



HIL101

Quality. Performance. Convenience.

Designed to meet the rigorous demands of educational environments, our FPGA based HIL101 offers high performance capabilities combined with unparalleled ease of use – all at an affordable price.



www.typhoon-hil.com



FPGA BASED TECHNOLOGY WITH HIGH PRECISION AT AN AFFORDABLE PRICE

Unleash Your Academic Potential with the HIL101

Harnessing FPGA-based technology with high precision at an affordable price, the HIL101 is tailored to elevate academic research and education. Serving as both an entry-level simulator and an integral part of our flagship HIL solutions, it proves indispensable for educational research.

Designed specifically for Real-Time Control Prototyping (RCP) and general simulations. The HIL101 empowers users to seamlessly integrate converter power stage models into the Typhoon HIL schematic editor and advanced compiler capability allows for the graphical creation and swift deployment of real-time models. With its built-in deep memory mixed-signal oscilloscope, the HIL101 facilitates comprehensive validation of controller performance, ensuring meticulous testing that enhances the efficacy of research and educational projects.

Our versatile toolchain also supports integrations with popular software like Matlab/Simulink, JMAG-RT, ANSYS, and other simulation tools. It enables seamless model imports from third-party tools, making the HIL101 a robust and adaptable testing environment suitable for applications such as battery storage, power quality, and motor drives, delivering accurate and reliable results.

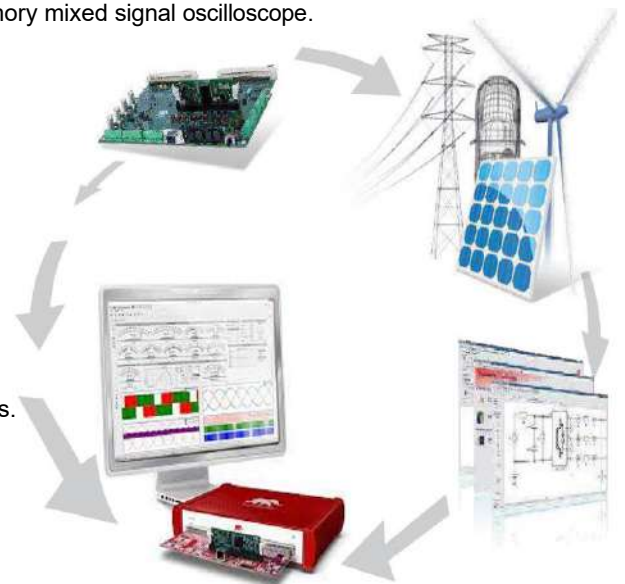
Unleash the HIL101

Engage the powerful HIL101 through the hallmark of Typhoon HIL user-friendly design with industry-leading software toolchain.

- Draw a converter power stage model in the Typhoon HIL schematic editor, press compile and run the model with a single click
- Verify the performance of your controller through a built-in deep memory mixed-signal oscilloscope.
- Execute test scenarios directly from the control center.
- Automate the verification process with Python scripts.

Our HIL101 device enables:

- Down to 250ns simulation step for general circuits.
- 50ns DC-DC solver simulation step.
- A 4.5ns GDS oversampling on all digital inputs.
- Up to 3 processing cores.
- Real-time emulation of non-linear machines with spatial harmonics.
- Real-time emulation of semiconductor switches power losses.
- The most accurate Dual Active Bridge (DAB) converter model.
- The most accurate resonant DC/DC converter model.
- JMAG-RT FEM electric machine model import.
- HIL connectivity exploded: USB3.0, Ethernet, Gb/s serial link, JTAG, General Purpose IO (GPIO).



Easy to use software tool-chain

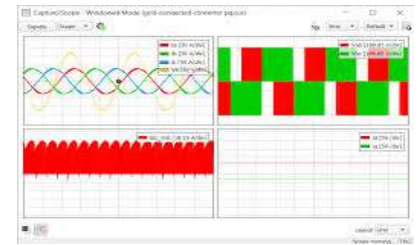
User-friendly and intuitive software is easy to use and master, even for first-time users. Build your models and perform sophisticated test scenarios, in the comfort of your Institute/Lab.

Application

This compact, extremely powerful, HIL will give you all the tools you need to test your power electronics controllers in a wide range of applications: solar and wind power generation, battery storage, power quality and motor drives.

Built-in Scope and Capture

Typhoon HIL integrated oscilloscope and capture functions put you in control. With 16 analog and 32 digital channels, 32 Mpts record length, and 1 MHz sample rate you will gain MRI (magnetic resonance imaging) vision into the inner workings of your control system even under the most extreme conditions, the conditions that are impossible or impractical to create in the laboratory.



Custom User Interface

A whole new level of user convenience.

Drag-and-drop gauges, meters, trace graphs, and monitors in order to customize the test environment according to your specific needs. Even the most complex test environment is only a few mouse clicks away.

Test away from lab

Renewable energy systems comprise power electronics converters that interface with the electrical grid. Exhaustively testing power electronics control system's performance in the laboratory is costly and suffers from inherently limited opportunities for test automation. The HIL101 provides a safe, high-fidelity environment for automatic test and verification of converters control systems.



Test what you never could in the lab

Typhoon HIL101 environment allows you unprecedented control of active and reactive power flow, current harmonics and grid voltage sources with arbitrary magnitude, frequency and phase in just a few mouse clicks.

Furthermore, you can easily emulate utility grid disturbances such as voltage sags, spikes, phase angle jumps, magnitude ramps, frequency changes, harmonic distortion, etc. Any test scenario you can imagine HIL101 will execute

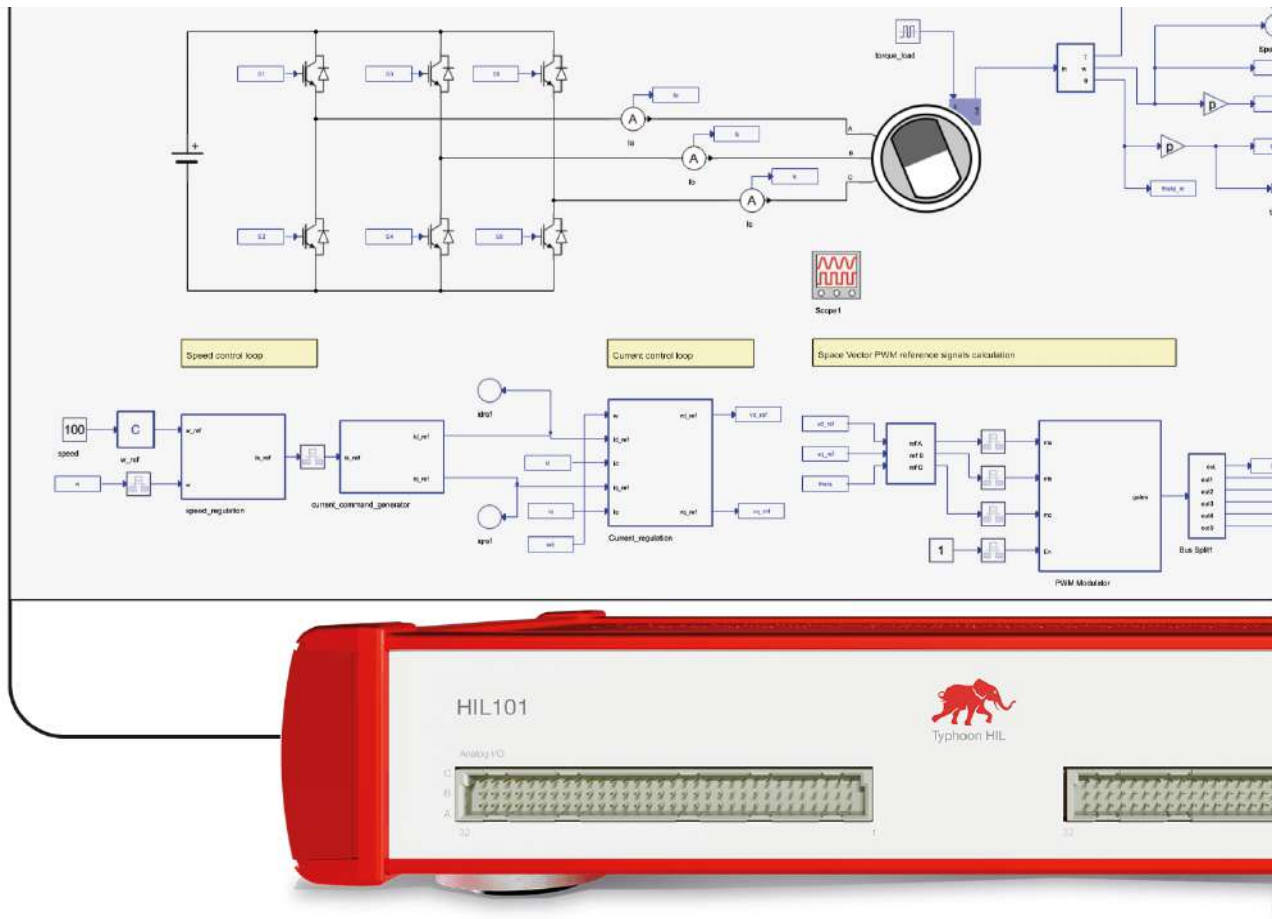
List of Suggested Labs

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

Please Note : The above-mentioned list of experiments can be conducted by faculties/users. Typhoon HIL/Quarbz will not provide any experimental manual nor any experimental documents. For more related to experiments please refer to "HIL Academy" (<https://hil.academy/>).

Setting new standards in HIL simulations for education.

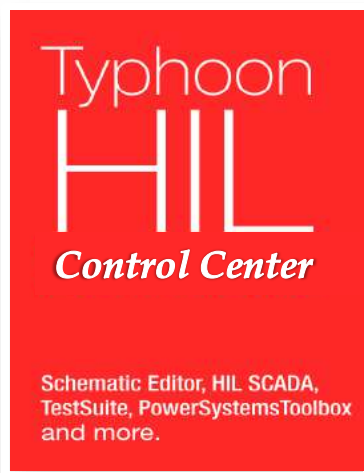
The HIL101 represents a leap forward in academic research and education, blending high-performance FPGA-based simulation capability with unparalleled ease of use and affordability. It equips students and educators across diverse power engineering disciplines with a versatile tool capable of both rapid control prototyping and advanced real-time simulations.



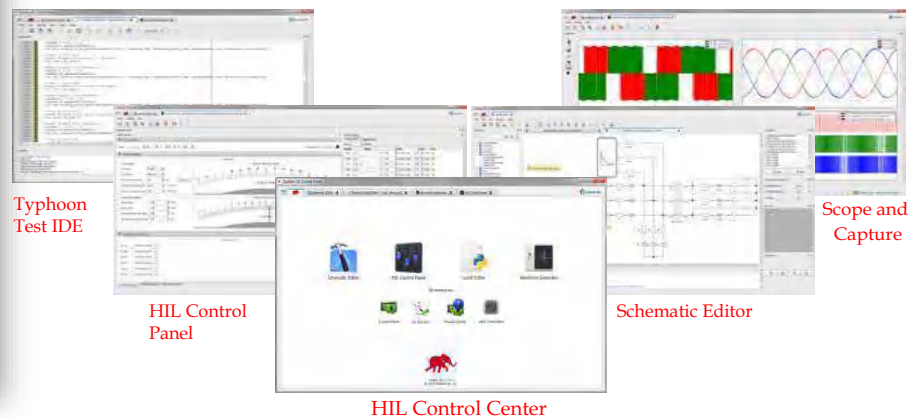
Current Market Solutions

- Current market solutions are often expensive.
- Lack a clear path toward controller hardware and industrial applications.
- Reliance on multiple software toolchains requires creating and maintaining multiple models.
- Reduces productivity by increasing workload and the risk of modeling errors.





Typhoon HIL Device



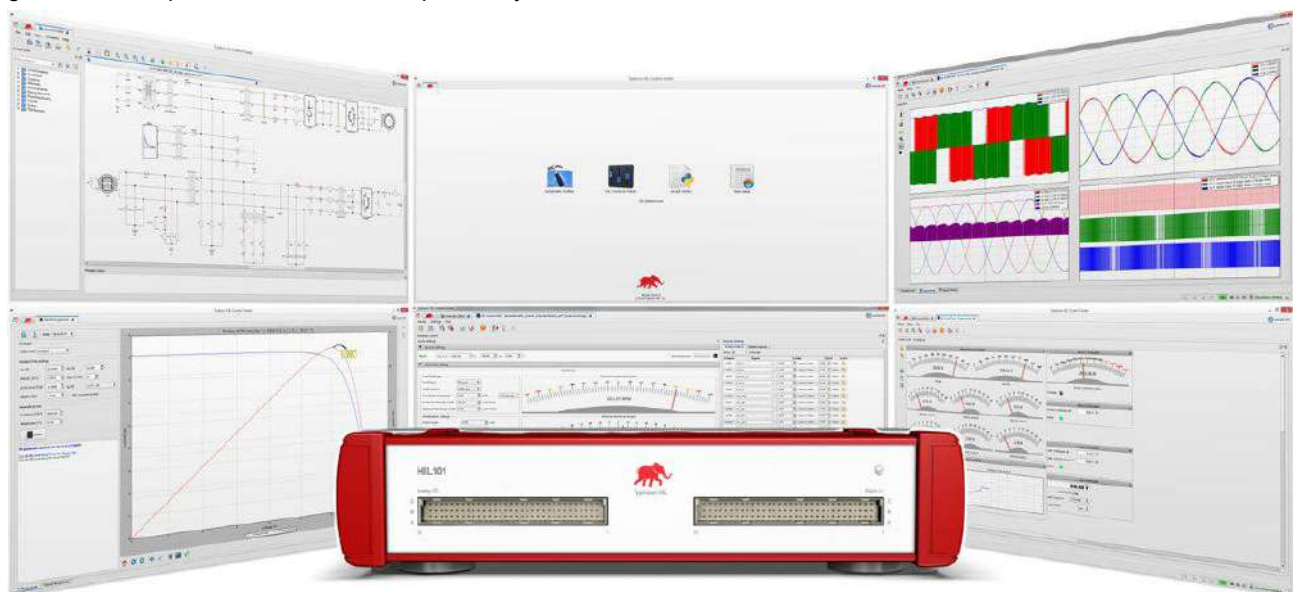
Typhoon HIL Control Center is the window which opens when you start Typhoon HIL's software. In this section general description of Typhoon HIL Control Center & the main software components accessible from it, as well as additional software tools which can be directly invoked from its interface.

Schematic Editor allows you to create high-fidelity 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 dock Undo/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.

TyphoonTest IDE 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 TyphoonTest 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.



Expand your knowledge, Enhance your skills and test freely and relentlessly!

This "Typhoon HIL Device" is a software toolbox within a HIL tool-chain that enables HIL models to run on a PC instead of on a Typhoon HIL device. Typhoon HIL Device is a truly game-changing addition to any teaching lab. With it, any computer lab based on Windows®-based PCs can be instantly transformed into a power electronics knowledge and skill factory where students can create their own models and test scripts. Moreover, it is the perfect tool to make the flipped classroom teaching methodology work. Using their own PCs with Typhoon HIL Device, students can develop their power electronics intuition and knowledge at their own pace in the comfort.

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 TyphoonTest IDE 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 Compatibility.
Simulation Capabilities:	Embedded library of power electronics, power systems and microgrid components. Real time simulation of power electronics converters with switching frequency up to 250 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.
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 Offline simulation supported communication protocols: Ethernet; CAN; RS232; GPIO; HSSL; JTAG; USB 3.0

Area of Application

Power Electronics	Electric Drives	Power Quality	Power Plant Engineering
Marine	Traction	Energy Storage	Signal Processing
Pre-certification	Rapid Control Prototyping	Adaptive Control	Real Time Simulation
Renewable Energy Solar Power, Wind Power	Power System Analysis and Studies	Different Loads (Variable, resistance, inductance)	Electric Vehicle & Plugged – in – Hybrid Electric Vehicle
Controller Hardware-in-Loop Studies (C-HIL)	HVAC, HVDC, FACTS Devices	Micro Grid	Smart & Microgrid Testing, commissioning & communication
MMC Studies	PHIL (Power Hardware in Loop Studies)	Biomedical Application	Power Quality Studies, Aerospace

FEATURES HIGH-LIGHTED :

- No use of third - party tools. Our comprehensive electrical engineering - based library gives full advantage to model your Plants.
- Offers permanent software license with unlimited number of users.
- FPGAs as the computational platform to achieve the precision in tune in order of 1 us. However, will be operating on slower clock frequency comparative to other HIL devices.
- 3 User programmable CPUs.
- Communication wise, Offers same capabilities as HIL404.
- Minimum simulation time step achieved is 250ns and 50ns for dc-dc converters.
- DI Sampling resolution rate is 4.5ns.
- Typhoon HIL model library is developed for direct REAL TIME execution on the FPGA.
- There is no need to develop first offline model and then retransforming the same into real time.
- Signal processing and DSP interface solutions for easy control prototyping and easy deployment of target platforms.
- Completely integrated Typhoon HIL software tool chain.
- Tailored to elevate academic research and education
- Versatile tool capable of both rapid control prototyping (RCP) and advanced real-time simulations
- Real-time emulation of non-linear machines with spatial harmonics
- Real-time emulation of semiconductor switches power losses

Device Configuration Table

HIL Device

HIL101

Param name \ Configuration		1	2	3
▼	Standard Processing Cores	2	3	2
	SPC peak processing power [GMACS]	0.88	0.88	0.88
	SPC matrix memory [KWords]	16.0	16.0	16.0
	Max converter weight (ideal switches)	3	3	4
	Contactors (ideal switches)	6	6	6
	Non-ideal switches	0	0	8
	Time varying elements	16	16	16
	Global GDS oversampling	yes	yes	yes
	Switch-level GDS oversampling	no	no	yes
	GDS switching delay	yes	yes	yes
	Converter power loss calculation	yes	yes	yes
	Converter forward voltage drop	yes	yes	yes
▼	Machine solvers	1	0	0
	Nonlinear machine support	yes	no	no
	Nonlinear machine LUT size [KWords]	32	0	0
	Absolute encoder protocol support	yes	no	no
	DC-DC converter solvers	0	0	1
	Signal generators	12	12	12
	Look Up Tables	8	8	8
	PWM modulators	12	12	12
	PWM analyzers	4	0	0
	Parallel DTV detectors	0	0	0
▶	Interfaces			



HIL101 Technical Details

Processor	3 cores Zynq Ultrascale SoC
Channels	16 x Analog inputs (AI); 16 x Analog outputs (AO); 32 x Digital inputs (DI); 32 x Digital outputs (DO)
Built-in scope	Yes
Resolution	16 bit
Connectivity	1 x USB 2 x Ethernet 2 x CAN 2 x RS232 2 x SFP 1 x GPIO 1 x JTAG
Power	12 V 5 A adapter
Housing	293 x 195 x 52 [mm], 2.1 kg
Software	Typhoon HIL Control Center (THCC)

Please Note : Specification and features are subject to change without any prior notice.

Welcome to HIL Academy The online learning hub for students and professionals.



Become a certified HIL Specialist! For Free

Typhoon HIL : Enroll in the course specially designed to help you master the latest generation of Model and Simulation – Based Systems Engineering tools.

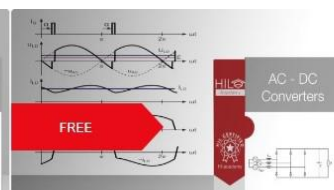
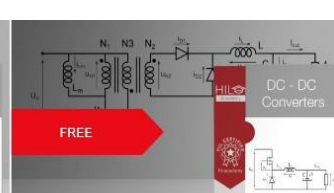
HIL Academy

Login at : <https://hil.academy>

Certified HIL Specialist

This course is carefully designed to get you working fast within the Hardware in the Loop (HIL) paradigm, in a way that develops your skills and confidence with the tool set which expands with each unit. You will learn how power electronics and power systems engineers use HIL to design, test and verify complex and dynamic control and power management systems of all levels. In order to follow the course units and acquire these skills at your own pace, you need a licence for Typhoon HIL Device, which you can download from this page.

HIL Academy Courses

 FREE AC - AC Converters	 FREE AC - DC Converters	 FREE Communication Protocols	 FREE Control of Microgrids
2 Modules AC – AC Converters	3 Modules AC – DC Converters	8 Modules Communication Protocols	2 Modules Control of Microgrids
 FREE DC - AC Converters	 FREE DC - DC Converters	 FREE Digital Control of Grid-Tied Converters	 FREE HIL for Microgrids
2 Modules DC – AC Converters	11 Modules DC – DC Converters	5 Modules Digital Control of Grid-Tied Converters	7 Modules HIL for Microgrids
 FREE HIL for Power Electronics	 FREE HIL Fundamentals	 FREE HIL Simulation for Power System Protection	 FREE HILの基礎
6 Modules HIL for Power Electronics	6 Modules HIL Fundamentals	6 Modules HIL Simulation for Power System Protection	5 Modules HILの基礎
 FREE Introduction to Digital Control of Power Converters	 FREE Operation of Li-ion Batteries (Preview)	 FREE Semiconductor Components	 FREE Test Automation
2 Modules Introduction to Digital Control of Power...	1 Module Operation of Li-ion Batteries (Preview)	8 Modules Semiconductor Components	6 Modules Test Automation

HIL Fundamentals

HIL Fundamentals is the first course in the HIL Specialist 2.0 specialization program authored by Typhoon HIL engineers. This course series is designed to raise your skill and knowledge of the Typhoon HIL toolchain so that you can confidently and successfully execute your own hardware-in-the-loop (HIL) projects.

More Details Click Here :

<https://hil.academy/courses/hil-fundamentals>



Become a certified HIL Specialist!

Enroll in the course specially designed to help you master the latest generation of Model and Simulation – Based Systems Engineering tools.

[READ MORE](#)

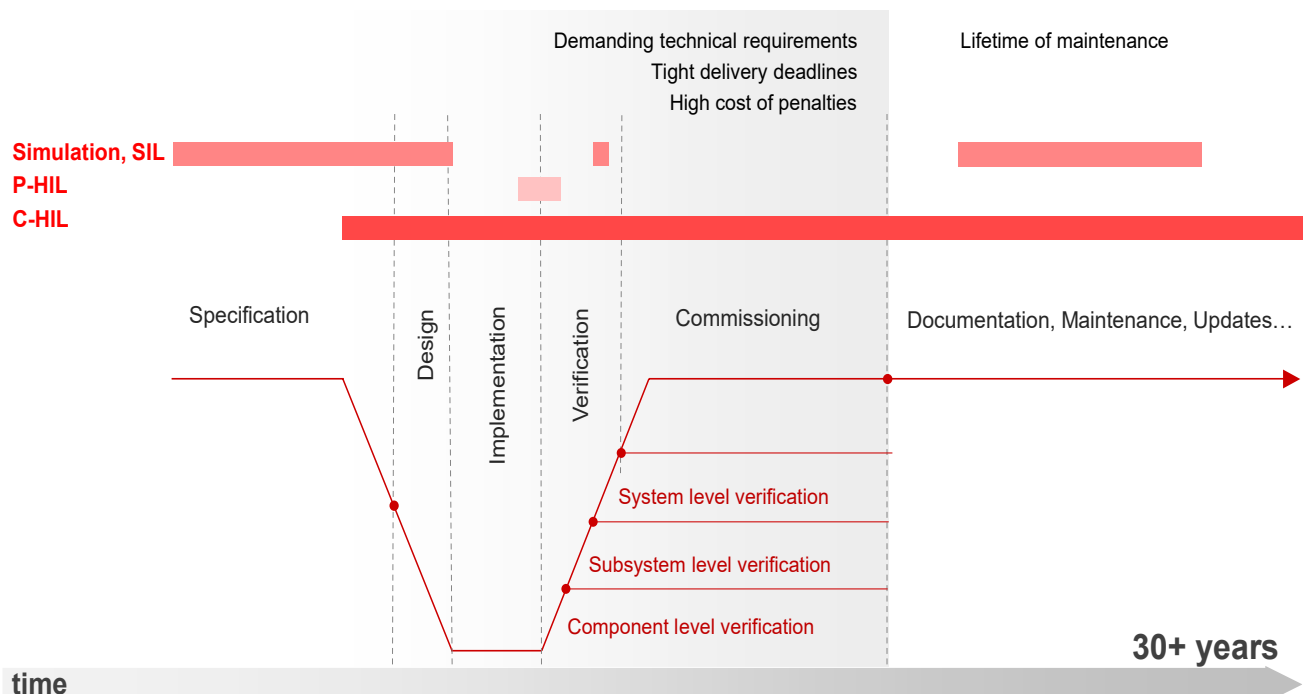
Rapid Control Prototyping Functionality

A faster HIL means faster tests. Rapid Control Prototyping (RCP) is one of the key ways you can take profit of the high speed and fidelity of the HIL101. Coupled with Typhoon HIL's software, RCP with the HIL101 drastically accelerates your controller development cycle, saving you development time and cost, all while reducing investment risk.

The source of this speed comes from the significant hardware upgrades to the HIL101. over previous generations. With real-time datalogging, analog I/O resolution as low as 250ns, and digital I/O resolution as low as 4.5ns, you can have the confidence in the high-fidelity models you use. But don't just trust us: the diversity of connection ports in the HIL101, plus Typhoon HIL's wide array of native communication protocol support, means you can connect your hardware connections directly to the model and perform Controller Hardware-In-the-Loop (C-HIL) tests yourself.

With C-HIL in your RCP process, you can test the real unmodified controllers with its real hardware, software, and firmware. The controller under test cannot 'feel' any difference between controlling real equipment or the ultra- high fidelity, real-time simulation. It receives current / voltage signals, temperature signals, and position sensor signals from the real-time HIL simulator and sends the gate drive signals back to the real-time HIL simulator.

Typhoon HIL's software lets you use the same models from Model-in-the Loop (MIL), Software-in-the-Loop (SIL), and Controller Hardware-in-the-Loop (C-HIL) tests. This means that you can catch potential issues earlier in the development process and iterate new prototypes in your controllers before performing costly and potentially dangerous power lab tests. RCP and C-HIL testing also lets you have a greater test breadth, giving you greater confidence that new equipment will behave in the field as it does in the lab.



Other Product from Typhoon HIL GmbH, Switzerland

SWISS  QUALITY - Engineering Tools for Power Industry.



HIL606

Our HIL606 is our top-of-the-line product which encompasses the best features from our entry level devices together with our mid-tier devices providing the perfect balance of speed, power, and flexibility to integrate and scale seamlessly. With these unique connectivity options, your controller won't

Introducing the HIL606. Now you have the speed you love from our latest 4th generation devices together with the power of our 6-series, 8-core processors, balanced with the flexibility you require to connect to the devices you need. What's New? - Built for the most demanding applications with future-proof connectivity options. Plug and Play Upgrade Down to 200ns time-step Down to 200ns Analog Output update Rate 3.5ns GDS oversampling on all Digital Inputs 24 Detailed DER Models (3ph) M.2 Slot for long-term Data Acquisition Back Panel Connectivity (4x Ethernet, 2x EtherCat, 2x CAN FD, 2x QSFP)



HIL506

Perfect for power electronics systems, motor drives, and grid modernization applications, the HIL506 is derived from our flagship hardware, tailored specifically for mid-range applications. Unleash the 6-core processor HIL for real-time emulation of complex multi-converter topologies.

The HIL506 is engineered to offer a versatile and affordable solution without sacrificing performance, seamlessly bridging the gap between our entry-level and high-end devices. Perfect for both industrial and academic settings, it sets the industry standard for ultra-low-latency, high-fidelity, real-time emulation with powerful, user-friendly, Python-based software. Whether you're testing a single power electronics converter control or managing a complex multi-converter system, the HIL506 delivers an integrated, scalable solution that grows with your needs.



HIL404

Our HIL404 delivers the unprecedented model fidelity needed for the most advanced motor drives and automotive power electronics applications. By leveraging the ultra-high fidelity and ease-of-use of the existing Typhoon HIL solutions, and by bringing the extra speed to the table, the HIL404 makes the

HIL testing methodology truly applicable for the emerging high frequency power conversion applications. Down to 200ns time-step, Down to 200ns Analog Output update rate, 3.5ns GDS oversampling on all Digital Inputs, Up to 4 processing cores, Real-time emulation of non-linear machines with spatial harmonics.

Microgrid Testbed

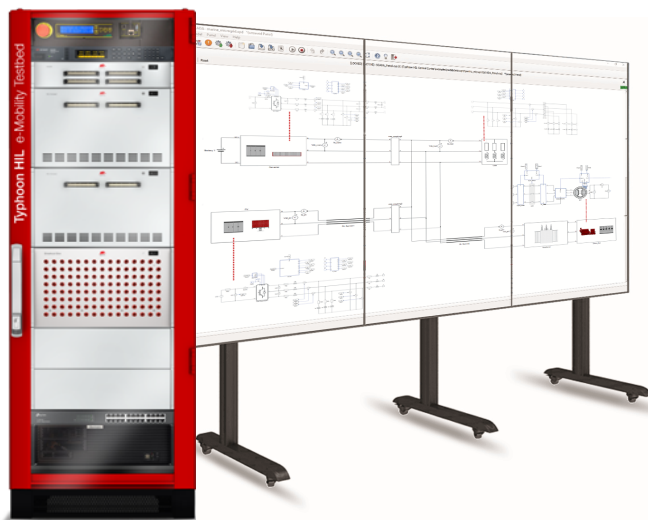
Solar and wind power generation, as well as battery storage, are all part of today's microgrids. Together with protective relays, communication networks and microgrid controllers they are complex power systems that need thorough testing and verification before their safe and reliable operation can be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



E-drive Test Bench

E-drive testbench will help you perform testing for your ECU and simulation of complete electric drivetrain including motor drive control testing, OBC, EVSE, communication & BMS testing as well.

The unique feature set for e-mobility is the ultra-low latency provided by our devices, native real-time emulation for high switching frequencies, various fault simulation capabilities like IGBT faults, Machine faults and so on. The real-time emulation of switching and conduction losses as well as built-in machine speed and position feedback signal are also possible.

Typhoon HIL's Accessories

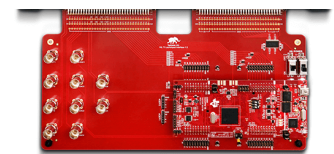
HIL interfaces play a critical role in HIL testing setups by enabling the seamless integration of real hardware into the simulation environment, facilitating accurate and efficient testing and validation of control systems in a controlled and safe manner. Typhoon HIL offers a wide variety of essential interfaces to create seamless integration and interaction to assess data communication, signal conditioning, real-time processing, I/O connectivity, communication protocols, safety features, and more.



HIL Connect



HIL Breakout Board



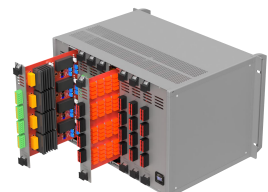
HIL TI Launchpad Interface



HIL Calibration Card



HIL DS Interface



HIL BMS Interface

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 Complex Power Electronics Networks, University of Texas at Arlington, USA



Typhoon HIL's Webinars

Please click on the link for Typhoon HIL's Latest & Recorder Webinars : <https://www.typhoon-hil.com/webinars/>

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