Series Compensator Based on Cascaded Transformers Coupled With Three-Phase Bridge Converters

Introduction:

Distribution power systems are suffering hard impact in their power quality. This is due to the intensive use of nonlinear loads added with the growth of renewable energy sources. Such aspects have been leading electrical power system to poor power quality levels. Most common disturbances include: 1) harmonic voltages/currents; 2) voltages imbalances; 3) voltage sags/swells; 4) flickers; 5) transients; and 6) interruptions.

Among them, voltage sags have been considered the most important power quality problem and have been attracting much attention in the literature. To mitigate voltage disturbances at the grid, some custom power devices have been introduced and investigated.

Existing system:

The series compensator (DVR or Series-APF) is commonly composed of the following: 1) injection transformers; 2) voltage source converter (VSC); 3) energy storage; 4) optional passive filters; and 5) protection circuits (e.g., bypass thyristors).

The VSC-based on two-level (2L) topology is the most common solution used for low-voltage systems. However, for high-voltage levels (i.e., high-power applications), 2L-based converters have experienced limitations and difficulty to penetrate in this market.
The cost associated for designing a 2L-based compensator for more than 690 Vrms (according to IEC) makes this solution not feasible for high-voltage applications. In this context, the multilevel-based VSC technology has become the most mature and feasible solution for this type of applications.

Dis-advantages:
- High number of dc-link capacitors.
- Increases cost and poor efficiency.

Proposed system:
A multilevel series compensator (MSC) to deal with voltage sags/swells, harmonic compensation, or reactive power compensation is proposed. Such a device can be considered as a dynamic voltage restorer or a series active power filter (series-APF). The MSC can improve the power quality of loads located in stiff systems. The configuration is based on three-phase bridge (TPB) converters connected by means of cascaded single-phase transformers. This arrangement permits the use of a single dc link.

A generalization for $k$-stages in which $k$-transformers are coupled with $k$-TPB converters is presented. The topology permits generating a high number of levels in the voltage waveforms with a low number of power switches in comparison with a classic topology. The multilevel waveforms are generated by the converters through a suitable pulse width modulation (PWM) strategy that takes into consideration the transformer turns ratios.

Advantages:
- The performance can be improved as well as can increase the power rating of the compensator.
- It does not need any additional dc-link capacitor.

**Applications:**
- Power distribution applications.

**Block Diagram:**

```
Ac source → Multilevel series compensator → Load

12VDC → Gate driver circuit → Buffer circuit

5VDC → Microcontroller circuit
```