

Enhancement of Power Quality by an application of DVR

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ABSTRACT: This paper narrates the application of DVR to optimize the power quality problems such as voltage sag, voltage swell and harmonics. Among all these three power quality problems, two are identified as the major concern to the customers namely voltage sag and voltage swell. One of the well known solutions to mitigate the power quality problem is to inject the voltage as well as power into the system with the help of DVR. The DVR is a power electronics based device that is commonly for voltage sag and voltage swell mitigation at the point of connection. A control technique based on a proportional integral (PI) controller is implemented. In fact with the aid of Pulse width modulation (PWM) inverters capable of generating accurate high quality voltage waveforms from the power electronic device. Simulation results shows the effectiveness of proposed method by MATLAB/Simulink.

Keywords - Dynamic Voltage Restorer (DVR), Power quality, Pulse Width Modulation (PWM), Voltage Source Converter (VSC).

I. INTRODUCTION

The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper. Power Quality problem such as voltage sag, voltage swell as well as momentary power loss are vital issues seen from the last decade due to the widespread use of sophisticated electronic equipment. Due to above problems the loads are becoming more sensitive and less tolerant to short term voltage disturbances in the form of voltage sag and voltage swell. A great effort has been made to enhance the power quality either from customer side or utility side.

The most effective way for enhancement of power quality is to install the DVR on a sensitive load side, which restores the line voltage to its nominal value. A DVR is a series connected solid device that injects the voltage to compensate voltage sag and swell. It is normally installed in a distribution network between the supply and a critical feeder at the so called point of common coupling (PCC). Its primary function is to boost up the load side voltage in the event of fault. Apart from voltage sag and swell compensation, DVR can also added other features like line voltage, harmonic compensation, reduction of transients in voltage and fault current limitations.

Pulse width modulation (PWM) inverters have been applied as a control scheme to mitigate voltage sag and swell in the test system.

This paper is organized as follows: Section II Objective function; Section III Description of DVR; Section IV Proposed Control Technique; Section V Simulation results and waveforms; Section VI Conclusion.

II. OBJECTIVE FUNCTION

The two main objective functions are considered in this paper that responsible are responsible for the power quality problems.

2.1 First objective function:

2.1.1 Voltage Sag: Voltage sag is a momentary decrease in the r.m.s voltage magnitude lasting

between half a cycle and several seconds [1]. Disruptive voltage sags are usually caused by fault conditions on the utility side or customer side. Voltage sag is generally described by two essential characteristics such as Magnitude and duration. Balanced voltage sags are due to the three phase faults.

2.2 Second objective function:

2.2.1 Voltage Swell: The increase of voltage magnitude between 1-2 and 1-8 p.u. is called voltage swell. The most accepted duration of a swell is from 0.5 cycles to 1 minute. They appear on the switching off of a large load; energizing a capacitor bank or voltage increase of the unfaulted phases during a single line to ground fault.

The possible effects of voltage swell are stress on computer components and they shorten their life. Also swell can upset electronic control and electric motor drives.

III. DESCRIPTION OF DYNAMIC VOLTAGE RESTORER

The Dynamic Voltage Restorer (DVR) is a powerful controller that is connected in series using transformer in delta (Δ) with line distribution system as shown in fig.1. The DVR is a solid state power electronics switching device consisting of either GTO or IGBT, a capacitor bank as a energy storage device and injection transformers. It can maintain load voltage by injecting three phase output voltages whose phase, magnitude and frequency can be controlled [2]. The basic idea behind the DVR is to inject a controlled voltage generated by a converter in a series to the bus voltage by means of an injecting transformer. A regulated DC voltage source is used by means of DC capacitor bank. A DC to AC inverter regulates this voltage by sinusoidal PWM technique. The DVR is used to generate or absorb reactive power but active power by means of some external energy source. The DVR expected time response is about 25 millisecond and which is less than some of the traditional methods of voltage correction such as tap-changing transformer.

A Dynamic voltage restorer (DVR) is a distribution voltage DC to AC solid state switching converter that injects three phase voltage in synchronized with the voltages in distribution system. Therefore, energy storage capacity is now become one of the constraint factors in the distribution compensation process, especially for sag and long duration fault. Moreover, DVR consists of three phase inverter, energy storage and booster transformer. In this paper, section IV deals with the controller to maintain a constant voltage magnitude.

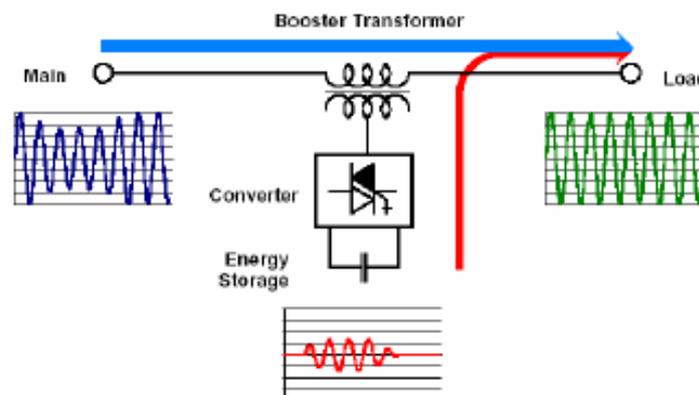


Fig. No.1 Block diagram of DVR

IV. CONCLUSION PROPOSED CONTROL TECHNIQUE

The main aim of the control system is to maintain constant voltage magnitude at the point where a sensitive load is connected, under line distribution system. The control system only measures the rms voltage at the load point [3] i.e. no reactive power measurement is required [4]. Here a sinusoidal PWM based control scheme is implemented in the test system to mitigate voltage sag and swell in practical applications. The voltage source converter (VSC) switching strategy is based on a sinusoidal and good response.PWM methods a more flexible option than the fundamental frequency switching (FFS) methods favored in FACTS applications.

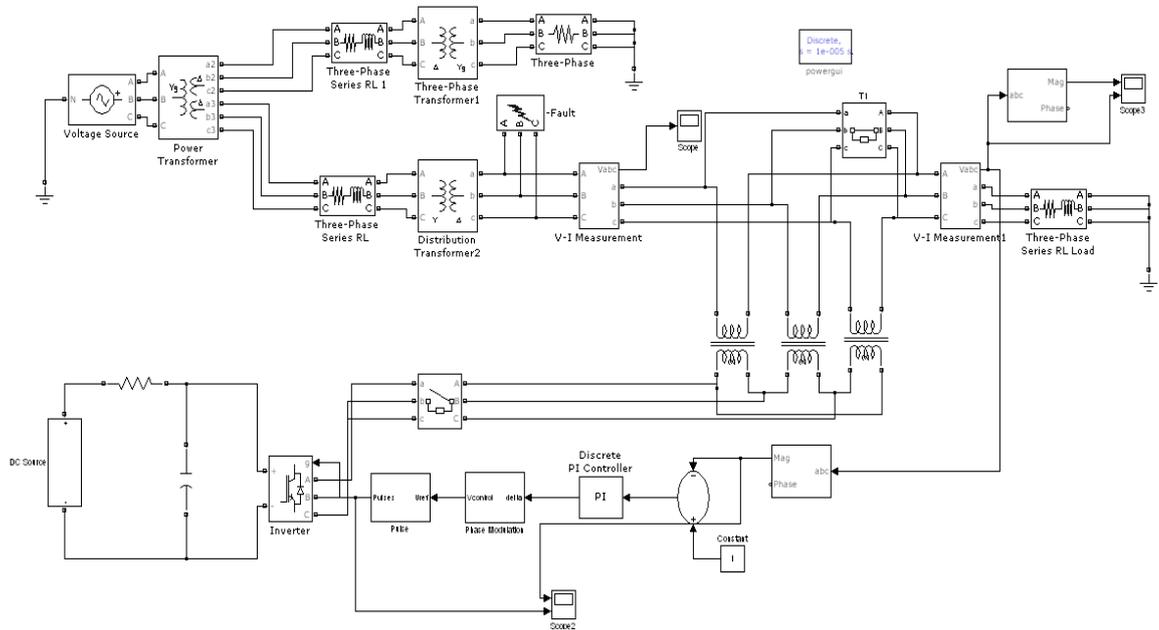


Fig.No.2 Test system and Control Scheme

V. SIMULATION RESULTS

An acknowledgement section may be presented after the conclusion, if desired It is assumed that the voltage magnitude is maintained at 1 p.u. during voltage sag and swell condition. Fig. No. 3 and 4 shows the simulation result for voltage sag condition. Fig. No. 5 and 6 represents the voltage swell simulation. Fig.No.3 shows the simulation result without DVR and three phase fault is applied during the period 0.3-0.5 sec. The voltage sag at the load point is 50 % with respect to the reference voltage.

When DVR and PI control is applied the voltage sag problem is almost optimized and required voltage is maintained at the load point. Similarly, Fig.No.5 shows the voltage swell occurs during the 0.2-0.3 sec and Fig. No. 6 shows the mitigation by applying DVR with PI controller.



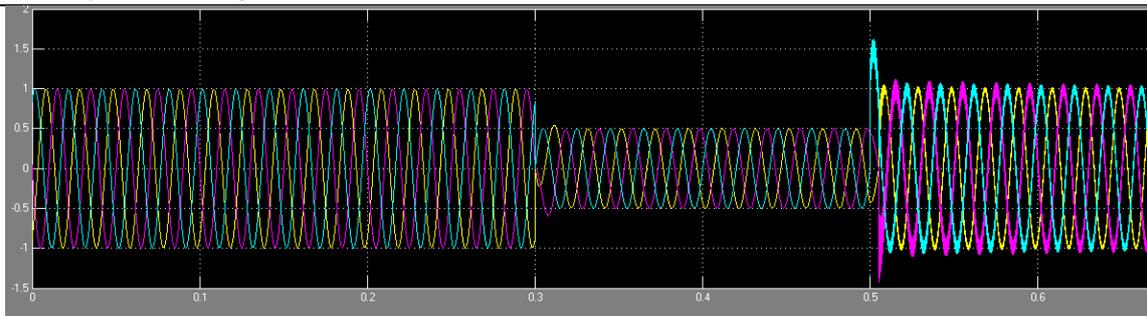


Fig.No.3. 50% Voltage sag without DVR

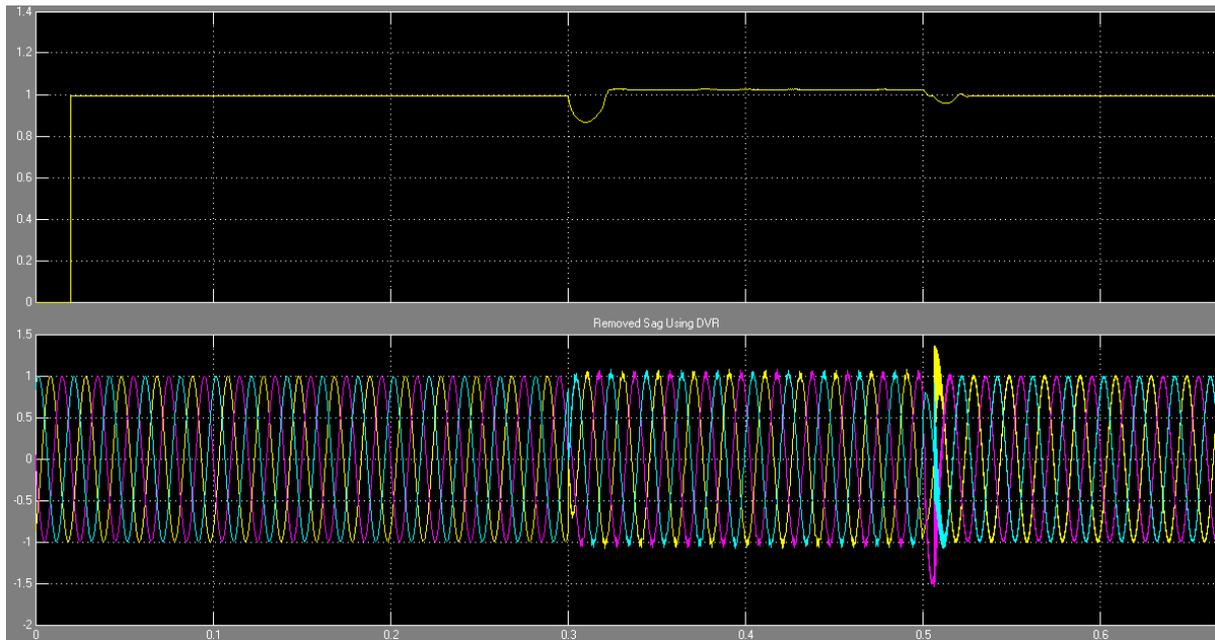


Fig .No. 4. 50 % sag correction using DVR based PI controller

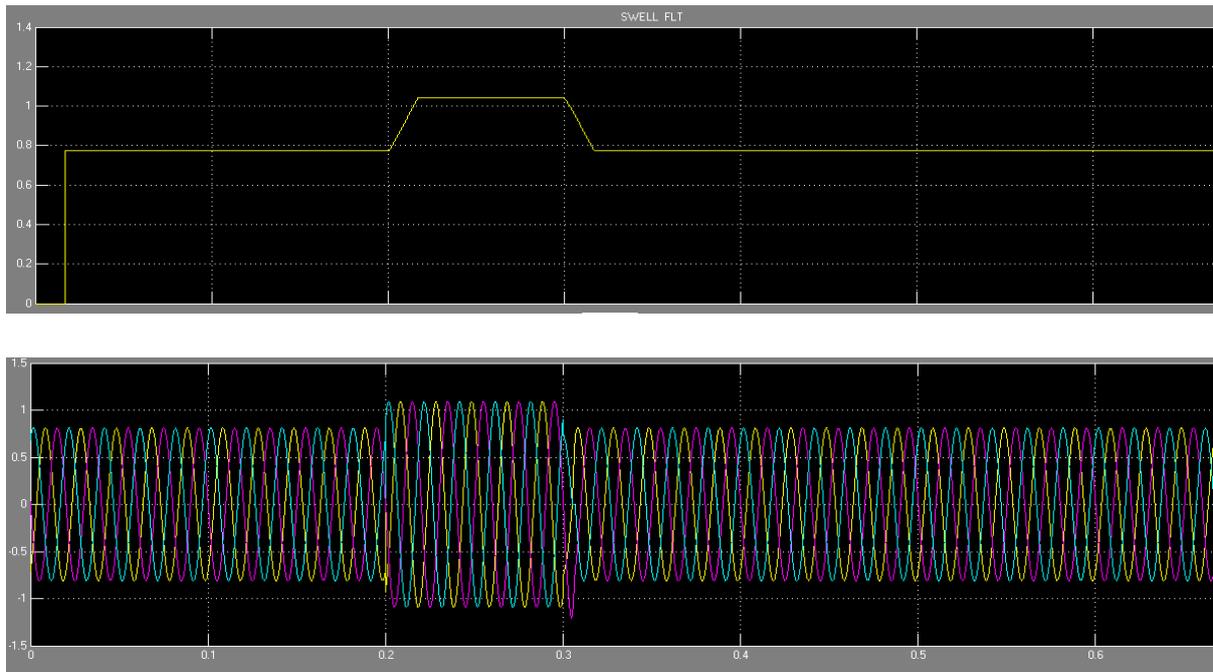


Fig.No.5. 25 % of voltage swell without DVR

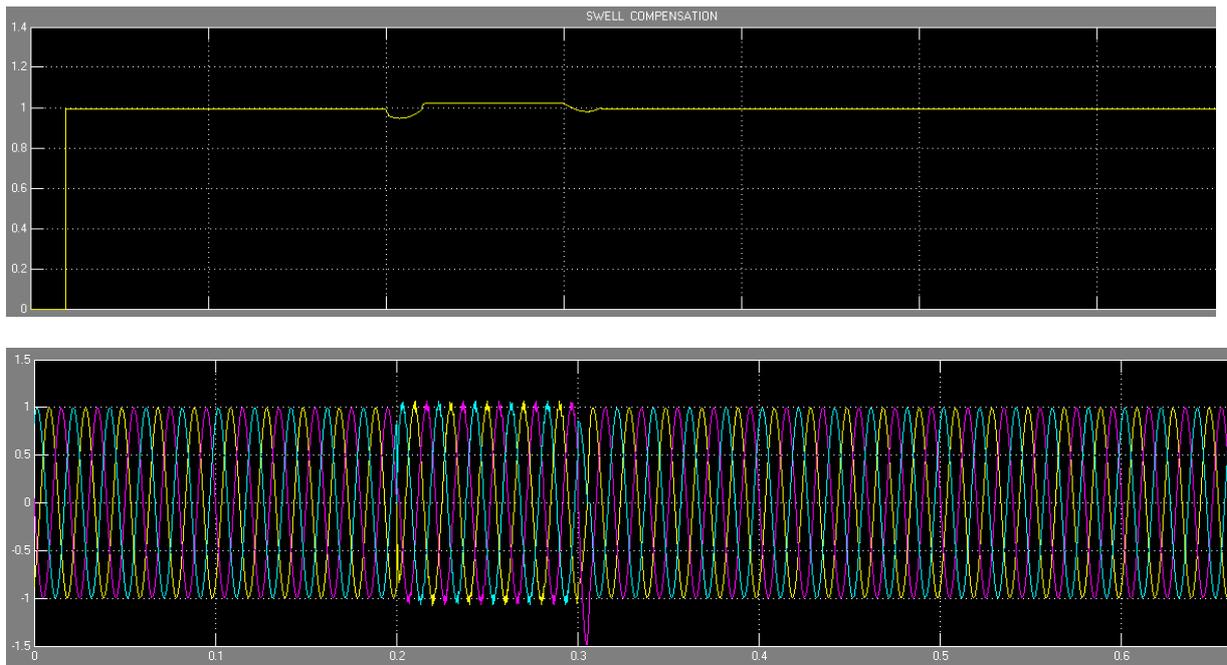


Fig.No.6. 25% swell mitigation by DVR with PI controller

VI. CONCLUSION

This paper investigates the novel technique to mitigate the power quality problems mainly voltage sag and voltage swell through DVR control scheme and provides excellent voltage regulation. The DVR control system not only to detect the start and end of voltage sag but also to determine the sag and swell depth. Also it handles efficiently handles the balanced and unbalanced situation without any difficulties and inject the voltage to keep the load voltage balanced and constant at the nominal values. The main purpose to use DVR is that its cost is less and control is simple.

The simulation will be using MATLAB software and the mitigation technique to show effectiveness of DVR.

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