Master internship in university Paris-Saclay followed by a PhD at EPFL :

High voltage and low power supply for an augmented aorta dielectric elastomer

Contact : Morgan Almanza, Université Paris-Saclay, morgan.almanza@ens-paris-saclay.fr (and Yoan Civet at Ecole Polytechnique federale de Lausanne)

Electroactif polymers paves new way in the field of electromechanical energy conversion. Dielectric elastomer actuators are soft and show high-energy conversion. Recent work on cardiac assist device based on aorta augmentation are very promising (Almanza et al., n.d.). To be implanted, the assisted device need a compact and efficient high voltage, around 7 kV.

Bidirectionnal flyback (Ravi, Satpathy, and Lakshminarasamma 2020; Mottet et al. 2021) as well as H-bridge converter (Pniak et al. 2020) both use stacked MOSFETs to overcome voltage limitation of the MOSFET. Nonetheless their efficiency over a full cycle is rather low, around 15% and they are far from being compact. Recently the University Paris-Saclay in a collaboration with EPFL proposed an approach based on a modified Marx generator (Almanza et al. 2022) where the level are controlled and supply through a magnetic field. This new prototype reaches 88% efficiency while being controlled and powered through a wireless system.

Although we establish the proof of concept, several challenges remain to be solve, in particular when considering in-vivo implantation. The internship will be located in the university Paris-Saclay in the SATIE laboratory in Gif sur Yvette, France while the PhD will be located in EPFL in the LAI laboratory (Yves Perriard) in Neuchatel, Switzerland.

In the frame of this work various researches axes are possible, depending on the student backgrounds and affinities, however the following points must be tackled:

- Improve the integration and use flexible substrate to reduce device thickness
- Reduce the current leakage, exploit low power mode of microcontrollers and improve the control law to increase the efficiency
- Ensure the biocompatibility of the device in term of material and magnetic/electric field

The candidate need to have strong background at least in two of those fields : power electronics, electronics, microcontroller, wireless power transfer,

Bibliography

Almanza, Morgan, Francesco Clavica, Jonathan Chavanne, David Moser, Dominik Obrist, Thierry Carrel, Yoan Civet, and Yves Perriard. n.d. “Feasibility of a Dielectric Elastomer Augmented Aorta.” *Advanced Science* n/a (n/a): 2001974. https://doi.org/10.1002/advs.202001974.

Almanza, Morgan, Thomas Martinez, Mickael Petit, Yoan Civet, Yves Perriard, and Martino LoBue. 2022. “Adaptation of a Solid-State Marx Modulator for Electroactive Polymer.” *IEEE Transactions on Power Electronics* 37 (11): 13014–21. https://doi.org/10.1109/TPEL.2022.3183437.

Mottet, Raphaël, Morgan Almanza, Lucas Pniak, Alexis Boegli, and Yves Perriard. 2021. “Ultra-High-Voltage (7-KV) Bidirectional Flyback Converter Used to Drive Capacitive Actuators.” *IEEE Transactions on Industry Applications* 57 (5): 5145–56. https://doi.org/10.1109/TIA.2021.3094460.

Pniak, Lucas, Morgan Almanza, Yoan Civet, and Yves Perriard. 2020. “Ultra High Voltage Switch for Bidirectional DC-DC Converter Driving Dielectric Elastomer Actuator.” *IEEE Transactions on Power Electronics*, 1–1. https://doi.org/10.1109/TPEL.2020.2995047.

Ravi, Vaishnavi, Subhransu Satpathy, and N. Lakshminarasamma. 2020. “An Energy-Based Analysis for High Voltage Low Power Flyback Converter Feeding Capacitive Load.” *IEEE Transactions on Power Electronics* 35 (1): 546–64. https://doi.org/10.1109/TPEL.2019.2915565.