ISSN 2395-1621

Simulation of Interline Dynamic Voltage Restorer (IDVR)

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ABSTRACT

Due to changes in load conditions, there are voltage disturbances like voltage sags. Because of such voltage disturbances, there is lot of effect on the load voltage, which may harm the sensitive load. Dynamic voltage restorer (DVR) is an advanced & also economical way which is used to mitigate voltage sags, thereby protecting sensitive loads. Several DVRs can be connected in different feeders to a common DC link. It is generally used in distribution systems. Instead of using a single DVR we can use interline dynamic voltage restorer (IDVR). An IDVR may consist of several DVR's & they share a common DC link between them. In IDVR, one DVR will compensate for the voltage sag & the other DVR will help to replenish the common DC link voltage so as to maintain the DC link voltage at a specified level.

ARTICLE INFO

Article History

Received: 4th November 2016

Received in revised form :

4th November 2016

Accepted: 6th November 2016

Published online :

15th November 2016

Keywords: **IDVR,DC link voltage, DVR**

I. INTRODUCTION

Power distribution systems, ideally, should provide their customers with an uninterrupted flow of energy at smooth sinusoidal voltage with constant magnitude level and frequency. However, in practice, power systems, especially the distribution system have numerous nonlinear loads, which significantly affect the quality of power supplies. As a result of the nonlinear loads, the purity of the waveform of supplies is lost. This ends up producing power quality problems. Due to use of induction motors at the load side, inductive load increases which leads to reduction in power factor. Voltage sag compensation will involve real & reactive power injection as per the requirement.

The DVR is one of the common solution & also effective for voltage sags at distribution feeder. Voltage sag can be defined as a reduction in supply voltage from 10% to 90% of the supply voltage. By injecting active or reactive power we can restore the voltage of distribution system. IDVR consists of two or more DVRs connected to a common DC link. The 2nd DVR is used to provide real power to the DC link energy storage & 1st DVR will be used to mitigate for voltage sag. There are several control techniques for voltage sag compensation. The DVR is a power electronic device used to inject three-phase voltages in series and in synchronism with the distribution feeder voltages in order to compensate for voltage sags. As we are using two DVR there will be two converters, each one can be operated in power control (PC) or voltage control (VC) mode.If voltage sag occurs then, on that feeder, its converter will act in VC mode & the required power for voltage restoration will now be absorbed from the DC link. Now, the remaining converter will act in PC mode, so that it can ful-fill the DC link voltage. In this way the power sharing between two DVRs will take place.

When all the feeders are healthy i.e during normal operating conditions there is not any requirement of sharing modes. At that time the DVRs can be bypassed via bypass switches. Hence we can mitigate for voltage sag & also power factor can be improved.

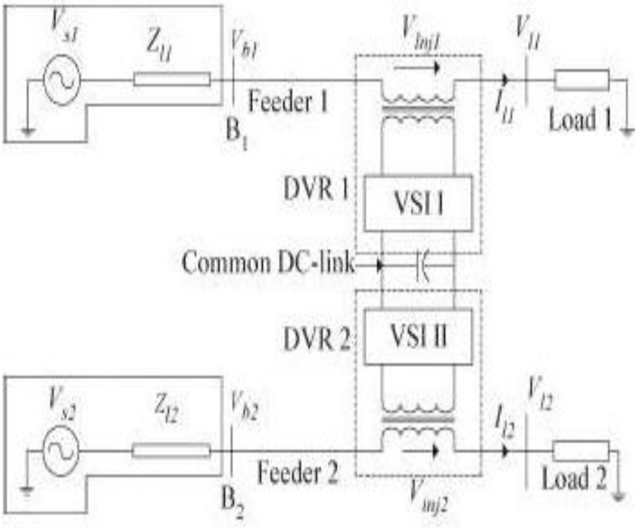

Fig 1: Interline dynamic voltage restorer

II. OPERATING PRINCIPAL OF IDVR

Both DVRs can operate in either power control (PC) or voltage control (VC) mode. It is very rare that the fault occurs at both the feeders at same time. So, if one of the feeder experiences voltage sag then only one DVR will operate. There are two modes of injecting voltage, one will be In-phase voltage injection & the other is Quadrature voltage injection. When the feeder is switched to power control mode, the in-phase voltage component will pump or absorb active power from the DC link. Similarly, when the feeder is switched to power control mode the quadrature voltage component will keep the load voltage magnitude constant.

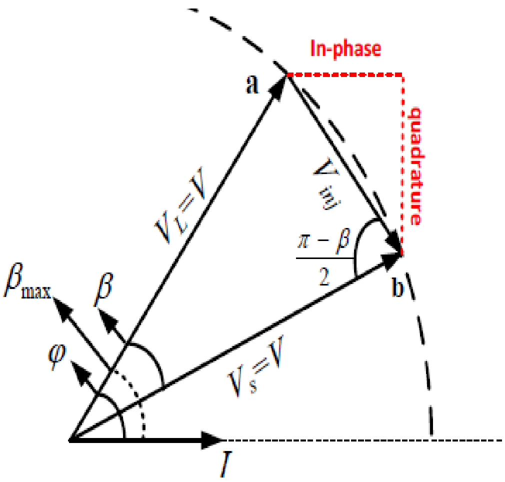

Fig. 2: Power Control mode

III. SIMULATION OF IDVR

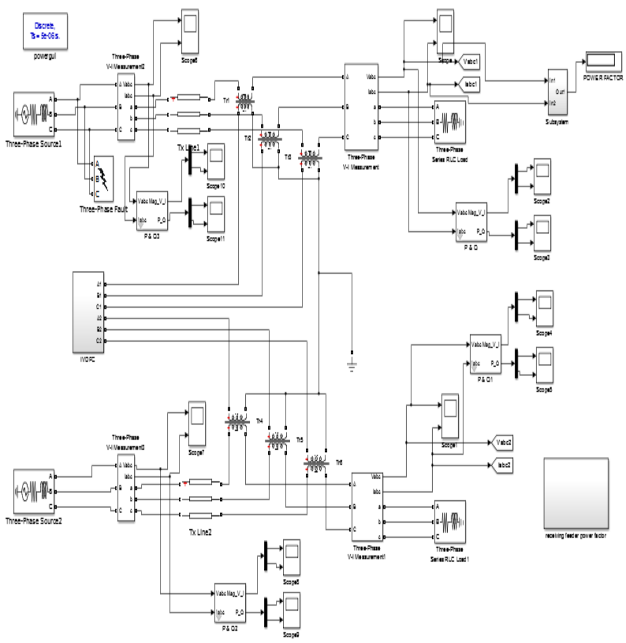

Fig 3: Simulation diagram of an IDVR

In order to mitigate voltage sags a discrete PWM based control scheme is implemented with reference to DVR, so as to maintain constant voltage magnitude at the load side. We can obtain the results for IDVR as shown.

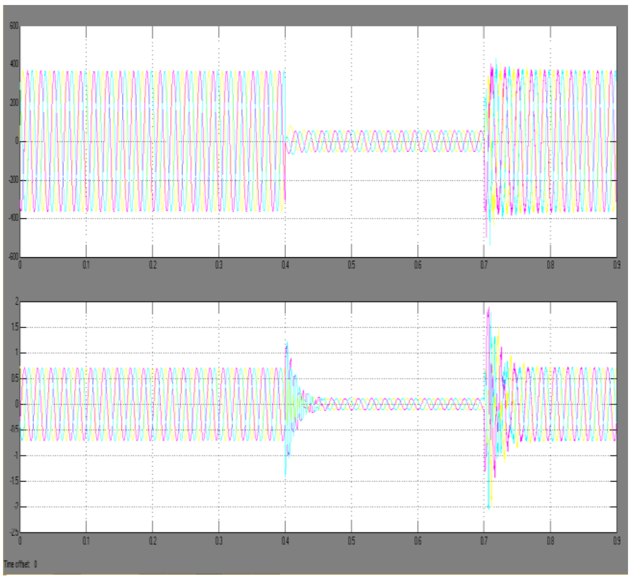

Fig 4: Voltage & current waveform during voltage sag i.e uncompensated

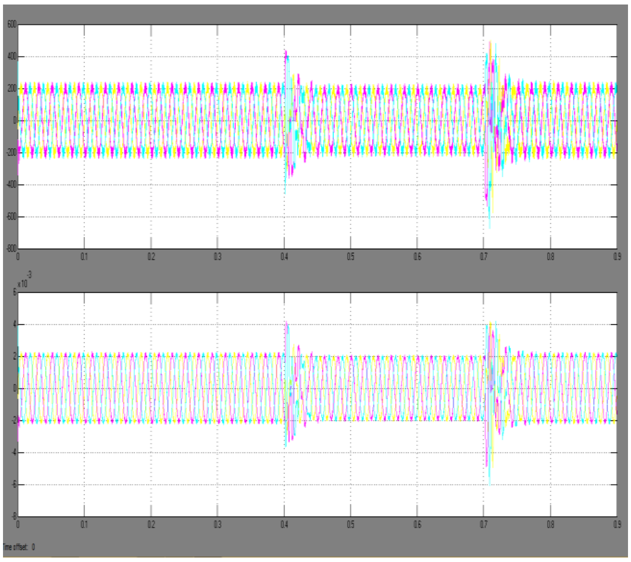

Fig 5: voltage & current waveform by using IDVR i.e compensated

We can clearly observe from Fig 5. that by using IDVR we can regain the voltage level to its normal level. The first figure i.e Fig 4. shows the voltage & current waveforms without using IDVR & then the next figure shows the voltage & current waveforms by using IDVR. Hence to maintain the load voltage at constant level & also it will indirectly improve the power factor in the line.

IV. CONCLUSION

When one of the DVRs compensates for voltage sag, the other DVRs are used to overcome the DC-link energy storage. The proposed control system is identical for both the voltage regulation and the real power control modes. This paper proposes a new operational mode for the IDVR to improve the displacement factor (DF) of different feeders under normal operation. In this mode, the DF of one of the feeders is improved via active and reactive power exchange (PQ sharing) between feeders through the common DC-link. The proposed concept has been supported with the simulation results.

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