



Muhammad Zarkab Farooqi

Nationality: Indian

Age: 28 Years

Marital status: Single

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I am Muhammad Zarkab Farooqi, currently pursuing a doctoral degree from the department of electrical engineering at the Indian Institute of Technology, Delhi. I am part of the PGML Lab, and working under joint supervision of [Prof. Bhim Singh](#) and [Prof. B.K.Panigrahi](#). My specific focus is on pioneering the development of novel integrated electronic capacitors with the aim to minimize the reliance on semiconductor switches and V/I sensors, all the while ensuring optimal system efficiency. I have dedicated significant effort to the development of both non-isolated and isolated DC-DC converters, focusing on implementing soft-switching techniques to enhance overall efficiency. Additionally, I have been involved in the analysis and design of integrated EV chargers, which involves combining both the traction and charging infrastructure into a unified entity. I have also put forth a modulation and control technique for these integrated systems to achieve improved performance and validated these advancements using ANSYS MAXWELL. Furthermore, I have developed 1.5kW all SiC based integrated isolated AC-DC-DC converter, dual-active bridge, dual-half bridge, totem-pole based series-stacked buffer along with isolated Gate Driver card operating at 200kHz using TI-UCC21750QDWQ1 IC for charging/ discharging a 120V battery.. I also developed a unified sensor+control board that incorporates the TMS320F28379D microcontroller for control of various converters.

My primary research interests include integrated EV chargers, electronic capacitors, wide-bandgap semiconductor based soft-switched converters, and advance control techniques in power electronic converters. My long term goal is to be a research oriented academician, dedicated to advancing sustainable solutions within the ongoing technological revolution in power electronics.

EDUCATION

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- [2019(Jan) - 2023(Dec)] Doctor of Philosophy in Electrical Engineering
Department of Electrical Engineering, Indian Institute of Technology, New Delhi, India
Advisors: [Prof. BHIM SINGH](#), [Prof. B.K.PANIGRAHI](#)
Thesis Title: **Improved Power Electronics based Solutions for AC-DC Converters**
CGPA: 8.75/10
 - [2014 - 2018] Bachelor of Technology in ELECTRICAL ENGINEERING
Department of Electrical Engineering, National Institute of Technology, Srinagar, India
Advisors: [Dr. TABISH NAZIR MIR](#), [Prof. ABDUL HAMID BHAT](#)
Thesis Title: **Comparative Analysis Of Modulation Strategies For Three-Phase Voltage Source Converters**
CGPA: 8.61/10 (4th Position)

RESEARCH INTERESTS

Integrated Chargers, Electronic Capacitors, Wide-bandgap Semiconductor based Soft-switched Converters, Non-linear and Planer Inductors, and Advance Control Techniques in PE Converters

WORK EXPERIENCE

OCT 2021 ONGOING	TEACHING ASSISTANT Department of Electrical Engineering IIT Delhi, Delhi, India
DEC 2018 OCT 2021	RESEARCH FELLOW Department of Science and Technology (DST), and IIT Delhi- (Project Code: RP03631)
JAN 2019 ONGOING	TECHNICAL ASSISTANT PGML Lab IIT Delhi, Delhi, India
AUG 2018- DEC 2018	ASST. MANAGER Tata Projects Ltd., Telangana, India

PROFESSIONAL EXPERIENCE

2022-23	<p>DEVELOPMENT OF INTEGRATED-ISOLATED DC-DC CONVERTER-SERB-NSC</p> <ul style="list-style-type: none">• The development of 0.85 kW based isolated integrated DC-DC converter to reduce the capacitor requirement while delivering desired output power to battery without using any extra switch.• SiC based full-bridge DAB was developed and integrated with a unfolding bridge to perform active power decoupling in multilevel converters, which have applications in ultra-fast EV charging stations, large-scale solar PV systems, railway traction system and split-battery energy storage system. <p>Submitted to IEEE Transactions on Industrial Electronics, IEEE IAS-2023</p>
2020-23	<p>CONTROL AND MODULATION STRATEGIES FOR BUCK-BASED ELECTRONIC CAPACITOR-GoI-DST</p> <ul style="list-style-type: none">• Developed a control strategy for 1kW SiC based electronic capacitor of which entitles the design of a faster decoupling control in CRM modulation, while ensuring the system stability and efficiency during dynamic periods.• A hybrid continuous and critical conduction mode which minimizes power loss attributed to buck-based electronic capacitor, over a wide power range, making it suitable for high-power applications. The modulation technique was verified by using specially designed high bandwidth current sensor board. <p>Published in IEEE Transactions on Industrial Informatics</p>
2021-22	<p>MULTI-FUNCTIONAL INTEGRATED PMSM BASED ON-BOARD CHARGER GoI-DST</p> <ul style="list-style-type: none">• A higher gravimetric and volumetric power density in the on-board charger was attained by employing an integrating set of components for charging the HV battery, LV battery, and traction purposes.• Components employed for charging a LV battery were reutilized for active power decoupling in grid connected mode.• An improved control and modulation was derived for input power quality and EMI improvement for proposed integrated charger and verified on 1kW hardware prototype. <p>Submitted to IEEE ECCE-2021, IEEE Transactions on Transportation Electrification</p>
2019-21	<p>CURRENT/ VOLTAGE SENSOR REDUCTION IN VARIOUS ELECTRONIC CAPACITORS.GoI-DST</p> <ul style="list-style-type: none">• Development a 1kW IGBT based experimental setup to validate sensorless operation of buck based active power decoupling converter using fixed frequency based modulated-model predictive control.• Formulated a control technique based on adaptive non-linear current observer for current sensorless operation of series-stacked buffer. <p>Published in IEEE Transactions on Transportation Electrification</p>

2020-23	<p>MENTORING STUDENTS FOR MASTER THESIS AND BACHELOR'S PROJECTS</p> <ul style="list-style-type: none"> • Project 1: Transformer Design using Finite Element Analysis (FEA). • Project 2: Control and Design of high frequency unfolded based isolated DC-DC converters. • Project 3: Planar Inductor Design using ANSYS MAXWELL. • Project 4: Single-stage isolated AC-DC converters for railway traction application
2017-18	<p>COMPARISON OF DIFFERENT MODULATION STRATEGIES FOR 3-PHASE VOLTAGE SOURCE CONVERTER PE Lab, NIT Srinagar</p> <ul style="list-style-type: none"> • Various modulation techniques of a three-phase voltage source converter were compared, analyzed and examined for their performance in generation for a sinusoidal output. Modulation techniques include Sine-PWM, Space-vector PWM, Delta-Sigma, Model Predictive Control and Modulated Model Predictive Control. • MATLAB/Simulink and Hardware implementation of different modulation techniques was verified on 1kW IGBT based 3-Phase VSI using D-Space(RTI 1104)

INDIVIDUAL PROJECTS

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- DESIGN AND ANALYSIS OF NON-LINEAR PLANAR INDUCTOR USING ANSYS MAXWELL AND KICAD
 - DESIGN OF ISOLATION TRANSFORMER FOR FLYBACK CONVERTER USING ANSYS MAXWELL (PE-MAG)
 - DESIGN OF 100kW IPMSM USING ANSYS MAXWELL (RMXPRT)

PATENTS

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- B. Singh, B.K.Panigrahi **M. Z. Farooqi**, *Single phase single stage isolated bidirectional converter for dc-link capacitor reduction*, Indian Patent Application No. 202111058797.
 - B. Singh, B.K.Panigrahi **M. Z. Farooqi**, *Electronic Capacitor based Full-bridge Integrated Isolated DC-DC Converter with Power Decoupling Unfolder Circuit*, Indian Patent (Submitted).

PUBLICATIONS

Selected Publications

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- [J1] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, "Robust Control for Enhanced Dynamic Performance of CRM based Active Power Decoupling Circuit," in *IEEE Transactions on Industrial Informatics*, Early Access (**IF:12.3**). [Link](#)
 - [J2] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, "Reduced Sensor-Based Model Predictive Control of Power Decoupling Circuit for On-Board EV Charger," in *IEEE Transactions on Transportation Electrification*, vol. 9, no. 2, pp. 2104-2114, June 2023. (**IF:7.0**). [Link](#)
 - [J3] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, "Performance Enhancement of Single-Phase Two-stage AC-DC Converter with Reduced DC-link Capacitance," in *IEEE Transactions on Industry Applications*, Early Access. (**IF:4.4**). [Link](#)
 - [C1] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, "Model Predictive Control for Modular Electric Vehicle Charger," in *2020 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, Jaipur, India, 2020, pp. 1-6.. [Link](#)
 - [C2] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, "Input Power Quality Control of Integrated On-Board Charger with Reduced DC-link Capacitance," in *2021 IEEE Energy Conversion Congress and Exposition (ECCE)*, Vancouver, BC, Canada, 2021, pp. 1669-1674. [Link](#)

Journal papers

- [J4] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, “Enhanced Control and Modulation of On-Board Integrated EV Charger with Active Power Decoupling Capability,” in *IEEE Transactions on Transportation Electrification*. **(IF:7.0)**(Under Review: TTE-Reg-2023-03-0514.R1)
- [J5] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, “Integrated Electronic Capacitors based Split BES-assisted Modular Multi-Port Power Electronic Transformer for Fast EV Charging Station,” in *IEEE Transactions on Industrial Electronics*. **(IF:7.7)**(Under Review: 2023-TIE-2990)

Conferences Papers

- [C3] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, “A Multiport EV-Fleet Charging Station Based on Modular Multilevel Converter,” in *2021 IEEE 12th Energy Conversion Congress & Exposition - Asia (ECCE-Asia)*, Singapore, Singapore, 2021, pp. 1765-1770. [Link](#)
- [C4] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, “Bi-Directional Isolated EV Charger with Reduced Switch Count and DC-link Capacitance,” in *2021 IEEE 6th International Conference on Computing, Communication and Automation (ICCCA)*, Arad, Romania, 2021, pp. 189-194. [Link](#)
- [C5] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, “Modified MPC Approach to Single-Phase Two-Stage AC-DC Converter for Reduced DC-link Capacitance,” in *2022 IEEE Global Conference on Computing, Power and Communication Technologies (GlobConPT)*, New Delhi, India, 2022, pp. 1-6. [Link](#)
- [C6] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, Rohit Kumar, “Single-Stage Isolated Bidirectional Soft-Switched AC-to-DC Converter with Active Power Decoupling,” in *14th IEEE Energy Conversion Congress and Exposition (ECCE)*, Nashville, TN, USA, 2023, (Accepted-Oral Presentation).
- [C7] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, Rohit Kumar, “Active Power Decoupling in Cascaded H-Bridge Converter using Secondary-Stage Isolated DC-DC Converters,” in *IEEE IAS Annual Meeting 2023 (IASAM)*, Omni Nashville, TN, USA, 2023, (Accepted-Oral Presentation).

COURSES TAKEN

- Digital Control of Power Electronics [Spring 2019]
- Switched-Mode Power Conversion [Spring 2019]
- Computer-Aided Design of Electric Machines [Spring 2019]
- Dynamic Modelling and Control of Grid Connected Converters [Spring 2019]
- High Power Converters [Fall 2019]
- Selected Topics in Power Electronics [Fall 2019]
- Selected Topics in Control Systems [Fall 2019]
- WBG based Soft-Switching Converters [Spring 2020]
- Resonant Power Conversion and Wireless Power Transfer [Fall 2023]

COURSE PROJECTS

- **HARDWARE IMPLEMENTATION AND ASSOCIATED CONTROL OF SOLAR PV BASED SINGLE-PHASE GRID CONNECTED DC-AC INVERTER** [2019]
Hardware Design, and Micro-controller Coding of wide-band based d 2kW DC-AC Grid Connected Inverter with improved performance under weak grid conditions

Advisor: Prof. Ramkrishan Maheshwari,

- COMPARISON OF DIFFERENT MODULATION STRATEGIES FOR ENHANCED DC UTILIZATION [2018]
Different modulation techniques such as SPWM, SVM PWM, Hysteresis modulation technique, 3rd harmonic injection, Delta Sigma Modulation, Predictive Control Modulation & Modified Predictive Control Modulation implementation and verification on 1 kW IGBT based hardware prototype.

Advisor: Prof. T.N.Mir

- ANALYSIS & DESIGN OF INTERLEAVED BOOST CONVERTER FOR ELECTRIC VEHICLE CHARGING [2019]

Controller Design of 10kW EV charger operating at 100kHz in discrete-time domain

Advisor: Prof. S.S. Nag

TEACHING EXPERIENCE

- Introduction to Electrical Engineering (ELL101)
- Introduction to Electrical Engineering Lab (ELP101)
- Electromechanics Laboratory Lab (ELP203)
- Electric Drive Systems (ELL752)
- Electrical Machines Lab (ELP850)
- Electric Drives Lab (ELP852)

AFFILIATIONS

- IEEE *Member*
- IEEE IAS *Member*
- IEEE PES *Member*
- IEEE Young Professional *Member*
- Reviewer *IEEE Transactions on Power Electronics*
- Reviewer *IEEE Transactions on Industrial Electronics*
- Reviewer *IEEE Transactions on Industry Applications*
- Reviewer *IET Power Electronics*
- Reviewer for Conferences: *APEC-2022, ITEC-2023, ECCE-2022-23.*

TALKS AND SEMINARS

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| Oct, 2023 | <i>Poster Presentation at IEEE IAS-AM 2023</i> on Integrated-Isolated Electronic Capacitor for DC-DC Power Conversion in Multi-level AC-DC-DC Converters. |
| April, 2023 | <i>Invited talk at JNTU, Kakinada, AP</i> on Implementation and Design of Isolated DC-DC Converters. |
| Feb, 2023 | <i>Invited talk at JNTU, Kakinada, AP</i> on Design and Implementation of Digital Controller for DC-DC & AC-DC Converters. |
| Oct, 2022 | <i>Invited talk at NITTTR, Chandigarh</i> on Control and Stability Analysis of Switched Mode Power Converters. |
| Oct, 2021 | <i>Paper Presentation at IEEE ECCE-US 2021</i> on Reducing DC-Link Capacitance in EV Chargers. |
| May, 2021 | <i>Paper Presentation at IEEE ECCE-Asia 2021</i> on Isolated Multilevel EV Chargers. |
| Dec, 2020 | <i>Paper Presentation at IEEE PEDES 2020</i> on Model Predictive Control in Multilevel EV Chargers. |

AWARDS AND CERTIFICATES

- 2023 *Graduate Student Grant* in IEEE Industry Applications Society (IAS) Annual Meeting 2023.
2023 *Research Excellence Travel award (RETA)* in IIT Delhi-2023.
2021 *Research Scholar Travel Award (RSTA)* in IIT Delhi-2021.
2018 *4th Rank* in the class of 75 students (B.Tech) in NIT Srinagar-2018.
2023 *Ansys Maxwell: High Frequency Power Magnetics* by Udemy (Online)

TECHNICAL SKILLS

SILICON CARBIDE BASED PE CONVERTERS	<i>Single-phase PFC based AC-DC Converter for bidirectional Power Flow</i> <i>Dual-Active Bridge for EV Charging</i> <i>Power Electronics based Capacitors</i> <i>Soft-switching in DC-DC Converters for Improved Efficiency</i>
GATE DRIVER DESIGN	<i>Gate Driver Design with De-saturation, and Over-current Protection</i> <i>Triggering 5kW SiC based Converter with 100kHz Switching Frequency</i>
DSP, FPGA & DSPACE	<i>Implementation of advance techniques for controlling PE converters</i>
CURRENT/VOLTAGE SENSOR	<i>Sensors with 1MHz bandwidth for controlling PE Converters</i>
MODELLING AND DESIGN	Multiphysics modelling ANSYS MAXWELL, PEMag and RMXprt Simplorer (for interfacing ANSYS and MATLAB)
CIRCUIT AND PCB	Circuit designing and verification in Simplis, and LT-spice PCB designing in KiCad, Design Spark, and Altium Designer
PROGRAMMING	Proficient in C & Embedded C, Intermediate knowledge of Python

REFERENCES

- **Prof. Bhim Singh (Ph.D. Supervisor)**
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Department of Electrical Engineering
Indian Institute of Technology Delhi, India
- **Prof. Bijaya Ketan Panigrahi (Ph.D. Supervisor)**
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HOD, Centre for Automotive Research and Tribology
Indian Institute of Technology Delhi, India
- **Dr. Tabish Nazir Mir (B.Tech Supervisor)**
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Department of Electrical and Electronic Engineering
University of Nottingham, United Kingdom