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

Part 1:

**General principles and terminology**

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

ISO 11451-1:2015

*Partie 1: Principes généraux et terminologie*

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ISO copyright office  
Ch. de Blandonnet 8 • CP 401  
CH-1214 Vernier, Geneva, Switzerland  
Tel. +41 22 749 01 11  
Fax +41 22 749 09 47  
copyright@iso.org  
www.iso.org

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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 fourth edition cancels and replaces the third edition (ISO 11451-1:2005), which has been technically revised. It also incorporates the Amendment ISO 11451-1:2005/Amendment 1:2008.

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)*

## Introduction

In recent years, an increasing number of electronic devices for controlling, monitoring, and displaying a variety of functions have been introduced into vehicle designs. It is necessary to consider the electrical and electromagnetic environment in which these devices operate.

Electrical and radio-frequency disturbances occur during the normal operation of many items of motor vehicle equipment. They are generated over a wide frequency range with various electrical characteristics and can be distributed to on-board electronic devices and systems by conduction, radiation, or both. Narrowband signals generated from sources on or off the vehicle can also be coupled into the electrical and electronic system, affecting the normal performance of electronic devices. Such sources of narrowband electromagnetic disturbances include mobile radios and broadcast transmitters.

The characteristics of the immunity of a vehicle to radiated disturbances have to be established. ISO 11451 provides various test methods for the evaluation of vehicle immunity characteristics (not all methods need be used to test a vehicle).

ISO 11451 is not intended as a product specification and cannot function as one (see A.1). Therefore, no specific values for the test severity level are given.

[Annex A](#) specifies a general method for function performance status classification (FPSC), [Annex B](#) specifies Artificial Networks (AN), Artificial Mains Networks (AMN) and Asymmetric Artificial Networks (AAN), while annex C explains the principle of constant peak test level. Typical severity levels are included in an annex of each of the other parts of ISO 11451.

Protection from potential disturbances needs to be considered in a total system validation, and this can be achieved using the various parts of ISO 11451.

NOTE Immunity measurements of complete 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. ISO 11452 specifies test methods for the analysis of component immunity, which are better suited for supplier use.

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

## Part 1: General principles and terminology

### 1 Scope

This part of ISO 11451 specifies general conditions, defines terms, gives practical guidelines, and establishes the basic principles of the vehicle tests used in the other parts of ISO 11451, for determining the immunity of passenger cars and commercial vehicles to electrical disturbances from narrowband radiated electromagnetic energy, regardless of the vehicle propulsion system (e.g. spark-ignition engine, diesel engine, electric motor).

The electromagnetic disturbances considered are limited to continuous narrowband electromagnetic fields. A wide frequency range (0,01 MHz to 18 000 MHz) is allowed for the immunity testing in this and the other parts of ISO 11451.

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### 2 Normative references (standards.iteh.ai)

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.

CISPR 16-1-2, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 1-2: Radio disturbance and immunity measuring apparatus — Ancillary equipment — Conducted disturbances; Edition 1.2.*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

#### 3.1

##### **absorber-lined shielded enclosure**

shielded enclosure/screened room with radio frequency absorbing material on its internal ceiling and walls

Note 1 to entry: The common practice is for the room to have a metallic floor, but absorbing material can also be used on the floor.

#### 3.2

##### **amplitude modulation**

##### **AM**

process by which the amplitude of a carrier wave is varied following a specified law, resulting in an AM signal

**3.3**  
**artificial mains network**  
**AMN**

provides a defined impedance to the EUT at radio frequencies, couples the disturbance voltage to the measuring receiver, and decouples the test circuit from the supply mains

Note 1 to entry: There are two basic types of AMN, the V-network (V-AMN) which couples the unsymmetrical voltages and the delta-network which couples the symmetric and the asymmetric voltages separately. The terms line impedance stabilization network (LISN) and V-AMN are used.

Note 2 to entry: This network is inserted in the power mains of the vehicle in charging mode and provides, in a given frequency range, a specified load impedance and which isolates the vehicle from the power mains in that frequency range.

**3.4**  
**artificial network**  
**AN**

network inserted in the supply lead or signal/load lead of apparatus to be tested which provides, in a given frequency range, a specified load impedance for the measurement of disturbance voltages and which can isolate the apparatus from the supply or signal sources/loads in that frequency range

Note 1 to entry: This network is inserted in the DC power lines of the vehicle in charging mode and provides, in a given frequency range, a specified load impedance and which isolates the vehicle from the DC power supply in that frequency range.

**3.5**  
**asymmetric artificial network**  
**AAN**

network used to measure (or inject) asymmetric (common mode) voltages on unshielded symmetric signal (e.g. telecommunication) lines while rejecting the symmetric (differential mode) signal

Note 1 to entry: This network is inserted in the communication/signal lines of the vehicle in charging mode to provide a specific load impedance and/or a decoupling (e.g. between communication/signal lines and power mains).

**3.6**  
**bonded (ground connection and DC resistance)**

grounding connection where the purpose of the bonding is to provide the lowest possible impedance (resistance and inductance) connection between two metallic parts with a d.c. resistance which shall not exceed 2,5 m $\Omega$

Note 1 to entry: A low current ( $\leq 100$  mA) 4-wire milliohm meter is recommended for this measurement.

**3.7**  
**bulk current**

total amount of common mode current in a harness

**3.8**  
**compression point**

input signal level at which the measurement system becomes non-linear

Note 1 to entry: When the measurement system is non-linear, the output value will deviate from the value given by an ideal linear system.

**3.9**  
**coupling**

means or device for transferring power between systems

[SOURCE: IEC 60050-726]



**3.10****current injection probe**

device for injecting current in a conductor without interrupting the conductor and without introducing significant impedance into the associated circuits

**3.11****current (measuring) probe**

device for measuring the current in a conductor without interrupting the conductor and without introducing significant impedance into the associated circuits

[SOURCE: IEC 60050-161]

**3.12****degradation (of performance)**

undesired departure in the operational performance of any device, equipment, or system from its intended performance

Note 1 to entry: The term “degradation” can apply to temporary or permanent failure.

[SOURCE: IEC 60050-161]

**3.13****dual directional coupler**

four-port device consisting of two transmission lines coupled together in such a manner that a single travelling wave in any one transmission line will induce a single travelling wave in the other, the direction of propagation of the latter wave being dependent upon that of the former

[SOURCE: IEC 60050-726]

**3.14****electromagnetic compatibility****EMC**

ability of equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance to anything in that environment

[SOURCE: IEC 60050-161]

**3.15****electromagnetic disturbance**

any electromagnetic phenomenon which can degrade the performance of a device, equipment, or system or adversely affect living or inert matter

EXAMPLE An electromagnetic disturbance can be an electromagnetic noise, an unwanted signal, or a change in the propagation medium itself.

[SOURCE: IEC 60050-161]

**3.16****electromagnetic interference****EMI**

degradation of the performance of equipment, transmission channel, or system caused by electromagnetic disturbance

Note 1 to entry: The English words “interference” and “disturbance” are often used indiscriminately.

[SOURCE: IEC 60050-161]

3.17

**(electromagnetic) susceptibility**

inability of a device, equipment, or system to perform without degradation in the presence of an electromagnetic disturbance

Note 1 to entry: Susceptibility is the lack of immunity.

[SOURCE: IEC 60050-161]

3.18

**forward power**

power supplied by the output of an amplifier or generator

3.19

**ground (reference) plane**

flat conductive surface whose potential is used as a common reference

[SOURCE: IEC 60050-161]

3.20

**immunity (to a disturbance)**

ability of a device, equipment, or system to perform without degradation in the presence of an electromagnetic disturbance

[SOURCE: IEC 60050-161]

3.21

**immunity level**

maximum level of a given electromagnetic disturbance incident on a particular device, equipment, or system for which it remains capable of operating at a required degree of performance

[SOURCE: IEC 60050-161]

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3.22

**narrowband emission**

emission which has a bandwidth less than that of a particular measuring apparatus or receiver

[SOURCE: IEC 60050-161]

3.23

**polarization (of wave or field vector)**

property of sinusoidal electromagnetic wave or field vector defined at a fixed point in space by the direction of the electric field strength vector or of any specified field vector, when this direction varies with time

Note 1 to entry: The property can be characterized by the locus described by the extremity of the considered field vector.

[SOURCE: IEC 60050-726]

3.24

**portable transmitter**

hand-held radio frequency communication device

Note 1 to entry: A portable transmitter could be a commercial device (e.g. cellular phone) or a simulated one.

3.25

**power mains**

general purpose alternating current (AC) or direct current (DC) electric power supply

**3.26**  
**pulse modulation**  
**PM**

process by which the amplitude of a carrier wave is varied following a specified law, resulting in a PM signal

**3.27**  
**(electromagnetic) radiation**

phenomenon by which energy in the form of electromagnetic waves emanates from a source into space; energy transferred through space in the form of electromagnetic waves

Note 1 to entry: By extension, the term “electromagnetic radiation” sometimes also covers induction phenomena.

[SOURCE: IEC 60050-161]

**3.28**  
**reflected power**

power reflected by the load due to impedance mismatch between RF-source and load

**3.29**  
**shielded enclosure**  
**screened room**

mesh or sheet metallic housing designed expressly for the purpose of separating electromagnetically the internal and external environment

[SOURCE: IEC 60050-161]

**3.30**  
**voltage standing wave ratio** (standards.iteh.ai)  
**VSWR**

ratio along a transmission line of a maximum to an adjacent minimum magnitude of a particular field component of a standing wave

$$VSWR = \frac{(1+r)}{(1-r)}$$

where  $r$  is the absolute value of the coefficient of reflection

[SOURCE: IEC 60050-726]

**3.31**  
**transmission line system**  
**TLS**

field-generating device that works in a similar way to a TEM (transverse electromagnetic) wave generator

EXAMPLE Stripline, TEM cell, parallel plate.

## 4 General aim and practical use

The test methods, procedures, test instrumentation, and levels specified in ISO 11451 are intended to facilitate vehicle specification for electrical disturbances by narrowband radiated electromagnetic energy. A basis is provided for mutual agreement between vehicle manufacturers and component suppliers intended to assist rather than restrict.

Certain devices are particularly susceptible to some characteristics of electromagnetic disturbance, such as frequency, severity level, type of coupling, or modulation.

Electronic devices are sometimes more susceptible to modulated, as opposed to unmodulated, radio-frequency (RF) signals. The reason is that high-frequency disturbances can be demodulated by semiconductors. In the case of unmodulated signals, this leads to a continuous shift of, for example, a voltage; in the case of amplitude-modulated signals, the resulting low-frequency fluctuations can be

interpreted as intentional signals (e.g. speed information) and therefore disturb the function of the device under test (DUT) more severely.

A single standard test may not reveal all the needed information about the DUT. It is thus necessary for users of ISO 11451 to anticipate the appropriate test conditions, select applicable parts of ISO 11451, and define function performance objectives. The main characteristics of each test method in ISO 11451-2 to ISO 11451-4 are presented in [Table 1](#).

**Table 1 — Main characteristics of test methods in ISO 11451**

Part of ISO 11451	Applicable frequency range	Coupling to	Test severity parameter and unit	Provisions
ISO 11451-2 Off-vehicle radiation sources	10 kHz to 18 GHz	Components and wiring harness	Electric field (V/m)	Absorber-lined shielded enclosure required
ISO 11451-3 On-board transmitter simulation	1,8 MHz to 5,85 GHz	Components and wiring harness	Power (W)	Absorber-lined shielded enclosure recommended
ISO 11451-4 Bulk current injection (BCI)	1 MHz to 400 MHz	Wiring harness	Current (mA)	Shielded enclosure recommended

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**5 General test conditions**

**5.1 General**

Unless otherwise specified, the following test conditions are common to all parts of ISO 11451:

- test temperature;
- supply voltage;
- modulation;
- dwell time;
- frequency step sizes;
- definition of test severity level;
- test signal quality.

NOTE The use of the same parameters as those used for the component test methods given in the corresponding parts of ISO 11451 will achieve better correlation.

Unless otherwise specified, the variables used shall have the following tolerances:

- ±10 % for durations and distances;
- ±10 % for resistances and impedances;
- and the following magnitude accuracy:
  - ±1 dB for power meter including power sensor;
  - ±3 dB for field probe.