# IEC TS 62764-1

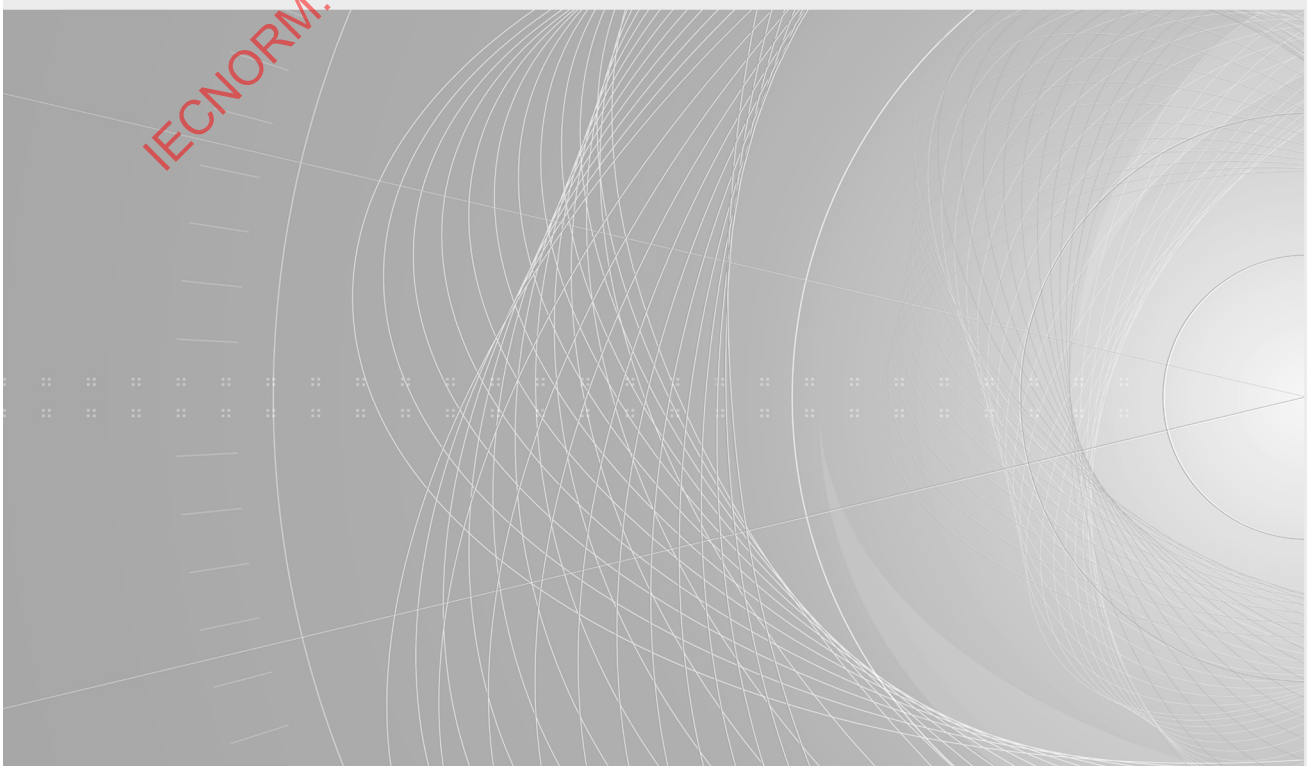
Edition 1.0 2019-09

# TECHNICAL SPECIFICATION



colour inside

**Measurement procedures of magnetic field levels generated by electronic and electrical equipment in the automotive environment with respect to human exposure –**
**Part 1: Low frequency magnetic fields**



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## Part 1: Low frequency magnetic fields

INTERNATIONAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

# MEASUREMENT PROCEDURES OF MAGNETIC FIELD LEVELS GENERATED BY ELECTRONIC AND ELECTRICAL EQUIPMENT IN THE AUTOMOTIVE ENVIRONMENT WITH RESPECT TO HUMAN EXPOSURE –

## Part 1: Low frequency magnetic fields

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Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62764-1, which is a Technical Specification, has been prepared by IEC technical committee 106: Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure.

The text of this Technical Specification is based on the following documents:

| Draft TS | Report on voting |
|---|---|
| 106/477/DTS | 106/493/RVDTS |

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

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

A list of all parts in the IEC 62764 series, published under the general title *Measurement procedures of magnetic field levels generated by electronic and electrical equipment in the automotive environment with respect to human exposure*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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- withdrawn,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.

A bilingual version of this publication may be issued at a later date.

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# INTRODUCTION

This document specifies a methodology for determining the exposure to multiple magnetic field sources for passenger cars and light commercial vehicles including standardized operating conditions and measurement volumes and/or surfaces.

# MEASUREMENT PROCEDURES OF MAGNETIC FIELD LEVELS GENERATED BY ELECTRONIC AND ELECTRICAL EQUIPMENT IN THE AUTOMOTIVE ENVIRONMENT WITH RESPECT TO HUMAN EXPOSURE –

## Part 1: Low frequency magnetic fields

## 1 Scope

This part of IEC 62764 applies to the assessment of human exposure to low frequency magnetic fields generated by automotive vehicles. For plug-in vehicles, this includes the electric vehicle supply equipment (EVSE) and associated cables provided by the car manufacturer.

The scope of this document establishes the measurement procedure for the evaluation of magnetic field levels in the automotive environment, for passenger cars and commercial vehicles of categories M1 and N1 as defined in ECE/TRANS/WP.29/78/Rev.3 [1][1], with respect to human exposure. It provides standardized operating conditions and defines recommended measurements to assess compliance to the applicable exposure requirements.

This document covers the frequency range 1 Hz to 400 kHz and is applicable to any type of engine and/or internal energy source.

It is not the scope of this document to define procedures for wireless power transfer (WPT). Human exposure due to WPT is covered by IEC 61980-1 [2].

Abnormal operation of the vehicle or equipment under test is not taken into consideration.

## 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.

IEC 61786-1:2013, *Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz to 100 kHz with regard to exposure of human beings – Part 1: Requirements for measuring instruments*

IEC 62311:2019, *Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz)*

## 3 Terms, definitions and abbreviated terms

### 3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

[1] Numbers in square brackets refer to the Bibliography.

**3.1.1**
**applicable requirement**
particular requirement regarding human exposure to low-frequency magnetic fields against which the vehicle under test is to be assessed using the methods outlined in this document

Note 1 to entry: Examples of such requirements can be found in [3] to [9].

**3.1.2**
**magnetic field exposure**
specific metric(s) that are used to quantify human exposure to low-frequency magnetic fields in the applicable requirements

Note 1 to entry: Examples of such metrics can be found in [3] to [9].

**3.1.3**
**powertrain**
main system that generates power and delivers it to the road surface

### 3.2 Abbreviated terms

EV electric vehicle
EVSE electric vehicle supply equipment
HEV hybrid electric vehicle, including mild hybrid electric vehicle (MHEV)
ICEV internal combustion engine vehicle
SOC state of charge indicated to the driver
WPT wireless power transfer

## 4 Measurement procedure

### 4.1 Measurement phases

The measurement procedure is divided into four parts regarding the operational vehicle use:

1) vehicle in stationary mode;
2) vehicle in driving mode;
3) vehicle in acceleration mode;
4) vehicle in plug-in charging mode.

These four parts are described in detail in Clause 6.

### 4.2 Measuring conditions

The measurements cover only sources of persistent magnetic field exposure. Continuous occurring sources, or repetitive transient sources such as fan, wipers are included. Transient electrical functions of short duration activated occasionally by the driver, passengers or the vehicle itself are not considered in this document, in particular the horn, the motorized mirror and the door-lock motor.

NOTE The rotation of the tyres can produce low-frequency magnetic fields (typically below 50 Hz, depending on the speed of the vehicle) in and surrounding the vehicle, due to the static magnetization of the tyres [10][11]. This can only contribute to measurements inside the vehicle (since no measurements are to be performed around the vehicle in dynamic mode).

The measurements are performed in the vehicle's standard modes of operation, generating the expected highest levels of magnetic field exposure in measuring volumes that are representative of the occupant (Annex B) and bystander locations.

### 4.3 Test site

Measurements shall be performed in an area having ambient magnetic field exposure values of less than 10 % of the values given in the requirements in the measurement volumes.

The ambient magnetic field exposure shall be measured with or without the vehicle under test, but in conditions that are representative of the vehicle test. This measurement can be performed before each test or periodically in accordance with the laboratory's quality management processes.

A dynamometer (or roller bench) may be used if it rotates all the driven wheels of the vehicle. It shall be set to simulate the outdoor dynamics of the vehicle including at least its steady-state torque in driving mode and its inertial mass during acceleration mode.

If an outdoor track is used, the grade of the portion used for the tests shall be in the range ±2 %.

NOTE In the case of a dynamometer, the ambient magnetic field exposure can depend on the torque and/or speed of the dynamometer.

### 4.4 Vehicle set-up

The following configuration is recommended within the passenger compartment, where practicable:

– all seats except the rearmost seats, if adjustable, centre-positioned horizontally and at the lowest position vertically;
– the rearmost seats, if horizontally adjustable, in their rearmost position;
– the headrests in the fully-back position;
– all seat backs except for the rearmost seats, if adjustable, approximately 15° back from the vertical;
– all seat backs of the rearmost seats, if adjustable, fully tilted backwards;
– the steering wheel centre-positioned vertically and horizontally.

Details of the configuration actually applied during the measurements shall be indicated in the test report, highlighting any deviations from the recommended settings outlined above.

### 4.5 Measurement locations

#### 4.5.1 General

Measurements are performed in all regions of the vehicle that are accessible by the driver and passengers, and in the immediate vicinity of the vehicle for bystanders. These include the driver and passenger area (cabin), the cargo storage area, the engine and/or the electric powertrain areas, and the areas around the outside of the vehicle.

The measurement distance between the surface of any part of the vehicle and the centre of the probe shall be 0,20 m (see Annex A).

#### 4.5.2 Inside the vehicle

Measurements shall be performed throughout the volumes accessible in normal vehicle use cases by parts of the human body to which the applicable exposure requirements apply. For example, in the passenger compartment, occupants are assumed to be seated in positions where restraint systems are provided.

Measurements are not required where the components are mounted (no components or parts have to be removed to perform the measurements).

An example of test volumes taking account of all body parts is illustrated in Figure 1.

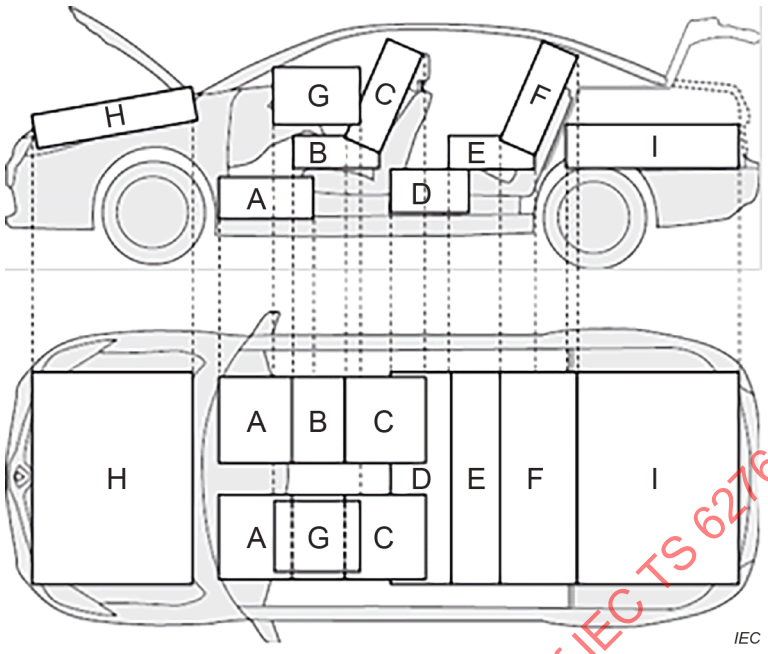


**Figure 1 – Example of test volumes taking account of all body parts for a left-hand drive vehicle**

In the example shown in Figure 1, the following apply.

– For individual seats, the occupants are represented by three volumes corresponding to (A) the feet, (B) the legs, and (C) the trunk and head. For bench seats, the occupants are represented by three common volumes: D, E and F.

– The volume G represents the arms and hands on the steering wheel (which can be on either or both the left-hand side and right-hand side of the vehicle, or in the centre).

– Measurements can also have to be performed over the engine and/or the electric powertrain in H and/or I only in stationary and charging modes and if people are permitted to access these areas while the engine is running and/or the electric powertrain is active. The bottom of H can be a smooth envelope above all contained components.

Volumes B, C, E and F could also take into account the positions of babies and infants.

NOTE These test volumes are examples defined with consideration of all body parts (including potential exposure of extremities in volumes A, D, G, H and I), but it is possible that some standards or regulations do not apply to the whole body.

Measurement in the areas of the driver's position can be achieved by different means including the use of a dynamometer. Appropriate safety measures shall be employed to avoid accidents due to operation of the dynamometer during measurements.

### 4.5.3 Outside the vehicle

Measurements shall be performed around the outside of the vehicle in all areas accessible to parts of the human body identified in the applicable requirements. Details of the areas shall be indicated in the test report.

# 5 Measurement technique

## 5.1 Measuring equipment

The measuring equipment shall include a probe covering the frequency range defined in Clause 1. The probe shall comply with the requirements of IEC 61786-1.

NOTE For measurements outside the range 1 Hz to 100 kHz, the provisions of IEC 61786-1 can still apply with appropriate calibration in the range 100 kHz to 400 kHz.

The area of the probe shall be at most 100 $cm^2$.

The complete measurement chain shall be verified to validate its performance and accuracy before each measurement programme.

## 5.2 Measurement of the magnetic field exposure

For each volume, the measurement of the magnetic field exposure shall be performed in two steps:

1) an initial scan of the entire volume to determine the location of the maximum magnetic field exposure;
2) a final measurement at the location of the maximum magnetic field exposure.

To scan the measurement volumes, the probe shall be moved sufficiently slowly to ensure that the spatial maximum is correctly located, especially when measuring sources between 1 Hz and 10 Hz.

The position of the probe relative to the vehicle structure shall remain constant during the final measurement.

# 6 Measurement procedure

## 6.1 Vehicle in stationary mode

### 6.1.1 General

In this step, measurements are performed with the vehicle under test stationary.

For ICEVs, EVs and HEVs, these measurements are not required if all the relevant vehicle functions can be tested simultaneously in driving mode.

### 6.1.2 Flowchart

The overall procedure is split into three phases as shown in Figure 2.

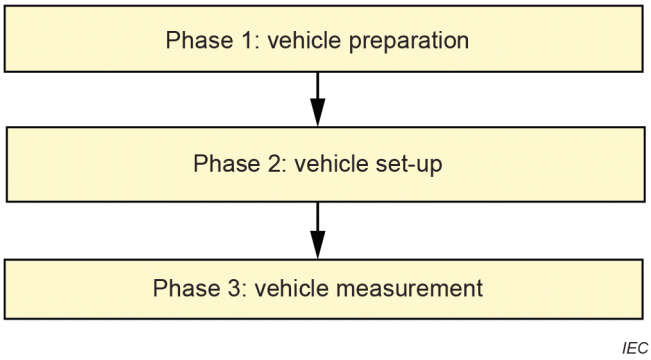


**Figure 2 – Specific stationary mode set-up and test**

### 6.1.3 Phase 1: vehicle preparation

The following conditions shall be applied.

– For ICEVs: idle (engine running).
– For EVs: ready to drive.
– For HEVs: ready to drive and/or idle (engine running).
– Vehicle parking brake enabled only if all functions can still be activated, otherwise utilize appropriate means to restrain the vehicle.
– Start/stop function (if present) disabled (with engine continuously running).
– Seats and steering wheel set as defined in 4.4.
– Front and rear openings of vehicle (e.g. cargo storage area, hood) closed except when measuring in associated volumes (e.g. H or I).

### 6.1.4 Phase 2: vehicle set-up

– Switch on the items of electrical equipment that are considered in 4.2.
– Where a range of settings are available (blower motor, heating), the worst-case mode of operation shall be used.

NOTE The worst-case mode of operation of an electrical system of the vehicle corresponds to the one producing the highest magnetic field exposure in the test volumes described in 4.5. The worst-case mode of operation can be specified by the car manufacturer in his own test plan, since it will depend on his type of vehicle. Otherwise, as noted in IEC 62311:2019, 5.3, "*For practical reasons it is acceptable to perform the assessment with the equipment being operated with settings that produce the maximum exposure levels (e.g., maximum rated load, maximum rated power consumption, maximum speed or other), consistent with reasonably foreseeable use. The equipment is operated for a sufficient period to ensure that the conditions of operation are stable.*"

– Operate the engine for ICEV (engine idle) with transmission disengaged (neutral) for both manual and automatic gearboxes.
– Switch on the electric powertrain for EVs and HEVs.

Caution: The engine fan or other equipment could start automatically without any warning.

### 6.1.5 Phase 3: vehicle measurement

Perform the measurement of magnetic field exposure in all volumes defined in 4.5 that are required by the applicable regulation being assessed.

NOTE Examples of such regulations can be found in [3] to [9].

During the measurements, the state of charge (SOC) indicated to the driver shall be kept above 20 % of the maximum SOC for vehicles having an electrical powertrain.

### 6.2 Vehicle in driving mode

#### 6.2.1 General

In this step, measurements are performed when the vehicle is in dynamic mode (moving).

#### 6.2.2 Flowchart

The overall procedure is split into four phases as shown in Figure 3.

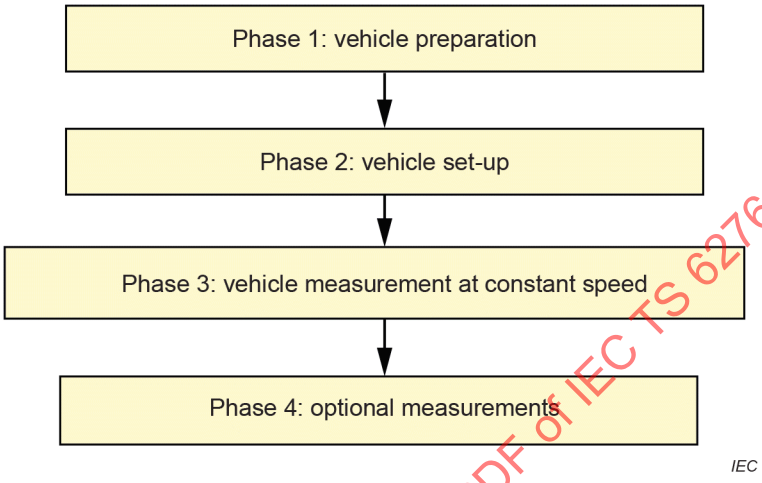


**Figure 3 – Specific driving mode set-up and test**

#### 6.2.3 Phase 1: vehicle preparation

The following conditions shall be applied:

– Seats and steering wheel set as defined in 4.4.

#### 6.2.4 Phase 2: vehicle set-up

– Switch on the items of electrical equipment that are considered in 4.2.

– Where a range of settings are available (blower motor, heating), the worst-case mode of operation shall be used. See note in 6.1.4.

#### 6.2.5 Phase 3: vehicle measurement (at constant speed)

For ICEVs and EVs, drive the vehicle at a constant speed of (40 ± 8) km/h as indicated to the driver: a cruise control regulator could be used.

For HEVs, drive the vehicle:

– either in single mode (e.g. serial hybrid) with both the electrical and the internal combustion propulsion systems functioning to operate the vehicle at (40 ± 8) km/h. The value of the engine speed shall be recorded in the test report;

– or in two separate modes (e.g. parallel hybrid): internal combustion engine operating alone, electric propulsion system operating alone.

In all cases, if the vehicle cannot reach (40 ± 8) km/h, the maximum speed shall be chosen and recorded in the test report.

During driving mode, the vehicle functions activated in stationary mode shall also be activated simultaneously when possible.

Perform the measurement of magnetic field exposure in all volumes defined in 4.5.

During the measurements, the state of charge (SOC) indicated to the driver shall be kept above 20 % of the maximum SOC for vehicles having an electrical powertrain.

#### 6.2.6 Phase 4: optional measurements

If required in the test plan, complementary measurements may be carried out in different vehicle driving conditions suspected to generate high magnetic field exposure.

### 6.3 Vehicle in acceleration mode

#### 6.3.1 General

In this step, measurements are performed when the vehicle is accelerating.

#### 6.3.2 Flowchart

The overall procedure is split into three phases as shown in Figure 4.

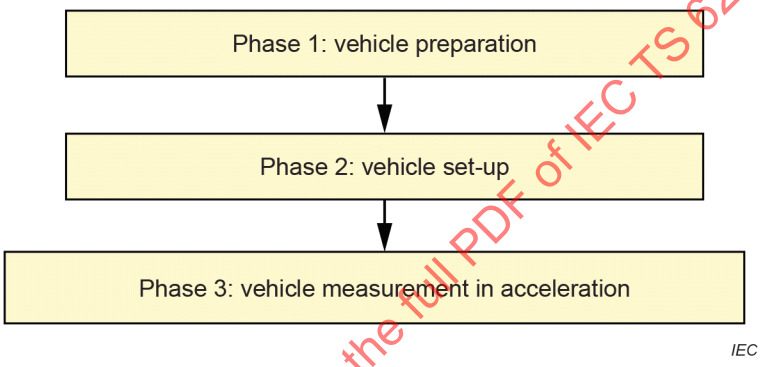


**Figure 4 – Specific acceleration mode set-up and test**

#### 6.3.3 Phase 1: vehicle preparation

The following conditions shall be applied.

– Seats and steering wheel set as defined in 4.4.

#### 6.3.4 Phase 2: vehicle set-up

– Switch on the items of electrical equipment that are considered in 4.2.

– Where a range of settings are available (blower motor, heating), the setting assumed to produce the highest magnetic field exposure level shall be used.

#### 6.3.5 Phase 3: vehicle measurement (in acceleration)

For each location of the maximum magnetic field exposure determined in the vehicle driving mode test, perform an acceleration and deceleration cycle and measure the maximum magnetic field exposure level during the acceleration stage.

The acceleration stage shall be performed from 0 km/h to 90 km/h, achieving at least 2,5 $m/s^2$ between 10 km/h and 75 km/h. In case the vehicle cannot maintain the specified acceleration for reasons other than power limitations due to battery temperature, or cannot reach the maximum speed due to the vehicle's capabilities (and not due to the limitations of the test facility), the achieved acceleration and/or the maximum speed shall be indicated in the test report. Otherwise another test facility allowing the vehicle to reach the specified acceleration shall be chosen.

NOTE 1 Storage of the vehicle at room temperature for at least 8 h prior to performing the test can prevent power limitations due to battery temperature.

For vehicles having an electrical powertrain, the minimum and maximum values of the SOC shall be chosen so that the electric mode of acceleration is fully exercised. These values shall be specified in the test plan and shall be recorded in the test report.

NOTE 2 Measurements during deceleration are not required because significant acceleration has generally been found to cause the highest magnetic field exposure from automotive electrified powertrains and is more reproducible than deceleration in terms of electric mode activation.

## 6.4 Vehicle in plug-in charging mode

### 6.4.1 General

This step is specific to vehicles equipped with an on-board rechargeable electrical energy storage system (EV, plug-in vehicle, etc.). The measurements are performed for each charging supply system and associated charging modes.

### 6.4.2 Flowchart

The overall procedure is split into three phases as shown in Figure 5.

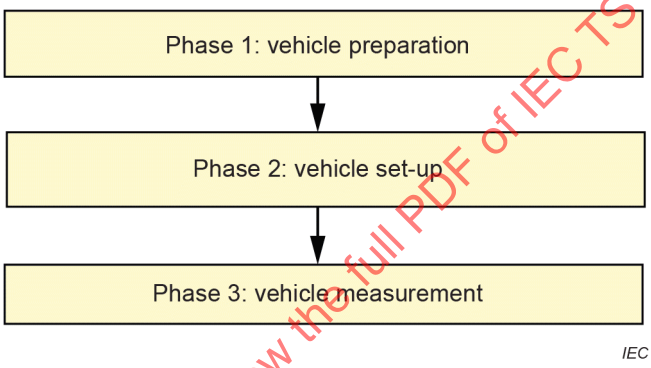


**Figure 5 – Specific plug-in charging mode set-up and test**

### 6.4.3 Phase 1: vehicle preparation

The following conditions shall be applied.

– At the beginning of the measurements, the state of charge (SOC) indicated to the driver shall be below 20 % of the maximum SOC for vehicles having an electrical powertrain.
– Vehicle parking brake enabled.
– Seats and steering wheel set as defined in 4.4.
– Cable(s) of the plug-in charging supply system(s) hanging vertically at a distance of 0,1 m ($^{+0,2}_{0}$ m) from the vehicle body as described in the examples in Figure 6 a) and Figure 6 b).
– The closures of volumes H and/or I closed unless measuring in those volumes.

*Dimensions in centimetres*


**a) Side view** **b) Top view**

**Figure 6 – Plug-in charging supply cable positioning**

### 6.4.4 Phase 2: vehicle set-up

– Key off.

– Switch off all electrical equipment.

### 6.4.5 Phase 3: vehicle measurement

Perform the measurement of magnetic field exposure in all volumes defined in 4.5 for each charging supply system and associated charging modes with a SOC less than 80 %.

A measurement shall be performed around the socket of each charging supply system. For each cable supplied by the car manufacturer, a measurement shall also be performed along and around the cable over its first 0,50 m. For cables including EVSE, measurements shall also be performed over the surface of the EVSE.

During the measurements, the state of charge (SOC) indicated to the driver shall be kept between 20 % and 80 % of the maximum SOC for vehicles having an electrical powertrain.

Care should be taken not to measure other sources, such as the wall-box or charging station.

## 7 Test report

The results of each assessment, test or measurement carried out shall be reported accurately, clearly, unambiguously and objectively and in accordance with any specific instructions in the required method(s). An example for the structure of the report can be found in [12].

All the information needed for performing repeatable assessments, tests, calculations, or measurements shall be summarized in a test report.

The test report shall include the information described in IEC 62311:2019, Clause 7, and in particular the combined uncertainty due to frequency response flatness, isotropy, linearity and calibration accuracy of the probe.

## 8 Assessment

If the magnetic field exposure measurement exceeds the applicable requirement, further investigations may be necessary in order to check the conformity with applicable limits on physical in-body quantities more directly related to the established health effects. Examples can be found in [13] and [14].

# Annex A
(informative)

# Practical measurement advice

## A.1 Motivation

In 4.5.1, the measurement locations concern all regions of the vehicle that are accessible by the driver and passengers, and in the immediate vicinity of the vehicle for bystanders. These include the driver and passenger area (cabin), the cargo storage area, the engine and/or the electric powertrain areas, and the areas around the outside of the vehicle.

The measurement distance between the surface of any part of the vehicle and the centre of the probe is 0,20 m.

Annex A suggests a practical way of ensuring this distance.

## A.2 Measurement adaptor

To ensure a distance of 0,20 m, a disc or hemispherical spacer can be added to the measurement probe in order to extend the physical boundaries of the probe to the required measurement distance $d$ = 0,20 m, as shown in Figures A.1 and A.2.

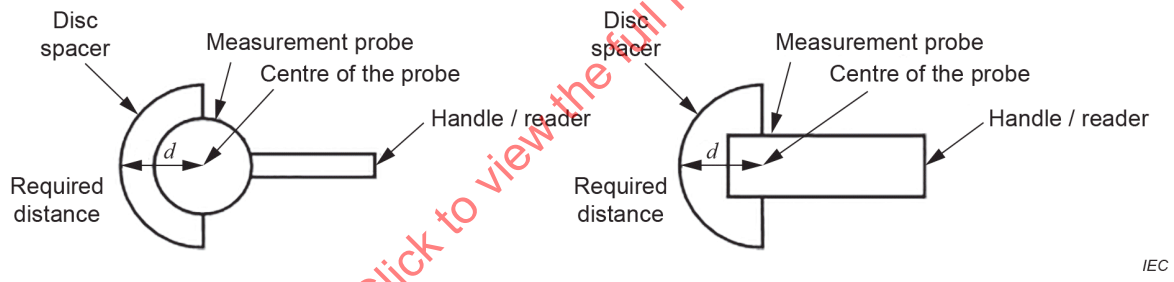


**Figure A.1 – Disc spacer around two types of measurement probes**

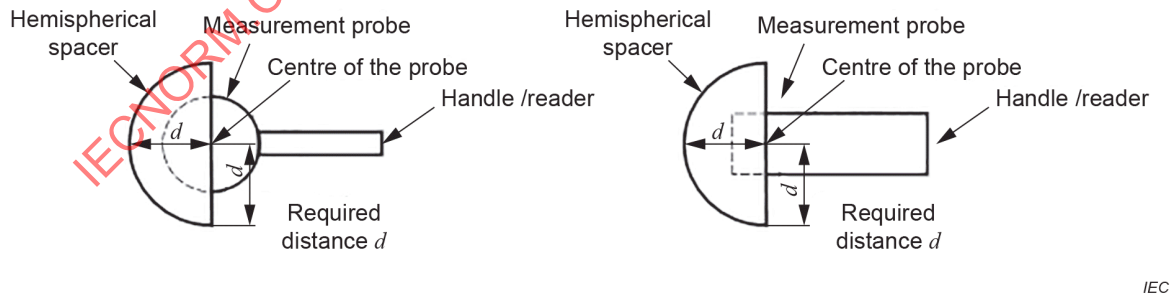


**Figure A.2 – Hemispherical spacer around two types of measurement probes**

The spacer is made of non-conductive and non-magnetic material. The relative permittivity of the different parts of the spacer is less than 1,4. The relative permeability of the different parts of the spacer is equal to 1.

# Annex B
(informative)

# Maximum extents of measurement volumes inside the vehicle

## B.1 Motivation

Vehicles in the target classes of this document (i.e. M1 and N1) vary significantly in terms of their internal dimensions and geometry. This makes detailed specification of the locations and extents of the measurement volumes, as outlined in 4.5.2, impossible for a generic standard.

Annex B therefore provides a summary of some relevant anthropometrical data to help guide the user in defining the maximum extents of the volumes to be investigated for any specific vehicle.

## B.2 Anthropometrical information

The most relevant anthropometrical parameters for this application are illustrated and quantified in Figure B.1.

*Dimensions in centimetres*

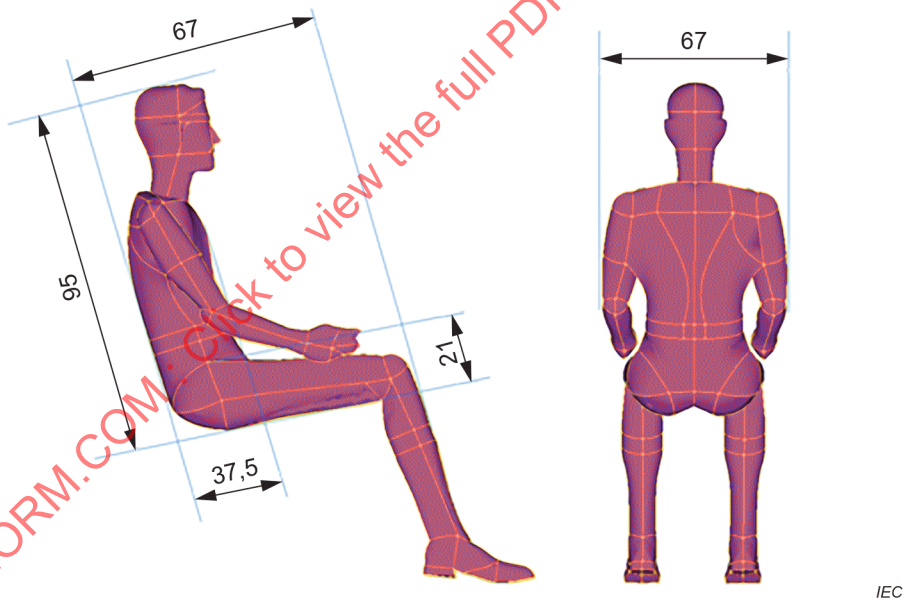


**Figure B.1 – Summary of relevant anthropometrical data**

People of European descent show the greatest standing and sitting heights (see Figure 9.1 of [15]) and the Dutch are reported to be the tallest group in Europe ([15], p. 174).

The parameters illustrated on the left of Figure B.1 are the maxima of the 95th percentile male and female values for:

– seat to top of head – Dutch adults aged 20–60 (Table 10.8 of [15]);
– torso depth – Dutch adults aged 20–60 (Table 10.8 of [15]);
– thigh thickness – French drivers (Table 10.9 of [15]);
– thigh length – US army personnel ([16], p. 81).