

Weiqian Cai

GRADUATE RESEARCH ASSISTANT · BBJ RENEWABLE AND POWER ELECTRONICS LAB · THE UNIVERSITY OF TEXAS AT AUSTIN

☎ (+1) 206-696-0477 | ✉ stratoscwq@utexas.edu

Education

The University of Texas at Austin

PH.D. CANDIDATE IN ELECTRICAL AND COMPUTER ENGINEERING

- Academic Track: Power Electronics and Power Systems
- Advisor: Dr. Brian Johnson

Austin, TX, USA

Aug. 2022 - Present

University of Washington, Seattle

PH.D. STUDENT IN ELECTRICAL AND COMPUTER ENGINEERING

- Advisor: Dr. Brian Johnson
- GPA: 4.0/4.0

Seattle, WA, USA

Sept. 2020 - Aug. 2022

Tsinghua University

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

- Advisor: Dr. Yu Shen, Dr. Zhengming Zhao
- GPA: 3.85/4.00 (Ranking: 14/89)
- Thesis: "Multiform Control of Low-voltage Ports for Electric Energy Router with High Frequency Bus"

Beijing, China

Aug. 2017 - Aug. 2020

Tsinghua University

BACHELOR OF ENGINEERING IN ELECTRICAL ENGINEERING

- Major: Electrical Engineering and Automation
- GPA: 90/100 (Ranking: 13/140)
- Thesis: "Simulation and Experimental Analysis of Three-port Electric Energy Router"

Beijing, China

Aug. 2013 - Aug. 2017

Selected Research Experience

Spontaneous Phase-balancing of Single-phase Grid-forming Inverters on Distribution Systems

GRADUATE RESEARCH ASSISTANT

- Proposed and modled a system architecture to provide uninterrupted three-phase power using only local single-phase grid-forming (GFM) inverters across distribution systems when the transmission system is islanded.
- Derived the angular dynamics and proved that three-phase balanced operation of such system is its large-signal stability.
- Validated our theoretical analysis via simulation and lab-scale hardware platform consisting of six 600W/120V single-phase inverters.

Austin, TX

Mar. 2022 - Mar. 2023

Parallel-operation of Heterogeneous Grid-forming Converters

GRADUATE RESEARCH ASSISTANT

- Verified the interoperability of heterogeneous three-phase converters in parallel under different GFM technology (dispatchable virtual oscillator, droop, and virtual synchronous machine), under both islanded and grid-connected mode with three 5kW/208V three-phase inverters.
- Designed and implemented three types of GFM controllers on TI-C2000 DSP.

Seattle, WA

Nov. 2021 - Aug. 2022

Emulation of Electrical Machine Loads with Power Electronics

GRADUATE RESEARCH ASSISTANT

- Proposed a generic emulation approach on electrical machine loads via power electronics converters.
- Implemented the approach on single-phase inverters to emulate the electrical behavior of a closed-loop constant frequency air conditioner (CFAC) and on three-phase inverters to emulate an electrically excited synchronous generator (EESG) power plant.
- Derived a numerical model of CFAC, including single-phase induction machine, thermostat, and mechanical dynamics.
- Validated the approach in PLECS simulation and hardware platform.

Seattle, WA

Nov. 2021 - May. 2023

Development and Operation of MVA-Level Four-port Electric Energy Routers

GRADUATE RESEARCH ASSISTANT

- Developed a 1 MVA 4-Port Solid State Transformer (SST) for a National Key Research and Development Program.
- Designed a dual-mode controller for low-voltage-ac (LVAC) and low-voltage-dc (LVDC) ports, including the seamless mode transfer strategy, and then get it verified by simulation on Simulink and experiments under different loads.
- Led the whole process of low-voltage power module test, communication test, installation, control software debugging and isolation testing on two low voltage ports.

Beijing, China

Sept. 2018 - May. 2020

Intelligent Lock for Urban Shared Bicycles

Beijing, China

UNDERGRADUATE RESEARCH

Sept. 2015 - Sept. 2016

- Participated in a self-conducted undergraduate research project sponsored by the university to design one kind of intelligent lock for urban shared bicycles controlled by cellphones with 5 other classmates.
- Contributed to programming on ARM, which involves communication with cellphones through GSM and mechanical control of the lock.
- Won the Grand Prize of the 34th Challenge Cup Tsinghua Extracurricular Academic and Technology Works Contest (one of five special prizes from around 300 entries).

Honors & Awards

2023	UT Engineering Fellowship Award , The Cockrell School of Engineering	Austin, TX, USA
2018	Mitsubishi Electric Scholarship (2nd Prize) , Mitsubishi Electric	Beijing, China
2016	MCM/ICM Honorable Mention , The Consortium for Mathematics and Its Application (COMAP)	Beijing, China
2016	Technology Innovation Award , Tsinghua University	Beijing, China
2016	Academic Excellence Award , Tsinghua University	Beijing, China
2016	Grand Prize , The <i>Challenge Cup</i> Tsinghua Extracurricular Academic and Technology Works Contest	Beijing, China
2015	Academic Excellence Award , Tsinghua University	Beijing, China
2014	Academic Excellence Award , Tsinghua University	Beijing, China
2013	Huaying Scholarship , Huaying Culture and Education Foundation	Changzhou, China

Skills

Software	MATLAB/Simulink, PLECS, CCS, PSIM, PSCAD, μ Vision, Quartus, Altium Designer, VS Code, LTSpice, Adobe Illustrator
Hardware	TI-C2000 DSP, TI-C6000 DSP, MSP430, FPGA
Programming	C, Verilog HDL, Matlab, LaTeX
Languages	Chinese (Mandarin & Wu, native), English (TOEFL: 103, fluent)

Reviewer Service

- IEEE Transactions on Power Electronics
- IEEE Journal of Emerging and Selected Topics in Power Electronics
- IEEE Transactions on Energy Conversion
- IEEE Power Engineering Letters
- IEEE Energy Conversion Congress and Exposition (ECCE)
- IEEE Workshop on Control and Modeling for Power Electronics (COMPEL)

Services & Leadership

2018	Volunteer , IEEE International Future Energy Challenge (IFEC)	Beijing, China
2017	Teaching Assistant , "C programming Basics"	Beijing, China
2015	Organizer of Electrical Engineering Undergraduate Basketball League , Tsinghua University	Beijing, China
2014	Minister of Electrical Engineering Volunteers Department , Tsinghua University	Beijing, China

Publications & Patents

PUBLICATIONS

- W. Cai, R. Mallik and B. Johnson, "Singular-perturbation-based Control Design of Single-phase Grid-forming Inverters," in Energy Conversion Congress and Exposition, 2024. (Accepted)
- S. Liu, W. Cai, H. Zhu and B. Johnson, "A Unified Approach for Learning the Dynamics of Power System Generators and Inverter-based Resources," in Hawaii International Conference on System Sciences, 2024. (Accepted)
- M. Lu*, W. Cai*, S. Dhople and B. Johnson, "Large-Signal Stability of Phase-Balanced Equilibria in Single-Phase Grid-Forming Inverter Systems," in IEEE Transactions on Power Electronics, vol. 39, no. 3, pp. 3623-3636, March 2024. (*: equally contributed)

- **W. Cai**, M. Lu and B. Johnson, “Inverter-based Emulation of Single-phase Air Conditioner Loads,” 2023 IEEE Energy Conversion Congress and Exposition (ECCE), Nashville, TN, USA, 2023, pp. 3069-3076.
- W. Wen, K. Li, Z. Zhao, L. Yuan, X. Mo and **W. Cai**, “Analysis and Control of a Four-Port Megawatt-Level High-Frequency-Bus-Based Power Electronic Transformer,” in IEEE Transactions on Power Electronics, vol. 36, no. 11, pp. 13080-13095, Nov. 2021.
- K. Li, W. Wen, Z. Zhao, L. Yuan, **W. Cai**, X. Mo and C. Gao, “Design and Implementation of Four-Port Megawatt-Level High-Frequency-Bus Based Power Electronic Transformer,” in IEEE Transactions on Power Electronics, vol. 36, no. 6, pp. 6429-6442, June 2021.
- **W. Cai**, Y. Shen, K. Li, W. Wen, J. Nie, L. Yuan, C. Zhang and Z. Zhao, “DC Port Control Strategy for Electric Energy Router With High Frequency AC Link,” in Power System Technology, vol. 44, no. 12, pp. 4600-4607, Sep. 2020.
- W. Wei, Z. Zhao, W. Wen, K. Li, L. Yuan and **W. Cai**, “Analysis of the High-frequency Oscillation Characteristics of a Multi-port Converter With an AC Link,” in Journal of Tsinghua University(Science and Technology), vol. 60, no. 9, pp. 751-762, July 2020.
- W. Wen, Z. Zhao, X. Mo, K. Li, **W. Cai** and G. Feng, “Energy Self-Circulation Scheme and Power Coordinated Control of High-Frequency-Bus Based Electric Energy Router,” in Transactions of China Electrotechnical Society, vol. 35, no. 11, pp. 2328-2338, June 2020.
- **W. Cai**, Y. Shen, X. Xiao, W. Wang, W. Zhang, K. Li, C. Zhang and Z. Zhao, “Design of the Neutral Line Inductor for Three-phase Four-leg Inverters,” 2019 IEEE Sustainable Power and Energy Conference (ISPEC), Beijing, China, 2019, pp. 2455-2460.
- Y. Shen, F. Zhu, C. Zhang, **W. Cai**, L. Yuan, K. Li and Z. Zhao, “Steady-state Model of Multi-port Electric Energy Router and Power Flow Analysis Method of AC/DC Hybrid System Considering Control Strategies,” in The Journal of Engineering, vol. 2019, no. 16, pp. 2794-2799, March 2019.

PATENTS

- Y. Shen, ..., **W. Cai**, et al., “Solid State Transformer DC Port Equivalent Full Power Test Circuit and Control Method,” China, 201910317638.0.
- X. Xiao, ..., **W. Cai**, et al., “Method, Device and Equipment of Microgrid Networking Based on Multi-port Electric Energy Router,” China, 201910329411.8.
- W. Wen, ..., **W. Cai**, et al., “Distributed Control System of Multi-port Electric Energy Router with High Voltage and Large Capacity,” China, 201910664242.3.
- W. Wen, ..., **W. Cai**, et al., “Medium-voltage Multi-port Solid State Transformer Control Software,” 2019SR0952882.