

# Weiqian Cai

GRADUATE RESEARCH ASSISTANT · BBJ RENEWABLE AND POWER ELECTRONICS LAB

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## Education

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### 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

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

GRADUATE RESEARCH ASSISTANT

- Developed a method to provide uninterrupted three-phase power using only local single-phase grid-forming (GFM) inverters when the transmission system is islanded.
- Proposed an aggregated model of the distribution network composed of single-phase GFM inverters.
- Derived the angular dynamics and showed that balanced three-phase voltage is small-signal stable.
- Proved the large-signal stability of three-phase balanced operation and verified it in lab-scale hardware platform.

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, in both islanded and grid-connected mode.
- 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

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

## Skills

<b>Software</b>	MATLAB/Simulink, PSCAD, PLECS, CCS, $\mu$ Vision, Quartus II, Altium Designer, Adobe Illustrator, VS Code
<b>Hardware</b>	TI-C2000 DSP, TI-C6000 DSP, MSP430
<b>Programming</b>	C, Verilog HDL, Matlab, LaTeX
<b>Languages</b>	Chinese (Mandarin & Wu, native), English (TOEFL: 103, fluent), Japanese $\boxtimes$ Entry $\boxtimes$

## Services & Leadership

2023	<b>Reviewer</b> , ECCE, COMPEL and IEEE Transactions on Energy Conversion (TEC).	
2017	<b>Teaching Assistant</b> , "C programming Basics"	Beijing, China
2014	<b>Minister of Volunteers' Group</b> , Department of Electrical Engineering, Tsinghua University	Beijing, China
2015	<b>Organizer of 2014-2015 Bluelight Student Basketball League</b> , Department of Electrical Engineering, Tsinghua University	Beijing, China

## Publications & Patents

### PUBLICATIONS

- M. Lu\*, **W. Cai**\*, S. Dhople, B. Johnson. "Large-signal Stability of Phase-balanced Equilibria in Single-phase Grid-forming Inverter Systems," IEEE Transactions on Power Electronics, 2023. (\*: equally contributed)
- **W. Cai**, M. Lu, B. Johnson. "Emulation of a Single-phase Induction Machine Load with Power Electronics," IEEE Energy Conversion Congress and Expo (ECCE), 2023.
- K. Li, W. Wen, Z. Zhao, L. Yuan, **W. Cai**, et al., "Design and Implementation of Four-port Megawatt-Level High-Frequency-Bus Based Power Electronic Transformer," IEEE Transactions on Power Electronics, 11 2020.
- **W. Cai**, Y. Shen, K. Li, et al., "DC Port Control Strategy for Electric Energy Router with High Frequency AC Link," Power System Technology, 9 2020.
- Y. Shen, H. Nie, **W. Cai**, et al., "Research and Simulation on Voltage Stability Control Strategy for AC Port of Power Electronic Transformer," The 16th International Conference on AC & DC Power Transmission (ACDC), 2020.
- W. Wen, Z. Zhao, X. Mo, K. Li, **W. Cai**, et al., "Energy Self-Circulation Scheme and Power Coordinated Control of High-Frequency-Bus Based Electric Energy Router," Transactions of China Electrotechnical Society, vol. 2020, no. 35, pp: 2328-2338.
- W. Wei, Z. Zhao, W. Wen, K. Li, L. Yuan, **W. Cai**, "Analysis of the High-frequency Oscillation Characteristics of a Multi-port Converter With an AC Link," Tsinghua Science and Technology, vol. 2020, no. 60, pp: 751-762.

- **W. Cai**, Y. Shen, X. Xiao, et al., “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**, et al., “Steady-state Model of Multi-port Electric Energy Router and Power Flow Analysis Method of AC/DC Hybrid System Considering Control Strategies,” The Journal of Engineering, vol. 2019, no. 16, pp. 2794-2799, 3 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.

#### SOFTWARE COPYRIGHT

- W. Wen, ..., **W. Cai**, et al., “Medium-voltage Multi-port Solid State Transformer Control Software,” 2019SR0952882.