Stanford

Juan Rivas-Davila

Assistant Professor of Electrical Engineering and Center Fellow, by courtesy, at the Precourt Institute for Energy

Bio

BIO

Professor Rivas came to Stanford as an assistant professor in January 2014. He was an assistant professor in Electrical Engineering at the University of Michigan. Before becoming a faculty member in 2011, he worked for the General Electric Global Research Center developing power electronics for medical imaging and aviation systems. He received the B.Sc. degree in electrical engineering from the Monterrey Institute of Technology (Mexico) in 1998. He obtained his masters (2003) and doctoral degree (2006) at the Massachusetts Institute of Technology. His research interests are in power electronics, RF power amplifiers, resonant converters, soft switching topologies and design of power converters for operation in harsh environments.

ACADEMIC APPOINTMENTS

- Assistant Professor, Electrical Engineering
- Center Fellow (By courtesy), Precourt Institute for Energy
- Member, Cardiovascular Institute

HONORS AND AWARDS

- Best Paper: HF Bidirectional Resonant Converter for High Conversion Ratio & Variable Load Operation, Control and Modeling for Power Electronics Workshop (2018)
- Faculty Early Career Development (CAREER) Program", National Science Foundation (2013)
- Best Paper Award: "13.56 MHz high voltage multi-level resonant DC-DC converter", Control and Modeling for Power Electronics Workshop (2015)
- Transactions Paper Award: "Resistance Compression Networks for Radio-Frequency Power conversion", IEEE Power Electronics Society (2007)
- 2nd Prize Award: High Frequency Resonant SEPIC Converter With Wide Input and Output Voltage Ranges", IEEE Power Electronics Society (2012)

PROGRAM AFFILIATIONS

- Stanford SystemX Alliance

PROFESSIONAL EDUCATION

- B.A., ITESM, Mexico City Campus , Electrical and Communications Engineering (1998)
- S.M., Massachusetts Institute of Technology , Output Power Increase at Idle Speed in Alternators (2003)
- Sc.D., Massachusetts Institute of Technology , Radio Frequency dc-dc Power Conversion (2006)

PATENTS

- Satish Prabhakaran, John Stanley Glaser, Ljubisa Dragoljub Stevanovic, Juan Manuel Rivas Davila. "United States Patent US 8567046 B2 Methods for making magnetic components", General Electric Company, Oct 29, 2013
- Rixin Lai, Luis Jose Garces, Juan Antonio Sabate, Juan Manuel Rivas Davila, Song Chi, Wesley Michael Skeffington,. "United States Patent US 8502539 B2 Gradient amplifier system", General Electric Company, Jul 31, 2013

- Mehmet Arik, Tunc Icoz, Juan Manuel Rivas Davila, Charles Erklin Seeley, Yogen Vishwas Utturkar, Stanton Earl Weaver, Jr.. "United States Patent US 8496049 B2 Heat sinks with distributed and integrated jet cooling", General Electric Company, Jul 30, 2013
- John Stanley Glaser, Juan Manuel Rivas Davila. "United States Patent US 7924580 B2 Switching inverters and converters for power conversion", General Electric Company, Apr 12, 2011
- David J. Perreault, Juan M. Rivas, Anthony D. Sagneri, Olivia Leitermann, Yehui Han, Robert C. N. Pilawa-Podgurski,. "United States Patent 7,889,519 B2 Methods and apparatus for a resonant converter", Massachusetts Institute Of Technology, Feb 15, 2011
- David J. Perreault, Juan M. Rivas, Yehui Han, Olivia Leitermann. "United States Patent 7535133 B2 Methods and apparatus for resistance compression networks", Massachusetts Institute Of Technology, May 19, 2009

LINKS

- SUPER-Lab: http://superlab.stanford.edu/

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Modern applications are driving demand for power systems with capabilities beyond what is presently achievable. High performance systems, like medical imaging systems and other applications impose challenging specifications on power density and bandwidth that are difficult to achieve with current circuit topologies. Power density can be improved with better semiconductor components and passive elements, and by reducing the energy storage requirements of the system. By dramatically increasing the switching frequency, it is possible to reduce the energy storage requirements and improve bandwidth. I'm interested in the development of system architectures and circuit topologies for dc-ac and dc-dc power conversion that can reach switching frequencies of 10’s to 100’s of MHz. Switching at these frequencies will lead to efficient converters with inductors and transformers having no magnetic material to limit their high frequency performance, and with small-valued capacitors.

At these switching frequencies, all inductors can be air-cored, eliminating core losses, saturation, and extending their operating temperature range. I have been involved in the development of dc-dc converter that archives a significant reduction in peak switch voltage stress, requires small passive components with low energy storage, and provides the capability for extremely rapid startup and shutdown.

Another goal of my work is to implement a value-added strategy in inexpensive printed circuit boards (PCB) by fabricating all passive devices of a power converter (inductors and capacitors) with traces, transforming the PCB into a 3-D resonant structure. This approach will eliminate tuning and component variation while simultaneously maintaining extraordinary levels of performance at reduced cost. Moreover, there a lot of exciting applications for these high frequency circuits.

Teaching

COURSES

2019-20

- Advanced Topics in Power Electronics: EE 254 (Spr)
- Power Electronics: EE 153, EE 253 (Win)
- Resonant Converters: EE 356A (Aut)

2018-19

- Magnetics Design in Power Electronics: EE 356B (Aut)
- Power Electronics: EE 153, EE 253 (Spr)

2017-18

- Power Electronics: EE 153, EE 253 (Win)
- Resonant Converters: EE 356A (Aut)

2016-17

- Advanced Topics in Power Electronics: EE 254 (Spr)
- Power Electronics: EE 153, EE 253 (Win)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Gabe Buckmaster, Jerry Chang, Francis Chen, Thaibao Phan, Gustavo Vianna Cezar, Kai Zhang

Postdoctoral Faculty Sponsor

Lei Gu

Doctoral Dissertation Advisor (AC)

Sanghyeon Park, Kawin Surakitbovorn, Zikang Tong, Jiale Xu, Jia Zhuang, Grayson Zulauf

Master's Program Advisor

Hira Akbar, Akwasi Owusu-Akyaw, Kevin Pham, Andrea Ramirez, Aaron Scherr, Aparna Tumkur

Doctoral Dissertation Co-Advisor (AC)

Nathan Volman

Doctoral (Program)

Weston Braun, Rachel Luo, Gift Nyikayaramba, Kawin Surakitbovorn, Lyne Tchapmi P., Jiale Xu, Jia Zhuang, Grayson Zulauf

Publications

PUBLICATIONS

- **On the Techniques to Utilize SiC Power Devices in High- and Very High-Frequency Power Converters** *IEEE TRANSACTIONS ON POWER ELECTRONICS*
  Tong, Z., Gu, L., Ye, Z., Surakitbovorn, K., Rivas-Davila, J.
  2019; 34 (12): 12181–92
- **Output Capacitance Loss Characterization of Silicon Carbide Schottky Diodes** *IEEE JOURNAL OF EMERGING AND SELECTED TOPICS IN POWER ELECTRONICS*
  Tong, Z., Zulauf, G., Xu, J., Plummer, A. D., Rivas-Davila, J.
  2019; 7 (2): 865–78
- **Empirical Circuit Model for Output Capacitance Losses in Silicon Carbide Power Devices**
  Tong, Z., Park, S., Rivas-Davila, J., IEEE
  IEEE.2019: 998–1003
- **Cascode GaN/SiC Power Device for MHz Switching**
  Xu, J., Gu, L., Ye, Z., Kargarrazi, S., Rivas-Davila, J., IEEE
  IEEE.2019: 2780–85
- **Duty Cycle and Frequency Modulations in Class-E DC-DC Converters for a Wide Range of Input and Output Voltages** *IEEE TRANSACTIONS ON POWER ELECTRONICS*
  Park, S., Rivas-Davila, J.
  2018; 33 (12): 10524–38
- **C-OSS Losses in 600 V GaN Power Semiconductors in Soft-Switched, High- and Very-High-Frequency Power Converters** *IEEE TRANSACTIONS ON POWER ELECTRONICS*
  Zulauf, G., Park, S., Liang, W., Surakitbovorn, K., Rivas-Davila, J.
  2018; 33 (12): 10748–63
- **A Wide-Input-Range High-Efficiency Step-Down Power Factor Correction Converter Using a Variable Frequency Multiplier Technique** *IEEE TRANSACTIONS ON POWER ELECTRONICS*
  Gu, L., Liang, W., Praglin, M., Chakraborty, S., Rivas-Davila, J.

2018; 33 (11): 9399–9411

- **An Integrated RF Power Delivery and Plasma Micro-Thruster System for Nano-Satellites** *FRONTIERS IN PHYSICS*
  Liang, W., Charles, C., Raymond, L., Stuchbery, A., Surakitbovorn, K., Gu, L., Boswell, R., Rivas-Davila, J.
  2018; 6
- **A Very High Frequency dc-dc Converter Based on a Class 2 Resonant Inverter**
  Rivas, J., M., Letermann, O., Han, Y., Perreault, D., J.
- **A high-frequency resonant inverter topology with low voltage stress**
  Rivas, J., M., Han, Y., Leitermann, O., Sagneri, A., D., Perreault, D., J.
- **Design of a Class-DE Rectifier with Shunt Inductance and Nonlinear Capacitance for High-Voltage Conversion** *IEEE TRANSACTIONS ON POWER ELECTRONICS*
  Park, S., Rivas, J. M.
  2018; 33 (3): 2282–94
- **Active Power Device Selection in High- and Very-High-Frequency Power Converters** *IEEE Transactions on Power Electronics*
  Zulauf, G. D., Tong, Z., Plummer, J. D., Rivas-Davila, J. M.
  2018: 1
- **FPGA-based Dynamic Duty Cycle and Frequency Controller for a Class-E-2 DC-DC Converter**
  Park, S., Rivas-Davila, J., IEEE
  IEEE.2018: 282–88
- **High-Frequency Resonant Converter with Synchronous Rectification for High Conversion Ratio and Variable Load Operation**
  Gu, L., Surakitbovorn, K., Rivas-Davila, J., IEEE
  IEEE.2018: 632–38
- **COSS Measurements for Superjunction MOSFETs: Limitations and Opportunities** *IEEE Transactions on Electron Devices*
  Zulauf, G. D., Roig-Guitart, J., Plummer, J. D., Rivas-Davila, J. M.
  2018: 1-7
- **A Wide Input Range Isolated Stacked Resonant Switched-Capacitor dc-dc Converter for High Conversion Ratios**
  Li, Y., Gu, L., Hariya, A., Ishizuka, Y., Rivas-Davila, J., Sanders, S., IEEE
  IEEE.2018
- **Designing a 40.68 MHz power-combining resonant inverter with eGaN FETs for plasma generation**
  Choi, J., Ooue, Y., Furukawa, N., Rivas, J., IEEE
  IEEE.2018: 1322–27
- **Substrate Bias Effect on E-Mode GaN-on-Si HEMT COSS Losses**
  Zhuang, J., Zulauf, G., Rivas-Davila, J., IEEE
  IEEE.2018: 130–33
- **Estimating the Reliability of Series-Connected Schottky Diodes for High-Frequency Rectification**
  Park, S., Zulauf, G., Rivas-Davila, J., IEEE
  IEEE.2018
- **Considerations for Active Power Device Selection in High- and Very-High-Frequency Power Converters**
  Zulauf, G., Tong, Z., Rivas-Davila, J., IEEE
  IEEE.2018
- **Design of a 13.56 MHz dc-to-dc resonant converter using an impedance compression network to mitigate misalignments in a wireless power transfer system**
  Choi, J., Xu, J., Makhoul, R., Rivas, J., IEEE
  IEEE.2018
- **A Study on Off-State Losses in Silicon-Carbide Schottky Diodes**
  Tong, Z., Zulauf, G., Rivas-Davila, J., IEEE

IEEE.2018

- **Design of a GaN-Based, Inductor-less, Wireless Power Transfer System at 40.68 MHz**
  Surakitbovorn, K., Rivas-Davila, J., IEEE
  IEEE.2018
- **High-Frequency Bidirectional Resonant Converter for High Conversion Ratio and Variable Load Operation**
  Gu, L., Surakitbovorn, K., Zulauf, G., Chakraborty, S., Rivas-Davila, J., IEEE
  IEEE.2018
- **Effect of Class 2 Ceramic Capacitance Variations on Switched Capacitor and Resonant Switched Capacitor Converters**
  Xu, J., Gu, L., Hernandez, E., Rivas-Davila, J., IEEE
  IEEE.2018
- **60 V-to-35 kV Input-Parallel Output-Series DC-DC Converter Using Multi-Level Class-DE Rectifiers**
  Park, S., Gu, L., Rivas-Davila, J., IEEE
  IEEE.2018: 2235–41
- **C-OSS Losses in Silicon Superjunction MOSFETs across Constructions and Generations**
  Zulauf, G., Rivas-Davila, J. M., IEEE
  IEEE.2018: 136–39
- **Vacuum Testing of a Miniaturized Switch Mode Amplifier Powering an Electrothermal Plasma Micro-Thruster** *FRONTIERS IN PHYSICS*
  Charles, C., Liang, W., Raymond, L., Rivas-Davila, J., Boswell, R. W.
  2017; 5
- **Universal Line Input Power Factor Preregulator Using VFX Technique**
  Gu, L., Liang, W., Praglin, M., Chakraborty, S., Rivas-Davila, J., IEEE
  IEEE.2017: 1810–15
- **A Portable Electrostatic Precipitator to Reduce Respiratory Death in Rural Environments**
  Talukder, S., Park, S., Rivas-Davila, J., IEEE
  IEEE.2017
- **Isolated Resonant DC-DC Converters with a Loosely Coupled Transformer**
  Park, S., Rivas-Davila, J., IEEE
  IEEE.2017
- **A compact RF power inverter with reduced EMI for a CubeSat electrothermal micro-thruster**
  Liang, W., Cui, X., Raymond, L., Gu, L., Charles, C., Boswell, R., Rivas-Davila, J., IEEE
  IEEE.2017
- **A Multi-resonant Gate Driver for Very-High-Frequency (VHF) Resonant Converters**
  Gu, L., Liang, W., Rivas-Davila, J., IEEE
  IEEE.2017
- **A Unified Model for High-Power, Air-Core Toroidal PCB Inductors**
  Zulauf, G., Liang, W., Rivas-Davila, J., IEEE
  IEEE.2017
- **Output Capacitance Losses in 600 V GaN Power Semiconductors with Large Voltage Swings at High- and Very-High-Frequencies**
  Zulauf, G., Liang, W., Surakitbovorn, K., Rivas-Davila, J., IEEE
  IEEE.2017: 352–59
- **Implementing an impedance compression network to correct misalignment in a wireless power transfer system**
  Choi, J., Rivas, J., IEEE
  IEEE.2017
- **Power Loss of GaN Transistor Reverse Diodes in a High Frequency High Voltage Resonant Rectifier**
  Park, S., Rivas-Davila, J., IEEE

IEEE.2017: 1942–45

- **3-D-Printed Air-Core Inductors for High-Frequency Power Converters** *IEEE TRANSACTIONS ON POWER ELECTRONICS*
  Liang, W., Raymond, L., Rivas, J.
  2016; 31 (1): 52-64
- **A Design Methodology for Class-D Resonant Rectifier with Parallel LC Tank**
  Park, S., Rivas-Davila, J., IEEE
  IEEE.2016
- **Evaluation of a 900 V SiC MOSFET in a 13.56 MHz 2 kW resonant inverter for wireless power transfer**
  Choi, J., Tsukiyama, D., Rivas, J., IEEE
  IEEE.2016
- **Comparison of SiC and eGaN devices in a 6.78 MHz 2.2 kW resonant inverter for wireless power transfer**
  Choi, J., Tsukiyama, D., Rivas, J., IEEE
  IEEE.2016
- **13.56 MHz High Density DC-DC Converter With PCB Inductors** *IEEE TRANSACTIONS ON POWER ELECTRONICS*
  Liang, W., Glaser, J., Rivas, J.
  2015; 30 (8): 4291-4301
- **27.12MHz GaN Resonant Power Converter with PCB Embedded Resonant Air Core Inductors and Capacitors**
  Liang, W., Raymond, L., Gu, L., Rivas, J., IEEE
  IEEE.2015: 4251–56
- **13.56 MHz 1.3 kW Resonant Converter with GaN FET for Wireless Power Transfer**
  Choi, J., Tsukiyama, D., Tsuruda, Y., Rivas, J., IEEE
  IEEE.2015
- **27.12MHz GaN Bi-directional Resonant Power Converter**
  Gu, L., Liang, W., Raymond, L. C., Rivas-Davila, J., IEEE
  IEEE.2015
- **Performance evaluation of diodes in 27.12 MHz Class-D resonant rectifiers under high voltage and high slew rate conditions** *IEEE 15th Workshop on Control and Modeling for Power Electronics (COMPEL)*
  Raymond, L. C., Liang, W., Rivas, J. M.
  IEEE.2014
- **3D Printed Air Core Inductors for High Frequency Power Converters**
  Liang, W., Raymond, L., Rivas, J., IEEE
  IEEE.2014: 971–79
- **A 13.56 MHz High Density dc-dc Converter with PCB Inductors**
  Liang, W., Glaser, J., S, Rivas, J., M.
  2013
- **13.56 MHz High Density dc-dc Converter with PCB Inductors**
  Liang, W., Glaser, J., Rivas, J., IEEE
  IEEE.2013: 633–40
- **27.12 MHz Large Voltage Gain Resonant Converter with Low Voltage Stress**
  Raymond, L., Liang, W., Choi, J., Rivas, J., IEEE
  IEEE.2013: 1820–27
- **27.12 MHz large voltage gain resonant converter with low voltage stress**
  Raymond, L., Liang, W., Choi, J., Rivas, J.
  2013
- **A Very High Frequency dc-dc Converter Based on a Class 2 Resonant Inverter** *IEEE Transactions on Power Electronics*
  Rivas, J., M., Leitermann, O., Han, Y., Perreault, D., J.

2011; 26 (10): 2980-2992

- **Opportunities and Challenges in Very High Frequency Power Conversion**
  Perreault, D., J., Jingying, H., Rivas, J., M., Han, Y., Leitermann, O., Pilawa-Podgurski, R., C.N.
  2009

- **A High-Frequency Resonant Inverter Topology With Low-Voltage Stress** *IEEE Transactions on Power Electronics*
  Rivas, J., M., Han, Y., Leitermann, O., Sagneri, A., D., Perreault, D., J.
  2008; 23 (4): 1759-1771

- **Design Considerations for Very High Frequency dc-dc Converters**
  Rivas, J., M., Jackson, D., A, Leitermann, O., Sagneri, A., D., Han, Y., Perreault, D., J.
  2006

- **New Architectures for Radio-Frequency dc-dc Power Conversion** *IEEE Transactions on Power Electronics*
  Rivas, J., M., Wahby, R., S., Shafran, J., S., Perreault, D., J.
  2006; 21 (2): 380-393

- **Performance improvement of alternators with Switched-Mode Rectifers** *IEEE Transactions on Energy Conversion.*
  Rivas, J., Perreault, D., Keim, T.
  2004; 19 (3): 561-568

- **New Architectures for Radio-Frequency dc-dc Power Conversion**
  Rivas, J., M., Wahby, R., S., Shafran, J., S., Perreault, D., J.
  2004

- **Performance improvement of alternators with switched-mode rectifiers**
  Rivas, J., M., Perreault, D., J., Keim, T.
  2003