Typhoon HIL604.

The most powerful HIL ever. With 8 processing cores, 64 analog outputs, 64 digital inputs and 8 lane gigabit/s serial link it is tailored for the most demanding Microgrid and power electronics controller test, verification, and pre-certification tasks.

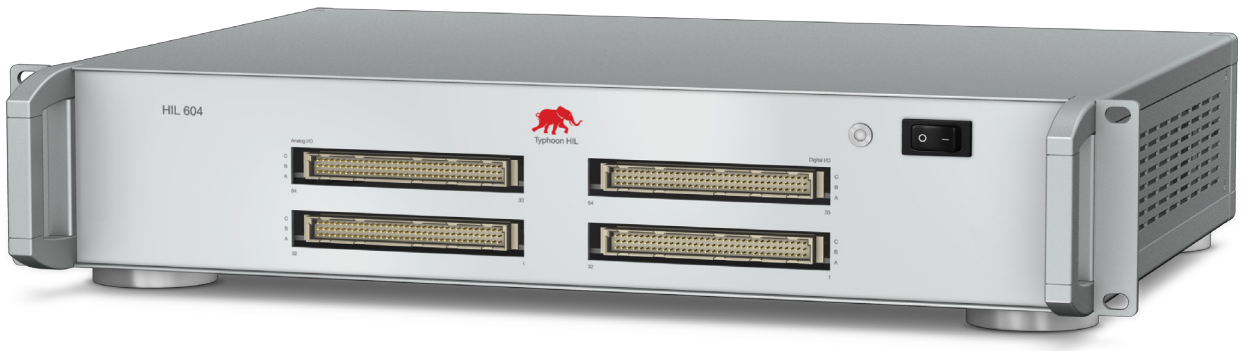
www.typhoon-hil.com

The only HIL made for Microgrid and Power Electronics Experts

Typhoon HIL

Typhoon HIL604.

Deploy the most powerful ultra-high fidelity Hardware in the Loop system for the most comprehensive microgrid and power electronics controls test, verification, and pre-certification.



Applications

Typhoon HIL604 real-time power electronics emulator is an ideal tool for development, testing, optimization, and quality assurance of grid connected converters (i.e. PV, wind, active filter), automotive converters, electric propulsion drives, micro-grids, and industry automation.

Easy to use software tool-chain

User friendly and intuitive software is easy to use and master, even for first time users. Build your models and perform sophisticated test scenarios, in the comfort of your office, in four simple steps:

1. Define converter model in the schematic editor and compile circuit with one click.
2. Run the model from the simulation control center and change sources, toggle contactors, load machines etc.
3. Capture signals, zoom in, and explore the waveforms around critical events.
4. Automate steps 1 to 3 via Python test scripts and let the HIL604 comprehensively test your controller around the clock.

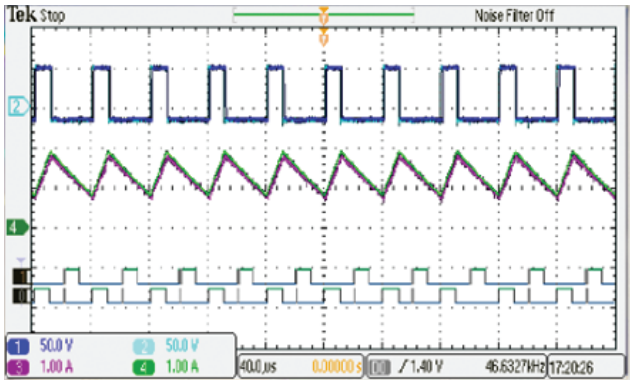
Features and Benefits

- Unleash the newest 8-core processor HIL for real-time emulation of up to 8 converters.
- Test your controller with 20 ns PWM resolution ultra-high fidelity HIL.
- Emulate your power stage with up to 2 MHz update rate.
- Quickly find problems and debug your controller with new Scope/*Capture Function*.
- Dive into your signals with 1 Megapoint capture record length for all 64 channels.
- Interface your controller via 64 analog outputs, 32 analog inputs, 64 digital inputs, and 64 digital outputs.
- Build converter models using our extensive library of power electronics components and prepackaged examples.
- Automate testing with Python scripts for the most comprehensive control software testing.
- Connect to host PC via USB2.0 .

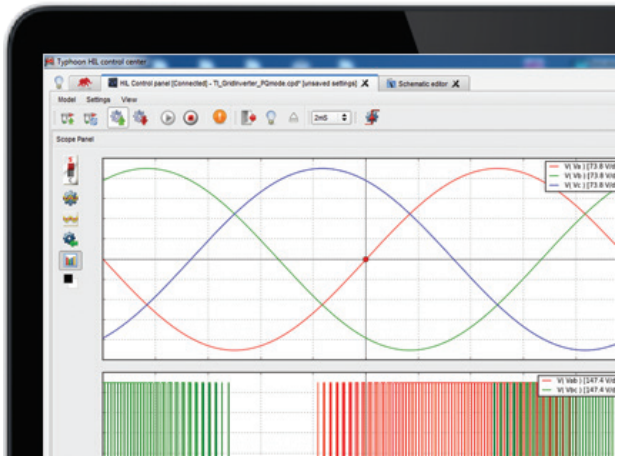
HIL604 highlights.

Test your controller with high fidelity, 20 ns sampling HIL.

20 ns PWM resolution combined with 1µs latency enables the most realistic power electronics controller test and development. For converter switching frequencies up to 200 kHz emulation error and latency are so small that it is difficult to tell the difference between real converter and HIL emulator measured waveforms.



Ultra-high fidelity: magenta: real boost MPPT converter current; green: HIL boost current; dark blue: real boost inductor voltage; light blue: HIL inductor voltage.



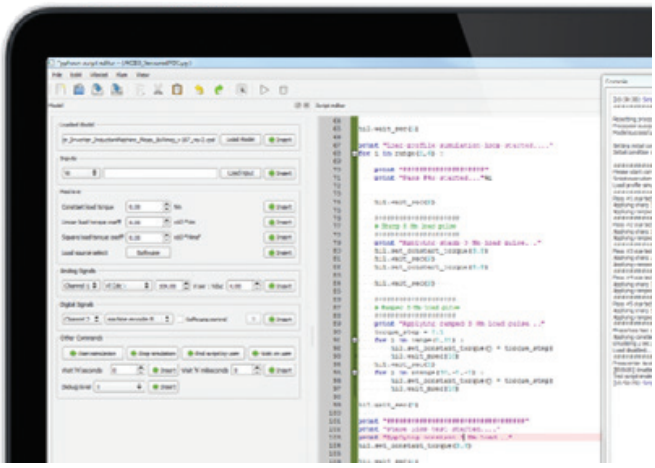
Capture HIL signals to quickly detect, debug, and characterize your controller performance.

Zoom in voltages and currents with Scope/*Capture Function's* microsecond "microscope."

Quickly debug control code with deep memory scope/capture function. Trigger on fault injection events and quantify the converter system response. With 1 Megapoint capture record length, on all 64 analog channels, and 1 MHz sample rate even tiny glitches in modulator algorithm are quickly identified.

Automate testing with Python: the ultimate ease of use.

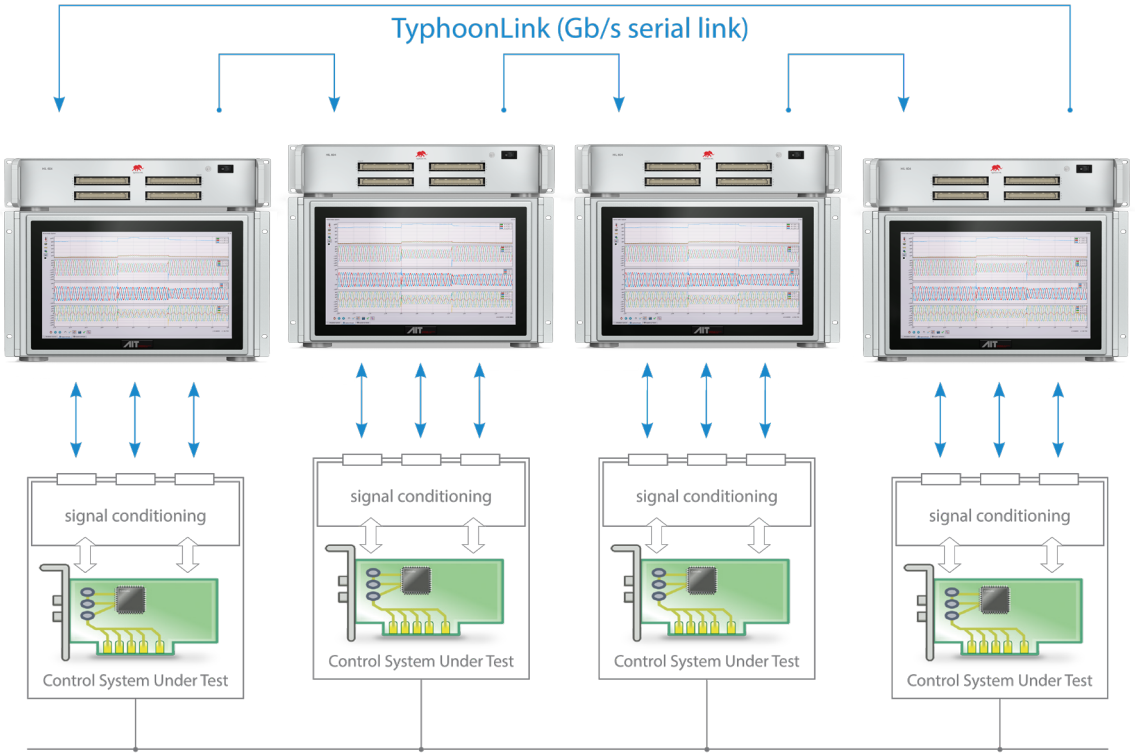
Automate controller testing processes with Python scripting and HIL604 platform. Discover the most comprehensive power electronics control software testing environment where fault injection such as grid disturbances, short and open circuits are just one Python command away. Use Python scripting and rich math function library to quantify system performance in spectrum of operating conditions under standard operating conditions and fault conditions (internal and external).



Automate testing with Python scripts to comprehensively and reproducibly test and qualify all your controllers.

Typhoon HIL Microgrid Testbed.

Complete HIL solution for micro-grid control system development, testing, and pre-certification.



MicroGrid HIL solution.

HIL604 provides the most comprehensive environment for design and testing of controllers for micro-grid power electronics converters. *TyphoonLink*-Gigabit per second serial link-enables seamless connection of 16 HIL604 units into one unified HIL system that can simulate more than hundred power electronics converters.

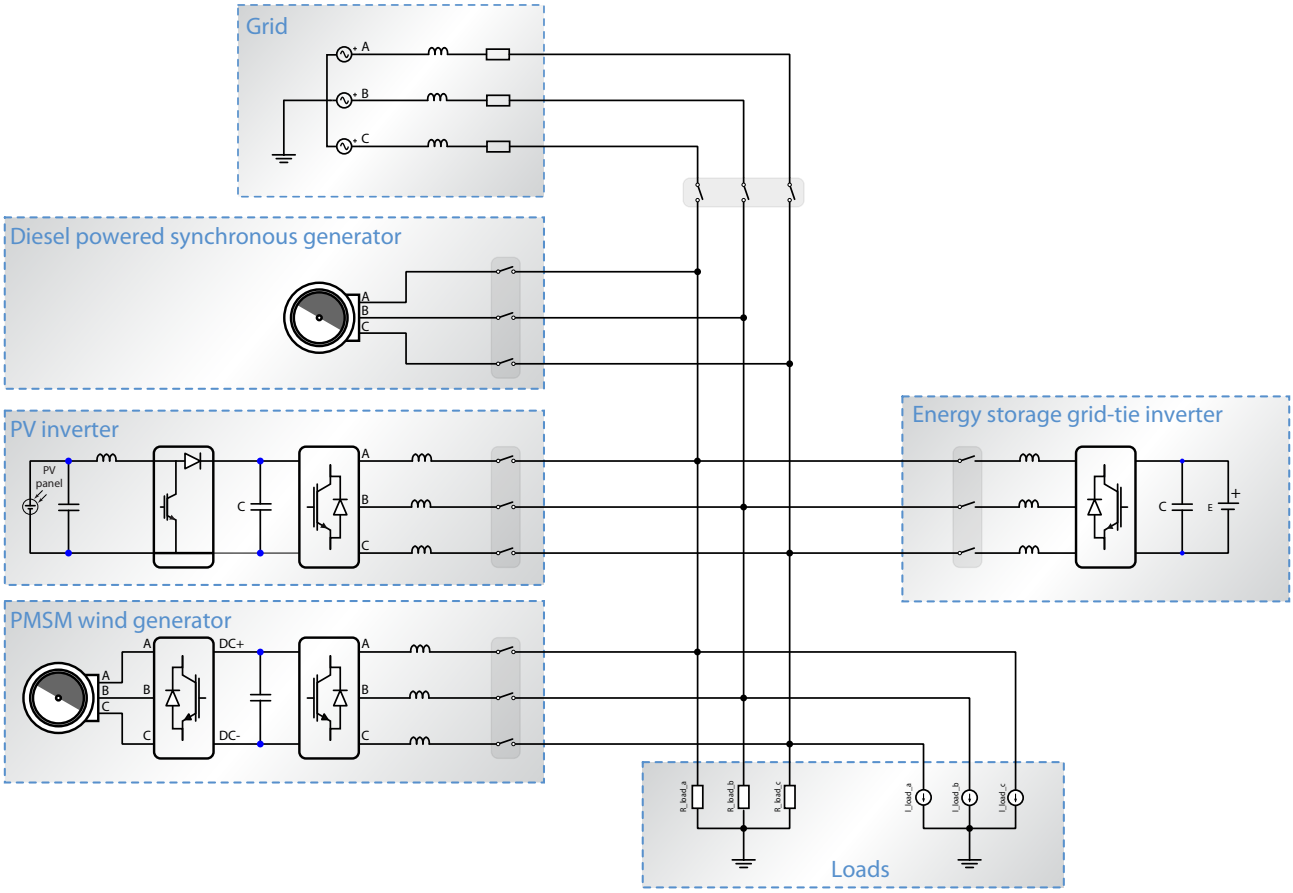
Whether you are testing a single converter control or multiple converter control (centralized or decentralized) HIL604 in the cluster configuration provides a unified environment that is as easy to use as if you were working with single HIL unit. Compile schematic diagram from the *Schematic Editor;* control the real-time emulation process via *HIL Control Panel*; quickly access all simulated signals via the *Scope/Capture* function-the same way as if you were using a single HIL. Finaly, automate testing with Python scripts via Typhoon API.

Features and Benefits

- Connect 16 *HIL604* units in *HIL Microgrid Testbed* configuration
- Deploy 128 real-time computational cores as one unified HIL real-time emulation fabric.
- Test one or multiple controllers in micro-grid environment for both centralized and decentralized micro-grid control configurations.
- Test both lower level and application/micro-grid level control layers.
- Interface seamlessly via Modbus, IEC 61850, Ethernet and AIO and DIO.
- Automate test and pre-certification processes with Python scripts via Typhoon API.

MicroGrid Energy storage converter.

Develop Micro-Grid energy storage converter control system.



Energy storage inverter.

In this case, a complete control software for a *battery energy storage inverter system* is developed using HIL. Complete micro-grid is simulated with the *HIL604 Microgrid Testbed.* Micro-grid model implemented provides the most realistic environment for development and testing of micro-grid power electronics systems.

In this system micro-grid model comprises intermittent photovoltaic power source, permanent magnet synchronous machine wind turbine generator, diesel powered synchronous generator, variable speed motor drive, resistive load, nonlinear current load, utility grid and main contactor that emulates both grid-connected and off-grid operational regimes. A truly flexible and easy to use ultra-high fidelity real-time simulation environment.

Test, optimize, pre-certify.

Control loops design and optimization for the *energy storage inverter* is done on an industrial controller platform directly interfaced with the *HIL604* via *HILConnect.* All controller functions—i.e. PWM modulator, PLL, current and voltage control loops etc.—as well as protection and high-level control functions (i.e. dynamic grid support) are tested for different operating conditions.

Indeed, HILCluster is ideal for test and pre-certification of micro-grid power electronics converter controllers. Automated test scripts cover a spectrum of test cases (including fault conditions and system unbalance) that provide a cost effective solution for compete test and verification of control system performance. In addition, *HIL Microgrid Testbed* provides easy to use development and test environment for system level micro-grid controller.

Unified HIL Software Environment.

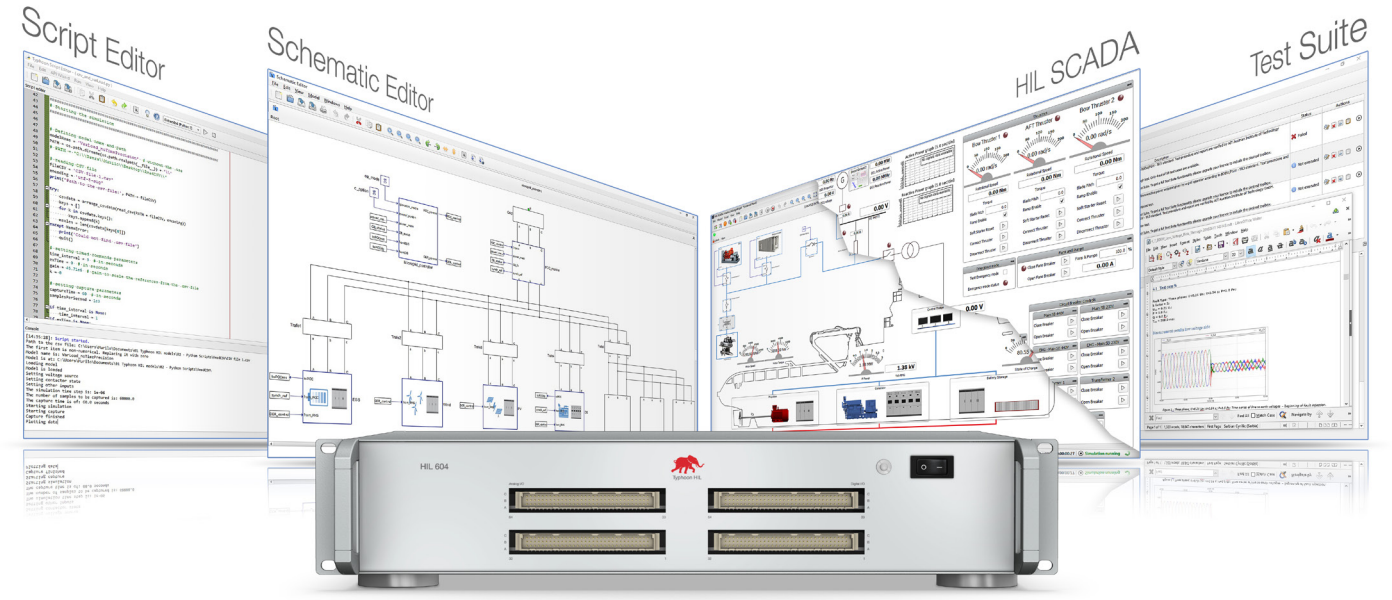
Experience integrated HIL software with automated testing.
Intuitive and easy to master, our software provides a unified environment for power electronics design, test automation and quality assurance.

Unified experience.

Model power electronics converters in our simple power electronics editor using a library of passive elements, converters, sources and machines. With only one click, rapidly compile the circuit into machine code that is executable on our HIL hardware. Open the HIL control panel to load the compiled model onto the hardware and launch the real-time simulation. Select signals you want to see on the scope and change sources and parameters for a fully interactive experience. With python script editor, automate your test processes and generate test reports, hands-off.

Discover simplicity.

- Vector graphics circuit editor with examples.
- Library of power electronics circuit elements.
- One click circuit compilation.
- Interactive control of real-time emulation.
- Dynamic routing of all signals.
- Waveform editor for source definition.
- Software control of digital inputs.
- Automatic testing via Python Scripts.
- Library of test scripts for testing grid compliance, protection etc.
- Python API.
- Automatically generate HTML test reports.



HIL Automatic Testing.

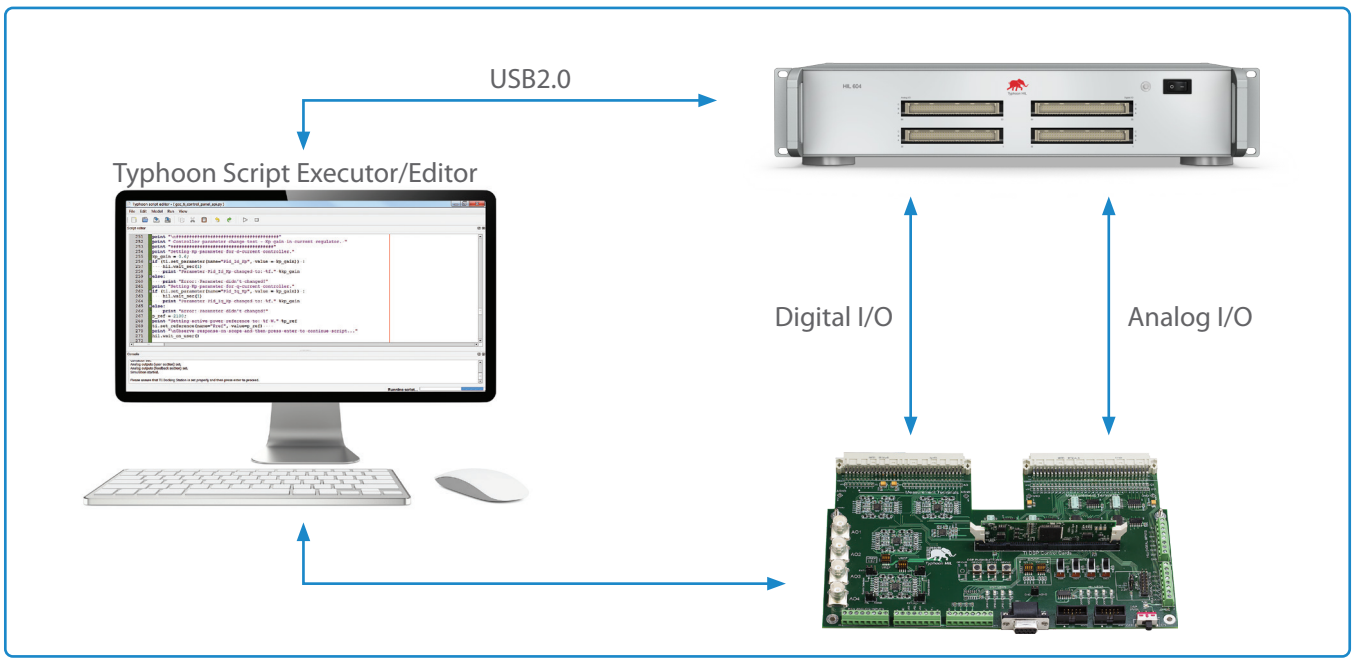
Test your power electronics controls until you run out of ideas, not time and money. With Python and API write test script libraries to test your designs under all operating conditions, faults, and corner cases.

Automate testing with ease.

Typhoon Script Editor enables you to build and execute test libraries to exhaustively test all aspects of a controller. Program test sequences under a spectrum of operating conditions, including faults. For grid connected converters test dynamic grid support, i.e. low voltage ride through, active and reactive power injection, protection etc. Use the library of test scripts to test against dynamic grid support standards such as German BDEW, UL1741 SA etc. In drives applications, program various drive cycles and test fault responses under both internal and external faults. For example, inject short and open circuit faults, switch faults, and test against parameter variations. Define performance envelopes and verify the system compliance.

The power of API.

Typhoon API comprises: HIL Control Panel API, Schematic Editor API, Texas Instruments DSP Control Panel API, and Test Executor. *HIL Control Panel API* provides an interface with the target HIL and enables control of the simulation process and all functions available through Control Panel. *Schematic Editor API* provides programmatic interface to manipulate existing schematic diagrams. It enables changing circuit parameters, compiling a circuit, setting target hardware platform, time step, simulation method etc. *Texas Instruments DSP Control Panel API* provides programmatic interface to control TI docking station and change controller parameters. *Test Executor Test* enables running one or more python scripts and generates html report files with test results.



HIL604 technical details.

Processor	Processor configurations	up to 8 processing cores; 2x ARM cores
Analog inputs (AI)	Channels	32 channels
	Resolution	16 bit ADC
	Input voltage range	± 10 V
	Sample rate	up to 1MSPS
	Linearity (DNL/INL)	1/2
	Gain error / offset error	0.01% / 1mV
	Input resistance	6.8 kΩ
	Protection	±24 V tolerant, ESD protection
Analog Outputs (AO)	Channels	64 channels
	Resolution	16 bit ADC
	Output voltage range	± 10 V
	Sample rate	up to 1MSPS
	Linearity (DNL/INL)	1/1
	Gain error; offset error	0.01% ; 1mV
	Output resistance	0 Ω
	Protection	±24 V tolerant, ESD protection
Analog IO connector	Connector	DIN 41612, type C 96 pin male connector
Externally available power supply	±5V	up to 2A, ressetable protection
	±12V analog	up to 2A, ressetable protection
	+3.3V digital	up to 2A, ressetable protection
	+5V digital	up to 2A, ressetable protection

Digital inputs (DI)	Channels	64 channels
	Input voltage range Vo	$-15V < V_o < 15V$
	Threshold voltages (low, high)	(V_{IL}(max) = 0.8 V; V_{IH}(min) 2 V)
	Input resistance	10 kΩ
	Protection	±24 V tolerant, ESD protection
Digital outputs (DO)	Channels	64 channels
	Output voltage range Vo	$0\ V < V_o < 5\ V$
	Threshold voltages (low, high)	(V_{OL}(max) = 0.2 V; V_{OH}(min) 4.8 V)
	Output resistance	430 Ω
	Protection	±24 V tolerant, ESD protection
Digital IO connector	Connector type	DIN 41612, type C 96 pin male connector
Connectivity	Ethernet	2x RJ45 connectors; 10/100/1000 Mbps
	USB2.0	2.0 high speed; 1x B type connector
	CAN	2x DB9 connector
	RS232	1x DB9 receptacle
	High speed serial link	8 lane, 5 GHz; 2x PCIe 4x connector
	Time synchronization	PPS and IRIG-B inputs
Housing	Dimensions	19" rack mountable; 2U height
	Weight	up to 10 kg
Power supply	Mains	90-240 V ; 250 W

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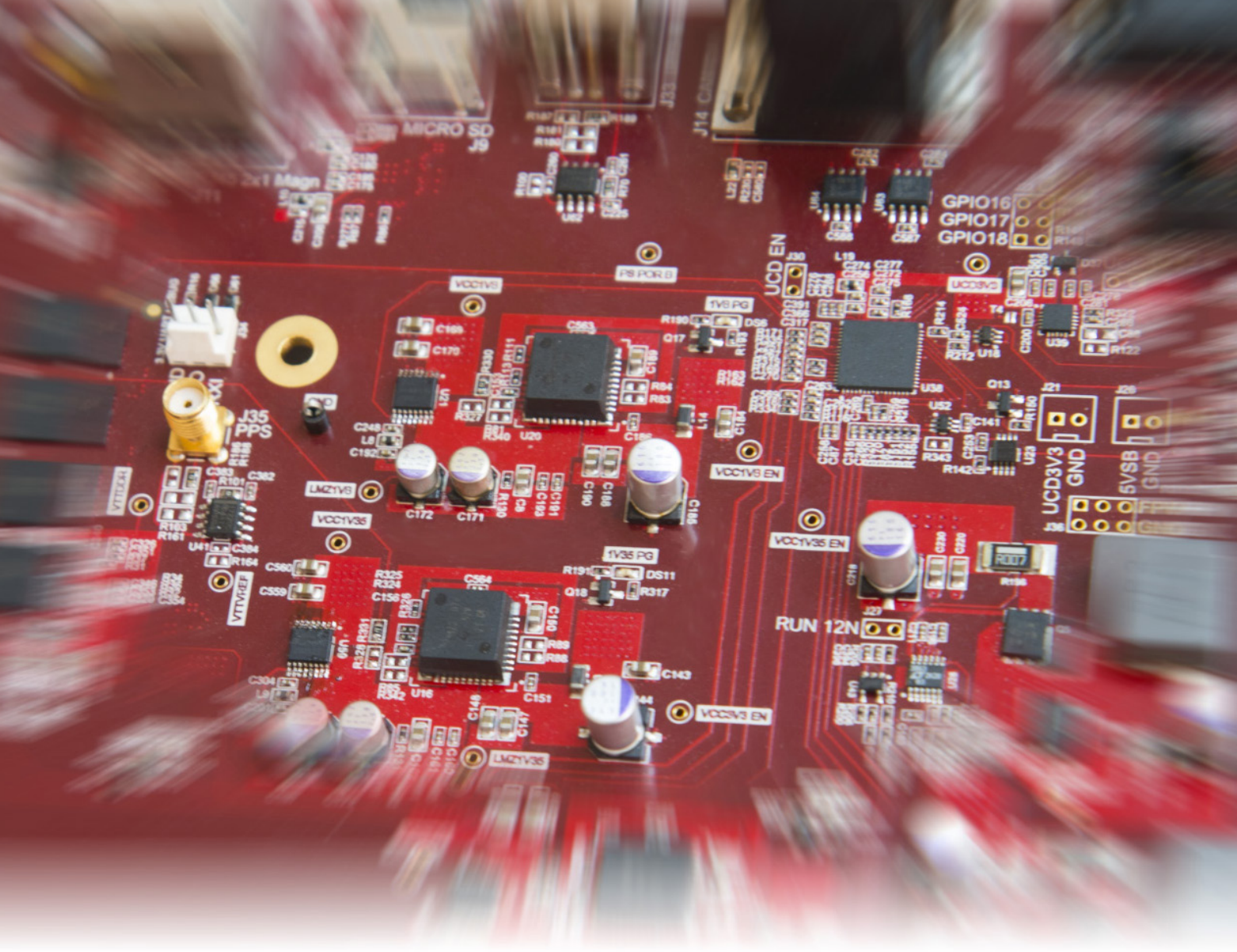

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