REAL-TIME SIMULATION FOR
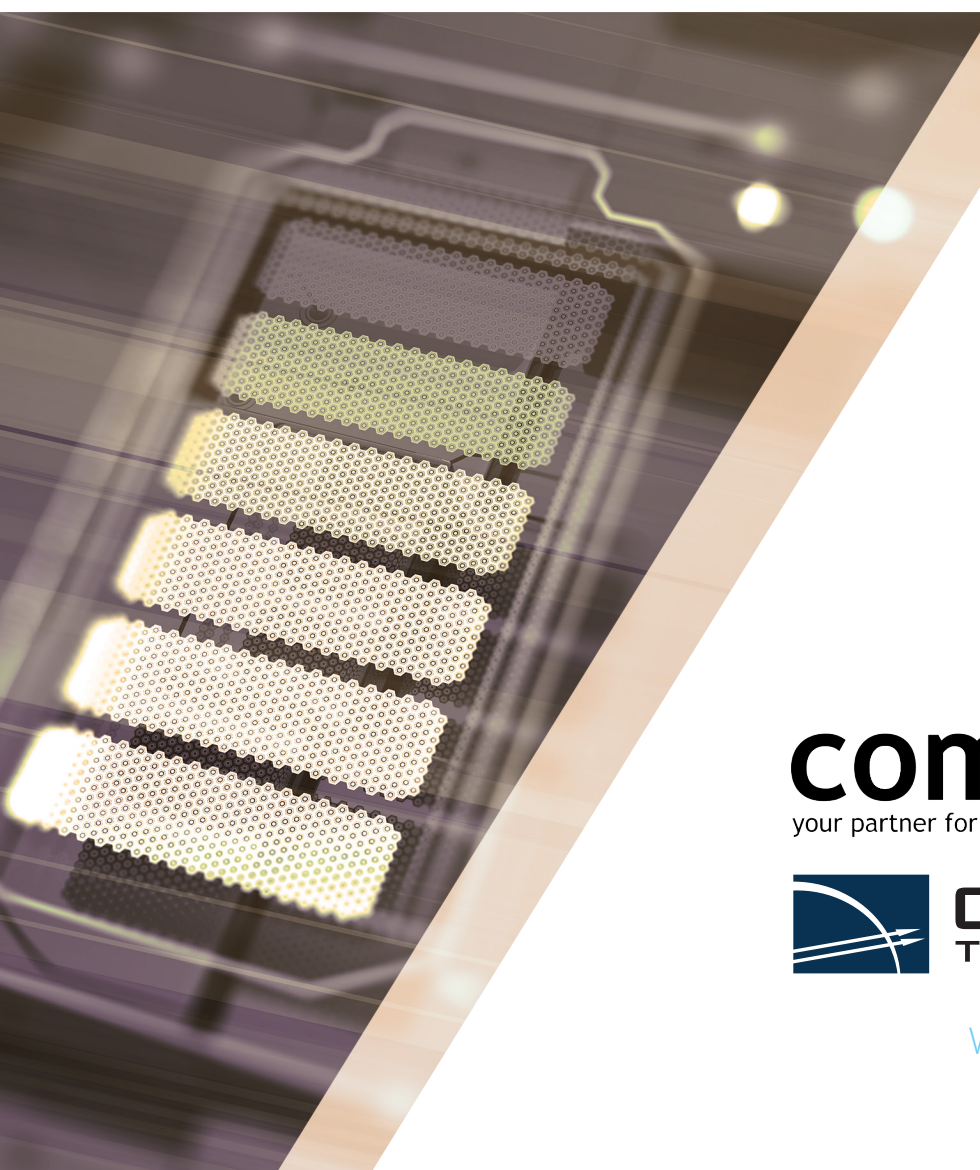# BATTERY MANAGEMENT SYSTEMS

comemso®
your partner for complex embedded solutions

OPAL-RT
TECHNOLOGIES

Where Flexibility Meets Performance

OPAL-RT TECHNOLOGIES, in partnership with comemso® , introduces top of the line Battery Management System HIL test solution.

Our flexible BMS approach makes it possible to integrate new technology as soon as it is introduced into the vehicle. Our real-time solution easily migrates existing physical testbeds onto real-time HIL simulation platforms for testing your BMS.

Controls Every Aspect of your BMS System

- Fault Insertion
  - Open-circuit voltage
  - Cell short-circuit
  - Cell polarity change
- Charge / Discharge (low and high rates possible)
- Single-cell balancing current (passive and active) up to 4.9A
- Protection
  - Single-cell overload
  - Single-cell over-discharge
  - Over-temperature
  - Battery chassis isolation
  - Release test
- CAN communication
- Battery Stack voltage and current emulation
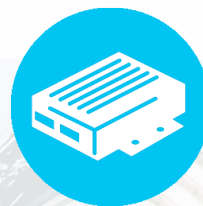
Battery Management System HIL Test Solution

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 real-time.

- OPAL-RT OP4510 and OP5707 real-time simulators
- National Instruments PXI™ and CompactRIO chassis

Engineering

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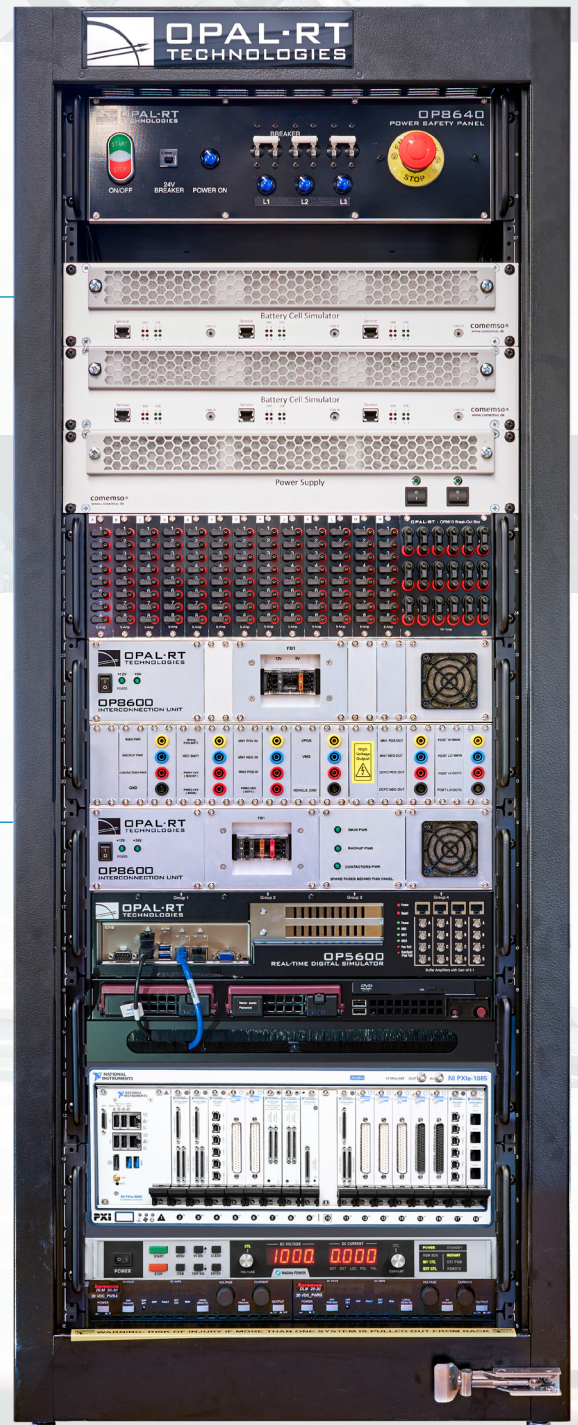
First In Its Class

Battery Cell Emulator

Flexible voltage source and current load adjustment and high-precision function tests of the BMS are possible with the comemso® BCS. Each cell has an electronic load, which can be used for active and passive balancing.
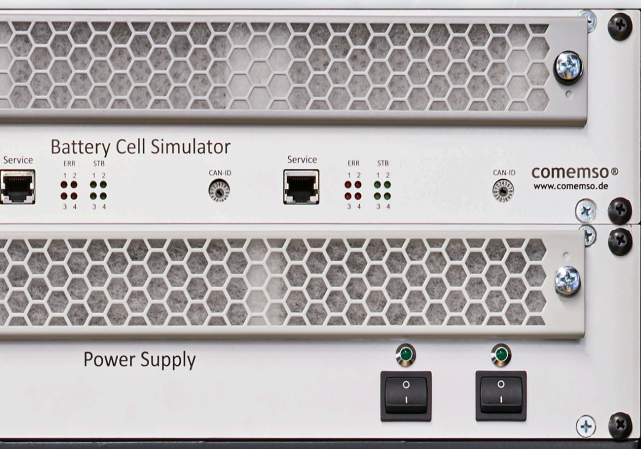
The comemso® BCS allows you to test your Battery Management System at the cell-level and with more dynamics than ever before. The electrical emulation of battery cells puts you in the position of achieving safe, reproducible and fully automated testing of your BMS. The Battery Cell Simulator is the core of a BMS test system.

Compact Battery Cell Simulator Options Overview

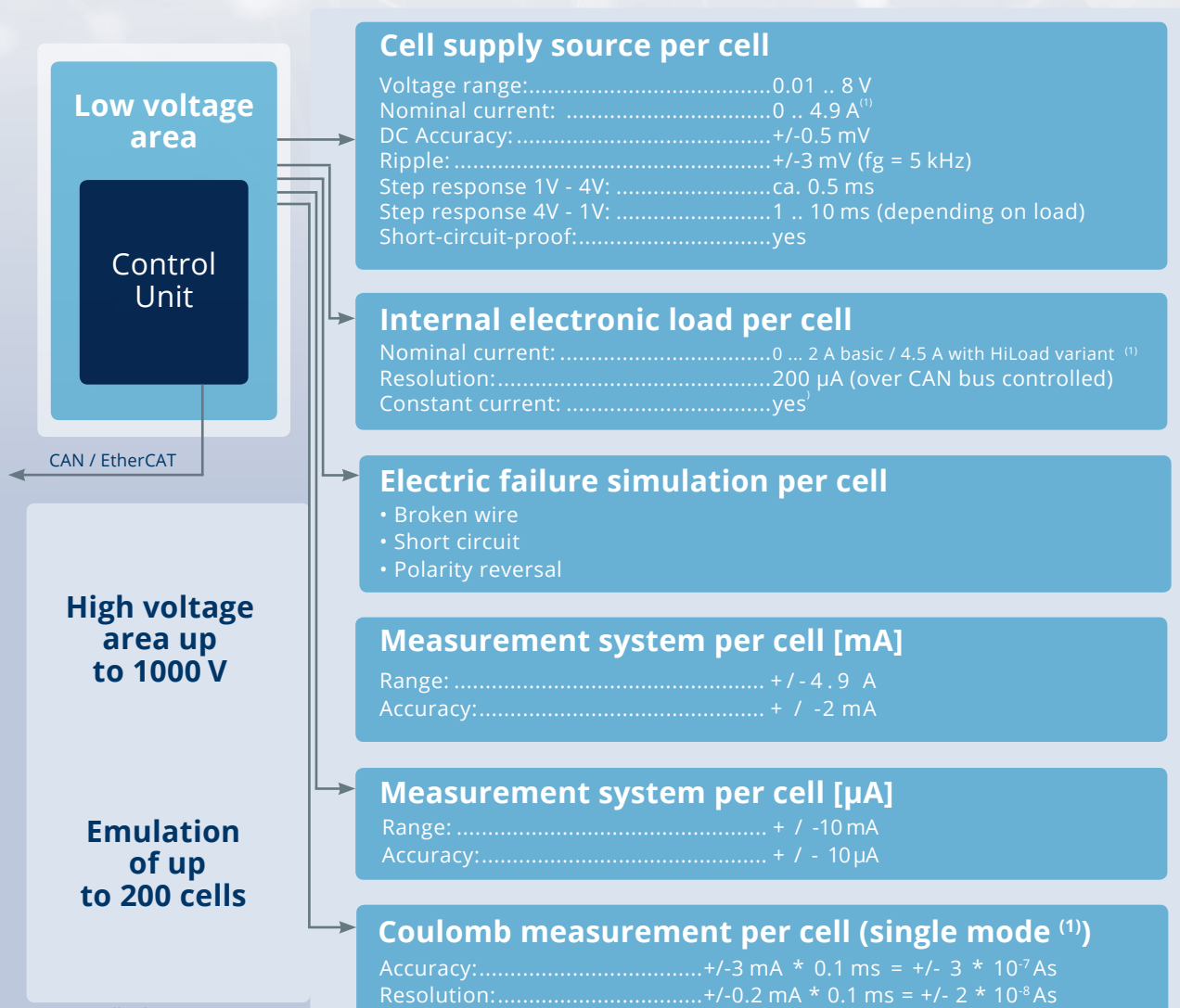| Product variant	Light	Basic	Basic+F	Basic+F+ µA	Basic+F+ Hiload	Full
Height	2 HU	2 HU	2 HU	2 HU	2 HU	2 HU
Cells per modules	12	12	12	12	12	12
Max. number of cells	200	200	200	200	200	200
Source [1]	1.0A	4.9A	4.9A	4.9A	4.9A	4.9A
Sink [1]	1.0A	2.0A	2.0A	2.0A	4.5A	4.5A
Fault simulation			✓	✓	✓	✓
Current measurement µA				✓		✓
Current measurement +/- 5A	✓	✓	✓	✓	✓	✓
Fast current measurement (Coulomb)		✓	✓	✓	✓	✓

[1] Sink and source: values can be reached separately – not in combination. Example: If sink has 2.0 A setting, then the source is only max. 2.9 A (4.9 A – 2.0 A)

Technical Data

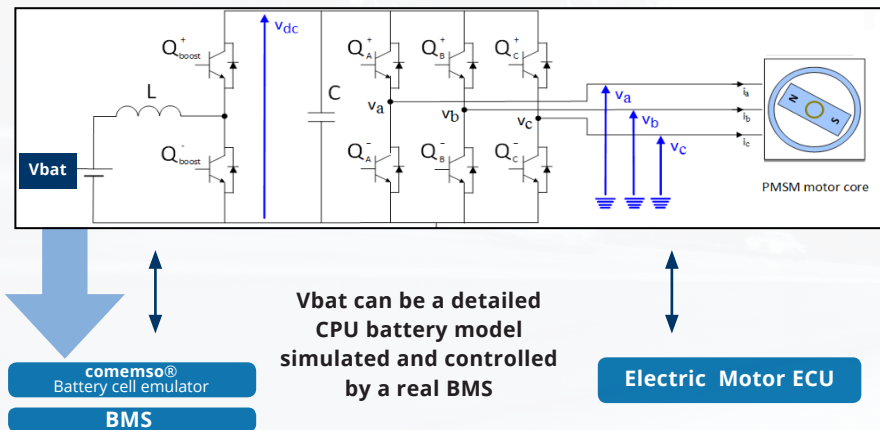|				
Communication :	CAN / EtherCAT 100Mbits/s		**Isolation cell/communication :**	2kV
Temperature range :	Lab conditions		**Isolation cell/cell :**	60V
Connector :	115V/230V or CEE 3 x 16 A		**Number of cells :**	12 to 200
Safety:	Integrated emergency shutdown management		**Capacity:**	Simulation of up to 144 cells per rack

Technical Data Overview

Low voltage area

Control Unit

CAN / EtherCAT

High voltage area up to 1000 V

Emulation of up to 200 cells

Cell supply source per cell
Voltage range:...0.01 .. 8 V
Nominal current: ....0 .. 4.9 A[1]
DC Accuracy:...+/-0.5 mV
Ripple: ....+/-3 mV (fg = 5 kHz)
Step response 1V - 4V: ....ca. 0.5 ms
Step response 4V - 1V: ....1 .. 10 ms (depending on load)
Short-circuit-proof:...............................yes

Internal electronic load per cell
Nominal current: ....0 ... 2 A basic / 4.5 A with HiLoad variant [1]
Resolution:...200 µA (over CAN bus controlled)
Constant current: ....yes¹

Electric failure simulation per cell
• Broken wire
• Short circuit
• Polarity reversal

Measurement system per cell [mA]
Range: .... +/- 4.9 A
Accuracy:... + / -2 mA

Measurement system per cell [µA]
Range: .... + / -10 mA
Accuracy:... + / - 10 µA

Coulomb measurement per cell (single mode [1])
Accuracy:....................................+/-3 mA * 0.1 ms = +/- 3 * 10^{-7} As
Resolution:................................+/-0.2 mA * 0.1 ms = +/- 2 * 10^{-8} As

(1) At 5 V cell voltage.
source is only max. 2.9 A (4.9 A – 2.0 A)

Extend your BMS HIL test coverage with high fidelity power electronics and motors for extended test capabilities

Real-time simulation of power electronics remains one of the greatest challenges in HIL simulation. The I/O capability to capture PWM frequency, the overall latency of the closed-loop simulation, mathematical solving of coupled switches and fault injection on all stages of complex power electronics converters are just some of the complexities of this evolving industry.

OPAL-RT brings you a scalable solution for your EV and energy storage test and research.

comemso®
Battery cell emulator

BMS

Vbat can be a detailed CPU battery model simulated and controlled by a real BMS

Electric Motor ECU

Reduce costs; combine comemso® cell emulator and PHIL

Power Hardware-in-the-Loop (PHIL) simulation represents a natural extension of HIL, in which the real-time simulation environment is capable of exchanging not just low-voltage, low-current signals, but the power required by any type of Device Under Test (DUT).

Using Power HIL simulation, a subset of cells will be emulated by the comemso® cell emulator and the full battery stack voltage/current is provided by a power supply or amplifier. This hybrid based solution cuts down cost while still allowing for full test coverage.
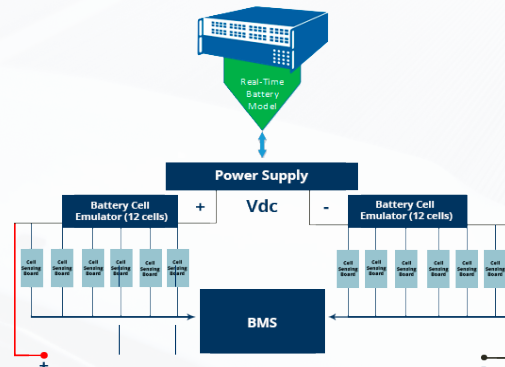
Add a BMS HIL Test Bench to a virtual power grid for Vehicle-to-Grid (V2G) testing and research

As the EV user base increases, we're discovering that the uncontrolled charging can cause under-voltages and network congestion within the existing electrical infrastructure.

Real-time simulation enables the capability to simultaneously study the interaction between the vehicle's battery, the charging station and the electrical grid. This approach is showing great promise in testing innovative charging strategies and in studying the battery's effects on the electrical network.

OPAL-RT Technologies, with its varied suites of targeted real-time software, is well-placed to address the most visionary V2G control approaches.
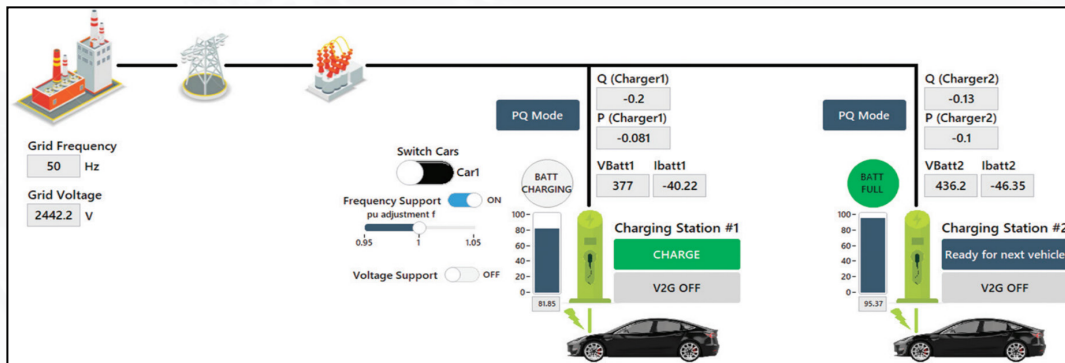
BMS Testbench Customers

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 manufacturer, 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, enables users to rapidly develop models suitable for real-time simulation, while minimalizing initial investment and their cost of ownership.

OPAL-RT also develops mathematical solvers and models specialized for accurate simulation of power electronics systems and electrical grid. RT-LAB 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

OPAL-RT CORPORATE HEADQUARTERS

1751 Richardson, Suite 2525 | Montréal, Québec, Canada | H3K 1G6
Tel: 514-935-2323 | Toll free: 1-877-935-2323 | Fax: 514-935-4994

U.S.A.
OPAL-RT Corporation
2532 Harte Dr
Brighton, MI
48114, USA
Phone: 734-418-2961
Toll free: 1-877-935-2323
Fax: 1-866-462-5120

EUROPE
OPAL-RT Europe S.A.
196 Houdan Street
Sceaux, Hauts-de-Seine
92330, France
Tel: +33 1 75 60 24 89

GERMANY
OPAL-RT Germany Gmbh I. Gr
Bucher Straße 100
Nürnberg,
90408, Germany
Tel: +49 1744926539

INTELLIGENT TRANSPORTATION SYSTEMS
OPAL-RT Intelligent Transportation Systems
10 Vivier Merle boulevard
Lyon, France, 69393
Tel: +33 67 60 80 36 08

INDIA
OPAL-RT Technologies India Pvt. Ltd.
648/A-4/5, 2nd Floor,
OM Chambers,
100 Foot Road
Indiranagar 1st Stage
Bangalore, Karnataka
560038, India
Tel: 080-25200305
Fax: 080-25200105

WWW.OPAL-RT.COM/BATTERY-MANAGEMENT-SYSTEM