High efficiency and fault tolerant power converters for stationary and embedded applications

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Abstract :

The goals of this project are firstly to share and grow methods of design and analysis of fault tolerant and high efficiency power converters (from FEMTO-ST and LAPLACE laboratories) in case of faults on power switches (embedded or stationary) and secondly to bring out new methods for monitoring, detection and reconfiguration based on the complementary practices of the two research teams on two application systems, an embedded a) and a stationary b):

- a low voltage and high current system (for example a fuel cell or a battery) for DC/DC converter topologies where an important adaptability is mandatory for embedded application;
- a high voltage wind turbine system or a medium voltage photovoltaic system connected to the power grid for DC/AC three-phase converter topologies for the stationary application.

Studied converter topologies will be a four-phase interleaved boost converter with coupled inductors (for the DC/DC topology) and a hybrid NPC multi-level converter with a flying capacitor redundant leg (for the DC/AC topology).

The constraints and requirements on the design of static converters are not exactly the same depending on the application: embedded or stationary about the continuity of service. In fact, for an embedded application, the addition of components, whether passive or active to reconfigure the faulty converter will hardly be allowed due to an over-volume and an over-weight while for stationary application, it is quite possible to include a redundant leg in order to have the nominal operation after the fault detection and reconfiguration (in the case of the proposed hybrid converter). For an embedded converter, after the detection and isolation of fault, the reconfiguration will be mainly on the control to maximize the performances of the system and allow a degraded mode (in the case of the four-phase interleaved boost converter).