Ain Shams University
Faculty of Engineering
Electric Power and Machines Department

Investigation of the Dynamic Behaviour of Brushless Doubly-Fed Induction Generator

Ph.D. thesis

by:

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A thesis submitted to the Faculty of Engineering –Ain Shams University in partial fulfillment of the requirements for the Ph.D. degree in Electrical Power and Machines Engineering

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Cairo 2010

بسم الله الرحمن الرحيم

وَمَا أُوتِيتُم مِّن الْعِلْمِ إِلاَّ قَلِيلاً

صدق الله العظيم

(سورة الإسراء – الآية الخامسة وثمانون)

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Statement

This thesis is submitted to Ain Shams University in partial fulfillment of the requirements for Ph.D. degree in Electrical Engineering.

The included work in this thesis has been carried out by the author at the Electrical Power and Machine Department, Ain Shams University. No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

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To my father, mother, wife, sisters and brothers

First of all, I am much thankful to Allah. I would like to express my deepest gratitude and thankfulness to Prof. Dr. Mohamed Abd-Alraheim Badr, Prof. Dr. Hussein Faried Soliman and Dr. Hany Hassanien for their great support, excellent supervision and encouragement shown during the period of this study

Special thanks to the Electrical Power and Machines Department, Faculty of Engineering; Ain Shams University, for their great support.

ABSTRACT

The performance of brushless doubly-fed induction generator (BDFG) controlled by field oriented control strategy is examined by implementing a simulation program using a Matlab-Simulink package. The system under study consists of a BDFG driven by a voltage source bi-directional converter. The machine model is obtained in the d-q power winding (PW) synchronously rotating reference frame. The vector control algorithm which contains two control pathes is then developed. The first path controls the active power of the PW and the other path controls its reactive power. Each path consists of two control loops (inner and outer).

Conventional proportional plus integral controllers are used in all control loops. The dynamic performance of the BDFG has been tested when the overall system is subjected to a sequential step changes in active and reactive power. Different values of integral gain have been tested in the simulation program.

A variable integral gain (VIG) controller, which is newly applied to the BDFG, is then introduced to achieve the advantages of low and large values of the integral gain.

Fuzzy logic controllers (FLCs) are implemented in the outer control loops and the effect of different structures of the FLC has been tested to select the best configurations of the FLC structures.

FLCs are then implemented in all control loops. Comparison between the dynamic response under PI, FLC in outer control loop only and FLC in all control loops are then carried out.

A PI speed controller and a fuzzy logic pitch controller are implemented for the purpose of optimizing and limiting the power extracted from the wind respectively. Two control methods of determining the optimum reference speed for the speed controller are investigated.

The transient response of the overall system when subjected to transient and sever conditions representing the large voltage dip and short circuit is also investigated.

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