Micro Grid Testbed

Typhoon HIL GmbH, Switzerland

General Brochure

www.typhoon-hil.com
E-mail : info@typhoon-hil.com

Typhoon HIL

www.quarbz.com
E-mail : hil.info@quarbz.com

QUARBZ

HIL Microgrid Testbed

Solar and wind power generation, as well as battery storage, are all part of today's microgrids. Together with protective relays, communication networks and microgrid controllers they are complex power systems that need thorough testing and verification before their safe and reliable operation can be guaranteed in all operating conditions.

What is a HIL Microgrid Testbed?

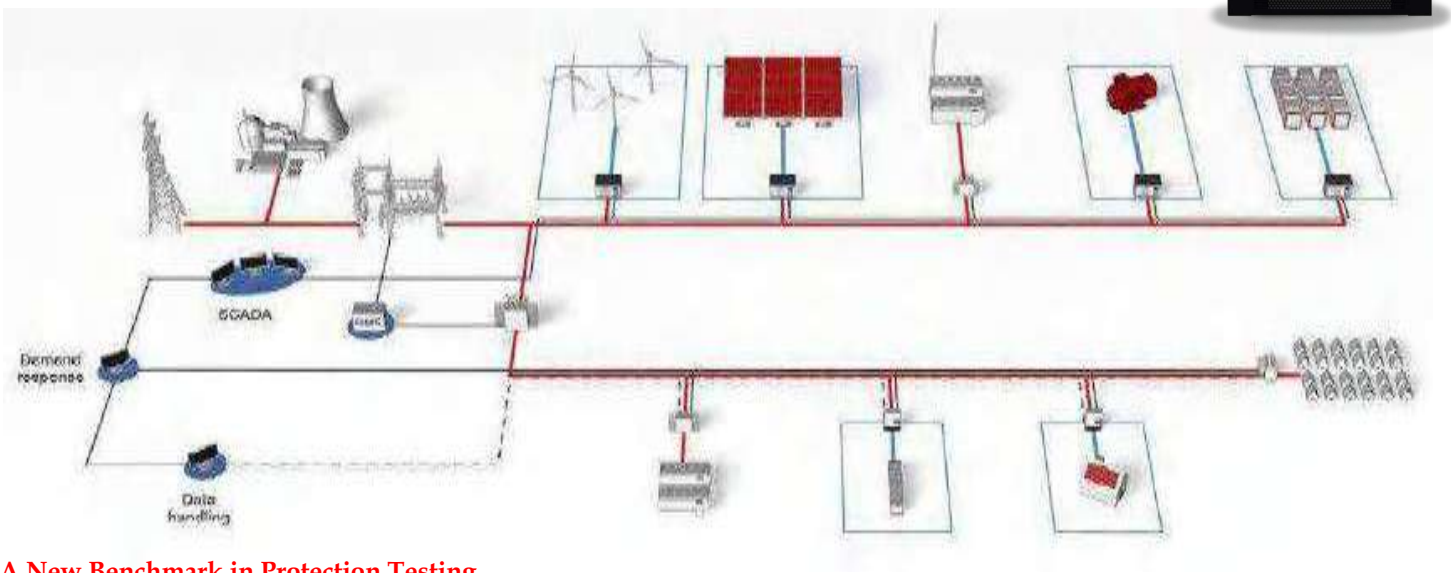
A Microgrid Testbed is a collection of HIL devices with integrated protection relays, microgrid controllers and controllers of solar inverters, battery inverters, diesel gensets, fuel cells, etc.

The main purpose of the Microgrid Testbed is to comprehensively test and validate primary and secondary control, communications and protection under all operating conditions including faults in both the islanded and grid-connected mode. Moreover, Microgrid Testbed can perform all its tests and generate its test reports in the fully automatic mode, thus boosting the productivity and improving test coverage even further.

How does the C-HIL Microgrid Testbed Work?

HIL Microgrid Testbed has identical control system as a real microgrid, only thepower hardware is digitized within the HIL devices.

High fidelity models of DER and distribution system hardware, comprising smart inverter hardware, PV panels, batteries, transformers, generators, switches, cables, active and passive loads etc. are simulated on ultra-low latency Microgrid testbed with time steps as low as 500ns.



A New Benchmark in Protection Testing

HIL Microgrid Testbed allows you to connect and communicate with your actual hardware relays. With Typhoon HIL API and Python scripts, you can fully automate testing against short circuits, phase losses, overvoltage's, low and over voltage ride troughs and component failures. Furthermore, HIL Microgrid Testbed allows you to conduct a sensitivity analysis of the whole network in real-time. With protection relays and all control components being real, and with the unparalleled accuracy of Typhoon HIL's industry-proven advanced numerical modelling algorithms.

AC Microgrid

The Microgrid Library toolbox is designed to provide you with realistic component-level building blocks that can be easily used for system-level modeling and real-time microgrid controller (MC) testing. Converter-based library components come in two varieties: switching and average.

DC Microgrid

A microgrid is an electrical distribution system with a set of interconnected consumption sources (energy consumers, batteries, etc) and distributed generation sources (renewable energy sources, batteries, etc) that operate as a single controlled source within clearly defined electrical boundaries.

Protection

Validate relay parameters and test the entire protection layer against short circuits, phase losses, overvoltage, low and overvoltage ride through as well as component failures. Connect the physical protection relays to your real- time replica of the microgrid on the signal, power, and communication level. Using Typhoon API and Python scripting, execute complex scenarios and fully automate your testing processes. The same environment enables you to conduct a sensitivity analysis of the whole system in real- time.

Communication

Develop and validate the full compatibility of your system components as soon as in the development phase. With our support for a wide array of communication protocols, you can maintain maximum efficiency even when developing complex system architectures. Interface the testing environment directly with your chosen PLC or hardware control to validate your complete control automation process. The protocols we support include: Modbus, IEC61850, C37.118, CAN Bus, Ethernet Variable Exchange, DNP3, … and more. Contact our sales team for answers for your specific use case.

Typhoon HIL offering

HIL604 real-time simulator

- Fidelity
  - 20ns sampling rate
  - 500ns step time
- Computation power
  - 8 FPGA processing cores
  - 2 co-processors
- Scalability
  - Up to 16 devices

- Connectivity
  - 64 Analog Outputs, 32 Analog Inputs
    - 1 MSPS update rate
  - 64 Digital Outputs, 64 Digital Inputs
    - 20ns oversampling, 7ns PWM modulation
  - USB, Ethernet, CAN, RS232, Time Synchronization, PCIe High-speed serial link

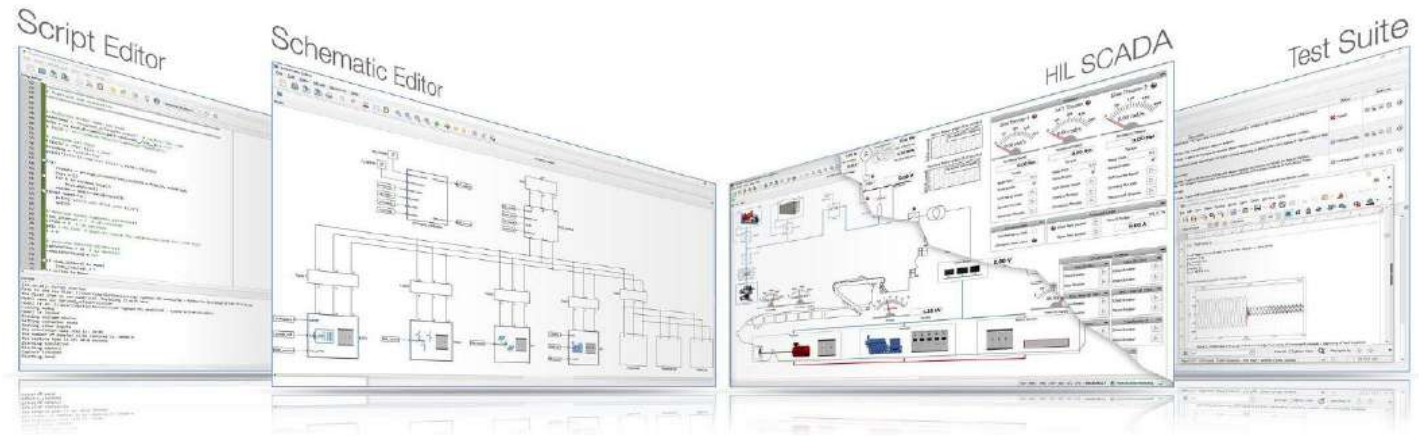
HIL606 real-time simulator

- Fidelity
  - 20ns sampling rate
  - 200ns step time
- Computation power
  - 8 FPGA processing cores
  - 3 co-processors
- Switching Frequency
  - 500 kHz

- Connectivity
  - 64 Analog Outputs, 32 Analog Inputs
    - 1 MSPS update rate
  - 64 Digital Outputs, 64 Digital Inputs
    - 20ns oversampling, 7ns PWM modulation
  - USB, Ethernet, CAN, RS232, EtherCAT, SFP, Time Synchronization, PCIe High-speed serial link

Typhoon HIL offering Overview

Vertically Integrated



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

Model-Based Engineering Toolchain that is (micro) second to none.

All the tools you will ever need. In one place.

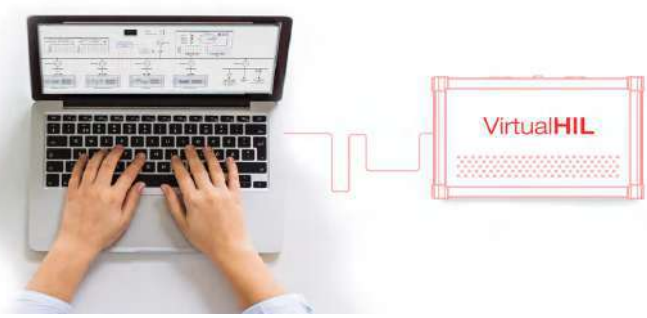
Each part of Typhoon HIL Software Manual is focused on a particular software tool in the software toolchain:

- Typhoon HIL Control Center is the window which opens when you start Typhoon HIL"s software. In this section general description of Typhoon HIL Control Center & the main software components accessible from it, as well as additional software tools which can be directly invoked from its interface.
- Schematic Editor allows you to create high-fidelty models of the power stage for your real-time simulations. This section, therefore, provides detailed explanations of all features and functionalities of panels, panes and buttons accessible from the Schematic Editors, which currently include: Schematic Editor menus and toolbar, Library explorer, Device explorer, Schematic diagram scene, Execution rate visualization, Compilation status dockUndo/redo history window, and Schematic model pan/zoom controls. In addition to descriptions of GUI elements, this section also provides guidelines which allow you to take full advantage of all Schematic Editor's modelling functionalities, such as: Basic schematic diagram rules, Creating wires and wire nodes (junctions), using Subsystem elements, Mask, Schematic Icon API and User Defined Libraries, and, finally, Compiling the model .
- HIL SCADA allows you to interact with the real-time simulation of the model you created in Schematic Editor. To use HIL SCADA to its full potential, this section first provides detailed explanations of all window elements contained in HIL SCADA: Command Toolbar, Library Dock, Panel Explorer Dock, Model Settings Dock, Panel Tabs, Message Log Dock, History Dock and Status Bar. Of course. the section also provides detailed information on how you can use and customize various widgets (Action widgets, Connection widgets, Data Logging Widgets, Visual widgets and the Capture/Scope Widget), as well as guidelines how to troubleshoot Widget Errors, set up Panel Initialization and how to create your own HIL standalone boot configuration.
- Script Editor provides full test-automation capabilities as it allows you to write, open and execute various automated testing scripts written in Python, using appropriate Typhoon API libraries. The Typhoon HIL Test Suite is highly flexible test execution and precertification tool. Its main purpose is Standard Qualification using automated tests covered with detailed test reports. This section provides guidelines on the functionalities of Typhoon HIL Test Suite itself.
- Wave generator tool is software toolbox which allows you to fully customize your real-time simulations with real-date, generated data or the combination of the two. On the one hand, with the Source file generator you can generate various types of signals which you can change on the point level. On the other hand, the PV file generator allows you to either generate a PV panel file using various parameters or to import an arbitrary I-V curve from a .csv file and thus generate a PV panel from real date acquired at your test site.

Test drive on Virtual HIL

Want to verify your HIL models without the controller hardware? Want to try Typhoon HIL toolchain before you buy the HIL device? You are looking for a tool to help you teach a power electronics class?

Eliminate the guesswork with Virtual HIL Device: the tool which offers you a way to harness the full power of Typhoon HIL signature software on your PC processor.



Download Control Center :

https://www.typhoon-hil.com/products/software-download/

Modelling Software with Real Time Interface : It is not dependent on any third party simulation software. It has its own simulation software with following specifications.

- Permanent software license for modelling as well as for Real-time Interface with unlimited number of users.
- Academic premium toolbox package with Graphical User Interface (GUI).
- Modeling environment for plant as well as Signal Processing with embedded library of components with inbuilt, i) Converter toolbox, ii) Microgrid toolbox, iii) Power System toolbox, iv) Signal processing toolbox, v) Test Suite and vi) Communication toolbox having IEC61850, UL 1741, CAN Bus protocol, Ethernet, DNP3, MOD Bus protocol etc.
- All the switching components in library have Internal or external both control option during modeling for HIL simulation.
- Ability to run Plant simulation without controller if required.
- High resolution built-in real time signal monitoring oscilloscope with at least 16 channels.
- All supported solvers (based on different applications) are available with modelling software.
- Scripting Environment based on python. In-built API for automation as well as for communicating with other software for co-simulation etc.
- Option for importing code generated for controller from other simulation software like MATLAB, Simulink, LabView, PSIM etc.
- Option for importing .dll files generated from PSCAD, EMTP, PSSE-DIgSIlent etc.

Schematic Editor

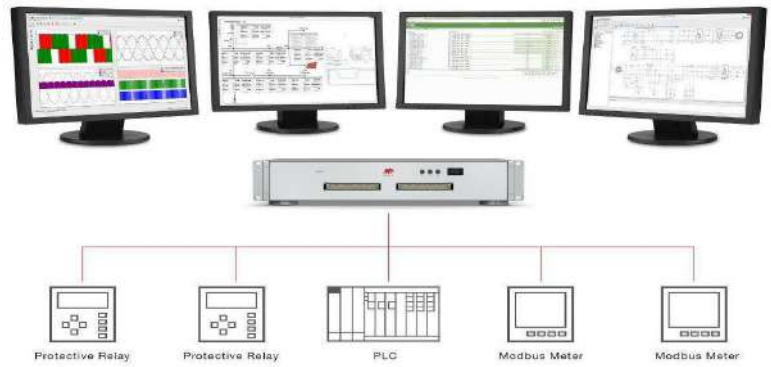
Designed by engineers for engineers. One editor to do it all and model it all

- Schematic Editor comes with a rich library of components, starting from basic elements, such as linear, non-linear and time-varying passive components, current and voltage sources, measurement components, contractors, circuit breakers, all the way to pre-packaged composite components, multilevel converters, multiphase machines, multi-winding transformers, variety of transmission lines and more.
- Simply draw your power circuits and distribution network together with control logic and deploy them in less than a minute with a state-of-the-art embedded compiler.
- From single converter applications and basic controller prototypes to multi-layer distribution networks, Schematic Editor will help virtualize your power system with ease.

HIL SCADA

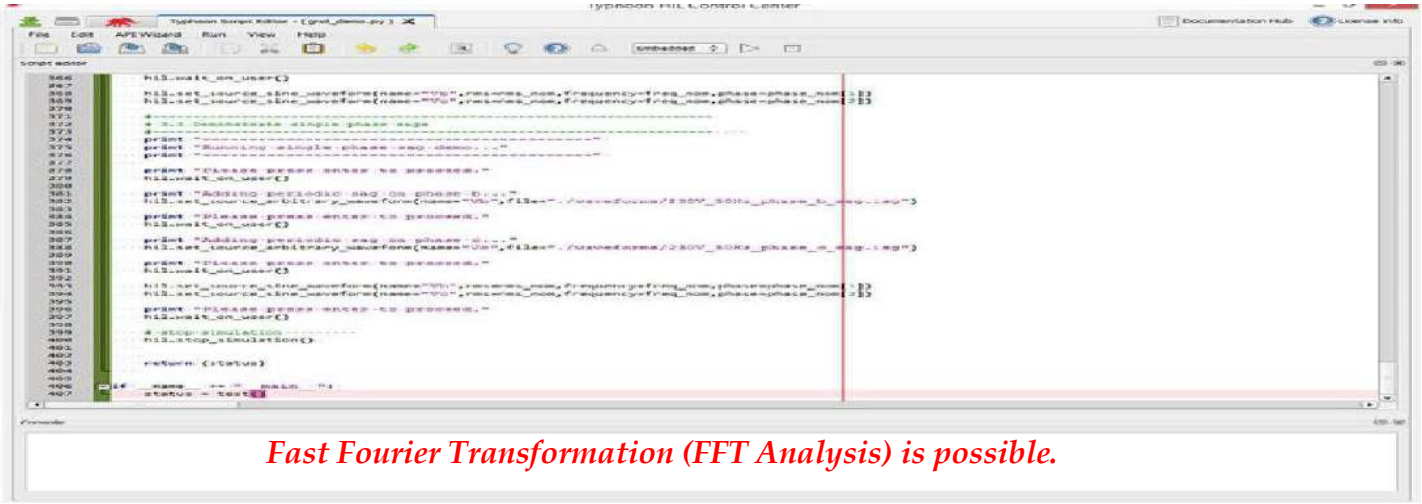
HIL Microgrid Testbed has an integrated HIL SCADA which allows monitoring all functions of the simulated microgrid, to interact with hardware control components and to use their communication infrastructure.

With Typhoon SCADA even the most complex test environments can be monitored with only a couple of mouse clicks, as the test environment is 100% customizable thanks to a wide selection of drag-and-drop gauges, meters, trace graphs, and monitors.



Script Editor

The Script Editor (with the graphical programming feature) to help you to develop converter and microgrid test scripts.



Fast Fourier Transformation (FFT Analysis) is possible.

Test Suite GUI

Pre-certify your control logic in-house (For all major standards around the world)

Let be realistic. There is one moment when even the hearts of hardened veteran engineers fill with anxiety and trepidation, and that is the time when a new product needs to get certified.

Test Suite, developed in cooperation with Austrian Institute of Technology GmbH (AIT), allows you to address these challenges in the most efficient way. You can think of the Test Suite as your personal, in-house, pre-certification institute featuring a growing selection of tests according to BDEW FGW TR3, IEC 62116, EN 50530, Rule 21 and UL 1741 (including the upcoming UL 1741 SA) grid codes.

Test Suite allows unlimited repetition of standard-compliant tests that all but guarantee your success the first time you go to the certifying institute.

Typhoon HIL offering Overview *HIL Accessories*

HIL Connect Universal Interface

Plug-and-play connectivity with Typhoon HIL devices.
Size: 19", 6U

- 32 AO channels
  - 16 x high voltage, ±183.3 V
  - 16 x high current, ±2A
- 16 AI channels
  - 16 x current, ±40 mA
  - 16 x voltage, ±10 V 32 D IO channels

HIL Connect Woodward easyGen 3500 genset controller

Plug-and-play connectivity with Typhoon HIL devices
Size: 19", 6U

Highlights

- Typhoon HIL compatible model
- True RMS voltage and current sensing (gen, bus and mains).
- CAN network communication/control to engine ECU Modbus RTU (slave) communication for SCADA and external control

***Requires HIL Connect Universal interface**

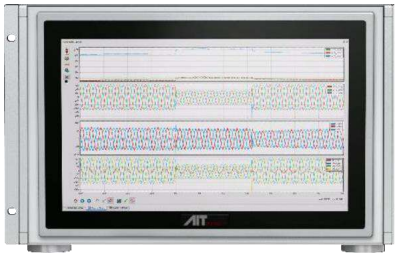
HIL Connect Protective relays (ABB REF615 / SEL 751 relays)

Plug-and-play connectivity with Typhoon HIL devices
Size: 19", 6U

Highlights

Typhoon HIL compatible model Protective functions :

- Overvoltage
- Undervoltage
- Overcurrent
- Undercurrent



HIL Connect AIT Smart Grid Controller

Plug-and-play connectivity with Typhoon HIL devices
Size: 19", 6U

Highlights

Typhoon HIL compatible model
Smart grid (PV, ESS, Harmonic filters and FACTS) and microgrid control platform.
SunSpec compliant
Standalone Power Panel GUI for AIT SGC control.
Built in host PC with an interactive Touchscreen display.

HIL Breakout Board

Onboard 192 pin snap-in terminal dramatically simplifies the wiring between your control hardware and your HIL system. As soon as the system is up and running there are 192 test terminals for easy access to all the interface signals: firing pulses, control feedback signals and other analog/digital I/O signals.

HIL Launchpad Features

LaunchPad Interface is the way to go for those who want to accelerate the development of Power Electronics applications for Texas Instrument family of DSPs. Typhoon HIL emulates power stage of a PE device that includes power converters, electrical machinery, filters, electrical grid, PV cells, passive elements, etc. with 1µs overall time resolution.

HIL Calibration Card Highlights:-

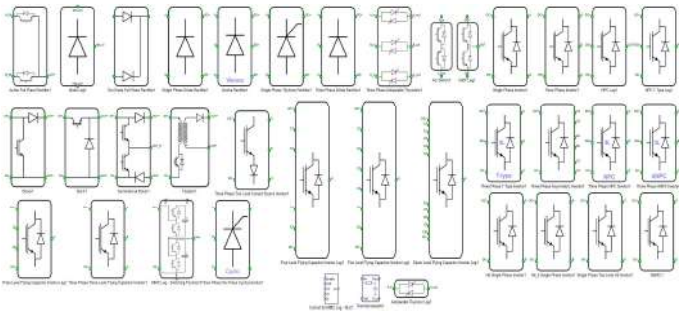
- < 1 LSB offset error on all HIL60x analog channels
- < 0.1% gain error on all HIL60x analog channels
- One-click calibration
- Maintenance free calibration device

HIL DS Interface

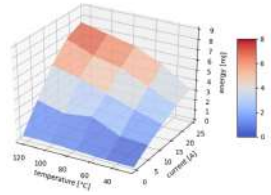
The HIL dS Interface Type-B provides a pin-to-pin compatible interface between all Typhoon HIL emulators (4-Series and 6-Series) and the dSPACE's MicroLabBox, top panel variant, as well DS1103 controllers.

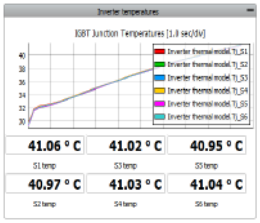
Typhoon HIL - Applications

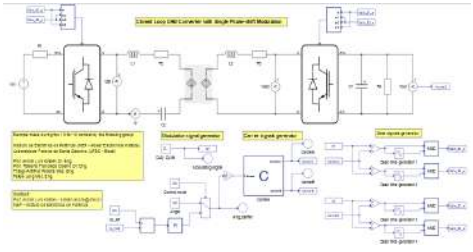
Power Electronics



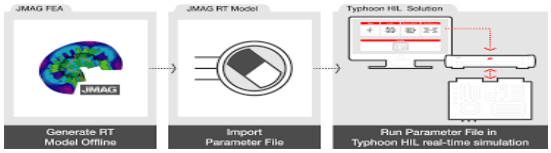
With any of Typhoon HIL real-time devices, you are getting a real-time calculation of switching and conduction losses in semiconductor switches. This allows you to precisely estimate converter losses and temperatures with firing pulses coming from a real production controller, giving you the ability to cover all imaginable operating conditions and load cycles. Accurate thermal behavior information can be one of the most valuable inputs for converter reliability assessment.

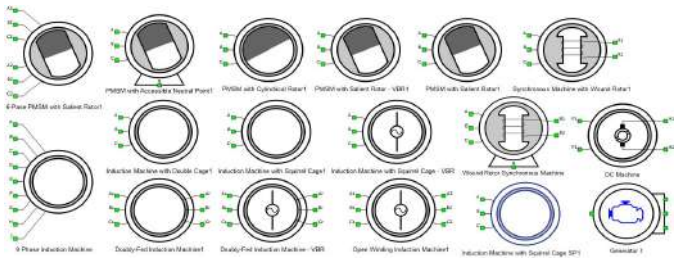






Electrical Machines and Drives





Emulate any machine model

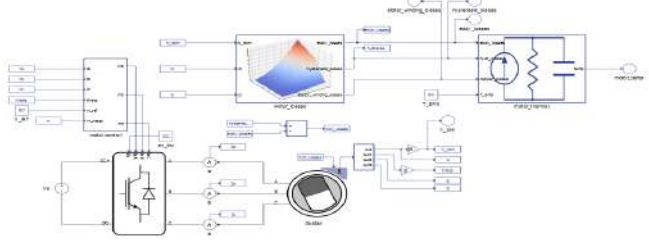
Linear flux-inductance; Flux saturation; Spatial effects; All are emulated.

The key to emulating various types of flux and spatial effects

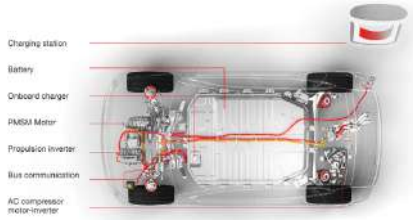
The Machine Solver is an FPGA module that simulates a particular machine model. It performs all of the associated state space calculations with the same time step as the external circuit (typically 1 µs).

Besides the standard machine models with a linear flux-inductance relationship, the Machine Solver allows you to simulate models with flux saturation. Spatial effects are also emulated. Such properties are parameterized and incorporated in the model in the form of a lookup table. Additionally, the Machine Solver generates feedback signals for your controller, specifically:

Incremental encoder Sine encoder Resolver Absolute encoder protocol



Electric Vehicle

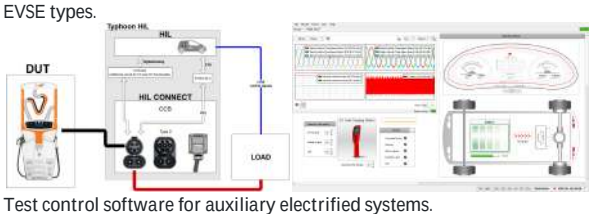


HIL Built for Electric Vehicles and e-Mobility

Our Hardware in the Loop (HIL) solution was tailor-built, without any compromises, for the design and testing of power electronics controllers for Electric Vehicles (EV), e-Mobility, and power converters. HIL solutions for EV drive-trains, electric vehicle stationary equipment (EVSE) such as fast DC chargers, onboard vehicle chargers, DC/DC converters, hybrid drive-trains, batteries, and fuel cells... – we have done it all. All applications of e-Mobility, for thingies that drive, swim and fly. Unleash the Typhoon HIL Advantage to test, design, verify and validate (V&V) your automotive control software.

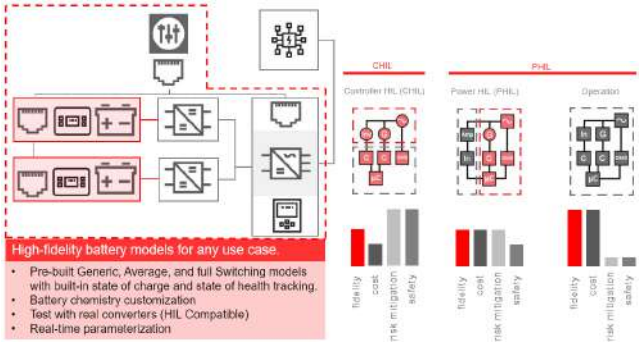
Charging Interface and Standards Solutions

- Models of EV's and EVSE optimized for ultra high-fidelity real-time simulations.
- Rich library of automated tests to provide constant 24/7 testing with clear reports and results.
- Tests of all existing standards (CCS, GB/T, CHAdeMO) as well as all EV and EVSE types.



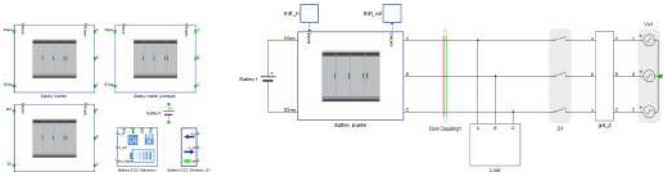
- Test control software for auxiliary electrified systems.
- Simulate next-generation electric motor driven compressors.
- Model variable-speed compressor drive in HIL as well as mechanical loads and coupled thermal loops.
- Deploy HIL to develop and test control for Heat Pump Air Conditioning Systems, the next-generation Heating, Ventilation, and Air Conditioning (HVAC) systems for pure e-Mobility.

Energy Storage

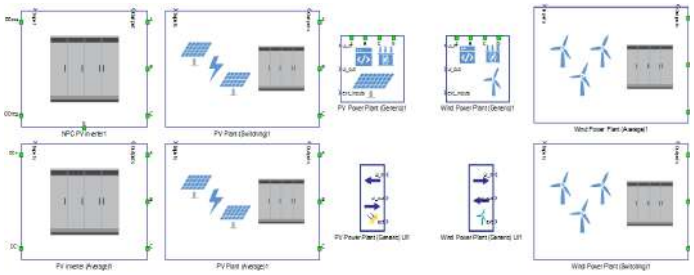


Battery Energy Storage Systems (BESS) are becoming central to reliable and high-quality power delivery. Maximizing the value of BESS means pushing BESS control to its limits WITHOUT sacrificing battery life. Controller Hardware in the Loop (HIL) real-time simulation lets you perform high-fidelity tests on every level of your BESS Controllers at every level to ensure you meet your client's needs.

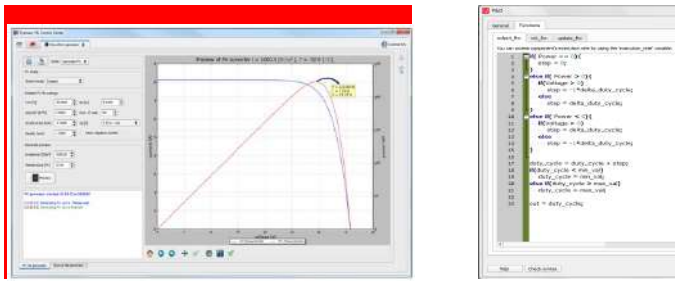
- A wider test coverage, including full system-level operation, extreme voltage conditions, faults, and communication layer tests;
- Time and money savings compared to Power HIL (PHIL) testing.
- With FPGA, ARM processors, and paralleling capability built-in, the Typhoon HIL Platform empowers you to build high-fidelity real-time simulation models of batteries and their power electronics converters.
- On top of this, our pre-built, drag-and-drop battery models and HIL Compatible converter models means more time focusing on testing your own innovations, such as a 200ns time-step behavioural analysis of a single car battery, or a grid storage system with dozens of batteries and inverters using generic "black-box" control or, just import your own model directly from Python, Matlab, or other modelling systems using our software.

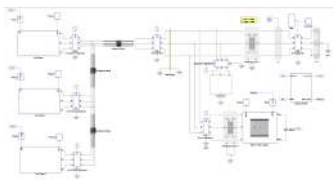


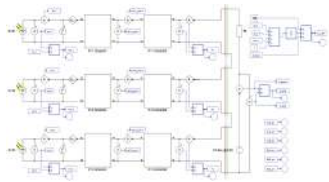
Renewables



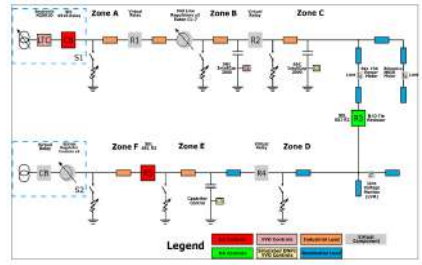
Wave generator tool is software toolbox which allows you to fully customize your real-time simulations with real-date, generated data or the combination of the two. On the one hand, with the Source file generator you can generate various types of signals which you can change on the point level. On the other hand, the PV file generator allows you to either generate a PV panel file using various parameters or to import an arbitrary I-V curve from a .csv file and thus generate a PV panel from real date acquired at your test site.







Power System & Protection



Time-domain Electromagnetic Transients Program (EMTP) type simulation.

Our small time-step simulation enables high-fidelity simulation of all power devices including inverter-based DERs.

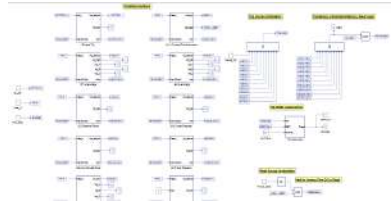
Our detailed library of Virtual DER models allows you to interface your designs with a high-fidelity digital model of the power system executed on ultra-low-latency real-time emulators and harness the benefits of test-driven development.

HIL Connect
Protective relays (ABB REF615 / SEL 751 relays)

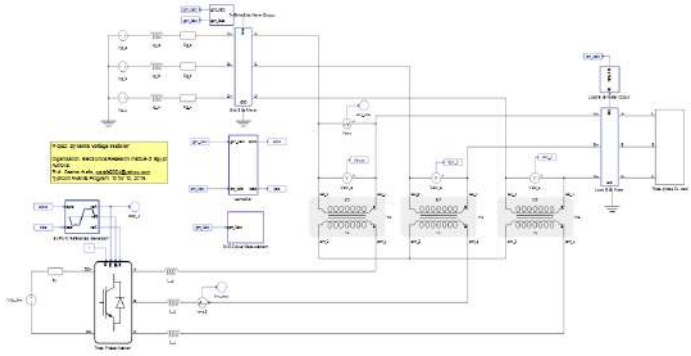
Plug-and-play connectivity with Typhoon HIL devices
Size: 19", 1U
Protective functions:
Overvoltage, overcurrent, undervoltage, undercurrent

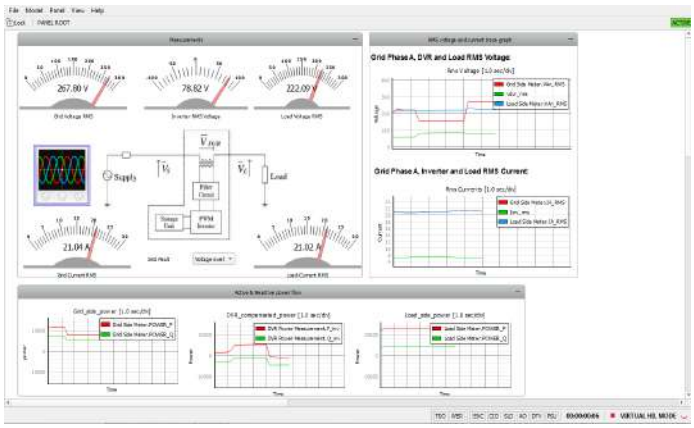
17 channels:
10 x high current, bandwidth 3 KHz, output ± 3A
7 x high voltage, bandwidth 10 KHz, output ± 180V

Validate relay parameters and test the entire protection layer against short circuits, phase losses, overvoltage's, low and overvoltage ride through as well as component failures. Connect the physical protection relays to your real-time replica of the microgrid on the signal, power, and communication level. Using Typhoon API and Python scripting, execute complex scenarios and fully automate your testing processes. The same environment enables you to conduct a sensitivity analysis of the whole system in real-time.



Power Quality





Insert Sag, Swell, Harmonics using API test relentlessly. Test with standard scenarios like LVRT, HVRT, LFRT, HFRT, IEC61850, UL1741 etc.

Typhoon HIL Resources for Electrical Engineering Laboratories

Any where in India

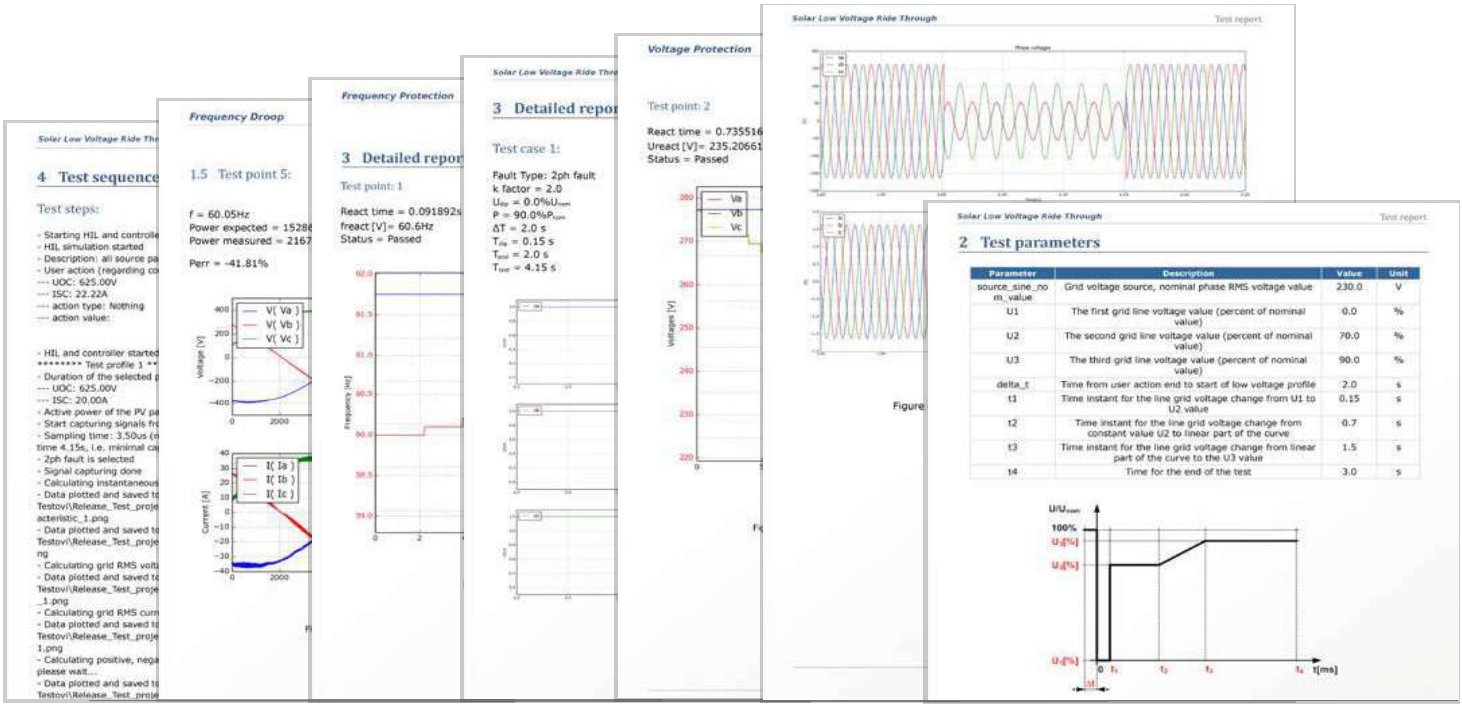
Real-time Simulation Setup at QUARBZ Info Systems Kanpur

List of Suggested Labs

1. Basic Electrical Engineering Lab
2. Networks and Systems Lab
3. Electrical Machine Laboratory
4. Electrical Machine Drive Lab
5. Control System Lab
6. Advance Control Systems Lab
7. Power Electronics Laboratory
8. Advance Power Electronics Laboratory
9. Power System Laboratory
10. Power Quality and FACTs Lab
11. Power System Optimization & Analysis Lab
12. Electrical Drives Laboratory
13. Smart Grid Lab
14. Renewable Energy Laboratory
15. HIL Switch Gear and Protection Lab
16. Micro Grid Laboratory
17. Electric Vehicle Lab
18. Energy Management Systems Lab
19. Data Management Lab
20. Co-simulation Lab
21. Minor & Major Projects

Certify your Microgrid. In - House.

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



Pre-certifcation reinvented

The new Precertifcation Toolbox, verifed 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-certifca-tion 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.

Certifcation, 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 amplifer and high-fdelity real-time models, testing with power is immensely safer & considerably cheaper than in a traditional power laboratory.

More importantly, Microgrid Testbed will automat- ically 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-certifcation and replicate certifcation procedures. In-house.

Software Key Features : -

Environment :	Typhoon HIL Proprietary modeling environment for high-fidelity real time simulation of power electronics and highly dynamic power systems.
HIL Software Tools :	Schematic Editor HIL SCADA Python Based Script Editor Waveform Generator Signal Analyzer
License :	Permanent (lifelong) software tool-chain license, quarterly updates / upgrades.
Toolboxes :	Signal Processing toolbox, Power Systems toolbox, Microgrid library toolbox, Communication toolbox, API support (MATLAB, LabView and other software). PHIL Toolbox, Converter toolbox, Machine Toolbox, PSIM & JMAG Compatability
Simulation Capabilities :	Embedded library of power electronics, power systems and microgrid components. Real time simulation of power electronics converters with switching frequency up to 200 KHz. Open/closed loop HIL testing and RCP Simulation of detailed IEEE distributions systems Simulation of detailed models of PV and WIND (DFIG and PMSG based) plants Control algorithm development and validation for laboratory scale converters used in renewable energy, power quality applications etc...Simulation and testing of industrial controls for drives such as Direct Torque Control, V/f etc... Control algorithm development and validation for drives applications, and SMPS and UPS Development of custom logic & algorithms used in advance control schemes (C function and Advanced C function) Dedicated solvers for Drives and Power electronics, 500kH₂
Others :	Test automation (scripting) using python Development support for project specific components. Ability to edit parameters of the system during real time execution. Internal PWM generator (6.7 ns) Offline simulation supported communication protocols: Modbus, IEC61850, CAN, DNP3 and Variable Ethernet Exchange. Power Supply: 230V, 50 Hz, 3.5ns, IEEE C37:118, Ethernet, OPC, Profinet, SFP Simulation Link

REAL-TIME HIL MICROGRID TESTBED

One Suggested Configuration

A. REAL TIME EMULATORS (HARDWARE)

1. **Processors :**
   - Main Processor : 8-Core FPGA for enabling short compilation time and low latency for small time-step, simulation.
   - Co-processors : 3 ARM, for simulation in signal domain.
2. **System Capability :**
   - Controller HIL and real-time simulation of maximum 8 switching converter models (3ph, 3 levels) with simulation time- step down to 200ns.
   - Controller HIL and real-time simulation of maximum 60 averaged converter models (3ph) with simulation time-step down to 200ns.
   - Real-time simulation of 150+ (3-phase) nodes/busses with full complexity at starting from 3µs to 1s simulation time-step.
   - Real time simulation of power electronic converters with switching frequency of up to 500 KHz.
3. **Option for External Interface *: In-built I/O***
   - 32 Analog inputs fully selectable with ± 10V range, 1 MSPS update rate, 16 bit resolution, 1% accuracy, ± 24V Tolerant ESD protection.
   - 64 Analog outputs fully selectable with ± 10V range, 1 MSPS update rate, 16-bit resolution and 1% accuracy, ± 24V Tolerant ESD protection.
   - 64 Digital inputs, 50MHz sample rate with 20ns sampling resolution on all channels, ± 24V Tolerant ESD protection.
   - 64 Digital outputs with at least 12 channels capable for PWM modulation with 7ns resolution, ± 24V Tolerant ESD protection.
4. **Academic Package Added Capabilities :**
   - The simulator supports multiple configurations without making any physical changes into hardware.
   - Free Firmware update is made available for all supported configurations by Simulator during support.
   - Connectivity: Ports for communication over standard communication protocols, including USB, Ethernet/IP, CAN, Modbus, IEC61850 Goose, EtherCAT, FDCAN, RS232, GPIO, HSSL, JTAG, SFP, QSFP, IRIG-B.
   - Scalable to multiple units (In case multiple device cascading is required in the future).
   - Option for Time synchronization i.e.PPS and IRIG-B inputs.
   - Input Power supply is 230 Volts, 50Hz.

B. Simulation Software with Real Time Interface : Simulator is not dependent on any third - party simulation Software. It has own simulation software with below mentioned specifications:

- Permanent software license for modelling as well as for Real-time Interface with free firmware updates and an unlimited number of software users.
- Academic premium toolbox package with Graphical User Interface (GUI/SCADA).
- Modeling environment for plant as well as Signal Processing with embedded library of components and toolboxes like, ***i) Converter toolbox, ii) Microgrid toolbox, iii) Power System toolbox, iv) Signal processing toolbox, v) Test Suite and vi) Communication toolbox having IEC61850, UL 1741, CAN Bus protocol, Ethernet, DNP3, MODBUS protocol etc.***
- All the switching components in library have Internal (for simulation and real-time simulation) or external (HIL
- simulation), both control option during modeling.
- Ability to run Plant simulation without controller if required for feasibility testing of plant.
- High resolution built-in real time signal monitoring oscilloscope with 16 channels.
- Dedicated solvers for switching devices, machines, signal generators, LUTs, etc. are available with simulation software.
- Simulation of numerical signals with multiple execution rates
- Test environment for testing models and generating Test-Reports.
- Scripting Environment based on python. In-built API for automation as well as for communication with other simulation software is provided.
- Option for importing code generated for controller from simulation software like MATLAB, Simulink, LabView, PSIM etc.
- Option for importing .dll files generated from PSCAD, EMTP, PSSE-DigSilent etc.

***Specifications are subject to change without notice**

REAL-TIME HIL MICROGRID TESTBED

One Suggested Configuration

A. REAL TIME EMULATORS (HARDWARE)

1. **Processors :**
   - Main Processor : 2X8-Core FPGA for enabling short compilation time and low latency for small time-step, simulation.
   - Co-processors: 2X3 ARM, for simulation in signal domain.
2. **System Capability :**
   - Controller HIL and real-time simulation of maximum 16 switching converter models (3ph, 3 levels) with simulation time- step down to 200ns.
   - Controller HIL and real-time simulation of maximum 120 averaged converter models (3ph) with simulation time-step down to 200ns.
   - Real-time simulation of 300+ (3-phase) nodes/busses with full complexity at starting from 3µs to 1s simulation time-step.
   - Real time simulation of power electronic converters with switching frequency of up to 500 KHz.
3. **Option for External Interface *: In-built I/O***
   - 64 Analog inputs fully selectable with ± 10V range, 1 MSPS update rate, 16 bit resolution, 1% accuracy, ± 24V Tolerant ESD protection.
   - 128 Analog outputs fully selectable with ± 10V range, 1 MSPS update rate, 16-bit resolution and 1% accuracy, ± 24V Tolerant ESD protection.
   - 128 Digital inputs, 50MHz sample rate with 20ns sampling resolution on all channels, ± 24V Tolerant ESD protection.
   - 128 Digital outputs with at least 12 channels capable for PWM modulation with 7ns resolution, ± 24V Tolerant ESD protection.
4. **Academic Package Added Capabilities :**
   - The simulator supports multiple configurations without making any physical changes into hardware.
   - Free Firmware update is made available for all supported configurations by Simulator during support.
   - Connectivity: Ports for communication over standard communication protocols, including USB, Ethernet/IP, CAN, Modbus, IEC61850 Goose, EtherCAT, FDCAN, RS232, GPIO, HSSL, JTAG, SFP, QSFP, IRIG-B.
   - Scalable to multiple units (In case multiple device cascading is required in the future).
   - Option for Time synchronization i.e.PPS and IRIG-B inputs.
   - Input Power supply is 230 Volts, 50Hz.

B. Simulation Software with Real Time Interface : Simulator is not dependent on any third - party simulation Software. It has own simulation software with below mentioned specifications:

- Permanent software license for modelling as well as for Real-time Interface with free firmware updates and an unlimited number of software users.
- Academic premium toolbox package with Graphical User Interface (GUI/SCADA).
- Modeling environment for plant as well as Signal Processing with embedded library of components and toolboxes like, ***i) Converter toolbox, ii) Microgrid toolbox, iii) Power System toolbox, iv) Signal processing toolbox, v) Test Suite and vi) Communication toolbox having IEC61850, UL 1741, CAN Bus protocol, Ethernet, DNP3, MODBUS protocol etc.***
- All the switching components in library have Internal (for simulation and real-time simulation) or external (HIL
- simulation), both control option during modeling.
- Ability to run Plant simulation without controller if required for feasibility testing of plant.
- High resolution built-in real time signal monitoring oscilloscope with 16 channels.
- Dedicated solvers for switching devices, machines, signal generators, LUTs, etc. are available with simulation software.
- Simulation of numerical signals with multiple execution rates
- Test environment for testing models and generating Test-Reports.
- Scripting Environment based on python. In-built API for automation as well as for communication with other simulation software is provided.
- Option for importing code generated for controller from simulation software like MATLAB, Simulink, LabView, PSIM etc.
- Option for importing .dll files generated from PSCAD, EMTP, PSSE-DigSilent etc.

***Specifications are subject to change without notice**

REAL-TIME HIL MICROGRID TESTBED

One Suggested Configuration

A. REAL TIME EMULATORS (HARDWARE)

1. **Processors :**
   - Main Processor : 3X8-Core FPGA for enabling short compilation time and low latency for small time-step, simulation.
   - Co-processors : 3X3 ARM, for simulation in signal domain.
2. **System Capability :**
   - Controller HIL and real-time simulation of maximum 24 switching converter models (3ph, 3 levels) with simulation time- step down to 200ns.
   - Controller HIL and real-time simulation of maximum 180 averaged converter models (3ph) with simulation time-step down to 200ns.
   - Real-time simulation of 450+ (3-phase) nodes/busses with full complexity at starting from 3µs to 1s simulation time-step.
   - Real time simulation of power electronic converters with switching frequency of up to 500 KHz.
3. **Option for External Interface *: In-built I/O***
   - 96 Analog inputs fully selectable with ± 10V range, 1 MSPS update rate, 16 bit resolution, 1% accuracy, ± 24V Tolerant ESD protection.
   - 192 Analog outputs fully selectable with ± 10V range, 1 MSPS update rate, 16-bit resolution and 1% accuracy, ± 24V Tolerant ESD protection.
   - 192 Digital inputs, 50MHz sample rate with 20ns sampling resolution on all channels, ± 24V Tolerant ESD protection.
   - 192 Digital outputs with at least 12 channels capable for PWM modulation with 7ns resolution, ± 24V Tolerant ESD protection.
4. **Academic Package Added Capabilities :**
   - The simulator supports multiple configurations without making any physical changes into hardware.
   - Free Firmware update is made available for all supported configurations by Simulator during support.
   - Connectivity: Ports for communication over standard communication protocols, including USB, Ethernet/IP, CAN, Modbus, IEC61850 Goose, EtherCAT, FDCAN, RS232, GPIO, HSSL, JTAG, SFP, QSFP, IRIG-B.
   - Scalable to multiple units (In case multiple device cascading is required in the future).
   - Option for Time synchronization i.e.PPS and IRIG-B inputs.
   - Input Power supply is 230 Volts, 50Hz.

B. Simulation Software with Real Time Interface : Simulator is not dependent on any third - party simulation Software. It has own simulation software with below mentioned specifications:

- Permanent software license for modelling as well as for Real-time Interface with free firmware updates and an unlimited number of software users.
- Academic premium toolbox package with Graphical User Interface (GUI/SCADA).
- Modeling environment for plant as well as Signal Processing with embedded library of components and toolboxes like, ***i) Converter toolbox, ii) Microgrid toolbox, iii) Power System toolbox, iv) Signal processing toolbox, v) Test Suite and vi) Communication toolbox having IEC61850, UL 1741, CAN Bus protocol, Ethernet, DNP3, MODBUS protocol etc.***
- All the switching components in library have Internal (for simulation and real-time simulation) or external (HIL
- simulation), both control option during modeling.
- Ability to run Plant simulation without controller if required for feasibility testing of plant.
- High resolution built-in real time signal monitoring oscilloscope with 16 channels.
- Dedicated solvers for switching devices, machines, signal generators, LUTs, etc. are available with simulation software.
- Simulation of numerical signals with multiple execution rates
- Test environment for testing models and generating Test-Reports.
- Scripting Environment based on python. In-built API for automation as well as for communication with other simulation software is provided.
- Option for importing code generated for controller from simulation software like MATLAB, Simulink, LabView, PSIM etc.
- Option for importing .dll files generated from PSCAD, EMTP, PSSE-DigSilent etc.

***Specifications are subject to change without notice**

REAL-TIME HIL MICROGRID TESTBED

One Suggested Configuration

A. REAL TIME EMULATORS (HARDWARE)

1. **Processors :**
   - Main Processor : 4X8-Core FPGA for enabling short compilation time and low latency for small time-step, simulation.
   - Co-processors : 4X3 ARM, for simulation in signal domain.
2. **System Capability :**
   - Controller HIL and real-time simulation of maximum 32 switching converter models (3ph, 3 levels) with simulation time- step down to 200ns.
   - Controller HIL and real-time simulation of maximum 240 averaged converter models (3ph) with simulation time-step down to 200ns.
   - Real-time simulation of 600+ (3-phase) nodes/busses with full complexity at starting from 3µs to 1s simulation time-step.
   - Real time simulation of power electronic converters with switching frequency of up to 500 KHz.
3. **Option for External Interface *: In-built I/O***
   - 128 Analog inputs fully selectable with ± 10V range, 1 MSPS update rate, 16 bit resolution, 1% accuracy, ± 24V Tolerant ESD protection.
   - 256 Analog outputs fully selectable with ± 10V range, 1 MSPS update rate, 16-bit resolution and 1% accuracy, ± 24V Tolerant ESD protection.
   - 256 Digital inputs, 50MHz sample rate with 20ns sampling resolution on all channels, ± 24V Tolerant ESD protection.
   - 256 Digital outputs with at least 12 channels capable for PWM modulation with 7ns resolution, ± 24V Tolerant ESD protection.
4. **Academic Package Added Capabilities :**
   - The simulator supports multiple configurations without making any physical changes into hardware.
   - Free Firmware update is made available for all supported configurations by Simulator during support.
   - Connectivity: Ports for communication over standard communication protocols, including USB, Ethernet/IP, CAN, Modbus, IEC61850 Goose, EtherCAT, FDCAN, RS232, GPIO, HSSL, JTAG, SFP, QSFP, IRIG-B.
   - Scalable to multiple units (In case multiple device cascading is required in the future).
   - Option for Time synchronization i.e.PPS and IRIG-B inputs.
   - Input Power supply is 230 Volts, 50Hz.

B. Simulation Software with Real Time Interface : Simulator is not dependent on any third - party simulation Software. It has own simulation software with below mentioned specifications:

- Permanent software license for modelling as well as for Real-time Interface with free firmware updates and an unlimited number of software users.
- Academic premium toolbox package with Graphical User Interface (GUI/SCADA).
- Modeling environment for plant as well as Signal Processing with embedded library of components and toolboxes like, ***i) Converter toolbox, ii) Microgrid toolbox, iii) Power System toolbox, iv) Signal processing toolbox, v) Test Suite and vi) Communication toolbox having IEC61850, UL 1741, CAN Bus protocol, Ethernet, DNP3, MODBUS protocol etc.***
- All the switching components in library have Internal (for simulation and real-time simulation) or external (HIL
- simulation), both control option during modeling.
- Ability to run Plant simulation without controller if required for feasibility testing of plant.
- High resolution built-in real time signal monitoring oscilloscope with 16 channels.
- Dedicated solvers for switching devices, machines, signal generators, LUTs, etc. are available with simulation software.
- Simulation of numerical signals with multiple execution rates
- Test environment for testing models and generating Test-Reports.
- Scripting Environment based on python. In-built API for automation as well as for communication with other simulation software is provided.
- Option for importing code generated for controller from simulation software like MATLAB, Simulink, LabView, PSIM etc.
- Option for importing .dll files generated from PSCAD, EMTP, PSSE-DigSilent etc.

***Specifications are subject to change without notice**

Lessons learned

Microgrid controller design and verification

At 2017. Microgrid & DER Controller Symposium, organized by the Massachusetts Clean Energy Center and MIT Lincoln Laboratories, the real, unadulterated industrial microgrid controllers from Eaton, General Electric, Schweitzer Engineering Laboratories, and Schneider Electric were in the spotlight.

They were controlling 3 feeders with 24 buses, one diesel generator, one natural gas generator with combined heat and power, a battery storage, a PV inverter, and nu merous loads running within the Microgrid Testbed. Microgrid controllers had to deal with a wide spectrum of disturbances, including: various faults, irradiance profiles, load profiles, and Distribution Management System (DMS) requests to the microgrid con troller (e.g. to export active/reactive power, to island, etc.)

The key finding is that, with today's technology, designing and testing microgrid control system is difficult (and costly), while designing and testing it without the right tools is impractical.

2017 MIT Lincoln Laboratory microgrid and DER controller symposium

Wind converter firmware design, test and verification

Woodward GmbH in Kempen, Germany, is the largest independent manufacturer of grid -tied converters for wind industry. Its installed base comprises more than 15,500 converters in onshore and offshore applications interfacing doubly-fed, synchronous and asynchronous generators to the grid.

Woodward GmbH built a large controller hardware in the loop (HIL) testing laboratory with multiple HIL based test cabinets to reduce the cost of software quality and to simplify the communication with its customers, such as General Electric, Suzlon, Senvion, and others.

"We can test much faster and more. Significantly less work is required in the field and on the test stands, which has brought significant advantages both in terms of safety, cost savings and cost of quality."

Aiko Classe
Renewable Power Systems, Woodward Kempen GmbH, Germany

Thanks to ultra-high fidelity real-time simulation HIL models and full test automation, Woodward dramatically increased the test coverage and reduced the cost of quality which was the main objective of the investment.

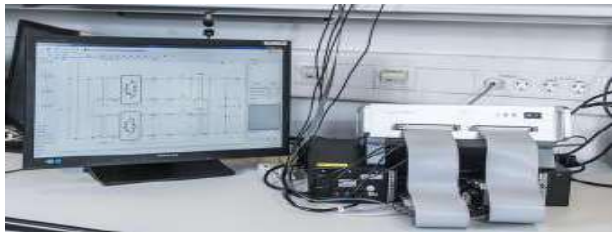
HIL plays key role in 48MW compressor drive integration project

Typhoon HIL Controller HIL technology provided a completely safe environment for ABB engineers enabling latest concepts for test automation and regression testing find their place in ABB power laboratories. System protection tuning in completely realistic environment and large reduction of commissioning time and cost are just few of the benefits enabled by the concept.

"We really appreciate how easy it is to work with Typhoon HIL equipment as well as the quality of technical support from Typhoon HIL"

Pieder Joerg
ABB Switzerland Ltd

Controller HIL for development of high performance battery emulators



"With an early porting of controller algorithm to the real target hardware, a large number of issues, especially in control hardware configuration, can be solved prior to system integration phase."

Dr. Roland Greul,
BU Electrification and Racing Test Systems,
AVL List GmbH, Graz, Austria

Nexts
UTD TX, USA

New, HIL Based Power Electronics Teaching Laboratory

"Typhoon HIL teaching laboratory provides engaging, hands-on, intuitive and 100% safe learning environment."

Prof. Kaushik Rajashekara
University of Texas at Dallas

For more details visit https://www.typhoon-hil.com/company/customers

Microgrid Testbed

Indian Institute of Technology, Kanpur

NITTTR - CHANDIGARH

National Institute of Technical, Teachers, Training & Research, Chandigarh

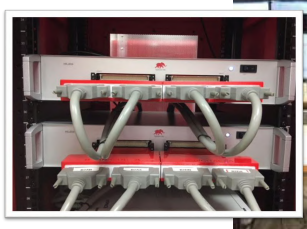
University of Houston,

Dr. Kaushik Rajashekara,
Professor,
Department of Electrical & Computer Engineering,

Application	▪ Terrestrial microgrids
Units used	▪ 3xHIL604
In the loop	▪ SEL 751 Relay ▪ Woodward genset controller ▪ HIL Connect
Success Story	▪ Terrestrial Microgrids

UT Arlington

University of Texas Arlington
Department of
Electrical Engineering
Ali Davoudi, Professor



Application	• Terrestrial microgirds
Units Used	• 10xHIL604
In the loop	• 5 dSPace controllers
Success Story	• Resilient self- Microgrids

Indian Institute of Technology, Bombay

Choice of Academic References

"The People from Typhoon HIL have been working with me to make sure that they are providing what I need as a customer from day one. They are working with you to help you reach your goal."

Dr. Reza Sabzehgar,
Assistant Professor, San Diego State University, USA

"We unplugged the control board from the HIL, put it in a real setup and let it run. It is working exactly the same without changing a single comma in the control code."

Prof. Alvaro Luna,
Universitat Politecnica de Catalunya, Spain

"Thanks to Typhoon HIL, We have reached new heights in control of power electronics systems. High-fidelity simulation environment with a wide range of simulation models give us the confidence needed to achieve our research goals efficiently & in a safe learning environment."

Dr. Ali Davoudi,
Director of Comp lex Power Electronics Networks,
University of Texas at Arlington, USA

"Typhoon HIL gave us an easy-to-use testing solution for all our usage scenarios. We were really surprised how easy it was to integrate Typhoon HIL into our research workflow. These units have greatly improved our testing and development times & have been a great asset in our lab."

Dr. Wayne W. Weaver
Associate Professor of Electrical Engineering, Michigan Technological University, USA

For more details visit https://www.typhoon-hil.com/applications/research

Sole Authorized Distributor in India :

QUARBZ INFO SYSTEMS

2nd Floor, Skylark Complex, 14/147, Chunniganj, Kanpur – 208 001, UP India
Email ID - hil.support@quarbz.com, Website :- www.quarbz.com
Mob. No. : +91-9838071684 - 85*