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**Intelligent Transport Systems (ITS);  
Radiocommunications equipment operating  
in the 5 855 MHz to 5 925 MHz frequency band;  
Harmonised Standard covering the essential requirements of  
article 3.2 of Directive 2014/53/EU**

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Reference

REN/ERM-TG37-024

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## Foreword

This draft Harmonised European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the combined Public Enquiry and Vote phase of the ETSI standards EN Approval Procedure.

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.5] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.4].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

<b>Proposed national transposition dates</b>	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	12 June 2017

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## Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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# 1 Scope

The present document applies to radio transmitters and receivers for Intelligent Transport Systems (ITS) operating in the frequency range 5 855 GHz to 5 925 GHz. The spectrum usage conditions are set out in ECC Decision (08)01 [i.1] for the frequency range 5 875 GHz to 5 925 GHz and in ECC Recommendation (08)01 [i.2] for the frequency range 5 855 GHz to 5 875 GHz. The Commission Decision 2008/671/EC [i.3] mandates a harmonised use of the frequency band 5 875 GHz to 5 905 GHz dedicated to safety-related applications of ITS throughout the member states of the European Union. Table 1 outlines the 5 GHz ITS frequency band segmentation.

**Table 1: 5 GHz ITS frequency band segmentation**

Frequency band	Frequency range	Usage	Regulation
ITS-G5B	5 855 MHz to 5 875 MHz	ITS non-safety applications	ECC Recommendation (08)01 [i.2]
ITS-G5A	5 875 MHz to 5 905 MHz	ITS road safety	Commission Decision 2008/671/EC [i.3], ECC Decision (08)01 [i.1]
ITS-G5D	5 905 MHz to 5 925 MHz	Future ITS applications	ECC Decision (08)01 [i.1]

The present document contains requirements to demonstrate that radio equipment both effectively uses and supports the efficient use of radio spectrum in order to avoid harmful interference.

Interference mitigation techniques in the present document are provided to protect road tolling applications using CEN DSRC or HDR DSRC.

## 2 References

### 2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are necessary for the application of the present document.

- [1] ETSI TS 102 792 (V1.2.1) (06-2015): "Intelligent Transport Systems (ITS); Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (CEN DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range".
- [2] ETSI EN 302 637-2 (V1.3.2) (11-2014): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service".
- [3] Void.
- [4] CISPR 16 (parts 1-1 (2015), 1-4 (2010) and 1-5 (2014)): "Specifications for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus".
- [5] ETSI TS 102 687 (V1.1.1) (07-2011): "Intelligent Transport Systems (ITS); Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; Access layer part".
- [6] ETSI TS 103 175 (V1.1.1) (06-2015): "Intelligent Transport Systems (ITS); Cross Layer DCC Management Entity for operation in the ITS G5A and ITS G5B medium".



- [7] CEN EN 12253:2004: "Road transport and traffic telematics - Dedicated short-range communication - Physical layer using microwave at 5,8 GHz".
- [8] ETSI ES 200 674-1 (V2.4.1) (05-2013): "Intelligent Transport Systems (ITS); Road Transport and Traffic Telematics (RTTT); Dedicated Short Range Communications (DSRC); Part 1: Technical characteristics and test methods for High Data Rate (HDR) data transmission equipment operating in the 5,8 GHz Industrial, Scientific and Medical (ISM) band".
- [9] ETSI TS 102 917-1 (V1.1.1) (01-2013): "Intelligent Transport Systems (ITS); Test specifications for the channel congestion control algorithms operating in the 5,9 GHz range; Part 1: Protocol Implementation Conformance Statement (PICS)".
- [10] ETSI TS 102 917-2 (V1.1.1) (01-2013): "Intelligent Transport Systems (ITS); Test specifications for the channel congestion control algorithms operating in the 5,9 GHz range; Part 2: Test Suite Structure and Test Purposes (TSS & TP)".
- [11] ETSI TS 102 917-3 (V1.1.1) (01-2013): "Intelligent Transport Systems (ITS); Test specifications for the channel congestion control algorithms operating in the 5,9 GHz range; Part 3: Abstract Test Suite (ATS) and partial Protocol Implementation eXtra Information for Testing (PIXIT)".
- [12] IEEE 802.11™-2012: "IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

## 2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] ECC Decision (08)01: "ECC Decision of 14 March 2008 on the harmonised use of the 5875-5925 frequency band for Intelligent Transport Systems (ITS)", approved 14 March 2008 and amended 3 July 2015.
- [i.2] ECC Recommendation (08)01: "Use of band 5855-5875 MHz for Intelligent Transport Systems (ITS)," approved 21 February 2008 and amended 3 July 2015.
- [i.3] Commission Decision 2008/671/EC of 5 August on the harmonised use of radio spectrum in the 5875-5905 MHz frequency band for safety related application of Intelligent Transport Systems (ITS).
- [i.4] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.
- [i.5] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.
- [i.6] ETSI TR 100 028 (all parts) (V1.4.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [i.7] ETSI TR 100 028-2 (V1.4.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2".

## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

For the purposes of the present document, the terms and definitions given in Directive 2014/53/EU [i.4] and the following apply:

**5 GHz ITS frequency band:** frequency bands ITS-G5A, ITS-G5B and ITS-G5D as outlined in Table 1

**dedicated antenna:** removable antenna supplied and tested with the radio equipment, designed as an indispensable part of the equipment

NOTE: The dedicated antenna has been designed or developed for one or more specific types of equipment. It is the combination of dedicated antenna and radio equipment that is expected to be compliant with the regulations.

**duty cycle:** defined as the ratio, expressed as a percentage of the maximum transmitter "on" time on one carrier frequency, relative to a second period

**integral antenna:** antenna designed as a fixed part of the equipment, without the use of an external connector and as such which cannot be disconnected from the equipment by the user

NOTE: An integral antenna may be fitted internally or externally.

**protected status:** status of a CEN DSRC or a HDR DSRC station that is eligible to deploy a roadside unit certificate to sign a protected zone CAM or/and is included in the official protected zone database

**radiated measurements:** measurements which involve the absolute measurement of a radiated field

**vehicle:** all kinds of land mobile vehicle

EXAMPLE: Road vehicle and rail vehicle.

### 3.2 Symbols

For the purposes of the present document, the following symbols apply:

$dB$	decibel
$dBi$	antenna gain relative to isotropic radiator in decibel
$dBc$	decibel relative to carrier power
$E$	electrical field strength
$f$	frequency
$f_c$	nominal centre frequency
$G$	antenna gain
$P_H$	highest power level
$P_L$	lowest power level
$R$	distance
$T_{max}$	maximum temperature
$T_{min}$	minimum temperature
$T_{off}$	minimum time between two transmissions
$T_{on}$	maximum duration of a transmission
$V_{max}$	maximum voltage
$V_{min}$	minimum voltage
$V_{nominal}$	nominal voltage
$\Omega$	ohm
$\mu s$	microsecond

### 3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternative Current
BPSK	Binary Phase Shift Keying
CAM	Cooperative Awareness Message
CBR	Channel Busy Ratio
CCH	Control Channel
CEN	Comité Européen de Normalisation (European Committee for Standardization)
CISPR	Comité International Spécial des Perturbations Radioélectriques (International Special Committee on Radio Interference)
DC	Direct Current
DCC	Decentralized Congestion Control
DSRC	Dedicated Short Range Communication (CEN DRSC = tolling at 5,8 GHz)
DUT	Device Under Test
e.i.r.p.	equivalent isotropically radiated power
e.r.p.	effective radiated power
EC	European Commission
ECC	Electronic Communication Committee
EMC	ElectroMagnetic Compatibility
HDR	High Data Rate
HS	Harmonised Standard
ITS	Intelligent Transport Systems
LP	Linear Polarized
OOB	Out-Of-Band
PD	mean Power Density
PER	Packet Error Rate
ppm	parts per million = $10^{-6}$
PSD	Power Spectral Density
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RMS	Root Mean Square
TPC	Transmit Power Control
VSWR	Voltage Standing Wave Ratio

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## 4 Technical requirements specifications

### 4.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be stated by the manufacturer. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the stated operational environmental profile.

Recommended environmental profile parameters are summarized in Annex D.

### 4.2 Conformance requirements

#### 4.2.1 Transmitter frequency stability

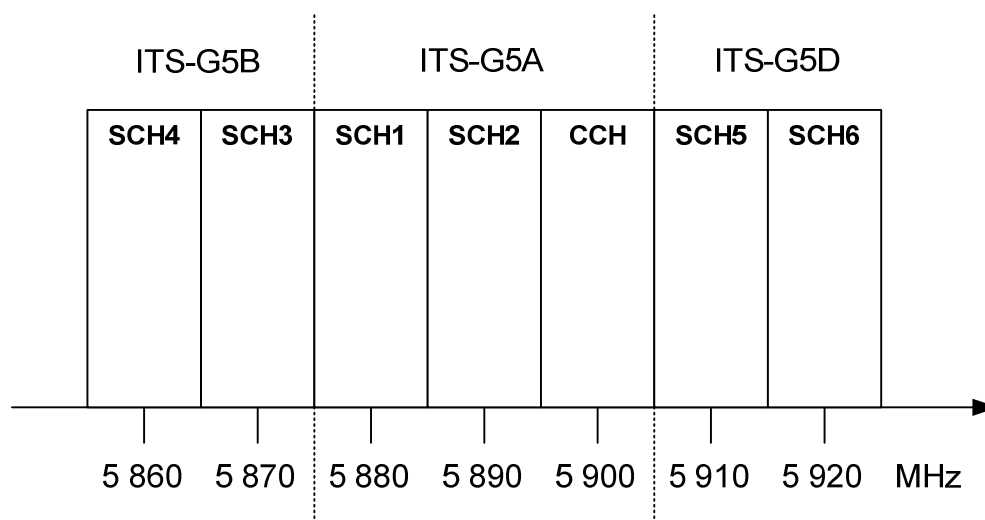
##### 4.2.1.1 Definition

The equipment is required to operate on the applicable specific carrier centre frequencies that correspond to the nominal carrier frequencies,  $f_c$ , as defined in Table 2.

**Table 2: Nominal carrier frequency allocations**

Channel name	Carrier centre frequency $f_c$ (MHz)	Maximum channel bandwidth (MHz)
G5-SCH4	5 860	10
G5-SCH3	5 870	10
G5-SCH1	5 880	10
G5-SCH2	5 890	10
G5-CCH	5 900	10
G5-SCH5	5 910	10
G5-SCH6	5 920	10

The frequency channels together with the channel names contained in the three different frequency bands are depicted in Figure 1.



**Figure 1: An overview of the three different frequency bands together with the channel names in each frequency band**

#### 4.2.1.2 Limits

The actual carrier centre frequency for any given channel given in Table 2 shall be maintained within the range  $f_c \pm 20$  ppm.

#### 4.2.1.3 Conformance

Conformance tests as defined in Clause 5.3.2 shall be carried out.

### 4.2.2 RF output power

#### 4.2.2.1 Definition

The radio frequency (RF) output power is the mean equivalent isotropically radiated power (e.i.r.p.) during transmission bursts.

#### 4.2.2.2 Limits

The maximum RF output power shall not exceed 33 dBm e.i.r.p.

#### 4.2.2.3 Conformance

Conformance tests as defined in Clause 5.3.3 shall be carried out.

## 4.2.3 Power spectral density

### 4.2.3.1 Definition

The power spectral density (PSD) is the mean e.i.r.p. spectral density during transmission bursts.

### 4.2.3.2 Limits

The maximum power spectral density shall not exceed 23 dBm/MHz e.i.r.p.

### 4.2.3.3 Conformance

Conformance tests as defined in Clause 5.3.3 shall be carried out.

## 4.2.4 Transmit power control

### 4.2.4.1 Definition

Transmit power control (TPC) is a mechanism to be used to ensure co-existence with CEN DSRC at toll plazas and to be used as one mechanism by decentralized congestion control (DCC) to reduce the congestion on the communication channel.

### 4.2.4.2 Limits

The TPC range shall at least be 3 dBm up to the maximum specified RF output power e.i.r.p of the equipment.

### 4.2.4.3 Conformance

Conformance test according to Clause 5.3.3 shall be carried out.

## 4.2.5 Transmitter unwanted emissions

### 4.2.5.1 Transmitter unwanted emissions outside the 5 GHz ITS frequency band

#### 4.2.5.1.1 Definition

These are radio frequency emissions outside the 5 GHz ITS frequency band (outside of 5 855 MHz to 5 925 MHz).

#### 4.2.5.1.2 Limits

In Table 3 and Table 4, transmitter unwanted emission limits in the spurious domain below 1 GHz and above 1 GHz are tabulated, respectively.

**Table 3: Transmitter unwanted emission limits in the spurious domain below 1 GHz**

Frequency range	Maximum power, (e.i.r.p.) (dBm)	Reference bandwidth
$30 \text{ MHz} \leq f < 1 \text{ GHz}$	-36	100 kHz

**Table 4: Transmitter unwanted emissions in the spurious domain above 1 GHz**

Frequency range	Maximum power, (e.i.r.p.) (dBm)	Bandwidth
1 GHz to 5,795 GHz	-30 dBm	1 MHz
5,950 GHz to 18 GHz	-30 dBm	1 MHz

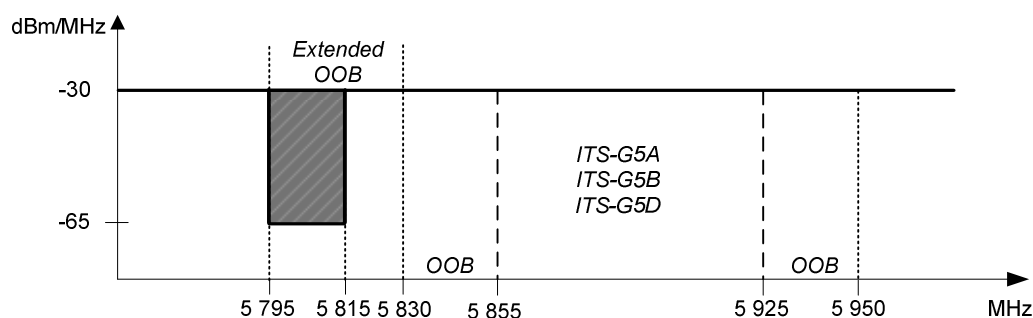
In Table 5, transmitter unwanted emission limits in the out-of-band domain of the 5 GHz ITS frequency band.

The out-of-band domain is defined as  $\pm 250\%$  of the channel bandwidth, and then the out-of-band (OOB) domain for the 5 GHz ITS frequency band is 5,830 GHz to 5,855 GHz at the lower part and 5,925 GHz to 5,950 GHz at the higher part of the frequency band. However, the out-of-band domain is larger for the 5 GHz ITS frequency band and is including parts of the spurious domain, see Table 5 and Figure 2.

**Table 5: Transmitter unwanted emission limits in the out-of-band domain of the 5 GHz ITS frequency band**

Frequency range	Maximum power, (e.i.r.p.) (dBm)	Reference bandwidth
5,795 GHz to 5,815 GHz	see Clause 4.2.9.2	1 MHz
5,815 GHz to 5,855 GHz	-30	1 MHz
5,925 GHz to 5,950 GHz	-30	1 MHz

In Figure 2, the transmitter unwanted emission limits are depicted for the 5 GHz ITS frequency band (ITS-G5A, ITS-G5B, and ITS-G5D frequency bands).



**Figure 2: Transmitter unwanted emission limits for the 5 GHz ITS frequency band**

#### 4.2.5.1.3 Conformance

Conformance tests as defined in Clause 5.3.4 shall be carried out.

#### 4.2.5.2 Transmitter spectrum mask within the 5 GHz ITS frequency band for 10 MHz channels

##### 4.2.5.2.1 Definition

Transmitter spectrum mask within the 5 GHz ITS frequency band for 10 MHz channels.

##### 4.2.5.2.2 Limits

The mean levels of the transmitted spectrum within the 5 GHz ITS frequency band shall not exceed the limits given in Table 6.

**Table 6: Transmitter spectrum mask for 10 MHz channel bandwidth**

Power Spectral Density at the carrier centre frequency $f_c$ (dBm/100 kHz)	$\pm 4,5$ MHz offset (dBm/100 kHz)	$\pm 5,0$ MHz offset (dBm/100 kHz)	$\pm 5,5$ MHz offset (dBm/100 kHz)	$\pm 10$ MHz offset (dBm/100 kHz)	$\pm 15$ MHz offset (dBm/100 kHz)
0	0	-26	-32	-40	-50

It has to be noted that the spectrum mask is only applicable within 5 855 MHz to 5 950 MHz. Below 5 855 MHz and above 5 950 MHz the requirements in Clause 4.2.5.1 apply.

#### 4.2.5.2.3 Conformance

Conformance tests as defined in Clause 5.3.5 shall be carried out.

### 4.2.6 Receiver spurious emissions

#### 4.2.6.1 Definition

Receiver spurious emissions are emissions at any frequency when the equipment is in receive mode.

#### 4.2.6.2 Limits

The spurious emissions of the receiver shall not exceed the limits given in Table 7.

**Table 7: Spurious radiated emission limits**

Frequency range	Maximum power	Measurement bandwidth	Special requirement
$30 \text{ MHz} \leq f < 1 \text{ GHz}$	-57 dBm (e.r.p.)	100 kHz	n/a
$1 \text{ GHz} \leq f \leq 5,795 \text{ GHz}$	-47 dBm (e.i.r.p.)	1 MHz	n/a
$5,795 \text{ GHz} \leq f \leq 5,815 \text{ GHz}$	-60 dBm (e.i.r.p.)	1 MHz	Applicable for an intended antenna installation $\leq 2$ meters above the ground level.
	-65 dBm (e.i.r.p.)	1 MHz	Applicable for an intended antenna installation $> 2$ meters above the ground level.
$5,815 \text{ GHz} \leq f \leq 18 \text{ GHz}$	-47 dBm (e.i.r.p.)	1 MHz	n/a

#### 4.2.6.3 Conformance

Conformance tests as defined in Clause 5.3.6 shall be carried out.

### 4.2.7 Receiver selectivity

#### 4.2.7.1 Definition

Receiver selectivity is a measure of the receiver's ability to discriminate between wanted signal to which the receiver is tuned to and unwanted signals stemming from other frequency bands. Receiver selectivity herein is comprised of:

- i) adjacent channel rejection;
- ii) alternate channel rejection; and
- iii) blocking.

The adjacent channel rejection is a measure of the capability of the receiver to operate satisfactorily in the presence of a signal in the adjacent channel, which differs in frequency from the wanted signal by  $\pm 10$  MHz.

The alternate channel rejection is a measure of the capability of the receiver to operate satisfactorily in the presence of a signal in the alternate adjacent channel, which differs in frequency from the wanted signal by  $\pm 20$  MHz.

Blocking is a measure of the capability of the receiver to operate satisfactorily in the presence of a signal in frequency band further away and it shall be tested at  $\pm 50$  MHz,  $\pm 100$  MHz, and  $\pm 200$  MHz. Blocking testing shall be performed at least at 6 different frequency offset positions. The manufacturer of the equipment can add additional frequency offsets positions.

The manufacturer of the equipment shall declare the most sensitive modulation scheme that the equipment is intended to operate with and declared modulation scheme shall be used for all receiver selectivity tests in Clause 5.3.7.

#### 4.2.7.2 Limits

The limits for the receiver selectivity parameters under specified conditions shall be equal to or greater than the limits in Table 8.

**Table 8: Limits for receiver adjacent channel rejection, alternate adjacent channel rejection, and blocking**

Modulation	Coding rate	Adjacent channel rejection (dB)	Alternate adjacent channel rejection (dB)
BPSK	1/2	16	32
BPSK	3/4	15	31
QPSK	1/2	13	29
QPSK	3/4	11	27
16-QAM	1/2	8	24
16-QAM	3/4	4	20
64-QAM	2/3	0	16
64-QAM	3/4	-1	15

NOTE: Table 8 contains the same values for adjacent channel rejection and alternate adjacent channel rejection as specified in Table 18-14 in IEEE 802.11-2012 [12]. Blocking is not addressed in IEEE 802.11-2012 [12].

The blocking level shall not be less than -30 dBm.

#### 4.2.7.3 Conformance

Conformance tests as defined in Clause 5.3.7 shall be carried out.

### 4.2.8 Receiver sensitivity

#### 4.2.8.1 Definition

The receiver sensitivity is defined as the minimum receive signal level at the antenna connector required for a given packet error rate and modulation scheme (noise factor of 10 dB and 5 dB implementation margins are assumed).

#### 4.2.8.2 Limits

The receiver sensitivity shall be less or equal to the values given in Table 9 for a packet error rate (PER) of  $10^{-1}$  for 1 000 octet frames assuming stationary, non-fading channel conditions.

**Table 9: Receiver sensitivity**

Modulation	Coding rate	Minimum sensitivity for 10 MHz channel spacing (dBm)
BPSK	1/2	-85
BPSK	3/4	-84
QPSK	1/2	-82
QPSK	3/4	-80
16-QAM	1/2	-77
16-QAM	3/4	-73
64-QAM	2/3	-69
64-QAM	3/4	-68

NOTE: Table 9 contains the same values for minimum sensitivity as specified in Table 18-14 in IEEE 802.11-2012 [12].

#### 4.2.8.3 Conformance

Conformance tests as defined in Clause 5.3.8 shall be carried out.



## 4.2.9 Interference mitigation for CEN DSRC and HDR DSRC in the frequency band 5 795 MHz to 5 815 MHz

### 4.2.9.1 Definition

To protect operation of electronic toll collection in the frequency band 5 795 MHz to 5 815 MHz from harmful interference, mitigation techniques have to be implemented as defined in ETSI TS 102 792 [1]. Different co-existence modes to protect CEN DSRC and HDR DSRC are defined in ETSI TS 102 792 [1]. If the equipment is continuously operating in co-existence mode A or co-existence mode B no further interference mitigation technique is needed, see ETSI TS 102 792 [1], Table 5.3. Simplified mitigation technique is allowed with fixed installed equipment fulfilling restrictions defined in ETSI TS 102 792 [1], Clause 5.5.2.

### 4.2.9.2 Limits

The limits provided in ETSI TS 102 792 [1], Table 5.3, shall not be exceeded.

The limits provided in ETSI TS 102 792 [1], Clause 5.2.5, shall not be exceeded.

The limits provided in ETSI TS 102 792 [1], Clause 5.2.5, are referring to a circular polarized antenna. For a linear polarized antenna subtract 3 dB to the values in ETSI TS 102 792 [1], Clause 5.2.5.

### 4.2.9.3 Conformance

Conformance tests as defined in Clause 5.3.9 and Clause 5.3.10 shall be carried out.

Equipment not continuously operating in co-existence mode A or co-existence mode B shall be capable of receiving a cooperative awareness message (CAM) as defined in ETSI EN 302 637-2 [2], to decode the protected zone information and to mitigate as defined in ETSI TS 102 792 [1], Clause 5.2.2.

One or both methods to detect road toll protected zones shall be implemented:

- a) Protected zone database, see ETSI TS 102 792 [1], Clause 5.2.4
- b) Short-range RF detector, see ETSI TS 102 792 [1], Clause 5.2.5

When using a short-range RF detector (b) also protected zone information in received CAMs from surrounding ITS stations equipped with short-range RF detector shall be considered, see ETSI TS 102 792 [1], Clause 5.2.2.2.

An equipment shall enter a co-existence mode as outlined in ETSI TS 102 792 [1], Table 5.3, when the equipment enters a protected zone, see ETSI TS 102 792 [1], Clause 5.1.

Personal equipment have special requirements defined in ETSI TS 102 792 [1], Clause 5.6.

## 4.2.10 Decentralized congestion control

### 4.2.10.1 Definition

Decentralized congestion control (DCC) is a mandatory mechanism to be used by the equipment to ensure that the radio channel is not congested by too many transmissions within a certain geographical range. The mechanism is such that the equipment adapts its transmission behaviour dynamically based on how occupied the channel is at the moment.

### 4.2.10.2 Limits

The channel busy time is used for determining the transmission behaviour. The determination of channel busy time for the equipment shall be as outlined in ETSI TS 102 687 [5], Clause A.1. Any other equivalent mechanism may be used providing channel busy times with a deviation of  $\pm 3\%$  compared to what is outlined in ETSI TS 102 687 [5], Clause A.1. The values provided in Table 10, shall not be exceeded.

**Table 10: Limits for determining the channel busy time**

Parameters	Value	Description
$T_p$	8 $\mu$ s	Probing time
$T_m$	100 ms	Measuring interval
$S_{th}$	$\leq -85$ dBm	Signal strength threshold for determining when the channel is busy or not.
$N_p$	12 500	Number of probes during the measuring interval $T_m$ .

Requirements on the DCC method below a CBR value of  $< 62\%$  is outlined in Table 11. The values in Table 11 shall not be exceeded.

**Table 11: Limits for the maximum utilization of the channel given CBR  $< 62\%$** 

Parameters	Value	Description
$T_{on}$	4 ms	A $T_{on}$ of 4 ms corresponds to transmitting a packet of length 1 500 bytes at a transfer rate of 3 Mbit/s.
$T_{off}$	25 ms	A $T_{off}$ of 25 ms corresponds to 40 Hz.
<i>duty cycle</i>	3 %	The duty cycle is defined as the ratio, expressed as a percentage of the maximum transmitter "on" time ( $\sum T_{on}$ ) on one carrier frequency, relative to a one second period
<i>Frame body</i>	1 500 byte	The Frame Body field in IEEE 802.11-2012 [12], Figure 8-1, shall not exceed 1 500 bytes.

Requirements on the DCC method when the channel busy time is  $\geq 62\%$  are provided by the limit function defined in ETSI TS 103 175 [6], Equation 1 in Clause 7.2, and the limits are outlined in Table 12.

**Table 12: Parameters for the maximum utilization of the channel given CBR  $\geq 62\%$** 

Parameters	Value	Description
$C_{TH}$	0,6	The congestion threshold.
$C_W$	1	The weight factor.

#### 4.2.10.3 Conformance

Conformance tests as defined in ETSI TS 102 917-1 [9], ETSI TS 102 917-2 [10] and ETSI TS 102 917-3 [11] shall be carried out.

## 5 Testing for compliance with technical requirements

### 5.1 Environmental conditions for testing

Tests defined in the present document shall be carried out at representative points within the boundary limits of the declared operational environmental profile.

Where technical performance varies subject to environmental conditions, tests shall be carried out under a sufficient variety of environmental conditions (within the boundary limits of the declared operational environmental profile) to give confidence of compliance for the affected technical requirements.

Recommended environmental profile parameters are summarized in Annex D.

### 5.2 Interpretation of measurement results

The interpretation of the results recorded in a test report for the measurements described in the present document shall be as follows:

- the measured value related to the corresponding limit shall be used to decide whether an equipment meets the requirements of the present document;

- the value of the measurement uncertainty for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or less than the figures in Table 13.

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated and shall correspond to an expansion factor (coverage factor)  $k = 1,96$  or  $k = 2$  (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)). Principles for the calculation of measurement uncertainty are contained in ETSI TR 100 028 [i.6], in particular in Annex D of ETSI TR 100 028-2 [i.7].

Table 13 is based on such expansion factors.

**Table 13: Maximum measurement uncertainty**

Parameter	Uncertainty
RF frequency	$\pm 10$ ppm
RF power conducted	$\pm 1,5$ dB
RF power radiated	$\pm 6$ dB
Humidity	$\pm 5$ %
Temperature	$\pm 1$ °C

## 5.3 Essential radio test suites

### 5.3.1 Product information

The following information shall be declared by the manufacturer in order to carry out the test suites. This information shall be included in the test report.

- the type of modulation used;
- the operating nominal carrier frequency range(s) of the equipment;
- the type of the equipment: integral antenna or dedicated antenna;
- the extreme operating conditions that apply to the equipment;
- the intended combination(s) of the radio equipment power settings and one or more antenna assemblies and their corresponding e.i.r.p. spectral density levels;
- the nominal operating voltages of the radio equipment or the nominal voltages of the host equipment (e.g. a vehicle or roadside equipment);
- test modulation used in detail.

### 5.3.2 Transmitter frequency stability

#### 5.3.2.1 Test purpose

To verify the required device under test's (DUT) transmitter frequency stability according to Clause 4.2.1.

#### 5.3.2.2 Test applicability

This test applies to all types of DUT.

For DUTs with antenna connector(s) towards dedicated external antenna(s), or for DUTs with integral antenna(s) but providing a temporary antenna connector, conducted test procedure shall be used.

For DUTs with integral antenna(s) only, radiated test procedure shall be used.

### 5.3.2.3 Test description

#### 5.3.2.3.1 Initial conditions

This test shall be performed for all nominal carrier frequencies according to Table 2 supported by the DUT.

The measurement is performed with the DUT in normal operation at maximum output power

#### 5.3.2.3.2 Conducted measurement

The test procedure shall be as follow:

##### Step 1:

- Connect the DUT transmitter output to the test setup and activate normal operation at the test centre frequency of interest

##### Step 2:

- Measure and record the DUT transmitter output carrier frequency

The measurement can be conducted as follows:

- i) connect the DUT to a spectrum analyser;
- ii) select Max Hold;
- iii) adjust centre frequency to the same as the DUT;
- iv) measure and record peak value of the power envelope;
- v) reduce span and move marker in positive frequency increment until the upper (relative to the centre frequency) -10 dBc point is reached;
- vi) denote this value f1;
- vii) move marker in negative frequency increment until the lower (relative to the centre frequency) -10 dBc point is reached;
- viii) denote this value as f2; and
- ix) calculate centre frequency as  $(f1 + f2) / 2$ .

#### 5.3.2.3.3 Radiated measurement

The test set up as described in annex B shall be used with a spectrum analyser (or alternative measurement instrument) attached to the test antenna.

The test procedure is as described under Clause 5.3.2.3.2.

### 5.3.2.4 Test requirements

The measured carrier centre frequencies  $f_c$  shall be within the range  $f_c \pm 20$  ppm, i.e. within the limits according to Clause 4.2.2.2, including the measurement uncertainty according to Table 13.

## 5.3.3 RF output power, power spectral density and transmit power control

### 5.3.3.1 Test purpose

To verify the DUT transmitter RF output power accuracy, transmit power control capability and the power spectral density.

### 5.3.3.2 Test applicability

This test applies to all types of DUT.

For DUTs with antenna connector(s) towards dedicated external antenna(s), or for DUTs with integral antenna(s) but providing a temporary antenna connector, conducted test procedure shall be used.

For DUTs with integral antenna(s) only, radiated test procedure shall be used.

### 5.3.3.3 Test description

#### 5.3.3.3.1 Initial conditions

This test shall be performed for all nominal carrier frequencies according to Table 2 supported by the DUT.

The measurement is performed with the DUT in normal operation at requested output power.

#### 5.3.3.3.2 Conducted measurement

##### 5.3.3.3.2.1 RF output power

The test procedure shall be as follow:

##### Step 1:

- Connect the DUT transmitter output to the test setup and activate normal operation at the highest output power level.

##### Step 2:

- Measure the duty cycle  $x$  of the DUT transmitter.
- The observed duty cycle of the transmitter ( $T_{on} / (T_{on} + T_{off})$ ) shall be noted as  $x$  ( $0 < x \leq 1$ ), and shall be recorded in the test report.

##### Step 3:

- Measure DUT transmitter output power.

##### Step 4:

- The observed value shall be noted as  $A$  (in dBm) 1.
  - The e.i.r.p. shall be calculated from the measured output power  $A$  (in dBm), the observed duty cycle  $x$ , with the stated antenna gain  $G$  in dBi and the cable and connector losses  $L$  in dB, according to  $P(e.i.r.p.) = A + L + G + 10 \times \log(1/x)$  (dBm).
- If more than one antenna assembly is intended for this power setting, the gain of the antenna assembly with the highest gain shall be used.

##### Step 5:

- $P(e.i.r.p.)$  shall be recorded in the test report as highest output power level  $P_H$

#### 5.3.3.3.2.2 Power spectral density

The test procedure shall be as follow:

##### Step 1:

- Connect the DUT transmitter output to the test setup and activate normal operation at highest output power level. The minimum transmitter on-time shall be 10  $\mu$ s.

**Step 2:**

- Measure the power spectral density  $D$ . The mean power density e.i.r.p. is calculated from the measured power density ( $D$ ), the observed duty cycle  $x$  (see Clause 5.3.3.3.2.1 step 2), and the applicable antenna assembly gain  $G$  in dBi, according to the formula below. If more than one antenna assembly is intended for this power setting, the gain of the antenna assembly with the highest gain shall be used:
  - $PD = D + G + 10 \times \log(1/x)$ ;
  - PD (dBm/MHz) shall be recorded in the test report.

**5.3.3.3.2.3 Transmit power control**

The test procedure shall be as follow:

**Step 1:**

- Connect the DUT transmitter output to the test setup and activate normal operation at its minimum TPC output power  $P_M$ , with  $P_M \leq 3$  dBm e.i.r.p. according to Clause 4.2.4.2.

**Step 2:**

- Measure the duty cycle  $x$  of the DUT transmitter.
- The observed duty cycle of the transmitter ( $T_{on} / (T_{on} + T_{off})$ ) shall be noted as  $x$  ( $0 < x \leq 1$ ), and shall be recorded in the test report.

**Step 3:**

- Measure DUT transmitter output power.

**Step 4:**

- The observed value shall be noted as  $A$  (in dBm).
  - The e.i.r.p. shall be calculated from the measured output power  $A$  (in dBm), the observed duty cycle  $x$ , with the stated antenna gain  $G$  in dBi and the cable and connector losses  $L$  in dB, according to  $P(\text{e.i.r.p.}) = A + L + G + 10 \times \log(1/x)$  (dBm).
- If more than one antenna assembly is intended for this power setting, the gain of the antenna assembly with the highest gain shall be used.

**Step 5:**

- $P(\text{e.i.r.p.})$  shall be recorded in the test report as lowest output power level  $P_L$ .

**Step 6:**

- Increase the current DUT transmit power  $P_T$  by 1 dB.
- If  $P_T < P_H$  repeat step 2 to step 4, else the test is completed.

**Step 7:**

- $P(\text{e.i.r.p.})$  shall be recorded in the test report as TPC output power level.
- Continue with step 6.

**5.3.3.3.3 Radiated measurement**

In the case of radiated measurements, using a test site as described in Annex B and applicable measurement procedures as described in Annex C, the power spectral density as defined shall be measured and recorded.

The test procedure is as described under Clause 5.3.3.3.2.

#### 5.3.3.4 Test requirements

The measured RF output power shall meet the limits specified in Clause 4.2.2.2, the PSD shall meet the limits specified in Clause 4.2.3.2, and the TPC shall meet the limits specified in Clause 4.2.4.2.

### 5.3.4 Transmitter unwanted emissions outside the 5 GHz ITS frequency band

#### 5.3.4.1 Test purpose

To verify the DUT transmitter unwanted emissions outside the 5 GHz ITS frequency band.

#### 5.3.4.2 Test applicability

This test applies to all types of DUT.

For DUT without an integral antenna and for a DUT with an integral antenna but with a temporary antenna connector, one of the following options shall be used:

- a) the level of unwanted emissions shall be measured as their power in a specified load (conducted unwanted emissions) and their radiated power when radiated by the cabinet or structure of the DUT with the antenna connector terminated by a specified load (cabinet radiation); or
- b) the level of unwanted emissions shall be measured as their radiated power when radiated by cabinet and antenna.

In the case where the DUT has an integral antenna, but no temporary antenna connector, only radiated measurements shall be used.

#### 5.3.4.3 Test description

##### 5.3.4.3.1 Initial conditions

This test shall be performed for all nominal carrier frequencies according to Table 2 supported by the DUT.

The measurement is performed with the DUT in normal operation at maximum output power.

##### 5.3.4.3.2 Conducted measurement

The test procedure shall be as follow:

##### Step 1:

- Connect the DUT transmitter output to the test setup and activate normal operation at maximum output power

##### Step 2:

- Initially the power level shall be measured in the ranges:
  - 30 MHz to 1 000 MHz;
  - with a resolution bandwidth of 1 MHz.

##### Step 3:

- If any measurement is greater than the limit of -36 dBm then measurements shall be taken with a resolution bandwidth of 100 kHz, at the 11 frequencies spaced 100 kHz apart in a band  $\pm 0,5$  MHz centred on the failing frequency.

EXAMPLE: A DUT fails at 495 MHz. Measurements are made in a 100 kHz bandwidth on 494,5 MHz; 494,6 MHz; 494,7 MHz; etc. up to 495,5 MHz.

**Step 4:**

- The power level shall be measured in the ranges:
  - 1 GHz to 5,855 GHz;
  - 5,925 GHz to 18 GHz;

The spectrum analyser can have the following settings:

- i) Sensitivity: at least 6 dB below the limits given in Tables 4 and 5.
- ii) The resolution bandwidth of the measuring receiver may be equal to the reference bandwidth as given in Clause 4.2.5.1.2 for measurements above 1 GHz. To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth can be different from the reference bandwidth. When the resolution bandwidth is smaller than the reference bandwidth, the result should be integrated over the reference bandwidth. When the resolution bandwidth is greater than the reference bandwidth, the result for broadband spurious emissions should be normalized to the bandwidth ratio. For discrete spurious, normalization is not applicable, while integration over the reference bandwidth is still applicable. The bandwidth used in this measurement for each spurious emission can be sufficiently narrow to reject emissions in any contiguous channels centred on the channel on which the transmitter is intended to operate.
- iii) Video bandwidth, not less than the resolution bandwidth.
- iv) Video averaging on, or peak hold.
- v) The video signal of the spectrum analyser is "gated" such that the spectrum measured shall be measured between 4,0  $\mu$ s before the start of the burst to 4,0  $\mu$ s after the end of the burst. The "start of the burst" is the centre of the first sample of the preamble heading the burst. The "end of the burst" is the centre of the last sample in the burst.

#### 5.3.4.3.3 Radiated measurement

The test set up as described in annex B shall be used with a spectrum analyser (or alternative measurement instrument) attached to the measurement antenna.

The measurements shall be conducted using a quasi-peak detector for frequencies below 1 GHz and a positive peak detector on frequencies of 1 GHz and above.

The test procedure is as described under Clause 5.3.4.3.2.

#### 5.3.4.4 Test requirements

The measured unwanted emissions shall meet the limits according to Clause 4.2.5.1.2.

### 5.3.5 Transmitter spectrum mask within the 5 GHz ITS frequency band for 10 MHz channel spacing

#### 5.3.5.1 Test Purpose

To verify the DUT transmitter unwanted emissions within the 5 GHz ITS frequency band.

#### 5.3.5.2 Test applicability

This test applies to all types of DUT.

For DUT without an integral antenna and for a DUT with an integral antenna but with a temporary antenna connector, one of the following options shall be used:

- a) the level of unwanted emissions shall be measured as their power in a specified load (conducted unwanted emissions) and their radiated power when radiated by the cabinet or structure of the DUT with the antenna connector terminated by a specified load (cabinet radiation); or
- b) the level of unwanted emissions shall be measured as their radiated power when radiated by cabinet and antenna.



In the case where the DUT has an integral antenna, but no temporary antenna connector, only radiated measurements shall be used.

### 5.3.5.3 Test description

#### 5.3.5.3.1 Initial conditions

This test shall be performed for all nominal carrier frequencies according to Table 2 supported by the DUT.

The measurement is performed with the DUT in normal operation at maximum output power.

#### 5.3.5.3.2 Conducted measurement

The test procedure shall be as follow:

##### Step 1:

- Connect the DUT transmitter output to the test setup and activate normal operation at maximum output power

##### Step 2:

- Measure the average power in the transmission bandwidth ( $f_c \pm 4,5$  MHz) using a resolution bandwidth of 100 kHz. This shall be recorded as the "Power Spectral Density at the carrier centre frequency  $f_c$ " according to Table 6.

##### Step 3:

- Measure the power level in the range of  $f_c \pm 15$  MHz with a resolution bandwidth of 100 kHz and record these values.

The video signal of the spectrum analyser can be "gated" such that the spectrum measured is measured 4,0  $\mu$ s before the start of the burst to 4,0  $\mu$ s after the end of the burst. The "start of the burst" can be the centre of the first sample of the preamble heading the burst. The "end of the burst" can be the centre of the last sample in the burst.

#### 5.3.5.3.3 Radiated measurement

The test set up as described in Annex B shall be used with a spectrum analyser (or alternative measurement instrument) attached to the test antenna.

The test procedure is as described under Clause 5.3.5.3.2.

### 5.3.5.4 Test requirements

The measured unwanted emissions shall meet the limits according to Clause 4.2.5.2.2.

## 5.3.6 Receiver spurious emissions

### 5.3.6.1 Test Purpose

To verify the DUT receiver spurious emissions.

### 5.3.6.2 Test applicability

This test applies to all types of DUT.

For DUTs with antenna connector(s) towards dedicated external antenna(s), or for DUTs with integral antenna(s) but providing a temporary antenna connector, conducted test procedure shall be used.

For DUTs with integral antenna(s) only, radiated test procedure shall be used.

### 5.3.6.3 Test description

#### 5.3.6.3.1 Initial conditions

The measurement is performed with the DUT in receive mode. This test shall be performed for all nominal carrier frequencies according to Table 2 supported by the DUT.

#### 5.3.6.3.2 Conducted measurement

The test procedure shall be as follow:

##### Step 1:

- Connect the DUT transmitter output and the DUT receiver input to the test setup and activate normal operation at maximum output power

##### Step 2:

- Activate a test transmission towards the DUT receiver at a power level of -60 dBm at the receiver input.
- The settings of the spectrum analyser can be as follows:
  - i) frequency scan allowed;
  - ii) resolution bandwidth: 1 MHz or 100 kHz;
  - iii) video bandwidth: 1 MHz; and
  - iv) video averaging on, or peak hold.

##### Step 3:

- Measure the power level of DUT emissions during test transmissions, in the frequency range specified in Table 7.

#### 5.3.6.3.3 Radiated measurement

The test set up as described in Annex B shall be used with a spectrum analyser (or alternative measurement instrument) attached to the measurement antenna.

The measurements shall be conducted using a quasi-peak detector for frequencies below 1 GHz and a positive peak detector on frequencies of 1 GHz and above.

The test procedure is as described under Clause 5.3.6.3.2.

### 5.3.6.4 Test requirement

The measured unwanted emissions shall meet the limits according to Clause 4.2.6.2.

If the limits in the band 5 795 MHz to 5 815 MHz are exceeded the following steps shall be taken:

- 1) Provide the attenuation value of the intended connecting cabling between the device output and the antenna,  $L$ .
- 2) Provide the maximum antenna gain in the vertical direction  $-50^\circ \leq \Theta \leq +70^\circ$ ,  $G$ . The vertical direction is defined as  $0^\circ$  upwards, and  $+90^\circ$  is in the forward direction of the vehicle where the antenna under test is intended to be used.
- 3) Calculate the receiver spurious emission levels at the antenna in the direction of the potential CEN DSRC and the HDR DSRC road side unit by using the maximum measured value obtained from the measurement in Clause 5.3.6.3.2 in the band 5 795 MHz to 5 815 MHz,  $P_{RXmax}$  and add the cable and connector losses  $L$  from step 1 and the antenna gain  $G$  in dBi from step 2.
- 4) The resulting value  $P_{RXres}$  ( $= P_{RXmax} + G - L$ ) shall meet the limits outlined in Clause 4.2.6.2.

## 5.3.7 Receiver selectivity

### 5.3.7.1 Test purpose

To verify that the DUT operates satisfactorily in the presence of a signal in the adjacent channel.

To verify that the DUT operates satisfactorily in the presence of a signal in the alternate adjacent channel.

To verify that the DUT operates satisfactorily in the presence of a signal in a frequency band further away for testing the blocking functionality.

### 5.3.7.2 Test applicability

This test applies to all types of DUT.

For DUTs with antenna connector(s) towards dedicated external antenna(s), or for DUTs with integral antenna(s) but providing a temporary antenna connector, conducted test procedure shall be used.

For DUTs with integral antenna(s) only, radiated test procedure shall be used.

### 5.3.7.3 Test description

#### 5.3.7.3.1 Initial conditions

This test shall be performed for all nominal carrier frequencies according to Table 2 supported by the DUT.

The measurement is performed with the DUT in normal operation.

#### 5.3.7.3.2 Conducted measurement

The test procedure shall be as follow:

**Step 1:**

- Connect the DUT receiver to the output of the test system.

**Step 2:**

- Activate a test transmission from the test system at the carrier frequency of the DUT, at a level adjusted + 3 dB above the sensitivity limit from Table 8 at the receiver input. Use the modulation scheme as declared by the manufacturer of the DUT.

**Step 3:**

- Activate a second signal with normal modulation at + 10 MHz relative to the carrier frequency of the receiver, at a power level relative to the test transmission of < 16 dB.

**Step 4:**

- Increase the power level of the second signal until the packet error ratio is  $10^{-1}$  or greater.

**Step 5:**

- Record the relative and absolute power levels of the second signal.

**Step 6:**

- Repeat step 3 to step 5 but for a second signal at lower adjacent channel at - 10 MHz relative to the carrier frequency of the receiver.

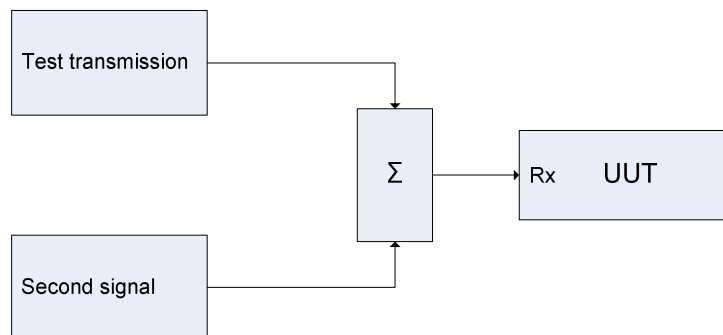
**Step 7:**

- Repeat step 3 to step 5 but for a second signal at alternate adjacent channels at - 20 MHz and + 20 MHz relative to the carrier frequency of the receiver.

**Step 8:**

- Repeat step 3 to step 5 but for a second unmodulated signal for at least six frequency offset points to test the blocking capability of the DUT. Frequency offset points shall be  $\pm 50$  MHz,  $\pm 100$  MHz, and  $\pm 200$  MHz, relative to the carrier frequency but are not limited to those.

For special protection requirements for the receiver it can be necessary to determine the receiver saturation. In this case the above measurements are repeated with a 25 dB increased level for the signal generator.



**Figure 3: A possible conducted measurement arrangement**

#### 5.3.7.3.3 Radiated measurement

A test site from Annex B shall be selected and the requirements from Annex B and Annex C apply. The procedure shall be the same as for the conducted measurement.

#### 5.3.7.4 Test requirement

The receiver selectivity parameters under specified conditions shall be equal to or greater than the limits given in Clause 4.2.7.2.

### 5.3.8 Receiver sensitivity

#### 5.3.8.1 Test purpose

To verify that the minimum receive signal level of the DUT fulfils the requirements.

#### 5.3.8.2 Test applicability

This test applies to all types of DUT.

For DUTs with antenna connector(s) towards dedicated external antenna(s), or for DUTs with integral antenna(s) but providing a temporary antenna connector, conducted test procedure shall be used.

For DUTs with integral antenna(s) only, radiated test procedure shall be used.

#### 5.3.8.3 Test description

##### 5.3.8.3.1 Initial conditions

The measurement shall be performed under normal test conditions only.

This test shall be performed for all nominal carrier frequencies according to Table 2 and all modulations and coding rates according to Table 9, supported by the DUT.

The measurement is performed with the DUT in normal operation.

### 5.3.8.3.2 Conducted measurement

The test procedure shall be as follow:

#### Step 1:

- Connect the DUT receiver to the output of the test system.

#### Step 2:

- Activate a test transmission from the test system at the carrier frequency of the DUT, at a level adjusted to reference sensitivity + 5 dB at the receiver input.

#### Step 3:

- Reduce the power level until the packet error rate PER is  $10^{-1}$ .

#### Step 4:

- Record the power level in the test report.
- The transmitter shall use a frame size of 1 000 octets. The PER is calculated from the number of sent packets  $Pkt_{Tx}$  and the number of correctly received packets  $Pkt_{Rx}$  as shown in Equation (1). At least 1 000 frames shall be used for evaluating the PER.

$$PER = \frac{Pkt_{Tx} - Pkt_{Rx}}{Pkt_{Tx}} \times 100 \% \quad (1)$$

### 5.3.8.3.3 Radiated measurement

A test site from Annex B shall be selected and the requirements from Annex B and Annex C apply. The procedure shall be the same as for the conducted measurement.

### 5.3.8.4 Test requirement

The receiver sensitivity under specified conditions shall be equal to or better than the limits given in Clause 4.2.8.2.

## 5.3.9 CEN DSRC and HDR DSRC protection

### 5.3.9.1 Test Purpose

To verify the DUT CEN DSRC and HDR DSRC protection.

### 5.3.9.2 Test applicability

This test applies to all types of DUT.

Test of RF output power shall be performed according to Clause 5.3.3.

Test of RF unwanted emissions shall be performed according to Clause 5.3.4.

### 5.3.9.3 Test description

#### 5.3.9.3.1 Initial conditions

This test shall be performed for all nominal carrier frequencies according to Table 2 supported by the DUT.

The measurement is performed with the DUT in normal operation.

### 5.3.9.3.2 Measurement of RF output power, unwanted emissions, and transmit duty cycle in coexistence mode

The test procedure shall be as follows:

#### Step 1:

- Connect the DUT transmitter to the test setup.

#### Step 2:

- The manufacturer shall declare which co-existence modes according to ETSI TS 102 792 [1], Table 5.3 the DUT is supporting. The DUT shall be tested with all supported co-existence modes.

#### Step 3:

- The DUT shall be in one of the co-existence mode A, B, C or D.

#### Step 4:

- If measurement results of DUT according to Clause 5.3.4 shows unwanted emissions in normal mode are less than the limits according to coexistence mode A in ETSI TS 102 792 [1], Table 5.3, it is not necessary to measure unwanted emissions in coexistence mode.

#### Step 5:

- If measurement results of DUT according to Clause 5.3.3 shows maximum output power in normal mode are less than the limits according to coexistence mode A in ETSI TS 102 792 [1], Table 5.3, it is not necessary to measure maximum output power in coexistence mode.

#### Step 6:

- If coexistence modes C and/or co-existence mode D are supported, connect a test signal generator to the DUT receiver that can simulate up to twelve surrounding ITS stations. The DUT shall be tested receiving zero, six and twelve surrounding ITS stations.

#### Step 8:

- Measure the RF output power according to Clause 5.3.3. Record these values.

#### Step 9:

- Measure the unwanted emissions according to Clause 5.3.4. Record these values.

#### Step 10:

- Measure  $T_{on}$  and  $T_{off}$ . Record these values.

### 5.3.9.4 Test requirements

The measured RF output power level, timings and unwanted emissions in Clause 5.3.9.2 shall meet the limits according to Clause 4.2.9.2.

## 5.3.10 CEN DSRC and HDR DSRC detection

### 5.3.10.1 Test Purpose

To verify the DUT CEN DSRC and HDR DSRC detection.

### 5.3.10.2 Initial conditions

The measurement is performed with the DUT in normal operation.

### 5.3.10.3 Test of detecting CEN DSRC and HDR DSRC transmissions

#### 5.3.10.3.1 Test purpose

To verify the DUT's CEN DSRC and HDR DSRC detector.

#### 5.3.10.3.2 Test applicability

This test applies to all DUTs that have implemented a short-range RF detector, see ETSI TS 102 792 [1], in Clause 5.2.5.

#### 5.3.10.3.3 Test description

The test procedure shall be as follows:

##### Step 1:

- Connect the DUT to the test setup and activate normal mode (not any of the co-existence modes A, B, C or D) transmitting CAM.

##### Step 2:

- Connect the DUT to a test signal receiver that can receive and analyse CAM [2].

##### Step 3:

- Connect the DUT to a test generator transmitting CEN DSRC frame headers as defined in CEN EN 12253 [7]. If no antenna is used, the signal generator shall be connected to the DUT antenna connector and the power level shall be compensated with the declared antenna gain.

##### Step 4:

- Set the CEN DSRC test generator to send messages with a signal power level at the DUT antenna of 3 dB greater than the upper limit in ETSI TS 102 792 [1], Clause 5.2.5.

##### Step 5:

- Receive the DUT transmitted CAMs. Analyse the information regarding CEN DSRC protected zone. There shall be protected zone information included in the CAM.

##### Step 6:

- Measure the RF output power and unwanted emissions using the test setup in Clause 5.3.9. The DUT shall activate coexistence mode when receiving CEN DSRC transmissions.

##### Step 7:

- Set the CEN DSRC test generator to send messages with a signal power level at the DUT antenna of 3 dB less than the lower limit in ETSI TS 102 792 [1], Clause 5.2.5.

##### Step 8:

- Receive the DUT transmitted CAMs for 10 seconds. Analyse the information regarding CEN DSRC protected zone. There shall be no protected zone information included in the CAM.

##### Step 9:

- Replace the CEN DSRC test signals with HDR DSRC wakeup trigger signals as defined in in ETSI ES 200 674-1 [8], Clause 6.8.6

##### Step 10:

- Set the HDR DSRC test generator to send messages with a signal power level at the DUT antenna of 3 dB greater than the upper limit in ETSI TS 102 792 [1], Clause 5.2.5.

**Step 11:**

- Receive the DUT transmitted CAMs. Analyse the information regarding HDR DSRC protected zone. There shall be protected zone information included in the CAM.

**Step 12:**

- Measure the RF output power and unwanted emissions using the test setup in Clause 5.3.9. The DUT shall activate coexistence mode when receiving HDR DSRC transmissions.

**Step 13:**

- Set the HDR DSRC test generator to send messages with a signal power level at the DUT antenna of 3 dB less than the lower limit in ETSI TS 102 792 [1], Clause 5.2.5.

**Step 14:**

- Receive the DUT transmitted CAMs for 10 seconds. Analyse the information regarding CEN DSRC protected zone. There shall be no protected zone information.

**Step 15:**

- Set the test generator to send NON CEN DSRC or HDR DSRC messages with a signal power level at the DUT antenna of -30 dBm LP.

**Step 16:**

- Receive the DUT transmitted CAMs for 10 seconds. Analyse the information regarding CEN DSRC protected zone. There shall be no protected zone information included in the CAM.

**5.3.10.3.4 Test requirements**

The limits defined in Clause 4.2.9.2 shall be fulfilled.



## Annex A (normative): Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.5] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.4].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in Table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

**Table A.1: Relationship between the present document and the essential requirements of Directive 2014/53/EU**

<b>Harmonised Standard ETSI EN 302 571</b>				
The following requirements are relevant to the presumption of conformity under the article 3.2 of Directive 2014/53/EU [i.4]				
<b>Requirement</b>			<b>Requirement Conditionality</b>	
<b>No</b>	<b>Description</b>	<b>Reference: Clause No</b>	<b>U/C</b>	<b>Condition</b>
1	Transmitter frequency stability	4.2.1	U	
2	RF output power	4.2.2	U	
3	Power spectral density	4.2.3	U	
4	Transmit power control	4.2.4	U	
5	Transmitter unwanted emissions	4.2.5	U	
6	Receiver spurious emissions	4.2.6	U	
7	Receiver selectivity	4.2.7	U	
8	Receiver sensitivity	4.2.8	U	
9	Interference mitigation for CEN DSRC and HDR DSRC in the frequency band 5 795 MHz to 5 815 MHz	4.2.9	U	
10	Decentralized congestion control	4.2.10	U	

### Key to columns:

#### Requirement:

**No** A unique identifier for one row of the table which may be used to identify a requirement.

**Description** A textual reference to the requirement.

**Clause Number** Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

#### Requirement Conditionality:

**U/C** Indicates whether the requirement shall be unconditionally applicable (U) or is conditional upon the manufacturers claimed functionality of the equipment (C).

**Condition** Explains the conditions when the requirement shall or shall not be applicable for a requirement which is classified "conditional".

Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

Other Union legislation may be applicable to the product(s) falling within the scope of the present document.

## Annex B (normative): Test sites and arrangements for radiated measurements

### B.1 Test sites

#### B.1.1 Open air test sites

The term "open air" should be understood from an electromagnetic point of view. Such a test site may be really in open air or alternatively with walls and ceiling transparent to the radio waves at the frequencies considered.

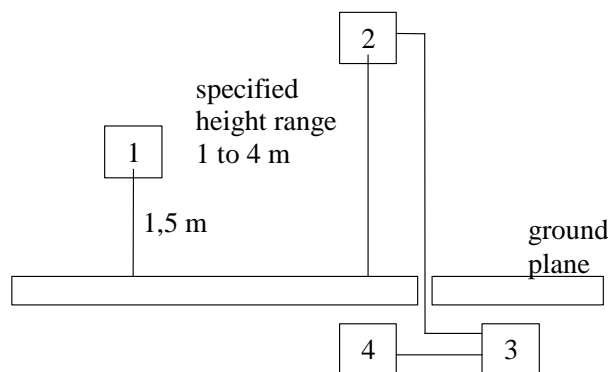
An open air test site may be used to perform the measurements using the radiated measurement methods described in Clause 5. Absolute or relative measurements may be performed on transmitters or on receivers; absolute measurements of field strength require a calibration of the test site. Above 1 GHz, measurements should be done in anechoic conditions. This may be met by semi anechoic sites provided reflections are avoided.

For measurements at frequencies below 1 GHz, a measurement distance appropriate to the frequency shall be used. For frequencies above 1 GHz, any suitable measuring distance may be used. The DUT size (excluding the antenna) shall be less than 20 % of the measuring distance. The height of the DUT or of the substitution antenna shall be 1,5 m; the height of the test antenna (transmit or receive) shall vary between 1 m and 4 m.

Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site do not degrade the measurement results, in particular:

- no extraneous conducting objects having any dimension in excess of a quarter wavelength of the highest frequency tested shall be in the immediate vicinity of the site according to CISPR 16 [4];
- all cables shall be as short as possible; as much of the cables as possible shall be on the ground plane or preferably below; and the low impedance cables shall be screened.

The general measurement arrangement is shown in Figure B.1.



- NOTE: 1: Device under test.  
2: Test antenna.  
3: High pass filter (as required).  
4: Spectrum analyser or measuring receiver.

**Figure B.1: Measuring arrangement**

## B.1.2 Anechoic chamber

### B.1.2.1 General

An anechoic chamber is a well shielded chamber covered inside with radio frequency absorbing material and simulating a free space environment. It is an alternative site on which to perform the measurements using the radiated measurement methods described in Clause C.2. Absolute or relative measurements may be performed on transmitters or on receivers. Absolute measurements of field strength require a calibration of the anechoic chamber. The test antenna, DUT and substitution antenna are used in a way similar to that at the open air test site, but are all located at the same fixed height above the floor.

### B.1.2.2 Description

An anechoic chamber should meet the requirements for shielding loss and wall return loss as shown in Figure B.2. Figure B.3 shows an example of the construction of an anechoic chamber having a base area of 5 m by 10 m and a height of 5 m. The ceiling and walls are coated with pyramidal absorbers approximately 1 m high. The base is covered with special absorbers which form the floor. The available internal dimensions of the chamber are 3 m × 8 m × 3 m, so that a maximum measuring distance of 5 m in the middle axis of this chamber is available. The floor absorbers reject floor reflections so that the antenna height need not be changed. Anechoic chambers of other dimensions may be used.

### B.1.2.3 Influence of parasitic reflections

For free-space propagation in the far field, the relationship of the field strength  $E$  and the distance  $R$  is given by  $E = E_0 \times (R_0 / R)$ , where  $E_0$  is the reference field strength and  $R_0$  is the reference distance. This relationship allows relative measurements to be made as all constants are eliminated within the ratio and neither cable attenuation nor antenna mismatch or antenna dimensions are of importance.

If the logarithm of the foregoing equation is used, the deviation from the ideal curve may be easily seen because the ideal correlation of field strength and distance appears as a straight line. The deviations occurring in practice are then clearly visible. This indirect method shows quickly and easily any disturbances due to reflections and is far less difficult than the direct measurement of reflection attenuation.

With an anechoic chamber of the dimensions given above at low frequencies below 100 MHz there are no far field conditions, but the wall reflections are stronger, so that careful calibration is necessary. In the medium frequency range from 100 MHz to 1 GHz the dependence of the field strength to the distance meets the expectations very well. Above 1 GHz, because more reflections will occur, the dependence of the field strength to the distance will not correlate so closely.

### B.1.2.4 Calibration and mode of use

The calibration and mode of use is the same as for an open air test site, the only difference being that the test antenna does not need to be raised and lowered whilst searching for a maximum, which simplifies the method of measurement.

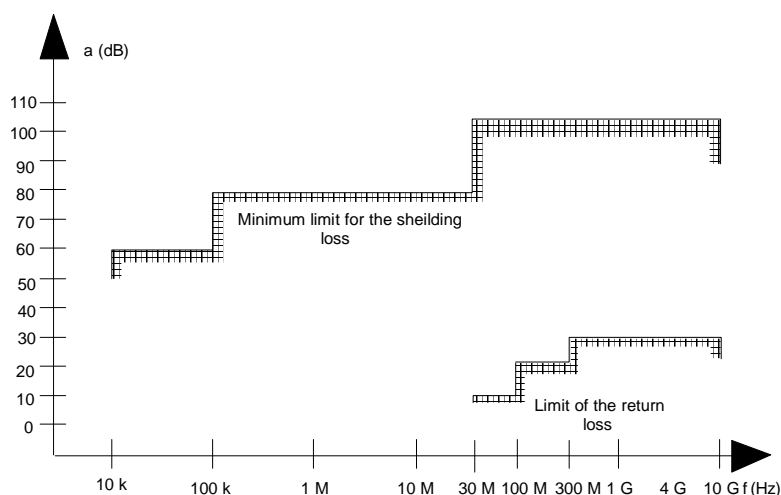


Figure B.2: Specification for shielding and reflections

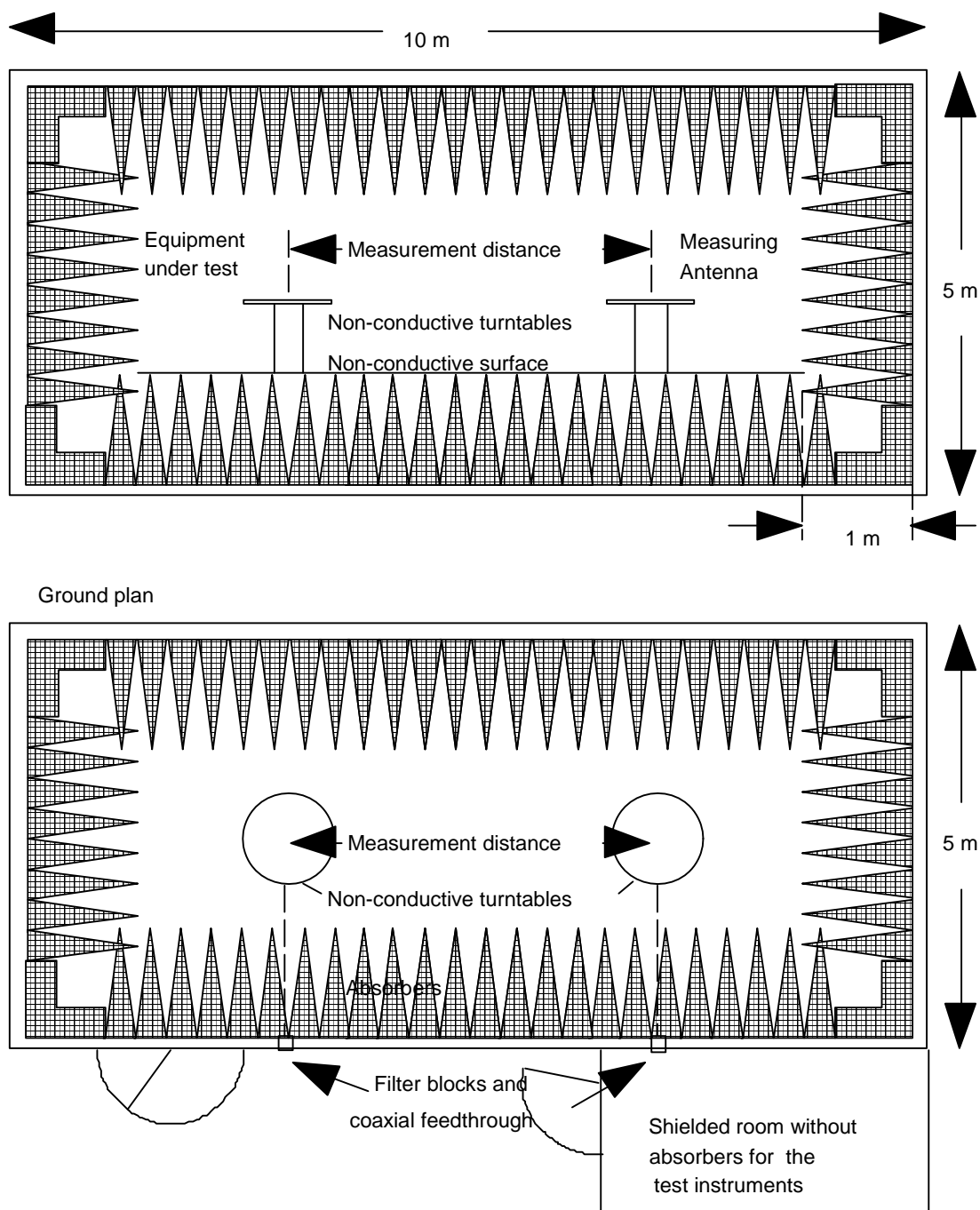


Figure B.3: Anechoic shielded chamber for simulated free space measurements

## B.2 Test antenna

When the test site is used for radiation measurements the test antenna shall be used to detect the field from both the test sample and the substitution antenna. When the test site is used for the measurement of receiver characteristics the antenna shall be used as a transmitting antenna. This antenna shall be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization and for the height of its centre above the ground to be varied over the specified range. Preferably test antennas with pronounced directivity should be used. The size of the test antenna along the measurement axis shall not exceed 20 % of the measuring distance.

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## B.3 Substitution antenna

The substitution antenna shall be used to replace the DUT in substitution measurements. For measurements below 1 GHz the substitution antenna shall be a half wavelength dipole resonant at the frequency under consideration, or a shortened dipole, calibrated to the half wavelength dipole. For measurements between 1 GHz and 4 GHz either a half wavelength dipole or a horn radiator may be used. For measurements above 4 GHz a horn radiator shall be used. The centre of this antenna shall coincide with the reference point of the test sample it has replaced. This reference point shall be the volume centre of the sample when its antenna is mounted inside the cabinet, or the point where an outside antenna is connected to the cabinet.

The distance between the lower extremity of the dipole and the ground shall be at least 30 cm.

NOTE: The gain of a horn antenna is generally expressed relative to an isotropic radiator.

## Annex C (normative): General description of measurement

### C.1 Introduction

This annex gives the general methods of measurements for RF signals using the test sites and arrangements described in Annex B.

### C.2 Conducted measurements

Conducted measurements may be applied to DUT provided with a 50  $\Omega$  antenna connector, e.g. by means of a spectrum analyser.

The Voltage Standing Wave Ratio (VSWR) at the 50  $\Omega$  connector shall not be greater than 1,5:1 over the frequency range of the measurement.

Conducted power measurements refer to RMS (root mean square) power values, i.e. shall use RMS power detectors.

### C.3 Radiated measurements

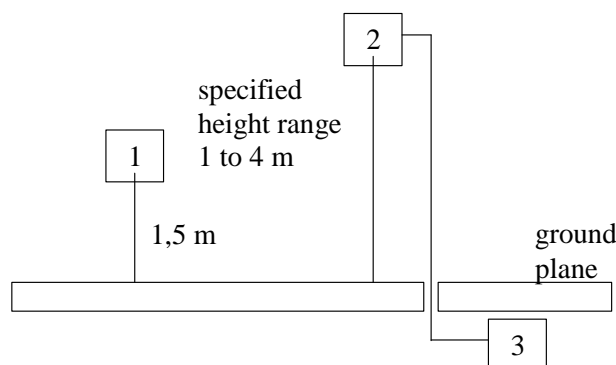
Radiated measurements shall be performed with the aid of a test antenna and measurement instruments as described in annex B. The test antenna and measurement instrument shall be calibrated according to the procedure defined in this annex. The DUT to be measured and the test antenna shall be oriented to obtain the maximum emitted power level. This position shall be recorded in the measurement report. The frequency range shall be measured in this position.

Radiated measurements should be performed in an anechoic chamber. For other test sites corrections may be needed (see annex B). The following test procedure applies:

- a) a test site which fulfils the requirements of the specified frequency range of this measurement shall be used. The test antenna shall be oriented initially for vertical polarization unless otherwise stated and the transmitter under test shall be placed on the support in its standard position (Clause B.1.1) and switched on;
- b) for average power measurements shall a non-selective voltmeter or wideband spectrum analyser (or alternative measurement instrument) be used. For other measurements shall a spectrum analyser or selective voltmeter (or alternative measurement instrument) be used and tuned to the measurement frequency.

In either case a) or case b), the test antenna shall be raised or lowered, if necessary, through the specified height range until the maximum signal level is detected on the spectrum analyser or selective voltmeter.

The test antenna need not be raised or lowered if the measurement is carried out on a test site according to Clause B.1.2.



- NOTE: 1: Device under test.  
2: Test antenna.  
3: Spectrum analyser or measuring receiver.

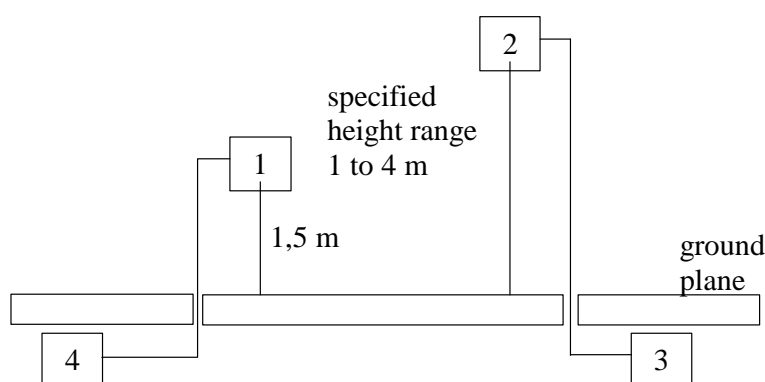
Figure C.1: Measurement arrangement 1

- The transmitter shall be rotated through 360° about a vertical axis until a higher maximum signal is received.
- The test antenna shall be raised or lowered again, if necessary, through the specified height range until a maximum is obtained. This level shall be recorded.
- This maximum may be a lower value than the value obtainable at heights outside the specified limits.

The test antenna need not be raised or lowered if the measurement is carried out on a test site according to Clause B.1.2. This measurement shall be repeated for horizontal polarization. The result of the measurement is the higher power obtained from the two measurements with the indication of the corresponding polarization.

## C.4 Substitution measurement

The actual signal generated by the measured DUT may be determined by means of a substitution measurement in which a known signal source replaces the device to be measured, see Figure C.2. This method of measurement should be used in an anechoic chamber. For other test sites corrections may be needed, see annex B.



NOTE: 1: Substitution antenna.  
 2: Test antenna.  
 3: Spectrum analyser or selective voltmeter.  
 4: Signal generator.

**Figure C.2: Measurement arrangement 2**

Using measurement arrangement 2, Figure C.2, the substitution antenna shall replace the transmitter antenna in the same position and in vertical polarization. The frequency of the signal generator shall be adjusted to the measurement frequency. The test antenna shall be raised or lowered, if necessary, to ensure that the maximum signal is still received. The input signal to the substitution antenna shall be adjusted in level until an equal or a known related level to that detected from the transmitter is obtained in the test receiver.

The test antenna need not be raised or lowered if the measurement is carried out on a test site according to Clause B.1.2.

The radiated power is equal to the power supplied by the signal generator, increased by the known relationship if necessary and after corrections due to the gain of the substitution antenna and the cable loss between the signal generator and the substitution antenna.

This measurement shall be repeated with horizontal polarization. The result of the measurement is the higher power obtained from the two measurements with the indication of the corresponding polarization.

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## Annex D (informative): Guidance on declaring the environmental profile

### D.1 Recommended environmental profile

The requirements of the present document should apply under the environmental profile for intended operation, either normal or extreme environmental conditions, which are recommended to be selected by the manufacturer in accordance with Clause D.2.

---

### D.2 Temperatures

#### D.2.1 Introduction

Before measurements are made the equipment should have reached the thermal balance in the test chamber. The equipment should be switched off during the temperature stabilizing period.

In the case of equipment containing temperature stabilization circuits designed to operate continuously, the temperature stabilization circuits may be switched on for 15 minutes after thermal balance has been obtained, and the equipment should then meet the specified requirements. For such equipment the manufacturer should provide for the power source circuit feeding the crystal oven to be independent of the power source for the rest of the equipment.

If the thermal balance is not checked by measurements, a temperature stabilizing period of at least one hour, or a longer period as may be decided by the testing laboratory, should be allowed. The sequence of measurements should be chosen, and the humidity content in the test chamber should be controlled so that excessive condensation does not occur.

#### D.2.2 Normal environmental conditions

The normal temperature and humidity conditions for tests should be any convenient combination of temperature and humidity within the following ranges:

- temperature: +15 °C to +35 °C;
- relative humidity: 20 % to 75 %.

When it is impracticable to carry out the tests under these conditions, a note to this effect, stating the ambient temperature and relative humidity during the tests, should be added to the test report.

#### D.2.3 Extreme environmental conditions

The extreme temperature and humidity conditions for tests should be any convenient combination of temperature and humidity within the following ranges:

- temperature: -30 °C to +70 °C,
- relative humidity: 20 % to 75 %.

The manufacturer can also declare under which extreme conditions the equipment is intended to be installed in.

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### D.3 Test power source

#### D.3.1 Introduction

During testing, the power source of the equipment should be replaced by a test power source capable of producing normal and extreme test voltages as specified in Clause D.3.2 and Clause D.3.3. The internal impedance of the test power source should be low enough for its effect on the test results to be negligible. For the purpose of tests, the voltage of the power should be measured at the input terminals of the equipment.



For battery operated equipment the battery should be removed and the test power source should be applied as close to the battery terminals as practicable.

During tests of DC powered equipment the power source voltages should be maintained within a tolerance of  $\pm 1$  % relative to the voltage at the beginning of each test. The value of this tolerance is critical for power measurements, using a smaller tolerance provides better measurement uncertainty values.

## D.3.2 Normal test power source

### D.3.2.1 AC mains voltage

The normal test voltage for equipment to be connected to the mains should be the nominal mains voltage. For the purpose of the present document, the nominal voltage should be the declared voltage or any of the declared voltages for which the equipment was designed.

The frequency of the test power source corresponding to the AC mains should be between 49 Hz and 51 Hz.

### D.3.2.2 Regulated lead-acid battery power sources used on vehicles

When the radio equipment is intended for operation from the usual types of regulated lead-acid battery power source used on vehicles the normal test voltage should be 1,1 times the nominal voltage of the battery (e.g., for nominal voltages of 6 V and 12 V, these are 6,6 V and 13,2 V, respectively).

### D.3.2.3 Other power sources

The normal test voltage should be that declared by the equipment manufacturer for operation from other power sources or types of battery (primary or secondary).

## D.3.3 Extreme test source voltages

### D.3.3.1 AC mains voltage

The extreme test voltage for equipment to be connected to an AC mains source should be the nominal mains voltage  $\pm 10$  %.

### D.3.3.2 Regulated lead-acid battery power sources used on vehicles

When the equipment is intended for operation from the usual types of regulated lead-acid battery power sources used on vehicles the extreme test voltages should be 1,3 and 0,9 times the nominal voltage of the battery (e.g., for a nominal voltage of 6 V, these are 7,8 V and 5,4 V respectively and for a nominal voltage of 12 V, these are 15,6 V and 10,8 V, respectively).

### D.3.3.3 Power sources using other types of batteries

The lower extreme test voltages for equipment with power sources using batteries should be as follows:

- for the nickel metal-hydride, leclanché or lithium type: 0,85 times the nominal battery voltage;
- for the mercury or nickel-cadmium type: 0,9 times the nominal battery voltage.

No upper extreme test voltages apply.

In the case where there is no upper extreme test voltage the nominal voltage ( $V_{\text{nominal}}$ ) is applicable, the corresponding extreme test conditions are then:

- $V_{\text{min}}/T_{\text{min}}$  and  $V_{\text{min}}/T_{\text{max}}$
- $V_{\text{nominal}}/T_{\text{min}}$  and  $V_{\text{nominal}}/T_{\text{max}}$ .

### D.3.3.4 Other power sources

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages should be those declared by the equipment manufacturer.

### D.3.4 Procedure for equipment designed for continuous transmission

If the manufacturer states that the equipment is designed for continuous transmission, the test procedure should be as follows. Before tests at the upper extreme temperature, the equipment should be placed in the test chamber, and left until thermal balance is attained. The equipment should then be switched on in the transmit condition for a period of half an hour, after which the equipment should meet the specified requirements.

Before tests at the lower extreme temperature, the equipment should be left in the test chamber until thermal balance is attained, then switched to the standby or receive condition for a period of one minute, after which the equipment should meet the specified requirements.

### D.3.5 Procedure for equipment designed for intermittent transmission

If the manufacturer states that the equipment is designed for intermittent transmission, the test procedure should be as follows. Before tests at the upper extreme temperature, the equipment should be placed in the test chamber, and left until thermal balance is attained. The equipment should then be switched on for one minute in the transmit condition, followed by four minutes in the receive condition, after which the equipment should meet the specified requirements.

For tests at the lower extreme temperature, the equipment should be left in the test chamber until thermal balance is attained, then switched to the standby or receive condition for one minute, after which the equipment should meet the specified requirements.

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## Annex E (informative): Bibliography

- ECC Report 101: "Compatibility studies in the band 5855- 5925 MHz between Intelligent Transport Systems (ITS) and other systems".
- Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC (EMC Directive).
- Directive 2006/95/EC of the European Parliament and of the Council of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (LV Directive).

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## Annex F (informative): Change History

Version	Information about changes
2.1.1	First published version covering Directive 2014/53/EU [i.4]. Major changes are: <ul style="list-style-type: none"><li>• Limits for RF output power, transmitter unwanted emissions and receiver blocking changed;</li><li>• Interference mitigation for CEN DSRC and HDR DSRC refers to ETSI TS 102 792 (V1.2.1) [1].</li></ul>

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## History

<b>Document history</b>		
V1.1.1	September 2008	Publication
V1.2.1	September 2013	Publication
V2.0.0	March 2016	EN Approval Procedure AP 20160623: 2016-03-25 to 2016-06-23