DVR-based distributed network with reduced voltage sag and swell for better power quality

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Abstract
Several voltage injection techniques for "dynamic voltage restorers (DVRs)" have been investigated in this publication. Voltages and currents in loads get out of balance when abruptly non-linear loads coupled at "point of common coupling (PCC)" in distribution network. Unbalanced voltages and currents have the potential to harm loads and circulate across the power system network. Series voltage controllers significantly reduce voltage sags, swells, and harmonics caused by rapid changes in load. DVR is a linked series device that enhances power quality.
Keywords: Power quality, DVR, Voltage Sag, Swell, flexible AC transmission frameworks (FACTS), Unified power quality Conditioner (UPQC), UVTG (unit vector template generation)

1 Introduction

Any power problem handled irregularly and current variance that causes equipment belonging to the client to malfunction are examples of the power quality. Maintaining the electric power quality within the necessary limits is a constant challenge. The main cause of the degradation in low power quality may be the use of power hardware devices, which respond nonlinearly under load. Low power quality causes a variety of problems in distribution systems, including harmonics, larger power losses, low distortion, and voltage sags. The number of sensitive loads that require "perfect sinusoidal supply voltage" for proper functioning has significantly increased due to the present advancements in communications, control framework, and digital devices. Therefore, it turned into vital to incorporate some compensation to meet boundaries suggested by guidelines. Here Various FACTS devices available to improve power quality those are DVR, SSSC, STATCOM, UPQC etc…,

Nonlinear load will be answerable for degradation in low power quality. While high power frameworks have been interconnected by comparatively low frequency oscillations & weak tie line have noticed. The current improvements in power electronics have prompted to progression of FACTS gadgets in power frameworks. The FACTS gadgets have able to handling the situation of network in quick way & this characteristic of FACTS might be misused to enhance power framework stability. To clammy electromechanical fluctuations in power framework, the supplementary controller might be applied with FACTS gadgets to enhance the framework damping. Those supplementary controllerwill be named “damping controller (DC)”. The DC has been intended to generate electrical torque in stage with speed deviation.

Power demand is variable in power system network means load variation critical load, nonlinear loads, non-critical loads always create suppress the power quality. PQ disturbances such as harmonics and starting as well as ending of unbalancing in whole stage load currents due any faults (Symmetrical/Asymmetrical) in power system network.

The UPQC is utilized to beat the issue of power quality [4]. The UPQC is group of shunt APFs & back to back connected series through general DC link voltage, 2 APFs function distinctively. The shunt active filter will be basically beneficial in eliminating the power related issues, power element development, & DC link voltage regulation. While the series APF supports in revision of voltage related issues by acting as “controlled voltage source”. The 2 control methodologies are described here that is synchronous reference frame, UVTG, P-Q method. The UVTG will be utilized to control for both shunt active power filter & series, while in different strategy synchronous reference outline system may be utilized to control for P-Q &SAF strategy may be utilized for control of shunt APF.

To attain a “low-carbon life, renewable energy sources” like solar &wind have been expected to exchange traditional fossil fuel. Nevertheless, stability problems into much severe with enough infiltration of such sources because of their irregular nature. The “Electric springs (ESs)” are suggested to guarantee the “critical loads (CLs)” to be worked in restricted ranges whereas passing the variances to “non-CLs (NCLs)” understanding a novel control standard.

The primary version & initial concept of ES have been introduced in [2] that work only in “pure reactive power compensation function”. The 2nd version with 8 compensation functions will be depicted. The dynamic suspension concept will be adopted in 3rd version that is included into “bidirectional grid-connected converters” without any NCLs.

The "Static Synchronous Compensator" will be "shunt-connected reactive power compensation gadget", which will be able to producing and/or "absorbing reactive power" at provided bus position and in output might be different[3].

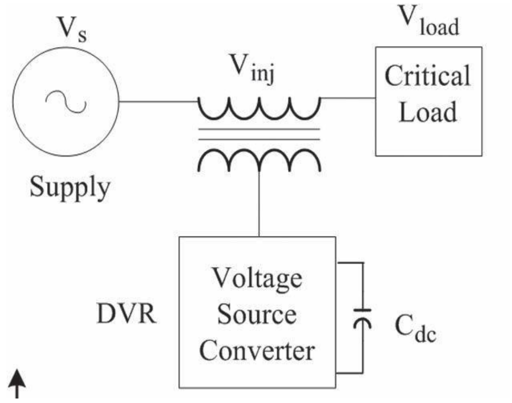

Fig.1. Structure of DVR

The DVR is currently suggested "series connected solid state device", which injects voltage into framework to handle "load side voltage". It is usually installed in distribution framework among critical load feeder & supply at "point of common coupling (PCC)".TheDVR might also include further features [1] such as: decrease of transients in voltage, line voltage harmonics compensation, & fault current boundaries. This device might offer a fully controlled series injected compensating voltage over an identical specified capacitor and inductive range, independently of magnitude of the transmission line current.

Compare all these FACTS devices Dynamic voltage restorers works very well to improve power quality problems.

Control Scheme

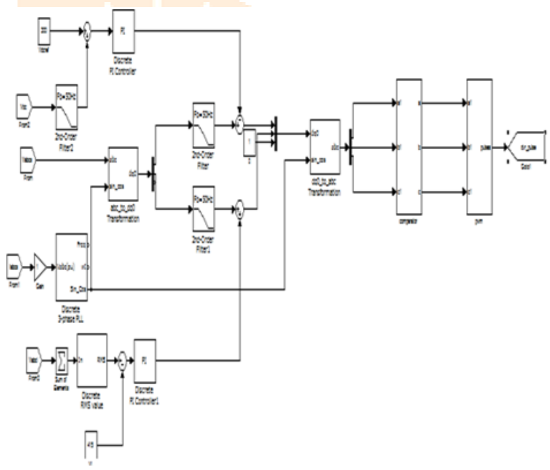

Fig.2. Proposed Control Scheme

The diagram of a DVR-connected framework will be represented Fig. 1(a). The voltage *V*inj will be inserted "load voltage *V* load" will be constant in magnitude and is undistorted, though "supply voltage *Vs"* will be not constant in magnitude or is distorted the phasor figure of diverse voltage injection methods of DVR. *VL*(pre−sag) will be voltage across critical load prior to voltage sag situation.

Through voltage sag, the voltage will be decreased to *Vs* with "phase lag angle" of θ. Present; DVR inserts a voltage such that "load voltage magnitude" will be preserved at pre-sag situation. As per phase angle of load voltage, voltages injection might be realized in 4 paths [19]. *V*inj1 signifies "voltage injected in-phase with supply voltage" with injection of *V*inj2, "load voltage magnitude" remains similar; however, it leads *Vs*by minor angle.

In Vinj3, load voltage recollects the similar phase as that of pre-sag situation that might be optimum angle deliberating the energy source [10]. *V*inj4 will be circumstance, while injected voltage is in quadrature with current, and this instance is appropriate for "capacitor-supported DVR" as this injection includes no active power [17]. Nevertheless, a least probable converter rating will be attained by *V*inj1. The DVR is executed in this method with "battery energy storage system (BESS)".

Simulation Results

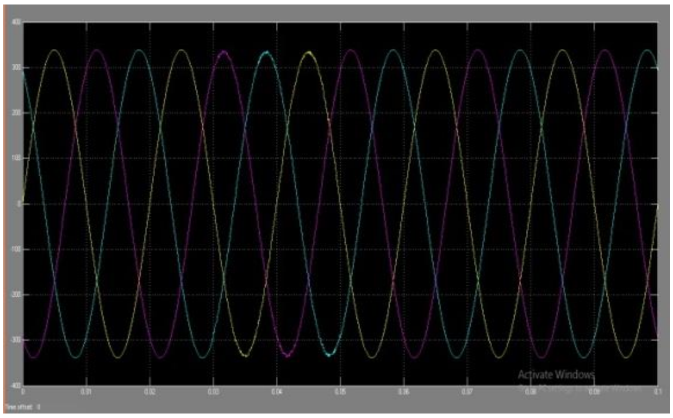

Fig.4. Simulated output waveform of A.C. Supply

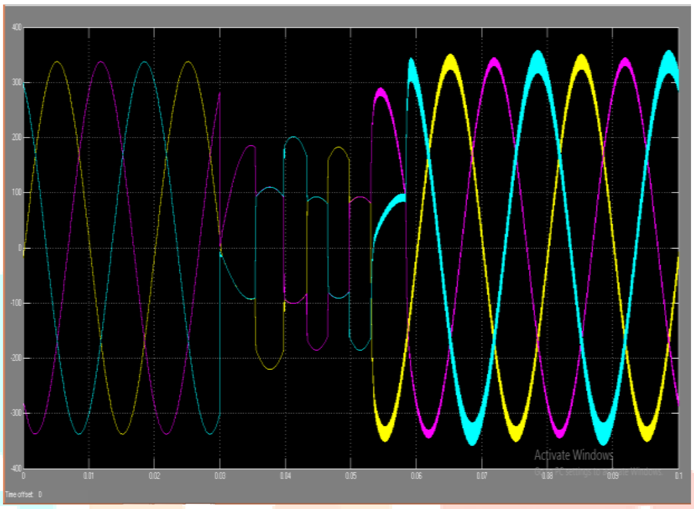

Fig.5. Simulated Output waveform at PCC due to Non linear loads

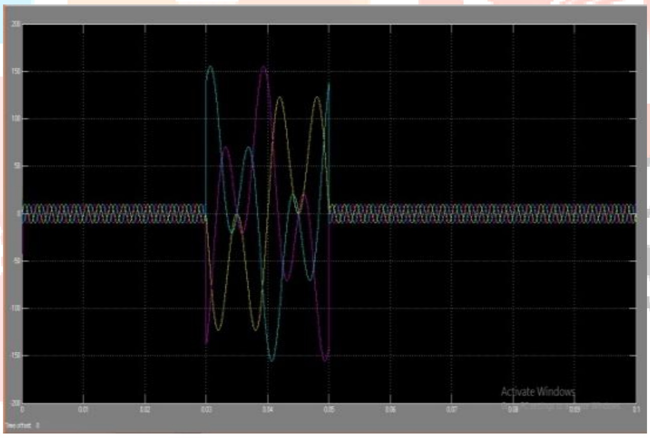

Fig.6. Injected voltage of DVR

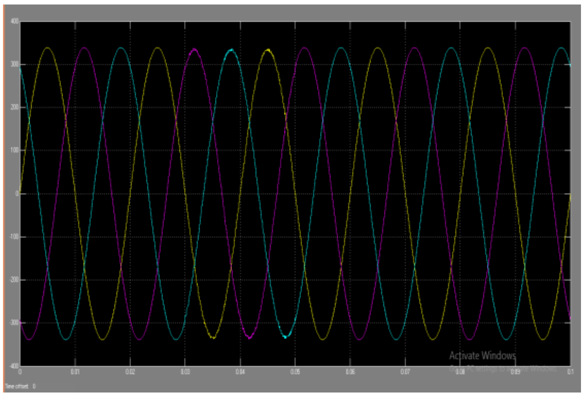

Fig.7. Simulated Output waveform of A.C Source

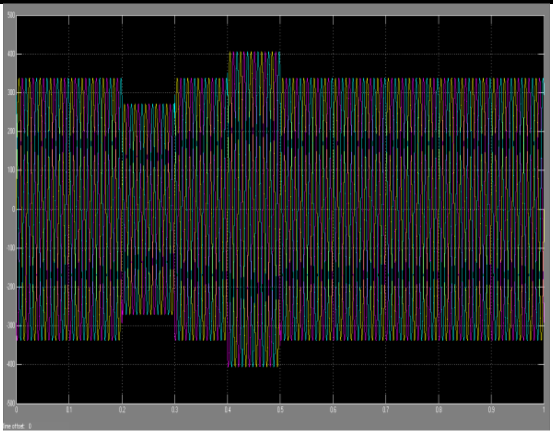

Fig.8. Simulated Output waveform at PCC due to Non linear loads

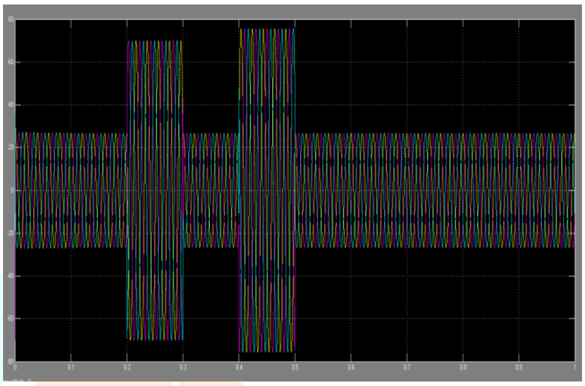

Fig.9. Injected voltage waveform of DVR

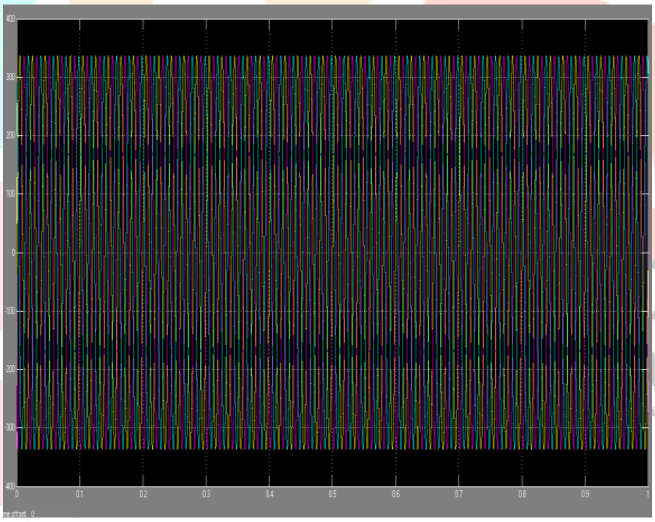

Fig.10 Simulated output voltage waveform at load

Conclusion

The DVR operation for another control strategy employing various voltage infusion strategies will be demonstrated. Using "reduced-rating VSC," which contains "capacitor-supported DVR," a comparison of DVR presentation using various techniques is carried out. With the aid of the unit vectors procedure, the "reference load voltage" is computed, and DVR control is reached, reducing voltage injection error. The "reference DVR voltages" are assessed using the SRF concept. The conclusion that "voltage infusion in-phase" with PCC voltage results in the lowest DVR rating may be closed.

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