

Test Report

Radio Frequency Devices – Intentional Radiators

Test Report – No.: 2226819KAU-001b
Date of issue: 2016-08-22
Type: TPMS EWM
Description of the EUT: Tire Pressure Monitor System
Serialnumber: See chapter 1.2
Manufacturer and Applicant: SKF France
Address: 204 Boulevard Charles de Gaulle
37540 Saint-Cyr-sur-Loire
France

Summary:

The EUT is a Tire Pressure Monitor System working in the frequency range 2.48 GHz.
Referring to the emission limits and the operating mode during the tests specified in this report the equipment complies with the requirements of 47 CFR Part 15, Subpart C, Intentional radiators, section 15.247
Test methods according to ANSI C63.10-2013

Test Laboratory:

Intertek Deutschland GmbH, Innovapark 20, 87600 Kaufbeuren

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This test report consists of 30 pages. All measurement results exclusively refer to the equipment, which was tested. Reproduction of this report except in its entirety is not permitted without written approval of Intertek Deutschland GmbH.

Revision History

Edition	Date	Description
1	2016-08-22	First release

Details about Accreditation/ Acceptance

EMC/ Radio National

	<p>The Intertek Deutschland EMC-Lab is accredited by the Deutsche Akkreditierungsstelle GmbH (DAkkS)</p> <p>Registration Number (EMC general): D-PL-12085-01-01</p> <p>Registration Number (EMC Med): D-PL-12085-01-03</p>
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International

	<p>The Intertek Deutschland EMC-Lab is accepted by the Worldwide System for Conformity Testing and Certification of Electrotechnical Equipment and Components (IECEE)</p> <p>CB Test Laboratory: TL118</p>
	<p>The Intertek Deutschland EMC-Lab is accredited at the Federal Communications Commission (FCC)</p> <p>Designation Number: DE0014</p> <p>Test Firm Registration Number: 359260</p>
	<p>The <i>Bundesnetzagentur</i> recognizes Intertek Deutschland GmbH as Conformity Assessment Body in the sector electromagnetic compatibility (EMC).</p>
	<p>The Intertek Deutschland EMC-Lab is listed at Industry Canada</p> <p>No. 8882A-1 (OATS) and 8882A-2 (3 m alternative test site)</p>

Automotive

<p>Anerkennungsstelle</p> <p>Anerkannt unter KBA-P 00046-03</p>	<p>The Intertek Deutschland EMC-Lab is recognized as technical service of the Kraftfahrt-Bundesamt (KBA)</p> <p>Registration Number: KBA-P 00046-03</p>
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1 Equipment under test (EUT)

1.1 Description of the EUT

The TPMS (Tire Pressure Monitor System) consists of two component types, which are located at different areas of the truck and can communicate to each other. The component types are:

- The External Wheel Module (EWM) which is located at each tire to measure tire data like tire pressure and temperature.
- The ECU which is located at each vehicle unit (e.g. truck and trailer) and collect all EWM data wireless. A connector is necessary e.g. for the power supply and CAN communication.

1.2 Identification of the EUT according to the manufacturer/client declaration

Type/ Model:	TPMS EWM	
Description of the EUT:	Tire Pressure Monitor System	
Serial numbers of the EUTs:	EWM with internal antenna cont. wave: ID0000027300 EWM with antenna connector fast transmit: ID0000027322	
Transmitter frequency range:	2480 MHz	
Digital modulated techniques:	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No
Frequency agile or hopping:	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
Antenna:	<input checked="" type="checkbox"/> Internal antenna ¹⁾	<input type="checkbox"/> External antenna ¹⁾
Antenna connector:	<input type="checkbox"/> None, internal antenna	<input checked="" type="checkbox"/> Yes, SMA (only the test sample)
Antenna directional gains: (according FCC §15.247 (b)(4))	<input checked="" type="checkbox"/> ≤6 dBi EWM	<input checked="" type="checkbox"/> >6 dBi ECU
Type of modulation:	Transponder: QPSK	
Temperature range:	<input checked="" type="checkbox"/> Category I (General): -20°C to +55°C <input type="checkbox"/> Category II (Portable equipment): -10°C to +55°C <input type="checkbox"/> Category III (Equipment for normal indoor use): +5°C to +35°C <input type="checkbox"/> Other:	
Power rating:	Power supply: 100-240V _{AC} , 50-60 Hz / EmbiPos: 12 V _{DC} , 1.5 A	
Transmitter stand by mode supported:	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No

1.3 Additional hardware information about the EUT

The EUT consists of the following units:

ECU (EUT radiated emission / test mode fast transmit)
ECU (EUT conducted tests / test mode fast transmit)
EWM (EUT radiated emission / test mode fast transmit)
EWM (EUT conducted tests / test mode conducted wave)

1.4 Peripheral equipment

Peripheral equipment is defined as equipment needed for correct operation of the EUT during the tests, but not included as a part of the testing and evaluation of the EUT.

See 2.4

1.5 Modification during the tests

No modifications have been made during the tests.

2 Test specifications

2.1 Standards

47 CFR Part 15, Subpart C, Intentional radiators, section 15.205, 15.209 and section 15.247

Test methods in:

ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices

2.2 Additions, deviations and exclusions from standards and accreditation

No additions, deviations or exclusions have been made from standards and accreditation.

2.3 Test site

Measurements were performed at:

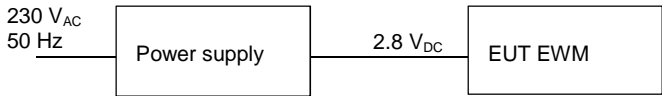
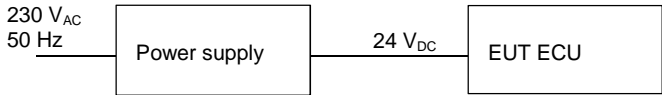
Intertek Deutschland GmbH, Innovapark 20, 87600 Kaufbeuren

Test sites:

Measurement Chamber	Type of chamber	IC Site filing #
OATS	10m	8882A-1
ANECHOIC CHAMBER 1	Semi-anechoic 3m	8882A-2

2.4 Test set-up

This is the principle block diagram.



2.5 Test conditions

The radiated emission tests of the EUT were done with different operation modes. Additional information see section of tests.

If not additionally specified, the tests were performed under the following environmental conditions:

Parameter	Normal	EUT
Nominal voltage:	24 V _{DC}	ECU
Nominal voltage:	2.8 V _{DC}	EWM

3 Test summary

The results in this report apply only to the tested sample:

Test	Result	Section in report	Note
Standard test methods			
Radiated test below 30 MHz	N/A	---	
Radiated emissions measurements from 30 MHz to 1000 MHz	Pass	4	
Radiated emissions measurements from 1 GHz to 10 GHz	Pass	5	
Conducted power	Pass	6	
Out of band conducted emission	Pass	7	
6 dB band width	Pass	8	
Power density	Pass	9	

NA = Not Applicable

4 Radiated emissions measurements from 30 MHz to 1000 MHz

Date of test:	2016-07-31	Test location:	Anechoic chamber 1
EUT Serial:	See chapter 1.2	Ambient temp.	24.8
Tested by:	UGR	Relative humidity	48%
Test result:	Pass	Margin:	>10 dB

4.1 Requirement

Reference: FCC §15.247 (d) , FCC §15.205 and FCC §15.209

Methods of measurement: ANSI C63.10:2013, Clause 6.5

Frequency (MHz)	Field strength ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	Measurement distance (m)
30 – 88	100	40.0	3
88 – 216	150	43.5	3
216 – 902	200	46.0	3
928 – 960	200	46.0	3
Above 960	500	54.0	3

But only in the restricted bands of operation according FCC §15.205

4.2 Test setup details

The EUT is a table-top EUT and was standing on a table made of Styrodur with a Pertinax plate on top and the dimensions 1.6 m x 1.0 m x 0.8 m (Length x Width x Height).

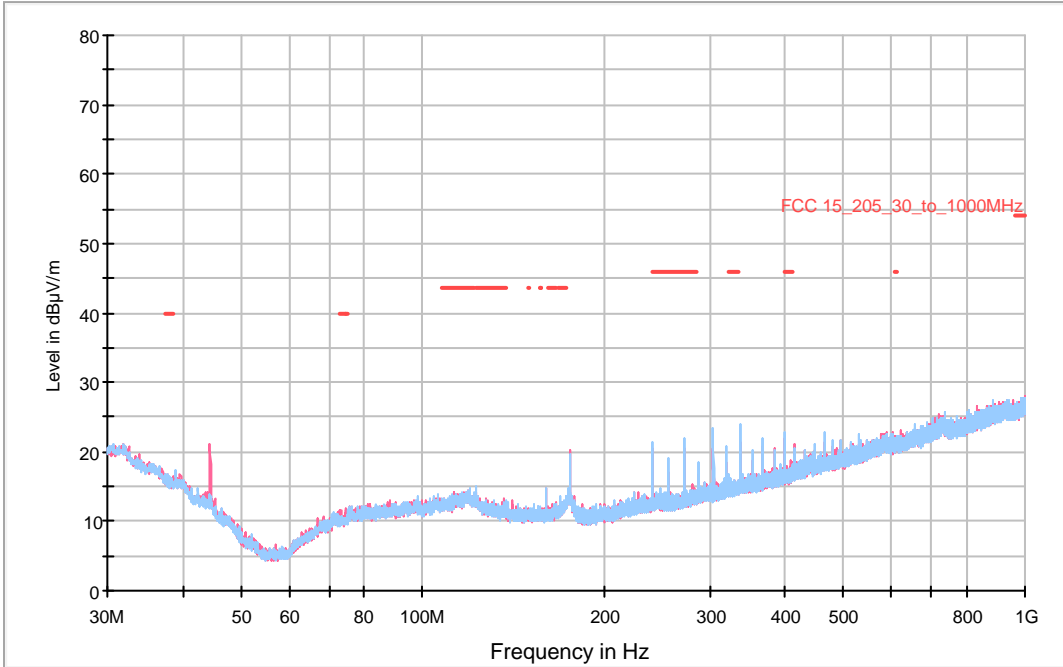
4.3 Test data of EWM

Overview sweeps performed with peak detectors and final measurement with quasi-peak detectors.

Intertek Emission Report

Common Information

Test Description:	Radiated Spurious Emission
Tested Device	EWM
Test Standard:	FCC part 15.247
Operating Conditions:	TX coninuous mode
Operator Name:	UGR
Comments:	
Project Number:	26819
Test Date:	2016-07-31



- FCC 15_205_30_to_1000MHz [..\EMI radiated\International]
- Preview Result 1V-PK+ [Preview Result 1V.Result:1]
- Preview Result 2V-QPK [Preview Result 2V.Result:2]
- Preview Result 1H-PK+ [Preview Result 1H.Result:1]
- Preview Result 2H-QPK [Preview Result 2H.Result:2]

4.4 Test equipment

Equipment type	Manufacturer	Model	Inv. No.	Cal. due date
Measurement software	Rohde & Schwarz	EMC 32	--	--
Receiver, 10 Hz- 7 GHz	Rohde & Schwarz	ESR 7	PM KF 2441	2016-07
Antenna, 30-3000 MHz	Rohde & Schwarz	HL 562	PM KF 1123	2018-02

5 Radiated emissions measurements from 1 GHz to 25 GHz

Date of test:	2016-07-30 2016-07-31 2016-08-03 2016-08-22	Test location:	Anechoic chamber 1
EUT Serial:	See chapter 1.2	Ambient temp.	26.9°C / 26.3°C / 24.8°C / 26.9 °C
Tested by:	UGR	Relative humidity	46% / 49% / 48% / 34%
Test result:	Pass	Margin:	2.4 dB

5.1 Requirement

Reference: FCC §15.247 (d), §205 and §15.209

Methods of measurement: ANSI C63.10:2013, Clause 6.6

Frequency (MHz)	Field strength ($\mu\text{V/m}$)	Field strength (dB $\mu\text{V/m}$)	Measurement distance (m)
1000 to 1240 MHz	500	54.0	3
1300 to 1427 MHz	500	54.0	3
1645.5 to 1646.5 MHz	500	54.0	3
1660 to 1710 MHz	500	54.0	3
1718.8 to 1722.2 MHz	500	54.0	3
2200 to 2300 MHz	500	54.0	3
2310 to 2390 MHz	500	54.0	3
2483.5 to 2500 MHz	500	54.0	3
2690 to 2900 MHz	500	54.0	3
3260 to 3267 MHz	500	54.0	3
3332 to 3339 MHz	500	54.0	3
3345.8 to 3358 MHz	500	54.0	3
3600 to 4400 MHz	500	54.0	3
4.5 to 5.15 GHz	500	54.0	3
5.35 to 5.46 GHz	500	54.0	3
7.25 to 7.75 GHz	500	54.0	3
8.025 to 8.5 GHz	500	54.0	3
9.0 to 9.2 GHz	500	54.0	3
9.3 to 9.5 GHz	500	54.0	3

But only in the restricted bands of operation according FCC §15.205

5.2 Test setup details

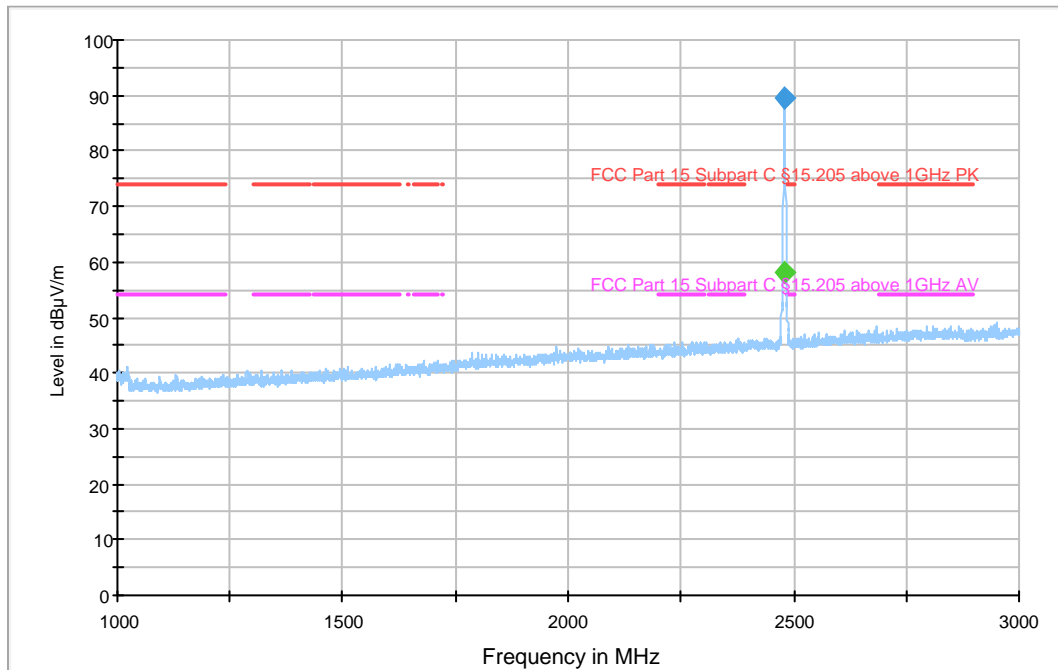
The EUT is a table-top EUT and was standing on a table made of Styrodur with a Pertinax plate on top and the dimensions 1.6 m x 1.0 m x 0.8 m (Length x Width x Height) and an additional support made of Styrodur with a Pertinax plate on top and the dimensions 0.5 m x 0.5 m x 0.7 m (Length x Width x Height)

5.3 Test data of EWM

Intertek Emission Report

Common Information

Test Description:	Radiated Spurious Emission
Tested Device	EWM
Test Standard:	FCC part 15.247
Operating Conditions:	See comments of result tables
Operator Name:	UGR
Comments:	
Project Number:	26819
Test Date:	2016-07-30



- FCC Part 15 Subpart C §15.205 above 1GHz PK [..\EMI radiated\International\]
- FCC Part 15 Subpart C §15.205 above 1GHz AV [..\EMI radiated\International\]
- Preview Result 1-PK+ [Preview Result 1.Result:1]
- ◆ Final Result 1 Average [Final Result 2.Result:1]
- ◆ Final Result 1-PK+ [Final Result 1.Result:1]

Final Result 1

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2480.400000	89.5	1000.0	1000.000	345.1	H	62.0	34.4	---	---

(continuation of the "Final Result 1" table from column 10 ...)

Frequency (MHz)	Comment
2480.400000	Fundamental) Mode: cont. wave

Final Result 2

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2480.400000	58.0	1000.0	1000.000	345.1	H	62.0	34.4	---	---

(continuation of the "Final Result 2" table from column 10 ...)

Frequency (MHz)	Comment
2480.400000	Fundamental Mode: fast transmit

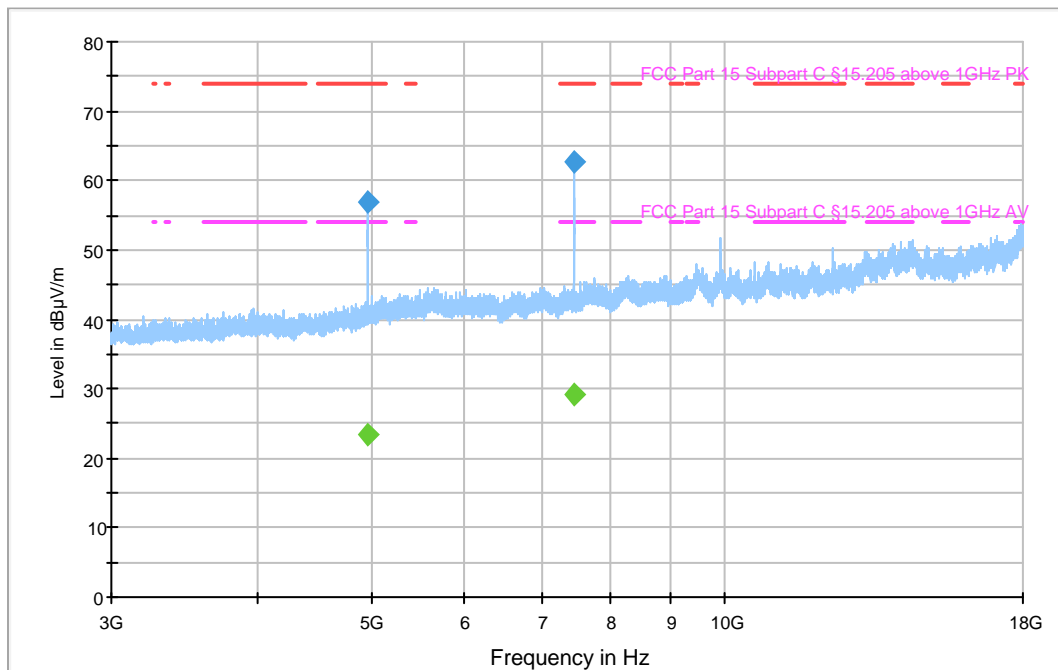
Test equipment

Equipment type	Manufacturer	Model	Inv. No.	Cal. due date
Measurement software	Rohde & Schwarz	EMC 32	--	--
Receiver, 10 Hz- 7 GHz	Rohde & Schwarz	ESR 7	PM KF 2441	2016-07
Antenna, 0.8-18 GHz	Rohde & Schwarz	HF906	PM KF 1047a	2017-10

Intertek Emission Report

Common Information

Test Description:	Radiated Spurious Emission
Tested Device	EWM
Test Standard:	FCC part 15.247
Operating Conditions:	See comments of result tables
Operator Name:	UGR
Comments:	
Project Number:	26819
Test Date:	2016-07-31



- FCC Part 15 Subpart C §15.205 above 1GHz PK [..\EMI radiated\International\]
- FCC Part 15 Subpart C §15.205 above 1GHz AV [..\EMI radiated\International\]
- Preview Result 1-PK+ [Preview Result 1.Result:1]
- ◆ Final Result 1-PK+ [Final Result 1.Result:1]
- ◆ Final Result 2-AVG [Final Result 2.Result:1]

Final Result 1

Frequency (MHz)	MaxPeak-ClearWrite (dBµV/m)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4958.906250	57.0	240.0	V	0.0	-7.4	17.0	74.0
7438.593750	62.6	310.1	H	308.0	-3.1	11.4	74.0

(continuation of the "Final Result 1" table from column 8 ...)

Frequency (MHz)	Comment
4958.906250	Mode: cont. wave
7438.593750	Mode: cont. wave

Final Result 2

Frequency (MHz)	Average-ClearWrite (dBµV/m)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4958.906250	23.5	240.0	V	0.0	-7.4	30.5	54.0
7438.593750	29.1	310.1	H	308.0	-3.1	24.9	54.0

(continuation of the "Final Result 2" table from column 8 ...)

Frequency (MHz)	Comment
4958.906250	Mode: fast transmit
7438.593750	Mode: fast transmit

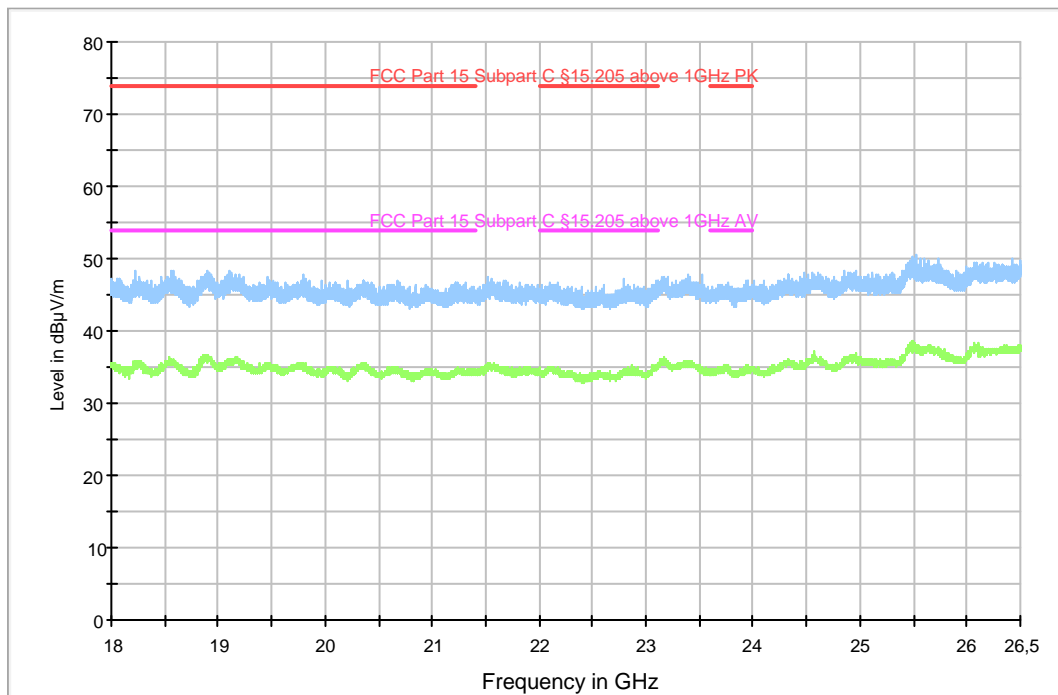
Test equipment

Equipment type	Manufacturer	Model	Inv. No.	Cal. due date
Measurement software	Rohde & Schwarz	EMC 32	--	--
Spectrum analyser	Rohde & Schwarz	FSV40	PM KF 2783	2016-10
Antenna, 2.6-18 GHz	Rohde & Schwarz	HF906	PM KF 1047a	2017-10
Preamplifier	Bonn	BLMA0118-4A	PM KF 1047	2017-10

Intertek Emission Report

Common Information

Test Description: Radiated Spurious Emission
 Tested Device: EWM
 Test Standard: FCC part 15.247
 Operating Conditions: TX coninuous mode
 Operator Name: UGR
 Comments:
 Project Number: 26819
 Test Date: 2016-08-22



- FCC Part 15 Subpart C §15.205 above 1GHz PK [..\EMI radiated\International\]
- FCC Part 15 Subpart C §15.205 above 1GHz AV [..\EMI radiated\International\]
- Preview Result 1-PK+ [Preview Result 1.Result:1]
- Preview Result 2-AVG [Preview Result 2.Result:2]

Equipment type	Manufacturer	Model	Inv. No.	Cal. due date
Measurement software	Rohde & Schwarz	EMC 32	--	--
Receiver 20Hz-26.5GHz	Rohde & Schwarz	ESIB 26	PM KF 0948	2017-03
Antenna, 15-40 GHz	Schwarzbeck	BBHA 9170	PM KF 1204	2018-07
Preamplifier	Schwarzbeck	BBV 9721	PM KF 2896	2018-07

5.4 Field strength / radiated power of fundamental:

Tested device EWM:

Channel	Frequency (MHz)	EIRP (dBm)
2480	89.5	-5.7

The EIRP calculations were performed by applying following formulas:

$$\text{EIRP}_{[\text{dBm}]} = E_{[\text{dB}\mu\text{V/m}]} - 95.21 \text{ dB}$$

6 Conducted power

Date of test:	2016-08-02 2016-08-10	Test location:	Test place 4
EUT Serial:	See chapter 1.2	Ambient temp.	24.3°C / 25.7°C
Tested by:	UGR	Relative humidity	45% / 39%
Test result:	Pass		

6.1 Requirement

Reference: FCC §15.247 (b)(2) and (b)(3)
 Methods of measurement: ANSI C63.10:2013, Clause 11.9

6.2 Test setup details

The EUT was conducted via a 10 dB attenuator to a spectrum analyzer

6.3 Test result:

Limit calculation because the antenna gain is above 6 dBi:

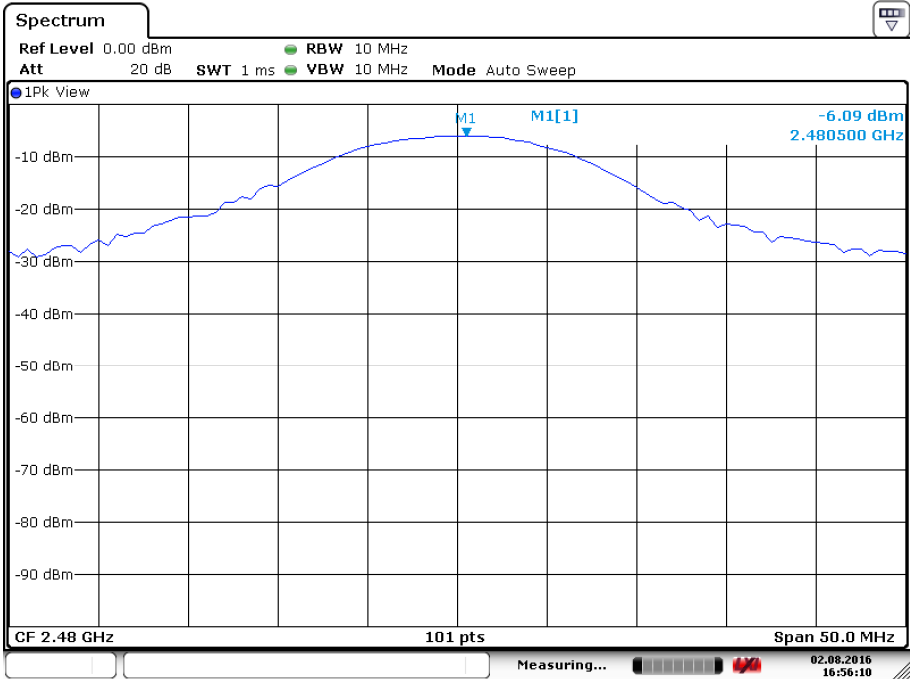
Limit = 30 dBm – (EIRP – Conducted power - 6 dBi)
 Limit = 30 dBm – (0.9 dBm – (-7.2 dBm) – 6dBi) = 27.9 dBm

EWM:

Channel	Frequency (MHz)	Conducted power	Limit
---	2480	-6.1 dBm	30 dBm

6.4 Test data

Conducted power EWM:



Date: 2.AUG.2016 16:56:10

6.5 Test equipment

Equipment type	Manufacturer	Model	Inv. No.	Cal. due date
Spectrum analyser	Rohde & Schwarz	FSV40	PM KF 2783	2016-10

7 Out of band conducted emission

Date of test:	2016-08-02 2016-08-03	Test location:	Test place 4
EUT Serial:	See chapter 1.2	Ambient temp.	24.3°C / 24.8°C
Tested by:	UGR	Relative humidity	45% / 48%
Test result:	Pass		

7.1 Requirement

Reference: FCC §15.247 (d)

Methods of measurement: ANSI C63.10:2013, Clause 11.11

7.2 Test setup details

The EUT was connected to a spectrum analyzer

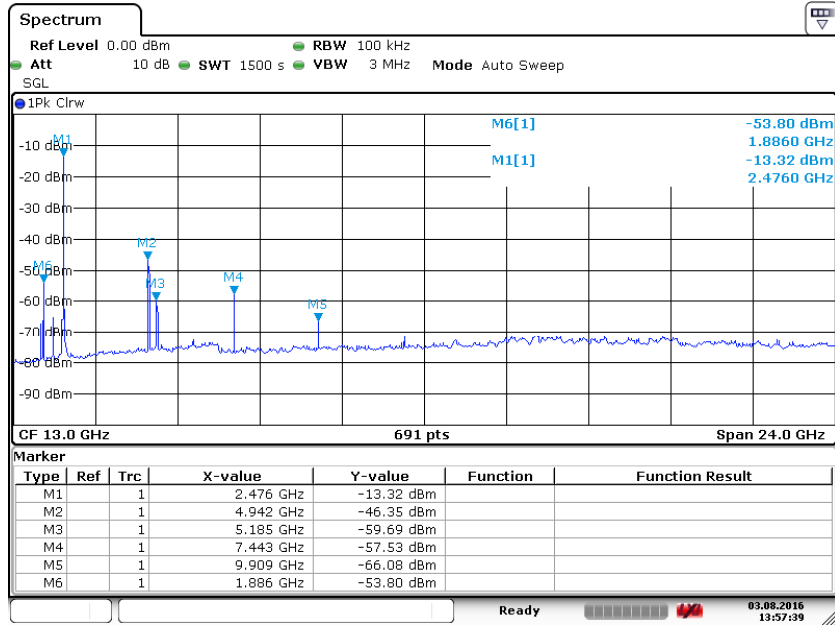
7.3 Test result:

EWM:

Channel	TX frequency (MHz)	Out of band conducted emission below carrier (dB)	Limit (dB)
Low	2480	33	20

7.4 Test data

Out of band conducted emission EWM:



Date: 3.AUG.2016 13:57:40

7.5 Test equipment

Equipment type	Manufacturer	Model	Inv. No.	Cal. due date
Spectrum analyser	Rohde & Schwarz	FSV40	PM KF 2783	2016-10

8 6 dB Band width

Date of test:	2016-08-02	Test location:	Test place 4
EUT Serial:	See chapter 1.2	Ambient temp.	24.3°C
Tested by:	UGR	Relative humidity	45%
Test result:	Pass		

8.1 Requirement

Reference: FCC §15.247 (a)(2)
 Methods of measurement: ANSI C63.10:2013, Clause 11.8

8.2 Test setup details

The EUT was connected to a spectrum analyzer

8.3 Test result:

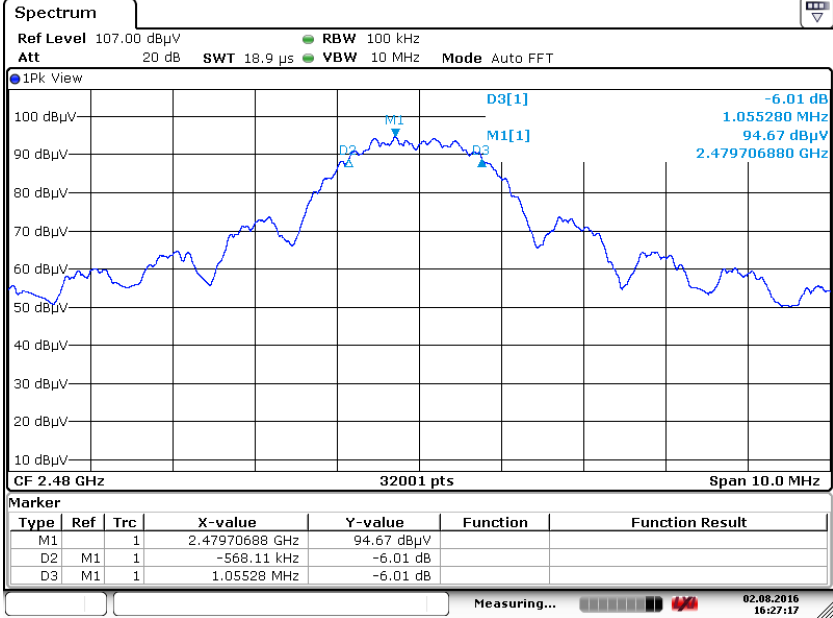
EWM:

Channel	Frequency (MHz)	6 dB BW (kHz)
---	2480	1623

Result:
 6 DB BW: >500 kHz pass

8.4 Test data

6 dB bandwidth EWM:



Date: 2.AUG.2016 16:27:17

8.5 Test equipment

Equipment type	Manufacturer	Model	Inv. No.	Cal. due date
Spectrum analyser	Rohde & Schwarz	FSV40	PM KF 2783	2016-10

9 Power density

Date of test:	2016-08-03 2016-08-04	Test location:	Test place 4
EUT Serial:	See chapter 1.2	Ambient temp.	24.8°C / 25.9°C
Tested by:	UGR	Relative humidity	48% / 41%
Test result:	Pass		

9.1 Requirement

Reference: FCC §15.247 (e)

Methods of measurement: ANSI C63.10:2013, Clause 11.10

9.2 Test setup details

The EUT was connected to a spectrum analyzer

9.3 Test result:

Limit calculation because the antenna gain is above 6 dBi:

Limit = 8 dBm – (EIRP – Conducted power- 6 dBi)

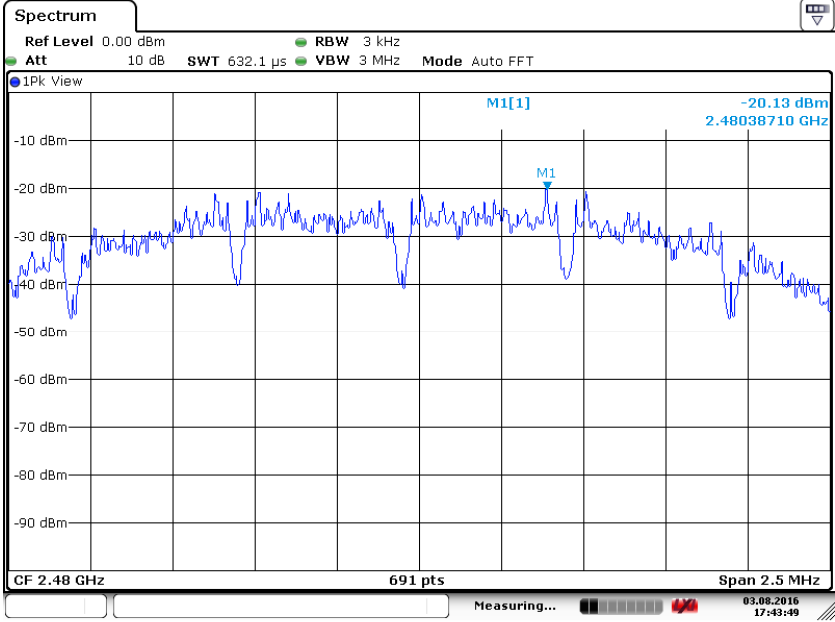
Limit = 8 dBm – (0.9 dBm – (-7.2 dBm) – 6dBi) = 5.9 dBm

EWM:

Frequency (MHz)	Power density	Limit
2480	-20.1 dBm	8 dBm

9.4 Test data

Power density EWM:



Date: 3.AUG.2016 17:43:48

9.5 Test equipment

Equipment type	Manufacturer	Model	Inv. No.	Cal. due date
Spectrum analyser	Rohde & Schwarz	FSV40	PM KF 2783	2016-10

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