

# Jinshui Zhang

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https://jinshui.me

## Research Interests

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Pioneering modular power electronics for clean energy, green transportation, and neuroscience.

## Education

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- Ph.D. in Electrical and Computer Engineering, Duke University** 2026
- Advisor: Stefan M Goetz (stefan.goetz@duke.edu)
  - Thesis: High-Power High-Fidelity Power Electronics
- M.S. in Electrical Engineering, Xi'an Jiaotong University** 2021
- Advisor: Yan Zhang (zhangyanjtu@xjtu.edu.cn)
  - Thesis: Design of Single-Phase Two-Stage Onboard Charger for Electric Vehicles
- B.S. in Electrical Engineering, Tianjin University** 2018

## Research Experience

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### MPS-TMS: Modular Pulse Synthesizer for Transcranial Magnetic Stimulation with Fully Adjustable Pulse Shape and Sequence

Funded by NIH (RF1MH124943), Duke University 2022.09 - present

- Launched world's first fully customizable wireless brain stimulation platform
- Engineered a 3 kV&6 kA modular pulse synthesizer circuit for therapeutic pulse delivery
- Programmed a pipeline of signal sampling, processing, and pulse synthesizing
- Collaborated with clinicians to carry out human studies

### MOANA: Magnetic, Optical, and Acoustic Neural Access Device, for High-Bandwidth, Non-Surgical Brain Computer Interfaces

Funded by DARPA (HR001118S0029-N3-FP), Duke University 2021.09 - 2023.03

- Constructed a Python-interfaced embedded control system for pulse optimization
- Prototyped a DC-to-5 MHz bandwidth 5 kW power amplifier for neurostimulation

### Configurable Battery Based Electric Vehicle Powertrain Development

Funded by Duke Energy Initiative (4411367), Duke University 2022.03 - present

- Invented an equally functional circuit using half amount of transistors as the-state-of-the-art
- Developed a 20 kW electric vehicle based on reconfigurable batteries

## Work Experience

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### Application Engineer

Longteng Semiconductor Co. 2019.05 - 2020.05

- Led a team of five to design a 3 kW 99.1% efficiency onboard charger with unlisted SiC chips

### Power Electronic Intern

Vertiv Co. 2018.05 - 2018.08

- Performed noise & mechanical test of uninterrupted power supply for data center

## Awards & Recognition

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Best Presentation Award at 50<sup>th</sup> IECON conference 2024

Excellent Graduate of Xi'an Jiaotong University 2019

Meritorious Winner of Mathematical Contest in Modeling 2017

Ultra High Voltage (UHV) Scholarship of State Grid Corporation of China 2016

Merit Student of Tianjin University 2015-2018

## Publications

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### Journal Papers

- **J. Zhang**, B. Wang, X. Tian, A. Peterchev, S. Goetz (2024). **DC-to-5-MHz Wide-output-bandwidth High-power High-fidelity Converter**. IEEE Transactions on Industrial Electronics.
- X. Tian, **J. Zhang**, H. Wang, S. Goetz (2024). **Design and Analysis of Automatic Modulation and Demodulation Strategy in Wireless Power and Drive Transfer System**. IEEE Transactions on Industrial Electronics.
- **J. Zhang**, B. Wang, X. Tian, A. Peterchev, S. Goetz (2024). **Analytical Model and Planar Magnetic Solution for Parallelization Surges in Switched-capacitor and Series/parallel Multilevel Circuits**. IEEE Transactions on Industrial Electronics.
- B. Wang, **J. Zhang**, Z. Li, W. Grill, A. Peterchev, S. Goetz (2023). **Optimized Monophasic Pulses with Equivalent Electric Field for Rapid-rate Transcranial Magnetic Stimulation**. Journal of neural engineering Vol. 20.0 No. 3.0 pp. 036027 IOP Publishing.
- **J. Zhang**, X. Tian, B. Wang, A. Peterchev, S. Goetz (2023). **Modulation-enhanced Nearest-level Quantization for a Wide Output Bandwidth**. IEEE Transactions on Power Electronics Vol. 39.0 No. 3.0 pp. 3289-3299 IEEE.
- Z. Li, **J. Zhang**, A. Peterchev, S. Goetz (2022). **Modular Pulse Synthesizer for Transcranial Magnetic Stimulation with Fully Adjustable Pulse Shape and Sequence**. Journal of neural engineering Vol. 19.0 No. 6.0 pp. 066015 IOP Publishing.
- **J. Zhang**, Y. Zhang, J. Liu, Y. Gao, X. Gao (2021). **Variable Switching Frequency Scheme Minimizing Inductor Saturation Margin for Totem-pole Rectifier Based on Frequency-domain Ripple Analysis**. IEEE Transactions on Industrial Electronics Vol. 69.0 No. 12.0 pp. 12632-12640 IEEE.

### Conference Papers

- A. Peterchev, **J. Zhang**, K. Ma, Y. Li, B. Wang, Z. Simsek, A. Vlasov, D. Murphy, M. Clinton, J. Choi (2025). **Experimental Platform Utilizing Tms Waveform and Direction in Probing and Neuromodulation**. Brain Stimulation: Basic, Translational, and Clinical Research in Neuromodulation Vol. 18.0 No. 1.0 pp. 312-313 Elsevier.
- **J. Zhang**, S. Goetz (2024). **Direction-selective Parallel Module Structure for Cascaded Bridge and Modular Multilevel Converters with Minimum Transistor Count**. IECON 2024-50th Annual Conference of the IEEE Industrial Electronics Society pp. 1-6 IEEE. *Best Presentation Award*
- **J. Zhang**, S. Goetz (2024). **A Novel Framework for Designing Asymmetrical Multilevel Circuits to Improve Fidelity and Practicality**. IECON 2024-50th Annual Conference of the IEEE Industrial Electronics Society pp. 1-6 IEEE.
- **J. Zhang**, A. Peterchev, S. Goetz (2024). **Frequency-dependent Impedance Variation in Multilevel Converters with Parallel Connectivity**. 2024 IEEE Applied Power Electronics Conference and Exposition (APEC) pp. 2337-2341 IEEE.
- **J. Zhang**, M. Al Munefi, A. Peterchev, S. Goetz (2024). **Overshoot Dynamics in Parallel Connectivity Enabled Multilevel Converters: Generalized Analytic Expression and Impact Analysis**. 2024 IEEE Applied Power Electronics Conference and Exposition (APEC) pp. 581-586 IEEE.
- **J. Zhang**, Z. Li, B. Wang, A. Peterchev, S. Goetz (2023). **Highly Flexible Electronics for Selective Noninvasive Stimulation Through Free Pulse Shaping in Transcranial Magnetic Stimulation and Magnetogenetics**. Brain Stimulation: Basic, Translational, and Clinical Research in Neuromodulation Vol. 16.0 No. 1.0 pp. 219 Elsevier.
- **J. Zhang**, S. Goetz, B. Wang (2023). **Gallium-nitride (gan) Transistor Design for Transient-overload Power Applications**. 2023 IEEE Applied Power Electronics Conference and Exposition (APEC) pp. 2441-2445 IEEE.
- B. Wang, **J. Zhang**, Z. Li, W. Grill, A. Peterchev, S. Goetz (2023). **Optimized Monophasic-equivalent Transcranial Magnetic Stimulation Pulses with Reduced Coil Heating**. Brain Stimulation: Basic, Translational, and Clinical Research in Neuromodulation Vol. 16.0 No. 1.0 pp. 186-187 Elsevier.
- **J. Zhang**, Y. Zhang, S. Zaman, R. Cao, X. Gao, M. Cao (2020). **Precise Correction of Current Zero-crossing Distortion of Totem Pole Pfc Converter**. 2020 IEEE 9th International Power Electronics and Motion Control Conference (IPEMC2020-ECCE Asia) pp. 2414-2419 IEEE.

- **J. Zhang, Y. Zhang, J. Liu (2020). Downsizing Design of Powdered Iron Core Inductor Based on Variable-frequency Modulation Targeted at Harmonics Suppression.** 2020 IEEE 21st Workshop on Control and Modeling for Power Electronics (COMPEL) pp. 1-8 IEEE.
- **R. Cao, Y. Li, Y. Zhang, X. Liu, C. Lv, J. Zhang (2020). Thermal Modeling of Power Semiconductor Devices with Heat Sink Considering Ambient Temperature Dynamics.** 2020 IEEE 9th International Power Electronics and Motion Control Conference (IPEMC2020-ECCE Asia) pp. 290-295 IEEE.
- **X. Li, Y. Zhang, P. Zeng, J. Zhang, J. Liu (2019). A Novel Interleaved Non-isolated Switched-capacitor Network High Step-up Dc/dc Converter.** 2019 10th International Conference on Power Electronics and ECCE Asia (ICPE 2019-ECCE Asia) pp. 2395-2401 IEEE.
- **K. Ding, Y. Zhang, J. Liu, P. Zeng, J. Zhang (2018). Dynamic Performance Improvement of Bidirectional Switched-capacitor Dc/dc Converter by Right-half-plane Zero Elimination.** 2018 international power electronics conference (ipecc-niigata 2018-ecce Asia) pp. 4181-4185 IEEE.

## Preprints

- **J. Zhang, A. Peterchev, S. Goetz (2025). Asymmetric Modular Pulse Synthesizer: a High-power High-granularity Electronics Solution for Transcranial Magnetic Stimulation with Practically Any Pulse Shape for Neural Activation Selectivity.** arXiv preprint arXiv:2503.06172.

## Talks

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### Flexible TMS: A Happier Machine

3 Minute Thesis, Duke University

2025.07

### Direction-Selective Parallel Module Structure for Cascaded Bridge and Modular Multilevel Converters with Minimum Transistor Count

Annual Conference of the IEEE Industrial Electronics Society, Chicago

2024.12

### A Novel Philosophy for Designing Asymmetrical Multilevel Circuits to Improve Fidelity and Practicality

Annual Conference of the IEEE Industrial Electronics Society, Chicago

2024.12

### Current Surging in Parallel Connectivity Enabled Multilevel Converters

IEEE Applied Power Electronics Conference and Exposition, Long Beach

2024.02

### Modular Transcranial Magnetic Stimulator – A Cure for Depression May Just Hide Inside Your Tesla

ECE Summer Workshop, Duke University

2022.09

## Service

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### Reviewing Conference & Journal Papers

- IEEE Transactions on Power Electronics
- IEEE Transactions on Industrial Electronics
- IEEE Journal of Emerging and Selective Topics in Power Electronics
- ACM Transactions on Computing for Healthcare,
- Applied Power Electronics Conference (APEC)
- Conference of the IEEE Industrial Electronics Society (IECON)

### Volunteering at Conferences & Communities

- Symposium on Power Electronics for Distributed Generation Systems (PEDG) 2019
- Power Electronics and Motion Control Conference (IPEMC2020-ECCE Asia) 2020

### Mentoring Students

- Ian Le (Undergrad @ Duke University)
- Zane Mannings (Undergrad @ Duke University, chair of Duke EV club)
- Majed Al Muneifi (Undergrad @ Duke University)
- Mingxin Liu (Undergrad @ NYU → Grad @ Duke University)
- Bryan Gonzalez (Duke University → R&D Engineer @ Children's National Hospital)
- Wei Chen (Grad @ Xi'an Jiaotong University → PhD @ Kiel University)

- Nimo Yu (Undergrad @ Duke University)
- Xiaoyang Gao (Grad @ Xi'an Jiaotong University → National Grid Co.)

## Teaching Experience

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### Teaching Assistant & Lab Instructor

ECE 431&531, Duke University

Spring 2022 & Spring 2024

- Designed and instructed a lab session on prototyping a closed-loop DC-DC converter
- Host office hours and graded for a class of 20+ undergrad & grad students

### Teaching Assistant

Modeling & Control of Power Electronic Circuits, Xi'an Jiaotong University

Spring 2020

- Assisted a class of 100+ grad students

### Student Investigator & Demonstrator

Superconductor Tech-Camp, Tianjin University

Summer 2016

- Established and demonstrated superconducting-based prototypes, e.g. mag-lev car
- Recruited a team of 17 volunteers to host 200+ undergraduate visitors