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An Advanced Dstatcom Topology with Improved Efficiency and Current Compensation Capability

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ABSTRACT:

This paper proposes an improved hybrid distribution static compensator (DSTATCOM) topology to compensate reactive and nonlinear loads with reduced VSI rating, DC link voltage and filter size. An LCL filter with small value of inductor compared to traditional L filter has been used at the front end of a voltage source inverter (VSI), which provides the elimination of switchingharmonics. Voltage of the DSTATCOM can be reduced with capacitor to be connected in series with an LCL filter. Consequentlythe power rating of the voltage source inverter has been decreased. With reduced dc-link voltage, the voltage across the shuntcapacitor of the LCL filter will be also less. It will reduce the power losses in the damping resistor as compared with thetraditional LCL filter with passive damping. Therefore, the proposed DSTATCOM topology will have reduced weight, cost,rating, and size with improved efficiency and current compensation capability compared with the traditional topology. Asystematic procedure to design the components of the passive filter has been presented. The effectiveness of the proposed DSTATCOM topology over traditional topologies is validated through simulation.

Index Terms:

Distribution static compensator (DSTATCOM), Hybrid topology, passive filter, power quality (PQ).

I.INTRODUCTION:

An electric power distribution system is the final stage in delivery of electrical power; it carries electricity from transmission system toindividual consumers.

Except in a very few special situations, electrical energy has been generated, transmitted, distributed, andutilized as alternating current (AC). However, alternating current has several distinct disadvantages. One of these is the necessity ofsupplying reactive power with active power. Due to stored energy in the load and again send back to source, or presence of nonlinearloads that distorts the wave shape of the current drawn from the source, due to this the apparent power will be greater than the real powers, which will effects the power factor. Due to this high currents energy lost in distribution system will increase, furtherequipment cost will increase. This incremental costs of equipment and wastage of energy causes electrical utilities to charge a highercost to industries or commercial customers where there is a low power factor. In traditional method, L-type filters with large value ofinductance were used to increase the quality of current to be injected. This large value of inductor has low slew rate for tracking thereference currents, and produces large voltage drop across it, intern it requires high value of dc-link voltage for the compensation.Therefore L-filters increases cost, size, and power rating. AN LCL filter is used at the front end of the VSI which will improve thetracking performance, but requires high value of dc-link voltage as that of L filter. In this paper an LCL filter is used to overcome theaforementioned draw backs. Capacitor is used in series with the LCL filter to decrease the voltage of DSTATCOM. This proposedmodel decreases the size of the passive components, rating of dc-link voltage, rating of VSI. It provides good tracking performance.

II.PRPOSED SYSTEM:
Principle of DSTATCOM:

DSTATCOM is power electronics based power quality improving device, which generates

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and /or absorbs the reactive power whoseoutput can be varied so as to maintain control of specific parameters of the electric power system. The DSTATCOM comprises of coupling transformer with internal leakage reactance, a three phase voltage source inverter (VSI) with self commutating switches(GTO/IGBT), and a DC-link capacitor. Fig.1 shows the basic configuration of DSTATCOM.The VSI converts the dc voltage across the storage device into ac output voltages. These ac voltages are in phase and coupled with theac system through the reactance of the coupling transformer. Inverter is the main component of the DSTATCOM. The objective of aVSI is to produce a sinusoidal AC voltage with minimal harmonic distortion from a DC voltage. The operation of the DSTATCOM isas follows: The voltage is compared with the AC bus voltage system (Vs). When the magnitude of AC bus voltage is above that of theVSI magnitude (Vc), the AC system considered that, DSTATCOM as inductance connected to its terminals.

Otherwise if the voltagemagnitude of VSI is above that of the AC bus voltage magnitude, the AC system sees the D-STATCOM as capacitance connected toits terminals. If the VSI voltage magnitude is equal to AC bus voltage magnitude, then the reactive power exchange is zero. SupposeDSTATCOM has a DC active element or energystorage elements or devices on its DC side, it can able to deliver real power to thepower system. This can be done by varying the phase angle of the DSTATCOM terminals and the phase shift of the AC powersystem. When VSI phase angle lags phase angle of the AC power system, the DSTATCOM absorbs the real power from the ACsystem, if the phase angle of VSI leads phase angle of AC power system, the DSTATCOM supplies real power to AC supply mains.

The main feature is governing of bus voltage magnitude by dynamically absorbing or generating reactive power. The Distribution Static Compensator (DSTATCOM) is a voltage source inverter based static compensator that is used for the correction of line currents. Connection (shunt) to the distribution network is via a standard power distribution transformer. The DSTATCOM is capable of generating continuously variable inductive or capacitive shunt compensation at a level up its maximum MVArating.The DSTATCOM continuously checks the line waveform with respect to a reference ac signal, and therefore, it can provide the correct amount of leading or lagging reactive current compensation to reduce the amount of voltage fluctuations.

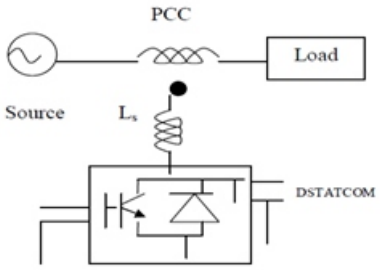

Fig 1.Block diagram of DSTATCOM circuit.

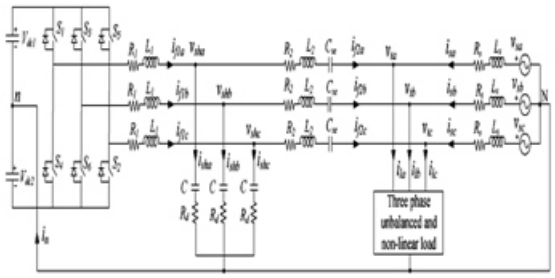

Fig. 2. Proposed DSTATCOM topology in the distribution system to compensate unbalanced and nonlinear loads.

Three-phase equivalent circuit diagram of the proposedDSTATCOM topology is shown in Fig. 1. It is realized usinga three-phase four-wire two-level neutral-point-clamped VSI.The proposed scheme connects an LCL filter at the front end of the VSI, which is followed by a series capacitor Cse. Introduction of the LCL filter significantly reduces the size of the passive component and improves the reference tracking performance.

III.CONTROL STRATEGY:

The overall control block diagram is shown in Fig.3. The DSTATCOM is controlled in such a way that the source currentsare balanced, sinusoidal, and in phase with the respectiveterminal voltages. In addition, average load power and losses in the VSI are supplied by the source. Since the source considered here is nonstiff, the direct use of terminal voltages to calculate reference filter currents will not provide satisfactory compensation Therefore, the fundamental positive sequence componentsof three-phase voltages are extracted to generate reference filter currents (i*f2a, i*f2b, and i*f2c) based on the instantaneoussymmetrical component theory.

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$$i^*_{f2a} = i_{la} - i^*_{sa} = i_{la} - \frac{v^+_{ta1}}{\Delta^+_1}(P_{lavg} + P_{loss})$$

$$i^*_{f2b} = i_{lb} - i^*_{sb} = i_{lb} - \frac{v^+_{tb1}}{\Delta^+_1}(P_{lavg} + P_{loss})$$

$$i^*_{f2c} = i_{lc} - i^*_{sc} = i_{lc} - \frac{v^+_{tc1}}{\Delta^+_1}(P_{lavg} + P_{loss}) \quad (1)$$

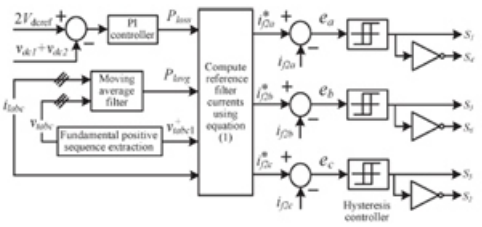

Fig. 3. Controller block diagram..

IV.SIMULATION RESULTS:

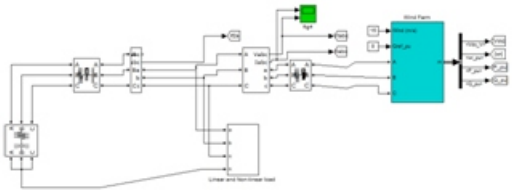

Fig:4 Windfarm based Without dstatcom

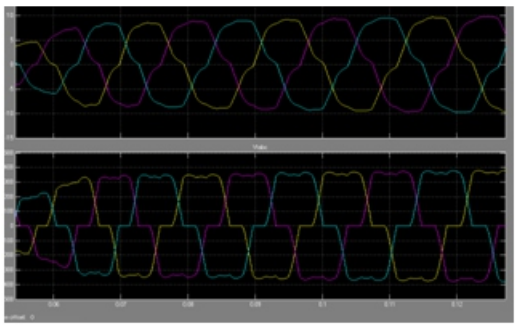

Fig.5: Source current & Load voltage

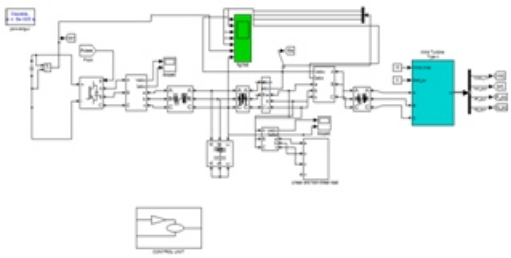

Fig.6: Wind farm based With dstatcom

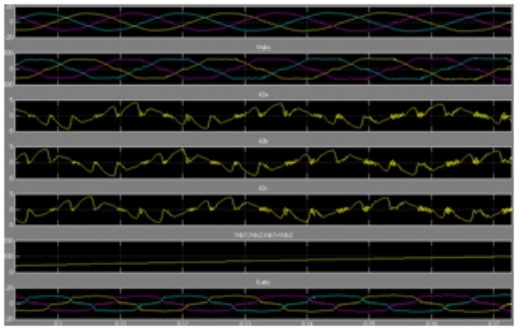

Fig.7 Source current,Load voltage,dstatcom currents (a,b,c), Vdc, Load Current

V.CONCLUSION:

The simulation results given that reduction of dc-link voltage, filter inductance, current through the shunt capacitor and dampingpower loss are reduced with DSTATCOM with LCL filter followed by series capacitance. This contribution shows reduction in cost, weight, size, and power rating of the traditional DSTATCOM topology. Effectiveness of the proposed topology has been validated through extensive computer simulation.

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