Improvement of Power Quality in Distribution Level Using Series Active Filter Dynamic Voltage Restorer (DVR)

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Abstract: The power quality (PQ) prerequisite is a standout amongst the most vital issues for power system. The principle issues of the power quality like voltage droops and swells in low voltage dissemination frameworks and on the transmission side because of delicate loads. There are distinctive strategies to pay of voltage sag and swell, a standout amongst the most well-known techniques for sag and swell is Dynamic Voltage Restorer (DVR), The Dynamic Voltage Restorer (DVR) is arrangement associated power electronic converter. It gives progressed and monetary answer to compensate voltage sag and swell. This gadget can be actualized to ensure a gathering of medium or low voltage customers. This investigation presents compensation of droops and swells voltage amid single line to ground (SLG) and three-stage shortcoming/faults. designing comes about completed by Matlab/Simulink confirm the execution of the proposed technique.

I. INTRODUCTION
Dynamic Voltage Restorer (DVR) can give the most financially effective answer for compensate voltage sags and swells by setting up the best possible voltage quality level that is required by client. At the point when a fault occurs in a distribution system, sudden voltage sag will show up on contiguous loads. DVR introduced on a sensitive load, reestablishes the line voltage to its normal voltage the reaction time of a couple of milliseconds in this way staying away from any power disturbance to the load. There are a wide range of strategies to alleviate voltage sag and swells, however the utilization of a DVR is thought to be the most cost effective strategy. The most well-known decision for the control of the DVR is the PI Controller since it has a straightforward structure and it can offer generally an acceptable execution over an extensive range of operation. The fundamental issue of this controller is the right decision of the PI gains and the way that by using fixed gains, the controller may not provide the required control performance, when there are variations in the system parameters and operating conditions. Different control methodologies have been created to alleviate the voltage sag and swell have been proposed for three stage voltage source PWM converters. They can be isolated into two principle gatherings: direct and nonlinear, Synchronous PI controller, state input controller and predicative dead beat controller. The hard-switched converter and the neural system and Fuzzy Logic controllers. Then, simulation results using MATLAB-SIMULINK provide a comparison between the proposed and the conventional PI controllers in terms of performance in voltage sag/swell compensation at the end, discussions of the results and conclusion are given proposed algorithm is applied to some disturbances in load voltage caused by induction motors starting, and a three-phase short circuit fault. Additionally, the ability of the proposed DVR has been tried to overcome the downstream fault current. The current limitation will restore the point of common coupling voltage and protect the DVR itself. The thought here is that the DVR goes about as a virtual impedance with the fundamental point of ensuring the pee voltage amid downstream fault. proposed quick acting DVR with controller to remunerate the short circuits, diminished the harmonic distortion and transient voltage for balanced and unbalanced load. In-stage technique with proceeds with two vector control calculation is utilized to recognize and compensate ΔV and ΔQ factors amid voltage sag and voltage swell. At the point when there is any phase angle or phase jump in supply voltage the reference voltage is acclimated to track the phase angle of the supply voltage. A phase locked loop is used to keep the load voltage synchronized continuously and tracks the source voltage. It is demonstrated that the proposed DVR controller enhances the system power quality.

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II. MODELLING OF DYNAMIC VOLTAGE RESTORER

Among the power quality issues voltage sag are the most extreme power quality issue. Keeping in mind the end goal to conquer these issues the idea of custom power device is presented as of late. One of those devices is the Dynamic Voltage Restorer (DVR), which is the most productive and successful present day custom power device utilized as a part of energy dispersion systems. DVR is a recently proposed arrangement associated solid state device that inject voltage into the system with a specific end goal to control the load side voltage. It is regularly introduced in a conveyance framework between the supply and the basic load feeder at the point of common coupling (PCC). Other than voltage sags and swells, DVR can likewise include different components like: line voltage harmonics compensation, reduction of transients in voltage and fault current restrictions. Every facts device must have four components they are given below

1. Energy Storage Unit

Amid voltage sag, the DVR injects a voltage to restore the loads supply voltages. The DVR needs a source for this energy. Two sorts of framework are viewed as; one utilizing the one using stored energy to supply the delivered power as appeared in Figure 2, and the other having no internal storage, where vitality is taken from the approaching supply through a shunt converter.

2. Inverter Circuit

The Voltage Source Inverter (VSI) or essentially the inverter changes over the dc voltage from the energy storing unit (or the dc interface) to a controllable three stage alternating voltage. The inverter Switches are normally fired utilizing a sinusoidal Pulse Width Modulation (PWM) conspire. Since by far most of voltage sags seen on utility systems are uneven, the VSI Will Often work with unbalanced switching functions for the three phases, and must therefore treat each phase Independently. In addition, droop on one stage may bring about a swell on another stage, so the VSI must be equipped for dealing with the two sag and swells at the same time. Another topology of the DVR is the utilization of multi-inverter framework in Cascade. This topology will include the voltage of the single fell inverters in arrangement with a specific end goal to get the coveted inverter voltage. This technique disposes of the infusion transformer utilized as a part of the essential arrangement of the DVR. This course of action is regularly called a transformer-less or multilevel inverter.

3 Filter Unit

Figure:1 Block diagram of DVR

The nonlinear characteristics of semiconductor devices because distorted waveforms associated with high frequency harmonics at the inverter output. To overcome this problem and provide high quality energy supply, a harmonic filtering unit is used. These filters can be placed either in the inverter side as shown in Figure 2 or in the line.

4. Series Injection Transformer

Three single-phase injection transformers are used to inject the missing voltage to the system at the load bus. To integrate the injection transformer correctly into the DVR, the MVA rating, the primary windings voltage and current ratings, the turn-ratio and the short-circuit impedance values of transformers are required. The existence of the transformers allows for the design of the DVR in a lower voltage level, depending upon the stepping up ratio.

Fig.2. Represents the connection of DVR to the distribution line for power quality improvement

III. COMPENSATION METHODS IN DVR

The type of the compensation strategy mainly depends upon the limiting factors such as DVR power ratings, various conditions of load, voltage sag type. Some loads are sensitive towards phase angle jump and some are sensitive towards change in magnitude and others are tolerant to these [16]. Therefore, the control strategies depend upon the type of load characteristics; there are three different methods of DVR voltage injection which are:

(a) Pre-sag compensation method
(b) In-phase compensation method
(c) Voltage tolerance method with minimum energy injection

(a) Pre-Sag/Dip Compensation Method

The pre-sag method tracks the supply voltage continuously and if it detects any disturbances in supply voltage it will inject the difference voltage between the sag or voltage at PCC and pre-fault
condition, so that the load voltage can be restored back to the pre-fault condition. Compensation of voltage sags in the both phase angle and amplitude. Sensitive loads would be achieved by pre-sag compensation method as shown in Figure 3. In this method the injected active power cannot be controlled and it is determined by external conditions such as the type of faults and load conditions. The voltage of DVR is given below:

\[ V_{DVR} = V_{prefault} - V_{sag} \]

(b) In-Phase Compensation Method

In this method the injected voltage is in phase with the supply side voltage irrespective of the load current and pre fault voltage as shown in Figure 5. The phase angles of the pre-sag and load voltage are different but the most important criteria for power quality that is the constant magnitude of load voltage are satisfied. The load voltage is given below: \[ |V_L| = |V_{prefault} - V_{sag}| \] One of the advantages of this method is that the amplitude of DVR injection voltage is minimum for certain voltage sag in comparison with other strategies. Practical application of this method is in non-sensitive loads to phase angle jump.

(c) Voltage Tolerance Method with Minimum Energy Injection

A small drop in voltage and small jump in phase angle can be tolerated by the load itself. If the voltage magnitude lies between 90%-110% of nominal voltage and phase angle variations between 5% -10% of nominal state that will not disturb the operation characteristics of loads. Both magnitude and phase are the control parameter for this method which can be achieved by small energy injection. In this method, the phase angle and magnitude of corrected load voltage within the area of load voltage tolerance are changed.

IV. SAG DETECTION TECHNIQUES

A voltage sag detection technique detects the occurrence of the sag, the start point, the end point, sag depth (magnitude to be restored) and phase shift. Common voltage sag detection Techniques are summarized as follows:

A. Peak value method:

The simplest way of monitoring the supply is to check the peak value, or amplitude, of the supply voltage, then comparing it with a reference signal or our required signal.

A controller identifies if there is a difference greater than a specified value (10%) and then the inverter will switch on.

B. Root Mean Square (rms) method

The start time of the sag can be defined as the first point of Vrms when drops below 0.9pu. To find the end time of the Sag, search for an interval where Vrms drops below 0.9pu for at least half a cycle. The recovery time is then chosen as the first point in this interval.

C. Space Vector method

The three phase voltages Vabc are changed into a two measurement voltage Vdq, which thusly can be moved into amplitude and phase angle. Any deviation in any amount of amplitude the event of an occasion. Contrasting these quantities and reference ones will measure the disturbance in the dq-outline, which must be changed back to the abc outline. This technique has no time delay, yet requires complex controller. It creates the impression that the nonlinear controller is more appropriate than the linear controllers since the DVR is genuinely a non-direct system because of the presence of energy semiconductor switches in the inverter connect. The most non-linear controllers are the Artificial Neural Networks (ANN), Fuzzy Logic (FL) and Space Vector Pulse Width Modulation (SVPWM).

ANN control technique has versatile and self-association limit. The ANN has natural learning ability that can give enhanced accuracy by insertion. FL controllers are an appealing decision when exact scientific details are impractical. At the point when a FL controller is utilized, the following mistake and transient overshoots of PWM can be impressively diminished. SVPWM control system is to receive a space vector of the inverter voltage to show signs of improvement execution of the trade are picked up in low exchanging recurrence conditions.
V. CONTROL TECHNIQUES

A. Linear Controllers:

The three fundamental voltage controllers, which have been proposed in writing, are feed forward (open circle), feedback (shut circle) and Multi-circle controller [13-18]. The fast forward voltage controller is the essential decision for the DVR, due to its straightforwardness and speed. The supply voltage is persistently checked and compared with a reference voltage; if the difference exceeds a certain tolerance, the DVR injects the required voltage. The downside of the open loop controller is the high steady state error. In the input control, the load voltage is measured and compared with the reference voltage; the missing voltage is provided by the DVR at the supply transport in a feedback control. This controller has the advantage of accurate response, Multi-loop control is utilized with an external voltage loop to Control the DVR voltage and an inward current loop to control the load current. This technique has the qualities of fast forward and feedback control strategies, on the cost of complexity and time delay.

B. Non-linear Controllers

It creates the impression that the nonlinear controller is more reasonable than the linear since the DVR is genuinely a non-linear network because of the presence of energy semiconductor switches in the inverter circuit. The most non-linear controllers are the Artificial Neural Networks (ANN), Fuzzy Logic (FL) and Space Vector Pulse Width Modulation (SVPWM) [19-24]. ANN control technique has versatile and self-association limit. The ANN has innate learning ability that can give enhanced exactness by interjection. FL controllers are an appealing decision when exact scientific plans are impractical. At the point when a FL controller is utilized, the following mistake and transient overshoots of PWM can be impressively diminished. SVPWM control procedure is to receive a space vector of the inverter voltage to show signs of the exchange is gained in low switching frequency conditions.

VI. RESULT AND DISCUSSION

To demonstrate the execution of the DVR in voltage drops alleviation, a simple radial distribution network is simulated using MATLAB/SIMULINK. what's more, appeared in fig 7. The parameters of the fundamental segments are provided below

A Three-stage 380V, 50Hz programmable voltage source is associated with a feeder at Point of Common Coupling (PCC). The DVR is associated in arrangement between PCC and the nonlinear load with the assistance of an injection transformer. The primary side of injection transformer is connected in series with the load and secondary side is connected in delta to the DVR. A three phase problem is created inside the voltage source to the framework keeping in mind the end goal to see the voltage sag. The DVR utilizes self-commutating IGBT active state control electronic changes to relieve voltage sags in the system. The voltage controlled three single-stage full bridge PWM inverters are utilized to generate the injected voltage. These inverters are associated with the normal DC voltage source. The DC voltage source is an outer wellspring of providing DC voltage to the inverter for AC voltage sources.

In this project we have created the voltage sag problem in the time interval of 0.5 to 1 and 2 to 2.5 as shown in fig .5 the source voltage has problem so load voltage is also having the same problem as shown in fig.6.After connecting the DVR to the power system the source voltage is same as before as shown in fig.7. But the load voltage is sag free as shown in fig.8.DVR compensated the voltage sag problem on load side by injecting required voltage. The injected voltage from DVR is shown in fig.9.
used to carry out extensive simulation study. Supply voltage is contrasted with reference voltage with get error signal which is given to the gate pulse generation circuit as a source of perspective sine wave which is contrasted with carrier signal to get pulses for inverter. Voltage sag estimates are central point in evaluating the DC storage value. The viability of a DVR system mostly relies on the rating of DC storage value and the rate voltage drop. In the test system it is observed that after a specific measure of voltage drop, the voltage level at the load terminal declines.

VIII. REFERENCES


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