Design, Modeling & Simulation of DSTATCOM for Distribution Lines for Power Quality Improvement

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Abstract- *A Power quality problem is an occurrence manifested as a nonstandard voltage, current or frequency that results in a failure or a mis-operation of end user equipments. Utility distribution networks, sensitive industrial loads and critical commercial operations suffer from various types of outages and service interruptions which can cost significant financial losses. With the restructuring of power systems and with shifting trend towards distributed and dispersed generation, the issue of power quality is going to take newer dimensions. In developing countries like India, where the variation of power frequency and many such other determinants of power quality are themselves a serious question, it is very vital to take positive steps in this direction .This paper presents a study on the modeling of a STATCOM (Static Synchronous Compensator) used for reactive power compensation on a distribution network. This paper deals with the simulation of distribution static synchronous compensator (DSTATCOM) for improving power quality of a distribution system feeding linear as well as non-linear loads. Nowadays, there are an increasing number of non-linear loads which inject harmonics into the system. A three-phase insulated gate bipolar transistor- (IGBT-) based current controlled voltage source inverter with a DC bus capacitor known as a DSTATCOM is used for power factor correction, harmonic compensation and for providing required reactive power to the load. A model of DSTATCOM connected to a power distribution system feeding linear and non-linear loads (diode bridge rectifier with R and R-C) is developed for predicting the behavior of system under transient conditions. Simulation is carried out in standard MATLAB environment using Simulink and power system blockset toolboxes. Finally the performance of DSTATCOM under various fault conditions is investigated.*

Keywords- D-STATCOM, Voltage Sags, Voltage Source Converter (VSC).

I. INTRODUCTION

One of the most common power quality problems today is voltage dips. A voltage dip is a short time (10 ms to 1 minute) event during which a reduction in r.m.s voltage magnitude occurs [1-2]. It is often set only by two parameters, depth/magnitude and duration. The voltage dip magnitude is ranged from 10% to 90% of nominal voltage (which corresponds to 90% to 10% remaining voltage) and with a duration from half a cycle to 1 min. In a three-phase system a voltage dip is by nature a three-phase phenomenon, which affects both the phase-to-ground and phase-to-phase voltages [3]. A voltage dip is caused by a fault in the utility system, a fault within the customer's facility or a large increase of the load current, like starting a motor or transformer energizing [4]. Typical faults are single-phase or multiple-phase short circuits, which leads to high currents. The high current results in a voltage drop over the network impedance. At the fault location the voltage in the faulted phases drops close to zero, whereas in the non-faulted phases it remains more or less unchanged.

Voltage dips are one of the most occurring power quality problems [5-10]. Off course, for an industry an outage is worse, than a voltage dip, but voltage dips occur more often and cause severe problems and economical losses. Utilities often focus on disturbances from end-user equipment as the main power quality problems [11]. This is correct for many disturbances, flicker, harmonics, etc., but voltage dips mainly have their origin in the higher voltage levels. Faults due to lightning, is one of the most common causes to voltage dips on overhead lines [12]. If the economical losses due to voltage dips are significant, mitigation actions can be profitable for the customer and even in some cases for the utility. Since there is no standard solution which will work for every site, each mitigation action must be carefully planned and evaluated. There are different ways to mitigate voltage dips, swell and interruptions in transmission and distribution systems [13]. At present, a wide range of very flexible controllers, which capitalize on newly available power electronics components, are emerging for custom power applications [3, 4, 14]. Among these, the distribution static compensator and the dynamic voltage restorer are most effective devices, both of them based on the VSC principle [15-20].

STATCOM is often used in transmission system. When it is used in distribution system, it is called D-STATCOM （STATCOM in Distribution system). D-STATCOM is a key FACTS controller and it utilizes power electronics to solve many power quality problems [21-24] commonly faced by distribution systems. Potential applications of D-STATCOM include power factor correction, voltage regulation, load balancing and harmonic reduction. Comparing with the SVC, the D-STATCOM has quicker response time and compact structure. It is expected that the D-STATCOM will replace the roles of SVC in nearly future D-STATCOM and STATCOM are different in

both structure and function [25-28], while the choice of control strategy is related to the main-circuit structure and main function of compensators [3], so D-STATCOM and STATCOM adopt different control strategy. At present, the use of STATCOM is wide and its strategy is mature, while the introduction of D-STATCOM is seldom reported [29]. Many control techniques are reported such as instantaneous reactive power theory (Akagi et al., 1984), power balance theory, etc. In this paper, an indirect current control technique (Singh et al., 2000a,b) is employed to obtain gating signals for the Insulated Gate Bipolar Transistor (IGBT) devices used in current controlled voltage source inverter (CC-VSI) working as a DSTATCOM [30]. A model of DSTATCOM is developed using MATLAB for investigating the transient analysis of distribution system under balanced/unbalanced linear and non-linear three-phase and single-phase loads (diode rectifier with R and R-C load). Simulation results during steady-state and transient operating conditions of the DSTATCOM are presented and discussed to demonstrate power factor correction, harmonic elimination and load balancing capabilities of the DSTATCOM system [31-34].

II. DISTRIBUTION STATIC COMPENSATOR (D-STATCOM)

2.1 Principle of DSTATCOM

A D-STATCOM (Distribution Static Compensator), which is schematically depicted in Fig.1, consists of a two-level Voltage Source Converter (VSC), a dc energy storage device, a coupling transformer connected in shunt to the distribution network through a coupling transformer. The VSC converts the dc voltage across the storage device into a set of three-phase ac output voltages. These voltages are in phase and coupled with the ac system through the reactance of the coupling transformer. Suitable adjustment of the phase and magnitude of the D-STATCOM output voltages allows effective control of active and reactive power exchanges between the DSTATCOM and the ac system. Such configuration allows the device to absorb or generate controllable active and reactive power.

The VSC connected in shunt with the ac system provides a multifunctional topology which can be used for up to three quite distinct purposes:

1. Voltage regulation and compensation of reactive power;
2. Correction of power factor; and
3. Elimination of current harmonics.

Here, such device is employed to provide continuous voltage regulation using an indirectly controlled converter.

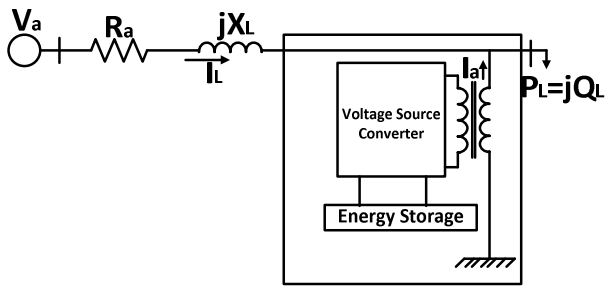


Figure. 1: DSTATCOM

Fig. 1 the shunt injected current I_{sh} corrects the voltage sag by adjusting the voltage drop across the system impedance Z_{th}. The value of I_{sh} can be controlled by adjusting the output voltage of the converter. The shunt injected current I_{sh} can be written as,

$$I_{sh} = I_L - I_S = I_L - (V_{th} - V_L) / Z_{th} \quad (1)$$
$$I_{sh} /\_\eta = I_L /\_- \theta$$

The complex power injection of the D-STATCOM can be expressed as,

$$S_{sh} = V_L I_{sh}^{*} \quad (2)$$

It may be mentioned that the effectiveness of the DSTATCOM in correcting voltage sag depends on the value of Zth or fault level of the load bus. When the shunt injected current Ish is kept in quadrature with VL, the desired voltage correction can be achieved without injecting any active power into the system. On the other hand, when the value of Ish is minimized, the same voltage correction can be achieved with minimum apparent power injection into the system.

2.2 Voltage Source Converter (VSC)

A voltage-source converter is a power electronic device that connected in shunt or parallel to the system. It can generate a sinusoidal voltage with any required magnitude, frequency and phase angle. The VSC used to either completely replace the voltage or to inject the 'missing voltage'. The 'missing voltage' is the difference between the nominal voltage and the actual. It also converts the DC voltage across storage devices into a set of three phase AC output voltages [8, 9]. In addition, D-STATCOM is also capable to generate or absorbs reactive power. If the output voltage of the VSC is greater than AC bus terminal voltages, D-STATCOM is said to be in capacitive mode. So, it will compensate the reactive power through AC system and regulates missing voltages. These voltages are in phase and coupled with the AC system through the reactance of coupling transformers. Suitable adjustment of the phase and magnitude of the DSTATCOM output voltages allows effectives control of active and reactive power exchanges between D-STATCOM and AC system. In addition, the

converter is normally based on some kind of energy storage, which will supply the converter with a DC voltage [10].

2.3 Controller for DSTATCOM

The three-phase reference source currents are computed using three-phase AC voltages (v_{ta}, v_{tb} and v_{tc}) and DC bus voltage (V_{dc}) of DSTATCOM. These reference supply currents consist of two components, one in-phase (I_{spdr}) and another in quadrature (I_{spqr}) with the supply voltages. The control scheme is represented in Fig. 2. The basic equations of control algorithm of DSTATCOM are as follows.

2.3.1 *Computation of in-phase components of reference supply current*

The instantaneous values of in-phase component of reference supply currents (I_{spdr}) is computed using one PI controller over the average value of DC bus voltage of the DSTATCOM (v_{dc}) and reference DC voltage (v_{dcr}) as

$$I_{Spdr(n)} = I_{Spdr(n-1)} + K_{pd}\{V_{de(n)} - V_{de(n-1)}\} + K_{id}V_{de(n)}$$

(3) where $V_{de(n)} = V_{dcc}\text{-}V_{dcn)}$ denotes the error in V_{dcc} and average value of V_{dc} *Kpd* and *Kid* are proportional and integral gains of the DC bus voltage PI controller. The output of this PI controller (I_{spdr}) is taken as amplitude of in-phase component of the reference supply currents. Three-phase in-phase components of the reference supply currents (i_{sadr}, i_{sbdr} and i_{scdr}) are computed using the in-phase unit current vectors (u_a, u_b and u_c) derived from the AC terminal voltages (v_{tan}, v_{tbn} and v_{tcn}), respectively.

$$u_a = V_{ta}/V_{tm}\ ,\ u_b = V_{tb}/V_{tm}\ ,\ u_c = V_{tc}/V_{tm} \quad (4)$$

where V_{tm} is amplitude of the supply voltage and it is computed as

$$V_{tm} = [(2/3)(V_{tan}^2 + V_{tab}^2 + V_{tab}^2)]^{1/2}$$

The instantaneous values of in-phase component of reference supply currents (i_{sadr}, i_{sbdr} and i_{scdr}) are computed as

$$i_{sadr} = I_{spdr}u_a, i_{sbdr} = I_{spdr}u_b, i_{scdr} = I_{spdr}u_c$$

2.3.1 *Computation of quadrature components of reference supply current*

The amplitude of quadrature component of reference supply currents is computed using a second PI controller over the amplitude of supply voltage (v_{tm}) and its reference value (v_{tmr})

$$I_{Spqr(n)} = I_{Spqr(n-1)} + K_{pq}\{V_{se(n)} - V_{se(n-1)}\} + K_{iq}V_{se(n)}$$

(5)

whereVac= Vtmc-Vmc(n) denotes the error in Vtmc and computed value *Vtmn* from Equation (3) and Kpqand Kiq are the proportional and integral gains of the second PI controller.

$$W_a = \{-u_b + u_c\}/\{(3)^{1/2}\}$$
$$W_b = \{u_a(3)^{1/2} + u_b - u_c\}/\{2(3)^{1/2}\}$$
$$W_c = \{-u_a(3)^{1/2} + u_b - u_c\}/\{2(3)^{1/2}\} \quad (6)$$

Three-phase quadrature components of the reference supply currents (i_{saqr}, i_{sbqr} and i_{scqr}) are computed using the output of second PI controller (I_{spqr}) and quadrature unit current vectors (w_a, w_b and w_c) as

$$i_{saqr} = I_{spqr}u_a, i_{sbqr} = I_{spqr}u_b, i_{scqr} = I_{spqr}u_c$$

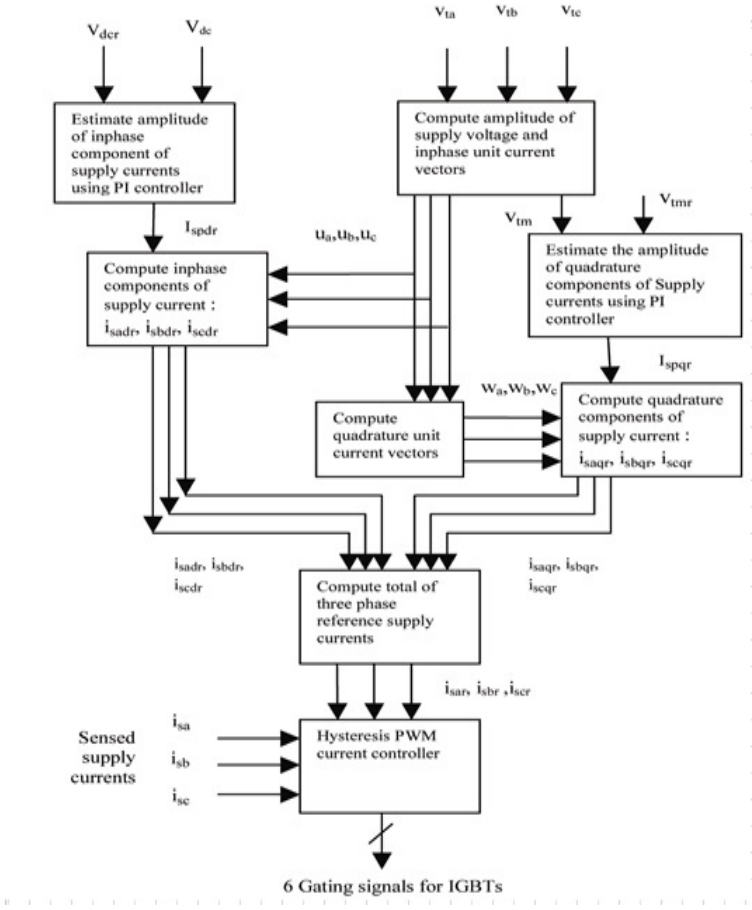


Figure. 2: Control method for DSTATCOM

2.3 Computation of total reference supply currents

Three-phase instantaneous reference supply currents (i_{sar}, i_{sbr} and i_{scr}) are computed by adding in-phase (i_{sadr}, i_{sbdr} and i_{scdr}) and quadrature components of supply currents (i_{saqr}, i_{sbqr} and i_{scqr}) as

$$i_{sar} = i_{adr} + i_{aqr}, i_{sbr} = i_{bdr} + i_{bqr}, i_{scr} = i_{cdr} + i_{cqr}$$

A hysteresis pulse width modulated (PWM) current controller is employed over the reference (i_{sar}, i_{sbr} and i_{scr}) and sensed supply currents (i_{sa}, i_{sb} and i_{sc}) to generate gating pulses for IGBTs of DSTATCOM.

2.4 Design of Single H-Bridge Cell

1. Device Current

The IGBT and DIODE currents can be obtained from the load current by multiplying with the corresponding duty cycles. Duty cycle, d = ½(1+Kmsinωt), Where, m =

modulation index K = +1 for IGBT, -1 for Diode. For a load current given by

$I_{ph} = \sqrt{2}\, I \sin(wt - \phi)$ (7)

Then the device current can be written as follows.

$$\therefore\ i_{device} = \frac{\sqrt{2}}{2} I \sin(wt - \emptyset) x\ (1 + km \sin wt) \quad (8)$$

The average value of the device current over a cycle is calculated as

$$i_{avg} = \frac{1}{2\pi} \int_{\varphi}^{\pi+\varphi} \frac{\sqrt{2}}{2} I \sin(wt - \emptyset) x\ (1 + km \sin wt)\, dwt$$

$$= \sqrt{2} I \left[\frac{1}{2\pi} + \frac{k\,m}{g} \cos\varphi\right] \quad (9)$$

The device RMS current can be written as

$$i_{rms} = \sqrt{\int_{\varphi}^{\pi+\varphi} \frac{1}{2\pi} (\sqrt{2} I \sin(wt - \emptyset))^2\, x\, \frac{1}{2} x\, ((1 + km \sin wt)\, dwt)}$$

$$= \sqrt{2} I \sqrt{\frac{1}{g} + \frac{km}{3\pi} \cos\varphi} \quad (10)$$

B IGBT Loss Calculation

IGBT loss can be calculated by the sum of switching loss and conduction loss. The conduction loss can be calculated by,

$P_{on\ (IGBT)} = V_{ceo} * I_{avg\ (igbt)} + I^2_{rms\ (igbt)} * r_{ceo}$ (11)

$$I_{avg\ (igbt)} = \sqrt{2} I \left[\frac{1}{2\pi} + \frac{m}{g} cos\varphi\right] \quad (12)$$

$$I_{rms\ (igbt)} = \sqrt{2} I \sqrt{\left[\frac{1}{g} + \frac{m}{3\pi} cos\varphi\right]} \quad (13)$$

Values of V_{ceo} and r_{ceo} at any junction temperature can be obtained from the output characteristics (Ic vs. Vce) of the IGBT as shown in Fig .3.

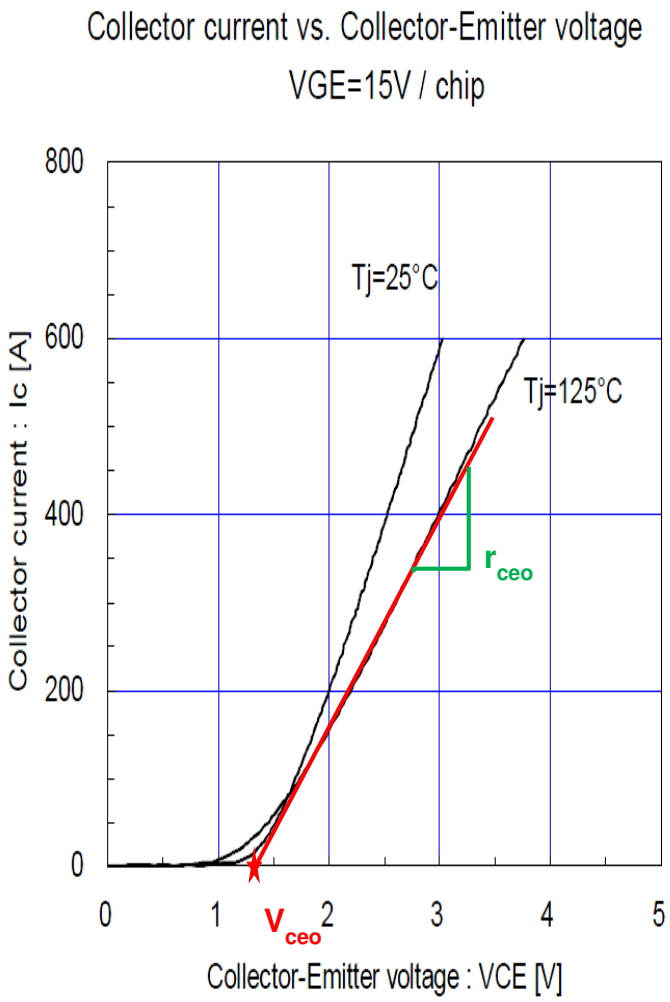


Figure. 3: IGBT output characteristics

The switching losses are the sum of all turn-on and turn-off energies at the switching events

$E_{sw} = E_{on} + E_{off} = a + bI + cI^2$ (14)

Assuming the linear dependence, switching energy

$$E_{sw} = (a + bI + cI^2) * \frac{V_{DC}}{V_{nom}} \quad (15)$$

Here V_{DC} is the actual DC-Link voltage and V_{nom} is the DC-Link Voltage at which E_{sw} is given. Switching losses are calculated by summing up the switching energies.

$$P_{sw} = \frac{1}{T_0} \Sigma_n E_{sw}(i) \quad (16)$$

Here 'n' depends on the switching frequency.

$$P_{sw} = \frac{1}{T_0} \Sigma_n (a + bI + cI^2) = \frac{1}{T_0} \left[\frac{a}{2} + \frac{bI}{\pi} + \frac{cI^2}{4}\right] \quad (17)$$

After considering the DC-Link voltage variations, switching losses of the IGBT can be written as follows.

$$P_{sw\ (IGBT)} = f_{sw} \left[\frac{a}{2} + \frac{bI}{\pi} + \frac{cI^2}{4}\right] * \frac{V_{DC}}{V_{nor}} \quad (18)$$

So, the sum of conduction and switching losses is the total losses given by

$P_{T\ (IGBT)} = P_{on\ (IGBT)} + P_{sw\ (IGBT)}$ (19)

C Diode Loss Calculation

The DIODE switching losses consist of its reverse recovery losses; the turn-on losses are negligible.

$$E_{rec} = a + bI + cI^2 \quad (20)$$

$$P_{sw\ (DIODE)} = f_{sw}\left[\frac{a}{2} + \frac{bI}{\pi} + \frac{cI^2}{4}\right] * \frac{V_{DC}}{V_{nor}} \quad (21)$$

So, the sum of conduction and switching losses gives the total DIODE looses.

$$P_{T\ (DIODE)} = P_{on\ (DIODE)} + P_{sw\ (DIODE)} \quad (22)$$

The total loss per one switch (IGBT+DIODE) is the sum of one IGBT and DIODE loss.

$$P_T = P_{T\ (IGBT)} + P_{sw\ (DIODE)} \quad (23)$$

D. Thermal Calculations

The junction temperatures of the IGBT and DIODE are calculated based on the device power losses and thermal resistances. The thermal resistance equivalent circuit for a module is shown in Fig 4. In this design the thermal calculations are started with heat sink temperature as the reference temperature. So, the case temperature from the model can be written as follows.

$$T_c = P_T R_{th\ (c\text{-}h)} + T_h \quad (24)$$

Here $R_{th(c\text{-}h)}$ = Thermal resistance between case and heat sink

$$P_T = \text{Total Power Loss (IGBT + DIODE)} \quad (25)$$

IGBT junction temperature is the sum of the case temperature and temperature raise due to the power losses in the IGBT.

$$T_{j\ (IGBT)} = P_{T\ (IGBT)} R_{th\ (j\text{-}c)\ IGBT} + T_c \quad (26)$$

The DIODE junction temperature is the sum of the case temperature and temperature raise due to the power losses in the DIODE.

$$T_{j\ (DIODE)} = P_{T\ (DIODE)} R_{th\ (j\text{-}c)\ DIODE} + T_c \quad (27)$$

The above calculations are done based on the average power losses computed over a cycle. So, the corresponding thermal calculation gives the average junction temperature. In order to make the calculated values close to the actual values, transient temperature values are to be added to the average junction temperatures.

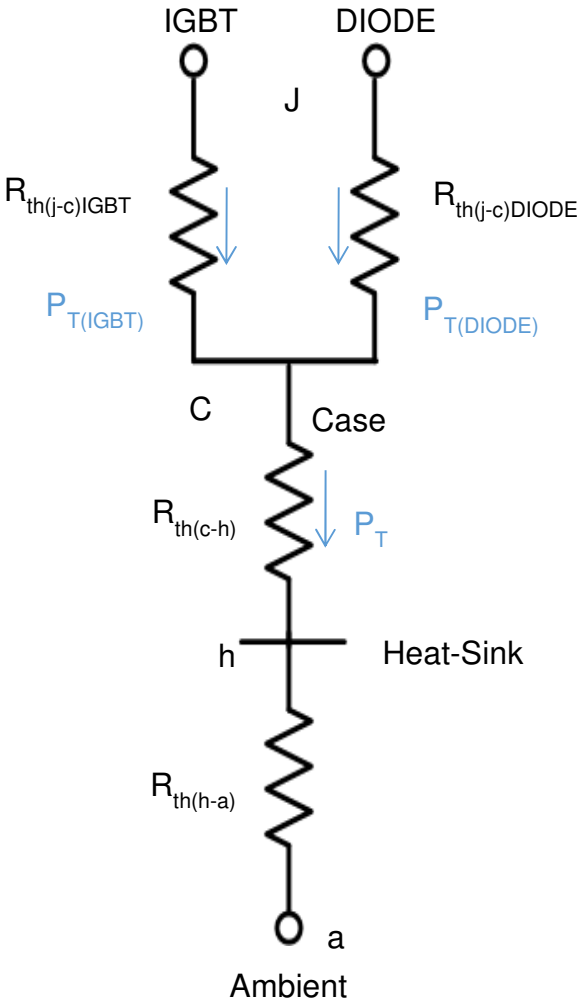


Figure. 4: Thermal resistance equivalent circuit

E. DC-Capacitor Selection

The required capacitance for each cell depends on the allowable ripple voltage and the load current. The rms ripple current flowing into the capacitor can be written as follows and the ripple current frequency is double the load current frequency.

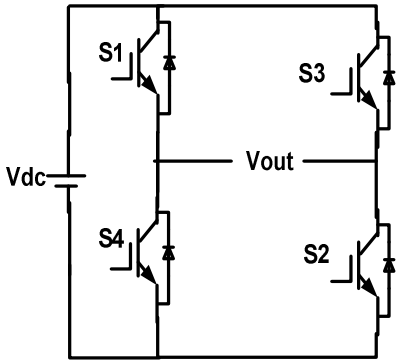


Figure. 5 H-Bridge converter

$$I_c = -\frac{1}{V_{dc}}\frac{1}{2}(|U_{ac}| * k + IwL)\sin(2wt) \quad (28)$$

Since the value of 'L' is very small, the above equation can be simplified to

$$I_c = -\frac{1}{V_{dc}}\frac{1}{2}(|U_{ac}| * k)\sin(2wt) \quad (29)$$

$$I_c = -k\frac{1}{2}\frac{|U_{ac}|}{V_{dc}} * \sin(2wt) = -k\frac{m}{2}\sin(2wt) \quad (30)$$

Here 'm' is the modulation index and

$I_{cp} = C\ \frac{du_{pp}}{dt}$; $\frac{m}{2} I\sqrt{2}$= C2w*ΔV V_{dc}

III. MATAB/SIMULINK MODELING OF DSTATCOM

3.1 Modeling of Power Circuit

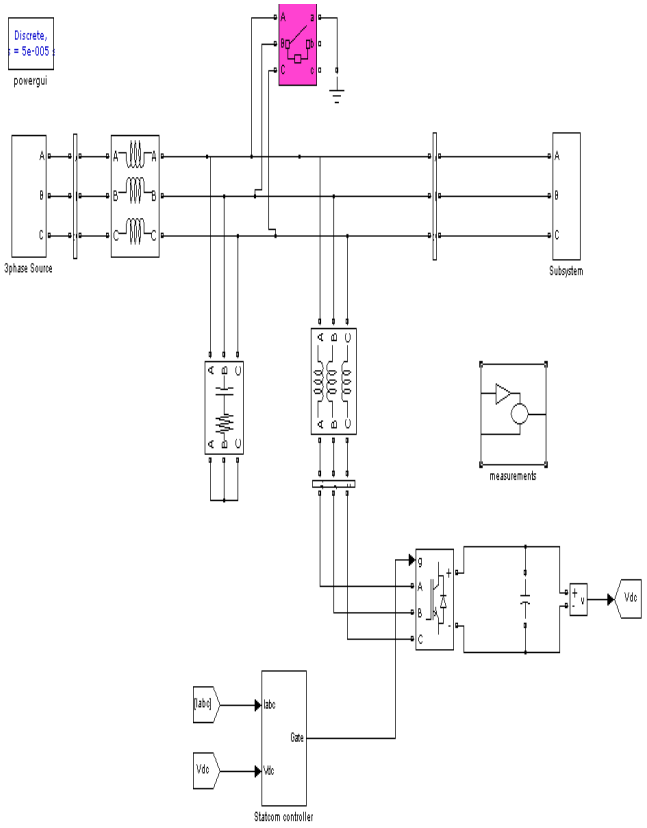
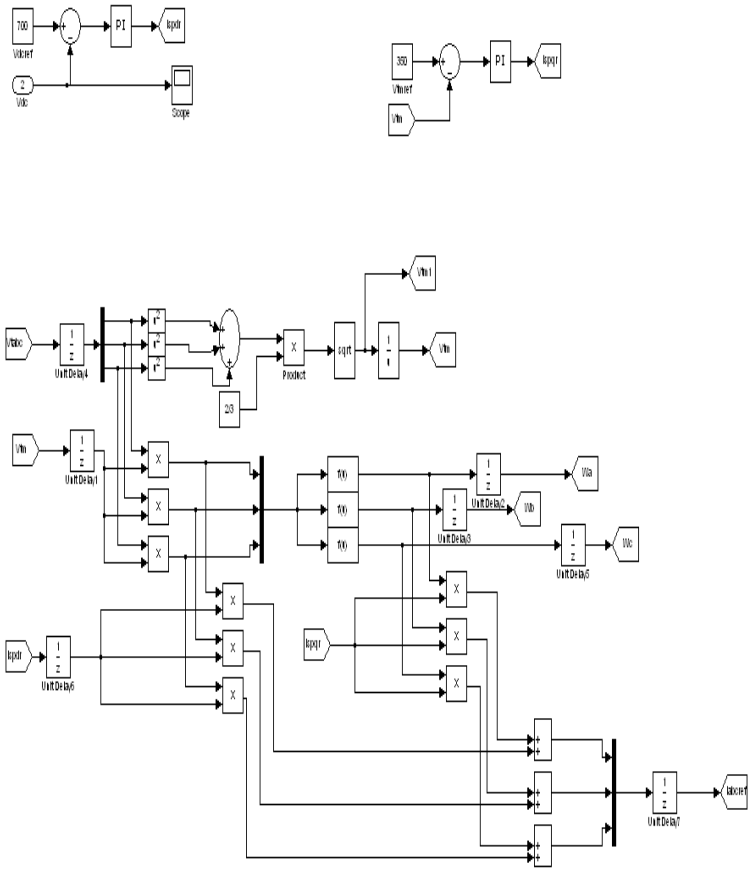


Figure. 6: Matlab/Simulink model of DSTATCOM Power Circuit

Fig. 6 shows the complete MATLAB model of DSTATCOM along with control circuit. The power circuit as well as control system are modelled using Power System Blockset and Simulink. The grid source is represented by three-phase AC source. Three-phase AC loads are connected at the load end. DSTATCOM is connected in shunt and it consists of PWM voltage source inverter circuit and a DC capacitor connected at its DC bus. An IGBT-based PWM inverter is implemented using Universal bridge block from Power Electronics subset of PSB. Snubber circuits are connected in parallel with each IGBT for protection. Simulation of DSTATCOM system is carried out for linear and non-linear loads. The linear load on the system is modelled using the block three-phase parallel R-L load connected in delta configuration. The non-linear load on the system is modelled using R and R-C circuits connected at output of the diode rectifier. Provision is made to connect loads in parallel so that the effect of sudden load addition and removal is studied. The feeder connected from the three-phase source to load is modelled using appropriate values of resistive and inductive components.

3.1 Modeling of Control Circuit

Figure below shows the control algorithm of DSTATCOM with two PI controllers. One PI controller regulates the DC link voltage while the second PI controller regulates the terminal voltage at PCC. The in-phase components of DSTATCOM reference currents are responsible for power factor correction of load and the quadrature components of supply reference currents are to regulate the AC system voltage at PCC.



The output of PI controller over the DC bus voltage (I_{spdr}) is considered as the amplitude of the in-phase component of supply reference currents and the output of PI controller over AC terminal voltage (I_{spqr}) is considered as the amplitude of the quadrature component of supply reference currents. The instantaneous reference currents (i_{sar}, i_{sbr} and

i_{scr}) are obtained by adding the in-phase supply reference currents (i_{sadr}, i_{sbdr} and i_{scdr}) and quadrature supply reference currents (i_{saqr}, i_{sbqr} and i_{scqr}). Once the reference supply currents are generated, a carrierless hysteresis PWM controller is employed over the sensed supply currents (i_{sa}, i_{sb} and i_{sc}) and instantaneous reference currents (i_{sar}, i_{sbr} and i_{scr}) to generate gating pulses to the IGBTs of DSTATCOM. The controller controls the DSTATCOM currents to maintain supply currents in a band around the desired reference current values. The hysteresis controller generates appropriate switching pulses for six IGBTs of the VSI working as DSTATCOM.

IV. Simulation Results

Here Simulation results are presented for four cases. In case one load is linear RL load, in case two non linear R load, in case three non linear RC load, and in case four we have considered line disturbance like single line to ground fault (SLG), without DSTATCOM and with DSTATCOM.

4.1 Case one

Performance of DSTATCOM connected to a weak supply system is shown in Fig.6 for power factor correction and load balancing. This figure shows variation of performance variables such as supply voltages (v_{sa}, v_{sb} and v_{sc}), terminal voltages at PCC (v_{ta}, v_{tb} and v_{tc}), supply currents (i_{sa}, i_{sb} and i_{sc}), load currents (i_{la}, i_{lb} and i_{lc}), DSTATCOM currents (i_{ca}, i_{cb} and i_{cc}) and DC link voltage (V_{dc}) for load changes from 36 kW (three-phase) to two-phase (24 kW) to single-phase (12 kW) to two-phase (24 kW) to three-phase (36 kW). The response shows that DSTATCOM balances unbalanced loads either of single-phase or two-phase type and improves the power factor of AC source to unity under varying load. Supply currents (i_{sa}, i_{sb} and i_{sc}), compensator currents (i_{ca}, i_{cb} and i_{cc}) and DC bus voltage (v_{dc}) settle to steady-state values within a cycle for any type of change in load.

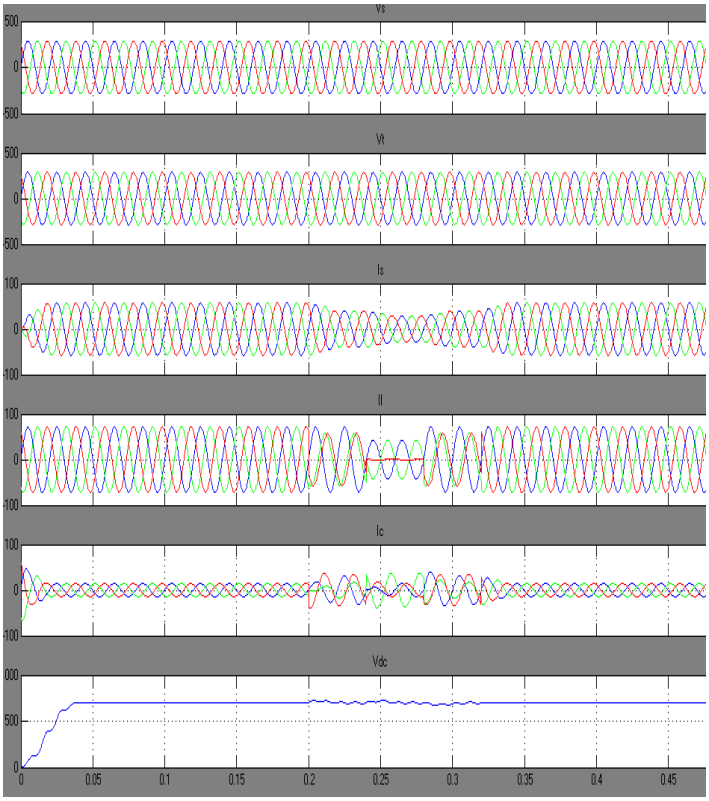


Figure. 7: Simulation results for linear RL Load

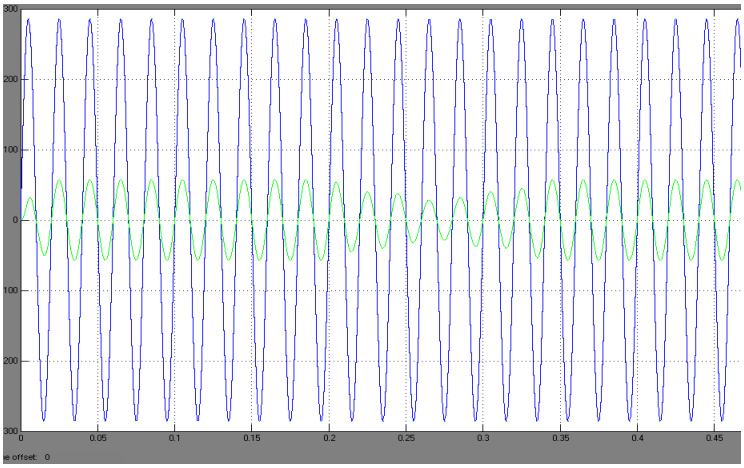


Figure. 8: Simulation results power factor for linear RL Load

4.2 Case two

Balanced three-phase non-linear load is represented by three-phase uncontrolled diode bridge rectifier with pure resistive load at its DC bus. Fig. 9 shows the transient responses of distribution system with DSTATCOM for supply voltages (v_{sabc}), supply currents (i_{sabc}), load currents (i_{la}, i_{lb} and i_{lc}), DSTATCOM currents (i_{ca}, i_{cb} and i_{cc}) along

with DC link voltage (V_{dc}) and its reference value (V_{dcr}) at rectifier nonlinear load.

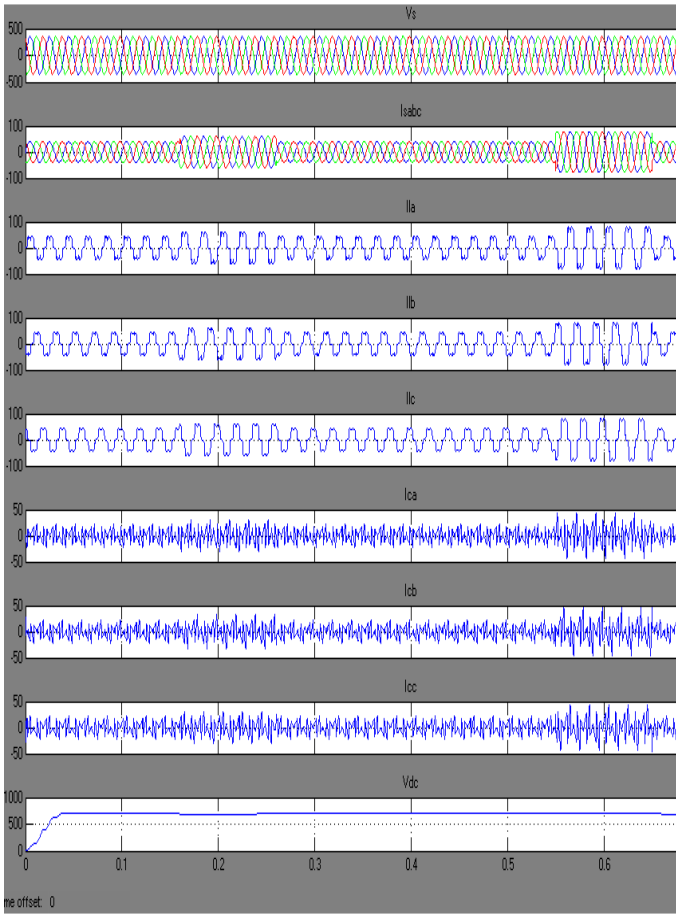


Figure. 9: Simulation results Non-linear R Load

At $t = 0.16$ sec, the DC load resistance is changed from 15 to 10 ohm to increase the loading thereby the power absorbed changes from 21 to 30 kW. Consequently, load, supply and DSTATCOM currents increase to provide demanded active and reactive power to the load. The increased load on the rectifier reflects in the form of undershoot in DC link voltage. At $t = 0.26$ sec, the load resistance is changed back to 15ohm and an overshoot is observed now, which settles down within a few cycles due to action of PI controller. Results show that the supply currents are balanced, sinusoidal and in-phase with the supply voltages.

4.3 Case three

Fig. 10 shows, the transient waveforms of all performance variables of distribution system with DSTATCOM supplying R-C load at the terminal of diode bridge rectifier. At $t = 0.55$ sec, DC link resistance of load is changed from 15 to 7.5ohm . The load has increased from 20 kW to 40 kW. It is observed that the DC bus voltage of DSTATCOM regulates itself at its reference value and thus a self-supporting DC bus is obtained. The supply currents are sinusoidal even though the load currents are non-linear in nature.

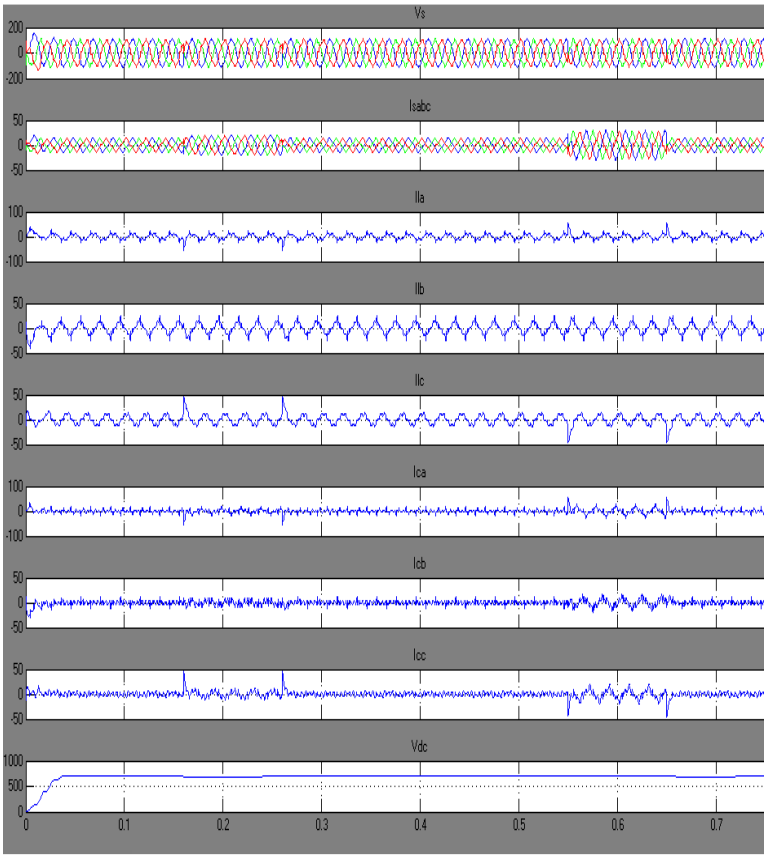


Figure. 10: Simulation results Non-linear RC Load

4.4 Case four

Fig. 11 shows RMS value of line voltage. Here at t=0.2 sec a SLG fault is created the line voltage fall from1 P.U to 0.78 P.U. Fig. 12 shows the RMS value of line voltage with DSTATCOM. Here at t=0.2 sec a SLG fault is created the line voltage fall from1 P.U to 0.98 P.U.

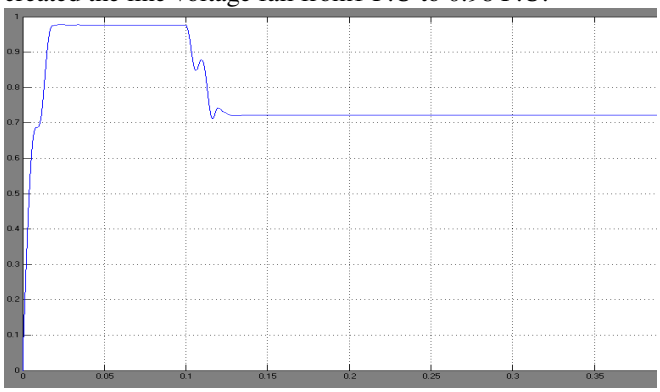


Figure. 11: PCC voltage without DSTATCOM during LG fault

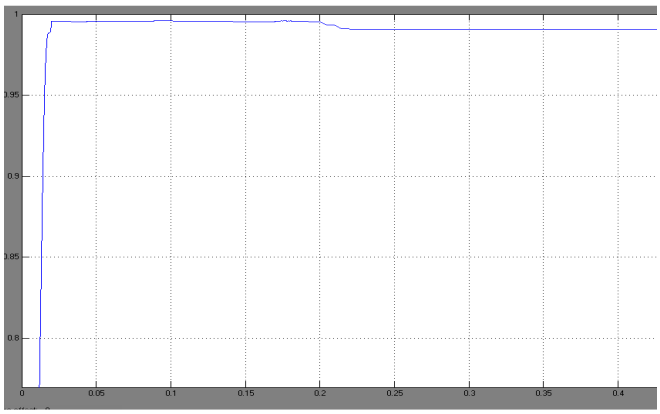


Figure. 12: PCC voltage with DSTATCOM during LG fault

V. CONCLUSION

DSTATCOM system is an efficient mean for mitigation of PQ disturbances introduced to the grid by DERs. DSTATCOM compensator is a flexible device which can operate in current control mode for compensating voltage variation, unbalance and reactive power and in voltage control mode as a voltage stabilizer. The latter feature enables its application for compensation of dips coming from the supplying network. The simulation results show that the performance of DSTATCOM system has been found to be satisfactory for improving the power quality at the consumer premises. DSTATCOM control algorithm is flexible and it has been observed to be capable of correcting power factor to unity, eliminate harmonics in supply currents and provide load balancing. It is also able to regulate voltage at PCC. The control algorithm of DSTATCOM has an inherent property to provide a self-supporting DC bus of DSTATCOM. It has been found that the DSTATCOM system reduces THD in the supply currents for non-linear loads. Rectifier-based non-linear loads generated harmonics are eliminated by DSTATCOM. When single-phase rectifier loads are connected, DSTATCOM currents balance these unbalanced load currents. The simulation results show that the voltage sags can be mitigate by inserting D-STATCOM to the distribution system. The same analysis can be carried out for Double Line to Ground (DLG) fault and Three Line to Ground (TLG) fault also.

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