« EMR Summer School 2025 Integration with Typhoon HIL »

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Agenda

- ☐ Introduction to Typhoon HIL
- ☐ Applications & Use Cases
- ☐ Solution Overview: Hardware Portfolio and Software Ecosystem
- ☐ Live Demonstration
- ☐ Q&A and Closing Remarks

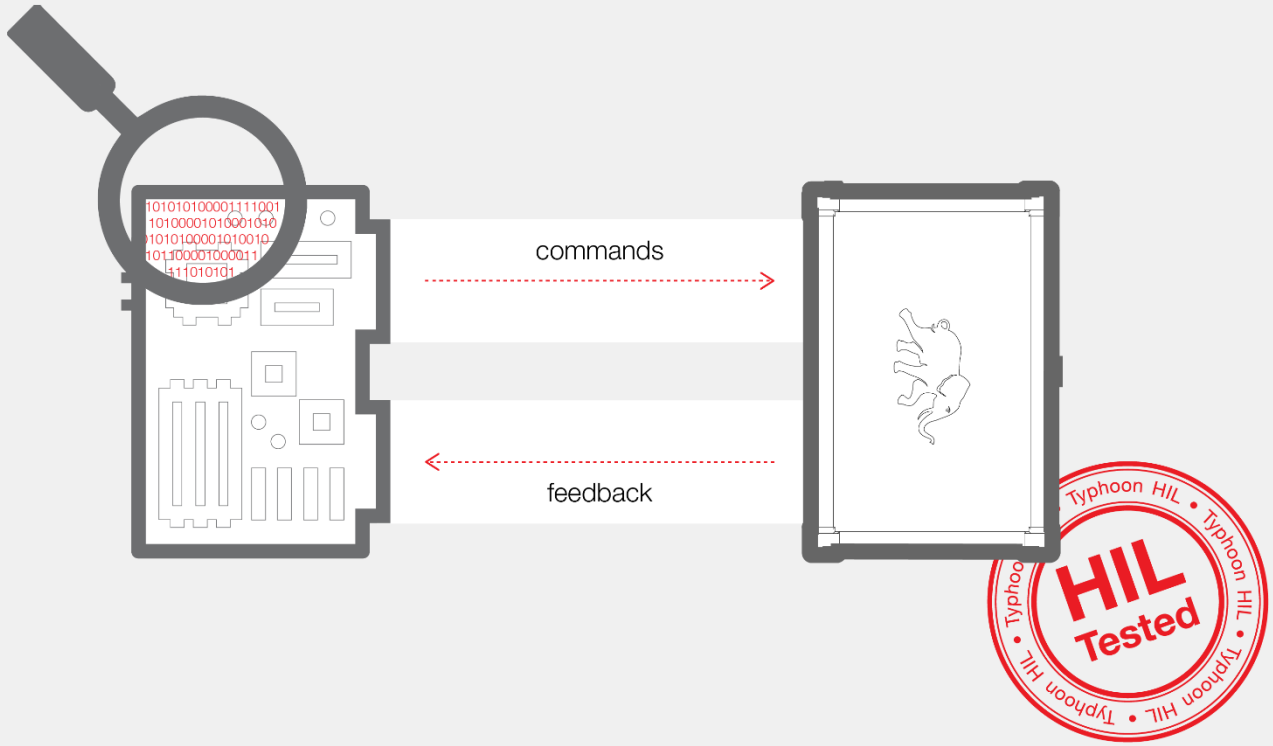
Who is Typhoon HIL, Inc.

- Spun off from MIT and ABB, funded by Ray Stata (Analog Devices), forged by power electronics industry.
- Laser focused on ultra-high fidelity **Hardware-in-the-Loop** (HIL) controller and software testing for power electronics
  - Pure play Controller Hardware-in-the-Loop (**HIL**) solutions provider
  - Down to **25ns** simulation time step (typically 250ns), **3.5ns** digital oversampling
  - **Vertically integrated** technology stack; best technical support in industry
  - Solution focus: providing **hardware, software, and engineering** services
- Serving Power Electronics HIL customers for **10+ years**.
- **800+** drives, EV, and power electronics customers since **2009**
- **130+** employees across **7** offices

What We Do?

Model-based test solutions for digital power.

- Started as a **test equipment** manufacturer.
- Today, model-based **test solutions** for digital power.
- Enabling test automation for digital power.



Typhoon HIL in 2025

7
offices

14
VARs and distributors

130+
employees

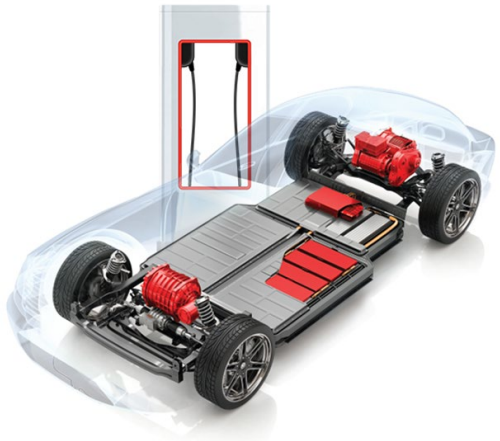
800+
customer sites

- Typhoon HIL Offices
- VARs / Technology & Engineering Centers
- Distributor

- Typhoon HIL Inc., Boston, MA, **USA.**
- Typhoon HIL GmbH, Baden, **Switzerland**.
- Tajfun HIL d.o.o., Novi Sad, **Serbia.**
- Typhoon HIL Canada, Vancouver, **Canada**.
- Typhoon HIL BR Ltda., Florianópolis, **Brazil**.
- Typhoon HIL Castelmayran, **France**
- Typhoon HIL Düsseldorf, **Germany**

Application Verticals

e-Mobility & Transportation



EV powertrain, e-Drive systems, BMS, OBC, EVSE, DC/DC converters.

Power Electronics & Industrial Applications

Motor drives, inverters, power conversion systems, active filters, industrial automation.

Grid Modernization & Power Systems

Distribution automation, digital substations, ESS, BESS, microgrids, residential and marine power systems.

Academia & Research

Selected References in e-Mobility

BorgWarner

DANA

TESLA

EATON

LIEBHERR

CANOO

HONDA

AAM

RIVIAN

CATERPILLAR

AVL

HANON SYSTEMS

Danfoss

Allison Transmission

ABB

Selected References in Grid Modernization

Join our academic network

Academic partnership with 250+ institutes on 6 continents.

Unique Value Proposition for Academia

From offline simulation to HIL, and beyond…

- **Industry-grade**, **full-featured**, model-based engineering solutions
- Easy-to-use, **Fully integrated** software toolchain - support the **entire academic journey.**

- The **essential link between classroom learning, cutting edge research, and real-world industry challenges**.

- Supported by a community of global industry and academia leaders
- … and a selection of initiatives and programs offered to develop its members.

HIL Teaching Stations

- HIL101 real-time simulator
- HIL TI Launchpad Interface
- Full Typhoon HIL Control Center Toolchain
  - TyphoonSim offline simulator
  - TI C2000 Toolbox for auto code generation

HIL Academy

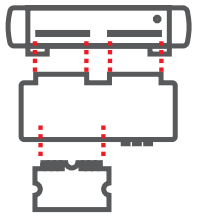
Typhoon HIL Forum

Relphie
AI HIL assistant

Turnkey Solutions for HIL

Services

- Testbed development and integration
- Test development and automation
- Process integration



Interfacing

Modeling

Test Automation

Fully Integrated SW Toolchain

- Rapid model development
- Ease of use infrastructure for interactive and automated testing
- Interoperable with other tools

Schematic Editor

HIL SCADA

TyphoonTest IDE

High Fidelity Real-time Simulator Platform

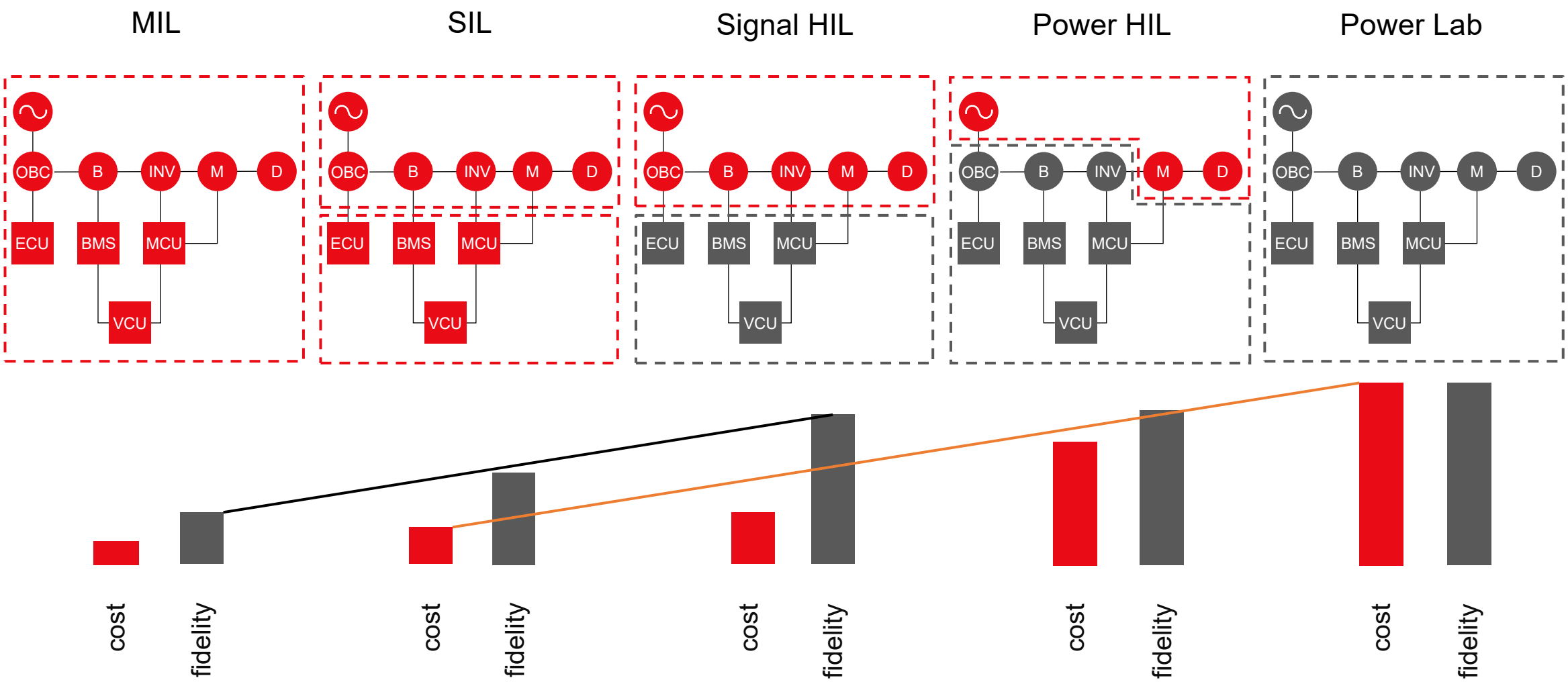
- High-fidelity
- Scalable
- Flexible

HIL Simulators

Interfaces / Signal Adaptation

Breakout / Fault Insertion

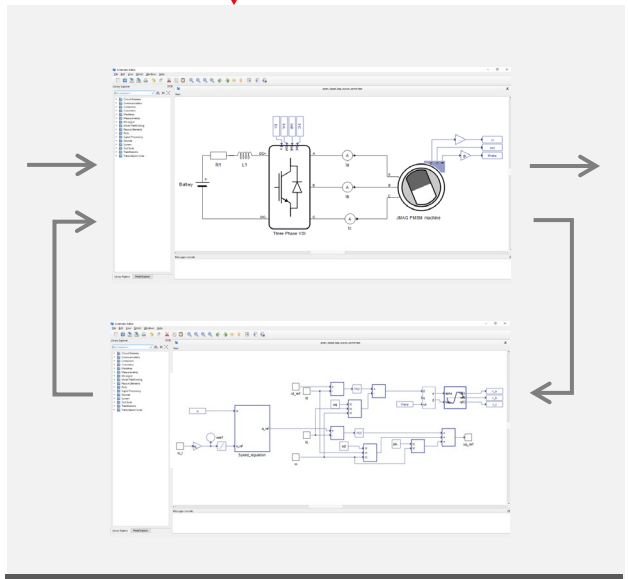
Simulation methodologies



From Model and Simulation to HIL

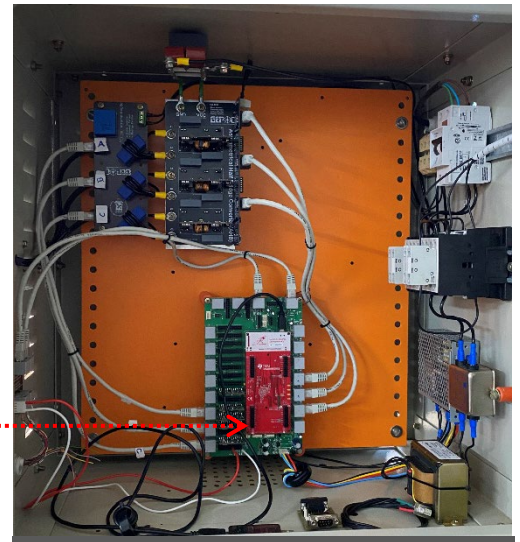
The entire journey - from design and testing all the way to converter prototype

Typhoon Test



Typhoon Sim and V-HIL
(MIL & SIL)

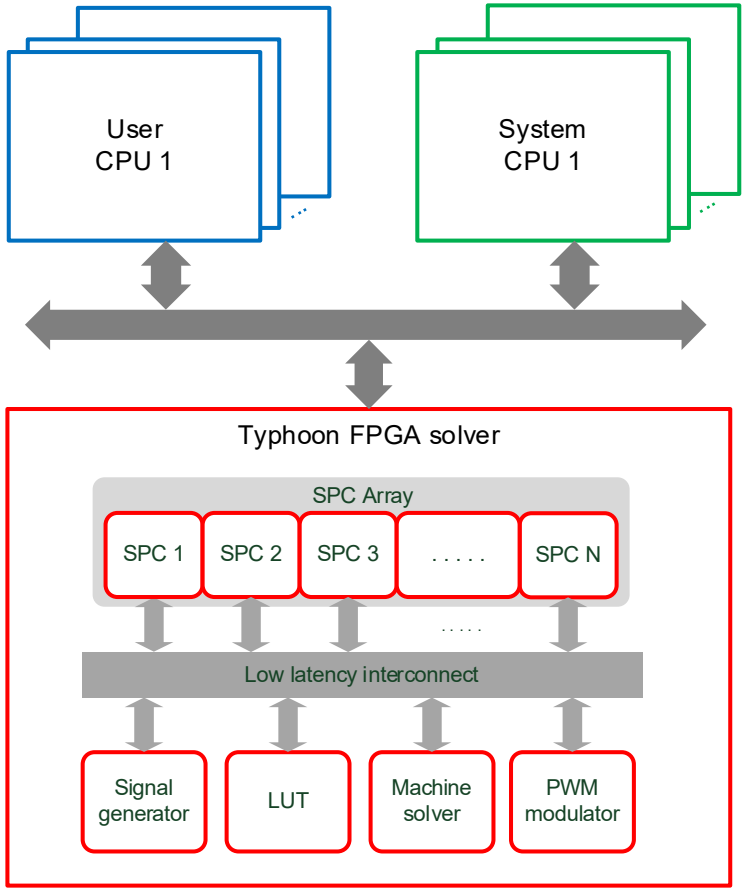
Controller Hardware in the Loop
(C-HIL)



Power Testbed(s)

System Architecture

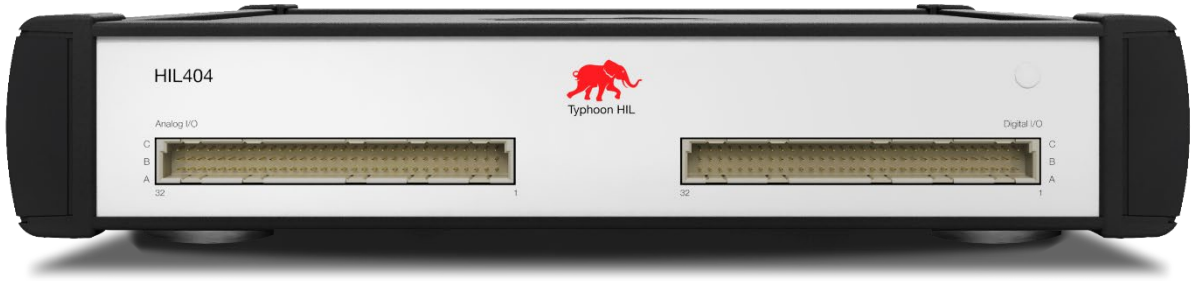
- **Typhoon FPGA solver** – a specialized, proprietary FPGA-based multi-core processor optimized for real-time simulation of electrical domain models.
- **System CPU** – one or more general purpose processors that are indirectly controlled by the user. Typically used to assist the FPGA with certain low dynamics electrical domain components.
- **User CPU** – one or more general purpose processors that are under direct user control. They execute sub-models composed of signal processing components. Typically used to simulate controls or low dynamics physical models.



HIL404 Simulator

Flagship 4th Generation Device

- Fidelity
  - 250ns Step Time (25ns for DAB, resonant)
  - 3.5ns GDS Oversampling
- Computation power
  - 4 FPGA processing cores
  - 3 ARM co-processors
- Connectivity
  - 16 Analog Outputs, 16 Analog Inputs
  - 32 Digital Outputs, 32 Digital Inputs
  - Ethernet
  - 2x CAN, RS232, GPIO, SFP



HIL606 Simulator

Flagship 4th Generation Device

- Fidelity
  - 250ns Step Time (25ns for DAB, resonant)
  - 3.5ns GDS Oversampling
- Computation power
  - 8 FPGA processing cores
  - 3 ARM co-processors
- Connectivity
  - 64 Analog Outputs, 32 Analog Inputs
  - 64 Digital Outputs, 64 Digital Inputs
  - Ethernet, EtherCAT
  - 4xCAN (2xCAN + 2xCAN-FD), RS232, GPIO, SFP

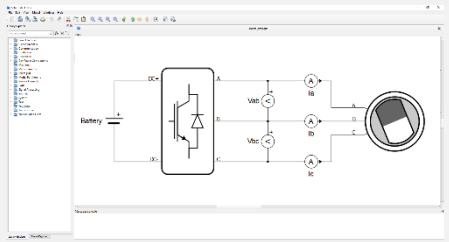
HIL Testbeds and HIL Compatibles

- ☐ e-Drive HIL Testbed
- ☐ BMS HIL Testbed
- ☐ Microgrid HIL Tesbed
- ☐ Digital Substation HIL Testbed
- ☐ HIL Digital Twins
- ☐ and more…

Workflow

Fully integrated toolchain

Schematic Editor

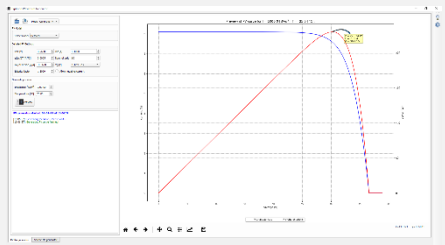


Draw the model
Parametrize all the components.

Define the real-world inputs.

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

Waveform Generator



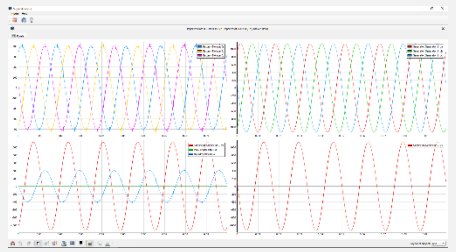
Generate arbitrary source waveforms and PV curves.

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

Signal Analyzer

Visualize and analyze the obtained waveforms.

Export data in a number of standard formats
Benefit from the multi-tab visualization options

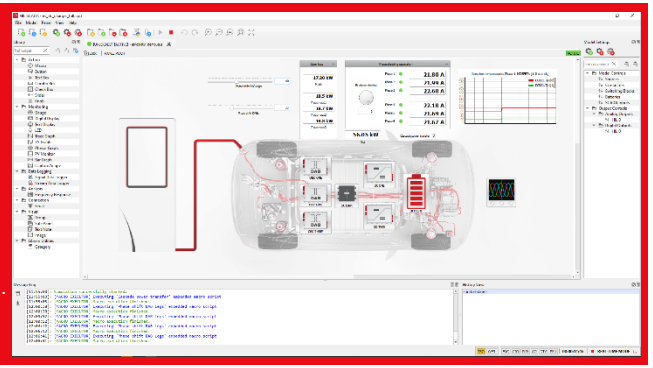


HIL SCADA

Create your personal interface to the simulation.

Run the HIL simulation and verify your control design interactively.

Start automating your tests through programmed sequences.



TyphoonTEST

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.

Schematic Editor

- Drag and Drop Modeling Environment
- .tse format
  - Text editor
  - Convenient for version management

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    execution_rate = "Ts"
    frequency = "f_lpf"
    sig_output = "True"
}
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    size = 64, 32
]

component "core/Product" Product1 {
}
[
    position = 8400, 8512
    hide_name = True
]

component "core/Probe" Pmeas {
    signal_type = "active power"
}
[
    position = 8704, 8512
]

component "core/Gain" deg2rad2 {
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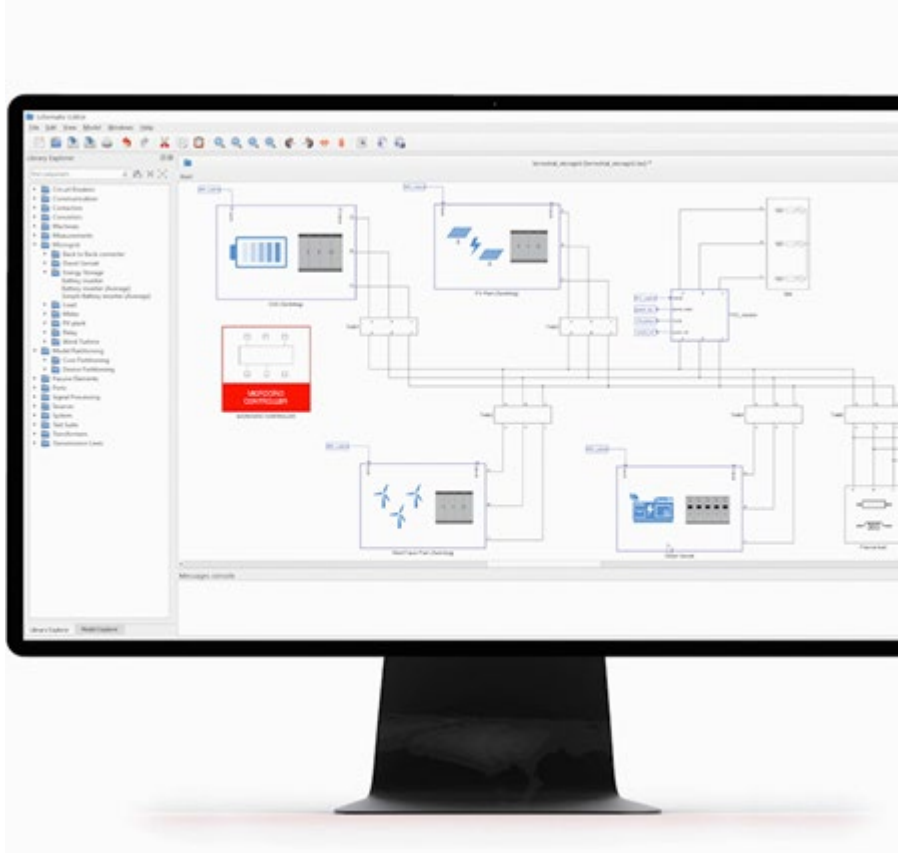
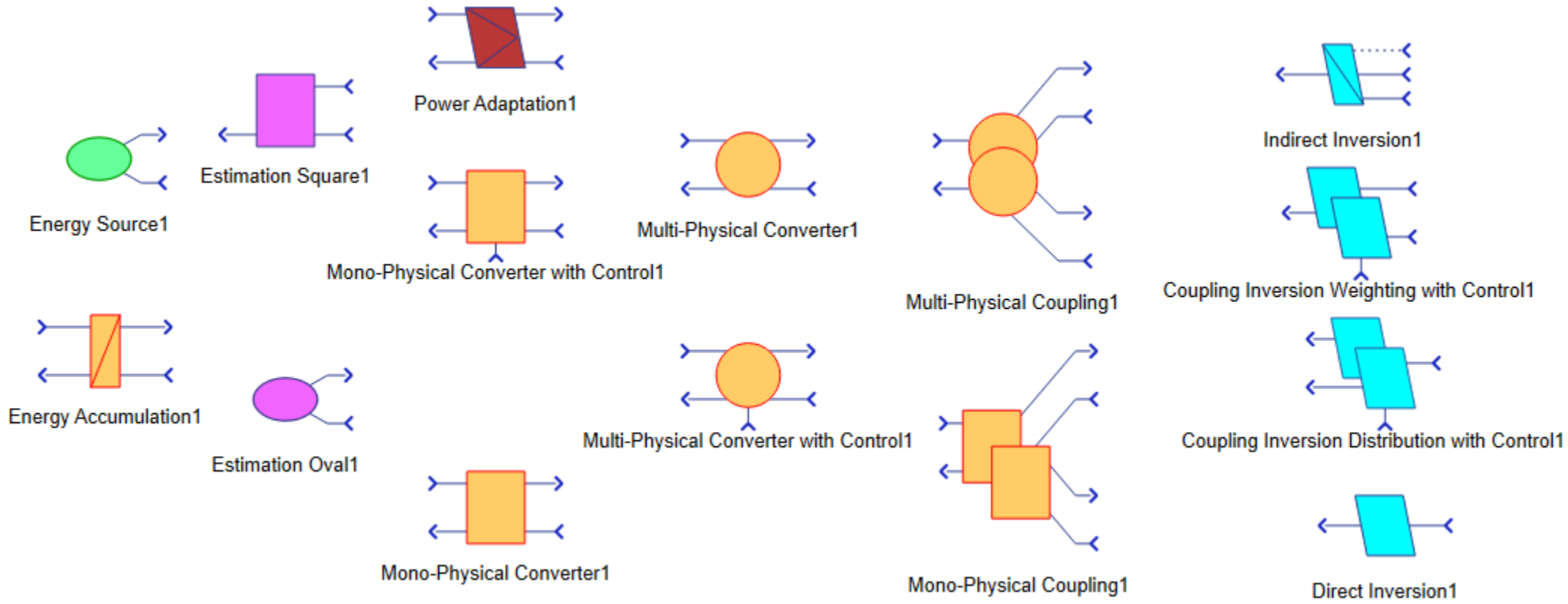
}
[
    position = 8504, 8512
    hide_name = True
]
```



EMR with Typhoon

Easy integration with Typhoon HIL Toolchain – Schematic Editor component library



HIL SCADA

- Real-time GUI for simulation control
  - .cus format
  - Text format

```
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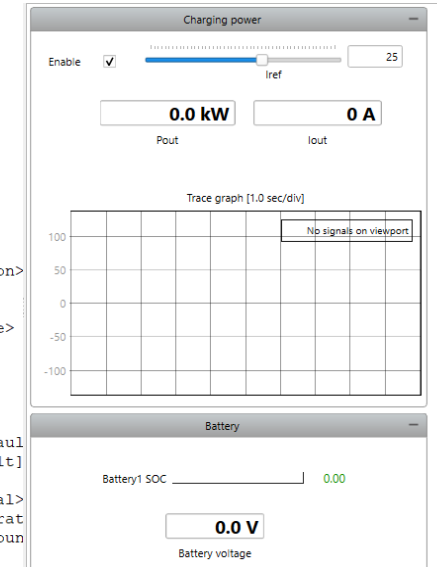
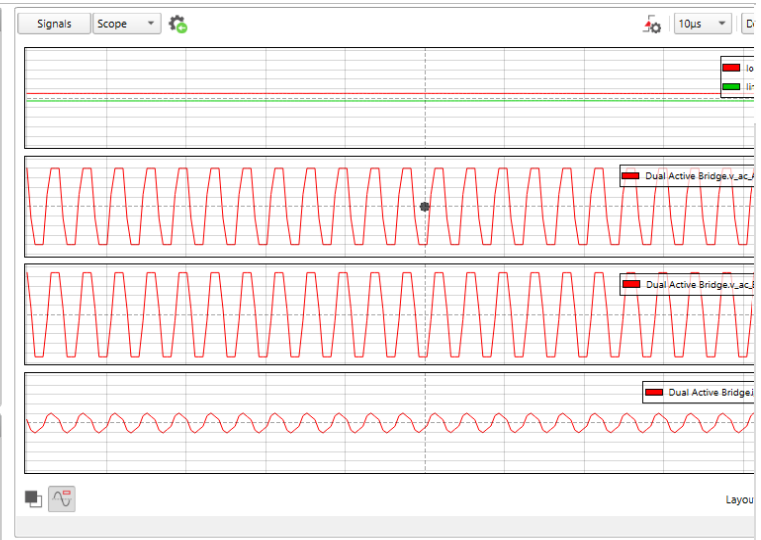
```

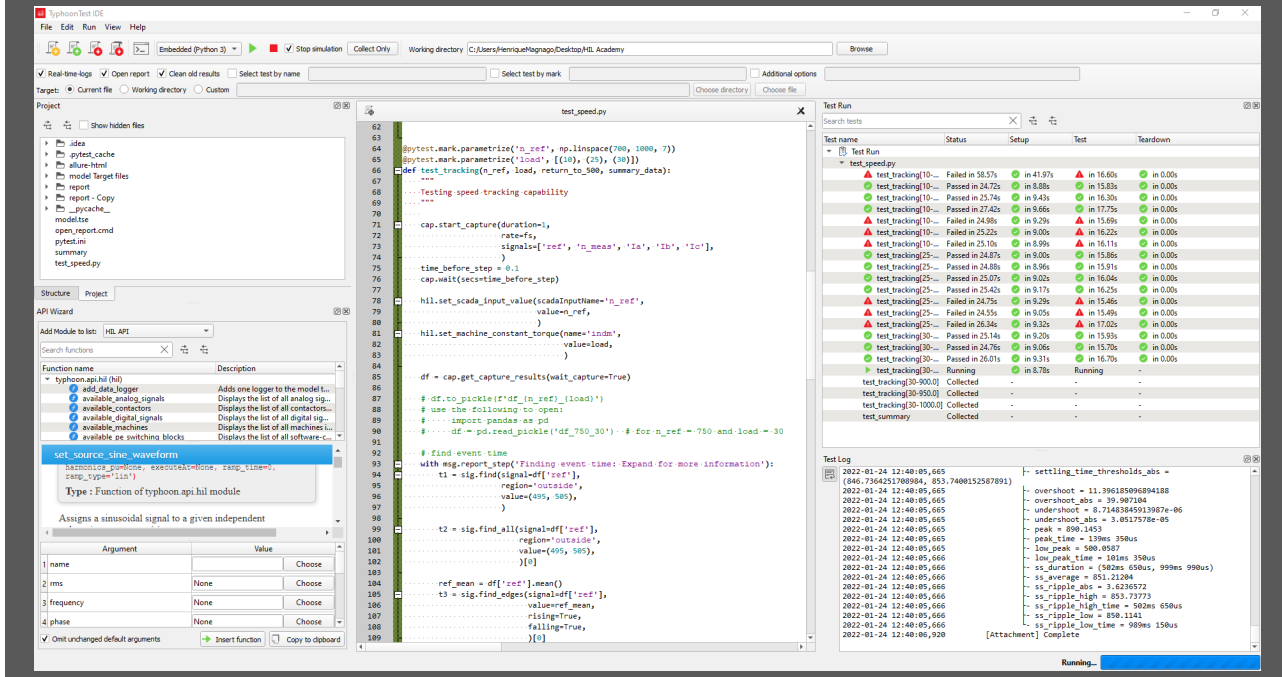


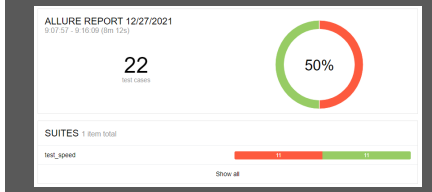


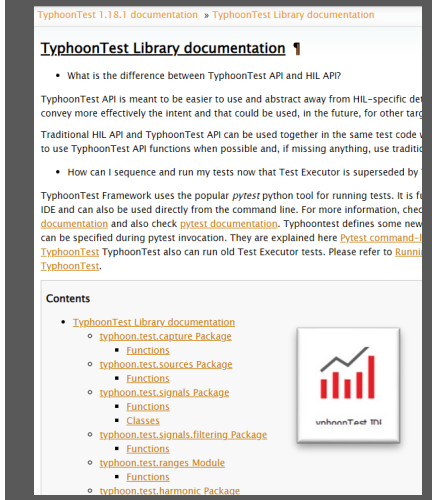
TyphoonTest

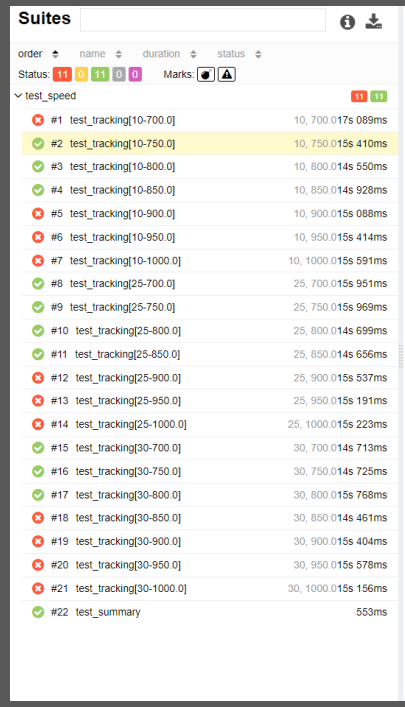
Automate your test execution

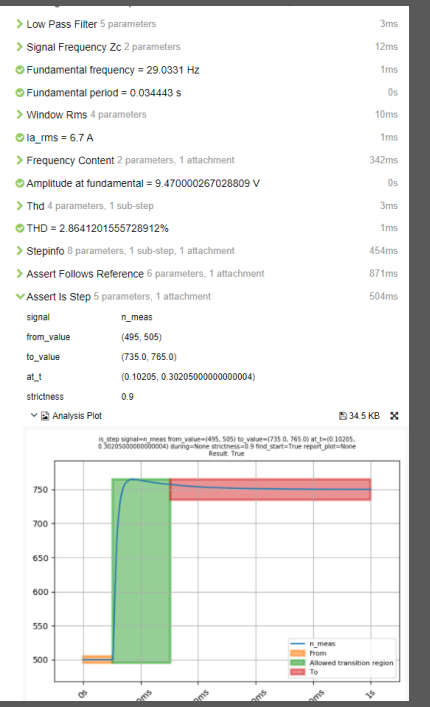
- Test framework base on PyTest
- Uses Allure as the reporting tool
  - Typhoon API function call automatically adds information to the report
  - Customizable
- Test procedure in code
  - Compatible with your Python IDE of choice
  - Flexibility and trackable (VCS)
  - With good abstraction, the same test can run for different DUTs and environments
- Wide range of power electronics focused functions
  - Filters, FFT, THD, power, RMS, …







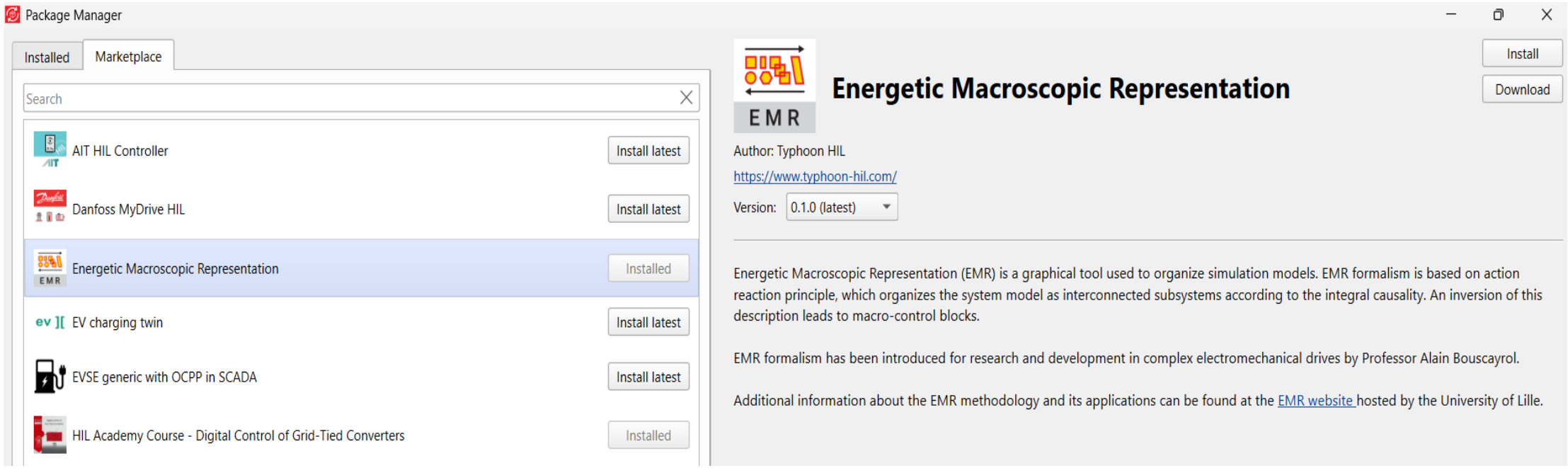




Typhoon HIL

EMR component library

Available on THCC Package Manager Marketplace



Thanks for your attention !