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Review on Study and Types of Dynamic Voltage Restorer

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Abstract: ***Power Quality is very important facet in power sector. The power quality downside is an event disclosed as a nonstandard voltage, current or frequency deviations that end in a failure of finish use equipment's. The most reason behind voltage sag is often thought of jointly of the key power quality issues and it became intense to industrial customers. Low power quality scale back performance of home and industrial equipment's. Now days nonlinear load increase on power system because of advance research and evolution of electronics component. Power quality downside increase with this quick change of nonlinear load rise to transient, harmonics, voltage sag/swell. Voltage sag/swell most vital factor to reduce the power quality. This power quality issue mitigate by compensating power injection into distribution system using various compensating devices. Dynamic voltage restorer (DVR) is best efficient compensating device to solve this PQ problem. DVR with its wonderful dynamic capabilities, once put in between the source and a crucial load. During this paper we tend to study dynamic voltage Restorer and it different types & different topologies.***

Keywords: DVR, Power Quality, voltage sag/ swell, FACTS, VSI.

I. INTRODUCTION

Prime power quality issue includes voltage sag/swell, harmonic flicker, voltage interruptions and transient because of nonlinear load switching, harmonic distortions. To mitigate such undesirable power quality issue is important as a result of these creates vast of loss in terms money, time and technical loss. Voltage sag is that the most typical and fewer avertible phenomena in grid Voltage sag and voltage swell are likely common reasons for failure in production plants and failure in user instrumentality. Tripping of apparatus in mechanical system will cause production interruption and heap of loss in value of production. To avoid these issues as way as attainable one in all the answer is to create instrumentality in contact or tolerate voltage sag. For correction of power quality many other FACTS devices introduce and research are going on. However these devices are designed for transmission purpose however throughout currently distribution system has all attention to enhance power quality. One in all resolution is to put in correct device at sensitive load location to scale back voltage sag and voltage swell is to use DVR. DVR is power electronic controller wont to compensate voltage sag and voltage swell. DVR is appended in series between source and load to improve the load voltage to normal. Figure shows typical DVR and also the manner it's connected to grid. Essentially DVR incorporates energy storage unit with voltage source invertor appended in series with grid through Injection electrical device and low pass filter.

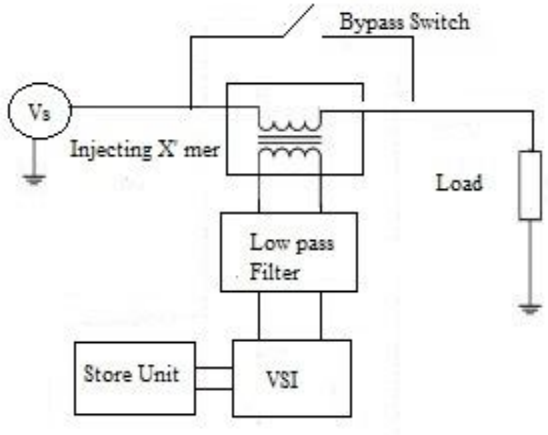


Fig.1. Construction of DVR System

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Various device such as Lead acid battery, capacitor bank and SMES employed as energy storage unit. DVR has two different types with and without energy storage device. In fig.1 we are using DVR with energy storage device. DVR is a bidirectional power exchange device. This energy storage in form of DC power. To convert power from DC to AC invertor is used. Different voltage source invertor used in DVR. DVR having different topologies by used of voltage invertor PWM technology, H Bridge invertor. Low pass filter used to convert inverter distortion waveform into sinusoidal pulse waveform. DVR corrected load voltage by injecting compensating voltage to grid though the series connected voltage injecting transformer. Solid state bypass switch is used to bypass the DVR from grid.

II. SYSTEM TOPOLOGIES FOR DVR

DVR has tendency to exchange compensating power to compensate the load voltage. If DVR require to supply active power to the load then it needs active energy source. This active power supply by DC energy storage unit. Two types of DVR system are considered here as followed.

A. DVR Without Employing Energy Unit

In this topology energy storage unit not used. Energy taken from direct supply with the help of passive shunt convertor connected parallel to supply side as of following in fig. 2. Fig. 3 shows the DVR without energy unit, energy utilise from load side to produce compensating power. This two topologies minimise the energy unit cost but increase convertor cost. This are not useful in very dip sag occur in distribution system.

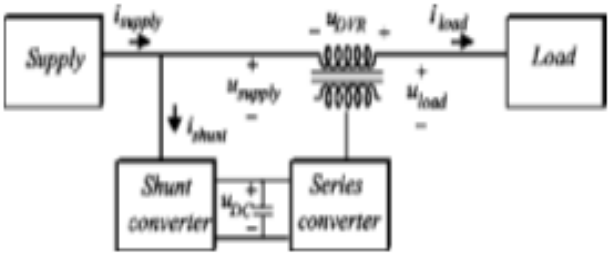


Fig. 2 DVR without employing energy unit with shunt converter at supply side

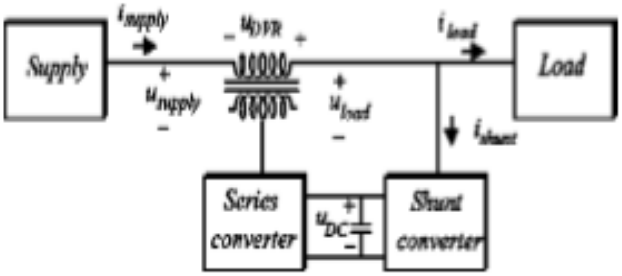


Fig.3 DVR without employing energy unit with shunt convertor at load side

B. DVR with Employing Energy Unit

To exchange the compensation power to compensate the load voltage DVR use energy unit. This active energy provided by lead acid battery, capacitor bank. This energy unit inject require voltage to source depend upon restoration methods. Tree types of restoration commonly use as pre fault, post fault, zero energy. This technic has capability to restore deep sag issue.

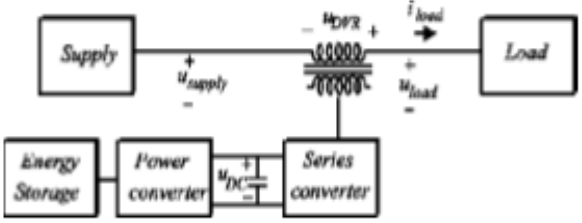


Fig.5 DVR with employing energy unit

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III. COMPARISON OF VARIOUS DVR TOPOLOGIES BASE ON INVERTOR TYPE

Different topologies of DVR base on invertor type are presented in this section. The three phase six switch voltage source invertor used in DVR. Normal three phase sinusoidal pulse width (SPWM) not restore the voltage sag/swell power quality issue. To mitigate voltage sag/swell other advance VSI we have to use for this take an account of split capacitor invertor. This two invertor produce mitigate unbalance voltage sag but have limitation of output voltage. To overcome this issue H bridge investor base DVR we have to use. In this section we compare different investor base DVR.

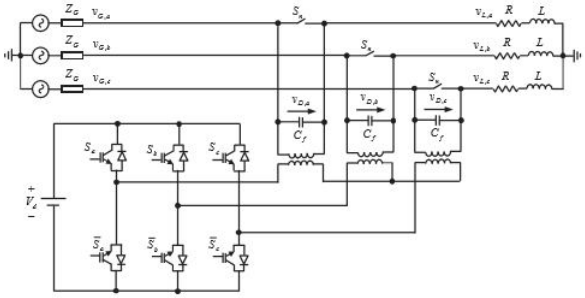


Fig.6. Three phase six switch inverter

Above Fig. show three phase six switch invertor also called three leg invertor. Compare to other less number of switches use in it. This three phase leg invertor use either sinusoidal pulse width (SPWM) technic or space vector PWM. Both of them not able to mitigate unbalance voltage sag /swell. To avoid this problem we go for other type called split capacitor invertor.

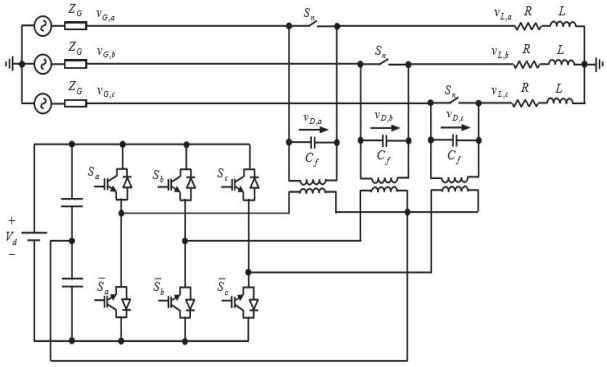


Fig.7 Three phase DVR with split capacitor VSI

Above Fig. show the different between two system only two split capacitor are added. In this technique Switch have capability to operate individually. So unbalance voltage sag/swell issue solved by this technique. One common disadvantage of each three phase six switch invertor is that the total output voltage of invertor is less than the source voltage.

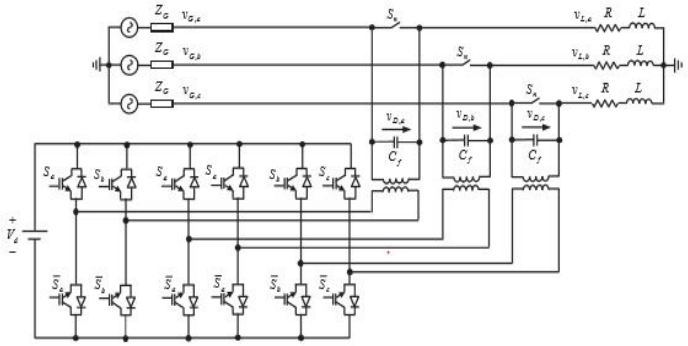


Fig.8 Three phase DVR employing three phase H bridge VSI

With taking account of output voltage of invertor we can use H bridge invertor which have double switches with double output voltage. The switches operated independently with consideration with each phase. This system has two advantage first unbalance voltage sag /swell can be mitigate and other more output voltage as compare to previous topologies.

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TABLE I Summary of the DVRs specifications

Fig types	Switches quantity	Switches voltage	Balance Operation capability	Compensation capacity voltage
Fig.6	6	6 Vd	No	$Vd/2\sqrt{2}$
Fig.7	6	6 Vd	Yes	$Vd/2\sqrt{2}$
Fig.8	12	12 Vd	Yes	$Vd/\sqrt{2}$

Table 1 shows the comparison of the three-phased DVR topologies. The first column elaborate different topology. The second column elaborate number switches. The third column of the table shows the total switches voltage. The fourth column shows capability of unbalance operation and last column elaborate the maximum compensation capacity. From this table we understand the H bridge inverter based topology has higher total voltage rating due to higher number of switches and twice compensation capacity. The compensation capability is the maximum voltage sags or swells that can be completely compensated. Also, the table suggests that the six switch topology shown in Fig. 6 is not suitable for DVR application since most of the voltage sags /swells are unbalanced in nature. This is because of the fact that major of the system faults that cause voltage sags are unbalanced faults such as single-phase faults.

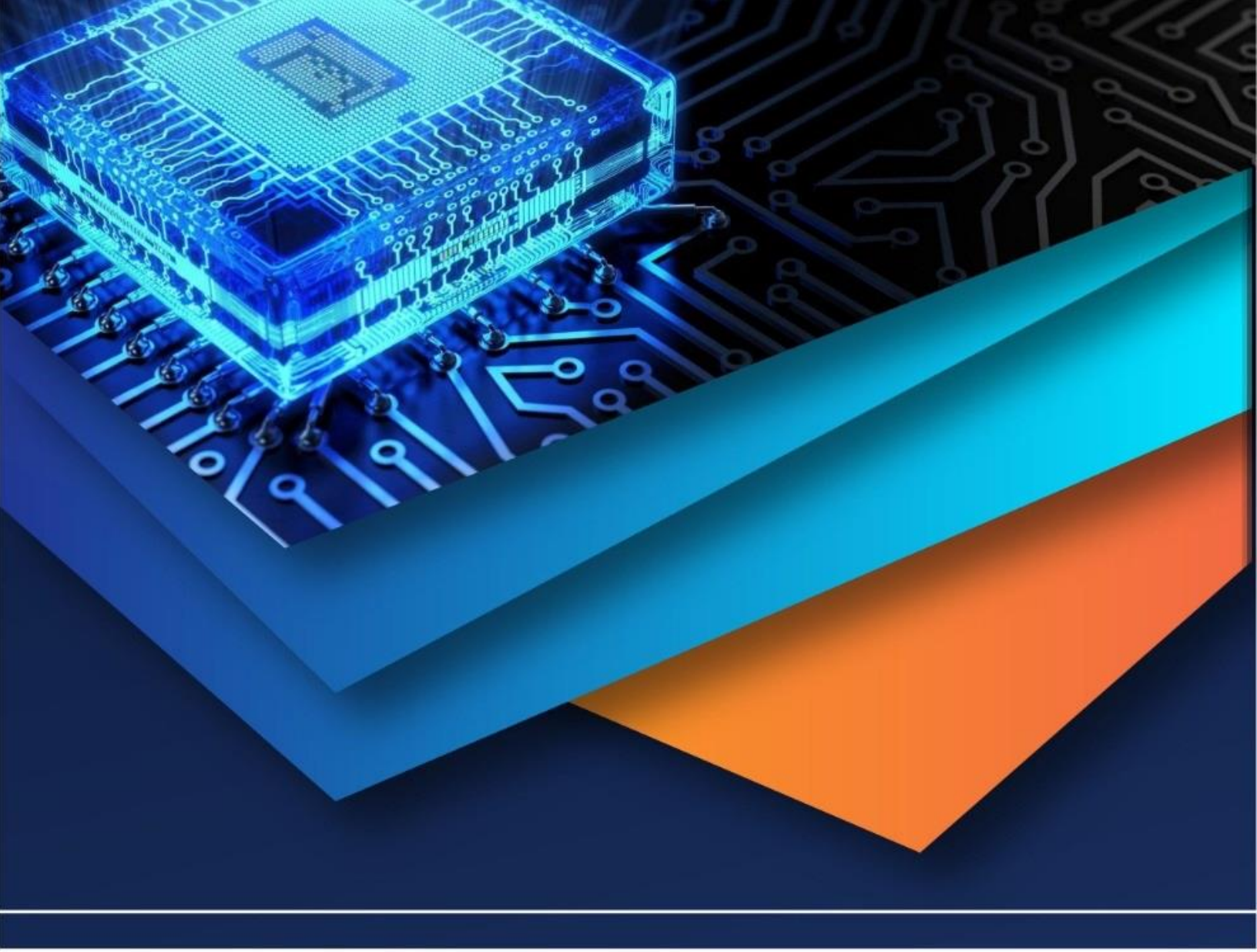
IV. CONCLUSIONS

In this paper research is made on basic DVR construction, different power quality defect respective with DVR, different types of DVR base on energy storage, different types of DVR base on investors. DVR is used to restore the voltage sag/ swell with inject compensating power in series with source. Many types of voltage invertor use for DVR but H bridge is best by which we can mitigate unbalance voltage sag issue as well as out voltage is double compare to other VSI. DVR with energy unit is more convenient because of capability of solving very deep sag issue. By this research analysis we can conclude that DVR is most suitable device for distribution system to restore voltage / swell issue as compare to other FACTS devices available in market.. DVR with DC energy unit and facilitated with H bride voltage source invertor gives profitable solution to distribution system for power quality problem.

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