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# Dynamic Voltage Restorer with H-Bridge Inverter used for Mitigation Voltage Sag

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***Abstract*— Nowadays, in modern power system the engineering devices are based on electronic drives. This devices is very sensitive for Power Quality problems. Such problems are voltage sag and swell. To overcome this problems some costume power devices are used such as distribution static compensator, static var compensator (D-STATCOM), dynamic voltage restorer (DVR) & unified power quality controller (UPQC). DVR is mostly common static device to overcome the power quality problems. This paper presents the compensating voltage sag and swell by using MATLAB simulation. H-Bridge inverter is used in the dynamic voltage restorer to mitigate voltage sag. Proposed setup is a good method to eliminate the Sag and Swells by using SPWM technique the hysteresis controller are used to generate the pulses. DVR injects with necessary magnitude the necessary voltage of reverse polarity. Results of DVR is validated with the help of MATLAB Simulation. The SPWM technique worn in the H Bridge simulation is indeed.**

***Keywords*— *Dynamic Voltage Restorer, Voltage Sag, voltage Swell, H-Bridge Inverter, Power Quality.***

## I. INTRODUCTION

In modern power system no of electronic devices are used due to PQ problems the loads are very sensitive. Such problems are voltage sag and swell, disturbances, harmonics etc. According to the IEEE 1159-1995 voltage sag is sudden decreases the r.m.s voltage between 0.1 & 0.9 p.u. in 0.5 cycles to several seconds. Voltage swell is define is sudden increases the r.m.s voltage between 1.1 & 1.8 p.u. in 0.5 to 1 minute [1-2].

To compensate the power quality problems DVR is used. Normally the DVR is operated by the voltage source inverter which is output is connected to the injected transformer. This injected transformer is used for the injecting voltage when sag is occurs in system and absorb the voltage and store in storage system when swell is occurs in system. In DVR [3] system for providing voltage and storage purpose batteries are used. For storage purpose batteries are extra power compared to the capacitor. For storage in market no of devices are used such as super capacitors etc [4]. The maintenance is high this devices. This paper presents the compensating voltage using the DVR which is present through the MATLAB simulation figure using the hysteresis control technique [5].

The high quality sinusoidal waveform is produced at power stations. The widespread applications of power electronic based non-linear devices as well as, the occurrence of faults cause deviation from pure sinusoidal waveform. Customers need constant sine wave shape, constant frequency and symmetrical voltage with a constant root mean square (rms) value to operate the load properly [6-7]. To satisfy these demands, the disturbances must be eliminated from the system. The typical power quality disturbances are voltage sags, voltage swells, interruptions, phase shifts, harmonics and transients. Voltage sag is considered the most severe cause since the sensitive loads are very susceptible to temporary changes in the voltage [8]. Voltage sag is produced by a magnitude change with or without a phase shift of the supply voltage. The voltage temporarily drops to a lower value and comes back again after a certain period of time. Short circuit faults, motor starting and transformer energizing will cause short duration increase in current, and this will cause voltage sag on the line [9-10].

## II. PROPOSED TOPOLOGY

The DVR schematic diagram is shown following. Fig. 1 is shows the DVR is connected in between the buses to control the bus voltage. It consist of following units:

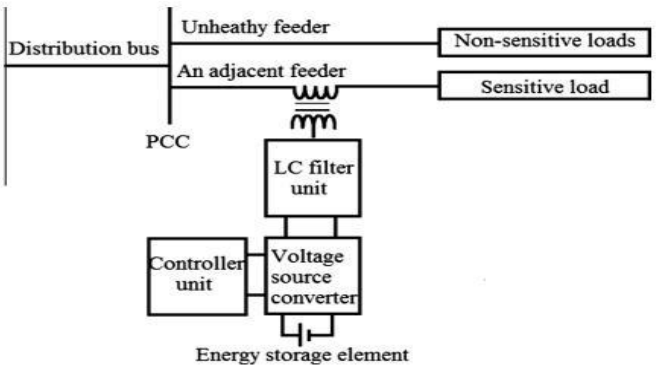


Fig. 1. DVR Arrangement Diagram

**Energy storage unit:** For supply the energy in system the energy storage unit is important. In market no. of units are available such as super capacitors, flywheel batteries. It gives fast response but cost is high due to conventional facilities & difficult to maintenance [2].


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**Booster transformer:** The transformer is connected to the VSC. The Booster transformer is widely used for to inject the voltage in the system when sag is occur also absorb the system voltage when swell is occur. The absorbed power is store in storage unit. Injection transformer is connected series in system [1, 3].

**Voltage source converter (VSC):** Voltage source converter used for to generate sinusoidal voltage with required magnitude, phase and frequency. It gives dc input to the energy storage unit.

**Filter:** A resistance, capacitance, inductance these are simple output of filter simple output filter. The main purpose of filter is remove the harmonics in the system. Filter occurs the sinusoidal waveform.

**Sidestep switch:** This switch protect the DVR from the high inrush currents.

**Control unit:** The control unit control the voltage in the system. When sag is occur in the system injected voltage control by the control unit. Also when swell is occur in system absorb voltage is control by the control unit. Also in order to decrease the magnitude the voltage and organize phase angle.

*A. The System operated in two main modes which are following*

**Standby mode:** In this mode transformer low voltage winding is shorted through the converter due to this full load current will pass through the main boosting mode.

**Injection mode:** In this mode transformer boost the required voltage in the DVR. Consequentially, DVR is a static device which connected series in system which is used for the compensating voltage sag and swell. For the compensating voltage no of devices are used likewise UPQC, SVC, D-STATCOM etc. but due to large size and critical operation this devices is sometimes used. DVR is cheapest in cost and simple operation so it widely used in system [4].

*B. Power SAG Estimate*

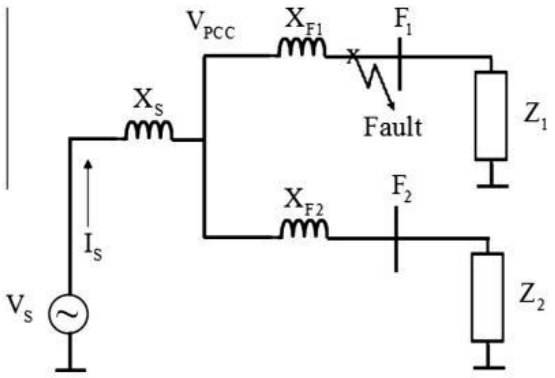


Fig. 2. Power sag/swell estimate diagram

Fig. 2 represented by Vs voltage source and Xs source reaction. It feeds two equal loads represented by Z1 and Z2 through two feeders F1 and F2, where Z is the load impedance and XF is the feeder reaction magnitude. Isthe current of the supply. Whatever you want here, the pre-sag voltage at the point of common coupling (Vpre-sag) and the supply current are given in normal operation as follows:

$$V_{\text{Pre-sag}} = V_S - I_S X_S \quad (1)$$

$$I_S = I_1 + I_2 = \frac{V_{\text{Pre-sag}}}{Z_1 + X_{F1}} + \frac{V_{\text{Pre-sag}}}{Z_2 + X_{F2}} \quad (2)$$

$$V_{\text{Sag}} = V_S - I_{S,\text{fault}} X_S \quad (3)$$

$$I_{S,\text{fault}} = \frac{V_{\text{Sag}}}{X_{F1}} + \frac{V_{\text{Sag}}}{Z_2 + X_{F2}} \quad (4)$$

When error occurs on F1, both a high current and supply current will flow through it. The supply current Is, error and voltage at the common coupling point during sag (Vsag) will be given in such a case as follows:

The power throughout the neighboring feeder F2 will therefore be decreased owing to the unnecessary voltage slump that will materialize throughout the Xs source reactance. As shown in Figure, a DVR represented by a prohibited electrical power source VDVR is placed between the prevalent coupling point and the delicate load Z2 in fig.3.

## III. DVR ORGANIZE ALGORITHM

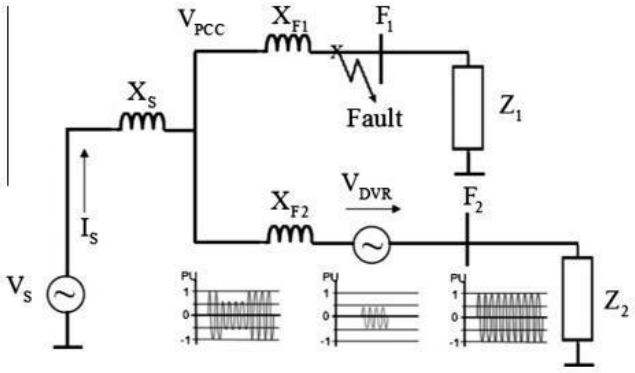


Fig. 3. DVR sag/swell diagram with error

The load bus voltage is monitored by the DVR controller. This voltage is therefore converted into its dq parts. The load power parts are compared to the dq parts of the reference voltage. Due to the disparity between the measured and reference voltage, if a sag voltage is detected, an error signal will be produced and the controller will be launched to inject the absent voltage. This signal of error drives a PI controller (proportional and integral) that regulates the system based on the signal of the fault. It is worth noting that the PI controller produced output signal is converted back into three phase abc voltage earlier than it is transmitted to the sinusoidal Pulse Width Modulation (SPWM) generator. A easy output filter is required at the converter output to get smooth and sinusoidal output voltage. The input to the filter is a modulated 50 Hz AC input with elevated frequency. For the suggested case, the changing signal that modulates the 50 Hz signal is taken as 5.5 kHz. A low-pass LC filter is therefore suggested that suppresses most of the harmonic frequencies produced. This will lead in an output voltage that is almost sinusoidal. The control technique for inverter switches is applied to the


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Sinusoidal Pulse Width Modulation (SPWM) to produce three phase 50 cycles per second sinusoidal voltage at the load terminals. As a result, its output signal regulates the inverter's pulses. In other words, with the required firing sequence, the SPWM generator will generate pulses to trigger the SPWM inverter. IGBT is the switching tool used for DVR operation with the H Bridge VSC because a diode is attached to each IGBT in an anti-parallel manner [3-5].

## IV. MATLAB SIMULATION AND RESULT

Fig.4 shows the DVR Simulink model.

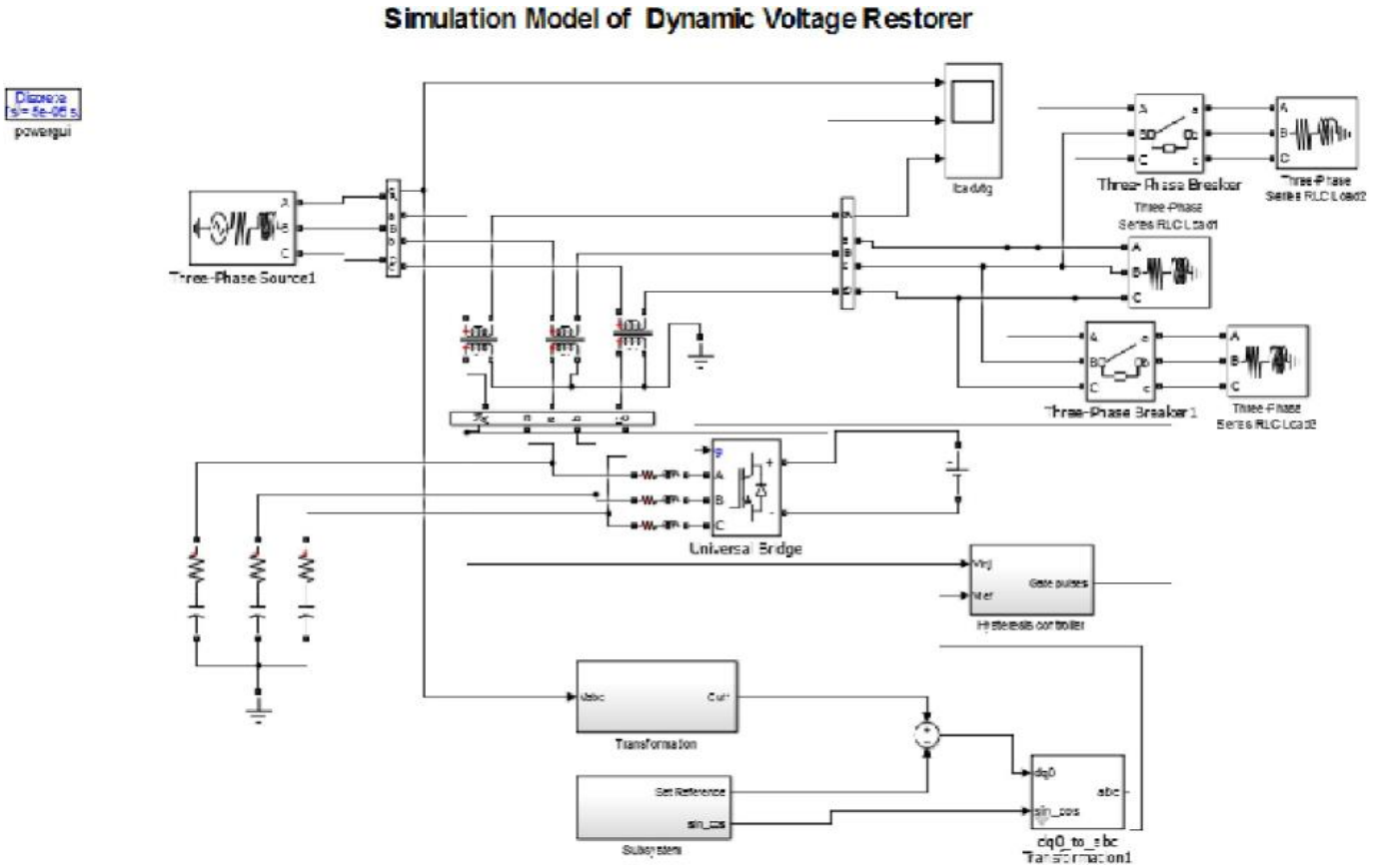


Fig.4. DVR Simulink Model

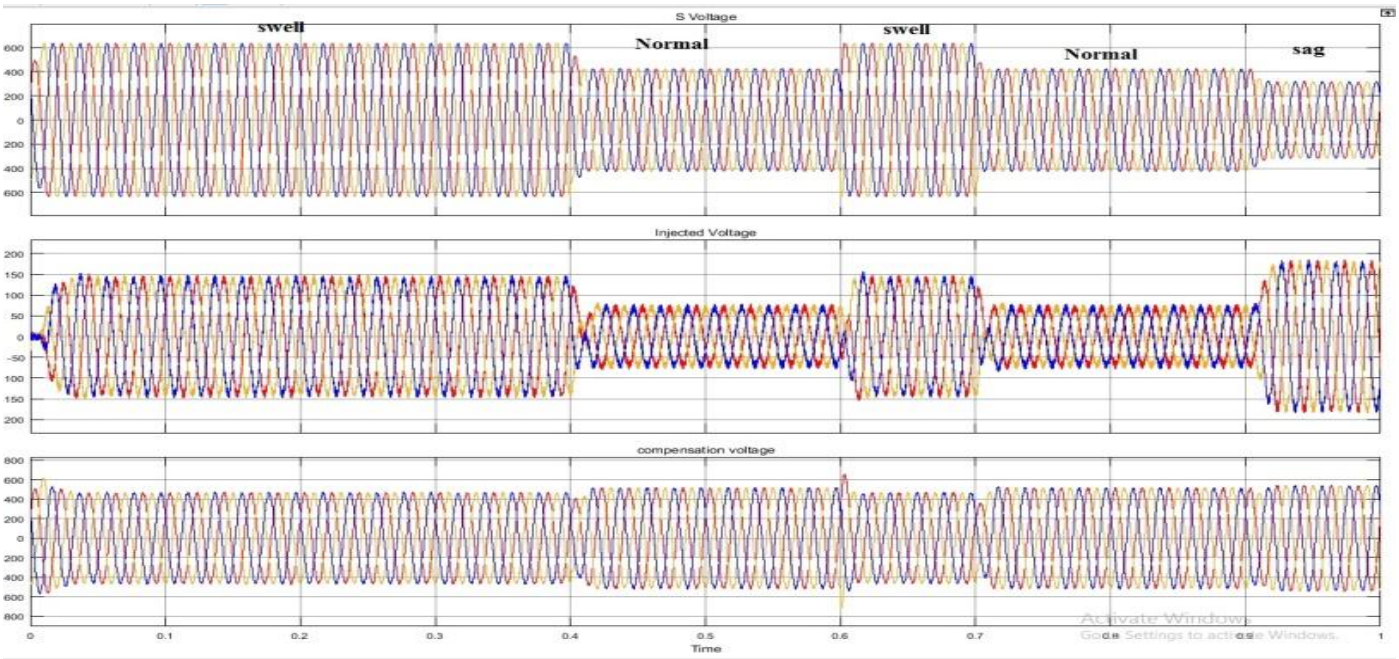


Fig. 5. Sag voltage and Swell Voltage with time interval


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**Sag Circumstance:** Error is applied to the feeder at 0.2-0.3secs intervals DVR injects voltage into the scheme. As seen in fig 1 the primary voltage of the input has two circumstances

of sag. Sag can be matched by voltage injection, the source phase to phase voltage is 300Volts from the simulation outcomes. Sag at an interval of 0.2-.03 secs is about 60-90volts, so the load is wrong, so DVR injects the necessary voltage, i.e. 60-90volts into the scheme.

**Swell Circumstance:** System failure can also trigger swelling, i.e. a rise in voltage compared to the voltage of the input hand. The DVR system is therefore able to handle such faults. Figure 1 indicates the swell in the scheme that the swell happens at an interval of 0.5-0.6secs.

DVR injects with necessary magnitude the necessary voltage of reverse polarity. Swell is about 10volts at an interval of 0.5sec to 0.6 sec. When error is crate in system voltage is rise compare to source side voltage. DVR skilled to manage the error in the system. Figure shows the swell in system. The simulation results for the voltage boosting can be shown in fig.5. Hence the result figure conclude DVR manage the sag voltage and swell voltage. Final remunerated Voltage. The Sag and swell in the system compensated by boosting the necessary voltage with the DVR setup can be seen from the results obtained from the Matlab Simulation.

## V. CONCLUSION

The simulation model findings were provided above and the DVR Proposed setup was a nice method to eliminate the Sag and Swells by using SPWM technique. Different intervals were in use to represent the sag and swell in the scheme, in the above scenario we took 0.1 sec interval between two time fall DVR Proposed scheme from the simulation outcomes demonstrates that both the sag and the swell were removed from the scheme efficiently. The SPWM technique worn in the H Bridge simulation is indeed a nice method.

## REFERENCES

[1] Christoph Meyer, Student Member, IEEE, Rik W. De Doncker, Fellow, IEEE, Yun Wei Li, Member, IEEE, and Frede Blaabjerg, Fellow, IEEE "Optimized Control Strategy for a Medium-Voltage DVR—Theoretical Investigations and Experimental Results" IEEE Transactions On Power Electronics, VOL. 23, NO. 6, NOVEMBER 2008

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[3] Rajkumari R. Patil ; Smita P. Patil ; Swapnil D. Patil ; Anwar M. Mulla, "Designing Of Z-source inverter for photovoltaic system using MATLAB/SIMULINK" International Conference on Circuit ,Power and Computing Technologies (ICCPCT), 2017, IEEE Conference Publications, ISBN: 978-1-5090-4967-7, DOI: 10.1109/ICCPCT.2017.8074331, pp.

[4] Sumant Lokhande, Swapnil Patil, Kushal Shende, Dadaso Patil, Anwar Mulla, "Introduction to FC-TBSR based SVC for Voltage Regulation and Reactive Power Compensation", IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES) IEEE Conference Publications 978-1-4673-8888-7/16/$31 .00 ©2016 IEEE, DOI: 10.1109/PEDES.2016.7914416 Year 2016 Pages 1 – 5.

[5] P. Jayaprakash, B. Singh, D. P. Kothari, A. Chandra and K. Al-Haddad, "Control of reduced-rating dynamic voltage restorer with a battery energy storage system" IEEE Transactions on Industrial Apl., vol. 50, no. 2, pp. 1295-1303, 2014.

[6] H. K. Al-Hadidi, Student Member, IEEE, A. M. Gole, Senior Member, IEEE, and David A. Jacobson, Senior Member, IEEE "A Novel Configuration for a Cascade Inverter-Based Dynamic Voltage Restorer With Reduced Energy Storage Requirements" IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 23, NO. 2, APRIL 2008

[7] C. Zhan, V.K. Ramachandramurthy, A.Arulampalam, C.Fitzzer, M.Barnes, N.Jenkins, "Control of a battery supported dynamic voltage restorer", IEEE proceedings on Transmission and Distribution, Vol.149 (No.5), Sep. 2002, pg.533-542.

[8] P.T. Nguyen, Tapan K. Saha, "Dynamic Voltage Restorer against balanced and unbalanced voltage sags: Modelling and simulation". IEEE transactions on Power Delivery, 2004, pg1-6.

[9] G. Ramtharan, S.G. Abeyratne, A.Atputharajah,"Constant frequency control of an active power filter", National Science Foundation, Sri Lanka, 2006,34(1)pg.21-28 Shairul Wizmar Wahab and Alia Mohd Yusof "Voltage Sag and mitigation Using Dynamic Voltage Restorer (DVR) System" Faculty of Electrical Engg.

[10] Ebrahim babaei, mohammad farhadi and Mehran sabahi "Dynamic voltage restorer based on multilevel inverterwith adjustable dc link voltage". IET Power electronics.


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