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Power quality improvement using renewable energy

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Abstract. This paper presents a three-phase Active Power Conditioner to improve power quality in microgrids based on renewable energy. Three hysteresis controllers are used to control the six IGBT bridge. In a microgrid which is a weak electrical grid the disturbances can be very important. The Active Power Conditioner (APC) presented in this paper acts as an interface between renewable energy sources and the AC bus of microgrid. The improved control strategy used offer the possibility to inject electrical energy from the renewable sources and on the other hand to improve the power quality in the same microgrid. This control strategy named *Extended Indirect Control Strategy* is capable to achieve better values for the following power quality indicators: THD_I (Total Harmonic Distortion), PF (Power Factor), current and voltage balancing. Simulation results show the validity of the innovative control strategy.

Key words

Active Power Conditioner, Renewable Energy, Power Quality, Microgrids, Current hysteresis control.

1. Introduction

Nowadays the advances in power electronics give us the possibility to use the renewable sources in different configurations. Using power electronics interfaces the renewable sources can be connected with distribution grid or interconnected with other renewable and non-renewable generators, storage systems and loads in microgrids [1]. A microgrid is different from a main grid system which can be considered as an unlimited power so that load variations do not affect the stability of the system. On the contrary, in a microgrid, large and sudden changes in the load may result in voltage transient of large magnitudes in the AC bus. Moreover, the proliferation of non-linear load such computation technique, switching power converters can decrease the power quality indicators especially in microgrids. The power quality also in grid is affected by nonlinear loads, but in microgrids this can be very poor under mentioned conditions.

A possible solution to overcome the above mentioned drawback is to use the APC as a power interface between the renewable energy sources and the AC bus of the microgrids as shown in Fig. 1.
APC have proved to be an important alternative to compensate current and voltage disturbances in power distribution systems [2], [3]. Different APC topologies have been presented in the technical literature [4], but most of them are not adapted for microgrids applications.

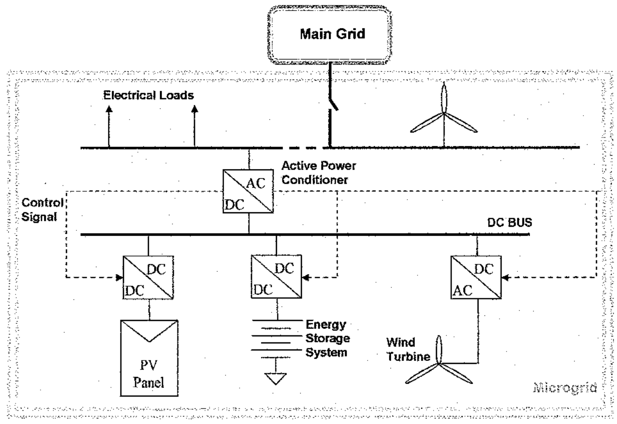

Fig. 1. APC for microgrid applications

This paper presents an APC used to improve the power quality in a microgrid. The attention will be mainly focused on the innovative control strategy, which allows injecting energy in the microgrid, compensating the current harmonics, correcting the power factor and balancing the supply voltage at the PCC (Point of Common Coupling). The validity of the control strategy has been proved through many simulation tests using SimPowerSystems from MATLAB.

2. Active Power Conditioner Topology

The most utilised topology, to manage four currents, is four-leg converters [5]. This topology has proved better controllability [6] than the classical three-leg four-wire converter but the latter is preferred because of its lower number of power semiconductor devices. In this paper, it is shown that using an adequate control strategy, even with a simple three-leg four-wire system, it is possible to mitigate disturbances like voltage unbalance, THD and others. The topology of the investigated APC and its interconnection with the microgrid is presented in Fig. 2. It consists of a three-leg four-wire voltage source inverter. In this type of applications, the VSI operates as a current controlled voltage source. In order to provide the neutral point, two capacitors are used to split the DC-link voltage and tie the neutral point to the mid-point of the two capacitors. This topology allows the current to flow in both directions through the switches and the capacitors, causing voltage deviation between the DC capacitors.

$$i_{fa} + i_{fb} + i_{fc} = i_{fN} \quad (1)$$