



BNetzA-CAB-21/21-21

Test Report

Test report no.: 24100656-44703-0

Date of issue: 2025-06-10

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

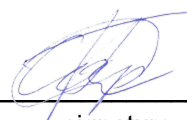
TMSS5G2

Radio Frequency Testing according to:

Title 47
FCC Regulations Subpart 15C
§15.231

Tested by
(name, function, signature)

Piotr Sardyko
Lab Manager RF


signature

Approved by
(name, function, signature)

Janoschka Sebastian
Head of Department Radio


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.xP Dual Band
Model/Type reference	TMSS5G2
FCC ID	OYGTMSS5G2

Disclaimer and Notes

The content of this report relates to the mentioned test sample(s) only.
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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:
 Decision rule based on simple acceptance without guard bands, binary statement, based on mutually agreed uncertainty tolerances with expansion factor k=2.

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2 GENERAL INFORMATION

2.1 Administrative details

Testing laboratory	IBL-Lab GmbH Heinrich-Hertz-Allee 7 66386 St. Ingbert / Germany Fon: +49 6894 38938-0 Fax: +49 6894 38938-99 URL: https://ib-lenhardt.com/ E-Mail: info@ib-lenhardt.com
Accreditation / Designation	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: ○ Attachment to the accreditation certificate D-PL-21375-01-00 ○ Electronics ○ Electromagnetic Compatibility ○ Radio ○ Electromagnetic Compatibility and Telecommunication (FCC requirements) ○ Telecommunication (TC) and Electromagnetic Compatibility (EMC) for Canadian Standards ○ Automotive EMC Website DAkkS: https://www.dakks.de/ The Deutsche Akkreditierungsstelle GmbH (DAkkS) is also a signatory to the ILAC Mutual Recognition Arrangement. ○ Designations ○ FCC Testing Laboratory Designation No. DE0024 ○ ISED Company Number 27156 ○ Testing Laboratory CAB Identifier DE0020 ○ Krafftahrt-Bundesamt KBA-P 00120-23
Testing location	IBL-Lab GmbH Heinrich-Hertz-Allee 7 66386 St. Ingbert / Germany
Date of receipt of test samples	2025-05-12
Start – End of tests	2025-05-12 – 2025-05-23

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

2.6 Further documents

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

Measurement plots: 24100656-44703-0_Annex A

EUT photographs: 24100656-44703-0_Annex B

Test setup photographs: 24100656-44703-0_Annex C

2.7 Formula for determination of correction values (E_C)

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

$$M = L_T - E_C \quad (2)$$

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).

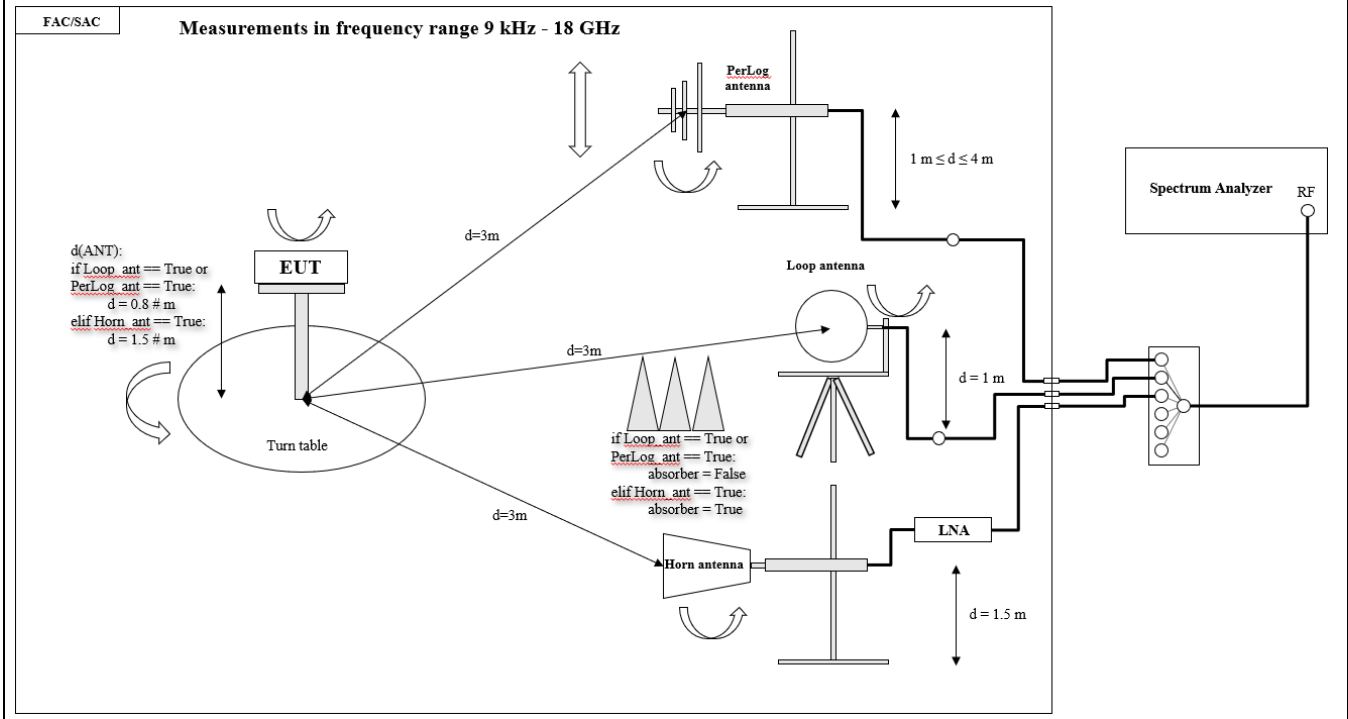
(Instrument) Firmware Version: **4.61**

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 of lab

Temperature	20°C ± 5°C
Relative humidity	25-75 % R.H.
Barometric Pressure	860-1060 mbar
Power supply	Battery and External power supply

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*

TPMS Sensor for Tire Pressure Monitoring System (TPMS) of passenger cars. The Sensor will be installed inside the tire by the use of a special TPMS valve. The device measure the pressure, temperature and acceleration and transmit the data to the TPMS ECU in the car. The RF transmissison take place in the ISM band 434 MHz (SRD application) or 315 MHz (North America/Japan).

*: declared by the applicant

5.2 Technical Data of Equipment*

TX Frequency band:	[433.050 – 434.790] MHz
Number of channel:	2
Modulation type:	FSK and ASK
Channel bandwidth:	150 kHz (FSK), 65 kHz (ASK)
Channel tested:	f _{cent1} : 433.92 MHz, f _{cent2} : 315 MHz
Spectrum Access Mechanism:	Duty Cycle
Adaptive Frequency Agility:	No
DSSS:	No
RF mode:	TX
Antenna Type:	Internal
Antenna gain:	-25 dBi
Antenna connector:	None
Equipment type:	Production model
Temperature range:	Tmin: -40 °C, Tmax: 120 °C
Type of power source:	3 V lithium battery
Operational voltage(minimal, nominal and maximal):	Vmin: 2.55 VDC, Vnom: 3 VDC, Vmax: 3.4 VDC

*: declared by the applicant

5.3 Test Item (Equipment Under Test) Description*

Short designation	EUT Model	EUT Description	ID number	Hardware status	Software status
EUT A	TMSS5G2	Radiated sample with housing S5.1P	2000DD18	300.378.00	253.04
EUT B	TMSS5G2	Radiated sample with housing S5.2P	2000DD21	300.378.00	253.04
EUT C	TMSS5G2	Radiated sample with housing S5.5P	2000DD2C	300.378.00	253.04

*: declared by the applicant

5.4 Auxiliary Equipment (AE) Description*

AE short designation	AE Name (if available)	AE Description	Serial number (if available)	Software (if used)
AE 1	SmarTool	TPMS Trigger Tool	-	-

*: declared by the applicant

5.5 Test Item Operating Modes Description*

EUT operating mode no.	Description of operating modes	Additional information
op. 1	CW low	unmodulated, 433.88 MHz
op. 2	CW mid	unmodulated, 433.92 MHz
op. 3	CW high	unmodulated, 433.96 MHz
op. 4	FSK mode	modulated, FSK, 9.6 Kbps 433.92 MHz
op. 5	ASK mode	modulated, ASK, 4.2 Kbps 433.92 MHz
op. 6	CW low	unmodulated, 315 MHz
op. 7	CW mid	unmodulated, 315 MHz
op. 8	CW high	unmodulated, 315 MHz
op. 9	FSK mode	modulated, FSK, 9.6 Kbps 315 MHz
op. 10	ASK mode	modulated, ASK, 4.2 Kbps 315 MHz

*: declared by the applicant

5.6 Test Item Set-ups Description

set. 1	EUT A + AE1
set. 2	EUT B + AE 1
set. 3	EUT C + AE 1

5.7 Test conditions

Temperatur, [°C]		Voltage, [V]	
Tnom	20 ± 5	Vnom	3
Tmax	-	Vmax	-
Tmin	-	Vmin	-

5.8 Additional Information

Test items differences	-
Additional application considerations to test a component or sub-assembly	The EFS measurement was done with 3 EUTs. All 3 EUTs have the same PCBA but different cabinets: EUT A – S5.1P, EUT B – S5.2P, EUT C – S5.5P. Fundamental field strength test respectively RFS test in frequency range 30 MHz – 1 GHz was made for op. 2/7 (middle channel) for all set-ups. The results of these tests didn't show any significant differences. Thus, the type of the cabinet barely has influence on the FS radiated from PCBA. Nevertheless, the set-up 1 showed slightly higher results than other set-ups. Therefore, it was decided to make fundamental field strength test and radiated FS test with op. 1/5 and op. 3/8 only with set-up 1. The results showed again no significant differences. But op. 2/7 had a slightly higher value of FS than other Ops. Thus, RFS in frequency range 1 GHz – 12.75 GHz was done for set-up 1 op. 2/7 as the one with highest FS. Please see results table in Chapter 7.1.

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	1, 2, 3	1-3, 6-8	Please see additional explanation in Subchapter 5.8.	Pass
Radiated field strength measurements	Nominal	1, 2, 3	1-3, 6-8	RFS test for frequency range > 1 GHz was done only for Set-up 1 Op. 1 and 6 (constellations with the highest field strength). Please see additional explanation in Subchapter 5.8.	Pass
Transmit time	Nominal	1	4, 5, 9, 10	None	Pass
Occupied Bandwidth	Nominal	1	4, 5, 9, 10	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, SW2

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 30 MHz- 1 GHz: 120 kHz.

See photos in Annex C for test Set-up and block diagram in Chapter 2.9.

Limits

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

Frequency [MHz]	Frequency [MHz]		Frequency [MHz]	Frequency [MHz]
	[μV/m]	[dBμV/m]		
40.66-40.70	40.66-40.70	40.66-40.70	40.66-40.70	40.66-40.70
70-130	70-130	70-130	70-130	70-130
130-174	130-174	130-174	130-174	130-174
174-260	174-260	174-260	174-260	174-260
260-470	260-470	260-470	260-470	260-470
Above 470	Above 470	Above 470	Above 470	Above 470

Measurement Level = Reading Level + Correction Factor.

Limit(μV/m@433.9MHz):

$X_{11}=260$, $Y_{11}=1500$, $X_{12}=470$, $Y_{12}=5000$

$f(x)=mx+b$, $m=(5000-1500)/(470-260)=3500/210=16.66$, $b=f(x)-mx=5000-16.66*470=-2833.33$

$\Rightarrow f(x)=16.66*x-2833.33 \Rightarrow$

$f(433.9)=16.66*433.9-2833.33=4398.33$

$f(315)=16.66*315-2833.33=4398.33$

Limit dBμV/m RMS/Peak:

433.92 MHz: Average/RMS Limit = $20\text{LOG}(4398.33) = 72.86$ dBμV/m. Peak Limit = RMS Limit + 20 dB=92.86 dBμV/m.

315 MHz: Average/RMS Limit = $20\text{LOG}(2414.57) = 67.65$ dBμV/m. Peak Limit = RMS Limit + 20 dB=87.65 dBμV/m.

Results Peak Detector*

Set./ Op.	Peak field strength, [dBμV/m]	Limit Peak, [dBμV/m]	Margin [dB]	DC CorFac**, [dB]	AV field strength, [dBμV/m]	Limit AV, [dBμV/m]	Margin [dB]	Verdict
Set.1, Op. 2	75.12	92.86	17.74	-10.96	64.16	72.86	8.70	Pass
Set.2, Op. 2	74.5	92.86	18.36	-10.96	63.54	72.86	9.32	Pass
Set.3, Op. 2	74.65	92.86	18.21	-10.96	63.69	72.86	9.17	Pass
Set.1, Op. 1	74.66	92.86	18.2	-10.96	63.70	72.86	9.16	Pass
Set.1, Op. 3	74.33	92.86	18.53	-10.96	63.37	72.86	9.49	Pass
Set.1, Op. 7	69.57	87.66	18.0868	-10.96	58.61	67.66	9.04	Pass
Set.2, Op. 7	69.2	87.66	18.4568	-10.96	58.24	67.66	9.41	Pass
Set.3, Op. 7	69.35	87.66	18.3068	-10.96	58.39	67.66	9.26	Pass
Set.1, Op. 6	69.29	87.66	18.3668	-10.96	58.33	67.66	9.32	Pass

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Set. 1, Op. 8	69.05	87.66	18.6068	-10.96	58.09	67.66	9.56	Pass
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* Please see measurement plots in Annex A.
** Please see Plot 3.2 in Annex A: $20 \cdot \text{LOG}(\text{DC}/100) = 20 \cdot \text{LOG}(0.2832) = -10.96 \text{ dB}$ (wors case DC)

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, R1, SW2

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, R1, SW2

Frequency range 1 GHz – 12.75 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, R1, F4, SW 2

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: 200 Hz, 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)	Magnetic field strength (HField) ($\mu\text{A/m}$)**	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490*	6.37/F (F in kHz)	2400/F(kHz)	300
0.490-1.705*	63.7/F (F in kHz)	24000/F(kHz)	30
1.705-30.0*	0.08	30	30

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

** the measurement was done with dBuV/m units. Please see the appropriate dBuV/m limits in the same table

Limits

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

Frequency [MHz]	Field strength@3m		Measurement distance [meters]	Remarks
	[$\mu\text{V/m}$]	[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*

Op./ Set.	Frequency	Detector	Test distance [m]	Level [dB $\mu\text{V/m}$]	Limit [dB $\mu\text{V/m}$]	Margin [dB]	Verdict
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Op.1-3, Set.1-3, 6-8	9 kHz – 30 MHz	Peak	3	Noise only			Pass
Set.1, Op. 2	30 MHz – 1 GHz	Quasi-Peak	3	39.58	46	6.42	Pass
Set.2, Op. 2	30 MHz – 1 GHz	Quasi-Peak	3	40.05	46	5.95	Pass
Set.3, Op. 2	30 MHz – 1 GHz	Quasi-Peak	3	36.34	46	9.66	Pass
Set.1, Op. 1	30 MHz – 1 GHz	Quasi-Peak	3	40.48	46	5.52	Pass
Set.1, Op. 3	30 MHz – 1 GHz	Quasi-Peak	3	40.38	46	5.62	Pass
Set.1, Op. 7	30 MHz – 1 GHz	Quasi-Peak	3	39.76	46	6.24	Pass
Set.2, Op. 7	30 MHz – 1 GHz	Quasi-Peak	3	37.77	46	8.23	Pass
Set.3, Op. 7	30 MHz – 1 GHz	Quasi-Peak	3	38.86	46	7.14	Pass
Set.1, Op. 6	30 MHz – 1 GHz	Quasi-Peak	3	39.78	46	6.22	Pass
Set.1, Op. 8	30 MHz – 1 GHz	Quasi-Peak	3	39.23	46	6.77	Pass
Set.1, Op. 2	1 GHz – 12.75 GHz	Peak	3	61.86	74	12.14	Pass
Set.1, Op. 2	1 GHz – 12.75 GHz	RMS	3	50.9**	54	3.1	Pass
Set.1, Op. 7	1 GHz – 12.75 GHz	Peak	3	48.99	74	25.01	Pass
Set.1, Op. 7	1 GHz – 12.75 GHz	RMS	3	46.79	54	7.21	Pass
All Readings below 1 GHz are Quasi-Peak or Peak detector, above 1 GHz with Peak and RMS detector.							

* Please see measurement plots in Annex A.

*** the limit for average detector is 54 dBuV/m. There are two values above this limit, measured with peak detector (M1: 61.86 dBuV/m at 1.301750 GHz, M2: 59.35 dBuV/m at 3.471150 GHz). It is the 3rd and 8th harmonic of the main signal. Please see chapter to OBW measurement. Correction factor is used to get an average value. Correction factor = $20 \cdot \log(0.2832) = -10.96$ dB (please see Chapter to Transmit time measurements).

=> M1_average value=61.86 dBuV/m - 10.96 dB = **50.9** dBuV/m

=> M2_average value=59.35 dBuV/m - 10.96 dB = **48.39** dBuV/m

7.3 Transmit time

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

Radiated: R4, A4, C3

Description

Please see test set-up photos in Annex C.
Measurement was done radiated.

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*

Plot No	Set./ Op.	Frequency, [MHz]	Measured value, [ms]	Limit**, [sec]	Result
3.3	1, 4	433.92	912.291	<1	Pass
3.1	1, 4	433.92	29.27	>27.36	Pass
3.6	1, 5	433.92	914	<1	Pass
3.1	1, 5	433.92	29.38	>27.42	Pass
3.9	1, 9	315	912	<1	Pass
3.7	1, 9	315	29.25	>27.36	Pass
3.12	1, 10	315	914	<1	Pass
3.10	1, 10	315	29.37	>27.42	Pass

* 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: R4, A4, C3

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 (99% BW), [kHz]	Limit, [kHz]	Result
Set.1, Op. 4	433.92	153.442	1084.8	Pass
Set.1, Op. 5	433.92	65.671	1084.8	Pass
Set.1, Op. 9	315	140.092	787.5	Pass
Set.1, Op. 10	315	56.806	787.5	Pass
Set./ Op.	Frequency, [MHz]	Measured value (20dB BW), [kHz]	Limit, [kHz]	Result
Set.1, Op. 4	433.92	140.8	1084.8	Pass
Set.1, Op. 5	433.92	28.8	1084.8	Pass
Set.1, Op. 9	315	140	787.5	Pass
Set.1, Op. 10	315	29.6	787.5	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	2023-05-05	2026-05-05
2.	Ultrabroadband antenna	HL562E	Rohde & Schwarz	102005	LAB000150	2022-12-22	2025-12-22
3.	Double-Ridged Waveguide Horn Antenna	HF-907	Rohde & Schwarz	102899	LAB000151	2023-05-15	2026-05-15
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	-	-

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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	Babylon 5 (SAC 5)	Albatross Projects GmbH	20168.PRB	LAB000235	2024-02-28	2026-02-28
2.	Climatic chamber	T-65/50	CTS GmbH	204002	LAB000110	2024-06-07	2025-06-07
3.	Shielding Cover	CMU-Z11	Rohde & Schwarz	100876	LAB000039	-	-
4.	Climatic chamber	T-70/350	CTS GmbH	194027	LAB000066	2024-07-01	2025-07-01
5.	Shielded room	Sputnik 1 (Schirmkabine)	Albatross Projects GmbH	-	LAB000257	-	-
6.	Semi/Fully Anecoic Chamber	Atlas 5 (SAC 5)	Albatross Projects GmbH	P31018	LAB000492	-	-
Corner Reflector (CR):							
1.	Trihedral Corner Reflector	SAJ-080-S1	ERAVANT	04756-01	LAB000201	-	-
Directional coupler (DC):							
1.	Directional coupler	CPL-5230-10-SMA-79	Midwest Microwave	-	LAB000672	-	-
Distance meter (DM):							
1.	Laser distance meter	GLM 50 C	Bosch	-	-	-	-
2.	Laser distance meter	GLM 120 C	Bosch	-	-	-	-
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	-	-
5.	High-pass filter (1.3 GHz – 12.75 GHz)	H1G713G1	Microwave Circuits Inc	1896-01	LAB000670	-	-
6.	Bandstop filter (30MHz – 3GHz for 900 MHz Band)	WRCG876/960-847/989-50/8SS	Wainwright Instruments GmbH	-	LAB000671	-	-
Harmonic mixers (H):							
1.	Harmonic Mixer	FS-Z60	Rohde & Schwarz	101350	LAB000375	2025-04-15	2026-04-15
2.	Harmonic Mixer	FS-Z75	Rohde & Schwarz	102015	LAB000112	2025-03-27	2026-03-27
3.	Harmonic Mixer	FS-Z90	Rohde & Schwarz	102020	LAB000113	2025-05-07	2026-05-07
4.	Harmonic Mixer	FS-Z110	Rohde & Schwarz	102000	LAB000114	2025-03-27	2026-03-27
5.	Harmonic Mixer	FS-Z170	Rohde & Schwarz	100996	LAB000126	2025-03-27	2026-03-27
6.	Harmonic Mixer	FS-Z220	Rohde & Schwarz	101039	LAB000116	2025-04-25	2026-04-25
7.	Harmonic Mixer	FS-Z325	Rohde & Schwarz	101015	LAB000117	2025-04-09	2026-04-09
LISN (L):							
1.	Two-line V-Network	ENV216	Rohde & Schwarz	102597	LAB000220	2023-11-07	2025-10-28
2.	Two-line V-Network	ENV216	Rohde & Schwarz	102598	LAB000217	2024-06-06	2025-06-06
Multimeters (M):							
1.	Multimeter	U1242B	Keysight	MY59240021	LAB000187	2024-06-20	2026-06-20
2.	Multimeter	U1242B	Keysight	MY59160026	LAB000018	2024-09-06	2025-09-05
Multipliers (Mp):							
1.	Multiplier	SMZ75	Rohde & Schwarz	101307	-	2018-03-15	-
2.	Multiplier	SMZ110	Rohde & Schwarz	100001	-	2020-05-09	-

Oscilloscopes (O):							
1.	Oscilloscope	RTE 1104	Rohde & Schwarz	1317.2500K04 - 101439-Rn	LAB000849	2025-01-31	2026-01-31
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	-	-
2.	Power meter	NRP110T	Rohde & Schwarz	101151	LAB000119	2025-05-16	2026-05-16
Receivers and Spectrumanalyzers (R):							
1.	Test Receiver, SAC5	ESW-26	Rohde & Schwarz	101517	LAB000363	2025-01-10	2026-01-10
2.	Test Receiver	ESW-26	Rohde & Schwarz	101481	LAB000236	2023-07-09	2025-07-09
3.	Spectrum Analyzer 1 Hz – 50 GHz	FSW-50	Rohde & Schwarz	101450	LAB000111	2024-07-19	2025-07-19
4.	Spectrum Analyzer 2 Hz – 43 GHz	FSW-43	Rohde & Schwarz	101391	LAB000289	2024-06-04	2025-06-04
Signal Generators (SG):							
1.	Signal generator 8 kHz – 50 GHz	SMA100B	Rohde & Schwarz	103838	LAB000118	2024-06-28	2025-06-28
2.	Vector Signal Generator	SMW200A	Rohde & Schwarz	109775	LAB000870	2023-10-18	2026-10-18
3.	Signal generator 100 kHz – 20 GHz	SMB100A	Rohde & Schwarz	178175	LAB000276	2024-04-03	2025-04-03
Software (SW):							
No	Type	Name	Manufacturer	Version	Int. No.	Build	Rev
1.	Software	R&S Power Viewer	Rohde & Schwarz	11.3, 3.2.2020	-	7338	3230
2.	Software	R&S EMC32	Rohde & Schwarz	11.20	-	-	-
3.	Software	R&S Elektra EMC test software	Rohde & Schwarz	13.00	-	-	-

* 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	$\leq \pm 6 \text{ dB}$
Occupied bandwidth	$\pm 100 \text{ kHz}$
Time domain measurement	$\pm 2.32 \text{ ms}$
DC and low frequency voltages	$\pm 3 \%$
Temperature	$\pm 1 \text{ }^{\circ}\text{C}$
Humidity	$\pm 3 \%$

*) 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.: 24100656-44703-0

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1 Fundamental field strength

1.1 Set-up 1, Op. 2

Please see Plot 2.2.1.

1.2 Set-up 2, Op. 2

Please see Plot 2.2.2.

1.3 Set-up 3, Op. 2

Please see Plot 2.2.3.

1.4 Set-up 1, Op. 1

Please see Plot 2.2.4.

1.5 Set-up 1, Op. 3

Please see Plot 2.2.5.

1.6 Set-up 1, Op. 7

Please see Plot 2.2.6.

1.7 Set-up 2, Op. 7

Please see Plot 2.2.7.

1.8 Set-up 3, Op. 7

Please see Plot 2.2.8.

1.9 Set-up 1, Op. 6

Please see Plot 2.2.9.

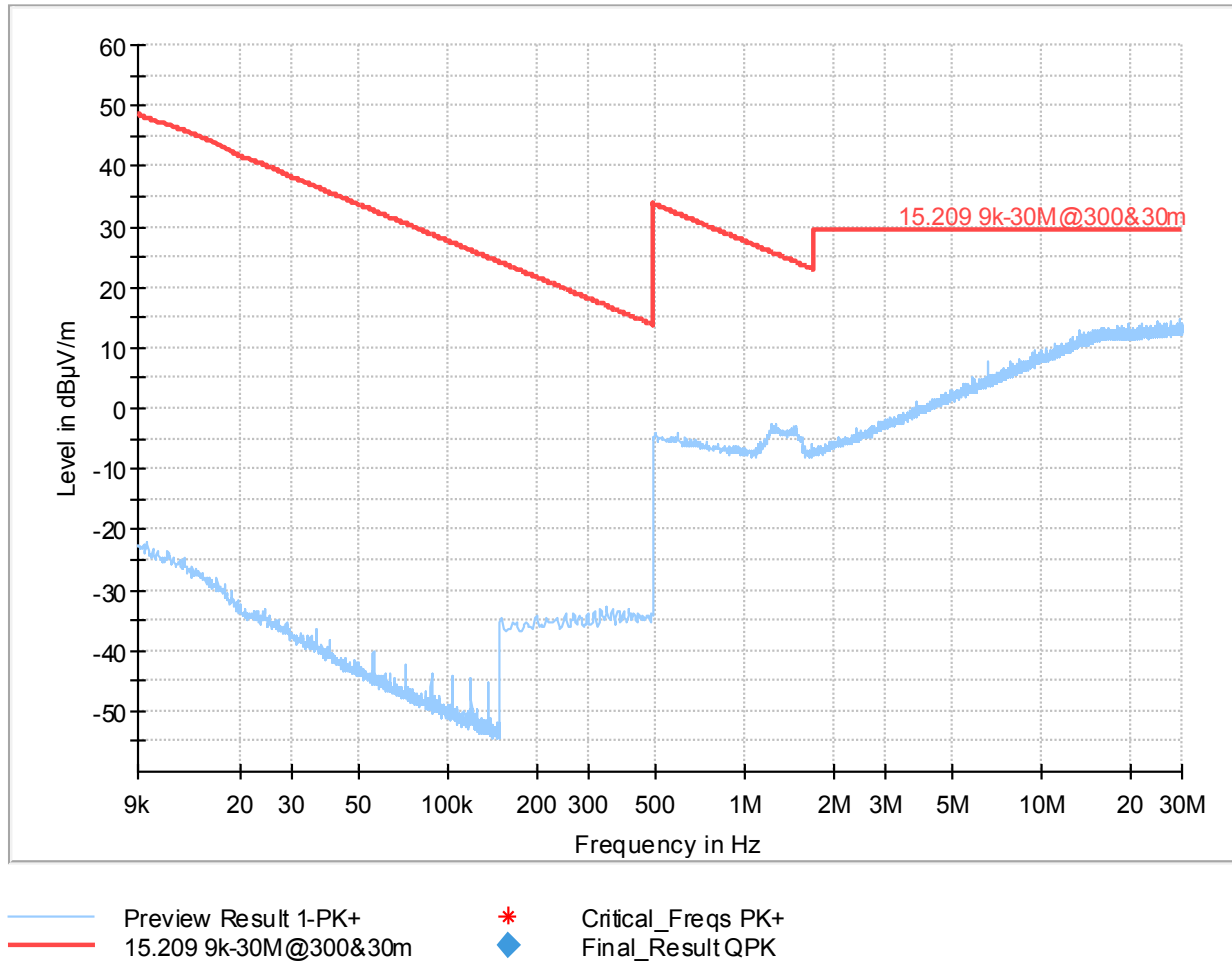
1.10 Set-up 1, Op. 8

Please see Plot 2.2.10.

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

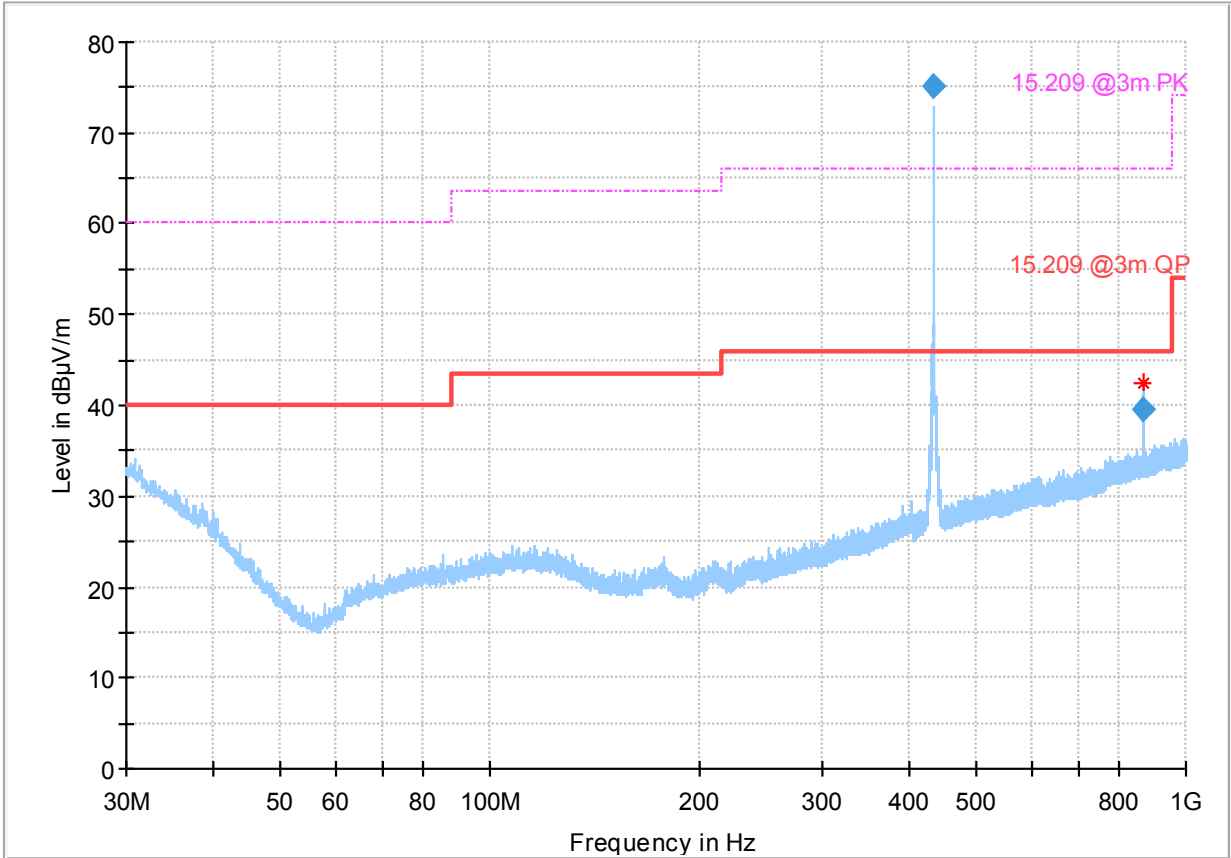
2.1 Radiated field strength measurements ($f < 30$ MHz)

2.1.1 Set-up 1-3, 9 kHz – 30 MHz, Op. 1-3/6-8, EUT lying + standing



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

2.2.1 Lying, Set-up 1, Op. 2, lying + standing (2 pos.)



Preview Result 1-PK+

*

Critical_Freqs PK+

15.209 @3m QP

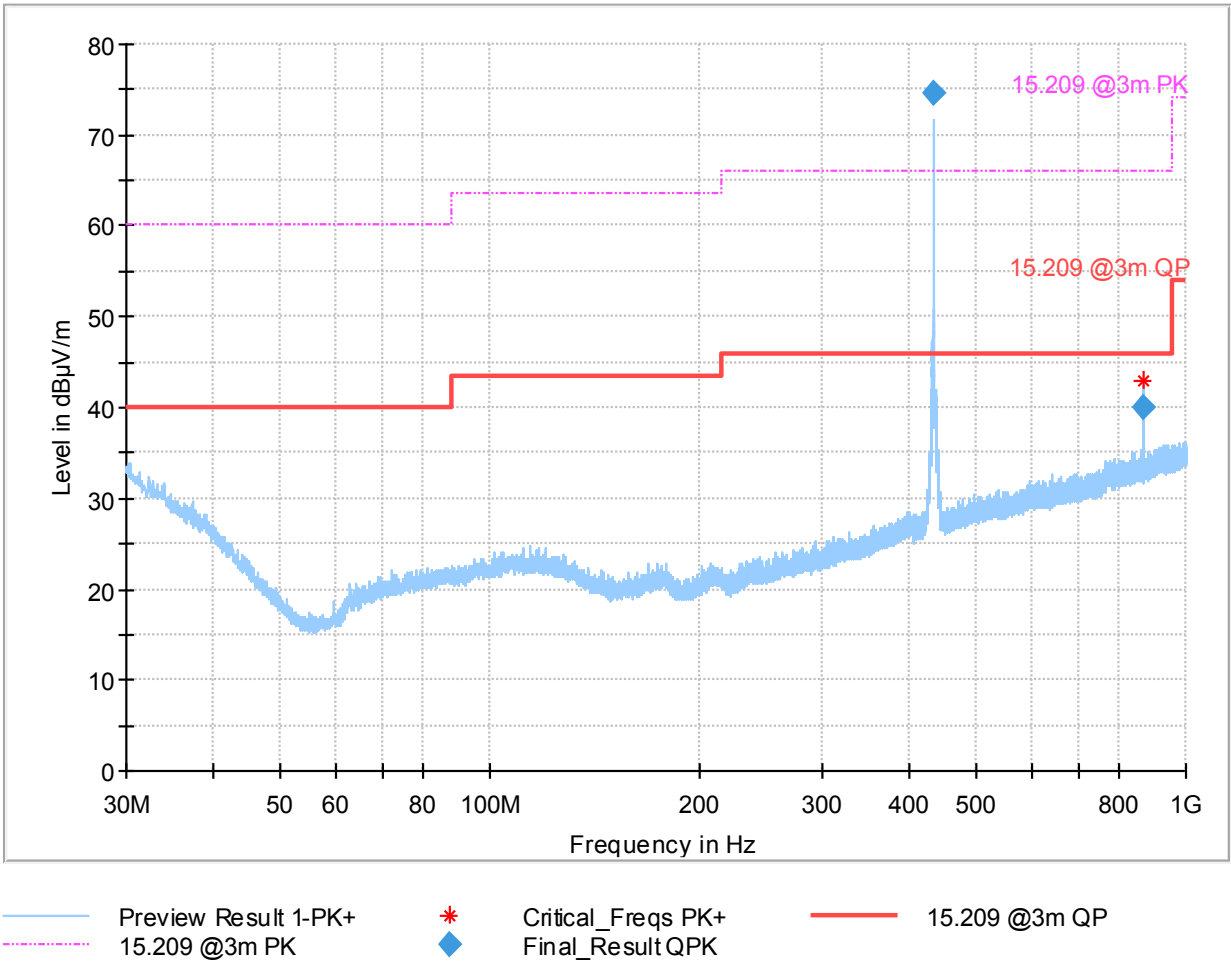
15.209 @3m PK

Final_Result QPK

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
433.925000	75.12	46.00	-29.12	100.0	120.000	138.0	V	207.0
867.855000	39.58	46.00	6.42	100.0	120.000	100.0	H	-3.0

2.2.2 Lying, Set-up 2, Op. 2, lying + standing (2 pos.)

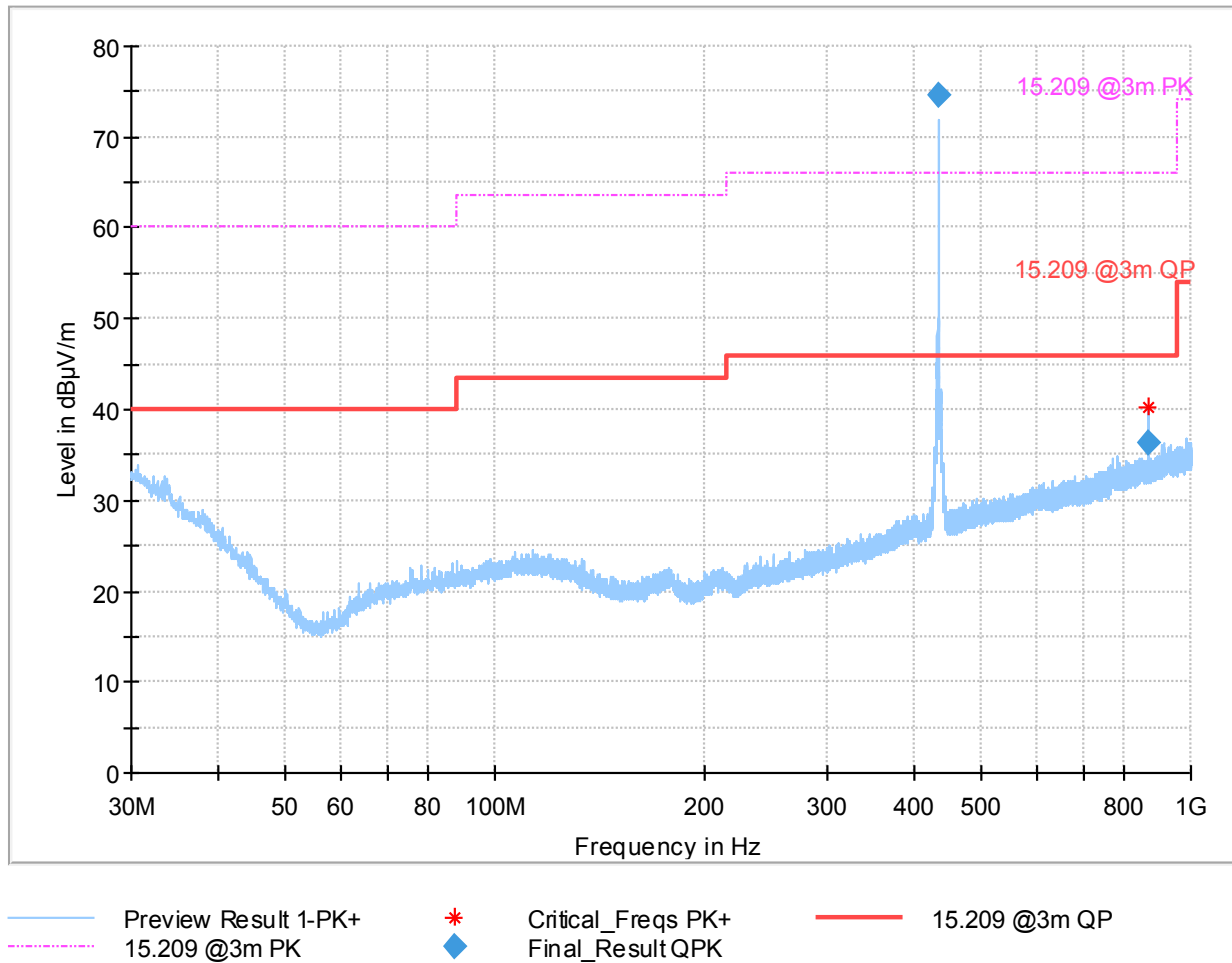


Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
433.925000	74.50	46.00	-28.50	100.0	120.000	142.0	V	208.0
867.825000	40.05	46.00	5.95	100.0	120.000	103.0	H	0.0

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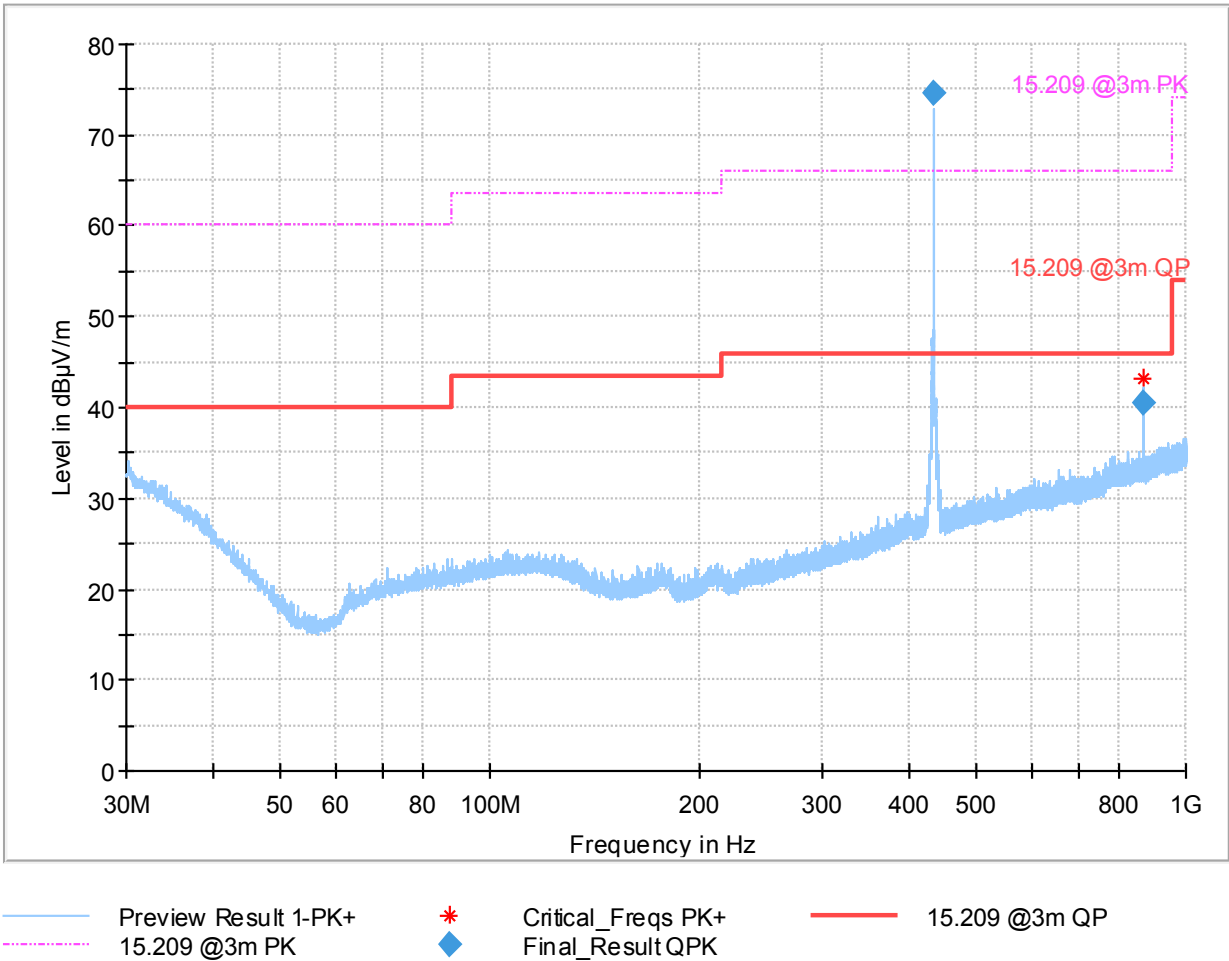
2.2.3 Lying, Set-up 3, Op. 2, lying + standing (2 pos.)



Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
433.925000	74.65	46.00	-28.65	100.0	120.000	128.0	V	203.0
867.825000	36.34	46.00	9.66	100.0	120.000	100.0	H	165.0

2.2.4 Lying, Set-up 1, Op. 1, lying + standing (2 pos.)

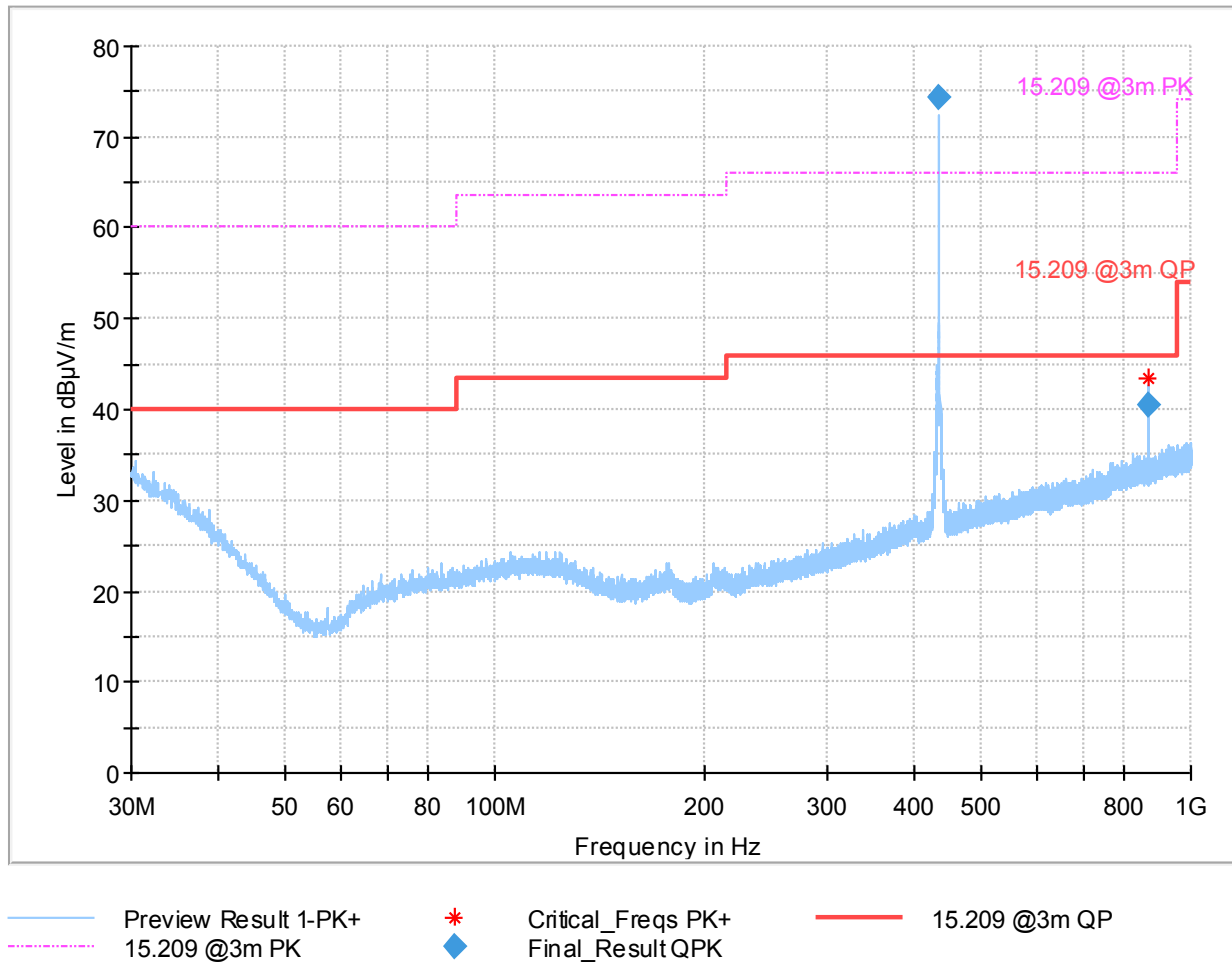


Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
433.875000	74.66	46.00	-28.66	100.0	120.000	130.0	V	28.0
867.750000	40.48	46.00	5.52	100.0	120.000	100.0	H	188.0

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2.2.5 Lying, Set-up 1, Op. 3, lying + standing (2 pos.)

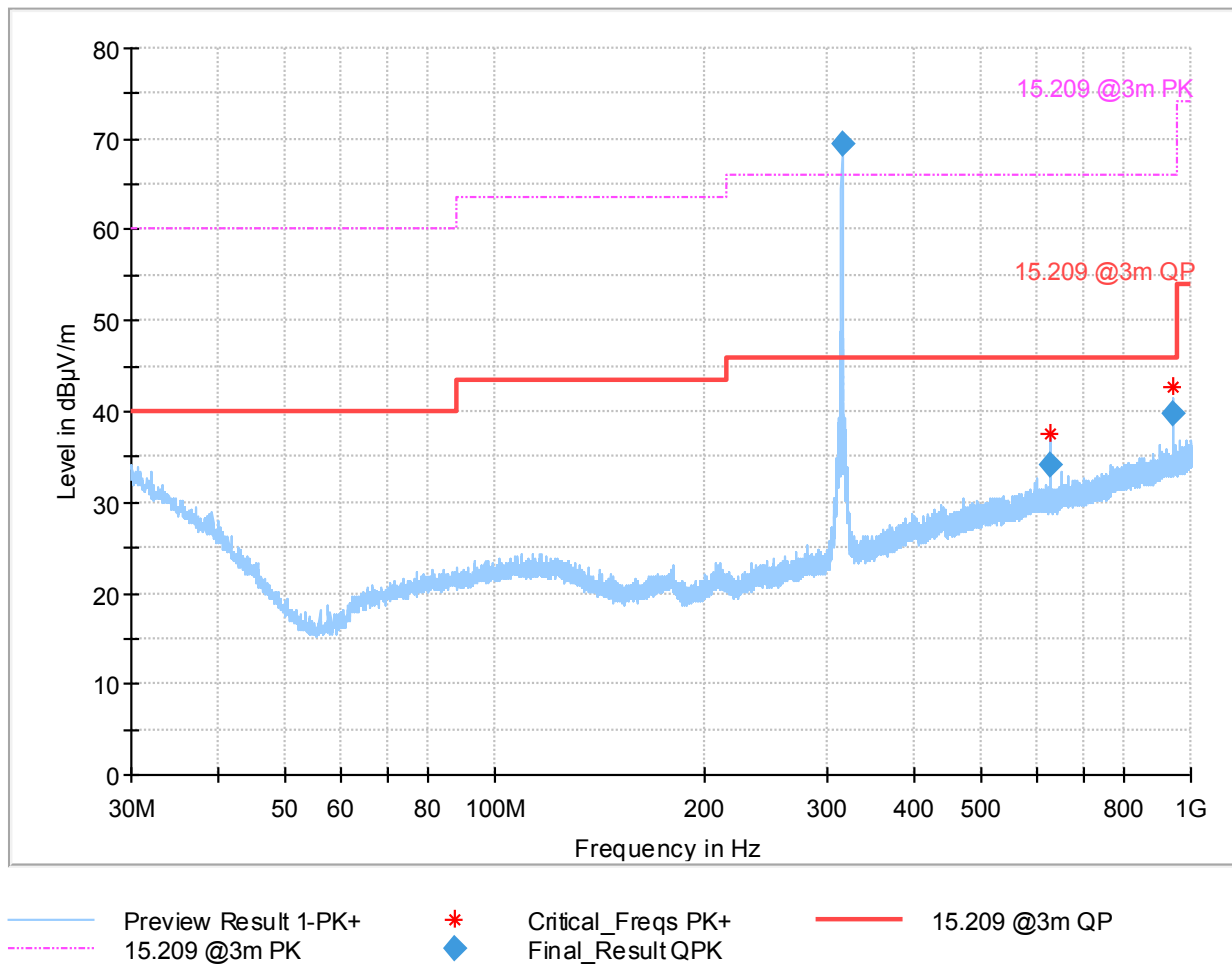


Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
433.950000	74.33	46.00	-28.33	100.0	120.000	128.0	V	27.0
867.925000	40.38	46.00	5.62	100.0	120.000	100.0	H	192.0

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2.2.6 Lying, Set-up 1, Op. 7, lying + standing (2 pos.)

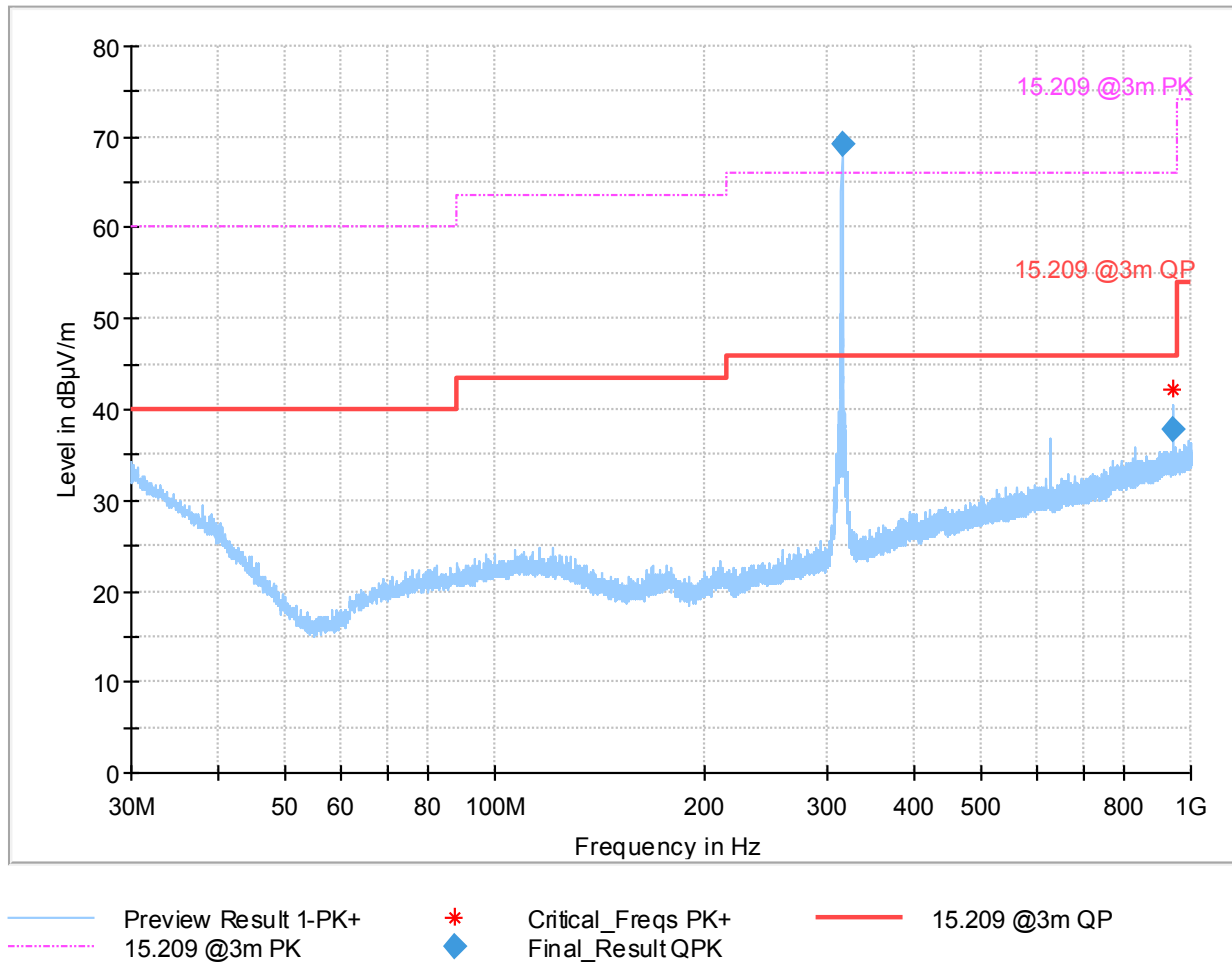


Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
315.000000	69.57	46.00	-23.57	100.0	120.000	100.0	H	34.0
630.000000	34.18	46.00	11.82	100.0	120.000	100.0	V	187.0
945.000000	39.76	46.00	6.24	100.0	120.000	148.0	H	-16.0

Annex A of TR no.: 24100656-44703-0

2.2.7 Lying, Set-up 2, Op. 7, lying + standing (2 pos.)

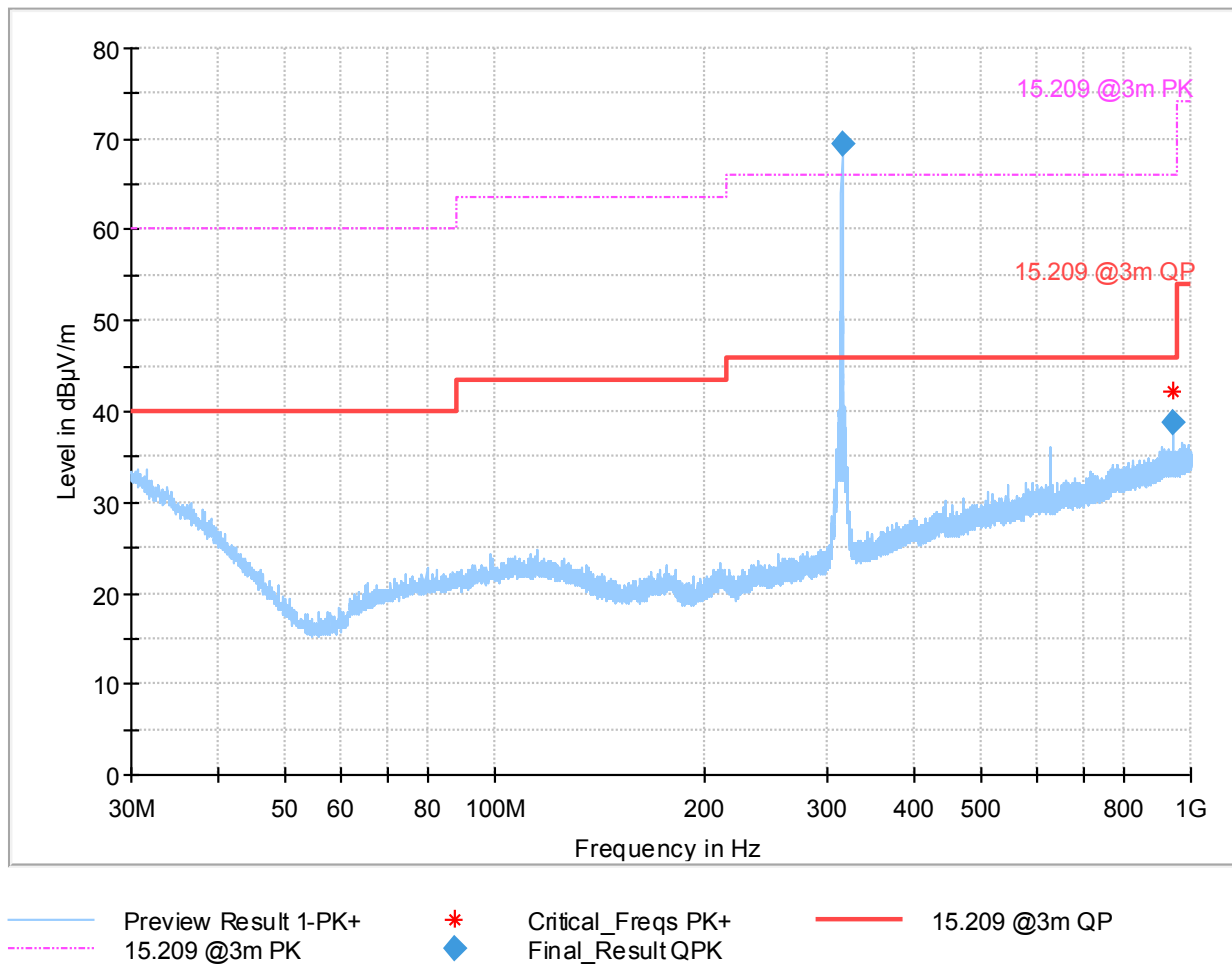


Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
315.000000	69.20	46.00	-23.20	100.0	120.000	100.0	H	31.0
945.000000	37.77	46.00	8.23	100.0	120.000	136.0	H	-10.0

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2.2.8 Lying, Set-up 3, Op. 7, lying + standing (2 pos.)

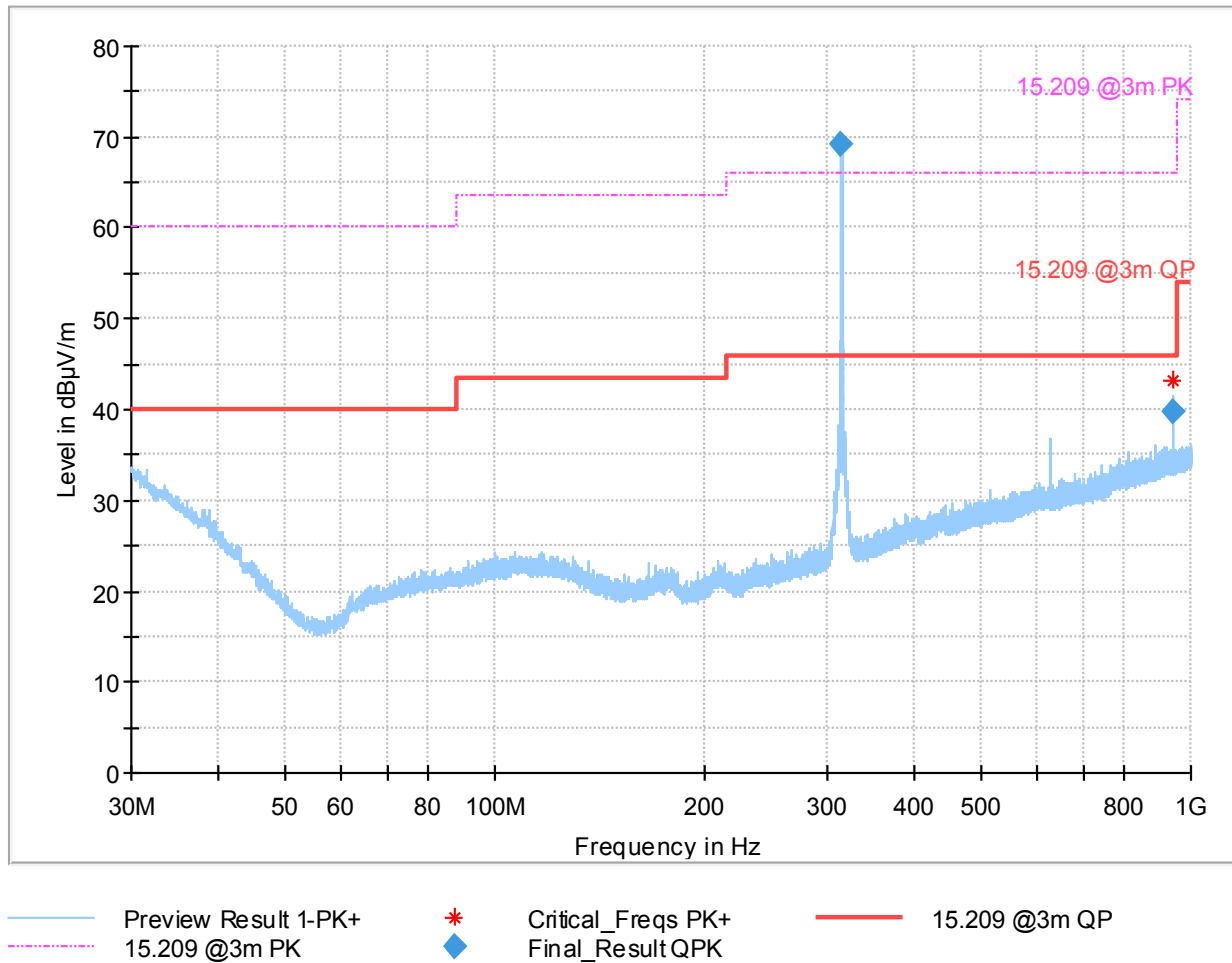


Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
315.000000	69.35	46.00	-23.35	100.0	120.000	100.0	H	29.0
945.000000	38.86	46.00	7.14	100.0	120.000	151.0	H	341.0

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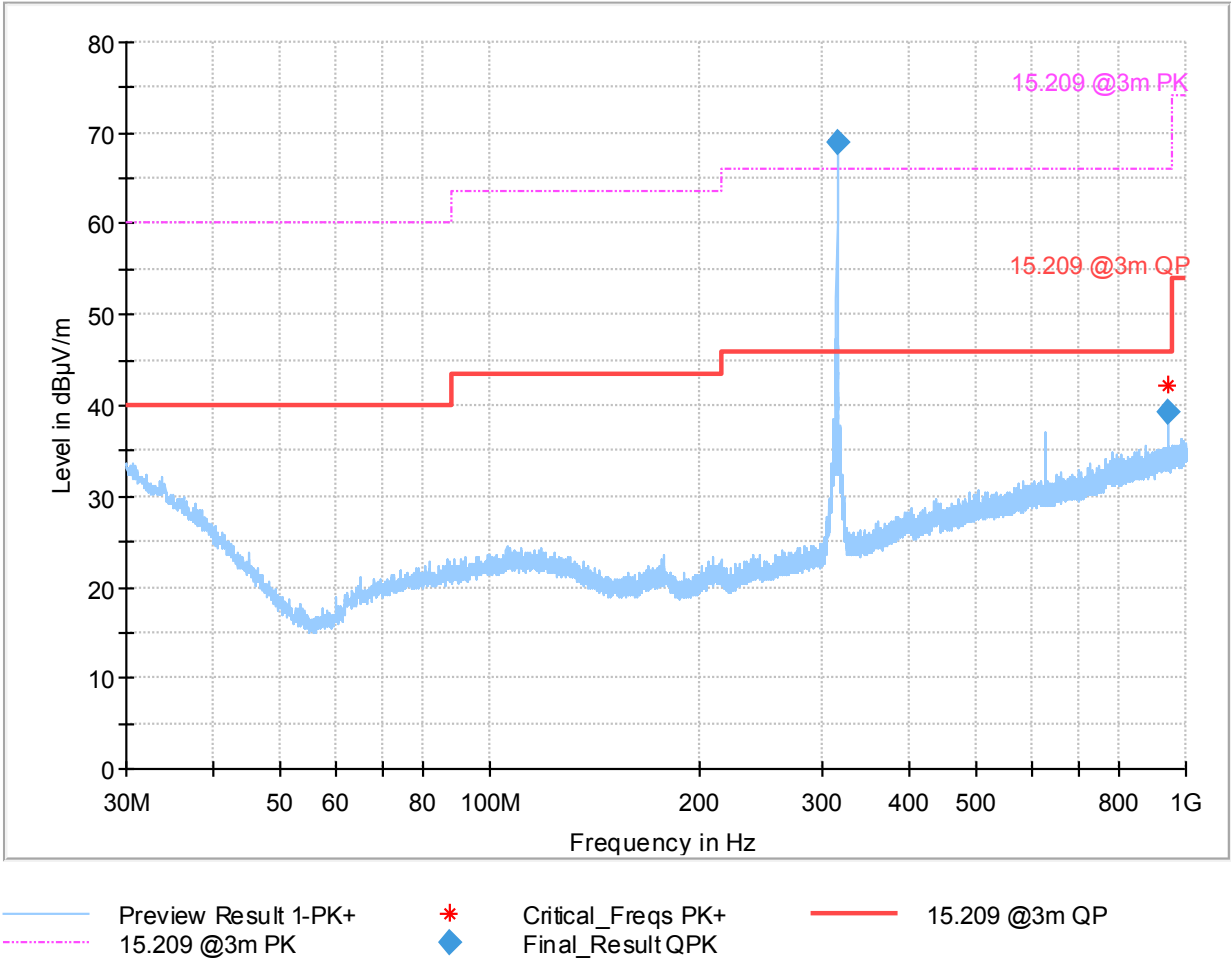
2.2.9 Lying, Set-up 1, Op. 6, lying + standing (2 pos.)



Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
314.950000	69.29	46.00	-23.29	100.0	120.000	100.0	H	28.0
944.875000	39.78	46.00	6.22	100.0	120.000	151.0	H	-3.0

2.2.10 Lying, Set-up 1, Op. 8, lying + standing (2 pos.)

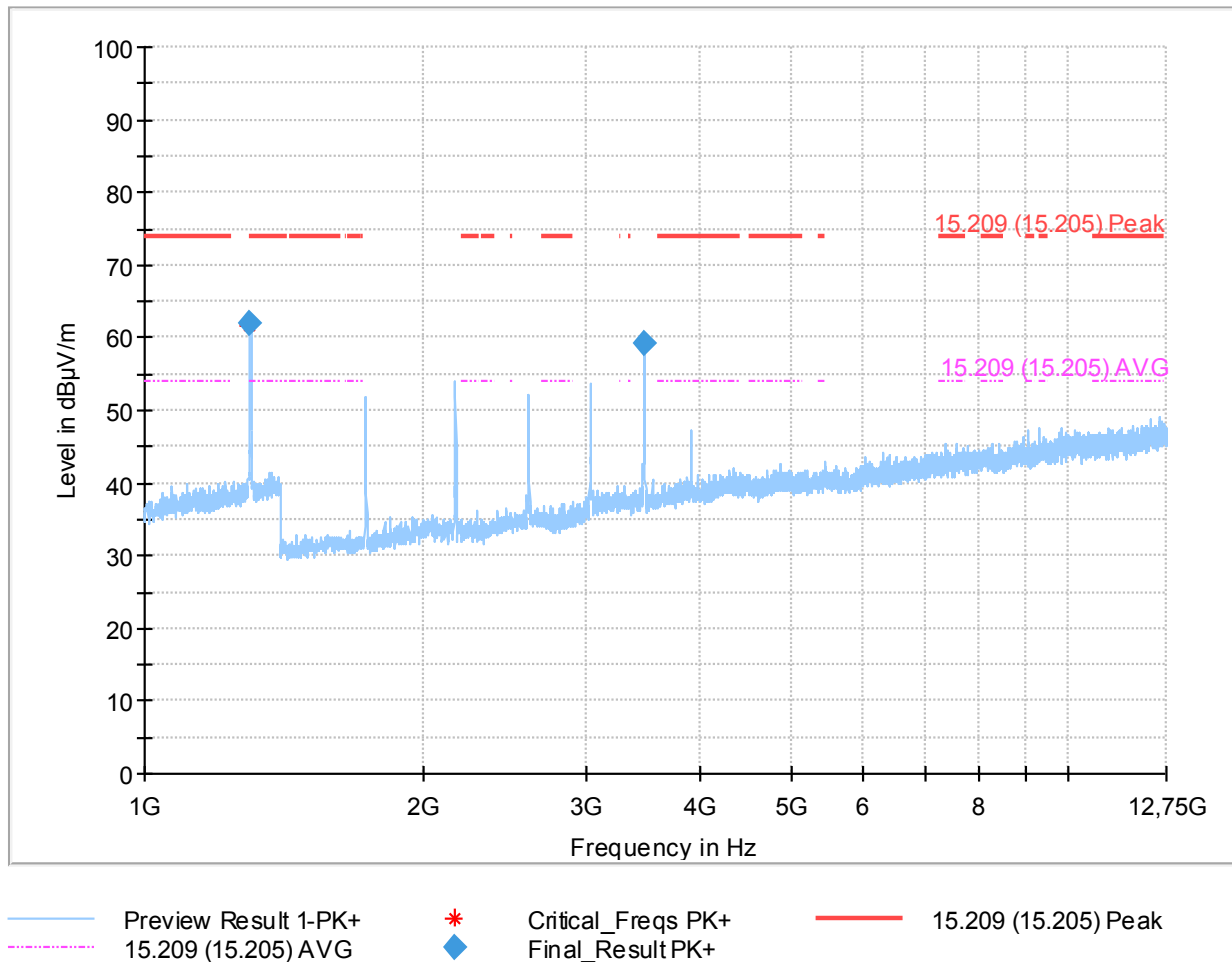


Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
315.050000	69.05	46.00	-23.05	100.0	120.000	100.0	H	31.0
945.100000	39.23	46.00	6.77	100.0	120.000	148.0	H	-14.0

2.3 Radiated field strength measurements (1 GHz < f < 12.75 GHz)

2.3.1 960 MHz – 1400 MHz, Set-up 1, Op. 2, lying + standing, Peak detector*



Final_Result

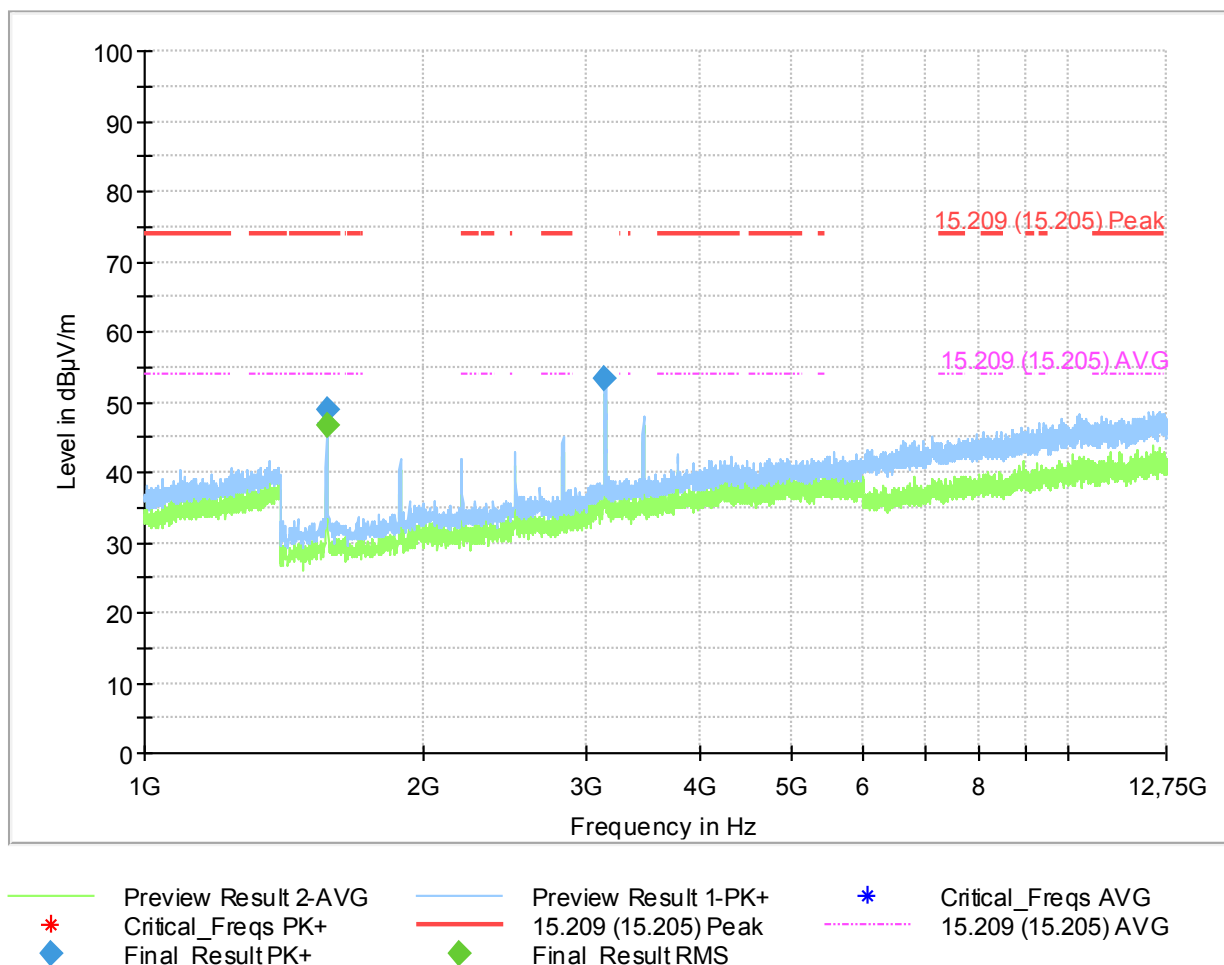
Frequency (MHz)	MaxPeak (dBuV/m)	RMS (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1301.750000	61.86	---	74.00	12.14	1000.0	1000.000	150.0	H
3471.150000	59.35	---	---	---	1000.0	1000.000	150.0	H

* the limit for average detector is 54 dBuV/m. There are two values above this limit, measured with peak detector (M1: 61.86 dBuV/m at 1.301750 GHz, M2: 59.35 dBuV/m at 3.471150 GHz). It is the 3rd and 8th harmonic of the main signal. Please see chapter to OBW measurement. Correction factor is used to get an average value. Correction factor = $20 \cdot \log(100/100) = 20 \cdot \log(0.2832) = -10.96$ dB (please see Chapter to Transmit time measurements).

=> M1_average value = 61.86 dBuV/m - 10.96 dB = **50.9** dBuV/m

=> M2_average value = 59.35 dBuV/m - 10.96 dB = **48.39** dBuV/m

2.3.2 960 MHz – 1400 MHz, Set-up 1, Op. 7, lying + standing, Peak+AVG detector



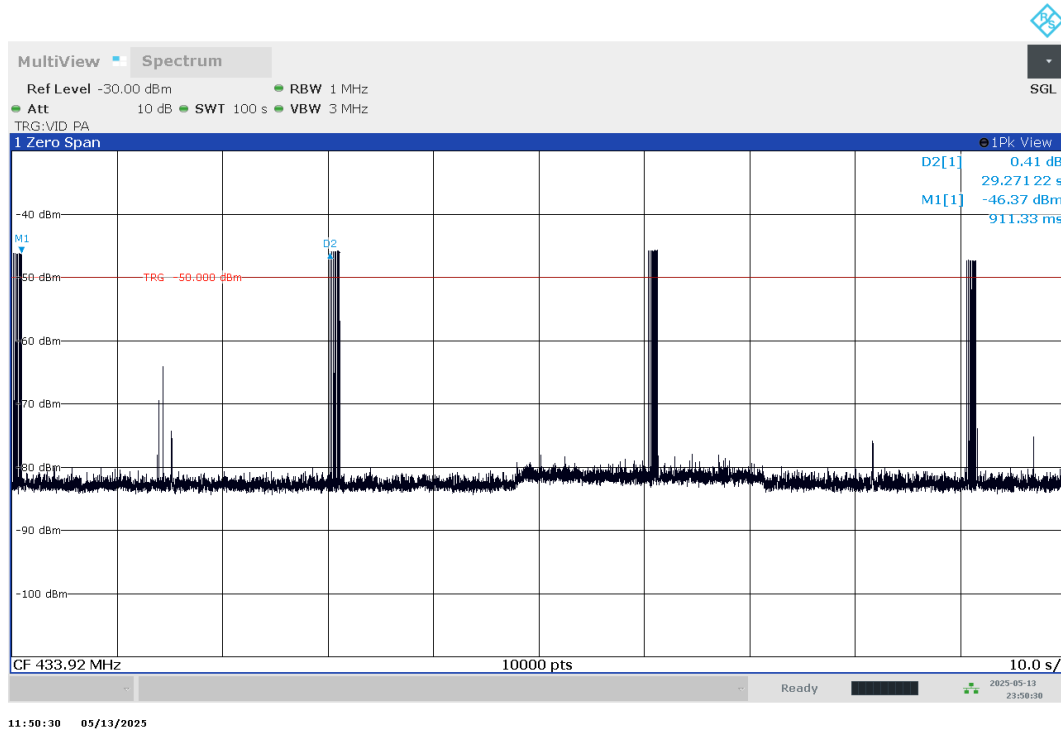
Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1575.050000	---	46.79	54.00	7.21	1000.0	1000.000	150.0	V
1575.050000	48.99	---	74.00	25.01	1000.0	1000.000	150.0	H
3150.300000	53.35	---	---	---	1000.0	1000.000	150.0	V

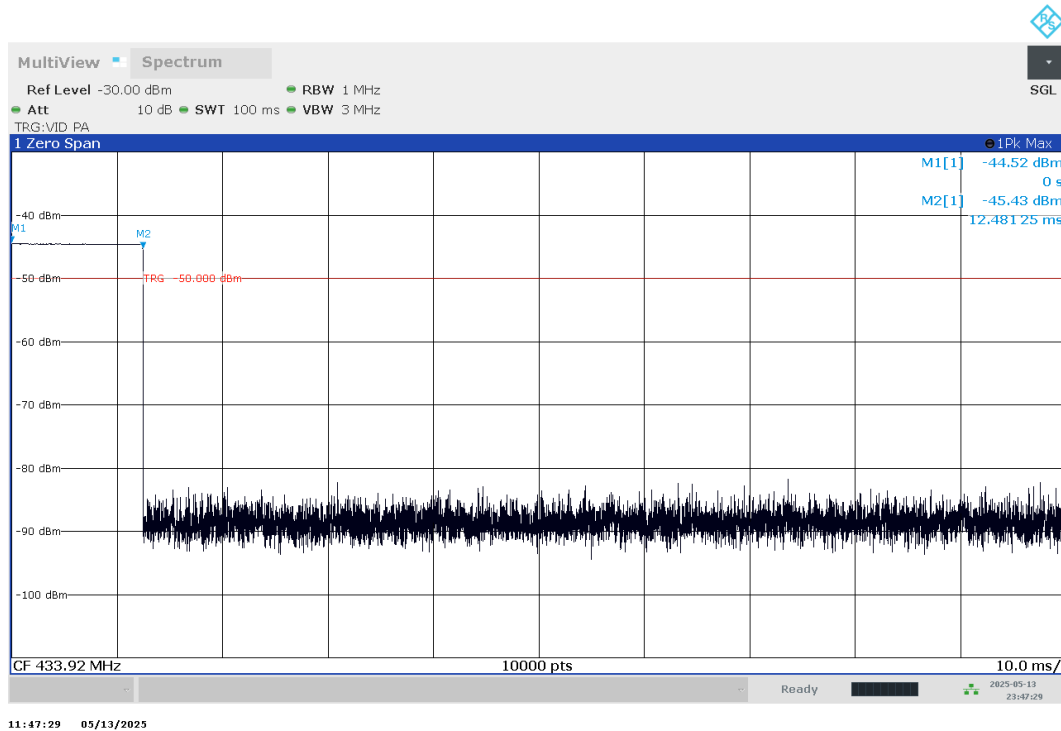
Annex A of TR no.: 24100656-44703-0

3 Transmit time

3.1 Set-up 1, Op. mode 4, Measurement time 100 s



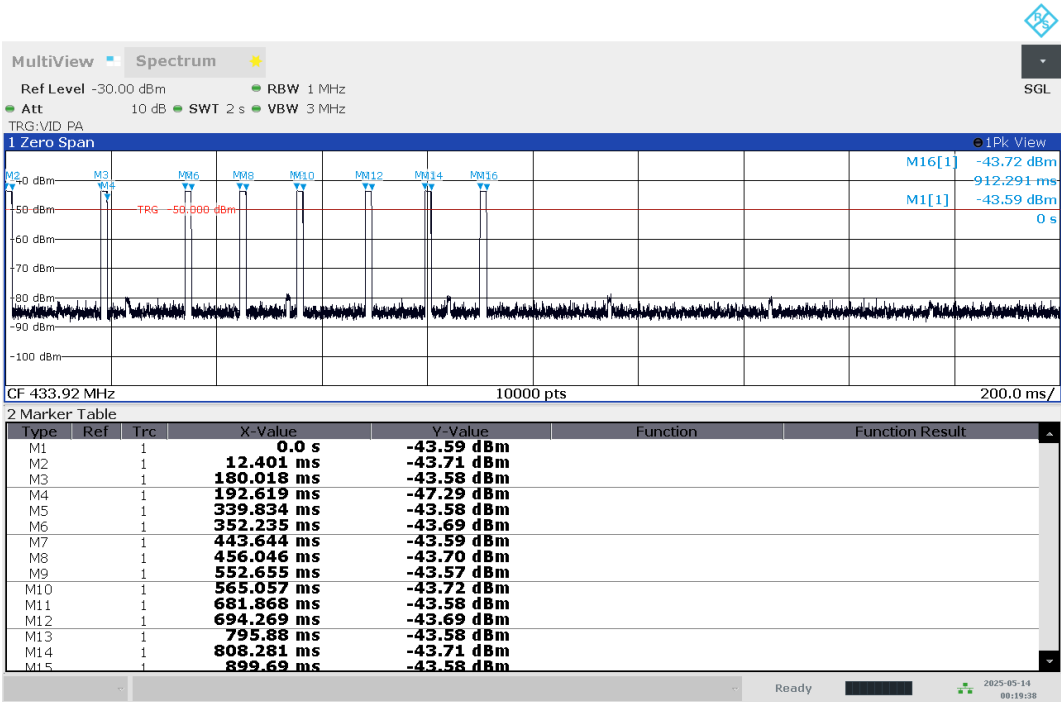
3.2 Set-up 1, Op. mode 4, Measurement time 100 ms



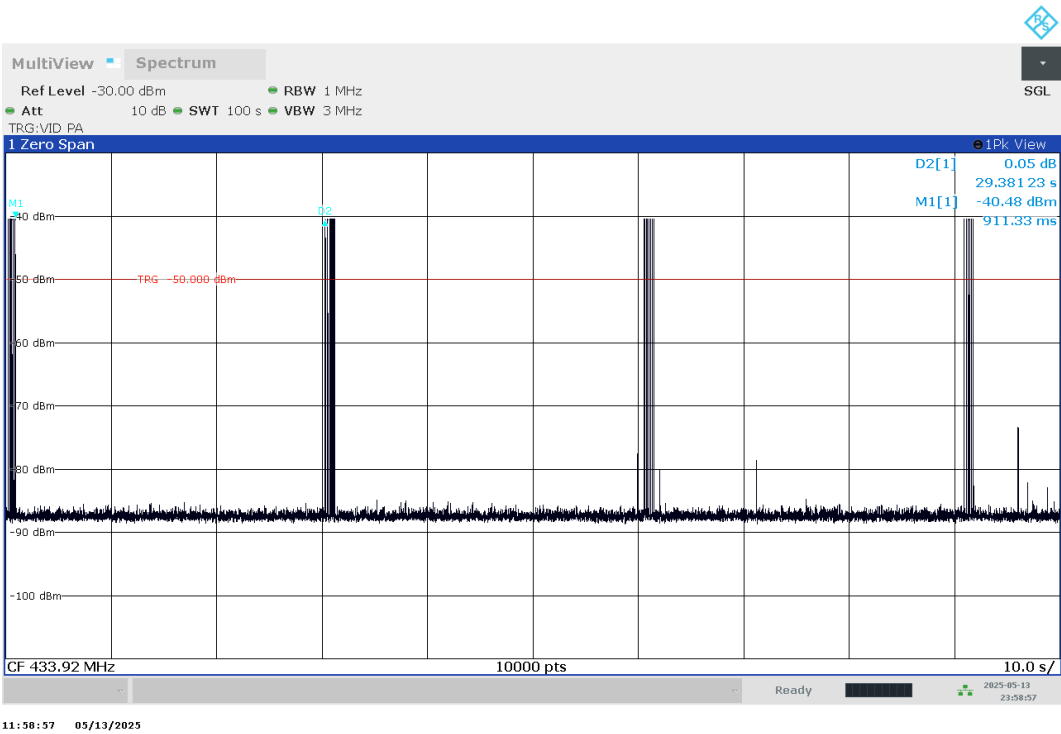
DC= 12.48%

Annex A of TR no.: 24100656-44703-0

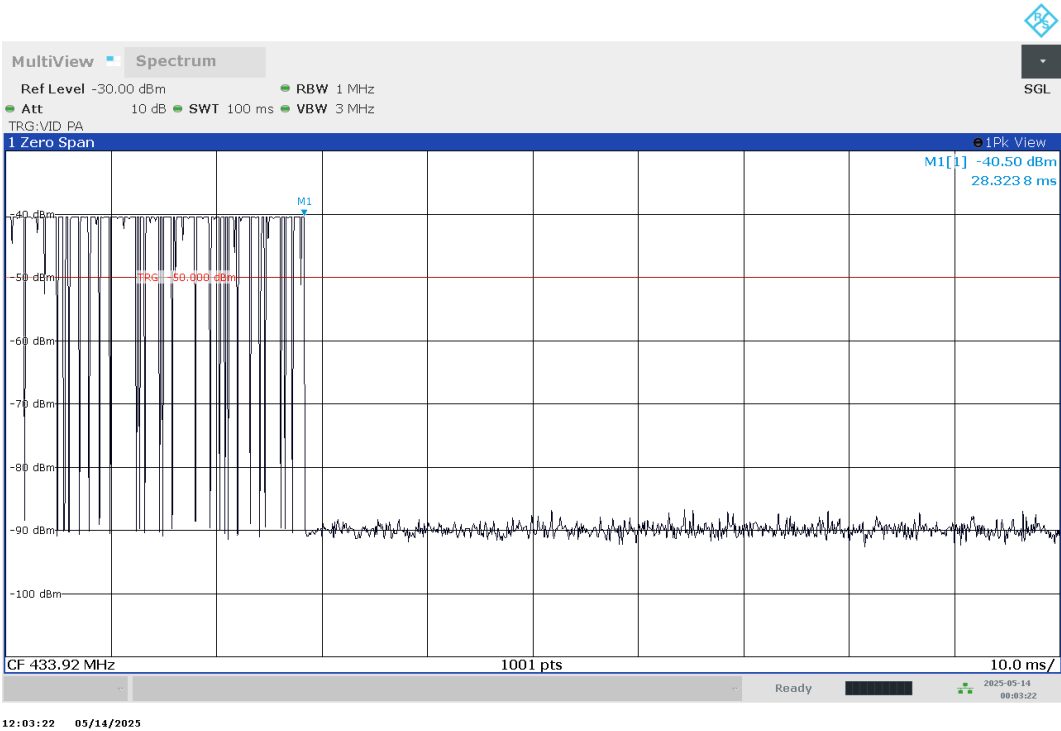
3.3 Set-up 1, Op. mode 4, Measurement time 2 s



3.4 Set-up 1, Op. mode 5, Measurement time 100 s

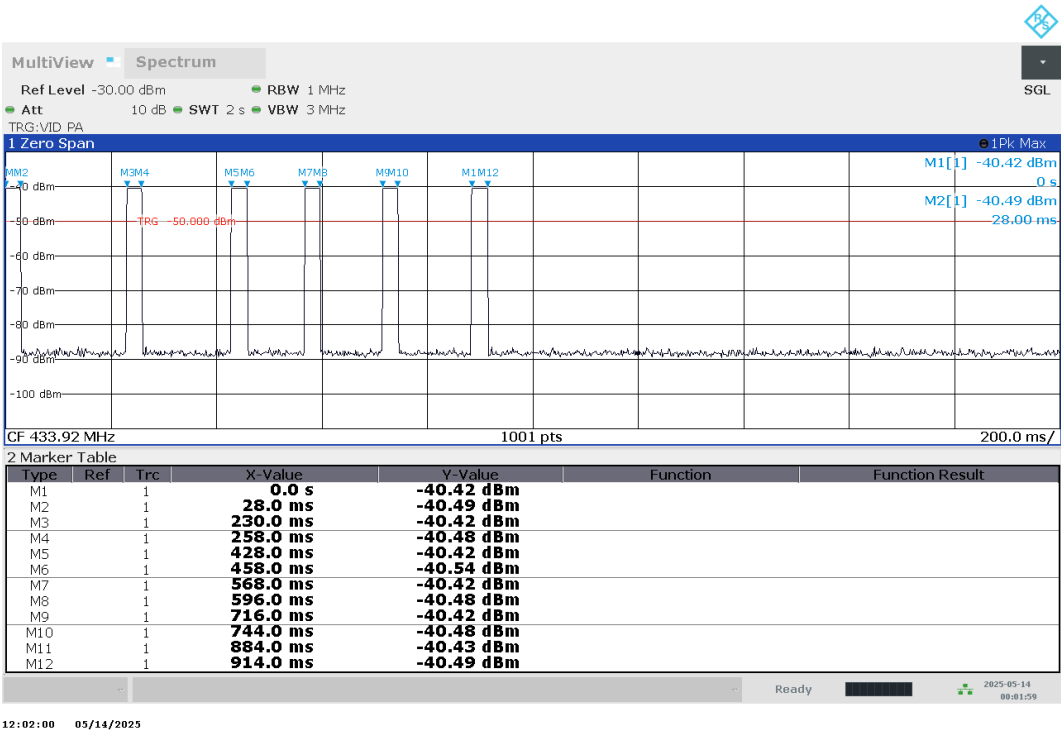


3.5 Set-up 1, Op. mode 5, Measurement time 100 ms



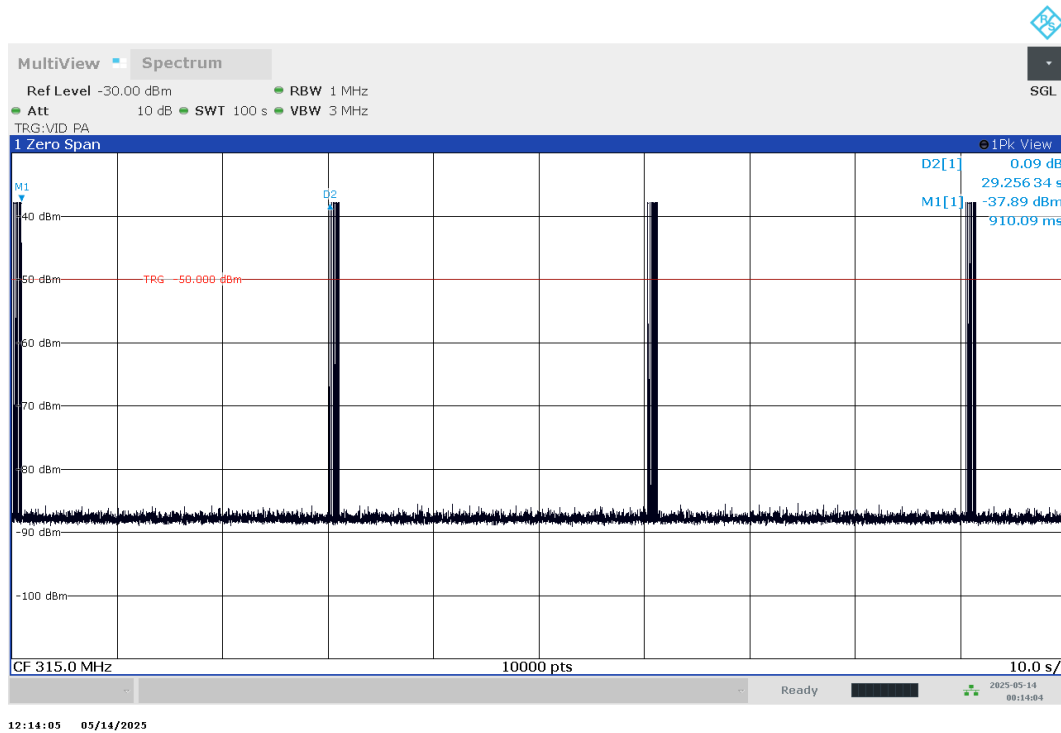
DC= 28.32%

3.6 Set-up 1, Op. mode 5, Measurement time 2 s

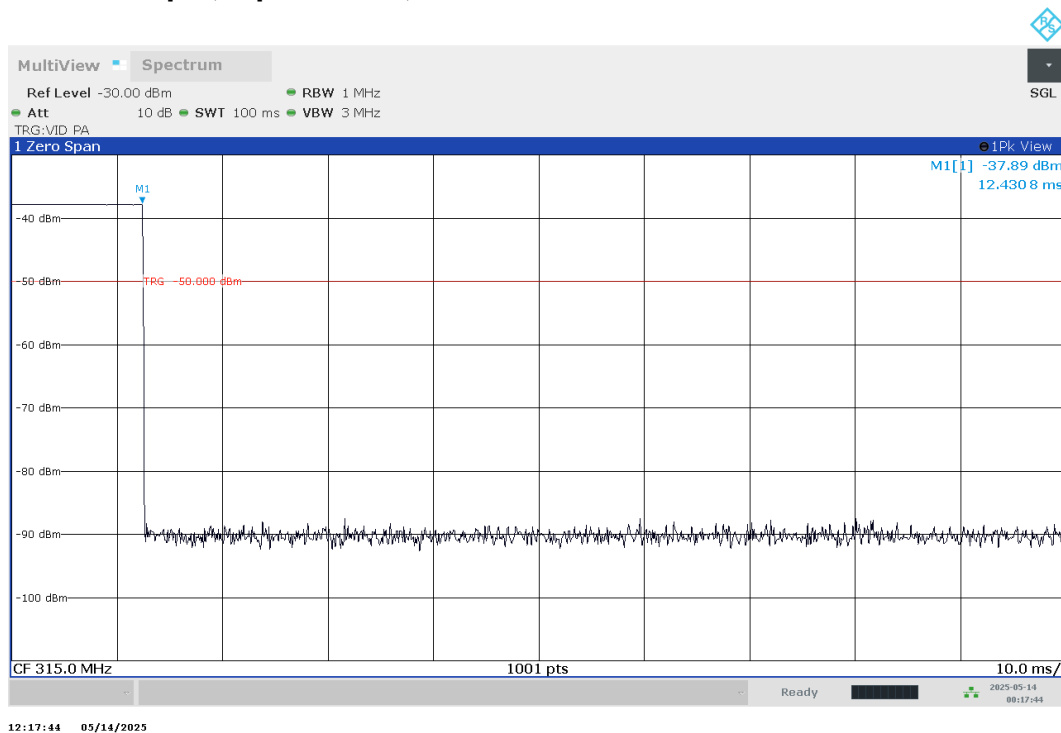


Annex A of TR no.: 24100656-44703-0

3.7 Set-up 1, Op. mode 9, Measurement time 100 s



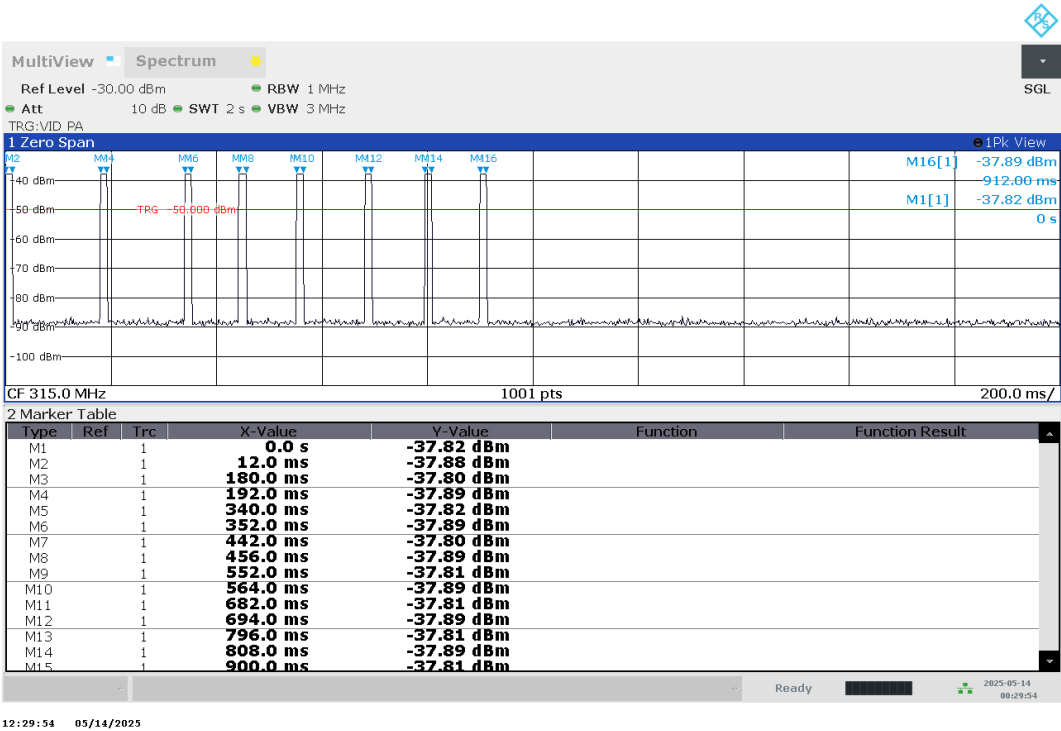
3.8 Set-up 1, Op. mode 9, Measurement time 100 ms



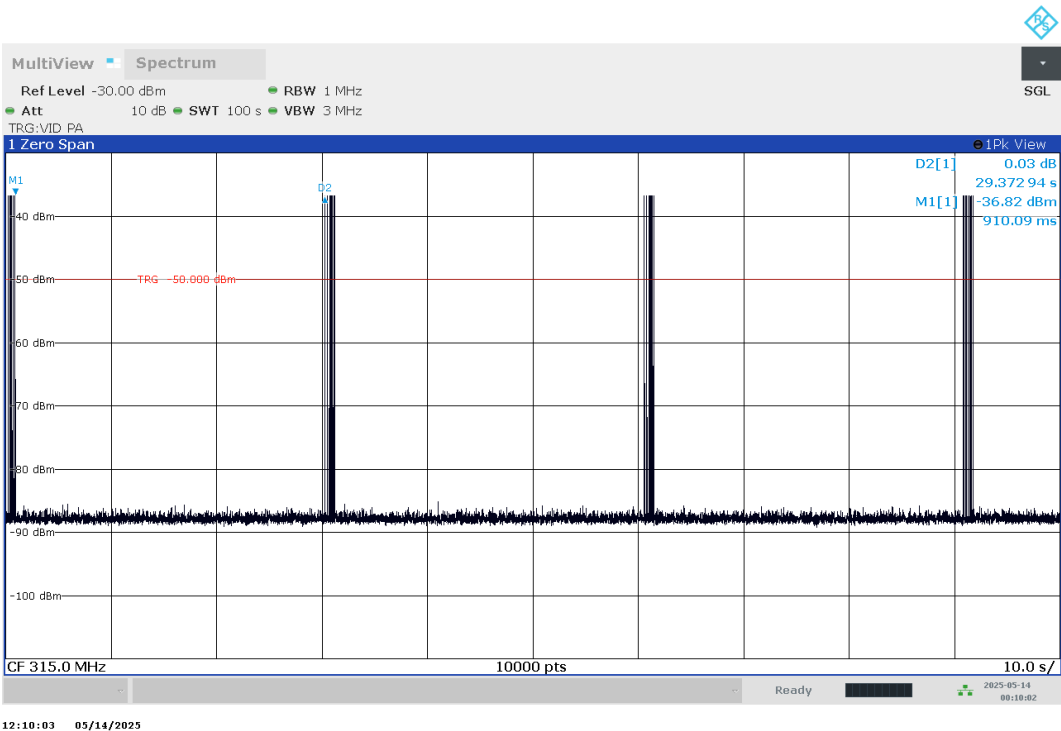
DC= 12.43%

Annex A of TR no.: 24100656-44703-0

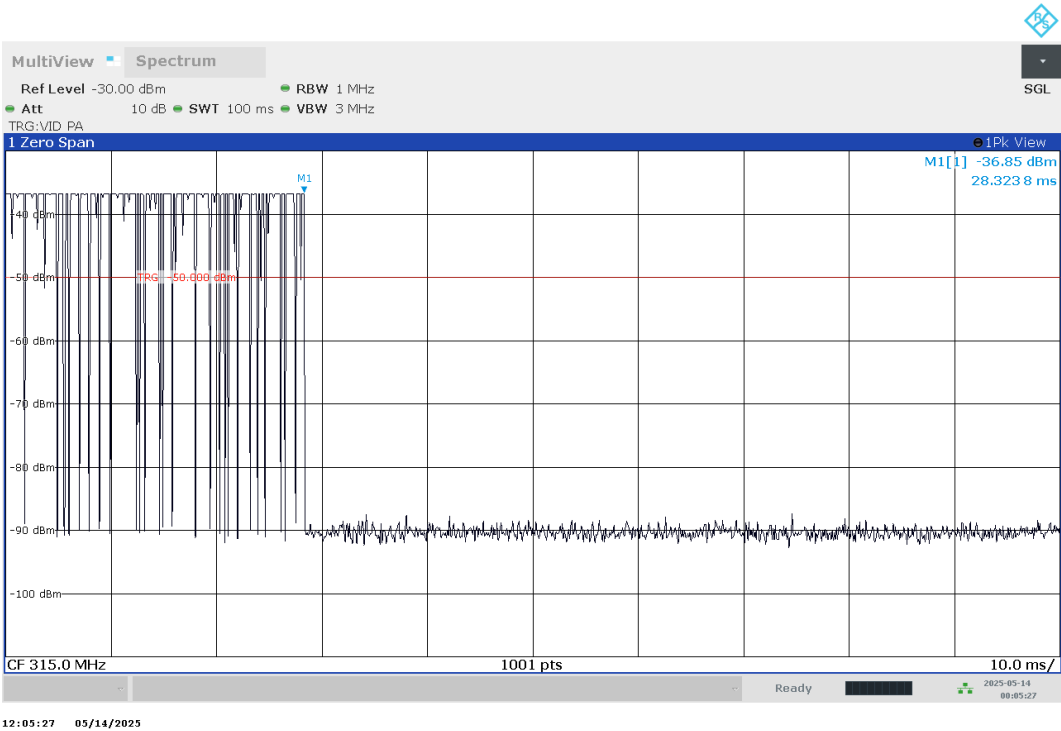
3.9 Set-up 1, Op. mode 9, Measurement time 2 s



3.10 Set-up 1, Op. mode 10, Measurement time 100 s

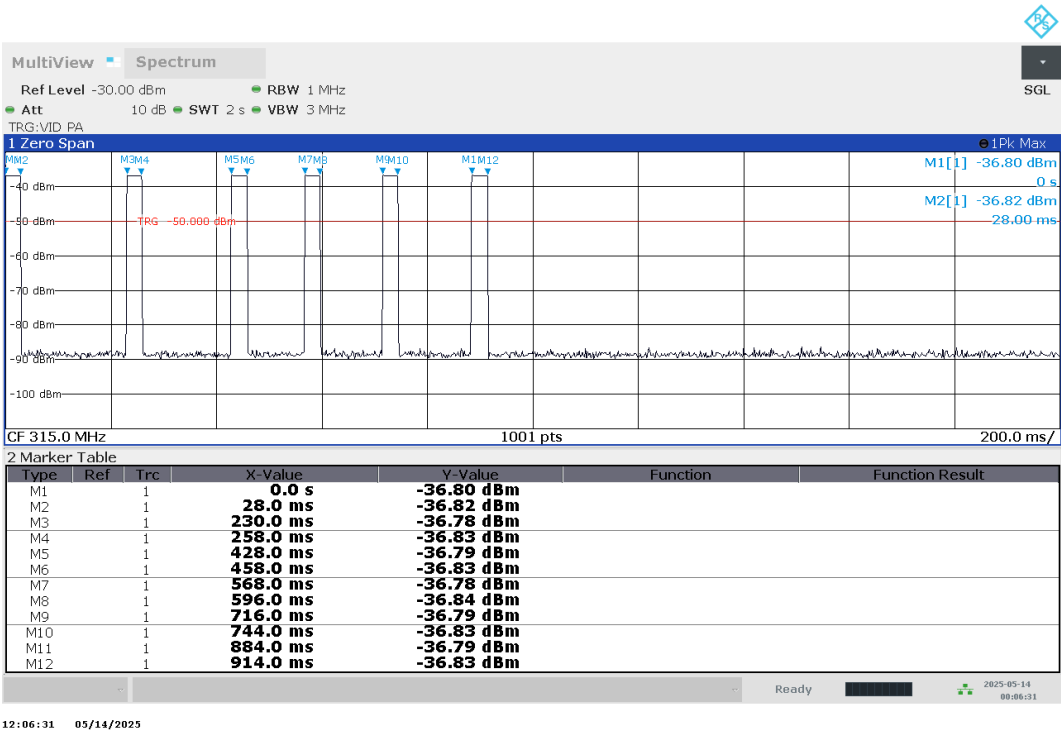


3.11 Set-up 1, Op. mode 10, Measurement time 100 ms



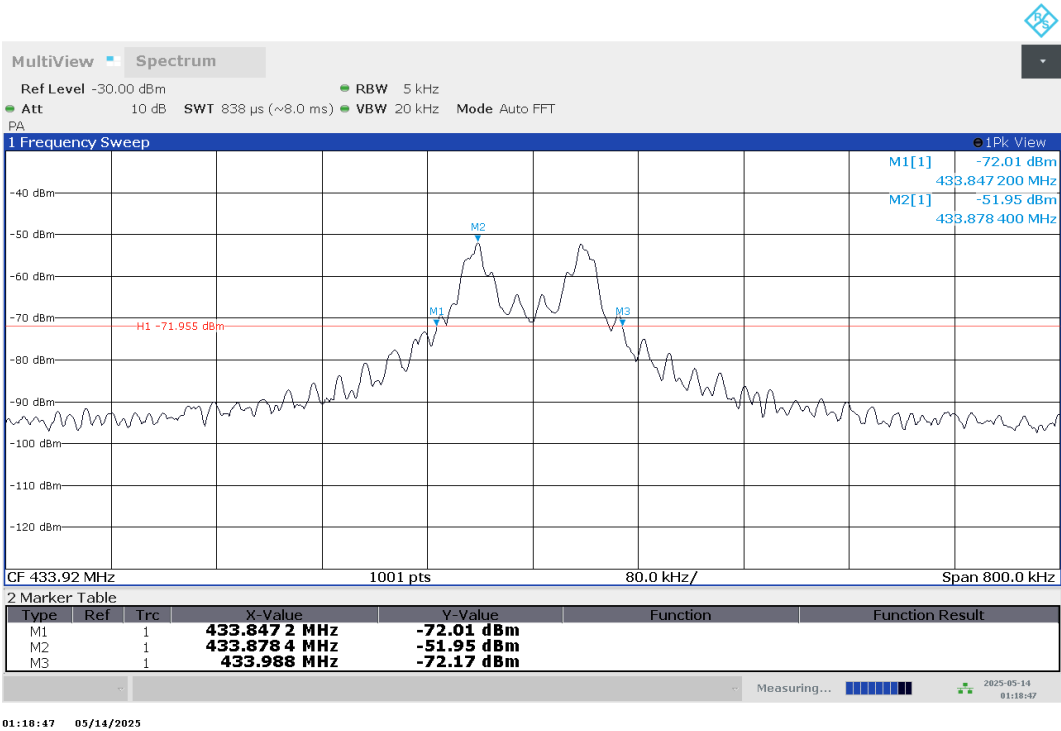
DC= 28.32 %

3.12 Set-up 1, Op. mode 10, Measurement time 2 s

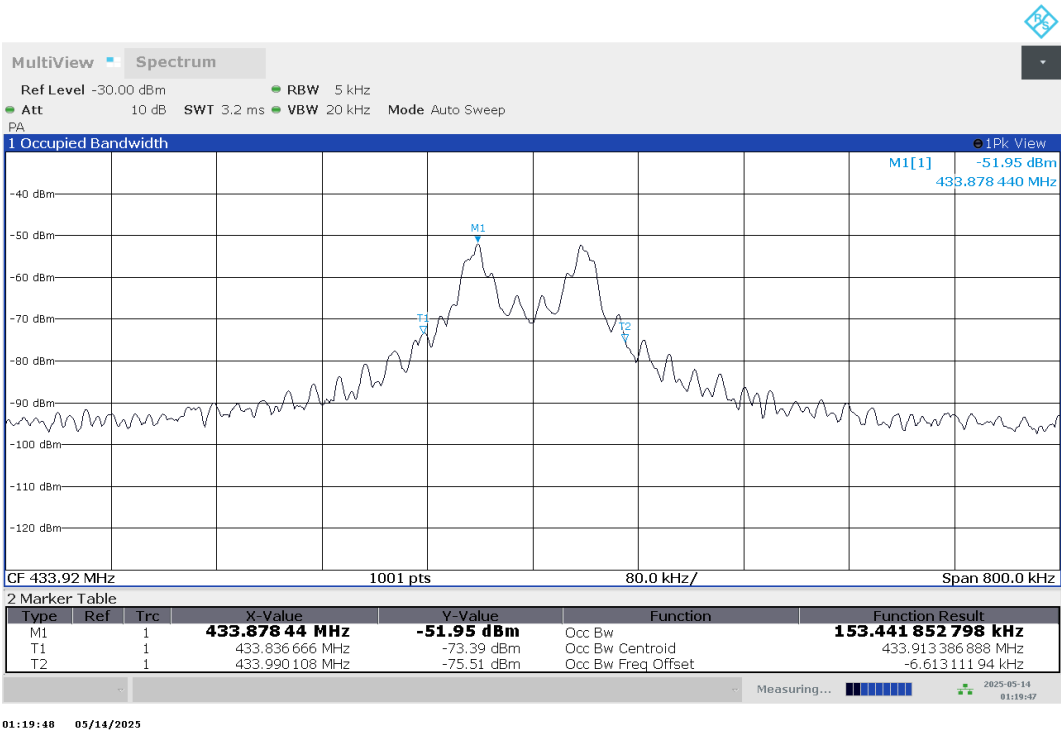


4 Occupied Bandwidth

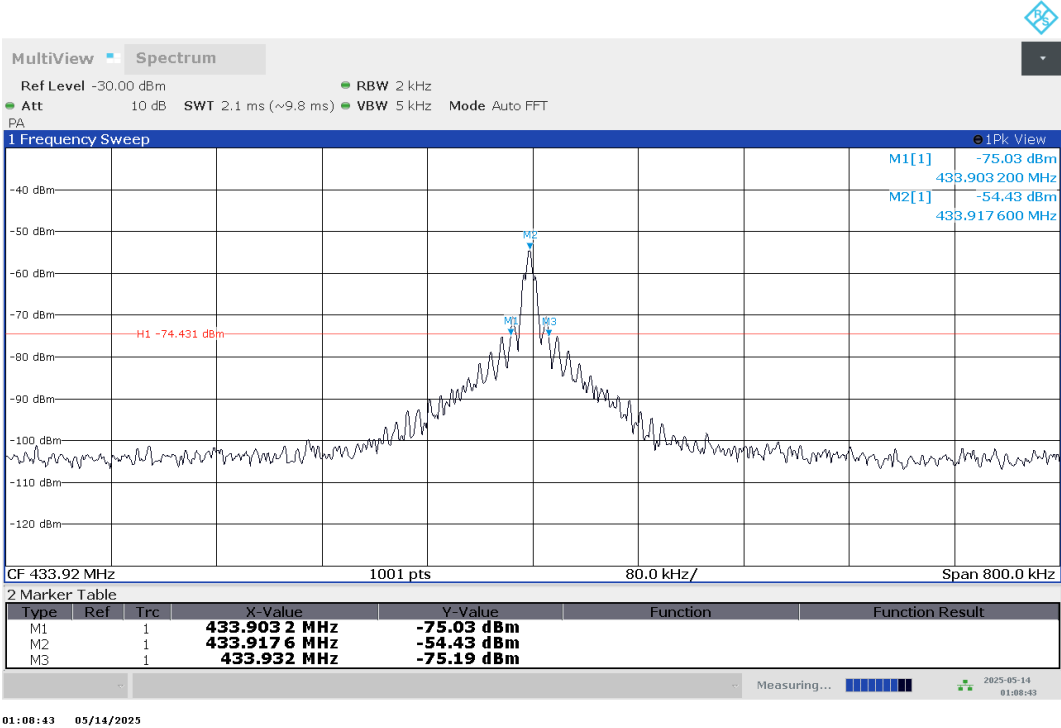
4.1 20 dB bandwidth, set-up 1, op. 4



4.2 99 % occupied bandwidth, set-up 1, op. 4

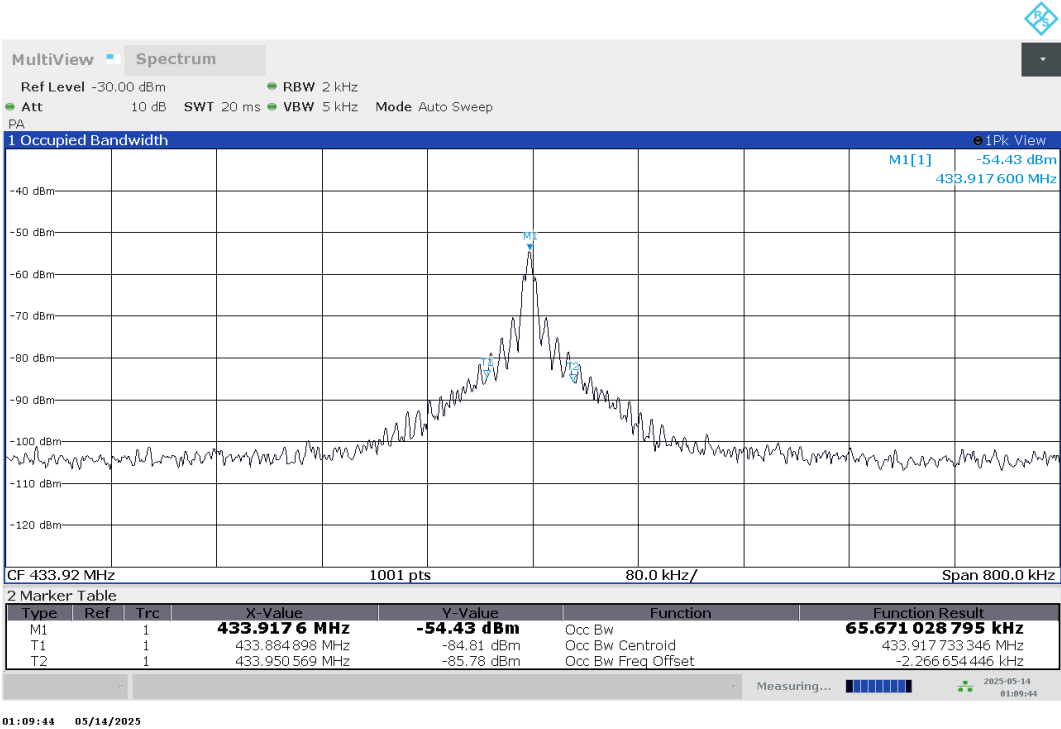


4.3 20 dB bandwidth, set-up 1, op. 5



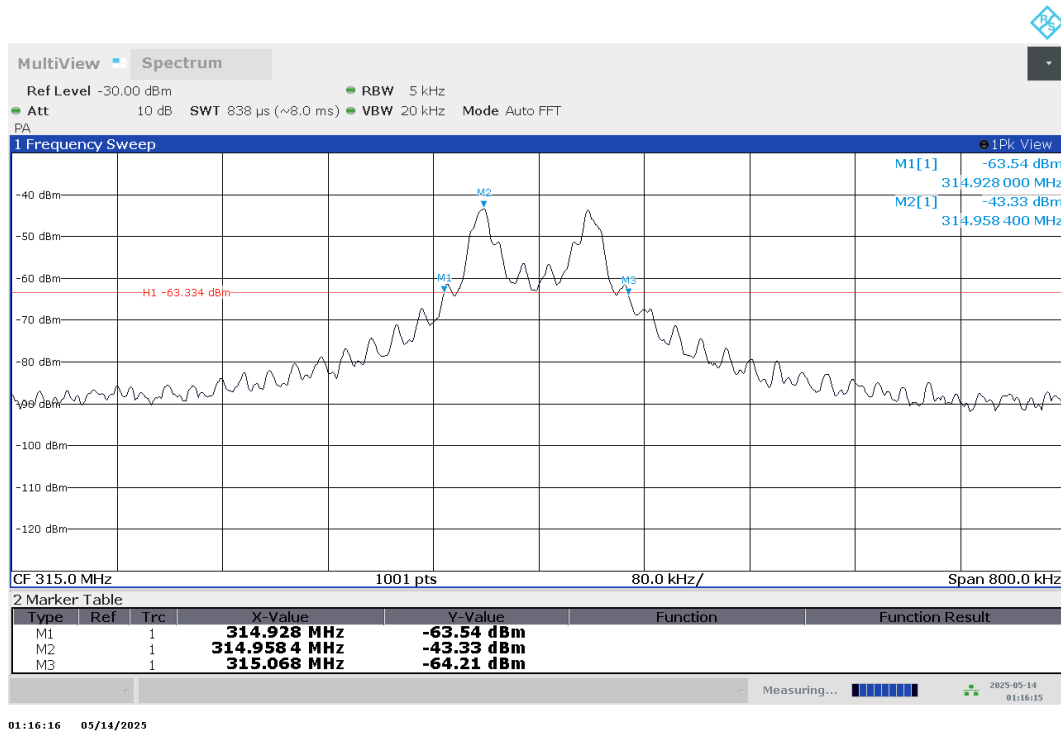
01:00:43 05/14/2025

4.4 99 % occupied bandwidth, set-up 1, op. 5

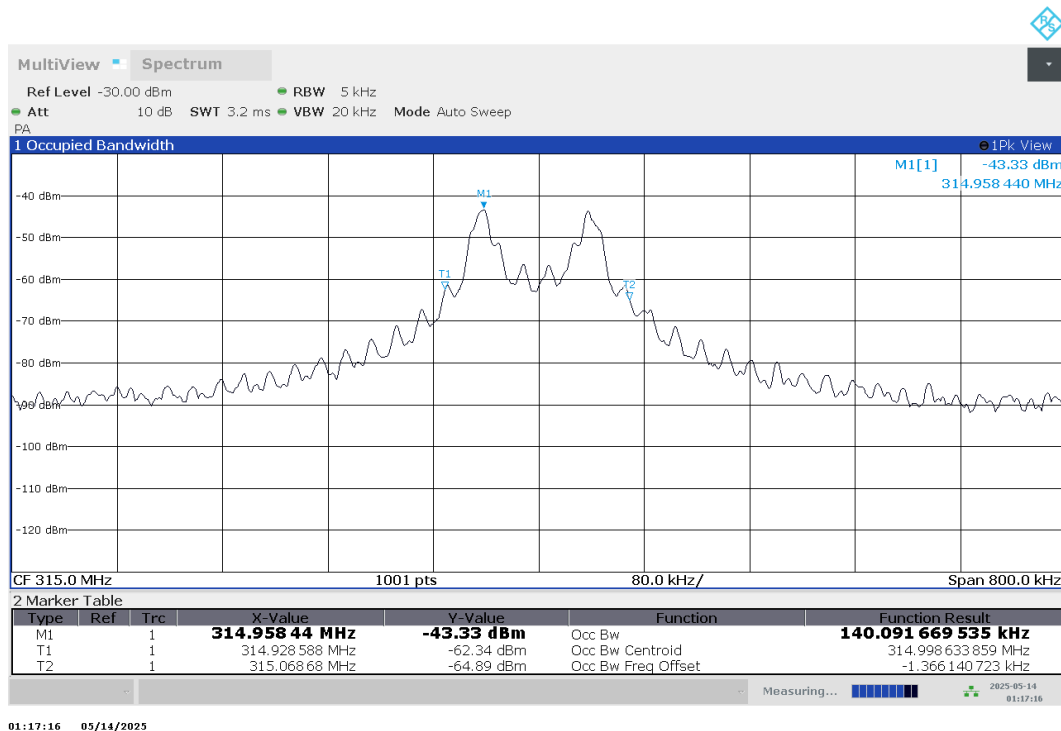


01:09:44 05/14/2025

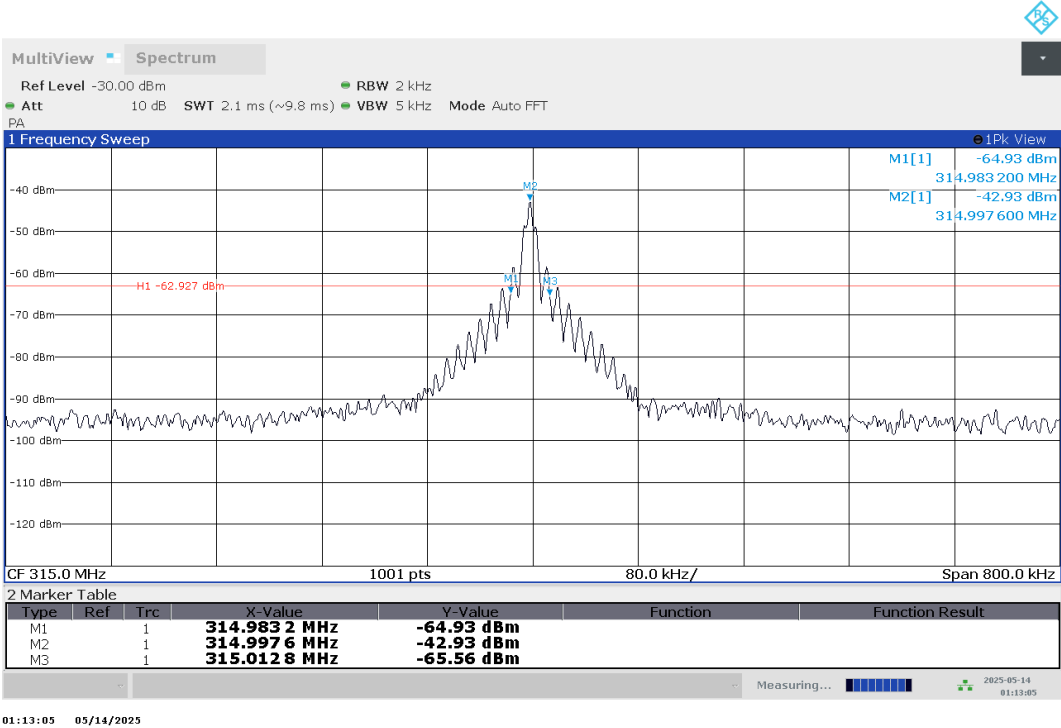
4.5 20 dB bandwidth, set-up 1, op. 9



4.6 99 % occupied bandwidth, set-up 1, op. 9



4.7 20 dB bandwidth, set-up 1, op. 10



4.8 99 % occupied bandwidth, set-up 1, op. 10

