Microgrid Testbed.

Now with full P-HIL support.

Rein in microgrid complexity. With ease.

Typhoon HIL

SPS
SMART POWER SYSTEMS

Outsmart the microgrid.

Typhoon HIL

SPS SMART POWER SYSTEMS

C-HIL Microgrid Testbed

Ultimate test solution for microgrid control system verification

What is a microgrid?

Microgrid is a collection of distributed energy resources (DER) that insure high power quality and can also be seamlessly connected to a wider distribution system.

What is Microgrid Testbed?

Microgrid Testbed is a collection of HIL devices from Typhoon HIL with integrated DER controllers, protection relays and microgrid controllers.

What is the purpose of Microgrid Testbed?

The main purpose of the Microgrid Testbed is to comprehensively test Microgrid controller's hardware, firmware, software and communications under all operating conditions including faults in both the island and grid-connected mode.

To reach a high level of test productivity, the Microgrid Testbed performs all its tests and generates test reports automatically.

How does Microgrid Testbed work?

DER and distribution system hardware models comprising smart inverter hardware, PV panels, batteries, transformers, generators, switches, cables, active and passive loads etc. are running inside a HIL device with a 1 µs time step. Smart inverter controllers control the operation of smart inverter models. Relays control the protective switches and microgrid controllers provide the overall supervisory control.

In other words the Microgrid Testbed has identical control system as a real microgrid, only the power hardware is digitized.

P-HIL Microgrid Testbed

Ultimate test solution for full system verification

How P-HIL complements C-HIL?

C-HIL and P-HIL belong to the same testing circle. Once control software and hardware is fully optimized thanks to C-HIL testing with emulated power, it is safe to proceed to P-HIL testing of the critical parts of the system with power.

What is P-HIL Microgrid Testbed?

P-HIL Microgrid Testbed is an expansion of the C-HIL Microgrid testbed that allows testing with power. For example, using high-bandwidth power amplifiers from SPS (Smart Power Systems) it is possible to test grid connected converters and their interaction with the virtual grid components. P-HIL Microgrid Testbed establishes a high-speed high-fidelity feedback loop with C-HIL Microgrid Testbed, enabling a 360° testing of any power electronics device.

What is the purpose of P-HIL Microgrid Testbed?

The main purpose of P-HIL Microgrid Testbed is to comprehensively test the entire converter or inverter in a wide variety of tests scenarios that can be found in the real life.

In addition to testing power converters and FACTS devices, P-HIL Microgrid Testbed is also a perfect match for testing all terrestrial, marine and emerging airborne electrical propulsion systems because the modular SPS amplifiers can cover the range from 10 kW to more than 400 kW, with voltages up to 730 Vrms (line to line voltage) and currents up to 1.200 Arms.

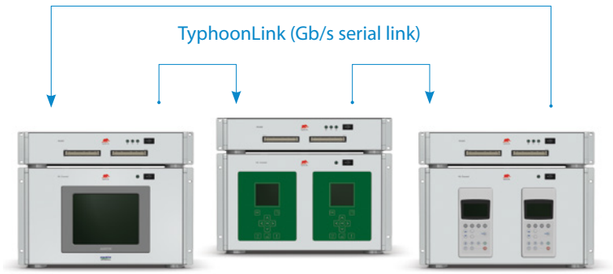
How does P-HIL Microgrid Testbed work?

Thanks to SPS high fidelity amplifiers generating and absorbing power, P-HIL Microgrid Testbed connects your device(s) under test, e.g. an inverter, to the real-time emulator running high-fidelity models of a battery, electric motor/generator, or a complete Microgrid with all of its control and power components.

In other words, P-HIL Microgrid Testbed allows you to test your actual converter using real power in a completely realistic electrical environment.

Modular and scalable by design...

First, test each microgrid control component.
Then test the whole microgrid control system.



Distributed HIL for distributed energy resources testing

The future grid comprising a distributed and decentralized collection of microgrids requires a fast, powerful, high-performance decentralized HIL system where one HIL device models one microgrid island while the Microgrid Testbed models a collection of islands, i.e. the distribution grid.

This is precisely the scalability inherent in desktop HIL devices from Typhoon HIL.

Smart inverter control testing

Undoubtedly, the smart inverter is one of the key enabling technologies for microgrid development. The smart inverter is the interface between the DER and the microgrid distribution system and to a large extent comprises the intelligence behind the DER. Additionally, smart inverters are in charge of active and reactive power regulation, voltage and frequency regulation as well as mitigation of the harmonics in the grid.

Effective testing of the smart inverter controller is the foundation for the effective testing of the microgrid and that is where Typhoon HIL truly shines.

Test the relay protection and SCADA

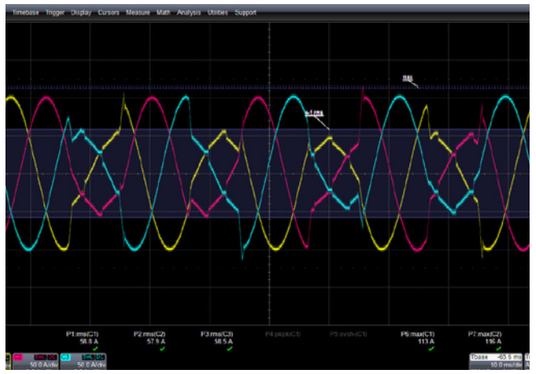
Add the relays into your Microgrid Testbed and then put your microgrid/distribution grid through its paces: short circuits, phase losses, overvoltages, low voltage ride throughs and component failures.

Finally, top it all with the whole network sensitivity analysis.

With all other control components being real, it is only natural to use a real SCADA with all its functions and communication infrastructure.

…in both the C-HIL and P-HIL mode.

Once control testing is done, test with power.
Individual converters or the complete Microgrid.

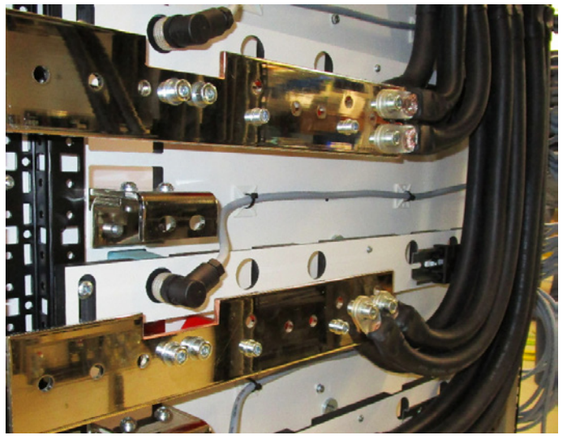


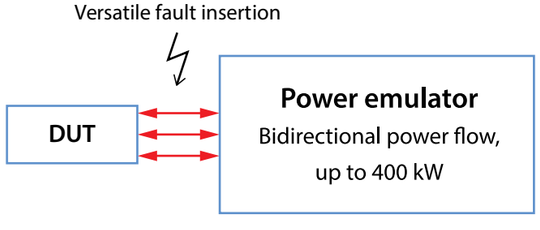
Test with real power.

Testing of control software (SW) and hardware (HW) with emulated power is a precondition for testing the complete unit(s) with real power. Before Microgrid Testbed, the switch from controller HW and SW testing to unit testing meant a switch of testing facilities and a great deal of additional work. Thanks to seamless integration of C-HIL and P-HIL modules in a single system, Microgrid Testbed now allows you to switch between simulated power and emulated (real) power in a single facility and in a matter of minutes.

Use as much (or little) power as your converter(s) need.

Testing with emulated power is useful because you do not have to scale-down your system to fit to limitations of your testbed power rating. That is why the P-HIL module of Microgrid Testbed, just like its C-HIL counterpart, is fully scalable. Whether you need 110 Vrms or 240 Vrms, 10 kW or 400 kW, 150 ARMS or 1200 ARMS, the P-HIL amplifier of Microgrid Testbed can be scaled to fit your exact requirements.



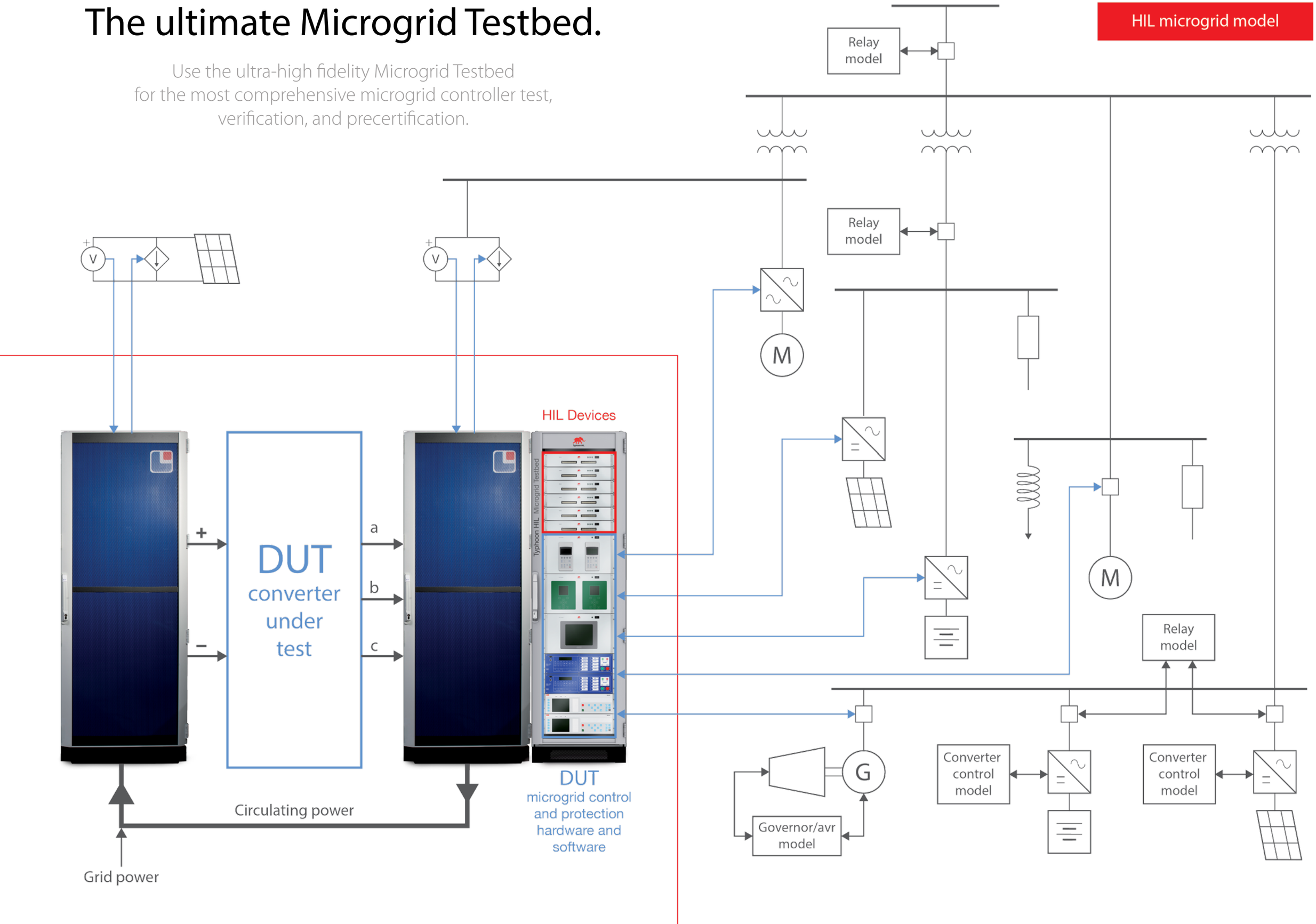


Do fault simulations. With real power. Safely.

In contrast to any other testing paradigm, a combination of C-HIL and P-HIL in a single testbed allows a unique possibility: to simulate faults with real power, but without any danger to the user. This is possible because the power is real, but the unit under test interacts with a high-fidelity real-time model. In other words, a unit under test, or the entire microgrid, can be subjected to variation of frequency, phase, amplitude, asymmetric three phase voltages, etc. – with real power and without any safety hazards or risks.

The ultimate Microgrid Testbed.

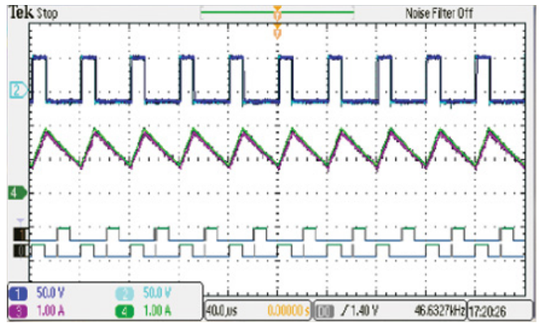
Use the ultra-high fidelity Microgrid Testbed
for the most comprehensive microgrid controller test,
verification, and precertification.



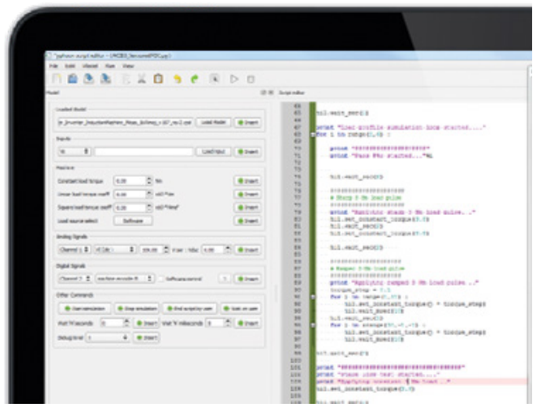
Microgrid Testbed highlights.

Test your smart inverter controller with a 20 ns time resolution.

A 20 ns PWM resolution combined with 0.5 µs simulation time step enables the most realistic, and most comprehensive smart inverter controller tests. From DC to 200 kHz switching frequency, the extreme time resolution of Typhoon HIL devices simply shines.



Real boost MPPT converter current; HIL boost current; Real boost inductor voltage; HIL inductor voltage.



Automate testing with Python scripts to comprehensively and reproducibly test and qualify all your controllers.

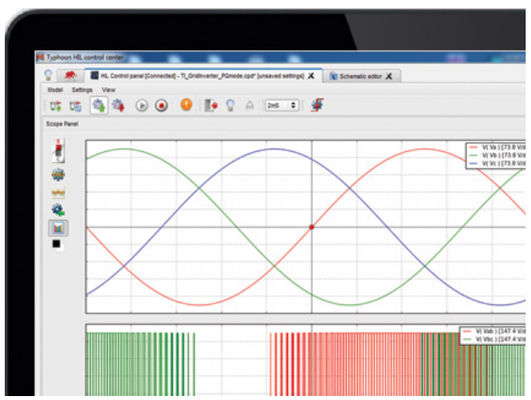
Automate testing with Python: the ultimate ease of use.

Automate controller testing processes with Python scripting. Discover the most comprehensive power electronics control software testing environment where fault injection, such as grid disturbances, short and open circuits, are just one Python command away.

Use Python scripting and rich mathematical function library to quantify system performance in a broad spectrum of operating conditions, under standard operating conditions as well as under fault conditions (internal and external).

Zoom in voltages and currents with Typhoon HIL Scope Function's microsecond "microscope".

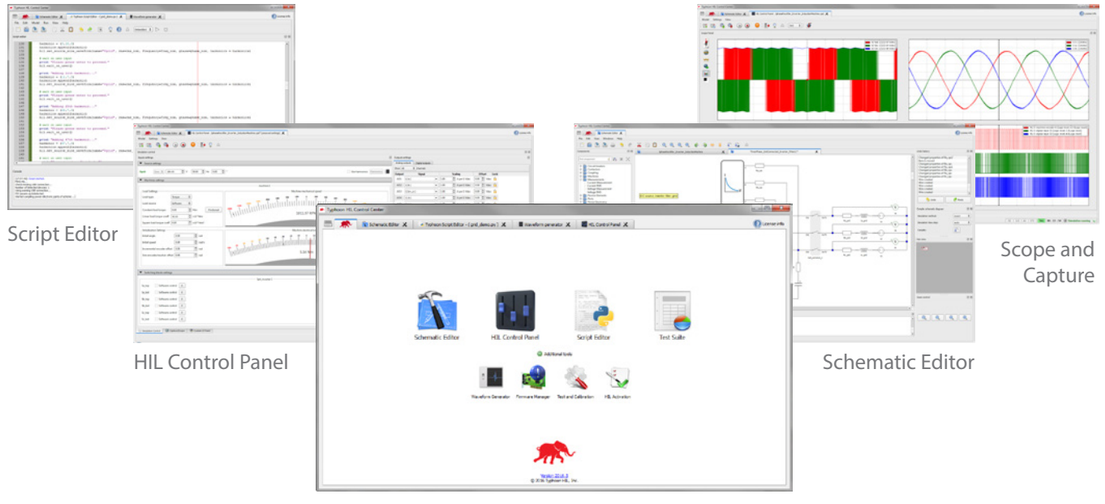
Quickly debug control code with deep memory scope/capture function. Trigger on fault injection events and quantify the converter system response. With 1 megapoint capture record length, on all 32 analog channels, and 1 MHz sample rate even tiny glitches in modulator algorithm are quickly identified. Capture HIL signals to quickly detect, debug, and characterize your controller performance.



Capture HIL signals to quickly detect, debug, and characterize your controller performance.

Unified Software Environment.

Experience integrated HIL software with automated testing. Intuitive and easy to master, our software provides a unified environment for microgrid design, test automation and quality assurance.



Unified experience.

Model smart converters with our simple to use schematic editor with a rich library of passive elements, converters, sources and machines. With only one click, rapidly compile the circuit into real-time executable machine code for our HIL hardware.

Open the HIL control panel to load the compiled model onto the hardware and launch the real-time simulation. Select signals you want to see on the scope and change sources and parameters for a fully interactive experience. With a built-in Python script editor, automate your test processes and generate test reports, automatically.

Discover simplicity.

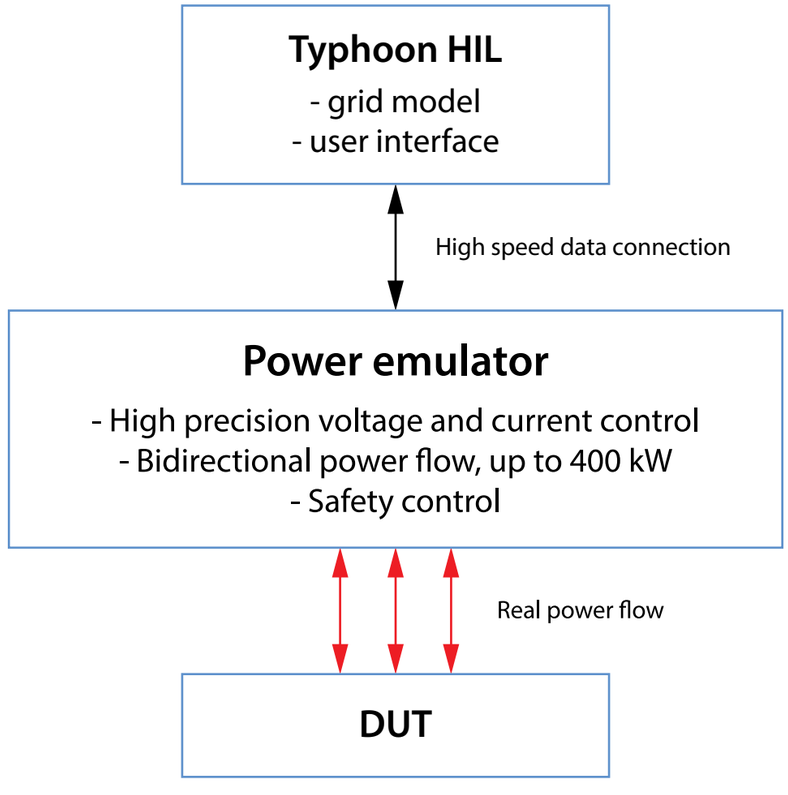
- Schematic editor with vector graphics.
- Library of power electronics circuit elements.
- One click circuit compilation.
- Interactive control of real-time emulation.
- Waveform editor for source definition.
- Software control of digital inputs.
- Automatic testing via Python scripts.
- Library of test scripts for testing grid complance, protection etc.
- Python API.
- Automatically generated HTML test reports.

Microgrid Testbed control testing

Performance	Simulation capacity	1 µs timestep simulation of up to 40 multilevel converters (720 switches) for HIL applications with DER controllers 10 µs time step simulation of large distribution systems with up to 500 buses
Analog I/O	Channels (fully selectable)	up to 500 channels
	Resolution	16 bit
	Accuracy	1 %
	Voltage outputs (user defined)	Range ± 10 V LV, ± 350 V HV (four quadrant) Compliance range ± 10 mA Bandwidth > 50 kHz LV, ~ 10 kHz HV
	Current outputs (user defined)	Range ± 50 mA LC, ± 500 mA MC, ± 3 A HC (four quadrant) Compliance range ± 10 V, ± 1.5 V HC Bandwidth ~ 10 kHz
	Analog inputs range	User defined
	Analog inputs impedance	User defined
	Sample rate	1 MSPS
	Protection	ESD and overvoltage protection
	Connector types	User defined
Digital I/O	Channels (fully selectable)	up to 500 channels
	Resolution	20 ns
	Voltage inputs	Levels 3.3 V, 5 V, 15 V, 24 V Impedance > 10 k
	Voltage outputs	Levels 3.3 V, 5 V, 15 V, 24 V Impedance 1 k (3.3 V, 5 V), 10 k (15 V, 24V)
	Optical IO	Coupling 1 mm POF Data rate 5 MBd max
Connectivity	Supported protocols	Ethernet / IP Modbus IEC 61850 SunSpec Custom protocols
Power supply outputs	Output voltage	User defined
	Output power	User defined
Host interface	HIL Control Center	Vertically integrated toolchain Drag&Drop model library (Power system, power electronics and signal processing libraries)
	Data acquisition	HIL Scada Built in multi-channel oscilloscope up to 240 Mpoints data buffer
	Host connectivity	USB Ethernet

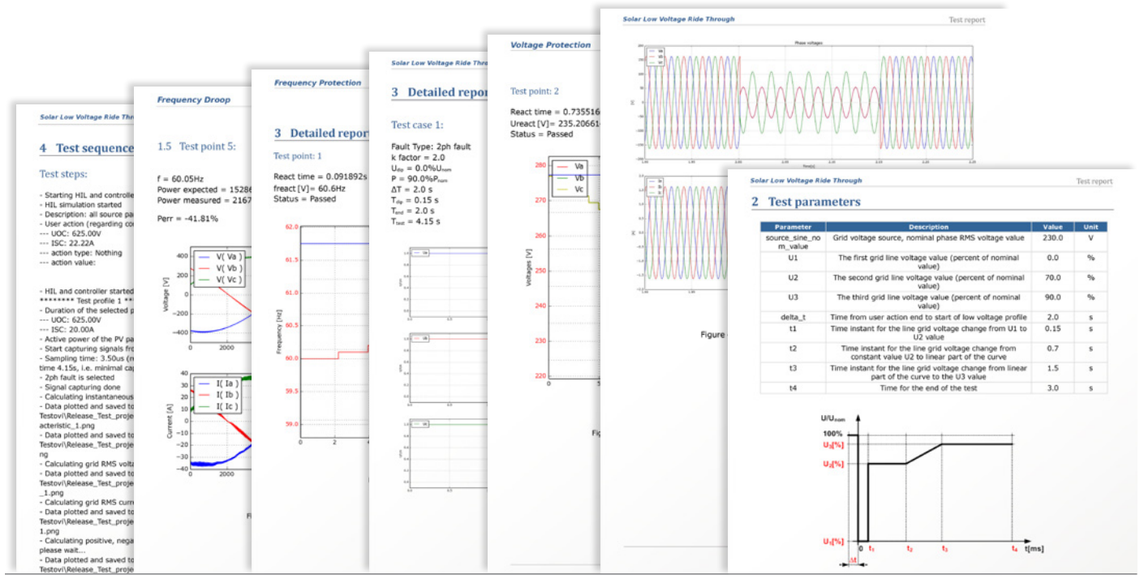
Microgrid Testbed power testing

Number of emulated phases	3 with optional N
Phase output voltage (L-N)	Up to 420 V_{RMS}
Phase current (AC)	Up to 1200 A_{RMS}
Phase power (total)	Up to ± 400 kW source/sink
Frequency	Up to 5 kHz
Voltage slew rate	5 V/µs resistive load
Phase protections	Adjustable active phase current limitation, Overload protection
Operating Modes	4-Q-Operation AC, DC, AC + DC
Control Interface	CAN 2.0 B, Ethernet 10/100 Mbit, EtherCAT



Certify your microgrid. In-house.

First of a kind Microgrid Testbed optimized
for grid-code pre-certification. And certification, too.



Pre-certification reinvented

The new Precertification Toolbox, verified by the AIT Austrian Institute of Technology, allows you to exhaustively test your inverter control software in- house against national and international grid codes. Moreover, you will do it at a fraction of the time and cost. This allows you to do pre-certification with a simple push of a button.

Even the highly demanding Low Voltage Ride Through and Frequency Droop test procedures can be completed with just few clicks thanks to the Typhoon HIL built-in test libraries.

Certification, too

Thanks to full P-HIL support, Microgrid Testbed also enables repeatable, formalized unit testing with power for a wide selection of operating conditions. With a high-quality, high-power amplifier and high-fidelity real-time models, testing with power is immensely safer and considerably cheaper than in a traditional power laboratory.

More importantly, Microgrid Testbed will automatically generate highly-detailed reports for all test operations with all test-relevant data captured in high-resolution. This means that you can move beyond pre-certification and replicate certification procedures. In-house.

Outsmart the microgrid.

Typhoon HIL

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