ETSI TR 102 834 V1.1.1 (2009-05)

Technical Report

Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Technical characteristics for airborne Ultra-WideBand (UWB) applications operating in the frequency bands for 3,1 GHz to 4,8 GHz and 6 GHz to 8,5 GHz

Reference

DTR/ERM-TGUWB-0121

Keywords

SRDoc, UWB

ETSI

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Foreword

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

Introduction

Use of wireless UWB communications in airborne platforms offers significant advantages to operators of aircraft by increasing operational flexibility while reducing costs.

The document is intended to also help to find solutions on this subject by defining the spectrum needs for airborne UWB applications.

The EC funded FP 7 European R&D Project EUWB [i.6] has work package 8A on airborne UWB applications and work package 9 dedicated to standardization and regulation.

The purpose of producing the present document is to lay a foundation for industry to quickly bring innovative and useful products to the market while avoiding harmful interference with other services and equipment.

1 Scope

The present document provides information on radio frequency usage for airborne Ultra Wide Band (UWB) applications.

These airborne UWB applications are operating in the frequency range from 3,1 GHz to 4,8 GHz and from 6 GHz to 8,5 GHz.

The operating radio link distance is limited typically to a maximum of about 30 m.

Airborne UWB devices may be installed onboard an aircraft or may form an integral part of other portable electronic equipment carried by the passengers, such as future generation cellular phones equipped with UWB enabled Bluetooth V 3.0.

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), including:

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

The present document does not cover equipment compliance with relevant civil aviation regulations. In this respect, an installed wireless airborne UWB-based communications is subject to additional national or international civil aviation airworthiness certification, for example to EUROCAE ED-14E [i.5].

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.
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  - for informative references.

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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. .

[i.2] CEPT/ERC Report 25: "The European table of frequency allocations and utilisations covering the frequency range 9 kHz to 3000 GHz - Lisboa 02- Dublin 03- Kusadasi 04- Copenhagen 04- Nice 07- Baku 08". .

[i.3] CEPT/ECC/DEC/(06)04: "ECC Decision of 24 March 2006 amended 6 July 2007 at Constanta on the harmonised conditions for devices using UWB technology in bands below 10,6 GHz".

[i.4] CEPT ECC/DEC/(06)12: "ECC Decision of 1 December 2006 amended Cordoba, 31 October 2008 on supplementary regulatory provisions to Decision ECC/DEC/(06)04 for UWB devices using mitigation techniques.

[i.5] EUROCAE ED-14E (2005) (Equivalent to RTCA DO-160E): "Environmental Conditions and Test Procedures for Airborne Equipment".

[i.6] EUWB consortium.

NOTE: Available at http://www.euwb.eu.

[i.7] CEPT ECC Report 93: "Compatibility between GSM equipment on board aircraft and terrestrial networks".

[i.8] NASA/TP-2005-213606 (Vol. 1): "UWB EMI To Aircraft Radios: Field Evaluation on Operational Commercial Transport Airplanes", Ely, J.J. Martin, W.L. Fuller, G.L. Shaver, T.W. Zimmerman.

[i.9] ETSI EN 302 065: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Ultra WideBand (UWB) technologies for communication purposes; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[i.10] IEEE 802.15.4a (August 2007): "Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs) - Amendment 1: Add Alternative PHYs".

[i.11] ECMA 368 (3rd edition, December 2008): "High Rate Ultra Wideband PHY and MAC Standard".

[i.12] ECMA 369 (3rd edition, December 2008): "MAC-PHY Interface for ECMA-368".

[i.13] ETSI TR 102 631 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Technical Characteristics for Airborne In-Flight Entertainment Systems operating in the frequency range 5 150 MHz to 5 875 MHz".

[i.14] FCC 03-33: "Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems".

[i.15] ACARE (Advisory Council for Aeronautics Research in Europe): "Strategic Research Agenda", (published in 2004 and amended in 2008).

3 Definitions, symbols and abbreviations

3.1 Definitions

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

In-Flight Entertainment (IFE): any of several modalities of In-Flight Entertainment, including but not limited to fixed streaming audio, audio on demand, fixed streaming video, video on demand, and public announcement audio and/or video

3.2 Symbols

For the purposes of the present document, the following symbol applies:

c	velocity of light in a vacuum

3.3 Abbreviations

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

ACARE	Advisory Council for Aeronautics Research in Europe
AP	Access Point
AVOD	Audio/Video on Demand
BW	BandWidth
CEPT	Conference Europeenne des Administrations de Postes et des Telecommunications
CMS	Cabin Management System
CVMS	Cabin Video Monitoring System
DAL	Design Assurance Level
dBm	deciBel relative to 1 mW
DL	DownLink
ECC	Electronic Communications Committee
EMI	ElectroMagnetic Interference
ERC	European Radiocommunications Committee
ERM	Electromagnetic compatibility and Radio spectrum Matters
HDR-LT	High Data Rate - Location Tracking
IFE	In-Flight Entertainment
ITU	International Telecommunication Union
IU	Illumination Unit
LDC	Low Duty Cycle
LDR-LT	Low Data Rate - Location Tracking
LT	Location Tracking
MBOFDM	Multi-Band Orthogonal Frequency Division Multiplexing
PA	Passengers Announcement
PAX	PAssenger
PSU	Passenger Service Unit
RF	Radio Frequency
SEB	Seat Electronic Box
UL	UpLink
USB	Universal Serial Bus
UWB	Ultra Wide Band
VHF	Very High Frequency

4 Executive summary

4.1 Comments on the System Reference Document

No statements have been received on the present document yet.

4.1.1 Status of the System Reference Document

The present document has been created by TC ERM TG31A. It was in ETSI internal consultation and, in parallel, already submitted to ECC (WGFM and WGSE) for information. Comments from the consultation were considered and resulted in a revised draft document. Final approval for publication of the present version is expected for ERM#37. The final document will be submitted to WGFM and WGSE for their considerations.

Table 4.1: Documnt status

Target version	Pre-approval date version				
V1.1.1	**a**	**s**	**m**	**Date**	**Description**
V1.1.1		0.0.1		5th October 2008	First version chairman TG31A
V1.1.1		0.0.2		5th December 2008	Second version chairman TG31A based on input from EUWB [i.6] project
V1.1.1		0.0.3		8th December 2008	Third version from ERM TG31A#25 discussions
V1.1.1		0.0.4		17th December 2008	Fourth version after confirmation from EADS/Airbus and EUWB - for submission to ERM
V1.1.1		0.0.5		18th February 2009	Resolution of comments received from MINEA-NL as well as Bosch and EADS (on WAIC clarification) - version for submission to ERM#37

4.2 Market information

There are four main application fields for airborne UWB:

- The Cabin Management System (CMS) application field.
- Passenger communication and in-flight entertainment.
- Mobile devices which will become part of the future cabin equipment for crew or maintenance staff.
- Communication headsets for pilots in the cockpit to ground and for the flight crew.

Wireless distribution offers many distinct advantages over a similar wired system; including: less weight, increased reliability due to fewer connectors, less likelihood of damage since no cables run through the floor or up the seat legs. Additionally, reconfiguring the cabin can be reduced to simply moving the seat, rather than needing to replace all the wiring bundles.

Entertainment while travelling has become an expectation of the flying public, and a competitive advantage among airlines attempting to gain or protect market share. Consequently, IFE systems continue to evolve with added functionality, capability, and user convenience being the highest priorities. The current state-of-art IFE systems offer video and audio "on demand", meaning that every passenger may be watching or listening to different content. This type of system requires independent distribution systems to each seat location, and if a wired system, can incorporate hundreds of kilometres of wiring.

Not only is wiring heavy and bulky, leading to increase fuel burn, it is difficult to maintain due to the number of connectors with resulting reliability issues. Furthermore, the need to frequently reconfigure the cabin means that the cabling will be moved, replaced, and adjusted often during the life of the IFE system.

Currently pilots use wired headsets to communicate to ground stations. Use of wireless headsets will increase the pilot freedom of movement, comfort and increase efficiency. This application specifically calls for the use of UWB due to high interference immunity in existing avionics/navigations equipments.

Medical emergency headsets or biometric data systems will help in-flight crew assist an unexpected emergency, where flight crew need to communicate via aircraft systems to get urgent medical assistance from ground. This application can be design as a part of the CMS or part of the pilot to ground communication system.

UWB technology is only used for wireless communication inside the aircraft. The connection to the outside world will be provided with the normal aircraft communication means as usual.

All of the above described use cases need high reliable, low latency, and robust communications. The large channel capacity provided by UWB technology facilitates the employment of highly redundant, interference-robust and encrypted communications which are considered to not affect other electronics inside the Aircraft.

Nevertheless, the envisaged applications do not plan to use UWB technology for safety- relevant system components or avionic equipments which are being contemplated in the discussions on WAIC systems (Wireless Avionics Intra-Communications) in CEPT/WGFM and ITU-R WP5B.

For detailed market information see annex A.

4.3 Technical system description

The content delivery for the current generation of wireless IFE systems depends upon reliable network performance of approximately 1 Mbit/s to each seat-back display to achieve high-quality motion video. Every seat potentially can be watching different content (or different locations in the same video stream), thus the network bandwidth is needed to support a 1 Mbit/s video stream to every seat in the cabin. Cabins typically range between 130 and 350 seats. Longer-range aircraft, where good IFE is more important, tend to have larger cabins.

The aggregated total application bandwidth needed for new larger aircraft such as the A380 will exceed 800 Mbit/s.

In the aircraft environment the envisaged applications range from location and tracking to signalling and data communication. The spectrum masks, the mitigation techniques and activity factors which will be implemented are thought to be compatible with ECC Decisions [i.3] and [i.4]. Both options for LT are still considered, LDR-LT based on pulsed transmissions (similar to IEEE 802.15.4a [i.10]) as well as HDR-LT based on MBOFDM (similar to ECMA 368 [i.11]).

Usage of UWB in portable devices can be predicted for the future, as UWB devices will be widely used. Normally it will not be possible to enforce the use of UWB devices onboard an aircraft. The only possible technical way to control the UWB devices on board is to use the fixed installation of UWB base stations to control the portable UWB devices and put them into in-flight mode.

In in-flight mode, the on board systems can monitor the signal power levels and indicate non-compliant UWB devices. In this mode critical communication such as medical/ safety emergencies and pilot to crew and ground communications is given precedence to other entertainment/ business communications.

For detailed technical information see annex B.

4.4 Compatibility Issues

It is expected that new ECC studies will be based on existing material from ECC Report 64 [i.1] with additional dedicated consideration on airborne UWB usage.

Tests performed by Boeing in 2004 [i.13] related to the measurements of aircraft fuselage attenuation in the 5 GHz band showed results that the aircraft fuselage can provide average attenuation of 5 GHz signals in excess of 17 dB. This information was recently given to CEPT/ECC-SE24 when having studied usage of 5 GHz frequencies for airborne usage. Those tests were already performed on the new aircraft 787 with composite fuselage. Comparison between a normal aluminium aircraft door and a composite fuselage was also made and it was found that the attenuation of the aluminium fuselage was greater than 30 dB in the 5 GHz band. Additionally, since on the Boeing 787 its windows are larger than a normal aircraft and are also shielded, the tests above have also shown that the attenuation of these windows will be greater than 30 dB.