DAkkS Deutsche Akkreditierungsstelle D-PL-21375-01-03 D-PL-21375-01-04

Bundesnetzagentur BNetzA-CAB-21/21-21

INGENIEURBÜRO LENHARDT

Test Report

Test report no.: 21096285-23872-1
Date of issue: 2022-05-10

Test result: The test item **- passed -** and complies with the listed standards.

Applicant

Huf Baolong Electronics Bretten GmbH

Manufacturer

Huf Baolong Electronics Bretten GmbH

Test Item

TSSRE4AR

Radio Frequency Testing according to:

Title 47
FCC Regulations Subpart 15C
§15.231

Tested by (name, function, signature)	*B.Sc. Piotr Sardyko* *Deputy Test Lab Manager Radio*	signature
Approved by (name, function, signature)	*Andreas Bender* *Deputy Managing Director*	signature

Applicant and Test item details	
Applicant	Huf Baolong Electronics Bretten GmbH Gewerbestr. 40, 75015 Bretten Germany
Manufacturer	Huf Baolong Electronics Bretten GmbH Gewerbestr. 40, 75015 Bretten Germany
Test item description	TPMS Sensor S5.32 433 MHz for Tire Pressure Monitoring
Model/Type reference	TSSRE4AR

FCC ID	OYGTSSRE4AR

Disclaimer and Notes

The content of this rest report relates to the mentioned test sample(s) only.
Without a written permit of IBL-Lab GmbH, this test report shall not be reproduced, except in full.

Within this test report, a ☒ point / ☐ comma is used as a decimal separator.
If otherwise, a detailed note is added adjected to its use.

Decision rule: Binary Statement for Simple Acceptance Rule according ILAC-G8:09/2019

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2 GENERAL INFORMATION

2.1 Administrative details

Testing laboratory	**IBL-Lab GmbH** Heinrich-Hertz-Allee 7 66386 Sankt Ingbert / Germany Fon: +49 6894 38938-0 Fax: +49 6894 38938-99 URL: www.ib-lenhardt.de E-Mail: info@ib-lenhardt.de
Accreditation	The testing laboratory is accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025:2018. Scope of testing and registration number: • Electromagnetic Compatibility and Telecommunication (FCC requirements) D-PL-21375-01-03 • Telekommunikation (TK) D-PL-21375-01-05 ISED Company Number 27156 Testing Laboratory CAB Identifier DE0020 Website DAkkS: https://www.dakks.de/ The Deutsche Akkreditierungsstelle GmbH (DAkkS) is also a signatory to the ILAC Mutual Recognition Arrangement
Date of receipt of test samples	2021-12-13
Start – End of tests	2021-12-14 – 2021-12-19 2022-05-10

2.2 Possible verdicts of the results

Test sample meets the requirements	P (PASS) – the measured value is below the acceptance limit, AL = TL
Test sample does not meet the requirements	F (FAIL) – the measured value is above the acceptance limit, AL = TL
Test case does not apply to the test sample	N/A (Not applicable)
Test case not performed	N/P (Not performed)

2.3 Observations

No additional observations other than the reported observations within this test report have been made.

2.4 Opinions and Interpretations

No appropriate opinions or interpretations according ISO/IEC 17025:2017 clause 7.8.7 are within this test report.

2.5 Revision History

-0 Initial Version

-1: Page 2: FCC ID is added
Page 8, Table 5.3.: EUT D and EUT E were added in the table.

Page 9, Table 5.5.: Additional operation mode is added in the table. Othe modes described more detailed.
Page 10: Op.Mode for fundamental field strength test is corrected
Page 11: Fundamental field strength was remeasured with sample, that uses internal battery (not external power supply) with RMS and Peak detector. Thus, the measurement results are replaced. Description of the measurement method is corrected. Detailed calculation if limit level is added.
Page 14: Emergency condition (rapid pressure loss) mode with “worst case” time behavior was measured additionally. The results to this measurement were presented in Transmit time measurement chapter. The limits for this measurement were described in this chapter more detailed.
Page 18: Comment for passive measurement equipment is added.
General: It is a pure FCC Report. Thus, all mentions of ISED are removed.
Annex A, Plots 1.1 - 1.3: Fundamental field strength was remeasured with sample, that uses internal battery (not external power supply). Thus, the plots were replaced.
Annex A, Plots 3.3 - 3.6: Emergency condition (rapid pressure loss) mode with “worst case” time behavior was measured additionally. The plots to this measurement were presented in Transmit time measurement chapter.
Annex B, Page 6-7: Photos for EUT D and EUT E were added.
Annex C, Chapter 1: Fundamental field strength was remeasured with sample, that uses internal battery (not external power supply). Thus, the photos to this measurement were replaced.
Annex C, Chapter 5: Emergency condition (rapid pressure loss) mode with “worst case” time behavior was measured additionally. The photos to this measurement were presented in Transmit time measurement chapter.
This test report **21096285-23872-1** replaces the previous test report **21096285-23872-0**.

2.6 Further documents

List of further applicable documents belonging to the present test report:

Measurement plots:	21096285-23872-1_Annex A
EUT photographs:	21096285-23872-1_Annex B
Test setup photographs:	21096285-23872-1_Annex C

2.7 Formula for determination of correction values (E_C)

$E_C = E_R + AF + C_L + D_F - G_A$ (1)

$M = L_T - E_C$ (2)

E_C = Electrical field – corrected value
E_R = Receiver reading
M = Margin
L_T = Limit
AF = Antenna factor
C_L = Cable loss
D_F = Distance correction factor (if used)
G_A = Gain of pre-amplifier (if used)

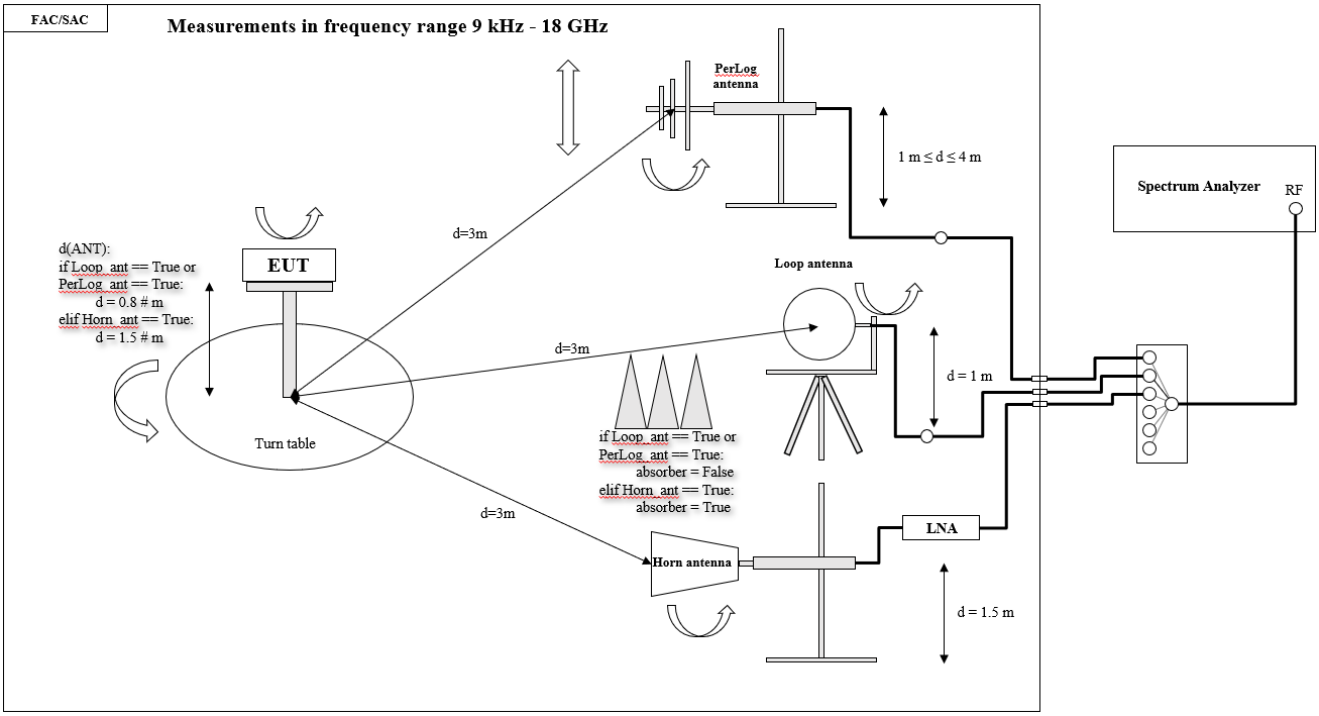
All units are dB-units, positive margin means value is below limit.

2.8 Software/Firmware used for measurements

All measurements were done directly with spectrum analyzer or SW R&S EMC32.
In some measurements (please see test equipment list for each test) R&S ESW 26 was used (please see chapter 8).
(Instrument) Firmware Version: **1.70**
In some measurements (please see test equipment list for each test) R&S FSW 50 was used (please see chapter 8).
(Instrument) Firmware Version: **4.61**
In some measurements SW R&S EMC32 was used.
Version: **11.10.00**

2.9 Block diagrams

Block diagram 1:



3 ENVIRONMENTAL & TEST CONDITIONS

3.1 Environmental conditions	
Temperature	20°C ± 5°C
Relative humidity	25-75 % r.H.
Barometric Pressure	860-1060 mbar
Power supply	3V DC (external) or 3V battery

4 TEST STANDARDS AND REFERENCES

Test standard (accredited)	
FCC CFR Title 47 Part 15 Subpart C:2016	---
ANSI C63.10: 2013	---

Test standard (not accredited)
None

Reference	**Description**
none	---

5 EQUIPMENT UNDER TEST (EUT)

5.1 Product Description*

The sensor module will be installed inside the tire by the use of a special TPMS valve. The device measures pressure, temperature and acceleration and transmit the data to the TPMS ECU in the car. The RF transmisison take place in the ISM band 434 MHz (SRD application).

*: declared by the applicant

5.2 Technical Data of Equipment*

Number of channel:	1
Channel bandwidth:	113 kHz (FSK)
Channel tested:	f_{cent}: 433.92 MHz
Spectrum Access Mechanism:	Duty Cycle
Antenna Type:	Internal
Antenna connector:	None
Equipment type:	Production model
Type of power source:	DC power supply
Test source voltage:	Vmin: 2.4 VDC, Vnom: 3 VDC, Vmax: 3.3 VDC

*: declared by the applicant

5.3 Test Item (Equipment Under Test) Description*

Short designation	EUT Model	EUT Description	Serial number	Hardware status	Software status
EUT A	TSSRE4AR	TPMS, EMC mode, uses ext. power supply	2000A8C0	300.316.00	56.5.4
EUT B	TSSRE4AR	TPMS, CW mode, uses ext. power supply	2000A8A3	300.316.00	56.5.4
EUT C	TSSRE4AR	TPMS, normal mode, uses internal battery	2000A3D8	300.316.00	56.5.4
EUT D	TSSRE4AR	TPMS, CW mode, uses internal battery	2000A3C9	300.316.00	56.5.4
EUT E	TSSRE4AR	TPMS, emergency condition (rapid pressure loss) mode	22A5C871	300.316.00	56.5.4

*: declared by the applicant

5.4 Auxiliary Equipment (AE) Description*

AE short designation	EUT Name (if available)	EUT Description	Serial number (if available)	Software (if used)
AE1	-	-	-	-

*: declared by the applicant

5.5 Test Item Operating Modes Description*

EUT operating mode no.	Description of operating modes	Additional information
op. 1	EMC Mode	DC@100ms= 11 %, cycle time = app. 1 s. This mode was used for measurement of occupied bandwidth. The EUT in this measurement was using external power supply.
op. 2	CW Mode	DC@100ms= 100 %, continuous transmitting. This mode was used for Fundamental field strength and Radiated field strength measurements. During Radiated field strength measurements, the EUT was using external power supply. During Fundamental field strength, the EUT was using internal battery.
op. 3	Normal Mode	DC@100ms= 19 %, cycle time = app. 30 s. This mode was used in Transmit time measurement. Also, this mode was used for calculation of duty cycle correction factor.
op. 4	Emergency condition (rapid pressure loss) mode	DC@100ms= 5.8 %, cycle time = app. 1.2 s. This mode was used in Transmit time measurement for checking of “worst case” behavior of the EUT.

*: declared by the applicant

5.6 Test Item Set-ups Description

set. 1	EUT A
set. 2	EUT B
set. 3	EUT C
set. 4	EUT D
set. 5	EUT E

5.7 Normal est conditions

Temperatur, [°C]		Voltage, [V]	
Tnom	20 ± 5	Vnom	3

5.8 Additional Information

Test items differences	EUT C was supplied with original 3V battery. This sample was used only for time measurement test. Other samples were using external power supply.
Additional application considerations to test a component or sub-assembly	None

6 SUMMARY OF TEST RESULTS

Test specification
FCC 15.231

Requirement / Test Case	Test Conditions	Set-up	Operating mode	Result / Remark	Verdict
Fundamental field strength	Nominal	4	2	None	**Pass**
Radiated field strength measurements	Nominal	2	2	None	**Pass**
Transmit time	Nominal	2,3,5	2,3,4	None	**Pass**
Occupied Bandwidth	Nominal	1	1	None	**Pass**

Notes
None

Comments and observations
None

7 TEST RESULTS

7.1 Fundamental field strength

Test equipment (Please see Chapter 8 for exact information of test equipment)

Radiated: C1, R1, A2, P2, M1

Description

The measurement was done according to ANSI C63.10-2013, Chapter 6.5.
See photos in Annex C for test Set-up and block diagram 1 in Chapter 2.9.
For spectrum analyzer settings please see plots in Annex A.

Limits

According to FCC 15.231(e) Field strength of fundamental:

Frequency [MHz]	Field strength@3m		Measurement distance [meters]	Remarks
	[µV/m]	[dBuV/m]		
40.66-40.70	1000	60	3	Linear interpolation
70-130	500	53.98		
130-174	500 to 1500	53.98 to 63.52		
174-260	1500	63.52		
260-470	1500 to 5000	63.52 to 73.98		
Above 470	5000	73.98		

Measurement Level = Reading Level + Correction Factor.
Limit (uV/m@433.9 MHz):
X_{11}=260, Y_{11}=1500, X_{12}=470, Y_{12}=5000
f(x)=mx+b, m=(5000-1500)/(470-260)=3500/210=16.66, b=f(x)-mx=5000-16.66*470=-2833.33
=> f(x)=16.66*x-2833.33 => f(433.9)=16.66*433.9-2833.33=4398.33
Limit dBuV/m RMS/Peak:
Average/RMS Limit = 20LOG(4398.33) = 72.86 dBµV/m. Peak Limit = RMS Limit + 20 dB=92.86 dBµV/m.

Results Peak Detector*

Set./ Op.	Peak field strength, [dBµV/m]	Limit Peak, [dBµV/m]	Margin [dB]	Verdict
Set.1, Op. 2	78.43	92.86	14.43	Pass

Results RMS Detector*

Correction factors:
CF_Op.1 = 10*LOG(DC@100ms_Op.3/ DC@100ms_Op.2) = 10*LOG(0.1904/1)=-7.2
CF: Please see Chapter 3 in Annex A for Duty Cycle (DC) values.

Set./ Op.	AV field strength measured, [dBµV/m]	DC CorFac, [dB]	AV field strength corrected, [dBµV/m]	Limit AV, [dBµV/m]	Margin [dB]	Verdict
Set.1, Op. 2	78.11	-7.2	70.91	72.86	1.95	Pass

* Please see measurement plots in Annex A.

7.2 Radiated field strength measurements

Test equipment

Frequency range 9 kHz – 30 MHz

Measurement in a semianechoic room with the distance between the EUT and the reference point of the antenna 3 m (see photos in Annex B). The measurement was done with software R&S EMC 32 V11.00.

Radiated: A1, C1, M1, P1, R1

Frequency range 30 MHz – 1 GHz

Measurement in a semianechoic room with the distance between the EUT and the reference point of the antenna 3 m (see photos in Annex B). The measurement was done with software R&S EMC 32 V11.00.

Radiated: A2, C1, M1, P1, R1

Frequency range 1 GHz – 5 GHz

Measurement in a fully anechoic room with the distance between the EUT and the reference point of the antenna 3 m (see photos in Annex B). The measurement was done directly with spectrum analyzer.

Radiated: A3, Amp2, C1, F4, M1, P1, R1

Description

The measurement test set-up and test procedure are in accordance with the provisions described in ANSI 63.10: 2013.
The measurement antenna was situated in 3 m distance to the EUT.
RBW for frequency range 9 kHz- 30 MHz: 9 kHz.
RBW for frequency range 30 MHz- 1 GHz: 120 kHz.
RBW for frequency range 1 GHz- 5 GHz: 1 MHz.
See photos in Annex C for test Set-up and block diagram in Chapter 2.9.

Limits

According to FCC 15.209(a):

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490*	2400/F(kHz)	300
0.490-1.705*	24000/F(kHz)	30
1.705-30.0*	30	30

* Limit line was corrected due to measurement distance of 3 m

Limits

According to FCC 15.231(e) Field strength of spurious emission:

Frequency [MHz]	Field strength@3m		Measurement distance [meters]	Remarks
	[µV/m]	[dBuV/m]		
40.66-40.70	100	40	3	Linear interpolation
70-130	50	33.98		
130-174	50 to 150	33.98 to 43.52		
174-260	150	43.52		
260-470	150 to 500	43.52 to 53.98		
Above 470	500	53.98		

Results*

No	Op./ Set.	Frequency	Detector	Test distance [m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Verdict
1	Op.2, Set.2	9 kHz – 30 MHz	Quasi-Peak	3	35***	45**	10	**Pass**

2	Op.2, Set.2	30 MHz – 1 GHz	Quasi-Peak	3	53.16	54	0.84	**Pass**
3	Op.2, Set.2	960 MHz – 1.4 GHz	Peak	3	44.93	74	29.07	**Pass**
4	Op.2, Set.2	960 MHz – 1.4 GHz	RMS	3	42.91	54	11.09	**Pass**
5	Op.2, Set.2	1.4 GHz – 5 GHz	Peak	3	59.81	74	14.19	**Pass**
6	Op.2, Set.2	1.4 GHz – 5 GHz	RMS	3	51.46****	54	2.54	**Pass**
All Readings below 1 GHz are Quasi-Peak detector, above 1 GHz- with Peak and RMS detector.								

* Please see measurement plots in Annex A.
** Limit line was corrrected due to measurement distance of 3 m
*** Noise level.
***** Please see plot 3.1 and 3.3. in Annex A. Duty cycle correction factor was used:
10*LOG(DC@100ms_Op.3/ DC@100ms_Op.2) =
10*LOG(0.1904/1)=-7.2

7.3 Transmit time

Test equipment (Please see Chapter 8 for exact information of test equipment)
Radiated: C1, R1, R3, A2, A4, P2, M1

Description

Please see test set-up photos in Annex B and and block diagram in Chapter 2.9.

Measurement was done radiated.

The correction factor is used for Fundamental field strength calculations (Av) and for Radiated field strength calculations (Av).

Limits

FCC 15.231(e):

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.

FCC 15.231(a)(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.

Results*

Set./ Op.	Frequency, [MHz]	Measured value, [ms]	Limit**, [sec]	Result
3 / 3	433.94	173.1 / 30000	1 s / t_between < 10 s or t_sign*30	Pass
5 / 4	433.94	204 / 1200 (**Note 1**)	1 s / **Note 1**	Pass

Note 1:

This behaviour concerns FCC 15.231 (a)(4). According to customers information: „*In the case of an emergency condition (rapid pressure loss), the devise will transmit tire pressure and temperature information throughout the duration of the condition. If the pressure is stable and has not changed by >=50 mbar in 10s, the sensor exit Delta-P mode and go back to normal mode.* “

* Please see measurement plots in Annex A.

** The manufacturer is responsible for not exceeding this requirement.

7.4 Occupied Bandwidth

Test equipment (Please see Chapter 8 for exact information of test equipment)

Radiated: C1, R1, A2, P2, M1

Description

The measurement test set-up and test procedure are in accordance with the provisions described in ANSI 63.10: 2013.
Please see test set-up photos in Annex C and block diagram in Chapter 2.9.
Please see Plots in Annex A for spectrum analyzer settings.
Measurement was done radiated.

Limits

The bandwidth of the emission shall be not wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be not wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

Results*

Set./ Op.	Frequency, [MHz]	Measured value (20 dB BW), [kHz]	Limit, [MHz]	OBW 99%, [kHz]	Result
Set.1, Op. 1	433.85	119.880	1.084625	113.32	Pass

* Please see measurement plots in Annex A.

8 MEASUREMENT EQUIPMENT

No	Equipment	Type	Manufacturer	Serial No.	Int. No.	Last Calibration	Next Calibration
Antennas (**A**):							
1.	Active Loop Antenna	HFH2-Z2E	Rohde & Schwarz	100108	LAB000108	2020-03-25	2023-03-25
2.	Ultrabroadband antenna	HL562E	Rohde & Schwarz	102005	LAB000150	2020-07-05	2023-07-05
3.	Double-Ridged Waveguide Horn Antenna	HF-907	Rohde & Schwarz	102899	LAB000151	2020-04-23	2023-04-23
4.	Rod Antenna	-	-	-	LAB000290	-	-
5.	Horn Antenna (2.6 GHz – 3.95 GHz)	PE9863/SF-10	Pasternack	-	LAB000312	2021-01-13	-
6.	Horn Antenna (3.95 GHz – 5.85 GHz)	PE9861/SF-10	Pasternack	-	LAB000264	2020-09-29	-
7.	Horn Antenna (10 GHz – 15 GHz)	PE9855 SF-20	Pasternack	-	LAB000263	2020-09-29	-
8.	Horn Antenna (12.4 GHz – 18 GHz)	62-HA20-A-SMF	TTE Europe	-	LAB000282	2020-09-29	-
9.	Horn Antenna (17.6 GHz – 26.7 GHz)	20240-20	Flann Microwave Ltd	266402	LAB000127	2020-06-29	-
10.	Horn Antenna (26.4 GHz – 40.1 GHz)	22240-20	Flann Microwave Ltd	270447	LAB000129	2020-06-29	-
11.	Horn Antenna (33 GHz – 50.1 GHz)	23240-20	Flann Microwave Ltd	273430	LAB000132	2020-07-01	-
12.	Horn Antenna (49.9 GHz – 75.8 GHz)	25240-20	Flann Microwave Ltd	272860	LAB000133	2020-07-01	-
13.	Horn Antenna (60.5 GHz – 91.5 GHz)	26240-20	Flann Microwave Ltd	273417	LAB000135	2020-07-01	-
14.	Horn Antenna (73.8 GHz – 114 GHz)	27240-20	Flann Microwave Ltd	273368	LAB000138	2020-07-01	-
15.	Horn Antenna (114 GHz – 173 GHz)	29240-20	Flann Microwave Ltd	273382	LAB000139	2020-07-01	-
16.	Horn Antenna (145 GHz – 220 GHz)	30240-20	Flann Microwave Ltd	273390	LAB000178	2020-08-01	-
17.	Horn Antenna (217 GHz – 330 GHz)	32240-20	Flann Microwave Ltd	273469	LAB000152	2020-08-01	-
18.	Horn Antenna (49.9 GHz – 75.8 GHz)	25240-20	Flann Microwave Ltd	272861	LAB000134	2020-07-01	-
19.	Horn Antenna (60.5 GHz – 91.5 GHz)	26240-20	Flann Microwave Ltd	273418	LAB000136	2020-08-01	-
Amplifiers (**Amp**):							
1.	Pre-Amplifier	BBV 9718 C	Schwarzbeck Mess-Elektronik OHG	84	LAB000169	-	-
2.	Low noise amplifier	BZ-01000900-111550-202320	B&Z Technologies	24336	LAB000296	-	-
3.	Low noise amplifier	BZ-08001800-180855-202020	B&Z Technologies	22105	LAB000297	-	-

4.	Low noise amplifier	BZ-18004000-270845-252525	B&Z Technologies	22449	LAB000298	-	-
Attenuator (**Att**):							
1.	Attenuator	25081-20 (49.9 GHz - 75.8 GHz)	Flann Microwave Ltd	234411	LAB000229	-	-
2.	Attenuator	27081-20 (73.8 GHz – 112 GHz)	Flann Microwave Ltd	270004	LAB000230	-	-
RF Cables (**Cab**):							
1.	Coaxial cable	LU7-022-1000	Rosenberger	33	LAB000153	-	-
2.	Coaxial cable	LU7-022-1000	Rosenberger	34	LAB000153	-	-
3.	Coaxial cable	SF101/1.5m	Huber & Suhner	503987/1	LAB000165	-	-
Chambers (**C**):							
1.	Semi/Fully Anecoic Chamber	SAC5	Albatross Projects GmbH	20168.PRB	LAB000235	2021-08-24	2022-08-24
2.	Climatic chamber	T-65/50	CTS GmbH	204002	LAB000110	2021-06-18	2022-06-18
3.	Shielding Cover	CMU-Z11	Rohde & Schwarz	100876	LAB000039	-	-
4.	Climatic chamber	T-70/350	CTS GmbH	194027	LAB000066	2021-06-30	2022-06-30
Corner Reflector (**CR**):							
1.	Trihedral Corner Reflector	SAJ-080-S1	ERAVANT	04756-01	LAB000201	-	-
Filter (**F**):							
1.	High-pass filter (84 GHz – 110 GHz)	10-WHPF-84.5-UG387	TTE	-	LAB000299	-	-
2.	High-pass filter (7 GHz – 23 GHz)	HPF 7-23	AtlantRF	-	LAB000444	-	-
3.	High-pass filter (3.3 GHz – 12.75 GHz)	HPF 3.3-11	AtlantRF	-	LAB000382	-	-
4.	High-pass filter (1.3 GHz – 12.75 GHz)	H1G713G1	Microwave Circuits Inc	46291	LAB000443	-	-
Harmonic mixers (**H**):							
1.	Harmonic Mixer	FS-Z60	Rohde & Schwarz	101350	LAB000375	2022-03-18	2023-03-18
2.	Harmonic Mixer	FS-Z75	Rohde & Schwarz	102015	LAB000112	2022-04-20	2023-04-20
3.	Harmonic Mixer	FS-Z90	Rohde & Schwarz	102020	LAB000113	2022-04-05	2023-04-05
4.	Harmonic Mixer	FS-Z110	Rohde & Schwarz	102000	LAB000114	2022-03-11	2023-03-11
5.	Harmonic Mixer	FS-Z170	Rohde & Schwarz	100996	LAB000126	2022-04-12	2023-04-12
6.	Harmonic Mixer	FS-Z220	Rohde & Schwarz	101039	LAB000116	2022-03-28	2023-03-28
7.	Harmonic Mixer	FS-Z325	Rohde & Schwarz	101015	LAB000117	2022-04-12	2023-04-12
Multimeters (**M**):							
1.	Multimeter	U1242B	Keysight	MY59240021	LAB000187	2020-06-24	2022-06-24
2.	Multimeter	U1242B	Keysight	MY59160026	LAB000018	2020-06-24	2022-06-29
Multipliers (**Mp**):							
1.	Multiplier	SMZ75	Rohde & Schwarz	101307	-	2018-03-15	-
2.	Multiplier	SMZ110	Rohde & Schwarz	100001	-	2020-05-09	-
Power Supply (**P**):							

1.	Power Supply	PS 2042-10 B	Elektro-Automatic GmbH	2878350263	LAB000190	-	-
2.	Power Supply	PS 2042-10 B	Elektro-Automatic GmbH	2878350322	LAB000192	-	-
3.	Power Supply	E3640A	Agilent	MY40005693	LAB000036	-	-
Power meters (PM):							
1.	Power meter	NRP-Z81	Rohde & Schwarz	106194	LAB000120	2021-05-26	2022-05-26
Receivers and Spectrumanalyzers (R):							
1.	Test Receiver, SAC5	ESW-26	Rohde & Schwarz	101517	LAB000363	2022-02-03	2023-02-03
2.	Test Receiver	ESW-26	Rohde & Schwarz	101481	LAB000236	2021-07-01	2022-07-01
3.	Spectrum Analyzer 1 Hz – 50 GHz	FSW-50	Rohde & Schwarz	101450	LAB000111	2021-07-22	2022-07-22
4.	Spectrum Analyzer 2 Hz – 43 GHz	FSW-43	Rohde & Schwarz	101391	LAB000289	2021-07-02	2022-07-02
Signal Generators (SG):							
1.	Signal generator 8 kHz – 50 GHz	SMA100B	Rohde & Schwarz	103838	LAB000118	2020-07-08	2022-07-08
2.	Vector Signal Generator	SMW200A	Rohde & Schwarz	108822	LAB000288	-	-

* The gain values of Amp and attenuation values of Cab and Att are remeasured annually internal.

9 MEASUREMENT UNCERTAINTIES

Test case	Measurement uncertainty*
Radiated field strength	≤ ± 6 dB
Occupied bandwidth	± 100 kHz
Time domain measurement	± 2.32 ms
DC and low frequency voltages	± 3 %
Temperature	± 1 °C
Humidity	± 3 %

*) The indicated expanded measurement uncertainty corresponds to the standard measurement uncertainty for the measurement results multiplied by the coverage factor k = 2. The true value is located in the corresponding interval with a probability of 95 %.

END OF THE REPORT

Annex A

Measurement plots

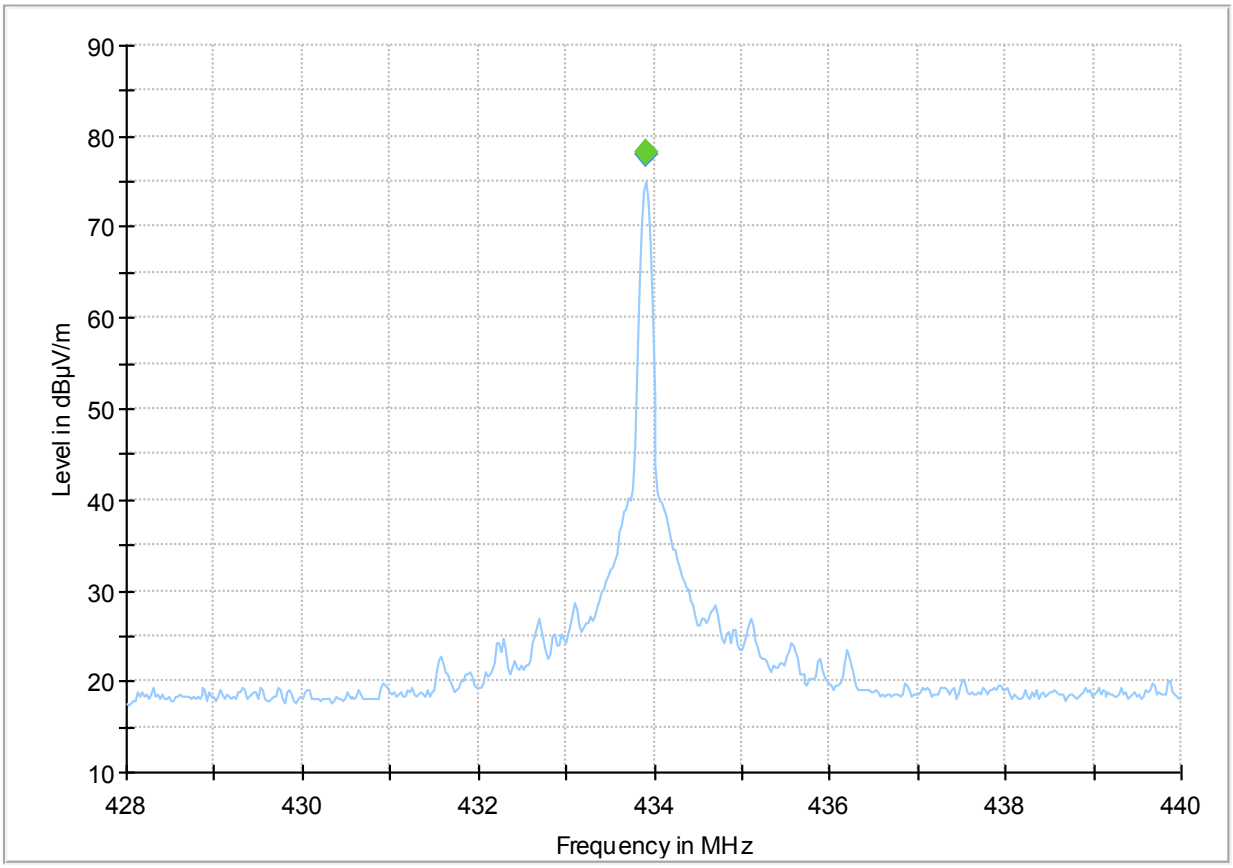
part of / in addition to

Test report no.: 21096285-23872-1

Table of contents:

1 Fundamental field strength

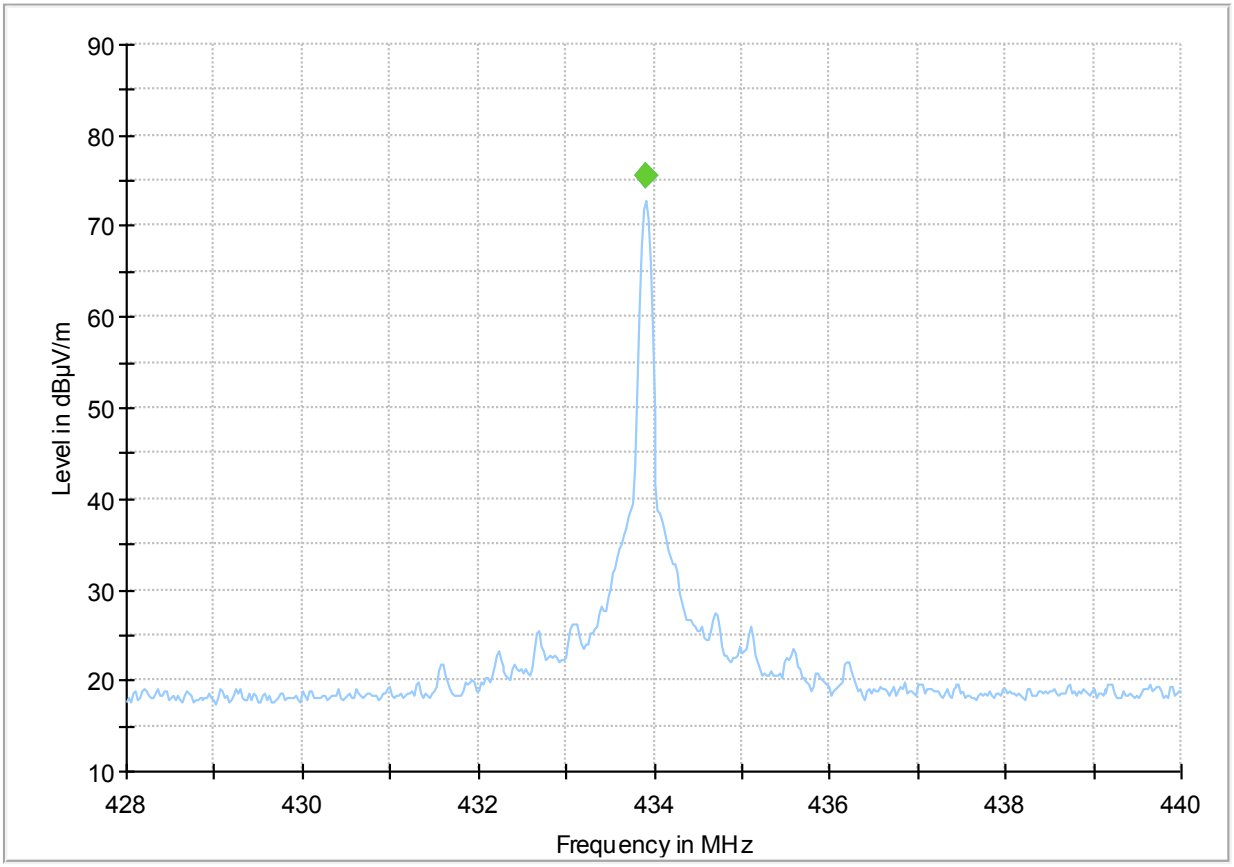
1.1 Set-up 4, Op. 4, lying, antenna up



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
433.900000	---	78.11	---	---	100.0	120.000	135.0	V
433.900000	78.06	---	---	---	100.0	120.000	135.0	V

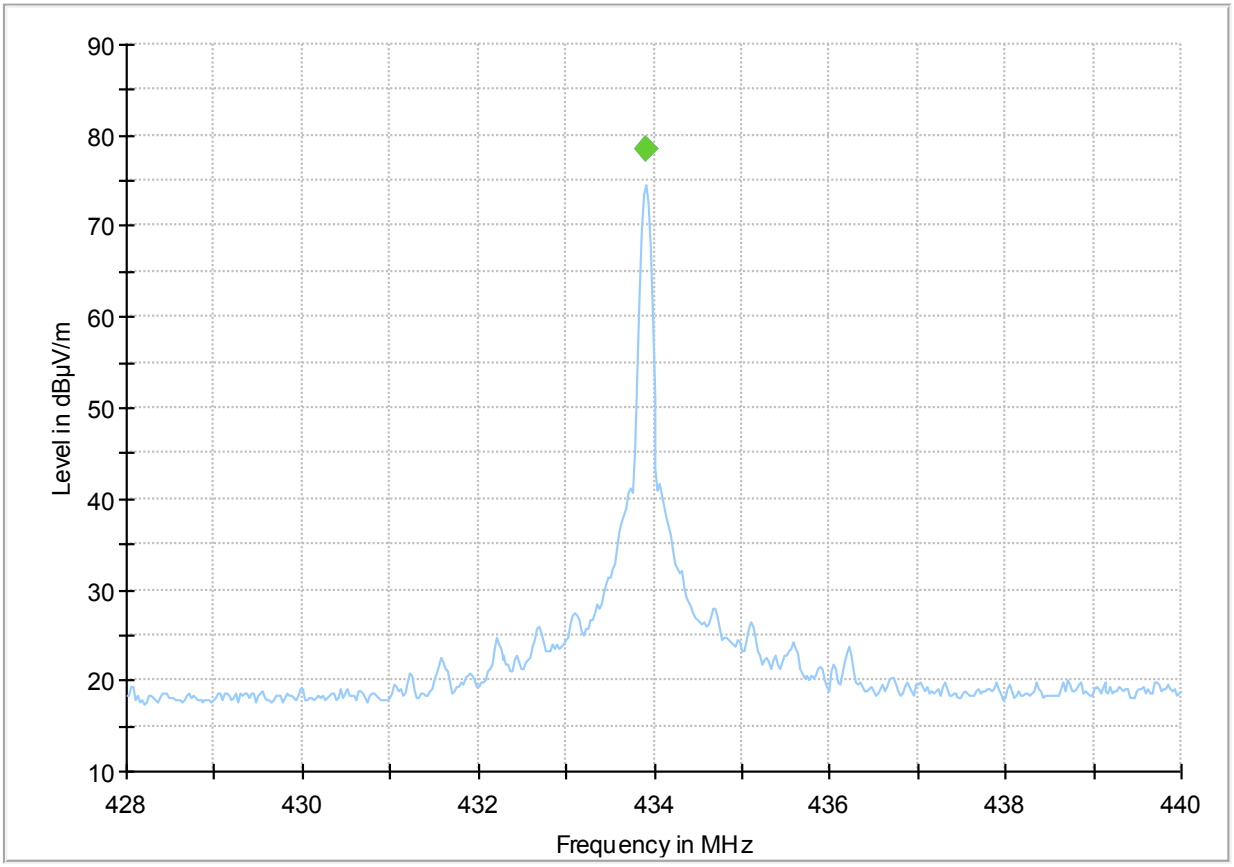
1.2 Set-up 4, Op. 4, lying, standing



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
433.900000	---	75.58	---	---	100.0	120.000	135.0	V
433.900000	75.53	---	---	---	100.0	120.000	135.0	V

1.3 Set-up 4, Op. 4, lying, antenna down



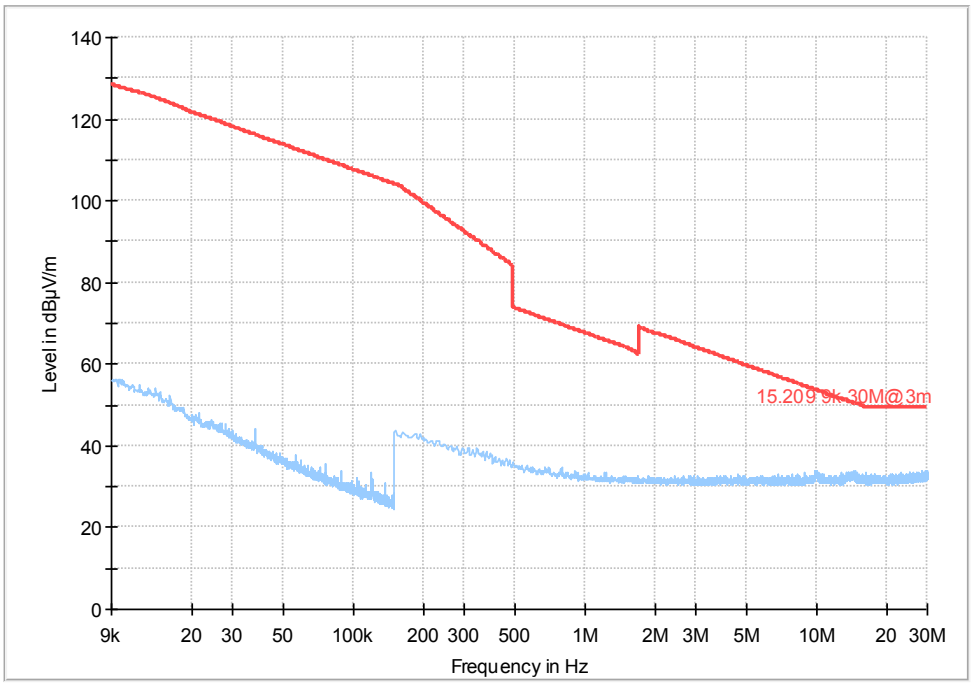
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
433.900000	---	78.48	---	---	100.0	120.000	133.0	V
433.900000	78.43	---	---	---	100.0	120.000	133.0	V

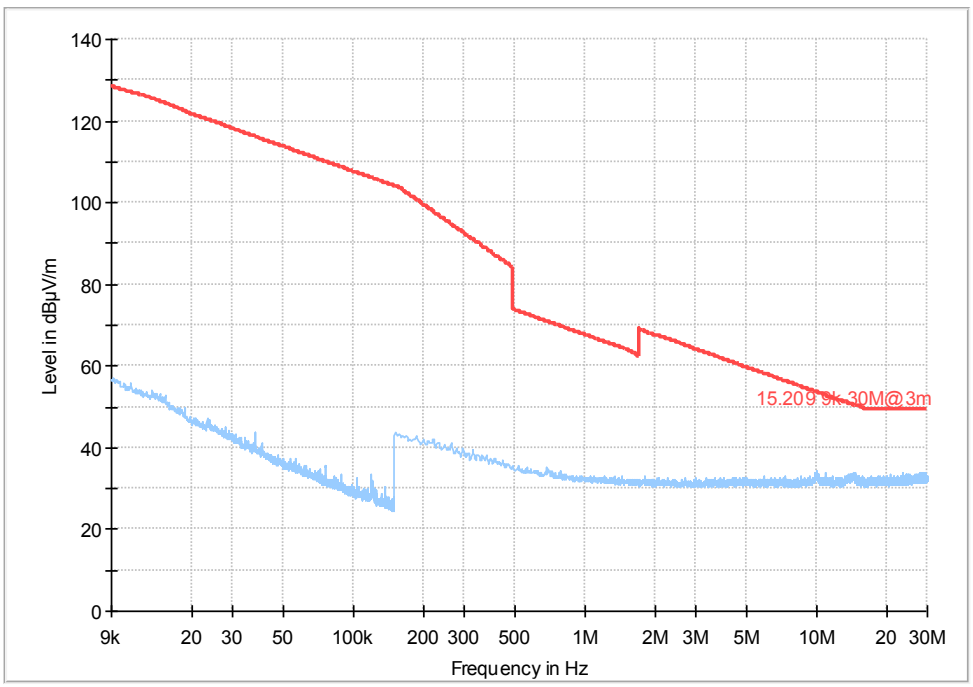
2 General Limit - Radiated field strength emissions, 9 kHz - 5 GHz

2.1 Radiated magnetic field strength measurements (f < 30 MHz)

2.1.1 Lying, Set-up 2, Op. 2

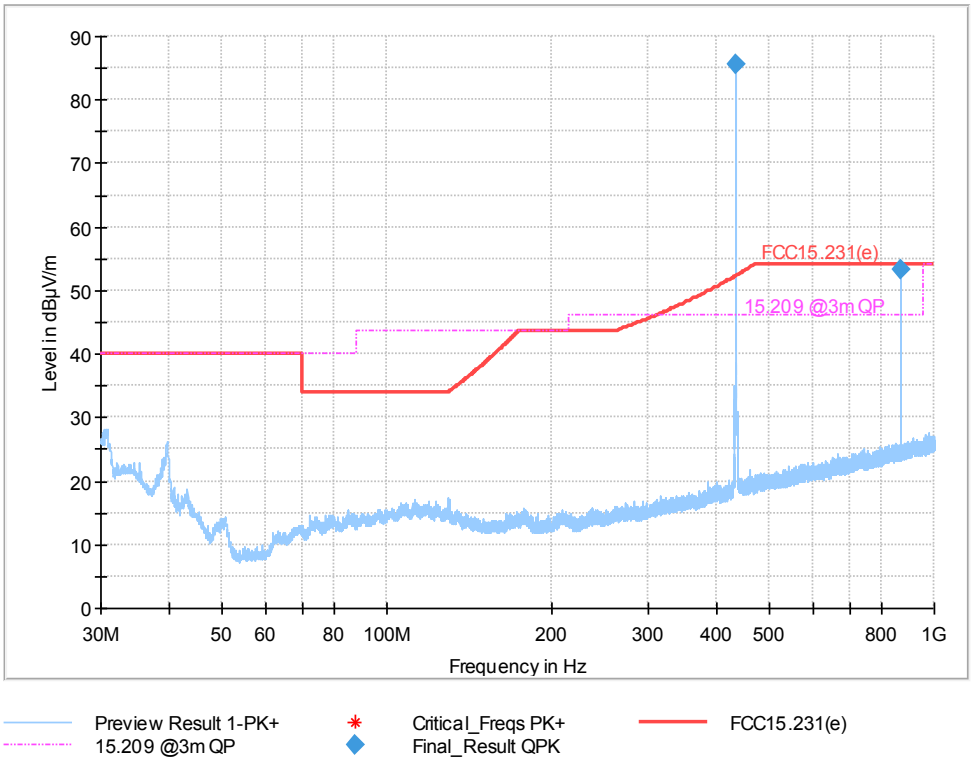


2.1.2 Standing, Set-up 2, Op. 2



2.2 Radiated magnetic field strength measurements (30 MHz < f < 1000 MHz)

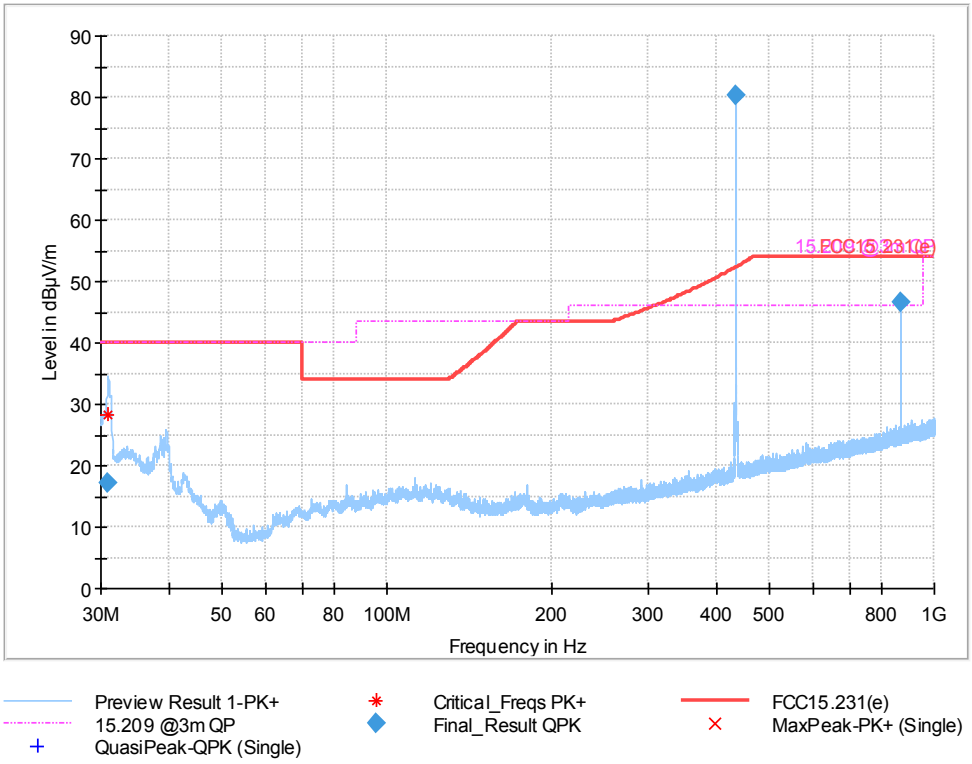
2.2.1 Lying, Set-up 2, Op. 2



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
433.900000	85.64	100.0	120.000	103.0	V	256.0
867.800000	53.16	100.0	120.000	100.0	V	147.0

2.2.2 Standing, Set-up 2, Op. 2

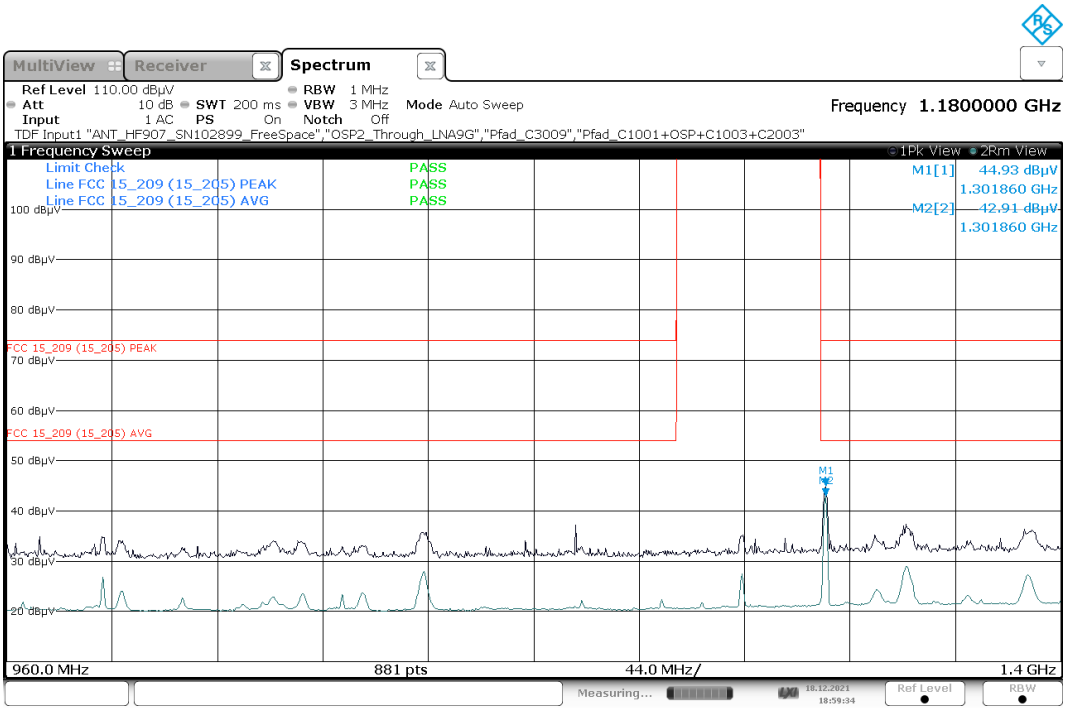


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.825000	17.01	100.0	120.000	100.0	V	30.0
433.900000	80.16	100.0	120.000	113.0	V	320.0
867.800000	46.45	100.0	120.000	100.0	V	170.0

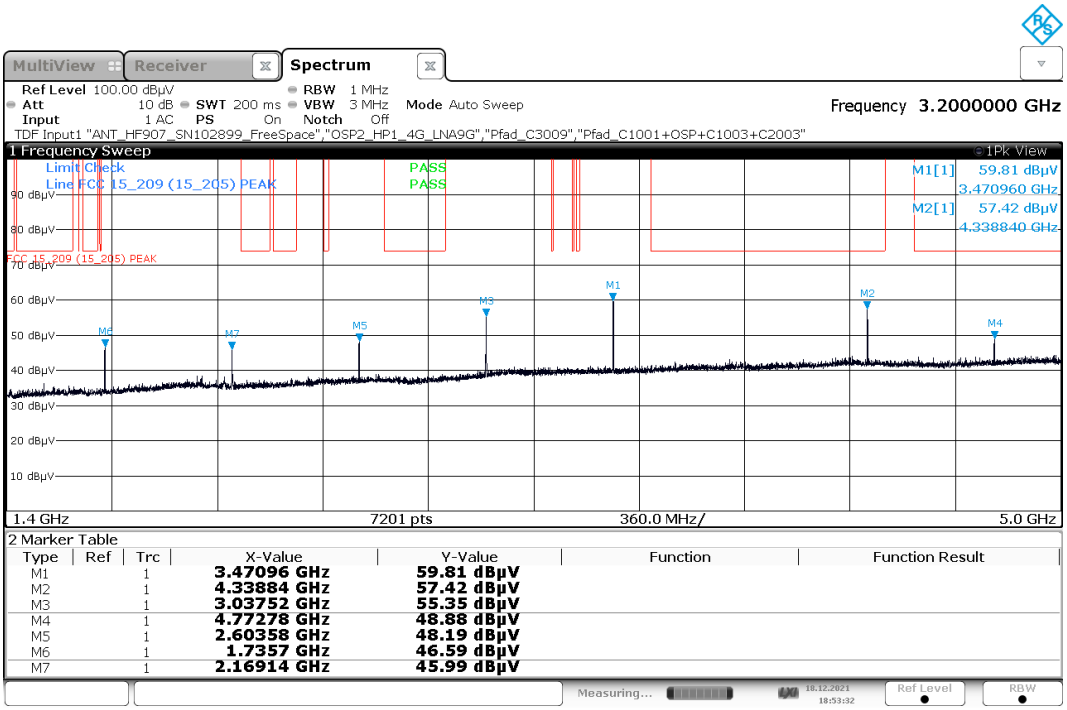
2.3 Radiated magnetic field strength measurements (1 GHz < f < 5 GHz)

2.3.1 960 MHz – 1400 MHz, Set-up 2, Op. 2



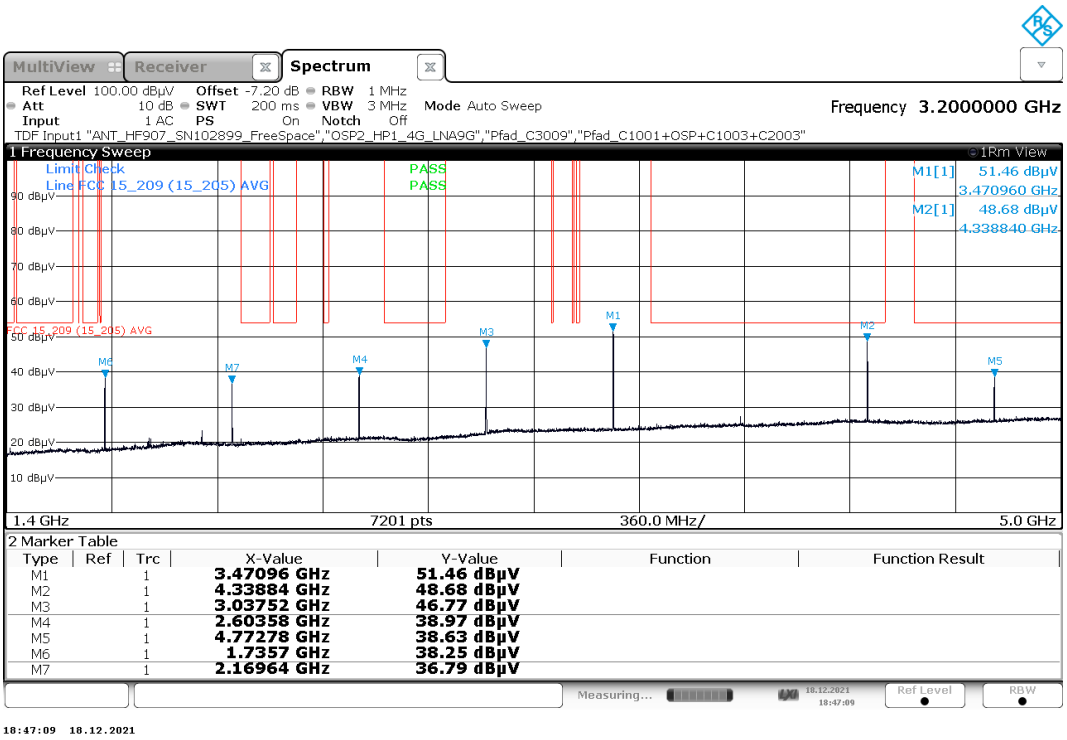
18:59:34 18.12.2021

2.3.2 1400 MHz – 5000 MHz, DET PEAK, Set-up 2, Op. 2



18:53:32 18.12.2021

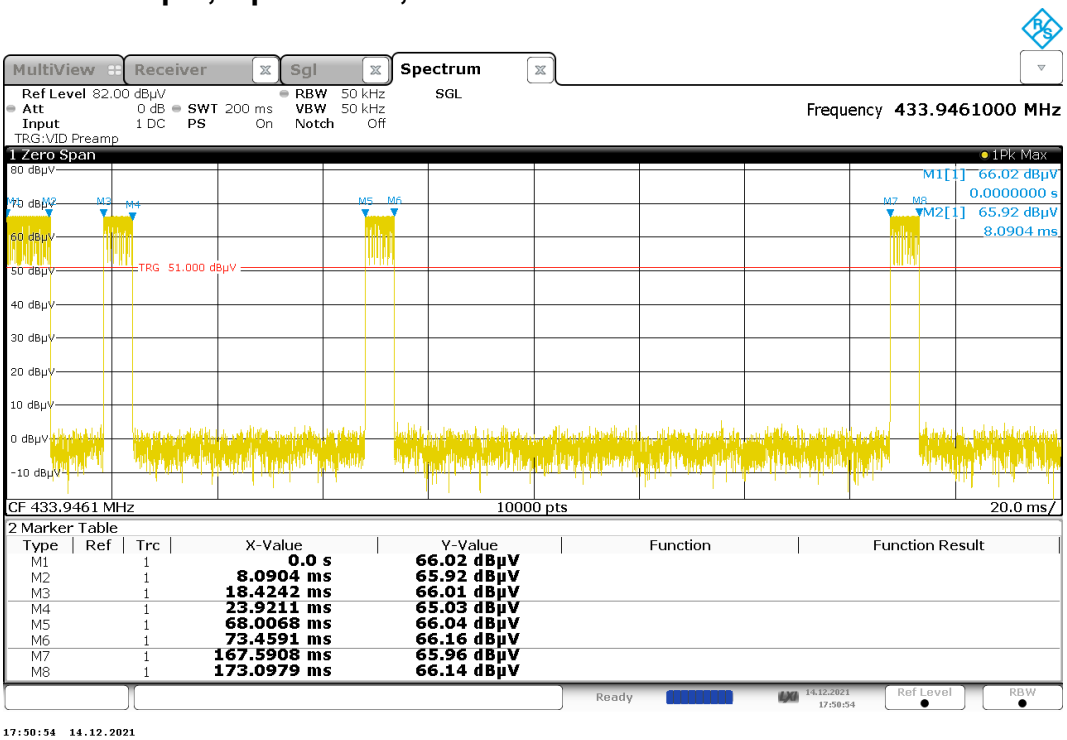
2.3.3 1400 MHz – 5000 MHz, DET RMS, Set-up 2, Op. 2, Offset = -7.2 dB*



* Please see plot 3.1 and 3.3.
Duty cycle correction factor =
10*LOG(DC@100ms_Op.3/ DC@100ms_Op.2) =
10*LOG(0.1904/1)=-7.2

3 Transmit time

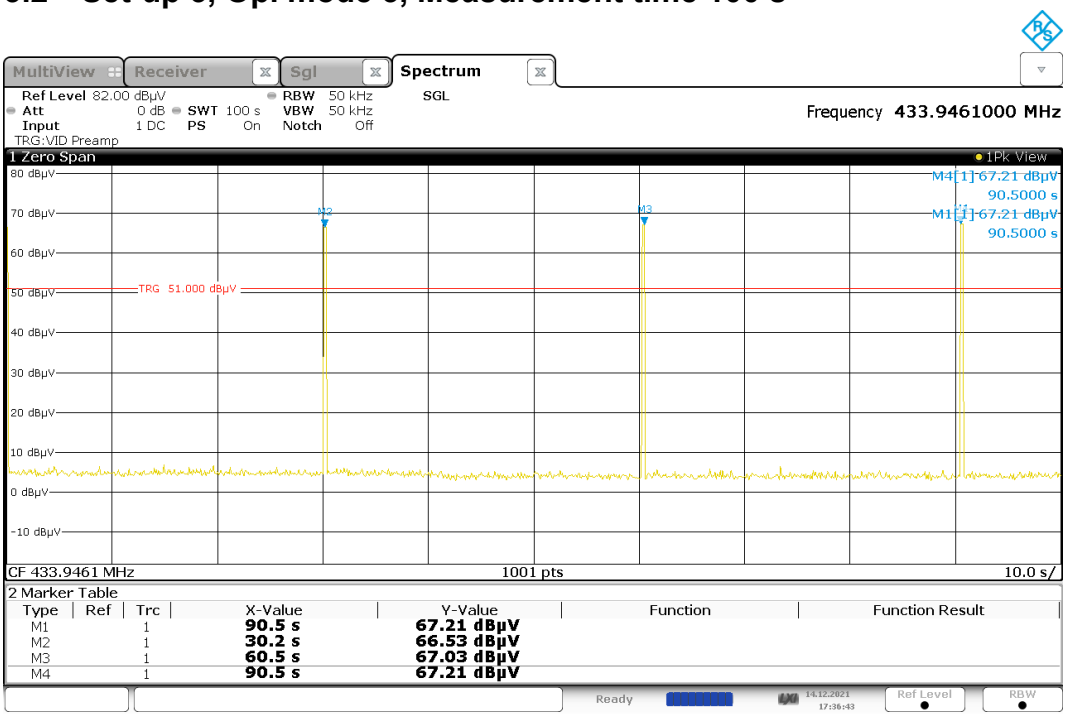
3.1 Set-up 3, Op. mode 3, Measurement time 200 ms



17:50:54 14.12.2021

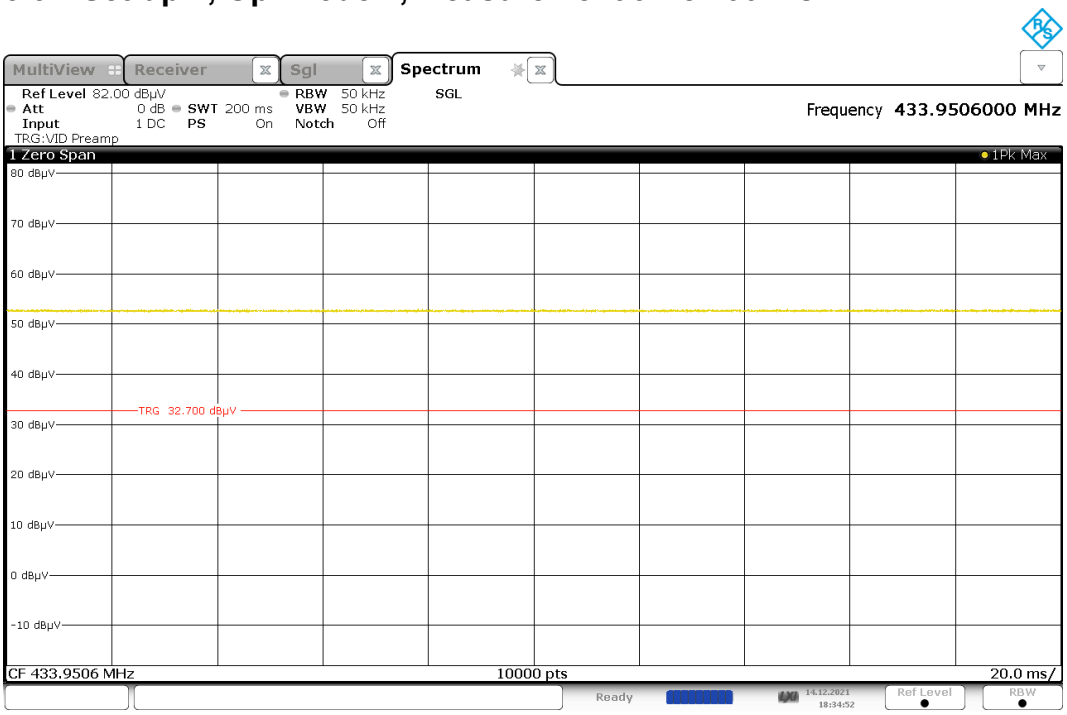
Duty cycle (DC) = 19.04 ms / 100 ms = 0.1904.

3.2 Set-up 3, Op. mode 3, Measurement time 100 s



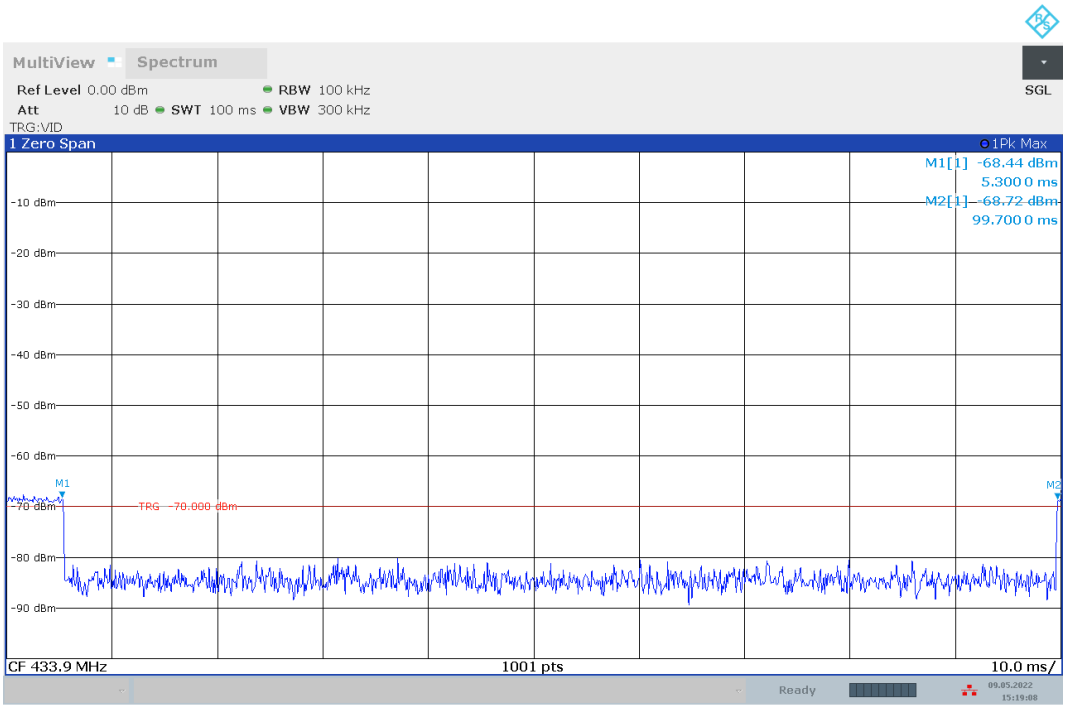
17:36:44 14.12.2021

3.3 Set-up 2, Op. mode 2, Measurement time 200 ms



18:34:52 14.12.2021

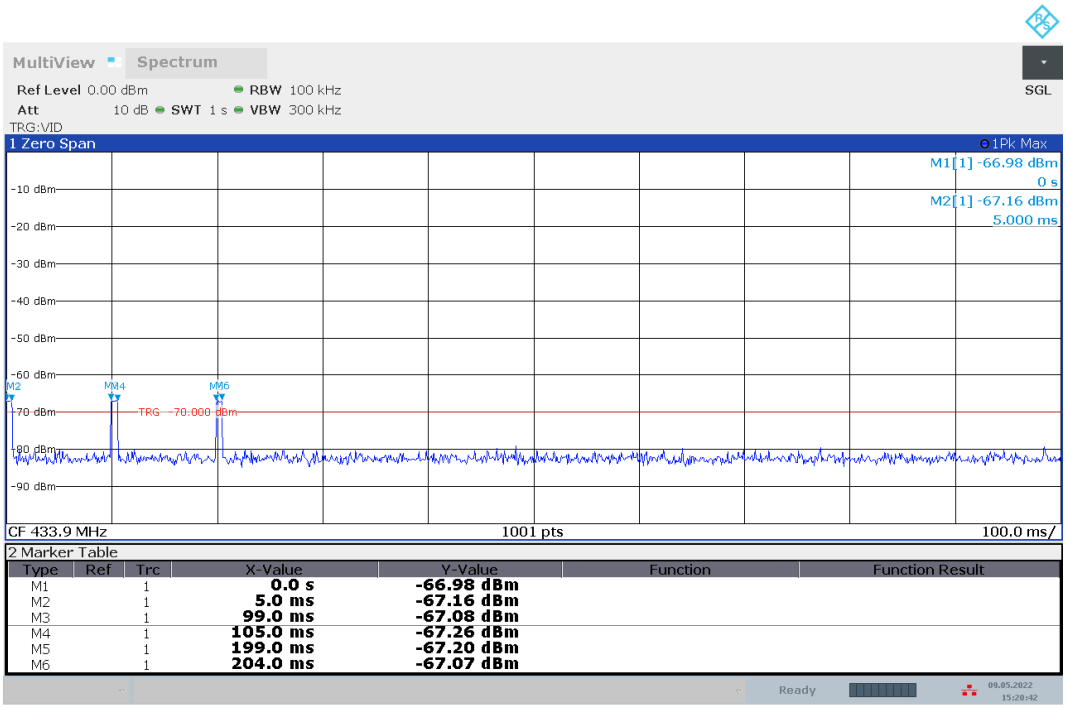
3.4 Set-up 5, Op. mode 4, Measurement time 100 ms



15:19:08 09.05.2022

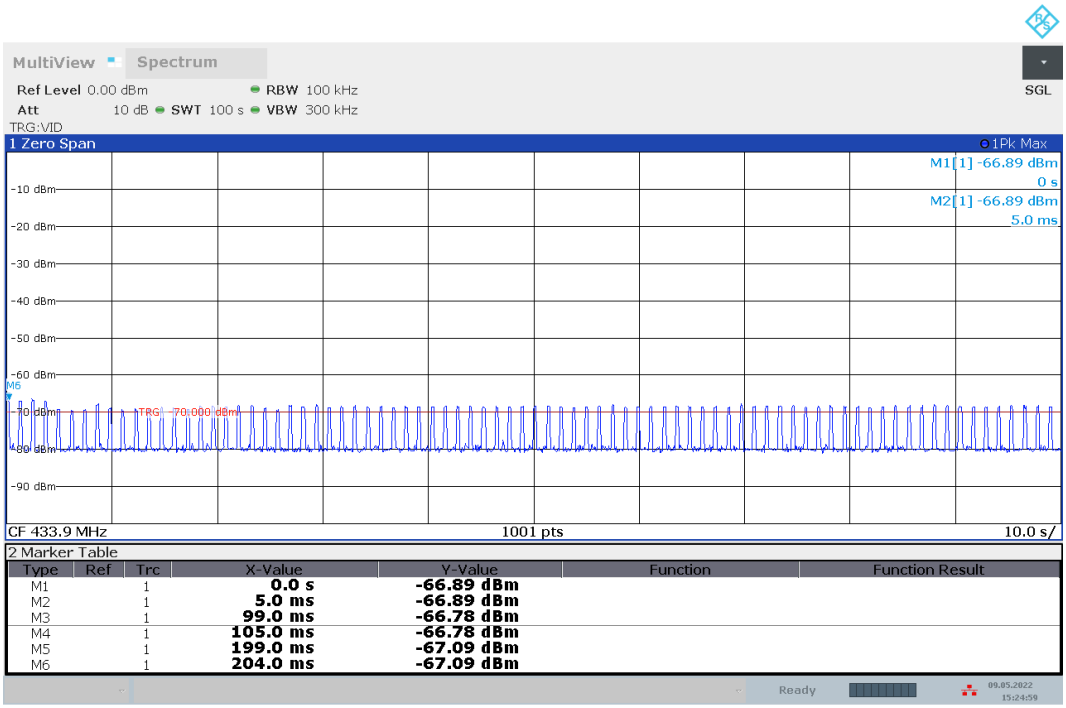
Duty cycle (DC) = 5.79 ms / 100 ms = 0.0579.

3.5 Set-up 5, Op. mode 4, Measurement time 1 s



15:20:43 09.05.2022

3.6 Set-up 5, Op. mode 4, Measurement time 100 s*

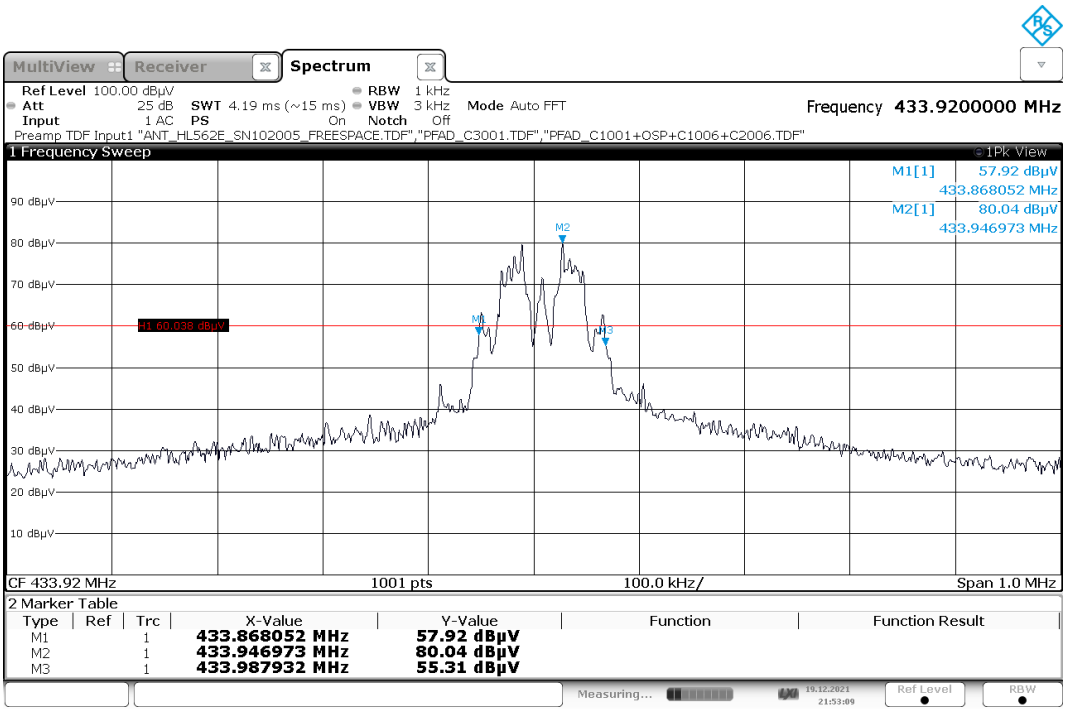


15:24:59 09.05.2022

* This behaviour concerns FCC 15.231 (a)(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.*
According to customers information: „*In the case of an emergency condition (rapid pressure loss), the devise will transmit tire pressure and temperature information throughout the duration of the condition. If the pressure is stable and has not changed by >=50 mbar in 10s, the sensor exit Delta-P mode and go back to normal mode.* “

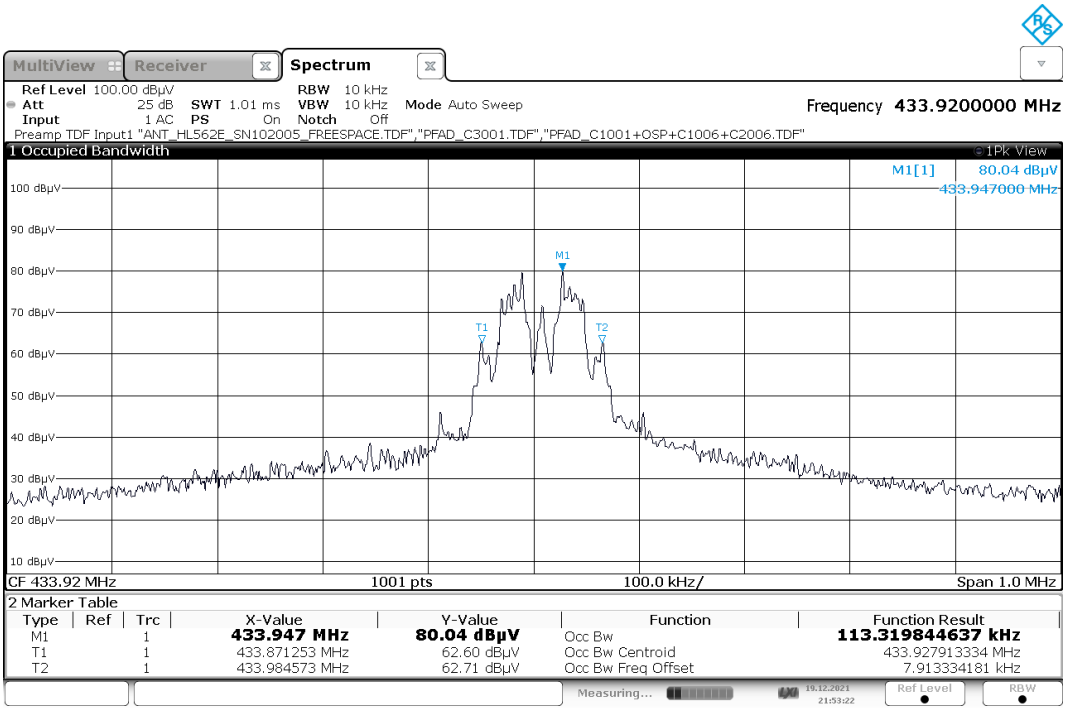
4 Occupied Bandwidth

4.1 20 dB bandwidth, set-up 1, op. 1



21:53:09 19.12.2021

4.2 99 % occupied bandwidth, set-up 1, op. 1



21:53:22 19.12.2021