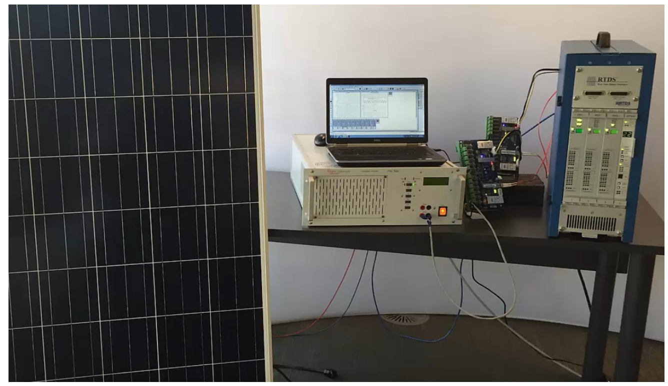
the world standard for real time digital power system simulation

Power hardware in the loop

The RTDS® Simulator is used by electric utilities, protection and control equipment manufacturers, and learning/research institutions worldwide for real time power system simulation and the closed-loop testing of power system equipment. Power hardware in the loop (PHIL) simulation is becoming an increasingly important and popular application of real time simulation.

PHIL simulation involves the real-time simulation environment exchanging power with real, physical power equipment, such as renewable energy hardware, electric vehicles, batteries, motors and loads. The RTDS Simulator has been successfully used for performing power hardware in the loop (PHIL) experiments in a wide range of applications.

PHIL simulation is often used for studying the impacts of integrating distributed energy resources in transmission and distribution grids.



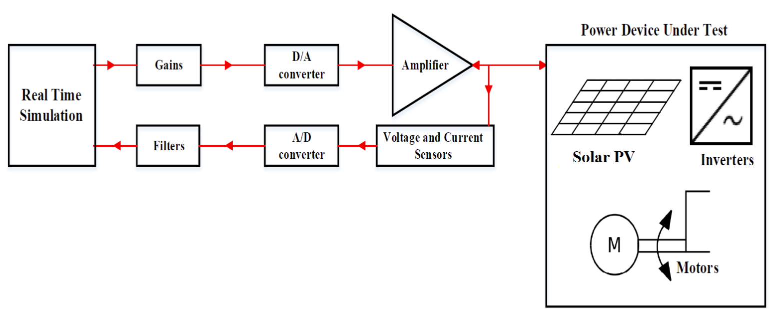
PHIL interface with a solar panel, microinverter, portable RTDS Simulator, and linear four-quadrant amplifier

Learn more about PHIL with the RTDS Simulator at:
www.rtds.com/PHIL

Examples of PHIL projects carried out with the RTDS Simulator

- The testing of MW-range motors of electric ships and motor drives
- Virtual Synchronous Generator (VSG) testing
- Testing of MW-range variable-speed wind turbine generators
- Three-phase power converter synchronization tests
- Photovoltaic inverter (PV) testing

Developing a PHIL interface



The digital to analog converters included on the GTAO card of the RTDS Simulator provide analog signals scaled down to electronic levels within ±10Vpk. These voltage levels are well below the operating voltage/current range of the power device under test, therefore amplifiers are required to scale these signals. PHIL simulations require more complex circuitry and hardware maintenance compared to traditional control– and protection-hardware-in-the-loop applications. In addition, the interface between the RTDS Simulator and the device under test is non-ideal due to time delays, noise, and the limited bandwidth of the interface devices. These non-idealities impact the stability and accuracy of PHIL simulations and must be carefully considered for any PHIL simulation. The user must select the simulation timestep, amplifier type (2– or 4-quadrant operation, linear or switched-mode), amplifier specifications (power ratings, slew rate, bandwidth, and input/output ratings), filter parameters, and interface algorithm in order to minimize delay and create a stable and appropriate PHIL interface.

Read our report further detailing the technical considerations of developing a PHIL interface at www.rtds.com/rtds_PHIL_report.

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