

# ETSI TR 102 495-5 V1.1.1 (2009-01)

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*Technical Report*

**Electromagnetic compatibility  
and Radio spectrum Matters (ERM);  
System Reference Document;  
Short Range Devices (SRD);  
Technical characteristics for SRD equipment using  
Ultra Wide Band Sensor technology (UWB);  
Part 5: Location tracking applications type 2 operating  
in the frequency bands from 3,4 GHz to 4,8 GHz and from 6 GHz to 8,5 GHz  
for person and object tracking and industrial applications**

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## Reference

DTR/ERM-RM-263-5

## Keywords

radar, radio, short range, SRDoc, testing, UWB

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## Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document is part 5 of a multi-part deliverable covering Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Short Range Devices (SRD); Technical characteristics for SRD equipment using Ultra Wide Band technology (UWB) as identified below:

- Part 1: "Building material analysis and classification applications operating in the frequency band from 2,2 GHz to 8 GHz";
- Part 2: "Object Discrimination and Characterization (ODC) applications for power tool devices operating in the frequency band from 2,2 GHz to 8,5 GHz";
- Part 3: "Location tracking applications type 1 operating in the frequency band from 6 GHz to 8,5 GHz for indoor, portable and mobile outdoor applications";
- Part 4: "Object Identification for Surveillance applications operating in the frequency band from 2,2 GHz to 8,5 GHz";
- Part 5: "Location tracking applications type 2 operating in the frequency bands from 3,4 GHz to 4,8 GHz and from 6 GHz to 8,5 GHz for person and object tracking and industrial applications";**
- Part 6: Void;
- Part 7: "Location tracking and sensor applications for automotive and transportation environments operating in the frequency band from 3,1 GHz to 4,8 GHz and 6 GHz to 9 GHz".

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## Introduction

The original spectrum request for UWB location tracking applications was covered by part 3 of the present multi-part deliverable. This original request is now being enhanced by the proposals covered in the present document (part 5). Therefore, these additional location tracking devices are called type 2. The performance attributes of type 2 devices include an extended operating range compared with the earlier devices (i.e. type 1) as well as the new frequency range from 3,4 GHz to 4,8 GHz in addition to the 6 GHz to 8,5 GHz frequency range. It is foreseen that individual licensing of operators on a site-specific basis will be required.

The total addressable market for type 2 devices is expected to be considerable larger than that under the original request.

UWB location tracking is a viable positioning technology that meets industrial requirements in the following markets:

- 1) Healthcare.
- 2) Workplace/Office.
- 3) Public buildings.
- 4) Security.
- 5) Defence training.
- 6) Professional multimedia production.
- 7) Logistics, warehouses.
- 8) Manufacturing assembly lines.
- 9) Prisons and correctional institutes.
- 10) Large and hazardous industrial sites, such as oil refineries.

The purpose of producing the present document is to lay a foundation for industry to quickly bring innovative and useful products to the market.

The present document includes necessary information to support the co-operation between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Post and Telecommunications Administrations (CEPT).

#### Status of pre-approval draft

The present document has been created by ERM TG 31C. It has undergone an ETSI internal consultation and it was approved for publication as ETSI Technical Report by ERM at ERM#36 (November 2008). The present version is now intended for submission to ECC WGFM and ECC WGSE for consideration at their next meetings.

Target version	Pre-approval date version (see note)			Date	Description
	a	s	m		
V1.1.1		0.0.4		10 January 2008	Approved by TG31C and sent to ETSI ERM for consultation and subsequent approval.
V1.1.1		0.0.5		27 June 2008	Mini ETSI internal enquiry version.
V1.1.1		0.0.6		21 <sup>st</sup> August 2008	Incorporation of comments received during ETSI internal consultation.
V1.1.1		0.0.9		15 <sup>th</sup> October 2008	Version after internal ETSI consultation and rework in TG31c. Approved by TG31c.
V1.1.1		0.0.10		6 November 2008	ERM approved version for publication.

NOTE: See clause A.2 of EG 201 788 [i.13].

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# 1 Scope

The present document defines the requirements for radio frequency usage for Ultra Wide Band (UWB) location tracking devices type 2. These devices would operate in the frequency ranges from 3,4 GHz to 4,8 GHz and from 6 GHz to 8,5 GHz. Operation is foreseen for indoor and outdoor applications as for the earlier type (i.e. type 1) covered in TR 102 495-3 [i.9]. The operating distance may be limited to about 200 metres. It would include applications from all different markets (see list of markets in introduction). Site-specific licensing of fixed outdoor tracking systems using higher emission levels is possible and proposed by the present document.

The present document covers ultra-wideband location tracking tags which are attached to people or objects. The tags are tracked using a base station infrastructure. Equipment covered by the present document is fitted with an integral or dedicated antenna.

Additional information is given in the following annexes:

- Detailed market information (annex A),
- Technical information (annex B),
- Expected compatibility issues (annex C).

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# 2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
  - for informative references.

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.

## 2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

## 2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

- [i.1] CEPT/ECC Report 64: "The protection requirements of radiocommunications systems below 10,6 GHz from generic UWB applications", Helsinki, February 2005".
- NOTE: <http://www.ero.dk/doc98/Official/pdf/ECCREP064.pdf>.
- [i.2] CEPT/ERC Report 25: "The European table of frequency allocations and utilisations in the frequency range 9 kHz to 1000 GHz Lisboa 02 - Dublin 03 - Kusadasi 2004 -Copenhagen 04 - Nice 07".
- [i.3] Document TG3#7-19R0 ("Effects of PSD limits on UWB positioning systems"), submitted to ECC TG3 meeting, Brest, 1-3 March 2005.
- [i.4] FCC 03-33: "Revision of Part 15 of the Commission's Rules Regarding UWB Transmission Systems".
- [i.5] ECC/DEC/(06)04: "ECC Decision of 24 March 2006 amended 6 July 2007 at Constanta on the harmonised conditions for devices using Ultra-Wideband (UWB) technology in bands below 10.6 GHz".
- [i.6] ECC/DEC/(06)12: "Decision of 1 December 2006 on the harmonised conditions for devices using Ultra-Wideband (UWB) technology with Low Duty Cycle (LDC) in the frequency band 3,4-4,8 GHz".
- [i.7] Report developed by the European Conference of Postal and Telecommunications Administrations (CEPT) in response to the European Commission (EC) under the Mandate dealing with the harmonized technical conditions for the use in the European Union of the mitigation techniques for UWB applications.
- [i.8] ITU-R, Radio Regulations, Geneva, 2004.
- [i.9] ETSI TR 102 495-3: "Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Short Range Devices (SRD); Technical Characteristics for SRD equipment using Ultra-Wideband Sensor Technology (UWB); Part 3: Location tracking applications type 1 operating in the frequency band from 6 GHz to 8,5 GHz for indoor, portable and mobile outdoor applications".
- [i.10] EC Mandate M/407: Standardisation mandate forwarded to CEN/CENELEC/ETSI for harmonised standards covering ultra-wideband equipment.
- [i.11] NIST Construction Automation Program Report #3 (Electromagnetic Signal Attenuation in Construction Materials).
- [i.12] EC Mandate: Final and adopted Mandate to CEPT to identify the conditions relating to the harmonised introduction in the EU of radio applications based on ultra-wideband (UWB) technology (Mandate 4).
- [i.13] ETSI EG 201 788: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guidance for drafting an ETSI System Reference Document".

## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

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

**activity factor:** effective transmission time ratio, actual on-the-air time divided by active session time or actual on-the-air emission time within a given time window

**duty cycle:** defined as the ratio, expressed as a percentage, of the transmitter "on" relative to a given period as specified in the technical requirements

**fixed equipment:** UWB location tracking device on a fixed position

**mobile equipment:** UWB location tracking device to be used while in motion or during halts at unspecified points

**portable equipment:** UWB location tracking device normally used on a stand-alone basis and to be carried around

**range resolution:** ability to resolve two targets at different ranges

**tag:** mobile or portable UWB location tracking device

### 3.2 Symbols

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

c	velocity of light in a vacuum
$\delta R$	range resolution or multipath rejection resolution
dBm	decibel relative to 1 mW
$T_p$	pulse width

### 3.3 Abbreviations

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

2D/3D	Two Dimensional/Three Dimensional
CCTV	Closed Circuit TeleVision
CEPT	Conference Europeenne des Administrations de Postes et des Telecommunications
DCR	Duty Cycle Restriction
ECC	Electronic Communications Committee
ERC	European Radiocommunications Committee
ERM	Electromagnetic compatibility and Radio spectrum Matters
FS	Fixed Service
FSS	Fixed Satellite Service
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
ITU	International Telecommunication Union
LAN	Local Area Network
LDC	Low Duty Cycle
LORAN	LOng RANge Navigation
LOS	Line-Of-Sight
LT2	Location Tracking devices type 2
NLOS	Non-Line-Of-Sight
RA	National Regulatory Authorities
OoB	Out of Band
PRF	Pulse Repetition Frequency
PSD	Power Spectral Density
RF	Radio Frequency
SRD	Short Range Device



ToR	Terms of Reference
TPC	Total Power Control
UWB	Ultra Wide Band

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## 4 Comments on the System Reference Document

No statements have been received on the present document so far.

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## 5 Executive summary

### 5.1 Background information

The present document describes devices using Ultra Wide Band sensor technology for location tracking applications.

In UWB location tracking, small mobile or portable tags, operating as either transmitters or receivers, or both, are attached to the objects to be located, or are carried by personnel within an area under surveillance. A network of fixed equipment around the area to be covered, communicate with the tags. By analysing, e.g. the time-of-arrival and/or angle-of-arrival of the radio signal relative to the known reference stations, the 2D/3D position of the tag can be found. Typically, the range between a tag and a reference station might be up to 200 m, depending on the area to be observed.

There is evidence that these devices can address versatile industrial requirements in many different markets and therefore, a socio-economic benefit is given.

It is also possible that such a system will significantly enhance the security and safety of persons monitored in different applications such as process industries, healthcare, prisons (guards) and lone workers.

A high precision in range measurement is required. This means that the signals necessarily have a very large bandwidth to provide the required accuracy.

### 5.2 Market information

The proposed changes will lead to a greater addressable market that also includes new location tracking applications not considered before.

Detailed market information is given in annex A.

### 5.3 Technical system description

Small UWB transmitter tags are attached to the objects to be located, or are carried by persons.

A tracking system in the present document can be realized in 3 different ways:

- **transmitting tags and receiving fixed equipment** (see figure B.1.1)  
The UWB signals emitted by a small transmitting tags (carried by persons or attached to the objects to be located) are detected by a network of receiving fixed equipment placed at known, fixed points around the area to be covered. By centralized computational means the location of the tags can be determined. Typical application.
- **receiving tags and transmitting fixed equipment** (see figure B.1.2)  
The UWB signals emitted by a network of transmitting fixed equipment are detected by receiving tags, which need to have computational means to a detect their own position. Comparable to a GPS system.
- **receiving/transmitting tags and receiving/transmitting fixed equipment** (see figure B.1.3)  
A combination of 1 and 2; both the tag and the fixed equipment can receive and transmit UWB-signals.

The 3D position information / position can be calculated by detecting the UWB signal at a number of receivers (system set-up 1 or 3) or by detecting different (known) information from different transmitters at one receiver (system set-up 2 or 3), and analysing the time-of-arrival and/or angle-of-arrival of each radio signal.

In a typical application (system set-up 1), the range between a tag and the fixed equipment might be between 10 m to 200 m, depending on the level of building obstruction between the two.

Since the transmitting tags can only work in combination with the fixed equipment, a useful activity-control strategy could be to only allow the tags to transmit when they are ordered to do so, or when they receive a "system heartbeat". For receiving such a command or heartbeat the tags should also have a receiving part (not necessarily on UWB-basis).

Detailed technical information is given in annex B.

## 5.4 Regulations

### 5.4.1 Current Regulations

The current regulation (amended ECC/DEC(06)04 [i.5] and ECC/DEC(06)12 [i.6]) excludes fixed outdoor installations.

### 5.4.2 Radio spectrum requirements and justification

The addition of the lower frequency ranges (i.e. 3,4 GHz to 4,8 GHz) is attractive due to the availability of chipsets having lower costs and higher antenna efficiency but also because of the lower propagation losses.

Higher emission levels above 6 GHz are necessary for the application scenarios. A detailed description of the emissions levels is added in clause B.2.2.

The following requirements are proposed for Location Tracking Type 2 applications as shown in table 5.1. These proposed limits broaden the set of applications which can be addressed by UWB location tracking systems, by increasing the emissions levels applicable to indoor systems (but with additional duty-cycle restrictions), and by enabling fixed outdoor systems (with both duty-cycle restrictions and a requirement for individual licensing which ensures compatibility with existing users of the radio spectrum).

**Table 5.1: Proposed regulation**

Frequency (GHz)	Individual site specific licensing	Without individual licencing	
	Maximum value of mean power spectral density (dBm/MHz)	Maximum value of mean power spectral density (dBm/MHz)	
	New regulation requested	New regulation requested	Present regulation
$3,4 < f \leq 4,8$	$\leq -41,3$ ( fixed outdoor) subject to implementation of DCR (see note 1)		$\leq -41,3$ indoor (implementation of LDC as per ECC/DEC(06)12 [i.6])
$6 < f \leq 8,5$	$\leq -41,3$ (fixed outdoor) + DCR (see note 1)	$\leq -31,3$ ( indoor) subject to implementation of DCR (see note 2)	$\leq -41,3$ (indoor)

NOTE 1: An individual site licensing approach as proposed in clause 5.4.3.  
DCR: duty cycle restriction: 5 % / s.

NOTE 2: LDC is accepted to replace TPC as a mitigation in the related scenarios (ECC TG3#24).

#### LDC - parameters (as in ECC/DEC(06)12):

- Ton max = 5 ms.
- Toff mean  $\geq 38$  ms (averaged over 1 sec).
- $\Sigma$  Toff > 950 ms per second.
- $\Sigma$  Ton < 5 % per second and 0,5 % per hour.