ABB

ABB uses an OPAL-RT real time simulator to validate controls of medium voltage power converters

ABB is a leader in power and automation technologies that enable utility and industry customers to improve performance while lowering environmental impact. The ABB Group of companies operates in around 100 countries and employs about 135,000 people. The company designs large electric conversion systems that enable the transformation of electric power into controlled power.

1. Challenge

ACS 6000 medium voltage drives from ABB deliver cutting-edge solutions for critical industrial applications (transportation, metals, etc.) that have to deal with high power and stability related problems.

To reach their objective, ABB needed tools sophisticated enough to design and perform highly detailed real-time simulation of power converters and to emulate their behaviors under critical and extreme conditions. The challenge was to offer a testing tool to assure that all converters were properly functioning and safe. ABB had very high expectations for the results.

It was a natural progression to ask OPAL-RT to design a real time digital simulator to set up and test the converters series. These converters connected to large electrical drives from 3 to 27 MW, provided new technical challenges to OPAL-RT's team:

- The real-time calculation must be very fast to catch up with the cycle time of the tested control units – no more than 25 microseconds cycle time

- The system contains a large number of tightly coupled power electronics switches (up to 80 IGCT and diodes) which are traditionally very difficult to simulate. With such a complex system, simulation time tends to be longer.
- Very fast sensor signals (encoders) and customized communication protocols (DDCS) have to be simulated.

2. Solution

When it comes to validating more complex topologies and control strategies in medium-voltage (MV) drives, a digital hardware-in-the-loop (HIL) simulator exhibits great advantage over a traditional analog test stand in terms of cost and flexibility. However, a significant effort to develop a proper solver and optimize the hardware and firmware design and fine-tuning of the model is required to maintain sufficient accuracy of the HIL test stand.

After a successful trial period, OPAL-RT has delivered to ABB a configuration corresponding to the full testing scope. The HIL simulator emulates electrical systems and physical phenomenon faster and more precisely than physical test stands alone. It enables us to:

- Simulate a converter and its connection to one or several electric drives,
- Do speed, performance and torque testing, when starting or while running,
- Conduct speed, performance and torque testing of the complete operating cycle,
- Assure that the electric conversion chain is functioning properly, regardless of the configuration that the end user may require,

- Conduct a series of tests under extreme conditions (unbalanced power supply, voltage sag) to validate the control and protection schemes.

Key features of ABB Medium-Voltage AC Drive ACS 6000
- Modular drive for single or multi-motor applications, 3 -27 MW
- For induction, synchronous and/or permanent magnet motors
- DTC control platform for exceptionally high torque and speed performance
- Common DC bus for single and multiple-motor operation and energy recuperation

3. OPAL-RT key features

eDRIVEsim HIL Simulator

eDRIVEsim™ is a scalable hardware-in-the-loop simulator for power electronics application that integrates:
- A powerful multi-processor real-time computer
- Direct integration with MATLAB/Simulink and SimPowerSystems
- RT-LAB integrated simulation environment with many features making model development and testing easier
- fast and reconfigurable I/O system based on Field Programmable Gate Array (FPGA)

ARTEMIS Real-Time Solver

An innovative power systems real-time solver which combines the classic nodal solution and state-space:

- Allow high order, high-stability discretization of the state-space
- Enable parallel computation of electric systems on different CPU cores

- Facilitate to decouple the circuit without any extra delay
- Enable to simulate a very large number of switches in real-time

EXU (Excitation Unit) Protocol Implementation
- Use of customizable FPGA found in OPAL-RT's standard I/O system
- FPGA firmware can be graphically designed with Xilinx Signal Generator toolbox under Simulink environment, and RT-XSG library from OPAL-RT

The close proximity of OPAL-RT Europe engineers ensures that all installation, training and technical support issues are handled quickly, eliminating the need to deal with overseas technical support. "The support is available from OPAL-RT so that is why I am happy about it: the dedication is there, the commitment is there"

4. Achievement

OPAL-RT simulators enable digital reproduction of all the system's electric converters, the network and one or several electric drives in order to test them in a highly detailed and accurate environment. The solution enables:

- Faster and more precise simulated environment
- Fast and very easy programming
- Conducting more tests in a shorter time
- Lowering costs, reducing risks and time-to-market cycle.

 "We've come a long way. There were several issues that had been troubling us in the past. OPAL-RT has worked to solve them – and the result is there. Thanks to OPAL-RT, our control engineers are working with the simulator on a day to day basis. That means the new algorithms we develop, the new control strategies we develop, and implement on our controllers, are now thoroughly tested on OPAL-RT's system. It is really an essential tool for us, applied on critical applications. It delivers a great performance that helps us to maintain such a high level of development."

"The solution is good and I am looking forward for the next project. We had a really good cooperation. The return on investment is good. I would recommend OPAL-RT internally, to colleagues or customers. I would point out the achievement we have had and the test results we have achieved, the performance of the system, and also the support".

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Ata Douzdouzani,
Medium-Voltage Drive Control System Team Leader
ABB Switzerland

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