OPAL-RT TECHNOLOGIES

Success Story

APERT uses an OPAL-RT system for FPGA simulation of matrix power converters

The Applied Electronics Research Team (APERT) is formed by teachers and researchers of the Electronic Technology Area of the Electronics Department and all of them carry out their activities at the Faculty of Engineering of Bilbao, Spain. Part of the research work of APERT is focused on power and control circuits for energy converters

1. Challenge

Simulation of a model containing power converter is tedious. This is mainly due to two factors. On one hand, in most applications of the converters, the power semiconductors switch at a several kHz. Furthermore, the activation times of the semiconductors are some orders of magnitude less than the modulation period. As a consequence, in order to simulate the effect of the modulation, it is necessary that the mathematical equations describing the model are resolved in very short simulation steps, leading to long simulation times.

On the other hand, power converters are part of complex systems, such as a wind turbine. It consists of other parts such as turbine, PMSG, control algorithms, etc.

As a result, the model becomes more complicated, and the time required to solve the mathematical equations which describe it is lengthened even more. Likewise, considering that the validation of certain features may require very long simulation time, the model should be simulated in real time.

2. Solution

Shaping a tool to design and study various applications from renewable generation to transmission of electrical power

The APERT's research field is oriented to the design and study of power converters for renewable generation, conversion, storage and transmission of electrical power. Nowadays, the team is working in three specific topics:

- Matrix converters: Advanced direct AC/AC converter topologies including their modulation and control techniques (parallel connection, fault tolerant systems, etc.)
- Direct Current Transmission: Viability of new offshore transmission systems below 50 km transmission systems
- Small wind: New power conversion and control alternatives specifically adapted to low power wind converters

Enabling parallel execution

Using OPAL-RT eFPGAsim digital simulator and its parallel computing capability along with new averaging methods, real-time simulation of complex models with power converters have been performed. All these models have been built in MATLAB/Simulink™ and separated into two subsystems in order to maximize parallel execution.

Likewise, the control algorithms validated in simulation have been implemented in the eFPGAsim simulator giving rise to the Rapid Control Prototyping (RCP). To do this, the

modulation techniques for the power converters have been implemented in the OP5130 FPGA using eFPGAsim (RT-XSG).

"The simulator OPAL-RT has meant a boost in our research. This boost has resulted in improving the quality of our publications as well as in reducing the implementation time of our projects"

Iñigo Kortbarria
Doctor Ingeniero En Electrónica Industrial, APERT

.

3. Achievement

The simulation platform increases the speed of development and implementation of new control algorithms. Moreover, real time simulation allows validating all the functionalities of the application, including those that involve risk. Once control algorithms have been validated in simulation, RCP facilitates the implementation of these algorithms on a real prototype.