OPAL-RT Training

OPAL-RT TECHNOLOGIES

www.opal-rt.com/training

" An investment in knowledge pays the best interest."

Benjamin Franklin

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OPAL-RT Training

Your keys to success in the challenging field of real-time simulation are education and experience.

OPAL-RT Training delivers highly focused, practical and theoretical training on the crucial tools and methodologies used in real-time simulation and Hardware-in-the-Loop (HIL) testing of critical systems.

Since 1997, the OPAL-RT Training has taught hundreds of engineering students and professionals how to quickly and efficiently set up real-time simulators and to properly select and use mathematical solvers for specific simulation applications. They learn about the processes behind simulating complex systems, and reinforce their studies with extensive hands-on workshops.

OPAL-RT Training instructors are selected amongst experienced professionals to deliver valuable content and motivate you to surpass your maximum potential.

A Word from Mathieu Mayer-Girouard,

OPAL-RT Training Program Manager

It is with great pleasure that I personally welcome you to OPAL-RT Training. Our Field Application Engineers have been specifically selected as the training instructors for their knowledge and presentation skills, to offer you the best learning experience. We assist our students through the steps required to achieve advanced knowledge in Rapid-Control Prototyping, Hardware-in-the-Loop and/or Power Hardware-in-the-Loop. If you are looking for experienced and passionate professionals who are always ready to help, you've come to the right place.

For any questions, do not hesitate to contact us at:
www.opal-rt.com/training

Training Formats

Head Office Training

OPAL-RT hosts training sessions at our head office and at our subsidiaries.
- Network with other users
- Connect with a larger group of OPAL-RT specialists

On-Site Training

Our engineers travel the world to deliver personalized training sessions at your office or university.
- Choose a standard course with the possibility to customize
- Train several employees at a time

Tutored E-Learning

Training sessions can be given online through our e-Learning Platform.
- Attend at your convenience from anywhere
- Includes remote Q&A time with an OPAL-RT instructor

Self-Paced E-Learning

Learn at your own pace with our e-Learning Platform.
- Optimize your training budget
- Attend at your convenience from anywhere

Fundamental Courses

Fundamental courses cover the essentials of real-time simulation, giving you a detailed overview of OPAL-RT's software platforms: RT-LAB, HYPERSIM and the FPGA-based Power Electronics Add-On (eHS) for NI VeriStand. For On-Site Trainings, the OPAL-RT Training instructor sets up the OPAL-RT equipment.

OP101

RT-LAB - Real-Time Simulation Systems Fundamentals

Duration: 2 Days

Prerequisite:
*   *Basic knowledge of Matlab®/Simulink®*

This course introduces OPAL-RT systems and applications using RT-LAB. This course is a prerequisite for ARTEMiS, eFPGASIM, and ePHASORSIM. RT-LAB is used in a variety of domains, including power systems, power electronics, automotive applications, aerospace, mechatronics and more.

It includes a half-day lab set-up, where the instructor will configure the real-time simulator with the user's lab environment.

GOALS:

■   Learn the fundamentals of real-time simulation
■   Get started with RT-LAB Software
■   Understand when and how to use distributed and parallel real-time simulation
■   Connect models to physical devices using I/O channels

OP102
HYPERSIM® - Introduction to Power Systems Real-Time Simulation

Duration: 4 Days

This course teaches the basics of the HYPERSIM® real-time simulation software platform and its operating principle.

It includes a half-day lab set-up, where the instructor will configure the real-time simulator with the user's lab environment.

GOALS:

- Understand the operating principles of HYPERSIM and the electromagnetic transients algorithm used
- Understand the HYPERSIM software suite (TestView and ScopeView) and its modules
- Build and run a number of power system simulation cases showing the capabilities of HYPERSIM
- Connect models to physical devices using I/O channels and communication protocols
- Use TestView to automate the process of running simulation cases
- Use ScopeView to generate reports and analyze results

OP103

NI VeriStand Add-On (eHS) - Introduction to Power Electronics Real-Time Simulation

Duration: 3 Days

This course covers the configuration of a real-time system using the OPAL-RT Power Electronics Add-On for NI VeriStand on the National Instruments hardware platform.

It includes a half-day lab set-up, where the instructor will configure the real-time simulator with the user's lab environment.

GOALS:

- Learn the fundamentals of real-time simulation
- Review the basics of NI VeriStand and the NI hardware platforms
- Understand FPGA-based simulation of power electronics using the eHS solver
- Configure the real-time system using the OPAL-RT Power Electronics Add-On for NI VeriStand
- Connect to physical systems using I/O channels

Application-Oriented Courses
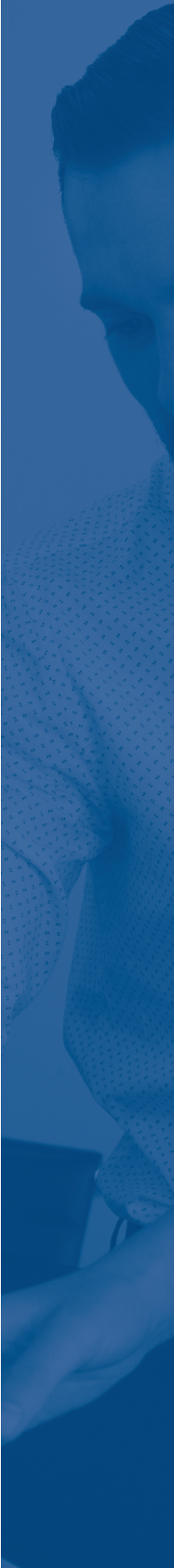
Application-Oriented courses have been designed to cover OPAL-RT's complete product portfolio based on our two main simulation platforms, RT-LAB and HYPERSIM.

OP203
ARTEMiS - Power Systems Real-Time Simulation

Duration: 1 Day

Prerequisite:
*   *OP101: RT-LAB - Real-Time Simulation Systems Fundamentals*

This course is intended for professionals who want to simulate power systems with ARTEMiS by converting their Simulink® SimPowerSystems™-based model into a complete HIL system.

GOALS:

■ Learn how to run power systems models in real-time for HIL applications
■ Take advantage of dedicated toolboxes for real-time simulation of power systems and power electronics
■ Understand Artemis-SSN, State-Space Nodal solver, as well as its applications
■ Learn how to improve the real-time simulation switching results with RT-EVENTS
■ Learn how to adapt your SimPowerSystems model for real-time simulation

OP204
ePHASORSIM - Electro-Mechanical Real-Time Simulation

Duration: 1 Day

Prerequisite:
* *OP101: RT-LAB - Real-Time Simulation Systems Fundamentals*

This course is intended for new ePHASORSIM users who want to learn phasor domain real-time simulation. ePHASORSIM simulates electro-mechanical transient stability phenomena of very large power grids with thousands of buses, generators, transformers, transmission lines, loads and controllers.

GOALS:

- Understand the concept of phasor domain simulation features, benefits and limitations
- Import PSS/E, DIgSILENT PowerFactory or other model-based design tools into ePHASORSIM
- Connect I/Os and communication buses with ePHASORSIM
- Learn about the interaction of ePHASORSIM and RT-LAB

OP205
eHS - Power Electronics Real-Time Simulation

Duration: 1 Day

Prerequisite:
* *OP101: RT-LAB - Real-Time Simulation Systems Fundamentals*

This course is intended for power electronics and control engineers who want to perform fast power electronics real-time simulation using the combined power of FPGA and OPAL-RT's unique dedicated solver eHS.

GOALS

- Discover the features, flexibility and limitations of FPGA for power electronics real-time simulation
- Understand the overall architecture of a real-time simulator between processors and FPGA
- Learn about power electronics real-time FPGA applications using an eHS solver

OP206

MMC - Modular Multilevel Converter Real-Time Simulation Applications

Duration: 2 Days

Prerequisite:
• OP101: RT-LAB - Real-Time Simulation Systems Fundamentals
OR
• OP102: HYPERSIM® - Introduction to Power Systems Real-Time Simulation

This course is designed for power electronics and control engineers who want to use the capabilities of FPGA programming and OPAL-RT's dedicated Modular Multilevel Converter (MMC) library to perform fast, real-time simulation and controller logic design.

GOALS:

- Discover the features and capabilities of MMC real-time simulation on FPGA
- Learn how to modify MMC simulation parameters and apply faults
- Understand the overall architecture of real-time simulation between processors and FPGA
- Obtain hands-on experience with MMC CPU and MMC FPGA features for real-time applications

OP207
RT-XSG - Introduction to I/O Management on FPGA

Duration: 2 Days

Prerequisites:
* *OP101: RT-LAB - Real-Time Simulation Systems Fundamentals*
* *Basic knowledge of FPGA technologies*

RT-XSG (XILINX System Generator) is a Simulink® toolbox that enables engineers to generate custom, application-specific firmwares that can be implemented onto an FPGA device for multiple applications. This course covers the basic concepts needed to adapt an I/O to an FPGA model with eHS.

GOALS:

- ■ Discover the features, flexibility and limitations of FPGA RT-XSG
- ■ Understand the overall architecture of a real-time simulator between processors and FPGA
- ■ Learn the floating point concept
- ■ Learn how to generate and load your firmware on the FPGA for a new application

OP208
Communication Protocols in Real-Time Simulation

Duration: 0.5 Days per protocol

OPAL-RT provides a wide range of communication protocols covering multiple fields that are needed in various real-time simulation applications. This course describes how to implement specific communication protocols, such as: EtherCAT, OPC-UA, CAN Bus, FlexRay, LIN, DNP3, IEC60870-5-104, IEC61850 (GOOSE, Sampled Values and MMS), Modbus, C37.118, ARINC 429, RS-232, RS-485, and more.

GOALS:

- Discover the features, flexibility and limitations of the protocol of your choice
- Understand the architecture, modeling and operation of communication protocols through real-time simulation
- Perform hands-on exercises with communication protocols in a real-time application

OP210
Introduction to 4-Quadrant PHIL Testbench

Duration: 3 Days

Prerequisite:
* *OP101: RT-LAB - Real-Time Simulation Systems Fundamentals*

This course covers the installation and SAT of an OP1400 series 4-Quadrant PHIL Testbench.

It includes a half-day lab set-up (Installation), where the instructor will help the end-user configure the real-time simulator, the amplifier(s), the cabling and other parts of the Testbench with a consideration for the lab environment and security.

GOALS:

- Installation of the Testbench (simulator, amplifiers, cabling, etc.)
- Introduction to PHIL concepts
- Execution of SAT models in open-loop to test all DERs (multiple configurations depending on the power rating of the Testbench).

OP211
Introduction to 4-Quadrant PHIL Microgrid Testbench

Duration: 4 Days

Prerequisites:
- *OP101: RT-LAB - Real-Time Simulation Systems Fundamentals*
- *OP203: ARTEMiS - Power Systems Real-Time Simulation*

This course covers the installation and SAT of an OP1420 series 4-Quadrant PHIL Microgrid Testbench.

It includes a half-day lab set-up (Installation), where the instructor will help the end-user configure the real-time simulator, the amplifier(s), the cabling and other parts of the Testbench with a consideration for the lab environment and security.

GOALS:

- Installation of the Testbench (simulator, amplifiers, cabling, etc.)
- Introduction to PHIL concepts
- Execution of SAT models in open-loop to test all DERs (multiple configurations depending on the power rating of the Testbench).
- Demonstration of a MicroGrid Model

Advanced Courses

Advanced courses are intended for users who have already acquired a basic knowledge of our Fundamental and Application-Oriented courses.

OP301

Increasing Productivity with RT-LAB: Test Automation, Report, User Interface and API

Duration: 1 Day

Prerequisite:
* *OP101: RT-LAB - Real-Time Simulation Systems Fundamentals*

Performing 24/24 HIL test coverage, combining RT-LAB experimentation with another test platform or developing custom user interfaces are a few of the many applications that can improve testing efficiency. This class covers peripheral software applications which, combined with RT-LAB, will accelerate your experiments.

GOALS:

* Learn advanced Python scripting language for test automation
* Learn how to build complete user interfaces using LabView and how to perform accurate reports using ScopeView
* Discover the complete Application Programming Interface (API) architecture
* Perform hands-on exercises to develop your own customized testing interface

OP302
Functional Mock-up Unit (FMU) Integration in ePHASORSIM

Duration: 2 Days

Prerequisite:
• *OP204: ePHASORSIM - Electro-Mechanical Real-Time Simulation*

The FMU method extends the scope of study with ePHASORSIM to allow users to integrate specific blocksets from an external power analysis software (PSSE, DIgSILENT PowerFactory or others) into an ePHASORSIM environment.

GOALS:

■ Learn the basics needed to create an FMU in ePHASORSIM using OpenModelica
■ Understand the features, benefits and limitations of FMUs
■ Perform hands-on exercises to create your very own FMU in ePHASORSIM

OP303
Real-Time Simulation of an Electrical Motor on FPGA

Duration: 1 Day*

Prerequisite:
*   *OP205: eHS - Power Electronics Real-Time Simulation*

For HIL-testing of Electronic Control Units (ECUs), the real-time simulation of an electrical motor should be as close to reality as possible. Reaching a reliable implementation of HIL for Electric Vehicles (EV) requires a specific methodology and specific know-how. The objective of this course is to provide the notions required to succeed in your electrical motor HIL implementation.

GOALS:

- Learn FPGA electrical motor characteristics
- Successfully configure and calibrate I/Os
- Perform step-by-step implementation involving closed-loop control testing

* Two extra days are needed if implementation with a real ECU is required.

OP511

Model-Based Protection and Control System Testing with Real-Time Simulation - Part 1

Duration: 1 Day

Prerequisite:
* *OP102: HYPERSIM® - Introduction to Power Systems Real-Time Simulation*

In this first part of model-based protection and control system testing with real-time simulation training, the attendee will learn about Hardware-in-the-Loop (HIL) protection and control system testing with IEC 61850 and DNP3 with the use of practical examples. A second part (optional) is offered to learn protection and control system testing with C37.118 and test automation.

GOALS:

- Learn the fundamentals of model-based protection and control system testing with real-time simulators.
- Understand the basics of IEC 61850 (GOOSE, SV, MMS)
- Integrate EC 61850 Substation Automation Scheme with a hardware relay with the use of Sampled Values.
- Configure GOOSE on a hardware relay to enable overcurrent protection scheme.
- Use Integrity Data Manipulation feature for SV stream manipulation.
- Understand the basics of DNP3.
- Integrate DNP3 master (HMI) and slave (outstation or IED) in a software-in-the-loop scheme
- Configure DNP3 in a HIL scheme with SEL 451.

OP512
Model-Based Protection and Control System Testing with Real-Time Simulation - Part 2

Duration: 1 Day

Prerequisites:
- *OP102: HYPERSIM® - Introduction to Power Systems Real-Time Simulation*
- *OP511: Model-Based Protection and Control System Testing with Real-Time Simulation - Part 1*

While part one of this training covered protection and control system testing with IEC 61850 and DNP3, this second part focuses on protection and control system testing with C37.118 and test automation. The training is based on practical examples to explain and demonstrate the course content.

GOALS:

- Understand the PMU model in HYPERSIM.
- Detect Out-of-Step using the PMU model in HYPERSIM.
- Implement a HIL setup with real PMU hardware.
- Automate protection relay testing with different fault scenarios.
- Use TestView in HYPERSIM to automate distance relay testing and generate test reports.
- Use a Python script to automate overcurrent relay testing.

OPAL-RT
Certifications

OPAL-RT offers certifications for our software platforms and toolboxes. Our certifications aim to confirm that an individual meets all the objectives of the training by mastering the basic knowledge and skills needed to use our products. Each certification involves passing a test on our e-Learning platform. Demonstrate your knowledge and take your skills to the next level!

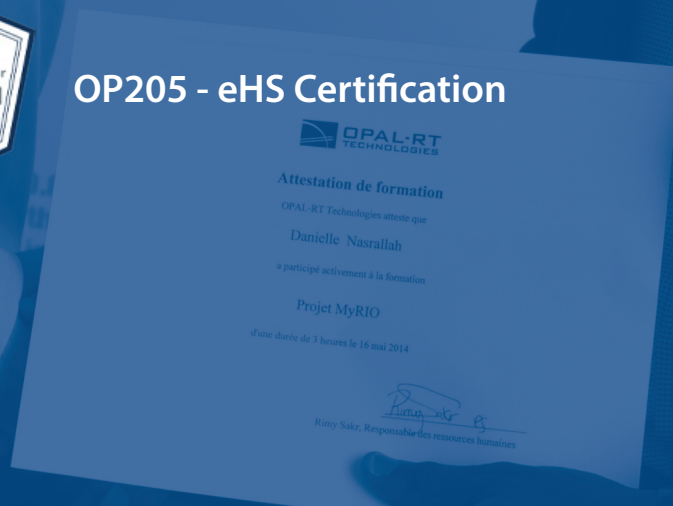**OP101 - RT-LAB Certification**

OP102 - HYPERSIM Certification

OP203 - ARTEMiS Certification

OP204 - ePHASORSIM Certification

OP205 - eHS Certification

Additional Resources

Custom Training

At OPAL-RT, we believe the only limitation of real-time simulation is your imagination. We understand that needs vary and we are open to discussing any specific training that is not currently part of the existing course selections.

Please contact your Sales Representative if you require custom training.

OPAL-RT Knowledge Base

Our knowledge base is used to store simple to complex tips and tricks discovered by experienced users and Application Specialists from OPAL-RT.

Discover our knowledge base at: https://www.opal-rt.com/support-knowledge-base/

Live Events and Webinars

Complimentary technical sessions are presented live at local OPAL-RT events as well as virtually via webinars to help you obtain additional knowledge and to provide you with updates on the latest OPAL-RT product and technology developments.

Stay tuned for upcoming events and webinars at: www.opal-rt.com/events

Technical Support Resources

Technical support resources such as online product manuals and written tutorials are available on our website.

Access our resources directly at: www.opal-rt.com/support-home/

Obtain Support from an Engineer

Are you unable to gain the skill level required in the time allotted for your project? Our Field Application Engineers can provide you with the resources you need to successfully complete your project on time.

Please contact your Sales Representative for more information.

To request a training, visit www.opal-rt.com/training

Our Worldwide Classroom Locations

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TECHNOLOGIES

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About OPAL-RT TECHNOLOGIES

OPAL-RT is the world leader in the development of PC/FPGA Based Real-Time Digital Simulator, Hardware-In-the-Loop (HIL) testing equipment and Rapid Control Prototyping (RCP) systems to design, test and optimize control and protection systems used in power grids, power electronics, motor drives, automotive industry, trains, aircraft and other various industries, as well as R&D centers and universities.

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