INTERNATIONAL STANDARD

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

Part 4:
Harness excitation methods

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

Partie 4: Méthodes d'excitation des faisceaux

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11452-4 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This fourth edition cancels and replaces the third edition (ISO 11452-4:2005), which has been technically revised.

ISO 11452 consists of the following parts, under the general title *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy*:

— *Part 1: General principles and terminology*

— *Part 2: Absorber-lined shielded enclosure*

— *Part 3: Transverse electromagnetic (TEM) cell*

— *Part 4: Harness excitation methods*

— *Part 5: Stripline*

— *Part 7: Direct radio frequency (RF) power injection*

— *Part 8: Immunity to magnetic fields*

— *Part 9: Portable transmitters*

— *Part 10: Immunity to conducted disturbances in the extended audio frequency range*

— *Part 11: Reverberation chamber*

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

Part 4:
Harness excitation methods

1 Scope

This part of ISO 11452 specifies harness excitation test methods and procedures for determining the immunity of electronic components of passenger cars and commercial vehicles regardless of the propulsion system (e.g. spark-ignition engine, diesel engine, electric motor).

The bulk current injection (BCI) test method is based on current injection into the wiring harness using a current probe as a transformer where the harness forms the secondary winding.

The tubular wave coupler (TWC) test method is based on a wave coupling into the wiring harness using the directional coupler principle. The TWC test method was developed for immunity testing of automotive components with respect to radiated disturbances in the GHz ranges (GSM bands, UMTS, ISM 2,4 GHz). It is best suited to small (with respect to wavelength) and shielded device under test (DUT), since in these cases the dominating coupling mechanism is via the harness. For DUTs which are larger than a wavelength (e.g. 0,1 m at 3 GHz), direct field coupling to the printed circuit board (PCB) becomes of equal importance. The user of the TWC test method should take this into account and determine the applicability of the method.

The electromagnetic disturbances considered in this part of ISO 11452 are limited to continuous narrowband electromagnetic fields.

2 Normative references

The following referenced documents are indispensable for the application 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 11452-1:2005, *Road vehicles — Component 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 11452-1 apply.

4 Test conditions

The applicable frequency ranges of the BCI and the TWC test methods are direct functions of the transducer characteristics (current probe or tubular wave coupler). More than one type of transducer may be required.

To test automotive electronic systems, the typical applicable frequency range

— of the BCI test method is 1 MHz to 400 MHz,

— of the TWC test method is 400 MHz to 3 GHz.

NOTE Current probes and tubular wave couplers are available which allow testing outside these frequency ranges.

The users shall specify the test severity level(s) over the frequency range. Suggested test levels are included in Annex E.

Standard test conditions are given in ISO 11452-1 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 tests shall be performed in a shielded enclosure.

6 Test instrumentation

6.1 BCI test method

6.1.1 General

BCI is a method of carrying out immunity tests by inducing disturbance signals directly into the wiring harness by means of a current injection probe. The injection probe is a current transformer through which the wiring harnesses of the device under test (DUT) are passed. Immunity tests are carried out by varying the test severity level and frequency of the induced disturbance.

The following equipment is used:

— ground plane;

— current injection probe(s);

— current measurement probe(s);

— artificial network(s) [AN(s)];

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

— power amplifier;

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

— current measurement equipment.

6.1.2 Injection probe

An injection probe or set of probes capable of operating over the test frequency range is required to couple the test signal to the DUT. The probe(s) shall be capable of withstanding the necessary input power for the maximum test level over the test frequency range regardless of the test set-up loading.

Saturation of the injection probe should be taken into consideration in establishing the test levels.

6.1.3 Current measurement probe

The current measurement probe or set of probes shall be capable of operating over the test frequency range.

6.1.4 Stimulation and monitoring of the DUT

The DUT shall be operated as required in the test plan 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 equipment monitoring electromagnetic interference reactions of the DUT may be accomplished by using fibre-optics, or high-resistance leads. Other type of leads may 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 DUT may cause malfunctions of the DUT. Extreme care shall be taken to avoid such an effect.

6.2 TWC test method

6.2.1 General

The approach of this test method is an equivalent coupling to a plane wave coupling into a wiring harness of automotive components. To realize this, a short 50 Ω coaxial line configuration with open ends, an inner tube-shaped conductor and matched terminations are used to generate a transverse electromagnetic (TEM) wave inside. The wiring harness leads through the inner conductor of the wave coupler. This leads to two disturbing components for the DUT: a TEM wave component coupled via the cable, and a radiated component, caused by the scattering field from the primary TEM wave in the connecting cable between the coupler and the DUT.

The following equipment is used:

— ground plane;

— tubular wave coupler;

— artificial networks(s) [AN(s)];

— RF generator with internal or external modulation capability;

— power amplifier;

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

6.2.2 Tubular wave coupler

A tubular wave coupler is used to couple the disturbances into the test wiring harness. It shall be capable of coupling the test power over the test frequency range into the wiring harness and shall have a sufficiently high coupling and power rating.

6.2.3 50 Ω load resistor

A 50 Ω load resistor is used to match the output of the tubular wave coupler. The power rating shall be equal or greater than the applied forward power.

6.2.4 Stimulation and monitoring of the DUT

See 6.1.4.

7 Test set-up

7.1 Ground plane

The ground plane shall be made of 0,5 mm thick (minimum) copper, brass or galvanized steel.

The minimum width of the ground plane shall be 1 000 mm. The minimum length of the ground plane shall be

— 1 500 mm for the BCI method using the closed-loop method with power limitation,

— 2 000 mm for all other methods defined in this part of ISO 11452, or

— underneath the entire equipment plus 200 mm, whichever is larger.

The ground plane shall be bonded to the walls or the floor of the shielded enclosure such that the d.c. resistance shall not exceed 2,5 mΩ. The distance from the edge of the ground strap to the edge of the next strap shall not be greater than 300 mm. The maximum length to width ratio for the ground straps shall be 7:1.

7.2 Power supply and AN

Each DUT power supply lead shall be connected to the power supply through an AN.

Power supply is assumed to be negative ground. If the DUT utilizes a positive ground then the test set-ups shown in the figures need to be adapted accordingly. Power shall be applied to the DUT via 5 µH/50 Ω AN (see Annex C for artificial network schematic). Requirements vary depending on the intended DUT installation in the vehicle.

— For a DUT remotely grounded (vehicle power return line longer than 200 mm), two ANs are required, one for the positive supply line and one for the power return line (see Annex D).

— For a DUT locally grounded (vehicle power return line 200 mm or shorter), one AN is required for the positive supply (see Annex D).

The AN(s) shall be mounted directly on the ground plane. The case(s) of the AN(s) shall be bonded to the test bench ground plane.

The power supply return shall be connected to the test bench ground plane [between the power supply and the AN(s)].

The measuring port of each AN shall be terminated with a 50 Ω load which is capable of dissipating the coupled RF power.

7.3 Location of the DUT

The DUT shall be placed on a non-conductive, low relative permittivity (dielectric constant) material ($\varepsilon_r \leq 1{,}4$), at (50 ± 5) mm above the metallic surface of the table.

The case of the DUT shall not be grounded to the metallic surface of the table unless it is grounded in the actual vehicle.

The face of the DUT shall be located at least 100 mm from the edge of the ground plane.

There should be a distance at least 500 mm between the DUT and any metal part such as the walls of the shielded room, with the exception of the ground plane on which the DUT is placed.

7.4 Length and location of the test harness

Unless otherwise specified in the test plan, the length of test harness between the DUT and the load simulator shall be:

— $\left(1\,700^{+300}_{\;\;0}\right)$ mm for all test methods defined in this part of ISO 11452 except for the BCI test method using the closed-loop method with power limitation;

— $\left(1\,000^{+200}_{\;\;0}\right)$ mm for the BCI test method using the closed-loop method with power limitation.

The wiring type is defined by the actual system application and requirement.

The wiring harness shall be straight:

— over at least 1 400 mm starting at the DUT for all test methods defined in this part of ISO 11452 except for the BCI test method using the closed-loop method with power limitation;

— over its entire length for the BCI test method using the closed-loop method with power limitation.

The wiring harness should be fixed (position and number of wires).

The wiring harness should pass through the current injection and current measurement probes or the tubular wave coupler. The length of the wires in the load simulator should be short by comparison with the length of the harness. The wires within the load simulator should be fixed.

NOTE If all wires in the load simulator and the wiring harness have the same lengths, strong resonance effects might occur. This can be avoided by using or adding wires of different lengths in the load simulator.

The test harness (or each branch) shall be placed on a non-conductive, low relative permittivity (dielectric constant) material ($\varepsilon_r \leq 1{,}4$), with a thickness of (50 ± 5) mm.

For DUTs with multiple harness branches, the branches not included in the probe shall be placed at least 100 mm away from the branch included in the probe.

7.5 Location of the load simulator

Preferably, the load simulator should be placed directly on the ground plane. If the load simulator has a metallic case, this case shall be bonded to the ground plane.

Alternatively, the load simulator may be located adjacent to the ground plane (with the case of the load simulator bonded to the ground plane) or outside of the test chamber, provided the test harness from the DUT passes through an RF boundary bonded to the ground plane.

When the load simulator is located on the ground plane, the DC power supply lines of the load simulator shall be connected through the AN(s).

7.6 Location of the harness excitation

7.6.1 BCI test method

7.6.1.1 Substitution method

The injection probe shall be placed at (150 ± 50) mm from the connector of the DUT. Additional tests at d = (450 ± 50) mm and d = (750 ± 50) mm may be required.

If a current measurement probe is used during the test, it shall be placed at (50 ± 10) mm from the connector of the DUT.

An example of a test configuration is shown in Figure 1.

7.6.1.2 Closed-loop method with power limitation

The injection probe shall be placed at (900 ± 10) mm from the connector of the DUT.

The current measurement probe shall be placed at (50 ± 10) mm from the connector of the DUT.

An example of a test configuration is shown in Figure 2.

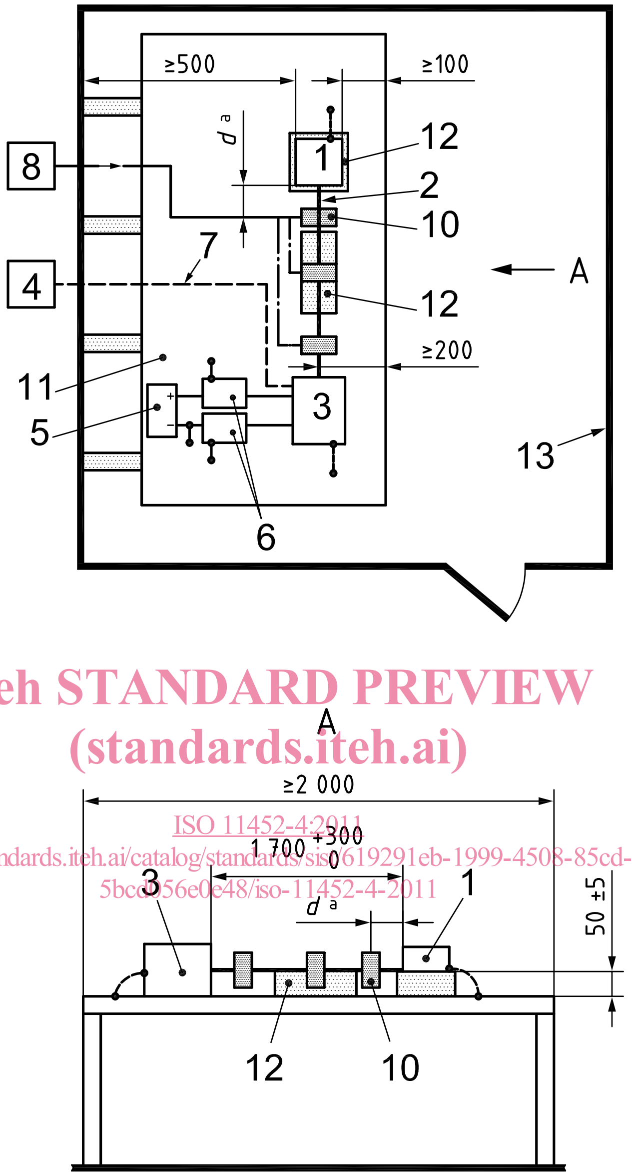
7.6.2 TWC test method

The tubular wave coupler shall be placed at (100 ± 10) mm from the DUT and isolated from the ground plane. It shall be connected to the high-frequency equipment at the port, which is closer to the DUT. The 50 Ω load resistor shall be placed isolated from the ground plane at a minimum distance of 200 mm from the wiring harness and connected to the second port of the TWC

Figure 3 gives an example for the test set-up.

Dimensions in millimetres

Top view



Side view

Key

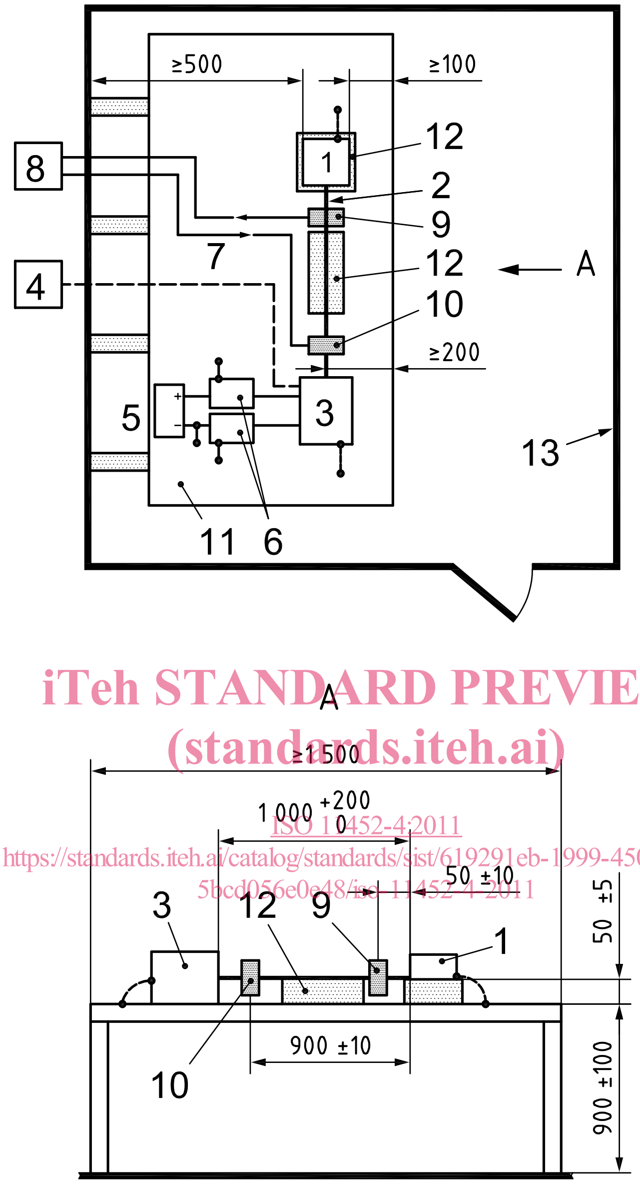
1 DUT (connected to ground if specified in the test plan)
2 wiring harness (S)
3 load simulator (placement and ground connection according to 7.5)
4 stimulation and monitoring system
5 power supply
6 AN
7 optical fibres
8 high-frequency equipment
9 optional current measurement probe (not shown in this figure, but shown in Figure 2)
10 injection probe (represented at 3 positions)
11 ground plane (connected to the shielded room)
12 low relative permittivity support ($\varepsilon_r \leq 1{,}4$)
13 shielded room

[a] See 7.6.1.1.

Figure 1 — BCI configuration — Substitution method

Dimensions in millimetres

Top view



Side view

Key

1 DUT (connected to ground if specified in the test plan)
2 wiring harness
3 load simulator (placement and ground connection according to 7.5)
4 stimulation and monitoring system
5 power supply
6 AN
7 optical fibres
8 high-frequency equipment
9 current measurement probe
10 injection probe
11 ground plane (connected to the shielded room)
12 low relative permittivity support ($\varepsilon_r \leq 1,4$)
13 shielded room

Figure 2 — BCI configuration — Closed-loop method with power limitation