



OP7020 VIRTEX 7™ Unit

RCP/HIL Virtex 7™ FPGA Processor Expansion Unit

Scalable, powerful and cost-effective, the OP7020 is a compact VIRTEX 7™ FPGA processor and fiber optic I/O expansion unit. It can be connected to OPAL-RT real-time multi-core simulators to simulate complex power electronics circuits and to develop control systems. As an example, the OP7020 can emulate HVDC modular multi-level converters (MMC) with thousands of cells and can be interconnected to controllers under test through 16 high-speed fiber optic links using Small Form-factor Pluggable (SFP) transceivers. The OP7020 can also be used as an FPGA-based rapid control prototyping (RCP) system to develop complex MMC controller algorithms before implementing the controller logic in the final hardware.

Product Highlights

- High-end XILINX VIRTEX 7™ FPGA chips
- Capable of simulating up to 1500 MMC sub-modules with a detailed model, fault simulation capability across cells and valve controller with a time step of 500 nanoseconds.
- Several OP7020 can be interconnected to simulate large multi-terminal HVDC MMC grids.
- Open modeling software, such as XILINX System Generator and RT-LAB RT-XSG integrated with MATLAB and SIMULINK allow users to implement their valve controller and power electronic circuit with OPAL-RT eHS FPGA solver
- Supports 16 SFP and SFP+ transceivers multi-mode fiber modules for high-speed communication, with signaling rates up to 5Gbps with Aurora, Gigabit Ethernet or custom protocols
- 20-Gbits/s PCI Express x4 links to interface with any OPAL-RT real-time multi-core simulator for the simulation of large AC-DC grids.

Typical Applications

MMC Hardware-in-the-Loop (HIL) Simulator – The OP7020 can emulate MMC systems and HVDC grids and be interconnected to user controllers through fiber optics with the same protocol used in a real project. The controller under test will then behave the same way as if it was connected to a real MMC device.

MMC Rapid Control Prototyping (RCP) System – Users can also implement their prototype valve control and gate signal generation in the OP7020 and connect to an MMC analog bench or its emulator to test the prototype controller functionalities.

HVDC Grids Using Several Modular Multilevel Converters – Several OP7020 can be interconnected to simulate several HVDC MMCs in real time and interfaced with complex AC-DC grid models. It enables research institutes or manufacturers to perform specific studies on the HVDC grid consisting of several MMC converters equipped with several thousands of cells.

Small Form-Factor Pluggable Transceiver and PCI Express interfaces

An SFP is a compact, hot-pluggable transceiver used for data communication applications.

- The OP7020 accommodate up to 16 high-speed fiber optic modules used to communicate IGBT firing orders and cell capacitor voltages to the MMC controller under test.
- Communication layer provided to exchange thousands of gating signals and measurements.
- Protocols are based on customer requirements and built on top of standard Aurora or Gigabit Ethernet communication layers.
- OP7020 are interfaced with high-performance OPAL-RT real-time simulator like OP5600 using PCI Express x4 (20 Gbits/s) for the simulation of complex AC-DC grids.

MMC Leadership

OPAL-RT pioneered the use of standard commercial computer and operating systems for real-time simulation, demonstrating its leadership for advanced power electronic simulator.

- MMC HIL simulators and RCP are constantly enhanced to enable greater processing performance and I/O bandwidth to achieve the best accuracy.
- Systems with up to ten OP7020 have been delivered to simulate HVDC grids with five converters having 3000 cells each.
- OPAL-RT has also developed specific communication protocols to exchange data between the MMC model running in the FPGA of the OP7020 and customer controllers using fast SFP optical fiber interfaces.



From Imagination... to Real-Time

General Specifications

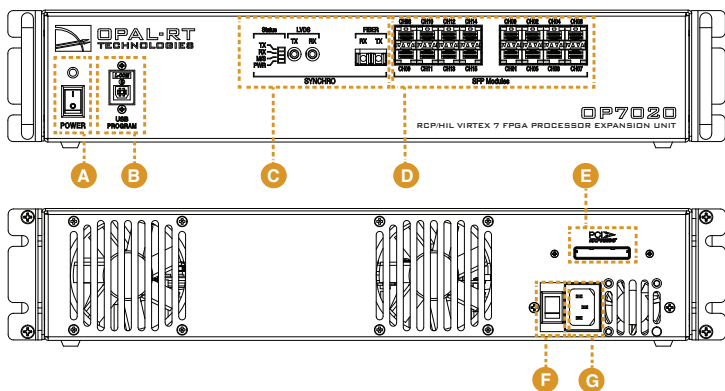
Product name	OP7020 RCP/HIL Virtex 7 FPGA Processor Expansion Unit
FPGA	VIRTEX 7™ FPGA (1 FPGA VIRTEX 7 simulates up to 1500 cells at 500 nanoseconds) Slices: 75900, Each 7 series FPGA slice contains four LUTs and eight flip-flops RAM: 37080 kb (37080 x 1024 bits) DSP: 2800, Each DSP slice contains a pre-adder, a 25 x 18 multiplier, an adder, and an accumulator
Pre-made MMC model	255 cell/arm * 6 arms, or 511 cell/arm * 3 arms
Communication systems with RT-LAB simulators	PCI Express x4 (20 Gbits/s)
Number of SFP	Up to 16
SFP	Up to 16 sockets with speeds from 1 to 5 Gbps
Fault simulation capability	Enabled
Protocols standard	Aurora (1 to 5 Gbits) and Gigabit Ethernet (1 Gbit); custom protocol can be implemented
Dimensions (HxWxD)	87.5mm (3.45in) x 432mm (17in) x 362mm (14.25in)

Optional FPGA Models and Software

Pre-made MMC model	Time step of 500 nanos, fault simulation, capability, standard configuration: 255 cell/arm * 6 arms, or 511 cell/arm * 3 arms ; other configurations are available
eHS FPGA nodal solver	To simulate any power electronic circuits using the circuit diagram editor of SimPowerSystem, PLECS ¹ and PSIM ¹
RT-XSG	255 cell/arm * 6 arms, or 511 cell/arm * 3 arms

¹ Available 2014-Q1

I/O and connectors



- A** Power Switch
- B** JTAG connection to program the FPGA board
- C** SYNCHRO: LVDS (copper) and fiber optic connectors and LEDs for synchronization
- D** SFP sockets for 16 SFP modules
- E** PCIe connector to interface with a real-time simulator
- F** AC power supply on/off switch
- G** Power cable connector

“ We give you the freedom to simulate complex systems with ever increasing precision and execution speed by offering open and off-the-shelf technologies in combination with our real-time simulation know-how ”

Jean Bélanger, CEO & CTO

NOTE: TECHNICAL DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE.

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, aircrafts and various industries, as well as R&D centers and universities.

1751 Richardson, Suite 2525, Montreal, Quebec, Canada H3K 1G6 | Tel.: +1 514-935-2323 | www.opal-rt.com