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# Power Quality Improvement Using Dynamic Voltage Restorer

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## ABSTRACT

Power system consist of large number of non linear load which causes power quality issues. Sensitive components like electronic devices, medical equipment working on power supply are vulnerable to power quality problems. Voltage sag ,Swell ,harmonics ,noise are considered to be some important power quality issues .Voltage dips are the major disturbance affecting the power system .On load tap changers can be used to compensate voltage dip but it is not economical. Dynamic voltage restorer (DVR) is an alternate to conventional method of compensating the voltage .These are custom power devices. The main applications of DVR is to protect sensitive loads that are severely affected by fluctuations in system voltage.

## I. INTRODUCTION

A Power system is having number of components which are to be operated in such a way to satisfy certain criteria. One such criteria is power quality. It plays a very important role in determining efficiency and performance of a power system. As the number of consumers increase, the demand for the power also increasing drastically .Along with its quality, continuity of supply has to be ensured for good economy. The power quality issues that are most likely to occur in a power system are voltage sag, voltage swell, flickering and harmonics. These causes malfunctioning in electrical equipment. Due to large and complex power system voltage sag/swell became important power quality issues . The electronic device like oscilloscope are used in hospitals are affected due to harmonics created in the system and flicker causes an irritation to the eyes. All these problems can be overcome by making use of FACT devices which are easy to design and control. Some FACT devices are D-STATCOM, DVR etc. Here in our paper we are making use of a DVR i.e Dynamic voltage restorer to reduce power quality problems.

DVR is used to reduce voltage sags/swells by injecting required amount of voltages in series with the supply voltage and load point, and maintains reliability of power supply. In steady state condition, DVR will not absorbs/delivers real power. But, whenever voltage sag/swell or unbalance in supply voltage arises in the power system, DVR will operate.

## POWER QUALITY PROBLEMS

### A. Voltage sag

A drop in the voltage level to 10-90% of its rated value is known as voltage sag as shown in Figure 3.1. Voltage sag is also referred to as under voltage condition. The causes of voltage sag are faults in power system, overloading of the electrical equipment and high starting currents drawn. Voltage sag results in failure of relays and contactor, dim light and fluctuating power.

### B. Voltage Swell

A rise in the voltage level to 110%-180% of its rated value is known as voltage swell as shown in Figure 3.2. Voltage swell is also referred as over voltage condition.The causes of Swell are sudden disconnection of large load, LG fault.It results in breakdown of insulation, overheating of electrical equipment and damage to electronic equipment.

### C. Voltage interruptions

Reduction in rms voltage by below 0.1 pu of rated or complete failure of supply voltage is known as Voltage interruptions. It can be further divided into two classes based on interruption time period:

1) Short interruption
2) Long interruption

### D. Waveform distortion

The voltage and current waveform should be sinusoidal in nature .The change in the waveform pattern is called Distortion. These are caused due to:

1. Harmonics: Integral multiple of fundamental frequency is called Harmonics. This is caused due to non-linear loads.
2. Noise: Unwanted signal that causes distortion of main signal is called as Noise.
3. Transients: Transients induces oscillations which are undesirable. These are the short duration and they are caused by internal or external faults.

## II. DYNAMIC VOLTAGE RESTORER

A DVR is a custom power device which is connected in series to inject the required voltage to the load bus in order to maintain the voltage level. The compensating voltage is injected by three single phase transformer. These voltages are in synchronism with the load voltage.

The basic structure of DVR shown in Figure 1consists of following blocks: VSI , Injection transformer, Passive filter , Energy storage unit , Control circuit.

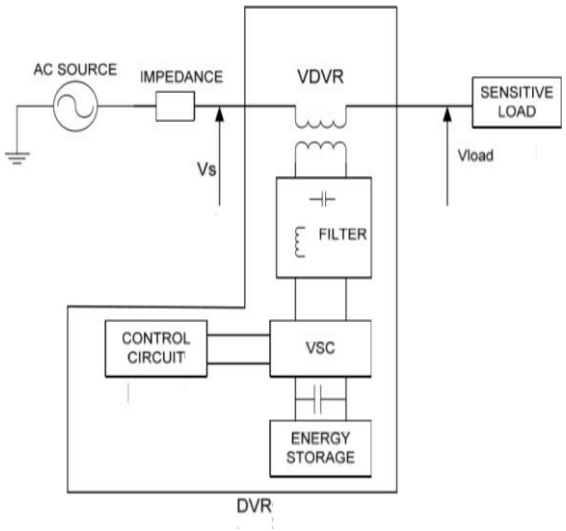


**Figure 1.** Schematic diagram of a DVR connected distribution system

1. Voltage Source Inverter (VSI): A circuits which can create AC voltage from DC source is called VSI.
2. Voltage injection transformer: The AC voltage generated by VSI is stepped up by an transformer called injection transformer to the to nominal voltage level. The amount of voltage sag/swell compensated by DVR depends upon the rating of injection transformer and inverter.
3. Passive filter: The harmonics present in the output of the VSI should be eliminated before injecting it to line. It can be done by using the passive filter which can be connected either side of the transformer.
4. Energy storage unit: During compensation,the required injection voltage is supplied by this unit.The Energy storage devices are lead acid batteries.
5. Control circuit: Control circuit monitors performance of the system. It detects/observes the disturbances in the system voltage by comparing the supply voltage with reference voltage . It generates the gate signals for the gate circuit of converter which in turn develop the compensating voltage .

The Simulink model for the DVR is as shown in Figure 2

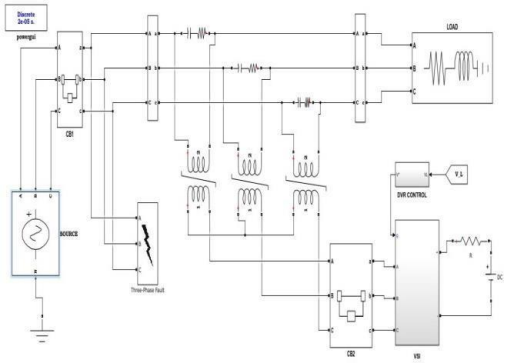

**Figure 2.** Simulink model of DVR

## III. MODELING AND SIMULATION

### A. Voltage sag compensation

1) .Compensation of voltage sag: The voltage sag is created for a time duration of 0.1 to 0.2s as shown in Figure 3. DVR will inject the re quired voltage in this duration. The compensating voltage is shown in Figure 4. After the operation of DVR the load voltage is shown in Figure 5

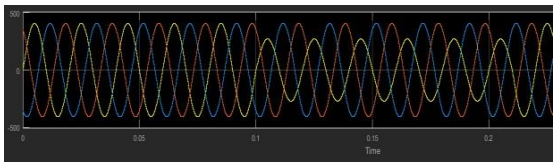

**Figure 3.** Voltage sag

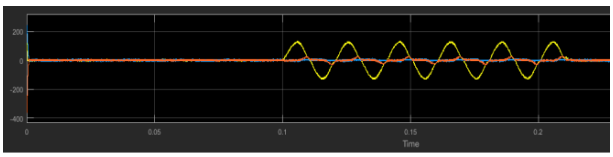

**Figure 4.** Compensating voltage

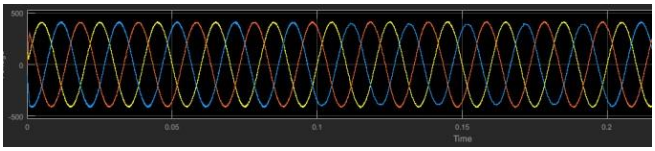

**Figure 5.** Load voltage

### B. Voltage swell compensation

1) Compensation of voltage swell: A voltage swell is created in the network in the time of 0.1 to 0.2s. as shown in figure 6 .The compensating voltage injected by DVR is shown in Figure 7. After compensation, the load voltage is shown in Figure 8.

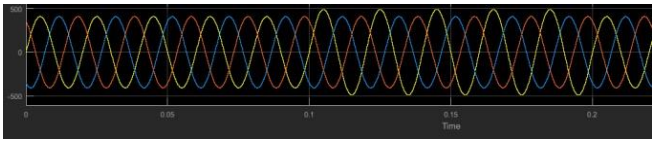

**Figure 6.** Voltage swell

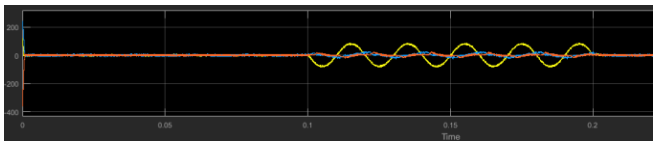

**Figure 7.** Compensating voltage

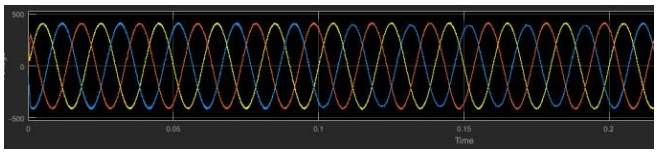

**Figure 8.** Load voltage

## IV. CONCLUSION

Power quality plays a vital role in performance of power system. The power quality gets affected due to sag, swell, distortion. In these, voltage unbalance is considered to be major problem . Flexible AC Transmission devices are used to overcome these problems. Among which DVR is considered as most reliable one. Voltage sag, swell are simulated and results are shown in figures. The above waveforms shows compensation results of sag/swell by DVR. The DVR performance is found to be satisfactory .

THD value after simulation in power system is found 2% - 4%.

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