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A REVIEW OF DYNAMIC VOLTAGE RESTORER FOR MITIGATION OF VOLTAGE SAG/SWELL.

Aditya Doble[1], Prachi Moje[2], Sujata Bawankar[3],

Pankaj Shripad[4] , Prof. Sagar Bhaisare[5]

Department of Electrical Engineering
K.D.K. College of Engineering, Nagpur
Rashtrasant Tukadoji Maharaj Nagpur University,
Nagpur

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Abstract - The most noticeable topic for electrical engineering is power quality in recent year. Power quality problem is an occurrence manifested as a nonstandard voltage, current or frequency. The frequently occurring power quality issues are voltage unbalance, voltage sag and swell, transients, flickers and harmonic distortions. These power quality issues can cause serious malfunctions and lost production in industries. Among the custom power devices, we can consider Dynamic Voltage Restorer (DVR) as the most economic and efficient solution for voltage sag and swell compensation in distribution systems. The proposed control method is expected to be very efficient for detecting and clearing power quality disturbance in distribution systems. Results are simulated using PSCAD software.

Key Words: Power Quality, Voltage sag, Voltage Swell, Dynamic Voltage Restorer(DVR)

1.INTRODUCTION

Dynamic Voltage Restorer (DVR) is a power electronic device used for mitigating voltage sags and swells in power distribution systems. Voltage sags and swells are short-term fluctuations in voltage that can lead to equipment malfunctions and downtime, resulting in significant economic losses. Therefore, maintaining a stable voltage profile is crucial for reliable operation of electrical equipment.

DVRs are used to improve power quality by providing real-time voltage support to critical loads during voltage sags and swells. The device operates by injecting a compensating voltage into the system to restore the supply voltage to its nominal value. This technology has gained popularity in recent years due to its high efficiency, fast response time, and ability to support large loads.

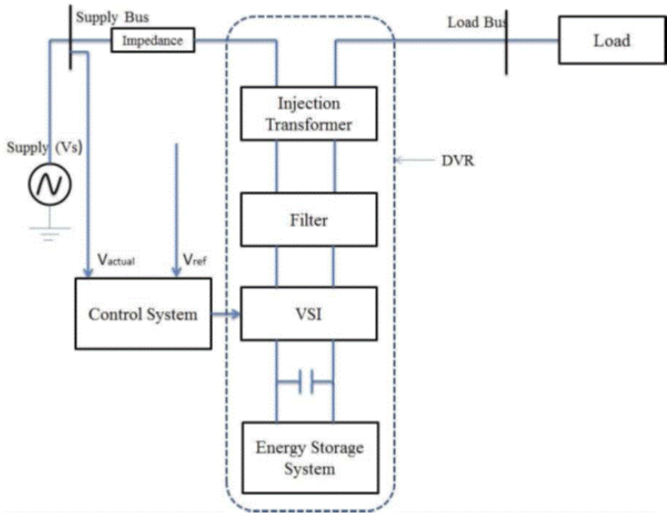

Fig -1: Genral Block Daigram

This review will discuss the working principle of DVR, its advantages and limitations, and its application in mitigating voltage sags and swells. Additionally, we will also compare DVR with other voltage regulation technologies and highlight its potential for future development.

2. Related Work

In [1] The modeling and simulation of a DVR with Sinusoidal PWM based controller for 3ĭ 415V, 50 Hz distribution system has been developed by using Matlab/Simulink. The simulation results show that the DVR compensates the sag and swell effectively and provides excellent voltage regulation. The control system implemented here is based on dqo technique which is a scaled error between supply side of the DVR and its set reference value.

In [2] Proposes a filter structure for improving the performance of switching band controller based DVR. Analytical expressions for the switching frequency variation with respect to injected voltage are derived. Based on the expressions, a systematic design procedure for the filter inductance is presented. The relations between inverter rating and other parameters are obtained and used for designing the band resistor and filter capacitor. The proposed filter structure and its design procedure are validated through an extensive simulation study using PSCAD.

In [3] A dynamic control strategy has been proposed in this paper to be used for voltage sag/swell mitigations. The MV-DVR presented in this paper has an output LC-filter between the multilevel VSC and the injection transformer to suppress harmonics.The proposed algorithm is implemented in the synchronous frame and involves an inner current loop and an outer voltage loop. The injecting capability of the MV-DVR with control algorithm has been tested through a Matlab /Simulink simulation model.

In [4] The main objectives for the utilization of the studied equipment to mitigate the voltage sag and voltage swell. In order to protect critical loads from more sever fault in distribution network. The facility available in MATLAB/SIMULINK is used to carry out extensive simulation study. Supply voltage is compared with reference voltage to get error signal which is given to the gate pulse generation circuit as a reference sine wave which is compared with carrier signal to get pulses for inverter. PLL circuit is used to extract angle from supply voltage so that this circuit can be used at supply of any frequency so the error signal will be synchronisedsupply frequency.

In [5] A systematic study of a dynamic voltage regulator that can tightly regulate voltage at the load terminals against any variation in the supply side voltage while consuming no real power in the steady state. The paper demonstrates the capability of the device through steady state analysis, which is then extended to obtain time varying DVR reference voltages. Two different DVR structures are studied in which the DVR is realized by voltage source inverters. It has been shown that both these have almost identical performance with a deadbeat switching band controller. The disadvantage of the DVR with a capacitor filter in the feeder side is that it has high transformer loss and also that it requires a larger rating capacitor that needs to be put in series with the distribution feeder. The DVR with LC filter does not suffer from these drawbacks. The simulation studies presented in this paper assume that the DVR is supplied by a dc source, whereas in practical systems a dc storage capacitor is used. The capacitor voltage then must be regulated to a reference value for the proper functioning of the DVR. The formulations presented in this paper are based on the assumption that the load is strictly balanced. The case where the load is not balanced is a more involved problem and is not considered here.

In [6] The effects of DVR location to mitigate the voltage sag using sensitive and nonsensitive loads. The highly developed graphical facilities available in PSCAD/EMTDC program have been used very effectively to carry out all aspects of the system implementation. In order to compensate voltage sag, it is possible to use DVR at MV or LV distribution system. The simulation results demonstrated the capability of DVR, this was confirmed by the results of which sample are given in this paper. Finally, DVR is an effective custom power device for voltage sags mitigation. The impact of voltage sags on sensitive equipment is severe when the DVR located at the MV system. Therefore, DVR is considered to be an efficient solution due to its relatively low cost and small size, also it has a fast dynamic response.

In [7] The restoration of load voltage through a VSI-based series compensator has been considered. It is shown that during voltage sag, the restoration process almost inevitably requires energy injection from the SC to the external system. However, maintaining the load-side voltage during a voltage swell could lead to a rise in the VSI energy storage voltage . This is because the SC device will have to absorb active power from the external network. It is shown that only the energy-saving method, incorporating the zero-power injection strategy, is capable of maintaining constant. The method is based on the adjustment of the phase angle of the injected voltage. For unbalanced voltage disturbances, the analysis shows that it is only necessary to consider the positive phase-sequence component of the voltages. The same injection strategy as that for balanced disturbances can be applied. From the analytical results obtained, a generalized compensation strategy for voltage sag/swell disturbances has been proposed. With this method, the load voltage can be restored for sag and swell while can also be controlled.

In [8] it was found that the required voltage amplitude of the DVR with the proposed optimized control strategy was reduced by 25%, compared to the pre-sag controller. In other words, the maximum compensation time is increased by approximately the same amount. Taking into consideration that a phase jump of 12 is not extremely high and that the advantages increases with larger phase jumps, an even higher gain is possible in practical systems. Summarizing all advantages up, it can be stated that the compensation time of existing DVR systems under pre-sag control can be significantly improved when applying the proposed optimized strategy. In newly designed DVRs, the DC-link capacitance can be decreased without reducing the range of operation.

In [9] Two tuning coefficients r and m are introduced to improve the signal energy concentration in frequency domain as well as the time-frequency resolutions of both ST and TT, which demonstrates to be facilitated to extract the PQDs feature information precisely. In accordance with the 4 kinds of feature information of 5 PQDs, a SVC model with 94.68% classification accuracy created to identify the disturbance classes of 5 typical PQDs, presents preferable identification capability by comparing with BP-ANN possessing 88.23% correct ratio. Consequently, the improved TT combined with SVC verifies to be a reliable approach in identifying PQDs' classes efficiently.

In [10] A concerted effort between The University of Texas and Electrotek Concepts under the financial support of EPRI to develop an event identification module. Wewould like to thank Electrotek's power engineers, especially,M.F. McGranaghan, R. F. Scott, and Dr. H. V. Nguyen in providing technical assistance. Valuable discussions with A. C. Parsons of The University of Texas at Austin are appreciated.

3. CONCLUSIONS

The study of DVR has proven to be an effective solution for mitigating voltage sag/swell problems. The device provides a quick and accurate response to voltage fluctuations, ensuring that the voltage remains stable and within the required limits. Additionally, DVR offers several advantages, including its ability to provide continuous voltage support during sag/swell events, high efficiency, and low maintenance requirements.However, despite its effectiveness, DVR is relatively expensive compared to other power quality solutions. The cost of the device and its associated equipment, such as transformers and power electronics, can be a significant barrier to adoption. Furthermore, the size and weight of DVRs can also present challenges, especially in applications where space is limited.Overall, the benefits of using DVR outweigh the costs, making it an excellent solution for mitigating voltage sag/swell problems. As the demand for reliable and high-quality power continues to increase, DVR is likely to play an increasingly important role in ensuring that power systems operate efficiently and effectively.

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