ELECTRIC VEHICLE

THE MOST ACCURATE EV POWERTRAIN REAL-TIME SIMULATION

WWW.OPAL-RT.COM

OPAL-RT TECHNOLOGIES

Infinite Possibilities for HIL Simulation

Accelerate the development, testing, and validation of electric transportation systems with an open platform adaptable to evolving research requirements.

In the rapidly transforming automotive industry, **Electric Vehicles (EVs)** and **Hybrid Electric Vehicles (HEV)** play an increasingly pivotal role. OPAL-RT, in collaboration with National Instruments (NI), offers a **powerful and flexible Hardware-in-the-Loop (HIL) and Power Hardware-in-the-Loop (PHIL) testing system**. This solution can easily be customized to adapt to changing testing requirements by combining modular hardware and off-the-shelf components.

Transportation manufacturers and suppliers strive to reduce development effort and costs, as well as time-to-market. OPAL-RT's HIL simulation system, aligned with NI's assets, **provides a comprehensive environment for development, test, and validation**. Industry experts endorse the flexibility and efficiency of HIL simulation in addressing the challenges of the ever-evolving transportation sector.

EV HIL requires high-fidelity models to **accurately represent** the behavior of various components. Fast FPGA simulation enables the implementation of **detailed and optimized models with high accuracy, ensuring that the simulated environment closely resembles the actual operating conditions of an electric vehicle.**

FPGA and high-fidelity simulation for precise analysis and enhanced performance.

In EV and HEV development, precise simulation of cogging torque is crucial for refining control systems, addressing uneven motion, and efficiency losses. Combining high-fidelity motor simulation on FPGA provides real-time processing capabilities and enhanced faulting scenario options. This **accelerates closed-loop control integration, optimizing algorithms to mitigate cogging effects, and enabling efficient rapid prototyping for enhanced EV motor performance** in a virtual environment.

Find refined and flexible solutions with OPAL-RT.

Our solutions are supported by our **extensive expertise in highly cutomized and complex test benches**. Additionally, we provide training modules built upon the **latest advancements in automotive applications worldwide**.

Battery Management Systems

OPAL-RT's solutions include flexible configurations and scalable options, while being compatible with the most common applications and third party components.

Converters, Inverters and Motors

Find OPAL-RT's strategies for DC-DC Converters for Power Distribution as well as the main Traction Drive or auxiliary drives.

On-Board-Chargers

OPAL-RT provides the worldwide fastest and most accurate Power Electronics solver to test OBC' controls efficiently. Converters with switching frequencies of >400kHz can be reflected accurately by capturing the gating signals below 1 Nanosecond. Test systems may include communication protocols verification as need be.

HIL Motor Emulation

OPAL-RT provide a motor emulator that mimics all the characteristics of a Permanent Magnet Synchronous Machine (PMSM – IPM – SPM) in both motor and generation mode, at full power–with no moving parts and requiring very little maintenance.

More than 2000 users currently running OPAL-RT. Worldwide.

Ford JAGUAR gm PEUGEOT TATA TATA MOTORS RENAULT Valeo

Revolutionizing Powertrain Emulation for EV/HEV Systems

Safely explore the performance of EV inverters, DC-DC converters, and battery packs without limitations.

Innovation meets precision as D&V and OPAL-RT collaborate to redefine Power Hardware in the Loop (PHIL) simulation. Our solution offers capabilities for testing **EV/HEV motor drive inverters and DC power systems on power level**, revolutionizing product development compared to traditional analog test benches..

Diverse Test Cases

Run an extensive array of test cases with multiple failure configurations, previously inconceivable with traditional methods.

End-to-End Control Design

Extend your control design and test strategy seamlessly from Hardware-in-the-Loop (HIL) validation in R&D to manufacturing, reducing costs and enhancing product development.

Full Power Testing

Conduct full-power testing without the need for users in the vehicle or real vehicle components, streamlining the testing process.

Real power in your laboratory.

D&V's power amplifiers and emulators, coupled with OPAL-RT's real-time simulation, provide engineers with **heightened accuracy and testing capabilities**. Ideal for simulating electric/hybrid vehicles, our dynamic technologies cover components such as **battery packs, chargers, inverters, motors, and high-voltage DC power systems.**

Highlights and benefits

High Fidelity: OPAL-RT's FPGA solution ensures complete, fast, and high-fidelity simulation of faults on converters and motors.

Flexibility: Equipped with user-selectable operating modes and high-power HIL compatibility, the DC emulator suits existing and planned test labs.

Full Integration: Achieve full vehicle system integration and component compatibility testing, enabling component replacement and accurate load emulation.

Simulation platforms for all your needs.

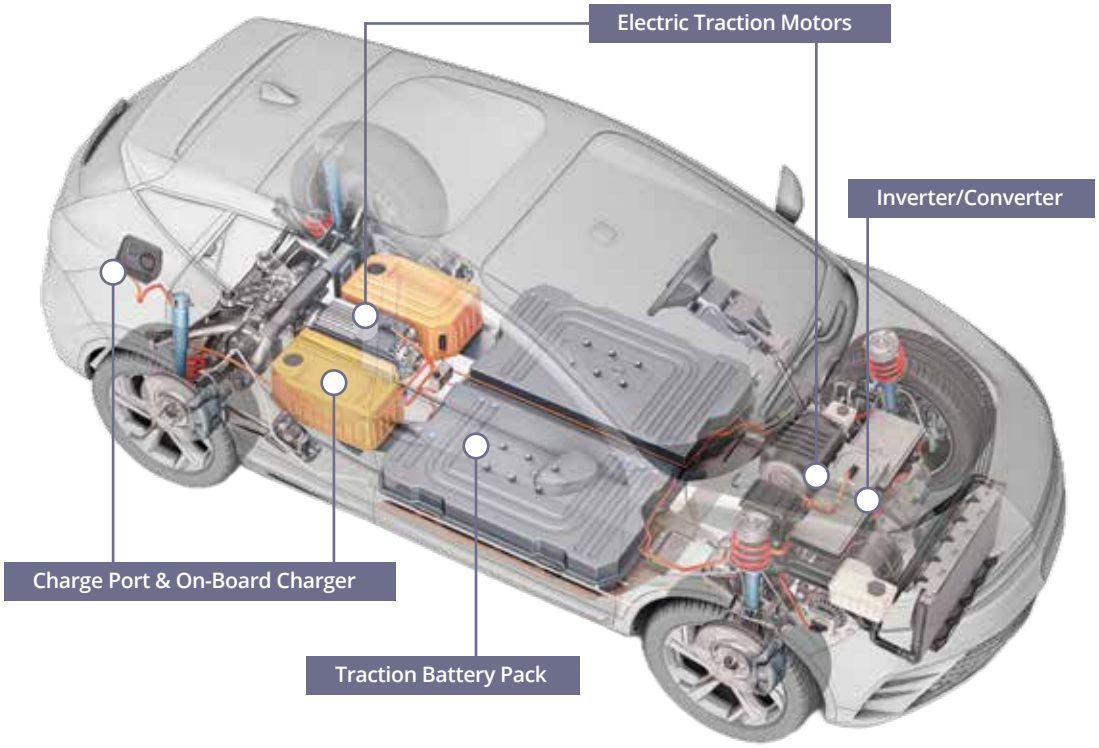
D&V Electronics' PHIL Motor and DC Emulators are compatible with OPAL-RT's and NI's systems.

The **OP4512** is a compact, entry-level simulator that combines all of OPAL-RT's strengths in high-performance Rapid Control Prototyping and Hardware-in-the-loop simulation.

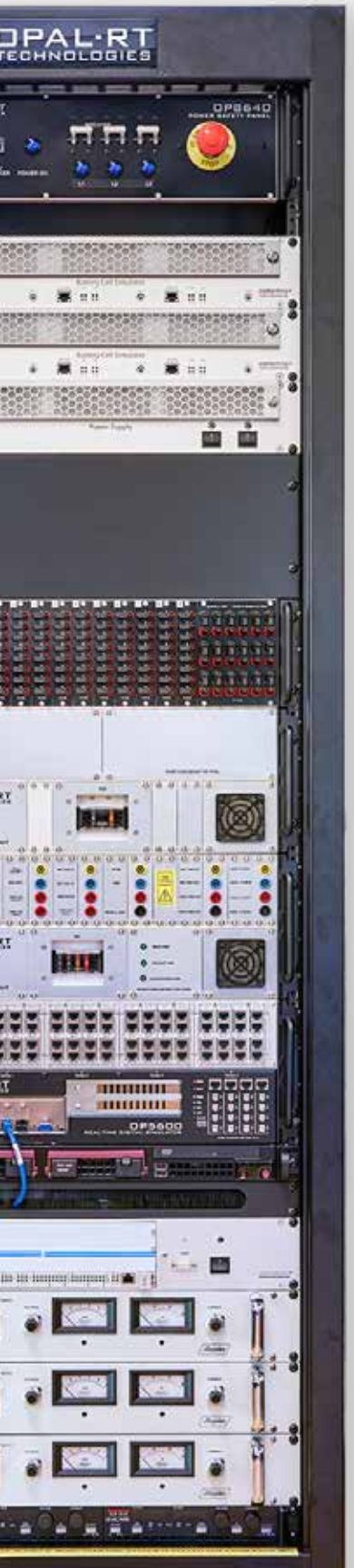
The **OP5707XG** offers an unequaled level of FPGA performance and optical connectivity to meet top-level requirements.

The **PXI** combines PCI electrical-bus features with the modular, Eurocard packaging of CompactPCI and then adds specialized synchronization buses and key software features.

Test any component with PHIL simulation.



Battery Management Systems Innovation with OPAL-RT and comemso®



Introducing a top-of-the-line Hardware-in-the-Loop solution.

Battery Cell Simulator by comemso®

Each comemso® BCS unit provides 12 cells and combines high-precision battery cell emulation with active sense adjustment on each voltage. Each cell includes fault simulation for generating short circuits, cable breakage and reverse polarity, as well a high precision current measurement system.

State-of-the-Art Real-Time Simulator

All simulators support MATLAB/SIMULINK™, where models of batteries, high fidelity power electronics & motors and virtual control unit can all be simulated in realtime.

- NI PXI™ chassis
- OPAL-RT real-time simulators

Engineering

OPAL-RT provides the engineering to extend the BMS HIL Test Bench functionalities; from extra protection, shunt emulation, break-out box, currentand voltage sensing to complete vehicle control or ADAS systems integration.

Safe, Reproducible, Automated

The comemso® BCS allows you to test your Battery Management System at the cell-level and with more dynamics than ever before. The electrical emulation of battery cells puts you in the position of achieving safe, reproducible and fully automated testing of your BMS. The Battery Cell Simulator is the core of a BMS test system.

Virtual Cell Simulation

OPAL-RT Cell Monitoring Device Emulation (CMDE) enables FPGA emulation of BMS chipsets from major providers such as ADI that can be daisy-chained via IsoSPI™.

Success Story on On-Board-Charging (OBC)

Driving progress: Valeo's transformative journey in shaping the future of mobility.

In the fast-evolving landscape of automotive technology, Valeo is a pivotal partner to global automakers and emerging players in the mobility sector. Committed to shaping a **cleaner, safer, and smarter future**, Valeo focuses on **electrification, advanced driver assistance systems, interior experience reinvention, and innovative lighting solutions**. Listed on the Paris Stock Exchange, Valeo's 2021 sales reached 17.3 billion euros, with a substantial 8.7% investment in research and development.

At the heart of Valeo's groundbreaking advancements in power electronics for electrified mobility is Moctar Coulibaly, the OBC and DC/DC R&D Platform Director at Valeo Powertrain Electrified Mobility in France. Boasting over 17 years of experience, Coulibaly and his team are instrumental in overseeing the development and market introduction of Valeo's **On-Board Charger (OBC) and Combos, including DCDC, for high-voltage products**.

Amid the surging popularity of electric vehicles (EVs) as sustainable transportation choices, Valeo recognizes the **multifaceted challenges in ensuring seamless and rapid charging while navigating the complexities of a strained power network**. In this pursuit, the collaboration with Moctar Coulibaly and OPAL-RT has proven to be a game-changer.

The introduction of the **FPGA-Based Power Electronics Toolbox (eHS Gen5)** marks a significant milestone in improving the robustness of Valeo's On-Board Charger and the entire system, addressing challenges related to the dynamic behavior of resonant converters and grid control. **eHS Gen5 played a critical role in enhancing the resilience of Valeo's technology, with a particular focus on achieving an acceptable level of battery current ripple**.

The implementation of Pulse Width Modulation (PWM) resolution below 1ns emerged as a key factor in meeting customer requirements and ensuring optimal battery performance. Additionally, the collaboration **facilitated easy replication of on-field events, enhancing the On-Board Charger's control interface with the simulator**.

The longstanding partnership between Moctar Coulibaly, previously at GE Energy, and OPAL-RT underscores the significance of a collaborative approach in tackling custom and complex projects. Recognizing OPAL-RT's expertise as crucial to success, Valeo leveraged this alliance to overcome challenges and drive forward innovations in power electronics.

In conclusion, Valeo's collaboration with OPAL-RT encapsulates the spirit of problem-solving and innovation. This strategic partnership not only contributes to Valeo's core competencies but also introduces **groundbreaking solutions to the wider world**. As the automotive industry embraces the era of electric mobility, Valeo remains at the forefront, continually pushing boundaries to shape the future of cleaner, safer, and smarter transportation.

ABOUT US

Founded in 1997, OPAL-RT TECHNOLOGIES is the leading developer of open real-time digital simulators and Hardware-In-the-Loop testing equipment for electrical, electro-mechanical and power electronic systems.

OPAL-RT simulators are used by engineers and researchers at leading manufacturers, utilities, universities and research centres around the world.

OPAL-RT's unique technological approach integrates parallel, distributed computing with commercial off-the-shelf technologies.

The company's core software, RT-LAB and HYPERSIM, enables users to rapidly develop models suitable for real-time simulation, while minimizing initial investment and their cost of ownership. OPAL-RT also develops mathematical solvers and models specialized for accurate simulation of power electronic systems and electrical grids. RT-LAB, HYPERSIM and OPAL-RT solvers and models are integrated with advanced field programmable gate array (FPGA) I/O and processing boards to create complete solutions for RCP and HIL testing.

OPAL-RT TECHNOLOGIES

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