# Study of an Improved Hybrid DSTATCOM Topology for Power Quality Enhancement

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***Abstract-*** In this analysis paper, a topology for a better-quality hybrid distribution stage static compensator (DSTATCOM) is conversed to treatise some real-world matters like compensation performance, power assessment, filter size and power loss. A pi-configuration filter has been castoff at the front end of a voltage source inverter (VSI) to distribute improved switching harmonics rejection although using much smaller value of an inductor as compared with the conventional L filter. A capacitor is used in series with an L-C-L filter to diminish the dc-link voltage of the DSTATCOM. This accordingly reduces the power rating of the VSI. With reduced dc-link voltage, the voltage across the shunt capacitor of the L-C-L filter will be also less. It will decrease the power losses in the damping resistor as paralleled with the traditional L-C-L filter with passive damping. The hybrid scheme has glitches of protection, synchronization and power quality out of which, here we are debating around power quality.

Therefore, the projected DSTATCOM topology will have a condensed weight, cost, rating, and size with better-quality in efficiency and current compensation capability. A methodical technique to project the machineries of the passive filter has been offered. The usefulness of the proposed DSTATCOM topology over outmoded topologies is authenticated through both simulation and experimental studies.

***Keywords:*** *DSTATCOM, LCL Filter, Power quality*

## I. INTRODUCTION

Conventionally, static capacitors and passive filters have been employed to progress power quality (PQ) in a distribution system. Nonetheless, these regularly have difficulties like fixed compensation, system-parameter-dependent performance, and conceivable resonance with the line reactance. A distribution static compensator (DSTATCOM) has been projected in many works to overcome these downsides. It injects reactive and harmonics component of load currents to make source currents stable, sinusoidal, and in-phase with the load voltages.

Nonetheless, DSTATCOM requires a high-power-rating voltage source inverter (VSI) for load reparation. The power rating of the DSTATCOM is directly proportionate to current to be compensated and the dc-link voltage. Normally, the dc-link voltage is preserved at much higher value than the maximum value of the phase-to-neutral voltage in a three-phase four-wire system for agreeable compensation (in a 3-phase, 3-wire system, it is higher than phase-to-phase voltage). However, a higher DC-link voltage increases the rating of the VSI, makes the VSI substantial, and results in higher voltage rating of insulated gate bipolar transistor (IGBT) switches. It leads to the intensification in the cost, size, weight, and power rating of the VSI. Some hybrid topologies have been projected to contemplate the above-mentioned boundaries of the outmoded DSTATCOM, where a abridged rating active filter is used with the passive components hybrid filters.

In this paper, i have attained a reduction in the dc-link voltage for reactive load compensation. However, the reduction in voltage is limited due to the use of an *L*-type interfacing filter. This also makes the filter bigger in size and has a lower slew rate for reference tracking.

An *L-C-L* filter has been planned as the front end of the VSI in the works to overwhelmed the limitations of an *L* filter. It delivers improved reference tracking performance while using much lower value of passive components. This also reduces the cost, weight, and size of the passive component.

However, the *LCL* filter uses a similar dc-link voltage as that of DSTATCOM employing an *L* filter. Hence, disadvantages due to high dc-link voltage are still present when the *LCL* filter is used. Another serious issue is resonance damping of the *LCL* filter, which may push the system toward instability

## II. EXISTING SYSTEM

The basic principle of a DSTATCOM installed in a power system is the generation of a well-regulated AC voltage source by a voltage source inverter (VSI) in addition with DC capacitor as a storage device. The AC voltage source seems behind a transformer leakage reactance. The active and reactive power transfer between the power system and the DSTATCOM is caused by the voltage difference across this reactance. The DSTATCOM is associated to the distribution power networks at a point of common coupling [5], where the voltage-quality is a matter of concern. All required voltages and currents are measured and are fed into the controller in order to compare with the commands [6]. The controller then accomplishes

feedback regulation and outputs a set of switching signals to drive the main semiconductor switches, normally IGBT of the power converter. The basic structure of the DSTATCOM is publicized in Fig1.

A DSTATCOM is a controlled reactive source, which comprises of a Voltage Source Converter (VSC) and a DC link capacitor associated in shunt, capable of generating and/or absorbing reactive power. The operating principles of a DSTATCOM are based on the exact equivalence of the conservative rotating synchronous compensator. The AC terminals of the VSC are connected to the PCC over and done with an inductance, which could be a filter inductance or the leakage inductance of the coupling transformer. The DC side of the converter is connected to a DC capacitor, which carries the input ripple current of the converter and is the main reactive energy storage element.

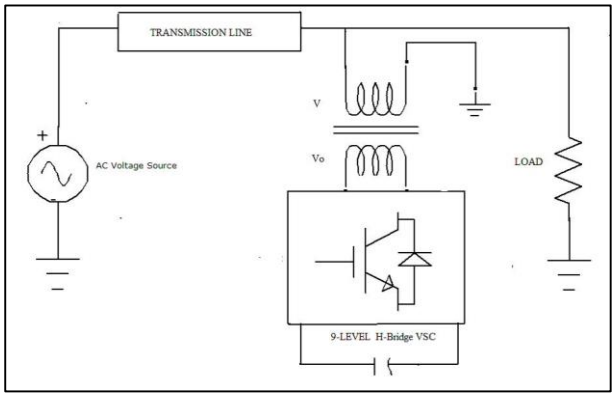


Fig.1. Model of STATCOM

## III. PROPOSED DSTATCOM TOPOLOGY

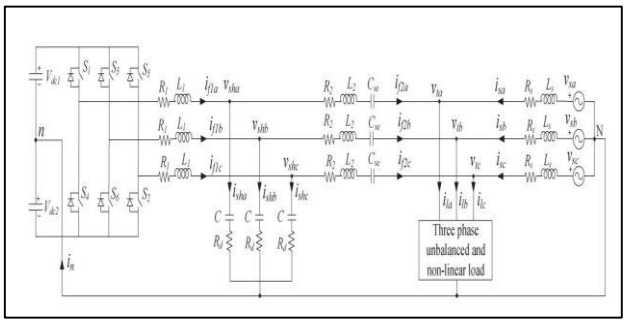


Fig.2. Proposed DSTATCOM topology

The suggested DSTATCOM 3-phase correspondent circuit diagram is shown in figure 2. It is comprehended by using 3-phase 4-wire 2-level neutral-point-clamped VSI inverter. An L-C-L filter is connected at the front end of voltage source inverter with sequenced series capacitance. This L-C-L filter diminishes the size of the passive components here $R_1$ and $L_1$ characterize resistance and inductance at VSI side; and characterizes inductance and resistance at load end side of the organization. *C* is filter capacitance which methods L-C-L filter in all 3-phases. $R_d$ is damping resistance used in series with the capacitance *C*, arrange for passive damping of the overall system and damp out the resonance. Here $i_{f1a}$ and $i_{f2a}$ are filter currents in phase A and similar in all 3-phases. $V_{sha}$ is voltage across L-C-L filter and is current flowing through L-C-L filter, this is comparable for other two phases. The voltage across the DC-link capacitors are maintained constant i.e. $V_{dc1}=V_{dc2}=V_{dcref}$. The source and load of DSTATCOM are connected to a common point called PCC.

The work suggests a better-quality hybrid distribution static compensator (DSTATCOM) topology to address particular applied issues such as selection of power rating, filter size, compensation performance, and power loss. An *L-C-L* filter has been used at the front end of a voltage source inverter (VSI), which make available improved switching harmonics elimination while using much slighter value of an inductor as compared with the outmoded *L* filter. A capacitor sequenced in series with an *L-C-L* filter to reduce the DC linked voltage of noted DSTATCOM. A 3-phase equivalent circuit diagram of the anticipated for the DSTATCOM topology. It is realized using a 3-phase 4-wire two-level neutral point clamped configuration of VSI. The anticipated scheme connects an *L-C-L* filter at the front end of the VSI, which is followed by a sequenced series capacitor $C_{se}$. Introduction of the *L-C-L* filter suggestively diminishes the size of the passive component and progresses the reference tracking presentation of performance.

Totaling to the series capacitor, which reduces the DC-link voltage and, therefore, the power rating of the VSI. Here, *R*1 and *L*1 represent the resistance and inductance, individually, at the VSI side; *R*2 and *L*2 characterize the resistance and inductance, correspondingly, at the load side; and *C* is the filter capacitance establishing the *L-C-L* filter part in all three phases. A damping resistance *Rd* is used in series with *C* to damp-out resonance and to provide the proper passive damping to the overall arrangement.

To legalized and anticipated arrangement result, the conventional DSTATCOM topology, traditional hybrid DSTATCOM topology and L-C-L filter created DSTATCOM generalized topology is considered, the same VSI is connected to PCC. The outmoded design of hybrid DSTATCOM results are obtained by simulating the system in software tool as well as validated by experimental hardware. In the L-C-L filter based topology in which the LCL filter is connected after VSI and before PCC.

### *A. Advantages:*

1. The voltage across, and consequently the current through the shunt part of the L-C-L filter, is momentously reduced.
2. An L-C-L filter has be situated, will used at the front end of a voltage source inverter (VSI), which arrange for better

switching harmonics eradication while using much smaller value of an inductor as compared with the traditional L filter.

3. It will decrease the power losses in the damping resistor as associated with the traditional *LCL* filter by means of passive damping.
4. The DSTATCOM topology has reduced weight, cost, rating, and size with better-quality in efficiency and current compensation proficiency compared with the traditional topology.

## VI. CONCLUSION

In this paper, design and operation of an improved hybrid DSTATCOM topology is proposed to compensate reactive and harmonics loads. The hybrid interfacing filter used here consists of an LCL filter followed by a series capacitor. This topology provides improved load current compensation capabilities while using reduced dc-link voltage and interfacing filter inductance. Moreover, the current through the shunt capacitor and the damping power losses are significantly reduced compared with the LCL filter-based DSTATCOM topology. These contribute significant reduction in cost, weight, size, and power rating of the traditional DSTATCOM topology. Effectiveness of the proposed topology has been validated through extensive computer simulations and experimental studies.

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