Elimination of Power Quality Issues In Grid By Fuzzy Based Dynamic Voltage Restorer (DVR)

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Abstract-*This paper focuses on power quality problem is an occurrence manifested as a non standard voltage, current, or frequency .One of the major problem deal here is the voltage sag, swell, flicker. To solve this problem, custom power devices are used. One of those devices is the Dynamic Voltage Restorer (DVR), which is the most effective modern custom power device used in power distribution networks. Commonly, sensitive loads are electronic-based devices which generate harmonics. Typical DVR works in standby mode when no fault occurs. However, some disadvantage of this P, PI, PID controller is its inability to still working well under a wider range of operating conditions. So, as a solution fuzzy controller is proposed. The compensation capability of a DVR depends primarily on the maximum voltage injection ability and the amount of stored energy available within the restorer. This device is connected in series with the distribution feeder at medium voltage. Its appeal includes lower cost, smaller size, and its fast dynamic response to the disturbances. It is a power electronic device to protect sensitive loads.*

Keywords-DVR, Fuzzy logic control, Power quality Voltage sag, Voltage swell.

I. INTRODUCTION

The power quality has serious economic implications for customers, utilities and electrical equipment manufacturers. Modernization and automation of industry involves increasing use of computers, microprocessors and power electronic systems such as adjustable speed drives .The power electronic systems also contribute to power quality problem (generated harmonics). The electronic devices are very sensitive to disturbances and become less tolerant to power quality problems such as voltage sags, swells and harmonics. Custom power devices are mainly of three categories such as series-connected compensators known as dynamic voltage restorers (DVRs), shunt-connected compensators such as distribution static compensators, and a combination of series and shunt-connected compensators known as unified power quality conditioner. The DVR can regulate the load voltage from the problems such as sag, swell, and harmonics in the supply voltages. Hence, it can protect the critical consumer loads from tripping and consequent losses .

Voltage sags in an electrical grid are not always possible to avoid because of the finite clearing time of the faults that cause the voltage sags and the propagation of sags from the transmission and distribution systems to the low- voltage loads. Voltage sags are the common reasons for interruption in production plants and for end-user equipment malfunctions in general. In particular, tripping of equipment in a production line can cause production interruption and this problem is to make the equipment itself more tolerant to sags, either by intelligent control or by storing “ride- through” energy in the equipment. An alternative solution, instead of modifying each component in a plant to be tolerant against voltage sags, is to install a plant wide uninterruptible power supply system for longer power interruptions or a DVR on the incoming supply to mitigate voltage sags for shorter periods . DVRs can eliminate most of the sags and minimize the risk of load tripping for very deep sags, but their main drawbacks are their standby losses, the equipment cost, and also the protection scheme required for downstream short circuits.

Voltage sag and swell can cause sensitive equipment to fail, shutdown and create a large current unbalance. These effects can incur a lot of expensive from the customer and cause equipment damage. The voltage dip magnitude is ranged from 10% to 90% of nominal voltage and with duration from half a cycle to 1 min and swell is defined as an increase in rms voltage or current at the power frequency for durations from 0.5 cycles to 1 min. Typical magnitudes are between 1.1 and 1.8 p.u. There are many different methods to mitigate voltage sags and swells, but the use of a custom power device is considered to be the most efficient method, There are different types of Custom Power devices used in electrical network to improve power quality problems. Each of the devices has its own benefits and limitations. The dynamic voltage restorer is a custom power device for series connection into a distribution line. When connected in series between a source and a load, the DVR can control

the voltage applied to the load by injecting a voltage of arbitrary amplitude, phase and harmonic content into the line.

II. DYNAMICVOLTAGERESTORER(DVR)

Dynamic Voltage Restorer (DVR) is a series connected device capable of regulating the load side voltage in a distribution network. The DVR provides a three phase independently controlled voltage source utilizing power electronic components, whose voltage vector (magnitude and angle) is added to the source voltage to restore the load voltage to a prescribed level . The main function of DVR is the protection of sensitive loads from voltage sags/swells arising from the distribution network. Thus it is generally installed in a distribution system between the supply and the sensitive load feeders. In addition to voltage sags and swells compensation, DVR can also be used for line voltage harmonics compensation, voltage transients reductions and fault current limitations. Various circuit topologies and control schemes are available that can be used to implement a DVR. It is power electronic device installed in series with distribution system line as can be seen in Figure 1. DVR uses semiconductor device to maintain voltage of sensitive load by injecting voltage whose magnitude, phase, and frequency can be controlled. How a DVR works to compensate harmonics is shown in Figure 2. From Figure 1 and Figure 2 it can be seen that, the topology of DVR as voltage sag compensator is similar to that of as harmonics compensator. Therefore, the DVR can compensate both voltage sag and voltage distortion caused by harmonics.

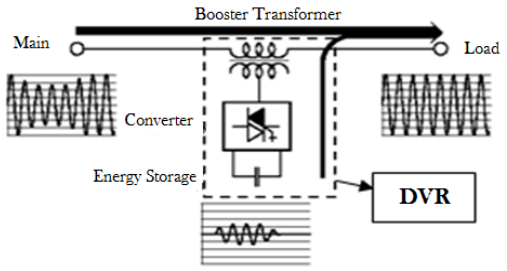

Fig. 1.DVR topology as voltagesag compensator

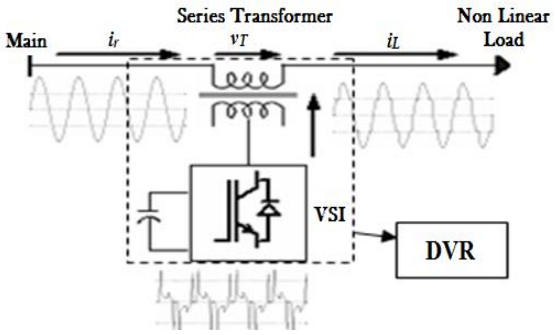

Fig. 2. DVR topology as harmonics compensator

III. CONTROL METHODS FOR DVR

DVR Control strategies fall mainly in one of the two categories namely linear control methods and Non- linear control methods. Linear control methods can be employed with the feedback, the feed-foreword and the combined feed controllers. Non-Linear control methods comprising the Artificial Neural Networks (ANN), the Fuzzy Logic (FL) and the Space Vector (SV) controllers. Although feedback controllers are popular, they require load and source tracking, whereas feed-foreword controllers are much simpler yet open-looped, there is no feedback from the load voltage or current. The proposed DVR utilizes capacitors as the energy storage units fed through the supply mains via the rectifier. The compensation strategy is chosen to be the in phase compensation method due to its simplicity of implementation and induction motor no being sensitive to phase angle jumps. And the control of the proposed DVR is based on a fuzzy logic based feedback controller.

IV. PROPOSED SYSTEM

In proposed system Power quality problem is an occurrence manifested as a non-standard voltage, current or frequency. Utility distribution networks, sensitive industrial load and critical commercial operation suffer from various types of outages and service interruptions that can cost significant financial losses. There are various forms of power quality problem or disturbances like Voltages Sags, swells, harmonic distortion, flicker and interruptions. Voltage sag is more frequent than voltage swell and hence its impact is more on power distribution system.

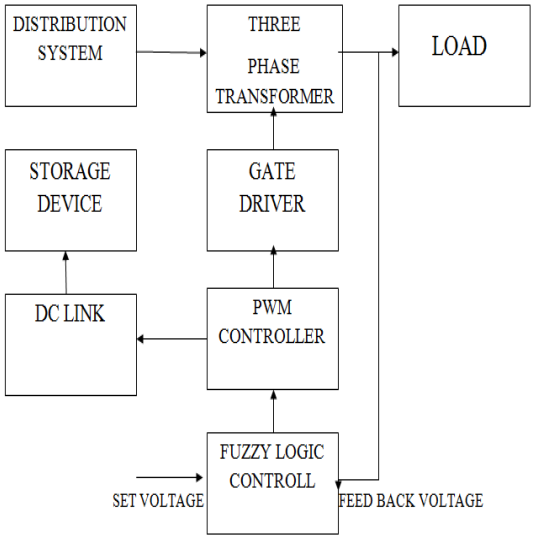

Fig. 3.Block diagram

V. PROPOSED SYSTEM MODULE AND DEVICES

In proposed system used for Voltage Source Inverter, Pulse Width Modulation, Fuzzy Logic Control.

DVR Operating Mode: The DVR will be isolated from the system if the system parameters exceed the predetermined limits primarily current on load side. The main reason for isolation is protecting the DVR from the over current in the load side due to short circuit on the load or large inrush currents. The control system detects faults or abnormal conditions and manages bypass (transfer) switches to remove the DVR from system thus preventing it from damages as shown in Figure.

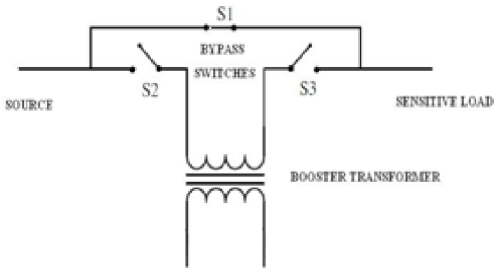

Fig 4. Protection Mode

During the over current period, S1 will be closed, S2 and S3 will be opened so there will be another path for current to flow. By removing the DVR from system at fault condition, the effects of additional disturbances that can be caused by the DVR are prevented onto the system.

Voltage Source Inverter : The three phase inverters re commonly used to supply three-phase loads by means of separate single-phase inverters. It is a voltage controller. This model mainly demonstrates a DC-AC converter. Inverters are used in a large number of power applications. Within the last decade, there have been major upgrading in power electronics. An Inverter is basically a converter that converts DC-AC power. The function of an inverter is to convert DC power to AC, these are offered to as Voltage Source Inverters (VSI). A voltage source inverter (VSI) is one that takes in a fixed voltage from a device, such as a dc power supply, and converts it to a variable-frequency AC supply.

Pulse Width Control : The advent of the transformer less multilevel inverter topology has brought forth various pulse width modulation (PWM) schemes as a means to control the switching of the active devices in each of the multiple voltage levels in the inverter. The most efficient method of controlling the output voltage is to incorporate pulse width modulation control (PWM control) within the inverters. In this method, a fixed D.C. input voltage is supplied to the inverter and a controlled A.C. output voltage is obtained by adjusting the on and–off periods of the inverter devices. Voltage-type PWM inverters have been applied widely to such fields as power supplies and motor drivers. This is because: inverters are well adapted to high-speed self turn-off switching devices that, as solid-state power converters, are provided with recently developed advanced circuits; and they are operated stably and can be controlled well.

Fuzzy Logic Control : Fuzzy logic theory is considered as a mathematical approach combining multi-valued logic, probability theory, and artificial intelligence to replicate the human approach in reaching the solution of a specific problem by using approximate reasoning to relate different data sets and to make decisions. The harmonics is generated in the load terminals using six pulse converters with fixed firing angle are connected to the main drive nonlinear load which is parallel to the sensitive load. Voltage sag is created at load terminals via a three phase fault. The above voltage problems are sensed separately and passed through the sequence analyzer. The control system of the general configuration typically consists of a voltage correction method which determines the reference voltage that should be injected by DVR and the VSI control which is in this work consists of PWM with Fuzzy controller. The controller input is an error signal obtained from the reference voltage and the value of the injected voltage. The Fuzzy Logic (FL) and the Space Vector (SV) controllers although feedback controllers are popular, they require load and source tracking, whereas feed-foreword controllers are much simpler yet open-looped, there is no Feedback from the load voltage or current. The control of the proposed DVR is

based on a fuzzy logic The PWM signal generator that controls the DVR inverter to generate therequired injected voltage.

VI. SIMULATION CIRCUIT DIAGRAM

A test system is simulated with a three phase fault with the duration of 0.05 sec to 0.1 sec. The fault is generated with a three phase to ground condition so as to get all three phases get affected. The supply is a 400V, 50 Hz, three phase supply. The simulation model is given in the figure 3. The sag generated waveforms are observed in the scope. The swell is created by replacing the three phase source with a programmable one. The swell is generated for the time duration of 0.15 sec to 0.2 sec, and the corresponding wave form is observed in the scope.

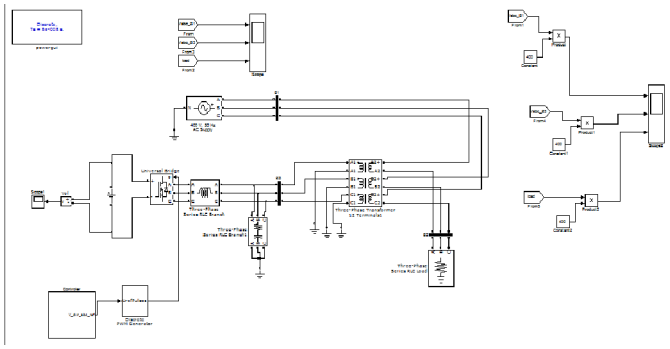

Fig 5. Simulation circuit

VI. SIMULATION

Step1: Click on Windows 7 professional. To open the simulink software in MATLAB 7.9.0 (R2009B)

Step2: The supply is a 230V, 50 Hz, 1.0 p.u three phase supply. If the voltage value decrease (sag) or increase(swell) in three phase supply.

Step3: The voltage value has decreased to 1.0 p.u to 0.6 p.u

Step 4: The volage value has increased to 1.0 p.u to 1.2 p.u

Step 5: If the increase and decrease value has to compensate the DVR . finally we get the Simulation output

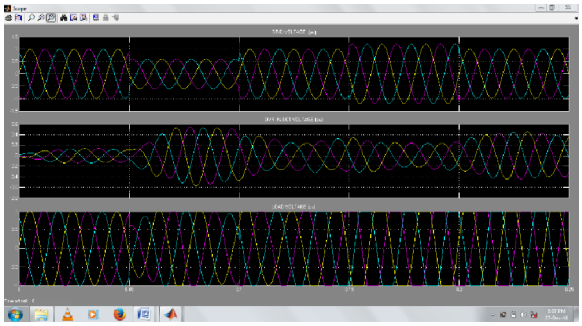

Fig.6. Simulation output

Step 6: In each and every cycle the voltage value has to compensate the DVR.

The system is designed to operate at a frequency of 50 Hz. The sag and swell wave forms are observed and the corresponding correction is applied using the DVR in FUZZY control system.

VII. FFT ANALAYSIS

The simulations are carried out for voltage sag and swell events. The simulation is executed in the variable step discrete instead of the lack of continues states. It is observed that the voltage wave form obtained after the compensation made by the DVR .

It is clearly observed the injection voltage level of the DVR's injection transformer. For the test purpose an additional scope is connected. In the future work, this voltage reading can be used in the smart grids. The compensation of FUZZY based Dynamic voltage restorer .

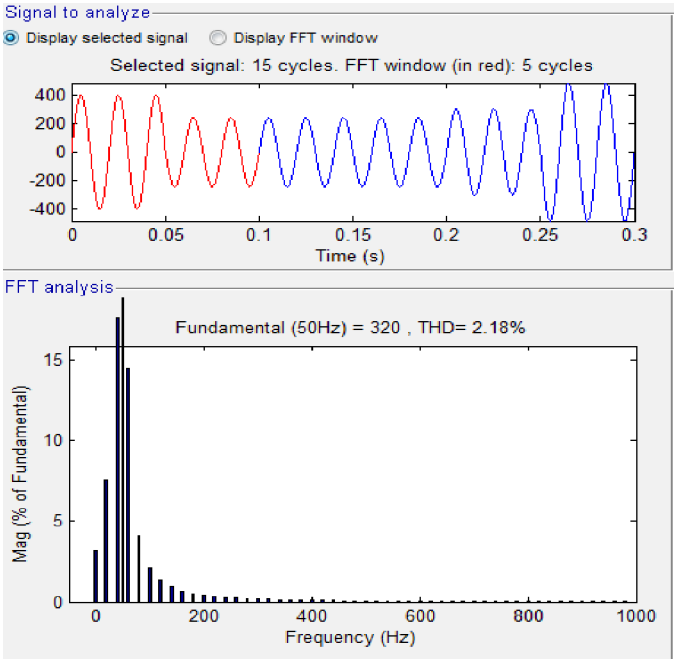

Fig 5. display Selected Signal

The Total Harmonic Distortion (THD) is measured by using FFT analysis and is found as 2.18%. the FFT Window is 5 of 15 cycles in given signal.

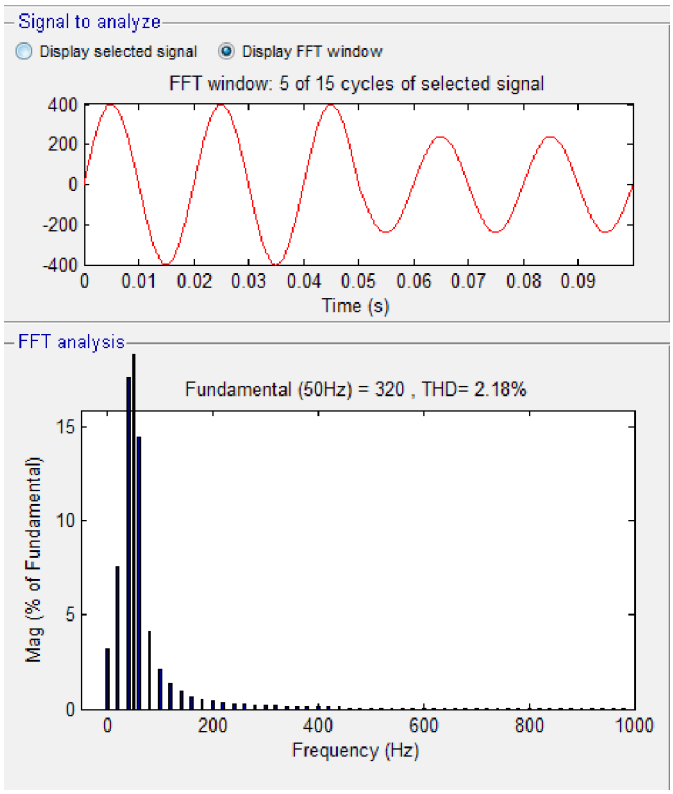

Fig 6. FFT Window

The voltage sag and swell at a duration of 0.05 seconds; the DVR injects series voltage with phase angle of 180° voltage supply and compensates the voltage sag and swell. The compensation voltage is shown in figure . The Total Harmonic Distortion (THD) is measured by using FFT analysis and is found as 2.18%.

VII. CONCLUSION

A new control method for a elimination of voltage sag / swell mitigation based on a fuzzy logic control. The control strategy is simple and is based on injecting voltages in phase with the system voltage and is easier to implement when the DVR system has the ability to provide active power. The DVR handled both balanced and unbalanced situations without any difficulties and injected the appropriate voltage component to correct rapidly any anomaly in the supply voltage to keep the load voltage balanced and constant at the nominal value. The efficiency and the effectiveness in voltage sag/swell compensation showed by the DVR makes it an interesting power quality device compared to other custom power devices. The future on the distribution grid to respond to dynamic changes in the voltage profiles of the grid and prevent sensitive loads from voltage disturbances

REFERENCES

[1] Ali Yazdanpanah Goharrizi , Seyed Hossein Hosseini , Mehran Sabahi and Gevorg B. Gharehpetian, (2012)" Three-Phase HFL-DVR With Independently Controlled Phases" IEEE Transactions On Power Electronics, Vol. 27, No. 4, pp. 1706-1718.

[2] Majid Moradlou and Hamid R. Karshena (2011) " Design Strategy for Optimum Rating Selection of Interline DVR" IEEE Transactions on Power Delivery, Vol. 26, No. 1, pp. 242-249.

[3] F.Mohammad Mahdianpoor, Rahmat Allah Hooshmand, and Mohammad Ataei(2011) " A New Approach to Multifunctional Dynamic Voltage Restorer Implementation for Emergency Control in Distribution Systems" IEEE Transactions on Power Delivery, Vol. 26, No. 2, pp. 882-890.

[4] Carl Ngai-Man Ho,and Henry Shu-Hung Chung, (2010)"Implementation and Performance Evaluation of a Fast Dynamic Control Scheme for Capacitor-Supported Interline DVR" IEEE Transactions on Power Electronics, Vol. 25, No. 8, pp. 1975-1988.

[5] J. Dionísio Barros and J. Fernando Silva, (2010) "Multilevel Optimal Predictive Dynamic Voltage Restorer" IEEE Transactions on Industrial Electronics, Vol. 57, No. 8, pp. 2747-2760.

[6] Ebrahim Babaei, Mohammad Farhadi Kangarlu,and Mehran Sabahi (2010) "Mitigation of Voltage Disturbances Using Dynamic Voltage Restorer Based on Direct Converters" IEEE Transactions on Power Delivery, Vol. 25, No. 4, pp. 2676-2683.

[7] Ahmed M. Massoud, Shehab Ahmed,Prasad N. Enjeti, and Barry W. Williams (2010) "Evaluation of a Multilevel Cascaded-Type Dynamic Voltage Restorer Employing Discontinuous Space Vector Modulation" IEEE Transactions on Industrial Electronics, Vol. 57, No. 7, pp. 2398-2410

[8] Pedro Roncero-Sánchez,Enrique Acha, Jose Enrique Ortega-Calderon, Vicente Feliu, and Aurelio García-Cerrada, (2009) "A Versatile Control Scheme for a Dynamic Voltage Restorer for Power-Quality Improvement" IEEE Transactions on Power Delivery, Vol. 24, No. 1, pp. 277-284.

[9] Juan A. Martinez, and Jacinto Martin-Arnedo (2006) "Voltage Sag Studies in Distribution Networks—Part I: System Modeling" IEEE Transactions on Power Delivery, Vol. 21, No. 3, pp. 1670-1678.

[10] D. Mahinda Vilathgamuwa, H. M. Wijekoon, and S. S. Choi (2006) "A Novel Technique to Compensate Voltage Sags in Multiline Distribution System—The Interline Dynamic Voltage Restorer " IEEE Transactions on Industrial Electronics, Vol. 53, No. 5, pp.1603-1611