EdgeTunePower

# HARDWARE-IN-THE-LOOP | HIL TESTING

www.edgetunepower.com

# HIL TESTING

**Hardware-In-the-Loop**

Full-scale verification of Power Plant Controllers (PPCs), IBRs and DERs controllers 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.

# FULLY-INTEGRATED, SCALABLE SOLUTIONS FOR DATA CENTERS OF ALL SIZES

- **Validate designs early:** Verify system behavior—load steps, transients, GFM/GFL functions, dispatch logic—without putting equipment at risk.
- **Ensure utility and grid-code compliance:** Test against IEEE 2800, NERC, and utility requirements, including ride-through, IEC-104/61850 communication, and load-shedding.
- **Reduce downtime and redesign costs:** Identify control or protection issues before commissioning and avoid costly changes in the field.
- **Improve reliability and resilience:** Simulate worst-case scenarios such as generator failures, PV intermittency, or rapid load swings to confirm stability and redundancy.
- **Scale confidently:** Evaluate modular and hyperscale architectures, ensuring seamless integration as power demand grows.

# 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 per each simulation rack!

## Real-time Simulation of Fast Transients

Our real-time simulator represents super fast transients and high-frequency components in the timescale of nanoseconds to microseconds such as flickers and forensic events!

## 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 PPCs, DERs and IBRs control & protection devices.

# PPC, IBR, AND DER CONTROL SYSTEM HIL TESTING

## Power-Plant-Controller (PPC) Performance Verification (Model-Quality-Test)

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

## IBRs & DERs Performance Verification (Unit-Model-Validation)

- Connection impact assessment & mitigation
- Control of IBRs at the transmission level
- Performance verification of DERs at the distribution level
- Anti-islanding operation
- Voltage & frequency ride-through capability
- IEEE-1547, UL-1741 & CSA 22.3 compliance
- Sub-synchronous Resonance (SSR) Studies


## Microgrid Operation, Control, and Protection (P&C Coordination)

- 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

# DESIGN OF RELIABLE PROTECTION SCHEME

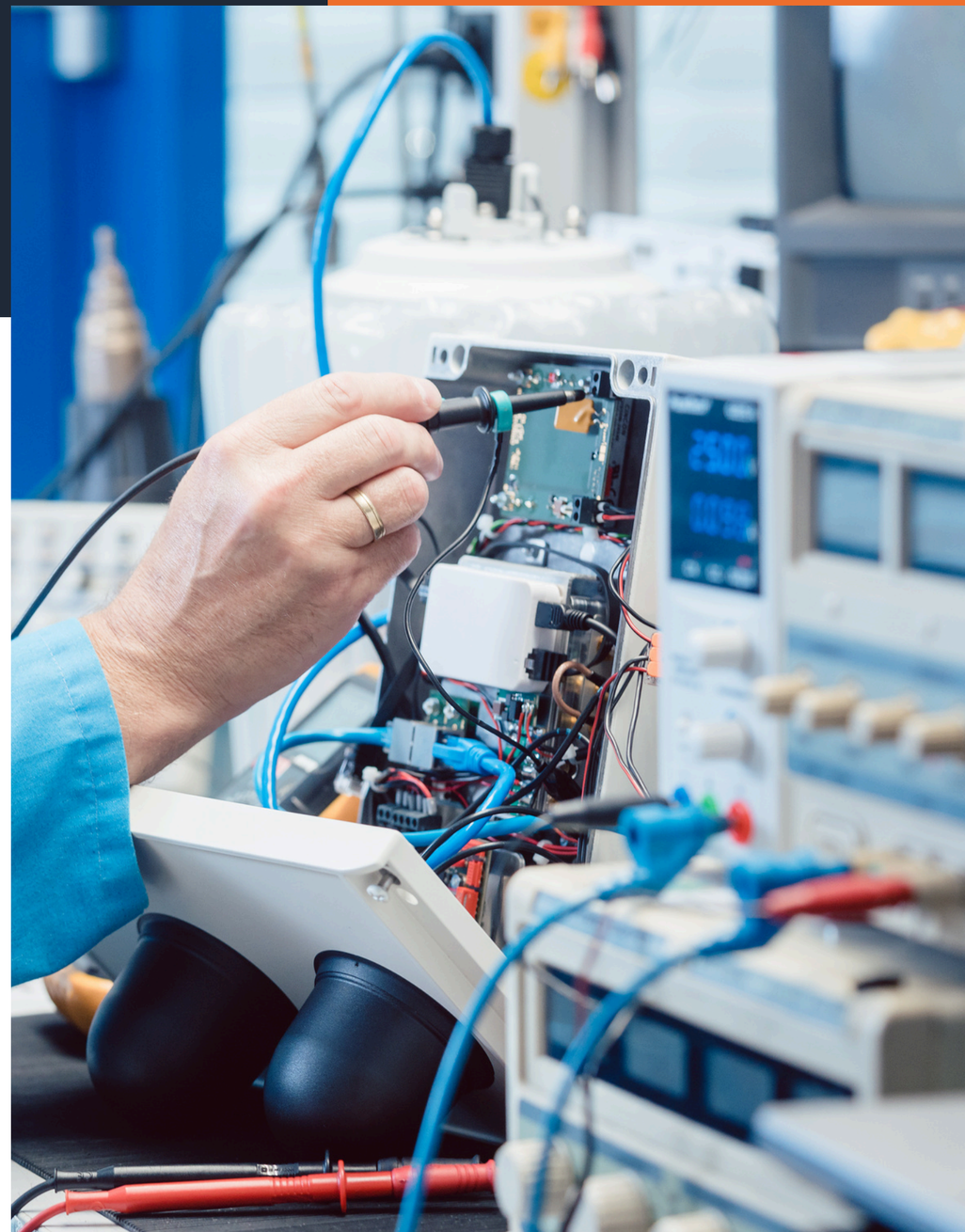
**Protection of Transmission, Distribution, and Microgrid Systems**

- 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

# 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.



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.*

# STRUCTURING HARDWARE-IN-THE-LOOP (HIL) TESTING PLATFORM

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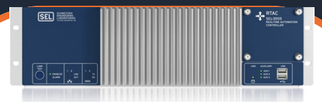

**IBR and DER Controllers**

The simulator and the DuT exchange data over:

- Industrial Communication Protocols, e.g., IEC-61850
- Analog and Digital IOs, and
- Fiber Optic

**Data Center Power Controller iT-2000**

**(EMS+PPC+PMS)**

The control commands (or setpoints) and protection trip signals, issued by the DuT, are sent back to the real-time simulator

Wide range of electric grid signals such as voltage, current and breaker status are sent to the DuT

**Protection Relays**

**Real-Time Simulator:**
Detailed model of the power system, including IBRs, DERs, electrical machines, loads as well as transmission and distribution equipment is simulated in real time.

**Monitoring Devices**

Dynamic performance of a wide range of embedded control and protection components (i.e. DuT), are verified., such as IBRs and DERs control systems, Power-Plant-Controllers (PPCs)

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# CONTACT US

## GET YOUR FREE DEMO TODAY AND EXPLORE OUR ENERGY SOLUTIONS!


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