Brief Resume of **Santanu Kapat, Ph.D.**

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Google Scholar page **Scopus page** **Researchgate page** **LinkedIn page**

PROFESSIONAL EXPERIENCE

- May – June 2023: **Visiting International Faculty**, University of Padova, Italy
- Dec. 2019 – present: **Associate Professor**, Dept. of Electrical Engineering, **IIT Kharagpur**
- Jul. 2019 – Nov. 2019: **Associate Professor**, Dept. of Electrical Engineering, **IIT Delhi**
- Mar. 2018 – Jul. 2019: **Associate Professor**, Dept. of Electrical Engineering, **IIT Kharagpur**
- Aug. 2011 – Mar. 2018**: Assistant Professor**, Dept. of Electrical Engineering, **IIT Kharagpur**
- Aug. 2010 – Aug. 2011: **Research Engineer**, **GE Global Research**, Bangalore, India
- Aug. 2009 – Jul. 2010: **Visiting Scholar**: Dept. of ECE., **University of Illinois (UIUC),** USA

AWARDS/RECOGNITIONS

- **Visiting International Faculty** (during May-June, 2023), University of Padova, Italy (host: Prof. Paolo Mattavelli)
- **Faculty Excellence Award (Associate Professor),** IIT Kharagpur, **2022**
- **Qualcomm Faculty Award** in 2022 from Qualcomm (link)
- **Associate Editor**, *IEEE Transactions on Power Electronics* since 2015 onward (link)
- **Associate Editor**, *IEEE Journal of Emerging & Selected Topics in Power Electron. since 2020 (link)*
- **Associate Editor**, *IEEE Transactions on Circuits and Systems II: Express Briefs* since 2018 (link)
- **Editor, IETE Technical Review,** from 2022 onwards (link)
- **Invited tutorial speaker** at *IEEE PESGRE 2023* conference to be held in December 2023
- **Invited tutorial speaker** at Summer School conduced by at IIT Bhubaneswar and *IEEE PELS*, July 2023
- **Highest number of papers in APEC 2022 worldwide (jointly with Virginia Tech., USA)**
- **Two Invited Webinars,** Invited by IEEE Power Electronics Society, **January 2023, December 2021**
- **Among top 2% Global Scientists** in Electrical and Electronics Engineering (jointly prepared by Stanford University and Elsevier publisher)**, 2020, 2021, 2022.**
- **INSA Medal for Young Scientist** in 2016 from Indian National Science Academy (link)
- **INAE Young Engineering Award** in 2016 from Indian National Academy of Engineering (link)

INDUSTRY ADVANCED TRAINING PROGRAM DEVELOPMENT

Industry name	Training course title	Hours	Time
Qualcomm	Modeling Techniques and Validation Methodologies in Closed-Loop Switched Mode Power Converter Products	**40**	June/July 2022
STMicroelectronics	Modeling, Analysis and Design of Fixed-Frequency Control Methods in DC-DC Converters and MATLAB based Design Automation	**40**	January – June, 2022
HCL Technologies	Digital Control Techniques in Switched Mode Power Converters	**48**	April – July 2021
Qualcomm	Control Techniques in Switched Mode Power Converters	**30**	May – July 2021
STMicroelectronics	Power Management Circuits, Modelling, Control, Analysis, and Design	**40**	March 2020
NXP Semiconductor	Modeling and Control of Switched Mode Power Converters	**20**	2018-2019

ONLINE CERTIFICATION COURSE DEVELOPMENT

- **Developed an Online (NPTEL) certification course on** "Digital Control of Switched Mode Power Converters and FPGA-based Prototyping", started in **July, 2022.** YouTube link.
- **Developed an Online (NPTEL) certification course on** "Control and Tuning Methods in Switched Mode Power Converters", YouTube link.

EDUCATION

- **Ph.D.** Electrical Engineering IIT Kharagpur 2010
- **M.Tech.** Electrical Engineering IIT Kharagpur 2006
- **B.E.** Instrumentation Technology VTU, Belgaum 2003

RESEARCH INTERESTS and STUDENT GUIDANCE

- **Research Interests**: High-frequency (HF) switched mode power converters (SMPC); digital control, nonlinear control, nonlinear dynamics; mixed-signal power management circuits; GaN and SiC-based HF SMPC; Applications to portable devices, data center, automotive, 48V-to-direct PoL converters, fast battery chargers, LED driving, DC grid, and BMS.

- **PhD student guidance**:

Sl. No.	Student Name	Present affiliation	Joining Year	Status
1.	Bipin Chandra Mandi	Assist. Prof., **IIIT Naya Raipur**	Autumn 2011	**Degree awarded** in 2017
2.	Amit Kumar Singha	Assist. Prof., **IIT Mandi**	Autumn 2012	**Degree awarded** in 2017
3.	Vedula Inder Kumar	Postdoctoral fellow, UC Boulder	Autumn 2014	**Degree awarded** in 2019
4.	K. Hariharan	Specialist, Tata Elxsi, India	Spring 2013	**Degree awarded** in 2021
5.	Rabishankar Roy	Research Engineer, GE, Bangalore	Autumn 2015	**Degree awarded** in 2020
6.	Somnath Khatua	Research Engineer, GE, Bangalore	Autumn 2015	**Submitted** PhD thesis in May 2023
7.	Prantik Majumdar	Research Scholar, IIT Kharagpur	Spring 2017	**To submit thesis** by June 2024
8.	Ruturaj Garnayak	Research Scholar, IIT Kharagpur	Spring 2017	**To submit thesis** by April 2024
9.	Dipayan Chatterjee	Research Scholar, IIT Kharagpur	Spring 2019	**Completed** registration seminar

10.	Anirban Nanda	Research Scholar, IIT Kharagpur	Autumn 2020	**Completed** registration seminar
11.	Faraz Ahmad	Research Scholar, IIT Kharagpur	Spring 2020	**Completed** PhD coursework
12.	Teja Golla	PMRF fellow, IIT Kharagpur	Autumn 2021	**Completed** PhD coursework
13.	Calvin Paul	PMRF fellow, IIT Kharagpur	Autumn 2022	**Completed** PhD coursework
14.	Arindam Maulik	Research Scholar, IIT Kharagpur	Autumn 2023	**Recently started** Ph.D. coursework

- **M.Tech/M.S. student guidance**: Successfully completed **23 M.Tech guidance and 2 MS; 1 M.Tech** and **1 MS guidance** ongoing

SUMMARY RESEARCH PUBLICATIONS/PATENTS

	Single-authored publications	Multi-authored publications	Total
Journal publications	**5**	**30**	**35**
Conference papers	**14**	**58**	**72**
Patents filed/granted		**9** filed + **2** granted	**11**

- The complete list of publications is given at the end.

DEVELOPMENT INITIATIVES

- Developed **Embedded Power Management Lab** in 2014
- Carrying out **High Performance Digital Control** Research and Development Activities
- Received more than **INR 50 million** fund from external agencies
- Offered industry **advanced training** programs
- Collaboration with **STMicroelectronics, Qualcomm, Texas Instruments, GE Global Research, NXP Semiconductor, HCL Technologies**

GaN-based RESEARCH & DEVELOPMENT ACTIVITIES

- **Project title**: "GaN-Based 48V Battery Driven High Power Density DC Power Supply Architectures for Advanced Driver Assistance System (ADAS) in Future Hybrid Vehicles"

  Outcomes: Ongoing project to develop GaN-based bidirectional 48V to PoL converters for automotive applications

  Funding agency – **Science and Engineering Research Board (SERB), India**
- **Project title**: "Development of Scalable GaN-Based Distributed Dynamic Power Management System for IoT Applications with On-Demand Thermal Management"

  Outcomes: Completed project and developed GaN-based 48V to PoL converters for data centre and telecom applications

  Funding agency – **Ministry of Education** and **Department of Electronics and Information Technology** under the IMPRINT India initiative
- **Project title**: "Development of Scalable GaN-based Distributed Dynamic Power Management System for IoT Applications with On-Demand Dynamic Thermal Management – Extended Work"

Outcomes: Completed project and developed GaN-based 380V to 48V bidirectional dual active bridge converter

Funding agency – **GE India Technology Center Pvt. Ltd.**

- **Project title:** "DC-DC and Class D Amplifier Modeling and Design Consultancy"

  Outcomes: Completed project and developed GaN-based class D audio amplifier

  Funding agency **– NXP India Private Limited**

SiC-based RESEARCH & DEVELOPMENT ACTIVITIES

- **Title**: "Design and development of state-of-the-art hardware and firmware solutions for SiC-based power conversion systems using latest digital control solutions for PFC and LLC converters for emerging applications, battery chargers, DC grid, etc**.**"

  Outcomes: Ongoing project to develop SiC-based bidirectional 10~kW three-phase PFC and CLLC converters; Currently developed SJMOSFET based 10~kW CLLC, which is under test and valodation

  Funding agency – **STMicroelectronics Pvt. Ltd**

Power Management IC with Mixed-Signal Control– RESEARCH & DEVELOPMENT ACTIVITIES

- **Title**: "Input Multiple Output (SIMO) DC-DC Converter for Normal SOCs"

  Outcomes: Ongoing project to develop PMIC for digitally controlled single-inductor-dual-output buck converter; currently Cadence simulation is ongoing

  Funding agency – **STMicroelectronics International N.V.**

THEORY COURSES DEVELOPED/TAUGHT at IIT Kharagpur

- Introduced a course **Embedded Control of Switching Power Converters** in 2014
- M. Tech courses taught: **Embedded Control of Switching Power Converters, Electric Vehicle (partly taught), Automotive Electronics (partly taught), Nonlinear Control, Control Theory, Digital Control, Estimation of Signals and Systems, Modelling and Identification, Programmable and Embedded Systems**
- B.Tech courses taught: **Control System Engineering (partly taught), Electrical Technology, Embedded Systems (partly taught)**

Journal publications

[1] R. Garnayak, S. Kapat, C. Chakraborty, ``Constant On/Off-Time Digital Current Control and Design Methods in 3-Level Flying Capacitor Boost Converters for Fast Transient and Voltage Balancing", under major revision, *IEEE Trans. Power Electron.,* 2023

[2] R. Garnayak, P. Majumder, S. Kapat, C. Chakraborty, `` A Hybrid Design Framework for Fast Transient and Voltage Balancing in a Three-level Flying Capacitor Boost Converter with Digital Current Mode Control", accepted for publication, *IEEE Trans. Power Electron.,* July 2023

[3] H. Sahoo, S. Kapat, B. Singh, `` Small-Signal Modelling and Analysis of Converter Interactivity in 48 V DC Grid", accepted for publication, *IEEE Trans. Industry Applications,* May 2023

[4] S. Khatua, D. Kastha and S. Kapat, "A Dual Active Bridge Derived Hybrid Switched Capacitor Converter Based Two-Stage 48 V VRM," *IEEE Trans. Power Electron.*, vol. 36, no. 7, pp. 7986-7999, July 2021.

[5] A. Acharya, V. I. Kumar and S. Kapat, "Dynamic Bus Voltage Reconfiguration in a Two-Stage Multiphase Converter for Fast Transient," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 9, no. 1, pp. 48-57, Feb. 2021

[6] R. Roy and S. Kapat, "Input Filter-Based Ripple Injection for Mitigating Limit Cycling in Buck Converters Driving CPL," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 9, no. 2, pp. 1315-1327, April 2021

[7] R. Roy and S. Kapat, "Discrete-Time Framework for Analysis and Design of Digitally Current-Mode-Controlled Intermediate Bus Architectures for Fast Transient and Stability," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 8, no. 4, pp. 3237-3249, Dec. 2020.

[8] S. Khatua, D. Kastha and S. Kapat, "A New Single-Stage 48-V-Input VRM Topology Using an Isolated Stacked Half-Bridge Converter," *IEEE Trans. Power Electron.,* vol. 35, no. 11, pp. 11976-11987, Nov. 2020

[9] S. Kapat and P. T. Krein, "A Tutorial and Review Discussion of Modulation, Control and Tuning of High-Performance DC-DC Converters based on Small-Signal and Large-Signal Approaches" **(download)**, *IEEE Open Journal of Power Electronics,* vol. 1, pp. 339 - 371, Aug. 2020.

[10] R. Roy, I. Kumar, and S. Kapat, "Ripple Voltage Injection to Mitigate Limit Cycle in Digitally Controlled Intermediate Bus Architectures", *IEEE Trans. Power Electron.,* vol. 35, No. 3, pp. 3127 - 3138, Mar. 2020.

[11] K. Hariharan, S. Kapat, and S. Mukhopadhyay, "Constant Off-Time Digital Current-Mode Controlled Boost Converters with Enhanced Stability Boundary" **(download)**, *IEEE Trans. Power Electron.,* vol. 34, No. 10, pp. 10270 - 10281, Oct. 2019.

[12] S. Kapat, "Sampling-Induced Border Collision Bifurcation in a Voltage-Mode DPWM Synchronous Buck Converter" **(download)**, *IEEE Trans. Cir. Syst. II,* vol. 66, No. 6, pp. 1048 - 1052, June 2019.

[13] K. Hariharan, S. Kapat, and S. Mukhopadhyay " Constant On/Off-Time Hybrid Modulation in Digital Current-Mode Control using Event-Based Sampling," **(download)**, *IEEE Trans. Power Electron.,* vol. 34, No. 4, pp. 3789 - 3803, April 2019.

[14] K. Hariharan and S. Kapat, "Near Optimal Controller Tuning in a Current-Mode DPWM Boost Converter in CCM and Application to a Dimmable LED Array Driving," **(download)**, *IEEE Journal of Emerging and Selected Topics in Power Electronics,* vol. 7, No. 2, pp. 1031 - 1043, June 2019.

[15] B. C. Mandi, S. Kapat, and A. Patra, "Unified Digital Modulation Techniques for DC-DC Converters over a Wide Operating Range: Implementation, Modeling, and Design Guidelines " **(download)**, *IEEE Trans. Cir. Syst. I,* vol. 65, No. 4, pp. 1442 - 1453, Apr. 2018.

[16] A. K. Singha and S. Kapat, " Analyzing the Effects due to Discontinuous Output-Voltage Ripple in a Digitally Current-Mode Controlled Boost Converter, " **(download)**, *IET Power Electron.,* vol. 11, No. 6, pp. 1055 - 1065, Jun. 2018.

[17] A. K. Singha, S. Banerjee, and S. Kapat, " Enhanced Stability Caused by One-Cycle Delay in a Digital Current-Mode Controlled Buck Converter, " **(download)**, *IEEE Trans. Cir. Syst. II,* vol. 65, No. 12, pp. 1979 - 1983, Dec. 2018.

[18] S. Kapat and I. Kumar, "Single-Inductor Multi-Output-Level Buck Converter for Reducing Voltage-Transition Time and Energy Overheads in Low Power DVS-Enabled Systems " **(download)**, *IEEE Trans. Power Electron.,* vol. 33, No. 3, pp. 2254 - 2266, Mar. 2018.

[19] S. Kapat, " Parameter-Insensitive Mixed-Signal Hysteresis-Band Current Control for Point-of-Load Converters with Fixed Frequency and Robust Stability," **(download)**, *IEEE Trans. Power Electron.,* vol. 32, No. 7 pp. 5760 - 5770, Jul. 2017.

[20] K. Hariharan and S. Kapat, "Need for Variable Frequency Control in DC-DC Switching Converters – Challenges and Opportunities using Digital Implementation," **(download)**, Early access, *Proceedings of the Indian National Science Academy,* 2017.

[21] I. Kumar and S. Kapat, "Power Management Architectures for Dynamic Voltage Scaling (DVS) Applications – Challenges and Opportunities," **(download)**, *Annals of the Indian National Academy of Engineering,* vol. XIV, pp. 197 - 207, April 2017.

[22] A. K. Singha and S. Kapat, "A Unified Framework for Analysis and Design of a Digitally Current-Mode Controlled Buck Converter," **(download)**, *IEEE Trans. Cir. Syst. I,* vol. 63, No. 11, pp. 2098 - 2107, Nov. 2016.

[23] I. Kumar and S. Kapat, "Unified Digital Current Mode Control Tuning with Near Optimal Recovery in a CCM Buck Converter," **(download)**, *IEEE Trans. Power Electron.,* vol. 31, No. 12 pp. 8461 - 8470, Dec. 2016.

[24] S. Kapat, "Reconfigurable Periodic Bi-frequency DPWM with Custom Harmonic Reduction in DC-DC Converters," **(download)**, *IEEE Trans. Power Electron.,* vol. 31, No. 4, pp. 3380 - 3388, Apr. 2016.

[25] S. Kapat, B. C. Mandi, and A. Patra, "Voltage-mode Digital Pulse Skipping Control of a DC-DC Converter with Stable Periodic Behavior and Improved Light-load Efficiency," **(download)**, *IEEE Trans. Power Electron.,* vol. 31, No. 4, pp. 3372 - 3379, Apr. 2016.

[26] S. Kapat, "Configurable Multi-mode Digital Control for Light Load DC-DC Converters with Improved Spectrum and Smooth Transition," **(download)**, *IEEE Trans. Power Electron.,* vol. 31, No. 3, pp. 2680 - 2688, Mar. 2016.

[27] A. K. Singha, S. Kapat, S. Banerjee, and J. Pal, "Nonlinear Analysis of Discretization Effects in a Digital Current Mode Controlled Boost Converter," **(download)**, *IEEE J. Emerg. Selected Topics Cir. Systs.* , vol. 5, No. 3, pp. 336 - 344, Sept. 2015.

[28] S. Kapat, "Selectively Sampled Sub-harmonic Free Digital Current Mode Control Using Direct Duty Control" **(download)**, *IEEE Trans. Cir. Syst. II,* vol. 62, No. 3, pp. 311 - 315, March 2015.

[29] S. Kapat, P. Shenoy, and P. Krein, "Near Null Response to Large Signal Transients in an Augmented Buck Converter: A Geometric Approach" **(download)**, *IEEE Trans. Power Electron.*, vol. 27, No. 7, pp. 3319 - 3329, July 2012.

[30] S. Kapat and P. Krein, "Formulation of PID Control for DC-DC Converters Based on Capacitor Current: A Geometric Context" **(download)**, *IEEE Trans. Power Electron.*, vol. 27, No. 3, pp. 1424 - 1432, March 2012.

[31] S. Kapat and P. Krein, "Improved Time Optimal Control of a Buck Converter Based on Capacitor Current" **(download)**, *IEEE Trans. Power Electron.*, vol. 27, No. 3, pp. 1444 - 1454, March 2012.

[32] S. Kapat, S. Banerjee, and A. Patra, "One-dimensional Discontinuous Map Analysis of DC-DC Converters Under Voltage Controlled Pulse Skipping Modulation" **(download)**, *Int. J. Bifur. Chaos*, World Scientific Journal, vol. 22, No. 3, March 2012.

[33] S. Kapat, A. Patra, and S. Banerjee, "Improving Load Regulation in Current Mode Control through Inductor Current Filtering" **(download)**, *Int. J. Power Electron.*, Vol. 4, No. 1, pp. 71 - 93, January 2012.

[34] S. Kapat, A. Patra, and S. Banerjee, "Achieving Monotonic Variation of Spectral Composition in DC-DC Converters using Pulse Skipping Modulation" **(download)**, *IEEE Trans. Cir. Syst. I*, vol. 58, No. 8, pp. 1958 - 1966, August 2011.

[35] S. Kapat, S. Banerjee, and A. Patra, "Discontinuous Map Analysis of a DC-DC Converter Governed by a Pulse Skipping Modulation" **(download)**, *IEEE Trans. Cir. Syst. I*, vol. 57, no. 7, pp. 1793 - 1801, July 2010.

[36] S. Kapat, A. Patra, and S. Banerjee, "A Current Controlled Tri-State Boost Converter with Improved Performance through RHP Zero Elimination" **(download)**, *IEEE Trans. Power Electron.*, vol. 24, no. 3, pp. 776 - 786, March 2009.

Conference publications

The complete list of conference papers is available on *IEEExplore*:

Conference paper link

Patents filed/granted

[1] R. Roy and S. Kapat, " An improved method to mitigate the sub harmonic instability in the closed-loop intermediate bus converter of a non-isolated intermediate bus architecture ", filed Indian Patent, 2019.

[2] A. Acharya, I. Kumar, and S. Kapat, " Dynamic Bus Voltage Reconfiguration in a Two-Stage Multi-Phase Buck Converter for Transients Mitigation ", filed Indian Patent, 2019.

[3] K. Hariharan and S. Kapat, " Multi-mode Digital control of Constant On-Time modulation in a DC-DC converter with Superior Performance and Programmable Switching Frequency ", filed Indian Patent, Application number 201931011799, 2019.

[4] R. Roy and S. Kapat, " A novel control mechanism for mitigating the limit cycle oscillations in a non-isolated intermediate bus converter driving a constant power load ", filed Indian Patent with reference number PP-2718, 2019.

[5] R. Roy, I. Kumar, and S. Kapat, " A Novel Control Mechanism for Mitigating the Limit Cycle Oscillations in Intermediate Bus Architecture - A Fixed Frequency DPWM Technique for the PoL Converter Using the Intermediate Voltage Ripple ", filed Indian Patent, Application number 201831038708, 2018.

[6] I. Kumar and S. Kapat, " A Dynamic Voltage Scaling Enabled Per Cluster/Core Ultra-Fast Power Supply System For Multi-Core Processors ", filing Indian Patent, Application number 201731032852, 2018.

[7] S. Kapat, " Apparatus Equipped for Reconfiguring DC-DC Converter Augmentation for Ultra-fast Transient Recovery ", filing Indian Patent, Application No.: 1083/KOL/2013, dt. 19th September, 2013.

[8] S. Kapat and K. Hariharan, " Methods of Formulating and Tuning a Current Mode Controlled DC-DC Boost Converter for High Performance Using Normalized Output Current ", filed Indian Patent, Application No.: 1000/KOL/2013, dt. 29th August, 2013.

[9] S. Kapat et al., " Reduction in architectural complexity and distributed control formulation for an Energy Optimized DC Nano-grid architecture for Data centre applications ", filed Indian Patent,Application No.: 938/KOL/2013, dt. 28th August, 2013.

[10] S. Kapat, A. Patra, and S. Banerjee, "Switching Power Converter Adapted for Improved Output Impedance and Load Regulation through Inductor Current Filtering", **granted** Indian patent in 2022.

[11] S. Kapat and A. Patra, "Method for Improvement of Light Load Efficiency of a DC-DC Converter by Skipping Pulses through a Voltage Mode Control Loop", **granted** Indian patent in 2022.