Digital real time simulator for testing and training

Real Time Digital Simulator (RTDS)

Figure 1: Technical equipment of the simulator (from left to right): RTDS, amplifiers, signal distributor, protection devices

At a glance

Increased demands on network availability, with simultaneously increased complexity, result in high demands not only on protection devices, but also on the reliability of the setting values, which cannot be verified theoretically.

Siemens Power Technologies International (Siemens PTI) offers safety by a real time digital simulator (RTDS), and also protection simulation tests with the following benefits:

· setting values of different fault cases can be optimized, verified and discussed

· customers learn to operate the devices by means of DIGSI and to evaluate the fault printouts by means of SIGRA

· transient processes in the network during short circuit can be analyzed and thus better understood

· the performance of the protection devices is demonstrated by measuring (triggering) times

The challenge

When a new system is installed, the appropriate protection devices need to be selected and the settings determined. Depending on the size of the network this may be a complex task, because the functionalities and the operation of the different protection devices may vary substantially. Therefore, it may be helpful to learn how to operate a certain device to be able to decide whether it is suitable for application in a certain system. Real time digital simulation allows users to learn about the operating principles of different protection devices and to decide on their acceptability.

In an existing protection system, the setting values determine if and when the circuit breaker disconnects the faulted grid element. Disconnections due to wrong protection setting values can lead to unnecessary, often fairly high, expenses for the network operator. Such unnecessary costs can be avoided by optimizing the setting values of the installed protection devices. These values can be optimized and verified for different fault cases by means of digital simulation.

Our solution

Technical details

Siemens PTI's RTDS performs calculations for networks with up to 100 single nodes with a sampling rate of around 20 kHz. Users can simulate generators, sources, multi-circuit lines, transformers, loads, current transformers with saturation, capacitive voltage transformers, circuit breakers, etc. Real protection devices work with the simulator in a closed loop to carry out complex sequences like unsuccessful and single-pole re-closings or secondary faults. Voltage amplifiers and current amplifiers up to 40 amperes and a documentation system complete the simulator.

Evaluation

After a certain system disturbance has been simulated in the RTDS, the protection alarms and messages are analyzed and the fault recordings are evaluated. This step is crucial to understanding the actual events and technical processes in the system, and also the behavior of the protection devices at both line ends.

Unlike with disturbances in real operation, in the simulation all information is available and the events and processes are clearly known – so that customers can train analyzing the protection responses.

DIGSI often compiles information on several individual events into single protection alarms or messages, in order to provide details on complex configurations or sequences. The analysis via SIGRA in the impedance level helps to understand the actual events and processes in the real system, e.g. with respect to distance measuring.

Specification tests

Depending on whether the simulations are more concentrated on tests or on the training aspect, approximately 50 to 150 tests can be carried out for a period of several weeks in a row.

Workshops

Siemens Power Academy TD offers experts workshops with an emphasis on exchange of experience and training; however, fault simulation is also a topic that is covered.

Application example

Test results are documented in our data acquisition system. Figure 2 shows an example of a results page. Current and/or voltage-wave forms as well as binary output contacts including trip times of the relays will be recorded. This ensures an accurate storing of the simulated network faults and shows the reaction of the protection device.
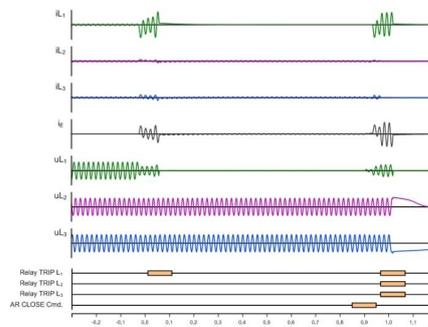

Figure 2: Example of a simulation results page