PhD Public Defence

Title:	Three-Phase Slim DC-Link Permanent Magnet Machine Sensorless Drive
Location:	Pontoppidanstræde 111, auditorium
Time:	Monday 11 December at 13:00
PhD defendant:	Yang Feng
Supervisor:	Professor Frede Blaabjerg
Moderator:	Associate Professor Tomislav Dragicevic
Opponents:	Associate Professor Erik Schaltz, Dept. of Energy Technology, Aalborg University (Chairman) Professor Jiabin Wang, University of Sheffield, UK Professor Bojoi Iustin Radu, Politehnico Torino, Italy

All are welcome. The defence will be in English.

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Abstract:

Variable speed drive with low cost diode rectifier has been widely used in many applications, which may significantly increase grid current harmonics. On another side, the low power motor drive makes up the largest market share, where the physical cost is one of the key concerns besides the reliability. With this end, the scheme of slim dc-link motor drive has been attracted many attentions. However, the slim dc-link drive suffers from instability and harmonics issues, especially when fed by a soft grid condition. Literature survey shows that most of the works are carried out to study active damping control to solve the instability issue but only few researches have discussed the harmonics issue related to this. Moreover, most of studies are based on sensor control, and very few have considered the sensorless control.

The aim of the PhD project is to estimate the effect of distorted dc-link voltage, and to determine how to solve both challenging issues, i.e., system instability and harmonic issues, in a sensorless controlled slim dc-link drive. To this end, three main research questions are defined: 1) What are the mechanisms of the active damping control to affect the two aforementioned issues? 2) What is the influence by using the sensorless control, or what is the system mathematic model under sensorless control? 3) Also, how to solve the two challenge issues completely without deteriorating the motor torque and speed performance?

These research questions are answered through theoretical analysis, experimental tests and simulations. Chapter 2 gives an overview of the state-of-the-art active damping control methods. Chapter 3 develops a general mathematical model for the sensor controlled motor drive system by using the principle of transfer function matrix. Chapter 4 investigates the active damping control for the slim dc-link motor drive system with reference to the above mentioned technique challenges, and demonstrates the corresponding pros and cons. The first question is answered in this chapter. Chapter 5 proposes a mathematic model for the sensorless controlled slim dc-link motor drive as well as investigates the active damping control based on the obtained model. In this process, both the first and second research questions are discussed simultaneously. Chapter 6 proposes an active circuit scheme for the sensorless controlled slim dc-link drive. The principle is discussed, and verified by simulation results for answering the 3rd research question.

On this basis, it is recommended that the active damping control can be used where a moderate shaft performance is required but with a strong grid condition, while the proposed active circuit scheme can be used where the high shaft performance is required. Further research could be done to identify other potential constraints or other improved solutions for the sensorless controlled slim dc-link drive. It is concluded finally that new solutions have been achieved to accommodate the slim dc-link drive.