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Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy — ~~Part 3: On-board transmitter simulation~~

~~*Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy -*~~ **Part 3: On-board transmitter simulation**

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

Partie 3: Simulation des émetteurs embarqués

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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 document 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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 32, *Electrical and electronic components and general system aspects*.

This fourth edition cancels and replaces the third edition (ISO ~~1151~~11451-3:2015), which has been technically revised.

The main changes are as follows:

— ~~—~~change of the frequency range from 1,8 MHz – 5,85 GHz to 1,8 MHz – 6 GHz;

— ~~—~~suppression of test methodology with commercial transmitters;

— ~~—~~use of modulation from ISO ~~11452~~ 11451-1;

— ~~—~~addition of new Annex A~~Annex A~~ with description of test methodology for net power characterization procedure;

— ~~—~~addition in Annex C~~Annex C~~ of microwave broadband dipole antenna and HF broadband sleeve antenna;

— ~~—~~addition of Annex D~~Annex D~~ on function performance status classification (FPSC~~;~~).

~~— — addition of Annex E on future work.~~

A list of all parts in the ISO 11451 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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

Part 3:
On-board transmitter simulation

1 Scope

This document specifies methods for testing the immunity of passenger cars and commercial vehicles to electromagnetic disturbances from on-board transmitters connected to an external antenna and portable transmitters with integral antennas, regardless of the vehicle propulsion system (e.g. spark ignition engine, diesel engine, electric motor).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. 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 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
integral antenna
permanent fixed antenna which may be built-in, designed as an indispensable part of the portable transmitting device

3.2
peak power sensor
power sensor that allows direct measurement of the peak power of the modulated carrier signal

3.3
average power sensor
power sensor that allows direct measurement of the average power of the modulated carrier signal

4 Test conditions

The applicable frequency range of the test method is 1,8 MHz to 6 GHz.

The user shall specify the test severity level(s) over the frequency range. Suggested test levels are included in Annex DAnnex D.. Typical on-board transmitter characteristics (frequency bands, power level and modulation) are given in Annex BAnnex B..

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

— —test temperature;

— —supply voltage;

— —dwell time;

— —Frequencyfrequency step;

— —modulation;

— —test signal quality.

NOTE Alternate modulations, if required, can be found in Annex BAnnex B.. Users of this document are advised that Annex BAnnex B is for information only and cannot be considered as an exhaustive description of various portable transmitters available in all countries.".

5 Test location

5.1 General

This test should typically be performed in an absorber lined shielded enclosure (ALSE). Where national regulations permit, the test can also be performed at an outdoor test site.

5.2 Absorber lined shielded enclosure (ALSE)

An absorber lined shielded enclosure with the characteristics specified in ISO 11451--2 should be used for this test.

NOTE At frequencies where absorbers are not effective, the reflections in the chamber can affect the exposure of the vehicle.

5.3 Outdoor test site

Where national regulations permit the use of an outdoor test site, the outdoor test site should have an area with a radius of 10 m free from large metal structures or objects. When performing outdoor test-site tests, it is important to be aware of harmonic suppression regulations.

6 Test instrumentation

6.1 General

The following test instrumentation is used:

— —radio frequency (RF) generator with internal or external modulation capability;

— —power amplifier;

— —power measuring instrumentation to measure the forward and reverse power;

— ——dual directional coupler;

— ——low loss coaxial cables;

— ——vector network analyser (VNA);

— ——transmit antenna;

— ——direct current charging artificial network (DC- charging AN), and/or artificial mains networks (AMN), and/or asymmetric artificial networks (AAN).

6.2 Signal sources

6.2.1 Transmitters with antenna outside the vehicle

Signal sources for transmitters with antenna outside the vehicle should be simulated on-board transmitters (use of a signal generator and broadband power amplifier located external to the vehicle capable of generating radio frequency (RF) power in their operational frequency ranges with specific output power delivered to a test antenna or ~~Original Equipment Manufacturer~~original equipment manufacturer (OEM) antenna fitted to the vehicle).

When using simulated on-board transmitters located external to the vehicle, it is advisable to place an RF choke (ferrite or powdered iron toroid) around the coaxial cable to the antenna to produce a minimum lossy impedance of 200 ohms. This ~~is required to reduce~~facilitates reduction in cable shield skin currents and more closely simulate a transmitter installed in the vehicle.

6.2.2 Transmitters with antenna inside the vehicle

Signal sources for transmitters with antenna inside the vehicle should be simulated portable transmitters (use of a signal generator and broadband power amplifier located external to the vehicle capable of generating radio frequency (RF) power in their operational frequency ranges with specific output power). The power is delivered to a small passive antenna within the vehicle. Antennas used for this testing are described in Annex C~~Annex C.~~

6.3 Power monitoring

6.3.1 General

Either power sensors or a spectrum analyser (or measurement receiver) shall be used for measurement of the forward and reflected power at the dual directional coupler. When power sensors are used to measure forward and reflected power:

— ——CW or AM signal shall be measured either with an average power sensor or a peak power sensor (peak conservation may be applied for AM per ISO 11451-1);

— ——pulsed power modulation shall be measured with a peak power sensor;

— ——when applying Broadband test signal, power measurement instrumentation shall be capable of measuring average and peak values of the channel power;

— ——power sensors should be connected directly to the coupler ports;

— ——power sensors shall exhibit a VSWR ~~<~~ ≤ 1,2 and measurement accuracy ~~<~~ ≤ 0,5 dB.

When a spectrum analyser (or measurement receiver) is used to measure forward and reflected power, it shall exhibit the same VSWR and measurement accuracy as required for power sensors. When the sensors or a spectrum analyser (or measurement receiver) are connected to the coupler via coaxial cables, the cable's transmission loss shall be taken into account during characterization. See Annex AAnnex A for details.

6.3.16.3.2 Dual directional coupler

The coupler shall exhibit the following characteristics:

— coupling factor:→ > 20 dB (40 dB recommended),

— mainline port VSWR← < 1,3,

— coupling port VSWR:← < 1,5,

— mainline transmission loss:← < 0,5 dB,

— directivity:→ > 18 dB,

— power rating compatible with testing needs.

6.3.26.3.3 Low loss coaxial cable

The 50 Ω coaxial cable assembly (including all adaptors, switches, etc.) connecting the dual directional coupler to the transmit antenna shall exhibit a VSWR← < 1,1 and transmission loss← < 6 dB. Verification shall be performed in accordance with Annex AAnnex A.

6.4 Vector network analyser (VNA)

The VNA shall exhibit the following characteristics:

— frequency range: 1,8 MHz –to 6 GHz,

— dynamic range:→ > 60 dB (IF bandwidth← < 3 kHz),

— return loss:→ > 32 dB,

— transmission loss accuracy:← < 0,1 dB,

— minimum number of points: 401,

— IF bandwidth: selected to meet return and transmission loss requirements (typically 1 kHz),

— VNA calibration kit to facilitate TOSM (through, open, short, matched) measurements:

  — termination through: return loss→ > 35 dB,

  — termination short/open: deviation in nominal phase← < 2°,

  — termination match: return loss→ > 40 dB.

The following characteristics are recommended:

— frequency step: specified by the manufacturer (logarithmic step recommended),

— ——power level: 0 dBm (recommended value),

— ——averaging capability (optional),

— ——it is recommended to use the same connector type to match that of the interconnecting cable assembly and transmit antenna (avoid using adaptors).

6.5 Antennas

6.5.1 Simulated on-board transmitters

When an OEM antenna is not installed on the vehicle, the antenna(s) described below shall be used.

— ——For frequency ranges ~~≤~~ ≤ 30 MHz, loaded antennas shall be used. Loaded antennas employ lumped or distributed reactive components with a radiating element physically shorter than quarter wave at resonance. It is recommended to use a "screw-driver" antenna which allows use of a single antenna thus reducing installation time. Use of this antenna also facilitates automation techniques.

— ——For frequency ranges ~~>~~ > 30 MHz, for example, for the very high frequency (VHF) and ultra-high frequency (UHF) bands, quarter wave antennas should be given preference over 5/8 wave antennas, since there are higher skin currents created by quarter wave antennas.

NOTE ~~a~~A screwdriver antenna is a vertical antenna for mobile operation in amateur HF band. It can cover from 10 m to 160 m band according to adjust a centre loading coil remotely. It is named from an electric screwdriver, because of its tuning method by a reversible DC electric motor.

All antennas shall be tuned on the vehicle for minimum voltage standing wave ratio (VSWR, typically less than 2:1) unless otherwise specified in the test plan. As a minimum, the VSWR value shall be measured and recorded with the antenna on the vehicle at the lower and upper band edge and at a middle frequency. See Annex A~~Annex A~~ for procedures to make these measurements.

6.5.2 Simulated portable transmitter

Unless otherwise specified, the simulated portable transmitter antenna shall be a passive antenna. For characteristics of a passive antenna, see Annex C~~Annex C~~.

6.6 Stimulation and monitoring of the vehicle

If remote stimulation and monitoring are required in the test plan, the vehicle shall be operated by 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 monitoring equipment can be accomplished by using fibre-optics or high resistance leads. Other types of leads can be used, but they 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

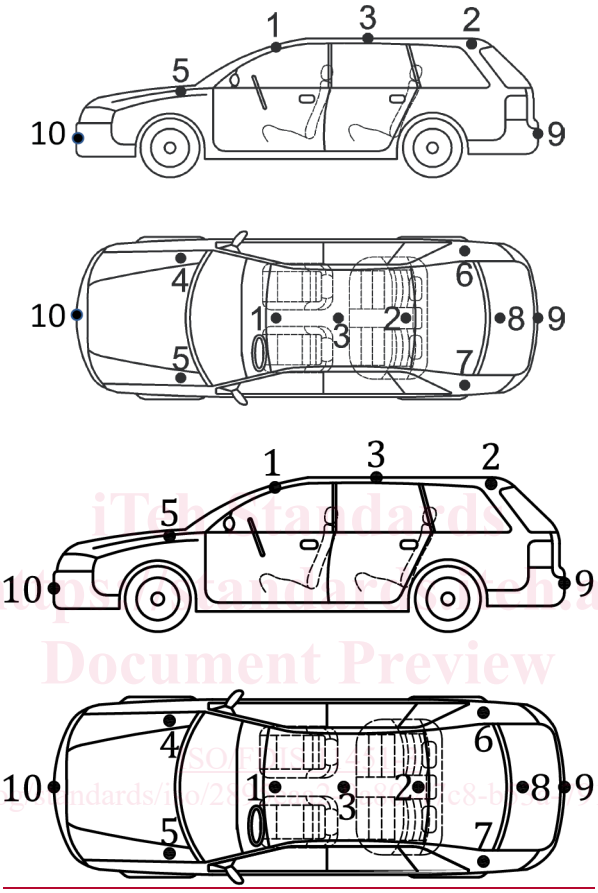
7.1 Transmitters with antenna outside the vehicle

The test can be performed with test antenna(s) or with the vehicle's OEM antenna, as defined in 6.5.1~~6.5.1.~~

When a test antenna is used, the location(s) of the antenna on the vehicle shall be defined in the test plan. If no specific location(s) are agreed between the users of this document, the following location (s) are recommended, as illustrated in Figure 1~~Figure 1~~:

— ~~—~~locations 1 (vehicle roof, front) and 2 (vehicle roof, rear) are the default locations for frequencies ≥ 30 MHz. Locations 3 through 8 are optional.

— ~~—~~location 9 (bumper) is the default location for frequencies < 30 MHz. Location 10 is optional.



Key

1	vehicle roof (front)	6	fender (rear, right)
2	vehicle roof (rear)	7	fender (rear, left)
3	vehicle roof (middle)	8	trunk lid (middle)
4	fender (front, right)	9	bumper (middle) ~~<~~ < 30 MHz only
5	fender (front, left)	10	front bumper ~~<~~ < 30 MHz only

Figure 1 — Recommended locations for antennas outside the vehicle

Examples of test set-up for simulated on-board transmitters are shown in Figure 2~~Figure 2~~ (use of test antenna) and Figure 3~~Figure 3~~ (use of vehicle OEM antenna).

When the vehicle OEM antenna is used, it should be used as it is installed in the vehicle without any change of antenna characteristics (location, VSWR, etc.).

When the vehicle OEM antenna is used for multiple transmitters/receivers frequency, it is advisable not to use a simulated on-board transmitter (with “broadband” amplifier). The amplifier noise level can be sufficient to