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Interline Dynamic Voltage Restoration (IDVR) in Transmission Line

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Abstract

IDVR is a device where more than two DVR connected in multi-transmission line. Performance of DVR is to inject the voltage to the line for long period voltage sag/swell. Generally, DVR in IDVR device compensates voltage sag/swell other DVR's connected in common DC link capacitor which replenish the energy and keep up the DC link at constant. Design, modeling, and performance of IDVR are proposed in this paper. IDVR consist of two different lines with two DVR devices to compensate the voltage sag. Series connected compensator (DVR) compensates sending end voltage disturbance voltage sag. In this paper, analyse the closed loop control of IDVR system is using PID controller and their output results are verified using MATLAB/Simulink.

Keywords: Interline Dynamic Voltage Restorer (IDVR), voltage swell/sag, PID Controller technique.

1. Introduction

In present time power production, distribution and transmission is not expanded straightly to fulfill the thorough power need. Despite the fact that, generated power can be move through transmission line is to be improved. There is a requirement for protecting the power system from voltage sag and swell. Reactive power in the line/system causes the high transmission losses and diminishes the steadiness of the system. This reactive power can be compensated by compensators [1-4].

DVR is efficient, small in size, and the arrangement associated in power system and it protect the sensitive load from harm of voltage sag. Voltage injection of transmission line, and real, reactive power connected by the DVR [5] these are relies upon the swell components. It doesn't require any energy system and the energy is utilized to replenish the long term voltage

drop. IDVR has turned out to be most tempting solution for improve the execution of decrease the imbalanced stage voltage in transmission line. It limits the DC source. In spite of the fact that one of the DVR remunerates the voltage droop and other connected to the DC link for replenish the energy [6]. Injection rating of transformer in IDVR is a three-single phase transformer which connected in series with source side and the converter side transformer is in star connected. Specifications and operation of converter depends on compensation topology. In 1ϕ and 3ϕ system DVR is suitable for reducing the power system problems [7]. Injected voltage is equal to the primary winding of transformer. Then the injected voltage can be determined by condition.

Control topologies are used to control and regulate the voltage where the load is in unstable. Controls methods of DVR can be classified into two types are open loop control and close loop control [8]. Voltage compensation of power system is analyzed using IDVR based three phase inverter with common DC link with PID control is implemented in this paper. The proposed configuration and its operation are analyzed using MATLAB/Simulink.

2. Proposed Works

The proposed system is shown in fig.1 and it consists of AC source, VSI, injecting transformer and linear and nonlinear load. In this paper two different lines are used to compensate the voltage sag with the help of IDVR setup. It is connected with the common DC link voltage. Source voltage fed to the load through transformer normally in both line. Fault or voltage sag/swell in line-2 that can be compensate by another healthy line-1. If voltage sag/swell in the line-1, that can be compensate by line-2. If the fault is occurred continuously, the process will be repeated.

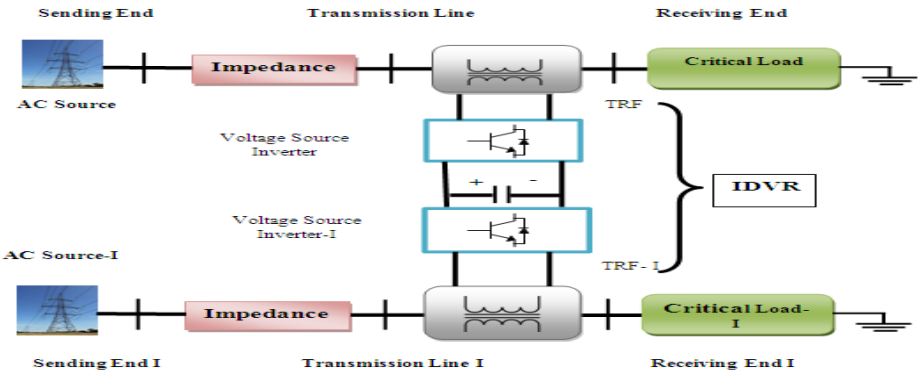

Figure. 1 Proposed Block Diagram

3. IDVR

IDVR in transmission line using three phase voltage source inverter is proposed in this paper. It converts the voltage one form into another form (DC to AC) voltage. It consist of 6 switches namely S1, S2, S3, S4, S5, and S6 and it is controlled by using PID control technique. Fig. 2 represents the generalized diagram of 3 -VSI. IDVR structure starts to compensate the voltage swell at both conditions as normal and abnormal. IDVR system consists of two back to back voltage source inverter (VSI) is connected to a common DC link in series. Number of DVR's connected to different lines and two different supply voltage lines and it has two separate sources. Voltage swell occurs in line 1 then the power is injected by DVR 1and an equation of the power delivered is represented in below equation (1). DVR in line 1 acts as inverter and line 2 DVR acts as rectifier.

$$P_{DVR1} = P_{Source1} - P_{Load1} \tag{1}$$

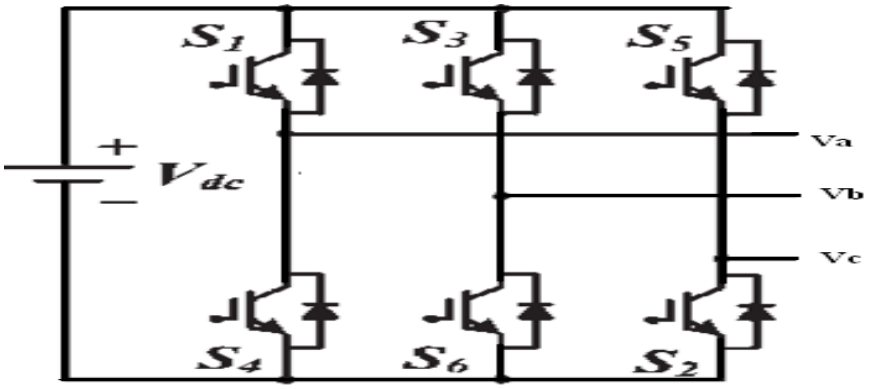

Figure. 2 Single Diode PV Model

4. Control scheme of IDVR system

Control strategy of IDVR is introduced to compensate the voltage swell during the fault period. In IDVR simulink model utilized PID controller for voltage swell compensation in the line. Here, PID control technique is used to produce switching pulse to the rectification and inversion. DVR-2 at line-2 performed as rectifier and DVR-1 at line-1 act as inverter. Capacitor is connected between the operation of rectifier and inverter. Capacitor restocks the energy to the system. Hence, separate switching pulses are required to the inverter and rectifier.

5. Simulation Results

The IDVR model is designed and their performance, output results are verified using MATLAB/Simulink. Two different lines are connected in different line circuits that are implicit to linear or non linear load. Swell voltage is compensated by from DC link voltage. Simulink model of IDVR using MATLAB is represented in fig. 3.

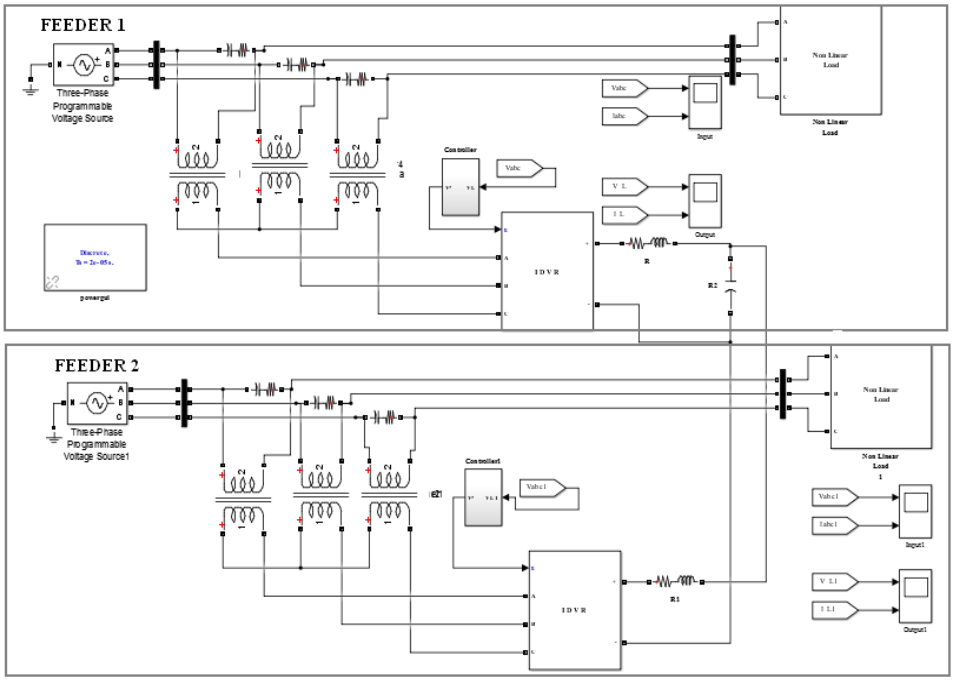

Figure. 3 Simulink Model of PID Controller Based IDVR Structure

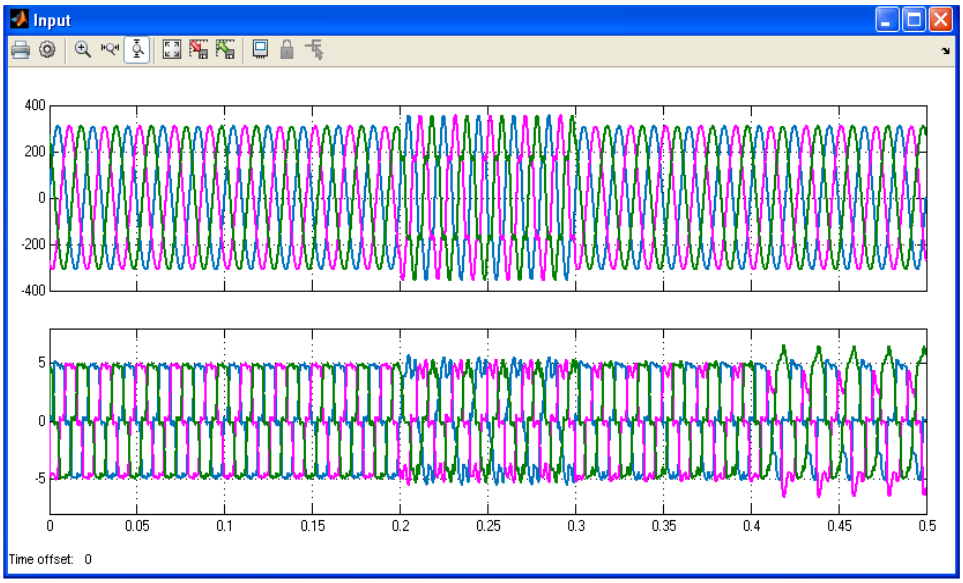

Fig. 4 Voltage Swell in Line-1

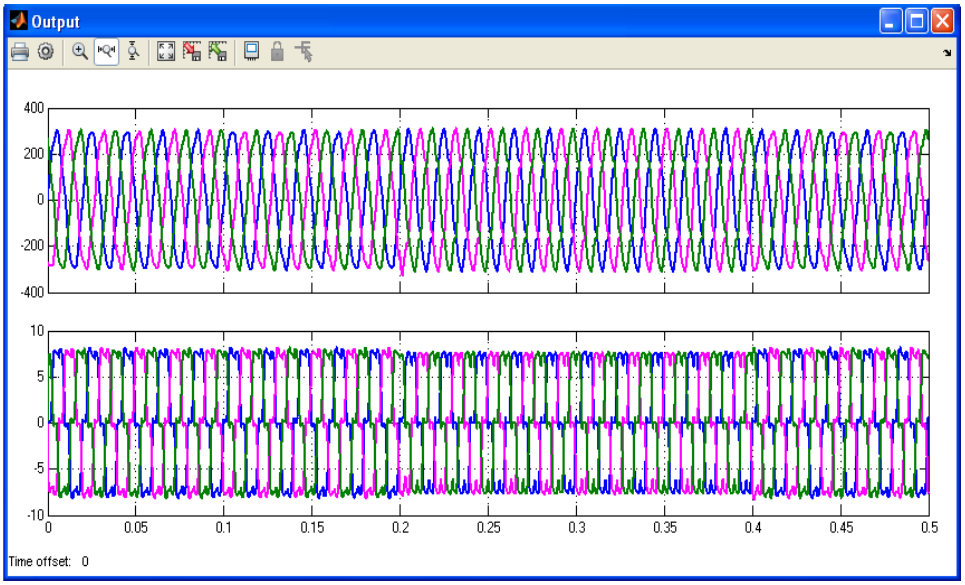

Figure. 5 Compensated Swell Voltage in Line-1

Fig. 4 presents the voltage swell at line 1 of 2.4kV. Swell voltage compensated by DVR-1 in the line-1. Suddenly voltage has to be increased at certain time is monitor by DVR system in transmission line. Voltage swell time of the system is 0.2sec-0.3sec. Compensated voltage in

line-1 is shown in fig.5. Then the output voltage and current is about 300V, 8A. Fig. 6 represents the voltage swell at line-2 of 1.5kV. DVR-2 in line-2 compensates the swell. Fig.7 shows the line-2 compensated output voltage. Output voltage is 300V and current is 5A.

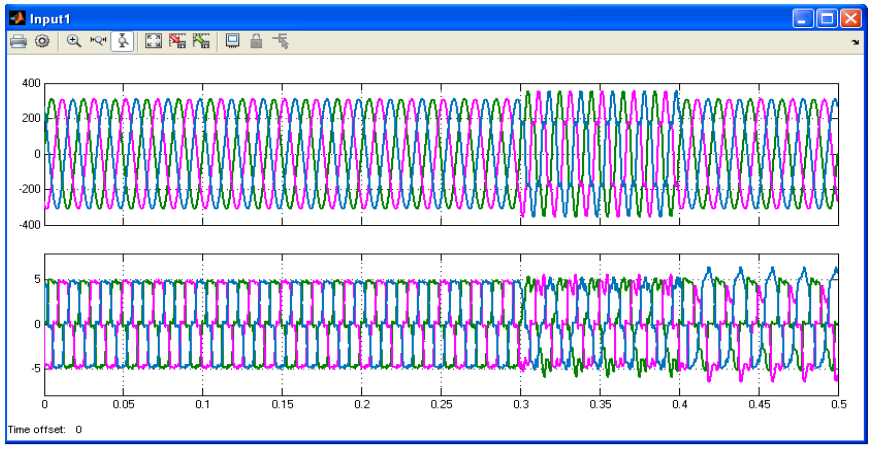

Figure. 6 Voltage Swell at Line-2

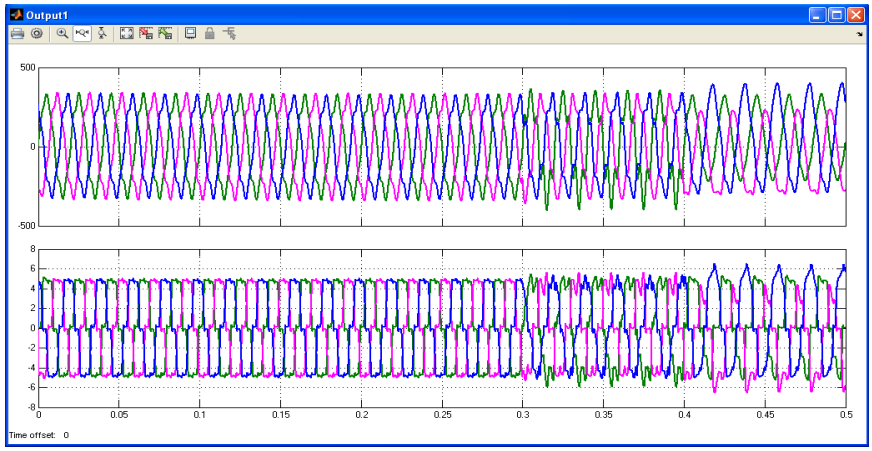

Figure. 7 Compensated Voltages at Line-2

7. Conclusion

Design, modeling and performance two- line interline dynamic voltage restoration is proposed. Injection of voltage at sag period is depends the compensation capability of 3ϕ- inverter in DVR. By proper designing of DC link capacitor, replenish energy is utilized in

effective way. Maintain the constant load voltage which is better compare to existing compensation techniques. 10% of voltage swell is compensated by using PID controller and it is implemented and analyzed, verified through using MATLAB/Simulink.

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