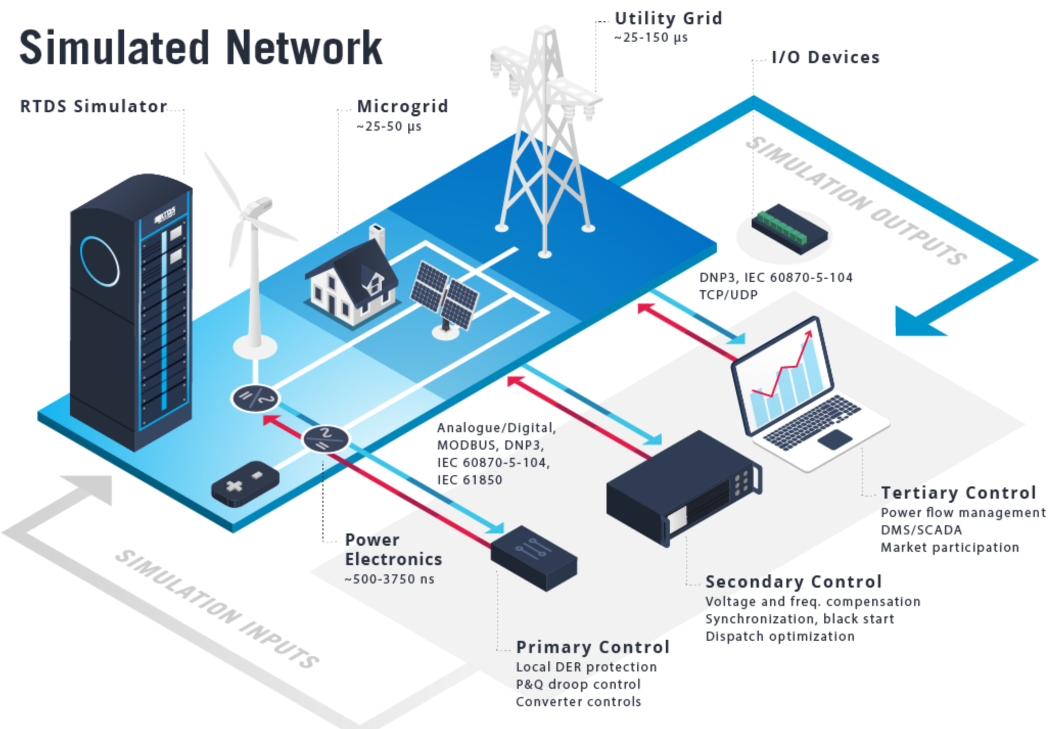
APPLICATIONS

HARDWARE-IN-THE-LOOP TESTING FOR MICROGRIDS

As microgrids and renewable energy sources increasingly dominate the power system, the availability of detailed study tools and comprehensive testing facilities is more relevant than ever. The behaviour of protection, control, and power devices in a microgrid environment can be nuanced and unpredictable. Microgrids must supply resilient and reliable power while operating securely for a wide range of power system conditions. Hardware-in-the-loop testing allows the engineer to verify the secure operation of microgrids, optimize environmental and economic performance, and de-risk the deployment of novel control and protection systems in the safety of a laboratory.



- Electromagnetic transient microgrid simulation
- Closed-loop testing of secondary-level voltage/frequency management and primary-level device controllers
- Closed-loop testing of islanding detection and decoupling schemes
- Characterization of converters for distributed generation

DISTRIBUTED ENERGY RESOURCE MODELLING

The RTDS® Simulator's modelling library contains a variety of renewable/distributed energy resources that can be configured by the user to represent their system of interest.

Wind Turbines: The wind turbine model can be configured to represent wind energy systems of various types. Control components can be used for pitch angle, reactive power, startup/shutdown, and other control schemes.

Solar PV: The user can define the module and array size for a PV system. Control components can be used to implement decoupled current control, maximum power point tracking, and other schemes.

Battery Storage: A lithium-ion battery model with either Min/Rincon-Mora or Huria/Ceraolo/Gazzari/Jackey dynamics is available.

Fuel Cells: A PEM type fuel cell model is available.

Machines: Wound rotor / doubly fed induction machine models, squirrel cage indication machines, permanent magnet synchronous machines, and a phase domain synchronous machine with stator-ground faults are available.

POWER ELECTRONIC CONVERTER SIMULATION

SWITCHING FREQUENCIES IN THE 50 KHZ RANGE ARE SUPPORTED

Substep: Detailed, fully-switched representation of converters

- Switching frequencies in the 50 kHz range are supported
- Power electronic models (consisting of user-configured individual switching elements or set topology models) run at timesteps a fraction of the size of the main simulation timestep
- Data is exchanged between the Substep subnetwork and the main network every main timestep, allowing the user to study the interactions between power electronics and the AC network
- Appropriate for testing firing pulse controls

Average Models: Accurate simulation requiring less hardware

- Controllable current sources accurately represent the steady state and transient behaviour of power electronic converters without detailed representation of high-frequency switching
- Uses the same detailed controls as the fully-switched model, without the low-level firing controls
- Many converters can be simulated with a relatively small simulation hardware requirement
- Appropriate for testing dispatch controls

COMMUNICATION PROTOCOLS FOR INTERFACING EXTERNAL DEVICES

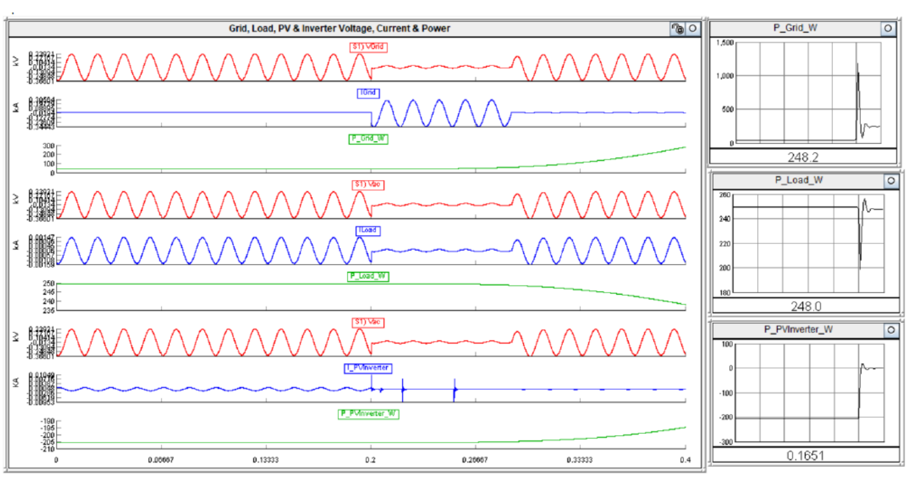
The RTDS Simulator's network interface card is used to provide Ethernet-based input/output between the real-time simulator and any external control or protection device.

IEC 61850 Sampled Values and GOOSE Messaging
DNP3 and IEC 60870-5-104 for SCADA applications
MODBUS over TCP/IP (including ASCII or RTU over TCP)
Standard-compliant synchrophasor data for PMU applications
Generic TCP/UDP socket communication

THE RTDS SIMULATOR IS USED TO TEST A REAL-TIME AUTOMATION CONTROLLER FOR MICROGRID FREQUENCY CONTROL VIA DNP3 AND GOOSE MESSAGING

POWER-HARDWARE-IN-THE-LOOP TESTING FOR RENEWABLE ENERGY, BATTERIES, AND MORE

The RTDS Simulator can be connected to loads, motors, generators, and renewable energy sources and their inverters. Power-hardware-in-the-loop testing provides an opportunity to characterize the behaviour of power hardware under contingency scenarios in the safety of the laboratory prior to deployment. **A four-quadrant amplifier is required for providing an interface between the RTDS Simulator and external power hardware.**



SIMULATION RESULTS FOR POWER-HARDWARE-IN-THE-LOOP TESTING OF A PV MICROINVERTER FOR A 5 CYCLE L-G FAULT

LEARN MORE ABOUT MICROGRID TESTING AT WWW.RTDS.COM/APPLICATIONS/MICROGRIDS-RENEWABLE-ENERGY