DYNAMIC VOLTAGE RESTORES

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Abstract:

Voltage sags and swells in the medium and low voltage distribution grid are considered to be the most frequent type of power quality problems based on recent power quality studies. Their impact on sensitive loads is severe. The impact ranges from load disruptions to substantial economic losses up to millions of dollars.

Key words: Dynamic Voltage Restorer (DVR), voltage sags, voltage swells, power quality

INTRODUCTION

Dynamic voltage restores (DVRs) are now becoming more established in industry to reduce the impact of voltage dips on sensitive loads[1-3]

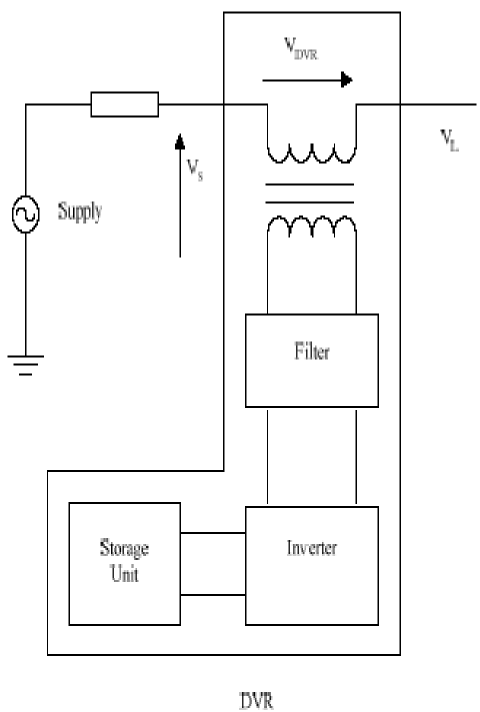

Fig. 1: DVR series connected topology

ere are different ways to mitigate voltage dips, swells and interruptions in transmission and distribution systems.

DYNAMIC VOLTAGE RESTORER

A Dynamic Voltage Restorer (DVR) is a recently proposed series connected solid state device that injects voltage into the system in order to regulate the load side voltage. The DVR was first installed in 1996[6].

It is normally installed in a distribution system between the supply and the critical load feeder[7]. Its primary function is to rapidly boost up the load-side voltage in the event of a disturbance in order to avoid any power disruption to that load[8,9]. There are various circuit topologies and control schemes that can be used to implement a DVR. In addition to voltage sags and swells compensation,

The general configuration of the DVR consists of an Injection/Booster transformer, a Harmonic filter,

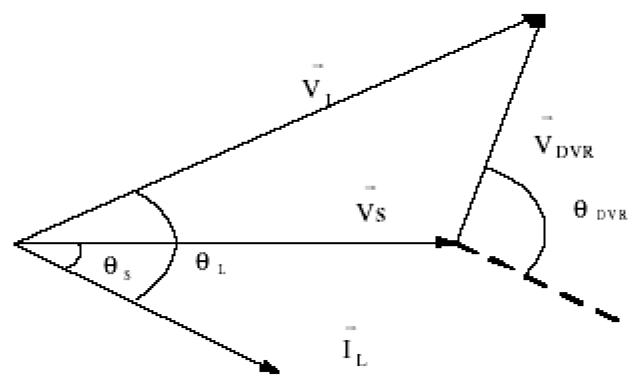

Fig. 2: Single-phase vector diagram of the PDC method

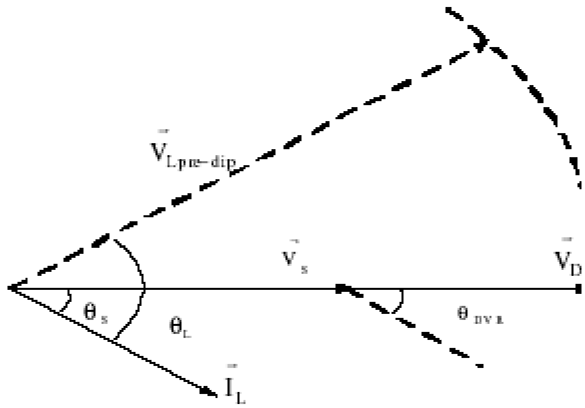

Fig. 3: Single-phase vector diagram of the IPC m

Voltage Source Converter (VSC), DC charging circuit
and a Control and Protection system as shown in Fig. 1.

Pre-Dip Compensation (PDC): The PDC method tracks supply voltage continuously and compensates load voltage during fault to pre-fault condition.

In this method, the load voltage can be restored ideally, but the injected active power cannot be controlled and it is
determined by external conditions such as the type of faults and load conditions. The lack of the negative sequence detection in this method leads to the phase oscillation
in the case of single-line faults. Figure 2
shows the single-phase vector diagram of this method.

According to Fig. 2, the apparent power of DVR is:

$$S_{1DVR} = I_L V_{1DVR} = I_L \sqrt{V_L^2 + V_S^2 - 2V_L V_S \cos(\theta_L - \theta_S)}$$

And the active power of DVR is:

$$P_{1DVR} = I_L (V_L \cos\theta_L - V_S \cos\theta_S)$$

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The magnitude and the angle of the DVR voltage are:

$$V_{1DVR} = \sqrt{V_L^2 + V_S^2 - 2V_L V_S \cos(\theta_L - \theta_S)}$$

$$\theta_{1DVR} = \tan^{-1}\left(\frac{V_L \sin\theta_L - V_S \sin\theta_S}{V_L \cos\theta_L - V_S \cos\theta_S}\right)$$

In-Phase Compensation (IPC): This is the most used

The apparent and active powers of DVR are:

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$$S_{2DVR} = I_L V_{DVR} = I_L (V_L - V_S)$$

$$P_{2DVR} = I_L V_{DVR} \cos\theta_S = I_L (V_L - V_S)\cos\theta_S$$

The magnitude and the angle of the DVR voltage are:

The magnitude and the angle of the DVR voltage are:

$$V_{2DVR} = V_L - V_S$$
$$\theta_{2DVR} = \theta_S$$

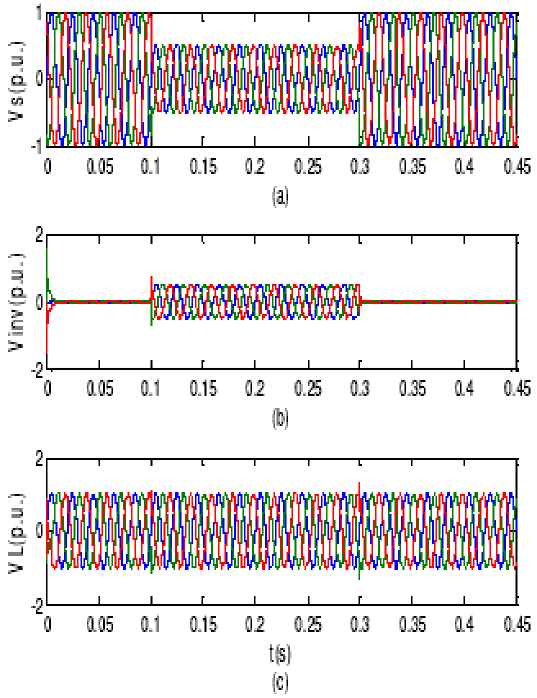

Fig. 4: Three-phase voltage sag; (a): Source voltages, (b): Injected voltages; (c): Load voltages

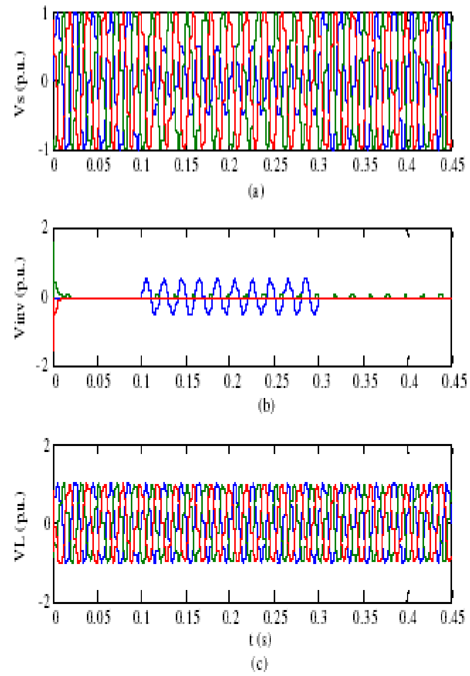

Fig. 5: Single-phase voltage sag; (a): Source voltages; (b): Injected voltage, (c): Load voltages

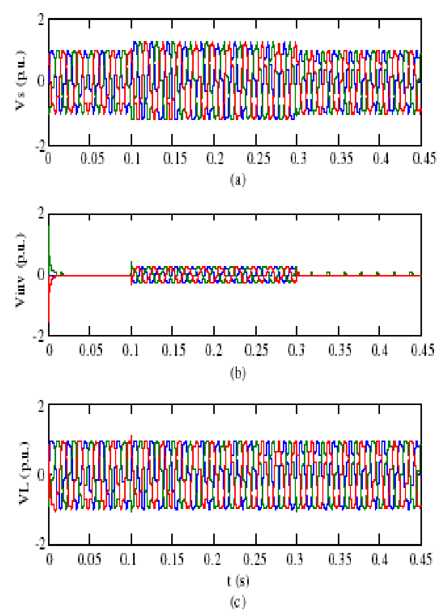

Fig. 6: Three-phase voltage swell; (a): Source voltages; (b): Injected voltages; (c): Load voltages

correct the supply voltage.

SIMULATION

CONCLUSION

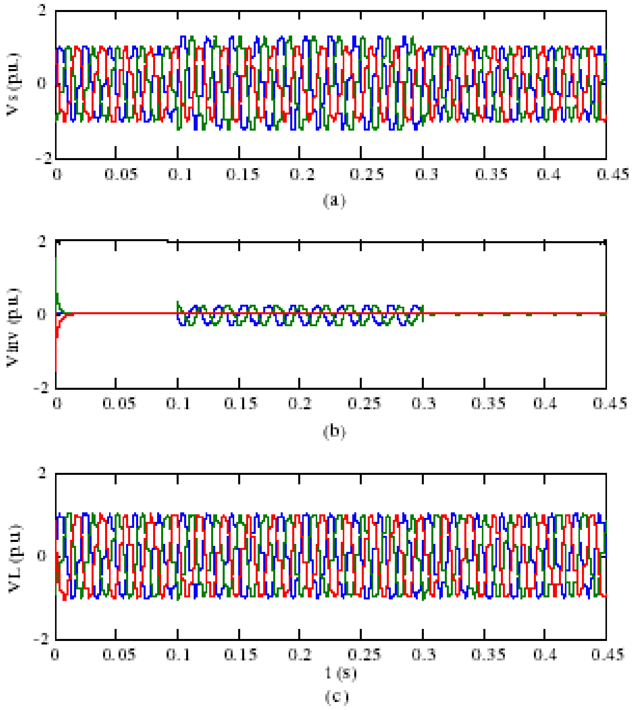

Fig. 7: Two-phase voltage swell; (a): Source voltages; (b): Injected voltages; (c): Load voltages

The simulation results showed clearly the performance of the DVR in mitigating voltage sags and swells. The DVR handled both balanced

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