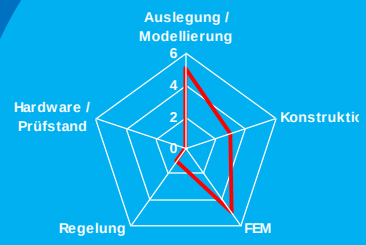
Universität Stuttgart
Institut für Elektrische Energiewandlung

FA/SA /MA



Preliminary Investigation of PCB-based Electrically Excited Axial Flux Machines: Design, Analysis, and Performance Evaluation

Electrically excited machines (EEMs) provide an alternative to permanent magnet machines by offering variable excitation and eliminating the dependence on rare-earth materials. Axial Flux Machines (AFMs) are particularly attractive due to their high power density, compact design, and modularity, making them well-suited for applications such as electric vehicles, aerospace, and renewable energy systems. Unlike conventional radial flux machines, AFMs allow for a more compact and lightweight design, which is beneficial in applications where space efficiency is critical.

A novel approach to EEAFMs involves using printed circuit boards (PCBs) for **both** the stator and rotor windings. PCB-based windings enable precise manufacturing, reduced losses, improved thermal management, and simplified assembly. By leveraging PCB technology, it is possible to create highly scalable and efficient machine designs while reducing manufacturing complexity. Additionally, PCB-based EEAFMs offer flexibility in optimizing winding layouts, which can enhance overall machine performance.

This thesis focuses on development of a 2D model using simulation tools such as COMSOL or ANSYS Maxwell to evaluate the electromagnetic performance. The study will involve parameterized modeling to assess the potential advantages of PCB-based windings in electrically excited axial flux topologies. Finally, a comparison will be carried out between PCB-based and conventional wound EEAFMs.

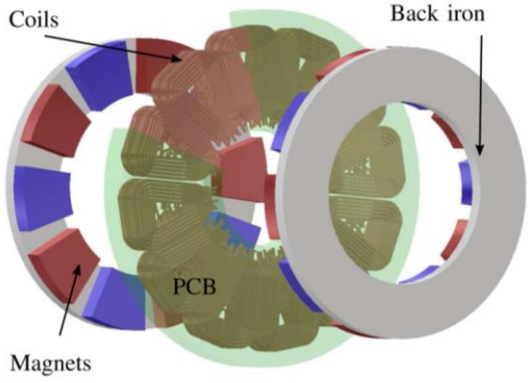


Fig. 1: 3D view of a PCB AFPM machine [1].

[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:

→ Ability to work independently and a strong interest in the design of electrical machines
→ Basic knowledge of Finite Element Method (FEM)
→ Ideally, students should have attended the lectures Electrical Machines 1,2 and 3

Work packages:

- Literature review of existing EEAFM topologies and PCB-based winding applications
- Define base requirements for the PCB-based EEAFM
- Initial analytical sizing and design decisions
- Establish geometry parameterization for both the stator and rotor
- Develop scripts for automatic geometry creation
- Create a script for automatic extraction of performance parameters from the machine models
- Examine the differences between PCB-based EEAFM and conventional EEAFM
- Comparison of different PCB winding configurations in terms of efficiency, losses, and manufacturability

Ansprechpartner: Parisa Rezapour

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