Draft ETSI EN 303 851 V1.0.0 (2025-01)

**Radio Frequency Identification;
Equipment operating in the band 2 446 MHz to 2 454 MHz
with power levels up to a maximum of 500 mW e.i.r.p.
and up to a maximum of 4 W e.i.r.p.;
Harmonised Standard for access to radio spectrum**

Reference

DEN/ERM-TG34-269

Keywords

harmonised standard, radio, SRD, testing

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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 Standardisation Request deliverable Approval Procedure (SRdAP).

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.3] 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.7].

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.

Proposed national transposition dates	
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):	18 months after doa

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).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document specifies technical characteristics and methods of measurements for Radio Frequency IDentification (RFID) devices operating in the frequency range 2 446 MHz to 2 454 MHz with power levels up to a maximum of 500 mW e.i.r.p. and up to a maximum of 4 W e.i.r.p.

The frequency usage conditions for RFID are EU wide harmonised in the band 2 446 MHz to 2 454 MHz with a power up 500 mW e.i.r.p. according to [i.1].

NOTE 1: It should be noted that RFID systems in this frequency band with a power of 4 W e.i.r.p. have only a limited implementation status within the European Union and the CEPT countries. CEPT/ERC/REC 70-03 [i.4] provides in Appendix 1 an overview of countries where the band is implemented.

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

NOTE 2: The relationship between the present document and essential requirements of article 3.2 of Directive 2014/53/EU [i.7] is given in Annex A.

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.

Referenced documents which are not found to be publicly available in the expected location might be found in the ETSI docbox.

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

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

[1] EN IEC 55016-1-1:2019: "Specification for radio disturbance and immunity measuring apparatus and methods; Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus".

[2] EN IEC 55016-1-4:2019/A1:2020 + A2 (2023): "Specification for radio disturbance and immunity measuring apparatus and methods; Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements".

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.

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

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] Commission Implementing Decision (EU) 2019/1345 of 2 August 2019 amending Decision 2006/771/EC updating harmonised technical conditions in the area of radio spectrum use for short-range devices.

[i.2] ETSI EG 203 336 (V1.2.1): "Guide for the selection of technical parameters for the production of Harmonised Standards covering article 3.1(b) and article 3.2 of Directive 2014/53/EU".

[i.3] 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.4] CEPT/ERC/Recommendation 70-03 (2022): "Relating to the use of Short Range Devices (SRD)".

[i.5] Recommendation ITU-R SM.329-13 (09/2024): "Unwanted emissions in the spurious domain".

[i.6] CEPT/ERC/Recommendation 74-01 (2022): "Unwanted emissions in the spurious domain".

[i.7] 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 (RE-Directive).

[i.8] Recommendation ITU-T O.153 (10/1992): "Basic parameters for the measurement of error performance at bit rates below the primary rate".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

adjacent channels: two channels offset from the nominal channel by the nominal channel bandwidth

NOTE: See Figure 1.

alternate adjacent channels: two channels offset from the nominal channel by double the channel bandwidth

NOTE: See Figure 1.

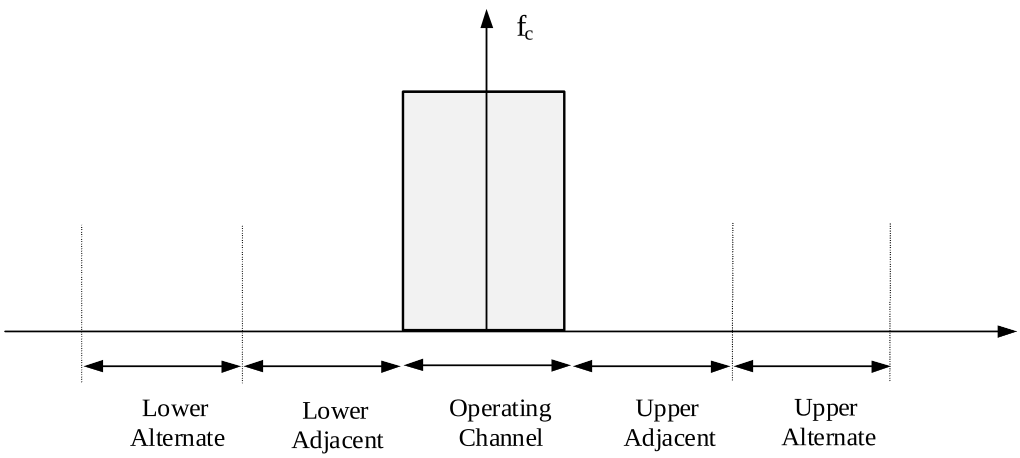

Figure 1: Adjacent and alternate adjacent channel definitions

artificial antenna: non-radiating dummy load

assigned frequency band: frequency band within which the device is authorized to operate and to perform the intended function of the equipment

chip: unit of modulation used in Direct Sequence Spread Spectrum (DSSS) modulation

chip rate: number of chips per second in DSSS

conducted measurements: measurements which are made using a direct connection to the equipment under test

cumulative on-time (T_{on_cum}): sum of T_{on}, within T_{obs}

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

Direct Sequence Spread Spectrum (DSSS): form of modulation where a combination of data to be transmitted and a code sequence (chip sequence) is used to directly modulate a carrier, e.g. by phase shift keying

NOTE: The chip rate determines the occupied bandwidth.

Duty Cycle (DC): ratio expressed as a percentage, of the cumulative duration of transmissions T_{on_cum} within an observation interval T_{obs}. $DC = \left(\frac{T_{on\_cum}}{T_{obs}}\right)_{Fobs}$ on an observation bandwidth F_{obs}

equivalent isotropically radiated power: maximum radiated power of the transmitter and its antenna

fixed station: equipment intended for use in a fixed location

Frequency Hopping Spread Spectrum (FHSS): spread spectrum technique in which the transmitter signal occupies a number of frequencies in time, each for some period of time, referred to as the dwell time

NOTE: Transmitter and receiver follow the same frequency hop pattern. The number of hop positions and the bandwidth per hop position determine the occupied bandwidth.

identification system: equipment consisting of a transmitter(s), receiver(s) (or a combination of the two) and an antenna(s) to identify objects by means of a transponder

integral antenna: permanent fixed antenna, which may be built-in, designed as an indispensable part of the equipment

mobile station: equipment normally fixed in a vehicle or used as a transportable station

observation bandwidth (F_{obs}): bandwidth in which the energy of an equipment is considered for the purposes of assessing transmission timings

observation period (T_{obs}): reference interval of time

occupied bandwidth: width of a frequency band such that, below the lower and above the upper frequency limits the mean powers emitted are each equal to 0,5 % of the total mean power of a given emission

off-time (Toff): time duration between two successive transmissions

on-time (Ton): duration on a Transmission Operating Channel (OC)

Operating Channel (OC): frequency range in which the transmission from the equipment occurs; defined by two frequency edges values: F_{low} and F_{high}

Operating Channel Width (OCW): bandwidth between the two frequencies F_{low} and F_{high} channel

operating frequency: nominal frequency at which equipment is operated; this is also referred to as the operating centre frequency

NOTE: Equipment may be able to operate at more than one operating frequency.

operating frequency range: range of operating frequencies over which the equipment can be adjusted through tuning, switching or reprogramming

out-of-band emissions: emission on a frequency or frequencies outside the occupied bandwidth which results from the modulation process, but excluding spurious emissions

portable station: equipment intended to be carried, attached or implanted

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

radiodetermination: determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relating to these parameters, by means of the propagation properties of radio waves

spread spectrum: modulation technique in which the energy of a transmitted signal is spread throughout a large portion of the frequency spectrum

spurious emissions: emission on a frequency or frequencies which are outside the occupied bandwidth and the level of which may be reduced without affecting the corresponding transmission of information

NOTE: Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

telecommand: use of radio communication for the transmission of signals to initiate, modify or terminate functions of equipment at a distance

telemetry: use of radio communication for indicating or recording data at a distance

transponder: device which responds to an interrogation signal

3.2 Symbols

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

D_{ant}	Aperture dimension of the radiating antenna
dB	deciBel
dBi	gain in deciBels relative to an isotropic antenna
dBm	deciBel-milliwatts
E	Electrical field strength
f	Frequency
f_c	Carrier frequency
P	Power
R	Distance
t	Time
λ	wavelength

3.3 Abbreviations

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

ac	alternating current
ACS	Adjacent Channel Selectivity
ARQ	Automatic Repeat Request
BER	Bit Error Rate
BW	Band Width
CW	Continuous Wave (transmission)
dc	direct current
DC	Duty Cycle
DSSS	Direct Sequence Spread Spectrum
e.i.r.p.	equivalent isotropically radiated power
ERC	European Radiocommunication Committee
EUT	Equipment Under Test
FAR	Fully Anechoic Room
FEC	Forward Error Correction
FH	Frequency High
FHSS	Frequency Hopping Spread Spectrum
FL	Frequency Low
FOC	Frequency Operating Channel
ITU-R	International Telecommunications Union, Radio sector
ITU-T	International Telecommunications Union, Telecommunications sector
MSR	Message Success Ratio
NRI	National Radio Interfaces
NSA	Normal Site Attenuation
OC	Operating Channel
OCW	Operating Channel Width

OFDM	Orthogonal Frequency Division Modulation
PFB	Permitted Frequency Band
RBW	Reference BandWidth
RF	Radio Frequency
RFID	Radio Frequency IDentification
RMS	Root Mean Square
SCU	System Control Unit
SRD	Short Range Device
Tx	Transmitter
VSWR	Voltage Standing Wave Ratio

4 Technical requirements specifications

4.0 General

All limits mentioned in clause 4 assume testing under normal test conditions unless otherwise mentioned.

4.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be in accordance with its intended use. The equipment shall comply with all the technical requirements of the present document, which are identified as applicable in Annex A, at all times when operating within the boundary limits of the operational environmental profile defined by its intended use.

4.2 General conditions for operating

4.2.1 Conformance requirements

For the purpose of the receiver performance tests, the receiver shall produce:

- after demodulation, a raw data signal with a Bit Error Ratio $\leq 10^{-3}$ without correction; or
- after demodulation, a message success ratio equivalent to the above Bit Error Ratio.

The message success ratio (MSR) can be computed by the expression:

$$MSR = (1-p)^n \quad (1)$$

where p is the probability of a single bit error (10^{-3}) and n is the number of bits in the message.

Some designs may include permanent channel coding as an integral part of information transmission. Such designs may not be able to operate without correction inherent in the channel coding. For the purposes of receiver test suites in the present document, the wanted performance criteria are specified with optional FEC &/or ARQ mechanisms disabled.

4.2.2 Designated frequencies

4.2.2.1 EU wide harmonised national radio interface 2 446 MHz to 2 454 MHz

In the Permitted Frequency Band the equipment shall comply with all parameters, exclusions and notes from the corresponding row in Table 1.

Table 1: EU wide harmonised national radio interface for 2 446 MHz to 2 454 MHz according to EC Decision (EU) 2019/1345 [i.1]

Operational Frequency Band	Transmit power limit/field strength limit/power density limit	Additional parameters (channelling and/or channel access and occupation rules)	Band number from EC Decision (EU) 2019/1345 [i.1]
2 446 MHz to 2 454 MHz	500 mW e.i.r.p.	Techniques to access spectrum and mitigate interference that provide at least equivalent performance to the techniques described in the present documen shall be used.	58

4.2.2.2 National Radio Interfaces not EU wide harmonised from 2 446 MHz to 2 454 MHz

In addition to EU wide harmonised radio [i.1] interface listed in Table A.1 nations may implement National Radio Interfaces with associated technical requirements to ensure spectrum compatibility. Usually these requirements come from CEPT/ERC/REC 70-03 [i.4] which sets out the general position on spectrum designations for Short Range Devices (SRDs) for countries within the CEPT. It is also used as a reference document by the CEPT member countries when preparing their national regulations in order to keep in line with the provisions of the Radio Equipment Directive [i.7].

Appendix 1 in CEPT/ERC/REC 70-03 [i.4] provides an indicative overview of the implementation status in European countries.

Table 2 provides an indicative list of these NRIs which might be available in some EU countries. Manufacturers are advised to check the most recently published version of any given NRI.

Table 2: National Radio Interfaces not EU wide harmonised 2 446 MHz to 2 454 MHz derived from CEPT/ERC/REC 70-03 [i.4]

Operational Frequency Band	Maximum Power	Spectrum access and mitigation requirements	Modulation/ maximum occupied bandwidth	Notes	CEPT/ERC/REC 70-03 Annex Number [i.4]	CEPT/ERC/REC 70-03 Frequency band [i.4]
2 446 MHz to 2 454 MHz	> 500 mW to 4 W e.i.r.p.	≤ 15 % duty cycle FHSS techniques should be used	Not specified	Power levels above 500 mW are restricted to be used inside the boundaries of a building and the duty cycle of all transmissions shall in this case be ≤ 15 % in any 200 ms period (30 ms on/170 ms off).	11	a

4.2.3 Operating conditions

Where the Permitted Frequency Band (PFB) is not divided into channels by regulation Operating Channel(s) (OC) shall be such that:

- They lie entirely within the PFB
- In the case of FHSS they do not overlap.
- The Nominal Operating Frequency (f_{nom}) is the mid-point of the OC.

Operating conditions shall be as given in Table 3.

Table 3: Equipment Operating conditions

Parameter	Value
Operating Channel lower edge frequency	$FOC_{low} \geq FB_{low}$
Operating Channel upper edge frequency	$FOC_{high} \leq FB_{high}$
Operating Channel Width	$OCW = FOC_{high} - FOC_{low}$
Nominal Operating Frequency	$f_{nom} = FOC_{low} + \frac{OCW}{2}$
Operating channels edges of equipment using FHSS technique	FOC_{high} (n) ≤ FOC_{low} (n+1) for any operating channels. See note.
NOTE: FOC_{high} (n) and FOC_{low} (n+1) represent two consecutive operating channels edges numbered as n and n+1.	

4.3 Transmitter requirements

4.3.1 Transmitter measurement requirements

4.3.1.1 Applicability

The general requirements in clause 4.3.1.2 shall apply to all EUT when in transmit mode.

4.3.1.2 Methods of measurement and limits for transmitter parameters

Where the transmitter is designed with adjustable carrier power, then all transmitter parameters shall be measured using the highest power level. The equipment shall then be set to the lowest carrier power setting, and the measurements for spurious emissions shall be repeated (see clause 4.3.5).

If the equipment to be tested is designed with a permanent external 50 Ω RF connector and a dedicated or integral antenna, then full tests shall be carried out using this connector. If the RF connector is not 50 Ω, then a calibrated coupler or attenuator shall be used to provide the correct termination impedance to facilitate the measurements. The equivalent isotropically radiated power is then calculated from the determined antenna gain.

If a system includes transponders, these are measured together with the interrogator.

In addition, the following tests shall be carried out with the dedicated or integrated antenna:

- equivalent isotropically radiated power (see clause 4.3.2);
- spurious emissions (see clause 4.3.5).

4.3.2 Equivalent isotropically radiated power (e.i.r.p.)

4.3.2.1 Indoor and outdoor transmitters of 500 mW or less

4.3.2.1.1 Applicability

The equivalent isotropically radiated power requirement shall apply to all transmitters with 500 mW indoor and outdoor.

4.3.2.1.2 Definition

The e.i.r.p. is defined as the maximum radiated power of the transmitter and its antenna, and is measured and calculated according to the procedure given in clause 4.3.2.1.3. See clause 5 for the test conditions.

4.3.2.1.3 Limits

The transmitter maximum e.i.r.p. under normal and extreme test conditions shall not exceed 500 mW as provided in Table 4.

Table 4: Maximum radiated power (e.i.r.p.)

Frequency Band	Power limit, e.i.r.p. (note 1)	Use of equipment	Comments
2 446 MHz to 2 454 MHz	+ 27 dBm	No restriction	FHSS or unmodulated carrier See also Table 7 and Annex C
2 446 MHz to 2 454 MHz	+36 dBm notes 2 and 3	In-door use only	FHSS only See also Table 7 and Annex C

NOTE 1: e.i.r.p. including an antenna with the following data:
a) equal or less than ±45 degrees horizontal beamwidth;
b) equal or more than 15 dB sidelobe attenuation;
c) physical protection (e.g. antenna dome) which dimension limits a power transfer from the RFID antenna to a quarter wave matched dipole at positioned at an extreme close proximity to ≤ +15 dBm.

NOTE 2: The use of power levels above +27 dBm (e.i.r.p.) shall by technical means be restricted to in building use only and shall have a duty cycle less than or equal to 15 % averaged over any 200 ms period (30 ms on/170 ms off).

NOTE 3: The spectrum ranges in some entries are not harmonised throughout all EU territory, specifically entry has been identified as such. Implementers are cautioned to refer to CEPT/ERC Recommendation 70-03 [i.4] as well as current National Radio plans to verify acceptance within intended regions of use.

NOTE 4: Indoor 4 W e.i.r.p. RFID equipment shall be constructed with 2 power levels as described below:
a) 500 mW e.i.r.p.; and
b) 4 W e.i.r.p.

The default power level is 500 mW e.i.r.p. or less.
The 4 W e.i.r.p. level is only enabled by a secure software code built into the equipment and which is only accessible by the manufacturer or his representative. The way in which the software code controls the power level shall be as below:

1) Fixed mounted 4 W RFID equipment shall be mounted inside a building and shall have a tamper proof function, which shall ensure self-destruction of the special software code if the RFID equipment is removed from its fixed mounting position. Such action shall reduce the power automatically to the default value of 500 mW e.i.r.p. or less.
2) Portable 4 W RFID equipment shall, via an inside building short range link, have a continuous update of the special software code. This code is generated by a fixed mounted control unit installed in the same indoor room or area in which the RFID equipment is to be used. Without a signal from this control unit, the RFID equipment shall reduce its power automatically to the default level of 500 mW e.i.r.p. or less. The control unit shall have a tamper proof function, which shall ensure self-destruction of the special software code if the unit is removed from its fixed, in building, mounting position.

Further information related to the above requirement is given in Annex E.

4.3.2.1.4 Conformance

The transmitter maximum e.i.r.p. measurements shall be performed as described in clause 5.9.2 and not exceed the limits in clause 4.3.2.1.3. The values and measurement method utilized shall be stated in the test report.

4.3.2.2 Indoor transmitters of 4 W or less

4.3.2.2.1 Applicability

The equivalent isotropically radiated power requirement shall apply to all transmitters 4 W indoor.

4.3.2.2.2 Definition

The e.i.r.p. is defined as the maximum radiated power of the transmitter and its antenna, and is measured and calculated according to the procedure given in clause 4.3.2.2.3. See clause 5 for the test conditions.

4.3.2.2.3 Limits

The transmitter maximum e.i.r.p. under normal and extreme test conditions shall not exceed the 4 W as provided in Table 4.

4.3.2.2.4 Conformance

The transmitter maximum e.i.r.p. measurements shall be performed as described in clause 5.9.2.1.4 and not exceed the limits in clause 4.3.1.2. The values and measurement method utilized shall be stated in the test report.

4.3.3 Permitted range of operating frequencies

4.3.3.1 Applicability

The Permitted range of operating frequencies shall apply to all transmitters.

4.3.3.2 Definition

The permitted range of operating frequencies includes all frequencies on which the equipment may operate within an assigned frequency band.

The frequency range of the equipment is determined by the lowest and highest frequencies occupied by the power envelope in accordance with clause 4.3.2.1.3, Table 4.

FH is the highest frequency of the power envelope, it is the frequency furthest above the frequency of maximum power where the output power envelope drops below the level of -75 dBm/Hz spectral power density (e.g. -30 dBm if measured in a 30 kHz reference bandwidth) e.i.r.p.

FL is the lowest frequency of the power envelope; it is the frequency furthest below the frequency of maximum power where the output power drops below the level of -75 dBm/Hz spectral power density (e.g. -30 dBm if measured in a 30 kHz reference bandwidth) e.i.r.p.

Where differing modes of emission are available, all modes and their associated bandwidths shall be stated.

4.3.3.3 Limits

The width of the power spectrum envelope is f_H - f_L for a given operating frequency. In equipment that allows adjustment or selection of different operating frequencies, the power envelope takes up different positions in the allowed band. The frequency range is determined by the lowest value of f_L and the highest value of f_H resulting from the adjustment of the equipment to the lowest and highest operating frequencies.

The occupied bandwidth (i.e. the bandwidth in which 99 % of the wanted emission is contained) of the transmitter shall fall within the assigned frequency band.

For all equipment the frequency range shall lie within the frequency band given by clause 4.3.2.1.3, Table 4. For non-harmonised frequency bands the available frequency range may differ between national administrations.

4.3.3.4 Conformance

The permitted range of operating frequency shall be measured as described in clause 5.9.4 and not exceed the limits in clause 4.3.3.3.

4.3.4 Transmitter spectrum masks

4.3.4.1 Applicability

The requirement for transmitter spectrum mask shall apply to all transmitters.

4.3.4.2 Definition

A transmitter spectrum mask is the maximum allowed power emitted by the transmitter as a function of frequency, either expressed in power density versus frequency, or in total power within defined frequency band.

4.3.4.3 Limits

The spectrum mask shall comply with the limits in Table 5.

Table 5: Spectrum mask

Frequency off-set, f (f_0 = 2 450 MHz)	Limit	Measurement resolution bandwidth
f ≤ f_0 - 4,20 MHz and f ≥ f_0 + 4,20 MHz	-5 dBm	30 kHz
f ≤ f_0 - 6,83 MHz and f ≥ f_0 + 6,83 MHz	-30 dBm	300 kHz
f ≤ f_0 - 20 MHz and f ≥ f_0 + 20 MHz	-30 dBm	1 MHz

4.3.4.4 Conformance

Conformance test shall be performed as described in clause 5.9.4 and not exceed the limits in clause 4.3.4.3. The values shall be stated in the test report.

4.3.5 Unwanted emissions in the spurious domain

4.3.5.1 Applicability

The unwanted emissions in the spurious domain requirement shall apply to all transmitters.

4.3.5.2 Definition

According to CEPT/ERC/Recommendation 74-01E [i.6], and Recommendation ITU-R SM.329-13 [i.5], the boundary between the out-of-band and spurious domains is ±250 % of the occupied bandwidth from the centre frequency of the emission. Out-of-band and spurious emissions are measured as spectral power density under normal operating conditions.

Unwanted emissions in the spurious domain (spurious emissions) are those at frequencies beyond the limit of 250 % of the occupied bandwidth above and below the centre frequency of the emission.

4.3.5.3 Limits

The maximum power limits of any unwanted emissions in the spurious domain are given in Table 6.

Table 6: Spurious emissions

Frequency ranges	47 MHz to 74 MHz 87,5 MHz to 108 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies ≤ 1 000 MHz	Frequencies > 1 000 MHz < 13 GHz
State			
Operating	4 nW	250 nW	1 µW
Standby	2 nW	2 nW	20 nW

4.3.5.4 Conformance

The level of unwanted emissions in the spurious domain shall be measured as described in clause 5.9.5 and not exceed the limits in clause 4.3.5.3.

4.3.6 Duty cycle

4.3.6.1 Applicability

Duty Cycle (DC) shall apply to RFID devices transmitting more than 500 mW e.i.r.p.

4.3.6.2 Definition

Duty cycle is the ratio expressed as a percentage, of the cumulative duration of transmissions T_{on_cum} within an observation interval T_{obs}. $DC = \left(\frac{T_{on\_cum}}{T_{obs}}\right)_{Fobs}$ on an observation bandwidth F_{obs}.

T_{obs} is 1 hour and the observation bandwidth F_{obs} is the operational frequency band.

Each transmission consists of an RF emission, or sequence of RF emissions separated by intervals < T_{Dis}.

An equipment may operate on several bands simultaneously (i.e. multi transmissions), Duty Cycle of each band applies to each transmission.

In case of a multicarrier modulation in a band, the duty cycle applies to the whole signal used for a transmission (e.g. OFDM).

NOTE: Duty Cycle value may depend on the presence of a primary radio service.

Equipment may be triggered manually, by internal timing or by external stimulus. Depending on the method of triggering the timing may be predictable or random.

4.3.6.3 Limits

The maximum duty cycle is given in Table 7.

Table 7: Duty cycle limits

Frequency Band	Duty cycle	Application	Use of equipment	Comments
a) 2 446 MHz to 2 454 MHz	No Restriction	RFID	No Restriction	FHSS or unmodulated carrier (CW) only
b) 2 446 MHz to 2 454 MHz	≤ 15 % averaged over any 200 ms period (30 ms on/170 ms off)	RFID	In-building only	FHSS only
NOTE: This spectrum range is not harmonised in some countries throughout all EU territory, specifically entry 2 has been identified as such. Implementers are cautioned to refer to CEPT/ERC Recommendation 70-03 [i.4] as well as current National Radio plans to verify acceptance within intended regions of use.				

For devices with a 100 % duty cycle transmitting an unmodulated carrier most of the time, a time-out shut-off facility shall be implemented in order to improve the efficient use of spectrum.

4.3.6.4 Conformance

The duty cycle shall be measured as described in clause 5.9.6. Equipment that requires duty cycle per clause 4.3.6.1 shall not exceed the duty cycle limits provided in Table 7. The assessment of clause 4.3.6.2 shall be included in the test report.

The shut-off facility should be tested according the method in clause 5.9.2.1.4.

NOTE: The maximum duty cycle of the transmitter under test should not be confused with the duty cycle of the equipment under normal operating conditions.

4.3.7 Additional requirements for FHSS equipment

4.3.7.1 Applicability

The requirements in this clause apply only to equipment using FHSS modulation.

4.3.7.2 Definition

Equipment employing FHSS shall transmit over multiple channels by moving its transmission frequency from channel to channel.

4.3.7.3 Limits

FHSS modulation shall make use of at least 20 channels hopping over > 90 % of the assigned frequency band.

The dwell time per channel shall not exceed 1 s. While the equipment is operating (transmitting and/or receiving) each channel of the hopping sequence shall be occupied at least once during a period not exceeding four times the product of the dwell time per hop and the number of channels.

4.3.7.4 Conformance

The total number of hops, the dwell time and the maximum separation of hops measurements shall be performed as described in clause 5.9.7 and not exceed the limits in clause 4.3.7.3. The values and measurement method utilized shall be stated in the test report.

4.4 Receiver requirements

4.4.1 General performance criteria

For the purpose of the receiver performance tests, the receiver shall produce an appropriate output under normal conditions as indicated below:

- after demodulation, a data signal with a bit error ratio of 10^{-2} without correction; or
- after demodulation, a message acceptance ratio of 80 %; or
- an appropriate false alarm rate or sensing criteria guaranteeing a read probability required for proper functioning of the system.

4.4.2 Blocking or desensitization

4.4.2.1 Applicability

This requirement applies to all receivers.

4.4.2.2 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 occupied bandwidth.

4.4.2.3 Limits

The blocking level shall not be less than -60 dBm + k, except at frequencies on which spurious responses are found.

The correction factor, k, is as follows:

$$k = -20\log f - 10\log BW \qquad (2)$$

Where:

- *f* is the frequency in GHz;
- *BW* is the occupied bandwidth in MHz.

The factor k is limited within the following:

$$-40 \text{ dB} < k < 0 \text{ dB}.$$

The measured blocking level shall be stated in the test report.

4.4.2.4 Conformance

The blocking or desensitization measurements shall be performed as described in clause 5.10.2 and not exceed the limits in clause 4.4.2.3 The values and measurement method utilized shall be stated in the test report.

4.4.3 Spurious radiations

4.4.3.1 Applicability

This requirement applies to all receivers, except receivers used in combination with permanently co-located transmitters continuously transmitting. Co-located is defined as < 3 m. In these cases the receivers will be tested together with the transmitter in operating mode.

4.4.3.2 Definition

Spurious radiations from the receiver are components at any frequency, radiated by the equipment and antenna.

4.4.3.3 Limits

The power of any spurious emission shall not exceed 2 nW in the range 25 MHz to 1 GHz and shall not exceed 20 nW on frequencies above 1 GHz up to 13 GHz.

4.4.3.4 Conformance

The spurious radiations measurements shall be performed as described in clause 5.10.3 and not exceed the limits in clause 4.4.3.3. The values and measurement method utilized shall be stated in the test report.

4.4.4 Receiver sensitivity

4.4.4.1 Applicability

This requirement applies to all receivers.

4.4.4.2 Definition

The receiver sensitivity is the minimum signal power input to the receiver which produces the general performance criterion stated in clause 4.4.1.

4.4.4.3 Limits

The sensitivity for receivers shall be below or equal to -60 dBm.

4.4.4.4 Conformance

The receiver sensitivity measurements shall be performed as described in clause 5.10.4 and not exceed the limits in clause 4.4.4.3. The values and measurement method utilized shall be stated in the test report.

4.4.5 Adjacent channel selectivity

4.4.5.1 Applicability

The adjacent channel selectivity requirement shall apply to all receivers.

4.4.5.2 Definition

Adjacent channel selectivity is a measure of the capability of the receiver to identify a tag to receive a wanted modulated signal without exceeding the general performance criteria stated in clause 4.4.1 due to the presence of an unwanted input signal in the adjacent channels.

4.4.5.3 Limits

The adjacent channel selectivity shall not be less than -60 dBm.

4.4.5.4 Conformance

The adjacent channel selectivity measurements shall be performed as described in clause 5.10.5 and not exceed the limits in clause 4.4.5.3. The values and measurement method utilized shall be stated in the test report.

4.4.6 Receiver spurious response rejection

4.4.6.1 Applicability

The receiver spurious response rejection requirement shall apply to all types of receivers.

4.4.6.2 Definition

The spurious response rejection is a measure of the capability of the receiver to receive a wanted signal without exceeding a given degradation due to the presence of an unwanted signal at any frequency at which a response is obtained. The frequencies of the adjacent signals (channels) are excluded.

4.4.6.3 Limits

The Receiver spurious response rejection shall be equal to or better than the following limits:

- For (fc / 3) -34 dBm.
- For (fc / 2) -34 dBm.

4.4.6.4 Conformance

The receiver spurious response rejection measurements shall be performed as described in clause 5.10.6 and not exceed the limits in clause 4.4.6.3. The values and measurement method utilized shall be stated in the test report.

4.4.7 Receiver maximum input signal level

4.4.7.1 Applicability

The receiver maximum input signal level requirement shall apply to all types of receivers.

4.4.7.2 Definition

Maximum input signal level is the maximum signal power input to the receiver which produces the general performance criterion stated in clause 4.4.1. The test input signal is generated at the frequency of the selected channel and modulated with normal modulation.

4.4.7.3 Limits

The measured maximum input signal level shall not be less than the limits given in Table 8.

Table 8: Limits for receiver maximum input signal level

Parameter	Limit
Rx maximum input signal level	-30 dBm

4.4.7.4 Conformance

The receiver maximum input signal level measurement shall be performed as described in clause 5.10.7 and not exceed the limits in clause 4.4.7.3. The values and measurement method utilized shall be stated in the test report.

5 Testing for compliance with technical requirements

5.0 General

All tests mentioned in clause 5 assume testing under normal test conditions unless otherwise mentioned.

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 defined by its intended use.

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.

5.2 Presentation of equipment for testing purposes

5.2.1 General

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

A test fixture for equipment with an integral antenna may be supplied (see clause 5.8.3).

To simplify and harmonise the testing procedures between the different testing laboratories, measurements shall be performed according to the present document on samples of equipment defined in clauses 5.2.2 to 5.2.4.2, these clauses are intended to give confidence that the requirements set out in the present document have been met without the necessity of performing measurements on all frequencies.

Each interrogator is designed to work with a specific type of tag (passive, battery assisted, battery operated). If a tag is needed for a test the appropriated tag shall be used.

5.2.2 Choice of model for testing

One or more samples of the equipment, as appropriate, shall be tested.

Standalone equipment shall be tested complete with any ancillary equipment needed for testing. The number of samples tested shall be stated in the test report.

If equipment has optional features considered not to affect the RF parameters, then the tests need only to be performed on the equipment configured with that combination of features considered to be the most complex. Where practicable, equipment offered for testing shall provide a 50 Ω connector for conducted RF power measurements.

In the case of 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 50 Ω antenna connector fitted to facilitate testing, see clause 5.2.4.

5.2.3 Testing of equipment with alternative power levels

If a family of equipment has alternative output power levels provided by the use of separate power modules or add on stages, or additionally has alternative frequency coverage, then all these shall be declared. Each module or add on stage shall be tested in combination with the equipment. The necessary samples and tests shall be based on the requirements of clause 5.2.2. As a minimum, measurements of the radiated power (e.i.r.p.) and spurious emissions shall be performed for each combination and shall be stated in the test report.

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

5.2.4.1 Equipment with an internal permanent or temporary antenna connector or using a dedicated test fixture

The means to access and/or implement the internal permanent or temporary antenna connector shall be stated with the aid of a diagram. Alternately, a suitable test fixture may be provided by the manufacturer. The fact that use has been made of the internal antenna connection, or of a temporary connection, or a suitable test fixture to facilitate measurements shall be recorded in the test report.

For further information on the test fixture, see clause 5.8.3.

5.2.4.2 Equipment with a temporary antenna connector

One set of equipment, with the normal antenna connected, may be tested to enable radiated measurements to be made. For radiated measurements equipment to be tested shall be delivered with an antenna and temporary antenna connector.. No antenna connector shall be connected or disconnected during the testing

Alternatively, two sets of equipment may be submitted to the test laboratory, one fitted with a temporary antenna connector with the antenna disconnected and another equipment with the antenna connected. Each equipment shall be used for the appropriate tests. There shall be a declaration that the two sets of equipment are identical in all aspects except for the antenna connector.

5.2.5 Testing of devices using duty cycle

When making transmitter tests on equipment designed for intermittent operation the maximum duty cycle of the transmitter shall not be exceeded. The actual duty cycle used shall be recorded and stated in the test report.

NOTE: The maximum duty cycle of the transmitter under test should not be confused with the duty cycle of the equipment under normal operating conditions.

When performing transmitter tests on equipment designed for intermittent operation it may be necessary to exceed the duty cycle associated with normal operation. Where this is the case, care should be taken to avoid heating effects having an adverse effect on the equipment and the parameters being measured. The maximum transmit on-time shall be stated by the test laboratory where applicable. This on-time shall not be exceeded and details shall be stated in the test report.

5.3 Mechanical and electrical design

5.3.1 General

Transmitters and receivers may be individual or combination units.

5.3.2 Transmitter shut-off facility

If the transmitter is equipped with an automatic transmitter shut-off facility, it should be made inoperative for the duration of the test. In case this not possible, a proper test method shall be described and documented.

5.3.3 Receiver mute or squelch

If the receiver is equipped with a mute, squelch or battery-saving circuit, this circuit shall be made inoperative for the duration of the tests. In the case this not possible, a test method shall be described and documented.

5.4 Auxiliary test equipment

All special-to-type test signal sources and set-up information shall accompany the equipment when it is submitted for testing.

5.5 Test power source

5.5.1 General

The equipment shall be tested using the appropriate test power source as specified in clauses 5.5.2 or 5.5.3. Where equipment can be powered using either external or internal power sources, then the equipment shall be tested using the external power source as specified in clause 5.5.2 then repeated using the internal power source as specified in clause 5.5.3.

The test power source used shall be stated in the test report.

5.5.2 External test power source

During testing, the power source of the equipment shall be replaced by an external test power source capable of producing normal and extreme test voltages as specified in clauses 5.6.2 and 5.7.2. The internal impedance of the external test power source shall be low enough for its effect on the test results to be negligible. For the purpose of the tests, the voltage of the external test power source shall be measured at the input terminals of the equipment. The external test power source shall be suitably de-coupled and applied as close to the equipment battery terminals as practicable. For radiated measurements, any external power leads should be so arranged so as not to affect the measurements.

During tests, the test power source voltages shall be within ±1 % relative to the voltage at the beginning of each test. The value of this tolerance can be critical for certain measurements. Using a smaller tolerance will provide a better uncertainty value for these measurements.

5.5.3 Internal test power source

For radiated measurements on portable equipment with integral antenna, fully charged internal batteries should be used. The batteries used should be as supplied or recommended by the manufacturer. If internal batteries are used, at the end of each test the voltage shall be within ±5 % relative to the voltage at the beginning of each test. Where this is not appropriate, a note to this effect shall be appended to the test report.

If appropriate, for conducted measurements or where a test fixture is used, an external power supply at the required voltage may replace the supplied or recommended internal batteries. This shall be stated on the test report.

5.6 Normal test conditions

5.6.1 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 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.

5.6.2 Normal test power source

5.6.2.1 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.

5.6.2.2 Battery power sources

When the radio equipment is intended for operation with the usual types of battery power source, the normal test voltage shall be 1,1 multiplied by the nominal voltage of the battery (e.g. 6 V, 12 V, etc.).

5.6.2.3 Other power sources

For operation from other power sources or types of battery (primary or secondary), the normal test voltage shall be used. Such values shall be stated in the test report.

5.7 Extreme test conditions

5.7.1 Extreme temperatures

5.7.1.1 Procedure for tests at extreme temperatures

5.7.1.1.1 General

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 shall be switched on for 15 minutes after thermal balance has been obtained, and the equipment shall then meet the specified requirements.

If the thermal balance is not checked by measurements, a temperature stabilizing period of at least one hour, or such period as may be decided by the test 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.

5.7.1.1.2 Procedure for equipment designed for continuous operation

If the equipment is designed for continuous operation, 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 a half hour 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 on for a period of one minute after which the equipment shall meet the specified requirements.

5.7.1.1.3 Procedure for equipment designed for intermittent operation

If the equipment is designed for intermittent operation, 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 in the oven. The equipment shall then either:
    - transmit on and off duty cycle for a period of five minutes; or
    - if the on period exceeds one minute, then:
        - transmit in the on condition for a period not exceeding one minute, followed by a period in the off or standby mode for four minutes; 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.

5.7.1.2 Extreme temperature ranges

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in clause 5.7.1.1, at the upper and lower temperatures of one of the following ranges, either:

a) the rated temperature range of the equipment; or

b) one of the following specified temperature ranges:

- Temperature range: General equipment: -20 °C to +55 °C;
- Temperature range: Portable equipment: -10 °C to +55 °C;
- Temperature range: Equipment for normal indoor use: 5 °C to +35 °C.

The test report shall state which range is used.

5.7.2 Extreme test source voltages

5.7.2.1 Mains voltage

The extreme test voltages for equipment to be connected to an ac mains source shall be the nominal mains voltage ±10 %. For equipment that operates over a range of mains voltages clause 5.7.2.4 applies.

5.7.2.2 Battery power sources

When the radio equipment is intended for operation from the usual type of battery power sources the extreme test voltages shall be 1,3 and 0,9 multiplied by the nominal voltage of the battery (6 V, 12 V, etc.).

For float charge applications using "gel-cell" type batteries the extreme voltage shall be 1,15 and 0,85 multiplied by the nominal voltage of the declared battery voltage.

5.7.2.3 Power sources using other types of batteries

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

- for equipment with a battery indicator, the end point voltage as indicated;
- for equipment without a battery indicator the following end point voltages shall be used:
  - for the Leclanché or the lithium type of battery:
    - 0,85 multiplied by the nominal voltage of the battery.
  - for the nickel-cadmium type of battery:
    - 0,9 multiplied by the nominal voltage of the battery.
- for other types of battery or equipment, the lower extreme test voltage shall be determined by the amount of discharge where irreversible damage to the battery takes place. For lead acid batteries this is 50 %, for other types this depends on the technology.

The nominal voltage is considered to be the upper extreme test voltage in this case.

5.7.2.4 Other power sources

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages depend on the applied technology. This shall be recorded in the test report.

5.8 General conditions

5.8.1 Normal test signals and test modulation

5.8.1.1 General

The test modulating signal is a signal which modulates a carrier, is dependent upon the type of equipment under test and also the measurement to be performed. Modulation test signals only apply to products with an external modulation connector.

Test signals may be generated by applying test baseband signals to a modulation port on the device or be generated internally by the device. Operation in a test mode may involve suitable temporary internal modifications of the equipment under test or the use of special software. Details of the method employed shall be recorded in the test report.

Where appropriate, a test signal shall be used with the following characteristics:

- representative of normal operation;
- causes greatest occupied RF bandwidth.

For equipment using intermittent transmissions the test signal shall be such that:

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

Details of the test signal shall be recorded in the test report.

If there is no provision for external test modulation, then normal operating modulation shall be used.

5.8.1.2 Normal test signals for data

Where the equipment has an external connection for general data modulation, the normal test signals are specified as follows:

D-M2: a test signal representing a pseudo-random bit sequence of at least 511 bits in accordance with Recommendation ITU-T O.153 [i.8]. This sequence shall be continuously repeated. If the sequence cannot be continuously repeated, the actual method used shall be stated in the test report.

D-M3: a test signal shall be used according to the intended use of the equipment in case selective messages are used and are generated or decoded within the equipment.
The test signal may be formatted and may contain error detection and correction.

5.8.2 Artificial antenna

Where applicable, tests shall be carried out using an artificial antenna which shall be a substantially non-reactive non-radiating load connected to the antenna connector.

5.8.3 Test fixture

5.8.3.1 General

With equipment intended for use with a small aperture integral antenna, and not equipped with a 50 Ω RF output connector, a suitable test fixture may be used. An example test fixture is shown in Figure 2.

This fixture is a radio frequency device for coupling the integral antenna to a 50 Ω RF terminal at all frequencies for which measurements need to be performed.

The test fixture shall be fully described.

In addition, the test fixture may provide:

a) a connection to an external power supply;

b) a method to provide the input to or output from the equipment. This may include coupling to or from the antenna. The test fixture could also provide the suitable coupling means e.g. for data or video outputs.

The test fixture shall normally be supplied by the manufacturer.

The performance characteristics of the test fixture shall conform to the following basic parameters:

a) the coupling loss shall not be greater than 30 dB;

b) bandwidth in line with the frequency ranges to be tested;

c) a coupling loss variation over the frequency range used in the measurement which does not exceed 2 dB;

d) circuitry associated with the RF coupling shall contain no active or non-linear devices;

e) the VSWR at the 50 Ω socket shall not be more than 1,5 over the frequency range of the measurements;

f) the coupling loss shall be independent of the position of the test fixture and be unaffected by the proximity of surrounding objects or people. The coupling loss shall be reproducible when the equipment under test is removed and replaced. Normally, the text fixture is in a fixed position and provides a location for the EUT;

g) the coupling loss shall remain substantially constant when the environmental conditions are varied.

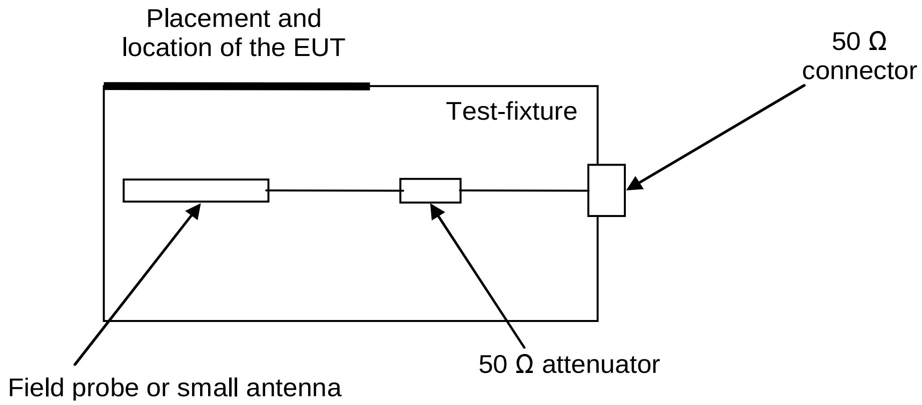

Figure 2: Test fixture

The field probe (or small antenna) needs to be properly terminated.

The characteristics and validation shall be included in the test report.

5.8.3.2 Validation of the test-fixture in the temperature chamber

The test fixture is brought into a temperature chamber (only needed if test fixture measurements performed under extreme temperature conditions).

Step 1:

A transmit antenna connected to a signal generator shall be positioned from the test-fixture at a far field distance of not less than one 12 cm. The test fixture consists of the mechanical support for the EUT, an antenna or field probe and a 50 Ω attenuator for proper termination of the field probe. The test fixture shall be connected to a spectrum analyser via the 50 Ω connector. A signal generator shall be set on the EUT's nominal frequency (see Figure 3). The unmodulated output power of the signal generator shall be set to a value such that a sufficiently high level can be observed with the spectrum analyser. This determined value shall be recorded. The signal generator shall then be set to the upper and the lower band limit of the EUT's assigned frequency band. The measured values shall not deviate more than 1 dB from the value at the nominal frequency.

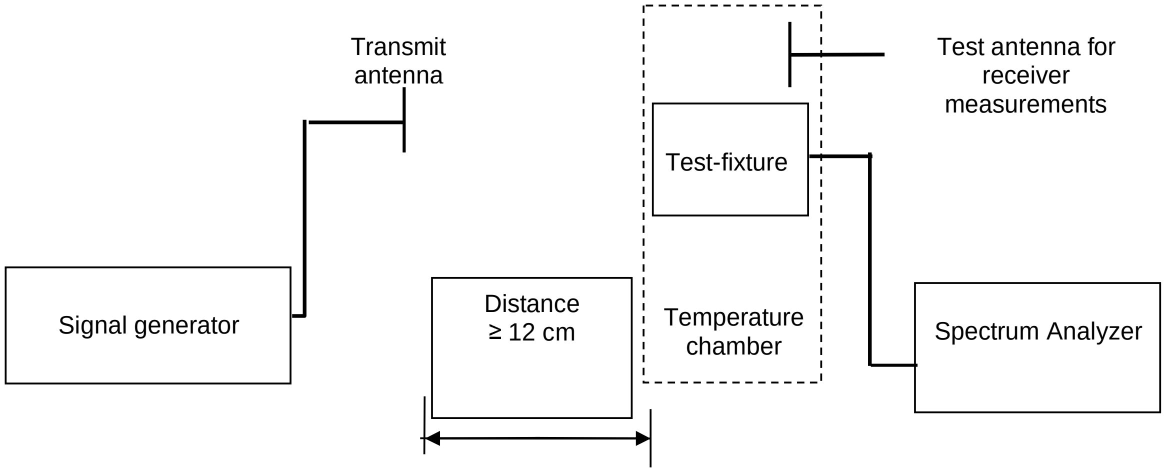

Figure 3: Validation of test set-up without EUT

If receiver tests under extreme temperature conditions are performed, a receiver test antenna is also brought into the temperature chamber to ensure its influence in the chamber is known.

Step 2:

During validation and testing the EUT shall be fitted to the test fixture in a switched-off mode, see Figure 4. Step 1 shall be repeated, this time with the EUT in place. The measured values shall be compared with those from step 1 and shall not vary by more than 2 dB. This shows that the EUT does not cause any significant shadowing of the radiated power.

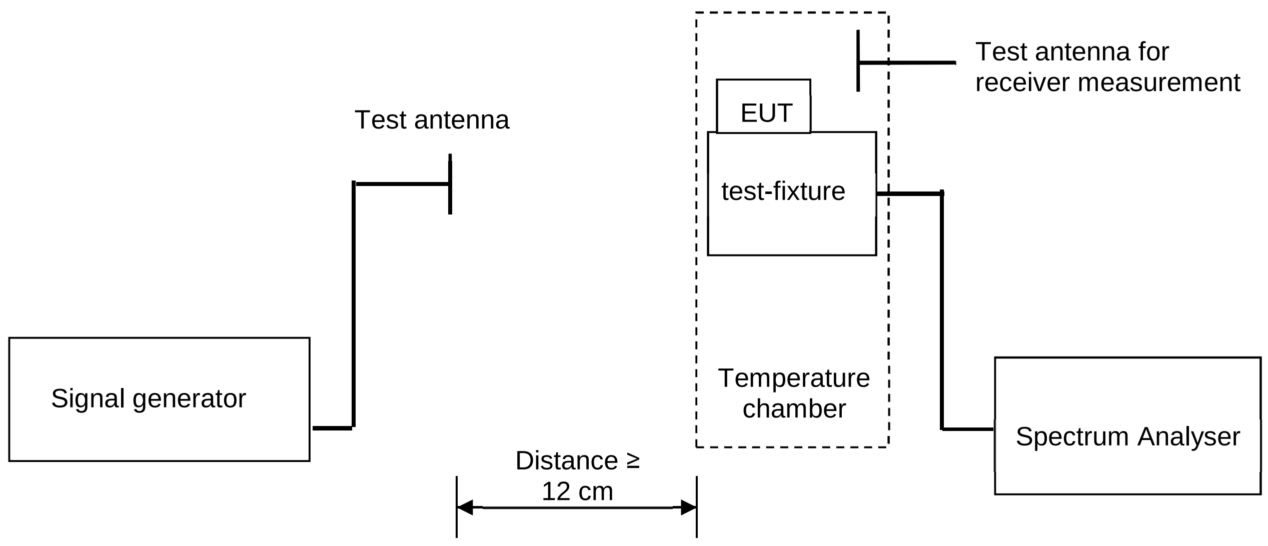

Figure 4: Validation of test set-up with EUT in place

Step 3:

In case of a battery operated EUT that is supplied by a temporary voltage feed as well as temporary signal- and control line, a decoupling filter shall be installed directly at the EUT in order to avoid parasitic, electromagnetic radiation (see Figure 5).

In this step the signal generator and the transmit antenna are removed.

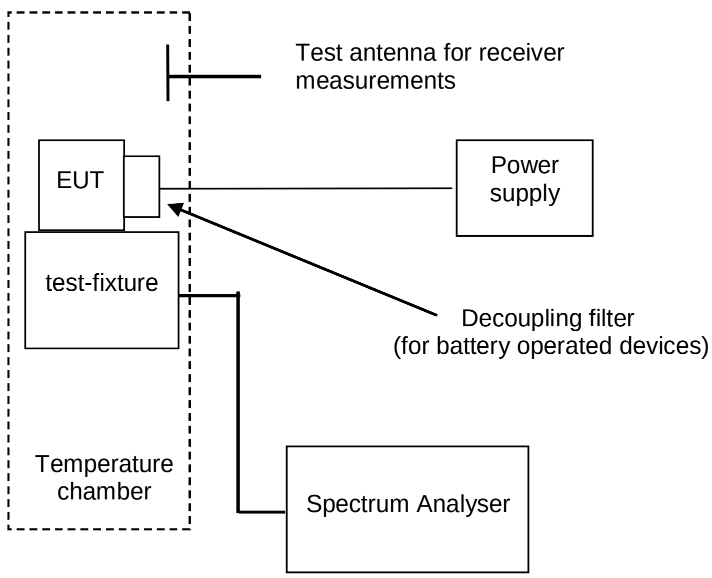

Figure 5: Test of EUT

5.8.3.3 Mode of use

The test fixture may be used to facilitate some of the transmitter and receiver measurements in the case of equipment having an integral antenna.

It is used particularly for the measurement of the radiated carrier power and usable sensitivity expressed as a field strength under extreme conditions. The test fixture shall only be used for relative power measurements or for measurements not dependent on coupling ratio. The measurements under extreme conditions are preceded by calibrated measurements according to Annex C.

5.8.4 Test sites and general arrangements for radiated measurements

For guidance on radiation test sites, see clause C.2. Detailed descriptions of radiated measurement arrangements are included in this annex.

5.8.5 Measuring receiver

The term "measuring receiver" refers to a frequency-selective voltmeter or a spectrum analyser. An RMS detector is used if not defined otherwise for a specific measurement. The measurement bandwidth of the measuring receiver shall be according to EN IEC 55016-1-1 [1], Table 3. In order to obtain the required sensitivity, a narrower measurement bandwidth may be necessary, and in such cases, this shall be stated in the test report form. Preferably the bandwidth of the measuring receiver shall be as given in Table 9.

Table 9: Preferred bandwidth measurement

Frequency range (f)	Receiver reference bandwidth BWref
30 MHz ≤ f ≤ 1 000 MHz	100 kHz
f > 1 000 MHz	1 MHz

In case a narrower measurement bandwidth was used, the following conversion formula has to be applied:

$$B = A + 10 \log \frac{BWref}{BW_{MEASURED}} \quad (3)$$

Where:

- A is the value at the narrower measurement bandwidth;
- B is the value referred to the reference bandwidth; or
- use the measured value, A, directly if the measured spectrum is a discrete spectral line. (A discrete spectrum line is defined as a narrow peak with a level of at least 6 dB above the average level inside the measurement bandwidth.)

5.9 Transmitter requirements

5.9.1 Transmitter measurement requirements

5.9.1.1 Methods of measurement and limits for transmitter parameters

Where the transmitter is designed with adjustable carrier power, then all transmitter parameters shall be measured using the highest power level. The equipment shall then be set to the lowest carrier power setting, and the measurements for spurious emissions shall be repeated (see clause 4.3.5).

If the equipment to be tested is designed with a permanent external 50 Ω RF connector and a dedicated or integral antenna, then full tests shall be carried out using this connector. If the RF connector is not 50 Ω, then a calibrated coupler or attenuator shall be used to provide the correct termination impedance to facilitate the measurements. The equivalent isotropically radiated power is then calculated from the determined antenna gain.

If a system includes transponders, these are measured together with the interrogator.

In addition, the following tests shall be carried out with the dedicated or integrated antenna:

- equivalent isotropically radiated power (see clause 4.3.2);
- spurious emissions (see clause 4.3.5).

5.9.2 Equivalent isotropically radiated power (e.i.r.p.)

5.9.2.1 Method of measurement

5.9.2.1.1 General requirements

To measure e.i.r.p. it is first necessary to determine the appropriate method of measurement, see clauses 5.9.2.1.2 and 5.9.2.1.3. The -6 dB transmitter bandwidth shall be determined using a 100 kHz measuring bandwidth in order to establish which measurement method is applicable:

- clause 5.9.2.1.2 for Non spread spectrum transmitters with a -6 dB bandwidth of up to 20 MHz and spread spectrum transmitters with channel bandwidth of up to 1 MHz;
- clause 5.9.2.1.3 for all other transmitter bandwidths.

Using the applicable measurement procedure as described in the present clause 5.9.2.1 and Annex C, the power output shall be measured and recorded in the test report. The method of measurement shall be documented in the test report.

Measurements shall be performed at normal test conditions (see clause 5.6).

Where possible, the equipment shall be able to operate in a continuous transmit mode for testing purposes.

5.9.2.1.2 Non spread spectrum transmitters with a -6 dB bandwidth of up to 20 MHz and spread spectrum transmitters with channel bandwidth of up to 1 MHz

5.9.2.1.2.1 General

The method of measurement in clauses 5.9.2.1.2.2 or 5.9.2.1.2.3 shall only be used for:

- non spread spectrum equipment with a -6 dB bandwidth of 20 MHz or less and a duty cycle above 50 %;
- spread spectrum equipment with a -6 dB channel bandwidth of 1 MHz or less.

A spectrum analyser or frequency-selective voltmeter shall be used and tuned to the transmitter carrier at which the highest level is detected.

For FHSS systems, the hop frequency which provides the maximum indicated level shall be used. The frequency shall be indicated in the test report.

Other transmitters are tested according to clause 5.9.2.1.2.3.

5.9.2.1.2.2 Equipment measured as constant envelope modulation equipment

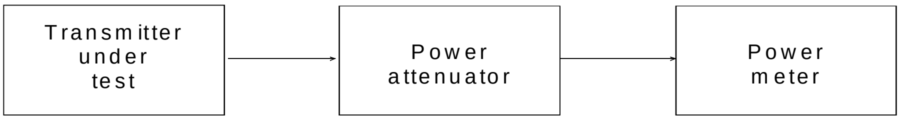

Figure 6: Measurement arrangement

For practical reasons, measurements shall be performed only at the highest power level at which the transmitter is intended to operate. The measurement arrangement in Figure 6 shall be used.

The measurement shall be performed preferably in the absence of modulation.

When it is not possible to measure it in the absence of modulation, this fact shall be stated in test reports.

The transmitter shall be set in continuous transmission 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.

The transmitter shall be connected to an artificial antenna (see clause 5.8.2) and the power delivered to this artificial antenna shall be measured.

The equivalent isotropically radiated power is then calculated from the measured value, the known antenna gain, relative to an isotropic antenna, and if applicable, any losses due to cables and connectors in the measurement system.

5.9.2.1.2.3 Equipment measured as non-constant envelope modulation equipment

The measurement shall be performed with test signals D-M2 or D-M3 as appropriate.

The transmitter shall be preferably set in continuous transmission mode. If this is not possible, the measurement can be performed in discontinuous mode.

The transmitter shall be connected to an artificial antenna (see clause 5.8.2) and the power delivered to this artificial antenna shall be measured. The measuring instrument shall have a measurement bandwidth not less than sixteen times the channel bandwidth.

The equivalent isotropically radiated power is then calculated from the measured value, the known antenna gain, relative to an isotropic antenna, and if applicable, any losses due to cables and connectors in the measurement system.

5.9.2.1.3 Transmitters other than those defined in clause 5.9.2.1.2

This method of measurement shall be used for:

a) equipment with a -6 dB bandwidth greater than 20 MHz, and equipment with a duty cycle below 50 %; or for

b) spread spectrum equipment with a channel bandwidth above 1 MHz.

The equivalent isotropically radiated power shall be determined and recorded.

In case of radiated measurements on smart antenna systems using symmetrical power distribution across the available transmit chains, the EUT should, where possible, be configured so that only one transmit chain (antenna) is activated while the other transmit chains are disabled. Where this is not possible, the method used shall be documented in the test report. If only one transmit chain was tested, the result for the active transmit chain shall be corrected to be valid for the whole system (all transmit chains).

NOTE: The power (in mW) for one transmit chain needs to be multiplied with the number of transmit chains to obtain the total power for the system.

The measurement shall be performed using normal operation of the equipment with the test modulation applied (see clause 5.8.1).

The test procedure shall be as follows:

Step 1:

- using a suitable means, the output of the transmitter shall be coupled to a matched diode detector;
- the output of the diode detector shall be connected to the vertical channel of an oscilloscope;
- the combination of the diode detector and the oscilloscope shall be capable of faithfully reproducing the envelope peaks and the duty cycle of the transmitter output signal;
- the observed duty cycle of the transmitter (Tx on/(Tx on + Tx off)) shall be noted as x, $(0 < x < 1)$ and recorded.

Step 2:

- the average output power of the transmitter shall be determined using a wideband, calibrated RF power meter with a matched thermocouple detector or an equivalent thereof and, where applicable, with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be recorded as "A" (in dBm);
- the e.i.r.p. shall be calculated from the above measured power output A and the applicable antenna assembly gain "G" in dBi, according to the formula:

$$P = A + G \tag{4}$$

  - P shall not exceed the value specified in clause 4.3.2.1.3.

The measurement shall be repeated at the lowest, the middle, and the highest frequency of the stated frequency range. These frequencies shall be recorded. FHSS equipment shall be made to hop continuously to each of these three frequencies separately.

5.9.2.1.4 Tests for indoor transmitters of 4 W

For fixed mounted 4 W equipment: Conformance is tested by checking the output power of the mounted interrogator. This should be 4 W. After this, the interrogator is removed from its mounting position, this can be done in either switched on or switched off condition. If the transmitter it is switched off and switched on again and its output power is tested again, the output power should be 500 mW. The interrogator is put back in its mounted position, and its output power is tested again, the output power should be still 500 mW.

For portable 4 W equipment test 1: Conformance is tested by checking the output power of the portable transmitter. This should be 4 W. After this, the control unit is removed from its mounting position, this can be done in either switched on or switched off condition. If the control unit is switched off and switched on again and the output power of the portable equipment is tested again, the output power should be 500 mW. The control unit is put back in its mounted position, and its output power is tested again, the output power should be still 500 mW.

For portable 4 W equipment test 2: For this test it is necessary to set a control area on the transmitter, this is a factory programmed area in which the 4 W portable device is intended to operate representing the applicable indoor situation (typically 4 m). Conformance is tested by checking the output power of the portable transmitter. This should be 4 W. After this the portable transmitter is moved outside the control area of the control unit. The output power of the portable equipment is tested, this should be 500 mW. After this the portable transmitter is moved inside the control area of the control unit. The output power of the portable equipment is tested, this should be 4 W.

5.9.3 Permitted range of operating frequencies

5.9.3.1 Method of measurement

The method of measurement for equipment employing stepped frequency modulation and FHSS is given in this clause and in clause 5.9.3.2.

Using applicable conducted measurement procedures, as described in Annex C, the frequency range(s) shall be measured and recorded in the test report.

Where applicable, during these measurements the test data sequence as specified in clauses 5.8.1 and 5.8.1.2 shall be used. The transmitter power level shall be set to the rated power level. During the test, the transmitter shall be set in continuous transmission 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.

These measurements shall be performed under both normal and extreme operating conditions except for the occupied bandwidth assessment for which measurement at normal operating conditions is sufficient.

The measurement procedure shall be as follows:

a) put the spectrum analyser in video trace averaging mode with a minimum of 50 sweeps selected;

b) select the lowest operating frequency of the equipment under test and activate the transmitter with modulation applied. The RF emission of the equipment shall be displayed on the spectrum analyser;

c) using the marker of the spectrum analyser, find the lowest frequency below the operating frequency at which the spectral power density drops below the level given in clause 4.3.3.2. This frequency shall be recorded in the test report;

d) select the highest operating frequency of the equipment under test and find the highest frequency at which the spectral power density drops below the value given in clause 4.3.3.2. This frequency shall be recorded in the test report;

e) the difference between the frequencies measured in steps c) and d) is the operating frequency range. It shall be recorded in the test report.

5.9.3.2 Method of measurement for equipment using FHSS modulation

Using an applicable conducted measurement procedure as described in Annex D the frequency range of the equipment shall be measured and recorded in the test report.

During these measurements the test data sequence, as specified in clause 5.8.1, shall be used. During the test, the transmitter shall be set in continuous transmission 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.

The transmitter power level shall be set to the maximum power level if controllable.

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

The measurement procedure shall be as follows:

a) put the spectrum analyser in video trace averaging mode with a minimum of 50 sweeps selected;

b) select the lowest hop frequency of the equipment under test and activate the transmitter with modulation applied;

c) find the lowest frequency below the operating frequency at which the spectral power density drops below the level given in clause 4.3.3.2. This frequency shall be recorded in the test report;

d) select the highest hop frequency of the equipment under test and find the highest frequency at which the spectral power density drops below the level given in clause 4.3.3.2. This frequency shall be recorded in the test report;

e) the difference between the frequencies measured in steps c) and d) is the frequency range. It shall be recorded in the test report.

5.9.4 Transmitter spectrum mask

5.9.4.1 Method of measurement

The following steps shall be carried out the band in which the interrogator is designed to operate.

The RF output of the EUT shall be connected to a spectrum analyser via a 50 Ω connector. In the case of EUT with an integral antenna, the EUT shall be placed in the test fixture (see clause 5.8.3) and the test fixture shall be connected to the spectrum analyser. Measurements shall be made on the declared channels of operation of the interrogator on those channels requiring full tests as defined in Table 9.

Step 1: Interrogator shall be operated at the carrier power measured under normal test conditions in see clause 5.6.1. The attenuator shall be adjusted to give an appropriate display on the spectrum analyser screen.

Step 2: The interrogator shall be configured to generate a succession of modulated transmit pulses. Each transmit pulse shall be modulated by the normal test signal (see clause 5.8.1).

Step 3: The output power of the interrogator, with or without a test fixture, shall be measured using a spectrum analyser, which shall be set to the following values:

a) Resolution bandwidth: 1 kHz.

b) Video bandwidth: Equal to the RBW.

c) Sweep Time: ≥ 4 seconds.

d) Span: 2 MHz.

e) Number of Sweep Points: ≥ Span/RBW.

f) Trace mode: Max. hold sufficient to capture all emissions.

g) Detection mode: Average.

Step 4: The measured values are the absolute values. The absolute levels of RF power shall be compared to the spectrum mask in Table 9.

Step 5: Where the interrogator includes multiple transmitter outputs, all of the outputs shall be connected via a suitable combiner network to the spectrum analyser. With the interrogator set up as in step 1 and configured to transmit the test signal described in step 2 while in its operational mode, the spectrum mask shall be measured at the spectrum analyser. The measured values shall be adjusted to compensate for the attenuation of the combiners and compared to the spectrum mask at Table 9.

NOTE: If for any reason the spectrum is measured with a resolution bandwidth other than 1 kHz, the measured values may be converted to the absolute values using formula (1):

$$B = A + 10\log\frac{1kHz}{BW_{MEASURED}} \tag{5}$$

Where:

- A is the value at the measured resolution bandwidth;
- B is the absolute value referred to a 1 kHz reference bandwidth; or

use the measured value, A, directly if the measured spectrum is a discrete spectral line (a discrete spectrum line is defined as a narrow peak with a level of at least 6 dB above the average level inside the measurement bandwidth).

5.9.5 Unwanted emissions in the spurious domain

5.9.5.1 Method of measurement

5.9.5.1.1 General Requirements

The level of spurious emissions shall be measured as either:

a) their power level in a specified load (conducted emission); and their effective radiated power when radiated by the cabinet and structure of the equipment (cabinet radiation); or

b) their effective radiated power when radiated by the cabinet and the integral or dedicated antenna, in the case of equipment fitted with such an antenna and no permanent RF connector.

For measurements above 1 000 MHz the peak value shall be measured using a spectrum analyser. The "max hold" function of a spectrum analyser shall be used. For measurements up to 1 000 MHz the quasi-peak detector set in accordance with the specification of EN IEC 55016-1-1 [1], clause 5, shall be used.

The correction for RBW described in clause 5.8.5 is to be applied to the measured results as applicable.

5.9.5.1.2 Conducted spurious emission

This method of measurement applies to transmitters having a permanent antenna connector.

Additional requirements for equipment employing FHSS modulation are given in clause 5.9.7.

a) The transmitter shall be connected to a measuring receiver through a test load, 50 Ω power attenuator, and if necessary, an appropriate filter to avoid overload of the measuring receiver. The bandwidth of the measuring receiver shall be adjusted until the sensitivity of the measuring receiver is at least 6 dB below the spurious emission limit given in clause 4.3.5.3. This bandwidth shall be recorded in the test report.

   For the measurement of spurious emissions below the second harmonic of the carrier frequency, the filter used shall be a high "Q" (notch) filter centred on the transmitter carrier frequency, which attenuates this signal by at least 30 dB.

   For the measurement of spurious emissions at and above the second harmonic of the carrier frequency the filter used shall be a high pass filter with a stop band rejection exceeding 40 dB. The cut-off frequency of the high pass filter shall be approximately 1,5 times the transmitter carrier frequency.

   Precautions may be required to ensure that the test load does not generate or that the high pass filter does not attenuate, the harmonics of the carrier.

b) The transmitter shall be unmodulated and operating at the maximum limit of its specified power range. If modulation cannot be inhibited then the test shall be carried out with modulation (see clause 5.8.1) and this fact shall be recorded in the test report.

c) The frequency of the measuring receiver shall be adjusted over the frequency range 25 MHz to 5 times the carrier frequency. The emissions within the channel occupied by the transmitter carrier and, for channelized systems its adjacent channels, shall not be recorded.

d) If the measuring receiver has not been calibrated in terms of power level at the transmitter output, the level of any detected components shall be determined by replacing the transmitter by the signal generator and adjusting it to reproduce the frequency and level of every spurious emission noted in step c). The absolute power level of each of the emissions shall be noted.

e) The frequency and level of each spurious emission measured and the bandwidth of the measuring receiver shall be recorded in the test report.

f) If a user accessible power adjustment is provided then the tests in steps c) to e) shall be repeated at the lowest power setting available.

g) The measurement in steps c) to f) shall be repeated with the transmitter in the standby condition if this option is available.

5.9.5.1.3 Method of measurement - cabinet spurious radiation

This method of measurement applies to transmitters having a permanent antenna connector. For equipment without a permanent antenna connector see clause 5.2.4.

Additional requirements for equipment employing FHSS modulation are given in clause 5.9.7.

a) A test site selected from clause C.2 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 and connected to a measuring receiver. The bandwidth of the measuring receiver shall be adjusted until the sensitivity of the measuring receiver, after allowing for the coupling loss, is at least 6 dB below the spurious emission limit given in clause 4.3.5. This bandwidth shall be recorded in the test report.

   The transmitter under test shall be placed on the support in its standard position, connected to an artificial antenna (see clause 5.8.2) and switched on without modulation. If modulation cannot be inhibited then the test shall be carried out with modulation, (see clause 5.8.1), and this fact shall be recorded in the test report.

b) The frequency of the measuring receiver shall be adjusted over the frequency range 25 MHz to 10 times the carrier frequency.

NOTE: If the test site is disturbed by interference coming from outside the site, this qualitative search may be performed in a screened room, with a reduced distance between the transmitter and the test antenna.

c) At each frequency at which an emission has been detected, the measuring receiver shall be tuned and the test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the measuring receiver.

d) The transmitter shall be rotated through 360° about a vertical axis, to maximize the received signal.

e) The test antenna shall be raised or lowered again through the specified height range until a maximum is obtained. This level shall be noted.

f) The substitution antenna (see clause C.3.2) shall replace the transmitter antenna in the same position and in vertical polarization. It shall be connected to the signal generator.

g) At each frequency at which an emission has been detected, the signal generator, substitution antenna, and measuring receiver shall be tuned. The test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the measuring receiver. The level of the signal generator giving the same signal level on the measuring receiver as in item e) shall be noted. After corrections due to the gain of the substitution antenna and the cable loss between the signal generator and the substitution antenna, is the radiated spurious emission at this frequency.

h) The frequency and level of each spurious emission measured and the bandwidth of the measuring receiver shall be recorded in the test report.

i) Steps c) to h) shall be repeated with the test antenna oriented in horizontal polarization.

j) If a user accessible power adjustment is provided then the tests in steps c) to h) shall be repeated at the lowest power setting available.

k) Steps c) to i) shall be repeated with the transmitter in the standby condition if this option is available.

5.9.5.1.4 Method of measurement - radiated spurious emission

This method of measurement applies to transmitters having an integral antenna.

Additional requirements for equipment employing FHSS modulation are given in clauses 5.9.5.1.5 and 5.9.7:

a) A test site selected from clause C.2 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 and connected to a measuring receiver, through a suitable filter to avoid overloading of the measuring receiver if required. The bandwidth of the measuring receiver shall be adjusted until the sensitivity of the measuring receiver, after allowing for the coupling loss, is at least 6 dB below the spurious emission limit given in clause 4.3.5.3. This bandwidth shall be recorded in the test report.

   - For the measurement of spurious emissions below the second harmonic of the carrier frequency the optional filter used shall be a high "Q" (notch) filter centred on the transmitter carrier frequency and attenuating this signal by at least 30 dB.

   - For the measurement of spurious emissions at and above the second harmonic of the carrier frequency the optional filter used shall be a high pass filter with a stop band rejection exceeding 40 dB. The cut-off frequency of the high pass filter shall be approximately 1,5 times the transmitter carrier frequency.

   - The transmitter under test shall be placed on the support in its standard position and shall be switched on without modulation. If modulation cannot be inhibited then the test shall be carried out with modulation (see clause 5.8.1) and this fact shall be recorded in the test report.

b) The same method of measurement as steps b) and k) of clause 5.9.5.1.3 shall be used.

5.9.5.1.5 Additional requirements for equipment employing FHSS modulation

Measurements shall be carried out while the equipment is hopping between two frequencies separated by the maximum hop frequency change, one of which is the lowest hop frequency.

The measurements shall be repeated on two frequencies separated by the maximum hop frequency change, one of which is the highest hop frequency.

5.9.6 Duty cycle

5.9.6.1 Method of measurement

An assessment of the overall Duty Cycle shall be made for a representative period of T_{obs} over the observation bandwidth F_{obs}. Unless otherwise specified, T_{obs} is 1 hour and the observation bandwidth F_{obs} is the operational frequency band.

The representative period shall be the most active one in normal use of the device. As a guide "Normal use" is considered as representing the behaviour of the device during transmission of 99 % of the [emissions] generated during its operational lifetime.

Procedures such as setup, commissioning, and maintenance are not considered part of normal operation.

For manual operated or event dependant devices, with or without software controlled functions, it shall determine whether the device once triggered, follows a pre-programmed cycle, or whether the transmitter remains on until the trigger is released or the device is manually reset. The application for the device including a typical usage pattern shall be described. The typical usage pattern as shall be used to determine the duty cycle and compare to the limit in clause 4.3.6.3, Table 7.

Where an acknowledgement is required, the additional transmitter on-time shall be included.

5.9.7 Additional requirements for FHSS equipment

5.9.7.1 Method of measurement

5.9.7.1.0 General

The total number of hops, the dwell time and the maximum separation of hops measurements shall be performed as described in clauses 5.7.1.1 and 5.7.1.2. The values and measurement method utilized shall be stated in the test report.

5.9.7.1.1 Total number of hops and maximum separation of hops

- Place the equipment in FHSS mode if there is a separate setting for this.
- Connect a spectrum analyser either directly to the device or use a suitable test antenna. Antenna calibration is not critical for this test. The span of the spectrum analyser should be set at > 25 % larger than the expected operational frequency range.
- Adjust the resolution bandwidth of the analyser till the individual hop frequencies are visible with the device transmitting.
- Place the analyser in trace maxhold with peak detector and record the maximum of at least 100 sweeps/acquisitions.
- Determine the number of hops from the recording, this should be at least 20.
- Identify the highest and lowest hop frequency using markers and determine if the difference is at least 90 % of the operational bandwidth.
- Use markers to determine the frequency difference between individual hop frequencies.

The values and measurement method utilized shall be stated in the test report.

5.9.7.1.2 Dwell time

The dwell time is the maximum time a signal allowed to be on one frequency or phrased differently the time between frequency changes. As RFID readers have a simple hop sequence and fixed hop times a simplified procedure is sufficient.

- Place the equipment in FHSS mode if there is a separate setting for this.
- Connect a spectrum analyser either directly to the device or use a suitable test antenna. Antenna calibration is not critical for this test. The span of the spectrum analyser should be set at > 25 % larger than the expected operational frequency range.
- Adjust the resolution bandwidth of the analyser till the individual hop frequencies are visible with the device transmitting.
- Set the analyser as manual trigger single sweep/acquisition, peak detector, sweep/acquisition time < 1 sec.
- Perform a number of manual triggered sweeps/acquisitions. On each of these sweeps/acquisitions at least two hop frequencies need to be visible.

The results and measurement method utilized shall be stated in the test report.

5.10 Receiver requirements

5.10.1 General performance criteria

For the purpose of the receiver performance tests, the receiver shall produce an appropriate output under normal conditions as indicated in clause 4.4.1.

Tthe measurements shall be performed using normal operation of the equipment with the equipment operating in accordance utilizing the worst-case configuration with regards to the requirement to be tested. For each of the requirements in the present document, this worst-case configuration shall be documented in the test report to assure that the equipment is performing in accordance with its intended use. Special software or other alternative methods may be used to operate the equipment in this mode.

5.10.2 Blocking or desensitization

5.10.2.1 Method of measurement

This measurement shall be conducted under normal conditions.

Two signal generators A and B shall be connected to the receiver via a combining network to the receiver as shown in Figure 6.

5.10.2.2 Method of measurement for blocking or desensitization

5.10.2.2.1 Test Conditions

1) The measurements shall be performed on the EUT set to one of the channels.
2) Conducted method of measurement is shown in clause 5.10.2.2.2.
3) Radiated method of measurement is shown in clause 5.10.2.2.3.

5.10.2.2.2 Conducted measurement

Two signal generators A and B shall be connected to the EUT via a combining network as shown in Figure 7.

The measurements in clause 5.10.2.2.4 shall be performed.

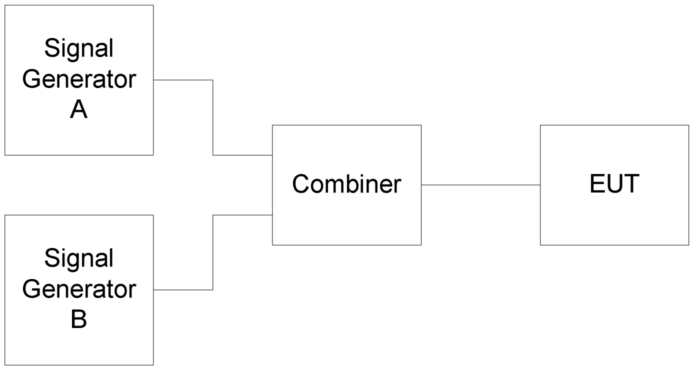

Figure 7: Measurement arrangement

5.10.2.2.3 Radiated measurement

A test site is selected from those described in clause C.2.

Signal generators A and B together with the combiner, shown in Figure 7 shall be placed outside the test site.

The output of the combiner shall be connected to a transmit test antenna with the same antenna polarization as the EUT. The transmit test antenna shall be placed in the test site.

The EUT shall be placed at the location of the turntable at the orientation of the most sensitive position.

The measurements in clause 5.10.2.2.4 shall be performed using appropriate radiated measurement methods described in clause D.3.

5.10.2.2.4 Measurement procedure

The method of coupling to the receiver shall be stated in the test report.

Signal generator A shall be at the nominal frequency of the receiver, with normal modulation of the wanted signal. Signal generator B shall be unmodulated and shall be adjusted to a test frequency at approximately 10 times, 20 times and 50 times of the occupied bandwidth above upper band edge of occupied bandwidth.

Initially signal generator B shall be switched off and using signal generator A the level which still gives sufficient response shall be established. The output level of generator A shall then be increased by 3 dB.

Signal generator B is then switched on and adjusted until the wanted criteria are met. This level shall be recorded.

The measurement shall be repeated with the test frequency for signal generator B at 10 times, 20 times and 50 times of the occupied bandwidth below the lower band edge of the occupied bandwidth.

The blocking or desensitization shall be recorded as the level in dBm of lowest level of the unwanted signal (generator B).

Signal generator A may be replaced by a physical tag positioned at 70 % of the measured system range in metres. In this case, the blocking or desensitization shall be recorded as the ratio in dB of lowest level of the unwanted signal (generator B) resulting in a non-read of the tag to the sensitivity of the receiver +3 dB.

5.10.3 Spurious radiations

5.10.3.1 Method of measurement for spurious radiation

5.10.3.1.1 General Requirements

The level of spurious radiations shall be measured by either:

a) their power level in a specified load (conducted spurious emission) and their effective radiated power when radiated by the cabinet and structure of the equipment (cabinet radiation); or

b) their effective radiated power when radiated by the cabinet and the integral or dedicated antenna, in the case of portable equipment fitted with such an antenna and no permanent RF connector.

For measurements above 1 000 MHz the peak value shall be measured using a spectrum analyser. The "max hold" function of a spectrum analyser shall be used. For measurements up to 1 000 MHz the quasi-peak detector set in accordance with the specification of EN IEC 55016-1-1 [1], clause 5 shall be used.

5.10.3.1.2 Method of measurement conducted spurious components

Spurious emission levels from a transmitter and receiver of full duplex equipment using a common port are measured simultaneously and the test only needs to be conducted once. A test load, 50 Ω power attenuator, may be used to protect the measuring receiver (see clause 5.8.5) against damage when testing a receiver combined in one unit with a transmitter.

The measuring receiver used shall have sufficient dynamic range and sensitivity to achieve the required measurement accuracy at the specified limit. The bandwidth of the measuring receiver shall be adjusted until the sensitivity of the measuring receiver is at least 6 dB below the spurious emission limit given in clause 4.4.4.3. This bandwidth shall be recorded in the test report:

a) The receiver input terminals shall be connected to a measuring receiver having an input impedance of 50 Ω and the receiver is switched on.

b) The frequency of the measuring receiver shall be adjusted over the frequency range 25 MHz to 25,54 GHz.

c) If the detecting device is not calibrated in terms of power input, the level of any detected components shall be determined by replacing the receiver by the signal generator and adjusting it to reproduce the frequency and level of every spurious component noted in step b). The absolute power level of each spurious component shall be noted.

d) The frequency and level of each spurious emission measured and the bandwidth of the measuring receiver shall be recorded in the test report.

5.10.3.1.3 Method of measurement cabinet radiation

This method of measurement applies to receivers having a permanent antenna connector:

a) A test site selected from clause C.2 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 and connected to a measuring receiver. The bandwidth of the measuring receiver shall be adjusted until the sensitivity of the measuring receiver is at least 6 dB below the spurious emission limit given in clause 4.4.4.3. This bandwidth shall be recorded in the test report.

   The receiver under test shall be placed on the support in its standard position and connected to an artificial antenna, see clause 5.8.2.

b) The frequency of the measuring receiver shall be adjusted over the frequency range 25 MHz to 13 GHz. The frequency of each spurious component shall be noted. If the test site is disturbed by radiation coming from outside the site, this qualitative search may be performed in a screened room with reduced distance between the transmitter and the test antenna.

c) At each frequency at which a component has been detected, the measuring receiver shall be tuned and the test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the measuring receiver.

d) The receiver shall be rotated up to 360° about a vertical axis, to maximize the received signal.

e) The test antenna shall be raised or lowered again through the specified height range until a maximum is obtained. This level shall be noted.

f) The substitution antenna (see clause C.3.2) shall replace the receiver antenna in the same position and in vertical polarization. It shall be connected to the signal generator.

g) At each frequency at which a component has been detected, the signal generator, substitution antenna and measuring receiver shall be tuned. The test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the measuring receiver. The level of the signal generator giving the same signal level on the measuring receiver as in step e) shall be noted. This level, after correction due to the gain of the substitution antenna and the cable loss, is the radiated spurious component at this frequency.

h) The frequency and level of each spurious emission measured and the bandwidth of the measuring receiver shall be recorded in the test report.

i) Measurements b) to h) shall be repeated with the test antenna oriented in horizontal polarization.

5.10.3.1.4 Method of measurement radiated spurious components

This method of measurement applies to receivers having an integral antenna.

a) A test site selected from Annex C 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 and connected to a measuring receiver. The bandwidth of the measuring receiver shall be adjusted until the sensitivity of the measuring receiver is at least 6 dB below the spurious emission limit given in clause 4.4.3.3. This bandwidth shall be recorded in the test report.

   The receiver under test shall be placed on the support in its standard position.

b) The same method of measurement as items b) to i) of clause 5.10.3.1.3 shall apply.

5.10.4 Receiver sensitivity

5.10.4.1 Method of measurement for receiver sensitivity

5.10.4.1.1 Test Conditions

1) The measurements shall be performed on the EUT set to one of the channels.

2) Conducted method of measurement is shown in clause 5.10.4.1.2.

3) Radiated method of measurement is shown in clause 5.10.4.1.3.

5.10.4.1.2 Method of measurement conducted receiver sensitivity

The EUT shall be connected to the output of a signal generator.

The measurements in clause 5.10.4.1.4 shall be performed.

5.10.4.1.3 Method of measurement radiated receiver sensitivity

A test site is selected from those described in clause C.2.

The output of the signal generator shall be connected to a transmit test antenna with the same antenna polarization as the EUT. The transmit test antenna shall be placed in the test site.

The EUT shall be placed at the location of the turntable at the orientation of the most sensitive position.

The measurement in clause 5.10.4.1.4 shall be performed using appropriate radiated measurement methods described in clause D.3.

5.10.4.1.4 Measurement procedure

The signal generator, modulated with an appropriate test signal, shall be set to the same channel as mentioned under this clause.

Step 1:

The operation of the EUT shall be started as a receiver on the normal operating frequency.

Step 2:

The level of the input signal to the EUT shall be adjusted until the wanted criterion of -60 dBm is just exceeded.

Step 3:

With the signal generator settings unchanged, the power received by EUT shall be established by appropriate means. The receiver sensitivity shall be noted.

Step 5:

The information shown in Table 10 shall be recorded in the test report.

Table 10: Information Recorded in the Test Report

Value	Notes
Test signal	The test signal used
Data rate	EUT data rate
Measurement method	BER/message success ratio/other
Measurement description	Description of message success ratio calculation/other measurement method if applicable
Operating frequency	
Receiver sensitivity	Measured signal generator power level

5.10.5 Adjacent channel selectivity

5.10.5.1 Method of measurement for adjacent channel selectivity

5.10.5.1.1 Test conditions

1) The measurements shall be performed on the EUT set to one of the channels in the band.

2) Conducted method of measurement is shown in clause 5.10.5.1.2.

3) Radiated method of measurement is shown in clause 5.10.5.1.3.

5.10.5.1.2 Conducted measurement

Two signal generators A and B shall be connected to the EUT via a combining network as shown in Figure 6.

5.10.5.1.3 Radiated measurement

A test site is selected from those described in clause C.2.

Signal generators A and B together with the combiner, shown in Figure 7 shall be placed outside the test site.

The output of the combiner shall be connected to a transmit test antenna with the same antenna polarization as the EUT. The transmit test antenna shall be placed in the test site.

The EUT shall be placed at the location of the turntable at the orientation of the most sensitive position.

The measurements in clause 5.10.5.1.4 shall be performed using appropriate radiated measurement methods described in clause D.3.

5.10.5.1.4 Measurement procedure

Signal generator A shall be configured to generate the wanted signal at the nominal operating frequency of the EUT receiver.

Signal generator B shall be configurated to generate the same type of signal as the wanted signal and shall be adjusted to the Adjacent Channel centre frequency immediately above the operating channel.

Signal generator B shall be powered off.

Signal generator A shall be set to the minimum level which gives the wanted performance criterion of the EUT or the reference level of -60 dBm, whichever is the higher. 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 to the minimum level at which the wanted performance criterion is just not achieved.

The ACS is then the power received from generator B at the EUT antenna connector.

This can either be measured on the antenna connector in case of conducted tests or be calculated for radiated test

The measurements shall be repeated with signal generator B adjusted to the Adjacent Channel centre frequency immediately below the Operating Channel.

The information shown in Table 11 shall be recorded in the test report for each measured Adjacent Channel.

Table 11: Information Recorded in the Test Report

Value	Notes
EUT frequency	Operating Frequency of the receiver
Upper Adjacent Channel Selectivity at Nominal operating Frequency plus OCW	
Lower Adjacent Channel Selectivity at Nominal Operating Frequency minus OCW	

5.10.6 Receiver spurious response rejection

5.10.6.1 Method of measurement for receiver spurious response rejection

5.10.6.1.1 Test conditions

1) The measurements shall be performed on the EUT set to one of the channels.

2) Conducted method of measurement is shown in clause 5.10.6.1.2.

3) Radiated method of measurement is shown in clause 5.10.6.1.3.

5.10.6.1.2 Conducted measurement

Two signal generators A and B shall be connected to the EUT via a combining network as shown in Figure 3.

The measurements in clause 5.10.6.1.4 shall be performed.

5.10.6.1.3 Radiated measurement

A test site is selected from those described in clause C.2.

Signal generators A and B together with the combiner, shown in Figure 7, shall be placed outside the test site.

The output of the combiner shall be connected to a transmit test antenna with the same antenna polarization as the EUT. The transmit test antenna shall be placed in the test site.

The EUT shall be placed at the location of the turntable at the orientation of the most sensitive position.

The measurements in clause 5.10.6.1.4 shall be performed.

5.10.6.1.4 Measurement procedure

The spurious response shall be performed at frequencies: carrier frequency fc / 2 and carrier frequency fc / 3. Signal generator A shall be configured to generate the wanted signal at the operating frequency of the EUT receiver. Signal generator B shall be adjusted to radiate an un-modulated signal at test frequencies of approximately carrier frequency fc / 2 and carrier frequency fc / 3.

Step 1:

Signal generator B shall be switched off. Signal generator A shall be set to the minimum level which gives the wanted performance criterion of EUT or the reference level of -60 dBm, whichever is the higher. The output level of generator A shall then be increased by 3 dB.

Step 2:

Signal generator B is then switched on and the signal amplitude is adjusted to the minimum level at which the wanted performance criterion is just not achieved.

With signal generator B settings unchanged, the receiver shall be replaced with a RF power measuring equipment. The power into the measuring equipment shall be measured and noted.

The spurious response rejection is then the conducted power received from generator B at the EUT antenna connector.

This can either be measured on the antenna connector for conducted test or be calculated for radiated test (see Annex D).

Spurious response rejection values shall not be less the requested technical requirement.

The information shown in Table 12 shall be recorded in the test report for each measurement.

Table 12: Information Recorded in the Test Report

Value	Notes
Operating Frequency	Nominal centre frequency of the receiver
Signal generator A	Power level of signal generator A
Spurious response rejection	Power level of signal generator B
NOTE: If several Operational Frequency bands are used by the equipment, measurement have to be performed in each band.	

5.10.7 Receiver maximum input signal level

5.10.7.1 Method of measurement for receiver maximum input signal level

5.10.7.1.1 Test conditions

1) The measurements shall be performed on the EUT set to one of the channels.
2) Conducted method of measurement is shown in clause 5.10.7.1.2.
3) Radiated method of measurement is shown in clause 5.10.7.1.3.

5.10.7.1.2 Conducted measurement

The EUT shall be connected to the output of a signal generator.

The measurements in clause 5.10.7.1.4 shall be performed.

5.10.7.1.3 Radiated measurement

A test site is selected from those described in clause C.2.

The output of the signal generator shall be connected to a transmit test antenna with the same antenna polarization as the EUT. The transmit test antenna shall be placed in the test site.

The EUT shall be placed at the location of the turntable at the orientation of the most sensitive position.

The measurement in clause 5.10.7.1.4 shall be performed using appropriate radiated measurement methods described in clause D.3.

5.10.7.1.4 Measurement procedure

Step 1:

The signal generator shall be configured to generate the wanted signal of the operating frequency The operation of the EUT shall be started as a receiver on the same nominal operating frequency.

Step 2:

The level of the input signal to the EUT shall be increased until the wanted criteria (see clause 4.2) is no longer obtained or the limit specified of -60 dBm is reached.

Step 3:

With the signal generator settings unchanged, the output of the signal generator shall be connected to an RF power measuring equipment.

For a conducted test:

- The power into the measuring equipment shall be measured.

For a radiated test:

- The power into the measuring equipment plus the gain of the test antenna minus cables losses shall be measured.

The receive power level shall be noted.

Step 4:

The information shown in Table 13 shall be recorded in the test report.

Table 13: Information Recorded in the Test Report

Value	Notes
Test signal	The test signal used
Data rate	EUT data rate
Measurement method	BER/message success ratio/other
Measurement description	Description of message success ratio calculation/other measurement method if applicable
Operating frequency	
Maximum input signal level	Measured power level

Step 5:

Steps 1 to 4 shall be repeated for each data rate at which the EUT is able to operate.

Annex A (informative): 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.3] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU [i.7] 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.

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 [i.7]

Harmonised Standard ETSI EN 303 851					
Requirement				**Requirement Conditionality**	
No	**Description**	**Essential requirements of Directive**	**Clause(s) of the present document**	**U/C**	**Condition**
1a	e.i.r.p.	3.2	4.3.2.1	C	Applies to transmitters for indoor and outdoor use up to 500 mW
1b	e.i.r.p.	3.2	4.3.2.2	C	Applies to transmitters for outdoor use up to 4 W
2	Permitted range of operating frequencies	3.2	4.3.3	U	
3	Transmitter Spectrum mask	3.2	4.3.4	U	
4	Unwanted emissions in the spurious domain	3.2	4.3.5	U	
5	Duty Cycle	3.2	4.3.6	C	Transmitting more than 500 mW e.i.r.p. power
6	Additional requirements for FHSS equipment	3.2	4.3.7	C	Equipment utilizing FHSS modulation
7	Blocking or desensitization	3.2	4.4.2	U	
8	Spurious radiation	3.2	4.4.3	C	Applies to all receivers, except receivers used in combination with permanently co-located transmitters continuously transmitting
9	Receiver sensitivity	3.2	4.4.4	U	
10	Adjacent channel selectivity	3.2	4.4.5	U	
11	Receiver spurious response rejection	3.2	4.4.6	U	
12	Receiver maximum input signal level	3.2	4.4.7	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.

Essential requirements of Directive

Identification of article(s) defining the requirement in the Directive.

Clause(s) of the present document

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 unconditionally applicable (U) or is conditional upon the manufacturer's claimed functionality of the equipment (C).

Condition Explains the conditions for the requirement is.

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 (informative): Selection of technical parameters

B.1 Introduction

ETSI EG 203 336 [i.2] lists candidate technical parameters to be included in a Harmonised Standard aimed at providing a presumption of conformity of radio equipment with the essential requirements in articles 3.1(b) and 3.2 of the Radio Equipment Directive 2014/53/EU [i.7].

Essential requirements are high level objectives described in European Directives. The purpose of the Harmonised Standard is to translate those high level objectives into detailed technical specifications.

This annex provides information regarding selected parameters that may be in or not in the present document.

Annex C (normative): Radiated measurements

C.1 General requirements for measurements involving the use of radiated fields

Measurements involving radiated fields require a prepared test site, well-characterized antenna equipment, calibrated test instrumentation, appropriate ancillary equipment such as cabling and filters, and appropriate test plans and methods. This annex provides minimum requirements and examples of suitable practice.

Test sites shall be suitable for radiated measurements and shall be designed to eliminate significant effects of objects or materials capable of influencing the interaction between test sample or substitute antenna and test antenna and instrumentation.

Test sites may consist of:

- Indoor sites.
- Anechoic test sites.

The nature of the test site, precautions taken and evidence of suitability shall be recorded with the results of the tests.

Principal items of equipment are:

- Equipment under test with associated cabling.
- Antennas:
    - Test antenna.
    - Substitution antenna.
    - Artificial antenna.
- Test equipment:
    - Calibrated measuring receiver, spectrum analyser or other appropriate receiving instrument.
    - Calibrated filtering equipment.
    - Calibrated recording equipment.

The provisions below describe minimum acceptable standards for test sites, test methods and equipment and scope of testing.

The provisions below are appropriate for measurements in the far-field. Test result shall record where the near-field conditions are entered and the additional measurement uncertainty shall be evaluated, recorded and added to the test result, see clause C.5.

C.2 Test Sites

C.2.0 General

There is a choice between two different test sites indoor - and shielded anechoic test site. The two alternatives will yield the same level of secureness and will give an objective, verifiable evidence of conformance.

Argumentation:

The standard deals with radiated emissions in terms of far field. The choice of test site or measurement chamber is therefore not relevant in terms of outcome as long as the calibration is valid for the used frequency range.

Uncertainty however exists in terms of measurement uncertainty caused by reflections and shielding, this is part of the radiated emission uncertainty as stated in Table G.1. The total measurement uncertainty should be determined by the individual performing the test and deemed sufficient for the test according Table G.1.

C.2.1 Indoor test site

An indoor site may be used for test frequencies above 80 MHz. If an indoor site is used, this shall be recorded in the test report.

An indoor test site, see Figure C.1, shall provide:

- Floor, ceiling above 2,7 m, test sample wall and test antenna wall separated by at least 7 m and side walls separated by at least 6 m.
- A test antenna providing adequate sensitivity over the range of test frequencies and also providing adequate isolation from the effects of floor, ceiling, test antenna wall and side walls.

EXAMPLE: A corner reflector antenna.

- A test sample wall treated with anechoic material to render its effect negligible.
- Non-conducting supports for the test item or substitution antenna and the test antenna.
- Measured support positions on the long axis of the site and at least 3 m apart for the test item or substitution antenna and the test antenna.
- Sufficient precautions to ensure that the presence of objects within the room does not degrade the measurement results. This shall be validated with the NSA method in accordance with EN IEC 55016-1-4 [2], clause 6.7 or with the reference site method in accordance with EN IEC 55016-1-4 [2], clause 6.6.
- Provision for free-mounting test samples to be supported 1,5 m above the ground and rotated through 360° in the horizontal plane.
- Provision for floor-standing equipment to be mounted 100 mm above the ground and rotated through 360° in the horizontal plane.
- Provision for the test antenna to be centred at a height more than 1,35 m above the floor and more than 1,35 m below the ceiling, and to be rotated for operation in any plane of polarization.
- Provision for a substitution antenna to replace the equipment under test and to be moved up to ±0,1 m in any direction.

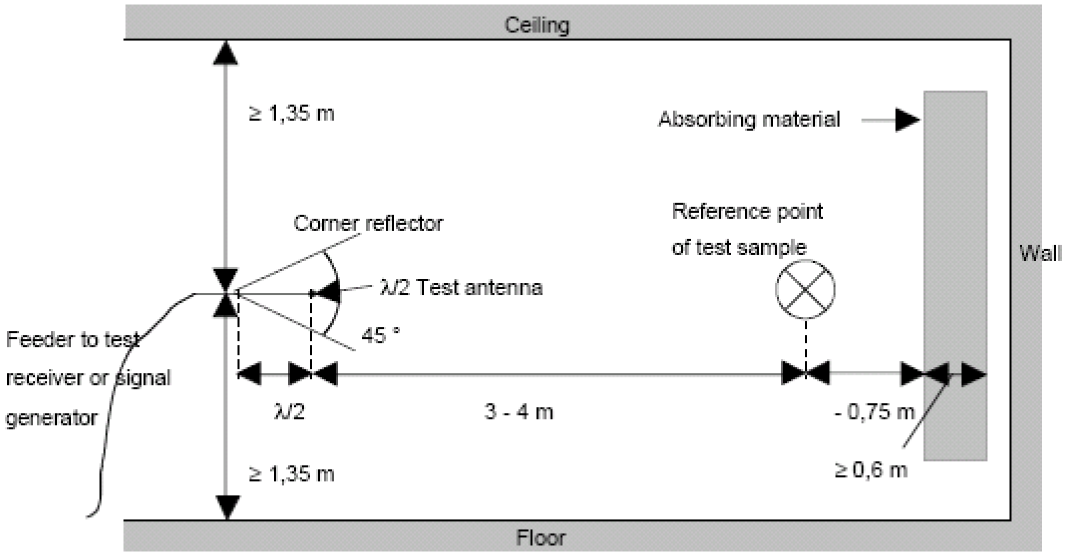

Figure C.1: Indoor site arrangement (shown for horizontal polarization)

C.2.2 Shielded anechoic test site

C.2.2.0 General

"Anechoic" means that the walls, floor and ceiling of the enclosed test site are treated to substantially reduce radio reflections.

For radiation measurements under the present document a shielded, calibrated anechoic chamber may be used to simulate a free space environment. Such use shall be frequencies above 100 MHz unless specific treatment and calibration evidence at lower frequencies is provided. Calibration by a competent body shall confirm reflection attenuation at the walls to meet the limits provided in Figure C.2. Shielding better than the limits provided by Figure C.2 is desirable. An example of the construction of an anechoic chamber is shown in Figure C.3.

The chamber shall provide sufficient space to carry out tests as in the general method. If such a chamber is used, this shall be recorded in the test report.

The test antenna, measuring receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method.

C.2.2.1 Influence of parasitic reflections in anechoic chambers

With an anechoic chamber of the dimensions suggested in clause C.2.2.0 at low frequencies up to 100 MHz far field conditions are not met and specific calibration procedures will be required. Careful attention is also required to the chamber calibration for frequencies above 1 GHz.

C.2.2.2 Calibration of the shielded RF anechoic chamber

The chamber shall be calibrated over the range 30 MHz to 66 GHz.

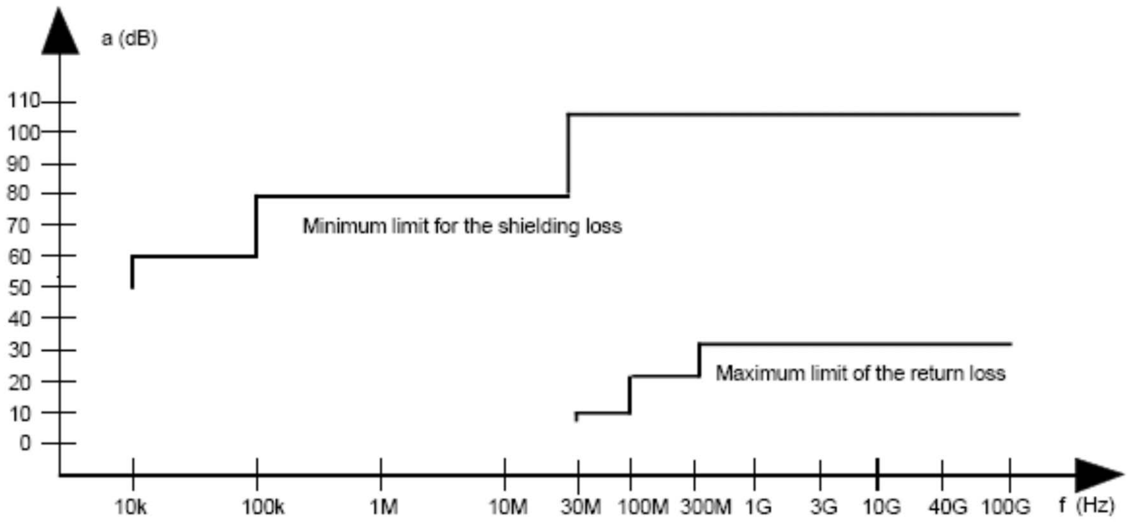

Figure C.2: Specification for shielding and reflections

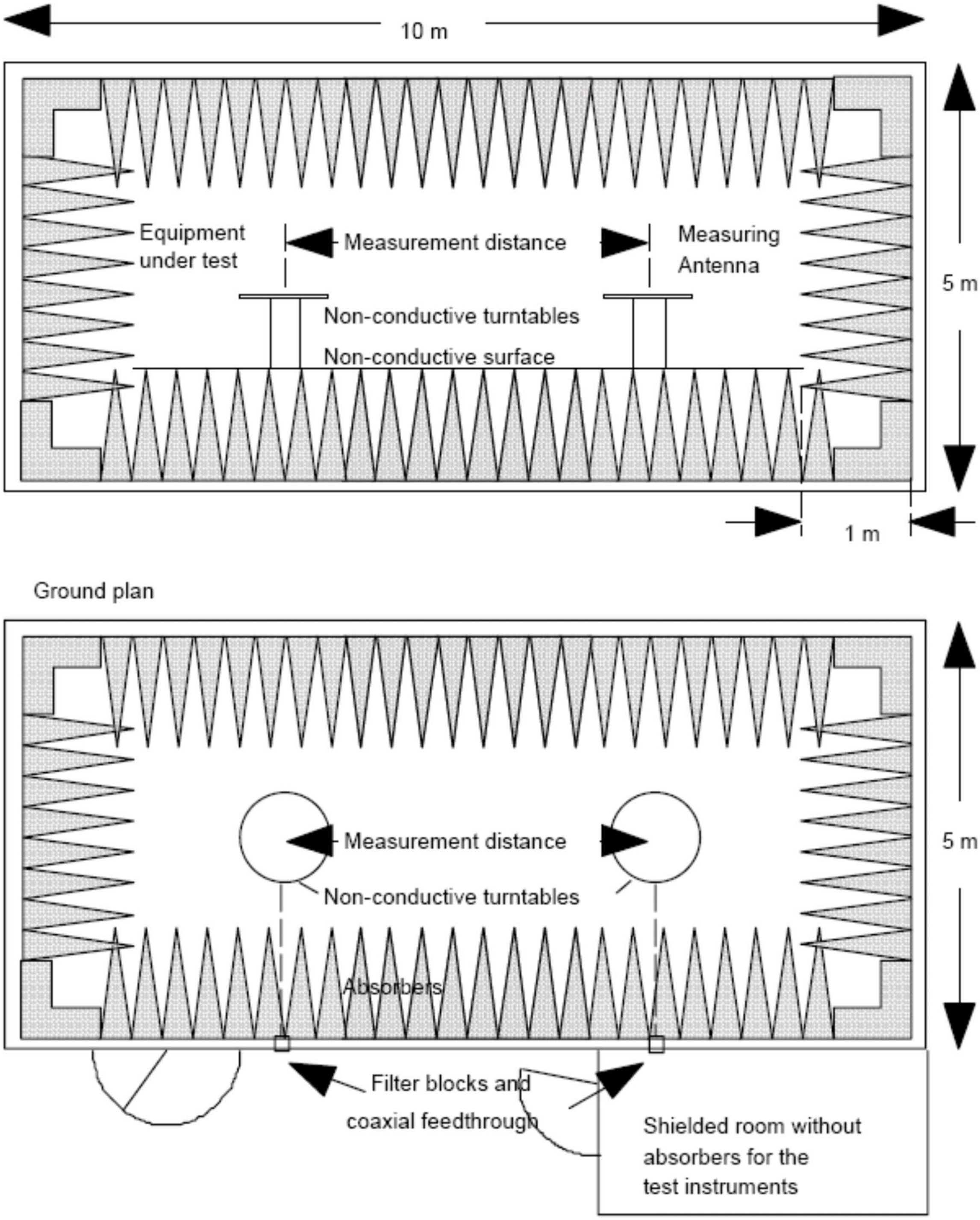

Figure C.3: Example of construction of an anechoic shielded chamber

C.3 Antennas

C.3.1 Test antenna

The test antenna is used to detect the radiation from both the test sample and the substitution antenna for emission measurements. It is used as a transmitting antenna for the measurement of receiver characteristics.

The test antenna support provides for either horizontal or vertical polarization and for the height of its centre above ground to be varied over the range 1 m to 4 m or to the ceiling of an indoor or anechoic chamber, whichever is less. The test antenna shall provide boresight directivity equal to at least half the wall reflectivity limit prescribed in Figure C.2. The length of the test antenna along the measurement axis shall not exceed 20 % of the measuring distance.

For emission measurements, the test antenna is connected to a calibrated measuring receiver capable of being tuned to any frequency under investigation.

For receiver sensitivity measurements, the test antenna is connected to a calibrated signal generator capable of being tuned to any frequency under investigation.

Height variation shall be used to find the point at which the radiation is a maximum near the initial position.

C.3.2 Substitution antenna

A substitution antenna may be used in place of the equipment under test when comparing equipment emissions with standard emissions.

When measuring in the frequency range up to 1 GHz the substitution antenna shall be a λ/2 dipole, resonant at the operating frequency, or a shortened dipole, calibrated to the λ/2 dipole. When measuring in the frequency range above 4 GHz, a horn radiator shall be used. For measurements between 1 GHz and 4 GHz either a λ/2 or a horn radiator may 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 internally, or the phase centre of an external antenna.

The distance between the lower extremity of the dipole and the ground shall not be less than 0,3 m.

The substitution antenna shall be connected to a calibrated signal generator when the site is used for spurious radiation measurements and transmitter effective radiated power measurements. The substitution antenna shall be connected to a calibrated measuring receiver when the site is used for the measurement of receiver sensitivity.

The signal generator and the receiver shall be connected to the antenna through suitable matching and balancing networks.

Where a shortened dipole antenna is used at these frequencies, details of the type of antenna used shall be included with the results of the tests and correction factors shall be taken into account.

The substitution antenna shall be moved through a distance of ±0,1 m in the direction of the test antenna as well as in the two directions perpendicular to this first direction to find the position of maximum response. If these changes of position cause a signal change of greater than 2 dB, the test sample should be re-sited and measurements repeated until a change of less than 2 dB with the substitution antenna is obtained.

C.3.3 Artificial antenna

An artificial antenna may be connected to the equipment output port when cabinet or enclosure emissions are being tested and shall be substantially non-radiating.

Where possible, a direct connection should be used between the artificial antenna and the test sample. In cases where it is necessary to use a connecting cable, precautions should be taken to reduce the radiation from this cable by, for example, the use of ferrite cores or double screened cables.

C.4 Test Practice and Auxiliary Test Equipment

Antenna characteristics and positions and test equipment settings shall be recorded with each test result.

Test equipment calibration shall be traceable to appropriate European standards. Test equipment, antenna and cable types or characteristics shall be recorded with the results of the tests.

Test methods shall comply with operator instructions for each item of equipment, with the measurements and limits described in the present document, and with the provisions and guidelines given below.

All test equipment shall be calibrated with traceability to European standards and used in accordance with the manufacturer's recommended operating procedures.

C.5 Measuring distance

C.5.0 General

Under the conditions provided in this annex, measurement frequencies will be above 25 MHz and the measuring distance should be greater than $2D^2/\lambda$ or $\lambda/2$, whichever is greater, at the frequency of measurement where D is the largest transmitting aperture dimension (far-field conditions). Outdoor sites will be required for low frequency measurements unless special provisions are made at an indoor, anechoic or near field site.

C.5.1 Standard position

The standard position in all test sites, except for equipment which is intended to be worn on a person, shall be as follows:

- for equipment with an integral antenna, it shall be placed in the position closest to normal use;
- for equipment with a rigid external antenna, the antenna shall be vertical;
- for equipment with non-rigid external antenna, the antenna shall be supported by a non-conducting support at the initial height of the test antenna.

C.5.2 Auxiliary cables

The position of auxiliary cables (power supply and microphone cables, etc.) which are not adequately de-coupled, may cause variations in the measurement results. In order to get reproducible results, cables and wires of auxiliaries should be arranged vertically downwards (through a hole in the non conducting support), or as specified in the technical documentation supplied with the equipment.

Care shall be taken to ensure that test cables do not adversely affect the measuring result.

Annex D (normative): General description of measurement methods

D.0 General

This annex gives the general methods of measurements for RF signals using the test sites and arrangements described in Annex C. In addition, this annex gives a simple measurement method for radiated emissions based on a calculated rather than measured path loss.

D.1 Conducted measurements

In view of the low power levels of the equipment to be tested under the present document, conducted measurements may be applied to equipment provided with an antenna connector. Where the equipment to be tested does not provide a suitable termination, a coupler or attenuator that does provide the correct termination value shall be used.

The equivalent isotropically radiated power is then calculated from the measured value, the known antenna gain, relative to an isotropic antenna, and if applicable, any losses due to cables and connectors in the measurement system.

D.2 Radiated measurements

Radiated measurements shall be performed with the aid of a test antenna and measurement receiver as described in Annex C. The test antenna and measurement receiver, spectrum analyser or selective voltmeter, 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.

Preferably, radiated measurements shall be performed in an anechoic chamber. For other test sites corrections may be needed (see Annex C).

a) A test site which fulfils the requirements of the specified frequency range of this measurement shall be used.

b) The transmitter under test shall be placed on the support in its standard position (clause C.5.1) and switched on.

c) The test antenna shall be oriented initially for vertical polarization unless otherwise stated. The test antenna shall be raised or lowered, through the specified height range until the maximum signal level is detected on the measuring receiver.

   The test antenna need not be raised or lowered if the measurement is carried out on a test site according to clause C.2.2.

d) The transmitter shall be rotated through 360° about a vertical axis to maximize the received signal.

e) 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).

f) This measurement shall be repeated for horizontal polarization.

g) 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 transmitter (carrier) frequency.

h) Steps c) to f) shall be repeated.

i) 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.

j) This measurement shall be repeated with horizontal polarization.

k) 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.

D.3 Radiated measurement for receivers

Preferably, radiated measurements shall be performed in a FAR.

Measurements on receiving equipment are essentially the reverse of measurements on transmitters, with a signal generator connected to the measuring antenna. Calibration relies on the principle of replacing the EUT with a substitution antenna and suitable measuring equipment.

Clause D.2 substitution antenna applies.

NOTE: This does not require an actual half wave dipole, only an antenna with known gain relative to a half wave dipole.

There are two methods:

a) Connect the substitution antenna to a calibrated measuring receiver and read the measurement result directly.

b) Measure the path loss from the measurement antenna to the substitution antenna and subtract this from the signal generator level to reach the measurement result.

For method a) the level received in some measurements is likely to be too low, so it may be necessary to raise the signal generator by a suitable amount and apply an equivalent offset to the measurement result.

Method b) means that one calibration measurement can be used for multiple tests.

Annex E (informative): Example of implementation for restriction of 4 W RFID to in-building use only

This annex provides guidance for RFID manufacturers to design an automatic inside/outside building power control, thus in order to meet the essential requirement as stated in the present document for radiated power levels of 2 W e.i.r.p. and 500 mW e.i.r.p. as relevant of the present document. Any other technical design may be implemented to achieve the same result.

The present annex describes an automatic inside/outside building power control scheme. A special, permanently fixed in-building mounted, System Control Unit (SCU) restricts the higher power of 4 W RFID to an operation inside a building only. In case the same RFID reader is moved outside the building or the RF beam is turned away from the in-building fixed installed SCU, e.g. towards windows or doors, then the power is automatically reduced to a default power level of 500 mW.

The SCU has a very short communication range (up to approximately 4 m) and transmits an access code to the RFID reader to obtain the higher power of 4 W. The RFID SCU is required to be installed at a permanent fixed position inside a building where the higher power (4 W) is needed.

The above-mentioned schemes will prevent an RFID reader to transmit the higher power when moved outside the range of the SCU. The result of such action is the reader loses its high power access code and consequently the power is automatically reduced to 500 mW. Furthermore, the user of the RFID system does not need to do anything special.

To enforce the use of 4 W inside a building only, the following design options are suggested for SCUs, either:

a) SCU units are equipped with a tamper switch to prevent these units from being removed together with its high power access code from their fixed mounting position inside a building. Any tampering with these units causes permanent loss of the access code for the higher power level. This prevents the user from moving the SCU functionality to a position outside the building. It is further suggested that only a manufacturer's representative can obtain the necessary tools to generate new high power access code. Or

b) SCUs are mounted by a special tool that is not for general sale. Or

c) SCUs are designed to be installed once; if removed, they are permanently destroyed.

An example for 2,45 GHz RFID installation using this principle is shown in Figure E.1.

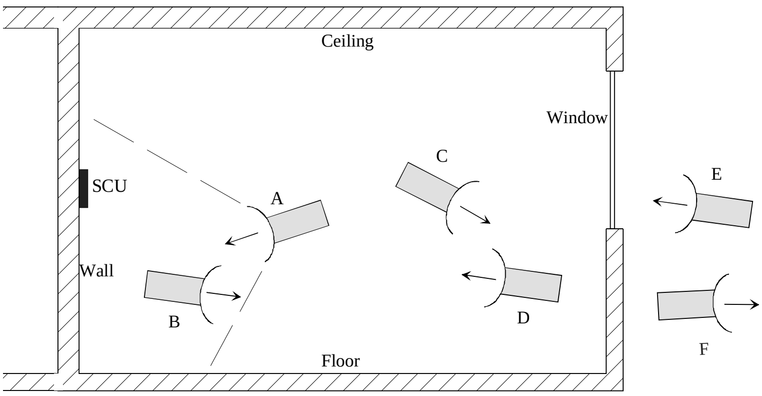

Figure E.1: Example for RFID system with an automatic RF power control for in- and outside building operation

RFID readers, A to F in Figure E.1, are all of same type having both 4 W and 500 mW radiated power (e.i.r.p.) with a default power level of 500 mW. Only reader A is able to communicate with the System Control Unit (SCU) via its antenna main beam at close distance and is therefore allowed to radiate with the higher power of 4 W e.i.r.p. All other readers, B to F, are either out of range or outside the antenna main beam concerning the SCU and are therefore forced to radiate with the default power level of 500 mW e.i.r.p.

As an example, the SCU may be passive (without any transmitter) if control communication system is based on radio. In this case, the SCU is only re-modulating and reflecting reader transmitted signals like a normal RFID tag. As the reader receiver sensitivity is limited to approximately -62 dBm the SCU to reader range is limited to approximately 3 m and 5 m for reader radiated power of 500 mW and 4 W respectively. This will effectively limit the maximum distance between the reader and the SCU to approximately 3 m in order to turn-on the 4 W power level.

Annex F (informative): Selection of receiver parameters

F.0 Introduction

Receiver parameters under article 3.2 of Directive 2014/53/EU [i.7] listed in ETSI EG 203 336 [i.2] are analysed and the parameters which are applicable to the present document are specified in respective clauses.

F.1 Receiver sensitivity

Receiver sensitivity is the ability to receive a wanted signal at low input signal levels while providing a pre-determined level of performance. Receiver sensitivity is specified in clause 4.4.4.

F.2 Receiver co-channel rejection

Receiver co-channel rejection is a measure of the capability of a receiver to receive a wanted signal, without exceeding a given degradation, due to the presence of an unwanted signal, both signals being at the nominal frequency of the receiver.

In frequency bands covered by the present document, any modulation, channel width, centre frequency and data rate may be used. A combination of many signals of widely different characteristics manifests itself primarily as an increase in the noise floor.

Thus, a specific test for co-channel rejection is not included because the co-channel rejection performance of the receiver combined with the receiver noise figure directly affects the sensitivity performance, which is tested. The required limits for sensitivity ensure that products have the required co-channel rejection.

Moreover, the wideband data transmission SRD device employs listen-before-talk technique to ensure the device operates in a channel with limited co-channel energy.

F.3 Receiver adjacent signal selectivity

Adjacent channel selectivity is a measure of the receiver capability to receive a wanted modulated signal without exceeding the general performance criteria stated in clause 4.2 due to the presence of an unwanted input signal in the adjacent channels. Adjacent channel selectivity is specified in clause 4.4.5.

F.4 Receiver spurious response rejection

The spurious response rejection is a measure of the capability of the receiver to receive a wanted signal without exceeding a given degradation due to the presence of an unwanted signal at any frequency at which a response is obtained. The frequencies of the adjacent signals (channels) are excluded.

Receiver spurious response rejection is specified in clause 4.4.6.

F.5 Receiver blocking

Blocking is a measure of the receiver capability 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. Receiver Blocking is specified in clause 4.4.2.

F.6 Receiver radio-frequency intermodulation

Intermodulation rejection is a measure of the ability of a receiver to operate in the presence of two or more unwanted signals the frequencies of which have a specific frequency relationship to the wanted signal.

Limits for reciprocal mixing effects are difficult to specify for wideband data transmission with frequency bands with a wide range of modulations, channel widths and data rates.

Intermodulation effects will manifest themselves as blocking effects and the present document relies on limits and test suites for blocking and adjacent channel selectivity to ensure receiver resilience in the shared spectrum environment.

F.7 Receiver dynamic range

Receiver dynamic range is defined as the range of the wanted input signal level over which a receiver functions at a specified performance level. Dynamic range is provided by a combination of the sensitivity requirement and the maximum input signal level requirement. Maximum input signal level is specified in clauses 4.4.2 and 4.4.7.

F.8 Desensitization

Desensitization is a measure of the ability of the receiver to operate in the presence of a strong interfering signal. Receiver susceptibility to desensitization is provided by the blocking requirement and adjacent channel selectivity requirement.

F.9 Receiver unwanted emissions in the spurious domain

As a default, the limit for unwanted emissions in the spurious domain referenced at the antenna port should respect those in ERC/REC 74-01 [i.6]. Receive unwanted emissions are specified in clause 4.4.3.

Annex G (informative): Interpretation of the measurement results

The measurements described in the present document are based on the following assumptions:

- the measured value related to the corresponding limit will 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 parameteris included in the test report.

Table G.1 shows the recommended values for the maximum measurement uncertainty figures.

Table G.1: Measurement Uncertainty

Parameters	Uncertainty
Radio frequency	±1 x 10^{-7}
RF power (conducted)	±1,5 dB
Radiated emission of transmitter, valid to 26,5 GHz	±6 dB
Radiated emission of receiver, valid to 26,5 GHz	±6 dB
Temperature	±1 °C
Humidity	±5 %
Voltage (dc)	±1 %
Voltage (ac < 10 kHz)	±2 %

Annex H (informative): Change history

Date	Version	Information about changes
08/2021	V0.0.1	Created the structure of the draft standard based on EN 300 440 V2.2.1 (2018-07).
12/2021	V0.0.2	Added technical details.
08/2022	V0.0.3	Added additional receiver requirements and included Annex F Selection of receiver parameters.
11/2022	V0.0.4	Cleaned-up after resolution meeting.

History

Document history		
V1.0.0	January 2025	SRdAP process EV 20250413: 2025-01-13 to 2025-04-14