ISSN: 2278-0181
Vol. 2 Issue 7, July - 2013

Performance Evaluation And Sag Mitigation With IDVR For Parallel Feeder Transmission System

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Abstract : *The dynamic voltage restorer (DVR) is one of the modern devices used in transmission and distribution systems to protect power flow against sudden changes in voltage amplitude. The proposed method is applied to some disturbances in load voltage caused by induction motors starting,a three-phase short circuit faul etct. Also, the capability of the proposed DVR has been tested to limit the downstream fault current. This paper originates a comprehensive evaluation strategy among the Interline Dynamic Voltage Restorer (IDVR). The fundamental opearation of IDVR is explained. The two feeder IDVR connected transmission line performance is presented in a strategic approach and results performed using MATLAB/Simulink based model developed for IDVR and the output response of the system with remarkable conclusion proposed.*

Keywords: *Interline Dynamic Voltage Restorer, Interline Power Flow Controller, Voltage Sag*

1. INTRODUCTION

Voltage sag is one of the most important power-quality problems that encompass almost 80% of the transmission system PQ problems. According to the IEEE 1959–1995 standard, voltage sag is the decrease of 0.1 to 0.9 p.u. in the rms voltage level at system frequency and with the duration of half a cycle to 1 min . Short circuits, starting large motors, sudden changes of load, and energization of transformers are the main causes of voltage sags

Nowadays Flexible AC Transmission Systems (FACTS) controllers are playing a vital role in terms of power flow control, transient stability and oscillation damping enhancement as reported in [1-3]. Researchers have presented design of FACTS-based stabilizers for SVC, TCSC, TCPS, and Unified Power Flow Controller (UPFC) in [5].

Interline Power Flow Controller (IPFC) is an advanced voltage sourced Converter based FACTS controller [2] which employs a number of dc to ac converters each providing a series compensation for a different lines.

VSC-based FACTS controllers include the Static Synchronous Compensator (STATCOM) for shunt reactive power compensation, the Static Synchronous Series Compensator (SSSC) for series reactive power compensation, the Unified Power Flow Controller (UPFC) with the unique capability of independently controlling both the active and reactive power flow in the line.

Generally speaking, the IPFC employs a number of VSCs linked at the same DC terminal, each of which can provide series compensation for its own line. It can also be regarded as several SSSCs sharing a common DC link.

In this way, the power optimization of the overall system can be realized in the form of appropriate power transfer through the common DC link from over-loaded lines to under-loaded lines [7].

An IDVR, which is two DVRs installed in two feeders with common dc bus, has the capability of active power exchange between two DVRs, and thus the energy storage device is not an issue. Therefore, the design criteria for the Selection of rating of an individual DVR are not applicable in IDVR structure.

These Voltage sag disturbances, mainly due to faults and start-up of large loads [9], are normally Characterized by the number of occurrences, the amplitude and the duration of sag [10].

IDVR consists of several DVRs on different distribution lines sharing a common DC link.References [11 12] discuss the two-line IDVR system. The system utilizes the pre-sag compensation method to mitigate the voltage sag problem in one feeder provided that the voltage of the other is normal.

A novel minimal energy consumption strategy for the IDVR is proposed in [12] where two different voltage distribution systems are protected using two DVRs. The first is a low voltage DVR operating in voltage sag mitigation mode injecting active power from the DC link capacitor. Simultaneously, the other medium voltage DVR keeps the voltage of the DC link capacitor constant. In [13], the optimum rating for two DVRs when used for IDVR system is designed

An IDVR is similar to the inter line power flow controller (IPFC) in transmission systems [11] but to distribution systems. In this paper a performance comparison among interline power flow control and interline dynamic voltage restorer has presented. The approach carried out with application of performance of the system with IPFC and IDVR made and result analysis presented in the system.

2. OPERATIONAL BEHAVIOR OF IDVR

A typical DVR-connected distribution system is shown in Fig. 1, where the DVR consists of essentially a series-connected injection transformer, a voltage-source inverter, an inverter output filter, and an energy storage device that is connected to the dc link. Before injecting the inverter output to the system, it must be filtered so that harmonics due to switching function in the inverter are eliminated[11].

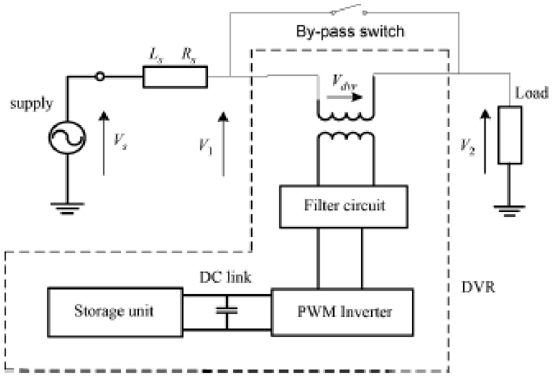

Fig. 1 General DVR Structure

It should be noted that when using the DVR in real situations, the injection transformer will be connected in parallel with a bypass switch. When there is no disturbances in voltage, the injection transformer will be short circuited by this switch to minimize losses and maximize cost effectiveness. Also, this switch can be in the form of two parallel thyristors, as they have high on and off speed. A financial assessment of voltage sag events and use of flexible ac transmission systems (FACTS) devices, such as DVR, to mitigate them. It is obvious that the flexibility of the DVR output depends on the switching accuracy of the pulse width modulation (PWM) scheme and the control method. The PWM generates sinusoidal signals by comparing a sinusoidal wave with a saw tooth wave and sending appropriate signals to the inverter switches [11].

3. VOLTAGE SAG COMPENSATION IN A PARALLEL FEEDER IDVR SYSTEM

The IDVR system consists of several DVRs in different feeders, sharing a common DC-link. A two-line IDVR system shown in Figure 3 employs two DVRs are connected to two different feeders where one of the DVRs compensates for voltage sag or swell produced, the other DVR in IDVR system operates in power-flow control mode.

Firstly, unlike individual DVRs, the duration of compensation in an IDVR is not usually restricted. The reason is that the required energy for compensation comes from another feeder, which is supposed to be healthy. However, energy absorption from the healthy feeder via dc link may cause overload and unacceptable sag in the healthy feeder. Therefore, some inherent limitations always exist which depends on feeder parameters and the depth of sags,but not on the duration of sags. Based on this reasoning, minimum energy strategy is not necessarily applicable in compensation, and it may lead to larger rating and over-size DVR.

The voltage sag in a two-feeder IDVR system is caused due to sudden increase of the load across a feeder. Consider the condition when the DVR in the IDVR system operates in Voltage-sag compensating mode while the DVR operates in power-flow control mode to keep the DC-link voltage at a desired level. When there is no voltage disturbance, the load voltage of Feeder is equal to the bus voltage V during Voltage sag, the DVR should be operated to meet this condition while supplying real power to the common DC-link.

The harmonic elimination in any system is one of the important requirements nowadays. The total harmonic distortion in the response obtained can be reduced abruptly with interline dynamic voltage restorer.

4. SIMULATION RESULTS

From the simulink model proposed the IDVR model is presented with a line length 300 kilo meters; a three phase rms voltage of13.8 KV; Three phase transformer with 6*350 MVA, 13.8/735 kv in fig.2.

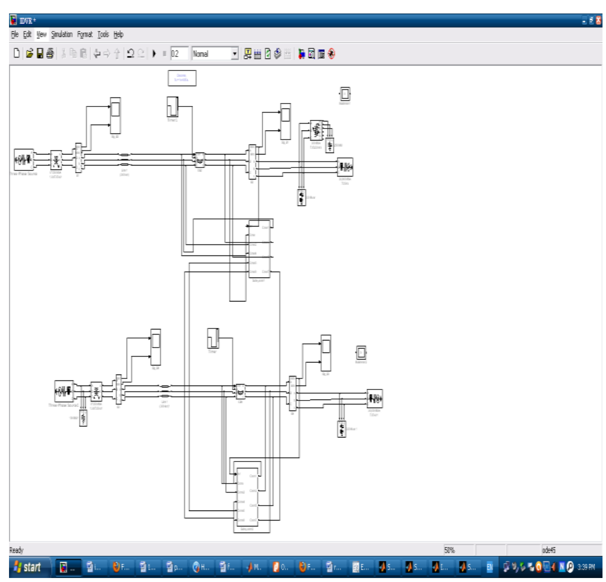

Fig. 2 Interline Dynamic Voltage Restorer (IDVR) with two DVR s in the line

The distorted condition of load voltage appear when the IDVR is not added as in fig.3 and the distorted condition of load voltage appear when the IDVR is not added as in fig.4. The fault mitigated load voltage when IDVR is included and load currents when IDVR is included are shown in fig 5

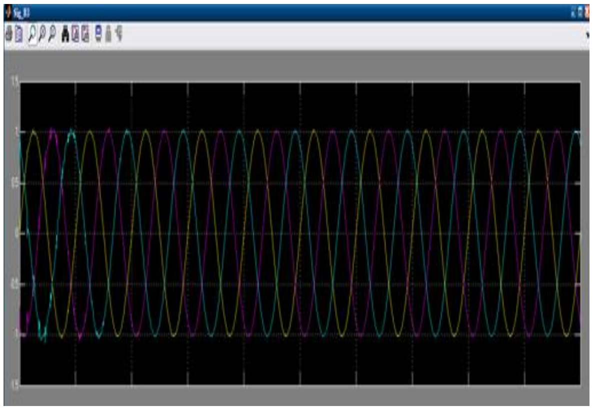

Fig. 3 The output response of load voltage when IDVR is not added

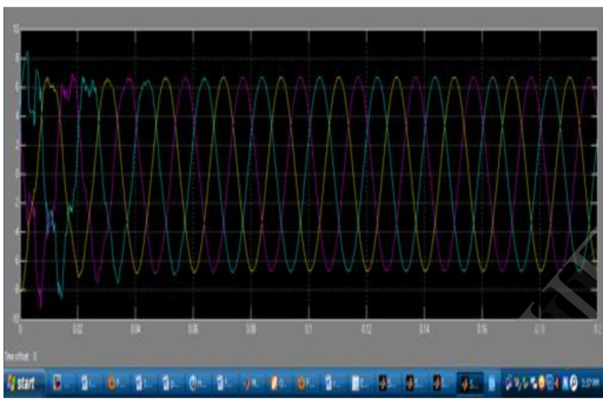

Fig. 4 The output response of load current when IDVR is not added

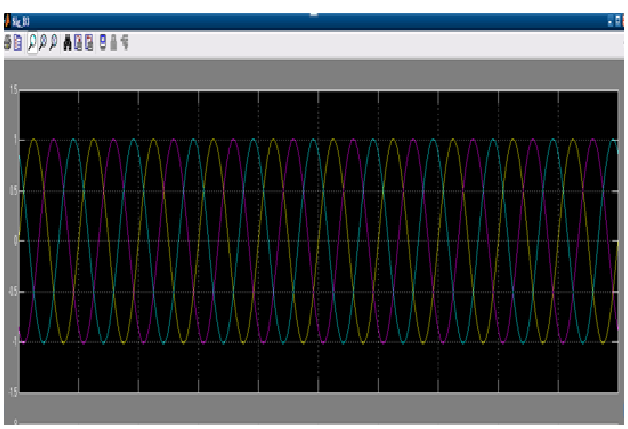

Fig. 5 The stabilized output response load voltage when IDVR is added

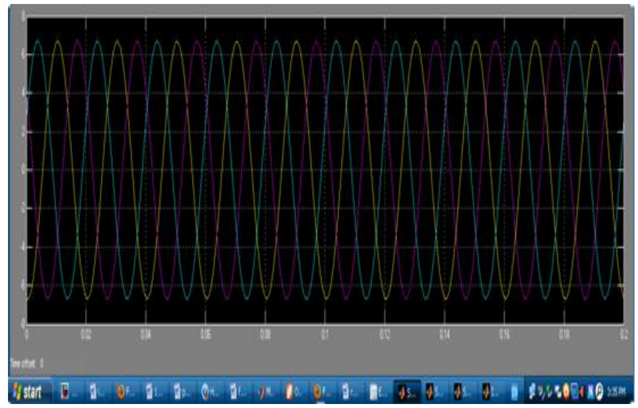

Fig. 5 The stabilized output response of load current when IDVR is added

5. CONCLUSION

This paper estimates the comprehensive performance among interline dynamic voltage restorer presented. The operation behavior of the IDVR starting from fundamental structure has carried out in an effective manner. The feasibility of proposed method was verified through computer simulations and observation of the load response presented in order to give effective performance of IDVR using Matlab/simulink models. The DVR with proposed method can effectively compensate the voltage sag or interruption for sensitive loads and limiting the downstream fault currents.

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