Design and characterization of an integrated current sensor for Additive Manufactured high voltage high current SiC smart Power Module

Context

A project leaded by DeepConcept(*) has been proposed for funding's. It deals with Additive Manufactured high voltage high current diode less SiC smart Power Module. The project is denoted AM:PM. They are three partners, 2 industrial partners (DeepConcept and Safran) and one academic (IETR Nantes). The LGP-ENIT is part of the project being a stakeholder (associated of DeepConcept) of a workpackage. The overall project aims to design an inverter leg 3,3kV @ 500A, with integrated cooling, full Sic and diode less technology. The innovative part will concern the packaging as the gate driver will be integrated, the insulating layer will face harsh aeronautic environments and sensors will be embedded. Most of these components should be achieved thanks to additive manufacturing. Transport applications are the main challenges that drive design AM:PM specification data.

In such a context, DeepConcept will work on module integration (material, geometry and processes), Safran will develop its expertise on additive manufacturing and the IETR will develop smart gate driver that will be finally integrated. LGP-ENIT will work as an associate into the integration workpackage for current sensor integration.

(*) https://www.deepconcept.fr/

Subject

The subject deals with the design of a current sensor. The sensor will be embedded (integrated) into the power module. The use of additive manufacturing will be studied to get an innovative sensor design. Among these process technics, alumina Selective Melting Laser will be specifically considered.

The project has already started. A previous work did a state of the art analysis for current sensing. It described possible technologies, along with practical developments for power electronics modules. Two main technologies were firstly selected: shunt measurement and Rogowski coils. After experimental characterizations, the development is now focusing onto wide frequency band Rogowski coils. The scientific and technical challenges to address deals with the sensor design as, sensitivity, bandwidth and modeling have to target a good accuracy.

The workload planning proposed for the Post-doc is:

- Design, and develop models for Rogowski based current sensor. Sensors should be made by additive manufacturing process (with support of other project partners). The design will be developed meanwhile integration process will be studied. Models should cover a wide frequency bandwidth.
- Experimentally characterization of isolated sensors (and their coupling mode if needed). Indicators of performance and sensor efficiency would be pointed out and analyzed: linearity, sensitivity, robustness, noise/measure ratio quantification.
- Experimental measurement on a functional power module.

Candidate profile

Diploma [1]

The candidate must justify a PhD diploma. The subject of the PhD must be related (at least partially) to current sensing (design - ideally -, or characterization and use), when applied to power electronics (ideally). The PhD subject can also be related to RF design and modeling of coils and transformers developed in power electronics application.

Main expertise (mandatory) [1]

- Electrical modeling, RF models (transmission line theory) and characterization techniques (Impedance analyzer, S-parameter, etc.).
- Electronic: circuit design.
- Signal analysis.
- Simulation and use of Scilab (or Matlab), LTSPICE.

Secondary field of knowledge[1]

- Microelectronic assembly (an extra plus will be an experience in integration processes and microelectronic)
- Power electronics basics
- Numeric modeling (3D) for full wave electromagnetic simulation and comparison (ADS).

Human skills expected[1]

- Willing to work in a team
- Ability of taking initiative
- Able to communicate with efficiency its scientific results.

Salary

The salary will be paid monthly for 12 months. It corresponds to the French public index: “Ingénieur d’étude”. Depending on the candidate experience a net salary between 1700 € to 2000 € per month will be proposed. The job can start in September 2021 or later following candidate profile and wish.

Location

Two places of work situated in the same town:

- Laboratoire Génie de Production, Ecole Nationale d’Ingénieurs de TARBES, 47 Avenue d’AZEREIX, 65000 TARBES, France;
- Plateforme PRIMES, 67 Boulevard Pierre Renaudet, 65000 Tarbes, France.

Contact

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Applications have to be done by e-mail until 16/07/2021. A curriculum vitae and a specific motivation letter must be inserted. The motivation letter must describe what in your knowledge and skills makes you the best candidate for the profile.

[1] Candidate applications will be considered when applicants match these items. The receipt notification for your application will send accordingly.