

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 3, March 2018

Design of Interline Dynamic Voltage Restorer for Voltage Sag Compensation

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ABSTRACT : With the widespread use of electronic equipment, loads are becoming more sensitive and less tolerant to short term voltage disturbances in the form of voltage sags. Custom power is a technology-driven product and service solution, which embraces a family of devices to provide power quality enhancement functions. Over the existing systems, the Dynamic Voltage Restorer is the advance technology and economically Related device for voltage sag mitigation in distribution systems. The conventional DVR functions by injecting Alternating Current voltages in series with the input three-phase network, the purpose of which is to improve voltage quality by an adjustment in wave shape, voltage magnitude, and phase shift. The Voltage sag compensation involves the injection of real power and the reactive power to the distribution system. The reactive power requirement can be generated electronically within the voltage source inverter of the Dynamic Voltage Restorer.

KEYWORDS: DVR, IDVR, SVPWM, DC-link

I. INTRODUCTION

Two-line Interline Dynamic Voltage Restorer (IDVR) consists of two back-to-back Dynamic Voltage Restorers (DVRs) connected to independent distribution feeders with a common DC link Sensitive electronic loads such as medical and automation equipment are vulnerable to power supply disruptions. Consequently, high power quality and voltage regulation are needed. Voltage sags and swells are common power supply disruptions that occur in electrical systems. They generate costly production losses caused by disoperation and interruption of sensitive loads devices .It defines sag as a decrease in Root Mean Square (RMS) nominal line voltage between 0.1 and 0.9 p.u. that lasts between half a cycle to one minute. Similarly, swell is defined as an increase in RMS nominal line voltage between 1.1 to 1.8 p.u. that lasts half cycle to a few seconds. Sags are classified as instantaneous, momentary and temporary events. Instantaneous sags last between 0.5 cycles to 30 cycles, momentary sags last between 30 cycles to 3 seconds, and temporary sags last between 3 seconds to 1 minute. Thus, sags and swells are voltage variations caused by remote faults such as short circuits in distribution or transmission lines connected to a common coupling point, starting currents of large motors, sudden changes in load line, changes in network operation., (etc)

II. LITRETURE SURVEY

Power quality in electric network is one of the day most concern area of electric power system. The power quality has series economic implication for consumer, utilization and electric equipment manufacture. The impact of power quality problem is increasingly felt by customer-industrial, commercial and even residential. Some of the main power quality problems are sag/swell, harmonics and flickers etc.,

By custom power devices refers to power electronics static controller used for power quality improvements on distribution system rate from 1 to 38 KV. This interest in the power quality devices arises from the need of growing power quality levels to meet the everyday growing sensitivity of customer needs and expectations. One of those devices in dynamic voltage restorer, which is the most efficient and effective modern custom power devices, used in

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power distribution networks. Its application includes lower cost, small size, and it is fast dynamic response to the disturbance.

Several research papers and reports addressed the subject of improving power quality in distribution system by the use of custom power devices.

III. EXISTING SYSTEM

The numbers of loads on the distribution side are gradually becoming more sensitive. These sensitive loads are easily affected due to various disturbances in the system which is known as power quality issues.

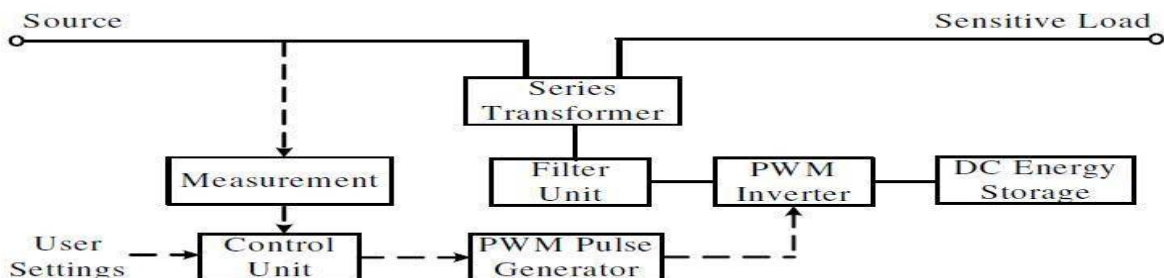


Fig. 1. Block Diagram of Existing System

There are various traditional methods like capacitor banks, synchronous condenser etc., to mitigate the voltage sag/swell. The drawback of capacitor banks is limited range of protection and also the life span is less. The main disadvantages of these devices are requirement of large DC link to mitigate large voltage sags and also the devices are restricted to be connected to only one feeder.

IV. PROPOSED SYSTEM

A power electronic converter based series compensator that can protect critical loads from all supply side disturbances other than outages is called a dynamic voltage restorer. The restorer is capable of generating or absorbing independently controllable real and reactive power at its AC output terminal.

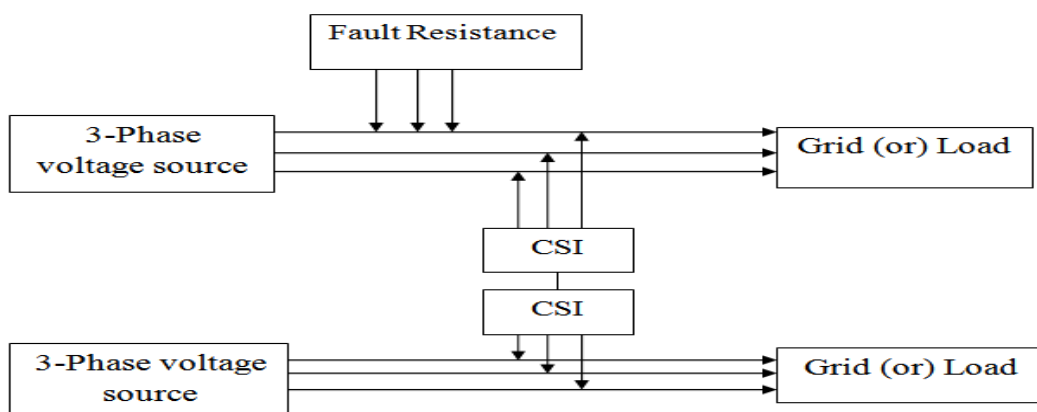


Fig. 2. Block diagram of proposed system

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A DVR is a solid state power electronic switching device consisting of either GTO or IGBT, a capacitor bank as an energy storage device and injection transformers. It is connected in series between a distribution system and a load. The basic idea of the DVR is to inject a controlled voltage generated by a forced commuted converter in a series to the bus voltage by means of an injecting transformer. A DC capacitor bank which acts as an energy storage device, provides a regulated dc voltage source.

V. CURRENT SOURCE INVERTER

CSI are the type of inverters fed with a current source with high impedance. The source at the AC side of the inverter may be a current source or inductor in series with a DC source. As the input voltage is constant in VSI, in CSI the input current is constant but adjustable. The amplitude of the output current is independent of load. The waveform and magnitude of the output voltage depends on nature of load.

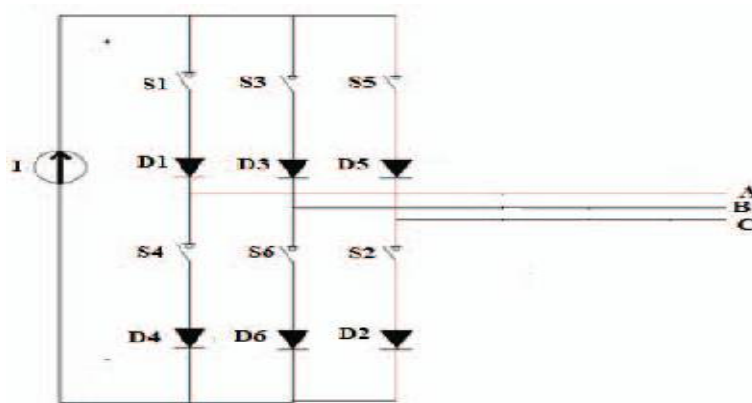


Fig. 3. Schematic diagram of CSI

Fig. 3 represents the three phase CSI . In Fig. 3, S1 to S6 represents the switches (MOSFET or IGBT) and D1 to D6 are the diodes connected in series to the switches to block the reversal of current. The advantages of CSI are its excellent current control capability, easy protection from short circuit or over current, and output current is ripple free, though it is costlier than VSI. Fig. 3. Schematic diagram of CSI A PV source is used at the DC link of IDVR to provide necessary energy while IDVR is mitigating the voltage sag. The next section covers total simulation results of IDVR system.

VI. INTERLINE DYNAMIC VOLTAGE RESTORER

The schematic diagram of IDVR is shown in Fig. 4. A two line IDVR is considered in this paper. The IDVR consists of two DVRs connected to two different feeders. PI controller along with CSI and filter is present inside the building blocks of IDVR. In Fig.4 V_{s1} and V_{s2} are source voltages while V_{b1} and V_{b2} are voltages of bus 1 (B1) and bus 2 (B2) at the distribution side where IDVR is connected. Z_{L1} and Z_{L2} are impedances of feeder 1 and feeder 2 respectively.

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Load 1 and load 2 are connected to each of the buses as shown with V_{L1}, I_{L1} and V_{L2}, I_{L2} as the load voltages and currents.

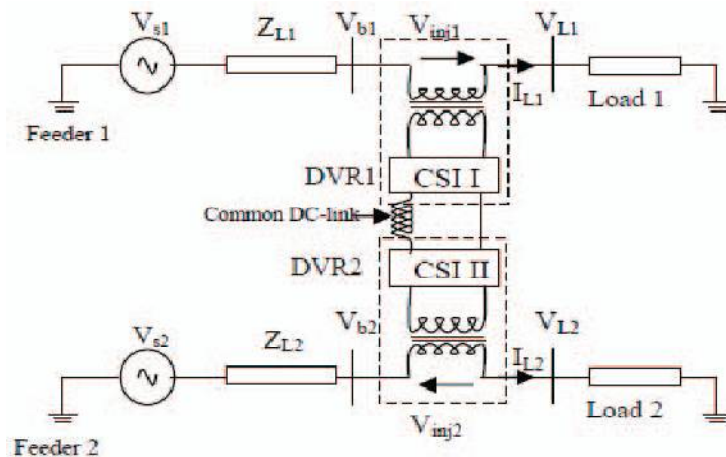
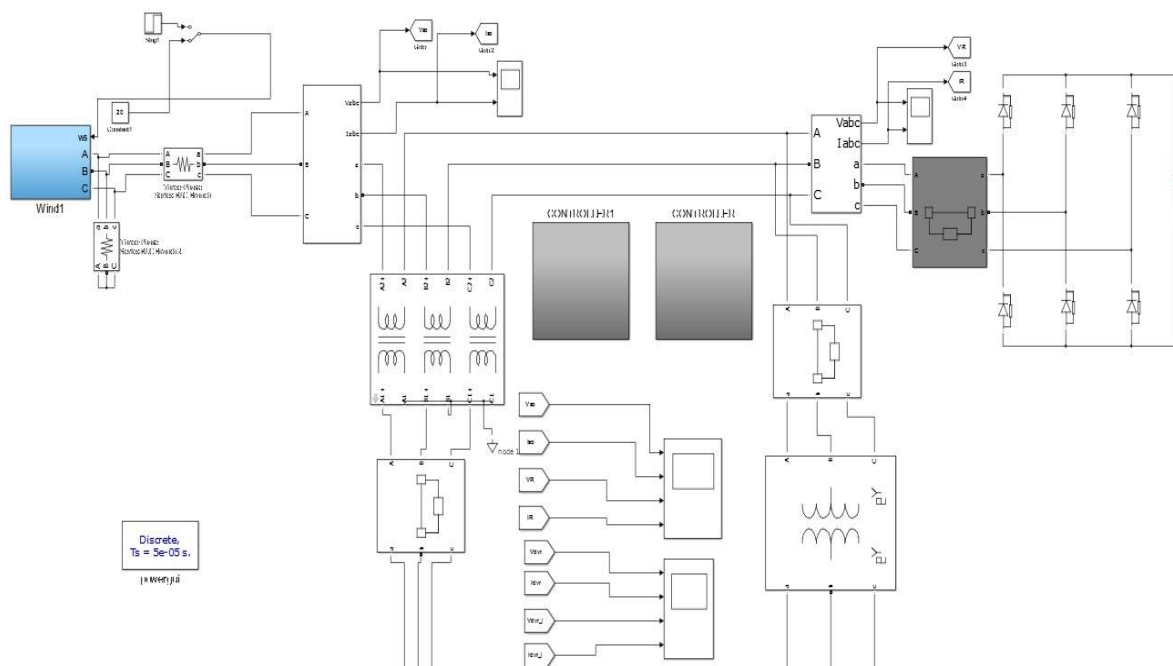


Fig. 1. Schematic layout of Interline Dynamic Voltage Restorer

Both these loads are assumed to be sensitive and they need protection from voltage sag and harmonics. V_{inj1} and V_{inj2} are voltages injected by DVR1 and DVR2 respectively during the voltage sag conditions. The building blocks of IDVR, CSI is discussed in the following section.

VII. SIMULATION RESULTS



The above figure shows the front end of the simulation diagram

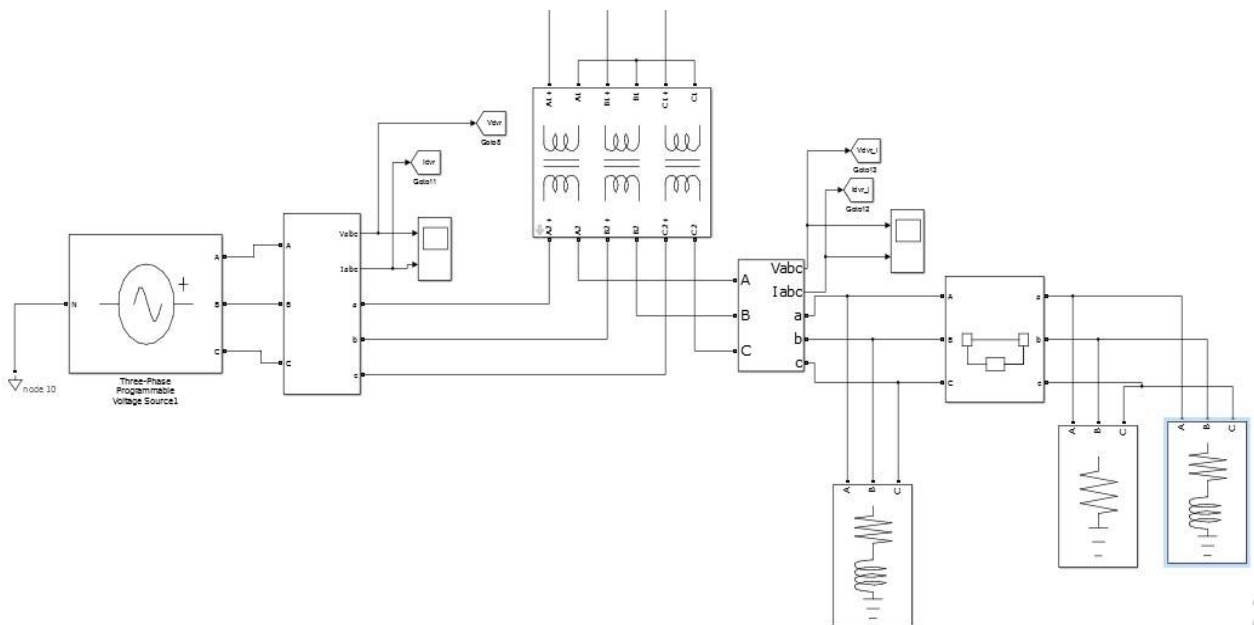
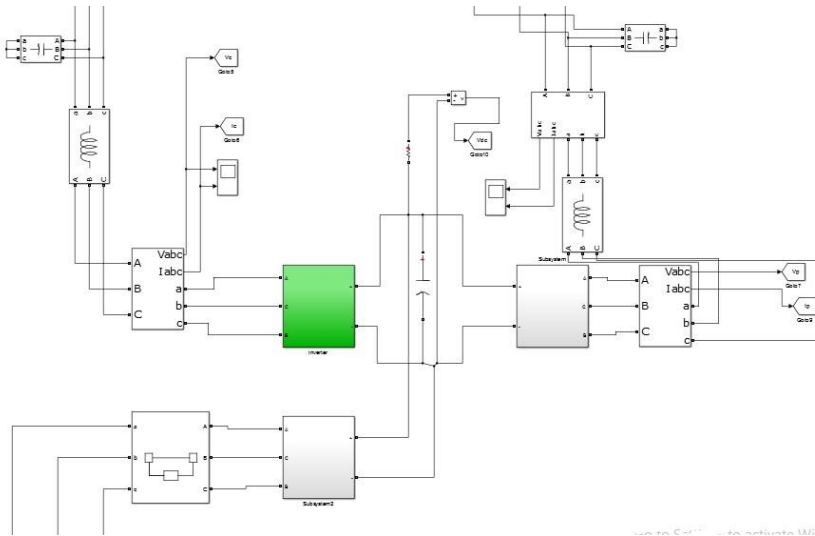
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The below figure shows the mid part of the simulation diagram



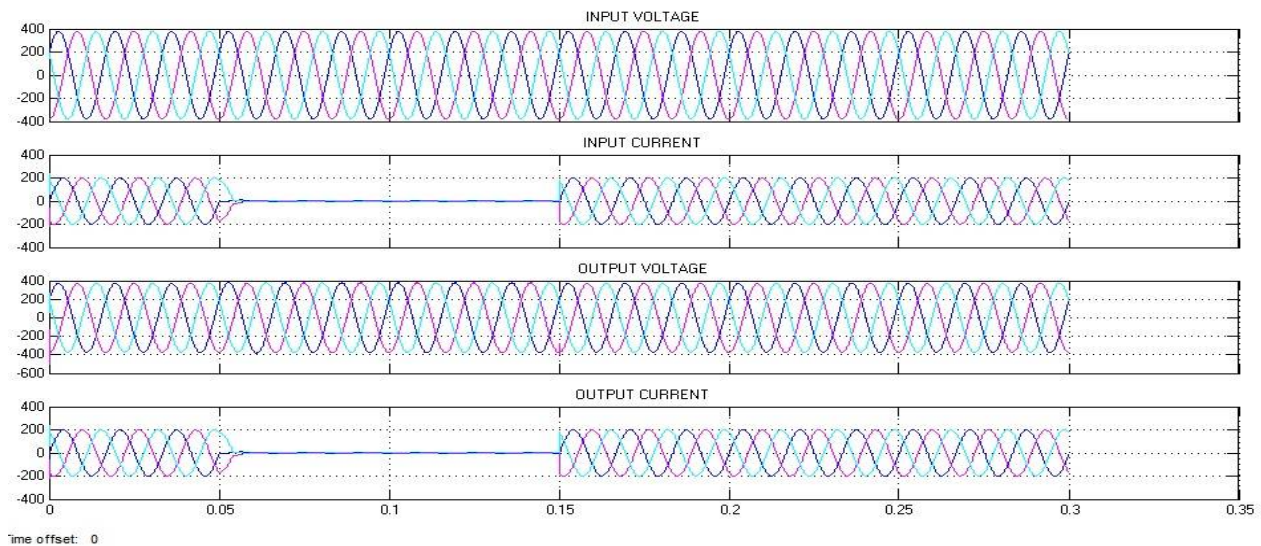
The above figure shows the back end of the simulation diagram

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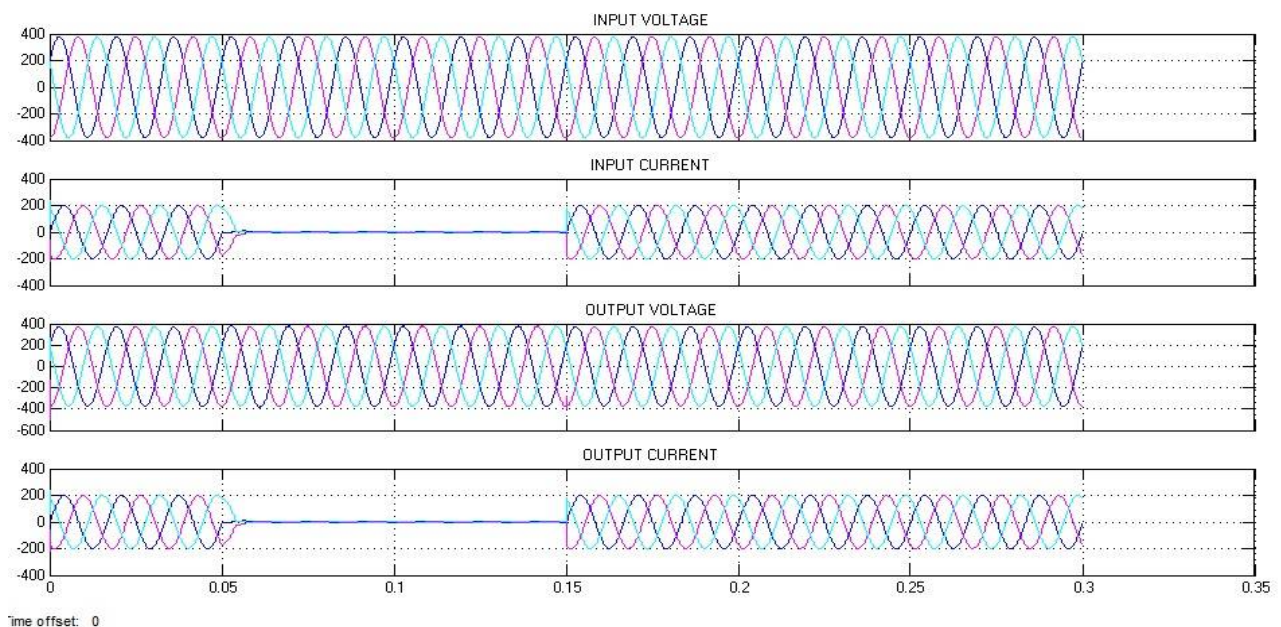
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The above figure shows the simulation result of the transmission line 2 in the simulation diagram



The above figure shows the simulation result of renewable energy in the simulation diagram

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VIII. CONCLUSION

In this paper the performance of IDVR with CSI at its building block along with a PV source at its DC link is proposed. The purpose of IDVR is to mitigate the voltage sag/swell which occurs at the load end. To provide necessary energy for IDVR to mitigate voltage sag/swell, a PV source is provided at the DC link of IDVR. The PV source is connected along with charged SMES coil, which acts as back up for PV source. The charged SMES coil provides necessary energy for IDVR to mitigate voltage sag if the PV source fails to operate. In this paper, the voltage sag/swell is created in four different conditions and at each condition the performance of IDVR in mitigating the voltage sag is investigated. The total simulation is performed using MATLAB Simulink software. The results that are obtained in all the different cases indicate that the IDVR is mitigating the voltage sag/swell irrespective of the severity of voltage sag. In the presence of PV source at the DC link, the IDVR restores the DC link energy and thus mitigate the voltage sags which are occurring simultaneously in both feeders. The harmonics which are observed in some cases along with voltage sag are eliminated by the filter which is connected to the IDVR. Therefore a conclusion can be drawn that the IDVR along with PV source at its DC link is able to mitigate the voltage sag/swell in all the proposed conditions

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