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

Part 8:

**Immunity to magnetic fields**

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

ISO 11452-8:2015

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Partie 8: Méthodes d'immunité aux champs magnétiques



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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.

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](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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*.

This second edition cancels and replaces the first edition (ISO 11452-8:2007), of which it constitutes a minor revision.

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

- *Part 1: General principles and terminology*
- *Part 2: Absorber-lined shielded enclosure*
- *Part 3: Transverse electromagnetic mode (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 transmitter*
- *Part 10: Immunity to conducted disturbances in the extended audio frequency range*
- *Part 11: Reverberation chamber*

[Annex A](#) of this part of ISO 11452 is for information only.

## Introduction

Immunity measurements of complete road vehicles are generally able to be carried out only by the vehicle manufacturer, owing to, for example, high costs of absorber-lined shielded enclosures, the desire to preserve the secrecy of prototypes, or a large number of different vehicle models.

For research, development, and quality control, a laboratory measuring method can be used by both vehicle manufacturers and equipment suppliers to test electronic components.

ISO 11452-1 specifies general test conditions, definitions, practical use, and basic principles of the test procedure.

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

## Part 8: Immunity to magnetic fields

### 1 Scope

This part of ISO 11452 specifies tests for electromagnetic immunity of electronic components for passenger cars and commercial vehicles, regardless of the propulsion system (e.g. spark-ignition engine, diesel engine, electric motor), to magnetic fields. These sources are classified into “internal magnetic field” (sources internal to the vehicle, e.g. vehicle electro-mechanical motors, actuators,...) and “external magnetic field” (sources external to the vehicle e.g. power transmission lines, generating stations,...). To perform this test, the device under test (DUT) is exposed to a magnetic disturbance field.

The radiating loop method can be applied to small DUTs or to larger DUTs by positioning the coil in multiple locations.

The Helmholtz coil is sometimes used as an alternative method. This technique is limited by the relationship between the size of the DUT and the size of the coils. The electromagnetic disturbances considered in this part of ISO 11452 are limited to continuous narrowband electromagnetic fields.

### 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 11452-1, *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 1: General principles and terminology*

VG 95377-13:1993, *Electromagnetic compatibility — Measuring devices and measuring equipment — measuring antennas, measuring coils and field probes*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11452-1 apply.

### 4 Test conditions

#### 4.1 General

The applicable frequency range of this test method is d.c. and 15 Hz to 150 kHz.

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

Standard test conditions are given in ISO 11452-1 for the following:

— test temperature;

- supply voltage;
- dwell time;
- definition of test severity levels.

## 4.2 Frequency step sizes

The tests shall be conducted at d.c. and at frequencies of 16,67 Hz, 50 Hz, 60 Hz, 150 Hz, and 180 Hz and with frequency step sizes (logarithmic or linear) not greater than those specified in [Table 1](#). The step sizes agreed upon by the users of this part of ISO 11452 shall be documented in the test report.

Table 1 — Maximum frequency steps sizes

Frequency band kHz	Linear steps kHz	Logarithmic steps %
0 (d.c.)	-	-
0,015 to 0,1	0,01	10
0,1 to 1	0,1	10
1 to 10	1	10
10 to 150	10	10

NOTE The 5th harmonic of 16,67 Hz, 50 Hz and 60 Hz can also be tested.

If it appears that the susceptibility thresholds of the DUT are very near to the chosen test level, these frequency step sizes should be reduced in the frequency range concerned in order to find the minimum susceptibility thresholds.

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## 5 Test location

A shielded room is not required.

**IMPORTANT — The appropriate guidelines (national regulation, ICNIRP,<sup>[2]</sup><sup>[3]</sup> etc.) shall be followed for the protection of the test personnel.**

## 6 Test apparatus description and specification

### 6.1 General

The test apparatus shall consist of the following:

- field-generating device(s): radiating loop or Helmholtz coil;
- magnetic field strength monitor;
- low-frequency (LF) generator;
- low-frequency (LF) amplifier (capable of driving inductive load);
- voltmeter;
- current monitor;
- artificial network(s) (AN) (optional, see ISO 11452-1 for characteristics).



## 6.2 Field-generating device

### 6.2.1 Radiating loop

The radiating loop of MIL STD 461 F is recommended (not suitable for high level d.c. fields), but any similar coil may be used. The MIL STD 461 F coil has the following characteristics:

- diameter: 120 mm;
- number of turns: 20;
- wire: approximate diameter 2,0 mm (AWG12).

For d.c. fields up to 3 000 A/m, a specialized coil is required in accordance with VG 95377-13.

The magnetic flux density  $B_{50\text{mm}}$  of this radiating loop of MIL STD 461 F with a current  $I$  at a distance of 50 mm from the plane of the loop is given by Formula (1):

$$B_{50\text{mm}} = \mu_0 H = 95I \quad (1)$$

where

$B$  is the magnetic flux density, in microtesla;

$H$  is the magnetic field, in amperes per metre;

95 is a constant, in volt. second per ampere per square meter;

$I$  is the coil current, in amperes.

The magnetic field strength  $H_{50\text{mm}}$  of this radiating loop of MIL STD 461 F with a current  $I$  at a distance of 50 mm from the plane of the loop is given by Formula (2):

$$H_{50\text{mm}} = 75,6I \quad (2)$$

where

$H$  is the magnetic field, in amperes per metre;

75,6 is a constant, per metre;

$I$  is the coil current, in amperes.

The radiating loop should be characterized over the frequency range. Linearity characteristics shall be considered in determining the calculated current value for the DUT test.

### 6.2.2 Helmholtz coil

Ideally, Helmholtz coils set up a region of uniform magnetic fields. The primary usage of the coils is to expose the DUT to a uniform magnetic field.

The radius of the coils is determined by the size of the DUT. In order to obtain a uniform magnetic field ( $\pm 10\%$ ), the relationship between the coils and the DUT should be met, as shown in [Figure 3](#). The uniform field region shown in [Figure 3](#) should be a minimum of 300 mm  $\times$  300 mm  $\times$  300 mm.

For Helmholtz coils spaced one radius apart, the magnetic flux density at the centre of the system is given by Formula (3):

$$B = \mu_0 H = \frac{0,899 \times N \times I}{R} \tag{3}$$

where

- $B$  is the magnetic flux density, in microtesla;
- $N$  is the number of wire turns on the coil;
- $R$  is the coil radius, in metres;
- $I$  is the coil current, in amperes;
- $H$  is the magnetic field, in amperes per metre;
- $\mu_0$  is the magnetic constant, permeability of the vacuum, in henry per metre;
- 0,899 is a constant, in henry per metre.

The magnetic field,  $H$ , at the centre of the system is given by Formula (4):

$$H = \frac{0,7155NI}{R} \tag{4}$$

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where

- $H$  is the magnetic field, in amperes per metre;
- $N$  is the number of wire turns on the coil;
- $R$  is the coil radius, in metres;
- $I$  is the coil current, in amperes.

The current-carrying capability and number of turns of the coils should be selected such that the test specification can be met.

The coils shall not have a self-resonant frequency at or lower than the upper frequency of 150 kHz.

The Helmholtz coil should be characterized over the frequency range. Linearity characteristics shall be considered in determining the calculated current value for the DUT test.

### 6.3 Current monitor

The current monitor shall ensure that true RMS current measurement is made within the frequency range d.c. and 15 Hz to 150 kHz, either by using a clamp-on probe or by measuring voltage across a shunt resistor.

An oscilloscope, a true RMS a.c. voltmeter, or a true RMS a.c. current meter may be used.

### 6.4 Magnetic field strength monitor

For the radiating loop method, the magnetic field strength monitor to be used is as follows:

- For d.c., the magnetic field strength monitor shall be a Hall-sensor-based measuring instrument.

A typical magnetic field strength monitor should be capable of measuring a magnetic field strength of at least 3 000 A/m at d.c..

- If  $f \geq 15$  Hz, the recommended magnetic field strength monitor is a loop sensor having the following specifications:
  - diameter: 40 mm;
  - number of turns: 51;
  - wire: approx. 0,071 mm (7 strand 41 AWG);
  - shielding: electrostatic;
  - correction factor: see manufacturer's data for factor to convert sensor coil voltage to magnetic intensity.

The open-circuit voltage,  $U$ , measured in volts by means of a high-impedance voltmeter, is induced in the loop sensor and is calculated as shown in Formula (5):

$$U = 2\pi f N A B \quad (5)$$

where

- $f$  is the frequency, in Hertz;
- $N$  is the number of wire turns in the coil;
- $A$  is the cross-sectional area of the coil, in square metres, calculated with the average diameter of the coil;
- $B$  is the magnetic flux density, in tesla.

A typical magnetic field strength monitor should be capable of measuring a magnetic field strength of at least 1 000 A/m across the frequency range 15 Hz to 150 kHz.

## 6.5 Stimulation and monitoring of the DUT

If required in the test plan, the DUT shall be operated by actuators which have minimum effect on the electromagnetic characteristics, e.g. plastic blocks on the push buttons or pneumatic actuators with plastic tubes.

Connections to equipment monitoring electromagnetic interference reactions of the DUT can be accomplished by using fibre optics or high-resistance leads. Other types 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 might cause malfunction of the device. Extreme care shall be taken to avoid such effects.

## 7 Test set-up

### 7.1 General

The test area should be of a suitable size to house all of the required test equipment and shall be free from disturbances that might affect the test results. The magnetic field generator (radiating loop or Helmholtz coil) should be at least 2 m away from the DUT monitoring equipment. The magnetic field generator shall be maintained at a minimum of 1 m from metal surfaces parallel to the plane of the coil(s).

**IMPORTANT** — The appropriate guidelines (national regulation, ICNIRP,<sup>[2][3]</sup> etc.) shall be followed for the protection of the test personnel.