



Technical Report

**Electromagnetic compatibility
and Radio spectrum Matters (ERM);
System Reference document (SRdoc);
Technical characteristics for pan European harmonized
communications equipment operating
in the 5,855 GHz to 5,925 GHz range intended for
road safety and traffic management,
and for non-safety related ITS applications**

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Foreword

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

Introduction

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 Post and Telecommunications Administrations (CEPT).

In the present document the existing frequency allocation for Intelligent Transport Systems (ITS) including the out-of-band spectrum mask will be reviewed. This review will include a detailed analyses of the interference potential of the ITS systems operating in the 5 GHz band towards potential victim services.

1 Scope

The present document describes the updated spectrum usage requirements for equipment related to:

- roadside/infrastructure to vehicle communications (RVC);
- inter-vehicle communications (IVC);
- restricted portable devices to vehicle communications;

with the main focus onto the out-of-band spectrum mask in the band between 5 725 MHz to 5 965 MHz in order to allow for an efficient system implementation.

It includes necessary information to support the co-operation between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Post and Telecommunications Administrations (CEPT), including:

- Market information in annex A.
- Technical information in annex B.
- Coexistence information in annexes C and D.

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.

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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] CEPT ECC/DEC/(04)08 of 12 November 2004 on the harmonised use of the 5 GHz frequency bands for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs).
- [i.2] FCC Rules and Regulations, (August 3, 2004): "Regulations governing the licensing and use of frequencies in the 5850 – 5925 MHz band for Dedicated Short Range Communications Service".
- [i.3] Car-2-Car Communication Consortium (Press Release of 10 October 2012): "European vehicle manufacturers working hand in hand on deployment of cooperative Intelligent Transport Systems and Services (C-ITS)".

NOTE: Available at: <https://www.car-2-car.org/car2car08/index.php?id=20>.

- [i.4] ETSI EN 300 674: "ElectroMagnetic Compatibility and Radio Spectrum Matters (ERM); Road Transport and Traffic Telematics (RTTT); Technical characteristics and test methods for Dedicated Short Range Communication (DSRC) transmission equipment (500 kbit/s/250 kbit/s) operating in the 5,8 GHz Industrial, Scientific and Medical (ISM) band".
- [i.5] Commission Decision 2008/671/EC of 5 August 2008 on the harmonised use of radio spectrum in the 5 875-5 905 MHz frequency band for safety-related applications of Intelligent Transport Systems (ITS).
- [i.6] ETSI EN 302 571 (V1.2.1): "Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".
- [i.7] ECC/DEC/(08)01: "ECC Decision of 14 March 2008 on the harmonised use of the 5875-5925 MHz frequency band for Intelligent Transport Systems (ITS)".
- [i.8] ECC/REC/(08)01: "ECC Recommendation (08)01 on the use of the band 5855-5875 MHz for Intelligent Transport Systems (ITS)".
- [i.9] ECC Report 101: "Compatibility studies in the band 5855- 5925 MHz between Intelligent Transport Systems (ITS) and other systems", Bern, February 2007.
- [i.10] ECC Report 109: "The aggregate impact from the proposed new systems (ITS, BBDR and BFWA) in the 5725-5925 MHz band on the other services/systems currently operating in this band", Budapest, September 2007.
- [i.11] IEEE 802.11j: "Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks-Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications- Amendment 7: 4.9 GHz-5 GHz Operation in Japan".
- [i.12] IEEE 802.11a: "Information Technology – Telecommunications and Information Exchange Between Systems – LAN/MAN – Specific Requirements".
- [i.13] IEEE 802.11-2012: "IEEE Standard for Information technology–Telecommunications and information exchange between systems Local and metropolitan area networks–Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".
- [i.14] IEEE 802.11h: "Standard for IT – Telecommunications and information exchange between systems – LAN/MAN – Specific requirements Part 11: Wireless MAC and PHY Specifications – Spectrum and Transmit Power Management Extensions in the 5 GHz Band in Europe".
- [i.15] SRDMG(13)Info3: "Implementation status ECC/DEC/(08)01 at the end of 2012".
- [i.16] ETSI TR 101 607: "Intelligent Transport Systems (ITS); Cooperative ITS (C-ITS); Release 1".
- [i.17] ETSI TS 102 792: "Intelligent Transport Systems (ITS); Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (CEN DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range".
- [i.18] ETSI EN 302 665: "Intelligent Transport Systems (ITS); Communications Architecture".
- [i.19] Project: SimTD: Sichere Intelligente Mobilität: Testfeld Deutschland.
- NOTE: Available at <http://www.simtd.de/>.
- [i.20] European Commissions Mandate M/453: "Standardisation Mandate addressed to CEN, CENELEC and ETSI in the field of information and communication technologies to support the interoperability of Co-operative Systems for Intelligent Transport in the European Community", Brussels, October 2009.
- [i.21] CEPT/ERC Report 25: "The European Table of Frequency Allocations and Utilisations Covering the Frequency Range 9 kHz to 275 GHz".

- [i.22] Recommendation ITU-R F.1613: "Operational and deployment requirements for fixed wireless access systems in the fixed service in Region 3 to ensure the protection of systems in the Earth exploration-satellite service (active) and the space research service (active) in the band 5 250-5 350 MHz".
- [i.23] Recommendation ITU-R M.1638: "Characteristics of and protection criteria for sharing studies for radiolocation, aeronautical radionavigation and meteorological radars operating in the frequency bands between 5 250 and 5 850 MHz".
- [i.24] Recommendation ITU-R SA.1632: "Sharing in the band 5 250-5 350 MHz between the Earth exploration-satellite service (active) and wireless access systems (including radio local area networks) in the mobile service".
- [i.25] CEN EN 12795: "Road transport and traffic telematics – Dedicated Short Range, Communication (DSRC) – DSRC data link layer: medium access and logical link control".
- [i.26] ERC Rec 70-03: "Relating to the use of Short Range Devices (SRD)", Tromsø 1997, amended October 2013.
- [i.27] CEN EN 13372: "Road transport and traffic telematics – Dedicated Short Range Communication (DSRC) – Profiles for RTTT applications".
- [i.28] CEN EN 12253: "CEN EN 12253: "Road transport and traffic telematics – Dedicated Short Range Communication (DSRC) – Physical layer using microwave at 5,8 GHz".
- [i.29] ETSI TR 102 654: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Road Transport and Traffic Telematics (RTTT); Co-location and Co-existence Considerations regarding Dedicated Short Range Communication (DSRC) transmission equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range and other potential sources of interference".
- [i.30] ETSI TR 102 960: "Intelligent Transport Systems (ITS); Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (RTTT DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range Evaluation of mitigation methods and techniques".
- [i.31] Recommendation ITU-R SM.329: "Unwanted emissions in the spurious domain".
- [i.32] Recommendation ITU-R SM.1539: "Variation of the boundary between the out-of-band and spurious domains required for the application of Recommendations ITU-R SM.1541 and ITU-R SM.329".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

inter-vehicle communications: generic expression for bi-directional communications between vehicles

NOTE: May include multi-hop routing involving several vehicles.

On-board unit: radio, transmitter and receiver, installed in a vehicle

NOTE: A portable user device brought into the vehicle and connected to the vehicle's electronic system will also fall under this definition.

Pedestrian-to-vehicle communications: communications between a mobile or portable user device and a vehicle

portable unit: pedestrian device, e.g. a portable user device that can send and receive vehicular safety messages

road-side unit: radio, transmitter and receiver, usually fixed as part of the road infrastructure installed along a road, e.g. on gantries above the lane or at poles beside the lane

NOTE: Can be a single RSU in a stand-alone fashion or a group of RSUs connected to infrastructure.

Roadside-to-vehicle communications: communication between a RSU and a mobile ITS station, also referred to as downlink communications

roadside-vehicle communications: generic expression for communications between a roadside and a vehicle, which may include both downlink and uplink communications

NOTE: May include multi-hop routing involving several vehicles, may allow for Internet access, may be based on handover between adjacent roadside units.

Road Transport and Traffic Telematic (RTTT): Transport and traffic telematics systems for the dedicated use in road environments

Transport and Traffic Telematic (TTT): systems in which information and communication technologies are applied in the field of transport (depending on technical restrictions for road rail, water and air), traffic management, navigation and mobility management, as well as for interfaces with other modes of transport including communication in vehicles between vehicles (e.g. car-to-car), and between vehicles and fixed locations (e.g. car-to-infrastructure).

NOTE: In the actual regulatory discussion and documents RTTT is being replaced with TTT, see ERC REC 70-03 [i.26].

Vehicle-to-roadside communications: communication between a mobile ITS station and an RSU, also referred to as uplink communications

3.2 Symbols

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

P_e	received power in dBm
P_s	transmit power in dBm
G_s	transmit antenna gain in dBi
G_e	receive antenna gain in dBi
L	path loss in dB
L_0	path loss in dB up to the breakpoint
d	distance
d_0	breakpoint
λ	carrier wave length
r	radius of first Fresnel zone
n	path loss coefficient

3.3 Abbreviations

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

ABS	Antilock Braking system
ACC	Automotive Cruise Control
BER	Bit error ratio
BPSK	Binary Phase shift Keying
BSA	Basic set of applications
BW	Bandwidth
C2C-CC	Car-to-Car Communication Consortium
CALM M5	CALM for the 5 GHz Microwave range
CALM	Continuous Air interface Long and Medium range
CAM	Cooperative awareness message
CEN	European Committee for Standardization
CEPT	European Conference of Postal and Telecommunications Administrations
dBm	Power in decibel relative to 1 mW

DCC	Decentralized Congestion Control
DENM	Decentralized Environmental Notification Message
DFS	Dynamic Frequency Selection
DSRC	Dedicated Short Range Communication
e.i.r.p.	equivalent isotropically radiated power
EC	European Commission
ECA	European Common Allocation
ECC	Electronic Communication Committee
EIRP	Equivalent Isotropically Radiated power
EN	European Norm
ERC	European Radiocommunications Committee
EU	European Union
FCC	Federal Communication Commission
FIXED	no abbreviations
FSS	Fixed Satellite System
GI	Guard Interval
GSO	Geostationary Satellite Orbit
IEEE	Institution of Electrical and Electronic Engineers
Ipv6	Internet Protocol version 6
ISM	Industrial, Scientific and Medical
ISO	International Standards Organization
ITS	Intelligent Transport Systems
ITS-G	5,9 GHz Cooperative ITS system
ITU-R	International Telecommunication Union - Radio
IVC	Inter-Vehicle Communications
LBT	Listen-Before-Talk
LHCP	Left Hand Circular Polarization
MAC	Medium Access Control
MSS	Mobile Satellite station
OBU	On-Board Unit
OEM	Original Equipment Manufacturer
PHY	Physical Layer
QPSK	Quadrature Phased Shift Keying
R&TTE	Radio Equipment & Telecommunications Terminal Equipment
R2V	Roadside-to-Vehicle
RF	Radio Frequency
RLAN	Radio Local Area Network
RR	Radio resource
RSU	Road-Side Unit
RTTT	Road Transport and Traffic Telematics
RVC	Roadside-Vehicle Communications
RX	Receiver
SRD	Short Range Device
TB	Technical Body
TBD	To be discussed
TC	Technical Committee
TPC	Transmit Power Control
TR	ETSI Technical Report
TS	Technical Specification
TTT	Transport and Traffic Telematic
TX	Transmitter
US	United States
USA	United States of America
V2R	Vehicle-to-Roadside
V2V	Vehicle-to-Vehicle
VTS	Vessel Traffic Service
WAS	Wireless Access System
WAVE	Wireless Access in Vehicular Environment

NOTE: Name of WLAN for Vehicular Environments technology in IEEE 802.11-1012 [i.13].

WLAN Wireless Local Area Network

4 Executive summary

ECC Decision (08)01 and Commission Decision 2008/671/EC [i.5] identify the frequency band 5 875 MHz to 5 905 MHz on a non-exclusive basis for ITS road safety applications. ECC Decision (08)01 is currently implemented in 39 CEPT countries including all EU member states. TR 101 607 [i.16] includes the standards developed under the mandate 453 and was **agreed in early 2013 as the Release 1 for ITS in the spectrum 5 875 MHz to 5 905 MHz**. The objectives for a release process are:

- An organized process for standardization activity for cooperative ITS.
- Standardization based on agreed functionalities to be deployed by the stakeholders.
- The release process to be coordinated between the CEN and ETSI as far as possible.
- The functionalities and technologies (i.e. the features) to be subject to a consultation process with stakeholder deploying the cooperative ITS.

Release 1 is basically the "minimum set of standards" for interoperability provided in accordance with M/453 [i.20]. These standards are intended for the initial deployment of cooperative ITS and have been developed by ETSI and CEN. They include a basic set of ITS applications (BSA).

The application and facility layer standards cover the requirements deriving from the basic use cases identified by the involved stakeholders for the initial deployment. This includes agreed message sets as well as the higher layer data exchange protocols required for driver information and for dissemination of hazard warnings.

In addition a standard for a simplified point of interest notification service for electrical vehicles has been developed within ETSI and published.

The focus has been set on direct V2V communication, an access technology agnostic approach has been at all times followed, this guaranteeing the future validity of Release 1 standards.

The developed communication standards include the network and transport layers, GeoNetworking for ITS-G5 (GPS/Galileo positioning information is used) and Basic Transport Protocol being fully specified. The required standards for enabling IPv6 based services to be deployed have been also developed and are part of the Release 1 document set.

Access and media standards for 5,9 GHz spectrum usage (profiling IEEE 802.11), multichannel operation, decentralized congestion control and coexistence of ITS and CEN-DSRC based services (road tolling/electronic fee collection) in the 5,8 GHz and 5,9 GHz bands have been covered by standards intended for this initial ITS release.

Furthermore, basic management and security standards as well as reference architecture standards, test specifications and reports from interoperability tests are included in Release 1.

Major car manufacturers recently signed a Memorandum of Understanding to signal their intentions to provide cooperative systems from 2015 on [i.3]. V2V communications will be integrated in the refined telematics platform of the vehicles and its applications will mainly evolve the three areas:

- advanced driver assistance increasing road safety;
- increasing traffic efficiency with traffic congestion control;
- user communications and information services (comfort and business applications).

The first implementation under Release 1 will most likely only use parts of the spectrum identified by ECC and EC.

The present document supports the review of the ITS regulation in the CEPT ECC and proposes reconsideration in particular on the following items:

- 1) Investigate the optimization of the existing spectrum mask for the deployment of ITS systems in the 5,9 GHz range with the main focus on the out-of-band emissions and the emissions in the spurious domain.

- 2) ECC is requested to consider exemption from individual licensing for all ITS stations, including the roadside-to-vehicle communications and portable ITS stations with restricted capabilities. In this context, it should be noted that in the ITS station concept, there is no difference in the functions between a vehicle-based station, a fixed installed station or a portable ITS station, i.e. all ITS stations can support all features and facilities.
- 3) Introduction of additional mitigation factors and methods for optimized coexistence.

5 Current regulations

5.1 Overview

The current regulation of the ITS G5 system is based on the EC decision 2008/671/EC of 5 August 2008 [i.5] as well as ECC/DEC/(08)01 [i.7] covering the ITS G5A channels from 5,875 GHz to 5,905 GHz and the ECC Recommendation ECC/REC/(08)01 [i.8] covering the ITS G5B channels from 5,855 GHz to 5,875 GHz. The essential requirements to fulfil the R&TTE Directive are covered in the Harmonized Standard EN 302 571 [i.6] for the band 5,855 GHz to 5,925 GHz. In the following clause the details of the existing regulation will be presented.

The ECC/DEC/(08)01 has been implemented by 38 CEPT administrations by the end of 2012 including all EU member states. While the authorization regime for inter-vehicle communications is clear, the process for roadside-to-vehicle, i.e. for fixed installed ITS stations, is not so clear and several administrations expressed the need to clarify the situation or see this under study. Two administrations use individual authorizations for roadside-to-vehicle communications while many others use license-exemption (see SRDMG(13)Info3 [i.15]). ECC Decision (08)01 is up for review in 2014.

5.2 Spectrum regulation for the ITS system in the band 5,855 GHz to 5,925 GHz

In table 1 the current regulatory limits for the total RF output power and the power spectral density as given in [i.5], [i.6] and [i.7] are depicted.

Table 1: Limits for total RF output power and Power Spectral Density at the highest power level based on [i.5], [i.6] and [i.7]

Frequency range (MHz)	RF output power limit (e.i.r.p.) (dBm)	Power spectral density limit (e.i.r.p.) (dBm/MHz)	Remark
5 855 to 5 875	33	23	ECC/REC/(08)01 [i.8]
5 875 to 5 905	33	23	ECC/DEC/(08)01 [i.7] and EC decision 2008/671/EC [i.5]
5 905 to 5 925	33	23	ECC/DEC/(08)01 [i.7]

The out-of-band spectrum requirements defined in Europe as part of the EU regulations in EU Decision 2008/671/EC [i.5], ECC/DEC/(08)01 [i.7] and ECC/REC/(08)01 [i.8] are given in table 2.

Table 2: Out of band Spectrum Requirements for ITS G5 systems defined in 2008/671/EC [i.5], ECC/DEC/(08)01 [i.7] and ECC/REC/(08)01 [i.8]

Frequency range	Maximum power, (e.i.r.p.) (dBm)	Reference bandwidth
1 GHz < f < 5,795 GHz	-30	1 MHz
5,795 GHz < f < 5,815 GHz	-65	1 MHz
5,815 GHz < f < 5,850 GHz	-55	1 MHz
5,850 GHz < f < 5,855 GHz	-30	1 MHz
5,925 GHz < f < 5,965 GHz	-65	1 MHz
5,965 GHz < f < 18 GHz	-30	1 MHz

In addition a power control range of 30 dB is required for ITS systems operating in the band 5,855 GHz to 5,925 GHz.