Test Report
Radio Frequency Devices – Intentional Radiators

Test Report – No.:	**2226819KAU-001a**
Date of issue:	**2016-08-22**
Type:	TPMS ECU
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

Compiled by:	U. Gronert Senior Project Engineer
Approved by:	R. Dressler Technical Manager EMC/ Radio

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Revision History

Edition	Date	Description
1	2016-08-22	First release

Details about Accreditation/ Acceptance

EMC/ Radio National

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

International

IECEE CB SCHEME	The Intertek Deutschland EMC-Lab is accepted by the Worldwide System for Conformity Testing and Certification of Electrotechnical Equipment and Components (IECEE) CB Test Laboratory: **TL118**
FCC Federal Communications Commission	The Intertek Deutschland EMC-Lab is accredited at the Federal Communications Commission (FCC) Designation Number: **DE0014** Test Firm Registration Number: **359260**
Bundesnetzagentur BNetzA-CAB-16/21-10	The *Bundesnetzagentur* recognizes Intertek Deutschland GmbH as Conformity Assessment Body in the sector electromagnetic compatibility (EMC).
Industrie Canada Industry Canada Canada	The Intertek Deutschland EMC-Lab is listed at Industry Canada No.**8882A-1** (OATS) and **8882A-2** (3 m alternative test site)

Automotive

KBA Anerkennungsstelle Anerkannt unter KBA-P 00046-03	The Intertek Deutschland EMC-Lab is recognized as technical service of the Kraftfahrt-Bundesamt (KBA) Registration Number: **KBA-P 00046-03**

Table of Contents

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 ECU	
Description of the EUT:	Tire Pressure Monitor System	
Serial numbers of the EUTs:	ECU with internal antenna fast transmit: ECU with antenna connector fast transmit:	T0000005139 T0000005351
Transmitter frequency range:	2480 MHz	
Digital modulated techniques:	☒ Yes	☐ No
Frequency agile or hopping:	☐ Yes	☒ No
Antenna:	☒ Internal antenna [1)]	☐ External antenna [1)]
Antenna connector:	☐ None, internal antenna	☒ Yes, SMA (only the test sample)
Antenna directional gains: (according FCC §15.247 (b)(4))	☒ ≤6 dBi EWM	☒ >6 dBi ECU
Type of modulation:	Transponder: QPSK	
Temperature range:	☒ Category I (General): -20°C to +55°C ☐ Category II (Portable equipment): -10°C to +55°C ☐ Category III (Equipment for normal indoor use): +5°C to +35°C ☐ Other:	
Power rating:	Power supply: 100-240V_{AC}, 50-60 Hz / EmbiPos: 12 V_{DC}, 1.5 A	
Transmitter stand by mode supported:	☒ Yes	☐ 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.
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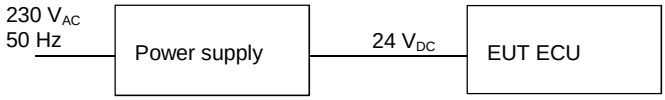
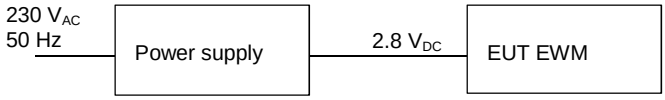




2.5 Test conditions

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 (µV/m)	Field strength (dBµV/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).

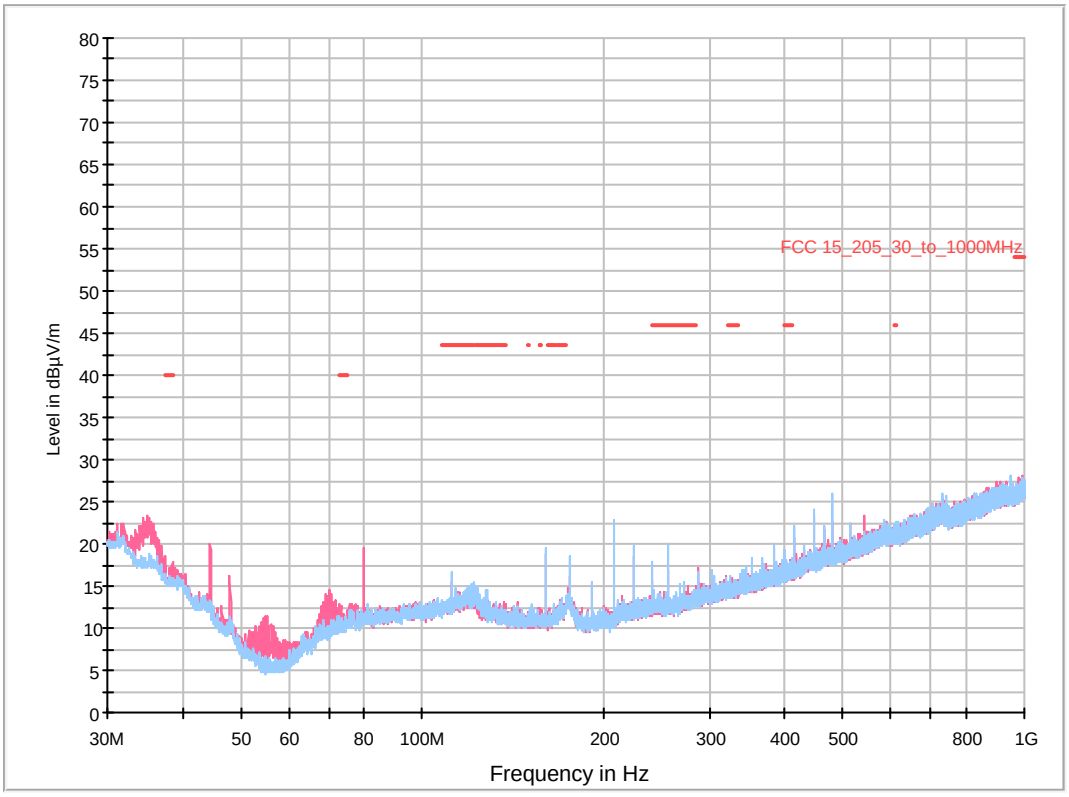
4.3 Test data of ECU

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	ECU
Test Standard:	FCC part 15.247
Operating Conditions:	TX fast transmit
Operator Name:	UGR
Comments:	
Project Number:	26819
Test Date:	2016-07-31



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 (µV/m)	Field strength (dBµV/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

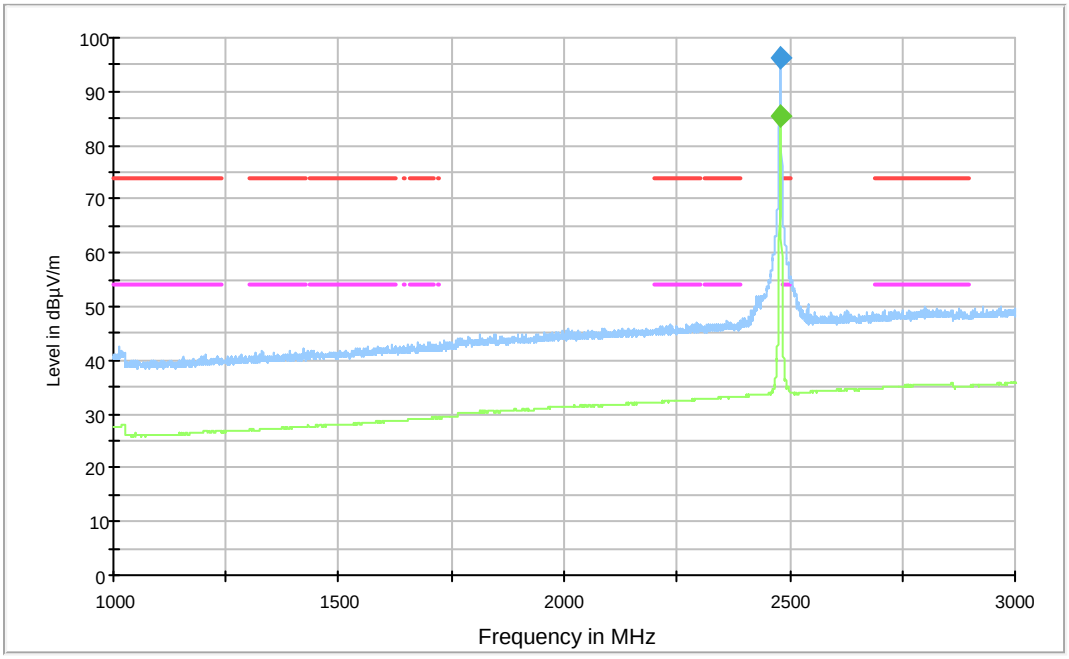
The EUT is a table-top EUT and was standing on a table made of Styrodur with a Pertinax plate on top and the dimensions 1.6 m x 1.0 m x 0.8 m (Length x Width x Height) and an additional support made of Styrodur with a Pertinax plate on top and the dimensions 0.5 m x 0.5 m x 0.7 m (Length x Width x Height)

5.3 Test data of ECU

Intertek Emission Report

Common Information

Test Description:	Radiated Spurious Emission
Tested Device	ECU
Test Standard:	FCC part 15.247
Operating Conditions:	TX fast transmit
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]
Preview Result 2-AVG [Preview Result 2.Result:2]
Final Result 1-PK+ [Final Result 1.Result:1]
Final Result 2-AVG [Final Result 2.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)
2479.400000	96.1	1000.0	1000.000	170.1	H	205.0	34.4	---	---

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

Frequency (MHz)	Comment
2479.400000	fundamental

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)
2480.050000	85.4	1000.0	1000.000	135.1	H	209.0	34.4	---	---

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

Frequency (MHz)	Comment
2480.050000	Fundamental

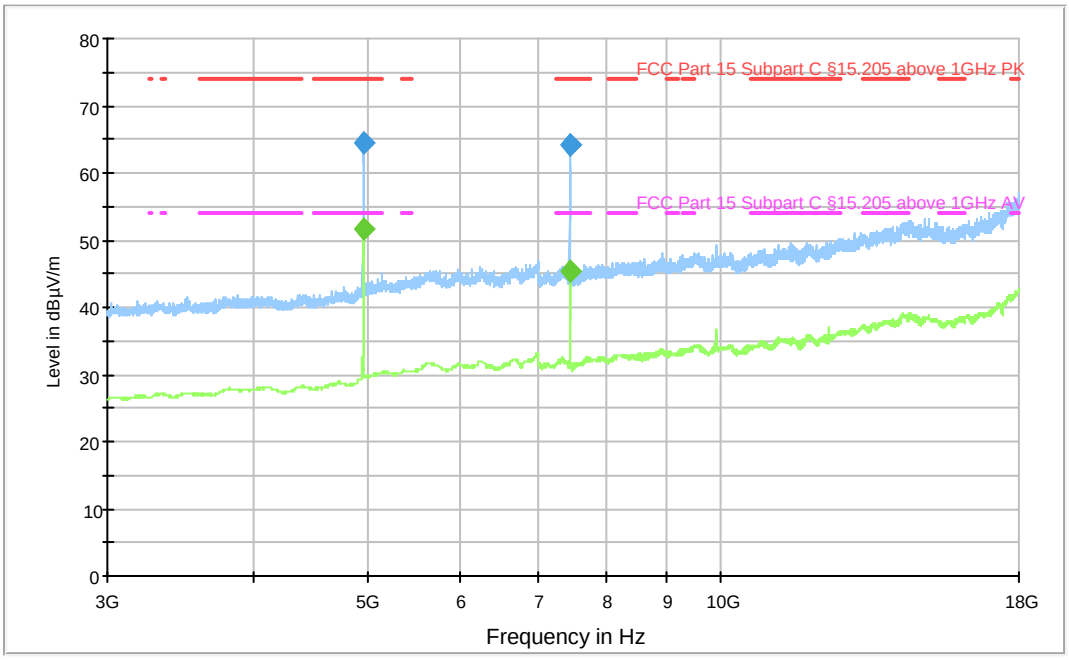
Test equipment

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	ECU
Test Standard:	FCC part 15.247
Operating Conditions:	TX fast transmit
Operator Name:	UGR
Comments:	
Project Number:	26819
Test Date:	2016-08-03



Preview Result 1-PK+ [Preview Result 1.Result:1]
Preview Result 2-AVG [Preview Result 2.Result:2]
Final Result 1-PK+ [Final Result 1.Result:1]
Final Result 2-AVG [Final Result 2.Result:1]
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\]

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)
4958.8000	64.4	1000.0	1000.000	240.1	H	167.0	-7.4	9.6	74.0
7441.8000	64.0	1000.0	1000.000	380.0	H	143.0	-3.1	10.0	74.0
7441.8000	64.0	1000.0	1000.000	380.1	H	143.0	-3.1	10.0	74.0

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)
4958.8000	51.6	1000.0	1000.000	240.0	H	173.0	-7.4	2.4	54.0
7438.2000	45.4	1000.0	1000.000	380.0	H	146.0	-3.1	8.6	54.0

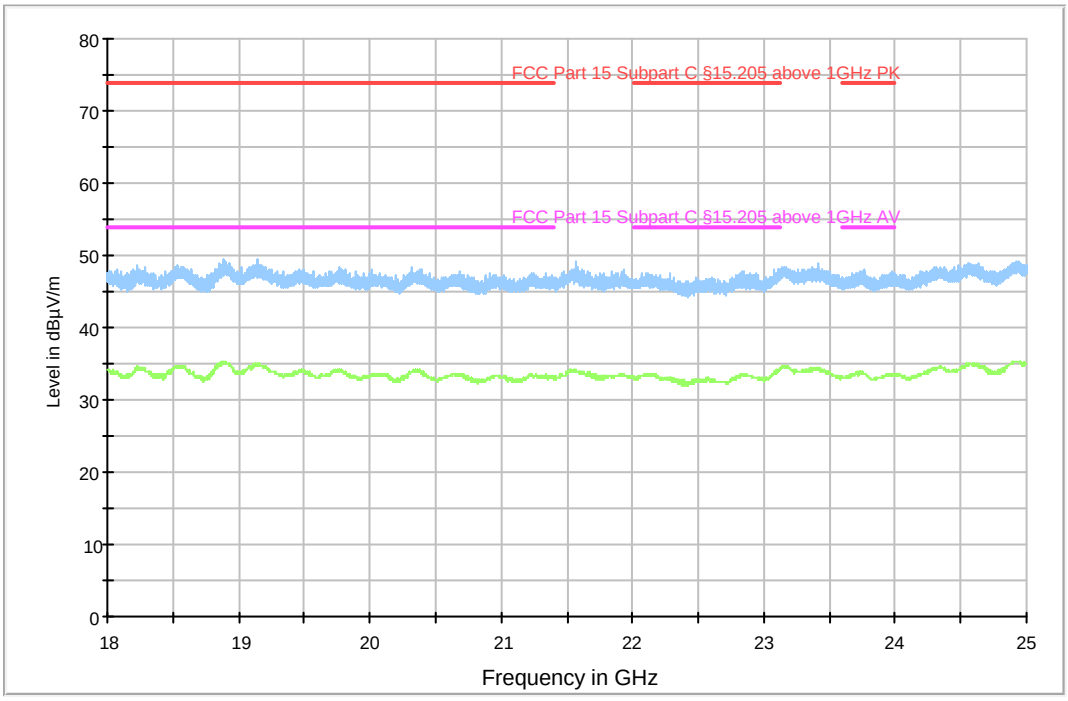
Test equipment

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, 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	ECU
Test Standard:	FCC part 15.247
Operating Conditions:	TX fast transmit
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 ECU:

Frequency (MHz)	Field strength (dBµV/m)	EIRP (dBm)
2480	96.1	0.9

The EIRP calculations were performed by applying following formulas:

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

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:

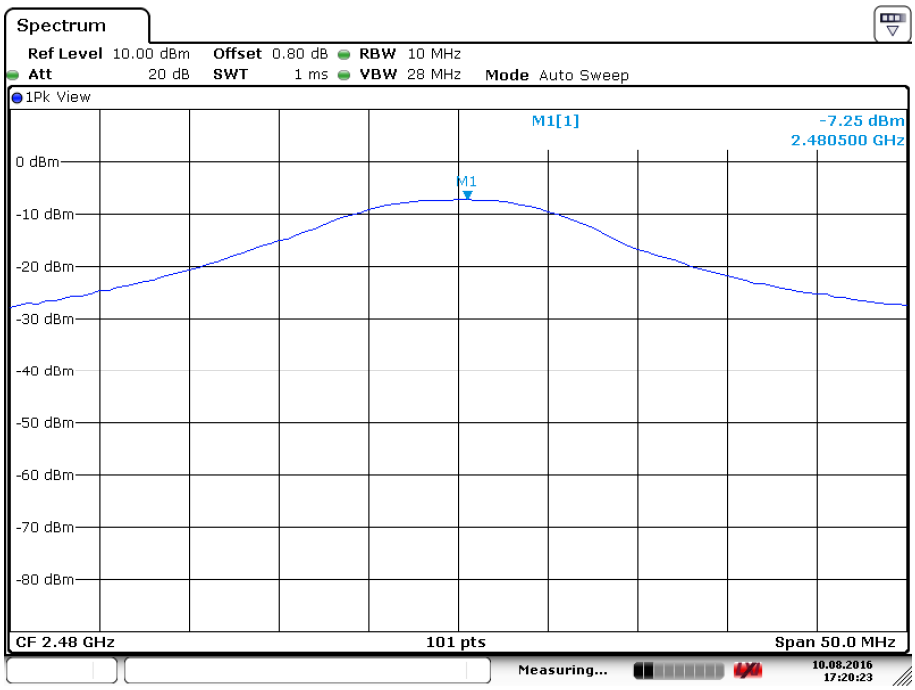
ECU:

Channel	Frequency (MHz)	Conducted power	Limit
---	2480	-7.2 dBm	27.9 dBm

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

6.4 Test data

Conducted power ECU:



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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

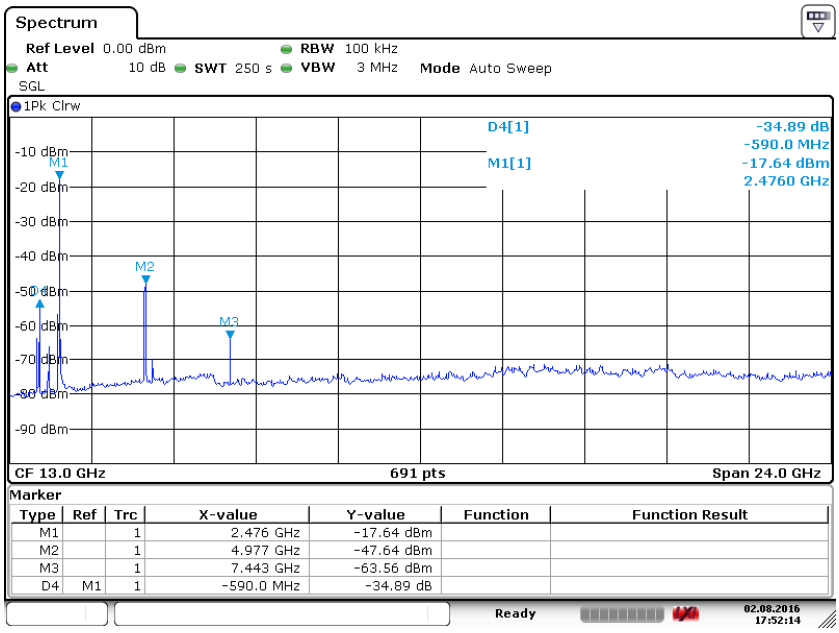
7.3 Test result:

ECU:

Channel	TX frequency (MHz)	Out of band conducted emission below carrier (dB)	Limit (dB)
Low	2480	30	20

7.4 Test data

Out of band conducted emission ECU:



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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:

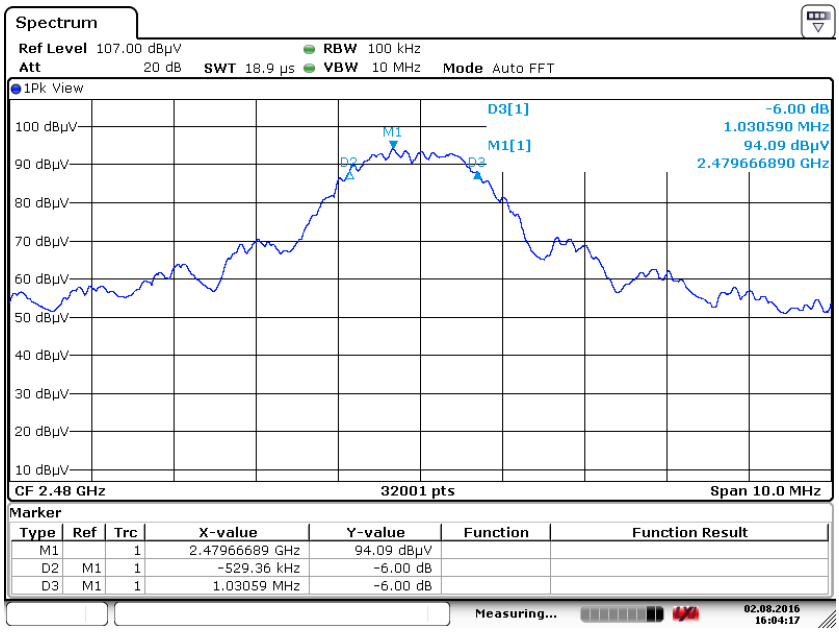
ECU:

Channel	Frequency (MHz)	6 dB BW (kHz)
---	2480	1560

Result:
6 DB BW: ☒ >500 kHz ☒ pass

8.4 Test data

6 dB bandwidth ECU:



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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:

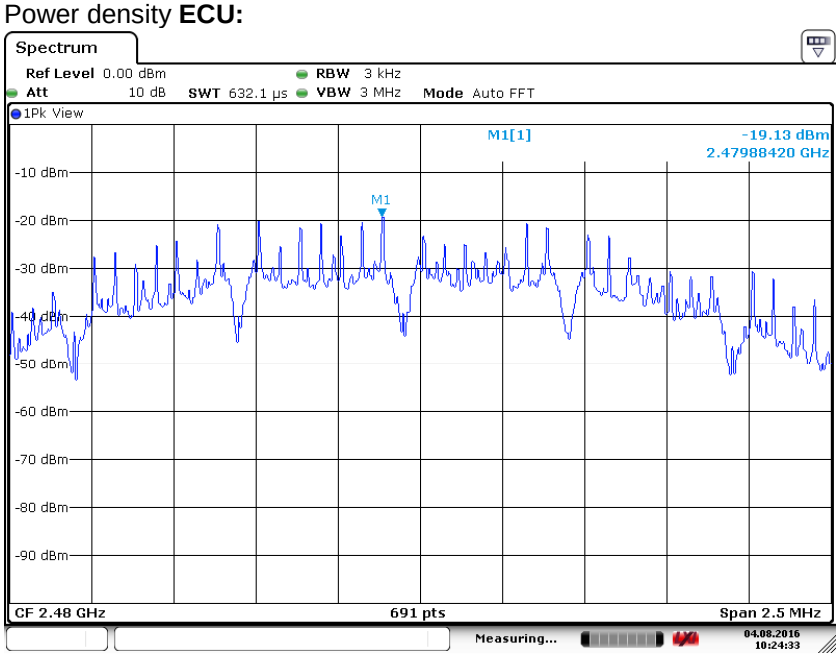
ECU:

Frequency (MHz)	Power density	Limit
2480	-19.1 dBm	5.9 dBm

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

9.4 Test data

Power density **ECU:**



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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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