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Mitigation of Voltage Sags & Swells in LV Distribution System Using Dynamic Voltage Restorer

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Abstract: *In recent years, Power quality is one of the major concerns in modern power system.It has become important especially with the introduction of new advance devices, which are very sensitive to the power quality and their performance is dependent of quality of power. In modern industries, electronic controllers to control load equipment which are highly sensitive to poor voltage quality and will shut down if the supply voltage is low and may mal-function in other ways if harmonic content of the supply voltage is high. In this paper work among the different custom power devices, Dynamic Voltage Restorer (DVR) has been used to improve the quality of power under different conditions.*

Keywords: *Power quality, DVR, Sag & swell, Voltage disturbances*

1. INTRODUCTION

Power quality problems is an occurrence manifested as nonstandard voltage, current or frequency, the result in failure or miss operation of end user equipment. Much of this modern load equipment itself uses electronic switching devices which themselves could be responsible or lead to poor voltage quality in network. The introduction of competition into power sector has created larger business awareness of the problems of power quality whereas instrumentality is has become possible to measure current and standard of the voltage wave so quantify the problem.

With a rapid change in technology in industrial control process, electric utilities are experiencing more demanding requirements on the power quality from the large industrial power consumers and the organization of the worldwide economy has evolved towards globalization and the profit margins of many activities tend to decrease. The increased sensitivity of the vast majority of processes like (industrial, services and even residential) to power quality problems turns the availability of electric power with quality a necessary factor for every activity sector. The information technology services and the continuous process industry are most critical area. Due to disturbance, in power supply or poor power quality may result in huge amount of economic losses, with the consequent loss of productivity and affordability.

2. DYNAMIC Voltage RESTORER:

The DVR is a power quality device, which can protect these industries against the bulk of these disturbances, i.e. voltage sags and swells related to remote system faults. A DVR compensates for these voltage excursions, provided that the supply grid does not get disconnected entirely

through breaker trips. Modern pulse-width modulated (PWM) inverters capable of generating accurate high quality voltage waveforms form the power electronic heart of the new Custom Power devices like DVR. Because the performance of the overall control system largely depends on the quality of the applied control strategy, a highperformance controller with fast transient response and good steady state characteristics is required. The main considerations for the control system of a DVR include: sag detection, voltage reference generation and transient and steady-state control of the injected voltage.

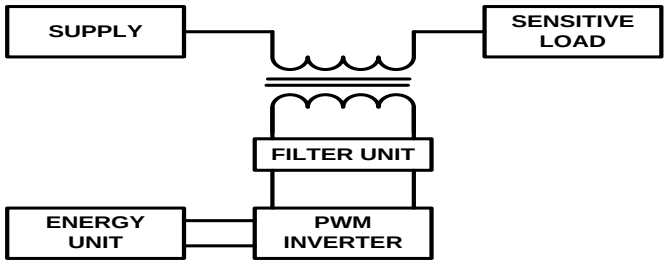

Figure 1 Typical application of DVR and its output.

Futures of DVR

- Lower cost, smaller size, and its fast dynamic response to the disturbance.
- Ability to control active power flow.

Among the voltage transients (sags, swells, harmonics…), the voltage sags are the most severe disturbance. The users may improve end-use devices or use protection devices to reduce

- Higher energy capacity and lower costs compared to the SMES device.
- Less maintenance required. UPS is costly; it also requires a high level of maintenance because batteries leak and have to be replaced as often as every five years.

LOCATION OF DVR

DVR is connected in the utility primary distribution feeder. This location of DVR mitigates the certain group of customer by faults on the adjacent feeder as shown in Figure2.The point of common coupling (PCC) feds the load and the fault. The voltage sag in the system is calculated by using voltage divider rule. [1]

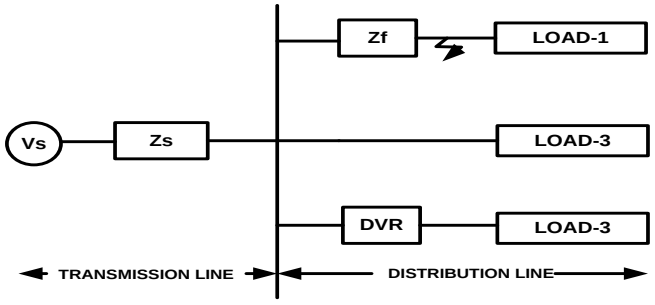

Figure 2 Location of DVR

3. WORKING OF DVR

the number of voltage sags. But overall solution to mitigate the voltage sags and recovering the load voltage to the pre-fault value is using a Dynamic Voltage Restorer (DVR).

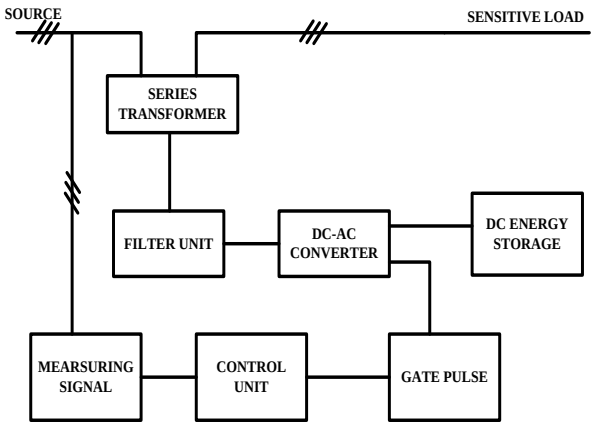

Figure 3Function blocks of designed DVR

It is a solid state DC to AC switching power electronic converter that injects threesingle-phase AC voltages in series between the feeder and sensitive load. Using a DVR is more reliable and quick solution to maintain with a clean supply of electricity for customers. But standby losses, equipment costs and required large investigation for design are the main drawbacks of DVR. The PWM inverter unit produces required missing voltage by evaluating the control unit signals and this compensating voltage is inserted to the system by injection transformers.

As mentioned in block diagram of DVR. 1st step in design of the DVR is to make the Phase Locked Loop for tracking continuously the fundamental frequency of measured system voltages. Two

4. Simulink Model of Dynamic Voltage Restorer

Figure 4 shows the diagram for the system under fault condition using DVR. By proper tuning of the controller required voltage to mitigate the voltage sag for few cycle is injected through series connected transformer, so that the voltage across the line remain at its nominal value even under fault condition.

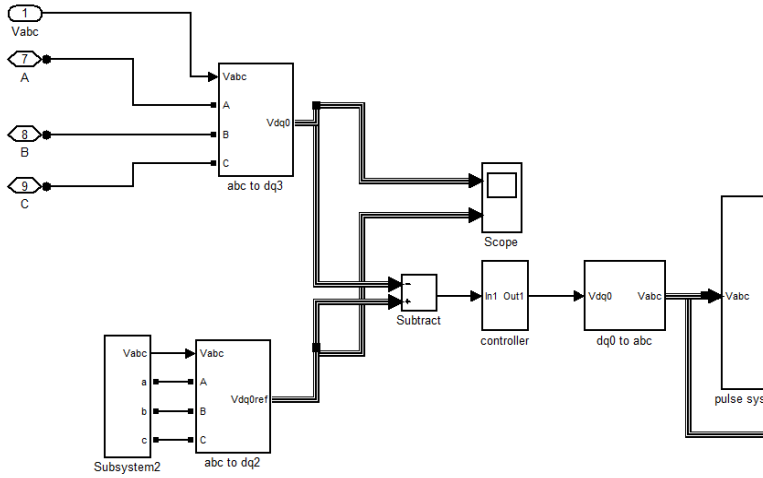

Figure 4 Dynamic Voltage Restorer

Simulation of Phase Locked Loop

fictitious curents with amplitude 1 pu are generated as the output of the PLL circuit which wiil be used to determine the possitive sequence component under fault condition.

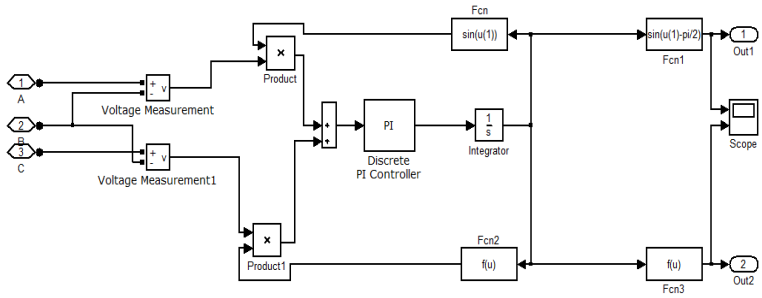

Figure 5 Phase Locked Loop

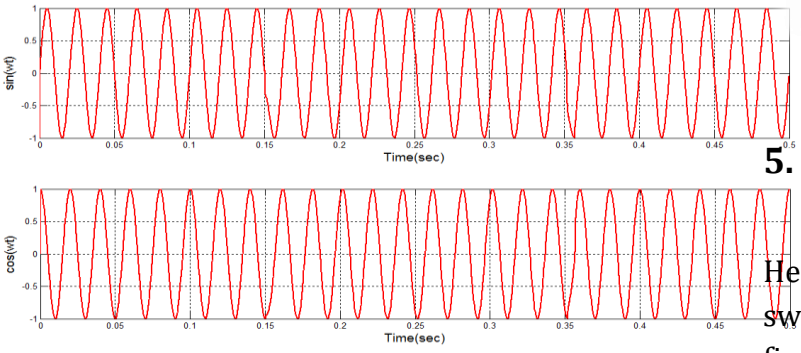

Figure 6 Outputs of PLL

Generation of gate pulses

Now for the generation of pulses, compensated voltage signal is compared with the triangular wave of amplitude 1pu and having the frequency of 1.5 kHz. The generated pulses are as shown in figure7.

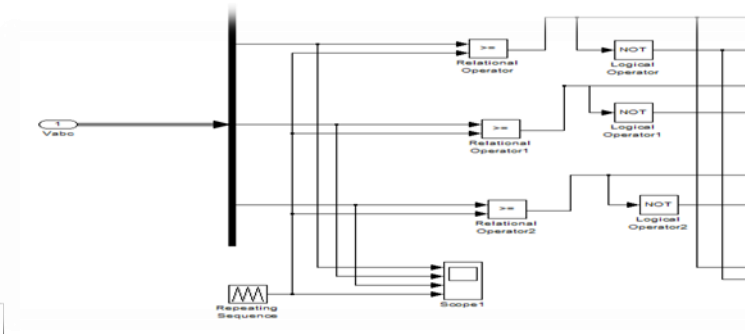

Figure 7 Generation of Gate pulse

5. SIMULATION RESULTS FOR CONSECUTIVE SAG AND SWELL

Here in this case both the voltage sag and voltage swells occurs for certain duration. As shown in figure 8 there is voltage sag from 0.1 sec to 0.2 sec. and after some time there is a voltage swell from 0.3 sec to 0.4 sec. now DVR has a capability to compensate both the voltage sag and voltage swell condition.

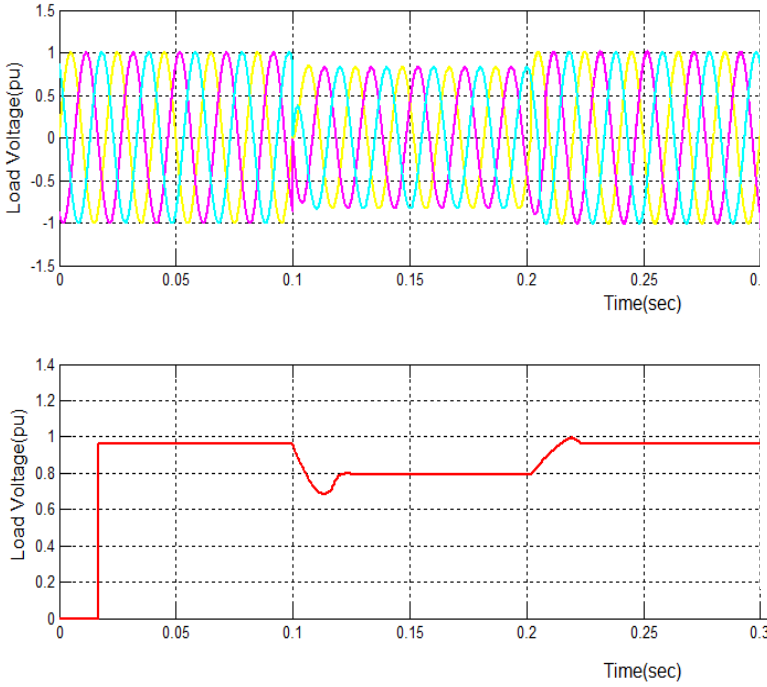

Figure 8 Load Voltages under sag and swell condition

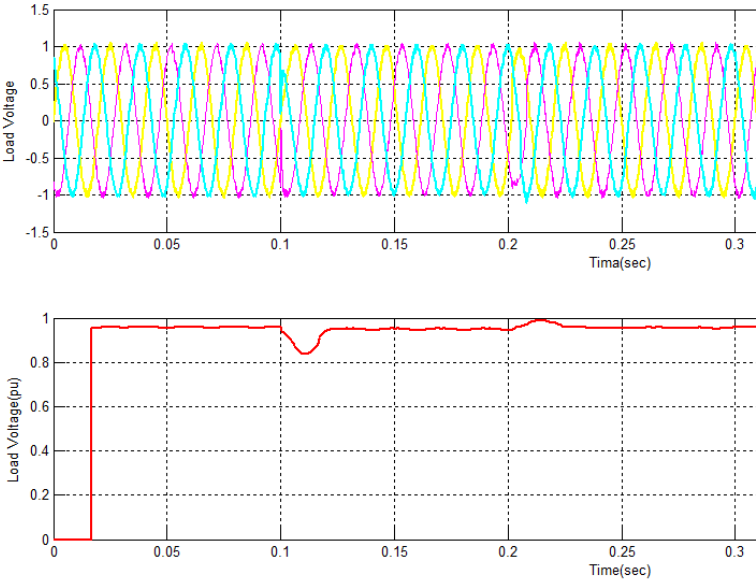

Fig. 10 Load voltages after consecutive sag and swell compensation

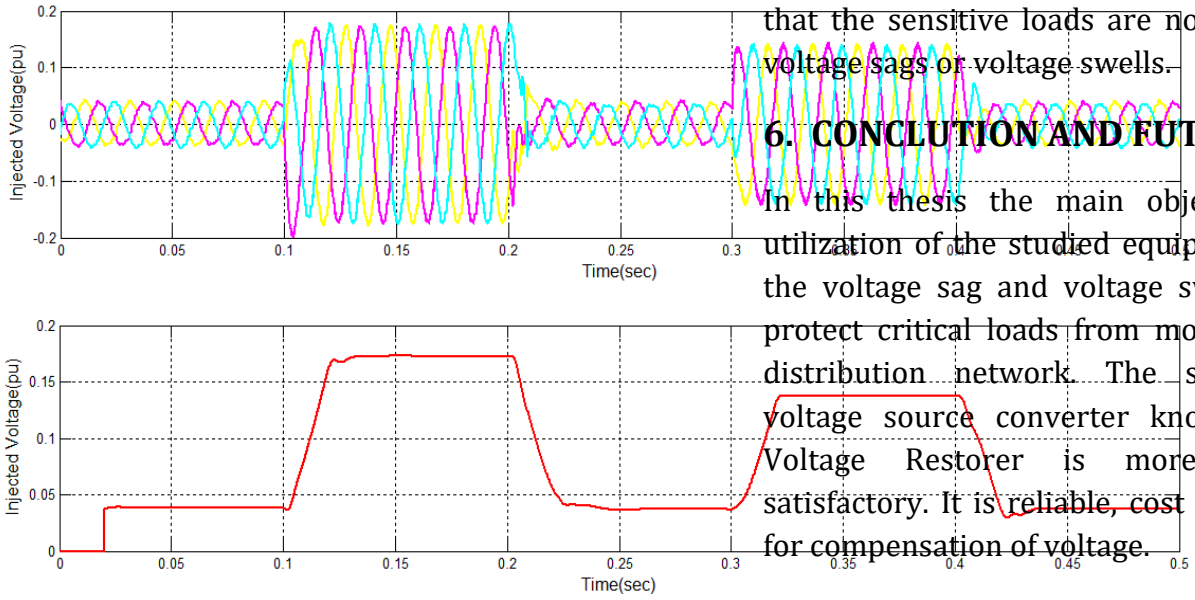

Figure 9 Injected Voltage by DVR

After the injection of the voltage by the DVR the voltage across the line remains constant such that the sensitive loads are not affected by the voltage sags or voltage swells.

6. CONCLUTION AND FUTURE WORK

In this thesis the main objective s 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 series connected voltage source converter known as Dynamic Voltage Restorer is more suitable and satisfactory. It is reliable, cost effective solution for compensation of voltage.

FUTURE SCOPE

- It is possible to use shunt converter topology instead of constant battery storage element.
- Other methods such as phase advance method may be implemented.

Other technique for the generation of pulses may be implemented.

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