# COMMISSION IMPLEMENTING DECISION (EU) 2019/785

## of 14 May 2019

## on the harmonisation of radio spectrum for equipment using ultra-wideband technology in the Union and repealing Decision 2007/131/EC

*(notified under document C(2019) 3461)*

**(Text with EEA relevance)**

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Decision No 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community (Radio Spectrum Decision) ([1]), and in particular Article 4(3) thereof,

Whereas:

(1) Commission Decision 2007/131/EC ([2]) harmonises the technical conditions for spectrum use by radio equipment based on ultra-wideband ('UWB') technology in the Union. It ensures that radio spectrum is available across the Union under harmonised conditions, eliminates barriers to the take-up of UWB technology and aims at creating an effective single market for UWB systems with significant economies of scale and benefits to the consumer.

(2) Although ultra-wideband signals are typically of extremely low power, the possibility of harmful interference with existing radiocommunication services exists and needs to be managed. Therefore, this Decision on the harmonisation of radio spectrum for UWB equipment should avoid harmful interference (including where this might arise from access to the radio spectrum by radio astronomy, earth exploration satellite and space research systems) and balance the incumbent services' interests against the overall policy objective of providing favourable conditions for the introduction of innovative technologies for the benefit of society.

(3) On 16 March 2017, the Commission issued a permanent mandate, pursuant to Decision No 676/2002/EC, to the European Conference of Postal and Telecommunications Administrations ('CEPT') to identify the technical conditions for the harmonised introduction of radio applications based on UWB technology in the Union in order to provide updated technical conditions for such applications.

(4) In response to that permanent mandate, CEPT adopted a report ([3]) where it proposed four measures. Firstly, the technical conditions should describe material sensing devices in a more neutral way in order to allow for innovative solutions. Secondly, it should be possible to use the conditions for generic UWB usage also for material sensing applications. Thirdly, there should be a − 65 dBm/MHz limit for all material sensing devices including building material analysis (BMA) in the 8,5-10,6 GHz band. Fourthly, the possibility of a trigger-before-transmit mitigation for vehicular access control systems based on UWB technology should be introduced in the 3,8-4,2 GHz and 6-8,5 GHz frequency bands.

(5) This Decision should support the overall harmonisation of the UWB regulatory framework in order to improve consistency of limits and mitigation techniques between the different UWB regulations and allow for innovative solutions in the field of UWB technology.

(6) This Decision provides for regulatory limits and identifies mitigation techniques to ensure an efficient usage of spectrum while ensuring coexistence with other spectrum users. Technological evolution may provide other solutions that ensure at least an equivalent level of spectrum protection. For this reason, the use of alternative mitigation techniques, such as solutions found in future possible harmonised standards produced by the

([1]) OJ L 108, 24.4.2002, p. 1.
([2]) Commission Decision 2007/131/EC of 21 February 2007 on allowing the use of the radio spectrum for equipment using ultra-wideband technology in a harmonised manner in the Community (OJ L 55, 23.2.2007, p. 33).
([3]) CEPT Report 69 – Report from CEPT to the European Commission in response to the Mandate 'Ultra-Wideband technology in view of a potential update of Commission Decision 2007/131/EC', approved on 26 October 2018 by the Electronic Communications Committee.

European Standardisation Organisations, should be allowed provided they ensure at least an equivalent level of performance and spectrum protection and verifiably respect the established technical requirements of this regulatory framework.

(7) Decision 2007/131/EC has been amended several times. In the interest of legal clarity Decision 2007/131/EC should be repealed.

(8) The measures provided for in this Decision are in accordance with the opinion of the Radio Spectrum Committee,

HAS ADOPTED THIS DECISION:

*Article 1*

The purpose of this Decision is to harmonise the technical conditions for the availability and efficient use of radio spectrum by equipment using ultra-wideband technology in the Union.

*Article 2*

For the purposes of this Decision, the following definitions shall apply:

(a) 'equipment using ultra-wideband technology' means equipment incorporating, as an integral part or as an accessory, technology for short-range radiocommunication, involving the intentional generation and transmission of radio-frequency energy that spreads over a frequency range wider than 50 MHz, which may overlap several frequency bands allocated to radiocommunication services;

(b) 'non-interference and non-protected basis' means that no harmful interference may be caused to any radiocommunication service and that no claim may be made for protection of these devices against interference originating from radiocommunication services;

(c) 'indoors' means inside buildings or places in which the shielding will typically provide the necessary attenuation to protect radiocommunication services against harmful interference;

(d) 'motor vehicle' has the same meaning as set out in Article 3(11) of Directive 2007/46/EC of the European Parliament and of the Council ([4]);

(e) 'railway vehicle' has the same meaning as set out in Article 3(1)(4) of Regulation (EU) 2018/643 of the European Parliament and of the Council ([5]);

(f) 'e.i.r.p.' means equivalent isotropically radiated power, which is the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain);

(g) 'maximum mean power spectral density' means the average power per unit bandwidth (centred on that frequency) radiated in the direction of the maximum level under the specified conditions of measurement and which is specified as e.i.r.p. of the radio device under test at a particular frequency;

(h) 'peak power' means the power contained within a 50 MHz bandwidth at the frequency at which the highest mean radiated power occurs, radiated in the direction of the maximum level under the specified conditions of measurement and which is specified as e.i.r.p.;

(i) 'total power spectral density' means the average of the mean power spectral density values measured over a sphere around the measurement scenario with a resolution of at least 15 degrees;

(j) 'onboard aircraft' means the use of radio links for communications purposes inside an aircraft;

(k) 'LT1' means systems intended for general location tracking of people and objects that can be put into service on an unlicensed basis.

([4]) Directive 2007/46/EC of the European Parliament and of the Council of 5 September 2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles (OJ L 263, 9.10.2007, p. 1).

([5]) Regulation (EU) 2018/643 of the European Parliament and of the Council of 18 April 2018 on rail transport statistics (OJ L 112, 2.5.2018, p. 1).

*Article 3*

Within six months after this Decision takes effect, Member States shall designate and make available the radio spectrum, on a non-interference and non-protected basis, for equipment using ultra-wideband technology provided that such equipment meets the conditions set out in the Annex and it is used indoors or, if it is used outdoors, it is not attached to a fixed installation, a fixed infrastructure or a fixed outdoor antenna. Equipment using ultra-wideband technology which meets the conditions set out in the Annex shall also be allowed in motor and railway vehicles.

*Article 4*

Member States shall monitor the use of the bands identified in the Annex by equipment using ultra-wideband technology, in particular to ensure that all the conditions laid down in Article 3 of this Decision continue to be relevant, and report their findings to the Commission.

*Article 5*

Decision 2007/131/EC is repealed.

*Article 6*

This Decision is addressed to Member States.

Done at Brussels, 14 May 2019.

*For the Commission*
Mariya GABRIEL
*Member of the Commission*

*ANNEX*

## 1. **GENERIC ULTRA-WIDEBAND (UWB) USAGE**

| Technical requirements | | |
|---|---|---|
| Frequency range | Maximum mean power spectral density (e.i.r.p.) | Maximum peak power (e.i.r.p.) (defined in 50 MHz) |
| f ≤ 1,6 GHz | – 90 dBm/MHz | – 50 dBm |
| 1,6 < f ≤ 2,7 GHz | – 85 dBm/MHz | – 45 dBm |
| 2,7 < f ≤ 3,1 GHz | – 70 dBm/MHz | – 36 dBm |
| 3,1 < f ≤ 3,4 GHz | – 70 dBm/MHz<br>or<br>– 41,3 dBm/MHz using LDC ([1]) or DAA ([2]) | – 36 dBm<br>or<br>0 dBm |
| 3,4 < f ≤ 3,8 GHz | – 80 dBm/MHz<br>or<br>– 41,3 dBm/MHz using LDC ([1]) or DAA ([2]) | – 40 dBm<br>or<br>0 dBm |
| 3,8 < f ≤ 4,8 GHz | – 70 dBm/MHz<br>or<br>– 41,3 dBm/MHz using LDC ([1]) or DAA ([2]) | – 30 dBm<br>or<br>0 dBm |
| 4,8 < f ≤ 6 GHz | – 70 dBm/MHz | – 30 dBm |
| 6 < f ≤ 8,5 GHz | – 41,3 dBm/MHz | 0 dBm |
| 8,5 < f ≤ 9 GHz | – 65 dBm/MHz<br>or<br>– 41,3 dBm/MHz using DAA ([2]) | – 25 dBm<br>or<br>0 dBm |
| 9 < f ≤ 10,6 GHz | – 65 dBm/MHz | – 25 dBm |
| f > 10,6 GHz | – 85 dBm/MHz | – 45 dBm |

([1]) Within the 3,1 GHz to 4,8 GHz band. The Low Duty Cycle ('LDC') mitigation technique and its limits are defined in clauses 4.5.3.1, 4.5.3.2 and 4.5.3.3 of ETSI Standard EN 302 065-1 V2.1.1. Alternative mitigation techniques may be used if they ensure at least an equivalent performance and level of spectrum protection in order to comply with the corresponding essential requirements of Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC (OJ L 153, 22.5.2014, p. 62) and respect the technical requirements of this Decision.

([2]) Within the 3,1 GHz to 4,8 GHz and 8,5 GHz to 9 GHz bands. The Detect and Avoid ('DAA') mitigation technique and its limits are defined in clauses 4.5.1.1, 4.5.1.2 and 4.5.1.3 of ETSI Standard EN 302 065-1 V2.1.1. Alternative mitigation techniques may be used if they ensure at least an equivalent performance and level of spectrum protection in order to comply with the corresponding essential requirements of Directive 2014/53/EU and respect the technical requirements of this Decision.

## 2. **LOCATION TRACKING SYSTEMS Type 1 (LT1)**

| Technical requirements | | |
|---|---|---|
| Frequency range | Maximum mean power spectral density (e.i.r.p.) | Maximum peak power (e.i.r.p.) (defined in 50 MHz) |
| f ≤ 1,6 GHz | – 90 dBm/MHz | – 50 dBm |
| 1,6 < f ≤ 2,7 GHz | – 85 dBm/MHz | – 45 dBm |

| Technical requirements | | |
|---|---|---|
| Frequency range | Maximum mean power spectral density (e.i.r.p.) | Maximum peak power (e.i.r.p.) (defined in 50 MHz) |
| 2,7 < f ≤ 3,4 GHz | – 70 dBm/MHz | – 36 dBm |
| 3,4 < f ≤ 3,8 GHz | – 80 dBm/MHz | – 40 dBm |
| 3,8 < f ≤ 6,0 GHz | – 70 dBm/MHz | – 30 dBm |
| 6 < f ≤ 8,5 GHz | – 41,3 dBm/MHz | 0 dBm |
| 8,5 < f ≤ 9 GHz | – 65 dBm/MHz<br>or<br>– 41,3 dBm/MHz using DAA (1) | – 25 dBm<br>or<br>0 dBm |
| 9 < f ≤ 10,6 GHz | – 65 dBm/MHz | – 25 dBm |
| f > 10,6 GHz | – 85 dBm/MHz | – 45 dBm |

(1) The DAA mitigation technique and its limits are defined in clauses 4.5.1.1, 4.5.1.2 and 4.5.1.3 of ETSI Standard EN 302 065-2 V2.1.1. Alternative mitigation techniques may be used if they ensure at least an equivalent performance and level of spectrum protection in order to comply with the corresponding essential requirements of Directive 2014/53/EU and respect the technical requirements of this Decision.

3. **UWB DEVICES INSTALLED IN MOTOR AND RAILWAY VEHICLES**

| Technical requirements | | |
|---|---|---|
| Frequency range | Maximum mean power spectral density (e.i.r.p.) | Maximum peak power (e.i.r.p.) (defined in 50 MHz) |
| f ≤ 1,6 GHz | – 90 dBm/MHz | – 50 dBm |
| 1,6 < f ≤ 2,7 GHz | – 85 dBm/MHz | – 45 dBm |
| 2,7 < f ≤ 3,1 GHz | – 70 dBm/MHz | – 36 dBm |
| 3,1 < f ≤ 3,4 GHz | – 70 dBm/MHz<br>or<br>– 41,3 dBm/MHz using LDC (1) + e.l. (4)<br>or<br>– 41,3 dBm/MHz using TPC (3)+ DAA (2) + e.l. (4) | – 36 dBm<br>or<br>≤ 0 dBm<br>or<br>≤ 0 dBm |
| 3,4 < f ≤ 3,8 GHz | – 80 dBm/MHz<br>or<br>– 41,3 dBm/MHz using LDC (1) + e.l. (4)<br>or<br>– 41,3 dBm/MHz using TPC (3)+DAA (2) + e.l. (4) | – 40 dBm<br>or<br>≤ 0 dBm<br>or<br>≤ 0 dBm |
| 3,8 < f ≤ 4,8 GHz | – 70 dBm/MHz<br>or<br>– 41,3 dBm/MHz using LDC (1) + e.l. (4)<br>or<br>– 41,3 dBm/MHz using TPC (3)+DAA (2) + e.l. (4) | – 30 dBm<br>or<br>≤ 0 dBm<br>or<br>≤ 0 dBm |
| 4,8 < f ≤ 6 GHz | – 70 dBm/MHz | – 30 dBm |

| Technical requirements | | |
|---|---|---|
| Frequency range | Maximum mean power spectral density (e.i.r.p.) | Maximum peak power (e.i.r.p.) (defined in 50 MHz) |
| 6 < f ≤ 8,5 GHz | – 53,3 dBm/MHz<br>or<br>– 41,3 dBm/MHz using LDC ([1]) + e.l. ([4])<br>or<br>– 41,3 dBm/MHz using TPC ([3]) + e.l. ([4]) | – 13.3 dBm<br>or<br>≤ 0 dBm<br>or<br>≤ 0 dBm |
| 8,5 < f ≤ 9 GHz | – 65 dBm/MHz<br>or<br>– 41,3 dBm/MHz using TPC ([3])+DAA ([2]) + e.l. ([4]) | – 25 dBm<br>or<br>≤ 0 dBm |
| 9 < f ≤ 10,6 GHz | – 65 dBm/MHz | – 25 dBm |
| f > 10,6 GHz | – 85 dBm/MHz | – 45 dBm |

([1]) The LDC mitigation technique and its limits are defined in clauses 4.5.3.1, 4.5.3.2 and 4.5.3.3 of ETSI Standard EN 302 065-3 V2.1.1. Alternative mitigation techniques may be used if they ensure at least an equivalent performance and level of spectrum protection in order to comply with the corresponding essential requirements of Directive 2014/53/EU and respect the technical requirements of this Decision.

([2]) The DAA mitigation technique and its limits are defined in clauses 4.5.1.1, 4.5.1.2 and 4.5.1.3 of ETSI Standard EN 302 065-3 V2.1.1. Alternative mitigation techniques may be used if they ensure at least an equivalent performance and level of spectrum protection in order to comply with the corresponding essential requirements of Directive 2014/53/EU and respect the technical requirements of this Decision.

([3]) The Transmit Power Control ('TPC') mitigation technique and its limits are defined in clauses 4.7.1.1, 4.7.1.2 and 4.7.1.3 of ETSI Standard EN 302 065-3 V2.1.1. Alternative mitigation techniques may be used if they ensure at least an equivalent performance and level of spectrum protection in order to comply with the corresponding essential requirements of Directive 2014/53/EU and respect the technical requirements of this Decision.

([4]) The exterior limit (e.l.) ≤ – 53,3 dBm/MHz is required. The exterior limit is defined in clauses 4.3.4.1, 4.3.4.2 and 4.3.4.3 of ETSI Standard EN 302 065-3 V2.1.1. Alternative mitigation techniques may be used if they ensure at least an equivalent performance and level of spectrum protection in order to comply with the corresponding essential requirements of Directive 2014/53/EU and respect the technical requirements of this Decision.

Technical requirements to be used within the bands 3,8-4,2 GHz and 6-8,5 GHz for vehicular access systems using trigger-before-transmit are defined in the following table.

| Technical requirements | | |
|---|---|---|
| Frequency range | Maximum mean power spectral density (e.i.r.p.) | Maximum peak power (e.i.r.p.) (defined in 50 MHz) |
| 3.8 < f ≤ 4,2 GHz | – 41,3 dBm/MHz with trigger-before-transmit operation and LDC ≤ 0,5 % (in 1h) | 0 dBm |
| 6 < f ≤ 8,5 GHz | – 41,3 dBm/MHz with trigger-before-transmit operation and LDC ≤ 0,5 % (in 1h) or TPC | 0 dBm |

'Trigger-before-transmit' mitigation is defined as a UWB transmission that is only initiated when necessary, specifically where the system indicates that UWB devices are nearby. The communication is either triggered by a user or by the vehicle. The subsequent communication can be considered as 'triggered communication'. The existing LDC mitigation applies (or alternatively TPC in the 6 GHz to 8,5 GHz range). An exterior limit requirement must not be applied when using the trigger-before-transmit mitigation technique for vehicular access systems.

Trigger-before-transmit mitigation techniques that provide an appropriate level of performance in order to comply with the essential requirements of Directive 2014/53/EU shall be used for vehicular access systems. If relevant techniques are described in harmonised standards or parts thereof the references of which have been published in the *Official Journal of the European Union* under Directive 2014/53/EU, performance at least equivalent to these techniques shall be ensured. These techniques shall respect the technical requirements of this Decision.

## 4. UWB ONBOARD AIRCRAFT

The values for maximum mean power spectral density (e.i.r.p.) and maximum peak power (e.i.r.p.) for short-range devices using UWB technology, with or without use of mitigation techniques are listed in the table below.

| Technical requirements | | | |
|---|---|---|---|
| Frequency range | Maximum mean power spectral density (e.i.r.p.) | Maximum peak power (e.i.r.p.) (defined in 50 MHz) | Requirements for mitigation techniques |
| f ≤ 1,6 GHz | – 90 dBm/MHz | – 50 dBm | |
| 1,6 < f ≤ 2,7 GHz | – 85 dBm/MHz | – 45 dBm | |
| 2,7 < f ≤ 3,4 GHz | – 70 dBm/MHz | – 36 dBm | |
| 3,4 < f ≤ 3,8 GHz | – 80 dBm/MHz | – 40 dBm | |
| 3,8 < f ≤ 6,0 GHz | – 70 dBm/MHz | – 30 dBm | |
| 6,0 < f ≤ 6,650 GHz | – 41,3 dBm/MHz | 0 dBm | |
| 6,650 < f ≤ 6,6752 GHz | – 62,3 dBm/MHz | – 21 dBm | notch of 21 dB should be implemented to meet the – 62,3 dBm/MHz ([1]) level |
| 6,6752 < f ≤ 8,5 GHz | – 41,3 dBm/MHz | 0 dBm | 7,25 to7,75 GHz (FSS and MetSat (7,45 to 7,55 GHz) protection) ([1]) ([2])<br>7,75 to 7,9 GHz (MetSat protection) ([1]) ([3]) |
| 8,5 < f ≤ 10,6 GHz | – 65 dBm/MHz | – 25 dBm | |
| f > 10,6 GHz | – 85 dBm/MHz | – 45 dBm | |

([1]) Alternative mitigation techniques, such as the use of shielded portholes, may be used if they ensure at least an equivalent performance.

([2]) 7,25 to 7,75 GHz (Fixed Satellite Service) and 7,45 to 7,55 GHz (Meteorological Satellite) protection: $-51{,}3 - 20 \times \log_{10}(10[\text{km}]/x[\text{km}])$(dBm/MHz) for heights above ground of over 1 000 m, where x is the aircraft height above ground in kilometres, – 71,3 dBm/MHz for heights above ground of 1 000 m and below.

([3]) 7,75 to 7,9 GHz (Meteorological Satellite) protection:
$-44{,}3 - 20 \times \log_{10}(10\ [\text{km}]/x[\text{km}])$ (dBm/MHz) for heights above ground of over 1 000 m, where x is the aircraft height above ground in kilometres, and – 64,3 dBm/MHz for heights above ground of 1 000 m and below.

## 5. MATERIAL SENSING DEVICES USING UWB TECHNOLOGY

### 5.1. Introduction

UWB material sensing devices are split into two classes:

— Contact based UWB material sensing devices, for which the UWB transmitter is only switched on when in direct contact with the material under investigation;

— Non-contact based UWB material sensing devices, for which the UWB transmitter is only switched on when it is near the investigated material and the UWB transmitter is directed towards the material under investigation (for example manually by using a proximity sensor or by mechanical design).

Material sensing devices based on UWB technology shall comply either with the generic UWB regulation based on technical conditions specified in section 1 of this Annex or with the specific limits for material sensing devices as defined in sections 5.2 and 5.3.

The generic UWB regulation excludes fixed outdoor installations. Emissions radiated by a material sensing device must not exceed the limits of the regulation for generic UWB usage specified in section 1. Material sensing devices must fulfil the requirements of mitigation techniques specified for the generic use of UWB in section 1.

The specific limits for material sensing devices including the mitigation techniques are listed in the following tables. Emissions radiating from material sensing devices permitted under this Decision must be kept to a minimum and in any case not exceed the emission limits within the following tables. Compliance with the specific limits must be ensured by the device placed on a representative structure of the investigated material. The specific limits listed in the following tables are applicable in all environments for material sensing devices, except those to which note 5 of these tables, which excludes fixed outdoor installation in certain applicable frequency ranges, applies.

5.2. **Contact based material sensing devices**

The specific limits for maximum mean power spectral density (e.i.r.p.) and maximum peak power (e.i.r.p.) for contact based material sensing devices using UWB technology are defined in the table below.

| Technical requirements for contact based UWB material sensing devices | | |
|---|---|---|
| Frequency range | Maximum mean power spectral density (e.i.r.p.) | Maximum peak power (e.i.r.p.) (defined in 50 MHz) |
| f ≤ 1,73 GHz | − 85 dBm/MHz (1) | − 45 dBm |
| 1,73 < f ≤ 2,2 GHz | − 65 dBm/MHz | − 25 dBm |
| 2,2 < f ≤ 2,5 GHz | − 50 dBm/MHz | − 10 dBm |
| 2,5 < f ≤ 2,69 GHz | − 65 dBm/MHz (1) (2) | − 25 dBm |
| 2,69 < f ≤ 2,7 GHz (4) | − 55 dBm/MHz (3) | − 15 dBm |
| 2,7 < f ≤ 2,9 GHz | − 70 dBm/MHz (1) | − 30 dBm |
| 2,9 < f ≤ 3,4 GHz | − 70 dBm/MHz (1) (6) (7) | − 30 dBm |
| 3,4 < f ≤ 3,8 GHz (4) | − 50 dBm/MHz (2) (6) (7) | − 10 dBm |
| 3,8 < f ≤ 4,8 GHz | − 50 dBm/MHz (6) (7) | − 10 dBm |
| 4,8 < f ≤ 5,0 GHz (4) | − 55 dBm/MHz (2) (3) | − 15 dBm |
| 5,0 < f ≤ 5,25 GHz | − 50 dBm/MHz | − 10 dBm |
| 5,25 < f ≤ 5,35 GHz | − 50 dBm/MHz | − 10 dBm |
| 5,35 < f ≤ 5,6 GHz | − 50 dBm/MHz | − 10 dBm |
| 5,6 < f ≤ 5,65 GHz | − 50 dBm/MHz | − 10 dBm |
| 5,65 < f ≤ 5,725 GHz | − 50 dBm/MHz | − 10 dBm |
| 5,725 < f ≤ 6,0 GHz | − 50 dBm/MHz | − 10 dBm |
| 6,0 < f ≤ 8,5 GHz | − 41,3 dBm/MHz (5) | 0 dBm |
| 8,5 < f ≤ 9,0 GHz | − 65 dBm/MHz (7) | − 25 dBm |

| Technical requirements for contact based UWB material sensing devices | | |
|---|---|---|
| Frequency range | Maximum mean power spectral density (e.i.r.p.) | Maximum peak power (e.i.r.p.) (defined in 50 MHz) |
| 9,0 < f ≤ 10,6 GHz | − 65 dBm/MHz | − 25 dBm |
| f > 10,6 GHz | − 85 dBm/MHz | − 45 dBm |

([1]) Devices using the Listen Before Talk ('LBT') mechanism are permitted to operate in the 1,215 GHz to 1,73 GHz frequency range with a maximum mean e.i.r.p. spectral density of -70 dBm/MHz and in the 2,5 GHz to 2,69 GHz and 2,7 GHz to 3,4 GHz frequency ranges with a maximum mean e.i.r.p. spectral density of − 50 dBm/MHz and a maximum peak e.i.r.p. of − 10 dBm/50 MHz. The LBT mechanism is defined in clauses 4.5.2.1, 4.5.2.2 and 4.5.2.3 of ETSI Standard EN 302 065-4 V1.1.1. Alternative mitigation techniques may be used if they ensure at least an equivalent performance and level of spectrum protection in order to comply with the corresponding essential requirements of Directive 2014/53/EU and respect the technical requirements of this Decision.

([2]) To protect the radio services, non-fixed installations must fulfil the following requirement for total radiated power:
(a) In the 2,5 GHz to 2,69 GHz and 4,8 GHz to 5 GHz frequency ranges, the total power spectral density must be 10 dB below the maximum e.i.r.p. spectral density.
(b) In the 3,4 GHz to 3,8 GHz frequency range, the total power spectral density must be 5 dB below the maximum e.i.r.p. spectral density.

([3]) To protect the Radio Astronomy Service (RAS) in the 2,69 GHz to 2,7 GHz and 4,8 GHz to 5 GHz bands, the total power spectral density must be below -65 dBm/MHz.

([4]) Limitation of the Duty Cycle to 10 % per second.

([5]) No fixed outdoor installation is permitted.

([6]) Within the 3,1 GHz − 4,8 GHz band, devices implementing LDC mitigation technique are permitted to operate with a maximum mean e.i.r.p. spectral density of -41,3 dBm/MHz and a maximum peak e.i.r.p. of 0 dBm defined in 50 MHz. The LDC mitigation technique and its limits are defined in clauses 4.5.3.1, 4.5.3.2 and 4.5.3.3 of ETSI Standard EN 302 065-1 V2.1.1. Alternative mitigation techniques may be used if they ensure at least an equivalent performance and level of spectrum protection in order to comply with the corresponding essential requirements of Directive 2014/53/EU and respect the technical requirements of this Decision. When LDC is implemented, note 5 applies.

([7]) Within the 3,1 GHz − 4,8 GHz and 8,5 GHz - 9 GHz bands, devices implementing DAA mitigation technique are permitted to operate with a maximum mean e.i.r.p. spectral density of − 41,3 dBm/MHz and a maximum peak e.i.r.p. of 0 dBm defined in 50 MHz. The DAA mitigation technique and its limits are defined in clauses 4.5.1.1, 4.5.1.2 and 4.5.1.3 of ETSI Standard EN 302 065-1 V2.1.1. Alternative mitigation techniques may be used if they ensure at least an equivalent performance and level of spectrum protection in order to comply with the corresponding essential requirements of Directive 2014/53/EU and respect the technical requirements of this Decision. When DAA is implemented, note 5 applies.

### 5.3 **Non-contact based material sensing devices**

The specific limits for maximum mean power spectral density (e.i.r.p.) and maximum peak power (e.i.r.p.) for non-contact based material sensing devices using UWB technology are defined in the table below.

| Technical requirements for non-contact based UWB material sensing devices | | |
|---|---|---|
| Frequency range | Maximum mean power spectral density (e.i.r.p.) | Maximum peak power (e.i.r.p.) (defined in 50 MHz) |
| f ≤ 1,73 GHz | − 85 dBm/MHz ([1]) | − 60 dBm |
| 1,73 < f ≤ 2,2 GHz | − 70 dBm/MHz | − 45 dBm |
| 2,2 < f ≤ 2,5 GHz | − 50 dBm/MHz | − 25 dBm |
| 2,5 < f ≤ 2,69 GHz | − 65 dBm/MHz ([1]) ([2]) | − 40 dBm |
| 2,69< f ≤ 2,7 GHz ([4]) | − 70 dBm/MHz ([3]) | − 45 dBm |
| 2,7 < f ≤ 2,9 GHz | − 70 dBm/MHz ([1]) | − 45 dBm |
| 2,9 < f ≤ 3,4 GHz | − 70 dBm/MHz ([1]) ([6]) ([7]) | − 45 dBm |
| 3,4 < f ≤ 3,8 GHz ([4]) | − 70 dBm/MHz ([2]) ([6]) ([7]) | − 45 dBm |
| 3,8 < f ≤ 4,8 GHz | − 50 dBm/MHz ([6]) ([7]) | − 25 dBm |

| Technical requirements for non-contact based UWB material sensing devices | | |
|---|---|---|
| Frequency range | Maximum mean power spectral density (e.i.r.p.) | Maximum peak power (e.i.r.p.) (defined in 50 MHz) |
| 4,8 < f ≤ 5,0 GHz ([4]) | − 55 dBm/MHz ([2]) ([3]) | − 30 dBm |
| 5,0 < f ≤ 5,25 GHz | − 55 dBm/MHz | − 30 dBm |
| 5,25 < f ≤ 5,35 GHz | − 50 dBm/MHz | − 25 dBm |
| 5,35 < f ≤ 5,6 GHz | − 50 dBm/MHz | − 25 dBm |
| 5,6 < f ≤ 5,65 GHz | − 50 dBm/MHz | − 25 dBm |
| 5,65 < f ≤ 5,725 GHz | − 65 dBm/MHz | − 40 dBm |
| 5,725 < f ≤ 6,0 GHz | − 60 dBm/MHz | − 35 dBm |
| 6,0 < f ≤ 8,5 GHz | − 41.3 dBm/MHz ([5]) | 0 dBm |
| 8,5 < f ≤ 9,0 GHz | − 65 dBm/MHz ([7]) | − 25 dBm |
| 9,0 < f ≤ 10,6 GHz | − 65 dBm/MHz | − 25 dBm |
| f > 10,6 GHz | − 85 dBm/MHz | − 45 dBm |

([1]) Devices using the Listen Before Talk ('LBT') mechanism are permitted to operate in the 1,215 GHz to 1,73 GHz frequency range with a maximum mean e.i.r.p. spectral density of − 70 dBm/MHz and in the 2,5 GHz to 2,69 GHz and 2,7 GHz to 3,4 GHz frequency ranges with a maximum mean e.i.r.p. spectral density of − 50 dBm/MHz and a maximum peak e.i.r.p. of − 10 dBm/50 MHz. The LBT mechanism is defined in clauses 4.5.2.1, 4.5.2.2 and 4.5.2.3 of ETSI Standard EN 302 065-4 V1.1.1. Alternative mitigation techniques may be used if they ensure at least an equivalent performance and level of spectrum protection in order to comply with the corresponding essential requirements of Directive 2014/53/EU and respect the technical requirements of this Decision.

([2]) To protect the radio services, non-fixed installations must fulfil the following requirement for total radiated power:
(a) In the 2,5 GHz to 2,69 GHz and 4,8 GHz to 5 GHz frequency ranges, the total power spectral density must be 10 dB below the maximum e.i.r.p. spectral density.
(b) In the 3,4 GHz to 3,8 GHz frequency range, the total power spectral density must be 5 dB below the maximum e.i.r.p. spectral density.

([3]) To protect the Radio Astronomy Service (RAS) in the 2,69 GHz to 2,7 GHz and 4,8 GHz to 5 GHz bands, the total power spectral density must be below − 65 dBm/MHz.

([4]) Limitation of the Duty Cycle to 10 % per second.

([5]) No fixed outdoor installation is permitted.

([6]) Within the 3,1 GHz − 4,8 GHz band, devices implementing LDC mitigation technique are permitted to operate with a maximum mean e.i.r.p. spectral density of − 41,3 dBm/MHz and a maximum peak e.i.r.p. of 0 dBm defined in 50 MHz. The LDC mitigation technique and its limits are defined in clauses 4.5.3.1, 4.5.3.2 and 4.5.3.3 of ETSI Standard EN 302 065-1 V2.1.1. Alternative mitigation techniques may be used if they ensure at least an equivalent performance and level of spectrum protection in order to comply with the corresponding essential requirements of Directive 2014/53/EU and respect the technical requirements of this Decision. When LDC is implemented, note 5 applies.

([7]) Within the 3,1 GHz − 4,8 GHz and 8,5 GHz - 9 GHz bands, devices implementing DAA mitigation technique are permitted to operate with a maximum mean e.i.r.p. spectral density of − 41,3 dBm/MHz and a maximum peak e.i.r.p. of 0 dBm defined in 50 MHz. The DAA mitigation technique and its limits are defined in clauses 4.5.1.1, 4.5.1.2 and 4.5.1.3 of ETSI Standard EN 302 065-1 V2.1.1. Alternative mitigation techniques may be used if they ensure at least an equivalent performance and level of spectrum protection in order to comply with the corresponding essential requirements of Directive 2014/53/EU and respect the technical requirements of this Decision. When DAA is implemented, note 5 applies.

Peak power threshold values for the LBT mechanism to ensure the protection of radio services listed below are defined in the following table.

| Technical requirements of the LBT mechanism for material sensing devices | | |
|---|---|---|
| Frequency range | Radio service to be detected | Peak power threshold value |
| 1,215 <f ≤ 1,4 GHz | Radiodetermination service | + 8 dBm/MHz |
| 1,61<f ≤ 1,66 GHz | Mobile satellite service | − 43 dBm/MHz |

| Technical requirements of the LBT mechanism for material sensing devices | | |
|---|---|---|
| Frequency range | Radio service to be detected | Peak power threshold value |
| 2,5 < f ≤ 2,69 GHz | Land mobile service | – 50 dBm/MHz |
| 2,9 < f ≤ 3,4 GHz | Radiodetermination service | – 7dBm/MHz |

Additional requirements for radar detection: continuously listening and automatic switch-off within 10 ms for the related frequency range if the threshold value is exceeded (table with LBT mechanism). A silent time of at least 12 s while listening continuously is necessary before the transmitter can be switched on again. This silent time during which only the LBT receiver is active must be ensured even after the device is switched off.