TEST REPORT # EMCC-110010IBB, 2014-05-21

EQUIPMENT UNDER TEST:

Trade Name:	Transmitter Module
Model:	PTM 215ZGP
Serial No:	Sample #14, Sample #18
Equipment Category:	Transmitter
Manufacturer:	EnOcean GmbH
Address:	Kolpingring 18 a 82041 Oberhaching GERMANY
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RELEVANT STANDARD(S): 47 CFR Part 15C

RSS-210 Issue 8 (2010-12)

MEASUREMENT PROCEDURE USED:

☒ ANSI C63.4-2009 ☒ RSS-Gen Issue 3 ☐ Other

TEST REPORT PREPARED BY:

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TEST PERSONNEL:

Manuel Zenk

HEAD OF GROUP:

Wolfgang Döring

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1 GENERAL INFORMATION

1.1 Purpose

The purpose of this report is to show compliance to the FCC regulations for unlicensed devices operating under section 15.249 of the Code of Federal Regulations title 47.
Further the report addresses compliance with the Industry Canada RSS-210 requirements for the certification of licence-exempt (i.e. unlicensed) low-power radio communication devices (LPDs) defined as Category I equipment.

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
Accreditation No.:	D-PL-12067-01-00
Address of Head Office and Labs I, II, III:	EMCCons DR. RAŠEK GmbH & Co. KG Moggast, Boelwiese 8 91320 Ebermannstadt GERMANY
Address of Labs IV and V:	EMCCons DR. RAŠEK GmbH & Co. KG Stoernhofer Berg 15 91364 Unterleinleiter GERMANY
Test Laboratory:	EMCCons DR. RAŠEK GmbH & Co. KG, Test Laboratory IV located at Stoernhofer Berg 15, 91364 Unterleinleiter, Germany The 3 m & 10 m semi-anechoic chamber site has been fully described in a report submitted to the FCC, and accepted in the letter dated December 24, 2013, Registration Number 878769. The 3 m & 10 m semi-anechoic chamber site has been fully described in a report submitted to IC. This 3 m / 10 m alternative test site is approved by Industry Canada under the file number 3464C-1.
Name for contact purposes:	Mr Manuel Zenk
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1.4 Manufacturer

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Country:	GERMANY
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E-mail:	sebastian.meineke@enocean.com

1.5 Dates and Test Location

Date of receipt of EUT:	2014-05-14
Test Date:	see table below
Test Location:	Test laboratory IV

1.6 Ordering Information

Purchase Order and Date:	2014-10486, 2014-05-05
Vendor Number:	K701624

1.7 Climatic Conditions

Date	Temperature [°C]	Relative Humidity [%]	Air Pressure [hPa]	Customer attended tests
2015-05-15	22	37	975	No
2014-05-16	22	39	984	No
2014-05-19	22	46	967	No

2 PRODUCT DESCRIPTION

2.1 Equipment Under Test (EUT)

Trade Name:	Transmitter Module
Model:	PTM 215ZGP
Serial Number:	Sample #14, Sample #18
Application:	Wireless switch
Power:	Electro dynamic power supply device, for testing purposes Sample #14 was equipped with a 3 V battery
Transmit Frequency:	16 RF channels in the frequency range 2.405 GHz to 2.480 GHz. Tests performed at channel 26, 2.480 GHz, only acc. to customer´s request.
Modulation:	Offset QPSK with DSSS (PN9)
Emission designator:	G1D
Lowest frequency in EUT:	> 100 kHz (DC/DC converter)
Antenna:	Internal PCB antenna
Interface ports:	none
Variants:	none
Test samples:	Sample #14 was used for the tests Sample #18 was used for duty cycle measurement, only
Remarks:	none

2.2 Test Samples and Mode of Operation During Testing

There were two different modes for test purposes available as well as the normal operating mode:

CW / Continuous modulated transmission:
Sample #14: Software modified unit (factory mode) with modulation (PN9) and without modulation (CW). Power supply is a Lithium battery, CR2032, 3.0 V which is used for testing the max. radiated field strength of the fundamental, harmonics and spurious emissions and bandwidth measurement.

Normal operating mode:
Sample #18: The EUT was programmed to its normal operating algorithm. Power supply is an electro dynamic power device. Used for testing the duty cycle characteristics.

2.3 EUT Peripherals

None.

2.4 Modifications Required for Compliance

None.

3 TEST RESULTS SUMMARY

Requirement	47 CFR Section	RSS, Section	Report Section	Test Result
Antenna Requirement	15.203	RSS-Gen Issue 3 (2010-12), 7.1.2	4	Pass
AC Line Conducted Emissions	15.207	RSS-Gen Issue 3 (2010-12), 7.2.4	5	N.A.[1]
Radiated Spurious Emissions	15.249(d), 15.209, 15.205(b)	RSS-210 Issue 8 (2010-12), A2.9(b)	6	Pass
Field Strength Limits (Fundamental)	15.249(a)	RSS-210 Issue 8 (2010-12), A2.9(a)	6	Pass
Field Strength Limits (Harmonics)	15.249(a)	RSS-210 Issue 8 (2010-12), A2.9(a)	6	Pass
20 dB Bandwidth (Occupied Bandwidth)	15.215(c)		7	Pass
99 % Power Bandwidth (Occupied Bandwidth)		RSS-Gen Issue 3 (2010-12), 4.6.1	7	Pass

N.A.[1] – Not applicable. The EUT is powered by electro dynamic device, only. The EUT is not designed to be connected to the public utility (AC) power line.

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 procedure ANSI C63.4 - 2009 and all applicable Public Notices received prior to the date of testing. All emissions from the device 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: Manuel Zenk
Issuance Date: 2014-05-21

4 ANTENNA REQUIREMENT

Test Requirement: FCC 47 CFR, Part 15C, Industry Canada RSS-Gen Section 7.1.2

4.1 Regulation

15.203 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 Part 15C. The manufacturer may design the unit so that the user can replace a broken antenna, 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 Sections 15.211, 15.213, 15.217, 15.219, or 15.221. 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 Section 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.

According to DA 00-2225 "OET Extends Effective Date of Antenna Connector Requirement Indefinitely", dated September 28, 2000, the OET extends the effective date of Public Notice, DA 00-1087, indefinitely.

4.2 Result

Equipment Under Test (EUT): PTM 215ZGP, Sample #14; PTM 215ZGP, Sample #18

The antenna is a permanently attached antenna (PCB antenna).

The EUT meets the requirements of this section.

5 CONDUCTED EMISSIONS TEST

Test Requirement: FCC 47 CFR, Part 15C, Industry Canada RSS-Gen Section 7.2.1
Test Procedure: ANSI C63.4-2009, Industry Canada RSS-Gen

5.1 Regulation

Section 15.207 (a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak (QP)	Average (AV)
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

Section 15.207 (c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provision for, the use of battery chargers which permit operating while charging, AC adaptors or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

5.2 Test Equipment

Not applicable.

5.3 Test Procedures

Not applicable.

5.4 Test Results

Equipment Under Test (EUT): None

The EUT is powered by electro dynamic power device only. Therefore - according to Section 15.207 (c) - conducted emissions measurements to demonstrate compliance with the conducted limits are not required.

6 RADIATED EMISSIONS TESTS

Test Requirement: FCC 47 CFR, Part 15C, Industry Canada RSS-210 Annex 2
Test Procedure: ANSI C63.4-2009, Industry Canada RSS-Gen

6.1 Regulation

Section 15.33 Frequency range of radiated measurements:
(a) Unless otherwise noted in the specific rule section under which the equipment operates 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.
(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)-(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.

Section 15.35 Measurement detector functions and bandwidths.
The conducted and radiated emission limits shown in this part are based on the following, unless otherwise specified elsewhere in this part:
(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 instrument using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Interference (CISPR) of the International Electrotechnical Commission. 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, properly adjusted for such factors as pulse desensitization, as long as the same bandwidths as indicated for CISPR quasi-peak measurements are employed.
NOTE: For pulse modulated devices with a pulse-repetition frequency of 20 Hz or less and for which CISPR quasi-peak measurements are specified, compliance with the regulations shall be demonstrated using measuring equipment employing a peak detector function, properly adjusted for such factors as pulse desensitization, using the same measurement bandwidths that are indicated for CISPR quasi-peak measurements.
(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, 15.255, and 15.509–15.519, 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.
(c) Unless otherwise specified, e.g. § 15.255(b), 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 seconds. As an alternative provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

Section 15.209 (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	Field Strength	Measurement Distance
(MHz)	(microvolts/meter)	(meter)
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

(b) In the emission table above, the tighter limit applies at the band edges.
(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
(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.
(f) In accordance with Section 15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in Section 15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in Section 15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in Section 15.109 that are applicable to the incorporated digital device.

Section 15.249 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz.
(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 (MHz)	Field Strength of Fundamental (millivolts/meter)	Field Strength of Harmonics (microvolts/meter)
902-928	50	500
2400-2483.5	50	500
5725-5875	50	500
24000-24250	250	2500

(b) Fixed, point-to-point operation as referred to in this paragraph shall be limited to systems employing a fixed transmitter transmitting to a fixed remote location. Point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information are not allowed. Fixed, point-to-point operation is permitted in the 24.05-24.25 GHz band subject to the following conditions:

(1) The field strength of emissions in this band shall not exceed 2500 millivolts/meter.

(2) The frequency tolerance of the carrier signal shall be maintained within ±0.001% of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

(3) Antenna gain must be at least 33 dBi. Alternatively, the main lobe beamwidth must not exceed 3.5 degrees. The beamwidth limit shall apply to both the azimuth and elevation planes. At antenna gains over 33 dBi or beamwidths narrower than 3.5 degrees, power must be reduced to ensure that the field strength does not exceed 2500 millivolts/meter.

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

(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.

(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.

6.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Calibration Interval
Loop Antenna (9 kHz - 30 MHz)	Rohde & Schwarz HFH2-Z2	374	2014-05	36 months
Antenna (30 MHz - 1 GHz)	EMCO Model 3143	898	2014-01	24 months
Receiver (9 kHz - 1 GHz)	Rohde & Schwarz ESS	303	2013-02	24 months
Antenna (1 GHz – 18 GHz)	Schwarzbeck BBHA 9120 D	3235	2013-02	36 months
Standard Gain Horn Ant. (18 GHz – 26.5 GHz)	Mid Century MC 20/31B	1330	n.a.	n.a.
Spectrum Analyser (20 Hz – 50 GHz	Rohde & Schwarz FSU50	3831	2013-07	12 months
Bandpass Filter	Microphase / K0918	1038	2013-06	24 months
Bandpass Filter	Microphase / K0919	1035	2013-06	24 months
Highpass Filter	Microphase / HTP 9000AB	1017	2013-06	24 months

6.3 Test Procedures

Portable, small, lightweight, or modular devices that may be hand-held, worn on the body, or placed on a table during operation shall be positioned on a no conducting platform, the top of which is 80 cm above the reference ground plane. Ceiling and wall-mounted devices shall also be positioned on a tabletop for testing purposes.
The EUT was tested on a 0.8 meter high platform. For better alignment with the test antenna for test at frequencies > 1GHz the EUT was placed at 1.0 meter and 1.5 m height, respectively.
Preview tests are performed to determine the "worst case" mode of operation. With the EUT operating in "worst case" mode, emissions from the unit are maximized by adjusting the polarization and height of the receive antenna and rotating the EUT on the turntable. Manipulating the system cables also maximizes EUT emissions *[Remark: Not applicable]*. All tests performed with the EUT placed in 3 axes on the nonconductive platform. Worst case emissions are listed under chapter: test results.

A new battery was installed at the beginning of the tests.

Radiated Emissions Test Characteristics	
Frequency range	9 kHz – 25 GHz
Test distance	1 / 3 m*
Test instrumentation resolution bandwidth	200 Hz (9 kHz - 150 kHz)
	10 kHz (150 kHz - 30 MHz)
	120 kHz (30 MHz - 1,000 MHz)
	1 MHz, 100 kHz (1,000 MHz - 25,000 MHz)
Receive antenna scan height	1 m – (1.5) 4 m (E-field antenna only)
Receive antenna polarization	Horizontal (H-field, f < 30 MHz)
	Vertical/Horizontal (E-field, f > 30 MHz)

* According to Section 15.31 (f)(1): At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near

field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. (...) When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).
According to Section 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).

H-field measurement up to 30 MHz was performed in a semi-anechoic room at a test distance of 3 m. A calibrated loop antenna as specified in ANSI C63.4 clause 4.1.5.1 was positioned at the test distance from the EUT and rotated about its vertical axis for maximum response at each azimuth of the EUT. In a second test run the EUT position was turned by 90 degrees. I.e. tests performed for 2 EUT orientations. The centre of the loop antenna was 1 m above the ground.

E-field measurements above 30 MHz were performed as follows:
- pre-scan up to 1 GHz at a distance of 3 m,
- final test up to 1 GHz in semi-anechoic room at a test distance of 3 m
- all tests above 1 GHz at a closer distance of 1 m (in fully anechoic room).

6.4 Calculation of Field Strength Limits

Fundamental field strength limits for frequencies 2400 – 2483.5 MHz (fundamental frequency F = 2405 MHz):
µV/m at 3 meters = 50 mV/m corresponds with 94 dBµV/m (average value).

The maximum permitted harmonics level is 500 µV/m corresponding with 54 dBµV/m (average value). The same level applies acc. to 15.209 for spurious emissions above 960 MHz.

For the peak limiting value the provisions in § 15.35 apply, i.e. by adding 20 dB.
Carrier peak limit is 114 dBµV/m and unwanted emissions peak limit above 1 GHz is 74 dBµV/m.

6.5 Calculation of Average Correction Factor

The average correction factor is computed by analysing the "worst case" on time in any 100 mSec time period and using the formula:

Corrections Factor (dB) = 20*log (worst case on time/100 mSec)

6.6 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor, Cable Factor and external Filter Attenuation, if applicable. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF + FA
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
FA = Filter Attenuation in dB

Assume a receiver reading of 23.5 dBµV is obtained. The Antenna Factor of 7.4 dB(1/m) and a Cable Factor of 1.1 dB are added, giving a field strength of 32 dBµV/m. The 32 dBµV/m value can be mathematically converted to its corresponding level in µV/m.
FS = 23.5 + 7.4 + 1.1 = 32 [dBµV/m]
Level in µV/m = Common Antilogarithm (32/20) = 39.8

Note: the Correction Factor in following tables consists of Antenna Factor, Cable Attenuation and Filter Attenuation if applicable.

For test distance other than what is specified, but fulfilling the requirements of Section 15.31 (f)(1) the field strength is calculated by adding additionally an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements). The basic equation with a sample calculation is as follows:

FS = FST + DF
where
FS = Field Strength in dBµV/m
FST = Field Strength at test distance in dBµV/m
DF = Distance Extrapolation Factor in dB,
where DF = 20 log (Dtest/Dspec) where Dtest = Test Distance and Dspec = Specified Distance

Assume the tests performed at a reduced test distance of 1 m instead of the specified distance of 3 m giving a Distance Extrapolation Factor of DF = 20 log (1m/3m) = -9.5 dB.

Assuming a measured field strength level of 39.5 dBµV/m is obtained. The Distance Factor of -9.5 dB is added, giving a field strength of 30 dBµV/m. The 30 dBµV/m value can be mathematically converted to its corresponding level in µV/m.
FS = 39.5 - 9.5 = 30 [dBµV/m]
Level in µV/m = Common Antilogarithm (30/20) = 31.6

6.7 Test Results

Equipment Under Test (EUT): PTM 215ZGP, Sample #14

The EUT meets the requirements of this section.

Test Personal: Manuel Zenk

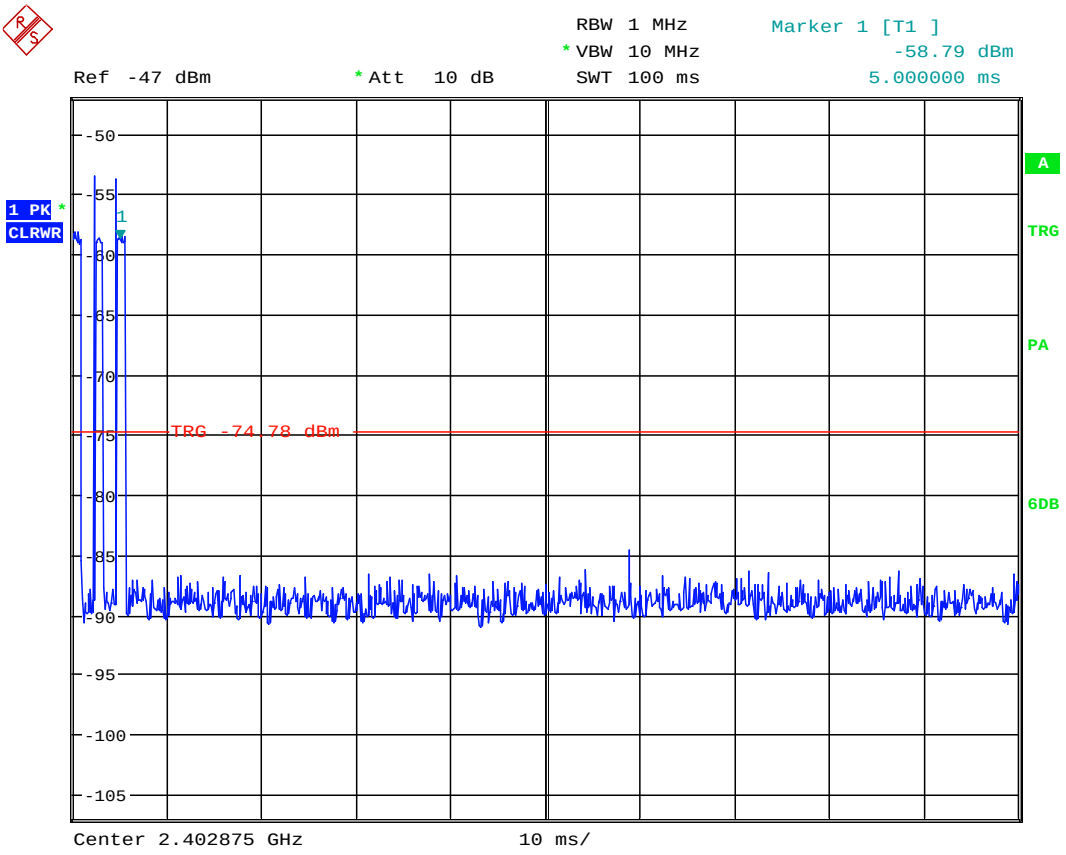
Test Date: 2014-05-15, 2014-05-16 and 2014-05-19

Detailed test data please refer to the following pages.

6.7.1 Duty Cycle

Duty cycle was tested with the EUT placed close to the receive antenna to get sufficient signal level. The spectrum analyser was set to zero span and to 1 MHz resolution bandwidth.

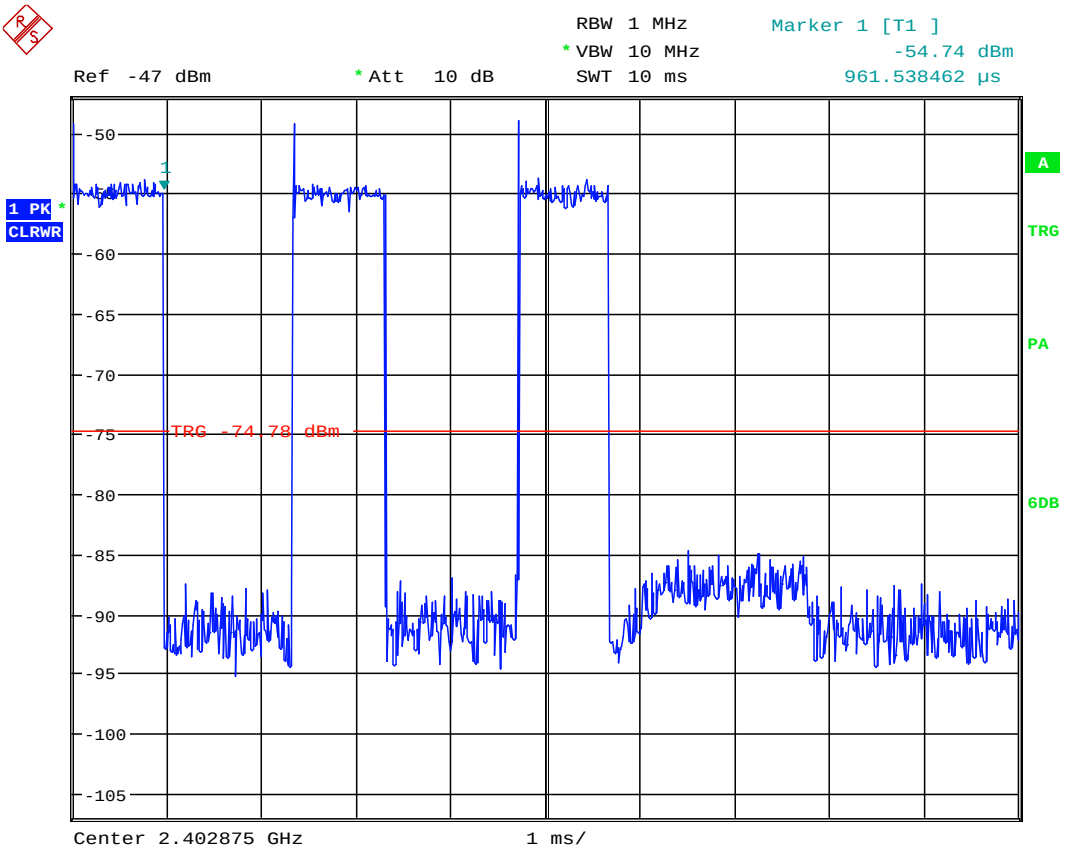
Equipment Under Test (EUT): PTM 215ZGP, Sample #18



EUT18

Date: 19.MAY.2014 12:19:14

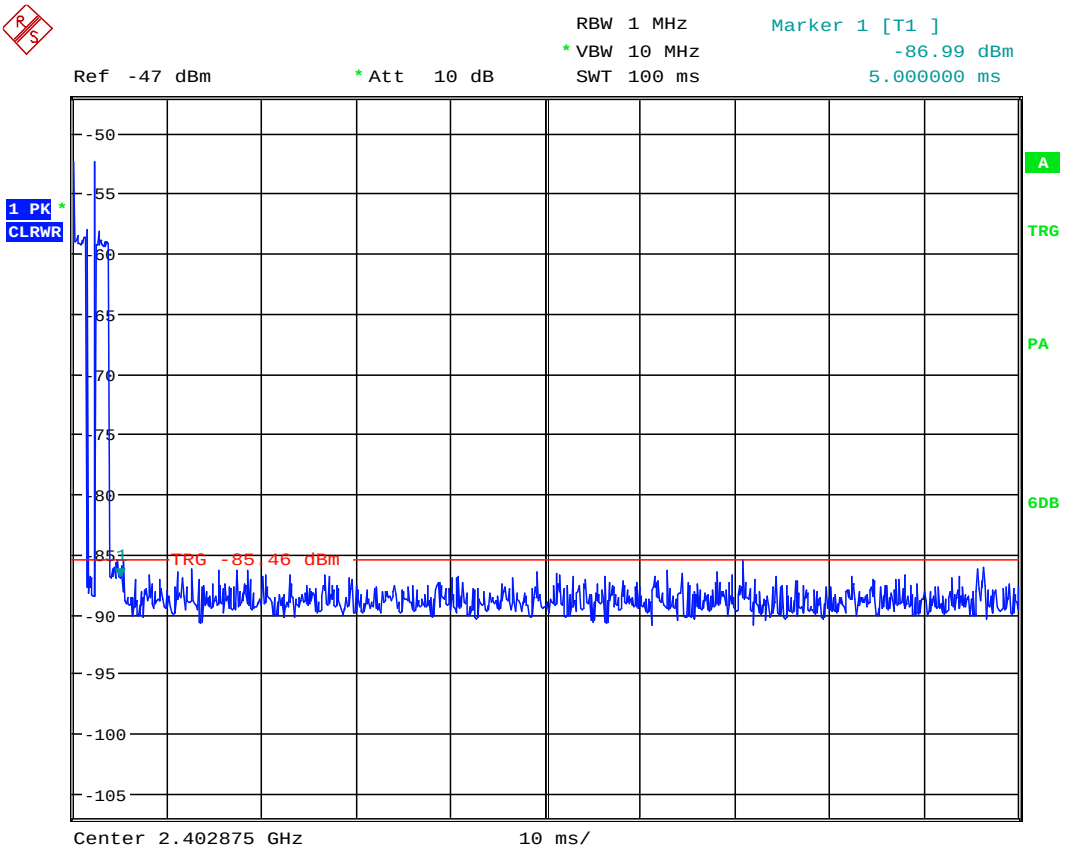
Plot 6.7.1-1: PTM 215ZGP, Sample #18, Complete transmission pattern after starting at line TR (= video trigger); normal mode



EUT18

Date: 19.MAY.2014 12:21:47

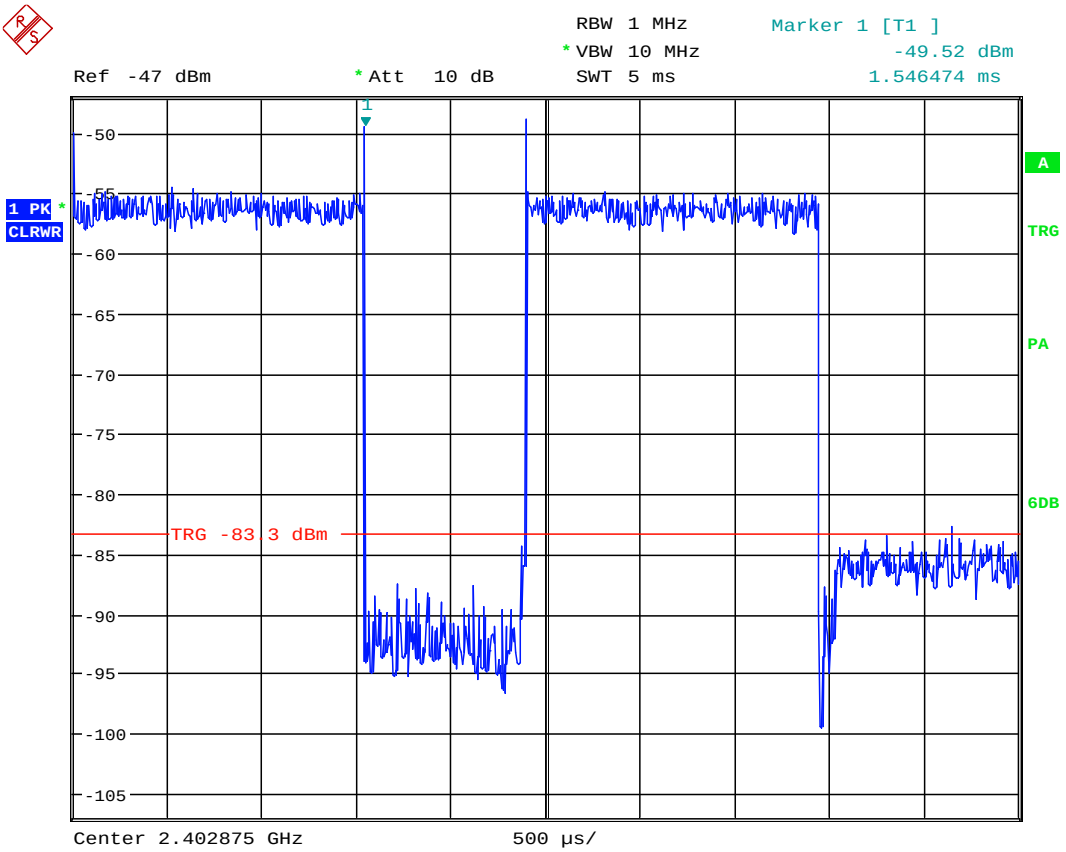
Plot 6.7.1-2: PTM 215ZGP, Sample #18, Complete transmission pattern after starting at line TR (= video trigger); normal mode, duration of one block, t_{on1} = 0.962 ms, t_{on2} = 0.963 ms, t_{on3} = 0.963 ms, t_{on} = 2.888 ms



EUT18

Date: 19.MAY.2014 16:18:04

Plot 6.7.1-3: PTM 215ZGP, Sample #18, Complete transmission pattern after starting at line TR (= video trigger); commissioning telegram



EUT18

Date: 19.MAY.2014 16:19:52

Plot 6.7.1-4: PTM 215ZGP, Sample #18, Complete transmission pattern after starting at line TR (= video trigger); commissioning telegram, duration of one block, t_{on1} = 1.546 ms, t_{on2} = 1.544 ms, t_{on} = 3.09 ms

The duty cycle is computed by analysing the "worst case" on time in any 100 mSec time period and using the formula:

duty cycle = worst case on time/100 mSec = t_{on} / 100 ms

$t_{on} = \sum t_{on\,1} + t_{on\,2} + \ldots\ldots t_{on\,x}$

$t_{on} = t_{on1} + t_{on2}$ = 3.09 ms

duty cycle = 3.09 ms / 100 ms → = 0.0309

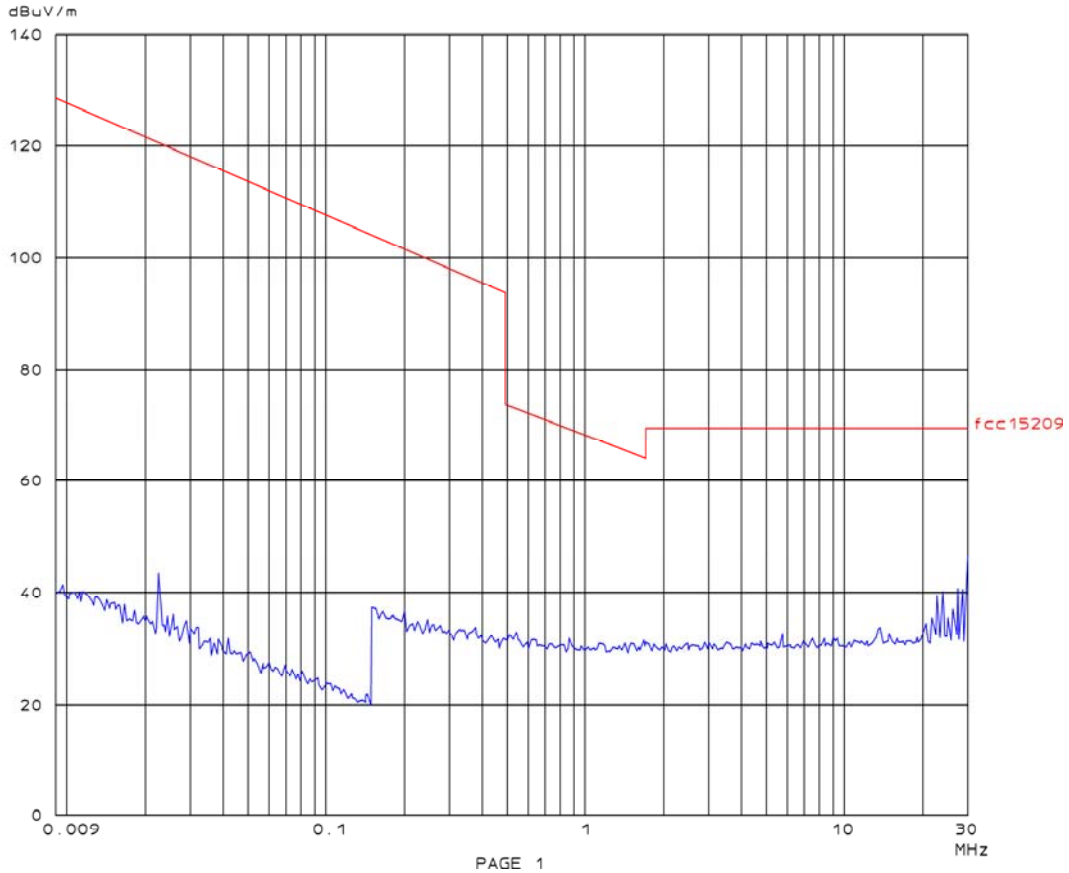
duty cycle factor (dB) = 20*log duty cycle = 20*log(0.03089) = -30.2 dB.

Result: The measured worst case duty cycle factor (AV factor) is -30.2 dB.

6.7.2 Magnetic Field (f = 9 kHz to 30 MHz)

The magnetic field test was performed in a distance of 3 m. Therefore distance correction factors of 80 dB (= correction from 300 m to 3 m) or 40 dB (= correction from 30 m to 3 m) are applicable.
The plot below shows the worst case emissions of the EUT with corrected limit line.

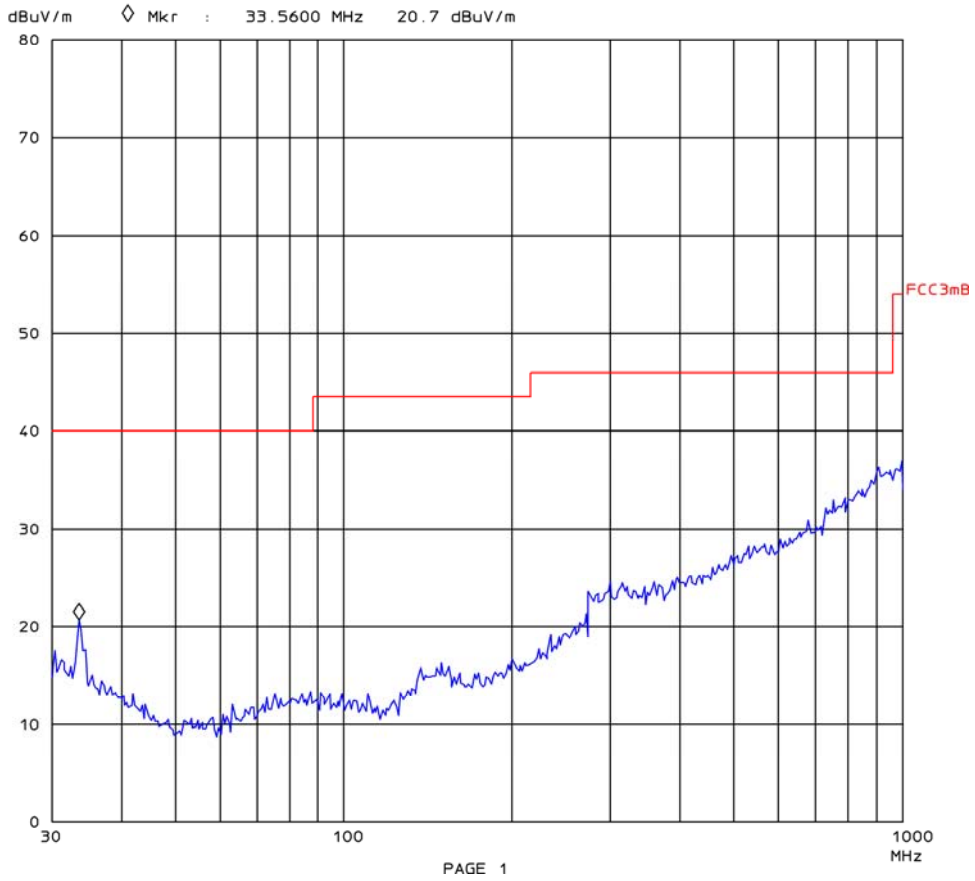
```
EMCCons DR. RASEK                                   15. May 14  10:38
Radiated Emissions H Field in SAR, d=3m

EUT:            PTM 215ZGP
Manuf:          ENocean
Op Cond:        continues tx, modulated, ch. 26
Operator:       Zenk, Reusch
Test Spec:      FCC 15, RSS-210
Comment:        antenna in 2 orientations
                EUT 4 orient.

Scan Settings (2 Ranges)
|--------- Frequencies ----------||---------- Receiver Settings ------------|
  Start       Stop         Step      IF BW  Detector  M-Time Atten Preamp OpRge
   9k         150k         100Hz      200Hz     PK       1ms AUTO LD OFF   30dB
 150k          30M           5k        10k      PK       1ms AUTO LD OFF   30dB

Final Measurement: x Hor-Max / + Vert-Max
                   Meas Time:     1 s
                   Subranges:    25
                   Acc Margin:   30dB
```



Plot 6.7.2-1: PTM 215ZGP, Sample #14, Magnetic Field emissions at 3 m distance; channel 26

6.7.3 Electric Field (f = 30 MHz to 1 GHz)

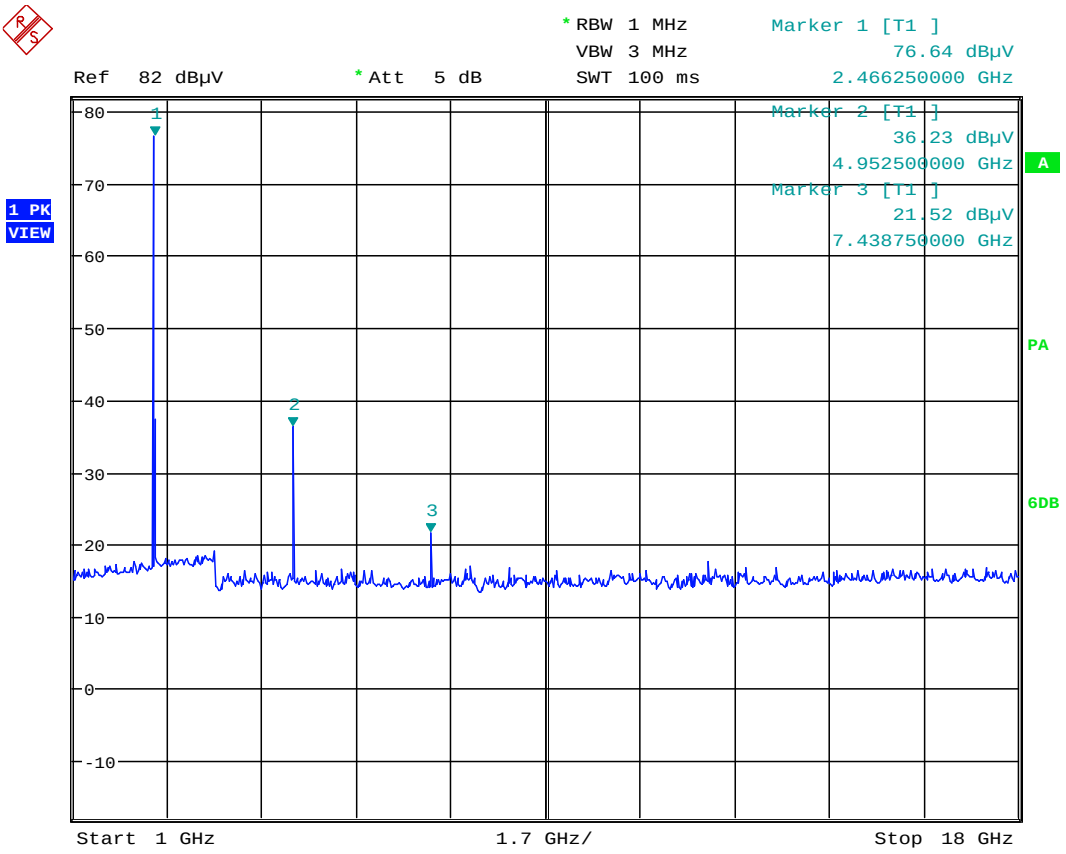
```
EMCCons DR. RASEK                                   15. May 14  13:34
Radiated Emissions Prescan in SAR, d=3m

EUT:            PTM 215ZGP
Manuf:          enocean GmbH
Op Cond:        continous modulated transmission Ch. 26
Operator:       Zenk, Reusch
Test Spec:      FCC15
Comment:        4 sides, hor. and vert. pol. 3/4 heights
                EUT vert

Fast Scan Settings (1 Range)
|--------- Frequencies -----------||----------- Receiver Settings ------------|
  Start       Stop          Step      IF BW  Detector  M-Time Atten Preamp OpRge
  30M        1000M          40k        120k      PK     0.10ms   0dBLN ON    60dB

                                    Transducer No. Start      Stop       Name
                                                21   30M      1000M      89826K33
```



Plot 6.7.3-1: PTM 215ZGP, Sample #14, pre-scan plot d = 3 m (30 MHz to 1 GHz); channel 26

6.7.4 Electric Field (f = 1 GHz to 25 GHz)

Remark: Plots below = analyser reading w/o antenna factor and cable attenuation (to be added)



EUT14, Channel 26
Date: 16.MAY.2014 15:27:31

Plot 6.7.4-1: PTM 215ZGP, Sample #14, worst-case pre-scan plot d = 1 m (1 MHz to 18 GHz), channel 26, antenna polarisation: vertical

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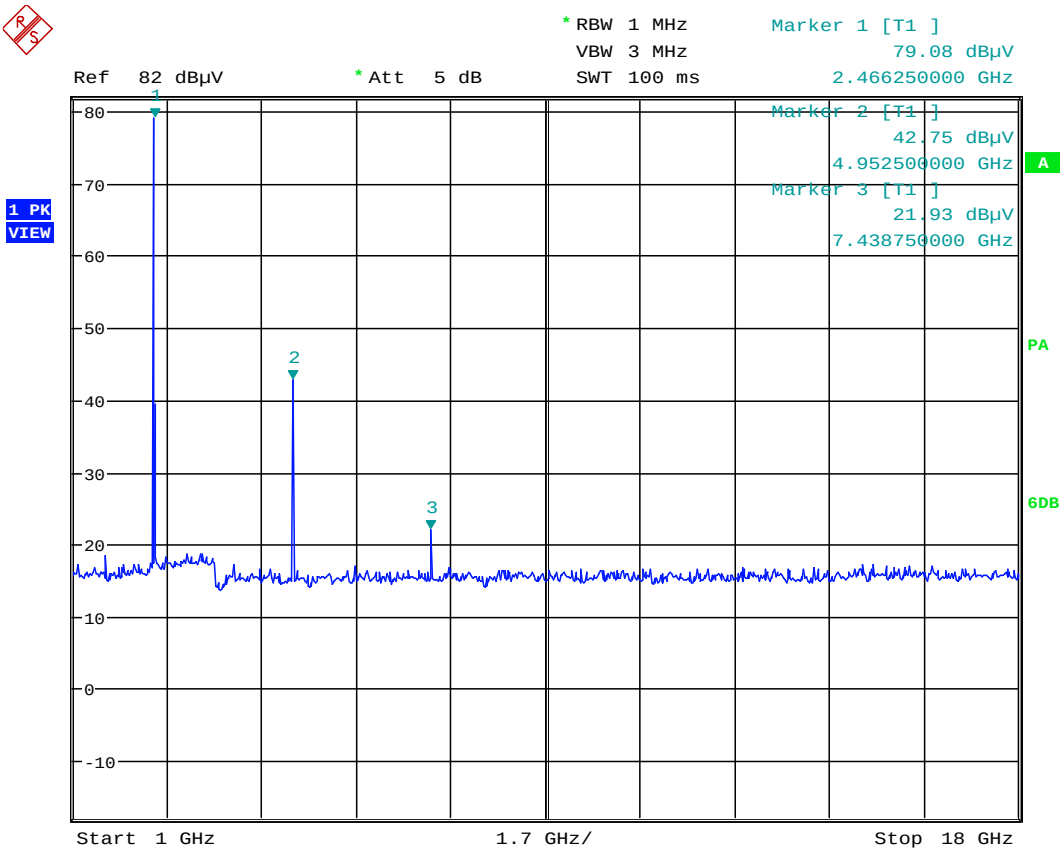
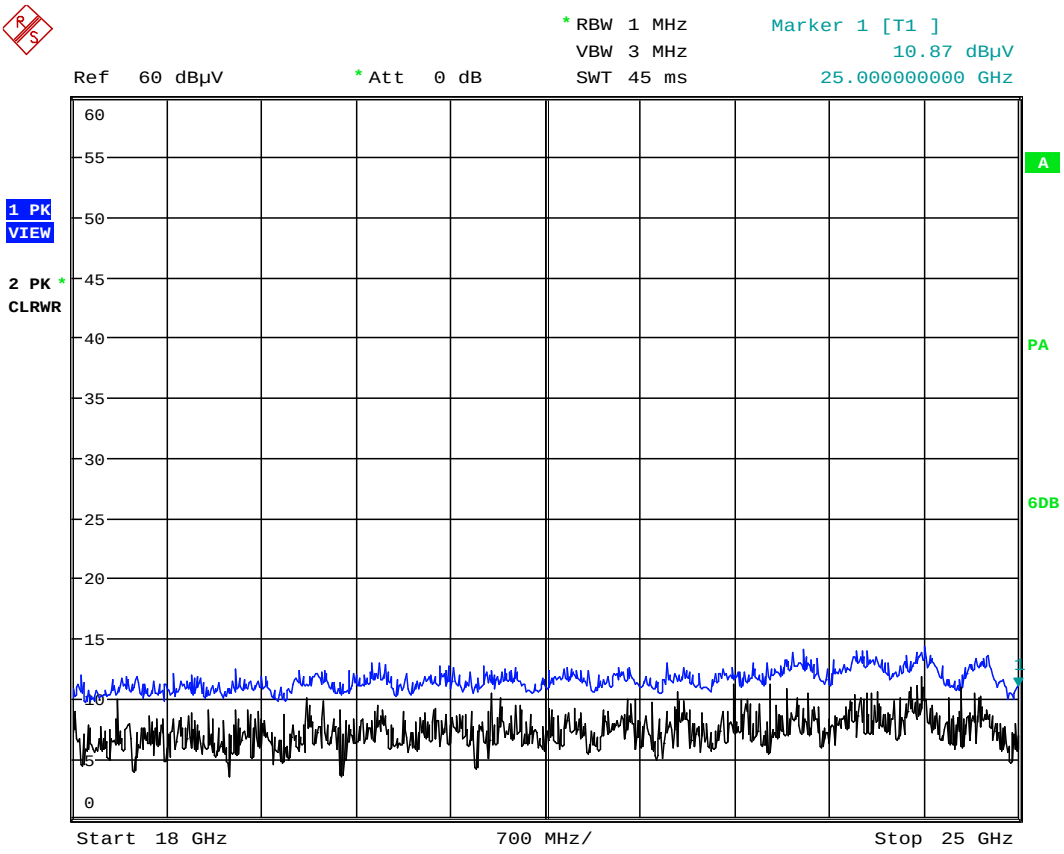


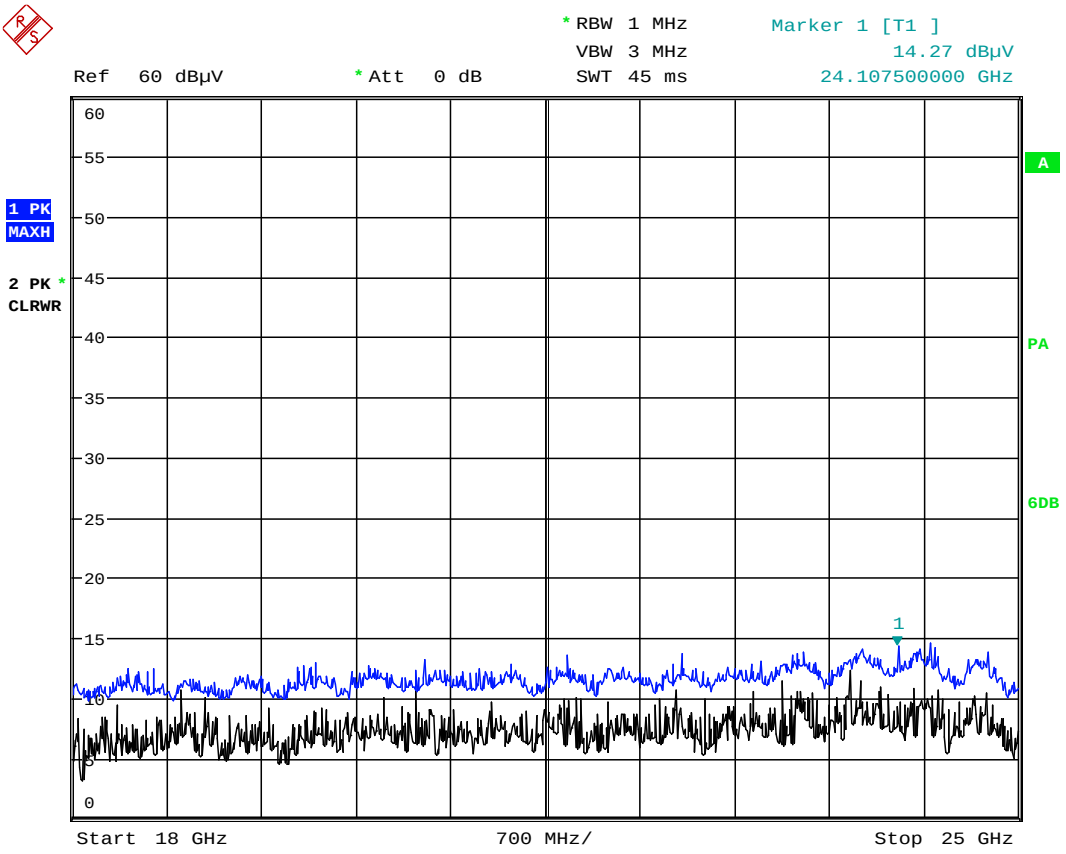
EUT14, Channel 26
Date: 19.MAY.2014 09:06:19

Plot 6.7.4-2: PTM 215ZGP, Sample #14, worst-case pre-scan plot d = 1 m (1 MHz to 18 GHz), channel 26, antenna polarisation: horizontal



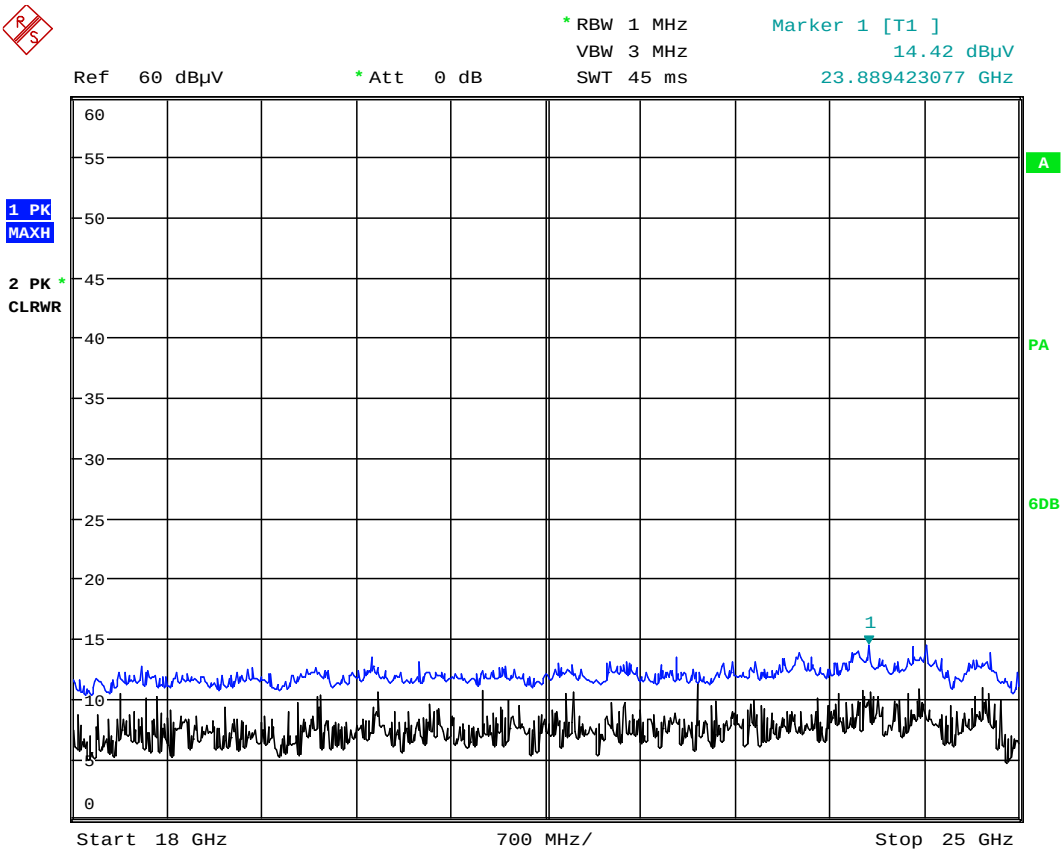
EUT14, Channel 26
Date: 19.MAY.2014 11:44:50

Plot 6.7.4-3: PTM 215ZGP, Sample #14, pre-scan plot d = 1 m (18 GHz to 25 GHz); channel 26, antenna polarisation: vertical



EUT14, Channel 26
Date: 19.MAY.2014 11:31:00

Plot 6.7.4-4: PTM 215ZGP, Sample #14, pre-scan plot d = 1 m (18 GHz to 25 GHz); channel 26, antenna polarisation: horizontal

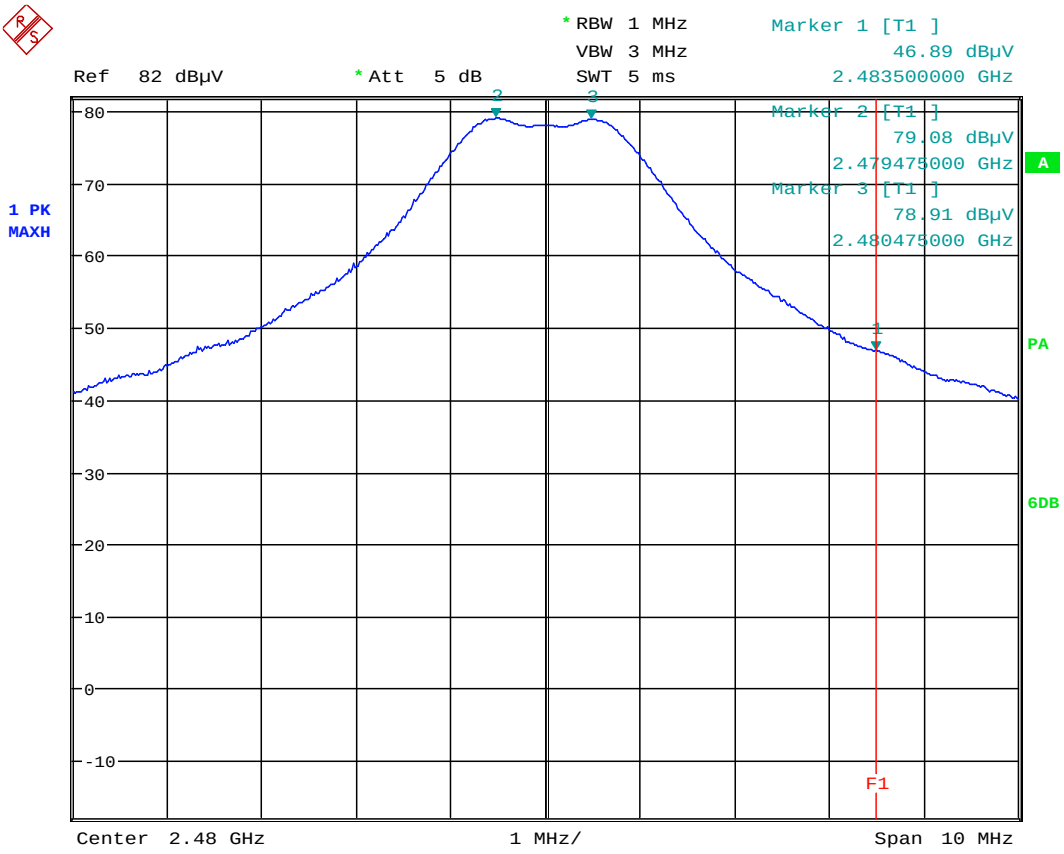


Date: 7.AUG.2013 15:16:59

Plot 6.7.4-6: PTM 215ZGP, Sample #14, pre-scan plot d = 1 m (18 GHz to 25 GHz); channel 25

6.7.5 Electric Field (Bandedge)

Remark: Plots below = analyser reading w/o antenna factor and cable attenuation (to be added)



EUT14, Channel 26
Date: 19.MAY.2014 10:08:09

Plot 6.7.5-1: PTM 215ZGP, Sample #14, upper band-edge d = 1 m; channel 26

Equipment under test (EUT): PTM 215ZGP, Sample #14, operating at channel 26

FINAL RESULTS: PRODUCT EMISSIONS **PEAK** DATA											
No	Emission Frequency [MHz]	Receiver Mode and Bandwidth [kHz]	Test Distance [m]	Receiver Reading RA [dB(µV)]	Correction Factor AF+CF [dB(1/m)]	DF [dB]	Result = Corrected Reading FS [dB(µV/m)]	Spec Limit PK [dB(µV/m)]	Polarization Antenna	Polarization EUT	Margin [dB]
1	2480	Pk, 1000	1	79.6	28.4	-9.5	98.5	114	h	v	15.5
2	2483.5	Pk, 1000	1	46.9	28.4	-9.5	65.8	74	h	v	8.2
3	4960	Pk, 1000	1	26.6	34.3	-9.5	51.4	74	h	v	22.6
4	7440	Pk, 1000	1	23.2	39.6	-9.5	53.3	74	h	v	20.7
5	9920	Pk, 100	1	7.4	41.4	-9.5	39.3	74	h	v	34.7
6	12400	Pk, 100	1	10.6	41.8	-9.5	42.9	74	v	v	31.1

The following results are calculated from the PEAK data by adding the duty cycle factor of - 30.2 dB

FINAL RESULTS: PRODUCT EMISSIONS **AVERAGE** DATA								
No	Emission Frequency [MHz]	Receiver Mode and Bandwidth [kHz]	PEAK data result FS [dB(µV/m)]	Duty cycle Factor [dB]	Result AV FS [dB(µV/m)]	Spec Limit AV [dB(µV/m)]	Margin [dB]	Notes
1	2480	Pk, 1000	98.5	-30.2	68.3	94	25.7	carrier
2	2483.5	Pk, 1000	65.8	-30.2	35.6	54	18.4	upper bandedge
3	4960	Pk, 1000	51.4	-30.2	21.2	54	32.8	2nd harmonic
4	7440	Pk, 1000	53.3	-30.2	23.1	54	30.9	3rd harmonic
5	9920	Pk, 100	39.3	-30.2	9.1	54	44.9	4th harmonic
6	12400	Pk, 100	42.9	-30.2	12.7	54	41.3	5th harmonic

7 BANDWIDTH

Test Requirement: FCC 47 CFR, Part 15C, Industry Canada RSS-Gen
Test Procedure: ANSI C63.4-2009, Industry Canada RSS-Gen

7.1 Regulation

FCC 15.215(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. 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.

IC RSS-Gen Chapter 4.6.1 Occupied Bandwidth
When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99 % emission bandwidth, as calculated or measured.

7.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Calibration Interval
Antenna (1 GHz – 18 GHz)	Schwarzbeck BBHA 9120 D	3235	2013-02	36 months
EMI Analyser (20 Hz – 8 GHz)	Rohde & Schwarz FSU50	3831	2013-07	12 months

7.3 Test Procedure

ANSI C63.4-2009 Section 13.7 Occupied Bandwidth Measurements.
(...)The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or the first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. Once the reference level is established, the equipment is conditioned with typical modulating signals to produce the worst-case (i.e., the widest) bandwidth. (...)
In order to measure the modulated signal properly, a resolution bandwidth that is small compared with the bandwidth required by the procuring or regulatory agency shall be used on the measuring instrument. However, the resolution bandwidth of the measuring instrument shall be set to a value within 1% to 5% of the signal bandwidth requirements. When no bandwidth requirements are specified, the minimum resolution bandwidth of the measuring instrument is given in Table 5.

Table 5 – Minimum instrument bandwidth

Fundamental frequency	**Minimum resolution bandwidth**
9 kHz to 30 MHz	1 kHz
30 to 1000 MHz	10 kHz
1000 MHz to 40 GHz	100 kHz

Supply the EUT with nominal ac voltage or install a new or fully charged battery in the EUT. Turn the EUT ON and set it to any convenient frequency within its operating range. Set a reference level on the measuring instrument at any location that will allow measuring the specified bandwidth (e.g., –20 dB below the unmodulated carrier).
Supply the EUT with modulation as specified in 13.2.2. Observe and record with plotted graphs or photographs the worst-case (i.e., widest) occupied bandwidth produced by these different modulation sources.

IC RSS-Gen Chapter 4.6.1 Occupied Bandwidth
When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99 % emission bandwidth, as calculated or measured.
The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
The span of the analyser shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1 % of the selected span as is possible without being below 1 %. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual.
The trace data points are recovered and directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 % of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth.

7.4 Test Result

Equipment Under Test (EUT): PTM 215ZGP, Sample #14

The measured 20 dB bandwidth is: ..... 2452 kHz
The measured 99 % bandwidth (according to RSSGen) is: ..... 2363 kHz

For detailed bandwidth plots refer to the following page.

The EUT meets the requirements of this section.

Test Personnel: Manuel Zenk

Test Date: 2014-05-19

Detailed test data plots refer to the following pages.

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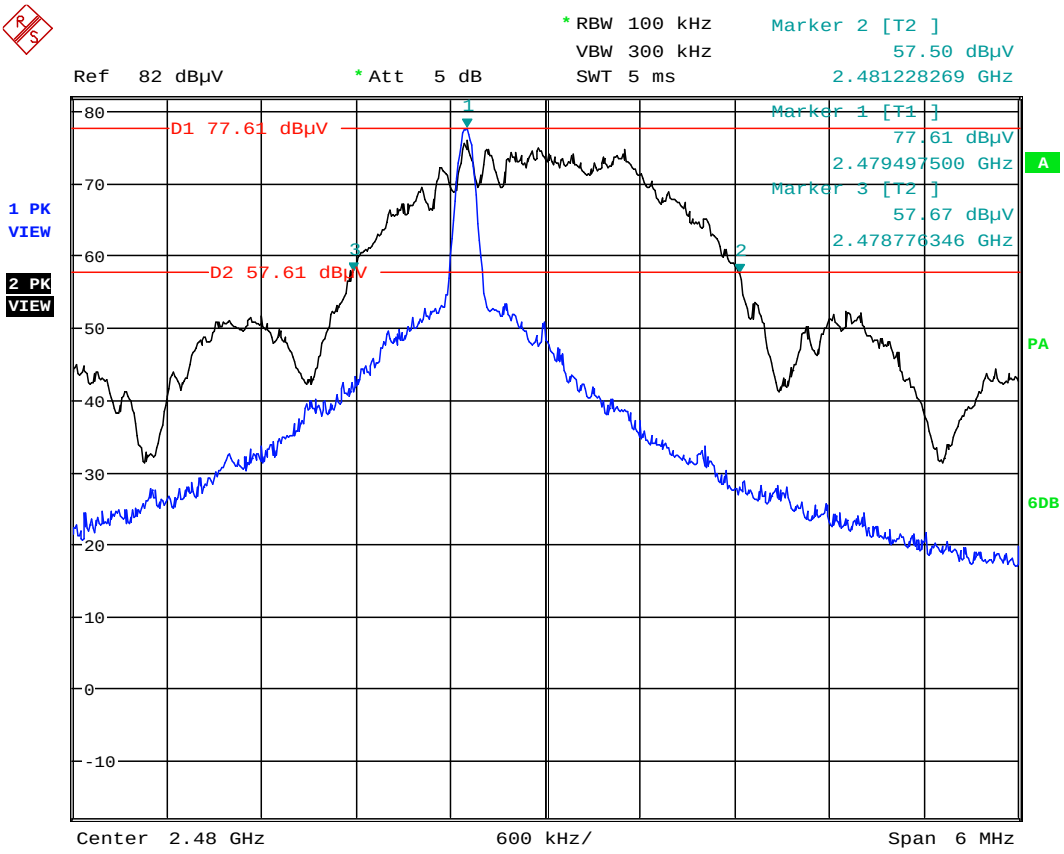

EUT14, Channel 26

Date: 19.MAY.2014 10:27:56

Plot 8.5-1: PTM 215ZGP, Sample #14, operating at channel 26, bandwidth plot – 20 dB bandwidth

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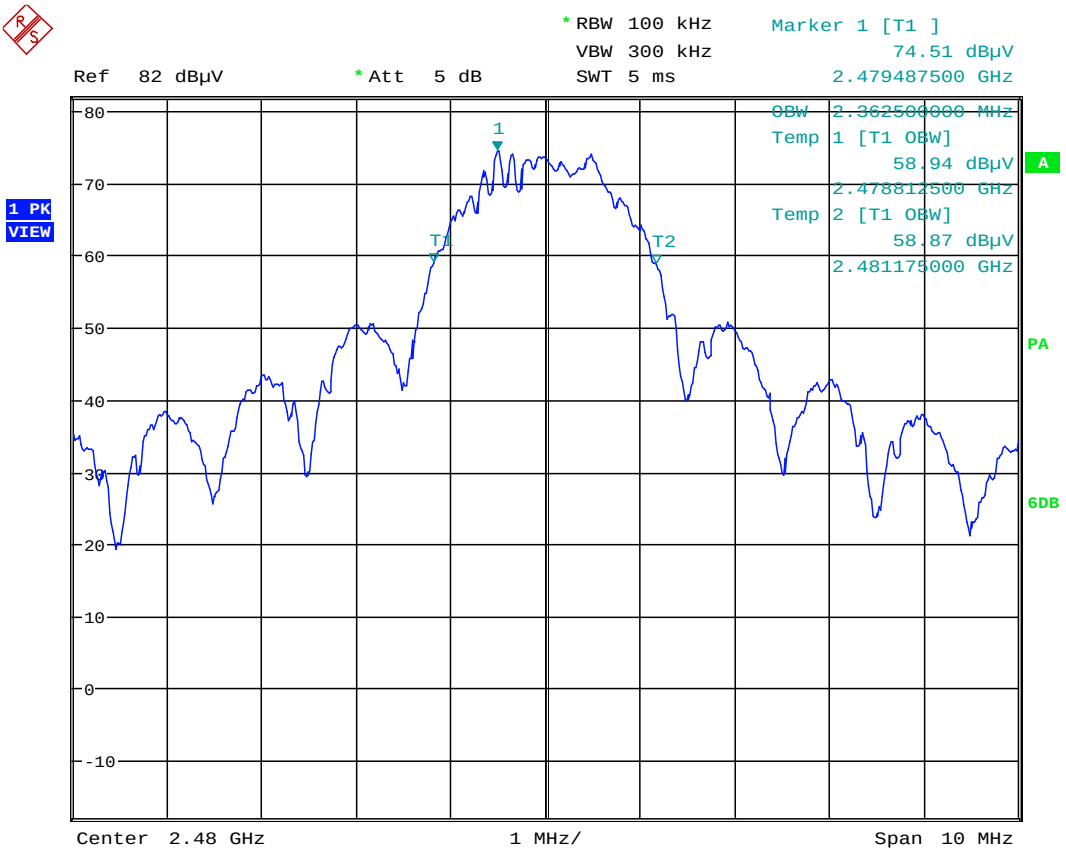
to 47 CFR Part 15C and RSS-210 Issue 8 (2010-12)



EUT14, Channel 26
Date: 19.MAY.2014 10:18:09

Plot 8.5-2: PTM 215ZGP, Sample #14, operating at channel 26, bandwidth plot – 99 % bandwidth

8 MISCELLANEOUS COMMENTS AND NOTES

None.

9 LIST OF ANNEXES

The following annexes are separated parts to this test report. These annexes may be file attachments for electronic filing.

Annex	Description	Pages
Annex 1	Photographs of Test Setups	5
Annex 2	Photographs of Equipment Under Test (EUT), external view	5
Annex 3	Photographs of Equipment Under Test (EUT), internal view	7