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Short Range Devices (SRD) and Ultra Wide Band (UWB); Part 2: Measurement techniques for receiver requirements

Reference

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Foreword

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

The present document is part 2 of a multi-part deliverable covering Short Range Devices (SRD) and Ultra Wide Band (UWB), as identified below:

Part 1: "Measurement techniques for transmitter requirements";

Part 2: "Measurement techniques for receiver requirements".

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
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Modal verbs terminology

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

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Introduction

The present document provides measurement procedures for receiver requirements to address the spectrum efficiency requirements of the RED [i.10].

The basis for this RX concept was developed by ETSI during two Special Task Forces.

First Special Task Force: ETSI STF 494; Update of the UWB related Harmonised Standards covering the essential requirements of article 3.2 of the RED [i.10].

The STF 494:

- Started: 2015-05-25
- Ended: 2016-03-31

Outcome:

- ETSI TS 103 361 [i.4]

The second Special Task Force: ETSI STF 541; Signal interferer handling, a new RX requirement to cover the essential requirements of article 3.2 of the RED [i.10], was a continuation to implement and consider comments received after the publication of the ETSI TS 103 361 [i.4].

The STF 541:

- Started: 2017-10-06
- Ended: 2019-05-31

Outcome:

- ETSI TR 103 566 [i.2]
- ETSI TS 103 567 [i.3]

There is no specification of receiver parameter values within the present document. These values will be derived from technical specification defined by the responsible ETSI Technical Committees and/or the findings of regulatory studies conducted by the relevant bodies like CEPT ECC WG SE. The limits/values for the baseline RX-conformance requirements will be specified in the related standard.

In addition to the two receiver baseline requirements it can be necessary that the RX spurious emission requirement could be a further RX requirement in the related standard. This could be necessary if the EUT has a receive only mode or if it is not collocated to the transmitter. The present document specifies the receiver spurious emission requirement and the corresponding test and measurement procedure in clause 5.2.

The present document provides practical information and guidance for the compliance receiver tests of UWB and Short Range technology and devices.

It is recommended that, in drafting the related standards, a thorough analysis is conducted on all possible applicable receiver parameters (see annex C), selecting the most appropriate RX-requirements and having a robust reasoning for those that are disregarded.

1 Scope

The present document provides measurement procedures for receiver requirements to address the spectrum efficiency requirements of the RED [i.10].

The baseline receiver concept is a set of two parameters given in clause 5 of the present document providing guidance for HS development, which can be further refined by the responsible TB.

Baseline receiver concept comprises the following parameters:

- Receiver Baseline Sensitivity (RBS); and
- Receiver Baseline Resilience (RBR).

The Baseline receiver concept is a further development of the signal interferer handling concept, see ETSI TS 103 361 [i.4].

2 References

2.1 Normative references

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

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

Not applicable.

2.2 Informative references

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

[i.2] ETSI TR 103 566 (V1.1.1): "Evaluation status on receiver requirement on Signal interferer handling".

[i.3] ETSI TS 103 567 (V1.1.1): "Requirements on signal interferer handling".

[i.4] ETSI TS 103 361 (V1.1.1): "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Receiver technical requirements, parameters and measurement procedures to fulfil the requirements of the Directive 2014/53/EU".

[i.5] ERC REC 74-01: "Unwanted emissions in the spurious domain", approved 1998, amended 29 May 2019.

[i.6] ETSI EN 303 883-1 (V1.2.0): "Short Range Devices (SRD) and Ultra Wide Band (UWB); Part 1: Measurement techniques for transmitter requirements".

[i.7] "RCS measurement results for automotive related objects at 23-27 GHz"; Tom Schipper; Joaquim Fortuny-Guasch; Dario Tarchi; Lars Reichardt; Thomas Zwick. Proceedings of the 5th European Conference on Antennas and Propagation (EUCAP).

[i.8] EUR - Scientific and Technical Research Reports: "Radar Cross Section Measurements of Pedestrian Dummies and Humans in the 24/77 GHz Frequency Band". FORTUNY GUASCH Joaquim and CHAREAU Jean-Marc, 2013.

[i.9] ETSI TR 103 181-2 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band (UWB);Transmission characteristics Part 2: UWB mitigation techniques".

[i.10] 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 (RED).

[i.11] European Communications Office: "EFIS: ECO Frequency Information System".

NOTE: Available at https://efis.cept.org/.

[i.12] ETSI TR 103 181-1 (V1.1.1): "Short Range Devices (SRD) using Ultra Wide Band (UWB); Technical Report Part 1: UWB signal characteristics and overview CEPT/ECC and EC regulation".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

antenna port: physical port, for connection of an antenna used for intentional transmission and/or reception of radiated RF energy

co-located: receiver is located in the same device/EUT housing as the transmitter

event failure rate: ratio of failed tests compared to total number of tests

mainbeam: direction of maximum radiation

Received Power at the EUT ($P_{@EUT}$): received power at the EUT and represents the signal the EUT is able to detect. $P_{@EUT}$ is similar to the specified sensitivity level for the EUT as specified in the related standard (kind of power (e.g. dBm or dBm/MHz) and limit, see note)

NOTE: $Sensitivity\ @\ EUT = P_{@EUT}$.

Receiver Baseline Resilience (RBR): capability to maintain a pre-determined minimum acceptable level of performance in the presence of unwanted signals over the frequency band of operation, applicable adjacent and remote frequency bands

Receiver Baseline Sensitivity (RBS): capability to receive a wanted signal at application related defined input signal levels while providing a pre-determined minimum acceptable level of technical performance

NOTE 1: The pre-determined minimum acceptable level of technical performance is the basis for all other receiver parameters.

NOTE 2: The purpose of the sensitivity requirement is to assure a basic measure of efficient use of spectrum that strikes balance between sensitivity and the need to avoid being sensitive to interference.

3.2 Symbols

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

σ	Radar Cross Section
ΔD	degradation of the distance from RBR test
Δf	additional frequency range to increase the range (ORF_{RBR}) for the RBR interferer assessment
A	size of the antenna aperture
A_{eff}	effective area of the antenna [m²]
att	attenuation of the "Variable Attenuator" in [dB]
c	the velocity of light [m/s]
ca	cable attenuation
cf	coupling factor of the coupler in [dB]
d_g	degradation of the sensitivity in [dB]
dB	decibel
dBi	gain in decibels relative to an isotropic antenna
dBm	gain in decibels relative to one milliwatt
dl	attenuation of the "Delay Line" in [dB]
D_{int}	distance between interfering antenna and EUT
D_{min}	minimum distance from EUT to a specified object the EUT is able to detect
D_{real}	real distance between EUT and target simulator in [m]
D_{sens}	minimum range from an ideal/companion source to the EUT (RX) value in [m]
D_{scal}	scaled distance for the RBS tests
D_{sim}	simulated target distance within target simulator in [m]
f	test frequency in [GHz]
f_C	centre frequency of the EUT OFR
F_{LOWER}	lowest frequency of receiver spurious emission test
F_{UPPER}	highest frequency of receiver spurious emission test
$g_{measure}$	measurement antenna gain in [dBi] at test frequency f
g_t	measurement test antenna gain in [dBi] at test frequency f
g_e	EUT antenna gain in [dBi]
g_{rt}	measurement receiving test antenna gain in [dBi] at test frequency f
G_{int}	interfering transmit antenna
g_{int}	antenna gain of test antenna to transmit interfering signal [dBi]
G_{RX}	gain of the receiving antenna
G_{TX}	gain of the transmitting antenna
il	insertion loss of the coupler in [dB]
$IP_{@EUT}$	interfering Power@EUT
IP_{out}	output power of the interference signal source (generator)
ORF_{RBR}	Frequency range for the RBR interferer assessment
$P_{@EUT}$	Sensitivity @ EUT
P_{EUT}	measured transmitted power of the EUT [e.g. dBm/MHz] or in [W]
P_{meas}	measured received power with the spectrum analyser
P_{out}	output power of the signal generator A
P_{reg}	maximum regulated radiated emission for ideal TX/companion device
P_{RX}	power received back from the object by the EUT [W]
P_{trans}	measured transmitted power from the EUT in [dB]
P_{TX}	transmitter power [W]
$RBR_{in\text{-}band}$	frequency range for the RBR interferer assessment ($ORF_{RBR} + 2\Delta f$)
RX_{ref}	sensitivity limit at antenna port
$RX_{refsense}$	scaled sensitivity limit for the RBS test
SCP	Scaling factor (absolute value)
X_{VALUE}	symbol for a value/limit specified in the related standard

3.3 Abbreviations

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

ACS	Adjacent Channel Selectivity
ADM	Accuracy in Distance Measurement
BER	Bit Error Rate
CATR	Compliant And TRansportable far-field
CEPT	European Conference of Postal and Telecommunications administrations
CW	Continuous Wave
DAA	Detect And Avoid
ECC	Electronic Communications Committee
ECO	European Communications Office
EFIS	ECO Frequency Information System
EFR	Event Failure Ratio
EN	European Norm
ENAP	EN Approval Process
ERM	Electromagnetic compatibility and Radio spectrum Matters
EUT	Equipment Under Test
EUT-RX	Receiver of the Equipment Under Test
FCC	Federal Communications Commission
FMCW	Frequency Modulated Continuous Wave
HH	Horizontal - Horizontal
LAES	Location tracking Applications for Emergency Services
LBT	Listen Before Talk
LT1	Location Tracking type 1
LT2	Location Tracking type 2
MIMO	Multiple Input Multiple Output
NA	Not Applicable
ODP	Object Detection Probability
OFR	Operating Frequency Range
OOB	Out Of Band
OTA	Over The Air
PER	Packet Error Rate
RBR	Receiver Baseline Resilience
RBS	Receiver Baseline Sensitivity
RBW	Resolution BandWidth
RC	Remote Consensus
RCS	Radar Cross Section
RED	Radio Equipment Directive
RF	Radio Frequency
RMS	Root Mean of Squares
RP	Radiated Power
RX	Receiver
SE	Spectrum Engineering
SRD	Short Range Device
STF	Special Task Force of ETSI
TB	Technical Body
TG	Technical Group
TPC	Total Power Control
TX	Transmitter
UWB	Ultra Wide Band
VBW	Video BandWidth
VV	Vertical - Vertical
WG	Working Group

4 General

The present document provides practical information and guidance for the compliance receiver tests of UWB and Short Range technology and devices.

The baseline receiver requirements were developed based on the findings of ETSI TR 103 566 [i.2] and ETSI TS 103 567 [i.3], where the signal interferer handling concept from ETSI TS 103 361 [i.4] has been analysed on its applicability for the RED [i.10].

The baseline receiver concept is a set of two parameters given in clause 5 of the present document providing guidance for harmonised standard development, which can be further refined by the responsible TB.

Baseline receiver concept comprises the following parameters:

- Receiver Baseline Sensitivity (RBS); see clause 5.4; and
- Receiver Baseline Resilience (RBR); see clause 5.5.

The baseline receiver concept is a further development of the signal interferer handling concept, see ETSI TS 103 361 [i.4].

In annex C these two parameters are put in relation to existing receiver parameters given in ETSI EG 203 336 [i.1] and the assessments prepared by ETSI STF 494 and 541. Annex C additionally provides the summary assessment/justification for this new baseline receiver concept described in the present document.

5 Receiver Requirements

5.1 General Guidance on RX measurement

Complementary information to the conformance tests in the clauses below are provided in annexes A and B of ETSI EN 303 883-1 [i.6], for example:

- test conditions, power supply and ambient temperatures (see clause A.5 of ETSI EN 303 883-1 [i.6]);
- measurement uncertainty and the interpretation of the measurement results (see clause A.8 of ETSI EN 303 883-1 [i.6]);
- test setups and radiated measurements (see annex B of ETSI EN 303 883-1 [i.6]).

5.2 Receiver Spurious Emissions

5.2.1 Description

The RX spurious emissions shall be measured within the frequency range defined in table 2.

Only applicable for receive only EUT (TX not present) or for EUT which has a receive only mode (TX inactive).

5.2.2 Limits

The limit for RX spurious emissions could be provided in the applicable related standard

If no limits for RX spurious emissions are provided in the related standard, then the limits in table 1 shall apply.

Table 1: Receiver spurious emission limits in line with ERC REC 74-01 [i.5]

Frequency range	Limit values
F_{LOWER} to 1 000 MHz (see note)	-57 dBm
1 GHz < f ≤ F_{UPPER} (see note)	-47 dBm
NOTE: F_{UPPER} and F_{LOWER} are linked with the OFR of the EUT, see table 2.	

Table 2: Frequency range for the RX spurious emission test, linked with EUT OFR in line with ERC REC 74-01 [i.5]

Fundamental frequency range defined by f_L and f_H (see note 2)	Frequency range for measurements	
	Lower frequency (F_{LOWER}) (see note 3)	Upper frequency (F_{UPPER})
300 - 600 MHz	30 MHz	3 GHz
600 MHz - 5,2 GHz	30 MHz	5th harmonic (see note 1)
5,2 - 13 GHz	30 MHz	26 GHz
13 - 150 GHz	30 MHz	2nd harmonic (see note 1)
150 - 300 GHz	30 MHz	300 GHz
NOTE 1: F_{UPPER} is the stated harmonic of f_H (the upper edge of the OFR, which is measured in ETSI EN 303 883-1 [i.6], clause 5.2).		
NOTE 2: F_{LOWER} has to be selected based on f_L and F_{UPPER} based on f_H (f_L and f_H can be measured according to ETSI EN 303 883-1 [i.6], clause 5.2); for receive only devices f_H and f_L of the related EUT/companion device shall be used.		
NOTE 3: For EUT operating below 300 MHz the spurious emissions limits below 30 MHz shall be specified in the related standard.		

5.2.3 Conformance

5.2.3.1 General

The following conformance test shall be used for RX unwanted emissions (OOB and spurious emissions) if not otherwise specified in the related standard.

The conformance test shall be performed in two steps:

- step 1: pre-scan with peak detector (see clause 5.2.3.2);
- step 2: if necessary, measurement with RMS detector (see clause 5.2.3.3).

NOTE: The split in two steps is done because: a complete scan with RMS could take a long time. The measurement with peak detector is an "overestimation" of the emission and is only to find the frequencies with the highest emissions that will be verified in step 2.

5.2.3.2 Step 1: Measurement with Peak Detector

The following spectrum analyser settings shall be used:

- Start frequency: F_{LOWER}
- Stop frequency: F_{UPPER}

NOTE 1: There could be a need to split the measurement into different frequency ranges depending on the measurement set-up (e.g. external mixers, bandwidth of antennas and waveguides, RBW).

- Resolution BandWidth (RBW):
  - ≥ 100 kHz between 30 MHz and 1 GHz
  - ≥ 1 MHz above 1 GHz
- Video BandWidth (VBW): ≥ RBW
- Detector mode: peak