INTERNSHIPS AND RESEARCH PROJECTS

APPLIED PROJECTS IN POWER ELECTRONICS

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Addressed to: Any R&D-performing academic institution or industrial company

CONTROL OF A DOUBLY-FED INDUCTION GENERATOR (DFIG) FOR WIND TURBINES

Motivations: Imperix wishes to develop application examples that demonstrate the capabilities of its digital controllers in various types of applications.

Objectives: Implement with the B-Box RCP a working example of a complete closed-loop vector control for an DFIG. This includes the coding of the converter control as well as its practical validation on a Hardware-In-the-Loop (HIL) simulator.

Skills: A solid knowledge of power electronics and drives is required.

Level: This project is best addressed by a master-level student.

MODEL-PREDICTIVE CONTROL (MPC) OF A NEUTRAL-POINT-CLAMPED (NPC) INVERTER

Motivations: The fast advance of power electronics imposes imperix to continuously confront its hardware and software to the evolution of control techniques. This contributes to grow its expertise in the field as well as provide detailed performance validation for specific cases and conditions.

Objectives: Implement with the B-Box RCP a working converter control using Model Predictive Control techniques (MPC). A basic three-phase grid-tied inverter can be considered, as well as a three-level Neutral-Point-Clamped topology (NPC). This project can be done either in C/C++ or Simulink, and be implemented to Hardware-In-the-Loop (HIL) simulation or a low-power prototype (2kW), or both.

Skills: Prior knowledge of Model-Predictive Control (MPC) highly recommended.
A solid general knowledge of power electronics is also required.

Level: This project is best addressed at the end of master-level studies.

MODELING AND SIMULATION OF IMPERIX POWER CONVERTER PRODUCTS

Motivations: Imperix would like to develop accurate simulation models of its power modules, as well as of the resulting power converters. To this end, functional aspects should be taken into account, as well as conduction and switching losses.

Objectives: Develop an experimental test-bench in order to characterize existing power modules. Then, a measurement campaign will allow establishing more or less detailed simulation models, which will be complemented by surrounding passive elements (inductor, capacitors, etc.). In the end, the student should contribute to implementing a Simulink/PLECS library of most imperix products.

Skills: A good general knowledge of power electronics is recommended. Prior experience with Simulink and/or PLECS is recommended.

Level: This project is targeting a master student interested in both modeling and experimental activities.

CONTROL DESIGN AND IMPLEMENTATION FOR A LLC RESONANT DC/DC CONVERTER

Motivations: Imperix publishes several application examples on its online knowledge base. This documentation is provided together with the corresponding source code (Simulink / PLECS / C++), so that the developement of control software can be facilitated for its customers. This project aims to develop one of such application examples.

Objectives: Develop and implement control for an LLC-based DC/DC converter. After conducting computer-based simulations, implement a laboratory-scale prototype and validate the developed software experimentally. A fast battery charger will be used as an application.

Level: This project is best addressed during master-level studies.

Skills: Some prior knowledge of power electronic control and design is required.

CONTROL OF A MULTILEVEL STATIC VAR COMPENSATOR (STATCOM)

Motivations: Imperix publishes several application examples on its online knowledge base. This documentation contributes to facilitating control implementation efforts for existing customers, as well as showcasing the capabilities of imperix solutions to future customers. The project results shall be published as one of such examples.

Objectives: Design and implement suitable control algorithms for a multilevel converter based on cascaded H-bridges. After computer-based simulations, implement a laboratory-scale prototype using imperix products. Validate experimental the implemented software.

Skills: Some prior knowledge of power electronic control and design is required.

Level: This project should preferentially be addressed by a master student.

CONTROL DESIGN AND IMPLEMENTATION OF A TOTEM-POLE RECTIFIER

Motivations: Imperix wishes to develop application examples that demonstrate the capabilities of its digital controllers in various types of applications. Such examples are often published on the online knowledge base so that they can serve as a basis for control implementation by imperix customers. This project aims to develop one of such application examples.

Objectives: Design and implement control for a totem-pole rectifier. Validate experimentally the control software on a low power prototype, implemented using imperix products.

Skills: Some prior knowledge of power electronic control and design is required.

Level: This project can be addressed by a bachelor student.

AUTOMATED IDENTIFICATION OF MACHINE PARAMETERS FOR MOTOR DRIVES

Motivations: Imperix wishes to develop a Simulink-based automated machine parameters identification protocol for both permanent magnet and induction motors. This protocol could eventually serve for self-testing and -commissioning procedures.

Objectives: Extend the existing Field-Oriented Control (FOC) examples to include autonomous identification of the machine parameters. This includes the coding of the converter control as well as its practical validation on a motor testbench.

Skills: Good prior knowledge of power electronic drives and their control is required.

Level: This project is best addressed by a master student.

COORDINATED AC VOLTAGE CONTROL OF MICROGRID-CONNECTED INVERTERS

Motivations: Imperix wishes to further explore control techniques for the voltage control of AC microgrid when multiple grid-forming inverters are operated in parallel.

Objectives: Review the existing literature on the voltage control of non-inertial power systems. Develop suitable simulation models and implement selected voltage control techniques. Validate experimentally the implemented control algorithms using multiple laboratory-scale inverters in grid-connected and islanded mode of operation.

Skills: A solid theoretical background on the control of power electronics and power systems is required. Prior experience with experimental activities is a plus.

Level: This project is best addressed at the end of master-level studies.

REAL-TIME CONTROL INTERFACES FOR DISTRIBUTED GENERATION UNITS

Motivations: Imperix has developed embedded control software for its power converters when used in grid-tied applications (electrical grid, microgrid, or islanded mode). However, no user-friendly interface is currently available to easily monitor and interact with the power converters in such applications.

Objectives: Review existing tools and approaches for building user-friendly graphic interfaces together with imperix products (Matlab App Designer, LabView, responsive web app, etc.). Identify key configuration and monitoring parameters for conventional DG units (solar, wind, energy storage, etc.). Implement GUIs for selected scenarios and implement modeling support when needed (e.g. battery charge or wind profiles, etc.). Validate experimentally the proper operation of the developed GUIs.

Skills: Some prior knowledge of both power electronics and power systems required.

Level: This project is best addressed by a master student.

OPTIMIZED PULSE PATTERNS FOR THE MODULATION OF HIGH POWER CONVERTERS

Motivations: Imperix wishes to improve its existing modulator dedicated to low pulse number applications (e.g. high power converters or high-speed drives). Notably, improved ease of use is desired for designing and programming optimized pulse patterns, such as selective harmonic elimination (SHE).

Objectives: Review the existing software and firmware. Implement and document a framework for assisting users with the derivation and implementation of optimized pulse patterns. If needed, improve the existing FPGA-based firmware. Validate in a Hardware-In-the-Loop (HIL) configuration the implemented software and firmware.

Skills: A solid theoretical background in power electronics is required. Previous experience with FPGA firmware development is highly recommended.

Level: This project is best addressed by a master-level student.