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Analysis of DSTATCOM for PV Based Micro Grid

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Abstract: As the power demand is increasing in India the PV grid is playing important role in power distribution the main problem in PV based microgrid is power quality problem In this paper proposes a new method to generate reference voltage for overcome harmonic in line voltage the a distribution static compensator (DSTATCOM) operating in PV based micro grid. The proposed method ensures that nearly unity power factor (UPF) is attained at the load terminal during nominal operation. Also the compensator injects lower currents and therefore reduces losses in the feeder. The rating of DSTATCOM is achieved which will improve the quality of voltage by to mitigate voltage sag and swell. In this paper we analysis DSTATCOM for PV grid in MATLAB simulation.

Keywords: Power quality (PQ), micro grid, DSTATCOM, voltage control, PI controller.

I.) INTRODUCTION

In recent years the PV based micro grid has been growing due to its several potential and economic advantages like, the microgrid has small investment. The micro-grid has less energy losses and higher overall energy efficiency. The micro-grid is designed based on the renewable energy sources near by the Load. The fuel cells and PV cell technology are mainly used in the micro grid to full-fill the load demand with hybrid technology. In hybrid micro-grid the power quality problem is the measures aspect, which is affecting the load demand. The main reason of power quality problem is power electronic components, which necessary in micro grid to convert dc to ac. The output of the inverter in micro grid should be compatible in voltage and frequency with load. In ac micro-grid dc power from photovoltaic panels has been converted into ac using dc/dc boosters and dc/ac inverter in order to connect the ac load. Due to static devices in converter results are harmonics injection and lower power factor to electric power system. The load equipment's of the modern generation are additional sensitive. Due to harmonics can initiate production loss, financial loss and environmental effect.

A Distribution system suffers from current as well as voltage-related power-quality (PQ) problems, which include poor power factor, distorted source current, and voltage disturbances A DSTATCOM [1] connected at the point of common coupling (PCC),[4] has been utilized to mitigate both types of PQ problems [2] When operating in current control mode (CCM),[7] it injects reactive and harmonic components of load currents to make source currents balanced, sinusoidal, and in phase with the PCC voltage. In voltage-control mode (VCM) the DSTATCOM regulates PCC voltage at a reference value to protect critical loads from voltage disturbances, such as sag and swell However, the advantages of CCM and VCM cannot be achieved simultaneously with one active filter device, since two modes are independent of each other. In CCM operation, the DSTATCOM [5] cannot compensate for voltage disturbances. Hence CCM operation of DSTATCOM is not beneficial under voltage disturbances, which is a major disadvantage of this mode of operation. Usually, in VCM operation, the DSTATCOM regulates the PCC voltage at 1.0 p.u [3]-[6]. However, a load works satisfactorily for a allowable voltage range. Hence, it is not necessary to standardize the PCC voltage at 1.0 p.u. While conserving 1.0-p.u. voltage, DSTATCOM compensates for the voltage drop in feeder. For this, the compensator has to supply an additional reactive current which increases the source currents.

II.) DSTATCOM

Power quality (PQ) in distribution systems affects is a measure of deviations in voltage, current, frequency of a specific system and associated components [16]. The equipment draw harmonics currents from AC mains and increase the supply demands. These loads can be grouped as linear (lagging power factor loads), nonlinear (current or voltage source type of harmonic generating loads), unbalanced and mixed types of loads. Some of power quality problems (PQ) associated [16] with these loads include harmonics, high reactive power problem, load unbalancing, voltage variation etc. A analysis on power quality problems is considered for classification, suitable corrective and protective actions to identify these problems [16]. A variety of custom power devices are developed and successfully implemented to compensate various power quality problems in a distribution system. These custom power devices are classified as the DSTATCOM (Distribution Static Compensator), DVR (Dynamic Voltage Restorer) and UPQC (Unified Power Quality Conditioner). The DSTATCOM is a shunt-connected device, which can moderate the current associated power quality problems [16]. The effectiveness of DSTATCOM depends upon the used control method for generating the switching signals for the voltage source converter and value of interfacing inductors. For the control of DSTATCOM, many control algorithms are reported in the literature based on the immediate reactive power theory, deadbeat or predictive control [17].

A.) Basic Configuration Of D-STATCOM

The DSTATCOM is connected shunt with line to regulate the voltage. The DSTATCOM is operating in voltage control mode. In this paper DSTATCOM is used in both current control and voltage control modes is the same, its operating principle is different [18]. In the current control mode it is required to monitor a set of reference currents while in the voltage control mode it is required to follow a fixed reference voltages. This paper discusses the reference voltage generation method and the control of DSTATCOM in the voltage control mode (VCM) [19]. The basic configuration of DSTATCOM is shown in fig.1

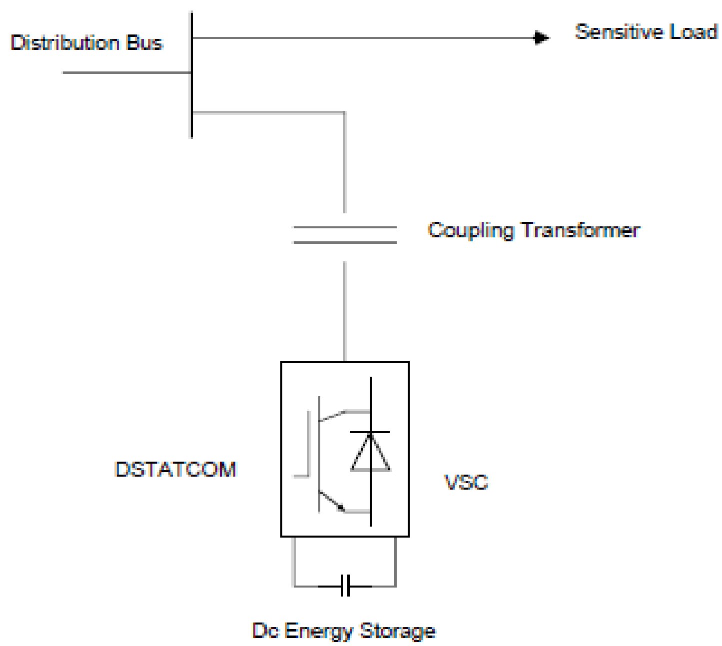

Fig.1: Basic Configuration of D-STATCOM

III.) PRINCIPLE OF D-STATCOM

DSTATCOM is to suppress voltage difference and control reactive power in phase with system voltage.. Fig.2 shows the vector diagram at the fundamental frequency for capacitive and inductive modes and for the conversion states from capacitive to inductive and vice versa. The terminal voltage (Vbus) is equal to the sum of the inverter voltage (Vvsc) and the voltage across the coupling transformer reactive VL in both capacitive and inductive methods. I mean that if output voltage of DSTATCOM [11] (Vvsc) is in phase with bus terminal voltage (Vbus) and Vvsc is more than Vbus, DSTATCOM provides reactive power to system [12]. And if Vvsc is lesser than Vbus, DSTATCOM absorbs reactive power from power system. Vbus and Vvsc have the same phase, but actually they have a slight phase difference to component the loss of transformer winding and inverter switching, so absorbs a sum of real power from system.

DSTATCOM vector diagrams which show inverter output voltage VI, system voltage VT, reactive voltage VL and line current I in association with magnitude and phase angle (δ). Figure 2.a and b explain how VI and VT produce capacitive or inductive power by controlling the magnitude for inverter output voltage VI in phase with both. Figure 2.c and d show

DSTATCOM creates or absorbs real power with VI and VT having phase ±δ. The transition from inductive to capacitive mode precede place by charging angle δ from zero to a negative value. The active power is transferred from the AC [13] terminal to the DC capacitor and effects the DC link voltage to rise. The active and reactive power may be expressed by the resulting equations:

P = (VbusVvsc/XL)sin δ ------- (1)

Q = (V2bus/XL) - (VbusVvsc/XL)cos δ ---------- (2)

In any practical DSTATCOM there are losses in the transformer windings and in the converter switching. These losses consume active power from the AC terminals. Consequently, a small phase difference always exists between the VSC voltage [14] and the AC system voltage. A summary of the power exchanges between the DSTATCOM [11] and the AC system as a function of the DSTATCOM output voltage Vvsc and the AC system voltage Vbus.

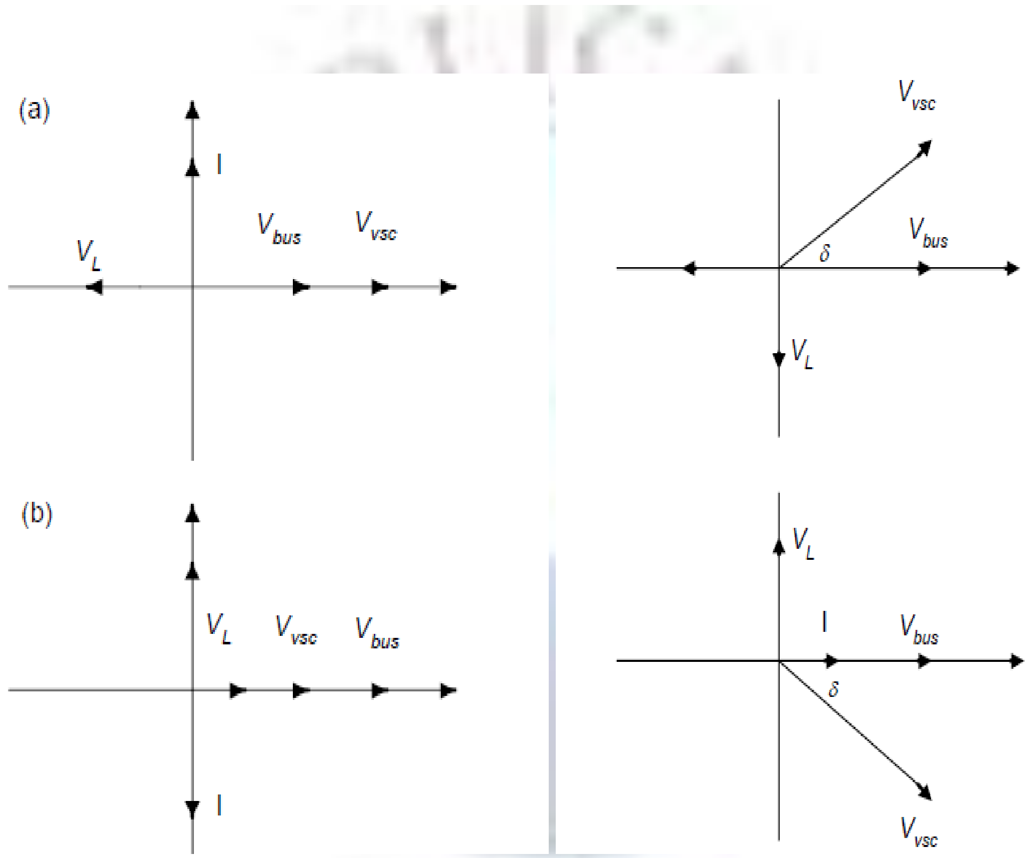

Fig.2: Vector diagram of DSTATCOM (a) capacitive mode operation (b) inductive mode operation, (c) Active power release mode and (d) Active power absorption mode

III. Simulation Analysis of DSTATCOM for PV Grid

The Figure -3 is shown the PV Grid is connected to the three phase load and at Load side we integrate the DSTATCOM to improve the voltage quality at Load buses. The DC/AC convertion is done with help of inverter when the load is increasing the distribences are highly at the load end. the DSTATCOM is connected on the shunt to overcome the voltage and current distrubances.

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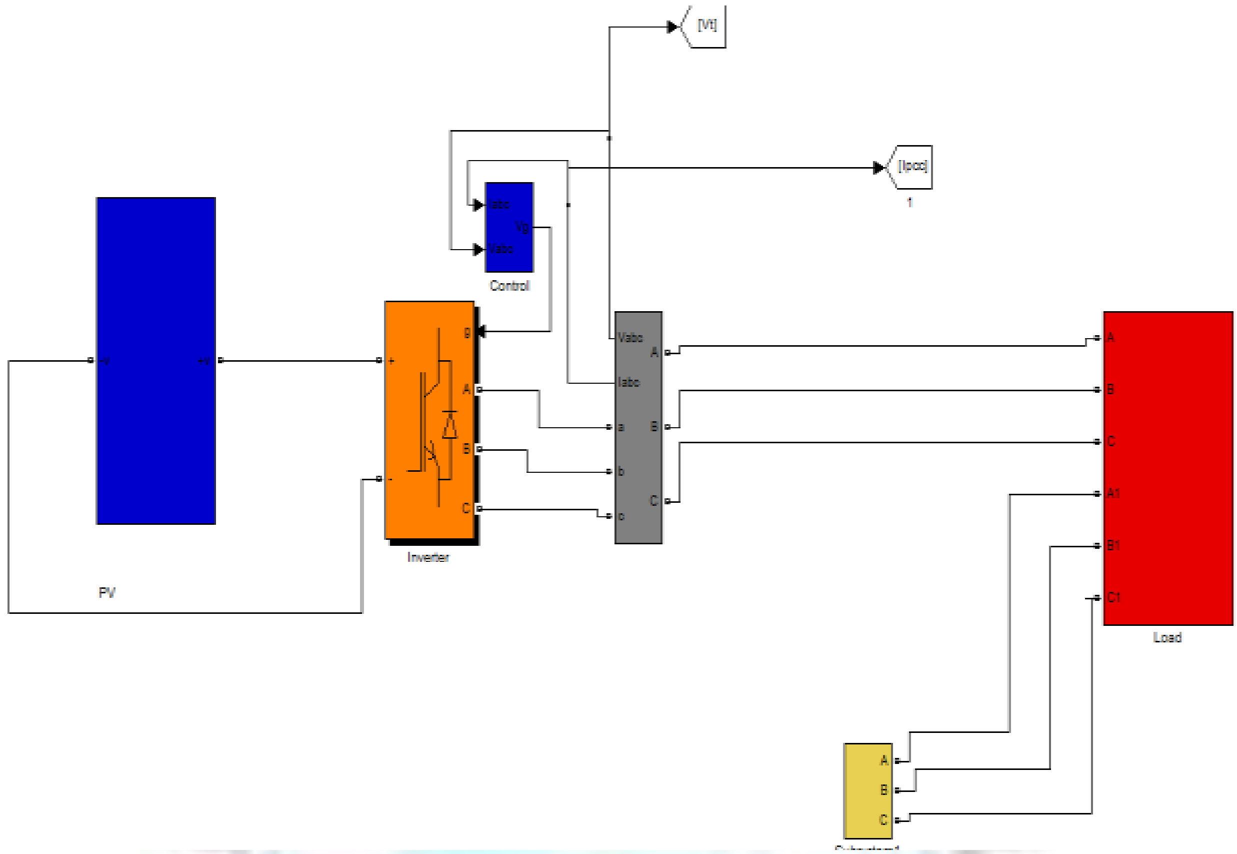

Fig. 3: Simulation Analysis of PV Grid with DSTATCOM

From the above simulation we analysis the three phase output voltage at the Load as shown in Figure-4. The FFT analysis of output voltage is shown in Figure-5. From the FFT analysis we can say the impact of DSTATCOME on the output voltage is more for power quality improvement in PV grid. The Figure-6 is shown the injected voltage and current from DSTATCOME.

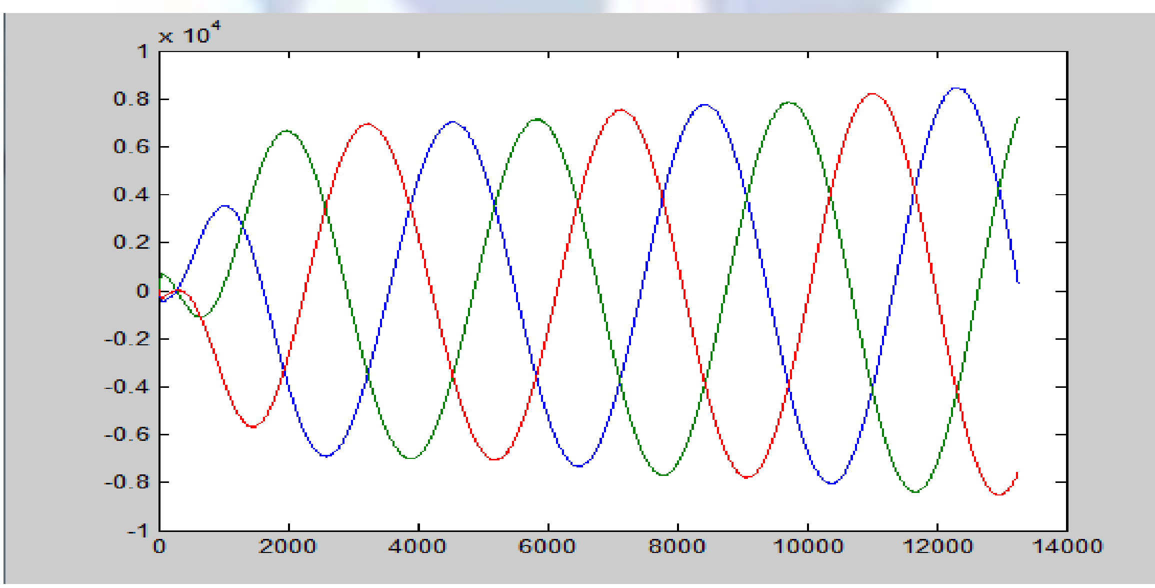

Fig -4 The Three Phase output voltage from PV Grid

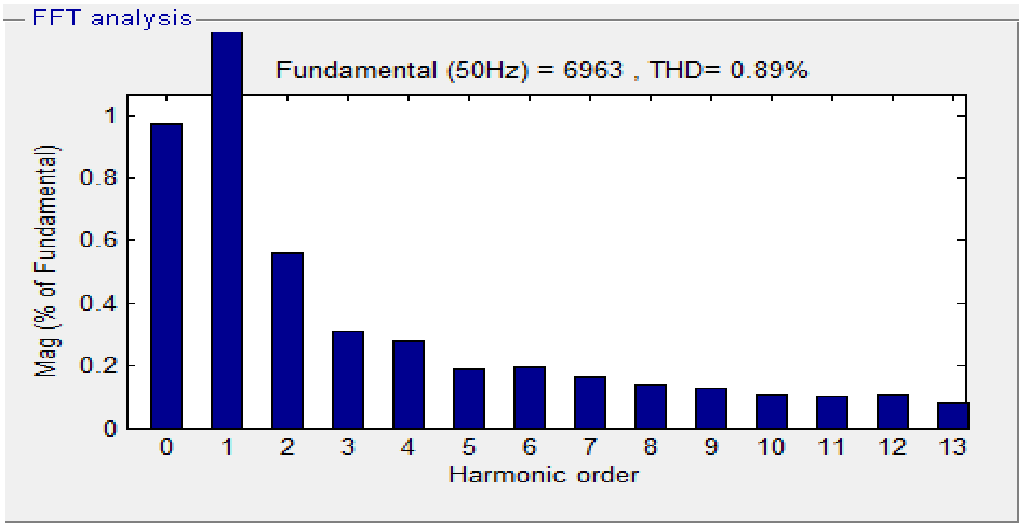

Fig 5: FFT Analysis for three phase Load Voltage.

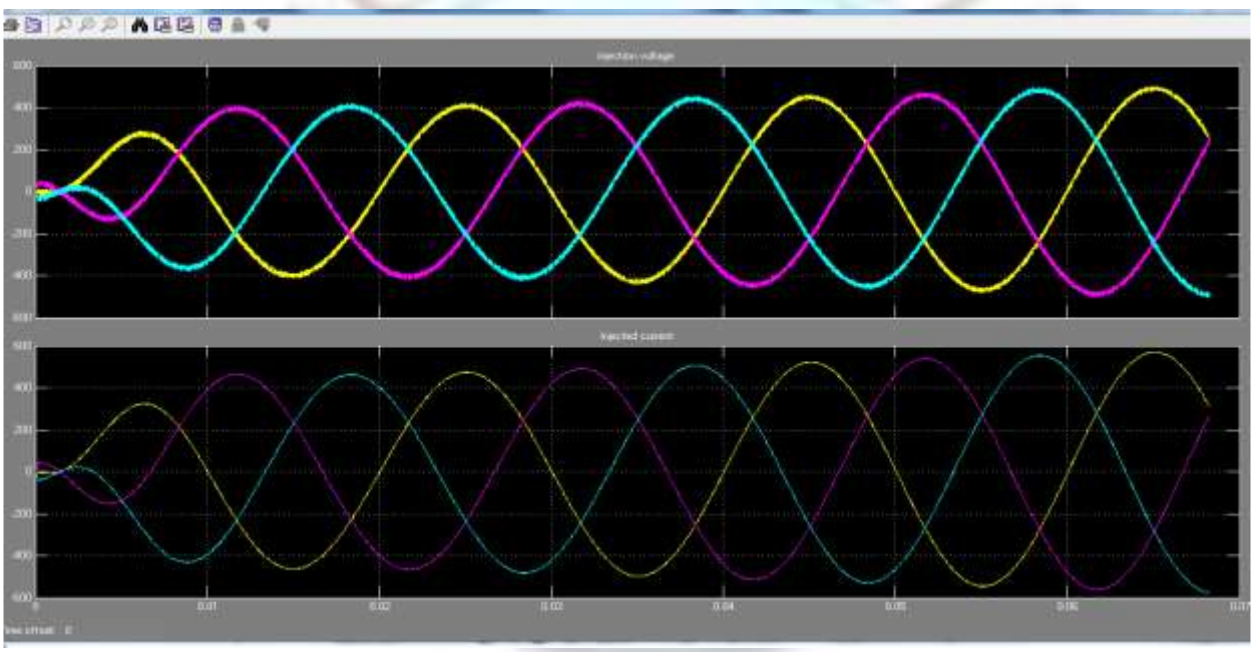

Fig 6: Injected voltage and current from DSTATCOME

CONCLUSION

In this paper, a control has been proposed for the generation of reference load voltage to improve power quality (PQ) in PV grid. The compensator injects reactive and harmonic components of load currents, resultant in UPF and nearly UPF is maintained for a load change always it has fast voltage regulation has been achieved during voltage disturbances and losses in the VSI and feeder are reduced considerably, it has higher sag associate capability with the same VSI rating compared to the traditional method The simulation and experimental results shows the proposed method provides DSTATCOM, a capability to improve several PQ problems PV grid.

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