EAA Lehrstuhl für Elektrische Antriebstechnik und Aktorik
Chair of Electrical Drives and Actuators

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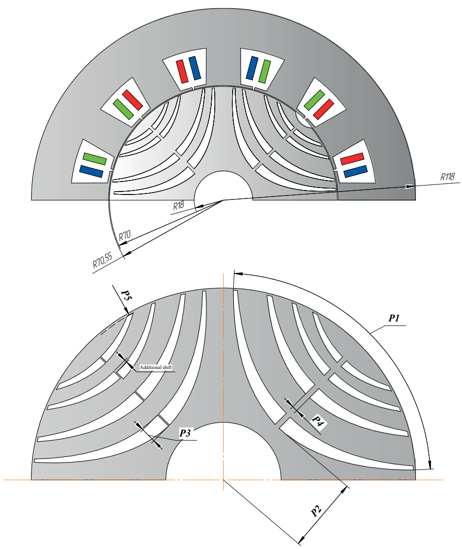
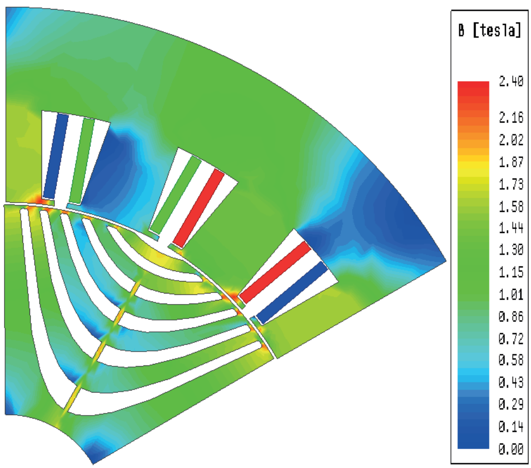
Hrsg.: Prof. Dr.-Ing. Dieter Gerling

Volodymyr Bilyi

Optimized synchronous reluctance drive for effective application in wind turbines and battery electric vehicles





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2. Prof. Dr.-Ing. Christian Kreischer

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Preface

This thesis was written during my time as a research assistant at the Universitaet der Bundeswehr Muenchen at the chair of electrical drives and actuators (EAA), which is very well-known with its scientific publications around the world. I am very grateful that I got the opportunity to work with this team.

I am very thankful to the head of the EAA department and my supervisor Prof. Dr.-Ing. Dieter Gerling for the opportunity to work on the state-of-the-art problematics of modern electrical engineering, for all resources at the department and perfect working conditions as well as for the support in technical and also personal problem-solving, regardless of the subject matter.

I would like to thank Prof. Dr.-Ing. Christian Kreischer for taking over the review of my doctoral thesis.

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I am very grateful to my brother and colleague, Dr.-Ing. Dmytro Bilyi, for his permanent support on all occasions of my daily life, to my parents for their support and the opportunity to move and study in Germany. I want to thank my wife, Svitlana, for her permanent support.

Also, I would like to appreciate my colleagues and friends Dr.-Ing. Oleg Moros, Dr.-Ing. Hans-Christian Lahne, Dr.-Ing. Sachar Spas, M.Eng. Yevgen Polonskiy, for great cooperation during my work at EAA.

Some sections of this work were published in author′s scientific papers [1], [2], [3], [4], [5], [6], [7].

Summary

The presented doctoral thesis handles the analysis of the optimized synchronous reluctance drive for effective application in wind turbines and battery electric vehicles. Herefor, the fractional slot concentrated and conventional distributed windings electric machine for traction applications shall be analyzed and optimized, which will show that the short end-turns and high slot fill factor in case of the FSCW cause an improvement in torque capability, power factor, and efficiency.

Besides that, for the wind energy application area, the synchronous reluctance machine with double-layer integer-slot concentrated winding will be taken under the loupe. The analysis will prove the validity of the cost-effective, high-efficient synchronous reluctance machine for large-scale wind energy conversion systems.

Herewith for achieving such results, the developed special flux barrier design method for torque ripple reduction in synchronous reluctance machine will be described. The simulation results using this special design method will show the reduced values for the torque ripples, and thus the applicability of the method to different winding types will also be shown.

In order to optimize the synchronous reluctance drive further by improving the quality of the magnetomotive force in combination with a decrease of a torque pulsation and by the increasing of fault tolerance, synchronous reluctance machine with multiphase cage-winding will be introduced and investigated.

Based on developments on the topic of rotor geometry optimizations, results on investigations on intelligent stator cage drive with reluctance rotor will be introduced. The represented flux barrier design method will prove itself as applicable, and important improvements in the machine characteristics are resulting from that.

The entire doctoral thesis introduces the in-depth research on the optimized synchronous reluctance drives, which could be used in several different types of applications, e.g., for the effective application in wind turbines and in battery electric vehicles, which will be confirmed by results from this thesis as feasible and very reasonable.

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