OPTIMISATION OF VOLTAGE SAG AND SWELL USING DYNAMIC VOLTAGE RESTORER

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ABSTRACT: Demand for good quality to be directly observed in electrical power engineering since many years, condescension the fact resources worldwide for many years are working for improvement of voltage quality what exactly is termed as power quality. There are various power quality problems and each of which will take dissimilar and diverse in results. Regular power quality problems are voltage sag, harmonics, notching, swell etc. Control of power quality problems includes relationship between network provider, customer and also equipment supplier. A DVR is a series compensator which injects the reference voltage in synchronizing with the voltage of distribution system. Here two main power quality problems will mitigate they are voltage sag and swell. The formulas are developed for determining the voltage and power injected from each of three DVR phases. The results are gotten, taking into account a model system.

Key Words: DVR, Voltage sag, Voltage swell etc.

I- INTRODUCTION

In power system various type of power quality issues are there which affects the reliability of power distribution, economical consideration and industrial applications. So it's become concern for industries which are depending on regularly electronics drives, programmable logic controller, and accuracy electronics instruments which are demanding greater power quality in distribution network. These devices are sensitive to voltage disturbance like sag and swell or harmonic distortions flickers and transient and these types of disturbances happen and because of these plants shut down and ends in loss of production or process. Voltage sags/swells can occur more frequently than other power quality problem. Voltage Sag or Voltage Dip is defined by the IEEE 1159 as the decrease in the RMS voltage level to 10% - 90% of nominal, at the power frequency for durations of ½ cycles to oneminute. The IEC (International Electro-technical Commission) terminology for voltage sag is dip. The IEC defines voltage dip as a sudden reduction of the voltage at a point in the electrical system, followed by voltage recovery after a short period, from ½ a cycle to a few seconds. Voltage sags are usually related with system faults but it also generated by energization of large loads or at the time of starting up large motors which can draw 6 to 10 times its full load current during starting.Voltage Swell is defined by IEEE 1159 as the increase in the RMS voltage level to 110% - 180% of nominal, at the power frequency for durations of ½ cycles to one minute. Swells may also be a result of switching off a large load or energizing a large capacitor bank and are identified by their magnitude (RMS value) and duration. In industry quality of power is stringently related to the economic result associated with the equipment. So the need for solution of this sympathetic of disturbance fast response of voltage regulation is required. Further it required separate the characteristics of voltagesags/swells and phase angle. Voltage sags/swells are also accompanied by change in phase angle called phase angle jump. To overcome this type of disturbance custom power devices are used which capable of injecting minimum energy so as to regulate load voltage to its previous value. Dynamic Voltage restorer (DVR) is one of the custom power device which would provide effective solution of compensate the voltage sags/swells by establishing load voltage to the pre fault voltage. The major benefit of DVR is the keep the high-quality constant voltage and continuousness of production. In this thesis dynamic voltage restorer with proportional integral (PI) controller is used to compensation power quality problem related with voltage sags/swells and maintaining required level of supply voltage at load terminal. The simulation of DVR is accomplished using MATLAB/Simulink and the performance of DVR at different voltage disturbance is tested.

II- POWER QUALITY PROBLEMS

A- **Voltage sag-** According to IEEE 1159, voltage sag or dip is described as a drop in the rms voltage level to 10% -90 percent of nominal at the power frequency for durations of 0.5 cycles to one minute. Voltage sag is referred to as dip by the IEC (International Electro-technical Commission). According to the IEC, a voltage dip is described as an unexpected drop in voltage. voltage at a point in the electrical system, as determined by voltage recovery after a brief time, ranging from 0.5 to a few seconds.

B- **Voltage swell-** According to IEEE 1159, the increase in the rms voltage level minute is known as voltage swell. As a result, it falls under the category of a short-duration voltage difference phenomenon, which is one of the most basic types of power quality issues. The word"temporary overvoltage" is often used instead of "swell." The transient voltage increase on the well system phases causes swells. Throughout a single-line-to-ground fault, Swells can also be produced by switching off a large load or energization of a large capacitor bank and considered by magnitude and duration.

C- **Voltage interruption-** Interruption occurs when the power supply is turned off for a period of time. Normally, the supply signal (voltage or current) tends to zero. They are of the following forms, depending on the time frame.

D- **Transients-** Transients are sudden changes in voltage and current signals in the power system that lastjust a few seconds. Impulsive and oscillatory transients are the two most common forms of transients. Impulsive transients are often unidirectional, while oscillatory transients have swings that rapidly change polarity.

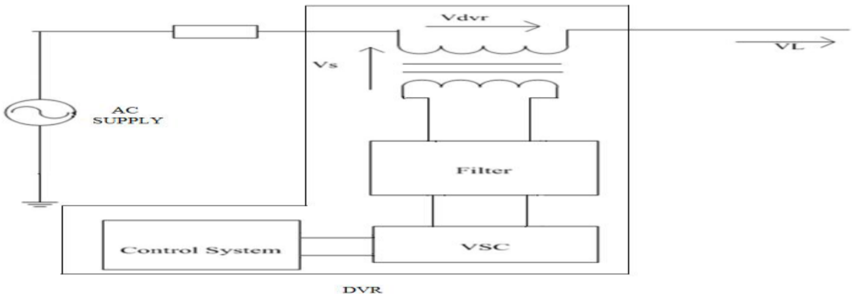
E- Voltage Fluctuations- Voltage fluctuations are either incremental or spontaneous changes in the amplitude of the voltage (which lies in the range of 0.9p.u. to 1.1p.u.).

F- Voltage Flicker- Variation of input voltage sufficient in duration to allow visual observation of a change in electric light source electric light source intensity. Flicker may be expressed as the change in voltage over nominal expressed as a percent.

III- CONFIGURATION OF DVR

The basic configuration of the DVR consists of:

a) An injection transformer
b) Storage devices and DC charging circuit
c) A voltage source converter/inverter
d) Harmonics filter
e) Control and protection system



Block diagram Of DVR

IV- OPERATING MODE OF DVR

Protection mode-

Because of the increased current fault current or inrush current flow load side over current created during this mode, the DVR isolated to systems (S2 and S3 will open) and provide another path for current (S1 will be closed).

Injection Mode-

When a disturbance in supply voltage is detected in this mode, $V_{DVR}>0$, and DVR injects a compensating voltage via injection transformer.

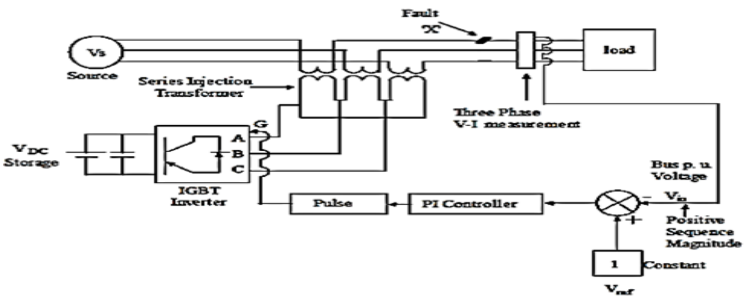
Standby Mode-

DVRs are usually in standby mode. The low voltage winding of the injecting transformer is shorted with the converter and in this mode $V_{DVR}=0$. In this mode, no semiconductor switching occurs, and full load current flows through the main. As a result, loss minimization in DVR should be achieved.

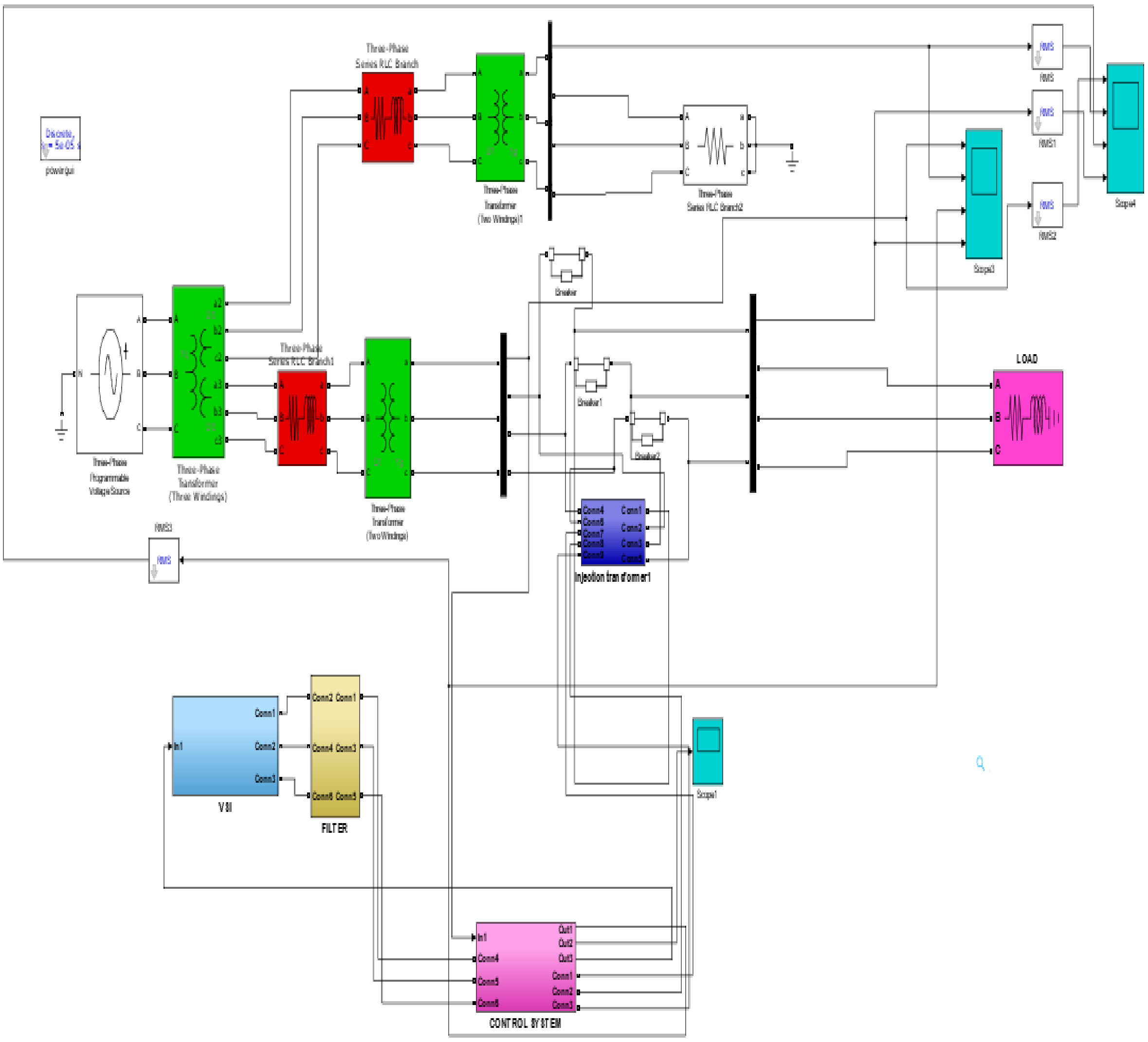
V- COMPENSATION TECHNIQUES IN DVR

a) Pre-sag compensation method
b) In phase compensation method
c) In phase advance compensation methods

VI-CONTROL CIRCUIT OF DVR SYSTEM

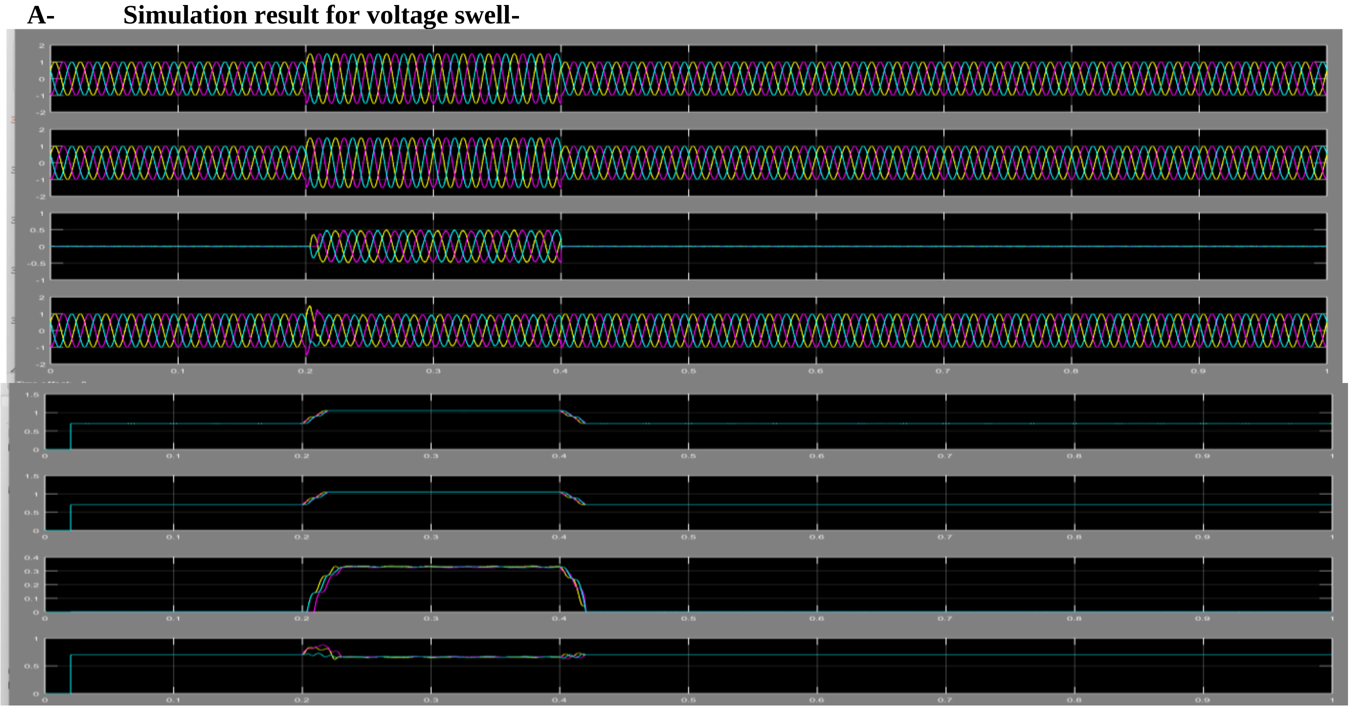


VII- IMPLEMENTATION OF DVR SYSTEM USING MATLAB / SIMULATION

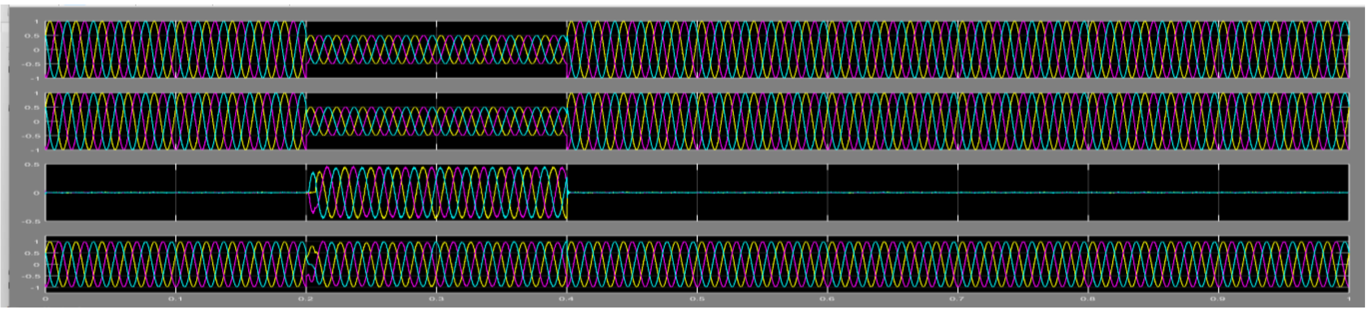


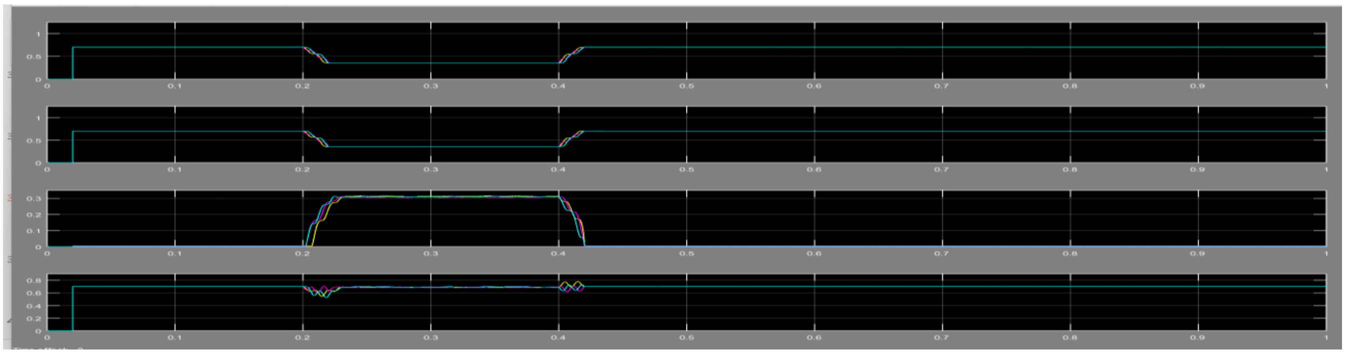
VIII-SIMULATION RESULTS

A- Simulation result for voltage swell-



B- Simulation result for voltage sag-





IX- EXPERIMENTAL PARAMETERS

S.No.	Component	Ratings
1	Source	3 phase, 13kV rms (phase to phase), 50Hz, 500e6 Shortcircuit level (VA), 11kV Base voltage, X/R = 0.5.
2	Converter	IGBT based, 3 arms, 6 pulse
3	PI Controller	Kp=0.5, Ki=30, Sampling time=50e^{-6}
4	Load	R-Lload (30 KW,100VAR)
5	Transformer	Nominal power 200e3 VA, 50 Hz, Δ/Y/Y(grounded) 115KV/1100/1100,R1/R2/R3,L1/L2/L3= (0.002/0.002/0.002,0.08/0.08/0.08)

X- CONCLUSION

DVR was modelled and simulated in MATLAB Simulink for this dissertation. Linear load and induction motor load were used to evaluate DVR output. In industrial distribution systems, a Dynamic Voltage Restorer (DVR) is proposed to compensate for voltage sag/swelland other fault situations. The induction motor load is particularly important. The utility of DVR using a PI controller has been proven for both linear and load applications, and its control is simple.

As a result, it can be inferred that DVR effectively decreases voltage disturbance voltage sag and swell from load voltage and renders it even. As a result, we may conclude that DVR is aneffective system for restoring power quality.

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Ashutosh Pandey, AMIE received his BE degree in Electrical Engineering from Institution of Engineers (India) in year 2013. He is having a 17 years of work experience in Aviation Electrical System. He is a Senior Tech Analyst in Aviation Field, specialized in Aviation Electrical System. He is currently pursuing M. Tech in Electrical Engineering from Gujarat Technical University. His area of interest is Power Quality and Power System.