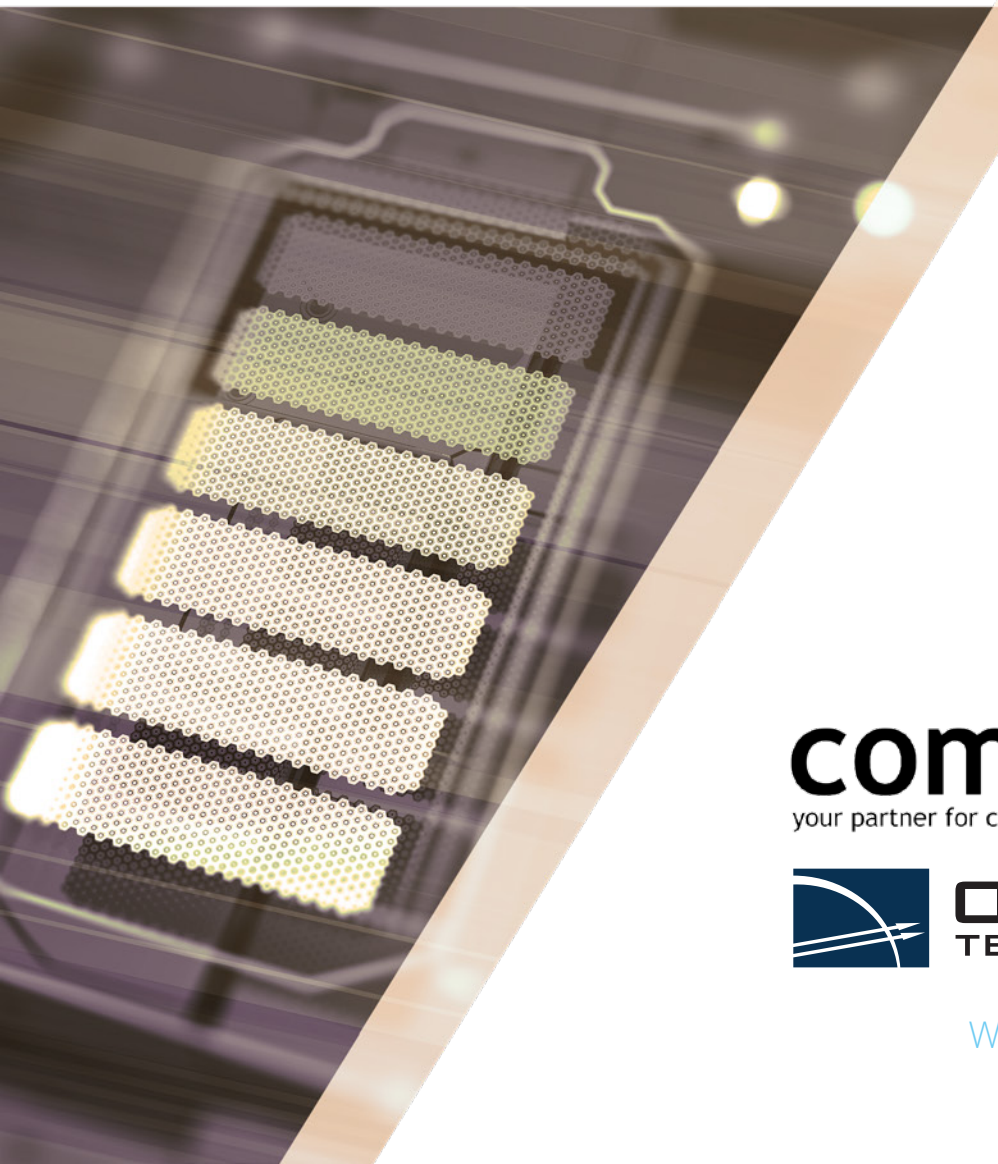
REAL-TIME SIMULATION FOR

BATTERY MANAGEMENT SYSTEMS



comemso®

your partner for complex embedded solutions

OPAL-RT TECHNOLOGIES

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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

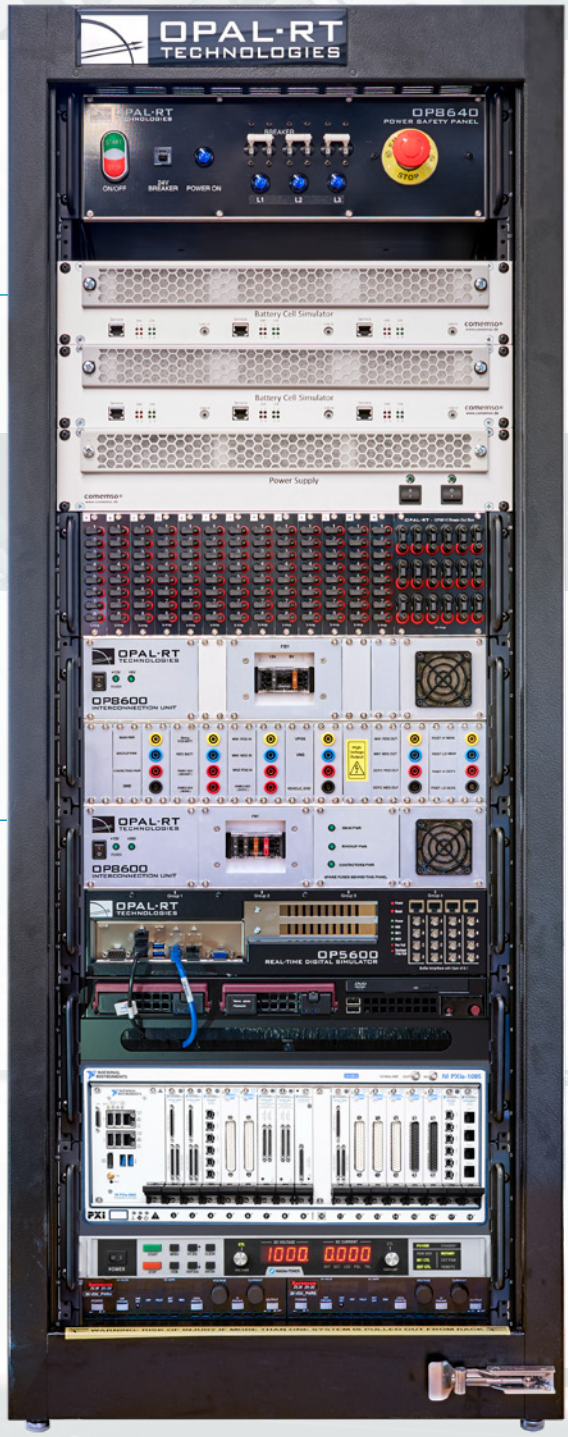


Battery Management System HIL Test Solution

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. Possible to emulate BMS chipsets from major OEMs to virtually test isoSPI™ communication and functionality.

A comprehensive range of hardware includes:

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

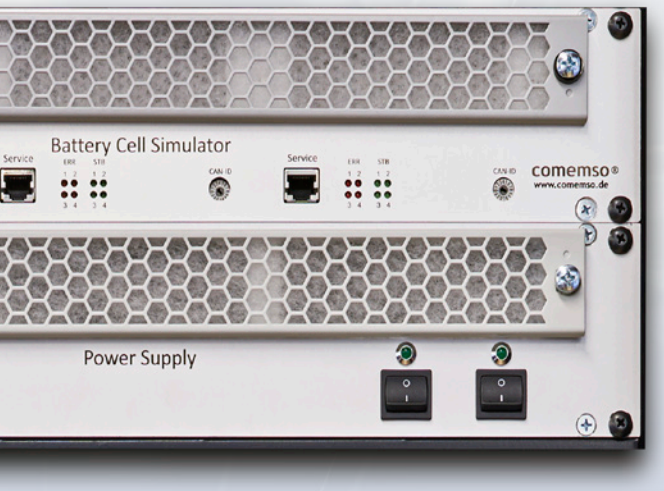
Engineering

OPAL-RT provides the engineering to extend the BMS HIL Test Bench functionalities; from extra protection, shunt emulation, break-out box, 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	Light + F	Basic	Basic+F	Basic+F+ µA	Basic+F+ Hiload	Full
Height	2 HU	2 HU	2 HU	2 HU	2 HU	2 HU	2 HU
Cells per modules	12	12	12	12	12	12	12
Max. number of cells	204	204	204	204	204	204	204
Source [1]	1.0A	1.0A	5.0A	5.0A	5.0A	6.0A	6.0A
Sink [1]	1.0A	1.0A	5.0A	5.0A	5.0A	6.0A	6.0A
Fault simulation		✓		✓	✓	✓	✓
Current measurement **µA**					✓		✓
Current measurement **+/- 5A**	✓	✓	✓	✓	✓	✓	✓
Fast current meas. (Coulomb)			✓	✓	✓	✓	✓
CAN-Baud rate 500 kBd	✓	✓	✓	✓	✓	✓	✓
CAN-Baud rate 1 MBd	✓	✓	✓	✓	✓	✓	✓

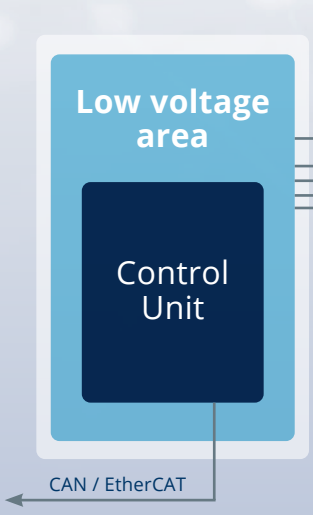
[1] Sink and source: values can be reached separately – not in combination. Example: If sink has 2.0 A setting, then the source is only max. 2.9 A (4.9 A – 2.0 A)

Technical Data

Communication :	CAN / EtherCAT 100Mbits/s
Temperature range :	Lab conditions
Connector :	115V/230V or CEE 3 x 16 A
Safety:	Integrated emergency shutdown management

Isolation cell/communication :	2kV
Isolation cell/cell :	60V
Number of cells :	12 to 200
Capacity:	Simulation of up to 144 cells per rack

Technical Data Overview



Cell supply source per cell

Voltage range:.....0.01 .. 8 V
Nominal current: .....0 .. 5 A[1]
DC Accuracy:.....+/-0.5 mV
Ripple:.....+/-3 mV (fg = 5 kHz)
Step response 1V - 4V:.....ca. 0.3 ms
Step response 4V - 1V:.....1 .. 10 ms (depending on load)
Short-circuit-proof:.....yes

Internal electronic load per cell

Nominal current:.....0 ... 5 A basic / 6 A with HiLoad variant [1]
Resolution:.....200 µA (over CAN bus controlled)
Constant current:.....yes

Electric failure simulation per cell

- Broken wire
- Short circuit
- Polarity reversal

Measurement system per cell [mA]

Range:..... +/- 6.5 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

High voltage area up to 1000 V

Emulation of up to 200 cells

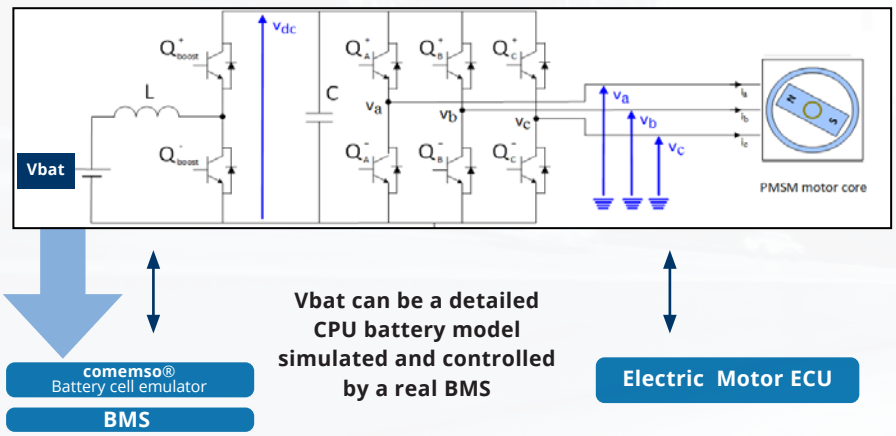
(1) At 5 V cell voltage.
source is only max. 3 A (5 A – 2.0 A)

Benefits of real-time simulation for BMS testing

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.

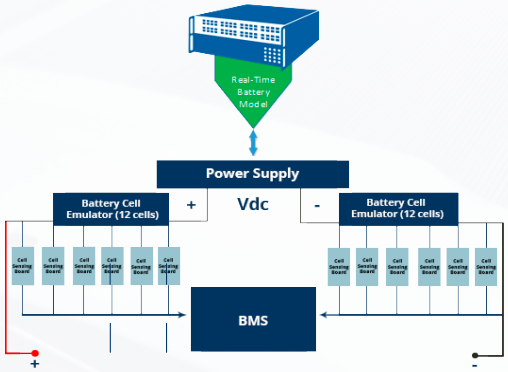
OPAL-RT brings you a scalable solution for your EV and energy storage test and research.



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 sub-set 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.



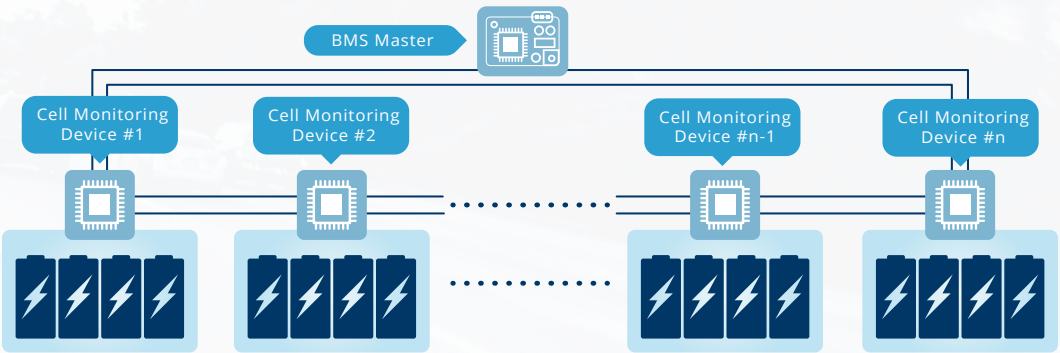
Cell Monitoring Device Emulation (CMDE)

OPAL-RT has developed its own emulation of BMS cell monitoring devices from major brands such as Analog Devices, Inc. (ADI). With OPAL-RT's CMDE add-on for NI VeriStand, quickly test and validate your BMS control by emulating the battery cells and BMS chipset register commands using isoSPI™, while maintaining the integrity of the SPI communication daisy-chain. As a plus, the CMDE add-on also allows for physical Comemso cells to be connected real BMS chipsets, while the remaining daisy-chain is emulated.

The CMDE tool reduces cost and extends testing coverage, allowing users to validate their BMS software and meet demanding deadlines.

CELL MONITORING DEVICE EMULATION

Emulate cell monitoring devices such as LTC6810 and LTC6813, while maintaining isoSPI™ communication link. Remove the need of redundant cell emulation.



BMS Testbench Customers

Sandia National Laboratories

Virgin hyperloop

Vestas

ARAI® Progress through Research

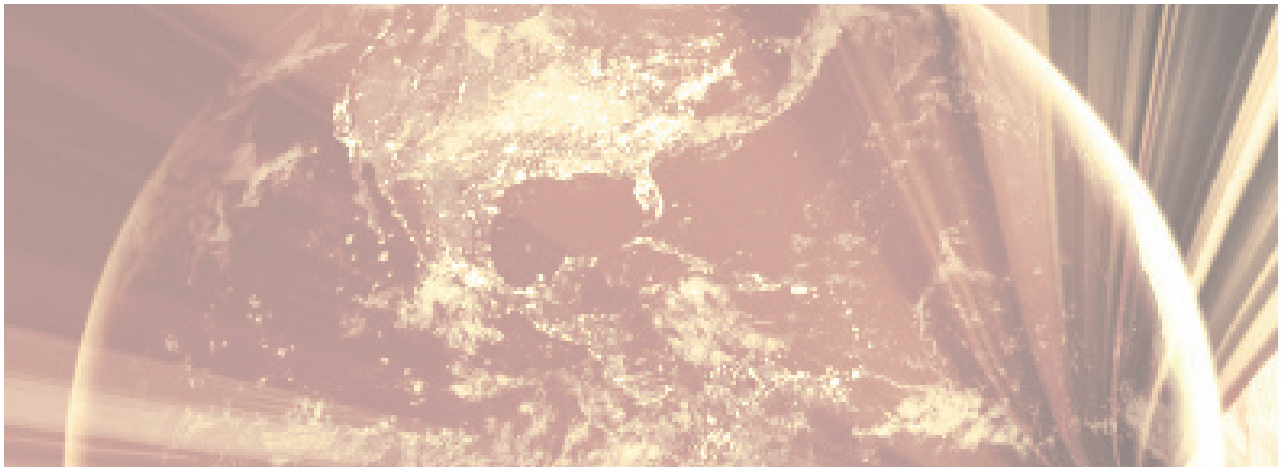
Harley-Davidson Motor Cycles

CAT

XOS

RIVIAN

TATA TATA MOTORS



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

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