Typhoon HIL

HIL Solutions for DC Fast Chargers

Powering e-Mobility Forward

www.typhoon-hil.com

CalPower

Via Acquanera, 29 22100 COMO
tel. 031.526.566 (r.a.) fax 031.507.984
info@calpower.it www.calpower.it

Electrifying the Road

Speeding up the charge

e-Mobility is a centerpiece for achieving a smart, low-carbon, environmentally friendly future. However, in order to achieve mass acceptance and deployment of electric vehicles, charging times need to be drastically reduced and driving range increased, as well as charging stations should become widely available to enable long-distance driving.

With the development of direct-current fast chargers (DCFC), several challenges that hold back EVs from becoming mainstream have been overcome. These charges offer several advantages compared to AC chargers, including **increased power densities, higher efficiencies, and reduced charging time (charging the battery up to 80% within 30~60 minutes, depending on the EV).**

Roadblocks in the development of DCFC

Despite of all these benefits, the development and testing process of DC fast chargers is complex and many challenges need to be faced, such as:

- In-house pre-certification testing against different charging standards
- Control validation for different EV models
- Power converters testing against faults
- Precise evaluation of semiconductors losses and operational temperatures

Why HIL is a game-changer

Hardware-in-the-loop (HIL) devices have been revelutionizing control development for e-Mobility, enabling high-fidelity simulations and the testing of all the components of the EV powertrain, such as electric motors, power electronics, batteries, and charging systems. By taking advantage of HIL, e-Mobilty engineers can evaluate DC fast chargers earlier in the design cycle, saving time and increasing test coverage.

The Typhoon HIL approach

Our HIL solution was tailor-built, without any compromises, for the testing of power electronics controllers and communication systems for EVs and electric vehicles supply equipment (EVSE).

Our vertically integrated hardware and software, ultra high model fidelity, compatibility with other design and testing tools make Typhoon HIL the perfect HIL choice for developing DC fast chargers. Typhoon's compatibility with control development tools (e.g. Matlab/Simulink), motor design tools (e.g. JMAG), project management tools, and other test automation tools enables seamless workflow.

Unleash the Typhoon HIL advantage to test, design, verify and validate (V&V) your automotive control software.

Continuous Integration & Validation

- Cloud-based solution to manage and deploy tests, and access reports
- HIL testbeds with test management software, test automation server, and project management
- Validate control software and firmware during the whole product lifecycle

Enhanced test automation

- Compatible with 3rd-party test automation tools
- Automatic report generation
- Create tests with minimum code using the TyphoonTest IDE

Tailor-Built for Power Electronics

- Ultra-high fidelity models of power converters
- Most advanced MOSFET/IGBT loss/thermal models
- Down to 200 ns time step with 3.5 ns resolution

Leading the DC Fast Charge

Challenges in the testing of power electronics for DC fast chargers

In order to charge EVs faster, DCFC operate at high power levels with increased voltages and currents. Moreover, aiming to reach higher efficiencies and optimized performance, these chargers utilize more complex DC-DC converters topologies, usually requiring more advanced controllers.

When validating controllers for DCFC with physical prototypes, the testing process is complex and involves many safety risks. These power converters operate at high power levels and are tested under extreme conditions, including grid faults, current/voltage spikes, overcurrent/overvoltage conditions, and faults occurring on the EV or charging station. These conditions are hard to recreate in the laboratory and can increase the development costs caused by damaging power electronics.

In addition, new market trends also impose modifications to the DCFC converters and controllers. An example is the Vehicle-to-Grid (V2G) concept, which requires a bidirectional power flow capability of power converters, increasing control and hardware complexity.

The main challenges related to the testing of DC charging stations can be summarized as follows:

- Evaluating power converters against fault events from the EV and grid side and internal to the DCFC
- Testing controls for high switching frequency power converter topologies
- Validation of operating points when connected to different EVs
- Measuring semiconductor losses and operating temperatures precisely
- Availability of EV or EVSE hardware on-site

Simplified control testing of DC-DC converters

Learn more on Typhoon HIL e-mobility website page.

Our HIL solution empowers e-Mobility engineers with a simplified path for testing controllers for DC fast chargers. Based on ultra-high-fidelity models available in the component library, the Typhoon solution is robust and highly effective in testing power electronics converters and controllers. By taking advantage of test-driven model-based design, you can evaluate DC fast chargers earlier in the design cycle, improve project schedule performance, reduce the number of software bugs, enable teams to be more productive, and increase test coverage.

Benefits of using Typhoon HIL solutions

- Test power converters with the highest fidelity, accurately evaluating power losses and semiconductos temperatures in real-time
- Simulate the latest generation of wide-band-gap semiconductor switches like SiC and GaN
- Take advantage of our extensive component library with several ready-to-use models of power electronic converters
- Replicate testing scenarios that are hard to recreate in the lab, such as voltage spikes and fault conditions to evaluate the reliability of power electronic controllers
- Use the intuitive graphical user interface to create tests and define test steps. Run tests with a click of a button; follow the progress in real-time
- Validate controllers for synchronization with the grid in a safe enviroment with reduced costs

Boosting the Validation of EV Charging Protocols

Taking DC fast chargers to the highest level with ISO 15118

Charging standards, such as the IEC61851, define the characteristics of connections, operation, and safety for on-board and off-board EV chargers to ensure a reliable charging process. However, smart charging, like the DCFC, requires advanced communication protocols to specify the digital communication layer between the EV and EVSE and reach a seamless charging experience. ISO 15118 makes DCFC possible, establishing a digital communication protocol covering wired (AC and DC) and wireless charging applications.

ISO 15118 protects the driver's and EV's information based on cryptographic tools and significantly improves the EV owner's experience, allowing:

- A user-friendly and secure Plug & Charge that enables a seamless end-to-end charging process, including automatic authentication, authorization, and billing
- EVs to integrate into the smart grid through V2G (vehicle-to-grid), enabling EVs to consume from and supply energy to the grid for both AC and DC charging
- Fleet-charging management and grid services provision by EVs

Example setup includes:

Typhoon HIL 606 Device

Typhoon HIL CSS Interface (PLC)

Challenges in the validation of ISO 15118

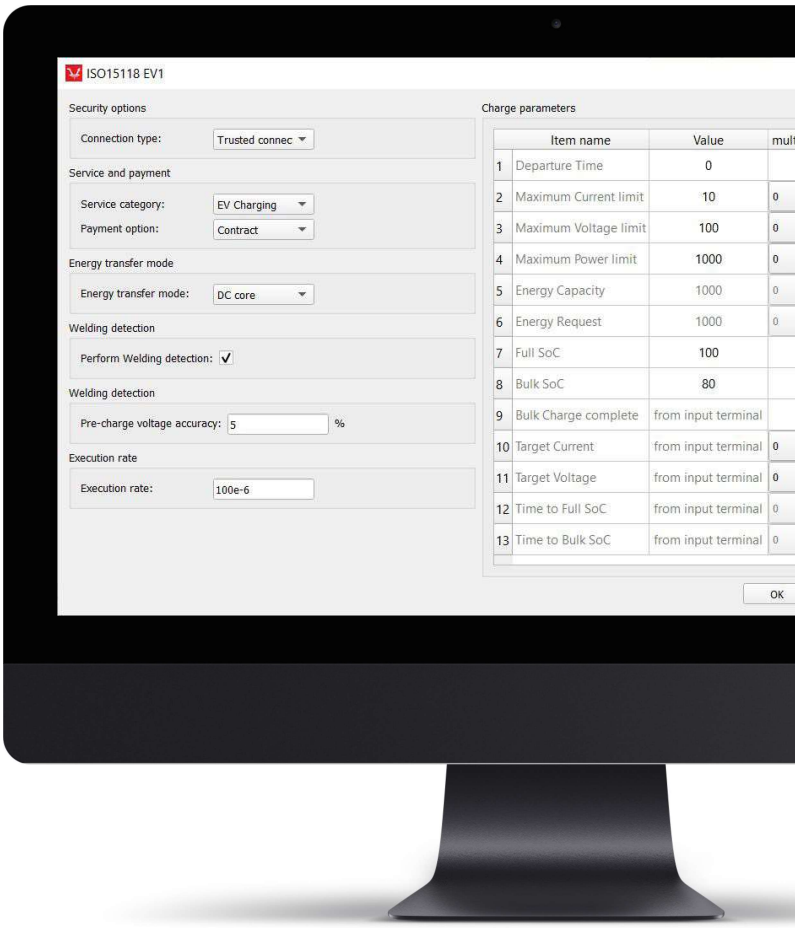
Although this protocol offers several benefits to EVs, engineering challenges related to the developmen t and validation process impose challenges to the ISO 15118 adoption by automakers, such as:

- Availability of different EVSE and EVs hardware on-site to validate communica munication systems during conditions that are hard to re-create in the lab, such faults
- Complexity of conformance tests and the increased cost of pre-certification testing

Validating charging protocols with Typhoon HIL

The Typhoon HIL all-in-one toolchain was tailor-built for testing power electronics controllers and communication systems for e-Mobility applications. It enables you to quickly build a digital twin of the charging system and test the communication systems before ever building a real prototype. Thus, testing and validation of charging standards and communication protocols can be performed in-house without requiring EV and EVSE hardware.

Typhoon specialized components supply simulation models for power converters and communication systems. For the ISO15118, Typhoon provides ready-to-use EVCC (Electric Vehicle Communication Controller) and SECC (Supply Equipment Communication Controller) components and implementation examples. Thus, Typhoon rules out all the complexity of implementing the sequence of messages and procedures of ISO 15118, speeding up your product development.



- Validate communication protocols for different models of EVs and EVSE and test against existing charging standards
- Recreate fault events, such as a broken wire or a short circuit, to evaluate the reliability of communication systems
- Validate DC fast chargers interoperability with different EVs without the ISO 15118 implementation complexity
- Perform conformance tests in-house, avoiding certification failures and reducing development costs
- Take advantage of automated tests and automatic report generation to accelerate ISO 15118 compliant development
- Test the integration of the V2G management system with the grid in real-time validating controllers and power converters for bidirectional power flow

Typhoon HIL

Typhoon HIL, Inc.
15 Ward Street, 2nd Floor
Somerville, MA 02143
USA

Phone: +1 800-766-3181

Typhoon HIL GmbH.
Seminarstrasse 85
CH-5430 Wettingen
Aargau, Switzerland

Phone: +41 (0)56 521 00 25

Tajfun HIL d.o.o.
Bajci Zilinskog bb
21000 Novi Sad
Republic of Serbia

Phone: +381 21 3010 476

www.typhoon-hil.com
e-mail: info@typhoon-hil.com