Neural Network Controller Based Dstatcom for Voltage Sag Mitigation and Power Quality Issue

Husham Idan Hussein
Dept. of Electrical Power & Machines Engineering,
College of Engineering, Diyala University
32001, Baqubah, Diyala , Iraq.
Hishamhussein40@gmail.com

Abstract- **In this paper review and describe one of the most important electric power systems problems, it's a voltage sag. When this phenomenon occurs, the impact on devices and equipment used in all types of domestic, commercial and industrial loads, which leads to malfunction, many of which will be a serious and very significant effects, particularly in industrialized loads being represent the backbone of life. This made as a major part of electric power quality provides the consumers. Power quality is one of the most important areas of generation, transmission and distribution systems of the power system. In this paper, design model of the electric power system which has been generating a voltage sag phenomenon has also been the study and analysis of the reasons for it. D.STATCOM device used to reduce and damp of this phenomenon, where it was used to prove that the device is perfect device for this purpose, its works as a compensator reactive power (VAR) to the system in case of any failure and the emergence of the phenomenon of voltage sag. Neural network method is used as a control on D.STATCOM and is proven as a good way to control. All simulation results obtained regarding the voltage sag as well as D.STATCOM device and also used to control method represented by neural network (NN), was studied, analysis, achieved and discussed.**

Keywords: Harmonics; Neural Network (NN); Power Disturbances; Power Quality; and Voltage Sag.

I. INTRODUCTION

The term power quality can be characterized as the level of variation of voltage, current and frequency. It is described as the pure sinusoidal waveform of declared voltage and frequency. The pure sinusoidal wave becomes ideal now as it can only be seen in books. As we know we cannot conveniently store electrical energy anywhere so it needs a continuous flow and hence cannot be put through quality guarantee checks before it is used. This creates problems in power quality known as power shortage. The advantage of DSTATCOM is that, it has a very sophisticated power electronics based control which can efficiently regulate the current injection into the distribution bus. The second benefit is that, it has multifarious applications [1]. Voltage sag is defined as a reduction to between 0.1 and 0.9 p.u. RMS voltages at the power frequency for durations of half-cycle to one minute as showed in Fig. 1[2].

The most common cause of voltage sags is the flow of fault current through the power system impedance to the fault location. Hence, power system faults in transmission or distribution networks can affect respectively a large or small number of customers. A fault in a transmission line affects sensitive equipment up to hundreds of kilometres away from the fault [3]. In both, transmission and distribution networks, voltage sags due to faults in parallel feeders, produce incorrect operation of industrial customer equipment [4].

FACTS devices are introduced to electrical system to improve the power quality of the electrical power. Use of these FACTS controllers to enable corresponding power to flow through such line under normal and contingency conditions there are different type of FACTS device DVR, STATCOM, DSTATCOM, UPQC, UPFC, SVC, SSG, TCR, TSC, TSR, SSSC and etc. the DSTATCOM was selected in this paper. The reactive power at the terminals of the STATCOM is dependent on the amplitude of the voltage source. And these STATCOM in the distribution system are called DSTACOM (Distribution-STACOM) [5].

The purpose of a voltage sag generator is used to test the immunity of equipment against the voltage sag. The magnitude and angle of three phase voltage sags can calculate from equation (1 – 7) as shown in Table I [6].

Fig.2 shows the Phaser Diagram for all types of voltage sag according to IEEE 1159-1995[8].

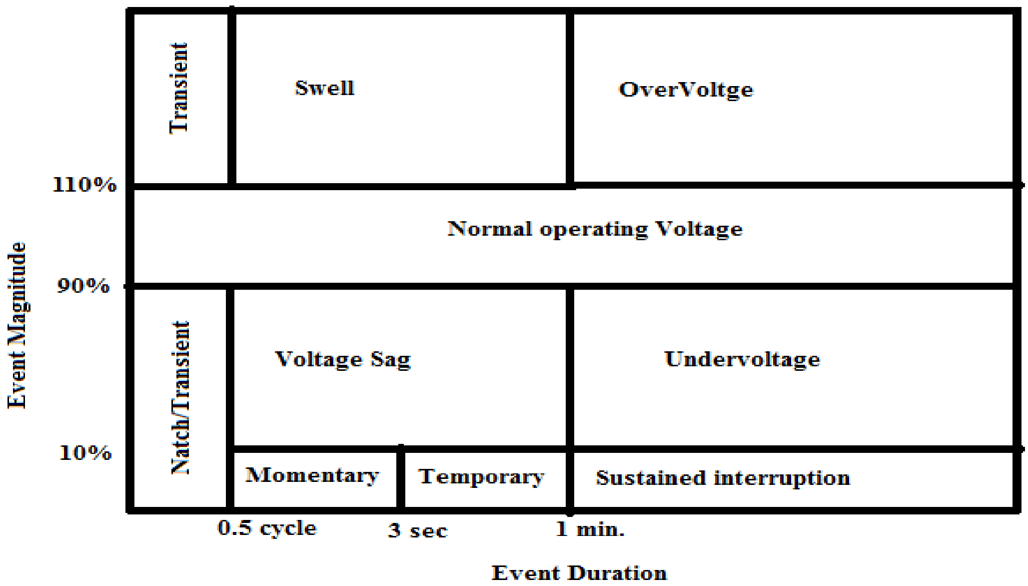

Fig. 1. Event definitions according to IEEE 1159-1995.[8].

TABLE I. Seven types of Voltage Sag and equations.

TAYPES	V_A	V_B	V_C
A	V	$-\frac{1}{2}v - j\frac{\sqrt{3}}{2}v$	$-\frac{1}{2}v + j\frac{\sqrt{3}}{2}v$
B	V	$-\frac{1}{2}v - j\frac{\sqrt{3}}{2}$	$-\frac{1}{2}v + j\frac{\sqrt{3}}{2}$
C	1	$-\frac{1}{2}v - j\frac{\sqrt{3}}{2}v$	$-\frac{1}{2}v + j\frac{\sqrt{3}}{2}v$
D	V	$-\frac{1}{2}v - j\frac{\sqrt{3}}{2}$	$-\frac{1}{2}v + j\frac{\sqrt{3}}{2}$
E	1	$-\frac{1}{2}v - j\frac{\sqrt{3}}{2}v$	$-\frac{1}{2}v + j\frac{\sqrt{3}}{2}v$
F	V	$-j\frac{\sqrt{3}}{3} - \frac{1}{2}v - \frac{\sqrt{3}}{6}v$	$-j\frac{\sqrt{3}}{3} - \frac{1}{2}v + \frac{\sqrt{3}}{6}v$
G	$\frac{2}{3} + \frac{1}{3}v$	$-\frac{1}{3} - \frac{1}{6}v - \frac{\sqrt{3}}{2}v$	$-\frac{1}{3} - \frac{1}{6}v - \frac{\sqrt{3}}{2}v$

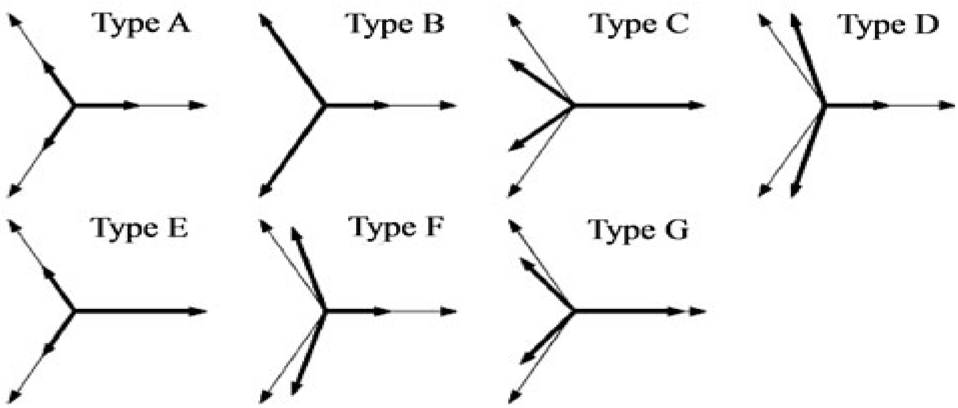

Fig.2. Phaser Diagram for all types of voltage sag according to IEEE 1159-1995[8].

Finally, this paper presents a study of a voltage sag and D-STATCOM (Distribution Static Compensator) used for mitigating voltage sags. The neural network Controller (NN) is the method of control. The performance of this work system is verified through simulations using MATLAB software with its Simulink.

II. POWER QUALITY

Power quality problems are increasing with the increasing demand on non linear loads. The recent equipments that are used in home and commercial may be damaged due to harmonics and also affected the poor power factor. The power quality problem is further due to the different faults conditions occurring on the power system network [7]. These conditions cause voltage sag or swell in the system and malfunctioning of devices which damage the sensitive loads. In this paper we will expose the voltage sag and mitigation with details and measured the response of the DSTATCOM as well.

III. VOLTAGE SAG

A Voltage sag as defined by IEEE Standard 1159-1995. IEEE Recommended Practice for Monitoring Electric Power Quality, is a decrease in RMS voltage at the power frequency for durations from 0.5 cycles to 1 minute, reported as the remaining voltage. The measurement of a Voltage Sag is stated as a percentage of the nominal voltage; it is a measurement of the remaining voltage and is stated as sag to a percentage value. Thus a Voltage Sag to 60% is equivalent to 60% of nominal voltage, or 288 volts for a nominal 480 volt systems as showed in Fig.3 [8].

Fig.3. Reduced voltage for a limited period [8].

IV. FACTORS THAT AFFECT VOLTAGE SAG TYPE

There are many factors that can affect and cause voltage sags such as [9].

- Fault types

  (SLG) Fault, (LL) Fault, (LLG) Fault, and (3Φ) Fault. All of these faults have different affects to the voltages.

- Transformer Winding Connection, It is three types:

  1. Wye Grounded-Wye grounded (Yg Yg). This type has no change in voltages.
  2. The Delta-delta (Dd), Delta-zigzag (Dz) and the Wye-wye (with both windings ungrounded or with only one star point grounded). This type removes the zero-sequence voltage.
  3. Delta-wye (Dy), Wye-delta (Yd) and the Wye-zigzag (Yz). This type changes line and phase voltages.

- Load Connection

  1. Wye-connected load.
  2. Delta-connected load.

V. METHODOLOGY

The applications of power electronics cause big problems such the harmonics and then make degree of waveform distorted increasingly. This harmonic will be effect on the cost of the power system and make the power factor poor. Therefore, we need to use a reliable and efficient solution to solve problems and this solution must be covering utilities and customers. In this paper, the methodology adopted for the solution of harmonics problem is as follows:

1- Voltage sag created and explanation has been carried out.

2. Power quality explanation has been performed.

3- Chose DSTATCOM as solution for voltage sag mitigation, power quality improvement, and for the reduction of harmonics caused by non linear loads.

4. DSTATCOM has been modeled employing comparative information using MATLAB/SIMULINK.

5. Comprehensive review on control techniques needs to be done to provide gating signals to the VSI of DSTATCOM.

6. A control theory named neural network Controller (NN) adopted as a controller for DSTATCOM.

7. Neural network Controller (NN) is modeled in the Matlab /SIMULINK environment and analyzed.

8. Application of DSTATCOM to power system model and the performance is discussed.

VI. DESIGN AND CONSIDERATIONS

A. Voltage Sages Model generating

The model consists of

- 11 KV 50 Hz three phase source blocks feeding through a 11KV/415 ,1 MVA delta/wye transformer to a 500KVA RL load.
- Fault block located at the source feeder line to simulate various types of line faults and a multistage fault block to simulate a multistage fault. This line fault model is capable of simulating various line faults including all types of faults Fig.4[10].

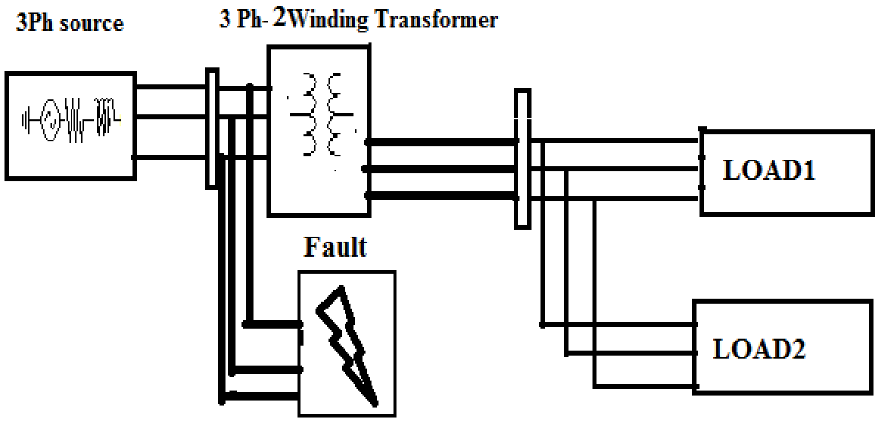

Fig. 4. General Diagram for the line fault model.

B. Dstatcom Operation and Constructions

The D-STATCOM is a three-phase and shunt connected power electronics based device. It is connected near the load with the distribution systems. The major components of a D-STATCOM are shown in Figure (5). It comprises of a dc capacitor, three-phase inverter (thyristor) module, ac filter, coupling transformer and a control strategy. The basic electronic block of the D-STATCOM is the voltage-source inverter that converts an input dc voltage into a three -phase output voltage at fundamental frequency. Voltage Source Converter (VSC) and a DC link capacitor connected in shunt, capable of generating and/or absorbing reactive power. Operating principles of a DSTATCOM are based on the exact equivalence of the conservative rotating synchronous compensator as showed in Fig.5.

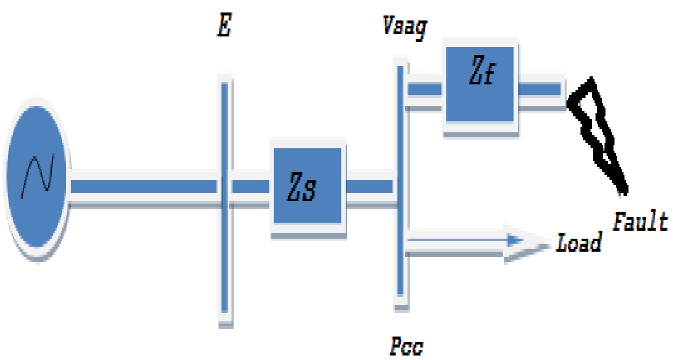

Fig.5. Voltage divider for sag magnitude calculation.

$$Vsag = \frac{Zf}{Zs+Zf} E \qquad (1)$$

Where

Zf: feeder impedance (pcc &point of fault)

Zs: source impedance(source &Pcc)

E: source voltage.

C. Dstatcom Calculations And Considerations

- ❖ 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:

$I_{sh} = I_L - I_s$ (2)

$IL - Is = IL - \left(\frac{(Vth - VL)}{Zth}\right)$ (3)

$Ish\angle\eta = IL\angle - \theta - \frac{Vth}{Zth}(\delta - \beta) + \frac{Vth}{Zth}\angle - \beta$ (4) (4)

The complex power injected of the DSTATCOM can be expressed as

$S_{sh} = V_L\ I_{sh}^*$ (5)

Where

I_L: load current, I_s= source current, V_{th} thevenin voltage V_L= load current, Zt=impedance(Z_{th}= R+jx).

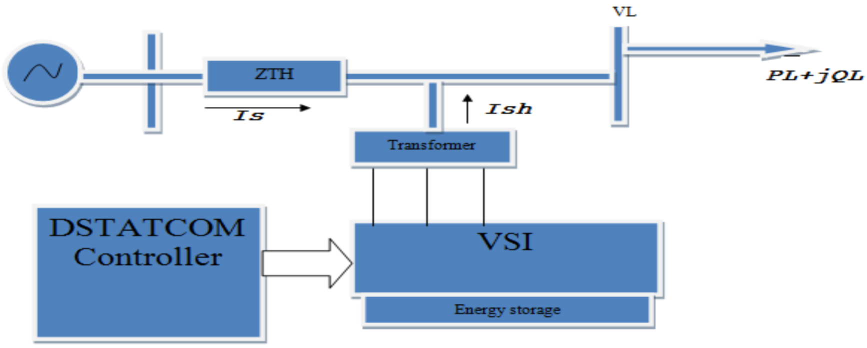

Fig.6. Basic circuit diagram of D.STATCOM.

The effectiveness of the D-STATCOM in correcting voltage sag depends on the value of Z_{th} or fault level of the load bus. When the shunt injected current I_{sh} is kept in quadrature with V_L, the desired voltage correction can be achieved without injecting any active power into the system when the value of I_{sh} is minimized.

A Fig.6 shows D-STATCOM connection is based on an input current I_S is equal to the sum of I_C and I_L and a simple two-level VSC which is controlled by using Neural Network to generate conventional sinusoidal pulse width modulation (PWM) [7].

D. Control Algorithm

Neural network Controller (NN): Fig.7 shows the diagram of Neural Network controller, it is employed in this control system, and it is consists of three neuron layers, the input, the hidden and the output layer. The Neural Network controller has three inputs (Va, Vb, Vc) and three outputs (Va*, Vb*, Vc *). The output of NN passes through a comparator and is compared with a carrier signal before applying as reference variable to the PWM pulse generator. The NN is formed by varying the weights Wij and the biases Bj. The training criterion is taken as the mean square error of the Neural Network output with a value of 0.0001 and the error function is determined by the following Equation (6).

$$\boldsymbol{J} = \sum_{i=1}^{N} \boldsymbol{e}(\boldsymbol{i})^2 \quad (6)$$

Where, N is the number of output neurons and e(i) is the instantaneous error between the actual and estimated values of the output.

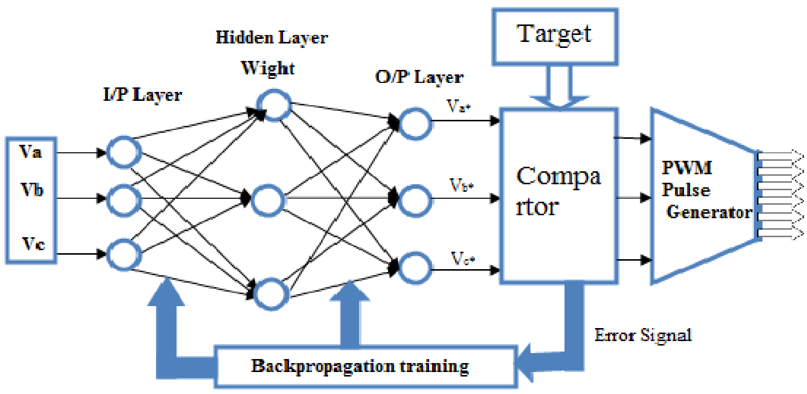

Fig.7. Neural Network controllers.

The training is completed when the value of j is less than 0.0001 [11].

The neuron has a bias , which is summed with the weighted inputs to form the net input :

$n = w1{,}1p1 + w1{,}2p2 + \cdots + w1, RpR$ (7)

This expression can be written in matrix form:

$n = Wp + b$ (8)

Where the matrix for the single neuron case has only one row.

Now the neuron output can be written as:

$a = f(Wp + b)$ (9)

Commonly one neuron, even with many inputs, is not enough. We might need four, five or…. Ten, operating in parallel, that is called a layer. A single-layer network of neurons is illustrated in Fig.7a.

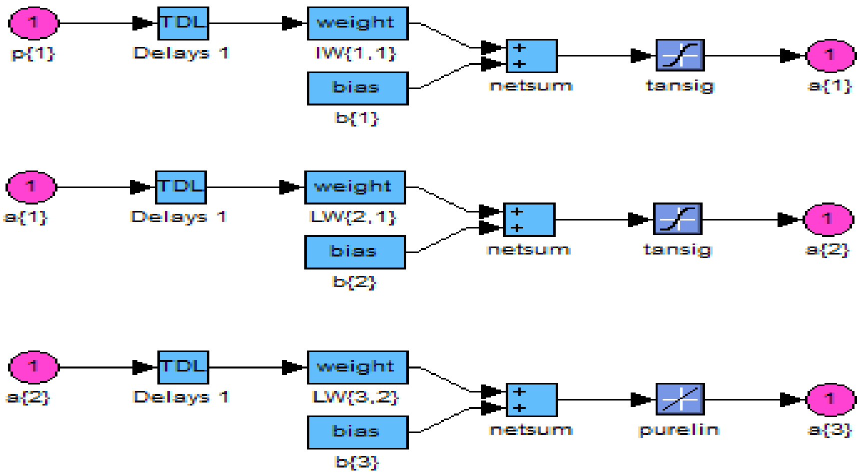

Fig.7a. Neuron in matrix form at each layer

Note that each of the inputs is connected to each of the neurons and that the weight matrix now has rows. The layer includes the weight matrix, the summers, the bias vector, the transfer function boxes and the output vector as showed in Fig.7b.

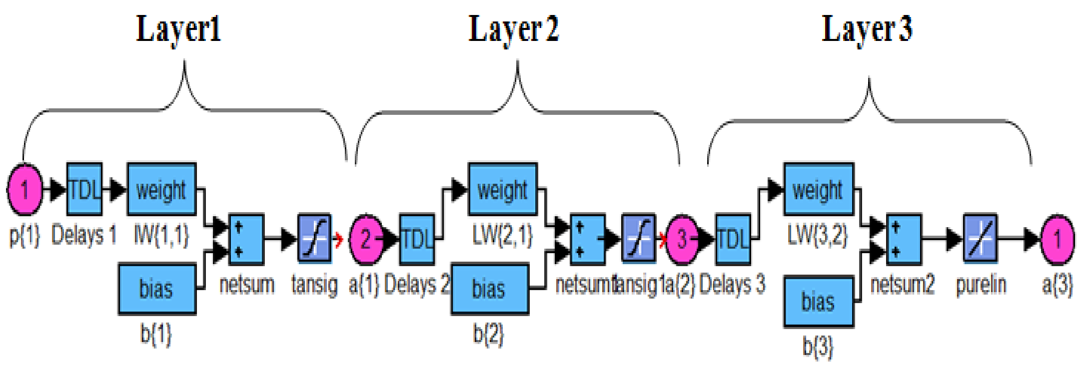

Fig. 7b. Three-Layer Network

NN controller based D-STATCOM is modeled and simulated by using MATLAB/Simulink. The learning process of NN is prepared in MATLAB, aided by the neural network toolbox. At an initial stage non critical load is related to the distribution network system. During that time rated voltage is available across load 1 i.e., no voltage sag. When the critical load is connected to the distribution network system, the system voltage drops to 50% of its nominal value. The voltage sag occurs. To mitigate the voltage sag the required voltage is injected by the neural network controller based on DSTATCOM.

VII.SIMULATION RESULTS

A. *Created All Types Of Voltage Sag*

By changing the fault type in the fault block, Transformer connection and load connection we can obtain different types of sag for different conditions of these factors. On the Table II, explanation for all types of voltage sag take in account the transformer connection and load connection [12].

TABLE II. Summarizes of voltage sag types.

Voltage sag type	Fault type	Transformer type			Load connection	
		1	2	3	Wye	Delta
A	Three phase	Not depend			Not depend	
B	Line- Ground	√			√	
C	Line-Ground	√				√
			√			√
				√	√	
	Line-Line	√			√	
			√		√	
				√		√
D	Line-Ground		√		√	
				√		√
	Line-Line	√				√
			√			√
				√	√	
E	Line-Line-Ground	√			√	
F	Line-Line-Ground	√				√
				√	√	
G	Line-Line-Ground		√		√	
				√		√

1. Case1 Sag A

There is equal drop in phases A,B & C and the phase displacement between the phases are 120º due to symmetrical fault. As shown in Fig.8.

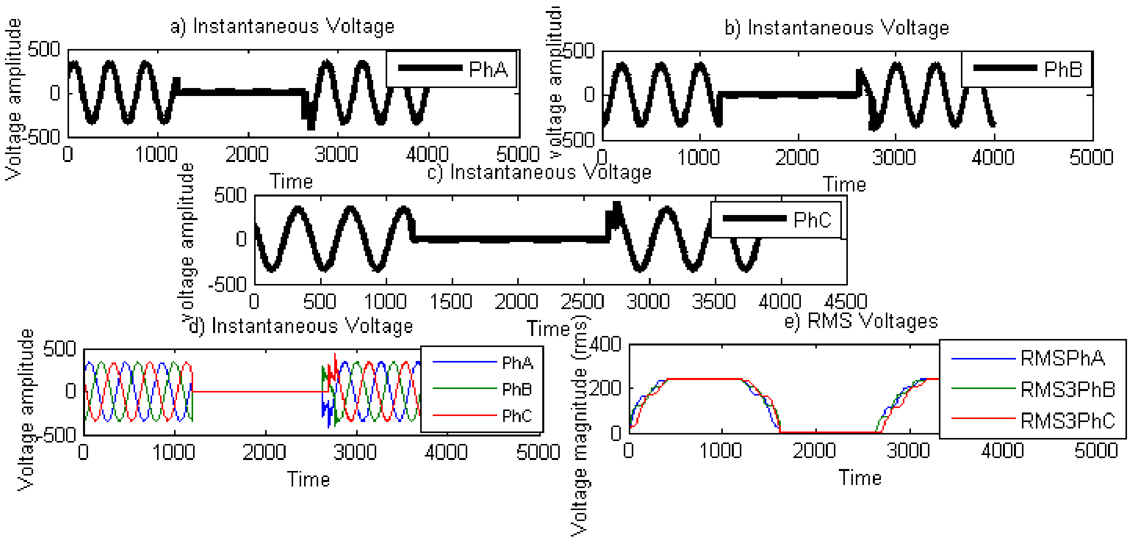

Fig. 8. a) Phase to ground Voltage waveform of phase A (b) Phase to ground Voltage waveform of phase B (c) Phase to ground Voltage waveform of phase C, d) Phase to ground Voltage waveform of all the three phases A,B & C ,d) Voltage (rms) waveform.

2 Case2: Sag B

There is no drop in phase C and B, drop in Phase A only and the phase displacement is 120 º. As shown in Fig.9.

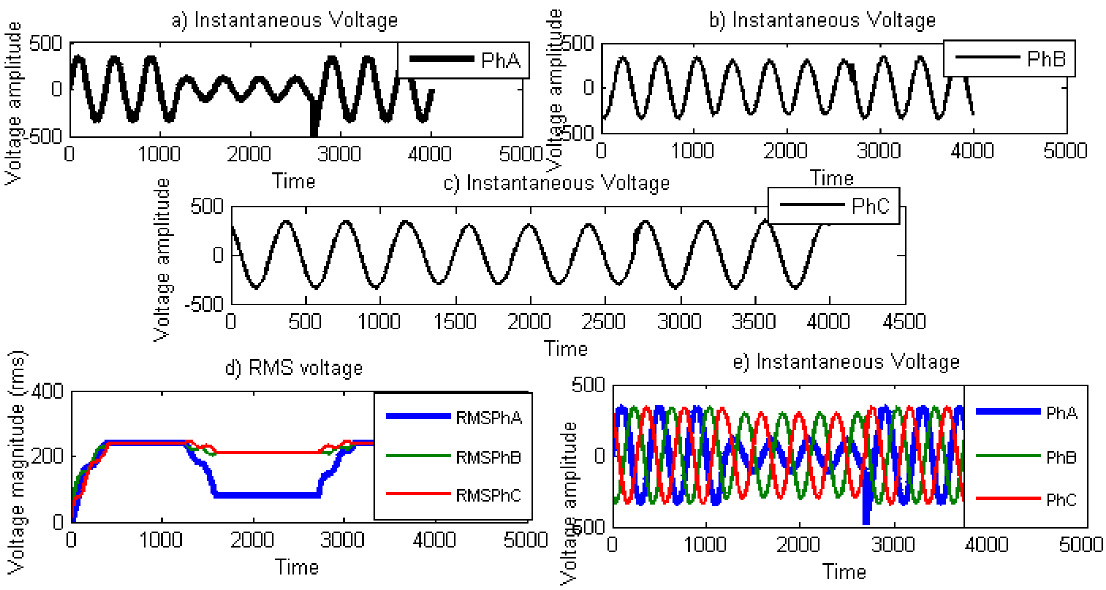

Fig. 9. a)Phase to ground Voltage waveform of phase A (b) Phase to ground Voltage waveform of phase B (c) Phase to ground Voltage waveform of phase C, d) Voltage (rms) waveform ,e) Phase to ground Voltage waveform of all the three phases A,B & C.

3 *Case3: Sag C*

There is no drop in phase A and drop in Phases B & C and the phase displacement is no longer 120 º due to unsymmetrical fault. As shown in Fig.10.

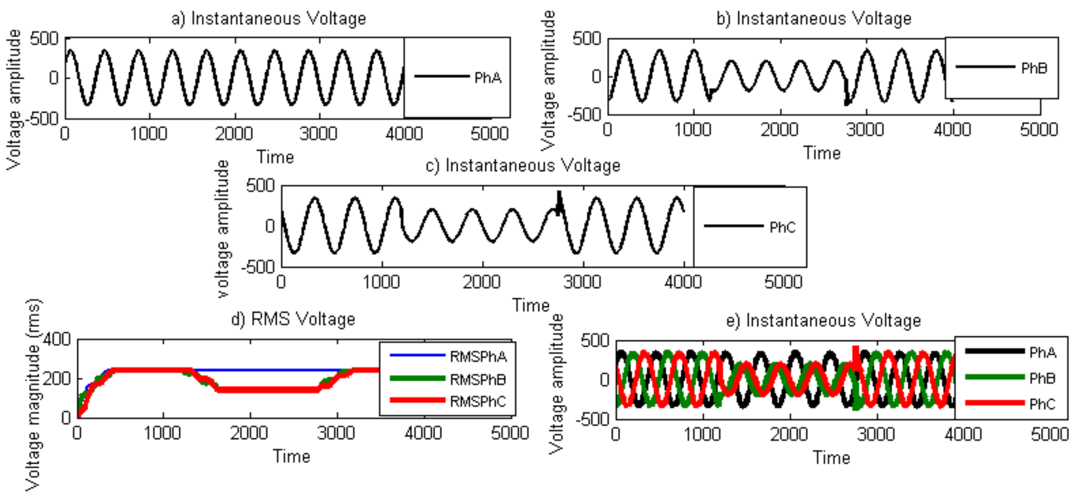

Fig.10. a) Phase to ground Voltage waveform of phase A (b) Phase to ground Voltage waveform of phase B (c) Phase to ground Voltage waveform of phase C, d) Voltage (rms) waveform ,e) Phase to ground Voltage waveform of all the three phases A,B & C.

4 *Case4: Sag D*

There is more drop in phase B than Phases A & C and the phase displacement is no longer 120 º due to unsymmetrical fault. As shown in Fig.11.

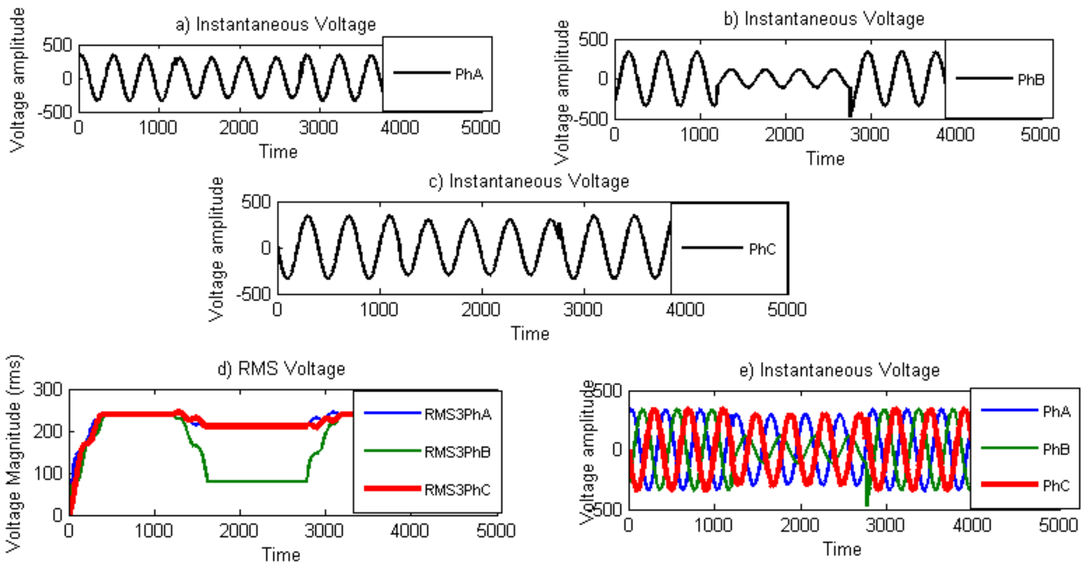

Fig.11. a) Phase to ground Voltage waveform of phase A (b) Phase to ground Voltage waveform of phase B (c) Phase to ground Voltage waveform of phase C, d) Voltage (rms) waveform ,e) Phase to ground Voltage waveform of all the three phases A,B & C.

5 *Case5: Sag E*

where there is drop in phase A and no drop in phase B and the phase displacement is 120 º. As shown in Fig.12.

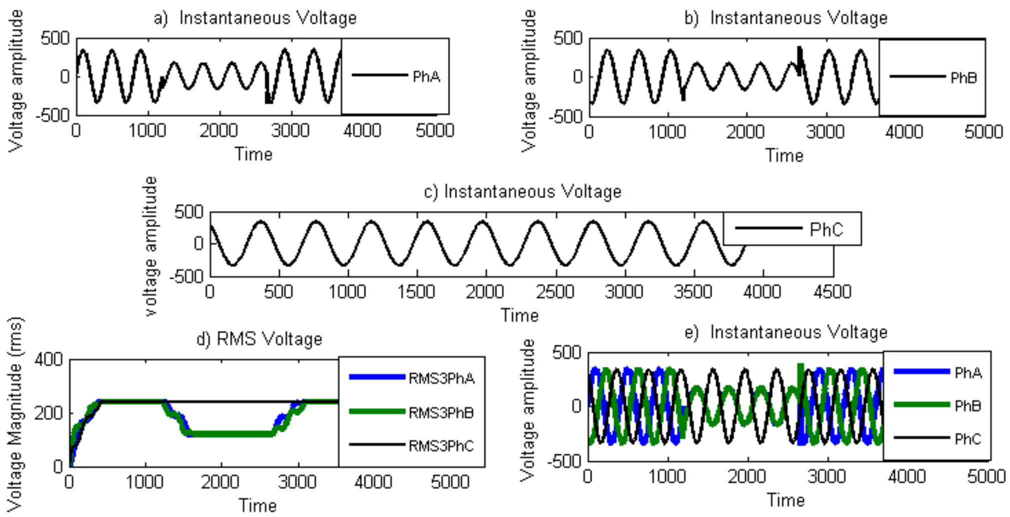

Fig. 12. a) Phase to ground Voltage waveform of phase A (b) Phase to ground Voltage waveform of phase B (c) Phase to ground Voltage waveform of phase C, d) Voltage (rms) waveform ,e) Phase to ground Voltage waveform of all the three phases A,B & C.

6 *Case6: Sag F*

There is greater drop in phases non-faulted phase B as compared to faulted phases A & C and the phase displacement between the phases are not 120º due to unsymmetrical fault. As shown in Fig.13.

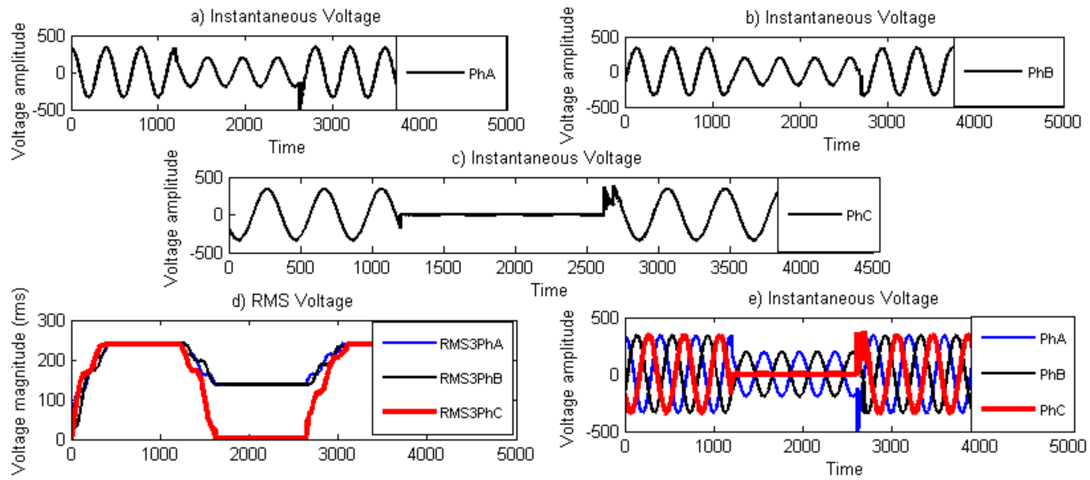

Fig. 13. a)Phase to ground Voltage waveform of phase A (b) Phase to ground Voltage waveform of phase B (c) Phase to ground Voltage waveform of phase C, d) Voltage (rms) waveform ,e) Phase to ground Voltage waveform of all the three phases A,B & C.

7 *Case7: Sag G*

There is greater drop in phases non-faulted phase B as compared to faulted phases A & C and the phase displacement between the phases are not 120º due to unsymmetrical fault. As shown in Fig.14.

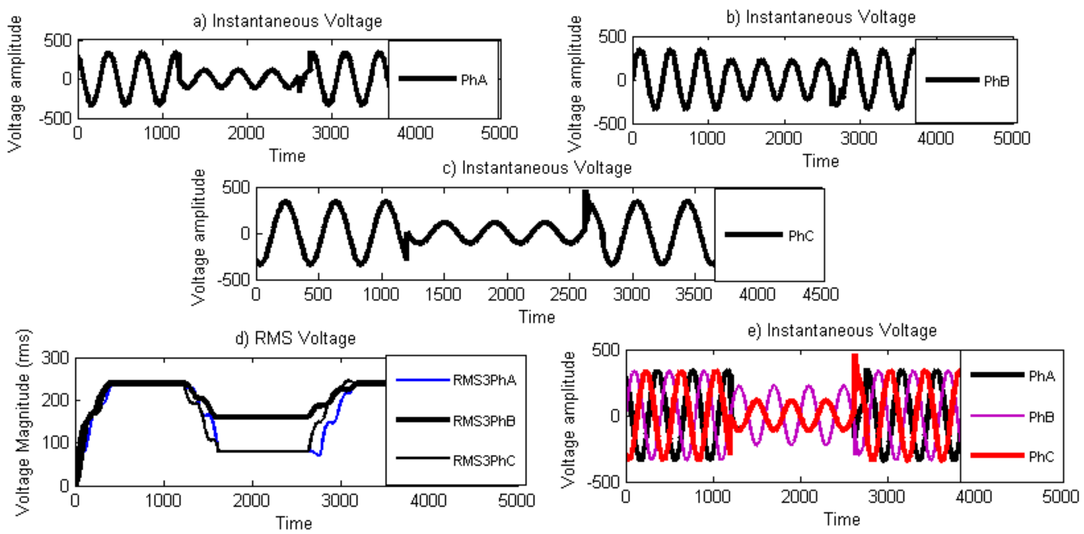

Fig. 14. a) Phase to ground Voltage waveform of phase A (b) Phase to ground Voltage waveform of phase B (c) Phase to ground Voltage waveform of phase C, d) Voltage (rms) waveform ,e) Phase to ground Voltage waveform of all the three phases A,B & C.

B. WITH AND WITHOUT DSTATCOM

In this paper a model built to generate sag on load, injecting harmonics in the system and reducing the voltage steady state for the enhancement of power quality in the distribution system a DSTATCOM connected to the system in parallel. DSTATCOM property is to compensate the reactive power of the system

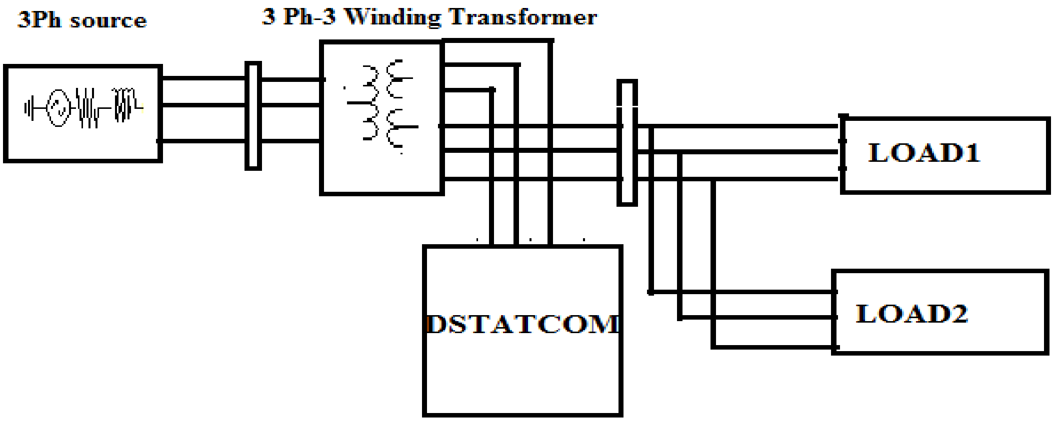

Fig.15. line fault model with D.STATCOM.

As showed in Fig.15 three phase sources are fed to the primary side of a 3-winding transformer. Further it distributed into two parallel feeders, at each terminal load connected having different resistance value. A DSTATCOM is connected to the system and it connected to the tertiary winding of the transformer also to support instantaneously. After DSTATCOM connection to system it will supply (Q) and by compensating reactive power it will mitigate the voltage sag. The FFT analysis of voltage sag befor and after componsitor during voltage sag ,as showed in Fig.19 and Fig.21. Fig.16 shows the Simulation of the current on the load (three-phase fault) , voltages on the load (three-phase fault) Fig.17 shows the RMS voltage on the load (three-phase fault) Fig.18 shows the VSI GATES PULSES two switches works at time ,S1S4 , S3S6 and S5S2. Fig.20 shows the RMS voltage on the load (three-phase fault) after compensating (during sag mitigation). Fig.21. shows the THD after compensating (during sag mitigation).

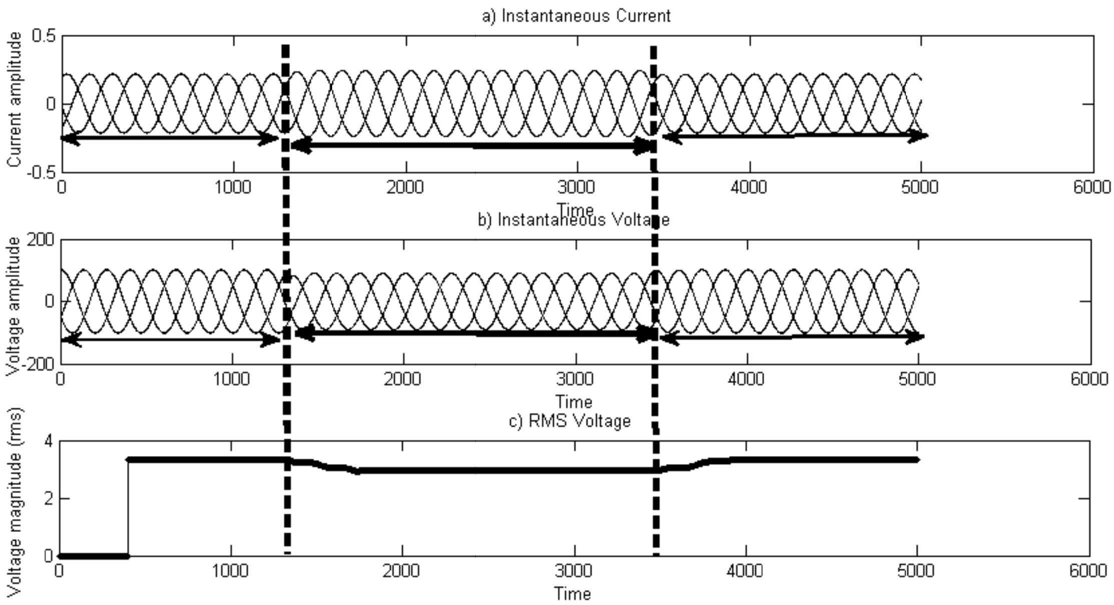

Fig. 16. Simulation of a) current on the load (three-phase fault) b) voltages on the load (three-phase fault) c)RMS voltage.

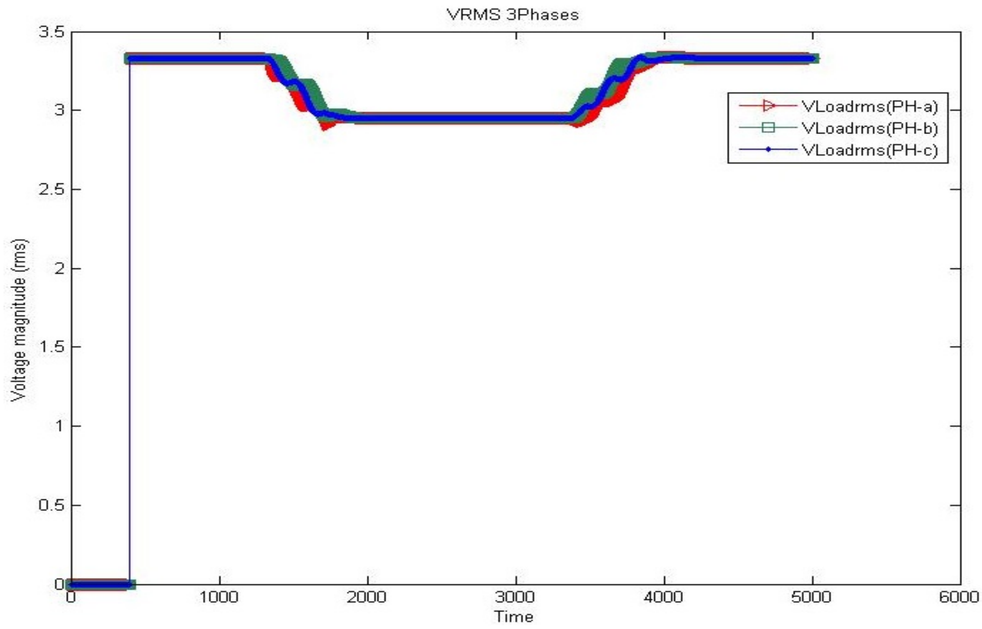

Fig.17. RMS voltage on the load (three-phase fault)

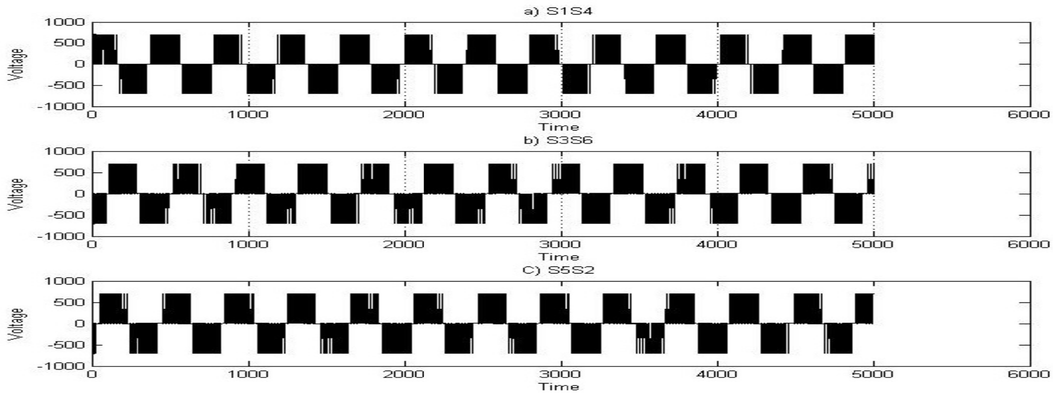

Fig.18. VSI GATES PULSES a) S1S4 b) S3S6 and c)S5S2.

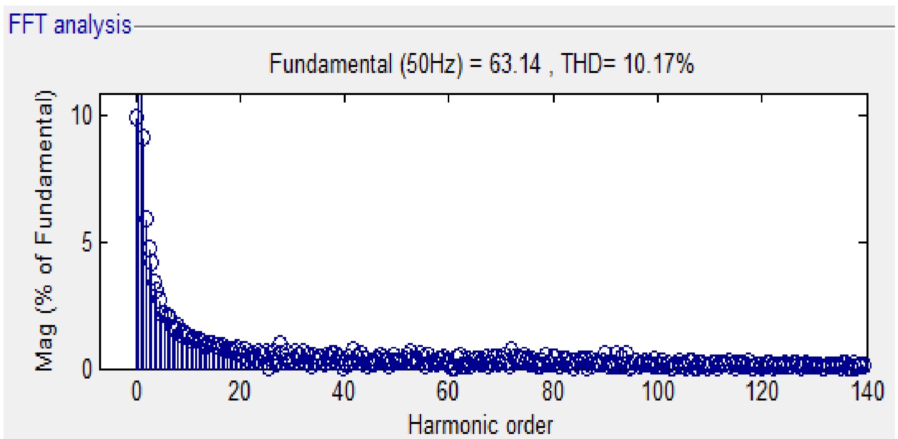

Fig. 19. THD before compensating (during sag).

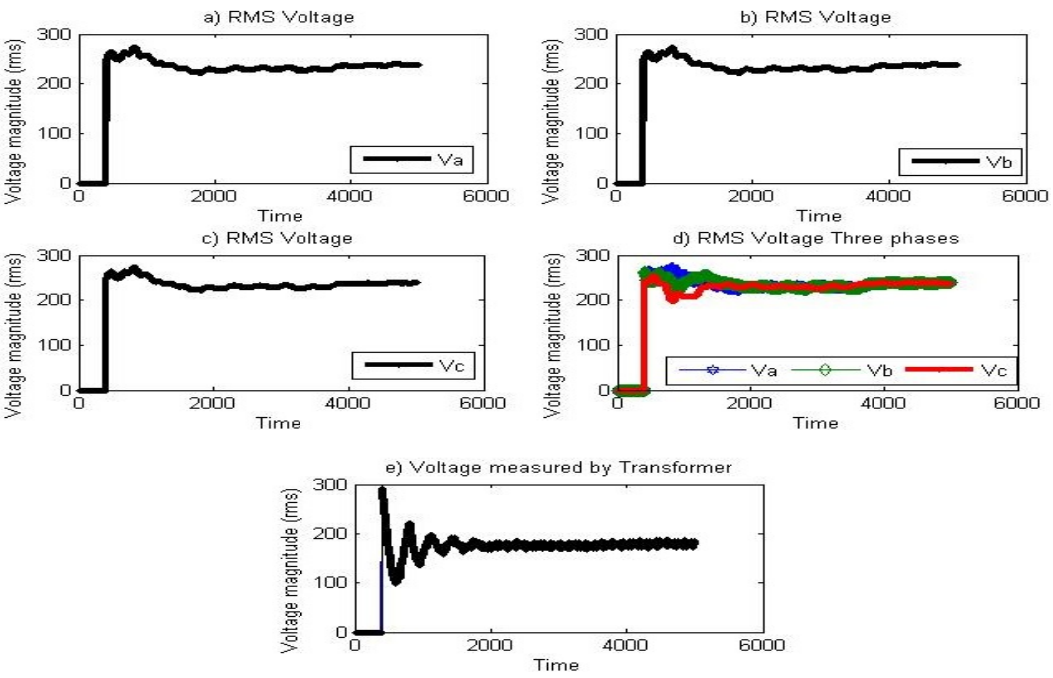

Fig.20. RMS voltage on the load (three-phase fault) after compensating (during sag mitigation).

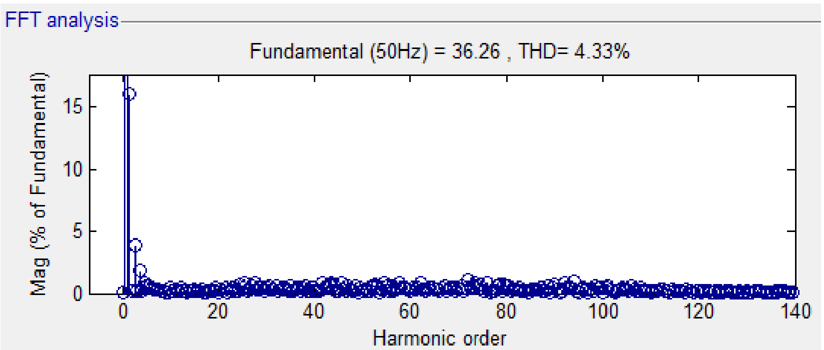

Fig.21. THD after compensating (during sag mitigation).

C. *Dstatcom Performances With Nonlinear Loads*

Fig.22 shows the General block diagram of DSTATCOM with nonlinear loads the DC bus capacitance 3000µ F, Rs= 0.1 Ω and inductance of 0.8 mH. Load resistance and inductance are chosen as 30 mH and 60 Ω respectively.

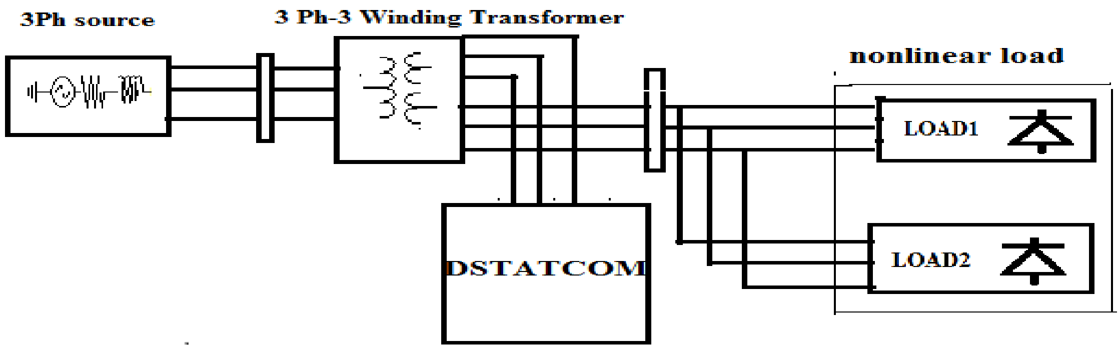

Fig.22. General block diagram of DSTATCOM with nonlinear loads

In this case a 3Φ. to ground fault is considered for both the feeders and the Rf is 0.001Ω and the resistance to ground is 0.001 ohm. in Fig.23 shown the RMS for each phase and to three phases during fault (during sag) and voltage and current load without compensation , as well the THD value before compensation was 2,54%.as shown in Fig. 23.

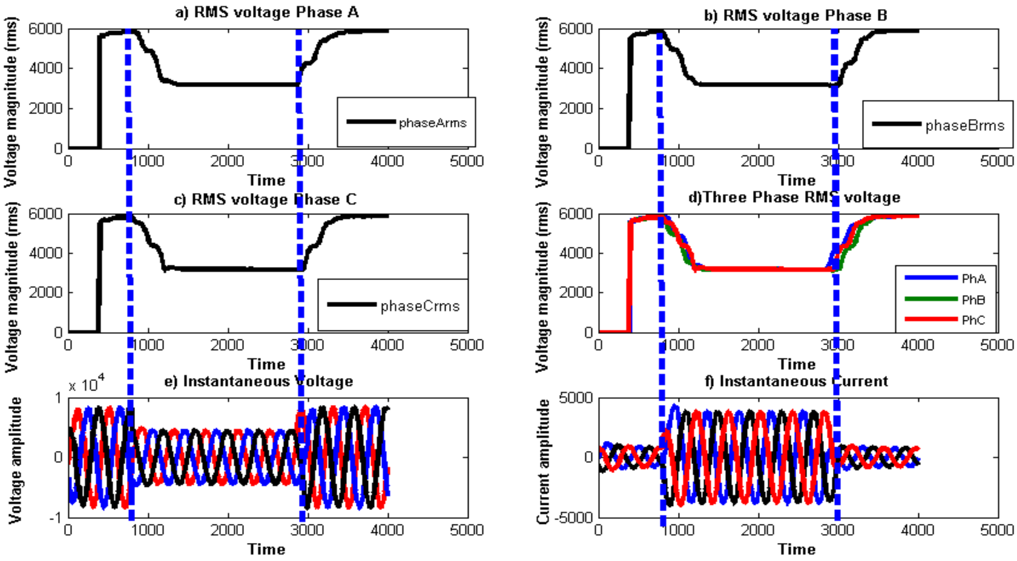

Fig. 23. a-d) Voltage (rms) waveform for each phase and three phase ,e) 3Φ Voltage waveform during sag, f) 3Φ Voltage waveform during sag .

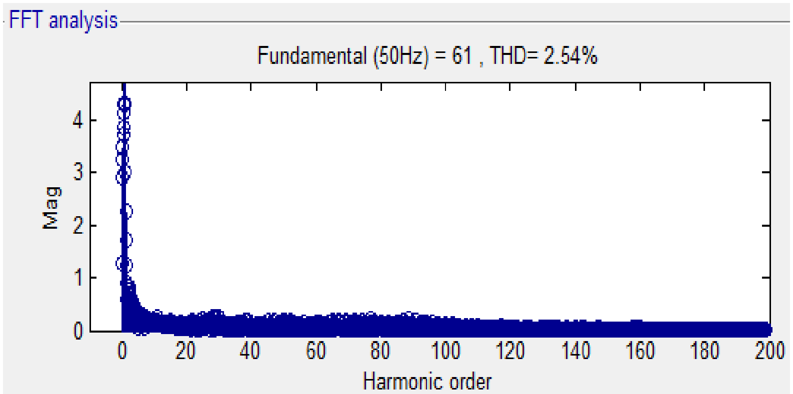

Fig. 24. THD value before compensation

After connected the DSTATCON to model system in Fig.22 will be injected Reactive power and it is clear from the output wave forms that the current in the phase where fault is created is increasing during the fault duration in the uncompensated feeder, that is why here the unbalancing in the system . However, these results become clear from the total harmonic distortion graphs. according to this figure in balanced voltage sag the injected current is balanced and in unbalanced voltage sag the injected current is unbalanced as expected. In this case the voltage decrease in one phase is higher than others. The injected current amplitude for one phase is larger than other two phases taken one by one for compensated and non compensated feeders with non linear loads. , as well the THD value after compensation was 1.93%. As showed Fig.25.

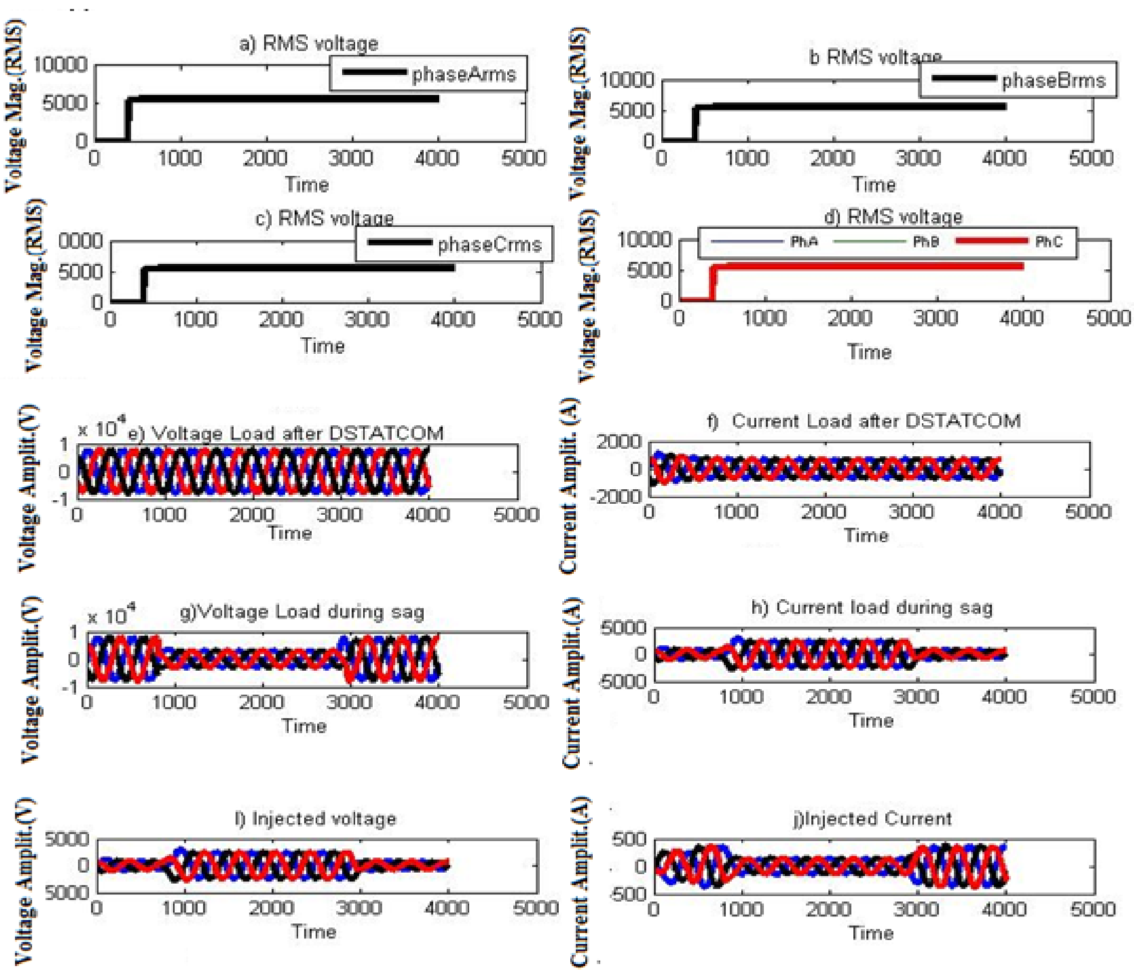

Fig.25. a-d) Voltage (rms) waveform for each phase and three phase during sag mitigation, e &f) Voltage and current load after DSTATCOM , g &h) Voltage and current load during sag, i& j) injected Voltage and injected current.

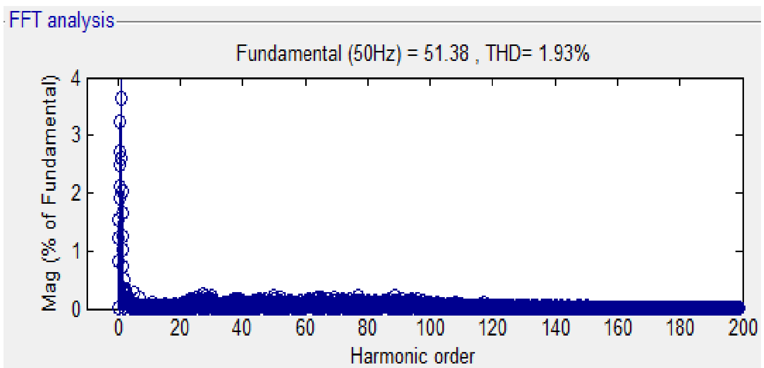

Fig. 26. THD value after compensation.

VIII. CONCLUSION.

In this paper, model of transmission lines power system network for sag generation, and other specific tools for power quality analysis was developed and implemented in Simulink as a part of the power system tool. The types of all voltage sags are produced with precise details and all the factors that affect it is analysis and explained, and the voltage sags can be mitigated by inserting D STATCOM to the feeder distribution system. The DSTATCOM investigation is conducted to improve the power quality in distribution networks with non linear loads of harmonics eliminated on the source side which is caused due to non linear load. NN controller based D STATCOM used and simulated in MATLAB-SIMULINK environment. Three multilayer neural networks are used to identify and regulate the voltage across the sensitive load. The performance analysis which covers the voltage sag effects and controls away on related waveforms of output voltage, and current is discussed and achieved.

REFERENCES

[1] M. Hojabri. A. Toudeshki, Power Quality Consideration for Off-Grid Renewable Energy Systems . Elsevier, Energy and Power Engineering Volume: 05,NO.05, Pages: 377-383. 2013.

[2] L. Gidwani,. H. Tiwari,. R.C. Bansal, Improving power quality of wind energy conversion system with unconventional power electronic interface. Elsevier, International Journal of Electrical Power and Energy Systems, Volume: 44 ,NO. 1..pp. 445-453. 2013. DOI: 10.1109/ICEPE.2012.6463609.

[3] IEEE Standards Coordinating Committee 22 on Power Quality. IEEE Std 1346. IEEE Recommended Practice for Evaluating Electric Power System Compatibility With Electronic Process Equipment. 1998. DOI: 10.1109/IEEESTD.1998.87816.

[4] R. Dugan, Electrical Power Systems Quality, 2nd ed. McGraw-Hill, , pp.43–110. 2004.

[5] Bollen MHJ. 2000." Understanding Power quality problems voltage sags and interruption". IEEE Press. 193 – 196.

[6] S . Bhavsar, VA .Shah, V. Gupta. Voltage dips and short interruption immunity test generator as per IEC 61000-4-11. in Proc. of 15th National Power Systems Conference. Bombay, India, 2008.

[7] Ch. Siva Koti Reddy, .Linga Reddy. A DSTATCOM-Control Scheme for Power Quality Improvement of Grid Connected Wind Energy System for Balanced and Unbalanced Non linear Loads. International Journal of Modern Engineering Research (IJMER) Vol.2, NO..3, May-June pp-661-666. 2012.

[8] IEEE Standard Board, IEEE Std. 1159-1995, IEEE Recommended Practice for Monitoring Electric Power Quality, IEEE Inc. New York, 1995.

[9] Svec, J. Muller, Z. Kasembe, A. Tlusty, J. Valouch, V. Hybrid power filter for advanced power quality in industrial systems. Elsevier, Electric Power Systems Research. Volume: 103. PP. 157-167. 2013.

[10] H . Rodney G. Tan and V.K. Ramachandaramurthy, Simulation of Power Quality Events Using Simulink Model. PEOCO2013, June 2013.

[11] S. Mohaghegi,., Y.D. Valle, G.K. Venayagamoorthy and R.G. Harley. A comparison of PSO and Back propagation for training RBF neural networks for identification of a power system with STATCOM. Proceedings of the IEEE Swarm Intelligence Symposium, Swarm Intelligence Symposium, Jun. 8-10.. pp: 381 384. 2005

[12] K. R. Padiyar, FACTS Controllers in Transmission & Distribution. New Delhi, India: New Age Int., 2007.

AUTHOR PROFILE

Husham I. Hussein was born in Baghdad, Iraq, in 1978.received his B.Sc from University Technology / Iraq in 2002, M.Sc from University Technology of Malaysia (UTM) in 2012. He is currently work in the Department of Electrical Power and machines Engineering, College of Engineering, University of Diyala/ Iraq. Professional Strength and Skills: His current research interests are optimization power system, power quality, power electronics, and Renewable Energy. He has good experience in practice of Electrical engineering in different fields such as installation of industrial plants and other electrical design and executing works. He is teaching several basic subjects of the Electrical Engineering, University of Diyala Iraq.