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Make ideas real

DEVELOPMENT OF A POWER INVERTER FOR A HYDROGEN AIRCRAFT

The student team from Cellsius Project H2 uses an R&S®RTA4004 oscilloscope to validate the functionality of its inverter.

AT A GLANCE

- **Customer**: Cellsius Project H2 (www.cellsius.aero) organized by ETH Zurich
- **Task/project**: Development and validation of an inverter for use in a hybrid powertrain
- **Challenge**: Construction of a small aircraft based on a hydrogen/battery hybrid drive for more sustainable aviation
- **Solution/product**: R&S®RTA4004 oscilloscope from Rohde & Schwarz

The project

Students in the final year of their bachelor's degree in mechanical and electrical engineering can participate in the Cellsius Project H2 organized by ETH Zurich. The goal is to develop a small hydrogen-powered aircraft, thereby providing a roadmap for carbon-neutral aviation. This includes modification of the airframe as well as the design and testing of an innovative powertrain based on a hydrogen fuel cell system. Because weight plays a key role in aviation and all of the powertrain components have to work together perfectly, many of the subsystems are developed by the students themselves.

A major part of the project is developing infrastructure for tests with hydrogen as well as for electrical tests in a high voltage environment.

The concept

The powertrain's main energy source is a fuel cell in which hydrogen reacts with oxygen from the air, producing water and electric power. Since the fuel cell has precise requirements for parameters such as air pressure and temperature, a complex supply system is needed. To handle power peaks, the fuel cell system is supported by a backup battery. The electric power from both sources is combined and used to power an AC motor. To convert the direct current produced by the battery and fuel cell into alternating current for the motors, the students are developing a power inverter.

For more information, visit
www.rohde-schwarz.com/product/rta4000

Thanks to the high 10-bit resolution, overshoots can be examined in detail.

Remote access is another key feature, since the security concept prohibits anyone from being in the test area during tests that involve high voltages. This feature allows all measurements to be monitored and recorded during operation.

Due to its portability and ease of use, the R&S®RTA4004 is suitable for performing measurements along the entire powertrain.

> "Thanks to the R&S®RTA4004, we can analyze the performance of our powertrain – it's a key tool for optimizing our systems."
>
> Simon Jutzi, Cellsius Project H2, Power Electronics team

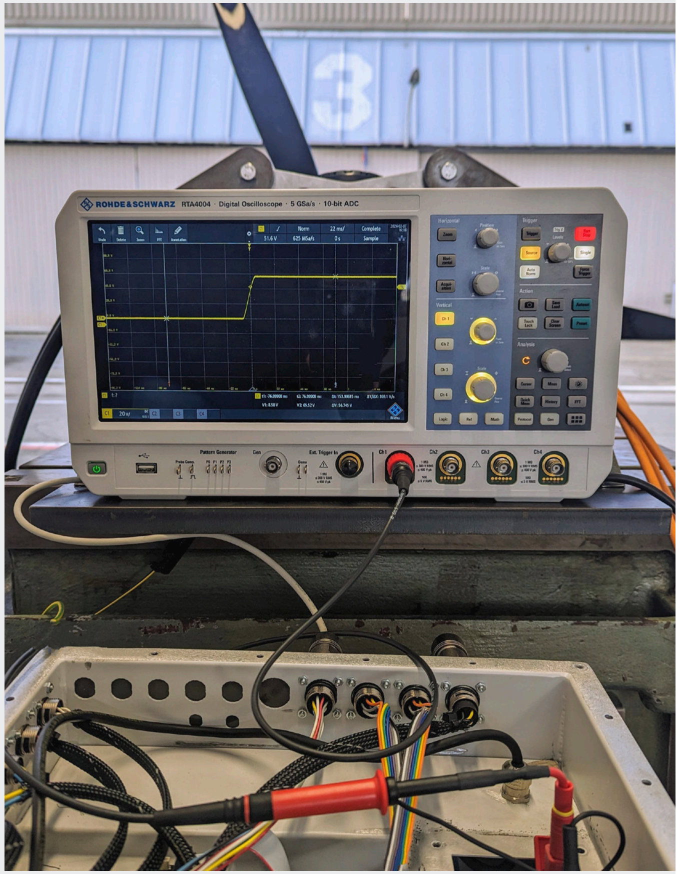
This inverter is designed for an intermediate circuit voltage of 800 V and continuous power of 100 kW. The inverter is operated with a communications/control board. It is very important to prevent signals from being disrupted by electromagnetic interference that may occur during operation. Silicon carbide power semiconductors are used for efficient inversion in the high voltage range. Proper switching performance is critical to ensure safe and reliable operation of the electric motor.

Testing and validation

During the inverter's testing and validation process, the R&S®RTA4004 oscilloscope is used for a wide variety of measurements.

To investigate how electromagnetic interference due to switching operations affects low voltage signals, the Fourier spectra of the voltage curves are analyzed. Moreover, operation of CAN communications networks can be validated by performing protocol analysis with the R&S®RTA4004.

Due to the high intermediate circuit voltage, normal probes cannot be used. Instead, the R&S®RT-ZH10 high voltage probe from Rohde & Schwarz is used. This allows e.g. analysis of the semiconductor switching performance.



Achievements and outlook

The R&S®RTA4004 oscilloscope has helped to verify the functionality of the inverter and of other systems in the powertrain. Following overall testing of the powertrain, it will be installed in a custom-modified small aircraft and hopefully soon be able to conquer the skies – without carbon emissions.

R&S®RTA4004

The R&S®RTA4004 oscilloscope helps students from Cellsius Project H2 with the following:

- ▶ High-resolution measurements for high voltage systems
- ▶ Analysis of the influence of electromagnetic interference
- ▶ Identification of error sources in various electrical systems
- ▶ Acquisition and export of measured values
- ▶ Verification of communications protocols

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