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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

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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 "**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.

Introduction

The present document reflects current understanding of this highly technical subject matter and is subject to change. Therefore, it should be treated as guidance rather than a formal reference for judging the content of Harmonised Standards.

It should be noted that this is not a mandatory document, transmitters and receivers should be assessed on their expected use and appropriate parameters selected by the Technical Body.

1 Scope

The present document has been produced to help a Technical Body (TB) to produce a Harmonised Standard (HS) covering the 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]).

NOTE 1: Article 3.1(b) of Directive 2014/53/EU [i.1] states:

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

NOTE 2: 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."

The present document does not cover the production of HSs 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

Normative references are not applicable in the present document.

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] Void.

[i.5] Void.

[i.6] CEPT/ECC/Recommendation (02)05: "Unwanted emissions".

[i.7] Void.

[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 EN 301 489-1: "ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements; Harmonised Standard for ElectroMagnetic Compatibility".

[i.11] ETSI EG 203 367: "Guide to the application of harmonised standards covering articles 3.1b and 3.2 of the Directive 2014/53/EU (RED) to multi-radio and combined radio and non-radio equipment".

[i.12] RSPG 19-031: "RSPG Report on European Spectrum Strategy".

[i.13] ETSI TS 103 567 (V1.1.1): "Requirements on signal interferer handling".

[i.14] ETSI EN 301 489 (all parts): "ElectroMagnetic Compatibility (EMC) standard for radio equipment and services".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in article 2 of Directive 2014/53/EU [i.1] and the following apply:

adaptive frequency agility: technique used by some radio transmitters to avoid transmission in channels that are already occupied by other spectrum users

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

NOTE: See figure 1.

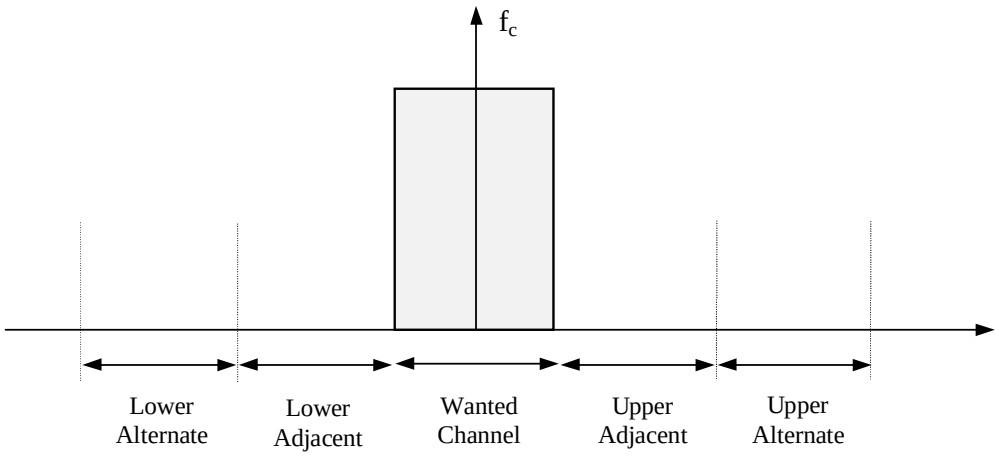

Figure 1: Adjacent and alternate channel/signal definitions

adjacent band: frequency band adjacent to the operating band

adjacent signal: signal adjacent to the wanted signal

alternate channels: channel(s) offset from the wanted channel by twice the channel spacing

NOTE: See figure 1.

cabinet radiation: emissions from the equipment, radiated from the enclosure port, other than those present at the antenna port

detect and avoid: mechanism which mitigates interference potential by avoiding use of frequencies upon detection of other transmissions on those frequencies

jitter (phase noise): short term variations of the significant instants of a digital signal from their reference positions in time

operating band: frequency band in which the EUT is intended to transmit and/or receive

transmitter spectrum mask: 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

3.2 Symbols

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

f_c	Carrier frequency
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
ADCO	ADministrative COoperation groups
AFA	Adaptive Frequency Agility
AM	Amplitude Modulation
CENELEC	European Committee for Electrotechnical Standardization
CEPT	European Conference of Postal and Telecommunications Administrations
CISPR	International Special Committee on Radio Interference (a subcommittee of IEC)
DAA	Detect And Avoid
DDC	Digital Down Conversion
DFS	Dynamic Frequency Selection
EC	European Commission
ECC	Electronic Communications Committee
EIRP	Effective Isotropic Radiated Power
EMC	ElectroMagnetic Compatibility
ERP	Effective Radiated Power
ESO	European Standards Organization
EU	European Union
EUT	Equipment Under Test
HS	Harmonised Standard
IEC	International Electrotechnical Commission
LBT	Listen Before Talk
LO	Local Oscillator
OCG	Operational Co-ordination Group
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
RIS	Radio Interface Specifications
RLAN	Radio Local Area Network
RX	Receiver
SRD	Short Range Device
TB	Technical Body
TPC	Transmitter Power Control
UWB	Ultra WideBand
VHF	Very High Frequency
WAS	Wireless Access Systems

4 Applicability of Radio Parameters

4.1 General

The essential requirements of the Radio Equipment Directive are general and do not identify specific design criteria. ETSI HSs define criteria for fulfilling the essential requirements by providing applicable radio parameters for the development and manufacturing of radio equipment.

The TB should identify the parameters and/or tests necessary to be specified in an HS for the radio system under consideration to fulfil the essential requirements in article 3.2 of Directive 2014/53/EU [i.1] by considering the radio parameters in the following clauses of the present document.

The parameters in clause 5 of the present document are the minimal set TBs should consider including in HSs. These parameters are relevant for most equipment, but TBs may consider including additional parameters where relevant. The order of the parameters is not significant.

TBs not including one or more of the parameters in clause 5, or including additional parameters, should include a technical justification of such deviation from the present document in the HS or in a referenced separate ETSI deliverable.

The guidance in clause 6 applies when producing an HS 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.

When drafting HSs, relevant ETSI TBs should take into consideration all applicable CEPT/ECC deliverables.

4.2 Additional Information required

4.2.1 Operating frequency range

The operating frequency range consists of the radio frequency band(s) over which the transmitter and receiver operate in accordance with the intended use of the equipment, as referred to in Article 10(8) of the Radio Equipment Directive [i.1]:

> *"Manufacturers shall ensure that the radio equipment is accompanied by instructions and safety information in a language which can be easily understood by consumers and other end-users, as determined by the Member State concerned. Instructions shall include the information required to use radio equipment in accordance with its intended use. …*
>
> *The following information shall also be included in the case of radio equipment intentionally emitting radio waves:*
>
> *(a) frequency band(s) in which the radio equipment operates;*
>
> *(b) maximum radio-frequency power transmitted in the frequency band(s) in which the radio equipment operates."*

However, this type of information is not part of the normative requirements included in the HSs covering article 3.1(b) and article 3.2 of Directive 2014/53/EU, which are within the scope of the present document.

4.2.2 Other information

At the discretion of the TB, other information may be required, for example to facilitate testing. Informative annexes may be included where appropriate.

TBs should not include requirements for manufacturers declarations within the normative part of HSs.

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

5.1 General

Harmonised Standards (HSs) 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). An EUT in an HS should be regarded as a "black box".

Some equipment may implement features relevant to article 3.2 using embedded software. Where appropriate, TBs should include provisions in an HS that prevent unintended configurations potentially leading to non-conformity with article 3.2.

An "Environmental Profile" clause should be included which indicates that technical requirements should be met throughout the environmental conditions indicated in the HS. Example text is provided in the skeleton document for HSs 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, in order to ensure repeatability, HSs should specify, when necessary, test procedures and corresponding test conditions.

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

5.2.1 General

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."

When deciding which transmitter parameters to include in the HS, TBs should consider both in-band and adjacent-band. Relevant Electronic Communications Committee (ECC) and/or European Union (EU) deliverables may provide useful information.

In order to facilitate the application of HSs, the technical conditions attached to spectrum regulations (including conditions to support a general licence) should be taken into consideration when drafting the HS compliance conditions.

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 usages. The HS should be developed such that compliance with the essential requirements is ensured when operating in any operational mode.

5.2.2 Transmitter power limits

HSs may include transmitter power limits. However, TBs should note that these are defined in national Radio Interface Specifications (RIS) 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.

For devices without an antenna connector, the maximum power allowed may be specified as Total Radiated Power, ERP or EIRP.

5.2.3 Transmitter power accuracy

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

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 an HS.

5.2.4 Transmitter Spectrum mask

"Transmitter Spectrum mask" is a generic term for 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).

TBs may choose to specify the above parameters by the means of a transmitter spectrum mask.

A transmitter spectrum mask may be defined as absolute terms, or relative to the measured transmitter output and should be consistent with values used in ECC spectrum studies.

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

- a transmitter 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 equipment operating in adjacent frequency bands.

5.2.5 Transmitter frequency stability

Frequency stability impacts the ability of 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 may be specified relative to the actual operating frequency where the system operates (e.g. in parts per million or a percentage of the assigned/occupied bandwidth) or expressed as an absolute value, over a range of temperature, voltage and, where appropriate, 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.

TBs should consider specifying this parameter for base stations where use on shared radio sites is foreseen. TBs 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

5.2.7.1 General

Transmitter unwanted emissions are specified as OOB and spurious emissions, for further details see CEPT/ECC/Recommendation (02)05 [i.6].

5.2.7.2 Transmitter unwanted emissions in the out of band domain

The level of emissions in the OOB domain affects the ability of other equipment to operate in adjacent spectrum. TBs may specify OOB emission limits by defining a transmitter spectrum mask (see clause 5.2.4) or adjacent and alternate channel power requirements (see figure 1) based upon expected separation distances.

5.2.7.3 Transmitter unwanted emissions in the spurious domain

The limits specified in HSs for unwanted emissions in the spurious domain should respect those in CEPT/ERC/Recommendation 74-01E [i.2]. Where deviation from these limits is necessary, a justification should be provided, taking into account CEPT advice.

Where applicable, radiated limits for cabinet radiation should be specified.

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 relevant coexistence studies and in consequential relevant EC Decisions, ECC Decisions or 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 EUT to share spectrum with other EUTs of similar or dissimilar systems. Therefore, the transmitter time domain characteristics should be considered by the TB for inclusion in the HS.

5.2.9 Transmitter transients

For transmitter systems that do not transmit continuously the TB should consider the impact of transients that occur during the turn on and turn off of the transmission envelope. This may affect coexistence with other systems. Therefore, the impact of transmitter transients should be considered by the TB for inclusion in the HS.

5.3 Receiver parameters under article 3.2 of Directive 2014/53/EU

5.3.1 General

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

The intention of the essential requirements in 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."

When selecting receiver parameters for inclusion in an HS, TBs should consider the influence of possible unwanted signals on the receiver's performance, in particular from adjacent channels or spectrum. If a relevant ECC coexistence study recommends a certain level of receiver performance, then this should also be taken into consideration when drafting the HS.

In cases where it is not possible to use some or all of the parameters described in the following clauses, alternative parameters can be used. An example is provided in ETSI TS 103 567 [i.13], which describes a concept and parameters suitable for UWB and potentially applicable to certain types of SRD equipment. This should be addressed on a case-by-case basis and justified by the TB (see clause 4.1).

5.3.2 Receiver sensitivity

5.3.2.1 General

Receiver sensitivity is the ability to receive a specified wanted signal level while providing a pre-determined level of performance.

Receiver sensitivity should be considered for inclusion in HSs 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 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: As sensitivity is often a trade-off with other receiver parameters, TBs may need to take into account that a more sensitive receiver is not always beneficial for the application concerned. For example, a highly sensitive receiver may result in an excessive link budget potentially resulting in increased susceptibility to interference [i.12].

TBs should specify receiver sensitivity 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.

5.3.2.2 Applicability considerations

Where the HS requires equipment to operate sharing and interference mitigation techniques based on received signals, such as (but not only) LBT, DAA, DFS, or Adaptivity, that require the receiver to be able to detect signals down to a specified level (often derived by ECC sharing and compatibility studies), a separate sensitivity requirement may not be relevant for assessing spectrum efficiency.

For certain other systems the TB may decide not to specify receiver sensitivity as a separate parameter where it may not contribute to the spectrum efficiency of the system under consideration. Such decisions should be clearly justified by the TB.

Including receiver sensitivity as a measure of spectrum efficiency may not be relevant where this is defined indirectly by other parameters. This should be addressed on a case-by-case basis and justified by the TB (see clause 4.1).

5.3.2.3 Desensitization

Desensitization is a degradation of the receiver sensitivity caused by the presence of an unwanted signal.

As desensitization is a receiver effect addressed by other parameters, its inclusion as a separate parameter in an HS is not required.

5.3.3 Receiver co-channel rejection

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

Receiver co-channel rejection is an essential parameter in frequency planning, in particular to enable the spatial re-use of the same frequency, e.g. in nearby geographic areas or in other sectors/directions.

Therefore, consideration should be given to specifying receiver co-channel rejection.

NOTE: Spatial reuse is also affected by system planning factors which may include: choice of modulation scheme, antenna diversity and antenna beam steering. Adequate co-channel rejection performance is an important receiver parameter as it can make it possible to increase the number of communication channels available for use and thus support a more efficient use of the spectrum.

5.3.4 Receiver Selectivity

5.3.4.1 General

Receiver selectivity is a measure of a receiver's ability to receive a wanted signal in the presence of an unwanted signal outside its operating bandwidth, e.g. on an adjacent channel or frequency or on a frequency outside its operating band.

It is 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 an HS is left to the individual TB to formulate however they should identify in the HS which parameters cover receiver selectivity.

TBs may combine the requirements of receiver adjacent channel/adjacent band selectivity and blocking performance into a single requirement, if considered appropriate.

5.3.4.2 Receiver adjacent channel selectivity (adjacent band selectivity)

5.3.4.2.1 Receiver adjacent channel selectivity

Receiver adjacent channel selectivity 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, in the adjacent channel (see figure 1).

NOTE: This parameter is sometimes referred to as adjacent channel rejection.

TBs should consider the usage scenario of the receiver, for example in channelized use the requirements for selectivity may differ from scenarios without channelization. Also mixed bandwidth scenarios may require different selectivity measures.

5.3.4.2.2 Receiver adjacent band selectivity

Receiver adjacent band selectivity 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, near the band edges of the operating band but within the adjacent band.

TBs should consider when specifying adjacent band selectivity requirements that there may be services operating in the upper and lower adjacent bands with differing technical characteristics and as such the technical requirements for selectivity may need to be different in each case.

5.3.4.3 Receiver blocking

Receiver blocking 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 input signal at any frequency other than those of the spurious responses or of the adjacent channels.

TBs should recommend practical measurement methods as testing at "any frequency" is clearly an unbounded requirement.

Where receiver spurious response rejection and receiver blocking are both specified, receiver blocking should usually be specified at a more stringent level than that specified (see note in clause 5.3.4.4) for receiver spurious response rejection (clause 5.3.4.4) at frequencies relatively far removed from the operating frequency.

TBs should include a receiver blocking parameter in HSs.

5.3.4.4 Receiver spurious response rejection

Receiver 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. TBs should specify the frequency range over which this requirement should be evaluated.

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

NOTE: TBs 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.

5.3.4.5 Receiver radio-frequency intermodulation

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.

TBs should consider specifying a minimum of second order intermodulation and third order intermodulation performance. The following second order terms should be considered, where F_{if} is the intermediate frequency and F_{rx} is the nominal frequency of the receiver:

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

TBs 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 HSs, 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 to 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 TBs should consider how to include this in test methods if considered appropriate.

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.

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 CEPT/ERC/Recommendation 74-01E [i.2].

5.3.6 Other receiver effects

5.3.6.1 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. The lower end of this range is normally the sensitivity of the receiver. The upper end of a receiver's dynamic range determines how strong a received signal can be before producing degradation due to overloading.

Many receivers are deployed in a manner that results in a situation where it is impossible to receive a wanted signal that is high enough to produce any overloading effect. In these cases, TBs may decide not to specify receiver dynamic range.

The dynamic range of a receiver may be specified in an HS as a "stand-alone" requirement where the operational situation provides minimum/maximum operational distances from a common transmitter.

In all other cases it is considered that the dynamic range of the receiver is implicitly covered in an HS where interference characteristics are specified in terms of selectivity requirements, including blocking.

5.3.6.2 Reciprocal mixing

Reciprocal mixing occurs when noise sidebands of the Local Oscillator (LO) mix with interfering signals at distances from wanted signal comparable to the LO offset range where phase noise is higher than the thermal noise (i.e. from few hundreds Hz to few MHz) converting unwanted noise at the frequency of the receiver which may result in "desensitization" of the receiver (see note 1), additional to that produced by the interference itself. In direct Digital Down Conversion receivers (DDC) a similar effect occurs caused by the phase jitter (see note 2) of the clock associated with the ADC.

It is considered that the reciprocal mixing effects are implicitly covered in HSs where comprehensive interference characteristics are specified in terms of selectivity and/or blocking requirements, thus removing the need for this parameter to be included in HSs as the effects of receiver selectivity and reciprocal mixing cannot be separated.

NOTE 1: In communications receivers intended for use in interference limited rather than noise limited environments, degradation due to reciprocal mixing may occur before degradation due to non-linearity. As a result, reciprocal mixing may be the dominant effect in those receivers' performance.

NOTE 2: 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.

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 HSs.

As use of shared spectrum increases, the ability of equipment and services to share is of paramount importance to efficient use of the radio spectrum. The coexistence of various combinations of equipment, applications and services are studied in ECC coexistence studies which recommend, in some cases, a set of technical conditions necessary to support sharing. Such technical conditions may apply to transmitters and/or receivers.

Where dynamic spectrum sharing properties depend on specific technologies, these dependencies should be minimized in order to respect an overall policy of technology neutrality in HSs.

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

5.4.2 Transmitter Power Control (TPC)

Regulatory spectrum management measures may specify a defined range of Transmitter Power Control (TPC). Where ECC compatibility/coexistence studies include or simulate TPC operation at specific levels, HSs should include TPC with at least equivalent range and precision.

5.4.3 Listen Before Talk (LBT)

Listen Before Talk (LBT) is a common spectrum sharing mechanism, which is often combined with Adaptive 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 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 5 GHz 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 HS. 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 equipment, 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.

HSs 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 TBs should not include antenna characteristics in the HS. For further information, see note.

NOTE: Where the antenna is supplied separately as an accessory or a component of the radio equipment TBs 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 TB decides to standardize the characteristics of antennas, these may be included in 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

TBs should consider the EMC parameters in this clause of the present document when producing HSs 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 [i.1] 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 HS and the article 3.1(b) HS should result in no unassessed gap in the radio spectrum either from conducted or radiated interference phenomena. As a consequence, 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 TBs producing the article 3.2 HSs liaise closely with ETSI ERM WG-EMC, who produce the ETSI article 3.1(b) HSs, 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 HSs 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 HS.

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

6.2 Exclusion bands

Exclusion bands in EMC HS 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 HS. Care should be taken that for both emissions and immunity, the frequency bands covered by radio and EMC HSs are aligned without overlap or gaps.

6.3 Combined equipment within the scope of Directive 2014/53/EU

An HS 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 HSs 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.

NOTE: Further information regarding combined equipment may be found in ETSI EG 203 367 [i.11].

7 Structure of Harmonised Standards

7.1 General

The final structure of the HS will be a decision for the individual TBs, 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 HS addressing the article 3.2 requirements will be separate from HSs 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 HSs under the Directive 2014/53/EU [i.1], whilst production of the article 3.1(b) HSs 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.

- Clauses addressing technical requirements may be structured by including subclauses, for example:
  - 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 HSs.

TBs should take care to provide sufficient detail regarding significant changes between different editions of HSs. This is done in a specific "Change History" informative annex of the HS. Further details can be found in the notes within the skeleton referenced from annex A of the present document.

7.2 Measurement information

Where technical parameters are specified, these should be accompanied by a test/assessment method, related to the required limits and pass/fail criteria.

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 HSs.

Where the TB decides to include measurement uncertainty in an HS it should not be within a normative part of the HS.

7.3 Scope

The scope of an HS should define the equipment types and their relevant frequency band(s) that are covered by the HS.

7.4 Structure of the ETSI EN 301 489 series of EMC standards

ETSI EN 301 489-1 [i.10] contains a standard set of EMC parameters, limits and test methods that should be used in all other ETSI EMC HSs. It is recommended that this is achieved by normatively referencing the required clauses in ETSI EN 301 489-1 [i.10] from the product-specific parts of the ETSI EN 301 489 series [i.14].

However, it is recognized that certain technologies and applications may need to deviate from this "standard set" for specific justified reasons, e.g. where equipment is expected to be operated in a harsher electromagnetic environment than is usual for most equipment. In these cases, the product-specific part of the ETSI EN 301 489 series, i.e. part 2 onwards, may specify different test limits and/or test set-up arrangements to address these situations.

It should be noted that in the absence of a product-specific part within the ETSI EN 301 489 series [i.14], ETSI EN 301 489-1 [i.10] may be used in its own right to demonstrate compliance with article 3.1(b) of Directive 2014/53/EU [i.1].

Annex A:
Harmonised Standard Skeleton Document

All ETSI HSs 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/Standards-development/Drafting/Skeletons.

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 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 TBs.

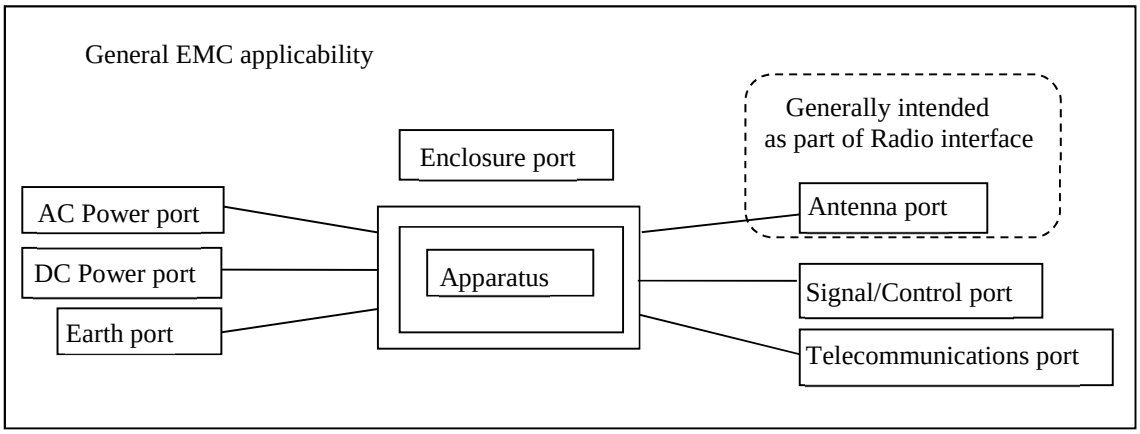

Figure B.1: Current ETSI and international understanding of EMC and radio parameters subdivision

Annex C:
Change History

C.1 Differences between V1.1.1 and V1.2.1

Table C.1 briefly describes the major revisions to the current document compared to the previous edition.

Table C1: Revisions in v1.2.1 of the present document

Clause	Description of Revision
Overall	No parameters were deleted compared with the previous edition, although some were merged and moved to improve the readability of the guide.
4.1	New text added highlighting recording of decisions taken during drafting process, as proposed in document ERM(18)066022.
5.3.2	New sub clauses added providing extra guidance on situation where RX Selectivity may not be required as a specific standalone test. Desensitization text moved to a sub-clause.
5.3.3	Improved text.
5.3.4	Improved text and addition of alternative terms i.e. adjacent band.
5.3.6.2	Reciprocal mixing text revised to explain that this is effectively covered by other parameters.
7.2	Removal of guidance on measurement uncertainty in line with ADCO advice that measurement uncertainty is not required in Harmonised Standards (discussed at OCG REDEMCD#70 and ERM#66).
7.4	New paragraph describing revised structure of ETSI EMC standards for radio products.
Annex C	New Annex added to detail changes between different version of the present document. Proposed and agreed during meeting 1, see minutes in document ERM(18)000016.

Annex D: Bibliography

- Recommendation ITU-R SM.332-4: "Selectivity of Receivers".
- 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 2016.

NOTE: Available at 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).

NOTE: Available at http://webapp.etsi.org/AgreementView/AgreementSearch.asp.

- ECC Report 310 Evaluation of receiver parameters and the future role of receiver characteristics in spectrum management, including in sharing and compatibility studies.

NOTE: Above document currently on public enquiry.

History

Document history		
V1.1.1	August 2015	Publication
V1.2.0	February 2020	Membership Approval Procedure MV 20200428: 2020-02-28 to 2020-04-28