

Power Quality Improvement Using Dynamic Voltage Restorer

M.Subramanyam¹, P.Nagendra²

^{1,2}Assistant Professor Department of EEE CVRT Engineering College, Tadipatri

ABSTRACT

The series connected DVR will inject three-phase compensating voltages through the three phase injection transformer or three single-phase injection transformers with the main supply. The filtered VSI output voltage is boosted the desired level with the injection transformer. The transformer also isolates the DVR circuit from the distribution system. The capacity of the voltage source inverter (VSI) and the values for the link filter connected between the injection transformer and the inverter play a crucial in the design of the DVR. In this research project, new Dynamic Voltage Restorer (DVR) topology has been proposed. The capacity of the voltage source inverter (VSI) and values of the link filter is small that will improve the compensation capabilities for voltage harmonic, swell and voltage sag mitigation under various fault conditions. The new RLC filter is able to eliminate the switching harmonics. The capacity of the dc supply voltage is reduced when the value of inductance is small. The new DVR topology has high efficiency and the ability to improve the quality of voltage. An outline architecture of the RLC filter parameters for the specific model has been presented. The new DVR with proposed controlled Dynamic Voltage Restorer topology is modelled and simulated using the MATLAB. The control scheme has good control dynamics with minimum transient current overshoot.

1. INTRODUCTION

The term "power quality" refers to the degree to which electrical power is delivered to consumers without interruption, fluctuations, or disturbances. Poor power quality can lead to equipment damage, system failures, and increased operating costs for industrial, commercial, and residential users.

One effective way to improve power quality is through the use of a Dynamic Voltage Restorer (DVR). A DVR is a power electronics device that is connected to the electrical network and is used to mitigate voltage sags and swells caused by faults or other disturbances in the system.

The DVR operates by monitoring the voltage at its connection point and injecting a voltage of equal magnitude but opposite phase to the system when a voltage sag or swell is detected. This restores the voltage to its nominal level and protects sensitive loads from damage.

DVRs are highly effective at improving power quality and are increasingly being used in a range of industrial and commercial applications. They can be used to protect sensitive equipment such as computer systems, medical devices, and production lines from voltage fluctuations, and can also be used to improve the reliability and efficiency of the overall electrical system.

Overall, the use of DVRs is an effective way to improve power quality, protect equipment, and reduce operating costs in a range of industrial and commercial settings.

Power Quality refers to the level of voltage, frequency, and waveform consistency that determines the suitability of electrical power for the safe and efficient operation of electrical

equipment. Power quality issues can arise due to various factors, such as voltage sags, swells, interruptions, harmonics, flicker, and other disturbances.

Dynamic Voltage Restorer (DVR) is a power electronic device that can mitigate voltage sags, swells, and other disturbances in the power system by injecting the required voltage to maintain the load voltage within the acceptable limits. The DVR is a series-connected device that compensates for voltage sags and swells by injecting the required voltage in series with the load.

The DVR consists of a voltage source converter (VSC), a DC capacitor, a coupling transformer, and control circuits. The VSC is used to inject the required voltage to compensate for voltage sags and swells. The coupling transformer is used to connect the DVR in series with the load, and the control circuits are used to monitor the voltage and current signals and to control the VSC to inject the required voltage.

The use of DVR in power systems has several advantages, including fast response time, high efficiency, and improved power quality. The DVR can improve the power quality by mitigating voltage sags and swells, reducing the downtime of equipment, and enhancing the reliability of the power system.

In conclusion, the Dynamic Voltage Restorer is a power electronic device that can improve the power quality in power systems by mitigating voltage sags, swells, and other disturbances. The DVR can enhance the reliability of the power system and reduce the downtime of equipment, thereby improving the overall performance of the power system.

2. LITERATURE SURVEY

Johan H. R. Enslin and Peter J. M. Heskes, “Harmonic interaction between a large number of distributed power inverters and the distribution network,” In this paper discussed the harmonic interaction between a large number of distributed power inverters and the distribution network. This paper is to analyze the observed phenomena of harmonic interference of large populations of these inverters and to compare the network interaction of different inverter topologies and control options. Uffe Borup, Frede Blaabjerg and Prasad N. Enjeti “Sharing of nonlinear load in parallel-connected three-phase converters,” Presented about the sharing of linear and nonlinear loads in three-phase power converters connected in parallel, without communication between the converters. The paper focuses on solving the problem that arises when two converters with harmonic compensation are connected in parallel.

Pichai Jintakosonwit Hideaki Fujita, Hirofumi Akagi and Satoshi Ogasawara “Implementation and performance of cooperative control of series active filters for harmonic damping throughout a power distribution system,” This paper proposes cooperative control of multiple active filters based on voltage detection for harmonic damping throughout a power distribution system. The arrangement of a real distribution system would be changed according to system operation, and/or fault conditions. In addition, series capacitors and loads are individually connected to, or disconnected from, the distribution system.

Soeren Baekhoej Kjaer, John K. Pedersen and Frede Blaabjerg “A review of single-phase grid-connected inverters for photovoltaic modules” Presents a Review of Single-Phase Grid-

Connected Inverters for Photovoltaic Modules. This paper focuses on inverter technologies for connecting photovoltaic (PV) modules to a single-phase grid. The inverters are categorized into four classifications: 1) the number of power processing stages in cascade; 2) the type of power decoupling between the PV module(s) and the single-phase grid; 3) whether they utilize a transformer (either line or high frequency) or not; and 4) the type of grid-connected power stage. F. Blaabjerg, R. Teodorescu, M. Liserre, and A. V. Timbus "Overview of control and grid synchronization for distributed power generation systems," This paper gives an overview of the structures for the DPGS based on fuel cell, photovoltaic, and wind turbines. In addition, control structures of the grid-side converter are presented, and the possibility of compensation for low-order harmonics is also discussed. Moreover, control strategies when running on grid faults are treated. This paper ends up with an overview of synchronization methods and a discussion about their importance in the control.

3. PROPOSED SYSTEM

Simulink is a software package for modelling, simulating, and analysing dynamical systems. It supports linear and non-linear systems, modelled in continuous time, sampled time, or a hybrid of the two. For modelling, Simulink provides a graphical user interface (GUI) for building models as block diagrams, using click-and-drag mouse operations. Models are hierarchical, so we can build models using both top-down and bottom-up approaches. We can view the system at a high level, then double-click on blocks to go down through the levels to see increasing levels of model detail.

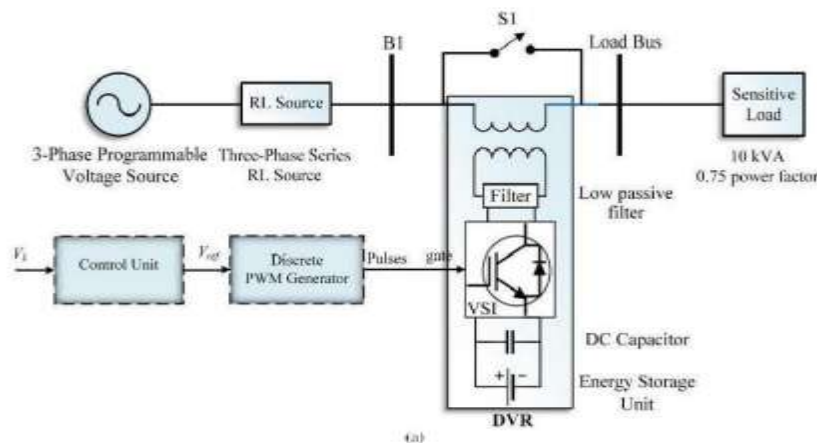


Fig.1: Basic Configuration of DVR.

This approach provides insight into how a model is organized and how its parts interact. After we define a model, we can simulate it, using a choice of integration methods, either from the Simulink menus or by entering commands in MATLAB's command window. Using scopes and other display blocks, we can see the simulation results while the simulation is running. In addition, we can change parameters and immediately see what happens, for "what if" exploration. The simulation results can be put in the MATLAB workspace for post processing and visualization. Simulink can be used to explore the behaviour of a wide range of real-world dynamic systems, including electrical circuits, shock absorbers, braking systems, and many other electrical, mechanical, and thermodynamic systems. Simulating a

dynamic system is a two-step process with Simulink. First, we create a graphical model of the system to be simulated, using Simulink's model editor. The model depicts the time dependent mathematical relationships among the system's inputs, states, and outputs. Then, we use Simulink to simulate the behaviour of the system over a specified time span. Simulink uses information that you entered into the model to perform the simulation.

4. SIMULATION RESULTS

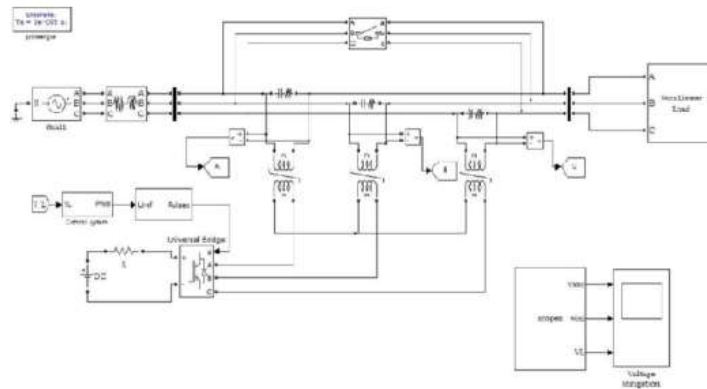
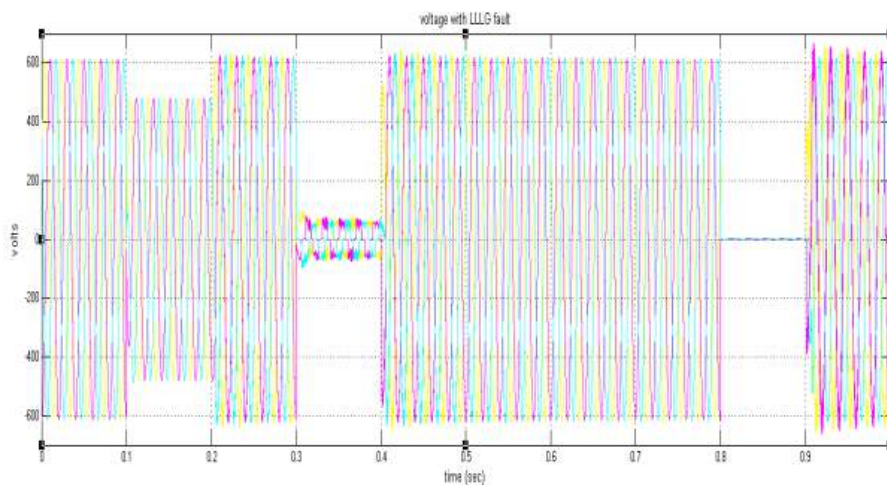
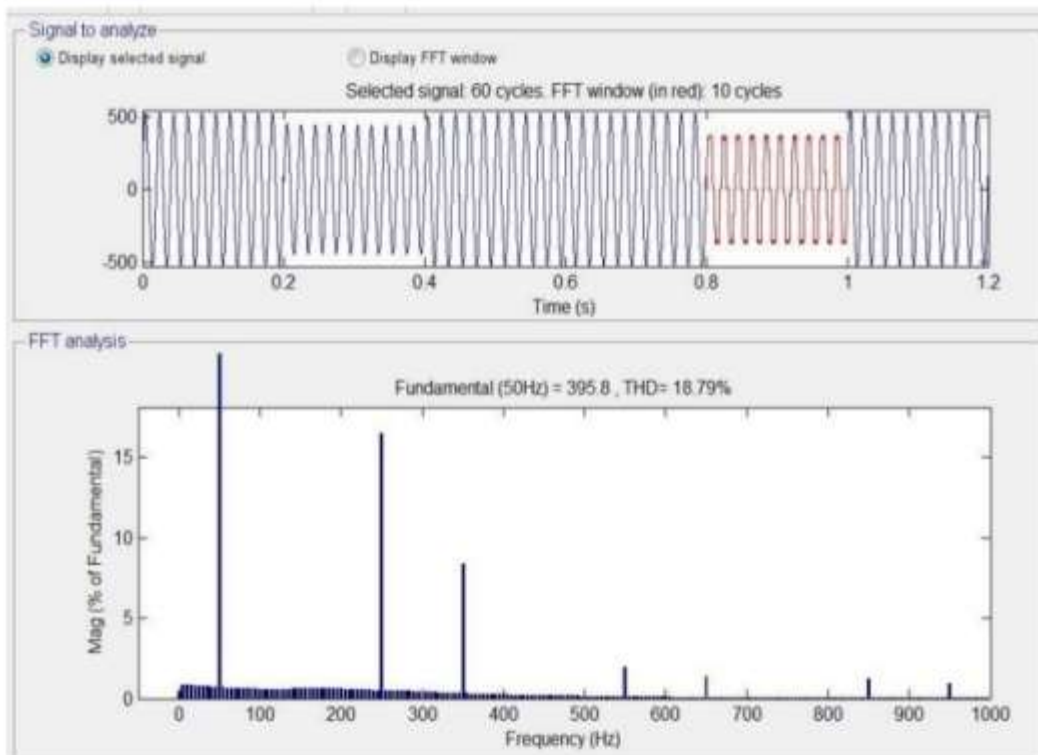


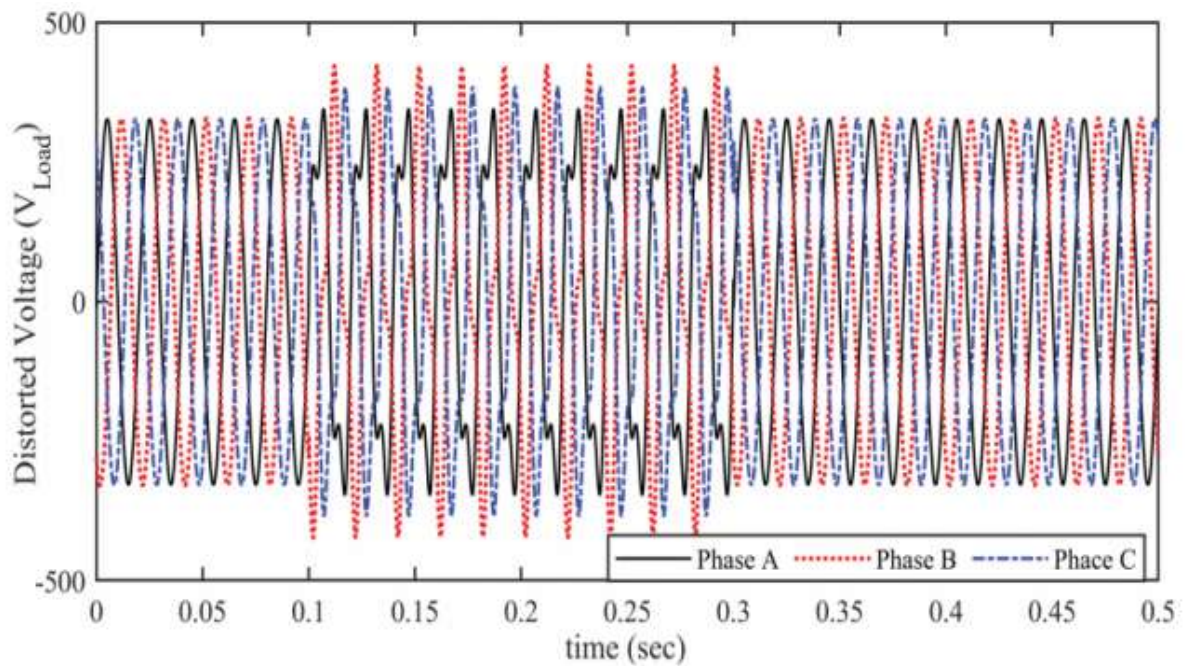
Fig.1: Simulation model of test system with DVR



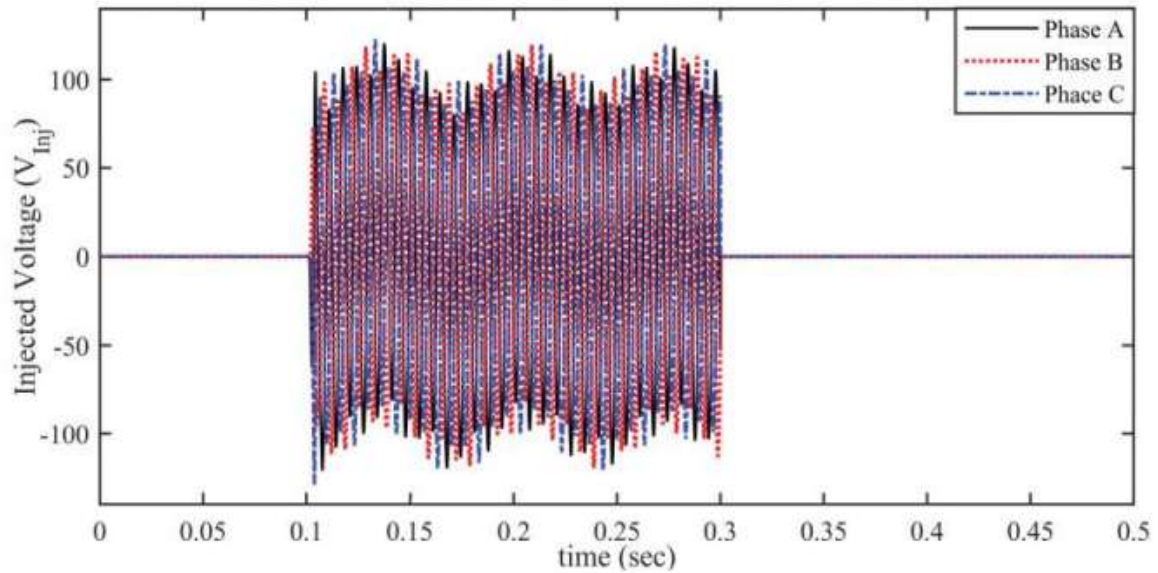
Voltage profile without DVR



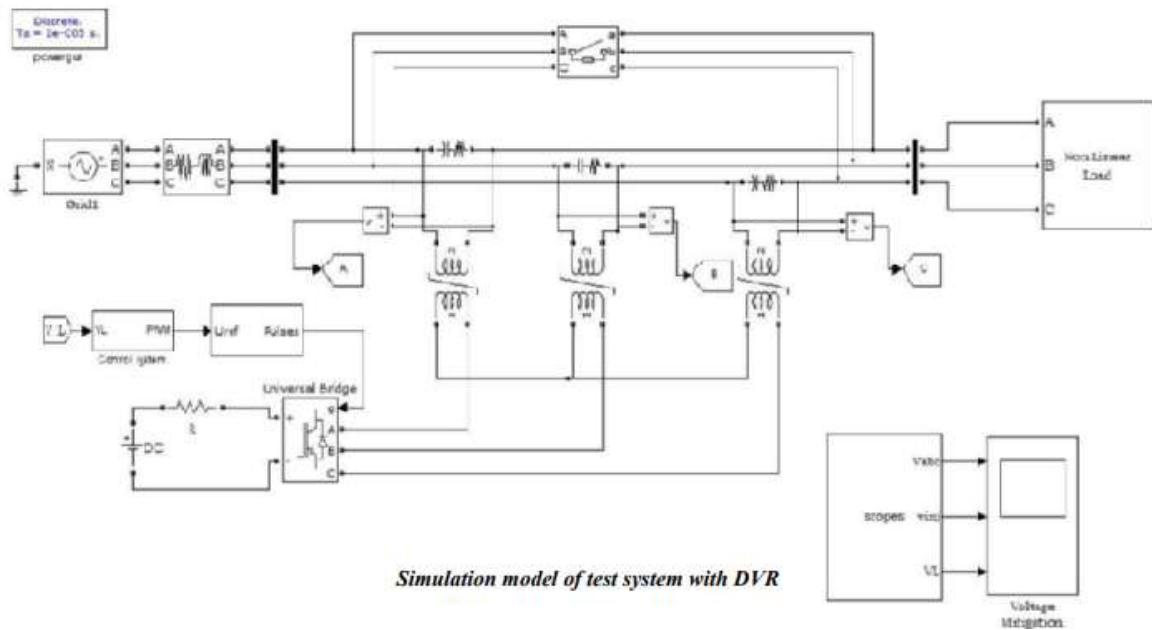
Total harmonic distortion



Disorted load voltage waveform before compensation



Injected voltage (V_{inj}) by DVR in all three phases



Simulation model of test system with DVR

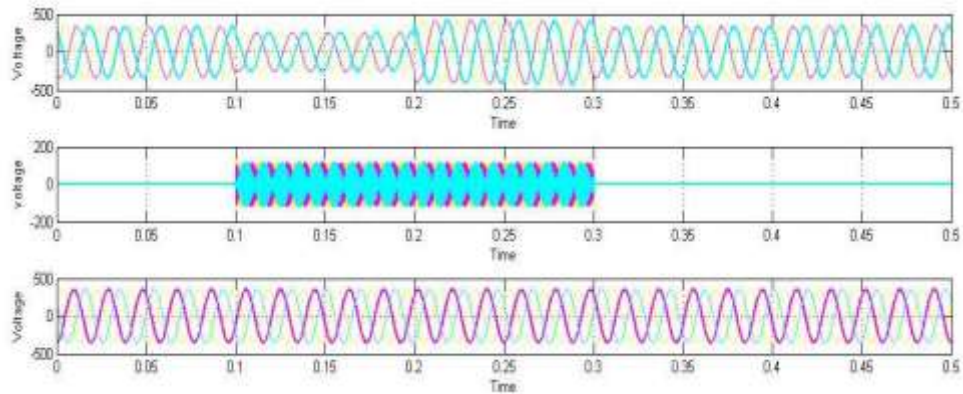


Fig.2: Output waveforms with using DVR

5. CONCLUSION

DVR is proposed as the most noteworthy device to enhance the quality of power and proved to be a useful and well-performing device. Through the platform of MATLAB/ Simulink, a simulation of DVR with a power circuit is carried out by structure and modeling of the control circuit and power system with a sensitive load. The DVR is implemented with the test system and investigated with and without DVR. A programmable voltage source is used to supply a distorted voltage with first with 3rd harmonic content and then with 5th harmonic insertion in the supply voltage. The proposed DVR based control strategy was effective in compensation of the distorted load voltage and maintained a better steady and smooth voltage profile with very less harmonic content in it. To maintain the load voltage normal and steady at the optimal range, the correction of any problem in voltage supply is possible when the DVR injects the suitable voltage component into it. While maintaining the compensation of voltage profile, the THD was reduced to around 4%. Like for scenario 1, the observed THD with DVR case was 2.69%, 2.40%, and 2.69%, and for scenario 2, there were 3.74%, 4.04%, and 3.60% THD in the voltage profile. This improvement and reduction in the THD in load voltage explain the effectiveness of the DVR based control strategy used in this work. The application of control strategy based on soft computing like adaptive NeuroFuzz controllers for power quality improvement is a promising future perspective of this research. Authors have already implemented Type-2 NeuroFuzzy controls for enhancement of power system stability using STATCOM. Other power quality problem that occurs in power system network has to be compensated. Fuzzy controlled and PI controller can be used as a mitigation technique for DVR.

6. REFERENCES

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