Abstract

Renewable generation sources reshape the power system, increasing the use of power electronics to interface the energy supply and demand. This characteristic introduces new technical challenges concerning system stability and synchronization, voltage and frequency regulation, and load power sharing. In addition to this issues, unbalanced and nonlinear load presence, as in traditional electrical systems, decrease power quality and might cause problems on equipment; and therefore, needs to be treated carefully. Virtual oscillator control (VOC) is a new technique for coordinating parallel inverter in a microgrid such that they can synchronize their AC output without communications between inverters. This new technique is expected to supersede the existing control methods, due to its advantages, such as a faster voltage and frequency regulation in comparison with the droop control. Moreover, in a system level, each VOC can stabilize rapidly arbitrary initial conditions and load transients. A multibus islanded microgrid is simulated in Matlab/Simulink, where the inverters are controlled by a virtual oscillator. Additionally, a nonlinear control, sliding mode control (SMC), is implemented to enhance the overall system performance, focusing on harmonic content reduction and unbalance voltage mitigation. The use of a simple sliding surface in combination with a so-called super twisting algorithm shows excellent performance, offering a good capability of perturbation rejection, and at the same time low chattering levels. To handle all types of unbalance, a similar SMC is implemented not only in a traditional three legs inverter but also in a four legs inverter, giving a zero sequence path, allowing the connection of any type of load. The variable to be controlled is the voltage at the point of common coupling (PCC) without direct measurements of the load; instead, an estimated voltage is calculated using current and voltage values from the load side filter, reducing the number of sensors required and hence increasing the chances of practical implementation. More specifically, a combination of a second-order generalized integrator (SOGI) together with a self-tuning filter is used, in order to calculate the feedback value. The system stability is analyzed using Lyapunov's theorem. Three different cases for each system model show the performance of the solution, with a nonlinear and unbalanced load. In all the situations, the controller fulfilled the standards requirements, even when the loads were far outside of their permissible limits. Similarly, power sharing is achieved without the need for additional controllers.