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# Power Factor Improvement in Distribution System using DSTATCOM Using Unit Vector Template Control Algorithm

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**Abstract:** ***The power factor is also an important component of the control system equipment. In this paper, we introduce the design and implementation of a static compensator distribution system with a star - delta transformer to improve the power factorIn this paper, the control algorithm for a 3P4W linear loading system was implemented. The proposed algorithm is efficient and can be easily manipulated. MATLAB simulates the offer test model in the field. Results from the simulations show that the present algorithm is efficient.***

**Keywords:** Distribution static compensator, power quality, power factor improvement, star - delta transformer, unit vector template method.

## 1. Introduction

In the electrical power distribution systems are facing a vital problem day by as increasing the demand of supply the issue like overload, worst voltage regulation, and harmonics extra current demand. When the supply system will affect then the supply system automatic affected by the problem of electrical power virtue system, etc. [1]. The low power factor is also a power virtuecomplication and needs anexact correction. Mahmud *et al.* [2], described the power virtueconcern, abnormalities such as voltage sag, voltage swell, harmonics, and capacitor switching which are destructed sinusoidal waveforms and decrease power virtue as well as network reliability. These are abnormalities that affect the consumer as well as equipment. DSTATCOM is used to requite, power quality problems such as voltage fluctuation, unbalanced load, harmonics in the network system. A DVR is used to protect the voltage issue like voltage sag and swell, balance the unbalance voltage and requite for voltage harmonic distortions but in the case of UPQCrequiting for load current harmonics, reactive power satisfying, correction of power factorand regulating DC circuit voltage. Bhim Singh *et al*. [3], grantedthe numbers of power devices refined and successfully implemented to compensate for various power quality problems in a distribution system. Bhim Singh *et al.* [4], presented a complete review of the power quality issues. In [5], the authorsproposed that astrategy for nonpartisan current remuneration including Scott transformer, T associated transformer, star hexagon transformer, and star polygon transformer intended for MMF (magnetomotive power) balance. Bhim Singh *et al*. [6] have examined the new methods for power quality improvement with the commitment of DSTATCOM is incorporated for the Improvement of receptive power for voltage guideline or power factor amendment with load adjusting and unbiased current pay alongside the disposal of harmonics at the reason behind normal coupling. In [7] creators have proposed power quality Improvement dependent on 3P4W DSTATCOM star/delta transformer association with mitigates the neutral current, power quality, balance the unbalance load, reactive power, and harmonics. Three single - stage transformers are associated as a star/delta transformer for interfacing to a three - stage four - wire power appropriation framework and the necessary rating of the VSC is decreased. The star/delta transformer has been found powerful for remunerating the zero - succession fundamental and harmonics flows and the kVA rating of the star/delta transformer has been checked by recreation. It is seen that the kVA rating of the transformer is about 40% of the load kVA and the responsive force is to be redressed. In [8], the authors want to describe the controlled distribution with the use of the appropriate method and devices like power devices. They also want to show by t use of different transformer configurations with different controlling methods, for example, A Zig - zag transformer is used for the compensation of reactive power, for voltage regulation, for load balancing along balancing the unbalance load elimination of harmonic currents and neutral current compensation at the point of common coupling. In [9], the authors proposeda three - phase four - wire power filter comprising a three - phase three - wire APF, and a Zig - Zag transformer is developed. Bhim Singh*et al.* [9] have proposed another method for power quality improvement in a three - stage four - wire dispersion framework comprising of an H - connect VSC and a star/delta transformer. In [10], the authors have proposed a technique for power quality improvement in three - phase four - wire distribution systems. A two - leg VSC is integrated with a star/hexagon transformer for the compensation of reactive power for voltage regulation or power factor correction along with load balancing, and neutral current compensation. Bhim Singh*et al. [*11], described a new assignment for voltage monitoring or editing of power factor by the editing of reactive poweralong with harmonics rejection or neutral current settlement in a three - phase four - wire distribution

system with star/delta transformer. The transformer connection is provided as described here, star connected system is in primary and delta connected system is on the secondary side and theneutral point is connected to the junctionofthe neutral start winding so that it provides a path to the zero - sequence fundamental as well as harmonics neutral currents. Bhim Singh *et al.* [13], wanted to explain their proposed system with two legs to mitigate the problems of the distribution plan, a zigzag transformer is very much useful to edit the power system issue. In [14], the authors want to explain the method by which can edit and regain their original system after a transient time, T - connected transformer is also Important to the editing of power quality, reactive power foradjustment of voltage or elimination of neutral current. In [15], they also presented a broad review of the neutral current settlement technique.

This paper describes the editing ofpower factors in the distribution system using DSTATCOM with a star - delta transformer. A control technique nameunit vector template method - based the DSTATCOM has been proposed in this paper for power factor improvement.

This paper is classified into five sections. Starting with an introduction in Section I, Section II describes the arranged test system. The expected control algorithm has been described in Section III. The simulation results and their discussionsfor power factor progressionare presented in Section IV. Finally, the conclusions are presented in Section V.

## 2. Proposed Test System

The given circuit diagram is described as follows, there is a power devices name DSTATCOM that is connected in shunt mode whichis very much an important part of the system it is connected with a distribution system name 3P4WS with the linear load as shown in Fig.1. A transformer that is connected to the load side, the configuration of the transformer is star - Delta into the load side, and the DSTATCOM is made up of the combination of six insulated gates bipolar transistor (IGBTs) with anti - parallel diode and DC - link Capacitor. The dc - link capacitor is helpful to improve ripples by charging and discharging, reduce the interfacing ripples by compensating current with the help of adding an inductor. The fast switching of DSTATCOM is controlled by the controlling of switching ripples in the Point of common coupling with RC filters.

The power device DSTATCOM is also helpful to edit the reactive power, decrease the harmonics at load and point of common coupling. The proposed design is also playinga vital role to edit power factors by changing the system from voltage to PFC mode the phase shift has concerning PCC voltage. For the desired reference value ZVR mod is got a voltage injected by the power devices, in the injecting zero voltage case power may be leading or lagging current depending on the load and applied voltages. The system Supply voltage is 415v, 50Hz. Supply impedance is 0.1+j0.628.

The value of the DC - link capacitor is 8000µF and the operating voltage is 800 V. The value of interfacing frequency is 2.3mH switching frequency 10Khz. For the use of ripple, filter capacitance is 20 µF and resistance is 2**Ω**. The configuration of star - delta transformer 7.5KVA, 415v. The description of DSTATCOM is explained in [16].

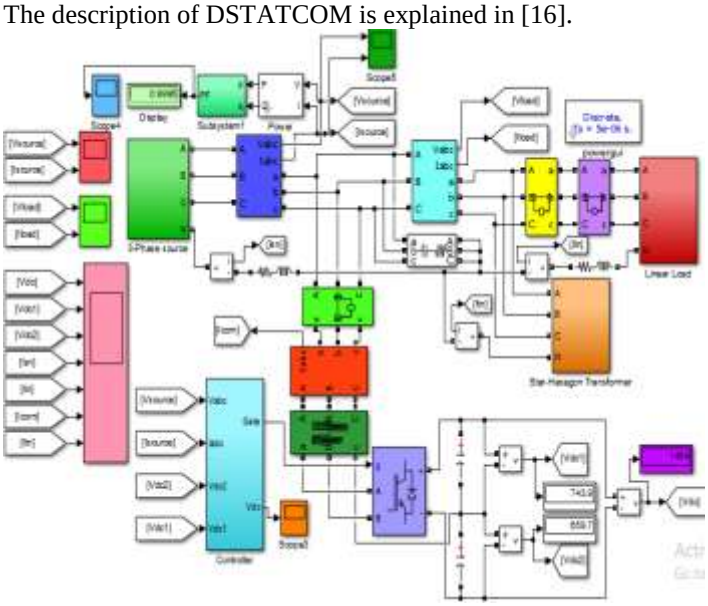

**Figure 1:** SLG of the proposed test model

**Proposed Control Algorithm**

The main diagram of the proposed system is shown in Fig.2 for the creating of the pulse IGBTs is used and VSC is also used for creating sinusoidal PWM is used. The whole controlling is based on unit vector control theory, In the provided method there are two PIs are used for the controlling of DC - link voltage and the second PI is used for the AC terminal voltage, one PI can be used for the controlling of DC - Link Voltage, What Parameter we use are detailed in Fig.2 expect this every kind of signals used for the controlling of DSTATCOM. One PI is used for the controlling of DC - link voltage which is provided for Solid devices like IGBTs, thyristor, etc

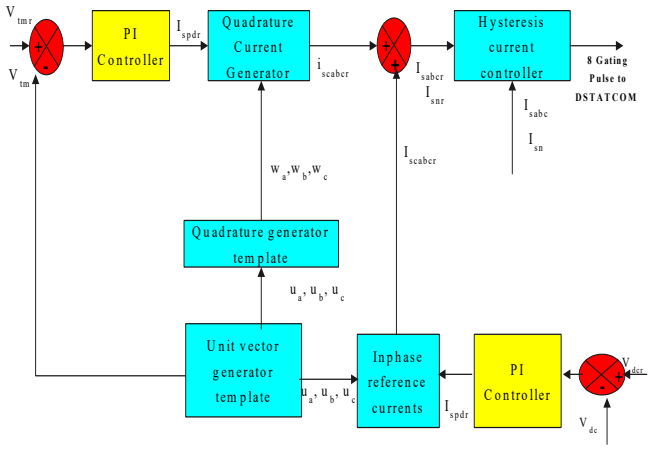


**Figure 2:** Proposed control algorithm

## 3. Simulation Results for the Different Condition and Discussion

This segment discusses the various results performed by the proposed Control algorithm and transformer configuration, Star - delta, which is very much helpful to the improvement of power factor with the editing of reactive power are detailed in the following sections.

**a) Power Factor Correction with Unbalanced Load**

The pole of the circuit breaker corresponding to phase A has been opened at 45th cycles and reclosed at 50th cycles to simulate the unbalanced load in the absence of the DSTATCOM. The power factor of all three phases is shown in Fig 6.1. It can be observed that the power factor corresponding to phase A (shown by red colour) decreases drastically without the presence of any type of compensation in the network. The power factor of other phases is also changed but the change in these phases is less as compared to phase A. Hence, without compensation, the power factor is changed drastically which may affect the efficiency of the system.

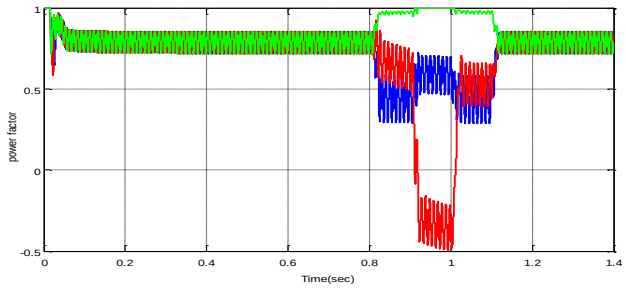


**Figure 3:** Power factor of all the phases without DSTATCOM and with an unbalanced load

The pole of the circuit breaker corresponding to phase A has been opened at 45th cycles and reclosed at 50th cycles to simulate the unbalanced load in the presence of the DSTATCOM. The power factor of all three phases is shown in Fig.6.2. It can be observed that the power factor corresponding to all three has been improved significantly in the presence of DTSTACOM in the network. Hence, the use of DSTATCOM significantly improves the power factor in the presence of an unbalanced load.

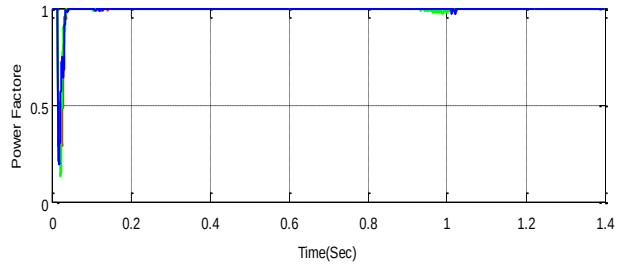


**Figure 4:** Power factor of all the phases with DSTATCOM and unbalanced load

**b) Power Factor Correction with Tripping of Three - Phase Load**

The circuit breaker connecting the load to the system has been opened at 45th cycles and reclosed at 50th cycles to simulate the tripping of a three - phase balanced load in the absence of the DSTATCOM. The power factor of all three phases is shown in Fig.6.3. It can be observed that the power factor without compensation is low and maintained near 0.8. During the transient period, the power factor is drastically changed. At the time of transients, the power factor decreases drastically upto the value of 0.2 and then increases. A similar phenomenon is also observed at the time of reclosing the circuit breaker. Hence, in the absence of compensation, the power factor is changed drastically which may affect the efficiency of the system.

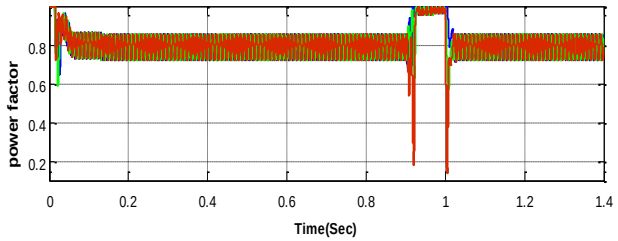


**Figure 5:** Power factor of all the phases during tripping of three - phase load without DSTATCOM.

The circuit breaker connecting the load to the system has been opened at 45th cycles and reclosed at 50th cycles to simulate the tripping of a three - phase balanced load in the presence of DSTATCOM. The power factor of all three phases is shown in Fig.6.4. It can be observed that the power factor in the presence of DSTATCOM is maintained at unity. When the load is switched off, the power factor is maintained at unity (leading). Hence, in the presence of compensation, the power factor is maintained at the unity with and without a load in the presence of the DSTATCOM.

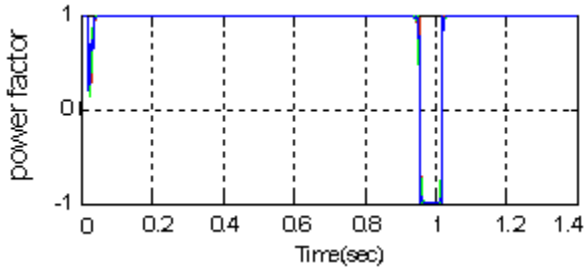


**Figure 6:** Power factor of all the phases during tripping of three - phase load with DSTATCOM

**c) Power Factor Correction with Tripping of Two Phases of a Three - Phase Load**

Two poles (phases A and B) of the circuit breaker connecting the load to the system have been opened at 45th cycles and reclosed at 50th cycles to simulate the unbalanced tripping of a three - phase balanced load in the absence of the DSTATCOM. The power factor of all three phases is shown in Fig.6.5. It can be observed that the power factor without compensation is low and maintained near 0.8. During the transient period, the power factor is drastically changed in the phases which have been disconnected from the system. At the time of transients, the power factor is decreased drastically and reduces to the value of - 0.5 during the transient period. The power factor of the other faulty phase (phase B) is also reduced to the value of 0.5. The power factor of the healthy phase also changes but this change is less as compared to the case study I.

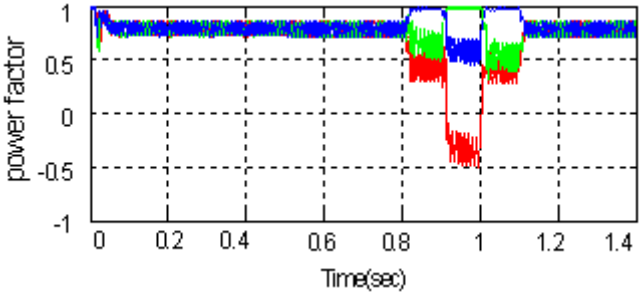


**Figure 7:** Power factor of all the phases during tripping of two phases of three - phase load without DSTATCOM

Two poles (phases A and B) of the circuit breaker connecting the load to the system have been opened at 45th cycles and reclosed at 50th cycles to simulate the unbalanced tripping of a three - phase balanced load in the presence of the DSTATCOM. The power factor of all three phases is shown in Fig.6.6. It can be observed that the power factor with compensation using DSTATCOM is maintained near unity. During the transient period, the power factor is maintained near unity by using the DSTATCOM. Hence, the use of DSTATCOM improves the power factor significantly.

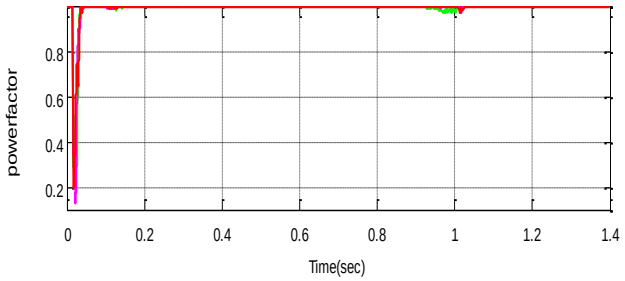


**Figure 8:** Power factor of all the phases during tripping of two phases of three - phase load without DSTATCOM.

## 4. Conclusion

This research work also presents power factor correction in the three - phase distribution system using DSTATCOM with a star - delta transformer. The unit vector - based control of the DSTATCOM has been proposed for the power factor improvement. It has been observed that with the application of the star - delta transformer, the power factor improvement has been achieved with the help of DSTATCOM successfully. The power factor correction has been achieved in all the cases of study such as opening and closing of the single pole of the circuit breaker, two poles of the circuit breaker, and all the three phases of the circuit breaker connecting the three - phase load. The results have been simulated in the MATLAB/Simulink environment.

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