



# UWB Radio Certification Process in the USA

Application Note  
**APR002**

## 1 Introduction

How to take Qorvo based UWB products through the FCC certification process.

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## 2 Overview

Product certification is concerned with ensuring that a product complies with all the relevant regulations and legislation that apply to it in a particular jurisdiction. UWB based products are required to seek certification in all the jurisdictions the manufacturer wishes to sell them.

This document sets out to provide an overview of that portion of the certification process related to UWB; however, you should seek advice from a competent authority on the best approach to certifying your product for the markets of interest to you.

UWB regulations differ from jurisdiction to jurisdiction and while regulatory requirements are broadly similar in many regions of the world there is no harmonised certification process. Thus, it is necessary to seek certification in each jurisdiction in which you wish to sell your product.

### 2.1 About this document

This document begins by outlining the concept of certification as it applies to electronic products in general and radio-based products in particular. It goes on to discuss the certification process for UWB based products with the FCC.

Appendices cover detailed technical aspects around setting up your product for certification testing with particular emphasis on radiated power measurements and peak power measurements – both of which are very relevant to meeting the various regulatory requirements.

This document is structured as follows: -

**Table 1: Organisation of this document**

Section	Title	Description
Section 1	This section	Introduction
Section 2	Outline of the certification process	Gives an outline of the certification process in general without reference to specific regional variations
Section 3	General test setup	Describes the test setup generally employed in certification testing, again without reference to specific regional variations
Section 4	Regulation & Certification with the FCC	Describes the current FCC regulations
Section 5	The FCC certification process	Describes the FCC certification process
Appendix 1	Specific measurements of relevance to UWB radios	Describes several measurements used during the certification process that are relevant to UWB radios
Appendix 2	List of accredited test houses	Provides a list of test houses that are accredited to various regional regulatory bodies
Appendix 3	Form 731	Provides details of form 731 used to make an application for certification to the FCC
Appendix 4	Text of the CFR 47 regulations relevant to UWB devices	This appendix reproduces the text of the Code of Federal Regulations as per the FCC website as of 10/12/2014.
	Abbreviations	Glossary of terms used in this document
	References	Lists external references
	Document history	Revision history of this document

## 3 Overview of the Certification Process

### 3.1 Introduction

This section provides a general overview of the product certification process.

The process of “certification” involves testing a product in a defined way against regulatory limits defined by a nominated regulatory body in a particular jurisdiction. Usually, products may not be used, or may only be used under very specific circumstances, in a given jurisdiction unless they are certified under the regulations for that jurisdiction.

The rules for any particular jurisdiction are established by the regulatory body for that jurisdiction (the Federal Communications Commission – FCC – in the US for example). The regulatory body sets out rules which generally establish what tests should be carried out and what the test limits are for each test. Usually, the regulatory body will qualify individual test houses (a process known as accreditation) in the jurisdiction and possibly in other jurisdictions also to carry out this testing.

A product developer wishing to launch a product to market that falls under the regulations must submit it to an accredited test house for testing. Assuming the product passes all relevant tests at the test house it is deemed to meet the regulations and, once certain formalities are observed, is declared “certified” under the regulations.

Generally, when a product is certified there are certain requirements regarding the labelling that should appear on the product. Labelling a product to indicate that it is certified when in fact it is not, is generally an offence which may result in a fine or prison term depending on the jurisdiction.

Most regions in the world certify products in generally the same way although the details of the applied tests and the allowed measurement limits for each of those tests may vary considerably between regions and between individual use cases.

There are a few general areas that are tested during the certification process: -

- **Safety related tests:** these are tests to ensure the product, in the form in which it is intended to be sold, cannot cause injury to users; in the technology product area this usually relates to the risk of electrical shock but also includes issues such as chemical emissions and use of hazardous materials.
- **Conducted emissions tests:** these are tests related to emissions that are carried from the product down any cables or connections to the product. Of particular interest is the mains power cable if the product is intended to be mains powered.
- **Radiated emissions tests:** these are tests related to emissions radiated from the product. There are two sub-categories here: -
  - Intended emissions as in the case of a radio transmitter
  - Unintended emissions related to electromagnetic “noise” radiated from the product in normal operation.
- **Susceptibility to emissions tests:** these are tests designed to determine the product’s ability to function correctly and / or without damage in the presence of external electromagnetic fields.

### 3.2 Tests

#### 3.2.1 Relevant tests

The certification tests that are relevant to a particular product depend on the type of product and its intended function. In some cases, the same product could be certified under several different regulations depending on the use for which it is intended. It is important to seek guidance on this matter to make the correct choice and avoid trying to certify a product under stringent regulations in one section of the regulatory code when it may be possible to certify it more easily under a different section of the regulatory code.

## 3.2.2 Conducted emissions tests

These tests focus on *unintended* emissions that are carried by any cable connected to the product under test. They apply to any cables that are intended to be attached to the product in normal operation.

In particular, if the product is intended to be: -

- Powered by an external power supply then the emissions that are conducted via the power supply cable is of interest.
- Connected via a cable to any kind of communications network, then the emissions that are conducted via the communications cable(s) are of interest.

In the context of UWB products conducted emissions tests will apply to anchor nodes in an RTLS that are powered from an external source or use Ethernet or some other cable-connected backhaul to the location engine.

## 3.2.3 Commonly applicable radiated emissions tests

As mentioned, there are two cases to consider here:

### 3.2.3.1 Intended radiated emissions

Clearly this is relevant to UWB radios, given that they include a transmitter.

In this case, regulatory bodies set limits on the allowable radiated power at any given frequency – we will cover this topic in detail later.

### 3.2.3.2 Unintended radiated emissions

All electronic equipment generates a certain amount of “noise”. Digital clocks and switching circuits, DC/DC converters and many other circuits generate switching transients that, if not handled properly by design and / or shielding, can generate sizeable spurious emissions from a product. Unintended emissions tests are designed to measure these emissions and ensure they are kept below defined limits to as to avoid interfering with the correct operation of other equipment and sensitive receivers intended to receive intentional emissions.

If these emissions are present, they can be challenging to manage and may require shielding to contain them. In extreme cases, circuit redesign may be necessary to modify or eliminate the source and ensure compliance with regulatory limits.

## 3.2.4 Commonly applied electromagnetic compatibility tests

These tests are designed to verify the correct operation of the product in the presence of external electromagnetic energy.

## 4 General test setup

### 4.1 Introduction

This section discusses the general setup used in the tests described in the previous section. Specific jurisdictional differences are noted in subsequent sections.

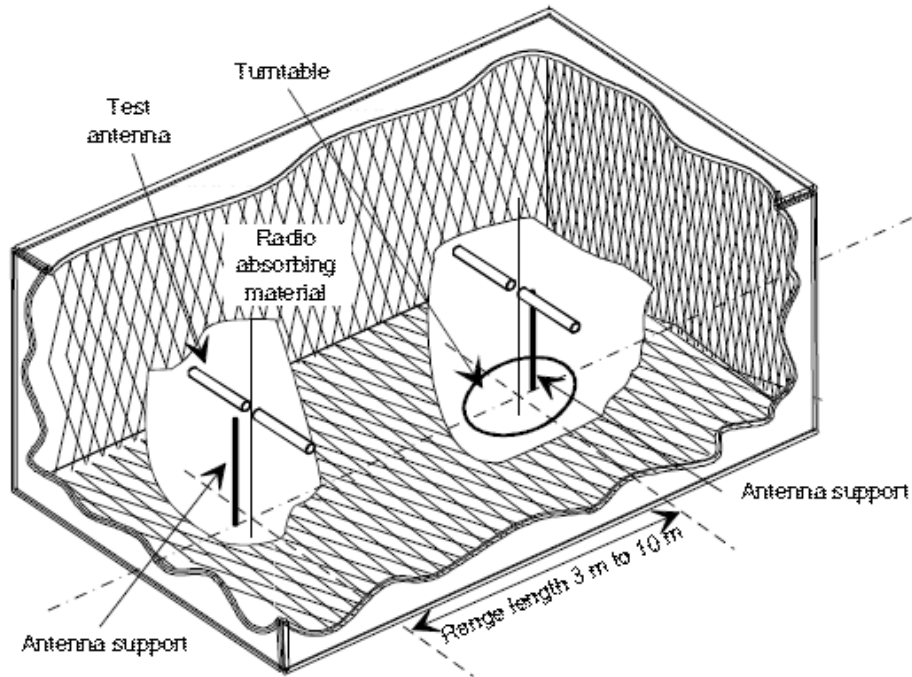
### 4.2 Emissions tests

#### 4.2.1 Introduction

These tests involve placing the device under test (DUT) in what is known as an “anechoic chamber”. This chamber is designed to eliminate all external sources of EM radiation and to eliminate all RF reflections within the chamber. This allows the directly transmitted signal from the DUT to be measured accurately.

An antenna in the chamber is connected via a port in the chamber to external measurement instruments so

that emissions from the unit under test can be measured. The DUT is mounted on a turntable that allows it to be orientated at any angle to the test antenna. The test antenna can also be raised and lowered on its vertical axis.



**Figure 1: Typical anechoic chamber**

The chamber setup is characterized and calibrated to account for losses between the DUT and the test antenna, the antenna gain or loss, and any attenuation in the cables connecting the antenna to external measurement instruments. These factors are then used to correct the actual measurements.

## 4.2.2 Intended emissions tests

For intended emissions tests the applicable regulations specify the maximum allowed radiated power level from the DUT over the frequency range of interest. For UWB devices this spans from 0 GHz to more than 10.5 GHz.

These emission limits vary across regulatory jurisdictions. They also vary by applications and use case, so it is important to agree with the accredited test house for which use cases your product is being certified.

The measurement instrument, generally a spectrum analyser, is set up for the frequency span of interest, various other parameters are appropriately set, and the DUT is configured to transmit at the maximum intended power level (generally -41.3 dBm / MHz for UWB applications). It is desirable to configure the DUT into back-to-back repeated frame mode because this allows the spectrum analyser to capture the transmitted spectrum more quickly but if this is not possible the DUT should be configured for the fastest transmission repetition rate possible.

The test starts by measuring the radiated spectrum from the DUT with the DUT and the antenna in a specific orientation. The orientation of the DUT relative to the antenna is then changed by rotating the turntable and adjusting the antenna height and the measurement process is repeated. In this way the radiated maxima and minima from the DUT are determined. The maxima are then investigated further to see if they exceed the relevant regulatory limits.

For a UWB device, because the allowed transmit power is so low (-41.3 dBm/MHz) it is desirable to ensure the radiated transmit power is as close to the maximum limit as possible to maximise communications range. This may require that the Tx power be tuned at the test house to ensure the product meets the regulatory limits – this tuned value is the one that will be required to be used in the final product to ensure compliance with the regulations.

Details of the setup for specific measurements relevant to Qorvo products are listed in Section 7 Appendix 1. **Please pay particular attention to the measurement method for peak transmit power.**

## 4.2.3 Unintended emissions tests

These tests are carried out in the same way as the intended emissions tests but here the focus is on emissions outside the bands of intended operation of the device. The limits here are generally very low. Depending on your product design it may be necessary to implement RF shielding to prevent unintentional radiation.



## 5 Regulation & Certification with the FCC

### 5.1 Introduction

Certification in the US is handled by the Federal Communications Commission (FCC) according to its Code of Federal Regulations (CFR).

“Certification” is an equipment compliance authorization issued by the Federal Communications Commission (FCC) or a Telecommunications Certification Body (TCB) designated by the FCC, based on representations and test data submitted by the applicant. [47 CFR, Section 2.907].

### 5.2 Relevant regulations

There are several sections of the CFR that are applicable to UWB devices. These are generally contained in Part 15 of the code although other parts of the code are also applicable.

FCC Code designation	Description
FCC ET Docket 98-153, FCC 02-48 First Report and Order	Revision of Part 15 of the Commission’s Rules regarding Ultra Wideband transmission systems; First Report & Order.  This is the initial order from the FCC, issued in 2002, originally permitting UWB devices. It is not necessary to study this publication because the CFR includes the relevant updates.
ANSI C63.4: 2004	Methods of measurement of radio noise emissions from low voltage electrical and electronic equipment in the range of 9 kHz to 40 GHz.  The test laboratory testing your product for compliance with the CFR will be familiar with these measurement methods.
FCC CFR 47, Part 15, Subpart A	Code of Federal Regulations, Part 15 Subpart A: General These are regulations that apply to <b>ALL</b> radio frequency devices.
FCC CFR 47, Part 15, Subpart B	Code of Federal Regulations, Part 15 Subpart B: Unintentional Radiators These are regulations that apply to all devices that are <b>UNINTENTIONAL</b> radiators of electromagnetic energy.
FCC CFR 47, Part 15, Subpart C	Code of Federal Regulations, Part 15 Subpart C: Intentional Radiators These are regulations that apply to all devices that are <b>INTENTIONAL</b> radiators of electromagnetic energy.
FCC CFR 47 Part 15, Subpart F	Code of Federal Regulations Part 15 Subpart F: Ultra Wideband Operation These are regulations that apply specifically to <b>UWB</b> devices.
CISPR 16-1	C.I.S.P.R specification for Radio Interference Measurement Apparatus and Measurement Methods.  The test laboratory testing your product for compliance with the CFR will be familiar with these measurement methods.

Specifically under Part 15 Subpart F the following clauses, highlighted in red, are relevant to Qorvo based systems: -

FCC Code designation	Description
Part 15.250	Operation of wideband systems within the band 5925-7250 MHz
Part 15.505	Cross reference. This is particularly important in that it states under sub-

FCC Code designation	Description
	<p>section (b) that “the requirements of this subpart (i.e. 15.5xx) apply only to the radio transmitter, i.e., the intentional radiator, contained in the UWB device” and by implication the requirements do <b>not</b> apply to the receiver.</p> <p>This leaves the way open for <b>fixed outdoor receive antennas</b> provided it can be shown that those antennas are for reception only and do not / cannot radiate.</p>
Part 15.507	<b>Marketing of UWB equipment</b>
Part 15.509	Technical requirements for ground penetrating radars and wall imaging systems.
Part 15.510	Technical requirements for through D-wall imaging systems
Part 15.511	Technical requirements for surveillance systems
Part 15.513	Technical requirements for medical imaging systems
Part 15.515	Technical requirements for vehicular radar systems
Part 15.517	<b>Technical requirements for indoor UWB systems</b>
Part 15.519	<b>Technical requirements for hand held UWB systems</b>
Part 15.521	<b>Technical requirements applicable to all UWB devices</b>
Part 15.523	<b>Measurement procedures</b>
Part 15.525	Coordination requirements

The text of these regulations is reproduced in Section 10 Appendix 4.

## 5.3 Specific guidance on the regulations

### 5.3.1 Choice of section under which to certify

You should carefully consider the section of the code under which you wish to certify. 15.5xx UWB codes impose certain restrictions whose implications need to be carefully considered in light of your intended application.

### 5.3.2 General use restrictions under 15.5xx

The following general use restrictions apply to products certified under section 15.5xx of the CFR: -

1. UWB devices may not be employed for the operation of toys.
2. Operation on board an aircraft, a ship or a satellite is prohibited
3. The provisions of 15.203 and 15.204 apply to products certified under 15.5xx. These relate to the use of replaceable antennas and external power amplifiers respectively. The intention here is that the product as certified / shipped should not be capable of modification while in the field in such a way as to radiate more power than when it was certified.
4. The frequency at which the highest radiated emission occurs,  $f_m$ , must be contained within the UWB bandwidth.
5. There is no requirement to measure emissions beyond 40 GHz provided  $f_c$  is less than 10 GHz – this is the case with Qorvo IC’s.

### 5.3.3 Specific use restrictions under 15.5xx

#### 5.3.3.1 Use restrictions under 15.517 (indoor UWB systems)

The following restrictions apply to products certified under section 15.517: -



1. Systems certified under this section of the code may only operate indoors and the FCC will look for evidence that the product / system can only be used in this way.
2. These systems may not use antennas specifically directed outside the building in which they are installed to implement an outdoor system.
3. Systems certified under this section of the code may not use antennas mounted on fixed outdoor infrastructure – see 5.3.4 below.
4. The UWB bandwidth of a device operating under the provisions of this section must be contained between 3,100 MHz and 10,600 MHz – so any of the Qorvo product channels are permitted.

### 5.3.3.2 Use restrictions under 15.519 (hand-held UWB systems)

The following use restrictions apply to products certified under section 15.519: -

1. Section 15.519 requires that products certified under this section only transmit to an “associated” receiver and they must receive an acknowledgement from that receiver in order to continue transmitting. This requires that the unit either act as a UWB transceiver or have some other communications channel between the UWB transmitter and receiver to indicate that the transmitter is permitted to continue transmission.
2. The UWB bandwidth of a device operating under the provisions of this section must be contained between 3,100 MHz and 10,600 MHz – so any of the Qorvo product channels are permitted.

### 5.3.4 Specific wording of the application

Generally speaking the FCC is supportive of UWB technology, applications and products and will not seek to intentionally block the certification of such products provided that compliance with the relevant regulations can be established. The way an application is phrased / constructed can have an impact here. It is important to understand the intention behind the FCC’s use of certain words and to avoid those words in your application where possible.

Word / Phrase in the Code of Federal regulations	Comment
Aircraft	<p>The FCC does not permit any device certified under 15.5xx to operate on-board an aircraft. This has a number of implications: -</p> <ul style="list-style-type: none"><li>• Products intended for use on-board aircraft should not use UWB technology.</li><li>• You must ensure, if your product is being transported by air, that the UWB transmitter is not enabled</li><li>• If there is any question over whether your application involves an “aircraft” then you should phrase it such that the word “aircraft” does not appear in the application</li></ul>
Fixed (Installation)	<p>The term “fixed” is generally used by the FCC in the context of outdoor installations.</p> <p>The FCC’s thinking in this regard is that if there are fixed installations radiating UWB signals close to particular facilities (including but not limited to airports &amp; radio astronomy sites) then there is the potential to raise the noise floor in those areas to the point where it begins to interfere with the operation of other systems in the locality such as radio altimeters and radio telescopes.</p> <p>The FCC does not explicitly define the term “fixed”, so a scheme in which outdoor transmitters are mounted in holders from which they may be removed once an operation is complete may be acceptable.</p>
Outdoor	<p>The regulations do not define the term “outdoor” and rely on a common-sense interpretation of the meaning of the word. The intention here is that signals from systems operating indoors will be attenuated by the structure of buildings</p>



Word / Phrase in the Code of Federal regulations	Comment
	and therefore regulations can be less restrictive. Outdoor installations on the other hand, because they do not experience the attenuating effect of a structure are more likely to interfere with nearby installations, airports and radio astronomy.
Satellite	The regulations do not define the term “satellite” but generally this can be taken to mean any device intended to remain in earth orbit. Qorvo UWB products are not rad-hardened so it is unlikely this restriction will be an issue for the majority of customers.
Ship	The regulations do not define the term “ship” and rely on a common-sense interpretation of the meaning of the word. There may be room for manoeuvre here depending on your specific application and the type of vessel for which it is intended so if possible you should avoid the explicit use of the word “ship” in your application to the FCC.
Toys	The regulations do not define the term “toy” and rely on a common-sense interpretation of the meaning of the word.  There is latitude here so if your product is, for example, a “toy” intended to promote learning in children then it could be classified as an educational tool in your application to the FCC and potentially overcome this restriction.

## 6 The FCC certification process

### 6.1 Overview of the certification process

The FCC operates the certification process under 3 basic categories: -

1. Certain products may be certified by Telecommunications Certified bodies (TCB's) (see 6.1.1 below) without further reference to the FCC.
2. Certain products may be certified by a TCB under what is known as a "Permit but Ask" scheme i.e. the TCB can grant certification but only after it has checked with the FCC and the FCC has given the necessary approvals.
3. The third class of products are those on what is known as the "TCB Exclusion List" where TCBs are not permitted to grant certification under any circumstances and an application for certification must be made directly to the FCC.

Until recently UWB products fell into category 3 but as of October 31<sup>st</sup>, 2013, the FCC modified this categorization to move them into category 2.

#### 6.1.1 The groups involved

**OET:** Office of Engineering Technology. This is the section in the FCC responsible for reviewing all applications for certification.

**TCB:** Telecommunications Certified Bodies. These are accredited organisation(s) outside the FCC that have been approved by the FCC to grant FCC certification of products either directly or under a "Permit but Ask" (PBA) scheme.

**Test house:** An approved laboratory that is certified to carry out the necessary measurements on your product. In many cases the test house and TCB are the same entity although this is not necessary.

#### 6.1.2 Confidentiality concerns

Various elements of your submission to the FCC via a TCB may be granted permanent or temporary confidentiality depending on their nature. Whether or not confidentiality will be granted by the FCC depends on the nature of the exhibit.

##### 6.1.2.1 Short-term confidentiality:

Exhibits that will be hidden from public view in the FCC database for a period of up to 180 days from the Grant of Authorization or the date of first marketing or sale, whichever comes first; after which, they will become and remain visible. The applicant may specify the length of the short-term confidentiality period prior to its expiry, by letter request to the TCB.

##### 6.1.2.2 Permanent confidentiality

Exhibits that will never appear to public view in the FCC database – but are accessible to the FCC.

The following table shows which exhibits may be granted short term / long term confidentiality. Most exhibits will be granted short-term confidentiality in the interests of competitive secrecy but once the product has been granted certification and is launched to market the FCC's view is that any documentation or information provided to the market with the product does not qualify for long term confidentiality unless there are mitigating circumstances.

**Table 2: Applicability of short-term and permanent confidentiality**

<b>Exhibit</b>	<b>Short-term confidentiality (up to 180 days)</b>	<b>Permanent confidentiality</b>
Cover letters	N	N
Attestation letters	N	N
Block diagrams	Y	Y
External Photos	Y	N
FCC ID label and location	N	N
Internal Photos	Y	Y but only with additional justification
Operational Description	Y	Y
Test set-up photos	Y	N
Test Report	N	N
Tune Up procedure (if applicable)	Y	N
User's Manual	Y	Y but only with additional justification
RF Exposure Information	N	N

## 6.2 The details of the process

### 6.2.1 Introduction

This section describes the process of submitting your UWB product for certification by the FCC. This

### 6.2.2 Step 1: Obtain the necessary identification codes

If you have never received an FCC Grant of Authorization before, you will need to obtain one or more identification codes. You need to do this only once, for all future filings.

#### 6.2.2.1 FCC registration number

An FCC Registration Number (FRN) is required for accounting purposes. Visit the CORES website at: <https://fjallfoss.fcc.gov/coresWeb/publicHome.do> to obtain; it is free

#### 6.2.2.2 Grantee code

A Grantee Code, identifying the party responsible for compliance of the device is also required. To obtain this, visit: <https://fjallfoss.fcc.gov/oetcf/eas/forms/GranteeRegistration.cfm> . There is a \$60 fee which must be paid on-line. The Grantee Code becomes part of the FCC ID you must display on your approved product.

The fee for the assignment of an Applicant / Grantee Code is a one-time charge. Payment must be submitted in a timely manner. If the payment is not received / verified within thirty (30) calendar days of the date of the Grantee Code assignment, the Grantee Code will be automatically removed from the OET Grantee Code Database and the applicant will then be required to obtain another Grantee Code. It is suggested that the payment be submitted no later than seven (7) calendar days after the Grantee Code assignment. It is also suggested that labels should not be printed unless / until the fee payment has been verified.

### 6.2.3 Step 2: The TCB requests guidance from the FCC (the “Ask” portion of the PBA process)

A TCB is responsible for ensuring that guidance is received from the FCC for testing of devices on the PBA Conditions list, which includes UWB devices.

Such guidance may be initially requested by the test firm, manufacturer, or responsible party or the guidance



shall be requested as part of a Knowledge Data Base (KDB) Inquiry by the TCB.

In the inquiry the TCB must indicate the class of equipment for which certification is being sought – in this case UWB.

The TCB submits the Inquiry and retains the KDB Inquiry Tracking Number assigned at the time. The FCC will correspond using this Inquiry Tracking Number, and may request additional information, may decline the request, or may give the TCB permission to finalize the Form 731 application.

### 6.2.4 Step 3: Apply for Equipment Authorization, FCC Form 731

Form 731 is the primary means by which an application is made for FCC certification. The TCB will complete and submit this on your behalf (see Section 9).

You must pay the appropriate fee (Section 0).

After the TCB receives permission to finalize Form 731, the TCB will enter all Form 731 information, including upload of required application exhibits and will respond to any questions raised by the FCC.

When the Form 731 application is finalized, and the application is ready for FCC review, the TCB submits a “Reply to FCC Response” using the initial KDB Inquiry Tracking Number.

### 6.2.5 Step 4: Submit the exhibits that must accompany the 731 form

Various exhibits must be uploaded either with, or shortly after you submit form 731. The FCC states that exhibits must be uploaded within five (5) calendar days of the application submittal and / or fee payment must be submitted and processed within fifteen (15) calendar days of the application submittal or the application may be dismissed.

The TCB will advise you exactly what is required.

Table 3: Key words

Item	Description
Confidentiality request letter	Only required if you wish to avail yourself of the confidentiality provisions of the certification process.
User's Manual	A copy of the installation and operating instructions to be furnished to the user as defined in the CFR section 2.1033. Contains information per Sections 15.21, 15.105 and 18.213 of the CFR and RF Safety instructions as needed. A draft document is acceptable if it reflects the actual required FCC text that will be present in the final document, which should be provided when available.
Operational description	A brief description of the circuit functions of the device along with a statement describing how the device operates, including a description of the radio circuitry and how the radio signal is developed. This statement should contain a description of the ground system and antenna, if any, used with the device per Section 2.1033. For certification for licensed radio under CFR rule parts other than 11, 15, and 18, the following additional items must be included: <ul style="list-style-type: none"><li>• The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range.</li><li>• A description of all circuitry and devices provided for determining and stabilizing frequency, for suppression of spurious radiation, for limiting modulation, and for limiting power.</li><li>• For equipment employing digital modulation techniques, a detailed description of the modulation system to be used, including the</li></ul>

Item	Description
	response characteristics (frequency, phase and amplitude) of any filters provided, and a description of the modulating wave-train, shall be submitted for the maximum rated conditions under which the equipment will be operated.
Block Diagram	A block diagram showing the frequency of all oscillators in the device. The signal path and frequency shall be indicated at each block as per CFR section 2.1033(b)(5). This exhibit is only required for unlicensed devices operating under parts 11, 15, or 18.
Schematic	A schematic diagram for intentional radiators per CFR section 2.1033. This is required for all intentional radiators (radio devices)
Test Report	A report of measurements showing compliance with the pertinent FCC technical requirements. This report shall identify the test procedure used, the date the measurements were made, the location where the measurements were made, and the device that was tested as per CFR section 2.1033, as well as sample calculations for all measurement calculations in the report.
Test Setup Photographs	Test Set up photos shall be provided as a separate exhibit.
External Photographs	A sufficient number of photographs to clearly show the exterior appearance, the construction, the component placement on the chassis, and the chassis assembly as per CFR section 2.1033.
Internal Photographs	A sufficient number of photographs to clearly show construction, component placement, chassis assembly as per CFR section 2.1033
ID / Label locations	Label in sufficient detail so that the name and FCC identifier can be read. In lieu of a photograph of the label, a sample label (or facsimile thereof) may be submitted together with a sketch showing where this label will be placed as per CFR section 2.1033. When it is not practical or desirable to include the applicable label text, it may be moved to the manual however the FCC ID must be displayed on the label. Electronic display of the FCC ID is also an option. See KDB784748 on Labelling for details.

### 6.2.6 Step 5: Await the response of the FCC

The FCC will review the Form 731 application and the KDB Inquiry for consistency with the PBA guidance for UWB products. If the Form 731 application is acceptable, the FCC engineer will modify the application to permit the grant to be issued, and inform the TCB through the KDB (under the same KDB Inquiry Tracking Number) that the Grant can be issued.

A review by the Office of Engineering Technology may take up to 60 days if the submission is complete and there are no problems

### 6.2.7 Step 6: The TCB grants the application (the “Permit” portion of the PBA process)

The TCB grants the application to you.



### 6.2.8 Schedule of fees

The filing of an equipment authorization involves a several fees, see:

<https://www.fcc.gov/general/equipment-authorization-fee-filing-guide>.

An assignment of a grantee code is required, for which a fee is payable. The TCB will file FCC Form 731 (Applications for Equipment Authorization) on your behalf for which a further payment is due. The latest FCC Schedule of Fees is available from:

<https://www.fcc.gov/licensing-databases/fees/application-processing-fees>.

### 6.2.9 Labelling requirements

General labelling requirements are given in section 15.19 of the code. The exact labelling of your product depends on the section of the code under which it was certified. Some examples are given below: -

#### 6.2.9.1 FCC requirement from 47 CFR 15.19 and applicable to UWB devices

“This device complies with 47 CFR Part 15 of the FCC rules. Operation is subject to 1) this device may not cause harmful interference and 2) this device must accept any interference received including interference that may cause undesired operation.”

#### 6.2.9.2 FCC requirement from 47 CFR 15.517 (indoor operation)

“This equipment may only be operated indoors. Operation outdoors is in violation of 47 U.S.C 301 and could submit the operator to serious legal penalties”

In cases where the product is too small (very small tags for example) to allow labels to be fixed to it, the FCC permits the labels to be reproduced on the packaging and in the instruction manuals for the product.

You should check with your TCB for the specific labelling requirements that apply to your product.

## 7 Appendix 1: Specific measurements of relevance to Qorvo products

### 7.1 Introduction

This section details two specific measurements that will be required with your Qorvo UWB based product. Specifically, these are: -

- Maximum mean power spectral density
- Maximum peak power

### 7.2 Maximum mean power spectral density

#### 7.2.1 Definition

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

This measurement verifies that at no frequency is there a transmitted signal with an average power that exceeds the spectrum mask limit of relevance in your jurisdiction.

#### 7.2.2 Measurement method

The following is a typical measurement method employing a calibrated test setup. Other methods are permissible also. You should contact your local test house for further information.

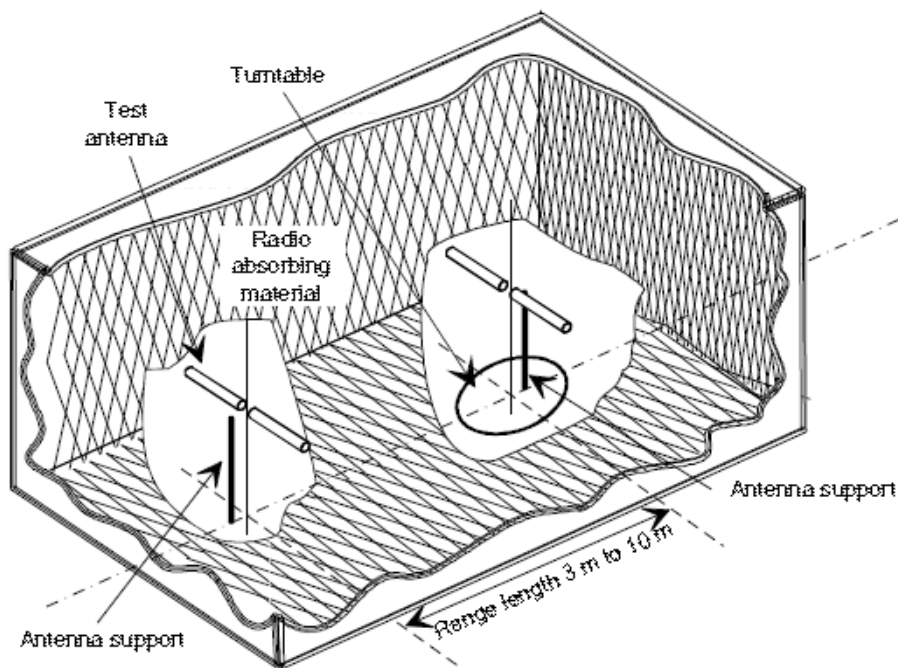


Figure 2: Measuring max mean PSD

In a calibrated test setup, the measurement receiver, test antenna and all associated equipment (e.g. cables, filters, amplifiers, etc.) will have been recently calibrated against known standards at all the frequencies on which measurements of the equipment under test (EUT) are to be made.

The EUT is placed at the specified height on a support, and in the position closest to normal intended use.



The test antenna is chosen to match the channel frequency of the unit under test and is initially oriented for vertical polarization.

The output of the test antenna is connected to the spectrum analyser via whatever (fully characterized) equipment is required so that the signal is measurable (e.g. amplifiers).

The EUT is switched on, if possible without modulation although operation with modulation is acceptable, and the spectrum analyser is tuned to the channel centre frequency of the EUT.

The test antenna is raised and lowered through the specified range of height until a maximum signal level is detected by the spectrum analyser.

The EUT is then rotated through 360° in the horizontal plane, until the maximum signal level is detected by the spectrum analyser.

The test antenna is then raised and lowered again through the specified range of height until a maximum signal level is detected by the spectrum analyser.

The maximum signal level detected by the spectrum analyser is noted and converted into radiated power by using the pre-determined calibration coefficients for the measurement equipment being used.

The test is repeated for horizontal polarization of the test antenna.

Many test houses use an automated process to drive the antenna raising / lowering device, the turntable and the spectrum analyser so that the entire process, once configured, is carried out without operator intervention.

The FCC specifically state that if absorber is used on the floor of the anechoic chamber, then an additional 4.7 dB must be added to the measured power to take account of gain due to constructive interference between the directly radiated signal and the reflected signal from the ground plan. To avoid having to do this, absorber should not be used on the floor of the chamber and the EUT should not be configured for back-to-back frame mode. You should discuss with the test house the distance to be used between the DUT and the test antenna because this has a direct impact on whether constructive interference will occur or not.

### 7.2.3 Measurement conditions

Measurements should be carried out over the frequency range from 30 MHz to 40 GHz as per the CFR and should be applied to all combination(s) of the radio device and its intended antenna(s).

Where the RF power level is user adjustable, all measurements shall be made with the highest power level available to the user for each radio device / antenna combination. For a UWB tag, for example, it is most likely that the antenna will be integrated into the tag and the power level will be fixed at manufacturing time so only one measurement configuration is required.

### 7.2.4 Maximum mean power measurement

When measuring maximum mean power spectral density from the EUT, the spectrum analyser or equivalent should be configured as follows unless otherwise stated:

**Table 4: Max mean power measurement parameters**

Parameter	Value
Resolution bandwidth	1 MHz
Video bandwidth	Not less than the resolution bandwidth
Detector mode	RMS (power average)
Display Mode	Max. hold
Average time	1 ms or less (per sweep point on spectrum analyser scan)
Note: "Average time" may not be an explicit setting. In some cases, it may be determined by setting the number of measurement points and the time taken for a sweep.	
Frequency Span	Equal to or less than the number of sweep points multiplied by the resolution bandwidth, preferably less than half as much.

The measurement results should be recorded over the specified frequency ranges given in the CFR.

## 7.3 Maximum peak power

### 7.3.1 Definition

The maximum peak power specified as e.i.r.p. 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.

This measurement verifies that at no frequency is there a transmitted signal with a peak power that exceeds the FCC spectrum mask limit.

### 7.3.2 Measurement method

The FCC say that the resolution bandwidth shall not be lower than 1 MHz or greater than 50 MHz, and the measurement shall be centered on the frequency at which the highest radiated emission occurs,  $f_m$  as recorded under section 7.2.

Measurements shall be carried out over the frequency range from 30 MHz to 40 GHz.

When measuring maximum peak power from the EUT, the spectrum analyser used should be configured as follows:

**Table 5: Max peak power measurement parameters**

Parameter	Value
Resolution bandwidth	50 MHz
<p><b>Note:</b> Using a lower resolution bandwidth will lead to an overestimation of the peak power.</p> <p>The FCC allows the use of a resolution bandwidth lower than 50 MHz. They state that if a bandwidth lower than 50 MHz IS employed, the peak EIRP limit shall be <math>20 \log (RBW/50)</math> dBm where RBW is the resolution bandwidth in megahertz that is employed. This may be converted to a peak field strength level at 3 meters using <math>E (dBuV/m) = P (dBm EIRP) + 95.2</math>. If RBW is greater than 3 MHz, the application for certification filed with the Commission must contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed in the testing.</p> <p><b>This method will result in a test fail and should not be used. A 50 MHz RBW instrument should always be used.</b></p>	
Video bandwidth	Not less than the resolution bandwidth
Detector mode	Peak



Display Mode	Max. hold
Measurements shall be continued with the transmitter emitting the normal test signal (see clause 5.2) until the displayed trace no longer changes	

## 8 Appendix 2: FCC accredited UWB test houses

Refer to [qorvo.com](http://qorvo.com) for a list of UWB test partners.



## 9 Appendix 3: FCC form 731

### 9.1 Introduction

Form 731 is the primary means by which the TCB applies for FCC certification.

### 9.2 The form itself

#### 9.2.1 Applicant Information

<b>Applicant's complete, legal business name:</b>	The name under which you are applying for certification
<b>FCC Registration Number (FRN):</b>	You must have a valid FRN to make an application for certification. If you do not have one you should obtain one, or ask the TCB to obtain one on your behalf – see note 1 below
<b>Line one:</b>	
<b>Line two:</b>	
<b>P.O. Box:</b>	
<b>City:</b>	Your address
<b>State:</b>	
<b>Country:</b>	
<b>Zip Code:</b>	

Note 1: All entities doing business with the FCC must obtain an FCC Registration Number (FRN). To register for an FRN, change previously submitted FRN information, or search for an FRN, visit <https://apps.fcc.gov/coresWeb/publicHome.do>. A Tax Identification Number (TIN), Employee Identification Number (EIN), or Social Security Number (SSN) is required for all entities within the USA. All entities outside of the USA will be assigned a TIN at the time an FRN is assigned.

#### 9.2.2 FCC Identification

<b>Grantee Code:</b>	3 digit code assigned by the FCC. You must have an FCC Grantee Code. A grantee code is assigned to a specific applicant at a specific address and is the first portion of each FCC Identifier (ID) for devices authorized under the Certification procedure (Section 2.925 47 CFR) for them – see Note 2 below.
<b>Product Code:</b>	Code 14 Maximum characters (letters, numbers, and dash)

Note 2: To obtain a new grantee code, click Grantee Registration under Filing Options at <https://apps.fcc.gov/oetcf/eas/index.cfm>. Any representative of the applicant may obtain the grantee code and/or pay the fee for the assigned code; the representative may be an individual, test firm, TCB, etc. Regardless who obtains the new code, the applicant should be provided with, and retain, the assignment page which indicates the new Grantee Code; the Grantee Code Registration Number (GC#); and the date that both were assigned.

#### 9.2.3 Person at the applicant's address to receive grant or for contact

<b>First Name:</b>	
<b>Middle Name:</b>	Person in your organisation to whom the grant will be sent and for any contact in relation to the application
<b>Last Name:</b>	
<b>Title:</b>	Person's title
<b>Telephone Number:</b>	
<b>Fax Number:</b>	
<b>Email:</b>	Person's contact details
<b>Mail Stop:</b>	

#### 9.2.4 Technical Contact

The person at the test house who the FCC should contact in the event of any technical questions with your application.



**Firm Name:** \_\_\_\_\_ The name of the test house you are using  
**First Name:** \_\_\_\_\_  
**Middle Name:** \_\_\_\_\_ Person's name  
**Last Name:** \_\_\_\_\_  
**Line 1:** \_\_\_\_\_  
**Line 2:** \_\_\_\_\_  
**P.O. Box:** \_\_\_\_\_  
**City:** \_\_\_\_\_ The address of the test house  
**State:** \_\_\_\_\_  
**Country:** \_\_\_\_\_  
**Zip Code:** \_\_\_\_\_  
**Telephone Number:** \_\_\_\_\_  
**Fax Number:** \_\_\_\_\_  
**Email:** \_\_\_\_\_ Contact details for the test house  
**Mail Stop:** \_\_\_\_\_

### 9.2.5 Non-Technical Contact

The person at the test house who the FCC should contact in the event of any non-technical / administrative questions with your application.

**Firm Name:** \_\_\_\_\_ The name of the test house you are using  
**First Name:** \_\_\_\_\_  
**Middle Name:** \_\_\_\_\_ Person's name  
**Last Name:** \_\_\_\_\_  
**Line 1:** \_\_\_\_\_  
**Line 2:** \_\_\_\_\_  
**P.O. Box:** \_\_\_\_\_  
**City:** \_\_\_\_\_ The address of the test house  
**State:** \_\_\_\_\_  
**Country:** \_\_\_\_\_  
**Zip Code:** \_\_\_\_\_  
**Telephone Number:** \_\_\_\_\_  
**Fax Number:** \_\_\_\_\_  
**Email:** \_\_\_\_\_ Contact details for the test house  
**Mail Stop:** \_\_\_\_\_

### 9.2.6 Long-Term Confidentiality

“Does this application include a request for confidentiality for any portion(s) of the data contained in this application pursuant to 47 CFR § 0.459 of the Commission Rules? Yes / No”

You should indicate which parts of your submission you want covered by the long-term confidentiality measures and submit reasons why you believe these parts of your submission qualify for that long-term confidentiality.

### 9.2.7 Short-Term Confidentiality

“Does short-term confidentiality apply to this application? Yes / No”

You should indicate which parts of your submission you want covered by the short-term confidentiality measures and submit reasons why you believe these parts of your submission qualify for that long term confidentiality.



### 9.2.8 Grant Deferral

“Does the applicant request that the Commission defer grant of this application pursuant to 47 CFR § 0.457(d)(1)(ii)? Yes / No

If so, specify date when grant may be issued (MM/DD/YYYY format)”

You may choose to delay the date of grant of the application by the FCC to suit your commercial schedules. In general, the FCC issues grants as soon as valid applications are processed. At this point the confidentiality timing begins and after 45 days the temporary confidentiality limit expires and all material covered under that temporary confidentiality becomes publicly available. This may not suit your commercial / product introduction schedules so consideration should be given to a potential deferral.

### 9.2.9 Software Defined Radio

“Is this application for software defined radio authorization? Yes / No”

Select "Yes" if this application meets the definition of a software defined / cognitive radio (SDR) and is being applied for in this application.

Software defined / cognitive radio, for regulatory purposes, is defined as "a radio that includes a transmitter in which the operating parameters of the transmitter, including the frequency range, modulation type or maximum radiated or conducted output power can be altered by making a change in software without making any hardware changes."

At the present time TCBs cannot certify Software Defined Radios. These applications must be sent directly to the FCC for certification.

### 9.2.10 Equipment Class

The FCC publishes a long list of different classes of equipment. For the purposes of this document only two are relevant: -

Class code	Description	Applicable portion of the CFR
UWB	Ultra Wideband Transmitter	15F
WBT	Wideband Transmitter	15.250 / 15.252

### 9.2.11 Related OET Knowledge Data Base Inquiry

“Is there a Knowledge Database (KDB) inquiry associated with this application? Yes / No”

Have you made a request for clarification or other inquiry to the OET Knowledge Data Base in relation to this application?

### 9.2.12 Modular Equipment

Modular Type:

- Single Modular Approval
- Limited Single Modular Approval
- Does not apply

### 9.2.13 Application Purpose

You must state the purpose of this application. Is it for certification of a new product, a change in the identification of already authorized equipment or a change in the functionality of already authorized equipment?



“What is the purpose of this application? Is it for: -

- Original equipment
- Change in identification of presently authorized equipment

FCC ID	
Grant Date	

- Class II Permissive Change or modification of presently authorized equipment
- Class III permissive change to software defined radio. NOTE: This may only be filed for applications pertaining to Software Defined Radio”

### 9.2.14 Composite / Related Equipment

“Is the equipment in this application a composite device subject to an additional equipment authorization? Yes / No”

If so, the related application:

- has been granted under the FCC ID listed below
- is in the process of being filed under the FCC ID listed below
- is pending with the FCC under the FCC ID listed below

FCC ID:            ”

For example, if the product contains both a Qorvo UWB device and another radio that also requires certification then you need to indicate the status of that other certification.

### 9.2.15 Equipment Specifications

Line Entry	Lower Frequency	Upper Frequency	Power Output (Watts)	Tolerance (insert units)	Emission Designator	Microprocessor Number	Rule Parts	Grant Notes
1								
2								
.								
n								

You should enter the technical specifications of your product here.



### 9.2.16 Test Firm Information

The name of the test firm and the contact person on file with the FCC if different from the applicant or contact person

<b>Firm Name:</b>	_____
<b>First Name:</b>	_____
<b>Middle Name:</b>	Person's name
<b>Last Name:</b>	_____
<b>Line 1:</b>	_____
<b>Line 2:</b>	_____
<b>P.O. Box:</b>	_____
<b>City:</b>	The address of the test house
<b>State:</b>	_____
<b>Country:</b>	_____
<b>Zip Code:</b>	_____
<b>Telephone Number:</b>	_____
<b>Fax Number:</b>	Contact details for the test house
<b>Email:</b>	_____
<b>Mail Stop:</b>	_____

### 9.2.17 Grant Comments

“Enter any text that you would like to appear at the bottom of the Grant of Equipment Authorization”

### 9.2.18 Section 5301 (Anti-drug-abuse) certification

“The applicant must certify that neither the applicant nor any party to the application is subject to a denial of Federal benefits, that include FCC benefits, pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. § 862 because of a conviction for possession or distribution of a controlled substance. See 47 CFR 1.2002(b) for the definition of a "party" for these purposes.”



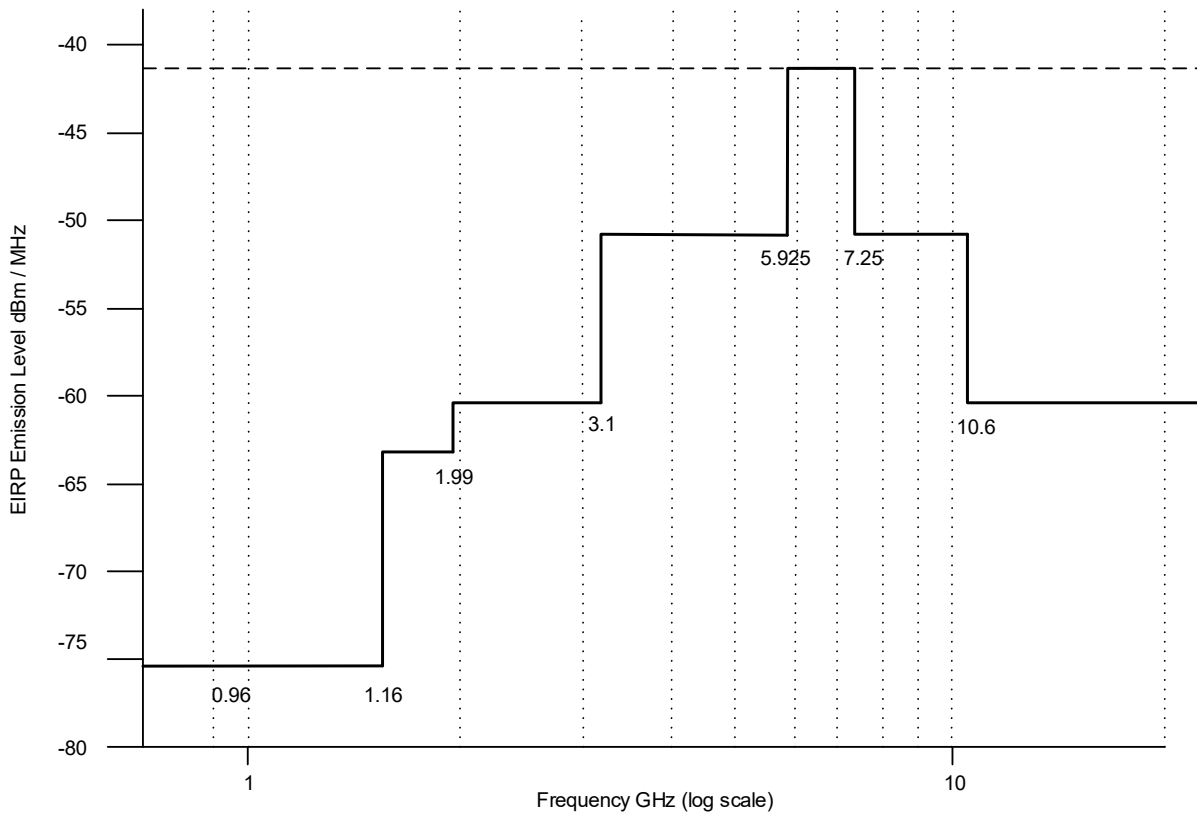
## 10 Appendix 4: Text of the CFR regulations relevant to UWB

### 10.1 Introduction

This appendix reproduces the text of the Code of Federal Regulations as per the FCC website.

<b>10.2 Part 15.250</b>	Operation of wideband systems within the band 5925-7250 MHz.
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- a. The -10 dB bandwidth of a device operating under the provisions of this section must be contained within the 5925-7250 MHz band under all conditions of operation including the effects from stepped frequency, frequency hopping or other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage.
- b. The -10 dB bandwidth of the fundamental emission shall be at least 50 MHz. For transmitters that employ frequency hopping, stepped frequency or similar modulation types, measurement of the -10 dB minimum bandwidth specified in this paragraph shall be made with the frequency hop or step function disabled and with the transmitter operating continuously at a fundamental frequency following the provisions of §15.31(m).
- c. Operation on board an aircraft or a satellite is prohibited. Devices operating under this section may not be employed for the operation of toys. Except for operation on-board a ship or a terrestrial transportation vehicle, the use of fixed outdoor infrastructure is prohibited. A fixed infrastructure includes antennas mounted on outdoor structures, e.g., antennas mounted on the outside of a building or on a telephone pole.
- d. Emissions from a transmitter operating under this section shall not exceed the following equivalent isotropic radiated power (EIRP) density levels:
  1. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following RMS average limits based on measurements using a 1 MHz resolution bandwidth:



**Figure 3: Emission limits for wideband systems under 15.250**

Frequency in MHz	EIRP in dBm
960-1610	-75.3
1610-1990	-63.3
1990-3100	-61.3
3100-5925	-51.3
5925 – 7250	-41.3
7250 – 10600	-51.3
Above 10600	-61.3

2. In addition to the radiated emission limits specified in the table in paragraph (d)(1) of this section, transmitters operating under the provisions of this section shall not exceed the following RMS average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency in MHz	EIRP in dBm
1164-1240	-85.3
1559-1610	-85.3

3. There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs and this 50 MHz bandwidth must be contained within the 5925-7250 MHz band. The peak EIRP limit is  $20 \log(\text{RBW}/50)$  dBm where RBW is the resolution bandwidth in megahertz that is employed by the measurement instrument. RBW shall not be lower than 1 MHz or greater than 50 MHz. The video bandwidth of the measurement instrument shall not be less than RBW. If RBW is greater than 3 MHz, the application for certification filed with the Commission shall contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed in the testing.



4. Radiated emissions at or below 960 MHz shall not exceed the emission levels in §15.209.
5. Emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in §15.209 provided it can be clearly demonstrated that those emissions are due solely to emissions from digital circuitry contained within the transmitter and the emissions are not intended to be radiated from the transmitter's antenna. Emissions from associated digital devices, as defined in §15.3(k), e.g., emissions from digital circuitry used to control additional functions or capabilities other than the operation of the transmitter, are subject to the limits contained in subpart B of this part. Emissions from these digital circuits shall not be employed in determining the -10 dB bandwidth of the fundamental emission or the frequency at which the highest emission level occurs.

e. Measurement procedures:

1. All emissions at and below 960 MHz are based on measurements employing a CISPR quasi-peak detector. Unless otherwise specified, all RMS average emission levels specified in this section are to be measured utilizing a 1 MHz resolution bandwidth with a one millisecond dwell over each 1 MHz segment. The frequency span of the analyzer should equal the number of sampling bins times 1 MHz and the sweep rate of the analyzer should equal the number of sampling bins times one millisecond. The provision in §15.35(c) that allows emissions to be averaged over a 100 millisecond period does not apply to devices operating under this section. The video bandwidth of the measurement instrument shall not be less than the resolution bandwidth and trace averaging shall not be employed. The RMS average emission measurement is to be repeated over multiple sweeps with the analyzer set for maximum hold until the amplitude stabilizes.
2. The peak emission measurement is to be repeated over multiple sweeps with the analyzer set for maximum hold until the amplitude stabilizes.
3. For transmitters that employ frequency hopping, stepped frequency or similar modulation types, the peak emission level measurement, the measurement of the RMS average emission levels, and the measurement to determine the frequency at which the highest level emission occurs shall be made with the frequency hop or step function active. Gated signals may be measured with the gating active. The provisions of §15.31(c) continue to apply to transmitters that employ swept frequency modulation.
4. The -10 dB bandwidth is based on measurement using a peak detector, a 1 MHz resolution bandwidth, and a video bandwidth greater than or equal to the resolution bandwidth.
5. Alternative measurement procedures may be considered by the Commission.

<b>10.3 Part 15.505</b>	<b>Cross Reference</b>
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(a) Except where specifically stated otherwise within this subpart, the provisions of subparts A and B and of §§15.201 through 15.204 and 15.207 of subpart C of this part apply to unlicensed UWB intentional radiators. The provisions of §15.35(c) and 15.205 do not apply to devices operated under this subpart. The provisions of Footnote US 246 to the Table of Frequency Allocations contained in §2.106 of this chapter does not apply to devices operated under this subpart.

(b) The requirements of this subpart apply only to the radio transmitter, i.e., the intentional radiator, contained in the UWB device. Other aspects of the operation of a UWB device may be subject to requirements contained elsewhere in this chapter. In particular, a UWB device that contains digital circuitry not directly associated with the operation of the transmitter also is subject to the requirements for unintentional radiators in subpart B of this part. Similarly, an associated receiver that operates (tunes) within the frequency range 30 MHz to 960 MHz is subject to the requirements in subpart B of this part.

<b>10.4 Part 15.507</b>	<b>Marketing of UWB equipment</b>
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"In some cases, the operation of UWB devices is limited to specific parties, e.g., law enforcement, fire and

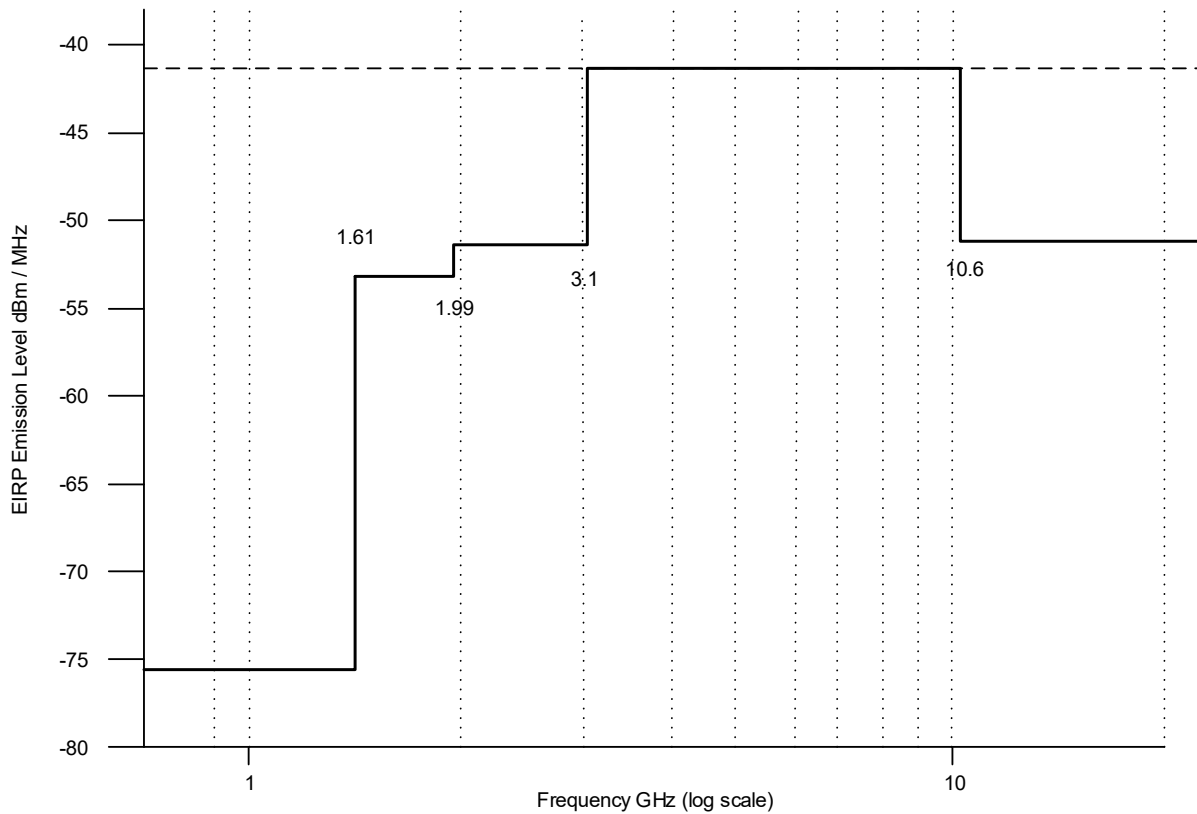


rescue organizations operating under the auspices of a state or local government. The marketing of UWB devices must be directed solely to parties eligible to operate the equipment. The responsible party, as defined in §2.909 of this chapter, is responsible for ensuring that the equipment is marketed only to eligible parties. Marketing of the equipment in any other manner may be considered grounds for revocation of the grant of certification issued for the equipment.”

**10.5 Part 15.517**

**Technical requirements for indoor UWB systems**

- a. Operation under the provisions of this section is limited to UWB transmitters employed solely for indoor operation.
  - i. Indoor UWB devices, by the nature of their design, must be capable of operation only indoors. The necessity to operate with a fixed indoor infrastructure, e.g., a transmitter that must be connected to the AC power lines, may be considered sufficient to demonstrate this.
  - ii. The emissions from equipment operated under this section shall not be intentionally directed outside of the building in which the equipment is located, such as through a window or a doorway, to perform an outside function, such as the detection of persons about to enter a building.
  - iii. The use of outdoor mounted antennas, e.g., antennas mounted on the outside of a building or on a telephone pole, or any other outdoors infrastructure is prohibited.
  - iv. Field disturbance sensors installed inside of metal or underground storage tanks are considered to operate indoors provided the emissions are directed towards the ground.
  - v. A communications system shall transmit only when the intentional radiator is sending information to an associated receiver.
- b. The UWB bandwidth of a UWB system operating under the provisions of this section must be contained between 3,100 MHz and 10,600 MHz.
- c. The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in §15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:



**Figure 4: Emission limits for indoor systems under 15.517**

Frequency in MHz	EIRP in dBm
960-1610	-75.3
1610-1990	-53.3
1990-3100	-51.3
3100-10600	-41.3
Above 10600	-51.3

d. In addition to the radiated emission limits specified in the table in paragraph (c) of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency in MHz	EIRP in dBm
1164-1240	-85.3
1559-1610	-85.3

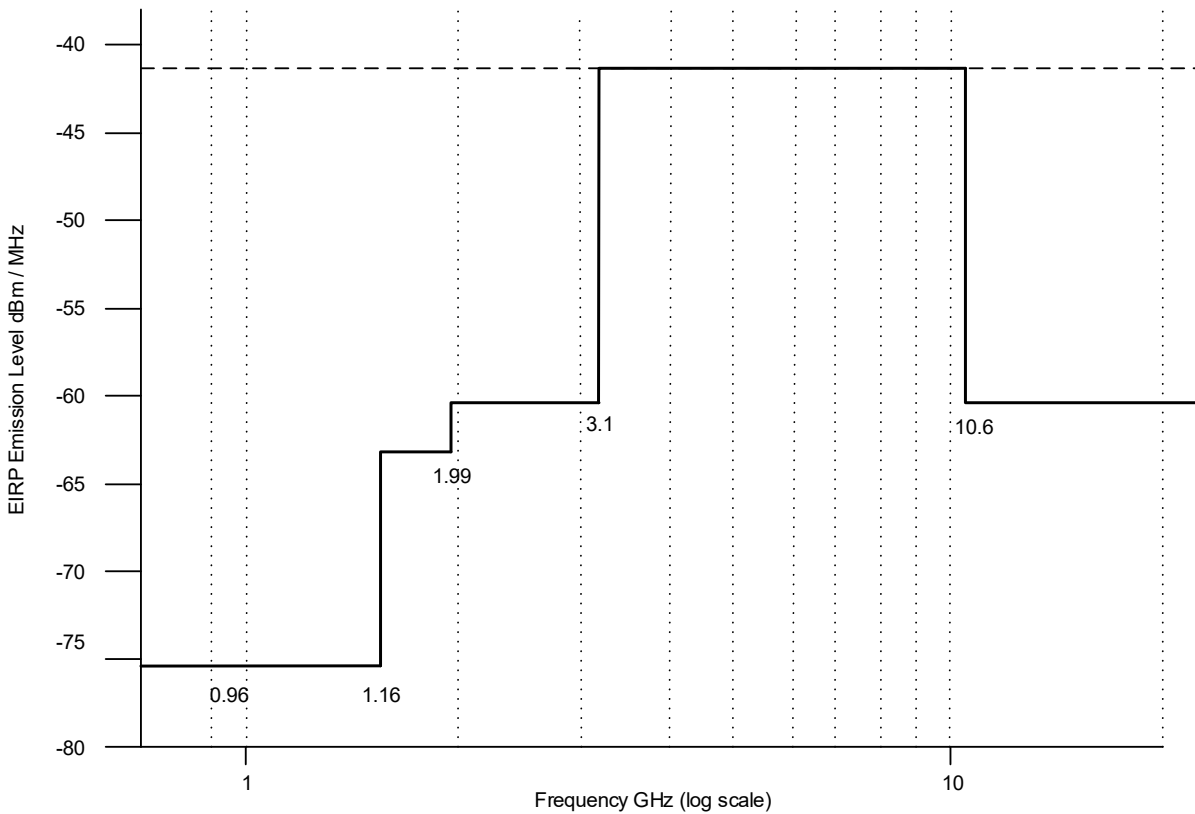
e. There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs,  $f_M$ . That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in §15.521.

f. UWB systems operating under the provisions of this section shall bear the following or similar statement in a conspicuous location on the device or in the instruction manual supplied with the device:

“This equipment may only be operated indoors. Operation outdoors is in violation of 47 U.S.C. 301 and could subject the operator to serious legal penalties.”

**10.6 Part 15.519**      **Technical requirements for hand held UWB systems**

- a. UWB devices operating under the provisions of this section must be hand held, i.e., they are relatively small devices that are primarily hand held while being operated and do not employ a fixed infrastructure.
- b. A UWB device operating under the provisions of this section shall transmit only when it is sending information to an associated receiver. The UWB intentional radiator shall cease transmission within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received. An acknowledgment of reception must continue to be received by the UWB intentional radiator at least every 10 seconds or the UWB device must cease transmitting.
- c. The use of antennas mounted on outdoor structures, e.g., antennas mounted on the outside of a building or on a telephone pole, or any fixed outdoors infrastructure is prohibited. Antennas may be mounted only on the hand held UWB device.
- d. UWB devices operating under the provisions of this section may operate indoors or outdoors.
- b. The UWB bandwidth of a device operating under the provisions of this section must be contained between 3,100 MHz and 10,600 MHz.
- c. The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in §15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:



**Figure 5: Emission limits for handheld systems under 15.519**



Frequency in MHz	EIRP in dBm
960-1610	-75.3
1610-1990	-63.3
1990-3100	-61.3
3100-10600	-41.3
Above 10600	-61.3

- d. In addition to the radiated emission limits specified in the table in paragraph (c) of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency in MHz	EIRP in dBm
1164-1240	-85.3
1559-1610	-85.3

- e. There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs,  $f_M$ . That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in §15.521.

<b>10.7 Part 15.521</b>	<b>Technical requirements applicable to all UWB devices</b>
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- a. UWB devices may not be employed for the operation of toys. Operation on board an aircraft, a ship or a satellite is prohibited.
- b. Manufacturers and users are reminded of the provisions of §§15.203 and 15.204.
- c. Emissions from digital circuitry used to enable the operation of the UWB transmitter shall comply with the limits in §15.209, rather than the limits specified in this subpart, provided it can be clearly demonstrated that those emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and that the emissions are not intended to be radiated from the transmitter's antenna. Emissions from associated digital devices, as defined in §15.3(k), e.g., emissions from digital circuitry used to control additional functions or capabilities other than the UWB transmission, are subject to the limits contained in Subpart B of this part.
- d. Within the tables in §§15.509, 15.511, 15.513, 15.515, 15.517, and 15.519, the tighter emission limit applies at the band edges. Radiated emission levels at and below 960 MHz are based on measurements employing a CISPR quasi-peak detector. Radiated emission levels above 960 MHz are based on RMS average measurements over a 1 MHz resolution bandwidth. The RMS average measurement is based on the use of a spectrum analyzer with a resolution bandwidth of 1 MHz, an RMS detector, and a 1 millisecond or less averaging time. Unless otherwise stated, if pulse gating is employed where the transmitter is quiescent for intervals that are long compared to the nominal pulse repetition interval, measurements shall be made with the pulse train gated on. Alternative measurement procedures may be considered by the Commission.
- e. The frequency at which the highest radiated emission occurs,  $f_M$ , must be contained within the UWB bandwidth.
- f. Imaging systems may be employed only for the type of information exchange described in their specific definitions contained in §15.503. The detection of tags or the transfer of data or voice information is not permitted under the standards for imaging systems.



- g. When a peak measurement is required, it is acceptable to use a resolution bandwidth other than the 50 MHz specified in this subpart. This resolution bandwidth shall not be lower than 1 MHz or greater than 50 MHz, and the measurement shall be centered on the frequency at which the highest radiated emission occurs,  $f_M$ . If a resolution bandwidth other than 50 MHz is employed, the peak EIRP limit shall be  $20 \log(RBW/50)$  dBm where RBW is the resolution bandwidth in megahertz that is employed. This may be converted to a peak field strength level at 3 meters using  $E(\text{dBuV/m}) = P(\text{dBm EIRP}) + 95.2$ . If RBW is greater than 3 MHz, the application for certification filed with the Commission must contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed in the testing.
- h. The highest frequency employed in §15.33 to determine the frequency range over which radiated measurements are made shall be based on the center frequency,  $f_c$ , unless a higher frequency is generated within the UWB device. For measuring emission levels, the spectrum shall be investigated from the lowest frequency generated in the UWB transmitter, without going below 9 kHz, up to the frequency range shown in §15.33(a) or up to  $f_c + 3/(\text{pulse width in seconds})$ , whichever is higher. There is no requirement to measure emissions beyond 40 GHz provided  $f_c$  is less than 10 GHz; beyond 100 GHz if  $f_c$  is at or above 10 GHz and below 30 GHz; or beyond 200 GHz if  $f_c$  is at or above 30 GHz.
- i. The prohibition in §2.201(f) and 15.5(d) of this chapter against Class B (damped wave) emissions does not apply to UWB devices operating under this subpart.
- j. Responsible parties are reminded of the other standards and requirements cross referenced in §15.505, such as a limit on emissions conducted onto the AC power lines.

<b>10.8 Part 15.523</b>	Measurement procedures
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Measurements shall be made in accordance with the procedures specified by the Commission.

## Abbreviations

Acronym	Full Name	Explanation
ANSI	American National standards Institute	American institution which has served as coordinator of the U.S. private sector, voluntary standardization system for more than 90 years.
CISPR	Comité International Spécial des Perturbations Radioélectriques or in English the International special committee on Radio Interference	A special committee under the sponsorship of the International Electrotechnical Commission (IEC). The membership is from national committees of the IEC, and other international organizations interested in the reduction of radio interference. CISPR was founded in 1934.
CFR	Code of Federal Regulations	The FCC rules governing all matters related to electromagnetic emissions & susceptibility and the certification of products to ensure compliance with regulations.
DUT	Device under test	Used to denote the unit or product being tested
FCC	Federal Communications Commission	The FCC regulates private users, state and local governments in the USA on all matters related to electromagnetic emissions & susceptibility and is an independent agency.
KDB	Knowledge Data Base	A database of queries maintained by the FCC <a href="https://apps.fcc.gov/oetcf/kdb/index.cfm">https://apps.fcc.gov/oetcf/kdb/index.cfm</a>
PBA	Permit But Ask	A scheme operated by the FCC that allows TCB's to grant FCC certification subject to clarification with the FCC
TCB	Telecommunications Certification Body	A test house or other organisation that has been accredited by the FCC to grant product certification on its behalf subject to certain conditions
UWB	Ultra Wideband	A method of radio transmission where the minimum bandwidth of the transmitted signal is 500 MHz

## References

[1] FCC, Code of Federal Regulations (CFR).

## Document History

Rev	Date	Section	Changes
1.0	16 <sup>th</sup> January, 2015		Initial release
1.1	30 <sup>th</sup> September, 2016		Scheduled update
1.2	30 <sup>th</sup> -August-2018		Logo Update
1.3	16 <sup>th</sup> May 2024		Scheduled update
B	1 <sup>st</sup> April 2025		Converted to Qorvo application note format. Revision A covers Rev 1.0 through 1.3



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