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MITIGATION OF VOLTAGE SAG USING DVR

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ABSTRACT

Power quality is one of the major concerns in the era of power system. Power quality problem occurred due to non- standard voltage, current or frequency, that result in a failure of end user equipment. To overcome this problem, Dynamic Voltage Restorer (DVR) is used, which eliminate voltage sag. This paper narrates the application of DVR to optimize the power quality problems such as voltage sag,The DVR is a power electronics based device that is commonly for voltage sagmitigation at the point of connection. A control technique based on a proportional (P) controller is implemented. In fact with the aid of Pulse width modulation (PWM) inverters capable of generating accurate high quality voltage waveforms from the power electronic device. Simulation results shows the effectiveness of proposed method by MATLAB.

KEYWORDS: Power quality, Dynamic Voltage Restorer (DVR), Voltage Source Converter (VSC), Voltage sag.

INTRODUCTION

Nowadays, more and more power electronics equipment, so-called “sensitive equipment”, are used in the industrial process to attain high automatic ability. Susceptibility of these end-user devices draws attention of both end customers and suppliers to the questions of power quality, especially, short duration power disturbances, such as voltage dips, swells and short interruptions. The most common form of power quality disruption is the voltage sag, which accounts 70% of all power disturbances [8].

Voltage sag and voltage swell are two of the most important power-quality (PQ) problems that encompass almost 80% of the distribution system [6], these voltage problems can be solved using a series connected custom power device called dynamic voltage restorer (DVR). The emphasis has been given for switching control strategy [3].

Pulse width modulation (PWM) inverters have been applied as a control scheme to mitigate voltage sags and swell in the test system [2].
A new control strategy has been developed for achieving maximum benefits by eliminating or mitigating voltage sag / swell and power quality problem when abnormal condition occur in the distribution system, for this purpose the dynamic voltage restorer is proposed to improve the power quality and to reduce the sag and swell problem in the system. The DC link capacitor clamped converter is connected with series through transformer. We have proposed that if DC source is integrated with grid, with developing adequate control of grid-interfacing inverter, all objectives can be accomplished either individually or simultaneously. We have implemented the features of DVR for maximum utilization of distribution voltage, which are not fully utilized due to intermittent nature of distribution voltage because our system was highly tapped [5].

DYNAMIC VOLTAGE RESTORER

Operating Principle: "A DVR is a distribution voltage DC to AC solid state switching converter that injects three phase voltage in synchronized with the voltages in distribution system".

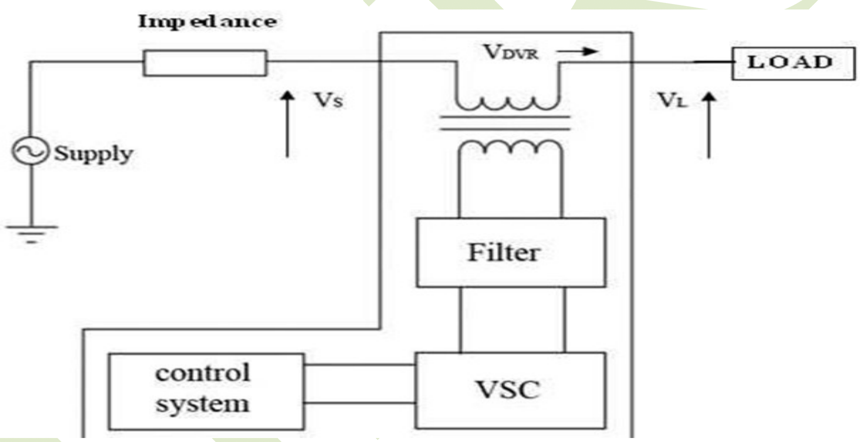


Fig1: Block diagram of DVR.

The general configurations of DVR consist of:

INJECTION/ BOOSTER TRANSFORMER:

The Injection / Booster transformer is a specially designed transformer that attempts to limit the coupling of noise and transient energy from the primary side to the secondary side.

HARMONIC FILTER:

The main task of harmonic filter is to keep the harmonic voltage content generated by the VSC to the permissible level.

VOLTAGE SOURCE CONVERTER:

A VSC is a power electronic system consists of a storage device and switching devices, which can generate a sinusoidal voltage at any required frequency, magnitude, and phase angle. In the DVR application, the VSC is used to temporarily replace the supply voltage or to generate the part of the supply voltage which is missing.

DC CHARGING CIRCUIT:

The dc charging circuit has two main tasks:
The first task is to charge the energy source after a sag compensation event. The second task is to maintain dc link voltage at the nominal dc link voltage.

CONTROL AND PROTECTION

The control mechanism of the general configuration typically consists of hardware with programmable logic. All protective functions of the DVR should be implemented in the software. Differential current protection of the transformer, or short circuit current on the customer load side are only two examples of many protection functions possibility.

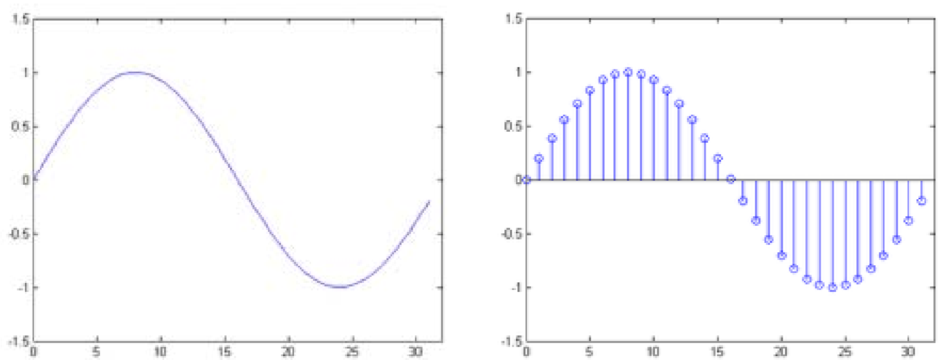


Fig 2: Analog wave & Discrete wave.

DISCRETE PWM-BASED CONTROL SCHEME:

In order to mitigate the simulated voltage sags in the test system of each compensation technique, also to compensate voltage sags in practical application, a discrete PWM-based control scheme is implemented, with reference to DVR. The aim of the control scheme is to maintain a constant voltage magnitude at the sensitive load point, under the system disturbance. The control system only measures the rms voltage at load point, for example, no reactive power measurement is required.
It should be noted that, an assumption of balanced network and operating conditions are made. The modulating angle δ or delta is applied to the PWM generators in phase A, whereas the angles for phase B and C are shifted by 240° or -120° and 120° respectively.

$$V_A = \sin(\omega t + \delta) \qquad V_B = \sin(\omega t + \delta - 2\pi/3) \qquad V_C = \sin(\omega t + \delta + 2\pi/3)$$

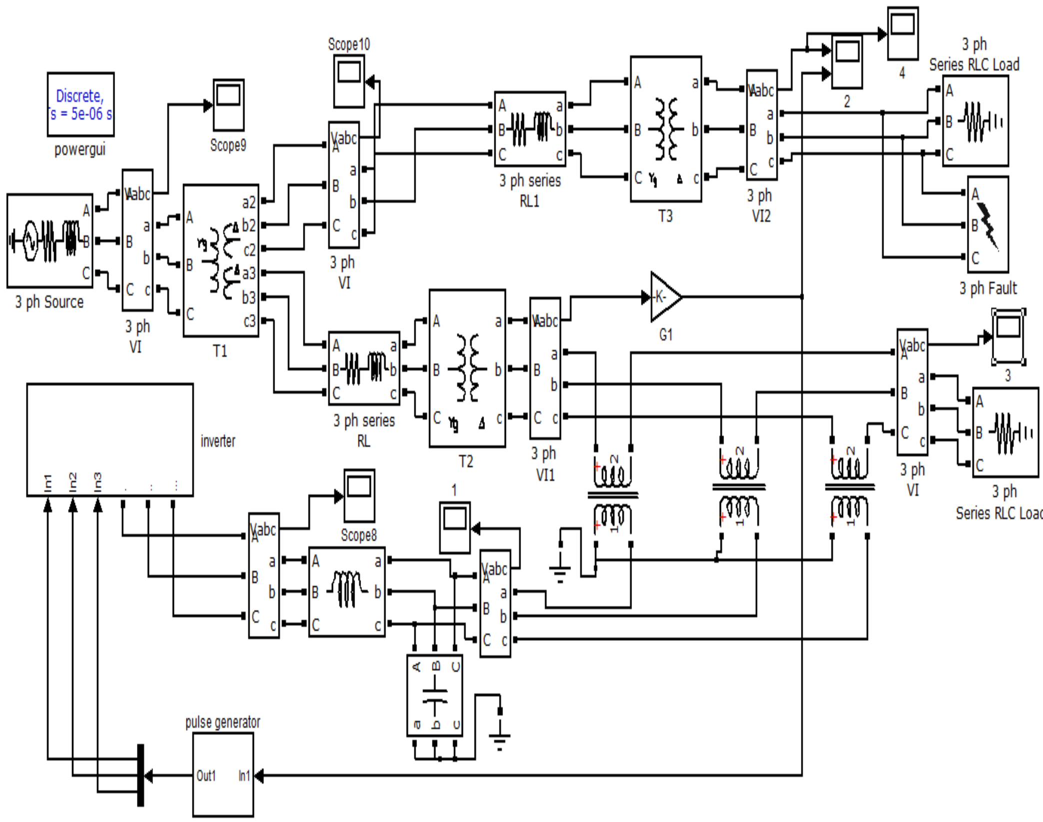


Fig 3: Simulink Model

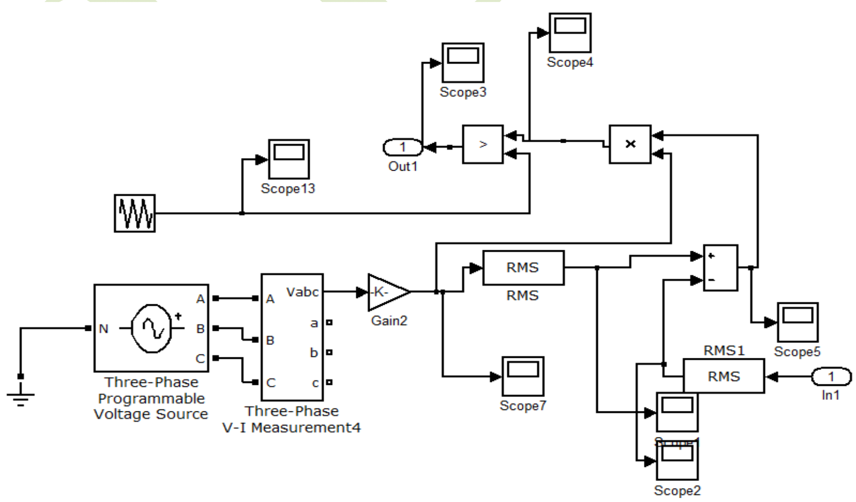


Fig 4: Subsystem 1

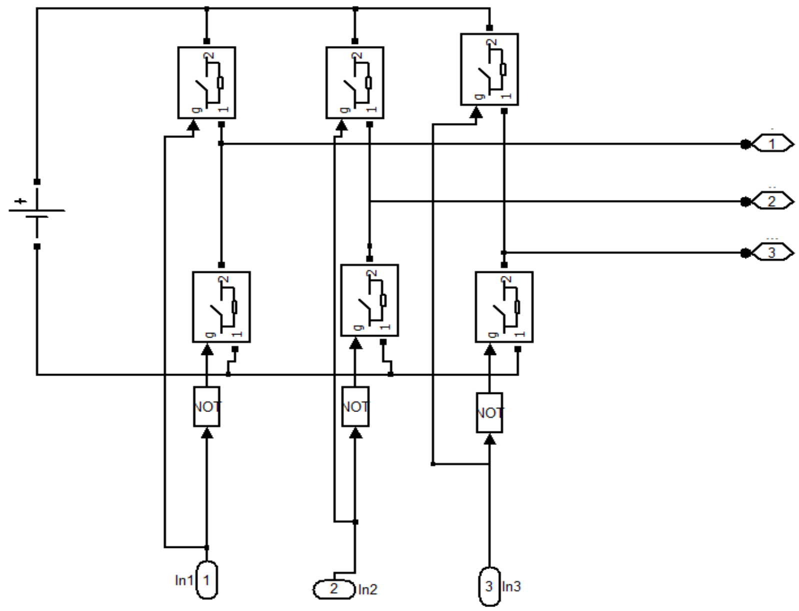
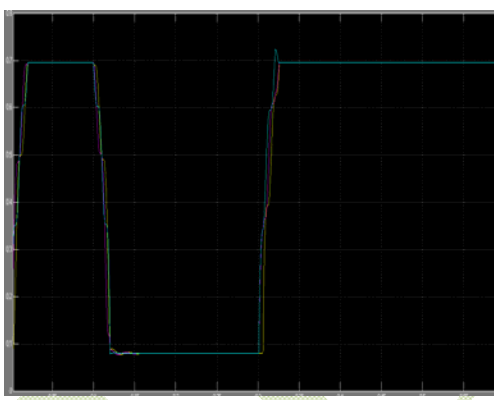


Fig 5: Subsystem 2



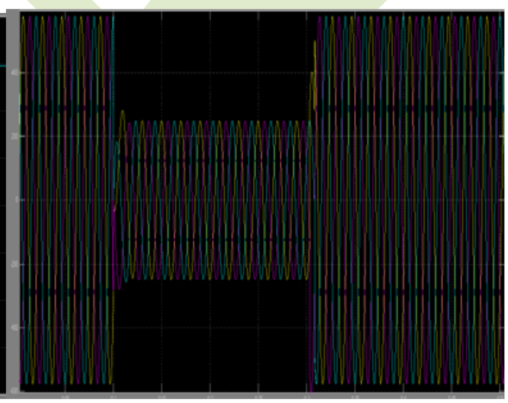
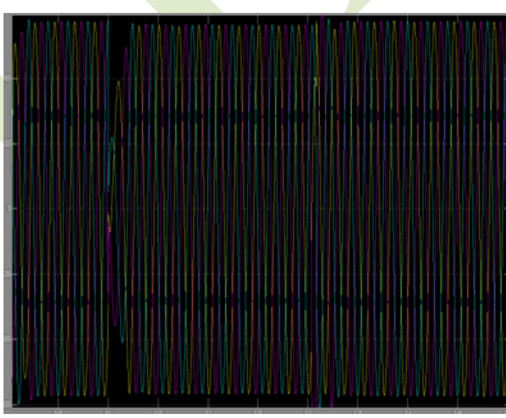


Fig.6: P.U Voltage at load, with 3-Ø fault **Fig.7: 3Ø Voltage at load, with 3-Ø fault.**



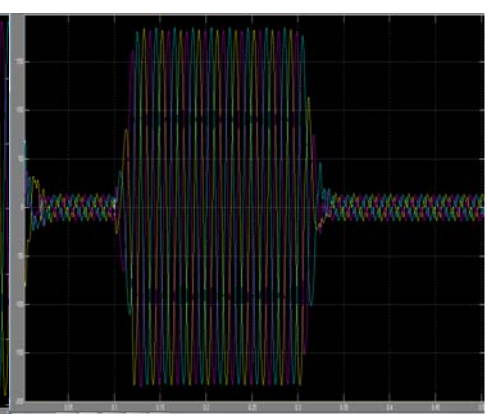


Fig.8:3Ø Voltage at load, with DVR **Fig.9:3Ø Injected Voltage through Transformer**

CONCLUSION

This project has presented the power quality problems such as voltage dips, distortions and harmonics. Compensation techniques of custom power electronic devices DVR was presented. The design and applications of DVR for voltage sags and comprehensive results were presented. A PWM-based control scheme was implemented. As opposed to fundamental frequency switching schemes already available in MATLAB, this PWM control scheme only requires voltage measurements. This characteristic makes it ideally suitable for low-voltage custom power application.

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