European Metrology
Research Programme
Delivering Impact

DASY8 Module WPT determining the exposure by a wireless power transfer pad while charging a phone and a watch.

Ensuring the safety of wireless power transfer systems

Electromagnetic fields (EMFs) pervade everyday life, emitted by such things as telecommunication networks and electrical power grids. A new source is wireless power transfer (WPT), an emerging technology that can remotely charge electronic devices and electric cars. Both inductive low frequency and radiative WPT technologies require new assessment approaches to ensure compliance with international guidelines on human exposure to EMFs.

Europe's National Measurement Institutes working together

The European Metrology Programme for Innovation and Research (EMPIR) has been developed as part of Horizon 2020, the EU Framework Programme for Research and Innovation. EMPIR funding is drawn from 28 participating EURAMET member states to support collaborative research between Measurement Institutes, academia and industry both within and outside Europe to address key metrology challenges and ensure that measurement science meets the future.

Challenge

Non-ionizing radiation in the radiofrequency range from 600 MHz to 300 GHz provides the basis for connectivity in mobile communication applications. Additionally, electromagnetic fields (EMFs) generated by inductively coupled coils at low frequencies (typically below 10 MHz) are widely used for contactless charging of household appliances and electric vehicles.

Exposure to EMFs can have adverse health effects, however, as EMFs penetrate the body and can cause tissue heating and, below 10 MHz, may also cause unintended stimulation of nerves. International safety guidelines set 'basic restrictions' in terms of body-induced field levels to prevent health hazards as well as permissible exposure levels measured outside the body, known as 'reference levels', that ensure that basic restrictions are met.

Yet, reference levels only account for exposure to uniform fields, whereas WPT systems show a strong gradient in proximity to the coils that decays with distance, meaning reference levels greatly overestimate the exposure in case of WPT.

Hence exposure measurements and estimates must be accurate to ensure the general public's safety without greatly overestimating the exposure as this would hinder technological advances.

Solution

The MICEV project addressed this challenge by developing a Best Practice Guide (BPG) to implement precise measurements in electric vehicle charging systems and by significantly contributing to the new specification IEC PAS 63184 that was published in 2021 and will soon become a definitive standard.

As part of the MICEV project, Schmidt and Partner Engineering AG (SPEAG) developed a mathematical model that transforms the 'incident' magnetic fields into body-internal basic restriction quantities. Simulations were performed examining the effects of EMFs from 3 kHz to 10 MHz on a 'virtual population' of humans of different height, age (children to adults), sex, and body-mass index.

The method was validated by numerical analysis of human exposure to actual WPT sources at various locations and distances from a human phantom. It was then compared to the existing compliance test methods using incident fields.

As a result of the work, SPEAG was able to establish a novel compliance testing method that mitigates the overestimation of EMF exposure while maintaining the simplicity of the testing procedure.

Impact

SPEAG, based in Switzerland, is the world leader in instrumentation and numerical tools for evaluating EMFs in complex environments, with customers including leading mobile device manufacturers, governments, and regulatory agencies.

The metrology developed in the MIVEV project – the first in the world – for the assessment of the body-induced EMFs by measurement below 4 MHz – has been integrated into SPEAG's measurement capabilities, which now cover the frequency range from 3 kHz to 300 GHz.

Two new instruments have been developed. The Magnetic Amplitude and Gradient Probe System (MAGPy) is a handheld device for in situ evaluation of inductive WPT systems from 3 kHz to 10 MHz. It is capable of real-time 3D electric and magnetic field and field gradient measurements, and its small sensors (< 1 cm^2) can overcome the inaccurate estimations of non-homogenous fields made by larger sensors. For laboratory testing, SPEAG now offers the DASY8 Module WPT for high precision robot-based evaluations, allowing manufacturers of WPT devices to demonstrate full compliance with the new IEC standard.

These instruments and capabilities will help to introduce future WPT systems in Europe and ensure that already existing systems are safe to use.

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 BPG 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.

EMPIR EURAMET

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