ELECTRONIC COMMUNICATIONS COMMITTEE

ECC Decision
of 30 March 2007
on specific Material Sensing devices
using Ultra-Wideband (UWB) technology

(ECC/DEC/(07)01)
amended 26 June 2009

EXPLANATORY MEMORANDUM

1 INTRODUCTION

This ECC Decision has been developed in response to market demands for Building Material Analysis (BMA) and Object Discrimination and Characterisation (ODC) devices using UWB technology devices. The ECC Decision should ensure that frequency bands are available on a harmonised basis to enable the introduction of UWB devices in a timely manner and ensuring economies of scale while ensuring protection of existing applications or services.

It should be noted that this ECC Decision is designed to be part of a "regulatory package" on UWB, with various regulatory and legal provisions. The generic regulation for UWB devices in Europe consists of Decision ECC/DEC/(06)04 supplemented by Decision ECC/DEC/(06)12 and was developed to respond primarily to the core market demand for communication applications and cable replacement. It enables also various types of radiodetermination applications using UWB technology in bands below 10.6 GHz e.g. location-tracking, sensor technologies. In addition, Decision ECC/DEC/(06)08 on the conditions for use of the radio spectrum by Ground- and Wall- Probing Radar (GPR/WPR) imaging systems was developed to respond to a specific UWB requirement that shall be subject to an appropriate licensing regime.

In CEPT Report 10 developed in response to an EC Mandate on UWB Specific Applications, it was emphasized that the generic UWB regulation shall remain the cornerstone of European regulatory package on UWB. Additional ECC Decisions for specific UWB applications, which could result in confusion for the industry, spectrum users and market surveillance authorities, should be avoided.

Requirements from the industry for specific UWB applications ought obviously to be considered for applications with clear benefits from using UWB technology that cannot fit under the generic Decision on UWB. The use of UWB technology in accurate imaging applications is expected to be the main application for which the development of specific UWB regulations can be justified because of physical reasons (e.g. reflections of clutter and penetration depth). The narrow pulses used by UWB imaging systems enable them to make sophisticated signal measurements, allowing material differentiation and analysis in 3-dimensional immediate vicinity on a millimetre-level positioning.

BMA and ODC devices will have a direct impact in a number of markets, such as workplace, security, and manufacturing. Development of this market will depend on the high accuracy and reliability provided by UWB systems. Compared to generic UWB applications, the market for BMA and ODC is not expected to be a mass market and the deployment will be significantly lower.

Users of BMA and ODC devices include skilled workers, experts, art historians, architects, planners, environmentalists, civil engineers as well as ordinary DIYs ("do-it-yourself"). The markets and applications for this technology are expected to primarily involve professional usage and low density deployments.

2 BACKGROUND

In response to demands brought to the attention of ECC by industry, harmonised frequency bands are required for the introduction of BMA and ODC devices ensuring economies of scale and a harmonised introduction of these devices inside CEPT.

BMA devices can be described as field perturbation sensors, or radiodetermination systems, that are designed to detect the location of objects within a building structure or to determine the physical properties of a building material.

In case of ODC devices, two types of applications were distinguished in the compatibility studies:

- Application A: Proximity Sensing of Human tissue
- Application B: "Break through" protection and direct contact avoidance for building work

Application A is intended for:

- detection of small objects like a finger or other extremities in the presence of obstacles (e.g. wood), positioned close to a hazard like a saw blade;
- applications typically for consumer market, like safety devices for power tools or dangerous machines;
- usage in close proximity to potentially hazard area (0 to 40 cm).

Application B will be used for high end drilling and percussion drilling machines. It is planned to mount it directly to the tool. A parallel usage is possible. The UWB sensor application monitors the drilling process and controls the drilling machine also depending on the inhomogenities in the material. The user will be warned acoustically or optically in case of a collision with unexpected objects inside the material (e.g. gas- water pipes or electric cables) may happen. The UWB application may be active synchronously to the operation of the drilling machine which will be supported by this application.

The detailed compatibility studies performed by CEPT considered the specific deployment scenarios and mitigation factors of BMA or ODC and have led to highly specific requirements in different frequency bands, taking into account specificities of the victim services and operational requirements for BMA or ODC.

3 REQUIREMENT FOR AN ECC DECISION

The allocation or designation of frequency bands under specified conditions in CEPT member countries is laid down by law, regulation or administrative action. ECC Decisions are required to deal with the carriage and use of equipment throughout Europe. The ECC also recognizes that for UWB devices to be introduced successfully throughout Europe, confidence must be given on the one hand to manufacturers to make the necessary investment in the new pan European Radiocommunications systems and services and on the other hand to users of existing services that their protection will be ensured.

The harmonisation on a European basis would support the *Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity*.

A commitment by CEPT member countries to implement an ECC Decision will provide a clear indication that the required frequency range will be made available on time and on a Europe-wide basis and that the means to ensure protection of existing services will be applied.

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Comparable technical specifications to those in this ECC Decision are given in EC Decision 2009/343/EC. EU member states and, if so approved by the EEA Joint Committee, Iceland, Liechtenstein and Norway are obliged to implement the EC Decision.

"The European Conference of Postal and Telecommunications Administrations,

considering

a) That Commission decision 2007/131/EC on allowing the use of the radio spectrum for equipment using ultra-wideband technology in a harmonised manner in the Community amended by Commission decision 2009/343/EC of 21 April 2009 defines conditions of use of the spectrum for BMA devices;

b) that Ultra-Wideband (UWB) technology shall mean technology for short-range radiocommunication, involving the intentional generation and transmission of radio-frequency energy that spreads over a very large frequency range, which may overlap several frequency bands allocated to radiocommunication services;

c) that the generic UWB regulation consisting of Decision ECC/DEC/(06)04 supplemented by Decision ECC/DEC/(06)12 should primarily be used for applications using UWB technology in bands below 10.6 GHz;

d) that, in order to allow the introduction of Building Material Analysis (BMA) and Object Discrimination and Characterisation (ODC) devices using UWB technology within the CEPT, the use of the frequency range 2.2 to 8.5 GHz has been requested by the industry because:
   - there is a need for higher emission limits than those contained in Decision ECC/DEC/(06)04 in certain frequency ranges,
   - a larger bandwidth is required for spatial resolution,
   - lower frequency bands are required for material penetration and clutter suppression,
   - the technology is available;

e) that the radiated emissions of BMA and ODC devices are intended to be transmitted into a structure or material for the purpose of detecting the location of objects within the structure or to determine the physical properties of the material;

f) that a regulatory framework for specific licence-exempt material sensing devices using UWB technology will enable the operation of BMA and ODC devices as well as other types of radiodetermination applications with similar characteristics;

g) that the impact of ODC on radio communication services has been investigated in ECC Report 123, making a distinction between ODC application A (Proximity Sensing of Human tissue) and application B ("Break through" protection and direct contact avoidance for building work) and subsequent corresponding technical requirements;

h) that the density and activity of operation of these devices is expected to be low;
   - for BMA within the technical studies a maximum density of 6.7 units/km² for very dense urban areas with an average activity factor of 0.28% was considered;
   - for ODC within the technical studies a maximum density of 19 units/km^2 for dense urban areas with an average activity factor of max 3% was considered

i) that these BMA and ODC devices are not intended for communications purposes;

j) that the consideration of the specific deployment scenarios and mitigation factors of BMA or ODC has led to specific requirements in different frequency bands, taking into account also specificities of the victim services and operational requirements for BMA or ODC compared to the generic regulation for UWB;

k) that BMA and ODC devices have to reduce the probability of interference to radio services by mitigation techniques and factors such as
   - manually controlled operation without a locking switch,
   - emissions only when in contact or close proximity to the investigated material,

- movement detector,
- handheld devices using internal battery power source,
- low duty cycle,
- Listen Before Talk (LBT), Total Radiated Power (TRP) limitation, Transmit Power Control (TPC)
- Antenna Pattern design;

l) that technical requirements for LBT mechanisms given in this ECC Decision need to be supplemented by adequate guidance on LBT measurement procedures and test patterns as defined in relevant standards (e.g. relevant versions of EN 302 435 and EN 302 498-2 including Harmonised European Standards adopted under Directive 1999/5/EC);

m) that the LBT mechanism for BMA devices may not be fully efficient to detect meteorological radars in some of their specific operational modes but that, recognising the low activity factor of BMA, potential corresponding interference situations are assumed as relating to very low interference probability;

n) that the efficiency of LBT may need to be further investigated for the protection of mobile terminals in idle mode;

o) that the aggregate power in radio astronomy receivers that would result from the operation of licence-exempt BMA and ODC devices in bands allocated to the Radio Astronomy Service may exceed the threshold levels of interference detrimental to radio astronomy observations given in ITU-R Recommendation RA.769;

p) that administrations are encouraged to monitor the impact of BMA and ODC devices on radiocommunication services, especially on RAS;

q) that based on the experience gained, a review of this Decision should take place in 2010, consider in priority the technical requirements for BMA devices which were originally agreed in 2007, and if necessary further measures could be introduced like automatic deactivation, light licensing or more stringent limits;

r) that in EU/EFTA countries the radio equipment that is under the scope of this Decision shall comply with the R&TTE Directive. Conformity with the essential requirements of the R&TTE Directive may be demonstrated by compliance with the applicable harmonised European standard(s) or by using the other conformity assessment procedures set out in the R&TTE Directive;

DECIDES

1. that this ECC Decision defines harmonised conditions for the use in CEPT countries of Material Sensing devices using UWB technology;
2. that, for the purpose of this Decision, the following definitions apply:
    a. Material Sensing device: a device enabling radiodetermination application designed to detect the location of objects within a structure or to determine the physical properties of a material.
    b. Building Material Analysis (BMA) device: a type of Material Sensing device that is designed to detect the location of objects within a building structure or to determine the physical properties of a building material;
3. that the devices permitted under this ECC Decision are exempt from individual licensing and shall operate on a non-interference, non-protected basis;
4. that the technical requirements detailed in Annex 1 and Annex 3 apply to Material Sensing device devices permitted under this ECC Decision;
5. that the technical requirements detailed in Annex 2 and Annex 3 apply to BMA devices permitted under this ECC Decision;
6. that this Decision enters into force on 26 June 2009;
7. that the preferred date for implementation of this Decision shall be 31 December 2009;
8. that CEPT administrations shall communicate the national measures implementing this Decision to the ECC Chairman and the Office when the Decision is nationally implemented."

Note:

1. *Please check the Office web site (http://www.ero.dk) for the up to date position on the implementation of this and other ECC decisions.*

ANNEX 1

Technical requirements for Material Sensing devices using UWB technology

1. Material Sensing devices permitted under this Decision shall fulfil the following requirements:

   - **Fixed installation (application A)**
     - The transmitter has to switch off if the machine is not running, "running sensor"
     - The transmitter shall implement a TPC with a dynamic range of 10 dB, as described in the harmonised standard EN 302 498-2 for ODC applications
     - The transmitter has to be attached to a fixed installation

   - **Non fixed installation (application B)**
     - Transmitter-On only if manually operated with a non-locking switch (e.g. it may be a sensor for the presence of the operators hand) plus being in contact or close proximity to the investigated material and the emissions being directed into the direction of the object (e.g. measured by a proximity sensor or imposed by the mechanical design)
     - The transmitter has to switch off if the machine is not running, "running sensor"

2. Emissions radiating from Material Sensing devices permitted under this decision shall be kept to a minimum and in any case not exceed the e.i.r.p. spectral density limits within the following Table 1. The compliance with the limits of Table 1 for non fixed installations (application B) has to be ensured with the device on a representative structure of the investigated material (e.g. representative wall as defined in Annex 3).

Frequency range	**Fixed installations (Application A)**		**Non fixed installations (Application B)**
	Maximum mean e.i.r.p spectral density	**Maximum mean e.i.r.p spectral density in the horizontal plane (-20 to 30° elevation)**	**Maximum mean e.i.r.p. spectral density**
Below 1.73 GHz	-85 dBm/MHz		-85 dBm/MHz
1.73 to 2.2 GHz	-65 dBm/MHz	-70 dBm /MHz	-70 dBm/MHz
2.2 to 2.5 GHz	-50 dBm/MHz		-50 dBm/MHz
2.5 to 2.69 GHz	-65 dBm/MHz Note 1	-70dBm/MHz	-65 dBm/MHz Note 1 & Note 2
2.69 to 2.7 GHz	-55 dBm/MHz	-75 dBm/MHz	-70 dBm/MHz Note 3
2.7 to 2.9 GHz	-50 dBm/MHz	-70 dBm/MHz	-70 dBm/MHz
2.9 to 3.4 GHz	-50 dBm/MHz	-70 dBm/MHz	-70 dBm/MHz Note 1
3.4 to 3.8 GHz	-50 dBm/MHz	-70 dBm/MHz	-50 dBm/MHz Note 2 & Note 3
3.8 to 4.8 GHz	-50 dBm/MHz		-50 dBm/MHz
4.8 to 5 GHz	-55 dBm/MHz	- 75 dBm/MHz	-55 dBm/MHz Note 2 & Note 3
5 to 5.25 GHz	-50 dBm/MHz		-50 dBm/MHz
5.25 to 5.35 GHz	-50 dBm/MHz	- 60 dBm/MHz	-60 dBm/MHz
5.35 to 5.6 GHz	-50 dBm/MHz		-50 dBm/MHz
5.6 to 5.65 GHz	-50 dBm/MHz	-65 dBm/MHz	-65 dBm/MHz
5.65 to 5.725 GHz	-50 dBm/MHz	-60 dBm/MHz	-60 dBm/MHz
5.725 to 8.5 GHz	-50 dBm/MHz		-50 dBm/MHz
8.5 to 10.6 GHz	-65 dBm/MHz		-65 dBm/MHz
Above 10.6 GHz	-85 dBm/MHz		-85 dBm/MHz

Table 1

Note 1: devices using a Listen Before Talk (LBT) mechanism, as described in the harmonised standard EN 302 498-2, which meet the technical requirements defined within Appendix 1 to this Annex, are permitted to operate in frequency ranges 2.5 to 2.69 and 2.9 to 3.4 GHz with a maximum mean e.i.r.p. spectral density of –50 dBm/MHz.

Note 2: to protect the radio services, non fixed installations (application B) must fulfil the following requirement for Total Radiated Power:

a) In the frequency ranges 2.5 to 2.69 GHz and 4.8 to 5 GHz, the Total Radiated Power spectral density has to be 10dB below the max e.i.r.p. spectral density

b) In the frequency ranges 3.4 to 3.8 GHz, the Total Radiated Power spectral density has to be 5dB below the max e.i.r.p. spectral density

Note 3: Limitation of the Duty Cycle to 10% per second

Appendix 1

Technical requirements of the "Listen Before Talk" mechanism for Material Sensing devices

1. Peak power threshold value for the "Listen Before Talk" (LBT) mechanism to ensure the protection of the listed services are defined within Table 2 below.

Frequency range	**Radio service to be detected**	**Peak power threshold value**
2.5 - 2.69 GHz	Land Mobile service	-50 dBm/MHz
2.9 - 3.4 GHz	Radiodetermination Service	-7 dBm/MHz

Table 2

2. Additional requirements for Radar detection: Continuously listening and automatic switch-off within 10ms for the related frequency range if the threshold value is exceeded (Table 2). A silent time of at least 12s while listening continuously is necessary before the transmitter can be switched on again. This silent time during which only the LBT receiver is active has to be ensured even after the device is switched off by the functions described in Annex 1, the proximity sensor and manual operation.

ANNEX 2

Technical requirements for Building Material Analysis (BMA) devices using UWB technology

1. BMA Devices permitted under this Decision shall fulfil the following requirements:
   a) Transmitter-On only if manually operated with a non-locking switch (e.g. it may be a sensor for the presence of the operators hand) plus being in contact or close proximity to the investigated material and the emissions being directed into the direction of the object (e.g. measured by a proximity sensor or imposed by the mechanical design);
   b) The BMA transmitter has to switch-off after max 10s without movement;
   c) The Total Radiated Power spectral density (Definition at the end of Annex 1) has to be 5 dB below the maximum mean e.i.r.p. spectral density limits in Table 3;

2. Emissions radiating from BMA devices permitted under this decision shall be kept to a minimum and in any case not exceed the e.i.r.p. spectral density limits within the following Table 3. The compliance with the limits of Table 3 has to be ensured with the BMA device on a representative wall (see definition in Annex 3).

Frequency range	**Maximum mean e.i.r.p. spectral density**
Below 1.73 GHz Note 1	-85 dBm/MHz
1.73 to 2.2 GHz	-65 dBm/MHz
2.2 to 2.5 GHz	-50 dBm/MHz
2.5 to 2.69 GHz Note 1	-65 dBm/MHz
2.69 to 2.7 GHz Note 2	-55 dBm/MHz
2.7 to 3.4 GHz Note 1	-70 dBm/MHz
3.4 to 4.8 GHz	-50 dBm/MHz
4.8 to 5 GHz Note 2	-55 dBm/MHz
5 to 8.5 GHz	-50 dBm/MHz
Above 8.5 GHz	-85 dBm/MHz

Table 3

Note 1: devices using a Listen Before Talk (LBT) mechanism, as described in the harmonised standard EN 302 435, which meets the technical requirements defined within appendix 1 to this Annex, are permitted to operate in frequency range 1.215 to 1.73 GHz with a maximum mean e.i.r.p. spectral density of –70 dBm/MHz and in the frequency ranges 2.5 to 2.69 and 2.7 to 3.4 GHz with a maximum mean e.i.r.p. spectral density of –50 dBm/MHz

Note 2: to protect the RAS bands 2.69 to 2.7 GHz and 4.8 to 5 GHz, the Total Radiated Power spectral density has to be below -65 dBm/MHz.

Appendix 1

Technical requirements of the "Listen Before Talk" mechanism for BMA devices

1. Peak power threshold value for the "Listen Before Talk" mechanism to ensure the protection of the listed services are defined within Table 4 below.

Frequency range	**Radio service to be detected**	**Peak power threshold value**
1.215 - 1.4 GHz	Radiodetermination Service	+8 dBm/MHz
1.61 - 1.66 GHz	Mobile Satellite service	-43 dBm/MHz
2.5-2.69 GHz	Land Mobile service	-50 dBm/MHz
2.7 - 3.4 GHz	Radiodetermination Service	-7 dBm/MHz

Table 4

2. Additional requirements for Radar detection: Continuously listening and automatic switch-off within 10ms for the related frequency range if a threshold value is exceeded (Table 4). A silent time of at least 12s while listening continuously is necessary before the transmitter can be switched on again. This silent time during which only the LBT receiver is active has to be ensured even after the device is switched off by the functions described in Annex 2, the proximity sensor and manual operation.

ANNEX 3

OTHER REQUIREMENTS

- **Pulse Repetition Frequency (PRF)**

The pulse repetition frequency (PRF) for pulsed UWB devices shall not be less than 5MHz. This restriction does not apply to burst repetition frequency.

- **Maximum Peak Power**

The peak e.i.r.p. (in dBm) measured in a bandwidth of 50MHz shall be less than a limit that is obtained by adding a conversion factor (in dB) to the 'maximum mean e.i.r.p. spectral density' (in dBm/MHz) limit. By default, the conversion factor for material sensing devices using UWB technology is 25 dB. In case of BMA devices, this conversion factor is 40 dB.

DEFINITIONS

- **Maximum mean e.i.r.p. spectral density**

The highest signal strength measured in any direction at any frequency within the defined range. The mean e.i.r.p. spectral density is measured with a 1MHz resolution bandwidth, an RMS detector and an averaging time of 1ms or less.

- **Maximum peak e.i.r.p.**

The highest signal strength measured in any direction at any frequency within the defined range. The peak e.i.r.p. is measured within a 50 MHz bandwidth centred on the frequency at which the highest mean radiated power occurs.

- **Total Radiated Power spectral density**

The average of the mean e.i.r.p. spectral density values measured over a sphere around the measurement scenario with a resolution of at least 15 degree. The detailed measuring setup is contained within ETSI EN 302 435.

- **Representative wall**

The radiations into the air as a result of the operation of BMA and non fixed Material Sensing (application B) devices are highly dependent on the operational conditions and are only meaningful if coupled with the material being investigated; therefore a measurement scenario with a representative wall is necessary and is defined within ETSI EN 302 435 and ETSI EN 302 498-2; the representative wall has to meet the wall attenuation values within Table 5 of this Decision:

Frequency GHz	Wall attenuation values for the representative wall dB		
	min	average	max
1	5	7	9
2	8	10	12
3	10	12	14
4	12	14	16
5	14	16	18
6	16	18	20
7	18	20	22
8	20	22	24

Table 5