

AN001

SRD regulations for licence free transceiver operation

Keywords

- *CEPT recommendations*
- *ETSI standards*
- *R&TTE directive*
- *Part 15 devices*
- *Type approval*
- *Equipment testing*

Introduction

International regulations and national laws regulate the use of radio receivers and transmitters. This document is a summary of the most important aspects of these regulations for licence free operation of radio receivers and transmitters.

Although the operation of transceivers in certain frequency bands is licence free,

the product itself has to be type approved. The type approval procedure will also be reviewed in this document.

Chipcon is a worldwide distributor of transceiver chips designed to comply with the specifications discussed in this document.

Regulations overview

CEPT is an organ for the PTT (post-telephone -telegraph) authorities in the European countries and has the responsibility for the use of frequencies and output power. This is described in the ERC recommendation CEPT/ERC/70-03. In the present document we review the regulations for the 433 MHz and the 868MHz band.

The co-operation of type approvals by mutual recognition in Europe is stated in the CEPT ERC decision (97) 10.

ETSI is working on standards for the testing and type approvals for transmitters and receivers. Detailed specifications and testing methods are outlined. Several

standards cover the different frequency ranges:

EN 300 220 covers 25MHz – 1GHz
ETSI 300 330 covers 9 kHz – 25 kHz
ETSI300 440 covers 1 – 25GHz

Radio transmitters and transceivers must also have an EMC certificate based on the requirements outlined in ETS 300 683.

In the United States the legal issues governing the manufacture and sale of RF products for unlicensed operation is regulated under the FCC (Federal Communications Commission) CFR47, Part 15. In the present document we review the regulations for the 260-470 MHz and 902-928 MHz band.

This document contains information based on documents available from several telecommunication authorities and is believed to be correct. Chipcon is not responsible for any errors or changes that might occur.

CEPT ERC RECOMMENDATION 70-03

A summary of the recommendation for the 433MHz and 868MHz band SRDs follows based on the 19 August 1999 edition. The complete document can be downloaded from www.ero.dk.

Class	Frequency band	Power e.r.p.	Duty cycle	Channel spacing	Comments
1e	433.050-434.790	10mW	10%	No channel spacing specified	
10c	863.000 – 865.000	10mW	100%	200kHz	Consumer radio microphones
13a	863.000 – 865.000	10mW	100%	No channel spacing specified (300kHz for analogue systems)	Wireless audio (cordless loudspeakers and headphones) Integrated antenna only
1f	868.000 - 868.600	25mW	1%	25kHz, wideband, 100kHz spread spectrum	
7a	868.600 - 868.700	10mW	0.1%	25kHz	Alarms in general
1g	868.700 - 869.200	25mW	0.1%	25kHz wideband, 100kHz spread spectrum	
7d	869.200 - 869.250	10mW	0.1%	25kHz	Social Alarms
7b	869.250 - 869.300	10mW	0.1%	25kHz	Alarms in general
1h	869.300 – 869.400	t.b.d.	t.b.d.	25kHz	
1i	869.400 - 869.650	500mW	10%	25kHz. Or one broadband channel	
7c	869.650 - 869.700	25mW	10%	25kHz	Alarms in general
1k	869.700 - 870.000	5mW	100%	25kHz or 50kHz, or wideband	

e.r.p. = effective radiated power

Alarm systems

Specific sub-bands are recommended exclusively for alarm systems (indicated in the rightmost column above).

Audio applications

Specific sub-bands are recommended for audio systems (indicated in the rightmost column above). We do not recommend the 433MHz band for such applications, even though a few national regulations allow 100% duty cycle in this band.

Antenna

The antenna shall be an integrated part of the product (no external antenna socket), or a dedicated antenna shall be used (type approved with the equipment). The dedicated antenna should be a permanently fixed antenna, or an antenna using an otherwise not commonly used connector. In the last case we recommend the use of a reversed polarity SMA.

Channel spacing

No specified channel spacing means that the whole frequency band can be used. However, the product can be designed to use appropriate channel widths and spacing inside this band as long as the overall requirement is met.

Licensing

If the product is approved according to the relevant requirements, no license is required to operate these products.

Product marking

The product shall be marked indicating which class the equipment is designed for. SRDs in the 433 MHz band will be "1e". Further instructions for marking is given by the type approval body.

Transmitter duty cycle

The transmitter duty cycle is defined as the ratio of the maximum "on" time, relative to a one-hour period. If message acknowledgement is required, the additional "on" time shall be included. For duty cycle restrictions in the 433 MHz band, national regulation authorities should be consulted.

Special national restrictions

The national authorities have stated some restrictions to the implementation of this Recommendation. Some of these are given below. Please contact your national telecommunication authorities for full details.

Denmark:

Audio and voice are allowed in the 433.050-434.790 MHz band if the ERP is below 100 μ W.

France:

No duty-cycle limit in the band 433.05-434.79 MHz.

Germany:

Germany does not intend to commit itself to this Decision. Although essential parts of the provisions of this Decision are at present reflected by the relevant national regulations, Germany holds the view that all of them will be superseded by the R&TTE Directive which most probably enter into force at the beginning of 2000, whereafter this Decision need to be amended.

Italy:

Present legislation requires that use of SRD is subject to licence, except door openers and radio toys. The band at 869.3-869.65 MHz will be excluded. Audio and voice signals will not be allowed in the frequency band 433.05-434.79 MHz.

United Kingdom:

Audio and voice are not allowed in the 433.050-434.790 MHz band. For the 868.000-868.600, 867.700-869.200 and 869.700-870.00 MHz bands where the modulation used results in wide band a channel spacing up to 200 kHz may be used.

Norway:

Audio and voice are not allowed in the 433.050-434.790 MHz band. A 10% duty-cycle limit will be imposed by national regulations in the 433 MHz band according to the PTT.

Sweden:

In 433.050-434.790 MHz band 25mW is currently allowed. For the moment 868-870 MHz requires a licence.
Alarms are allowed at 429.450MHz (500mW).

CEPT ERC DECISION (97) 10

This ERC Decision on mutual recognition of conformity states that if one product is type approved in one of the following countries, the type approval will also be recognised by the other countries on the list. The complete document can be downloaded from www.ero.dk.

These countries have signed the mutual agreement:

Austria
Croatia
Denmark
Finland
France
Iceland
Ireland
Italy
Liechtenstein
Netherlands
Norway
Slovenia
Sweden
Switzerland
United Kingdom

ETSI EN 300 220

The ETSI EN 300 220 specifies in detail the requirements and test methods to be used for type approvals of licence free operated radio equipment. The following is a summary of the most important requirements. The complete document can be downloaded from www.etsi.fr.

Frequency error (section 8.1)

The maximum frequency error depends on type of use; base/mobile or portable, and of the channel separation. The requirement applies only when a channel spacing is specified.

Frequency band	10/12.5kHz channel spacing	20/25 kHz channel spacing	Comment
300-500 MHz	1 / 1.5 / 2.5	2 / 2 / 2.5	Figures is in kHz for base/mobile/portable
500-1000MHz	N.A.	2.5 / 2.5 / 3	

Carrier power, conducted (section 8.2)

This requirement applies for equipment with external antenna connector. The maximum power depends on equipment class. The class is found in the table on page 4

Class	Maximum power mW / dBm
7a	5 / 7
8	10 / 10
9	25 / 14
11	100 / 20
12	500 / 27

Effective radiated power (section 8.3)

This requirement applies for equipment with dedicated or integral antenna. The test method is different from equipment with external antenna connector, but the test limits are the same as above.

TX modulation (section 8.4)

This test apply to analogue speech systems only (FM and AM).

Adjacent channel power (section 8.5)

This test is applicable for equipment operating in bands with specified channel separation and bandwidths.

For 25kHz channel spacing, which is the narrowest channel spacing used in the 868MHz band, the test receiver bandwidth and filter shape for the adjacent channel is specified as follows:

Offset kHz	Attenuation dB
6	-2
8	-6
9.25	-26
13.25	-90

(There is special test instruments made for this kind of measurements, for example the Rhode & Swartz test receiver CMTA 84)

The test should be used using test modulation patterns D-M3 (package) or D-M2 (data stream).

The requirement for 25kHz channel spacing is 200nW = -37dBm for normal test conditions, and 640nW = -32dBm for extreme test conditions.

Modulation bandwidth for wideband equipment (>25kHz) (section 8.6)

This test is applicable when no channel spacing is specified, or channel spacing is larger than 25kHz.

The power envelope shall be measured with a spectrum analyser, RBW=100 Hz, VBW=10kHz, using the maximum hold display function. The bandwidth is defined as the bandwidth of the power envelope where the power is above the required spurious level. The spurious level limit is 250nW = -36dBm.

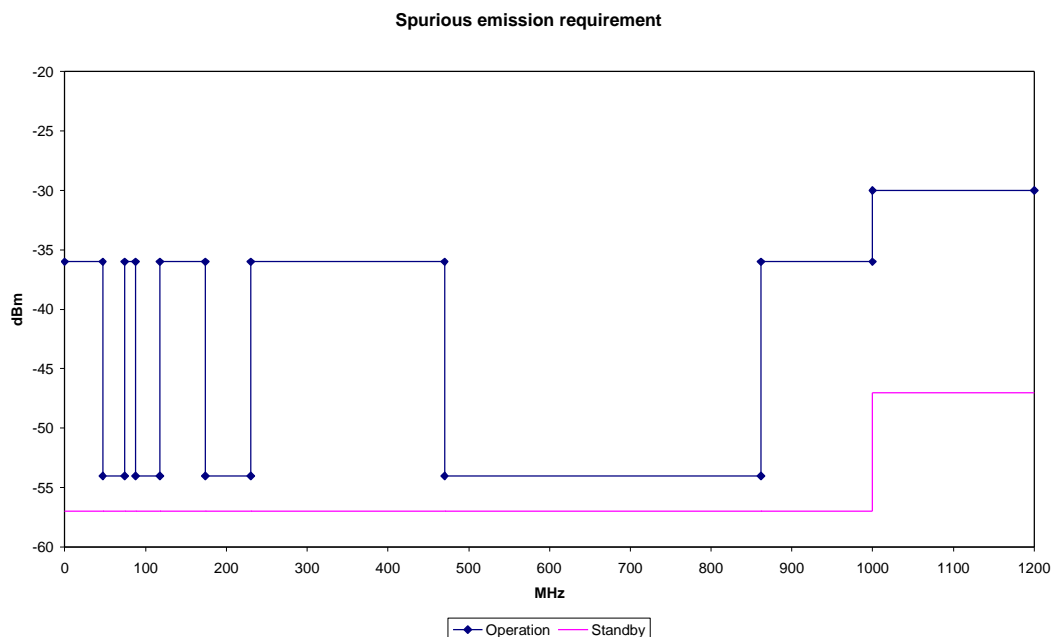
Spurious emission (section 8.7)

The spurious emission is a measurement of unwanted emitted signals. The device shall be measured without modulation applied.

If the carrier frequency is < 470 MHz the equipment shall be measured for unwanted emissions from 9kHz to 4 GHz. If the carrier frequency is >470 MHz, the upper limit is 12.75 GHz.

All spurs except emission at the intended channel and the adjacent channels shall be measured. The requirement is given in the table, and illustrated in the figure below.

State	47-74 MHz 87.5-118 MHz 174-230 MHz 470-862MHz	Other frequencies below 1000 MHz	Above 1000 MHz
Operating	4nW = -54 dBm	250nW = -36dBm	1 μ W = -30dBm
Standby	2nW = -57dBm	2nW = -57dBm	20nW = -47dBm



Frequency stability for low voltage, battery operation (section 8.8)

This requirement applies for battery operated equipment only.

The requirement is that when reducing the operating voltage to zero, the equipment should stay on the desired frequency, or cease to function altogether.

Duty cycle (section 8.9)

This requirement states the transmitter on/off ratio measured during 1 hr period. The duty cycle ratio is found in the table on page 4.

Receiver spurious radiation (section 9.1)

For equipment with integral antenna the radiated emission from the receiver shall be measured. Equipment with external antenna connector shall be measured for both conducted spurious emission and cabinet radiation.

If the carrier frequency is < 470 MHz the equipment shall be measured for unwanted emissions from 9kHz to 4 GHz. If the carrier frequency is >470 MHz, the upper limit is 12.75 GHz.

The radiation limit is given in the table below.

State	Below 1000 MHz	Above 1000 MHz
Receive	2nW = -57dBm	20nW = -47dBm

Receiver spurious response or blocking (section 9.2)

The ETSI standard does not give any mandatory requirements to receiver spurious response or blocking.

EN 300 683

This standard on electromagnetic compatibility and radio spectrum matters shall be used for testing of SRD transmitters. The complete document can be downloaded from www.etsi.fr.

The equipment shall be tested for both RF immunity and RF emission.

Test conditions

The frequencies on which SRDs are intended to operate are excluded from all the conducted and radiated RF immunity tests, and conducted and radiated emission tests of transmitters. No exclusion bands apply for receiver emission measurements.

The exclusion band for receiver immunity is +/- 5% referred to the operating frequency when used in a channelized frequency band. In a non-channelized frequency band, the exclusion band is 5% below the lower frequency and 5% above the upper frequency of the operation frequency band.

For transmitters operating in a channelized frequency band, the exclusion band is three times the maximum occupied bandwidth. For wide-band transmitters the exclusion band is twice the intended operating band.

Performance criteria

Different performance criteria are defined for different type of equipment depending on the result of too low performance; 1) physical risk to persons or goods, 2) inconvenience to persons, which simply cannot be overcome by other means, and 3) inconvenience to persons which can simply be overcome by other means (e.g. manual).

For type 1 and 2, there shall be no loss of functions during continuous phenomena, there may be loss of function during transient phenomena, but these shall be self-recoverable after the test. The performance requirement is stronger for type 1 than for type 2. For type 3, there may be loss of function during transient or continuous phenomena, but shall be recoverable by the user. There shall be no degradation of performance after the test for any of the classes.

Emission and immunity tests

Several phenomena are to be tested. The application of the tests depends on the equipment use; as base station, mobile or portable.

For emission tests the phenomena are:

- Radiated emission (from enclosure)
- Conducted emission (DC power I/O and AC mains I/O)
- Harmonic current emission (AC mains input)
- Voltage fluctuations and flicker (AC mains input)

For immunity tests the phenomena are:

- RF EM field, 80-1000 MHz (at enclosure)
- Electrostatic discharge, ESD (at enclosure)
- Fast transients, common mode (signal, DC and AC ports)
- RF common mode, 0.15-80 MHz (signal, DC and AC ports)
- Transients and surges (DC input)
- Voltage dips and interrupts (AC input)
- Surges, common and differential mode (AC input)

For portable equipment these tests are applicable: Radiated emission, RF EM field immunity and ESD.

For mobile equipment these tests are applicable: Radiated and conducted emission, RF EM immunity, ESD, RF common mode, transients and surge.

For base stations all tests apply, except transients and surges at DC input.

Emission test limits

At 10 meter measuring distance the radiated emission test limits are as given in the table below.

Frequency range	Quasi-peak
30 – 230 MHz	30 dB μ V/m
230 - 1000 MHz	37 dB μ V/m

Immunity test limits

The test level for RF EM immunity shall be 3V/m (measured unmodulated), with 80% AM modulation at 400 Hz, performed over the frequency range 80 – 1000 MHz.

The ESD test limits are +/-2kV and +/-4kV for contact discharge, and +/-2kV, +/-4kV and +/-8kV for air discharge. The ESD shall be applied to all surfaces, except the centre pin of shielded RF connectors.

Type approval and certification

All equipment intended to be used in the license-free bands has to be type approved (according to the present approval regime in Europe; see below for the new R&TTE directive). The testing of the equipment can be done by any test laboratory with the necessary measurement instruments and facilities according to the EN 300 220. They will put together a test report which should be enclosed the approval application.

Radio transmitters (or transceivers) must in addition also have an EMC certificate based on tests according to ETS 300 683.

The application for approval of radio equipment together with the test report shall be sent to the national telecommunication authorities (referred to as the “conformity assessment body”). They will also ask for a statement that an application for approval has not been lodged with any other conformity assessment bodies of a CEPT country (ref CEPT/ERC/DEC(97)10 clause 4.2.).

R&TTE Directive

From April 2000, the approval regime in the European Union for radio and telecommunication terminal equipment will be changed. The Radio Equipment and Telecommunications Terminal Equipment (R&TTE) Directive, 1999/5/EEC, replaces existing legislation around Europe and introduces a self-declaration regime similar to that used for other European directives. The directive becomes law in the EU member states from April 2000 with a one year transition period, ending April 2001, during which equipment can be approved in accordance with existing rules.

The new directive, changing to self-declaration, make the conformity assessment process quicker and more flexible, and bring radio and telecommunications equipment into line with other product types. The Low voltage and EMC directives are integrated into the new directive, so manufacturers only need to declare conformity with the new one. This new approach makes the process easier, but it also means that manufacturers take even more responsibility for the conformity of their products, as there is no third party approval authority.

There are three options for conformity assessment of radio equipment for which a harmonised standard has been applied. These are given in the directive annexes III, IV and V. That is, either by conformity assessment procedure based on internal production control plus specific apparatus tests (annex III), based on technical construction file (annex IV), or based on full quality assurance (annex V).

The marking requirements are given in the directive annex VII. They include CE marking, notified body number (if used), equipment class identifier (if defined), manufactures name, type batch and/or serial number.

The Directive itself can be found in the European Law section of the European Union's Web site: www.europa.eu.int/eur-lex/en/lif/dat/1999/en_399L0005.html

FCC Code of Federal Regulations, Title 47, Part 15

In the United States the FCC (Federal Communications Commission) is responsible for the regulation of all RF devices. RF products intended for unlicensed operation is regulated by CFR 47, Part 15. A product intended to be used for unlicensed operation has to be subject to compliance testing. If the product is approved, the FCC will issue an identification number. The final product has to be marked with a FCC identification label (ref. Part 2.925 and 2.926). The entire CFR can be downloaded from the web at www.access.gpo.gov/nara/cfr.

The specific frequency bands used for unlicensed radio equipment is regulated by section 15.231 for the 260-470 MHz band, and section 15.239 for the 902-928 MHz band.

The 260 – 470 MHz band

For the 260-470 MHz band the FCC does not only regulate the fundamental power, harmonic levels and allowed bandwidth, but also considers the data being sent, and their intended function (15.231).

Under part 15.231 it is allowed to transmit

- control or command signals,
- recognition / ID codes
- radio control signals during emergencies.

It is not allowed to

- control toys
- do continuous transmissions such as voice or video

If the transmission is activated manually, the operation must cease within 5 seconds of switch being released. If the transmission is activated automatically, it must cease within 5 seconds of activation. Periodic transmissions at regular predetermined intervals are not permitted. However, periodic polling or supervision of transmitters used in security or safety applications are allowed if the periodic rate of transmission does not exceed one transmission of not more than one second duration per hour for each transmitter.

There are some restricted bands inside the 260-470 MHz band where only spur emissions are permitted (15.205). The field strength emission level shall not exceed the limits given in the table below (15.209):

Frequency range	Quasi-peak
240 – 285 MHz	200µV/m at 3 m distance
322 – 335.4 MHz	
399.9 - 410	

The maximum fundamental field strength in the 260 – 470 MHz band is increasing proportional and linear to the operating frequency, starting at 3750 µV/m and ending at 12500 µV/m measured at 3 m distance. Since free space attenuation also increase proportionate to the frequency, the range performance is equal across the band. This equation can be used to calculate the maximum field strength for a given frequency (µV/m at 3 m):

$$E = 41.6667 f - 7083.3333 \text{ µV/m, where } f \text{ is frequency in MHz}$$

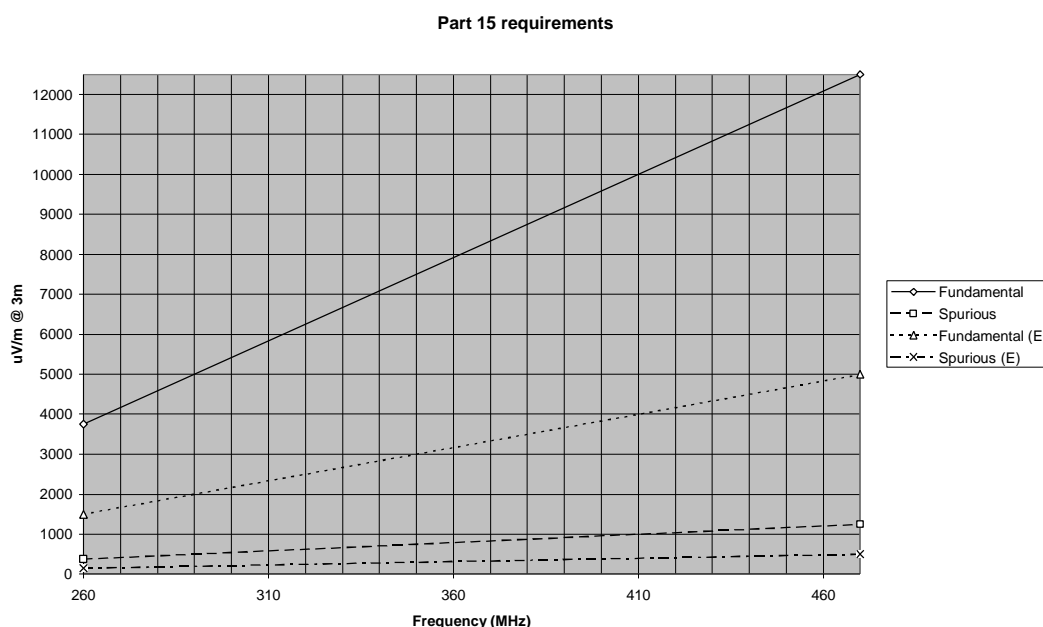
The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.

The bandwidth shall not be wider than 0.25% of the centre frequency. The bandwidth is determined at the points 20 dB down from the modulated carrier.

Devices may operate at a periodic rate exceeding that specified above, and may be employed for any type of operation, provided that (part 15.231 E):

- the fundamental field strength is reduced
- each transmission do not exceed 1 second
- minimum silent period is 30 times the duration of each transmission, but never less than 10 seconds
- The maximum fundamental field strength in the 260 – 470 MHz band is increasing proportional and linear to the operating frequency, starting at 1500 $\mu\text{V/m}$ and ending at 5000 $\mu\text{V/m}$ measured at 3 m distance, that is
 $E = 16.6667 f - 2833.3333 \mu\text{V/m}$, where f is frequency in MHz
- unwanted emission level is 20 dB below fundamental power

The field strength limits are illustrated in the figure below.



902 – 928 MHz band

Most systems at 902 – 928 MHz are certified under Part 15.249. The regulations in this band are much simpler than for the 260 – 470 MHz band. There are no restrictions that limit the applications, the content or duration of a transmission. The freedom to send analogue voice and continuous data has made this band very popular and hence also congested.

The transmitter field strength is restricted to 50mV/m at 3 meters distance. Harmonics emission is restricted to 500 $\mu\text{V/m}$ at 3 meters distance (that is -40 dBc). Spurious emission (other than harmonics) is restricted to 50 dBc.

Direct sequence and frequency hopping systems is regulated by part 15.247. Direct sequence systems must have a minimum 6 dB bandwidth of 500 kHz, minimum 10 dB processing gain and maximum 1 W output power.

Frequency hopping systems must use at least 50 hopping frequencies if the 20 dB bandwidth is < 250 kHz, having a duration of <0.4 s of a 20 s period, and maximum 1W output power. For bandwidths >250kHz, at least 25 channels must be used, having a duration of <0.4s of a 10 s period, and maximum 0.25W output power. Maximum 20 dB bandwidth is 500kHz.

Antenna restrictions

The transmitter must be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device (section 15.203). Either the antenna must be integrated, permanently attached, or a unique connector must be used. The connector could be a reverse polarity SMA.

This application note is written by the staff of Chipcon to the courtesy of our customers. Chipcon is a world-wide distributor of integrated radio transceiver chips designed to meet the requirements discussed in this application note. For further information on the products from Chipcon please contact us or visit our web site.

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