SOLID STATE TRANSFORMERS: TOPOLOGIES, USE CASES, DESIGN CONSIDERATIONS, AND CHALLENGES

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Tutorial Objectives:

Solid State Transformers (SST) are highly attractive both in industry and academia as they provide interface between medium-voltage AC (or DC) grids and low-voltage AC (or DC) grids and bring the benefits of modularity, flexibility, scalability, smaller footprint, less weight, bidirectional power flow and high-power quality to the units at the grid connection. Back in the 1990s they were attractive in the industry mainly to reduce weight and volume of the AC/DC converters in the rail applications. However, the interest in SST decreased due to its complex design and lower efficiency compared to conventional transformers.

In the last two decades the increasing DC applications in the area of Electric Mobility, Renewable Energy, Smart Grids, Datacenters and DC Microgrids brought back the interest to SST systems. Various topologies and control methods were proposed, and several demonstrators have been developed since then.

In this tutorial an SST overview will be shared with the audience and design criteria will be explained.

Target Audience:

In this paragraph, please describe the target audience of the tutorial that you propose. Please make sure the target audience is clearly described.

The scope of the tutorial will be valuable to those power electronics design engineers and academics who would like to have big overview about SST and learn about the design considerations.

Topical Outline:

Introduction: (Estimated time: 30 minutes)

- Introduction
- SST history

SST Overview: (Estimated time: 50 minutes)

- Advantages of SST
- SST topologies
- SST use cases

SST Design Considerations and Their Impact on Efficiency, Cost, Reliability, Size, etc. (Estimated time: 120 minutes)

- Topology selection
- Power semiconductor type selection
- Resonant circuit type
- Medium frequency transformer
- Modulation scheme
- Control structure
- Protection coordination
- Insulation coordination

Conclusions (Estimated time: 10 minutes)

- Summary and recommendations

Provisional Schedule of the Tutorial:

Schedule:

13:00 - 14:50 : Introduction / SST Overview / SST Design Considerations
14:50 - 15:20 : Coffee break
15:20 – 17:00 : SST Design Considerations / Conclusions

About the Lecturers:

Ilknur COLAK studied MSc. and PhD. in electrical engineering program in Istanbul Technical University, in Turkey. In the last 22 years she worked in industry and research centers such as CERN, ABB, Ansaldo Richerche, MR, and TUBITAK. Since January 2022, Colak is working at Schneider Electric-Secure Power as Technical Director. Colak is owner many patents and publications. Her research area includes modular and multilevel high power converters, power conversion systems for Medium Voltage and Low Voltage applications, insulation-coordination, EMC and grounding, and reliability.

Rafael COELHO-MEDEIROS received his MSc. degree in electrical engineering in 2018 from the National Polytechnic Institute of Toulouse in France and his Ph.D. from the Paris-Saclay University/CentraleSupélec in 2022. During his Ph.D., he worked with EDF (Electricité de France) on the world's first integration of a modular multilevel converter and superconducting coils for High-voltage Direct-Current applications. In 2022, he joined Schneider Electric as a Power Electronics R&D Engineer at the Secure Power CTO Innovation Team. His research interests include grid-connected power electronics converters, Multiphysics modeling for power electronics, technical and economic assessment for power electronics-based conversion systems, real-time simulation, and power-hardware in the loop testing.

Ahmed MELIGY Received his B.Sc. in Electrical Engineering from the American University of Sharjah (AUS), United Arab Emirates, in 2018. He then pursued a M.Sc. in Renewable Energy Engineering and Management at Albert-Ludwigs-Universität Freiburg, Germany, from 2019 to 2022. He is currently pursuing an industrial PhD degree in Electrical Engineering with the Électronique, Électrotechnique, Automatique, Traitement du Signal (EEATS) Doctoral School at Université Grenoble Alpes. His PhD is carried out in collaboration with Schneider Electric, France, where he fulfills his role as a power electronics research engineer. His research interests include solid-state transformers, battery energy storage systems, smart grids, and optimization.