M. Sc., Eng. Kamil Klimkowski
Institute of Electrical Machines, Drives and Measurements
Faculty of Electrical Engineering
Wroclaw University of Science and Technology

Wrocław, 3.07.2017

Abstract of PhD dissertation entitled:

„ANALYSIS OF MEASUREMENT SENSORS FAULT TOLERANT INDUCTION MOTOR DRIVES"

In this PhD thesis, the problems connected with speed and current sensors faults are investigated. The main aim of the dissertation is to analyse the possibility to detect speed and current sensors failures in vector controlled induction motor drives using basic logic systems, artificial neural networks and state variables observers theory. An additional goal of this thesis is to design a complete measurement sensors fault tolerant motor drive. The dissertation consists of ten chapters, biography and three attachments.

The first introductory chapter presents the basic terms related to fault tolerant systems in which a general overview of basic research problems including the electric drives failure diagnosis is presented. The main part on this chapter is devoted to methods of monitoring and diagnostics of industrial processes and devices and issues related to fault tolerant control systems. Particular attention to the diagnostics of measuring systems used in complex drive systems with induction motors was paid in this part of the dissertation.

In the next part of the thesis, the designing process of inverted-fed motor drivers and control methods of power electronics systems is described. This chapter presents basic topologies of commonly used AC/DC and DC/AC converters followed by control algorithms for such power electronics systems.

In the next chapter of this dissertation, a frequency control techniques for induction motors have been characterized, starting with the simplest scalar methods, and ending with advanced vector control algorithms DRFOC and DTC-SVM. The issue of the estimation of difficult-to-measure or inaccessible state variables of the induction motor including stator/rotor flux and angular velocity is discussed in the next section of the thesis. The most popular techniques for estimating these variables, their disadvantages, advantages and comparison are presented.

In chapter V the basic measuring methods and measurements sensors for the mechanical and electrical variables used in the induction motors are presented. Especially, the techniques of measuring the position and speed of the machine rotor and the stator current and voltage are described.

Next part of the dissertation deals with the influence of various sensor failures on the performance of vector controlled motor drive systems. Simulated results on this issue were presented and analysed based on the failures impact on the transients of basic state variables in the internal control loop. Various motor drive operation states have been investigated.

In the next part of the thesis, the issue related to fault tolerant control, based on simple, analytical and logic systems and state variables observers, are described. The algorithms for detection and compensation of individual sensors fault for each control structure were discussed. The results of simulations and experiments were presented and deeply analysed. In the next part, an alternative analytical method for the detection of the stator current transducers failures based on the measured current signals is proposed, described and analysed.

In eighth chapter, an attempt to design the artificial neural network that would allow for the analysed sensors faults detection was made. Each stage of this process is presented and described. At the end of this chapter the experimental verification results of the sensors fault-tolerant motor drive system with neural diagnostic unit is presented.

Next chapter deals with a complete fault tolerant motor drive system that is robust to multiple sensor failures in one cycle of motor operation. A fault compensation method based on a control topology changes has been proposed and analysed. Experimental results of two possible sensor faults combinations are presented.

In last chapter a summary and general research conclusions are presented. The overall comparison of proposed diagnostic algorithms, including their advantages and disadvantages is made and described. The annexes contain a description of the laboratory set-up used in experimental research. Sensitivity analysis of the proposed detectors during induction motor parameters changes, the inverter transistor and the rotor cage rods failures has been performed and analysed.