eFPGASIM

REAL-TIME SIMULATION
FOR POWER ELECTRONICS ON FPGA

OPAL-RT TECHNOLOGIES

WWW.OPAL-RT.COM

Choose eFPGASIM for your next power electronics project

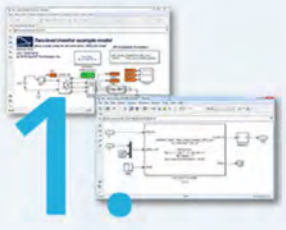
- Microgrids
- Photo Voltaic Inverters
- Distributed Energy Resources
- Wind Turbine Converter
- Electric motors and drives
- Hybrid & Electric Vehicles
- Electric Aircraft
- Electric Ships
- Energy Conversion Controls
- Modular Multi-Level Converters (MMC)

Hardware-in-the-Loop (HIL) Testing with eFPGASIM

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

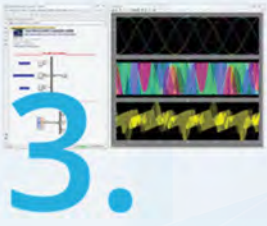
After two decades of real-time simulation research and development, and hands-on power electronics experience, OPAL-RT has delivered eFPGASIM, the industry's most powerful and intuitive FPGA-based real-time solution. eFPGASIM is optimal for development, testing and validation of control systems or feasibility studies requiring sub-microsecond time step capacity.

From Modelling to FPGA Execution in 3 Steps



Develop your power electronic diagram with your favorite circuit editor (SPS, Plecs, PSIM, Multisim...)

Then, configure your I/O channels and compile your model for sub-microsecond time steps.



Finally, execute the real-time simulation and perform manual and automated tests.

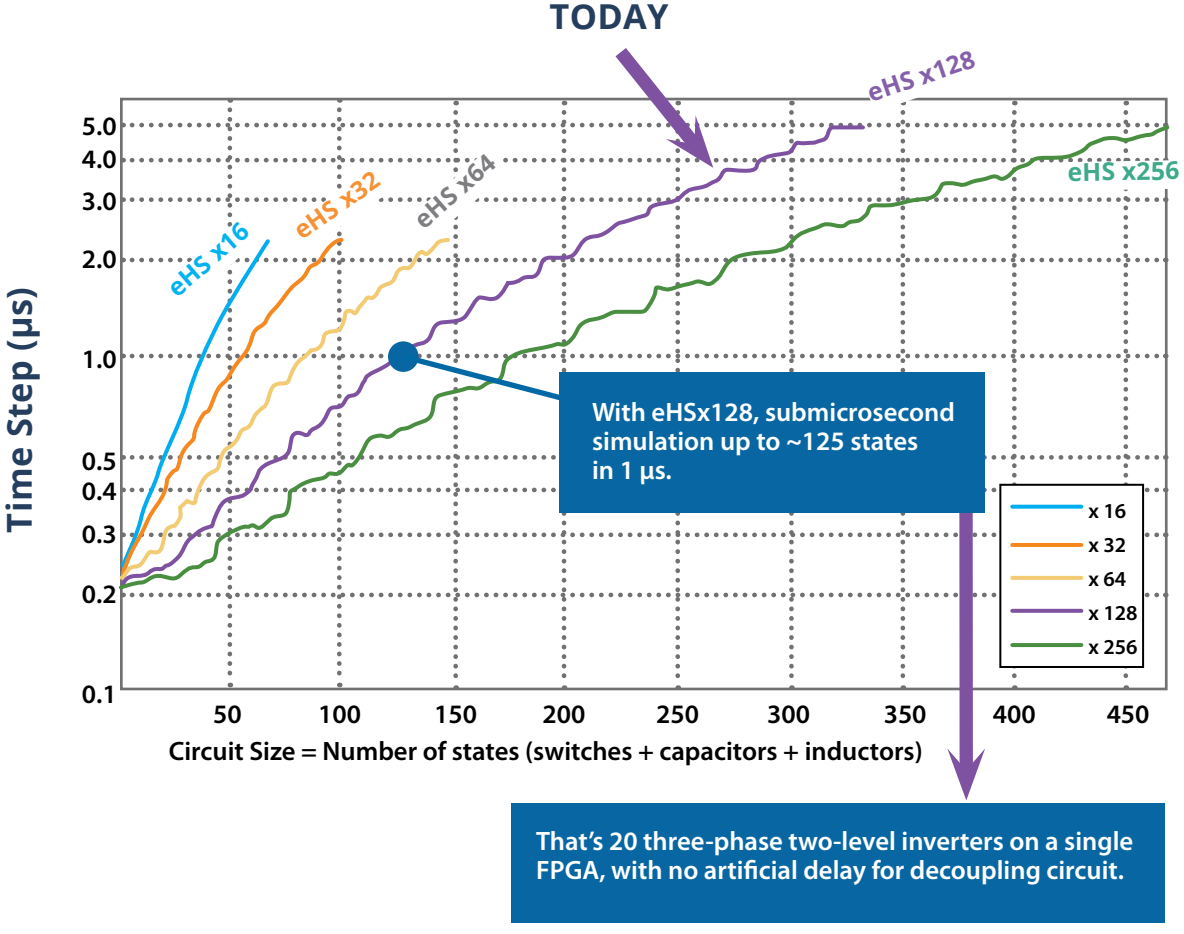
eHS makes it easy to run test sequences and make on-the-fly changes to simulation parameters by using the eHS Test scenario feature. It lets the test engineer to jump from one set of values to the next without stopping the simulation.

Powered by Performance

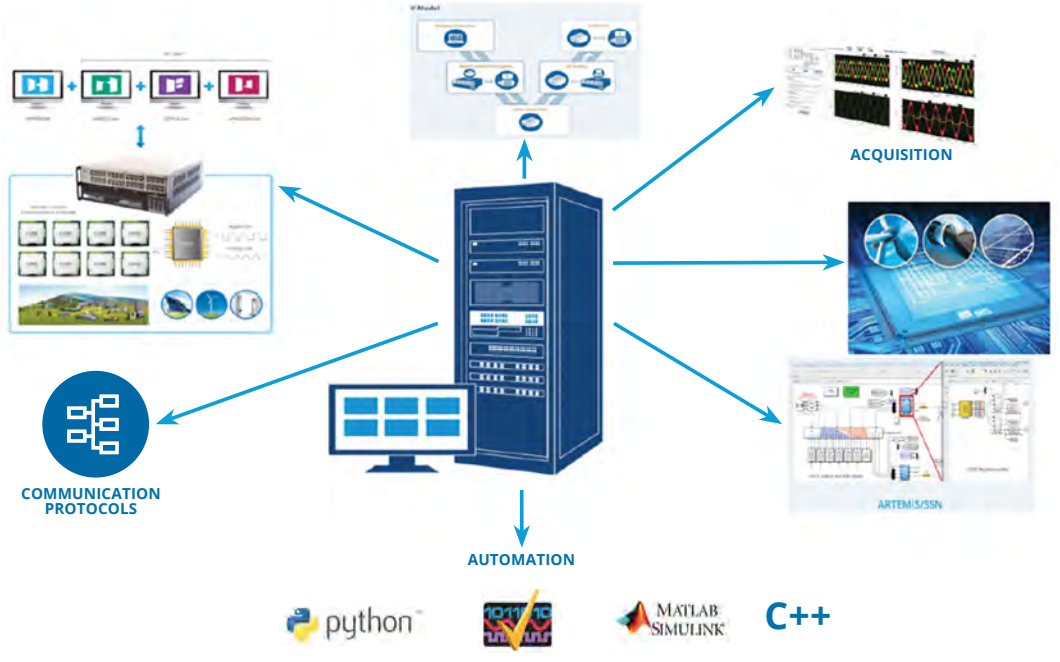
Witness what makes eFPGASIM the industry's most powerful and intuitive FPGA-based real-time solution

With its latest version of eFPGASIM, OPAL-RT has made it possible to simulate highly complex electrical circuits in real-time with unsurpassed precision and performance. Its new solver has been optimized to simulate much larger circuits, with 50% more states, switches and measurements.

This breakthrough means that it is now possible to solve much more complex circuits without needing to break down equations by adding artificial delays, which can have a major impact on accuracy. It can also run simulations with a significantly smaller sampling rate, which makes it easier to develop and test equipment that requires shorter loop times and has faster inputs and outputs, like the ones used to capture PWM and send analog signals.



Full Ecosystem Testing



eFPGASIM offers the most extensive solution for power electronic HIL testing. Not only does it offer the most advanced hardware and software solvers, it also allows power electronic engineers to test their controller at its optimal performance and in its normal environment. The eFPGASIM system are compatible with a range of the OPAL-RT products, such as:

- eMEGASIM, allows users to connect their power electronics device from a microgrid to a large power grid.
- ePHASORSIM, works with integration of renewables and the progressively overloaded transmission network, cybersecurity concerns, and the complexity of operation, monitoring, and control and protection on power grids.
- Communication protocols such as Modbus, IEC 61850, DNP3, CAN, ARINC 429, MIL-STD-1553 and many others, for a complete compatibility with automotive or aerospace controllers.
- A complete suite of API, allowing customers to use eFPGASIM with other applications, such as Python, TestStand, LabVIEW, C++, Java and any other programming language that can manage ".dll" calls.

The eFPGASIM suite

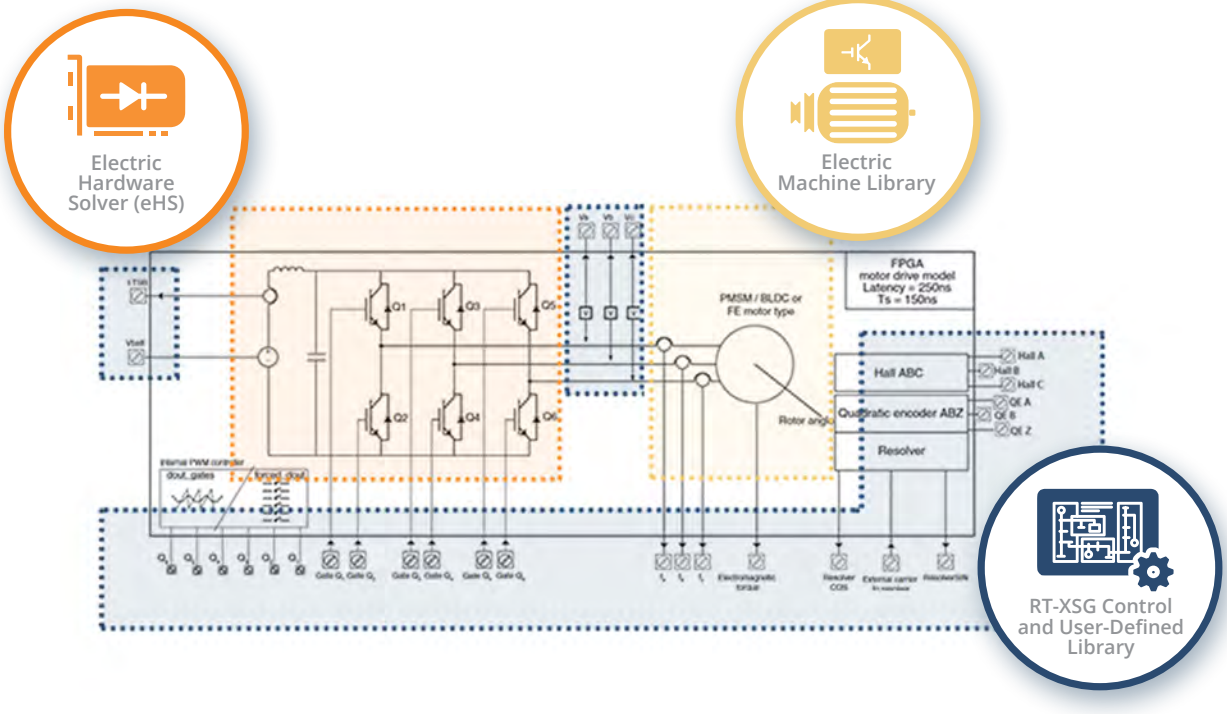
The eFPGASIM suite is used for testing and validation of power electronics systems and covers a wide range of applications, from renewable energy conversion to highly complex multi-modular converters. The eFPGASIM library also contains optimized power electronics models for widely used 2 level inverters, DC/DC converters and H-bridge drives with embedded fault capability.

eFPGAsim is comprised of three key software technologies:

eHS: At the heart of eFPGASIM suites, eHS enables users to create power electronics real-time models, using a range of simulation tools.

FPGA electric motor library: Offers a broad spectrum of electric machines. These machines are programmable to fit with the most common industry configurations.

RT-XSG: Used to edit custom FPGA configurations, and to transfer high-bandwidth data between the simulation models and the user-defined code running on eFPGASIM.



Compatible Hardware

Simulator Platform Comparison Chart

	OP4200	OP4510	OP5707
CPU	ARM7	INTEL XEON E3	INTEL XEON E5
Number of cores	2	4	4, 8, 16, or 32
XILINX FPGA (Standard configuration)	Zync7030 (125T)	Kintex 7 (325T)	Virtex 7 (485T)
SFP optical interferance (GTX 5 Gbits/s)	2	4	16
I/O modules with 16 analog or 32 digital signals	4	4	8
Maximum number of I/O channels	128	128	256

NATIONAL INSTRUMENTS

Perfect Partnership for Power Electronics and Power System HIL

OPAL-RT has partnered with NI, a global leader in test, measurement, and control solutions, to expand its real-time simulation offering to its customers with even more accessible, cutting-edge, real-time simulation technology.

The eFPGASIM software and eHS solver are compatible with NI hardware.

NI CRIO

CompactRIO is a real-time embedded industrial controller from National Instruments for industrial control systems.

PXI

PXI is a rugged PC-based platform for measurement and automation systems. PXI combines PCI electrical-bus features with the modular, Eurocard packaging of CompactPCI and then adds specialized synchronization buses and key software features.

HARDWARE LIST

NI-PXI-797x / K7 325T - FlexRIO, NI-PXIe-78x8R / K7 325T - R Series,
NI-cRIO 903x / K7 325T - CompactRIO, NI-PXIe-7822R / K7 325T - R Series.

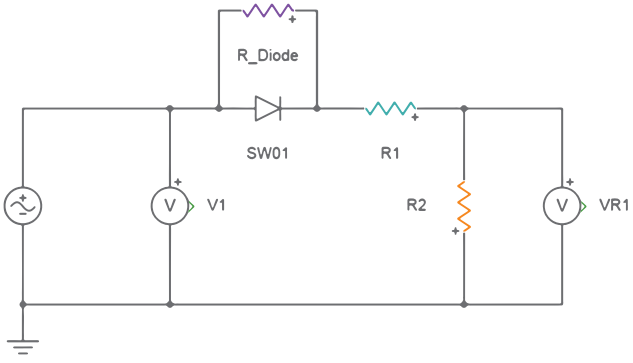
eFPGASIM Power Electronics Toolbox

eHS ELECTRICAL SOLVER

A generic and reprogrammable FPGA-based electromagnetic transient (EMT) solver at the heart of the eFPGASIM suite, eHS provides a convenient software environment that enables users to bring models into real-time in a matter of seconds.

- Facilitates the design cycle of complex circuit simulation by allowing a gradual simulation integration from offline simulation into FPGA simulation.
- Increases the simulation accuracy of complex and fast electric circuits and drives by achieving very small model time step updates.
- Compatible with many platforms: Simscape Power System, PLECS Blockset and PSIM and with National Instruments' Multisim.
- Simulates the most advanced and complex power electronic schematics
- Make changes to power electronic parameters, such as the topology of the schematic, without recompilation and while the simulation is running
- Requires no VHDL or FPGA programming skills.

CHOOSE SCENARIO COMPONENTS

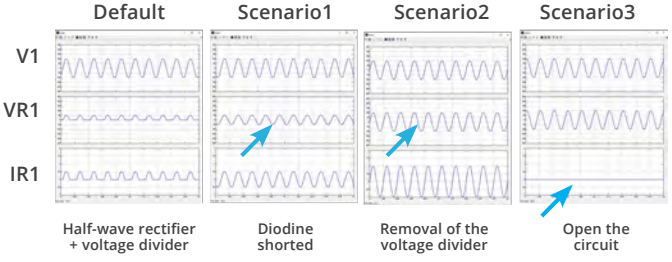


DEFINE SCENARIOS

	A	B	C	D	E	F
1		R1	R2	R_Diode	snubber: SW01	SW01_Ron
2	Default	100	100	1000000	10000	0,001
3	Scenario1	100	100	0,001	10000	0,001
4	Scenario2	0,001	100	0,001	10000	0,001
5	Scenario3	0,001	1000000	0,001	10000	0,001

Create customized test scenarios to generate faults or simulate other events and manoeuvers. Perform on-the-fly parameter changes in your simulated circuit without reloading or recompiling your model.

SEE EFFECTS OF DIFFERENT SCENARIOS



SimScape Power System

plecs PSIM

RT-XSG LIBRARY

An important part of the eFPGASIM suite is RT-XSG, a Simulink™ library, based on the Xilinx System Generator library. It provides a state-of-the-art solution for advanced FPGA-accelerated real-time and HIL system simulation of user-developed models and control systems. It enables engineers to generate custom, application-specific code and algorithms that can be implemented on an FPGA device.

- Offers greater flexibility by allowing users to implement their own calculations on FPGA.
- Allows the use of dedicated FPGA processors for sub-microsecond computation loops.
- Accessible to non-VHDL experts in fixed and floating points.
- Saves time when conducting FPGA-based co-simulation by automatically managing configuration file generation on each supported platform.
- Signal generator, PMSM

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ELECTRICAL MACHINE LIBRARY

The Electric Machine Library fits in the eFPGASIM suite as the ideal platform for designing and testing controllers. It includes detailed mathematical machines of different types of electric machines, such as permanent magnet, asynchronous machine, induction, and switched reluctance machines.

- Supports fault simulation and advanced finite element models
- Provides speed and position sensors, such as encoders, resolvers and hall effect.
- Provides communication protocols adapted to Andat and BiSS machines.

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eFPGASIM


ABB
Advanced Energy
aselsan
ASTRI
BOĞAZİÇİ ELEKTRİK DAĞITIM
BOMBARDIER AEROSPACE
BYD
CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD
CAT
CATERPILLAR
CENER
CEPRI
NREL
Curtin University
DELTA ELECTRONICS
DRS Technologies
EATON
EGSTON
ELDOR
Entergy
EON
EPRI
ELECTRIC POWER RESEARCH INSTITUTE
First Solar
Ford
Fraunhofer
GE
GEORGIA SOUTHERN UNIVERSITY
GPTech
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BHEL

The industry leaders who chose to trust us

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, 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 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.

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