Master Thesis

800V SiC 3-Phase Power Electronic Motor/Generator Controller for a Drag Power Kite

Contact/Applications to:

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Motivation

Power generating kites have the potential to generate clean energy with 10x less material demand and at a very low cost (see e.g. [1, 2, 3] and references therein). "Drag power" kites generate power with onboard wind turbines and generators by flying fast crosswind motions, see Fig. 1 with video link in the description. Electrical power is transmitted to the ground at a medium voltage level via electric cables in the tether.

Figure 1: Flying Kitekraft demonstrator. (Video available online: https://youtu.be/42jvQpgfm94, accessed: Jan 11, 2022).

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Tasks, Suggested Solution Approach, Expected Results

The TUM spinoff and project Kitekraft is developing and researching drag power kites. In this master thesis, a 800 V Silicon Carbide (SiC)-based power electronics converter for each of the 8 onboard electrical machines connected to a rotor/propeller/wind turbine is to be designed or extended, respectively. Two previous student works (which includes one master thesis) set the basis, a design and built prototype are already available. Preliminary high voltage tests have been conducted. However, the PCB design needs to be iterated and further tests at high voltage and full power, including various stress testing scenarios representative for operation on a power generating kite, have to be conducted, before the converter can be used in an actual kite demonstrator or later product. Also, electrical machines have to be rewound to the higher voltage to be usable with the SiC converter on the kite. The detailed design shall also be evaluated in terms of costs, complexity, and reliability for a 100 kW product version or larger scale kites, in which the DC links of the power converters for one electrical machine with more than 3 phases are connected in series. Besides the documented hardware designs and setup, the master thesis as theory documentation and test reports are important outcomes. This multidisciplinary task is supported by the members of the Kitekraft team.

Starting Point

This announcement, the literature list below, and additionally provided internal documents upon start.

Report and Presentation Guidelines

One report (or thesis) and at least one presentation of the results are required. Guidelines and templates can be downloaded from https://github.com/floba/StudentGuidelines.

Your Profile

This student work will be jointly supervised by the Institute for Electrical Drive Systems and Power Electronics and the TUM startup project Kitekraft. The ideal candidate

- is a student in electrical engineering or related fields,
- has good skills/background knowledge in electronic circuit design, KiCAD or comparable software, math, MATLAB, Office, LaTeX,
- is motivated in the respective field of science and engineering,
- has good English and German language skills.

References

[1] M. Loyd, "Crosswind kite power," Journal of Energy, vol. 4, no. 3, pp. 106–111, 1980.

[2] U. Ahrens, M. Diehl, and R. Schmehl, Eds., Airborne Wind Energy, ser. Green Energy and Technology. Springer Berlin Heidelberg, 2013.

[3] Kitekraft: Website, https://www.kitekraft.de, accessed: Jan 11, 2021.