Fraunhofer IEE

RICOSO

Comprehensive Development EcoSystem for RCP and P-HiL Testing

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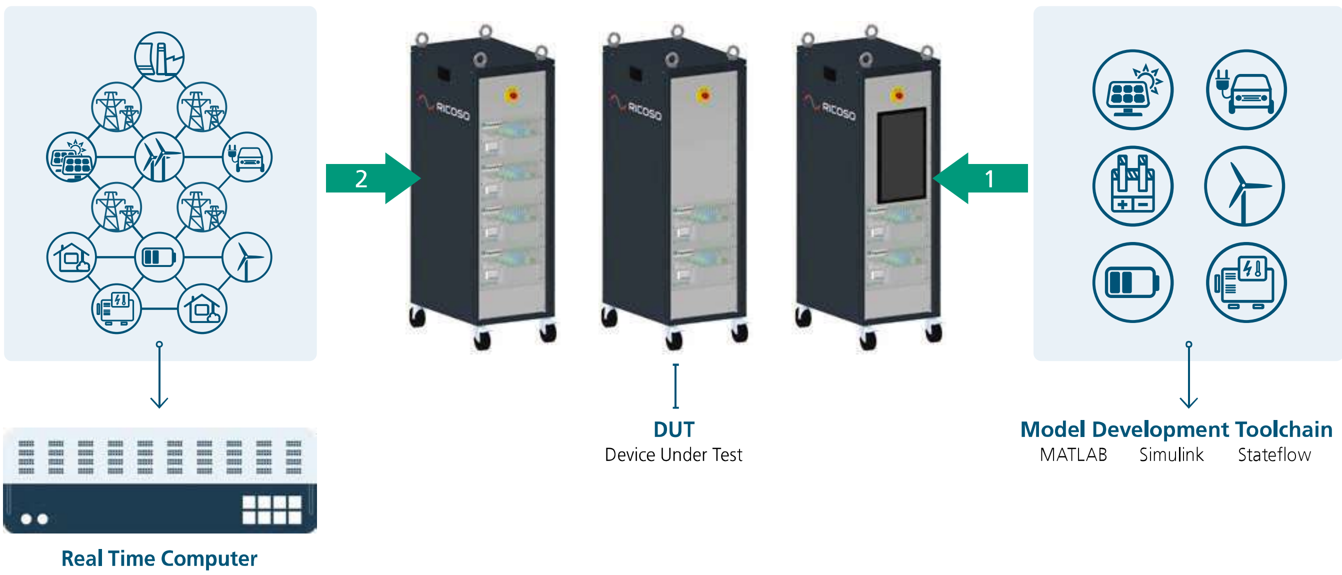
Rapid Inverter Control Prototyping and Power Hardware-in-the-Loop Solution

The RICOSO development ecosystem accelerates the development cycles of one of the most important components of the energy transition, the inverter.

Figure:
Using the RICOSO system as Rapid Inverter Prototyping Solution (1), Power Hardware-in-the-Loop (2)

The RICOSO-System

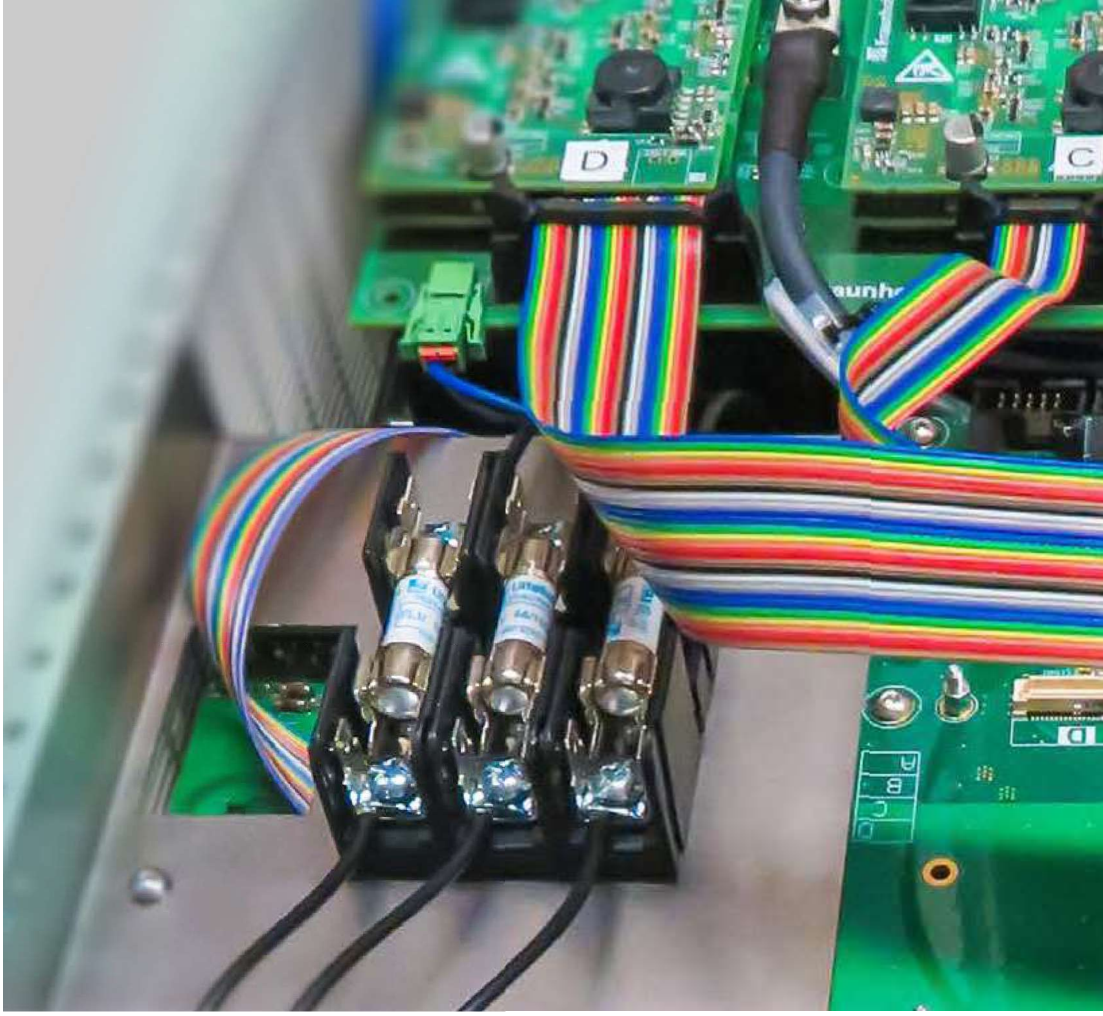
The integrated **RICOSO** system offers the infrastructure to quickly, reliably, and safely develop and test controls for grid inverters. The system consists of highly dynamic power amplifiers and can be model-based programmed with libraries from the Matlab/Simulink development environment. Through the development ecosystem, the entire development and validation process of inverter controls can remain in the hands of one researcher.



Up to

200

kVA



RICOSO offers solutions for different applications:

- Representation of the use cases: Simulation of EV charging stations, EV on-board chargers, battery inverters, PV storage systems (grid-side), or standalone grid inverters
- Use as a grid emulator for the reproducible study of different grid conditions, both symmetric and asymmetric.
- Further possibilities for AC loads or generators that can be mapped according to their future development.
- Automatic pre-compliance testing and evaluation for grid connection guidelines

The use cases enable accelerated development times and simplified workflows in both development and testing processes, helping to reduce costs, achieve faster time-to-market, and lower risks.

For initial and further developments of inverters, as well as for research purposes and training – the areas of application are extensive.

High-performance RICOSO power amplifiers

The integrated 34.5 kVA power inverters utilize SiC MOSFETs in a 3-level topology, enabling a high dynamic range with a switching frequency of 70 kHz. The 4-wire technology allows symmetrical and asymmetrical operation. For varying power classes, up to six systems can be connected in parallel and operate identically, scaling the power up to 200 kVA.

RICOSO by Fraunhofer IEE

Services for power converter development, models and control methods

- The models and controls are directly programmed onto the target hardware. One-click programming with automatic code generation from Matlab/Simulink is employed.
- You can also profit from our family of patents not exclusively for grid-forming inverters. In addition to a plug&play control especially for weak grids and island grids, we also have suitable current limiting methods in our portfolio that do not require larger inductances.
- If you are dealing with SiC or GaN power converters, a very fast detection of grid faults could be promising in order to dimension filters smaller and save material.

The integrated RICOSO development environment

The integrated **RICOSO** development environment provides a model-based workflow with Matlab/Simulink. This allows industry standard libraries for control engineering from Matlab/Simulink to be supplemented and extended by specially developed and tested libraries from Fraunhofer IEE, which support the development and operation of safe and stable inverters.

You can either develop directly on our development board or connect real-time computers from various manufacturers. Specifically, procedures for controlling grid-forming inverters, including a suitable, performant current limitation and fast grid fault detection for voltage deviations, are implemented to ensure that the inverters maintain grid-stabilizing and grid-forming properties.

Since grid-forming power converters ideally contain dynamic storage, a library with accurate models of different battery technologies is included, which enables a fast and practical demonstration of these battery storage systems (see: www.battery-simulation-studio.com/en)

In further steps, RICOSO will be extended for automated testing according to customer- or gridcode-based testing protocol (e.g. SunSpec openSVP from IEA TCP ISGAN-SIRFN).

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RICOSO Rack with one built-in amplifier

General Data

Dimensions 19'' rack (W x H x D)	600 mm x 1817 mm x 800 mm
Dimensions converter slot (W x H x D)	480 mm x 270 mm x 500 mm
Weight (Standard Configuration)	60 kg

Electrical Data

Supply

AC Supply Voltage $U_{LL,eff}$	400 V (3 Phase)
Connector	63A CEE Plug

Output (Testgrid, DuT)

Rated AC Output Voltage $U_{LL,eff}$	400 V – 520 V
Rated Frequency	50 Hz
Frequency Range	Up to 300 Hz
Total Harmonic Distortion	< 1.5 %

Amplifier

Nominal Apparent Power S_N	34.5 kVA @ 400 V
Maximum Apparent Power $S_{N,max}$ Short-Time Overload (1 s)	40.0 kVA @ 400 V
Rated AC Phase Current $I_{LN,eff}$	50 A
Nominal Neutral Conductor Current $I_{NN,eff}$	50 A
Max. Efficency	> 98 %
Power Factor Range at Rated Current	Symmetrical (3 phases): Inductive/Capacitive 0.03 … 1.0
	Asymmetrical (1 phase): Inductive/Capacitive 0.5 … 1.0
Maximum unbalanced Load	Zero sequence maximum 1/3 S_N (corresponds to zero conductor current of $I_N = I_{NN,RMS}$)
Bandwidth	Large Scale: up to 300 Hz Small Scale: up to 2000 Hz
Voltage measurement accuracy	+/- 0.5 % (0 … 1000 V)
Frequency measurement accuracy	+/- 0.1 % (0 … 300 Hz)
Topology	T-NPC 4-Leg @ 70 kHz
Operation	3-Level and 2-Level

Communication Interface

Wired Connection	CAN
Fiber Optics	Ethernet TCP/IP 1G
	High-Speed Aurora Interface 10G
Optional	PROFINET

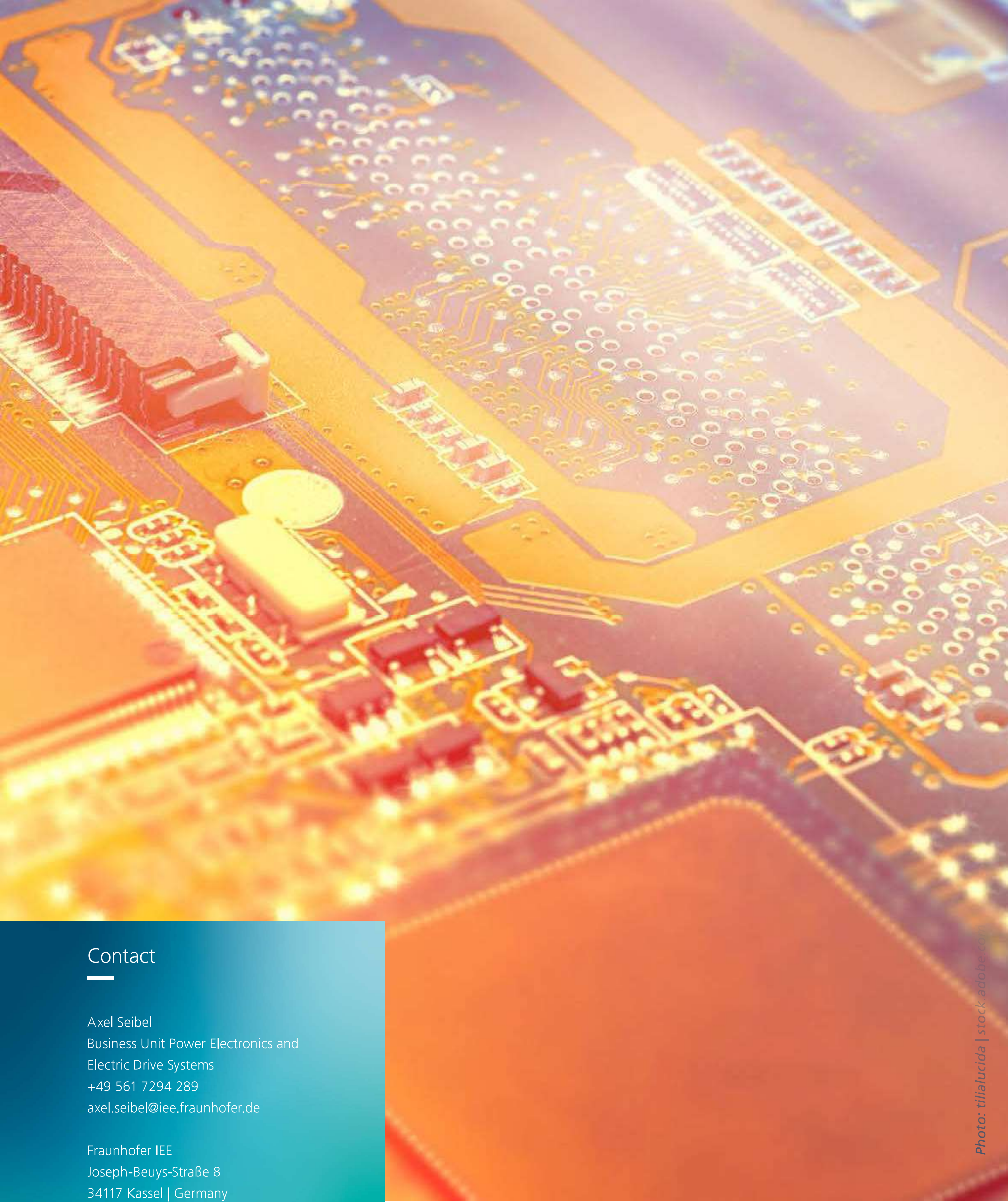

Photo: tilialucida | stock.adobe

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