



# CISPR/D/429/CD

COMMITTEE DRAFT (CD)

IEC/TC or SC: CISPR/D		Project number CISPR 36 Ed. 1	
Title of TC/SC: Electromagnetic disturbances related to electric/electronic equipment on vehicles and internal combustion engine power devices		Date of circulation <b>2016-05-20</b>	Closing date for comments <b>2016-08-12</b>
		Also of interest to the following committees CISPR/B, TC69	
Supersedes document CISPR/D/402/NP CISPR/D/406A/RVN			
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## Title:

Electric and hybrid road vehicles - Radio disturbance characteristics - Limits and methods of measurement for the protection of off-board receivers below 30 MHz

(Titre) :

## Introductory note

The document was prepared by a project team under the roof of WG1 of CISPR/D to cover the special needs for vehicles equipped with an electric propulsion system. It provides measurement methods and a set of limits for the magnetic disturbance field strength.

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

**ELECTRIC AND HYBRID ROAD VEHICLES – RADIO DISTURBANCE  
CHARACTERISTICS – LIMITS AND METHODS OF MEASUREMENT FOR THE  
PROTECTION OF OFF-BOARD RECEIVERS BELOW 30 MHZ**

## FOREWORD

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International Standard CISPR 36 has been prepared by CISPR subcommittee D: Electromagnetic disturbances related to electric/electronic equipment on vehicles and internal combustion powered devices.

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- withdrawn,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.

The National Committees are requested to note that for this publication the stability date is 20XX.

THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED AT THE PUBLICATION STAGE.

103

## INTRODUCTION

104 There is a specific need for standards to define acceptable low frequency performance of all  
105 electrical/electronic products. CISPR 36 has been developed to serve the Road Vehicle and related  
106 industries with test methods and limits that provide satisfactory protection for radio reception.

107

108

**ELECTRIC AND HYBRID ROAD VEHICLES  
RADIO DISTURBANCE CHARACTERISTICS –  
LIMITS AND METHODS OF MEASUREMENT FOR THE PROTECTION  
OF OFF-BOARD RECEIVERS BELOW 30 MHz**

**1 Scope**

The limits in this International Standard are designed to provide protection for broadcast receivers in the frequency range below 30 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.

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.

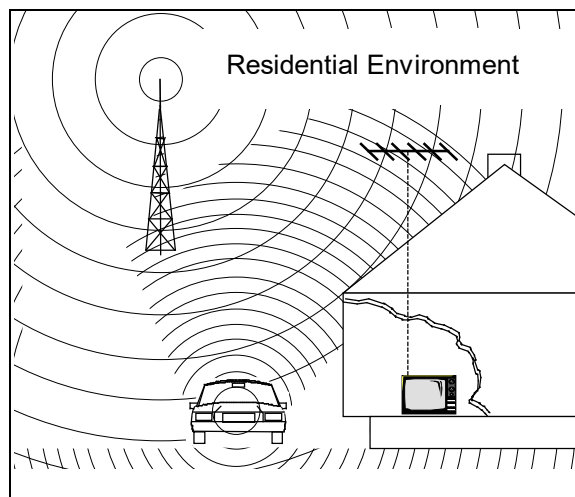
This standard applies to the emission of electromagnetic energy which may cause interference to radio reception and which is emitted from:

- vehicles propelled by an internal traction battery (see 3.1 and 3.4);

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 A lists work being considered for future revisions.



## 139 2 Normative references

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

143 SAE J 551-5:2012, *Performance levels and methods of measurement of magnetic and electric field*  
144 *strength from electric vehicles, 150 kHz to 30 MHz.*

145 CISPR 11:2015, *Industrial, scientific and medical equipment – Radio-frequency disturbance*  
146 *characteristics – Limits and methods of measurement*

147 CISPR 16-1-1:2010, *Specification for radio disturbance and immunity measuring apparatus and*  
148 *methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

149 CISPR 16-1-1:2010/AMD1:2010

150 CISPR 16-1-1:2010/AMD2:2014

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

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

157 CISPR 16-1-4:2010, *Specification for radio disturbance and immunity measuring apparatus and*  
158 *methods – Part 1-4: Radio disturbance and immunity measuring apparatus –Antennas and test sites for*  
159 *radiated disturbances measurements*

160 CISPR 16-1-4:2010/AMD1:2012

161 CISPR 16-2-3:2010, *Specification for radio disturbance and immunity measuring apparatus and*  
162 *methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance*  
163 *measurements*

164 CISPR 16-2-3:2010/AMD1:2010

165 CISPR 16-2-3:2010/AMD2:2014

166 CISPR 16-4-2:2011 *Specification for radio disturbance and immunity measuring apparatus and networks*  
167 *– Part 4-2: Uncertainties, statistics and limit modelling – Measurement instrumentation uncertainty*  
168 CISPR 16-4-2:2011/AMD1:2014

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

## 171 3 Terms and definitions

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

### 174 3.1

#### 175 vehicle

176 machine operating on land which is intended to carry persons or goods and/or that is operated by an  
177 on-board person

178

179

180 **3.2**181 **Outdoor Test Site (OTS)**

182 measurement site similar to an open area test site as specified in CISPR 16, however a ground plane is  
183 not required and there are dimensional changes

184 NOTE Specific requirements are defined in this document.

185 **3.3**186 **residential environment**

187 environment having a 10 m protection distance between the source and the point of radio reception

188 NOTE Examples of a residential environment include rooming houses, private dwellings, entertainment halls, theatres,  
189 schools, public streets, etc.

190 **3.4**191 **traction battery**

192 high voltage (HV) battery used for electric or hybrid vehicle

193 **3.5**194 **unladen**

195 not carrying any additional weight in the vehicle (passengers or cargo)

196 **3.6**197 **absorber lined shielded enclosure (ALSE)**

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

200 **4 Limits of disturbance**201 **4.1 Determination of conformance of vehicle with limits**

202 In the 0,15 MHz – 30 MHz frequency range, the vehicle shall comply for magnetic field with peak  
203 detector limits when the vehicle is in “Propulsion” mode (see 5.3.2.1)

204 The limits given in this standard take into account uncertainties.

205 **4.2 Peak detector limits**

206 The limit for emissions measured with peak detector at 3 m antenna distance is given in the Table 1 and  
207 is shown graphically in Figure 1. For more accurate determination, the equations given in Table 1 shall  
208 be used.

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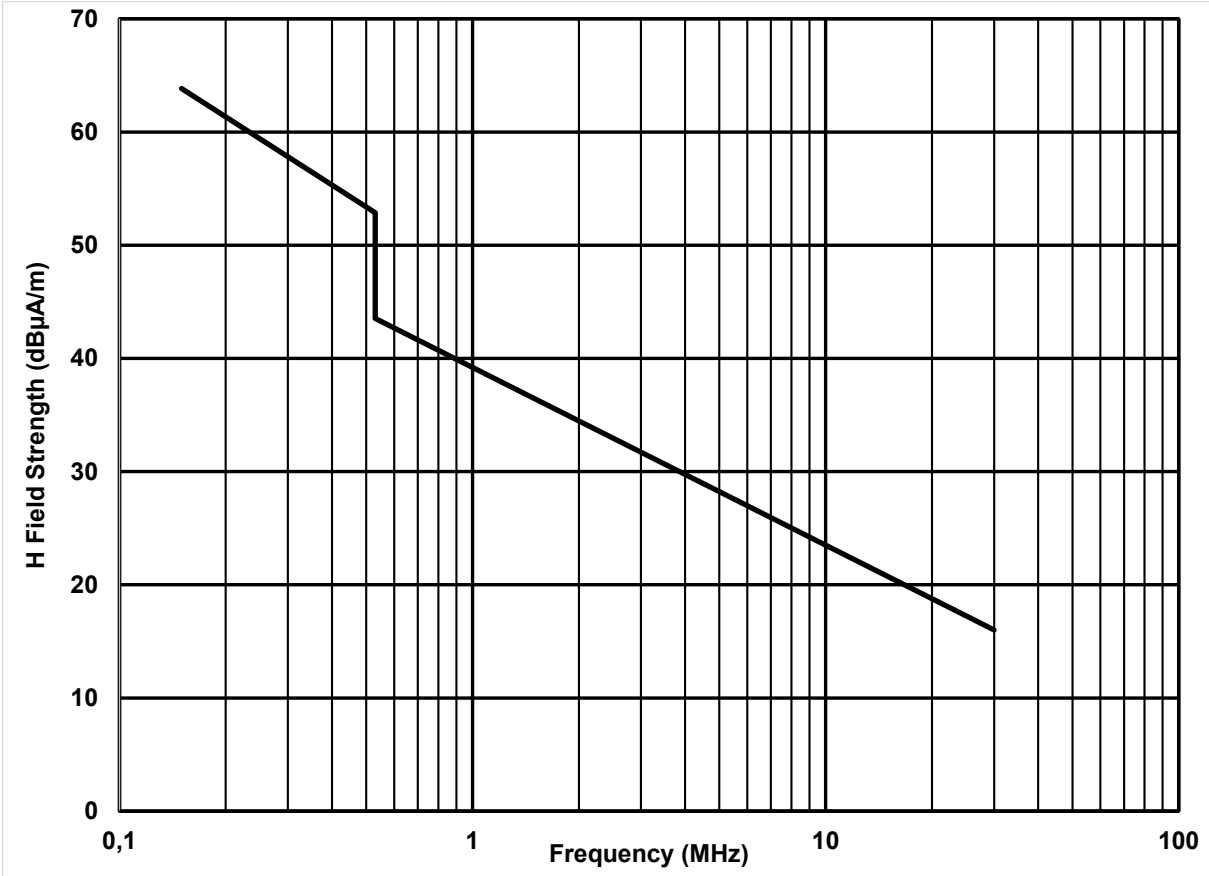


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**Table 1 - Limit of disturbance (Peak detector at 3 m antenna distance)**

Frequency MHz	H dB(μA/m)
0,15 – 0,53	$47,36 - 20 \times \lg(f_{\text{MHz}})$
0,53 – 30	$39,10 - 15,64 \times \lg(f_{\text{MHz}})$

211



212

**Figure 1 – Magnetic field limit of disturbance (peak detector)  
at 3 m antenna distance**

213  
214

215

## 216 5 Methods of measurement

### 217 5.1 Measuring receiver

#### 218 5.1.1 General

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

221 NOTE 1 Spectrum analysers and scanning receivers are particularly useful for disturbance measurements.

222 NOTE 2 A preamplifier may be used between the antenna and measuring receiver in order to achieve the 6 dB noise floor  
223 requirements. If a preamplifier is used to achieve the 6 dB noise floor requirement, the laboratory should establish a procedure  
224 to avoid overload of the preamplifier, such as using a step attenuator.

#### 225 5.1.2 Spectrum analyser parameters

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

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

231 The minimum scan time and resolution bandwidth (RBW) are listed in Table 2

232 **Table 2 – Spectrum analyser parameters**

Frequency range MHz	Peak detector	
	RBW at -3 dB	Scan time
0,15 to 30	9 or 10 kHz	10 s / MHz

233

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

#### 236 5.1.3 Scanning receiver parameters

237 The dwell time of the scanning receiver shall be adjusted for the CISPR frequency band and detection  
238 mode used. The minimum dwell time, maximum step size and bandwidth (BW) are listed in Table 3.

239 **Table 3 – Scanning receiver parameters**

Frequency range MHz	Peak detector		
	BW at -6 dB	Step size	Dwell time
0,15 to 30	9 kHz	5 kHz	50 ms

240

241

242 **5.1.4 Antenna type**

243 **5.1.4.1 Magnetic field Antenna**

244 For measurement of the magnetic component of the radiation, an electrically-screened loop antenna of  
245 dimension such that the antenna can be completely enclosed by a square having sides of 60 cm in  
246 length shall be used (see CISPR 16-1-4).

247 The unit of the magnetic field strength is  $\mu\text{A/m}$  or, in logarithmic units,  $20 \times \lg(\mu\text{A/m}) = \text{dB}(\mu\text{A/m})$ . The  
248 associated emission limit shall be expressed in the same units.

249 **5.1.5 Accuracy**

250 The measurement system consisting of the antenna, transmission line and the measuring receiver, but  
251 excluding the source and the measuring site, shall measure magnetic field strength over the frequency  
252 range of 0,15 MHz to 30 MHz with an accuracy of  $\pm 3$  dB. See Clause 4 of CISPR 16-1-4. The frequency  
253 accuracy shall be better than  $\pm 1$  %.

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

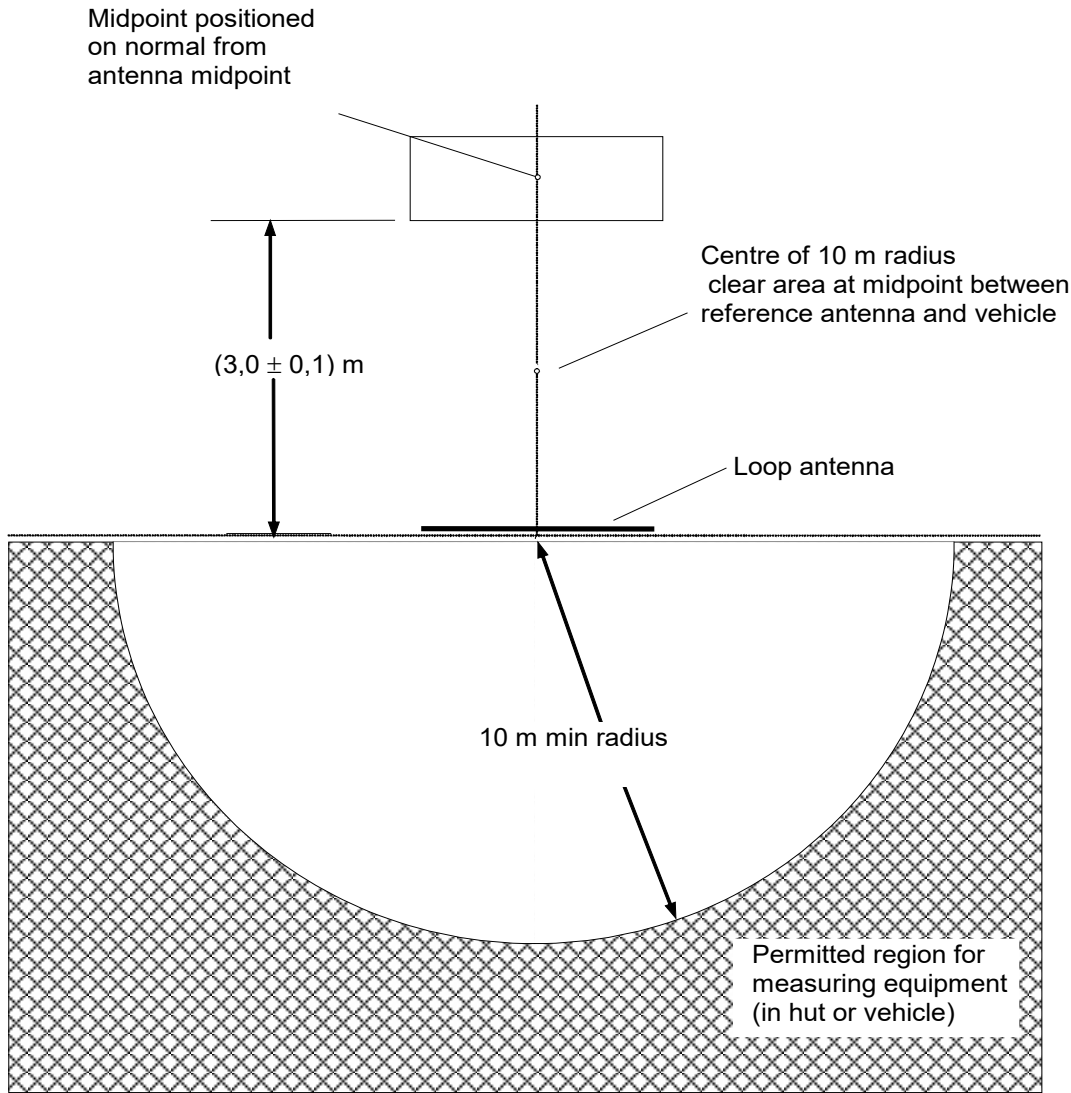
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**5.2 Measuring location requirements**

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

**5.2.1.1 OTS for vehicles**

The test site shall be a clear area, free from electromagnetic reflecting surfaces within a circle of minimum radius 10 m radius measured from a point midway between the vehicle and the antenna. As an exception, the measuring equipment, and test hut or vehicle in which the measuring equipment is located (when used) may be within the test site, but only in the permitted region indicated by the crosshatched area of Figure 2.



**Figure 2 – Measuring site (OTS) for vehicles**

**5.2.1.2 Ambient magnetic field 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 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 in order to be excluded.

**5.2.2 Absorber lined shielded enclosure (ALSE) requirements****5.2.2.1 Ambient magnetic field 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 H field antenna requirements**

At each measurement frequency (including the end frequencies), measurements shall be taken for two loop orientations (H radial and H transverse).

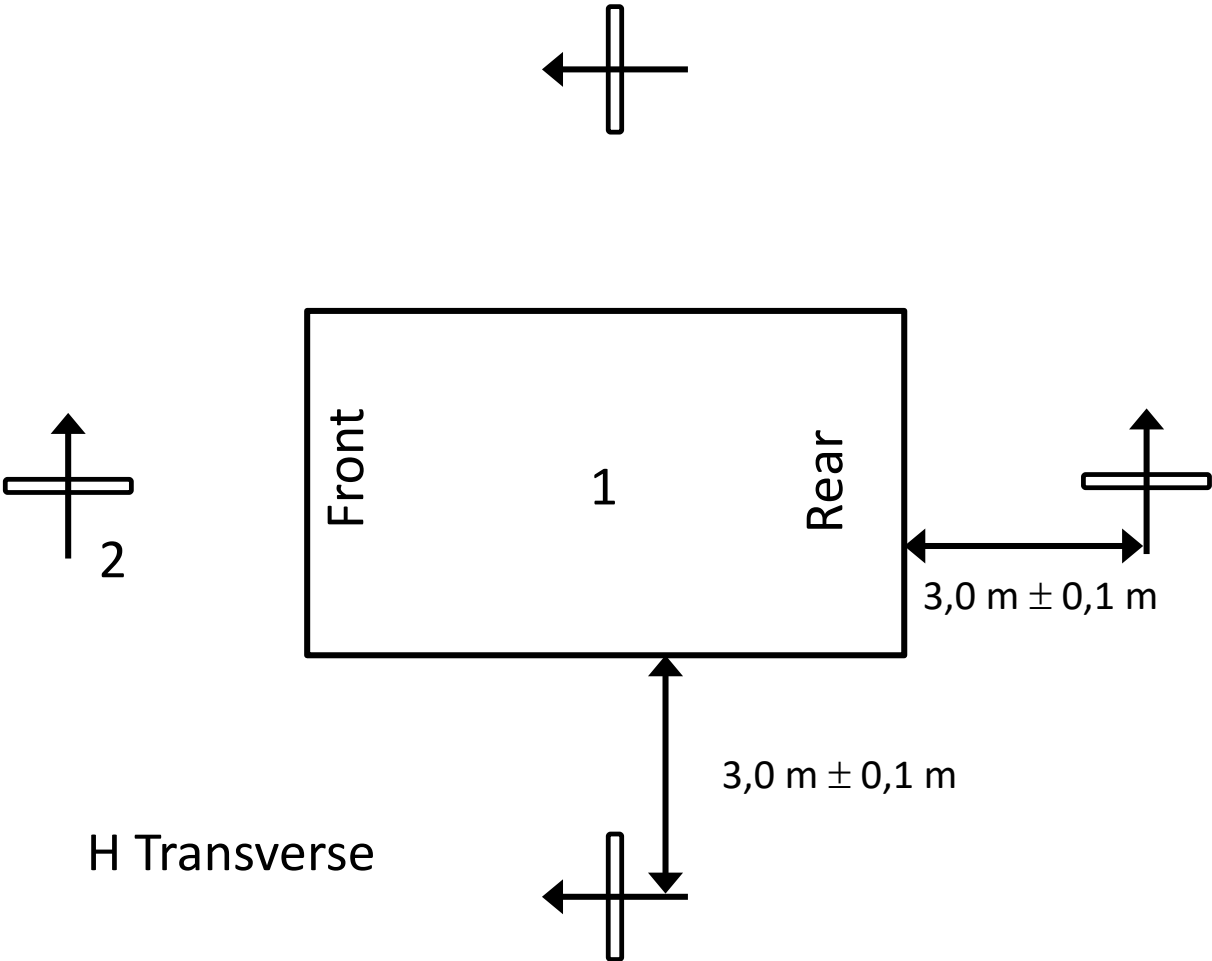
Electrical interaction between the antenna elements and the antenna support/guy system shall be avoided.

**5.2.3.1 Antenna position and distance**

Four antenna positions are required. The same positions shall be used for both loop orientations measurements (see Figures 3 and 4):

- front of the vehicle with the centre of the loop aligned with the vehicle longitudinal axis
- rear of the vehicle with the centre of the loop aligned with the vehicle longitudinal axis
- left of the vehicle with the centre of the loop aligned with the vehicle transversal axis
- right of the vehicle with the centre of the loop aligned with the vehicle transversal axis

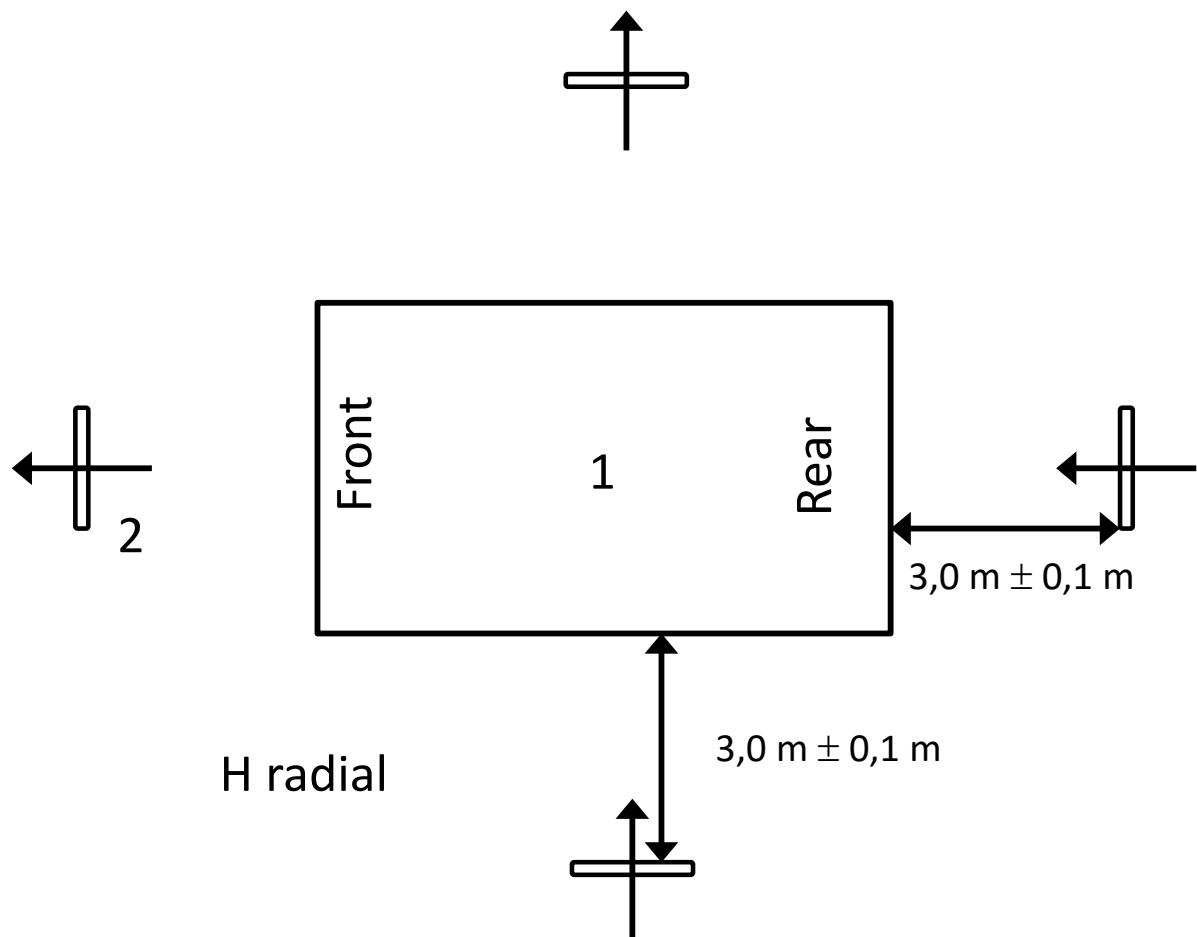
The horizontal distance between the centre of the loop antenna and to the nearest metal part of the vehicle shall be  $3,00 \text{ m} \pm 0,1 \text{ m}$  for all antenna positions.



**Key**

- 1 Vehicle under test
- 2 Antenna (four positions)

**Figure 3 – Magnetic field measurement – transverse loop orientation**



**Figure 4 – Magnetic field measurement – radial loop orientation**

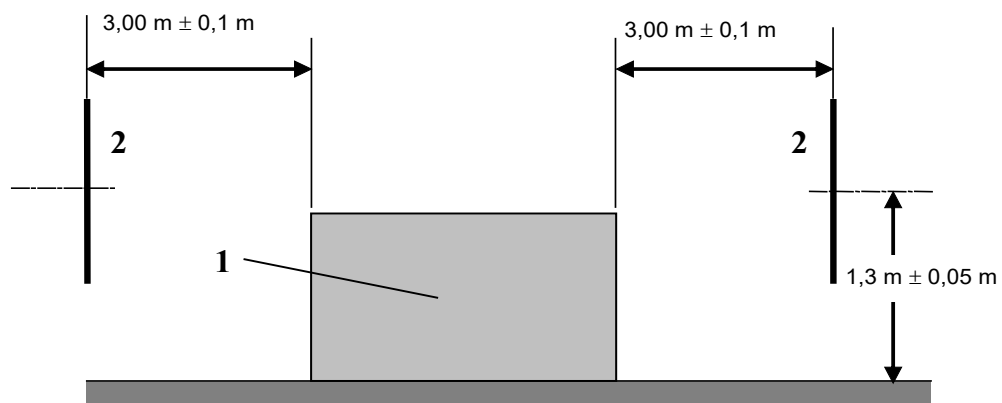
**Key**

- 1 Vehicle under test
- 2 Antenna (four positions)

**5.2.3.2 Height**

The height of the loop centre shall be  $1,3\text{ m} \pm 0,05\text{ m}$  above the ground level for all antenna positions defined in 5.2.3.1.

Antenna height conditions are represented in Figure 5 for right and left positions.



Drawing not to scale

**Key**

- 1 Vehicle under test (front view)
- 2 Loop antenna

**Figure 5 – Magnetic field antenna height – Elevation view (radial loop orientation)**



322 **5.3 Operating conditions**

323 **5.3.1 General**

324 Measurements made while the vehicle is dry or made more than 10 min after precipitation has stopped  
325 falling are preferred.

326 **5.3.2 Vehicles**

327 All equipment which is automatically switched on together with the propulsion system shall be measured  
328 while operating in a manner which is as representative of normal operation as possible. The engine  
329 shall be at normal operating temperature.

330 For vehicles with independent electric and internal combustion propulsion systems in the same vehicle,  
331 only the electric propulsion systems shall be tested.

332 Measurements shall be made for "Propulsion" mode.

333 This operating condition is applicable for vehicles propelled by an internal traction battery.

334

335 **5.3.2.1 "Propulsion" mode operating conditions**

336 **5.3.2.1.1 Vehicle with an electric propulsion motor**

337 Vehicles equipped with an electric propulsion motor shall be tested with the vehicle driven on a  
338 dynamometer without a load, or on non-conductive axle stands, with a constant speed of 40 km/h  $\pm$  20%,  
339 or the maximum speed, if this is less than 40 km/h.

340 **5.3.2.1.2 Vehicle with hybrid propulsion system**

341 The vehicle shall be tested:

342 – Vehicles driven on a dynamometer without a load, or on non-conductive axle stands, with both the  
343 electrical and the internal combustion propulsion systems functioning to operate the vehicle at  
344 40 km/h  $\pm$  20%.

345 – The value of the vehicle speed shall be recorded in the test report.

346

347 **5.4 Data collection**

348 The entire required frequency range shall be measured.

349 The results of peak measurements shall be expressed in terms of dB ( $\mu$ A/m).

350 The results of peak measurements shall be expressed in accordance with the bandwidth shown in  
351 Table 2 or Table 3.

## **Annex A** (informative)

### **Items Under Consideration**

#### **A.1 Introduction**

This annex contains future work items that are under consideration.

#### **A.2 Correlation between OTS and ALSE Measurements**

The work on this topic has been started in the CISPR/D Task Force.

#### **A.3 Uncertainty**

- Measurement instrumentation uncertainty (Normative Annex)
- Uncertainty budget for radiated disturbance measurement of magnetic field strength (Informative Annex)

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## Bibliography

- 367 [1] IEC 60050-161:1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161:*  
368 *Electromagnetic compatibility*  
369 IEC 60050-161:1990/AMD1:1997  
370 IEC 60050-161:1990/AMD2:1998  
371 IEC 60050-161:1990/AMD3:2014  
372 IEC 60050-161:1990/AMD4:2014  
373 IEC 60050-161:1990/AMD5:2015

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