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# Mitigation of Voltage Sag and Swell under Fault Conditions in Power System Using Renewable Based Custom Power Devices

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**ABSTRACT:** The main challenge in today's power system is to supply continuous, reliable power and satisfy the high demand. The incorporation of renewable energy sources into the utility grid system can be accomplished. However, the renewable sources are intermittent in nature and the loads work dynamically and cause imbalances to the system voltage within an immediate time. Intermittent renewable sources affect the voltage of the power grid system. Photovoltaic (PV) power generation with Custom Power Device (DVR) is used to avoid that. For step-up low DC voltage to required AC voltage for the compensation of the voltage disturbance. This paper introduces a new system design for voltage sag and swelling compensation using a Dynamic voltage restorer based on a Solar Photovoltaic Inverter. The common DVR topics listed here have some shortcomings, such as high-cost, more harmonic and easier electromagnetic interference and are only used to mitigate voltage disturbances. The proposed design also injects the reactive power to the sensitive load. The PV based DVR system consists of a PV system with a low-power and high-power DC-DC booster converter, a series injection transformer and semiconductor switches. PV based DVR execution is simulated under dynamic conditions and the load contains various parameters such as steady state error, Efficiency, Total Harmonic Distortion (THD). All of these conditions are performed in MATLAB-Simulink software.

**KEYWORDS:** Dynamic Voltage Restorer (DVR), Voltage Sags, Control System, Voltage Source Converter (VSC), Power Quality, PV-DVR, MATLAB

## I. INTRODUCTION

In recent years, the application of nonlinear loads such as adjustable-speed drives, switched mode power supplies and electronic fluorescent lamp ballasts etc., in industries, residential applications and in commercial establishment has created a hazard to power system in terms of power quality issues such as harmonics. This led to have more emphasis on the quality of power delivered to the customer. Any kind of power problem which causes any deviation in the voltage, current/frequency and in turn results in equipment failure/fail to function normally is characterized as Power quality. Power quality issues such as short duration voltage variations, long duration voltage variations, waveform distortions, transients, voltage imbalance and voltage flicker plays a vital role in a power system. Amongst the numerous varieties of power quality issues, voltage sag, voltage swell and harmonics are the more foremost concern in the distribution system. A dynamic voltage restorer based on a photovoltaic solar is used. A DVR is a series compensation device to alleviate voltage sag and voltage swelling. It is also used as a series active filter to attenuate harmonics. In this work, photovoltaic and inverter cells are modelled and combined to make a perfect model. The Solar-Based Photovoltaic Inverted Dynamic Inverter (SPVI-DVR) is used to provide an economical solution to compensate for voltage sag. The DVR voltage and swell compensation DVR using with PI controller on the side of the inverter is applied and can be compensated with the voltage sag and swelling in the sensitive load, but the compensating power of compensation in the load is not perfectly matched [1-3]. DVR plays an essential role in the control program and DVR provides an enhanced control scheme using dual velocity control (DVC) with cascading delayed signal cancellation (CDSC) under unbalanced and distorted phase conditions [4-5]. Improve power quality by using DVR and improve three-phase performance. LVRT integrated low voltage rider with a combined distributed generation (DG) system. The combined system PV generator and Wind Power Generator (WPG), which is an essential

advantage for the load to the continuous power [6]. Provide a dynamic dynamics voltage adapter (DVR) with fuzzy regulator. Particle weapon optimization (PSO) -based simulation technique and the fuzzy system are used to adjust the parameters such as, steady state error, THD. The power generation provides a predicted voltage control scheme to control the Transformer smaller DVR. A predicted voltage control scheme uses a unique model of a voltage source inverter circuit (VSI) and an interface filter to generate the process of switching inverter switches.

## II. MITIGATION OF POWER QUALITY PROBLEMS

The recent development in technologies has introduced many power electronic based devices to address the power quality issues and to improve the trustworthiness of the distribution systems. Custom Power (CP) is an approach which is formulated to meet out the industrial as well as commercial standards. The main aim of this CP approach is to introduce power electronic controller devices (CP devices) in power a distribution system which guarantees a quality of power to the equipment present in the distribution system. These CP devices can be categorized into two categories namely Network reconfiguration type and Compensation type as depicted in Figure 1.7. Among these CP devices, this proposed research work has chosen Dynamic Voltage Restorer (DVR) to mitigate the voltage variation problems of PV based standalone system. The vast development in industrialization has created power quality issues. Power quality is nothing but a measure of ability of the electrical power source to meet out the demand offered by the load connected to it. If there is any operational problems arise on the load side of the system, then there will be power quality problem. The term 'power quality' refers to maintenance of bus voltages at rated magnitude and frequency. When quality of power gets deteriorated, it will affect the end user. However, the conventional power generation by means of fossil fuel and coal causes environmental pollution. Hence, in order to overcome the power quality issues along with usage of conventional energy sources, this work proposed a novel Dynamic Voltage Restorer (DVR) to diminish the power quality issues such as voltage sag and harmonics. In this design, the PV system is employed as a DC source of DVR and artificial intelligent based controller techniques are utilized to control the operation of DVR.

## III. PROPOSED METHODOLOGIES

The variations in the line voltage of a distribution networks are mainly due to unexpected changes in the load conditions. These variations cause severe damage to the power electronic equipment attached to the distribution network. Hence, it is essential to maintain the line voltage so as to safeguard the equipment from damage regardless of the voltage fluctuations. A DVR is the most efficient device which is used to address a voltage sag issues in the distribution network. Thus an objective of this work is to improve the quality of power in distribution system using DVR. Hence, the solar power is employed as the input to the DVR to improve the power quality. Thus it developed an efficient photovoltaic model with Boost converter based P&O MPPT technique to track maximum power. Conventional Voltage source inverters are used to afford the power to the distribution network. The converter is most likely a Voltage Source Inverter (VSI), which sinusoidal Pulse Width modulates (SPWM) the DC from the DC-link/storage to AC-voltages injected into the system. A VSI is a power electronic system, which consists of capacitor storage and switching devices, which can generate a sinusoidal voltage at required constant frequency, magnitude, and phase angle. In the DVR application, the VSI is used to transitory replace the supply voltage or to generate the part of the supply voltage which is missing. However, the efficiency of the DVR mainly depends upon the performance of the controllers. Several control techniques have been proposed by researchers to realize the DVR and this chapter describes a sag compensation technique with effective compensation systems.

The block diagram representation of the proposed topology is depicted in Figure 1. The major components of DVR are a VSI, a DC source, an AC filter and a coupling transformer. Here the DC source is a PV system and the power from the PV system is tracked using P&O algorithm.

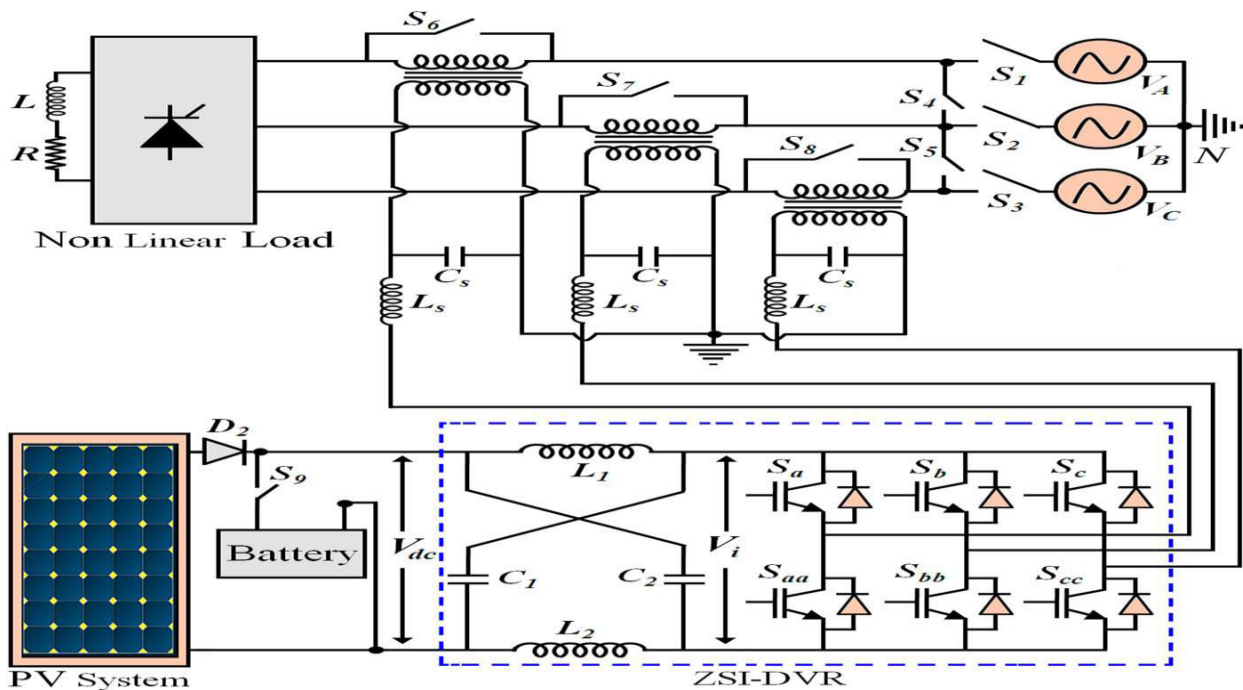


Figure 1. Proposed solar PV power generation with a ZSI-based dynamic voltage restorer

DVR is a power electronic circuitry that is used to transform voltages from the DC battery/PV system to the AC system as a voltage source inverter (VSI). The boost transformer unit transmits the voltage to the distribution system from the DVR for the compensation of voltage based disturbances. The primary winding is connected to the power system in series and the secondary winding with the DVR is connected. The harmonic filter consists of an LC circuit to minimize the waveform harmonic distortion generated by VSI. Figure 4.1 displays the proposed solar PV power generation with a dynamic voltage restorer. The solar PV system's main module comprises solar PV with boost converters, ZSI converter, and battery storage unit with DC-DC converter, AC loads, and the power grid. The utility grid is fed to the load through the DVR. The DC link is interfaced with solar photovoltaic with DC-DC converter and battery storage unit. The critical loads are protected by DVR and by the solar PV generation connected with the grid. The voltage is also regulated at the DC-link and the power transmission efficiency in the distribution line is increased. The battery storage system stabilizes power during the intermittent nature of the solar photovoltaic. The solar photovoltaic system with the battery supports the DC-link when the maximum energy is needed in the daytime.

#### IV. SIMULATION RESULT AND DISCUSSION

The PV Based DVR with controller is implemented in the MATLAB Simulink software system. Enhanced PI controller technique provides power quality in the distributed system whose performance is measured in the current condition. The simulation of SPVI-DVR, the input voltage are in three phase test system was consider. The sensitive loads take only the standard real and reactive power. Change the power source variation of a series filter that will act as the reactive power of the system and compensate for the power oscillation. At the initial stage, the harmonics present in the nonlinear load are high. After complete harmonic conversion of series filter, low current. The diversity of the proposed model with its output parameters such as source voltage, load voltage and injection transformer voltage is reflected in the scope of the system. The test systems of SPVI-DVR for three phase distribution system is consider and the system parameters are depicted in Table 1. The proposed SPVI-DVR result of line voltage was subjected to the voltage sag of 60% and time duration from 01.sec. to 02.sec. the voltage swell subjected to 30% and time duration from 0.25 sec to 0.3sec.

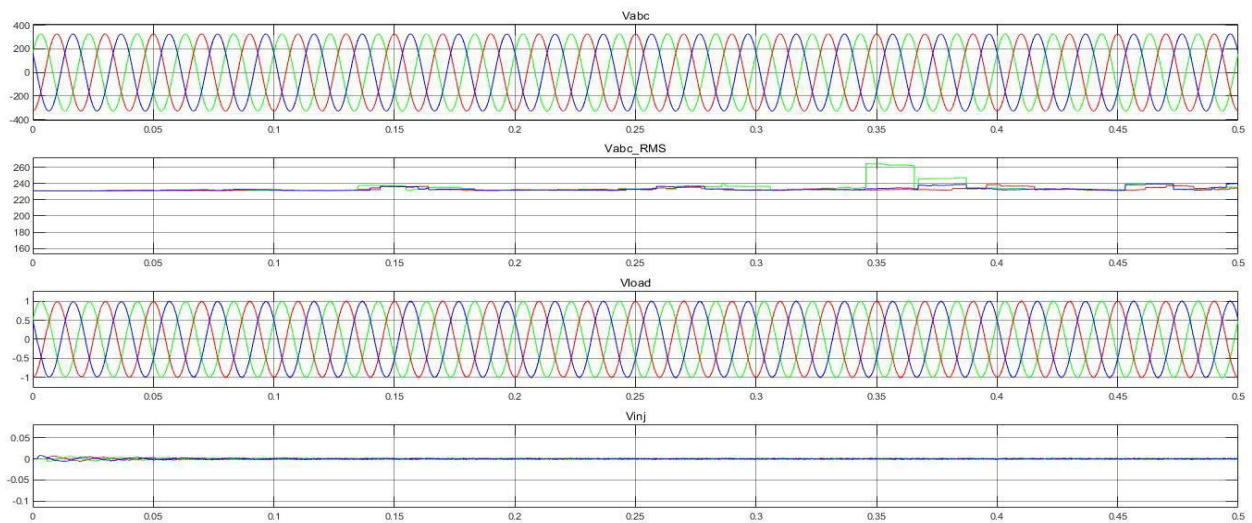


Fig..2 Simulation results of the proposed three phase PV Based DVR without fault

These results suggest that the proposed SPVI-DVR is capable of mitigating major sag and swell power quality issues in the three-phase distribution networks. It is assumed that there is a single line fault in the ground in the three-phase system. Line-to-line voltages are reduced between the R&B and R&B phases. The DVR applied injection voltage per phase and line voltage through a compensated phase to line. A double line to ground fault is also imagined to study the performance of the DVR.

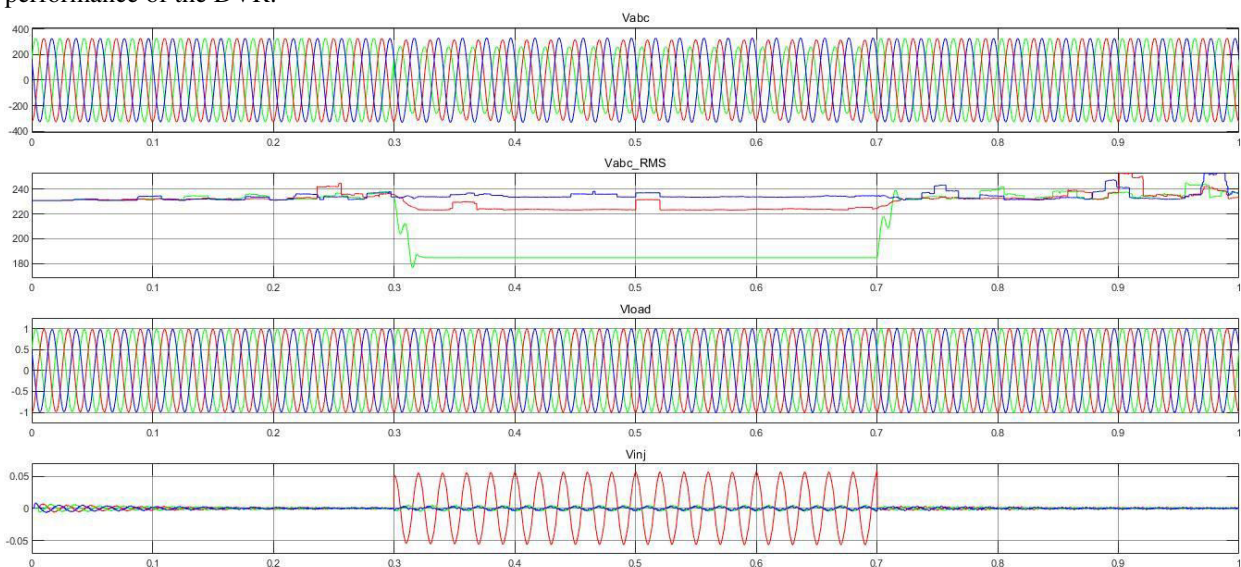


Fig.3 Simulation results of the proposed three phase PV Based DVR with LG fault

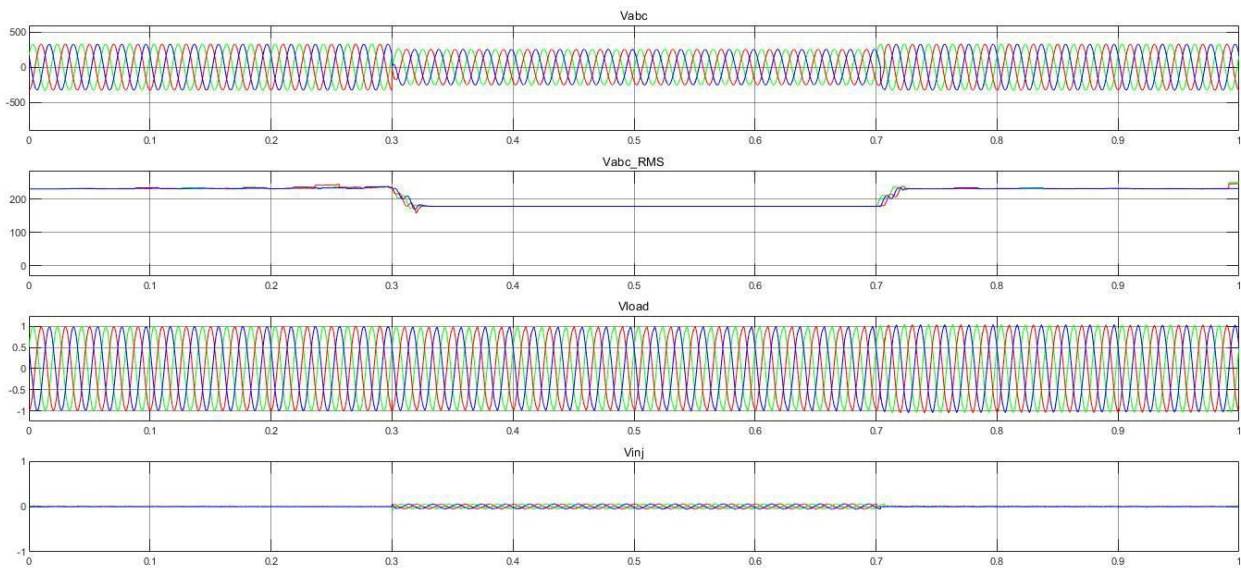


Fig.4 Simulation results of the proposed three phase PV Based DVR with LLG fault

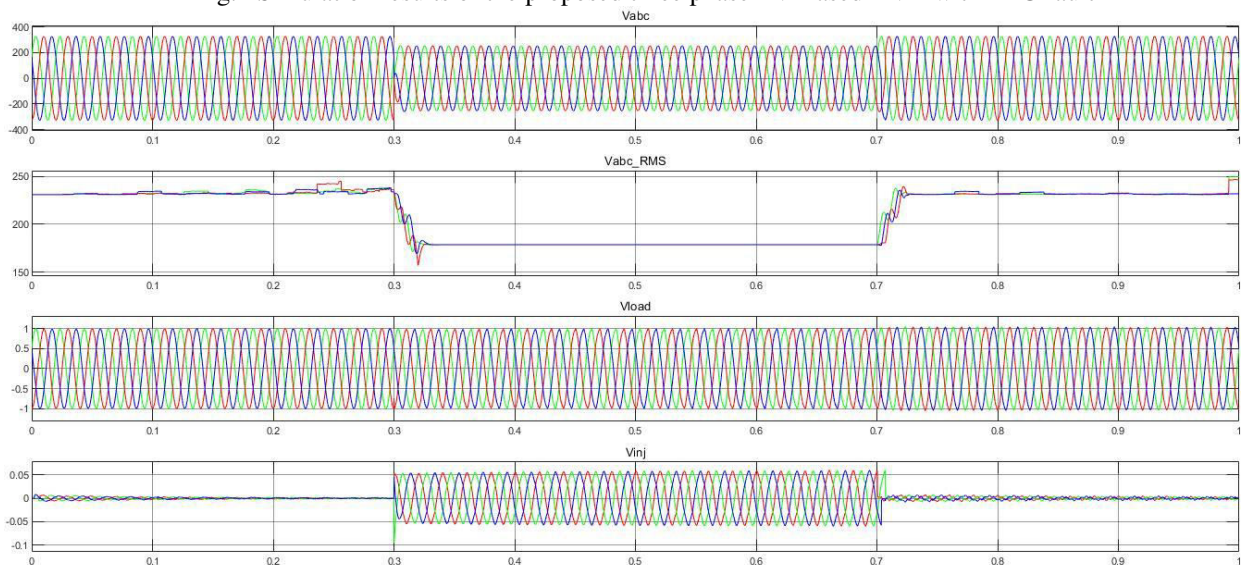


Fig.5 Simulation results of the proposed three phase PV Based DVR with LLLG fault

## V. CONCLUSION

In this work the three phase balanced distribution system was considered and which was analysed the DVR in the distribution network. It can compensate the power quality issue like voltage sag and swell in sensitive load. The new control technique was introduced in the DVR, the Solar Photovoltaic Inverter DVR (PV-DVR) can reduce the switching losses in the inverter operation at the time of voltage sag injection, minimize the energy storage losses and also analysis with various parameters such as steady state, efficiency and Total Harmonic (THD) distortion with dynamic current condition. In addition to that, the sag compensation time is very fast compared conventional DVR. The SPVI-DVR suppresses the THD which is 2.2% and also the overall performance of PV Based DVR was increased which is reflected in the output waveform. The maintenance cost of the PV based DVR is less.

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