

Experimental Investigation of a PCB-based Electrically Excited Axial Flux Machine

Electrically excited axial flux machines (EEAFMs) offer an attractive alternative to permanent-magnet machines by eliminating the need for rare-earth materials while enabling controllable excitation fields. In recent work, a PCB-based EEAFM concept has been developed and investigated using analytical methods and finite-element simulations.

This student project focuses on the **experimental investigation and validation** of such a PCB-based EEAFM. The main objective is to experimentally characterize the machine's electrical, electromagnetic, and thermal behavior using an existing prototype or demonstrator. Measurements will be carried out under various operating conditions to evaluate machine performance, including excitation behavior, torque production, losses, efficiency, and temperature rise.

A key part of the work is the **comparison between measured results and previously obtained simulation and analytical predictions**. Through this comparison, deviations between modeled and real machine behavior will be identified and discussed, providing insight into the practical limitations and strengths of PCB-based electrically excited axial flux machines. The project aims to generate a reliable experimental dataset that can be used to validate models, support future design improvements, and guide subsequent prototype development.

By the end of the project, the student is expected to deliver a comprehensive experimental evaluation of the PCB-based EEAFM, assess the suitability of PCB technology for electrically excited axial flux machines from a practical testing perspective, and derive recommendations for improved design, modeling, and testing methodologies.

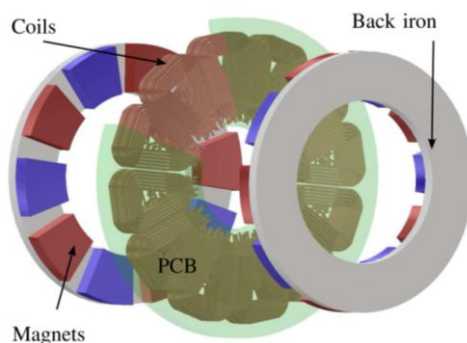


Fig. 1: 3D view of a PCB AFPM machine [1].

[1]: F. Marcolini, et al.: "Design of a Printed Circuit Board Axial Flux Permanent Magnet Machine for High Speed Applications". 2024

Working language:

→ Only English

Requirements for students:

- Strong interest in experimental work and electrical machine testing
- Ability to work independently and systematically
- Basic knowledge of electrical machines
- Ideally, attendance of the lectures Electrical Machines 1 and 2 (Electrical Machines 3 is a plus)

Work packages:

- Familiarization with the PCB-based EEAFM concept and existing design and simulation results
- Review of relevant experimental and measurement techniques for electrical machines
- Definition of measurement objectives and operating points
- Design and setup of a suitable test bench, including power supply, load, sensors, and data acquisition
- Electrical measurements (currents, voltages, excitation characteristics)
- Electromagnetic performance measurements (torque, speed, etc.)
- Thermal measurements and evaluation of temperature rise
- Comparison of experimental results with simulation and analytical models
- Documentation, discussion of results, and identification of improvement potential