POWER QUALITY IMPROVEMENT BY SRF BASED CONTROL USING D-STATCOM

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Abstract: *Now a days severe power quality problems such as poor voltage regulation , high reactive power and harmonics current burden , load unbalancing have been faced by Three phase three wire distribution system . For the improvement of power quality FACTS devices such as SSSC, UPFC, SVC , D-STATCOM etc. are used In this paper D-STATCOM is used to solve power quality problems. There are many Different control strategies are Instantaneous power theory (IRP) , Synchronous Reference frame theory (SRF) , Symmetrical component theory (SC), modified p-q theory etc. In this SRF control strategy is used to control the D-STATCOM. MATLAB simulation is presented with D-STATCOM using SRF control strategy.*

Key Words: **D-STATCOM, voltage source converter , control strategy (SRF)**

1. INTRODUCTION

Initially FACTS devices like static synchronous compensator (STATCOM), static synchronous series compensator (SSSC), inter line power flow controller (IPFC), and unified power flow controller (UPFC) etc are introduced for the improvement of power quality or reliability of the system. These FACTS devices are designed for the transmission system. But these devices are modified and known as custom power devices. The term" custom power" describes the value-added power that electric utilities will offer to their customers. The value addition involves the application of high power electronic controllers to distribution systems, at the supply end of industrial, commercial consumers. Distribution static synchronous compensate or (DSTATCOM) is the main custom power devices which are used in distribution system for power quality improvement. A DSTATCOM is used to eliminate the harmonics from the source currents and it also balances them in addition to providing reactive power compensation to improve power factor or regulate the load bus voltage. For power quality improvement the voltage source inverter (VSC) bridge structure is generally used for the development of custom power devices, while the use of current source inverter (CSI) is less utilised.. A Distribution Static Compensator is in short known as D-STATCOM. It is a power electronic converter based device used to protect the distribution bus from voltage unbalances. It is connected in shunt to the distribution bus generally at the PCC. The schematic diagram of a D-STATCOM is as shown in Fig.1.1 [1]

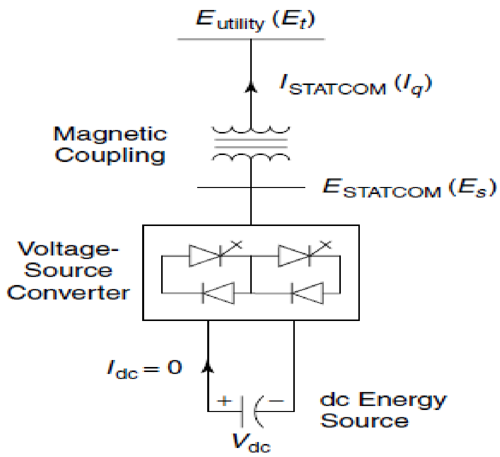


Fig.1.1 Schematic Diagram of D-STATCOM

2. CONTROL TECHNIQUE FOR STATCOM

2.1. Synchronous Reference Frame Theory (SRF) Theory

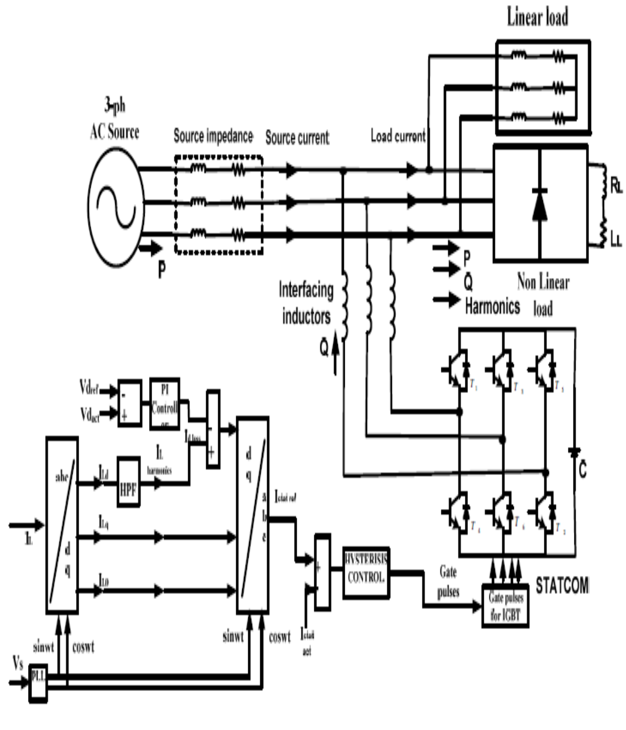


figure.2 shows The internal view of Synchronous Reference Frame Theory (SRF) control strategy for STATCOM. In this control strategy the SRF-based STATCOM control technique is used to generate gate pulses for controlling of STATCOM. Here from the control strategy is designed with abc frame to d-q frame conversion block, PLL block, HPF, PI controller, DQ to ABC conversion block and hysteresis controller. The abc frame to d-q frame conversion block converts 3Ø load current parameters (Iabc) to dq0 parameters frame by using parks transformation. The phase locked loop generates Sinwt and coswt signals for transformation block. Initially, the current components from block in α–β co-ordinates are generated. Iabc phases can then be transformed into α– β coordinates. HPF is high pass filter is used to block low frequency components coming from conversion block. The Vd reference and actual value is compared then given to pi controller is again compared with Id loss value then given to inverse transformation block and then the output of inverse transformation block is STATCOM reference current is compared with actual STATCOM current then given to Hysteresis controller which will generate gate pulses for switches.All this process is given in figure 3

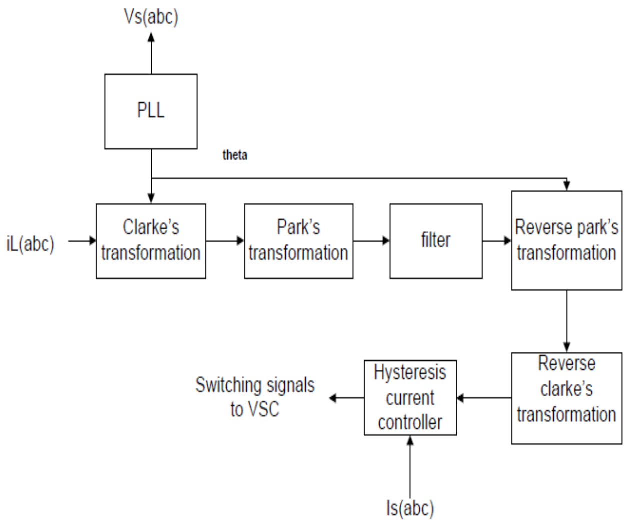
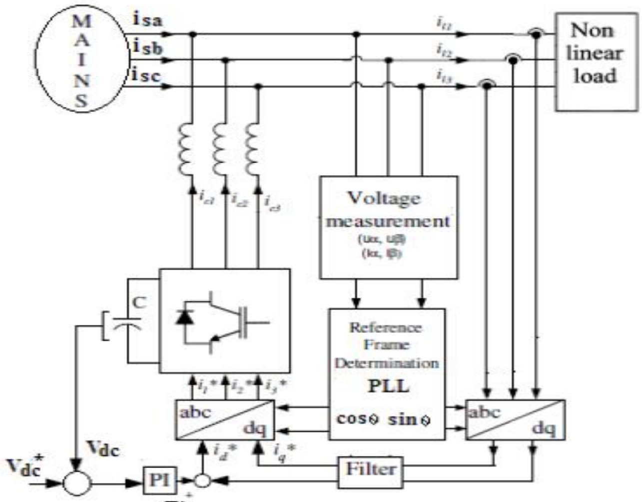


Fig 3.Block diagram of SRF theory

Synchronous Reference Theory (SRF) In the SRF [5], the load current signals are transformed into the conventional rotating frame d-q. If theta is the transformation angle, the transformation is defined by:

$$\begin{bmatrix} x_d \\ x_q \\ x_0 \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} \cos(\theta) & \cos\left(\theta - \frac{2\pi}{3}\right) & \cos\left(\theta - \frac{4\pi}{3}\right) \\ -\sin(\theta) & \sin\left(\theta - \frac{2\pi}{3}\right) & -\sin\left(\theta - \frac{4\pi}{3}\right) \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix} \begin{bmatrix} x_a \\ x_b \\ x_c \end{bmatrix}$$

Fig.4shows the basic configuration of synchronous reference frame. In the SRF is a time varying angle that represents the angular position of the reference frame which is rotating at constant speed in synchronism with the three phase ac voltages. In the SRF Ɵ is a time varying angle that represents the angular position of the reference frame which is rotating at constant speed in synchronism with the three phase ac voltages.



3.SIMULATION OF DSTATCOM

The basic simulation model consists of a source, load, DSTATCOM and control block. The linear load connected is a combination of resistance and inductance in series for each phase and the nonlinear load is a diode bridge rectifier. This DSTATCOM is simulated with the above described Synchronous Reference Frame theory and and new back propagation control algorithm

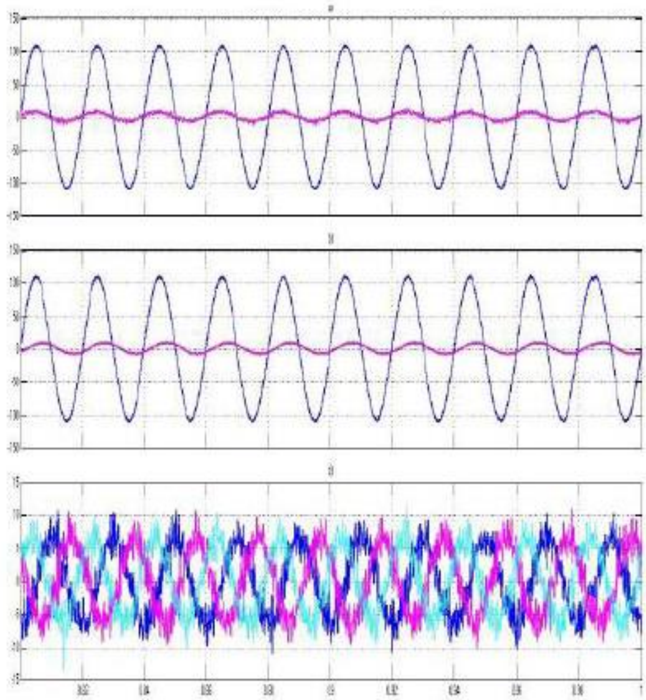


Fig 5: the waveforms of (a) Source voltage and source current (b) Source voltage and Load current (c) DSTATCOM current for linear load

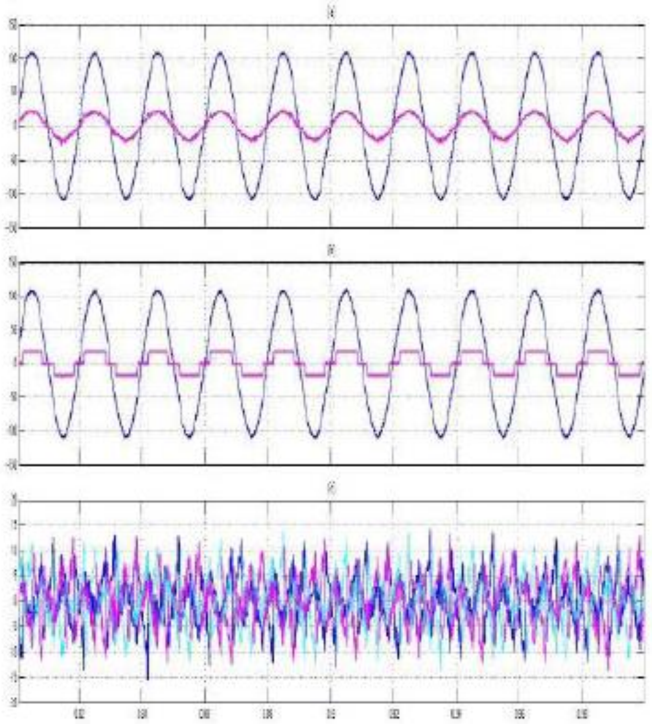


Fig 6: the waveforms of (a) Source voltage and source current (b) Source voltage and Load current (c) DSTATCOM current for nonlinear load.

Fig 5 (a) and (b) shows the waveforms of source voltage, source current and load current for linear loads when Synchronous Reference Frame Theory is used. From this waveforms we can see that the source voltage and source current are in phase with each other and load current lags behind source voltage. Fig 5(c) shows the waveform of DSTATCOM current. Fig 6 (a) and (b) shows the waveforms of source voltage, source current and load current for nonlinear loads. Here source voltage and source current are in phase and load current lags behind the source voltage. For both loads, the magnitude of load current is less than the source current. Fig 6 (c) shows the waveform of DSTATCOM current. Due to the presence bridge rectifier, harmonics are injected in the system. These harmonic current is injected by DSTATCOM and harmonics can be successfully eliminated and source current can be made

4. CONCLUSION

The performance analysis of proposed STATCOM with SRF control theory is found to be quiet satisfactory for harmonic elimination and reactive power compensation for linear and non linear loads. The STATCOM effectively compensate the reactive power & harmonics for linear and non linear load cases. For non linear load case the effect is compensated by STATCOM and power factor is maintained at unity. The harmonic content of the current at source side is 1.52% when non linear load is connected.

5.FUTURE SCOPE

- The power demand is always increasing day by day. The power quality problems are also following the same trend and increasing day by day.
- So there is need to reduce such power quality problems like voltage sag and swell and make the supply system efficient.
- STATCOM is one of the promising technologies to enhance the power quality of system.
- The power quality can be still improved by using soft computing techniques like Unified power flow controller, Dynamic Voltage Restorer etc.
- FACT devices can be controlled through different control techniques to get better coordination between real and reactive power.

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