# Real-time, Hardware-In-the-Loop (HIL) Testing

EdgeTunePower

Empowering Your Business At the **Edge**

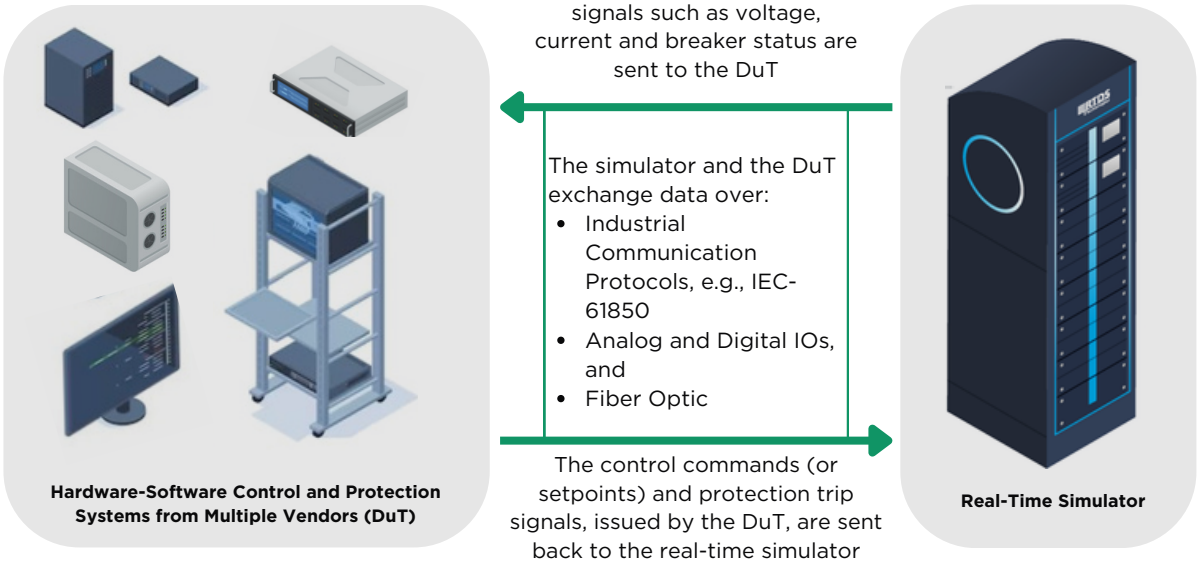
## Hardware-In-the-Loop (HIL) Testing

Full-Scale Verification of Control and Protection Platforms Prior to Field Implementation.

Hardware-In-the-Loop (HIL) testing is a critical step in ensuring that your embedded system's control and protection platforms meet performance requirements before field implementation. At ETP, we offer full-scale performance verification of your system using our HIL testing procedure.

## Structuring Hardware-In-the-Loop (HIL) Testing Platform

Our HIL testing approach uses the embedded control and protection components[1] of the system as the Device-under-Test (DuT) and connects them to our real-time simulators. We perform system-level testing[2] using customized scenarios that replicate your specific requirements and challenges, ensuring that the embedded control and protection solutions meet your objectives while minimizing projects' costs and time without risking real assets.




Dynamic performance of a wide range of embedded control and protection components (i.e. DuT), are verified.

Detailed model of the power system, including DERs, electrical machines, loads as well as transmission and distribution equipment, is simulated in real time.

1. Embedded control and protection systems are the combination of hardware and software platforms, e.g., BESS local control system, protection relays
2. System-level Testing: Opposite to component-level testing, in system-level testing, the impact of interconnection and interaction of energy resources with electrical energy systems will be investigated to reassure compliance with grid codes and standards.

**Get in touch with our team to schedule a real-time live demo!**

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## Key Features of Our Real-time Simulation Platform

### Real-time Simulation of Large-scale Grids

Our computationally-powerful, fiber-enhanced simulation platform enables real-time simulation of massive electrical energy systems with up to 900 three-phase electrical nodes!

### Real-time Simulation of Fast Transients

Our state-of-the-art real-time simulator represents super fast transients and high-frequency components in the timescale of nanoseconds to microseconds!

### Flexible and Modular Simulation Environment

The simulation platform is equipped with high-speed analog & digital IOs, IEC-61850-compliance communication mediums & fiber optic gateways that allow for seamless interconnection of a wide range of control & protection devices.

### Control System Development and Testing

**Wide-area Power System Control**

- Managing weak system strength
- Oscillation damping
- Mitigating reduced inertia
- Sub-Synchronous-Resonance (SSR) mitigation
- Voltage stabilizers and regulators
- Power system conditioners
- Load-flow Study
- Short-Circuit Analysis
- Arc Flash Study
- Transient Stability Analysis
- System Strength Test
- Sub-synchronous Impedance Testing

**Interconnection & Control of DERs at the Distribution Level**

- Connection impact assessment & mitigation
- Control of renewables, L-3 EV Chargers & BESS
- Enable behind-the-meter operation, e.g., peak-shaving
- Anti-islanding operation
- Voltage & frequency ride-through capability
- IEEE-1547 & CSA compliance
- Sub-synchronous Resonance (SSR) Studies

**Microgrid Operation, Control, and Protection**

- Microgrid supervisory control (EMS)
- Dynamical local control of microgrid DERs (e.g. solar-PV, BESS, generators, wind turbines)
- Black-start capability
- In-rush Current Analysis
- Seamless mode transition
- Behind-the-Meter Operation
- Virtual-Power-Plant (VPP) operation
- Evaluation of Storage Systems as Grid-Forming and Grid-Following Units within the Context of Microgrid Systems

### Design of Reliable Protection Scheme

**Protection of Transmission, Distribution, and Microgrid Systems**

- Phasor-based fault current calculations for microgrids, distribution & transmission systems
- HIL testing of communication-assisted protection schemes such as POTT, PUTT and DCB
- Control parameter determination for reliable DER and BESS protection
- Relay protection system design and evaluation for microgrids and high-voltage systems
- Fault detection and isolation for protection relays
- Relay coordination studies in the event of faults or disturbances
- Recommending upgrades and modifications for DER and BESS integration
- Advanced protection, automation, and communication system design based on IEC-61850
- Fault location scheme design for microgrids and distribution systems

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