High resolution inverter using WBG semiconductor

Master thesis project

Background:
The high power inverter with silicon based power electronics has been used for decades. Recently new wide bandgap semiconductors transistors using SiC and GaN became available that offer significant advantages. Firstly, the losses can be reduced by more than a half which means that smaller cooling systems can be used and energy can be saved. Secondly, due to the better switching performance and higher voltage capability of the WBG devices, it becomes possible to increase the dynamics of systems that translates into faster and higher resolution performance. In this project potential technical solutions to apply WBG semiconductors in high resolution application will be investigated.

Problem definition:
The existing topology of the inverter is traditional Si-base cascaded H-bridge topology. It is bulky and lossy, and it is difficult to extend to high power application with high resolution requirement.

The goal of the project is to propose new, better circuit toplogy. A theoretical study will be conducted by a master student, based on models derived from results of the first investigation, exploring new circuit topologies that:

- recover the magnetic energy of the output inductor load during discharging,
- enhance the applied voltages to the output inductor load,
- couple energy exchange between the x, y and z phases.
- investage the WBG semiconductors in the above circuit topology.

Method:
The first part of the project will be a theorical study about the relevant background theory and literature conducted at UT. The student will prepare one or more design supported by first order analysis to be approved by the supervisors. The final phase of the project will be conducted in the lab of an external partner. {Briefly explain what the master student will do in the project. Does he have to develop models, do experimental work or is it simulation only? Will the student work in our lab or will he do the work at an external partner.}

Research outcomes:
A report exploring new circuit topologies that apply the principle of magnetic energy recovery – supported by modeling and simulation.

Courses and supervision:
The students need to follow the compulsory courses in the PE program at UT. Supervision will be by Dr. Jelena Popović and Dr. Ronan van der Zee. The students will spend 3 months to work with external partner (provided that the COVID restrictions allow for this) and will be supervised by experts of external partners. Associated with the project is a 6000Euro bursary to cover the travel and subsistence. The possibility exist for students to follow master courses in power electronics at the Zhejiang University in Hangzhou.

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