



**Short Range Devices (SRD);  
Tank Level Probing Radar (TLPR) equipment operating in the  
frequency ranges 4,5 GHz to 7 GHz, 8,5 GHz to 10,6 GHz,  
24,05 GHz to 27 GHz, 57 GHz to 64 GHz, 75 GHz to 85 GHz;  
Harmonised Standard covering the essential requirements  
of article 3.2 of the Directive 2014/53/EU**

*PREVIEW*  
*https://standards.etsi.org/standards-search/EN-302-372-V2-1-0-2016-04*  
*4aa7-8ba0-97cfc-8880-f59f*

---

Reference

REN/ERM-TGUWB-131

---

Keywords

EHF, harmonised standard, radar, regulation,  
SHF, short range, SRD, testing, UWB

**ETSI**

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

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

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

---

**Important notice**

The present document can be downloaded from:

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

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

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at

<https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>

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

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

---

**Copyright Notification**

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

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

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

© European Telecommunications Standards Institute 2016.

All rights reserved.

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

**GSM®** and the GSM logo are Trade Marks registered and owned by the GSM Association.

# Contents

Intellectual Property Rights .....	8
Foreword.....	8
Modal verbs terminology.....	8
Introduction .....	8
1 Scope .....	10
2 References .....	11
2.1 Normative references .....	11
2.2 Informative references.....	11
3 Definitions, symbols and abbreviations .....	12
3.1 Definitions.....	12
3.2 Symbols.....	13
3.3 Abbreviations .....	14
4 Technical requirements specifications .....	15
4.1 Environmental conditions.....	15
4.2 General .....	15
4.3 Transmitter conformance requirements.....	15
4.3.1 Permitted frequency range of operation.....	15
4.3.1.1 Applicability.....	15
4.3.1.2 Description.....	15
4.3.1.3 Limits .....	15
4.3.1.4 Conformance.....	16
4.3.2 Operating bandwidth.....	16
4.3.2.1 Applicability.....	16
4.3.2.2 Description .....	16
4.3.2.3 Limits .....	16
4.3.2.4 Conformance.....	16
4.3.3 Maximum value of mean power spectral density .....	17
4.3.4 Maximum value of peak power .....	17
4.3.4.1 Applicability.....	17
4.3.4.2 Description.....	17
4.3.4.3 Limits .....	17
4.3.4.4 Conformance.....	17
4.3.5 Exterior limits .....	17
4.3.6 Low duty cycle .....	17
4.3.7 Other emissions .....	17
4.3.8 Transmitter unwanted emissions.....	17
4.3.8.1 Applicability.....	17
4.3.8.2 Description .....	18
4.3.8.3 Limits .....	18
4.3.8.4 Conformance.....	18
4.4 Receiver conformance requirements .....	18
4.4.1 Receiver requirements .....	18
4.4.2 Receiver spurious emissions.....	18
4.4.2.1 Applicability.....	18
4.4.2.2 Description .....	18
4.4.2.3 Limits .....	18
4.4.2.4 Conformance.....	19
4.4.3 Interferer signal handling.....	19
4.4.3.1 Applicability.....	19
4.4.3.2 Description .....	19
4.4.3.3 Limits .....	20
4.4.3.4 Conformance.....	20
4.5 Requirements for spectrum access .....	20
4.5.1 Detect and avoid (DAA).....	20

4.5.2	Listen-before-talk (LBT) .....	20
4.5.3	Low duty cycle (LDC) .....	20
4.6	Antenna requirements .....	20
4.7	Other requirements and mitigation techniques .....	21
4.7.1	General .....	21
4.7.2	Adaptive power control (APC) .....	21
4.7.3	Activity factor and duty cycle .....	21
4.7.3.1	Applicability .....	21
4.7.3.2	Description .....	21
4.7.3.3	Limits .....	22
4.7.3.4	Conformance .....	22
4.7.4	Frequency domain mitigation .....	22
4.7.4.1	Applicability .....	22
4.7.4.2	Description .....	23
4.7.4.3	Limits .....	23
4.7.4.4	Conformance .....	23
4.7.5	Shielding effects .....	23
4.7.5.1	Applicability .....	23
4.7.5.2	Description .....	23
4.7.5.3	Limits .....	23
4.7.5.4	Conformance .....	23
4.7.6	Thermal radiation .....	23
4.7.7	Site registration .....	23
4.7.8	Equivalent mitigation techniques .....	23
4.7.8.1	Applicability .....	23
4.7.8.2	Description .....	23
4.7.8.3	Limits .....	24
4.7.8.4	Conformance .....	24
4.7.9	Range of modulation parameters .....	24
4.7.9.1	Applicability .....	24
4.7.9.2	Description .....	24
4.7.9.3	Limits .....	24
4.7.9.4	Conformance .....	24
5	Testing for compliance with technical requirements .....	24
5.1	Environmental conditions for testing .....	24
5.2	General conditions for testing .....	24
5.2.1	Product information .....	24
5.2.2	Product information useful to facilitate testing .....	24
5.2.3	Requirements for the test modulation .....	25
5.2.4	Test conditions, power supply and ambient temperatures .....	25
5.2.5	Choice of equipment for test suites .....	25
5.2.6	Multiple operating bandwidths and multiband equipment .....	25
5.2.7	Testing of host connected equipment and plug-in radio devices .....	25
5.2.8	Radiated measurement arrangements .....	26
5.3	Interpretation of the measurement results .....	26
5.3.1	General .....	26
5.3.2	Conversion loss data and measurement uncertainty .....	27
5.3.3	Measurement uncertainty is equal to or less than maximum acceptable uncertainty .....	28
5.3.4	Measurement uncertainty is greater than maximum acceptable uncertainty .....	28
5.3.5	Emissions .....	28
6	Conformance test suite .....	28
6.1	Introduction .....	28
6.2	Initial measurement steps .....	28
6.3	Radiated measurements .....	28
6.3.1	General .....	28
6.3.2	Test sites and general arrangements for measurements involving the use of radiated fields .....	29
6.3.3	Guidance on the use of a radiation test site .....	29
6.3.4	Coupling of signals .....	29
6.3.5	Standard test methods .....	29
6.3.6	Standard calibration method .....	29

6.4	Conducted measurements.....	29
6.4.1	General Setup.....	29
6.4.2	Specific Setup.....	29
6.5	Conformance test suite for transmitter parameters.....	29
6.5.1	General.....	29
6.5.2	Method of measurements of the Ultra-Wideband emissions.....	29
6.5.3	Permitted frequency range of operation.....	29
6.5.4	Operating bandwidth.....	30
6.5.5	Mean power spectral density measurements.....	31
6.5.6	Peak power measurements.....	33
6.5.6.1	Description.....	33
6.5.6.2	Radiated test procedure.....	34
6.5.6.3	Conducted test procedure.....	34
6.5.7	Exterior limit measurement.....	34
6.5.8	Total Power.....	34
6.5.9	Other Emissions.....	34
6.6	Conformance test suite for receiver parameters.....	34
6.6.1	Receiver spurious emissions.....	34
6.6.2	Receiver sensitivity.....	34
6.6.3	Interferer signal handling.....	35
6.6.3.1	Description.....	35
6.6.3.2	Interferer frequencies and power levels.....	35
6.6.3.3	Real scenario.....	35
6.6.3.4	Equivalent scenario.....	36
6.6.3.5	Radiated test setup for the equivalent scenario.....	36
6.6.3.6	Conducted test setup for the equivalent scenario.....	39
6.6.3.7	Test procedure for the equivalent scenario.....	40
6.6.3.8	Alternative scenario.....	41
6.6.3.9	Radiated test setup for the alternative scenario.....	42
6.6.3.10	Conducted test setup for the alternative scenario.....	42
6.6.3.11	Test procedure for the alternative scenario.....	43
6.7	Conformance test suites for spectrum access.....	43
6.7.1	Detect and avoid mechanisms.....	43
6.7.2	Listen before talk.....	44
6.7.3	Low duty cycle.....	44
6.8	Conformance test suites for antenna requirements.....	44
6.9	Other test suites.....	44
6.9.1	Adaptive power control (APC).....	44
6.9.2	Activity factor and duty cycle.....	44
6.9.3	Frequency domain mitigation.....	44
6.9.4	Shielding effects.....	44
6.9.5	Thermal radiations.....	44
6.9.6	Site registration.....	44
<b>Annex A (normative):</b>	<b>Relationship between the present document and the essential requirements of Directive 2014/53/EU.....</b>	<b>45</b>
<b>Annex B (informative):</b>	<b>Application form for testing.....</b>	<b>46</b>
B.1	Introduction.....	46
B.2	General information as required by ETSI EN 302 372, clause 5.2.....	46
B.2.1	Type of equipment (stand-alone, combined, plug-in radio device, etc.).....	46
B.2.2	The nominal voltages of the stand-alone radio equipment or the nominal voltages of the combined (host) equipment or test jig in case of plug-in devices.....	46
B.3	Signal related information as required by ETSI EN 302 372, clause 5.3.....	47
B.3.1	Introduction.....	47
B.3.2	Operational frequency range(s) of the equipment.....	47
B.3.3	Nominal channel bandwidth(s).....	47
B.3.4	The type of modulation used by the equipment.....	47
B.3.5	The worst case mode for each of the following tests.....	47

B.4	RX test information as required by ETSI EN 302 372, clause 4.4	47
B.4.1	Worst case mode for RX tests	47
B.4.2	Performance criterion and level of performance	48
B.4.3	RX test setup	48
B.4.4	Definition of interfering signals	48
B.5	Information on mitigation techniques as required by ETSI EN 302 372, clause 4.7	48
B.5.1	Mitigation techniques	48
B.6	Additional information provided by the applicant	49
B.6.1	About the equipment under test	49
B.6.2	Additional items and/or supporting equipment provided	49
<b>Annex C (normative): Radiated measurement</b>		<b>50</b>
C.1	Test sites and general arrangements for measurements involving the use of radiated fields	50
C.1.0	General	50
C.1.1	Anechoic chamber	50
C.1.2	Anechoic chamber with a conductive ground plane	51
C.1.3	Open area test site (OATS)	52
C.1.4	Minimum requirements for test sites for measurements above 18 GHz	53
C.1.5	Test antenna	55
C.1.6	Substitution antenna	55
C.1.7	Measuring antenna	55
C.2	Guidance on the use of radiation test sites	55
C.2.0	General	55
C.2.1	Verification of the test site	55
C.2.2	Preparation of the EUT	56
C.2.3	Power supplies to the EUT	56
C.2.4	Range length	56
C.2.5	Site preparation	57
C.3	Coupling of signals	57
C.4	Standard test methods	57
C.4.0	General	57
C.4.1	Calibrated setup	57
C.4.2	Substitution method	58
<b>Annex D (normative): Conducted measurements</b>		<b>59</b>
<b>Annex E (normative): Installation requirements of Tank Level Probing Radar (TLPR) equipment</b>		<b>60</b>
<b>Annex F (normative): Requirements on test tank</b>		<b>61</b>
<b>Annex G (informative): Electromagnetic leakage from a EUT</b>		<b>62</b>
G.1	General	62
G.2	Survey of sources of leakage	62
<b>Annex H (informative): Measurement antenna and preamplifier specifications</b>		<b>64</b>
<b>Annex I (informative): Practical test distances for accurate measurements</b>		<b>65</b>
I.1	Introduction	65
I.2	Conventional near-field measurements distance limit	65
<b>Annex J (normative): Range of modulation parameters</b>		<b>66</b>
J.1	Pulse modulation	66
J.1.1	Definition	66
J.1.2	Operating parameters	67

J.2	Frequency modulated continuous wave .....	67
J.2.1	Definition .....	67
J.2.2	Operating parameters .....	68
<b>Annex K (informative): Atmospheric absorptions and material dependent attenuations.....</b>		<b>69</b>
K.1	Atmospheric absorptions .....	69
K.2	Material dependent attenuations.....	71
<b>Annex L (informative): General requirements for RF measurement equipment .....</b>		<b>73</b>
L.1	RF cables .....	73
L.2	RF waveguides .....	73
L.3	External harmonic mixers .....	74
L.3.1	Introduction .....	74
L.3.2	Signal identification .....	75
L.3.3	Measurement hints .....	75
L.4	Preamplifier .....	76
L.5	Measuring receiver .....	76
<b>Annex M (informative): Radar targets for radiated measurements.....</b>		<b>77</b>
M.1	Introduction .....	77
M.2	Radar cross sections of suitable radar targets.....	77
M.3	Boundary conditions of the RCS equations.....	80
<b>Annex N (informative): Boundary conditions for the radar equation.....</b>		<b>81</b>
N.1	Introduction .....	81
N.2	Far-field condition.....	81
N.3	Point target condition .....	82
<b>Annex O (informative): Bibliography.....</b>		<b>84</b>
History	.....	85

## Intellectual Property Rights

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

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

## Foreword

This 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 standards EN Approval Procedure.

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.8] 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.6].

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

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

There have been no significant technical changes incorporated from the previous version of the present document.

## 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

Clauses 1 and 3 provide a general description on the types of equipment covered by the present document and the definitions and abbreviations above.

Clause 2 provides the information on normative and informative reference documentation.

Clause 4 lists all technical requirements specifications. This includes transmitter and receiver conformance requirements as well as requirements for spectrum access, antennas and mitigation techniques.



Clause 5 addresses the conditions for testing. This includes the environmental conditions and product information of the equipment to be tested. It also gives advice on the interpretation of the measurement results and gives the maximum measurement uncertainty values.

Clause 6 provides the information on conformance test suites. This includes test suites for transmitter and receiver parameters as well as test suites for spectrum access, antenna requirements and others.

Annex A explains the relationship between the present document and the essential requirements of Directive 2014/53/EU [i.6].

Annex B provides an application form for facilitating the test preparation.

Annex C lists general requirements on radiated test setups.

Annex D provides information about the requirements of conducted measurements.

Annex E lists the installation requirements of a Tank Level Probing Radar (TLPR) on a tank.

Annex F establishes the requirements on the test tank.

Annex G deals with electromagnetic leakage from a tank with an installed TLPR.

Annex H gives recommendations on measurement antennas and preamplifiers.

Annex I deals with practically useful approximations of the far field conditions for radiated measurements.

Annex J specifies the allowed range of modulation parameters for TLPR instruments.

Annex K gives information on the atmospheric absorption of electromagnetic waves as a function of frequency.

Annex L gives practical information on RF measurements, especially in higher frequency bands.

Annex M gives information on radar targets for radiated measurements.

Annex N describes the boundary conditions for the Radar equation.

Annex O (bibliography) lists further related documents.

# 1 Scope

The present document applies to the following equipment types:

Tank Level Probing Radar (TLPR) applications are based on pulse RF, FMCW or similar wideband techniques. TLPR radio equipment types are capable of operating in all or part of the frequency bands as specified in table 1.

**Table 1: Tank Level Probing Radar (TLPR) permitted frequency bands [i.7]**

	TLPR assigned frequency bands (GHz)
Transmit and Receive	4,5 to 7
Transmit and Receive	8,5 to 10,6
Transmit and Receive	24,05 to 27
Transmit and Receive	57 to 64
Transmit and Receive	75 to 85

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

Table 1 shows a list of the frequency bands as assigned to Tank Level Probing Radars in the EC-Decision 2013/752 [i.7] and Recommendation CEPT/ERC/REC 70-03 [i.1] as known at the date of publication of the present document.

TLPRs are used for tank level measurement applications in many industries concerned with process control to measure the amount of various substances (mostly liquids or granulates). TLPRs are used for a wide range of applications such as process control, custody transfer measurement (government legal measurements), water and other liquid monitoring, spilling prevention and other industrial applications. The main purposes of using TLPRs are:

- to increase reliability by preventing accidents;
- to increase industrial efficiency, quality and process control;
- to improve environmental conditions in production processes.

The present document applies to TLPRs radiating RF signals towards the surface of a substance contained in a closed tank. Any radiation outside of the tank is caused by leakage and is considered as unintentional emission. The present document does not necessarily include all the characteristics, which may be required by a user, nor does it necessarily represent the optimum performance achievable, it applies only to TLPRs fitted with dedicated antennas.

TLPRs always consist of a combined transmitter and receiver and are used with an integral or dedicated antenna. The TLPR equipment is for professional applications where installation and maintenance are performed by professionally trained individuals only.

The scope is limited to TLPRs operating as Short Range Devices (SRD), in which the devices are installed in closed metallic tanks or reinforced concrete tanks, or similar enclosure structures made of comparable attenuating material, holding a substance, liquid or powder.

The TLPR applications in the present document are not intended for communication purposes. Their intended usage excludes any intended radiation into free space.

## 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 at <http://docbox.etsi.org/Reference>.

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

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

- [1] ETSI TR 100 028 (all parts) (V1.4.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [2] CISPR 16-1-1 (2015): "Specification for radio disturbance and immunity measuring apparatus and methods; Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus".
- [3] ETSI TR 102 273 (all parts) (V1.2.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".
- [4] ANSI C63.5 (2006): "American National Standard for Electromagnetic Compatibility - Radiated Emission Measurements in Electromagnetic Interference (EMI) Control - Calibration of Antennas (9 kHz to 40 GHz)".
- [5] ETSI EN 303 883 (V1.1.0) (02-2016): "Short Range Devices (SRD) using Ultra Wide Band (UWB); Measurement Techniques".
- [6] 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".

### 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] CEPT/ERC/Recommendation 70-03: "Relating to the use of Short Range Devices (SRD)".
- [i.2] Recommendation ITU-R SM.1754: "Measurement techniques of Ultra-wideband transmissions".
- [i.3] ETSI TS 103 051: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Expanded measurement uncertainty for the measurement of radiated electromagnetic fields".
- [i.4] ETSI TS 103 052: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radiated measurement methods and general arrangements for test sites up to 100 GHz".
- [i.5] Recommendation ITU-R P.676-10 (09-2013): "Attenuation by atmospheric gases".

- [i.6] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC, (OJ L153, 22.5.2014, p62).
- [i.7] European Commission Decision 2013/752/EU amending Decision 2006/771/EC on harmonisation of the radio spectrum for use by short-range devices and repealing Decision 2005/928/EC.
- [i.8] 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.9] European Commission Decision 2009/343/EC amending Decision 2007/131/EC on allowing the use of the radio spectrum for equipment using ultra-wideband technology in a harmonised manner in the Community.
- [i.10] ETSI TR 102 215: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Recommended approach, and possible limits for measurement uncertainty for the measurement of radiated electromagnetic fields above 1 GHz".
- [i.11] CEPT/ERC/REC 74-01 (2005): "Unwanted emissions in the spurious domain".

## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

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

**ActivityFactor (AF):** factor which is used to describe different modulation parameters and activity levels of TLPR devices and defined as the ratio of active measurement periods  $t_{\text{meas}}$  (bursts, sweeps, scans) within the overall repetitive measurement cycle  $T_{\text{meas\_cycle}}$ , i.e.  $t_{\text{meas}}/T_{\text{meas\_cycle}}$

**dedicated antenna:** antenna that is designed as an indispensable part of the equipment

**Device Under Test (DUT):** TLPR under test without a test tank

**Duty cycle (DC):** ratio of the total on time of the transmitter to the total time in any one hour period reflecting normal operational mode

**emissions:** signals that leaked or are scattered into the air within the frequency range (that includes harmonics) which depend on equipment's operating bandwidth

NOTE: For TLPRs there is no intended emission outside the tank.

**Equipment Under Test (EUT):** TLPR under test mounted on a test tank

**equivalent isotropically radiated power (e.i.r.p.):** total power transmitted, assuming an isotropic radiator

NOTE: e.i.r.p. is conventionally the product of "power into the antenna" and "antenna gain". e.i.r.p. is used for both peak and average power.

**equivalent radiated power (e.r.p.):** total power transmitted, assuming a directional power transmitted from a theoretical half-wave dipole antenna radiator

**Frequency Modulated Continuous Wave (FMCW) radar:** radar where the transmitter power is fairly constant but possibly zero during periods giving a big duty cycle (such as 0,1 to 1)

NOTE: The frequency is modulated in some way giving a very wideband spectrum with a power versus time variation which is clearly not pulsed.

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

**operating frequency (operating centre frequency):** nominal frequency at which equipment is operated

**power spectral density (psd):** amount of the total power inside the measuring receiver bandwidth expressed in dBm/MHz

**pulsed radar (or here simply "pulsed TLPR"):** radar where the transmitter signal has a microwave power consisting of short RF pulses

**Pulse Repetition Frequency (PRF):** inverse of the Pulse Repetition Interval (PRI), averaged over a sufficiently long time to cover all PRF variations

**Pulse Repetition Interval (PRI):** time period between two consecutive transmit pulses in a pulsed TLPR

**radiated measurements:** measurements that involve the absolute measurement of a radiated field

**radiation:** signals emitted intentionally inside a tank for level measurements

**step response time (of a TLPR):** time span after a sudden distance change until the output value (distance value) reaches 90 % of the final value for the first time

## 3.2 Symbols

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

AF	Activity factor
$f$	Frequency
$f_C$	Frequency at which the peak power of the emission is at maximum
$f_H$	Highest frequency of the operating bandwidth
$f_L$	Lowest frequency of the operating bandwidth
t	Time
$t_{\text{meas}}$	active measurement period
$T_{\text{meas\_cycle}}$	overall repetitive measurement cycle
$t_G$	blanking time
k	Boltzmann constant
c	speed of light
T	Temperature
G	efficient antenna gain of radiating structure or gain of the TLPR antenna in the direction of main radiation (main lobe axis)
$G_\alpha$	gain of the TLPR antenna in an angle $\alpha$ off the main lobe axis (see figure 5)
$G_t$	gain of the test antenna in the direction of main radiation (main lobe axis)
$G_a$	declared measurement antenna gain
d	Largest dimension of the antenna aperture of the TLPR or extent of the main lobe in slant distance $R_T$
$d_1$	Largest dimension of the TLPR antenna (m)
$d_2$	Largest dimension of the test antenna (m)
DC	Duty cycle
$P_s$	Output power of the signal generator measured by power meter
$\Delta f$	Bandwidth
$BW_{\text{ref}}$	reference bandwidth
$BW_{\text{measured}}$	measurement bandwidth
X	Minimum radial distance (m) between the DUT and the test antenna
$\lambda$	wavelength in general or wavelength of the TLPR transmit signal at centre frequency
dB	decibel
dB <sub>i</sub>	antenna gain in decibel relative to an isotropic antenna