POWER QUALITY ENHANCEMENT BY UNIFIED POWER QUALITY CONDITIONING SYSTEM WITH STORAGE DEVICE

T. Parameshwar  
Associate Professor  
Dept of Electrical & Electronics Engineering

A. RadhaKrishna  
Associate Professor  
Dept of Electrical & Electronics Engineering

K. Swapna  
Assistant Professor  
Dept of Electrical & Electronics Engineering

Vidya Jyothi Institute of Technology  
Hyderabad Telangana

Gurunanak Institutions  
Hyderabad Telangana

Vidya Jyothi Institute of Technology  
Hyderabad Telangana

ABSTRACT: This paper presents a new concept of co-ordinated active power sharing between shunt and series converters of unified power quality conditioner (UPQC) for distributed generation applications with PID controller. Normally, the UPQCs are used to mitigate both voltage and current power quality problems. However, these UPQCs are also used for delivering active power in addition to its power quality improvement by integrating distributed generation (DG) at the DC link of back to back connected converters. But, only the shunt converters are used to carry the whole active power from the DG sources and the series converters are used to handle only voltage related power quality problems. So, the shunt converter is loaded heavily and the series converter is kept idle in steady state cases. The more dependency on the shunt converter also reduces the reliability of the total system. This proposed control strategy is used to carry active power through both series converter and shunt converter even at the steady state conditions. The proposed method improves the utilization of the converters and also the reliability of the system. The effectiveness of the proposed control strategy is demonstrated by comparing with the conventional control algorithm, where only the shunt converter is used to carry active power.

Keywords—Distributed Generation; unified power quality control (UPQC); PID Controller

I. INTRODUCTION

The challenging issues of a successful placement and integration of unified power quality conditioner (UPQC) in a distributed generation (DG)-based grid connected microgrid (μG) system are 1) Control complexity for active power transfer; 2) ability to compensate non-active power during the islanded mode; and 3) difficulty in the capacity embellishment in a modular way [1]. For a smooth power transfer between the grid-connected system and islanded mode, various operational changes are presented, such as switching between the current and voltage control mode, robustness against the islanding detection and reconnection delays and method and so on [2], [4]. Clearly, these further increase the control complexity of the microgrid systems. To extend the operational flexibility and to improve the power quality in grid connected microgrid systems, a new control strategy placement and integration technique of UPQC have been proposed in [3], which is termed as UPQC μG. In the UPQC μG integrated distributed system, micro grid (with storage) and shunt part of the UPQC μG are placed at the Point of common coupling. The series of the UPQC is placed before the Point of common coupling and in series with the grid. DC link is connected to the storage also, if present.

In this paper, the control technique of the presented UPQC μG and PID controller in [4] is enhanced hence; it is termed as UPQC μG–IR. The benefits offered by the proposed UPQC μG–IR over the conventional UPQC are as follows. To observe the effect on the characteristic of voltage sag / swell and interruption for the techniques. Both in the interconnected and islanded modes, the μG provide only the active power to the load. Therefore, it can reduce the control complexity of the DG converters. Islanding detection and reconnection technique are introduced in the proposed UPQC as a secondary control. To maintain the operation in islanded mode and reconnection through the UPQC and PID, communication process between the UPQC μG and μG system is mentioned in [5]. In this paper, the control technique of the presented UPQC μG and PID controller in [6] is enhanced by implementing an intelligent islanding and novel re connection technique with reduced number of switches that will ensure seamless operation of the μG without interruption [7]. Hence, it is termed as UPQC μG–IR. The benefits offered by the proposed UPQC μG–IR over the conventional UPQC areas follows.

- It can compensate voltage interruption/sag/swell and non-active current in the interconnected mode.

- Therefore, the DG converter can still be connected to the system during these distorted conditions. Thus, it enhances the operational flexibility of the DG converters/μG system to a great extent, which is further elaborated in later section.

- Shunt part of the UPQC Active Power Filter (APFsh) can maintain connection during the islanded mode and also compensates the non-active Reactive and Harmonic Power (QH) power of the load.
Both in the interconnected and islanded modes, the μG provides only the active power to the load. Therefore, it can reduce the control complexity of the DG converters.

Islanding detection and reconnection technique are introduced in the proposed UPQC as a secondary control. A communication between the UPQC and μG is also provided in the secondary control. The DG converters may not require having islanding detection and reconnection features in their control system [8-12].

Fig.1 shows the system configuration of the UPQC integrated with the distributed generation (DG) at the DC link of back to back connected converters. This distributed energy resource may consists of different renewable sources e.g., solar, wind, biogas and fuel cell in conjunction with ultra-capacitor as energy storage system. However, in the present case only ultra-capacitor is considered for demonstration purpose. The main purpose of the UPQC is to transfer the power generated from the DG to the load and also to improve the voltage and current power quality problems.

![Fig 1 configuration of UPQC with DG](image)

II. CONVENTIONAL CONTROL STRATEGY:

UPQC The schematic block diagram of conventional UPQC-Q is shown in the Fig.2. The UPQC consists of two 3-phase voltage source inverters connected in cascade through a common DC link capacitor. The DVR and the STATCOM are series and shunt connected voltage source inverters (VSIs) respectively. The main objectives of STATCOM are to compensate for the reactive power demanded by the load, to eliminate the harmonics from the supply current, and to regulate the DC link voltage. The STATCOM operates with hysteresis current control mode to force the source current, is, in phase with $V_s$ such that input power factor is always maintained unity.

![Fig.2 Block diagram of UPQC](image)

To minimize voltage harmonics and to balance and control, the terminal voltage of the load or line, using a series transformer series AF is connected in series with the mains before the load. It is used to reduce negative-sequence voltage and control the voltage on three-phase systems. It can be installed by electric utilities to damp out harmonic propagation caused by resonance with line impedances and passive shunt compensators and to compensate voltage harmonics.
III. PROPOSED CONTROL STRATEGY:

This section presents the proposed control algorithms for series converter, shunt converter, and battery energy storage system (BESS). The main objective of this UPQC is to transfer active power from the DG and also to improve the voltage and current power quality problems.

A. Series Converter control algorithm

The main purpose of the series converter is to improve the voltage power quality and also to transfer active power. The voltage power quality problems are eliminated by injecting the voltage in series through series transformer. The active power is transferred through the series transformer by phase shifting the load voltage from the grid voltage. So, the reference load voltage is generated in such a way to inject active power and also to improve the voltage power quality at the load terminals. The phasor diagram for the basic understanding of series converter voltage injection scheme is shown in Fig. 3. The control schematic for the series converter is presented in Fig. 3. The maximum active power that can be transferred through the series converter depends upon the kVA rating of the converter.

B. Shunt Converter Control Algorithm

A shunt active filter is used to transfer the active power from the DG in addition to the basic responsibilities such as load current harmonics compensation and load reactive power compensation. So, the shunt converter current consists of load current harmonics, the reactive component of load current and active power component of shunt converter current. However, indirect current control method is adapted for controlling the shunt converter. So, the grid currents are taken as reference, which should be free from harmonics. The complete control scheme for the shunt converter is presented in Fig. 4.
IV. MATLAB AND SIMULATION RESULTS:

The Simulation block diagram is shown in figure.5.

Case 1: Output Voltage waveforms are under sag conditions is shown in figure.6.
When there is a sag in the system the UPQC detects it and with the help of storage device it generates voltage i.e it injects the required voltage into the system with the help of series converter and maintains the voltage. Which improves the reliability and power quality of the system under voltage sag conditions.

**Case 2:** Output Voltage waveforms are under swell conditions is shown in figure.8 and power waveforms are shown in figure.9
When there is a swell in the system the UPQC detects it and observes the extra voltage from the system with the help of shunt converter and maintains the voltage. Which improves the reliability and power quality of the system under voltage swell conditions.

**Fig.8. a) Source Voltage b) Load Voltage c) observed Voltage d) Ultra capacitor capacitance.**

**Fig.9. a) Source power b) observer power c) Ultra capacitor power d) load power.**

**V. CONCLUSION:** A new coordinated active power control strategy has been proposed to share the active power between the shunt and series converters of the UPQC for distributed generation applications. This proposed control strategy
has been compared with the conventional control strategy of the UPQC. This control algorithm reduces the burden on the shunt converter and also improves the reliability of the system.

REFERENCES: