

Radio disturbance characteristics for the protection of receivers used on board vehicles, boats, and on devices — Limits and methods of measurement

The European Standard EN 55025:2003 has the status of a
British Standard

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National foreword

This British Standard is the UK implementation of EN 55025:2003, incorporating corrigendum March 2004. It is identical with CISPR 25:2002.

The UK participation in its preparation was entrusted by Technical Committee GEL/210, EMC — Policy committee, to Subcommittee GEL/210/11, EMC — Product standards.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

CENELEC Interpretation Sheet, February 2007 is incorporated in National Annex NA (informative).

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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**Radio disturbance characteristics for the protection of receivers
used on board vehicles, boats, and on devices -
Limits and methods of measurement
(CISPR 25:2002)**

Caractéristiques des perturbations
radioélectriques pour la protection
des récepteurs utilisés à bord des
véhicules, des bateaux et des engins -
Limites et méthodes de mesure
(CISPR 25:2002)

Funk-Entstörung zum Schutz
von Empfängern in Fahrzeugen,
Booten und Geräten -
Grenzwerte und Messverfahren
(CISPR 25:2002)

This European Standard was approved by CENELEC on 2002-12-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document CISPR/D/271/FDIS, future edition 2 of CISPR 25, prepared by CISPR SC D, Electromagnetic disturbances related to electric/electronic equipment on vehicles and internal combustion engine powered devices, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 55025 on 2002-12-01.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2003-09-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2005-12-01

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes C, E and ZA are normative and annexes A, B, D, F, G and H are informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard CISPR 25:2002 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

This standard is designed to protect receivers from disturbances produced by conducted and radiated emissions arising in a vehicle.

Test procedures and limits given are intended to provide provisional control of vehicle-radiated emissions, as well as component/module conducted/radiated emissions of long and short duration.

To accomplish this end, this standard:

- establishes a test method for measuring the electromagnetic emissions from the electrical system of a vehicle;
- sets limits for the electromagnetic emissions from the electrical system of a vehicle;
- establishes test methods for testing on-board components and modules independent from the vehicle;
- sets limits for electromagnetic emissions from components to prevent objectionable disturbance to on-board receivers;
- classifies automotive components by disturbance duration to establish a range of limits.

NOTE 1 Component tests are not intended to replace vehicle tests. Exact correlation between component and vehicle test performance is dependent on component mounting location, harness length, routing and grounding, as well as antenna location. Component testing, however, permits components to be evaluated prior to actual vehicle availability.

NOTE 2 Annex B provides helpful methodology for resolution of disturbance problems.

RADIO DISTURBANCE CHARACTERISTICS FOR THE PROTECTION OF RECEIVERS USED ON BOARD VEHICLES, BOATS, AND ON DEVICES – LIMITS AND METHODS OF MEASUREMENT

1 Scope

This International Standard contains limits¹ and procedures for the measurement of radio disturbances in the frequency range of 150 kHz to 1 000 MHz. The standard applies to any electronic/electrical component intended for use in vehicles and devices. Refer to International Telecommunications Union (ITU) publications for details of frequency allocations. The limits are intended to provide protection for receivers installed in a vehicle from disturbances produced by components/modules in the same vehicle². The methods and limits for a complete vehicle are in Clause 5 and the methods and limits for components/modules are in Clause 6.

NOTE Achieving satisfactory compatibility with on-board radio reception will also in most cases provide satisfactory compatibility with adjacent radio receiver reception.

The receiver types to be protected are: sound and television receivers³, land mobile radio, radio telephone, amateur and citizens' radio. For the purpose of this standard, a vehicle is a machine, which is self-propelled. Vehicles include (but are not limited to) passenger cars, trucks, agricultural tractors and snowmobiles. Annex A provides guidance in determining whether this standard is applicable to a particular equipment.

The limits in this standard are recommended and subject to modification as agreed between the vehicle manufacturer and the component supplier. This standard is also intended to be applied by manufacturers and suppliers of components and equipment which are to be added and connected to the vehicle harness or to an on-board power connector after delivery of the vehicle.

This International Standard does not include protection of electronic control systems from radio frequency (RF) emissions, or from transient or pulse-type voltage fluctuations. These subjects are expected to be included in ISO publications.

The methods described in Clauses 5 and 6 apply to the suppression of on-board radio disturbances for motor vehicles, devices and working machinery, to achieve acceptable radio reception with on-board radio receivers. The requirements contained herein specify the maximum permissible disturbance voltage at the receiver end of the vehicle antenna transmission line in the frequency range of 150 kHz to 1 000 MHz.

On-board radio disturbance suppression reduces the radio disturbance energy which is applied by electrical equipment within the vehicle to the on-board power supply of a vehicle. Disturbances can also be coupled from vehicle wiring to the receiving antenna on the vehicle. Both articles describe methods of safeguarding radio reception in the same vehicle in which the disturbance arises. Annex B provides a helpful methodology for resolution of disturbance problems.

¹ Only a complete vehicle test can be used to determine the component compatibility with respect to a vehicle's limit.

² Adjacent vehicles can be expected to be protected in most situations.

³ Adequate television protection will result from compliance with the levels at the mobile service frequencies.

Since the mounting location, vehicle body construction and harness design can affect the coupling of radio disturbances to the on-board radio, Clause 6 of this standard defines multiple limit levels. The level class to be used (as a function of frequency band) will be agreed upon between the vehicle manufacturer and the component supplier.

The World Administrative Radiocommunications Conference (WARC) lower frequency limit in region 1 was reduced to 148,5 kHz in 1979. For vehicular purposes, tests at 150 kHz are considered adequate. For the purposes of this standard, test frequency ranges have been generalized to cover radio services in various parts of the world. Protection of radio reception at adjacent frequencies can be expected in most cases.

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.

IEC 60050-161:1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

CISPR 12, *Vehicles, boats and internal combustion engine driven devices – Radio disturbance characteristics – Limits and methods of measurement for the protection of receivers except those installed in the vehicle/boat/device itself or in adjacent vehicles/boats/devices*

CISPR 16-1:1999, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus*

3 Definitions

For the purpose of this International Standard, the following definitions apply.

3.1

receiver terminal voltage (antenna voltage)

voltage generated by a source of radio disturbance and measured in dB(μ V) by a radio disturbance measuring instrument conforming to the requirements of CISPR 16-1

3.2

component continuous conducted emissions

noise voltages/currents of a steady-state nature existing on the supply or other leads of a component/module which may cause disturbance to reception in an on-board receiver

3.3

antenna matching unit

unit for matching the impedance of an antenna to that of the 50 Ω measuring instrument over the antenna measuring frequency range

3.4**antenna correction factor**

factor which is applied to the voltage measured at the input connector of the measuring instrument to give the field strength at the antenna

NOTE The antenna correction factor is comprised of an antenna factor and a cable factor.

3.5**compression point**

input signal level at which the gain of the measuring system becomes non-linear such that the indicated output deviates from an ideal linear receiving system's output by the specified increment in dB

3.6**class**

performance level agreed upon by the purchaser and the supplier and documented in the test plan

3.7**device**

machine driven by an internal combustion engine which is not primarily intended to carry persons or goods

NOTE Devices include, but are not limited to, chainsaws, irrigation pumps, snow blowers, air compressors, and landscaping equipment.

3.8**RF boundary**

element of an EMC test set-up that determines what part of the harness and/or peripherals are included in the RF environment and what is excluded

NOTE It may consist of, for example, ANs, BANs, filter feed-through pins, RF absorber coated wire, and/or RF shielding.

3.9**artificial network (AN)**

line impedance stabilization network (LISN⁴)

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 may isolate the apparatus from the supply or signal sources/loads in that frequency range

[IEV 161-04-05, modified]

3.10**bandwidth (of an equipment)**

width of a frequency band over which a given characteristic of an equipment or transmission channel does not differ from its reference value by more than a specified amount or ratio

NOTE The given characteristic may be, for example, the amplitude/frequency characteristic, the phase/frequency characteristic or the delay/frequency characteristic.

[IEV 161-06-09, modified]

3.11**bandwidth (of an emission or signal)**

width of the frequency band outside which the level of any spectral component does not exceed a specified percentage of a reference level

[IEV 161-06-10]

⁴ In the USA.

3.12

broadband emission

an *emission* which has a *bandwidth* greater than that of a particular measuring apparatus or receiver

NOTE An emission which has a pulse repetition rate (in Hz) less than the bandwidth of a particular measuring instrument can also be considered as a broadband emission.

3.13

disturbance suppression

action which reduces or eliminates electromagnetic disturbance

[IEV 161-03-22]

3.14

disturbance voltage

interference voltage (deprecated)

voltage produced between two points on two separate conductors by an electromagnetic disturbance, measured under specified conditions

[IEV 161-04-01]

3.15

narrowband emission

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

NOTE An emission which has a pulse repetition rate (in Hz) greater than the bandwidth of a particular measuring instrument can also be considered as a narrowband emission.

3.16

peak detector

a detector, the output voltage of which is the peak value of an applied signal

[IEV 161-04-24]

3.17

quasi-peak detector

a detector having specified electrical time constants which, when regularly repeated identical pulses are applied to it, delivers an output voltage which is a fraction of the peak value of the pulses, the fraction increasing towards unity as the pulse repetition rate is increased

[IEV 161-04-21]

3.18

average detector

a detector the output voltage of which is the average value of the envelope of an applied signal

NOTE The average value must be taken over a specified time interval.

[IEV 161-04-26]

3.19

electromagnetic environment

the totality of electromagnetic phenomena existing at a given location

[IEV 161-01-01]

3.20

shielded enclosure

screened room

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

[IEV 161-04-37]

3.21

ground (reference) plane

a flat conductive surface whose potential is used as a common reference

[IEV 161-04-36]

4 Requirements common to vehicle and component/module emissions measurement

4.1 General test requirements and test plan

4.1.1 Test plan

A test plan shall be established for each item to be tested. The test plan shall specify the frequency range to be tested, the emissions limits, the disturbance classification (broadband long or short duration – or narrowband), antenna types and locations, test report requirements, supply voltage and other relevant parameters.

4.1.2 Determination of conformance of EUT with limits

If the type of disturbance is unknown, tests shall be made to determine whether measured emissions are narrowband and/or broadband to apply limits properly as specified in the test plan.

Figure 1 outlines the procedure to be followed in determining conformance with limits.

4.1.3 Categories of disturbance sources (as applied in the test plan)

Electromagnetic disturbance sources can be divided into three types:

- a) continuous/long duration broadband and automatically actuated short-duration equipment;
- b) manually actuated short-duration broadband;
- c) narrowband.

NOTE For examples, see 4.1.4 and 4.1.5 and table 1.

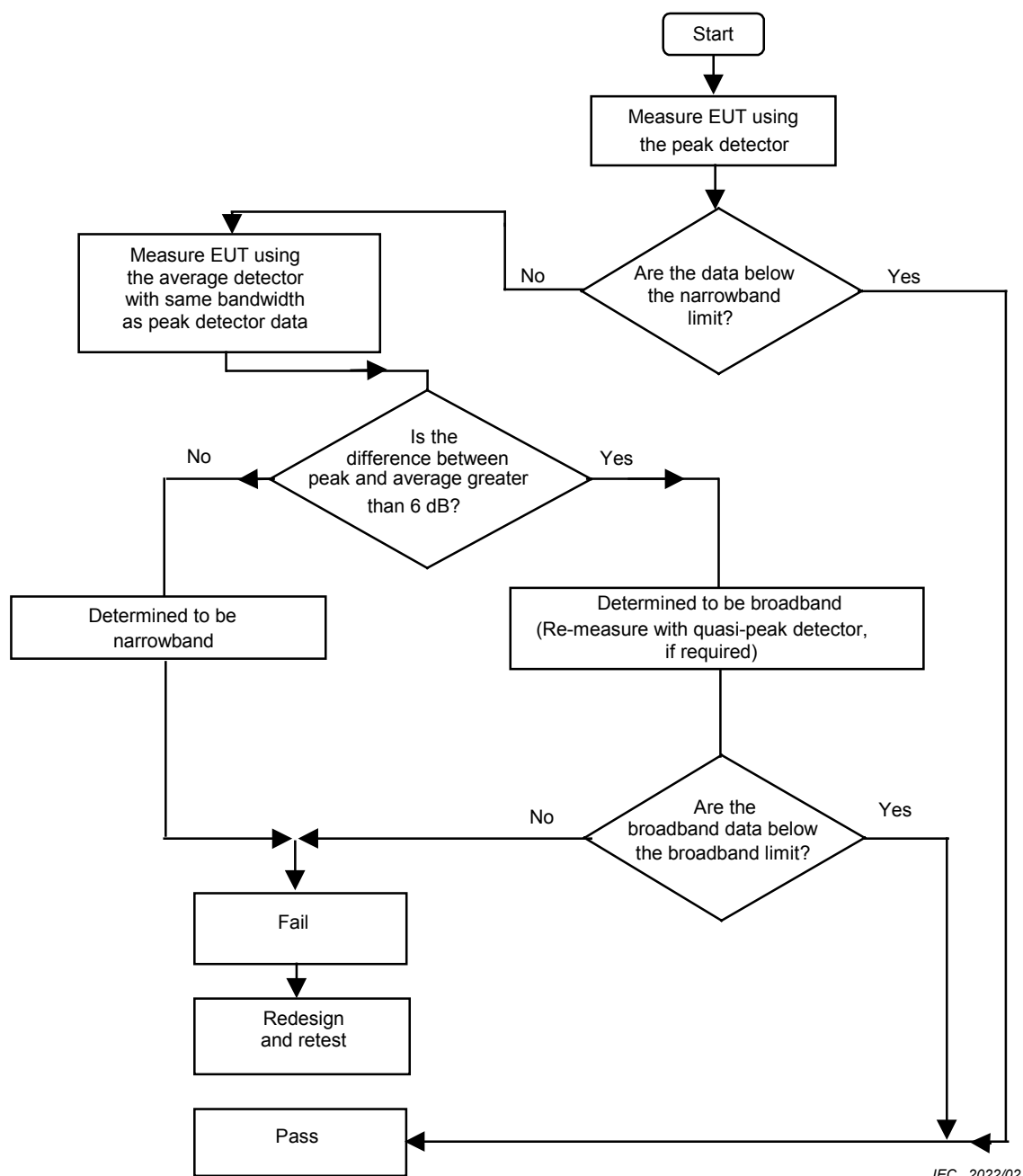


Figure 1 – Method of determination of conformance of radiated/conducted disturbance

4.1.4 Examples of broadband disturbance sources

NOTE 1 The examples in table 1 are intended as a guide to assist in determining which limits to use in the test plan.

NOTE 2 When testing components with short duration disturbances, the users of this standard may consider a lower performance class or an increased test level (6 dB difference typical).

Table 1 – Examples of broadband disturbance sources by duration

Continuous	Long duration *	Short duration *
Ignition system	Wiper motor	Power antenna
Active ride control	Heater blower motor	Washer pump motor
Fuel injection	Rear wiper motor	Door mirror motor
Instrument regulator	Air conditioning compressor	Central door lock
Alternator	Engine cooling	Power seat
* As defined in the test plan.		

4.1.5 Narrowband disturbance sources

Disturbances from sources employing microprocessors, digital logic, oscillators or clock generators, etc. cause narrowband emissions.

4.1.6 Operating conditions

Different operating conditions of the EUT can influence emission measurement results. When performing component/module tests, the EUT shall be exercised using typical loads and conditions, which simulate installation and operation in the vehicle. The operating conditions shall be specified in the test plan.

To ensure correct operation of components/modules during test, a peripheral interface unit shall be used which simulates the vehicle installation. Depending on the intended operating modes, all significant sensor and actuator leads of the EUT shall be connected to a peripheral interface unit. The peripheral interface unit shall be capable of controlling the EUT in accordance with the test plan.

The peripheral interface unit may be located internal or external to the shielded enclosure. If located in the shielded enclosure, the disturbance levels generated by the peripheral interface unit shall be at least 6 dB below the test limits specified in the test plan.

4.1.7 Test report

The report shall contain the information agreed upon by the customer and the supplier.

4.2 Measuring equipment requirements

All equipment shall be calibrated on a regular basis to assure continued conformance of equipment to required characteristics. The measuring equipment noise floor shall be at least 6 dB less than the limit specified in the test plan.

4.3 Shielded enclosure

The ambient electromagnetic noise levels shall be at least 6 dB below the limits specified in the test plan for each test to be performed. The shielding effectiveness of the shielded enclosure shall be sufficient to assure that the required ambient electromagnetic noise level requirement is met.

NOTE Although there will be reflected energy from the interior surfaces of the shielded enclosure, this is of minimal concern for the measurement of conducted disturbances because of the direct coupling of the measuring instrument to the leads of the EUT. The shielded enclosure may be as simple as a suitably grounded bench-top screened cage.

4.4 Absorber-lined shielded enclosure (ALSE)

For radiated emission measurements, however, the reflected energy can cause errors of as much as 20 dB. Therefore, it is necessary to apply RF absorber material to the walls and ceiling of a shielded enclosure that is to be used for radiated emissions measurements. No absorber material should be placed on the floor for vehicle tests but the floor may be lined with absorber material for component tests. The following ALSE requirements shall also be met for performing radiated RF emissions measurements:

4.4.1 Reflection characteristics

The reflection characteristics of the ALSE shall be such that the maximum error caused by reflected energy from the walls and ceiling is less than 6 dB in the frequency range of 70 MHz to 1 000 MHz.

4.4.2 Size

For radiated emissions tests, the shielded enclosure shall be of sufficient size to ensure that neither the vehicle/EUT nor the test antenna shall be closer than a) 2 m from the walls or ceiling, and b) 1 m to the nearest surface of the absorber material used, except that used on the floor.

4.4.3 Objects in ALSE

In particular, for radiated emissions measurements the ALSE shall be cleared of all items not pertinent to the tests. This is required in order to reduce any effect they may have on the measurement. Included are unnecessary equipment, cable racks, storage cabinets, desks, chairs, etc. Personnel not actively involved in the test shall be excluded from the ALSE.

4.5 Measuring instrument

The measuring instrument shall comply with the requirements of CISPR 16-1. Either manual or automatic frequency scanning may be used.

NOTE 1 Spectrum analysers and scanning receivers are particularly useful for disturbance measurements. The peak detection mode of spectrum analysers and scanning receivers provides a display indication which is never less than the quasi-peak indication for the same bandwidth. It may be convenient to measure emissions using peak detection because of the faster scan possible than with quasi-peak detection.

NOTE 2 A preamplifier may be used between the antenna and measuring instrument in order to achieve the 6 dB noise floor requirements.

When quasi-peak limits are being used, and a peak detector is used for time efficiency, any peak measurements with results at or above the test limit shall be re-measured using the quasi-peak detector.

4.5.1 Maximum scan rate

The scan rate of a spectrum analyser or scanning receiver shall be adjusted for the CISPR frequency band and detection mode used. The maximum scan rate is listed in table 2.

Table 2 – Maximum scan rate

Band ^a	Peak detection	Quasi-peak detection
A 9 kHz to 150 kHz	Does not apply	Does not apply
B 0,15 MHz to 30 MHz	100 ms/MHz	200 s/MHz
C, D 30 MHz to 1 000 MHz	1 ms/MHz or 100 ms/MHz ^b	20 s/MHz
NOTE Certain signals (e.g. low repetition rate signals) may require slower scan rates or multiple scans to ensure that the maximum amplitude has been measured. For the measurement of pure broadband emission with a scanning receiver, frequency steps greater than the measurement bandwidth are permitted, thus accelerating the measurement of the emission spectrum.		
^a Band definition from CISPR 16-1.		
^b When 9 kHz bandwidth is used, the 100 ms/MHz value shall be used.		

4.5.2 Measuring instrument bandwidth

The bandwidth of the measuring instrument shall be chosen such that the noise floor is at least 6 dB lower than the limit curve. The bandwidths in table 3 are recommended. For mobile service bands, the 9 kHz bandwidth shall be used for narrowband/broadband discrimination (described in figure 1) with peak and average detector.

NOTE 1 When the bandwidth of the measuring instrument exceeds the bandwidth of a narrowband signal, the measured signal amplitude will not be affected. The indicated value of impulsive broadband noise will be lower when the measuring instrument bandwidth is reduced.

NOTE 2 A pre-amplifier may be used between the antenna and the measuring instrument in order to achieve the 6 dB noise floor requirement.

Table 3 – Measuring instrument bandwidth (6 dB)

Service/Frequency range MHz	Broadband peak or quasi-peak kHz	Narrowband peak or average kHz
AM broadcast 0,15 to 30	9	9
FM broadcast 76 to 108	120	120
Mobile service 30 to 960	120	9 ^a
^a In practice and in order to reduce the total sweep time duration in the mobile service frequency bands, it is allowed to perform the measurements with a bandwidth of 120 kHz. If the result of the measurement with a 120 kHz bandwidth is lower than the narrowband limit indicated in the test plan, then the test result is accepted. The value of the measurement bandwidth used in these frequency ranges shall be indicated in the test report.		

If a spectrum analyser is used for peak measurements, the video bandwidth shall be at least three times the resolution bandwidth.

For the narrowband/broadband discrimination according to figure 1, both bandwidths (with peak and average detectors) shall be identical.

4.6 Power supply

The power supply shall have adequate regulation to maintain the supply voltage U_s within the ranges specified:

Vehicle tests: $U_s = \left(12^{+2}_0 \right)$ V for systems with 12 V nominal supply voltage

$U_s = \left(24^{+4}_0 \right)$ V for systems with 24 V nominal supply voltage

NOTE Most of the vehicle tests will be performed without the engine running, but with the ignition switched on, therefore care must be taken to ensure that the battery is sufficiently well charged. The battery voltage shall be monitored during the tests.

Component/module tests: $U_s = (13,5 \pm 0,5)$ V for systems with 12 V nominal supply voltage

$U_s = (27 \pm 1)$ V for systems with 24 V nominal supply voltage

The power supply shall also be adequately filtered such that the RF noise produced by the power supply is at least 6 dB lower than the limits specified in the test plan.

When specified in the test plan, a vehicle battery shall be connected in parallel with the power supply.

5 Measurement of emissions received by an antenna on the same vehicle

5.1 Antenna measuring system

5.1.1 Type of antenna

An antenna of the type to be supplied with the vehicle shall be used as the measurement antenna for the bands for which it is designed to be used for radio reception. The antennas of table 4 shall be used for all other bands.

If no antenna is to be furnished with the vehicle (as is often the case with a mobile radio system), the antenna types in table 4 shall be used for the test. The antenna type and location shall be included in the test plan.

If an active antenna is used, the noise floor of the measured signal at the radio antenna connector may increase (see also clause 5.3).

Table 4 – Antenna types

Service/Band ^a	Frequency MHz	Antenna type
Broadcast LW AM MW AM SW AM VHF FM	0,15 to 0,3 0,53 to 2,0 5,9 to 6,2 76 to 108	1 m monopole 1 m monopole 1 m monopole 1 m monopole
Mobile services VHF VHF VHF UHF UHF	30 to 54 68 to 87 142 to 175 380 to 512 820 to 960	Loaded quarter-wave monopole Quarter-wave monopole Quarter-wave monopole Quarter-wave monopole Quarter-wave monopole
^a LW: Long wave MW: Medium wave SW: Short wave VHF: Very high frequency UHF: Ultra high frequency AM: Amplitude modulation FM: Frequency modulation		

5.1.2 Measuring system requirements

5.1.2.1 Broadcast bands

For each band, the measurement shall be made with instrumentation which has the following specified characteristics.

5.1.2.1.1 AM broadcast:

Long wave (0,15 MHz to 0,3 MHz)

Medium wave (0,53 MHz to 2,0 MHz)

Short wave (5,9 MHz to 6,2 MHz)⁵

⁵ Although there are several other short-wave broadcast bands, this particular band has been chosen because it is most commonly used in vehicles. It is expected that other short-wave bands will be protected by conformance to the limits in this band.

The measuring system shall have the following characteristics:

- output impedance of impedance matching equipment: 50 Ω resistive;
- gain: the gain (or attenuation) of the measuring equipment shall be known with an accuracy of $\pm 0,5$ dB. The gain of the equipment shall remain within a 6 dB envelope for each frequency band as shown in figure 2. Calibration shall be performed in accordance with annex C;

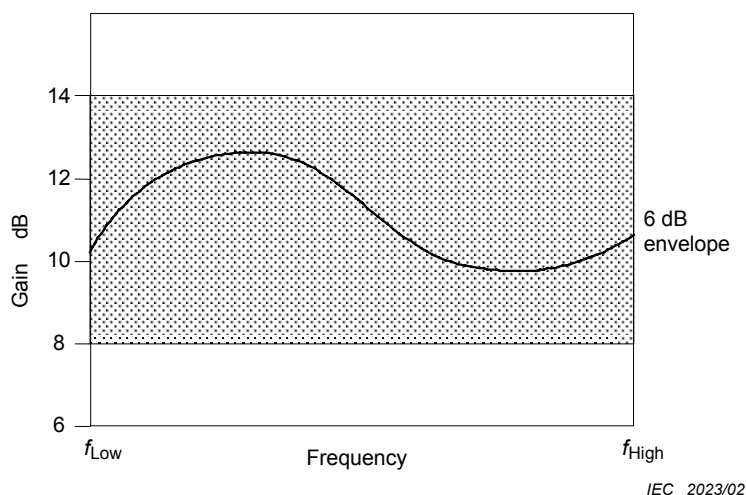


Figure 2 – Example of gain curve

- compression point: the 1 dB compression point shall occur at a sine wave voltage level greater than 60 dB(μ V);
- measurement system noise floor: the noise floor of the combined equipment including measuring instrument, matching amplifier, and preamplifier (if used) shall be at least 6 dB lower than the limit level;.
- dynamic range: from the noise floor to the 1 dB compression point;
- Input impedance: the impedance of the measuring system at the input of the matching network shall have a resistance of at least 100 k Ω in parallel with a maximum capacitance of 10 pF.

Active antennas, in general, will increase the noise floor.

5.1.2.1.2 FM broadcast (76 MHz to 108 MHz)

Measurements shall be taken with a measuring instrument which has an input impedance of 50 Ω . If the standing wave ratio (SWR) is greater than 2:1 an input matching network shall be used. Appropriate correction shall be made for any attenuation/gain of the matching unit

5.1.2.2 Mobile services (30 MHz to 960 MHz)

The test procedure assumes a 50 Ω measuring instrument and a 50 Ω antenna in the frequency range 30 MHz to 960 MHz.

If a measuring instrument and an antenna with differing impedances are used, an appropriate network and correction factor shall be used.

5.2 Method of measurement

To determine the disturbance characteristics of individual disturbance sources or disturbance systems, all sources shall be forced to operate independently across their range of normal operating conditions (transient effects to be determined).

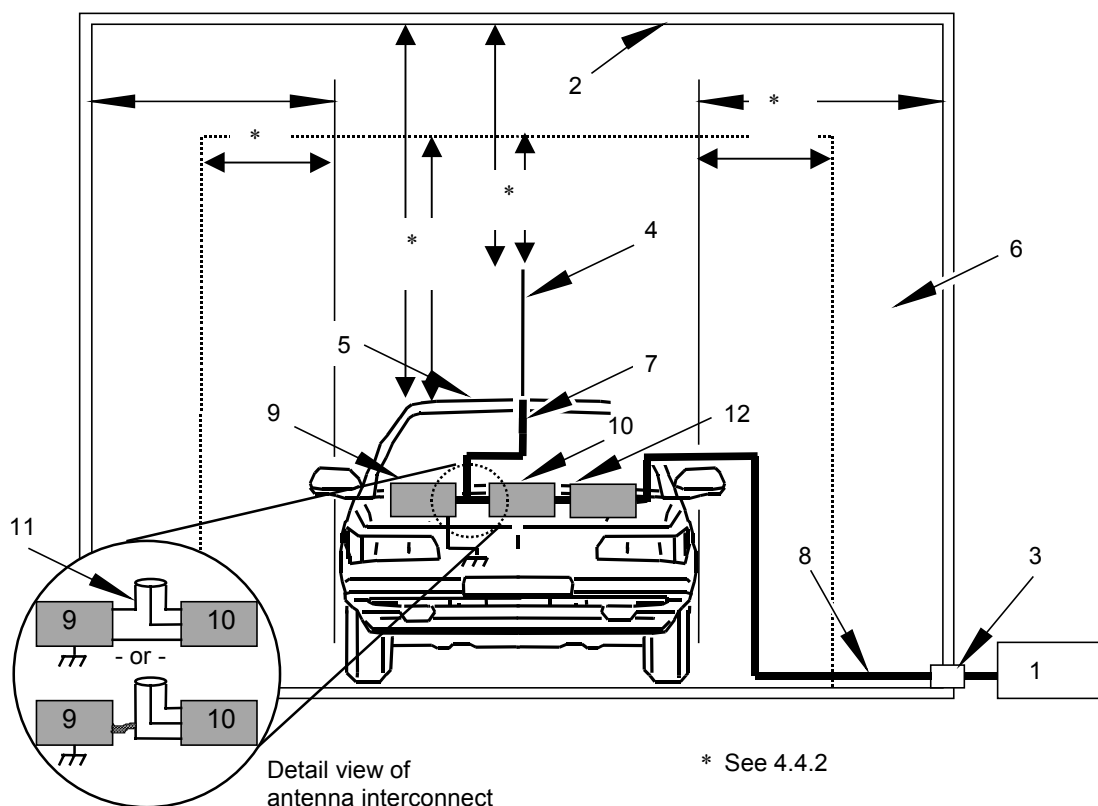
The disturbance voltage shall be measured at the receiver end of the antenna coaxial cable using the ground contact of the connector as reference. The antenna connector shall be grounded to the housing of the on-board radio. The radio housing shall be grounded to the vehicle body using the production harness. A coaxial bulkhead connector shall be used for connection to the measuring instrument outside the shielded room. See figure 3. In the case of an active vehicle antenna which is fed by the radio via the antenna cable (phantom network), a decoupling network similar to that used in the radio shall be installed at the antenna connector to feed the active antenna from the vehicle supply voltage.

When making measurements in the AM broadcast bands (LW, MW, SW), the vehicle/matching unit ground and ground of the ALSE shall be electrically isolated from each other by means such as an isolation transformer, sheath-current suppressor, battery-powered measurement instrumentation, fiber optics, etc. Appropriate correction shall be made for the insertion loss of any isolation network (see annex H for an example of a sheath-current suppressor).

NOTE The use of a high-quality double-shielded cable for connection to the measuring instrument is recommended as well as the use of ferrite rings on the cable for suppression of surface currents.

Some vehicles may allow a receiver to be mounted in several locations (e.g. under the instrument panel, under the seat, etc.). In these cases a test shall be carried out as specified in the test plan for each receiver location.

When vehicle measurements are made without the engine running, the power supply of 4.6 shall be used, when needed, to maintain the system voltage within its required range.



IEC 2024/02

Key

- 1 Measuring instrument
- 2 ALSE
- 3 Bulkhead connector
- 4 Antenna (see 5.1.1)
- 5 EUT
- 6 Typical absorber material
- 7 Antenna coaxial cable
- 8 High-quality double-shielded coaxial cable (50 Ω)
- 9 Housing of on-board radio
- 10 Impedance matching unit (when required)
- 11 Modified coaxial "T" connector
- 12 AM broadcast band ground isolation network (when required)

**Figure 3 – Vehicle-radiated emissions – Example for test layout
(end view with monopole antenna)**