Abstract

In this paper, a nonlinearity- compensation control scheme is used in combination with an Extended Kalman Filter estimation algorithm, in order to ensure AC current shaping and DC voltages regulation for a three-phase three-wire Vienna converter. This approach aims to reduce the high number of sensors, needed by the traditional nonlinear control approach, thus reducing realization costs and improving circuit reliability. For this aim, source and DC loads voltages are numerically reconstructed by an extended Kalman filter, based on the converter averaged model. Consequently, only two current sensors may be used in the circuit, versus 10 sensors for the conventional method. A multi-loop nonlinear control technique is, then, applied to the rectifier, using the estimated voltages instead of the measured ones. The measured currents and the estimated partial DC bus voltages are controlled via inner loops. The total output DC bus voltage is regulated in an outer loop, based on power balance consideration. The proposed method is experimentally verified on a 1.5 kVA prototype of the rectifier, using the DS1104 controller board of dSPACE and real-time workshop of Matlab. It is proved that the implemented nonlinear observer exhibits high estimation precision within acceptable response time, thus ensuring very satisfactory operation of the converter in steady state.

Index Terms— Extended Kalman Filter (EKF), nonlinear control scheme, real-time systems, sensorless control, three-phase rectifiers, power factor correction, harmonics compensation, DC bus voltage regulation.