

Protection and Automation

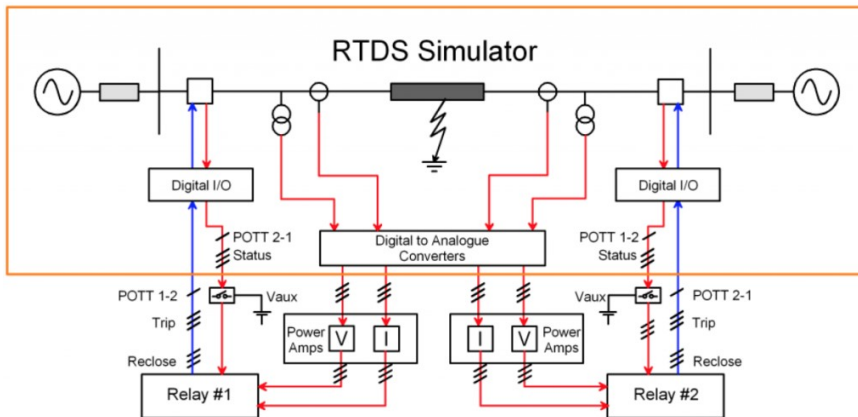
The RTDS® Simulator offers the most advanced and effective means available for testing protection systems. Since the simulation runs in real time, the physical protection equipment can be connected in closed-loop with the power system model.

The controlled and flexible environment of the digital simulation allows protection equipment to be subjected to virtually all possible faults and operating conditions. The closed-loop interaction of the protection system with the network model provides insight on both the performance of the relay scheme as well as its effect on the power system.



Testing via Electrical Interface

A model of the power system is implemented on the RTDS Simulator that includes the high voltage components (e.g. lines, breakers, instrument transformers, power transformers, generators, etc.), plus the required protection and control functions



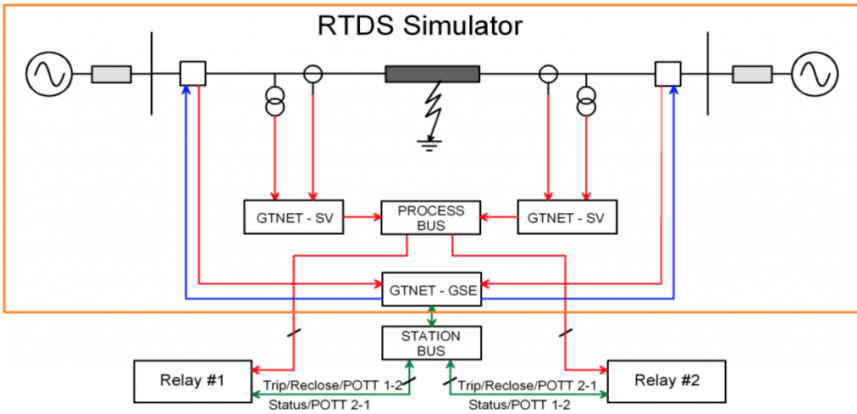
Typically, detailed models of the instrument transformers (CT, PT and CVTs) are used to provide signals to digital to analogue (D/A) converters. These signals are proportional to the secondary voltage and current signals the protection equipment would see in service. Including the instrument transformers in the model makes it possible to evaluate their effect on the performance of the protection system. Alternatively the primary voltage and current signals can be sent directly to the protection equipment using the appropriate scaling factor.

The analogue output of the RTDS Simulator is provided by the GTA0 card, which utilizes 16-bit D/A converters and allows high accuracy gain and offset calibration. The GTA0 operates over a maximum range of $\pm 10 V_{peak}$. To provide secondary voltage and current to the protection equipment, the GTA0 output is connected to power amplifiers. In some cases, however, the GTA0 output is connected directly to the protection equipment for "low level" testing, which bypasses the auxiliary current and voltage transformers inside the protection equipment.

The protection should respond to faults by providing trip and possibly subsequent reclose signals. Since the network model is simulated in real time, the signals from the protection will be used to operate breakers modeled in the simulation. The breaker models can include the mechanical operating time (either fixed or statistically varied) and provide breaker status via dry contacts.

There are several ways for the breaker commands to be imported into the real time simulation from the protection equipment. If the protection provides signals via conventional dry contacts they can be input either via a Low Voltage Digital Input/Output Interface Panel, which is included with the RTDS cubicle, or a GTDI card.

Testing via IEC 61850 Interface



The RTDS Simulator's IEC 61850 communication capability is provided by the GTNETx2 card with the Sampled Values (GTNET-SV) and/or GOOSE (GTNET-GSE) firmwares installed.

When testing IEC 61850-compliant devices, the secondary voltage and current signals can be provided to the protection equipment via a GTNETx2 card running the GTNET-SV protocol. Each GTNET-SV firmware, when used with a GTSYNC card to synchronize the simulation timestep with an external time source, can be used to transmit 2 streams of Sampled Values at a rate of 80 samples/cycle or 1 stream at 256

samples/cycle. Each stream can contain up to 4 current and 4 voltage channels. GTNET-SV can also be configured to receive sampled value data from one merging unit (4 current and 4 voltage channels). GTNET-SV can also publish 1 data stream, for up to 24 configurable channels (voltages or currents), at a rate of 80 samples/cycle, that complies with the Chinese National Standard for SV merging units.

The breaker commands can be imported into the simulation using the GTNET-GSE protocol. Each GTNET-GSE firmware supports up to 4 TX/RX modules, which can be arranged to simulate 1-4 IEDs. Each module is capable of sending and receiving up to 64 data points via GOOSE messaging. GTNET-GSE can receive messages from up to 16 unique external IEDs.

MMS Voyager Client Program

The MMS Voyager client program can be used to test IEC 61850 compliant server devices through RSCAD. MMS Voyager is capable of testing the connection setup with the server device, presenting the server data model for viewing its contents, and invoking available services. All typical communication procedures performed by a SCADA system or other testing system can be achieved using MMS Voyager.

Combining Physical and Simulated Protection Devices

RSCAD includes predefined models for generator, differential, distance, and overcurrent relays. This allows the user to run protection system testing involving simulated protection devices, physical protection devices, or a combination of both.

Phasor Measurement Unit (PMU) Applications

PMUs can be represented in RSCAD using our software model, which complies with the IEEE C37.118 standard. The output of this model can be streamed using the GTNET or GTNETx2 card with the PMU firmware (GTNET-PMU). Each GTNET-PMU firmware supports 8 streams of PMU data, each containing 12 phasors, or 24 streams of data containing only positive sequence data. The simulation timestep must be synchronized to an external time source using a GTSYNC card for streaming PMU output.

The PMU Test Utility available in RSCAD can be used to test PMU total vector error. Based on test parameters controlled from within the PMU Test Utility, the PMU Waveform Generator creates waveforms which are input to the PMU under test. The Test Utility then gathers the PMU data via IEEE C37.118-compliant streaming, analyzes the data, and exports the results.

Learn more about protection system testing and other applications of the RTDS Simulator at www.rtds.com/applications.