



Analysis of DVR in Distribution System during Voltage Sags & Voltage Swells

KEYWORDS

Power Quality, DVR, Voltage Swags, Voltage Swells, Power Distribution, Pulse Generator Module.

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ABSTRACT Now days Power quality is a premier fact by which the high-tech devices are getting affected. Power quality problem is quite natural and is often occurs, such as non-sinusoidal voltage, frequency of current which in turn results in the failure of end use equipments. Main problem is voltage perturbation during voltage sags & voltage swells. To figure out these difficulties, custom power devices can be used. These problems can be solved up to a greater extent. This article focuses on the performance of DVR for voltage compensation which is done by using MATLAB Software to explain PI Controller & discrete PWM Pulse Generator Module have been used.

Introduction

Electrical energy is the most Efficient and enormous form of energy and all of us are desperately dependent on the electric supply. At the same time the quality and existence of electric power supplied is also very important for the proper functioning of the end user equipment is required at all cost. Almost the entire commercial sector demands high quality uninterrupted power. Thus maintaining the quality of power is of important.

Power quality is becoming an increasingly important topic in the performance of many industrial applications such as information technology devices related to communication, advanced control, automation, precise manufacturing technique and online service.

Power Distribution systems ideally should provide their customers with an incessant flow of energy at smooth sinusoidal voltage at the slender magnitude level and frequency. However in practice power systems especially the distribution systems have many nonlinear loads which substantially impact the quality of power supplies.

Power Quality disturbance can be defined as the deviation of the voltage and the current from its perfect waveform. So many methods are used to extenuate/palliate voltage sags and swells, but we use the most efficient method of custom power devices, e.g. FACTS for transmission systems which make the power transfer capabilities and stability margin better.

The DVR has a higher energy capacity compared to the SMES and UPS devices. Moreover, the DVR is smaller in size and economical as compared to the DSTATCOM and other custom power devices. The DVR is fast, flexible and efficient. In addition to voltage sags and swells compensation, DVR having one more quality of harmonic s correction. DVR eliminates or mitigates the voltage sag/ swell and power quality problem when unnatural condition occur in distribution system.

Power quality problem

The basic measures for power quality are constant rms value, constant frequency, symmetrical three-phases, pure sinusoidal wave shape and limited THD. This power quality disturbance makes the malfunctioning of equipment and also makes it inefficient. Power quality problems embrace a wide range of dis-

turbances and they are voltage sags, voltage swell, harmonic distortion, impulse transient and interruptions.

The main reasons to concern with Power Quality are given as:

Due to many microprocessor based controls end user device becomes more sensitive.

Large computer systems in many businesses facilities

Power electronics equipment used for enhancing system stability, operation & efficiency. They are major source of bad PQ and are defenseless to bad PQ as well.

Deregulation of the power industry

Continuous development of high performance equipment. Such equipment is more susceptible to power disturbances.

A. Power Quality Issues

Voltage Sags : It is short duration decrease in rms voltage value from 0.1 to 0.9 pu .

Causes of Voltage sags:

- Equipment failure
- Power system failure,
- Customer load additions and large load additions in the utility service area.

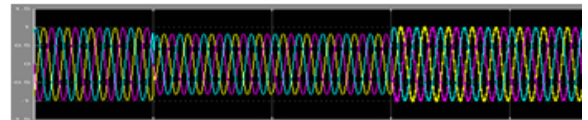


Fig 2.1 Presentation of Voltage Sags

Voltage Swells: Voltage Swell is opposite of Voltage Sag and less common in nature. And it is defined as short duration increase in voltage values level 110% - 180% of nominal voltage for duration of ½ cycles to one minute.

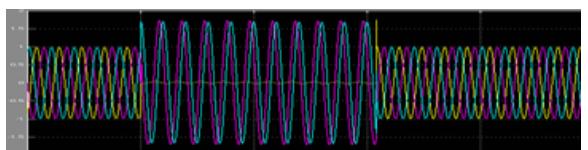


Fig 2.2 Presentation of Voltage Swell
Causes of voltage Swell:

- Although they can also be caused by loose neutral connection,
- By capacitor bank load and power line switching.
- Change in ground reference on ungrounded phases
- Dynamic Voltage Analysis

Power quality means the fitness of electrical power system. And if any disturbances generated in system then it causes damage. To solve this problems the concept of custom power device is introduced.

One of them device is dynamic voltage restorer. Which is the most efficient & effective device. It is series connected solid state device that injects voltage into the system in order to modulate the load side voltage.

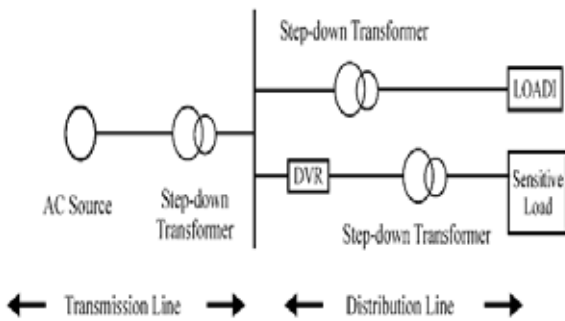


Fig.3.1 Location of DVR

The energy storage unit is common voltage source for PWM inverter which is composed of DC capacitor. The PWM inverter unit produces required missing voltage by evaluating the control unit signals and this required voltage is inserted to the system by injection transformers.

A. Classification of DVR

The DVR can be classified as follows:

- An Injection Transformer / Booster transformer
- Filter
- Storage Device
- Voltage source Converter (VSC)
- Control unit

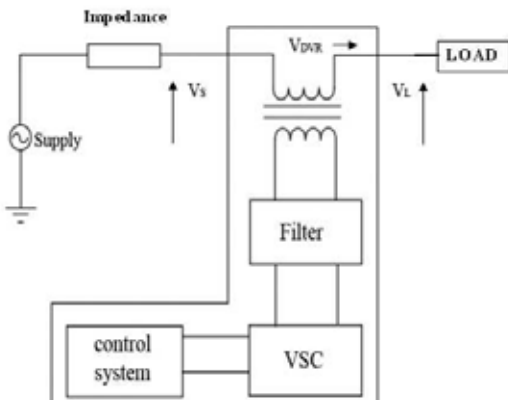


Fig3.2 Schematic diagram of DVR
B. Equation of DVR

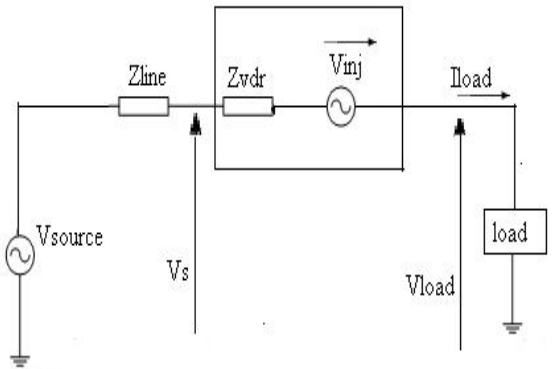


Fig.3.3 Equivalent circuit of DVR

Above diagram represents the equivalent circuit of DVR. The fault of a load bus depends on the system impedance Z_{th} . When source voltage is dip or increases (V_{TH}), then the DVR injects a series voltage (V_{inj}) through injection transformer. So the load voltage magnitude which we look for V_L is set up. Now the equation is written as :

$$V_{DVR} = V_L + Z_{TH} I_L - V_{TH}$$

Where

V_L = Magnitude of load voltage

Z_{TH} = Load Impedance

I_L = Load Current

V_{TH} = System voltage during fault

The load current I_L is ,

$$I_L = \frac{[V_L + jQ_L]}{V}$$

When V_L is considered as a reference equation can be re-written as ,

$$V_{DVR} = V_L \angle 0 + Z_{TH} \angle (\beta - \theta) - V_{TH} \angle \delta$$

α, β, δ are angles of V_{DVR}, V_{TH} & Z_{TH} , respectively and θ is load power angle.

$$\theta = \tan^{-1} (Q_L / P_L)$$

The complex power angle of DVR can be

$$S_{DVR} = V_{DVR} I_L^*$$

It requires only reactive power injection and DVR itself generates reactive power.

Formulation

A. Discrete PWM

To compensation the sag voltage in realistic application , a discrete PWM (Pulse Width Modulation) technique is used. It is extremely popular method of high switching frequency in industrial application. The main function of PWM is to keep a constant voltage magnitude of sensitive load under system disturbance. They only measures rms voltage. When there is voltage sag then an error occurs which is observed by PI controller and based on error value PWM generates pulses to the IGBT switch in VSI.

PI Controller observes the error produced by the difference between the fault voltage & the supply voltage. Then it generates a required δ angle to drive the error to zero. With this phase angle a control voltage is generated. The magnitude of control voltage is depends on phase angle δ . The phase angle is proportional to the degree of disturbance. The generated voltage is called the controlled voltage.

The advantage of using PWM technique is, it is less in cost. No energy storage device is used and less number of switches required.

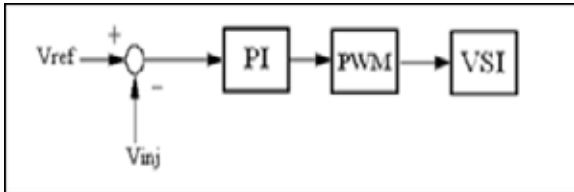


Fig4.1 PI Controller Block Representation
B.Phase Modulation

Phase modulation used in much application to carry both analogue and digital signals. Maintain the amplitude of the

signal constant the phase is varied to bring the required information or signal. The modulation angle δ is generated by phase modulation. And δ angle is applied to PWM generators in phase A, where as the angle for phase B & C are shifted by 240° or -120° & 120° respectively

$$V_A = \sin(\omega t + \delta)$$

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

$$V_C = \sin(\omega t + \delta + 2\pi/3)$$

CONCLUSION

This research paper has presented the power quality problems of voltage sags and swells analysis through DVR in Distribution System During Voltage Sags & Voltage Swells. Compensation technique of DVR is presented to solve the problem of distortion. The design & simulation of DVR was presented. The aim of this is to compensate the voltage sag and swell problem. This simulation shows DVR provides better regulation. In this PI controller is used to composite the error.

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