Typhoon HIL

4th Generation HIL.

HIL606.

Speed, power and flexibility.
Together as one.

www.typhoon-hil.com

HIL606

The 4th Generation flagship has arrived.

Robustness meets speed with future-proof connectivity options.

Approach physical tests of your control system with confidence. With the speed of our latest 4th generation devices, together with the power of our 6-series, 8-core processors, you can control more high-fidelity models than ever before. And with new unique connectivity options, your controller won't know the difference between your test models and the devices in the field, no matter your use case.

What's new?

- Upgrade in a flash with backwards compatibility for all devices and pin-to-pin compatibility with HIL604
- Model converters at timesteps as fast as 200 ns
- Down to 200 ns Analog Output update rate
- 3.5 ns Gate Drive System (GDS) Oversampling on all Digital Inputs
- Simulate your full microgrid with capacity for up to 24 Average Converter models
- Built-in M.2 slot for long-term data storage
- Unparalleled connectivity options:
  - 6 Ethernet ports, including 2 EtherCAT ports
  - 4 CAN ports, including 2 ports for flexible data rates (CAN FD)
  - 2 Quad-SFP (QSFP) ports

Visit Typhoon HIL HIL606 website page.

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.

0.2µs
Min. Simulation Step

3.5ns
DI Sampling Resolution

24(3PH)*
Detailed DER Models

16/8(1PH/3PH)*
Detailed Converter Models

16units
Paralleling

*per HIL unit

Easy to use software toolchain.

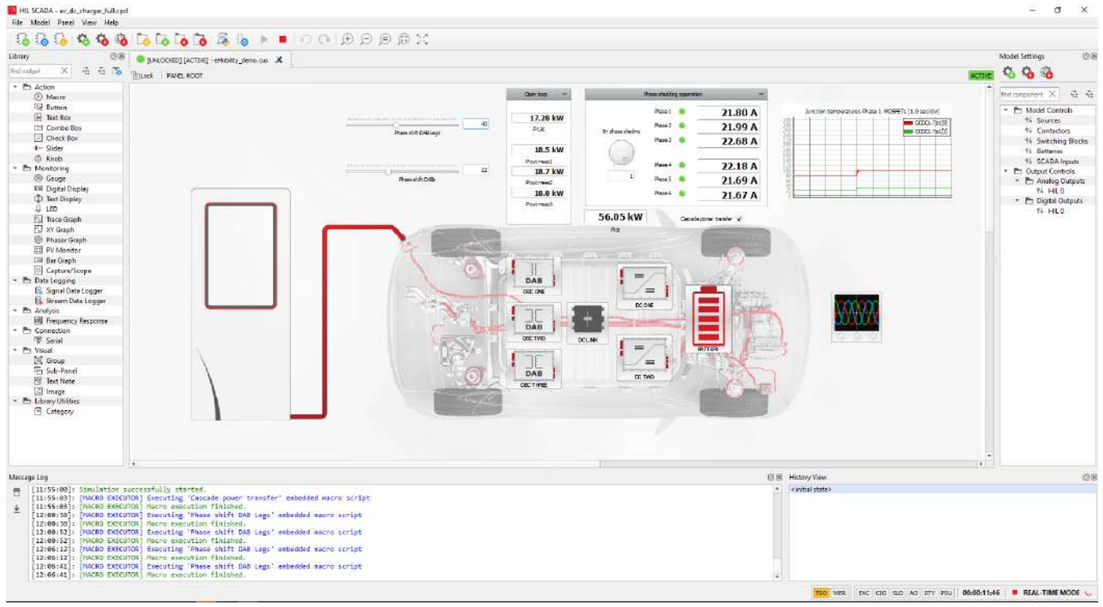
Together with Typhoon HIL's easy to use software toolchain and top of the line support, you have the tools you need to perform rapid control prototyping with sophisticated real-time test scenarios from the comfort of the office, no matter your experience level.

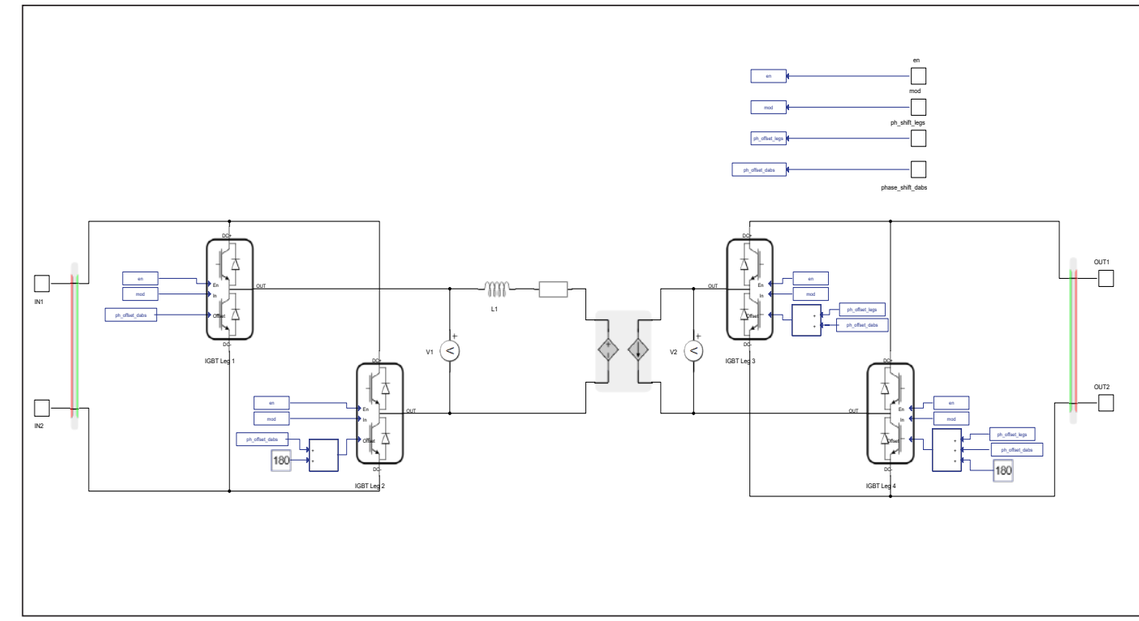
Speed

for modeling and testing
fast-switching converters.

SCADA demonstration of an EV DC Charger example running on a single HIL606 at 250ns timestep

Learn more on Typhoon HIL e-Mobility website page.





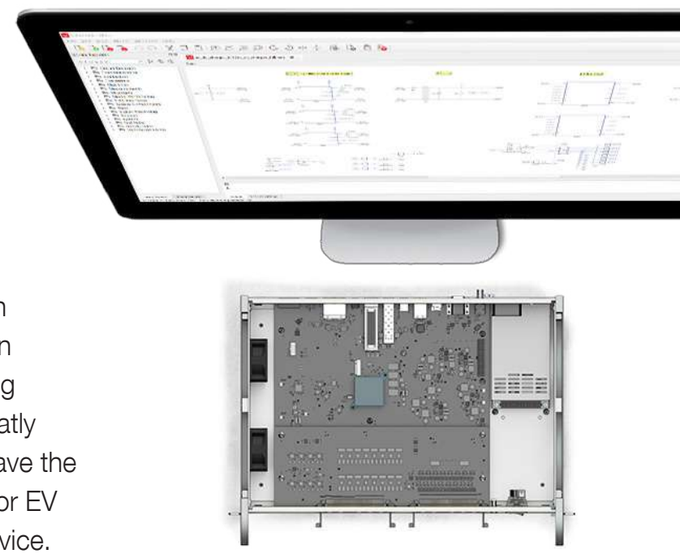
The model above represents of 1 of 3 DC/DC high frequency isolation stages of the featured EV DC charging example, using 3 Dual Active Bridge (DAB) converters in parallel.

> Early porting of the controller algorithm to the real hardware solves a large number of issues prior to system integration. This results in significant development time and cost savings.

Read more:

Dr. Roland Greul
Manager of Department at AVL

Need to model several dual-active bridges together at the highest switching frequencies?



With the HIL606, you can test many high-switching frequency complex converters with multi-module Si-C based converters between the 50 to 500 kHz range at once. With analog time resolution at 200 nanoseconds and greatly increased processing and IO capacity you have the tools you need to test your full electric drive or EV charging system in real-time with a single device.

Power

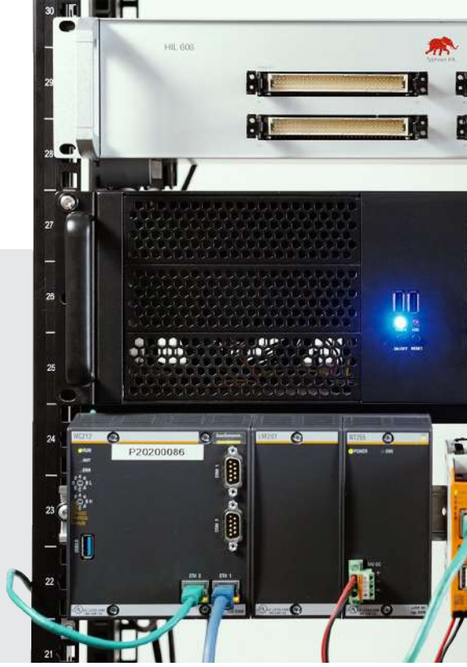
to run complex models at short timesteps.

Learn more on Typhoon HIL Microgrid website page.

Read more:

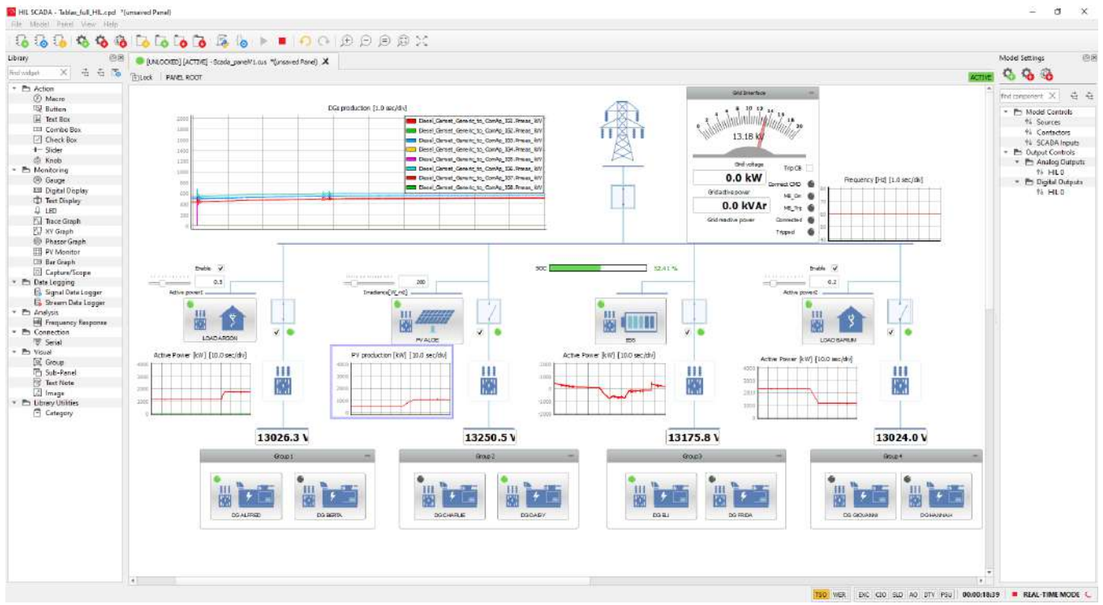
"We need a powerful real-time simulation platform in order to test our control system correctly."

David Dunnett
Head of Software Development at Rolls-Royce Solutions

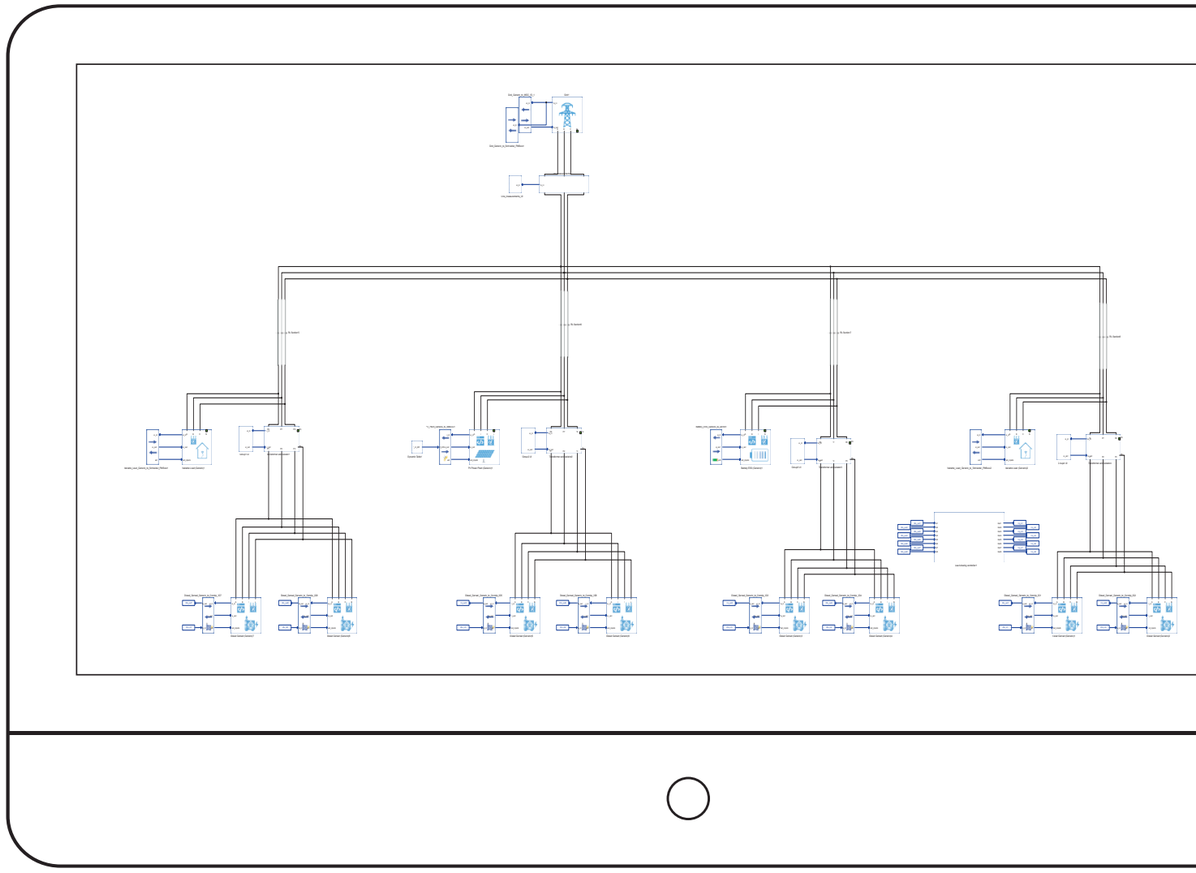


Worried your microgrid models are too complex to integrate real hardware and low-level controllers in your test setup?

The HIL606 supports 24 average distributed energy resource (DER) models in real-time at once, and at very short timesteps. This means you are extremely well-equipped for simulating full microgrid models in real-time with real equipment at the highest level of detail.



HIL SCADA demonstration of an islanded microgrid response to changes in DER production



Example Rolls-Royce Solutions Berlin microgrid model setup for testing their mtu Microgrid Controller over Modbus TCP communication. This model uses only 4 of the HIL606's 8 available cores.

Flexibility

to customize your testbed integration.

Flexibility to customize your testbed integration. Best-in-class connectivity right out of the box.

Need flexible data rates for your CAN-connected vehicle components? Or just a faster response when connecting to third-party devices?

Now you can connect and use your HIL testbed with more flexibility than ever, thanks to completely new interfaces like EtherCat, CAN FD, and even an M.2 slot for long-term data storage. Expanded Quad Small Form-Factor Pluggable (QSFP) and Ethernet options give you strong support for low-level and time-critical internet-based protocols.

And of course, HIL606 is fully compatible with Typhoon HIL's growing portfolio of interface boards and devices, making connecting to power electronic devices, controllers, and even popular dSPACE and Texas Instruments devices possible right out of the box.

"dSPACE" and "Texas Intruments" are registered trademarks of dSPACE GmbH and Texas Instruments Incorporated, respectively, in the United States of America or other countries, or both.

Analog I/O

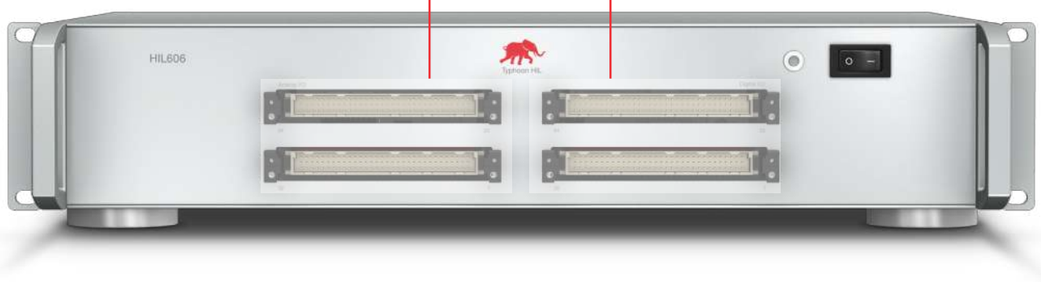
- 32 Analog Inputs and 64 Analog Outputs
- 200 ns minimum sampling resolution

Digital I/O

- 64 Digital Inputs and 64 Digital Outputs
- 3.5 ns minimum oversampling resolution

M.2 slot inside

Optional SSD for long-term offline data acquisition



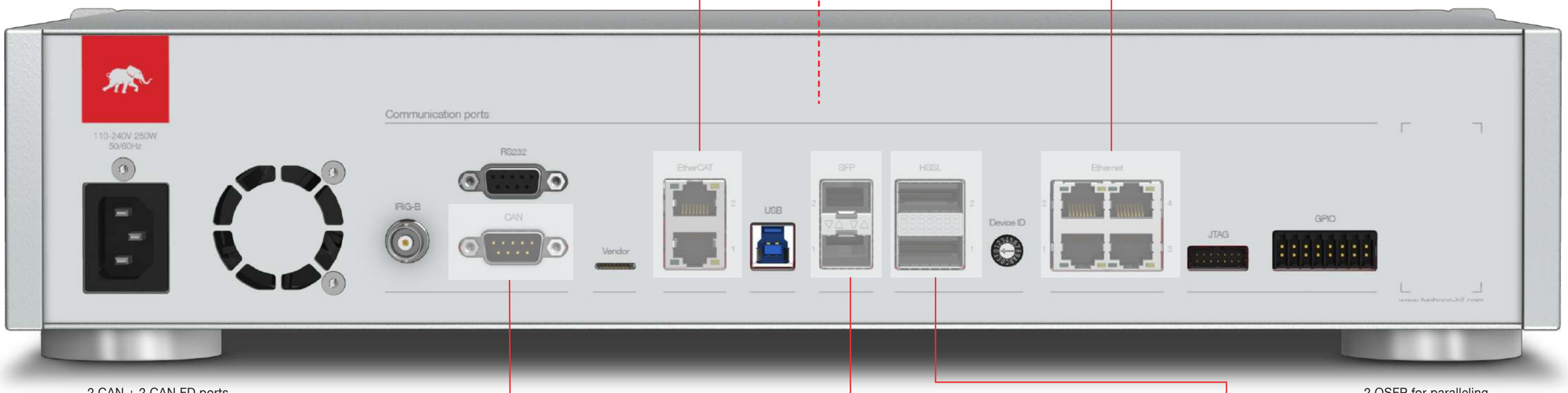
4 Ethernet ports

The first HIL device to have 4 Ethernet ports for greater flexibility to support multiple networks and different protocols.

- 2 ports for high level protocols
  - Modbus, DNP3, OPC UA
  - Including THCC communication
- 2 ports for time critical protocols
  - IEC 61850 SV, Ethernet VE

2 EtherCAT ports

- Hardware-supported slave interfaces
- Low latency daisy chaining with other EtherCAT devices



2 CAN + 2 CAN FD ports

- Double the connectivity options with CAN devices
- Full support for flexible data rates in CAN FD ports
- Ideal for e-Mobility

2 SFP ports

- Communication with other devices only
- SFP Simulation Link capable

2 QSFP for paralleling

Connect 16 devices with more connection flexibility

- Bidirectional link
- Not required to close the ring

Drive your tests faster than ever before.

E-mobility is fast, so its control systems must be faster. Testing performance requires criteria such as high dynamics, broad voltage ranges, and system stability despite rapidly changing loads and conditions.

The HIL606 was designed with these needs in mind. With timesteps as low as 200 nanoseconds and 3.5 nanoseconds digital oversampling resolution, MOSFET, IGBT losses, and thermal losses can be modeled just as they would behave in the real device.

Best of all, with Typhoon HIL's complete solution, you don't need 3rd party software tools at any stage of the V-curve development. Still, the HIL606 does play well with others: direct compatibility with a wide array of existing software and hardware solutions mean you can easily start using HIL where you need it most.

"We decided to use the Typhoon HIL hardware-in-the-loop simulation platform to shorten development time.

Ryota Kitamoto
Engineer at Honda R&D

Read more:

Go wild with test cases.

Designing control systems for microgrids is a very delicate task. Controllers need to perform with a wide variety of devices and standards that continually evolve. Connected PV inverters can lose communication, even while the PV continues to inject energy into the grid.

With HIL, you have full control over the whole powerplant. You can test without any of the physical and safety constraints that come with real-world and power lab testing to see how the system responds in potentially catastrophic situations. You can address communication issues in advance by using the real protocols you will in the field. Powerful test automation tools make it easy to test as you develop.

In short, HIL606 lets you simulate more, faster.

"We can get good test coverage of the system behavior and thereby have good confidence that the control solution we developed will work in a real plant scenario.

Tilo Buehler
Global Product ManagerGrid Edge Solutions at Hitachi ABB

Read more:

main processor
FPGA

analog and digital
IO

co-processor
CPU

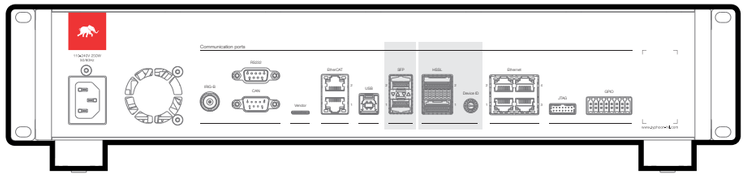
model capacity
DER

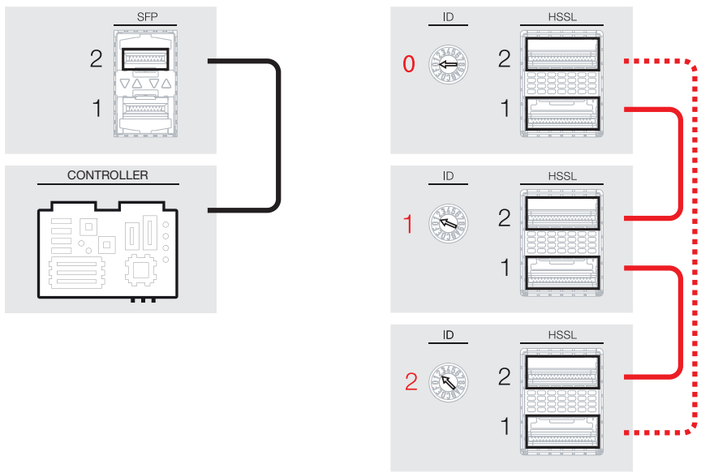
Uncompromising performance.

Parallel your HILs. Explode your potential.

Use the high-speed optical link to parallel your HIL606's while maintaining the small timestep. With the ability to parallel up to 16 units, you can model hundreds of detailed converter models in real-time without sacrificing model speed or model fidelity.

Easy connectivity options let you build a high performing P-HIL testbed in a day. Just connect the optical link interface to any amplifier and start emulating your powertrain or full microgrid.





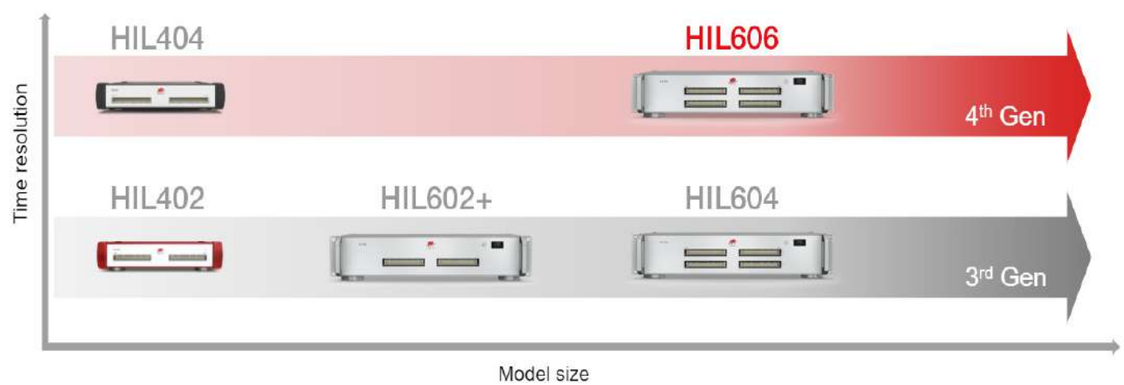
Four Small Form Factor Pluggable (SFP) ports:

- All can be used for parallelingg
- Two QSFP ports allow for faster than ever paralleling capacity

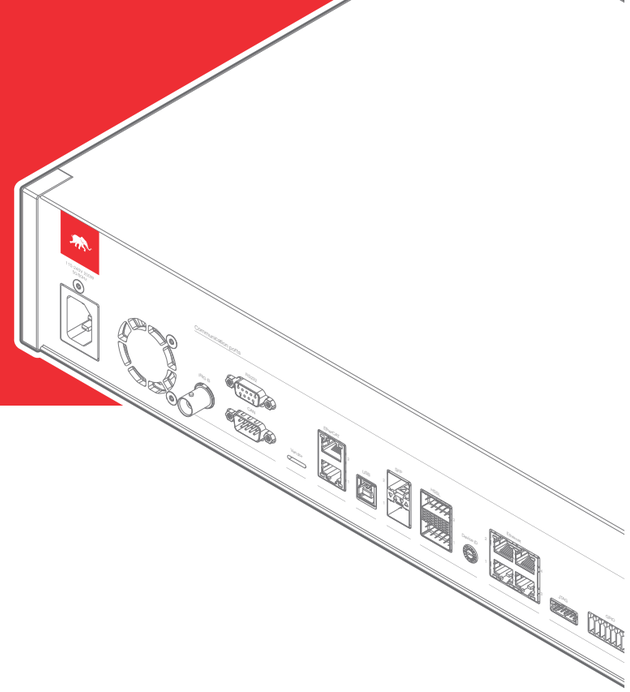
I/O 16 64 256 ... and more!

HIL device comparison.

	HIL402	HIL404	HIL604	HIL606
Model capacity				
Detailed converter models (1ph / 3ph)	8 / 4	8 / 4	16/8	16/8
Average converter models (3ph)	8	12	10	24
Distribution network simulation	✓	✓	✓	✓
Time resolution				
Minimal simulation step	500 ns	200 ns	500 ns	200 ns
DI sampling resolution	6.2 ns	3.5 ns	6.2 ns	3.5 ns
IO				
Analog I/O per unit	16/16	16/16	32/64	32/64
Digital I/O per unit	32/32	32/32	64/64	64/64
Connectivity				
USB	✓	✓	✓	✓
Ethernet	✓	✓	✓	✓
CAN		✓	✓	✓
RS232		✓	✓	✓
EtherCAT				✓
SFP		✓		✓
Time synchronization (PPS and IRIG-B)			✓	✓
Paralleling		up to 4 units	up to 16 units	up to 16 units



HIL606 technical details.



For more technical details read Typhoon HIL Hardware documentation.

Processor	Processor	ZU9EG Zynq UltraScale+ MPSoC
	Processor configurations	up to 8 processing cores
Analog inputs (AI)	Channels	32
	Resolution	16 bit ADC
	Input Voltage Range:	±10 V
	Sample Rate	up to 1 MSPS
	Linearity (DNL/INL)	1/2
	Gain error / Offset error	0.01 % / 1 mV
	Input Resistance	~30 kΩ
	Protection	±24 V tolerant, ESD protection
Analog Outputs (AO)	Channels	64
	Resolution	16 bit ADC
	Output Voltage Range	±10 V
	Sample Rate	up to 5 MSPS
	Linearity (DNL/INL)	1/1
	Gain error / Offset error	0.01 % / 1 mV
	Output Resistance	~0 Ω
	Protection	±24 V tolerant, ESD protection
Analog IO connector	Connector	DIN 41612, type C 96 pin male connector

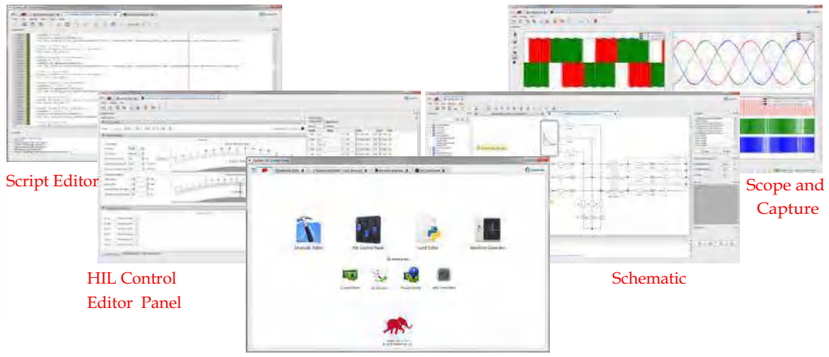
User Power Supply Stage (PSU)	±5 V analog	up to 2 A, resettable protection
	±12 V analog	up to 2 A, resettable protection
	+3.3 V digital	up to 2 A, resettable protection
	+5 V digital	up to 2 A, resettable protection
Digital inputs (DI)	Channels	64 channels
	Input voltage range Vi	-15 V < V_i < 15 V
	Threshold voltages (low, high)	(V_{IL}(max) = 0.8 V; V_{IH}(min) = 2 V)
	Input resistance	10 kΩ
	Protection	±24 V tolerant, ESD protection
	DI sampling resolution	3.5 ns
Digital outputs (DO)	Channels	64 channels
	Output voltage range Vo	0 V < V_o < 5 V
	Threshold voltages (low, high)	(V_{OL}(max) = 0.2 V; V_{OH}(min) = 4.8 V)
	Output resistance	430 Ω
	Protection	±24 V tolerant, ESD protection
Digital IO connector	Connector type	DIN 41612, type C 96 pin male connector
Connectivity	Ethernet	4x RJ45 connectors; 10/100/1000 Mbps
	USB 3.0	1x type B connector
	CAN	2x DE9 male Connector
	FDCAN	2x DE9 male Connector
	RS232	DE9 Female Connector
	High speed serial link	
	Quad SFP	
	JTAG	Molex 87833-1420
	GPIO	12+ multi-purpose IO pins, terminal blocks
	EtherCAT	2x
	Time synchronization (IRIG-B)	1x
Housing	Dimensions	19” rack mountable; 2U height
	Weight	up to 10 kg
Power supply	Input voltage	100 - 250 VAC
	Power consumption	up to 250 W

Typhoon HIL

Control Center

Schematic Editor, HIL SCADA, TestSuite, PowerSystemsToolbox and more.

Virtual HIL Device



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.

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

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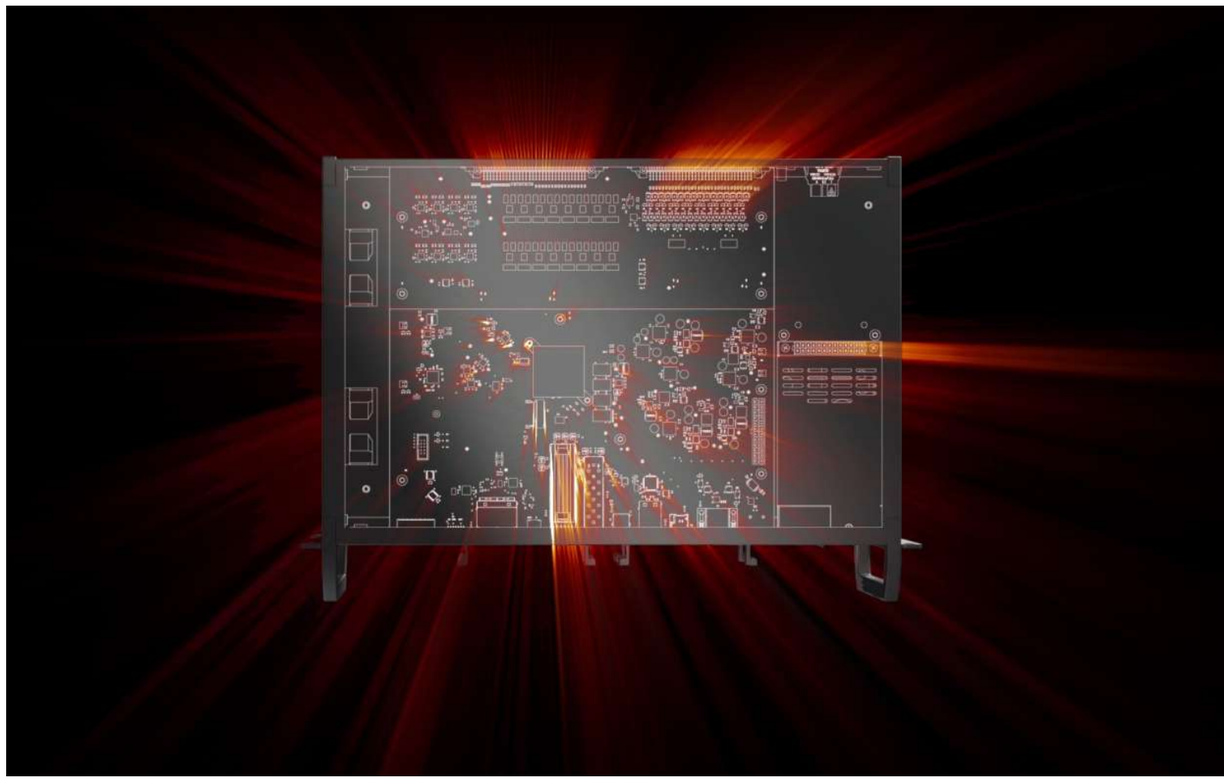
Certified HIL Specialist This course is carefully designed to get you working fast within the Hardware in the Loop (HIL)paradigm, in a way that develops your skills andconfidence with the tool set which expands witheach unit. You will learn how power electronics and power systems engineers use HIL to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

Typhoon HIL



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