Fraunhofer
IEE

RICOSO

One Solution for RCP and PHiL Testing

ricoso.de

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

With the RICOSO-System you develop and test controls more effectively even prior to completion of your hardware

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

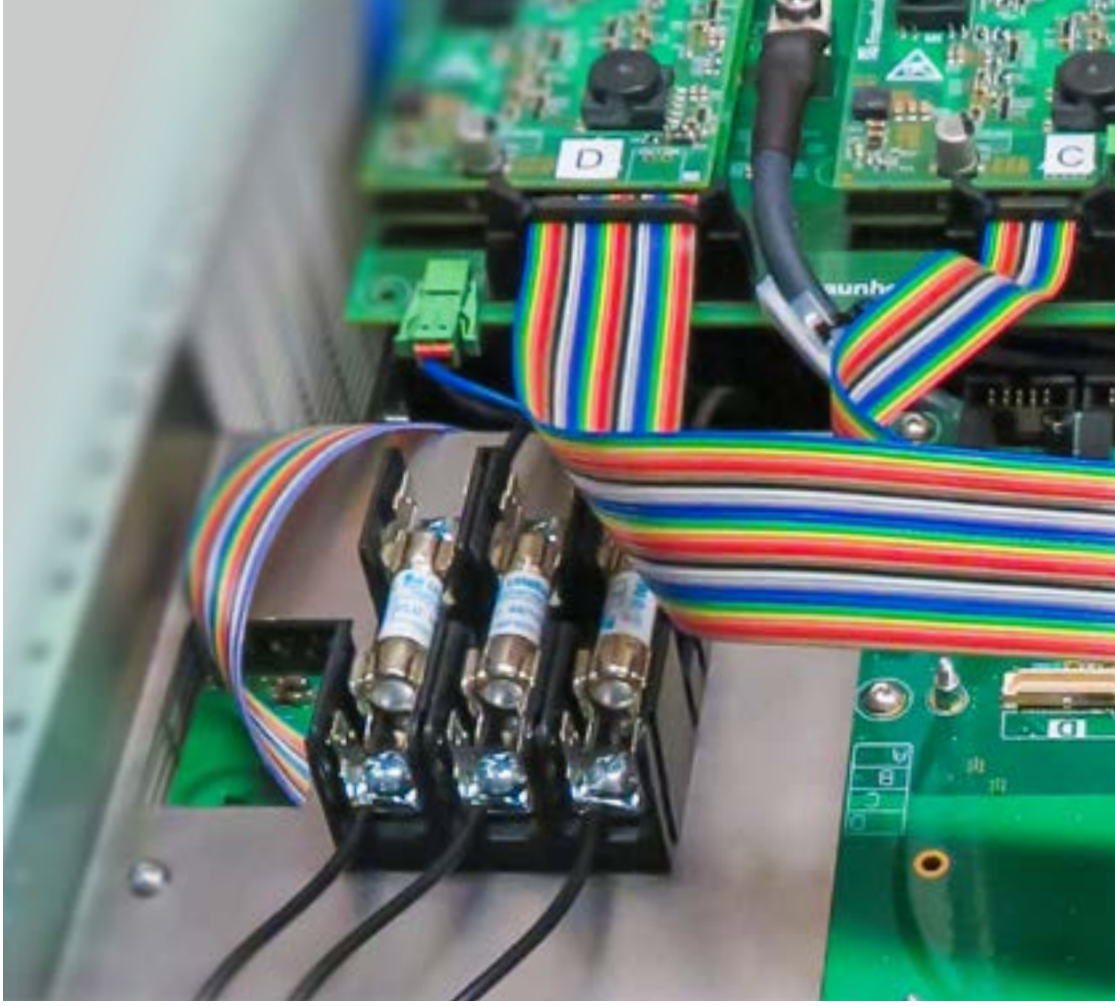
The RICOSO-System

The integrated **RICOSO-System** provides the infrastructure to develop and test controls for power system inverters quickly, reliably and safely. The system consists of highly dynamic power amplifiers and can be programmed in a model-based manner using special libraries of the Matlab/Simulink development environment.

Up to

200

kVA



RICOSO offers solutions for different applications:

- The power electronics of the system can represent different use cases such as emulating EV charging station, EV on-board chargers, battery inverters, PV storage systems (grid side) or stand-alone grid inverters
- The system can be used as a grid emulator to reproducibly investigate different grid conditions symmetrically or asymmetrically
- Further possiblities for AC loads or generators to be mapped according to their future developments

The use cases provide accelerated development times and simplified workflows in development and test processes and help to save costs in development, faster time-to-market and lower risk.

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

High-performance RICOSO AMP43 power amplifiers

The integrated 43 kVA power inverters are designed with SiC MOSFETS in a 3-level topology, so that a high dynamic range is achieved with a switching frequency of 70 kHz. Due to the 4-wire technology, symmetrical and asymmetrical operation is possible. For different power classes, up to five systems can be connected in parallel and react identically. Thus, up to 200 kVA power can be generated or absorbed.

RICOSO by Fraunhofer IEE

Services for power converter development, models and control methods

- The Fraunhofer IEE research team develops and tests inverters, models and controls for various applications. The models and controls are programmed directly on the target hardware. We realise efficient programming with SoM chips, which combine FPGA and microprocessors. For larger models such as grid models, it is possible to connect real-time computers to the system.
- 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.

In doing so, you can either develop directly on our development board, or connect real-time computers from different manufacturers. In particular, procedures for the control of grid-forming inverters including a suitable performant current limitation as well as a fast grid fault detection for voltage deviations are implemented here, so that the inverters can still have grid-stabilising 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).

www.battery-simulation-studio.com/en

General Data for one inverter included in the RICOSO Rack

Weight	60 kg
Dimensions converter slot (W×H×D)	480 mm × 270 mm × 500 mm
480 mm × 270 mm × 500 mm	600 mm × 1817 mm × 800 mm

Electrical Data

Nominal apparent power S_N	43,5 kVA @ 400 V
Maximum apparent power $S_{N, max}$	68 kVA @ 620 V *
Rated grid voltage $V_{LL, eff}$	400-620 V
Maximum DC link voltage (incl. fluctuation due to e.g. skewed load)	1200 V
DC current	75 A
Rated phase current I_{LN}	63 A
Nominal neutral conductor current I_{NN}	63 A
Power factor range at rated current	*Symmetrical (3 phases)*: Inductive / capacitive 0.03 … 1.0 *Asymmetrical (1 phase)*: Inductive / capacitive 0.5 … 1.0
Topology	ANPC 4-Leg @ 72 kHz
Maximum skewed load	Zero sequence maximum 1/3 S_N (corresponds to zero conductor current of $I_N = I_{NN, RMS} = 63$ A)
Total harmonic distortion	1,33 % at rated power
Efficiency of inverter	> 98 % (target value)
Bandwidth	1 kHz without derating max. 2,3 kHz with derating *

Communication Interfaces

Ethernet TCP/IP	available
CAN	available
PROFINET	available
Fibre Optics (direct FPGA access)	available

* to be verified

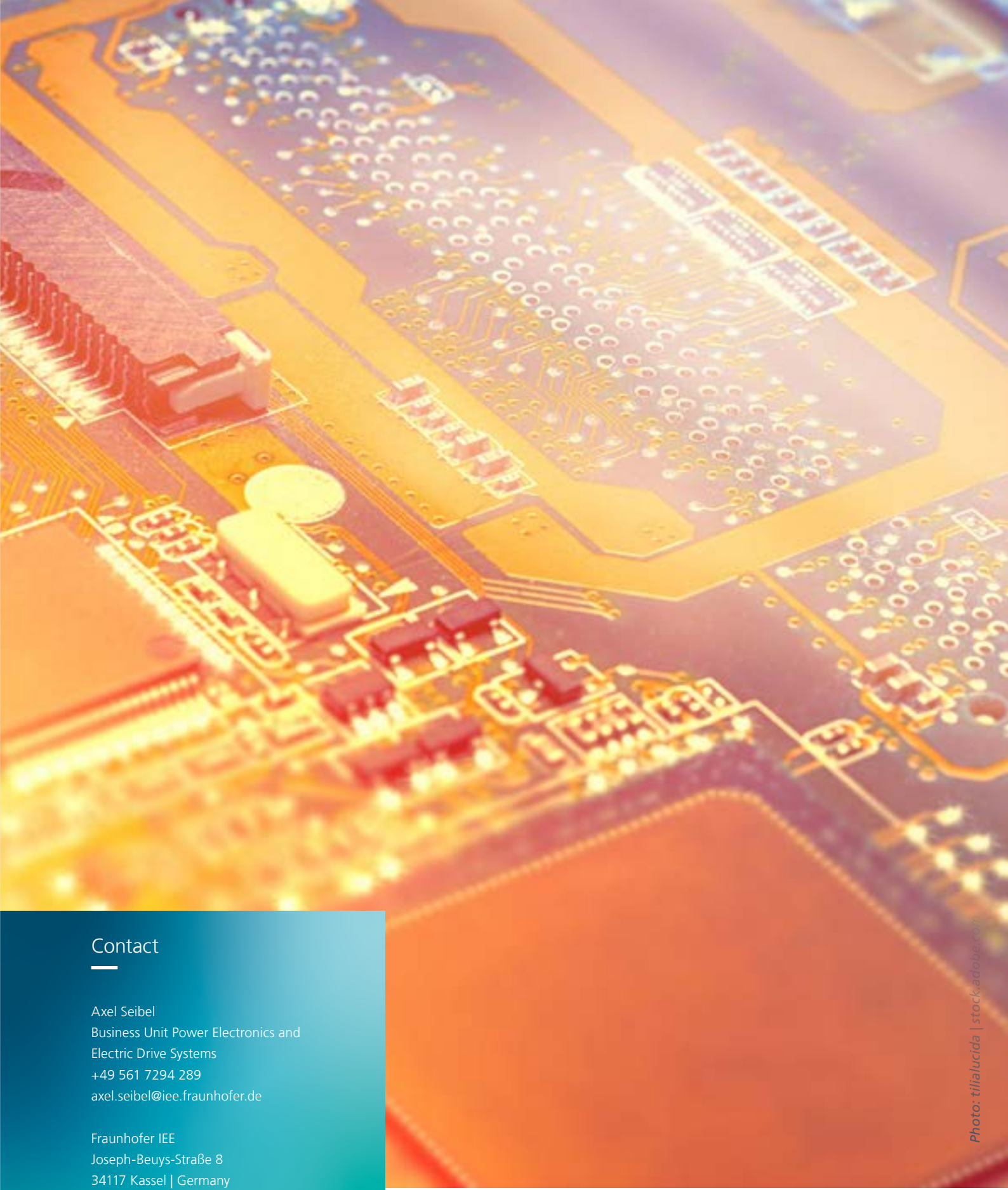


Photo: tilialucida | stock.adobe.com

Contact

Axel Seibel
Business Unit Power Electronics and
Electric Drive Systems
+49 561 7294 289
axel.seibel@iee.fraunhofer.de

Fraunhofer IEE
Joseph-Beuys-Straße 8
34117 Kassel | Germany

www.iee.fraunhofer.de/ricoso-en