Medium Frequency Transformer Development and Validation for Solid-State Transformer

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Project Type:	MSc Thesis	Section:	SEL
Official Start Date:	09.03.2026		
Submission of Final Report:	10.07.2026		
Presentations at Group Meeting:	Mid-term and Final Presentations (dates TBD)		
Delivery of project results:	Assembled Transformers, Prototype, MSc Thesis		

Context, Background, and Motivation:

As a cornerstone of next-generation power conversion for large-scale data centers, the Solid-State Transformer (SST) enables modular, efficient, and compact power delivery from medium-voltage grids directly to the chip level. The Power Electronics Laboratory is currently developing a 3.3 kV, 250 kW SST based on the Modularized Bridge Rectifier (mBR) topology. This architecture offers a streamlined structure with fewer components, promising higher overall efficiency. Furthermore, as a key contribution to EPFL's heatingbits project, the final prototype will serve as a pioneering medium-voltage power supply solution for the data centers of the future.

Project Objectives:

This project focuses on the development and validation of a multi-winding medium-frequency transformer (MFT), a critical component of the Solid-State Transformer (SST) that provides both voltage scaling and galvanic isolation. To implement this multi-winding configuration, three distinct construction methodologies are considered. While all three designs are functionally equivalent in terms of voltage conversion and insulation, the specific integration method significantly dictates the MFT's performance—particularly regarding power density and efficiency—and influences the operation of the primary and secondary-side power electronics. Given that existing literature lacks a comprehensive comparison or a detailed discussion of the design trade-offs between these configurations, this thesis seeks to bridge that gap. Establishing a robust selection framework for the optimal multi-winding solution serves as the core motivation for this research.

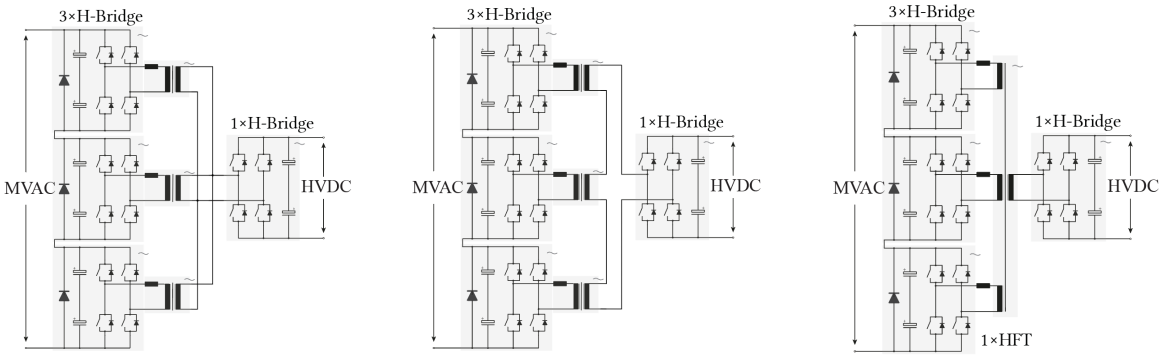

Figure 1. *Multi-port Transformer Building Options. Two-winding MFTs with parallel secondary sides (left). Two-winding MFTs with a series secondary side (middle). Four-winding MFT (right).*

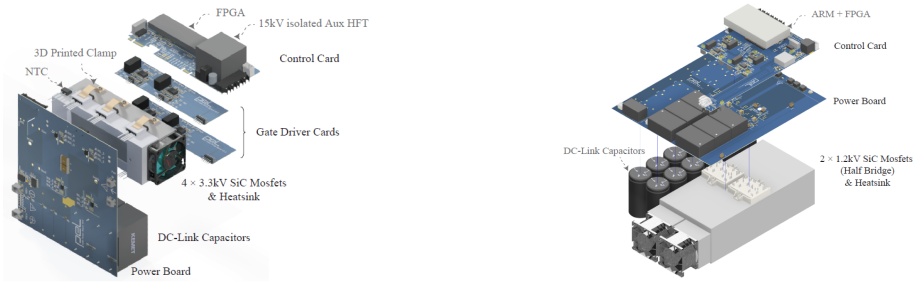

Figure 2. *Existing design of mBR Primary-side Hardware (left) and Secondary-side Hardware (right)*

The main part of the MSc thesis work is:

- To design, assemble, and evaluate three distinct MFT configurations alongside their power stages, ultimately identifying the optimal design architecture for the mBR SST.
- To develop a comprehensive test setup for branch converters, enabling the evaluation of power hardware and control software under realistic mBR operational conditions.

Prerequisite knowledge:

- Power electronics converters
- Magnetic devices
- Electric circuit design
- Altium
- FPGA/DSP programming

Available equipment:

- All the equipment required to fulfill the project's goals
- Preliminary design of MFTs is available as a starting point

Methodology and foreseen steps of the project:

- Getting familiar with the operation of the dual-active bridge converter (DAB) and mBR SST
- Assemble three primary-side power circuits and test without transformer connected
- Getting familiar with the control firmware and being able to use it during testing
- Assemble three different types of transformers and test their electrical parameters
- Test three types of transformers along with power stages, ultimately identifying the optimal design concept
- Design and implement the test setup for branch converters

Student gain:

- High-Power Converter Design
- FPGA/DSP control system coding
- Transformer Design and Testing
- High Voltage Design

References:

- Will be provided as needed