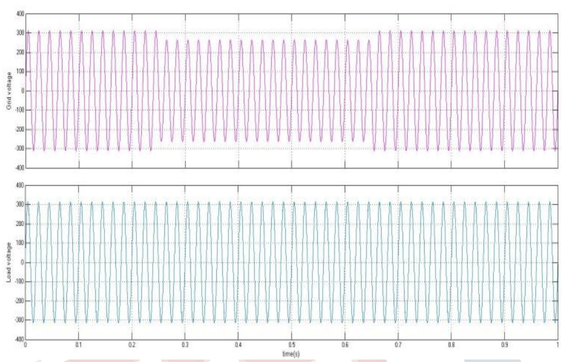

Fig.8. Converter controlled grid voltage and load voltage

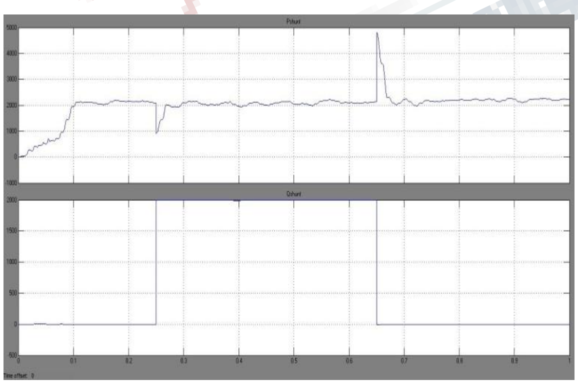

Fig.9. the active and reactive power provided by the multifunctional shunt connected controller

VI.CONCLUSION

The PV system with shunt controller has presented the repetitive controller algorithm of the PV inverter voltage, MPPT algorithm specially is designed for the voltage controlled converter. The MPPT working algorithm is working based on incremental conductance method and MPPT has also change the phase displacement of the grid voltage and converter voltage and the maximum power extraction from the PV panels from the voltage converter.

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