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Harmonized European Standard

**Intelligent Transport Systems (ITS);
Radiocommunications equipment operating
in the 5 855 MHz to 5 925 MHz frequency band;
Harmonized EN covering the essential requirements
of article 3.2 of the R&TTE Directive**

Reference

REN/ERM-TG37-009

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Foreword

This Harmonized European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document has been produced by ETSI in response to mandate M/284 issued from the European Commission under Directive 98/34/EC [i.1] as amended by Directive 98/48/EC [i.1].

The title and reference to the present document are intended to be included in the publication in the Official Journal of the European Union of titles and references of Harmonized Standard under the Directive 1999/5/EC [i.2].

See article 5.1 of Directive 1999/5/EC for information on presumption of conformity and Harmonised Standards or parts thereof the references of which have been published in the Official Journal of the European Union.

The requirements relevant to Directive 1999/5/EC [i.2] are summarised in annex A.

Equipment compliant with the present document can be intended for fitment into road vehicles, therefore it is subject to automotive EMC type approval and Directive 95/54/EC [i.3]. For use on vehicles outside the scope of Directive 95/54/EC [i.3], compliance with an EMC directive/standard appropriate for that use is required.

National transposition dates	
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Introduction

The present document is part of a set of standards developed by ETSI and is designed to fit in a modular structure to cover all radio and telecommunications terminal equipment within the scope of the R&TTE Directive [i.2]. The modular structure is shown in EG 201 399 [i.4].

1 Scope

The present document applies to corporate communications using radio transmitters and receivers for Intelligent Transport Systems (ITS). ITS communications may comprise vehicle-to-vehicle, vehicle-to-infrastructure and infrastructure-to-vehicle.

Table 1a: Radiocommunications service frequency bands

Radiocommunications service frequency bands	
Transmit	5 855 MHz to 5 925 MHz
Receive	5 855 MHz to 5 925 MHz

The equipment is comprised of a transmitter and associated encoder and modulator and/or a receiver and associated demodulator and decoder. The types of equipment covered by the present document are as follows:

- On Board Equipment (OBE equipment fitted with an integral or dedicated antenna(s), intended for use in vehicles, e.g. a road or a rail vehicle);
- Road Side Equipment (RSE equipment fitted with an antenna socket, integral or dedicated antenna(s), normally used as a fixed station); e.g. a road or rail infrastructure.

2 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 reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at <http://docbox.etsi.org/Reference>.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

2.1 Normative references

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

- [1] 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".
- [2] CISPR 16 (parts 1-1 (2007), 1-4 (2008) and 1-5 (2003)): "Specifications for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus".
- [3] ETSI EN 302 663 (V1.2.1) (11-2012): "Intelligent Transport Systems (ITS); Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band".
- [4] 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".
- [5] ETSI TS 102 724 (V1.1.1) (10-2012): "Intelligent Transport Systems (ITS); Harmonized Channel Specifications for Intelligent Transport Systems operating in the 5 GHz frequency band".

- [6] ETSI TS 102 792 (V1.1.1) (10-2012): "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".
- [7] 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)".
- [8] 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)".
- [9] 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)".

2.2 Informative references

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] Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations.
- [i.2] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).
- [i.3] Commission Directive 95/54/EC of 31 October 1995 adapting to technical progress Council Directive 72/245/EEC on the approximation of the laws of the Member States relating to the suppression of radio interference produced by spark-ignition engines fitted to motor vehicles and amending Directive 70/156/EEC on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers.
- [i.4] ETSI EG 201 399 (V2.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); A guide to the production of candidate Harmonized Standards for application under the R&TTE Directive".
- [i.5] ETSI TR 102 070-2 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guide to the application of harmonized standards to multi-radio and combined radio and non-radio equipment; Part 2: Effective use of the radio frequency spectrum".
- [i.6] ECC Decision (08)01: "ECC Decision of 14 March 2008 on the harmonized use of the 5875-5925 frequency band for Intelligent Transport Systems (ITS)".
- [i.7] ECC Recommendation (08)01: "Use of band 5855-5875 MHz for Intelligent Transport Systems (ITS)".
- [i.8] ECC Report 101: "Compatibility studies in the band 5855- 5925 MHz between Intelligent Transport Systems (ITS) and other systems".
- [i.9] ETSI TR 102 273 (2001-12) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement of radiated methods of measurement (using test sites) and evaluation of the corresponding measurement uncertainties".
- [i.10] ANSI C63.5 (2004): "American National Standard for Electromagnetic Compatibility-Radiated Emission Measurements in Electromagnetic Interference (EMI) Control-Calibration of Antennas (9 kHz to 40 GHz)".
- [i.11] ETSI TR 102 492-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Intelligent Transport Systems (ITS); Part 1: Technical characteristics for pan-European harmonized communications equipment operating in the 5 GHz frequency range and intended for critical road-safety applications; System Reference Document".

- [i.12] ETSI TR 102 492-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Intelligent Transport Systems (ITS); Part 2: Technical characteristics for pan European harmonized communications equipment operating in the 5 GHz frequency range intended for road safety and traffic management, and for non-safety related ITS applications; System Reference Document".
- [i.13] 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.14] Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive).
- [i.15] Council Directive 73/23/EEC of 19 February 1973 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (LV Directive).

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

available channel: channel identified as available for use as an *Operating* Channel having performed a "listen before talk check" first

channel: amount of spectrum used by a single ITS device operating on one of the carrier frequencies listed in table 2b of the present document

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.

Decentralized Congestion Control (DCC): technique in which the transmitter output power and transmission timing limits are controlled resulting in less congestion on the radio channel

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

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

Listen Before Talk (LBT): monitoring method in which the RF channel is checked for activity before transmitting

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

Transmit Power Control (TPC): technique in which the transmitter output power is controlled resulting in reduced interference to other users

Transmit Power Control range: power range over which the TPC is able to control the transmitter output power

vehicle: all kinds of land mobile vehicle, e.g. a road or 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
PH	highest power level
R	distance
T_{max}	maximum temperature
T_{min}	minimum temperature
Tx on	effective transmitter on-time
Tx off	effective transmitter off-time
V_{max}	maximum voltage
V_{min}	minimum voltage
Ω	ohm
μs	microsecond

3.3 Abbreviations

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

BPSK	Binary Phase Shift Keying
BW	bandwidth
CEN	Comitee Europeen de Normalisation (European Committee for Standardization)
CISPR	Comité International Spécial des Perturbations Radioélectriques (International Special Committee on Radio Interference)
CW	Continuous Wave
DC	Direct Current
DCC	Decentralized Channel Control
DCR	Duty Cycle Restriction
DSRC	Dedicated Short Range Communication (CEN DRSC = tolling at 5,8 GHz)
e.i.r.p.	equivalent isotropically radiated power
e.r.p.	effective radiated power
EC	European Commission
ECC	Electronic Communication Committee
EMC	Electro Magnetic Compatibility
EUT	Equipment Under Test
FEC	Forward Error Correction
HS	Harmonized Standard
IF	Intermediate Frequency
ITS	Intelligent Transport Systems
ITS-G5	Frequency band for Intelligent Transportation Systems ranging from 5,875 up to 5,925 GHz
LBT	Listen Before Talk
OBE	On Board Equipment
PD	mean Power Density
PER	Packet Error Rate
PH	Highest power level
PL	Lowest power level
ppm	parts per million = 10^{-6}
PSD	Power Spectral Density
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RBW	Resolution Bandwidth
RF	Radio Frequency

RSE	Road Side Equipment
RSU	Road Side Unit
TPC	Transmit Power Control
TTE	Telecommunication Terminal Equipment
TX	Transmit
UUT	Unit Under Test
VSWR	Voltage Standing Wave Ratio

4 General

4.1 Presentation of equipment for testing purposes

Each equipment submitted for testing shall fulfil the requirements of the present document on all frequencies over which it is intended to operate.

The provider shall declare the frequency ranges, the range of operating conditions and power requirements as applicable, to establish the appropriate test conditions.

Additionally, technical documentation and operating manuals, sufficient to make the test, shall be supplied.

4.1.1 Choice of model for testing

The provider shall provide one or more samples of the equipment, as appropriate for testing.

Stand-alone equipment shall be offered by the provider complete with any ancillary equipment needed for testing.

If an equipment has several optional features considered not to affect the RF parameters, then the tests need only to be performed on the equipment configured with the combination of features considered to be the most complex, as proposed by the provider and agreed by the test laboratory.

Where practicable, equipment offered for testing shall provide a 50 Ω connector for conducted RF power level measurements.

In the case of a dedicated integral antenna equipment, if the equipment does not have an internal permanent 50 Ω connector, then it is permissible to supply a second sample of the equipment with a temporary antenna connector fitted to facilitate testing.

The performance of the equipment submitted for testing shall be representative of the performance of the corresponding production model.

The equipment may contain digital circuit elements, radio circuit elements and other elements whose performance is not covered by the present document. These elements of the equipment shall meet the appropriate performance requirements for those components, as specified in other standards.

An ITS device which is combined with other system(s) should meet at least the requirements of the present document (for the elements of the device concerned with radio communications), and the requirements of any relevant standard for EMC compatibility of the other equipment for the elements of the device which are not concerned with radio communications.

EXAMPLE: An ITS communications device combined with a navigation system.

NOTE: For further information on this topic see TR 102 070-2 [i.5].

4.1.1.1 Auxiliary test equipment

All necessary test signal sources, setting up instructions and other product information shall accompany the equipment when it is submitted for testing.

4.1.1.2 Declarations by the provider

The provider shall declare the necessary information of the equipment with respect to all technical requirements set by the present document.

4.2 Mechanical and electrical design

4.2.1 General

The equipment shall be designed, constructed and manufactured with the aim of minimizing harmful interference to other equipment and services.

4.2.2 Controls

Those controls, which if maladjusted, might increase the interfering potentialities of the equipment shall not be accessible for adjustment by the user.

4.3 Testing using bit streams or messages

The manufacturer may elect to have the equipment tested using bit streams or data packets.

4.4 Measuring continuous mode equipment

In the case of measurements performed on equipment designed to operate only in continuous mode, requirements such as "equipment shall be set in continuous mode" shall be interpreted as "equipment shall be used in its normal transmission mode (in this case, the continuous mode)".

4.5 Measuring discontinuous mode equipment

When it is specified that the transmission shall be continuous for the duration of the measurement(s), the transmitter under test shall be set to operate in continuous mode. If this is not possible, the measurements shall be carried out in a period shorter than the duration of the transmitted burst. It may be necessary to extend the duration of the burst.

When measurements are made in discontinuous mode, the reported values can be average values. This averaging shall be made using a set of measurements, each of these measurements being made during a burst or a part of it.

4.6 Receiver category

The product family of ITS radio devices is divided into three receiver categories, see table 1b, each having a set of relevant receiver requirements and minimum performance criteria. The set of receiver requirements depends on the choice of receiver category by the equipment provider.

Manufacturers when designing their ITS receivers shall choose one of the three receiver categories according to the grade of operational reliability they provide, therefore the provider shall specify the receiver category of his choice and this shall be declared in the product literature provided to the user. In particular where an ITS device which may have to support road-safety related applications, manufacturers and users should pay particular attention to the potential for interference from other systems operating in the same or adjacent bands. Manufacturers should provide advice to users on the risks of potential interference and its consequences.

Table 1b: Receiver categories

Receiver category	Risk assessment of receiver performance
Enhanced 1	Medium reliable ITS communication media e.g. causing inconvenience to persons, which cannot simply be overcome by other means.
Minimum	Standard reliable ITS communication media e.g. inconvenience to persons, which can simply be overcome by other means.

The receiver category Enhanced 1 or Minimum shall be stated in both the test report and in the user's manual for the equipment.

4.6.1 General performance criteria

For the purpose of the receiver performance tests, the receiver shall produce an appropriate output under normal conditions after demodulation, a packet error rate of 10^{-1} (for packesize see clause 6.10.2).

Where the indicated performance cannot be achieved, the performance criteria used to determine the performance of the receiver shall be declared and published by the provider.

5 Test conditions, power sources and ambient temperatures

5.1 Normal and extreme test conditions

Testing shall be made under normal test conditions, and also, where stated, under extreme test conditions.

The test conditions and procedures shall be as specified in clauses 5.2 to 5.5.

5.2 Test power source

During testing the power source of the equipment shall be replaced by a test power source capable of producing normal and extreme test voltages as specified in clauses 5.3.2 and 5.4.2. The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of tests, the voltage of the power source shall be measured at the input terminals of the equipment.

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

During tests of DC powered equipment the power source voltages shall 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 will provide better measurement uncertainty values.

5.3 Normal test conditions

5.3.1 Normal temperature and humidity

The normal temperature and humidity conditions for tests shall 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, shall be added to the test report.

5.3.2 Normal test power source

5.3.2.1 Mains voltage

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall 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 shall be between 49 Hz and 51 Hz.

5.3.2.2 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 shall 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).

5.3.2.3 Other power sources

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

5.4 Extreme test conditions

5.4.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in clause 5.5, at the upper and lower temperatures:

- temperature: -30 °C to +70 °C.

The manufacturer can also declare which extreme conditions the equipment is intended to be installed in. In this case the upper temperature can be above +70 °C and the lower temperature can be below -30 °C as declared by the manufacturer.

5.4.2 Extreme test source voltages

5.4.2.1 Mains voltage

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

5.4.2.2 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 shall 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).

5.4.2.3 Power sources using other types of batteries

The lower extreme test voltages for equipment with power sources using batteries shall 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 is applicable, the corresponding four extreme test conditions are:

- V_{\min}/T_{\min} , V_{\min}/T_{\max} ;
- $(V_{\text{nominal}})/T_{\min}$, $(V_{\text{nominal}})/T_{\max}$.

5.4.2.4 Other power sources

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

5.5 Procedure for tests at extreme temperatures

Before measurements are made the equipment shall have reached thermal balance in the test chamber. The equipment shall 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 shall then meet the specified requirements. For such equipment the manufacturer shall 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, shall be allowed. The sequence of measurements shall be chosen, and the humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

5.5.1 Procedure for equipment designed for continuous transmission

If the manufacturer states that the equipment is designed for continuous transmission, the test procedure shall be as follows.

Before tests at the upper extreme temperature, the equipment shall be placed in the test chamber, and left until thermal balance is attained. The equipment shall then be switched on in the transmit condition for a period of half an hour, after which the equipment shall meet the specified requirements.

Before tests at the lower extreme temperature, the equipment shall 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 shall meet the specified requirements.

5.5.2 Procedure for equipment designed for intermittent transmission

If the manufacturer states that the equipment is designed for intermittent transmission, the test procedure shall be as follows.

Before tests at the upper extreme temperature, the equipment shall be placed in the test chamber, and left until thermal balance is attained. The equipment shall then be switched on for one minute in the transmit condition, followed by four minutes in the receive condition, after which the equipment shall meet the specified requirements.

For tests at the lower extreme temperature, the equipment shall 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 shall meet the specified requirements.

5.5.3 Testing of equipment that does not have an external 50 Ω RF connector (integral antenna equipment)

Where equipment has an internal 50 Ω connector it shall be permitted to perform the tests at this connector.

Equipment may also have a temporary internal 50 Ω connector installed for the purposes of testing.

No connection shall be made to any internal permanent or temporary antenna connector during the performance of radiated emissions measurements, unless such action forms an essential part of the normal intended operation of the equipment, as declared by the manufacturer.

6 Technical requirements specifications

6.1 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.

6.2 Carrier Frequencies

6.2.1 Definition

The ITS carrier frequencies are those identified by the European profile standard on the physical and medium access layer of 5 GHz ITS EN 302 663 V1.2.1 [3] as shown in tables 2a and 2b.

Table 2a: Frequency allocation in the European Union

Frequency range	Usage	Regulation
5 905 MHz to 5 925 MHz	Future ITS applications	ECC Decision [i.6]
5 875 MHz to 5 905 MHz	ITS road safety	ECC Decision [i.6] Commission Decision [i.13]
5 855 MHz to 5 875 MHz	ITS non-safety applications	ECC Recommendation [i.7]

The equipment is required to operate on the applicable specific carrier centre frequencies that correspond to the nominal carrier frequencies f_c defined in table 2b.

Table 2b: 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

6.2.2 Limits

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

6.2.3 Conformance

Conformance tests as defined in clause 7.3.2 shall be carried out.

6.3 RF Output Power, Transmit Power Control (TPC) and Power Spectral Density (PSD)

6.3.1 Definitions

6.3.1.1 RF output power

The RF output power is the total mean equivalent isotropically radiated power during a transmission burst.

6.3.1.2 Decentralized Congestion Control

Decentralized Congestion Control (DCC) is a mandatory mechanism to be used by the UUT to ensure that the radio channel is not congested by too many transmitters which can be heard within a certain geographical range. The mechanism is such that the UUT adapts its transmitter output power and transmission timing dynamically based on how occupied the channel is at the moment. The implementation shall be in accordance with TS 102 687 [4] for the access layer and shall comply to the testing procedures defined in TS 102 917-1 [7], TS 102 917-2 [8] and TS 102 917-3 [9].

6.3.1.3 Power Spectral Density

The Power Spectral Density (PSD) is the mean equivalent isotropically radiated power spectral density during a transmission burst.

6.3.2 Limits

6.3.2.1 Total RF output power and power spectral density at the highest power level

The total RF output power and the power spectral density when configured to operate at the highest stated power level of the TPC range shall not exceed the levels given in table 3.

Table 3: Limits for total RF output power and Power Spectral Density at the highest power level

Frequency range (MHz)	RF output power limit (e.i.r.p.) (dBm)	Power spectral density limit (e.i.r.p.) (dBm/MHz)
5 855 to 5 925	33 23 for G5-SCH2 and G5-SCH3 0 for G5-SCH4	23 13 for G5-SCH2 and G5-SCH3 -10 for G5-SCH4

6.3.2.2 Total RF output power and power spectral density at the lowest power level

The total RF output power and the power spectral density when configured to operate at the lowest stated power level of the TPC range shall not exceed the levels given in table 4.

Table 4: Limits for total RF output power and Power Spectral Density at the lowest power level

Frequency range (MHz)	RF output power limit (e.i.r.p.) (dBm)	Power Spectral Density limit (e.i.r.p.) (dBm/MHz)
5 855 to 5 925	-7	-17

6.3.3 Conformance

Conformance tests as defined in clause 7.3.3 shall be carried out.

6.4 Transmitter unwanted emissions

6.4.1 Transmitter unwanted emissions outside the 5 GHz ITS frequency bands

6.4.1.1 Definition

These are radio frequency emissions outside the 5 GHz ITS bands from 5 855 MHz to 5 925 MHz.

6.4.1.2 Limits

The power level of any spurious emission, occurring less than $2,5 \times$ wanted channel bandwidth from the centre of the channel on which the transmitter is intended to operate, shall not exceed the values given in table 6a.

The power level of any spurious emission, occurring $2,5 \times$ wanted channel bandwidth or more from the centre of the channel on which the transmitter is intended to operate, shall not exceed the values given in tables 5 and 6b.

Table 5: Transmitter unwanted emission limits below 1 GHz

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

Table 6a: Transmitter unwanted emission limits from 1 GHz to 18 GHz and outside the 5 GHz ITS frequency bands outside the frequency offsets specified in table 6b

Frequency range	Maximum power, (e.i.r.p.) (dBm)	Reference bandwidth
$1 \text{ GHz} \leq f < 5,795 \text{ GHz}$	-30	1 MHz
$5,795 \text{ GHz} \leq f < 5,815 \text{ GHz}$	-65	1 MHz
$5,815 \text{ GHz} \leq f < 5,850 \text{ GHz}$	-55	1 MHz
$5,850 \text{ GHz} \leq f < 5,855 \text{ GHz}$	-30	1 MHz
$5,925 \text{ GHz} \leq f < 5,965 \text{ GHz}$	-65	1 MHz
$5,965 \text{ GHz} \leq f \leq 18 \text{ GHz}$	-30	1 MHz

Table 6b: Reference bandwidths to be used close to the wanted emission for equipment

Frequency offset from carrier	RBW
less than 250 % of the channel bandwidth	1 kHz
20 MHz to less than 40 MHz	30 kHz
40 MHz to less than 60 MHz	300 kHz

Best measurement practice:

The resolution bandwidth of the measuring receiver should be equal to the reference bandwidth as given in the tables above. 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 emissions, normalization is not applicable, while integration over the reference bandwidth is still applicable.

6.4.1.3 Conformance

Conformance tests as defined in clause 7.3.4 shall be carried out.

6.4.2 Transmitter unwanted emissions within the 5 GHz ITS frequency bands

6.4.2.1 Definition

These are unwanted radio frequency emissions (e.i.r.p.) from the transmitter within the 5 GHz ITS bands at the highest power level of the equipment.

6.4.2.2 Limits

The mean levels of the transmitted spectrum within the 5 GHz ITS bands shall not exceed the limits given in table 7.

Table 7: Transmitter unwanted emission limits inside the 5 GHz ITS bands (e.i.r.p.) - 10 MHz channel bandwidth

Power Spectral Density at the carrier centre frequency f_c (dBm/MHz)	$\pm 4,5$ MHz Offset (dBm/MHz)	$\pm 5,0$ MHz Offset (dBm/MHz)	$\pm 5,5$ MHz Offset (dBm/MHz)	± 10 MHz Offset (dBm/MHz)	± 15 MHz Offset (dBm/MHz)
23	23	-3	-9	-17	-27
The limits are reduced by 10 dB for the G5-SCH2 and G5-SCH3 channels and by 33 dB for G5-SCH4.					

For unwanted emissions outside the frequency range from 5 855 MHz to 5 925 MHz the limits in clause 6.4.1.2, tables 5, 6a and 6b apply.

6.4.2.3 Conformance

Conformance tests as defined in clause 7.3.5 shall be carried out.

6.5 Receiver spurious emissions

6.5.1 Definition

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

6.5.2 Limits

The spurious emissions of the receiver shall not exceed the limits given in table 8.

Table 8: Spurious radiated emission limits

Frequency range	Maximum power	Measurement bandwidth
$30 \text{ MHz} \leq f < 1 \text{ GHz}$	-57 dBm (e.i.r.p.)	100 kHz
$1 \text{ GHz} \leq f \leq 18 \text{ GHz}$	-47 dBm (e.i.r.p.)	1 MHz

6.5.3 Conformance

Conformance tests as defined in clause 7.3.6 shall be carried out.

6.6 Listen Before Talk threshold

6.6.1 Definitions

The LBT threshold is defined as the received signal level above which the equipment can determine that the channel is not available for use. If the received signal is below the LBT threshold then the equipment can determine that the channel is available for use.

This requirement applies only to equipment operating in the frequency range from 5 855 MHz to 5 875 MHz.

6.6.2 Limits

The maximum LBT threshold for the receiver is given in table 9.

Table 9: LBT threshold values

ITS Power Spectral Density (dBm/MHz)	LBT threshold value (see notes 1 and 2)
23	-85 dBm
NOTE 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna. NOTE 2: For ITS frames transmitted at a lower e.i.r.p. spectral density and/or with a different receive antenna gain G (dBi), the LBT threshold for this frame follows the following relationship: LBT Detection Threshold (dBm) = -85 + 23 – ITS e.i.r.p. Spectral Density (dBm/MHz) + G (dBi). See table 10 for example calculations.	

Table 10: Example interference threshold values

Maximum e.i.r.p. (dBm)	Channel Width (MHz)	ITS Spectral Density (dBm/MHz)	LBT Threshold (dBm), for receive antenna gain G (dBi) = 5	LBT Threshold (dBm), for receive antenna gain G (dBi) = 8
33	10	23	-80	-77
30	10	20	-77	-74
27	10	17	-74	-71

6.6.3 Conformance

Conformance tests as defined in clause 7.3.7 shall be carried out.

6.7 Receiver blocking or desensitization

6.7.1 Definition

Blocking is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted input signal at any frequencies other than those of the spurious responses or the adjacent channels or bands.

This requirement applies only to equipment operating in the frequency range from 5 855 MHz to 5 875 MHz.

6.7.2 Limits

The absolute blocking level into the receiver shall not be less than -35 dBm for a wanted signal level for generator A (see clause 7.3.8.2) of +16 dB above the LBT threshold.

6.7.3 Conformance

Conformance tests as defined in clause 7.3.8 shall be carried out.

6.8 Receiver adjacent channel rejection

6.8.1 Definition

The adjacent channel rejection is a measure of the capability of the receiver to operate satisfactorily in the presence of an ITS signal in the adjacent channel, which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

The receiver saturation is a measure of the capability of the receiver to operate as intended in the presence of a strong signal in the wanted channel together with a strong signal in the adjacent channel, which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

6.8.2 Limits

The receiver adjacent channel rejection under specified conditions shall be equal to or greater than the limits in table 10a.

Table 10a: Limit for receiver adjacent channel rejection at BPSK rate $\frac{1}{2}$

Center frequency (MHz)	Adjacent channel rejection (dB)	Alternate adjacent channel rejection (dB)
5 860	28 (Enhance 1) 16 (Minimum)	42 (Enhanced 1) 32 (Minimum)
5 870	28 (Enhance 1) 16 (Minimum)	42 (Enhanced 1) 32 (Minimum)
5 880	28 (Enhance 1) 16 (Minimum)	42 (Enhanced 1) 32 (Minimum)
5 890	28 (Enhance 1) 16 (Minimum)	42 (Enhanced 1) 32 (Minimum)
5 900	28 (Enhance 1) 16 (Minimum)	42 (Enhanced 1) 32 (Minimum)
5 910	28 (Enhance 1) 16 (Minimum)	42 (Enhanced 1) 32 (Minimum)
5 920	28 (Enhance 1) 16 (Minimum)	42 (Enhanced 1) 32 (Minimum)

6.8.3 Conformance

Conformance tests as defined in clause 7.3.9 shall be carried out.

6.9 Transient power

6.9.1 Definition

Transient power is the power falling into adjacent spectrum due to switching the transmitter on and off during normal operation.

6.9.2 Limits

At all frequencies where the emission levels measured in step 1 exceed the spurious domain limits, the power level measured in step 1 shall not exceed the power level measured in step 2 by more than 3 dB.

6.9.3 Conformance

Conformance tests as defined in clause 7.3.10 shall be carried out.

6.10 Receiver sensitivity

6.10.1 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).

6.10.2 Limits

The receiver sensitivity is specified in EN 302 663 [3] and shall be less or equal to the values given in table 10b for a packet error rate of 10 % for 1 000 octet frames.

Table 10b: Receiver sensitivity

Modulation	Coding rate	Minimum sensitivity (dBm) (10 MHz channel spacing)
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

6.10.3 Conformance

Conformance tests as defined in clause 7.3.11 shall be carried out.

6.11 CEN DSRC protection

6.11.1 Definition

To ensure coexistence the ITS-G5 equipment shall not interfere with CEN DSRC equipment. This shall be achieved by implementing at least one of the coexistence methods specified in TS 102 792 [6]. Other mitigation techniques compatible with the methods specified in TS 102 792 [6] providing an equivalent or better protection shall be allowed.

6.11.2 Limits

The ITS-G5 equipment shall not exceed the limits given in TS 102 792 [6].

6.11.3 Conformance

The ITS-G5 equipment shall be conform to TS 102 792 [6].

7 Testing for compliance with technical requirements

7.1 Conditions for testing

7.1.1 Normal and extreme test conditions

Tests defined in the present document shall be carried out under normal test conditions and where stated, under the extreme test conditions as declared by the manufacturer.

7.1.2 Test modulation

The test modulation used should be representative of normal use of the equipment. Where the equipment is not capable of continuous RF transmission, the test modulation shall be such that:

- the generated RF signal is the same frame structure with random data for each transmission;
- transmissions occur regularly in time;
- sequences of transmissions can be repeated accurately.

The same test modulation shall be used for all measurements on the same equipment. For transmitters that have multi-modulation schemes incorporated, the manufacturer shall declare the modulation scheme to be used for the tests.

The test transmissions shall be fixed in length in a sequence and shall exceed the transmitter minimum activity ratio of 10 %. The minimum duration of the sequence shall be adequate for the test purposes.

Implemented transmitter timeout functionality shall be disabled for the sequence of the test suite.

7.1.3 Presentation of equipment

Each equipment submitted for testing, where applicable, shall fulfil the requirements of the present document on all of the nominal carrier frequencies as shown in table 2b over which it is intended to operate.

The provider shall provide one or more samples of the equipment, as appropriate for testing.

Additionally, technical documentation and operating manuals, sufficient to allow testing to be performed, shall be supplied.

The performance of the equipment submitted for testing shall be representative of the performance of the corresponding production model.

Equipment shall be offered by the provider complete with any ancillary equipment needed for testing. The provider shall declare the frequency range(s), the range of operation conditions and power requirements, as applicable, in order to establish the appropriate test conditions.

7.2 Interpretation of the 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 lower than the figures in table 11.

For the test methods to determine RF power levels, according to the present document, the measurement uncertainty figures shall be calculated in accordance with TR 100 028-1 [1] and TR 100 028-2 [1] 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)).

Table 11 is based on such expansion factors.

Table 11: Maximum measurement uncertainty

Parameter	Uncertainty
RF frequency	$\pm 1 \times 10^{-5}$
RF power conducted	$\pm 1,5$ dB
RF power radiated	± 6 dB
Humidity	± 5 %
Temperature	± 1 °C

7.3 Essential radio test suites

7.3.1 Product information

The following information is necessary in order to carry out the test suites:

- 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 car or RSU);
- the test modulation used in detail.

7.3.2 Carrier Frequencies

7.3.2.1 Test conditions

These measurements shall be performed under both normal and extreme test conditions.

For a UUT with antenna connector(s) and using dedicated external antenna(s), or for a UUT with integral antenna(s) but with a temporary antenna connector provided, conducted measurements shall be used.

For a UUT with integral antenna(s) and without a temporary antenna connector, radiated measurements shall be used.

7.3.2.2 Test methods

7.3.2.2.1 Conducted measurement

This method is used with the UUT in operation in an modulated mode.

The UUT shall be connected to the spectrum analyser.

The settings of the spectrum analyser shall be adjusted to optimize the instruments frequency accuracy.

Max Hold shall be selected and the centre frequency adjusted to that of the UUT.

The peak value of the power envelope shall be measured and recorded. The span shall be reduced and the marker moved in a positive frequency increment until the upper, (relative to the centre frequency), -10 dBc point is reached. This value shall be noted as f1.

The marker shall then be moved in a negative frequency increment until the lower, (relative to the centre frequency), -10 dBc point is reached. This value shall be noted as f2.

The centre frequency is calculated as $(f1 + f2) / 2$.

7.3.2.2.2 Radiated measurement

The test set up as described in annex B shall be used with a spectrum analyser of sufficient accuracy attached to the test antenna.

The test procedure is as described under clause 7.3.2.2.1.

7.3.3 RF Output Power, Transmit Power Control (TPC) and Power Spectral Density (PSD)

7.3.3.1 Test conditions

These measurements shall be performed under both normal and extreme test conditions.

For a UUT with antenna connector(s) and using dedicated external antenna(s), or for a UUT with integral antenna(s) but with a temporary antenna connector provided, conducted measurements shall be used.

For a UUT with integral antenna(s) and without a temporary antenna connector, radiated measurements shall be used.

7.3.3.2 Test method

7.3.3.2.1 Conducted measurement

7.3.3.2.1.1 RF output power at the highest power level

The UUT shall be configured to operate at the highest stated transmitter output power level of the TPC range.

Step 1:

- a) using suitable attenuators, the output power of the transmitter shall be coupled to a matched diode detector or equivalent thereof. The output of the diode detector shall be connected to the vertical channel of an oscilloscope;
- b) the combination of the diode detector and the oscilloscope shall be capable of faithfully reproducing the duty cycle of the transmitter output signal;
- c) the observed duty cycle of the transmitter (Tx on/(Tx on + Tx off)) shall be noted as x ($0 < x \leq 1$), and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal to or greater than 0,1.

Step 2:

- a) the RF output power of the transmitter when operating at the highest power level shall be determined using a wideband calibrated RF power meter with a matched thermocouple detector or an equivalent thereof and with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be noted as "A" (in dBm);
- b) the e.i.r.p. shall be calculated from the above measured power output A (in dBm), the observed duty cycle x , and the stated antenna gain "G" in dBi, according to the formula in c). If more than one antenna assembly is intended for this power setting or TPC range, the gain of the antenna assembly with the highest gain shall be used;
- c) $P_H = A + G + 10 \log (1/x)$ (dBm);

- d) P_H shall be recorded in the test report.

7.3.3.2.1.2 RF output power at the lowest power level

The UUT shall be configured to operate at the lowest stated transmitter output power level of the TPC range.

Step 1:

- a) using suitable attenuators, the output power of the transmitter shall be coupled to a matched diode detector or equivalent thereof. The output of the diode detector shall be connected to the vertical channel of an oscilloscope;
- b) the combination of the diode detector and the oscilloscope shall be capable of faithfully reproducing the duty cycle of the transmitter output signal;
- c) the observed duty cycle of the transmitter (Tx on/(Tx on + Tx off)) shall be noted as x ($0 < x \leq 1$), and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal to or greater than 0,1.

Step 2:

- a) the RF output power of the transmitter when operating at the lowest power level of the TPC range shall be determined using a wideband calibrated RF power meter with a matched thermocouple detector or an equivalent thereof and with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be noted as "A" (in dBm);
- b) the e.i.r.p. shall be calculated from the above measured power output A (in dBm), the observed duty cycle x , and the stated antenna gain "G" in dBi, according to the formula in c). If more than one antenna assembly is intended for this TPC range, the gain of the antenna assembly with the highest gain shall be used;
- c) $P_L = A + G + 10 \log (1/x)$ (dBm);
- d) P_L shall be recorded in the test report.

7.3.3.2.1.3 Power Spectral Density

The UUT shall be operated as described in clause 7.3.3.2.1.1. Furthermore, for the purpose of this test, the minimum transmitter on-time shall be 10 μ s.

The transmitter shall be connected to the measuring equipment via a suitable attenuator and the power spectral density as defined shall be measured and recorded.

The power spectral density shall be determined using a spectrum analyser of adequate bandwidth in combination with an RF power meter.

Connect an RF power meter to the narrow IF output of the spectrum analyser and correct its reading using a known reference source, e.g. a signal generator.

NOTE: The IF output of the spectrum analyser may be 20 dB or more below the input level of the spectrum analyser. Unless the power meter has adequate sensitivity, a wideband amplifier may be required.

The test procedure shall be as follows:

Step 1:

- a) the measurement set-up shall be calibrated with a CW signal from a calibrated source; the reference signal shall be set to a level equal to the value for the applicable limit for e.i.r.p. spectral density (reduced by the highest applicable antenna gain) and at a frequency equal to the centre frequency of the channel being tested;
- b) the settings of the spectrum analyser shall be:
 - centre Frequency: equal to the signal source;
 - resolution BW: 1 MHz;

- video BW: 1 MHz;
- detector mode: positive peak;
- averaging: off;
- span: zero Hz;
- reference level: equal to the level of the reference signal.

Step 2:

- a) the calibrating signal power shall be reduced by 10 dB and it shall be verified that the power meter reading also reduces by 10 dB.

Step 3:

- a) connect the UUT. Using the following settings of the spectrum analyser in combination with "max hold" function, find the frequency of highest power output in the power envelope:
 - centre Frequency: equal to operating frequency;
 - resolution BW: no change to the setting in step 1;
 - video BW: no change to the setting in step 1;
 - detector mode: no change to the setting in step 1;
 - averaging: no change to the setting in step 1;
 - span: 1,5 times the spectrum width;
 - reference level: no change to the setting in step 1;
- b) the frequency found shall be recorded;
- c) the centre frequency of the spectrum analyser shall be set to the recorded frequency, the span shall be further reduced to 1 MHz and the frequency of the highest power output shall be found. If this frequency is different from the previous recorded frequency, the new frequency shall be recorded.

Step 4:

- a) set the centre frequency of the spectrum analyser to the found frequency and switch to zero span. The power meter indicates the measured power density (D). The mean power density e.i.r.p. is calculated from the above measured power density (D), the observed duty cycle x (see clause 7.3.3.2.1.1 step 1), 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 or TPC range, the gain of the antenna assembly with the highest gain shall be used:
 - $PD = D + G + 10 \log (1/x)$;
 - PD shall be recorded in the test report.

The above procedure shall be repeated for each of the frequencies declared by the provider.

Where the spectrum analyser bandwidth is non-Gaussian, a suitable correction factor shall be determined and applied.

Where a spectrum analyser is equipped with a facility to measure power density, this facility may be used instead of the above procedure to measure the power density across the occupied channel bandwidth.

7.3.3.2.2 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 7.3.3.2.1.

7.3.4 Transmitter unwanted emissions outside the 5 GHz ITS bands

7.3.4.1 Test conditions

The measurements shall be performed under normal test conditions. The UUT shall be configured to operate at the highest stated power level.

For UUT without an integral antenna and for a UUT 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 equipment 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 UUT has an integral antenna, but no temporary antenna connector, only radiated measurements shall be used.

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.

7.3.4.2 Test method

7.3.4.2.1 Conducted measurement

The UUT shall be connected to a spectrum analyser capable of RF power measurements. The test procedure shall be as follows:

- a) the settings of the spectrum analyser shall be as follows:
 - sensitivity: at least 6 dB below the limits given in tables 5 and 6a;
 - as a general rule, the resolution bandwidth of the measuring receiver should be equal to the reference bandwidth as given in clause 6.4.1.2 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 shall be sufficiently narrow to reject emissions in any contiguous channels centred on the channel on which the transmitter is intended to operate;
 - video bandwidth: not less than the resolution bandwidth;
 - video averaging on, or peak hold;

The video signal of the spectrum analyser shall be "gated" such that the spectrum measured shall be measured between 4,0 μ s before the start of the burst to 4,0 μ s after the end of the burst.

NOTE: 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.

This gating may be analogue or numerical, dependent upon the design of the spectrum analyser:

- b) initially the power level shall be measured in the ranges:
 - 30 MHz to 1 000 MHz;with a resolution bandwidth of 1 MHz and in a frequency scan mode;

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

EXAMPLE: A UUT 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.

- d) the power level shall be measured in the ranges:

- 1 GHz to 5,795 GHz;
 - 5,965 GHz to 18 GHz;
- in a frequency scan mode;

- e) the power level shall be measured in the range:

- 5,795 GHz to 5,855 GHz;
- 5,925 GHz to 5,965 GHz;
- and with zero frequency span.

7.3.4.2.2 Radiated measurement

The test set up as described in annex B shall be used with a spectrum analyser of sufficient accuracy attached to the test antenna.

The test procedure is as described under clause 7.3.4.2.1.

7.3.5 Transmitter unwanted emissions within the 5 GHz ITS bands

7.3.5.1 Test conditions

The measurements shall be performed under normal test conditions. The UUT shall be configured to operate at the highest stated power level.

For UUT without an integral antenna and for a UUT 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 equipment 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 UUT has an integral antenna, but no temporary antenna connector, only radiated measurements shall be used.

7.3.5.2 Test method

7.3.5.2.1 Conducted measurement

The settings of the spectrum analyser shall be as follows:

- resolution bandwidth: 1 MHz;
- video bandwidth: 30 kHz;
- video averaging on.

The video signal of the spectrum analyser shall be "gated" such that the spectrum measured shall be measured between 4,0 μ s before the start of the burst to 4,0 μ s after the end of the burst.

NOTE: 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.

This gating may be analogue or numerical, dependent upon the design of the spectrum analyser.

Determination of the reference average power level:

The spectrum analyser shall be tuned to measurement frequencies at every 1 MHz interval within $f_c - 4$ MHz to $f_c + 4$ MHz, with zero frequency scan. The maximum average power within $f_c - 4$ MHz to $f_c + 4$ MHz (except f_c) is the reference level for relative power measurements on the channel centred at f_c and shall be recorded to compute relative power levels as described below.

Determination of the relative average power levels:

The power level shall be measured in the range from 5 855 MHz to 5 925 MHz excluding the interval $f_c - 4$ MHz to $f_c + 4$ MHz with a resolution bandwidth of 1 MHz and in a frequency scan mode. The average value of power relative to the reference average power level for the channel shall be recorded.

7.3.5.2.2 Radiated measurement

The test set up as described in annex B shall be used with a spectrum analyser of sufficient accuracy attached to the test antenna.

The test procedure is as described under clause 7.3.5.2.1.

7.3.6 Receiver spurious emissions

7.3.6.1 Test conditions

The measurement shall be performed under normal test conditions.

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

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

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

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.

7.3.6.2 Test method

7.3.6.2.1 Conducted measurement

Using a directional coupler, circulator or gating to remove the test transmissions (and/or other means to isolate the emissions measurements instrument from the test data signals transmitted) the radio emissions from the UUT shall be measured while the UUT receives test data.

The settings of the spectrum analyser shall be as follows:

- frequency scan allowed;

- resolution bandwidth: 1 MHz or 100 kHz;
- video bandwidth: 1 MHz;
- video averaging on, or peak hold.

Tuning the spectrum analyser centre frequency over the measurement frequency bands specified in table 8, the power level of UUT receiver emissions shall be measured during test transmissions. If gating is used to remove the unwanted energy from the test data transmissions, the tuning of the spectrum analyser shall not change during the gated-out time interval.

7.3.6.2.2 Radiated measurement

The test set up as described in annex B shall be used with a spectrum analyser of sufficient accuracy attached to the test antenna.

The test procedure is as described under clause 7.3.5.2.1.

7.3.7 Receiver LBT threshold

7.3.7.1 Test conditions

This measurement shall be conducted under normal conditions.

7.3.7.2 Test method

A signal generator and a power meter are each combined via appropriate attenuators into the equipment antenna connector. The test set-up in figure 1 shall be used for conducted measurements.

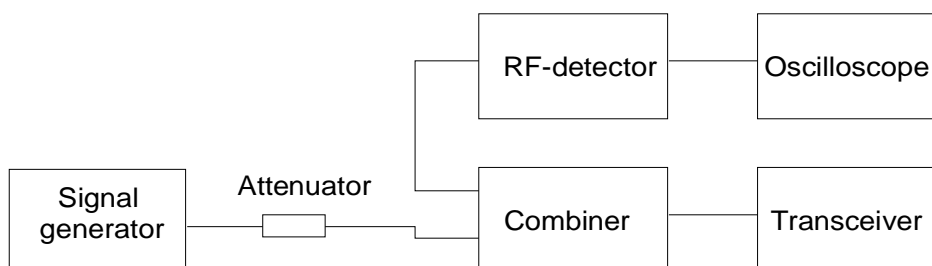


Figure 1: Conducted measurement arrangement

For equipment with integral antenna the connection to the equipment can be made to a temporary 50 Ω antenna connector.

In addition:

- the LBT function of the transceiver shall be active;
- the attenuator shall provide sufficient attenuation to protect the signal generator from burn-out by the transmitter of the transceiver;
- the signal generator with normal test modulation shall be adjusted to the receiving frequency. The level shall be increased to approximately 20 dB above the receiver sensitivity;
- the equipment shall be switched to an intended transmit mode;

NOTE: The equipment is not transmitting because the transceiver recognizes a busy channel from the signal generator.

- the level of the signal generator shall be reduced in steps of 1 dB until the equipment starts to transmit. This specific signal generator level present at the receiver input of the transceiver is the LBT threshold;

The level of the received LBT threshold shall be recorded in the test report.

f) the steps c) and e) shall be repeated over all carrier frequencies.

The limit for total listen time for the receiver for the LBT check shall not exceed 8 μ s in a 10 MHz channel and 4 μ s in a 20 MHz channel. This shall be declared by the provider and recorded in the test report.

Alternatively, equipment having a dedicated or integral antenna may use a radiated measurement setup. For this, a test site from annex B shall be selected and the requirements from annexes B and C apply.

Signal generators A and B together with a combiner shall be placed outside the anechoic chamber and a TX test antenna shall be placed with the EUT's antenna polarisation. The EUT shall be placed at the location of the turntable at the orientation of the most sensitive position.

The procedure shall be the same as for the conducted measurement.

7.3.8 Receiver blocking or desensitization

7.3.8.1 Test conditions

This measurement shall be conducted under normal conditions.

7.3.8.2 Test method

The test set-up in figure 2 shall be used for performing conducted measurements.

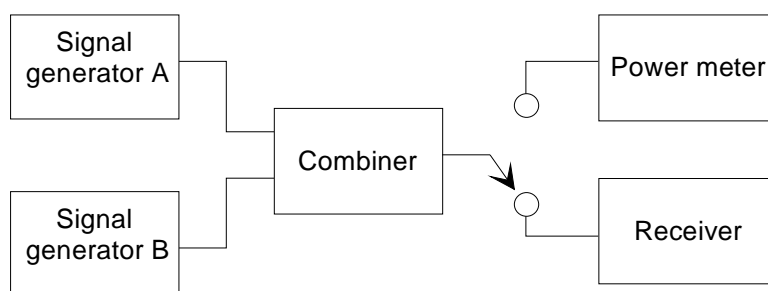


Figure 2: Conducted measurement arrangement

Two signal generators A and B shall be connected to the receiver via a combining network to the receiver antenna connector. For equipment with integral antenna the connection to the equipment can be made to a temporary 50 Ω antenna connector for performing a conducted measurement.

Signal generator A shall be at the carrier frequency of the receiver, with normal modulation of the wanted signal. Signal generator B shall be unmodulated and shall be adjusted to a test frequencies of approximately +10 MHz relative to the carrier frequency of the receiver. Initially signal generator B shall be switched off and using signal generator A at a level adjusted +16 dB above the LBT threshold.

Signal generator B is then switched on and adjusted until the wanted criteria, i.e. after demodulation, a message acceptance ratio of 90 % is just exceeded.

With signal generator B settings unchanged the power into the receiver is measured by replacing the receiver with a power meter. This level shall be recorded.

The tests shall be repeated with the frequency of signal generator B at approximately -10 MHz from the carrier frequency of the receiver.

Alternatively, equipment having a dedicated or integral antenna may use a radiated measurement setup. For this, a test site from annex B shall be selected and the requirements from annexes B and C apply.

Signal generators A and B together with a combiner shall be placed outside the anechoic chamber and a TX test antenna shall be placed with the EUT's antenna polarisation. The EUT shall be placed at the location of the turntable at the orientation of the most sensitive position.

The procedure shall be the same as for the conducted measurement.

7.3.9 Receiver adjacent channel rejection

7.3.9.1 Test conditions

This measurement shall be conducted under normal conditions.

7.3.9.2 Test method

The following test set-up shall be used for conducted measurements.

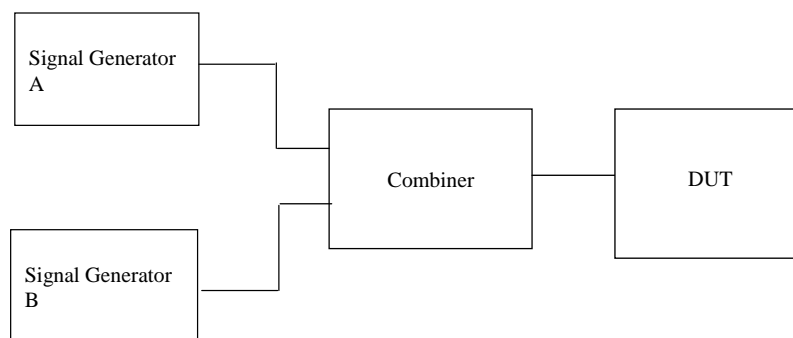


Figure 3: Conducted measurement arrangement

For this test the adjacent channel rejection is performed for a specific reception rate. This inherently defines the FEC for the specific rate. The values specified in table 10a are for BPSK rate $\frac{1}{2}$. This rate shall be used for the tests under this clause.

Two signal generators A and B shall be connected to the receiver via a combining network to the receiver antenna connector.

For equipment with integral antenna the connection to the equipment is made either to a temporary antenna connector, or alternatively, a radiated measurement may be performed.

Signal generator A shall be at the nominal frequency of the receiver, with normal test modulation of the wanted signal. Signal generator B shall be also with normal test modulation and shall be adjusted to the adjacent channel center frequency immediately above the wanted channel as shown in figure 4.i.e. at a 10 MHz frequency offset.

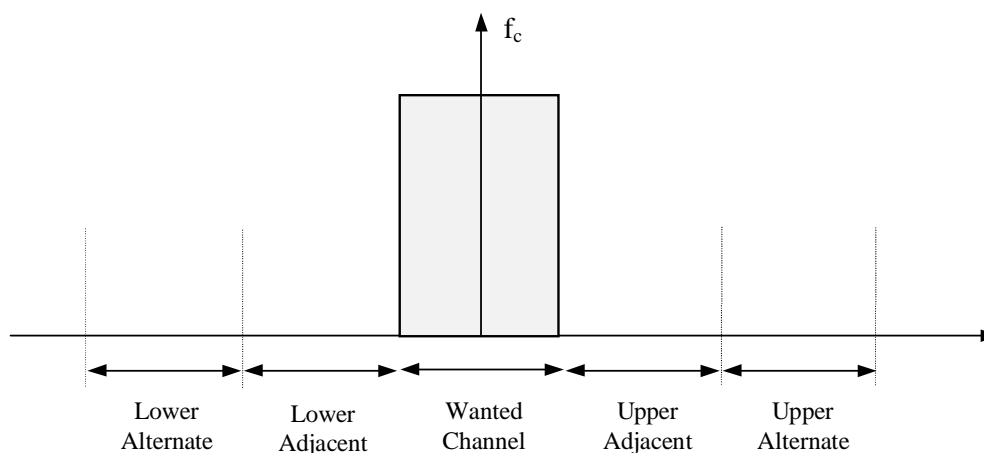


Figure 4: Adjacent and alternate adjacent channel definitions

Initially signal generator B shall be switched off and using signal generator A the level which still gives sufficient response shall be established, however, the level at the receiver input shall not be below the sensitivity limit of -85 dBm. The output level of generator A shall then be increased by 3 dB.

Signal generator B is then switched on and the signal amplitude is adjusted until the wanted performance criteria is just exceeded, i.e. the level of the input signal to the receiver is adjusted until the bit error ratio is 10^{-2} or greater.

With signal generator B settings unchanged the power into the receiver is measured by replacing the receiver with a power meter or a spectrum analyzer. This power level shall be recorded.

The measurements shall be repeated immediately below the wanted channel for the lower adjacent channel at 10 MHz frequency offset and then for the alternate adjacent channels at 20 MHz frequency offset.

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

For radiated measurement signal generators A and B together with a combiner shall be placed outside the anechoic chamber and a TX test antenna shall be placed with the EUT's antenna polarisation. The EUT shall be placed at the location of the turntable at the orientation of the most sensitive position.

Receiver adjacent channel rejection is the difference between signal generator B and signal generator A levels.

7.3.10 Void

Figure 5: Void

7.3.11 Receiver sensitivity

7.3.11.1 Test conditions

The measurement shall be performed under normal test conditions.

For a UUT without an integral antenna and for a UUT with an integral antenna but with a temporary antenna connector, conducted or radiated measurements shall be used.

For a UUT with an integral antenna radiated measurements shall be used.

7.3.11.2 Test method

7.3.11.2.1 Conducted measurement

The proposed test setup is shown in figure 6. An ITS-G5 transmitter with fixed output power level is used as signal generator. The instantaneous output power level is monitored with an RF-detector. The receive power level is adjusted with a step attenuator.

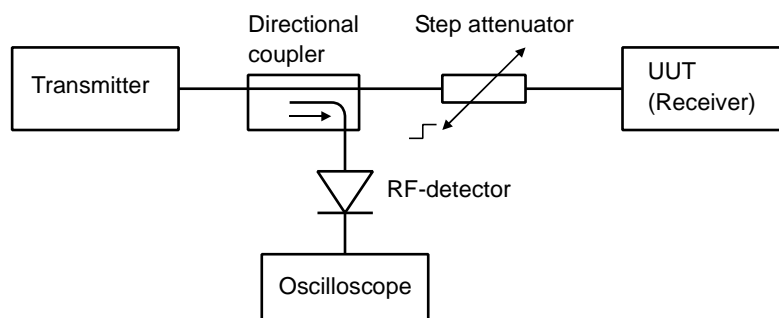


Figure 6: Proposal for a conducted sensitivity measurement setup

The transmitter shall use a frame size of 1 000 octets. The packet error rate PER is calculated from the number of sent packets Pkt_{Tx} and the number of correctly received packets Pkt_{Rx} as shown in (1).

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

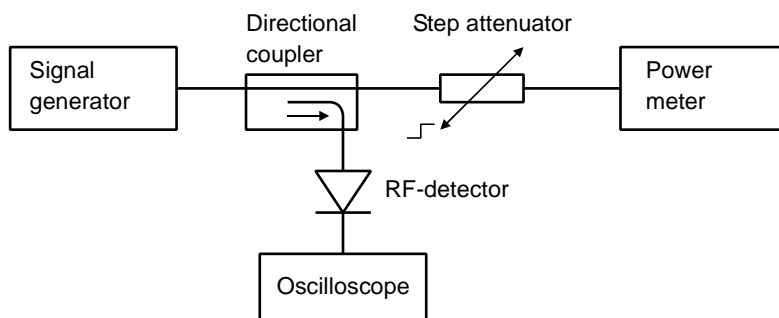


Figure 7: Proposal for a substitution setup for conducted sensitivity measurement setup

The test setup shall be calibrated with a substitution measurement equivalent to the one shown in figure 7.

The sensitivity measurement shall be performed by reducing the step attenuator value until the PER gets better than 10 %.

At least 1 000 frames shall be used for evaluating the PER.

7.3.11.2.2 Radiated measurement

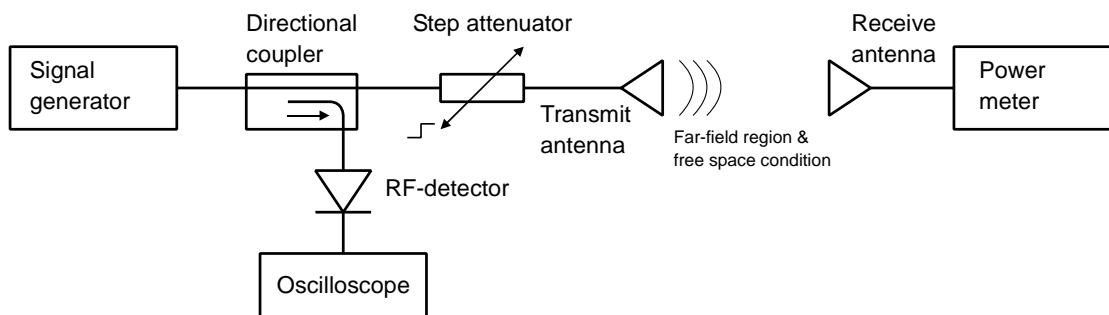


Figure 8: Proposal for a substitution setup for radiated sensitivity measurements

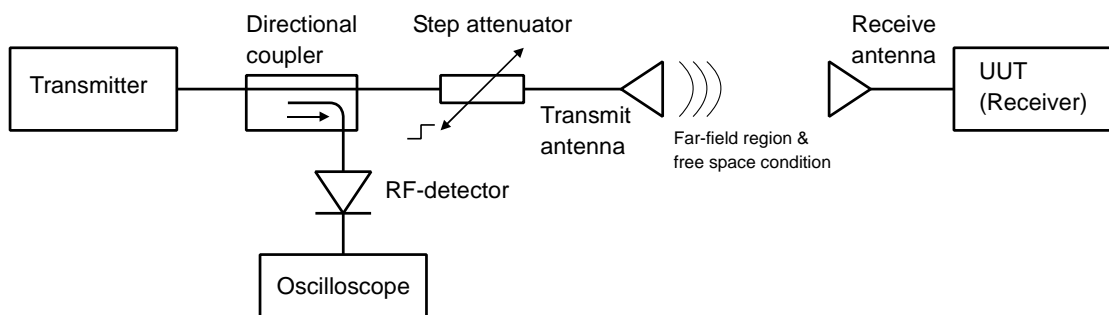


Figure 9: Proposed setup for radiated sensitivity measurements

The test setup for radiated measurement of the receiver sensitivity is similar to the conducted measurement, as can be seen in figure 9. The calibration of the test setup shall be done by a substitution measurement equivalent to figure 8.

The test procedure shall be the same as for conducted measurements as described in clause 7.3.6.2.1.

7.3.12 CEN DSRC protection

7.3.12.1 Test conditions

The test shall be performed under normal conditions.

7.3.12.2 Test method

The equipment supplier shall declare which coexistence methods are implemented. The DCR method shall be tested by monitoring the ITS-G5 output power level with a time resolution of 100 μ s and a power level accuracy of ± 1 dB under different simulated ITS-G5 station densities. Muting, power regulation, and any combination of DCR with them shall be tested by emulation.

Annex A (normative): HS Requirements and conformance Test specifications Table (HS-RTT)

The HS Requirements and conformance Test specifications Table (HS-RTT) in table A.1 serves a number of purposes, as follows:

- it provides a statement of all the requirements in words and by cross reference to (a) specific clause(s) in the present document or to (a) specific clause(s) in (a) specific referenced document(s);
- it provides a statement of all the test procedures corresponding to those requirements by cross reference to (a) specific clause(s) in the present document or to (a) specific clause(s) in (a) specific referenced document(s);
- it qualifies each requirement to be either:
 - Unconditional: meaning that the requirement applies in all circumstances; or
 - Conditional: meaning that the requirement is dependant on the manufacturer having chosen to support optional functionality defined within the schedule.
- in the case of Conditional requirements, it associates the requirement with the particular optional service or functionality;
- it qualifies each test procedure to be either:
 - Essential: meaning that it is included with the Essential Radio Test Suite and therefore the requirement shall be demonstrated to be met in accordance with the referenced procedures;
 - Other: meaning that the test procedure is illustrative but other means of demonstrating compliance with the requirement are permitted.

Table A.1: HS Requirements and conformance Test specifications Table (HS-RTT)

Harmonized Standard EN 302 571						
The following requirements and test specifications are relevant to the presumption of conformity under the article 3.2 of the R&TTE Directive [i.2]						
Requirement			Requirement Conditionality		Test Specification	
No	Description	Reference: Clause No	U/C	Condition	E/O	Reference: Clause No
1	Carrier Frequencies	6.2	U		E	7.3.2
2	RF output power, Transmit Power Control (TPC) and Power Spectral Density (PSD)	6.3	U		E	7.3.3
3	Transmitter unwanted emissions outside the 5 GHz ITS frequency bands	6.4.1	U		E	7.3.4
4	Transmitter unwanted emissions within the 5 GHz ITS frequency bands	6.4.2	U		E	7.3.5
5	Receiver spurious emissions	6.5	U		E	7.3.6
6	Listen Before Talk threshold	6.6	C	Applies only for equipment operating in the frequency range from 5 855 MHz to 5 875 MHz	E	7.3.7
7	Receiver blocking or desensitization	6.7	C	Applies only for equipment operating in the frequency range from 5 855 MHz to 5 875 MHz	E	7.3.8
8	Receiver adjacent channel rejection	6.8	U		E	7.3.9

Harmonized Standard EN 302 571						
The following requirements and test specifications are relevant to the presumption of conformity under the article 3.2 of the R&TTE Directive [i.2]						
Requirement			Requirement Conditionality		Test Specification	
No	Description	Reference: Clause No	U/C	Condition	E/O	Reference: Clause No
9	Transient Power	6.9	U		E	7.3.10
10	Receiver sensitivity	6.10	U		E	7.3.11
11	CEN DSRC protection	6.11	U		E	7.3.12

Key to columns:**Requirement:**

No A unique identifier for one row of the table which may be used to identify a requirement or its test specification.

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 is to 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 technical requirement which is classified "conditional".

Test Specification:

E/O Indicates whether the test specification forms part of the Essential Radio Test Suite (E) or whether it is one of the Other Test Suite (O).

NOTE: All tests whether "E" or "O" are relevant to the requirements. Rows designated "E" collectively make up the Essential Radio Test Suite; those designated "O" make up the Other Test Suite; for those designated "X" there is no test specified corresponding to the requirement. The completion of all tests classified "E" as specified with satisfactory outcomes is a necessary condition for a presumption of conformity. Compliance with requirements associated with tests classified "O" is a necessary condition for presumption of conformity, although conformance with the requirement may be claimed by an equivalent test or by manufacturer's assertion supported by appropriate entries in the technical construction file.

Clause Number Identification of clause(s) defining the test specification in the present document unless another document is referenced explicitly. Where no test is specified (that is, where the previous field is "X") this field remains blank.

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.

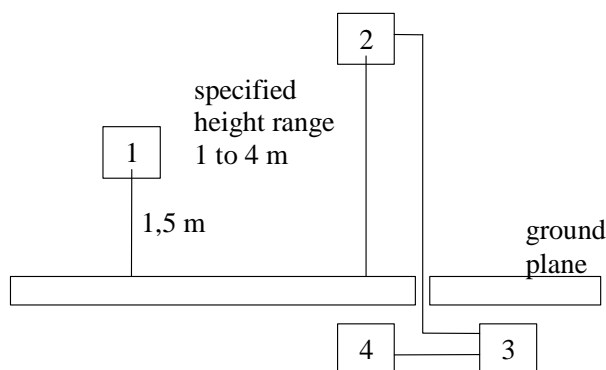
An open air test site may be used to perform the measurements using the radiated measurement methods described in clause 5. Absolute or relative measurements may be performed on transmitters or on receivers; absolute measurements of field strength require a calibration of the test site. Above 1 GHz, 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 equipment size (excluding the antenna) shall be less than 20 % of the measuring distance. The height of the equipment 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 [2];
- 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: Equipment 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, equipment under test 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 pyramidically formed 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 x 8 m x 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.

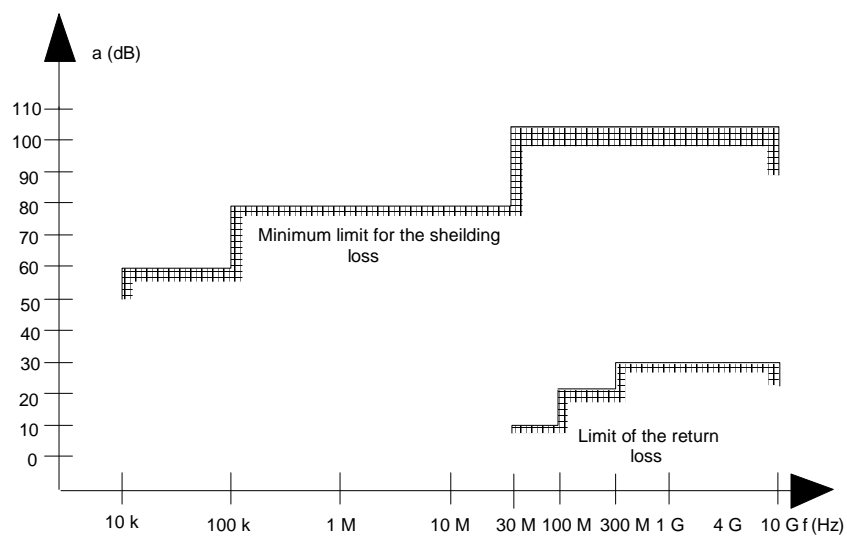


Figure B.2: Specification for shielding and reflections

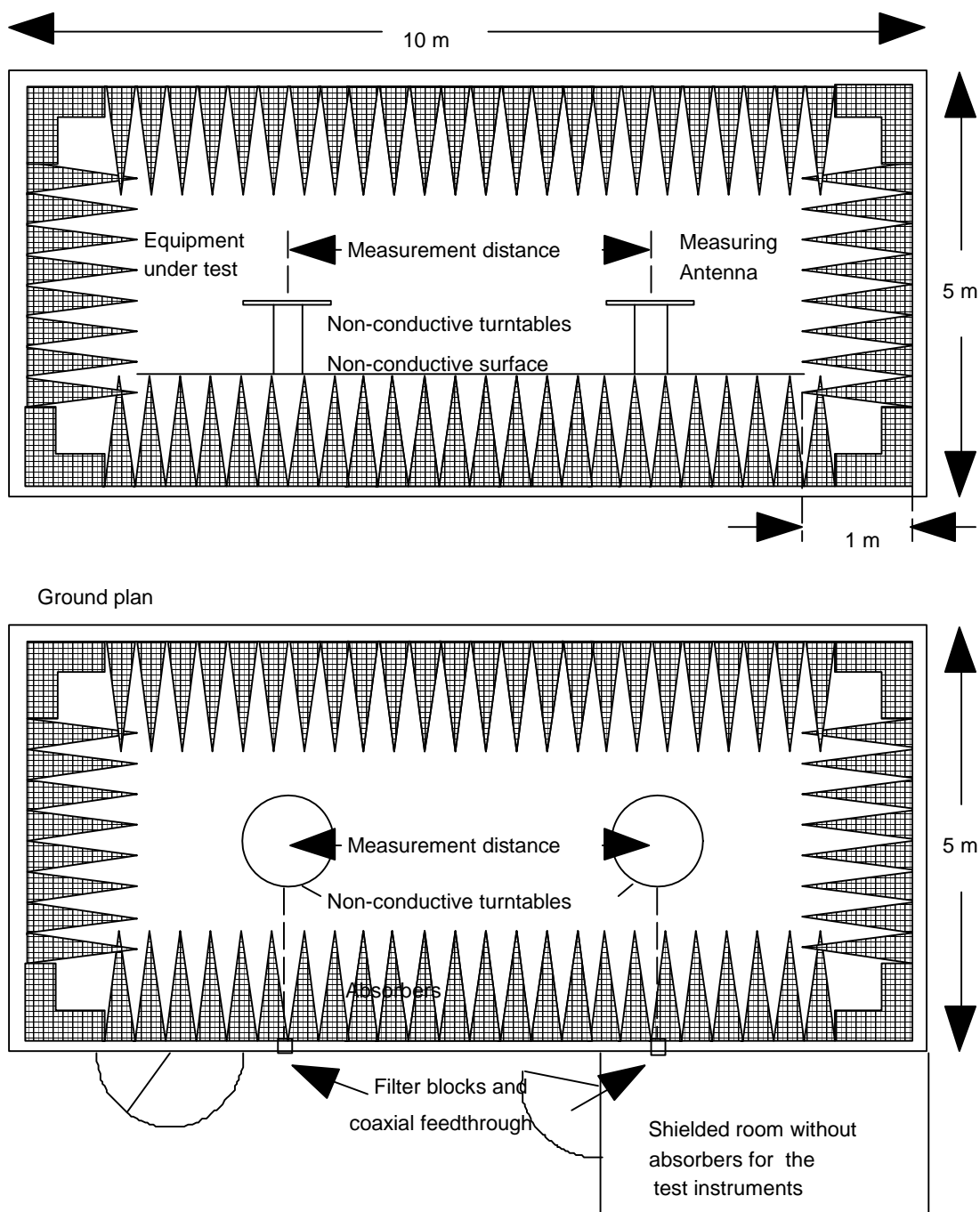


Figure B.3: Anechoic shielded chamber for simulated free space measurements

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.

B.3 Substitution antenna

The substitution antenna shall be used to replace the UUT 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

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

C.1 Conducted measurements

Conducted measurements may be applied to equipment provided with an 50 Ω antenna connector e.g. by means of a spectrum analyser.

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

C.2 Radiated measurements

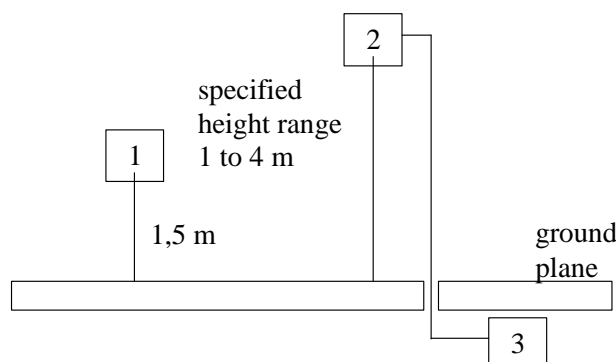
Radiated measurements shall be performed with the aid of a test antenna and measurement instruments as described in annex B. The test antenna and measurement instrument shall be calibrated according to the procedure defined in this annex. The equipment to be measured and the test antenna shall be oriented 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 a non-selective voltmeter or wideband spectrum analyser shall be used. For other measurements a spectrum analyser or selective voltmeter shall be used and tuned to the measurement frequency.

In either case a) or 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: Equipment under test.
2: Test antenna.
3: Spectrum analyser or measuring receiver.

Figure C.1: Measurement arrangement 1

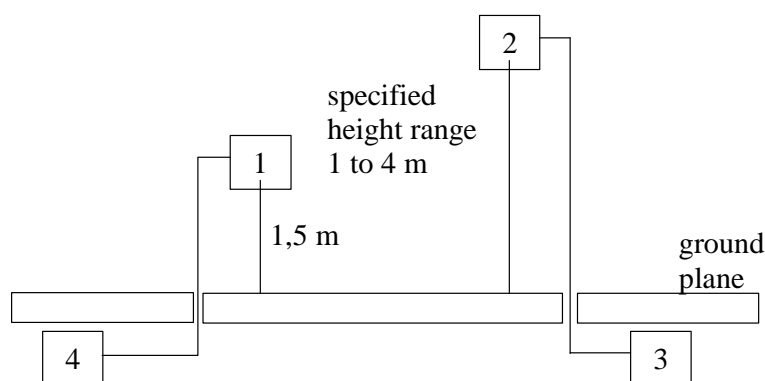
- The transmitter shall be rotated through 360° about a vertical axis until a higher maximum signal is received.
- The test antenna shall be raised or lowered again, if necessary, through the specified height range until a maximum is obtained. This level shall be recorded.

NOTE: 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.3 Substitution measurement

The actual signal generated by the measured equipment 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.

Annex D (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).

History

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