



Research subject for a PhD position

From 1st of September 2021 to 1st of September 2024

Title:

Investigations on solid-state pulsed power for a multi-pulse Inductive Voltage Adder (IVA) application

Thesis abstract:

The pulsed power domain and more precisely the high-power switching are historically produced by gas-filled switches. For a long time, only gas-filled switches were capable of operating in such extreme regimes. Nevertheless, there are well-known disadvantages including low pulse repetition frequency, low lifetime and instability of triggering. The gas-filled switches are also expensive to use, typically requiring gas flow systems, often expensive gases and re-circulators for repetitive operation. These disadvantages introduce a barrier to the widespread of pulsed power technologies.

Recent success in semiconductor physics and technology allows to produce a revolution in pulsed power, similar to the effect in the past of replacing a vacuum tube by a bipolar transistor in microelectronics. Since many years, new large wideband power components (SiC, GaN) can reach voltage blocking and switching frequency at 3kV and 1MHz respectively while having reduced conduction and switching losses. Regarding the architecture and accumulation of power components, it should be possible to replace and improve each drawback caused by gas-filled switches.

That is why, the HiVoSS project aims at exploring innovative developments in high voltage solid switch domain which is derived of power components in order to affirm solid state switches could create breakthrough technology and offer new perspectives in the future development of solid-state pulsed power system (more compact, more integrated, more performant).

In this project, one PhD subject is dedicated to study these new pulsed power components, with the association of snubber, as a consistent switch module in order to shape the high voltage plateau of high-power pulses produced by Inductive Voltage Adder (IVA) generator.

Key words: solid-state, pulsed power, wideband components, control system

Funding: This position is funded by CEA and by the project E2S-UPPA.



Working conditions:

Hosting laboratory: SIAME

Localisation address: Technopole Hélioparc, 2 Av P. Angot, 64053 PAU CEDEX 9

Laboratory expertise:

This PhD will be hosted by the SIAME laboratory that is a research unit located in Pau, France. SIAME has got an extensive and highly competitive research program that encompasses fundamental research, particularly in electrical engineering. The PhD will conduct research in the High Voltage Processes team headed by Professor L. Pecastaing. This team works primarily in the field of pulsed power physics and technology.

More information on the research group is available on the website:

<https://siame.univ-pau.fr/fr/organisation/equipes/equipe-procedes-haute-tension.html>

Research collaborations

The PhD student will work within the common laboratory SAGE which is the association of SIAME laboratory and CEA. The French Alternative Energies and Atomic Energy Commission (CEA) is a key player in research, development and innovation in four main areas:

- Defence and security,
- Low carbon energies (nuclear and renewable energies),
- Technological research for industry,
- Fundamental research in the physical sciences and life sciences.

Drawing on its widely acknowledged expertise, CEA actively participates in collaborative projects with a large number of academic and industrial partners. More information is available from this website:

<http://www.cea.fr/english>

Thesis Director: Laurent Pecastaing, Laboratoire SIAME

Starting Date: September 1st, 2021

Duration: 3 years

Gross salary: 1 870 € / month (which includes extra gratification for teaching duties – 32h per year)



Mission - Main activities:

Scientific framework

In the framework of the E2S UPPA project, CEA and UPPA have decided to join forces to set up a research program around new solid-state topologies for pulsed power called High VOLTage Solid Switch (HiVoSS) within the common laboratory SAGE.

One of the subjects in the HiVoSS project is dedicated for this PhD position. Its research program is the development of a new solid-state switch module to control the quality of high voltage plateau of pulses provided by a 2.6 MV IVA generator located at CEA CESTA. The main idea is to use state resistors of SiC Mosfets (R_{on} & R_{off}) at precise moments to reduce voltage unevenness created by mismatches in the generator.

At the same time, the PhD student will have the possibility to work on the control system (hardware & software) needed to drive each power components. The switching duration needed to be fast, so this task will be performed by a SoC-FPGA platform.

Then, it will lead to the design of a new solid-state pulsed power architecture to deal with higher objectives, up to a 200kV regulation rate of several high voltage plateau pulses.

The Purpose(s)

The main aim of this thesis is to develop a high voltage breaker module with solid switch technology. The design of the solid switch will be the result of parallel/series architecture of multi module composed by large wideband components in order to reach the 200kV blocking voltage. Each of module will need to block voltage and current until at 20kV/30kV and 3/4kA respectively.

To reach this goal, the PhD subject will be divided in 4 axes:

1. Bibliography study about solid-state components and architecture candidates for such applications
2. Design of a first "low level" module (30kV/4kA)
 - a. Simulation, modelling and development
 - b. Experimentation and validation
3. Assembly of multi solid-state switches to build a 200kV full scale module
 - a. Simulation, modelling and development
 - b. Experimentation and validation
4. Coupling experimentations on a multi-pulse high power generator.



Applicant's profile:

The ideal candidate has a master degree in Electrical Engineering. She/he is passionate for innovation, news technologies, power electronics, rigorous and highly motivated. A previous experience in pulsed power applications and computer engineering would be a plus. The candidate must have a good English level and the capacity to work autonomously.

Application - Evaluation criteria:

Application file assessment: Selection committee

Candidates will first be selected based on their application file. Application files will be evaluated based on the following criteria:

- Grades and ranking during Master degree, steadiness in academic background
- English language proficiency
- Candidate's ability to present her/his work and results
- Work experience similar to an internship in a laboratory – or likewise; previously achieved research work (reports, publications).

Those selected after this first step will then be interviewed.

Application will include: (in a single pdf file)

- CV
- Cover letter
- Master degree grade transcripts and ranking
- Reference letter
- Contact details of at least two people, from you work environment, who can be contacted for further reference

Application must be sent to the following email address with the title "PhD position – HiVoSS project": jeanmarie.larbaig@univ-pau.fr

For more details, please visit our websites: <http://e2s-uppa.eu/en/index.html> and <https://siame.univ-pau.fr/>

Application deadline: 10 of May 2021