

Abstract

Predictive control algorithms of an AC/DC/AC converter

The growing requirements for AC/DC/AC voltage converters (lower price, higher quality of electrical energy, higher efficiency) force the constant development of these devices in two main directions. The first one is related to improving the semiconductor devices (Silicon Carbide SiC, Gallium Nitride GaN) or magnetic components. The second trend is focused on improving the control algorithms, which are the main subject of this dissertation.

Special attention is given to finite control set – model predictive control (FCS-MPC), due to its simplicity, flexibility, inherent adaptation to power electronic circuits and their discrete nature, both in the finite number of switching states and the digital implementation on microprocessors. Taking into account the finite set of possible the power converter switching states, the optimization problem is reduced to the evaluation of all possible states and the selection of the one which minimizes the given cost function.

This work consists of two main parts. The first one is dedicated to the predictive control of an AC/DC converter. In order to fulfil the grid code requirements, it is necessary to introduce a line filter between the AC/DC converter and the grid. In grid-connected applications LCL filters are of significant interest due to the high level of harmonic attenuation that is offered relative to series inductors. The main challenge in the development of suitable control strategies for LCL filter based set-ups is the damping of the resonant frequency(ies) of the filter. The thesis presents new FCS-MPC algorithms with multivariable cost functions. In chapter 4 and 5 the new control schemes, simulation and laboratory test results were presented. New methods cause low grid current distortion, high dynamic and immunity for operation under distorted grid voltage.

In substantial, second part of this work the analysis of the DC/AC inverter-fed induction motor was presented. Predictive torque and flux control algorithms in dq rotating reference frame was presented in the 6th chapter. Weighting factor influence on the quality of torque and flux was investigated in the laboratory. The results indicated the correct method of calculating the optimum value of the weighting factor and proved the high quality of developed control algorithm.

An important supplement to the dissertation is chapter 7, which is dedicated to the problems with implementation of predictive control in a real system, such as the influences of: the dead time, the rotation of the converter voltage vectors (in dq rotating reference frame) and the computing time of the processor on the quality of the process variables. The method of selecting the weighting factors was also presented in this chapter.

To sum up, the work provide new control methods of the AC/DC/AC converter and each one face the modern requirements, but has different features. The final chapter compares the algorithms and supports the central thesis.