FCC ID: OYGTSSRE3C

EMI – TEST REPORT

- FCC Part 15.231 -

Test Report No. : **T37832-00-00HU**	17. March 2014 Date of issue

Type / Model Name : TSSRE3c

Product Description : TPMS Wheel Electronics G1.3 315MHz

Applicant : Huf Electronics Bretten GmbH

Address : Gewerbestr. 40

75015 Bretten, Germany

Manufacturer : Huf Electronics Bretten GmbH

Address : Gewerbestr. 40

75015 Bretten, Germany

Licence holder : Huf Electronics Bretten GmbH

Address : Gewerbestr. 40

75015 Bretten, Germany

Test Result according to the standards listed in clause 1 test standards:	**POSITIVE**

Deutsche Akkreditierungsstelle D-PL-12030-01-00

FCC ID: OYGTSSRE3C

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (October, 2013)

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements
Part 15, Subpart A, Section 15.35	Measurement detector functions and bandwidths

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (October, 2013)

Part 15, Subpart C, Section 15.203	Antenna requirement
Part 15, Subpart C, Section 15.204	External radio frequency power amplifiers and antenna modifications
Part 15, Subpart C, Section 15.205	Restricted bands of operation
Part 15, Subpart C, Section 15.207	Conducted limits
Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements
Part 15, Subpart C, Section 15.231	Periodic operation in the band 40.66-40.70 MHz and above 70 MHz

ANSI C63.4: 2003	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
ANSI C95.1: 1992	IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
CISPR 16-4-2: 2003	Uncertainty in EMC measurement
CISPR 22: 2005 EN 55022: 2006	Information technology equipment

2 SUMMARY

GENERAL REMARKS:

All radiated tests have been performed on samples which are in original state.

For activating the EuT a “Pressure Vessel” was used to power up the Wheel Unit Sensor in the different operation modes.

The EuT has an incorporated antenna and is powered by a primary battery.

For testing the manufacturer declares following transmitting intervals:

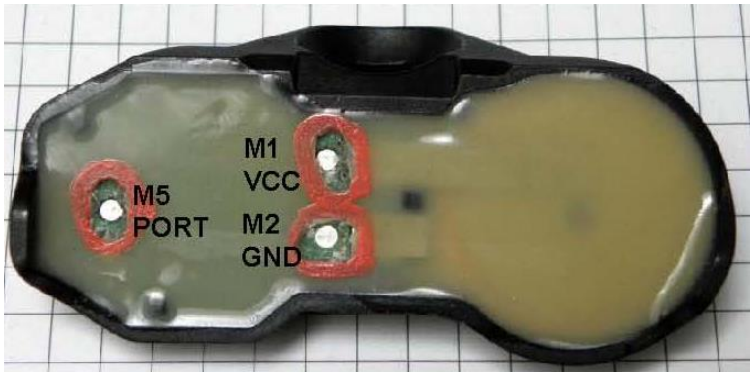
Each wheel electronic has its own code (ID) that is transmitted with the datagram at each transmission event. The RF transfer occurs in the 315MHz range. The samples are in standstill mode. For activating the EUT it has to be put into the pressure box where it is possible to change the pressure.

- Storage mode (mode 0): In storage mode no RF transmission takes place.
- Normal mode (mode 1) @ standstill and rotating: In normal mode, the wheel electronics measure the tire pressure and the approximate temperature of the air in the tire every three seconds but if the measured values are stable, RF transmitting processes only every 54 seconds.
- The alarm mode can be activated by the use of a pressure box. The pressure has to be set to 2 bar for 5 minutes. Now the sensor switches into normal mode.
- Alarm mode (mode 2) @ pressure loss: When a pressure loss > 0.2 bar on the last sent pressure value is detected, the wheel electronics switch immediately to alarm mode. In this situation, the wheel electronics measure and send every 1 seconds a RF datagram for 255 seconds. After this time it falls back to the normal mode.

The alarm mode can be activated by the use of a pressure box. The pressure in the box has to be set to 2 bar. Now the sensor switches for about 4 minutes into alarm mode. Then a rapid pressure drop of at least 0.2 bar must be generated again so that the alarm mode will continue.
Pulse duration for normal and alarm mode = 10.1 ms (+/-0.2 ms)

- Storage Mode: no RF transmission, the device is switched to sleep mode
  Switch: connect M5 to M2 for 9 sec

- Mode Tcw (continuous wave mode). RF transmitter works in continuous wave mode without modulation
  Timer: after 10 min the device will fall back to normal mode
  Switch: connect M5 to M1 for 5 sec



FINAL ASSESSMENT:

The equipment under test **fulfills** the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 24. February 2014

Testing concluded on : 27. February 2014

Checked by:

Klaus Gegenfurtner
I confirm the correctness and Integrity of this documents
2014.03.18 08:22:17 +01'00'

Klaus Gegenfurtner
Teamleader Radio

Tested by:

Markus Huber
I'm the author of this document
2014.03.17 09:04:55 +01'00'

Markus Huber

3 EQUIPMENT UNDER TEST

3.1 Photo documentation of the EUT – See Attachment A

3.2 Power supply system utilised

Power supply voltage : 3.0 V / DC (Lithium battery)

3.3 Short description of the Equipment under Test (EUT)

The wheel unit sensor is a part of a TPMS system embedded on a vehicle.
The device takes places in the tire, fix on rim of a vehicles wheel.

Number of tested samples: 2
Serial number: Prototype

EUT operation mode:

The equipment under test was operated during the measurement under the following conditions:

- Tx mode at frequency 315 MHz, Alarm mode

- Tx mode at frequency 315 MHz, CW mode

- Tx mode at frequency 315 MHz, Normal mode

EUT configuration:

The following peripheral devices and interface cables were connected during the measurements:

- Pressure Vessel Model : Supplied by manufacturer
- _____ Model : _____
- _____ Model : _____
- _____ Model : _____
- _____ Model : _____
- _____ Model : _____

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 ° C
Humidity:	30-60 %
Atmospheric pressure:	86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor k = 2. The true value is located in the corresponding interval with a probability of 95 % The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

4.4 Measurement Protocol for FCC, VCCI and AUSTEL

4.4.1 GENERAL INFORMATION

4.4.1.1 Test Methodology

Conducted and radiated disturbance testing is performed according to the procedures set out by the International Special Committee on Radio Interference (CISPR) Publication 22, European Standard EN 55022 as shown under section 1 of this report.
The test methods used comply with CISPR Publication 22, EN 55022 - " Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement" and with ANSI C63.4 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". In compliance with 47 CFR Part 15 Subpart A, Section 15.38 testing for FCC compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

4.4.1.2 Justification

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

5 TEST CONDITIONS AND RESULTS

5.1 Conducted emissions

For test instruments and accessories used see section 6 Part **A 4**.

5.1.1 Description of the test location

Test location: NONE

5.1.2 Photo documentation of the test set-up

5.1.3 Applicable standard

According to FCC Part 15C, 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.

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
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

5.1.4 Description of Measurement

The measurements are performed on the power interface 120 V / 60 Hz using a receiver, which has CISPR characteristic bandwidth, quasi-peak detection and line impedance stabilization network with 50Ω/50 µH (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 cm above the floor and is positioned 40 cm from the vertical ground plane (wall) of the screen room. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emissions are remeasured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

To convert between dBµV and µV, the following conversions apply:

dBµV = 20 log µV

µV = 10^(dBµV/20)

5.1.5 Test result

Remarks: The measurement is not applicable.

The EuT has no AC mains connections.

The EuT is separated powered by a 3.0 V battery.

5.2 Field strength of the fundamental wave

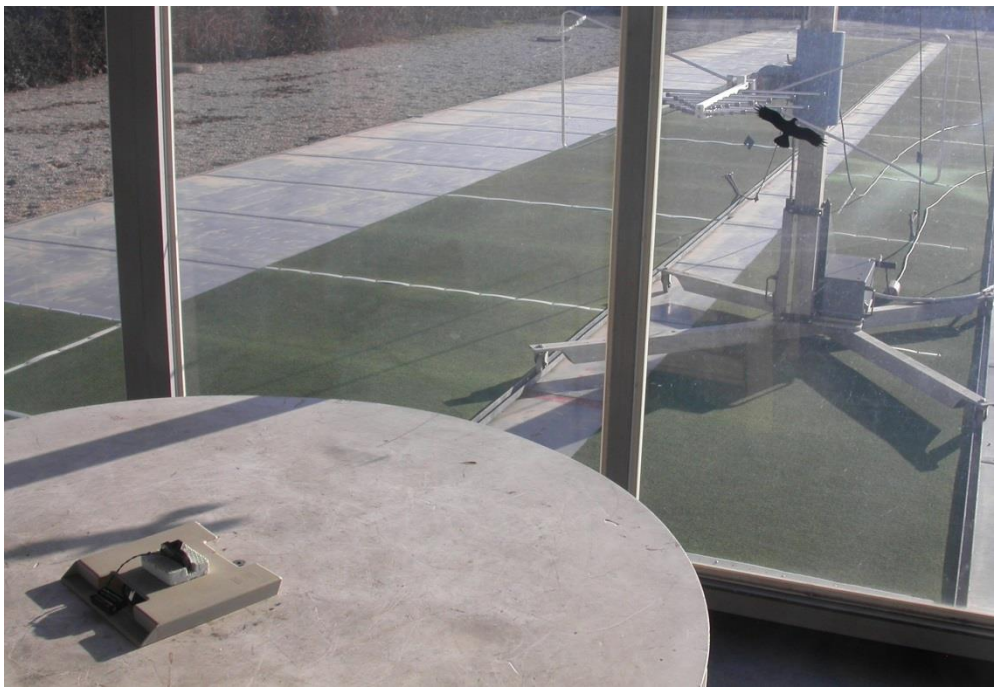
For test instruments and accessories used see section 6 Part **CPR 2**.

5.2.1 Description of the test location

Test location: OATS1

Test distance: 3 metres

5.2.2 Photo documentation of the test set-up



5.2.1 Applicable standard

According to FCC Part 15C, Section 15.231(e):
The field strength of emissions from intentional radiators shall not exceed the effective field strength limits.

5.2.2 Description of Measurement

The radiated power of the fundamental wave from the EUT is measured in the frequency range of 30 to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 metres non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The set up of the EUT will be in accordance to ANSI C63.4. The Interface cables that are closer than 40 centimetres to the ground plane are bundled in the centre in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the centre of the table and to a screen room located outside the test area. The antenna was positioned 3, 10 or 30 metres horizontally from the EUT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres, measurement scans are made in horizontal and vertical antenna polarization's and the EUT is rotated 360 degrees.

The resolution bandwidth during the measurement is as follows:
30 MHz – 1000 MHz: RBW: 120 kHz

Example:

Frequency (MHz)	Level (dBµV)	+	Factor (dB)	=	Level dB(µV/m)	-	Limit dB(µV/m)	=	Delta (dB)
170.5	5	+	20	=	25	-	30	=	-5

5.2.3 Test result

Frequency (MHz)	Level Pk (dBµV)	Level QP (dBµV)	Bandwidth (kHz)	Correct. factor (dB)	Duty Cycle Correct. factor (dB)	Level Pk dB(µV/m)	Calculated Level Av dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
315.0	32.9	28.7	120	16.3	-19.41	49.2	29.73	67.66	-37.9

Limit according to FCC Section 15.231(e):

Frequency (MHz)	Field strength of fundamental @ 3m		Effective limit for 433.92 MHz	
	(µV/m)	dB(µV/m)	(µV/m)	dB(µV/m)
40.66 – 40.70	1000	60		
70 - 130	500	54		
130 - 174	500 to 1500*	54 to 63.5*		
174 - 260	1500	63.5		
260 - 470	**1500 to 5000***	**63.5 to 74***	**2416.77**	**67.66**
Above 470	5000	81.9		

*Linear interpolation

The requirements are **FULFILLED.**

Remarks: The level of Field Strength are identically in all Tx operation modes.

The test was performed in “CW Mode” of the EuT.

5.3 Spurious emissions (magnetic field) 9 kHz – 30 MHz

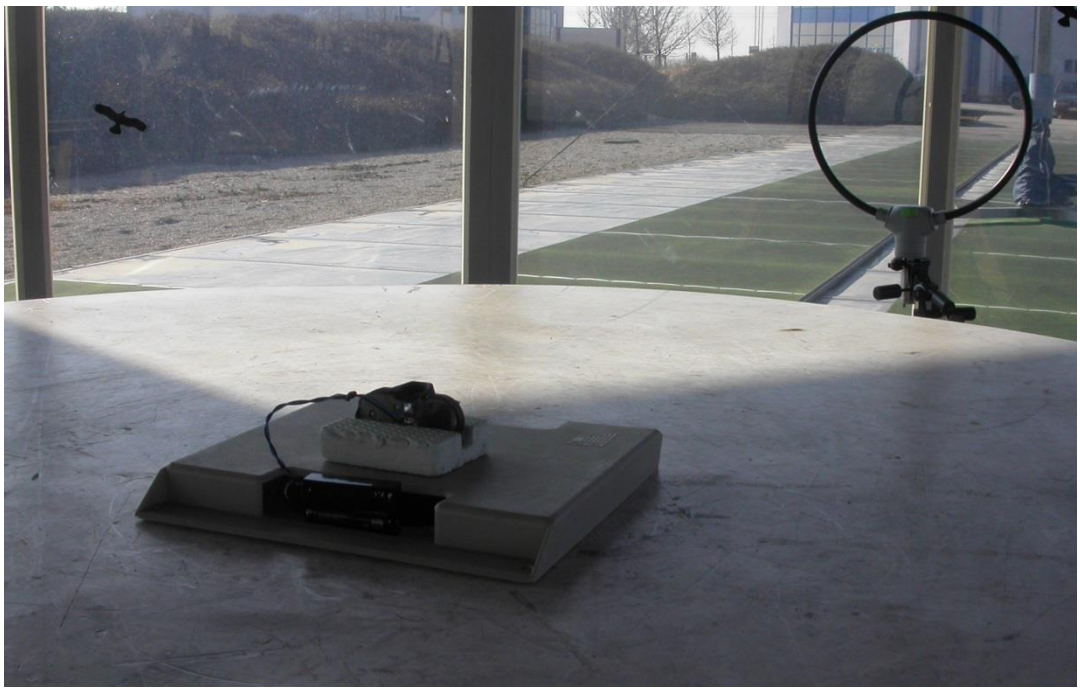
For test instruments and accessories used see section 6 Part **SER 1**.

5.3.1 Description of the test location

Test location: OATS1

Test distance: 3 metres

5.3.2 Photo documentation of the test set-up



5.3.3 Applicable standard

According to FCC Part 15C, Section 15.209:
The emissions from intentional radiators shall not exceed the effective field strength limits.

5.3.4 Description of Measurement

The magnetic field strength from the EUT will be measured on an open area test site in the frequency range of 9 kHz to 30 MHz using a tuned receiver and a shielded loop antenna. The set up of the Equipment under test will be in accordance to ANSI C63.4. The antenna was positioned 3, 10 or 30 meters horizontally from the EUT. Measurements have been made in all three orthogonal axes and the shielded loop antenna was rotated to locate the maximum of the emissions. In the case where larger measuring distances are required the results will extrapolated based on the values measured on the closer distances according to Section 15.31(f)(2)(2). The final measurement will be performed with an EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 to 490 kHz where an average detector will be used according to Section 15.209(d)(2).

The resolution bandwidth during the measurement is as follows:
9 kHz – 150 kHz: RBW: 200 Hz
150 kHz – 30 MHz: RBW: 9 kHz

Example:

Frequency (MHz)	Level (dBµV)	+	Factor (dB)	=	Level dB(µV/m)	-	Limit dB(µV/m)	=	Delta (dB)
1.705	5	+	20	=	25	-	30	=	-5

5.3.5 Test result

Measurement distance: 3 m

Frequency [kHz]	L: QP [dBµV]	L: AV [dBµV]	Bandwidth [kHz]	Correct. [dB]	L: QP [dBµV/m]	L: AV [dBµV/m]	Limit [dBµV/m]	Delta [dB]
536.8	24.1	19.7	9.0	20	44.1	39.7	73.0	-33.3
1073.6	23.4	18.0	9.0	20	43.4	38.0	67.0	-29.0
1342.0	21.6	15.9	9.0	20	41.6	35.9	65.0	-29.1

⇨ No unwanted emissions from the EuT could be measured in the relevant frequency ranges.
⇨ Only ambient noises could be detected.

Limit according to FCC Part 15C Section 15.209(a):

Frequency	Field strength of spurious emissions		Measurement distance
(MHz)	(µV/m)	dB(µV/m)	(metres)
0.009-0.490	2400/F(kHz)	--	300
0.490-1.705	24000/F (kHz)	--	30
1.705-30.0	30	29.5	30

The requirements are **FULFILLED.**

Remarks: All unwanted emissions in the frequency range from 9 kHz to 30 MHz are below 10 dBµV/m at a test distance of 3 metres.

The level of Field Strength are identically in all Tx operation modes.

The test was performed in “CW Mode” of the EuT.

5.4 Spurious emissions radiated (electric field)

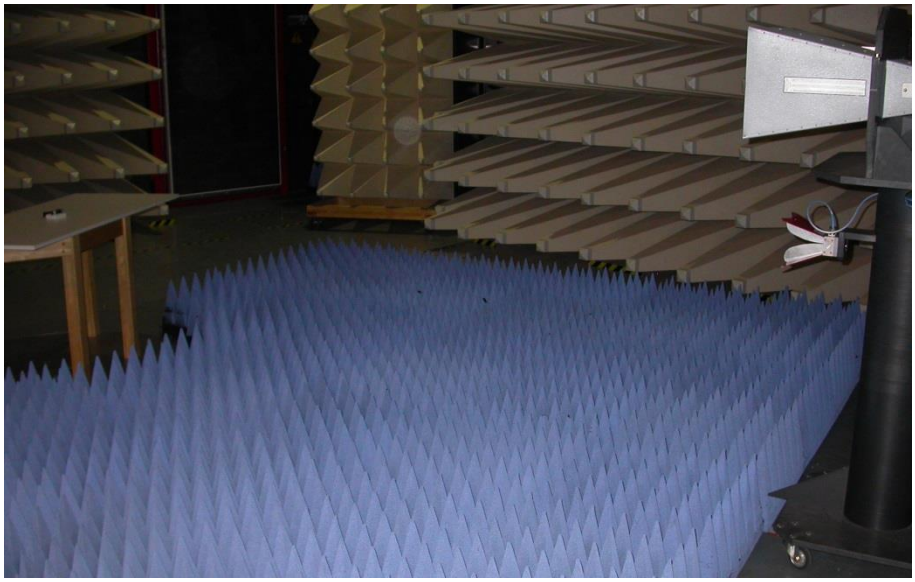
For test instruments and accessories used see section 6 Part **SER 2, SER 3**.

5.4.1 Description of the test location

Test location: OATS1
Anechoic Chamber A1

Test distance: 3 metres

5.4.2 Photo documentation of the test set-up



5.4.3 Applicable standard

According to FCC Part 15C, Section 15.231(e), Section 15.209(a) and Section 15.205(a):
The emissions from intentional radiators shall not exceed the effective field strength limits.

5.4.4 Description of Measurement

The radiated power of the spurious emission from the EUT is measured in the frequency range of 30 to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 cm above the ground plane. Floor standing equipment is placed directly on the turntable ground plane. The set up of the EUT will be in accordance to ANSI C63.4. The interface cables closer than 40 cm to the ground plane are bundled in the centre in a serpentine fashion so they are at least 40 cm away from the ground plane. Cables to simulators/testers are routed through the centre of the table to a screen room located outside the test area. To locate maximum emission from the test sample the antenna is varied in height from 1 to 4 m, measurement scans are made in horizontal and vertical antenna polarization and the EUT is turned 360 degrees.
The radiated power of the spurious emission from the EUT is measured in the frequency range above 1 GHz using a spectrum analyser and appropriate linear polarised antennas. Measurements are made in the horizontal and vertical polarization of the antenna. The set up of the EUT will be in accordance to ANSI C63.4. The interface cables closer than 40 cm to the ground plane are bundled in the centre in a serpentine fashion so they are at least 40 cm away from the ground plane. Hand-held or body-worn devices are rotated through three orthogonal axes to determine which attitude and configuration results in the highest emission and therefore shall be used for final testing. During the tests the EUT is turned 360 degrees to find the maximum level of emission. For testing above 1 GHz, if the emission level of the EUT in peak mode complies with the average limit is 20 dB lower, then testing will be stopped and peak values of the EUT will be reported, otherwise the emission will be measured in average mode again and reported.

The resolution bandwidth during the measurement is as follows:
30 MHz – 1000 MHz: RBW: 120 kHz
1000 MHz – 18000 MHz RBW: 1 MHz
Example:

Frequency (MHz)	Level (dBµV)	+	Factor (dB)	=	Level dB(µV/m)	-	Limit dB(µV/m)	=	Delta (dB)
170.5	5	+	20	=	25	-	30	=	-5

5.4.5 Test result f < 1 GHz

Frequency (MHz)	Level Pk (dBµV)	Level QP (dBµV)	Bandwidth (kHz)	Correct. factor (dB)	Duty Cycle Correct. factor (dB)	Level Pk dB(µV/m)	Calculated Level Av dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
630.0	28.3	23.9	120	24.2	-19.41	48.9	29.49	47.66	-18.2
945.0	12.8	8.6	120	28.8	-19.41	36.5	17.09	47.66	-30.6

5.4.6 Test result f > 1 GHz

Frequency (MHz)	L: PK (dBµV)	L: AV (dBµV)	Bandwidth (kHz)	Correct. (dB)	Duty Cycle Correct. factor (dB)	PK level dB(µV/m)	Calculated AV level dB(µV/m)	Effective limit dB(µV/m)	Delta (dB)
1260.0	83.8	--	1000	-18.3	-19.41	65.4	45.99	54.0	-8.0
1575.0	88.0	--	1000	-50.8	-19.41	67.3	47.89	54.0	-6.1
1890.0	76.0	--	1000	-15.5	-19.41	60.4	40.99	54.0	-13.0
2205.0	65.4	--	1000	-15.8	-19.41	49.5	30.09	54.0	-23.9
2520.0	70.8	--	1000	-13.2	-19.41	57.6	38.19	54.0	-15.8
2835.0	73.3	--	1000	-12.7	-19.41	60.7	41.29	54.0	-12.7
3150.0	55.7	--	1000	-12.5	-19.41	43.1	23.69	54.0	-30.3
3465.0	66.0	--	1000	-12.0	-19.41	54.0	34.59	54.0	-19.4

Limit according to FCC Section 15.231(e), Section 15.209(a) and Section 15.205(a):

Frequency (MHz)	Field strength of spurious emissions @ 3m		Effective limit for 315.0 MHz	
	(µV/m)	dB(µV/m)	(µV/m)	dB(µV/m)
40.66 – 40.70	100	40		
70 - 130	50	34		
130 - 174	50 to 150*	34 to 43.5*		
174 - 260	150	43.5		
260 - 470	**150 to 500***	**51.4 to 54**	**241.67**	**47.66**
Above 470	500	54		

*Linear interpolation

Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in the table above or to the general limits shown in the table below according to § 15.209, whichever limit permits a higher field strength.

Frequency (MHz)	15.209 Limits (µV/m)	15.209 Limits dB(µV/m)
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

Additionally there is a limit according to §15.35(b) on the radio frequency emissions, as measured with a peak detector, corresponding to 20 dB above the maximum permitted average limits.

FCC ID: OYGTSSRE3C

Restricted bands of operation according to FCC Part 15C, Section 15.205(a):

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
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	Above 38.6

The requirements are **FULFILLED.**

Remarks: The level of Field Strength are identically in all Tx operation modes.

The test was performed in “CW Mode” of the EuT.

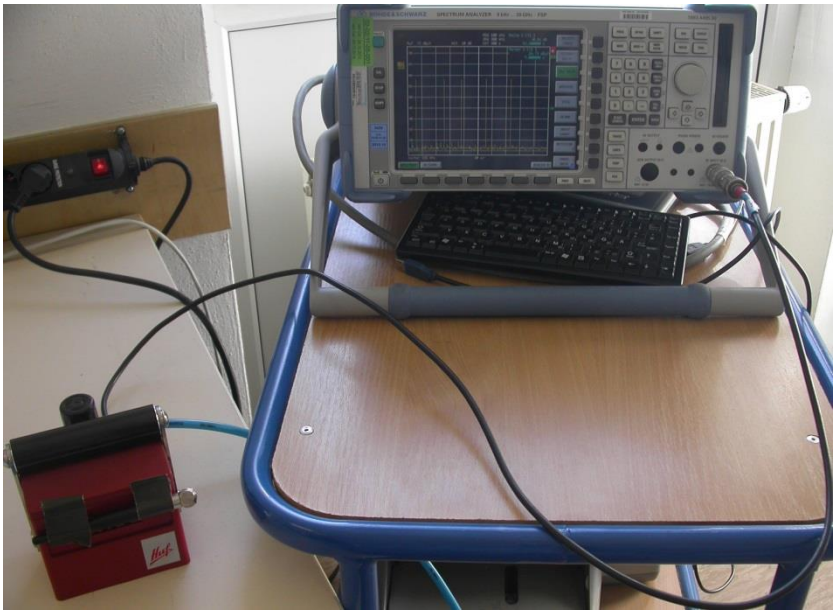
5.5 Correction for pulse operation (duty cycle)

For test instruments and accessories used see section 6 Part **DC**.

5.5.1 Description of the test location

Test location: AREA 4

5.5.2 Photo documentation of the test set-up



5.5.3 Applicable standard

According to FCC Part 15C, Section 15.35(c):
The emissions from intentional radiators shall not exceed the effective field strength limits.

5.5.4 Test result

The Duty cycle factor (dB) is calculated applying the following formula:

$$K_E = 20 \log ((t_{iB})/100)$$

K_E:	pulse operation correction factor	(dB)
t_{iB}	pulse duration for one pulse	(ms)

Maximum transmitting duration in every 100ms period:

$$K_E = 20 \log ((10.17)/100) = -19.41 \text{ dB}$$

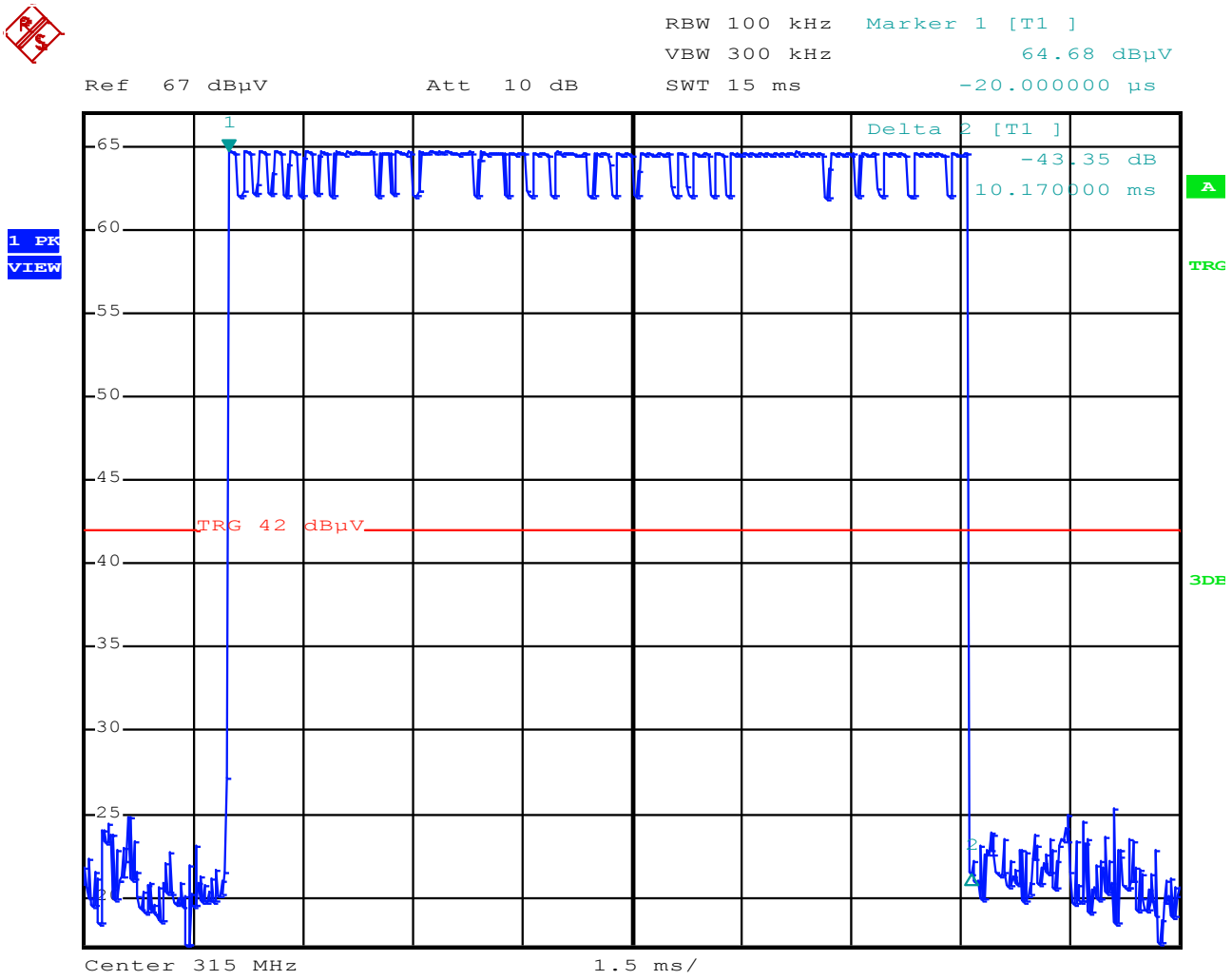
Remarks: _____

5.5.5 Test protocol

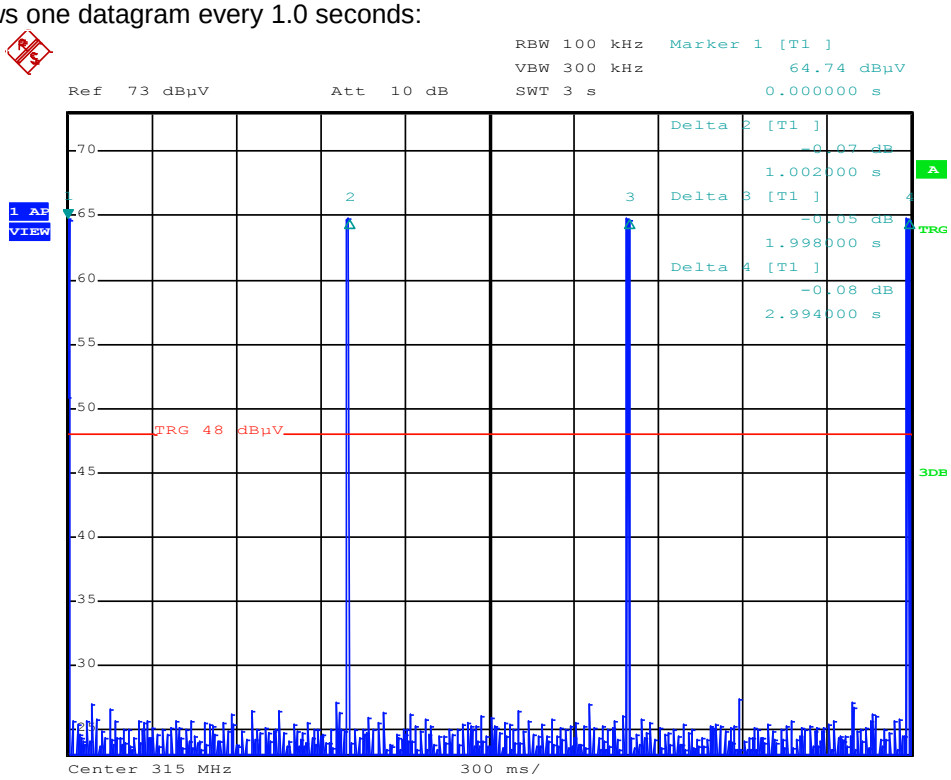
Correction for pulse operation (duty cycle)
FCC Part 15C, Section 15.35(c)

Pulse duration for one pulse (Identically in all Tx operation modes)

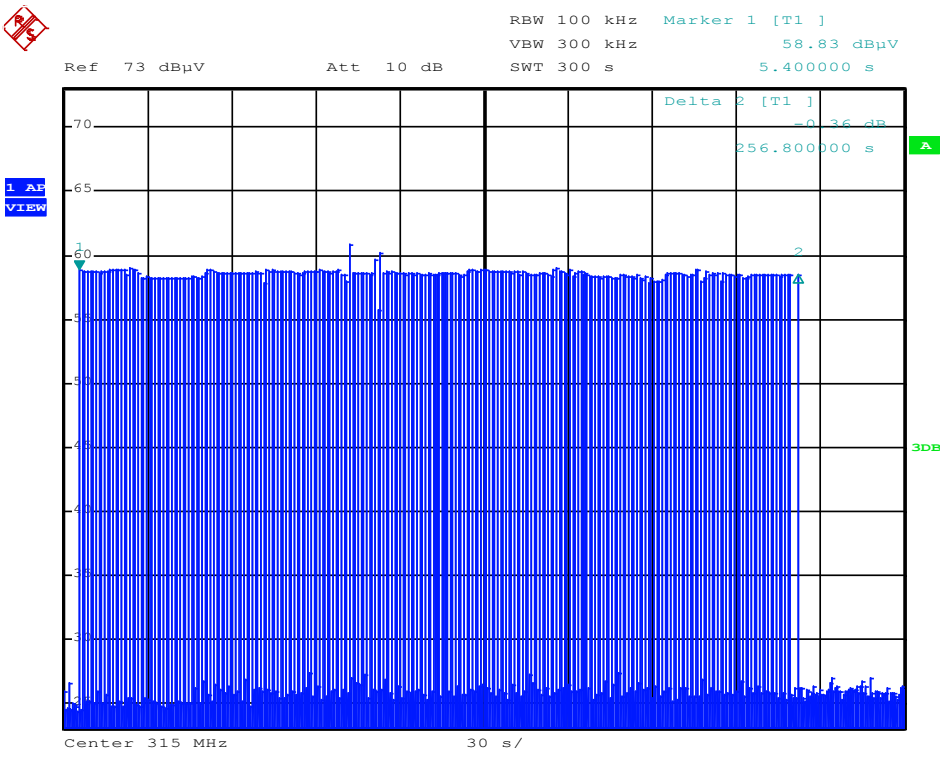
Worst case Tx on time - Alarm mode (mode 2) @ pressure loss:
Electronics switch immediately to alarm mode. In this situation, the wheel electronics measure and send every 1 seconds a RF datagram for 255 seconds. After this time it falls back to the normal mode.
Pulse duration for normal and alarm mode = 10.1 ms (+/-0.2 ms)



- Plot shows one datagram every 1.0 seconds:

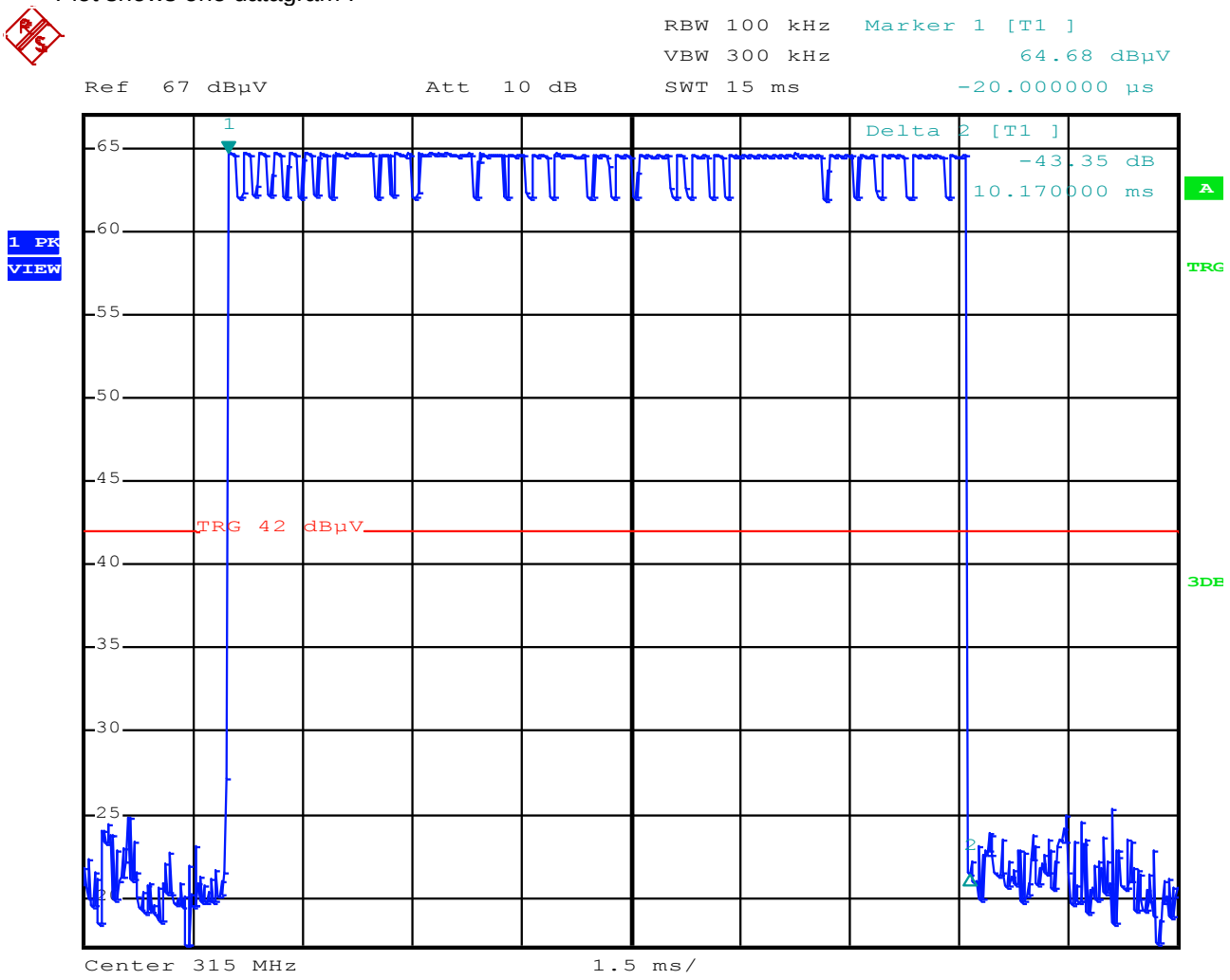


- Plot shows 255 datagrams:

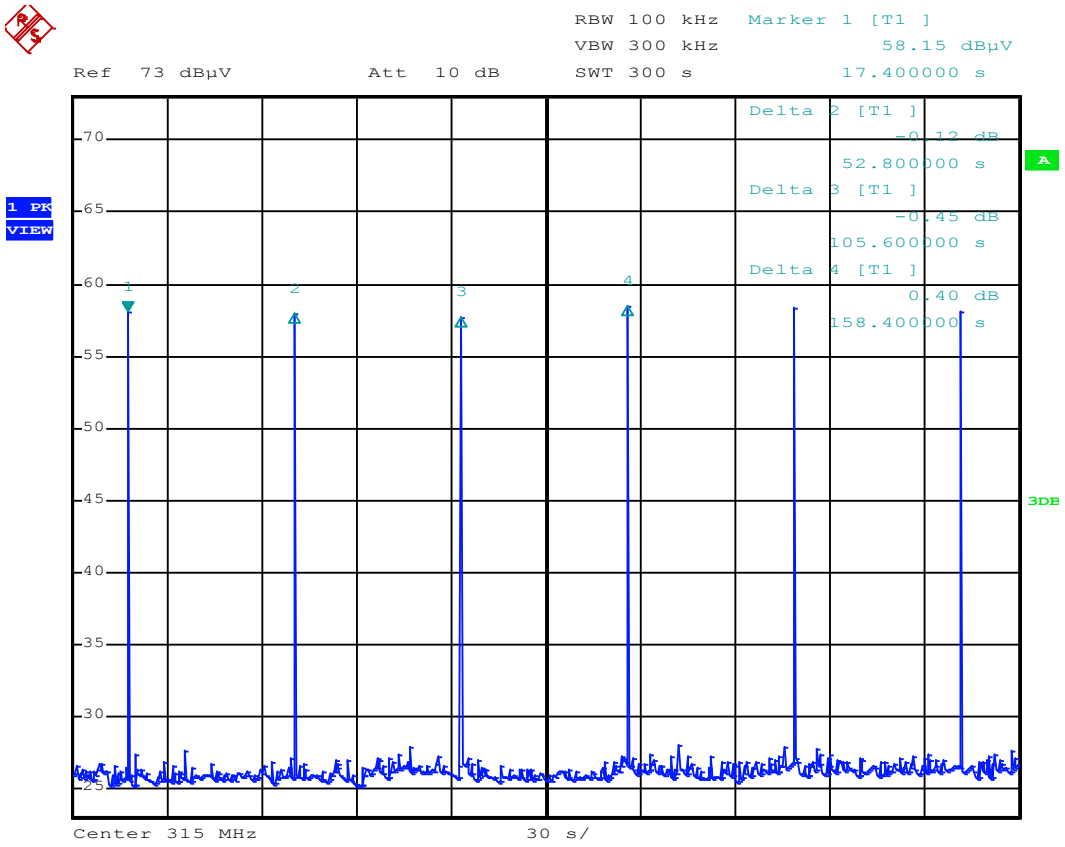


Normal mode (mode 1) @ standstill and rotating:
In normal mode, the wheel electronics measure the tire pressure and the approximate temperature of the air in the tire every three seconds but if the measured values are stable, RF transmitting processes only every 54 seconds.

- Plot shows one datagram :



- Plot shows one datagram every 54.0 seconds:



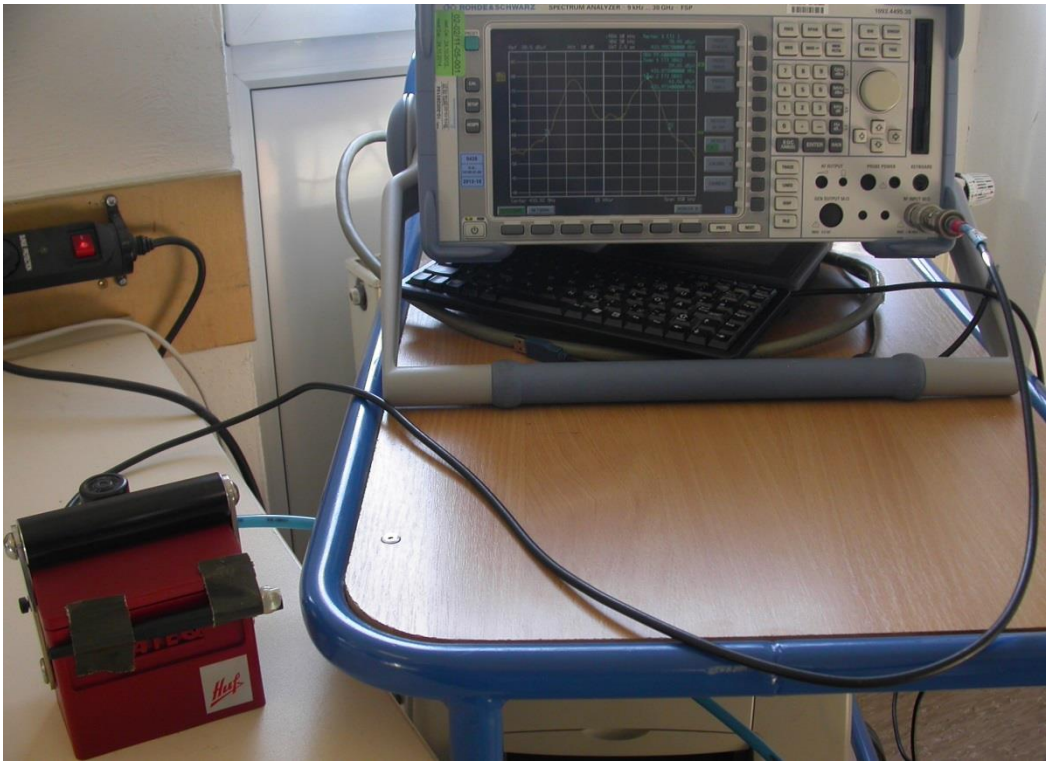
5.6 Emission bandwidth

For test instruments and accessories used see section 6 Part **MB**.

5.6.1 Description of the test location

Test location: AREA4

5.6.2 Photo documentation of the test set-up



5.6.3 Applicable standard

According to FCC Part 15C, Section 15.231(c):
The bandwidth of the emission shall not exceed the effective limits.

5.6.4 Description of Measurement

The measurement was performed conducted with intentional modulation using a spectrum analyser. The analyser span was set wide enough to capture the most of the power envelope of the signal. The function “20-dB-down” is used to determine the BW. For an overview on the adjacent restricted bands the span was set as wide as needed to show that the restricted bands are not affected.

5.6.5 Test result

Fundamental [MHz]	20dB Bandwidth F1 [MHz]	20dB Bandwidth F2 [MHz]	Measured Bandwidth [MHz]	LIMIT Fundamental f*0,0025 [MHz]
315.0	314.9253	315.0387	0.1134	0.7875

Limit according to FCC Part 15C Section 15.231(c):

Frequency (MHz)	20 dB BW limit dependent of the carrier (%)
70 – 900	0.25
above 900	0.50

The bandwidth of the emission shall be no wider than 0.25% of the centre frequency for devices operating above 70 MHz and below 900 MHz. Bandwidth is determined at the points 20 dB down from the modulated carrier.

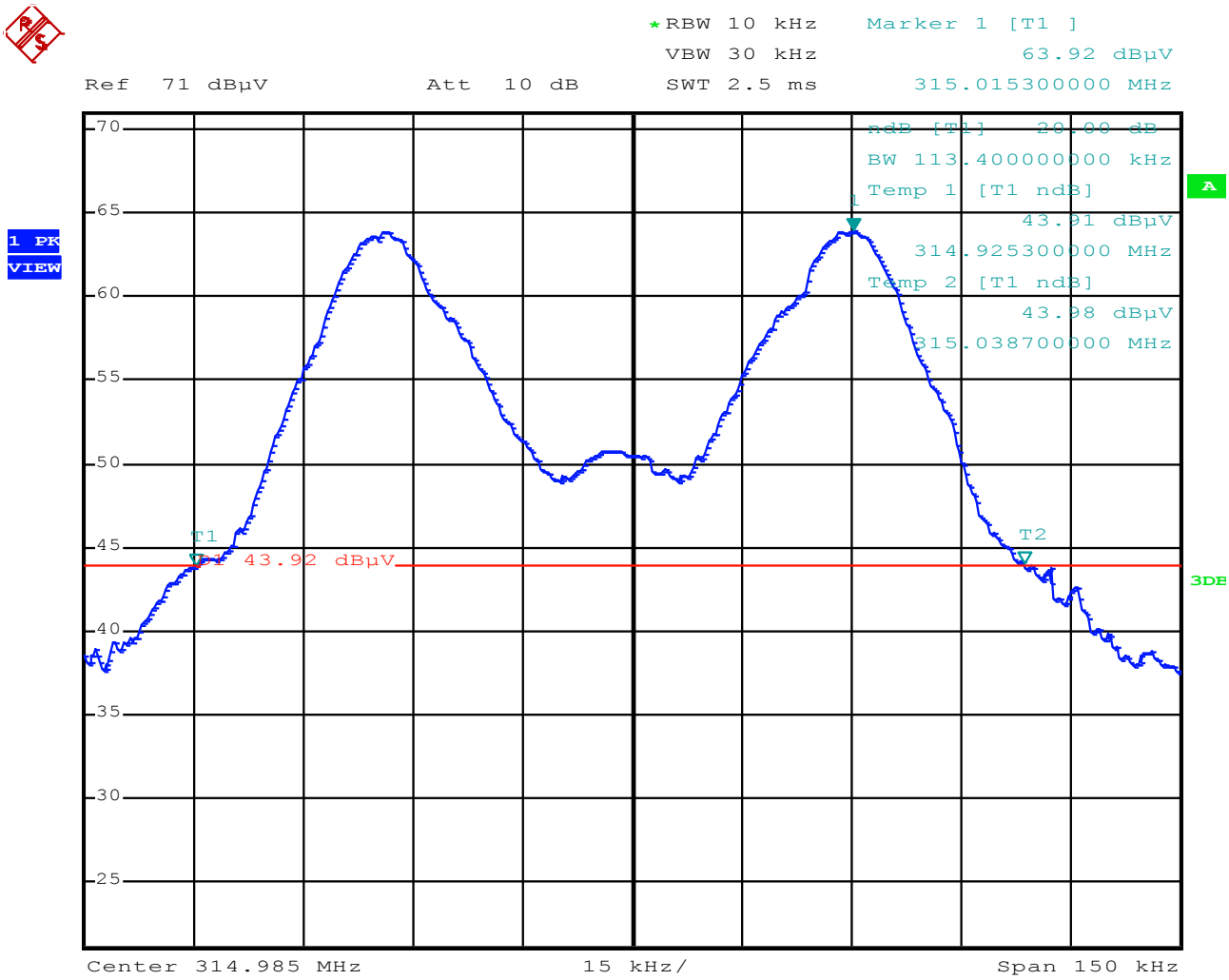
The requirements are **FULFILLED.**

Remarks: For detailed results, please see the test protocol below.

5.6.6 Test protocol

Emission bandwidth

FCC Part 15C, Section 15.231(c)



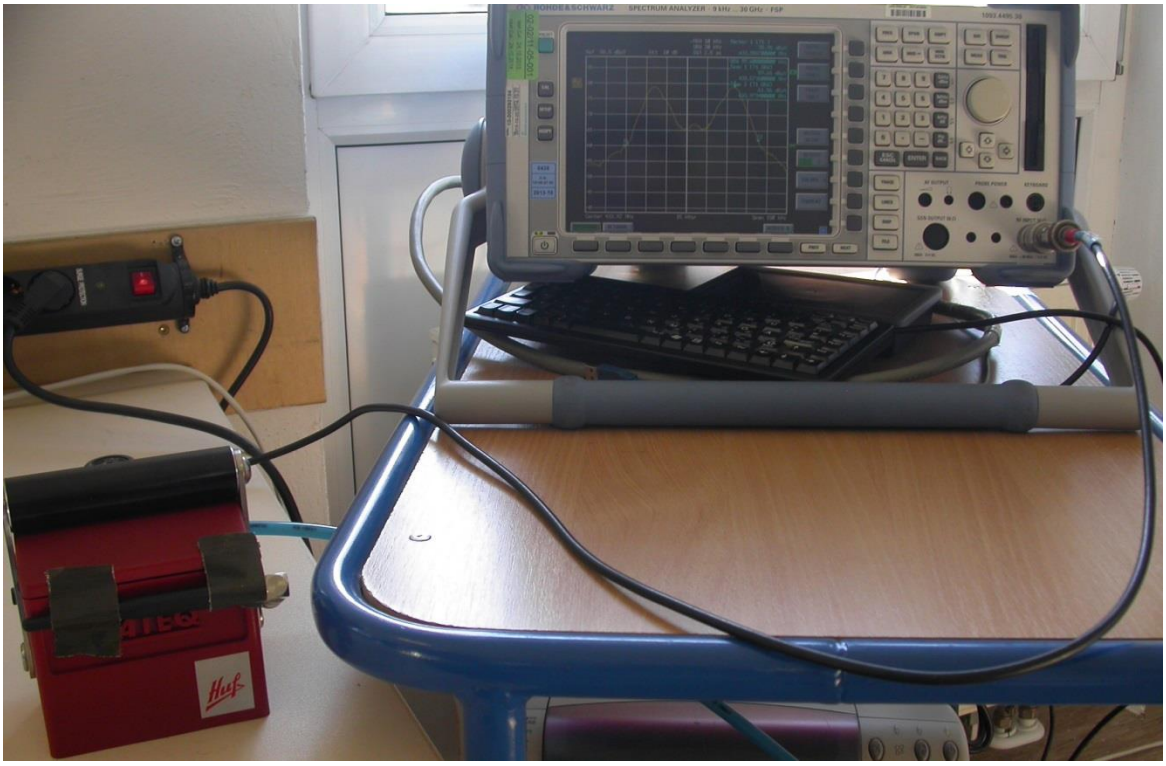
5.7 On / Off Period

For test instruments and accessories used see section 6 Part **MB**.

5.7.1 Description of the test location

Test location: AREA 4

5.7.2 Photo documentation of the test set-up



5.7.3 Applicable standard

According to FCC Part 15C, Section 15.231(e):

5.7.4 Description of Measurement

The duration of transmission is measured with the spectrum analyzer. The sweep points were set to maximum for higher the time resolution. The signal is modulated; the marker of the analyzer is set to maximum amplitude at normal temperature and zero span. The analyser was set to single sweep and triggered on the button, the marker was set to the edges in order to measure the duration time and than recorded.

5.7.5 Test result

The manufacturer declares following transmitting intervals:

- Storage mode (mode 0):
  No emissions take place.

-Normal mode (mode 1) @ standstill and rotating:
  The wheel electronics measure the tire pressure and the approximate temperature of the air in the tire every three seconds but if the measured values are stable, RF transmitting processes only every 54 seconds.

Duration of transmission (ms)	Limit (s)
10.17	1.0

Silent period (s)	Limit (s)
54.0	> 10.0

Limit according to FCC Part 15C, Section 15.231(e):

In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

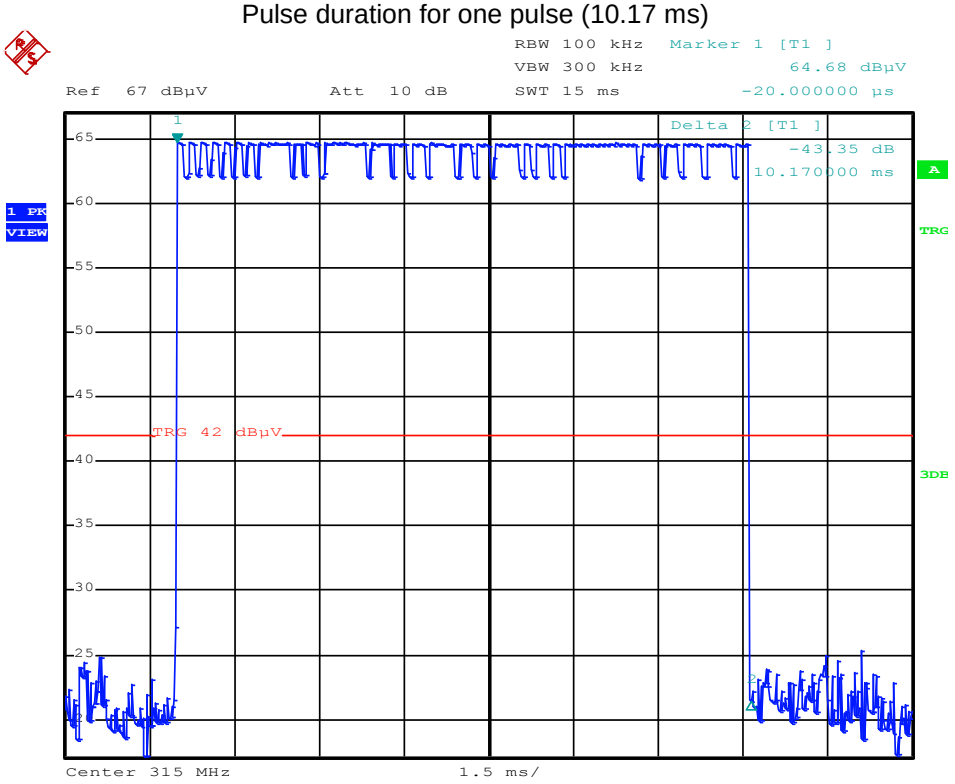
The requirements are **FULFILLED.**

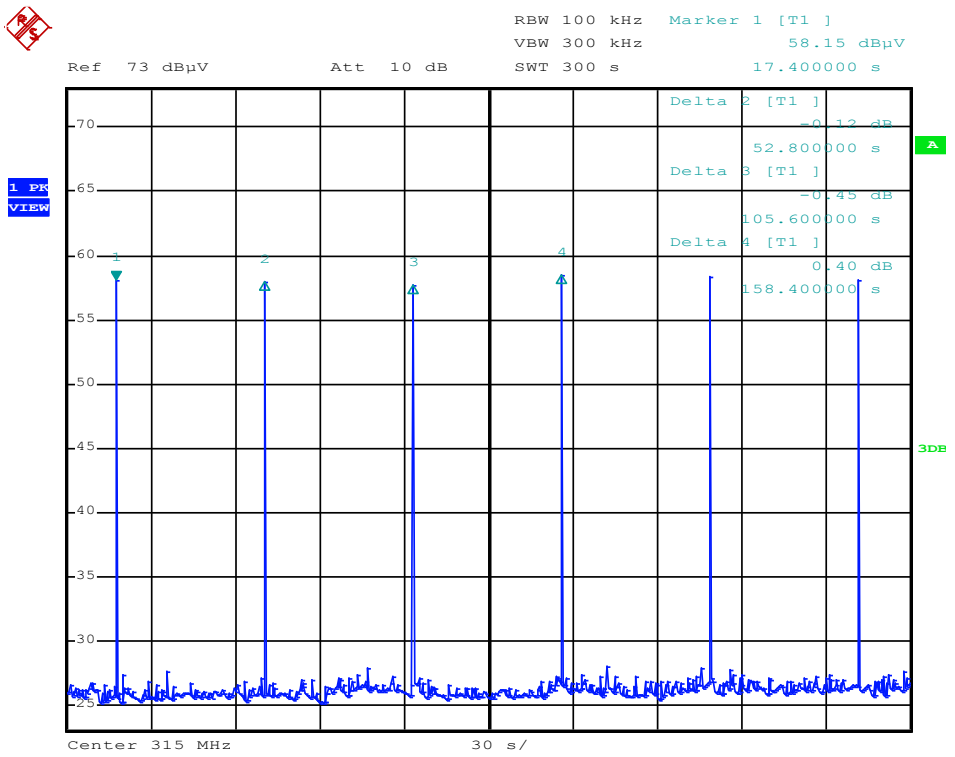
Remarks: For detailed test results, please see the test protocol below.

5.7.6 Test protocol

Signal deactivation
FCC Part 15C, Section 15.231(e)

Pulse duration for one pulse (10.17 ms)





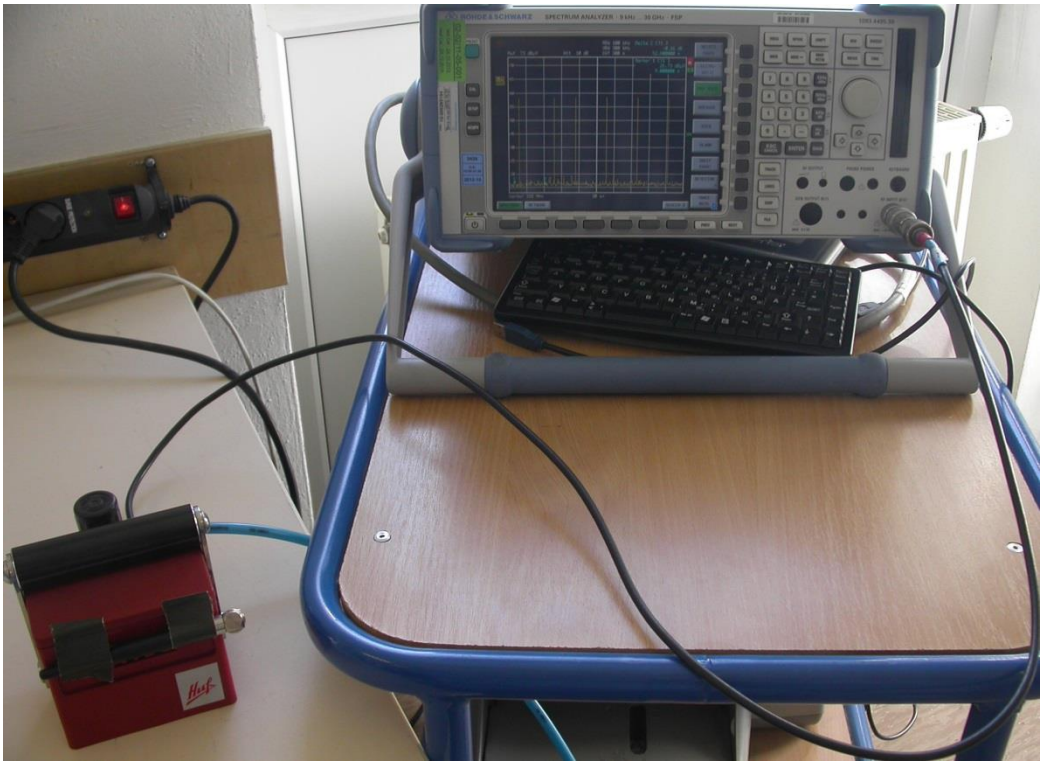
5.8 Signal deactivation

For test instruments and accessories used see section 6 Part **MB**.

5.8.1 Description of the test location

Test location: AREA 4

5.8.2 Photo documentation of the test set-up



5.8.3 Applicable standard

According to FCC Part 15C, Section 15.231(a):

5.8.4 Description of Measurement

The duration of transmission is measured with the spectrum analyzer. The sweep points were set to maximum for higher the time resolution. The signal is modulated; the marker of the analyzer is set to maximum amplitude at normal temperature and zero span. The analyser was set to single sweep and triggered on the button, the marker was set to the edges in order to measure the duration time and than recorded.

5.8.5 Test result

The manufacturer declares following transmitting intervals:

- Alarm mode (mode 2) @ pressure loss:
Worst case Tx on time:
Fast Transmission Mode automatically transmits one datagram (10.2 ms) every 1.0 seconds until
255 datagrams have been sent. After all 255 datagrams the sensor moves back to its previous mode.

Duration of transmission (ms)
10.17

Limit according to FCC Part 15C, Section 15.231(a)(4):

(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released and a transmitter activated automatically shall cease transmission within 5 seconds after activation.

(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

(3) Periodic transmissions at regular predetermined inervals are not permitted. However, polling or supervision transmissions, including data, to determine systems integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds.
(4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

The requirements are **FULFILLED.**

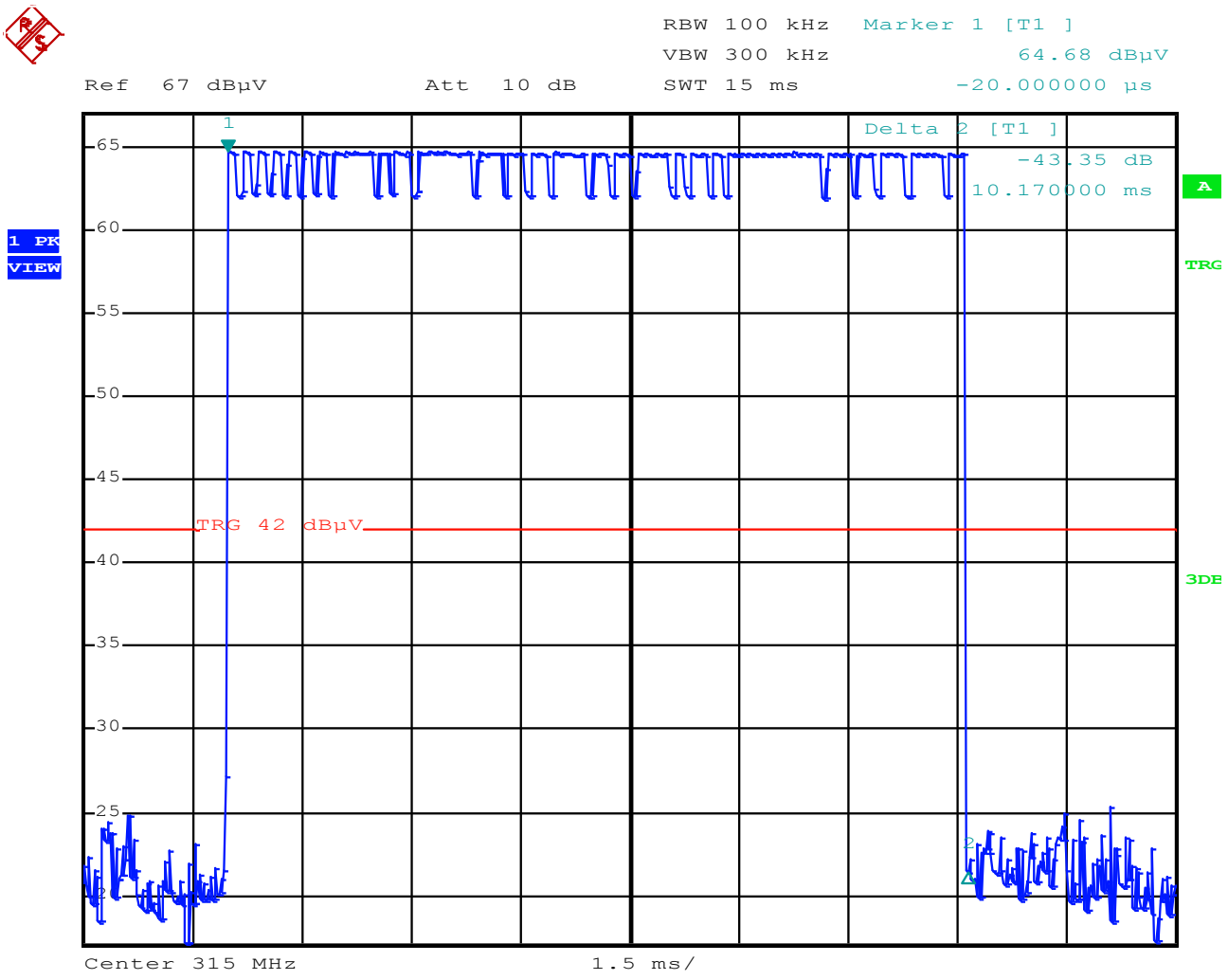
Remarks: For detailed test results, please see the test protocol below.

5.8.6 Test protocol

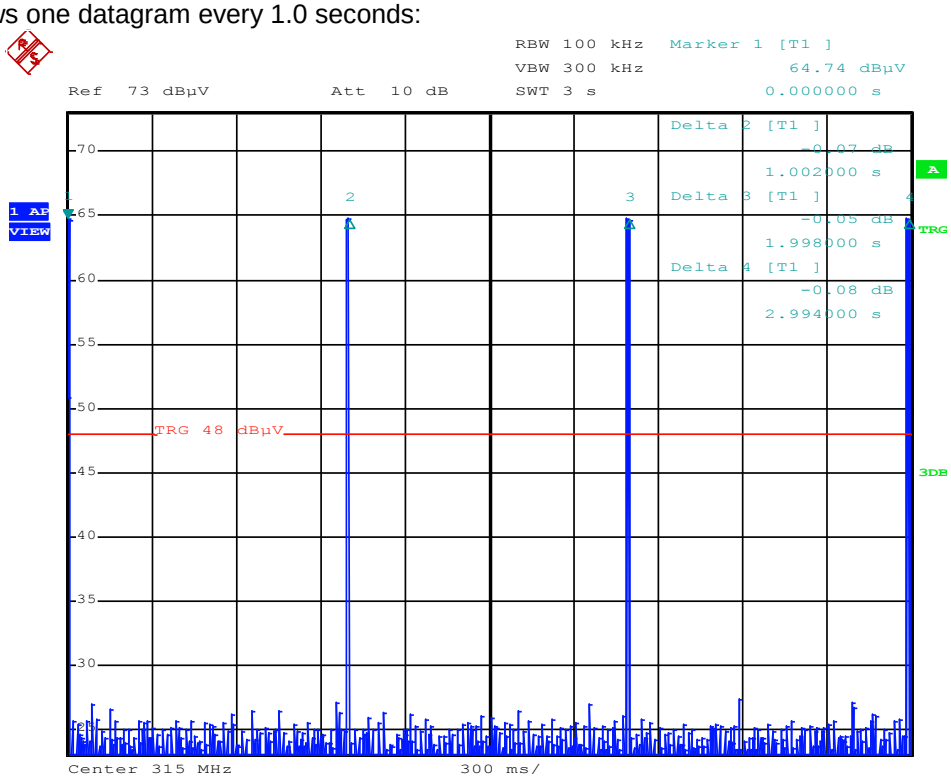
Signal deactivation

FCC Part 15C, Section 15.231(a)

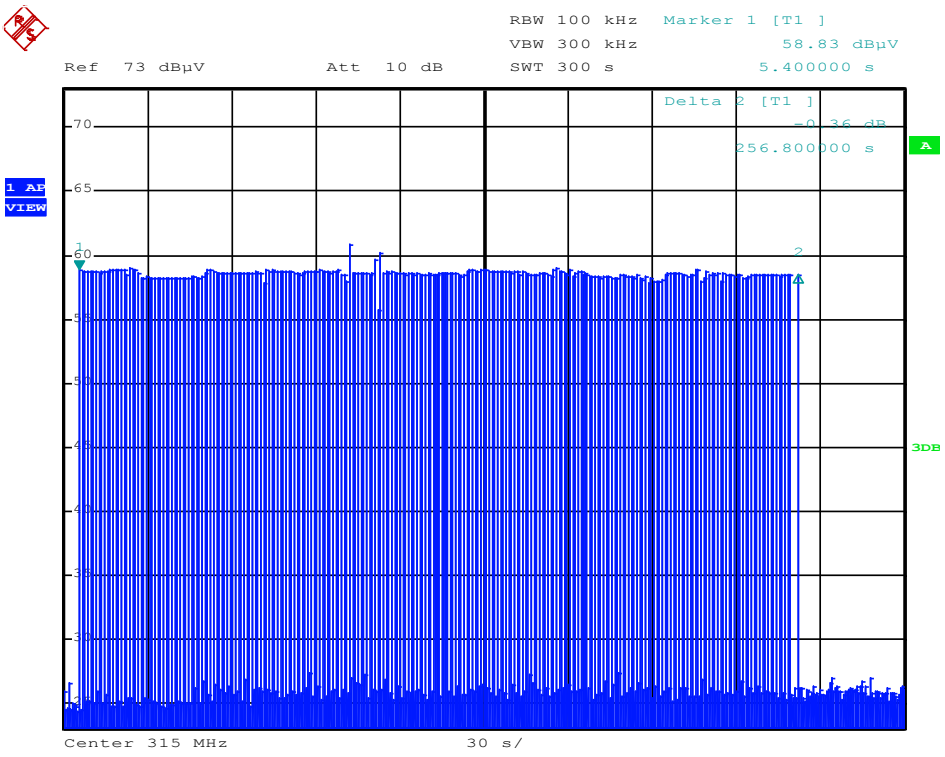
Worst case Tx on time:
Fast Transmission Mode automatically transmits one datagram (10.17 ms) every 1.0 seconds until 255 datagrams have been sent. After all 255 datagrams the sensor moves back to its previous mode.



- Plot shows one datagram every 1.0 seconds:



- Plot shows 255 datagrams:



6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
CPR 2	ESVS 30	02-02/03-05-006	28/06/2014	28/06/2013		
	VULB 9168	02-02/24-05-005	11/04/2014	11/04/2013	04/03/2014	04/09/2013
	S10162-B	02-02/50-05-031				
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
MB	FSP 30	02-02/11-05-001	24/10/2014	24/10/2013		
	RF Antenna	02-02/24-05-032				
	METRA HIT World	02-02/32-10-001	05/08/2014	05/08/2013		
SER 1	HFH2-Z2	02-02/24-05-020			13/02/2015	13/02/2014
	ESR 7	02-02/03-13-001	21/05/2014	21/05/2013		
	S10162-B	02-02/50-05-031				
	KK-EF393-21N-16	02-02/50-05-033				
	NW-2000-NB	02-02/50-05-113				
SER 2	ESVS 30	02-02/03-05-006	28/06/2014	28/06/2013		
	VULB 9168	02-02/24-05-005	11/04/2014	11/04/2013	04/03/2014	04/09/2013
	S10162-B	02-02/50-05-031				
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
SER 3	FSP 30	02-02/11-05-001	24/10/2014	24/10/2013		
	AFS5-12001800-18-10P-6	02-02/17-06-002				
	AFS4-01000400-10-10P-4	02-02/17-13-002				
	AMF-4F-04001200-15-10P	02-02/17-13-003				
	3117	02-02/24-05-009	04/04/2014	04/04/2013		
	Sucoflex N-1600-SMA	02-02/50-05-073				
	Sucoflex N-2000-SMA	02-02/50-05-075				
	SF104/11N/11N/1500MM	02-02/50-13-015				