Design the future: Research and teach with HIL

The Ray and Maria Stata Centre at MIT in Boston *

Typhoon HIL

"Embedded smart digital controls have become indispensable in electronics. The difficulty is that we need to program them, and if we make a mistake, we risk damaging the electronics. So we use a HIL device that emulates the behavior of our power electronics application to test if the programmed control works correctly."

Philippe Barrade, Professor UAS
Head of the research group "Industrial Electronics and Drives"
HES-SO Valais-Wallis

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Research, educate, progress

* Long tradition of research on MIT has given birth to many successful academic and business stories, worldwide. Typhoon HIL, with its own roots in Boston area, is a proud member of this community, owing a special thanks to Raymond Stata, an entrepreneur, engineer and a member of the American Academy of Arts and Sciences and the National Academy of Engineering.

Ray and Maria Stata Center is an academic complex on the MIT campus, designed by the famous architect Frank O. Gehry. (front cover)

Why?

Education is the basis of society and the key to its progress. Fundamentally, the future starts at universities. Educators, thinkers and tinkerers create concepts, form their ideas into demonstrations, collaborate with industry and inspire their students along this journey. Furthermore, the digital transformation we are going through created the current skill shortage. This makes the essential work done at educational institutions even more valuable.

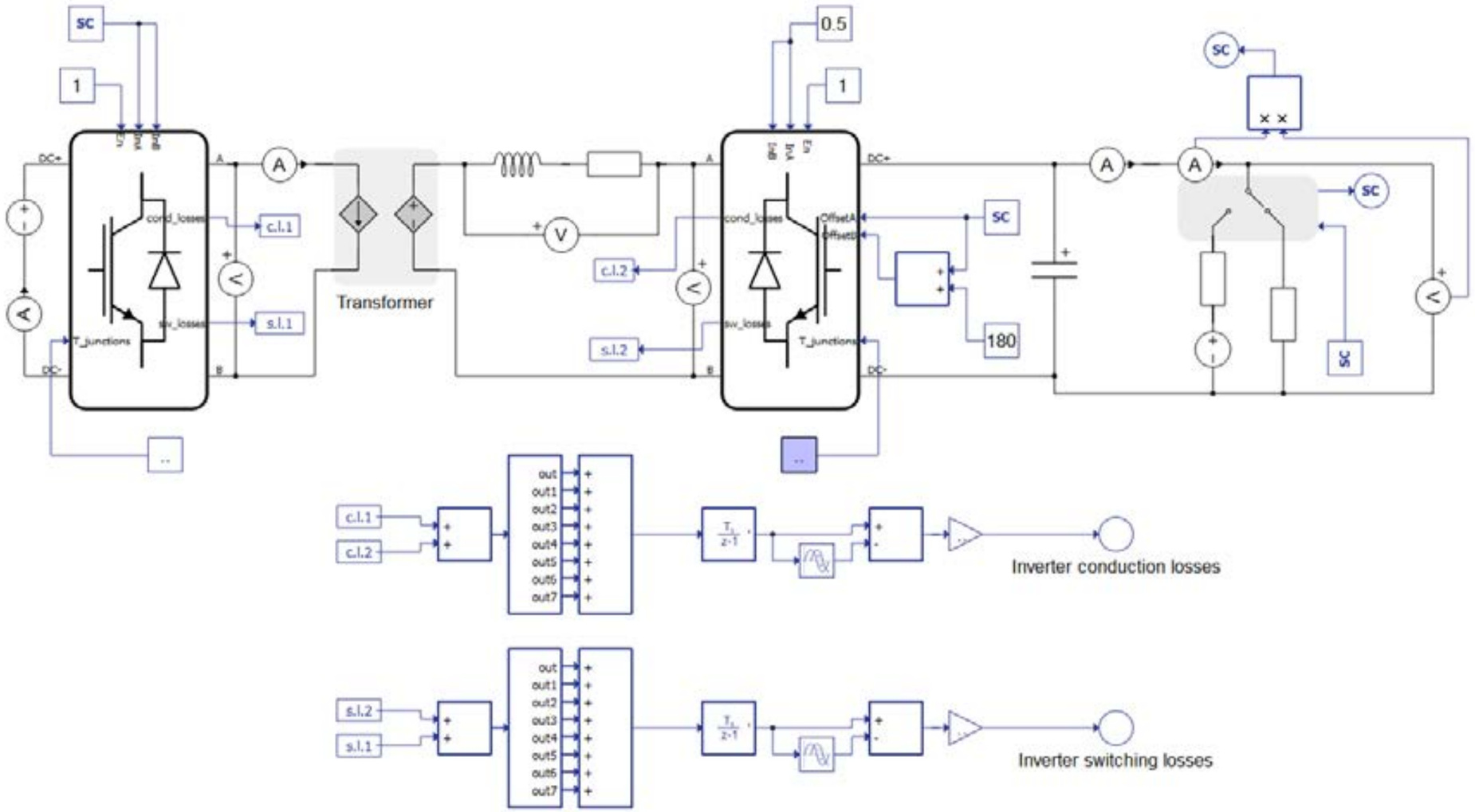
Transforming the energy system is a difficult technical challenge. Building renewable energy plants, electrifying transportation and fundamentally reinventing the grid have strong implications on the future of power systems. Without the newly acquired knowledge, attained through research and the efforts of the academic community, the velocity of the aforementioned transformation would be severely affected.

Having that in mind, it is easy to grasp that supporting this transformation requires supporting educational and research activities, conducted by the academia. Many fields of application yield the best results after academic forces are joined with the industrial – together, their joint mission has a much bigger chance of success.

Applications

- Microgrids
- Controllers
- EV & HEV
- Drives
- Traction
- Protection
- Marine power systems
- Renewable energy
- ESS
- Cyber security

Dual Active Bridge (DAB) converter



CONTROLLERS

Model highlights

> 50kHz Dual Active Bridge (DAB) Converter with inverter conduction losses and switching losses

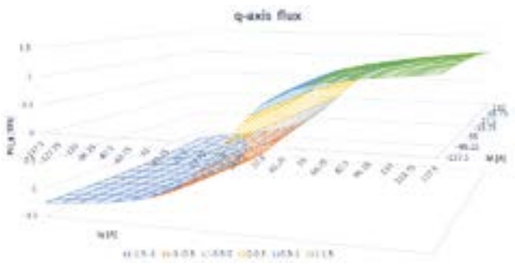
> Duty cycle (1st inverter) and Phase offset (2nd inverter) changeable during the simulation

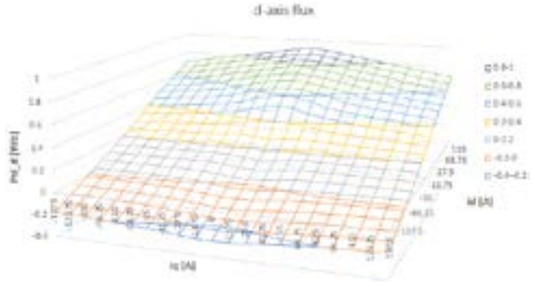
> Open loop control of inverter phase shift in signal processing

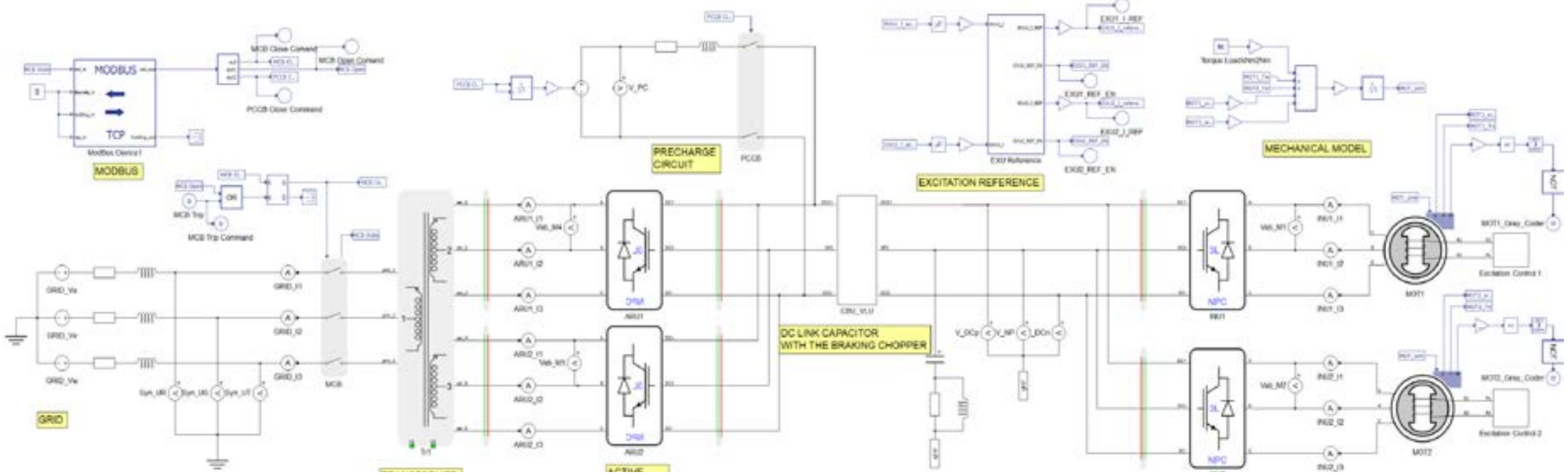
> Only one of four available main processors is used

COMPILATION TIME **~ 90 sec.**

Medium Voltage Synchronous Machine Drive







DRIVE

Model highlights

> Mains Circuit Breaker controlled through Modbus

> 3-level Active Front End Converter (switching model)

> DC Link with a Braking Chopper, Pre-charge circuit controlled through Modbus

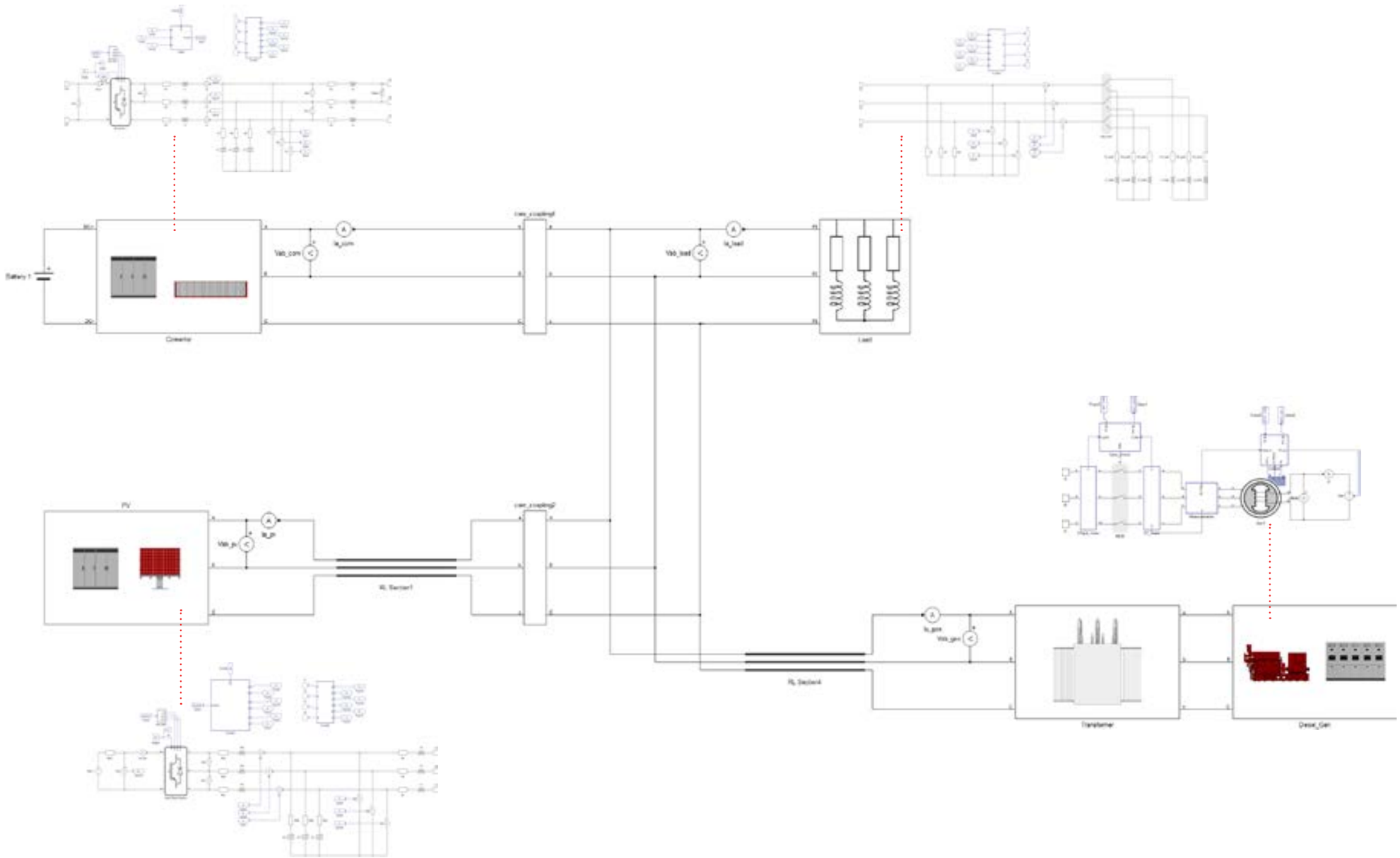
> 3-level NPC Inverters drive the synchronous machines

> Nonlinear machines with fluxes as functions of current magnitudes

> Machine Excitation Control implemented in signal processing, current reference provided through Ethernet Variable Exchange

COMPILATION TIME **~ 300 sec.**

Terrestrial microgrid



MICROGRIDS

Model highlights

> 2 x 3-phase (switching) inverters

> 1 x 3-phase two winding transformer

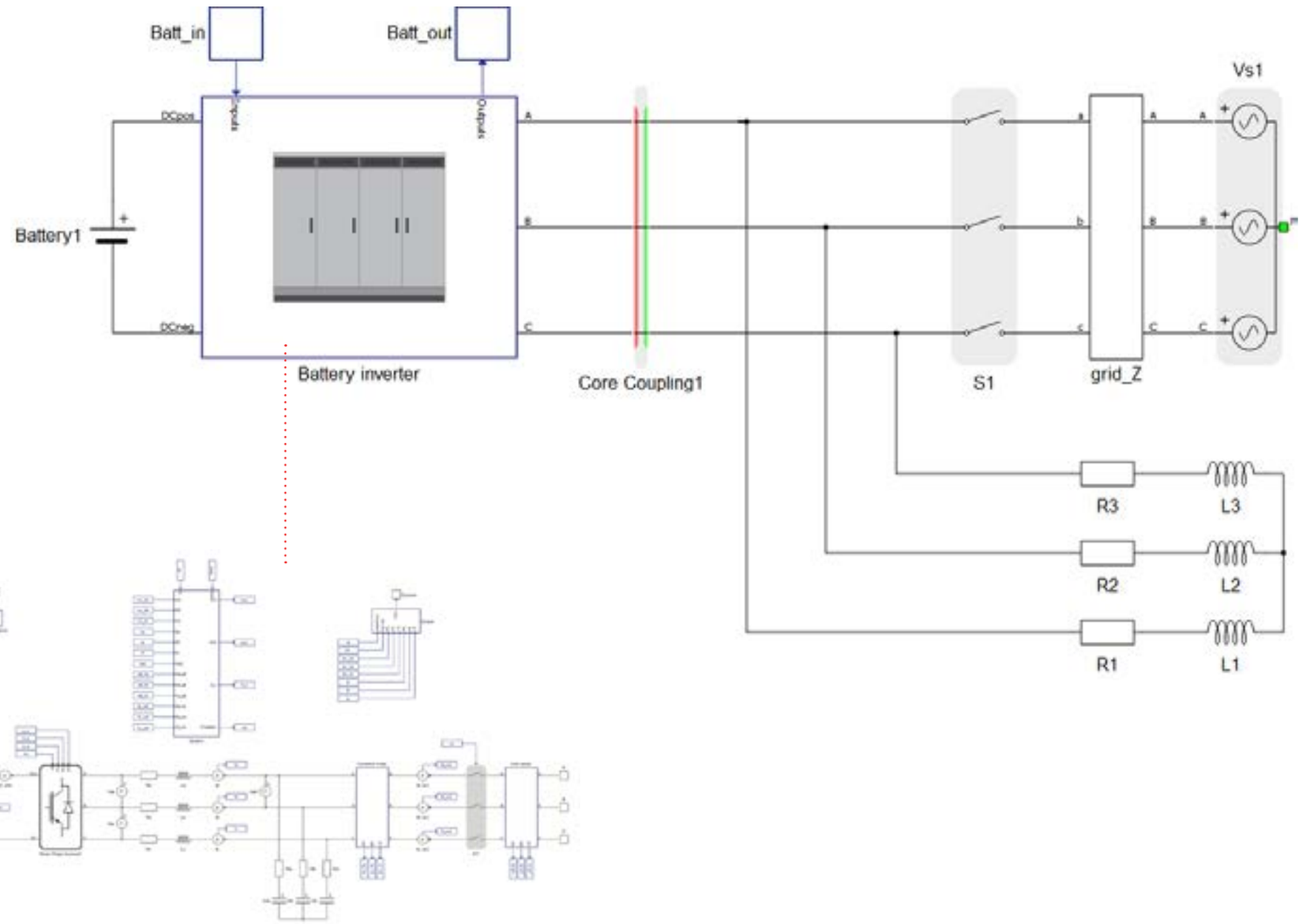
> 1 x induction machine with wound rotor

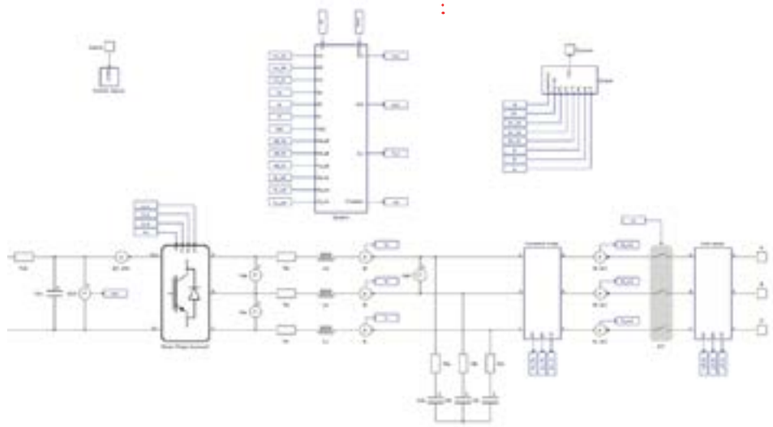
> 1 x generator average model

> Highly detailed PV, battery and diesel genset control algorithm with governor and exciter in signal processing

COMPILATION TIME **~ 50 sec.**

Battery inverter (µGrid Lib)





ESS

Model highlights

> 1 x 3-phase (switching) inverter

> 1 x passive load

> Highly detailed Battery Inverter control algorithm in signal processing with current and voltage control loops and synchronization to grid capabilities

> The Battery Inverter is capable of operating in grid forming (islanded) or grid following (grid tied)

COMPILATION TIME **~ 25 sec.**

Academic breakthrough

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.

There controllers 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 numerous 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 controller (e.g. to export active/reactive power, to island, etc.).

2017 MIT Lincoln Laboratory microgrid and DER controller symposium

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.

More on the results of the research: Banshee distribution network benchmark and prototyping platform for hardware-in-the-loop integration of microgrid and device controllers

Bridging the gap between industry and research

"Most surprising was fidelity or accuracy of real-time simulation. It is simply plug and play. If the model is done correctly and compiled into HIL, then it just runs. As simple as that."

Zoran Miletic,
Senior Research Engineer and Power Electronics Design Specialist, AIT, Vienna, Austria

As Europe's premiere research and technology organization, the Austrian Institute of Technology (AIT), bridges the gap between industry and research by utilizing innovative solutions to key infrastructure issues. Recently, they developed its powerful pre-certification toolbox to design and test smart grid converters for grid-code compliance using Controller-Hardware-in-the-Loop (C-HIL) technology.

Hardware-in-the-Loop testing came handy in all aspects of the development process: controls development, testing, validation, software integration and pre-certification at the end. Moreover, with test automation, it was possible to cut time in pre-certification and time to market: lab testing of certain low voltage ride through requirements takes days, but with automated C-HIL testing, it takes minutes to complete the test.

Reducing the cycle time of design, validation and testing of DC microgrid controllers from academia to industry

At the Future Renewable Electric Energy Delivery and Management (FREEDM) Systems Center at North Carolina State University, U.S. universities and industry partners focus on modernizing the electric grid using advanced power electronics.

"Once you validate your controller on the Typhoon system, then there is no need to do any more changes to the controller before you can actually put it on to your real converter."

Dr. Subhashish Bhattacharya, FREEDM System Center
North Carolina State University, USA

Aside from reducing the cycle time from active research to a field deployment and industry validation part of it, HIL results are accepted by the academic journals instead of hardware results. However, what was especially pointed out was that the learning curve for the students at FREEDM was the shortest with Typhoon HIL as it offers the most robust systems, thus providing the motivational factor for students, who get really interested very fast and are able to explore a lot of things.

Emerging converter topologies, control methods, and mixed-signal IC design for power electronics

The Twentieth IEEE Workshop on Control and Modelling for Power Electronics, IEEE COMPEL 2019, brought together researchers, engineers and students from academia and industry for an interactive discussion on the latest advances in modelling, simulation, analysis and control of power electronic devices, circuits and systems. It took place at the University of Toronto.

Workshop themes included (but were not limited to):
- Power Electronics Converter Topologies
- Control of Power Converters
- Modeling and Simulation
- Mixed Signal IC design for Power Electronics
- Design, Optimization and Simulation Tools
- Passive and active components
- Applications (electro mobility, power harvesting, IoT)
- Education & Innovation

"COMPEL is a great opportunity to bring together control people to understand the impact of everything we do from the energy harvesting types of devices all the way to the infrastructure."

Francesce Carobolante,
Founder at IoTissimo

Enabling cooperation

Demand Response Integration tEchnologies project | DRIvE

DRIvE
Unlocking DR Potential

Project partners:

Enervalis
SCHOLT ENERGY CONTROL
CARDIFF UNIVERSITY
COMSA CORPORACIÓN
AIRBUS
LECO
Blaenau Gwent
cea

Demand Response Integration tEchnologies project, acronym: DRIvE, is one of H2020 research and innovation projects with the goal of developing next generation innovative technologies enabling smart grids, storage and energy system integration with an increasing share of renewables.

Specifically, DRIvE will develop a cloud+gateway infrastructure for aggregating residential and tertiary buildings, making them controllable for Demand-Response programs. The programs will optimize the flexibility of energy use, which will reduce overall energy consumption, but also provide ancillary services to Distribution Systems Operators (such as frequency and voltage regulation, power quality support, congestion management, etc.) while increasing flexibility and controllability of the assets in the grid.

Typhoon HIL has a critical role in creating this unique management platform for aggregators, through which they will be able to communicate with grid users in their portfolios, on the one hand, and with DSOs and energy providers, on the other. More explicitly, Typhoon HIL is enabling consortium partners to do a wide range of tests: emulation-based tests where the grid is modeled, but fed by real data, and hybrid cyber-physical tests where the grid is partially modeled, but some devices are real and fed by real data. Ultimately, pilot sites are represented as their digital twin replicas enabling the validation of the full DRIvE platform and illustrating the possibility of handling various assets in different locations, which all together represent the complexity of the future smart grid.

Europian Union`s Horizon 2020
research and innovation programme
under grant agreement n° 774431

Visit the project website

Visit the project website

Powerful Advanced N-Level Digital Architecture for models of electrified vehicles and their components | PANDA

panda

PANDA (Powerfull Advanced N-Level Digital Architecture for models of electrified vehicles and their components), project funded by the European Commission in the Research and Innovation Action, aims at providing unified organizations of digital models for seamless integration in virtual and real testing of all types of electrified vehicles and their components. A total of 11 organizations from 6 different countries work together in order to reduce the development time (time-to-market) by 20% through standardization of model/simulation, enabling easy reuse of models for different tasks, and a reduction of the real testing of subsystems by virtual seamless testing.

EU-funded projects

Europian Union`s Horizon 2020
research and innovation programme
under grant agreement n° 824256

Project partners:

UBFC UNIVERSITÉ BOURGOGNE FRANCHE-COMTÉ
Valeo
UNIRESEARCH
TÜV SÜD
SIEMENS Ingenuity for life
UNIVERSITATEA TEHNICĂ
RENAULT
VUB VRIJE UNIVERSITEIT BRUSSEL

Empowering community

Only two steps are needed for you to be able to start contributing to the growing HIL community: download the software and test-drive it with Virtual HIL, and get trained at HIL Academy.
It's that simple!

HIL Academy is a free online learning space for power electronics and power systems using HIL methodology, based on Typhoon HIL's free Virtual HIL Device software. Set up as a place of gathering for young engineers, it is quickly growing into a community where you can gain or brush-up your HIL skills and competencies by means of various guided tutorials, while also connecting and exchanging thoughts with people with similar interests.

Register for your free Virtual HIL license

"High-fidelity simulation environment with a wide range of simulation models give us the confidence needed to achieve our research goals efficiently and in a safe learning environment."

Dr. Ali Davoudi,
Director of Complex Power Electronics Networks,
University of Texas at Arlington

Join the community

In terms of gaining new skills, HIL academy offers you a general HIL course for first-time Typhoon HIL users, as well as more than a dozen 60-minute topic-focused tutorials which you can follow using Typhoon HIL's Virtual HIL Device. After finishing the course and taking the certification exam, you will be awarded a "HIL Specialist" digital certificate which is valid for a period of one year.

To get in touch with other HIL enthusiasts, but also to share your suggestions, comments and ideas, as well as get you questions about HIL answered by Typhoon HIL engineers, feel free to join the HIL Insiders group on LinkedIn.

If you would like to contribute or learn more about the latest academic achievements in the field of "Hardware-in-the-loop Simulation of Power Electronics and Microgrids", you are more than welcome to follow this project on ResearchGate.

To join this ResearchGate project as a project collaborator, or to simply share or disseminate some information on your research project among fellow HIL researchers, reach out to the e-learning team at HIL Academy.

On the other hand, if you are not in the academic community, there is still a simple way to get your hands on the relevant Journals and Conference papers.

Get free online teaching materials

Digital control of grid-tied converters course

The power electronics field has matured over the last sixty years. It is the enabling technology for the integration of the renewable generation into the electric grid. Thus, it will play a key role in the renovation of the existing electric network.

To address the challenges arising in this process, especially with regard to the design of power converters, the development teams of GEPOC-UFSM and Typhoon HIL have joined efforts to demonstrate the potential of the test-driven design process. Their unique approach uses real-time simulation to describe the performance of controllers under various operating conditions.

In this course on HIL Academy, you will learn how to design and validate different controllers required for the proper operation of grid-tied converters using real-time simulation within Typhoon HIL tools. Whenever possible, standards and grid codes requisites will be used to compare the performance of the controllers, as well as the impact of their parameters.

Start learning at HIL Academy today!

Be amongst the first to educate the new generation of test engineers, harvesting the only complete vertically integrated environment for development, testing, optimization and quality assurance of power electronics.

"Enabling the students to not only follow the world trends but to truly experience and work with today`s most advanced equipment."

Simone Castellan,
Assistant professor of Power Electronics,
University of Trieste

Ask for the free HIL training for your students and research team

In order to be sure your R&D team is using the HIL tools in the best way possible and is utilizing the power of the Typhoon HIL's testing platform to the maximum, feel free to arrange a HIL training for your team. With a wide range of tailor-made training webinars and hands-on workshops delivered by Typhoon HIL's engineering specialists, your team members will be empowered with new, ready-to-use skills to overcome every possible testing challenge.

Be it at the introductory or at an advanced level, each HIL training allows for a quicker upskilling of test engineers of the new generation, preparing them to reshape the contours of today's testing practices.

Contact us to schedule free training at your University

University of Vaasa
Finland, December 2018

Get industry partners excited to collaborate

Powerstar's rigorous quality assurance process

Powerstar's integrated EMS combines its voltage optimization technology with energy storage solution. This not only secures power, but lowers energy costs and provides demand side response services to the grid.

"If we didn't have this, we'd be stuck using a platform that we couldn't change and therefore optimize. It really helps with confidence."

Solon Mardapittas,
CTO, Powerstar, UK

Through their extensive development and testing process, Powerstar encounter major challenges in simulating different types of loads and generation, as well as creating their customer's network (as opposed to building a physical one). HIL technology allows them to model microgrids in HIL simulations, build virtual setups for client demonstrations and accelerate testing with test automation.

Test and verify the highest quality control system

FlexGen leads the energy storage industry worldwide with its breakthrough hybrid energy storage software and power conversion products for oil and gas, marine, and industrial power systems. Their energy storage system was commissioned by power producer andw retailer, Vista Energy, to build its 10-megawatt/42-megawatt-hour storage system, making it the largest battery in Texas (solar+storage).

Aside from allowing for the design verification testing to be done in a small, low-power lab with just the HIL and their control boards, HIL made it possible for FlexGen to also create repeatable test benches for each of the grid faults, where they can modify the durations and the severity in a way that would be just cost prohibitive in a real system.

"We explored a lot of different types of generators, and different types of loads, and pretty much everything. We've really run the gauntlet in the Typhoon library."

Preston Miller, FlexGen
Houston, Texas, USA

Schneider Electric gives its customers a peace of mind

Nicolas LaRue
Schneider Electric's AccuSine, Salem, Oregon, USA

"HIL tested for my product means I have the confidence to put a product on the market that has been thoroughly tested. Because what we are looking for is giving the customer a peace of mind for a product that's been put through a series of extensive testing."

Schneider Electric's active harmonic filters division in the quiet town of Salem, Oregon develops solutions for active harmonic filtering in industrial installations. Hardware-in-the-Loop was used in all facets of their product lifecycle: in the research phase, product development, verification and validation phase. HIL allowed for the engineers to try and push things to the limits and see how the controller responds.

According to their testimonies, HIL has brought a tremendous boost in increasing their engineering efficiency, by shortening the development time, as well as by improving the quality of their product. If they were to do the test cases in the lab, it could take up to two or three weeks to cover only up to 100 cases: with the HIL, thousands of cases can be covered within 12 or 18 hours. Also, automatic tests can run overnight, allowing for 40 to 50 times more test coverage compared to what can be done in the actual lab tests.

Read more in our blog

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.

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

"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

Next-gen test-driven development

Company vision

Typhoon HIL Inc. is the market and technology leader in the rapidly-growing field of ultra-high-fidelity controller-Hardware-in-the-Loop (C-HIL) simulation for power electronics, microgrids, and distribution networks. We provide industry-proven, vertically integrated test solutions along with highest-quality customer support. The company was founded in 2008 and since then has been creating products distinguished by the ultimate ease of use, unrivaled performance, leading-edge technology and affordability.

Designed with love, from ground up, Typhoon HIL tools offer a unique user experience free of third-party software and hardware complexities. We deeply believe that less is more when it comes to test equipment complexity and third-party dependencies, so we stand behind our seamlessly integrated, complete technology stack, that empowers our customers to continuously exceed their controller software quality, performance, and time-to-market goals.

Moreover, as a group of professionals who stem from the academic circles and the world of research, we do our best to return to society through cooperating with the academia and enhancing their initiatives. With these actions, we hope to help solve the most prominent issues the world of technology is facing lately, such as digitalization, decarbonization and decentralization.

Technical

Features	Benefits
Interface to any controller by means of up to 64 analog outputs, 32 analog inputs, 64 digital inputs, and 64 digital outputs, all featuring over-voltage and short-circuit protection	Seamless integration of external components
Controller-agnosticism	Typhoon HIL equipment can be interfaced with any controller on the market
Easily interfaceable with other simulation environments, modeling tools and testing frameworks	Minimum effort to reuse the models from previous research projects
I/O and core expandability by paralleling HIL devices	Great scalability options according to your needs
Up to 8 cores per device and 500ns cycle time	Real-time simulation of bigger systems with higher accuracy - see more than before!
20ns PWM resolution and power stage emulation with up to 2 MHz update rate	Jitter-free real-time simulation of various types of converters with switching frequencies up to 200 kHz
Standardized communication protocols, such as IEC 61850, Modbus, IEC 61400, DNP3, OPC UA	Easily attainable external units' and systems' communication with the emulation
Constantly expanding extensive library of power electronics components and prepackaged examples	Have a digital twin of your physical system that can be changed on-the-fly and every change tested in real-time
Extensive Scope/Capture functionalities	Capture all your signals at full resolution for smooth and intuitive control troubleshooting and perfect documentation
4 software releases per year	Full backward compatibility and your HIL setup gets better every three months
- API - TyphoonTest - Python scripts	Efficiently achievable, fully reproducible results through completely automated testing procedure - weeks long testing routines

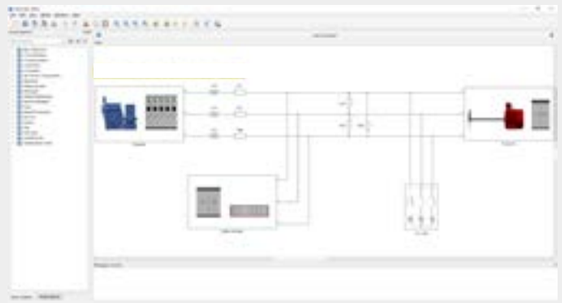
General

Industry's only single vendor - perfectly integrated software and hardware	Vertical integration allows for clear and simplified communication with the supplier – focus on testing, and not the set-up headaches
Virtual HIL Software suite: free modeling & simulation tool	Absolutely hassle-free transition from simulation to real-time, in no time – ideal for teaching purposes
An online ticketing system	Full HW and SW technical support
HIL Academy	Access to a free HIL online teaching and learning platform
Favorable offers, with access to premium content	Tailored specifically for the academic needs

Fully integrated toolchain

Get your innovative projects done employing the test-driven, model based development in a single toolchain.

Schematic Editor

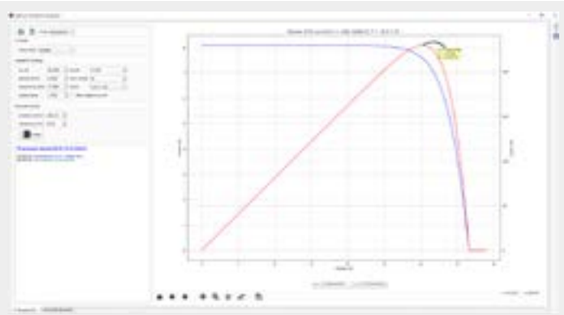


Draw the model

Parametrize all the components

Define the real-world inputs

Waveform Generator



Generate arbitrary source waveforms and PV curves

Import/export signal data from/to .mat or .csv files

Compile:

Acquire all the information about your model prior to the simulation start

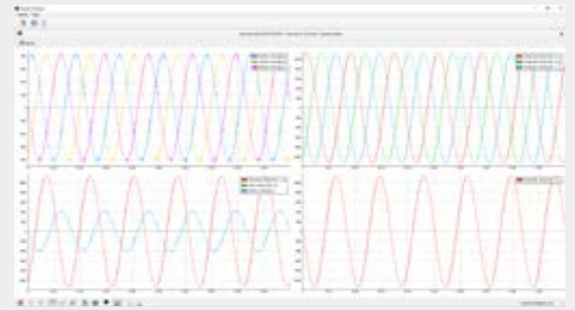
Continuous Integration:
Automate your test execution using CI tools of your choice

Signal Analyzer

Visualize and analyze the obtained waveforms

Export data in a number of standard formats

Benefit from the multi-tab visualization options



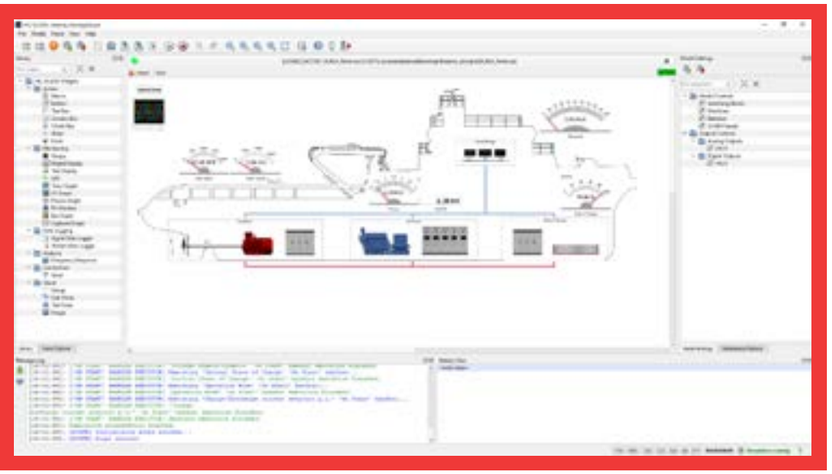
HIL SCADA

Create your personal interface to the simulation

Assign the I/O

Run the HIL simulation and verify your control design interactively

Start automating your tests through programmed sequences



TyphoonTEST IDE

Fully automate your testing by reusing your HIL SCADA code snippets

Easily generate huge number of test-cases using fixtures

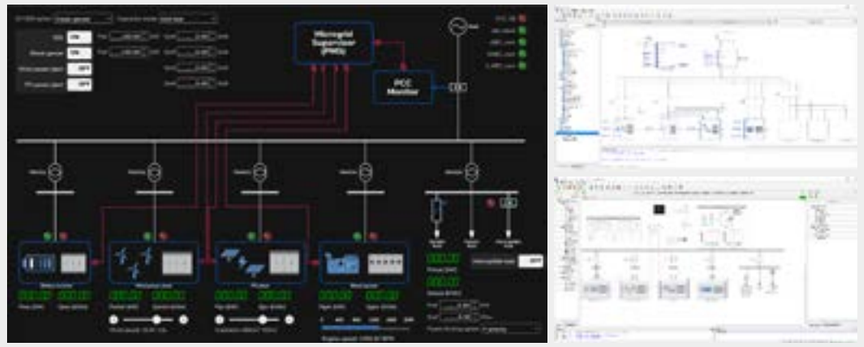
Analyze your test-data by using TyphoonTEST analysis library

Seamlessly generate interactive and informative HTML reports

Typhoon HIL offering overview

Software

- Vertically integrated
- Graphical modeling
- Custom test interfaces
- Test automation with Python
- Pre-certification



Services

- Expert consulting by application engineers
- Technical support
- Development and Customization
- On-/Off-Site training

Hardware

HIL Simulators

Interfaces

Network Devices

HIL Simulators




	HIL402	HIL404	HIL602+	HIL604
Generation	3rd	4th	3rd	3rd
Simulation capacity				
Detailed (switching) DER models (1ph / 3ph)	8 / 4	8 / 4	12/6	16/8
Average DER models with detailed control loops (3ph)	20	30	30	40
Distribution network simulation	✓	✓	✓	✓
Time resolution				
Minimal simulation step	500 ns	**200 ns**	500 ns	500 ns
DI sampling resolution	6.2 ns	**3.5 ns**	6.2 ns	6.2 ns
IO				
Analog I/O	16/16, +/- 10V, 16bit	16/16, +/- 10V, 16bit	16/32, +/- 10V, 16bit	32/64, +/- 10V, 16bit
Digital I/O	32/32	32/32	32/32	64/64
Connectivity				
USB	✓	✓	✓	✓
Ethernet	✓	✓	✓	✓
CAN		✓	✓	✓
RS232		✓	✓	✓
Time synchronization (PPS and IRIG-B)				✓
Paralleling		up to 4 units	up to 4 units	up to 16 units

Academic offering

Propelling the possibilities and quality of contemporary academic programs and degrees is one of the cornerstones of Typhoon HIL's mission and a strategic commitment.

Having in mind the importance and value of contributions to a particular academic field of endeavor, Typhoon HIL has developed a special program of Academic Memberships which awards their holders with unique pricing terms as well as with premium access to Typhoon HIL platforms, networks, channels and content.

Whether you are a professor, a researcher or a student affiliated with some academic institution, you are fully eligible to participate in the program and earn a unique membership status together with your colleagues, peers or students, which will provide you with premium level of resources and services for your academic efforts. Memberships can be earned by doing what the academic community does best – giving recognized contribution to HIL community in your chosen field of interest.

	HIL402 Academic package	HIL 6 series Academic package	Microgrid Testbed
			
HIL Device	✓	✓	
Typhoon HIL Control Center toolchain (THCC)	Unlimited number of installations	Unlimited number of installations	
Schematic editor	✓	✓	
HIL SCADA	✓	✓	
Script editor	✓	✓	
Academic service package	Basic	Premium *	
License	✓	✓	
License type	Device license	Device license	
License validity	Permanent	Permanent	
Member price	starting from 9.990 USD	starting from 28.300 USD	starting from 74.000 USD

* with Gold Membership status

Typhoon HIL offers various benefits for academic groups through:

- free use of Typhoon software tools
- access to high quality educational content
- access to community resources and networking channels
- investments in developments of academic programs
- numerous award programs, and
- favorable pricing

	Academic user (without membership*)	Academic user (with membership*)
Software		
Typhoon HIL Control Center toolchain	Freemium license	Freemium license
Number of installations	Unlimited	Unlimited
Premium features and libraries	Academic Premium	Academic Premium
Licenses		
Virtual HIL Device license	✓	✓
Number of instances (installations)	Unlimited	Unlimited
Service package		Premium service package
Remote support		✓
On-boarding assistance		✓
MyTyphoon account setup and maintenance		✓
Access to premium educational content		✓
Offer services through Typhoon ecosystem		✓
Pricing	Academic User pricing	Academic Member pricing

Member contribution examples:

Join
Invite your colleagues to register at HIL Academy.

Enroll
Take free online courses and win certificates.

Produce
Produce hands-on tutorials and promote your work.

Commit
Exchange the libraries with colleagues around the globe.

Contribute
Contribute to the development of academic programs.

See our latest academic offerings

Find out about the benefits of joining our academic network.

Sign up for academic membership today!

HIL gets you published

Access the
Published papers

* The 2018 Typhoon Awards program was dedicated to the 10th company anniversary. Academic community helped the company become a standard in the power industry worldwide and through this program Typhoon HIL wanted to thank and help the community to be in line with the latest technology standards.

The picture represents a selection of winning teams that participated in the program which awarded 50 HIL emulators in the total value of one million dollars to 50 academic instutions around the world. Moreover, every team created valuable content which enriched the knowledge base of the ever growing HIL community. (back cover)

Typhoon HIL

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"Typhoon HIL enables us to educate power engineers for the future smart grid, while also empowering us to do top-notch research and work with the industry."

Dr. Leopold Herman and Dr. Ambroz Bozicek
Laboratory of Electricity Networks and Devices
University of Ljubljana

10for10*
academic program winners

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