RECOMMENDATION ITU-R SM.1538

Technical and operating parameters and spectrum requirements for short-range radiocommunication devices

(Question ITU-R 213/1)

(2001)

The ITU Radiocommunication Assembly,

considering

a) that there is increasing demand for and use of short-range radiocommunication devices (SRDs) for a wide variety of applications throughout the world;

b) that such devices generally operate with low power;

c) that according to operational requirements the radio parameters for such devices vary;

d) that in general it is assumed that such devices cannot claim protection from other radiocommunication services, however, some countries have identified specific cases where protection has been granted due to the nature of the application;

e) that the implementation of regulations for SRDs is a matter for national administrations;

f) that national regimes for implementation be as simple as possible in order to minimize the burden on administrations and users of SRDs;

g) that by their nature SRDs are being used on a worldwide basis either as an independent device or as an integral part of other systems and are often carried and used across national borders;

h) that some agreements have been reached resulting in the mutual recognition of certified measurement laboratories operated by administrations,

recommends

1 that for SRDs the technical and operating parameters and spectrum requirements, listed in Annex 1 and Annex 2 should be considered;

2 that these devices should not be restricted more than necessary in their use and should be subject to recognized certification and verification procedures.

ANNEX 1

1 Introduction

This Recommendation sets out common technical and non-technical parameters for SRDs and widely recognized approaches for managing their use on a national basis. When using this Recommendation it should be remembered that it represents the most widely accepted views but it should not be assumed that all given parameters are accepted in all countries.

It should also be remembered that the pattern of radio use is not static. It is continuously evolving to reflect the many changes that are taking place in the radio environment; particularly in the field of technology. Radio parameters must reflect these changes and the views set out in this Recommendation is therefore subject to periodic review.

Moreover, almost all administrations still have national regulations. For these reasons, those wishing to develop or market SRDs based on this Recommendation are advised to contact the relevant national administration to verify that the position set out herein applies.

SRDs are used virtually everywhere. For example, data collection with auto identification systems or item management in warehousing, retail and logistic systems, baby monitors, garage door openers, wireless home data telemetry and/or security systems, keyless automobile entry systems and hundreds of other types of common electronic equipment rely on such transmitters to function. At any time of day, most people are within a few metres of consumer products that use short-range radiocommunication transmitters.

SRDs operate on a variety of frequencies. They must share these frequencies with other applications and are generally prohibited from causing harmful interference to those applications. If an SRD does cause interference to authorized radiocommunications, even if the device complies with all of the technical standards and equipment authorization requirements in the national rules, then its operator will be required to cease operation, at least until the interference problem is solved.

However, some national administrations may establish radiocommunication services, using SRDs, whose importance to the public requires that these devices be protected to some degree from harmful interference. This may be done by provision for secondary status. One example for this kind of arrangement is the ultra low power active medical implant communication device as defined below.

2 Definition of short-range radiocommunication devices

For the purpose of this Recommendation the term, short-range radiocommunication devices, is intended to cover radio transmitters which have low capability of causing interference to other radio equipment.

In general, such devices are permitted to operate on a non-interference, no protection from interference basis.

SRDs use either integral, dedicated or external antennas and all types of modulation and channel pattern can be permitted subject to relevant standards or national regulations.

Simple licensing requirements may be applied, e.g. general licences or general frequency assignments or even licence exemption, however, information about the regulatory requirements for placing short-range radiocommunication equipment on the market and for their use should be obtained by contacting individual national administrations.

3 Applications

Due to the many different applications provided by these devices, no description can be exhaustive, however, the following categories are amongst those regarded SRDs:

3.1 Telecommand

The use of radiocommunication for the transmission of signals to initiate, modify or terminate functions of equipment at a distance.

3.2 Telemetry

The use of radiocommunication for indicating or recording data at a distance.

3.3 Voice and video

In connection with SRDs, voice covers applications like walkie-talkie, baby monitoring and similar use. Citizen band (CB) and private mobile radio (PMR 446) equipment is excluded.

With video applications, non-professional cordless cameras are meant mainly to be used for controlling or monitoring purposes.

3.4 Equipment for detecting avalanche victims

Avalanche beacons are radio location systems used for searching for and/or finding avalanche victims, for the purpose of direct rescue.

3.5 Radio local area networks (RLANs) and high performance radio local area networks (HIPERLANs)

3.5.1 RLAN

RLANs were conceived in order to replace physical cables for the connection of data networks within a building, thus providing a more flexible and, possibly, a more economic approach to the installation, reconfiguration and use of such networks within the business and industrial environments.

These systems often take advantage of spread spectrum modulation or other redundant (i.e. error correction) transmission techniques, which enable them to operate satisfactorily in a noisy radio environment. In the lower microwave or in UHF bands, satisfactory in-building propagation may be achieved but systems are limited to low data rates (up to 1 Mbit/s) because of spectrum availability.

3.5.2 HIPERLAN

HIPERLANs are radio systems based on local area networking solutions requiring higher data rates and consequently greater bandwidth to take into account spectrum requirements for new multimedia applications. They are intended for connectivity between traditional business products such as PCs, laptops, workstations, servers, printers and other networking equipment as well as digital consumer electronic equipment in the wireless home network environment.

To ensure compatibility with other radio applications in the 5 GHz band a number of restrictions and mandatory features are required. Other studies on RLANs and HIPERLANs are going on in the Radiocommunication Study Groups.

3.6 Railway applications

Applications specifically intended for use on railways comprise mainly the following three categories:

3.6.1 Automatic vehicle identification (AVI)

The AVI system uses data transmission between a transponder located on a vehicle and a fixed interrogator positioned on the track to provide for the automatic and unambiguous identification of a passing vehicle. The system also enables any other stored data to be read and provides for the bidirectional exchange of variable data.

3.6.2 Balise system

Balise is a system designed for locally defined transmission links between train and track. Data transmission is possible in both directions. The physical data transmission path length is of the order of 1 m, i.e. it is significantly shorter than a vehicle. The interrogator is secured under the locomotive and the transponder is positioned at the centre of the track. Power is supplied to the transponder by the interrogator.

3.6.3 Loop system

The loop system is designed for the transmission of data between train and track. Data transmission is possible in both directions. There are short loops and medium loops which provide for intermittent and continuous transmissions. In case of short loops the contact length is of the order of 10 m. The contact length in the case of medium loops is between 500 m and 6 000 m. No train location functions are possible in the case of continuous transmission. The contact length is greater than in the case of intermittent transmission and generally exceeds the length of a block. A block is a section of the track in which only one train may be situated.

3.7 Road transport and traffic telematics (RTTTs)

(Also referred to as dedicated short-range communications for transport information and control systems (TICSs).)

RTTT systems are defined as systems providing data communication between two or more road vehicles and between road vehicles and the road infrastructure for various information-based travel and transport applications, including automatic toll-collection, route and parking guidance, collision avoidance and similar applications.

3.8 Equipment for detecting movement and equipment for alert

Equipment for detecting movement and equipment for alert are low power radar systems for radiodetermination purposes. Radiodetermination means the determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relating to these parameters, by means of the propagation properties of radio waves.

3.9 Alarms

3.9.1 Alarm in general

The use of radiocommunication for indicating an alarm condition at a distant location.

3.9.2 Social alarms

The social alarm service is an emergency assistance service intended to allow people to signal that they are in distress and allow them to receive the appropriate assistance. The service is organized as any assistance network, generally with a team available on a 24-hour basis in a station where alarm signals are received and appropriate steps are taken to provide the required assistance (calling a doctor, the fire brigade etc.).

The alarm is usually sent via the telephone line, automatic dialling being ensured by fixed equipment (local unit) connected to the line. The local unit is activated from a small portable radio device (trigger) worn by the individual.

Social alarm systems are typically designed to provide as high a level of reliability as is practically feasible. For radio systems, the interference risk would be limited if frequencies were reserved for their exclusive use.

3.10 Model control

Model control covers the application of radio model control equipment, which is solely for the purpose of controlling the movement of the model (toy), in the air, on land or over or under the water surface.

3.11 Inductive applications

Inductive loop systems are communication systems based on magnetic fields generally at low RF frequencies.

The regulations for inductive systems are different in various countries. In some countries this equipment is not considered as radio equipment, and neither type approval nor limits for the magnetic field are set. In other countries inductive equipment is considered as radio equipment and there are various national or international type approval standards.

Inductive applications include for example car immobilizers, car access systems or car detectors, animal identification, alarm systems, item management and logistic systems, cable detection, waste management, personal identification, wireless voice links, access control, proximity sensors, anti-theft systems including RF anti-theft induction systems, data transfer to handheld devices, automatic article identification, wireless control systems and automatic road tolling.

3.12 Radio microphones

Radio microphones (also referred to as wireless microphones or cordless microphones) are small, low power (50 mW or less) unidirectional transmitters designed to be worn on the body, or hand held, for the transmission of sound over short distances for personal use. The receivers are more tailored to specific uses and may range in size from small hand units to rack mounted modules as part of a multichannel system.

3.13 RF identification (RFID) systems

The object of any RFID system is to carry data in suitable transponders, generally known as tags, and to retrieve data, by hand- or machine-readable means, at a suitable time and place to satisfy particular application needs. Data within a tag may provide identification of an item in manufacture, goods in transit, a location, the identity of persons and/or their belongings, a vehicle or assets, an animal or other types of information. By including additional data the prospect is provided for supporting applications through item specific information or instructions immediately available on reading the tag. Read-write tags are often used as a decentralized database for tracking or managing goods in the absence of a host link.

A system requires, in addition to tags, a means of reading or interrogating the tags and some means of communicating the data to a host computer or information management system. A system will also include means for entering or programming data into the tags, if this is not undertaken at the source by the manufacturer.

Quite often an antenna is distinguished as if it were a separate part of an RFID system. While its importance justifies this attention it should be seen as a feature that is present in both readers and tags, essential for the communication between the two. While the antenna of tags is an integral part of the device, the reader or interrogator can have either an integral or separate antenna in which case it shall be defined as an indispensable part of the system (see also section 7: Antenna requirements).

3.14 Ultra low power active medical implant communication systems (MICS)

Ultra low power active medical implants are part of a MICS for use with implanted medical devices, like pacemakers, implantable defibrillators, nerve stimulators, and other types of implanted devices. The MICS uses UHF transceiver modules for radiofrequency communication between an external device referred to as a programmer/controller and a medical implant placed within a human body.

These communication systems are used in many ways, for example: device parameter adjustment (e.g. modification of the pacing parameters), transmission of stored information (e.g. electro-cardiograms stored over time or recorded during a medical event), and the real time transmission of monitored vital life signs for short periods.

MICS equipment is used only under the direction of a physician or other duly authorized medical professional. The duration of these links is limited to the short periods of time necessary for data retrieval and reprogramming of the medical implant related to patient welfare.

3.15 Wireless audio applications

Applications for wireless audio systems include the following: cordless loudspeakers, cordless headphones, cordless headphones for portable use, i.e. portable compact disc players, cassette decks or radio receivers carried on a person, cordless headphones for use in a vehicle, for example for use with a radio or mobile telephone etc. in-ear monitoring, for use in concerts or other stage productions.

Systems should be designed in such a way that in the absence of an audio input no RF carrier transmission shall occur.

3.16 RF (radar) level gauges

RF level gauges have been used in many industries for many years to measure the amount of various materials, primarily stored in an enclosed container or tank. The industries in which they are used are mostly concerned with process control. These short-range radiocommunication devices are used in facilities such as refineries, chemical plants, pharmaceutical plants, pulp and paper mills, food and beverage plants, and power plants among others.

All of these industries have storage tanks throughout their facilities where intermediate or final products are stored, and which require level measurement gauges.

Radar level gauges may also be used to measure the level of water of a river (e.g. when fixed under a bridge) for information or alarm purposes.

Level gauges using an RF electromagnetic signal are insensitive to pressure, temperature, dust, vapours, changing dielectric constant and changing density.

The types of technology used in RF level gauge products include:

– pulsed radiating; and

– frequency modulated continuous wave (FMCW).

4 Technical standards/regulations

There are a number of conformity assessment standards on short-range radiocommunication devices produced by various international standards organizations, and national standards that have gained international recognition. These are *inter alia* the European Telecommunications Standards Institute (ETSI), International Electrotechnical Commission (IEC), European Committee for Electrotechnical Standardization (CENELEC), International Organization for Standardization (ISO), Underwriters Laboratories Inc. (UL), Association of Radio Industries and Business (ARIB), Federal Communications Commission (FCC) Part 15, among others. In many cases there are mutual agreements of the recognition of these standards between administrations and/or regions which avoids the need to have the same device assessed for conformity in each country where it is to be deployed (see also section 8.3).

It should be noted that in addition to the technical standards on the radio parameters of devices there may be other requirements which have to be met before a device can be placed on the market in any country such as electromagnetic compatibility (EMC), electrical safety, etc.

5 Common frequency ranges

There are certain frequency bands which are used for short-range radiocommunication devices in all regions of the world. These common bands are indicated in Table 1. Although this Table represents the most widely accepted set of frequency bands for short-range radiocommunication devices it should not be assumed that all of these bands are available in all countries.

However, it should be noted that short-range radiocommunication devices may generally not be permitted to use bands allocated to the following services:

– radio astronomy;

– aeronautical mobile;

– safety of life services including radionavigation.

It should further be noted that the frequency bands mentioned in Nos. 5.138 and 5.150 of the Radio Regulations (RR) are designated for industrial, scientific and medical (ISM) applications. Short-range radiocommunication devices operating within these bands must accept harmful interference which may be caused by these applications.

Since short-range radiocommunication devices generally operate on a non-interference, no protection from interference basis (see definition of short-range radiocommunication devices in § 2), ISM bands, among others, have been selected as home for these devices.

In the different regions there are a number of additional recommended frequency bands identified to be used for short-range radiocommunication applications. Details of those frequency bands may be found in the appendices.

TABLE 1

Commonly used frequency ranges

ISM within bands under RR Nos. 5.138 and 5.150	
	6 765-6 795 kHz
	13 553-13 567 kHz
	26 957-27 283 kHz
	40.66-40.70 MHz
	2 400-2 483.5 MHz
	5 725-5 875 MHz
	24-24.25 GHz
	61-61.5 GHz
	122-123 GHz
	244-246 GHz
Other commonly used frequency ranges	
9-135 kHz:	Commonly used for inductive short-range radiocommunication applications
402-405 MHz:	Ultra low power active medical implants Recommendation ITU-R SA.1346
5 795-5 805 MHz:	Transport information and control systems Recommendation ITU-R M.1453
5 805-5 815 MHz:	Transport information and control systems Recommendation ITU-R M.1453
76-77 GHz:	Transport information and control system (radar) Recommendation ITU-R M.1452

6 Radiated power or magnetic or electric field strength

The radiated power or magnetic or electric field strength limits shown in Tables 2 to 5 are the required values to allow satisfactory operation of SRDs. The levels were determined after careful analysis and are dependent on the frequency range, the specific application chosen and the services and systems already used or planned in these bands.

6.1 European Conference of Postal and Telecommunications Administrations (CEPT) member countries

TABLE 2

Radiated power or magnetic field strength

Maximum radiated power or magnetic field strength level	Frequency bands
7 dB(μA/m) at 10 m	457 kHz
42 dB(μA/m) at 10 m	2 275 Hz 59.750-60.250 kHz 70-119 kHz 6 765-6 795 kHz 13.553-13.567 MHz 26.957-27.283 MHz
72 dB(μA/m) at 10 m (at 30 kHz descending 3.5 dB/octave)	9.0-59.75 kHz 60.25-70.0 kHz 119-135 kHz
9 dB(μA/m) at 10 m	7 400-8 800 kHz
25 μW(1)	402-405 MHz
2 mW(1)	173.965-174.015 kHz
5 mW(1)	869.700-870.000 MHz
10 mW(1)	26.957-27.283 MHz 40.660-40.700 MHz 138.2-138.45 MHz 433.050-434.790 MHz 863-865 MHz 868.600-868.700 MHz 869.200-869.300 MHz 2 400-2 483.5 MHz
25 mW(1)	868.000-868.600 MHz 868.700-869.200 MHz 869.650-869.700 MHz 2 400-2 483.5 MHz 5 725-5 875 MHz 9 200-9 975 MHz

(1) Levels are either effective radiated power (e.r.p.) (below 1 000 MHz) or equivalent isotropically radiated power (e.i.r.p.) (above 1 000 MHz).

TABLE 3

Power level

Maximum power level	Frequency bands
100 mW(1)	2 400-2 483.5 MHz (for RLANs only) 17.1-17.3 GHz 24.00-24.25 GHz 61.0-61.5 GHz 122-123 GHz 244-246 GHz
200 mW(1)	5 150-5 350 MHz (indoor use only)
500 mW(1)	869.400-869.650 MHz 2 446-2 454 MHz (railway applications only)
1 W(1)	5 470-5 725 MHz
2 W(1)	5 795-5 815 MHz (for specific licensed applications only)
8 W(1)	5 795-5 815 MHz (for specific licensed applications only)
55 dBm peak power(1) 50 dBm average power(1) 23.5 dBm average power(1) (pulsed radar only)	76-77 GHz

(1) Levels are either effective radiated power (e.r.p.) (below 1 000 MHz) or equivalent isotropically radiated power (e.i.r.p.) (above 1 000 MHz).

6.2 United States of America (FCC) and Canadian general limits

TABLE 4

General limits for any intentional transmitter

Frequency (MHz)	Electric field strength (μV/m)	Measurement distance (μV/m)
0.009-0.490	2 400/*f* (kHz)	300
0.490-1.705	24 000/*f* (kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Exceptions or exclusions to the general limits are listed in Appendix 2.

6.3 Japan

TABLE 5

Tolerable value of electric field strength 3 m distant from a radio station emitting extremely low power

Frequency band	Electric field strength (μV/m)
$f \leq 322$ MHz	500
322 MHz $< f \leq 10$ GHz	35
10 GHz $< f \leq 150$ GHz	$3.5 \times f$ [(1), (2)]
150 GHz $< f$	500

(1) f (GHz).

(2) If $3.5 \times f > 500$ μV/m, the tolerable value is 500 μV/m.

7 Antenna requirements

Basically three types of transmitter antennas are used for short-range radiocommunication transmitters:

– integral (no external antenna socket);

– dedicated (type approved with the equipment);

– external (equipment type approved without antenna).

In most cases short-range radiocommunication transmitters are equipped with either integral or dedicated antennas, because changing the antenna on a transmitter can significantly increase, or decrease, the strength of the signal that is ultimately transmitted. Except for some special applications, the RF requirements are not based solely on output power but also take into account the antenna characteristics. Thus, a short-range radiocommunication transmitter that complies with the technical standards with a particular antenna attached could exceed the power limits given if a different antenna is attached. Should this happen a serious interference problem to authorized radiocommunications such as emergency, broadcast and air-traffic control communications could occur.

In order to prevent such interference problems, short-range radiocommunication transmitters shall be designed to ensure that no type of antenna can be used other than one which has been designed and type approved by the manufacturer to show conformity with the appropriate emission level. This means that normally short-range radiocommunication transmitters must have permanently attached, or detachable antennas with a unique connector. A unique connector is one that is not of a standard type found in electronic supply stores or not normally used for RF connection purposes. National administrations may define the term unique connector differently.

It is recognized that suppliers of short-range radiocommunication transmitters often want their customers to be able to replace an antenna in case of breakage. With this in mind, manufacturers are allowed to design transmitters in such a way that the user can replace a broken antenna with an identical one.

8 Administrative requirements

8.1 Certification and verification

8.1.1 CEPT countries

In 1994, the European Radiocommunications Committee (ERC) adopted Recommendation ERC/REC 01-06 "Procedure for mutual recognition of type testing and type approval for radio equipment". This Recommendation is applicable to all kinds of radio equipment and all international standards adopted within the CEPT/ERC can be used as a basis for conformity assessment. This Recommendation aims at removing the requirement for testing the equipment in every country, but still includes the requirement to apply for conformity assessment in every CEPT country.

Further, ERC has adopted the Decision CEPT/ERC/DEC/(97)10 "Decision mutual recognition procedures including marking of conformity assessment of radio and radio terminal equipment". This Decision (including the Decisions on the adoption of harmonized standards) will set the framework for CEPT wide collaboration in this field.

The purpose of marking equipment is to indicate its conformance to relevant European Commission (EC) Directives, ERC Decisions or Recommendations and national regulations.

In almost 100% of cases, requirements for marking and labelling approved and licensed equipment is set in national law. Most administrations require at least that the logo or name of the approval authority is shown on the label, along with the approval number which may also indicate the year of approval.

Since 8 April 2000 placing on the market, free circulation and putting into service of radio equipment is regulated for European Economic Area (EEA) countries by European Union (EU) legislation, namely by Directive 1999/5/EC on: Radio equipment and telecommunications terminal equipment and the recognition of their conformity, the R&TTE Directive.

Apart from EEA countries, candidate EU Member States are also implementing the R&TTE Directive.

The new R&TTE Directive is intended to shorten the time-to-market by placing the development and path to market of radiocommunication and telecommunication equipment on a par with most other forms of electronic equipment. It covers all terminal equipment, and all radio equipment, with the exception of equipment mentioned in Annex 1 of the R&TTE Directive, whether using harmonized or non-harmonized frequency bands. It abolishes the need for national approval regulations for these classes of equipment.

The safeguards for the spectrum are also largely market-determined. It is assumed that manufacturers will not sell products where they cannot be used, and places an obligation on them to inform users about geographical limitations on the use of products. It does allow for some licensing of frequency bands and for some special provisions for marking some classes of equipment. However, in all cases there is a presumption that the product is allowed on to the market and places the burden of proof on any authority trying to stop it coming to the market to prove that it is harmful and therefore not permitted in that country.

All manufacturers must, of course, continue to comply with electrical safety and EMC regulations. They may not make equipment that degrades the service to other users, and radio equipment must make effective use of the spectrum. Optional requirements to ensure disabled people are not hindered from using the equipment, that it does not interfere with emergency or security services equipment, that it has sufficient anti-fraud protection and that it will not invade privacy or infringe data protection regulations may also be enacted, but these require decisions at the Community level.

The underlying philosophy of the Directive is that there should be full market harmonization, and the Community principles of free movement of goods and a minimum of market access controls will be applied. It will be monitored largely through market surveillance, with manufacturers being subject to the normal range of product liability regulations.

The conformity assessment procedures will be extremely simple. A manufacturer's declaration will be all that is needed, with a modified form (containing some additional radio tests) for radiocommunication equipment. A technical construction file may be made, and this lodged with a notified body who may issue an opinion (though this is not a requirement). The conformity assessment procedures of the EMC and low voltage directives (LVD’s) will apply and should be used for compliance with those.

8.1.2 United States of America (FCC)

A “Part 15” transmitter must be tested and authorized before it may be marketed. There are two ways to obtain authorization: certification and verification.

Certification

The certification procedure requires that tests be performed to measure the levels of radio frequency energy that are radiated by the device into the open air or conducted by the device onto the power lines. A description of the measurement facilities of the laboratory where these tests are performed must be on file with the Commission's laboratory or must accompany the certification application. After these tests have been performed, a report must be produced showing the test procedure, the test results, and some additional information about the device including design drawings, internal and external photos, expository statement, etc. The specific information that must be included in a certification report is detailed in Part 2 of the FCC Rules and in the rules that govern the equipment.

Verification

The verification procedure requires that tests be performed on the transmitter to be authorized using a laboratory that has calibrated its test site or, if the transmitter is incapable of being tested at a laboratory, at the installation site. These tests measure the levels of radio frequency energy that are radiated by the transmitter into the open air or conducted by the transmitter onto the power lines.

After these tests are performed, a report must be produced showing the test procedure, the test results, and some additional information about the transmitter including design drawings. The specific information that must be included in a verification report is detailed in Part 2 of the FCC Rules and the rules governing the device.

Once the report is completed, the manufacturer (or importer for an imported device) is required to keep a copy of it on file as evidence that the transmitter meets the technical standards in Part 15. The manufacturer (importer) must be able to produce this report on short notice should the FCC ever request it.

TABLE 6

Authorization procedures for Part 15 transmitters

Low power transmitter	Authorization procedure
Amplitude modulation (AM) band transmission systems on the campuses of educational institutions	Verification
Cable locating equipment at or below 490 kHz	Verification
Carrier current systems	Verification
Devices, such as a perimeter protection systems, that must be measured at the installation site	Verification of first three installations with resulting data immediately used to obtain certification
Leaky coaxial cable systems	If designed for operation exclusively in the AM broadcast band: verification; otherwise: certification
Tunnel radio systems	Verification
All other Part 15 transmitters	Certification

A detailed description of the certification and verification procedures as well as marking requirements is contained in Appendix 2. Additional guidance on authorization processes for specific low power devices can be found in Part 15 of the FCC rules.

8.2 Licensing requirements

Licensing is an appropriate tool for administrations to control the use of radio equipment and the efficient use of the frequency spectrum.

There is a general agreement that when the efficient use of the frequency spectrum is not at risk and as long as harmful interference is unlikely, the installation and use of radio equipment may be exempt from a general licence or an individual licence.

Short-range radiocommunication devices are generally exempt from individual licensing. However, exceptions may be made based on national regulations.

When radio equipment is subject to an exemption from individual licensing, generally speaking, anyone can buy, install, possess and use the radio equipment without any prior permission from the administration. Administrations will not register the individual equipment but the use of the equipment can be subject to national provisions. Furthermore, the sale and possession of some short-range radiocommunication equipment such as ultra low power active medical implant devices may be controlled by either the manufacturer or the national administration.

8.3 Mutual agreements between countries/regions

Administrations have in many cases found it beneficial and efficient to establish mutual agreements between countries/regions providing for the recognition by one country/region of the conformity test results of a recognized/accredited test laboratory in the other country/region.

The EU, inspired by this approach, has now established on a broader basis mutual recognition agreements (MRAs) between the EU on the one hand and the United States of America, Canada, Australia and New Zealand on the other.

These MRAs enable manufacturers to have the conformity of their products assessed in accordance with the regulatory requirements of the relevant third country by appropriately designated laboratories, inspection bodies and conformity assessment bodies (CABs) in their own countries, hence reducing the costs of such assessments and the time needed to access markets.

The agreements comprise a framework agreement which establishes the mutual recognition principles and procedures, and a series of sectoral annexes which detail, for each sector, the scope in terms of products and operations, the respective legislation, and any specific procedures.

8.3.1 The MRA with the United States of America

The MRA between the EU and the United States of America entered into force on 1 December 1998.

The MRA aims to avoid duplication of controls, increase transparency of procedures, and reduce time-to-market for products in six industrial sectors: telecommunications equipment, electromagnetic compatibility, electrical safety, recreational craft, medicinal products, and medical devices. The Agreement should benefit manufacturers, traders and consumers.

8.3.2 MRAs – Canada

Canada has entered into MRAs with Korea, the EU, the Asia-Pacific Economic Cooperation (APEC), Switzerland and the Inter-American Telecommunication Commission (CITEL). By virtue of these agreements manufacturers in these countries will be able to have the conformity of their products assessed in line with Canadian regulatory requirements by appropriately designated laboratories. This reduces assessment costs and time-to-market, while Canadian manufacturers will benefit from the same advantages in respect of their market.

8.3.3 The MRAs with Australia and New Zealand

The MRAs between the EU and Australia and New Zealand entered into force on 1 January 1999.

The agreements provide for the reciprocal acceptance of the testing, certification and approval of products by each party against the regulatory requirements of the other party. Products can therefore be certified by recognized CABs in Europe to Australian and New Zealand requirements and then be placed on those markets without the need for any further approval procedures.

8.3.4 Global harmonization of regulations

As long as the regulations in the countries/regions are not globally harmonized in the same way as the R&TTE Directive provides for EEA-wide harmonization, MRAs are the next best solution to facilitate trade between countries/regions for the benefit of manufacturers, suppliers and users.

9 Additional applications

Additional applications of SRDs continue to be developed and implemented. Annex 2 contains the technical parameters of several types of these additional applications. These so far are short-range radiocommunication devices operating in 59-64 GHz band for use for high speed data communications and RF level gauges.

ANNEX 2

Additional Applications

1 SRDs operating in the 59-64 GHz band

Short-range radiocommunication devices transmitting in the 59-64 GHz oxygen absorption band will make use of large amounts of contiguous spectrum for very high speed data communications at rates of 100 Mbit/s to greater than 1 000 Mbit/s.

Applications may include digital video links, position sensors, short-range wireless point to multipoint data links, wireless local-area networks, and broadband wireless access for both fixed and mobile information appliances.

In many cases, the proposed applications will operate over the 59-64 GHz band with broadband or swept signals. Often, due to the very high data rates, or the large number of frequency channels required for a network, the entire 59-64 GHz spectrum will be used by a pair, or group, of short-range radiocommunication devices. Also, short-range position sensors used to generate accurate position information for machine tools operate with swept signals, could encompass the entire 59-64 GHz band.

The FCC developed a spectrum etiquette to govern operation of SRDs in the 59-64 GHz frequency band.

The United States of America etiquette consists of the following limits:

– Total transmitter output power limit = 500 mW peak

Interference probability is most directly related to total transmitter output power.

– Total transmitter output power limit = 500 mW (emission bandwidth/100 MHz) for emission bandwidth < 100 MHz

Narrow-band transmitters can interfere with broadband communications if there is any overlap of frequencies. This provision protects broadband communicators.

– *e.i.r.p.*= (*transmitter output power*) × (*antenna gain*) = 10 W average, 20 W peak

By limiting the intensity of focused beams, the maximum range over which interference can occur is limited to less than 1 km even for very narrow beams. The FCC specifies this radiated power limit as a power density of 18 μW/cm^2 measured at a distance of 3 m from the source.

In addition, the United States of America has imposed an additional interference mitigation requirement on 59-64 GHz SRDs. This requires that short-range radiocommunication transmitter broadcast identification at intervals of at least 1 s.

The FCC has dealt separately with fixed field disturbance sensors operating in the 61-61.5 GHz band. It has limited radiated power to an e.i.r.p. of 20 mW peak, which is equivalent to a power density of 18 nW/cm^2 measured at a distance of 3 m from the source.

In Europe, SRD power limits in the band 61-61.5 GHz are: e.i.r.p. = 100 mW.

2 RF-level gauges

The operating parameters and spectrum requirements of RF level gauges which are in operation today throughout the world are indicated in Tables 7 to 9.

2.1 Pulsed systems

Pulsed systems are low cost and have low power consumption. Today they operate at 5.8 GHz which is the centre frequency of the ISM allocation. However, manufacturers are expecting products in the 10 GHz, 25 GHz, and 76 GHz ranges. The exact frequency of operation will depend on a particular product. Typical characteristics are in Table 7.

TABLE 7

Characteristic	Value
Bandwidth	0.1 × frequency
Tx power (peak) (dBm)	0 to 10
Pulse width	200 ps to 3 ns
Duty cycle (%)	0.1 to 1
Pulse repetition frequency (MHz)	0.5 to 4

Pulse RF systems radiate a pulse with or without a carrier through air.

2.2 FMCW systems

This type of system is well developed. The FMCW is robust and uses advanced signal processing which provides good reliability. The characteristics of FMCW systems are in Table 8.

TABLE 8

Characteristic	Value
Frequency (GHz)	10, 25
Bandwidth (GHz)	0.6, 2
Tx power (dBm)	0 to 10

2.3 RF level gauge operating parameters and spectrum requirements

TABLE 9

Frequency band (GHz)	Power	Antenna	Duty cycle (%)
0.5-3	10 mW	Integral	0.1 to 1
4.5-7	100 mW	Integral	0.1 to 1
8.5-11.5	500 mW	Integral	0.1 to 1
24.05-27	2 W	Integral	0.1 to 1
76-78	8 W	Integral	0.1 to 1

NOTE 1 – Operation of these gauges may not be possible and/or may require certification in certain portions of these frequency ranges in accordance with existing national and international regulations.

APPENDIX 1

TO ANNEX 2

(Region 1; CEPT Countries)

Technical and operating parameters and spectrum requirements for SRDs

CONTENTS

1 Recommendation CEPT/ERC/REC 70-03

Recommendation CEPT/ERC/REC 70-03 "Relating to the use of short-range devices (SRD)", sets out the general position on common spectrum allocations for SRDs for countries within the CEPT. It is also intended that it can be used as a reference document by the CEPT member countries when preparing their national regulations in order to keep in line with the provisions of the R&TTE Directive.

The Recommendation describes the spectrum management requirements for SRDs relating to allocated frequency bands, maximum power levels, equipment antenna, channel spacing, duty cycle, licensing and free circulation.

In addition for CEPT countries which have not implemented the R&TTE Directive it also sets out the conformity assessment and marking requirements. However, for CEPT countries that have implemented the R&TTE Directive, Article 12 (CE-marking) which states that "any other marking may be affixed to the equipment provided that the visibility and legibility of the CE-marking is not hereby reduced" and Article 7.2 which states that "Member States may restrict the putting into service of radio equipment only for reasons related to the effective and appropriate use of the radio spectrum, avoidance of harmful interference or matters relating to public health" apply.

2 Applications

Currently the applications as follows are regarded as SRDs and are covered by annexes of Recommendation CEPT/ERC/REC 70-03:

Non-specific SRD (telemetry, telecommand, data in general)

Equipment for detecting avalanche victims

LANs, RLANs and HIPERLANs

AVI railways

RTTT

Equipment for detecting movement and equipment for alert

Alarms

Model control

Inductive applications

Radio microphones

RFID

Ultra low power active medical implants

Wireless audio applications

It should be noted that Recommendation CEPT/ERC/REC 70-03 is regarded as a "living document" and additional annexes for further applications may be added if required.

3 Technical Requirements

3.1 ETSI standards

The ETSI is responsible for producing standards for telecommunications and radiocommunications equipment. Until about the end of 1996 these Standards were either European Telecommunications Standards (ETS) or Interim European Telecommunications Standards (I-ETS). The standards starting to be developed according to the new ETSI rules and expected to be used for regulative purposes are European Norms (EN).

Radio standards contain by their nature several requirements which relate to the efficient use of the spectrum and many radio standards developed by ETSI specify requirements which are intended to be used for conformity assessment purposes. The application of standards as developed by ETSI is voluntary. The national standardization organizations are, however, obliged to transpose European Standards for Telecommunications (ETSs or ENs) into national standards, and to withdraw any conflicting national standards.

With regard to SRDs, ETSI developed three generic standards (EN 300 220; EN 300 330 and EN 300 440) and a number of specific standards covering specific applications. All SRD relevant standards are listed in Appendix 2 of Recommendation CEPT/ERC/REC 70-03.

3.2 EMC and safety

3.2.1 EMC

In general, one can say that all European countries have EMC requirements, based on IEC and CISPR standards or in some cases on the ETSI EMC standards. In the EEA (EEA = EU and European Free Trade Association (EFTA)) the European harmonized standards from ETSI and CENELEC are the reference documents for presumption of conformity with the "essential requirements" of EMC Directive 89/336/EEC (most of these European standards are referred to in Recommendation CEPT/ERC/REC 70-03). The manufacturer may affix the CE marking to his radiocommunication products, based on a conformity certificate issued by a notified body for EMC (competent body). This body will base its certificates mainly on conformity with the relevant ETSI/CENELEC harmonized standards. Most European harmonized standards in the EEA are based on IEC/CISPR standards.

The European countries outside the EEA mostly accept a test report from an accredited EEA laboratory as proof of conformity. However, some request a conformity test report from one of their national laboratories.

3.2.2 Safety

In general, the European countries have (electrical) safety requirements, based on IEC standards. In most cases IEC 950 + Amendments apply to radiocommunication equipment.

In the EEA the European harmonized standards from CENELEC are the reference documents for presumption of conformity with the "essential requirements" of the Low Voltage Directive 73/23/EEC. The most relevant European harmonized standard for radiocommunication equipment is EN 60950 + Amendments, which is based on IEC 950.

The European countries outside the EEA, usually require, a CB Scheme Certificate (international certification scheme under IECEE), granted by one of the members of the CB scheme as proof of conformity to IEC 950.

NOTE 1 – Most customs authorities of the EU, require that equipment coming from outside the EEA, should be CE-marked for EMC and (electrical) safety and that an EC declaration of conformity (of the manufacturer) should be presented, before they grant an import licence.

3.3 National type approval specifications

Currently all European countries which are members of CEPT have national specifications for radio equipment which are based on transposed ENs or ETSs or still in some cases based on their predecessors as CEPT Recommendations or fully national standards.

4 Spectrum requirement

4.1 Frequency bands

This list of frequencies sets out the general position on common spectrum allocations for SRDs for countries within the CEPT. It should be remembered that it represents the most widely accepted position within the CEPT but it should not be assumed that all allocations are available in all countries.

RR No. 5.138 (ISM - bands):

6 765-6 795 kHz

433.05-434.79 MHz

61-61.5 GHz

122-123 GHz

244-246 GHz

RR No. 5.150 (ISM - bands):

13 553-13 567 kHz

26 957-27 283 kHz

40.66-40.70 MHz

2 400-2 483.5 MHz

5 725-5 875 MHz

24-24.25 GHz

Other recommended frequency bands:

2 275 Hz (avalanche detection)

9-135 kHz (inductive applications)

457 kHz (avalanche detection)

4.515 MHz (railway applications – Euroloop)

7.40-8.80 MHz (inductive applications)

27.095 MHz (railway applications – Eurobalise)

35.03-35.20 MHz (model control)

138.2-138.45 MHz (non-specific SRD)

402-405 MHz (medical implants)

863-865 MHz (audio applications and radio microphones)

868-870 MHz (non-specific SRD and alarms)

1 785-1 800 MHz (professional radio microphones)

2 446-2 454 MHz (railway applications - AVI)

5 150-5 250 MHz (HIPERLAN)

5 250-5 300 MHz (HIPERLAN extension band)

5 470-5 725 MHz (HIPERLAN)

5 795-5 805 MHz (RTTTs)

5 805-5 815 MHz (RTTTs)

9 200-9 500 MHz (movement detection)

9 500-9 975 MHz (movement detection)

10.5-10.6 GHz (movement detection)

13.4-14.0 GHz (movement detection)

17.1-17.3 GHz (HIPERLAN)

63-64 GHz (RTTTs)

76-77 GHz (RTTTs)

4.2 Radiated power or magnetic field strength

The radiated power or H-field strength limits mentioned in Recommendation CEPT/ERC/REC 70-03 are the required values to allow satisfactory operation of SRDs. The levels were determined after careful analysis within ETSI and ERC and are dependent on the frequency range and the applications chosen. The H-field strength/power levels vary between 7 dB(μA/m) at 10 m and 8 W.

4.3 Transmitter antenna source

Basically three types of transmitter antennas are used for SRDs:

– integral (no external antenna socket),

– dedicated (type approved with the equipment),

– external (equipment type approved without an antenna).

Recommendation CEPT/ERC/REC 70-03 in its annexes describes the transmitter antenna source permitted for the different applications.

4.4 Channel spacing

Channel spacings for SRDs are defined according to the needs of the different applications. They may vary between 5 kHz and 200 kHz or in some cases even "no channel spacing – whole stated frequency band may be used" apply.

4.5 Duty cycle categories

EN 300 220-1 V1.3.1 defines the duty cycle as follows:

For the purpose of the present document the term duty cycle refers to the ratio of the total on time of the "message" to the total off time in any one-hour period. The device may be triggered either automatically or manually and depending on how the device is triggered will also depend on whether the duty cycle is fixed or random.

For software controlled or preprogrammed devices, the manufacturer shall declare the duty cycle class or classes for the equipment under test.

For manually operated or event dependant devices, with or without software controlled functions, the manufacturer shall declare whether the device once triggered, follows a preprogrammed cycle, or whether the transmission is constant until the trigger is released or manually reset. The manufacturer shall also give a description of the application for the device and include a typical usage pattern. In the case of manually operated devices, the typical usage pattern as declared by the manufacturer shall be used to determine the duty cycle and hence the duty cycle class.

Where an acknowledgement message is required, the additional transmitter "on" time shall be included and declared by the manufacturer.

For software controlled or preprogrammed devices the maximum transmitter "on" time and minimum "off" time are given in Table 10.

TABLE 10

	Name	Transmitting time/full cycle (%)	Maximum transmitter "on" time[(1)] (s)	Minimum transmitter "off" time[(1)] (s)	Explanation
1	Very low	<0.1	0.72	0.72	For example, 5 transmissions of 0.72 s within one h
2	Low	<1.0	3.6	1.8	For example, 10 transmissions of 3.6 s within one h.
3	High	<10	36	3.6	For example, 10 transmissions of 36 s within one h.
4	Very high	Up to 100	–	–	Typically continuous transmissions but also those with a duty cycle greater than 10%.

(1) These limits are advisory with the view to facilitating sharing between systems in the same frequency band.

5 Administrative requirements

5.1 Licensing requirements

Licensing is an appropriate tool for administrations to regulate the use of radio equipment and the efficient use of the frequency spectrum.

There is a general agreement that when the efficient use of the frequency spectrum is not at risk and as long as harmful interference is unlikely, the installation and use of radio equipment can be exempted from a general licence or an individual licence.

In general the CEPT administrations apply similar systems of licensing and exemption from individual licensing. However, different criteria are used to decide whether radio equipment should be licensed or exempted from an individual licence.

Recommendation CEPT/ERC/REC 01-07 lists harmonized criteria for the administrations to decide whether an exemption of individual licensing should be applied.

SRDs are generally exempted from individual licensing. Exceptions are stated in the annexes and Appendix 3 of Recommendation CEPT/ERC/REC 70-03.

When radio equipment is subject to an exemption from individual licensing, anyone can buy, install, possess and use the radio equipment without any prior permission from the administration. Furthermore, the administration will not register the individual equipment. The use of the equipment can be subject to general provisions.

5.2 Conformity assessment, marking requirements and free circulation

In 1991, the ERC adopted Recommendation T/R 71-03, which dealt with the mutual recognition of test reports and was applicable to radio equipment for non-public land mobile networks. The scope of this Recommendation was broadened in the revised version of 1994 being Recommendation ERC/REC 01-06 "Procedure for mutual recognition of type testing and type approval for radio equipment". This Recommendation is applicable to all kinds of radio equipment and all international standards adopted within the CEPT/ERC can be used as a basis for conformity assessment. This Recommendation aims at removing the requirement for testing the equipment in every country, but still includes the requirement to apply for conformity assessment in every CEPT country.

Further, ERC has adopted Decision CEPT/ERC/DEC/(97-10) "Decision on mutual recognition procedures including marking of conformity assessment of radio and radio terminal equipment". This Decision (including the Decisions on the adoption of harmonized standards) will set the framework for CEPT wide collaboration in this field.

The purpose of marking an equipment is to indicate its conformance to relevant EC Directives, ERC Decisions or Recommendations and national regulations.

In almost 100% of cases, requirements for marking and labelling of approved and licensed equipment is set in national law. Most administrations require at least that the logo or name of the approval authority is shown on the label, along with the approval number which may also indicate the year of approval.

Recommendation CEPT/ERC/REC 70-03 recommends three different possibilities of marking and free circulation for SRDs dependent on the conformity assessment used.

For EEA member countries a fundamental change to the regulations for conformity assessment, marking, placing on the market and free movement of SRDs has taken place when the R&TTE Directive came into force on 8 April 2000 (see Section 7).

6 Operating parameters

SRDs in general operate in shared bands and are not permitted to cause harmful interference to other radio services.

SRDs cannot claim protection from other radio services.

The technical parameter limits should not be exceeded by any function of the equipment.

When selecting parameters for new SRDs, which may have inherent safety of human life implications, manufacturers and users should pay particular attention to the potential for interference from other systems operating in the same or adjacent bands.

7 The R&TTE Directive

The European Parliament and Council reached an agreement on the proposal for the R&TTE Directive at the conciliation meeting on 24 November 1998. The Directive (1999/5/EC) was finally adopted on 9 March 1999 and published in the Official Journal of the European Communities on 7 April 1999.

The aim of the Directive is to establish a common regulatory framework for the placing on the market and free movement of R&TTE. It also establishes a regulatory framework for the putting into service of radio equipment and for telecommunications terminal equipment which attaches to fixed networks. The new Directive replaces the terminal Directive 91/263/EEC and Directive 93/68/EEC.

The Directive entered into force, 12 months after its publication in the Official Journal, on 8 April 2000. After this date, manufacturers were able to sell any product they considered safe anywhere in the Community without any form of prior approval procedure. However, as all *a priori* control of radio equipment is abolished, it is important to establish proper market surveillance in order to avoid interference problems. The Commission has started in cooperation with ERC and its working groups, ETSI and industry the detailed preparatory work for the implementation of the Directive.

7.1 The philosophy of the R&TTE Directive

The R&TTE Directive is intended to abolish a whole suite of regulations deemed unnecessary, to greatly shorten the time-to-market and to put the development and path to market of radiocommunication and telecommunication equipment on a par with most other forms of electronic equipment. It covers all terminal equipment, and all radio equipment, with the exception of equipment mentioned in Annex 1 of the R&TTE Directive, whether using harmonized or non-harmonized frequency bands. It abolishes the need for national approval regulations for these classes of equipment.

The safeguards for the spectrum are also largely market-determined. It is assumed that manufacturers will not sell products where they cannot be used, and places an obligation on them to inform users about geographical limitations on the use of products. It does allow for some licensing of frequency bands and for some special provisions for marking some classes of equipment. However, in all cases there is a presumption that the product is allowed on to the market and an onus on any authority trying to stop it coming to the market to prove that it is harmful.

All manufacturers must, of course, continue to comply with electrical safety and EMC regulations. They may not make equipment that degrades the service to other users, and radio equipment must make effective use of the spectrum. Optional requirements to ensure disabled people are not hindered from using the equipment, that it does not interfere with emergency or security services equipment, that it has sufficient anti-fraud protection and that it will not invade privacy or infringe data protection regulations may also be enacted, but these require decisions at the Community level.

The underlying philosophy of the Directive is that there should be full market harmonization, and the Community principles of free movement of goods and a minimum of market access controls will be applied. It will be monitored largely through market surveillance, with manufacturers being subject to the normal range of product liability regulations.

The conformity assessment procedures will be extremely simple. A manufacturers declaration will be all that is needed, with a modified form (containing some additional radio tests) for radiocommunication equipment. A technical construction file may be made, and this lodged with a notified body who may issue an opinion (though this is not a requirement). The conformity assessment procedures of the EMC and LVD Directives will apply and should be used for compliance with those.

The implementation of the R&TTE Directive will give the EU the lightest regulatory regime in the world. It will need a concentrated effort by all parties to work smoothly, and to give industry the benefits of a lighter regulatory regime and shorter time-to-market without leading to customer frustration if equipment is poorly manufactured or marketed either for the wrong purpose or in the wrong region and consequently fails to work as the customer wishes. The Commission has produced a detailed implementation plan (http://europa.eu.int/comm/enterprise/rtte/) and has set up a consultative structure with five committees on essential requirement, interface publication, market surveillance, equipment classes and ETSI to ensure this runs smoothly. A standing committee, TCAM (Telecommunication Conformity Assessment and Market Surveillance Committee), has started its work in April 1999.

8 Update of Recommendation CEPT/ERC/REC 70-03 "Relating to the use of short-range devices (SRD)"

The actual version of Recommendation CEPT/ERC/REC 70-03 may be downloaded free of charge from the website of the European Radiocommunication Office: http://www.ero.dk.

APPENDIX 2

TO ANNEX 2

(United States of America)

Understanding the FCC rules for legal low-power, non-licensed transmitters

1 Introduction

Part 15 of the Rules permits the operation of low power radio frequency devices without a licence from the Commission or the need for frequency coordination. The technical standards for Part 15 are designed to ensure that there is a low probability that these devices will cause harmful interference to other users of the spectrum. Intentional radiators, i.e. transmitters, are permitted to operate under a set of general emission limits or under provisions that allow higher emission levels, than those for unintentional radiators, in certain frequency bands. Intentional radiators generally are not permitted to operate in certain sensitive or safety-related bands, designated as restricted bands, or in the bands allocated for television broadcasting. The measurement procedures for determining compliance with the technical requirements for Part 15 devices are provided or referenced within the rules.

Low-power, non-licensed transmitters are used virtually everywhere. Cordless phones, baby monitors, garage door openers, wireless home security systems, keyless automobile entry systems and hundreds of other types of common electronic equipment rely on such transmitters to function. At any time of day, most people are within a few metres of consumer products that use low-power, non-licensed transmitters.

Non-licensed transmitters operate on a variety of frequencies. They must share these frequencies with licensed transmitters and are prohibited from causing interference to licensed transmitters. Licensed primary and secondary services are protected from Part 15 devices.

The FCC has rules to limit the potential for harmful interference to licensed transmitters by low-power, non-licensed transmitters. In its rules, the FCC takes into account that different types of products that incorporate low-power transmitters have different potentials for causing harmful interference. As a result, the FCC's Rules are most restrictive on products that are most likely to cause harmful interference, and less restrictive on those that are least likely to cause interference.

2 Low-power, non-licensed transmitters – general approach

The terms low-power transmitter; low-power, non-licensed transmitter, and Part 15 transmitter, all refer to the same thing: a low-power, non-licensed transmitter that complies with the Rules in Part 15 of the FCC Rules. Part 15 transmitters use very little power, most of them less than a mW. They are non-licensed because their operators are not required to obtain a licence from the FCC to use them.

Although an operator does not have to obtain a licence to use a Part 15 transmitter, the transmitter itself is required to have an FCC authorization before it can be legally imported into or marketed in the United States of America. This authorization requirement helps ensure that Part 15 transmitters comply with the Commission's technical standards and, thus, are capable of being operated with little potential for causing interference to authorized radiocommunications.

If a Part 15 transmitter does cause interference to authorized radiocommunications, even if the transmitter complies with all of the technical standards and equipment authorization requirements in the FCC rules, then its operator will be required to cease operation, at least until the interference problem is corrected.

Part 15 transmitters receive no regulatory protection from interference.

3 Definition list

Biomedical telemetry device: An intentional radiator used to transmit measurements of either human or animal biomedical phenomena to a receiver.

Cable locating equipment: An intentional radiator used intermittently by trained operators to locate buried cables, lines, pipes and similar structures or elements. Operation entails coupling a RF signal onto the cable, pipe, etc. and using a receiver to detect the location of that structure or element.

Carrier current system: A system, or part of a system, that transmits RF energy by conduction over the electric power lines. A carrier current system can be designed such that the signals are received by conduction directly from connection to the electric power lines (unintentional radiator) or the signals are received over-the-air due to radiation of the RF signals from the electric power lines (intentional radiator).

Cordless telephone system: A system consisting of two transceivers, one a base station that connects to the public switched telephone network (PSTN) and the other a mobile handset unit that communicates directly with the base station. Transmissions from the mobile unit are received by the base station and then placed on the PSTN. Information received from the switched telephone network is transmitted by the base station to the mobile unit.

NOTE 1 – The domestic public cellular radio telecommunications service is considered to be part of the switched telephone network. In addition, intercom and paging operations are permitted provided these are not intended to be the primary modes of operation.

Field disturbance sensor: A device that establishes a radio frequency field in its vicinity and detects changes in that field resulting from the movement of persons or objects within its range.

Harmful interference: Any emission, radiation or induction that endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunications service operating in accordance with FCC Rules.

Perimeter protection system: A field disturbance sensor that employs RF transmission lines as the radiating source. These RF transmission lines are installed in such a manner that allows the system to detect movement within the protected area.

Spurious Emission. Emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, inter-modulation products and frequency conversion products, but exclude out-of-band emissions.

4 Technical standards

4.1 Conducted emission limits

Part 15 transmitters that obtain power from the electrical power lines are subject to conducted emission standards that limit the amount of RF energy they can conduct back onto these lines in the band 450 kHz-30 MHz. This limit is 250 μV.

An exception to the conducted emission requirements is made for carrier current systems. These systems are not subject to any conducted emission limits unless they produce emissions (fundamental or harmonic) in the 535-1 705 kHz band and are not intended to be received by standard AM broadcast receivers, in which case they are subject to a 1 000 μV limit.

Although carrier current systems are, for the most part, not subject to conducted emission limits, they are still subject to radiated emission limits.

4.2 Radiated emission limits

Section 15.209 contains general radiated emission (signal strength) limits that apply to all Part 15 transmitters using frequencies at 9 kHz and above. There are also a number of restricted bands in which low power, non-licensed transmitters are not allowed to operate because of potential interference to sensitive radiocommunications such as aircraft radionavigation, radio astronomy and search and rescue operations. If a particular transmitter can comply with the general radiated limits, and at the same time avoid operating in one of the restricted bands, then it can use any type of modulation (AM, FM, PCM, etc.) for any purpose.

With the exception of intermittent and periodic transmissions, and biomedical telemetry devices, Part 15 transmitters are not permitted to operate in the TV broadcast bands.

Special provisions have been made in the Part 15 Rules for certain types of transmitters that require a stronger signal strength on certain frequencies than the general radiated emission limits provide. For example, such provisions have been made for cordless telephones, auditory assistance devices and field disturbance sensors, among other things. The emission limit for each type of operation, and the type of detector used to measure emissions (average with a peak limit, "A", or quasi-peak, "Q") is specified. When a transmitter power limit is specified instead of an emission limit, no emission detector is specified.

TABLE 11

General limits for any intentional transmitter

Frequency (MHz)	**Field strength (μV/m)**	**Measurement distance (m)**
0.009-0.490	2 400/f (kHz)	300
0.490-1.705	24 000/f (kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Table 12 contains exceptions or exclusions (indicated) to the general limits, otherwise the general limits can still be used.

TABLE 12

Exception or exclusions from the general limits

Frequency band	Type of use	Emission limit	Detector A-average Q-quasi-peak
9-45 kHz	Cable locating equipment	10 W peak output power	
45-101.4 kHz	Cable locating equipment	1 W peak output power	
101.4 kHz	Telephone company electronic marker detectors	23.7 µV/m at 300 m	A
101.4-160 kHz	Cable locating equipment	1 W peak output power	
160-190 kHz	Cable locating equipment	1 W peak output power	
	Any	1 W input to final RF stage	
190-490 kHz	Cable locating equipment	1 W peak output power	
510-525 kHz	Any	100 µW input to final RF stage	
525-1 705 kHz	Any	100 µW input to final RF stage	
	Transmitters on grounds of educational institutions	24 000/*f* (kHz) µV/m at 30 m outside of campus boundary	Q
	Carrier current and leaky coax systems	15 µV/m at 47 715/*f* (kHz) m from cable	Q
1.705-10 MHz	Any, when 6 dB bandwidth ≥ 10% of centre frequency	100 µV/m at 30 m	A
	Any, when 6 dB bandwidth < 10% of centre frequency	15 µV/m at 30 m or bandwidth in (kHz)/*f* (MHz)	A

TABLE 12 (*continued*)

Frequency band	Type of use	Emission limit	Detector A-average Q-quasi-peak
13.553-13.567 MHz	Any 15.225	10 000 µV/m at 30 m	Q
26.96-27.28 MHz	Any 15.227	10 000 µV/m at 3 m	A
40.66-40.7 MHz	Intermittent control signals	2 250 µV/m at 3 m	A or Q
	Periodic transmissions	1 000 µV/m at 3 m	A or Q
	Any 15.229	1 000 µV/m at 3 m	Q
	Perimeter protection systems	500 µV/m at 3 m	A
43.71-44.49 MHz	Cordless telephones	10 000 µV/m at 3 m	A
46.6-46.98 MHz	Cordless telephones	10 000 µV/m at 3 m	A
48.75-49.51 MHz	Cordless telephones	10 000 µV/m at 3 m	A
49.66-49.82 MHz	Cordless telephones	10 000 µV/m at 3 m	A
49.82-49.9 MHz	Any 15.235	10 000 µV/m at 3 m	A
	Cordless telephones	10 000 µV/m at 3 m	A
49.9-50 MHz	Cordless telephones	10 000 µV/m at 3 m	A
54-70 MHz	Exclusively non-residential perimeter protection systems	100 µV/m at 3 m	Q
70-72 MHz	Exclusively either intermittent control signals	1 250 µV/m at 3 m	A or Q
	Or periodic transmissions	500 µV/m at 3 m	A or Q
	Or non-residential perimeter protection systems	100 µV/m at 3 m	Q
72-73 MHz	Auditory assistance devices	80 000 µV/m at 3 m	A
	Intermittent control signals	1 250 µV/m at 3 m	A or Q
	Periodic transmissions	500 µV/m at 3 m	A or Q

TABLE 12 (*continued*)

Frequency band	**Type of use**	**Emission limit**	**Detector A-average Q-quasi-peak**
74.6-74.8 MHz	Auditory assistance devices	80 000 µV/m at 3 m	A
	Intermittent control signals	1 250 µV/m at 3 m	A or Q
	Periodic transmissions	500 µV/m at 3 m	A or Q
75.2-76 MHz	Auditory assistance devices	80 000 µV/m at 3 m	A
	Intermittent control signals	1 250 µV/m at 3 m	A or Q
	Periodic transmissions	500 µV/m at 3 m	A or Q
76-88 MHz	Exclusively either intermittent control signals	1 250 µV/m at 3 m	A or Q
	Or periodic transmissions	500 µV/m at 3 m	A or Q
	Or non-residential perimeter protection systems	100 µV/m at 3 m	Q
88-108 MHz	Intermittent control signals	1 250 µV/m at 3 m	A or Q
	Periodic transmissions	500 µV/m at 3 m	A or Q
	Any 15.239 (≤ 200 kHz bandwidth)	250 µV/m at 3 m	A
121.94-123 MHz	Intermittent control signals	1 250 µV/m at 3 m	A or Q
	Periodic transmissions	500 µV/m at 3 m	A or Q
138-149.9 MHz	Intermittent control signals	(625/11) × f (MHz) – (67 500/11) µV/m at 3 m	A or Q
	Periodic transmissions	(250/11) × f (MHz) – (27 000/11) µV/m at 3 m	A or Q
150.05-156.52475 MHz	Intermittent control signals	(625/11) × f (MHz) – (67 500/11) µV/m at 3 m	A or Q
	Periodic transmissions	(250/11) × f (MHz) – (27 000/11) µV/m at 3 m	A or Q
156.52525-156.7 MHz	Intermittent control signals	(625/11) × f (MHz) – (67 500/11) µV/m at 3 m	A or Q
	Periodic transmissions	(250/11) × f (MHz) – (27 000/11) µV/m at 3 m	A or Q

TABLE 12 (*continued*)

Frequency band	Type of use	Emission limit	Detector A-average Q-quasi-peak
156.9-162.0125 MHz	Intermittent control signals	(625/11) × f (MHz) – (67 500/11) µV/m at 3 m	A or Q
	Periodic transmissions	(250/11) × f (MHz) – (27 000/11) µV/m at 3 m	A or Q
167.17-167.72 MHz	Intermittent control signals	(625/11) × f (MHz) – (67 500/11) µV/m at 3 m	A or Q
	Periodic transmissions	(250/11) × f (MHz) – (27 000/11) µV/m at 3 m	A or Q
173.2-174 MHz	Intermittent control signals	(625/11) × f (MHz) – (67 500/11) µV/m at 3 m	A or Q
	Periodic transmissions	(250/11) × f (MHz) – (27 000/11) µV/m at 3 m	A or Q
174-216 MHz	Exclusively either intermittent control signals	3 750 µV/m at 3 m	A or Q
	Or periodic transmissions	1 500 µV/m at 3 m	A or Q
	Or biomedical telemetry devices	1 500 µV/m at 3 m	A
216-240 MHz	Intermittent control signals	3 750 µV/m at 3 m	A or Q
	Periodic transmissions	1 500 µV/m at 3 m	A or Q
285-322 MHz	Intermittent control signals	(125/3) × f (MHz) – (21 250/3) µV/m at 3 m	A or Q
	Periodic transmissions	(50/3) × f (MHz) – (8 500/3) µV/m at 3 m	A or Q
335.4-399.9 MHz	Intermittent control signals	(125/3) × f (MHz) – (21 250/3) µV/m at 3 m	A or Q
	Periodic transmissions	(50/3) × f (MHz) – (8 500/3) µV/m at 3 m	A or Q
410-470 MHz	Intermittent control signals	(125/3) × f (MHz) – (21 250/3) µV/m at 3 m	A or Q
	Periodic transmissions	(50/3) × f (MHz) – (8 500/3) µV/m at 3 m	A or Q
470-512 MHz	Exclusively either intermittent control signals	12 500 µV/m at 3 m	A or Q
	Or periodic transmissions	5 000 µV/m at 3 m	A or Q

TABLE 12 (*continued*)

Frequency band	Type of use	Emission limit	Detector A-average Q-quasi-peak
512-566 MHz	Exclusively either intermittent control signals	12 500 µV/m at 3 m	A or Q
	Or periodic transmissions	5 000 µV/m at 3 m	A or Q
	Or biomedical telemetry devices for hospitals	200 µV/m at 3 m	Q
566-608 MHz	Exclusively either intermittent control signals	12 500 µV/m at 3 m	A or Q
	Or periodic transmissions	5 000 µV/m at 3 m	A or Q
614-806 MHz	Exclusively either intermittent control signals	12 500 µV/m at 3 m	A or Q
	Or periodic transmissions	5 000 µV/m at 3 m	A or Q
806-890 MHz	Intermittent control signals	12 500 µV/m at 3 m	A or Q
	Periodic transmissions	5 000 µV/m at 3 m	A or Q
890-902 MHz	Intermittent control signals	12 500 µV/m at 3 m	A or Q
	Periodic Transmissions	5 000 µV/m at 3 m	A or Q
	Signals used to measure the characteristics of a material	500 µV/m at 30 m	A
902-928 MHz	Spread spectrum transmitters	1 W Output power	
	Field disturbance sensors	500 000 µV/m at 3 m	A
	Any 15.249	50 000 µV/m at 3 m	Q
	Signals used to measure the characteristics of a material	500 µV/m at 30 m	A
	Intermittent control signals	12 500 µV/m at 3 m	A or Q
	Periodic transmissions	5 000 µV/m at 3 m	A or Q

TABLE 12 (*continued*)

Frequency band	**Type of use**	**Emission limit**	**Detector A-average Q-quasi-peak**
928-940 MHz	Intermittent control signals	12 500 µV/m at 3 m	A or Q
	Periodic transmissions	5 000 µV/m at 3 m	A or Q
	Signals used to measure the characteristics of a material	500 µV/m at 30 m	A
940-960 MHz	Intermittent control signals	12 500 µV/m at 3 m	A or Q
	Periodic transmissions	5 000 µV/m at 3 m	A or Q
1.24-1.3 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
1.427-1.435 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
1.6265-1.6455 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
1.6465-1.66 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
1.71-1.7188 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
1.7222-2.2 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
1.91-1.92 GHz	Asyncronous personal communications service devices	Varies	
1.92-1.93 GHz	Isocronous personal communications service devices	Varies	
2.3-2.31 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A

TABLE 12 (*continued*)

Frequency band	**Type of use**	**Emission limit**	**Detector A-average Q-quasi-peak**
2.39-2.4 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Asyncronous personal communications service devices	Varies	
	Periodic transmissions	5 000 µV/m at 3 m	A
2.4-2.435 GHz	Spread spectrum transmitters	1 W output power	
	Any 15.249	50 000 µV/m at 3 m	A
2.435-2.465 GHz	Spread spectrum transmitters	1 W output power	
	Field disturbance sensors	500 000 µV/m at 3 m	A
	Any 15.249	50 000 µV/m at 3 m	A
2.465-2.4835 GHz	Spread spectrum transmitters	1 W output power	
	Any 15.249	50 000 µV/m at 3 m	A
2.5-2.655 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
2.9-3.26 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
	AVI systems	3 000 µV/m per MHz of bandwidth at 3 m	A
3.267-3.332 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
	AVI systems	3 000 µV/m per MHz of bandwidth at 3 m	A
3.339-3.3458 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
	AVI systems	3 000 µV/m per MHz of bandwidth at 3 m	A

TABLE 12 (*continued*)

Frequency band	**Type of use**	**Emission limit**	**Detector A-average Q-quasi-peak**
3.358-3.6 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
	AVI systems	3 000 µV/m per MHz of bandwidth at 3 m	A
4.4-4.5 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
5.15-5.35 GHz	National information infrastructure devices	Varies	
5.25-5.35 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
5.46-5.725 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
5.725-5.825 GHz	National information infrastructure devices	Varies	
5.725-5.785 GHz	Spread spectrum transmitters	1 W output power	
	Any 15.249	50 000 µV/m at 3 m	A
5.785-5.815 GHz	Spread spectrum transmitters	1 W output power	
	Field disturbance sensors	500 000 µV/m at 3 m	A
	Any 15.249	50 000 µV/m at 3 m	A
5.815-5.85 GHz	Spread spectrum transmitters	1 W output power	
	Any 15.249	50 000 µV/m at 3 m	A
5.85-5.875 GHz	Any	50 000 µV/m at 3 m	A
5.875-7.25 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A

TABLE 12 (*continued*)

Frequency band	**Type of use**	**Emission limit**	**Detector A-average Q-quasi-peak**
7.75-8.025 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
8.5-9 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
9.2-9.3 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
9.5-10.5 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
10.5-10.55 GHz	Field disturbance sensors	2 500 000 µV/m at 3 m	A
	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic Transmissions	5 000 µV/m at 3 m	A
10.55-10.6 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
12.7-13.25 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
13.4-14.47 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
14.5-15.35 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
16.2-17.7 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
21.4-22.01 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
23.12-23.6 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
24-24.075 GHz	Any 15.249	250 000 µV/m at 3 m	A

TABLE 12 (*end*)

Frequency band	**Type of use**	**Emission limit**	**Detector A-average Q-quasi-peak**
24.075-24.175 GHz	Field disturbance sensors	2 500 000 µV/m at 3 m	A
	Any 15.249	250 000 µV/m at 3 m	A
24.175-24.25 GHz	Any 15.249	250 000 µV/m at 3 m	A
24.25-31.2 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
31.8-36.43 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
36.5-38.6 GHz	Intermittent control signals	12 500 µV/m at 3 m	A
	Periodic transmissions	5 000 µV/m at 3 m	A
46.7-46.9 GHz	Vehicle mounted field disturbance sensors	Varies	
59-64 GHz	Not aircraft, not satellite, not field disturbance sensors (with a qualified fixed exception)	Varies	
76-77 GHz	Vehicle mounted field disturbance sensors	Varies	

5 Antenna requirement

Changing the antenna on a transmitter can significantly increase, or decrease, the strength of the signal that is ultimately transmitted. Except for carrier current devices, tunnel radio systems, cable locating equipment or operation in the bands 160-190 kHz, 510-1 705 kHz, the standards in Part 15 are not based solely on output power but also take into account the antenna characteristics. Thus, a low power transmitter that complies with the technical standards in Part 15 with a particular antenna attached can exceed the Part 15 standards if a different antenna is attached. Should this happen it could pose a serious interference problem to authorized radiocommunications such as emergency, broadcast and air-traffic control communications.

In order to prevent such interference problems, each Part 15 transmitter must be designed to ensure that no type of antenna can be used with it other than the one used to demonstrate compliance with the technical standards. This means that Part 15 transmitters must have permanently attached antennas, or detachable antennas with unique connectors. A "unique connector" is one that is not of a standard type found in electronic supply stores.

It is recognized that suppliers of Part 15 transmitters often want their customers to be able to replace an antenna if it should break. With this in mind, Part 15 allows transmitters to be designed so that the user can replace a broken antenna. When this is done, the replacement antenna must be electrically identical to the antenna that was used to obtain FCC authorization for the transmitter. The replacement antenna also must include the unique connector described above to ensure it is used with the proper transmitter.

6 Restricted bands

Intentional radiators are not permitted to operate in the following bands.

TABLE 13

Restricted bands – spurious emissions only with limited exceptions (not indicated)

(MHz)	(MHz)	(MHz)	(GHz)
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1 240	7.25-7.75
4.125-4.128	25.5-25.67	1 300-1 427	8.025-8.5
4.17725-4.17775	37.5-38.25	1 435-1 626.5	9.0-9.2
4.20725-4.20775	73-74.6	1 645.5-1 646.5	9.3-9.5
6.215-6.218	74.8-75.2	1 660-1 710	10.6-12.7
6.26775-6.26825	108-121.94	1 718.8-1 722.2	13.25-13.4
6.31175-6.31225	123-138	2 200-2 300	14.47-14.5
8.291-8.294	149.9-150.05	2 310-2 390	15.35-16.2
8.362-8.366	156.52475-156.52525	2 483.5-2 500	17.7-21.4
8.37625-8.38675	156.7-156.9	2 655-2 900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3 260-3 267	23.6-24.0
12.29-12.293	167.72-173.2	3 332-3 339	31.2-31.8
12.51975-12.52025	240-285	3 345.8-3 358	36.43-36.5
12.57675-12.57725	322-335.4	3 600-4 400	38.6-46.7
13.36-13.41			46.9-59
			64-76
			Above 77 GHz

7 Equipment authorization

A Part 15 transmitter must be tested and authorized before it may be marketed. There are two ways to obtain authorization: certification and verification.

TABLE 14

Authorization procedures for Part 15 transmitters

Low power transmitter	Authorization procedure
AM-band transmission systems on the campuses of educational institutions	Verification
Cable locating equipment at or below 490 kHz	Verification
Carrier current systems	Verification
Devices, such as perimeter protection systems, that must be measured at the installation site	Verification of first three installations with resulting data immediately used to obtain certification
Leaky coaxial cable systems	If designed for operation exclusively in the AM broadcast band: verification; otherwise: certification
Tunnel radio systems	Verification
All other Part 15 transmitters	Certification

7.1 Certification

The certification procedure requires that tests be performed to measure the levels of radio frequency energy that are radiated by the device into the open air or conducted by the device onto the power lines. A description of the measurement facilities of the laboratory where these tests are performed must be on file with the Commission's laboratory or must accompany the certification application. After these tests have been performed, a report must be produced showing the test procedure, the test results, and some additional information about the device including design drawings. The specific information that must be included in a certification report is detailed in Part 2 of the FCC Rules.

Certified transmitters also are required to have two labels attached: an FCC ID label and a compliance label. The FCC ID label identifies the FCC equipment authorization file that is associated with the transmitter, and serves as an indication to consumers that the transmitter has been authorized by the FCC. The compliance label indicates to consumers that the transmitter was authorized under Part 15 of the FCC rules and that it may not cause, nor is it protected from, harmful interference.

The FCC ID. The FCC ID must be permanently marked (etched, engraved, indelibly printed, etc.) either directly on the transmitter, or on a tag that is permanently affixed (riveted, welded, glued, etc.) to it. The FCC ID label must be readily visible to the purchaser at the time of purchase.

The FCC ID is a string of 4 to 17 characters. It may contain any combination of capital letters, numbers, or the dash/hyphen character. Characters 4 through 17 may be designated, as desired, by the applicant. The first three characters, however, are the “grantee code”, a code assigned by the FCC to each particular applicant (grantee). Any application filed with the FCC must have an FCC ID that begins with an assigned grantee code.

The Grantee Code. To obtain a code, new applicants must send in a letter stating the applicant's name and address and requesting a grantee code. This letter must be accompanied by a completed “Fee Advice Form” (FCC Form 159), and a processing fee.

The Compliance Label. The applicant for a grant of certification is responsible for having the compliance label produced and for having it affixed to each device that is marketed or imported. The wording for the compliance label is in Part 15, and may be included on the same label as the FCC ID, if desired.

The compliance label and FCC ID label may not be attached to any devices until a grant of certification has been obtained for the devices.

Once the report demonstrating compliance with the technical standards has been completed, and the compliance label and FCC ID label have been designed, the party wishing to get the transmitter certified (it can be anyone) must file a copy of the report, an “Application for Equipment Authorization” (FCC Form 731) and an application fee, with the FCC.

After the application is submitted, the FCC’s lab will review the report and may or may not request a sample of the transmitter to test. If the application is complete and accurate, and any tests performed by the FCC’s lab confirm that the transmitter is compliant, the FCC will then issue a grant of certification for the transmitter. Marketing of the transmitter may begin after the applicant has received a copy of this grant.

7.2 Verification

The verification procedure requires that tests be performed on the transmitter to be authorized using a laboratory that has calibrated its test site or, if the transmitter is incapable of being tested at a laboratory, at the installation site. These tests measure the levels of radio frequency energy that are radiated by the transmitter into the open air or conducted by the transmitter onto the power lines. After these tests are performed, a report must be produced showing the test procedure, the test results, and some additional information about the transmitter including design drawings. The specific information that must be included in a verification report is detailed in Part 2 of the FCC Rules.

Once the report is completed, the manufacturer (or importer for an imported device) is required to keep a copy of it on file as evidence that the transmitter meets the technical standards in Part 15. The manufacturer (importer) must be able to produce this report on short notice should the FCC ever request it.

The Compliance Label. The manufacturer (or importer) is responsible for having the compliance label produced, and for having it affixed to each transmitter that is marketed or imported. The wording for the compliance label is included in Part 15. Verified transmitters must be uniquely identified with a brand name and/or model number that cannot be confused with other, electrically different transmitters on the market. However, they may not be labelled with an FCC ID or in a manner that could be confused with an FCC ID.

Once the report showing compliance is in the manufacturer's (or importer's) files and the compliance label has been attached to the transmitter, marketing of the transmitter may begin. There is no filing with the FCC required for verified equipment.

Any equipment that connects to the PSTN, such as a cordless telephone, is also subject to rules in Part 68 of the FCC Rules and must be registered by the FCC prior to marketing. The rules in Part 68 are designed to protect against harm to the telephone network.

8 Special cases

8.1 Cordless telephones

Cordless telephones are required to incorporate circuitry that uses digital security codes to help prevent the phone from unintentionally connecting to the PSTN when it encounters RF noise from another cordless phone or from some other source. Cordless phones that do not have this circuitry (phones that were manufactured or imported prior to 11 September 1991) are required to have a statement on the package in which they are sold that warns of the danger of unintentional line seizures and indicates what features the packaged phone has to help prevent them.

8.2 Tunnel radio systems

Many tunnels have naturally surrounding earth and/or water that attenuates radio waves. Transmitters that are operated inside these tunnels are not subject to any radiation limits inside the tunnel. Instead, the signals they produce must meet the Part 15 general radiated emission limits on the outside of the tunnel, including its openings. They also must comply with the conducted emission limits on the electric power lines outside of the tunnel.

Buildings and other structures that are not surrounded by earth or water (e.g. oil storage tanks) are not tunnels. Transmitters that are operated inside such structures are subject to the same standards as transmitters operated in an open area.

8.3 Home-built transmitters that are not for sale

Hobbyists, inventors and other parties that design and build Part 15 transmitters with no intention of ever marketing them may construct and operate up to five such transmitters for their own personal use without having to obtain FCC equipment authorization. If possible, these transmitters should be tested for compliance with the Commission's rules. If such testing is not practicable, their designers and builders are required to employ good engineering practices in order to ensure compliance with the Part 15 standards.

Home-built transmitters, like all Part 15 transmitters, are not allowed to cause interference to licensed radiocommunications and must accept any interference that they receive. If a home-built Part 15 transmitter does cause interference to licensed radiocommunications, the Commission will require its operator to cease operation until the interference problem is corrected. Furthermore, if the Commission determines that the operator of such a transmitter has not attempted to ensure compliance with the Part 15 technical standards by employing good engineering practices then that operator may be fined.

Non-residential operation is permitted under limited circumstances. For example, these home-built transmitters may be demonstrated at a trade show, but marketing is not allowed until authorization is obtained.

9 Commonly asked questions

9.1 What happens if one sells, imports or uses non-compliant low-power transmitters?

The FCC rules are designed to control the marketing of low-power transmitters and, to a lesser extent, their use. If the operation of a non-compliant transmitter causes interference to authorized radiocommunications, the user should stop operating the transmitter or correct the problem causing the interference. However, the person (or company) that sold this non-compliant transmitter to the user has violated the FCC marketing rules in Part 2 as well as federal law. The act of selling or leasing, offering to sell or lease, or importing a low-power transmitter that has not gone through the appropriate FCC equipment authorization procedure is a violation of the Commission's rules and federal law. Violators may be subject to an enforcement action by the Commission that could result in:

– forfeiture of all non-compliant equipment;

– a criminal penalty for an individual/organization;

– a criminal fine totalling twice the gross gain obtained from sales of the non-compliant equipment;

– administrative fines.

9.2 What changes can be made to an FCC-authorized device without requiring a new FCC authorization?

The person or company that obtained FCC authorization for a Part 15 transmitter is permitted to make the following types of changes:

For certified equipment, the holder of the grant of certification, or the holder's agent, can make minor modifications to the circuitry, appearance or other design aspects of the transmitter. Minor modifications are divided into two categories: Class I permissive changes and Class II permissive changes. Major changes are not permitted.

Minor changes that do not increase the radio frequency emissions from the transmitter do not require the grantee to file any information with the FCC. These are called Class I permissive changes.

NOTE 1 – If a Class I permissive change results in a product that looks different to the one that was certified it is strongly suggested that photos of the modified transmitter be filed with the FCC.

Minor changes that increase the radio frequency emissions from the transmitter require the grantee to file complete information about the change along with results of tests showing that the equipment continues to comply with FCC technical standards. In this case, the modified equipment may not be marketed under the existing grant of certification prior to acknowledgement by the Commission that the change is acceptable. These are called Class II permissive changes.

Major changes require that a new grant be obtained by submitting a new application with complete test results. Some examples of major changes include: changes to the basic frequency determining and stabilising circuitry; changes to the frequency multiplication stages or basic modulator circuit; and, major changes to the size, shape or shielding properties of the case.

No changes are permitted to certified equipment by anyone other than the grantee or the grantee's designated agent; except, however, that changes to the FCC ID without any other changes to the equipment may be performed by anyone by filing an abbreviated application.

For verified equipment, any changes may be made to the circuitry, appearance or other design aspects of the device as long as the manufacturer (importer, if the equipment is imported) has on file updated circuit drawings and test data showing that the equipment continues to comply with the FCC rules.

9.3 What is the relationship between µV/m and W?

Watts (W) are the units used to describe the amount of power generated by a transmitter. Microvolts per metre, µV/m, are the units used to describe the strength of an electric field created by the operation of a transmitter.

A particular transmitter that generates a constant level of power, W, can produce electric fields of different strengths, µV/m, depending on, among other things, the type of transmission line and antenna connected to it. Because it is the electric field that causes interference to authorized radiocommunications, and since a particular electric field strength does not directly correspond to a particular level of transmitter power, most of the Part 15 emission limits are specified in field strength.

Although the precise relationship between power and field strength can depend on a number of additional factors, a commonly-used equation to approximate their relationship is:

$$PG / 4\pi D^2 = E^2 / 120\pi$$

where:

P: transmitter power (W)

G: numerical gain of the transmitting antenna relative to an isotropic source

D: distance of the measuring point from the electrical centre of the antenna (m)

E: field strength (V/m)

$4\,\pi\,D^2$: surface area of the sphere centred at the radiating source whose surface is D m from the radiating source

$120\,\pi$: characteristic impedance of free space (Ω).

Using this equation, and assuming a unity gain antenna, $G = 1$ and a measurement distance of 3 m, $D = 3$, a formula for determining power (given field strength) can be developed:

$$P = 0.3\,E^2$$

where:

P: transmitter power (e.i.r.p.) (W)

E: field strength (V/m).

The actual version of Part 15 of the FCC Regulation 47 CFR Ch. may be downloaded free of charge from the website of the FCC: http://www.fcc.gov.

APPENDIX 3

TO ANNEX 2

(People's Republic of China)

Technical and operating parameters requirements and spectrum requirements for SRDs used in China at present

1 Technical parameters requirements

1.1 Cordless telephone

Transmit frequencies used for base set (MHz):	45.000, 45.025, 45.050, ..., 45.475
Transmit frequencies used for hand set (MHz):	48.000, 48.025, 48.050, ..., 48.475
Total channel number:	20
Maximum transmit power:	20 mW
Maximum occupied bandwidth:	16 kHz
Frequency tolerance:	1.8 kHz
Maximum adjacent channel power:	0.5 mW
Maximum spurious emission power:	25 μW

1.2 Wireless audio transmitters

–	Operating frequency band:	88.0 to 108.0 MHz
	Maximum transmit power:	3 mW
	Minimum spurious emission power attenuation:	30 dB
–	Operating frequency band:	75.4 to 76.0 MHz

Maximum transmit power:	10 mW
Minimum spurious emission power attenuation:	30 dB
– Operating frequency band:	84.0 to 87.0 MHz
Maximum transmit power:	10 mW
Minimum spurious emission power attenuation:	40 dB
– Operating frequency bands:	470.0 to 510.0 MHz, 702 to 798 MHz
Maximum transmit power:	50 mW
Minimum spurious emission power attenuation:	30 dB
Modulation type:	F3E
Maximum occupied bandwidth:	200 kHz;
Frequency tolerance:	100×10^{-6}

1.3 Radio transmitters used for control of models

Operating frequencies (MHz):	26.975, 26.995, 27.015, 27.045, 27.065, 27.095, 27.115, 27.145, 27.195, 27.225
Maximum transmit power:	1 W
Maximum occupied bandwidth:	8 kHz
Frequency tolerance:	20×10^{-6}
Minimum spurious emission power attenuation:	45 dB

1.4 Equipment for detecting pipelines underground

Operating frequency bands: 14.0 to 95.0 kHz, 105.0 to 200.0 kHz

Maximum transmit peak power:

– 10 W for frequency band from 14.0 to 45.0 (excluding 45.0) kHz

– 1 W for frequency band from 45.0 to 200.0 kHz

1.5 General radio remote-control devices

Operating frequency bands:	470.0 to 566.0 MHz, 606.0 to 798.0 MHz
Maximum signal strength:	12 500 μV/m at 3 m
Maximum occupied bandwidth:	1 MHz
Maximum spurious emission strength:	1 250 μV/m at 3 m

1.6 Biomedical telemetry transmitters

Operating frequency band:	175.0 to 215.0 MHz
Maximum signal strength:	1 500 µV/m at 3 m
Maximum occupied bandwidth:	200 kHz
Frequency tolerance:	100×10^{-6}
Maximum spurious emission strength:	150 µV/m at 3 m

1.7 Equipment for lifting

Operating frequencies (MHz):	223.100, 223.700, 223.975, 224.600, 225.025, 225.325, 230.100, 230.700, 230.975, 231.600, 232.025, 232.325
Maximum transmit power:	20 mW
Occupied bandwidth:	16 kHz
Frequency tolerance:	4×10^{-6}
Maximum spurious emission power:	2.5 µW

1.8 Equipment for weighing

–	Operating frequencies (MHz):	223.300, 224.900, 230.050, 233.050, 234.050
	Maximum occupied bandwidth:	50 kHz
–	Operating frequencies (MHz):	450.0125, 450.0625, 450.1125, 450.1625, 450.2125
	Maximum occupied bandwidth:	20 kHz
	Maximum transmit power:	50 mW
	Frequency tolerance:	4×10^{-6}
	Maximum spurious emission power:	2.5 µW

1.9 Radio remote-control equipment used in industry

Operating frequencies (MHz):	418.950, 418.975, 419.000, 419.025, 419.050, 419.075, 419.100, 419.125, 419.150, 419.175, 419.200, 419.250, 419.275
Maximum transmit power:	10 mW
Occupied bandwidth:	16 kHz
Frequency tolerance:	4×10^{-6}
Maximum spurious emission power:	2.5 µW

1.10 Equipment for transporting data

Operating frequencies (MHz):	223.150, 223.250, 223.275, 223.350, 224.050, 224.250, 228.050, 228.100, 228.200, 228.275, 228.425, 228.575, 228.600, 228.800, 230.150, 230.250, 230.275, 230.350, 231.050, 231.250
Maximum transmit power:	10 mW
Maximum occupied bandwidth:	16 kHz
Frequency tolerance:	4×10^{-6}
Maximum spurious emission power:	2.5 μW

1.11 Alarm transmitters

Operating frequency bands:	315.0 to 316.0 MHz
Maximum occupied bandwidth:	300 kHz
Operating frequency bands:	430.0 to 432.0 MHz
Maximum occupied bandwidth:	25 kHz
Maximum signal strength:	6 000 μV/m at 3 m
Maximum spurious emission strength:	600 μV/m at 3 m

1.12 General SRDs

– Equipment A:

Operating frequency bands (MHz):	1.7 to 2.1, 2.2 to 3.0, 3.1 to 4.1, 4.2 to 5.6, 5.7 to 6.2, 7.3 to 8.3, 8.4 to 9.9
Maximum signal strength:	50 μV/m at 3 m
Occupied bandwidth:	200 kHz
Frequency tolerance:	100×10^{-6}

– Equipment B:

Operating frequency bands (MHz):	6.765 to 6.795, 13.553 to 13.567
Maximum signal strength:	10 020 μV/m at 3 m
Frequency tolerance:	100×10^{-6}

– Equipment C:

Operating frequency band:	26.957 to 27.283 MHz
Maximum signal strength:	10 000 μV/m at 3 m
Frequency tolerance:	100×10^{-6}

– Equipment D:

Operating frequency band:	40.66 to 40.70 MHz
Maximum signal strength:	1 000 μV/m at 3 m
Frequency tolerance:	100×10^{-6}

– Equipment E:

Operating frequency band:	24.000 to 24.250 GHz
Maximum signal strength:	250 000 μV/m at 3 m
Minimum spurious emission power attenuation:	60 dB

2 Operating parameters requirements

2.1 The use of SRDs is forbidden when it causes harmful interference to other legal radio stations. If it causes harmful interference, the operation must be stopped. It can be put into operation again only after special measures are taken to eliminate such interference.

2.2 The use of SRDs must avoid or bear the interference from other legal radio stations or radiation interference from ISM devices. There is no legal protection for SRDs when it encounters interference. But the user can make an appeal to the local radio regulatory office.

2.3 Its use is forbidden near airports or airplanes.

2.4 The use of SRDs need not be licensed, but the necessary examination or test from the radio regulatory office is required so as to ensure that the SRDs perform within the acceptance range.

2.5 In order to develop, produce or import SRDs, they must go through the relevant formalities according to the relevant rules issued by the State Radio Office.

2.6 SRDs, without type approval by the State Radio Office, cannot be produced, sold and used in China.

2.7 For SRDs having passed the type approval of the State Radio Office, manufacturers and users cannot change the operating frequency or increase the transmitting power arbitrarily (including the addition of an extra RF amplifier). They cannot install any external antenna or replace the original one by another transmitting antenna, and cannot change the original design specification and function arbitrarily.

2.8 SRDs must be installed inside an integrated cabinet. Its external adjustment and control are only used within the range of the technical specifications of the approved type.

2.9 When using the SRDs listed below the followed stipulations must be applied:

2.9.1 Wireless audio transmitter, biomedical telemetry equipment:

They cannot be used locally when the used frequency is the same as that of the local radio or TV stations.

Their operation must be stopped if they interfer with local stations. They can be reused only after eliminating the interference and adjusting the frequency to a free one.

2.9.2 Equipment for lifting, equipment for weighing:

Before installation, the EMC environment must be tested so as to avoid interference to other equipment which can cause unnecessary production accidents.

Their operation must be stopped immediately when they cause harmful interference. They can be reused only after removing the interference by adjusting the frequency to a free one.

In order to protect the radio astronomy service of the Beijing observatory, devices operating within the frequency band of 229.0-235.0 MHz are forbidden of use inside the Beijing area.

2.9.3 Radio remote-control equipment used in industry:

It must be used inside the industrial workshop (or inside the building). The time interval between two transmissions should be not less than 5 s.

2.9.4 Equipment for transporting data:

It must be used inside the building. The time interval between two transmissions should be not less than 5 s.

In order to protect the radio astronomy service of the Beijing observatory, devices operating within the frequency band of 229.0-235.0 MHz are forbidden of use inside the Beijing area.

2.9.5 Alarm transmitters:

The duration for each radio wave emission should be not more than 1 s, the time interval between two emissions should be not less than 1 min.

They cannot be used for radio remote-control toys.

2.9.6 General radio remote-control devices:

They should be used with automatic control devices. Radio transmitting duration for radio control equipment working periodically should not exceed 1 s, the time interval between two emissions should be not less than 60 min. Radio transmitting duration for equipment working periodically should not exceed 5 s, the time interval between two transmissions should be not less than 60 min.

They cannot be used for radio remote control toys.

They cannot be used locally when the used frequency is the same as that of local radio or TV stations.

Their operation must be stopped if they cause harmful interference to local radio or TV stations. They can be reused only after removing the interference by adjusting the frequency to a free one.

2.9.7 Radio transmitters used for control of models:

They are limited to one-way control.

They cannot be used near airports or inside the air traffic control areas.

They cannot be used inside military control areas.

APPENDIX 4

TO ANNEX 2

(Japan)

Japanese requirements for low-power, non-licensed radio equipment

In Japan, establishment of a radio station requires a licence from the Ministry of Post and Telecommunications (MPT). However, radio stations listed in § 1) and 3) of Article 4 of the Radio Law (radio stations emitting extremely low power and low-power radio stations) can be established without obtaining a licence from the Minister of the MPT. A licence, for a radio station which has had all its equipment granted certification of conformity with the required technical standards, can be obtained without a provisional licence or radio station inspection.

Radio stations listed in § 1) and 3) of Article 4 of the Radio Law:

1 Radio stations emitting extremely low power

A radio station licence is not required if the electric field strength is lower than the value shown in Fig. 1 and Table 15 at a location 3 m distant from the radio equipment.

FIGURE 1

Tolerable value of electric field strength 3 m distant from a radio station emitting extremely low power

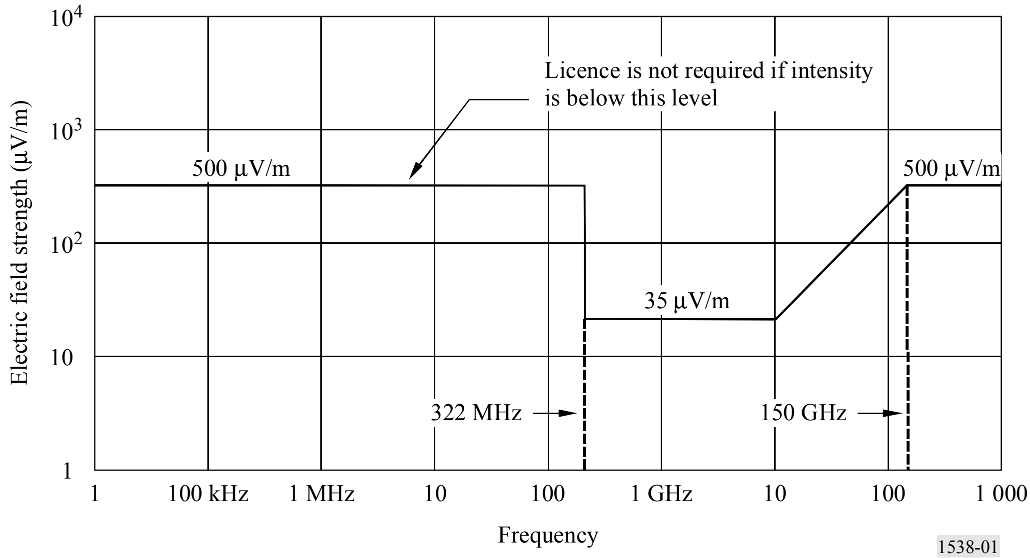

TABLE 15

Tolerable value of electric field strength 3 m distant from a radio station emitting extremely low power

Frequency band	**Electric field strength (μV/m)**
$f \leq 322$ MHz	500
322 MHz $< f \leq$ 10 GHz	35
10 GHz $< f \leq$ 150 GHz	$3.5 \times f$ (1), (2)
150 GHz $< f$	500

(1) f (GHz).

(2) If $3.5 \times f > 500$ μV/m, the tolerable value is 500 μV/m.

2 Low-power radio stations

Radio stations using only radio equipment 10 mW or less in antenna power and certified for technical standards compliance can be established without obtaining a licence if they are intended for the following uses:

(limited only to stations using frequencies specified by the MPT)

– Telemeter and telecontrol and data transmission
– Wireless telephone
– Radio pager
– Radio microphone
– Medical telemeter
– Hearing aid
– Mobile land stations for personal handy phone (PHS)
– Radio stations for low-power data communication systems/wireless LAN
– Wireless card
– Millimeter-wave radar
– Radio stations for cordless phones
– Mobile station identification
– Radio stations for low-power security systems
– Radio stations for digital cordless phones
– Mobile land stations for toll-road automatic toll collection systems.

TABLE 16

Technical regulations for representative low-power radio stations

Type of emission	Frequency band (MHz)	Occupied bandwidth (kHz)	Antenna power (W)	Antenna gain	Carrier sense
Telemeter, telecontrol and data transmission					
F1D, F1F, F2D, F2F, F7D, F7F, G1D, G1F, G2D, G2F, G7D, G7F, D1D, D1F, D2D, D2F, D7D or D7F	426.025-426.1375 (12.5 kHz spacing)	≤ 8.5	≤ 0,001	≤ 2.14 dB (e.i.r.p.: 2.14 dBm)	Not required
	426.0375-426.1125 (25 kHz spacing)	> 8.5 ≤ 16			
	429.175-429.2375 (12.5 kHz spacing)	≤ 8.5	≤ 0.01	≤ 2.14 dB (e.i.r.p.: ≤ 12.14 dBm)	7 µV
	429.25-429.7375 (12.5 kHz spacing)				
	429.8125-429.9250 (12.5 kHz spacing)				
	449.7125-449.8250 (12.5 kHz spacing)				
	449.8375-449.8875 (12.5 kHz spacing)				
	469.4375-469.4875 (12.5 kHz spacing)				
	1 216-1 216.5 (50 kHz spacing)	> 16 ≤ 32			4.47 µV
	1 252-1 252.5 (50 kHz spacing)				
	1 216.55-1 217 (50 kHz spacing)				
	1 252.5-1 253 (50 kHz spacing)				
	1 216.0125-1 216.5125 (25 kHz spacing)	≤ 16			
	1 252.0125-1 252.5125 (25 kHz spacing)				
	1 216.5375-1 216.9875 (25 kHz spacing)				
	1 252.5375-1 252.9875 (25 kHz spacing)				

TABLE 16 (*continued*)

Type of emission	**Frequency band (MHz)**	**Occupied bandwidth (kHz)**	**Antenna power (W)**	**Antenna gain**	**Carrier sense**
Wireless telephone					
F1E, F2E, F7W, G1D, G1E, G2D, G2E, G7E, G7W, D1D, D1E, D2D, D2E, D3E, D7E or D7W	422.2-422.3 (12.5 kHz spacing)	≤ 8.5	≤ 0.01	≤ 2.14 dB (e.i.r.p.: ≤ 12.14 dBm)	7 μV
	421.8125-421.925 (12.5 kHz spacing)				
	440.2625-440.375 (12.5 kHz spacing)				
	422.05-422.1875 (12.5 kHz spacing)				
	421.575-421.8 (12.5 kHz spacing)				
	440.025-440.25 (12.5 kHz spacing)				
Radio pager					
F1B, F2B, F3E, G1B or G2B	429.75 429.7625	≤ 8.5	≤ 0.01	≤ 2.14 dB (e.i.r.p.: ≤ 12.14 dBm)	7 μV
	429.775 429.7875 429.8				
Radio microphone					
F3E, F8W, F2D or F9W	806.125-809.75 (125 kHz spacing)	≤ 110	≤ 0.01	≤ 2.14 dB	Not required
	322.025-322.15 (25 kHz spacing)	≤ 30	≤ 0.001	≤ 2.14 dB	Not required
	322.25-322.4 (25 kHz spacing)				

TABLE 16 (*continued*)

Type of emission	**Frequency band (MHz)**	**Occupied bandwidth (kHz)**	**Antenna power (W)**	**Antenna gain**	**Carrier sense**
Medical telemeter					
F1D, F2D, F3D, F7D, F8D or F9D	420.05-421.0375, 424.4875-425.975, 429.25-429.7375, 440.5625-441.55, 444.5125-445.5 and 448.675-449.6625 (12.5 kHz spacing)	≤ 8.5	≤ 0.001	≤ 2.14 dB	Not required
F7D, F8D or F9D	420.0625-421.0125, 424.5-425.95, 429.2625-429.7125, 440.575-441.525, 444.525-445.475, 448.6875-449.6375 (25 kHz spacing)	> 8.5 ≤ 16			
F7D, F8D, F9D or G7D	420.075-420.975, 424.5125-425.9125, 429.275-429.675, 440.5875-441.4875, 444.5375-445.4375, 448.7-449.6 (50 kHz spacing)	> 16 ≤ 32			
F7D, F8D, F9D or G7D	420.1-420.9, 424.5375-425.8375, 429.3-429.6, 440.6125-441.4125, 444.5625-445.3625, 448.725-449.525, (100 kHz spacing)	> 32 ≤ 64			
F7D, F8D, F9D or G7D	420.3, 420.8, 424.7375, 425.2375, 425.7375, 429.5, 440.8125, 441.3125, 444.7625, 445.2625, 448.925, 449.425	> 64 ≤ 320	≤ 0.01		
Hearing aid					
F3E or F8W	75.2125-75.5875 (12.5 kHz spacing)	≤ 20	≤ 0.01	≤ 2.14 dB	Not required
F3E or F8W	75.225-75.575 (25 kHz spacing)	> 20 ≤ 30			
F3E or F8W	75.2625-75.5125 (62.5 kHz spacing)	> 30 ≤ 80			

TABLE 16 (*continued*)

Type of emission	Frequency band (MHz)	Occupied bandwidth (kHz)	Antenna power	Antenna gain	Carrier sense
PHS (land mobile station)					
G1C, G1D, G1E, G1F, G1X, G1W, G7C, G7D, G7E, G7F, G7X or G7W	1 893.65-1 919.45	≤ 288	≤ 10 mW	≤ 4 dBi	Not required
Wireless LAN					
SS (spread spectrum) (DS (direct sequence), FH (frequency hopping), FH/DS) or other	2 400-2 483.5	FH or FH/DS: ≤ 85.5 MHz DS and others: ≤ 26 MHz	DS, FH or FH/DS: ≤ 10 mW/MHz(1) Others: 10 mW	≤ 2.14 dBi (e.i.r.p.: 12.14 dBm/MHz)	Not required
SS (DS, FH or FH/DS)	2 471-2 497	≤ 26 MHz	≤ 10 mW/MHz	≤ 2.14 dBi (e.i.r.p.: 12.14 dBm/MHz)	Not required
SS (DS), MRDF, MDP or other	5 150-5 250	≤ 18 MHz	≤ 10 mW/MHz(2)	(e.i.r.p.: 10 dBm/MHz)	100 mV/m
Wireless card					
–	13.56	7R (R: modulation rate)	10 mW	≤ 30 dBi (e.i.r.p.: 20 dBm)	Not required
Millimetre-wave radar					
–	60.5 GHz 76.5 GHz	≤ 500 MHz	10 mW	≤ 40 dBi (e.i.r.p.: 50 dBm)	Not required

TABLE 16 (*end*)

Type of emission	Frequency band (MHz)	Occupied bandwidth (kHz)	Antenna power (mW)	Antenna gain	Carrier sense
Radio stations for cordless phones					
F1D, F2A, F2B, F2C, F2D, F2N, F2X or F3E	253.8625-254.9625 (12.5 kHz spacing) 380.2125-380.3125 (12.5 kHz spacing)	≤ 8.5	10	–	2 µV
Mobile station identification					
N0N, A1D, AXN, F1D, F2D or G1D	2 440 (2 427-2 453) 2 450 (2 434.25-2 465.75) 2 455 (2 439.25-2 470.75)	≤ 5.5	10	≤ 20 dBi (e.i.r.p.: 30 dBm)	Not required
Radio stations for low-power security systems					
F1D, F2D or G1D	426.25-426.8375 (12.5 kHz spacing)	≤ 8.5	10	–	Not required
	426.2625-426.8375 (25 kHz spacing)	> 8.5 ≤ 16			
Radio stations for digital cordless phones					
G1C, G1D, G1E, G1F, G1X, G1W, G7C, G7D, G7E, G7F, G1X or G7W	1 893.65-1 905.95 (300 kHz spacing)	≤ 288	10	≤ 4 dBi (e.i.r.p.: 14 dBm)	159 µV
Mobile land stations for toll-road automatic toll collection systems					
A1D	5.835 GHz 5.845 GHz	≤ 8 MHz	10	≤ 10 dBi (e.i.r.p.: 20 dBm)	Not required

OFDM: orthogonal frequency division multiplexing

PSK: phase shift keying

(1) For FH or FH/DS in the band 2 427-2 470.5 MHz, 3 mW/MHz.

(2) If transmitter antenna gain outweighs 0 dBi, the limit should be decreased by the excess gain.