TEST REPORT # EMCC-110010.1GCB, 2019-11-27

This test report supersedes test report # EMCC-110010.1GC dated 2019-10-30

EQUIPMENT UNDER TEST:

Trade Name:	PTM 215B
EUT Number, Serial Number(s):	EUT#1, none EUT#2, none EUT#3, none
Application:	Wireless Remote Control
FCC ID:	SZV-PTM215B
IC:	5713A-PTM215B
Manufacturer:	EnOcean GmbH
Address:	Kolpingring 18 a 82041 Oberhaching GERMANY

RELEVANT STANDARD(S) : 47 CFR § 15.249
RSS-210 Issue 9 (Amendment), Annex B.10

MEASUREMENT PROCEDURE: ANSI C63.10-2013, RSS Gen Issue 5 Amendment 1

TEST REPORT PREPARED BY:

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Dominik Krüger

Ludwig Kraft

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Reinhard Sauerschell
- Head of Laboratory -

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0 REVISION HISTORY

Project number	Issue date	Chapter	Description
110010.1GC	2019-10-30	n.a.	Initial issue
110010.1GCB	2019-11-27	n.a. n.a.	Correction of FCC ID Relevant Standard and Measurement Procedure amended

1 GENERAL INFORMATION

1.1 Purpose

The purpose of this report is to show compliance with the 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10 requirements for the certification of licence – exempted Intentional Radiator.

1.2 Limits and Reservations

The test results in this report apply only to the particular equipment under test (EUT) as declared in this report. This test report shall not be reproduced except in full without the written permission of EMCCons DR. RAŠEK GmbH & Co. KG.

1.3 Test Laboratory

Test Laboratory:	EMCCons DR. RAŠEK GmbH & Co. KG
DAkkS Accreditation No.:	D-PL-12067-01-03 D-PL-12067-01-04
FCC Test Firm Registration No.:	368753
Address of Labs I, II, III and Head Office:	EMCCons DR. RAŠEK GmbH & Co. KG Boelwiese 8 91320 Ebermannstadt GERMANY
Address of Labs IV and V:	EMCCons DR. RAŠEK GmbH & Co. KG Stoernhofer Berg 15 91364 Unterleinleiter GERMANY
Phone:	+49 9194 7262-0
Fax:	+49 9194 7262-199
E-Mail:	info@emcc.de
Web:	www.emcc.de

1.4 Customer

Company Name:	EnOcean GmbH
Street:	Kolpingring 18 a
City:	82041 Oberhaching
Country:	GERMANY
Name:	Mr Darius Draksas
Phone:	+49 89 6734 689-627
Fax:	+49 89 6734 689-56
E-Mail:	darius.draksas@enocean.com

1.5 Manufacturer

Company Name:	EnOcean GmbH
Street:	Kolpingring 18 a
City:	82041 Oberhaching
Country:	GERMANY
Phone:	+49 89 6734 689-0
E-Mail:	info@enocean.com

1.6 Dates and Test Location

Date of receipt of EUT: 2019-05-21
Test Date: see list below
Test Location: Lab IV

1.7 Ordering Information

Purchase Order: 11141
Date: 2019-05-14
Vendor-Number: K701624

1.8 Climatic Conditions

Date	Temperature	Relative Humidity	Air Pressure	Lab	Customer attended tests
--	°C	%	hPa	--	--
2019-07-30	27	55	973	IV	No
2019-07-31	26	56	977	IV	No
2019-09-09	23	46	972	IV	No
2019-10-09	22	47	970	IV	No

2 PRODUCT DESCRIPTION

2.1 Equipment Under Test (EUT)

The following data is based on customer's information.

Manufacturer:	EnOcean GmbH
Trade Name:	PTM 215B
EUT No, Serial No(s):	EUT#1, none (Frequency 2402 MHz) EUT#2, none (Frequency 2426 MHz) EUT#3, none (Frequency 2480 MHz)
Application:	Wireless Remote Control
No of variants:	None
Firmware version:	V1.3.0.0
Hardware version:	DC -6
FCC ID:	SZV-PTM215B
IC:	5713A-PTM215B
Highest internal frequency:	2480 MHz
TX operating frequency range:	2402 ... 2480 MHz
Used channels during test:	Fmin: 2402 MHz Fmid: 2426 MHz Fmax: 2480 MHz
Modulation	GFSK
Power source:	External power generator (typically ECO 200)
Voltage for testing:	External 3.6 V battery
Ports:	None
Antenna:	Internal
Max. antenna gain:	n/a
Remarks:	None

2.2 Intended Use

The following information was delivered by the customer.

"

PTM 215B enables the realization of energy harvesting wireless switches for EnOcean systems communicating based on the 2.4 GHz BLE communication standard.

PTM 215B is mechanically compatible with the established PTM 21x form factor enabling quick integration into a wide range of designs. Key applications are wall-mounted or portable switches either with up to two rockers or up to four push buttons.

PTM 215B pushbutton transmitters are self-powered (no batteries) and fully maintenancefree. They can therefore be used in all environments including locations that are difficult to reach or within hermetically sealed housings. The required energy is generated by an electro-dynamic energy transducer actuated by an energy bow located on the left and right of the module. This energy bow which can be pushed from outside the module by an appropriate pushbutton or switch rocker.

When the energy bow is pushed down or released, electrical energy is created and a 2.4GHz radio telegram according to the BLE standard is transmitted. This radio telegram transmits the operating status of all four contact nipples at the moment when the energy bow was pushed down or released.

PTM 215B radio telegrams are protected with AES-128 security based on a device-unique private key.

"

2.3 EUT Peripherals/Simulators

The EUT was powered by a 3.6V battery during all tests because the use of the intended external power generator was not suitable.

2.4 Mode of operation during testing and test setup

The equipment under test (EUT) was operated during the tests under the following conditions:

Continuous Transmit:
The EUT was continuously transmitting modulated data with a duty cycle of 100 % and maximum power. This mode of operation was used for all tests.

The 3 EUTs were programmed on fixed frequencies (EUT#1 2402 MHz, EUT#2 2426 MHz, EUT#3 2480 MHz).
The EUT was tested in 3 orientations. Up to 1000 MHz (below the operation frequency) only one EUT (frequency) was tested per orientation. Above 1000 MHz each EUT (frequency) was tested in 3 orientations.

2.5 Modifications required for compliance

None.

2.6 Duty-Cycle Correction

The following calculation is based on customer's information (please refer to annex 5 for detailed information provided by customer):

According to the description delivered by customer, in worst case the EUT generates 6 events within 100 ms (press and release of the switch). One event consists of 1 telegram per channel. One telegram transmits worst case 33 bytes with a duration of 0.320 ms (9.7 µs per byte).
The resulting ON-time per channel is 6 x 0.320 ms = 1.9 ms.

For average correction purposes, a duty cycle correction factor of (1.9 ms / 100 ms) * 100 = 1.9 % was used. Expressed in logarithmic terms, the correction factor DCF is 20 x log (1.9 ms / 100 ms) = -34.4 dB.

3 TEST RESULTS SUMMARY

Summary of test results for the following EUT:

Manufacturer: EnOcean GmbH
Device: PTM 215B
EUT#, Serial No.: EUT#1, none
EUT#2, none
EUT#3, none

Requirement	47 CFR Section	RSS Section	Report Section	Tested EUT	Result
Antenna Requirement	§ 15.203	-	4.1	EUT#1 , EUT#2, EUT#3	Passed
Occupied Bandwidth	§ 15.215	RSS-Gen 6.7	4.2	EUT#1 , EUT#2, EUT#3	Passed
Radiated Field Strength of Fundamental	§ 15.249	RSS-210 Annex B.10	4.3	EUT#1 , EUT#2, EUT#3	Passed
Band Edge Compliance	§ 15.209	RSS-Gen 8.9	4.4	EUT#1 , EUT#2, EUT#3	Passed
Radiated Emissions 9kHz – 30 MHz	§ 15.209	RSS-Gen 8.9	4.5.4	EUT#1 , EUT#2, EUT#3	Passed
Radiated Emissions 30 MHz – 1000 GHz	§ 15.209	RSS-Gen 8.9	4.5.8	EUT#1 , EUT#2, EUT#3	Passed
Radiated Emissions 1 GHz – 26 GHz	§ 15.209	RSS-Gen 8.9	4.5.9 - 11	EUT#1 , EUT#2, EUT#3	Passed

N.A. – not applicable; N.T. – Not tested acc. to applicant's order.

The client has made the determination that EUT Condition, Characterization, and Mode of Operation are representative of production units and meet the requirements of the specifications referenced herein.
Consistent with Industry practice, measurement and test equipment not directly involved in obtaining measurement results but having an impact on measurements (such as cable loss, antenna factors, etc.) are factored into the "Correction Factor" documented in certain test results. Instrumentation employed for testing meets tolerances consistent with known Industry Standards and Regulations.
The measurements contained in this report were made in accordance with the procedures described in ANSI C63.10-2013 and all applicable Public Notices received prior to the date of testing.All requirements were found to be within the limits outlined in this report.

The test results in this report apply only to the particular equipment under test (EUT) as declared in this report.

Test personnel: Ludwig Kraft
Issuance date: 2019-11-27

4 DETAILED TEST RESULTS

4.1 Antenna Requirement

4.1.1 Regulation

47 CFR §15.203 Antenna requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

RSS-Gen: 6.8 Transmit Antenna

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.
For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).
When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.
The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.
For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

> This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

No applicable antenna requirement specified in RSS-210.

4.1.2 Test Result

The EUT has an integrated antenna.

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#1, none
	EUT#2, none
	EUT#3, none
Test personnel:	Ludwig Kraft

The EUT meets the requirements of this section.

4.2 Occupied Bandwidth

4.2.1 Regulation

47CFR § 15.215 Additional provisions to the general radiated emission limitations.

(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

RSS-Gen 6.7 Occupied bandwidth

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

...

No bandwidth requirement in RSS-210 B.10

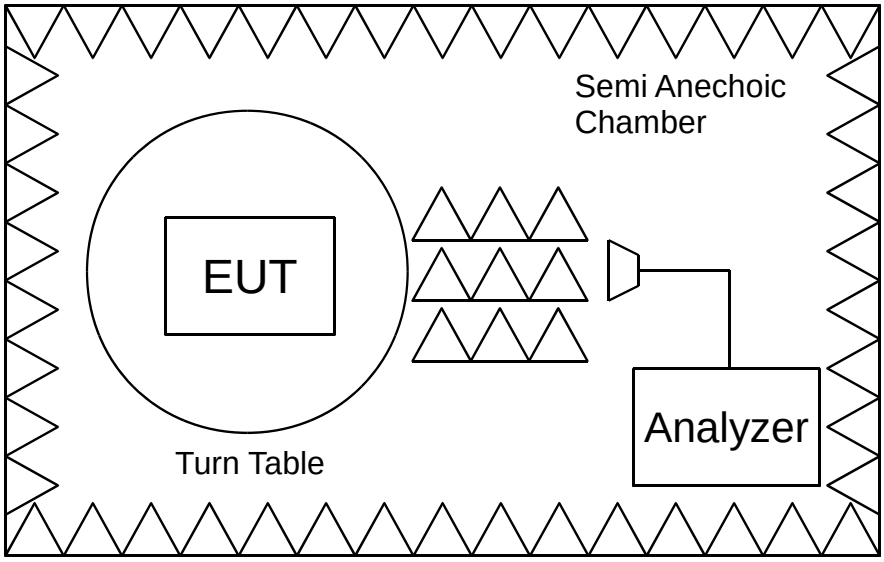
4.2.2 Test Procedures

Testing is performed acc. to ANSI C63.10-2013.

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.
b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.
c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.
d) Steps a) through c) might require iteration to adjust within the specified tolerances.
e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target "–xx dB down" requirement; that is, if the requirement calls for measuring the –20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.
f) Set detection mode to peak and trace mode to max hold.
g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).
h) Determine the "–xx dB down amplitude" using [(reference value) – xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument.
i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).
j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the "–xx dB down amplitude" determined in step h). If a marker is below this "–xx dB down amplitude" value, then it shall be as close as possible to this value. The occupied bandwidth is

the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the "–xx dB down amplitude" determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.
k) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

4.2.3 Test Setup



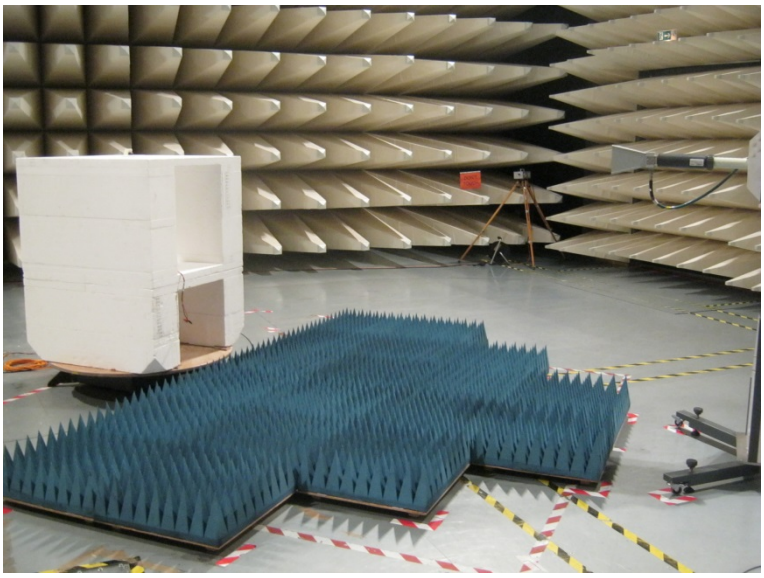
SCHEMATIC TEST SETUP

Requirement: 47 CFR, § 15.215, RSS-Gen 6.7
Procedure: ANSI C63.10-2013

Receiver: #3846
Antenna: #3236 (1 – 6 GHz)

Test Distance: 3 m

TEST EQUIPMENT USED:
Refer to chapter 5 of this document.
1889, 3236, 3846, 4075, 4717, 5392, 5535, 5536, 5545, 5616

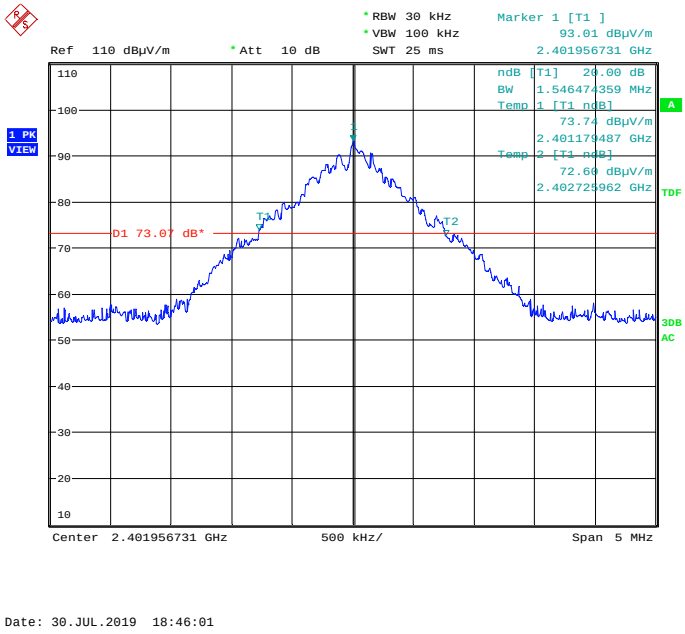


Sample photo of setup

4.2.4 Detailed Test Data

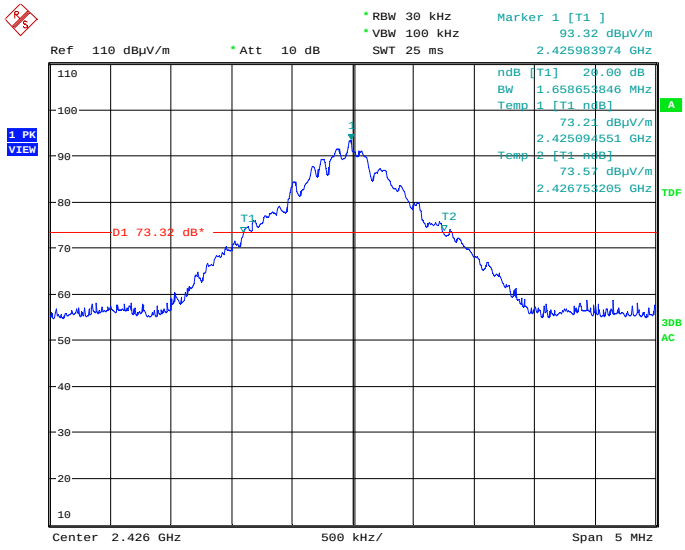
4.2.4.1 20dB Bandwidth

Manufacturer: Device: EUT No., Serial No: Frequency:	EnOcean GmbH PTM 215B EUT#1, none 2402 MHz



Date: 30.JUL.2019 18:46:01

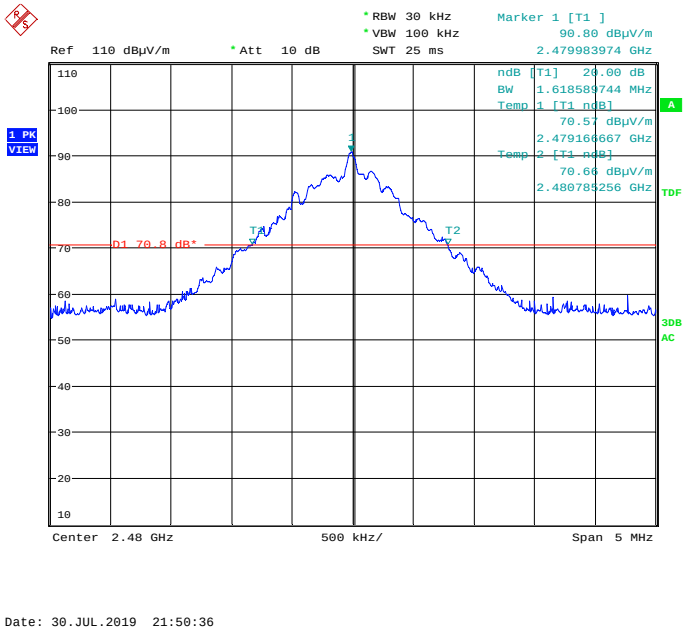
Manufacturer: Device: EUT No., Serial No: Frequency:	EnOcean GmbH PTM 215B EUT#2, none 2426 MHz



Date: 30.JUL.2019 20:36:41

Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#3, none
Frequency:	2480 MHz

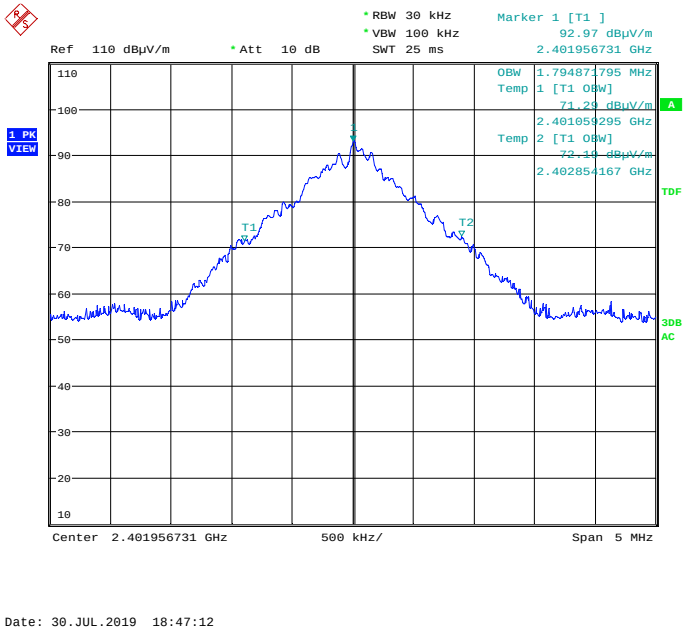


Final Result:

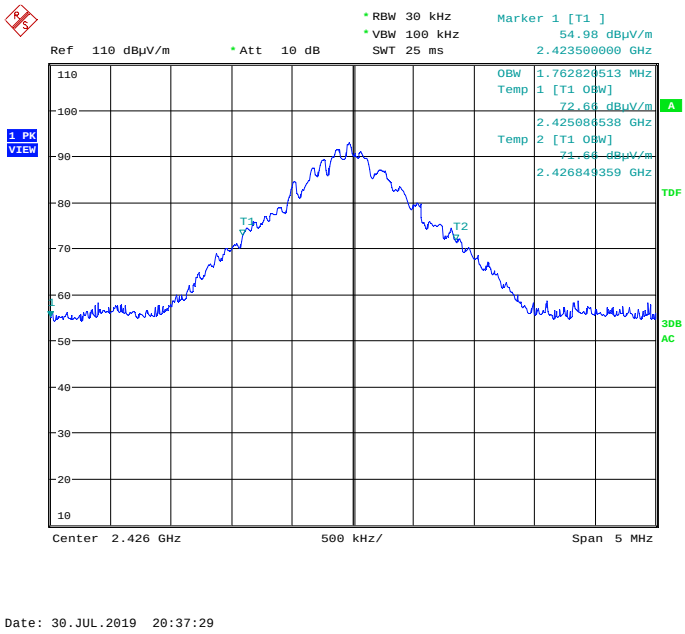
EUT	Operating Frequency (MHz)	Lower Edge (MHz)	Upper Edge (MHz)	Limit Frequency band (MHz)	20 dB Bandwidth (MHz)
#1	2402.0	2401.2	2402.7	2400 .. 2483.5	1.5
#2	2426.0	2425.1	2426.8	2400 .. 2483.5	1.7
#3	2480.0	2479.2	2480.8	2400 .. 2483.5	1.6

4.2.4.2 99% Bandwidth

Manufacturer: Device: EUT No., Serial No: Frequency:	EnOcean GmbH PTM 215B EUT#1, none 2402 MHz

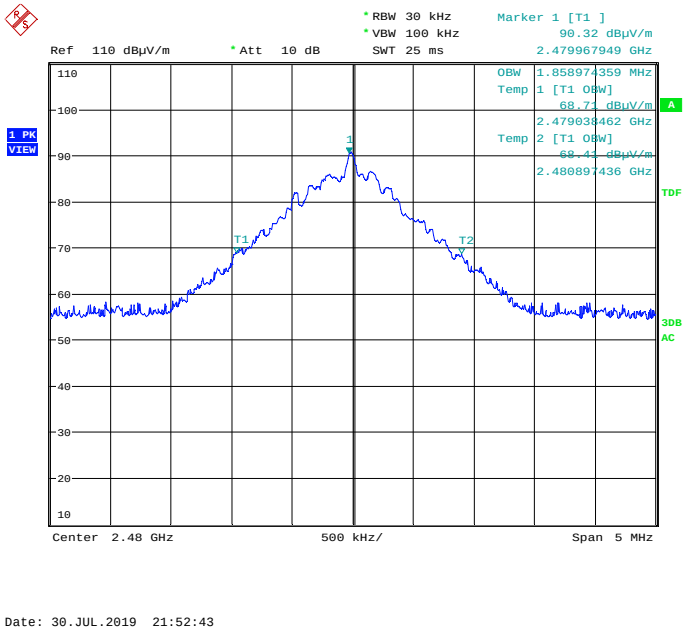


Manufacturer: Device: EUT No., Serial No: Frequency:	EnOcean GmbH PTM 215B EUT#2, none 2426 MHz



Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#3, none
Frequency:	2480 MHz



Final Result:

EUT	Operating Frequency (MHz)	Lower Edge (MHz)	Upper Edge (MHz)	Limit Frequency band (MHz)	99% Bandwidth (MHz)
#1	2402.0	2401.1	2402.9	2400 .. 2483.5	1.8
#2	2426.0	2425.1	2426.8	2400 .. 2483.5	1.7
#3	2480.0	2479.0	2480.9	2400 .. 2483.5	1.9

4.2.5 Test Result

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#1, none
	EUT#2, none
	EUT#3, none
Test date:	2019-07-30
Test personnel:	Dominik Krüger

The EUT meets the requirements of this section.

4.3 Radiated Field Strength of Fundamental

4.3.1 Regulation

47 CFR,§ 15.31

(m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

Frequency range over which device operates	Number of frequencies	Location in the range of operation
1 MHz or less	1	Middle.
1 to 10 MHz	2	1 near top and 1 near bottom.
More than 10 MHz	3	1 near top, 1 near middle and 1 near bottom.

47CFR § 15.249

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902 – 928 MHz	50	500
2400 – 2483.5 MHz	50	500
5725 – 5875 MHz	50	500
24.0 – 24.25 GHz	250	2500

(c) Field strength limits are specified at a distance of 3 meters.

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

RSS-210, Annex B.10 Bands 902–928, 2400–2483.5 and 5725–5875 MHz

Devices shall comply with the following requirements:

(a) The field strength of fundamental and harmonic emissions, measured at 3 m, shall not (a)exceed 50 mV/m and 0.5 mV/m respectively.
The field strength limits shall be measured using an average detector, except for the fundamental emission in the frequency band 902-928 MHz, which is based on measurements using an International Special Committee on Radio Interference (CISPR) quasi-peak detector.

(b) Emissions radiated outside of the specified frequency bands, except for harmonic (b)emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits listed in RSS-Gen, whichever is less stringent.

The provisions of RSS-Gen regarding pulsed operation do not apply to CISPR measurement for the band 902-928 MHz.

➔ The IC limits are equal to the FCC limits

4.3.2 Test Procedures

ANSI C63.10-2013, 6.6.4.1 General

Subclauses 6.6.4.2 and 6.6.4.3 describe the procedures that shall be used for making exploratory and final radiated emission tests for frequencies above 1 GHz. Measurements may be performed at a distance closer than that specified in the requirements; however, an attempt shall be made to avoid making measurements in the near field of both the measurement antenna and the EUT for final measurements.

In performing these measurements, the sensitivity of the complete measurement system relative to the limit shall be determined before the test. If the overall measurement sensitivity does not provide a noise floor more than 6 dB below the limit, then low-noise preamplifiers, closer test distances, higher gain antennas, or narrower bandwidths might be required. If closer measurement distances are used, then the beamwidth of the measurement antenna versus the size of the EUT shall be taken into account. Also, measurement system overload protection shall be determined to be adequate when preamplifiers are used [see item b) of 4.1.3]. The effects of using bandwidths different from those specified shall also be determined (see also 6.3). Any changes from the specific measurement conditions shall be described in the report of the measurements (see also Annex E).

Install an appropriate filter at the input of the measurement system power amplifier. This filter shall attenuate the fundamental emission of the EUT and allow an accurate measurement of the associated harmonics and spurious emissions. The filter shall be characterized, and any attenuation/loss factors shall be accounted for in the measurement results.

Data shall be recorded in peak and average detection upto the highest measurement frequency required (unless stated otherwise in the applicable requirements).

ANSI C63.10-2013, 6.6.4.3 Final radiated emissions measurements

The final measurements are performed on a site meeting the requirements of 5.2. Using the orientation and equipment arrangement of the EUT based on the measurement results found during the preliminary (exploratory) measurements per 6.6.4.2, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable), as well as the frequency and amplitude of the six highest spurious emissions relative to the limit. Emissions more than 20 dB below the limit do not need to be reported.

Measurements are performed with the EUT rotated from 0° to 360°; the antenna height scanned in accordance with 6.6.3.1, 6.6.3.2, or 6.6.3.3, as appropriate; and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Variations in cable or wire placement shall be explored to maximize the measured emissions.

The emission signal shall be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission from the EUT is measured. This may be achieved by either pointing the antenna at an angle toward the source of the emission or by testing the EUT as described in 6.6.3.3.

If the emission is pulsed, then refer to Annex C for guidelines on selecting bandwidth and determining pulse desensitization factors, as necessary.

As noted in 6.6.4.1, when performing these measurements, the sensitivity of the complete measurement system relative to the limit shall be determined before the test. If the overall measurement sensitivity is inadequate, then low-noise preamplifiers, closer measurement distances, higher gain antennas, or narrower bandwidths may be used. If closer measurement distances or higher gain antennas are used, then the beamwidth of the measurement antenna versus the physical size of the EUT shall be taken into account, so that the physical sizes of the EUT dimensions are encompassed by the beamwidth of the measurement antenna. Also, measurement system overload protection shall be determined to be adequate when preamplifiers are used. The effects on the measured emission value using bandwidths different from those specified shall be determined if such bandwidth changes are made. Any changes from the specific measurement conditions shall be described in the report of the measurements.

Unless specified otherwise by the regulatory authority, the instrumentation, detector functions, and bandwidths specified in 4.1.4.2.1 and 4.1.4.2.2 shall be used. For pulsed emissions, the procedure in 4.1.4.2.4 shall be used.

ANSI C63.10-2013, 4.1.4.2.4 Average value of pulsed emissions
Unless otherwise specified, when the radiated emission limits are expressed in terms of the average value of the emission and pulsed operation is employed, the average measurement shall be determined from the peak field strength after correcting for the worst-case duty cycle as described in 7.5. The exact method of calculating the average field strength shall be included in the test report.

ANSI C63.10-2013, 7.5 Procedure for determining the average value of pulsed emissions
Unless otherwise specified, when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 s (100 ms). In cases where the pulse train exceeds 0.1 s, the measured field strength shall be determined during a 0.1 s interval.
The following procedure is an example of how the average value may be determined. The average field strength may be found by measuring the peak pulse amplitude (in log equivalent units) and determining the duty cycle correction factor (in dB) associated with the pulse modulation as shown in Equation (10):

$$\delta(dB) = 20\log(\Delta) \qquad (10)$$

where

δ is the duty cycle correction factor (dB)

Δ is the duty cycle (dimensionless)

Radiated Emissions Test Characteristics	
Frequency range	1 GHz – 6 GHz
Test distance	3 m
Test instrumentation resolution bandwidth	1 MHz
Receive antenna height	1 m – 4 m
Receive antenna polarization	Vertical/Horizontal
Measurement chamber	Semi anechoic chamber (SAC)

4.3.3 Calculation of Field Strength Limits

E.g. radiated emissions field strength limits for the frequency band 2400 – 2483.5 MHz:

50 mV/m at 3 meters

Using the equation:

$E_{dB\mu V/m} = 20 \log (E_{\mu V/m})$

where

$E_{dB\mu V/m}$ = Field Strength in logarithmic units (in dBµV/m)

$E_{\mu V/m}$ = Field Strength in linear units (in µV/m)

A field strength limit of 50 mV/m corresponds with 94 dBµV/m.

4.3.4 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF
where
FS = Field Strength (in dBµV/m)
RA = Receiver Amplitude (in dBµV)
AF = Antenna Factor (in dB (1/m))
CF = Cable Attenuation Factor (in dB)

Assume a receiver reading of 66.4 dBµV is obtained. The Antenna Factor of 27.4 dB(1/m) and a Cable Factor of 1.5 dB are added, giving a field strength of 95.3 dBµV/m in the measurement distance. The field strength of 95.3 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

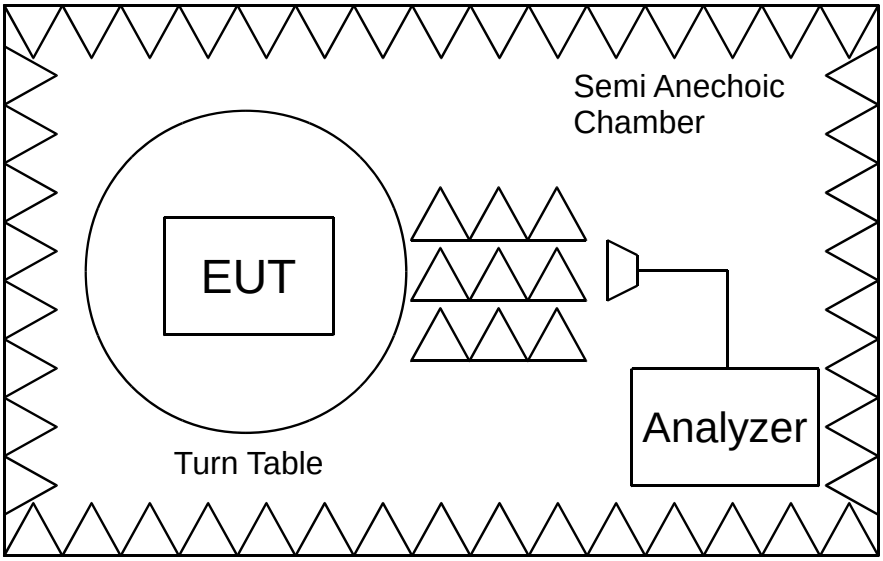
FS = 66.4 + 27.4 + 1.5 = 95.3
Level (in µV/m) = Common Antilogarithm (95.3/20) = 58210.3

For average measurements, the measured peak field strength is corrected additionally by a Duty Cycle correction factor DCF. Please refer to chapter 2.6 for details.

FSAV = FS + DCF
where
FSAV = Average Field Strength in dBµV/m
FS = Peak Field Strength in dBµV/m
DCF = Correction Factor in dB

Assuming a peak field strength of 95.3 dBµV/m, the value for the average field strength with a Duty Cycle correction factor DCF of -34.4 dB corresponds with 60.9 dBµV/m.

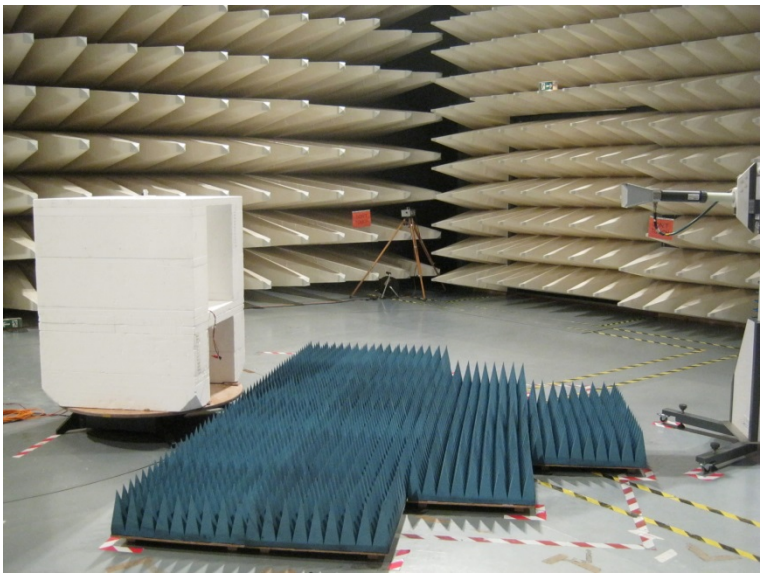
4.3.5 Test Setup



SCHEMATIC TEST SETUP

Requirement:	47 CFR, § 15.249 RSS-210, Annex B.10
Procedure:	ANSI C63.10-2013
Receiver:	#3846
Antenna:	#3236 (1 – 6 GHz)
Test distance:	3 m (1 – 6 GHz)

TEST EQUIPMENT USED:
Refer to chapter 5 of this document.
1889, 3061, 3236, 3846, 4717, 4075, 5392, 5535, 5536, 5545, 5616

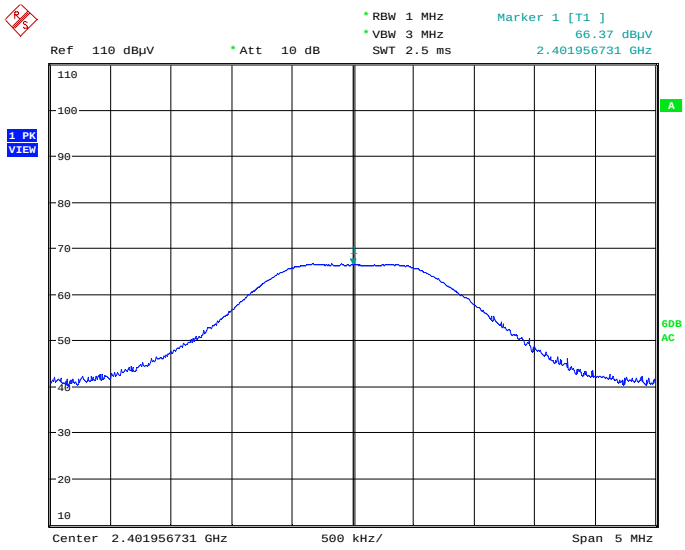


Sample photo of setup (1 – 6 GHz)

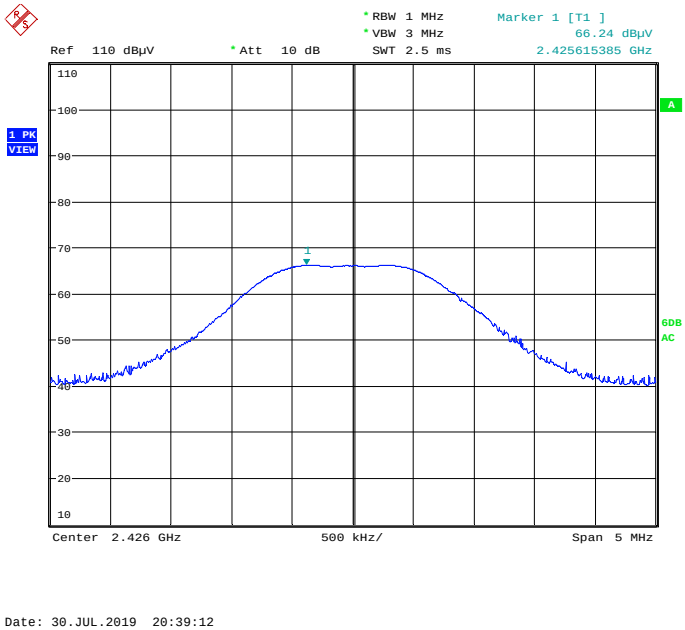
Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

4.3.6 Detailed Test Data

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#1, none
Frequency:	2402 MHz

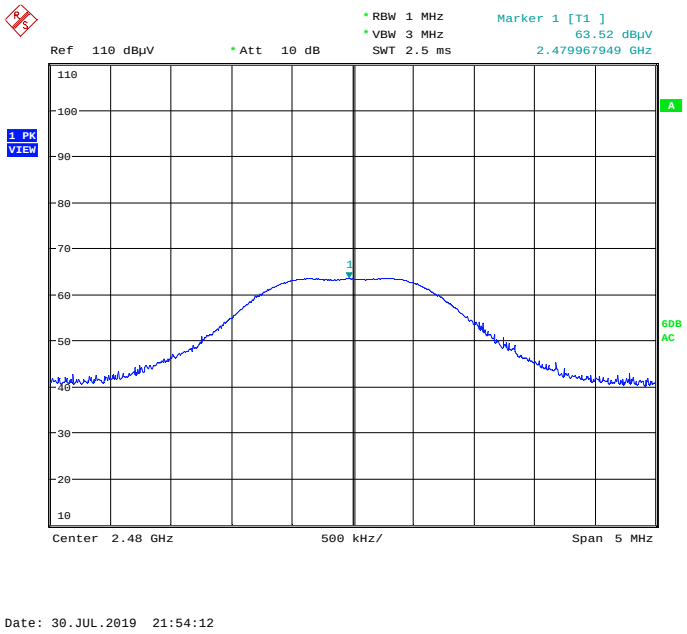


Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#2, none
Frequency:	2426 MHz



Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#3, none
Frequency:	2480 MHz



Final Result

Field Strength of Fundamental – Peak Results							
EUT	EUT Frequency (MHz)	RA Reading Pk (dBµV)	AF Antenna Factor (dB 1/m)	CF Cable Atten. (dB)	FS Result Pk (dBµV/m)	PK Limit (dBµV/m)	Margin (dB)
1	2402	66.4	27.4	1.5	95.3	114.0	18.7
2	2426	66.2	27.5	1.5	95.2	114.0	18.8
3	2480	63.5	27.5	1.5	92.5	114.0	21.5

Field Strength of Fundamental – Average Results						
EUT	EUT Frequency (MHz)	Result Pk (dBµV/m)	DCF (dB)	Result AV (dBµV/m)	Limit AV (dBµV/m)	Margin (dB)
1	2402	95.3	-34.4	60.9	94	33.1
2	2426	95.2	-34.4	60.8	94	33.2
3	2480	92.5	-34.4	58.1	94	35.9

Remark: Duty Cycle Correction Factor DCF added to peak reading to obtain average results.

All tests performed at the distance of d = 3 m.

4.3.7 Test Result

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#1, none
	EUT#2, none
	EUT#3, none
Test date:	2019-07-30
Test personnel:	Dominik Krüger

The EUT meets the requirements of this section.

4.4 Bandedge Compliance

4.4.1 Regulation

§15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	([2])
13.36-13.41			

[1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
[2] Above 38.6

(b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

47 CFR § 15.209 Radiated emission limits; general requirements.

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

47CFR § 15.249

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902 – 928 MHz	50	500
2400 – 2483.5 MHz	50	500
5725 – 5875 MHz	50	500
24.0 – 24.25 GHz	250	2500

(c) Field strength limits are specified at a distance of 3 meters.

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

RSS-210, Annex B.10 Bands 902–928, 2400–2483.5 and 5725–5875 MHz

Devices shall comply with the following requirements:

(a) The field strength of fundamental and harmonic emissions, measured at 3 m, shall not (a)exceed 50 mV/m and 0.5 mV/m respectively.
The field strength limits shall be measured using an average detector, except for the fundamental emission in the frequency band 902-928 MHz, which is based on measurements using an International Special Committee on Radio Interference (CISPR) quasi-peak detector.

(b) Emissions radiated outside of the specified frequency bands, except for harmonic (b)emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits listed in RSS-Gen, whichever is less stringent.

The provisions of RSS-Gen regarding pulsed operation do not apply to CISPR measurement for the band 902-928 MHz.

RSS-Gen, 8.9 Transmitter Emission Limits for Licence-Exempt Radio Apparatus

Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 5 – General field strength limit at frequencies above 30 MHz

Frequency (MHz)	Field strength (µV/m @ 3 m)
30-88	100
88-216	150
216-960	200
Above 960	500

RSS-Gen, 8.10 Restricted frequency bands
Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to the restricted frequency bands apply:
(a) The transmit frequency, including fundamental components of modulation, of licence-exempt radio apparatus shall not fall within the restricted frequency bands listed in table 7 except for apparatus compliant with RSS-287, Emergency Position Indicating Radio Beacons (EPIRB), Emergency Locator Transmitters (ELT), Personal Locator Beacons (PLB), and Maritime Survivor Locator Devices (MSLD).

(b) Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6.

(c) Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

Table 7 – Restricted frequency bands*

MHz	MHz	GHz
0.090 - 0.110	149.9 - 150.05	9.0 - 9.2
0.495 - 0.505	156.52475 - 156.52525	9.3 - 9.5
2.1735 - 2.1905	156.7 - 156.9	10.6 - 12.7
3.020 - 3.026	162.0125 - 167.17	13.25 - 13.4
4.125 - 4.128	167.72 - 173.2	14.47 - 14.5
4.17725 - 4.17775	240 - 285	15.35 - 16.2
4.20725 - 4.20775	322 - 335.4	17.7 - 21.4
5.677 - 5.683	399.9 - 410	22.01 - 23.12
6.215 - 6.218	608 - 614	23.6 - 24.0
6.26775 - 6.26825	960 - 1427	31.2 - 31.8
6.31175 - 6.31225	1435 - 1626.5	36.43 - 36.5
8.291 - 8.294	1645.5 - 1646.5	Above 38.6
8.362 - 8.366	1660 - 1710	
8.37625 - 8.38675	1718.8 - 1722.2	
8.41425 - 8.41475	2200 - 2300	
12.29 - 12.293	2310 - 2390	
12.51975 - 12.52025	2483.5 - 2500	
12.57675 - 12.57725	2655 - 2900	
13.36 - 13.41	3260 - 3267	
16.42 - 16.423	3332 - 3339	
16.69475 - 16.69525	3345.8 - 3358	
16.80425 - 16.80475	3500 - 4400	
25.5 - 25.67	4500 - 5150	
37.5 - 38.25	5350 - 5460	

MHz	MHz	GHz
73 - 74.6	7250 - 7750	
74.8 - 75.2	8025 - 8500	
108 - 138	--	

* Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

4.4.2 Test Procedure

ANSI C63.10-2013, 6.10.4 Authorized-band band-edge measurements (relative method)

These procedures are applicable for determining compliance at authorized-band band-edges where the requirements are expressed as a value relative to the in-band signal level. Procedures for determining compliance with field strength limits at or close to the band-edges are given in 6.10.6 (see also Table A.2).

[..]When performing radiated measurements, the measurement antenna(s) shall meet the specifications in 4.3. The EUT shall be connected to an antenna and operated at the highest power settings following procedures in 6.3.

For other than frequency-hopping devices, this test sequence shall be performed once. For devices that support frequency hopping, this test sequence shall be performed twice: once with the hopping function turned OFF and then repeated with the hopping function turned ON. The purpose of the test with the hopping function turned on is to confirm that the RF power remains OFF while the device is changing frequencies, and that the oscillator stabilizes at the new frequency before RF power is turned back ON. Overshoot of any oscillator, including phase-lock-loop stabilized oscillators, can cause the device to be temporarily tuned to frequencies outside the authorized band, and it is important that no transmissions occur during such temporary periods. Particular attention to the hopping sequence requirements specified below is needed in the case of adaptive frequency-hopping devices:

a) Connect the EMI receiver or spectrum analyzer to the EUT using an appropriate RF cable connected to the EUT output. Configure the spectrum analyzer settings as described in step e) (be sure to enter all losses between the unlicensed wireless device output and the spectrum analyzer).

b) Set the EUT to the lowest frequency channel (for the hopping on test, the hopping sequence shall include the lowest frequency channel).

c) Set the EUT to operate at maximum output power and 100% duty cycle, or equivalent “normal mode of operation” as specified in 6.10.3.

d) If using the radiated method, then use the applicable procedure(s) of 6.4, 6.5, or 6.6, and orient the EUT and measurement antenna positions to produce the highest emission level.

e) Perform the test as follows:

1) Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.

2) Reference level: As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

3) Attenuation: Auto (at least 10 dB preferred).

4) Sweep time: Coupled.

5) Resolution bandwidth: 100 kHz.

6) Video bandwidth: 300 kHz.

7) Detector: Peak.

8) Trace: Max hold.

f) Allow the trace to stabilize. For the test with the hopping function turned ON, this can take several minutes to achieve a reasonable probability of intercepting any emissions due to oscillator overshoot.

g) Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.

h) Repeat step c) through step e) for every applicable modulation.

i) Set the EUT to the highest frequency channel (for the hopping on test, the hopping sequence shall include the highest frequency channel) and repeat step c) through step d).

j) The band-edge measurement shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

Note 56: See specification for spread spectrum device operation under 47 CFR 15.247 and RSS-210 Annex 8; otherwise, per applicable regulation.

ANSI C63.10-2013, 6.10.5 Restricted-band band-edge measurements

The following test methodology shall be used for the restricted-band band-edge measurements:

a) For frequency-hopping systems, the hopping shall be turned OFF during this test.

b) Configure the spectrum analyzer settings as described in step e) (be sure to enter all losses between the unlicensed wireless device output and the spectrum analyzer).

c) Set the unlicensed wireless device to the lowest frequency channel.

d) Set the unlicensed wireless device to operate at maximum output power and 100% duty cycle, or equivalent “normal mode of operation” as specified in 6.10.3.
e) Perform the test as follows:
1) Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.
2) Reference level offset: Corrected for gains and losses of test antenna factor, preamp gain and cable loss, so as to indicate field strength, in units of dBµV/m at 3 m, directly on the instrument display. Alternatively, the reference level offset may be set to zero and calculations shall be provided showing the conversion of raw measured data to the field strength in dBµV/m at 3 m.
3) Reference level: As required to keep the signal from exceeding the maximum spectrum analyzer input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.
4) Attenuation: Auto (at least 10 dB preferred).
5) Sweep time: Coupled.
6) Resolution bandwidth:
iv) Above 1 GHz: 1 MHz
7) Video bandwidth:
i) VBW for Peak, Quasi-peak, or Average Detector Function: 3 × RBW
ii) VBW for alternative average measurements using peak detector function; refer to 4.1.4.2.3
8) Detector (unless specified otherwise):
ii) Peak and average above 1 GHz
9) Trace: Max hold for final measurement; a combination of two traces, clear-write and max hold, is recommended for maximizing the emission.
f) Using the applicable procedure(s) of 6.4, 6.5, or 6.6, orient the EUT and measurement antenna positions to produce the highest emission level.
g) Set the marker on the emission at the restricted band edge, or on the highest modulation product within the restricted band, if this level is greater than that at the band edge.
h) Repeat step d) through step g) for every applicable modulation.
i) Repeat step d) through step h) for the highest gain of each type of antenna to be used with the EUT.
j) Set the EUT to the highest frequency channel and repeat step d) through step i).
k) The band-edge measurement shall be reported by providing plot(s) of the measuring instrument display; the axes and the scale units per division shall be clearly labelled. Tabular data may be reported in addition to the plot(s).

4.4.3 Calculation of Field Strength Limits

E.g. general field strength limits above 960 MHz:

500 µV/m at 3 meters

Using the equation:

$E_{dB\mu V/m} = 20 \log (E_{\mu V/m})$

where

$E_{dB\mu V/m}$ = Field Strength in logarithmic units (in dBµV/m)

$E_{\mu V/m}$ = Field Strength in linear units (in µV/m)

A field strength limit of 500 µV/m corresponds with 54 dBµV/m.

4.4.4 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF
where
FS = Field Strength (in dBµV/m)
RA = Receiver Amplitude (in dBµV)
AF = Antenna Factor (in dB (1/m))
CF = Cable Attenuation Factor (in dB)

Assume a receiver reading of 33.3 dBµV is obtained. The Antenna Factor of 27.4 dB(1/m) and a Cable Factor of 1.5 dB are added, giving a field strength of 62.5 dBµV/m in the measurement distance. The field strength of 62.5 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = 33.2 + 27.4 + 1.5 = 62.5
Level (in µV/m) = Common Antilogarithm (62.5/20) = 1333.5

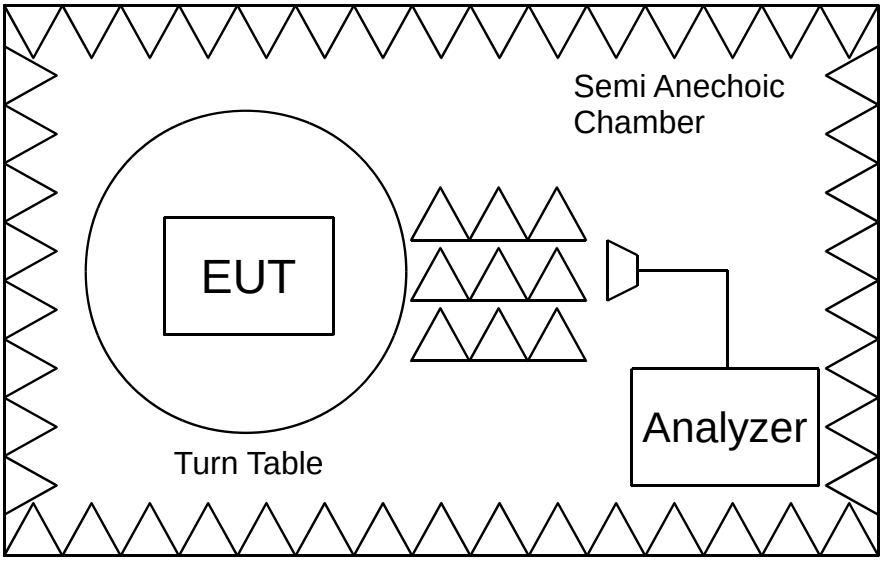
All emission measurements described in this chapter performed using the EMI receiver's transducer factor setting capability, i.e. the peak field strength value at the test distance was measured directly without the necessity of additional correction factors.

For average measurements, the measured peak field strength is corrected additionally by a Duty Cycle correction factor DCF. Please refer to chapter 2.6 for details.

FSAV = FS + DCF
where
FSAV = Average Field Strength in dBµV/m
FS = Peak Field Strength in dBµV/m
DCF = Correction Factor in dB

Assuming a peak field strength of 62.5 dBµV/m, the value for the average field strength with a Duty Cycle correction factor DCF of -34.4 dB corresponds with 28.1 dBµV/m.

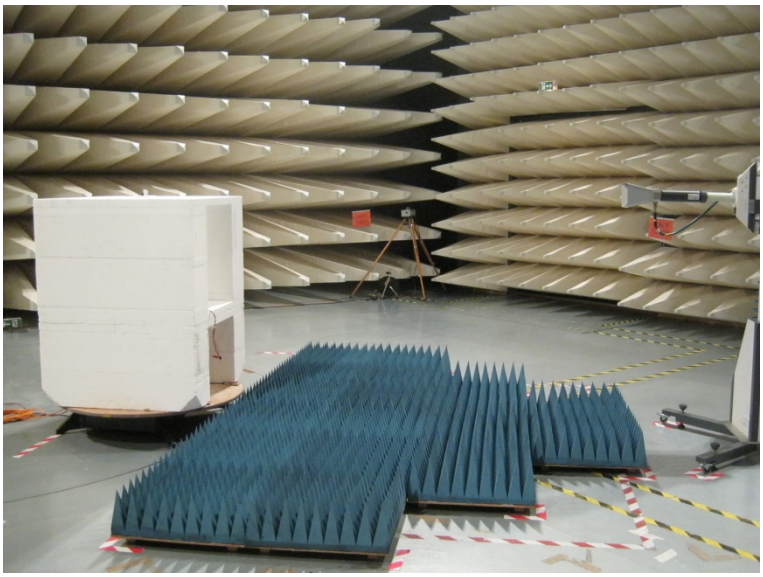
4.4.5 Test Setup



SCHEMATIC TEST SETUP

Requirement:	47 CFR, § 15.249 RSS-210, Annex B.10
Procedure:	ANSI C63.10-2013
Receiver:	#3846
Antenna:	#3236 (1 – 6 GHz)
Test distance:	3 m (1 – 6 GHz)

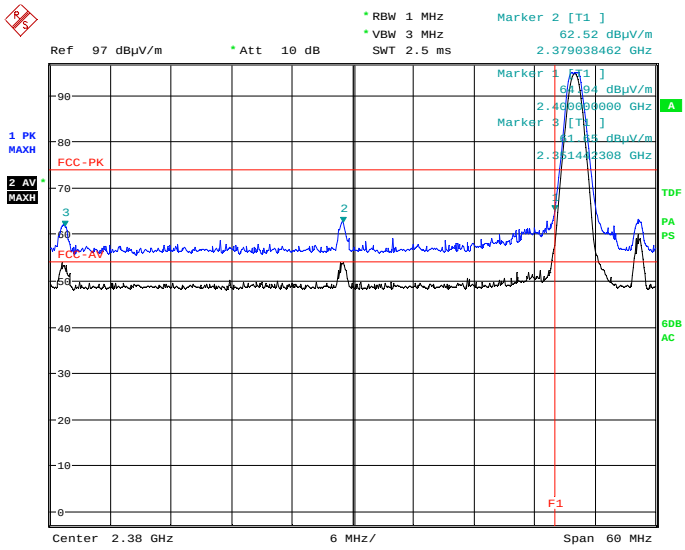
TEST EQUIPMENT USED:
Refer to chapter 5 of this document.
1889, 3061, 3236, 3846, 4717, 4075, 5392, 5535, 5536, 5545, 5616



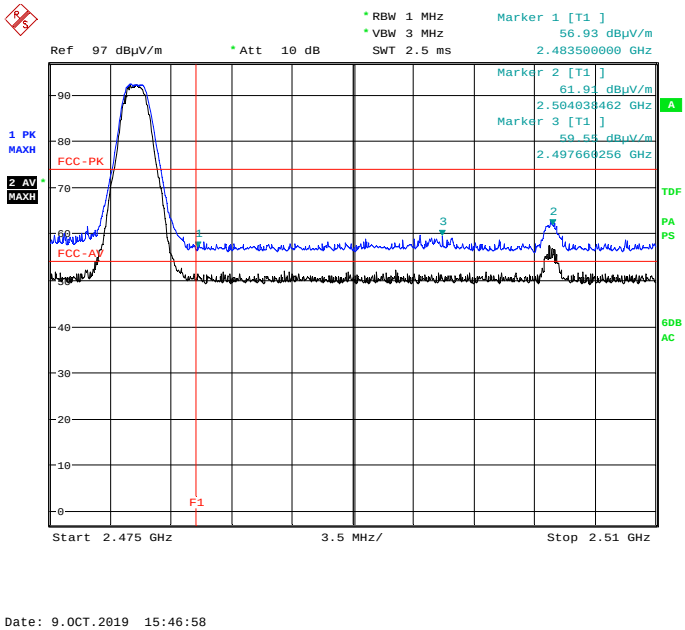
Sample photo of setup (1 – 6 GHz)

4.4.6 Detailed Test Data

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#1, none
Frequency:	2402 MHz



Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#3, none
Frequency:	2480 MHz



Note The trancducer factor (TDF) contains the Antenna Factor (AF) and the Cable Attenuation Factor (CF)

Final Result

Bandedge – Average Results							
EUT	EUT Frequency (MHz)	Frequency (MHz)	Peak Reading (dBµV/m)	DCF (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1	2402	2400.0	64.9	-34.4	30.5	54	23.5
1	2402	2379.0	62.5	-34.4	28.1	54	26.9
1	2402	2331.4	61.1	-34.4	26.7	54	27.3
3	2480	2483.5	56.9	-34.4	22.5	54	31.5
3	2480	2504.0	61.9	-34.4	27.5	54	26.5

Remark: The Peak reading includes the transducer factor (TDF), therefore no additional correction is needed.
Duty Cycle Correction Factor DCF added to peak reading to obtain average results.

Bandedge – Peak Results							
EUT	EUT Frequency (MHz)	Frequency (MHz)	Peak Reading (dBµV/m)	DCF (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1	2402	2400.0	64.9	n.a.	64.9	74	9.1
1	2402	2379.0	62.5	n.a.	62.5	74	11.5
1	2402	2331.4	61.1	n.a.	61.1	74	12.9
3	2480	2483.5	56.9	n.a	56.9	74	17.1
3	2480	2504.0	61.9	n.a	61.9	74	12.1

All tests performed at the distance of d = 3 m.

4.4.7 Test Result

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#1, none
	EUT#2, none
	EUT#3, none
Test date:	2019-10-09
Test personnel:	Dominik Krüger

The EUT meets the requirements of this section.

4.5 Radiated Emissions

4.5.1 Regulation

47 CFR,§ 15.31

(f)(2) At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). This paragraph (f) shall not apply to Access BPL devices operating below 30 MHz.

(m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

Frequency range over which device operates	Number of frequencies	Location in the range of operation
1 MHz or less	1	Middle.
1 to 10 MHz	2	1 near top and 1 near bottom.
More than 10 MHz	3	1 near top, 1 near middle and 1 near bottom.

47CFR § 15.33 Frequency range of radiated measurements

(a) For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:
(1) If the intentional radiator operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(2) If the intentional radiator operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.
(3) If the intentional radiator operates at or above 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 200 GHz, whichever is lower, unless specified otherwise elsewhere in the rules.
(4) If the intentional radiator contains a digital device, regardless of whether this digital device controls the functions of the intentional radiator or the digital device is used for additional control or function purposes other than to enable the operation of the intentional radiator, the frequency range shall be investigated up to the range specified in paragraphs (a)(1) through (a)(3) of this section or the range applicable to the digital device, as shown in paragraph (b)(1) of this section, whichever is the higher frequency range of investigation.

47 CFR § 15.35 Measurement detector functions and bandwidths.

(a) On any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrumentation using the CISPR quasi-peak detector can be found in ANSI C63.4-2014, clause 4 (incorporated by reference, see §15.38). As an alternative to CISPR quasi-peak measurements, the responsible party, at its option, may demonstrate compliance with the emission limits using measuring equipment employing a peak detector function as long at the same bandwidth as indicated for CISPR quasi-peak measurements are employed.
(b) Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz. When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, e.g., see §§15.250,

15.252, 15.253(d), 15.255, 15.256, and 15.509 through 15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device, e.g., the total peak power level. Note that the use of a pulse desensitization correction factor may be needed to determine the total peak emission level. The instruction manual or application note for the measurement instrument should be consulted for determining pulse desensitization factors, as necessary.

§15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	([2])
13.36-13.41			

[1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
[2] Above 38.6

(b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

47 CFR § 15.209 Radiated emission limits; general requirements.

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

(e) The provisions in §§15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

47 CFR, § 15.249

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

RSS-210, Annex B.10 Bands 902–928, 2400–2483.5 and 5725–5875 MHz

Devices shall comply with the following requirements:
(a)The field strength of fundamental and harmonic emissions, measured at 3 m, shall not exceed 50 mV/m and 0.5 mV/m respectively.

The field strength limits shall be measured using an average detector, except for the fundamental emission in the frequency band 902-928 MHz, which is based on measurements using an International Special Committee on Radio Interference (CISPR) quasi-peak detector.
(b) Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits listed in RSS-Gen, whichever is less stringent.
The provisions of RSS-Gen regarding pulsed operation do not apply to CISPR measurement for the band 902-928 MHz.

RSS-Gen, 8.9 Transmitter Emission Limits for Licence-Exempt Radio Apparatus

Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 5 – General field strength limit at frequencies above 30 MHz

Frequency (MHz)	Field strength (µV/m @ 3 m)
30-88	100
88-216	150
216-960	200
Above 960	500

Table 6 – General field strength limit at frequencies above 30 MHz

Frequency	Magnetic field strength (H-Field) (µA/m)	Measurement distance (m)
9 - 490 kHz [1]	6.37/F (F in kHz)	300
490 – 1705 kHz	63.7/F (F in kHz)	30
1.705 – 30 MHz	0.08	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

➔ IC limits for magnetic field strength were converted to µV/m, see calculation in 4.5.2

RSS-Gen, 8.10 Restricted frequency bands
Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to the restricted frequency bands apply:
(a) The transmit frequency, including fundamental components of modulation, of licence-exempt radio apparatus shall not fall within the restricted frequency bands listed in table 7 except for apparatus compliant with RSS-287, Emergency Position Indicating Radio Beacons (EPIRB), Emergency Locator Transmitters (ELT), Personal Locator Beacons (PLB), and Maritime Survivor Locator Devices (MSLD).

(b) Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6.

(c) Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

Table 7 – Restricted frequency bands*

MHz	MHz	GHz
0.090 - 0.110	149.9 - 150.05	9.0 - 9.2
0.495 - 0.505	156.52475 - 156.52525	9.3 - 9.5
2.1735 - 2.1905	156.7 - 156.9	10.6 - 12.7
3.020 - 3.026	162.0125 - 167.17	13.25 - 13.4
4.125 - 4.128	167.72 - 173.2	14.47 - 14.5
4.17725 - 4.17775	240 - 285	15.35 - 16.2
4.20725 - 4.20775	322 - 335.4	17.7 - 21.4
5.677 - 5.683	399.9 - 410	22.01 - 23.12
6.215 - 6.218	608 - 614	23.6 - 24.0

MHz	MHz	GHz
6.26775 - 6.26825	960 - 1427	31.2 - 31.8
6.31175 - 6.31225	1435 - 1626.5	36.43 - 36.5
8.291 - 8.294	1645.5 - 1646.5	Above 38.6
8.362 - 8.366	1660 - 1710	
8.37625 - 8.38675	1718.8 - 1722.2	
8.41425 - 8.41475	2200 - 2300	
12.29 - 12.293	2310 - 2390	
12.51975 - 12.52025	2483.5 - 2500	
12.57675 - 12.57725	2655 - 2900	
13.36 - 13.41	3260 - 3267	
16.42 - 16.423	3332 - 3339	
16.69475 - 16.69525	3345.8 - 3358	
16.80425 - 16.80475	3500 - 4400	
25.5 - 25.67	4500 - 5150	
37.5 - 38.25	5350 - 5460	
73 - 74.6	7250 - 7750	
74.8 - 75.2	8025 - 8500	
108 - 138	--	

* Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

4.5.2 Calculation of Field Strength Limits

RSS Gen limit in µA/m were converted to µV/m by using the equation:

$E_{dB\mu V/m} = H_{\mu A/m}$ x 377 Ω

Example: 0.08 µA/m x 377 = 30.2 µV/m

E.g. radiated emissions field strength limits for the frequency band 1.705 - 30 MHz:

30 µV/m at 30 meters

Using the equation:

$E_{dB\mu V/m} = 20 \log (E_{\mu V/m})$

where

$E_{dB\mu V/m}$ = Field Strength in logarithmic units (in dBµV/m)

$E_{\mu V/m}$ = Field Strength in linear units (in µV/m)

A field strength limit of 30 µV/m corresponds with 29.5 dBµV/m.

Distance correction (limit)
Remark: The preferred method is the correction of the measured field strength (refer to 4.2.3) instead of limit correction. Only one correction method shall be applied to a particular measurement.

For radiated emission from 9 kHz to 30 MHz the prescan limit was adjusted by a Distance Extrapolation Factor DF of 40 dB per decade, which is calculated by the following equation:

$DF = 40 \log (D_{test}/D_{specification})$
where

DF = Distance Extrapolation Factor (in dB)

D_{test} = Distance, where measurement was performed (in m)

$D_{specification}$ = Distance acc. to specification (in m)

Example: Assume a limit specified in 30 m and a measurement performed at 3 m: The distance correction factor is 40 log (30 / 3) = 40 dB. This factor is mathematically added to the limit by the following equation:
$E_{dB\mu V/m\_new} = E_{dB\mu V/m} + DF$
where

$E_{dB\mu V/m}$ = Field Strength limit in logarithmic units (in dBµV/m)

$E_{dB\mu V/m\_new}$ = Corrected Field Strength limit in logarithmic units (in dBµV/m)

DF = Distance Extrapolation Factor (in dB)

Example: Assume a limit of 29.5 dBµV/m specified in 30 m distance and the measurement performed at 3 m. The limit is adjusted by the distance correction factor of 40 dB to the new limit of 69.5 dBµV/m.

4.5.3 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF
where
FS = Field Strength (in dBµV/m)
RA = Receiver Amplitude (in dBµV)
AF = Antenna Factor (in dB (1/m))
CF = Cable Attenuation Factor (in dB)

Assume a receiver reading of 30 dBµV is obtained. The Antenna Factor of 10 dB(1/m) and a Cable Factor of 1.2 dB are added, giving a field strength of 41.2 dBµV/m in the measurement distance. The field strength of 41.2 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = 30 + 10 + 1.2 = 41.2
Level (in µV/m) = Common Antilogarithm (41.2/20) = 114.8

Distance correction (field strength)
Remark: The preferred method is the correction of the measured field strength instead of limit correction (refer to 4.2.2). Only one correction method shall be applied to a particular measurement..

If a measurement is performed at a different distance other than specified, the field strength at the specified distance can be obtained by the following equation:

$FS_{Dspecified} = FS_{Dtest} + 20 \log (D_{test}/D_{specified})$
where
$FS_{Dspecified}$ = Field Strength at specified distance $D_{specified}$ (in dBµV/m)
FS_{DTest} = Field Strength at specified distance D_{Test} (in dBµV/m)
D_{test} = Measurement distance where test was performed (in m)
$D_{specified}$ = Measurement distance as specified by the rules (in m)

Assuming a recorded field strength of 41.2 dBµV/m in a distance of 1 m. If the rules are specifying a limit in a distance of 3 m, the field strength recorded in 1 m is corrected by the distance. Therefore, the field strength $FS_{Dspecified}$ is 41.2 + 20 log (1 / 3) = 31.7 (in dBµV/m).
Remark: Using EMC32 software corrections are combined in the Corr. Factor as listed in the results' table.
"Result" represents the FS Result, "Corr." is the combined correction factor.

4.5.4 Radiated Emissions 9 kHz – 30 MHz

4.5.4.1 Test Procedures

ANSI C63.10-2013, 6.4.3 Measuring antenna selection, location, and test distance
Radiated emission tests shall be performed in the frequency range of 9 kHz to 30 MHz, using a calibrated loop antenna as specified in 4.3.2, at a suitable site and measurement distance as specified in 5.3. This method is applicable for measuring radiated RF emissions from all units, cables, power cords, and interconnect cabling or wiring of the EUT, by applying the guidance provided in 5.10 along with guidance provided subsequently.

ANSI C63.10-2013, 6.4.6 Exploratory radiated emission tests
The tests shall be performed in the frequency range specified in 5.5 and 5.6, using the procedures in Clause 5, applying the appropriate modulating signal to the EUT, to determine cable or wire positions of the EUT system that produce the emission with the highest amplitude relative to the limit.
Exploratory measurements below 30 MHz are useful in determining the maximum level of emissions while manipulating and rotating the EUT; however, exploratory and final measurements may be made concurrently, provided care is taken to determine the maximum level of emissions for all configurations and orientations.
The test arrangement, measuring antenna guidelines and operational configurations in 6.3.1 and 6.3.2, shall be followed.
The measurement antenna shall be positioned with its plane perpendicular to the ground at the specified distance.
When perpendicular to the ground plane, the lowest height of the magnetic antenna shall be 1 m above the ground and shall be positioned at the specified distance from the EUT. When the EUT contains a loop antenna that can only be placed in a vertical axis, normal measurements shall be made aligning the measurement antenna along the site axis, and then orthogonal to the axis. For each measurement antenna alignment, the EUT shall be rotated through 0° to 360° on a turntable. When the EUT contains a loop antenna that can be placed in a horizontal or vertical axis, normal measurements shall be made aligning the measurement antenna along the site axis, orthogonal to the axis, and then with the measurement antenna horizontal. For each measurement antenna alignment, the EUT shall be rotated through 0° to 360° on a turntable. The report shall list the six emissions with the smallest margin relative to the limit, for each of the three antenna orientations (parallel, perpendicular, and ground-parallel) unless the margin is greater than 20 dB, then the following statement shall be made: “all emissions were greater than 20 dB below the limit.”

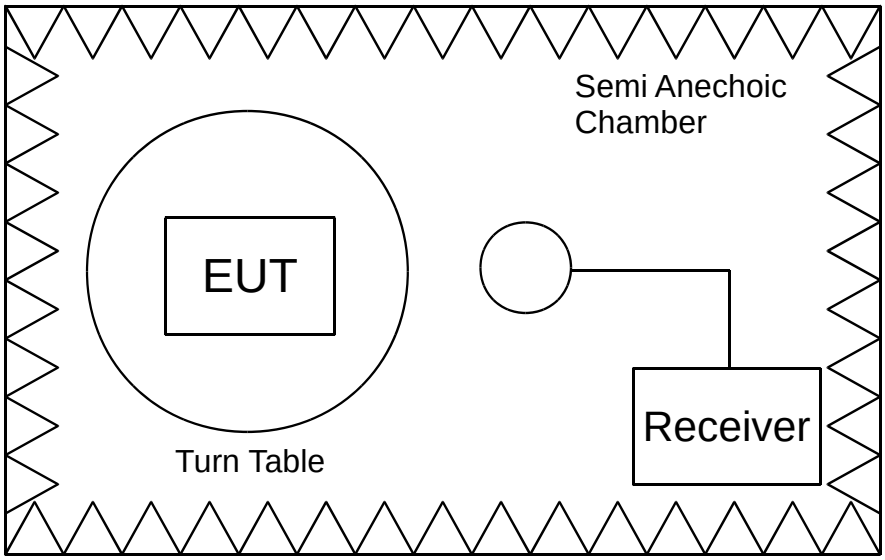
ANSI C63.10-2013, 6.4.7 Final radiated emission tests
Using the orientation and equipment arrangement of the EUT determined in 6.4.6, and applying the appropriate modulating signal to the EUT, perform final radiated emission measurements on the fundamental and highest spurious emissions.
Unless otherwise specified by the regulatory authority, the instrumentation, detector functions, and bandwidths specified in 4.1.4.2.1 shall be used. For pulsed emissions, the procedure in 4.1.4.2.4 shall be used.

Radiated Emissions Test Characteristics	
Frequency range	9 kHz – 30 MHz
Test distance	3 m
Test instrumentation resolution bandwidth	200 Hz (< 150 kHz) 9 kHz (≥ 150 kHz)
Receive antenna height	1 m
Receive antenna orientations	2
Measurement chamber	Semi anechoic chamber (SAC)

Following the test procedure described in KDB 414788, an open field measurement has to be performed in addition to the measurements performed in a semi anechoic chamber to evaluate a correction of the open field measurement to the semi-anechoic chamber measurement.
Hence laboratory experience has shown, that the correction factor is always negative, resulting in a lower level at the open field, these open field measurements are omitted, if there are all measurement emissions more than 20 dB below the limit.

As there was no emission identified the EUT was measured in 3 orientation one with Fmin, one with Fmid, and one with Fmax.

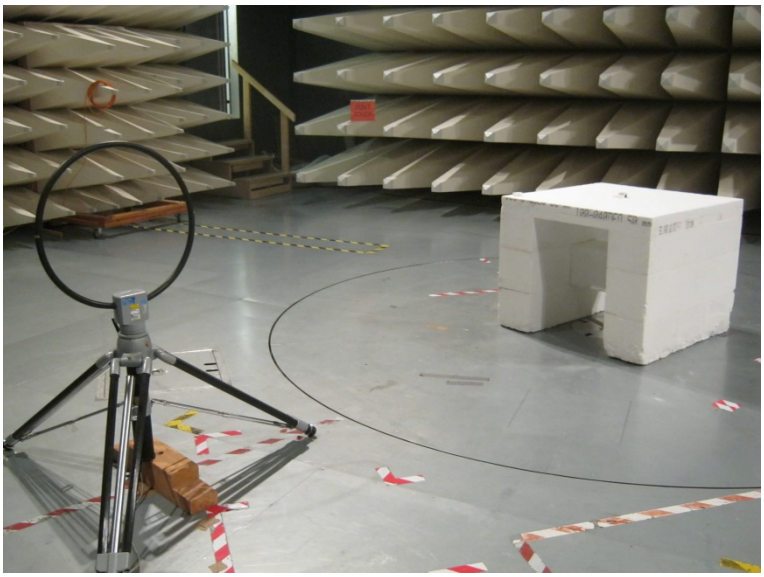
4.5.5 Test Setup



SCHEMATIC TEST SETUP

Requirement:	47 CFR, § 15.209 RSS-210, Annex B.10 RSS-Gen
Procedure:	ANSI C63.10-2013
Receiver:	#3846
Antenna:	#374
Test distance:	3 m

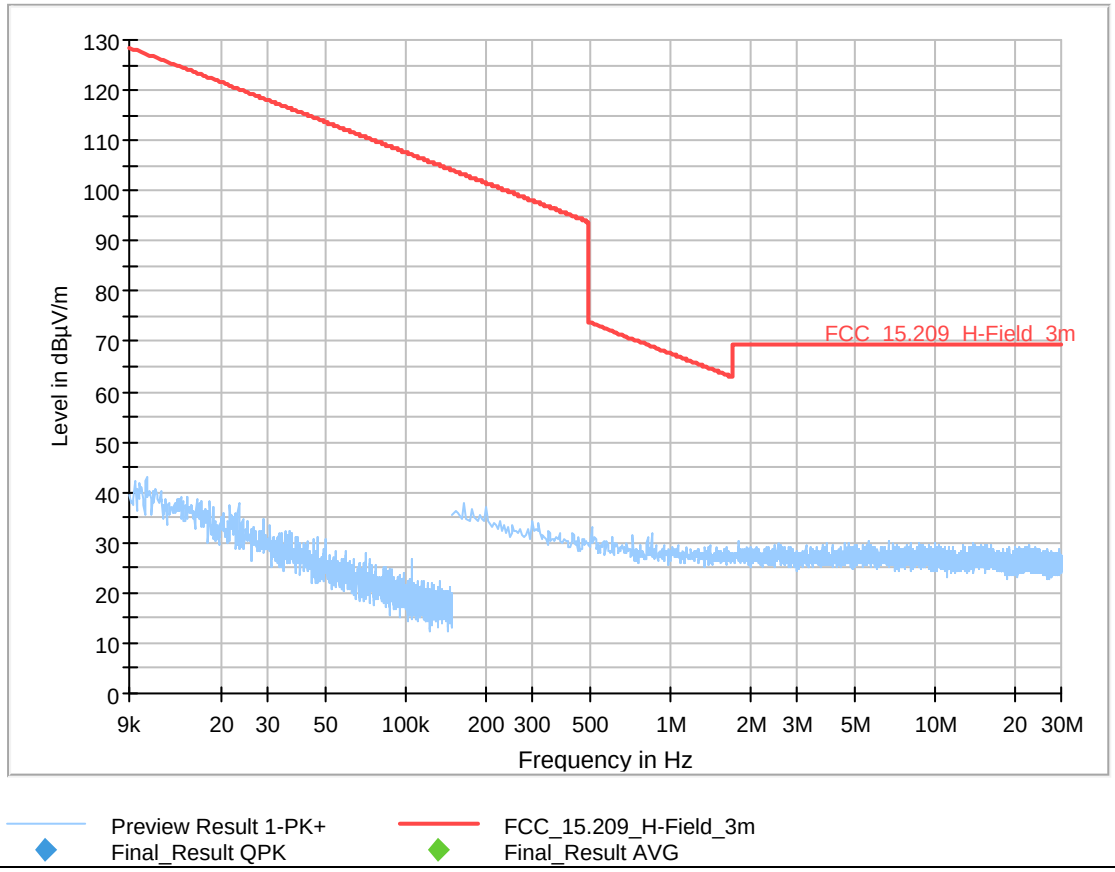
TEST EQUIPMENT USED:
Refer to chapter 5 of this document.
374, 1292, 1889, 3846, 4075, 4717, 5392



Sample photo of setup

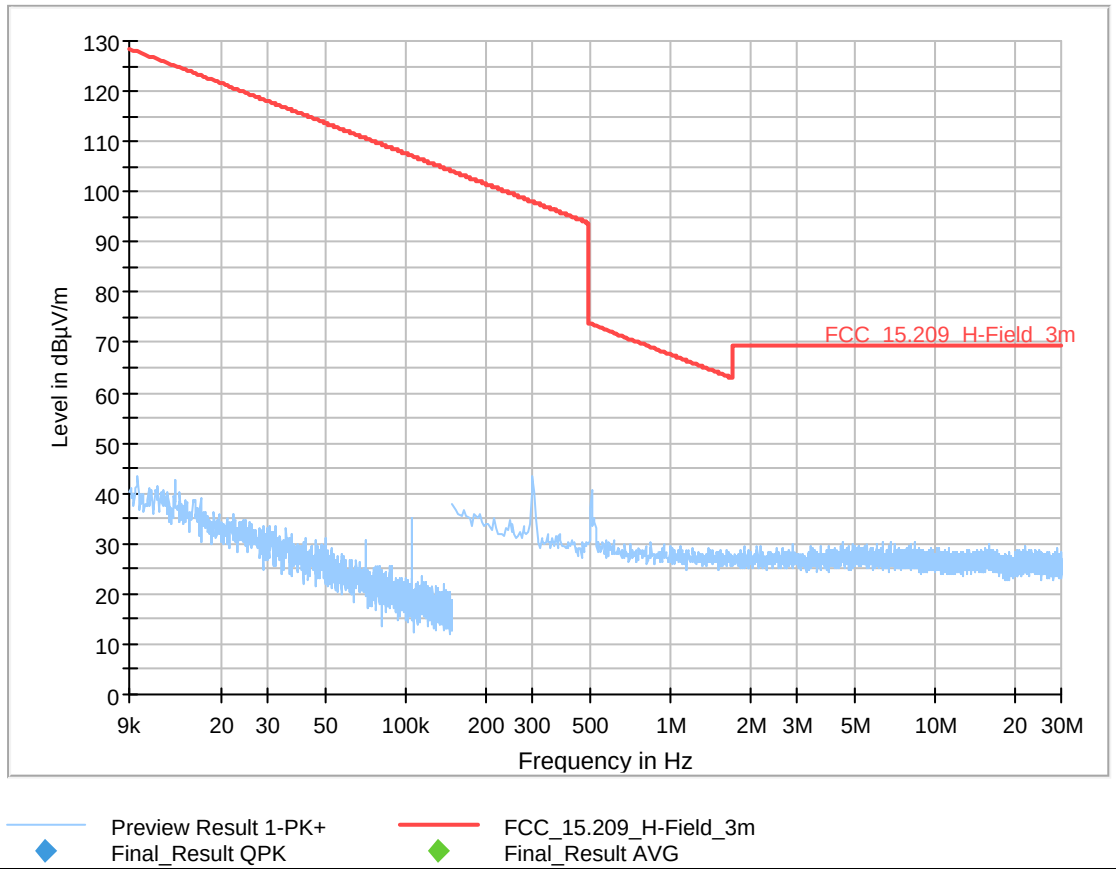
4.5.6 Detailed Test Data

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#1, none
EUT Orientation:	1



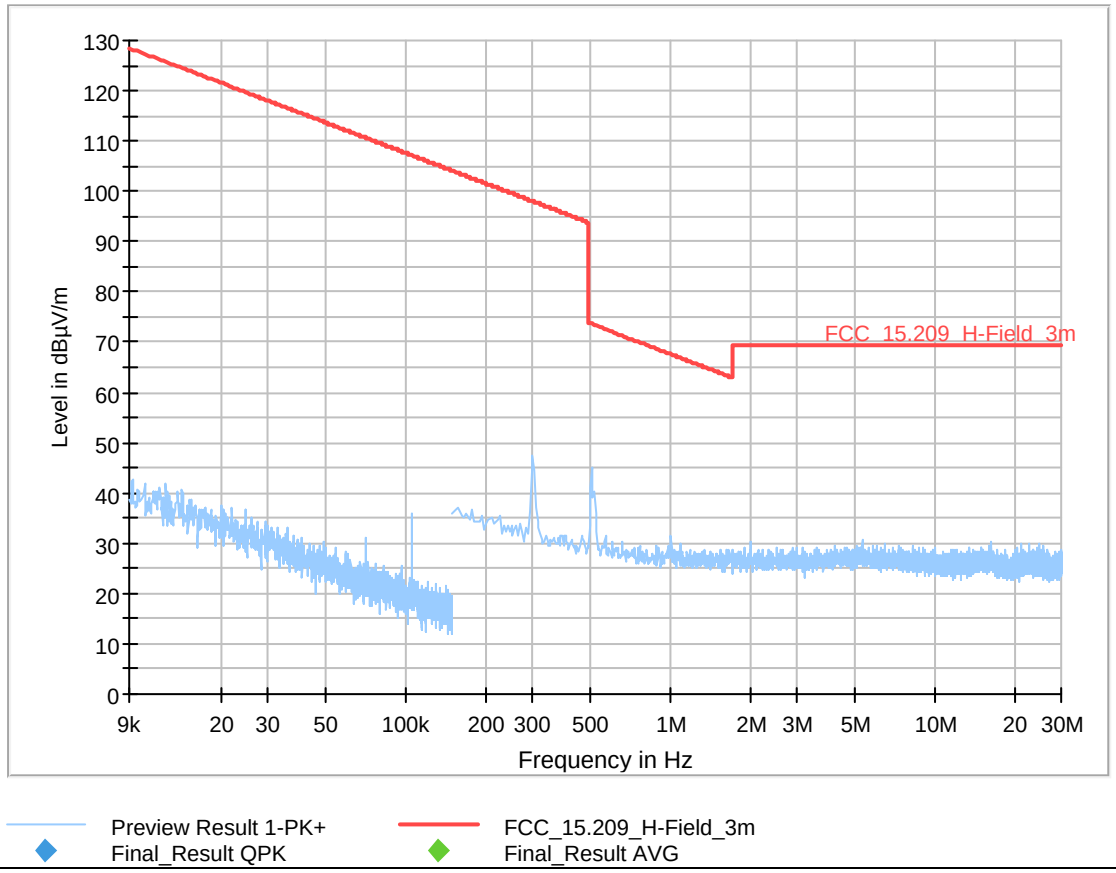
Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#2, none
EUT Orientation:	2



Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#3, none
EUT Orientation:	3



Final Result:

Frequency (MHz)	QuasiPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
All prescan results more than 20 dB below limit, therefore no final measurement performed.								

4.5.7 Test Result

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#1, none
	EUT#2, none
	EUT#3, none
Test date:	2019-07-30
Test personnel:	Ludwig Kraft

The EUT meets the requirements of this section.

4.5.8 Radiated Emissions 30 MHz – 1000 MHz

4.5.8.1 Test Procedures

ANSI C63.10-2013 6.5 Radiated emissions from unlicensed wireless devices in the frequency range of 30 MHz to 1000 MHz

This subclause specifies conditions for compliance testing in the frequency range above 30 MHz and below 1 GHz. The following subclauses describe the procedures that shall be used for making exploratory and final radiated emission tests for frequencies between 30 MHz and 1000 MHz. Measurements may be performed at a distance closer than that specified in the requirements, provided the measuring antenna is beyond its near-field range as determined by the Rayleigh criteria.

ANSI C63.10-2013, 6.5.3 Exploratory radiated emission tests

Exploratory measurements are used to identify the frequencies and amplitudes of the emissions while manipulating and rotating the EUT.

Exploratory radiated measurements shall be performed at the measurement distance or at a closer distance than that specified for compliance to determine the emission characteristics of the EUT. At near distances, for EUTs of comparably small size, it is relatively easy to determine the spectrum signature of the EUT and, if applicable, the EUT configuration that produces the maximum level of emissions. Exploratory measurements shall be made on a test site per 5.2. Shielded rooms, not treated with RF absorption material, shall not be used for exploratory measurements.

For each mode of operation required to be tested, the frequency spectrum shall be monitored. The highest signal levels relative to the limit shall be determined by rotating the EUT from 0° to 360° and with varying the measurement antenna height between 1 m and 4 m in vertical and horizontal polarizations.

ANSI C63.10-2013, 6.5.4 Final radiated emission tests

Using the orientation and equipment arrangement of the EUT, and based on the measurement results found during the exploratory measurement in 6.5.3, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable) and the frequency and amplitude of the six highest spurious emissions relative to the limit; emissions more than 20 dB below the limit do not need to be reported.

Measurements are performed with the EUT rotated from 0° to 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

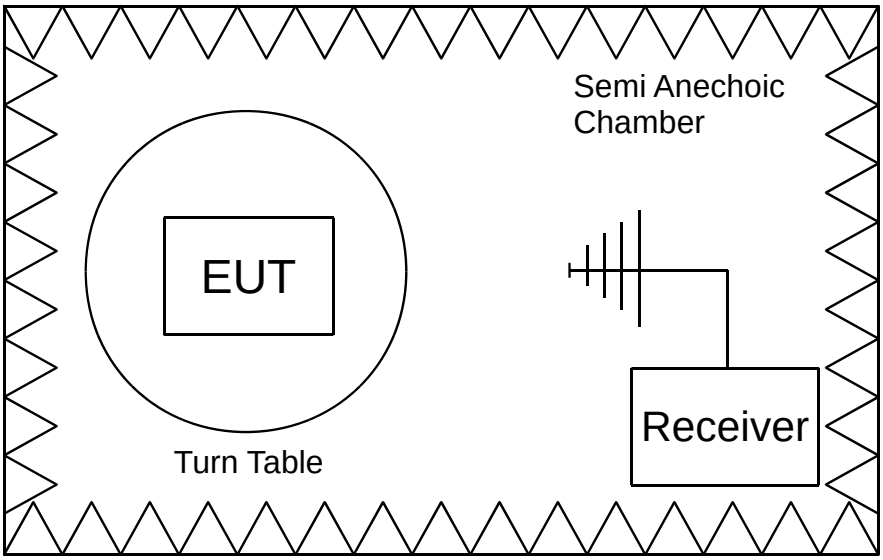
Variations in cable or wire placement shall be explored to maximize the measured emissions.

Unless specified otherwise by the regulatory authority, the instrumentation, detector functions, and bandwidths specified in 4.1.4.2.1 and 4.1.4.2.2 shall be used. For pulsed emissions, the procedure in 4.1.4.2.4 shall be used.

Radiated Emissions Test Characteristics	
Frequency range	30 MHz – 1000 MHz
Test distance	3 m
Test instrumentation resolution bandwidth	120 kHz
Receive antenna height	1 m - 4 m
Angular steps size during prescan:	90 °
Receive antenna polarization	Vertical/Horizontal
Measurement location	Semi Anechoic Chamber (SAC)

As there was no emission identified the EUT was measured in 3 orientation one with Fmin, one with Fmid, and one with Fmax.

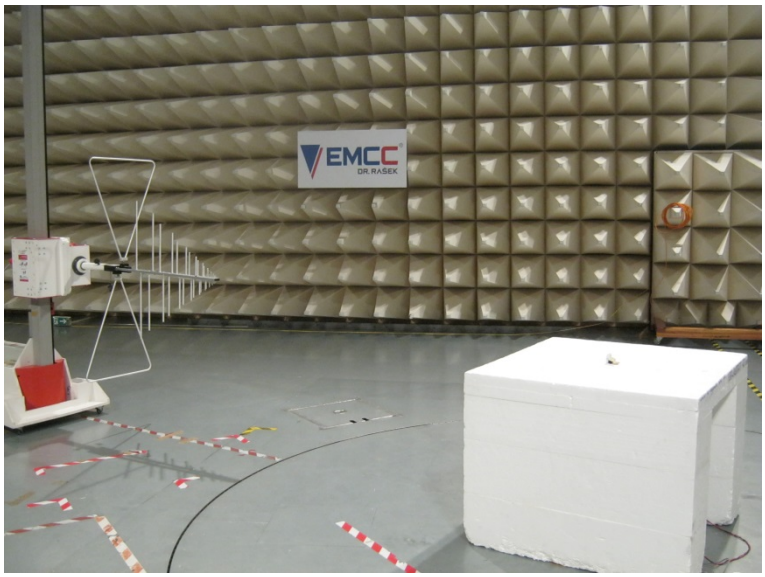
4.5.8.2 Test Setup



SCHEMATIC TEST SETUP

Requirement:	47 CFR, § 15.209 RSS-210, Annex B.10 RSS-Gen
Procedure:	ANSI C63.10-2013
Receiver:	#3846
Antenna:	#6041
Test distance:	3 m

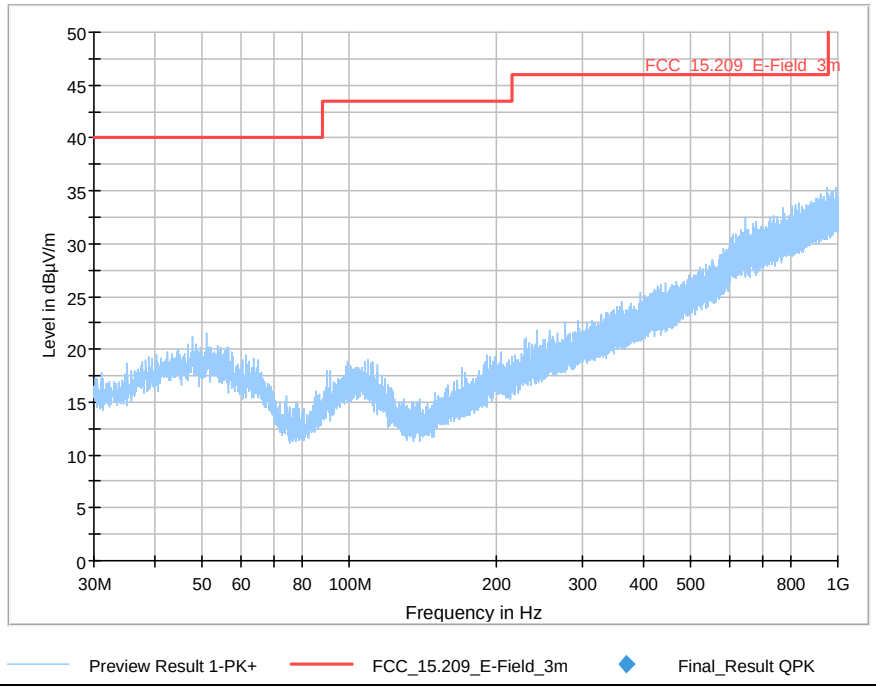
TEST EQUIPMENT USED:
Refer to chapter 5 of this document.
54, 553, 554, 1291, 1292, 1889, 2724, 3846, 4075, 4717, 5392, 6041



Sample photo of setup

4.5.8.3 Detailed Test Data

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#1, none
EUT Orientation:	2



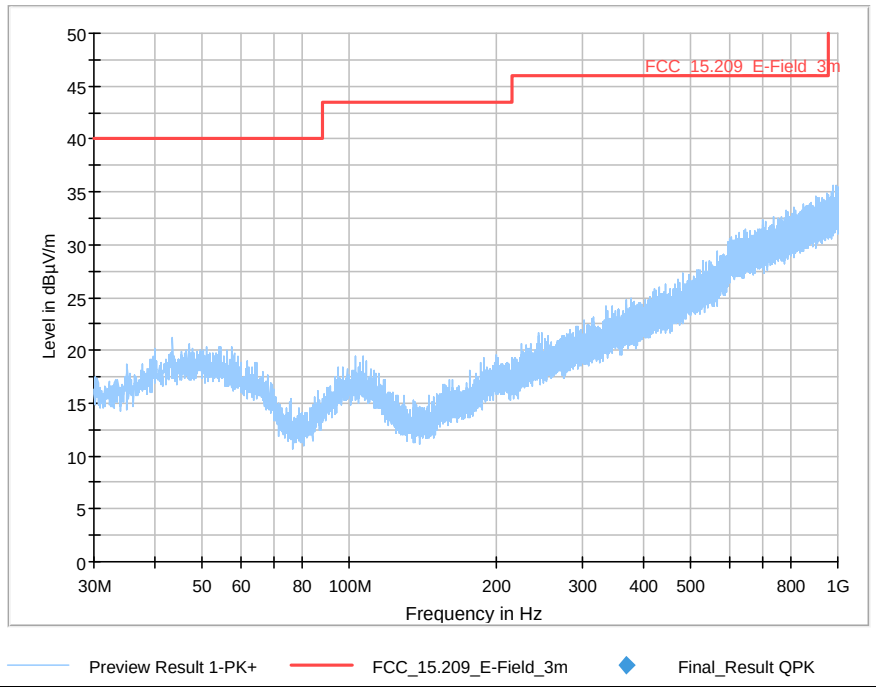
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
	All prescan results more than 20 dB below limit, therefore no final measurement performed.								

The table above contains worst-case emissions, only. For further details refer to the pre-scan test plot above.

Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#2, none
EUT Orientation:	1

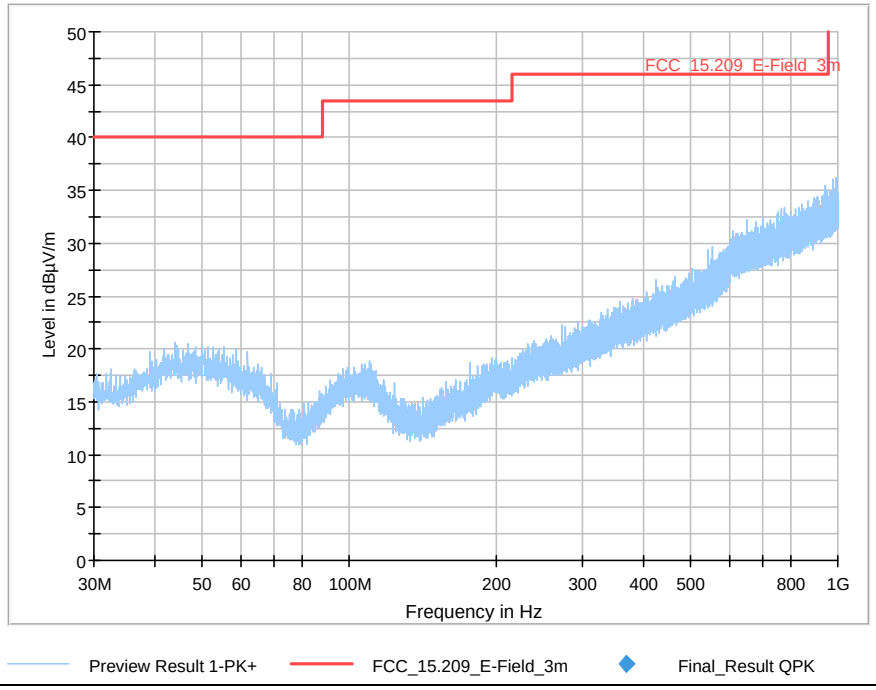


Final Result:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
	All prescan results more than 20 dB below limit, therefore no final measurement performed.								

The table above contains worst-case emissions, only. For further details refer to the pre-scan test plot above.

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#3, none
EUT Orientation:	3



Final Result:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
	All prescan results more than 20 dB below limit, therefore no final measurement performed.								

The table above contains worst-case emissions, only. For further details refer to the pre-scan test plot above.

4.5.8.4 Test Result

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#1, none
	EUT#2, none
	EUT#3, none
Test date:	2019-07-30
Test personnel:	Ludwig Kraft

The EUT meets the requirements of this section.

4.5.9 Radiated Emissions 1 – 6 GHz

4.5.9.1 Test Procedures

ANSI C63.10-2013, 6.6.4.1 General

Subclauses 6.6.4.2 and 6.6.4.3 describe the procedures that shall be used for making exploratory and final radiated emission tests for frequencies above 1 GHz. Measurements may be performed at a distance closer than that specified in the requirements; however, an attempt shall be made to avoid making measurements in the near field of both the measurement antenna and the EUT for final measurements.

In performing these measurements, the sensitivity of the complete measurement system relative to the limit shall be determined before the test. If the overall measurement sensitivity does not provide a noise floor more than 6 dB below the limit, then low-noise preamplifiers, closer test distances, higher gain antennas, or narrower bandwidths might be required. If closer measurement distances are used, then the beamwidth of the measurement antenna versus the size of the EUT shall be taken into account. Also, measurement system overload protection shall be determined to be adequate when preamplifiers are used [see item b) of 4.1.3]. The effects of using bandwidths different from those specified shall also be determined (see also 6.3). Any changes from the specific measurement conditions shall be described in the report of the measurements (see also Annex E).

Install an appropriate filter at the input of the measurement system power amplifier. This filter shall attenuate the fundamental emission of the EUT and allow an accurate measurement of the associated harmonics and spurious emissions. The filter shall be characterized, and any attenuation/loss factors shall be accounted for in the measurement results.

Data shall be recorded in peak and average detection upto the highest measurement frequency required (unless stated otherwise in the applicable requirements).

ANSI C63.10-2013, 6.6.4.2 Exploratory radiated emissions measurements

Exploratory radiated measurements shall be performed at the measurement distance or at a closer distance than that specified for compliance to determine the emission characteristics of the EUT and, if applicable, the EUT configuration that produces the maximum level of emissions. The frequencies of maximum emission may be determined by manually positioning the antenna close to the EUT, and then moving the antenna over all sides of the EUT while observing a spectral display. It is advantageous to have prior knowledge of the frequencies of emissions, although this may be determined from such a near-field scan. The near-field scan shall only be used to determine the frequency but not the amplitude of the emissions. Where exploratory measurements are not adequate to determine the worst-case operating modes and are used only to identify the frequencies of the highest emissions, additional preliminary tests can be required.

Preliminary tests shall be performed following the procedures in 6.3 on a site meeting the requirements of 5.2. For emissions from the EUT, the maximum level shall be determined by rotating the EUT and its antenna through 0° to 360°. For each mode of operation required to be tested, the frequency spectrum (based on findings from exploratory measurements) shall be monitored.

Broadband antennas and a spectrum analyzer or a radio-noise meter with a panoramic display are often useful in this type of test. If either antenna height or EUT azimuth are not fully measured during exploratory testing, then complete testing can be required at the OATS or semi-anechoic chamber when the final full spectrum testing is performed.

ANSI C63.10.2013, 6.6.4.3 Final radiated emissions measurements

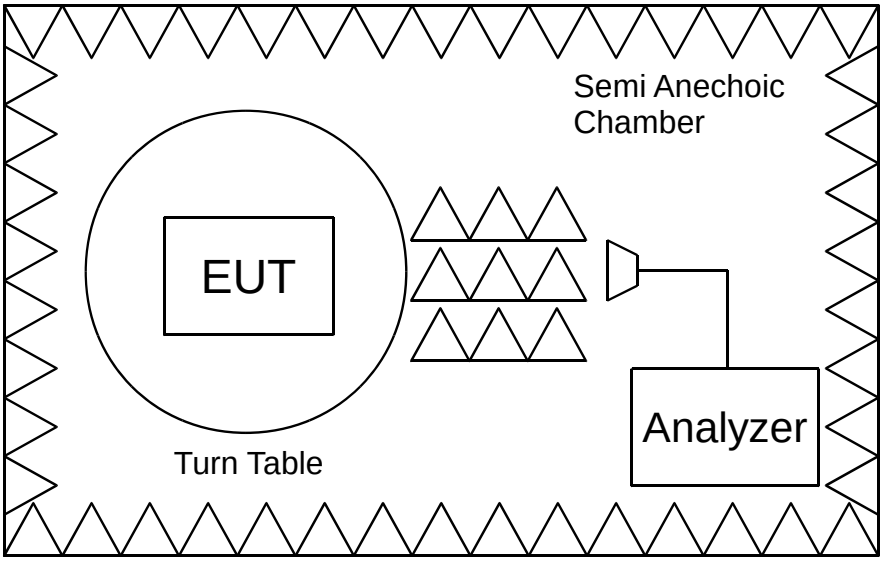
The final measurements are performed on a site meeting the requirements of 5.2. Using the orientation and equipment arrangement of the EUT based on the measurement results found during the preliminary (exploratory) measurements per 6.6.4.2, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable), as well as the frequency and amplitude of the six highest spurious emissions relative to the limit. Emissions more than 20 dB below the limit do not need to be reported.

Measurements are performed with the EUT rotated from 0° to 360°; the antenna height scanned in accordance with 6.6.3.1, 6.6.3.2, or 6.6.3.3, as appropriate; and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Variations in cable or wire placement shall be explored to maximize the measured emissions.

The emission signal shall be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission from the EUT is measured. This may be achieved by either pointing the antenna at an angle toward the source of the emission or by testing the EUT as described in 6.6.3.3.
If the emission is pulsed, then refer to Annex C for guidelines on selecting bandwidth and determining pulse desensitization factors, as necessary.
As noted in 6.6.4.1, when performing these measurements, the sensitivity of the complete measurement system relative to the limit shall be determined before the test. If the overall measurement sensitivity is inadequate, then low-noise preamplifiers, closer measurement distances, higher gain antennas, or narrower bandwidths may be used. If closer measurement distances or higher gain antennas are used, then the beamwidth of the measurement antenna versus the physical size of the EUT shall be taken into account, so that the physical sizes of the EUT dimensions are encompassed by the beamwidth of the measurement antenna. Also, measurement system overload protection shall be determined to be adequate when preamplifiers are used. The effects on the measured emission value using bandwidths different from those specified shall be determined if such bandwidth changes are made. Any changes from the specific measurement conditions shall be described in the report of the measurements.
Unless specified otherwise by the regulatory authority, the instrumentation, detector functions, and bandwidths specified in 4.1.4.2.1 and 4.1.4.2.2 shall be used. For pulsed emissions, the procedure in 4.1.4.2.4 shall be used.

Radiated Emissions Test Characteristics	
Frequency range	1 GHz – 6 GHz
Test distance	3 m
Test instrumentation resolution bandwidth	1 MHz
Receive antenna height	1 m – 4 m
Receive antenna polarization	Vertical/Horizontal
Measurement chamber	Semi anechoic chamber (SAC) with rf absorbers on the floor

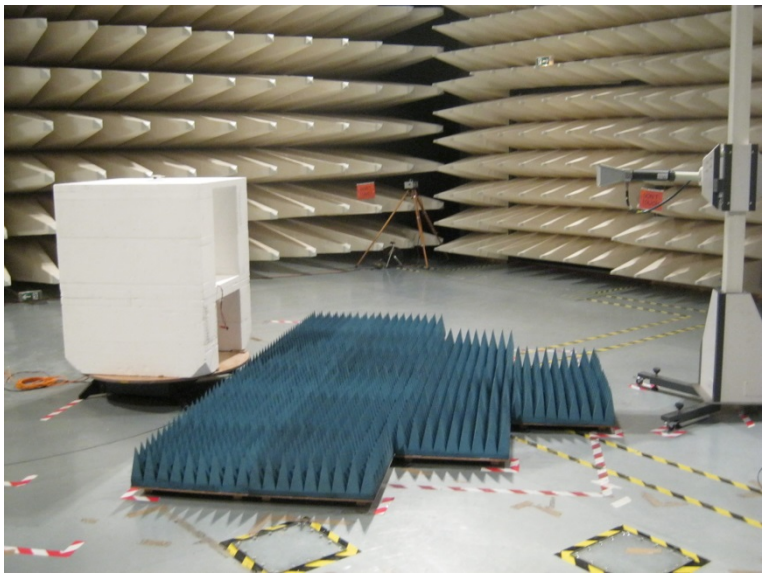
4.5.9.2 Test Setup



SCHEMATIC TEST SETUP

Requirement:	47 CFR, § 15.209 RSS-210, Annex B.10 RSS-Gen
Procedure:	ANSI C63.10-2013
Receiver:	#3846
Antenna:	#3236
Test distance:	3 m

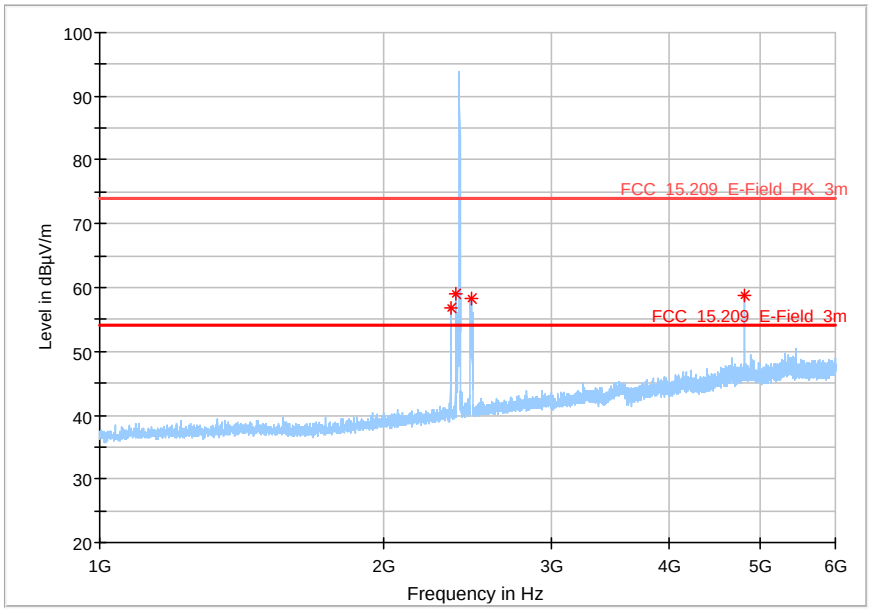
TEST EQUIPMENT USED:
Refer to chapter 5 of this document.
553, 554, 1889, 3236, 4075, 4717, 5392, 5535, 5536, 5544, 5545, 5616



Sample photo of setup

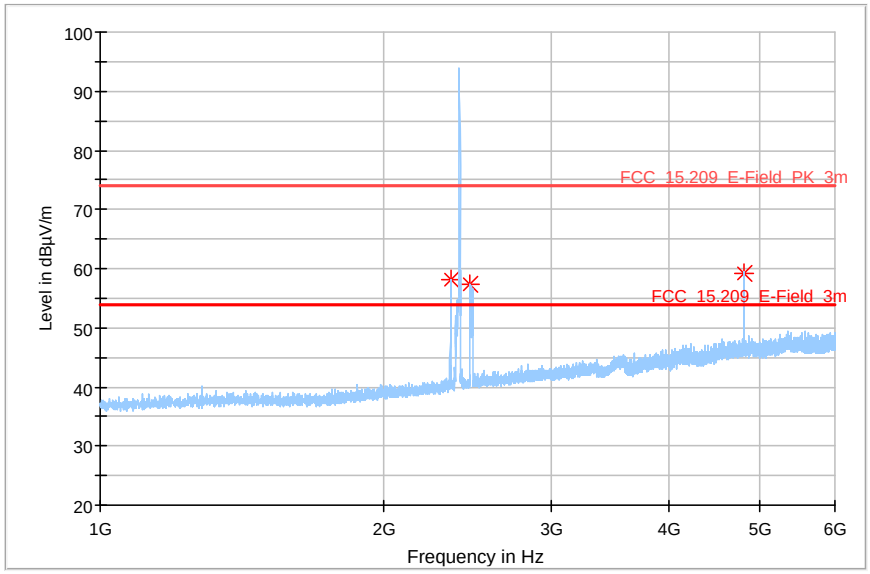
4.5.9.3 Detailed Test Data

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#1, none
EUT Orientation:	1



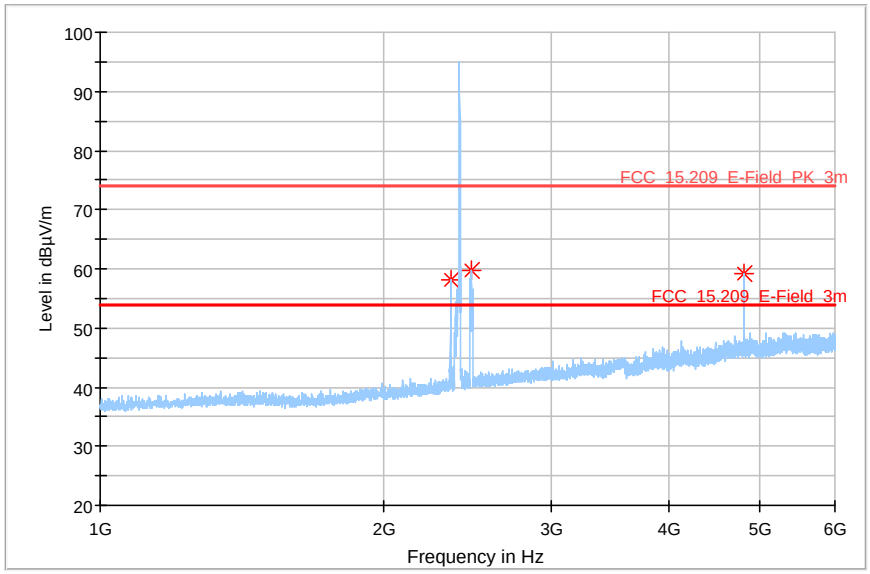
Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#1, none
EUT Orientation:	2



MaxPeak-PK+ [Critical_Freqs.Result:4]
Preview Result 1-PK+ [Preview Result 1.Result:1]
FCC_15.209_E-Field_PK_3m [..\EMI radiated\FCC_Part15\]
FCC_15.209_E-Field_3m [..\EMI radiated\FCC_Part15\]

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#1, none
EUT Orientation:	3



MaxPeak-PK+ [Critical_Freqs.Result:4]
Preview Result 1-PK+ [Preview Result 1.Result:1]
FCC_15.209_E-Field_PK_3m [..\EMI radiated\FCC_Part15\]
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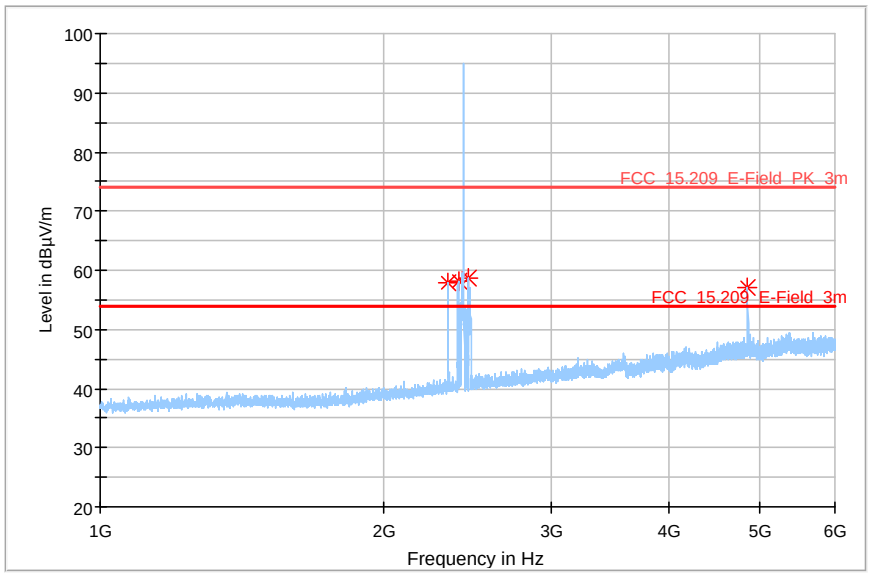
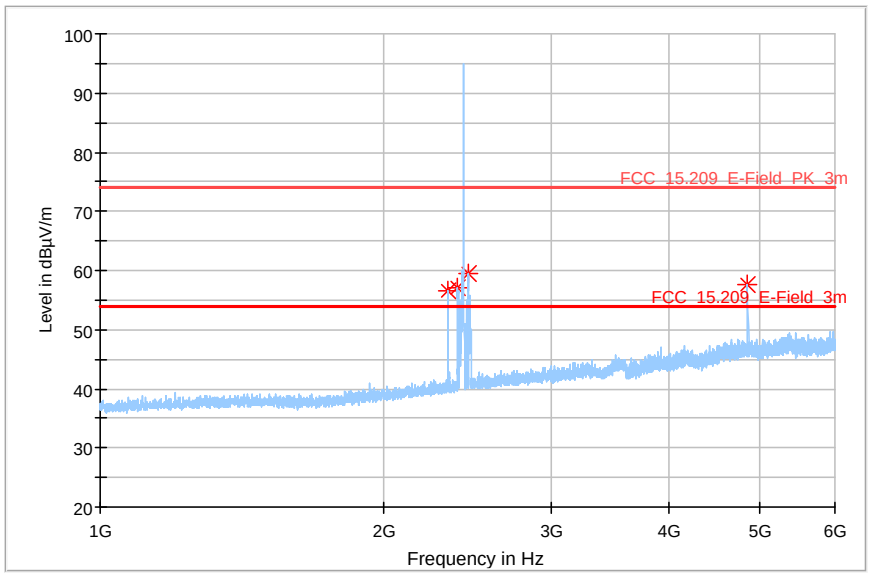
Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#2, none
EUT Orientation:	1



MaxPeak-PK+ [Critical_Freqs.Result:4]
Preview Result 1-PK+ [Preview Result 1.Result:1]
FCC_15.209_E-Field_PK_3m [..\EMI radiated\FCC_Part15\]
FCC_15.209_E-Field_3m [..\EMI radiated\FCC_Part15\]

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#2, none
EUT Orientation:	2



MaxPeak-PK+ [Critical_Freqs.Result:4]
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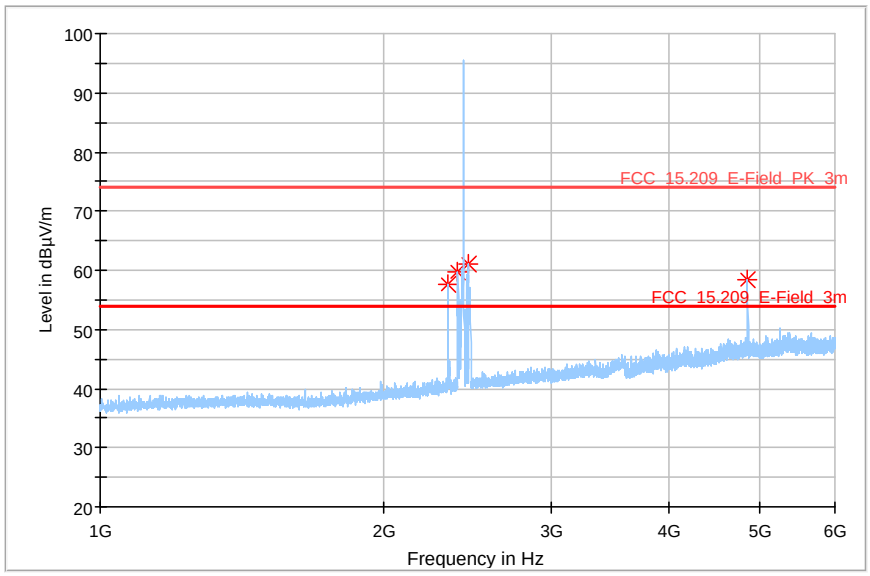
FCC_15.209_E-Field_3m [..\EMI radiated\FCC_Part15\]

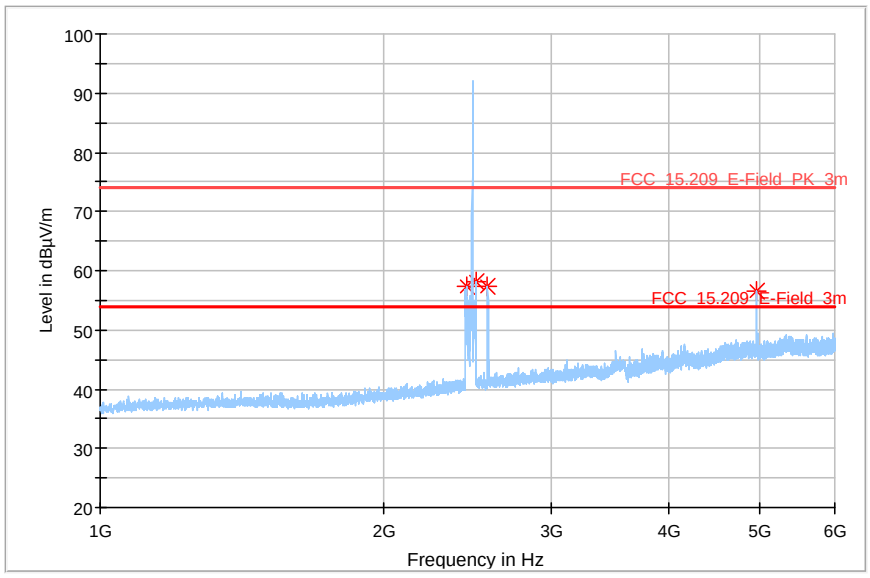
Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#2, none
EUT Orientation:	3



MaxPeak-PK+ [Critical_Freqs.Result:4]
Preview Result 1-PK+ [Preview Result 1.Result:1]
FCC_15.209_E-Field_PK_3m [..\EMI radiated\FCC_Part15\]
FCC_15.209_E-Field_3m [..\EMI radiated\FCC_Part15\]

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#3, none
EUT Orientation:	1



MaxPeak-PK+ [Critical_Freqs.Result:4]
Preview Result 1-PK+ [Preview Result 1.Result:1]
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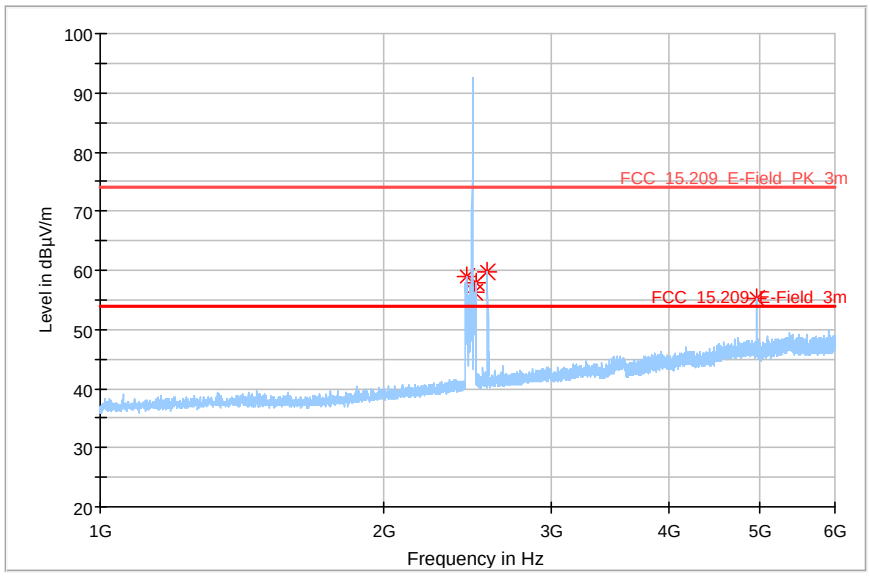
FCC_15.209_E-Field_3m [..\EMI radiated\FCC_Part15\]

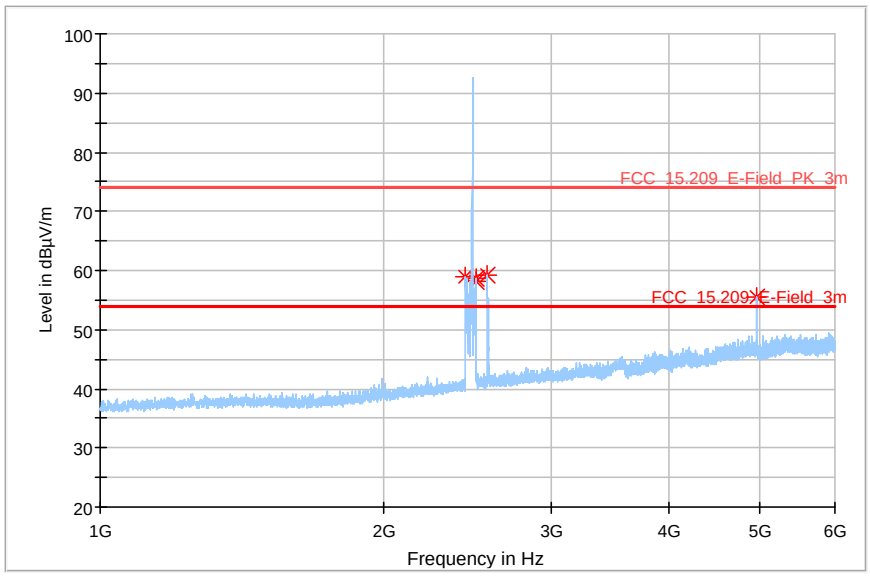
Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#3, none
EUT Orientation:	2



MaxPeak-PK+ [Critical_Freqs.Result:4]
Preview Result 1-PK+ [Preview Result 1.Result:1]
FCC_15.209_E-Field_PK_3m [..\EMI radiated\FCC_Part15\]
FCC_15.209_E-Field_3m [..\EMI radiated\FCC_Part15\]

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#3, none
EUT Orientation:	3



MaxPeak-PK+ [Critical_Freqs.Result:4]
Preview Result 1-PK+ [Preview Result 1.Result:1]
FCC_15.209_E-Field_PK_3m [..\EMI radiated\FCC_Part15\]
FCC_15.209_E-Field_3m [..\EMI radiated\FCC_Part15\]

Final Result:

Radiated Spurious Emissions 1 – 6 GHz – Average Results						
Frequency	**Field Strength**	**DCF**	**Result**	**Limit**	**Margin**	**Remarks**
[MHz]	**[dBµV/m]**	**[dB]**	**[dB(µV/m)]**	**[dB(µV/m)]**	**[dB]**	
2336.5	58.0	-34.4	23.6	54	30.4	EUT#2 2426 MHz
2350.5	58.3	-34.4	23.9	54	30.1	EUT#1 2402 MHz
2378.0	58.9	-34.4	24.5	54	29.5	EUT#1 2402 MHz
2393.5	59.6	-34.4	25.2	54	28.8	EUT#2 2426 MHz
2497.0	58.2	-34.4	23.8	54	30.2	EUT#3 2480 MHz
2502.0	58.7	-34.4	24.3	54	29.7	EUT#3 2480 MHz
4804.7	60.7	-34.4	26.3	54	27.7	EUT#1 2402 MHz
4851.3	59.7	-34.4	25.3	54	28.7	EUT#2 2426 MHz
4960.6	57.3	-34.4	22.9	54	31.1	EUT#3 2480 MHz

The table above contains worst-case emissions, only. For further details refer to the pre-scan test plot above.
Remark: Duty Cycle Correction Factor DCF added to peak reading to obtain average results.
For further details refer to chapter 2.1 of the report.

Radiated Spurious Emissions 1 – 6 GHz – Peak Results						
Frequency	**Field Strength**	**DCF**	**Result**	**Limit**	**Margin**	**Remarks**
[MHz]	**[dBµV/m]**	**[dB]**	**[dB(µV/m)]**	**[dB(µV/m)]**	**[dB]**	
2336.5	58.0	n.a.	58.0	74	16.0	EUT#2 2426 MHz
2350.5	58.3	n.a.	58.3	74	15.7	EUT#1 2402 MHz
2378.0	58.9	n.a.	58.9	74	15.1	EUT#1 2402 MHz
2393.5	59.6	n.a.	59.6	74	14.4	EUT#2 2426 MHz
2497.0	58.2	n.a.	58.2	74	15.8	EUT#3 2480 MHz
2502.0	58.7	n.a.	58.7	74	15.3	EUT#3 2480 MHz
4804.7	60.7	n.a.	60.7	74	13.3	EUT#1 2402 MHz
4851.3	59.7	n.a.	59.7	74	14.3	EUT#2 2426 MHz
4960.6	57.3	n.a.	57.3	74	16.7	EUT#3 2480 MHz

The table above contains worst-case emissions, only. For further details refer to the pre-scan test plots.

4.5.9.4 Test Result

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#1, none
	EUT#2, none
	EUT#3, none
Test date:	2019-07-30
Test personnel:	Dominik Krüger

The EUT meets the requirements of this section.

4.5.10 Radiated Emissions 6 – 18 GHz

4.5.10.1 Test Procedures

ANSI C63.10-2013, 6.6.4.1 General

Subclauses 6.6.4.2 and 6.6.4.3 describe the procedures that shall be used for making exploratory and final radiated emission tests for frequencies above 1 GHz. Measurements may be performed at a distance closer than that specified in the requirements; however, an attempt shall be made to avoid making measurements in the near field of both the measurement antenna and the EUT for final measurements.

In performing these measurements, the sensitivity of the complete measurement system relative to the limit shall be determined before the test. If the overall measurement sensitivity does not provide a noise floor more than 6 dB below the limit, then low-noise preamplifiers, closer test distances, higher gain antennas, or narrower bandwidths might be required. If closer measurement distances are used, then the beamwidth of the measurement antenna versus the size of the EUT shall be taken into account. Also, measurement system overload protection shall be determined to be adequate when preamplifiers are used [see item b) of 4.1.3]. The effects of using bandwidths different from those specified shall also be determined (see also 6.3). Any changes from the specific measurement conditions shall be described in the report of the measurements (see also Annex E).

Install an appropriate filter at the input of the measurement system power amplifier. This filter shall attenuate the fundamental emission of the EUT and allow an accurate measurement of the associated harmonics and spurious emissions. The filter shall be characterized, and any attenuation/loss factors shall be accounted for in the measurement results.

Data shall be recorded in peak and average detection upto the highest measurement frequency required (unless stated otherwise in the applicable requirements).

ANSI C63.10-2013, 6.6.4.2 Exploratory radiated emissions measurements

Exploratory radiated measurements shall be performed at the measurement distance or at a closer distance than that specified for compliance to determine the emission characteristics of the EUT and, if applicable, the EUT configuration that produces the maximum level of emissions. The frequencies of maximum emission may be determined by manually positioning the antenna close to the EUT, and then moving the antenna over all sides of the EUT while observing a spectral display. It is advantageous to have prior knowledge of the frequencies of emissions, although this may be determined from such a near-field scan. The near-field scan shall only be used to determine the frequency but not the amplitude of the emissions. Where exploratory measurements are not adequate to determine the worst-case operating modes and are used only to identify the frequencies of the highest emissions, additional preliminary tests can be required.

Preliminary tests shall be performed following the procedures in 6.3 on a site meeting the requirements of 5.2. For emissions from the EUT, the maximum level shall be determined by rotating the EUT and its antenna through 0° to 360°. For each mode of operation required to be tested, the frequency spectrum (based on findings from exploratory measurements) shall be monitored.

Broadband antennas and a spectrum analyzer or a radio-noise meter with a panoramic display are often useful in this type of test. If either antenna height or EUT azimuth are not fully measured during exploratory testing, then complete testing can be required at the OATS or semi-anechoic chamber when the final full spectrum testing is performed.

ANSI C63.10.2013, 6.6.4.3 Final radiated emissions measurements

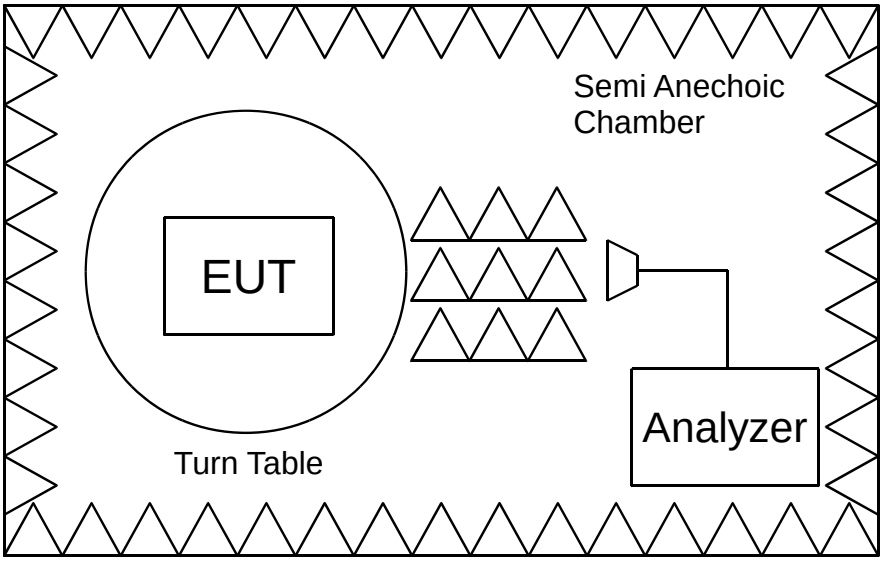
The final measurements are performed on a site meeting the requirements of 5.2. Using the orientation and equipment arrangement of the EUT based on the measurement results found during the preliminary (exploratory) measurements per 6.6.4.2, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable), as well as the frequency and amplitude of the six highest spurious emissions relative to the limit. Emissions more than 20 dB below the limit do not need to be reported.

Measurements are performed with the EUT rotated from 0° to 360°; the antenna height scanned in accordance with 6.6.3.1, 6.6.3.2, or 6.6.3.3, as appropriate; and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Variations in cable or wire placement shall be explored to maximize the measured emissions.

The emission signal shall be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission from the EUT is measured. This may be achieved by either pointing the antenna at an angle toward the source of the emission or by testing the EUT as described in 6.6.3.3.
If the emission is pulsed, then refer to Annex C for guidelines on selecting bandwidth and determining pulse desensitization factors, as necessary.
As noted in 6.6.4.1, when performing these measurements, the sensitivity of the complete measurement system relative to the limit shall be determined before the test. If the overall measurement sensitivity is inadequate, then low-noise preamplifiers, closer measurement distances, higher gain antennas, or narrower bandwidths may be used. If closer measurement distances or higher gain antennas are used, then the beamwidth of the measurement antenna versus the physical size of the EUT shall be taken into account, so that the physical sizes of the EUT dimensions are encompassed by the beamwidth of the measurement antenna. Also, measurement system overload protection shall be determined to be adequate when preamplifiers are used. The effects on the measured emission value using bandwidths different from those specified shall be determined if such bandwidth changes are made. Any changes from the specific measurement conditions shall be described in the report of the measurements.
Unless specified otherwise by the regulatory authority, the instrumentation, detector functions, and bandwidths specified in 4.1.4.2.1 and 4.1.4.2.2 shall be used. For pulsed emissions, the procedure in 4.1.4.2.4 shall be used.

Radiated Emissions Test Characteristics	
Frequency range	6 GHz – 18 GHz
Test distance	1 m
Test instrumentation resolution bandwidth	1 MHz
Receive antenna height	1.5 m
Receive antenna polarization	Vertical/Horizontal
Measurement chamber	Semi anechoic chamber (SAC)

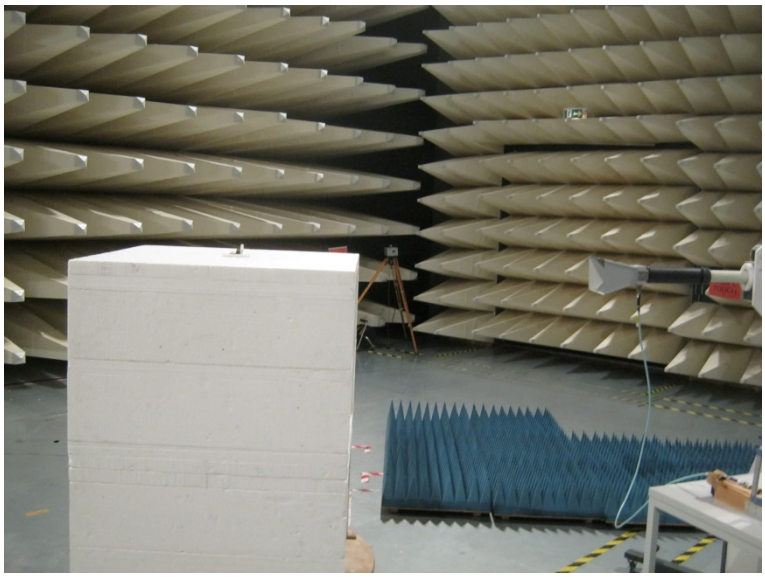
4.5.10.2 Test Setup



SCHEMATIC TEST SETUP

Requirement:	47 CFR, § 15.209 RSS-210, Annex B.10 RSS-Gen
Procedure:	ANSI C63.10-2013
Receiver:	#3831
Antenna:	#3236
Test distance:	1 m

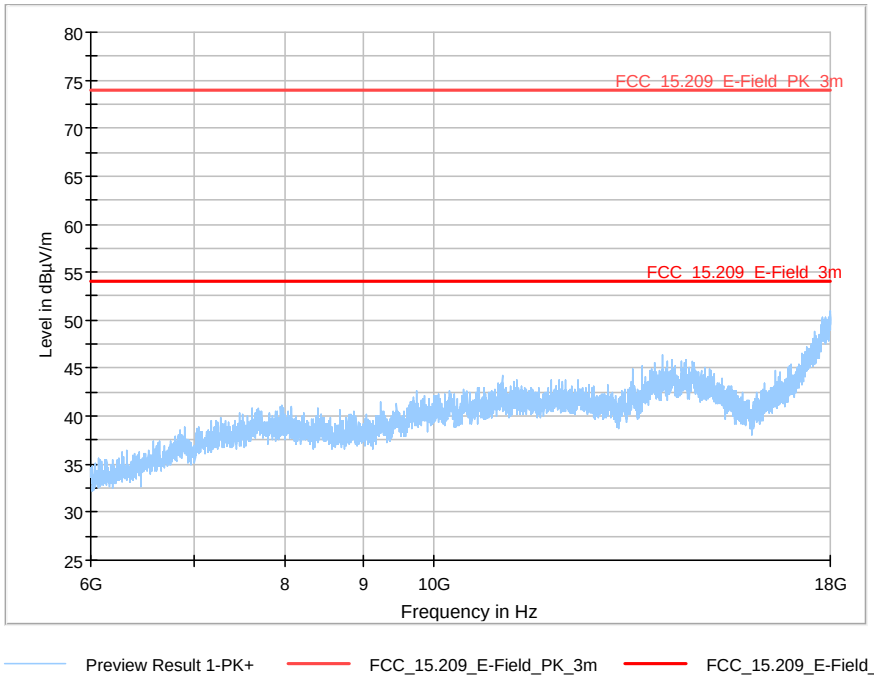
TEST EQUIPMENT USED:
Refer to chapter 5 of this document.
553, 554, 1889, 3236, 3831, 4075, 4717, 5366, 5392, 5535, 5536, 5544, 5545, 5620



Sample photo of setup

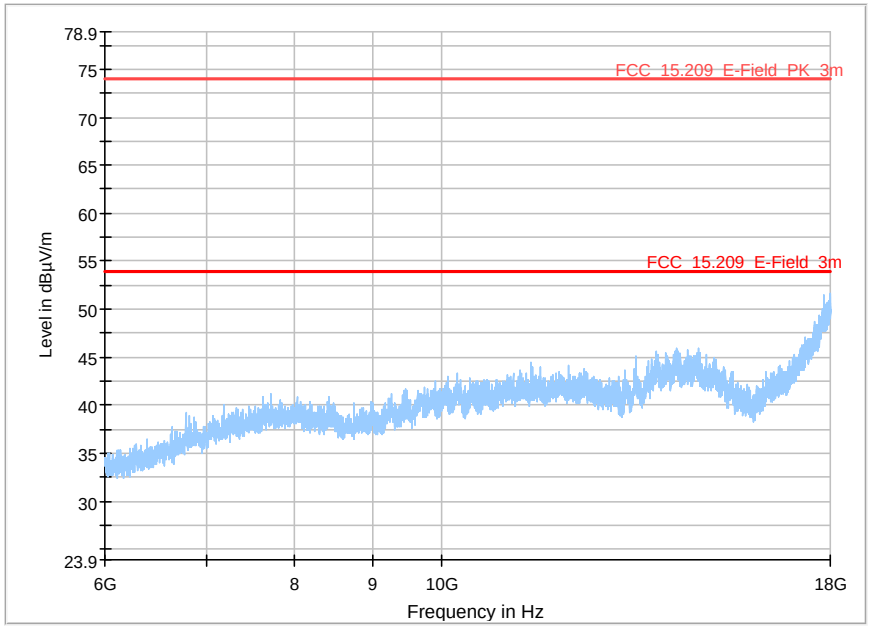
4.5.10.3 Detailed Test Data

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#1, none
EUT Orientation:	1

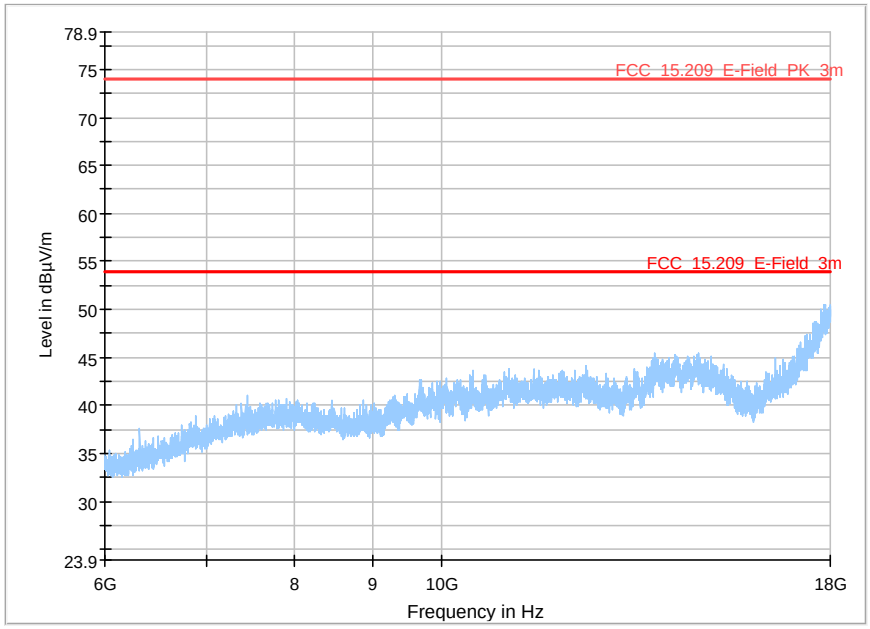


Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#1, none
EUT Orientation:	2

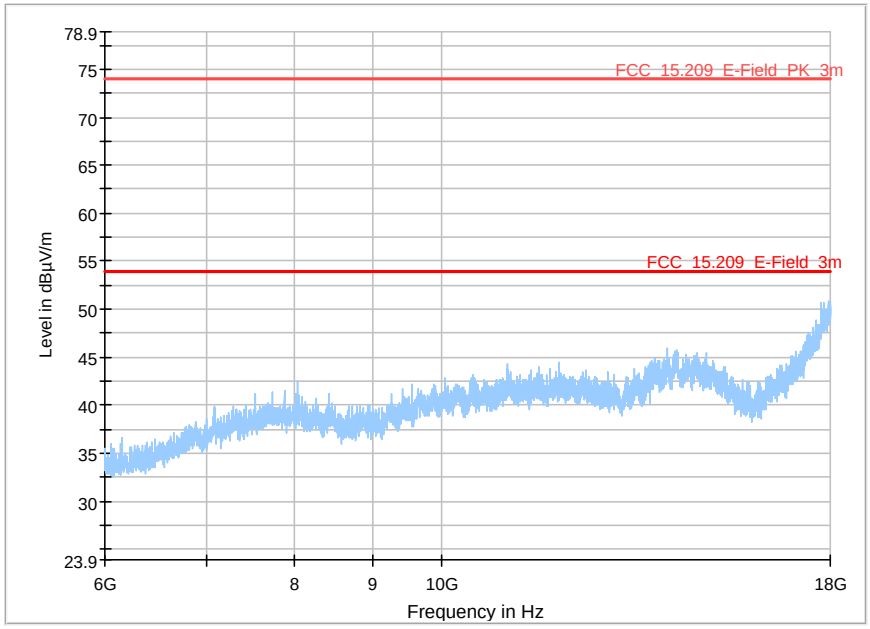


Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#1, none
EUT Orientation:	3

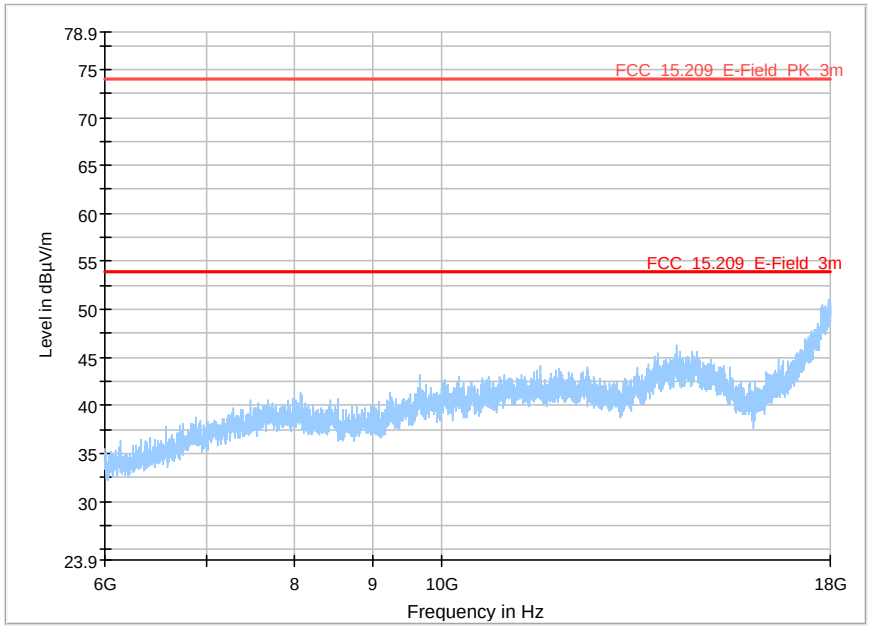


Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#2, none
EUT Orientation:	1

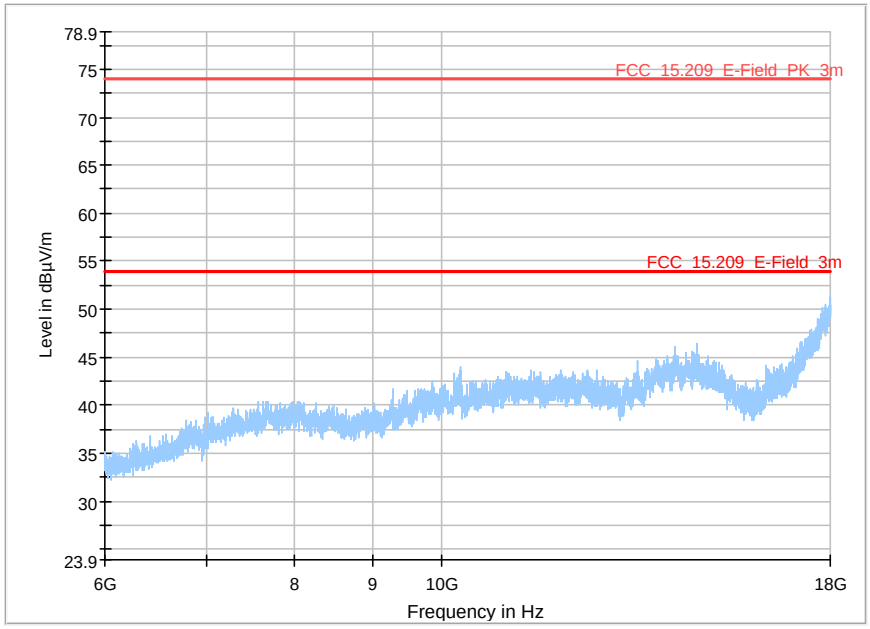


Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#2, none
EUT Orientation:	2

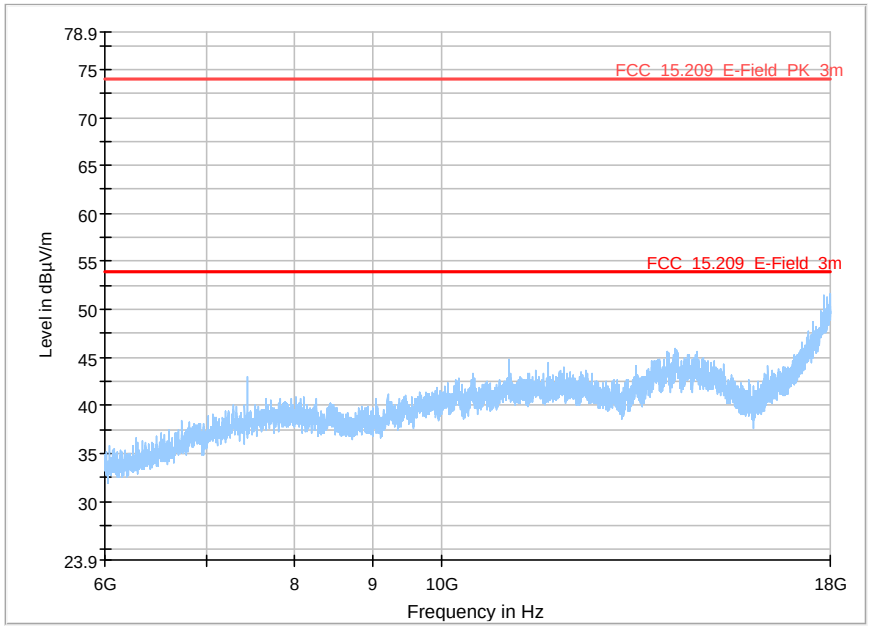


Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#2, none
EUT Orientation:	3

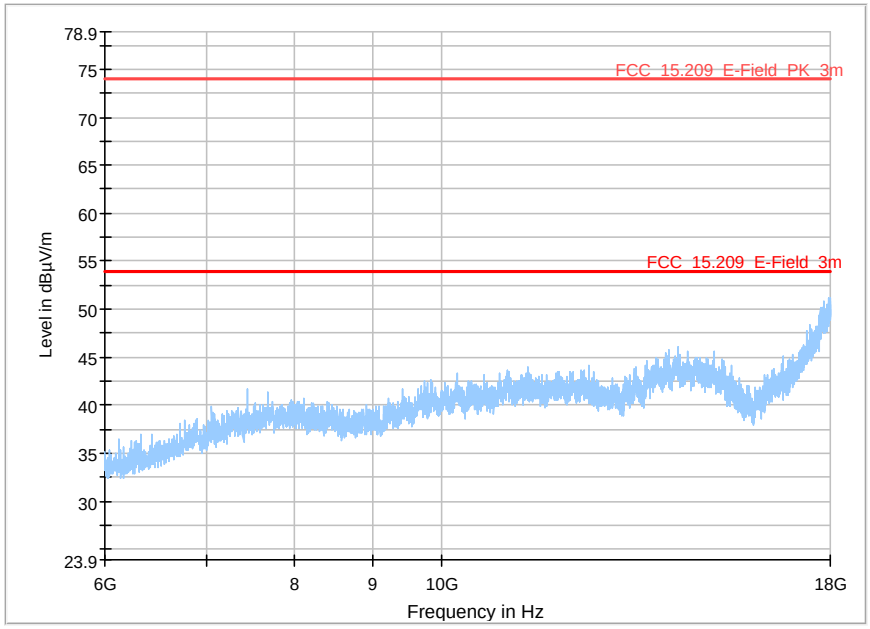


Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#3, none
EUT Orientation:	1

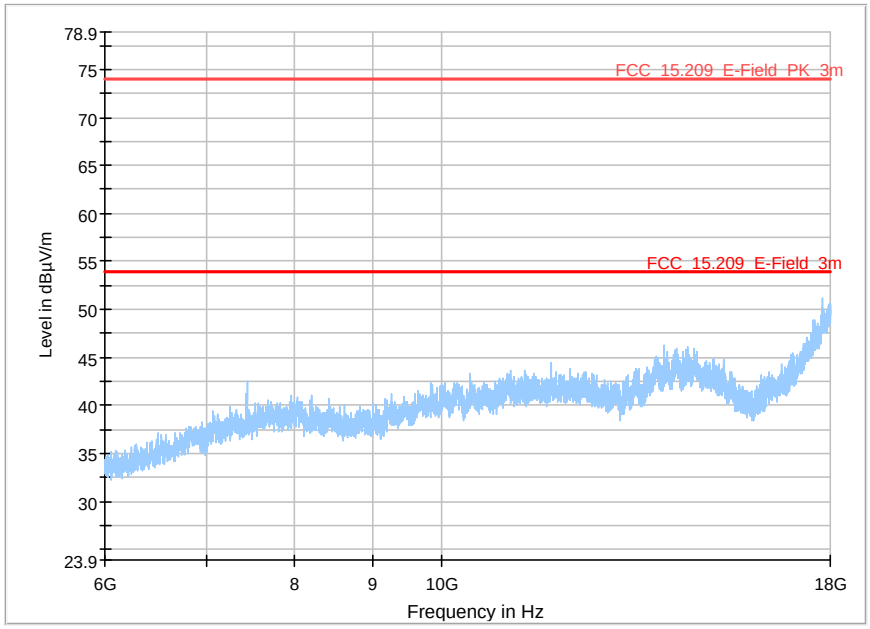


Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#3, none
EUT Orientation:	2



Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#3, none
EUT Orientation:	3



Final Result:

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
	All prescan peak results are below the average limit, therefore no final measurement performed.								

All tests performed at the distance of d = 1 m.

The table above contains worst-case emissions, only. For further details refer to the pre-scan test plot above.

4.5.10.4 Test Result

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#1, none
	EUT#2, none
	EUT#3, none
Test date:	2019-07-31
Test personnel:	Dominik Krüger

The EUT meets the requirements of this section.

4.5.11 Radiated Emissions 18 – 26.5 GHz

4.5.11.1 Test Procedures

ANSI C63.10-2013, 6.6.4.1 General

Subclauses 6.6.4.2 and 6.6.4.3 describe the procedures that shall be used for making exploratory and final radiated emission tests for frequencies above 1 GHz. Measurements may be performed at a distance closer than that specified in the requirements; however, an attempt shall be made to avoid making measurements in the near field of both the measurement antenna and the EUT for final measurements.

In performing these measurements, the sensitivity of the complete measurement system relative to the limit shall be determined before the test. If the overall measurement sensitivity does not provide a noise floor more than 6 dB below the limit, then low-noise preamplifiers, closer test distances, higher gain antennas, or narrower bandwidths might be required. If closer measurement distances are used, then the beamwidth of the measurement antenna versus the size of the EUT shall be taken into account. Also, measurement system overload protection shall be determined to be adequate when preamplifiers are used [see item b) of 4.1.3]. The effects of using bandwidths different from those specified shall also be determined (see also 6.3). Any changes from the specific measurement conditions shall be described in the report of the measurements (see also Annex E).

Install an appropriate filter at the input of the measurement system power amplifier. This filter shall attenuate the fundamental emission of the EUT and allow an accurate measurement of the associated harmonics and spurious emissions. The filter shall be characterized, and any attenuation/loss factors shall be accounted for in the measurement results.

Data shall be recorded in peak and average detection upto the highest measurement frequency required (unless stated otherwise in the applicable requirements).

ANSI C63.10-2013, 6.6.4.2 Exploratory radiated emissions measurements

Exploratory radiated measurements shall be performed at the measurement distance or at a closer distance than that specified for compliance to determine the emission characteristics of the EUT and, if applicable, the EUT configuration that produces the maximum level of emissions. The frequencies of maximum emission may be determined by manually positioning the antenna close to the EUT, and then moving the antenna over all sides of the EUT while observing a spectral display. It is advantageous to have prior knowledge of the frequencies of emissions, although this may be determined from such a near-field scan. The near-field scan shall only be used to determine the frequency but not the amplitude of the emissions. Where exploratory measurements are not adequate to determine the worst-case operating modes and are used only to identify the frequencies of the highest emissions, additional preliminary tests can be required.

Preliminary tests shall be performed following the procedures in 6.3 on a site meeting the requirements of 5.2. For emissions from the EUT, the maximum level shall be determined by rotating the EUT and its antenna through 0° to 360°. For each mode of operation required to be tested, the frequency spectrum (based on findings from exploratory measurements) shall be monitored.

Broadband antennas and a spectrum analyzer or a radio-noise meter with a panoramic display are often useful in this type of test. If either antenna height or EUT azimuth are not fully measured during exploratory testing, then complete testing can be required at the OATS or semi-anechoic chamber when the final full spectrum testing is performed.

ANSI C63.10.2013, 6.6.4.3 Final radiated emissions measurements

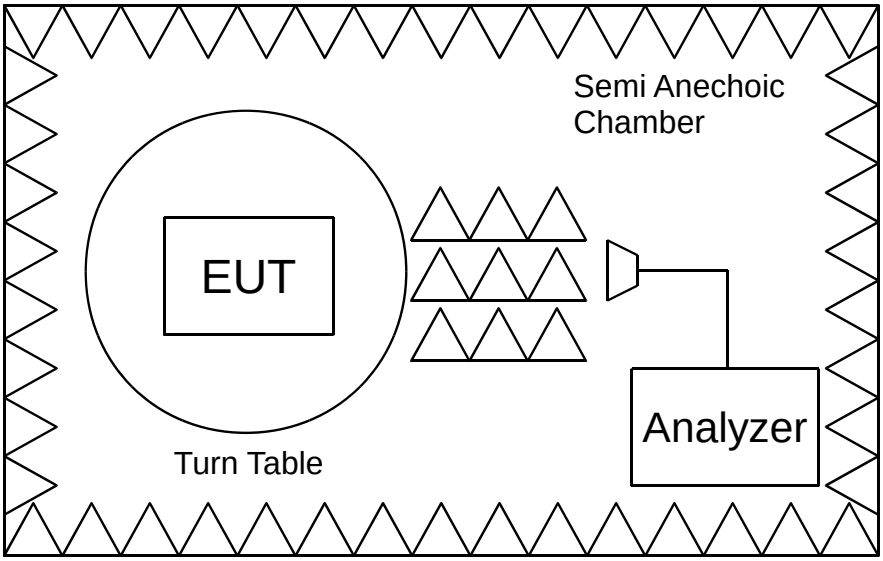
The final measurements are performed on a site meeting the requirements of 5.2. Using the orientation and equipment arrangement of the EUT based on the measurement results found during the preliminary (exploratory) measurements per 6.6.4.2, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable), as well as the frequency and amplitude of the six highest spurious emissions relative to the limit. Emissions more than 20 dB below the limit do not need to be reported.

Measurements are performed with the EUT rotated from 0° to 360°; the antenna height scanned in accordance with 6.6.3.1, 6.6.3.2, or 6.6.3.3, as appropriate; and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Variations in cable or wire placement shall be explored to maximize the measured emissions.

The emission signal shall be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission from the EUT is measured. This may be achieved by either pointing the antenna at an angle toward the source of the emission or by testing the EUT as described in 6.6.3.3.
If the emission is pulsed, then refer to Annex C for guidelines on selecting bandwidth and determining pulse desensitization factors, as necessary.
As noted in 6.6.4.1, when performing these measurements, the sensitivity of the complete measurement system relative to the limit shall be determined before the test. If the overall measurement sensitivity is inadequate, then low-noise preamplifiers, closer measurement distances, higher gain antennas, or narrower bandwidths may be used. If closer measurement distances or higher gain antennas are used, then the beamwidth of the measurement antenna versus the physical size of the EUT shall be taken into account, so that the physical sizes of the EUT dimensions are encompassed by the beamwidth of the measurement antenna. Also, measurement system overload protection shall be determined to be adequate when preamplifiers are used. The effects on the measured emission value using bandwidths different from those specified shall be determined if such bandwidth changes are made. Any changes from the specific measurement conditions shall be described in the report of the measurements.
Unless specified otherwise by the regulatory authority, the instrumentation, detector functions, and bandwidths specified in 4.1.4.2.1 and 4.1.4.2.2 shall be used. For pulsed emissions, the procedure in 4.1.4.2.4 shall be used.

Radiated Emissions Test Characteristics	
Frequency range	18 GHz – 26.5 GHz
Test distance	1 m (18 – 26.5 GHz)
Test instrumentation resolution bandwidth	1 MHz
Receive antenna height	1.5 m
Receive antenna polarization	Vertical/Horizontal
Measurement chamber	Semi anechoic chamber (SAC)

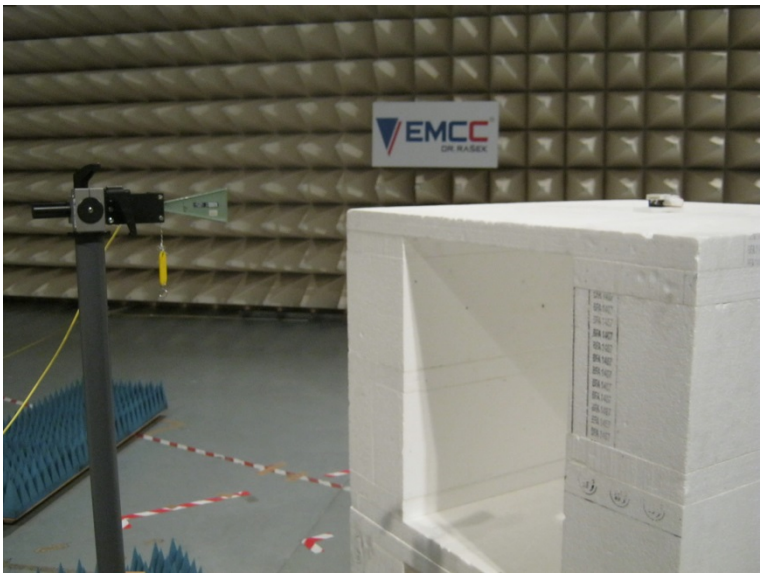
4.5.11.2 Test Setup



SCHEMATIC TEST SETUP

Requirement:	47 CFR, § 15.209 RSS-210, Annex B.10 RSS-Gen
Procedure:	ANSI C63.10-2013
Receiver:	#3831
Antenna:	#1300 (18 – 26.5 GHz)
Test distance:	1 m (18 – 26.5 GHz)

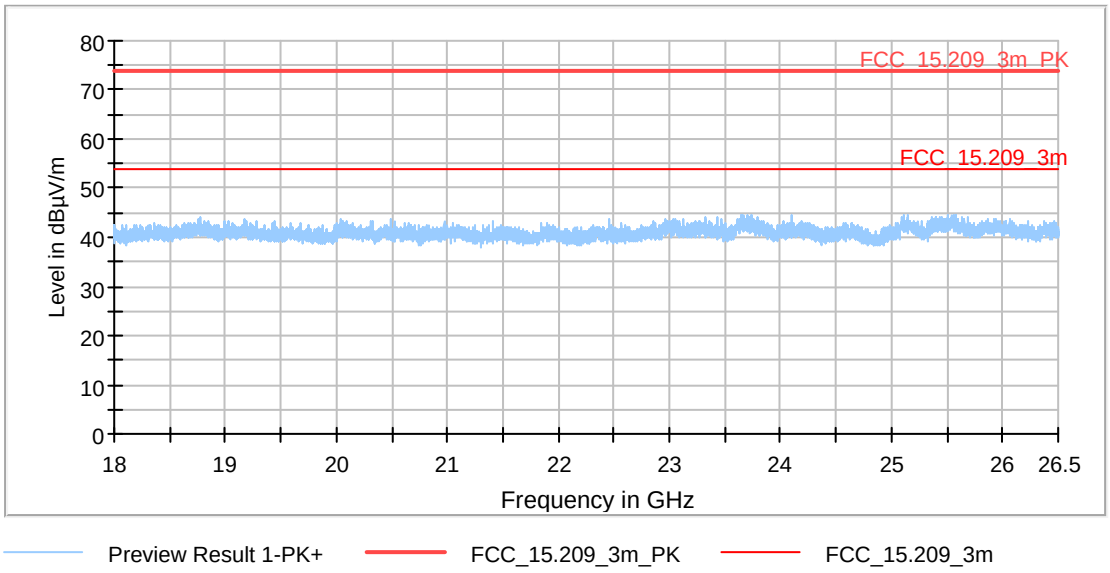
TEST EQUIPMENT USED:
Refer to chapter 5 of this document.
553, 554, 1300, 1889, 2048, 3061, 3831, 3880, 4075, 4717, 5392, 5535, 5536



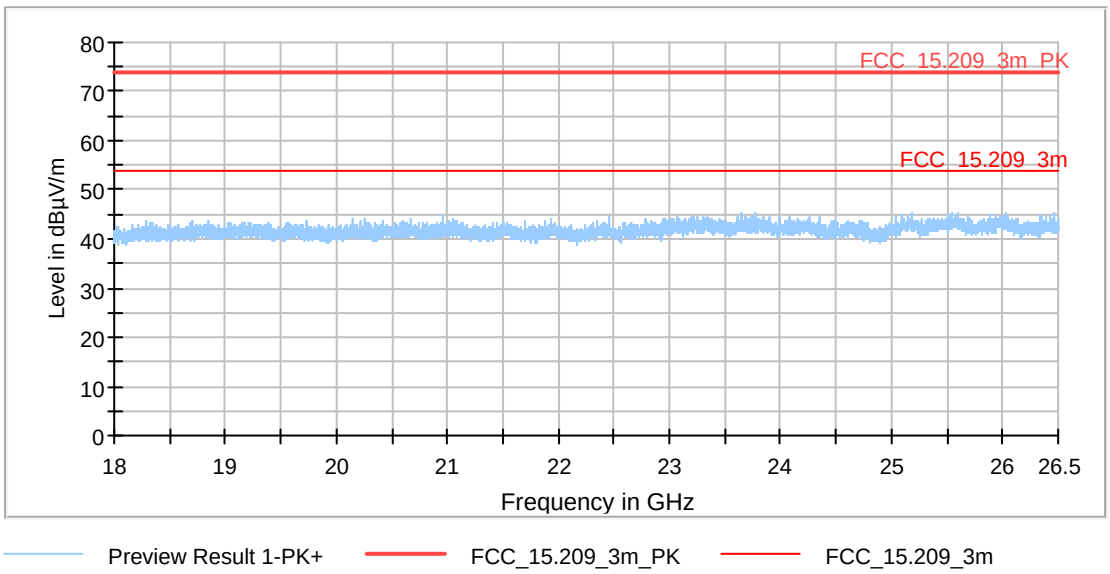
Sample photo of setup (18 – 26.5 GHz)

4.5.11.3 Detailed Test Data

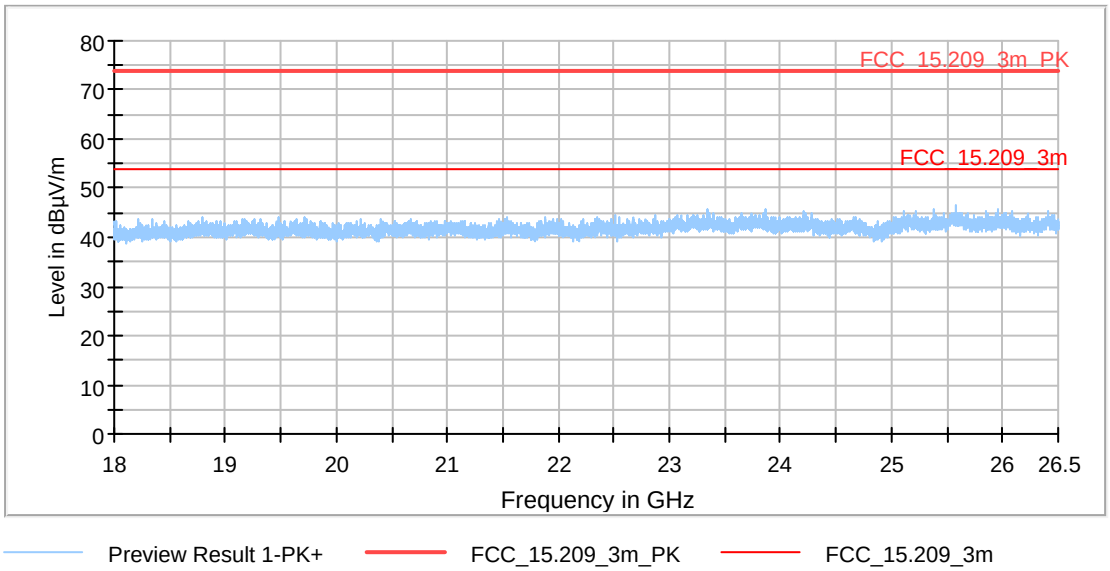
Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#1, none
EUT Orientation:	1



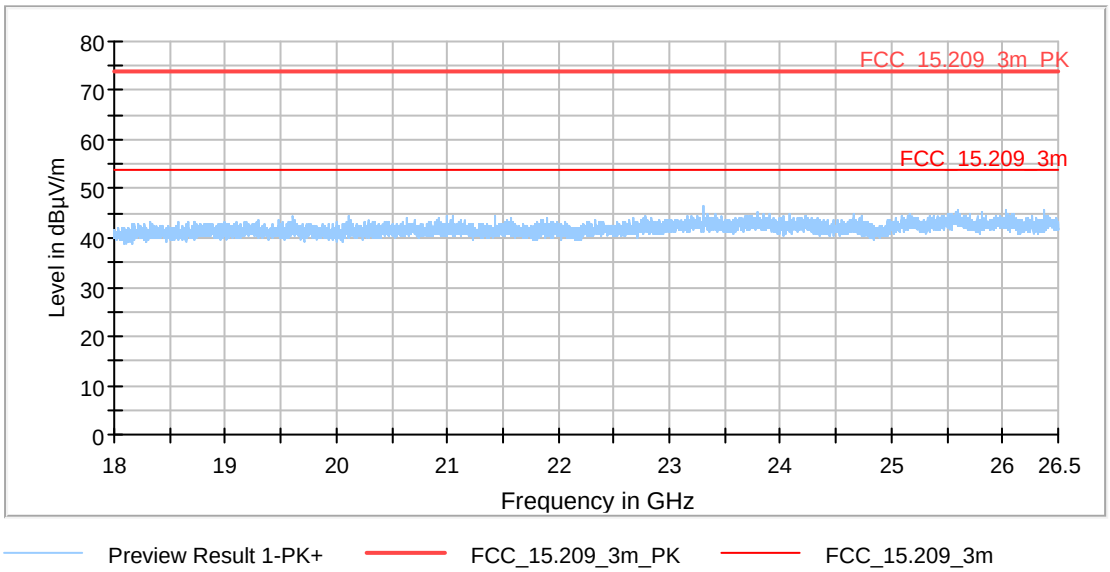
Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#1, none
EUT Orientation:	2



Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#1, none
EUT Orientation:	3

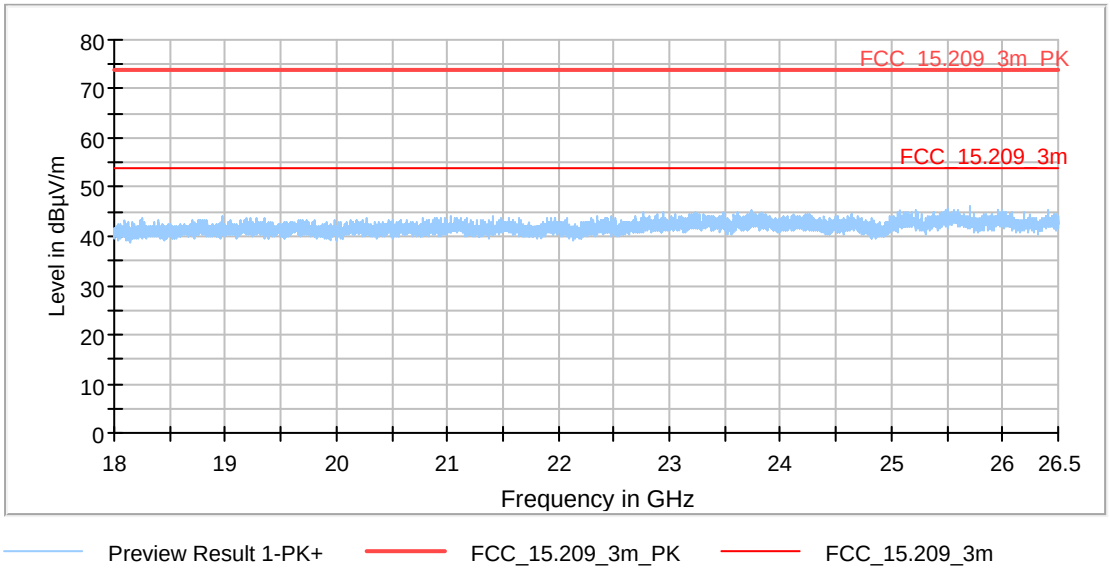


Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#2, none
EUT Orientation:	1

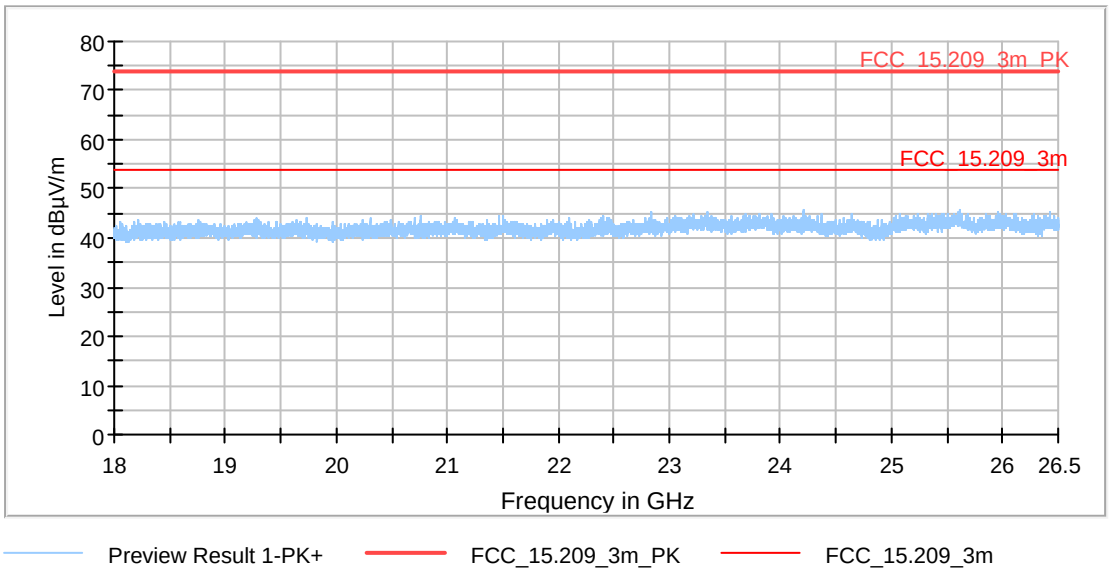


Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#2, none
EUT Orientation:	2

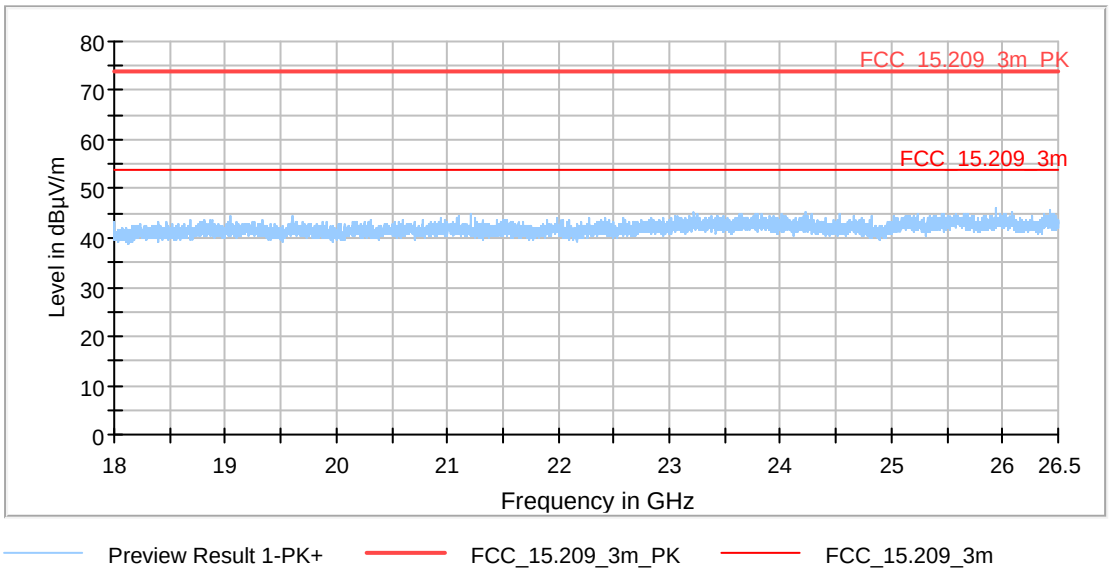


Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#2, none
EUT Orientation:	3

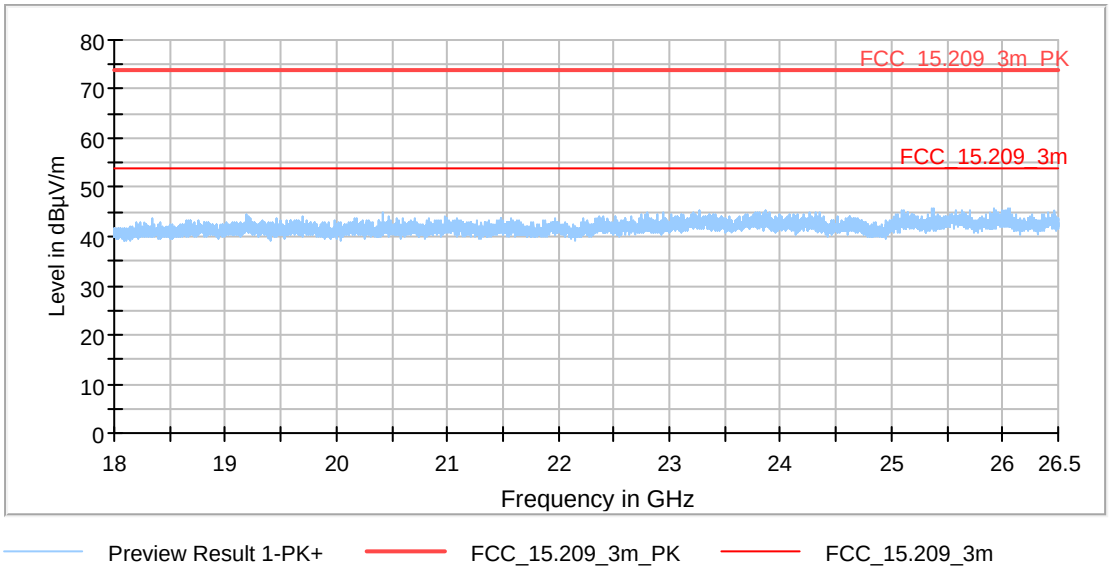


Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#3, none
EUT Orientation:	1

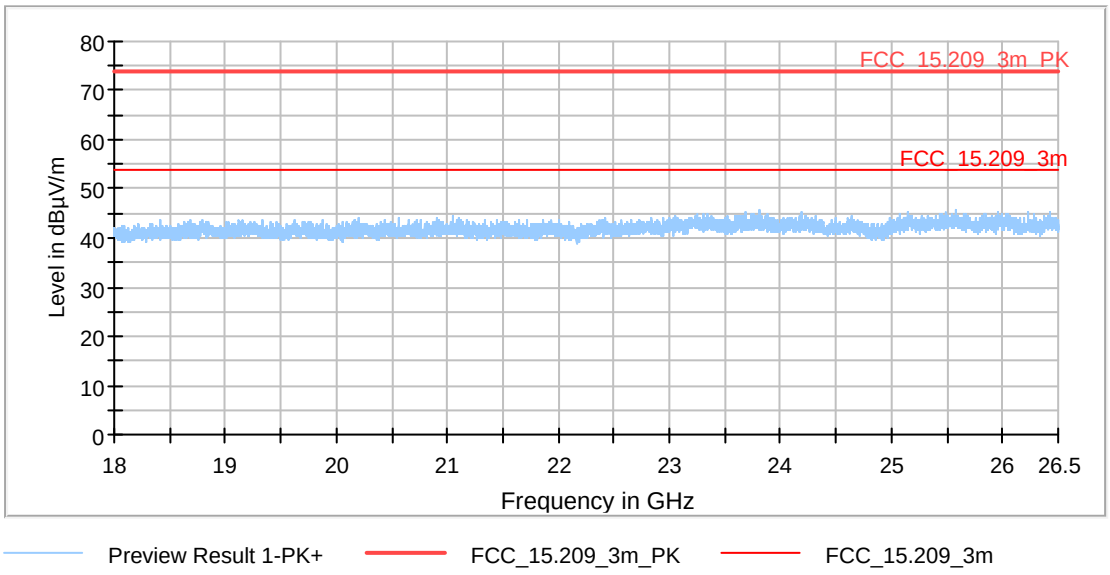


Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#3, none
EUT Orientation:	2



Test on EnOcean GmbH PTM 215B to 47 CFR § 15.249 and RSS-210 Issue 9 (Amendment), Annex B.10

Manufacturer:	EnOcean GmbH
Type:	PTM 215B
EUT no., Serial No:	EUT#3, none
EUT Orientation:	3



Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)

All prescan peak results are below the average limit, therefore no final measurement performed.

All tests performed at the distance of d = 1 m (18 – 26.5 GHz).

The table above contains worst-case emissions, only. For further details refer to the pre-scan test plot above.

4.5.11.4 Test Result

Manufacturer:	EnOcean GmbH
Device:	PTM 215B
EUT No., Serial No:	EUT#1, none
	EUT#2, none
	EUT#3, none
Test date:	2019-09-09
Test personnel:	Ludwig Kraft

The EUT meets the requirements of this section.

5 TEST INSTRUMENTS

Ident#	Instrument	Manufacturer	Type	Last Calibration	Calibration valid until
54	N-Cable N/50	Rohde & Schwarz	HFU2-Z5	n/a	n/a
374	Loop Antenna	Rohde & Schwarz	HFH 2-Z2	2018-11	2021-02
553	GPIB-140A	National Instruments	186135C-31	n/a	n/a
554	GPIB-140A	National Instruments	186135C-31	n/a	n/a
1291	Antenna Mast	Frankonia	FAM4	n/a	n/a
1292	Multi Device Controller	Frankonia	FC02	n/a	n/a
1300	Standard Gain Horn Antenna	Mid Century	MC 20/31B	2014-07	2024-07
1889	SR-ULL-01, Semi-Anechoic Chamber (SAC)	EMCC/FRANK.	SAC-10	n/a	n/a
2048	USB to GPIB adaptor	National Instruments	GPIB-USB-HS, 187965B-01	n/a	n/a
2724	5 W Attenuator 6dB	Weinschel	2	2019-07	2021-07
3061	K-Cable K/50	Insulated Wire	KPS-1501-600-KPS	2019-02	2020-02
3236	Double Ridged Guide Antenna	Schwarzbeck	BBHA 9120D	2019-01	2021-01
3831	Spectrum Analyzer	Rohde & Schwarz	FSU50	2018-10	2019-10
3846	EMI Test Receiver	Rohde & Schwarz	ESU8	2019-02	2020-02
3880	Digital Multimeter	Agilent	U1241B	2018-07	2020-07
4075	Workstation	Dell	Optiplex 7010	n/a	n/a
4717	Web-Thermo-Hygrobarograph	Wiesemann & Theis GmbH WUT	57613 Web-T/Rh/P	2018-01	2020-01
5366	High Pass Filter	dBd communications	DBD-FTR-15SH-U3500-O/O	2018-02	2020-02
5392	EMC Measurement Software (V10.35.02)	Rohde & Schwarz	EMC32	n/a	n/a
5535	Positioning controller	Rohde & Schwarz	HCC	n/a	n/a
5536	Rotary table	Rohde & Schwarz	HCT12	n/a	n/a
5544	Antenna Mast	innco systems GmbH	MA 5000-XPET	n/a	n/a
5545	Antenna Mast Controller	innco systems GmbH	CO 3000-1D	n/a	n/a
5616	RF cable assembly	Rosenberger	LA2-025-7000	n/a	n/a
5620	RF cable assembly	Rosenberger	LA2-001-2000	n/a	n/a
6041	TRILOG Broadband Antenna	Schwarzbeck	VULB 9163	2017-09	2019-09

6 MEASUREMENT UNCERTAINTY

Measurement	Measurement Uncertainty
Conducted Emissions, AC mains (150 kHz – 30 MHz)	±3.5 dB
Radiated Emissions below 1000 MHz	±5.6 dB
Radiated Emissions above 1 GHz	±5.3 dB

The reported uncertainty values are based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of 95%.

The given values have been calculated on the basis of the following documents:

TR 100 028-1 V1.4.1 (2001-12)
TR 100 028-2 V1.4.1 (2001-12)
ISO: Guide to the Expression of Uncertainty in Measurement: 1993.
CISPR 16-4-2:2011+A1:2014, Specification for radio disturbance and immunity measuring apparatus and methods - Part 4-2: Uncertainties, statistics and limit modelling - Measurement instrumentation uncertainty.

JCGM 100:2008, Evaluation of measurement data - Guide to the expression of uncertainty in measurement.

7 LIST OF ANNEXES

The following annexes are separated parts from this test report.

Description	Pages
Annex 1: Photographs of test setup	5
Annex 2: External photographs of equipment under test	6
Annex 3: Internal photographs of equipment under test	4
Annex 4: Photographs of ancillary equipment	2