ETSI TR 102 664 V1.2.1 (2010-04)

Technical Report

Electromagnetic compatibility and Radio spectrum Matters (ERM); Road Transport and Traffic Telematics (RTTT); Short range radar to be used in the 24 GHz to 27,5 GHz band; System Reference Document

Reference

RTR/ERM-TGSRR-052

Keywords

EHF, radar, radio, RTTT, short range, SRD, SRDOC, UWB

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Foreword

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

The present document presents a revision of V1.1.1. This revision includes:

- a review of the SRR scenarios developed since the publication of TR 102 664 V1.1.1 as well as recent technical developments of UWB SRR technology.

Executive summary

The present document describes the need for the proposed allocation of the new SRR frequency range for a 26 GHz UWB SRR band from 24,25 GHz to 27,5 GHz.

1) The shortcomings of the present UWB SRR regulation are such that the UWB SRR technology risks discontinuation in the automotive industry. This is because of the very low SRR penetration caused by the present regulations.

   The goal of the eSafety program of the European Commission for safety on the roads is at stake since the SRR car penetration has stalled at a low penetration level of 0,02 % with no outlook to increase e.g. over the next 5 years, unless the proposal for the new 26 GHz UWB SRR band is realized.

2) The present document describes a proposal for the 26 GHz UWB SRR band that allows the introduction of SRRs in the proposed range while protecting the passive services. It presents a cost efficient solution especially avoiding the cumbersome and costly inclusion of deactivation devices around radio astronomy sites.

3) The proposal of the present document fulfils the requirement of the EC Decision 2005/50/EC [i.1] for conducting a fundamental review to be completed by 2009.

   The proposal is created in support of the ECs final mandate to CEPT to undertake studies for alternative frequencies to the 24 GHz range for SRRs [i.27].

4) The proposed solution provides the global harmonization for UWB SRRs as pursued by the ITU-R during WRC 2007 within the present range of 24 GHz to 27,5 GHz.

   Secondly the proposed solution also provides a window for activities to achieve the global harmonization for the 79 GHz UWB SRR band until the production start. This is an essential requirement for the market acceptance and the effective proliferation of the 79 GHz automotive UWB SRRs.

5) The protection requirements of passive services in the 23,6 GHz to 24 GHz dictate a shift of frequency. Secondly in view of the close deadline and the short design-in cycle needed, the alternative 26 GHz solution, is the only realistic technology to bridge the gap and provide a seamless technology option for the deployment of UWB SRRs - otherwise at stake for the car industry.

6) The industry continues with strong commitment for continued development efforts to productize the 79 GHz SRR technology on the chip, the sensor module level as well as the assembly technology level for the earliest possible market introduction. The 79 GHz SRR technology provides the optimum performance combined with the synergy option to combine the long range 76 GHz ACC function with the short range surround looking performance in one module (see figure B.1.1).

Introduction

Over the past years, the industry has responded to European Commission programs and has developed new Short Range Radar (SRR) solutions for Road Safety and Intelligent Transport Systems. This is in support of such programs as *e*Safety, IST, the EU Approach to Road Safety and Intelligent Transport systems (ITS).

European programs funded by the Community made use of SRR technology, for instance the PREVENT projects as INSAFE, COMPOSE and APALACI [i.3]. See http://www.prevent-ip.org. The FP7 programme continues to consider these SRR technologies as a basis for next generation applications [i.16].

In particular, current programs as KOKON (vehicle high-frequency electronics), RoCC (Radar on Chip for Cars) aim to design, demonstrate (KOKON) and implement (RoCC) SRR technology for the 76 GHz to 81 GHz band [i.31].

The objective and focus of "The EU Approach to Road Safety and Intelligent Transport systems (ITS)", Intelligent Vehicle Systems are defined as to "improve safety, security, comfort and efficiency in all transport modes" and "focusing on advanced pilot/driver assistance systems (in support of vision, alertness, manoeuvring, automated driving compliance with the regulations, etc.)".

The current regulation 2005/50/EC [i.1] is focused on SRRs operating at 24 GHz. The Radio Spectrum Committee discussed part 2.2 of the 2005/50/EC [i.1] on SRR in the 24 GHz range i.e. to review the EC Decision by latest 2009:

> *"2. In addition to the review process in paragraph 1, a fundamental review shall be carried out by 31 December 2009 at the latest to verify the continuing relevance of the initial assumptions concerning the operation of automotive short range radar in the 24 GHz range radio spectrum band, as well as to verify whether the development of automotive short-range radar technology in the 79 GHz range is progressing in such a way as to ensure that automotive short range radar applications operating in this radio spectrum band will be readily available by 1 July 2013".*

The present document is related to one of the basic elements of the IST program for the automotive sector and is the base for a variety of SRR applications. The program as established in the present document is needed to enable and further to accelerate the proliferation of Short Range Radar (SRR) under the eSafety program of the EU Commission. The SRR technology otherwise risks to stagnate or to be discontinued. This is because most of the automotive OEMs noted that new SRR product introduction cannot be justified for the introduction of new car lines in view of the 2013 deadline for the 24 GHz band while the introduction of the 79 GHz SRRs is tied to the readiness of the technology which is still under development for mass market introduction.

The present document is created to enable and accelerate the process of introducing the SRRs to the extent that the automotive SRR technology is used in a significant higher percentage of cars. Only a high percentage allows the effective enhancement of safety on the roads.

The most recent report to the Commission on car penetration with SRRs shows that after five years after the production start and release of the 24 GHz UWB regulation, the car fleet penetration has only reached a very low level of 0,02 % with no outlook to increase significantly further [i.13]. This is in contrast to the anticipated penetration of appr. 4 % to 5 %, 5 years after the market introduction in 2005.

Considering the foregoing, the RSCOM document 08_24 [i.5] "*Third Party document - Request to initiate fundamental review of automotive short-range radar equipment operating in the 24 GHz radio spectrum band* ", indicates that members can testify that the consumer acceptance of 24 GHz SRR is high, providing that the option is offered, but only few automotive manufacturers have offered this option and those that presently do, are reconsidering whether to cancel or further implement it in upcoming model lines.

RSCOM issued a mandate to CEPT consisting of two parts [i.27]:

Part 1: to review of the EC Decision 2005/50/EC [i.1] on the *"continued relevance of the initial assumptions"* for the use of the 24 GHz band, and consider the 79 GHz developments *"…barriers" to the uptake of the 79 GHz band as permanent band for SRRs…"* [i.6];

Part 2: "…to undertake studies with regard to alternative approaches to the 24 GHz range for SRR use...".

The present document considers both addressed parts, tries to provide answers and proposes the way forward under the assumption that the 79 GHz technology still provides the long term SRR solution, for the automotive industry.

It is created in support of the Commissions final mandate to CEPT to undertake studies for alternative frequencies to the 24 GHz range for SRRs [i.27].

Status of the pre-approval draft

The present document has been created and agreed by TC-ERM_TGSRR.

Final approval for publication is expected at ERM#40.

Target version	**Pre-approval date version (see note)**				
V1.2.1	**A**	**s**	**m**	**Date**	**Description**
V1.2.1	0.0.1			Jan 2010	1st draft, SRR.
V1.2.1	0.0.2			February 5th 2010	2nd draft, for TGSRR M#4 approval.
V1.2.1	0.0.3			February 7th 2010	3rd draft, for TGSRR M#4 approval.
V1.2.1	0.0.4			February 9th 2010	4rd draft, approved by TGSRR M#4.
V1.2.1	0.0.5			February 18th 2010	5th draft, approved by TGSRR M#4, *Editorially revised table B.2.4. The mean power limit was added which was previously stated and approved. (see clause 6.2 in 4th §). The comments were added and the comparison part revised for clarity with no content change.*
V.1.2.1	0.0.6			March 5, 2010	Proposals by Ministry of Economic Affairs NL added, mostly to align with new template of EG 201 788 [i.34]. Also a few minor editorials have been added.
V1.2.1	0.0.7			March 5th 2010	Revised draft including comments from SIAE as approved by TGSRR #5. *(Not not including comments from MinEA since there were too late for the meeting TGSRR#5).*
V1.2.1	0.0.8			March 6th 2010	Final draft for approval by correspondence including MinEA comments received after TGSRR#5.

1 Scope

The present document provides a proposal for a complementary introduction of a 24,25 GHz to 27,5 GHz (26 GHz band) UWB SRR technology that is supposed to overcome the challenges experienced under the existing regulation.

It is to be noted that the existing regulation for 24 GHz as well as for 79 GHz is not intended to be modified but to be complemented by this new option.

The present document applies to Short Range Devices for automotive applications as defined by EC Decisions 2005/50/EC [i.1] and 2004/545/EC [i.7]. It considers the previous SRDoc TR 101 982 [i.11], reviews the present regulation for the 24 GHz UWB SRR band, analyses the situation in the automotive and the component supplier industry, addresses cost issues, the market penetration and regulatory shortcomings. Secondly it proposes forward looking solutions to improve the regulatory situation in order to allow a deployment of cars on the road, the global harmonization of SRRs, a more efficient contribution of the SRR technology to the road safety needed to comply with the goals of the eSafety program of the European Commission [i.8].

The latest SRR developments as covered in annex B reduce the emission levels in the 26 GHz band (24 GHz to 27,5 GHz). The new set of proposed emission parameters are proposed to facilitate the compatibility to other services operating in the same 26 GHz band.

The UWB emissions of the proposed document operates in the range 24,25 GHz to 27,5 GHz. Additional non-UWB SRR functions in the 24,05 GHz to 24,25 GHz can be combined with the UWB SRR system. These SRR functions in the 24,25 GHz to 27,5 GHz range are not included in the present document, they present state-of the-art ISM band 24 GHz NB SRR technology. Such additional non-UWB functions are covered in the EN 302 858 [i.35] (under development).

It includes in particular:

- market information;
- technical information;
- regulatory issues.

2 References

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

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

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

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

2.1 Normative references

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

Not applicable.

2.2 Informative references

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

[i.1] EC Decision 2005/50/EC of 11 of 17 January 2005 on the harmonisation of the 24 GHz range radio spectrum band for the time-limited use by automotive short-range radar equipment in the Community.

[i.2] Void.

[i.3] PREVENT projects as INSAFE, COMPOSE and APALACI.

NOTE: Available at http://www.prevent-ip.org/.

[i.4] ETSI EN 302 264 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices; Road Transport and Traffic Telematics (RTTT); Short Range Radar equipment operating in the 77 GHz to 81 GHz band.".

[i.5] RSCOM#24, Item 12: "Third Party document, Request to initiate fundamental review of automotive short-range radar equipment operating in the 24 GHz radio spectrum band".

[i.6] RSCOM08-71: "Fundamental review of EC Decision 2005/50/EC on the use of the 24 GHz band by automotive short-range radar applications (SRR)".

[i.7] Commission Decision 2004/545/EC of July 2004 on the harmonisation of radio spectrum in the 79 GHz range for the use of automotive short-range radar equipment in the Community.

[i.8] EC SPEECH/02/181: "Towards a comprehensive eSafety Action Plan for improving road safety in Europe", High level meeting on Safety Brussels 25 April 2002, Erkki Liikanen.

[i.9] ETSI EN 302 288-1 (V1.4.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices; Road Transport and Traffic Telematics (RTTT); Short range radar equipment operating in the 24 GHz range; Part 1: Technical requirements and methods of measurement".

[i.10] ECC Report #23: "Compatibility of automotive collision warning, short range radar operating at 24 GHz with FS,EESS and Radio Astronomy".

[i.11] ETSI TR 101 982: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radio equipment to be used in the 24 GHz band; System Reference Document for automotive collision warning Short Range Radar".

[i.12] Void.

[i.13] RSCOM09-37: Fourth annual report by SARA on the monitoring of the use of the 24 GHz frequency range by automotive short-range radars.".

[i.14] ECC/DEC/(04)10: "ECC Decision of 12 November 2004 on the frequency bands to be designated for the temporary introduction of Automotive Short Range Radars".

[i.15] Void.

[i.16] Seventh Research Framework Programme [FP7].

NOTE: Available at http://cordis.europa.eu/fp7/info-programmes_en.html.

[i.17] ETSI EN 301 091 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices; Road Transport and Traffic Telematics (RTTT); Radar equipment operating in the 76 GHz range".

[i.18] Mercedes Benz Press Information (June 2008): "20% fewer rear-end collisions thanks to DISTRONIC PLUS and Brake ASSIST PLUS".

[i.19] Bundesanstalt für Strassenwesen (BAST): "Volkswirtschaftliche Kosten der Personenschäden im Strassenverkehr", Publication of BAST, Issue M102, January 1999, Authors Herbert Baum, K-J Höhnscheid, University of Cologne.

[i.20] ECC Report 46 (May 2004): "Immunity of 24 GHz automotive SRRs operating on non interference and non-protected basis from emissions of the primary Fixed Service operating in the 23 GHz and 26 GHz frequency bands".

[i.21] ERC Report 25: "European Common Allocation Table (ECA)".

[i.22] Void.

[i.23] ITU-R Recommendation SM. 1757: "Impact of devices using ultra-wideband technology on systems operating within radiocommunication services".

[i.24] Void.

[i.25] Void.

[i.26] Void.

[i.27] RSCOM08-81 SRR Final Mandate to CEPT to undertake Technical studies on automotive short-range radar systems (SRR).

[i.28] Karlsruhe Institut of Technology (KIT): "Study on Interference Impact of Pulsed Frequency Hopping UWB Radarsystems", ECC-SE24 M5R0.

[i.29] Void.

[i.30] Karlsruhe Institut of Technology (KIT): "Study on Interference Impact of Pulsed Frequency Hopping UWB Radarsystems" amendment; DG-FM47-Doc-02.

[i.31] Draft CEPT Report 36 Report from CEPT to the European Commission in response to the Mandate on Short Range Radar.

[i.32] Helmut Schittenhelm: "The Vision of Accident Free Driving" 21st International Technical Conference on the Enhanced Safety of Vehicles, Stuttgart, 2009.

NOTE: Available at http://www-nrd.nhtsa.dot.gov/pdf/esv/esv21/09-0510.pdf.

[i.33] Claes Tingvall et al: "The Effects of Automatic Emergency Braking on fatal and serious Injuries", 21st International Technical Conference on the Enhanced Safety of Vehicles, Stuttgart, 2009.

NOTE: Available at http://www-nrd.nhtsa.dot.gov/pdf/esv/esv21/09-0419.pdf.

[i.34] ETSI EG 201 788: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guidance for drafting an ETSI System Reference document (SRdoc)".

[i.35] ETSI EN 302 858 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Road Transport and Traffic Telematics (RTTT); Short range radar equipment operating in the 24,05 GHz to 24,25 GHz frequency range for automotive application".

[i.36] ETSI EN 302 697 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Road Transport and Traffic Telematics (RTTT). Short Range Radar equipment operating in the 24 to 29 GHz band for UWB Short Range Radar ".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

bandwidth: range of frequencies, expressed in Hertz (Hz), that can pass over a given transmission channel

frequency allocation (of a frequency band): entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space **radiocommunication services** or the **radio astronomy service** under specified conditions

Industrial Scientific and Medical bands (ISM): frequency bands in which non-radio RF emissions can be allocated

instantaneous pulse bandwidth: instantaneous bandwidth of each single pulse, defined to be the inverse of the pulse duration

narrowband: classification for the spectral width of a transmission system

occupied bandwidth: bandwidth of an emission defined for UWB or alike systems as 10 dB bandwidth of the power spectral density

Power Spectral Density (dBm/Hz) (PSD): ratio of the amount of power to the used radio measurement bandwidth

NOTE: It is expressed in units of dBm/Hz or as a power in unit dBm with respect to the used bandwidth. In case of measurement with a spectrum analyser, the measurement bandwidth is equal to the RBW.

Pseudo Noise (PN): digital signal with noise-like properties

resolution: degree to which a measurement can be determined

separation: capability to discriminate two different events (e.g. two frequencies in spectrum or two targets over range)

Spread Spectrum (SS): modulation technique in which the energy of a transmitted signal is spread throughout a larger frequency range

ultra wideband: classification for the spectral width of a transmission system

wideband: classification for the spectral width of a transmission system

3.2 Symbols

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

ΔR	Range separation
dBm	Decibel, milliwatt
f	Frequency
P	Power
R	Distance

3.3 Abbreviations

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

ACC	Automotive Cruise Control
DC	Duty Cycle
ECC	Electronic Communications Committee
EESS	Environmental Earth System Science
FCC	Federal Communications Commission
FH	Frequency Hopping
iBw	Instantaneous Pulse bandwidth

ISM	Industrial Scientific, Medical
IST	Information Society Technologies
KBA	Kraftfahrt-Bundesamt (Germany)
LRR	Long Range Radar
OEM	Original Equipment Manufacturer
PN	Pseudo Noise
PPM	Pulse Position Modulation
PSD	Power Spectral Density (dBm/Hz)
RF	Radio Frequency
SOP	Start Of Production
SRD	Short Range Device
SRR	Short Range Radar
SS	Spread Spectrum
UWB	Ultra Wide Band

4 Comments on the System Reference Document

To be completed when feedback on the present document is available.

5 Background information

The experience with 24 GHz UWB SRR development and the deployment over the past 3 years to 5 years based on existing regulations [i.1], [i.14] and [i.9] have shown that the goals of the eSafety program of the EU cannot be met because of a discontinuity between the present deployment of the 24 GHz and the planned continuation with the 79 GHz UWB SRRs from 2013 onwards.

In the course of the revision of the planned EC Decision 2005/50/EC [i.1], an effective and realistic solution to bridge the gap is required and proposed in the present document.

What has changed since the issuance of the 24 GHz to 79 GHz 2-phase strategy is the fact that the timely availability of a 79 GHz production-ready technology was not given.

For a timely Start Of Production (SOP) of 79 GHz UWB SRRs by latest 2013, qualified 79 GHz SRR UWB sensors modules are expected to be available years prior to the SOP of a car line or model to manage car integration, the qualification tests and approvals in order to release production of new 79 GHz equipped car lines [i.31] and [i.13].

Since this was not the case, the 2-phase transition from 24 GHz to 79 GHz failed. At the same time the car manufacturers with their long design and production cycles could not commit to new 24 GHz UWB SRRs car lines because of the too short model lifetime hence the absence of acceptable business models.

This situation is summarized as follows:

1) The deadline of 2013 is a major barrier for most car-makers and prohibits the expected widespread SRR implementation in their car lines, which was the assumed basis for the deadline.

2) The 79 GHz UWB SRR technology is not available for seamless transition by 2013. The challenge for continued SRR deployment is now even greater due to the unexpected low deployment of 24 GHz SRRs on the European markets which in 2009 was approximately 0,02 % compared to the 2-phase strategy assumption of about 4 % to 5 %.

   It is however to note that the development of the 79 GHz technology is proceeding continuously although at a lower pace than forecasted. Presently, the first chipsets for qualification are noted to be available. This qualification will firstly yield the release of the 79 GHz sensors for design into the next generation of vehicles; secondly following this, the car design-in cycle and car series qualification has to be performed and takes a number of years until the production start will follow.

   The global harmonization of the 24 GHz UWB SRR range as defined in the EC Decision [i.1] is not achievable as various contacts with many administrations worldwide have shown, while the proposed 26 GHz SRR UWB range can be globally harmonized.

The proposed 26 GHz UWB SRR solution allow a timely window to achieve 79 GHz global harmonization until the product launch.

3) The automatic deactivation for 24 GHz UWB SRRs is a significant barrier to implement SRRs especially in middle and low class cars.

This was an additional hurdle for management decisions to launch new 24 GHz car lines at an earlier date needed intime for the potential transfer to 79 GHz by 2013. (These Decisions were needed already by 2005-2006).

4) The present stagnation of the 24 GHz sensor penetration is counterproductive for acceptance of 79 GHz SRRs.

A much higher SRR penetration rate is also a prerequisite for a valid business plan for the 79 GHz SRR implementation. The presently low (24 GHz) base SRR penetration is not a realistic departure situation to launch successfully 79 GHz SRRs.

5) The combination of the 24 GHz cut-off date and the non-availability of 79 GHz worldwide is the major obstacle for adoption of SRR in the market place.

6) Another challenge is the long development and production timelines in the automotive industry for which the current regulation was experienced to be insufficient.

7) There is an increasing risk that the UWB SRR technology may not be continued (at all).

This is because of the lack of an acceptable business case, combined with the gap between the cease of the 24 GHz deployment and the nonavailability of the 79 GHz sensors and the fact that other technologies (LIDAR) might be used. This situation is a real threat despite the fact that UWB SRR technology is superior, more robust and efficient than other safety and collision mitigation technologies.

ECC Decision (04)10 recommends to use *"the 79 GHz range for new SRR systems, or alternatively permitted technical solutions"*.

In consequence and because of the unavailability of 79 GHz sensors in time, the present document therefore provides a proposal for a complementary introduction of a 24 GHz to 27,5 GHz SRR technology.

Because of the addition of new technical and operational characteristics as given in annex B (which are more favourable than those assumed for developing ECC Report 23 [i.10]) it is supposed that the proposal of the present document will overcome the above depicted challenges. Especially the recent SRR technology enhancement provides SRRs with lower emissions to facilitate compatibility.

It is to be noted that the existing regulation for UWB SRRs for 24 GHz and 79 GHz is not intended to be modified but to be complemented by this new option.

The proposal is expected to be the only solution that fosters the implementation of the 79 GHz SRR technology in the market (see item 4 above) since a gap in SRR deployment severely risks the discontinuation of the UWB SRR technology for vehicle safety.

Further to note is that the 79 GHz SRR technology itself provides significant design advantages (e.g. size, performance, and the option of a combined 76 GHz to 79 GHz ACC/SRR platform) and will therefore definitely be the long term cost efficient choice for SRR applications under the precondition that a rather large SRR market already exists in Europe to be gradually shifted to 79 GHz. Especially the proposed solution will provide the best starting position for the 79 GHz technology.

The proposal avoids the 23,6 GHz to 24 GHz band covered by RR footnote 5.340 for Radio Astronomy Service and the Earth Exploration Satellite Service.

The existing EC Decision 2005/50/EC [i.1] of 17 January 2005 (published in OJ L 21 of 25 January 2005, p. 15) already requested a fundamental review of the SRR regulatory situation to be completed before end of 2009. A mandate from RSCOM to CEPT ECC has been issued and being worked on in ECC.

The quest for the present document is to consider the present proposal as contribution document for this review process and compatibility studies.

6 Technical information

The present 24 GHz SRR products rely mainly on pulsed UWB modulation which necessitate the emission of the UWB modulated residual carrier signal. For pulsed systems the carrier is positioned in the ISM band and generates approx. 2,5 GHz sideband emissions symmetrically to the carrier.

The SRR pulsed Frequency Hopping [i.28], [i.30] modulation techniques avoids a carrier emission in the centre of the spectrum and therefore can move the UWB spectrum above the ISM band.

This allows the SRR UWB signal to avoid the protected bands for passive services as defined in RR No. 5.340 of the Radio Regulations of 23,6 GHz to 24 GHz such as Radio Astronomy and EESS therefore giving full protection from the SRR UWB emissions. The 24,25 GHz to 27,5 GHz range is recommended, pending compatibility studies for the services affected. In addition, the experience made on current production of 24 GHz SRR permits an up-dating of the technical and operational characteristics with impact to the preliminary assumptions made for ECC Report 23 [i.10]. Therefore it is expected that the coexistence results with FS systems in 26 GHz band can be resolved.

The present regulation requires the incorporation of a SRR automatic deactivation mechanism to be activated in the vicinity of some 23 European locations where radio astronomy sites exist. This function requires additional non-SRR inherent circuitry for the control function [i.1], [i.14] and [i.9] which adds significant cost to the SRR modules.

This requested review of regulation and change of allocation is also in line with the ITU-R goal of global harmonization of frequencies for SRRs. In the case of SRRs the harmonized operating range is set for the range of 24,25 GHz to 27,5 GHz.

6.1 Detailed technical description

More technical detailed information is given in annex B.

6.2 Status of technical parameters

6.2.1 Current ITU and European Common Allocations

See clause C.1.

6.2.2 Sharing and compatibility studies (if any) already available

The compatibility studies which led to the development of ECC Decision (04)10 [i.14] should be taken into account as far as possible (ECC Reports 23 [i.10] and 46 [i.20]).

6.2.3 Sharing and compatibility issues still to be considered

See clause C.2.

6.3 Information on relevant standard(s)

See clause B.3.

7 Market information

7.1 Automotive radar technologies

Automotive radar function covers Long Range Radar (LRR) and UWB Short Range Radar (SRR). The eSafety functions and goals cover Long Range Radar (LRR) at 76 GHz as well as UWB SRRs.

LRR is used for distance scanning, which requires an operating range of approximately 150 m. One or multiple forward looking narrow beams control or scan the driving path in front of the car to determine the distance to the vehicle driving ahead for maintaining a constant minimum safety distance (see EN 301 091 [i.17]). The maximum bandwidth of LRR devices is below 1 GHz corresponding to a typical spatial resolution of 1 m.

UWB SRR units presently operate at 24 GHz and provide an operating range of approximately 30 metres. The bandwidth is below 5 GHz corresponding to a spatial resolution capability of ~10 centimetres.

They are used for a number of different applications to enhance the active and passive safety. Such applications include obstacle avoidance, collision warning, pre-crash, lane change warning, lane change aid, blind spot detection, parking aid and airbag arming.

For optimal function of collision avoidance, both the 76 GHz technologies as well as the 24 GHz respectively the 26 GHz technology will be needed as presently deployed in car lines.

Only the UWB SRR technology provides the "surround looking" capability as well as the high resolution for detecting various objects at a distance which is needed for the *e*Safety requirements. Therefore UWB SRRs allow a significant increase in safety, resulting in the saving of lives and avoiding damage of goods which is in the order of hundreds of Billion EUR/per annum [i.11] and [i.18].

24 GHz as well as the proposed 26 GHz SRR technology allows a cost-efficient design and keeps the product size small enough to fit the sensor in the space given behind vehicle bumper fascias. Transmission of mm waves through painted fascia material is feasible. Low cost is a pre-requisite for the use in mid-range class and low class cars. Therefore and because of their potential for high market penetration, it can significantly contribute to road safety.

7.2 Automotive SRR evolution, penetration and functionality

Development of automotive safety systems for collision mitigation has the goal to gain time to react and prepare a car in case that a crash might occur. A first step hereto was ESC (Electronic Stability Control), which observes the behaviour of the own car. As second step the SRR technology allows observation of the objects or obstacles in the vehicle surrounding to actuate preventive measures e.g. controlled airbag firing, seatbelt and seat adjustments and adaptive braking.

A further step in the development of the automotive safety technology will be cooperative vehicle to vehicle/vehicle- roadside communications to increase the relevant road information coverage for the vehicle driver.

The benefit of SRR collision avoidance compared to other automotive safety technologies is that enhanced safety on the roads is given and even more effective with lower penetration levels as compared to other safety systems as car-to-x communication. This is because such systems do not rely on other cars to have identical installations and require the functioning of a safety system installations. UWB SRR in cars operate autonomously to avoid or mitigate collisions.

Therefore the safety is enhanced with each additional car equipped with SRR, while other systems rely on higher penetration levels for comparable effects or safety results.

Nevertheless the penetration of SRR cars is vital for significant collision mitigation or avoidance and is a key technology for eSafety. The actual penetration analysis of the third annual report of the automotive industry which is based on the official KBA Report of 2009 [i.13] states a low penetration of 0,02 %.

What is more alarming and significant for the stall of the contribution of SRRs to road safety, is the fact that the rise of penetration e.g. from the preceding 2007 report to the 2008 records is only 0,002 %-age points which signals that the penetration stagnates for the coming years because of the approaching 2013 deadline.

The acceptance of the SRR by the market (where offered) was noted to be high [i.13], however the very low penetration is a result of the very limited offering of SRR technology by manufacturers and only offered for the top of the car line models. This is in contrast to the low cost potential of the 24 GHz SRR technology. The reason behind is that the automotive manufacturers do not see a business case for new SRR car developments in view of the short remaining time window of the current frequency regulation in Europe.

Since the 79 GHz technology is not yet mature for a one-by-one replacement of the car lines, the transition from the 24 GHz technology to 79 GHz cannot happen as foreseen. This roots back to the reasons stated above which caused a stall of 24 GHz SRR market proliferation in Europe, considered as the most important prerequisite to open the market also for 79 GHz next generation systems.

7.3 Outlook

The implementation of the proposal of the present document for the frequency range from 24,25 GHz to 27,5 GHz will remedy the shortcomings of the present market situation basically because of the nearly immediate availability of 26 GHz products. Therefore it provides a seamless UWB SRR transition from 24 GHz to 26 GHz

Going from 24 GHz to 26 GHz effectively bridges the gap, and no major costs for car design-in, qualifications and major timely delays are encountered; the new system can be deployed in a reasonable short time window with the result to accelerate the SRR car penetration significantly (see figure A.2.1).

In addition the avoidance of emissions causing undue interference to the passive band 23,6 GHz to 24 GHz removes severe regulatory and cost burdens.

The summarized benefits are:

- seamless continuation and deployment of UWB SRRs in vehicles beyond 2013;
- planning safety for the automotive industry for UWB SRRs;
- global harmonization, production and deployment of systems for all two upcoming UWB deployment phases;
- acceleration and a higher level of penetration while preserving the non-interference capability to existing services;
- larger and earlier impact on e-Safety program;
- lower cost to the car user because of higher production volume;
- the 26 GHz UWB designs and technology are available and can function as a replacement for the present UWB 24 GHz band SRR modules;
- no car (and bumper) redesign needs to be carried out;
- the ramp-up of the 26 GHz production bridges the gap to the introduction of the 79 GHz UWB SRR systems;
- no additional circuitry for the SRR deactivation function is needed resulting in less complex systems and lower cost to the user;
- avoids the imminent/pending risk that car makers cancel the UWB SRR technology in the industry because of the stagnation of the present penetration;
- the proposal will establish an UWB SRR market with sufficient volume, as a prerequisite for the introduction of 79 GHz UWB SRRs.

Independent from the proposed approach, the automotive industry is remaining committed and works intensively on the development of 79 GHz technology because of the potential of performance improvement in terms of range and resolution, low cost on a 76 GHz/79 GHz combined platform basis.

This is because the 24 GHz as well as the 26 GHz SRRs need the longer range 76 GHz system to complement an effective long and short range safety function. These are presently realized in a more costly hardware using two different radar sensor modules.

In the future both technologies will be on the market if the above preconditions can be achieved. Further details are given in annex B.

8 Regulations

8.1 Current regulations

8.1.1 SRRs operating in the range of 24,15 GHz ± 2,5 GHz and 24,05 GHz to 24,25 GHz

Relevant excerpt of the ECC Decision (04)10 [i.14]:

1) *that in order to allow early introduction of SRR applications in Europe the 24 GHz frequency range is designated for SRR systems on a temporary basis as follows:*

   a) *24,15 GHz ± 2,5 GHz for the Ultra Wideband component, with a maximum mean power density of -41,3 dBm/MHz e.i.r.p. and peak power density of 0 dBm/50 MHz e.i.r.p;*

   b) *24,05 GHz to 24,25 GHz for the narrow-band emission mode/component, which may only consist of an unmodulated carrier, with a maximum peak power of 20 dBm e.i.r.p and a duty cycle limited to 10 % for peak emissions higher than -10 dBm e.i.r.p.*

2) *that the temporary frequency designation for SRR equipment in the 24 GHz range is on a non-interference and non-protected basis;*

3) *that emissions within the 23,6 GHz to 24 GHz band that appear 30° or greater above the horizontal plane should be attenuated by at least 25 dB up to 2010 and 30 dB up to 1 July 2013 for SRR systems operating in the 24 GHz range as defined in Decides 2;*

4) *that 24 GHz SRR systems transmitting in the band 23,6 GHz to 24 GHz with an eirp higher than -74 dBm/MHz or in any band listed in considering ee) with an eirp higher than - 57 dBm/MHz, should be fitted with an automatic deactivation mechanism to ensure protection of Radio Astronomy sites as well as manual deactivation to ensure that emissions are restricted only to those countries that have implemented the temporary solution. In order to allow an early implementation of 24 GHz SRR Systems the automatic deactivation should be made mandatory from 1 July 2007. Before that date, manual deactivation is required;*

5) *that where an automatic deactivation mechanism is implemented, 24 GHz SRR systems should be de-activated within the specified separation distance from the radio astronomy sites referenced in annex 1.*

8.2 Proposed Regulation

The proposed 26 GHz UWB SRR frequency band ranges from 24,25 GHz to 27,5 GHz with a maximum average emission level of -41,3 dBm/MHz/ms e.i.r.p. A minimum total bandwidth of 3,25 GHz is needed. This is required to provide the needed object resolution for vehicle applications.

The proposed emissions within a 1 MHz bandwidth and a 1s averaging time are -50 dBm e.i.r.p. for mean power, this represents in comparison with the existing 24 GHz SRR a reduction of 8,7 dB in mean power.

The -50 dBm/MHz/s is the more stringent limit compared to original the -41,3 dBm/MHz/ms. The -41,3 dBm limit should be kept for non CEPT markets as reference to the FCC UWB limit.

The proposed peak power emissions within a 50 MHz bandwidth is -7 dBm. This represents in comparison with the existing 24 GHz SRR a reduction of 7 dB. This applies for systems with an instantaneous pulse bandwidth equal or larger than 50MHz. For systems with an instantaneous pulse bandwidth smaller than 50 MHz peak power limit should be reduced and calculated as: –7dBm – 20*log(50MHz/iBw) measured with RBW = iBw.

For example for a system with an 10 MHz iBw the peak power is reduced to -21 dBm.

A DC that is specified within a bandwidth of 50 MHz is limited to the range from 2 % to 10 % (for more detailed explanations of the DC see annex B). This results in an additional mitigation of 10 dB to 17 dB concerning peak power aggregation.

The proposed emissions within a 1 MHz bandwidth and a 1s averaging time are -50 dBm e.i.r.p. for mean power; this represents in comparison with the existing 24 GHz SRR a reduction of 8,7 dB in mean power.

The unwanted emissions in the frequency band 23,6 GHz to 24 GHz are proposed to not exceed -73 dBm/MHz e.i.r.p. to achieve coexistence with the passive services without deactivation:

a) an emission limit in the main beam will not exceed -73 dBm/MHz e.i.r.p.;

b) additional average antenna discrimination above 30 ° elevation will be at least 20 dB. The emissions above 27,5 GHz will be attenuated to a level of -61,3 dBm/MHz.

Annex A: Detailed market information

A.1 Applications

The UWB SRR technology provides a number of safety and driver convenience functions available within an UWB SRR design as shown in figure A.1 and in the list below. Some individual functions may be realizable with non-UWB technologies but not all listed performance items in a single UWB SRR realization (with the exception of the long range ACC function).

Short Range Radar UWB covered functions:

- Collision warning, collision mitigation, collision avoidance (in conjunction with 76 GHz ACC).
- Pre-crash sensing.
- Controlled firing of restraints, airbags.
- Stop and Go.
- Detection of all fixed and moving objects around the vehicle.
- Lane change warning.
- Blind spot detection.
- Parking aid.
- Low speed back-up driving.
- Pedestrian recognition.

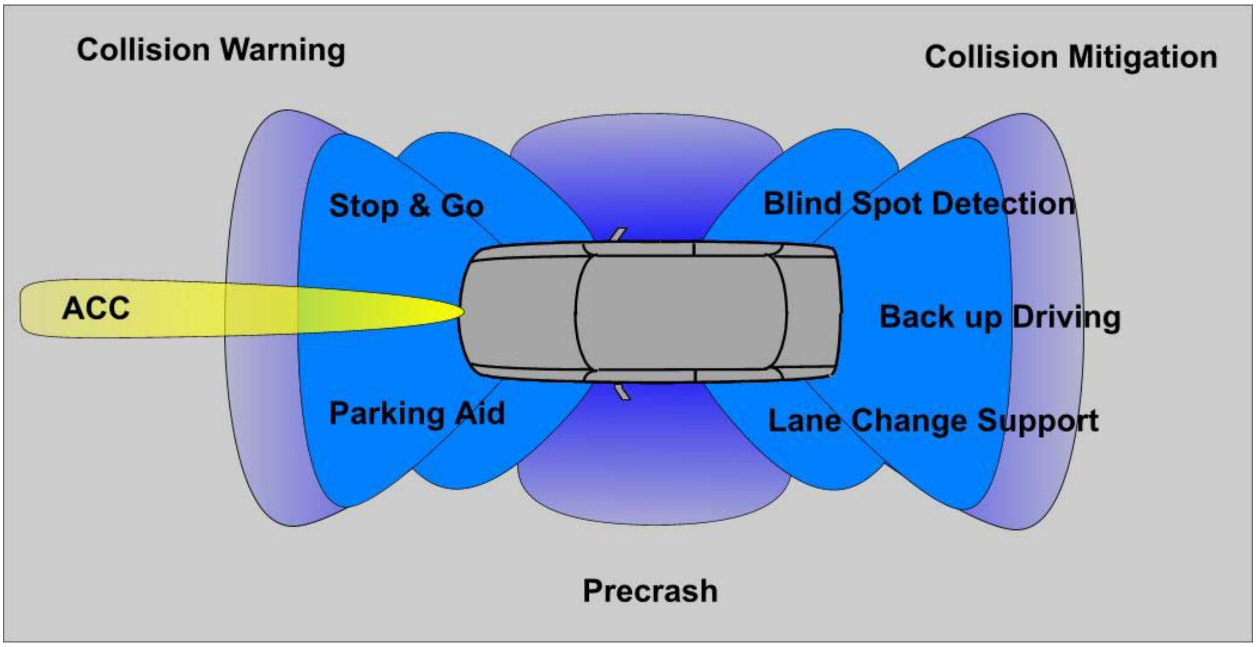

Figure A.1: Short Range Radar Applications and Functions

A.2 Market

A.2.1 Market penetration

Considering 5 years of experience in Europe and noting the high interest in e-Safety and the consumer acceptance of UWB SRRs, it is apparent that the low take-up of SRR is due to regulatory impediments which prevent the offering of UWB SRR technologies by car manufacturers to consumers.

Since some time after the issuance of the 24 GHz EC and ECC Decisions, it became clear that the timely availability of a 79 GHz qualified, and production ready technology was not given. Therefore the transition to 79 GHz as defined in the 2-phase strategy will fail, and therefore the car manufacturers with their long design and production cycles could not commit to 24 GHz UWB SRRs.

The market penetration curve in Europe is a function of this and has stalled at a low level of 0,02 % because the 2013 deadline proved to be an insurmountable obstacle for committing car manufacturers to 24 GHz UWB SRRs.

Despite strong and good faith efforts to develop alternative technology, [i.13], the 79 GHz technology today is not yet a viable technical and economic option for the coming years but it still presents an essential part of the roadmap for automotive high performance SRRs.

Meanwhile US automotive OEMs raised the prospect of 4 million to 6 million SRRs being supplied in the USA within the next years; economies of scale would raise market acceptance. The FCC regulation avoids passive band concerns in North America; their regulation is comparable to the proposal of the present document.

One large US OEM has launched its first car line in 2008 with SRR. However, this OEM will not offer UWB SRR equipped cars in Europe because of the restrictions in current frequency regulations. Further car makers are also entering the US market.

The predicted market penetration in the EU will rise similarly to North America if the UWB SRR regulation is amended as proposed in the present document.

According to the figure A.2.1, the market penetration of the different UWB SRR concepts show that considering both UWB SRR technologies of 79 GHz and 24,250 GHz to 27,5 GHz the penetration will outperform the projections of North America.

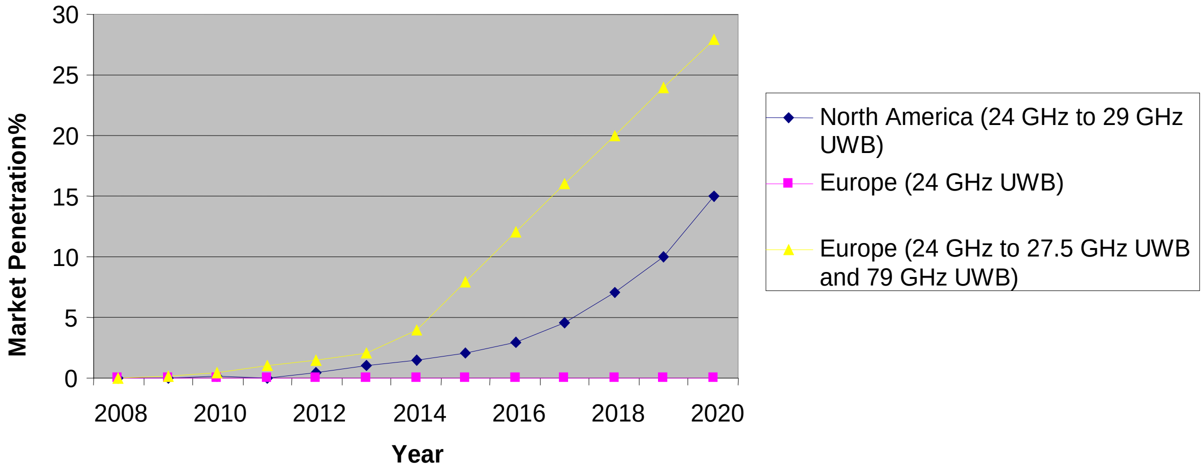

Figure A.2.1: SRR Market Penetration Forecast

A.2.2 Safety contribution and socio-economic benefit

UWB SRR is an enabling technology for enhanced active safety systems and in particular the mitigation of front-end crashes thus reducing damages and saving of lives.

Investigations of the automotive industry were made, which identify the following social economical benefit resulting from road accidents or avoidance thereof (e.g. in Germany ~36 billion Euro).

Accidents involving vehicles are related to traffic situations in which a faster reaction of the driver could have avoided crashes. Consequently, there is an increased need and appreciation for obstacle detection systems that operate at day and night.

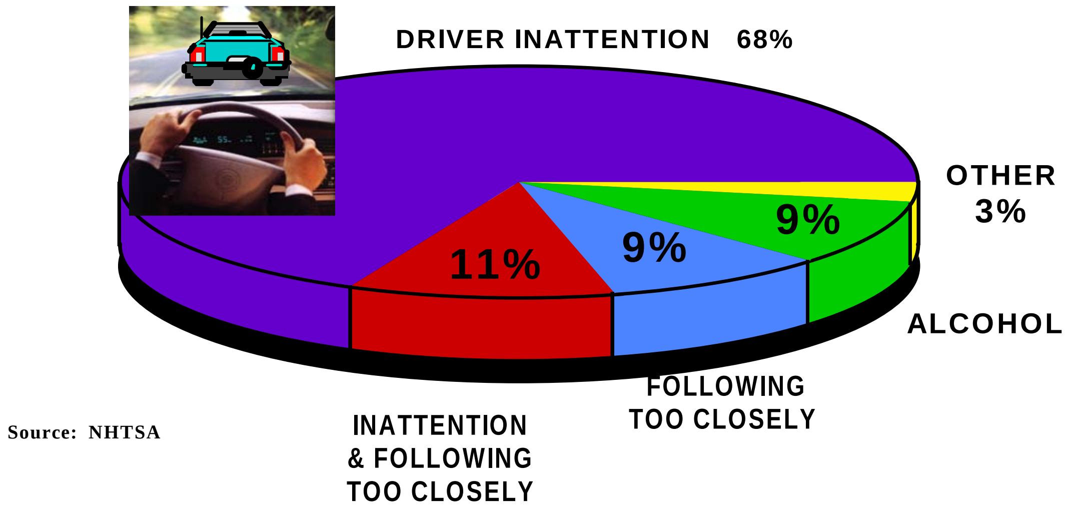

Figure A.2.2: Causes of Rear-Front Crashes

Annual damage cost caused by accidents in the EU is approximately billion EUR 100 which can be potentially avoided or minimized according to analysis given in "Volkswirtschaftliche Kosten der Personenschäden im Strassenverkehr" [i.19].

An accident study [i.18] published by Mercedes-Benz shows that 20 % of all rear end collisions can be avoided. Even more noteworthy, the findings also revealed that on motorways, where the impact of crashes are more severe than on roads, the rear-end collisions can be reduced even further to an average of 36 %.

The findings were based on a new procedure - for the first time it is possible to calculate and predict the usefulness of new safety technologies. Factors taken into account during the research included both official statistics and the analysis of the approximately 16 000 traffic accidents which have so far been studied within the framework GIDAS (German In-Depth Accident Study), as well as the reconstruction of more than 800 rear-end collisions.

Rear end collisions dominate in collision statistics. E.g. in Germany, there are over 50 000 severe rear-end accidents every year, with 5 700 death cases or serious injuries. In the U.S., around 30 % of all traffic accidents are the result of rear-end collisions. Reducing both by 20 % and additionally reducing the severity of an even higher percentage, would be a milestone in improving automotive safety.

Since the publication of TR 102 664 V1.1.1, additional safety benefit studies have been published, mainly at the 21st International Technical Conference on the Enhanced Safety of Vehicles, Stuttgart, held in June 2009:

- Helmut Schittenhelm, The Vision of Accident Free Driving - The *Swedish Road Administration* (SRA) published a study that reduction of collision impact speed by 10 % would reduce risk of fatalities by 30 %. [i.32]
- Claes Tingvall et al., The Effects of Automatic Emergency Braking on fatal and serious Injuries, 21st International Technical Conference on the Enhanced Safety of Vehicles, Stuttgart, 2009, http://www-nrd.nhtsa.dot.gov/pdf/esv/esv21/09-0419.pdf [i.34].

A.2.3 Global SRR scenario and regulations

Figure A.2.3 displays the different automotive radar systems, the associated standards and regulations for major countries in the ITU regions 1, 2 and 3.

While the 24 GHz UWB SRR is time limited and cannot achieve global harmonization, the proposed new regulation is the potential global solution for all ITU regions for UWB SRRs.

It is also to note that the 79 GHz regulation is to be addressed for regulatory amendments in the US and Canada.

	24 GHz NB Radar	24 GHz UWB SRR	24 GHz to 29 GHz UWB SRR	76 GHz ACC	79 GHz SRR
Europe	EN 302 858 SRD ISM band CEPT/REC 70-03 (see note 1)	EN 302 288 2005/50/EC (see note 2)	EN 302 697 2009/xx/EC *(will be issued in 2009 or 2010)*	EN 301 091 CEPT/ECC Decision DEC(02)01 CEPT/REC 70-03	EN 302 264 2004/545/EC
USA	Parts 15.245 (see note 3) and 15.249 (see note 4) general Part 15	Parts 15.515 and 15.252 FCC 02/42 and FCC 04/285	Parts 15.515 and 15.252 FCC 02/42 and FCC 04/285	Part 15.253 general Part 15	not available - will be addressed
Japan	RADIOLOCATION – Unlicensed Low Power Services in Annex 6-3-2-11	24 GHz SRR study started in 12/2006	*The 24 GHz to 29 GHz range is favoured but needs studies*	Low Power Service (millimeterwave radars) in Annex 6-3-2-8	78 GHz to 81 GHz in future frequency allocation plan (see note 5)
Canada	RSS-210	New regulation in final stage RSS-220 in RABC for approval	*New regulation In final stage RSS-220 in RABC for approval*	RSS-210	not available- will be addressed

Color Legend:

Standard for compliance
Decision or legal framework

NOTE 1: Not harmonized in Europe, national restrictions (not Class 1 equipment).
NOTE 2: Time limitation until 2013, then shift to 79 GHz.
NOTE 3: Field Disturbance Sensor band from 24,075 to 24,175 GHz with 32,7 dBm radiated power.
NOTE 4: Any frequency band from 24,00 to 24,25 GHz with 12,7 dBm radiated power.
NOTE 5: http://www.soumu.go.jp/menu_news/s-news/2006/pdf/061031_3_bt.pdf.

Figure A.2.3: Global SRR regulatory, standard status including proposed SRR regulation

Annex B: Technical information

B.1 Technical description

B.1.1 SRR systems overview

An SRR systems overview and operational parameters with technical descriptions is given in TR 101 982 [i.11] and in the following links:

- http://ftp.ero.dk/wgse/Se24/SE24_M14_Jan_02_London,/M14_05RO_SE24_24G_System-Tyco.pdf
- http://ftp.ero.dk/wgse/Se24/SE24_M14_Jan_02_London,/M14_14R0_SE24_WI02_01-24GHz_System_SV.pdf

All systems or devices are pursuant to the national regulations regarding peak and average e.i.r.p. power emission of the present regulations.

Due to different regional rule-making or standard implementations, the frequency emission masks can be different in shape and range; i.e. US and Canada do have a box shape type mask from 22 GHz to 29 GHz while Europe and Australia presently do have a mask that is centred around 24,125 GHz with slopes on both sides [i.9].

Figure B.1.1 provides an overview over the key parameters as Doppler (object distance) resolution, the angle resolution and range or object discrimination resolution.

The comparison shows that SRRs operating at the highest frequency and with high bandwidth provide the best SRR performance.

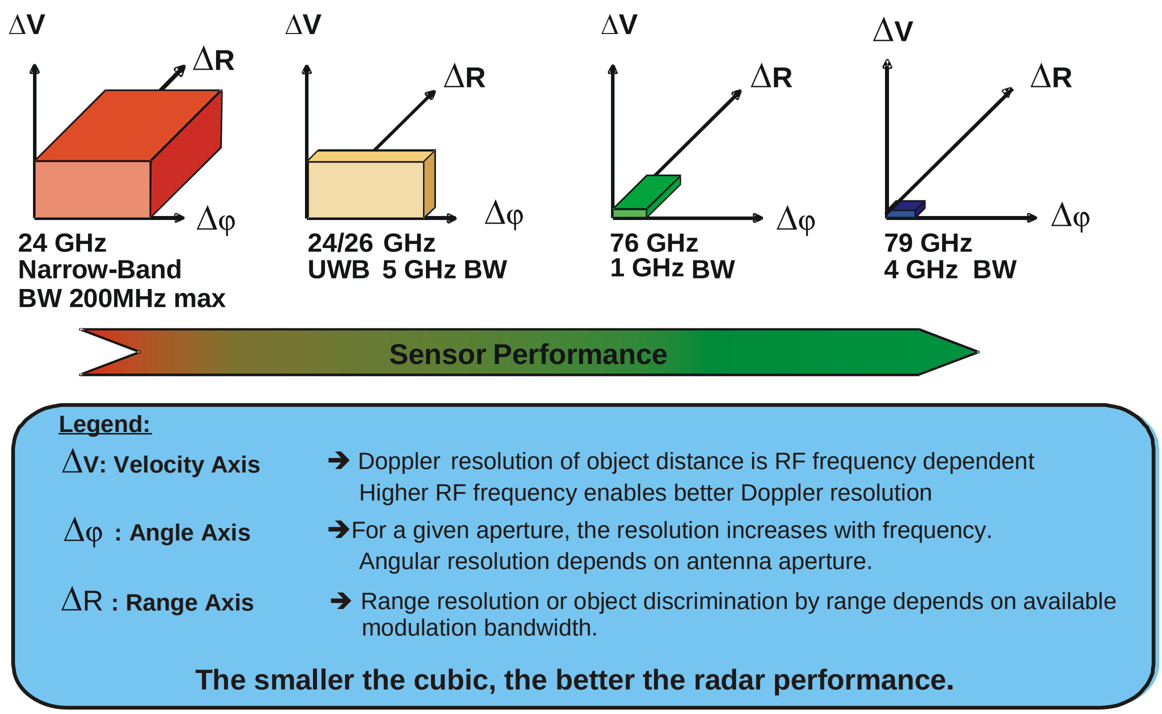

Figure B.1.1: Automotive Radar performance overview and evolution of systems

The 24 GHz narrowband radar uses the higher emission levels of the ISM band, the resolution of objects to be detected is limited by the available frequency bandwidth which is 200 MHz maximum. In order to provide the same functionality as UWB SRRs the system would have to employ several different sensor modules or restrict the functionality e.g. to distance measurements only.

The UWB SRR systems operating in the 24,15 GHz ± 2,5 GHz respectively 24 GHz to 27,5 GHz range provide a higher spatial resolution given by the higher bandwidth as shown in figure B.1.1 as compared to Narrow Band radars (NB). Also the range of the forward distance measurement to objects or cars is from near zero to about 30 meters. Several modules installed e.g. in front and backward bumpers provide a surround looking performance (see figure A.1).

The 76 GHz ACC radar is designed for long range forward looking distance measurement with narrow beam forming and combined with limited scanning performance. The systems are designed for automotive cruise control primarily on highways to maintain distance to proceeding vehicles within a pre-settable speed limit. The operating range is up to approximately 150 m but the minimum operational distance is 30 m.

The 79 GHz systems in conjunction with the 76 GHz provide enhanced performance for all three functions as measuring distance resolution, the detection and position determination of smaller object sizes and the relative velocity to other cars. The smaller size provides more designer freedom which is a continued requirement from the car industry.

The fact that the radar frequencies for ACC 76 GHz and 79 GHz SRR are adjacently allocated bands allows the combination of both sensor technologies in a single module. This lowers the system cost as compared to individual sensor modules provided for ACC and SRR individually.

The combined installation 24 GHz SRRs with 76 GHz ACC provides the optimum of safety functionality and is already practiced in cars on the road [i.13].

The UWB emissions for the main SRR function operates in the range 24,25 GHz to 27,5 GHz. Additionally SRR systems can be combined with some functions operating in the ISM band from 24,05 GHz to 24,250 GHz which are not covered in the present document. Such additional non-UWB functions are covered in the EN 302 858 [i.35] (under development).

B.1.2 Design considerations for 24 GHz to 27,5 GHz UWB SRR systems

The 24,15 GHz ± 2,5 GHz UWB SRR systems referenced in clause B.1.1 can be redesigned to the proposed frequency range without major redesign and can be placed onto the marketed as product variants. The transition time from the present 24,15 GHz ± 2,5 GHz systems to the proposed frequency range is rather short. Systems using modulation techniques based on pulsed frequency hopping have a reduced interference impact.

Pulsed frequency hopping (pulsed FH) systems have considerably reduced interference impact on narrowband radio links compared to Pulse Position Modulation (PPM) radars [i.28], [i.30]. This results in particular from the following facts.

- The single pulses of a pulsed FH radar system only occupy a small fraction of the total system bandwidth with the center frequency of the pulses being varied over the full system bandwidth. Hence only a small fraction of the total number of radiated pulses will be capable of interfering with a possible narrowband victim system.

- The single pulses of a pulsed FH radar system have much longer duration than the single pulses of a PPM system. Under the assumption of equal mean power and similar pulse repetition frequencies this results in a drastically lower peak power for the pulsed FH system, which reduces the interference impact in particular for wideband victim systems.

- The aggregated average power and the aggregated peak power from a high number of pulsed FH radar systems are drastically reduced compared to the aggregated average and peak power from the same amount of PPM radar systems due to the limited probability that two pulsed FH radars instantaneously occupy the same frequency slot. Moreover, the aggregated interference from pulsed FH radars shows a considerable lower peak to average ratio than the signal emitted from a single pulsed FH device when measured according to the regulations.

The bandwidth of the single pulse of a pulsed FH radar is only a small fraction of the total system bandwidth. Typically, the FH radar transmits a train of consecutive pulses on the same centre frequency in order to achieve a processing gain from the integration of the received pulses. Figure B.1.2.1 shows the temporal occupancy of the available spectrum resource caused by the pulsed FH radar.

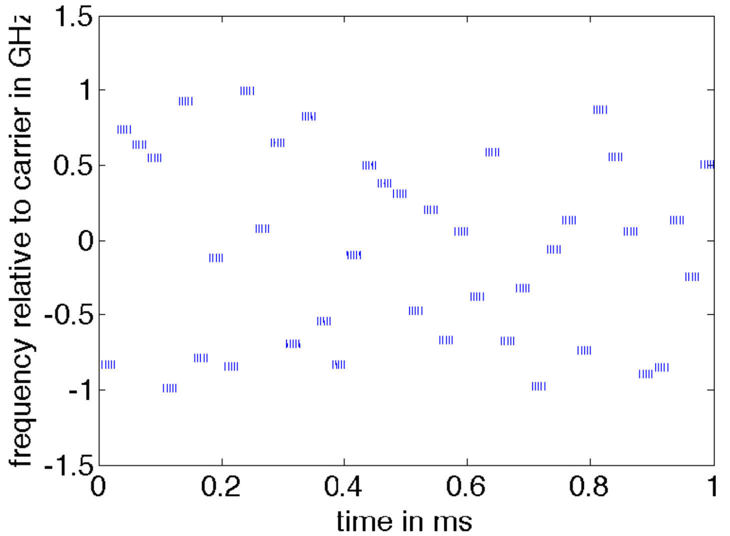

Figure B.1.2.1: Spectrum occupancy caused by a pulsed FH radar system

It can be clearly seen that at every time instant only a small fraction of the entire system bandwidth is occupied. An activity can only be observed for a small fraction of the total observation time and only a small fraction of the total amount of transmitted pulses will be detected. Hence, in contrast to the PPM radar, each pulse radiated from the pulsed FH radar has only a limited probability of causing interference on a narrowband receiver.

All pulses are radiated with a constant pulse repetition interval, which in contrast to the PPM radar does not smooth the spectrum but produces discrete spectral lines separated by the inverse of the pulse repetition interval. The total output spectrum is the product of these discrete lines and the single pulse spectrum. Hence the spectrum of the complete emitted pulse train will be much narrower than the single pulse spectrum. The output signal spectrum of the regarded pulsed FH radar is shown in figure B.1.2.2.

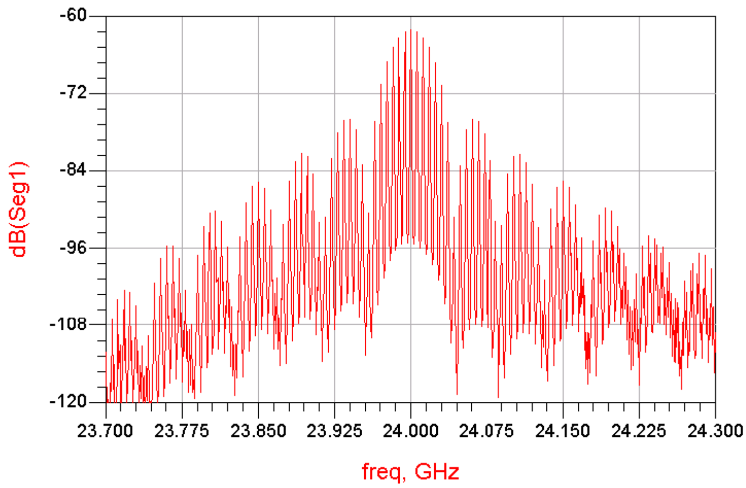

Figure B.1.2.2: Signal spectrum of one pulse train emitted from a pulsed FH radar system

After every transmission of this pulse train the FH radar changes the centre frequency of the transmitted pulses according to a predefined pattern. Typically, this pattern also incorporates frequency shifts that are smaller than the single pulse bandwidth, which results in the availability of a set of transmit channels that are completely orthogonal.

In the regarded system specification the discrete spectral lines are separated by 6 MHz. With the single pulse bandwidth being 50 MHz, there are 9 discrete spectral lines that lie inside the single pulse bandwidth and contain a significant power contribution. This can also be clearly seen in figure B.1.2.2, where 9 discrete spectral lines appear within a dynamic range of 10 dB. The 5th spectral line beside the center has an attenuation of more than 10 dB compared to the centre spectral line and hence can be assumed as negligible. The total amount of orthogonal channels that the system provides is the total number of frequency slots divided by number of the replica of the centre spectral line, which results in 2 048/9 = 228. In table B.1.2 the system parameters of the regarded pulsed FH radar system are summarized.

Table B.1.2: Example: a system specifications of a pulsed FH radar system

Parameter			
		Typical	**Maximum**
Total System Bandwidth	GHz	2	3,25
Single Pulse Bandwidth	MHz	50	80
Burst Duration	µs	20	29
PRI	ns	180	60
No of freq. Channels		2 048	2 048
Total Cycle Time	ms	40	60
Duty Cycle within 50 MHz	%	2,5	1,5
Peak Power in 50 MHz	dBm	-7	-7
Mean Power /MHz/ms	dBm/MHz	-42,6	-41,9
Mean Power /MHz/s	dBm/MHz	-51,4	-54,2

B.2 Technical justifications for spectrum

B.2.1 Power issues

The vehicular SRRs in the 24 GHz ranges operate at very low power levels of -41,3 dBm/MHz while in UWB mode. Some car manufacturers and equipment suppliers have designed automotive radar systems that operate in the SRD band from 24,05 GHz to 24,25 GHz with the higher emission power of +20 dBm over entire bandwidth. A mixed operation mode (either UWB or SRD band) is planned by some of the automotive suppliers.

A consideration of even lower limits as -41,3 dBm/MHz for UWB SRRs will cut the operational parameters and not meet the required functionality and is internationally not compatible.

B.2.2 Frequency issues

The main justification for the need of a UWB operation mode is resolution and object separation capability. For some safety-critical application a precise localization and separation is needed, which is mainly in the near vicinity around the car up to maximum 30 m (best fit for UWB operation). Other mid-range applications need less resolution but higher distance and therefore higher power (best fit for SRD band operation).

Due to mounting space restrictions, higher frequencies as the 79 GHz range are always in the focus, but economy of scales prevents a too fast shift up in frequencies. Therefore the 24,25 GHz to 27,5 GHz SRR designation is required. A minimum total bandwidth of 4 GHz as used by the 79 GHz SRR technology and within the 24 GHz to 27,5 GHz frequency range is required to provide the needed object resolution.

B.2.3 New radio parameter proposal

The constraints that are actually imposed to the operation of 24 GHz UWB SRR in Europe make an even moderate market proliferation impossible. Due to the severe limits imposed by the passive services in the 23,6 GHz to 24 GHz band a frequency shift avoiding the protected frequency range is the only reasonable way forward. A new European frequency mask (see figure B.2.3) is therefore proposed which avoids any intentional emission in the restricted band. As noted economical constraints prevent an immediate shift up to 79 GHz but do require this intermediate step.

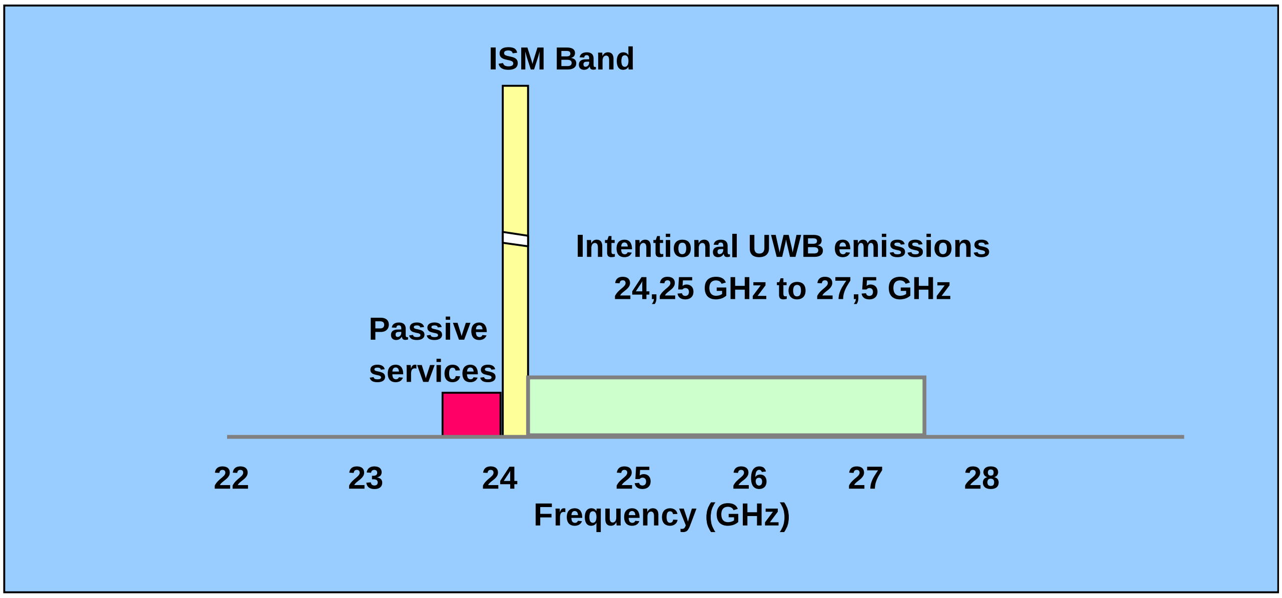

Figure B.2.3: Frequency band proposal for the 24,25 GHz to 27,5 GHz band

B.2.4 Summary of the new UWB SRR proposal versus 24 GHz UWB SRRs

Table B.2.4 compares the proposed parameters of the present 24 GHz solution as investigated in section 2 of the ECC Report 23 [i.10] to the proposed parameters in order to facilitate compatibility.

Table B.2.4: Parameter comparison of present proposal to 24 GHz SRR

Parameter	Limit	Comment
Original limit proposal of the SRDoc TR 102 664 (V1.1.1)		**Resulting Mitigation compared to current regulation**
SRR Frequency Range	24-29 GHz (5 GHz)	The passive band is avoided
Mean Power @ 1MHz/ms	-41,3 dBm/MHz	None
Peak power @ 50MHz	0 dBm	None
New or revised limits proposed for the revised TR 102 664 (see note 1)		**Resulting Mitigation compared to current regulation**
SRR Frequency Range	24,25 GHz to 27,5 GHz (3,25 GHz)	The passive band is avoided and the overall bandwidth for SRR is reduced by 1,75 GHz
Peak Power	–7 dBm/50 MHz (for iBW ≥ 50 MHz) or –7 dBm – 20*log(50 MHz/iBW) measured with RBW = iBW (for iBW < 50 MHz)	7 dB (see note 2)
Mean Power @ 1MHz/1s	-50 dBm/MHz	~9 dB for mean power aggregation (see note 2) 10 dB (DC=10 %) to 17dB (DC=2 %), in average, for peak power aggregation (additional to 7 dB mitigation due to the peak power reduction) (see note 3)
Duty Cycle (DC)	2 % to 10 % per 50 MHz and per sec	
Mean Power in 23,6 - 24 GHz Band @1MHz/s	-74 dBm/MHz	Main Beam Emission Level in the passive band to protect EESS and RA without deactivation
Definitions: DC = Ton/Toff % with: Ton defined as the duration of a burst irrespective of the number of pulses contained. Toff defined as the time interval between two consecutive bursts when the UWB emission is kept idle. iBW = instantaneous bandwidth of each single pulse, defined to be the inverse of the pulse duration (to be measured with frequency hopping, if any, stopped).		
NOTE 1: The new prescriptive proposal takes into account that new study has shown that the peak power interference increase would be much more impacting than an equivalent mean power interference increase. The benefit of a reduced Duty Cycle implies the burst-like nature of the SRR application; therefore a suitable burst limitation is proposed. NOTE 2: Compared with the limit for SRR of -41,3 dBm/MHz with 100 % Duty Cycle. NOTE 3: This improvement has been theoretically calculated from the proposed Duty Cycle limitation and would further limit the possible worst case interference due to undesired peak impact on a wideband victim receiver.		

Studies in ITU-R Task Group 1/8 have come to different conclusions as in ECC Report 23 [i.10] as a result of different assumptions. The studies derive different numerical conclusions based on two different FS deployment cases with the assumptions described below.

For a better understanding of compatibility in realistic traffic scenarios it is helpful to investigate different radio interference scenarios with suitable simulation tools, e.g. SEAMCAT.

B.3 Information on current version of relevant ETSI standard

The current version of the Harmonized Standard EN 302 288 (V1.4.1) [i.9] is not applicable because of the different frequency range and the number of restrictions imposed.

A new harmonized standard EN 302 697 [i.36] is under development.

Annex C: Expected compatibility issues

C.1 Existing allocations

The present allocations concerning the proposed frequency range are provided in table C.1.

Table C.1: Allocations in the range of 24,25 GHz to 27,5 GHz

Frequency band	Allocations	Applications
24,0 GHz to 24,05 GHz	AMATEUR AMATEUR-SATELLITE	Amateur-satellite Amateur (24,0 GHz to 24,25 GHz) ISM (24,0 GHz to 24,25 GHz) Non-specific SRDs (24,0 GHz to 24,25 GHz) SAP/SAB and ENG/OB (24,0 GHz to 24,25 GHz)
24,0 GHz to 24,25 GHz	RADIOLOCATION Amateur Earth Exploration-Satellite (active) Fixed Mobile	Amateur (24,0 GHz to 24,25 GHz) ISM (24,0 GHz to 24,25 GHz) Non-specific SRDs (24,0 GHz to 24,25 GHz) SAP/SAB and ENG/OB (24,0 GHz to 24,5 GHz) Defence systems Detection of movement Weather satellites Detection of movement (24,05 GHz to 27,0 GHz)
24,25 GHz to 24,45 GHz	FIXED MOBILE	SAP/SAB and ENG/OB (24,0 GHz to 24,5 GHz) Detection of movement (24,05 GHz to 27,0 GHz) SAP/SAB P to P audio links (24,25 GHz to 24,5 GHz) SAP/SAB P to P video links (24,25 GHz to 24,5 GHz)
24,45 GHz to 24,5 GHz	FIXED MOBILE	SAP/SAB and ENG/OB (24,0 GHz to 24,5 GHz) Detection of movement (24,05 GHz to 27,0 GHz) SAP/SAB P to P audio links (24,25 GHz to 24,5 GHz) SAP/SAB P to P video links (24,25 GHz to 24,5 GHz)
24,5 GHz to 24,65 GHz	FIXED	Detection of movement (24,05 GHz to 27,0 GHz) Fixed links (24,5 GHz to 26,5 GHz) Point-to-Multipoint (24,5 GHz to 26,5 GHz)
24,65 GHz to 24,75 GHz	FIXED	Detection of movement (24,05 GHz to 27,0 GHz) Fixed links (24,5 GHz to 26,5 GHz) Point-to-Multipoint (24,5 GHz to 26,5 GHz)
24,75 GHz to 25,25 GHz	FIXED	Detection of movement (24,05 GHz to 27,0 GHz) Fixed links (24,5 GHz to 26,5 GHz) Point-to-Multipoint (24,5 GHz to 26,5 GHz)
25,25 GHz to 25,5 GHz	FIXED INTER-SATELLITE MOBILE	Detection of movement (24,05 GHz to 27,0 GHz) Fixed links (24,5 GHz to 26,5 GHz) Point-to-Multipoint (24,5 GHz to 26,5 GHz)
25,5 GHz to 26,5 GHz	FIXED INTER-SATELLITE MOBILE Earth Exploration-Satellite (space-to-Earth)	Detection of movement (24,05 GHz to 27,0 GHz) Fixed links (24,5 GHz to 26,5 GHz) Point-to-Multipoint (24,5 GHz to 26,5 GHz)
26,5 GHz to 27,0 GHz	FIXED INTER-SATELLITE MOBILE Earth Exploration-Satellite (space-to-Earth)	Detection of movement (24,05 GHz to 27,0 GHz) Defence systems (26,5 GHz to 27,5 GHz)
27,0 GHz to 27,5 GHz	FIXED INTER-SATELLITE MOBILE Earth Exploration-Satellite (space-to-Earth)	Defence systems (26,5 GHz to 27,5 GHz)

It is noted that the frequency range 26,5 GHz to 27,5 GHz is a harmonized NATO band type 2 for planned military use (based on allocations for the Fixed and Mobile Service, but without allocation for the Radiolocation Service) according to the NJFA (NATO Joint civil/military Frequency Agreement) and according to ERC Report 25 (The European table of frequency allocations and utilizations in the frequency range 9 kHz to 3 000 GHz) [i.21].

C.2 Coexistence and sharing issues

Compatibility studies are needed, most notably for co-existence with Fixed Services, as far as not covered by existing studies performed for UWB SRRs in the ECC.ITU-R Recommendation SM.1757 [i.23] needs to be considered.

Annex D: Bibliography

- ETSI EN 300 440 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short range devices; Radio equipment to be used in the 1 GHz to 40 GHz frequency range".
- ITU-R Recommendation SM.1756: "Framework for the introduction of devices using ultra-wideband technology".
- Viviane Reding, Speech/08/: "Choose ESC, Choose life".

NOTE: See http://ec.europa.eu/information_society/activities/esafety/doc/2008/choose_esc_speech_vr.pdf.

- ERC Recommendation 74-01: "Unwanted emissions in the spurious domain".
- CEPT/ERC REC 70-03:" Relating to the Use of Short Range Devices (SRD)".
- CEPT/ECC Decision DEC(02)01: "ECC Decision of 15 March 2002 on the frequency bands to be designated for the coordinated introduction of Road Transport and Traffic Telematic Systems".
- SE24-DG FM47-02R0; Autoliv-Limit proposals for 26GHz SRR.

History

Document history		
V1.1.1	April 2009	Publication
V1.2.1	April 2010	Publication