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Enhance the Power Distribution Network in Three-Phase Three –Wire and Qualities Sag and Unbalance Mitigation Using DVR

Dr.P. Selvam, G. Devan, M.P. Sakthivel, P. Anandan, E. Boopathy

Abstract--- ***Power quality is one of the real worries in the present period. It has become important, especially, with the introduction of sophisticated devices, whose performance is very sensitive to the quality of power supply. A dynamic voltage restorer (DVR) based on photovoltaic (PV) generation/battery units is proposed to improve voltage quality in a micro-grid. The restorer is connected with the grid by a rectifier, which is in series with the point of common coupling (PCC). Power quality problem is an occurrence manifested as a nonstandard voltage, current or frequency that fails end-use equipment's. One of the major issues dealt here is the voltage sag. To take care of this issue, custom power gadgets are utilized. One of those gadgets is the Dynamic Voltage Restorer (DVR), which is the most productive and successful present-day custom power gadget utilized as a part of intensity dissemination systems. Its appeal includes lower cost, smaller size, and its fast dynamic response to the disturbance. This paper introduces power quality problems and diagram of Dynamic Voltage Restorer with the goal that youthful electrical designers come to think about such a cutting-edge custom power gadget for control quality change in the future era.***

Keyword--- PV Solar, Micro-grid, DVR, PCC, Power Quality.

1. INTRODUCTION

Now a day, because of the extensive utilization of delicate and nonlinear loads in electrical power frameworks and the quick development of sustainable power sources, the power quality issues are critical. The most normal power quality situations are voltage dip, voltage swell, and harmonic contents and so on. Voltage sag defined as a decrease in voltage magnitude of between0.1 to 0.9 p.u. & voltage swell is that of over1.1 p.u. During voltage droop, the power conveyed to the heap is decreased. The meaning of voltage plunge is needy upon two parameters, size, and span. Voltage hang and swell can cause touchy hardware, (for example, found in semiconductor or substance plants) to fall flat, or shutdown, and in addition make a substantial current unbalance that could blow wires or trek breakers. These effects can be costly for the customer, ranging from minor quality variations to production downtime & equipment damage. There are number of custom power units which are given below, Distribution STATCOM (D-STATCOM), Dynamic Voltage Restorer (DVR Active Power Filters, Battery Systems (BESS), Distribution Series Capacitors (DSC), Surge Arresters (SA), Uninterruptible Power Supplies (UPS), Solid State Fault Current Limiter (SSFCL) Static Electronic Tap Changers (SETC), and Solid-State Transfer Switches (SSTS. The CPD devices are either between in series or shunt or combination of both.

The DVR is recognized as a successful sort of custom power unit due to its following advantages:

1. It can manage the active power flow.
2. It has less cost compared with others
3. It requires less maintenance.
4. It has higher energy capacity.
5. DVR is more minor in size and expenses less compared with the DSTATCOM. Likewise, DVR recompenses the voltage dip, voltage swell; it can additionally include different features, for example, power factor correction and harmonics elimination.

For higher power sensitive loads where energy storage capabilities of UPS (uninterrupted power supply), become very costly. DVR provides more cost-effective. DVR can implement at both a low voltage & medium voltage levels and gives to protect high power applications from voltage disturbances. DVR uses a combined feedback & feed forward control to obtain good transient & steady-state responses. The Hysteretic Voltage Control can provide a fast transient response without additional loop compensation. The effect of DVR on the system is experimentally investigated under both faulted & non-faulted system states for a variety of linear & non-linear loads. In the end, MATLAB/SIMULINK model based simulated results were presented to validate the effectiveness of the proposed control method of DVR.

2. LITERATURE REVIEW

This project shows a novel technique for acknowledging one of the custom power controllers, the appropriation static synchronous compensator (D-STATCOM) utilizing a present source converter (CSC) topology.

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All the custom power controllers, for example, dynamic voltage restorer (DVR), bound together power quality conditioner (UPQC) including D-STATCOM are by and large outlined and executed by utilizing voltage source converters (VSC) and very little research productions with CSC based approach has been accounted for in the course of the most recent multi-decade. Since the D-STATCOM is a present infusion gadget, its execution can be enhanced when acknowledged by a present source converter which can produce a controllable current straightforwardly at its yield terminals and offers numerous worthwhile highlights. In this work, an endeavor has been made to contemplate the execution of a CSC based D-STATCOM appropriate for use in the power dissemination framework to mitigate voltage sag and improve power quality. Sags, consonant mutilation and low power factor utilizing Distribution Static Compensator (D-STATCOM) with LCL Passive Filter in the circulation framework. The model depends on the Voltage Source Converter (VSC) rule.

The D-STATCOM infuses a current into the system to alleviate the voltage sags. LCL Passive Filter was then added to D-STATCOM to enhance symphonious mutilation and low power factor. The execution of voltage-source converter-based shunt and arrangement compensators utilized for stack voltage control in electrical power circulation frameworks has been examined and looked at when a nonlinear load is associated over the heap transport. A static distribution compensator (DSTATCOM) as a shunt device. The voltage related power-quality (PQ) problems, such as sags and swells, voltage dips, harmonic distortions due to nonlinear loads and voltage unbalancing in electrical power distribution systems, have been a major concern for the voltage-sensitive loads. Load voltage regulation using VSC for different grid-connected applications has been recently attempted. Mainly the increased use of power electronics devices in the consumer products, the loads are becoming voltage sensitive and nonlinear. The proposed model uses a three-leg CSC whose switching strategy. The model has been simulated in the Mat lab/Simulink environment. The results of the simulation run under steady-state and dynamic load perturbation provide a first voltage and current waveforms that support the justification of the proposed model.

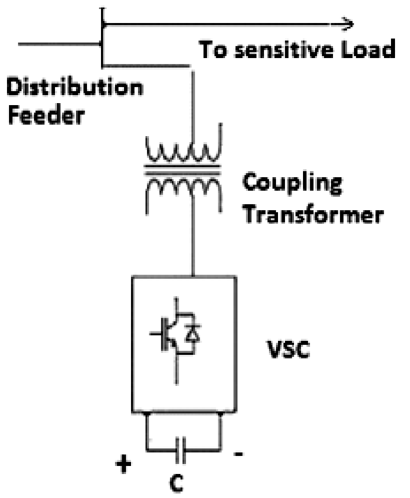

Fig. 1: Schematic Diagram of a VSC based D-STATCOM

3. PROPOSED METHOD

Power quality problems begin with non-standard voltage, current, and frequency which causes failure or operation of end-user equipment. Among that voltage, sag is a significant problem. To minimize this problem custom power devises are used such as and dynamic voltage restorer (DVR). This paper gives an investigation on DVR which having low cost, small in size and fast dynamic response to the disturbance. Modeling and analysis of dynamic voltage with sinusoidal pulse width modulation (SSVPWM) based controller using MATLAB/ Simulink are presented.

3.1 Block Diagram

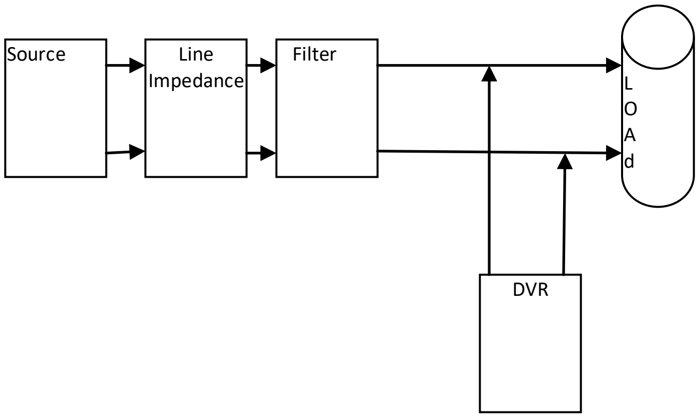

Fig 2: Block Diagram of Proposed Method

3.1.1 Block Diagram Description

The primary objective of the DVR is to increase the power utilization capacity of distribution feeders, minimize the losses and improve power quality at the load. The primary assumption is to neglect the variations in the source voltages. This necessarily implies that the dynamics of the source voltage is much slower than the load dynamics. DVR is a series voltage controller, and it is connected in series with the load. DVR consists of an injection transformer, the harmonic filter circuit, and voltage source Inverter, controller and dc charging circuit. In place of the dc charging super circuit capacitor is used to increase the energy storage capacity. The primary task of harmonic filter is to keep the harmonic voltage content generated by the VSC to the permissible level. A VSC is an electronic power framework comprises of a capacity gadget and exchanging gadgets, which can create a sinusoidal voltage at any required recurrence, extent, and stage edge. This is required to give dynamic capacity to the load during deep voltage sags. It is also possible to provide the required power on the DC side of the VSI by an auxiliary bridge converter that is fed from an auxiliary AC supply. The DVR will be secluded from the framework if the framework parameters surpass as far as possible basically current on the load side. The primary explanation behind separation is shielding the DVR from the over current in the heap side because of short out on the load or extensive inrush currents.

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The pre-droop strategy tracks the supply voltage constantly, and in the event that it distinguishes any unsettling influences in supply voltage, it will infuse the distinction voltage between the load or voltage at PCC and pre-fault condition so the load voltage can be reestablished back to the pre-blame condition. Pay of voltage lists in both stage edge and adequacy. Pre-shag remuneration technique would accomplish delicate burdens. In this technique, the infused dynamic power can't be controlled, and it is dictated by outer conditions, for example, the kind of issues and load conditions.

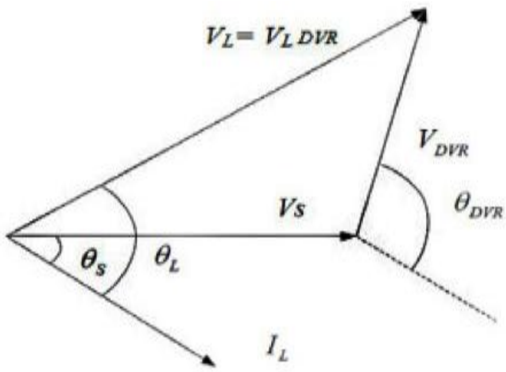

Fig. 3: Pharos diagram of pre-sag/dip method

3.2 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 12. The stage points of the pre-sag and load voltage are unique, yet the most critical criteria for control quality that is the steady extent of load voltage are fulfilled.

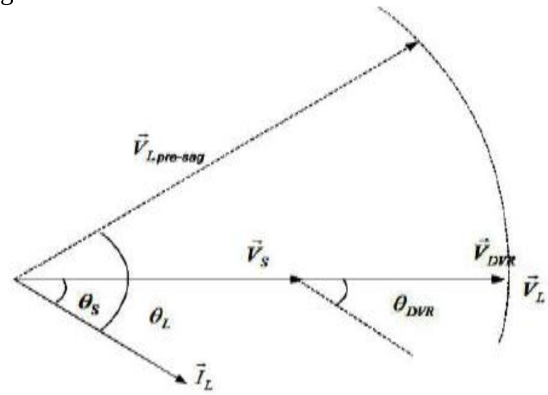

Fig. 4: Pharos diagram of an in-phase method

3.2 (a) Voltage Tolerance Method with Minimum Energy Injection

The load itself can tolerate a small drop in voltage and a little jump in phase angle. If the voltage magnitude lies between 90%-110% of nominal voltage and phase angle variations between 5% -10% of the ostensible express that won't bother the activity qualities of burdens. Both greatness and stage are the control parameter for this strategy which can be accomplished by little vitality infusion. In this strategy, the stage edge and greatness of the corrected load voltage within the area of load voltage tolerance are changed. The load itself can tolerate the small voltage drop and phase angle jump on load. The sensitivity of loads to phase angle jump and voltage magnitude is different.

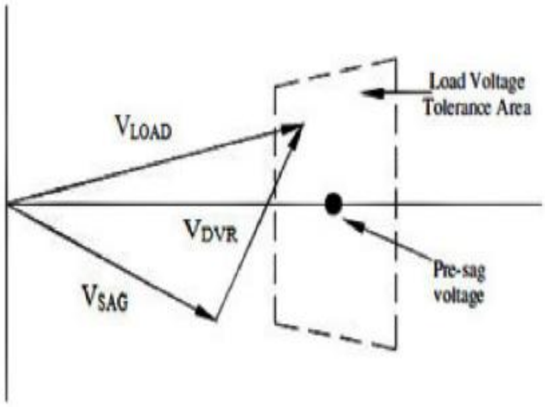

Fig. 5: Voltage tolerance method with minimum energy injection

3.3 Harmonic Requirements of the Load and of the System

These affect the harmonic filtering needed for the DVR and also influence the choice of a charging strategy for the capacitors. At the principal occurrence when outlining a DVR, some supposition could be made to streamline the examination, for example, Ideal switches DC-side capacitors are sufficiently substantial to keep up a ripple free DC bus voltage, even for unbalanced input voltage. Series transformer and output filter components are ideal.

3.3 (a) Process to be Controlled

The represents the part of the DVR referring to the central problem of the research work. The DVR is operating; the load current flows through the transformer secondary. A portion of this load current flow in the transformer primary in the opposite direction to the filter current.

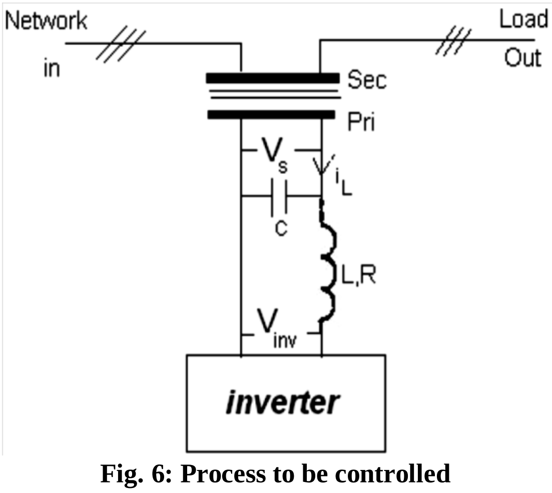

Fig. 6: Process to be controlled

The negative current reduces the magnitude of filter output voltage; More DC voltage is required to inject the missing voltage. The negative current also increases the stress on the inverter switches and PWM controller. The output voltage of the filter can be defined.

3.3 (b) Output Sensitivity Function

The represents the closed loop block diagram for a process to be controlled. K and P refer to the plant and the controller. The transfer function of the LC filter is considered as a plant.

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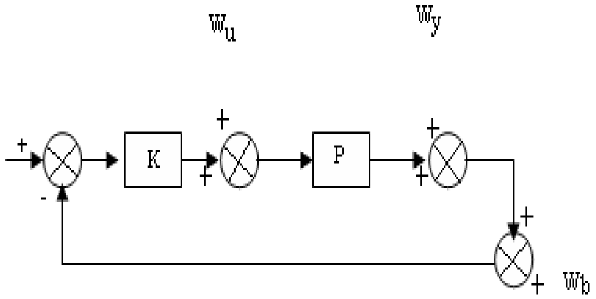

Fig. 7: Block diagram of a process to be controlled

3.4 The DVR Operation Modes

The fundamental operating principle of DVR measures the missing voltage by using a control unit and injecting the dynamically controlled absent voltage in series to the line and providing the load voltage unchanged during sag. The phase angle and amplitude of the pumped voltage are variable amid droop. This will permit the control of dynamic and receptive power trade between the DVR and the circulation system. By and large, the task of the DVR can be arranged into three activity mode: assurance mode, reserve mode (amid relentless state) and infusion mode (amid list). The essential capacity of the DVR is to infuse dynamically controlled voltage VDVR generated by a forced commutated converter in series to the bus voltage using a booster transformer. The momentary amplitudes of the three pumped phase voltages are controlled such as to reduce any detrimental effects of a bus fault on the load voltage VL. This means that any differential voltages caused by transient disturbances in the ac feeder will be compensated by an equivalent voltage generated by the converter and injected on the medium voltage level through the booster transformer.

3.4 (a) Protection Mode

The DVR will be secluded from the system if the framework parameters surpass as far as possible principally current on the heap side. The primary explanation behind separation is shielding the DVR from the over current in the heap side because of short out on the load or substantial inrush streams. The control framework distinguishes shortcomings or strange conditions and oversees sidestep (exchange) changes to expel the DVR.

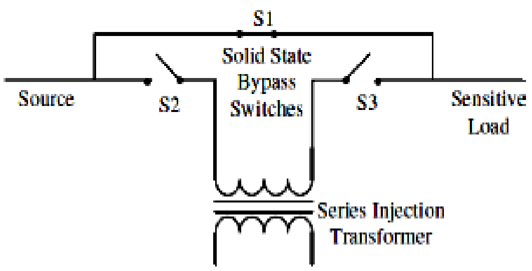

Fig. 8: Scheme of the protection mode.

During the over current period, S1 will be closed, S2 and S3 will be opened in this way, there will be another way for current to stream. By expelling the DVR from the system to blame condition, the impacts of extra unsettling influences that can be the concern by the DVR are forestalled onto the System.

3.4 (b) Standby modes

In standby mode (normal steady-state conditions), the DVR may either go into cut off or infuse little voltage to repay the voltage drop on transformer reactance or misfortunes. The short-circuit operation of DVR is generally a preferred solution in steady state because the low voltage drops don't aggravate the heap prerequisites. The strong state sidesteps changes are utilized to perform cut off, and they are set between the inverter and auxiliary (low side) of arrangement infusion transformer if the distribution circuit is weak there is a need to inject small compensation voltage to operate correctly. During short circuit operation, the injected voltages and magnetic fluxes are virtually zero, thereby full load current pass through the primary. So, the short circuit impedance of the injection transformer determines the voltage drop across the DVR

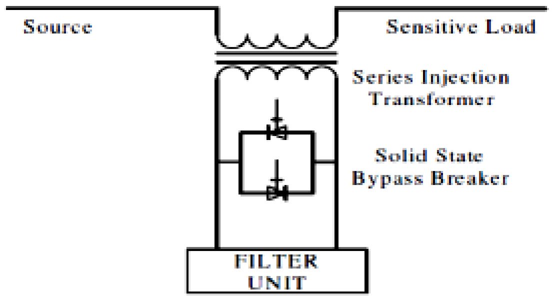

Fig. 9: Scheme of the standby mode

3.4 (c) Injection Modes

The primary function of the dynamic voltage restorer is compensating voltage disturbances on the distribution system. To achieve compensation, three single-phase ac voltages are injected in series with the required magnitude, phase and wave shape. The types of voltage sags,

Load conditions and power rating of the DVR will determine the possibility of compensating voltage sag.

3.5 Control Techniques

A Linear Controllers the three main voltage controllers, which have been proposed in the literature, are feed forward (open circle), Feedback (shut circle) and Multi-circle controller. The feed-forward voltage controller is the essential decision for the DVR, on account of its straightforwardness and speed. The supply voltage is persistently observed and contrasted and a reference voltage; if the distinction surpasses a specific resilience, the DVR infuses the required voltage. The disadvantage of the open circle controller is the high enduring state blunder. In the criticism control, the heap voltage is estimated and contrasted, and the reference voltage; the DVR supplies the missing voltage at the supply transport in an input circle. This controller has the upside of exact reaction, yet it is complicated and time-delayed. Multi-circle control is utilized with an external voltage circle to Control the DVR voltage and an internal circle to control the load current. This technique has the qualities of feed-forward and input control systems, at the expense of complexity and time delay.

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4. CIRCUIT DIAGRAM

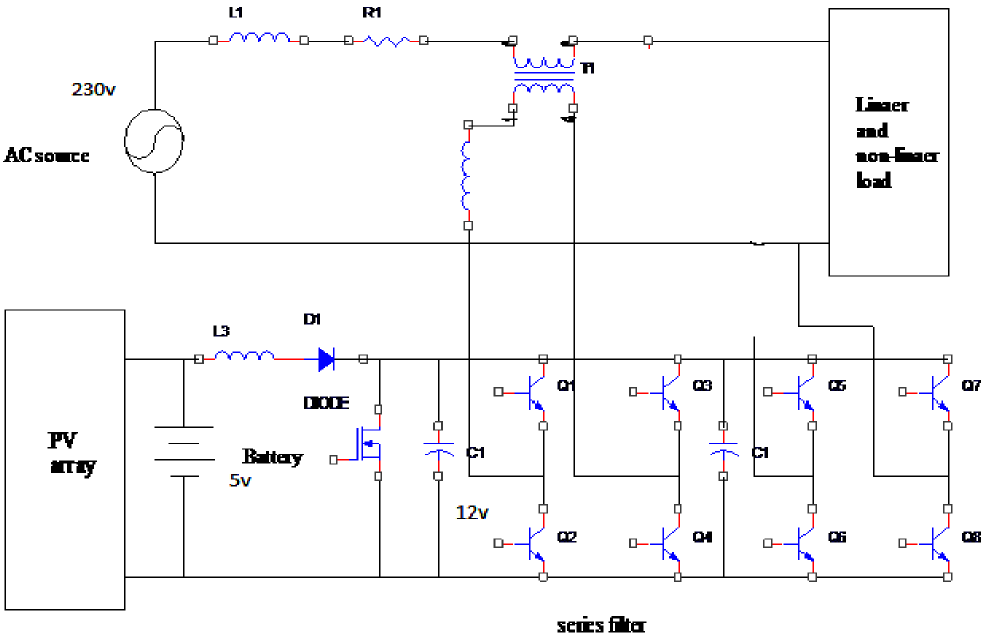

Fig. 10: Circuit Diagram for the DVR System

4.1 Circuit Diagram Explanation

The source of the grid power is unstable to perform them to drive the load operation. The PV power has been producing the variable voltage to generate the DC voltage up to(0-12)V. The reactive power of a DVR will improve the power up to (24-30)v AC to compensate the load. Both linear and non-linear loads. The LC filter will Be Implemented for reducing noise which is present in the circuit.

5. RESULT DISCUSSION

Fig. 11: Hardware output for a proposed technique

5.1 Hardware Output

S.NO	EXISTING SYSTEM	Ranges	PROPOSED SYSTEM	Ranges
1	Source voltage	(0-230v)	Source voltage	(0-230v)
2	Load	15w		15w
3	Dc capacitor	1000mf	DC capacitor	1000mf
4	Ripple factor	R=4.8	Ripple factor	R=4.8
		L=2mH		L=2mH
		C=100mf		C=100mf
5	THD	3.86	THD	2.45
6	Power factor	0.8669	Power factor	0.9996

5.2 Advantages

- Improve The Harmonics Detection.
- Capable Of Improving The Stability Output Voltage From Source To Feeder.
- Harmonics Current And Un-balanced Voltage Are Can Be Alleviated With The Compensation Of DVR.

5.3 Application

- Industrial Usage
- Renewable Energy Conversion
- Ups
- Electric Vehicles

6. CONCLUSION

This work presents a systematic study of a dynamic voltage restorer that can mitigate voltage sag at the load terminals due to fault occurs at the bus as well as along the line of a distribution system. The paper demonstrates the ability of the DVR through steady-state analysis. The proposed methodology can able to mitigate deep and long duration voltage sag. The mathematical models of DVR are described. Harmonic analysis is discussed with an experimental setup for generating online harmonic data. Placement of DVR is based on as per the maximum voltage sag occur for a particular topology. The proposed methodologies are applied in real Indian distribution systems. The improvement in voltage sag performance after the installation of the mitigation device(s) is not limited to the bus where a mitigation device is installed but improves the overall power quality of the system. The final goal of mitigation strategies is the reduction in process interruptions, making the total process disruption cost lower.

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