Sharad Sharma et al. International Journal of Recent Research Aspects ISSN: 2349-7688, Vol. 3, Issue 1, March 2016, pp. 73-75

Review on Power Quality Problem due to Sag

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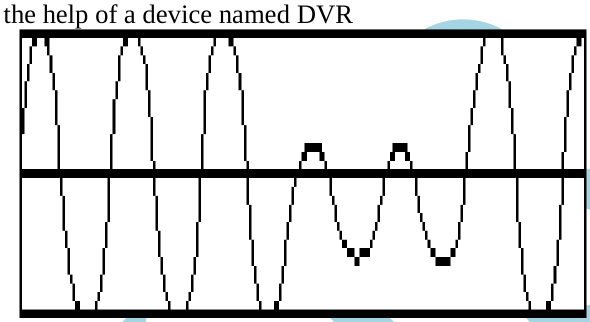
Abstract **-Due to rapid technological advancements and rise in world population, quality and reliable electrical power demand has increased significantly recently which is roughly estimated to double by next decade. This heavy burden on the present traditional power systems leads to many power quality problems , less reliability, frequency fluctuations .Out of these many problems being faced in transmission and distribution is Sag**

Index Terms: **- Power Quality, Mitigation, Voltage regulation,**

I. INTRODUCTION

With advancements in technology and increasing demand for power. The problem being faced by electrical engineers today is to maintain power quality in transmission and distribution. One such frequent problem being faced the world over is that of Sag. The term sag is related with the dip in voltage (rms value) due to short circuit, overload (starting of motor) etc. Although with advancements of technology the conventional power sector has also resorted to little and less changes comparatively. But a solution to this problem have been sorted with the help of a device named DVR



II. CAUSES OF SAG

Electrical appliances used in our home to machines used in manufacturing, all use electric motors. The startup of these motors are a major cause of sag. During a line to ground fault(due to lightning etc) ,there is a decrease in the voltage value uptil the protective switchgear operates. Excessive load or load during peak hours can also be a reason for sag. Vol sags can arrive from the utility but most are caused by in-building equipment. In residential homes, we usually see voltage sags when the refrigerator, air-conditioner or furnace fan start up. Thunderstorms and lightning strikes cause a significant number of voltage sags. If lightning strikes a power line and continues to ground, this creates a line to ground fault. The line to ground fault in turn creates a voltage sag and this reduced voltage can be seen over a wide area. Note the lightning strike to ground causes Voltage Sags on all other lines (See Fig 2). Circuit breakers and reclosers operate more frequently in poor weather conditions High winds can blow tree branches into power lines. As the tree branch strikes the line, a line to ground fault occurs which creates a voltage sag. If the line protection system does not operate immediately, a series of sags will occur if the branch repeatedly touches the power line. Broken branches landing on power lines cause phase to phase and phase to ground faults Snow and Ice build up on power line insulators can cause flash-over, either phase to ground or phase to phase. Similarly snow or ice falling from one line can cause it to rebound and strike another line. These events cause voltage sags to spread through other feeders on the system.Pollution is also a cause of sag. Salt spray build up on power line insulators over time in coastal areas, even many miles inland, can cause flash over especially in stormy weather. Dust in arid inland areas can cause similar problems. As circuit protector devices operate, voltage sags appear on other feeders.Equipment failure is also a cause. If electrical equipment fails due to overloading, cable faults etc., protective equipment will operate at the sub-station and voltage sags will be seen on other feeder lines across the utility system. Animals particularly squirrels, racoons and snakes occasionally find there way onto power lines or transformers and can cause a short circuit either phase to phase or phase to ground. Large birds, geese and swans, fly into power lines and cause similar faults. While the creature rarely survives, the protective circuit breaker operates and a voltage sag is created on other feeders.[1]

III. SOLUTION TO THE PROBLEM OF SAG

The need for solutions to power quality problems grows with every passing second. Currently many projects are under way and they are loooking at how to collect data to find and analyze power quality problems.In order to provide a optimal and cost effective solution to voltage sag problems it is necessary to determine which equipment is susceptible to unplanned stoppages. The need for solutions to power quality problems grows with every passing second. Currently many projects are under way and they are loooking at how to collect data to find and analyze power quality problems. Presently, the analysis ;of power quality problems is often difficult due to the fact that the source of a problem can be a few feet away in the form of a loose connection, or a hundred miles away in the form of a power system fault. If we look back at the stated power quality problems of sags, surges, harmonics, and wiring and grounding, one can see that each one has possible solutions to correcting these problems.

A) Prevent Faults by 1) Tree trimming. 2) Insulator washing. 3) Shield wires. 4) Improving pole grounds. 5) Modified conductor spacing. 6) Tree wire (insulated/covered conductor). 7) Line arresters. 8) Underground cables. 9) Animal guards.

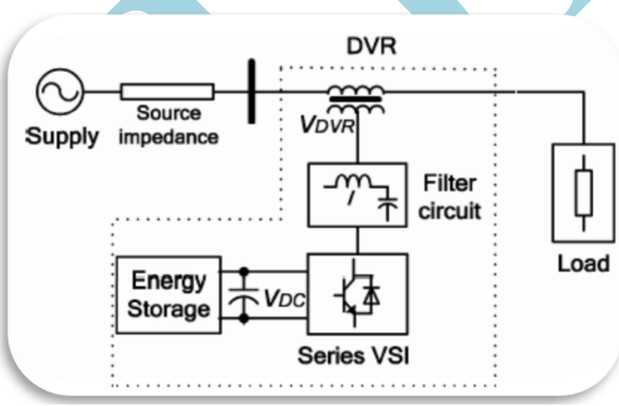
B. Modify fault-clearing practices

Taking in account the overcurrent coordination principles, and both types of main devices to clear faults, fuses and reclosers, it is possible to use different strategies, choosing between a fuse saving strategy and an eliminating fuse saving one[2]. The use of reclosers is often involved with transient faults (choosing between the two most common sequences in use on four-shot reclosers: one fast operation, three delayed; and two fast, two delayed), while the utilization of fuses is more appropriate to combat permanent faults. However there are some cases in which the use of reclosers may deteriorate the power quality (for example, when it is used in combination with fuse saving practices)[3].

Other solution is to resort to an increased sectionalising, adding a line recloser to the main feeder (from the substation breaker), reconfiguring the feeder with parallel subfeeders or designing a feeder with multiple threephase subfeeds off a highly reliable main feeder. A high redundancy level can be achieved by parallel operation, either with two feeders operated in parallel or with a loop system: the load will never see an interruption for a fault on one of the parallel feeders or on a branch of the loop. On the other hand, both designs lower the impedance between the load and the supplying substation, thus exposing other loads connected to the same substation to more severe voltage sags[3].

These and other designs can be applied in combination with fast transfer switches: the extremely fast operation of the solid-state switches allows the restoration of power to the load within a quarter of a cycle. This results in a very effective way of mitigating the effects of both short interruptions and voltage sags, by limiting not their magnitude, but their duration

C . By the use of DVR



Schematic Diagram of a DVR

Dynamic voltage restorer is a static device that has applications in a variety of transmission and distribution systems. It is a series compensation device, which protects sensitive electric load from power quality problems such as voltage sags, swells, unbalance and distortion through power electronic controllers that use voltage source converters (VSC). The first DVR was installed in North America in 1996 - a 12.47 kV system located in Anderson, South Carolina. Since then, DVRs have been applied to protect critical loads in utilities, semiconductor and food processing. Today, the dynamic voltage restorer is one of the most effective PQ devices in solving voltage sag problems. The basic principle of the dynamic voltage restorer is to inject a voltage of required magnitude and frequency, so that it can restore the load side voltage to the desired amplitude and waveform even when the source voltage is unbalanced or distorted. Generally, it employs a gate turn off thyristor (GTO) solid state power electronic switches in a pulse width modulated (PWM) inverter structure. The DVR can generate or absorb independently controllable real and reactive power at the load side. In other words, the DVR is made of a solid state DC to AC switching power converter that injects a set of three phase AC output voltages in series and synchronism with the distribution line voltages(4).The DVR will detect and compensate, almost instantaneously, voltage sags. The DVR injects ac, three-phase, voltage of controllable magnitude and frequency through a coupling transformer (boost). So the DVR is able to improve the quality of the voltage in the load (taking into account the capacity of the DVR: voltage injection, storage capacity, and bandwidth) when the quality voltage is out of the specified limits. For large voltage sags, the DVR can supply part of the active power to the load from the energy storage system, which will be recharged through the network during normal conditions[5]

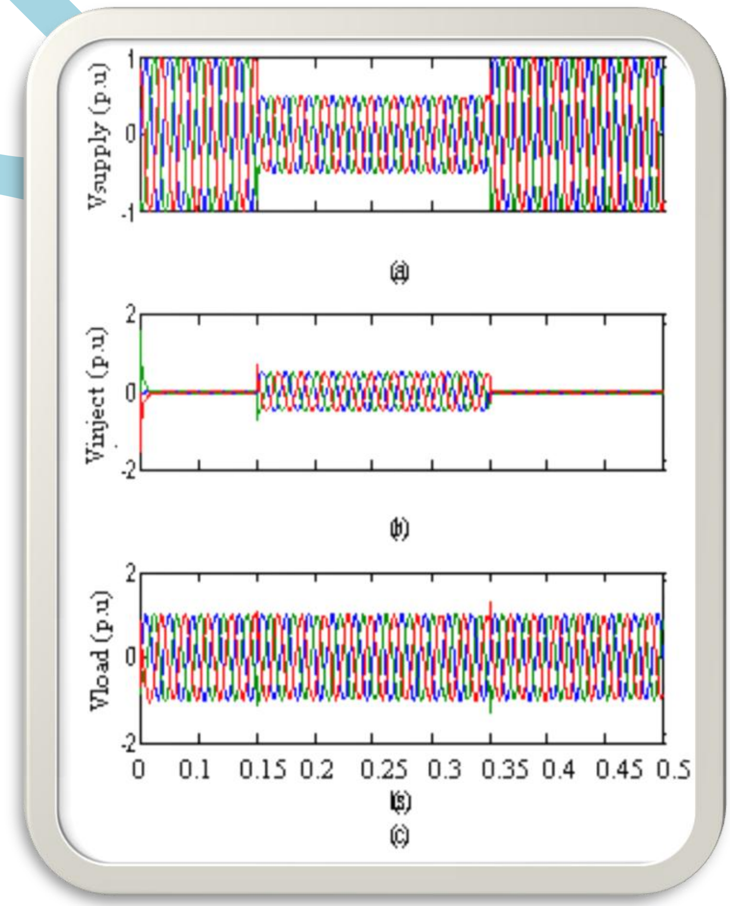


Fig-Three phase voltges Sag

The above diagram consists of three parts a),b) and c).The diagram a) consists of source voltage which contains the sag in it.In figure b) voltage is injected into the system and correspondingly in Fig c) we get is the corresponding load voltage .Thus in a way the drop in voltage is compensated by the voltage injected into the system.

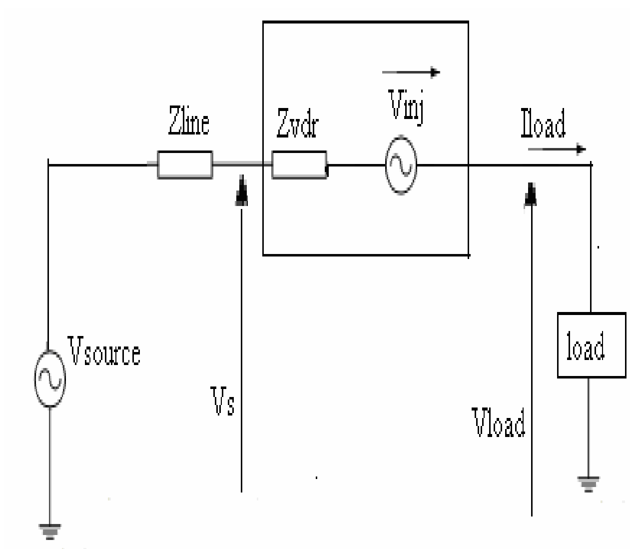


Fig-Equivalent circuit of DVR

The main principle behind working of DVR is that it injects dynamically controlled voltage

D.Other Methods of Improving Sag-

Phase Controlled Regulators

This technique uses phase controlled thyristors with LC filter to control output voltage. It has a slow response, high distortion especially with non-linear loads, over sized filters, very poor input line harmonics and will not handle surge currents such as motor starting. This scheme has good line transient suppression but will not suppress transients generated inside plant[6].

Ferroresonant Transformers (CVT)-

Ferroresonant transformers, also called constant-voltage transformers (CVT), can handle most voltage sag conditions (always beneath 20 kVA). In fact, they are specially attractive for constant, low-power loads. Variable loads, especially with high inrush currents, present more problems for CVT because of the tuned circuit on the output[7]. The ferroresonant transformer core structure is designed so that the secondary operates in flux saturation and the secondary winding resonates

Uninterrumpible Power Supplies (UPS); Battery Storage)

Utilities typically use batteries to provide an uninterruptible supply of electricity to power substation switchgear and to start backup power systems. They also increase power quality and reliability for residential, commercial, and industrial customers by providing backup and ride-through during power outages. The standard battery used in energy storage applications is the lead-acid battery. A lead-acid battery reaction is reversible, allowing the battery to be reused[8]. There are three types of UPS that use batteries to store energy. In an on-line UPS, the load is always fed through the UPS. The incoming ac power is rectified into dc power, which charges a bank of batteries. This dc power is then inverted back into ac power to feed the load

Magnetic Synthesizers

Magnetic synthesizers are generally used for large loads (50 kVA or even more[9]). They are utilized for big computers and other electronic equipment that is voltage sensitive. It is an electromagnetic device which takes incoming power and regenerates a clean, three-phase ac output waveform with little harmonic distortion, regardless of input power quality[7]. The device, powered from the ac utility line, uses no mechanically moving parts in the generation process, and utilizes no semiconductor elements in the power path. The output wave form is completely isolated and independent of the input in all parameters except two: the phase rotation and the frequency. The output phase rotation of the device is governed by the direction of the input phase rotation,

Conclusion

Voltage sags occur throughout the world with some areas more Prone than others, as the occurrence of events is related to climate and weather. Electrical devices are unable to remove the causes of voltage sags and this thingwill not change in the near future.

Industry has invested heavily in latest accuracy improving equipment which is more sensitive to voltage variation than conventional machinery. Power Quality issues have remained in the past and would continue to remain in the future if new and more innovative technologies like DVR's are introduced in the power sector. But for this huge investments are needed specially in the developing nations like india where power is a more prominent issue than power quality.

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