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ISO/FDIS 11452-1

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

Part 1: General principles and terminology

Véhicules routiers — Méthodes d'essai d'un équipement soumis à des perturbations électriques par rayonnement d'énergie électromagnétique en bande étroite —
Partie 1: Principes généraux et terminologie

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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

This fifth edition cancels and replaces the fourth edition (ISO 11452-1:2015), which has been technically revised.

The main changes are as follows:

— update of the frequency ranges in Table 1;

— update on modulations (type and frequency range);

— technical revision of Annex B;

— new Annex E on broadband test signal generation;

— new Annex F on remote / local grounding;

— new Annex G on evaluation of test instrumentation uncertainties.

A list of all parts in the ISO 11452 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.

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 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 or electronic system, affecting the normal performance of electronic devices. Such sources of narrowband electromagnetic disturbances include mobile radios and broadcast transmitters.

It is important to establish the characteristics of the immunity of components to radiated disturbances. The ISO 11452 series provides various test methods for the evaluation of component immunity characteristics. Not all test methods need to be used for a given device under test (DUT). For example, stripline and transverse electromagnetic (TEM) cell test methods provide very similar exposure to the DUT. Only those tests necessary for replicating the use and mounting location of the DUT are included in the test plan. This will help to ensure a technically and economically optimized design for potentially susceptible components and systems.

The ISO 11452 series 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.

It is important to consider protection from potential disturbances as a part of total vehicle validation as described in the ISO 11452 series, which covers vehicle test methods. A component test method described in the ISO 11452 series is performed prior to vehicle test. Due to the vehicle's shape, harness and component location diversities, conformity to parts of the ISO 11452 series does not guarantee conformity to parts of the ISO 11451 series. Nevertheless, the ISO 11452 series component tests are essential for giving a sufficient level of confidence before integration on vehicle(s).

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

Part 1: General principles and terminology

1 Scope

This document specifies general conditions, defines terms, gives practical guidelines, and establishes the basic principles of the component tests used in the other parts of the ISO 11452 series for determining the immunity of electronic components 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 (d.c. and 15 Hz to 18 GHz) is allowed for the immunity testing of the components in the ISO 11452 series.

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.

CISPR 16-1-2:2014, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 1-2: Radio disturbance and immunity measuring apparatus — Coupling devices for conducted disturbance measurements*

ISO 11452 (all parts), *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
1 dB compression point
input signal level at which a system becomes non-linear, when the output value will deviate by 1 dB of the value given by an ideal linear system

3.2
absorber-lined shielded enclosure
ALSE
shielded enclosure (3.33) 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 may also be used on the floor.

3.3
amplitude modulation
AM
process by which the amplitude of a carrier wave is varied following a specified law, resulting in an AM signal

3.4
artificial mains network
AMN
network that provides a defined impedance to the DUT 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.

3.5
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 (low voltage and/or high voltage) of the DUT which provides, in a given frequency range, a specified load impedance and which isolates the DUT from the DC power supply in that frequency range.

3.6
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).

3.7
auxiliary equipment
AE
equipment needed to exercise, monitor or both exercise and monitor the operation of the DUT

EXAMPLE *Load simulator* (3.25), charging cables, monitoring equipment, fibre optic interface modules, TV camera.

3.8
bonded
<ground connection and DC resistance> grounding connection with a DC resistance not exceeding 2,5 mΩ and that provides the lowest possible impedance (resistance and inductance) connection between two metallic parts

Note 1 to entry: See CISPR 16-2-1:2014/AMD1:2017, 5.3.

Note 2 to entry: A low current (≤100 mA) 4-wire milliohm meter is recommended for this measurement.

3.9
broadband artificial network
BAN
device used in power, signal, and control lines that presents a controlled impedance to the DUT over a specified frequency range while allowing the DUT to be interfaced to its support system

3.10
broadband signal
signal where the power is distributed over several megahertz, either by a broadband nature of the signal itself or by a collection of subcarriers

3.11
bulk current
total amount of common mode current in a harness

3.12
coupling
means or device for transferring power between systems

3.13
current injection probe
device for injecting current in a conductor without interrupting the conductor and without introducing significant impedance into the associated circuits

3.14
current measuring probe
device for measuring the current in a conductor without interrupting the conductor and without introducing significant impedance into the associated circuits

3.15
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.

3.16
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

3.17
electromagnetic compatibility
EMC
ability of equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable *electromagnetic disturbance* (3.18) to anything in that environment

3.18
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.

3.19
electromagnetic interference
EMI
degradation of the performance of equipment, transmission channel, or system caused by *electromagnetic disturbance* (3.18)

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

3.20
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.

3.21
forward power
power supplied by the output of an amplifier or generator

3.22
ground reference plane
flat conductive surface whose potential is used as a common reference

3.23
high voltage artificial network
HV-AN
network inserted in the high voltage DC 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 in that frequency range

3.24
immunity to a disturbance
ability of a device, equipment, or system to perform without degradation in the presence of an *electromagnetic disturbance* (3.18)

3.25
load simulator
physical device including real and/or simulated peripheral loads which are necessary to ensure DUT nominal and/or representative operation mode

3.26
lowest usable frequency
LUF
lowest frequency for which the field uniformity requirements are met for the reverberation chamber method and at least 12 independent stirring configurations can be achieved

3.27
net power
forward power (3.21) minus *reflected power* (3.31)

3.28
polarization
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.

3.29
portable transmitter
hand-held radio frequency communication device

3.30
pulse modulation
PM
process by which the amplitude of a carrier wave is varied following a specified law, resulting in a PM signal

3.31
reflected power
reverse power
power reflected by the load due to impedance mismatch between radio frequency (RF)-source and load

3.32
reverberation chamber
high Q shielded room (cavity) whose boundary conditions are changed via one or several rotating tuners or moving walls (including Vibrating Intrinsic Reverberation Chambers (VIRC) with or without conductive contact to the floor) or repositioning of the transmitting antenna(s)

Note 1 to entry: This results in a statistically uniform electromagnetic field.

Note 2 to entry: VIRC is defined in ISO 11451-5.

3.33
shielded enclosure
mesh or sheet metallic housing designed expressly for the purpose of separating electromagnetically the internal and external environment

3.34
stripline
terminated transmission line consisting of two parallel plates between which a wave is propagated in the *transverse electromagnetic mode* (3.39) to produce a specified field for testing purposes

3.35
susceptibility
inability of a device, equipment, or system to perform without degradation in the presence of an *electromagnetic disturbance* (3.18)

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

3.36
susceptibility threshold
minimum level of a given *electromagnetic disturbance* (3.18) incident on a particular device, equipment, or system for which it does not operate at a required degree of functional performance

3.37
test generator
generator capable of generating the required test signal

Note 1 to entry: The test generator can, e.g. include a vector signal generator, modulation sources, attenuators, broadband power amplifiers and filters.

3.38
transverse electromagnetic cell
TEM cell
enclosed system, often a rectangular coaxial line, in which a wave is propagated in the *transverse electromagnetic mode* (3.39) to produce a specified field for testing purposes

3.39
transverse electromagnetic mode
TEM mode
mode in which the longitudinal components of both the electric and magnetic field strength vectors are everywhere zero

3.40
tubular wave coupler
TWC
device to couple radio frequency (RF) power to a harness or a conductor without interrupting the conductor and without introducing significant impedance into the associated circuits

3.41
voltage standing wave ratio
VSWR
ratio, along a transmission line, of a maximum to an adjacent minimum magnitude of a particular field component of a standing wave

Note 1 to entry: This ratio is equal to: $(1+|\Gamma|)/(1-|\Gamma|)$ where $|\Gamma|$ is the magnitude of the complex reflection factor Γ.

3.42
white noise
flat random noise
random noise which has a continuous spectrum and a constant power spectral density in the frequency band considered

4 General aim and practical use

The test methods, procedures, test instrumentation and levels specified in the ISO 11452 series are intended to facilitate component 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, modulation or type of coupling.

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 DUT more severely.

A single standard test might not reveal all the needed information about the DUT. It is thus necessary for users of the ISO 11452 series to anticipate the appropriate test conditions, select applicable parts of the ISO 11452 series, and define function performance objectives. The main characteristics of each test method in ISO 11452-2 to ISO 11452-11 are presented in Table 1.

Table 1 — Main characteristics of test methods in the ISO 11452 series

Part of the ISO 11452 series	Applicable frequency range	Coupling to	Test severity parameter and unit	Provisions
ISO 11452-2 Absorber-lined shielded enclosure	80 MHz to 18 GHz	DUT and wiring harness	Electric field (V/m)	ALSE required
ISO 11452-3 TEM cell	10 kHz to 200 MHz [a]	DUT and wiring harness or DUT	Electric field (V/m)	DUT and/or wiring harness size limitation
ISO 11452-4 Harness excitation methods	100 kHz to 3 GHz	Wiring harness	Current (mA) Power (W)	Shielded enclosure required
ISO 11452-5 Stripline	10 kHz to 400 MHz	Wiring harness and/or DUT	Electric field (V/m)	ALSE recommended, shielded enclosure required: DUT size limitation
ISO 11452-7 Direct RF power injection	250 kHz to 400 MHz	Wiring harness	Power (W)	Influence of isolator on DUT sensor signals
ISO 11452-8 Immunity to magnetic fields	d.c. and 15 Hz to 150 kHz	DUT	Magnetic field (A/m)	-
ISO 11452-9 Portable transmitters	142 MHz to 6 GHz	DUT and wiring harness	Power (W)	ALSE required
ISO 11452-10 Immunity to conducted disturbances in the extended audio frequency range	15 Hz to 250 kHz	Wiring harness	Volt (peak to peak)	-
ISO 11452-11 Reverberation chamber	LUF (lowest usable frequency) to 18 GHz	DUT and wiring harness	Electric field (V/m)	Reverberation chamber required

[a] the upper frequency can be extended based on the TEM cell design.

5 General test conditions

5.1 General

Unless otherwise specified, the following test conditions are common to all parts of the ISO 11452 series:

— test temperature;

— supply voltage;

— modulation;

— dwell time;

— frequency step sizes;

— definition of test severity level;

— test signal quality.

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.

NOTE When estimating the instruments uncertainty, the calibration results and the uncertainties of the calibration laboratory can be used.

5.2 Test temperature

The ambient temperature during the test should be (23 ± 5) °C.

5.3 Supply voltage

5.3.1 Low voltage (LV) power supply

LV is used for DC operating voltages below 60 V (e.g. 12 V, 24 V, 48 V).

Unless otherwise stated in the test plan, the values below shall be used:

— (13 ± 1) V for 12 V electrical systems,

— (26 ± 2) V for 24 V electrical systems,

— (48 ± 4) V for 48 V electrical systems.

5.3.2 HV DC power supply (excluding charger)

The supply voltage and tolerances for high voltage electrical systems operating above 60 V d.c. shall be agreed between vehicle manufacturer and component supplier and shall be documented in the test plan.

5.3.3 Charger power supply (a.c. or d.c.) for HV battery

The DC power supply voltage during the test shall be nominal ±10 %.

The AC power supply voltage during the test shall be nominal -15 % +10 %. The rated value of the frequency shall be nominal ±1 %.

5.4 Modulation

The characteristics of the DUT determine the type and frequency of modulation to be used. If no values or specific modulation techniques are agreed between the users of the ISO 11452 series, the following modulations shall be used:

a) unmodulated sine wave (CW), see Figure 1 a);

b) sine wave amplitude modulated (AM) by 1 kHz sine wave at (80) % (modulation index m = (0,8)) [see Annex C and Figure 1 b)];

c) sine wave pulse modulated type 2 (PM, similar to radar), with t_{on} = 3 µs and period = 3 333 µs [see Figure 1 c)];

d) sine wave pulse modulated type 3 (PM, similar to digital mobile services), with t_{on} = 500 µs and period = 1 000 µs [see Figure 1 d)].