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Short Range Devices (SRD) using
Ultra Wide Band technology (UWB);
Harmonised Standard for access to radio spectrum;
Part 4: Material Sensing devices;
Sub-part 4: Exterior material sensing applications for ground based vehicles below 10,6 GHz

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Foreword

This draft Harmonised European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the combined Public Enquiry and Vote phase of the ETSI Standardisation Request deliverable Approval Procedure (SRdAP).

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.5] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.3].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

The present document is part 4, sub-part 4 of a multi-part deliverable. Full details of the entire series can be found in part 4, sub-part 1 [i.14].

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	18 months after doa

Modal verbs terminology

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

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

Introduction

ETSI TC ERM TGUWB decided to develop more specific standards; this means instead of one generic ETSI EN 302 065-4 [i.8] standard for UWB Material Sensing devices a standard family ETSI EN 302 065-4-x for UWB Material Sensing devices was started. The present document is sub-part 4 (ETSI EN 302 065-4-4) of the new standard family.

1 Scope

The present document specifies the technical requirements, limits and test methods for material sensing devices using UWB technology exterior material sensing devices for ground based vehicles below 10,6 GHz.

The present document only covers non-contact based UWB material sensing devices with antenna connectors according to ECC/DEC(07)01 [i.1] and Commission Decision 2024/1467/EU [i.2].

Further details of the covered EUT for external material sensing applications for ground-based vehicles and the related categories can be found in clause 4.2 of the present document.

NOTE: The relationship between the present document and essential requirements of article 3.2 of Directive 2014/53/EU [i.3] is given in annex A.

2 References

2.1 Normative references

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

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

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

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

[1] ETSI EN 303 883-1 (V2.1.1) (08-2024): "Short Range Devices (SRD) and Ultra Wide Band (UWB); Part 1: Measurement techniques for transmitter requirements".

[2] ETSI EN 303 883-2 (V2.1.1) (08-2024): "Short Range Devices (SRD) and Ultra Wide Band (UWB); Part 2: Measurement techniques for receiver requirements".

[3] ETSI EN 302 066 (V2.2.1) (06-2020): "Short Range Devices (SRD); Ground- and Wall- Probing Radio determination (GPR/WPR) devices; Harmonised Standard for access to radio spectrum".

[4] ETSI TS 103 941 (V1.1.1) (01-2024): "Short Range Devices (SRD) and Ultra Wide Band (UWB); Measurement setups and specifications for testing under full environmental profile (normal and extreme environmental conditions)".

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] ECC/DEC/(07)01: "ECC Decision of 30 March 2007 on the harmonised use, exemption from individual licensing and free circulation of Material Sensing Devices using Ultra-Wideband (UWB) technology", amended on 1 July 2022.

[i.2] Commission Implementing Decision (EU) 2024/1467 of 27 May 2024 amending Implementing Decision (EU) 2019/785 on the harmonisation of radio spectrum for equipment using ultra-wideband technology in the Union.

[i.3] 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.

[i.4] CEPT Report 45: "Report from CEPT to the European Commission in response to the Fifth Mandate to CEPT on ultra-wideband technology to clarify the technical parameters in view of a potential update of Commission Decision 2007/131/EC"; Report approved on 21 June 2013 by the ECC.

[i.5] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.

[i.6] Recommendation ITU-R SM.1755: "Characteristics of ultra-wideband technology".

[i.7] ETSI EG 203 336 (V1.2.1) (2020-05): "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.8] ETSI EN 302 065-4 (V1.1.1): "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 4: Material Sensing devices using UWB technology below 10,6 GHz".

[i.9] ECC/DEC/(20)/01: "ECC Decision of 20 November 2020 on the harmonised use of the frequency band 5945-6425 MHz for Wireless Access Systems including Radio Local Area Networks (WAS/RLAN)".

[i.10] ETSI TS 136 101 (V16.8.0): "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (3GPP TS 36.101)".

[i.11] ETSI TS 103 361 (V1.1.1) (03-2016): "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.12] ECO Frequency Information System.

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

[i.14] ETSI EN 302 065-4-1: "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonised Standard for access to radio spectrum; Part 4: Material Sensing devices; Sub-part 1: Building material analysis operating within 30 MHz to 10,6 GHz".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI EN 303 883-1 [1], ETSI EN 303 883-2 [2] and the following apply:

footsize: outside dimension of the EUT in the horizontal plane

3.2 Symbols

For the purposes of the present document, the symbols given in ETSI EN 303 883-1 [1], ETSI EN 303 883-2 [2] and the following apply:

c	Velocity of light in a vacuum
d, d_1,d_2	Measurement distance
D_1	Difference between *M* and *N*
D_2	Difference between *M* and *I*
d_{int}	Interferer distance
f_1	RBR test frequency within the middle of the EUT OFR
f_2	RBR test frequency between f_L and f_C of the EUT OFR
f_3	RBR test frequency between f_C and f_H of the EUT OFR
f_C	Centre frequency of the operating frequency range
f_H	Highest frequency of the operating frequency range
$f_{H1,2}$	RBR test frequency higher f_H of the EUT OFR
f_L	Lowest frequency of the operating frequency range
$f_{L1,2}$	RBR test frequency lower f_L of the EUT OFR
f_M	Frequency at which the peak power emission occurs
$G_{(f)}$	Antenna gain over frequency
G_A	Gain of the measurement antenna
I	Signal recorded by the receiver in presence of the interferer
M	Maximum signal for the receiver in the linear region of operation
N	Receiver noise level
$P_{e.i.r.p.}$	Spectral power density
R	Distance
TRP_{SD}	Total Radiated Power spectral density

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI EN 303 883-1 [1], ETSI EN 303 883-2 [2] and the following apply:

BBDR	BroadBand Disaster Relief
BFWA	Broadband Fixed Wireless Access
BS	Base Station
CDMA	Code Division Multiple Access
CW	Continuous Wave
dB	decibel
dBm	decibel reference to 1 mW
DCS	Digital Cellular System
e.i.r.p.	equivalent isotropic radiated power
EC	European Commission
EN	European Norm
E-UTRA	Evolved Universal Terrestrial Radio Access
EVS	External Vehicular Sensor
FDD	Frequency Division Duplex
FHSS	Frequency Hopping Spread Spectrum
GSM	Global System for Mobile
IMT	International Mobile Telecommunications
ITS	Intelligent Transport Systems
LBT	Listen Before Talk
LTE	Long Term Evolution
PCS	Personal Communication System
PMSE	Programme Making and Special Events
PPDR	Public Protection and Disaster Relief
RDR	Receiver Dynamic Range
RFID	Radio Frequency IDentification
RLAN	Radio Local Area Network
T-DAB	Terrestrial - Digital Audio Broadcast
TH	ThresHold

TRP	Total Radiated Power
TS	Technical Specification
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
WIMAX®	Worldwide Interoperability for Microwave Access
WTPC	Wanted Technical Performance Criteria

4 Technical requirements specifications

4.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be in accordance with its intended use, but as a minimum, shall be that specified in the test conditions contained in the present document. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the operational environmental profile defined by its intended use.

4.2 EUT categories

4.2.1 General

The present document covers one category of EUT for exterior material sensing applications at ground based vehicle below 10,6 GHz. This category is named as Exterior Vehicle Sensors (EVSs).

More details about the use-case, wanted technical performance criteria and the RX-test conditions of the EVS category is provided in annex C.

The specified EVS EUT sub-categories provide a clear classification for the wanted technical performance criteria, limits requirements and conformance test procedures.

The following criteria were considered for sub-categorization of EVS category:

- Regulation: ECC and EC recommendations and decisions, see clause 4.2.2.
- Modulation: kind of modulation of the TX signal, see clause 4.2.3.
- Usage of active UWB mitigation techniques (e.g. LBT, DAA), see clause 4.2.4.

An overview of the EVS EUT sub-categories is provided in clause 4.2.5, table 1.

4.2.2 Categorization by Regulation

The following regulation was considered for sub-categorization of EVS EUT:

- UWB regulations: ECC/DEC/(07)01 [i.1] and Decision (EU) 2024/1467 [i.2] for EVS EUT based on UWB technology with or without active mitigation techniques.

4.2.3 Categorization by Modulation

The following categorization of EVS EUT by modulation is used:

- TX1: for EUT with FHSS, sequential hopping/stepping or FMCW modulation.
- TX2: for any other modulation different from TX1.

4.2.4 Categorization by Active Mitigation Techniques

BMA EUT covered by ECC/DEC/(07)01 [i.1] and Decision (EU) 2024/1467 [i.2] can be categorized by use of active mitigation techniques (e.g. Listen Before Talk (LBT), Detect-and-Avoid (DAA)):

- EVS EUT based on UWB technology without active mitigation techniques.
- EVS EUT based on UWB technology with active mitigation techniques.

4.2.5 Summary EVS EUT categories

4 sub-categories of the EVS EUT are identified:

- EVS1: based on UWB technology without active mitigation techniques using TX1 (UWB regulations).
- EVS2: based on UWB technology without active mitigation techniques using TX2 (UWB regulations).
- EVS3: based on UWB technology with active mitigation techniques using TX1 (UWB regulations).
- EVS4: based on UWB technology with active mitigation techniques using TX2 (UWB regulations).

An overview of requirements for each EVS EUT categories is given in table 1.

Table 1: EVS EUT categories covered by the present document

Category	**Modulation**	**TX requirements**						**RX-requirements**	
		Emission requirements		**Additional requirements**		**Active mitigation**			
			Clause		**Clause**		**Clause**		**Clause**
EUT based UWB regulation; EUT without any active mitigation technique									
EVS1	TX1	OFR	4.3.2	DC	4.3.7			WTPC	C.2
		Indirect emissions	4.3.4	TRP	4.3.5			RBS	4.4.3
		TXUE	4.3.5					RBR	4.4.4
EVS2	TX2	OFR	4.3.2	DC	4.3.7			WTPC	C.2
		Indirect emissions	4.3.4	TRP	4.3.5			RBS	4.4.3
		TXUE	4.3.5					RBR	4.4.4
EUT based UWB regulation; EUT implemented the active mitigation technique LBT									
EVS3	TX1	OFR	4.3.2	DC	4.3.7	LBT	4.3.6	WTPC	C.2
		Indirect emissions	4.3.4	TRP	4.3.5			RBS	4.4.3
		TXUE	4.3.5					RBR	4.4.4
EVS4	TX2	OFR	4.3.2	DC	4.3.7	LBT	4.3.6	WTPC	C.2
		Indirect emissions	4.3.4	TRP	4.3.5			RBS	4.4.3
		TXUE	4.3.5					RBR	4.4.4

4.3 Transmitter requirements

4.3.1 General

Based on the different possible operational frequency ranges of the EUT categories covered in the present document different sets of transmitter conformance requirements are applicable. The applicability is governed by the operating frequency range as specified in clause 4.3.2.

4.3.2 Operating Frequency Range (OFR)

4.3.2.1 Applicability

The Operating Frequency Range (OFR) requirement shall apply to all EVS categories, see clause 4.2.5, table 1.

4.3.2.2 Description

For the description of the Operating Frequency Range (OFR), see ETSI EN 303 883-1 [1], clause 5.2.1.

Requirement for test parameter X as specified in ETSI EN 303 883-1 [1], clause 5.2.1:

X: 10 dB

NOTE: The present document is in accordance with the -10 dB bandwidth for UWB EUT below 10 GHz, as defined in annex 1 of Recommendation ITU-R SM.1755 [i.6].

4.3.2.3 Limits

The radio equipment within scope of the present document is capable of operating in all or part of the frequency bands given in table 2.

Table 2: Permitted frequency range in accordance with Decision (EU) 2024/1467 [i.2]

Permitted frequency range	
Transmit	30 MHz ≤ f ≤ 10,6 GHz
Receive	30 MHz ≤ f ≤ 10,6 GHz

The OFR shall be in the permitted frequency range of operation as given in table 2 and the OFR shall be equal or larger than 50 MHz.

4.3.2.4 Conformance

The conformance test suite for Operating Frequency Range (OFR) shall be as defined in clause 5.4.1 and shall be done under normal conditions as defined in clause 5.1.2.

4.3.3 Indirect emissions

4.3.3.1 Applicability

The Indirect emission requirement shall apply to all EVS categories, see clause 4.2.5, table 1.

For some frequency ranges the EUT shall fulfil additional requirements.

The additional requirements are applicable if the OFR is partly or fully overlapping with the frequency range for which the mitigation is requested.

An overview of the applicable additional requirements is provided in table 3.

Table 3: Possible applicable requirements

OFR is partly or full overlapping with frequency range [GHz]	**Additional requirement for EUT without any active mitigation technique**	**Additional requirements for EUT implemented the mitigation technique LBT**
	Sub-categories: EVS1 and EVS2	**Sub-categories: EVS3 and EVS4**
1,215 < f ≤ 1,73		LBT, see clause 4.3.6
2,5 < f ≤ 2,69	TRP, see clause 4.3.6	TRP, see clause 4.3.5
		LBT, see clause 4.3.6
2,69 < f ≤ 2,7	DC, see clause 4.3.7	DC, see clause 4.3.7
	TRP, see clause 4.3.6	TRP, see clause 4.3.5
2,7 < f ≤ 2,9		LBT, see clause 4.3.6

OFR is partly or full overlapping with frequency range [GHz]	Additional requirement for EUT without any active mitigation technique	Additional requirements for EUT implemented the mitigation technique LBT
	Sub-categories: EVS1 and EVS2	Sub-categories: EVS3 and EVS4
2,9 < f ≤ 3,4		LBT, see clause 4.3.6
3,4 < f ≤ 3,8	DC, see clause 4.3.7	DC, see clause 4.3.7
4,8 < f ≤ 5,0	DC, see clause 4.3.7	DC, see clause 4.3.7
	TRP, see clause 4.3.6	TRP, see clause 4.3.5

4.3.3.2 Description

For the description of the indirect emissions see ETSI EN 303 883-1 [1], clause 5.7.1.

For the Indirect Emission two power requirements are regulated in Decision (EU) 2024/1467 [i.2] for the emission within the OFR:

- Mean Power e.i.r.p. spectral density (defined in 1 MHz).
- Peak e.i.r.p. (defined in 50 MHz).

4.3.3.3 Limits for indirect emissions

4.3.3.3.1 EUT without any active mitigation techniques

The limits for the indirect emission requirement for the EUT without any active mitigation techniques (EVS1 and EVS2, table 1) are listed in table 4.

The exterior maximum mean power spectral density shall not exceed the limits given in table 4 measured in the direction of the highest emission level out of the scenario.

Table 4: Emission Limit for EUT without any active mitigation technique in accordance with Decision (EU) 2024/1467 [i.2]

Frequency range [GHz]	Maximum mean e.i.r.p. spectral density [dBm/MHz]	Maximum peak e.i.r.p. [dBm defined in 50 MHz]	Remarks
f ≤ 1,73	-85	-60	
1,73 < f ≤ 2,2	-70	-45	
2,2 < f ≤ 2,5	-50	-25	
2,5 < f ≤ 2,69	-65	-40	Note 1
2,69 < f ≤ 2,7	-70	-45	Notes 1 and 2
2,7 < f ≤ 2,9	-70	-45	
2,9 < f ≤ 3,4	-70	-45	
3,4 < f ≤ 3,8	- 70	-45	Note 2
3,8 < f ≤ 4,8	- 50	-25	
4,8 < f ≤ 5,0	-55	-30	Notes 1 and 2
5,0 < f ≤ 5,25	-55	-30	
5,25 < f ≤ 5,35	-50	-25	
5,35 < f ≤ 5,6	-50	-25	
5,6 < f ≤ 5,65	-50	-25	
5,65 < f ≤ 5,725	-65	-40	
5,725 < f ≤ 6,0	-60	-35	
6,0 < f ≤ 8,5	-41,3	-0	
8,5 < f ≤ 9,0	-65	-25	
9,0 < f ≤ 10,6	-65	-25	
10,6 < f	-85	-45	

NOTE 1: An additional requirement on TRP applies, see clause 4.3.5.
NOTE 2: An additional requirement on DC applies, see clause 4.3.7 reduced limits for mean e.i.r.p. spectral density do apply in case of trading DC and power according to table 14.

The measured results of the indirect emissions shall be recorded.

4.3.3.3.2 EUT with active mitigation techniques

The limits for the indirect emission requirement for the EUT (EVS3 and EVS4, table 1) with active mitigation techniques are listed in table 5.

The exterior maximum mean power spectral density shall not exceed the limits given in table 5 measured in the direction of the highest emission level out of the scenario.

Table 5: Emission Limit for EUT with active mitigation technique in accordance with Decision (EU) 2024/1467 [i.2]

Frequency range [GHz]	Maximum mean e.i.r.p. spectral density [dBm/MHz]	Maximum peak e.i.r.p. [dBm defined in 50 MHz]	Remarks
f < 1,215	-85	-60	
1,215 < f ≤ 1,73	-70	-45	Note 3
1,73 < f ≤ 2,2	-70	-45	
2,2 < f ≤ 2,5	-50	-25	
2,5 < f ≤ 2,69	-50	-10	Notes 1 and 3
2,69 < f ≤ 2,7	-70	-45	Notes 1 and 2
2,7 < f ≤ 2,9	-50	-10	Note 3
2,9 < f ≤ 3,4	-50	-10	Note 3
3,4 < f ≤ 3,8	-70	-45	Note 2
3,8 < f ≤ 4,8	-50	-25	
4,8 < f ≤ 5,0	-55	-30	Notes 1 and 2
5,0< f ≤5,25	-55	-30	
5,25 < f ≤ 5,35	-50	-10	
5,35 < f ≤ 5,6	-50	-10	
5,6 < f ≤ 5,65	-50	-10	
5,65 < f ≤ 5,725	-50	-10	
5,725 < f ≤ 6,0	-50	-10	
6,0 < f ≤ 8,5	-41,3	0	
8,5 < f ≤ 9,0	-65	-25	
9,0 < f ≤ 10,6	-65	-25	
10,6 < f	-85	-45	

NOTE 1: An additional requirement on TRP_{SD} applies, see clause 4.3.5.
NOTE 2: An additional requirement on DC applies, see clause 4.3.7; reduced limits for mean e.i.r.p. spectral density do apply in case of trading DC and power according to table 14.
NOTE 3: An additional requirement on LBT applies, see clause 4.3.6.

The measured results of the indirect emissions shall be recorded.

4.3.3.4 Conformance

The conformance test for indirect emission shall be as defined in clause 5.4.2 and shall be done under normal conditions as defined in clause 5.1.2.

4.3.4 TX Unwanted Emissions (TXUE)

4.3.4.1 Applicability

The TX Unwanted Emissions (TXUE) requirement shall apply to all EVS categories, see clause 4.2.5, table 1.

4.3.4.2 Description

For the description of TX Unwanted Emissions (TXUE) see ETSI EN 303 883-1 [1], clause 5.5.1.

As requested in ETSI EN 303 883-1 [1], clause 5.5.1 the limit for the parameter X_{TXUE} for EUT is specified to:

X_{TXUE}: 50 %

4.3.4.3 Limits

The TXUE for all EUT shall be assessed based on ETSI EN 303 883-1 [1], clause 5.5.2.

For the TXUE following limit shall apply: ETSI EN 303 883-1 [1], clause 5.5.2, table 1. In addition, the following limits shall apply as given in table 6.

Table 6: TXUE Limit for EUT below 30 MHz in accordance with ETSI EN 303 883-1 [1]

Frequency range	Limit values for TXUE (see note)
9 kHz ≤ f ≤ 30 MHz	-36 dBm/100 kHz
NOTE: Not applicable for RP emissions within the OFR.	

- Out-Of-Band Emission:

Based in TXUE specification of 50 % (see clause 5.4.3) there is no OOB-domain for EUTs covered in the present document. Therefore, an OOB domain is not applicable.

4.3.4.4 Conformance

The conformance test for TXUE requirement shall be as defined in clause 5.4.3 and shall be done under normal conditions as defined in clause 5.1.2.

4.3.5 Total Radiated Power spectral density (TRP_{SD})

4.3.5.1 Applicability

The Total Radiated Power spectral density (TRP_{SD}) requirement apply to all EUT categories if the OFR is partly of fully overlapping with the frequency ranges listed in table 7 and the measured indirect emission level is above the value specified in table 7.

Table 7: Frequency ranges for which the TRP_{SD} mitigation apply in accordance with Decision (EU) 2024/1467 [i.2]

Frequency range [GHz]	If indirect emission measurement result is above	
	Maximum mean e.i.r.p. spectral density	Maximum peak e.i.r.p. (defined in 50 MHz)
2,5 < f ≤ 2,69	-85 dBm/MHz	-45 dBm
2,69 < f ≤ 2,7	-85 dBm/MHz	-45 dBm
4,8 < f ≤ 5,0	-70 dBm/MHz	-30 dBm

4.3.5.2 Description

For the description of the Total Radiated Power spectral density (TRP_{SD}), see ETSI EN 303 883-1 [1], clause 5.6.1.

4.3.5.3 Limits

4.3.5.3.1 Limits for EUT without active mitigation techniques

The limits for the TPR_{SD} requirement for the EUT without any active mitigation techniques are listed in table 8.

Table 8: TRP_{SD} Limit for EUT without any active mitigation technique in accordance with Decision (EU) 2024/1467 [i.2]

Frequency range [GHz]	Total radiated power spectral density [dBm/MHz]
2,5 < f ≤ 2,69	-75
2,69 < f ≤ 2,7	-65
4,8 < f ≤ 5,0	-65
NOTE: This requirement needs to be assessed based on the results of the indirect emission requirement (see table 7) and shall be fulfilled in addition to the indirect emission requirement (see table 5) for each frequency range.	

4.2.5.3.2 Limits for EUT with active mitigation technique

The limits for the TRP_{SD} requirement for the EUT with the active mitigation techniques are listed in table 9.

Table 9: TRP_{SD} Limit for EUT with active mitigation technique LBT in accordance with Decision (EU) 2024/1467 [i.2]

Frequency range [GHz]	Total radiated power spectral density [dBm/MHz]
2,5 < f ≤ 2,69	-60
2,69 < f ≤ 2,7	-65
4,8 < f ≤ 5,0	-65
NOTE: This requirement needs to be assessed based on the results of the indirect emission requirement (see table 7) and shall be fulfilled in addition to the indirect emission requirement (see table 6) for each frequency range.	

The LBT mitigation technique shall be tested separately in clause 4.3.7.

4.3.5.4 Conformance

The conformance test for TRP_{SD} requirement shall be as defined in clause 5.4.2.4 and shall be done under normal conditions as defined in clause 5.1.2.

4.3.6 Listen Before Talk (LBT)

4.3.6.1 Applicability

The Listen Before Talk (LBT) requirement apply to EUT categories EVS3 and EVS4 (see clause 4.2.5, table 1). EUT categories EVS3 and EVS4 devices have to implement the active mitigation technique LBT (see clause 4.3.3.3 and Commission Implementing Decision (EU) 2024/1467 [i.2]). The LBT mitigation has to be implemented if the OFR is partly or fully overlapping with the frequency ranges listed in table 11 and if the measured indirect emission level (see clause 4.3.3) is above the value specified in table 10.

Table 10: Frequency ranges LBT active mitigation apply in accordance with Decision (EU) 2024/1467 [i.2]

Frequency range [GHz]	If indirect emission measurement result is above	
	Maximum mean e.i.r.p. spectral density [dBm/MHz]	Maximum peak e.i.r.p. (dBm defined in 50 MHz)
1,215 < f ≤ 1,73	-85	-30
2,5 < f ≤ 2,69	-65	-25
2,7 < f ≤ 2,9	-70	-30
2,9 < f ≤ 3,4	-70	-30

4.3.6.2 Description

For the description of the Listen Before Talk (LBT) mitigation, see reference to definition in ETSI EN 303 883-1 [1], clause 5.10.1.

4.3.6.3 Limits

The limits for the LBT requirement for the EUT are provided in table 11.

Table 11: Requirement for active mitigation technique LBT in accordance with Decision (EU) 2024/1467 [i.2]

Frequency range [GHz]	Following LBT requirement shall be fulfilled	Test signal
1,215 < f ≤ 1,73	ETSI EN 303 883-1 [1], table 6, band 1	ETSI EN 303 883-1 [1], clause 5.10.3.4
2,5 < f ≤ 2,69	ETSI EN 303 883-1 [1], table 6, band 2	ETSI EN 303 883-1 [1], clause 5.10.3.3.1
2,7 < f ≤ 2,9	ETSI EN 303 883-1 [1], table 6, band 3	ETSI EN 303 883-1 [1], clause 5.10.3.3.2
2,9 < f ≤ 3,4	ETSI EN 303 883-1 [1], table 6, band 4	ETSI EN 303 883-1 [1], clause 5.10.3.4

The measured results of the LBT shall be recorded.

4.3.6.4 Conformance

The conformance test for LBT mitigation technique shall be as defined in clause 5.4.5 and shall be done under normal conditions as defined in clause 5.1.2.

4.3.7 Duty Cycle

4.3.7.1 Applicability

The Duty Cycle requirement applies to all EUT categories, if the OFR measurement result (see clause 4.3.2) covers partly or fully one or more of the frequency ranges specified in table 12 and if the measured indirect emission limit (see clause 4.3.3.3) is above the specified limit in table 12. For these cases the Duty Cycle requirement apply for these ranges the OFR is partly or fully overlapping and indirect emission is over of the limit as specified in table 12).

Table 12: Frequency ranges for which the DC mitigation requirement apply in accordance with Decision (EU) 2024/1467 [i.2]

Frequency range [GHz]	If indirect emission measurement result is above	
	Maximum mean e.i.r.p. spectral density	Maximum peak e.i.r.p. (defined in 50 MHz)
2,69 < f ≤ 2,7	-85 dBm/MHz	-45 dBm
3,4 < f ≤ 3,8	-80 dBm/MHz	-40 dBm
4,8 < f ≤ 5,0	-70 dBm/MHz	-30 dBm

4.3.7.2 Description

For the description of the Duty Cycle (DC) mitigation, see ETSI EN 303 883-1 [1], clause 5.11.1.

4.3.7.3 Limits

The limits for the Duty Cycle requirement for the EUT are provided in table 13.

Table 13: Requirement for Duty Cycle in accordance with Decision (EU) 2024/1467 [i.2]

Frequency range	Duty Cycle requirement	Related Maximum mean e.i.r.p. spectral density from tables 5 and 6
2,69 < f ≤ 2,7	10 %/second	-55 dBm/MHz
3,4 < f ≤ 3,8	10 %/second	-50 dBm/MHz
4,8 < f ≤ 5,0	10 %/second	-55 dBm/MHz

According to CEPT Report 45 [i.4], clause 3.1.1 and annex 2, a trading between power and duty cycle is possible and this may give an equivalent limitation to the original limits in the regulation. Table 14 shows the resulting relaxed duty cycle requirements when reducing accordingly the mean power spectral density limits.

Table 14: Requirement for Duty Cycle trade off in accordance with CEPT Report 45 [i.4]

Frequency range	If indirect emission measurement assessment results (see clause 5.4.3)	Following Duty Cycle requirement apply
2,69 < f ≤ 2,7	< -58 dBm/MHz	20 %/second
	< -60 dBm/MHz	30 %/second
	< -61 dBm/MHz	40 %/second
3,4 < f ≤ 3,8	< -53 dBm/MHz	20 %/second
	< -55 dBm/MHz	30 %/second
	< -56 dBm/MHz	40 %/second
4,8 < f ≤ 5,0	< -58 dBm/MHz	20 %/second
	< -60 dBm/MHz	30 %/second
	< -61 dBm/MHz	40 %/second

The measured results of the Duty Cycle for each range shall be recorded separately.

4.3.7.4 Conformance

The conformance test for LBT mitigation technique shall be as defined in clause 5.4.6 and shall be done under normal conditions as defined in clause 5.1.2.

4.3.8 TX behaviour under the complete environmental profile

4.3.8.1 Applicability

The TX behaviour under the complete environmental profile requirement applies to all EVS EUT, see clause 4.2.5, table 1.

4.3.8.2 Description

The TX behaviour under the complete environmental profile verifies the conformance of the mean e.i.r.p. spectral density over the environmental profile as specified in clause 5.1.3.

For more information on the TX behaviour under the complete environmental profile, see ETSI TS 103 941 [4], clause 4.3.1

4.3.8.3 Limits for conducted assessment of the TX behaviour

The TX behaviour is obtained by measuring mean e.i.r.p. spectral density across the complete environmental profile (see clause for operation of the equipment as specified in clause 5.1.3 and assessing the variation with respect to an adjusted Regulated Limit (RL).

The procedure to adjust the regulated limit is descripted in ETSI TS 103 941 [4], clause 6.5 and to assess the TX-behaviour against the adjusted regulated limit, see ETSI TS 103 941 [4], clause 6.5.1.9.

The limits of mean e.i.r.p. spectral density for indirect emissions from clause 4.3.3 are applied over the full environmental profile (as specified in clause 5.1.3) with a relative measurement. The difference between each environmental profile relative measurement point (P_{step}) and the relative reference value REF_{power} at normal condition, both expressed in decibels, shall be smaller than the difference between the individual regulated mean e.i.r.p. spectral density limit (see clause 4.3.3, tables 4 and 5) and the maximum measured value obtained in an absolute measurement according to clause 4.3.3.

4.3.8.4 Conformance

The conformance test shall be done under the complete environmental profile (see clause 5.1.3); the parameters shall be measured as described in clause 5.4.7.

4.4 Receiver conformance requirements

4.4.1 General

The receiver requirements for EUT covered by the scope of the present document are justified in ETSI EN 303 883-2 [2], annex C.

The requirement "Receiver Spurious Emissions", as described in ETSI EN 303 883-2 [2], clause 5.1 is not applicable for the following reasons:

- TX and RX are co-located in the same device which is typical for such radiodetermination devices (monostatic radars).
- It is impossible to put the equipment to a receive only mode.

Based on this justification following Receiver requirements apply for the EUT covered by the present document:

- Receiver Dynamic Range (RDR), see clause 4.4.3.
- Receiver Baseline Resilience (RBR), see clause 4.4.4.

4.4.2 Wanted technical performance criteria

The basic wanted technical performance criteria for the all EUT covered by the present document are described in the related use-case/category specific annex:

- For the EVS use-case vehicular based ground sensor the wanted technical performance criteria is described in clause C.2.

4.4.3 Receiver Dynamic Range (RDR)

4.4.3.1 Applicability

The Receiver Dynamic Range (RDR) requirement shall apply to all EVS categories, see clause 4.2.5, table 1.

4.4.3.2 Description

Receiver dynamic range is defined in ETSI EG 203 336 [i.7] as the range of input signal levels over which a receiver functions at a specified performance level.

For EVS this performance criterion is set upon the difference D_1 between the maximum signal M for the RX in the linear region of operation and the noise level N:

$$D_1[\text{dB}] = M\ [\text{dB}] - N\ [\text{dB}]$$

More details on this RX-requirement are given in ETSI EN 302 066 [3], clause D.1.

4.4.3.3 Limits

For the Receiver dynamic range requirement the difference D_1 between the maximum signal M for the RX in the linear region of operation and the noise level N is specified as:

$$D_1 \geq 30\ \text{dB}$$

4.4.3.4 Conformance

The conformance test for all EVS sub-categories for the RDR requirement shall be as defined in clause 5.5.2.1 and shall be done under normal conditions as defined in clause 5.1.2.

4.4.4 Receiver Baseline Resilience (RBR)

4.4.4.1 Applicability

The Receiver Baseline Resilience (RBR) requirement shall apply to all EVS categories, see clause 4.2.5, table 1.

4.4.4.2 Description

For all EVS RBR is defined as the 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 within the operating bandwidth; it evaluates the capability of the EVS to operate as intended in coexistence with interferers. This parameter is also defined as "Interferer signal handling" in ETSI TS 103 361 [i.11]. The interfering signals are specified in clause D.2.1.

Operation as intended is evaluated using a performance criterion. For EVS this performance criterion is the difference D_2 between the maximum signal M for the RX in the linear region of operation and output signal I in presence of the interferer.

$$D_2[\text{dB}] = M\ [\text{dB}] - I\ [\text{dB}]$$

More details on this RX-requirement are given in ETSI EN 302 066 [3], clause D.1.

4.4.4.3 Limits

For the Receiver Baseline Resilience requirement the difference D_2 between the maximum signal M for the RX in the linear region of operation and output signal I in presence of the interferer specified as:

$$D_2 \geq 20\ \text{dB}$$

4.4.4.4 Conformance

The conformance test for all EVS sub-categories for the RBR requirement shall be as defined in clause 5.5.3.1 and shall be done under normal conditions as defined in clause 5.1.2.

5 Testing for compliance with technical requirements

5.1 Environmental conditions for testing

5.1.1 General

Tests defined in the present document shall be carried out at representative points within the boundary limits of the operational environmental profile defined by its intended use.

Where technical performance varies subject to environmental conditions, tests shall be carried out under a sufficient variety of environmental conditions (within the boundary limits of the operational environmental profile defined by its intended use) to give confidence of compliance for the affected technical requirements.

5.1.2 Normal test conditions

Normal test conditions shall be as defined in clause 4.5.3.1 of ETSI TS 103 941 [4].

5.1.3 Complete environmental profile test conditions

The complete environmental profile test conditions cover both the normal (see clause 5.1.2) and extreme test conditions.

Extreme test conditions shall be as defined in clause 4.5.3.2 of ETSI TS 103 941 [4] with a temperature range varying between -10 °C to +50 °C for all EUT categories. For all EUT categories the primary supply voltage varies from 90 % to 110 % of the nominal value.

NOTE: The nominal value of the supply voltage is usually provided by the user manual of the EUT.

5.2 General conditions for testing

General conditions for testing for the TX measurements shall be as defined in ETSI EN 303 883-1 [1], clauses A.3, A.5 and A.8.

General conditions for testing for the RX measurements shall be as defined in ETSI EN 303 883-2 [2], clauses A.5 and A.8 and annex B.

ETSI EN 303 883-1 [1], annex A provides additional information on general conditions for testing, e.g. test environment and test conditions, measurement uncertainty and interpretation of the measurement results. An overview is provided in ETSI EN 303 883-1 [1], clause A.1.

5.3 Conformance test suites

5.3.1 General

ETSI EN 303 883-1 [1], annex B provides additional information on test setups for testing, e.g. radiated and conducted measurements. An overview for radiated measurements is provided in ETSI EN 303 883-1 [1], clause B.2.1.

Complementary information to the conformance tests in clause 5.4 is provided in ETSI EN 303 883-1 [1], clause 5.1.1 for TX measurements and in ETSI EN 303 883-2 [2], clause 5.1 for RX measurements.

5.3.2 EUT orientation and reference points

All EUT covered by the EVS categories, see table 1, are developed in such a way that one side shall be directed to the structure or objects to be analyses (e.g. ground below the vehicle), see figure 1.

The EUT can be mounted onto or integrated into the vehicular structure. This information will be provided in the EUT manual.

Figure 2 provides the orientation and the reference points for all measurements in the test suite.

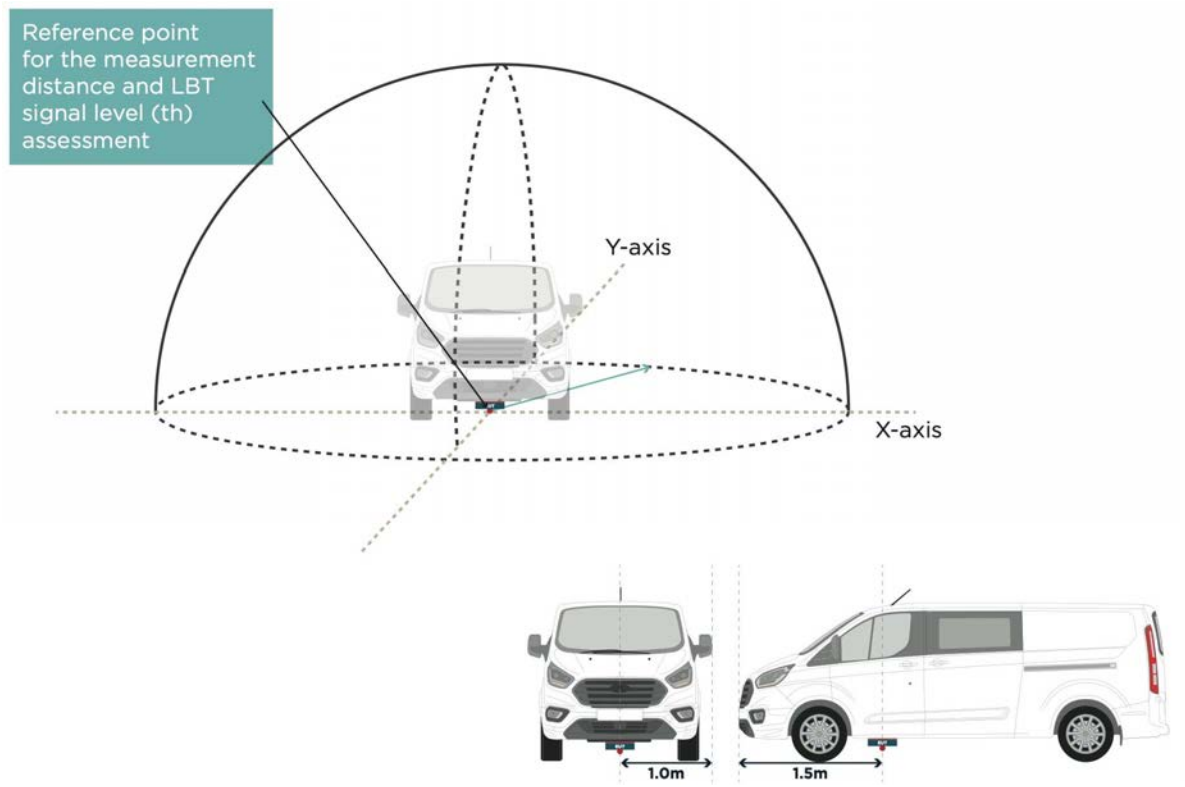

Figure 1: Vehicle with a mounted EVS below including Reference Point (red)

5.3.3 Test scenarios and setup for transmitter conformance tests

The transmitter conformance tests shall be an open area test side, see ETSI EN 303 883-1 [1], clause B.2.2.4 (OATS). The test setup shall be based on the standard test method as described in ETSI EN 303 883-1 [1], clause B.4. For the assessment of the measurement distance and the orientation of the EUT, see the reference point and horizontal plane in figure 1 and figure 2.

The combination of the EUT and the TX-test structure is shown on figure 1 including a typical mounting point for the EUT. Figure 2 specifies the reference point and reference plane for the tests.

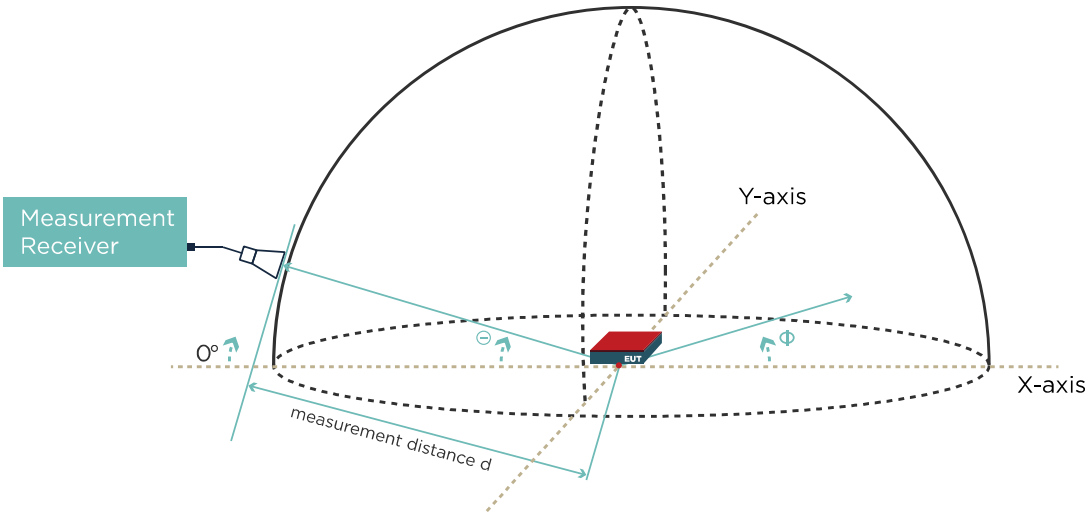

Figure 2: Reference Point for the EUT

5.4 Conformance methods of measurement for transmitter

5.4.1 Operating Frequency Range (OFR)

The basic test setup shall be as defined for each of the applications in annex C.

The OFR measurement shall be performed at the point with the highest emission around the EUT out of the scenario.

In figure 3 the basic measurement setup is depicted. The measurement receiver is positioned at the point where the highest indirect emission out of the scenario has been identified. The point with the highest indirect emission will differ from one application to another.

This point shall be identified and documented before the OFR measurement.

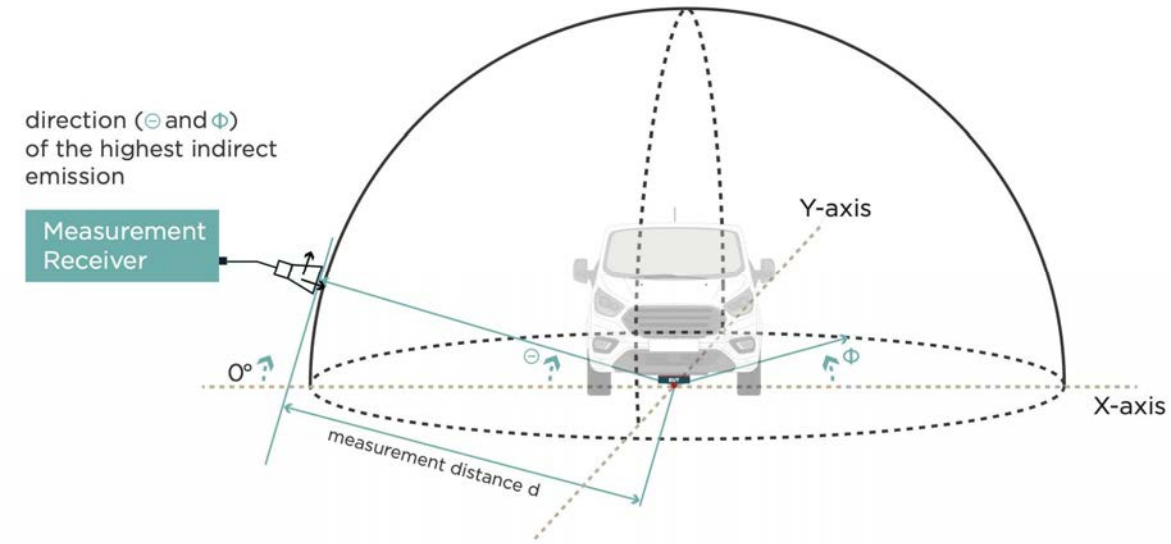

Figure 3: Basic measurement set-up OFR

The test procedure given in ETSI EN 303 883-1 [1], clause 5.2.2 shall be used.

NOTE: The actual antenna position depicted in figure 3 might be different for specific applications and measurement setups depicted in annex C. The identification of the direction of the highest indirect emission can be performed with different antenna setups. E.g. mast antennas as depicted in figure 4. Here the measurement antenna points in the direction of the EUTs reference point.

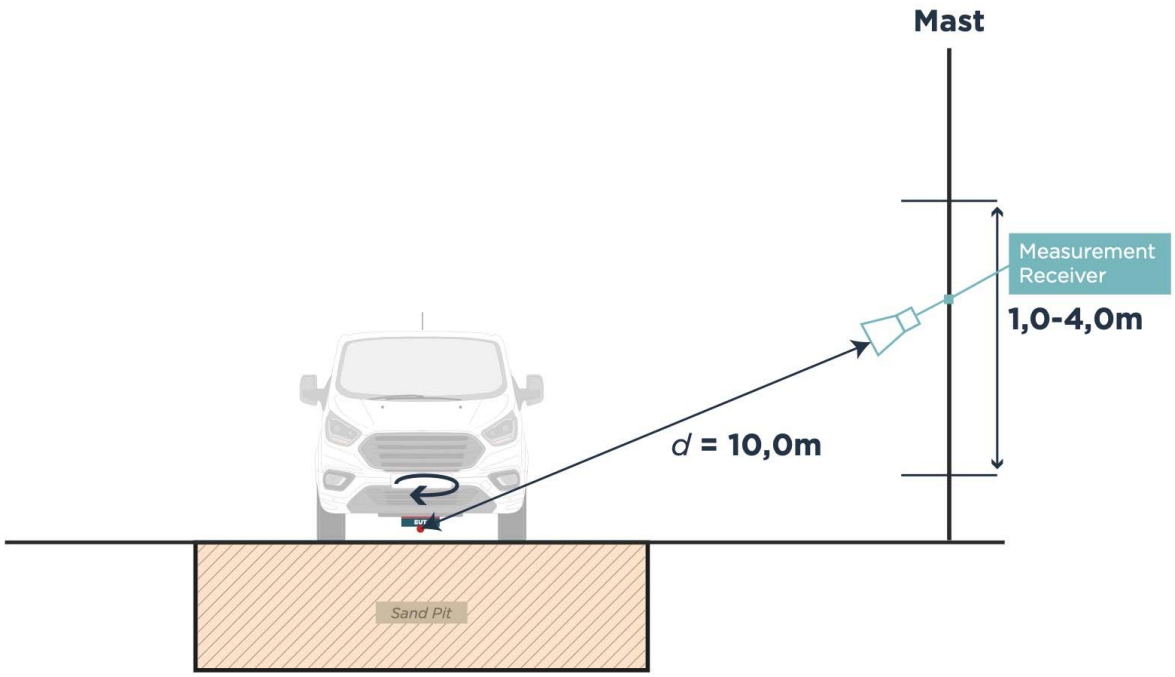

Figure 4: Basic measurement set-up OFR with mast antenna in open are test side as depicted in ETSI EN 303 883-1 [1]

The measurement distance d is specified from the reference point (see figure 4) to the test antenna. For the measurement distance d = 10 metres shall be used.

If based on the low emission levels of EUT the noise level of the overall measurement system (ETSI EN 303 883-1 [1], clause B.2.5) has less than 16 dB margin to the highest radiated emissions of the indirect emission measurement (see clause 5.4.3) for all EVS subcategories, a smaller measurement distance d shall be used, but in this case the measurement distance assessment procedure as descripted as range length in ETSI EN 303 883-1 [1], clause B.2.3.5 shall be done.

The measured results of the OFR and the measurement distance shall be recorded.

5.4.2 Indirect emissions

5.4.2.1 General

For the indirect emissions conformance test the set-up as specified in clause 5.3.3 shall be used.

The measurement distance *d* is specified from the reference point (as specified in clause 5.4, figure 4 to the test antenna). For the measurement distance *d* = 10 metres shall be used.

If based on the low emission levels of EUT the noise level of the overall measurement system (ETSI EN 303 883-1 [1], clause B.2.5) has less than 10 dB margin to the maximum mean e.i.r.p. spectral density limits in table 4 for EVS1 and EVS2 (see clause 4.3.3.3.1) or table 5 for EVS3 and EVS4 (see clause 4.3.3.3.2), a smaller measurement distance d can be used, but in this case the measurement distance assessment procedure as descripted as range length in ETSI EN 303 883-1 [1], clause B.2.3.5 shall be done.

Specific considerations if the indirect emissions results shall be used for a TRP assessment is dependent the EUT OFR (see clause 4.3.5.1). In this case the conformance test specification in clause 5.4.2.3 and clause 5.4.2.4 shall be considered.

If based on the EUT OFR no TRP assessment is required the conformance test specification in clause 5.4.2.2 and clause 5.4.2.3 shall be considered.

5.4.2.2 Considerations for conformance tests for EUT without TRP_{SD} assessment

For applications where the TRP_{SD} limits are not applicable due to the identified OFR as specified in clause 5.4.1, the direction of the highest indirect emission shall be identified and documented. This direction of the highest indirect emission shall then be used as the measurement point for the indirect emission limits and the TX Unwanted Emissions, see figure 5, measurement receiver.

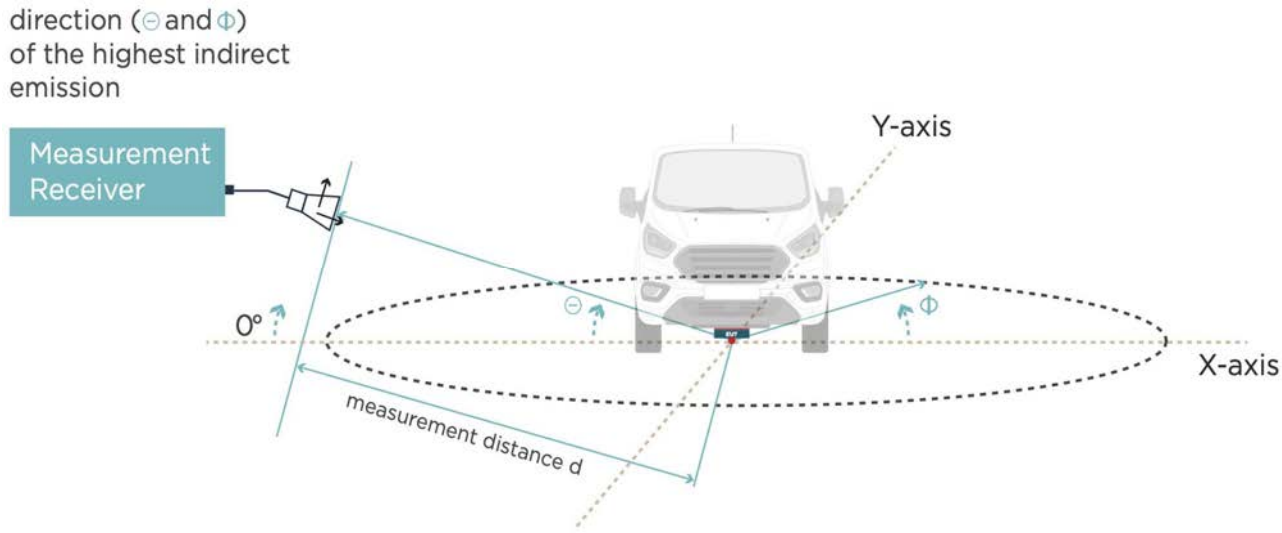

Figure 5: Basic measurement set-up for indirect emission measurements without TRP measurements, see also figure 3

5.4.2.3 Considerations for conformance tests for EUT with TRP_{SD} assessment

For applications where the TRP_{SD} limits are applicable due to the identified OFR as specified in clause 5.4.1, the results from the TRP_{SD} measurements specified in clause 5.4.5 can be reused. In this case the measurement receiver shall measure around the scenario as depicted in figure 6 with a 15° step size in azimuth and elevation. The limits for the indirect mean and peak emissions shall be fulfilled for all measurement points around the sphere.

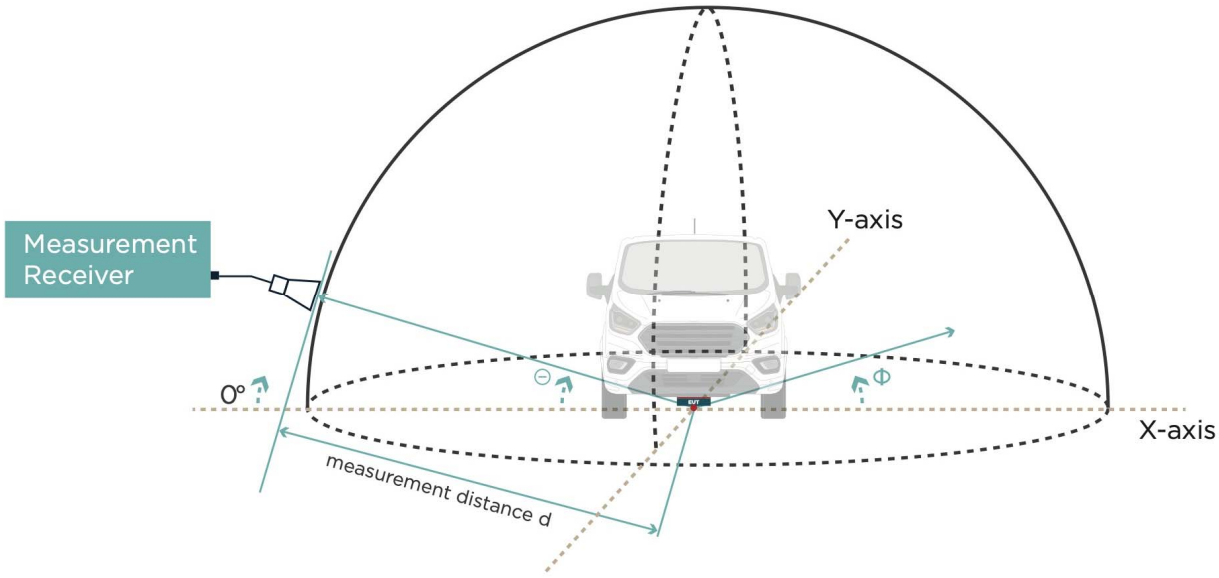

Figure 6: Basic measurement set-up for indirect emission measurements combined with TRP measurements

5.4.2.4 Common conformance test procedure for TRP_{SD}

For a full spherical assessment, the EUT needs to be turned by 180 degrees around the horizontal plane H (see figure 5 and ETSI EN 303 883-1 [1], clause B.4).

The applicable conformance test procedures are provided for mean power spectral density in table 15 and for peak power in table 16.

Table 15: Conformance test procedure for the mean power spectral density limit

EUT category	Conformance test procedure	Signal repetition time assessment
EVS1 and EVS2	ETSI EN 303 883-1 [1], clause 5.3.2.4 and signal repetition time assessment	ETSI EN 303 883-1 [1], clause C.3
	ETSI EN 303 883-1 [1], clause 5.3.2.3 without signal repetition time assessment	Not applicable
EVS3 and EVS4	ETSI EN 303 883-1 [1], clause 5.3.2.3	
NOTE 1: ETSI EN 303 883-1 [1], clause 5.4 and annex D, are providing guidance how to differentiate between emissions in the scope of the present document (article 3.2 of Directive 2014/53/EU [i.3]) and other sources (e.g. EMC). NOTE 2: For the step 2 as descripted in ETSI EN 303 883-1 [1], clause D.3 the conformance test procedure as specified in ETSI EN 303 883-1 [1], clause 5.3.2.3 shall be used.		

Table 16: Conformance test procedure for peak power spectral density limit

EUT category	Conformance test procedure	Comment
EVS1 and EVS2	ETSI EN 303 883-1 [1], clause 5.3.4.2	
	ETSI EN 303 883-1 [1], clause 5.3.4.3	The procedure is applicable: If based on the assessment procedure in ETSI EN 303 883-1 [1], annex D and the measurement result of the mean power (see table 15) it can be shown that only one spectral line is within 50 MHz.
EVS3 and EVS4	ETSI EN 303 883-1 [1], clause 5.3.4.2	

The measured results of the indirect emissions, measurement distance and the calculated TRP_{SD} shall be recorded.

5.4.3 TX Unwanted Emissions

For the TX Unwanted Emission conformance test the set-up as specified in clause 5.3.3 and the conformance test procedure as specified in ETSI EN 303 883-1 [1], clause 5.5.3 shall be used.

For the measurement distance d, the same distance than for the indirect emission conformance test shall be used.

The measured results of the TX Unwanted Emission measurements and the used measurement distance shall be recorded.

5.4.4 Total Radiated Power spectral density (TRP_{SD})

The Total Radiated Power spectral density (TRP_{SD}) assessment shall be based on indirect emissions conformance test results, see clause 5.4.2.3.

For the TRP spectral density (TRP_{SD}) conformance test the procedure specified in ETSI EN 303 883-1 [1], clause 5.6.4 shall be used.

The calculated results of the total radiated power spectral density shall be recorded.

5.4.5 Listen Before Talk (LBT)

For the Listen Before Talk (LBT) conformance test the set-up as specified in clause 5.3.3 shall be used. The signal source with the related test antenna to generate the victim signal shall be placed in the direction of the highest indirect emission (for the LBT frequency ranges) and the test antenna shall be pointing to the test vehicle. The test antenna shall be placed in centre line of the EUT at the vehicle. The arrangement of the test set-up is shown in figure 7.

NOTE: For each LBT frequency range (see table 11) the direction of the highest indirect emission could be different, see indirect emission conformance test (clause 5.4.3).

For the LBT conformance test the procedure specified in ETSI EN 303 883-1 [1], clause 5.10.3 shall be used.

The reference point for the assessment of the power level at the EUT is shown in figure 7 as red dot.

The test signals for Band 1 and 4 (see ETSI EN 303 883-1 [1], clause 5.10.3.4) shall be used.

The assessed power levels (th), related distance d and direction (see figure 7) and the LBT detection result shall be recorded.

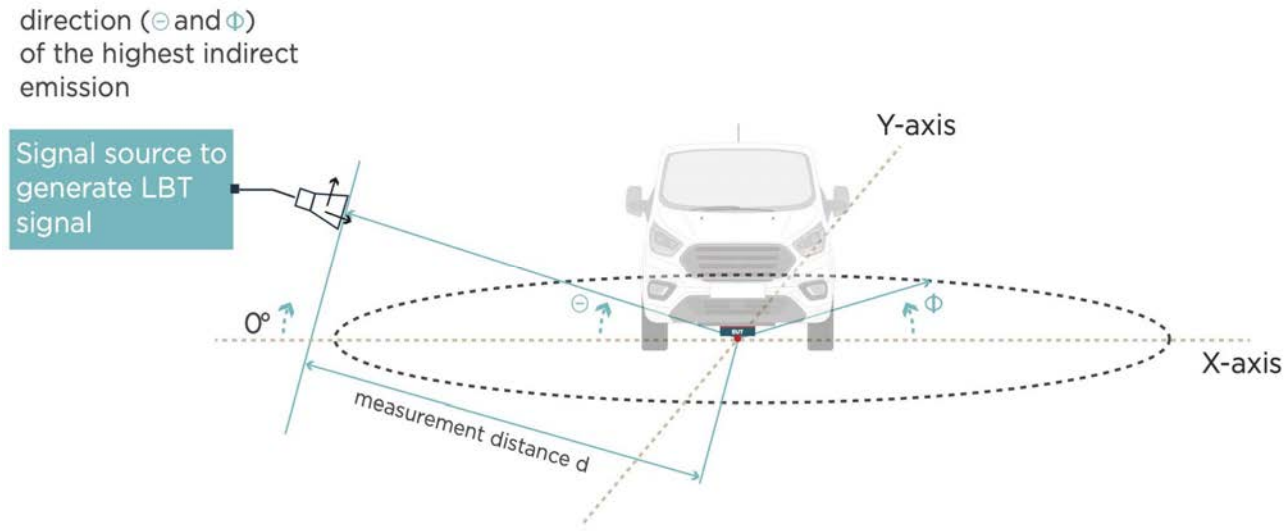

Figure 7: Set-up for LBT conformance test

The LBT test shall be performed as given in ETSI EN 303 883-1 [1], clause 5.10.

The test results of the LBT conformance test shall be recorded.

5.4.6 Duty Cycle

The Duty Cycle test shall be performed as given in ETSI EN 303 883-1 [1], clause 5.11.

The measurement receiver with the related measurement antenna shall be placed in the direction of highest indirect emission within the frequency range which shall be assessed for the duty cycle as depicted in figure 8.

Each frequency range with a DC requirement (see clause 4.3.7.3) shall be assessed separately. The arrangement of the test set-up is shown in figure 8.

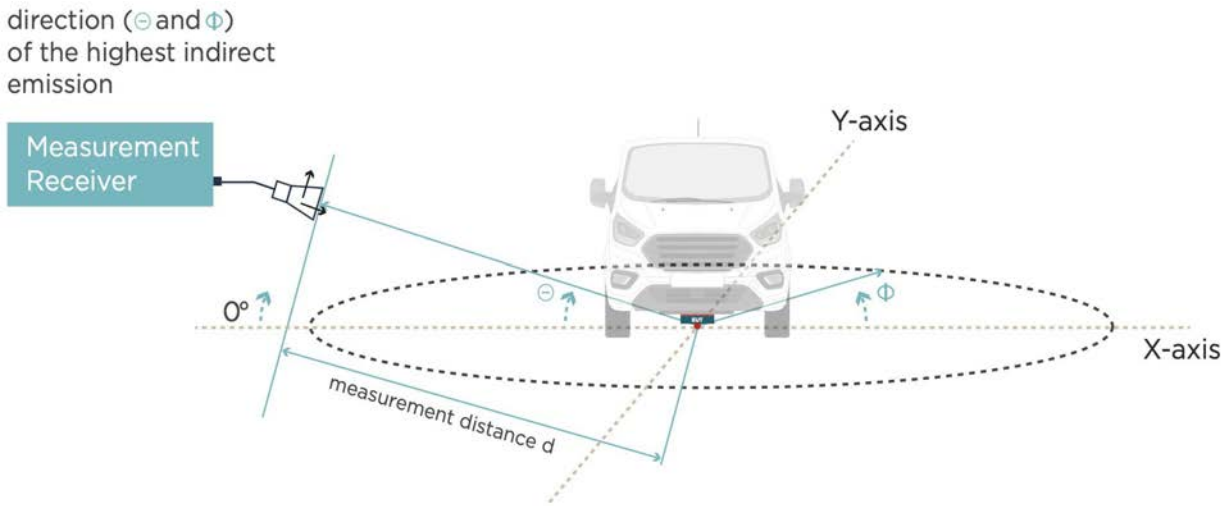

Figure 8: Set-up for Duty Cycle conformance test

NOTE: Duty Cycle conformance assessment is only necessary in the direction of the highest indirect emission, because with this test the nature of the TX-signal will be tested and not the complete emission of the EUT (see clause 5.4.3).

For the Duty Cycle conformance test the procedures as listed in table 17 shall be used. For the measurement distance d, the same distance than for the indirect emission conformance test shall be used (see clause 5.4.3).

Table 17: Conformance test procedure for the DC limit

EUT category	Conformance test procedure
EVS1 and EVS2	ETSI EN 303 883-1 [1], clause 5.11.2.4
EVS3 and EVS4	ETSI EN 303 883-1 [1], clause 5.11.2.1

The threshold level P_{Thresh} shall be set to 10 dB below the measured indirect emission (see clause 5.4.3) in the DC measurement direction (see figure 7).

The measured results of the Duty Cycle conformance test shall be recorded.

5.4.7 Conducted measurements of indirect emissions under complete environmental profile

5.4.7.1 General

The test set-up given in ETSI TS 103 941 [4], clause 5.2.4 shall be used. In the present document only devices with an antenna connector are considered.

5.4.7.2 EUT with antenna connectors

The assessment procedure shall be conducted according to ETSI TS 103 941 [4], clause 7.

5.5 Conformance methods of measurement for receiver

5.5.1 General for RDR and RBR conformance tests

EVS EUT equipment in the scope of the present document are installed on a vehicle and have to analyses material around the vehicle, like the ground below the vehicle.

To perform the receiver tests setup has to simulate an intended operation. Therefore, the RX-test shall be performed like a "normal" intended use as descripted for the intended use in the EUT user manual.

For this purpose, a test setup shall use the device on the specified sandpit (see annex C).

5.5.2 Receiver Dynamic Range (RDR)

5.5.2.1 RDR test

For all EUT covered by the present document, see table 1, the RX-test sandpit as specified in clause C.3 shall be used.

Test Procedure:

Step 1: Place (as descripted in the user manual) the EUT mounted on a vehicle onto the RX-test sandpit. The vehicle can be replaced by a conductive cover plate as depicted in figure 9 and specified clause C.4.

Step 2: Place a highly conductive metal plate as reflector below the EUT in a distance of 0,05 m. The size of the metal plate shall be at least the EUT foot size, see figure 9. The electrical specifications of the highly conductive metal plat are given in clause C.4.2.

Step 3: Perform the measurement of the value *M*, see ETSI EN 302 066 [3], clause 6.3.2.3.
The maximum signal M for the receiver in the linear region of operation shall be determined from the signal produced when the EUT is suspended 5 cm above a plane metal, see figure 9. The size of the metal plate shall be at least the EUT foot size. During this measurement, the interferer shall be deactivated. At least 100 measurements shall be recorded and averaged; M is defined as the maximum absolute value in Volts occurring in the averaged result.

Step 4: Remove the reflective plate, see figure 10a (surface mounted EUT) or figure 10b (integrated EUT).

Step 5: Perform the measurement of the value *N*, see ETSI EN 302 066 [3], clause 6.3.2.4.
Using the setup described in figure 10a or figure 10b and with the interference source switched off, at least 100 measurements shall be recorded collected and averaged. The result for *N* is defined as the maximum absolute value in Volts occurring in the averaged signal from the half to the end of the time window.

Step 6: Assess the measurement procedure result by calculating D_1 = *M*[dB] - *N*[dB].

To pass the test:

- The value D_1 has to fulfil the limit given in clause 4.4.3.3.

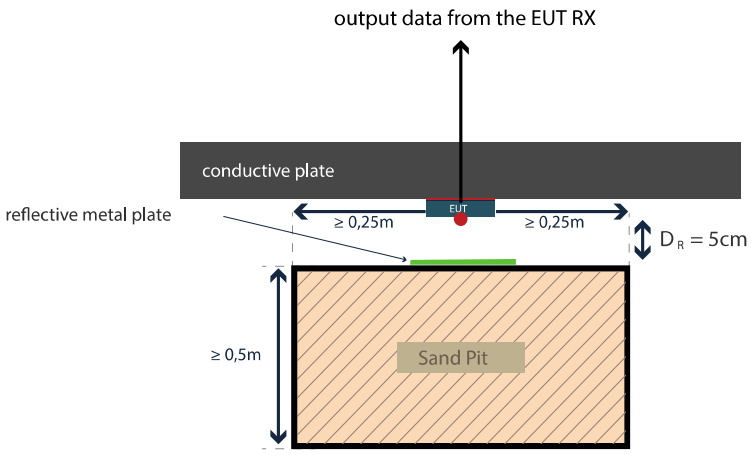

Figure 9: Dynamic range conformance set-up for EUT designed for ground analyses, here: measurement of level *M* including reflective plate

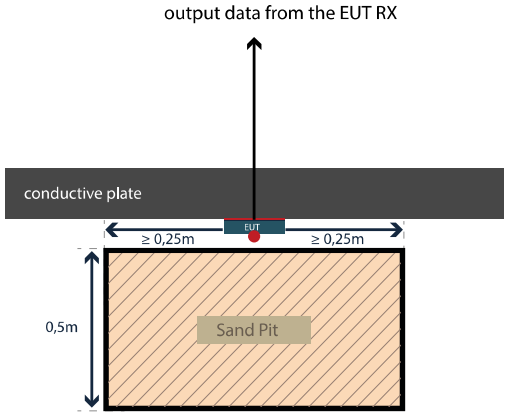

Figure 10a: Dynamic range conformance set-up for EUT designed for ground analyses, here: measurement of noise floor level *N* with surface mounted EUT, see clause C.2

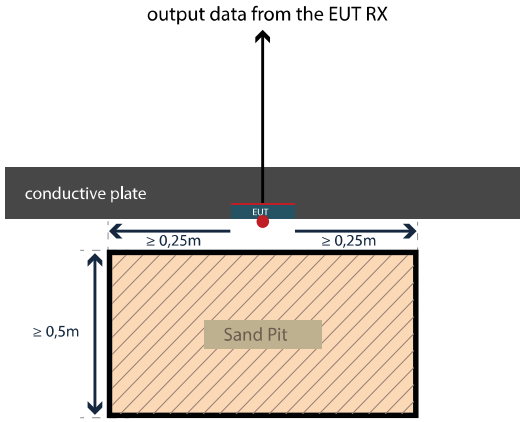

Figure 10b: Dynamic range conformance set-up for EUT designed for ground analyses, here: measurement of noise floor level *N* with integrated EUT, see clause C.2

The assessment results of the RDR conformance test shall be recorded.

5.5.3 Receiver Baseline Resilience (RBR)

5.5.3.1 RBR test

For all EUT categories covered in the present document the sand pit as specified in clause C.3 shall be used.

Test Procedure:

Step 1: Assessment of the interfering signals for RBR test:

- Take OFR and f_c from the OFR measurement, see clause 5.4.1.
- For the interferer information (frequency, signal, power), see annex D.
- Consider for the interferer assessment the LBT requirement. If the test frequency assessment would consider the same interferer which was tested during the LBT requirement this interferer is not applicable for the RBR test. If the LBT requirement was passed the EUT will not operate as intended (EUT will be not able to detect the object, because if signal is detected the EUT is not allowed to transmit), see LBT requirement description in ETSI EN 303 883-1 [1], clause 5.10.1.

Step 2: Arrange the set-up with the RX-test sand pit (see RBS/Receiver dynamic range test), a signal generator for the interfering signals and a test antenna to radiate the interfering signal to the RX-test scenario, see figure 11. The test antenna to radiate the interfering signal shall be put in the direction of the highest indirect emission as identified in clause 5.4.2. Set the output power of the signal generator so that the interfering power level at the EUT from annex D are fulfilled; use the guidance provided in ETSI EN 303 883-2 [2], clause A.3 to calculate the output power of the signal generator.

Step 3: Switch on Interferer source with one interferer signal as assessed in step 1.

Step 4: Perform the measurement procedure to measure the interfered noise floor *I* in presence of the interfering signal, see ETSI EN 302 066 [3], clause 6.3.2.5.
Using the setup described in figure 11 and the interfering signal evaluated in step 1, at least 100 measurements shall be recorded collected and averaged. The result for *I* is defined as the maximum absolute value in Volts occurring in the averaged signal from the half to the end of the time window.

Step 5: Assess the measurement procedure result by calculating $D_2 = M$[dB] - I[dB]. The value M[dB] shall be taken from the RDR measurements as defined in clause 5.5.2.1, step 3.

To pass the test:

- The EUT shall operate as intended at least in 7 of 10 test procedures.

NOTE: Operate as intended means:

- either the EUTs receiver dynamic range D_2 is in the limit given in clause 4.4.4.3 or the EUT provides information to the operator (as described in the manual) that the measurement was not valid due to the presents of interference.

Step 6: Repeat from step 3 for each interfering signal assessed in step 1.

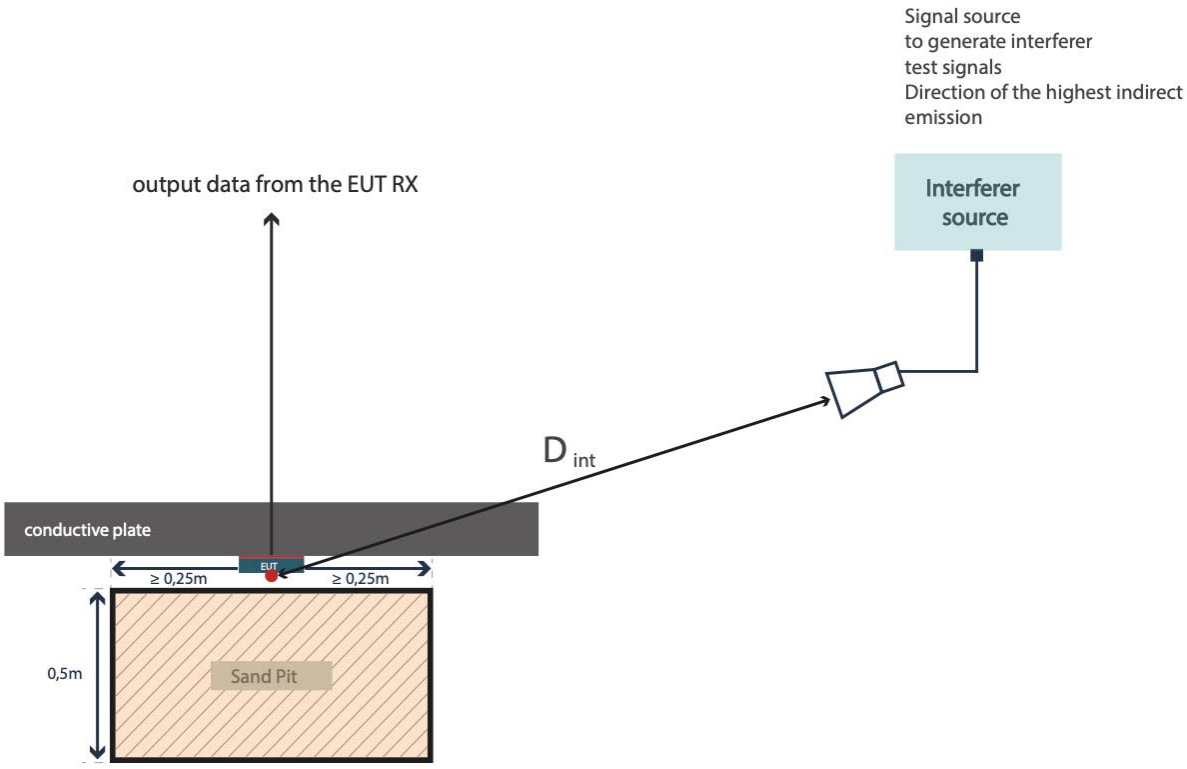

Figure 11: RBR conformance set-up for ground analysing EVS EUT

The assessment results of the RBR conformance test shall be recorded.

Annex A (informative): Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.5] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.3].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

Table A.1: Relationship between the present document and the essential requirements of Directive 2014/53/EU

Harmonised Standard ETSI EN 302 065-4-4					
Requirement				Requirement Conditionality	
No	**Description**	**Essential requirements of Directive**	**Clause(s) of the present document**	**U/C**	**Condition**
1	Operating Frequency Range (OFR)	3.2	4.3.2	U	
2	Indirect emissions	3.2	4.3.3	U	
3	TX Unwanted Emissions	3.2	4.3.4	U	
4	Total Radiated Power (TRP)	3.2	4.3.5	C	Only to EUT categories if the OFR is partly of fully overlapping with the frequency ranges listed in table 7 and the measured indirect emission level is above the value specified in table 7.
5	Listen Before Talk (LBT)	3.2	4.3.6	C	Only to EUT categories EVS3 and EVS4 if the OFR is partly or fully overlapping with the frequency ranges listed in table 11 and if the measured indirect emission level (see clause 4.3.3) is above the value specified in table 10.
6	Duty Cycle	3.2	4.3.7	C	Only to EUT where OFR measurement result (see clause 4.3.2) (partly) covers one or more of the frequency ranges (see table 12) and if the indirect emission measurement is above the limit in table 12.
7	Receiver Dynamic Range (RDR)	3.2	4.4.3	U	
8	Receiver Baseline Resilience (RBR)	3.2	4.4.4	U	

Key to columns:

Requirement:

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

Description A textual reference to the requirement.

Essential requirements of Directive

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

Clause(s) of the present document

Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

Requirement Conditionality:

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

Condition Explains the conditions when the requirement is or is not applicable for a requirement which is classified "conditional".

Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

Other Union legislation may be applicable to the product(s) falling within the scope of the present document.

Annex B (informative): Selection of technical parameters

ETSI EG 203 336 [i.7], clause 5 lists the technical parameters applicable to transmitters and receivers that should be considered when producing Harmonised Standards and that are intended to cover the essential requirements in article 3.2 of Directive 2014/53/EU [i.3]. 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. Table B.1 contains the parameters listed in ETSI EG 203 336 [i.7], clause 5 for transmitter and receiver, and cross references these to the clauses within the present document in which the requirements for measurement of such parameters are satisfied or justified.

Table B.1: Cross reference of clauses in the present document to technical parameters for transmitter and receiver listed in ETSI EG 203 336 [i.7]

ETSI EG 203 336 [i.7]		Present document		Justification
Clause	**Parameter**	**Clause**	**Parameter**	
5.2.2	Transmitter power limits	4.3.3	Indirect emissions	Mean e.i.r.p. and Peak e.i.r.p. is covered by Indirect emission requirement, see ECC/DEC/(07)01 [i.1].
		4.3.5	Total Radiated Power spectral density (TRP_{SD})	Based on clause 4.3.4, see ETSI EN 303 883-1 [1] and ECC/DEC/(07)01 [i.1].
		4.3.8	TX behaviour under the complete environmental profile	
5.2.3	Transmitter power accuracy	-	-	From the latest version of ETSI EG 203 336 [i.7]: "When regulatory limits imply only a maximum emission limit (e.g. products that operate under a general licence regime), this parameter need not to be considered for inclusion in an HS."
5.2.4	Transmitter spectrum mask	4.3.2	Operating Frequency Range (OFR)	
		4.3.8	TX behaviour under the complete environmental profile	TX behaviour requirement assessment shows the behaviour (in frequency) of the OFR over the environmental profile.
5.2.5	Transmitter frequency stability	-	-	See note.
5.2.6	Transmitter intermodulation attenuation	-	-	From latest version of ETSI EG 203 336 [i.7]. This parameter is only applicable "where high levels of quality services are required". This is not the case for generic short-range devices which are operating on the "no interference, no protection" principle under a licence exempt regime without any kind of regulatory protection. SRDs have to accept interferences.
5.2.7.2	Transmitter unwanted emissions in the out of band domain	4.3.4	TX Unwanted Emissions (TXUE)	
5.2.7.3	Transmitter unwanted emissions in the spurious domain	4.3.4	TX Unwanted Emissions (TXUE)	
5.2.8	Transmitter time domain characteristics	4.3.7	Duty Cycle	

ETSI EG 203 336 [i.7]		Present document		Justification
Clause	**Parameter**	**Clause**	**Parameter**	
5.2.9	Transmitter transients			Not applicable.
	Other mitigation, spectrum access requirements not specified in the ETSI Guide but specified in related ECC/EC framework	4.3.6	Listen Before Talk (LBT)	
5.3.2	Receiver sensitivity	-	-	Covered by RBS. See justification in ETSI EN 303 883-2 [2], annex C.
5.3.2.3	Desensitization	-	-	
5.3.3	Receiver co-channel rejection	-	-	
5.3.4.2.1	Receiver adjacent channel selectivity	-	-	
5.3.4.2.2	Receiver adjacent band selectivity	-	-	
5.3.4.3	Receiver blocking	-	-	
5.3.4.4	Receiver spurious response rejection	-	-	
5.3.4.5	Receiver radio-frequency intermodulation	-	-	
5.3.5	Receiver unwanted emissions in the spurious domain	-	-	Not applicable as the present document does not cover receive-only devices or transceivers with receive-only mode (see clause 4.4.1).
5.3.6.1	Receiver dynamic range	4.4.3		See ETSI EN 303 883-2 [2], table C.1 for more information.
5.3.6.2	Reciprocal mixing	-	-	Covered by RBR See justification in ETSI EN 303 883-2 [2], annex C.
5.3.1	Signal interferer handling	4.4.3 4.4.4	Receiver Dynamic Range (RDR) Receiver Baseline Resilience (RBR)	Signal interferer handling (ETSI EG 203 336 [i.7], clause 5.3.1) is an alternative method for specifying receiver parameters intended for receivers such as UWB and certain types of radar equipment. The present document is following this concept, see ETSI TS 103 567 [i.13] and ETSI EN 303 883-2 [2].
NOTE: Not explicit applicable for UWB/wideband devices based on kind of UWB modulations.				

Annex C (normative): Category non-contact-based ground analysing sensor devices

C.1 Description

The "External material sensing devices in ground based vehicular environments" category covered in this annex are designed to:

- Analyse the ground properties below a vehicle with a metalized frame structure.

The noncontact based vehicular UWB material sensing system can be mounted in front, behind, or under a vehicle to actively investigate the subsurface material properties. The collected data can be used for different purposes in the vehicular operation. The EUT can be mounted onto or integrated into the vehicle structure.

The measurement procedure/handling of the device is explained in the manual of the EUT.

C.2 Wanted Technical Performance Criteria (WTPC) and RX - requirement

C.2.1 Introduction

The minimum requirement for all EVS EUT in the category covered in this annex shall be to analyse the properties of the ground below the vehicle.

This object analysing performance offers the possibility to implement additional operational functions into the EUT (e.g. ground depth analyses, soil structure analyses, road condition analyses, humidity analyses).

Therefore, the wanted technical performance criteria for all EUT is the dynamic range as defined in ETSI EN 302 066 [3], annex D.

C.2.2 Performance criteria for EVS

Basing on concepts illustrated for GPR/WPR in ETSI EN 302 066 [3], clause D.1, for EVS the receiver performance criteria are set upon the dynamic range D1 and the difference D2 between the maximum signal M and output signal I in presence of the interferer (see figure C.1).

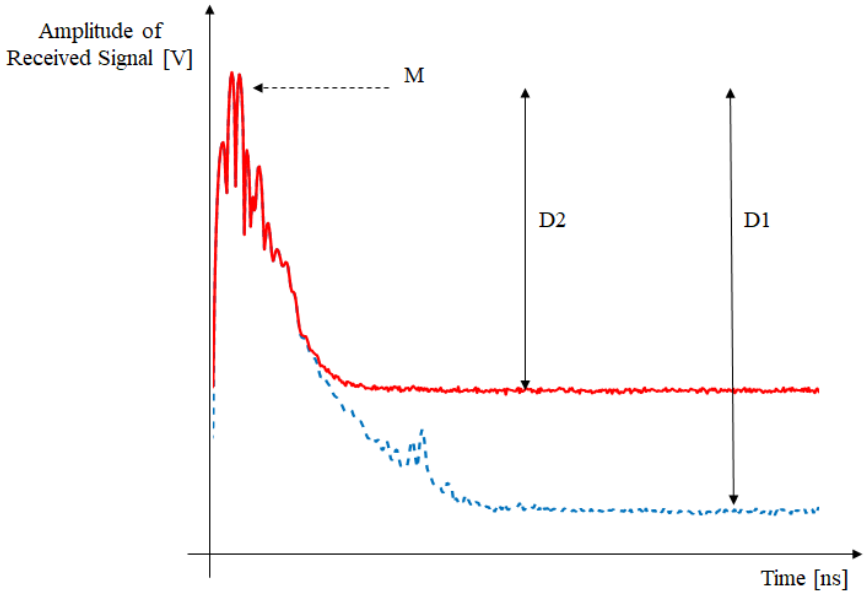

Figure C.1: Performance criterion for EVS

As indicated above, M is the maximum signal that the receiver senses, whereas N is the noise floor below which detectable return signals are not discernible; in this sense, it can be concluded that the low input signal level at the receiver ("wanted signal") is the one that exceeds by some amount the noise floor; this, in fact, is the minimum signal the EVS can detect, no matter of the characteristics of the target detected by the EVS which is producing such signal.

According to that, the term dynamic range for an EVS is specified by the parameter D1 in clause 4.4.3.2; this requires the evaluation of the DUT maximum signal, M and the noise floor, N.

The parameter so defined in dB (D1 = M - N) establishes a specified level of performance to be reached by the equipment (i.e. this can be interpreted as the "pre-determined level of performance" for an EVS in the specific test scenario), so that can be used to set a specification for the receiver sensitivity.

Performance of the EVS receiver in the presence of an external noise source is also assessed based on comparison with the parameter D1. The presence of a noise source will obviously impact the noise floor and change the value reducing the system sensitivity to weak signals. Setting a minimum required value for the parameter D2 is a meaningful method for assessing the resilience of EVS against interferences.

C.2.3 Justification for missing RX requirements from ETSI EG 203 336

ETSI EG 203 336 [i.7] uses the signal interferer handling concept from ETSI TS 103 361 [i.11], which has been developed for very broadband UWB applications (e.g. having more than 500 MHz bandwidth).

The interferer signal handling concept requires a receiver test with the tree strongest expected interferer within the operating bandwidth. It is therefore assumed that an EVS complying with such strong inband interferer will automatically comply with signals with the same magnitude in adjacent bands; therefore receiver tests outside the operating band are deemed as unnecessary.

Given that, other parameters listed in ETSI EG 203 336 [i.7] are linked to the selected receiver performance criteria in the present document as explained here below:

- Sensitivity: the received noise is measured and used in the dynamic range clause.
- Adjacent channel selectivity: this parameter is included in clause 4.4.4 on Receiver Baseline Resilience (RBR).
- Co-channel rejection: this parameter is covered by the signal interferer handling concept used with the Receiver Baseline Resilience (RBR).

- Spurious response rejection, Intermodulation and Reciprocal Mixing: these parameters are covered by the signal interferer handling concept used with Receiver Baseline Resilience (RBR).
- Desensitization is covered by the signal interferer handling concept with the three strongest inband interferer used with the dynamic range test in clause 4.4.3.

C.3 Reference ground and sand pit

The sand in the pit will be dry sand with water saturation as specified in ETSI EN 302 066 [3], annex E.

If the system is designed to be mounted under the vehicle, a metal plate of approximate vehicle size including the required power supply and devices shall be placed above it, see figure C.2.

The sandpit shall have at least a depth of 0,5 metre and the dimension of the sand pit shall be at least 25 cm larger on each side than the footsize of the EUT.

C.4 Conductive metal plate for measurements

C.4.1 Dimensions of metal cover plate for measurement purposes

A conductive metal plate shall be placed on top of the system to simulate the vehicle under which the system is mounted. For the characteristics of the conductive plat, see clause C.4.2. The conductive plate shall be grounded to the laboratory grounding point. Its dimensions shall be 2,0 metres by 3,0 metres, see figure C.3. If the intended use of the EUT assumes an integration of the EUT into the vehicle structure, the EUT may be integrated into the conductive cover plate as shown in figure C.4. The conductive cover plate shall be installed such that the bottom of the EUT is at least 5 cm above the sandpit surface, see figure C.2.

C.4.2 Measurement of resistance

The resistance of the conductive plate and the highly reflective plat in clause 5.5.2.1 shall be equal or smaller than 100 mΩ. The resistance of the plat shall be measured using an ohmmeter capable of mΩ level measurement. Affix the probes to measure the resistance of the longest dimension of the plate - in the case of a rectangular plate this would be the diagonal.

Record and document the resistance measured in the measurement report.

C.5 General Measurement setup

During the measurement, the EUT shall be placed on the testbed of sand with its antenna pointing directly into the sand and the test antenna is placed 10 metres away from the boresight (vertical centre axis) of the EUT reference point as depicted in figure C.2. The measurement antenna shall be mounted on a support capable of allowing to be used in either horizontal or vertical polarization. The antenna mast shall additionally allow the height of antenna centre above the ground to be varied from 1 metre to 4 metres to ensure that the maximum emission is recorded. The antenna shall point in the direction of the EUT reference point. Measurement shall be repeated for both the test antenna polarizations, by rotating the EUT from 0° to 360° with 45° step increment.

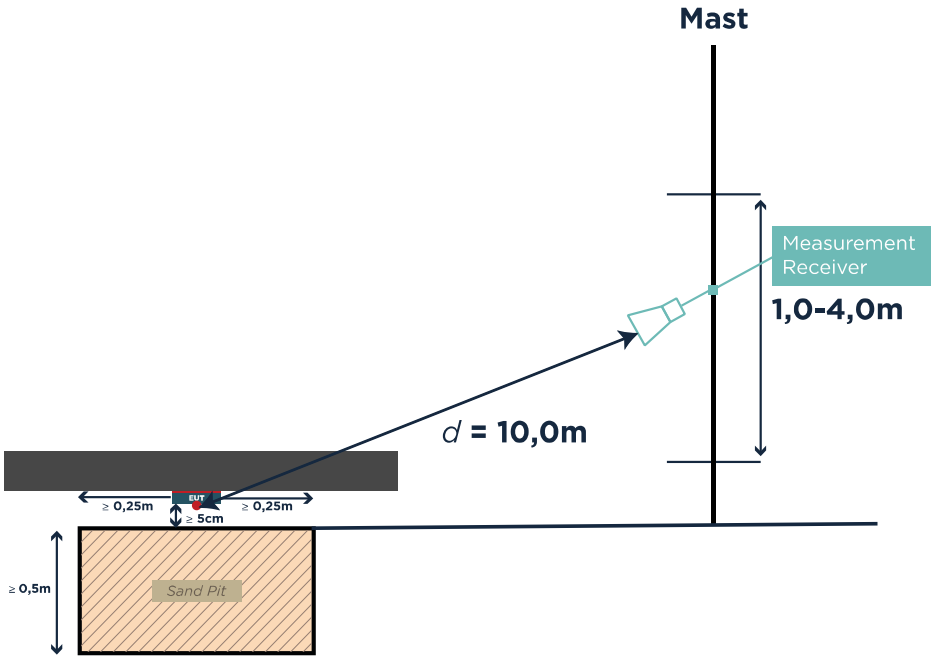

Figure C.2: Measurement set-up with EUT above sand pit using a mast antenna, for sand pit size, see clause C.3

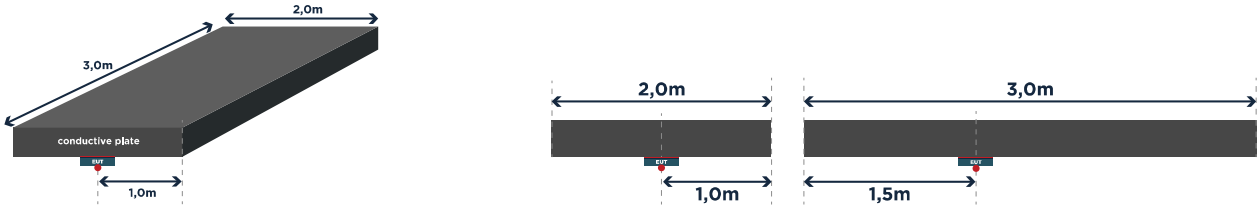

Figure C.3: Size of conductive cover plate including EUT

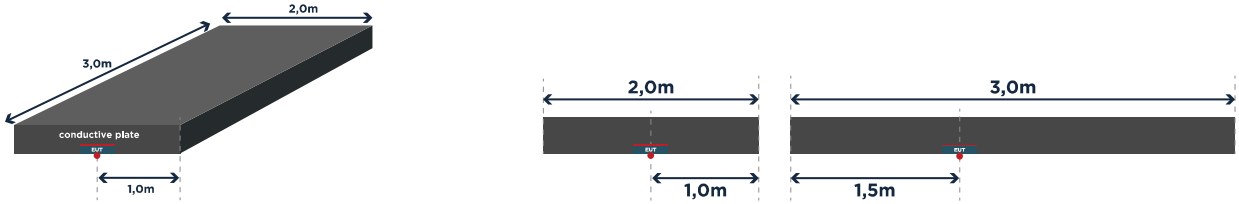

Figure C.4: Size of conductive cover plate including EUT integrated into the conductive plate

Annex D (normative): Interferer for RBR test

D.1 Interferer requirements for RBR tests

D.1.1 General test frequencies for RBR tests

ETSI EN 303 883-2 [2], clause A.2.1, usually defines the test frequencies inside and outside the OFR. One of two methods is selected depending on the OFR of the EUT. However, EUT covered by the present document operate over potentially very large bandwidths and therefore, to get realistic receiver test within the adjacent and blocking domain of the receiver, the test frequencies for the RBR tests shall be adjusted as follows:

- for EUT with OFR < 500 MHz: see clause D.1.2;
- for EUT with OFR ≥ 500 MHz: see clause D.1.3.

Despite the adjustment of the RBR test frequencies, the justification in terms of the of receiver requirements from ETSI EG 203 336 [i.7] given in ETSI EN 303 883-2 [2], clause C.1 is still valid for the EUT covered by the present document.

D.1.2 Test frequencies for EUT with OFR < 500 MHz

- Inband: one interferer test at frequency: $f_1 = f_C$
- Outside OFR, four interferer tests at:
  - frequency $f_{L2} = f_C - 2 \times OFR$
  - frequency $f_{L1} = f_C - 0,6 \times OFR$
  - frequency $f_{H1} = f_C + 0,6 \times OFR$
  - frequency $f_{H2} = f_C + 2 \times OFR$

For EUT with OFR < 500 MHz the interferer test frequencies in relation to the EUT OFR are shown in figure D.1.

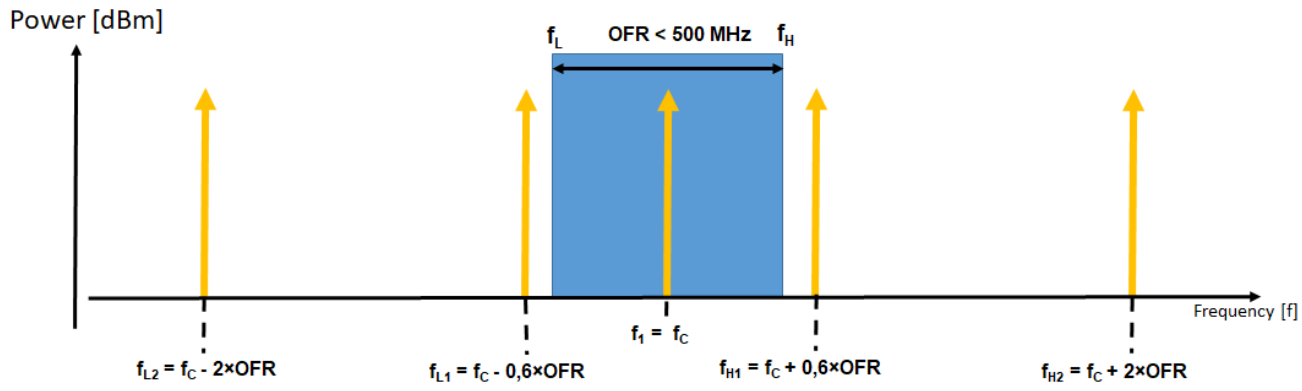

Figure D.1: Interferer test frequencies in relation to the OFR (for EUT OFR < 500 MHz)

D.1.3 Test frequencies for EUT with OFR ≥ 500 MHz

- Inband: three interferer test at:
  - frequency $f_1 = f_c$
  - frequency $f_2 = f_C - 0,4 \times OFR$
  - frequency $f_3 = f_c + 0,4 \times OFR$
- Outside OFR, four interferer tests at:
  - frequency $f_{L2} = f_c - 1 \times OFR$
  - frequency $f_{L1} = f_c - 0,6 \times OFR$
  - frequency $f_{H1} = f_c + 0,6 \times OFR$
  - frequency $f_{H2} = f_c + 1 \times OFR$

For EUT with OFR ≥ 500 MHz the interferer test frequencies in relation to the EUT OFR are shown in figure D.2.

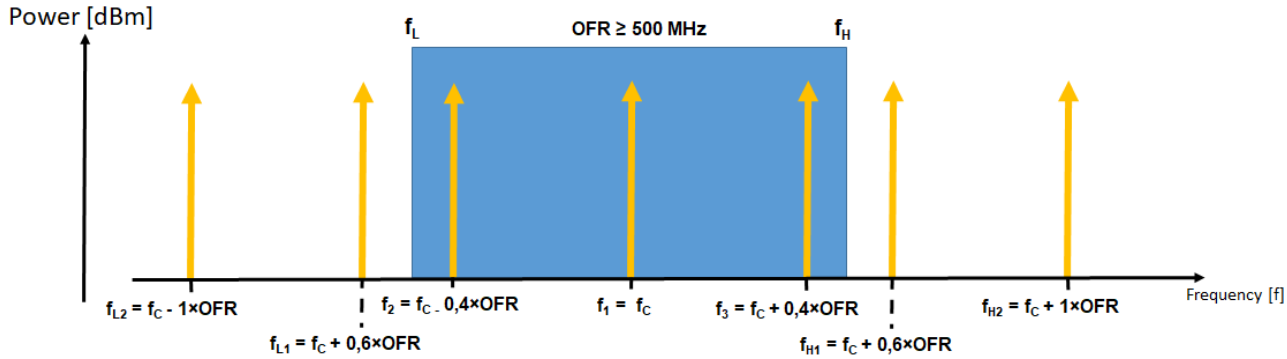

Figure D.2: Interferer test frequencies in relation to the OFR (for EUT OFR ≥ 500 MHz)

D.1.4 Interferer power levels and modulation

For the specification of the interfering signals and power levels which shall be used for EVS category RBR tests, following documents were assessed:

- ETSI EN 303 883-2 [2], clause A.2.1.1.
- Application class according to ETSI TS 103 361 [i.11]: EVS devices can be used outdoor only, therefore table 5 in ETSI TS 103 361 [i.11] provides the necessary information for the interferer assessment.
- Power level and duty-cycle according to the interferer assessment in ETSI TS 103 361 [i.11], table 5.

The assessment of the documents is described in clause D.3.

The outcome of the assessment is provided in table D.1. Table D.1 provides the necessary information for the RBR tests inside and outside the OFR in relation with the calculated test frequency.

Table D.1: List of interferers for EVS category RBR test

Calculated test frequency within range [MHz]	Radio application	Max. EIRP [dBm]	Power @ device [dBm]	Duty cycle
30 to 34,995	Active Medical Membrane Implants	0	-19	6 min on, 54 min off
34,995 to 35,225	SRD	20	1	100 %
40 to 40,25	On-site paging systems/Pocket device	17	-4	100 %
40,6 to 40,7	SRD/Model control	20	-1	1 % per second
47 to 68	T-DAB	60	-18	100 %
138,2 to 138,45	Generic SRD	10	-21	100 %
169,4 to 169,8	SRD/Meter reading	27	-6	100 %
174 to 240	T-DAB	60	-29	100 %
400,15 to 406	Meteorological Aids (radiosondes)	23	-18	100 %
433,05 to 434,79	Generic SRD/Non- specific use	41	-14	100 %
457,6 to 460	On-site paging systems/Pocket device	17	-25	100 %
703 to 748	LTE E-UTRA UE	23	-24	10 % per second
758 to 821	LTE E-UTRA BS	55	-45	100 %
823 to 832	Wireless Microphones	20	-27	100 %
832 to 862	LTE-E-UTRA UE	23	-24	10 % per second
863 to 870	SRD	27	-20	100 %
870 to 915	GSM 900 UE	39	-8	10 % per second
915 to 921	Generic SRD/RFID	36	-12	100 %
921 to 960	GSM 900 BS	58	-44	100 %
1 452 to 1 492	T-DAB	60	-46	100 %
1 710 to 1 785	LTE (E-UTRA UE)	23	-30	10 % per second
1 785 to 1 805	Wireless Microphones	17	-37	100 %
1 805 to 1 880	LTE (E-UTRA BS)	55	-53	100 %
1 920 to 1 980	IMT	24	-30	100 %
2 010 to 2 025	IMT (UTRA UE)	24	-31	10 % per second
2 025 to 2 110	PMSE	23	-66	100 %
2 110 to 2 170	IMT (UTRA BS)	55	-54	100 %
2 200 to 2 290	PMSE	23	-66	100 %
2 300 to 2 400	IMT (E-UTRA UE)	23	-33	10 % per second
2 400 to 2 483,5	Wideband data transmission	20	-36	5 ms on, 5 ms off
2 500 to 2 570	IMT (UTRA UE)	24	-33	10 % per second
2 585 to 2 600	IMT (UTRA BS)	55	-56	100 %
2 570 to 2 620	IMT (E-UTRA UE)	23	-34	10 % per second
2 570 to 2 620	IMT (UTRA UE)	24	-33	10 % per second
2 620 to 2 690	IMT (BS)	55	-56	100 %
3 400 to 3 600	IMT (E-UTRA UE)	26	-31	10 % per second
3 600 to 3 800	IMT (E-UTRA UE)	23	-34	10 % per second
4 400 to 4 800	PMSE	23	-73	100 %
4 800 to 4 990	BBDR-PPDR Terminal	26	-70	100 %
4 990 to 5 000	PMSE	12	-73	100 %
5 150 to 5 875	RLAN	27	-36	5 % per second
5 875 to 5 945	ITS	33	-45	5 ms on, 50 ms off
5 945 to 6 425	RLAN	23	-39	5 % per second
6 425 to 8 500	Fixed links	85	-75	100 %
8 500 to 10 150	Radiodetermination applications	30	-92	100 %
10 150 to 10 300	Fixed	85	-78	100 %
10 300 to 10 500	PMSE	67	-56	100 %
10 500 to 10 650	BFWA	85	-38	100 %

D.2 Interferer test signals for EVS

D.2.1 Interferer test signals

The OFR for EVS is between 30 MHz and 10,6 GHz (see table 1).

Based on clause D.1.2 the RBR test is depending on the OFR of the EUT.

The related test frequencies can be calculated based on the f_C of the OFR and the power levels can be taken from the interferer table D.1, clause D.1.4.

The test signals for the RBR test shall be as specified in clause D.3.3.

Table D.2 provides an overview of all requirements for the RBR test if the OFR is < 500 MHz; these requirements shall be used for the RBR test for EUT with such an OFR.

Table D.3 provides an overview of all requirements for the RBR test if the OFR is ≥ 500 MHz; these requirements shall be used for the RBR test for EUT with such an OFR.

Table D.2: List of interferers test signals for RBR tests with OFR < 500 MHz

Radio Service	Test frequency [MHz] (note 1)	Power @ device [dBm]	Signal modulation	Duty Cycle
Interferer within OFR	f_1 = fc	See table D.1	CW	See table D.1
Interferer outside OFR	f_{L2} = fc - 2 × OFR (note 2)	See table D.1	CW	See table D.1
	f_{L1} = fc - 0,6 × OFR (note 2)	See table D.1	CW	See table D.1
	f_{H1} = fc + 0,6 × OFR	See table D.1	CW	See table D.1
	f_{H2} = fc + 2 × OFR	See table D.1	CW	See table D.1
NOTE 1: If no requirements are provided for interferer at the calculated test frequencies, choose the next interferer requirements from table D.1 and adjust the test signal as follows: – f_1: choose the strongest of both adjacent interferer in frequency. – f_{L2}, f_{L1}: next interferer below the calculated frequency, see clause D.2.2. – f_{H1}, f_{H2}: next interferer higher the calculated frequency, see clause D.2.2. NOTE 2: If based on calculation the test frequency would be below 0 Hz this test is not applicable.				

Table D.3: List of interferers test signals for RBR tests of OFR ≥ 500 MHz

Radio Service	Test frequency [MHz] (note 1)	Power @ device [dBm] (note 3)	Signal modulation	Duty Cycle (note 3)
Interferer within OFR	f_1 = fc	See table D.1	CW	See table D.1
	f_2 = fc - 0,4 × OFR	See table D.1	CW	See table D.1
	f_3 = fc + 0,4 × OFR	See table D.1	CW	See table D.1
Interferer outside OFR	f_{L2} = fc - 1 × OFR (note 2)	See table D.1	CW	See table D.1
	f_{L1} = fc - 0,6 × OFR (note 2)	See table D.1	CW	See table D.1
	f_{H1} = fc + 0,6 × OFR	See table D.1	CW	See table D.1
	f_{H2} = fc + 1 × OFR	See table D.1	CW	See table D.1
NOTE 1: If no requirements are provided for interferer at the calculated test frequencies, choose the next interferer requirements from table D.1 and adjust the test signal as follows: – f_1: choose the strongest of both adjacent interferer in frequency. – f_2: next interferer higher the calculated frequency, see clause D.2.2. – f_3: next interferer lower the calculated frequency, see clause D.2.2. – f_{L2}, f_{L1}: next interferer lower the calculated frequency, see clause D.2.2. – f_{H1}, f_{H2}: next interferer higher the calculated frequency, see clause D.2.2. NOTE 2: If based on calculation the test frequency would be below 0 Hz this test is not applicable. NOTE 3: If the calculated test frequency would be below 30 MHz or above 10,6 GHz following interferer test signals shall be taken: – For test frequencies < 30 MHz: power at the EUT: -30 dBm; signal CW with DC 100 %. – For test frequencies > 10,6 GHz: power at the EUT: -30 dBm; signal CW with DC 100 %.				

D.2.2 Assessment if no interferer test signal provided at calculated test signals

If no requirements are provided for interferer at the calculated test frequencies (table D.1), choose the next interferer requirements from table D.1 and adjust the test frequency in relation to the frequency range of the interferer.

Figure D.3 and figure D.4 show the assessment procedure for the cases:

- Figure D.3 for the case "next interferer higher the calculated frequency".
- Figure D.4 for the case next interferer lower the calculated frequency".

For the frequency $f_1 = f_C$ it is requested to choose closest interferer in frequency, here the distance in frequency to the next interferer is relevant. The "closest" range shall be chosen. This could lead either to the case next interferer higher (see figure D.3) or the next interferer lower (see figure D.4) the calculated frequency.

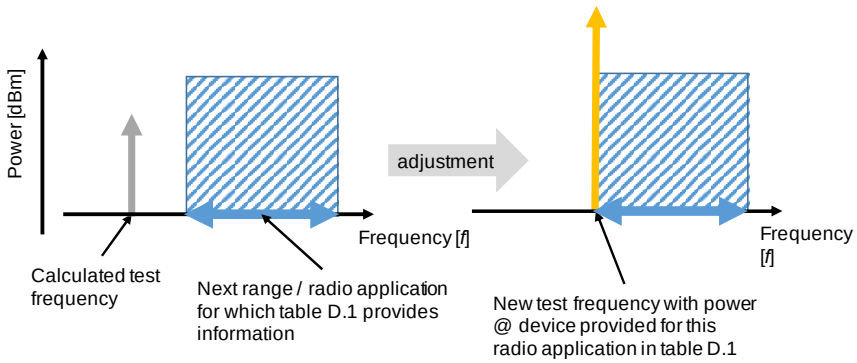

Figure D.3: Interferer test signal adjustment for the case "next interferer higher the calculated frequency"

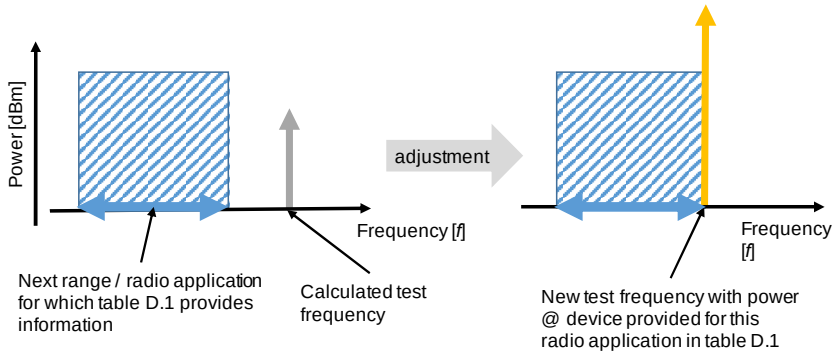

Figure D.4: Interferer test signal adjustment for the case "next interferer lower the calculated frequency"

D.3 List of interferer for RBR test; assessment procedure

D.3.1 General

The RBR limits in the present document are derived based on ETSI EN 303 883-2 [2], clause A.2.1.1.

Clause A.2.1.1 of ETSI EN 303 883-2 [2] is referencing to ETSI TS 103 361 [i.11], which includes the list of interferers from which the highest interferer for the in-band and out-of-band test are chosen.

The list of interferers specified for the outdoor usage in table 5 of ETSI TS 103 361 [i.11], clause 7.5 ("Interferers for outdoor applications") have been evaluated for the permitted frequency band of the present document and the highest level was taken as the limit and included in table D.1. Even though there are several interferers present in some frequency ranges in table D.1, only the highest interferer inside a frequency range is applicable. Therefore, the possible list of interferers was revised and amended, the result of the assessment is provided in clause D.1.4, table D.1.

The assessment procedure for the interference power level at the EUT is described in ETSI TS 103 361 [i.11] and was used for the new interferer added to the list of possible interferer, see clause D.3.2.4.

D.3.2 Assessment list of relevant interferer

D.3.2.1 Considering

To consider only the relevant interferers the tables provided in ETSI TS 103 361 [i.11] were reviewed.

The following points were considered:

- If several interferers are present within the same frequency range, only the highest shall be considered for the RBR test, see clause D.3.2.2 for details.
- If there is a partial overlap in the frequency ranges of interferers, the range of the interferer with the lower power level at the EUT has been adjusted, see clause D.3.2.3 for details.
- Review of the list of possible interferers, deletion of interferers which are no longer present or addition of newly allocated services, see clause D.3.2.4 for details.

D.3.2.2 Several interferer within the same frequency range

In case several interferers could be present in one frequency range, only the interferer with the highest power of interference at the EUT (based on the usage scenario) was kept.

As an example, table D.4 shows an excerpt from the "complete" list of the possible interferers (ETSI TS 103 361 [i.11], table 1 and table 7).

Table D.4: Excerpt from ETSI TS 103 361 [i.11], table 1 and table 7

Radio Service	Frequency [MHz]		Power @ device [dBm]
SRD, Radiodetermination	2 400	2 483,5	-42
Wideband data transmission	2 400	2 483,5	-36
RFID	2 446	2 454	-43
RFID (in building only)	2 446	2 454	-43

After the assessment, based on power level and probability of interference this is in table D.5.

Table D.5: Example result after assessment considering highest interferer within a frequency range

Radio Service	Frequency [MHz]		Power @ device [dBm]
Wideband data transmission	2 400	2 483,5	-36

D.3.2.3 Interferer overlapping in frequency range

In case of a (partial) overlap of interferers in frequency, the frequency range of the interferer with the higher emissions was kept, while the range with the lower level was reduced.

As an example, table D.6 shows an excerpt from the "complete" list of the possible interferers (ETSI TS 103 361 [i.11], table 1 and table 7).

Table D.6: Excerpt from ETSI TS 103 361 [i.11], table 1 and table 7

Radio Service	Frequency [MHz]	Test Frequency [MHz]	Max. EIRP [dBm]	Power @ device [dBm]	Radio Service
IMT (UTRA FDD Band XVI UE)	2 010 to 2 025	2 017,5	24	-31	3,84
PMSE	2 015 to 2 110	2 062	23	-66	10

After the assessment, the overlapping frequency range was removed, see table D.7.

Table D.7: Example result after assessment considering frequency range overlap of interferer

Radio Service	Frequency [MHz]	Power @ device [dBm]	Radio Service
IMT (UTRA FDD Band XVI UE)	2 010 to 2 025	-31	3,84
PMSE	2 025 to 2 110	-66	10

D.3.2.4 Status of interferer

During the revision of the list of possible interferers ("complete" list (ETSI TS 103 361 [i.11], table 1 and table 5)), the following changes were considered:

- GSM, CDMA, UMTS, DCS, PCS and WIMAX® systems are or soon will be no longer in service, E-UTRA, LTE systems will be considered instead.
- New RLAN allocation in 5 945 MHz to 6 425 MHz (see ECC/DEC/(20)/01 [i.9]) was added.
- Changes in the usage of 3 400 to 3 800 MHz, frequency range is not used by WIMAX® anymore, in this range E-UTRA, LTE systems will be considered, see ETSI TS 136 101 [i.10].

D.3.3 Kind of interferer signal

Based on the fact the OFR of the EUT categories covered by the present document are mostly broader than the bandwidth of a possible interfering signal, it can be assumed that in the interference case the bandwidth of the interfering signal will be completely within the OFR of the UWB EUT. Therefore, only the power level and the duty cycle of the interfering signal would be relevant. Therefore, a CW signal with the related DC shall be taken for the RBR tests within the OFR. For the DC requirement the related ECC compatibility reports were considered to choose the typical transmission behaviour, see EFIS [i.12].

Annex E (informative): Change history

Version	Information about changes
0.0.3	New version stable draft by FBC
0.0.4	New version stable draft by FBC
0.0.5	New version stable draft by FBC after TGUWB#57
0.0.6	New annex D, interferer specification for the RBR test
0.1.0	Version after 1. HASC assessment
0.1.2	Version after editHelp
0.1.3	Clean Version for second HASC assessment
0.1.4	Draft outcome resolution meeting 2nd HASC assessment
0.1.5	Clean Version for ENAP
0.1.6	Final accepted version (by TG UWB) for ENAP
2.1.1_0.0.3	Stable draft including environmental profile measurements
2.1.1_0.0.4	Input for TGUWB#69 approval for 1st HASTAC assessment
2.1.1_0.0.5	Outcome TGUWB#69 to request 1st HASTAC
2.1.1_0.1.0	Clean version
2.1.1_01.1	Version after editHelp clean-up, ETSI TO peer review and answering the questions
2.1.1_0.1.2	Clean version
2.1.1_0.1.3	Version with draft updates based on 1st HASC
2.1.1_0.1.4	Limited test site to open air testsite based on HASC request
2.1.1_0.1.5	Version after 1st HASTC assessment resolution meeting (TGUWB#70)
2.1.1_0.1.6	Approved version (TGUWB#70) for second HASTAC assessment
2.1.1_0.1.7	Outcome TGUWB resolution meeting for 2nd HASTAC assessment

ETSI EN 302 065-4 (V1.1.1)	First version of ETSI EN 302 065-4 for Material Sensing devices using UWB technology below 10,6 GHz; listed in the OJEU for Art. 3.2 of 2014/53/EU without restriction at 12 April 2017. It was a merge of ETSI EN 302 435-1/-2 and ETSI EN 302 498 -1/-2 into one EN. The main changes compared to the previous version(s) are: • Out-sourcing of standard measurement procedures into a separate ETSI EN 303 883 (V1.1.1). • Harmonisation of description of material sensing, building material sensing and object discrimination applications. • New requirement on receiver interferer signal handling. • New annex B "Application form for testing". • New annex C "Equivalent Mitigation techniques".
ETSI EN 302 065-4-4 (V1.1.1)	First version of ETSI EN 302 065-4-4 for Material Sensing devices for exterior material sensing application for ground based vehicles below 10,6 GHz; initial and specific version for such application/devices
ETSI EN 302 065-4-4 (V2.1.1)	Updated version of the ETSI EN 302 065 -4-4: • including TX requirements over environmental profile • and editorial improvement to be more precise and clearer

History

Document history		
V1.1.1	June 2022	Publication
V2.0.0	March 2025	SRdAP process EV 20250612: 2025-03-14 to 2025-06-12