Fault-Tolerant & Robust Predictive Control for Three-Level Converters and Data-Driven Modeling of SiC Power Devices

Research Focus

- Active or passive fault-tolerant control of three-level converters, combining **model predictive control (MPC)**.
- Robust control of power converters, focusing on **model-free predictive control** supported by **neural-network observers**
- **SiC power device modeling and loss analysis**, leveraging **double-pulse test (DPT)** measurements and **neural-network training**

Contact

- Tianxu Cao (tianxu.cao@tum.de)

Links

- https://ieeexplore.ieee.org/author/37088517370

Short Description

My research targets reliability and performance improvements in advanced power electronics. I develop fault-tolerant and robust predictive control strategies for three-level converter topologies, integrating data-driven fault diagnosis and neural-network-based observers to enhance disturbance rejection and resilience under abnormal conditions. In parallel, I build data-driven behavioral models for SiC power devices using DPT measurements, enabling accurate characterization of switching behavior and loss mechanisms for high-power applications.

Publications (if available)

- T. Cao, D. Kong, C. Zhang, B. Long and M. L. Heldwein, "Fault-Tolerant Model Predictive Control for Three-Level T-Type Converters Based on Fault-Induced State Equation Modeling," in *IEEE Transactions on Industrial Electronics*, doi: 10.1109/TIE.2025.3608037.
- T. Cao, D. Kong, C. Hu, B. Long and M. Lobo Heldwein, "Exploring the Inherent Fault-Tolerance of Model-Free Predictive Control in Three-Level T-Type Converters," in *IEEE*

Transactions on Power Electronics, vol. 40, no. 12, pp. 18214-18225, Dec. 2025, doi: 10.1109/TPEL.2025.3594869.

- T. Cao, Y. Yu, J. Zhang, J. Rodriguez, K. T. Chong and B. Long, "Pseudo-Three-Layer Sequential Model-Free Predictive Control With Neural-Network Observer for Parallel T-Type Three-Level Converters," in *IEEE Transactions on Power Electronics*, vol. 39, no. 7, pp. 7848-7862, July 2024, doi: 10.1109/TPEL.2024.3379419.