

# 姚俊涛

EMC Design Engineer at Apple, California, USA  
电磁兼容设计工程师 苹果公司 加州 美国

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出生年月: 1989 年 12 月



## 教育经历

- 博士, 电气工程, 美国佛罗里达大学, 2017-2021, 导师: Shuo Wang (IEEE Fellow)  
Thesis: Modeling and Reduction of Radiated Electromagnetic Interference in Power Converters
- 硕士, 电力系统及其自动化, 武汉大学, 2013-2016, 导师: 刘飞 查晓明  
Thesis: Coordination Control of DC Microgrids with Photovoltaic and Battery
- 学士, 电气工程与自动化, 武汉大学, 2009-2013, 导师: 刘飞 查晓明  
Thesis: Compound Controller Design for Active Power Filters

## 研究与设计领域

- 电力电子与电磁兼容 in consumer and automotive electronics, EMC compliance (emissions, bulk current injection (BCI), radiated immunity, transient immunity, and electrostatic discharge (ESD)) design including semiconductors, transformers, grounding, shielding, filters, and layout
- 电磁仿真 in ANSYS Q3D, HFSS, CST, EMCoS, and ADS; LTSpice, MATLAB Simulink, Saber, PSIM
- 硬件与软件 with vector network analyzer (VNA), impedance analyzer, spectrum analyzer, power analyzer, and oscilloscope; Python, MATLAB, and C

## 工作、研究经历

### Apple 苹果公司

- **EMC Design Engineer 电磁兼容设计工程师** May. 2021 - Present
  - Designed EMC in power converters and compute modules
  - Simulated resonance and power dissipations, and developed mitigation strategies
  - Optimized size and cost in EMC design, and validated in simulations and experiments
  - Designed EMC in high-speed / low-speed interfaces, and validated compliance
  - Worked with SIPI / HW / SW 信号完整性与电源完整性 / 硬件 / 软件 to assure synergy optimization of performance, cost, and EMC
  - Built 3D EM simulation models of filter and PCB, and investigated coupling mitigations
  - Investigated component non-linear characteristics and the impact on electromagnetic interference (EMI)
  - Predicted EMI based on noise source and filter modeling and simulations

### 美国佛罗里达大学 研究助理

- **EMI in Automotive Power Electronics 汽车电力电子电磁干扰** Aug. 2018 - Apr. 2021
  - *Sponsored by Monolithic Power Systems, Inc. San Jose, CA, USA*
    - Developed EMI models of automotive DC-DC power converters including switching noise sources, components, PCB layouts, and antennas
    - Built a virtual lab for EMI predictions. Based on ANSYS Q3D and HFSS simulations, and experiment correlation, extracted the self-parasitics of components and PCB traces, and extracted the mutual coupling parasitics between components, PCB traces, and power cables. Predicted EMI in automotive power converters

- Created and validated EMI solutions by circuit, component placement, and PCB layout optimizations, and near field coupling mitigations

• **Radiated EMI in GaN IC-based Power Adapters** 氮化镓电源辐射电磁干扰 Mar. 2018 - Oct. 2019

*Sponsored by Navitas Semiconductor, Inc. El Segundo, CA, USA*

- Developed radiated EMI models of GaN IC-based active clamp flyback power adapters
- Proposed radiated EMI solutions by shielding and grounding, filter, and layout optimizations
- Analyzed and mitigated near field couplings' impact on radiated EMI
- Built an ANSYS HFSS simulation model of a planar transformer

• **EMI in Flyback Power Adapters** 反激变换器电磁干扰

Jan. 2017 - Dec. 2017

- Developed conducted and radiated EMI models for flyback adapters including switching noise sources, transformers, EMI filters, and antennas
- Investigated VNA characterization techniques for transformers, chokes, and antennas
- Investigated transformer winding shielding, layer arrangement, and external component balancing techniques for EMI reduction

武汉大学大功率电力电子技术研究中心 研究助理

• **直流微电网的仿真与实证研究**

Sep. 2014 - June 2016

- Designed the architecture and simulation model of a DC microgrid including grid-tied power converters, solar panels, batteries, and DC/DC power converters
- Investigated the control strategy of power converters and the coordination strategy of the DC microgrid in grid-tied and standalone operation modes
- Designed the PCB layout of a grid-tied power converter

• **级联多电平变换器电机驱动**

June 2013 - June 2015

- Designed power cell configurations in a hybrid power converter consisting of unidirectional and bidirectional power cells
- Analyzed the control strategy of cascaded H-bridge multilevel inverters

• **并联有源电力滤波器**

Nov. 2012 - Aug. 2013

湖北省优秀学士学位论文

- Proposed a multi-internal-model based controller robust to grid frequency fluctuation
- Built a simulation model of an active power filter

## 研发成果

发表论文 20 余篇，申请（授权）美国专利 3 项

### 期刊论文

1. **J. Yao**, S. Wang, and Z. Luo, "Modeling, Analysis, and Reduction of Radiated EMI Due to the Voltage across Input and Output Cables in an Automotive Non-isolated Power Converter," IEEE Transactions on Power Electronics, vol. 37, no. 5, pp. 5455-5465, 2022.
2. **J. Yao**, Y. Li, S. Wang, X. Huang, and X. Lyu, "Modeling and Reduction of Radiated EMI in a GaN IC-Based Active Clamp Flyback Adapter," IEEE Transactions on Power Electronics, vol. 36, no. 5, pp. 5440-5449, May 2021.
3. **J. Yao**, S. Wang, and H. Zhao, "Measurement Techniques of Common Mode Currents, Voltages, and Impedances in a Flyback Converter for Radiated EMI Diagnosis," IEEE Transactions on Electromagnetic Compatibility, vol. 61, no. 6, pp. 1997-2005, Dec. 2019.

### 专利

1. **J. Yao**, and A. McDowell, "Reconfigurable Battery Pack," U.S. Patent App. US18342065, 2023. (With Apple.)
2. M. Bhattacharya, and **J. Yao**, "Damping Filters for Reduced Electromagnetic Emissions," U.S. Patent App. US18453606, 2023. (With Apple.)
3. S. Wang, **J. Yao**, and Y. Li, "Common Mode (CM) Electromagnetic Interference (EMI) Filters for Reducing Radiated EMI in Power Converters," U.S. Patent 11,356,011, 2022. (U.S. Patent, Issued)

4. Y. Xiong, F. Zhu, **J. Yao**, H. Yang, and F. Liu, "A Rectifier-fed Cascaded Multilevel Converter for Dual Motor Drive," China Patent, CN204859024U, Aug. 24, 2015. (Issued)
5. F. Zhu, Y. Xiong, **J. Yao**, H. Yang, and F. Liu, "A Symmetrical Three Port Cascaded Power Converter for Dual High Power Motor Drive," China Patent, CN204906233U, July 28, 2015. (Issued)
6. F. Liu, **J. Yao**, Y. Wang, K. Feng, C. Huang, and X. Zha, "A Repetitive Controller with Multiple Internal Models Considering the Frequency Deviation of the Power System," China Patent, CN104836233A, May. 25, 2015. (Issued)
7. **J. Yao**, K. Deng, F. Liu, J. Gong, L. Xiong, and X. Zha, "Hybrid Bidirectional Cells based Regenerative Cascaded Multilevel Converter and the Optimized Configuration of the Regenerative Cells," China Patent, CN104104240B, July 25, 2014. (Issued)
8. F. Liu, X. Lai, K. Deng, **J. Yao**, J. Sun, and Y. Li, "A Solid-state Electronic Switch Based Short Circuit Protection Method for DC Microgrids," China Patent, CN103928912B, May. 8, 2014. (Issued)
9. F. Liu, X. Zha, K. Deng, **J. Yao**, and J. Gong, "A Cascaded Multilevel Converter without Active Front for Dual Motor Drives," China Patent, CN103944439A, Apr. 28, 2014. (Issued)
10. **J. Yao**, G. Huang, C. Liu, W. Lyu, Y. Li, F. Liu, and X. Zha, "A DC Microgrid," China Patent, CN202586339U, May. 18, 2012. (Issued)
11. G. Huang, **J. Yao**, C. Liu, W. Lyu, Y. Li, F. Liu, and X. Zha, "Low-voltage Bipolar DC Micro-power Grid," China Patent, CN202586340U, May. 18, 2012. (Issued)
12. J. Sun, X. Zha, Y. Li, W. Lyu, C. Liu, G. Huang, and **J. Yao**, "A Three Wire DC Microgrid System and Control Method for Modern Buildings," China Patent, CN102593832B, Mar. 15, 2012. (Issued)

## 会议论文

1. **J. Yao**, A. McDowell, and J. Chiappe, "Modeling and Simulation of EMI Noise Source and Filter in Power Converters," in **Apple** Modeling and Simulation Conference, 2024.
2. **J. Yao**, S. Wang, and L. Du, "Modeling and Reduction of Radiated EMI in a Power Converter with Undesired Capacitive Couplings," in **Apple** Modeling and Simulation Conference, 2024.
3. **J. Yao**, Y. Lai, Z. Ma, and S. Wang, "Advances in Modeling and Reduction of Conducted and Radiated EMI in Non-isolated Power Converters," in 2021 IEEE Applied Power Electronics Conference and Exposition (APEC), 2021.
4. **J. Yao**, Y. Lai, Z. Ma, and S. Wang, "Investigation of Noise Spectrum and Radiated EMI in High Switching Frequency Flyback Converters," in 2021 IEEE Applied Power Electronics Conference and Exposition (APEC), 2021.
5. **J. Yao**, Z. Ma, Y. Lai, and S. Wang, "A Survey of Modeling and Reduction Techniques of Radiated EMI in Power Electronics," in 2021 IEEE Symposium on Electromagnetic Compatibility, Signal Integrity and Power Integrity (EMC, SI & PI), 2021.
6. Z. Ma, Y. Yang, **J. Yao**, S. Wang, H. Sheng, L. Jia, Z. Xu, S. Lakshmikanthan, "Radiated EMI Prediction in Power Converters with Power Cables based on Cable Antenna Voltage Gain Extraction," in 2022 IEEE Symposium on Electromagnetic Compatibility, Signal Integrity and Power Integrity (EMC, SI & PI), 2021.
7. Y. Lai, **J. Yao**, S. Wang, Z. Luo, and Y. Li, "Electric Near Field Emission from a 1MHz Power Converter for Electric Vehicles," in 2021 IEEE Energy Conversion Congress and Exposition (ECCE), 2021.
8. Z. Ma, **J. Yao**, S. Wang, H. Sheng, S. Lakshmikanthan, and D. Osterhout, "Radiated EMI Reduction with Double Shielding Techniques in Active-clamp Flyback Converters," in 2021 IEEE Symposium on Electromagnetic Compatibility, Signal Integrity and Power Integrity (EMC, SI & PI), 2021.
9. Z. Ma, **J. Yao**, Y. Lai, S. Wang, H. Sheng, and S. Lakshmikanthan, "Investigate and Improve the Distorted Waveforms for Core Loss Measurement with Arbitrary Excitations," in 2021 IEEE Applied Power Electronics Conference and Exposition (APEC), 2021.
10. **J. Yao**, Y. Li, Z. Ma, and S. Wang, "Advances of Modeling and Reduction of Conducted and Radiated EMI in Flyback Converters," in 2020 IEEE Energy Conversion Congress and Exposition (ECCE), 2020, pp. 3362-3369.
11. **J. Yao**, S. Wang, and Z. Luo, "Near Field Coupling's Impact on Radiated EMI and Mitigation Techniques for Power Converters in Automotive Applications," in 2020 IEEE Energy Conversion Congress and Exposition (ECCE), 2020, pp. 5882-5889.
12. **J. Yao**, S. Wang, and Z. Luo, "Radiated EMI Reduction by Layout Improvement in Power Converters in Automotive Applications," in 2020 IEEE 9th International Power Electronics and Motion Control Conference (IPEMC2020-ECCE Asia), 2020, pp. 1894-1899.
13. **J. Yao**, Y. Li, S. Wang, X. Huang, and X. Lyu, "Analysis and Reduction of Radiated EMI in High-Frequency GaN IC-based Active Clamp Flyback Converters," in 2020 IEEE Applied Power Electronics Conference and Exposition (APEC), 2020, pp. 664-671.
14. **J. Yao**, S. Wang, and Z. Luo, "Modeling and Reduction of Radiated EMI in Non-isolated Power Converters in Automotive Applications," in 2020 IEEE Applied Power Electronics Conference and Exposition (APEC), 2020, pp. 385-392.
15. **J. Yao**, M. El-Sharkh, Y. Li, Z. Ma, S. Wang, and Z. Luo, "Investigation of Radiated EMI in Non-isolated Power Converters with Power Cables in Automotive Applications," in 2019 IEEE Energy Conversion Congress and Exposition (ECCE), 2019, pp. 6957-6964.
16. Z. Ma, **J. Yao**, Y. Li, and S. Wang, "Comparative Analysis of Magnetic Core Loss Measurement Methods with Arbitrary Excitations," in 2019 IEEE Energy Conversion Congress and Exposition (ECCE), 2019, pp. 4125-4130.
17. Y. Li, **J. Yao**, and S. Wang, "Increase High Frequency Impedance of Ferrite Toroid Inductors Based on Electromagnetic Energy Analysis," in 2019 IEEE Energy Conversion Congress and Exposition (ECCE), 2019, pp. 6184-6191.
18. **J. Yao**, Y. Li, H. Zhao, and S. Wang, "Design of CM Inductor Based on Core Loss for Radiated EMI Reduction in Power Converters," in 2019 IEEE Applied Power Electronics Conference and Exposition (APEC), 2019, pp. 2673-2680.
19. H. Zhao, **J. Yao**, and S. Wang, "A Universal DM/CM Physical Model for Power Transformer EMI Analysis within both Conducted and Radiated Frequency Ranges," in 2018 IEEE Energy Conversion Congress and Exposition (ECCE), 2018, pp. 6592-6599.

20. **J. Yao**, Y. Li, H. Zhao, S. Wang, Q. Wang, Y. Lu, and D. Fu, “ Modeling and Reduction of Radiated Common Mode Current in Flyback Converters,” in 2018 IEEE Energy Conversion Congress and Exposition (ECCE), 2018, pp. 6613-6620.
21. **J. Yao**, S. Wang, H. Zhao, Y. Zhang, Q. Wang, Y. Lu, and D. Fu, “ Measurement Techniques of CM Currents, Impedance and Voltages for Radiated EMI in Isolated Power Converters,” in 2018 IEEE Symposium on Electromagnetic Compatibility, Signal Integrity and Power Integrity (EMC, SI & PI), 2018, pp. 438-443.
22. **J. Yao**, F. Liu, J. Gong, and X. Zha. “ Power Recovery and Cost Reduction Oriented Optimization of Regenerative Cells Embedded in Cascaded Multilevel Converter ” , in Energy Conversion Congress and Exposition (ECCE), 2015, pp. 5117 - 5123.
23. **J. Yao**, F. Liu, J. Gong, and S. Li. “ A Novel Partial Units Energy Feedback Cascaded Multilevel Inverter with Bypass Control ” , in International Future Energy Electronics Conference (IFEEC), 2013, pp. 494-499.

## 荣誉与奖励

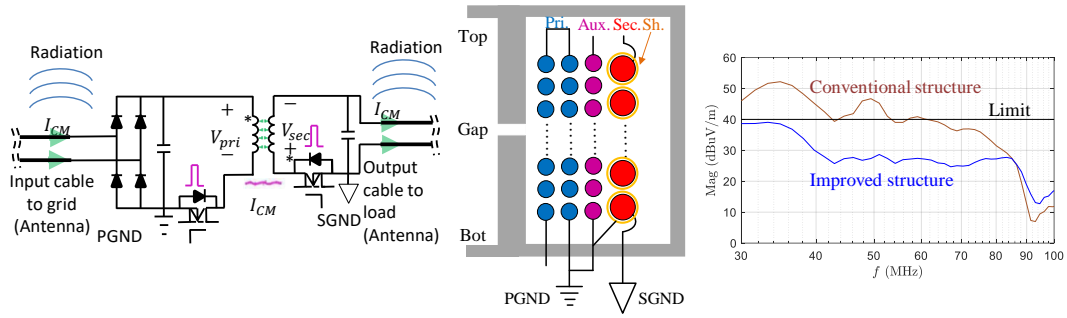
- Nominee of the Alec Courtelis Award at the University of Florida, for research and academic excellence, supported by Prof. Shuo Wang and Prof. Hitomi Yamaguchi Greenslet, and nominated by the College of Engineering, 2021
- Best Presentation Award, Applied Power Electronics Conference (APEC), 2021
- Outstanding Master Graduate (Top 3%), Wuhan University, 2016
- First-class Scholarship, Wuhan University, 2014
- Exceptional Bachelor Thesis in Hubei Province, China (Top 2%), 2013
- Outstanding Bachelor Graduate (Top 3%), Wuhan University, 2013
- Honorable Mention, USA Mathematical Contest in Modeling/Interdisciplinary Contest in Modeling (USA ICM/MCM), 2012
- All-round Excellent Student (Top 5%), Wuhan University, 2012
- Exemplary Student Leader, Wuhan University, 2012
- National Endeavor Scholarship (Top 5%), 2012
- Third Prize in the National Electrical Mathematical Contest in Modeling, 2011
- National Endeavor Scholarship (Top 5%), 2011
- Award for Creative Researcher, Wuhan University, 2011

## 学术、社会兼职

- Reviewer for Journals 期刊审稿人：IEEE Transactions on Power Electronics, IEEE Transactions on Industrial Electronics, IEEE Journal of Emerging and Selected Topics in Power Electronics, IEEE Transactions on Electromagnetic Compatibility, IEEE Transactions on Industry Applications, IEEE Open Journal of Power Electronics
- Vice President, Wuhan University Alumni Association in Northern California 武汉大学北加州校友会副会长
- Board Member, Silicon Valley Chapter, Asian Pacific American Public Affairs (APAPA) 亚太公共事务联盟硅谷分会理事

## Appendix: Innovation Highlights of Doctoral Research at the University of Florida

### Project I: Transformer Structure Improvement for Radiated EMI Reduction in Flyback Converters



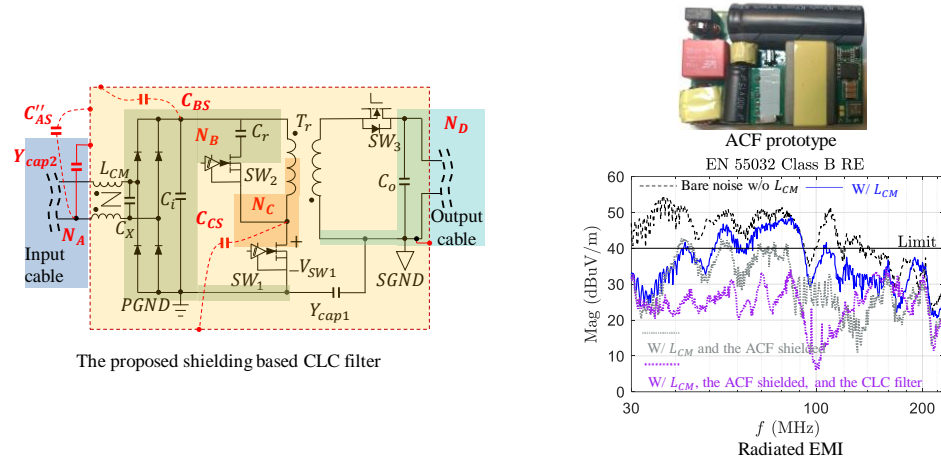
Radiated EMI in the flyback converter with power cables attached

Improved transformer structure with coaxial shielding

Radiated EMI

With the transformer structure improved, the radiated EMI is brought into compliance.

### Project II: Radiated EMI in GaN IC-based Active Clamp Flyback Adapters



The proposed shielding based CLC filter

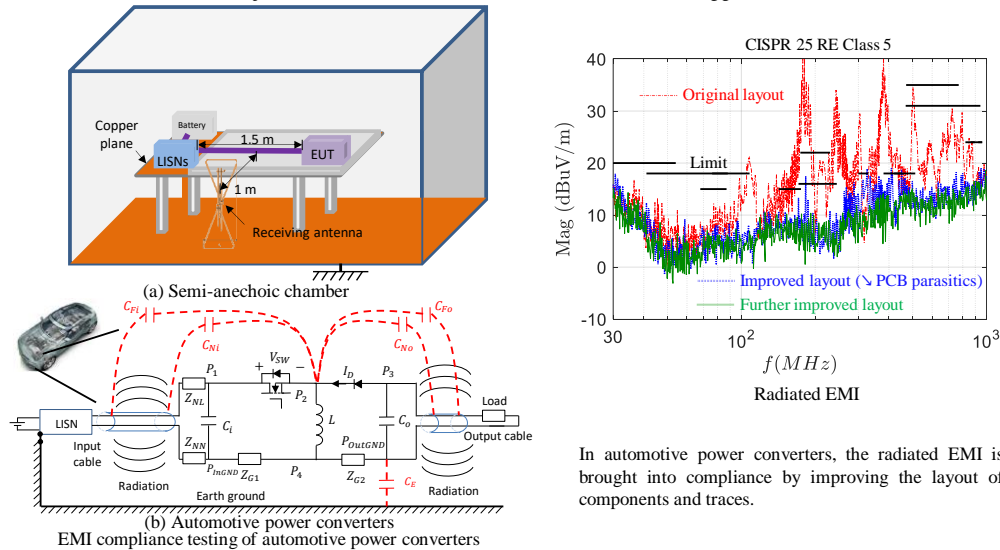
ACF prototype

EN 55032 Class B RE

Radiated EMI

In GaN IC-based ACF power adapters, the radiated EMI is brought into compliance by the proposed shielding based CLC filter.

### Project III: EMI in Power Converters in Automotive Applications



(a) Semi-anechoic chamber

(b) Automotive power converters

EMI compliance testing of automotive power converters

CISPR 25 RE Class 5

Radiated EMI

In automotive power converters, the radiated EMI is brought into compliance by improving the layout of components and traces.