Single-Phase to Three-Phase Unified Power Quality Conditioner Applied in Single Wire Earth Return Electric Power Distribution Grids

Introduction:

Electrical power distribution systems (EPDS) with single-wire earth return (SWER) have been commonly adopted as a solution for electrical power supplying. This is due to the fact that the reduction of costs in the distribution of energy to serve large territorial extensions with low demographic densities is an important requirement, since lower installation and maintenance costs are achieved.

Other alternatives are the use of energy distribution by means of two conductors (phase-to-neutral) without earth return, or even using two-phase systems (phase-to-phase). Considering these alternatives, capital investments for the realization of SWER distribution grid facilities installations are still lower.

Existing system:

The use of medium and high power three-phase voltage inverters involved in modern automated systems also justifies the need for three-phase grids in rural areas. Therefore, the presence of a local three-phase energy distribution system in areas that make use of the SWER distribution system becomes more and more indispensable.
For this purpose, several solutions and/or configurations of single-phase-to-three-phase (1Ph-to-3Ph) converters have been addressed in the literature. These include 1ph-to-3Ph four-wire converters, which are able of supplying three-phase and single-phase. Dedicated to feed three-phase three-wire loads and integrating the functioning of the unified power quality conditioner (UPQC), the 1Ph-to-3Ph converter presented performs universal filtering, i.e., it operates as series-parallel active power filter, in which the series converter is composed of a single-phase full-bridge inverter (two inverter legs), while the parallel converter is composed of a three-phase three-leg inverter, totaling five inverter legs.

**Proposed system:**

To validate experimentally the UPQC-1Ph-to-3Ph destined to feed single-and three-phase loads from the SWER power distribution systems, commonly found in rural and/or remote areas and suffer with PQ problems. By adopting the dual compensation strategy, the proposed UPQC-1Ph-to-3Ph makes possible to drain from the single-phase electrical grid a sinusoidal current in phase with the grid voltage. Furthermore, the system can also suppress harmonics from the grid voltage, as well as compensate for voltage disturbances, such as voltage sags/swell.

The topology of the UPQC-1Ph-to-3Ph such that this one is formed by two PWM converters, being a half-bridge inverter and a split-capacitor 3-Leg inverter sharing the same dc-bus. As can be noted, a half-bridge inverter is used to compose the series converter, while in it was composed of a full-bridge inverter. Thus, besides using one leg less compared to the topology presented, the dc-bus is formed by the split-capacitor configuration, allowing access to the earthed return conductor of the load, as well to be used in SWER distribution.
systems. As can be noted, the four-wire of the load is connected to the dc-bus central point.

The series converter, also called SAPF, is current controlled so that the input drained current is sinusoidal and in phase with the grid voltage, resulting in a power factor (PF) very close to one. A filter inductor is placed in series with the primary winding of the single-phase series coupling transformer.

**Advantages:**
- Good static and dynamic behaviour.
- Suppress Voltage stress.

**Applications:**
- Grid applications.
- Power distribution applications.
Block Diagram:

AC input → UPQC controller → Load

Series PWM converter → Parallel PWM converter

Gate driver circuit

Buffer circuit

Microcontroller circuit

12vdc

5vdc

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