OPAL-RT TECHNOLOGIES

Success Story

CSG uses OPAL-RT real-time simulators and FPGA MMC simulators to build and simulate the world's 1st 3-terminal MMC-based HVDC systems

CSG Technology Research Center is a branch company of China Southern Power Grid Co. Ltd. focusing on power grid technology research and development. Their researches mainly address power grid planning, construction, production, operation, and EHV DC power transmission.

1. Challenge

The challenges of CSG's three-terminal HVDC systems are that huge AC grids and offshore wind farms on the sea are connected to the systems. The sub modules of Modular Multilevel Converter (MMC) are more than 1200.

Thanks to OPAL-RT's real-time simulation technology, CSG can perform many complex tests safely as this is impossible to perform in a real power system. The platform based on OPAL-RT's real-time simulators provides a midway between laboratory tests and field tests.

2. Solution

A test method representative of real HVDC system

Nanao's HVDC system is the first multi-terminal HVDC project in the world. The design capacity of this project is 200,000 KW and the DC voltage level is ± 160 kV. It contains Qing'ao, Jinniu and Sucheng three converter stations.

OPAL-RT's real-time simulation technology simulates a real HVDC system which contains AD and DC grid, offshore wind farms on the sea, DC cables, MMC stations. Real-time simulators are connected to CSG's control and protection units. The test method, which is closest to the actual, provides comprehensive tests and preparation for Nanao's HVDC system before it runs on a real grid.

The real-time systems of HVDC based on OPAL-RT's CPU and FPGA platforms

The AC and DC grid are computed on real-time CPU targets. OPAL-RT and KELIANG chose the FPGA to simulate MMC because of the huge sub-modules included in each MMC station. The simulation time step on the FPGA emulator can be as low as 250ns.

New communication methods solve the bottleneck that number of digital I/Os is limited in traditional real-time simulation

Digital I/Os are passed through digital boards in traditional MMC-HVDC real-time simulation. Using this technique, it is difficult to increase the size of MMC simulation system because of the great number of signals that are required. OPAL-RT uses a rapid optical fiber based communication protocols to connect MMC FPGA models and CSG's MMC control units. This new means of communication solves the difficulty in expanding the number of I/Os and also improves the stability of the entire system.

Tests of the control and protection units used in HVDC system & experiments of AC and DC grids faults in the whole HVDC real-time simulation

The functions of the entire control and protection equipment are validated based on OPAL-RT's real-time simulation technology and hardware. The entire real-time simulation system can be used to simulate AC and DC faults in HVDC system and these tests are not possible in the actual system.

3. Achievement

Based on OPAL-RT's closed-loop real-time simulation system, CSG, with the help of KELIANG, considers this platform to reproduce a realistic power system. This gives the possibility to perform many test safely and achieve accurate and realistic results as close to real-life as possible. The OPAL-RT real-time simulation platform based on FPGA and CPU is essential to:

- Perform high speed simulation and achieve high accuracy results;
- Perform complete and comprehensive tests for control and protection equipment in Multi-terminal HVDC systems;
- Shorten the design cycle and provide a reliable assurance for running multi-terminal HVDC system