# ETSI TR 101 538 V1.1.1 (2012-10)


**Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); UWB location tracking devices in the railroad environment**

Reference
DTR/ERM-TGUWB-020

Keywords
SRD, 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***



Individual copies of the present document can be downloaded from:
http://www.etsi.org

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the 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
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services:
http://portal.etsi.org/chaircor/ETSI_support.asp

***Copyright Notification***

# Contents

Intellectual Property Rights ..... 4
Foreword ..... 4
Introduction ..... 4
1 Scope ..... 6
2 References ..... 7
2.1 Normative references ..... 7
2.2 Informative references ..... 7
3 Definitions, symbols and abbreviations ..... 8
3.1 Definitions ..... 8
3.2 Symbols ..... 8
3.3 Abbreviations ..... 8
4 Presentation of the system or technology ..... 9
4.1 Subway and underground ..... 11
4.2 Depot ..... 12
4.3 Ground Station or railway station ..... 12
4.4 Railway signals or POI along railroad ..... 14
5 Radio spectrum regulations and compliance ..... 14
5.1 Technical justification for spectrum ..... 14
5.1.1 Technical justification for power levels ..... 14
5.1.2 Technical justification for bandwidth ..... 16
5.2 Compliance to current regulations ..... 16
5.3 Additional compliance to ECC recommendation ..... 16
5.4 Summary UWB regulation for specific railway application ..... 17
**Annex A: Detailed market information ..... 18**
**Annex B: Detailed technical, density and activity information ..... 21**
B.1 Detailed technical description ..... 21
B.2 Density and activity ..... 24
B.2.1 Density of UWB transmitters ..... 24
B.2.2 Activity Factor ..... 28
B.3 Technical parameters and implications on spectrum ..... 30
B.3.1 Transmitter parameters ..... 30
B.3.1.1 Transmitter Output Power / Radiated Power ..... 30
B.3.1.1a Antenna Characteristics ..... 30
B.3.1.2 Operating Frequency ..... 30
B.3.1.3 Bandwidth ..... 31
B.3.2 Receiver parameters ..... 31
B.3.3 Channel access parameters ..... 33
History ..... 34

# 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 (http://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 Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

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

# Introduction



The present document describes devices using Ultra Wide Band (UWB) sensor technology for location tracking applications in railway environment.

The intended railway scenarios target both indoor and outdoor environments. For example, a subway station is located under the ground and therefore is essentially indoors, whereas a signal placed at the side of a railway line in open country is most definitely outdoor. Regulation for indoor UWB, and for some mobile and fixed outdoor UWB devices in certain circumstances is already included in the Electronic Communications Committee (ECC) decisions and recommendations issued in the recent years [i.1], [i.2], [i.3], [i.9], [i.10] and [i.11]. Nevertheless, no specific regulation is pointed for UWB applications having fixed outdoor installed devices or infrastructure belonging to rail or tram networks. There is evidence that location tracking application with good range resolution is needed in railways. Therefore, the present document describes a solution for location tracking in railway environment where fixed outdoor installation of UWB equipment is needed and may be operated according the current ECC regulations.

In UWB location tracking in railways, a transmitter (TX) or a receiver (RX), or both are installed in a moving rail vehicle. The vehicle is tracked by using fixed wayside network which can be implemented by using UWB TX, UWB RX or both. A network of fixed wayside equipment around an area to be covered, called as Area-Of-Interest (AOI), communicate with a UWB equipment installed in a rail vehicle. The 3D position of a rail vehicle can be found by analysing, e.g. time-of-arrival and/or angle-of-arrival of the radio signal relative to the known reference stations.

The presented system is tracking a rail vehicle within an area around a certain Point-Of-Interest (POI). Position information are applied to stop a rail vehicle in POI with sub-meter accuracy. When a rail vehicle is stopped, transmission is turned off.

A tracking system of presented application can be realized in three different ways:

- Transmitter installed into a rail vehicle and receiving fixed wayside equipment (option 1, see Figure B.1).

  The UWB signals emitted by a transmitter installed in a moving rail vehicle are detected by a wayside network of receiving fixed equipment placed at known, fixed points around the area to be covered. By centralized computational means the location of a rail vehicle can be determined. This is a typical application.

- Receiver installed into a rail vehicle and transmitting fixed wayside equipment (option 2, see Figure B.2).

  The UWB signals emitted by a wayside network of transmitting fixed equipment placed at known, fixed points around the area to be covered are detected by receiving equipment installed in a moving rail vehicle detecting their own position.

- Transmitter/receiver installed into a rail vehicle and transmitting/receiving fixed wayside equipment (option 3, see Figure B.3).

  A combination of options 1 and 2; both units installed in a rail vehicle and the fixed wayside equipment can receive and transmit UWB-signals.

In railways, high precision in range measurement is required. The ranging signals necessarily have to have a very large bandwidth to attain a good range resolution. Detailed technical description is given in annex B.

There is evidence that this system is needed in railway industry, and the proposed system will lead to greater addressable markets. Detailed market information are discussed in annex A.