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Technical Report

Electromagnetic compatibility and Radio spectrum Matters (ERM); Technical characteristics of Short Range Devices (SRD) and RFID in the UHF Band; System Reference Document for Radio Frequency Identification (RFID) and SRD equipment; Part 2: Additional spectrum requirements for UHF RFID, non-specific SRDs and specific SRDs

Reference

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Contents

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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 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).

The present document is part 2 of a multi-part deliverable covering RFID and SRD applications in the UHF range as identified below:

Part 1: "RFID equipment operating in the range from 865 MHz to 868 MHz";

Part 2: "Additional spectrum requirements for UHF RFID, non-specific SRDs and specific SRDs".

Introduction

The present document requests additional spectrum for UHF RFID, non-specific SRDs and specific SRDs. The additional spectrum is considered necessary because of the rapid growth rate of all these devices and their use in mass market applications. Furthermore the operation of this equipment in globally harmonized frequency bands is highly desirable, especially in view of the forthcoming SRD studies in the ITU-R as a consequence of the Radio Assembly 07 resolution [i.14] and the WRC 07 Resolution [i.15]. This could potentially lead to the global harmonization of spectrum for some of these applications.

The present document is a revision of the original proposal that includes an update to inform the ECC.

Target version	Pre-approval date version				
V1.2.1	**A**	**s**	**m**	**Date**	**Description**
V1.2.1	0.0.1			? February 2010	1st for approval by TG34
V1.2.1	0.0.2			26 February 2010	Approved by TG34 for submission to ERM
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1 Scope

The present document applies to UHF RFID, non-specific SRDs such as Home and Building Automation, Telemetry, Data Transmission and specific SRDs such as Metering (water and energy), Alarms, Automotive applications.

The present document describes the development of the RFID and SRDs industries and requests a study into additional frequency designations in the UHF frequency band to meet the medium and long term market requirements of this equipment.

The present document is intended to include all necessary information required by the Electronic Communications Committee (ECC) under the MoU between ETSI and the ECC.

2 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 reference 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.

2.1 Normative references

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

Not applicable.

2.2 Informative references

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] Commission Decision of 23 November 2006 on harmonization of the radio spectrum for radio frequency identification (RFID) devices operating in the ultra high frequency (UHF) band.

[i.2] "The RFID Revolution: Your voice on the Challenges, Opportunities and Threats".

NOTE: Available at http://ec.europa.eu/information_society/policy/rfid/documents/rfidswp_en.pdf.

[i.3] BRIDGE Building Radio frequency Identification solutions for the Global Environment, European passive RFID Market Sizing 2007 - 2022, GS1.

[i.4] ERC Recommendation 70-03: "Relating to the use of short range devices (SRD)".

NOTE: Available at http://www.erodocdb.dk/doks/implement_doc_adm.aspx?docid=1622.

[i.5] IDTechEx: "Boom in RFID will be reflected in Europe's Leading Conference".

NOTE: Available at http://www.idtechex.com/.

[i.6] Wireless Technology Propels Expansion of European Residential Security Market.

NOTE: Available at http://www.frost.com/prod/servlet/press-release.pag?Src=RSS&docid=95217860.

[i.7] ETSI EN 302 208 (all parts) (V1.3.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radio Frequency Identification Equipment operating in the band 865 MHz to 868 MHz with power levels up to 2 W".

[i.8] ETSI EN 300 220 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW".

[i.9] EC: "Towards an RFID Policy for Europe".

NOTE: Available at http://www.rfidconsultation.eu/docs/ficheiros/RFID_Workshop_Reports_Final.pdf.

[i.10] ISO/IEC 18000-6 (1st edition; 15 August 2004): "Information technology - Radio frequency identification for item management - Part 6: Parameters for air interface communications at 860 MHz to 960 MHz".

[i.11] ISO/IEC 18000-6 (2004) AMD1 (E) (19 June 2006): "Information Technology - Radio frequency identification for item management - Part 6: Parameters for air interface communications at 860 MHz to 960 MHz, Amendment 1: Extension with Type C and update of Types A and B".

[i.12] CEPT Report 14 (July 2006): "Develop a strategy to improve the effectiveness and flexibility of spectrum availability for Short Range Devices (SRDs) in response to the EU Commission mandate".

[i.13] ETSI TR 101 537: "Electromagnetic compatibility and radio spectrum matters (ERM); Second co-existence test between ER-GSM with RFID".

[i.14] ITU-R Radio Assembly 2007 Resolution 953 "Studies to achieve further harmonization for short-range radiocommunication devices (SRDs)".

[i.15] ITU-R World Radio Conference 2007 Resolution [COM6/4] (WRC-07): "Protection of radiocommunication services from emissions by short-range radio devices".

[i.16] Kyoto Protocol to the United Nations framework convention on climate change (United Nations 1998).

[i.17] Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings.

[i.18] Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.

[i.19] ECC Report 11: "Strategic plans for the future use of the frequency bands 862-870 MHz and 2400-2483.5 MHz for short range devices".

[i.20] Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products.

[i.21] CEN EN 14604:2005: "Smoke alarm devices".

[i.22] ECC Report 34: "Compatibility between narrow band digital PMR/PAMR and tactical radio relay in the 900 MHz band, Cavtat, May 2003".

[i.23] ECC Report 38: "Technical impact of introducing CDMA-PAMR on the UIC DMO & GSM-R radio systems in the 900 MHZ band, Granada, February 2004".

[i.24] ECC Report 40: "Adjacent band compatibility between CDMA-PAMR mobile services and short range devices below 870 MHz", Granada, February 2004.

[i.25] ECC Report 41: "Adjacent band compatibility between GSM and CDMA-PAMR at 915 MHz", Granada, February 2004.

[i.26] ECC Report 58: "Compatibility between TETRA Release 2 TAPS and tactical radio relays in the 870-876 AND 915-921 MHz bands", Stockholm, October 2004.

[i.27] ECC Report 96: "Compatibility between UMTS 900/1800 and systems operating in adjacent bands", Krakow, March 2007.

[i.28] ECC Report 37: "Compatibility of planned SRD applications with currently existing radiocommunication applications in the frequency band 863 - 870 MHZ", Granada, February 2004.

[i.29] CEN EN 54-25:2008: "Fire detection and fire alarm systems - Part 25: Components using radio links and system requirements".

[i.30] ETSI-ERM-TG34: 17-07-Analysis-of-RFID-Questionnaire.

[i.31] Commission Decision amending Decision 2006/771/EC on the harmonization of the radio spectrum for use by short range devices.

NOTE: Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:151:0049:0054:EN:PDF.

[i.32] ACEA: "Vehicles in use".

NOTE: Available at http://www.acea.be/index.php/news/news_detail/vehicles_in_use/.

[i.33] Study on legal, economic & technical aspects of "Collective Use of Spectrum" in the European Community (November 2006) by order of EU Commission.

[i.34] ECC Report 5: "Adjacent band compatibility between GSM and TETRA mobile services at 915 MHz".

[i.35] CEN EN 15232:2007: "Energy performance of buildings - Impact of Building Automation, Controls and Building Management".

[i.36] Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations.

[i.37] Directive 98/48/EC of the European Parliament and of the Council of 20 July 1998 amending Directive 98/34/EC laying down a procedure for the provision of information in the field of technical standards and regulations.

[i.38] ETSI TR 102 627: "Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Land Mobile Service; Additional spectrum requirements for PMR/PAMR systems operated by railway companies (GSM-R)".

[i.39] Federal Network Agency, Germany, Measurement Report: "Feasibility Tests between E-GSM-R and UHF RFID" at Kolberg, Germany, 25th to 26th June 2009.

[i.40] Federal Network Agency, Germany, Measurement Report: "Feasibility Tests between E-GSM-R and Low Duty Cycle SRD" at Kolberg, Germany, 19th to 20th August 2009.

[i.41] ETSI STF Methods, parameters and test procedures for cognitive interference mitigation for use by UHF RFID using Detect-And-Avoid (DAA) or other similar techniques.

[i.42] CEPT/ECC Decision (02)05 amended: "ECC Decision of 5 July 2002 on the designation and availability of frequency bands for railway purposes in the 876-880 MHz and 921-925 MHz bands amended 26 June 2009".

[i.43] CEPT/ECC Decision (04)06 amended: "ECC Decision of 19 March 2004 on the availability of frequency bands for the introduction of Wide Band Digital Land Mobile PMR/PAMR in the 400 MHz and 800/900 MHz bands amended annex 27-06-08/amended Decision 26 06 09".

[i.44] 046SE(09) annex 18: "Liaison Statement to WGFM on the extension band for GSM-R".

[i.45] ERC DEC (01)09: "ERC Decision of 12 March 2001 on harmonised frequencies, technical characteristics and exemption from individual licensing of Short Range Devices used for Alarms operating in the frequency bands 868.60 - 868.7 MHz, 869.25 - 869.3 MHz, 869.65 - 869.7 MHz".

[i.46] ERC DEC (97)06: "ERC Decision of 30 June 1997 on the harmonised frequency band to be designated for Social Alarm Systems".

NOTE: Withdrawn under ERC DEC (08)02.

[i.47] ECC DEC (05)02: "ECC Decision of 18 March 2005 on the use of the Frequency Band 169.4 - 169.8125 MHz".

[i.48] ETSI TR 102 649-2 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Technical characteristics of Short Range Devices (SRD) and RFID in the UHF Band; System Reference Document for Radio Frequency Identification (RFID) and SRD equipment; Part 2: Additional spectrum requirements for UHF RFID, non-specific SRDs and specific SRDs".

[i.49] SRDMG-11-96: "ACEA and CLEPA Contribution to the SRD/MG road map for the future use of spectrum for Short Range Devices for the automotive services".

[i.50] European Commission Guidance to CEPT on the fifth update of SRD Decision.

[i.51] ETSI TS 102 902: "Electromagnetic compatibility and radio spectrum matters (ERM); Methods, parameters and test procedures for cognitive interference mitigation towards ER-GSM for use by UHF RFID using Detect-And-Avoid (DAA) or other similar techniques".

[i.52] ETSI TS 102 903: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Compliance tests for cognitive interference mitigation for use by UHF RFID using Detect-And-Avoid (DAA) or other similar techniques".

[i.53] CEPT/ERC/REC 74-01E: "Unwanted emissions in the spurious domain".

[i.54] Federal Communications Commission Title 47 of the Code of Federal Regulations (CFR) "Telecommunication" - Section 15.247: "Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

alarms: fixed or portable device that uses radio communication for indicating an alert condition at a distant location

automotive: wireless communication for safety, environmental and comfort functions both inside and outside vehicles

channel: small frequency sub-band within the operating frequency band into which a Radio Signal fits

duty cycle: For the purposes of the ERC Recommendation 70-03 [i.4], the duty cycle is defined as the ratio, expressed as a percentage, of the maximum transmitter "on" time on one carrier frequency, relative to a one hour period.

NOTE 1: For frequency agile devices the duty cycle limit applies to the total transmission.

NOTE 2: For specific applications with very low duty cycles and very short periods of transmissions, the definition of duty cycle should be subject to study.

Home and Building Automation: business and residential control and system management by radio communication

Listen Before Talk (LBT): action taken by a device to detect an unoccupied channel prior to transmitting

NOTE: Also known as "listen before transmit".

metering: metering (water and energy) by radio communication

Predictable Sharing Environment (PSE): common behaviour for communication equipment and systems, common rules with common well defined technical parameters and mitigation techniques to provide better defined sharing conditions within a specified frequency band

NOTE: See [i.49].

Short Range Devices (SRDs): radio devices which provide either unidirectional or bi-directional communication and which have low capability of causing interference to other radio equipment

NOTE: SRDs use either integral, dedicated or external antennas and all modes of modulation can be permitted subject to relevant standards. SRDs are normally "license exempt".

specific SRDs: SRDs that are used in specific applications

NOTE: E.g. Applications of ERC Recommendation 70-03 [i.4], annexes 2 to 13.

tag, transponder: device that responds to an interrogation signal

Tari: reference time interval for a data-0 in Interrogator-to-Tag signalling

NOTE: The mnemonic "Tari" derives from the ISO/IEC 18000-6 (part A) specification [i.10], in which Tari is an abbreviation for Type A Reference Interval.

telegram: data transmitted during one duty cycle

tertiary sector (of industry): the service sector, or the service industry

NOTE: This is one of the three main industrial categories of a developed economy.

3.2 Symbols

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

d distance
E Electrical field strength
f frequency
fc centre frequency
P Power
t time
λ Wavelength

3.3 Abbreviations

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

ACEA European Automobile Manufacturers' Association

NOTE: See http://www.acea.be/.

AFA Adaptive Frequency Agility
BRIDGE Building Radio frequency Identification solutions for the Global Environment
BS Base Station
CEPT Conference of Post and Telecommunications Administrations
DAA Detect-And-Avoid
DSSS Direct Sequence Spread Spectrum
e.i.r.p. equivalent isotropic radiated power
e.r.p. effective radiated power
EC European Commission
ECC Electronic Communications Committee
ER-GSM Extended Railways GSM
ERM Electromagnetic compatibility and Radio spectrum Matters
EU European Union
EVVE The Association for Energy Cost Allocation

FHSS	Frequency Hopping Spread Spectrum
FSK	Frequency Shift Keying
GSM	Global System for Mobile Communications
GSM-R	GSM-Railway
LBT	Listen Before Talk
MS	Mobile Station
NRE	Non-Recurring Expenditure
PAMR	Public Access Mobile Radio
PIR	Passive InfraRed
PMR	Private Mobile Radio
PSE	Predictable Sharing Environment
RF	Radio Frequency
RFID	Radio Frequency Identification
RSCOM	Radio Spectrum Committee
Rx	Receiver
SRD	Short Range Device
TPMS	Tyre Pressure Monitor Systems
UHF	Ultra High Frequency
UMTS	Universal Mobile Telecommunications System
WG	Working Group

4 Comments on the System Reference Document

TC ERM has received a liaison statement from TC TETRA stating that they have no plans to use the dual band 870 MHz to 876 MHz and 915 MHz to 921 MHz. A copy of this letter is attached at annex D. It should be noted that in 2009 3GPP GERAN withdrew the T-GSM 900 specifications for the use of this frequency band due to the lack of implementation.

4.1 Recent and ongoing activities

In the spring of 2009 TC GSM-R prepared an SRDoc [i.38] which was submitted to ECC. This document [i.38] stated that in some European states the railways had identified an operational need for additional capacity. To meet this demand GSM-R requested an extension of their present band to include the frequency ranges 873 MHz to 876 MHz and 918 MHz to 921 MHz. WGFM considered this request and indicated that it was likely to be acceptable.

The frequencies requested by GSM-R are the same as part of the additional bands proposed in this SRDoc for use by SRDs and RFID. In order to determine if it would be possible for SRDs and RFID to share the bands with GSM-R, it was decided to undertake some informal feasibility tests. These were carried out in the presence of a representative from the railways at the BNetzA test laboratory in Kolberg. Reports on these tests are available in ETSI ERM [i.39] and [i.40]. The reports conclude that sharing of the bands by SRDs and RFID with GSM-R should be feasible. However due to the higher transmit powers proposed for RFID, it was considered that suitable mitigation techniques would be necessary by RFID to avoid unacceptable interference to ER-GSM.

Subsequently the reports on the feasibility tests were considered within ETSI. It was decided to initiate an STF with the objective of proposing acceptable methods of mitigation for RFID. This activity was undertaken jointly by members of TC RT ER-GSM and ERM_TG34. A TOR for the STF under the title "Methods, parameters and test procedures for cognitive interference mitigation for use by UHF RFID using Detect-And-Avoid (DAA) or other similar techniques" [i.41] was prepared and approved by the ETSI Board. Work on the STF commenced in February 2010 and took place in two phases. Phase 1 ended in September 2010 with the release of draft TS 102 902 [i.51]. Phase 2 involved the development of test procedures that would validate compliance of equipment to the specified mitigation techniques. It is intended that these tests will eventually be incorporated in a new version of EN 302 208 [i.7]. In addition some practical measurements were carried out at the BNetzA Test Laboratory in Kolberg using RFID interrogators and equipment provided by Deutche Bahn. These measurements established credible limits for potential interference between the two systems. The results of the measurements are recorded in TR 101 537 [i.13]. Also a demonstrator was built to validate that the proposed method of mitigation performed as intended. The output from Phase 2 was published in TS 102 903 [i.52].

To satisfy the railways of the adequacy of the proposals for compatibility between RFID and ER-GSM, ETSI plans to carry out a third phase. Two interrogators (to be called demonstrators) will be modified to include the preferred mitigation technique. These units will be installed at a working site (possibly a busy goods yard) provided by the railways and subjected to an agreed set of tests. Completion of the trial is anticipated at the end of 2012.

5 Executive summary

The present document requests the designation of additional spectrum in the UHF spectrum for RFID and SRDs. These devices are already installed in large numbers across a wide range of applications within Europe and their deployment is expected to increase. Additionally over the next 10-15 years a rapid growth is expected in new applications that will require new features. It is anticipated that the current designations of spectrum for RFID and SRDs will be inadequate to meet their future needs. The present document provides independent marketing data that predicts considerable market growth in RFID and SRDs. ECC is requested to undertake a compatibility study in order that additional spectrum may be made available.

The present document identifies two frequency bands, which currently are largely under-used on a pan-European basis, that could be designated for use by RFID and SRDs. It is believed that for technical reasons these bands cannot be used by the mobile industry (see clause 6.2). It is therefore proposed that the bands are re-designated so that they can be put to productive use.

This proposal provides the following justification for the designation of additional spectrum for RFID and SRDs, as already recognized by the CEPT Report 14 [i.12] (see clause 9.7.3.1) and the Collective Spectrum Use report [i.33], both mandated by the European Commission:

- It is predicted that the use of RFID in Europe will grow dramatically over the next 15 years. As the commercial benefits of RFID become more widely recognized, the technology will be adopted by many new industries. Some of these applications will require improvements to existing RFID performance. Typical examples include greater reading range, improved reading performance, faster data rates and the use of sensors (e.g. temperature, pressure, etc.) within tags. These requirements can only be met by the provision of additional spectrum. A detailed market analysis is given in annex A.
- The SRD industry has expanded considerably over recent years and has now developed into a number of different industrial sectors. These include metering, automotive applications, alarms, and in wider terms, non-specific SRDs such as Home and Building Automation, telemetry, data transmissions, etc. It is anticipated that the present trend in diversification and expansion will continue. An indication of the potential size of the market for SRDs is provided in annex A. Based on these predictions of market growth, it is very evident that additional spectrum will be necessary. This point was already identified in November 2006 in CEPT Report 14 [i.12] in response to a mandate from the EU Commission to develop a strategy to improve the effectiveness and flexibility of spectrum designation for SRDs. The Report recommended that:

  (i) "That CEPT ensures that only the minimum regulations are specified in Recommendation 70-03 and, where appropriate, the application-specific constraints to spectrum use are removed".

  (ii) "New bands should preferably be extensions of SRD bands or close to them".

  (iii) "Introduction of LBT and/or AFA in existing SRD bands is a first priority. However, any benefit from the introduction of LBT and/or AFA may be short lived if the anticipated growth in SRDs occurs. Therefore the identification of new spectrum for SRDs employing these techniques is a second priority".

- The present document has identified two frequency bands, unused by the PMR industry for 15 years. These bands are at 870 MHz to 876 MHz and at 915 MHz to 921 MHz. These could be designated for use by RFID and SRDs. For the reasons given in clause 6.2.1, it is not possible for the mobile industry to operate in these bands. ECC is therefore requested to undertake a compatibility study to determine how these bands could be designated for use by RFID and SRDs.

- As a result of their joint discussions, ETSI_ERM TG28 and TG34 concluded that it would be desirable to separate the high power transmissions of RFID from the low power levels associated with SRDs. The present document therefore proposes that the band 870 MHz to 876 MHz is designated for use by SRDs at less than 100 mW and the band 915 MHz to 921 MHz is designated for high power devices such as RFID (see clause 6.2.2). As important requirement from the industry is that the new SRD bands should be an extension of the present SRD bands or close to them.

- To satisfy the perceived future market requirements for RFID, it is proposed that interrogators will operate in the band 915 MHz to 921 MHz at power levels of up to 4 W e.r.p. in four channels of 400 kHz each. The remainder of the band will be used for the low level response from the tags. This will increase reading performance and potentially permit data rates that are four times faster than those currently possible. Details of the proposed channel plan are provided in annex A.

Furthermore the Commission has, in its guidance document on the fifth update of the SRD Decision [i.50], requested the CEPT to ensure the definition of appropriate spectrum access rules that facilitate predictable sharing arrangements and foster the beneficial coexistence of spectrum users.

From the spectrum requirements presented by industry, it is clear that some new services and functions, such as safety related applications, may require a more predictable sharing environment than that provided by traditional mitigation techniques. Different scenarios for combining services requiring a predictable sharing environment should be considered during the compatibility studies in order to determine an acceptable solution. This may involve the definition of common rules for the general use spectrum in the bands 870 MHz to 876 MHz and 915 MHz to 921 MHz that could provide a more predictable sharing environment for all services.

Designation of the bands 870 MHz to 876 MHz and 915 MHz to 921 MHz for use by SRDs will satisfy the foreseeable market requirements of the industry for the next 10-15 years. For technical reasons it is proposed:

- to divide the band 870 MHz to 876 MHz into a limited number of sub-bands to cover for example:
  - SRDs using duty cycle up to 1 % or LBT with AFA (or equivalent techniques).
  - SRDs that transmit intermittent very short bursts of power and rely on duty cycle for mitigation.
  - SRDs covering a number of services and functions with similar behaviour, technical parameters and mitigation techniques that would facilitate a more predictable sharing environment as requested by the European Commission.

- Alternatively, by careful specification of the technical parameters and mitigation techniques, it may be possible to create a predictable sharing environment for both bands that could apply to all SRDs.

This proposal is in accordance with the policy agreed by Member States at the Radio Spectrum Committee meeting of 4-5 December 2006 (see Report 14 [i.12], clause 5.2 for details). It also complies with the first key recommendation of the CEPT Report 14 [i.12] in response to a mandate from the EU Commission to develop a strategy to improve the effectiveness and flexibility of spectrum designation for SRDs (see clause 5.2 of the present document for details). *"That CEPT ensures that only the minimum regulations are specified in Recommendation 70-03 and, where appropriate, the application-specific constraints to spectrum use are removed"*.

It is, however, also realised that application specific short range device spectrum may be justified in particular cases.

5.1 Market information

5.1.1 RFID

Market information that supports the predicted rapid growth of RFID is provided at clause A.1 of the present document. In addition reference is made to a number of independent market studies such as given in clause A.1.1.

5.1.2 Non-specific SRDs

Market information for non-specific SRDs is provided in clause A.2.

5.1.3 Specific SRDs

Market information for specific SRDs of is provided in clause A.3.

The market information for non-specific SRDs and specific SRDs shows more rapid growth than the conclusions given in 2006 CEPT Report 14 [i.12] called *"Short Range Device Industry: Market and Technology Trends"*. The same applies to similar market studies and investigations contained in the Report on "Collective Spectrum Use" [i.33]. Both Reports are in response to a mandate from the European Commission.

Details are given in clause 7.2.2.2.

5.2 Technical issues

5.2.1 RFID

Clause B.1 shows the channel plan and spectrum mask details for RFID in the proposed band of 915 MHz to 921 MHz.

5.2.2 SRDs

Clauses B.2 and B.3 show the band plan and technical details for non-specific and specific SRDs in the proposed band 870 MHz to 876 MHz. Additional technical information is provided for each of the industrial sectors.

6 Future requirements

The common view of industry, the European Commission [i.33] and CEPT [i.12] is that the 865 MHz to 868 MHz band will be sufficient to cover the immediate spectral needs of UHF RFID. However a lack of spectrum in the UHF frequency range will arise. Unless addressed, this will seriously restrict the forecasted exponential market growth of the industry.

The situation for non-specific and specific SRDs is the same because of their rapidly increasing density and their expansion into a wider range of applications. In particular this is illustrated by the new generation of SRDs in Home and Building Automation, metering, alarms and automotive.

A more detailed description of the SRD applications and the justification for additional spectrum is given in clauses A.2 and A.3.

NOTE: The military use of the bands under consideration should be assessed by ECC during consideration of the present document.

6.1 RFID applications

RFIDs are used in item management, logistics and in a wide range of other applications. Details are provided in clause A.1.

Many of these applications require reading ranges of at least 2 meters, and in certain logistics applications ranges from 5 meters to 10 meters, These ranges cannot be provided by alternative technologies and at any other frequency due to the regulatory constraints.

Additional spectrum needs are based on increased RFID usage densities, greater operating distances, and higher data speeds that will permit applications where large numbers of RFID tags are read reliably and quickly.

6.2 SRDs

The proposed band 870 MHz to 876 MHz for use by SRDs could be divided into homogenous sub-bands (i.e. non-specific SRDs, specific SRDs and services requiring a predictable sharing environment) without further segmentation in each sub-band.

This fully complies with the recommendations for spectrum policy management in the "Collective Spectrum Use Report" [i.33] as mandated by the EU Commission and supported by Member States at the Radio Spectrum Committee meeting of 4-5 December 2006.

The proposal is based on the specification of a set of common generic characteristics in each sub-band, which ensures compatibility of equipment. This is a step forward compared to the previous approach used in the band 868 MHz to 870 MHz where the band is divided into many application specific sub-bands.

This simplified structure will improve spectrum efficiency, increase opportunities for technical innovation and simplify management of the spectrum.

This proposal also complies with the principal recommendation of CEPT Report 14 [i.12] that:

"CEPT ensures that only the minimum regulations are specified in Recommendation 70-03 and, where appropriate, the application-specific constraints to spectrum use are removed".

A list of applications for non-specific SRDs using either duty cycle or LBT + AFA (or equivalent techniques) is provided in clause A.2. A list of applications for specific SRDs using duty cycle only is provided in clause A.3 including safety related applications requiring a more predictable sharing environment.

7 Technical Radio Spectrum requirements and justification

7.1 Current regulations

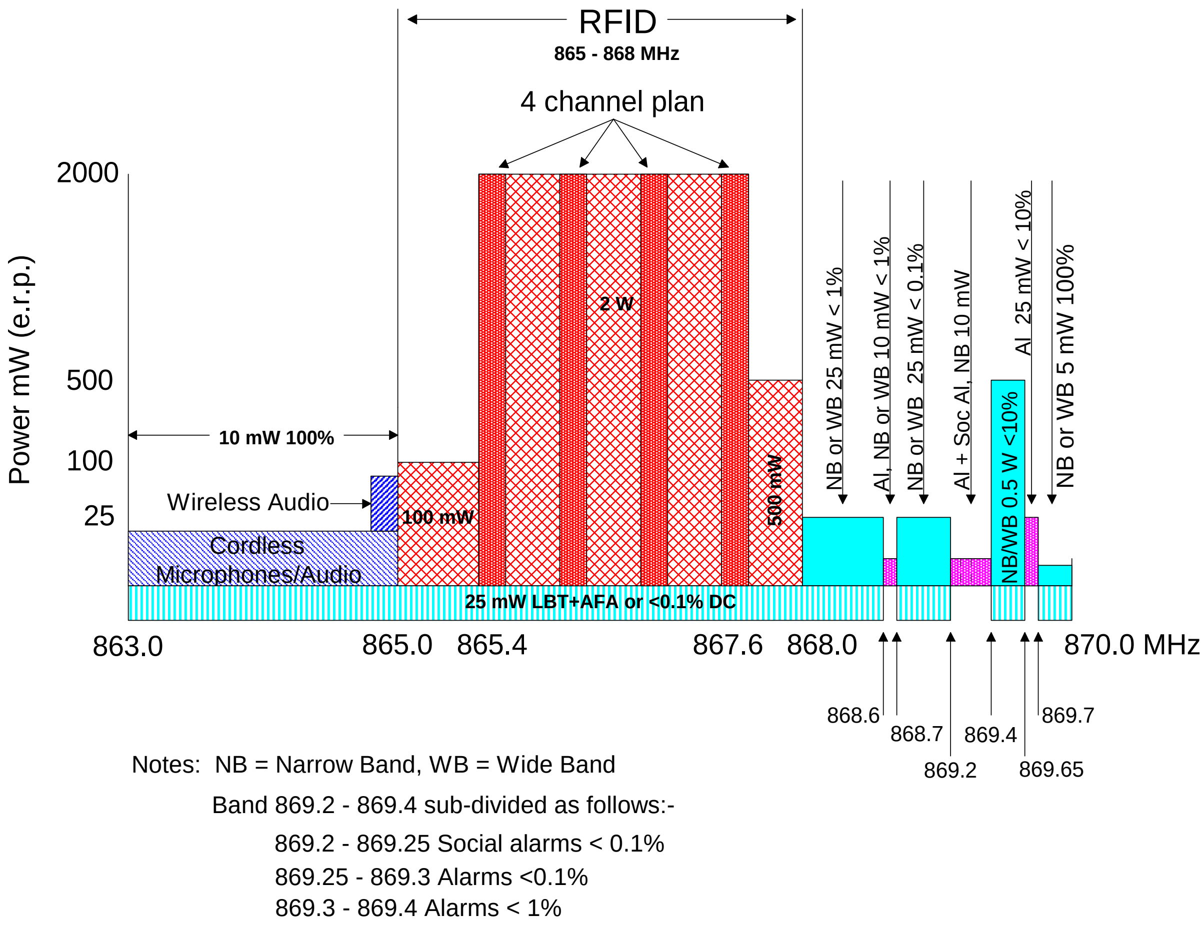
7.1.1 RFID

Operation of RFID in the band 865 MHz to 868 MHz falls under EC Decision 2004/804/EC [i.1]. In addition ERC Recommendation 70-03 [i.4], annex 11 contains a recommendation for RFID in the band 865 MHz to 868 MHz based on 200 kHz reader channels with power levels of up to 2 watts e.r.p., see figure 1. The present document proposes the designation of an additional UHF band to meet the future requirements of RFID.

7.1.2 SRDs

SRDs fall under the EC Decision 2006/771/EC [i.31] However it is anticipated that a revision to this EC Decision will be published shortly.

In addition the present designation of spectrum for SRDs is included in recommendation ERC Recommendation 70-03 [i.4], annex 1 and is shown in figure 1.



Source: CEPT Report 11 [i.19].
For latest and more detailed information consult the latest version of the ERC Recommendation 70-03 [i.4].

Figure 1: Overview of existing SRD band allocations according to ERC Recommendation 70-03 [i.4]

Table 1: Excerpt from ERC Recommendation 70-03 [i.4], annex 1

	Frequency Band	Power/Magnetic Field	Duty cycle	Channel spacing	ECC/ERC Decision	Notes
F	433,050 MHz to 434,790 MHz	10 mW e.r.p.	< 10 % (note 1)	No spacing		
f1	433,050 MHz to 434,790 MHz (note 4a)	1 mW e.r.p. -13 dBm/10 kHz	up to 100 %	No spacing		Power density limited to -13 dBm/10 kHz for wideband modulation with a bandwidth greater than 250 kHz
f2	434,040 MHz to 434,790 MHz (note 4a)	10 mW e.r.p.	up to 100 %	Up to 25 kHz		
G	863 MHz to 870 MHz (notes 3, 4a and 6)	≤ 25 mW e.r.p.	≤ 0,1 % or LBT (notes 1 and 5)	≤ 100 kHz for 47 or more channels (note 2)		FHSS modulation
		≤ 25 mW e.r.p. (note 6) Power density: -4,5 dBm/100 kHz (note 7)	≤ 0,1 % or LBT+AFA (notes 1, 5 and 6)	No spacing		DSSS and other wideband modulation other than FHSS
		≤ 25 mW e.r.p.	≤ 0,1 % or LBT+AFA (notes 1 and 5)	≤ 100 kHz, for 1 or more channels modulation bandwidth ≤ 300 kHz (note 2)		Narrow/wide-band modulation
g1	868,000 MHz to 868,600 MHz (note 4a)	≤ 25 mW e.r.p.	≤ 1 % or LBT+AFA (note 1)	No spacing, for 1 or more channels (note 2)		Narrow/wide-band modulation No channel spacing, however the whole stated frequency band may be used
g2	868,700 MHz to 869,200 MHz (note 4a)	≤ 25 mW e.r.p.	≤ 0,1 % or LBT+AFA (note 1)	No spacing, for 1 or more channels (note 2)		Narrow/wide-band modulation No channel spacing, however the whole stated frequency band may be used
g3	869,400 MHz to 869,650 MHz (note 4a)	≤ 500 mW e.r.p.	≤ 10 % or LBT+AFA (note 1)	25 kHz (for 1 or more channels)		Narrow/wide-band modulation The whole stated frequency band may be used as 1 channel for high speed data transmission
g4	869,700 MHz to 870,000 MHz (note 4a)	≤ 5 mW e.r.p. ≤ 25 mW e.r.p.	up to 100 % up to 1 % or LBT+AFA (note 1)	No spacing (for 1 or more channels)	ERC DEC (01)04	Narrow/wide-band modulation No channel spacing, however the whole stated frequency band may be used

	Frequency Band	*Power/Magnetic Field*	*Duty cycle*	*Channel spacing*	*ECC/ERC Decision*	*Notes*
NOTE 1: When either a Listen before Talk (LBT) or equivalent technique applies then it shall not be user dependent/adjustable and shall be guaranteed by appropriate technical means. For LBT devices without Adaptive Frequency Agility, or equivalent techniques, the duty cycle limit applies. For any type of frequency agile device the duty cycle limit applies to the total transmission unless LBT or equivalent technique is used. NOTE 2: The preferred channel spacing is 100 kHz allowing for a subdivision into 50 kHz or 25 kHz. NOTE 3: Sub-bands for alarms are excluded (see ERC Recommendation 70-03 [i.4], annex 7). NOTE 4: Audio and video applications are allowed provided that a digital modulation method is used with a max bandwidth of 300 kHz. Analogue and digital voice applications are allowed with a max bandwidth of ≤ 25 kHz. In sub-band 863 MHz to 865 MHz voice and audio conditions of annexes 10 and 13 apply retrospectively. NOTE 4a: Audio and video applications are excluded. Voice applications are allowed with a max bandwidth ≤ 25 kHz and spectrum access technique such as LBT or equivalent. The transmitter shall include a power output sensor controlling the transmitter to a maximum transmit period of 1 minute for each transmission. NOTE 5: Duty cycle may be increased to 1 % if the band is limited to 865 MHz to 868 MHz. NOTE 6: For wide-band modulation other than FHSS and DSSS with a bandwidth of 200 kHz to 3 MHz, duty cycle can be increased to 1 % if the band is limited to 865 MHz to 868 MHz and power to ≤ 10 mW e.r.p. NOTE 7: The power density can be increased to +6,2 dBm/100 kHz and +0,8 dBm/100 kHz, if the band of operation is limited to 865 MHz to 868 MHz and 865 MHz to 870 MHz respectively.						

Table 2: Excerpt from ERC Recommendation 70-03 [i.4] for Alarms, annex 7

	Frequency Band	*Power*		*Duty cycle*	*Channel spacing*	*ECC/ERC Decs*	*Notes*
A	*868,6 MHZ to 868,7 MHz*	*10 mW*	*e.r.p.*	*< 1,0 %*	*25 kHz*	*ERC DEC (01)09 [i.45]*	*The whole frequency band may also be used as 1 channel for high speed data transmissions*
B	*869,250 MHz to 869,300 MHz*	*10 mW*	*e.r.p.*	*< 0,1 %*	*25 kHz*	*ERC DEC (01)09 [i.45]*	
C	*869,650 MHz to 869,700 MHz*	*25 mW*	*e.r.p.*	*< 10 %*	*25 kHz*	*ERC DEC (01)09 [i.45]*	
D	*869,200 MHz to 869,250 MHz*	*10 mW*	*e.r.p.*	*< 0,1 %*	*25 kHz*	*ERC DEC (97)06 [i.46]*	*Social Alarms*
E	*869,300 MHz to 869,400 MHz*	*10 mW*	*e.r.p.*	*< 1,0 %*	*25 kHz*	*ECC DEC (05)02 [i.47]*	

7.2 Proposed Regulation

7.2.1 Justification for proposed new bands

It should be noted that, as of today, no pan-European PMR/PAMR installations exist in the European marketplace for the frequency duplex band 870 MHz to 876 MHz paired with 915 MHz to 921 MHz. Neither are there any implementations in these bands of TETRA or CDMA PAMR band class 12. Furthermore a recently approved work item from TETRA shows that they have no future plans to operate in this band (see annex D).

Even when considering the technical feasibility for future projects to operate in this band, it would apply only to a limited number of devices, which would make the business case for PMR/PAMR in this duplex band doubtful, i.e. potential operators will find it difficult to get attractive offers from manufacturers of PMR/PAMR radio equipment for operation in this duplex band. Furthermore, direct mode operation in this duplex band may also raise complex technical co-existence requirements.

The technical reasons behind this notion are considered in the following referenced documents: [i.22], [i.23], [i.24], [i.25], [i.26] and [i.27].

The decisive aspect with regard to the feasibility of PMR/PAMR mobile and portable stations (MS) in the duplex band is their receiver selectivity. The adjacent spectrum in Europe is used by GSM/UMTS. (MS to BS in 880 MHz to 915 MHz and BS to MS in 925 MHz to 960 MHz) In this case, an MS receiver still has a separation of 10 MHz from other MS transmissions at 915 MHz. This separation approaches 6 MHz in the case of GSM-R, which is allocated in 876 MHz to 880 MHz (MS to BS) and 921 MHz to 925 MHz (BS to MS). In the GSM-R case the total transmit bandwidth of the band however is limited to 5 MHz, which makes this approach possible. It may be feasible to manufacture PMR/PAMR MS with sufficient Rx selectivity for operation in the upper half of the duplex band but it seems not feasible for operation of the Receiver close to the 915 MHz band edge, i.e. the loss in sensitivity of the receiver is too high. In fact, an investigation of PMR equipment in the market place showed that the lowest separation between uplink and downlink was about 4,5 MHz.

Even if considered technically feasible, the loss in sensitivity of the PMR MS receiver through the intra-system interference would cause a material loss of the cell coverage area. For example consider the following:

1) Assuming wave propagation on the ground, a desensitization of 10 dB in the receiver would cause a reduction of the maximum operating distance between BS and MS of 50 %. Consequently, the loss of covered cell area would be 75 %.

2) If the desensitization increases by 30 dB, the cell radius shrinks to 1/8 and the cell coverage shrinks to 1/64.

Typically, GSM MS transmissions at or below 915 MHz do not use channel filters. This also applies to the total bandwidth of the uplink. In the GSM case, GSM MS handles this aspect by never transmitting and receiving at the same time (and not by filtering).

This fact has been known since 1992 when it was discussed in CEPT. Later on, ECC Report 5 [i.34] only investigated the scenario of TETRA TAPS BS interfering with a GSM BS. The scenario GSM MS into PMR/PAMR MS was not considered.

In some European countries, frequency managers have received a dispensation from the military to use the band also for civilian purposes.

In accordance with ECC DEC (04)06 [i.43] the frequency bands 873 MHz to 876 MHz paired with 918 MHz to 921 MHz has been designated for extension of the railway communication system GSM-R within the band 876 MHz to 880 MHz/921 MHz to 925 MHz However measurements have shown in Kolberg [I.13] that co-existence with RFID is possible.

7.2.2 Proposals for RFID and SRDs within the UHF bands

A summary of the main requirements covering RFID, non-specific SRDs and specific SRDs is provided below:

a) it is proposed to extend the current regulation for band (g) of annex 1 of ERC Recommendation 70-03 [i.4] from 863 MHz to 870 MHz to also include a sub-band within the 870 MHz to 876 MHz frequency range for narrow and wide band use with a 1 % D.C or LBT + AFA or equivalent mitigation technique (see table 3);

b) it is proposed to extend the current regulation for band (g) of annex 1 of ERC Recommendation 70-03 [i.4] from 863 MHz to 870 MHz to the frequency range 863 MHz to 873 MHz for FHSS and DSSS systems with a 0,1 % D.C or LBT + AFA or equivalent mitigation technique (see table 3);

c) it is proposed to designate a sub-band within the frequency range of 870 MHz to 876 MHz for devices with low duty cycles that cannot justifiably co-exist in the same frequency range with LBT + AFA devices (see table 3). The potential use of the band 873 MHz to 876 MHz is dependent upon sharing conditions with GSM-R. As indicated in figure 3 there is a minimum requirement for 2 MHz of usable spectrum for specific SRDs. The final proposal for SRDs in table 3 therefore depends on the compatibility studies;

d) it is proposed to designate a segment of spectrum to be used with the same technical parameters and mitigation techniques across a number of services and functions, which would allow for a more predictable sharing environment (PSE). This recommendation is dependent on the results of the compatibility studies and a clear proposal for specific frequency sub-bands for each type of segment is therefore not presently possible;

e) it is proposed to designate spectrum for UHF RFID high performance interrogators as shown in table 4 within the frequency range from 915 MHz to 921 MHz;

f) it is proposed that SRDs should share the band 915 MHz to 921 MHz with RFID. This will provide additional spectrum for SRDs and will be of particular benefit in situations where higher powers are required. To ensure compatibility between equipment, SRDs should use either LBT + AFA, or Duty Cycle, or an equivalent technique.

This proposal is in accordance with the recommendations of the EC (including RSCOM) [i.33] and of CEPT [i.12]. These recommendations promote the co-existence of multiple types of equipment within bands by the use of common technical characteristics.

Table 3: Proposal for SRDs

Frequency bands	Power	Duty cycle	Channel bandwidth	Notes
g4 869,7 MHz to 870 MHz (see note 4a of table 1)	≤ 25 mW e.r.p.	1 % D.C. or LBT + AFA	No spacing (for 1 or more channels)	Narrow/wide-band modulation No channel spacing, however the whole stated frequency band may be used. Audio applications excluded. Voice applications allowed with LBT together with 1 minute carrier time-out timer (see note)
	≤ 5 mW e.r.p.	Up to 100 % D.C. or LBT + AFA		
g5 The frequency range to be determined during the compatibility study	≤ 25 mW e.r.p.	1 % D.C. or LBT + AFA	no spacing	Narrow/wide-band, DSSS with 0,1 % duty cycle permitted FHSS duty cycle t.b.d. and spectrum density vs. minimum channels to be studied
g6 The frequency range to be determined during the compatibility study (see note of figure 3)	≤ 1 mW e.r.p. (to be studied) ≤ 25 mW e.r.p. ≤ 100 mW e.r.p.	Up to 5 % D.C Up to 1 % D.C Up to 0,1 % D.C (see figure 2)	No channel spacing	Narrow/wide-band, DSSS with 0,1 % duty cycle permitted FHSS duty cycle and t_{on} time of hops to be studied [i.28]
The frequency range to be determined during the compatibility study				Predictable sharing environment – to be further developed
NOTE: Taking advantage of the present spectrum re-farming plans for SRDs, it is also proposed to include devices with up to 25 mW e.r.p. and up to 1 % D.C. or LBT + AFA in the band 869,7 MHz to 870 MHz. For the power and duty cycle values of the frequency range g6, the trade-off of varying power and duty cycle can be interpolated from figure 2.				

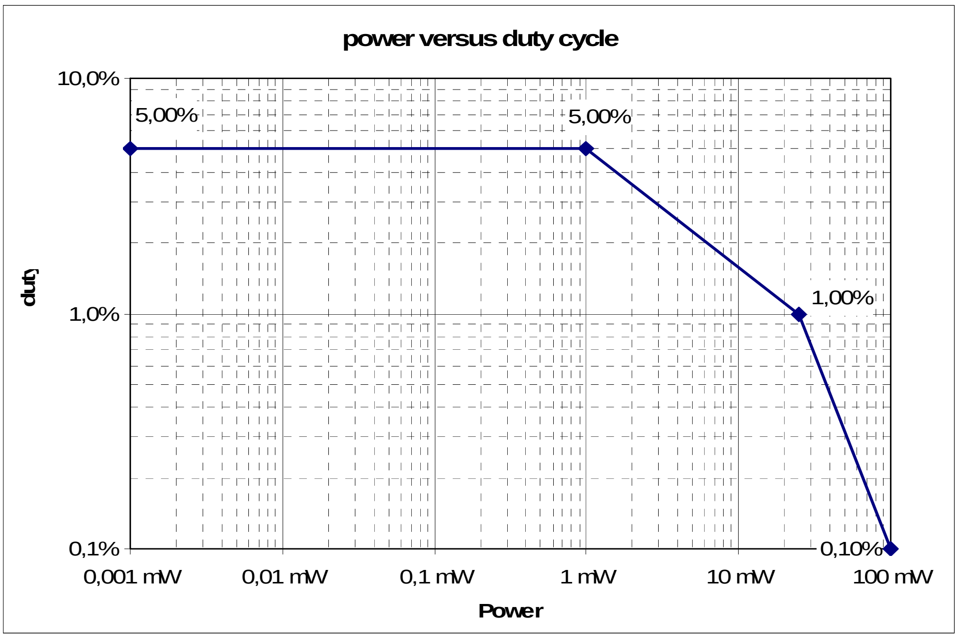
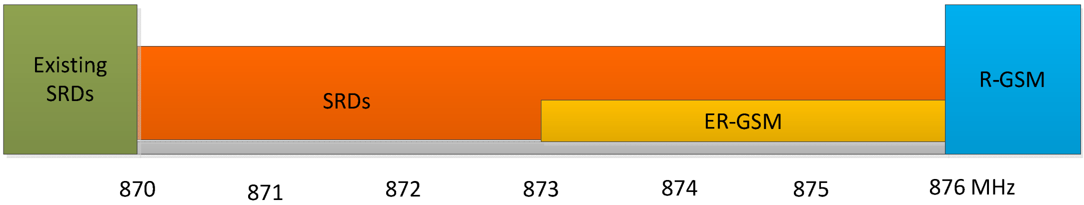


Figure 2: Allowed Pe.r.p. versus Duty cycle in the 873 MHz to 876 MHz band (see note of figure 3)

Figure 2 and table 3 are subject to further studies in the respective Work Item at SE24.



NOTE: It is expected that the boundary between non-specific and specific SRDs will lie somewhere between 873 MHz and 874 MHz. The exact frequency will be determined following the compatibility study when the impact of GSM-R on the upper part of the band has been quantified. It should be noted that specific SRDs have a minimum requirement for 2 MHz of usable spectrum.

Figure 3: Proposal for 870 MHz to 876 MHz frequency range

Table 4: Proposal for high performance RFID interrogators and SRDs

Frequency bands	Power	Duty cycle	Channel bandwidth	Notes
Interrogators: 915 MHz to 921 MHz Interrogator centre frequencies 916,3 MHz 917,5 MHz 918,7 MHz 919,9 MHz	≤ 4 W e.r.p. on a single interrogator channel for each individual interrogator	No mandatory limit for transmitter on-time. However interrogators will not be allowed to transmit longer than it is necessary to perform the intended operation	f_c ± 200 kHz	Interrogators may operate in any of the four high power channels
Tags: Between 915 MHz to 921 MHz	< -18 dBm e.r.p./ 100 kHz. per tag		f_c ± 1 000 kHz for tag response	
SRDs: 915 MHz to 921 MHz Center frequencies for high power SRD channels 916,3 MHz 917,5 MHz 918,7 MHz 919,9 MHz	≤ 0,1 W e.r.p. in RFID high power channels	0,1 % duty cycle or LBT + AFA	f_c ± 200 kHz	Transmit levels outside of high power channels will not be allowed to exceed 25 mW e.r.p.
NOTE: fc are the carrier frequencies of the interrogators. SRD receivers should be category 2 or better as specified in EN 300 220 [i.8]. To minimize the risk of interference from RFID, SRDs may use LBT with AFA or equivalent techniques in the high power channels. Suitable separation distances should be studied. To minimize the risk of interference from SRDs to RFID tag responses, SRDs should use LBT with AFA or equivalent techniques in the remaining 2,2 MHz. Suitable separation distances should be studied.				

Figure 4 is a graphical representation of the table 4 proposal for high performance RFID interrogators and SRDs.

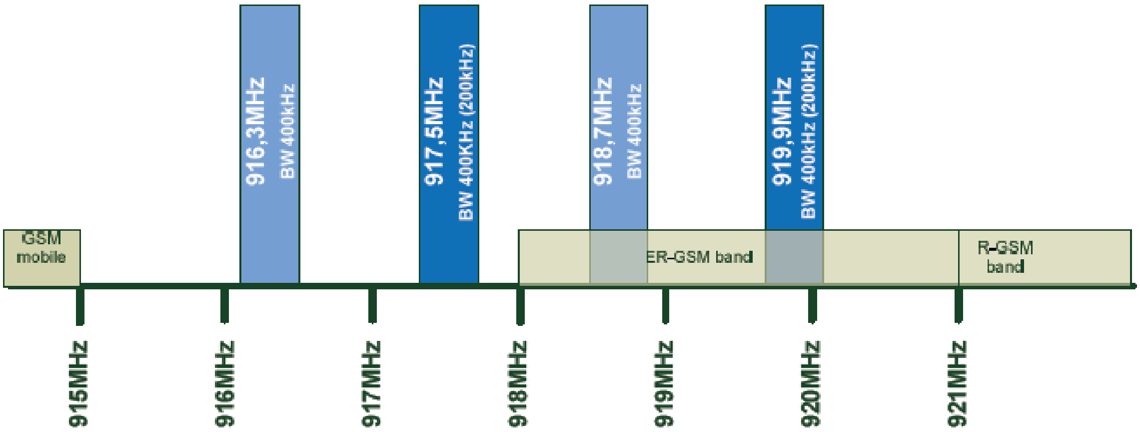


Figure 4: Proposal for high performance RFID and SRD applications

It should be noted that the separation between channels of 1,2 MHz permits the higher data rates required for the new applications and ensures that the receive bands do not overlap into the adjacent high power channels.

7.2.2.1 Justification for spectrum requirements for RFID

Market studies, as well as answers received from questionnaires, have demonstrated that additional spectrum will be required to accommodate a growing installed base and to offer increased performance. The high performance systems will meet the needs for higher data rates and longer reading ranges. Higher data rates will be used either for reading large numbers of tags or for future applications involving the movement of tagged items at greater speeds.

The main conclusions from the marketing information are:

- RFID at UHF will grow exponentially over the next 10 years to 15 years.
- Increased usage densities, higher data speeds, faster reading of higher numbers of tags, improved reading performance all require additional spectrum for operations at higher power levels. This should preferably be in the range around 915 MHz since this is the same frequency band used for RFID by many of the major non-European trading partners.
- Medium and long term spectrum planning according to the present document is needed in order to provide the regulatory environment that will ensure the continued growth of RFID at UHF and enable the market predictions to be realized.

7.2.2.2 Justification for spectrum requirements for non-specific SRDs

During 2005 - 2006 market studies were conducted by the major European industry associations i.e. EICTA and LPRA (see more in clause A.2). These studies included the detailed analysis of replies to questionnaires from association members. The results from this work provided a valuable contribution towards the CEPT Report 14 [i.12]. The present document was prepared in response to a mandate from the EU Commission to develop a strategy to improve the effectiveness and flexibility of spectrum designation for SRDs.

Similar market studies and investigations were conducted by a consortium of consultants (i.e. Mott MacDonald Ltd, Aegis System Ltd and Indipen) who also produced a Report on "Collective Use of Spectrum" [i.33] in response to a mandate from the EU Commission.

Both Reports demonstrated that additional spectrum will be required to accommodate the rapid growth in SRDs. In that regard a specific recommendation in both Reports advised that *"New bands should preferably be extensions of SRD bands or close to them"*.

Furthermore the CEPT Report 14 [i.12] stated that "Introduction of LBT and/or AFA in existing SRD bands is a first priority. However, any benefit from the introduction of LBT and/or AFA may be short lived if the anticipated growth in SRDs occurs. Therefore the identification of new spectrum for SRDs employing these techniques is a second priority".

A generation of SRDs using LBT + AFA has already been sold in large volumes with favourable results.

EXAMPLE: Based on the experience of several millions of installed devices using LBT and AFA, the Home and Building Automation industry reports that the technique is performing very satisfactorily.

Already the sale of devices in the Home and Building Automation sector exceeds estimates in the CEPT Report 14 [i.12] by 25 % (see clause A.1.2 for market details).

Information from the other non-specific SRD applications (see examples below) indicates that they will also continue to grow. For example telemetry is already producing, an annual turnover of approximately € 1 000 million. The combined effect of Building and Home Automation together with these other applications will place increasing pressure on the existing band 863 MHz to 870 MHz leading in the medium term to an unacceptable deterioration in performance.

7.2.2.3 Justification for spectrum requirements for specific SRDs (e.g. Metering of water and energy) and alarms

The requirements for the metering market are defined by the EC directive 2002/91/EC [i.17] and 2006/32/EC [i.18]. Both of these Directives focus on the efficient use of energy to mitigate anthropogenic climate change and to reduce the economic dependency of the EC on the import of primary energy resources. Metering and individual cost allocation are known to reduce significantly the consumption of primary energy resource by stimulating a change in consumers' behaviour.

Furthermore, it has been shown that metering and control systems with radio technology (according to class B systems EN 15232 [i.35]) will reduce total energy consumption by about 10 %.

The new requirements for time resolution for statistical data and control cannot be met without radio interfaces.

Figure 5 shows a "specific" SRD deployment in the home environment.

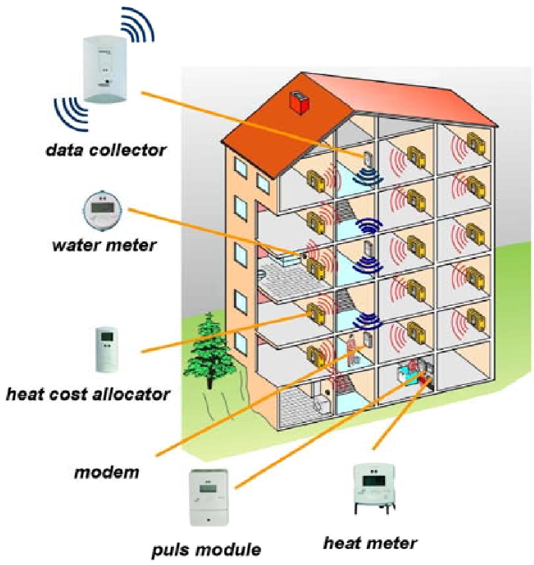


Figure 5: Scenario for specific SRDs

Due to the need for flexibility of use and low cost of installation, alarms also include radio devices and are battery powered. This holds not only for smoke detectors, but also for any kind of intrusion detection sensor, such as a PIR (passive infrared) sensor for motion detection.

In order to be compliant with European harmonized standards, developed under the mandates M/109 and M/139 of the European legislation Construction Products Directive 89/106/EEC [i.20], a minimum service life of 3 years (battery) is necessary for fire detection systems. It is also a legal requirement to provide a response time of less than 10 s and detection of defective devices within a few minutes.

Alarms also include personal alarms. See clause A.3.1 for market details.

7.2.2.4 Justification for automotive applications

Short Range Devices currently perform a variety of important functions in modern automobiles including keyless entry/immobilisation. In accordance with information provided by the European Automotive Manufacturers Association (ACEA), the existing passenger car fleet in Europe (ACEA: "Vehicles in use" in 2005) [i.32] consists of more than 250 million vehicles. By 2015 the number of vehicles in Europe is expected to increase to 400 million. Currently approximately 60 % of these vehicles are equipped with one or more SRDs. Approximately 6 million new vehicles are sold in Europe every year. 80 % of all new vehicles are currently equipped with SRD devices. Thus in future SRD equipment will be universally used by all vehicles on the roads in Europe.

In addition the variety of different SRDs used in vehicles is also increasing. This includes traditional remote keyless entry systems, which are developed further into passive entry systems and personal car communication systems. Also the adoption of safety related systems such as Tyre Pressure Monitoring Systems (TPMS) and Truck-trailer communication systems is increasing. In addition the deployment of security systems using SRDs is growing including vehicle alarm systems; diagnostic data exchange; freight protection and environmental systems. The adoption of short range communication services within the automotive industry is developing rapidly and is expected to grow further over the next 10-15 years. This is due to such factors as material savings, weight reduction, vehicle integration, safety, security, environment and comfort features. There is a general shift from car wired systems towards wireless communication, which offers improved comfort and convenience. This includes the introduction of integrated infotainment systems that are increasingly requested by customers.

The growing requirement for safety related devices, which are often mandated, increases the need for additional radio spectrum. To provide the increased reliability required for such applications, they should operate in a predictable sharing environment. This could be achieved by designating a sub-band of spectrum to a number of specified SRD services. Further work is needed, based on suitable scenarios, within the compatibility studies to be undertaken by the SE WG. This is applicable to both automotive and to other safety related services.

New active safety systems are required in vehicles and TPMS will be an integral part of measures required by the European Commission with the objective of achieving the EU policy targets for CO_2 emissions. By November 2014 TPMS systems will be mandated in all new vehicles.

A considerable number of malfunctions of the keyless entry systems are reported by customers and this trend will further increase as a consequence of the increase in general SRD applications operating in the existing frequency bands.

Access to new spectrum within the band 870 MHz to 876 MHz (see note of figure 3) provides the potential for a long term solution for automotive Short Range Devices.

8 Main conclusions

In order to achieve the commercial needs of the market, it is important that spectrum is made available as soon as possible. The ECC is therefore requested, as a matter of priority, to consider the designation of additional spectrum in the UHF frequency range for use by RFID and SRDs including those applications demanding a predictable sharing environment.

ETSI ERM TG34 intends to create a revision of the existing EN 302 208 [i.7] in line with the proposed changes and ECC study results.

ETSI ERM_TG28 intends to create a revision of the generic EN 300 220 [i.8] in line with the proposed changes and ECC study results. In addition, it is intended to generate a new harmonized standard for the specific SRDs as outlined in the present document.

8.1 UHF RFID

An up-to-date and comprehensive market study is given in [i.3] on the future size of the RFID industry. This study projects exponential growth for UHF RFID applications.

The need for high usage densities, higher data speeds, greater ranges, faster reading of increased numbers of tags, all require additional spectrum in a timely manner.

To satisfy the above requirements it will be necessary to designate more spectrums that will provide high performance reader channels.

An additional frequency designation in the range 915 MHz to 921 MHz is proposed for high performance RFID systems. This will harmonize the operation of RFID in Europe with many of the other major non-European countries as shown in figure A.1.

8.2 SRDs

Market studies have shown that the demand for SRDs is set to rise dramatically in response to end-user requirements.

Existing spectrum available for SRDs is insufficient to satisfy this growing demand, so an additional frequency designation in the range 870 MHz to 876 MHz as shown in figure 3 is requested.

CEPT Report 14 [i.12] and the "Collective Spectrum Use" Report [i.33], which were both prepared in response to a mandate from the EU Commission, have noted that additional spectrum will be required to accommodate the rapid growth of SRDs. A specific recommendation in both Reports advised that: *"New bands should preferably be extensions of SRD bands or close to them"*.

Furthermore the CEPT Report 14 [i.12] stated that *"Introduction of LBT and/or AFA in existing SRD bands is a first priority. However, any benefit from the introduction of LBT and/or AFA may be short lived if the anticipated growth in SRDs occurs. Therefore the identification of new spectrum for SRDs employing these techniques is a second priority"*.

Already the sale of devices in the Home and Building Automation sector is exceeding estimates in the CEPT Report 14 [i.12] by 25 % (see clause A.2 for market details). This rapid growth is expected to continue. Similarly information from the other non-specific SRD applications indicates that they will also continue to grow.

The rapidly emerging market for specific SRDs with their own particular technical requirements cannot be accommodated within the existing 868 MHz to 870 MHz band.

The combined effect of non-specific and specific SRDs will place increasing pressure on the existing band 863 MHz to 870 MHz leading in the medium term to an unacceptable level of performance.

8.3 Predictable sharing environment

Within the different industry sectors it is clear that a number of services, including in particular safety related systems, require a more predictable sharing environment than that available within the 863 MHz to 870 MHz band. This includes alarms, automotive applications, smart metering and different M2M applications.

By analysing the behaviour of short range devices used by different markets and by applying the same technical parameters and mitigation techniques across a number of services and functionalities, a more predictable sharing environment and more efficient use of spectrum could be achieved. Suitable scenarios need to be developed and considered within the SE WG compatibility studies.

This action is in line with the guidance document from the European Commission regarding the update of the technical annex to the SRD Decision of the European Commission [i.50] where it is indicated:

That in the fifth update of the SRD Decision the Commission requests the CEPT to ensure the definition of appropriate spectrum access rules that facilitate predictable sharing arrangements and foster the beneficial coexistence of spectrum users.

There are several possible solutions to achieve PSE within the SRD bands either for SRDs as a whole, or for certain specific services. For example a separate sub-band designated to meet the requirements for PSE would balance the spectrum requirements for NON-specific and Specific short range devices. Alternatively more general rules within the new band 870 MHz to 876 MHz might be achievable that would provide a more predictable sharing environment for all users.

The feasibility of the above options should be investigated in greater depth during the compatibility studies within WGSE-SE24. It may further be desirable to perform additional studies within the SE24 to determine if the conditions exist for a PSE in the band 915 MHz to 921 MHz.

Annex A: Detailed market information - Market size, Applications and requirements

A.1 RFID

A.1.1 Market evolution

Market forecasts indicate a very high growth rate for RFID applications. Some market studies are noted as follows:

1) The "*Final report from CEPT in response to the second mandate to CEPT to develop a strategy to improve the effectiveness and flexibility of spectrum availability for SRDs*", Chapter 6 entitled: "*Short Range Device Industry: Market and Technology Trends*" [i.12].

2) The Bridge study "European passive RFID market sizing 2007 - 2022" [i.3].

3) IDTechEx: Evolution of RFID, 1,71 billion tags sold in 2007, 2006-2017 from $2,77 billion to $27,88 billion [i.5].

4) RFID questionnaire to end users as well to the RFID industry. See clause A.3.

5) Excerpt from EC "Towards an RFID Policy for Europe":

   "*….cumulative sales of RFID tags have totalled 2.4 billion over the past 60 years, with 600 million tags being sold in 2005 alone, the value of the market, including hardware, systems and services, is expected to be multiplied by 10 between 2006 and 2016. The number of tags delivered in 10 years will be over 450 times the number actually to be delivered this year*" [i.9].

The European Commission is funding the BRIDGE project (Building Radio frequency Identification solutions for the Global Environment) [i.3].The project will develop easy-to-use technological solutions for the European business community including SMEs. This will ensure a basis for collaborative systems for efficient, effective and secure supply chains.

Based on the market analysis carried out under the BRIDGE project, it is predicted that in five years more than 170 000 RFID readers will be deployed in Europe at 30 000 locations. During this period these readers will process a total of about 3 billion tags. These numbers will grow significantly and by 2022, it is expected that more than 6 million readers will be operating at 450 000 locations, with about 86 billion tags purchased annually.

It is believed that these numbers are conservative, as they only represent a small percentage of the total potential number of objects that can be tagged. For example, the forecast is based on the estimate that in 2012 approximately 2 % of all items in retail will be tagged. In 2022 the forecast is that roughly 25 % of all non-food items and 5 % of all food items in retail will be tagged. If we experience a technology breakthrough in the next fifteen years that reduces the cost of an RFID tag to less than one cent, these numbers could increase dramatically. In particular the number of tags on food items could grow to hundreds of billions.

The European Commission has published the results of a consultation "The RFID Revolution" [i.2] stating that the present designation of spectrum for RFID at UHF is considered sufficient for the initial deployment of RFIDs but will be inadequate once the technology becomes ubiquitous.

Another publication by the Commission notes: "*Current trends and forecasts indicate that the RFID market will grow fast in the next 10 years. While cumulative sales of RFID tags have totalled 2.4 billion over the past 60 years, with 600 million tags being sold in 2005 alone, the value of the market, including hardware, systems and services, is expected to increase by a factor of 10 between 2006 and 2016. The number of tags delivered in 10 years will be over 450 times the number actually to be delivered in 2007*" [i.9].

The shortage of spectrum for UHF RFID in the medium and long term will arise due to:

- The proliferation of the RFID technology in industry, manufacturing, logistics and many applications in daily life.
- The need for higher data transmission speeds which requires larger bandwidth. This is necessary for reliable reading of data and also for writing data to tags.
- The penetration of "lossy" objects or packaging materials in stacks or pallets requires higher power and/or multiple reading at higher data transmission speeds providing redundancy in order to enhance reading performance. This applies especially in applications with fast moving goods like conveyor belts or production lines.

New RFID frequency designations will be needed to provide additional capacity for present systems. In addition they should offer improved performance to meet the needs of more demanding applications. Preferably they should operate at around 915 MHz where RFID tags are optimized for global markets. A possible European frequency band outside the cluster of bands around 915 MHz would suffer a loss in performance (see figure A.1).

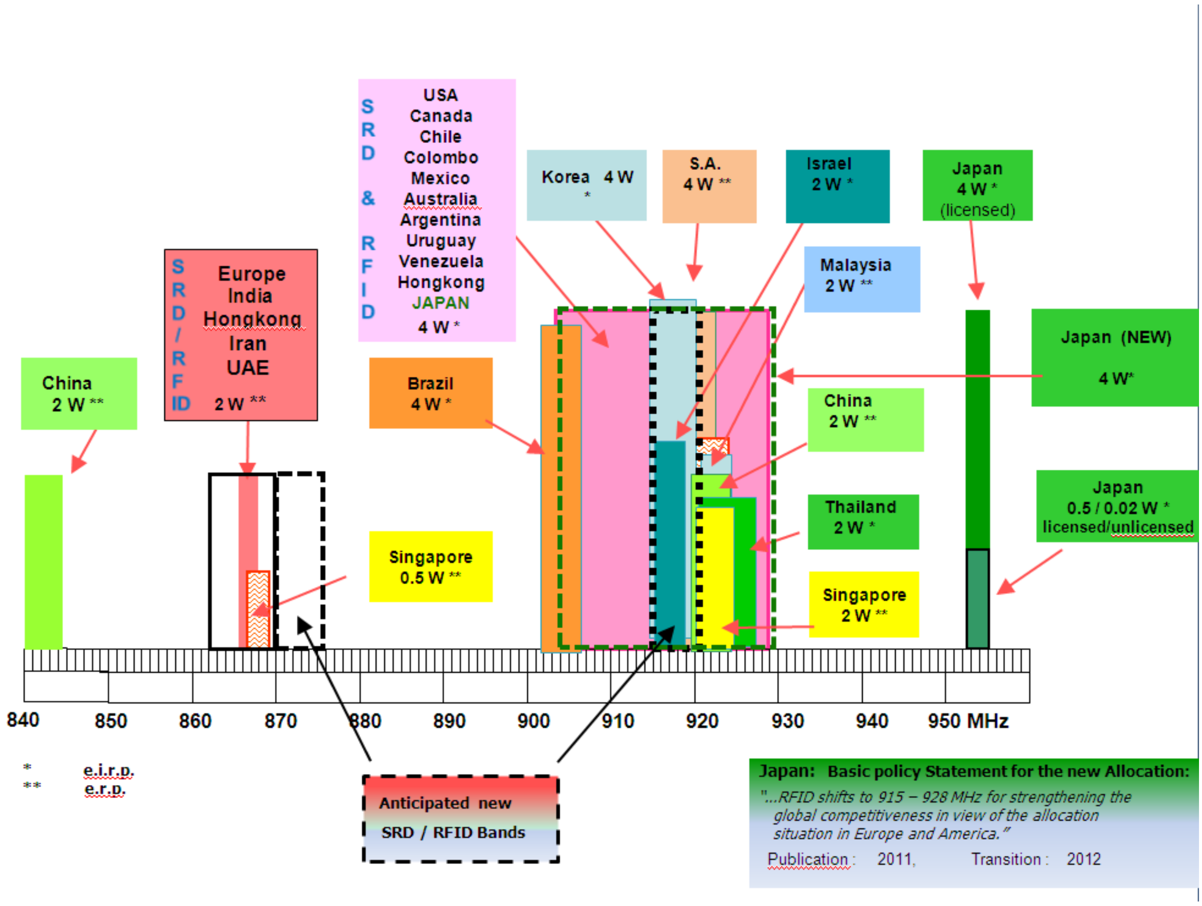
When considering a new frequency designation for RFID, the following criteria have to be considered:

- The designated spectrum for UHF RFID in many other countries outside of Europe is considerably larger than in Europe. Also UHF RFID in Europe operates in a lower frequency band than used by other major trading countries.
- A reader bandwidth of more than 200 kHz is needed in applications using higher data speeds or reading larger numbers of tags. Typical examples of such applications include rapidly moving conveyor systems and pallets carrying large numbers of tagged items.
- To compete with global performance in reading reliability, range, object penetration and also to be competitive in the global environment, sufficient spectrum for RFID should preferably be designated within the range of 900 MHz to 930 MHz. If not European industry will suffer a degradation in range, reading reliability and speed as compared to the countries which have allocations around 915 MHz.

A list of potential applications for RFID is provided below:

- automatic article identification;
- asset tracking;
- airline baggage handling;
- security and alarm systems;
- waste management;
- proximity sensors, anti-theft systems;
- location systems;
- data transfer to handheld devices;
- automotive and general manufacturing automation;
- wireless control systems;
- transport and logistics;
- military;
- libraries;
- medical and hospital applications;
- postal services;
- e-government.

A diagram showing the present designation of spectrum for RFID in Europe in relation to the frequencies used for RFID by the other major trading countries is given below in figure A.1. It will be seen that the frequencies used in Europe are separated by almost 50 MHz from the band that has most generally been adopted by the other regions.



Legend for power levels: e.i.r.p. *, e.r.p.: **

Figure A.1: Proposal for harmonization of RFID in Europe with the other Regions

Given the growing global deployment of RFID, there is no doubt that performance will continue to improve and tag prices will come down leading to yet further adoption of the technology. It seems highly likely that, in the future, RFID at UHF will become an integral part of business in Europe and other major industrialized countries. This will lead to an installed base of millions of interrogators reading billions of tags each year. Furthermore Europe is embedded in the global trading, and manufacturing environment. It is thus important that Europe conforms as far as possible to global trends.

Requirements

According to a recent survey [i.9], the logistics' industry and RFID system providers have stated that:

- The density of RFID tags in a typical load or transport unit can be up to 1 000 to 1 500 tagged objects. The separation between tags typically can be between 2 mm and 3 mm to 30 cm.
- According to the application the minimum separation between fixed interrogators as well as hand/mobile readers can be between 0 meter to 1 meter. This means that multiple channels are required in order to avoid tag to tag cross-interference.
- The reading range should be up to 9 meters.
- The time available for reading all tags in a bulk/pallet environment varies from 0,5 s to 2 s max. Also the data carried by a tag can vary from 96 bits to 256 bits.
- Acceptable reading performance on a pallet should approach 100 %. This requires higher power as well as high data rates for increased read redundancy.
- Additional features (e.g. monitoring of temperature, shock, humidity, pressure,) will be used in critical applications to assure the condition of delivered goods. This may require higher power and much increased data capacity.

- The performance of European RFID systems and tags should match global performance. Presently this cannot be guaranteed since European frequencies and power levels do not provide comparable reading performance to e.g. US, SA, Far East, Canada and South American countries.

A.1.2 Questionnaire on RFID

A Questionnaire was circulated by TG34 to system integrators and end users in order to obtain supplementary information not included in the marketing studies. In particular it was necessary to know the densities of RFID interrogators that are likely to exist on busy sites and the extent to which these interrogators will be fixed or portable devices. The report on the survey is available as input document 17_07 at the ERM_TG34 docbox and is called "Analysis of replies to Questionnaire on RFID" [i.30].

The principal conclusions from analysis of the responses to the Questionnaire are summarized below:

1) The responses were unanimous that RFID would lead to a reduction in costs and improved levels of efficiency within their business. These benefits will flow through to customers.

2) All of the respondents focussed their attention on the use of RFID for logistics and materials control. However it seems probable that over the next 15 years a much more varied range of applications will emerge.

3) Consideration should be given to channel planning in order to ensure that the predicted high densities of interrogators can co-exist satisfactorily.

4) The maximum reading ranges of up to 15 meters requested by end users will not be achievable with passive tags. This would require transmit levels in excess of 10 W e.r.p., which would be unacceptable to regulators and would also raise concerns over health and safety. It active tags are used at these ranges, it will be necessary to review their maximum permitted output levels.

5) A few end users requested the ability to read at rates of up to 2 000 tags per second. If a link frequency of fc ± 1 000 kHz is selected this will permit a reading rate in excess of 800 tags per second for tags holding 96 bits of data. However in practice some redundancy in the reading process is necessary so this figure will probably not be achieved in practice. The reading rates will thus be lower than those requested by some end users.

6) It seems very probable that in future tags will be introduced that will include sensors.

A.2 Non-specific SRDs

A.2.1 Market evolution

There is a strong market demand for non-specific SRDs in almost all areas of daily life including the enhancement of safety measures and caring e.g. for handicapped and elderly people.

As stated in clause 7.2.2.2 SRD market studies were conducted during 2005 to 2006 by the major European industry associations i.e. EICTA and LPRA. These studies included the detailed analysis of replies to questionnaires from association members. EICTA also sent questionnaires to all EU National Industry Associations. The results from this work provided a major contribution towards the section in CEPT Report 14 [i.12] called *"Short Range Device Industry: Market and Technology Trends"*.

CEPT Report 14 [i.12] was prepared in response to a mandate from the EU Commission to develop a strategy to improve the effectiveness and flexibility of spectrum designation for SRDs.

Similar market studies and investigations were conducted by a consortium of consultant firms (i.e. Mott MacDonald Ltd, Aegis System Ltd and Indipen) who also produced a Report on "Collective Spectrum Use" [i.33] in response to a mandate from the EU Commission.

Both Reports have demonstrated that additional spectrum will be required to accommodate the rapid growth in SRDs. In that regard a specific recommendation in both Reports advised:

"New bands should preferably be extensions of SRD bands or close to them".

Furthermore the CEPT Report 14 [i.12] stated:

"Introduction of LBT and/or AFA in existing SRD bands is a first priority. However, any benefit from the introduction of LBT and/or AFA may be short lived if the anticipated growth in SRDs occurs. Therefore the identification of new spectrum for SRDs employing these techniques is a second priority".

Several million SRDs have been installed by the Home and Building Automation industry using LBT and AFA. The industry reports that this technique is performing very satisfactorily.

Already the sale of devices in the Home and Building Automation sector exceeds estimates in the CEPT Report 14 [i.12] by 25 % (see clause A.1.2 for market details).

Other non-specific SRD applications will continue to grow at a steady rate from a significant base. For example telemetry is producing an annual turnover of approximately € 1 000 million. The combined effect of Building and Home Automation together with these other applications will place increasing pressure on the existing band 863 MHz to 870 MHz leading in the medium term to an unacceptable deterioration in performance.

A non-exhaustive list of applications for SRDs using either duty cycle or LBT + AFA (or equivalent techniques) is provided below.

- Home and Building Automation (some examples):
    - Lighting control.
    - Shutter control.
    - Awnings and blinds control.
    - Windows, doors and gates openers control, garage doors.
    - Electrical door lock systems.
    - Heating regulation.
    - Air conditions control.
    - Swimming pool surveillance and control.
    - Ventilation.
    - Combined scenarios.
    - Presence Simulation.
    - Automatic controls for comfort energy saving and security purposes.
    - Sensors (temperature, wind, light, rain).
    - Presence monitoring.
- Telemetry and telecommand (some examples):
    - Pumping station monitoring.
    - Electricity network monitoring.
    - Crane and machinery control.
    - Oil industry installations.
- Mixed speech and data (some examples):
    - Wireless door entry.
    - Alarm ambiance background scanning.
    - Baby and elderly monitoring.

- Access control (some examples):
  - Disabled persons access.
  - Security applications.
- Machine to Machine (some examples):
  - Remote data collection (state of machines).
  - Remote control (management).
  - Real time telemetry of sensors.
  - Remote payment.
  - Remote restaurant/bar customer orders data collection.
  - Portable Bar Code Scanner.
- Aviation and Maritime applications (some examples):
  - Remote data maintenance collection (service information of aircraft downloaded while taxiing).

A.2.2 Home and Building Automation

The European Home and Building Automation market includes applications such as shutters, terrace awnings, blinds and curtains, electrical door locks, electrical windows, garage door and gate openers, heating control, lighting control, etc.

For the last decade, the above applications have mainly been used as stand-alone devices, where users controlled only a single device at a time - *e.g. up, down, stop for a shutter or an opening/closing a door*. Simple command protocols were used.

Now the need for more **comfort**, more **security** and a strong emphasis on **energy saving** require the use of advanced system control protocols. These protocols permit the use of dynamic functions that coordinate the operation of actuators though advanced automatic controls and sensors - *e.g. a feature that is currently in high demand is the "indoor climate control" where the air inside the house remains healthy and fresh with a minimum of energy loss. When the humidity exceeds the desired level, specified roof and vertical windows are opened for a short period.*

The wide range of applications falling under Home and Building Automation represents the main market area for non-specific SRDs. Initially many devices, such as shutters and garage doors were mechanical. Today at least 50 % of shutters and 70 % of garage doors are controlled remotely using SRDs. With the arrival of low cost chip sets the industry has largely migrated to the use of LBT + AFA due to the superior performance of this technology and its ability to operate in congested environments.

By 2003/2004 the Home and Building Automation industry had already installed large volumes of first generation RF products based on unidirectional communication and Duty Cycle techniques. These first generation products provided simple and convenient control of electrical blinds, shutters, doors, etc.

Sales of Home and Building Automation devices in 2005 and 2010 are outlined in the CEPT Report 14 [i.12].

Table A.1: Sales of Home and Building Automation

Parameters	2005	2010
SRD units supplied annually	5 million	10 million
Systems installed to date	10 million	70 million
Annual Turnover	€ 10 000 million	€ 15 000 million
Work force	1 million	2 million

As the market matures volumes will rise and functionality will increase. France, Spain, Italy and Benelux now represent mass markets where customers purchase sophisticated Home and Building Automation systems, In these countries home automation systems already exceed 50 % of electrical equipment in buildings. In 2006 the European SRD industry installed around 15 million Home and Building Automation devices and a further 20 million alarm systems. The growing density of these devices means that co-existence will become of increasing importance.

During 2007 Home and Building Automation manufacturers sold more than 17 million devices, **which exceeded by 25 % the prediction in CEPT Report 14 [**i.12**]**. This growth was achieved as a consequence of considerable investment by manufacturers. Market data shows that this trend will continue. Therefore the number of units installed by 2010 will exceed by 25 % the forecast of 70 million devices in CEPT Report 14 [i.12].

Nowadays the need for more **comfort**, more **security** and a strong emphasis on **energy saving** requires the use of sophisticated system control protocols. These protocols permit the use of dynamic functions that coordinate the operation of actuators though advanced automatic controls and sensors - *e.g. a feature that is currently in high demand is the "indoor climate control" where the air inside the house remains healthy and fresh with a minimum of energy loss. When the humidity exceeds the desired level, specified roof and vertical windows are opened for a short period.*

When a Home and Building Automation system is installed in a residential house, it typically comprises fifty nodes (15 shutters, 2 garage door opener, 1 gate opener, 2 electrical door locks, 2 terrace awnings, 4 roof windows, 2-5 electrical vertical windows (ventilation control), 1 intrusion alarm, 8 heating zones and a dozen lighting terminals) This represents a sophisticated control system requiring advanced two-way communications (see figure A.2).

Such a system allows a user, who is leaving the home, to close down the system by means of a single command. This command might for example lock the door, set the alarm, close the shutters and reduce the heating level.

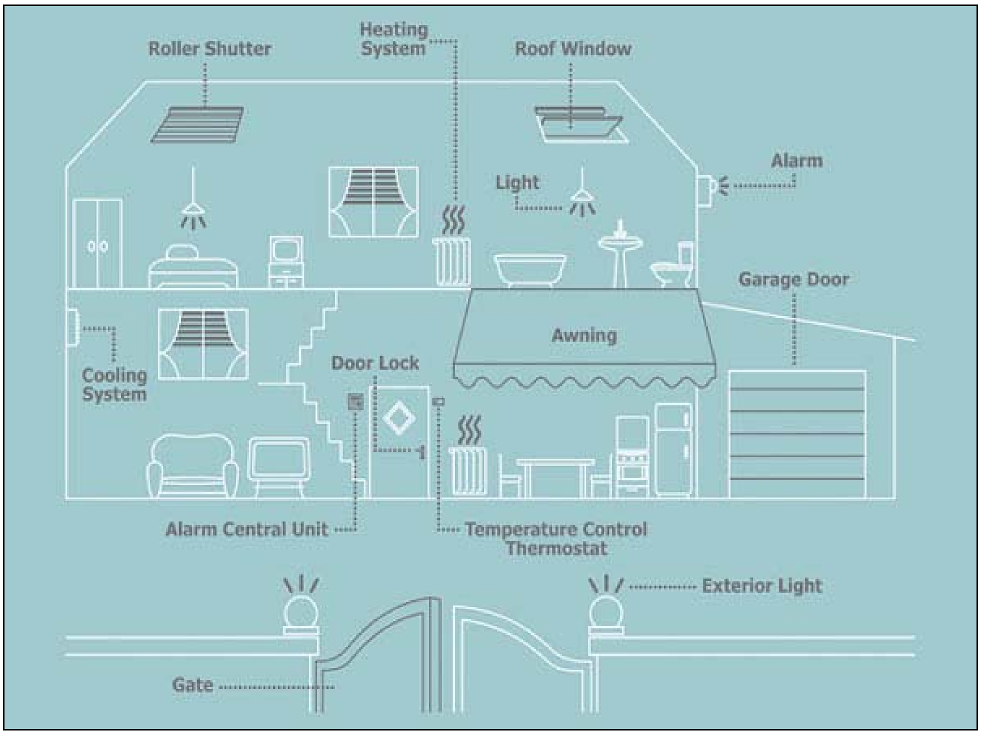


Figure A.2: Home and Building Automation applications

Figure A.3: Examples for Home and Building Automation

With growing interest in energy saving, home automation systems will place increasing emphasis on natural environmental control. This will include more use of automatic ventilation, solar panels and other similar techniques. Lighting will also form part of the home automation system since it can be used to provide energy savings and improved security.

The latest version of EN 300 220 [i.8] recognizes the continued need for low-end, low-cost products while also specifying advanced techniques for use in next generation products.

Technological facts

Home and Building Automation applications require:

1) **Short latency:** a rapid response to transmitted commands is essential.

2) **Signal transmission reliability:** the control address should be guaranteed to reach the target.

3) **Point-to-point communications** should be able to cover a whole building environment without recourse to the use of repeaters.

4) Control devices are mainly **battery powered** (or similar) with 5 years to 10 years lifetimes to virtually eliminate the need for regular maintenance (inside walls and ceilings).

5) A **medium data rate** in the range of a few tens of kilobits per second (kbps) e.g. 19,6 kbps to 38,4 kbps, that represents a balanced compromise between acceptable current consumption, radio range and functionality.

6) **Duty cycle rules that ensure sharing** and allow a dialogue between the controllers (wall switches, remote control, IP gateway, etc.), the actuators (windows, heating boiler, lighting, etc.) and the sensors. While a usage pattern cannot be predicted, typically it would be low (< 1 %).

Technologies above 1 GHz are unsuitable due to the poor propagation inside buildings. An operating frequency in the 863 MHz to 870 MHz and 433 MHz bands is therefore necessary.

Up to 2003/2004 home automation applications were mainly designed with one-way communication and a low duty-cycle (433,92 MHz). This provided only a limited set of controls for the application.

These old systems are being replaced by a new generation of bi-directional systems which offer increased benefits. Operation in the band 870 MHz to 873 MHz using LBT and AFA brings the following benefits:

- The ability to operate on any one of a number of channels provides greater reliability and low latency.
- When combined with stringent transmission time control, LBT with AFA provides an efficient mitigation technique that allows coexistence between multiple systems.

Home and Building Automation systems are designed with an efficient link budget using at least category 2 receivers. Typically a transmitter power of less than 25 mW e.r.p. is adequate, requiring a receiver sensitivity is in the range of -105 dBm or better.

This allows the end-user direct point-to-point control of all actuators within his premises from his roof window to his garage door in the basement. This is necessary since customers are unwilling to pay the added cost for repeaters.

A.2.3 Various non-specific SRDs

Other applications of non-specific SRDs include:

- Telemetry and telecommand.
- Mixed speech and data.
- Access control.
- Machine to machine.
- Aviation and maritime.

Some examples of applications for these other non-specific SRD sectors are given below.

Many of the above non-specific SRD sectors have adopted LBT with AFA due to the operational benefits and the increased availability of low cost integrated circuits.

The descriptions and views expressed in CEPT Report 14 [i.12] are still largely valid.

Non-specific SRD applications in the band 915 MHz to 921 MHz are also proposed subject to a positive outcome from the spectrum sharing study. The major potential benefit for SRDs would be the ability to operate at higher powers than are possible in the bands 863 MHz to 870 MHz and the new sub-band above 870 MHz. This may be beneficial for example for some telemetry applications that would be prepared to share the spectrum using polite techniques such as LBT + AFA (i.e. if a channel is occupied by RFID, the SRD will move to an unoccupied high power channel). From a spectrum policy point of view, this approach is consistent with the EC (RSCOM) and CEPT objectives, which seek to broaden the types of equipment that may operate within a single band. This contrasts with the present rigid sub-bands within the band 868 MHz to 870 MHz, which are each devoted to a specific application. A market trend similar to Home & Building Automation applies to other non-specific SRD applications. Major examples include:

- Telemetry and telecommand (some applications):
  - Pumping station monitoring.
  - Electricity network monitoring.
  - Crane and machinery control.
  - Oil industry installations.

- Mixed speech and data (some applications):
  - Wireless door entry.
  - Alarm ambiance background scanning.
  - Baby and elderly monitoring.
- Access control (some applications):
  - Disabled persons access.
  - Security applications.
- Machine to Machine (some applications)
  - Remote data collection (state of machines).
  - Remote control (management).
  - Real time telemetry of sensors.
  - Remote payment.
  - Remote restaurant/bar customer orders data collection.
  - Portable Bar Code Scanner.
- Aviation and Maritime applications (some applications):
  - Remote data maintenance collection (service information of aircraft downloaded while taxiing).

Summarizing:

Congestion in 868 MHz to 870 MHz band will increase with the growth not only of Home and Building Automation but also of the above sectors (For example, telemetry is producing an annual turnover of approximately € 1 000 million).

The conclusions reached in the CEPT Report 14 [i.12] on the above non-specific SRD applications are still largely valid.

Many of these applications have already adopted frequency agility and LBT techniques in the 868 MHz to 870 MHz spectrum due to the rapid availability of components at low cost.

A.3 Specific SRDs

The predicted growth rates for SRD applications in the field of metering and alarms will lead to a mass market for these devices. Prominent applications include Residential Metering Alarms and Energy Control.

There is a requirement for approximately 3 MHz of spectrum (see figure 3) in the specific SRD band to be designated for use by Residential Metering, Alarms and Energy Control. This will be shared with Automotive using only duty-cycle mitigation techniques.

It has been determined that these applications can co-exist within the same spectrum, given the inherent geographical separation between their normal areas of operation as well as the very low duty cycles involved.

The following is a non-exhaustive list of applications that covers Metering, Alarms and Automotive applications and includes:

- Alarms:
  - Portable personal security alarms.
  - Intruder alarm systems.
  - Change of state alert.

  - Leakage detection alert.
  - Smoke warning and fire detection device.

- Metering:
  - Heat and water cost allocation.
  - Heat consumption metering and usage monitoring.
  - Metering device monitoring.
  - Energy and water control applications.
  - Hot and cold water metering.
  - Leakage detection.
  - Gas, oil and electricity metering and usage monitoring.
  - Continuous smoke detector status monitoring.

A.3.1 The range of Metering and Alarms Applications

Currently consumption based billing is applied in more than 25 million dwellings. According to an analysis by the Association for Energy Cost Allocation (EVVE), the total market size is about 49 million dwellings. The number of meters used for consumption based billing varies from region to region depending on climatic conditions, the services offered, building's standard, etc. At the moment about 125 million Meters are used for heat and water cost allocation and this number is expected to double within the next 10 years.

Battery operation is a requirement due to the metering points being on radiators, water and heating pipes and ceilings (for HSDs). For economic use of the equipment, the market requires a service life of at least 10 years.

For most devices, the capacity of the battery is below 1,3 Ah. Less than half of the capacity is available for the radio interface. This means that average currents for the radio circuit are below 7 µA.

To minimize power consumption the maximum duty cycle of the transmitters in the meters is less than 0,1 %. However data collectors have to communicate with multiple devices and therefore should operate at duty cycles of between 0,1 % and 1 %.

To circumvent the high internal resistance of the small long-life batteries, buffer capacitors are used to supply the peak currents necessary during transmission. The size of the capacitors and the required transmit power limits the transmit time. This means that the transmit time should be very short, which requires a data rate in the range of 100 kbit/s. Taking into consideration the environmental and design constraints, this leads to channel bandwidth requirements of 250 kHz (see clause B.2).

The electronic compartment of a typical metering device is less than 15 cm long and the area is less than 80 cm^2. This space should accommodate the printed circuit board, battery and antenna. Both the metering circuit and the radio interface have to fit on the same printed circuit board. The limited space means that the device is not suited to frequencies below UHF.

As the metering devices will be distributed over the whole building, transmission through multiple walls is required in order to communicate with the data collectors. Due to the limited power available and the significant increase in attenuation with frequency, the required range cannot be achieved above 1 GHz. So, significantly higher frequencies are not suitable.

For efficient use of metering equipment, the distance between metering devices and data collectors is in the range of 15 meters to 25 meters, which corresponds to the distance across a typical residential building. A typical propagation path will pass through 3 to 5 walls. It has been found in practice, that 10 to 25 mW e.r.p. provides adequate propagation without overshooting into neighbouring dwellings.

Today 12 % of the installed meters are equipped with a radio interface. Due to changing requirements the market share for meters with radio technology is rapidly growing. The long service life of 5 to 10 years will ensure the continued long term growth of meters with radio interfaces. Members of the EVVE expect a market share of 66 % by 2017.

Figure A.4: Wireless detector devices

With the installation of growing numbers of smoke detectors, the density of monitoring devices in buildings will progressively increase. To simplify their monitoring and maintenance, it is probable that many of them will be interlinked by radio. To meet the requirements of the EC Legislation Directive 89/106/EEC for construction products [i.20] together with new regional building regulations, two harmonized standards (EN 14604:2005 [i.21] and the new EN 54-25:2008 [i.29] have been published. These standards have triggered interest amongst alarm service providers in offering home smoke detectors. Members of the E.V.V.E. expect to have more than 24 million Smoke alarms with radio technology in the market in the next 10 years.

A market study issued by Frost & Sullivan in 2006 [i.6] identified one of the key factors driving the European security market as follows:

"Wireless technology - The many advantages of wireless technology makes it one of the key drivers propelling the European residential security market. In 2005, wireless equipment made up for more than 50 percent of the total security intrusion alarms installation. Wireless is especially popular in retrofit and stimulates replacement".

This study included not only intrusion alarms, but also fire detection and smoke warning devices used for residential applications.

A.3.1.1 Metering and Alarms Details

Already there are more than 15 million devices installed with a market potential of a further 165 million devices. One of the most important applications is telemetric measurement of water and energy consumption by energy service providers.

The commitment to the Kyoto protocol in 1998 [i.16] has resulted in several measures being taken by the EU to reduce CO_2 emissions. According to the European Parliament, 40 % of the total consumption of primary energy is caused by buildings and the tertiary sector [i.17]. That is why energy savings in buildings will contribute significantly to the overall energy efficiency. The EC Directive on energy performance of buildings says:

"Increased energy efficiency constitutes an important part of the package of policies and measures needed to comply with the Kyoto Protocol and should appear in any policy package to meet further commitments" [i.17].

The EC directive 2006/32/EC on energy services [i.18] requires member states to ensure the provision of statistical information about the energy consumption of the end user. This means measurement of energy and water consumption using metering at many different points within individual dwellings. It is known that metered billing of services encourages users to reduce their energy consumption.

Residential metering, also known as sub-metering, cannot be provided with the required time resolution without telemetry. Therefore radio communication is becoming an important feature in the metering business. Currently more than 15 % of the market is equipped with radio interfaces and the market is growing rapidly. Sub-metering is already provided in about 25 million dwellings, equivalent to 50 % of the potential market in the EC.

For most devices, the capacity of the battery is below 1,3 Ah. Less than half of the capacity is available for the radio interface. This means that average currents for the radio circuit are below 7 µA.

To minimize power consumption the maximum duty cycle of the transmitters in the alarms is less than 0,1 %. However communications gateways have to communicate with multiple devices and therefore should operate at duty cycles of between 0,1 % and 1 %.

In addition, to circumvent the high internal resistance of the small long-life batteries, buffer capacitors are used to supply the peak currents necessary during transmission. The size of the capacitors and the required transmit power limits the transmit time.

In order to achieve maximum flexibility over acceptable distances, wireless alarm systems may use multi-hop or meshed networks. A drawback of such systems is the reduced response time per hop, which makes it difficult to comply with the regulations. This problem may be overcome by the use of higher data rates, which inevitably means more bandwidth.

It is not possible to operate alarm systems acceptably in situations in which they share the band with other devices that may transmit for extended periods (say up to 2 s). In such circumstances alarm systems would have to use much higher duty cycles in order to meet the required response time. This would reduce their battery life to unacceptable levels. Alarm systems should therefore operate in bands that only permit the use of equipment with short duty cycles and low transmitting power. Due to the quantity of data transmitted, and since the energy consumption of a device is proportional to the transmission time, data rates in the range of 100 kbit/s are needed. Taking into consideration the environmental and design constraints, this leads to channel bandwidth requirements of 250 kHz.

The dimensions of the housing of a typical fixed installed alarm device is less than 100 mm in diameter and height, which should contain the detector part including sounder, radio module, battery and antenna. This tight restriction on space means that the device is not suited to operate at frequencies below UHF because of the size of the antenna. The required range cannot be achieved at frequencies above 1 GHz due to the limited transmit power of the device and the significant increase in attenuation through walls. So, higher frequencies are also not suitable.

Figure A.5: Wireless smoke detector

Currently regional building regulations in Europe require the installation of home smoke detectors to reduce the number of people killed and injured in fires.

Modern commercial home smoke detectors offer a radio interface to interlink the various detectors within the dwelling to provide enhanced protection for vital escape routes. Long term reliability needs adequate monitoring and maintenance. Metering service providers are ideally placed to offer this service, which can effectively be provided by using the same radio system as used by metering.

For efficient use of the spectrum, the interface for both metering and alarm equipment, should preferably be compatible and use the same radio band. A total provision, installation and maintenance package can then be offered by metering service providers, using the same infrastructure as for energy metering and cost allocation.

At present, all metering applications use the frequency range 863 MHz to 870 MHz, as identified in ERC Recommendation 70-03 [i.4] for non-specific SRD devices. Two factors have changed the situation:

- The sub-bands identified for non-specific SRDs now have LBT + AFA sharing criteria, whereas previously sharing was effected by means of duty cycle. Energy metering devices have long-life lithium batteries, which can operate over very long periods by transmitting at very low duty cycles. The use of LBT would put additional strain on the batteries and significantly reduce their life. At the same time it would be extremely difficult for other LBT devices to detect metering applications where the transmitted telegram would be 1 ms to 40 ms in length and the probability of listening is less than 1/100 whereas the transmit time can be more than a second for LBT devices. This would lead to severe blocking in communication.

- The present SRD sub-bands are becoming more congested and with FHSS and DSSS devices, the noise floor is becoming higher. It is foreseen that there will be insufficient spectrum available to cater for future growth in this market.

The above factors all indicate that the present spectrum for metering is not sufficient and the spectrum for alarms is presently too restrictive. Metering and alarms could share spectrum with automotive and other duty-cycle-only applications.

The installation of smoke detectors is known to reduce the number of people killed or injured by smoke and fire. However, recent research has found that the number of casualties is increasing due to the lack of maintenance (e.g. depletion and/or removal of batteries, etc.), which has rendered the alarms ineffective. This trend can be reversed by the provision of a radio interface to enable monitoring and maintenance This will increase reliability and help to maintain the operational readiness of the alarms. If a fire detector interlink fails due to blocked communications it could result in injury and serious damage to property.

Range

Typical transmission ranges from the remote device to the data collector will be 15 meters to 25 meters, passing though 3 to 5 walls.

Density

On average, a typical dwelling will have between 3 meters and 7 meters. Alarm systems in typical residential installations can include around 20 detectors and activators (smoke, motion, silent alarm buttons, alarm indicators).

Typical data transmitted

The data generated by the meters can include a wide variety of parameters, which can be transmitted to the data collectors. For example, but not limited to, the data may include:

- Consumption.
- Flow temperature.
- Return temperature.
- Errors status.
- Date and Time.
- Transmission type.
- Time of next transmission.
- ID-Number.
- Tariff.
- Alarm status.
- Volume flow.
- Power.

Figure A.6: Wireless heat allocator

Time resolution

For metering and alarm systems, monitoring and control will be performed, on average, once every 2 minutes. Statistics will be gathered, on average, once per day. For alarm systems monitoring intervals can be as short as 10 s for both intrusion and fire detection systems.

Commercial justification

Commercially, Metering and Alarm applications offer:

- High NRE for the metering equipment.
- Long term operation.
- High reliability.
- Rapid response since for intrusion and fire detection systems.
- Monitoring intervals can be as short as 10 s.

Figure A.7: Wireless metering device

In contrast to the other applications in the SRD spectrum, the requirements for alarm systems can be summarized as follows:

- legislation and regulations concerning response time and system life time exist;
- simple and flexible installation of the system, which makes battery operation necessary;
- small ratio of overhead messages in order to extend battery life.

A.3.1.2 Portable alarm details

People working in high-risk environments (such as health care institutions, detention centres or businesses with large compounds) regularly face potential dangers. Rules issued by insurance companies often require tight monitoring of these people, since delay in providing assistance in cases of unforeseen incidents or accidents can be a threat to health and life. Carrying a "personal security" device provides extra safety by means of a manual or automatic alarm to detect a life threatening situation without user intervention, e.g. "no-move", "man-down" or "tear-off".

No dedicated frequency band has yet been designated for ***portable*** alarms. Until now several *non-harmonized* VHF- and UHF-frequencies of the legacy on-site paging standard have to be used. This has the advantage of being interference-free, but has the big disadvantage that for each site in each country a customer-specific frequency should be arranged, together with the corresponding site license.

Goal: to give fast supportive action in emergency by:

- offering help during daily work and emergencies when a person presses the alarm button on his portable alarm device. (manual alarm event; contains also location of person in alarm);
- generating an alarm when the user of a portable alarm device has a "no-move", "tear-off" or "man-down" situation. (automatic alarm event; contains also location of person in alarm);
- location tracking of a person in an alarm situation.

Figure A.8: Portable alarm equipment

System Features:

- Personal Security Management system with downlink to portables.
- 10 to over 1 000 portables with low-power uplink to one or more central receivers (Typically Category 1 as specified in EN 300 220 [i.8]).
- Uplink range is limited due to battery powered transmitter with (low efficiency-) internal antenna, and human body effect- plus multi-wall attenuation of building; typical range is 100 meters to 250 meters.
- System should cover from small (e.g. laboratory) to large areas (e.g. prison, hospital), but always be restricted to "on-site".
- An alarm event should reach the central (host or control unit) within 2 s.
- The portable should be monitored at least every 10 min.
- Short uplink telegrams comprising "events", to be acknowledged by the central control unit.

Relevant regulations:

- See Directives 98/34/EC [i.36] and 98/48/EC [i.37].
- Residential Security Markets [i.6].

Below are some application examples:

Lone workers

Industry

Prison guards

Health care

Figure A.9: Portable alarm applications

A.3.2 Automotive Applications

A wide range of vehicle applications and services for safety and comfort systems have been identified by the automotive industry and presented by ACEA/CLEPA to the ECC SRD/MG in document SRD_11_096 [i.49]. These requirements should be part of the activities covered by the roadmap, which was agreed by the ECC for extension of the frequency bands for RFID and SRDs. The frequency requirements listed in this annex are focused on the bands 863 MHz to 870 MHz and the extension bands 870 MHz to 876 MHz/915 MHz to 921 MHz. As mentioned in the input document SRD_11_096 to the SRD/MG [i.49], other new applications such as Wireless Cameras require spectrum within frequency bands outside the UHF bands and are therefore not mentioned in the present document.

The communication requirements are divided into two basic categories which will be gradually implemented in vehicles over the next 10-15 years:

- Safety related applications with operational requirements for low latency and requiring a predictable sharing environment.
- Comfort systems, which do not have a requirement for low latency and could therefore be operated within both new and existing UHF bands for Short Range Devices.

Table A.2 includes a description of the vehicle applications with operational requirements and available technical parameters and regulatory comments where available. In practice it is not possible for the automotive industry to decide and specify innovative applications and functions 15 years in advance of the start of the development of a new vehicle.

The vehicle production life cycle and the inter-linked standardized development, process, which needs to be followed by the vehicle manufacturers, does not enable the OEMs to specify the technical details much before starting their development process. During the development phase of their SRD devices, the specification may vary in order to optimise performance.

Table in A.2: Current and future automotive applications and services

Functionality	Short Description	Category and comments	Operational requirement	RF interface
Active Safety	Cooperative communication (vehicle to vehicle V2V) and vehicle to infrastructure (V2I) for certain advanced safety and traffic efficiency applications requiring UHF propagation conditions e.g. looking around corners. This band is not intended to substitute 5,9 GHz.	Safety An ongoing global requirement for 700 MHz to 800 MHz ITS spectrum. In Japan 715 MHz to 725 MHz allocated for Safety related	Transmission rate: 200 kBit/s to 600 kBit/s Communication range: ≤ 1 000 m Maximal latency: 100 ms Message transmission rate: 10/s	PHY 3 or 4 Bandwidth: 1 MHz Transmit power: 500 mW Mitigation techniques: TPC Duty-Cycle 1 %
	Pedestrian protection using wireless transponders (RFID tag)	Safety	Transmission rate: 200 kBit/s Communication range: ≤ 200 m Maximal latency: 30 ms	PHY 3 or 4 Transmit power: 50 mW to 100 mW Mitigation technique: LDC Duty-Cycle 1 %
Diagnostic data exchange	Diagnostic data exchange requires communication within but also to and from vehicles to provide for ongoing monitoring of vehicle functionalities and driver guidance. Diagnostic Data Exchange will support increased sustainability functionalities and reduction of CO_2 in vehicles. Communication with truck and trailer. Communication enables the driver to monitor the status of important points on the trailer - breaks, lighting - and tyre pressure individually.	Safety & environmental (Currently utilised for commercial vehicles but will be extended to passenger cars in the future.)	Communication range: 10 m	PHY 3 or 4 Transmit power: 100 mW Mitigation technique: LDC Duty-Cycle 1 %
Freight protection	Transfer of selected freight data. Authorities following commercial vehicles - special transports Cold store freight trailers providing data on temperature inside cargo container	Security	Data transfer from container to the truck driver Communication range < 20 m	PHY 4 Transmit power: 100 mW Mitigation technique: LDC Duty-Cycle 1 %
Environmental & safety systems	Tyre Pressure Monitoring Systems (TPMS) are designed to improve road safety and to reduce CO_2 emissions. (flat tyre/low pressure tyre). Wireless transmission of tyre pressure safely and securely	Safety & environmental (Regulatory requirement)	Transmission rate: 20 kBit/s Characteristic Communication range: ≤ 5 m Typical minimum RF-Link-budged: 80 dB (will be required to handle multipath and damping effects) Maximal latency: 200 ms Transmission interval: 15 s (monitoring) 1 s (warning, pressure loss)	PHY 3 Transmission power: 0,5 mW Mitigation technique: LDC Duty-Cycle < 2,5 %
	Vehicle alarm systems such as panic alarm initiating functions such as siren and	Safety	Operational range < 20 m	PHY 2 Transmit power: 25 mW

Functionality	Short Description	Category and comments	Operational requirement	RF interface
	flashing lights			Mitigation technique: LDC Duty Cycle 1 %
	Wireless seat occupancy detection	Safety	Transmission rate: 50 kBit/s Communication range: ≤ 2 m Maximal latency: 200 ms Shortest transmission interval: 5 s	PHY 2 Transmit power: 25 mW Mitigation technique: LDC Duty Cycle 1 %
	Wireless crash sensors, e.g. for pedestrian protection	Safety	Maximal latency: 20 ms Operational range < 5 m	PHY 3 Transmit power: 25 mW Mitigation technique: LDC Duty Cycle: 1 %
Remote key entry/keyless entry	Remote Key Entry allows the driver to manually open the vehicle with radio controlled key	Comfort Available in all new cars – state of the art	Message content 4…20 byte Multichannel systems (e.g. 3 channels) are state of the art	PHY 2 Transmit power: up to 25 mW Duty-cycle: < 0,1 % Mitigation techniques: LDC
	Keyless or passive entry systems based on bidirectional communication between vehicle and driver. Proximity sensors built into the door detects the approaching driver. Allow access, comfort installation of vehicle facilities and starting engine with button without key ignition. Passive start without ID is not possible.	Comfort Existing system but increasing requirement in all vehicles. System more sensitive than Remote Key Entry system	Message content: 4…20 byte Multichannel systems (e.g. 3 channels) state of the art Max latency < 100 ms Typical timeslot for RF transmission < 10 ms	Per channel: PHY 2 or PHY 3 Duty –Cycle: < 0,1 % Transmit power: up to 25 mW Mitigation techniques: LDC
In car remote operation	Wireless in car communication replaces existing wired connections for opening and closing of windows, sunroof, retractable hardtops, doors and trunk etc. Existing in-car remote operation will increase and in addition accessibility from outside the vehicle.	Comfort	Transmission rate: ≤ 50 kBit/s Maximal latency: 10 ms Typical minimum RF-Link-budged: 80 dB (will be required to handle multipath and damping effects) Communication range: ≤ 2 m	PHY 2 Transmit power: 0,5 mW Mitigation techniques: LDC, Duty Cycle 1 %
	Wireless in car communication for control	Comfort	Control: < 100 kBit/s Voice bidirectional 800 kBit/s Latency time 125 ms.	PHY 2 Transmit power: 0,5 mW Mitigation techniques: LDC, Duty Cycle 1 %

Functionality	Short Description	Category and comments	Operational requirement	RF interface
Comfort systems outside the vehicle	Personal car communication allowing driver to receive information at a greater distance telling such as That lights or infotainment system is on Detection of persons or animals left in the vehicle Status feedback of vehicle locking Fuel level reading Checking/controlling battery charging Activating vehicle WIFI/GSM/vehicle position/car finder Some of the functions need significantly longer distance than typical remote key entry systems but will be integrated in the remote key entry systems and thus appear in the same volume.	Comfort	Message content: 4…40 byte Maximum latency: 500 latency Communication range: ≤ 1 000 m Maximal latency: 500 ms	PHY1 or PHY1a Duty-Cycle: 0,1 % Transmit power: < 200 mW Mitigation techniques: LDC
	Wireless data link for transmitting diagnostic vehicle data in car workshops	Comfort	Transmission rate: 20 kBit/s Communication range: 100 m Maximal latency: 100 ms	PHY 2 Transmit power: 200 mW Mitigation techniques: DSSS/Narrowband

The technical parameters for the different applications are referenced in clause B.3.3.

Typical illustrations of implemented automotive functions are shown below.

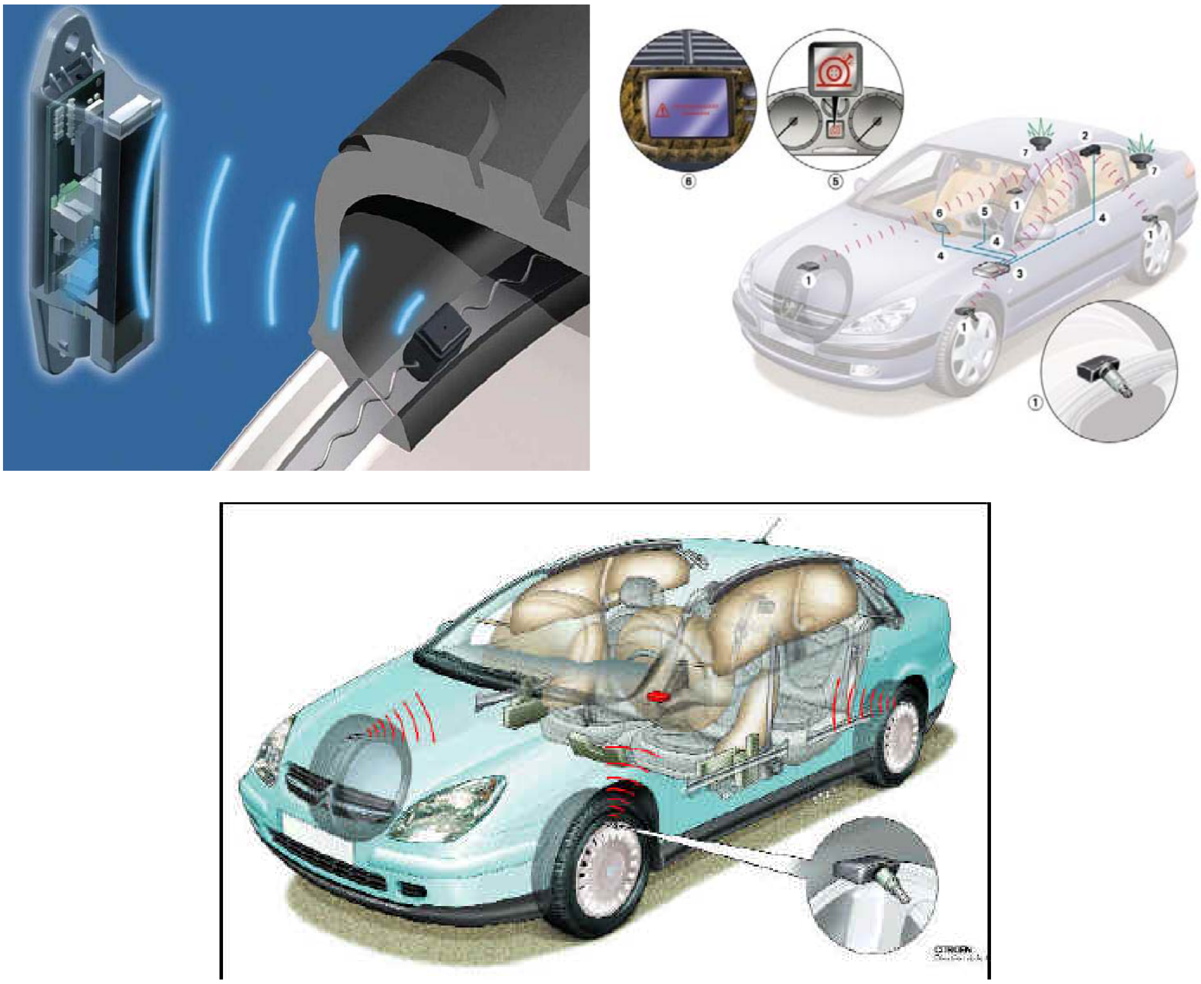


Figure A.10: TPMS Function and implementation

Figure A.11: Car Communicator devices

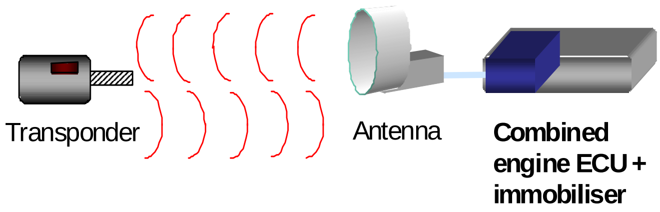


Figure A.12: Combined engine ECU + immobiliser

Figure A.13: Remote Key variants

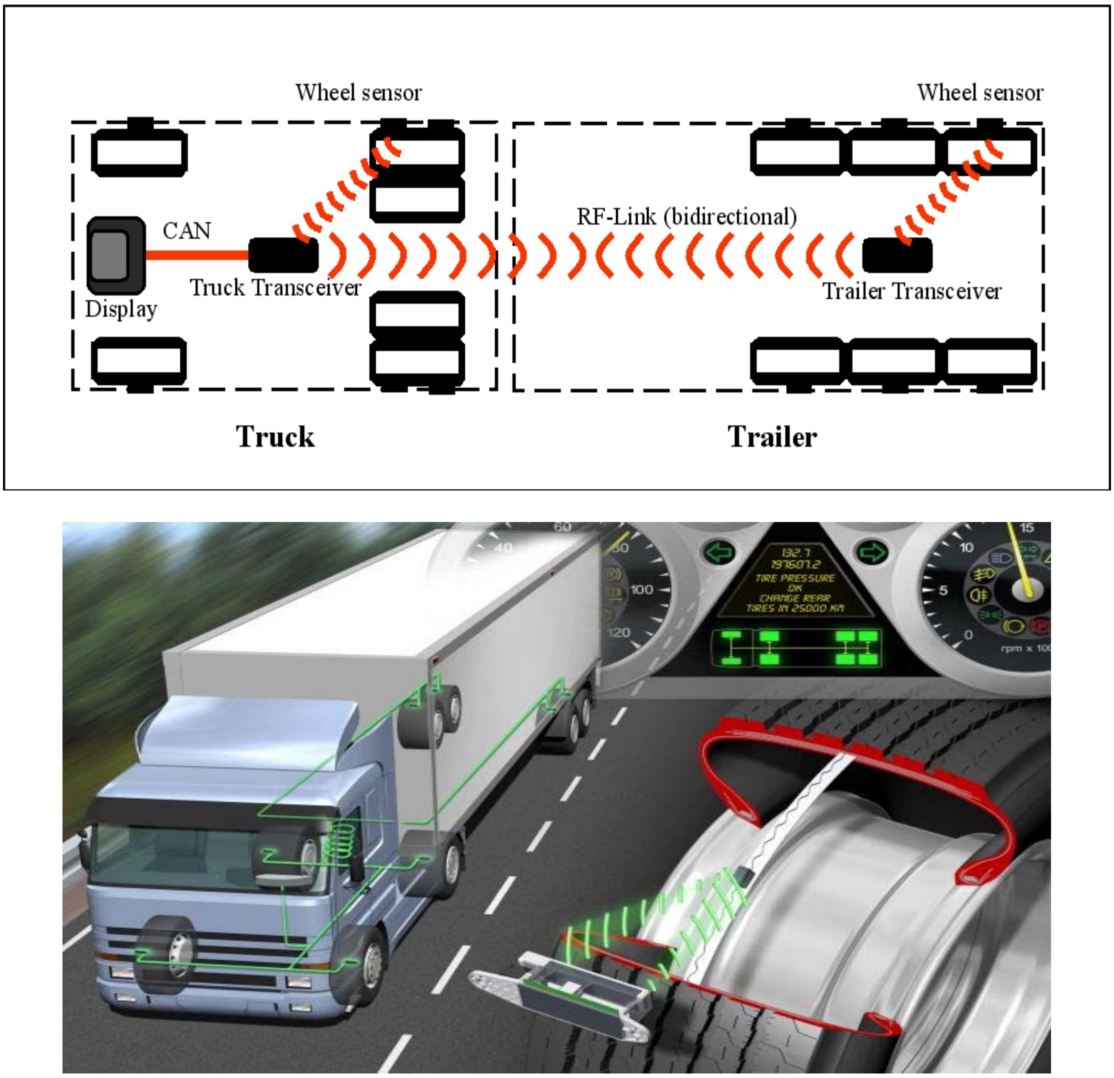


Figure A.14: Truck communicator with TPMS function

Annex B: Technical information

General

Spurious emissions from all equipment described in this annex should conform to the requirements in CEPT/ERC/REC 74-01 [i.53], which incidentally are more stringent for SRDs than for mobile. The specification of limits for acceptable compatibility with other equipment in adjacent bands will form part of the study within SE24.

B.1 RFID

B.1.1 Performance requirements from leading RFID manufacturers and users

The main market requirements are noted in clause A.1.1.

Tags that are used globally are manufactured with their centre frequencies tuned to around 915 MHz. Since tags have a fractional bandwidth of approximately 5 % to 8 %, there will be a noticeable performance penalty if such tags are read by interrogators complying with the present European standard EN 302 208 [i.7]. This is due to the frequency off-set of approximately 45 MHz and the higher transmit powers permitted in other non-European countries.

For comparable performance in Europe, interrogators should operate at around 915 MHz at power levels up to 4 W e.r.p.

B.1.2 Power

By comparison with the limit of 2 W e.r.p. in the current frequency range of 865 MHz to 868 MHz, an increase in the limit to 4 W e.r.p. in the new proposed frequency range of 915 MHz to 921 MHz would lead to the following:

- The read range in free space increases by a factor of 1,4.
- The power absorbed by tags in a pallet is doubled for a given range.
- If the reading performance for tagged items on a pallet reaches 70 % at 2 W, the reading performance increases to 100 % at 4 W. Thus the read probability can be increased from 70 % at 2 W up to 100 % at 4 W (see figure B.1).
- Transponders, which should be aligned parallel to the antenna at their maximum reading range, can be mis-aligned in the same position by up to 60° and still be read.

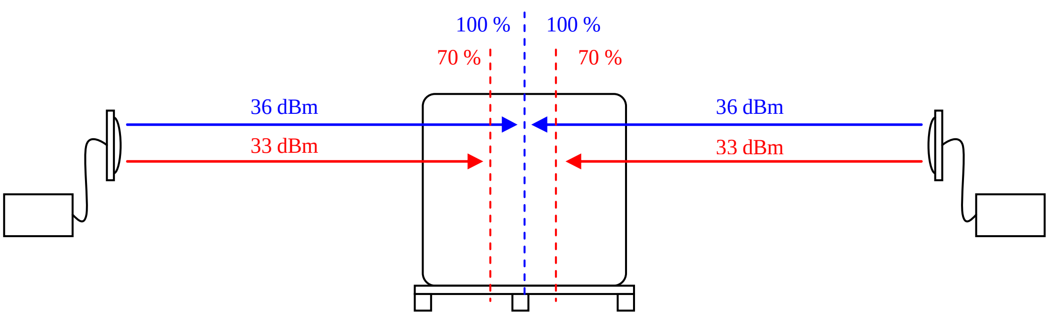


Figure B.1: Comparison of the read range within a pallet

B.1.3 Frequency

The current performance of UHF RFID in the logistic and supply chain market in Europe is limited by the channel bandwidth of only 200 kHz. This restricts UHF RFID in Europe to a reading rate of about 200 tags per second versus a need for 500 tags to 1 500 tags per second for future applications.

To achieve the large-scale roll-out of RFID in Europe, the performance has to fulfil the requirements of all end users. Many end users in the logistic and supply chain market require item level tagging or tagging of small sized cases. Typically this could mean that there might be 1 500 tagged objects on a single pallet. In order to read these objects on a conveyor belt or in dock door scenario, a higher data rate is required combined with greater penetration of goods by the energizing field.

To achieve an acceptable reading performance the proposed spectrum values are based on the highest data rate in ISO 18000-6 [i.10]. In addition to achieve the highest Reader to Tag data rate specified in ISO 18000-6C [i.11], a new European UHF RFID band is proposed with the following spectrum parameters:

- The bandwidth for each high power channel should be ~400 KHz wide to allow a Tari of 6,25 µs as specified in ISO 18000-6C [i.11].
- The channel for the tag response should be 0,8 MHz on both sides of each high power channel. This allows a return link frequency of 640 KHz, which is equivalent to a data rate of 320 kbps.

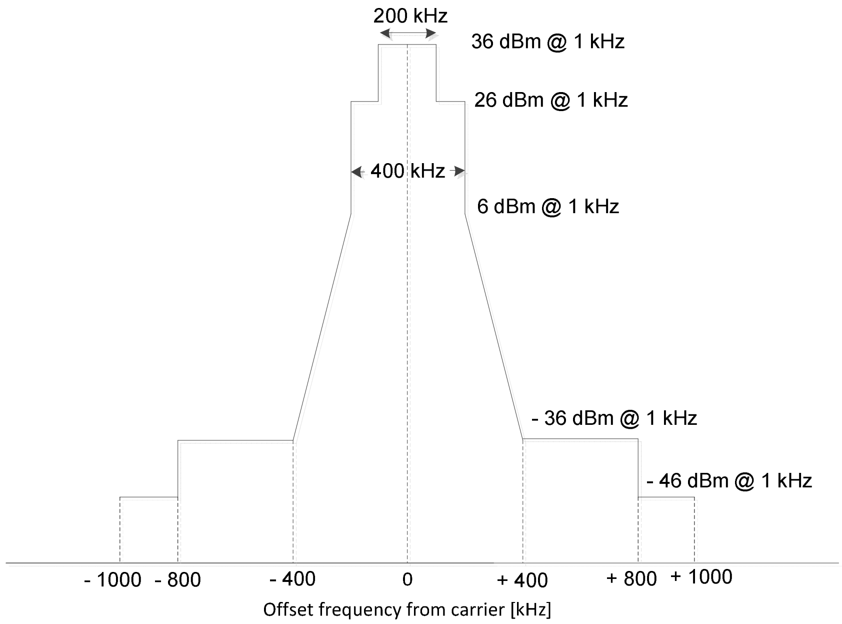
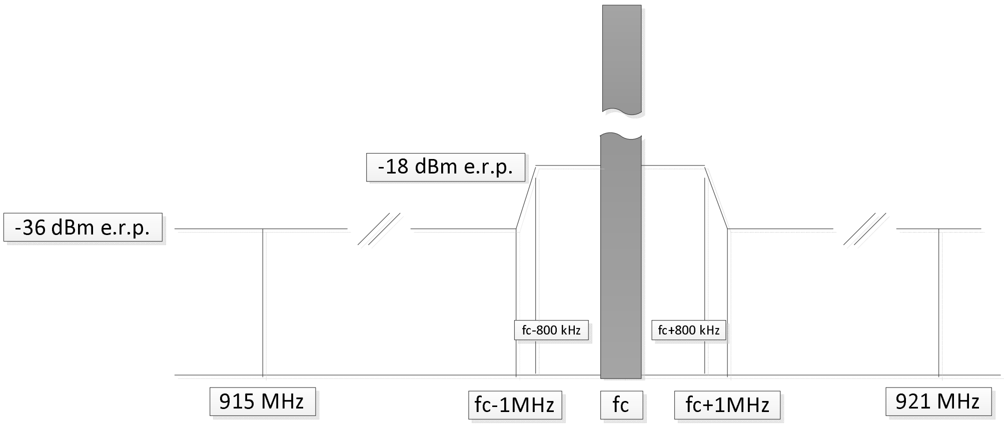


Figure B.2: High performance interrogator channel mask

Receiver parameters:

1) The beamwidth of the antenna(e) in the horizontal orientation should be ≤ 70 degrees.
2) The interrogator should identify a tag with a power level of -65 dBm.
3) The interrogator should identify a tag with a power level of -62 dBm in the presence of an un-modulated blocker with a power level of -35 dBm at a frequency that lies +2 MHz or -2 MHz away from the carrier frequency of the interrogator.
4) The receiver of the interrogator should have a bandwidth of (fc ± 1 MHz).

The spectrum mask for the tags is shown in figure B.3.



NOTE 1: fc is the centre frequency of the carrier transmitted by the interrogator.
NOTE 2: The transmit channel occupied by the interrogator is shown in grey.
NOTE 3: All power levels in the unwanted domain to be measured in accordance with CEPT/ERC/REC 74-01 [i.53].
NOTE 4: The radiated power of the tag should not exceed -10 dBm e.r.p., which is equivalent to a power spectrum density of -18 dBm/100 kHz e.r.p.

Figure B.3: Spectrum mask of tag

B.2 Non-specific SRDs

No change. Characteristics of transmitters and receivers should be as defined in EN 300 220 [i.8].

B.3 Specific SRDs

B.3.1 Metering and Alarms

Power

The maximum permitted radiated power should be 25 mW e.r.p.

This will permit a range of 15 meters to 25 meters, with propagation through 3 to 5 walls and a receiver sensitivity of -90 dBm.

Frequency

A data rate of 100 kbit/s is required.

Using FSK, an occupied bandwidth of 150 kHz can be achieved.

Because heat cost allocators are attached to hot water radiators, there is a large operating temperature range and therefore a significant frequency drift. This leads to a required channel width of 250 kHz.

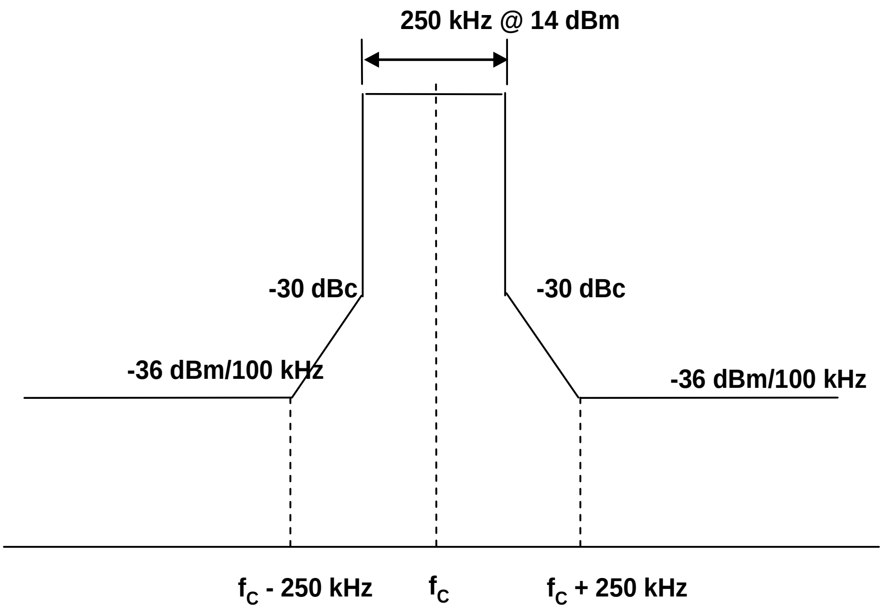


Figure B.4: Metering and Alarms Spectrum Mask

Mitigation techniques

A number of factors provide inherent interference mitigation. The data collectors are indoor applications, so some wall attenuation occurs. The distance from other applications and the very low duty cycles used provide further mitigation.

Duty Cycle

The remote sensors have a duty cycle of ≤ 0,1 %, but the data collectors need to concentrate the data from many sensors, so they need more transmit time. Data collectors typically transmit for about 30 ms with a cycle time of around 30 s.

The duty cycle should therefore be ≤ 1 %.

Alarm systems that are transmitter-receivers pose problems because energy is wasted due to collisions between messages. In addition, with a duty cycle regulation of 1 % as it is defined today on an hourly basis, it is possible to transmit for as much as 36 s without interruption. In the LBT enabled band, we currently also see a maximum allowed burst length of up to 4 s. This makes the use of certain channels impossible for alarm systems, due to the legal requirements for the confirmation of a successful transmission of an alarm message within 10 s. AFA does not solve the blocked channel problem, because the operation of switching to an unblocked channel takes more time and/or energy than is acceptable.

The solution for robust alarm transmission over radio links is to restrict the channel usage not only to a very low duty cycle possibly with LBT protection, but also to specify an upper bound on transmission burst length (ON-time) and a minimum inter-packet time (OFF-time) allowed on a channel.

B.3.2 Portable Alarms

LBT is not an acceptable technique for "Portable alarms for personal security". Instead they use very low duty cycle access techniques.

The spectrum mask conforms to figure B.5.

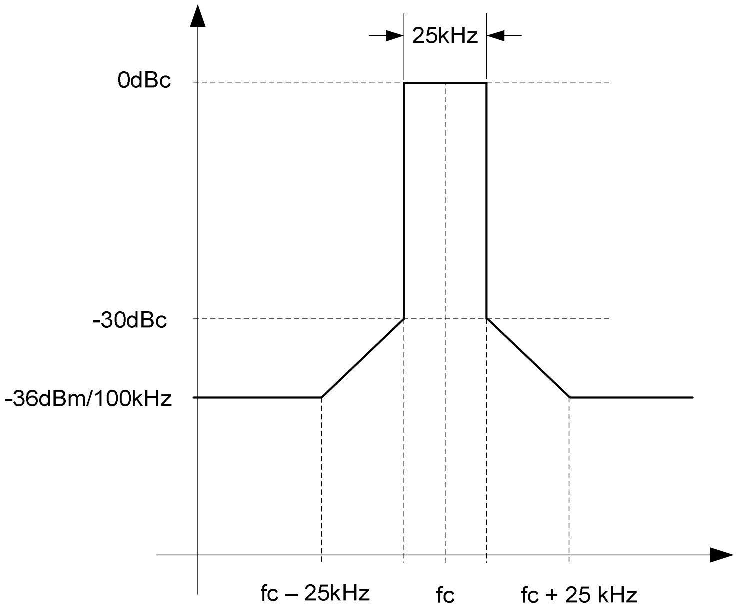


Figure B.5: Portable Alarms Spectrum Mask

- Power:
  The maximum permitted radiated power should be 100 mW e.r.p. This will permit a range of 100 meters to 250 meters in harsh indoor environments (e.g. prisons with reinforced concrete walls and steel doors, industry). A long range is desirable to minimize the number of (very expensive-) central receivers (Typically Category 1 according to EN 300 220 [i.8]).

- Duty cycle:
  The portable alarms transmit typically short data telegrams (~250 ms) with a low duty cycle (0,1 %).

- Modulation:
  Narrowband FSK, 25 kHz channel BW.

B.3.3 Automotive

As also mentioned in clause A.3.2 not all technical parameters can be provided for future applications prior to the detailed development phase of the vehicles. Table B.1 includes the typical physical layer parameters for the different categories of automotive applications including the typical spectrum masks.

The Mitigation techniques including duty cycle requirements are SRD function specific and thus provided in the main table in clause A.3.2.

Table B.1: Physical layer parameters for automotive applications

#	PHY Description	Applicable for/Examples
PHY1	Narrowband Channel bandwidth 25 … 50 kHz Data rate 1…2 kbit/s Modulation: Shaped FSK TX tolerance: <+-20 ppm	Personal Car Communicator
PHY2	Channel bandwidth < 200 kHz Data rate 4 … 10 kbit/s Modulation: (Shaped) FSK TX tolerance: <±80 ppm	Remote Keyless Entry Keyless Go/Passive Start and Entry
PHY3	Channel bandwidth ~200 kHz Data rate ~20 kbit/s Modulation: (Shaped) FSK TX tolerance: < +- 100 ppm	TPMS Keyless Go/Passive Start and Entry Car2X
PHY4	Channel bandwidth ~500 kHz Data rate > 100 kbit/s Modulation: t.b.d. TX tolerance: <+-80 ppm	Remote Diagnostic Car2X
PHY1a	DSSS Channel bandwidth ~1,2 MHz (Chip rate 600 kchip/s) Data rate 1…3 kbit/s TX tolerance: <+-10 ppm	Personal Car Communicator PHY to conform with FCC 15.247 [i.54] for WW harmonized band

B.3.3.1 Spectrum mask

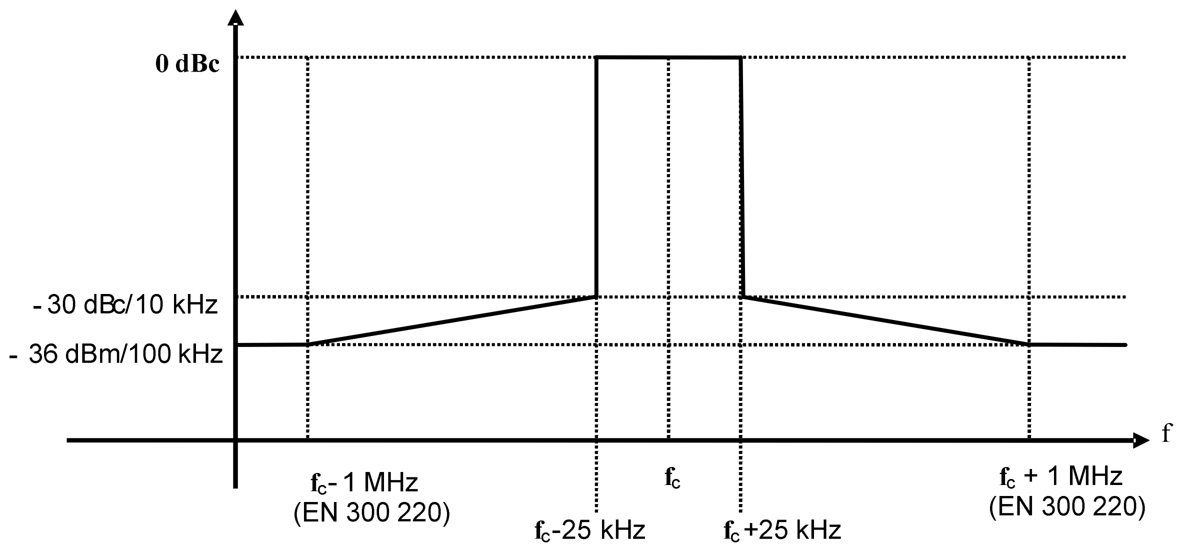


Figure B.6: Typical Spectrum Mask description for Physical layer 1 (PHY1)

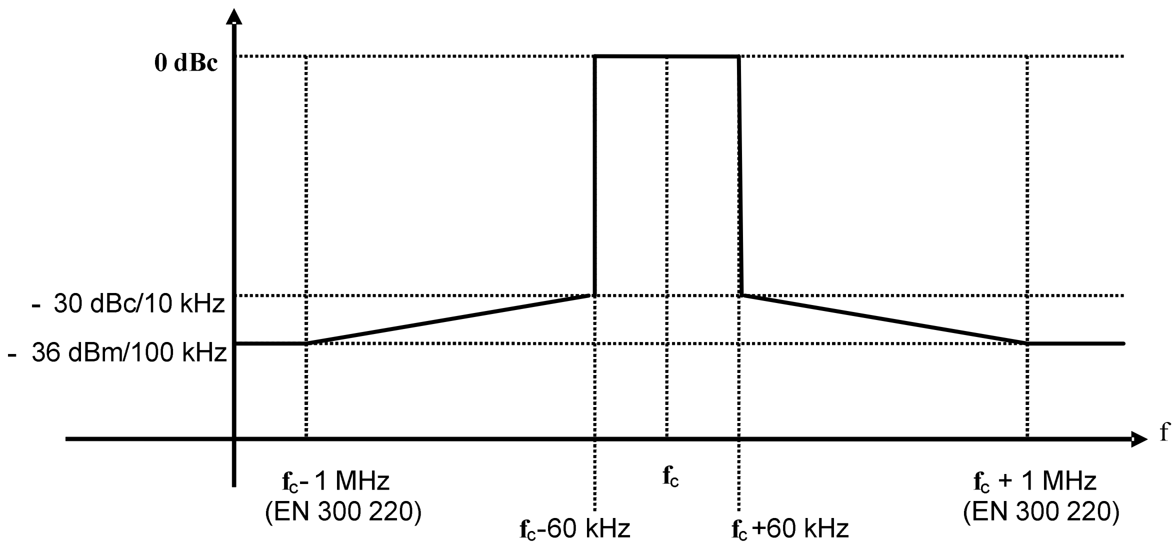


Figure B.7: Typical Spectrum Mask description for Physical layer 2 (PHY2)

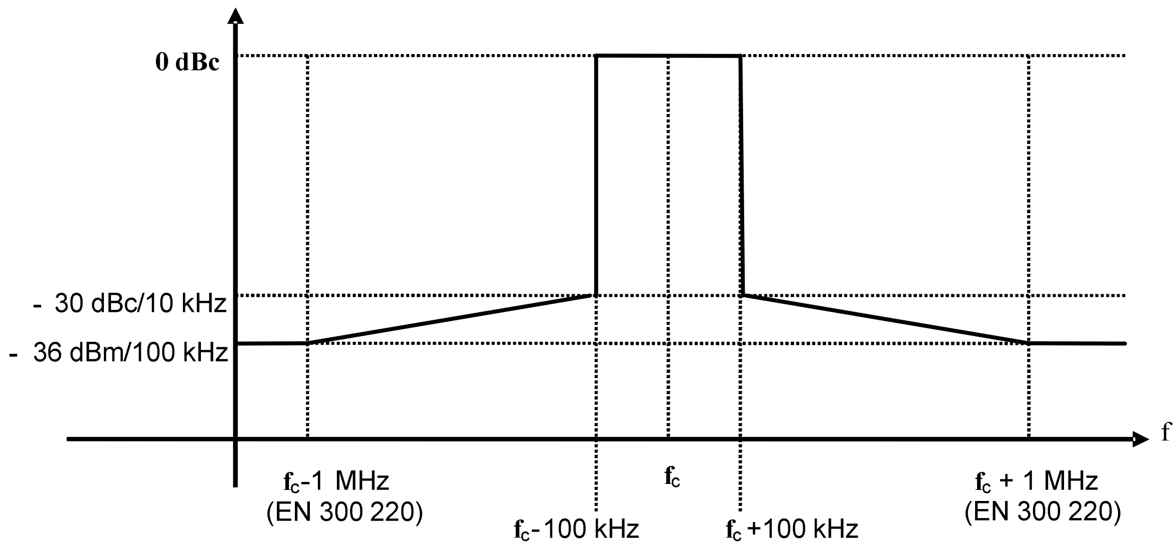


Figure B.8: Typical Spectrum Mask description for Physical layer 3 (PHY 3)

Typical Spectrum Mask description for Physical layer 4 (PHY4)

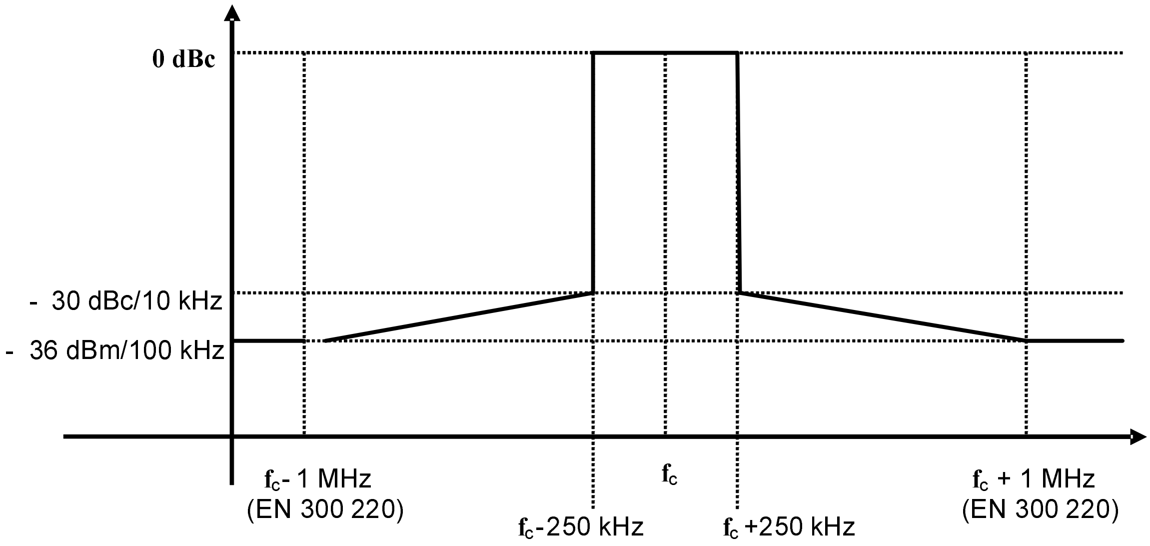


Figure B.9: Typical Spectrum Mask description for Physical layer 4 (PHY4)

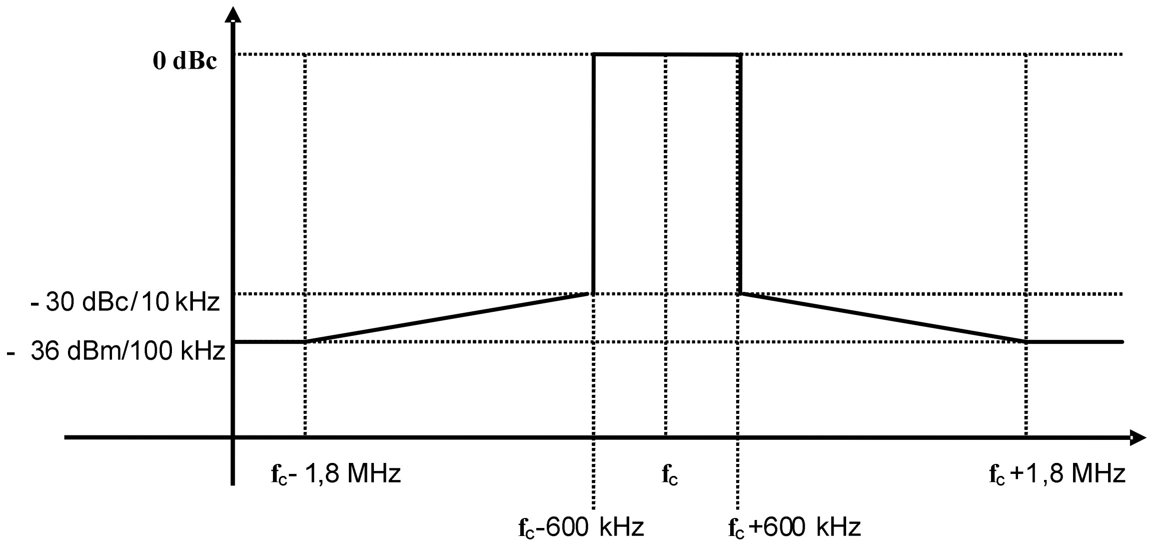


Figure B.10: Typical spectrum mask description for Physical layer 4a (DSSS)

B.3.4 Summarizing

The new frequency band should offer enough spectrum to provide for multi-channel systems since under some scenarios one system can use 2 or 3 channels. Instead of using adjacent channels, multi-channel operation should use channels that are spaced well apart. This should ensure that if one channel is subject to interference then the other channel should be free from interference.

The frequency band should provide sufficient channels to allow the operation of a number of systems in a given location. Therefore a spectrum of approximately 3 MHz would allow multi-channel operation as described above.

Annex C: Expected compatibility issues

C.1 Existing allocations

The European table of allocations for the UHF frequency range of concern is as follows.

870 MHz to 876 MHz paired with 915 MHz to 921 MHz	MOBILE RADIOLOCATION	Defence systems PMR/PAMR	There are no PMR/PAMR system implementations in this frequency band.

Figure C.1: Excerpt of European table of allocations for the frequency ranges under discussion

C.2 Information about ER-GSM frequency usage

Extended Railways GSM 900 Band, ER-GSM (includes Railways GSM 900 Band, Standard and Extended GSM 900 Band):

- for Extended Railways GSM 900 band, the system is required to operate in the following frequency bands:
  - 873 MHz to 915 MHz: mobile transmit, base receive;
  - 918 MHz to 960 MHz: base transmit, mobile receive.

Table C.1: Channel numbering

ER-GSM 900	Fl(n) = 890 + 0,2*n	0 ≤ n ≤ 124	Fu(n) = Fl(n) + 45
	Fl(n) = 890 + 0,2*(n - 1 024)	940 ≤ n ≤ 1 023	

The corresponding new channel numbers are ch 940 to ch 954.

C.2.1 Introduction and general description

The GSM-R system is a radio system used by Railway operators and networks for voice and data communications between track side base stations and mobile subscribers located in the drivers' compartment of the train. The system uses separate up and down links, presently 921 MHz to 925 MHz down and 876 MHz to 880 MHz up, with a 200 kHz channel spacing using a GMSK as the modulation scheme.

In order to understand the results of the testing it is necessary to have an understanding of the voice codec, data interleaving, frame structure and error correction schemes used by the system.

C.2.2 Frame structure

The basic data unit in the GSM's TDMA structure is a time slot of 577 µs which can carry 108 bits of data. There are 8 of these time slots in a frame of 4,615 ms.

C.2.3 Voice codec and error correction

The voice codec parses speech in 20 ms blocks. The encoded voice is split into different categories of bits, from most to least significant; Class 1a, Class 1b and Class 2. Of these:

- Class 1a is offered CRC error detection;

- Class 1a and 1b convolutional correction at half rate coding; and
- Class 2 bits no error detection or correction.

Each 20 ms of speech is represented by 456 bits of encoded speech.

C.2.4 Interleaving

The interleaving applied to data is dependent upon the data type. For voice data the interleaving depth is 8 and for other data it may be as much as 19.

Interleaving of voice is achieved by generating sub-blocks of data where data is taken from the previous and current voice codec blocks. These sub-blocks are then interleaved over 8 adjacent frames (40 ms). Because it is the sub-blocks which are interleaved, rather than the original encoded voice data block, data can always be recovered unless 2 adjacent frames of size 4 (20 ms) are destroyed.

For data interleaving the process is similar; sub-blocks are derived and these are interleaved to a maximum depth of 19 (380 ms).

The significance of the 20 ms and 380 ms figures will be shown in relationship to the test results.

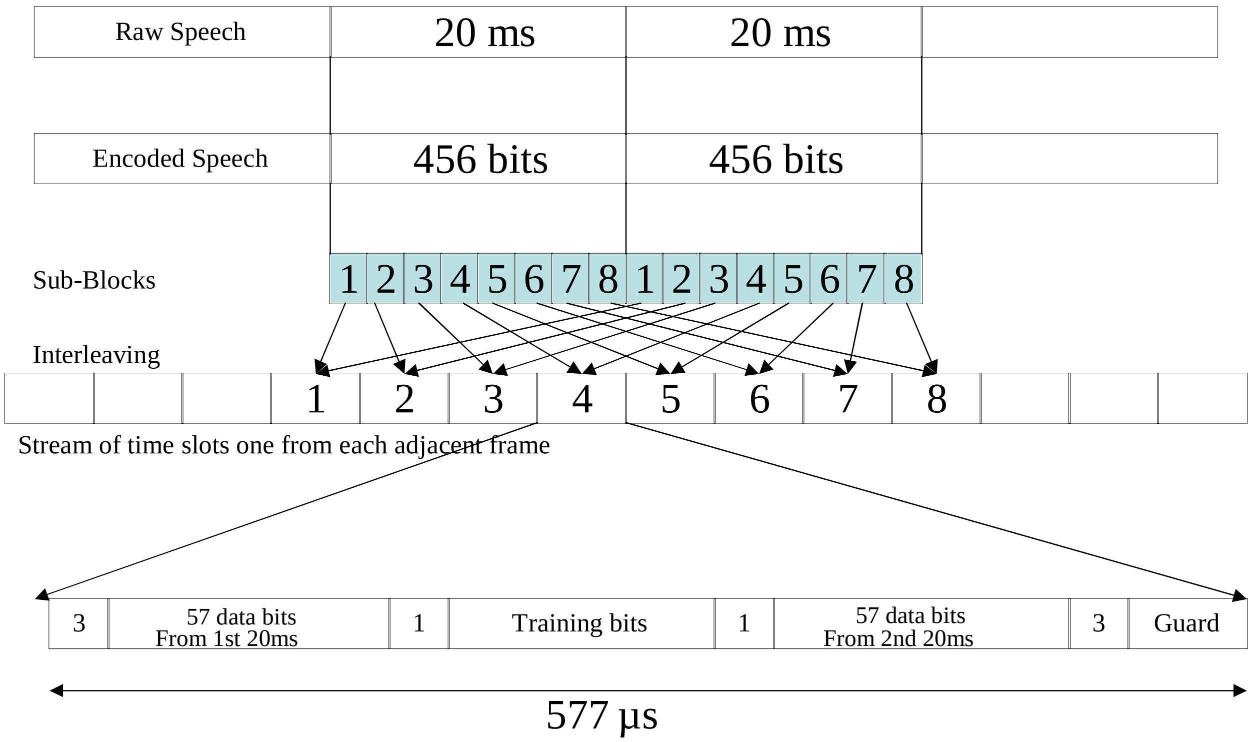


Figure C.2: Generic GSM Frame Structure

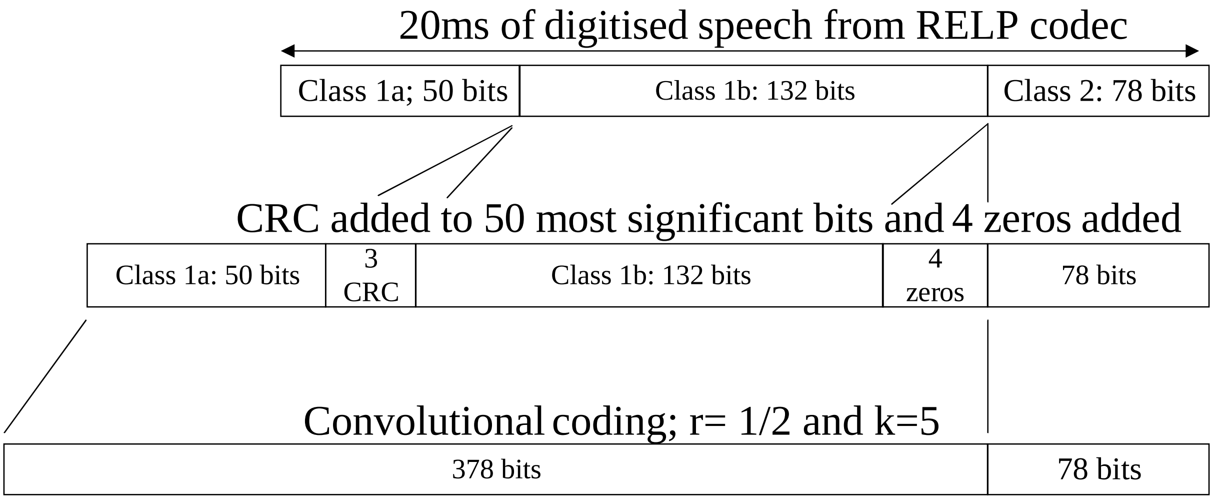


Figure C.3: Full Rate Speech coding

C.3 Coexistence and sharing issues

ETSI TC ERM is, through its TG34 (UHF RFID) task group, developing standards for UHF RFID applications.

In the summer of 2008 ETSI-ERM sent the ETSI System Reference Document TR 102 649-2 V1.1.1 [i.48] to CEPT/ECC requesting additional spectrum for UHF RFID. RFID would operate in the band 915 MHz to 921 MHz in four high power channels while the remainder of the frequency band would be used for the low power responses from the tags. Full details are available in the present document.

In parallel, ETSI TC RT on the subject of Extended GSM-R independently sent an ETSI System Reference Document to ECC requesting an extension of their existing band to include the frequencies 918 MHz to 921 MHz (E-GSM-R, paired with 873 MHz to 876 MHz).

CEPT/ECC has looked favourably on this request and it was decided to revise ECC Decisions (04)06 [i.43] and (02)05 [i.42] to include ER-GSM. Germany has already included ER-GSM in their frequency utilization plan and has also given a license to a railway operator for ER-GSM. It may be expected that other countries will also follow. According to the implementation plans for GSM-R in Europe, ER-GSM will be used on high speed railway tracks as well as locations with high railway usage, e.g. shunting areas, urban areas. In other areas, or in some countries, ER-GSM may not be used.

Testing, involving an administration, railway operator and members from the RFID community in ERM TG34, was performed in the summer of 2009 to understand under what conditions it might be feasible for RFID to co-exist with ER-GSM (i.e. ER-GSM BS transmit band) in the band 918 MHz to 921 MHz. RFID would operate as a secondary application and will not cause harmful interference in the PMR/PAMR band 915 MHz to 921 MHz. In theory it may be restricted to operate within defined areas (e.g. indoor use) and may also use intelligent Detect-And-Avoid (DAA) mechanisms. For example if the system is able to detect ER-GSM transmissions above a certain threshold on a particular channel, it could instruct the interrogator to select an alternative frequency of operation. Another way to improve compatibility would be to minimize the use of the 2 upper proposed RFID channels at 918,6 MHz and 919,8 MHz. In addition, interfering intermodulation products should be avoided.

The tests have shown that it is potentially feasible for RFID and ER-GSM to co-exist. To ensure that RFID does not interfere with ER-GSM, the interrogator should not transmit within a minimum frequency offset of transmissions from nearby base stations. This could be achieved by the use of intelligent detect-and-avoid (DAA) or other equivalent cognitive techniques. If the system is able to detect ER-GSM transmissions above a certain threshold on a particular channel, it could instruct the interrogator to select an alternative frequency of operation.

The RFID interrogator could perform an ER-GSM channel scan and measure the level of signals from the base station to determine whether a spare high power channel is available. The threshold set in the interrogator will determine the distance from the base station at which it may transmit on the same channel.

Another way to improve compatibility is to minimize the use of the 2 upper proposed UHF RFID channels above 918 MHz. The ETSI standardization group dealing with ER-GSM is TC RT TG EGSMR. ETSI ERM TG34 and ETSI TC RT TG EGSMR work together on a detailed concept for co-existence. Their work should be supported by compatibility studies in ECC WGSE.

This would necessitate the use of suitable mitigation techniques such as DAA. The ETSI board has approved an STF to investigate this concept, define a suitable DAA (or equivalent) method and apply it to a technology demonstrator, to be developed by the industrial members of ERM TG34.

The development of exact parameters, operation principles and the test definition for co-existence with ER-GSM is seen as a prerequisite for achieving this target.

Please note that although the technology demonstrator will concentrate on one particular application, i.e. protection of ER-GSM, the technique may ultimately be transferable to other sharing situations.

The following studies are considered necessary:

- Coexistence studies between the proposed UHF SRD applications in the frequency band 870 MHz to 876 MHz and both GSM Mobile Services at 876 MHz and ER-GSM in the band 873 MHz to 876 MHz.

- Coexistence studies between the proposed UHF RFID applications in the frequency band 915 MHz to 921 MHz and both GSM (MS Tx, BS Rx) at 915 MHz and GSM-R (MS Rx, BS-Tx) at 921 MHz, and with ER-GSM (MS Rx, BS Tx) in the band 918 MHz to 921 MHz.

- Sharing studies should be performed to investigate if there are any problems of incompatibility between RFID, SRDs and other users of the band.

Due to the great differences in the usage scenarios of the various radio applications, it is proposed to use the CEPT SEAMCAT simulation tool as the basis for the analysis.

The results from the study should also provide the necessary minimum receiver performance needed by RFID and SRD applications for sharing with the mobile Service in the adjacent band(s).

It is understood that the proposals in the present document can only be implemented on the basis of no protection for SRD/RFID devices operating in the proposed new bands.

Studies may be needed to assess the compatibility between Metering, Alarms, Automotive applications and non-specific SRDs proposed for the band 870 MHz to 876 MHz. The compatibility between all these devices and the allocated services or applications operating in the band above 876 MHz should also be studied.

RFID and other high power SRD applications may suffer interference from services in the adjacent bands (GSM MS Tx below 915 MHz and GSM-R BS Tx above 921 MHz as well as interference from ER-GSM BS Tx if used in close proximity. The proposed sharing studies should also investigate acceptable conditions and minimum separation distances in combination with appropriate receiver parameters for RFID and other high power SRDs.

Existing ERC/ECC Reports [i.22], [i.23], [i.24], [i.25], [i.26], [i.27], [i.28] and [i.29] contain technical information that should be used for conducting the necessary studies. Consideration on extension of the band for GSM-R was summarized by ECC WGSE in document [i.44].

Annex D: Letter from TC TETRA MC

TETRA31 (08) 21

European Telecommunications Standards Institute
TC TETRA#31
5-7th March 2008
Sophia Antipolis

To: **ERM**

From: **TC TETRA Management Committee (MC)**

Title: **Liaison Statement (LS) Regarding Use of the 870-876/915-921 MHz Frequency Band**

Date: **25th March 2008**

Dear Gabrielle,

We have no comments to the Draft SRDoc TR 102 649-2 RFID and SRDs in 870 MHz to 876 MHz and 915 MHz to 921 MHz as invited in your 14th March 2008 e-mail. However, we discussed this within the TC TETRA MC and we agreed it might be useful to provide an input to ERM explaining why we believe TETRA has not been deployed in this frequency band since it was first made available to TETRA in ERC Dec (96) 04.

The explanation as to why TETRA has not been deployed in this band falls into four main categories being:

- PMR Market
- Market Forces
- RF Propagation Characteristics
- Technical

PMR Market

The market for TETRA is primarily a replacement market for PMR user organizations that already use PMR networks operating in traditional PMR frequency bands, for example, VHF, 410 MHz to 430 MHz and 450 MHz to 470 MHz, with the exception of European Public Safety and Security (PSS) organizations that have allocated 2 x 5 MHz in the 380 MHz to 400 MHz band. Because of this, existing PMR users want to retain existing base station sites and utilize the same frequency bands to maintain the same RF coverage. As a consequence, the 870 MHz to 876 MHz/915 MHz to 921 MHz band is not required. Also, there are very few, if any, new PMR users that require medium to high capacity PMR networks, being the main requirement met by TETRA.

Market Forces

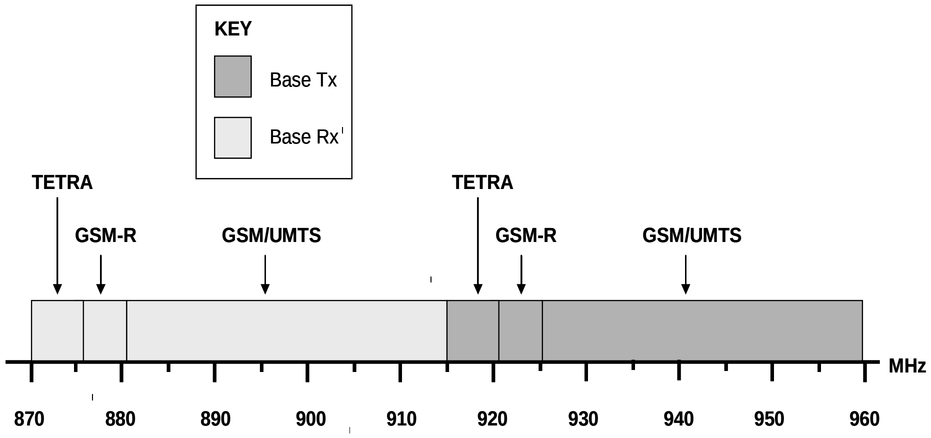
The market represented by the 870 MHz to 876 MHz/915 MHz to 921 MHz Frequency Band resides in Europe only. Also, because the useable spectrum is limited owing to interference (see technical section below) the overall market, compared with the globally harmonized bands of 410 MHz to 430 MHz and 450 MHz to 470 MHz, combined with the 2 x 5 MHz allocated in the 380 MHz to 400 MHz band for European PSS organizations (largest market for TETRA to date), makes the market less attractive, hence the reason why no products have been deployed.

RF Propagation Characteristics

As the majority of TETRA networks utilize multiple base station sites to provide wide area coverage, using the 870 MHz to 876 MHz/915 MHz to 921 MHz band, instead of the 410 MHz to 430 MHz or the 450 MHz to 470 MHz band, would require a greater number of base station sites to provide the same RF coverage. This would be economically unacceptable, especially as most PMR user organizations own their PMR networks.

Technical

An important performance aspect of Mobile Stations (MSs) operating in any duplex band is their receiver selectivity. The chart below explains this in more detail.



As can be seen from the chart the spectrum directly above and below the 915 MHz to 921 MHz (BS to MS) band is used by wideband GSM-R and GSM/UMTS respectively and above the 870 MHz to 876 MHz (MS to BS) band by wideband GSM-R. As a consequence, the guard band required between narrow band TETRA and these wideband technologies reduces the amount of useable spectrum within the 876 MHz/915 MHz to 921 MHz band for TETRA (see note), some estimates indicate as little as 2 x 3 MHz, especially as many traditional PMR user organizations require a high QoS and therefore cannot accept reduced RF coverage or loss of communications caused by interference.

Furthermore, Direct Mode Operation (DMO) in the 870 MHz to 876 MHz/915 MHz to 921 MHz band may also raise complex technical co-existence requirements.

Please note that the content of this LS is not meant to create any formal exchange between ERM and TC TETRA regarding the future use of the 870 MHz to 876 MHz/915 MHz to 921 MHz band but to simply explain why we believe TETRA has not been deployed in this band.

NOTE: The frequency range should read "870 MHz to 876 MHz/915 MHz to 921 MHz" instead of "876 MHz/915 MHz to 921 MHz".

Sincere Regards

Doug Gray

Chairman TC TETRA

Annex E:
Bibliography

- EPC™ Radio-Frequency Identity Protocols, Class-1 Generation 2 UHF RFID (Version 1.0.9, 31 January 2005): "Protocol for Communications at 860 MHz to 960 MHz".

History

Document history		
V1.1.1	September 2008	Publication
V1.2.1	June 2010	Publication
V1.3.1	August 2012	Publication