

EV Wireless Charging and Active Implanted Medical Devices

Defining Metrology for Regulatory Success



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EMF: Electric, Magnetic, and electromagnetic Fields

- The main objective of addressing EMF in WPT standards is to establish guidelines for limiting EMF exposure that will provide protection against known adverse health effects both directly in tissue and to active implanted medical devices (AIMD).
- The ICNIRP (International Commission on Non-Ionizing Radiation Protection) published guidelines are one source of existing documents that address human exposure at frequencies below 100 kHz.
- For our specific case related to automotive WPT systems we are focused on non-ionizing radiation (NIR) in approximately the 20 kHz to 90 kHz region of the spectrum and the subsequent prevention of electrostimulation.



NIR includes all radiations and fields of the electromagnetic spectrum that do not normally have sufficient energy to produce ionization in matter; characterized by energy per photon less than about 12 eV, wavelengths greater than 100 nm, and frequencies lower than 3 x10¹⁵ Hz.



EV Magnetic Field Scan and Human Body Exposure

- Picture below left shows a passenger side Reference Level EMF assessment to ICNIRP 2010 over region 2. The contour plots show the B-field distribution over the scan area.
- Picture below right shows a Basic Restriction EMF assessment for simulated E-field and B-field induced in a human body phantom for a prone position (worst case). AIMD data is also shown for comparison. More development on the methodology for basic restriction modeling in AIMDs is needed.



Photo Courtesy Nissan

EMF Standards Landscape for EV Wireless Power Transfer



Note: Partial list of standard's bodies, technical groups and standards for illustrative purposes.

EMF Route to Compliance: Basic Restrictions

<u>Basic Restrictions</u>: Limitations of exposure that are based on the physical quantity or quantities directly related to the established health effects are termed basic restrictions. In ICNIRP 2010 the physical quantity used to specify the basic restrictions on exposure to EMF is the internal electric field strength Ei, as it is the electric field that affects nerve cells and other electrically sensitive cells.



Note: The internal electric field strength is difficult assess. Electromagnetic simulations are performed to derive the values induced in the body or in the AIMD.

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EMF Route to Compliance: Reference Levels

<u>Reference Levels</u>: Reference levels are derived from relevant basic restrictions using measurement and/or computational techniques but some address perception (electric field) and adverse indirect effects of exposure to EMF. The derived quantities are electric field strength (E), magnetic field strength (H), magnetic flux density (B) and currents flowing through the limbs (IL). The quantity that addresses indirect effects is the contact current (IC).



Note: The reference levels specified in WPT standards are associated with the magnetic flux density (B), the electric field strength (E) and contact current (IC). These characteristics can be measured with external probes and weighting circuitry making them the most practical route to compliance.



Key Differences and Plans Towards Harmonization

- Limits: ICNIRP 1998, ICNIRP 2010, ISO14117, others
- Exposure Type: Standard Human Exposure versus AIMD Exposure
- Metrology Details: Field Type, Probe Type, Grid Size, Signal Weighting, etc.
- Boundary Definitions: Vehicle Protection Areas or Regions
- Compliance Route: Reference Levels and/or Basic Restrictions
- Test Distance: Minimum Separation Distances
- Simulation: Methodology, Phantom Type/Model, Device Model (AIMD)











