Shiladri Chakraborty

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PERSONAL DETAILS

Date of birth : March 22, 1986
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249 B B.B Chatterjee Road,
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ACADEMIC PROFILE

Degree	Year	Institute	Marks
Post-doctoral Associate	Since Nov. 2018	University of Maryland	NA
Doctor of Philosophy	2012-2018	Indian Institute of Technology Kharagpur	NA
Master of Technology	2010-2012	Indian Institute of Technology Kanpur	GPA - 9.79/10
Bachelor of Engineering	2004-2008	Jadavpur University, Calcutta	GPA - 8.56/10
Higher Secondary	2004	West Bengal Board	83.9 %
Secondary	2002	West Bengal Board	88.1 %

AWARDS, ACCOMPLISHMENTS

- Outstanding presentation award at IEEE APEC, 2016.
- Student travel grant from IEEE to attend ECCE 2016, APEC 2016 and from DST, Govt. of India to attend IEEE IECON 2017.
- IIT Kanpur Academic Excellence Award, 2012.
- 1st position in M.Tech - Power and Control at IIT Kanpur.
- AIR Rank 198 (Electrical) in GATE 2010.
- Jadavpur University Ganesh Janani Devi memorial medal, 2008 for best performance in subjects Electrical Machines II and III.
- 7th position in B.E Electrical at Jadavpur University (124 students).
- AIR Rank 171 in WBJEE 2004.
- Recipient of several awards and medals at school level for academic excellence.

RESEARCH EXPERIENCE

POST-DOCTORAL RESEARCH

I have been working on the following projects during my post-doctoral tenure.

- The first project titled "Compact and Low-Cost Microinverter for Residential Systems"aims to reduce the cost and improve the reliability and performance of **residential PV microinverters** by developing a 400 W, 240 V ac, grid-tied microinverter with bill-of-material **cost** less than **$0.07/W**, **MTTF** greater than **250,000 hrs**, CEC **efficiency higher than 97 %** and **power-density greater than 0.61 kW/litre**. The various technical approaches include the cost-efficiency Pareto-optimal design of a **GaN-based**, DAB-based, single-stage, dc-ac topology, use of an auxiliary active power decoupling (APD) circuit which eliminates the use of electrolytic capacitors, design of a novel, low-loss planar transformer with integrated leakage inductance, improved analytical modeling of a high-frequency DAB leading to better efficiency, design of a 3D-printed, low-cost power connector, control strategy for soft-startup, incorporation of smart grid features ensuring compliance to UL1741 standard and experimental reliability studies to identify failure mechanisms.
  Progress : Closed-loop hardware validation of main circuit with APD with efficiency of 96.7 % on a standalone resistive load completed.
  Publications : 2 conference papers in ECCE 2020, 1 journal paper in IEEE Trans. on Power Electron., 2 journal papers under preparation for submission to IEEE Trans. on Power Electron.
- The second project titled "Thermally Integrated 3D Package for **SiC-based DC-DC** Full Bridge Converter" aims to build a very high power-density (greater than **25 kW/litre**), **10 kW**, high-voltage (800 V) bidirectional, isolated dc-dc converter for army **electric vehicles** capable of operating at **very high switching frequencies (500 kHz-1 MHz)**. Technical highlights of the work include **wire-bondless assembly of bare-die SiC devices** with integrated dc-link capacitors and gate-drive circuitry, compact layout of the switches with better power loop and gate loop inductances than most state-of-the-art solutions, use of **3D-printed multi-functional elements** serving as both electrical bus-bars and switch heatsinks, design of a **cooling-system-integrated planar transformer with integrated leakage inductance**, capable of combined core and winding cooling and adoption of **electro-thermal co-design**.
  Progress : Experimental electrical characterization of switching behaviour at 600 V, 30 A completed; power testing completed upto 5 kW at 500 kHz, 350 V.
  Publications : 4 conference papers - 1 in ASME InterPACK 2019, 2 in ITEC 2020 and 1 in ITherm 2020; 1 provisional patent and 3 invention disclosures filed; 1 journal paper under review in IEEE Trans. on Power Electron., 2 journal papers under preparation for submission to IEEE Trans. on Transp. Electrific.
- As technical support for a short time on a project which aims to build a **900 W inductive wireless charger** for charging 24 V battery of electric scissor-lift vehicles, with a target power transfer distance of 20 cm. Contributions limited to analysis and comparison of various compensation networks and topologies.

DOCTORAL RESEARCH

Thesis title : "Efficiency Optimization and Topological Innovations of **Dual Active Bridge Based Converters**".
Contributions : In the first part of the thesis, **hitherto-unexplored, closed-loop realizable, modulation strategies** for both voltage-source and current-source dual active half-bridge dc-dc converter are proposed which reduce conduction and switching losses, thereby improving their power conversion efficiency. In the second part, **two novel DAB-based, fully soft-switched, electrolytic capacitor-less, isolated dc-ac topologies** are developed which lead to potential cost, efficiency and reliability benefits. Battery-integrated forms for both topologies are also proposed. The second topology is extendible for the general case of ac-ac conversion and also scalable to high-voltage applications. Additionally, worked with colleague on ac-side modulation of a phase-modulated, isolated dc-ac converter, which is shown to have better efficiency than conventionally-adopted dc-side modulation, due to reduction in circulating current and extension of ZVS range of primary devices.
Publications : 5 in IEEE Trans. on Power Electron., 3 in IEEE APEC, 5 in IEEE ECCE, 1 in IEEE IECON.

MASTER'S RESEARCH

Thesis title : "Design and Control Of High-Gain Isolated **Resonant Boost Converter** For PV Microinverter Application".
Contributions : Developed a novel LLC resonant tank-based, high-voltage-gain dc-dc converter with load-independent ZVS property using planar magnetics for use as the dc-dc front-end of a two-stage PV microinverter.
Publications : 5 in IEEE Trans. on Power Electron., 1 in IEEE ECCE, 1 in NPEC.

INDUSTRIAL EXPERIENCE

Year	Organization	Designation	Responsibility
2008-2010	Tata Motors Ltd.	Assistant Manager	Decommissioning, planning, maintenance

TEACHING EXPERIENCE

At IIT Kharagpur, served as teaching assistant for the following courses.

- Tutorial class for "Electrical Machines" (EE21002).
- Tutorial class for "Power System and Apparatus Design" (EE49004).
- Laboratory class for "Power Electronics and Machine Lab".
- Tutorial class for "Signals and Networks" (EE21101).
- Tutorial and laboratory classes for "Electrical Technology" (EE11101).

At the University of Maryland,

- Developed lab experiments for "Introduction to Electrical & Computer Engineering" (ENEE101) on 1) Energy harvesting from solar cell, piezoelectric and thermoelectric generators and 2) Operation of boost and buck-boost converters.
- **Instructor for "Renewable Energy" (ENEE476)** - Fall 2020.

PUBLICATION LIST

Journals

J7. M. D'Antonio, **S. Chakraborty** and A. Khaligh, "Improved Frequency-Domain Steady-State Modeling of the Dual-Active-Bridge Converter Considering Finite ZVS Transition Time Effects," *IEEE Trans. on Power Electron*, Early Access.

J6. S. Chakraborty and S. Chattopadhyay, "A Dual-Active-Bridge-based Fully-ZVS HF-isolated Inverter With Low Decoupling Capacitance," *IEEE Trans. on Power Electron.*, 35 (3), pp. 2615-2628, Mar. 2020.

J5. S. Chakraborty and S. Chattopadhyay, "A Dual-Active-Bridge-Based Novel Single-Stage Low Device Count DC-AC Converter," *IEEE Trans. on Power Electron.*, 34 (13), pp. 2339-2354, Mar. 2019.

J4. S. Chakraborty and S. Chattopadhyay, "Fully-ZVS, Minimum RMS Current Operation of the Dual-Active Half-Bridge Converter using Closed-loop Three Degree of Freedom Control," *IEEE Trans. on Power Electron.*, 33 (12), pp. 10188-10199, Dec. 2018.

J3. N. K. Kummari, **S. Chakraborty** and S. Chattopadhyay, "An Isolated High-frequency Link Microinverter Operated with Secondary-Side-Modulation for Efficiency Improvement," *IEEE Trans. on Power Electron.*, 33 (3), pp. 2187-2200, Mar. 2018.

J2. S. Chakraborty and S. Chattopadhyay, "Minimum-RMS-Current Operation of Asymmetric Dual Active Half-Bridge Converters with and without ZVS," *IEEE Trans. on Power Electron.*, 32 (7), pp. 5132-5145, July 2017.

J1. U. Kundu, **S. Chakraborty** and P. Sensarma, "Automatic Resonant Frequency Tracking in Parallel LLC Boost DC-DC Converter," *IEEE Trans. on Power Electron.*, 30 (7), pp. 3925-3933, July 2015.

Conferences

C23. M. D'Antonio, **S. Chakraborty** and A. Khaligh, "Design Optimization for Weighted Conduction Loss Minimization in a Dual-Active-Bridge-Based PV Microinverter," *IEEE IEEE Energy Conversion Congress and Exposition (ECCE), Oct. 2020.*

C22. Y. Shen, M. D'Antonio, **S. Chakraborty** and A. Khaligh, "CCM vs. CRM Design Optimization of a Boost-derived Parallel Active Power Decoupler for Microinverter Applications," *IEEE Energy Conversion Congress and Exposition (ECCE), Oct. 2020.*

C21. P. McCluskey,, H. Yun, C, Buxbaum, S, Yuruker, R. Mandel, M. Ohadi, Y. Park , **S. Chakraborty**, A. Khaligh, L. Boteler and M. Hinojosa, "Thermo-mechanical reliability design considerations of 3D-integrated SiC power device package," *IEEE Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems (ITherm), Jul. 2020.*

C20. Y. Park, **S. Chakraborty** and A. Khaligh, "A Bare-die SiC-based Isolated Bidirectional DC-DC Converter for Electric Vehicle On-board Chargers," *IEEE Transportation Electrification Conference and Exposition (ITEC), Jun. 2020.*

C19. Y. Park, S. Yuruker, **S. Chakraborty**, A. Khaligh, R. Mandel, P. McCluskey, M. Ohadi, L. Boteler and M. Hinojosa, "Electro-Thermal Co-Design of a Cooling System-Integrated High-Frequency Transformer," *IEEE Transportation Electrification Conference and Exposition (ITEC), Jun. 2020.*

C18. S. U. Yuruker, R. K. Mandel, P. McCluskey, M. Ohadi, **S. Chakraborty**, Y. Park, H. Yun, A. Khaligh, L. Boteler and M. Hinojosa, "Advanced Packaging and Thermal Management of High-Power DC-DC Converters," *ASME International Technical Conference and Exhibition on Packaging and Integration of Electronic and Photonic Microsystems (InterPACK), 2019*, Oct. 2019.

C17. S. Chaudhuri, **S. Chakraborty**, A. Banjare and S. Chattopadhyay, "A Battery-Integrated High-Frequency Transformer-Coupled Phase-Modulated PV Inverter," *IEEE Energy Conversion Congress and Exposition (ECCE), 2018*, pp. 6364-6371, Sep. 2018.

C16. S. Chakraborty and S. Chattopadhyay, "A Dual-active-bridge-based High-frequency Isolated Inverter for Interfacing Multiple PV Modules with Distributed MPPT," *IEEE Applied Power Electronics Conference and Exposition (APEC), 2018*, pp. 3256-3263, Mar. 2018.

C15. S. Chakraborty and S. Chattopadhyay, "Approaches for Continuous-Time Dynamic Modeling of the Asymmetric Dual-Active Half-Bridge Converter," *IEEE Applied Power Electronics Conference and Exposition (APEC), 2018*, pp. 952-958, Mar. 2018.

C14. S. Chakraborty and S. Chattopadhyay, "Operation of a Triple-active-bridge-based Battery-integrated Isolated PV Microinverter," *Annual Conference of the IEEE Industrial Electronics Society (IECON), 2017*, pp. 2611-2616, Nov. 2017.

C13. S. Chakraborty and S. Chattopadhyay, "A Multi-port, Isolated PV Microinverter with Low Decoupling Capacitance and Integrated Battery Charger," *IEEE Energy Conversion Congress and Exposition (ECCE), 2016*, Sep. 2016.

C12. S. Chakraborty, S. Tripathy and S. Chattopadhyay, "Minimum RMS Current Operation of the Dual Active Half-Bridge Converter using Three Degree of Freedom Control ," *IEEE Energy Conversion Congress and Exposition (ECCE), 2016*, Sep. 2016.

C11. N.K. Kummari, **S. Chakraborty** and S. Chattopadhyay, "Secondary Side Modulation of a Single-stage Isolated High-frequency Link Microinverter with a Regenerative Flyback Snubber," *IEEE Energy Conversion Congress and Exposition (ECCE), 2016*, Sep. 2016.

C10. S. Chakraborty and S. Chattopadhyay, "A Novel Single-stage Dual-Active Bridge based Isolated DC-AC Converter," *IEEE Applied Power Electronics Conference and Exposition (APEC), 2016*, pp. 1954-1961, Mar. 2016.

C9. S. Chakraborty and S. Chattopadhyay, "An Isolated Buck-Boost Type High-frequency Link Photovoltaic Microinverter," *IEEE Applied Power Electronics Conference and Exposition (APEC), 2016*, pp. 3389-3396, Mar. 2016.

C8. P. P. Das, S. Chattopadhyay and **S. Chakraborty**, "A Voltage Independent Islanding Detection Method & Low Voltage Ride Through of a Two-Stage PV Inverter," *IEEE Applied Power Electronics Conference and Exposition (APEC), 2016*, pp. 2652-2659, Mar. 2016.

C7. N.K. Kummari, **S. Chakraborty** and S. Chattopadhyay, "A hybrid isolated boost converter with reduced output capacitance and integrated auxiliary circuit for ZVS," *IEEE Energy Conversion Congress and Exposition (ECCE), 2015*, pp. 6320-6327, Sep. 2015.

C6. S. Chakraborty and S. Chattopadhyay, "An improved asymmetric half-bridge converter with zero DC offset of magnetizing current," *IEEE Applied Power Electronics Conference and Exposition (APEC), 2015*, pp. 1-8, Mar. 2015.

C5. S. Chakraborty and S. Chattopadhyay, "Analysis and comparison of voltage-source and current-source asymmetric dual-active half-bridge converters," *IEEE Energy Conversion Congress and Exposition (ECCE), 2014*, pp. 2072-2079, Sep. 2014.

C4. S. Chakraborty and S. Chattopadhyay, "Topology Variations and Design Improvements of a Single-Stage Flyback PV Microinverter," *IEEE Applied Power Electronics Conference and Exposition (APEC), 2014*, pp. 3026-3033, Mar. 2014.

C3. U. Kundu, **S. Chakraborty** and P. Sensarma, "Analog Controller for MPPT and Self-tuning of Resonant Frequency in Parallel LLC Boost Dc-Dc Converter for PV Microinverter," *National Power Electronics Conference (NPEC), 2013*, IIT Kanpur, India, Dec. 2013.

C2. S. Chakraborty, N. Gupta and S. Chattopadhyay, "A Digital Charge-Mode Control Algorithm for Power Decoupling in a Flyback Microinverter," *IEEE Energy Conversion Congress and Exposition (ECCE), 2013*, pp. 4785-4792, Sep. 2013.

C1. S. Chakraborty and P. Sensarma, "High gain high efficiency front end resonant dc-dc boost converter for PV microinverter," *IEEE Energy Conversion Congress and Exposition (ECCE), 2012*, pp. 180-187, Sep. 2012.

Manuscripts under review

Y. Park, **S. Chakraborty** and A. Khaligh, "Electrical Characterization of A Novel, Bare-die SiC-based, Wire-bondless Half-Bridge Module," *IEEE Trans. on Power Electron.* (major revision submitted).

Manuscripts under preparation

[3] M. D'Antonio, **S. Chakraborty** and A. Khaligh, "Efficiency Improvement of a Dual-Active-Bridge-based DC-AC Converter Using Improved Analytical Modeling Modeling Considering Finite Rise and Fall Time Effects," preparing for submission to *IEEE Trans. on Power Electron.*

[2] Y. Shen, M. D'Antonio, **S. Chakraborty** and A. Khaligh, "Comparison of CCM and CRM-basedBoost-derived Parallel Active Power Decoupler forMicroinverter Applications," preparing for submission to *IEEE Trans. on on Power Electron.*

[1] Y. Park, **S. Chakraborty** and A. Khaligh, "Design and Operation of a Bare-die SiC-based, 500 MHz, Dual Active-Bridge DC-DC Converter for On-board Chargers," preparing for submission to *IEEE Trans. on Transport. Electrific.*

PATENTS/ INVENTION DISCLOSURE

[3]. S. Chakraborty, Y. Park and A. Khaligh, "Ultra-low-inductance SiC-based Half-bridge Die with Integrated On-chip Decoupling Capacitor and Gate Resistors," Invention Disclosure filed, University of Maryland.

[2]. Y. Park, **S. Chakraborty** and A. Khaligh, "Wire-bondless integration of bare-die switch modules," Invention Disclosure filed, University of Maryland.

[1].R. Mandel, A. Khaligh, P. McCluskey, Y. Park, A. Mallik, **S. Chakraborty**, S. Yuruker, C. Buxbaum, "Wire-Bondless, Electro-Thermally-Integrated Switch Module," Provisional Patent filed, University of Maryland.

PROPOSAL WRITING EXPERIENCE

At IIT Kharagpur, worked with Ph.D. advisor to draft the following proposals.

- "A 1 kW rooftop solar installation system with module-level MPPT";
  Funding agency : Department of Science and Technology, Govt. of India.
- "Development of high-frequency planar magnetics";
  Funding agency : National Mission on Power Electronics Technology (NaMPET) Phase III, Ministry of Electronics and Information Technology, Govt. of India.
- "A combined ac and dc charging infrastructure for electric vehicles employing a PV array, a DG set and a supercapacitor for fast charging";
  Funding agency : Mission Innovation India (jointly with IIT Kanpur, IIT BHU).
- "Development of a current-fed DAHB-based low-device count, modular 5 kW, 70 V to 350 V dc-dc converter for spacecraft thruster application";
  Funding agency : Indian Space Research Organisation.
- "Development of a Single-Stage, Isolated PV inverter with MPPT, Battery Charging Capability and Low Decoupling Capacitance";
  Funding agency : Department of Science and Technology, Govt. of India.

At the University of Maryland, worked with Post-doc. advisor to draft the following proposals.

- "Innovative Virtual Learning Platform for Teaching Renewable Energy";
  Funding agency : University of Maryland.
- "Design of a high-voltage flyback dc-dc converter with integrated, wire-bond-less switch module for pulsed-power applications" (white paper submitted);
  Proposed Funding agency : U.S Army Research Laboratory.
- "Development of a 100 kW, high-power-density traction inverter for next-gen EVs with wire-bondless SiC switches" (in progress, in collaboration with Oak Ridge National Laboratory);
  Proposed Funding agency : U.S Department of Energy.

CONFERENCES ATTENDED

Year	Name	Number of papers presented
2018	IEEE APEC, San Antonio, Texas, U.S.A	2 (1 oral, 1 poster)
2017	IEEE IECON, Beijing, China	1 (oral)
2016	IEEE ECCE, Milwaukee, Wisconsin, U.S.A	3 (1 oral, 2 poster)
2016	IEEE APEC, Long Beach, California, U.S.A	1 (oral)
2013	NPEC, I.I.T Kanpur	1 (oral)

SERVICE, MEMBERSHIP

- Reviewer since 2014 for IEEE Trans. on Power Electron., IEEE Trans. on Ind. Electron., IEEE J. Emerg. Sel. Top. Power Electron., IEEE Trans. on Circuits Syst., APEC, ECCE, IECON.
- Member-IEEE, IEEE Power Electronics Society, Industrial Electronics Society, Industry Applications Society.

REFERENCES

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