

UN ECE Regulation 10 Test Setup Requirements for Vehicle EMC Tests

In this guide we are listing the test setup requirements for EMC testing of vehicles according to UN ECE Regulation 10 Revision 6. Our reference document is UN ECE R10 and its latest version of Revision 6. This regulation is applicable from the UN ECE website and it is free to download.

Please take into consideration of the features of the vehicle that will be tested and the revision of UN ECE R10.



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1. Vehicle Configurations

UN ECE R10 differentiates vehicles according to its features and configurations. There are two main features: REESS charging mode coupling and immunity related functions. These two features define the vehicle category and applicable EMC tests.

Vehicle Category	Vehicle Configuration Description
1	Vehicles in configurations other than REESS charging mode coupled to the power grid * vehicles without immunity related functions
2	Vehicles in configuration "REESS charging mode coupled to the power grid" * vehicles without immunity related functions
3	Vehicles in configurations other than REESS charging mode coupled to the power grid * vehicles with immunity related functions
4	Vehicles in configuration "REESS charging mode coupled to the power grid" * vehicles with immunity related functions

We can derive three vehicle categories in terms of EMC tests listed under UN ECE Regulation 10:

- * All Vehicle categories listed under the scope of UN ECE R10
- * Vehicles with immunity related functions
- * Vehicles with REESS charging mode

2. Charging Modes according to UN ECE R10

Charging mode of the vehicle tested is essential when applying EMC tests since test setups or limits might depend on the charging mode of the vehicle under tests.

There are four charging modes according to UN ECE R10. Mode 1, Mode 2 and Mode 3 are for AC charging, Mode 4 is for DC charging. Mode 1 and Mode 2 have no communication between the vehicle and AC supply. Mode 3 and Mode 4 have communication between the vehicle and the power supply or charging station. We listed these four modes on below table:

Charging Mode	Power Supply	Connection Type	Communication	ECE R10 Description
Charging Mode 1	AC mains	Direct	No	"Mode 1 Charging Mode" means charging mode as defined in IEC 61851-1 sub-clause 6.2.1 where the vehicle is connected directly to AC mains without any communication between the vehicle and the charging station and without any supplementary pilot or auxiliary contacts. In some countries Mode 1 charging may be prohibited or requires special pre-cautions.
Charging Mode 2	AC mains	Via Charging Harness	Vehicle-EVSE box (no communication between vehicle and AC supply)	"Mode 2 Charging Mode" means charging mode as defined in IEC 61851-1 sub-clause 6.2.2 where the vehicle is connected to AC mains using a charging harness including an Electric Vehicle Supply Equipment (EVSE) box providing control pilot signalling between the vehicle and the EVSE box and personal protection against electric shock. In some countries, special restrictions have to be applied for mode 2 charging. There is no communication between the vehicle and the AC supply network (mains).
Charging Mode 3	EVSE (charging station) with AC power	Via Charging Harness	Vehicle-Charging Station	"Mode 3 Charging Mode" means charging mode as defined in IEC 61851-1 sub-clause 6.2.3 where the vehicle is connected to an EVSE (e.g charging station, wallbox) providing AC power to the vehicle with communication between the vehicle and the charging station (through signal/control lines and/or through wired network lines)
Charging Mode 4	EVSE (charging)	Via Charging Harness	Vehicle-Charging Station	"Mode 4 Charging Mode" means charging mode as defined in IEC 61851-1

	station) with DC power			sub-clause 6.2.4 where the vehicle is connected to an EVSE providing DC power to the vehicle (with an off-board charger) with communication between the vehicle and the charging station (through signal/control lines and/or through wired network lines)
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Before applying any EMC tests to a vehicle you should define its charging mode and derive an EMC test plan.

3. EMC Tests for Vehicles

We will use these main three categories to list the applicable EMC tests for each category:

EUT Type / Category	EMC Test Type	Test Equipment Requirements	Test Site Requirements	Reference Standards
All Vehicles	Radiated Emissions (30MHz to 1GHz, Measurement distance: 3m or 10m)	EMI Receiver with QP, AV, P detectors, frequency range: 30-1000MHz, RBW: 100/120kHz, Biconical and Log-Periodic Antennas, Antenna Tripod, LISN/AMN, Artificial Network (AN), Asymmetric Artificial Network (AAN)	ALSE or OTS	Annex 4 of R10 Annex 5 of R10 CISPR 12 CISPR 25
Vehicles with immunity related functions	Radiated Immunity (20MHz to 2GHz, 25V/m) or BCI or TEM Cell	RF Signal Generator, RF Amplifier, Test Software, RF Probe, RF Cable, Artificial Networks (ANs), DC-charging ANs, AANs, Power Charging Harness, Charging Station / Power Mains	ALSE or OTS	Annex 6 of R10 ISO 11451-2 ISO 11452-1 ISO 11451-4
Vehicles with REESS charging mode	Conducted Emissions (0.15-30MHz) on AC or DC power lines	EMI Receiver, Spectrum Analyser or a Scanning Receiver (QP, AV, P detectors, 0.15-30MHz, RBW: 9/10kHz), AMN(s) (for AC power lines), High Voltage Artificial Networks (DC-charging-AN(s)) (for DC power lines), Charging harness, Power mains socket, Insulating support	ALSE, OATS or Shielded Enclosure	Annex 13 of R10 CISPR 16-2-1 CISPR 16-1-4
Vehicles with REESS charging mode	Conducted Emissions (0.15-30MHz) on wired network ports	EMI Receiver, Spectrum Analyser or a Scanning Receiver (QP, AV, P detectors, 0.15-30MHz, RBW: 9/10kHz), AANs grounded for communication lines, AMNs or DC-charging ANs grounded, Charging Station, Charging/Communication harness, Power mains socket, Insulating support	ALSE, OATS or Shielded Enclosure	Annex 14 of R10 CISPR 16-2-1 CISPR 16-1-4 CISPR 22 IEC 61000-6-3 CISPR 12
Vehicles with REESS charging mode	Harmonics Emissions on AC power lines	Harmonic Analyzer, Power Supply, Insulating support, Charging harness	-	Annex 11 of R10 IEC 61000-3-2 IEC 61000-3-12
Vehicles with REESS	Voltage Changes, Fluctuations,	Flicker Analyzer, Power Supply, Impedance Simulator, Insulating	-	Annex 12 of R10 IEC 61000-3-3

charging mode	Flicker Emissions on AC power lines	support, Charging harness		IEC 61000-3-11
Vehicles with REESS charging mode	Immunity to Electrical Fast Transient (EFT) / Burst disturbances	EFT/Burst Generator, CDN, Capacitive Coupling Clamp, Insulating Support, Charging Harness, Power Supply	Reference Ground Plane	Annex 15 of R10 IEC 61000-4-4
Vehicles with REESS charging mode	Immunity to Surges on AC and DC power lines	Surge Generator, CDN, Insulating Support, Charging Harness, Power Supply	Reference Ground Plane	Annex 16 of R10 IEC 61000-4-5

4. EMC Test Setup Examples

Annexes of UN ECE Regulation 10 shows example test setups for each test. We listed some of these example setups below.

4.1. Radiated Emissions Test Setup (Example, Annex 4)

Figure 3

Vehicle in configuration "REESS charging mode" coupled to the power grid:

Example of test setup for vehicle with socket located on vehicle side (charging mode 1 or 2, AC powered, without communication).

Figure 3a

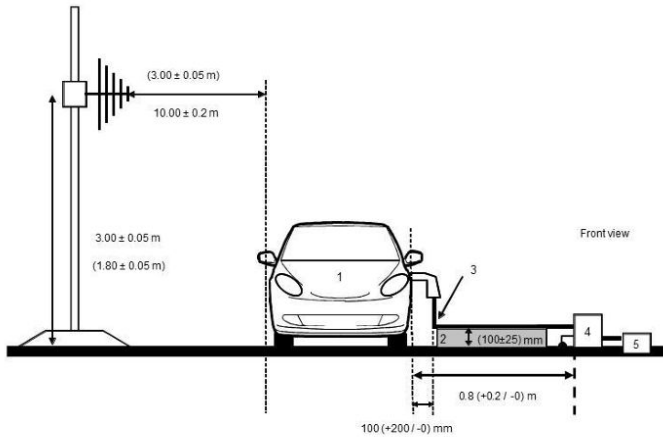
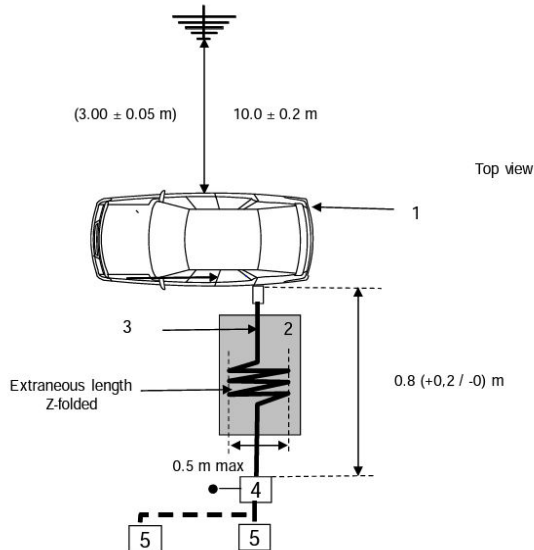


Figure 3b



Legend:

- 1: Vehicle under test.
- 2: Insulating support.
- 3: Charging harness (including EVSE for charging mode 2).
- 4: AMN(s) or DC-charging-AN(s) grounded.
- 5: Power mains socket.

4.2. Radiated Immunity Test Setup (Example, Annex 6)

Example of test setup for vehicle with socket located on vehicle side (charging mode 3 or mode 4, with communication)

Figure 4e

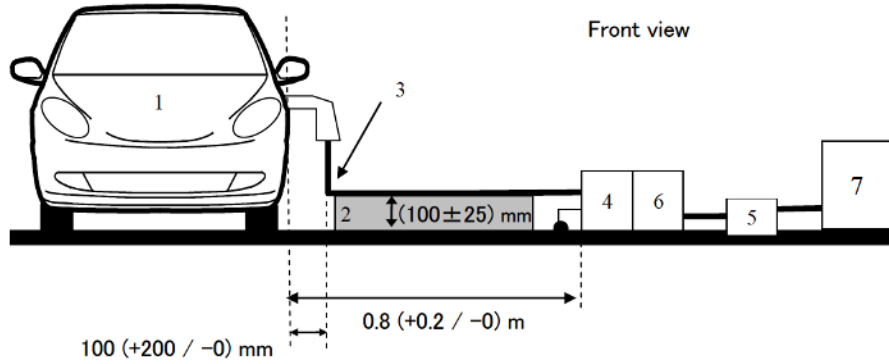
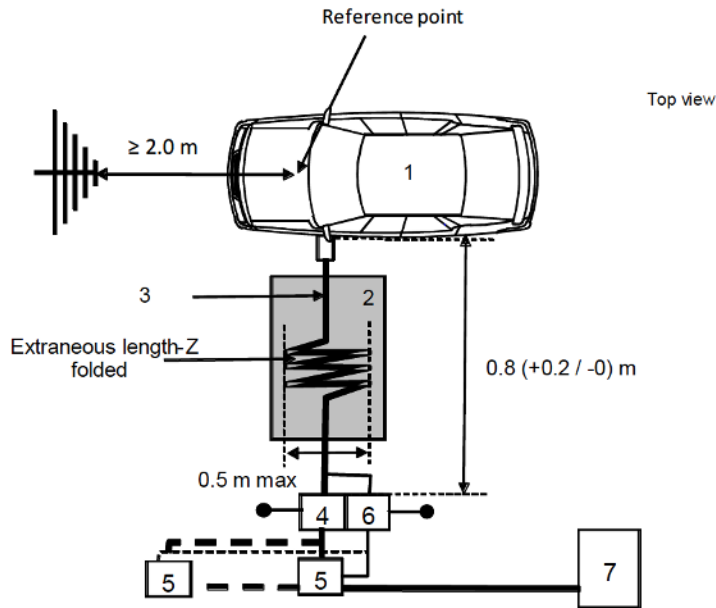


Figure 4f



Legend:

- 1 Vehicle under test
- 2 Insulating support
- 3 Charging harness with local/private communication lines
- 4 AMN(s) or DC-charging-AN(s) grounded
- 5 Power mains socket
- 6 AAN(s) grounded (optional)
- 7 Charging station

4.3. Harmonics Emissions Test Setup (Example)

Annex 11 – Appendix 1

Figure 1
Vehicle in configuration "REESS charging mode coupled to the power grid"

Example of test setup for vehicle with plug located on vehicle side

Figure 1a

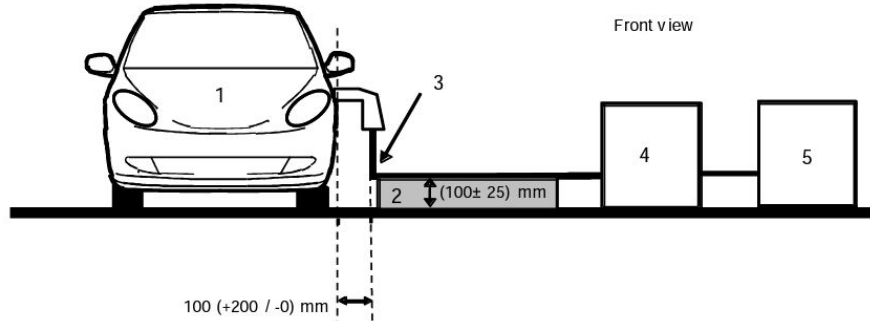
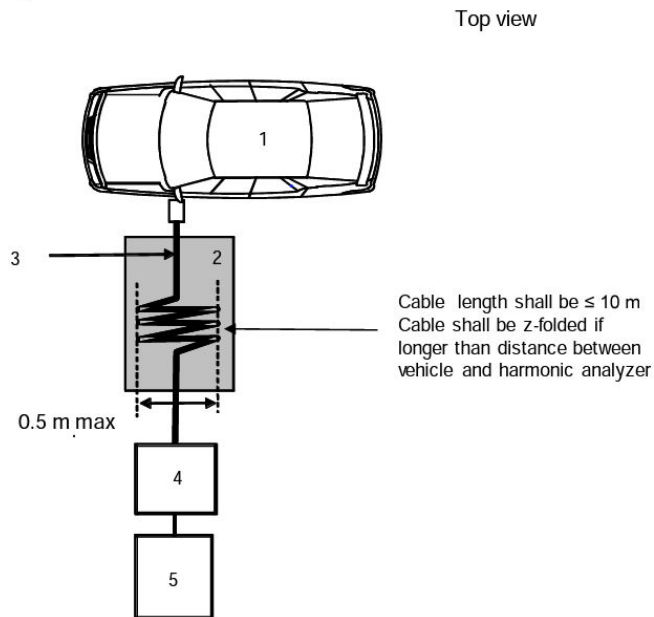


Figure 1b



Legend:

- 1 Vehicle under test
- 2 Insulating support
- 3 Charging harness
- 4 Harmonic analyzer
- 5 Power supply

4.4. Voltage changes, voltage fluctuations and flicker Emissions Test Setup (Example)

Annex 12 - Appendix 1

Figure 1
Vehicle in configuration "REESS charging mode coupled to the power grid"

Example of test setup for vehicle with plug located on vehicle side

Figure 1a

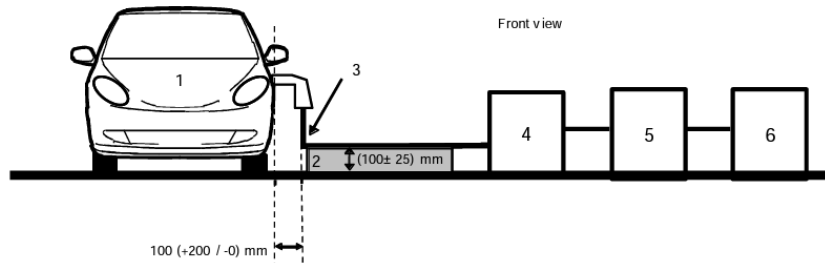
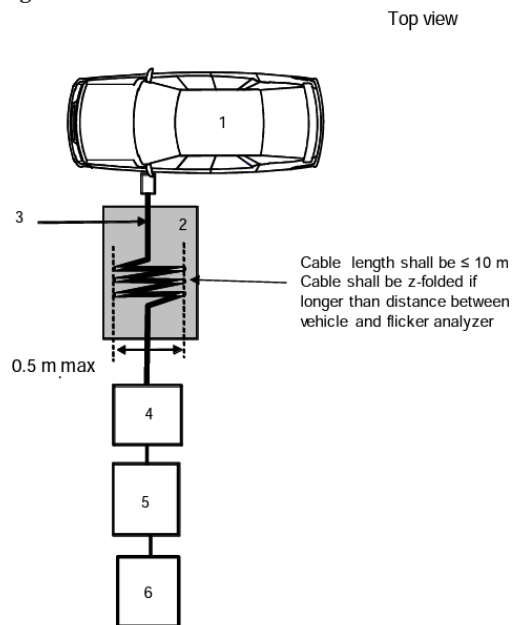


Figure 1b



Legend:

- 1 Vehicle under test
- 2 Insulating support
- 3 Charging harness
- 4 Flicker analyzer
- 5 Impedance simulator
- 6 Power supply

4.5. Conducted Emissions from AC or DC power lines Test Setup (Example)

Annex 13 - Appendix 1

Figure 1

Vehicle in configuration "REESS charging mode coupled to the power grid"

Example of test setup for vehicle with plug located on vehicle side (AC powered without communication)

Figure 1a

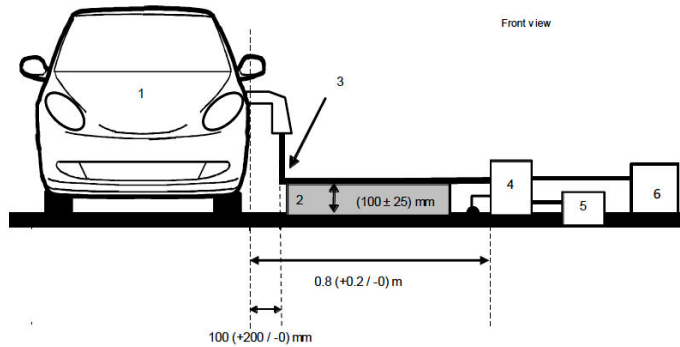
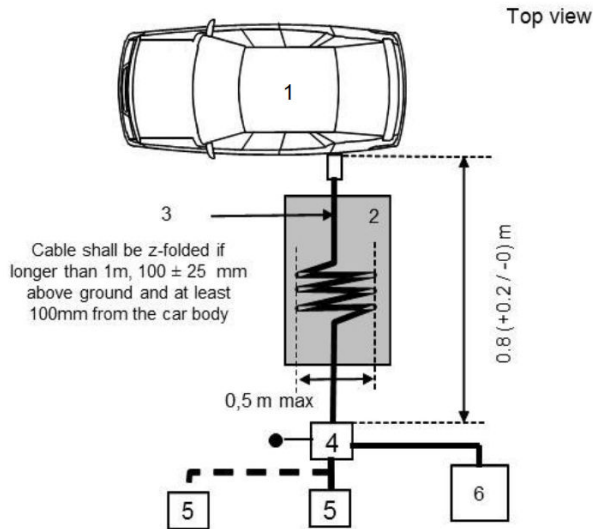


Figure 1b



Legend:

- 1 Vehicle under test
- 2 Insulating support
- 3 Charging harness
- 4 AMN(s) or DC-charging-AN(s) grounded
- 5 Power mains socket
- 6 Measuring receiver

4.6. Conducted Emissions from Wired Network Ports Test Setup (Example)

Annex 14 – Appendix 1

Figure 1
Vehicle in configuration "REESS charging mode coupled to the power grid"

Example of test setup for vehicle with plug located on vehicle side (AC or DC powered with communication)

Figure 1a

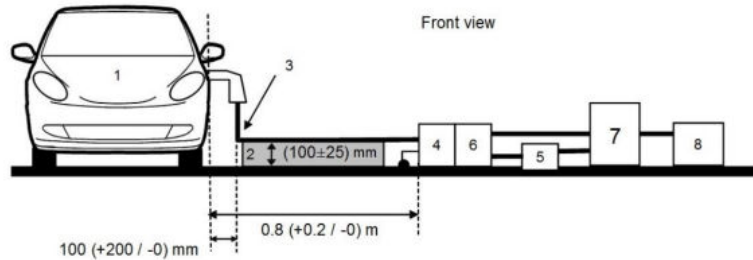
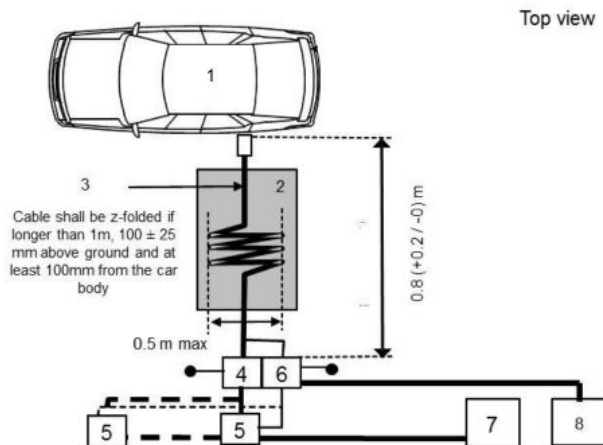


Figure 1b



Legend:

- | | | | |
|---|--------------------------------------|---|---|
| 1 | Vehicle under test | 5 | Power mains socket |
| 2 | Insulating support | 6 | AAN(s) grounded (for communication lines) |
| 3 | Charging / communication harness | 7 | Charging station |
| 4 | AMN(s) or DC-charging-AN(s) grounded | 8 | Measuring receiver |

4.7. Immunity of Vehicles to Surges conducted along AC and DC power lines Test Setup (Example)

Annex 16 - Appendix 1

Vehicle in configuration "REESS charging mode coupled to the power grid"

Figure 1

Vehicle in configuration "REESS charging mode coupled to the power grid"

Example of test setup for vehicle with plug located on vehicle side

Figure 1a

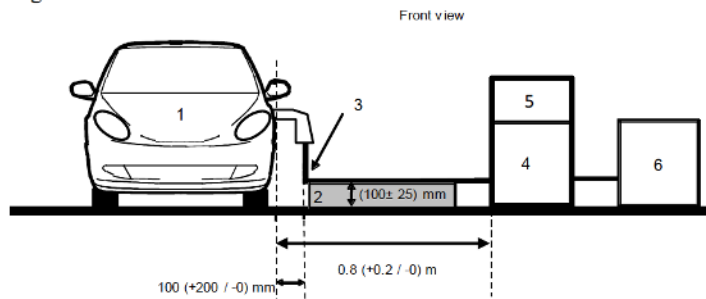
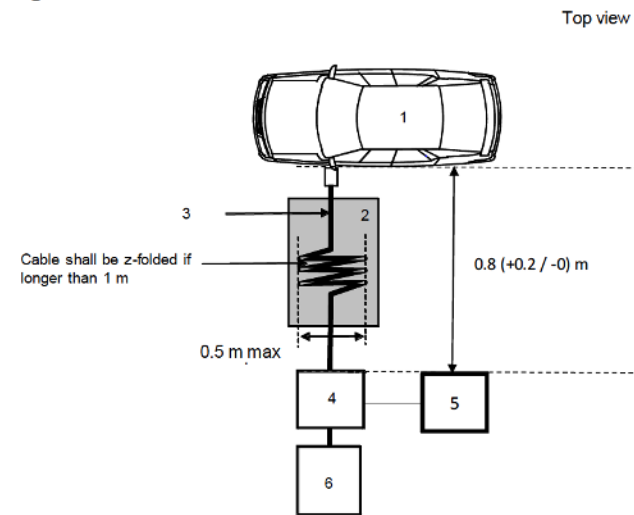


Figure 1b



Legend:

- 1 Vehicle under test
- 2 Insulating support
- 3 Charging harness
- 4 CDN
- 5 Surge generator
- 6 Power supply

Example of test setup for vehicle with plug located front/rear of vehicle

4.8. Immunity of Vehicles to Electrical Fast Transient (EFT) / Burst disturbances conducted along AC and DC power lines Test Setup (Example)

Annex 15 - Appendix 1

Figure 1
Vehicle in configuration "REESS charging mode coupled to the power grid"

Example of test setup for vehicle with plug located on vehicle side

Figure 1a

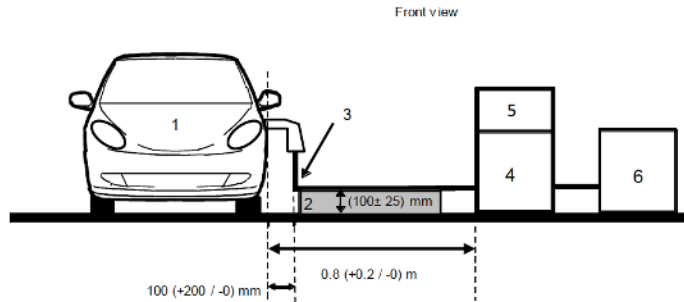
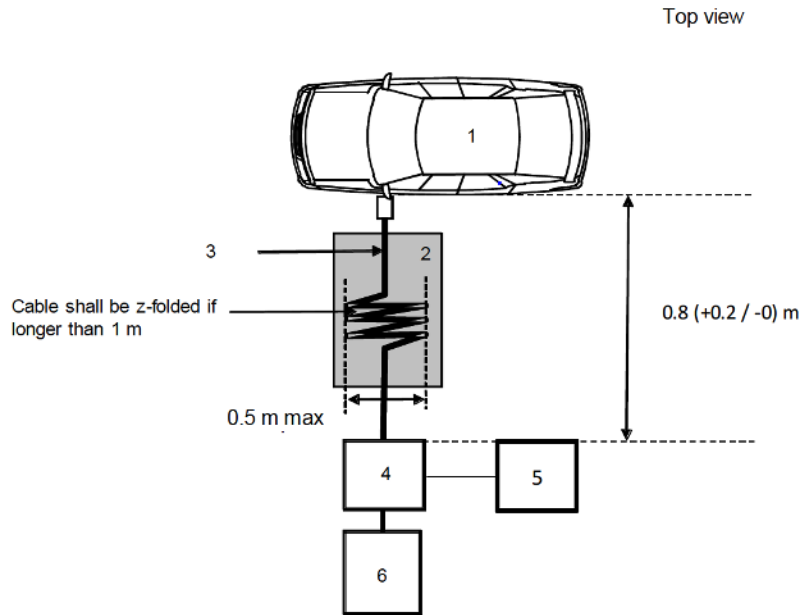


Figure 1b



Legend:

- 1 Vehicle under test
- 2 Insulating support
- 3 Charging harness
- 4 CDN
- 5 Fast Transients / Burst generator
- 6 Power supply

5. Test Site Requirements for Radiated Emissions (30MHz to 1GHz)

Annex 4 of UN ECE Regulation 10 allows alternative test sites:

“As an alternative to the requirements of CISPR 12 for vehicles of category L, the test surface may be any location that fulfils the conditions shown in the Figure of the appendix to this annex. In this case the measuring equipment shall lie outside the part shown in Figure 1 of Appendix 1 to this annex.”

“Absorber lined shielded enclosures (ALSE) and outdoor test site (OTS) may be used. An ALSE has the advantage of all all-weather testing, a controlled environment and improved repeatability because of the stable chamber electrical characteristics.”

Annex 5 of UN ECE Regulation 10 allows alternative test sites under the ‘Measuring location’ item:

“Absorber lined shielded enclosures (ALSE) and outdoor test site (OTS) may be used. An ALSE has the advantage of all all-weather testing, a controlled environment and improved repeatability because of the stable chamber electrical characteristics.”

6. Test Sites mentioned under UN ECE R10

Absorber Lined Shielded Enclosures (ALSE): RF Shielded Test Chamber whose inner walls covered by RF absorbing materials to minimize inner RF reflections. ALSE or Anechoic Chamber is used for radiated emissions and immunity tests. It can also be used for Conducted Emissions tests since it is a shielded enclosure. Compliance of ALSE is verified according to CISPR 16-1-4 standard which lists the requirements for EMC test sites. When compared to other test sites (like OATS or OTS), an ALSE has the advantage of all all-weather testing, a controlled environment and improved repeatability because of the stable chamber electrical characteristics.

Open Area Test Site (OATS): It is a test site which is located outside without or limited reflecting materials. Compliance of OATS is verified according to CISPR 16-1-4. Ambient noise of the OATS shall be taken into consideration before every measurement. Purpose of OATS is to create a free space without using any RF absorbing material. Thus reflecting obstacles are not allowed inside the measurement field. Ground floor is covered by a ground plane or flat reflecting metallic plane. All other five surfaces shall be open or covered by non-reflective materials like wood or plastic.

Outdoor Test Site (OTS): This measurement site is similar to an open area test site (OATS) as specified in CISPR 16, however a ground plane is not required and there are dimensional

changes. Floor of the OTS is mostly earth and no need to add an extra ground plane. OTS is an alternative test site to ALSE for Radiated Emissions and Immunity tests.

Shielded Enclosure: RF Shielded Test Chamber whose inner walls are not covered by any RF absorbing materials. This type of test rooms avoid RF interaction between inside and outside the room. Shielding Effectiveness of the shielded enclosure shows the shielding level. For instance if the Shielded Enclosure has a 100dB shielding effectiveness value at a certain frequency, it means the signal incoming/outgoing is decreased by 100dB due the metallic shield. Shielded Enclosures are mostly used for conducted emissions, and immunity tests that do not require RF absorbing materials.

Reference Ground Plane: This item is required by high voltage immunity tests like EFT/Burst and Surge. In order to perform these immunity tests a reference ground plane is needed even if any shielded enclosure is not required. Metallic like aluminum or copper plates are used as reference ground planes and connected to the ground.

7. Summary of EMC Tests for Vehicles according to UN ECE R10



Do you need any of these services or products for your organization?

- ECE R10 Training Services
- ECE R10 Testing and Certification Services
- ECE R10 Test Instruments and Systems
- ECE R10 Test Sites, Anechoic Chambers
Shielded Enclosures

Contact Testups:

<https://www.testups.com/contact/>

