European Metrology
Research Programme
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EURAMET

*EU Energy Label Measurements*

# Extending the range of European electrical power measurements

Use of power converters in new devices and in wireless power transfer technology makes accurate efficiency measurements non-trivial, while better efficiency is required by design and by the European Ecodesign Directive. Power analysers are integral to processes requiring increased efficiency, but measurement standards over power frequency were previously not widely available, hindering the industry ability to meet efficiency targets.

# Challenge

Conventionally, most electronic items in Europe operated at 50 Hz, matching the frequency of the domestic power supply. Recently, devices operating at higher frequencies have become prevalent in applications such as wireless power transfer, power converters for photovoltaics, and in industrial applications such as induction heaters, ultrasonic generators and for the charging and propelling of electric vehicles.

These technologies require better efficiency to reduce their energy consumption in line with the EU Ecodesign Directive which aims to improve efficiency of products entering the European market – reducing the impact of climate change. Integral to any energy efficiency process are power analysers, or power meters, which measure the amount of electricity entering electronic devices and compare this with the amount of energy used, helping to minimise energy loss. To do this these instruments require accurate calibration.

Electric cars, for example, contain many components operating above 50 Hz – such as inverters that change the DC from the battery to AC for the engine, which operate at a frequency hundreds of times higher. In this case a relative uncertainty of 0.5% in the measurement of the output power of an inverter operating at about 98% efficiency will result in a significant uncertainty on the efficiency of the device. As the efficiency of electric vehicles impacts performance and range, inaccurate power measurements can have a significant effect on sales.

To further increase the efficiency determination of these systems traceable calibration methods for power measuring systems up to and above 100 kHz were required. However only a handful of calibration laboratories in Europe had this measurement capability, hindering the ability of industry to meet directive targets.

# Solution

During the MICEV project members of the consortium developed a new reference power standard for the calibration of power measurement units at PTB, the German National Metrology Institute (NMI).

Two power measurement systems for AC and DC were developed, allowing AC signals to be combined with a variable DC component. A current sensor and a voltage divider were used to bring the voltage signals down to levels at which they could be digitised by two Analogue/Digital converters. The digitised values were then evaluated in measurement software, also created in the project. The AC/DC systems were combined allowing both quantities to be measured in a single instrument and the measurement uncertainties calculated.

After validation with a primary standard for power and comparison to two high-quality broadband power analysers the new standard demonstrated its ability to calibrate power analysers for both AC and DC signals up to 150 kHz and up to 200 kW.

# Impact

ZES ZIMMER Electronic Systems GmbH is the only company world-wide exclusively dedicated to high-precision power analysis. With clients from all sectors of the electronics area including electromobility, renewable energy, household appliances and electric motors, ZES ZIMMER was aware of the move from conventional 50 Hz devices to ones operating at higher frequencies. The company's LMG600 power analyser was one of the broadband power analysers used in the development of PTB's calibration standard. During this work ZES ZIMMER themselves developed a high accuracy and precision 150 kHz transfer standard with low measurement uncertainty, linked to PTB's new standard for power analyser calibration.

The company believe that their new standard, the REF600, with SI traceability to the primary standard at PTB, will make them more competitive with other companies offering active power measurements for instruments operating above 50 Hz. In addition, this will simplify existing calibrations for customers, open up new services and give increased confidence in the work they perform.

This will help ZES ZIMMER, and other European companies, ensure that the new, higher frequency instrumentation entering the market will be as efficient as possible in energy consumption, helping companies meet the Ecodesign requirements in reducing energy consumption and hence lower Europe's $CO_2$ footprint.

## Addressing the metrological challenges for electric vehicles.

The MICEV project has led to several important outcomes to address existing metrological challenges for electric vehicles.

Three new calibration facilities have been established: one for the calibration of magnetic field meters up to 150 kHz, one for field meters up to 10 MHz, and one for power meters up to 150 kHz. Instrumentation developed included a 1 kV and 300 kHz reference voltage divider and a power measurement unit for on-site calibration and characterization of inductive power transfer charging stations.

Two software models were created, one for evaluating the efficiency of static charging stations and one for dynamic charging of electric vehicles.

A best practice guide on the safety aspects of inductive charging was published, as was a report assessing the safety of electric fields for people with medical implants.

These results will facilitate the implementation of wireless charging for electric vehicles on public roads and highways and provide safety to the public when using this type of transportation and inductive charging technologies.

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