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Interested committees:

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Title: Draft BS CISPR 12 Ed.7.0 Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurements for the protection off-board receivers

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## Introduction

This draft standard is based on international discussions in which the UK has taken an active part. Your comments on this draft are welcome and will assist in the preparation of the consequent standard. There is a high probability that this text could be adopted by CENELEC as a reference document for harmonization or as a European Standard. Recipients of this draft are requested to comment on the text bearing in mind this possibility.

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| Date: xx/xx/20xx | Document: ISO/DIS xxxx |
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| 1  | 2                                          | (3)                           | 4               | 5                                                                                                                                  | (6)                                                                      | (7)                                                |
|----|--------------------------------------------|-------------------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|----------------------------------------------------|
| MB | Clause No./ Subclause No./Annex (e.g. 3.1) | Paragraph/ Figure/ Table/Note | Type of comment | Comment (justification for change) by the MB                                                                                       | Proposed change by the MB                                                | Secretariat observations on each comment submitted |
|    | 3.1                                        | Definition 1                  | ed              | Definition is ambiguous and needs clarifying.                                                                                      | Amend to read '...so that the mains connector to which no connection...' |                                                    |
|    | 6.4                                        | Paragraph 2                   | te              | The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK. | Delete reference to UV photometer.                                       |                                                    |



# CISPR/D/417/CD

COMMITTEE DRAFT (CD)

|                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                   |                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|
| IEC/TC or SC:<br>CISPR/D                                                                                                                                                        | Project number<br>CISPR 12 Ed. 7.0                                                                                                                                                                                                                                                                                |                                                |
| Title of TC/SC:<br>Electromagnetic disturbances related to<br>electric/electronic equipment on vehicles and internal<br>combustion engine power devices                         | Date of circulation<br><b>2014-05-23</b>                                                                                                                                                                                                                                                                          | Closing date for comments<br><b>2014-09-05</b> |
| Also of interest to the following committees                                                                                                                                    | Supersedes document<br>CISPR/D/415/RR                                                                                                                                                                                                                                                                             |                                                |
| Proposed horizontal standard<br><input type="checkbox"/> Other TC/SCs are requested to indicate their interest, if any, in this CD to the TC/SC secretary                       |                                                                                                                                                                                                                                                                                                                   |                                                |
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Title:

CISPR 12: Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of off-board receivers

(Titre) :

Introductory note

This draft is the result of the maintenance work on CISPR 12.

Besides an improvement of the wording the following changes were applied:

- New test setups for emission tests on electric and plug-in hybrid electric vehicles in charging mode
- Statements dealing with type approval, product surveillance are moved to an informative annex (Annex F)
- Definition of networks for impedance stabilization needed for the test setups for the charging mode (Annex G)
- New annexes covering measurement instrumentation uncertainties (Annex H and I)

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

**VEHICLES, BOATS AND INTERNAL COMBUSTION ENGINES – RADIO  
DISTURBANCE CHARACTERISTICS – LIMITS AND METHODS OF MEASUREMENT  
FOR THE PROTECTION OF OFF-BOARD RECEIVERS**

## FOREWORD

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International Standard CISPR 12 has been prepared by CISPR subcommittee D: Electromagnetic disturbances related to electric/electronic equipment on vehicles and internal combustion powered devices.

This seventh edition cancels and replaces the sixth edition published in 2007 and its Amendment 1 (2009). This edition constitutes a technical revision.

The following changes were made with respect to the previous edition:

- test setups for electric vehicles and plug-in hybrid vehicles in charging mode were added
- some statements dealing with series surveillance and type approval were moved into an informative annex
- annexes for measurement instrumentation uncertainties were added
- an annex describing networks to be used for the charging mode was added
- general improvements

The text of this standard is based on the following documents:

|            |                  |
|------------|------------------|
| FDIS       | Report on voting |
| XX/XX/FDIS | XX/XX/RVD        |

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

## INTRODUCTION

There is a specific need for standards to define acceptable radio frequency performance of all electrical/electronic products. CISPR 12 has been developed to serve the Road Vehicle and related industries with test methods and limits that provide satisfactory protection for radio reception.

CISPR 12 has been used for many years as a regulatory requirement in numerous countries, to provide protection for radio receivers in the residential environment. It has been extremely effective in protecting the radio environment outside the vehicle.

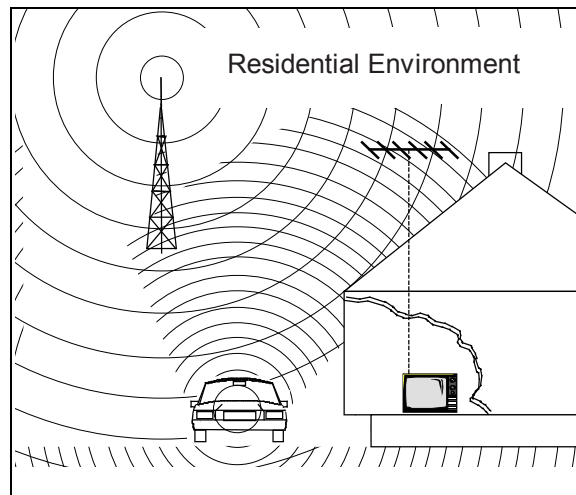
All items that concern specific use of this standard (as a regulatory requirement, surveillance of series production, quick prototype check) are defined in Annex F.

# VEHICLES, BOATS AND INTERNAL COMBUSTION ENGINES – RADIO DISTURBANCE CHARACTERISTICS – LIMITS AND METHODS OF MEASUREMENT FOR THE PROTECTION OF OFF-BOARD RECEIVERS

## 1 Scope

The limits in this International Standard are designed to provide protection for broadcast receivers in the frequency range of 30 MHz to 1 000 MHz when used in the residential environment. Compliance with this standard may not provide adequate protection for new types of radio transmissions or receivers used in the residential environment nearer than 10 m to the vehicle, boat or device.

NOTE 1 Experience has shown that compliance with this standard may provide satisfactory protection for receivers of other types of transmissions when used in the residential environment, including radio transmissions in frequency ranges other than that specified.



This standard applies to the emission of electromagnetic energy which may cause interference to radio reception and which is emitted from

- a) vehicles propelled by an internal combustion engine, electrical means or both (see 3.1);
- b) boats propelled by an internal combustion engine, electrical means or both (see 3.2). Boats are to be tested in the same manner as vehicles except where they have unique characteristics as explicitly stated in this standard;
- c) devices equipped with internal combustion engines or traction batteries (see 3.3).

See Annex E for a flow chart to help determine the applicability of CISPR 12.

This standard does not apply to aircraft, household appliances, traction systems (railway, tramway and electric trolley bus), vehicle / boat / device off-board chargers or to incomplete vehicles. In the case of a dual-mode trolley bus (e.g. propelled by power from either a.c./d.c. mains or an internal combustion engine), the internal combustion propulsion system shall be included, but the a.c./d.c. mains portion of the vehicle propulsion system shall be excluded from this standard.

NOTE 2 Protection of receivers used on board the same vehicle as the disturbance source(s) are covered by CISPR 25

The measurement of conducted electromagnetic disturbances while the vehicle is connected to power mains for charging is not covered in this standard. The user is referred to appropriate IEC and CISPR standards which define measurement techniques and limits for this condition.

Annex J lists work being considered for future revisions.

## 52 2 Normative references

53 The following referenced documents are indispensable for the application of this document. For dated  
54 references, only the edition cited applies. For undated references, the latest edition of the referenced  
55 document (including any amendments) applies.

56 IEC 60050(161): *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic*  
57 *compatibility*

58 CISPR 16-1-1:2010, *Specification for radio disturbance and immunity measuring apparatus and*  
59 *methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*  
60 *Amendment 1 (2010)*

61 CISPR 16-1-2:2006, *Specification for radio disturbance and immunity measuring apparatus and*  
62 *methods – Part 1-2: Radio disturbance and immunity measurement apparatus – Ancillary equipment –*  
63 *Conducted disturbances*

64 CISPR 16-1-3:2004, *Specification for radio disturbance and immunity measuring apparatus and*  
65 *methods – Part 1-3 Radio disturbance and immunity measuring apparatus – Ancillary equipment –*  
66 *Disturbance power*

67 CISPR 16-1-4:2007, *Specification for radio disturbance and immunity measuring apparatus and*  
68 *methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Ancillary equipment –*  
69 *Radiated disturbances*

70 CISPR 16-2-3:2010, *Specification for radio disturbance and immunity measuring apparatus and*  
71 *methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance*  
72 *measurements*  
73 *Amendment 1 (2010)*

74 CISPR 16-4-2:2011, *Specification for radio disturbance and immunity measuring apparatus and*  
75 *networks – Part 4-2: Uncertainties, statistics and limit modelling – Measurement instrumentation*  
76 *uncertainty*

77 CISPR 16-4-3:2004, *Specification for radio disturbance and immunity measuring apparatus and*  
78 *methods – Part 4-3: Uncertainties, statistics and limit modelling – Statistical considerations in the*  
79 *determination of EMC compliance of mass-produced products*  
80 *Amendment 1 (2006)*

81 CISPR 25: *Radio disturbance characteristics for the protection of receivers used on board vehicles,*  
82 *boats, and on devices – Limits and methods of measurement*

## 83 3 Terms and definitions

84 For the purpose of this document, the terms and definitions contained in IEC 60050-161 as well as the  
85 following apply.

### 86 3.1 87 vehicle

88 machine operating on land which is intended to carry persons or goods

89 NOTE Vehicles include, but are not limited to, cars, trucks, buses, mopeds, agricultural machinery, earth-moving machinery,  
90 material-handling equipment, mining equipment, floor treatment machines and snowmobiles

### 91 3.2 92 boat

93 vessel intended to be used on the surface of water, its length being no greater than 15 m

94 **3.3**  
95 **device**  
96 machine driven by an internal combustion engine which is not primarily intended to carry persons or  
97 goods

98 NOTE Devices include, but are not limited to, chainsaws, irrigation pumps, snow blowers, air compressors, walk-behind floor  
99 treatment machines and landscaping equipment

100 **3.4**  
101 **impulsive ignition noise**  
102 unwanted emission of electromagnetic energy, predominantly impulsive in content, arising from the  
103 ignition system within a vehicle, boat or device

104 **3.5**  
105 **ignition noise suppressor**  
106 that portion of a high-voltage ignition circuit intended to limit the emission of impulsive ignition noise

107 **3.6**  
108 **Outdoor test site (OTS)**  
109 measurement site similar to an open area test site as specified in CISPR 16, however a ground plane is  
110 not required and there are dimensional changes

111 NOTE Specific requirements are defined in this document.

112 **3.7**  
113 **resistive distributor brush**  
114 resistive pick-up brush in an ignition distributor cap

115 **3.8**  
116 **frequency sub-band**  
117 segment of the frequency spectrum (30 MHz to 1 000 MHz) defined to enable statistical evaluation of  
118 the test data acquired by swept frequency testing

119 **3.9**  
120 **representative frequency**  
121 assigned frequency of a frequency sub-band to be used for comparison of the data to the limit

122 **3.10**  
123 **characteristic level**  
124 controlling (or dominant) emission level experienced in each frequency sub-band. The characteristic  
125 level is the maximum field-strength level obtained for both antenna polarizations and for all the specified  
126 measurement positions of the vehicle, boat or device. Known ambient signals shall not be considered  
127 part of the characteristic level.

128 **3.11**  
129 **tracking generator**  
130 test signal oscillator (continuous wave, cw) that is frequency locked to the receive frequency of a  
131 measuring receiver

132 **3.12**  
133 **RF disturbance power**  
134 RF power measured with a current transformer of an absorbing clamp and an RF measuring receiver. It  
135 may be measured – as the RF disturbance voltage – in a peak or quasi-peak mode

136 **3.13**  
137 **spark discharge**  
138 in this document, the discharge of energy stored in the ignition coil, in an arc across the electrodes of a  
139 measuring spark-plug

140 **3.14**  
141 **resistive high-voltage (HV) ignition cable**  
142 ignition cable whose conductor has a high resistance (attenuation)

- 143 **3.15**  
144 **residential environment**  
145 environment having a 10 m protection distance between the source and the point of radio reception and  
146 where the source uses the public low voltage power system or battery power
- 147 NOTE Examples of a residential environment include rooming houses, private dwellings, entertainment halls, theatres,  
148 schools, public streets, etc.
- 149 **3.16**  
150 **traction batteries**  
151 high power batteries used for electric vehicle applications
- 152 **3.17**  
153 **unladen**  
154 not carrying any additional weight in the vehicle (passengers or cargo)
- 155 **3.18**  
156 **asymmetric artificial network (AAN)**  
157 network used to measure (or inject) asymmetric (common mode) voltages on unshielded symmetric  
158 signal (e.g. telecommunication) lines while rejecting the symmetric (differential mode) signal
- 159 Note: This network is inserted in the communication/signal lines of the vehicle in charging mode to provide a specific load  
160 impedance and/or a decoupling (e.g. between communication/signal lines and power mains)
- 161 **3.19**  
162 **artificial network (AN)**  
163 a network inserted in the supply lead or signal/load lead of apparatus to be tested which provides, in a  
164 given frequency range, a specified load impedance for the measurement of disturbance voltages and  
165 which may isolate the apparatus from the supply or signal sources/loads in that frequency range
- 166 Note : network inserted in the d.c power lines of the vehicle in charging mode which provides, in a given frequency range, a  
167 specified load impedance and which isolates the vehicle from the d.c power supply in that frequency range
- 168 **3.20**  
169 **artificial mains network (AMN)**  
170 provides a defined impedance to the EUT at radio frequencies, couples the disturbance voltage to the  
171 measuring receiver and decouples the test circuit from the supply mains. There are two basic types of  
172 AMN, the V-network (V-AMN) which couples the unsymmetrical voltages, and the delta-network which  
173 couples the symmetric and the asymmetric voltages separately. The terms line impedance stabilization  
174 network (LISN) and V-AMN are used
- 175 Note : network inserted in the power mains of the vehicle in charging mode which provides, in a given frequency range, a  
176 specified load impedance and which isolates the vehicle from the power mains in that frequency range"
- 177 **3.21**  
178 **controller area network (CAN)**  
179 a network documented in ISO 11898 that connects devices, sensors and actuators in systems
- 180 **3.22**  
181 **powerline communications (PLC)**  
182 a communication technique based on error tolerant modulation schemes which transmits information  
183 superimposed to electrical power over lines or cables
- 184 **3.23**  
185 **absorber lined shielded enclosure (ALSE)**  
186 shielded enclosure/screened room with radio frequency-absorbing material on its internal ceiling and  
187 walls
- 188 **3.24**  
189 **wireless power transfer (WPT)**  
190 the transfer of electrical energy from a power source to an electrical load via electric and/or magnetic  
191 fields or waves between a primary and a secondary device

## **4 Limits of disturbance**

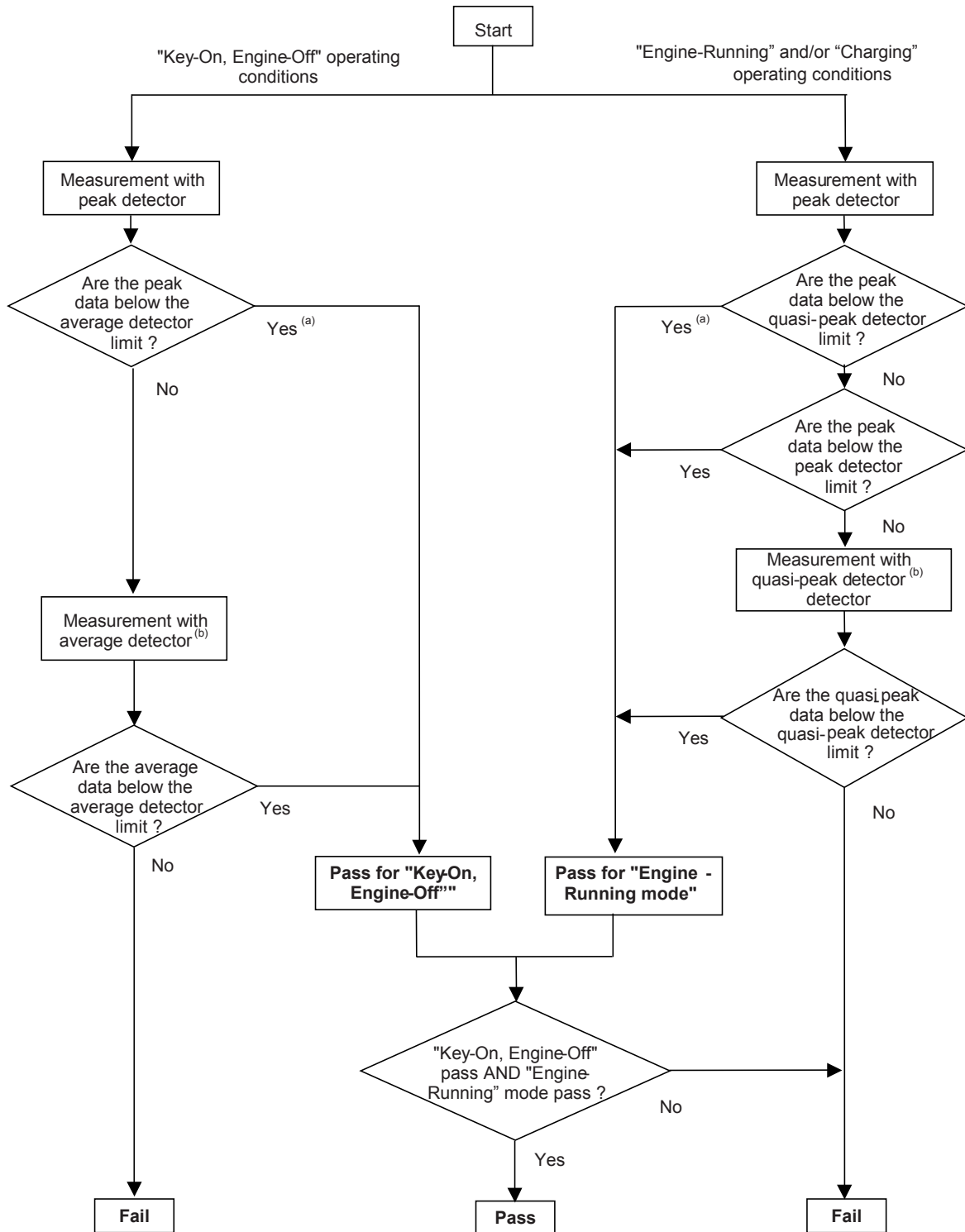
### **4.1 Determination of conformance of vehicle/boat/device with limits**

In the 30 MHz – 1 GHz frequency range, the vehicle/boat/device shall comply with both:

- average detector limits when the vehicle/boat/device is in “Key-On, Engine-Off” mode (see 5.4.2.1), and
- peak or quasi-peak detector limits when the vehicle/boat/device is in “Engine-Running” mode (see 5.4.2.2) and
- if applicable peak or quasi-peak detector limits when the vehicle/boat/device is in “Charging mode connected to the power grid” (see 5.4.2.3)

The limits given in this standard take into account uncertainties.

Figure 1 defines the method for determination of conformance.



203

204 a Because measurement with peak detector is always higher than or equal to measurement with quasi-peak detector  
 205 (and average detector respectively) and applicable peak detector limit is always higher than or equal to applicable  
 206 quasi-peak detector limit (and average detector limit respectively), this single detector measurement can lead to a  
 207 simplified and quicker conformance process.

208 b This flow-chart is applicable for each individual frequency, e.g only frequencies that are above the applicable limit  
 209 need to be remeasured with quasi-peak detector (and average detector respectively).

210

**Figure 1 – Method of determination of conformance**

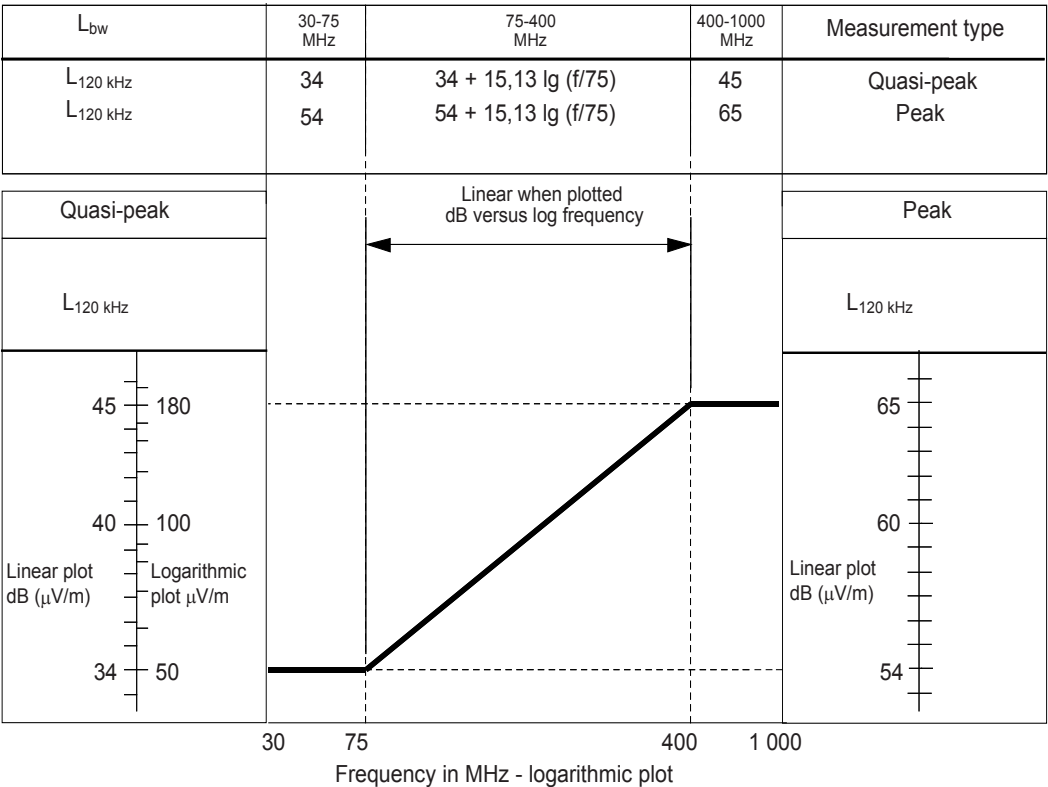
211

## 4.2 Peak and quasi-peak detector limits

212 The limit for emissions measured with peak or quasi-peak detector at 10 m antenna distance is given in  
 213 the table of Figure 2 and is shown graphically in Figure 2. For more accurate determination, the  
 214 equations given in Figure 2 shall be used. For measurements at 3 m antenna distance, 10 dB shall be  
 215 added to the limit.

216

Limit  $L_{bw}$  in dB ( $\mu\text{V/m}$ ) as a function of detector and frequency  $f$  in MHz



217

218 NOTE 1 For vehicles equipped with electric propulsion motors, see 5.4.2.

219 NOTE 2 For peak measurements, see 5.5.

220 **Figure 2 – Limit of disturbance (peak and quasi-peak detector)**  
221 **at 10 m antenna distance**

222 **4.3 Average detector limit**

223 The limit for emissions measured with the average detector at 10 m antenna distance is shown in  
224 Figure 3. Vehicles/boats/devices not including electronic oscillators with an operating frequency greater  
225 than 9 kHz shall be deemed to be in compliance with the requirements of this clause without performing  
226 tests for emissions with average detector. Vehicles/boats/devices which meet the average emissions  
227 requirements of CISPR 25, Clause 5 shall also be deemed to be in compliance with the average  
228 requirements of this subclause and no further testing is necessary.

229

For measurements at 3 m antenna distance, 10 dB shall be added to the limit.

The average detector is defined in CISPR 16-1-1.

Note: The definition of the AV detector was changed in CISPR 16-1 in 2002. The difference between the old definition and the new definition is described in Annex D of CISPR 16-2-3.

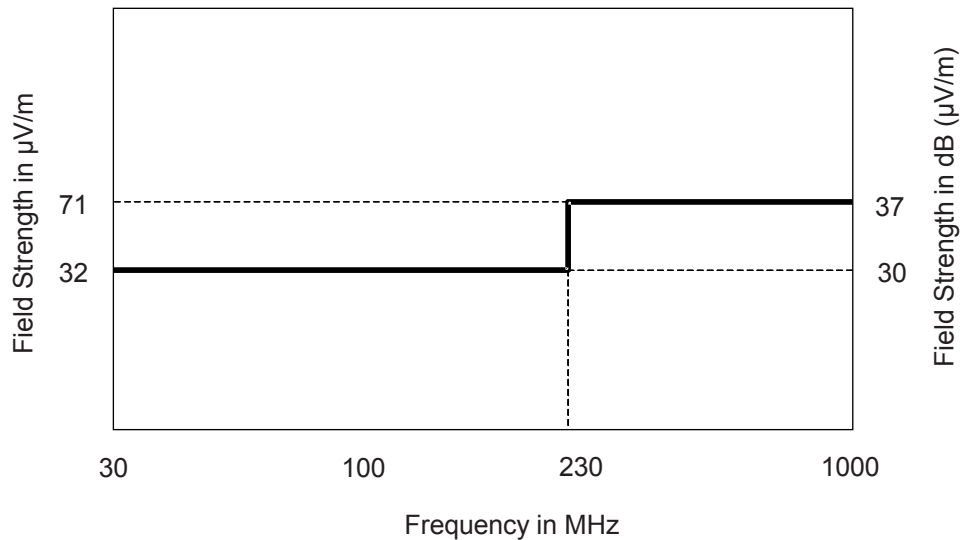


**Figure 3 – Limits of disturbance (average detector) at 10 m antenna distance**

## 5 Methods of measurement

### 5.1 Measuring receiver

#### 5.1.1 General

The measuring receiver shall comply with the requirements of CISPR 16-1-1. 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 receiver in order to achieve the 6 dB noise floor requirements. If a preamplifier is used to achieve the 6 dB noise floor requirement, the laboratory should establish a procedure to avoid overload of the preamplifier, such as using a step attenuator.

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

## 5.1.2 Spectrum analyser parameters

The scan rate of the spectrum analyser shall be adjusted for the CISPR frequency band and detection mode used. The maximum scan rate shall comply with the requirements of CISPR 16-2-3.

Spectrum analysers may be used for performing compliance measurements to this standard providing the precautions cited in CISPR 16-1-1 on the use of spectrum analysers are adhered to and that the broadband emissions from the product being tested have a repetition frequency greater than 20 Hz.

The recommended scan time and resolution bandwidth (RBW) are listed in Table 1

**Table 1 – Spectrum analyser parameters**

| Frequency range<br>MHz | Peak detector     |              | Quasi-peak detector |            | Average detector  |             |
|------------------------|-------------------|--------------|---------------------|------------|-------------------|-------------|
|                        | RBW at<br>-3 dB   | Scan time    | RBW at<br>-6 dB     | Scan time  | RBW at<br>-3 dB   | Scan time   |
| 30 to 1 000            | 100 or 120<br>kHz | 100 ms / MHz | 120 kHz             | 20 s / MHz | 100 or 120<br>kHz | 100 ms /MHz |

When a spectrum analyser is used for measurements, the video bandwidth shall be at least three times the RBW.

## 5.1.3 Scanning receiver parameters

The dwell time of the scanning receiver shall be adjusted for the CISPR frequency band and detection mode used. The minimum dwell time, maximum step size and bandwidth (BW) are listed in Table 2.

**Table 2 – Scanning receiver parameters**

| Frequency range<br>MHz | Peak detector  |           |            | Quasi-peak detector |           |            | Average detector |           |            |
|------------------------|----------------|-----------|------------|---------------------|-----------|------------|------------------|-----------|------------|
|                        | BW at<br>-6 dB | Step size | Dwell time | BW at<br>-6 dB      | Step size | Dwell time | BW at<br>-6 dB   | Step size | Dwell time |
| 30 to 1 000            | 120 kHz        | 50 kHz    | 5 ms       | 120 kHz             | 50 kHz    | 1 s        | 120 kHz          | 50 kHz    | 5 ms       |

## 269 **5.1.4 Antenna types**

### 270 **5.1.4.1 Preferred Antenna**

271 The antenna shall be a balanced dipole (see CISPR 16-1-4). Free-space antenna factors are to be used.  
272 For frequencies of 80 MHz or above, the antenna shall be resonant in length, and for frequencies below  
273 80 MHz it shall be the length equal to the 80 MHz resonant length. It shall be matched to the  
274 transmission line by a suitable symmetric-asymmetric transformer device.

### 275 **5.1.4.2 Alternative Antennas**

276 Any linearly polarized receiving antenna is permitted, provided that it can be normalized to the  
277 reference antenna.

278 A broadband antenna shall be used when making measurements with an automated receiving system  
279 using a scanning measuring receiver. Such a broadband antenna is usable for measuring emission  
280 levels (over the frequency spectrum covered by this standard), provided that its output can be  
281 normalized to the output of the reference antenna in the actual test environment at the actual test site.

282 When broadband antennas are used, they shall meet the requirements for complex antennas given in  
283 CISPR 16-1-4. Examples of factors to be considered include:

- 284 a) the effective aperture area of the antenna, including its polar response (horizontal and vertical  
285 planes).
- 286 b) the effect of a phase centre which moves with frequency.
- 287 c) the effect of ground reflection characteristics (including multiple ray reflections which may arise at  
288 specific frequencies at about 500 MHz vertical polarization and 900 MHz horizontal polarization).

289 See Annex B for alternate antenna characterization.

### 290 **5.1.5 Accuracy**

291 The measurement system consisting of the antenna, transmission line and the measuring receiver, but  
292 excluding the source and the measuring site, shall measure electric field strength over the frequency  
293 range of 30 MHz to 1 000 MHz with an accuracy of  $\pm 3$  dB. See Clause 4 of CISPR 16-1-4. The  
294 frequency accuracy shall be better than  $\pm 1$  %.

295 NOTE 1 To ensure that the measurements defined in this document are within the stated tolerances, consideration should be  
296 given to all pertinent characteristics of measuring equipment (for example, frequency and amplitude stability, image rejection,  
297 cross-modulation, overload levels, selectivity, time constants, and signal/noise ratio), as well as those affecting the antenna  
298 and transmission line.

299 NOTE 2 It is reasonable to expect additional variations in measurements made of an electric field (see C.13) within the range  
300 of 30 MHz to 1 000 MHz. These are caused by variations in ground conductivity and other factors influencing repeatability.

301

## 302 **5.2 Measuring location requirements**

### 303 **5.2.1 Outdoor Test Site (OTS) requirements**

#### 304 **5.2.1.1 OTS for vehicles and devices**

305 The test site shall be a clear area, free from electromagnetic reflecting surfaces within a circle of  
306 minimum radius 30 m (20 m radius for 3 m measurements) measured from a point midway between the  
307 vehicle or device and the antenna. As an exception, the measuring equipment, and test hut or vehicle in  
308 which the measuring equipment is located (when used) may be within the test site, but only in the  
309 permitted region indicated by the crosshatched area of Figure 4.

310 NOTE The site requirements defined in 5.2.1.1 and Figure 4 are the application of CISPR 16-1-4 to large automotive objects.

311 Vehicles and devices smaller than 2 m in length and width may be tested on an OTS with dimensions  
312 corresponding to CISPR 16-1-4, Figures 2 or 3.

#### 313 **5.2.1.2 OTS for boats**

314 The test site shall be a clear area free from electromagnetic reflecting surfaces within a circle of  
315 minimum radius 30 m (20 m radius for 3 m measurements) measured from a point midway between the  
316 engine under test and the antenna. Exceptions for the measuring equipment are specified in 5.2.1.2.1  
317 and also in 5.2.1.2.2. As an exception, the measuring equipment may be within the test site, but only in  
318 the permitted region indicated by the crosshatched area of Figure 5. The test hut or vehicle or non-  
319 metallic boat of test fixture in/on which the measuring equipment is located may be within the test site.

320 Boats or engines/motors for boats tested separately shall be tested in salt or fresh water at a measuring  
321 site as shown in Figure 5.

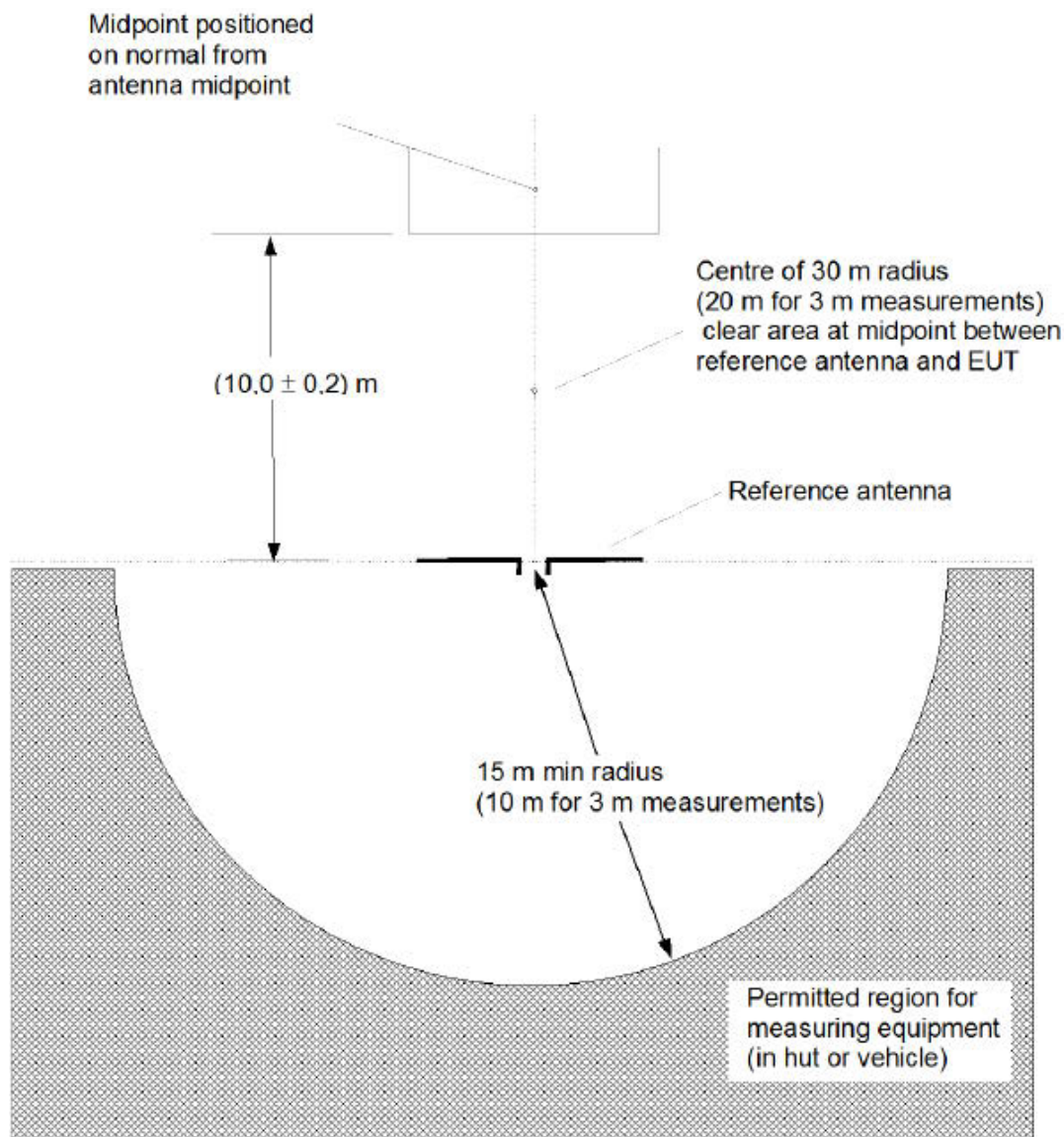
##### 322 **5.2.1.2.1 Land-based measuring equipment**

323 When the measuring equipment is on land, the test hut or vehicle in which the measuring equipment is  
324 located may be within the test site, but only in the permitted region indicated by the cross-hatched area  
325 of Figure 5.

##### 326 **5.2.1.2.2 Water-based measuring equipment**

327 The measuring equipment shall be installed in a non-metallic boat or non-metallic test fixture which may  
328 be within the test site, but only within the permitted region indicated by the cross-hatched area of  
329 Figure 5.

330



NOTE The 10,0 m ± 0,2 m dimension may be changed to 3,00 m ± 0,05 m in accordance with 5.2.3.2 and 5.2.3.4.

**Figure 4 – Measuring site (OTS) for vehicles and devices**

### 5.2.1.3 Ambient requirements

To ensure that there is no extraneous noise or signals of sufficient magnitude or density to affect materially the vehicle measurement, ambient measurements shall be taken before and after the main test, but without the vehicle/boat/device under test running. In both of these measurements, the ambient noise shall be at least 6 dB below the limits of disturbance given in Clause 4, excluding intentional radiators. When assessing compliance in accordance with Clause 6 any emission exceeding the limits shall require investigation to ensure that they are not attributable to the vehicle/boat/device in order to be excluded.

NOTE For further guidance, see 5.4 of CISPR 16-1-4.

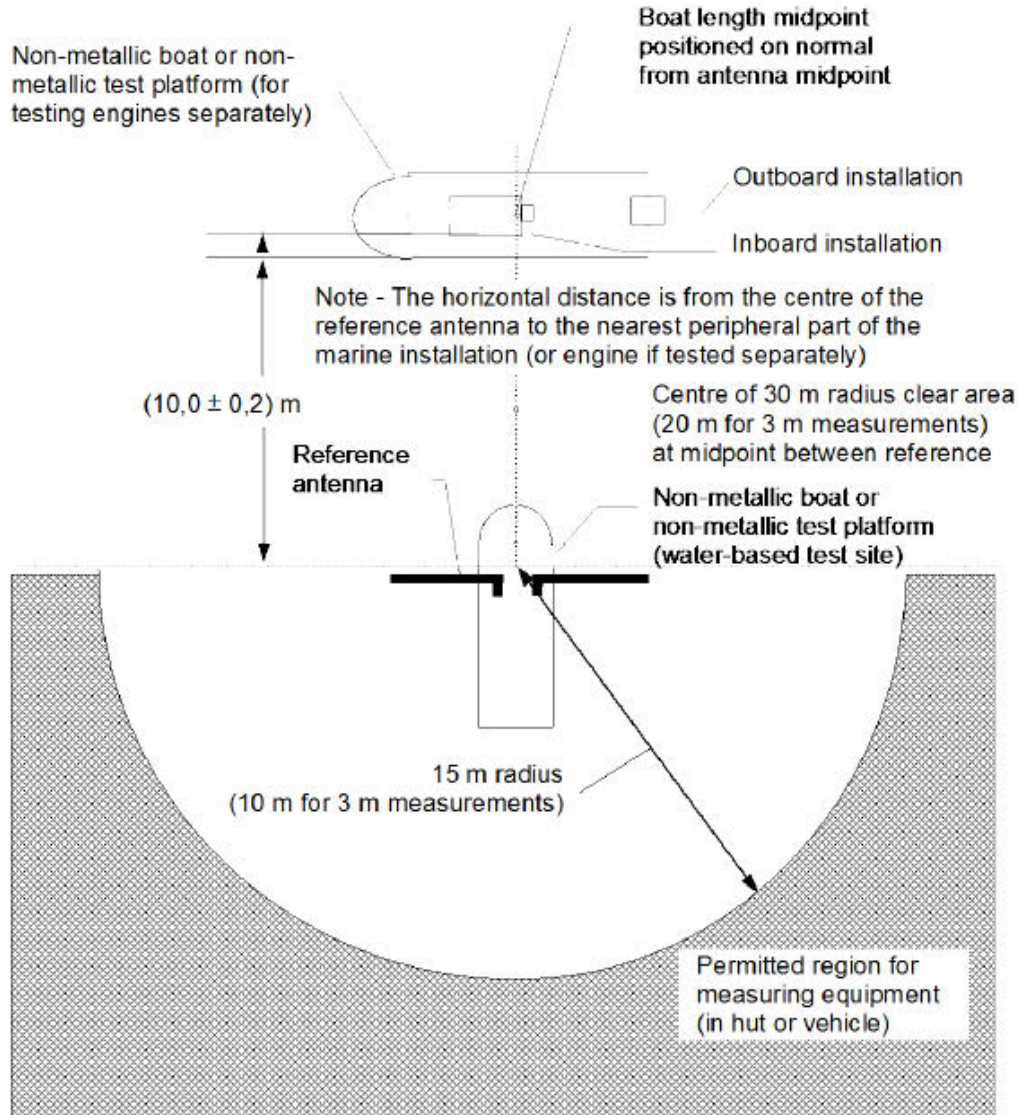


Figure 5 – Measuring site (OTS) for boats

## 5.2.2 Absorber lined shielded enclosure (ALSE) requirements

### 5.2.2.1 Correlation

Absorber lined shielded enclosures may be used provided that the results obtained can be correlated with those obtained using the OTS described in 5.2.1.

NOTE Such chambers have the advantages of all weather testing, controlled environment and improved repeatability because of stable chamber electrical characteristics.

### 5.2.2.2 Ambient requirements

The ambient noise level shall be at least 6 dB below the limits of disturbance given in Clause 4. The ambient level shall be verified periodically or when test results indicate the possibility of non-compliance.

### 5.2.3 Antenna requirements

At each measurement frequency (including the end frequencies), measurements shall be taken for horizontal and vertical polarization.

Electrical interaction between the antenna elements and the antenna support/guy system shall be avoided.

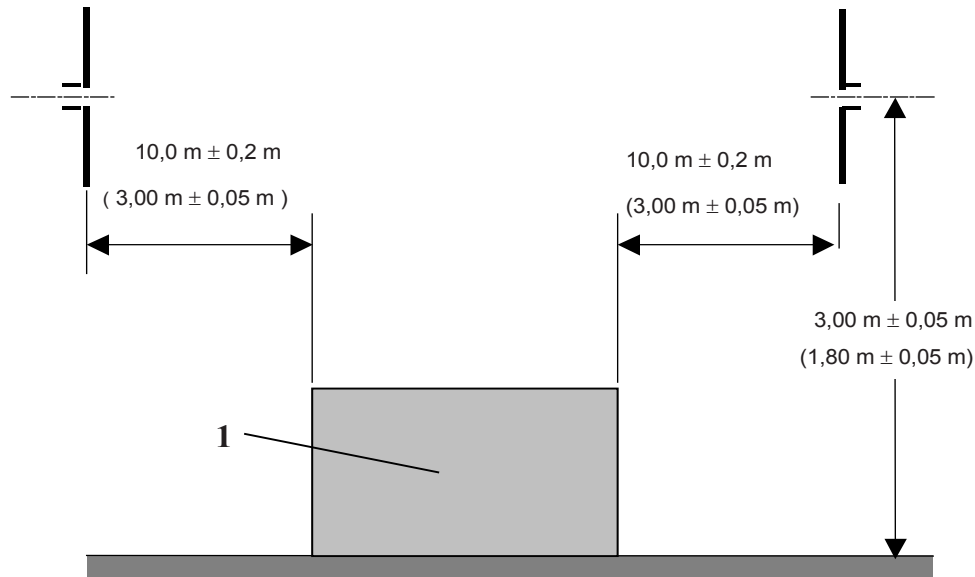
Theoretical considerations of antenna and transmission line geometry demand that the transmission line does not interact electrically with the antenna elements.

NOTE One acceptable transmission line geometry for a dipole antenna routes the transmission line horizontally rearward for a distance of 6 m at a height of 3 m (or 1,8 m for the 3 m antenna distance) before descending to ground level or below. Other geometries are acceptable if they can be shown not to affect the measurements, or if the effects can be included in equipment calibration.

#### 5.2.3.1 Height

For an antenna distance of 10 m, the centre of the antenna shall be  $3,00\text{ m} \pm 0,05\text{ m}$  above the ground/floor or water surface. For an antenna distance of 3 m, the height shall be  $1,80\text{ m} \pm 0,05\text{ m}$ .

Antenna height conditions are represented in Figure 6.



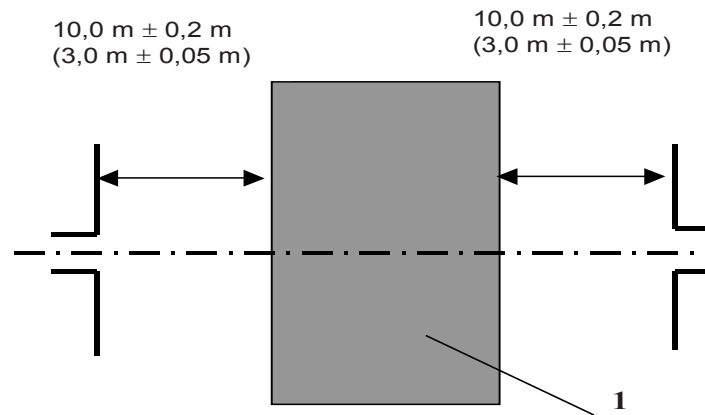
(Dimensions in brackets for 3 m antenna distance testing)

Drawing not to scale

#### Key

1 Equipment under test

**Figure 6 – Antenna height to measure emissions – Elevation view (Vertical polarization shown)**



(Dimensions in brackets for 3 m antenna distance testing)

Drawing not to scale

#### Key

1 Equipment under test

**Figure 7 – Antenna distance to measure emissions – Plan view (Horizontal polarization shown)**

#### 5.2.3.2 Distance

The preferred horizontal distance between the reference point of the antenna and to the nearest metal part of the vehicle/boat/device shall be  $10,0 \text{ m} \pm 0,2 \text{ m}$ ; as an alternative measurements may be made at a distance of  $3,00 \text{ m} \pm 0,05 \text{ m}$ .

Antenna distance conditions are represented in Figure 7.

#### 5.2.3.3 Position

##### 5.2.3.3.1 General

Multiple antenna positions are required (both for 10 m and 3 m antenna distance) if the length of the vehicle/boat/device is greater than the 3 dB beamwidth of the antenna. The same positions shall be used for both horizontal and vertical polarization measurements.

- if the length of the vehicle/boat/device is smaller than the 3 dB beamwidth of the antenna, only one antenna position is necessary. The antenna shall be aligned with the middle of the total vehicle/boat/device length (see Figure 8)

- if the length of the vehicle/boat/device is greater than the 3 dB beamwidth of the antenna, multiple antenna positions are necessary in order to cover the total length of the vehicle/boat/device (see Figure 9). The number of antenna positions shall allow to meet the following condition :

$$N \cdot 2 \cdot D \cdot \tan(\beta) \geq L \quad (1)$$

with

$N$  : number of antenna positions

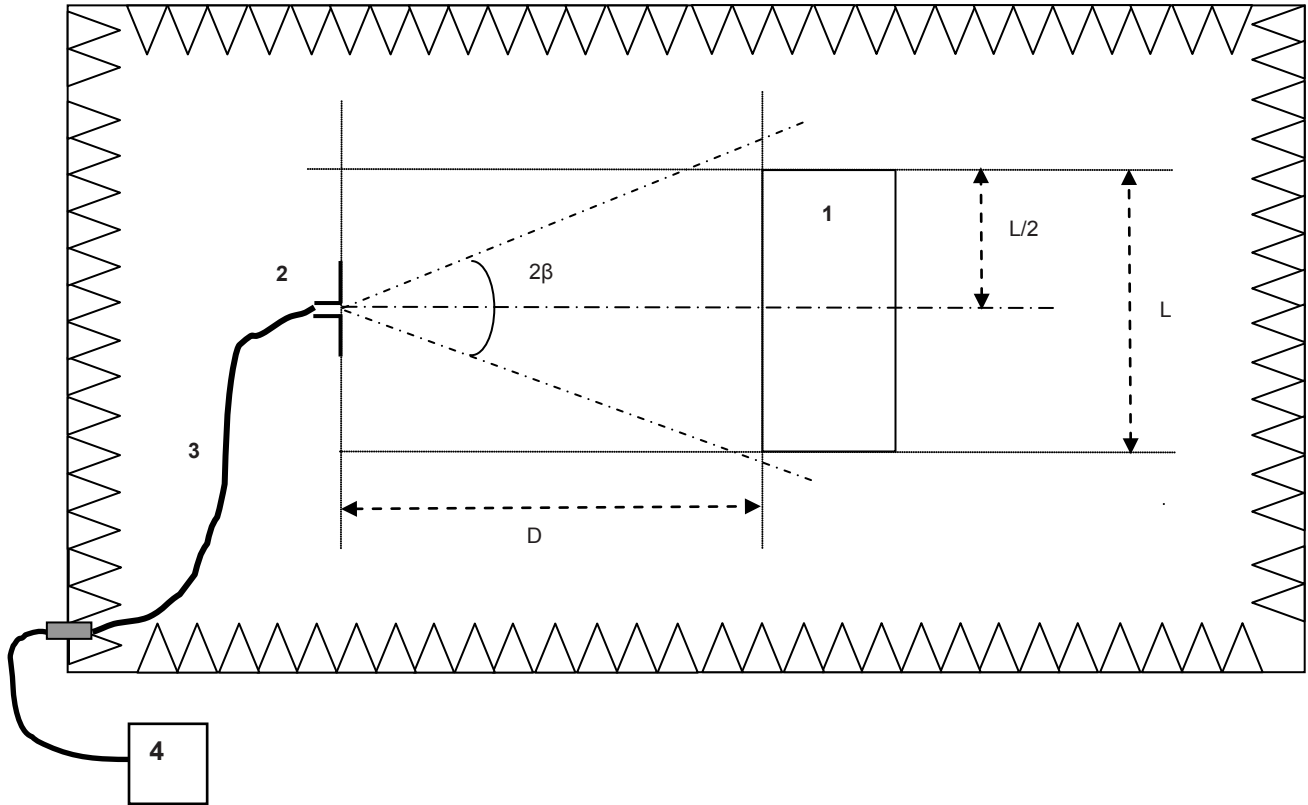
$D$  : measurement distance (3 m or 10 m)

$2 \cdot \beta$  : 3 dB antenna beamwidth angle

$L$  : total vehicle/boat/device length

For vehicle, measurements shall be made on the left and right sides of the vehicle/boat (see Figures 6 and 7)

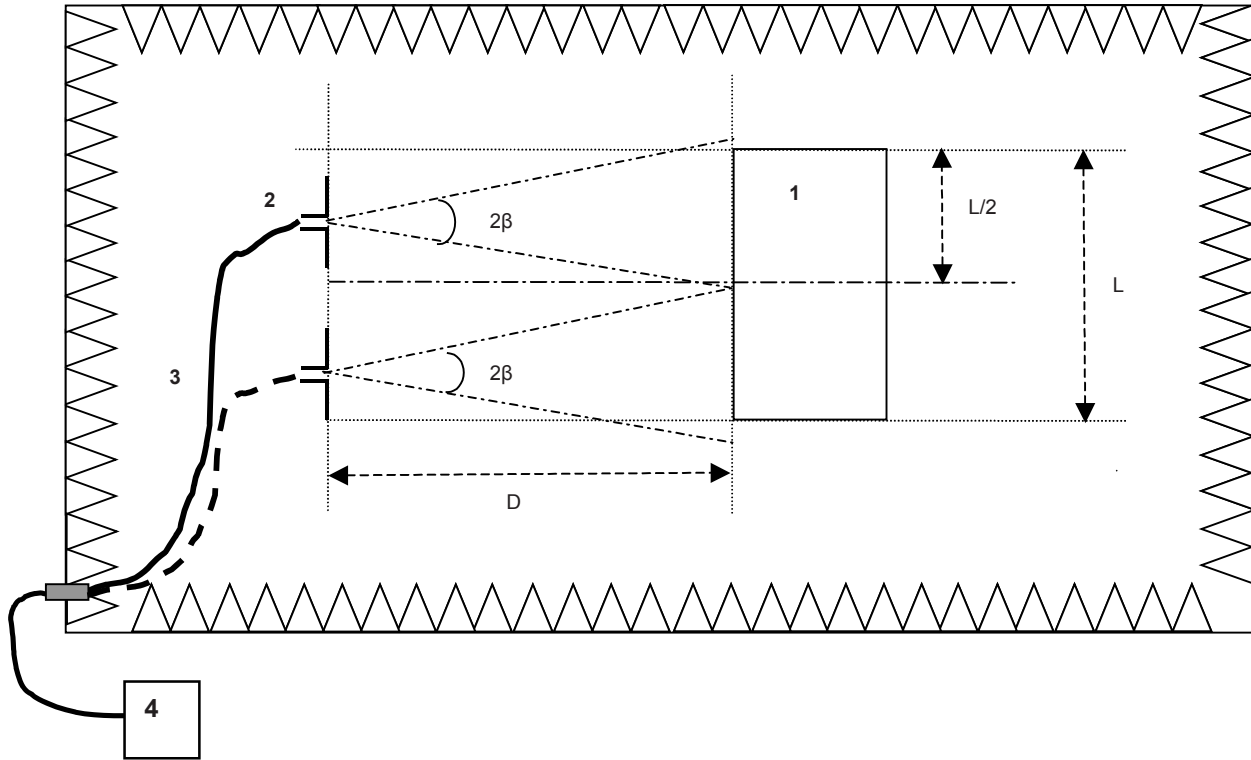
For devices, measurements shall be made in the direction of the maximum disturbance emission. Where practical, the device under test shall be measured in three orthogonal planes.



#### Key

- 1 Vehicle/boat/device under test
- 2 Antenna
- 3 Cable
- 4 Measuring equipment

**Figure 8 – Antenna position when length of the vehicle/boat/device is smaller than the 3 dB beamwidth of the antenna – Horizontal polarisation shown**



#### Key

- 1 Vehicle/boat/device under test
- 2 Antenna (two or more positions)
- 3 Cable
- 4 Measuring equipment

**Figure 9 – Multiple Antenna positions when length of the vehicle/boat/device is greater than the 3 dB beamwidth of the antenna - Horizontal polarisation shown**

#### 5.2.3.4 Auxiliary (multiple) antennas

Auxiliary antennas are permitted, but if two antennas are facing each other, one shall be vertically polarized while the other is horizontally polarized.

The test site clear area requirement of 5.2.1.1 shall be applied also to the point midway between the vehicle/boat/device and the auxiliary antenna(s).

#### 5.2.3.5 Multiple antenna positions

Multiple antenna positions can be avoided in the case where the measured emissions are lower than the original limit values minus a gain reduction calculated from the geometric dimensions of the test set-up and the antenna gain data (see Annex A).

**NOTE** A typical log periodic antenna has a 3 dB beamwidth of approximately 60°. This results in about 3,5 m of illumination at 3 m antenna distance, e.g. 1,75 m either side of the antenna centreline. Thus, a vehicle 8 m long requires three antenna positions on each side to quantify the radiation signature of that vehicle.

### 5.3 Test setup for vehicle in charging mode

#### 5.3.1 AC power charging without communication

This configuration concerns only slow charging mode