Typhoon HIL

4th Generation HIL606

HIL606.

Speed, power and flexibility. Together as one.

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.

Typhoon HIL Microgrid Testbed

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.
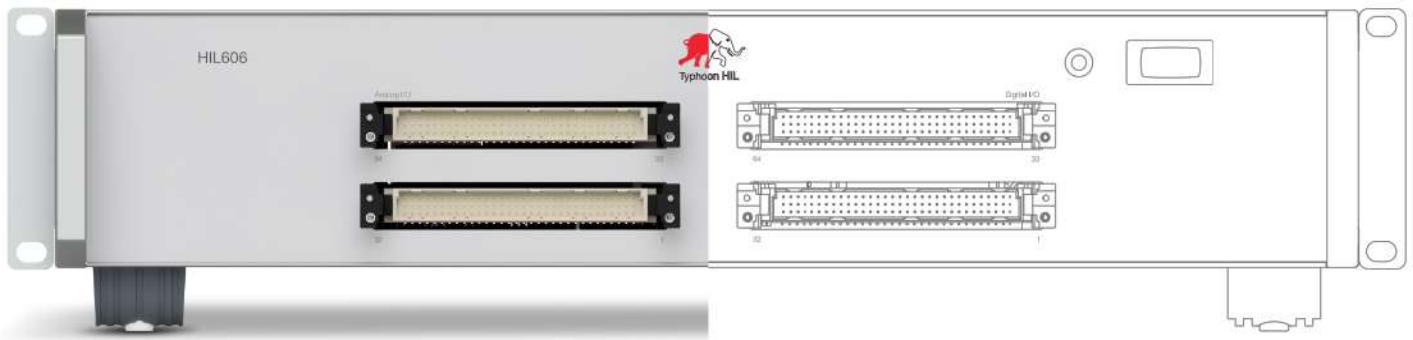
0.2μs	**3.5**ns	**24**(3PH)*	**16/8**(1PH/3PH)*	**16**units
Min. Simulation Step	DI Sampling Resolution	Detailed DER Models	Detailed Converter Models	Paralleling

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:
  - o   6 Ethernet ports, including 2 EtherCAT ports
  - o   4 CAN ports, including 2 ports for flexible data rates (CAN FD)
  - o   2 Quad-SFP (QSFP) ports

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.

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.

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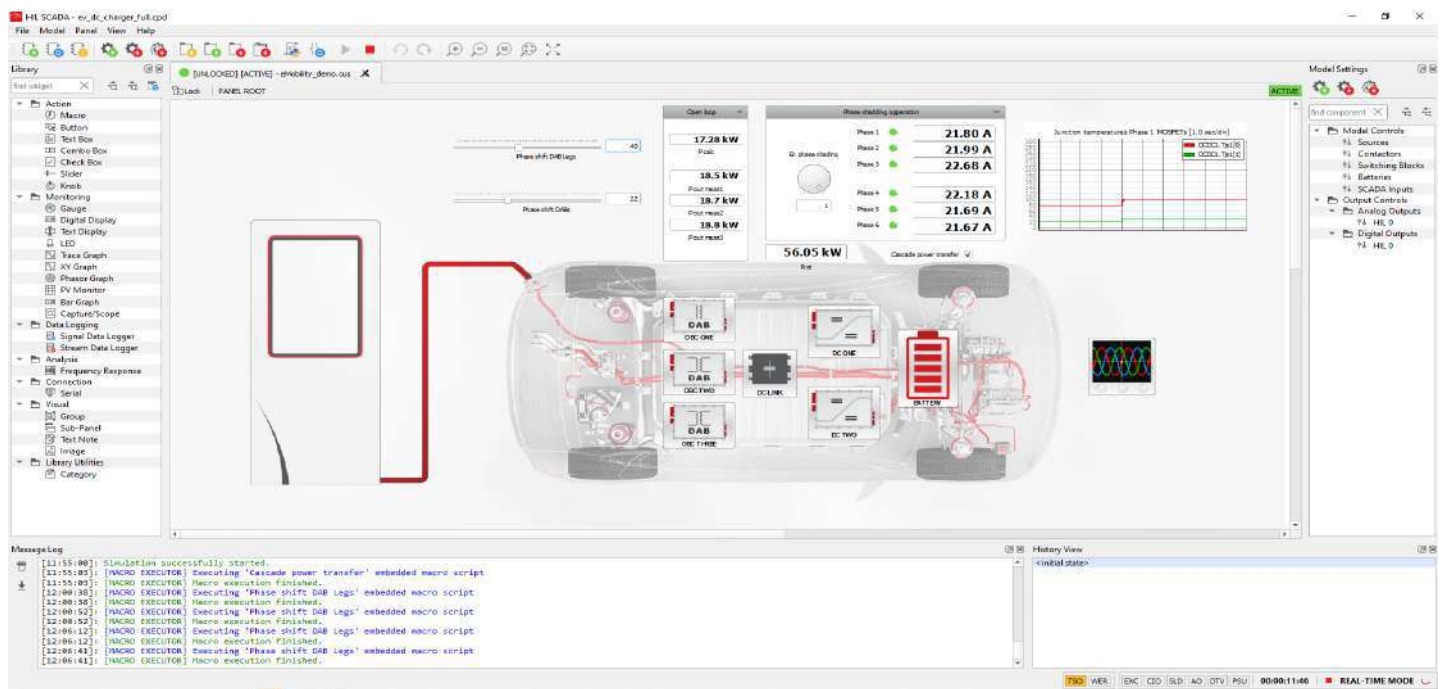

> Early porting of the controller algorithm to the real hardware solves a large number of issues prior to system integration. This results in significant development time and cost savings.
>
> **Dr. Roland Greul**
> Manager of Department at AVL

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.
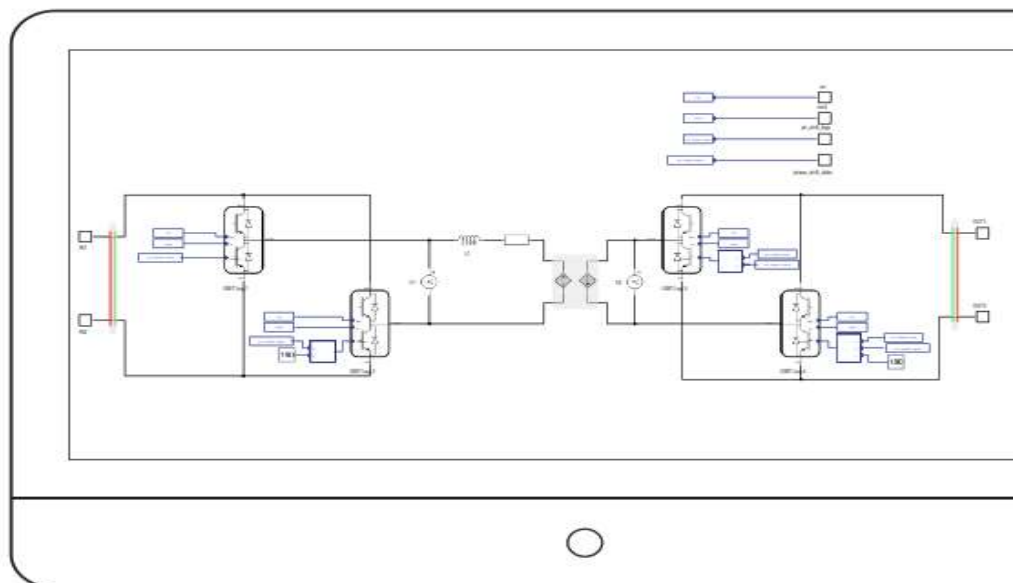
The model above represents of 1 of 3 DC/DC high frequency isolation stages of the featured EV DC charging example, using 3 Dual Active Bridge (DAB) converters in parallel.
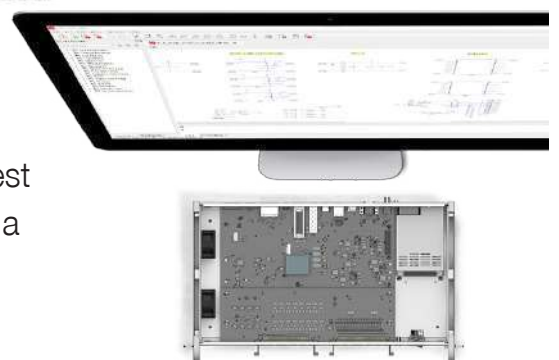
Worried your microgrid models are too complex to integrate real hardware and low-level controllers in your test setup?

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.
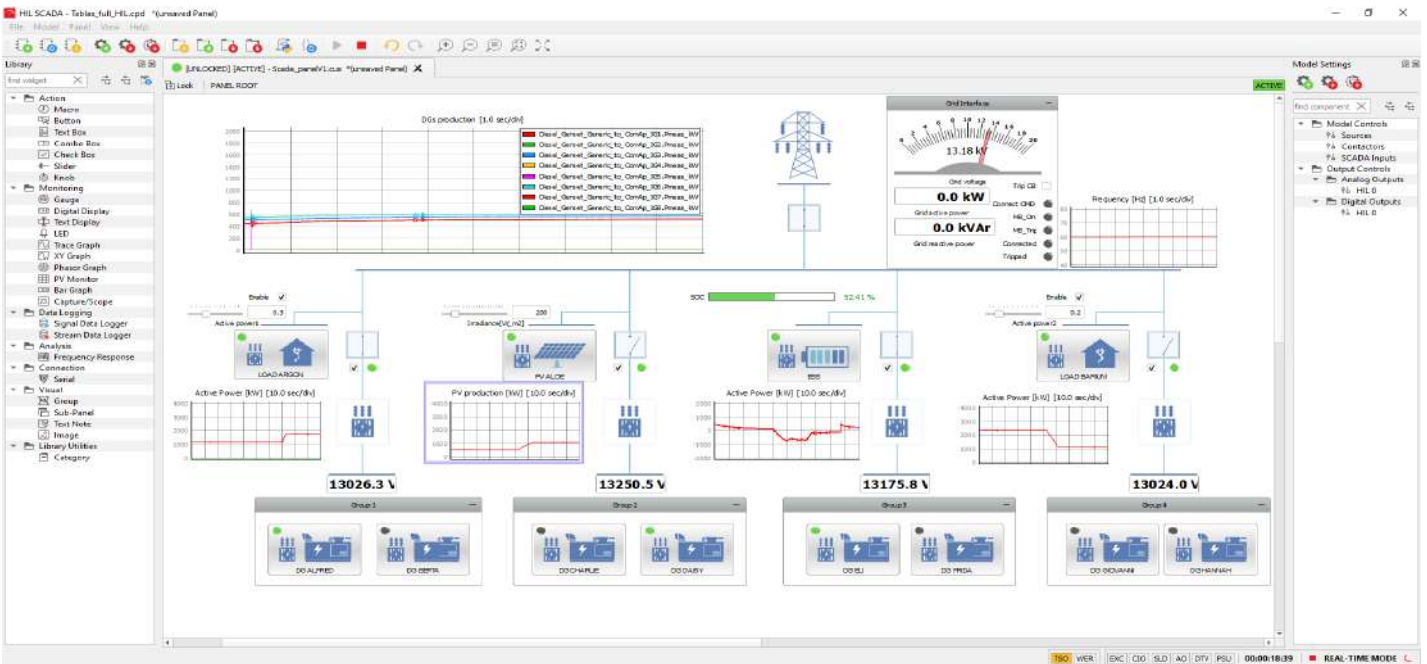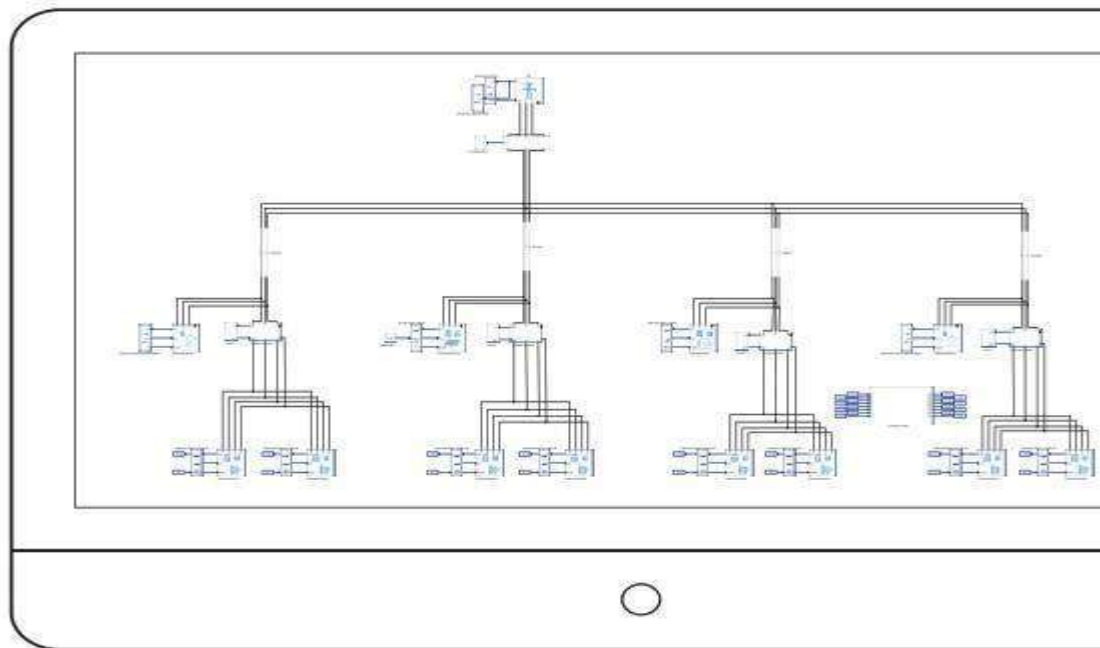

HIL SCADA demonstration of an islanded microgrid response to changes in DER production

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

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.
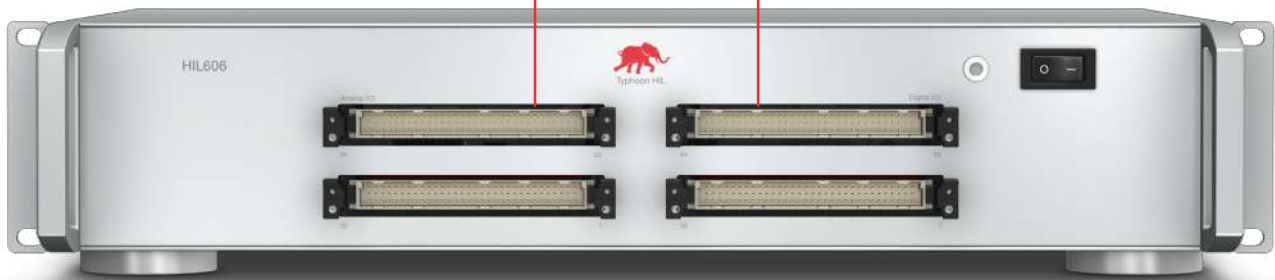
Analog I/O
- 32 Analog Inputs and 64 Analog Outputs
- 200 ns minimum sampling resolution

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

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.

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

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 Manager Grid Edge Solutions at Hitachi ABB

main processor
FPGA

HIL606 — **75% faster**

HIL604 —

co-processor
CPU

HIL606 — **10x faster**

HIL604 —

analog and digital
IO

HIL606 — **2.5x faster**

HIL604 —

model capacity
DER

HIL606 — **2.4x detailed 3ph models**

HIL604 —

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.
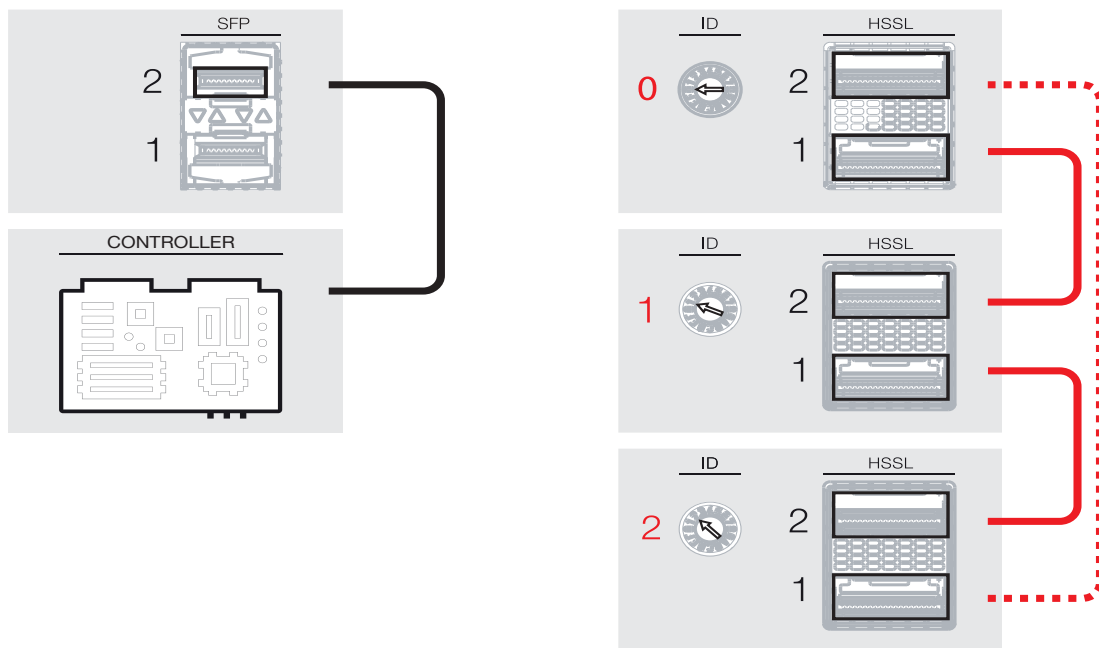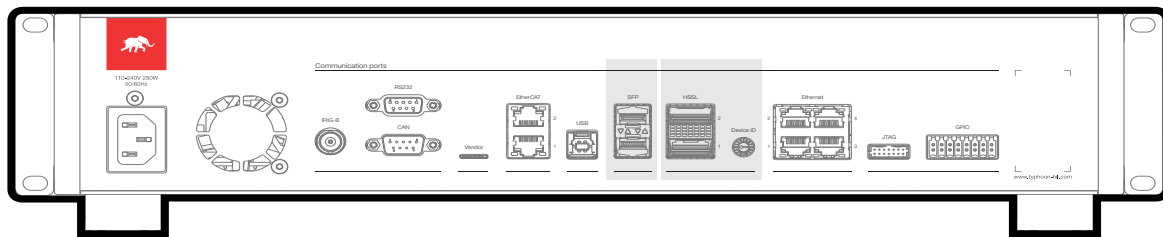
Four Small Form Factor Pluggable (SFP) ports:

- 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
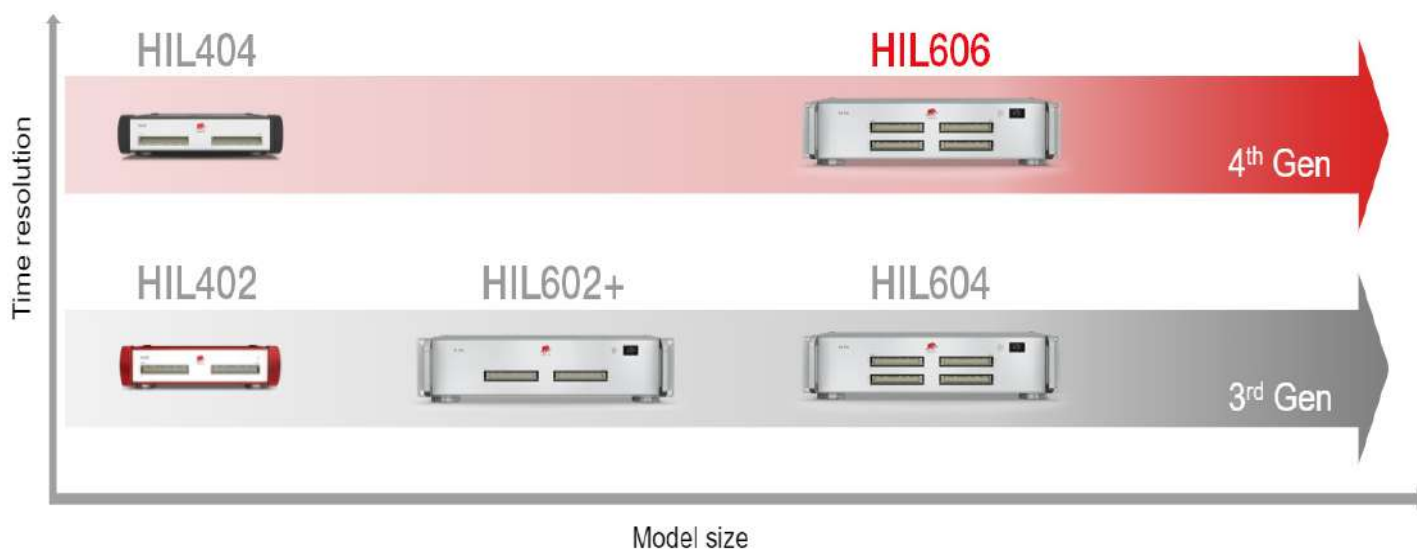
TYPHOON HIL REAL TIME EMULATOR
Model : HIL606
TECHNICAL SPECIFICATIONS

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: 3x 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 outputs fully selectable with ± 10V range, 1 MSPS update rate, 16-bit resolution and 1% accuracy, ± 24V Tolerant ESD protection.
- 64 Analog inputs fully selectable with ± 10V range, 1 MSPS update rate, 16 bit resolution, 1% accuracy, ± 24V Tolerant ESD protection.
- 64 Digital outputs with at least 12 channels capable for PWM modulation with 7ns resolution, ± 24V Tolerant ESD protection.
- 64 Digital inputs, 50MHz sample rate with 20ns sampling resolution on all channels, ± 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, MOD Bus 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 communicating with other simulation software.
- 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.

C. The laboratory resources listed above is suitable for the following applications:
1. Grid connected converter applications.
2. Power System and its applications
3. Renewable energy applications.
4. Microgrid and Smart Grid applications.
5. Parallel and Multilevel converter topologies.
6. Electrical and industrial drives applications.
7. Electric Vehicle Application
8. Pre-certification of smart inverter controllers.
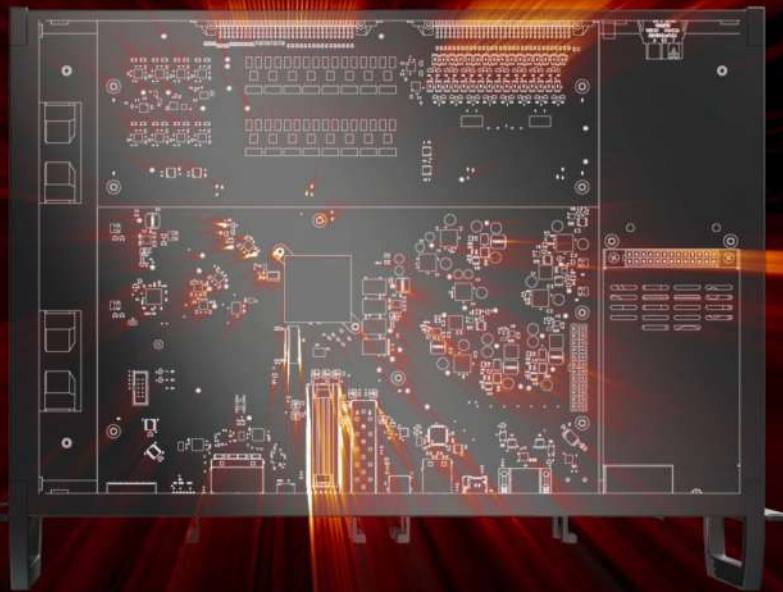
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