International Telecommunication Union

ITU-R

Radiocommunication Sector of ITU

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Impact of emissions from short-range devices on radiocommunication services

SM Series

Spectrum management

International Telecommunication Union

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REPORT ITU-R SM.2210

Impact of emissions from short-range devices on radiocommunication services

(2011)

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1 Introduction

Resolution **953 (WRC-07)** describes short-range devices (SRDs) as radio transmitters or receivers or both that generate and use radio frequencies locally. The Resolution describes ultra-wideband technologies (UWB), radio frequency identification devices (RFID) and similar devices as short-range devices. The Resolution also recognizes that SRDs, in particular RFID, hold promise for an array of new applications that may provide benefits for users. The Resolution requests the ITU-R to study emissions from SRDs, in particular RFIDs, inside and outside the frequency bands designated in the Radio Regulations for ISM applications to ensure adequate protection of radiocommunication services.

2 Propagation models to be used

The following propagation models can be used for studying the emissions of short-range devices in specific bands:

– Recommendation ITU-R P.1238 – Propagation data and prediction methods for the planning of indoor radiocommunication systems and radio local area networks in the frequency range 900 MHz to 100 GHz.

– Recommendation ITU-R P.1411 – Propagation data and prediction methods for the planning of short-range outdoor radiocommunication systems and radio local area networks in the frequency range 300 MHz to 100 GHz.

3 Characteristics and protection criteria of radiocommunication services

Interference analyses between short-range devices and radiocommunication services require knowledge of the protection criteria and technical characteristics of potentially affected radiocommunication systems. In the case of studies on UWB technology, the relevant ITU-R Recommendations and Reports are listed in Attachment A8 of Report ITU-R SM.2057 (Studies related to the impact of devices using ultra-wideband technology on radiocommunication services). This attachment also contains technical characteristics and protection criteria of potential victim systems. The characteristics and criteria are intended to aid interference calculations of devices using ultra wide band technology; however, they are also applicable in the study of emissions of short-range devices.

The following Reports and Recommendations provide protection criteria, characteristics and service quality objectives for various services that should be considered in the study of emissions of short-range devices.

– Report ITU-R BS.2104 – FM modulator interference to broadcast services.

– Report ITU-R M.2039 – Characteristics of terrestrial IMT-2000 systems for frequency sharing/interference analyses.

– Report ITU-R SM.2057 – Studies related to the impact of devices using ultra-wideband technology on radiocommunication services.

– Report ITU-R SM.2153 – Technical and operating parameters and spectrum use for short-range radiocommunication devices.

– Recommendation ITU-R BO.1773 – Criterion to assess the impact of interference to the broadcasting-satellite service from emissions of devices without a corresponding frequency allocation in the Radio Regulations, that produce fundamental emissions in the frequency bands allocated to the broadcasting satellite service.

– Recommendations ITU-R BT.1895 and ITU-R BS.1895 – Protection criteria for terrestrial broadcasting systems.

– Recommendation ITU-R M.1739 – Protection criteria for wireless access systems, including radio local area networks, operating in the mobile service in accordance with Resolution 229 (WRC-03) in the bands 5 150-5 250 MHz, 5 250-5 350 MHz and 5 470-5 725 MHz.

– Recommendation ITU-R M.1767 – Protection of land mobile systems from terrestrial digital video and audio broadcasting systems in the VHF and UHF shared bands allocated on a primary basis.

– Recommendation ITU-R M.1823 – Technical and operational characteristics of digital cellular land mobile systems for use in sharing studies.

– Recommendation ITU-R RA.314 – Preferred frequency bands for radio astronomical measurements.
– Recommendation ITU-R RA.517 – Protection of the radio astronomy service from transmitters operating in adjacent bands.
– Recommendation ITU-R RA.611 – Protection of the radio astronomy service from spurious emissions.
– Recommendation ITU-R RA.769 – Protection criteria used for radio astronomical measurements.
– Recommendation ITU-R RA.1031 – Protection of the radio astronomy service in frequency bands shared with other services.
– Recommendation ITU-R RA.1237 – Protection of the radio astronomy service from unwanted emissions resulting from applications of wideband digital modulation.
– Recommendation ITU-R RS.1028 – Performance criteria for satellite passive remote sensing.
– Recommendation ITU-R RS.1029 – Interference criteria for satellite passive remote sensing.
– Recommendation ITU-R RS.1166 – Performance and interference criteria for active spaceborne sensors.
– Recommendation ITU-R RS.1346 – Sharing between the meteorological aids service and medical implant communication systems (MICS) operating in the mobile service in the frequency band 401-406 MHz.
– Recommendation ITU-R S.1432 – Apportionment of the allowable error performance degradations to fixed-satellite service (FSS) hypothetical reference digital paths arising from time invariant interference for systems operating below 30 GHz.
– Recommendation ITU-R SM.1754 – Measurement techniques of ultra-wideband transmissions.
– Recommendation ITU-R SM.1755 – Characteristics of ultra-wideband technology.
– Recommendation ITU-R SM.1756 – Framework for the introduction of devices using ultra-wideband technology.
– Recommendation ITU-R SM.1757 – Impact of devices using ultra-wideband technology on systems operating within radiocommunication services.

4 Frequency and technical and operational characteristics of short-range devices

Technical and operational characteristics of many short-range devices can be found in Report ITU-R SM.2153 – Technical and operating parameters and spectrum use for short-range radiocommunication devices

In addition, Report ITU-R SM.2153 provides the applications, common frequency ranges and the radiated power limits of several regulatory regimes as guidance to administrations.

Ultra-wideband systems have been studied extensively in the ITU-R, resulting in the creation of four Recommendations, listed in § 3 of this Report:

– Recommendation ITU-R SM.1754 – Measurement techniques of ultra-wideband transmissions.
– Recommendation ITU-R SM.1755 – Characteristics of ultra-wideband technology.

– Recommendation ITU-R SM.1756 – Framework for the introduction of devices using ultra-wideband technology.

– Recommendation ITU-R SM.1757 – Impact of devices using ultra-wideband technology on systems operating within radiocommunication services.

Resolution **953 (WRC-07)** notes all of these Recommendations in *recognizing* a).

5 Compatibility studies

Short-range devices employ various interference mitigation techniques to achieve their performance while ensuring the protection of existing services that share the frequency band. The in-band compatibility study may be necessary only when specific frequency bands and services that require further protection, are clearly identified. This would be case-by-case study and cannot be carried out considering whole frequency bands.

The following is a list of Reports that contain the results of studies done by the Electronic Communications Committee (ECC) and the European Radiocommunication Committee (ERC)1 on compatibility between existing radiocommunication services and short-range devices in specific frequency bands.

List of ECC/ERC Reports related to short-range devices

Report No.	Title
ECC Report 001	Compatibility between inductive LF and HF RFID transponder and other radio communications systems in the frequency ranges 135-148.5 kHz, 4.78-8.78 MHz and 11.56-15.56 MHz
ECC Report 002	SAP/SAB (Incl. ENG/OB) spectrum use and future requirements
ECC Report 007	Compatibility between inductive LF RFID systems and radio communications systems in the frequency range 135-148.5 kHz
ECC Report 011	Strategic Plans for the future use of the frequency bands 862-870 MHz and 2 400-2 483.5 MHz for Short Range Devices
ECC Report 012	Ultra Low Power Active Medical Implant systems (ULP-AMI)
ECC Report 013	Adjacent band compatibility between Short Range Devices and TETRA TAPS mobile services at 870 MHz
ECC Report 023	Compatibility of automotive collision warning short range radar operating at 24 GHz with FS, EESS and Radio Astronomy
ECC Report 024	PLT, DSL, CABLE communications (Including CABLE TV), LANS and their effect on radio services
ECC Report 037	Compatibility of planned SRD applications in 863-870 MHz
ECC Report 040	Adjacent band compatibility between CDMA-PAMR mobile services and Short Range Devices below 870 MHz
ECC Report 056	Compatibility of automotive collision warning short range radar operating at 79 GHz with radiocommunication services
ECC report 064	The protection requirements of radiocommunication systems below 10.6 GHz from generic UWB applications
ECC Report 055	Compatibility between existing and proposed SRDs and other radiocommunication applications in the 169.4-169.8 MHz frequency band. See supplementary excel spreadsheets in download

1 These Reports are available on the European Communications Office (ECO) website: http://www.ero.dk/ (select first "deliverables" then "reports") or directly at: http://www.erodocdb.dk/doks/doccategoryECC.aspx?doccatid=4.

Report No.	Title
ECC Report 067	Compatibility study for generic limits for the emission levels of inductive SRDs below 30 MHz
ECC Report 068	Compatibility studies in the band 5 725-5 875 MHz between Fixed Wireless Access (FWA) systems and other systems
ECC Report 073	Compatibility of SRD in the FM radio broadcasting band
ECC Report 081	The coexistence between Ultra Low Power - Animal Implant Devices (ULP-AID) operating in the frequency band 12.5-20 MHz and existing radiocommunication systems
ECC Report 092	Coexistence between Ultra Low Power Active Medical Implants devices (ULP-AMI) and existing radiocommunication systems and services in the frequency bands 401-402 MHz and 405-406 MHz
ECC Report 094	Technical requirements for UWB LDC devices to ensure the protection of FWA systems
ECC Report 098	Studying the compatibility issues of the UIC EUROLOOP system with other systems in the frequency band 9.5 to 17.5 MHz
ECC Report 100	Compatibility studies in the band 3 400-3 800 MHz between broadband wireless access (BWA) systems and other services
ECC Report 111	Compatibility studies between Ground Based Synthetic Aperture Radar (GBSAR) and existing services in the range 17.1 GHz to 17.3 GHz
ECC Report 113	Compatibility studies around 63 GHz between Intelligent Transport Systems (ITS) and other systems
ECC Report 114	Compatibility studies between multiple GIGABIT wireless systems in frequency range 57-66 GHz and other services and systems (except its in 63-64 GHz)
ECC Report 120	Technical requirements for UWB DAA (Detect And Avoid) devices to ensure the protection of radiolocation in the bands 3.1-3.4 GHz and 8.5-9 GHz and BWA terminals in the band 3.4-4.2 GHz
ECC Report 135	Inductive limits in the frequency range 9 kHz to 148.5 kHz
ECC Report 139	Impact of Level Probing Radars (LPR), using Ultra-Wideband Technology on Radiocommunications Services
ECC Report 149	Compatibility of LP-AMI applications within 2 360-3 400 MHz, in particular for the band 2 483.5-2 500 MHz, with incumbent services
ECC Report 158	The impact of SRR 26 GHz applications using Ultra-Wide-Band (UWB) Technology on Radio Services
ECC Report 164	Compatibility between WLAM automotive radars in the frequency range 24.25 to 24.5 GHz, and other radiocommunication systems/services
ERC Report 001	Harmonisation of frequency bands to be designated for Radio Local Area Networks (RLANs)
ERC Report 003	Harmonisation of frequency bands to be designated for road transport information systems (RTTT)
ERC Report 005	ERC Report on frequency bands for Low Power Devices
ERC Report 008	General methodology for assessing compatibility between Radio Local Area Networks (RLANs) and the fixed Service
ERC Report 014	Co-existence of radio local area networks with the microwave landing system
ERC Report 015	Compatibility study between radar and RLANs operating at frequencies around 5.5 GHz
ERC Report 042	Handbook on radio equipment and systems radio microphones and simple wide band audio links
ERC Report 044	ERC Report on sharing inductive systems and radiocommunication systems in the band 9-135 kHz
ERC Report 047	ERC Report on compatibility fixed services and motion sensors at 10.5 GHz
ERC Report 062	Compatibility analysis regarding possible sharing between the UIC system and radio microphones in the frequency ranges 876-880 MHz and 921-925 MHz
ERC Report 063	ERC Report on radio microphone applications in the frequency range 1 785-1 800 MHz
ERC Report 067	Study of the Frequency sharing between HIPERLANs and MSS feeder links in the 5 GHz band

Report No.	Title
ERC Report 069	ERC Report on propagation model and interference range calculation for inductive systems in 10 kHz – 30 MHz
ERC Report 072	Compatibility studies related to the possible extension band for HIPERLANs at 5 GHz
ERC Report 074	ERC Report on RFID and the radio astronomy services at 13 MHz
ERC Report 088	Compatibility and sharing analysis between DVB-T and radio microphones in bands IV and V
ERC Report 092	ERC Report on sharing inductive Short Range Devices and radio communication systems in 10.2-11 MHz
ERC Report 095	ERC Report on the use of 3 155-3 400 kHz for general inductive applications
ERC Report 096	ERC Report on the use of 290-300 kHz and 500-510 kHz for general inductive applications
ERC Report 098	ERC Report on compatibility of Short Range Devices at 900 MHz with adjacent services
ERC Report 109	Compatibility of Bluetooth with other existing and proposed radiocommunication systems in the 2.45 GHz frequency band

A study was undertaken based on a request to use the guard band of GSM-900 (915-925 MHz) for a specific RFID in free flow traffic tolling applications. The studies were conducted to evaluate the impact of this RFID on the existing GSM network. While RFIDs are considered SRDs, this type of RFID reader with this power level could not be considered a short-range device in some countries.

A real time test setup was established on a minor road to conduct the tests. Both stationary tests with spectrum analyzer and then drive tests for GSM network were conducted to establish the impact of the RFID reader in OFF and ON state on the GSM network.

The RFID system consisted of a reader (transceiver) installed on a gantry with a tilt to energize and read the backscatter from the passive tag installed on the windscreen of a car with a speed range of 0 km/h to 120 km/h.

To simulate the real environment, three readers were installed on a gantry.

The following parameters are for the RFID reader parameters (In lane controller, i.e. one reader for each lane):

FIGURE 1

Reader parameters (In lane controller, i.e. one reader for each lane)

Downlink frequency	911.75-919.75 MHz adjustable in 0.25 MHz steps
Uplink frequency	902.25-903.75 MHz and 910.0-921.50 MHz adjustable in 0.25 MHz steps
Power to antenna	1 W, Transmits and receives with single antenna
Max distance to antenna	Max up to 26 m

Reader antenna parameters

Frequency range	902-928 MHz
Antenna Gain	13 dBi
Polarization	Linear, Horizontal
Cross Polarization	–20 dB (with respect to main beam)
Half power beam width	32^o E-plane and 35^o H-plane
Side lobes	$\leq$ –15 dB
VSWR	1.9:1
Type	Universal toll antenna in weather proof radome
Dimensions	80 × 5.7 × 50.8 cm

RFID Tag parameters

Type	Passive (Sticker Tag)
Frequency range	902-928 MHz
Polarization	Linear, Horizontal
Memory	EEPROM

Drive Test showed that in a real scenario with the mobile fixed on the dashboard (customers using hand free), there was interference level in the range of 4-6 dBs which affected the call quality, frame error rate and caused a drop call. The downlink problem was apparent in the E-GSM band 925 MHz (worst case scenario).

In cases of traffic congestion, the users in the vehicles in the close proximity of the RFID readers will face poor quality of service (dropped calls and degraded call quality).

6 Consideration of current practices for short-range devices

There are several different approaches to ensure that radiocommunication services operating in accordance with the Radio Regulations (RR) are adequately protected from SRDs. Currently, emission masks, restricted frequencies, and use of harmonized ISM bands are some of the practices in use. Emissions masks and restricted frequencies are given in the RR and in ITU-R Recommendations. As well, national approaches for managing the deployment of SRDs are found in Report ITU-R SM.2153.

6.1 Emission masks for short-range devices

The spurious domain emission limits given in Appendix 3 of Radio Regulations apply to short-range devices. Recommendation ITU-R SM.329 should be considered as well for the unwanted emission from short-range devices.

Regarding the frequency bands and power limits of short-range devices, Report ITU-R SM.2153 and Recommendation ITU-R SM.1756 can be used as guidelines. Those frequency bands and power limits were derived after consideration of the protection criteria, characteristics and service quality objectives of the various radiocommunication services.

SRDs can be deployed in close proximity to stations of a radiocommunication service; therefore, emission limits could be studied and developed by the ITU-R. These limits would define the required separation distance between SRDs and such stations and would allow for the adequate protection of radiocommunication services. As well, the ITU could influence emission characteristics of SRDs to provide adequate protection of radiocommunication services operating within the Radio Regulations. Finally, such emission limits and/or masks could be defined in the Radio Regulations and/or in ITU-R Recommendations/Reports.

6.2 Exclusion bands/restricted frequencies for short-range devices

Short-range devices may generally, unless specified, not use the bands allocated to the following services: radio astronomy, aeronautical mobile, and safety of life according to the relevant provisions of the Radio Regulations.

Some countries specify in their national regulations frequency bands in which the intentional emission is prohibited by short-range devices for protecting sensitive (safety and passive) radio communication services from short-range devices. The typical frequency bands are specified in Nos. 5.82, 5.108, 5.109, 5.110, 5.149, 5.180, 5.199, 5.200, 5.223, 5.226, 5.328, 5.337, 5.340, 5.375, 5.392, 5.441, 5.444A, 5.448B and 5.497 of the Radio Regulations.

NOTE 1 – No. 5.340 of the RR: all emissions are prohibited.

NOTE 2 – No. 5.149 of the RR: RAS bands.

Even though there are certain SRDs with transmitting power less than the general spurious emission limits in Recommendation ITU-R SM.329 and RR Appendix 3, these limits may not be stringent enough to protect sensitive services from interference generated by short-range devices. In these cases, additional mitigation techniques may be required as necessary.

As many SRDs could be carried by travellers across national boundaries, interference from these devices could potentially create unacceptable service degradation for radiocommunication services across those national boundaries. Restriction of frequencies to be used by SRDs on regional/global basis and their harmonization should be studied by the various services in ITU-R.

6.3 Harmonized bands

As shown in Report ITU-R SM.2153, many frequency bands for short-range devices are already globally or regionally harmonized for use by SRDs. The further harmonization of frequency use by short-range devices that can be carried by travellers across national boundaries, creating the potential for harmful interference from short-range devices to radiocommunication services, would benefit users, regulators, and manufacturers.

It would be very difficult to harmonize frequency bands for all short-range devices. Instead, a frequency tuning capability could be used to overcome the different frequency bands over the country by country or region by region. The harmonization of frequency tuning range might be necessary for some short-range devices which require circulation over national borders. This could be achieved through regional arrangements or ITU-R Recommendations/Reports which may be developed in the future for specific applications in accordance with Resolution ITU-R 54. It is noted that the CPM Report indicates some proposals, including a WRC Resolution, to address this issue at WRC-12.

RFIDs are an example of a short-range device for which globally harmonized frequency bands are desirable.

Spectrum regulations for RFID vary considerably from region to region and also among countries within regions. Many major countries have regulated some of the various frequency bands in which RFIDs are deployed in a common manner with similar field strength allowances. This minimal harmonization could be further enhanced.

Like other wireless communication technologies, the spectrum availability for RFID is the essential prerequisite for its functioning and global deployment.

7 Issues surrounding the regulation and deployment of short-range devices

SRDs are certified and regulated at the national level. As well, individual administrations decide in which bands SRDs can be deployed. Some countries allow for the introduction of SRDs on a licence-exempt basis in the ISM bands, as well as in non-ISM bands. In this latter case, these SRDs operate on a non-interference, non-protected basis with licensed services. Such operation is premised on the fact that these SRDs have been certified based upon emissions of very low signal levels. Emission limits and other technical/operating rules are usually established as a result of compatibility studies that are band and service specific.

Many SRDs are currently deployed worldwide and may be transported between and used in multiple countries, often in close proximity to stations of radiocommunication services. A lack of global or regional harmonization of SRD rules and frequency bands creates risks of harmful interference to radiocommunication services.

8 Role of the ITU-R

Further development of emissions limits and/or masks, study of restricting the use of frequencies by SRDs and harmonizing bands for use by SRDs may be required. These approaches could lead to the development ITU-R Recommendations and Reports that provide guidance to administrations.