INTERNATIONAL STANDARD

ISO 11451-2

Fourth edition
2015-06-01

Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy —

Part 2: Off-vehicle radiation sources

Véhicules routiers — Méthodes d'essai d'un véhicule soumis à des perturbations électriques par rayonnement d'énergie électromagnétique en bande étroite —

Partie 2: Sources de rayonnement hors du véhicule

Reference number
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 32, *Electrical and electronic components and general system aspects*.

Annex A of this part of ISO 11451 is for information only.

This fourth edition cancels and replaces the third edition (ISO 11451-2:2005) which has been technically revised.

ISO 11451 consists of the following parts, under the general title *Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy*:

— *Part 1: General principles and terminology*

— *Part 2: Off-vehicle radiation sources*

— *Part 3: On-board transmitter simulation*

— *Part 4: Bulk current injection (BCI)*

Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy —

Part 2: Off-vehicle radiation sources

1 Scope

This part of ISO 11451 specifies a method for testing the immunity of passenger cars and commercial vehicles to electrical disturbances from off-vehicle radiation sources, regardless of the vehicle propulsion system (e.g. spark ignition engine, diesel engine, electric motor).

The electromagnetic disturbances considered are limited to narrowband electromagnetic fields.

While this standard refers specifically to passenger cars and commercial vehicles, generalized as "vehicle(s)", it can readily be applied to other types of vehicles.

ISO 11451-1 specifies general test conditions, definitions, practical use, and basic principles of the test procedure.

Function performance status classification guidelines for immunity to electromagnetic radiation from an off-vehicle radiation source are given in Annex A.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11451-1, *Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 1: General principles and terminology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11451-1 apply.

4 Test conditions

The applicable frequency range of this test method is 0,01 MHz to 18 000 MHz. Testing over the full frequency range could require different field-generating devices, but this does not imply that testing of overlapping frequency ranges is required.

The user shall specify the test severity level or levels over the frequency range. Suggested test severity levels are given in Annex A of this International Standard.

Standard test conditions are given in ISO 11451-1 for the following:

— test temperature;

— supply voltage;

— modulation;

— dwell time;

— frequency step sizes;

— definition of test severity levels;

— test signal quality.

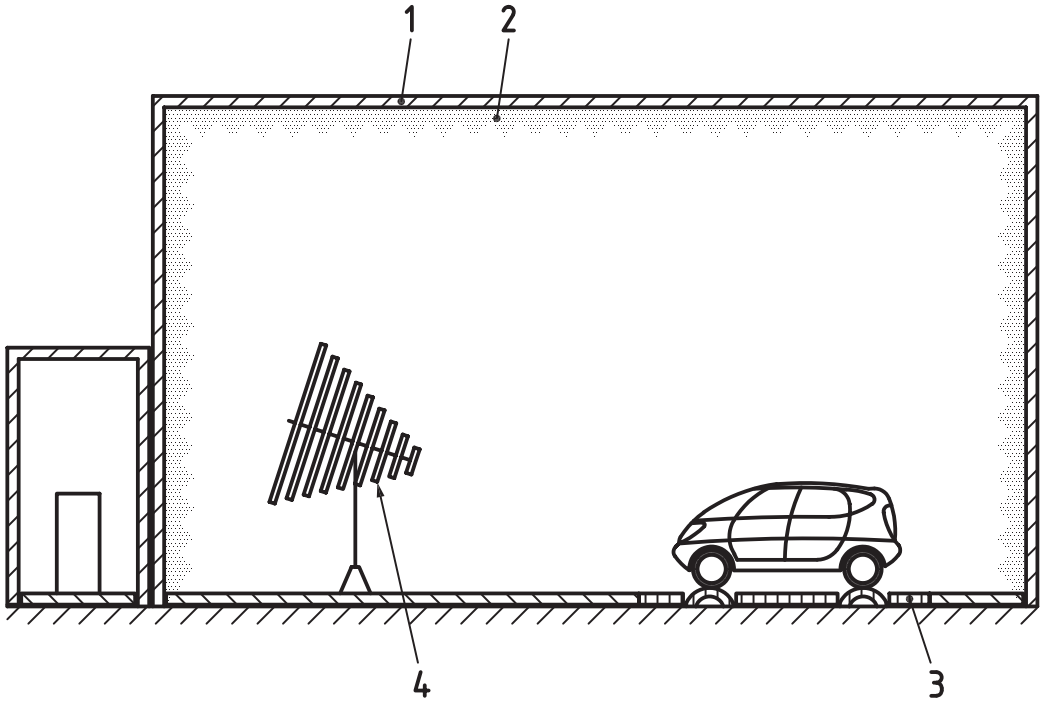
5 Test location

The test should be performed in an absorber-lined shielded enclosure.

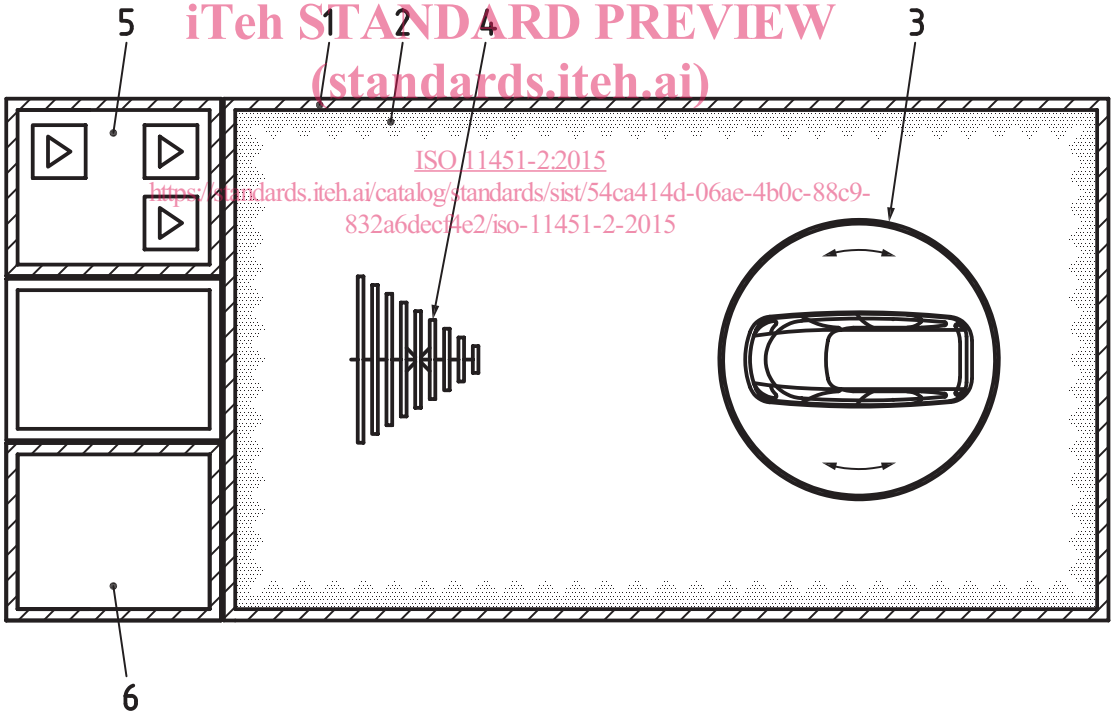
The aim of using an absorber-lined shielded enclosure is to create an indoor electromagnetic compatibility testing facility that simulates open field testing.

The size, shape, and construction of the enclosure can vary considerably. Typically, the floor is not covered with absorbing material, but such covering is allowed. Measurements in enclosures with or without floor absorbers can lead to different results. The minimum size of the shielded enclosure is determined by the size of the test region needed, the size of the field generation device or devices, the needed clearances between these and the largest vehicle to be tested, and the characteristics of the absorbing material. To create the test region, the absorber, field generation system and enclosure shape are selected such that the amount of extraneous energy in the test region is reduced to below a minimum value that will give the desired measurement accuracy. The design objective is to reduce the reflected energy in the test region to −10 dB or less over the test frequency range (not applicable to transmission line system (TLS) field generation systems). An example of a rectangular shielded enclosure is shown in Figure 1.

The test may alternatively be performed at an outdoor test site. The test facility shall comply with (national) legal requirements regarding the emission of electromagnetic fields.



a) Side view (vertical polarization)



b) Top view (horizontal polarization)

Key

1	absorber-lined shielded enclosure	4	antenna
2	RF absorber material	5	amplifier room
3	vehicle dynamometer on turntable[a]	6	control room

[a] Turntable shown rotatable through ±180° with two pairs of variable wheelbase rollers to accommodate all vehicle sizes and functions.

Figure 1 — Example of absorber-lined shielded enclosure

6 Test instrumentation

Testing consists of generating radiated electromagnetic fields using antenna sets with radio frequency (RF) sources capable of producing the desired field strength over the range of test frequencies.

The following test instrumentation is used:

— Field generating device(s): e.g. antenna(s);

— Field probe(s);

— RF signal generator with internal or external modulation capability;

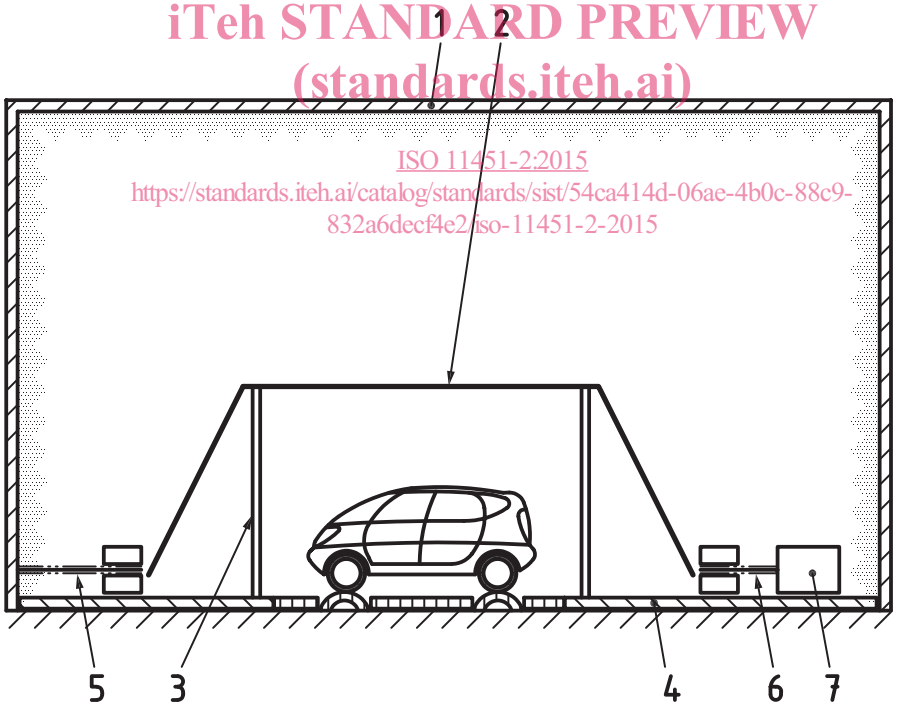
— High power amplifier(s);

— Powermeter (or equivalent measuring instrument) to measure forward power and reflected power.

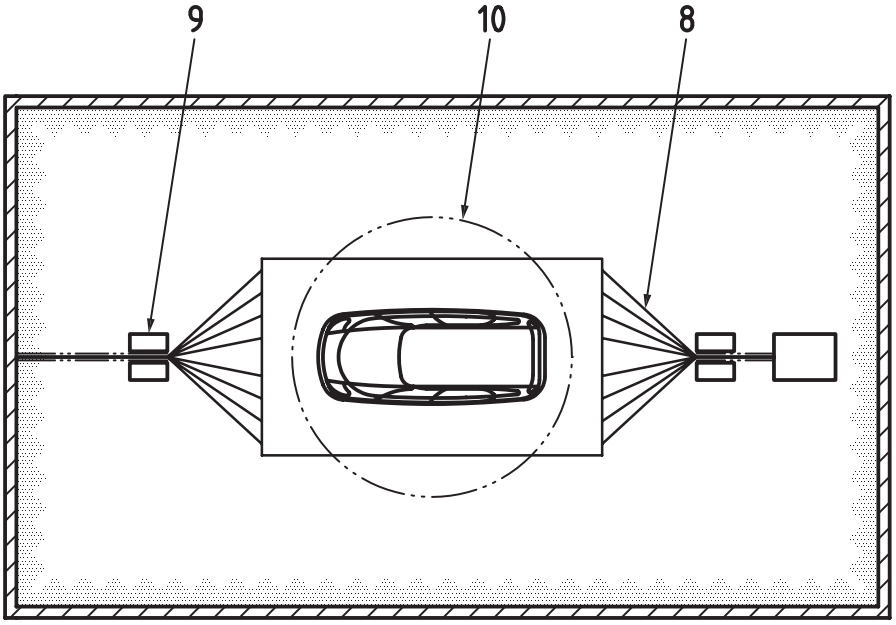
6.1 Field generating device

The field generating device can be an antenna or a TLS.

The construction and orientation of any field generating device shall be such that the generated field can be polarized in the mode specified in the test plan (see 8.1). An example of a parallel-plate TLS is shown in Figure 2. Multiple antennas, amplifiers and directional couplers could be necessary to cover the complete frequency range.



a) Side view



b) Top view

Key

1	shielded enclosure (absorbers permitted)	6	coaxial cable
2	conductive plate or set of wires	7	load
3	non-metallic supports	8	conductive wires
4	shielded enclosure floor	9	signal source feed connection
5	signal source feed line (coaxial cable)	10	turntable (not required for this test)

Figure 2 — Example of parallel-plate TLS

6.2 Field probes

Field probes shall be electrically small in relation to the wavelength and isotropic. The communication lines from the probes shall be fibre optic links.

6.3 Stimulation and monitoring of the device under test (DUT)

The vehicle shall be operated as required in the test plan by using actuators which have a minimum effect on the electromagnetic characteristics, e.g. plastic blocks on the push-buttons, pneumatic actuators with plastic tubes.

Connections to equipment monitoring electromagnetic interference reactions of the vehicle may be accomplished by using fibre-optics, or high resistance leads. Other type of leads can be used but require extreme care to minimize interactions. The orientation, length, and location of such leads shall be carefully documented to ensure repeatability of test results.

Any electrical connection of monitoring equipment to the vehicle can cause malfunctions of the vehicle. Extreme care shall be taken to avoid such an effect.

7 Test set-up

Three test setups are described:

— one for all types of vehicles when they are not connected to the power mains;

— one for vehicles in charging mode connected to the power grid (with or without communication);

— one for vehicles in charging mode through wireless power transmission (WPT).

7.1 Vehicle placement

The vehicle shall be placed in the test region. The test region can contain a vehicle dynamometer or turntable or both (see Figure 1).

7.2 Field generating device location (relative to vehicle and shielded enclosure)

The position or positions of the vehicle relative to the antenna or TLS shall be specified in the test plan (see 8.1).

The radiating elements of the field-generating device shall be no closer than 0,5 m to any absorbing material and no closer than 1,5 m to the wall of the shielded enclosure.

7.2.1 Antenna constraints

No part of the radiating antenna shall be closer than 0,5 m to the outer body surface of the vehicle.

The phase centre of the antenna shall be separated by at least 2 m horizontally from the reference point.

No part of an antenna's radiating elements shall be closer than 0,25 m to the floor.

There shall be no absorber material in the direct path between the transmitting antenna and the DUT.

7.2.2 TLS constraints

No part of a TLS, with the exception of the ground plane, shall be closer than 0,5 m to any part of the vehicle. The TLS radiating element or elements shall be separated by at least 1 m vertically from the reference point (see 8.2.1.1).

The TLS shall extend centrally over at least 75 % of the length of the vehicle.

Particular care needs to be taken when testing heavy vehicles such as buses and large trucks. Under certain conditions related to dimensions and frequency, it is possible that close to 100 % of the applied power can be coupled to the vehicle by a directional coupler mechanism. Room resonances can also have a significant effect on the field uniformity, amplitude and direction under the TLS.

7.3 Vehicle test configurations

The configuration of 7.3.1 is applicable to whatever the vehicle type (combustion engine, electric, or hybrid propulsion).

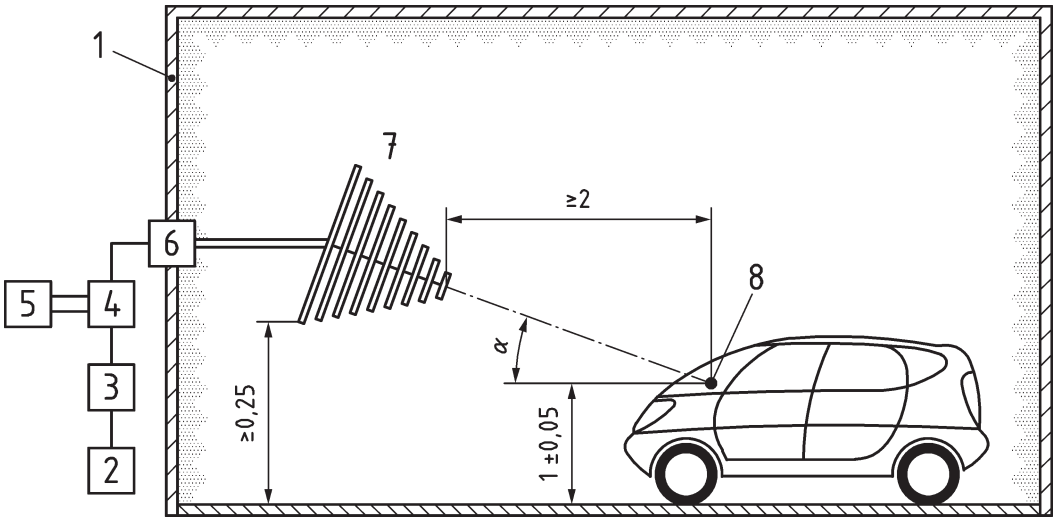
The configuration of 7.3.2 is applicable only to the electric or hybrid/plugin propelled vehicles when they are in charging mode and connected to the power grid.

The configuration of 7.3.3 is applicable only to the electric propelled vehicles when they are in charging mode through wireless power transmission (WPT).

7.3.1 Vehicle not connected to the power grid

An example of a test set-up is shown in Figure 3.

Dimensions in metres



Side view

Key

1 absorber-lined shielded enclosure
2 RF signal generator
3 power amplifier
4 dual directional coupler
5 power meter
6 coaxial feed through
7 field generating device
8 vehicle reference point (see 8.2.1.1.2)
α is the tilt angle of the antenna

Figure 3 — Example of test set-up

7.3.2 Vehicle in charging mode connected to the power grid

The various configurations (a.c. or d.c., with or without communication) are considered in this clause.

7.3.2.1 AC power charging without communication

7.3.2.1.1 Power mains

The power mains socket can be placed anywhere in the test location with the following conditions.

— It shall be placed on the ground plane.

— The length of the harness between the power mains socket and the AMN(s) shall be kept as short as possible.

— The harness shall be placed as close as possible of the ground plane.

Care shall be taken to avoid disturbances to the off-board peripheral equipment.

7.3.2.1.2 Artificial mains network

Power mains shall be applied to the vehicle through 50 µH/50 Ω artificial mains networks (AMN(s)) as defined in ISO 11451-1, Annex B.

The AMN(s) shall be mounted directly on the ground plane. The grounding connection of the AMN(s)/ AMN(s) shall be bonded to the ground plane with a low inductivity connection.

The measuring port of each AMN shall be terminated with a 50 Ω load.

The AMN shall be placed in front, aligned and on the same side of the vehicle power charging plug.

7.3.2.1.3 Power charging cable

The power charging cable shall be placed in a straight line between the AMN(s) and the vehicle charging plug and shall be routed perpendicularly to the vehicle longitudinal axis as shown in Figures 4 and 5. The distance between the AMN(s) and the vehicle body should be 0,8 (+0,2/0) m.

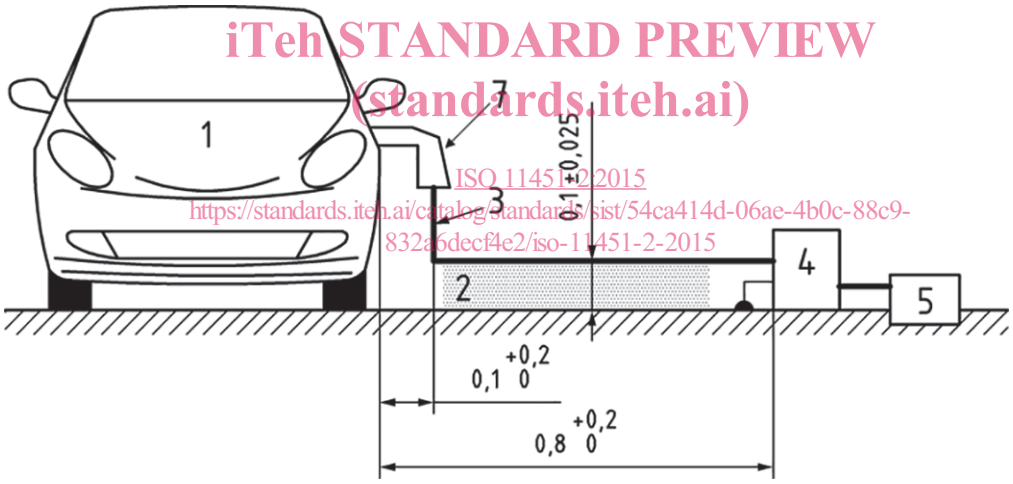
If the length of the cable is longer than 1 m, the extraneous length shall be "Z-folded" in less than 0,5 m width.

The charging cable at vehicle side shall hang vertically at a distance of 100 (+200/0) mm from the vehicle body.

The whole cable shall be placed on a non-conductive, low relative permittivity (dielectric-constant) material ($\varepsilon_r \leq 1{,}4$), at (100 ± 25) mm above the ground plane.

Examples of test set-ups are shown in Figures 4 and 5.

Dimensions in metres



a) Front view