Abstract

In this paper, a large-signal modeling technique has been developed for a three-phase, three-level Vienna rectifier operating in continuous conduction mode. The considered circuit is a fifth-order system with time-varying variables on the ac side. This model is first established in the direct *abc* reference frame using the state space averaging technique, then modified through an *abc*/*dqo* transform and adequate duty cycle alteration to avoid time-dependency. The system stability in a closed loop, using a multi-loop PI-based control scheme, is proved by the convergence of the phase plane trajectories to the nominal point for any initial condition. These curves are drawn as ac line peak currents as a function of total output dc voltage. The different relationships governing the system inputs/outputs are verified not only for the nominal operating point, but also for a wide operation range. The accuracy of the proposed model is verified on a 1.5-kW experimental prototype controlled by the DS-1104 board of dSPACE. The converter large signal behavior is experimentally analyzed using output time domain responses toward different input variations. Significantly high accordance between the experimental results and the theoretical model, implemented with SIMULINK/Matlab, is verified.

Index Terms— High power factor, large-signal modeling, low ac current total harmonic distortion (THD), phase plane curves, three-phase/switch/level rectifier, time response analysis.