INTEROP

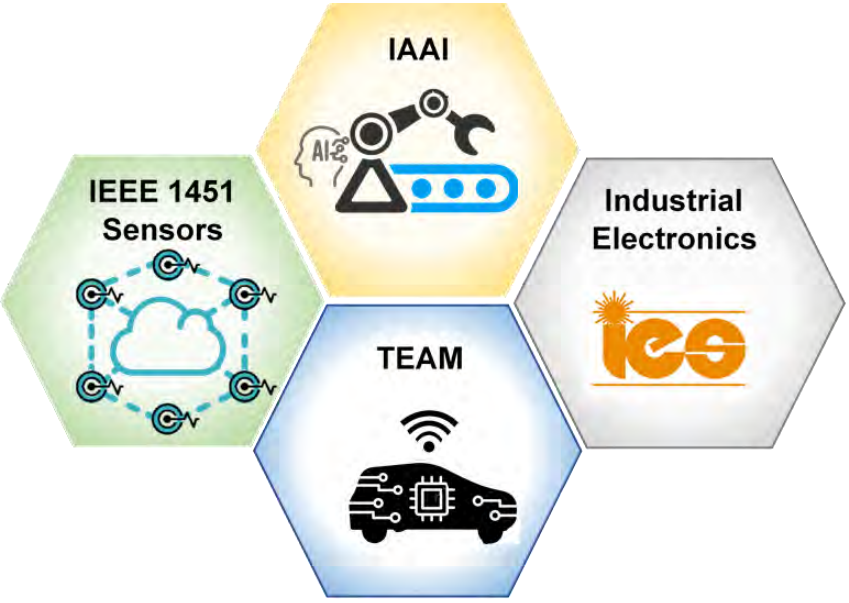
PLUGFEST 2021

INTEROPERABILITY PLUGFEST

Virtual Conference
Toronto, Canada

INTEROP 2021

IES STANDARDS AND INTEROPERABILITY PLUGFEST



IEEE 1451 Sensors Standards Cluster

1. *P1451.0*
2. *P1451.001-2017*
3. *P1451.002*
4. *P1451.5.X*
5. *P1451.1.5*
6. *P1451.1.6*

Industrial Automation-Artificial Intelligence (IAAI) Cluster

1. *P2805*
2. *P2668*

Industrial Electronics Cluster

1. *Smart Battery Gauge*
2. *P2023*
3. *TBD (Reza)*

Transportation Electrification & AutonoMous Vehicles (TEAM) Cluster

1. *E-mobility Cloud Computing - Siemens*
2. *RT HIL for grid & EVs – Typhoon HIL*
3. *Energy Management for EVs – NC State*

Industrial Electronics Society – IES Standards TC Standards Technical Committee

WELCOME – INTEROP PLUGFEST 2021

The INTEROP Plugfest at IECON 2021 is the fifth edition of the IES Standards Committee's INTEROP Plugfest series. New to this edition is an introductory cluster of automotive applications organized by members of the IES Transportation Electrification TC, to bring new areas of practical and demonstrative technologies and innovations focusing on IES fields of interest. In time, it is expected that multi-disciplinary interoperability development and trials can result from this experience, between the automotive cluster and our traditional IES technology clusters of sensor networks, industrial automation and industrial electronics.

The 2021 INTEROP Plugfest@IECON 2021 is held in Toronto, Canada on October 13 – 16, 2021 and features fourteen (14) active participants. Due to the worldwide Covid-19 pandemic, the Plugfest is held as a virtual event.

We welcome our participants and their Plugfest demonstrations, briefly elaborated in this brochure.

We thank you and your support to the IES Standards initiative and to the IES Standards Technical Committee and to the Industrial Electronics Society.

INTEROP Plugfest 2021 Organizers:

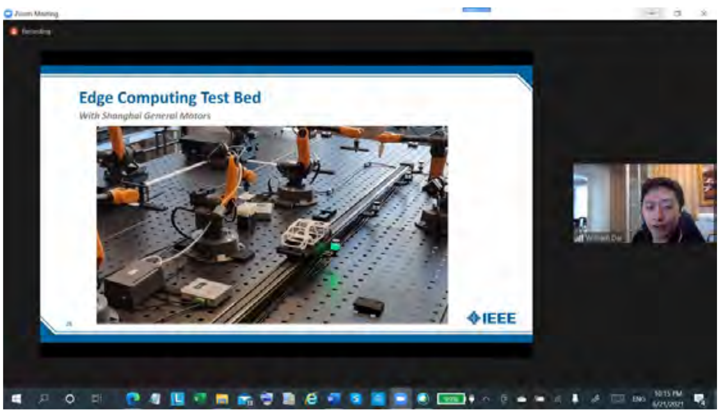
Victor Huang, Allen Chen, Dietmar Bruckner

ABOUT INTEROP

The INTEROP Plugfest was introduced by the Industrial Electronics Society's (IES) Standards Technical Committee in 2018 as an initiative for the Society's community to participate in a practical and demonstrative fashion in interoperability and potential standards compliance applications. This event is usually in conjunction with IES' yearly flagship conference, the Industrial Electronics Conference (IECON)

This is especially targeted to the society's academic and industry collaboration partners to come together in a physical neutral environment conducive to open technical discussions. The goal is to provide periodic gatherings of like-minded members to discuss progressive results and new ideas.

The past four editions were successfully held at ISIE 2021, Kyoto, Japan (June 21-22, 2021), in Singapore at IECON 2020 (October 18 – 21, 20200; in Lisbon, Portugal at IECON 2019 (October 14 – 17, 2019); and in Washington, DC, USA at the IECON 2018 (October 21 – 23, 2018).



Demo at 4th INTEROP Plugfest @ISIE 2021, Kyoto, Japan (virtual)

OBJECTIVES

The Objectives of the INTEROP Plugfest are three-fold.

First, to provide the IES Standards community with onsite verification and validation platforms for the standards so the community can test their development of their applications to these benchmarks, ensuring compliance and interoperability to their systems in IES fields of interest. The goal of these platforms is to support users with "turn-key approaches" to their applications, by providing relatively effortless initial start-up processes, allowing easy installation and configuration

Second, provide a forum for demonstrations and prototypes for interoperability and standards. In addition, a forum for onsite IES standards working groups sessions for active standards discussions and development.

Third, to encourage industry partners to participate in IEEE Standards by providing verification and validation platforms for standards compliance and interoperability in the industry context.

Lastly, and most importantly, the long term goal is to provide stable or permanent validation and compliance Centers of Expertise (COE) for industry and academia use, distributed globally under IES Standards support.

Second INTEROP at IECON2019 – Lisbon, Portugal

Brochure of the 3rd INTEROP at IECON 2020 – Singapore

Brochure of the 4rd INTEROP at ISIE 2021 2021 – Kyoto

INTEROP 2021 PRESENTATION DAY 2

Group	Organizer
Thursday October 14, 2021, 11:30 AM – 12:50 PM *Session 2: TEAM (Automotive)* ***Session Chair: Fei Gao & Akshay Rathore***	
Cloud Computing Simulation platform for e-mobility	*Siemens*
Real-Time Sim & HIL for grids & EVs	*Typhoon HIL*
Energy Management & EVs	*NC State University (MY Chow)*
OPEN DISCUSSIONS	*-- 20 minutes --*

Short Papers Collection

Cloud Computing simulation with Simcenter Amesim

Calin HUSAR
RTD Department
Siemens Industry Software SRL
Brasov, Romania
calin.husar@siemens.com

Marius CIOCAN
RTD Department
Siemens Industry Software SRL
Brasov, Romania
marius.ciocan@siemens.com

Cristi IRIMIA
RTD Department
Siemens Industry Software SRL
Brasov, Romania
cristi.irimia@siemens.com

Introduction

This demo will make an introduction into Simcenter Amesim, a system simulation software, where the simulations are done through the cloud simulation platform Rescale. A parallel representation between a structural and functional approach based on a battery electric vehicle model will be made. Also, the transfer of a virtual model from a simulation platform to a real-time and HiL platform will be presented.

Standard Overview

The automotive industry must be prepared to ensure a mass production of electrified vehicles by using innovative methods to significantly reduce their development and testing time. The big advantage of the use of simulations during development of a product is the reduced time for evaluation of the performance of vehicle systems and global vehicle performances. So, improving simulations will lead to a faster vehicle production, a cost reduction of the development and a cost optimization of the vehicle.

The different simulation packages can be classified in two categories [1, 2]. In the case of a structural-based simulation [3], figure 1, the system is described by *components* connected by real links. Libraries of components are available and the user just has to connect these components as in real life with respect to their physical interconnections. The main advantage of structural-based descriptions is user-friendliness.

In a functional-based simulation, figure 2, the system is described by *functions* connected through virtual links (i.e. variables). The drawback of the functional-based description is that the user has to define the function and I/Os of each component then solve the conflict of associations before simulation. However, if the functions are defined with the respect of the natural causality, the system analysis is easier to perform. Most of the actual simulation packages are developed based on structural description philosophy, because of it is user-friendly and benefits of the use of fast computation solvers. One of the graphical formalisms used in a functional-based simulation is Energetic Macroscopic Representation (EMR) method [4] which organize models and controls of multidisciplinary systems through specific EMR pictograms to describe energy sources, energy storage, energy conversion, energy distribution and control operations.

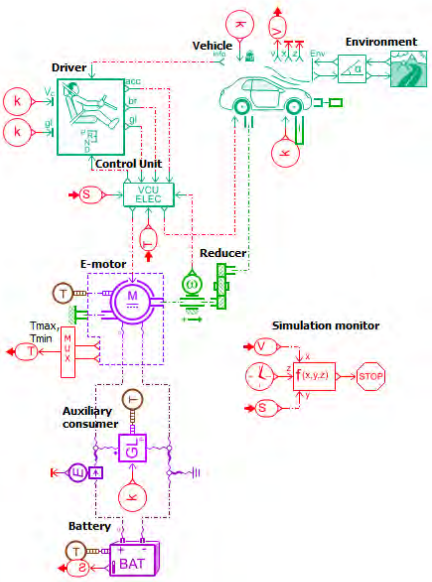


Figure 1: Sketch of a simple electric vehicle model - structural-based descriptions

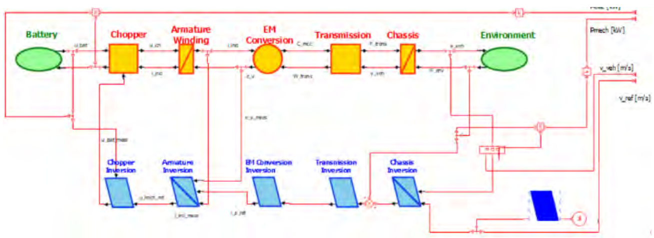


Figure 2: Sketch of a EMR functional-based electric vehicle model

Material and Equipment

The simulation tool used in this demo is Simcenter Amesim which present theirs cloud simulation capabilities through the partnership with the cloud simulation platform Rescale.

Simcenter Amesim is the leading integrated, scalable system simulation platform, allowing system simulation engineers to virtually assess and optimize the performance of mechatronic systems. This will boost overall systems engineering productivity from the early development stages until the final performance validation and controls calibration. Simcenter Amesim combines ready-to-use multi-physics libraries with industry-oriented solutions that with the leverage of powerful platform capabilities let rapidly create models and accurately analise their performance. This open environment can be easily coupled with major computer-aided engineering (CAE), computer-aided design (CAD), and controls software packages.

Rescale's strategic partnership with Siemens allows Siemens users to run their simulations quickly, easily, and securely on Rescale's industry-leading, cloud high-performance computing (HPC) platform and multi-cloud infrastructure network.

Siemens on Rescale is the web-based simulation solution that meets needs and simulation expectations. With Rescale, Siemens users get:

- **Fast results and boosted productivity:** Unlimited, scalable hardware from 36 data centers worldwide means the simulation jobs run lightning-fast and never wait in a queue.
- **Flexibility:** Access to a broad selection of Siemens solvers, including past versions, from a single cloud-based platform gives you the flexibility to use your favorite Siemens solution or experiment with new ones from anywhere in the world.
- An easy, out-of-the-box solution: An intuitive interface and user-friendly workflow allow for seamless setup and execution of Siemens simulations.
- **Excellent customer support:** CAE and cloud experts are available by phone or live chat to troubleshoot any issues you have.

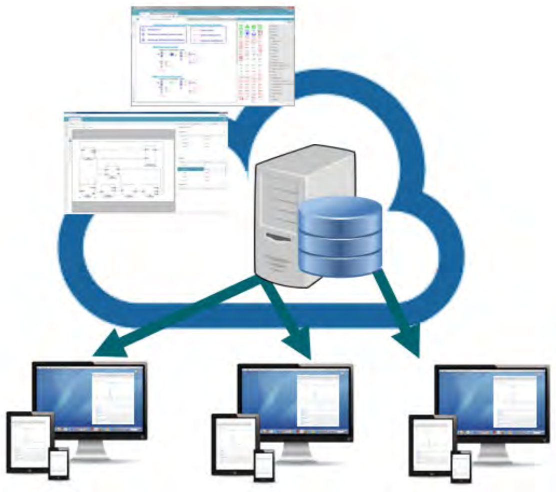


Figure 3: Cloud simulation infrastructures

Demo Structure

In order to show how easy it is to get a working model, the demo will walk through all the modelling and simulation scenarios that a user expects of a 1D simulation software.

Whilst using Rescale, both structural and functional models of a vehicle will be presented. The structural representation of the vehicle will be loaded from the vast library of demo models that come included with Simcenter Amesim, while the functional model will be generated with the help a tool which leverages the robust Amesim API. Additionally, with the help of the same API, a user built component library will be added to Amesim's already large collection to make use of the state-of-the-art functional representation principals.

Parametrization plays an important role in industrial software, a role which Simcenter Amesim takes seriously. With the help of exposed parameters and dashboards, controlling exactly which is of note is always easy.

After these two major steps comes the simulation. Besides the expected options (run-time, start delay, which results to track) it is also possible to select the integration method of the solver, be it either continuous or fixed-step (with multiple methods available.) To quickly compare the effect of a parameter on the results of a model, a batch simulation will also be ran, with the results which we are after being displayed on a saved graph.

Finally, the model will be exported to a real-time platform where the platform will be selected from a list of consecrated providers, directly from Simcenter Amesim.

Useful Links and Aditional Information

https://www.plm.automation.siemens.com/global/en/products/simcenter/simcenter-amesim.html (accessed on October 2021)

https://www.rescale.com/siemens/ (accessed on October 2021)

https://project-panda.eu (accessed on October 2021)

https://project-panda.eu/wp-content/uploads/2018/11/PANDA-D4.3-Report-on-the-virtual-testing-of-the-BEV_small.pdf (accessed on October 2021)

Acknowledgment

The presented document and the related demo are part of the Panda project which is a Research Innovation Action from the European H2020 program. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 824256 (PANDA) [5].

References

[1] C. Husar, M Grovu, C Irimia, A Desreveaux, A Bouscayrol, M Ponchant, P.Mangin, "Comparison of Energetic Macroscopic Representation and Structural Representation on EV Simulation under Simcenter Amesim", *IEEE VPPC'19*, Hanoi (Vietnam), October 2019.

[2] A. Bouscayrol, A. Lepoutre, C. Irimia, C. Husar, J. Jaguemont, A. Lievre, C. Martis, D. Zuber, V. Blandow, F. Gao, W.Van Dorp, G. Sirbu, J. Lecoutere, Power Advanced N-level Digital Architecture for models of electrified vehicles and their components Transport Reserach Arena (TRA), Helsinki, April 2020.

[3] C. Irimia, M. Grovu, G. Sirbu, A. Birtas, C. Husar, M. Ponchant, "The modeling and simulation of an Electric Vehicle based on Simcenter Amesim platform", 2019 Electric Vehicles International Conference & Show (EVSHOW'19), Bucharest, Romania, 2019

[4] Bouscayrol A., Hautier J.P., Lemaire-Semail B, 2012. Graphic Formalisms for the control of multi-physical energetic systems: from COG to EMR, in "Systemic Design Methodologies *for Electrical Energy"*, Chapter 3, (Ed.) ISTE Willey.

[5] https://project-panda.eu

HIL Testing of EV and EVSE Interoperability

Juliano Grigulo
Typhoon HIL inc.
Novi Sad, Serbia
juliano.grigulo@typhoon-hil.com

Ognjen Gagrica
Typhoon HIL inc.
Novi Sad, Serbia
ognjen.gagrica@typhoon-hil.com

Introduction

The electrical vehicle supply equipment (EVSE) is the encompassing term for the electrical infrastructure whose function is to ensure safe charging of an electric vehicle (EV). The two-way communication interface between the EV and EVSE is essential for the charging operation to happen seamlessly for the EV owner and without faults and interruptions to both the EV and the grid.

The signaling between the EV and EVSE is based on the international standard IEC 62196-1, which distinguishes 4 modes: 3 for AC and one for DC charging. Figure 1 summarizes the features for these modes. IEC 62196 also defines the used connectors dependent on their region.

Figure 1 - Modes and connectors for EV according to IEC 62196

Other important standard in the EV charging is the IEC 61851 which is an international standard for electric vehicle conductive charging systems, parts of which are currently still under development.

IEC 61851 consists of the following parts, detailed in separate IEC 61851 standard documents: IEC 61851-1: General requirements; IEC 61851-21-1: Electric vehicle on-board charger EMC requirements for conductive connection to AC/DC supply; IEC 61851-21-2: Electric vehicle requirements for conductive connection to an AC/DC supply - EMC requirements for off board electric vehicle charging systems; IEC 61851-23: DC electric vehicle charging station ; IEC 61851-24: Digital communication between a DC EV charging station and an electric vehicle for control of DC charging; IEC 61851-25: DC EV supply equipment where protection relies on electrical separation.

To apply DC-charging, significant information exchange between the battery and the external power supply is essential. Thus, high level communication is needed, details about this implementation are covered in the IEC 61851-24 and ISO 15118 (shown in Figure 1) standards, that ensure the communication between the electric vehicle and the charging station.

For AC charging, just the pilot signal is necessary. Although there is a strong push from the global EV market to adopt Vehicle to Grid (V2G) capabilities in all the charging stations (which is mapped in the mode 4 of IEC 62196-1 with the Combined Charging System-CCS connector type, allowing both AC and DC charging), the most stationary installed EVSEs currently apply mode 3 as it allows the highest flexible and high charging powers without requiring complex communication protocols.

This demo presents a high-fidelity EV-EVSE interface model with signalling scheme for AC charging according to IEC62196 - mode 3. The model is demonstrated on a real-time simulator and presents a digital twin of an actual hardware-in-the-loop (HIL) testbed for testing of the charging infrastructure.

Material and Equipment

The real-time simulator used is HIL606 along with Typhoon HIL Control Center software used to create model, user interface and automated tests.

The HIL 606 (Figure 2) device is chosen as it provides most complete solution for testing of E-mobility applications. Its FPGA-based electrical circuit solver is capable of time steps down to 200ns while digital inputs are sampled at 3.5ns. On the other hand, multi-processor architecture and hardware connectivity support a variety of industrial protocols relevant to EV and EVSE interoperability testing: CAN (used in GB/T and CHADEMO charging protocols), CAN FD, EtherCAT, Ethernet (used in ISO 15118 charging protocols) and SFP protocols for advanced interfacing with power amplifiers (P-HIL testing). This provides a versatile platform for testing many applications such as EV powertrain, ECU, charging infrastructure and BMS testing.

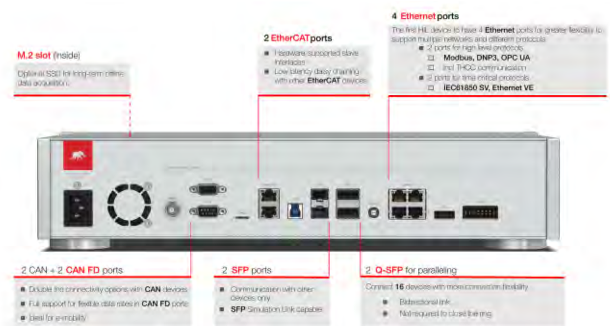


Figure 2 – HIL 606 connectivity and protocols

Model Description

Figure 3 shows the implemented model of an EV, a charging station, the connecting cable, and the public grid in the Typhoon HIL Control Center software. Since the demo focuses on communication and interface testing, the electrical part of the EV model is reduced to an EV battery model while powertrain is omitted. The IEC62196 Type 2 connector model with two-way signaling scheme is modelled in detail.

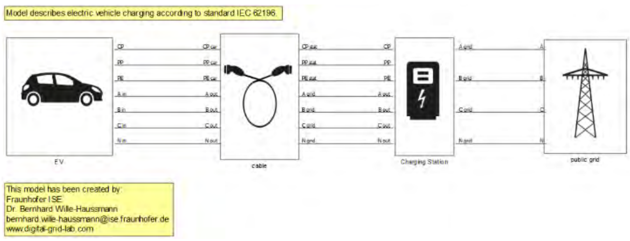


Figure 3 - Overall model of EV and EVSE

Figure 4 shows the signal of the pins CP, PE, and PP. A resistor placed between PE and PP on each end of the cable codes the maximum allowed current. The measurement of this resistance is included both in the EV and in the Charging Station subsystems. In order to demonstrate different cable types available at EVSE side, the resistor has been realized as a variable resistor.

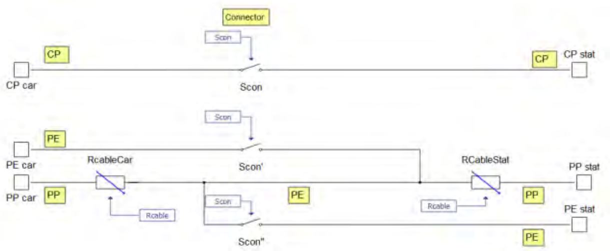


Figure 4 - Cable subsystem with CP, PE and PP

After the maximum current carrying capacity of the cable is detected, the EV charging requests need to be signalized, which is done via CP. On the CP pin the charging station provides a pulse width modulated (PWM) signal with an amplitude of ±12 V and a frequency of 1 kHz. This is evaluated on the EV side by the circuit shown in Figure 5. When the car is connected, the resistor R2 = 2.7 kΩ is in parallel and voltage on CP contacts drops down to 8.8 V, which signals that connection is established. With a charging request, the EV closes contactor Scar, which connects $R_{cp} = 1.3\ k\Omega$ in parallel to R2. This reduces the CP voltage to 5.6 V and indicates everything is set up for charging. The maximum available current by EVSE is communicated via the Duty Cycle (DC) of the PWM signal on CP. The EV evaluates the DC. The model realizes this in the detect duty cycle sub-system, which uses mainly edge detection and an integrator. The maximum current $I_{max\_DC} = 0.6\ DC\ [\%]$ is calculated by multiplying the DC percent by 0.6. Finally, the maximum current that can be provided by EVSE is the minimum of the two limits I_{max_cable} and I_{max_DC}.

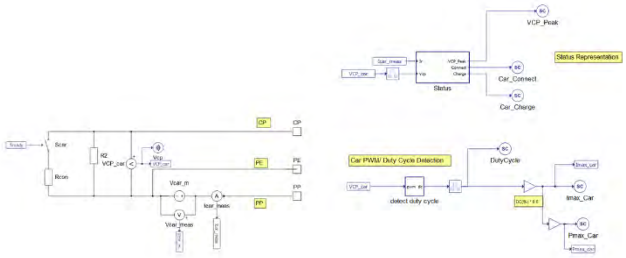


Figure 5 - Evaluation of CP signal on EV side

Simulation and Results

Figure 6 shows the HIL SCADA interface for controlling the simulation and interacting with the model.

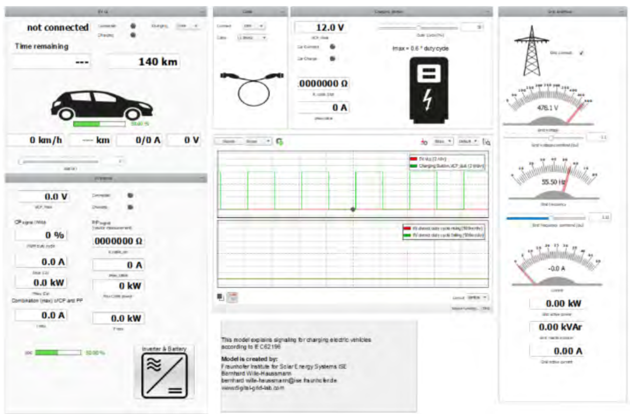


Figure 6 - SCADA panel

Once the simulation is started, it is possible to start the charging process. At first, it is necessary to connect the EV in the cable subsystem and enable charging at the EV side. To understand the status, it is helpful to observe V_{cp} (Figure 7). V_{cp} starts at 12 V, it drops to 8.8 V after connecting, and after the requesting charging, V_{cp} falls to 5.6 V.

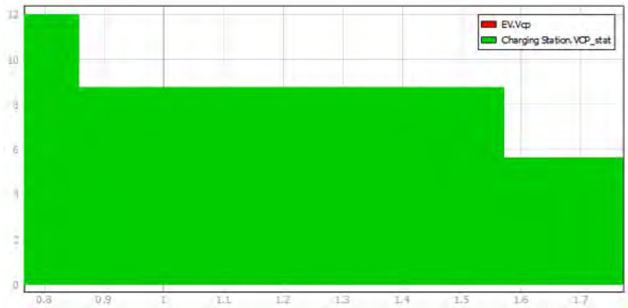


Figure 7 - Capture of V_{cp} signal at the charging station during the process of connecting and charging start

By selecting a charging current in the EV's user interface in the HIL SCADA, it is possible to observe an increase state of charge for the EV. The charging station dictates the maximum current and therefore prevents damage to the charging infrastructure.

Useful Links and Aditional Information

For more information about this model and the materials used please go to: https://www.typhoon-hil.com/documentation/typhoon-hil-application-notes/References/electric_vehicle_ac_charging.html