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Mitigation of Power Quality Problems by D-Statcom Using a Novel Control Scheme

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Abstract:
This paper presents the systematic procedure of the modeling and simulation of a Distribution STATCOM (DSTATCOM) for power quality problems, voltage sag based on a new control strategy i.e. VCM & CCM technique. Power quality is an occurrence manifested as a nonstandard voltage, current or frequency that results in a failure of end use equipments. The major problems deals here is the voltage sag. To solve this problem, custom power devices are used. One of those devices is the Distribution STATCOM (D-STATCOM), which is the most efficient and effective modern custom power device used in power distribution networks. D-STATCOM injects a current in to the system to correct the voltage sag. The control of the Voltage Source Converter (VSC) is done with the help of control strategy. The proposed D-STATCOM is modeled and simulated using MATLAB/SIMULINK software

Index Terms— Distribution STATCOM (D-STATCOM), MATLAB/ SIMULINK, Power quality problems, Voltage sag, Voltage Source Converter(VSC)

INTRODUCTION

Now a days, modern industrial devices are mostly based on the electronic devices such as programmable logic controllers and electronic drives. The electronic devices are very sensitive to disturbances and become less tolerant to power quality problems such as voltage sags, swells and harmonics. Voltage dips are considered to be one of the most severe disturbances to the industrial equipments . Voltage support at a load can be achieved by reactive power injection at the load point of common coupling. D-ST A TCOM injects a current into the system to correct the voltage sag and swell.

These power quality devices are power electronic converters connected in parallel or series with the lines and the operation is controlled by a digital controllers. The modeling of these complex systems that contains both power circuits and control systems can be done different bases. One of those power electronic solutions to the voltage regulation is the use of a Distribution STATCOM (DSTATCOM). D-STATCOM is a class of custom power devices for providing reliable distribution power quality. They employ a shunt of voltage boost technology using solid state switches for compensating voltage sags and swells. The DST A TCOM applications are mainly for sensitive loads that may be drastically affected by fluctuations in the system voltage.

The distribution system transports the power from the transmission system/substation to the customer. Distribution feeders can be radial or networked in an open loop configuration with a single or multiple

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alternate sources. Rural systems tend to be of the former and urban systems the latter. The equipment associated with the distribution system usually begins downstream of the distribution feeder circuit breaker. The transformer and circuit breaker are usually under the jurisdiction of a "substations department". The distribution feeders consist of combinations of overhead and underground conductor, 3 phase and single phase switches with load break and non-loadbreak ability, relayed protective devices, fuses, transformers (to utilization voltage), surge arresters, voltage regulators and capacitors.

In this paper we proposed Distribution STATCOM for power quality problems, voltage sag based on a new control strategy i.e. VCM & CCM technique. The major problems deals here is the voltage sag. To solve this problem, custom power devices are used. One of those devices is the Distribution STATCOM (D-STATCOM), which is the most efficient and effective modern custom power device used in power distribution networks. D-STATCOM injects a current in to the system to correct the voltage sag. The control of the Voltage Source Converter (VSC) is done with the help of control strategy. The proposed D-STATCOM is modelled and simulated using MATLAB/SIMULINK software.

POWER QUALITY PROBLEMS

Any problem manifested in voltage, current or frequency deviation that results in failure of customer equipment is known as “power quality problem”. Low power quality affects electricity consumer in many ways. The lack of quality can cause loss of production, damage to equipment and human health. Therefore it is obvious to maintain high standards of power quality.
The major types of power quality problems are: Voltage Sag, Voltage swell, Interruption, Distortion ,Harmonics, Transients.

In this project here occurs power quality problems like voltage sag

DISTRIBUTION STATIC COMPENSATOR (D-STATCOM)

DSTATCOM is a shunt connected FACTS Device.
Shunt FACTS devices may be variable impedance, variable source, or a combination of these. They inject current into the system at the point of connection.
The controllers inject capacitive or inductive current in quadrature with the line voltage.

The controllers supply /absorb variable RP(Reactive Power).

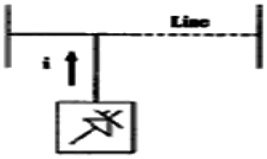

Fig 1 The symbol of shunt connected facts controller

DSTATCOM Distributed Static Compensator is a fast-compensating reactive power source that’s applied on the transmission or distribution system to reduce voltage variations such as sags, surges, and flicker, along with instability caused by rapidly varying reactive power demand. It is a shunt type controller. 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 MVA rating. 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.

The Block diagram of the D-SATCOM shows that phase locked loop (PLL) technique is used for voltage sag detection and mitigation. However, this technique provides good results only if voltage sag is not coupled with phase angle jump.

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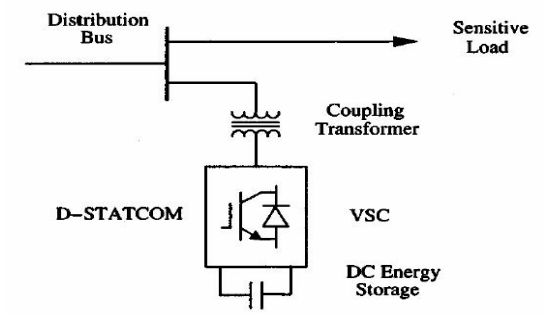

Fig. 2 Schematic representation of the D-STATCOM as a custom power Device

IV.PROPOSED CIRCUIT SCHEME

Circuit diagram of a DSTATCOM-compensated distribution system is shown in Fig.3. It uses a three-phase, four-wire, two-level, neutral-point-clamped VSI. This structure allows independent control to each leg of the VSI. Variable u is a switching function, and can be either +1 or-1 depending upon switching state. Filter inductance and resistance areL_f and R_f respectively. Shunt capacitor C_fc eliminates high-switching frequency components.

First, discrete modeling of the system is presented to obtain a discrete voltage control law, and it is shown that the PCC voltage can be regulated to the desired value with properly chosen parameters of the VSI. Then, a procedure to design VSI parameters is presented. A proportional-integral (PI) controller is used to regulate the dc capacitor voltage at a reference value.

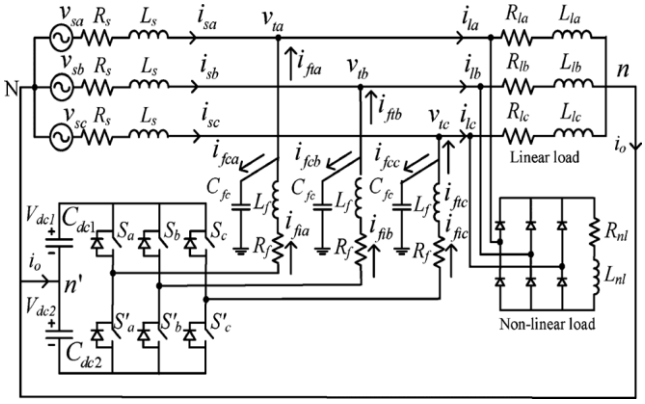

Fig. 3. Circuit diagram of the DSTATCOM-compensated distribution system

CIRCUIT DESCRIPTION

A three phase source is connected to linear load & nonlinear load . Across three phase source a filter and DSTATCOM device is connected in parallel. a reference voltage magnitude generation scheme is proposed that provides the advantages of CCM. Here resistance ,inductance &capacitor are acts as filter.

V.PROPOSED CONTROL SYSEM

The overall controller block diagram is shown in Fig. 4 A proportional-integral (PI) controller is used to regulate the dc capacitor voltage at a reference value. the reactive and harmonic component of load current is supplied by the compensator at any time of operation.

The deadbeat predictive controller is used to generate switching pulses. The control strategy is tested with a three-phase four-wire distribution system. A one-step-a head deadbeat voltage-control law is converted into the ON/OFF switching command to the corresponding VSI switches using a deadbeat hysteresis controller .The effectiveness of the proposed algorithm is validated through detailed simulation results

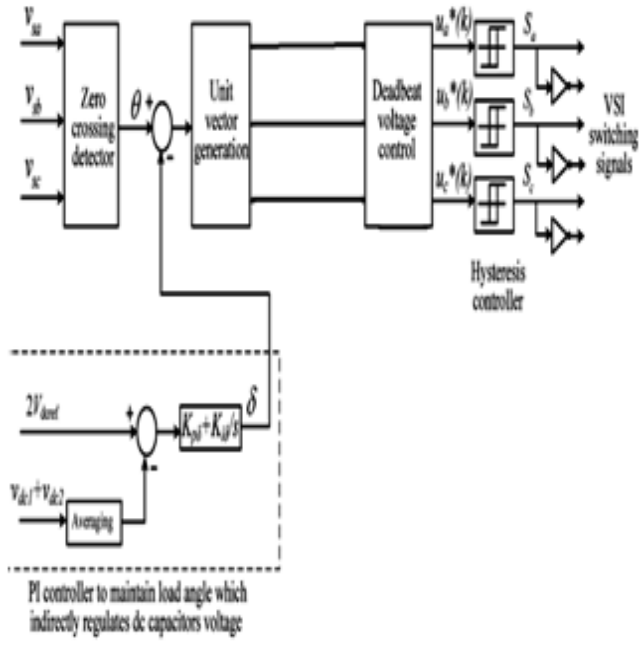

Fig.4 Overall block diagram of the controller to control DSTATCOM in a distribution system.

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VI. SIMULATION RESULTS

Simulation Circuit:

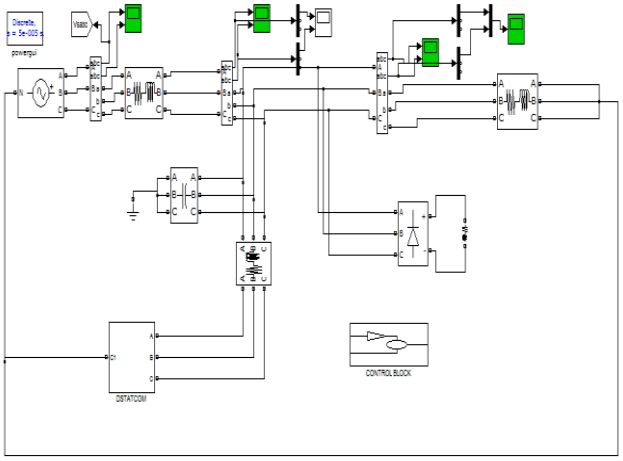

Fig.5. Matlab Simulation Circuit

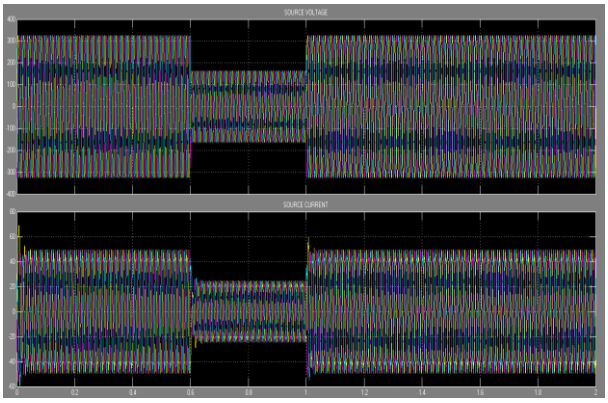

Fig.6 voltage source.

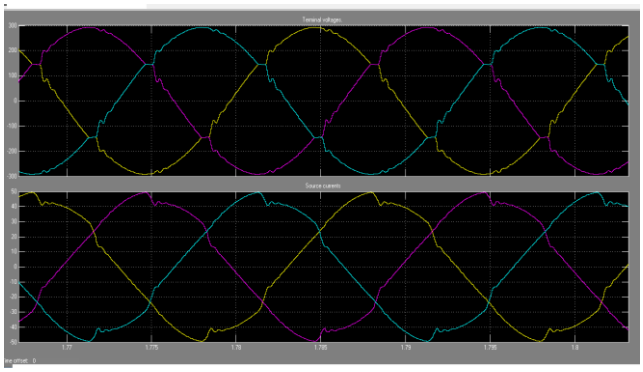

Fig.7 Before compensation. (a) Terminal voltages. (b) Source currents.

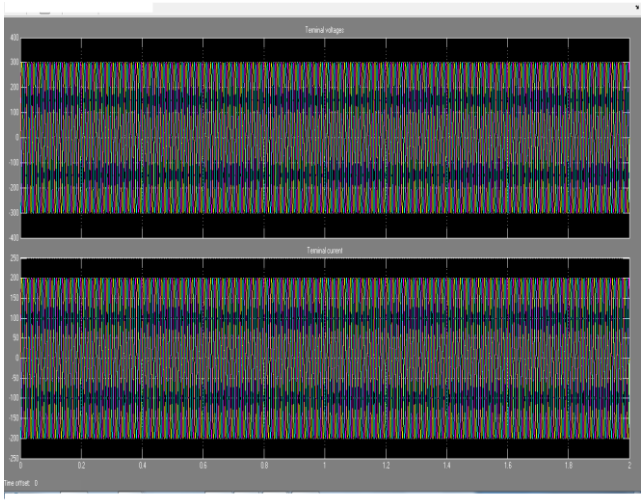

Fig.8 Load Voltage & Current.

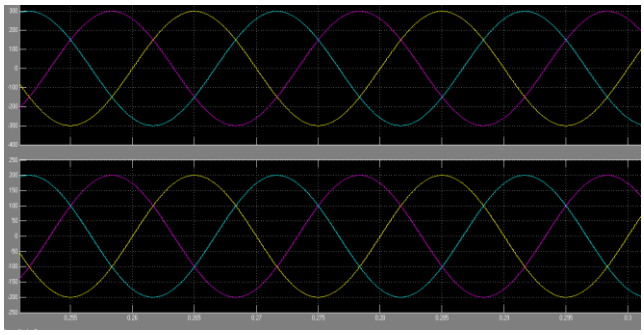

Fig.8 Zoomed Load Voltage & Current.

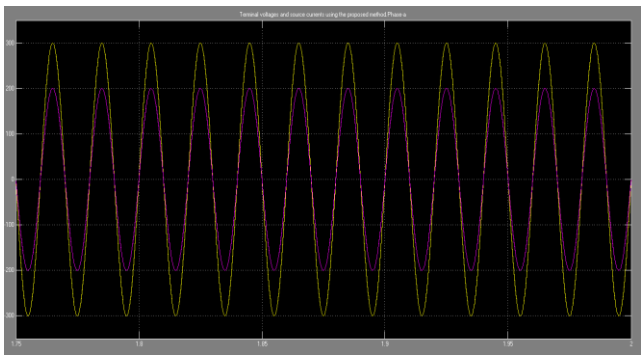

Fig.9 Terminal voltages and source currents using the proposed method. Phase-a

VII.CONCLUSION

This paper has presented the power quality problems such as voltage sags, total harmonic distortion in the distribution system and simulation techniques of a D-STATCOM. The simulation results show that the

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voltage sags can be mitigate by inserting D-STATCOM to the distribution system. By adding LCL Passive filter to D-STATCOM, the THD reduced. The power factor also increase close to unity. Thus, it can be concluded that by adding D-STATCOM with LCL filter the power quality is improved.

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