Review on Modelling And Simulation For Voltage Sags/Swells Mitigation Using Dynamic Voltage Restorer (DVR)

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Abstract- *In power system power quality of supply plays a major role. With advancement in technology there are some devices whose performance is very sensitive to the quality of supplied power. Low power quality may cause failure or damage to the equipment and also interruption in required working operation .Among such power quality problems voltage sag can in many cases be the most considerable power quality problem.In present time to solve this problem various devices are used.*

A Dynamic Voltage Restorer (DVR) is one of those devices, which is used to handle deep voltage sags, swells. The dynamic voltage restore has excellent dynamic capabilities, which can compensate for voltage sags/ swells. It can provide the most commercial solution to mitigation voltage sag by injecting voltage as well as power into the system. This paper presents modeling, analysis and simulation of a Dynamic Voltage Restorer (DVR) using MATLAB. The efficiency of the DVR depends on the performance of the efficiency control technique involved in switching the inverters. In this model a PI controller and Discrete PWM pulse generator was used.

Keywords: DVR, Sags, Swells, Power Quality

I. INTRODUCTION

An electrical power system is a network of electrical components deployed to supply, transfer, and use electric power. An example of a power Vsystem is the electrical grid that provides power to homes and industry within an extended area. In industry commercial area and homes we have requirements of continue power supply without any sag but we have many big drawbacks and harmonics .whenever the sudden power distribution has stop it will leads to the damage of whole units , system or appliances. We have lot of distortion in a power supply since the power system established.

Power quality is the most important for the reliable power system as there are sensitive load connected in power system. The power coming from the source is in sinusoidal form some times with the many distortion in the industrial, commercial as well as household consumers of electricity. As the system is consist of many sensitive load. During the supply there is problem of voltage sag and voltage swell. The sudden increase in voltage than the rated voltage is called as the voltage sag and the sudden decrease in voltage as compared with rated voltage is called as voltage swell. Both the conditions always cause to damage the equipment connect in the system or may be whole system. So to overcome this problem Dynamic voltage restorer is used. Dynamic voltage restorer(DVR) detects and compensate the voltage sag and voltage swell before damage and the system will continue to work without interruption.This study gives the information about the power quality problem and the concept of DVR as well as detail working of dynamic Voltage Restorer.

Every equipment of the power system is designed for the particular rating. when the power exceeds The rated ratings of that equipments it may cause the the damage of equipments the sudden change in power coming from the source can be defined as the the deviation of the voltage and current.To detect and compensate the change in voltage the DVR (dynamic voltage restorer) is used.voltage swells are not as important as voltage sags, because they are less common in distribution system. voltage sag is considered the most sever cause .voltage sag may occur from single phase to three phase. As soon as the fault occurs the action of of DVR starts. On event of fault which result in voltage sag ,the magnitude reduction is accompanied by phase angle shift and the remaining voltage magnitude with respective phase angle shift is provided by the DVR.

II. CONSTRUCTION OF DVR:

Power circuit and the control circuit are the two main parts of the DVR. There are various critical parameters of

control signals such as magnitude, phase shift, frequency etc. which are injected by DVR. These parameters are derived by the control circuit. This injected voltage is generated by the switches in the power circuit based on the control signals. Furthermore the basic structure of DVR is described by the power circuit and is discussed in this section. There are five main important parts of power circuit

i. An Injection/ Booster transformer
ii. A Harmonic filter
iii. Storage Devices
iv. A Voltage Source Converter (VSC)
v. A Control and Protection system

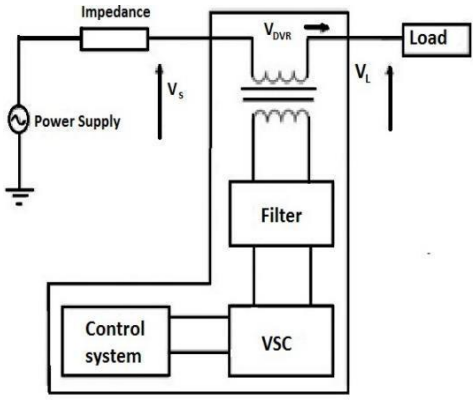

Fig.1: Construction of DVR

i. INJECTION/BOOSTER TRANSFORMER:

Injection transformer is connected in series to the distribution line. And their secondary/LV winding side is connected to the DVR power circuit. Basically it is a step up transformer which is used to increase voltage on the occurrence of sag condition. Having winding ratio of injection transformer to the required voltage at secondary side is important. High winding ratio means high magnitude current on primary side that can causes damaged to other parts of DVR. The HV winding transformers and couplers, injects compensating voltage witch is generated by a voltage source that is converted in to the incoming supply voltage. The main function of injection/booster transformer is to act as a filter reactance with a line side connected filter. It also balance the rated voltage and variation in voltage. Due to this minimize energy storage capacity and inverter voltage rating.

ii. HARMONIC FILTER:

Because of non-linear characteristics of semiconductor devices (like UPS,VRD inverter) distorted waveforms associated with high frequency harmonics at inverter output get generated.To reduce such harmonics and get good power quality power supply filters are used. As we knows parameters of non- linear semiconductor devices get varied with respect to current and voltage. Basically filter is used to avoid unwanted tripping of load and also to filter the harmonics in injection voltage. Harmonics can causes voltage drop in the system and also phase shift in a fundamental components of the inverter output.

Basically our filter is placed at the two sides, one is the high voltage side(line side filter)and another one is a low voltage side (inverter side filter).

iii. STORAGE UNIT:

During the voltage sag, DVR injects a voltage to restore the load supply voltage. DVR exchange active and reactive power. If active power is supplied to the load then it will need a source for this energy and its units are KW and MW. Also reactive power, is the power which flows back and fourth which means it moves in both the direction in a circuit or reacts upon itself and its unit are KVAR and MVAR. DVR takes energy from incoming supply. The shunt converter connected to the supply side and load side. Storage unit selection is a depends upon the installation of load MVA, load power factor, sag depth,sag duration, frequency of sag occurrence. In storage unit of DVR there are two types of systems, first is storage energy and another one is internal energy. Storage energy system contain battery, capacitors, flywheels and internal energy system there are superconducting magnetic energy storage. we can also use the hybrid energy storage in the system.

iv. VOLTAGE SOURCE CONVERTER:

VSC is a power electronic system which consists storage device and switching devices. It can generate a sinusoidal voltage at any required frequency, magnitude, and phase angle. There are two main purpose of VSC in DVR, one is to temporarily replace the supply voltage or to generate the part of the supply voltage which is missing.

Metal Oxide Semiconductor Field Effect Transistors (MOSFET), Gate Turn-Off thyristors (GTO), Insulated Gate Bipolar Transistors (IGBT), and Integrated Gate Commutated Thyristors (IGCT) are the four main types of switching devices. Among this four devices IGBT is the most suitable switching device.it can be place to reduce conduction losses. It has low cost and high gate drive speed. For real power absorption from utility additional rectifires are required. With the use of IGBT, need of battery charging unit can be reduced.

III. WORKING OPERATION OF DVR

When sag occurs on distribution system, then DVR compares between reference voltage and sag voltage. To boost up to the required voltage of load, energy stored in storage unit transferred to a converter. Then converter converts dc voltage to AC. Output of converter may contain some harmonics, to reduce those harmonics we use filter. This filtered output is passed through bypass switch to a injection transformer. Then injection transformer injects the required amount of voltage in distribution line.

Basically DVR is the the series connected power electronic device used to to inject voltage hand required magnitude and frequency . Rated voltage is compared with voltage variation and the voltage difference between these two us injected by DVR. DVR is an inverter and DC required for the the capacitor is given by this energy storage like PV system or fuel cell. Then the inverter convert DC into AC during the period of sag.

There are three mode of of operation of of DVR

1)Protection mode 2)Standby mode
3) Injection/ boost mode

1) **Protection mode:** If over current on the load side exceeds a a permissible limit due to short circuit on the load on large inrush current DVR will be isolated from the the systems by using the bypass switches and supplying another path for current.

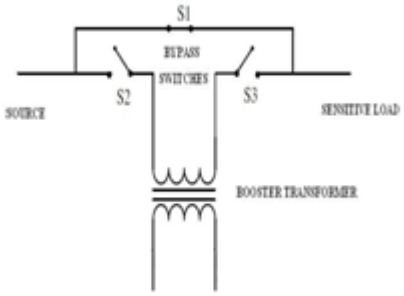

Fig.2: Protection Mode

2) **Standby mode:**In the standby mode the booster transformer low voltage winding is shorted through the converter. No switch of semiconductors occurs in this mode of operation and full load current will pass through the primary.

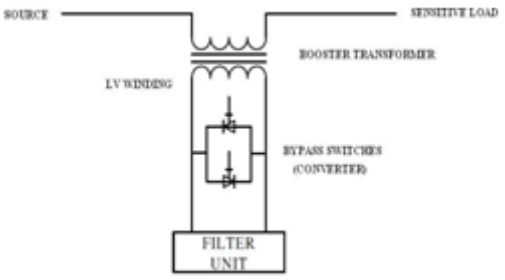

Fig.3: Standby Mode

1) Injection mode/ Boost mode:

Injection or boost transformer is specially designed transformer that attempt to limit coupling of noise and transient energy from the primary side to the secondary side. Its one more purpose is to isolate load from the system.

IV. SIMULATION AND RESULTS

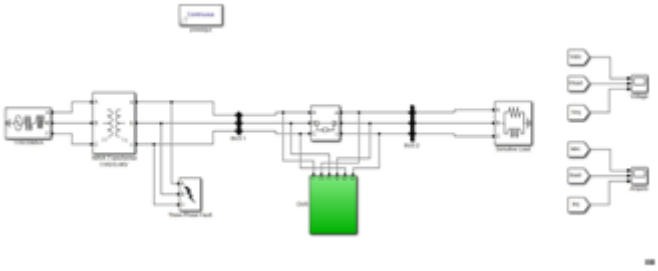

Fig.4: MATLAB Simulation with DVR

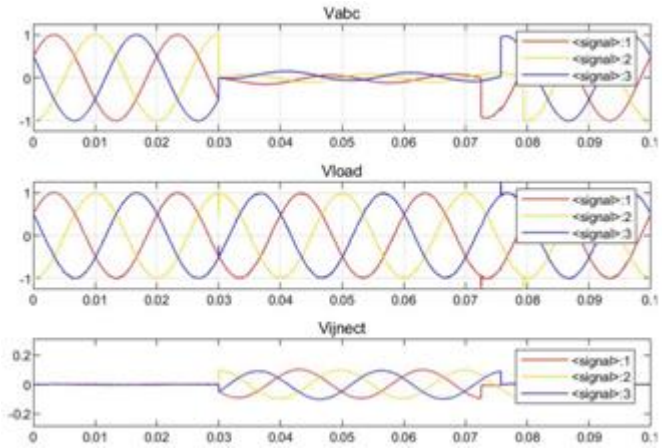

Fig.5: Voltage output with DVR

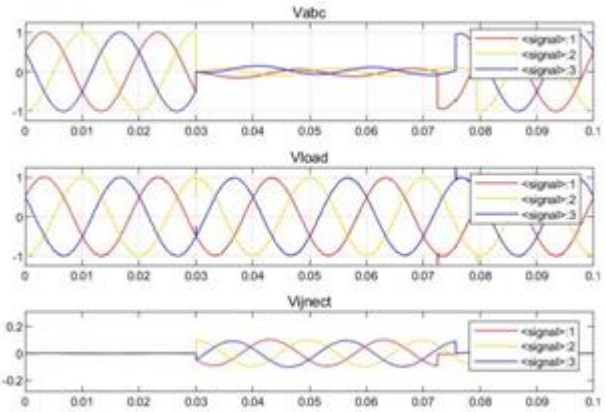

Fig.6: Current output with DVR

At first we run the simulation of power system with single phase and three phase fault. After connecting DVR in power system when sag condition occurred we observed that it got compensated. DVR helps to minimize sag as well as swell conditions in power system. It is connected in series with source side and load side, which help to provide better power quality. When sag takes place due to various causes, injection transformer inject voltage as required by sensitive load.

V. CONCLUSION

This paper has shown power quality problems (such as sags, swells), Which causes interruption in power supply to various sensitive loads.Also MATLAB demonstration of working of DVR with results is shown.

DVR is used to detect and compensate the sags and swells occurred in power system for better power quality, compared with other power compensating devices.DVR has low cost with high reliability.

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