



**RSE Uses OPAL-RT Real-Time Simulator
to Develop and Test Universal
Compensator Controllers**

1. Context

Ricerca sul Sistema Energetico - RSE SpA - is a joint stock company involved in electro-energy research, with particular focus on the strategic Italian national projects of general public interest, financed by the Italian Electricity System Research Fund (Fondo per la Ricerca di Sistema) of the Italian Economic Development Ministry.

2. Challenge

Power electronics for Power Quality improvement

Power Quality (PQ) is becoming a very important topic in electric distribution due to the increasing number of electronic loads, which are sensitive loads that create disturbances. Power electronics converters are gaining importance as active systems for PQ improvement, since they offers a great flexibility and can be configured as Universal Compensators (i.e. systems able to compensate load harmonics, unbalances, reactive power, flicker, etc.). Such systems can also be employed to supply loads in islanded mode, when grid disturbances occur. Developing and implementing compensator controls are challenging tasks, since they involve complex and heterogeneous functions and high switching frequencies (up to tens of kiloHertz). Moreover, laboratory testing of control prototypes is very difficult, due to risk of failures that can result in damages to both power electronics devices, loads and even grids.

3. Solution

Control Hardware-In-the-Loop simulation as a test bed

Federico Belloni, T&D researcher at RSE explained his reasons for opting for a real-time simulator to conduct research: “Assessing the feasibility and the performances of a Universal Compensator controller can gain great benefits from the availability of a real-time simulator able to reach simulation step down to tens of microseconds, like the OPAL-RT eMEGAsim simulator. Also the availability of MATLAB/Simulink ready-made models of power electronics systems and the possibility of developing models through a very intuitive graphical user interface are merit factor that accelerates the test of controllers.”

RSE has developed a complete model of a 9 kVA power electronics Universal Compensator, based on a three-phase IGBT controlled bridge switching at 12.8 kHz, connected to a distorting load (three-phase diode bridge rectifier) and to a static switch, all supplied by a low voltage distribution grid. The DC side of the compensator is connected to a storage system (batteries) that serves as power source during islanded operations. The model was connected to a real mixed analog-digital controller which was tested in a wide variety of situations.

“The large number of digital and analog I/O of the OPALRT EMEGASIM simulator guaranteed the monitoring of the whole system, and its complete integration with the MATLAB/Simulink environment easily allowed the post processing of all acquired data, in order to assess the real performances of the Universal Compensator”, added Mr Belloni.

4. Conclusion

The use of the OPAL-RT EMEGASIM simulator for the controller HIL simulation of power electronics Universal Compensators has the following main benefits:

- Reduced implementation and testing time;
- Reduced implementation costs;
- Possibility of simulation of potentially dangerous situations;
- Possibility of complete supervision of the system under test;
- Use of a single environment for simulation and data post processing.