

RECOMMENDATION ITU-R SM.1756-0*

Framework for the introduction of devices using ultra-wideband technology

(2006)

Scope

This Recommendation is offering a framework for the introduction of devices using ultra-wideband (UWB) technology together with guiding principles for administrations.

Keywords

Framework, ultra-wideband, national regulations

The ITU Radiocommunication Assembly,

considering

- a) that intentional transmissions from devices using (UWB) technology may extend over a very large frequency range;
- b) that devices using UWB technology are being developed with transmissions that span numerous radiocommunication service allocations;
- c) that devices using UWB technology may therefore impact, simultaneously, many systems operating within a number of radiocommunication services, including those which are used internationally;
- d) that UWB technology may be integrated into many wireless applications such as short-range indoor and outdoor communications, radar imaging, medical imaging, asset tracking, surveillance, vehicular radar and intelligent transportation;
- e) that it may be difficult to distinguish UWB transmissions from emissions or radiations in equipment that also contains other technologies, where different limits may apply;
- f) that applications using UWB technology may benefit sectors such as public protection, construction, engineering, science, medical, consumer applications, information technology, multimedia entertainment and transportation;
- g) that devices using UWB technology for certain applications may result in their high-density deployment in some environments where stations of radiocommunication services have already been or will be deployed;
- h) that the impact of a specific UWB application on a radiocommunication service will vary according to the characteristics and the protection requirements of that service and the characteristics of the specific type of UWB application;
- i) that the limits for unwanted emissions associated with radiocommunication services cannot be applied to devices using UWB technology;

* Radiocommunication Study Group 1 made editorial amendments to this Recommendation in the years 2015, 2019 and 2023 in accordance with Resolution ITU-R 1.

- j)* that UWB technology will be incorporated in mobile and/or portable devices that are expected to cross national boundaries;
- k)* that if devices using UWB technology in certain applications are not individually licensed, administrations may be unable to limit the density of deployment of those devices;
- l)* that it may not be practical to individually license devices using UWB technology which are expected to be of a ubiquitous nature;
- m)* that applications using UWB technology that are not presently recognized as operating under allocations to radiocommunication services would operate on a non-protected, non-interference basis,

recognizing

- a)* Nos. 1, 37 and 199 of the Constitution of the ITU;
- b)* Nos. **0.4, 1.59, 1.61, 1.138, 1.166, 1.167, 1.168, 1.169, 3.3, 4.4, 4.5, 4.10, 4.22, 5.223, 5.260, 5.267, 5.340¹, 13.15, 13.14**, relevant parts of Article 15, and Appendices 13 and 15 of the Radio Regulations (RR);
- c)* that passive services Earth exploration-satellite service (EESS), radio astronomy service (RAS) and space research service (SRS) measure natural radiation at very low levels;
- d)* that, in accordance with Resolution 952 (WRC-03), devices using UWB technology are not considered by ITU-R as ISM applications under RR No. 1.15,

noting

- a)* that the following ITU-R Recommendations can be used as a guide by administrations when considering the introduction of devices using UWB technology:
- Recommendation ITU-R SM.1755 which deals with characteristics of UWB technology;

¹ **5.340** All emissions are prohibited in the following bands:

1 400-1 427 MHz,	
2 690-2 700 MHz,	except those provided for by No. 5.422 ,
10.68-10.7 GHz,	except those provided for by No. 5.483 ,
15.35-15.4 GHz,	except those provided for by No. 5.511 ,
23.6-24 GHz,	
31.3-31.5 GHz,	
31.5-31.8 GHz,	in Region 2,
48.94-49.04 GHz,	from airborne stations
50.2-50.4 GHz ² ,	
52.6-54.25 GHz,	
86-92 GHz,	
100-102 GHz,	
109.5-111.8 GHz,	
114.25-116 GHz,	
148.5-151.5 GHz,	
164-167 GHz,	
182-185 GHz,	
190-191.8 GHz,	
200-209 GHz,	
226-231.5 GHz,	
250-252 GHz.	(WRC-03)

² **5.340.1** The allocation to the Earth exploration-satellite service (passive) and the space research service (passive) in the band 50.2-50.4 GHz should not impose undue constraints on the use of the adjacent bands by the primary allocated services in those bands. (WRC-97)

- Recommendation ITU-R SM.1754 which deals with measurement techniques of UWB transmissions;
 - Recommendation ITU-R SM.1757 which deals with the impact of devices using UWB technology on systems operating within radiocommunication services;
- b) that administrations have adopted, or are in the process of adopting, regulations that incorporate emission masks for UWB devices, some of which are shown in Attachments 1 to 3 to Annex 1 of this Recommendation;
- c) that some limits given in the Attachments to the Annex may not, by themselves, be sufficient to protect radiocommunication services, some limits may not allow UWB applications, while other limits may both protect radiocommunication services and allow UWB applications,

recommends

1 that the framework contained in Annex 1 to this Recommendation should be used as a guide by administrations when considering the introduction of devices using UWB technology and their impact on radiocommunication services;

2 that the following Notes will be considered as part of this Recommendation.

NOTE 1 – Administrations authorizing or licensing devices using UWB technology should ensure, pursuant to the provisions of the RR, that these devices do not cause interference to and do not claim protection from, or place constraints on, the radiocommunication services of other administrations as defined in the RR and operating in accordance with those Regulations.

NOTE 2 – Upon receipt of a notice of interference to the radiocommunication services referred to in Note 1, above, from devices using UWB technology, administrations should take immediate action(s) to eliminate such interference.

Annex 1

Framework for the introduction of devices using UWB technology

1 Introduction

This framework is intended to provide guidance to administrations when considering the introduction of devices using UWB technology. Even though the development and implementation of new technologies are important parts of meeting the changing and growing needs of the public, attention must be given to the impact of these new technologies on the operation of existing and planned stations within radiocommunication services.

UWB brings new challenges to administrations. Devices using UWB technology typically transmit at low-power and utilize bandwidths that extend over multiple bands allocated to numerous services.

Current devices using UWB technology do not belong to any radiocommunication service and they are considered as being short-range devices (SRD) not claiming protection from harmful interference. However, on a national basis, licensing of some specific UWB applications may provide protection for them from radiocommunication services operating within their national territory.

The susceptibility to interference from devices using UWB technology depends on the operational characteristics and sensitivity of the victim service, as well as on the spectral characteristics, deployment density, and operational parameters of the devices using UWB technology. The most significant challenge for administrations in the introduction of devices using UWB technology is the

protection of radiocommunication services from interference, while at the same time not unnecessarily impeding the development of devices using UWB technology.

The widespread deployment of devices using UWB technology could possibly raise the noise floor such that under some circumstances, the resulting interference to radiocommunication services could reduce the performance of the affected services. For example, an increase of the noise is of particular concern to highly sensitive passive service receivers that measure very low energy levels for purposes such as weather prediction and scientific research. As the passive services usually have instrumentation that is significantly more sensitive than that used by other radiocommunication services, they may be more vulnerable to interference from UWB transmissions.

2 Guiding principles for administrations relevant to the management of devices using UWB technology

2.1 Basis for operation of devices using UWB technology

The development and implementation of new technologies are important in meeting the changing and growing needs of the public. Devices using UWB technology are expected to operate within radio spectrum that is allocated to radiocommunication services. UWB transmissions, whether of a single device or of an aggregate nature, have the potential for interference into radiocommunication services, particularly in the safety and passive services bands. The following principles should be applied by administrations when considering the introduction of devices using UWB technology and their impact on radiocommunication services.

Guiding principles for consideration by administrations

- Administrations have a sovereign right to regulate the use of devices using UWB technology within their territory, provided that such devices do not impact stations of other administrations in accordance with the RR.
- National UWB regulations should reflect characteristics and appropriate mitigation techniques for devices using UWB technology, and be based on the protection criteria of all services in the affected frequency bands.
- National frameworks for the implementation of devices using UWB technology should take into account the inherent differences found in the various types of UWB applications.
- Special attention should be given to provide the required protection to safety services.
- Special attention should be given to provide the required protection to services operating in the frequency bands listed in RR No. 5.340.
- Consideration should be given as to how transmissions from devices using UWB technology may affect systems that provide global services.
- The authorization of devices using UWB technology on a licence-exempt or class authorization or general licence regime basis, as the case may be, should include appropriate strong certification procedures or relevant provisions incorporated into national regulations.
- The impact on the operation of stations of radiocommunication services as a result of the movement and use of devices using UWB technology across national borders should be considered.
- Relevant ITU-R Recommendations, particularly those indicated in *noting 1*, should be considered.

2.2 Impact on radiocommunication services

2.2.1 General

Providing protection to all radiocommunication services from interference caused by devices using UWB technology is essential for the introduction of UWB technology worldwide. Particular attention should be given to the protection of safety and passive services among others, as there may be a direct impact on operating certain UWB devices with respect to the protection of human life and property. These two categories are considered in the following subsections.

2.2.2 Safety services

Civil aviation and maritime systems depend on radio frequencies that can be used worldwide. Safety services, such as some elements of the radionavigation service, the radionavigation-satellite service and MMS, are radiocommunication services used for safeguarding human life and property. The aeronautical-mobile service (route) and the aeronautical mobile-satellite service (route) are reserved for communications related to safety and regularity of flight. Safety services often operate in the situation where interference can critically affect reception and impair the safety radiocommunications being provided. The necessity for safety systems to meet high levels of integrity, reliability, and availability makes it essential that these systems operate in an environment free from interference, due to the critical requirement to protect human life and property. Therefore, special attention should be given to the protection requirements of the safety services.

In some cases, it might be difficult to avoid frequency bands allocated to safety services. In those cases, administrations should consider factors such as the impact on safety service link margins, and consider techniques to preclude interference from devices using UWB technology that malfunction.

2.2.3 Passive services

The operations of the RAS, EESS (passive) and SRS (passive) necessarily involve the measurement of naturally-occurring radiations, of very low power levels, which contain essential information on the physical process under investigation. The relevant frequency bands are mainly determined by fixed physical properties (e.g. molecular resonance) that cannot be changed. Those properties support scientific activities including weather forecasting, as well as water and climate modelling. These frequency bands are, therefore, an important natural resource. Even low levels of interference received at the input of the passive sensors may have a degrading effect on passive service band usage. Additionally, in most cases the sensors are unable to discriminate between these natural radiations and man-made radiations. In this respect, RR No. 5.340 enables the passive services to deploy and operate their systems.

As an example, the EESS (passive) monitors the Earth and its atmosphere worldwide. Corrupted measurements from one or more areas may affect the ability to make reliable weather forecasts for the entire world, which may have significant economic and public safety impact.

Therefore, special attention should be given to the protection requirements of the passive services.

2.3 Consideration of different types of applications using UWB technology

UWB technology can be integrated into many applications. Some examples of UWB applications and their characteristics are given below.

2.3.1 Imaging applications

Due to the limited demand for these applications, it may be appropriate that imaging devices using UWB technology be licensed on an individual basis, or otherwise controlled or restricted in some manner. In the case of ground-penetrating radar and in-wall radar imaging devices, use could be

restricted to law enforcement professionals, fire and rescue organizations, scientific research institutions, commercial mining companies and construction companies. In the case of through-wall imaging devices, use could be restricted to law enforcement and fire and rescue organizations. In the case of medical imaging devices, use could be restricted to under the direction or supervision of a licensed healthcare practitioner. In the case of surveillance devices, use could be restricted to law enforcement, fire and rescue organizations, public utilities and industrial utilities.

Considering that it may be possible to control the use and deployment of imaging devices using UWB technology, it is not expected to be a difficult task to minimize the risk of interference to radiocommunication services.

2.3.2 Short-range indoor and outdoor communication applications

Foreseen short-range indoor and outdoor UWB communication applications are best suited for deployment under a licence-exempt or class authorization or a general licence regime, as the case may be. This is due to their low power, limited outdoor usage and expected large number. Licence exemptions should include limits on the type of use and emission masks to minimize the impact on other services or technologies.

2.3.3 Automotive short-range radar applications

UWB vehicular radar applications, also called automotive short-range radar (SRR), are currently envisaged to operate in the 24 GHz and/or 79 GHz bands. Such devices using UWB technology have an operating range of up to about 30 m and are used for a number of applications to enhance safety for all kinds of land transport vehicles. These devices are able to detect the location and movement of objects near a vehicle, enabling safety features such as near-collision avoidance warning, improved airbag activation, parking aid and pedestrian protection. UWB automotive short-range radar applications are best suited for deployment under licence-exempt or class authorization or a general licence regime, as the case may be.

At the same time, it is important to consider that the 23.6-24.0 GHz band is a unique natural resource. It is of crucial importance for weather forecasting, water and climate modelling and other related operations. It is also instrumental to environmental activities having social and economic implications, including enhancement of public safety. The potential loss of data at 24 GHz, that are assimilated in models, would affect the quality of weather forecasting.

2.4 Arrangements between administrations

Administrations are encouraged to develop bilateral or multilateral arrangements so as to avoid scenarios that may result in interference to radiocommunication services of other administrations. For example, special consideration should be given to difficult scenarios that may arise as a result of the aggregate effect of the deployment of devices, systems or networks using UWB technology, and trans-border circulation.

3 Examples of possible regulatory implementations

Regulatory implementations by individual administrations should take into account the inherent differences between the various types of UWB applications, while also considering the guiding principles provided in this Recommendation. Administrations may consider the frameworks adopted by other administrations. The following examples of regulatory implementations may be considered.

3.1 General regulatory implementations

The following generalized regulatory implementations could be considered to address interference concerns in developing a national framework for any UWB implementation, regardless of application and operational characteristics:

- technical limits such as appropriate maximum limits for average and peak UWB power or power spectral density;
- mitigation techniques as described in Recommendation ITU-R SM.1757 and in Report ITU-R SM.2057, to achieve the different protection criteria of various radiocommunication services, and especially of safety and passive services;
- technical controls, such as UWB activity factors and power kept to the minimum necessary, to support the intended operation; and
- appropriate operational restrictions according to geographical locations, modes of transportation, type of applications, and type of products into which devices using UWB technology may be embedded and used.

3.2 Application-dependent regulatory implementations

The following application-dependent regulatory implementations may be considered in developing a national framework for specific UWB applications:

- restrict the use of imaging devices to trained individuals such as law enforcement, emergency rescue, fire and medical personnel;
- require manual operation for the activation and operation of imaging devices, thereby limiting the UWB transmissions to periods when the device is in direct operation by personnel;
- imaging devices may lend themselves well to a limited-use licence or individual licence;
- restrict the use of UWB automotive short-range radar (SRR) to land transportation vehicles. Further, restrict these devices to operate only when the vehicle is operating, e.g. when the engine is running;
- employ technical means to require communication devices to only allow transmissions when in communication with their intended receiver;
- require that devices using UWB technology be employed only for the authorized application, e.g. prohibit UWB imaging devices from being used in the detection of tags, or in the transfer of data or voice information;
- prohibit the use of outdoor mounted antennas, e.g. antennas mounted on the outside of a building or on a telephone pole, or any other outdoor infrastructure;
- restrict devices using UWB technology designed for indoor use from being deployed outdoors;
- restrict devices using UWB technology designed for indoor use from intentionally emitting outside the building in which the equipment is located, such as through a window or a doorway, or to perform an outdoor function, such as the detection of persons about to enter a building;
- national authorization of UWB communication and automotive applications may be more suited to deployment under a licence-exempt or class authorization or a general licence regime, as the case may be.

3.3 Implementation summary

Procedures for administering and ensuring technical specifications and adherence to national regulations should be kept to the minimum necessary, but should include such provisions as may be necessary for the protection of radiocommunication services, as well as requirements for personnel training on the use of devices using UWB technology, as applicable. These procedures should also provide for UWB equipment measurements.

3.4 Attachments

Attachments 1 to 3 to this Annex include summaries of technical and operational provisions adopted or being considered by some administrations for UWB regulations.

These Attachments are provided for information only. They contain extracts of regional or national regulations which results in an inconsistency with the use of language compared to that used in the main body of the Recommendation.

Attachment 1: Summary of Regulations of the United States of America

Attachment 2: Summary of proposed European Conference of Postal and Telecommunications Administrations (CEPT) Regulations

Attachment 3: Specific technical requirements for Japan.

Attachment 1 to Annex 1

Summary of Regulations of the United States of America*

1.1 Introduction

The United States of America has adopted national rules for eight different UWB applications, which include emission limits for: ground-penetrating radars (GPR) and wall imaging systems, through-wall imaging systems, surveillance systems, medical imaging systems, vehicular radar systems, and short-range communication systems (indoor and outdoor).

Definitions associated with the rules of the United States include:

UWB bandwidth: The UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L . The frequency at which the highest radiated emission occurs is designated f_M .

Centre frequency: The centre frequency, f_C , equals $(f_H + f_L)/2$.

Fractional bandwidth: The fractional bandwidth equals $2(f_H - f_L)/(f_H + f_L)$.

Ultra-wideband (UWB) transmitter: An intentional radiator that, at any point in time, has a fractional bandwidth equal to, or greater than 0.20, or has a UWB bandwidth equal to, or greater than 500 MHz, regardless of the fractional bandwidth.

* The complete body of the United States of America ultra-wideband regulations is found in Subpart F of the US Code of Federal Regulations at the website: <https://www.ecfr.gov/current/title-47/chapter-1/subchapter-A/part-15/subpart-F>

The general technical requirements of the United States of America applicable to devices using UWB technology are:

- devices using UWB technology may not be employed for the operation of toys, or on board an aircraft, a ship or a satellite;
- emissions from digital circuitry used to enable the operation of the UWB transmitter must comply with the radiated emission limits of Table 2 (9 kHz-960 MHz), and of a field strength of 500 $\mu\text{V}/\text{m}$ at a measurement distance of 3 m (above 960 MHz);
- for devices using UWB technology where the frequency f_M , is above 960 MHz, there is a limit of 0 dBm e.i.r.p. on the peak level of the emissions contained within a 50 MHz bandwidth centred on f_M ;
- radiated emission levels at and below 960 MHz are based on measurements employing an International Special Committee on Radio Interference (CISPR) quasi-peak detector. Radiated emission levels above 960 MHz are based on RMS average measurements using a spectrum analyser with a resolution bandwidth of 1 MHz and an averaging time of 1 ms or less. If pulse gating is employed where the transmitter is quiescent for intervals that are long compared to the nominal pulse repetition interval, measurements must be made with the pulse train gated on;
- the frequency at which the highest radiated emission (f_M) occurs must be contained within the UWB bandwidth;
- when a peak measurement is required, it is acceptable to use a resolution bandwidth other than 50 MHz. This resolution bandwidth must not be lower than 1 MHz or greater than 50 MHz, and the measurement must be centred on f_M . If a resolution bandwidth other than 50 MHz is employed, the peak e.i.r.p. limit must be $20 \log (\text{RBW}/50)$ dBm where RBW is the resolution bandwidth in megahertz that is employed. This may be converted to a peak field strength level at 3 m.

1.2 National coordination requirements

Imaging systems require coordination through national spectrum managers before the equipment may be used. The operator must comply with any constraints on equipment usage resulting from this coordination. The coordination report must identify those geographical areas within which the operation of an imaging system requires additional coordination or within which the operation of an imaging system is prohibited.

1.3 Specific technical requirements for devices using UWB technology

A GPR system that is to be designed to operate while being hand-held and a wall imaging system must contain a manually operated switch that causes the transmitter to cease operation within 10 s of being released by the operator. In lieu of a switch located on the imaging system, it is permissible to operate an imaging system by remote control provided the imaging system ceases transmission within 10 s of the remote switch being released by the operator.

Regulations adopted by the United States of America require that emissions from a UWB vehicular radar in the 23.6-24.0 GHz band, at angles of 38° or greater above the horizontal plane, be attenuated 25 dB below the level in the horizontal plane. For equipment authorized, manufactured or imported on or after 1 January 2005, the required attenuation applies to emissions at angles of 30° or greater. On 1 January 2010, the required attenuation increases to 30 dB, and on 1 January 2014, it increases to 35 dB. This level of attenuation can be achieved through the antenna directivity, through a reduction in output power or any other means.

TABLE 1

UWB technical summary table for the United States of America

(In this Table, unless otherwise stated, the unit of frequency is MHz and the unit of e.i.r.p. is dBm/MHz)

	GPR and wall imaging systems* (see Fig. 1)	Through-wall imaging systems (1) (see Fig. 2)	Through-wall imaging systems (2) (see Fig. 3)	Surveillance systems (see Fig. 4)	Medical imaging systems (see Fig. 5)	Vehicular radar systems (see Fig. 6)	Indoor communication systems (see Fig. 7)	Outdoor, hand-held communication systems (see Fig. 8)
Operating bands	The UWB bandwidth of an imaging system must be below 10.6 GHz	Through-wall imaging systems with the UWB bandwidth below 960 MHz	For equipment operating with centre frequency, f_c , and f_m between 1 990 MHz and 10 600 MHz	The UWB bandwidth of a surveillance imaging system must be contained between 1 990 MHz and 10 600 MHz	The UWB bandwidth of a medical imaging system must be contained between 3 100 MHz and 10 600 MHz	The UWB bandwidth must be contained between 22 GHz and 29 GHz. The centre frequency and the frequency at which the highest level emission occurs must be greater than 24.075 GHz	The UWB bandwidth of an indoor UWB system must be contained between 3 100 MHz and 10 600 MHz	The UWB bandwidth of an outdoor, hand-held device must be contained between 3 100 MHz and 10 600 MHz
Limitations of service	Operation is limited to purposes associated with law enforcement, fire fighting, emergency rescue, scientific research, commercial mining, or construction	Operation is limited to through-wall imaging systems operated by law enforcement, emergency rescue or firefighting organizations that are under the authority of a local or State government	This equipment may be operated only for law enforcement applications, providing emergency services, and necessary training operations	Operation is limited to fixed surveillance systems operated by law enforcement, fire or emergency rescue organizations or by manufacturer licensees, petroleum licensees or power licensees	Operation is limited to medical imaging systems used at the direction of, or under the supervision of, a licensed healthcare practitioner. The operation of medical imaging systems requires coordination	Operation is limited to UWB field disturbance sensors mounted in terrestrial transportation vehicles. These devices must operate only when the vehicle engine is running	Operation is limited to UWB transmitters employed solely for indoor operation	UWB devices are relatively small and primarily hand-held while being operated, and do not employ a fixed infrastructure
Radiated emission limits of resolution bandwidth of 1 MHz	<i>Frequency e.i.r.p.</i> 960-1 610 -65.3 1 610-1 990 -53.3 1 990-3 100 -51.3 3 100-10 600 -41.3 Above 10 600 -51.3	<i>Frequency e.i.r.p.</i> 960-1 610 -65.3 1 610-1 990 -53.3 Above 1 990 -51.3	<i>Frequency e.i.r.p.</i> 960-1 610 -46.3 1 610-1 990 -41.3 Above 1 990 -51.3	<i>Frequency e.i.r.p.</i> 960-1 610 -53.3 1 610-1 990 -51.3 1 990-10 600 -41.3 Above 10 600 -51.3	<i>Frequency e.i.r.p.</i> 960-1 610 -65.3 1 610-1 990 -53.3 1 990-3 100 -51.3 3 100-10 600 -41.3 Above 10 600 -51.3	<i>Frequency e.i.r.p.</i> 960-1 610 -75.3 1 610-22 000 -61.3 22 000-29 000 -41.3 29 000-31 000 -51.3 Above 31 000 -61.3	<i>Frequency e.i.r.p.</i> 960-1 610 -75.3 1 610-1 990 -53.3 1 990-3 100 -51.3 3 100-10 600 -41.3 Above 10 600 -51.3	<i>Frequency e.i.r.p.</i> 960-1 610 -75.3 1 610-1 990 -63.3 1 990-3 100 -61.3 3 100-10 600 -41.3 Above 10 600 -61.3
Limits for resolution bandwidth of no less than 1 kHz	<i>Frequency e.i.r.p.</i> 1 164-1 240 -75.3 1 559-1 610 -75.3	<i>Frequency e.i.r.p.</i> 1 164-1 240 -75.3 1 559-1 610 -75.3	<i>Frequency e.i.r.p.</i> 1 164-1 240 -56.3 1 559-1 610 -56.3	<i>Frequency e.i.r.p.</i> 1 164-1 240 -63.3 1 559-1 610 -63.3	<i>Frequency e.i.r.p.</i> 1 164-1 240 -75.3 1 559-1 610 -75.3	<i>Frequency e.i.r.p.</i> 1 164-1 240 -85.3 1 559-1 610 -85.3	<i>Frequency e.i.r.p.</i> 1 164-1 240 -85.3 1 559-1 610 -85.3	<i>Frequency e.i.r.p.</i> 1 164-1 240 -85.3 1 559-1 610 -85.3

* See Table 2 for emission limits applicable to UWB ground-penetrating radar and wall-imaging systems in the frequency range 9 kHz-960 MHz.

TABLE 2

**Emission limits applicable to UWB GPR and wall-imaging radar
(based on CISPR quasi-peak-detection) from 9 kHz to 960 MHz**

Frequency (MHz)	Field strength ($\mu\text{V/m}$)	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
30.0-88.0	100	3
88.0-216.0	150	3
216.0-960.0	200	3

The emission limits shown in Table 2 are based on measurements employing a CISPR³ quasi-peak detector except for the frequency bands 9-90 kHz, and 110-490 kHz. Radiated emission limits in these two bands are based on measurements employing an average detector.

Note that in the United States of America, the UWB emission limits at or below 960 MHz are expressed in $\mu\text{V/m}$, while the e.i.r.p. UWB emission limits above 960 MHz are expressed in dBm/MHz. The emission limits above 960 MHz are also based on an average detector.

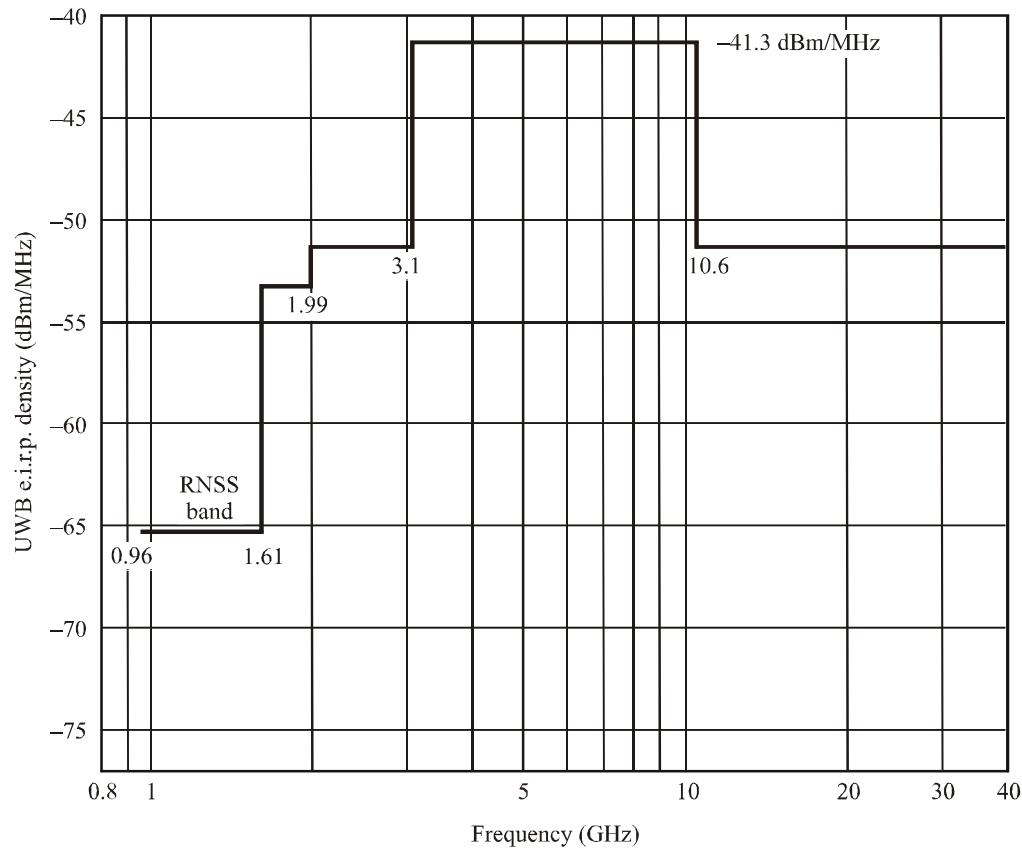
1.4 Emission masks of the United States of America

The following emission masks, in terms of e.i.r.p. density (dBm/MHz), have been adopted from the approved UWB emission limits in the United States of America.

³ CISPR 16:

- from 30 to 1 000 MHz: quasi-peak detector with measurement bandwidth = 120 kHz
- above 1 000 MHz: average detector with measurement bandwidth = 1 MHz.

FIGURE 1
Ground penetrating radar and wall imaging systems*



* Operation is limited to law enforcement, fire and rescue organizations, scientific research institutions, commercial mining companies, and construction companies.

GPR system: A field disturbance sensor that is designed to operate only when in contact with, or within one metre of, the ground for the purpose of detecting or obtaining the images of buried objects or determining the physical properties within the ground. The energy from the GPR is intentionally directed down into the ground for this purpose.

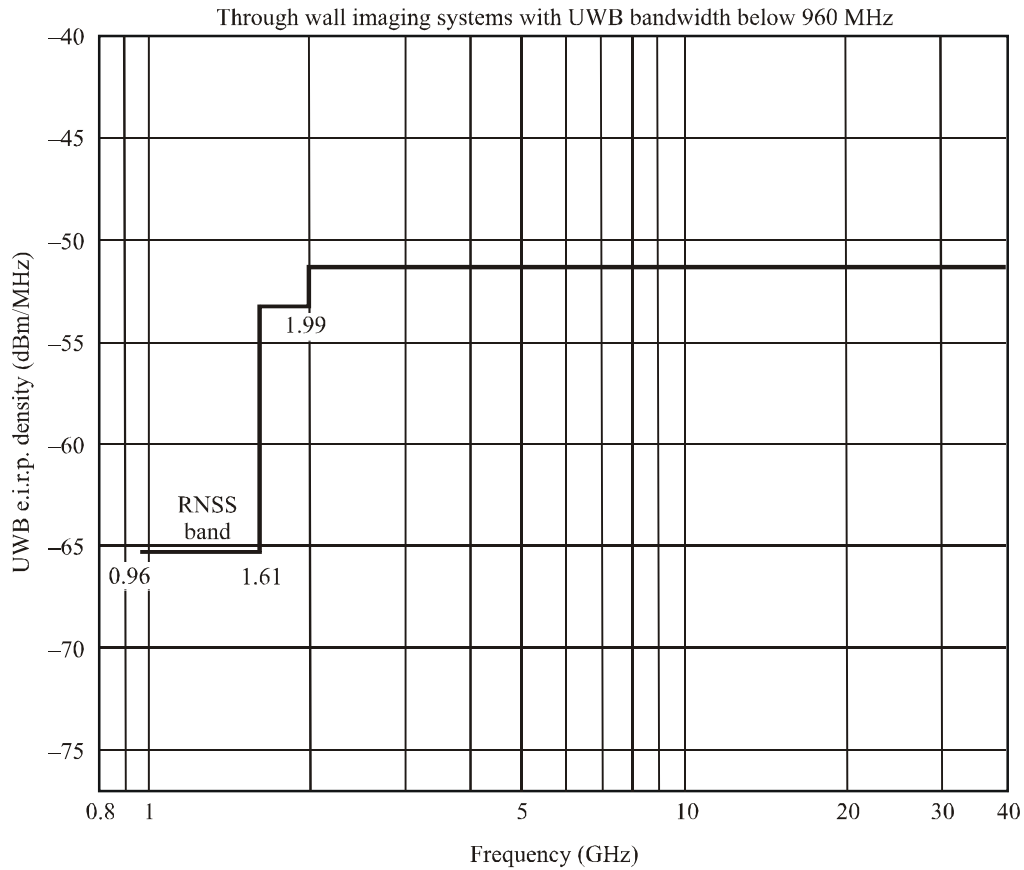
Wall imaging system: A field disturbance sensor that is designed to detect the location of objects contained within a "wall" or to determine the physical properties within the "wall". The "wall" is a concrete structure, the side of a bridge, the wall of a mine or another physical structure that is dense enough and thick enough to absorb the majority of the signal transmitted by the imaging system. This category of equipment does not include products such as "stud locators" that are designed to locate objects behind gypsum, plaster or similar walls that are not capable of absorbing the transmitted signal.

Note 1 – UWB emission limits above 960 MHz are based on e.i.r.p. measurements using an r.m.s. detector with 1 MHz resolution bandwidth.

Note 2 – At or below 960 MHz, Table 2 applies.

1756-01

FIGURE 2
Through-wall imaging systems (1)*



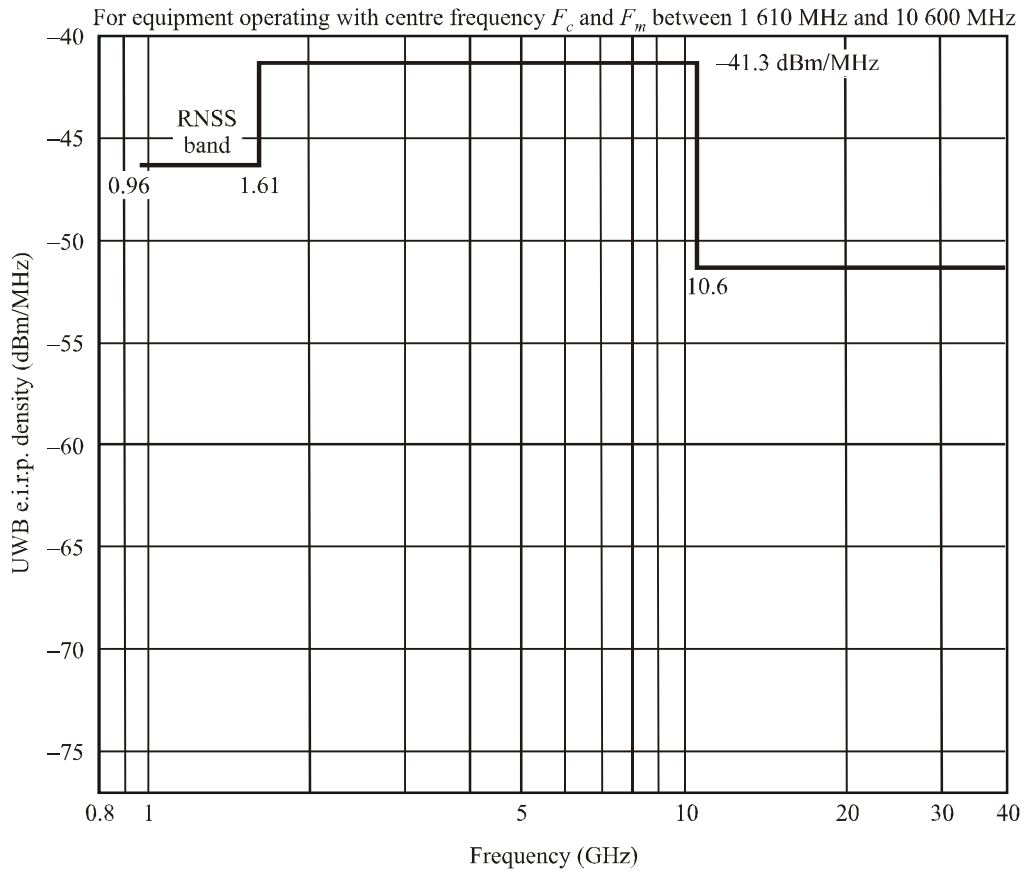
* Operation is limited to law enforcement and fire and rescue organizations that are under the authority of a local or state government.

Through-wall imaging system: A field disturbance sensor that is designed to detect the location or movement of persons or objects that are located on the other side of an opaque structure such as a wall or a ceiling. This category of equipment may include products such as “stud locators” that are designed to locate objects behind gypsum, plaster or similar walls that are not thick enough or dense enough to absorb the transmitted signal.

Note 1 – UWB emission limits above 960 MHz are based on e.i.r.p. measurements using an r.m.s. detector with 1 MHz resolution bandwidth.

Note 2 – At or below 960 MHz, Table 2 applies.

FIGURE 3
Through-wall imaging systems (2)*



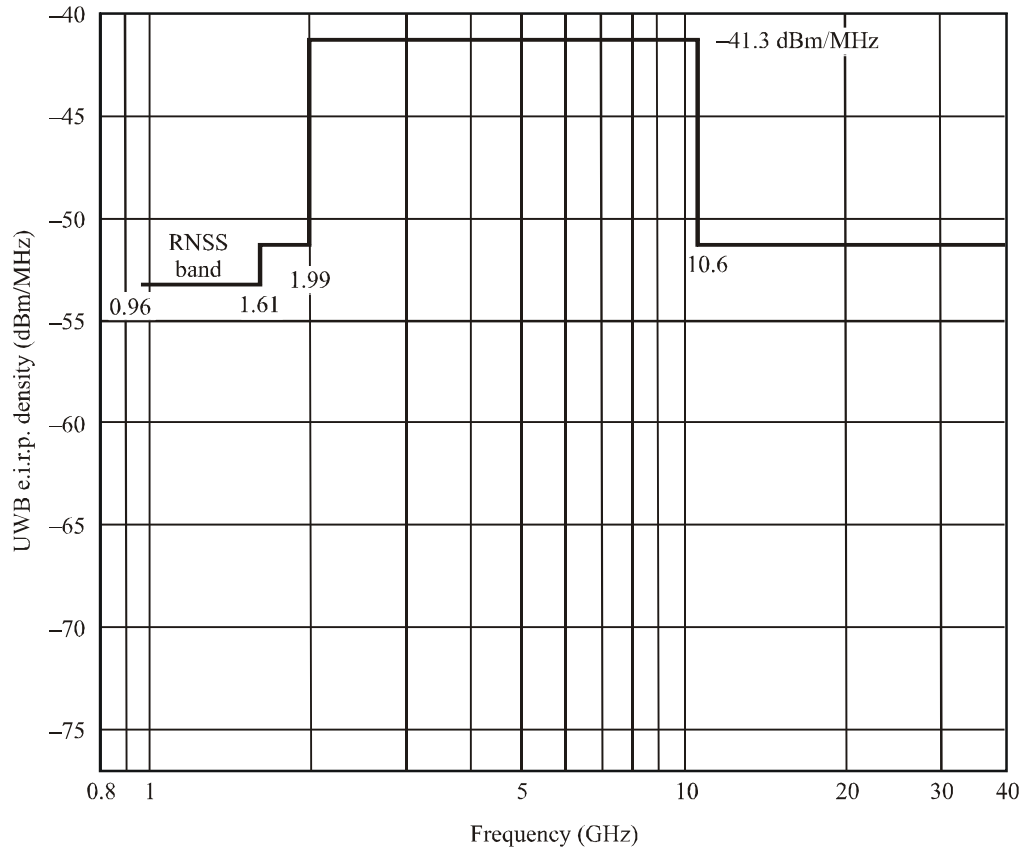
* Operation is limited to law enforcement and fire and rescue organizations that are under the authority of a local or state government.

Note 1 – UWB emission limits above 960 MHz are based on e.i.r.p. measurements using an r.m.s. detector with 1 MHz resolution bandwidth.

Note 2 – At or below 960 MHz, Table 2 applies.

1756-03

FIGURE 4
Surveillance systems*



* Surveillance systems may be operated by law enforcement, fire or emergency rescue organizations or by manufacturers licensees, petroleum licensees or power licensees.

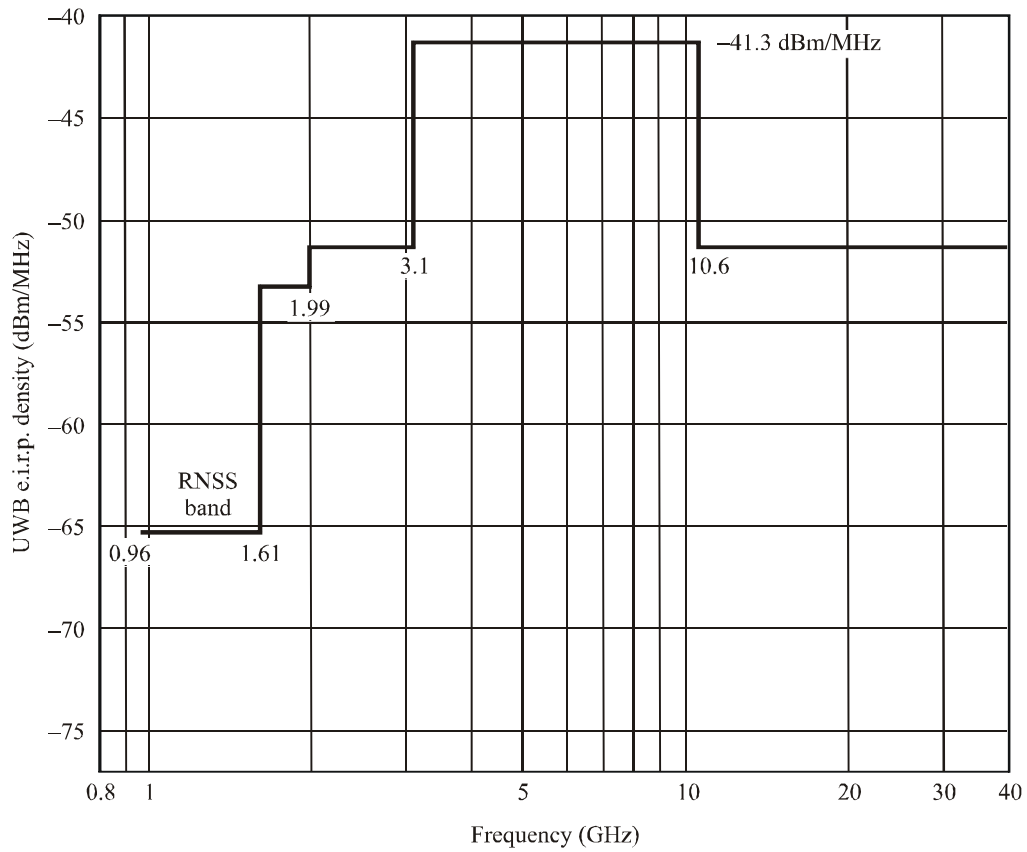
Surveillance system: A field disturbance sensor used to establish a stationary RF perimeter field that is used for security purposes to detect the intrusion of persons or objects.

Note 1 – UWB emission limits above 960 MHz are based on e.i.r.p. measurements using an r.m.s. detector with 1 MHz resolution bandwidth.

Note 2 – At or below 960 MHz, Table 2 applies.

1756-04

FIGURE 5
Medical imaging systems*



* Operation is limited to law enforcement, fire and rescue organizations, scientific research institutions, commercial mining companies, licensed healthcare practitioners, and construction companies.

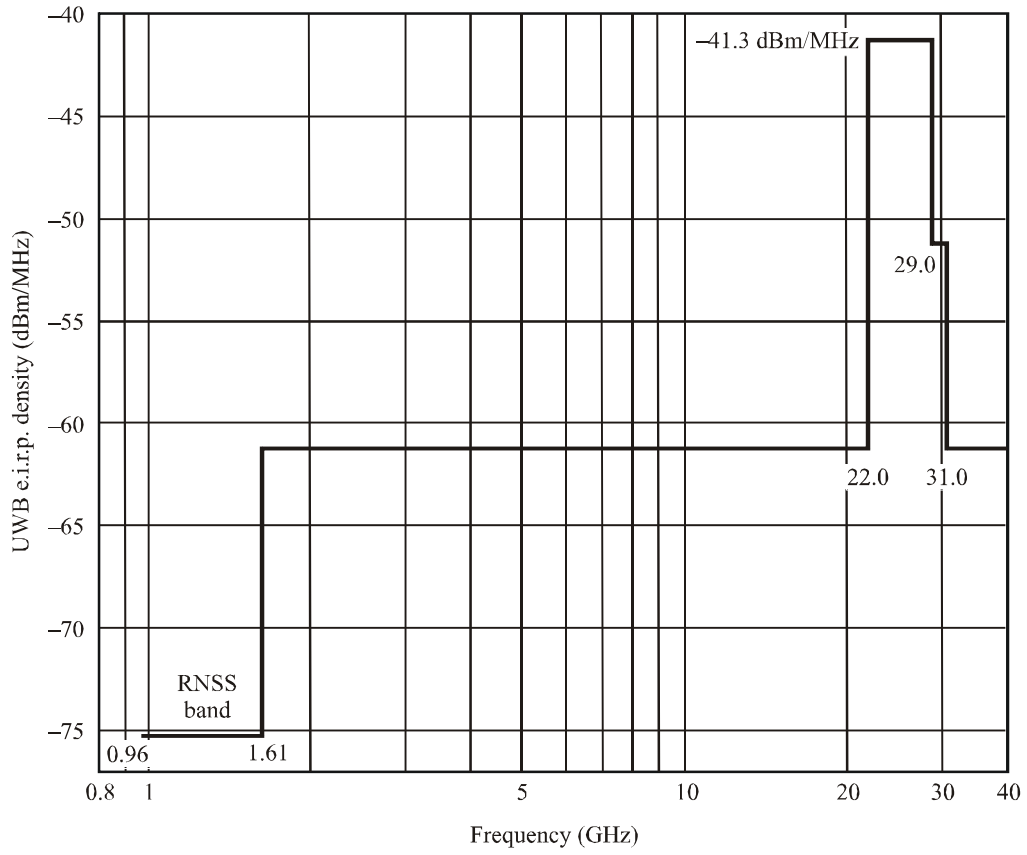
Medical imaging system: A field disturbance sensor that is designed to detect the location or movement of objects within the body of a person or animal.

Note 1 – UWB emission limits above 960 MHz are based on e.i.r.p. measurements using an r.m.s. detector with 1 MHz resolution bandwidth.

Note 2 – At or below 960 MHz, Table 2 applies.

1756-05

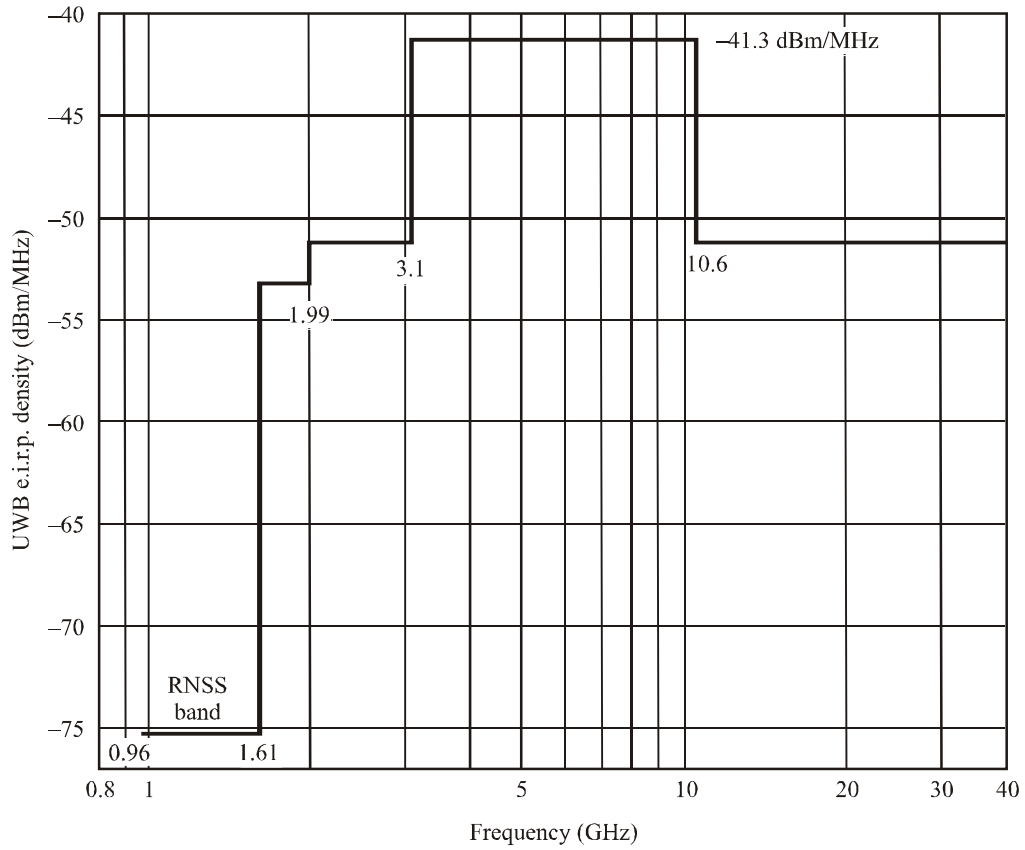
FIGURE 6
Vehicular radar systems



Note 1 – UWB emission limits above 960 MHz are based on e.i.r.p. measurements using an r.m.s. detector with 1 MHz resolution bandwidth.

Note 2 – At or below 960 MHz, Table 2 applies.

FIGURE 7
Indoor communication systems*



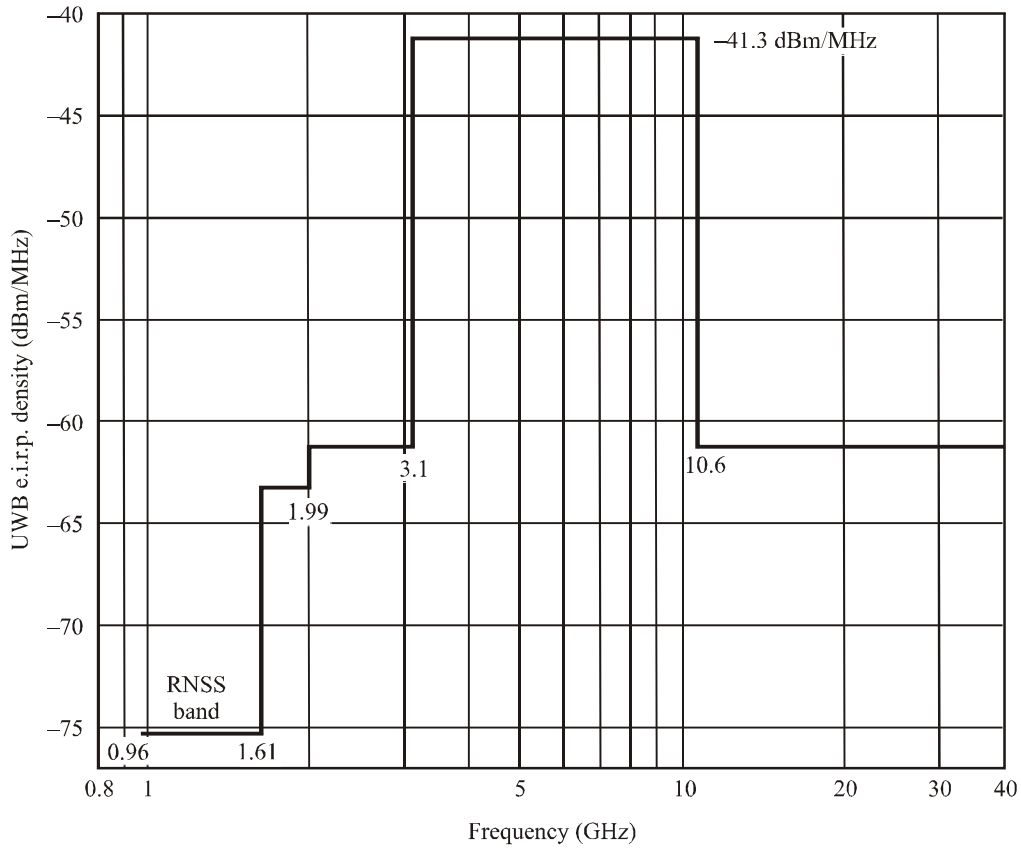
* Equipment must be designed to ensure that operation can only occur indoors or it must consist of hand-held devices that may be employed for such activities as peer-to-peer operation.

Note 1 – UWB emission limits above 960 MHz are based on e.i.r.p. measurements using an r.m.s. detector with 1 MHz resolution bandwidth.

Note 2 – At or below 960 MHz, Table 2 applies.

1756-07

FIGURE 8
Outdoor, hand-held communication systems*



* Equipment must be hand-held. A hand-held device is a portable device, such as a laptop computer or a personal digital assistant that is primarily hand-held while being operated and that does not employ a fixed infrastructure.

Note 1 – UWB emission limits above 960 MHz are based on e.i.r.p. measurements using an r.m.s. detector with 1 MHz resolution bandwidth.

Note 2 – At or below 960 MHz, Table 2 applies.

1756-08

Attachment 2 to Annex 1

Summary of proposed European Conference of Postal and Telecommunications Administrations (CEPT) Regulations

CEPT has developed UWB regulations for different applications that are applicable within these administrations, which include PSD masks and other regulatory provisions for generic UWB devices and vehicular radar systems.

Other regulations are also being developed for specific classes of UWB device (e.g. ground and wall penetrating radar) which do not meet the technical requirements for generic UWB devices.

2.1 Technical requirements for generic UWB devices⁴

CEPT has defined the harmonized conditions for the use of generic UWB devices below 10.6 GHz, subject to the final adoption process. These devices shall comply with the regulatory framework for placing on the market, free movement and putting into service of radio equipment in these countries, which may be demonstrated by compliance with harmonized standards or equivalent technical specifications. These devices are exempt from individual licensing and operate on a non-interference, non-protected basis.

The technical requirements for the permitted devices are defined in § 2.1.1.

These provisions are not applicable to:

- a) flying models⁵;
- b) outdoor installations and infrastructure, including those with externally mounted antennas;
- c) devices installed in road and rail vehicles, aircraft and other aviation.

(i.e. UWB devices in these types of product are not exempt from individual licensing.)

The following restrictions on use apply to permitted devices:

- a) operation not allowed at a fixed outdoor location.

It is still under consideration whether operation will be allowed on board an aircraft or a ship. An adequate regulatory mechanism for possibly banning such use would furthermore need to be identified.

UWB devices may be permitted to operate in the band 4.2-4.8 GHz without detect-and-avoid (DAA) until 30 June 2010, with a mean e.i.r.p. density limit of -41.3 dBm/MHz and a maximum peak e.i.r.p. density of 0 dBm/50 MHz. The situation would be reviewed in 3 years in the light of WRC-07 results.

In the frequency band 3.1-4.95 GHz CEPT administrations support investigation of DAA mechanisms with a view to allowing UWB devices in this band with a maximum average e.i.r.p. density of -41.3 dBm/MHz and a maximum peak e.i.r.p. density of 0 dBm/50 MHz, while ensuring the protection of radio services in the band. It has, however, to be noted that the reliable implementation of such DAA mechanisms, based on requirements that are to be defined, is not trivial and their feasibility has not yet been validated. Therefore, further investigation of DAA is needed. Only if the effectiveness of DAA mechanism is validated will UWB devices incorporating it be permitted to operate.

CEPT administrations will monitor the efficiency of video coding for UWB devices placed on the market to verify that no significant amount of devices will appear on the market which use less efficient coding and to review the proposed regulation otherwise.

⁴ The draft Decision containing these regulations has not yet been considered by the CEPT Electronic Communications Committee (ECC). The document will then be open for a period for public comments, before final adoption by ECC expected in March 2006.

⁵ It is still under consideration whether these provisions will apply to toys.

2.1.1 Technical requirements for UWB devices below 10.6 GHz

2.1.1.1 Maximum e.i.r.p. limits

Frequency range (GHz)	Maximum average e.i.r.p. density (dBm/MHz)	Maximum peak e.i.r.p. density (dBm/50 MHz)
Below 1.6	-90	-50
1.6-2.7	-85	-45
2.7-3.1	-70	-30
3.1-4.95 (see Notes 1 to 4)	-70	-30
4.95-6	-70	-30
6-9	-41.3	0
9-10.6	-65	-25
Above 10.6	-85	-45

NOTE 1 – In the frequency band 3.1-4.95 GHz, CEPT administrations support investigation of DAA mechanisms in order to ensure compatibility of UWB devices with radio services in the band with a view to allowing UWB devices in this band with a maximum average e.i.r.p. density of -41.3 dBm/MHz and a maximum peak e.i.r.p. density of 0 dBm/50 MHz. ECC will review the decision in the light of the results of these investigations.

NOTE 2 – In the frequency band 3.1-4.95 GHz, UWB devices may be permitted with a maximum average e.i.r.p. density (provisionally in the range of -41.3 to -45 dBm/MHz), a maximum peak e.i.r.p. density of 0 dBm/50 MHz and a maximum duty cycle of 5% over 1 s and 0.5% over 1 h.

NOTE 3 – In the frequency band 4.2-4.8 GHz, UWB devices may be permitted until 30 June 2010 with a maximum average e.i.r.p. density of -41.3 dBm/MHz and a maximum peak e.i.r.p. density of 0 dBm/50 MHz.

NOTE 4 – In the frequency band 3.1-4.95 GHz, CEPT administrations support investigation of possible other mitigation techniques, in order to ensure compatibility of UWB devices with radio services.

2.1.1.2 Other requirements

Pulse repetition frequency

The pulse repetition frequency (PRF) for UWB devices shall not be less than 1 MHz. This restriction does not apply to burst repetition frequency.

NOTE 1 – It may not be necessary to have this restriction as well as the peak e.i.r.p. limit.

Transmission activity

A communications system shall transmit only when it is sending information to an associated receiver or attempting to acquire or maintain association. The device shall cease transmission within ten seconds unless it receives an acknowledgement from an associated receiver that its transmission is being received. An acknowledgement of transmission must continue to be received by the UWB device at least every 10 s, or it must cease transmitting. A device operating as a communication system is characterized by transmission between at least two devices.

Non-communication systems, such as imaging systems, shall contain a manually operated switch that causes the transmitter to cease operation within 10 s of being released by the operator. In lieu of a switch located on the imaging system, it is permissible to operate an imaging system by remote control provided the imaging system ceases transmission within 10 s of the remote switch being released by the operator.

2.1.2 Definitions

Maximum PSD: the maximum PSD is the highest signal strength measured in any direction at any frequency within the defined range.

Average power: the UWB device shall be configured so that it is transmitting continuously at its maximum possible power. The power is measured with a 1 MHz resolution bandwidth, an r.m.s. detector and an averaging time of 1 ms or less.

Peak power: the peak level of transmission contained within a 50 MHz bandwidth centred on the frequency at which the highest average radiated power occurs.

Duty cycle: for these regulatory provisions, the duty cycle is defined as the ratio, expressed as a percentage, of the transmitter “on” relative to a given period as specified in the technical requirements.

Impulse, pulse and burst:

Impulse: a surge of unidirectional polarity that is often used to excite a UWB band limiting filter whose output, when radiated, is a UWB pulse.

Pulse: a radiated short transient UWB signal whose time duration is nominally the reciprocal of its UWB –10 dB bandwidth.

Burst: an emitted signal whose time duration is not related to its bandwidth.

2.2 Specific technical requirements for automotive short-range radars in the 24 GHz band in CEPT

- a) In these technical requirements, short-range radars (SRR) are defined as radio-communication equipment that falls in the general category of vehicular radar systems and provides collision mitigation and traffic safety applications.
- b) In order to allow early introduction of SRR applications in CEPT the 24 GHz frequency range is designated for SRR systems on a temporary basis as follows:
 - 24.15 GHz \pm 2.5 GHz for the UWB component, with a maximum mean power density of –41.3 dBm/MHz e.i.r.p. and peak power density of 0 dBm/50 MHz e.i.r.p;
 - 24.05-24.25 GHz for the narrow-band emission mode/component, which may only consist of an unmodulated carrier, with a maximum peak power of 20 dBm e.i.r.p and a duty cycle limited to 10% for peak emissions higher than –10 dBm e.i.r.p.
- c) The temporary frequency designation for SRR equipment in the 24 GHz range is on a non-interference and non-protected basis.
- d) Emissions within the 23.6-24 GHz band that appear 30° or greater above the horizontal plane shall be attenuated by at least 25 dB up to 2010 and 30 dB up to 1 July 2013 for SRR systems operating in the 24 GHz range as defined in b).
- e) 24 GHz SRR systems transmitting in the band 23.6-24 GHz with an e.i.r.p. higher than –74 dBm/MHz or in any neighbouring band to which RR No. 5.149 applies with an e.i.r.p. higher than –57 dBm/MHz, shall be fitted with an automatic deactivation mechanism to ensure protection of radio astronomy sites as well as manual deactivation to ensure that emissions are restricted only to those administrations that have implemented the temporary solution. In order to allow an early implementation of 24 GHz SRR systems the automatic deactivation shall be made mandatory from 1 July 2007. Before that date, manual deactivation is required.
- f) Where an automatic deactivation mechanism is implemented, 24 GHz SRR systems must be deactivated within the specified separation distance from specified radio astronomy sites.

- g) The 24 GHz frequency range may only be used for new SRR systems until the reference date, that is set to 1 July 2013. After this reference date, the 79 GHz range for new SRR systems, or alternative permitted technical solutions, must be used for road vehicle collision mitigation and traffic safety applications, while existing 24 GHz equipment may still operate in the 24 GHz band to the end of lifetime of the vehicles.
- h) The percentage of vehicles equipped with 24 GHz SRR devices must not exceed 7% in each administration.

2.3 Specific technical requirements for automotive SRRs in the 79 GHz band in CEPT

- a) In these technical requirements, SRR equipment is defined as applications providing road vehicle based radar functions for collision mitigation and traffic safety applications.
- b) The 79 GHz frequency range (77-81 GHz) is designated for SRR equipment on a non-interference and non-protected basis with a maximum mean power density of -3 dBm/MHz e.i.r.p. associated with an peak limit of 55 dBm e.i.r.p.

The maximum mean power density outside a vehicle resulting from the operation of one SRR equipment shall not exceed -9 dBm/MHz e.i.r.p.

Attachment 3 to Annex 1

Specific technical requirements for Japan

In Japan, discussion for the development of indoor UWB regulation has been initiated by using a preliminary UWB transmission mask illustrated in Fig. 9. With this preliminary mask, impact analysis regarding other incumbent radiocommunication systems will be continued, and Japan will make any necessary adjustments to the UWB transmission mask, as needed. The final report of the study is planned to be published by the end of March 2006.

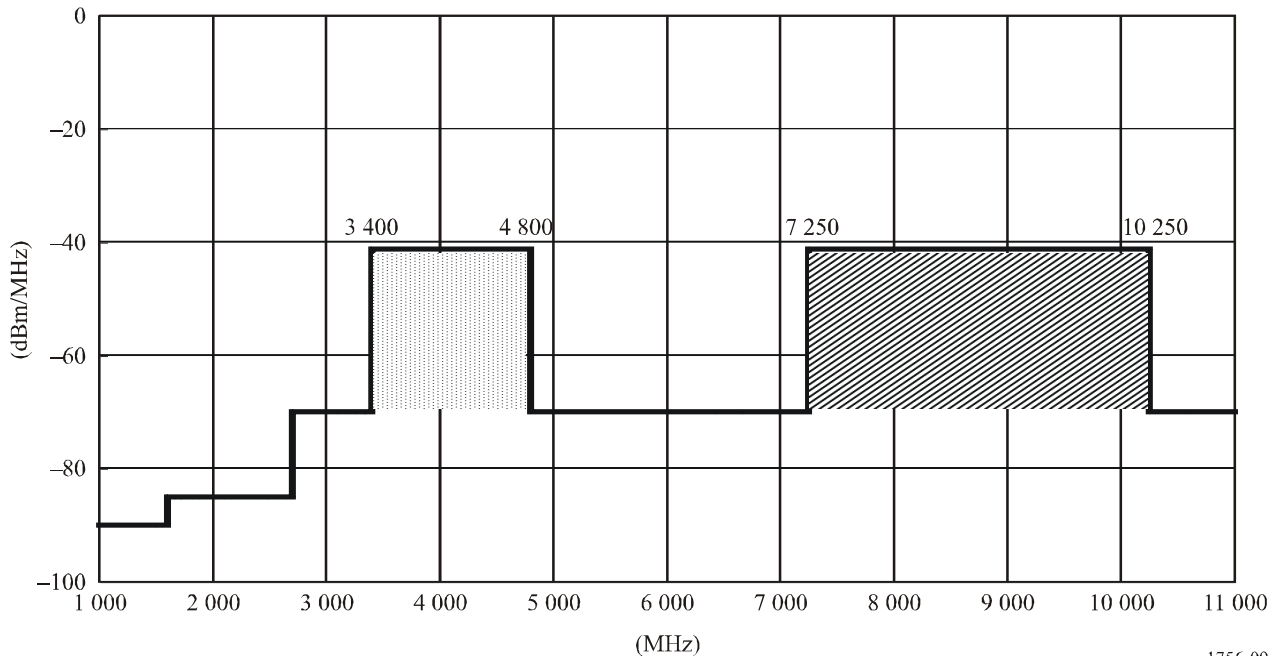
3.1 Purpose and status of the preliminary UWB transmission mask

- a) This preliminary mask was developed as a starting point of study and discussion toward the completion of Japanese UWB regulation. Japan expects this preliminary mask will accelerate future discussion to implement final regulation and the introduction of UWB devices in the Japanese market.
- b) Japan expects this preliminary mask will assist future international harmonization with other countries.
- c) With comprehensive consideration of UWB service requirements as well as technical characteristics of other radiocommunication services, such as sensitive passive services, this preliminary mask has been set as flat as possible.
- d) By using this preliminary mask, Japan will continue to analyse the impact to other radiocommunication services and to study possibility of compatibility between UWB devices and other radiocommunication services.
- e) Japan has been conducting interference analysis, taking account of the principle that UWB devices need be operated on a non-protected, non harmful interference basis (see RR No. 4.4) and Recommendation ITU-R SM.1757.

- f) Since Japan will continue its technical discussions regarding interference to other incumbent radiocommunication services, it recognizes that there is a possibility that this preliminary mask would be modified, taking account of results of technical studies, trends of international UWB studies, etc.

3.2 Basic concept of the preliminary UWB transmission mask

FIGURE 9
Preliminary UWB transmission mask for impact analysis
(only indoor use) of Japan



1756-09

- a) This preliminary mask is used under the condition that all UWB devices are limited to only indoor use.
- b) Lower band (3 400-4 800 MHz, dotted area): Taking account of the current situation that there are existing radiocommunication systems in this frequency band, and that this frequency band is expected to be used for future mobile communications as well as appropriate band for development of UWB devices, UWB devices could emit at equal to or less than the limit of -41.3 dBm/MHz of the FCC rule under the condition that UWB devices are equipped with interference avoidance techniques such as detect-and-avoid (DAA) that can protect systems beyond IMT-2000, ENG and other radiocommunication services effectively, when the techniques become available. The transmission level for UWB devices without interference avoidance techniques such as DAA will be equal to or less than the lower transmission level of -70 dBm/MHz proposed by CEPT (full details are contained in § 2.1.1.1 of Appendix 2 based upon the protection level for radiocommunication systems).
- c) Middle band (4 800-7 250 MHz): Taking account of the technical difficulty of frequency sharing with passive services, UWB devices could emit at equal to or less than the lower transmission level of -70 dBm/MHz proposed by CEPT, based upon the previous protection level for radiocommunication systems (current details are contained in § 2.1.1.1 of Attachment 2 to Annex 1).
- d) Higher band (7 250-10 250 MHz, see hatched area by oblique line in Fig. 9): Taking account of the requirement, development and dissemination of UWB devices as well as to initiate

further discussion, UWB devices could emit at equal to or less than the FCC rule level of -41.3 dBm/MHz.

- e) Lower out-of-band (below 3 400 MHz): UWB devices could emit at equal to or less than the transmission mask proposed by CEPT.
- f) Higher out-of-band (above 10 250 MHz): UWB devices could emit at equal to or less than the lower transmission level of -70 dBm/MHz proposed by CEPT, based upon the previous protection level for radiocommunication systems (current details are contained in § 2.1.1.1 of Attachment 2 to Annex 1).

3.3 Further studies

- a) Based on this preliminary mask, further impact analysis regarding systems beyond IMT-2000, ENG and radiocommunication services, such as MS, FS, FSS, MSS, RAS and EESS, will be continued, taking account of technical studies including Report ITU-R SM.2057.
- b) All technical assumptions employed for impact analysis (e.g. assumption of UWB device activity factor) should be examined carefully.
- c) Effectiveness of interference avoidance techniques such as DAA should be ensured by technical studies including experimental tests based on mutual agreement with the parties concerned.
- d) In the process of development of the UWB transmission mask, the assessment of whether UWB service requirements can be met would be also important.
- e) Currently, the MMAC forum⁶ is conducting UWB interference experiments with the participation of both manufacturers and incumbent users. At this moment, some results such as comparing UWB signals and additive white Gaussian noise (AWGN) characteristics have been obtained⁷. Furthermore, the results of this experiment should be analysed to evaluate impact on existing radiocommunication systems.
- f) Regulatory measurement, such as limiting the number of type approved devices, should be studied.

⁶ MMAC forum means the Multimedia Mobile Access Communication Systems forum.
<http://www.arib.or.jp/mmac/e/>

⁷ Since the parameters of the experiment are limited, the results are regarded as samples.