



**Electromagnetic compatibility  
and Radio spectrum Matters (ERM);  
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**

---

**Reference**

DEG/ERM-517

---

**Keywords**

Harmonised Standard, radio, receiver, regulation,  
transmitter

---

**ETSI**

650 Route des Lucioles  
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C  
Association à but non lucratif enregistrée à la  
Sous-Préfecture de Grasse (06) N° 7803/88

---

**Important notice**

The present document can be downloaded from:

<http://www.etsi.org/standards-search>

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the only prevailing document is the print of the Portable Document Format (PDF) version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status.

Information on the current status of this and other ETSI documents is available at

<http://portal.etsi.org/tb/status/status.asp>

If you find errors in the present document, please send your comment to one of the following services:

<https://portal.etsi.org/People/CommitteeSupportStaff.aspx>

---

**Copyright Notification**

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.

The content of the PDF version shall not be modified without the written authorization of ETSI.

The copyright and the foregoing restriction extend to reproduction in all media.

© European Telecommunications Standards Institute 2015.

All rights reserved.

**DECT™**, **PLUGTESTS™**, **UMTS™** and the ETSI logo are Trade Marks of ETSI registered for the benefit of its Members.  
**3GPP™** and **LTE™** are Trade Marks of ETSI registered for the benefit of its Members and  
of the 3GPP Organizational Partners.  
**GSM®** and the GSM logo are Trade Marks registered and owned by the GSM Association.

# Contents

Intellectual Property Rights .....	5
Foreword.....	5
Modal verbs terminology.....	5
1 Scope .....	6
2 References .....	6
2.1 Normative references .....	6
2.2 Informative references.....	6
3 Definitions, symbols and abbreviations .....	7
3.1 Definitions .....	7
3.2 Symbols.....	7
3.3 Abbreviations .....	7
4 Applicability of Radio Parameters .....	8
4.1 General .....	8
4.2 Information required.....	8
4.2.1 Operating frequency range.....	8
4.2.2 Other information .....	8
5 Technical parameters for article 3.2 of Directive 2014/53/EU .....	9
5.1 General .....	9
5.2 Transmitter parameters under article 3.2 of Directive 2014/53/EU .....	9
5.2.1 General.....	9
5.2.2 Transmitter power limits.....	10
5.2.3 Transmitter power accuracy.....	10
5.2.4 Spectrum mask.....	10
5.2.5 Transmitter frequency stability .....	11
5.2.6 Transmitter intermodulation attenuation.....	11
5.2.7 Transmitter unwanted emissions in the spurious domain .....	11
5.2.7.1 Unwanted emissions.....	11
5.2.7.2 Unwanted emissions in the out of band domain.....	11
5.2.7.3 Unwanted emissions in the spurious domain .....	11
5.2.8 Transmitter time domain characteristics .....	12
5.2.9 Transmitter transients .....	12
5.3 Receiver parameters under article 3.2 .....	12
5.3.1 General.....	12
5.3.2 Receiver sensitivity.....	12
5.3.3 Receiver co-channel rejection.....	13
5.3.4 Receiver Selectivity .....	13
5.3.4.1 General .....	13
5.3.4.2 Single signal selectivity.....	14
5.3.4.2.1 Receiver adjacent signal selectivity (adjacent channel selectivity) .....	14
5.3.4.2.2 Receiver spurious response rejection.....	14
5.3.4.3 Receiver multiple signal selectivity .....	14
5.3.4.3.1 Receiver blocking.....	14
5.3.4.3.2 Receiver radio-frequency intermodulation .....	14
5.3.4.3.3 Receiver adjacent signal selectivity (adjacent channel selectivity) .....	15
5.3.4.4 Other receiver effects .....	15
5.3.4.4.1 Receiver dynamic range .....	15
5.3.4.4.2 Reciprocal mixing .....	16
5.3.4.4.3 Desensitization .....	16
5.3.5 Receiver unwanted emissions in the spurious domain.....	16
5.4 Protocol elements, interference mitigation techniques and type of modulation .....	16
5.4.1 General.....	16
5.4.2 Transmitter Power Control (TPC) .....	16

5.4.3	Listen Before Talk (LBT).....	17
5.4.4	Equipment operating under the control of a network.....	17
5.5	Antennas.....	17
6	Technical parameters for article 3.1(b) (EMC) of Directive 2014/53/EU .....	18
6.1	General .....	18
6.2	Combined equipment within the scope of Directive 2014/53/EU .....	19
7	Structure of Harmonised Standards.....	19
7.1	General .....	19
7.2	Methods of Measurement .....	19
7.3	Scope .....	19
<b>Annex A:</b>	<b>Harmonised Standard Skeleton Document .....</b>	<b>20</b>
<b>Annex B:</b>	<b>Principles of the difference between radio and EMC requirements .....</b>	<b>21</b>
<b>Annex C:</b>	<b>Bibliography .....</b>	<b>22</b>
History .....		23

---

## Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (<http://ipr.etsi.org>).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

---

## Foreword

This final draft ETSI Guide (EG) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the ETSI standards Membership Approval Procedure.

---

## 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 has been produced to help an ETSI Technical Committee to produce 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 (Directive 2014/53/EU) [i.1].

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.

The present document does not cover the production of Harmonised Standards covering article 3.1(a) of Directive 2014/53/EU [i.1] which is the responsibility of CENELEC and article 3.3 which requires delegated acts by the European Commission (EC).

## 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 reference document (including any amendments) applies.

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

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

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

Not applicable.

### 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] 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, (OJ L153, 22.5.2014, p62).
- [i.2] CEPT/ERC/Recommendation 74-01E: "Unwanted emissions in the spurious domain".
- [i.3] Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility, (OJ L96 29.3.2014, P96).
- [i.4] ETSI EN 301 908 (all parts): "IMT cellular networks; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".
- [i.5] ETSI TR 101 506: "Fixed Radio Systems; Generic definitions, terminology and applicability of essential requirements under the article 3.2 of 1999/05/EC Directive to Fixed Radio Systems".
- [i.6] CEPT/ECC Recommendation (02)05: "Unwanted emissions".
- [i.7] Recommendation ITU-R SM.332-4: "Selectivity of Receivers".

- [i.8] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity, OJ L91, 7. 4. 1999.
- [i.9] ETSI EN 300 676-1: "Ground-based VHF hand-held, mobile and fixed radio transmitters, receivers and transceivers for the VHF aeronautical mobile service using amplitude modulation; Part 1: Technical characteristics and methods of measurement".
- [i.10] ETSI TR 100 028 (V1.4.1) (12-2001) (Parts 1 and 2): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

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

**adjacent channels:** channel offset from the wanted channel by the channel spacing

NOTE: See figure 1.

**alternate channels:** two channels offset from the wanted channel by double the channel spacing

NOTE: See figure 1.

**temporary antenna connector:** Radio Frequency (RF) connector to facilitate measurements without influencing the performance of the equipment under test

### 3.2 Symbols

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

$F_{rx}$	nominal frequency of the receiver
$F_{if}$	Intermediate frequency of the receiver

### 3.3 Abbreviations

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

ADC	Analogue to Digital Converter
AFA	Active Frequency Agility
AM	Amplitude Modulation
BEM	Block Edge Mask
CENELEC	European Committee for Electrotechnical Standardization
CISPR	International Special Committee on Radio Interference (a subcommittee of IEC)
DDC	Digital Down Conversion
DFS	Dynamic Frequency Selection
EC	European Commission
ECC	Electronic Communications Committee
EMC	ElectroMagnetic Compatibility
EU	European Union
EUT	Equipment Under Test
HS	Harmonised Standard
IEC	International Electrotechnical Commission
ITU-R	International Telecommunication Union - Radiocommunication Sector
LBT	Listen Before Talk
LO	Local Oscillator
NIR	National Interface Requirement
NZIF	Near-Zero Intermediate-Frequency
OOB	Out Of Band
PPDR	Public Protection and Disaster Relief

QoS	Quality of Service
RED	Radio Equipment Directive (2014/53/EU [i.1])
RF	Radio Frequency
RLAN	Radio Local Area Network
TB	Technical Body
TPC	Transmitter Power Control
VHF	Very High Frequency
WAS	Wireless Access Systems

## 4 Applicability of Radio Parameters

### 4.1 General

The generic radio characteristics described in the following clauses are the spectrum related aspects that should always be considered for inclusion in a Harmonised Standard. Based upon this consideration, the Technical Body (TB) should identify the parameters and/or tests necessary to be specified for the radio system under consideration in order to fulfil the essential requirement in article 3.2 of Directive 2014/53/EU [i.1].

The radio characteristics described in clause 4 of the present document are the minimal set to be considered for inclusion in the Harmonised Standard and are relevant for most equipment. However, ETSI Technical Bodies may consider including additional radio characteristics to satisfy particular needs. The order of the parameters presented in the present document does not necessarily need to be followed in a HS.

The guidance in clause 6 applies when producing a Harmonised Standard under article 3.1(b) of Directive 2014/53/EU [i.1] covering the ElectroMagnetic Compatibility (EMC) aspects of radio equipment.

Any differences from terminology used in the present document should be clarified in the HS or in a separate ETSI deliverable.

Whenever an ETSI Technical Body decides to deviate from the technical guidance in the present document, an explanation should be given. Such an explanation may be included in the Harmonised Standard itself (e.g. tables in ETSI EN 301 908 [i.4]) or in a separate ETSI Technical Report referenced in the Harmonised Standard (e.g. ETSI TR 101 506 [i.5]). This explanation is not necessary when technical parameters equivalent to those listed in the present document are specified in the HS.

### 4.2 Information required

#### 4.2.1 Operating frequency range

The operating frequency range consists of the radio frequency bands over which the transmitter and receiver are intended to operate. This parameter may be important, particularly where the range of frequencies available to each service has changed or a change is planned.

The transmitter and receiver operating frequency range(s) should be specified in cases where the spectrum plan permits the system to be able to select a suitable channel for operation within its operating frequency range, subject to satisfying the relevant coexistence criteria including interference mitigation techniques.

In addition to the operating frequency range, the manufacturer may also need to declare the signal bandwidth, for example in order to define exclusion bands in corresponding EMC standards.

The operating frequency range should not be confused with the receiver bandwidth.

#### 4.2.2 Other information

At the discretion of the ETSI Technical Body, other information may be required as necessary, for example to facilitate testing. Informative annexes may be included where appropriate.



---

## 5 Technical parameters for article 3.2 of Directive 2014/53/EU

### 5.1 General

Harmonised Standards are not intended to specify how products are designed but how they respond in the presence of various external stimuli, simulating other spectrum users and interference, i.e. the EUT can be regarded as a "black box".

Some equipment may implement requirements relevant to article 3.2 using embedded software. The TBs may include requirements in a Harmonised Standard that protect the equipment from unintended software configuration potentially leading to non-conformity.

This should not be confused with:

- article 3.3(i) and article 4, which are not yet applicable as they require Commission to invoke a delegated act; or
- protocol testing for interoperability.

An "Environmental Profile" clause should be included which indicates that technical requirements should be met throughout the environmental conditions indicated in the standard. Example text is provided in the skeleton document for Harmonised Standards available from the ETSI web site.

The Radio Equipment Directive (RED) does not contain an equivalent of "Essential Radio Test Suites" from annex III of Directive 1999/5/EC [i.8]. Nevertheless test procedures and conditions should be specified in Harmonised Standards when they are necessary to ensure repeatability.

### 5.2 Transmitter parameters under article 3.2 of Directive 2014/53/EU

#### 5.2.1 General

The technical requirements in this clause should be considered when producing Harmonised Standards that aim to cover the essential requirements in article 3.2 of Directive 2014/53/EU [i.1].

The essential requirement in article 3.2 of Directive 2014/53/EU [i.1] states:

*"Radio equipment shall be so constructed that it both effectively uses and supports the efficient use of radio spectrum in order to avoid harmful interference."*

This requirement applies to transmitters and receivers.

When deciding which transmitter parameters to include in the Harmonised Standard, Technical Bodies should consider both in-band and adjacent-band aspects. Relevant Electronic Communications Committee (ECC) or European Union (EU) deliverables may provide useful information. For example, an ECC coexistence study may recommend emission limitations, e.g. eirp and/or a Block-Edge Mask (BEM) to facilitate sharing.

NOTE: A Block-Edge Mask is not part of a Harmonised Standard.

These licensing conditions (including conditions to support a general licence) should be taken into account when drafting compliance conditions in Harmonised Standards in order to facilitate their application.

The Harmonised standard should cover the requirements of article 3.2 of Directive 2014/53/EU [i.1]. Justification for the requirements in relation to transmitters is given by recital 10 of the Directive which states:

*"...when the transmitter is properly installed, maintained and used for its intended purpose it generates radio waves emissions that do not create harmful interference, while unwanted radio waves emissions generated by the transmitter (e.g. in adjacent channels) with a potential negative impact on the goals of radio spectrum policy should be limited to such a level that, according to the state of the art, harmful interference is avoided;"*

Some equipment types may have a number of different operational transmission modes with different spectrum usage. The HS should be developed such that compliance with the essential requirements is ensured when operating in any of these operational modes.

### 5.2.2 Transmitter power limits

Harmonised Standards may include transmitter power limits. However, TBs should note that these are defined in National Interface Requirements (NIRs) and also in individual or general licence authorizations. Furthermore TBs should be aware that there may be relevant ECC and EU deliverables.

The transmitter power limits may include a minimum range of Transmitter Power Control (TPC) (see clause 5.4 on interference mitigation techniques).

Transmitter power limits may be specified and measured using a "spectrum mask" (clause 5.2.4) or as a total power in the transmit channel.

### 5.2.3 Transmitter power accuracy

When transmitter power is regulated through a specific RF power, e.g. in the station licence, the ability of a transmitter to remain accurate in its expected environment should be considered for inclusion in a Harmonised Standard. It should be defined as a percentage (or a ratio in dB) of the nominal or mandated value as appropriate.

When regulatory limits imply only a maximum emission limit (e.g. products that operate under a general licence regime), this parameter need not be considered for inclusion in a Harmonised Standard.

### 5.2.4 Spectrum mask

"Spectrum mask" is a generic term applied to the technique of defining transmitter spectral power requirements by specifying permitted power levels as a function of frequency.

Transmit requirements should be specified in terms of:

- transmit power (clause 5.2.2); and
- unwanted emissions in:
  - the Out Of Band (OOB) domain (clause 5.2.7.2);
  - the spurious domain (clause 5.2.7.3).

Technical bodies may choose to specify the above parameters by the means of a "spectrum mask".

A "spectrum mask" may be defined as absolute terms, or relative to the measured transmitter output and should be comparable with the results of ECC spectrum studies.

In the case of emissions significantly narrower than the operating band, technical bodies should consider the following guidance when setting "spectrum masks":

- a "spectrum mask" should be consistent with the operating channel size or the occupied bandwidth of the transmitted signal;
- should extend at least over the entire OOB domain;
- measurement bandwidths associated with the mask should be specified;
- detector modes and any other relevant spectrum analyser setting should be specified.

In the case where the bandwidth of emissions is similar to the allocated frequency band for the system/technology then other considerations may apply. Particular attention should be paid to equipment such as multi-channel amplifiers to ensure OOB emissions do not interfere with adjacent services.

## 5.2.5 Transmitter frequency stability

The frequency stability impacts the radio system transmitter to occupy, in all specified operating conditions, a bandwidth minimally larger than its own assigned portion of frequency (e.g. a channel) or occupied bandwidth.

Frequency stability is usually specified relative to the actual operating frequency where the system operates (e.g. in parts-per million (p.p.m.) or a percentage of the assigned/occupied bandwidth) or expressed as an absolute value, over a range of temperature, voltage and time period.

## 5.2.6 Transmitter intermodulation attenuation

The transmitter intermodulation attenuation is a measure of the capability of a transmitter to inhibit the generation of signals in its non-linear elements caused by the presence of the transmitter power and an interfering signal entering the transmitter via its antenna.

Technical Bodies should consider specifying this parameter for base stations where use on shared radio sites is foreseen. Technical bodies should also consider specifying this parameter for all equipment designed for use in particularly dense usage scenarios, for example Public Protection and Disaster Relief (PPDR) where very high levels of quality of service are required.

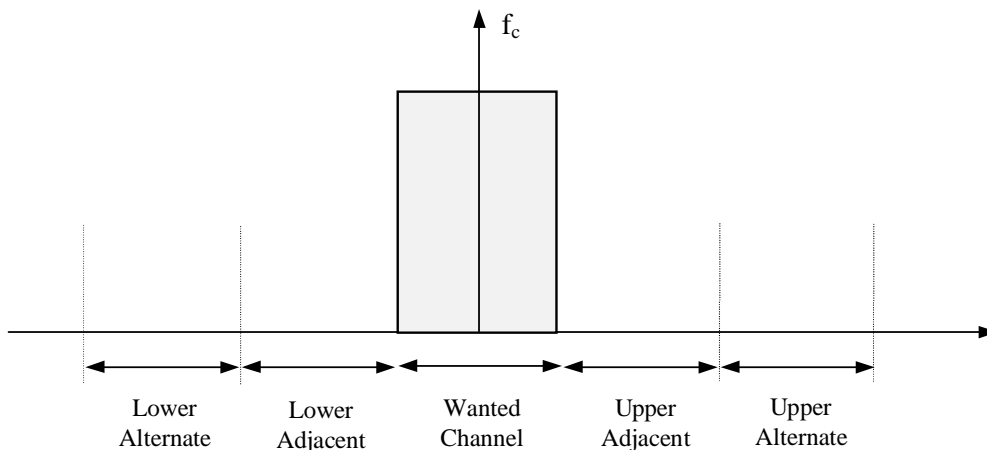
## 5.2.7 Transmitter unwanted emissions in the spurious domain

### 5.2.7.1 Unwanted emissions

Unwanted emissions are specified as OOB and spurious emissions, for further details see ECC/REC(02)05 [i.6].

### 5.2.7.2 Unwanted emissions in the out of band domain

The level of emissions in the OOB domain determines the ability for other users to operate in adjacent spectrum. Technical Bodies may specify OOB limits by defining a "spectrum mask" (see clause 5.2.4) or adjacent and alternate channel power requirements (see figure 1).



**Figure 1: Adjacent and alternate channel definitions**

### 5.2.7.3 Unwanted emissions in the spurious domain

The limits for unwanted emissions in the spurious domain at the antenna port (conducted) should respect those in ERC/REC 74-01 [i.2]. In the case of integral antenna equipment (without temporary antenna connectors) and cabinet radiation, a radiated limit should be specified. It is recognized that in certain circumstances deviation from these values may be justified.

NOTE: This parameter is technically different from the EMC "radiation" parameter (see annex B).

## 5.2.8 Transmitter time domain characteristics

The actual value(s) of time domain characteristics may have been defined in the relevant coexistence studies and in consequent relevant EC Decisions or, in its absence, ECC Decisions or, if also absent, ECC Recommendations.

Time domain characteristics (e.g. the duty cycle, turn-on and turn-off, frequency hopping cycle, dynamic changes of modulation scheme and others) of a transmitter, may impact the ability of the system to share or to be compatible with other systems. The appropriate requirements should be considered by the ETSI Technical Body for inclusion in the Harmonised Standard.

## 5.2.9 Transmitter transients

For transmitter systems that do not transmit continuously the ETSI Technical Body should consider the impact of transients that occur during the turn on turn off of the transmission envelope. This may affect coexistence with other systems. The appropriate requirements should be considered by the ETSI Technical Body for inclusion in the Harmonised Standard.

# 5.3 Receiver parameters under article 3.2

## 5.3.1 General

The receiver parameters in this clause should be considered when producing Harmonised Standards that aim to cover the essential requirements in article 3.2 of Directive 2014/53/EU [i.1].

NOTE: The order of the parameters identified in clause 5.3 follows the structure of Recommendation ITU-R SM.332-4 [i.7]. However, as noted in clause 4.1, HSs may follow a different sequence.

The intention of article 3.2 of Directive 2014/53/EU [i.1] in relation to a receiver is explained in recitals 10 and 11 of the Directive which state:

*"...in the case of a receiver, it has a level of performance that allows it to operate as intended and protects it against the risk of harmful interference, in particular from shared or adjacent channels, and, in so doing, supports improvements in the efficient use of shared or adjacent channels.*

*Although receivers do not themselves cause harmful interference, reception capabilities are an increasingly important factor in ensuring the efficient use of radio spectrum by way of an increased resilience of receivers against harmful interference and unwanted signals on the basis of the relevant essential requirements of Union harmonisation legislation."*

Receivers usually operate under spectrum conditions managed by radio regulators to use spectrum efficiently and share with current & future users. The receivers should be specified in order to use the spectrum as intended while respecting these spectrum use conditions.

Technical Bodies should consider the above conditions when fixing receiver parameters and their limit values for inclusion in a Harmonised Standard. For example, if a relevant ECC coexistence study recommends a certain level of receiver performance, then this should be respected in the Harmonised Standard. It is expected that intended use conditions are included in such studies, for example head and hand attenuation when appropriate.

If the "classical" parameters for a radiocommunications receiver provided in the present document are not relevant for some types of equipment (e.g. radar) the Technical Body should include suitable alternative technical means in the harmonised standard.

## 5.3.2 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 should be included in Harmonised Standards because:

- good sensitivity is generally valuable in minimizing interference as it allows the corresponding transmitter power to be lower for a particular link budget (see note);

- knowledge of sensitivity may also be needed to act as a performance reference point when specifying other parameters;
- knowing the sensitivity of receivers is essential when planning coverage areas for the siting of wide area transmitters, e.g. cellular base stations and broadcast transmitters, or the link budget calculation of fixed links for reaching the expected availability and QoS.

NOTE: In some cases (e.g. in license exempt bands), the receiver sensitivity may follow other considerations possibly suggesting that the "best practice" sensitivity is not worth to be pursued, for example a good receiver sensitivity might exceed the link budget required for the service resulting in reduced immunity to interference (i.e. because sensitivity is often a trade-off with receiver effective blocking).

Technical Bodies should specify receiver sensitivity also for integral-antenna equipment (in particular for mobile telephones and communication equipment used in safety of life applications) to ensure that the antenna performance is included in the assessment.

### 5.3.3 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.

When specifying tests for receiver co-channel rejection Technical Bodies should specify the unwanted signal which may be similar to the wanted signal or an unwanted interfering signal defined in ECC sharing or compatibility studies, or a suitable test signal defined by the relevant ETSI Technical Body.

Technical Bodies may consider specifying additional tests in a Harmonised Standard where the co-channel interfering signal has a frequency offset from the wanted signal (which is on the nominal frequency) in order to evaluate the effect of allowable frequency offsets (see clause 5.2.5).

NOTE: Receiver co-channel rejection is essential to determining the spatial reuse of the same frequency, e.g. in nearby geographic areas or in other sectors/directions in the same node. Contributions to co-channel rejection used for system planning are often complex: factors may include: choice of modulation scheme, antenna diversity and antenna beam steering.

### 5.3.4 Receiver Selectivity

#### 5.3.4.1 General

Receiver selectivity is described in Recommendation ITU-R SM.332-4 [i.7] identifying the capability to receive a wanted signal, without exceeding a given degradation, due to the presence of an unwanted signal, which differs in frequency from the wanted signal by a specified amount.

Recommendation ITU-R SM.332-4 [i.7] makes a distinction between single signal selectivity and multiple signal selectivity. Single signal selectivity refers to effects measured within the linear range of the receiver; for the purposes of the present document these are:

- attenuation slope; and
- spurious response rejection.

Attenuation slope is a parameter that was mainly applicable to historic systems using analogue modulation; an acceptable alternative in a Harmonised Standard is to specifying adjacent signal (or channel) selectivity.

Spurious response rejection includes all possible spurious responses of the receiver but Recommendation ITU-R SM.332-4 [i.7] specifically identifies image-rejection ratio and intermediate-frequency rejection ratio. Receivers with multiple intermediate-frequencies will have image responses and intermediate-frequency responses for each intermediate-frequency.

Multiple response rejection selectivity is considered as *effective selectivity* which includes blocking, adjacent-signal (adjacent-channel), selectivity and radio-frequency intermodulation.

Recognizing the importance of receiver selectivity, Technical Bodies should specify it Harmonised Standards.

Receiver selectivity is generally specified based on the channel separation or on the bandwidth defined in the spectrum-management plan.

### 5.3.4.2 Single signal selectivity

#### 5.3.4.2.1 Receiver adjacent signal selectivity (adjacent channel selectivity)

Technical Bodies should pay attention to the usage scenario of the receiver, for example in channelized use the requirements for selectivity differ from scenarios without channelization. Also mixed bandwidth scenarios require different selectivity measures.

It is also recognized that there are many ways of specifying receiver selectivity as a technical parameter which may be used in particular cases. The choice of how to satisfy the requirements of specifying receiver selectivity in a harmonised standard is left to the individual ETSI Technical Body to formulate however they should identify in the Harmonised Standard which parameters cover receiver adjacent-signal (adjacent-channel) selectivity.

NOTE: An adjacent signal (adjacent channel) selectivity test may also contribute to demonstrating *effective selectivity*, i.e. also be considered as part of the multiple signal selectivity, see also clause 5.3.4.2.3.

#### 5.3.4.2.2 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. Technical Bodies should specify the frequency range over which this requirement should be evaluated.

Technical Bodies may specify a frequency search method to identify the specific frequencies at which spurious responses occur.

NOTE: Technical Bodies may consider specifically identifying image-rejection and intermediate-frequency rejection as particular cases of receiver spurious responses. This may be done as part of the method of measurement or by setting specific limits for these particular cases. In the case of direct conversion receivers that do not have an image response, then the  $F_{rx} / 2$  and  $F_{rx} / 3$  may be considered.

### 5.3.4.3 Receiver multiple signal selectivity

#### 5.3.4.3.1 Receiver blocking

Where relevant, Technical Bodies should also consider receiver blocking as 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 input signal at any frequency other than those of the spurious responses or of the adjacent channels. Furthermore Technical Bodies should consider practical measurement methods as testing at "any frequency" is clearly an unbounded requirement.

Where spurious response rejection and blocking are both specified, receiver blocking should usually be specified at a more stringent level than that specified for spurious response rejection (clause 5.3.4.2.2) at frequencies relatively far removed from the operating frequency, but still within the operating frequency range, e.g. for narrowband systems, a typical practical blocking test may evaluate performance with unwanted signals at  $F_{rx} \pm 1$  MHz,  $\pm 2$  MHz,  $\pm 5$  MHz and  $\pm 10$  MHz.

Technical bodies may also limit the acceptable number of spurious response frequencies.

#### 5.3.4.3.2 Receiver radio-frequency intermodulation

The receiver radio-frequency intermodulation 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 at least two unwanted signals at frequencies  $F_1$  and  $F_2$  with a specific frequency relationship to the wanted signal frequency.

Technical bodies should consider specifying a minimum of second order intermodulation and third order intermodulation performance. Further information is available in Recommendation ITU-R SM.332-4 [i.7]. The following second order terms should be considered:

- $F_{if} = F_1 + F_2$  (tests should be made with frequencies such that the unwanted signals will have frequencies close to, but not necessarily equal to, half the intermediate frequency)

- $F_{if} = F_1 - F_2$
- $F_{rx} = F_1 + F_2$
- $F_{rx} = F_1 - F_2$

The following third order term should be considered:

- $F_{rx} = 2 F_1 - F_2$  when  $|F_1 - F_2| = f_x$ 
  - where:
    - tests should be carried out at all frequencies that meet the above conditions; and
    - typically  $f_x$  = channel spacing or twice the channel spacing.

Technical Bodies may consider specifying second order intermodulation by specifying a cross modulation test. Cross modulation is defined as the transposition of the Amplitude Modulation (AM) component from a strong unwanted signal to the wanted signal.

The testing of second order intermodulation has been unusual in Harmonised Standards, limited mainly to systems using analogue AM modulation such as VHF aeronautical service (e.g. ETSI EN 300 676-1 [i.9]). This is because with constant envelope modulations and superheterodyne receivers cross modulation is very unlikely to be a cause of receiver degradation. Many digital modulations which use amplitude and phase modulation can have significant AM content which makes cross modulation a more significant potential degradation mechanism. Furthermore the increasing prevalence of direct conversion receiver technology also increases the significance of second order intermodulation effects.

NOTE: In Digital Down Conversion (DDC) receivers non linearity of the Analogue – Digital Converter (ADC) may result in intermodulation with static signals. In this case dithering of the input signal is required for a meaningful test; this can be done in the ADC and Technical Bodies should consider how to include this in test methods if considered appropriate.

#### 5.3.4.3.3 Receiver adjacent signal selectivity (adjacent channel selectivity)

Receiver adjacent signal selectivity (adjacent channel selectivity) can be part of multiple signal selectivity because attenuation of the interfering signal will require linear signal processing in the receiver even if the specified interferer is a constant envelope signal.

For receivers using Near-Zero Intermediate-Frequency technology (NZIF), i.e. where the first intermediate frequency is similar or less than the receiver channel spacing (or receiver bandwidth), Technical Bodies should consider specifying adjacent channel selectivity tests with unwanted signals simultaneously applied on upper and lower adjacent channels (figure 1). This should be considered because the adjacent channel rejection of NZIF receivers may be asymmetric.

Technical Bodies may consider to test the adjacent channel selectivity both sides of the receive frequency simultaneously also in cases where adjacent channel interference level is expected to be significantly higher than the wanted signal.

See also clause 5.3.4.2.1.

#### 5.3.4.4 Other receiver effects

##### 5.3.4.4.1 Receiver dynamic range

Receiver "dynamic range" is a generic term broadly defined as the range of input signal levels over which a receiver functions at a specified performance level.

The "dynamic range" of a receiver may be specified in a Harmonised Standard by the selectivity parameters (clause 5.3.4).

#### 5.3.4.4.2 Reciprocal mixing

Reciprocal mixing is an important degrading effect in all receivers. Noise sidebands of the Local Oscillator (LO) mix with unwanted signals producing unwanted noise at the frequency of the receiver which may result in degraded receiver sensitivity. In direct Digital Down Conversion receivers (DDC) a similar effect occurs caused by the phase jitter of the clock associated with the ADC.

NOTE: The term "jitter" is often used in digital systems whereas the term "phase noise" is used in traditional radio systems however the two terms refer to the variation in phase of a signal and are therefore essentially the same phenomenon.

In many receivers degradation due to reciprocal mixing may occur before degradation due to non-linearity. As a result reciprocal mixing may be the dominant effect in a receiver's performance.

#### 5.3.4.4.3 Desensitization

Desensitization is a degradation of receiver sensitivity caused by the presence of a large unwanted signal. The term is most commonly applied when an unwanted signal is present in the receiver which is above a receiver's linear "dynamic range" resulting in desensitization for example by the process of gain compression. It should be noted that gain compression can occur in any stage of the receiver.

### 5.3.5 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.2].

## 5.4 Protocol elements, interference mitigation techniques and type of modulation

### 5.4.1 General

Regulatory spectrum management measures may require (for example):

- equitable spectrum access between sharing applications, that may potentially lead to equal degradation in case of congestion; or
- protection and specific rights to certain applications sharing the band.

TBs should respect such measures when setting requirements in Harmonised Standards.

With increasing use of shared spectrum the ability of equipment and services to share is paramount to efficient use of the radio spectrum. ECC conducts coexistence studies and concludes, in some cases, on a set of technical conditions (e.g. type of modulation, medium access protocol, mitigation technique) in order to allow coexistence between both similar and dissimilar users and equipment or efficient use of spectrum. These conditions should be respected in Harmonised Standards. It should be noted that these conditions may apply to both transmitters and receivers.

The process of achieving dynamic spectrum sharing implies a level of technology dependence. It is important when formulating these requirements into a Harmonised Standard that this technology dependence is at the minimum level, thus respecting European rules of technology-independent spectrum allocations.

The following clauses detail considerations of some possible spectrum sharing techniques.

### 5.4.2 Transmitter Power Control (TPC)

Regulatory spectrum management measures may assume a defined range of Transmitter Power Control (TPC). This should be considered as a parameter for inclusion in the Harmonised Standard.



### 5.4.3 Listen Before Talk (LBT)

Listen Before Talk (LBT) is a common spectrum sharing protocol, which is often combined with Active Frequency Agility (AFA). In its simplest form the equipment selects a channel, listens for a pre-determined time and if no signal above a pre-defined level is received during that time, then the channel is deemed clear for use and transmission can begin. If the selected channel is busy then the equipment may select another channel and start the process again after a pre-defined amount of time.

In this example, the TB should consider parameters such as: listen time (before the decision to start transmission is taken), receive signal level that defines a clear channel, algorithm for selecting next channel to listen, time for which a channel should not be re-used.

An enhanced version of this protocol is where the equipment is listening for specific signal types or patterns. This is used where regulatory spectrum management measures require the protection of particular applications, e.g. when Wireless Access Systems (WAS)/Radio Local Area Network (RLAN) equipment are required to avoid radars in the 5GHz band. Whilst this protocol is more commonly known as Dynamic Frequency Selection (DFS), it is still a form of Listen Before Talk. In this example, in addition to the parameters above, details of the specific signals to be avoided should also be defined in the Harmonised Standard. The level of detail of the information required to define these signals depends upon the nature of the application being protected.

### 5.4.4 Equipment operating under the control of a network

Some radio equipment, e.g. cellular handsets and WAS/RLAN client devices, may only transmit after receiving instructions from a central controller. Others may be required to shut down transmissions when instructed by the network controller.

In these cases the receiver performance of the terminal equipment should be of sufficient quality to enable correct operation of this function so as to avoid unauthorized transmission.

Harmonised Standards should contain requirements to ensure the equipment's ability to receive and react correctly to such an authorization signal or an absence thereof.

## 5.5 Antennas

For cases where mobile terminals use an integral antenna, the HS should specify requirements on the product including its antenna. For other equipment that contains an integral antenna or is supplied with a dedicated antenna, the TB should consider whether radiated and/or conducted requirements are appropriate.

Where the antenna is supplied separately from the radio equipment Technical Bodies should not include antenna characteristics in the Harmonised Standard. For further information, see note.

**NOTE:** Where the antenna is supplied separately as an accessory or a component of the radio equipment Technical Bodies should consider obligations under article 10.8 of Directive 2014/53/EU [i.1] which states:

"Manufacturers shall ensure that the radio equipment is accompanied by instructions... Instructions shall include the information required to use radio equipment in accordance with its intended use. Such information shall include, where applicable, a description of accessories and components, including software, which allow the radio equipment to operate as intended. Such instructions... shall be clear, understandable and intelligible..."

If the ETSI Technical Body decides to standardize the characteristics of antennas, these may be included a non-harmonised EN or other ETSI deliverable.

## 6 Technical parameters for article 3.1(b) (EMC) of Directive 2014/53/EU

### 6.1 General

Technical Bodies should consider the EMC parameters in this clause of the Guide when producing Harmonised Standards that aim to cover the essential requirements in article 3.1(b) of Directive 2014/53/EU [i.1]. Article 3.1(b) of Directive 2014/53/EU states:

*"Radio equipment shall be constructed so as to ensure... an adequate level of electromagnetic compatibility as set out in Directive 2014/30/EU."*

This essential requirement refers to the essential requirements of the EMC Directive 2014/30/EU [i.3]. However, for the purposes of the present document "EMC" should be considered as both the emission of and the impact of unwanted RF energy. The detailed treatment of other EMC phenomena is therefore not covered in the present document.

It is intended that the combination of the article 3.2 standard and the article 3.1(b) should result in no unassessed gap in the radio spectrum either from conducted or radiated interference phenomena. As a consequence of this, care should be taken when defining any exclusion bands (transmit and receive) in which the equipment is not subject to either EMC related measurements or stress. It is strongly recommended that the Technical Bodies producing the article 3.2 Harmonised Standard liaise closely with ETSI ERM WG EMC, who produce the ETSI article 3.1(b) Harmonised Standards, and are responsible for liaison with CENELEC & IEC/CISPR.

ETSI EMC standards are based on ENs produced by CENELEC, mirroring IEC standards and CISPR publications. Where variation from these is justified by particular technological and/or spectrum allocation limitations, ETSI Harmonised Standard should identify the reasons.

**NOTE:** CISPR publications consider a frequency range, practical for actual EMC disturbance phenomena (i.e. those coming from non-radio-specific antenna ports; see annex B) much more limited (e.g. up to 6 GHz) than that actually used for operating many radio equipment (e.g. going up to hundreds of GHz).

In addition, where test and assessment of specific equipment requires specific test arrangements etc., these should also be detailed in the Harmonised Standard.

It should be remembered that EMC requirements for certain equipment types are contained within CENELEC-produced Harmonised Standards that themselves are based upon CISPR publications. It is not the intention for ETSI to produce competing standards in these cases.

#### Exclusion bands

Exclusion bands in EMC standards are those frequency ranges that are omitted in the relevant EMC tests. The exclusion bands may differ for immunity and emission testing.

The reason for exclusion bands is twofold:

- Safety: to protect receivers from damage during immunity testing and measuring equipment from damage during emission testing.
- The test of "reasonableness": in the case of a transmitter intended to generate radio emissions in a particular band, it is not expected to have zero emissions in that band. In the case of a receiver intended to detect and respond to low levels of energy in a particular frequency band, it is not expected to be immune to high signal levels in that band.

In both these cases, it is expected that the relevant performance requirements are covered in a radio Harmonised Standard (HS). Care should be taken that for both emissions and immunity, the frequency bands covered by radio and EMC HS are aligned without overlap or gaps.

## 6.2 Combined equipment within the scope of Directive 2014/53/EU

A harmonised standard for combined equipment should:

- have a scope that covers the intended environment(s) where the equipment is intended to operate e.g. residential, industrial, etc.;
- specify all necessary requirements, normally by referencing the existing relevant EMC harmonised standards for both the radio and non- radio interfaces;
- apply the appropriate requirements that do not degrade the required immunity compared to existing (uncombined) individual equipment for common ports;
- respect the exclusion bands of the individual equipment;
- specify emission limits, Class A or Class B as appropriate for the intended environment where the product will be used.

---

## 7 Structure of Harmonised Standards

### 7.1 General

The final structure of the Harmonised Standard will be a decision for the individual ETSI Technical Bodies, but it should be based upon the skeleton referenced from annex A of the present document and respect the ETSI Drafting Rules.

However, it is expected that the Harmonised Standard addressing the article 3.2 requirements will be separate from standards addressing the article 3.1(b) requirements. One of the reasons for this is that ETSI will be responsible for the production of all article 3.2 standards under the Directive 2014/53/EU [i.1], whilst production of the article 3.1(b) standards under the Directive 2014/53/EU [i.1] may be split between ETSI and other ESOs (primarily CENELEC) owing to existing work partition arrangements between the various ESOs.

The following examples how to structure clauses addressing technical requirements, including:

- Sp.1 Definition of the parameter P and applicability
  - Sp.1.1 Definition
  - Sp.1.2 Applicability of the measurement
- Sp.2 Method of measurement
- Sp.3 Limit

This structure is widely used in ETSI Harmonised Standards.

### 7.2 Methods of Measurement

Where technical parameters are specified, these should be accompanied by a test/assessment method, limits, pass/fail criteria and measurement uncertainty.

The shared risk approach, which aims to equally share the risks of allowing equipment failing a limit and rejecting equipment that complies with a limit, is standard practice in ETSI Harmonised Standards.

Methods for the calculation of measurement uncertainty can be found in ETSI TR 100 028 [i.10].

### 7.3 Scope

The scope of a Harmonised Standard should define the equipment types and their relevant frequency bands that are covered by the standard.

---

## Annex A:

# Harmonised Standard Skeleton Document

All ETSI Harmonised Standards should be produced using the Harmonised Standard Skeleton Document which is produced and maintained by the ETSI Secretariat and available for download from:

<https://portal.etsi.org/Services/editHelp!/Standardsdevelopment/Drafting/Skeletons.aspx>.

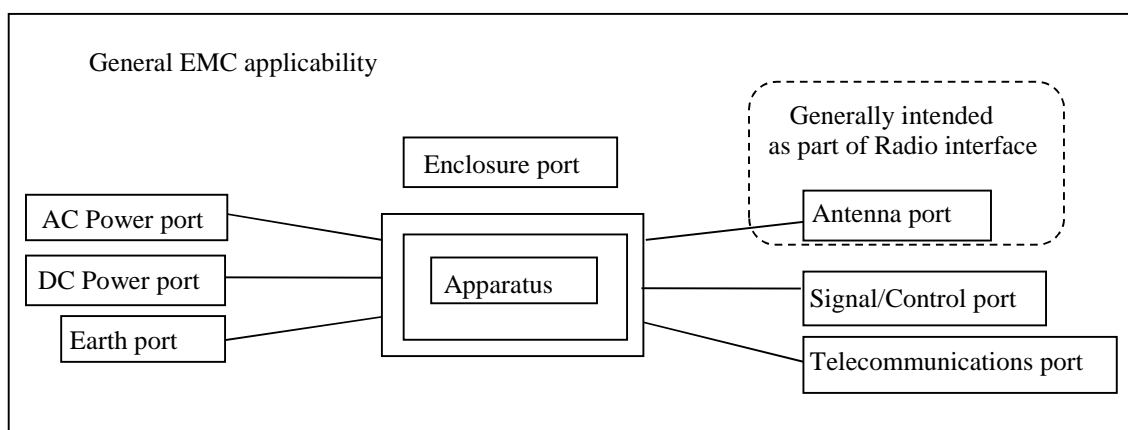
## Annex B:

# Principles of the difference between radio and EMC requirements

The radio parameters are defined worldwide to be those dealing with the air interface (antenna port). This includes both transmitter and receiver parameters applicable to the respective antenna port(s). All the other ports are considered to be covered by EMC requirements/parameters; figure B.1 below graphically shows the differences. EMC requirements however can also include requirements that are applicable to the antenna port (e.g. immunity to lightning surges).

The physical difference is also related to the limited range in frequency that potential disturbances can propagate to/from the wired apparatus ports and its case/enclosure. On the contrary, to/from the antenna port such disturbances can actually be present in all frequencies up to, and beyond, the frequency where the equipment operates.

Clearly, in some cases of very small equipment, with integrated antenna and radio operating in the limited EMC range, practical tests can be carried only in radiated way and the EMC and radio effects hardly distinguished. Nevertheless, in principle, the potential difference in applicable limits is still valid. In such cases, appropriate description of limits peculiarity and consequent assessment procedures (e.g. worst case only) should be developed by the responsible ETSI Technical Bodies.



**Figure B.1: Current ETSI and international understanding of EMC and radio parameters subdivision**

---

## Annex C:

### Bibliography

- Regulation (EU) No 1025/2012 of the European Parliament and of the Council of 25 October 2012 on European standardisation, amending Council Directives 89/686/EEC and 93/15/EEC and Directives 94/9/EC, 94/25/EC, 95/16/EC, 97/23/EC, 98/34/EC, 2004/22/EC, 2007/23/EC, 2009/23/EC and 2009/105/EC of the European Parliament and of the Council and repealing Council Decision 87/95/EEC and Decision No 1673/2006/EC of the European Parliament and of the Council, (OJ L316, 14.11.2012, P12).
- CENELEC EN 55032: "Electromagnetic compatibility of multimedia equipment - Emission requirements".
- CEPT/ECC Report 181: "Improving spectrum efficiency in SRD bands".
- ETSI EN 300 793: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Presentation of equipment for type testing".
- ETSI TR 102 070 (2 parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guide to the application of harmonized standards to multi-radio and combined radio and non-radio equipment".
- ETSI EG 202 150: "Electromagnetic compatibility and Radio spectrum Matters (ERM); "Common Text" for Application Forms/Short Equipment Description Forms".
- The "Blue Guide" on the implementation of EU product rules 2014:  
<http://ec.europa.eu/DocsRoom/documents/4942/attachments/1/translations/en/renditions/pdf>.
- ETSI TR 102 914: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Aspects and implications of the inclusion of receiver parameters within ETSI standards".
- Memorandum of Understanding between the Electronic Communications Committee (ECC) and the European Telecommunications Standards Institute (ETSI):  
<http://webapp.etsi.org/AgreementView/AgreementSearch.asp>.

---

## History

Document history		
V1.1.1	June 2015	Membership Approval Procedure    MV 20150817: 2015-06-18 to 2015-08-17