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A Modified Droop Controller for Parallel Operation of Single-Phase Inverters in Islanded Microgrid

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Abstract: Conventional droop control is a basic control strategy for power sharing in islanded microgrid applications. This strategy has several limitations, such as low transient response, frequency and voltage deviations. This paper presents a modified droop control method for the proper operation of parallel-connected inverters in islanded microgrid. The proposed method is able to improve transient response and achieved higher output power without voltage and frequency deviations by introducing a power derivative term into a conventional droop method. A new method of average power computation is proposed which significantly reduces the delay encountered in conventional approaches and provides the power signal without DC components. The simulation was developed in MATLAB/Simulink to verify the effectiveness of the modified droop control scheme. Based on the results, it can be concluded that the modified droop control strategy improves the performance of parallel-connected power electronic inverters in an islanded microgrid as compared to conventional droop control strategy.

Keywords: Active and reactive power, Distributed generation, Droop control, Inverter, Islanded microgrid.

1. Introduction

Distributed generation (DG) technology is undergoing rapid development in many countries because of the availability of different energy resources, such as solar panels, batteries, electric vehicles, and wind turbines. DG is usually managed in a decentralized manner through the concept of a microgrid (MG). MG technology offers numerous research possibilities because it is a new and developing technology. An MG is defined as a cluster of DG units, storage devices, and loads. In practice, MGs are needed to provide sufficient power quality and level to meet consumer demands [1–3]. Power quality is a significant issue because of insufficient or unstable output power from MGs directly affects its performance for short or long periods. In an islanded mode, the MG must maintain the system voltage and frequency; otherwise the variation in the component characteristics of the MG will collapse the system. Harmonic distortion in output power waveform is a serious issue that often occurs as a result of the high-speed operation of inverter switches. In addition, power sharing between the DG units is a critical concern for proper load sharing, especially in renewable energy resources those are not continuously available. The power quality of an MG mainly relies on the active and reactive power regulation because of MG behaviours, which are mostly influenced by the bulky power distribution system [4–5].

Researchers have proposed different methods such as: the droop, master–slave, and average-current-sharing control methods in order to improve power quality. Among these methods, droop control has gained higher popularity because it is based on the local measured information of the inverter. As it does not require any communication signals between the parallel-connected inverters, it can reduce the line losses in MG. However, the conventional droop control method has several drawbacks such as slow transient response, frequency and voltage deviations which limit the accuracy of power sharing [6]. In previous works