Andrea **Volpini**

Post-Doc Researcher ·

(+39) 3395319084 | andrea.volpini01@universitadipavia.it | andrea-volpini-8981781b8 | Andrea Volpini

Summary

I am a Ph.D. candidate at the Power Electronics Laboratory (PELAB) at the Department of Electrical, Computer and Biomedical Engineering of the University of Pavia. I earned a B.Sc. in Industrial Engineering in 2019 and an M.Sc. in Electrical Engineering in 2022 at the aforementioned university.

Education

University of Pavia

Pavia, Italy

Ph.D. in Electronics, Computer Science and Electrical Engineering — *Oct. 2022 - ongoing*

- Thesis: "A Full GaN Input-Series-Output-Parallel LLC Resonant Converter for Motorsport Applications" - Supervisor: Prof. Pericle Zanchetta, Co-Supervisor: Dr. Giulia Tresca.
- The focus of my Ph.D. research is developing an LLC Resonant Converter in Input-Series-Output-Parallel configuration using Gallium Nitride (GaN) devices for DC-DC conversion in motorsport applications.
- This Ph.D. program is conducted in collaboration with the multinational company Marelli S.p.A.
- This activity covers all key aspects of Power Electronics, including design, assembly, debugging, testing and control of power converters.
- Additionally, I have supervised B.Sc. and M.Sc. students during their thesis projects.

University of Nottingham

Nottingham, United Kingdom

Visiting Ph.D. Student — *Apr. 2024 - Sep. 2024*

- Supervisors: Dr. Liliana De Lillo and Prof. Lee Empringham, Co-Supervisor: Dr. Stewart Marchant.
- I joined the globally renowned Power Electronics and Machines Center at the University of Nottingham for a research visit.
- Gained experience in designing Printed Circuit Boards (PCBs) using Altium software, assembling them through soldering, and performing hardware debugging.

University of Pavia

Pavia, Italy

M.Sc. in Electrical Engineering [Final Grade 110/110 with Honors] — *Sep. 2019 - Apr. 2022*

- Thesis: "Advanced Model Predictive Control of a double-stage isolated AC-DC Converter for Vanadium Redox Flow Battery Applications" - Supervisor: Prof. Pericle Zanchetta, Co-Supervisor: Dr. Riccardo Leuzzi.
- Developed expertise in Electrical Engineering topics, including Electrical Motors and Drives, Power Electronics, Electromagnetic Fields, and Electric Power Systems, supplemented by advanced courses in Control Theory and MEMS sensors.
- My thesis involved designing a Model Predictive Control (MPC) algorithm for a double-stage bidirectional electronic converter for integrating Vanadium Redox Flow Batteries into the electrical grid. This single-controller MPC approach achieved faster response times compared to traditional PI-based schemes. Tools utilized: MATLAB and Simulink for parameter initialization and MPC implementation, and PLECS Blockset for electrical power system simulations.

University of Pavia

Pavia, Italy

B.Sc. in Industrial Engineering [Final Grade 110/110 with Honors] — *Sep. 2016 - Sep. 2019*

- Thesis: "Design of a Luminous Intensity Sensor (Optimized for Indoors)" - Supervisor: Prof. Piero Malcovati, Co-Supervisor: Prof. Marco Grassi
- Gained foundational knowledge across Industrial Engineering disciplines, spanning theoretical topics like Calculus and Physics to practical areas such as Thermal and Electrical Machines, Electronics, Energy Conversion, and Fluid Dynamics.
- For my thesis project, I programmed an Arduino microcontroller to measure luminous intensity in indoor environments. This involved comparing various analog circuits, utilizing operational amplifiers, photodiodes, and photoresistors, to obtain voltage measurements convertible to luminous intensity.

Professional Experiences

Researcher on DORNA Project (Project no. 872001)

Nottingham, United Kingdom

MATLAB, Simulink, LTSpice, Altium, LabVIEW, Power Electronics, Control Theory — *Apr. 2024 - July 2024*

- Design control and reliability of GaN based resonant multilevel converter structures for automotive applications.
- Design and realization of the GaN prototype.
- Design and implementation of the control architecture.
- Control algorithm implementation using LabVIEW.

Postgraduate Researcher

Pavia, Italy

MATLAB, Simulink, Simscape, Power Electronics, Control Theory — *May 2022 - Sep. 2022*

- Worked on the "Project, Simulation and Control of a Power Supply for an Electric Arc Furnace" project.
- Worked for the conference paper "A Unified Model Predictive Control for the Grid Integration of Vanadium Redox Flow Batteries".

Reviewer of Conference and Journal papers

IEEE *Apr. 2023 - ongoing*

- Reviewer for the IEEE Journal "IEEE Transactions on Industry Applications".
- Reviewer for the IEEE Journal "IEEE Open Journal of Industry Applications".
- Reviewer for the Conference "EPE'23 ECCE Europe".
- Reviewer for the Conference "ECCE24".

Projects

Design and Realization of an Input-Series-Output-Parallel LLC Resonant Converter *Pavia, Italy*

MATLAB, Simulink, LTSpice, Altium, LabVIEW, Power Electronics, Control Theory *Oct. 2022 - ongoing*

- Main PhD project in collaboration with Marelli Europe spa, aimed at the design and realization of an Input-Series-Output-Parallel (ISOP) LLC Resonant Converter.
- Simulations based in MATLAB/Simulink with PLECS Blockset and in LTSPice environments.
- Converter PCBs designed with Altium.
- Control system and modulator designed with LabVIEW and deployed on an FPGA board.

Real Time Simulation for Hardware-in-the-Loop Tests of an Enhanced-STATCOM Application *Pavia, Italy*

MATLAB, Simulink, Simscape, Real-Time Simulations, Power Electronics, Control Theory *Oct. 2024 - ongoing*

- Research project in collaboration with Nidec ASI, aimed at the development of a real-time simulation for a STATCOM.
- The converter under analysis is based on a Cascaded H-Bridge to interface supercapacitors with the high voltage grid.

Improved Synchronization Techniques in a Weak Naval Grid *Pavia, Italy*

MATLAB, Simulink, Simscape, Power Electronics, Control Theory *Jan. 2023 - Aug. 2023*

- Research project in collaboration with Nidec ASI, aimed at the analysis of the synchronization techniques in a naval grid.
- An improved synchronization technique based on a state-feedback Phase Locked Loop (PLL) has been adopted.
- All the simulations have been executed with MATLAB and Simulink softwares.
- The results showed how the improved synchronization technique could stabilize a system that was unstable with the conventional techniques.

Project, Simulation and Control of a Power Supply for an Electric Arc Furnace *Pavia, Italy*

MATLAB, Simulink, Simscape, Power Electronics, Control Theory *May 2022 - Jan. 2023*

- Research project in collaboration with Nidec ASI, aimed at the development of an electronic power converter for an electric arc furnace. The target was to improve the former situation where the load was connected to the electrical grid through a dedicated variable transformer.
- The control scheme under research has the purpose to generate a three-phase voltage to maximize the active power transferred to the load, and a closed-loop to limit the phase current.
- Furthermore, a theoretical analysis has been developed, aimed at defining how a negative voltage sequence can increase the active power transferred to the load during unbalanced load scenarios.
- In a first time, all the simulations have been executed with MATLAB and Simulink softwares.

Publications

- **A. Volpini**, S. Rokocakau, G. Tresca, F. Gemma, and P. Zanchetta, "ANN-Enhanced Modulated Model Predictive Control for AC-DC Converters in Grid-Connected Battery Systems," in Energies, 2025, 18, 3996, doi:10.3390/en18153996.
- **A. Volpini**, G. Tresca, F. Gemma and P. Zanchetta, "Performance Assessment of ISOP LLC with Buck-Boost Post-Regulator and ISOP LLC-DAB," 2025 International Conference on Clean Electrical Power (ICCEP), Villasimius, Italy, 2025, pp. 20-27, doi: 10.1109/ICCEP65222.2025.11143669.
- F. Shamsazad, S. Rokocakau, **A. Volpini**, G. Tresca and P. Zanchetta, "A Data-Driven Fault Diagnostics Approach for Dual Active Bridge Converters," 2025 IEEE Industry Applications Society Annual Meeting (IAS), Taipei, Taiwan, 2025, pp. 1-8, doi: 10.1109/IAS62731.2025.11061511.
- **A. Volpini**, S. R. D. Salvo, G. Tresca, R. Leuzzi and P. Zanchetta, "A Unified Modulated Model Predictive Control for a Two-Stage AC–DC Converter Interfacing a Vanadium Redox Flow Battery," in IEEE Transactions on Industry Applications, vol. 61, no. 4, pp. 6556-6566, July-Aug. 2025, doi: 10.1109/TIA.2025.3548583.
- **A. Volpini**, G. Tresca, S. Campailla, A. Dappiano and P. Zanchetta, "Optimal Module Count for ISOP LLC Resonant Converters based on an HF Transformer Genetic Algorithm Optimization in Motorsport Applications," 2024 IEEE Energy Conversion Congress and Exposition (ECCE), Phoenix, AZ, USA, 2024.
- F. Gemma, J. Riccio, G. Tresca, **A. Volpini** and P. Zanchetta, "Finite-Control-Set Model Predictive Control with Reduced Computational Burden in Cascaded H-Bridge Permanent Magnet Synchronous Motor Drives for EV Applications," 2024 IEEE Energy Conversion Congress and Exposition (ECCE), Phoenix, AZ, USA, 2024.
- R. Leuzzi, **A. Volpini**, S. R. Di Salvo, G. Tresca and P. Zanchetta, "A Unified Model Predictive Control for the Grid Integration of Vanadium Redox Flow Batteries," 2022 IEEE Energy Conversion Congress and Exposition (ECCE), Detroit, MI, USA, 2022, pp. 1-8, doi: 10.1109/ECCE50734.2022.9947417.
- **A. Volpini**, S. Granata, G. Postiglione and P. Zanchetta, "Negative Voltage Sequence Control for an Electric Arc Furnace Power Supply based on a Multilevel AC-AC Converter," 2023 IEEE Energy Conversion Congress and Exposition (ECCE), Nashville, TN, USA, 2023, pp. 2817-2824, doi: 10.1109/ ECCE53617.2023.10361978.

Undergraduate Projects

A five-level Vienna type rectifier and a comparison with other AC/DC converters

Pavia, Italy

MATLAB, Simulink, PLECS, Power Electronics, Control Theory — *Jan. 2022 - Mar. 2022*

- The purpose of the project was to investigate the five-level Vienna type rectifier existing in literature and to compare it with other AC/DC converters
- To control the converter two schemes have been proposed: one based on a hybrid PI-MPC controller, the other based on a unique MPC algorithm
- The five-level converter showed improvements in the power quality (lower THD) with comparison to a diode bridge rectifier and to a two level active rectifier

Analysis of voltage harmonics on an induction motor

Pavia, Italy

MATLAB, Electrical Motors — *Nov. 2020 - Dec. 2020*

- The purpose of the project was to investigate the effects of a distorted voltage supply on a single-phase induction motor
- For each voltage harmonic it was found the current harmonic absorbed by the motor, and the corresponding torque curve
- Then, by the principle of superposition of effects, the total torque developed by the motor
- This analysis was done with MATLAB

Design of a Single-Phase Grid Connected Inverter

Pavia, Italy

PLECS, Power Electronics, Control Theory — *Aug. 2020 - Sept. 2020*

- In this project a single-phase inverter has been designed to connect a photovoltaic system with a single-phase grid
- According to some requirements on the voltage and current ripples, an LC filter has been designed and later the correct sizing was verified
- The control signals for the inverter came from a control scheme, in which there was an external voltage loop and an internal current loop
- The project has been entirely done in PLECS

Identification Problem: Current Synthesis in a Fixed Geometry Coil, carried out with SVD

Pavia, Italy

MATLAB, Optimal Design in Electromagnetism — *May 2020 - July 2020*

- The project was aimed at finding the current density values to apply in each turn of a coil to reach a given induction target on the axis
- A numerical method (i.e. Singular Value Decomposition) has been applied, and the solution found was further investigated by varying the number of singular values kept

Design and Simulation of Bath Plate

Pavia, Italy

MagNet, Numerical Methods in Electromagnetism, Finite Element Analysis — *Feb. 2020 - July 2020*

- The scope of the project was the geometry design of a problem called ”Bath Plate”
- MagNet, a Finite Element Analysis software, was used to evaluate the induced current, the magnetic induction and the penetration depth of the fields in the material; this last result has been compared with the one obtained according to theoretical calculations

Languages

- Italian language: Mother tongue level
- English language: Advanced level
- Spanish language: Beginner level

Softwares

- MATLAB: advanced knowledge
- Simulink: advanced knowledge
- PLECS: advanced knowledge
- LTSpice: advanced knowledge
- RT-Lab: advanced knowledge
- Altium: intermediate knowledge
- LabVIEW: intermediate knowledge
- LabVIEW real-time and FPGA modules: intermediate knowledge
- MagNet: advanced knowledge
- ElecNet: advanced knowledge
- Autodesk Inventor: basic knowledge
- Microsoft Office: advanced knowledge
- LaTeX: advanced knowledge

Extracurricular Activity

Private Tutor

Italy

Private — *July 2016 - Sep. 2022*

- High School private tutor in: Mathematics, Physics and IT
- University private tutor in: Calculus, Linear Algebra, Statistics, Control Theory Fundamentals, Physics, Electrical Engineering Fundamentals and Electronics

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