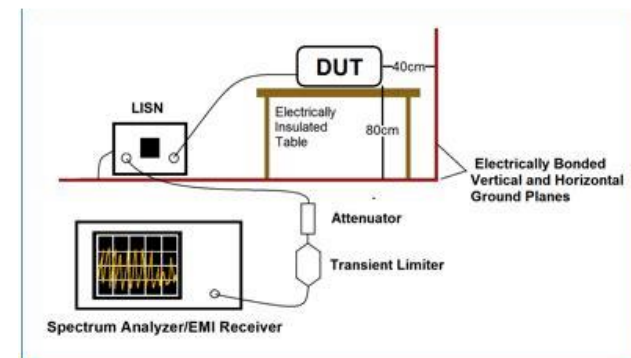
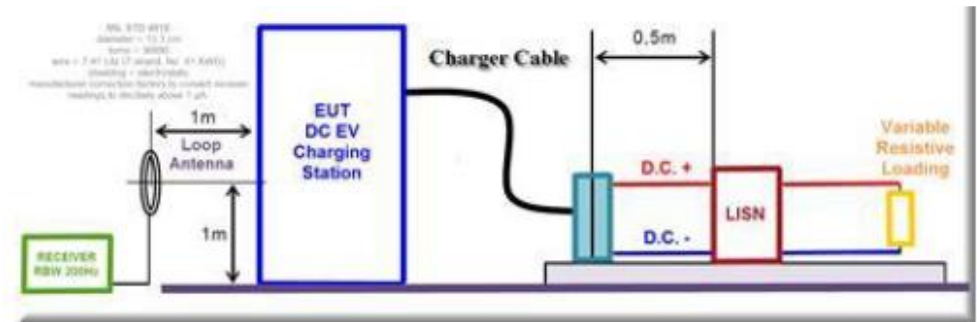


# Electromagnetic Compatibility Issues In Electric Vehicle Charging

## Charging Systems Can Cause Unintended Emissions of Energy

- Radio Frequency (RF) Radiated Emissions (RE):
  - Energy is directly radiated from charging system components to nearby object.
  - Can interfere with reception of intentional RF signals.
  - Received levels “fall off” at significant rate.
- RF Conducted Emissions (CE):
  - RF energy is conducted on cabling to vehicle and/or cabling to charging source (power grid).
  - Can become a strong source of RE, due to cable lengths acting as efficient “antennas”.

## Representative Tests Set-Up



# Applicable EMC Regulations and Standards (for both Conductive and “Wireless” Systems)

- United States Federal Communication Commission (FCC) has regulations for charging systems that are contained in two sets of documents
  - FCC “Title 47 – Part 15” which regulates intentional and unintentional radiators of RF energy.
  - FCC “Title 47 – Part 18”, and contains the EMC Requirements for Industrial, Scientific, and Medical Devices.
  - Regulations apply only to unintended emissions from charging systems.
- International Standards also cover maximum emissions and immunity to external sources of energy.
  - IEC61851 – EV Conductive Charging Systems
  - IEC6100 – EMC Immunity and Emission

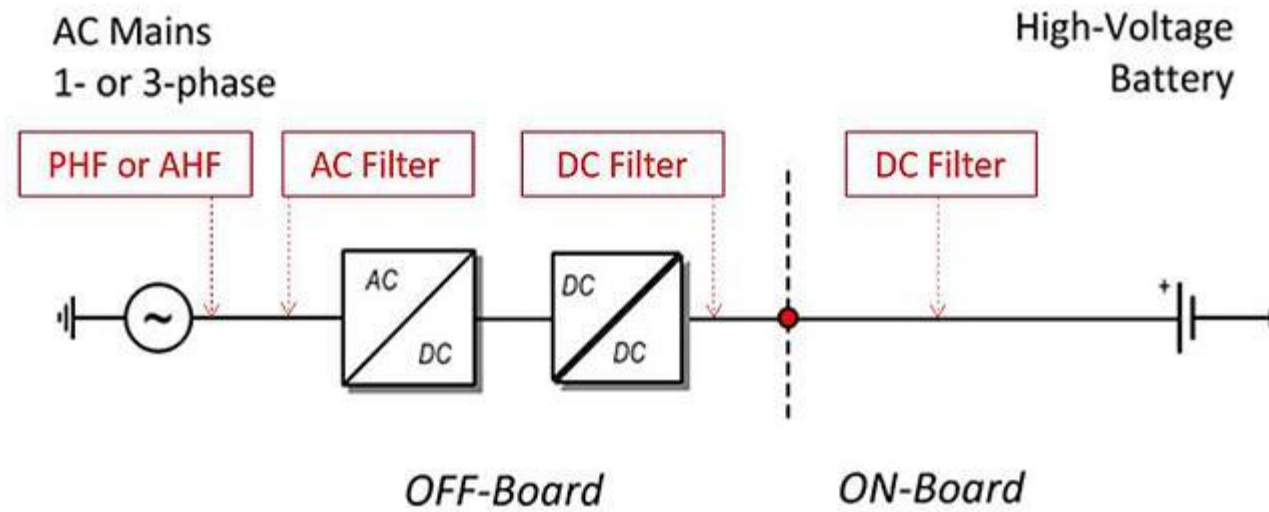


# IEC61851 Standard

- Applicable to all Off-board charging equipment, that can be used and installed in different locations.
- The standard covers all residential-, commercial-, light industrial- (acc. IEC61000-6-1 and -3) and industrial environments (acc. IEC61000-6-2 and -4), irrespective of whether the equipment is located in- or outdoor.
- In case the environment is not defined, the lowest emission limits and the highest immunity test levels shall be applied.

# IEC Standards Apply From charging station to grid power source

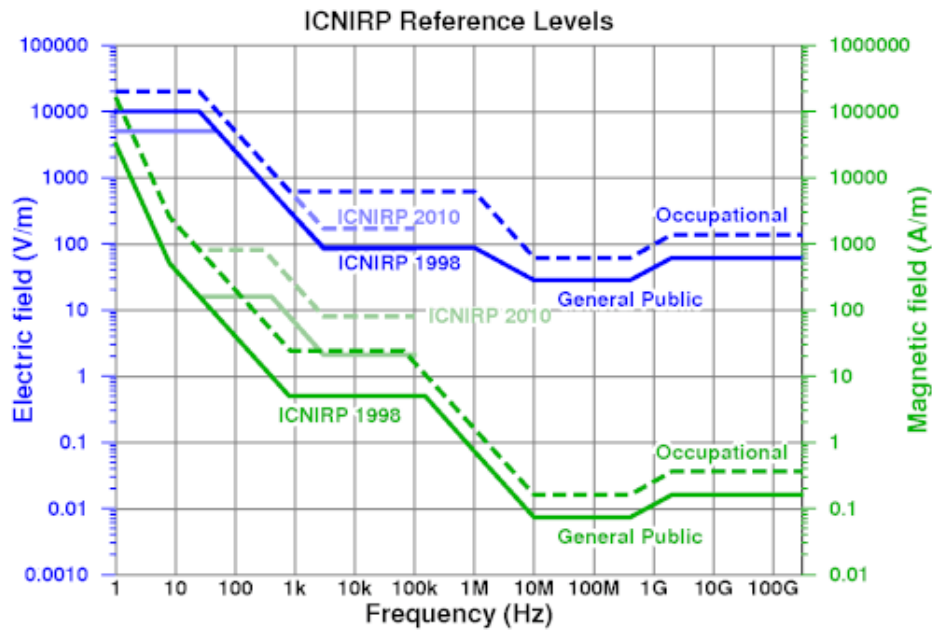
- IEC61000-6-2 & -3: EMC immunity and emission  
IEC 6100-3-12: Electromagnetic compatibility (EMC) - Limits for harmonic currents



# Additional IEC Standards Apply From charging station to EV

- **IEC61851-1**: Electric vehicle conductive charging system
- Part 1: General requirements and:
  - Emission Testing according to **IEC61000-6-3**
  - Immunity testing according to **IEC61000-6-1**
- Part 21-1: EMC requirements for On-board charger connected to an AC/DC supply
- Part 21-2: EMC requirements for Off-board AC/DC charging system
- Part 23: DC charging station
- Part 24: Communication between DC charging station and EV

# Potential Future Additional Requirements for Applicable to Wireless Charging



- Guidelines established for “safe” electric and magnetic field exposure levels.

- Documented in:



- Cited by United Nations World Health Organization as “ICNIRP” standards.

