International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8, Issue-2S11, September 2019

Implementation of Voltage Stability System in Distribution Network by using D-STATCOM

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Abstract— This project work presents a proposed D-STATCOM system, Which is implemented in the distribution network. In the present scenario, the customer or consumer should be supplied with a quality power. The power quality issues like voltage sag, swell, lightning surges etc, can be reduced by using several advanced techniques. Among all these power quality issues voltage sag is considered and has been compensated in this project work by using D-STATCOM. The major advantage of D-STATCOM is that instead of installing the compensating device in the transmission and distribution line, the D-STATCOM unit is implemented at the consumers premises to maintain stable voltage for the connected electrical equipment's and also to provide safe operation of the electrical equipment's by extending their life time. The software ie., implemented by using MATLAB Simulink and the results are also verified experimentally by a hardware unit.

Keywords— D-STATCOM, 3-Phase Voltage Source Inverter(VSI),PI Controller,Filters,Diode bridge rectifier,AC load,DC load .

I. INTRODUCTION

The quality of electric power has become an important issue for electric utilities and its customers. As a result, power quality study is gaining interest [1-6]. Degradation in quality of electric power is normally caused by power line disturbances such as voltage sag/swell with and without harmonics, momentary interruption, harmonic distortion, flicker, notch, spike and transients, causing problems such as malfunctions, instabilities, short lifetime, 15 failure of electrical equipments, etc. In an electric distribution network, faults may cause voltage sag or momentary interruption whereas switching off large load or charging of a large capacitor bank may lead to voltage swell. On the other hand, use of solid-state switching devices and nonlinear and power electronically switched loads such as rectifiers or inverters may cause harmonic distortion and notching in the voltage and current [7-10]. In this paper we face voltage dip (SAG) and harmonics. It can be compensated by FACTS devices like SVC, STATCOM, TCR, TCS, D-STATCOM. Among these for existing system SVC was used.SVC have limited overload capability and also have poor performance [11-13]. So we are move in to D-STATCOM which have unlimited overload capability and also have good performance [14-16]. Here we use sinusoidal pulse width modulation technique.

This paper presents: a) the proposed D-STATCOM control concepts, b) MATLAB simulation studies c) Laboratory implementation results and d) Hardware implementation.

The remainder of this paper is organized as follows; Section II illustrates the concept of existing and proposed system. Simulation of existing and proposed system in Section III. Section IV concludes the paper.

II. PROPOSED AND EXISTING SYSTEM

A) EXISTING SYSTEM:

The existing system consists of SVC is connected in distribution line with TCR.3-Phase ac load and dc load also connected in the system.Gate pulses are required for the system, so PI controller is used.The Rectifier used here is to convert ac to dc.Here Low pass filter is there.To convert from 3-phase to 2-phase abc to dq conversion method is used. In this system output voltage is not stable and harmonics also properly not reduced.

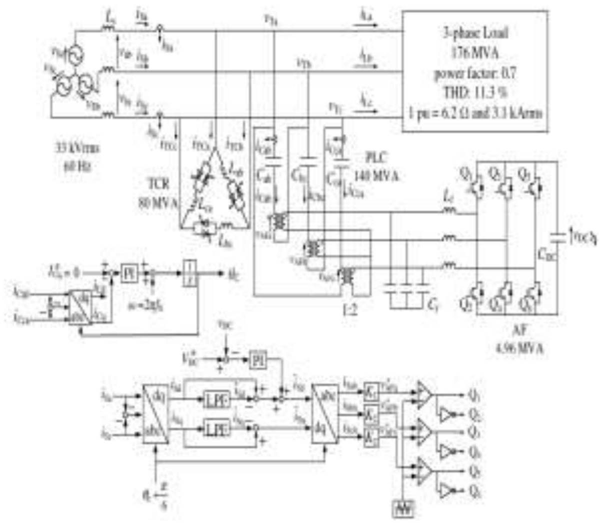

Fig 1:circuit diagram of existing system

Revised Version Manuscript Received on 10, September 2019.

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B) PROPOSED SYSTEM:

The proposed system consists of controller part, compensating device, linear and non-linear loads. Power is distributed from grid to both linear and non-linear loads. There is the fault on the distribution line. The fault is cleared by using compensating device which is D-STATCOM. This is connected to the PI controller. It generates the gate pulses to the Voltage Source Inverter (VSI) by using PWM technique. Potential and current transformers are used for measuring the voltage and current. The VSI is used to control the magnitude and frequency of the AC output voltage. The D-STATCOM have unlimited overload capacity and can inject the reactive power to distribution line.

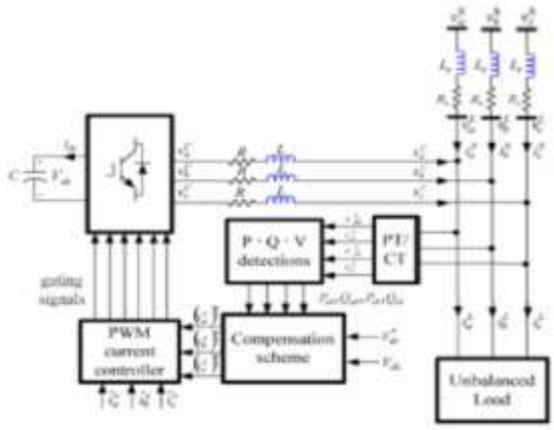

Fig 2: circuit diagram of proposed system

III. SIMULATION OF EXISTING AND PROPOSED SYSTEM

In this existing diagram many scopes are connected to see the output of the svc.Scope1 is connected with the supply to see the input waveform before implementing svc. Scope 2 is connected with svc to see the output of the injected voltage. The output waveform after implementing svc can be seen in scope 3.

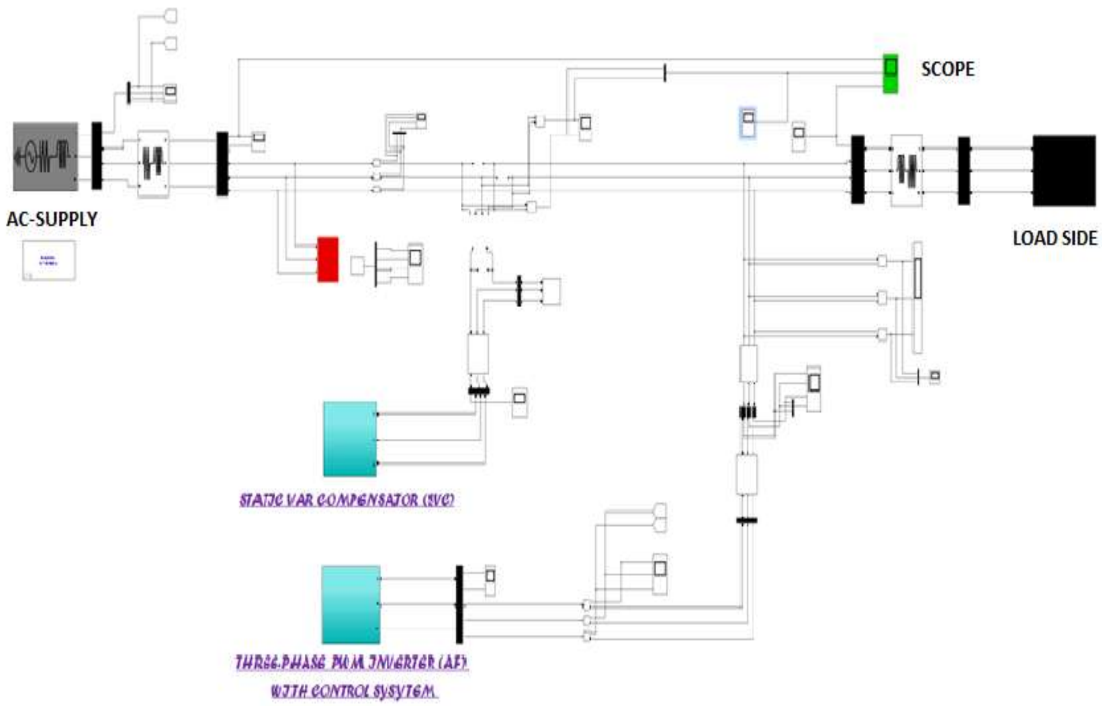

Fig 3: simulation diagram for existing system

Output Waveforms of Existing System without and With Compensation:

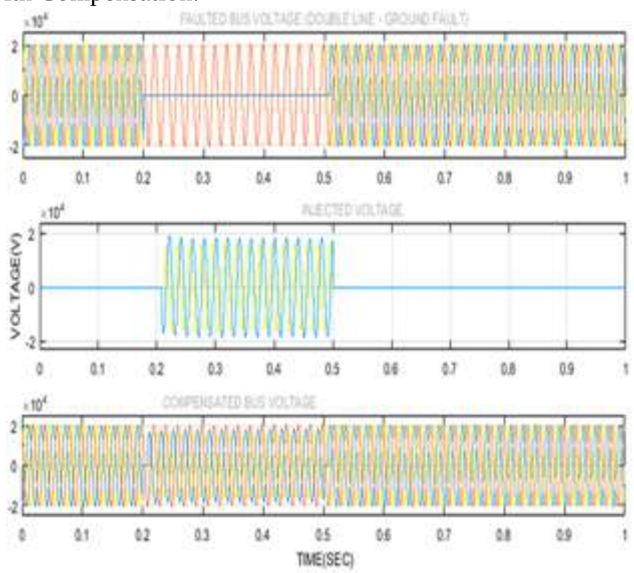

Fig 4: Waveform of SVC

Voltage values are shown in Y-axis and Time values are shown in X-axis. Three phase voltages are shown in the Fig 4.

Double Line to Ground fault occurs in the Distribution Line. In order to clear this fault SVC is implemented. The fault is not fully cleared. Here we can see that output voltage is not stable. So, to get a stable voltage we are moving to the D-STATCOM.

A. PROPOSED SYSTEM FOR OPEN LOOP:

In this proposed diagram we see the implementation of D-STATCOM. For measuring the voltage and current we connect the measuring elements in both input side and output side also. In load side also we connect the voltage measurement block.

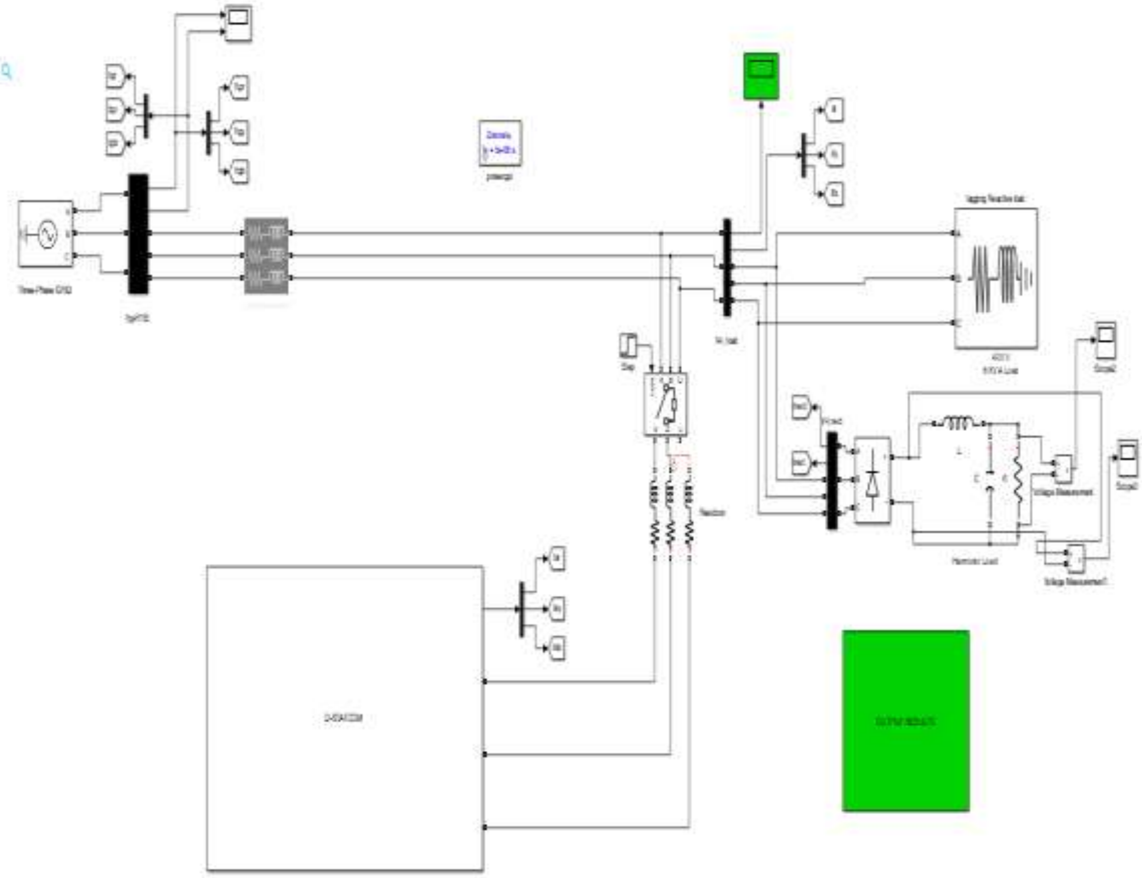

Fig 5: Simulation diagram for open loop

Fig.5 represents the open loop system there is no controller part for controlling the gate pulses. D-STATCOM connected in the distribution line along with the circuit breaker. Fig.6 shows the uncompensated output voltage and current waveform of the distribution system.

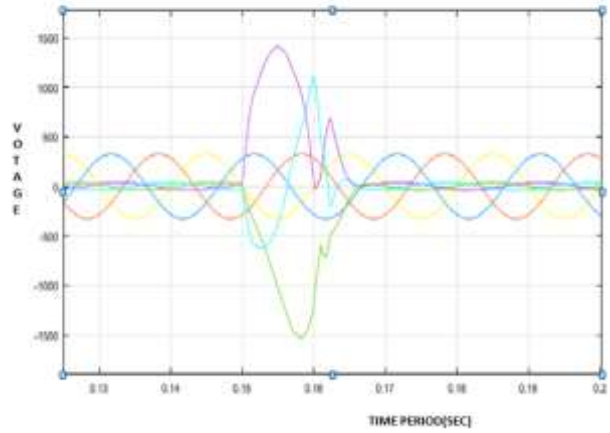

Fig 6: Voltage waveform without compensation

After implementation of the D-STATCOM Output voltage waveform can be seen in Scope 2.

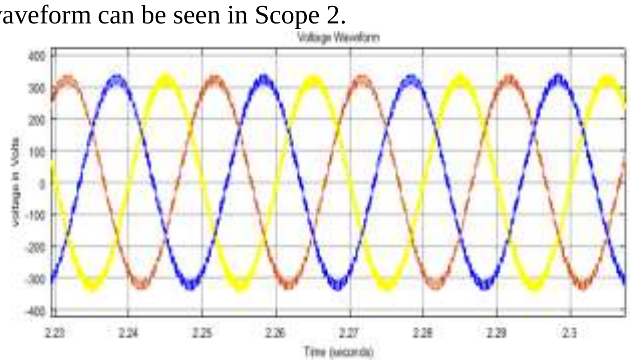

Fig 7: Voltage waveform with compensation

Fig.8 shows the rectifier output voltage waveform after D-STATCOM before implementing LC filter.

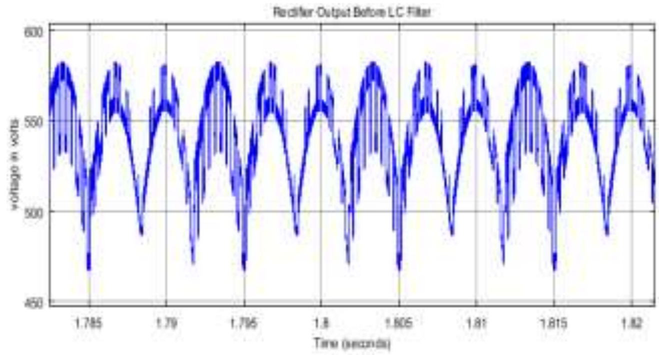

Fig 8: output voltage waveform before LC filter

Rectifier output waveform after implementing LC filter can be seen in Fig.9

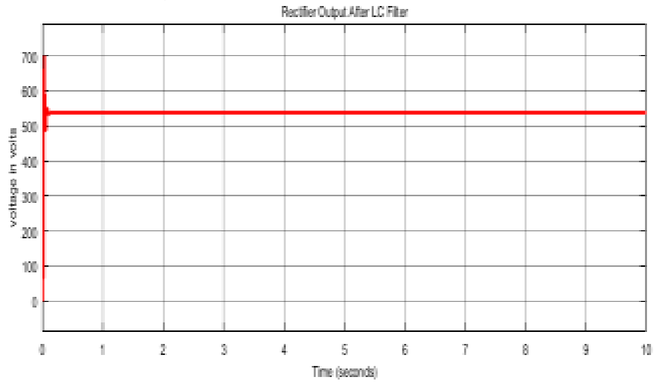

Fig 9: output voltage waveform after LC filter

After implementing the LC filter also there is some distortion in the waveform in the starting then only it is coming to the stable position. So, to overcome this distortion in the starting closed loop is implemented.

B. PROPOSED SYSTEM FOR CLOSED LOOP:

Here PI controller is connected with D-STATCOM to get the stable output voltage waveform.

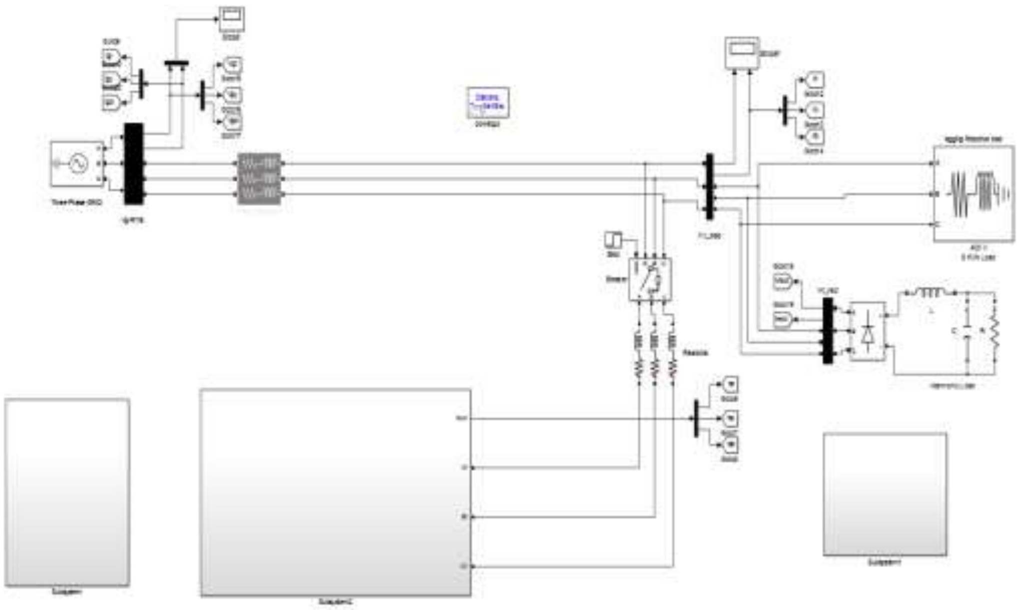

Fig 10: simulation diagram of closed loop

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Distribution network voltage waveform with disturbance is shown in fig 11.

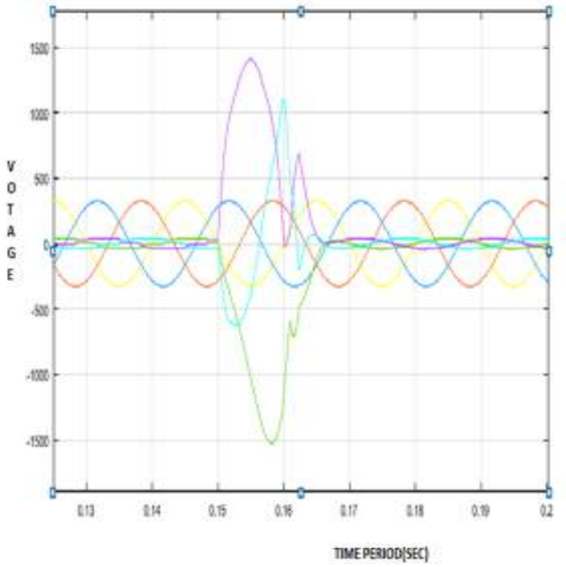

Fig11: voltage waveform before compensation

Compensated voltage and current waveforms with D-STATCOM is shown in fig 12

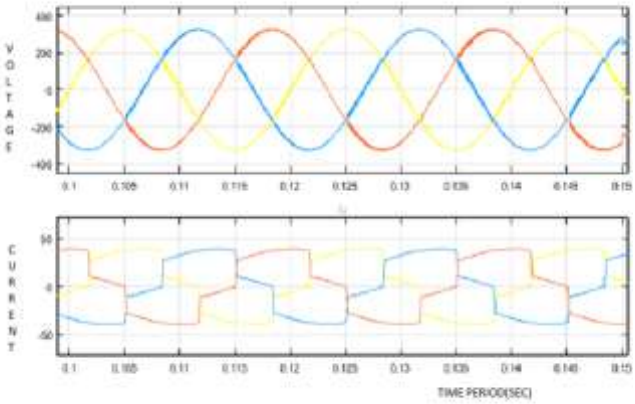

Fig 12: voltage and current waveforms after D-STATCOM

IV. HARDWARE DESCRIPTION & RESULTS

Fig 13: Hardware Circuit with Inductive Load

Fig 13 represents the hardware circuit with inductive load for implementation of DSTATCOM for maintaining the stable voltage at the distribution network. The Circuit consists of power supply unit, controller unit, Driver unit, Inverter Circuit and Inductive Load part. The experimental results are verified with CRO and Multimeter. The controller used here is pic microcontroller which is programmed to activate the DSTATCOM unit. The inverter circuit consists of IRF 840 MOSFET and the pulses to the MOSFETs are generated by using Sinusoidal Pulse Width Modulation technique. The Inductive load is used here which generates voltage sag that is compensated by the proposed system.

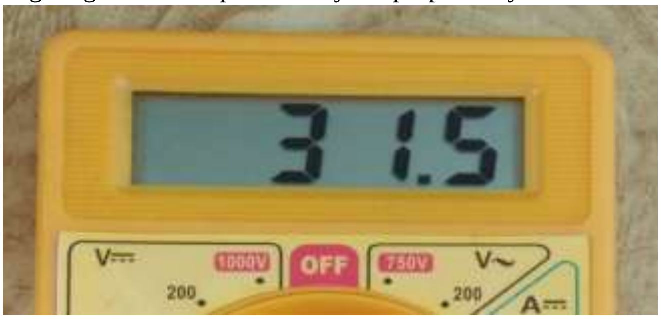

Fig 14: Output Voltage measured using Multimeter before compensation

Fig 14 shows the output voltage of the distribution system measured using a multimeter which shows the value as 31.5 V AC before compensation.

Fig 15: Output Voltage measured using Multimeter After compensation

Fig 15 shows the output voltage of the distribution system measured using a multimeter which shows the value as 43.8 V AC after compensation

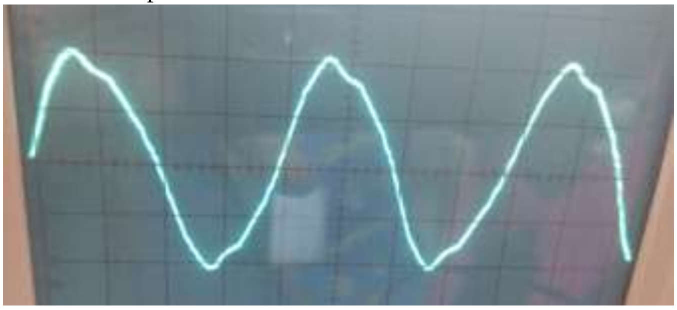

Fig 16: Voltage waveform of the proposed system before compensation

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Fig 16 represents the Voltage waveform of the proposed system before compensation. From the waveform we can analyze that the voltage of the distribution system gets distorted because of the voltage sag problem due to the application of inductive load.

Fig 17: Voltage waveform of the proposed system after compensation

Fig 17 represents the Voltage waveform of the proposed system after compensation. Thus the dip in voltage has been compensated by the dstatcom device utilized here.

V. CONCLUSION

In this proposed work D-STATCOM has been used as a compensating device for voltage fluctuations obtained during the application of inductive load in the distribution network.The D-STATCOM device has been tested by means of software and hardware.The matlab simulink software was used to obtained the simulation results.The simulation has carried out for both open loop and closed loop system.In closed loop PI controller was implemented. From the simultion results,we concluded that the closed loop system performed well when compared with the open loop system.Hardware implementation has been carried out for single phase system.The experimental results has verified by using both mulitimeter and CRO.Here,the hardware was implemented by considering the voltage sag parameter.From the above obtained results we can conclude that,D-STATCOM is a better compensating device for voltage fluctuation in distribution network when compared with SVC.So,that it can provide a quality power at the consumer's premises itself.

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