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"Compensation of Voltage Sags and Swells by using Dynamic Voltage Restorer Optical Current Transformer"

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Abstract

The most important aspect for electrical engineering is power quality in recent year. Power quality problem is an event of abnormal voltage, current. The major problems here are the voltage sag and swell such a problems is now mitigated advanced power electronics technology. The dynamic voltage restorer is a power electronics based device that provides three phase controllable voltage source whose magnitude and angle assist to the source voltage during sag event to restore the load voltage to pre sag condition. The new configuration of DVR has been proposed using d-q-0 controllable technique. A control technique based on PID controller. The simulations are carried out using MATLAB/SIMULINK software.

Keywords*: Dynamic Voltage Restorer, Voltage Source Converter, Power Quality, Voltage Sag and Swell, PID controller, etc.*

INTRODUCTION

In power distribution system the used of a large number of electrical and electronic equipment, such as computer, programmable logic controller and variable speed drive causes various power quality problems like voltage sag, swell and harmonics. These are the major concern of the industrial and commercial electrical consumer due to huge loss in terms of money and time [1].

The voltage sag and swell are major power quality problems. Voltage sag is defined as decreased in RMS voltage 10 to 90% of normal voltage for 0.5 cycle to 1 minute.

Swell is defined as increased in RMS voltage 10 to 80% of nominal voltage for 0.5 cycles to 1 minute [2]. There are many methods to compensate power quality issues are active power filters, battery energy storage system, surge arresters, static VAR compensator, Thyristor switched capacitor, and Dynamic voltage restorer. Out of that FACTS device such as Dynamic Voltage Restorer improve power transfer capability and stability [2].

DVR is a basically a voltage source converter is installed between the supply and a sensitive load. The DVR inject voltage to the system in order to compensate any disturbance occur due to supply [3].

The first DVR was installed in North America in 1996-a 12.47kv system located in Anderson, South Carolina. Since then, DVR have been applied to protect critical loads in utilities, semiconductor and food processing.

DYNAMIC VOLTAGE RESTORER

The major objective of the DVR is to increase the power utilization capacity of distribution feeders and improve power quality at the load. The main assumption is that neglects the source voltages variations and considers mainly load variations. It states that load dynamic slower than source dynamics.

DVR is a series voltage controller and it is connected in series with the load. DVR consists of an injection transformer, voltage source Inverter and, harmonic filter circuit, controller and dc charging circuit. In place of dc charging circuit super capacitor is used to increasing the energy storage capacity [3-5].

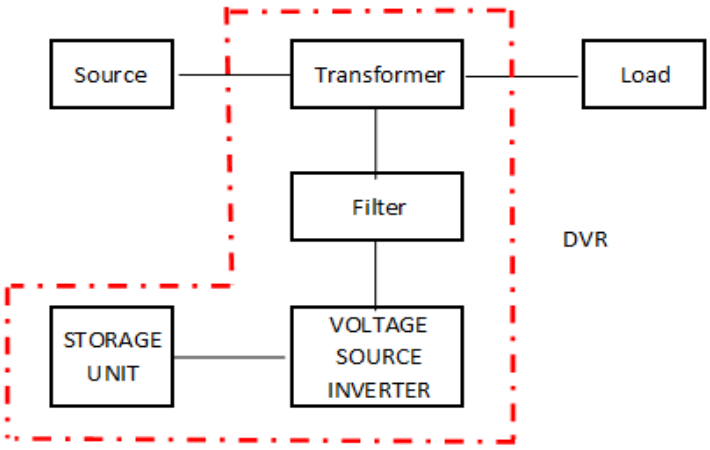

Fig.1. Block Diagram of DVR

The power circuit of DVR Consists of four components and these are:

A. Injection Transformer

It is the one of the major part of the DVR. It generally consists of three separate single phase transformers. These are connected either may be star/open star or delta/open star winding connections. It is placed in between the voltage source inverter and distribution feeder to supply the required amount voltage during compensation. During normal working condition it does not inject the any voltage into the system. The selection of the injection transformer or booster transformer depends on the type of the load and connections of the step down transformer.

B. Voltage Source Converter

The converter is most likely a Voltage Source Converter (VSC), which Pulse Width modulates (PWM) the DC from the DC-link/storage to AC voltages injected into the system. A VSC is a power electronic device consists of a storage device and switching devices, which can generate a AC voltage at any essential frequency, magnitude, and phase angle. In the DVR application, the VSC is used to provisionally replace the reference voltage or to generate the part of the supply voltage which is missing.

C. Harmonic Filter

The harmonic filter is inserted to reduce the switching harmonics; common sources of harmonics are electronic loads. Due to these sources of harmonics, harmonic currents generate harmonic voltage as they pass through the system impedance. These harmonic equipments can cause input voltage fluctuations, additional heating, over voltages in power system.

D. Energy Storage Device

This is required to provide required amount of power during voltage sags. During swell period it will storage energy and supply the energy during sag period. It is also possible to provide the required power to the DC side of the VSI by an auxiliary bridge converter that is fed from an auxiliary AC supply. In this super capacitor is used as energy storage device.

SYSTEM CONFIGURATION

Fig.2. Shows system configuration of the three phase distribution system connected to the DVR.

The three phase programmable voltage source is connected to the three phase sensitive load via three phase transformer.

Disturbance at the source side, affect the performance of sensitive loads. This disturbance can be compensated by DVR and it is connected in series to the system via injection transformer. The compensated voltage obtained from the DVR is injected to the system through the injection transformer. The DVR unit is built with VSI unit and super capacitor. The operation VSI unit depends on the control signals received from the control unit. The DVR is indicated as an ideal source of voltage. The reference voltages are generated from controlled algorithm tracked by controller [4,5].

The proposed DVR is connected to the system through the three single phase injection transformers. DVR is designed according to the voltage needed in the secondary side of transformer.

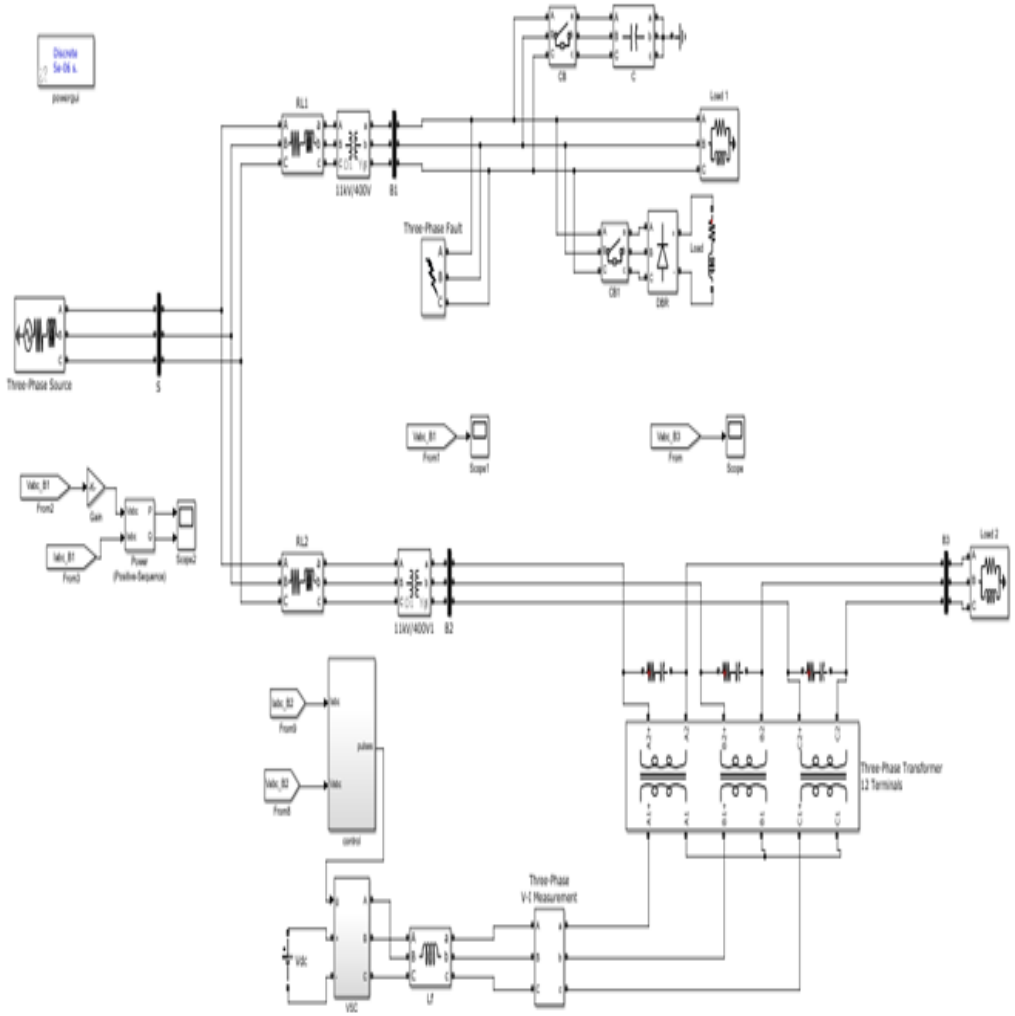

Fig.2. Matlab model of the DVR connected system

The DVR consists of three single phase VSI units. Each unit is connected to system through the injection transformer. It provides the isolation to the converter. The active power injection to the compensator is coming from Super capacitor. In three phase of the used system consist of R, L, C filters. The filters are installed on either low voltage or high voltage side of injection transformer.

CONTROL STRATEGY OF PROPOSED SYSTEM

When voltage sag/swell are detected, the DVr should react as fast as possible and inject ac voltage to the grid. It can be implemented using a feedback control technique based on the voltage reference and instantaneous values of supply and load voltage. There are various basic roles of a controller in a DVR. Detection of the sag/swell occurrences in the system; calculation of the compensating voltage, generation of the trigger pulses of PWM inverter and stop triggering pulses when the occurrence has passed [6, 7]

The control system employs abc to dq0 transformation to dq0 voltage. During normal condition and symmetrical condition, the voltage will be constant and d-voltage unity in pu and q-voltage is zero in pu, but during the abnormal condition it varies. After comparison d- voltage and q-voltage with the desired voltage, error d and error q are generated. These error components are converted into abc component using dq0 to abc transformation.

In the proposed control scheme reference signal are generated by using SRF theory with proportional integral derivative controller technique [9,10]. The reference signals obtained from, the three phase load voltages are transformation in to dq0 axis using following transformation equation

EQUATION

The reference voltages in d-q-O frame are obtained by using angle S. The S angle is obtained from Three Phase PLL Controller. The transformation for a-b-c to d-q-O frame is obtained using Equation (2) [11].

Equation

A three phase PLL (Phased lock loop) includes a phase comparator, low pass filter within the loop [9-12]. In phase comparator difference in the input and output signal is measured and passed to a loop filter, which filter out and produces an error signal it generate output voltage.

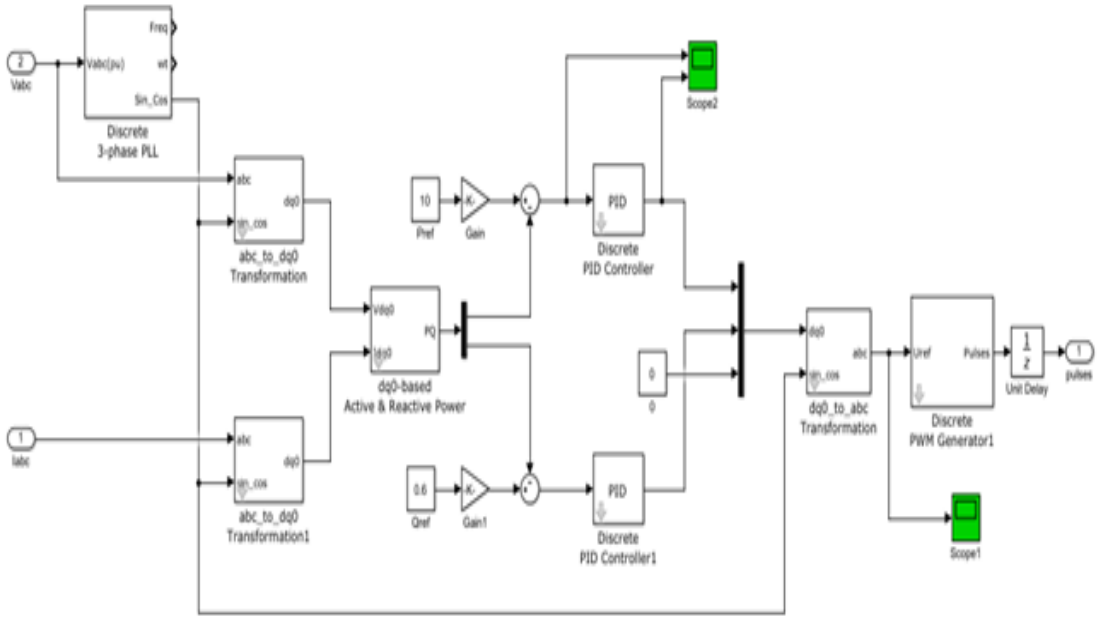

Fig3: Block diagram control scheme of DVR

SIMULATION RESULT

The performance of DVR with the proposed Methodis evaluated using Matlab/Simulink Software. The simulation results are obtained for the following Disturbances at the source side. Unbalanced Voltage Sag (a) source voltage, (b) injected voltage, (c) load voltage

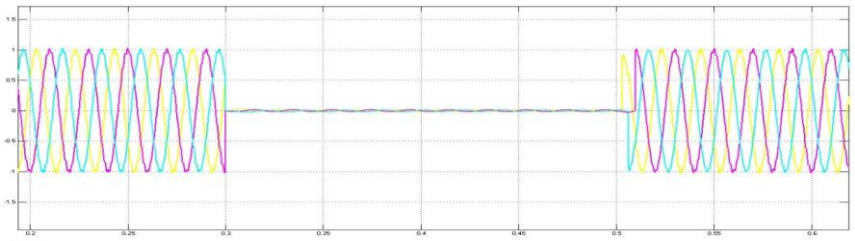

Fig 4.a

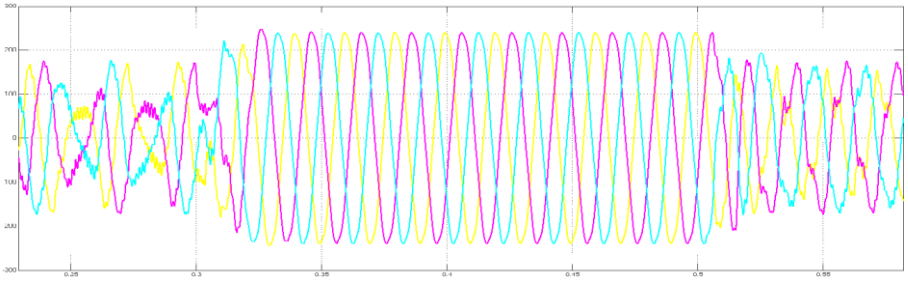

Fig 4.b

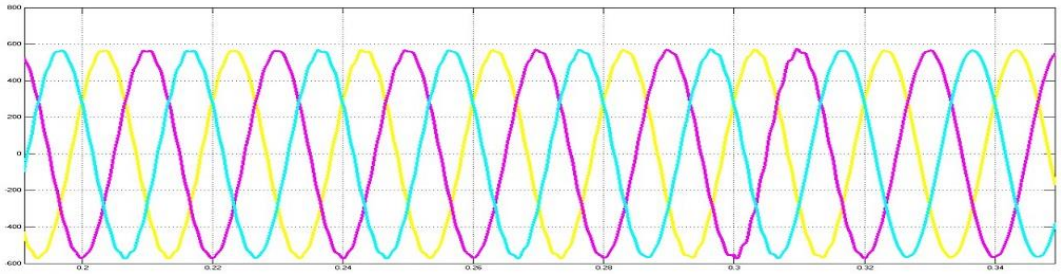

Fig 4.c

CONCLUSION

The DVR modeling and simulation has been shown by the aid of Matlab/ Simulink. The control system is based on dq0 technique which is a scaled error, between source side of the DVR and its reference for compensating sags and swells. The simulation shows that the DVR performance is efficient in mitigation of voltage sags and swells. From these discussion paper presents DVR may be work in Inferior cost, smaller size, and its quick dynamic response to the disturbance due to power quality issues, Ability to control active power flow, Higher energy capacity and lower costs compared to the other active devices and also Less maintenance required.

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