Test report for

15.247 (DSS), 15.209 and 15.207

RSS-247, RSS-Gen

The RvA is signatory to ILAC - MRA

Product name	: RF Module 915 MHz
Applicant	: Tyro Remotes B.V.
FCC ID	: SQL-LP915
IC	: 30985- LP915

Test report No. : P000393949 001 Ver 2.0

Laboratory information

Accreditation

Kiwa Nederland B.V. complies with the accreditation criteria for test laboratories as laid down in ISO/IEC 17025:2017. The accreditation covers the quality system of the laboratory as well as the specific activities as described in the authorized annex bearing the accreditation number L248 and is granted by the Dutch Council For Accreditation (RvA: Raad voor Accreditatie).

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The Industry Canada company number for Kiwa Nederland B.V. is: 4173A. The CABID is NL0001.

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Documentation

The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory. The documentation of the testing performed on the tested devices is archived for 10 years at Kiwa Nederland B.V.

Testing Location

Test Site	Kiwa Nederland B.V.
Test Site location	Wilmersdorf 50 7327 AC Apeldoorn The Netherlands Tel. +31 88998 3393
Test Site FCC	NL0001
CABID	NL0001

Revision History

Version	Date	Remarks	By
v0.50	08/08/24	First draft	LFD
v1.00	12/08/24	Initial release	LFD
V2.00	20/11/24	Added verification results with a second host	RvB

Table of Contents

Summary of Test results

FCC	ISED	Description	Section in report	Verdict
15.247(d) 15.209 (a)	RSS-Gen 8.9	Radiated spurious emissions	3.1	Pass
15.205 (a)	RSS Gen 8.10	Spurious emissions in the restricted bands	3.1	Pass
15.247 (a)	RSS-247 5.1(a)	20 dB bandwidth	3.2	Pass
--	RSS-Gen 6.7	99% bandwidth	3.3	Pass
15.247 (b)	RSS-247 5.4 (d)	RF output power	3.4	Pass
15.247 (d)	RSS-247 5.5	Band edge	3.5	Pass
15.207 (c)	RSS-Gen 8.8	AC power-line conducted emissions	3.6	Pass
15.247 (a)	RSS-247 5.1(c)	Dwell time	3.7	Pass
15.247 (a)	RSS-247 5.1(b)	Channel separation	3.8	Pass
15.247 (a)	RSS-247 5.1(c)	Number of hopping channels	3.9	Pass

Decision rule: Pass/Fail decisions are based on measurement results without taking into account measurement uncertainty.

1 General Description

1.1 Applicant

Client name:	Tyro Remotes
Address:	Bedrijvenpark Twente 299
Zip code:	7602 KK Almelo Netherlands
Telephone:	+31 612734017
E-mail:	j.nijkrake@tyroremotes.eu
Contact name:	John Nijkrake

1.2 Manufacturer

Manufacturer name:	Tyro Remotes
Address:	Bedrijvenpark Twente 299
Zip code:	7602 KK Almelo Netherlands
Telephone:	+31 612734017
E-mail:	j.nijkrake@tyroremotes.eu
Contact name:	John Nijkrake

1.3 Tested Equipment Under Test (EUT)

Product name:	LEAP 915 MHz radio modules 3V1 / 2V8
Brand name:	LEAP
FCC ID:	SQL-LP915
IC:	30985- LP915
Product description:	915 MHz radio module
Variant model(s):	LP915 - 2V8
Batch and/or serial No.	Not Applicable
Software version:	4.0.19
Hardware version:	P02
Date of receipt:	25/04/2024
Tests started:	29/04/2024
Testing ended:	01/05/2024

1.3.1 Auxiliary items

AUX1

Product name:	EUT host 1
Product type:	AC/DC Adaptor
Remarks:	Connects to EUT

AUX2

Product name:	EUT host 2
Product type:	DC powered
Remarks:	Connects to EUT

1.4 Product specifications of Equipment under test

Tx Frequency:	902 – 928 MHz
Rx frequency:	902 – 928 MHz
Occupied channel width:	100 kHz
Antenna type:	PCB Antenna
Antenna gain:	1.2 dBi
Type of modulation:	GFSK
Emission designator	74K1G1D / 74K2G1D

Disclaimer: The operating frequency bands are declared by the applicant

1.5 Environmental conditions

Normal test conditions:

Temperature (*) : +15°C to +35°C
Relative humidity(*) : 20 % to 75 %

1.6 Measurement standards

- ANSI C63.10:2013
- FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02

1.7 Applicable standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15 Subpart C §15.207
- FCC Part 15 Subpart C §15.209
- FCC Part 15 Subpart C §15.247
- RSS-Gen Issue 5
- RSS-247 Issue 3

1.8 Observation and remarks

There are two variants: The main one, with internal voltage of 3.1 V, and the second type using a voltage of 2.8 V. The former shall be called variant 3v1 and the latter will be the variant 2v8 for the rest of the document.
0 Ohm SMD resistor removed for conducted testing to avoid a power split.

1.9 Modifications to the EUT (Equipment Under Test)

No structural modifications. But parameter “RFPower” had to be reduced from 63, out of 63, to 5 for the 2v8 sample configured to operate on the Low Channel.

1.10 Conclusions

The sample of the product showed **NO NON-COMPLIANCES** to the specifications stated in paragraph 1.7 of this report.

The results of the test as stated in this report, are exclusively applicable to the product items as identified in this report. Kiwa Nederland B.V. accepts no responsibility for any properties of product items in this test report, which are not supported by the tests as specified in paragraph 1.7 *"Applicable standards".*

All tests are performed by:

Name : L. Fonseca Dias

Review of test methods and report by:

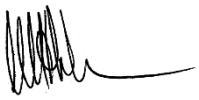
Name : P. van Wanrooij, BASc

The above conclusions have been verified by the following signatory:

Date : 20-11-2024

Name : ing. M.H. Khan

Function : Test Engineer

Signature : 

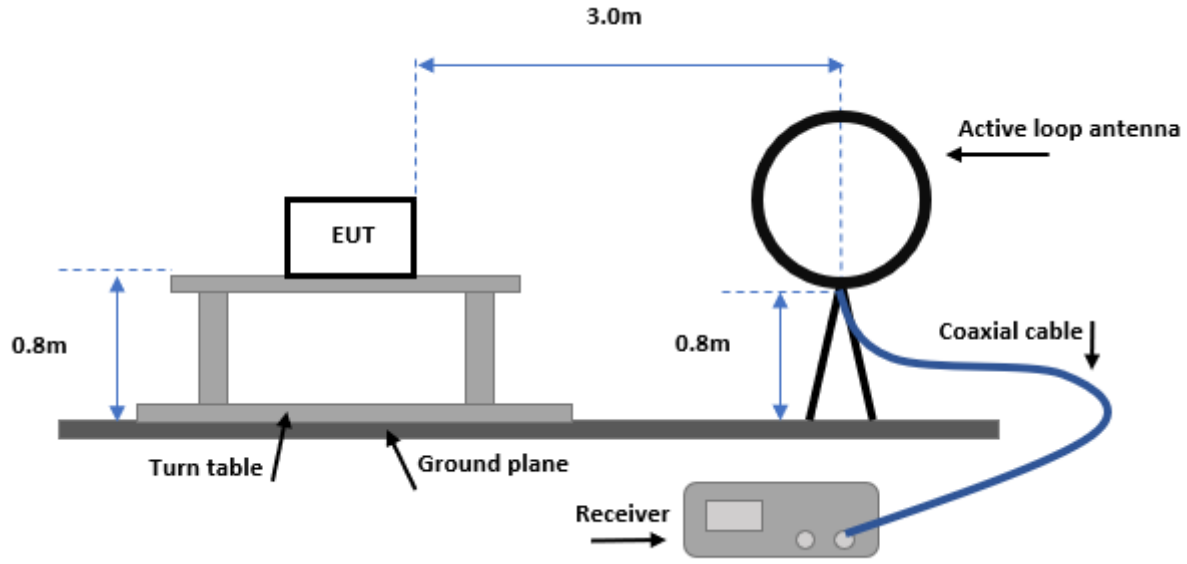
2 Test configuration of the Equipment Under Test

2.1 Test mode

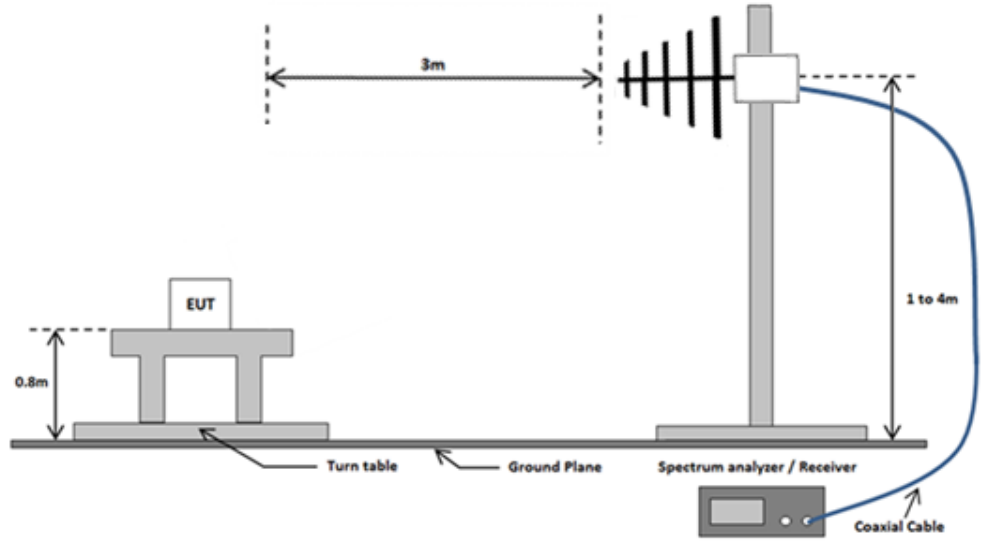
EUT operating at test mode with continuous transmission of modulated signal for subparts 20X.and on idle mode for 10X.

2.2 Test setups

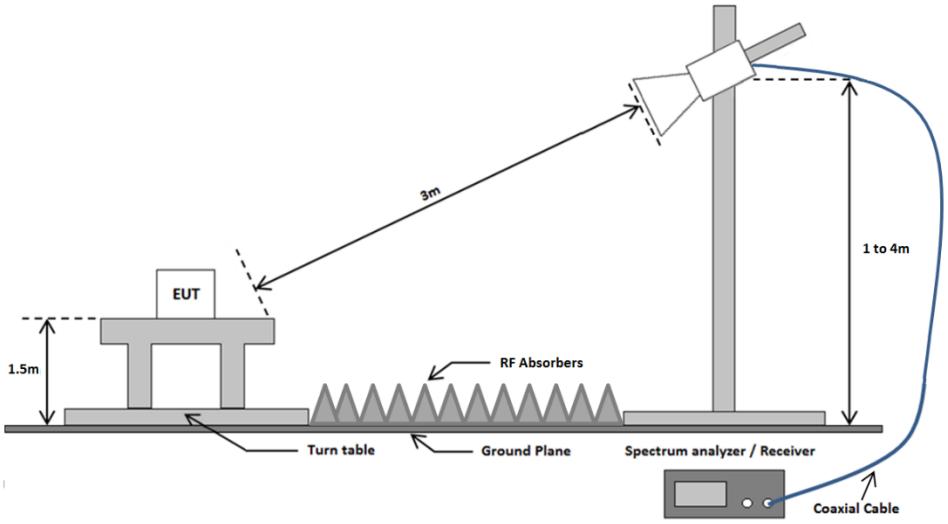
Radiated emissions test setup 9 kHz – 30 MHz



Radiated emissions test setup 30 MHz - 1 GHz

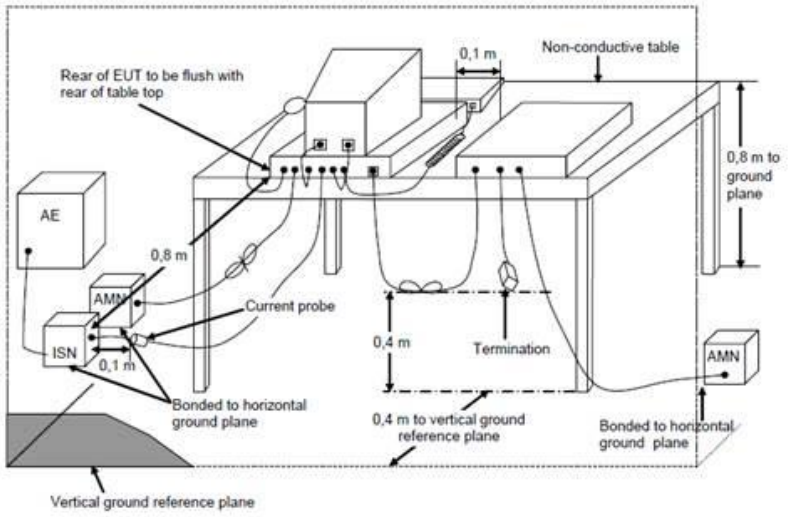


Radiated emissions test setup above 1 GHz



AC Power line conducted emissions test setup

Emissions test at AC mains



Antenna port conducted tests

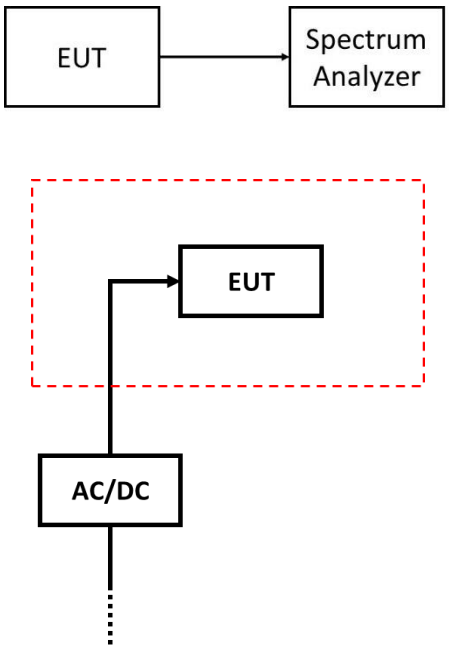


Figure 1. EUT and auxiliary setup

List of used cables					
Number	**Function**	**From**	**To**	**Length**	**Remarks**
1	AC Power	mains 120Vac 60 Hz	AUX1	< 3m	-
2	x Vdc power	AUX1	EUT	< 3m	-

2.3 Equipment used in the test configuration

Description	Manufacturer	Model	ID	Cal. Done date	Cal. due date	Used at Par.
EMI Receiver	Rohde & Schwarz	ESR7	114870	09-2022	09-2024	3.6
EMI Receiver	Rohde & Schwarz	ESR7	114605	07-2022	07-2024	3.1
Spectrum Analyzer	Rohde & Schwarz	FSV3044	114923	10-2023	10-2025	3.1
Spectrum Analyzer	Rohde & Schwarz	FSV3044	115043	03-2022	10-2024	3.2, 3.3, 3.4, 3.5, 3.7, 3.8, 3.9
1.1 GHz HPF	Wainwright	WHK1.1/15G-10EF	114679	03-2024	03-2026	3.1
Biconical antenna + 6dB attenuator	EMCO	3146	107818	06-2022	06-2025	3.1
Logperiodic antenna	EMCO	3147	114385	02-2021	02-2026	3.1
Horn antenna	EMCO	3115	114607	01-2021	07-2024	3.1
Preamplifier 1-18 GHz	µComp Nordic	MCNA-40-0010800-25-10P	114771	08-2024	08-2025	3.1
Semi-Anechoic Chamber	ETS Lindgren	SAR	114624	03-2023	03-2026	3.1
Test software	Raditeq	Radimation Version 2023.2.3	--	--	--	3.1, 3.6
LISN /Two line V-network	Rohde & Schwarz	ENV 216	114379	11-2023	11-2025	3.6

*Note: Standard gain horn antennas do not need calibration
NA= Not Applicable

2.4 Sample calculations

All formulas for data conversions and conversion factors are reported in chapter 4 of this test report.

3 Test results

3.1 Radiated spurious emissions

3.1.1 Limit

15.209(a)
The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance(m)
0.009 – 0.490	2400/F(kHz)	20*{log[2400]-log[F(kHz)]}	300*
0.490 – 1.705	24000/F(kHz)	20*{log[24000]-log[F(kHz)]}	30*
1.705 – 13.11 14.01 – 30.0	30	29.5	30*
30 -88	100	40	3
88 - 216	150	43,5	3
216-960	200	46	3
Above 960	500	54	3

*Note: Measured values in the plots 9 kHz to 30 MHz corrected to 30m or 300m limit distance according to the method described in ANSI C63.10-2013, clause 6.4

3.1.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.1.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.1.4 Test procedure

9 kHz – 30 MHz: According to ANSI C63.10-2013, section 6.4
30 MHz to 26.5 GHz: According to ANSI C63.10-2013, section 6.5 and 6.6

9 kHz to 30 MHz: IRN 441 – Method 10
30 MHz to 1 GHz: IRN 441 – Method 1
1 GHz to 18 GHz: IRN 441– Method 2
18 to 26 GHz: IRN 441– Method 3

In case of handheld and/or body-worn equipment, the EUT's orientation (X, Y, Z) was varied in order to ensure that maximum emission amplitudes were attained. In all other cases the associated cabling and the EUT orientation was varied for maximum emissions.

The spectrum was examined from 0.009 MHz to 10 times X GHz, not more than the 10th harmonic of the highest intentional generated frequency (X GHz). Final radiated emission measurements were made at 3m distance.

The 6 highest emission amplitudes relative to the appropriate limit were recorded in this report. Field strength values of radiated emissions at frequencies not listed in the tables are more than 20 dB below the applicable limit.

3.1.5 Measurement Uncertainty

Frequency range	Polarization	Uncertainty
9 kHz – 30 MHz	--	±1.6 dB
30 – 200 MHz	Horizontal	±4.5 dB
	Vertical	±5.4 dB
200 -1000 MHz	Horizontal	±3.6 dB
	Vertical	±4.6 dB
1 – 18 GHz	Horizontal	±5.7 dB
	Vertical	±5.7 dB
18 – 26.5 GHz	Horizontal	±4.9 dB
	Vertical	±4.9 dB

3.1.6 Test results

Variant 2v8:

Frequency (MHz)	Peak (dBµV/m)	Quasi-Peak (dBµV/m)	QP Limit (dBµV/m)	Operating Channel	Height (m)	Polarization	Status
764.522	39.6	37.7	46	Mid	1	Vertical	Pass
808.578	36.7	34.3	46	Mid	1	Vertical	Pass
824.517	41.4	40	46	Mid	1	Vertical	Pass
884.524	40.8	39.2	46	Mid	1	Vertical	Pass
944.533	39.2	36.6	46	Mid	1.5	Vertical	Pass

Variant 3v1

Frequency (GHz)	Peak (dBµV/m)	Peak Limit (dBµV/m)	Average (dBµV/m)	AVG Limit (dBµV/m)	Operating Channel	Height (m)	Polarization	Status
1.805	42.6	74	36.4	54	Low	2	Vertical	Pass
2.707	42.6	74	39.9	54	Low	2	Vertical	Pass

Variant 2v8

Frequency (GHz)	Peak (dBµV/m)	Peak Limit (dBµV/m)	Average (dBµV/m)	AVG Limit (dBµV/m)	Operating Channel	Height (m)	Polarization	Status
1.804	55.9	74	53.7	54	Low	1	Horizontal	Pass*

* RF Power parameter had to be set at 5/63 for the Pass.

Host 2

Frequency	Peak	Quasi-Peak	Quasi-Peak Limit	Status	Angle	Height	Polarization
204,919 MHz	44,3 dBµV/m	41,3 dBµV/m	43,5 dBµV/m	Pass	0 degrees	1,5 m	Horizontal
206,066 MHz	42,5 dBµV/m	38,3 dBµV/m	43,5 dBµV/m	Pass	59 degrees	1,5 m	Vertical
437,538 MHz	44,4 dBµV/m	42,8 dBµV/m	46 dBµV/m	Pass	62 degrees	3,5 m	Vertical

Low channel

Frequency	Peak	Status	Angle	Height	Polarization	Average	Average Limit	Peak Limit
2,708 GHz	53,1 dBµV/m	Pass	229 degrees	1,5 m	Horizontal	51 dBµV/m	54 dBµV/m	74 dBµV/m
2,708 GHz	51,5 dBµV/m	Pass	261 degrees	4 m	Vertical	48,9 dBµV/m	54 dBµV/m	74 dBµV/m

Middle channel

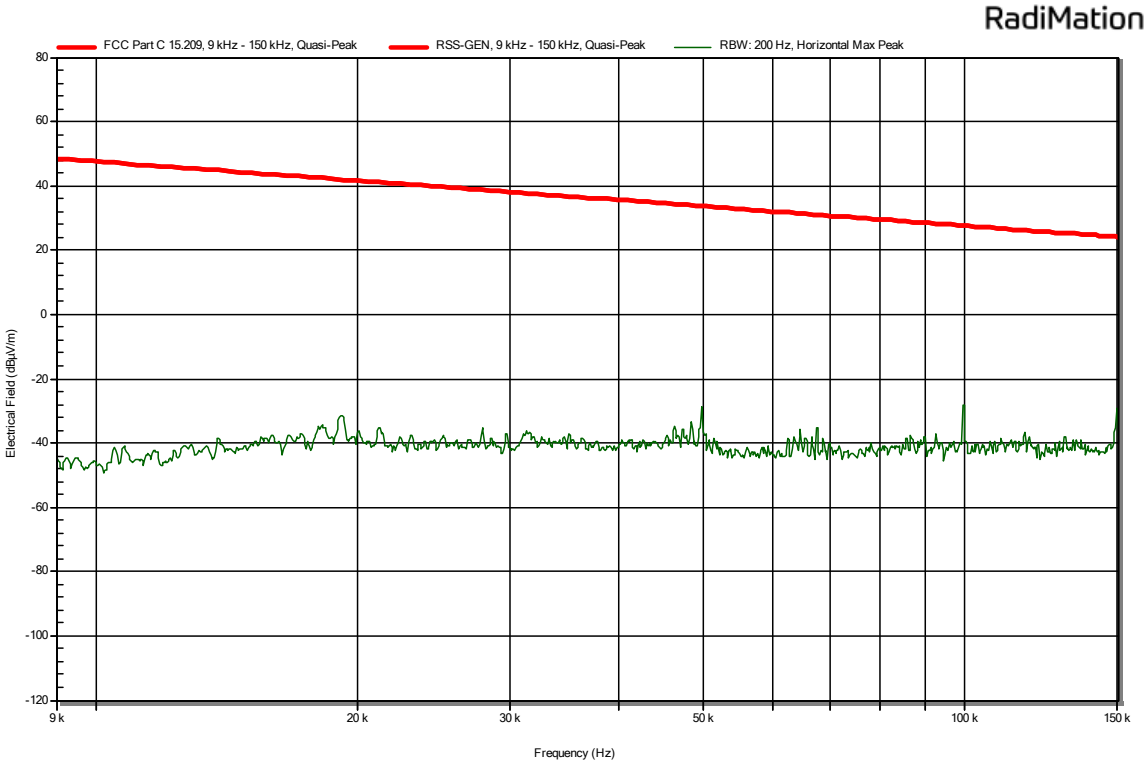
Frequency	Peak	Status	Angle	Height	Polarization	Average	Average Limit	Peak Limit
5,487 GHz	54,9 dBµV/m	Pass	183 degrees	2,8 m	Vertical	50,1 dBµV/m	54 dBµV/m	74 dBµV/m
5,487 GHz	55,9 dBµV/m	Pass	0 degrees	1,2 m	Horizontal	52 dBµV/m	54 dBµV/m	74 dBµV/m
7,316 GHz	55,3 dBµV/m	Pass	315 degrees	1 m	Horizontal	48,3 dBµV/m	54 dBµV/m	74 dBµV/m

High channel

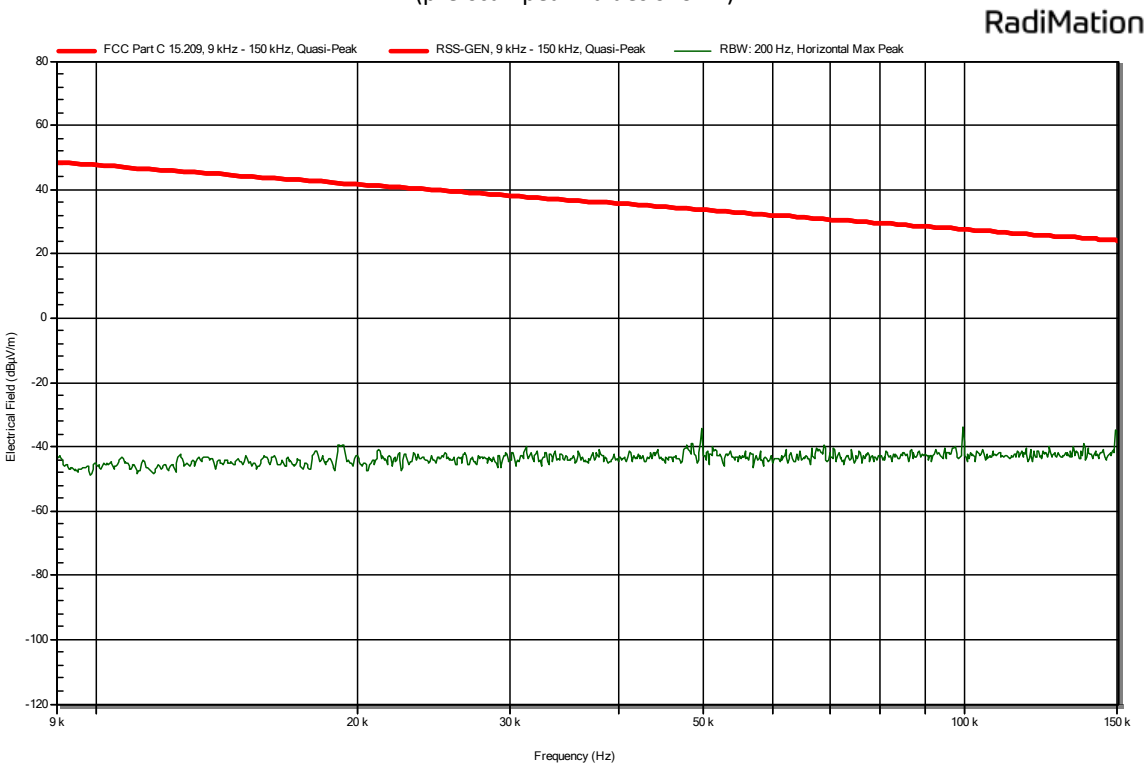
Frequency	Peak	Status	Angle	Height	Polarization	Average	Average Limit	Peak Limit
2,781 GHz	49,8 dBµV/m	Pass	250 degrees	2 m	Horizontal	46,5 dBµV/m	54 dBµV/m	74 dBµV/m
4,635 GHz	51,3 dBµV/m	Pass	235 degrees	1 m	Horizontal	44,2 dBµV/m	54 dBµV/m	74 dBµV/m
4,635 GHz	52,4 dBµV/m	Pass	108 degrees	1,5 m	Vertical	47,8 dBµV/m	54 dBµV/m	74 dBµV/m

The results of the radiated emission tests are depicted in the table above. A selection of plots is provided on the next pages.
Note: The peaks at the transmission band, 902-928 MHz, are disregarded as part of the active signal from the EUT.

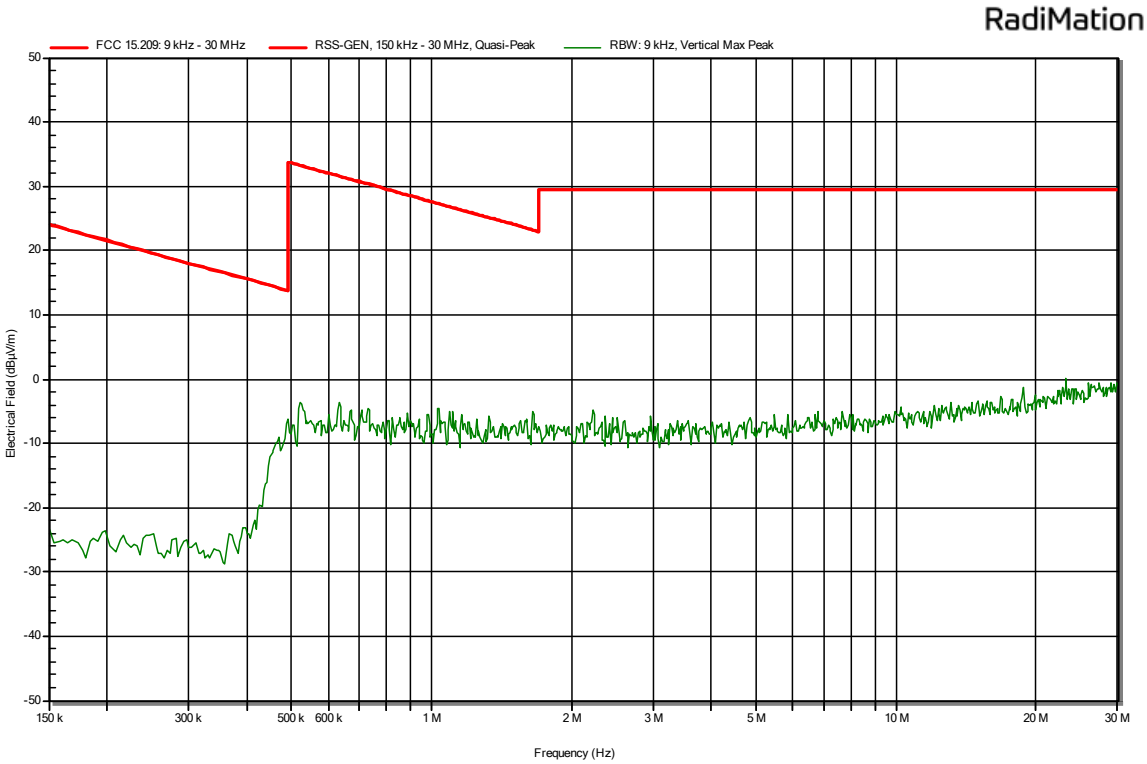
3.1.7 Plots of the Radiated Spurious Emissions Measurement



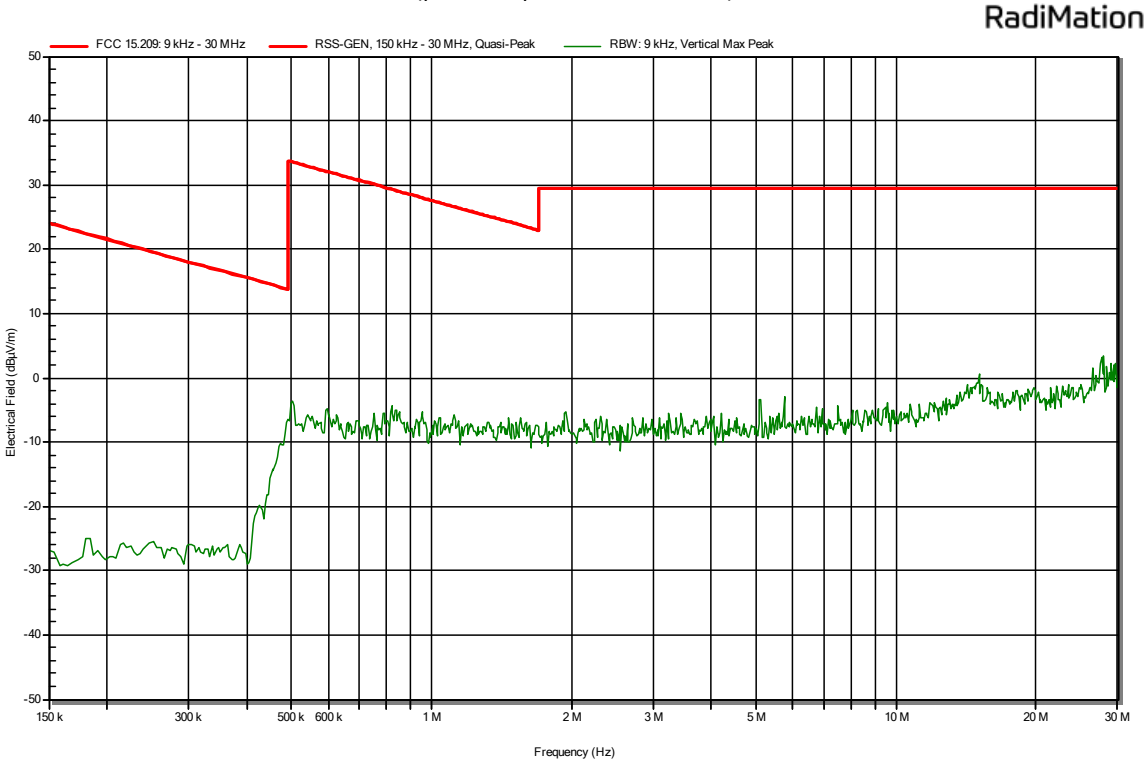
Plot 1a: radiated emissions of the EUT variant 3v1, Antenna perpendicular, in the range 9 – 150KHz (pre-scan peak values shown)



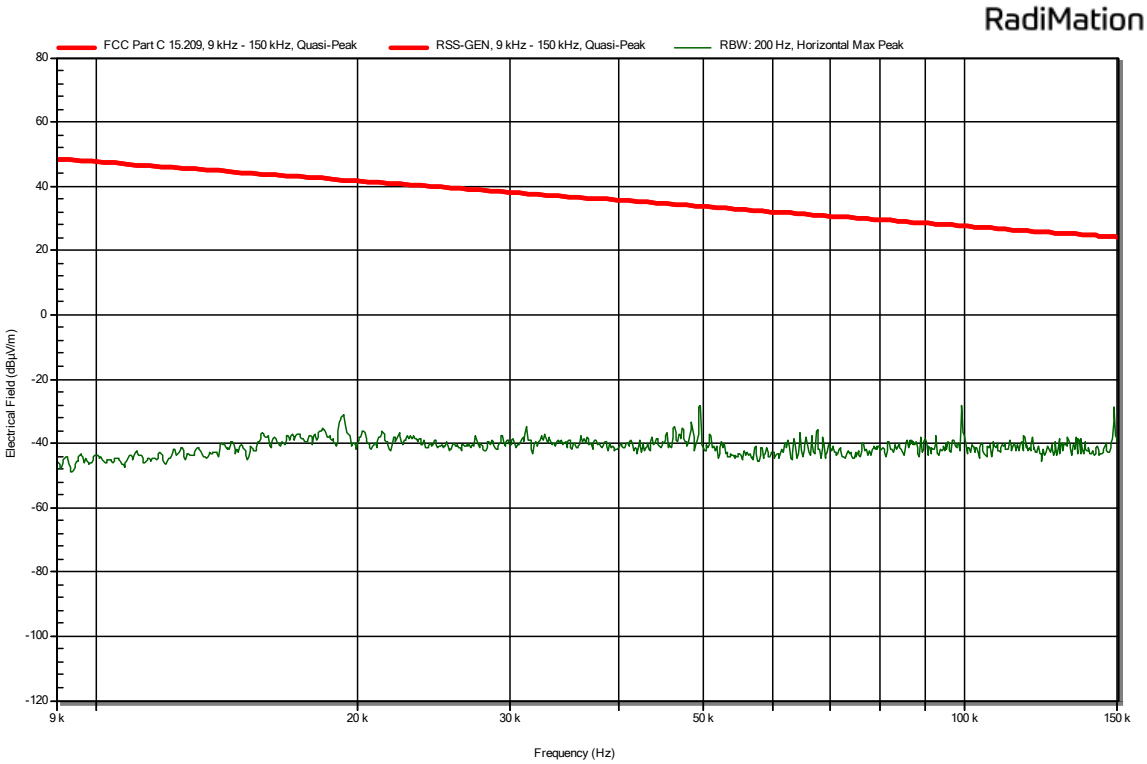
Plot 1b: radiated emissions of the EUT variant 3v1, Antenna parallel, in the range 9 – 150KHz (pre-scan peak values shown)



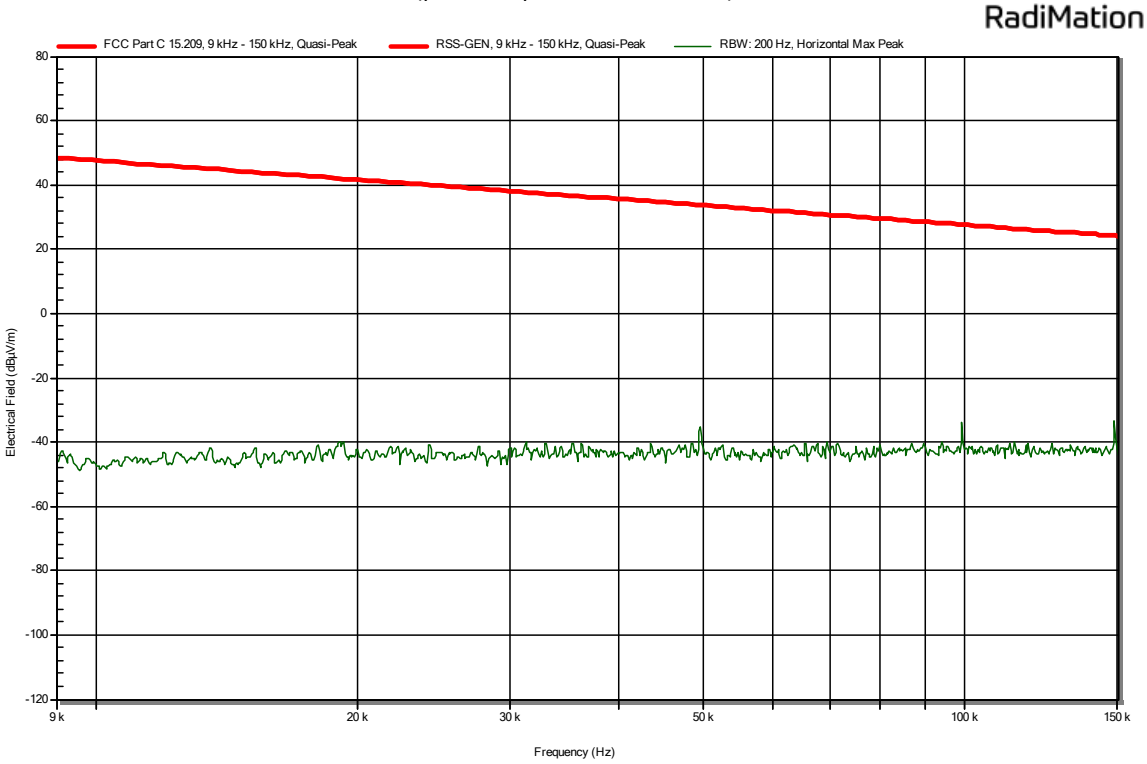
Plot 2a: radiated emissions of the EUT variant 3v1, Antenna perpendicular, in the range 150KHz-30 MHz (pre-scan peak values shown)



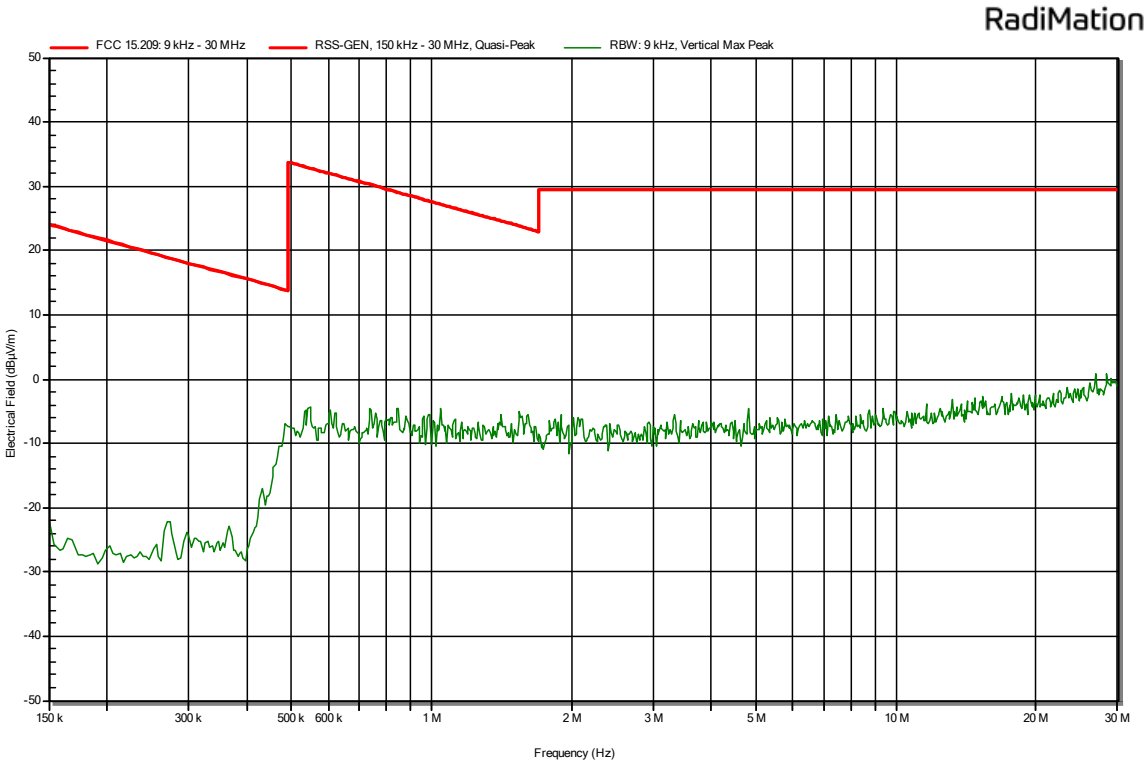
Plot 2b: radiated emissions of the EUT variant 3v1, Antenna parallel, in the range 150KHz-30 MHz (pre-scan peak values shown)



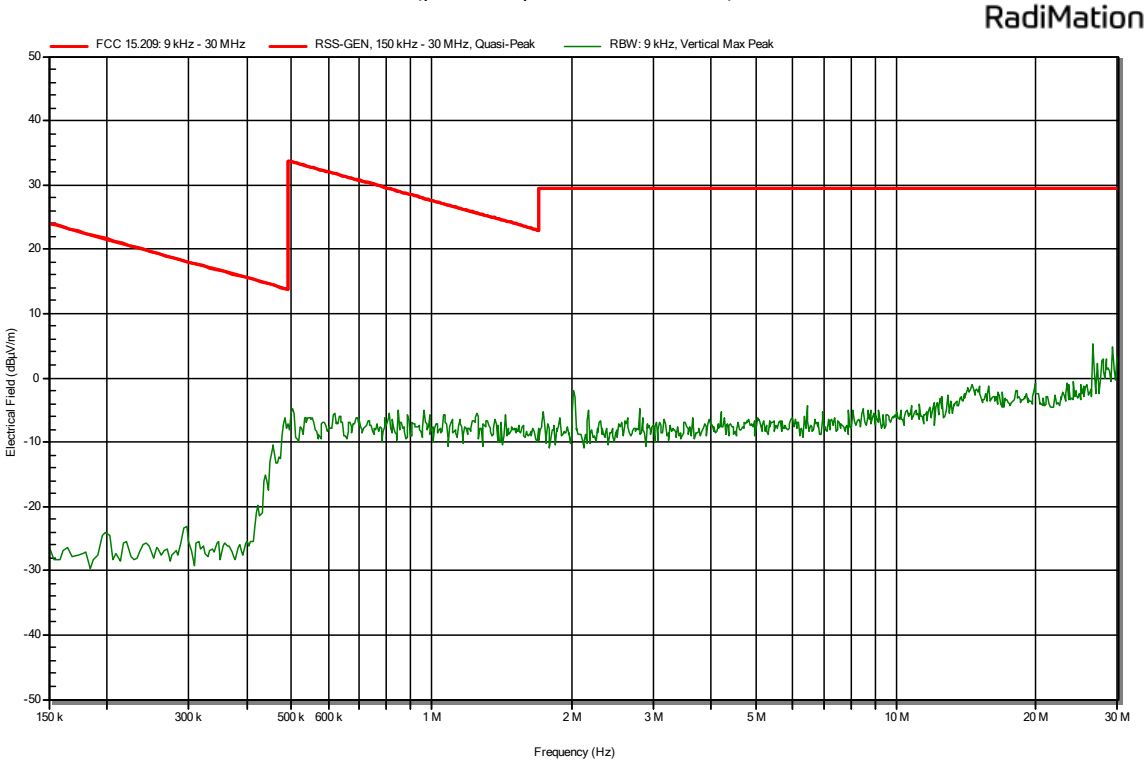
Plot 3a: radiated emissions of the EUT variant 2v8, Antenna perpendicular, in the range 9 – 150KHz (pre-scan peak values shown)



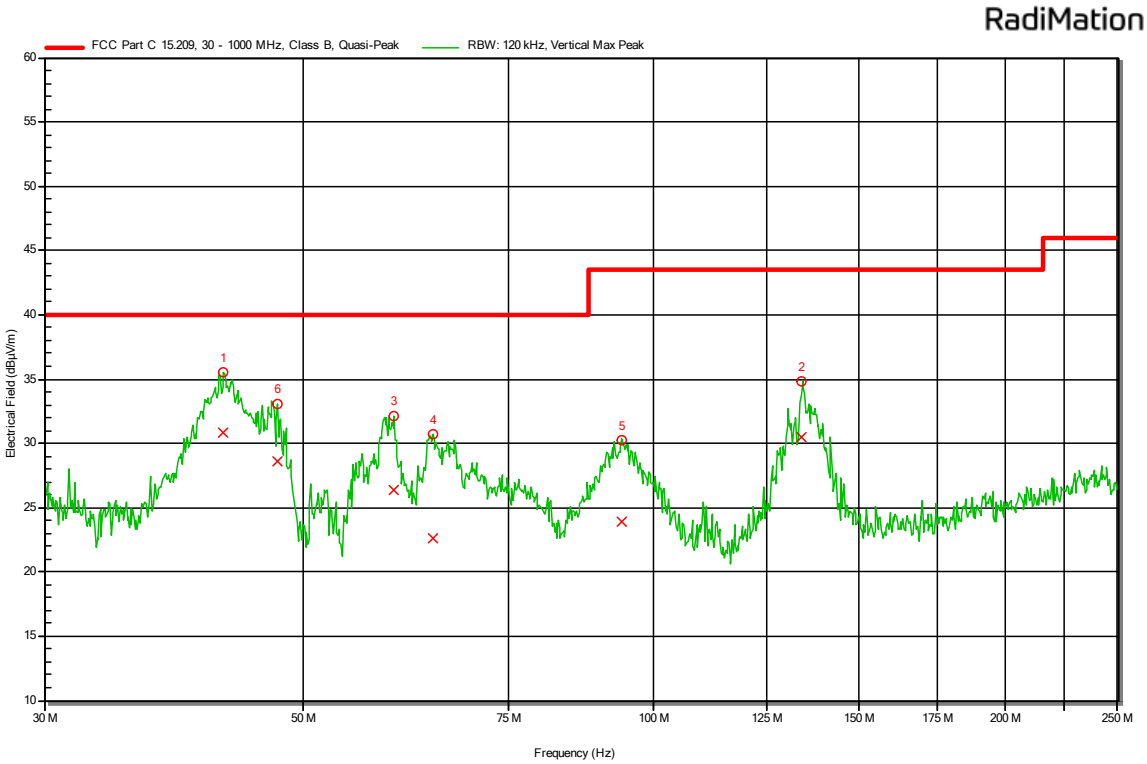
Plot 3b: radiated emissions of the EUT variant 2v8, Antenna parallel, in the range 9 – 150KHz (pre-scan peak values shown)



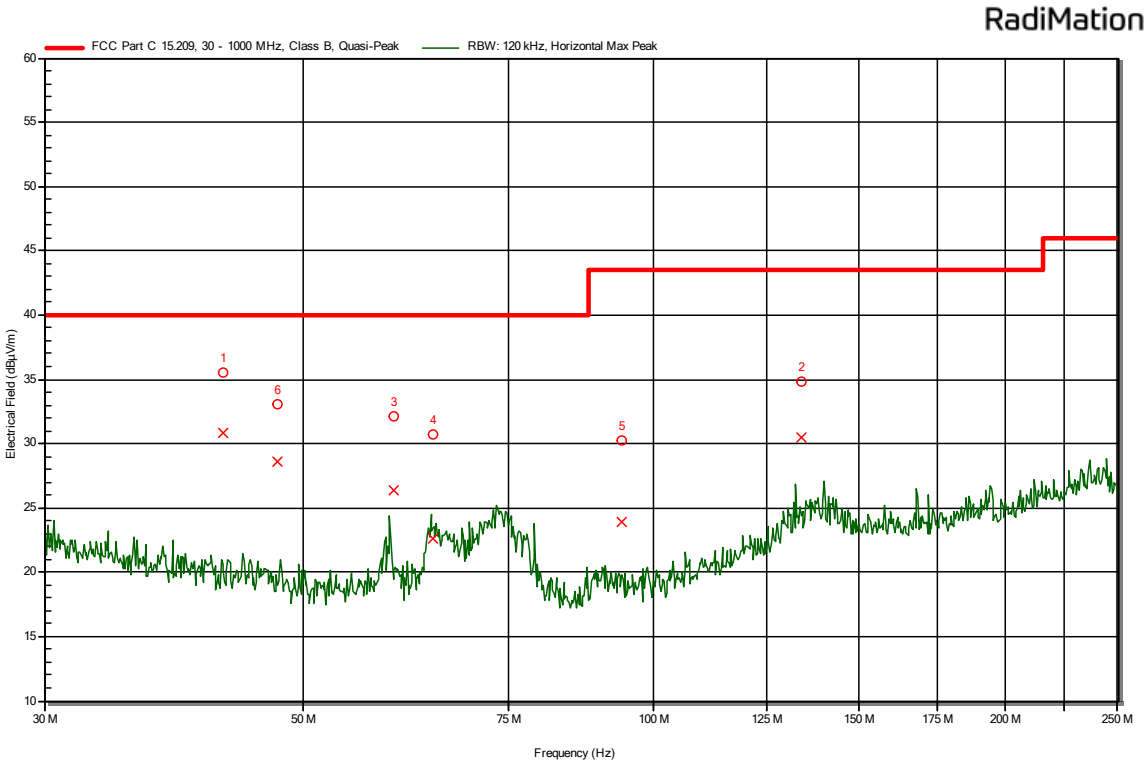
Plot 4a: radiated emissions of the EUT variant 2v8, Antenna perpendicular, in the range 150KHz-30 MHz (pre-scan peak values shown)



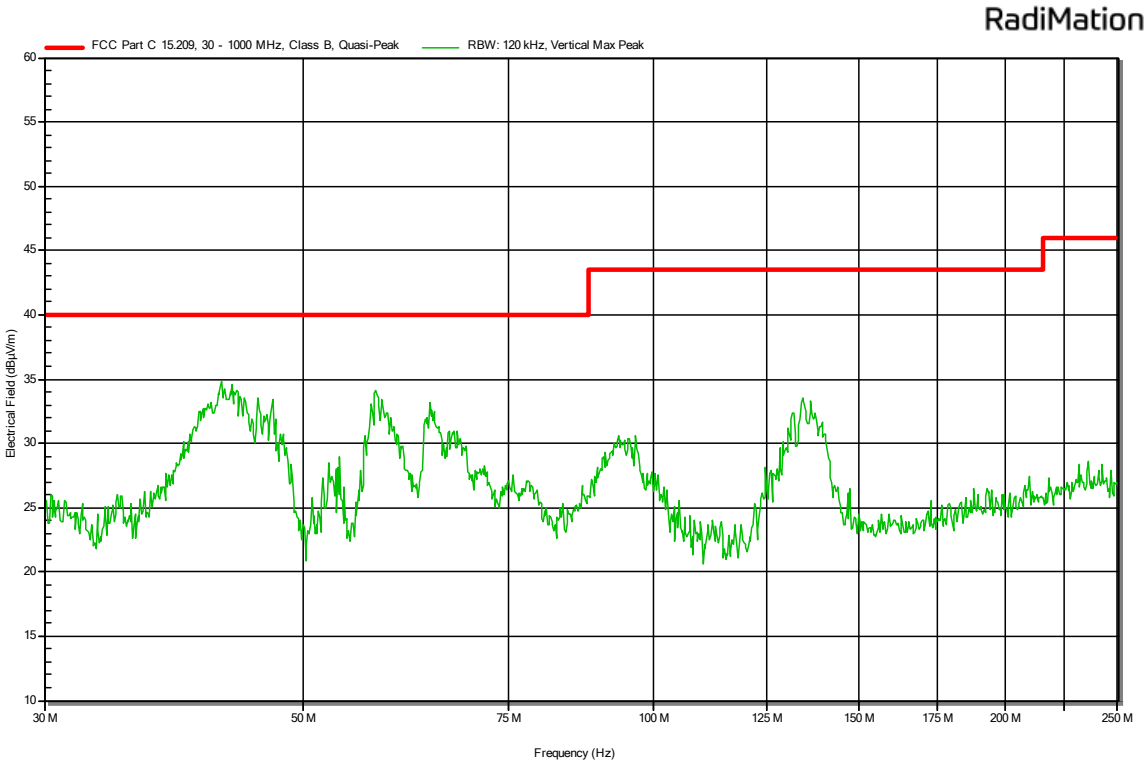
Plot 4b: radiated emissions of the EUT variant 2v8, Antenna parallel, in the range 150KHz-30 MHz (pre-scan peak values shown)



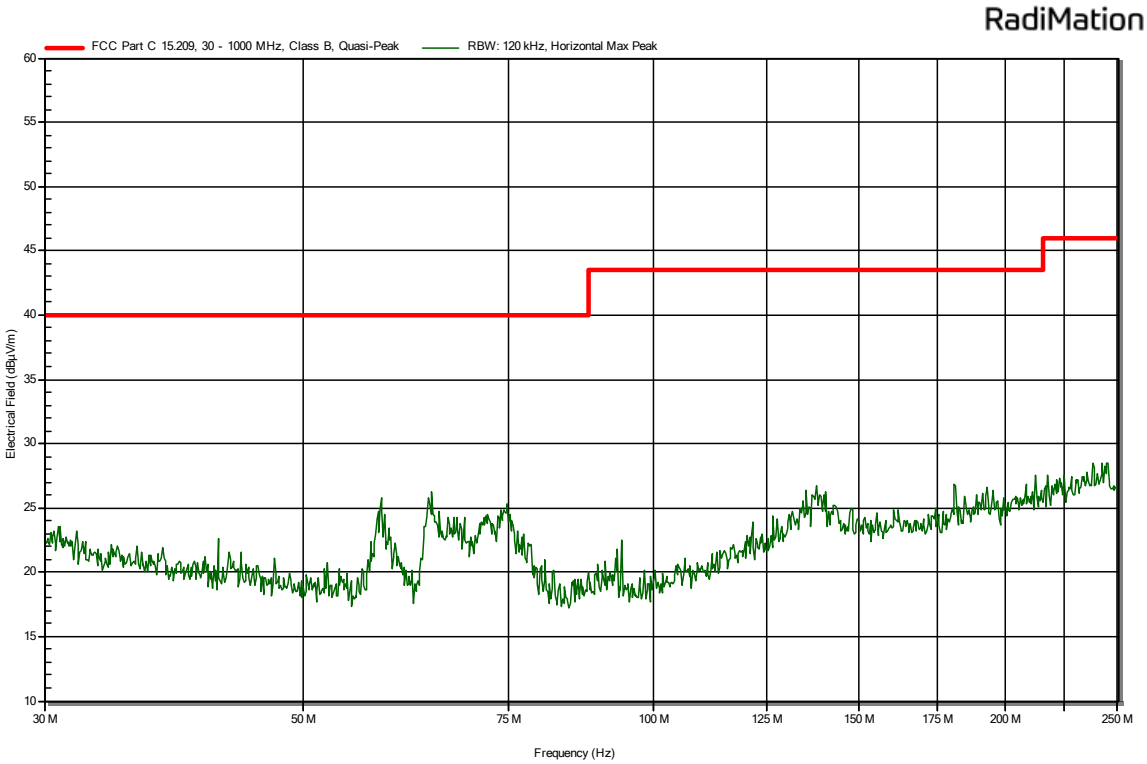
Plot 5a: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 30 – 250 MHz
(pre-scan peak values shown)
Low channel



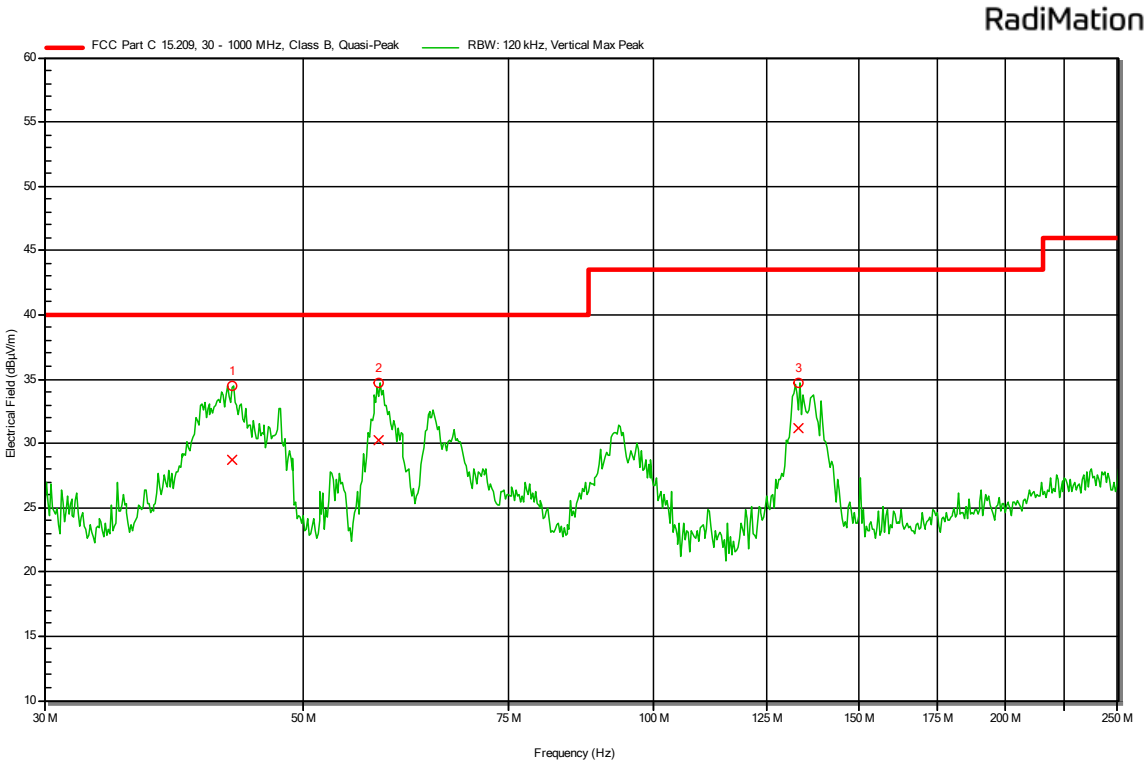
Plot 5b: radiated emissions of the EUT variant 3v1, Antenna horizontal, in the range 30 – 250 MHz
(pre-scan peak values shown)
Low channel



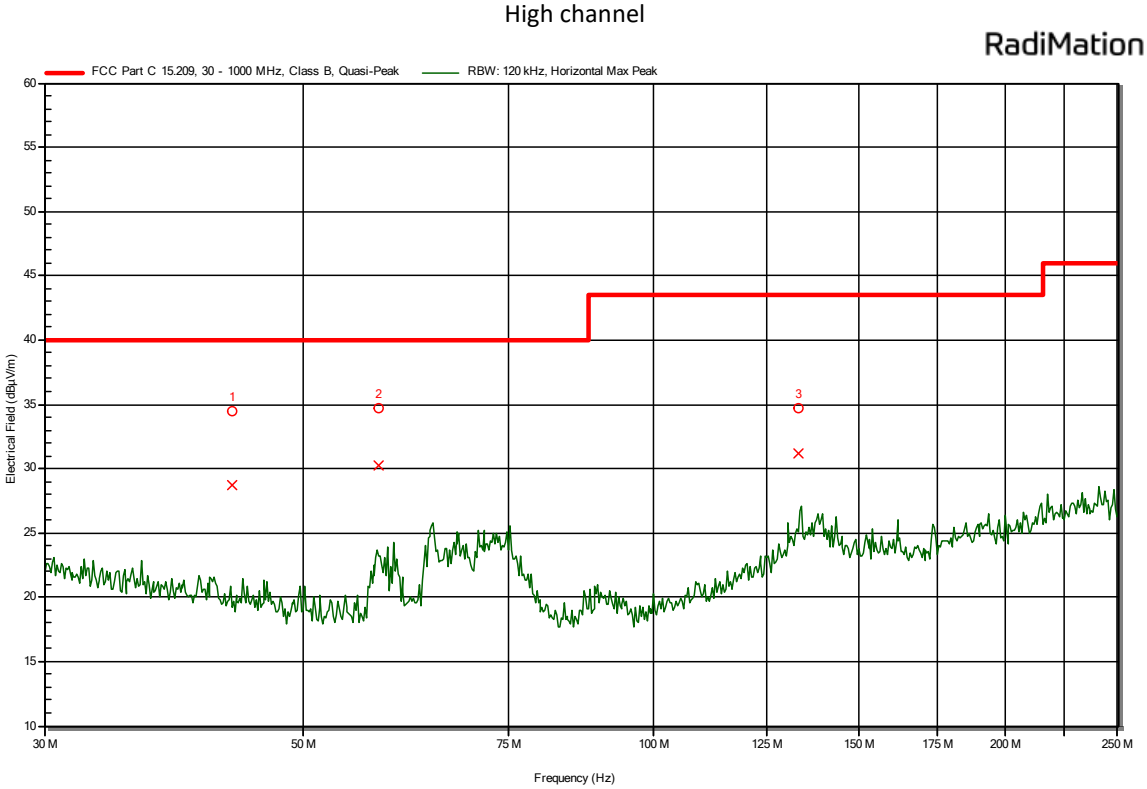
Plot 5c: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 30 – 250 MHz
(pre-scan peak values shown)
Middle channel



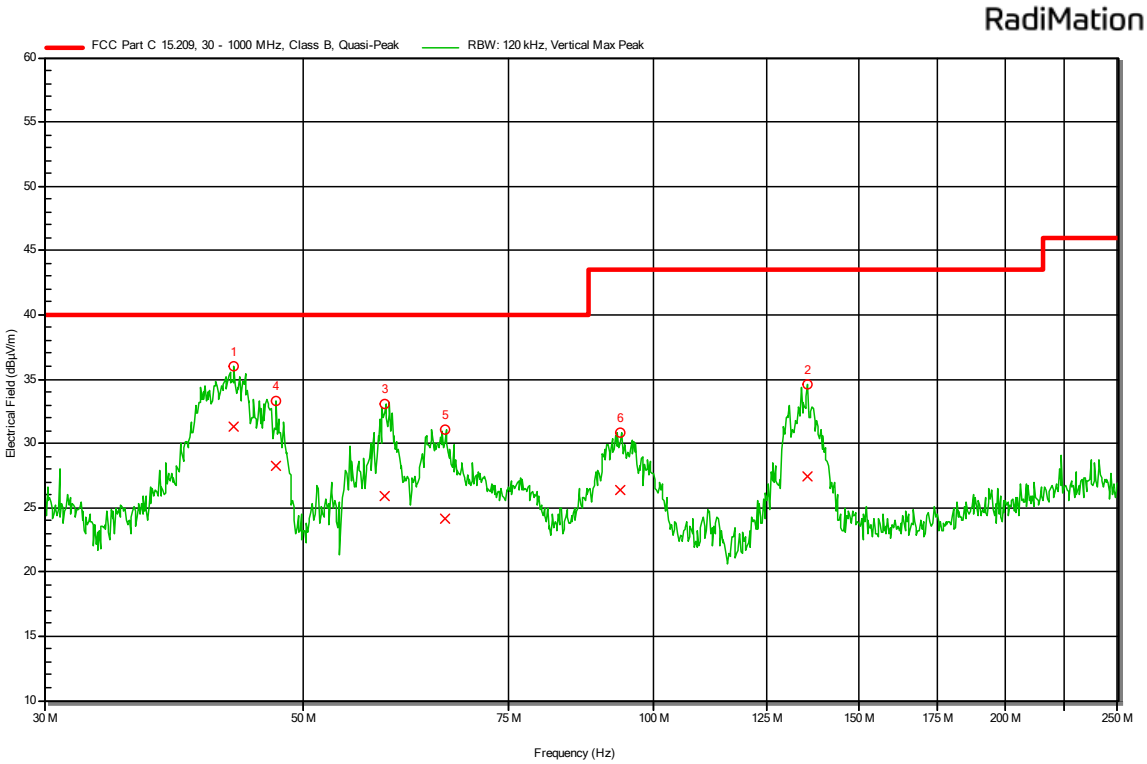
Plot 5d: radiated emissions of the EUT variant 3v1, Antenna horizontal, in the range 30 – 250 MHz
(pre-scan peak values shown)
Middle channel



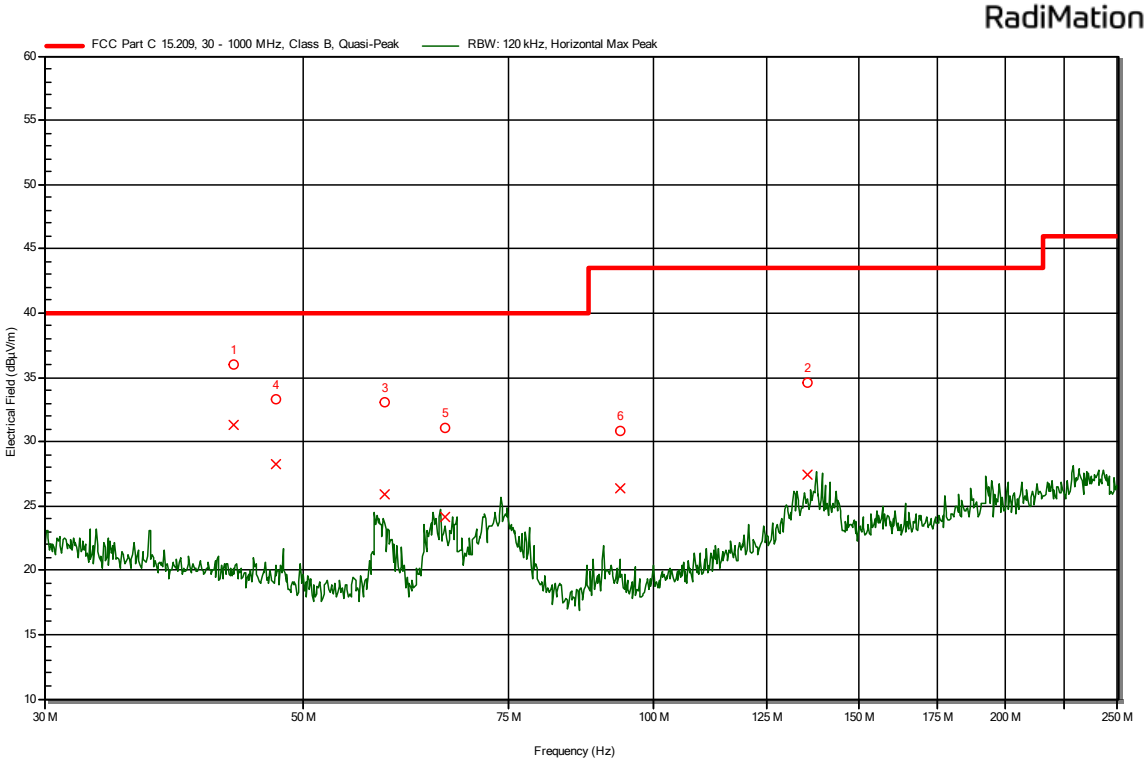
Plot 5e: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 30 – 250 MHz
(pre-scan peak values shown)
High channel



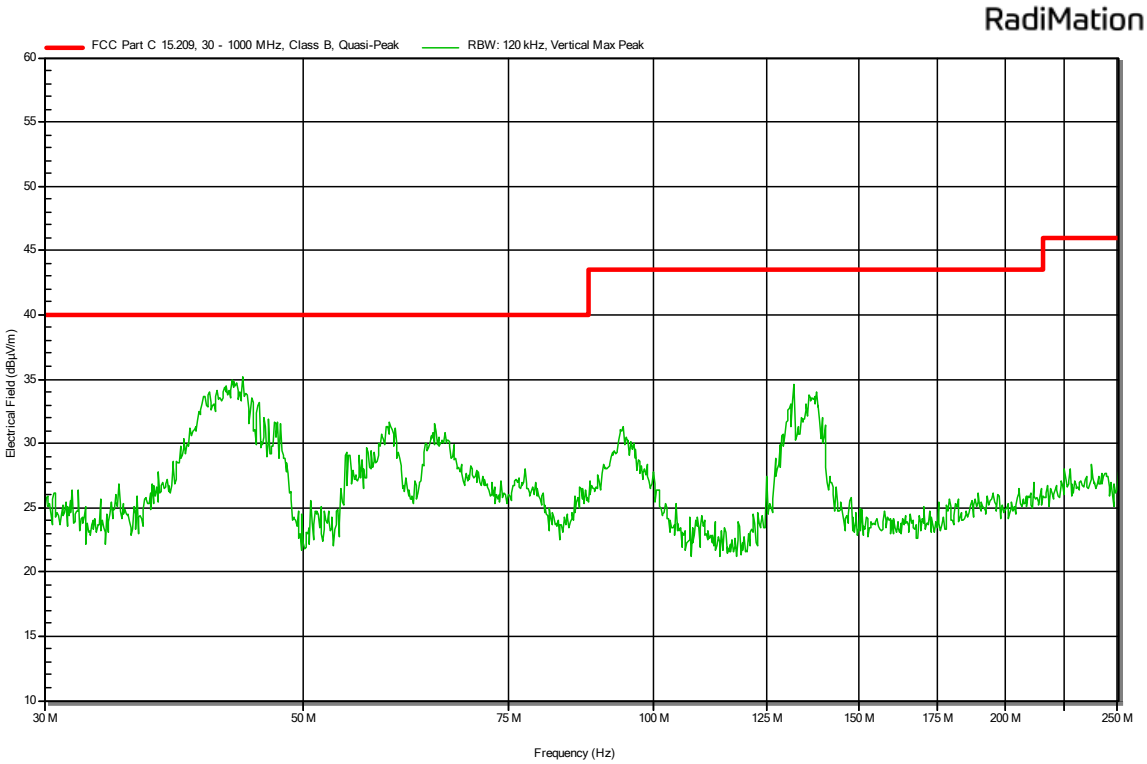
Plot 5f: radiated emissions of the EUT variant 3v1, Antenna horizontal, in the range 30 – 250 MHz
(pre-scan peak values shown)
High channel



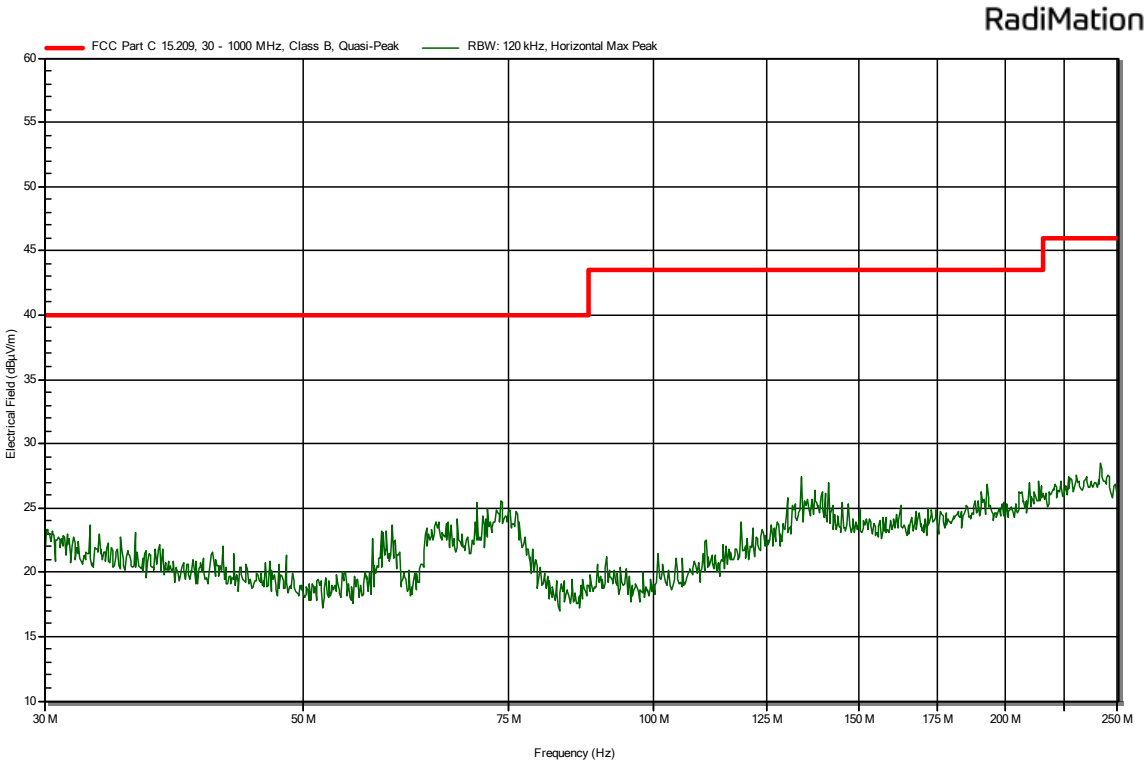
Plot 6a: radiated emissions of the EUT variant 2v8, Antenna vertical, in the range 30 – 250 MHz
(pre-scan peak values shown)
Low channel



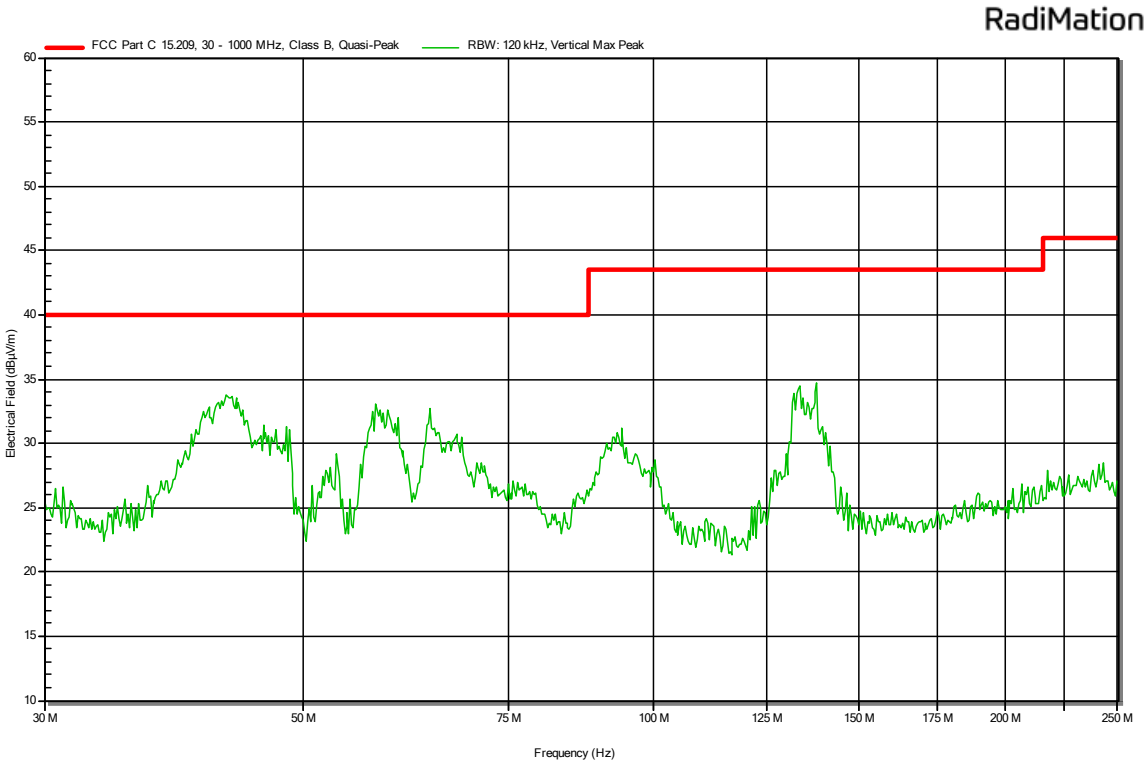
Plot 6b: radiated emissions of the EUT variant 2v8, Antenna horizontal, in the range 30 – 250 MHz
(pre-scan peak values shown)
Low channel



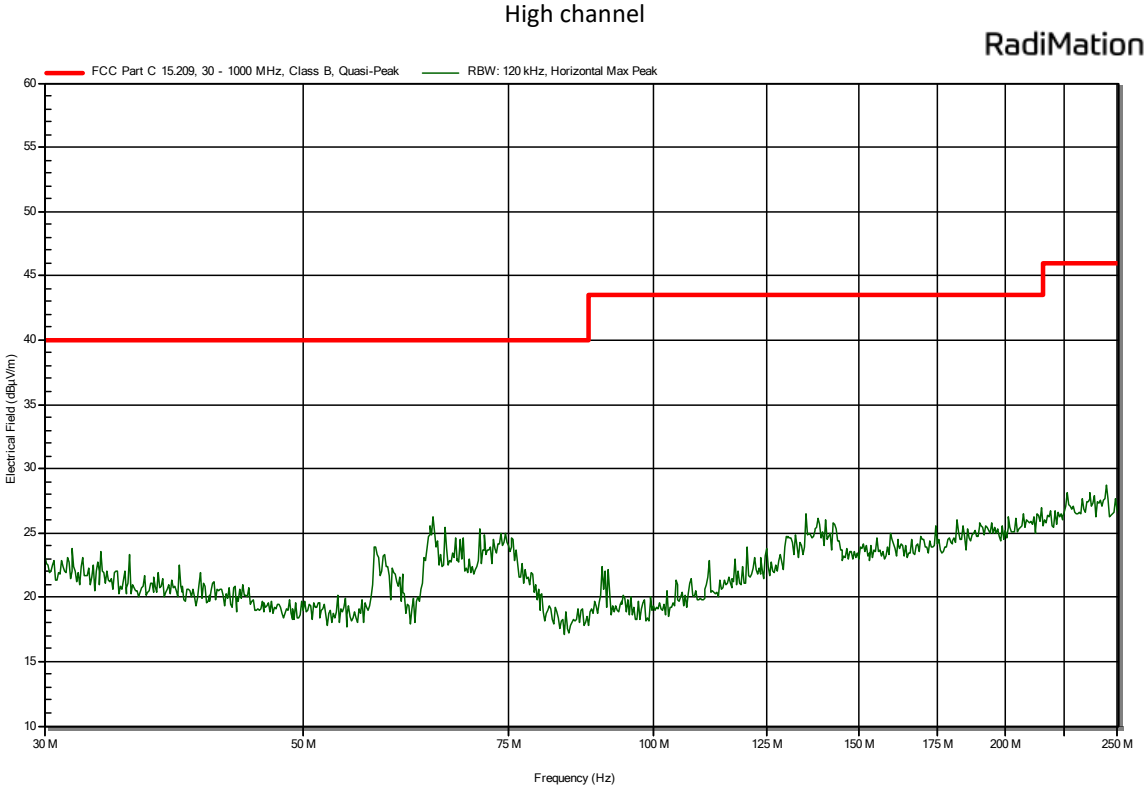
Plot 6c: radiated emissions of the EUT variant 2v8, Antenna vertical, in the range 30 – 250 MHz
(pre-scan peak values shown)
Middle channel



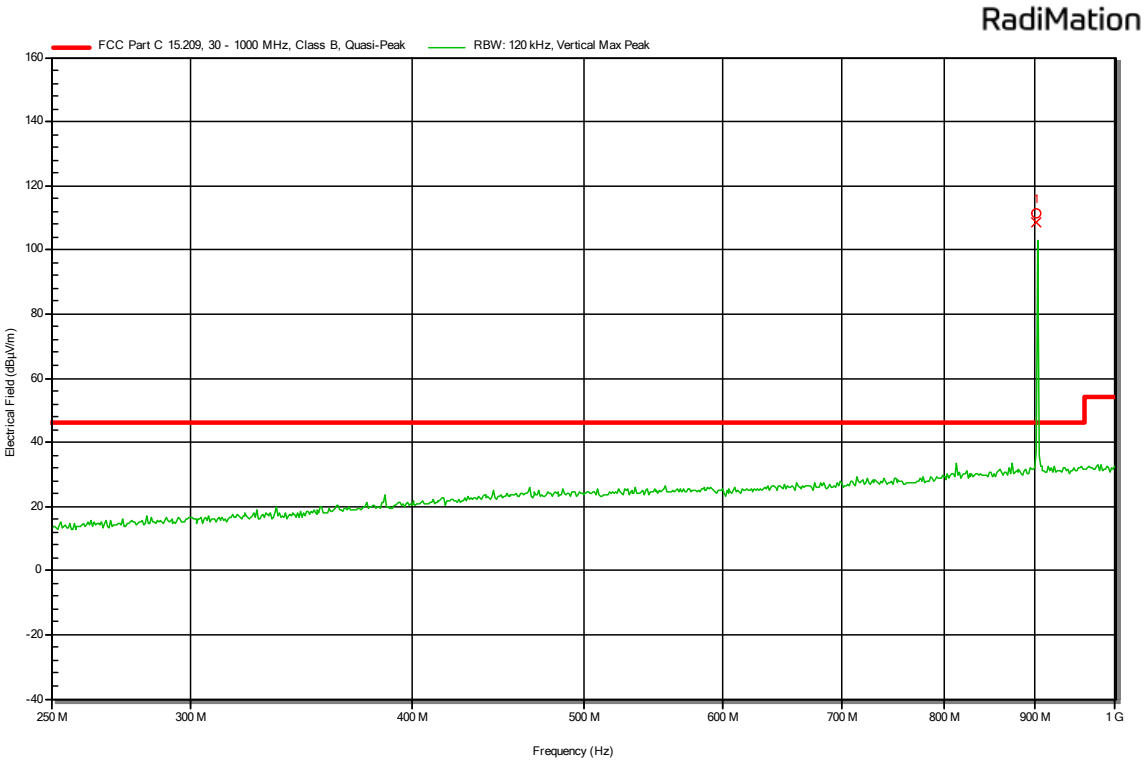
Plot 6d: radiated emissions of the EUT variant 2v8, Antenna horizontal, in the range 30 – 250 MHz
(pre-scan peak values shown)
Middle channel



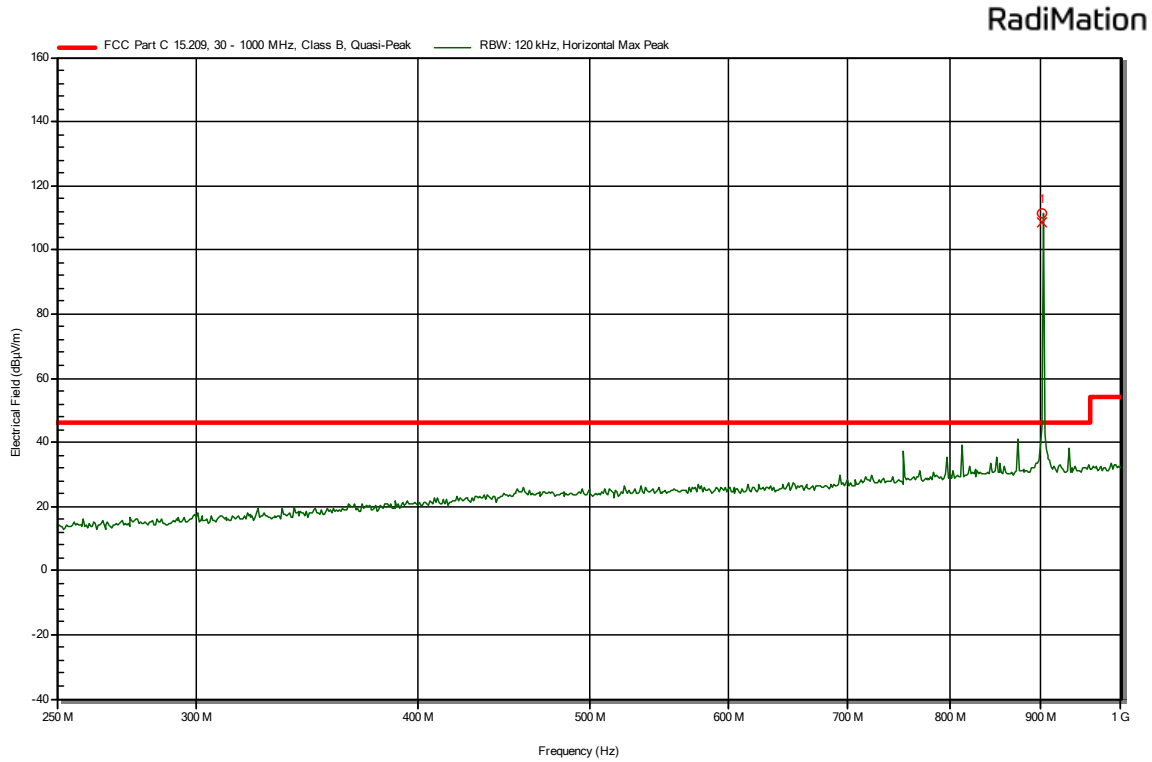
Plot 6e: radiated emissions of the EUT variant 2v8, Antenna vertical, in the range 30 – 250 MHz
(pre-scan peak values shown)
High channel



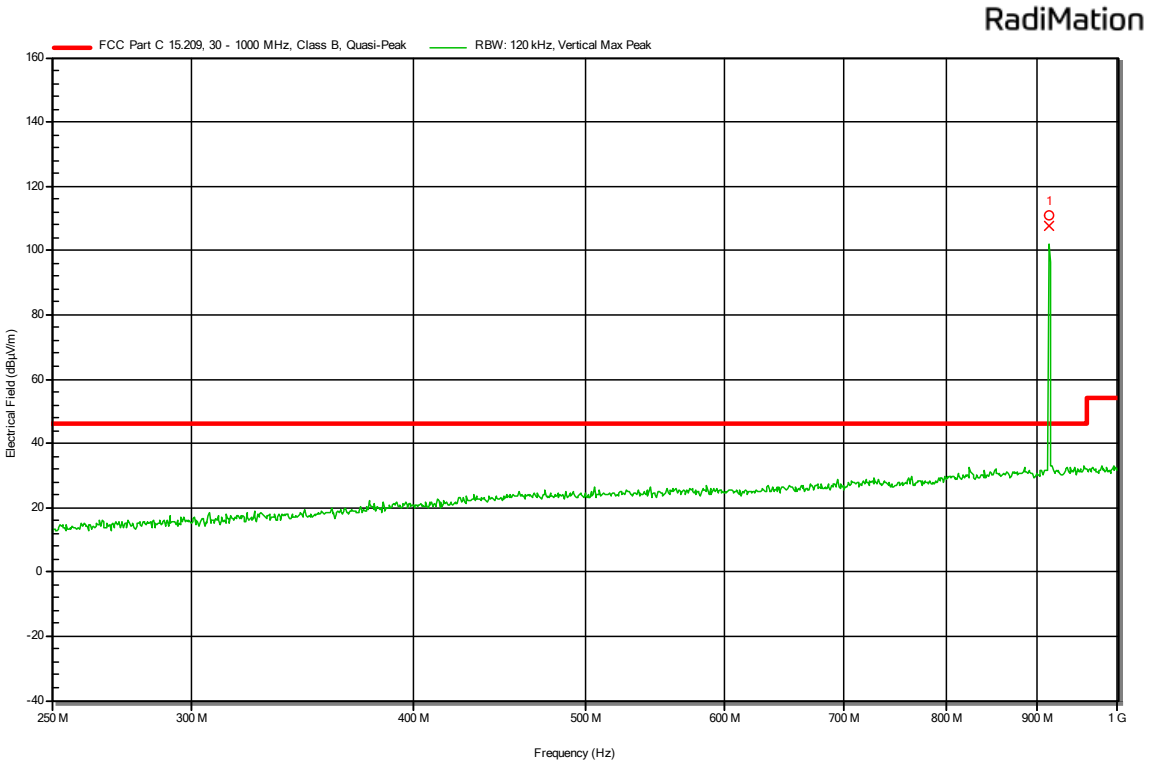
Plot 6f: radiated emissions of the EUT variant 2v8, Antenna horizontal, in the range 30 – 250 MHz
(pre-scan peak values shown)
High channel



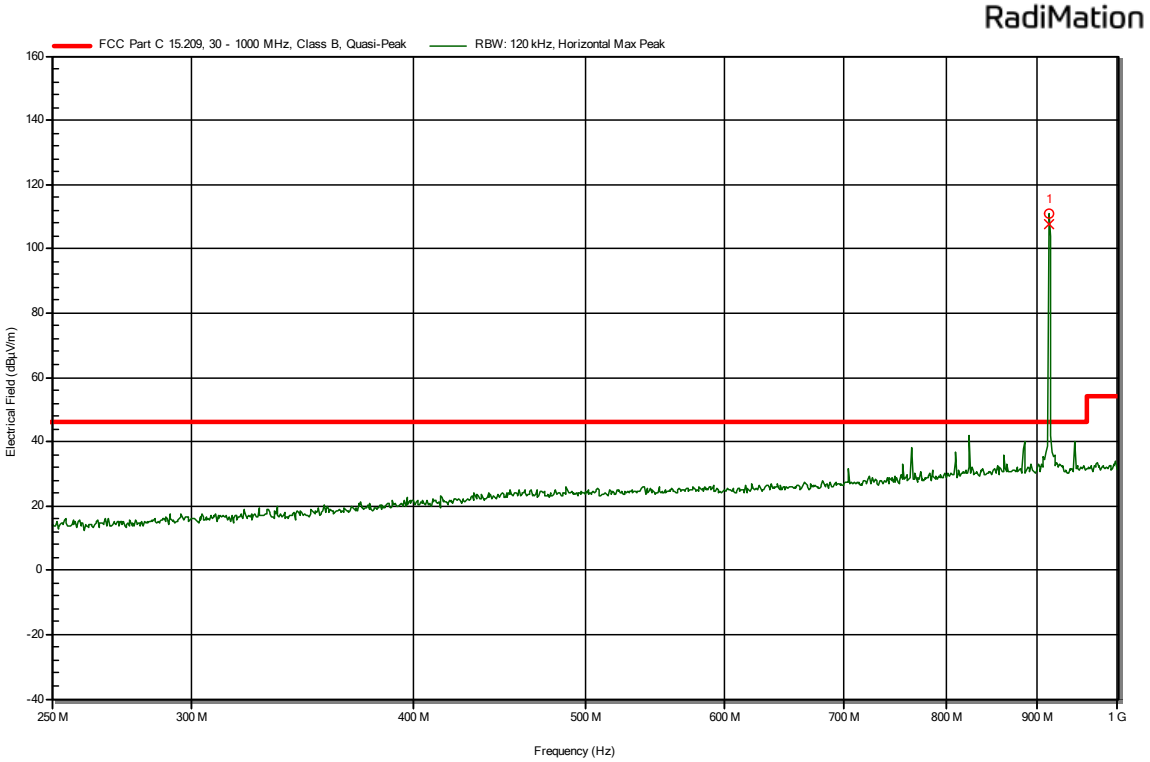
Plot 7a: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 250-1000 MHz (pre-scan peak values shown)
Low channel



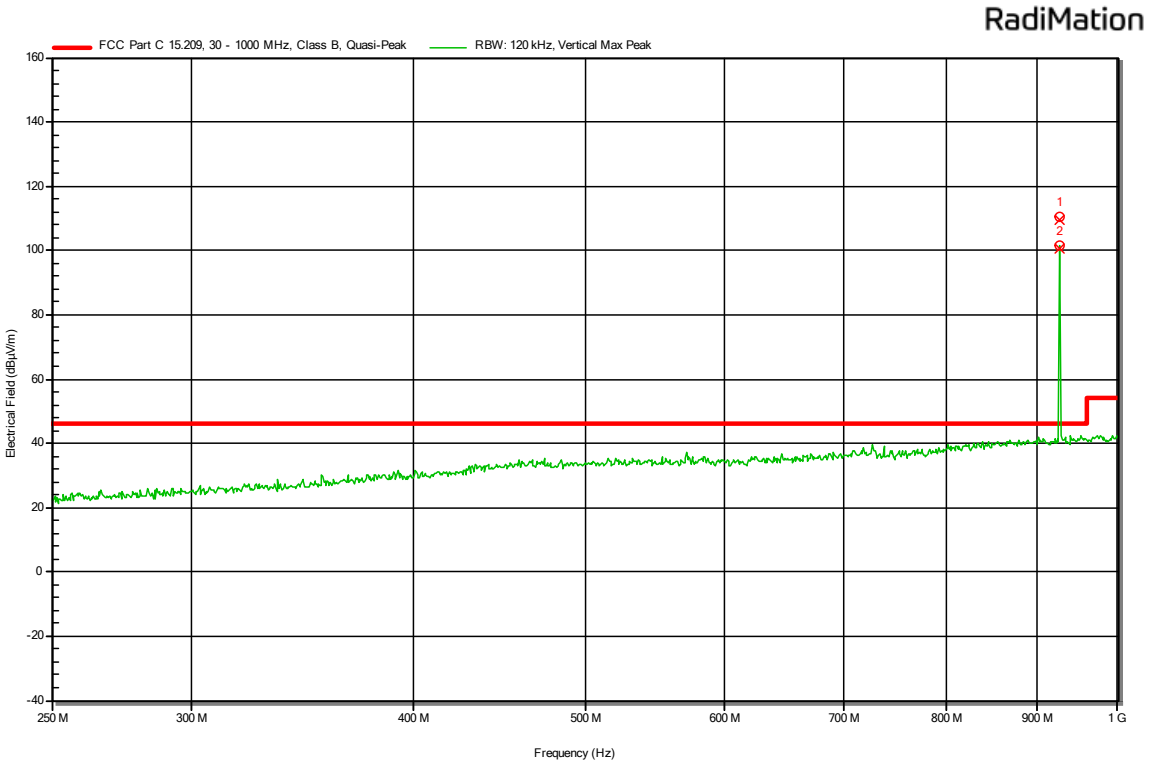
Plot 7b: radiated emissions of the EUT variant 3v1, Antenna horizontal, in the range 250-1000 MHz (pre-scan peak values shown)
Low channel



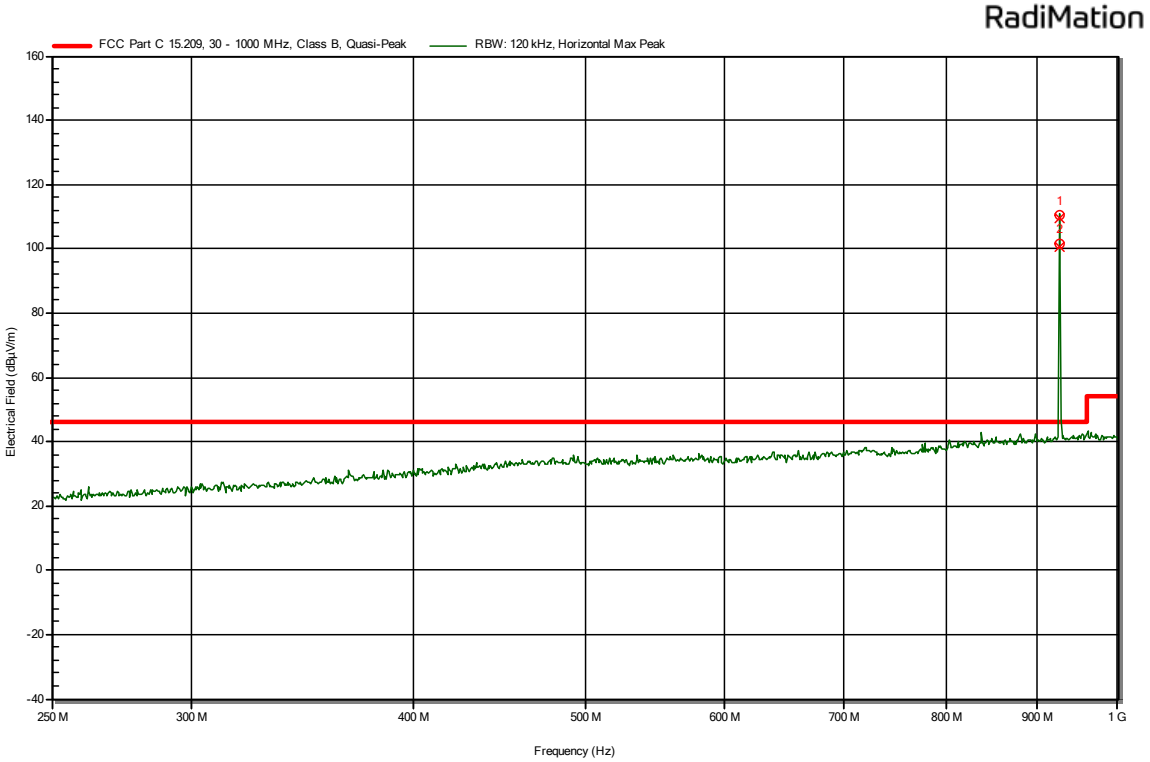
Plot 7c: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 250-1000 MHz
(pre-scan peak values shown)
Middle channel



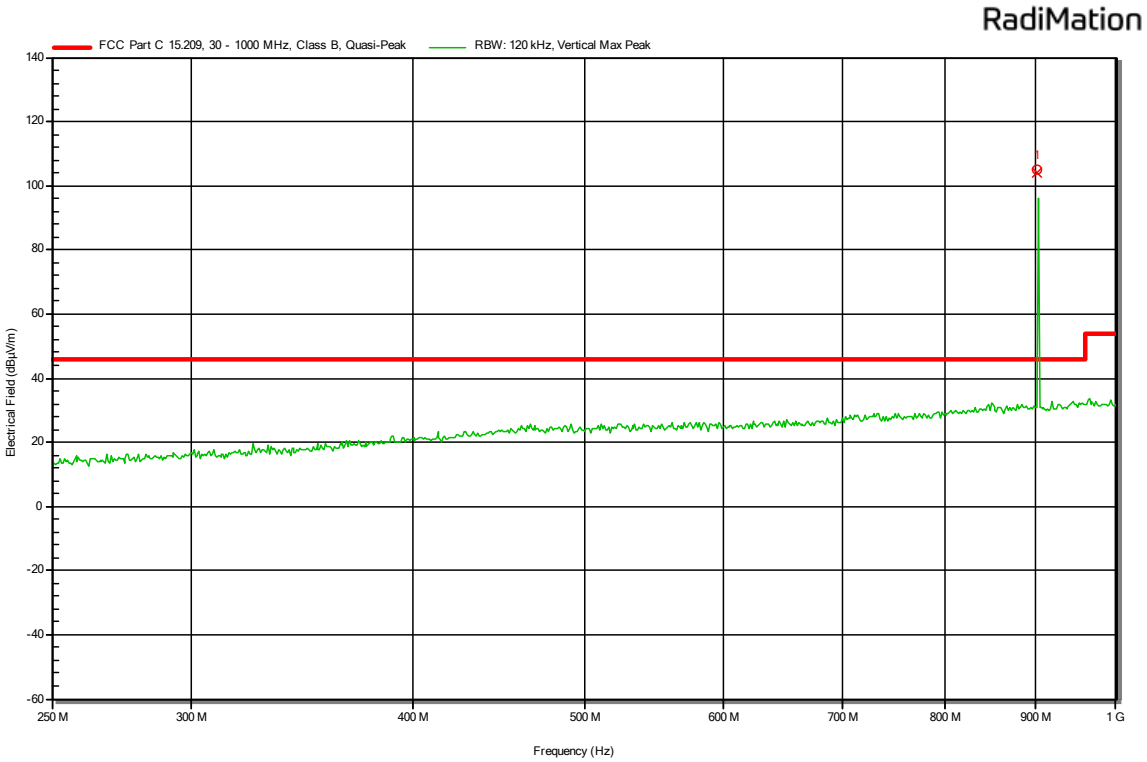
Plot 7d: radiated emissions of the EUT variant 3v1, Antenna horizontal, in the range 250-1000 MHz
(pre-scan peak values shown)
Middle channel



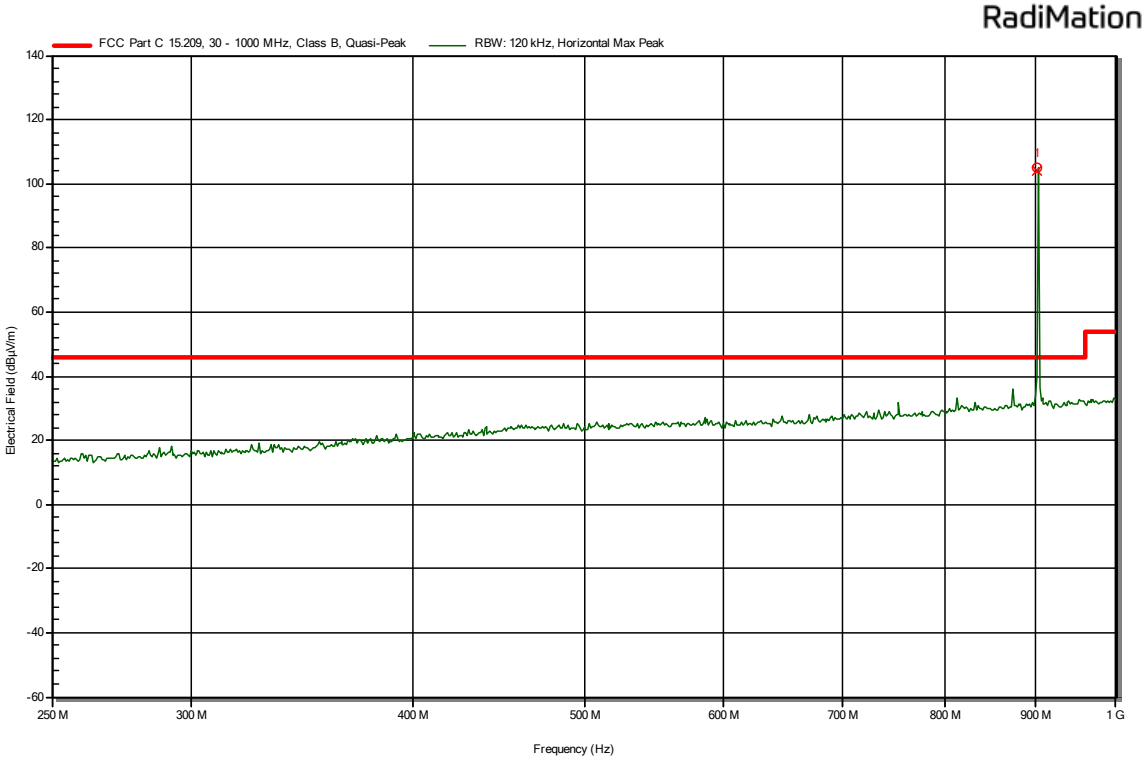
Plot 7e: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 250-1000 MHz
(pre-scan peak values shown)
High channel



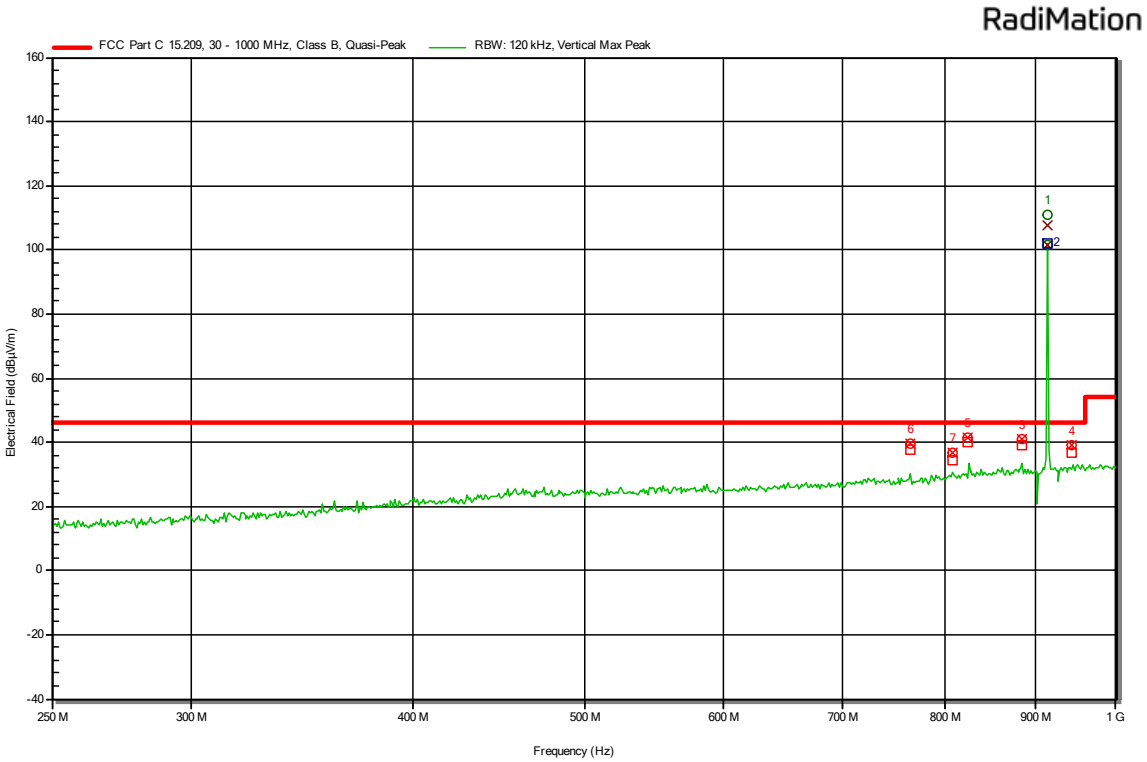
Plot 7f: radiated emissions of the EUT variant 3v1, Antenna horizontal, in the range 250-1000 MHz
(pre-scan peak values shown)
High channel



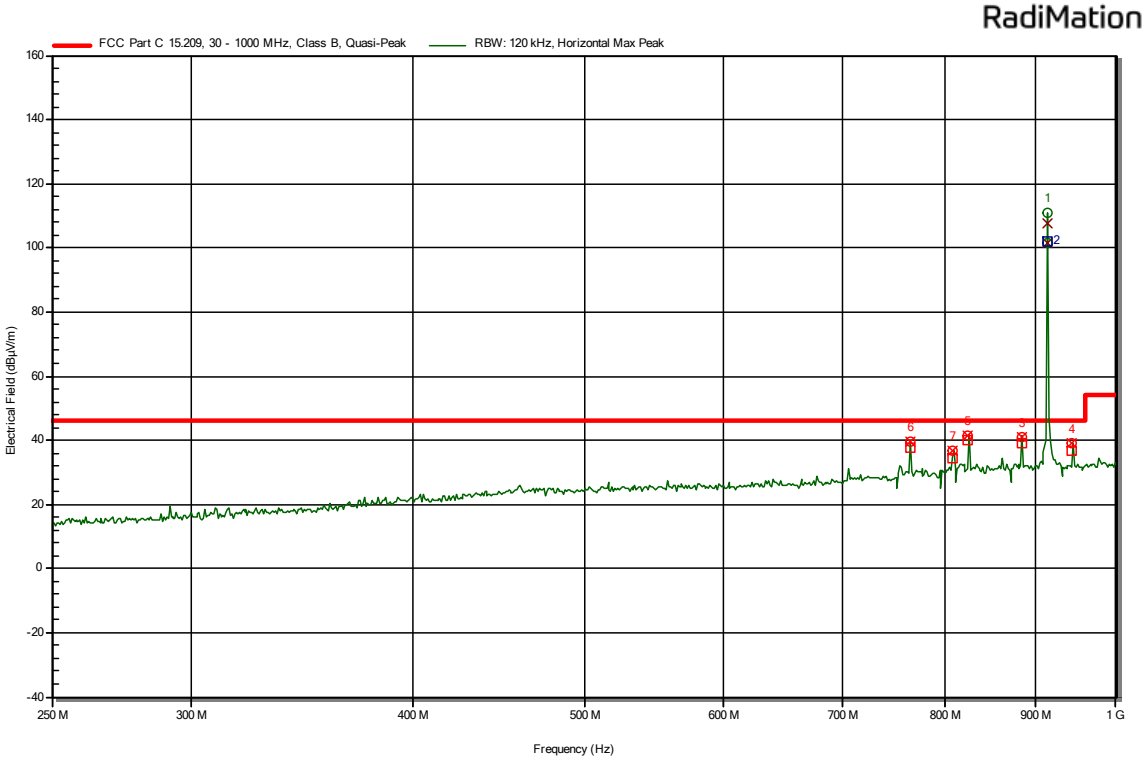
Plot 8a: radiated emissions of the EUT variant 2v8, Antenna vertical, in the range 250-1000 MHz
(pre-scan peak values shown)
Low channel



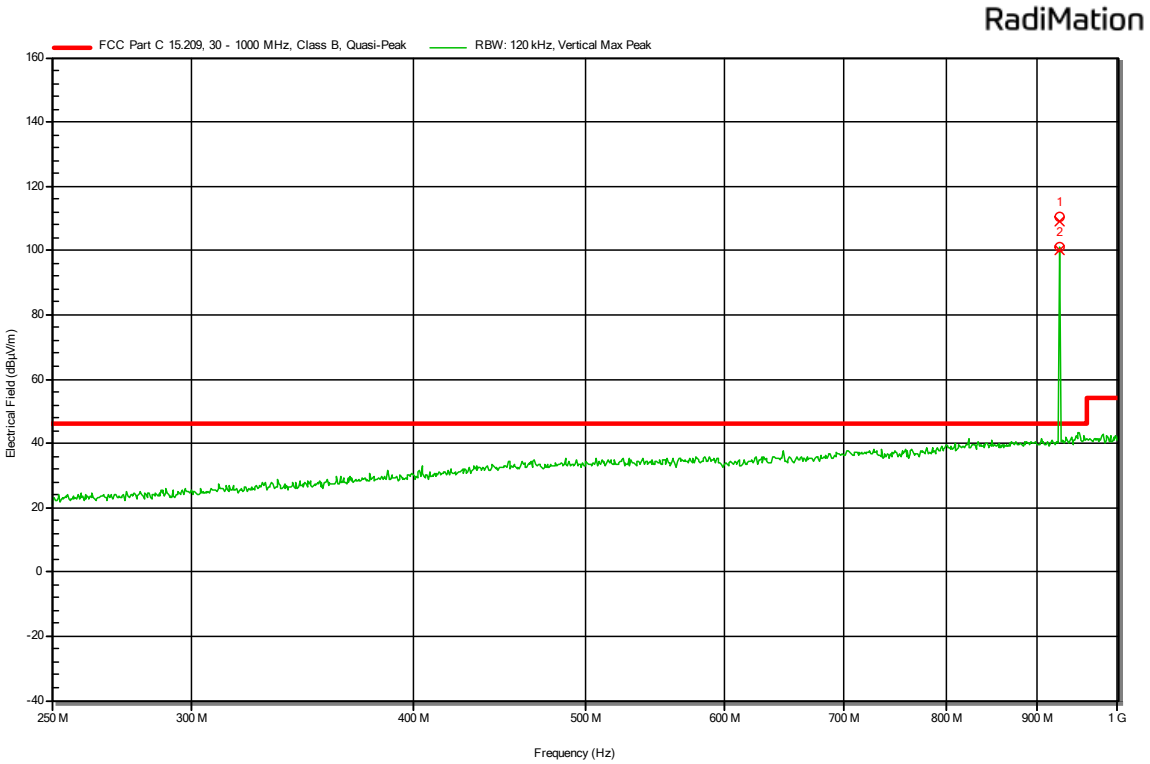
Plot 8b: radiated emissions of the EUT variant 2v8, Antenna horizontal, in the range 250-1000 MHz
(pre-scan peak values shown)
Low channel



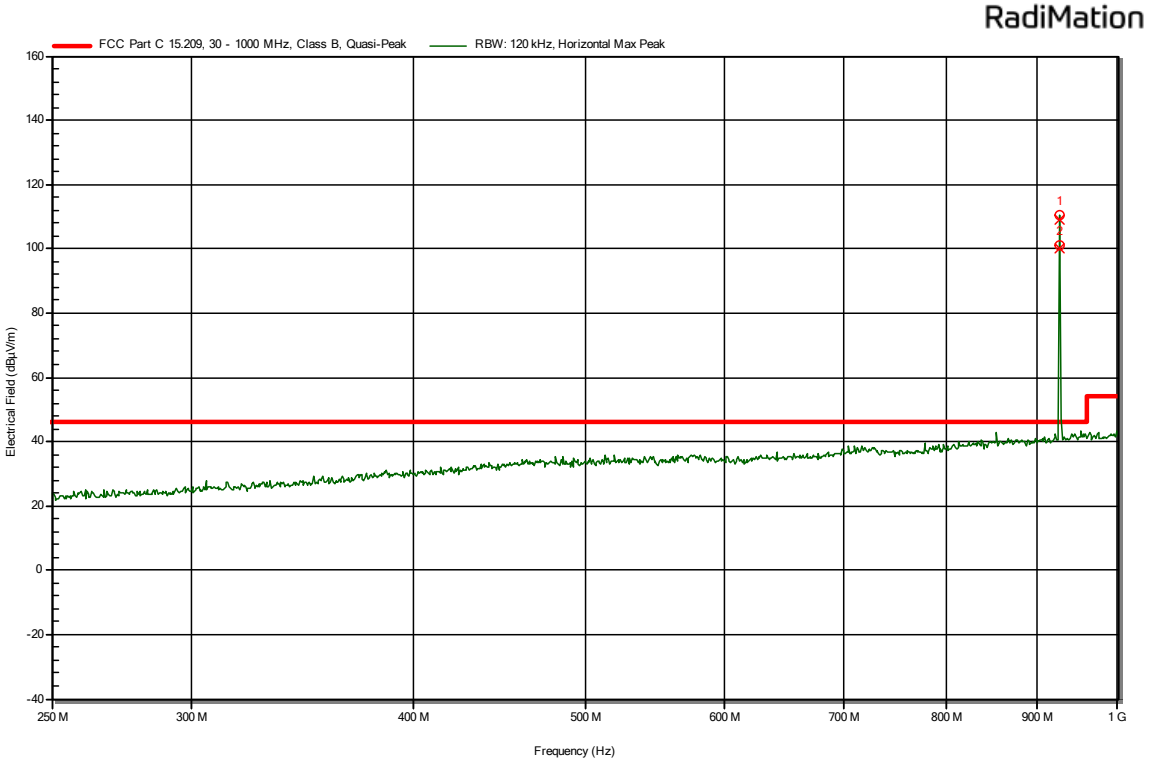
Plot 8c: radiated emissions of the EUT variant 2v8, Antenna vertical, in the range 250-1000 MHz
(pre-scan peak values shown)
Middle channel



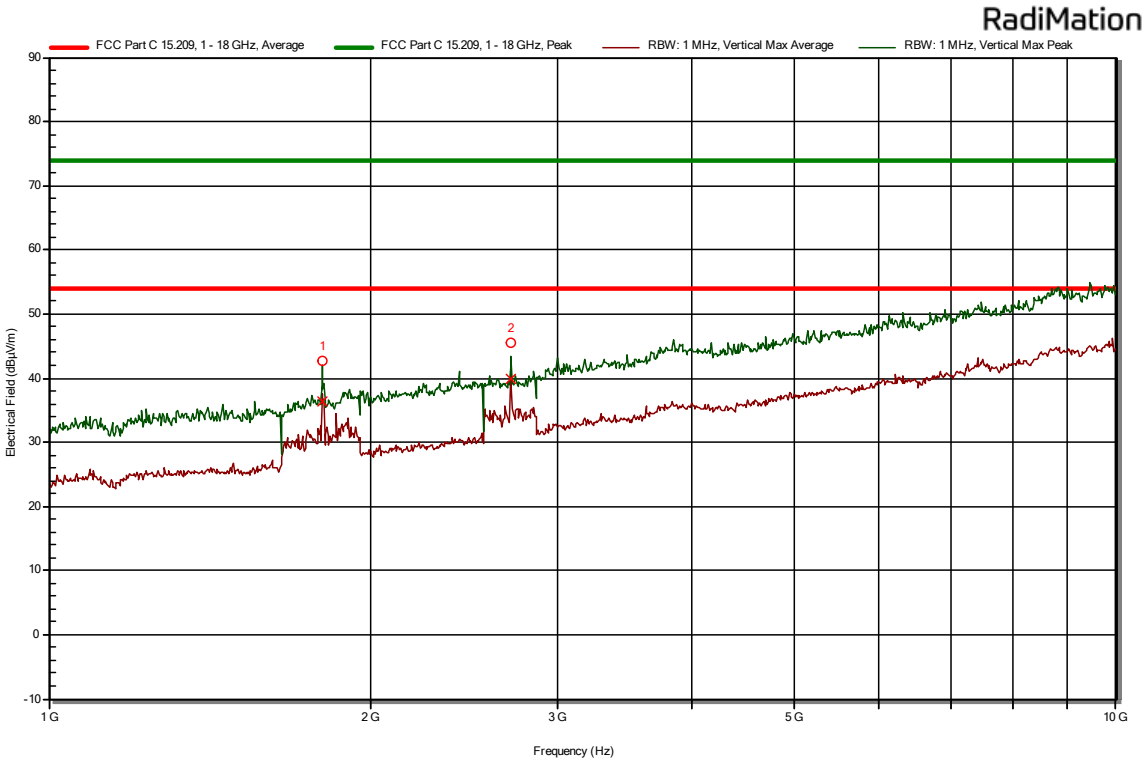
Plot 8d: radiated emissions of the EUT variant 2v8, Antenna horizontal, in the range 250-1000 MHz
(pre-scan peak values shown)
Middle channel



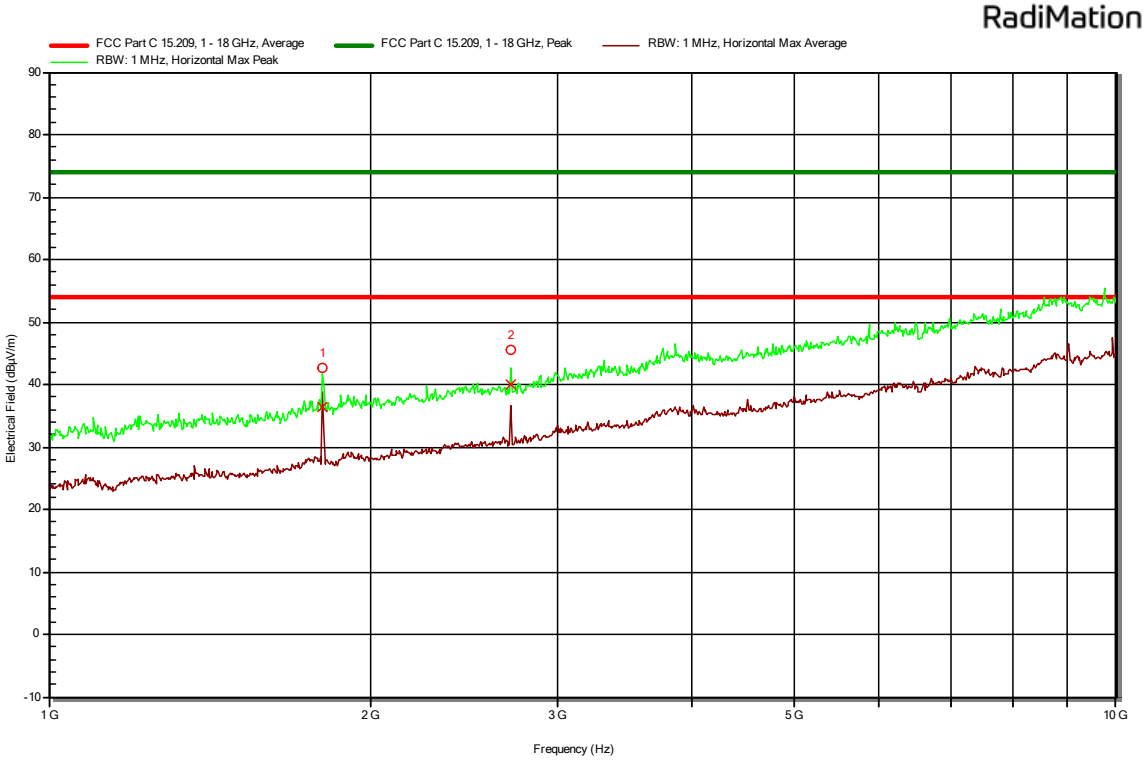
Plot 8e: radiated emissions of the EUT variant 2v8, Antenna vertical, in the range 250-1000 MHz
(pre-scan peak values shown)
High channel



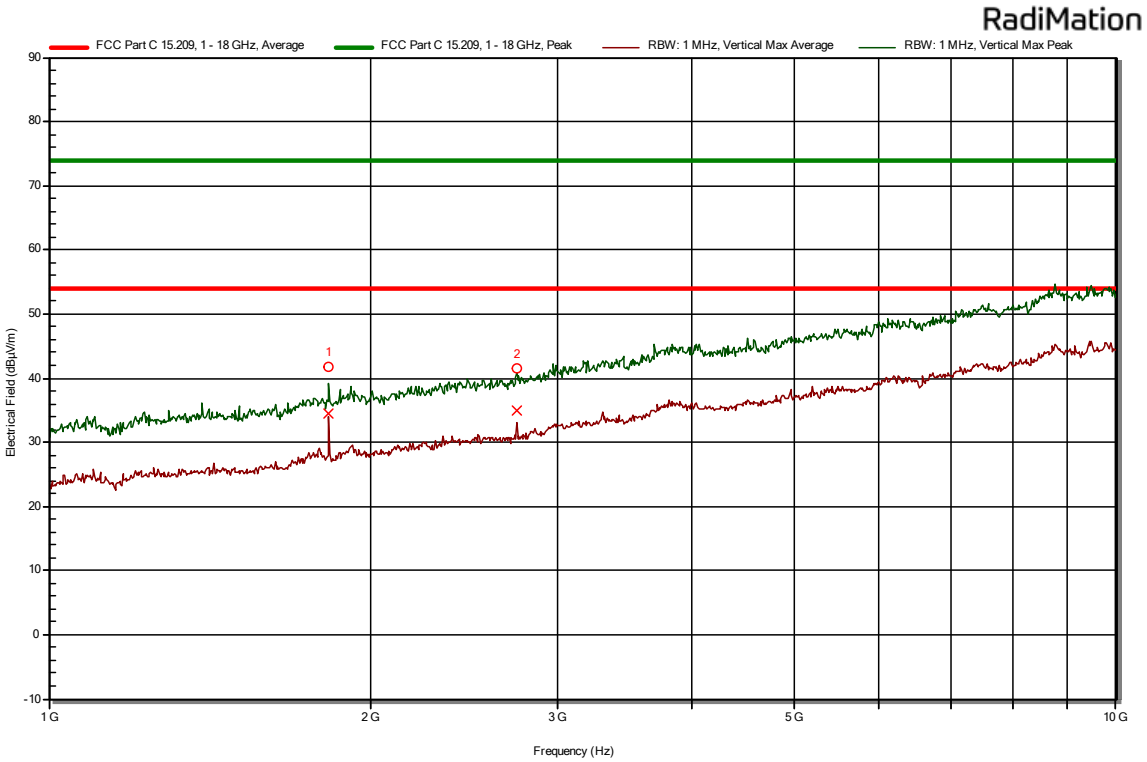
Plot 8f: radiated emissions of the EUT variant 2v8, Antenna horizontal, in the range 250-1000 MHz
(pre-scan peak values shown)
High channel



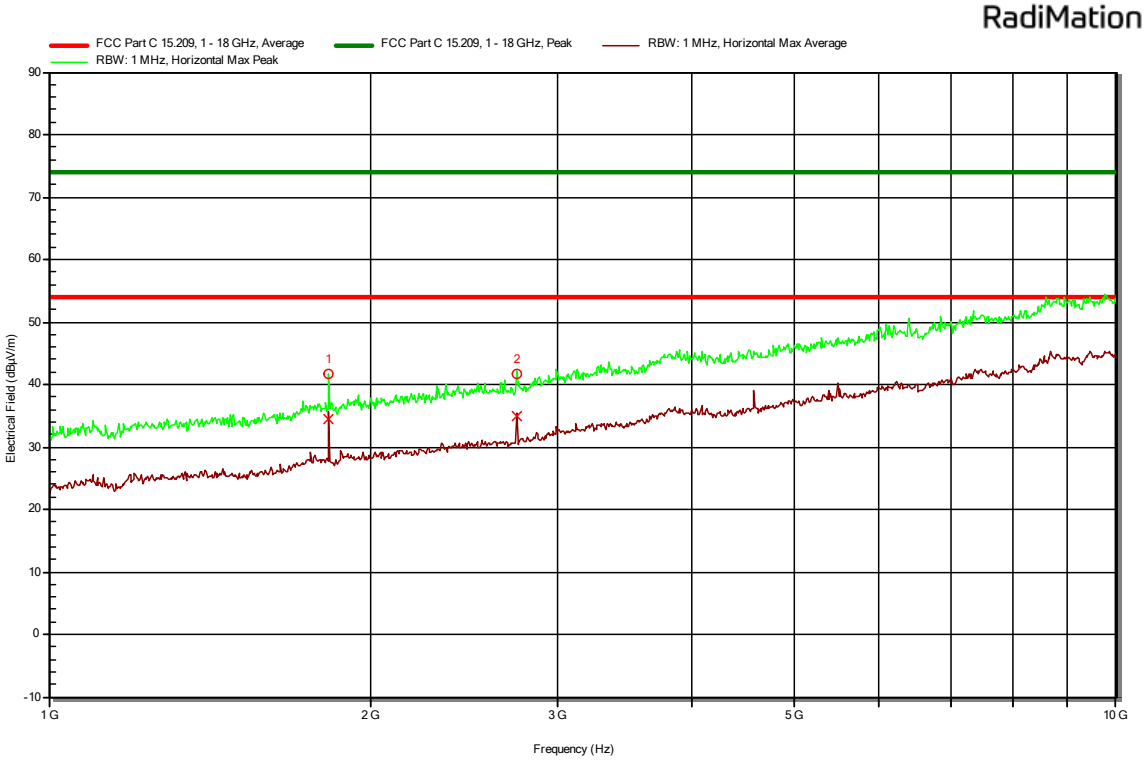
Plot 9a: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 1 – 10 GHz
(peak and average values shown)
Low channel



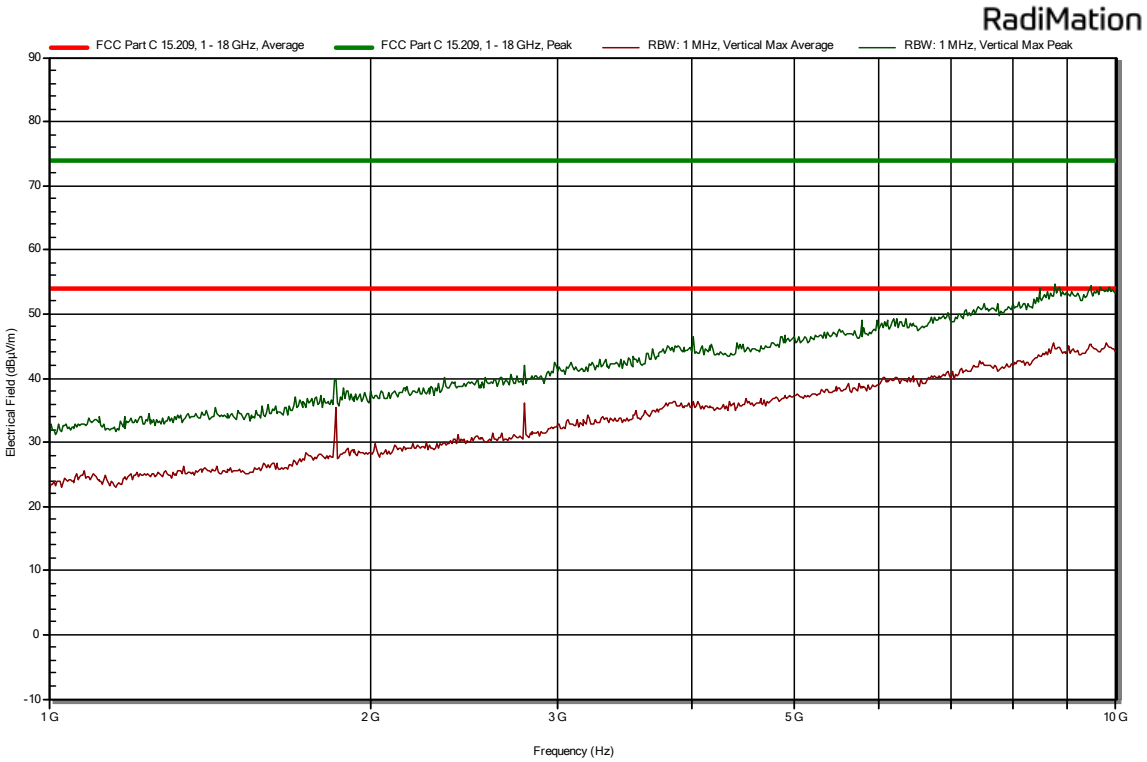
Plot 9b: radiated emissions of the EUT variant 3v1, Antenna horizontal, in the range 1 – 10 GHz
(peak and average values shown)
Low channel



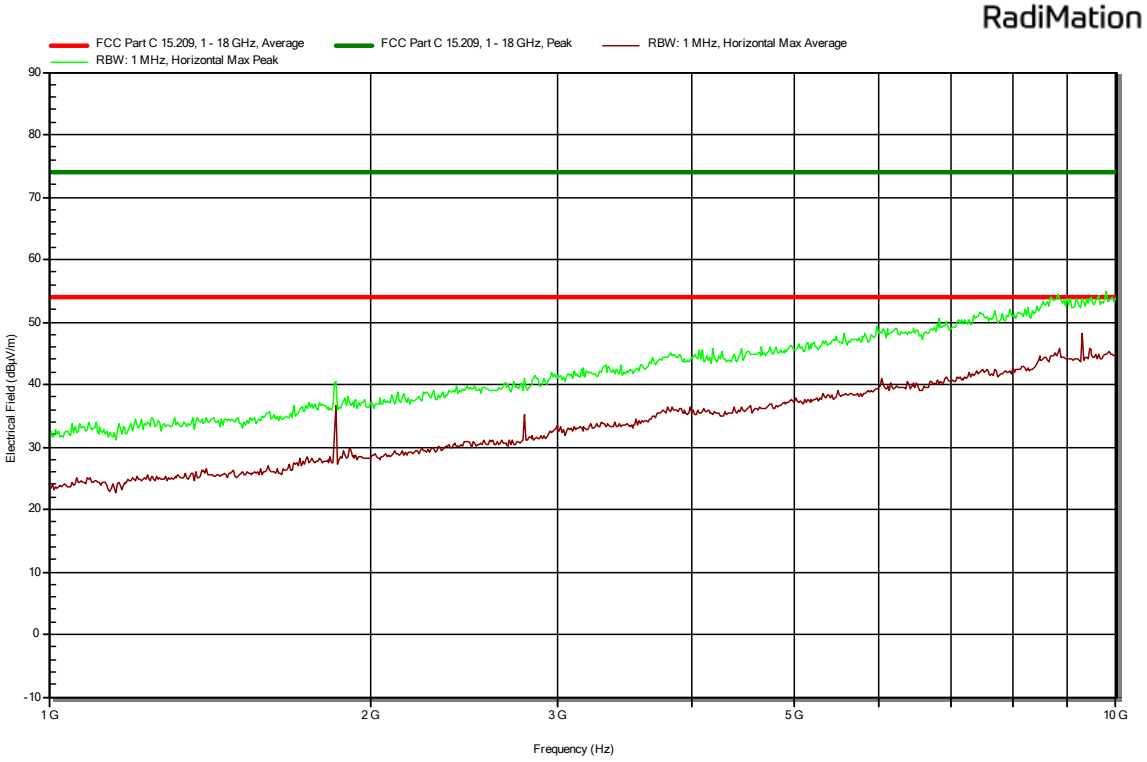
Plot 9c: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 1 – 10 GHz
(peak and average values shown)
Middle channel



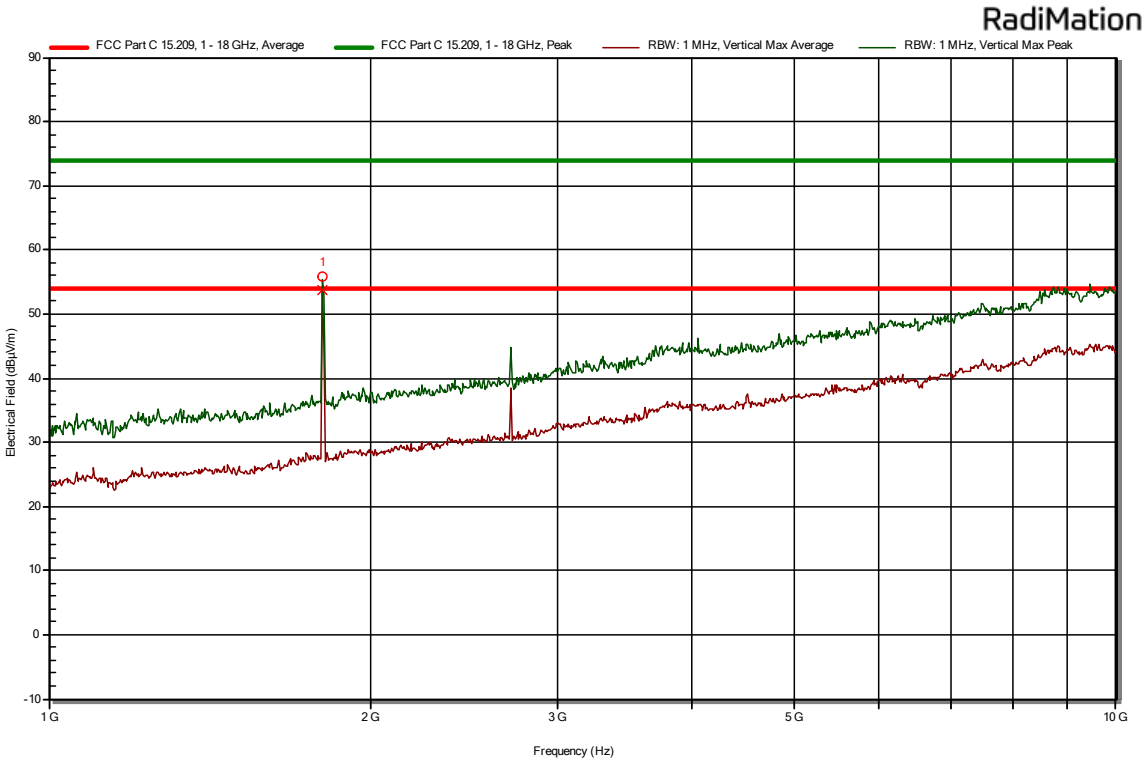
Plot 9d: radiated emissions of the EUT variant 3v1, Antenna horizontal, in the range 1 – 10 GHz
(peak and average values shown)
Middle channel



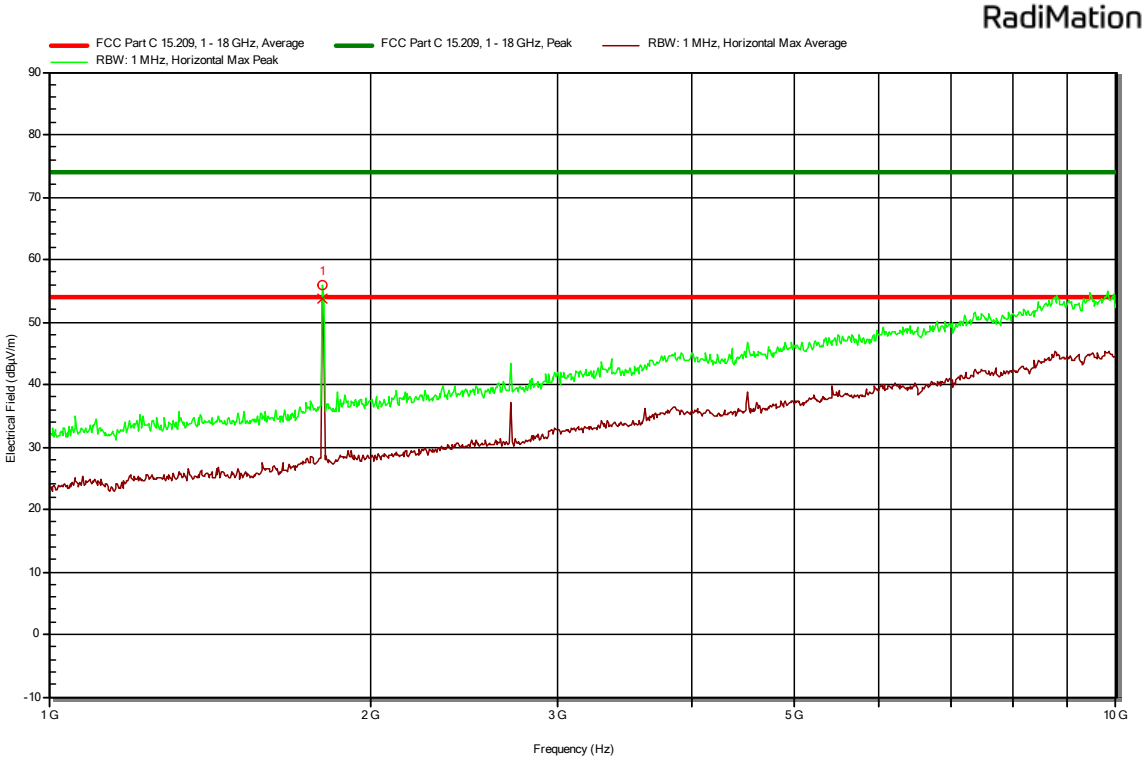
Plot 9e: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 1 – 10 GHz
(peak and average values shown)
High channel



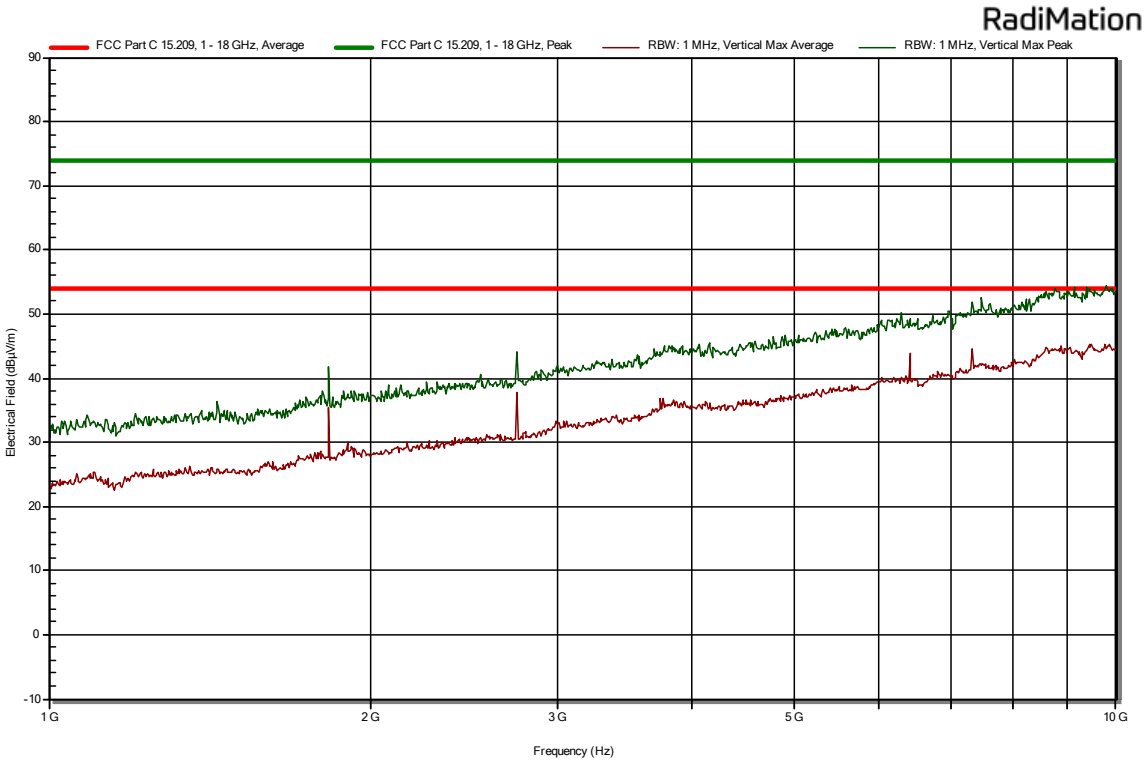
Plot 9f: radiated emissions of the EUT variant 3v1, Antenna horizontal, in the range 1 – 10 GHz
(peak and average values shown)
High channel



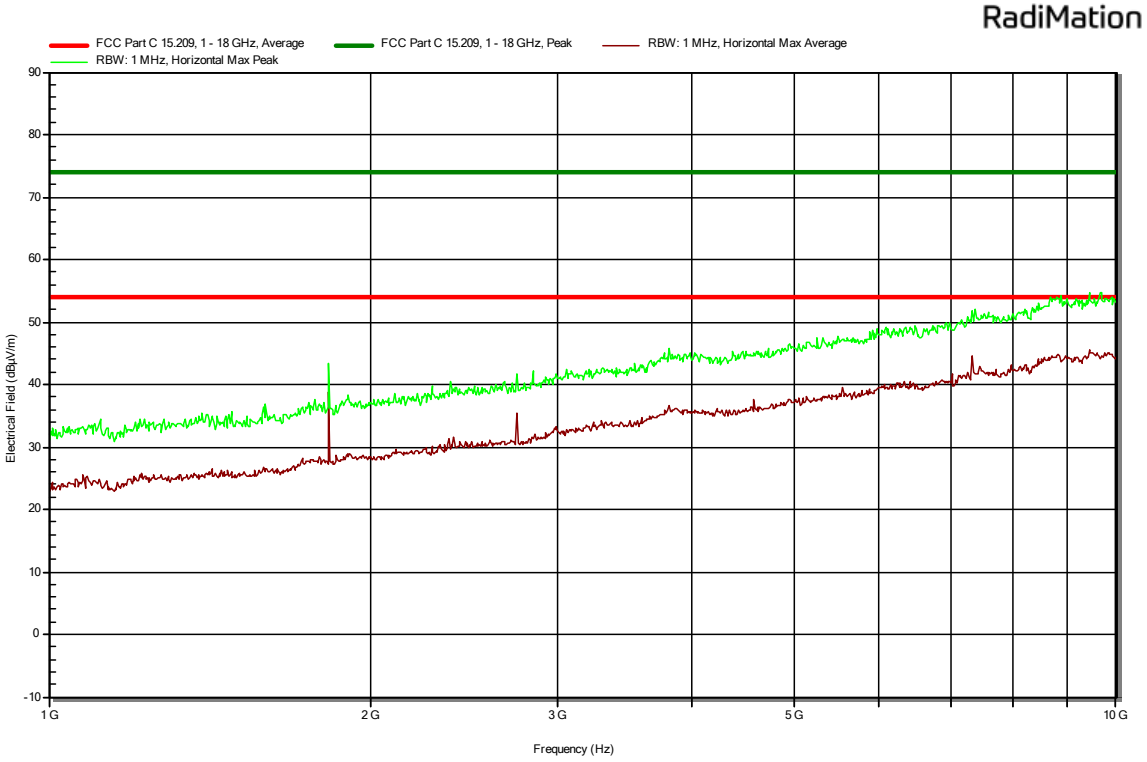
Plot 10a: radiated emissions of the EUT variant 2v8, Antenna vertical, in the range 1 – 10 GHz
(peak and average values shown)
Low channel



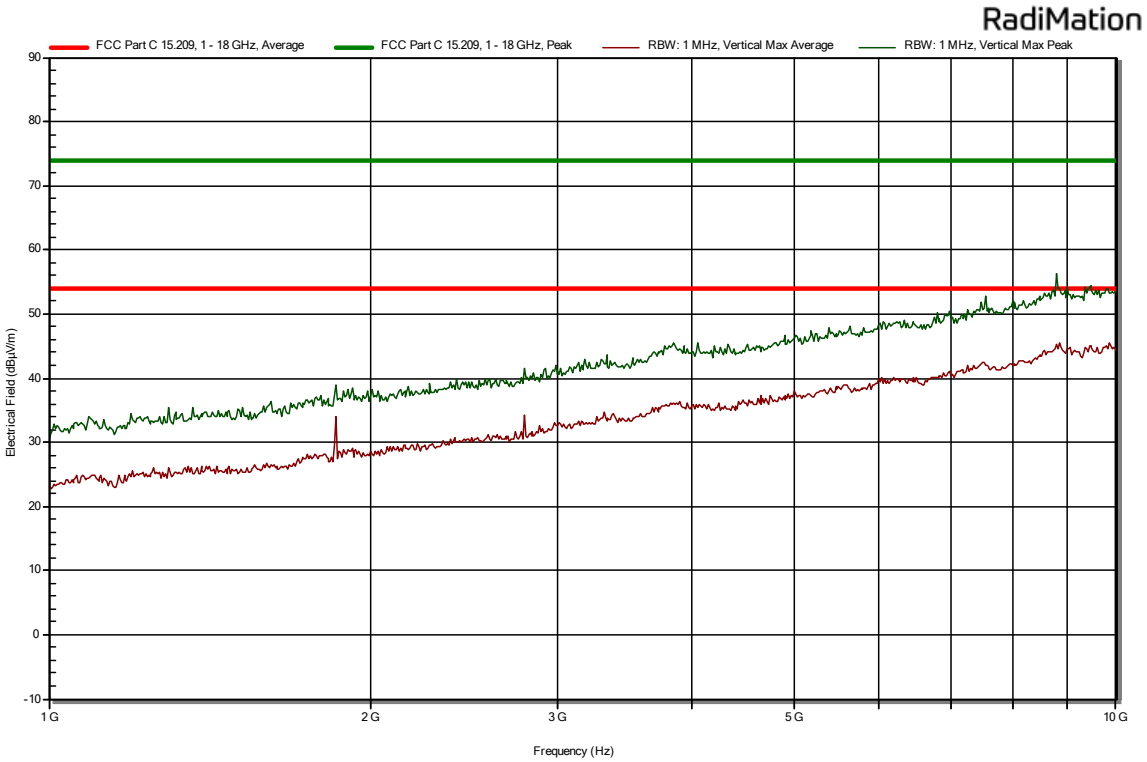
Plot 10b: radiated emissions of the EUT variant 2v8, Antenna horizontal, in the range 1 – 10 GHz
(peak and average values shown)
Low channel



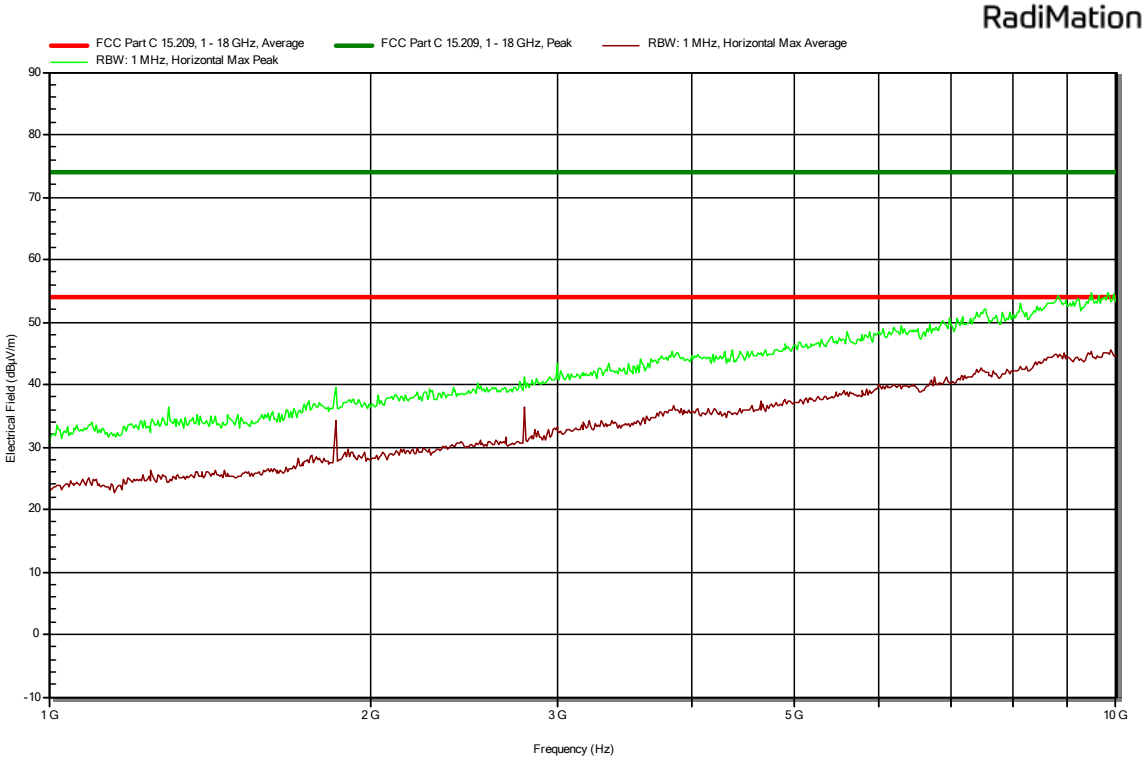
Plot 10c: radiated emissions of the EUT variant 2v8, Antenna vertical, in the range 1 – 10 GHz
(peak and average values shown)
Middle channel



Plot 10d: radiated emissions of the EUT variant 2v8, Antenna horizontal, in the range 1 – 10 GHz
(peak and average values shown)
Middle channel



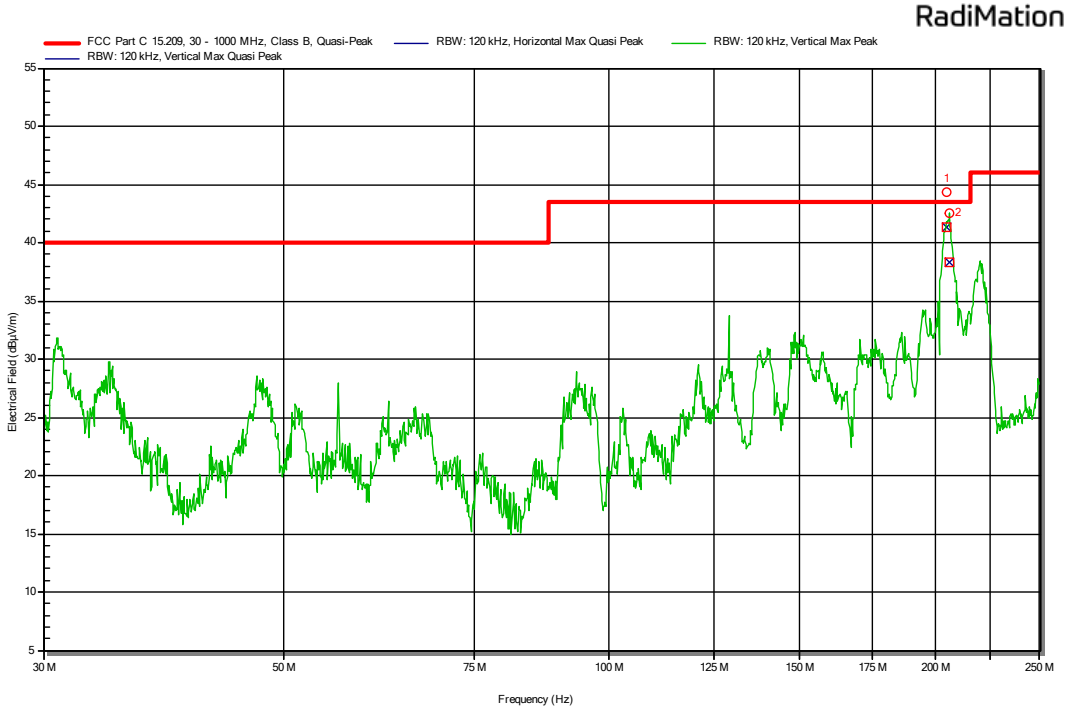
Plot 10e: radiated emissions of the EUT variant 2v8, Antenna vertical, in the range 1 – 10 GHz
(peak and average values shown)
High channel



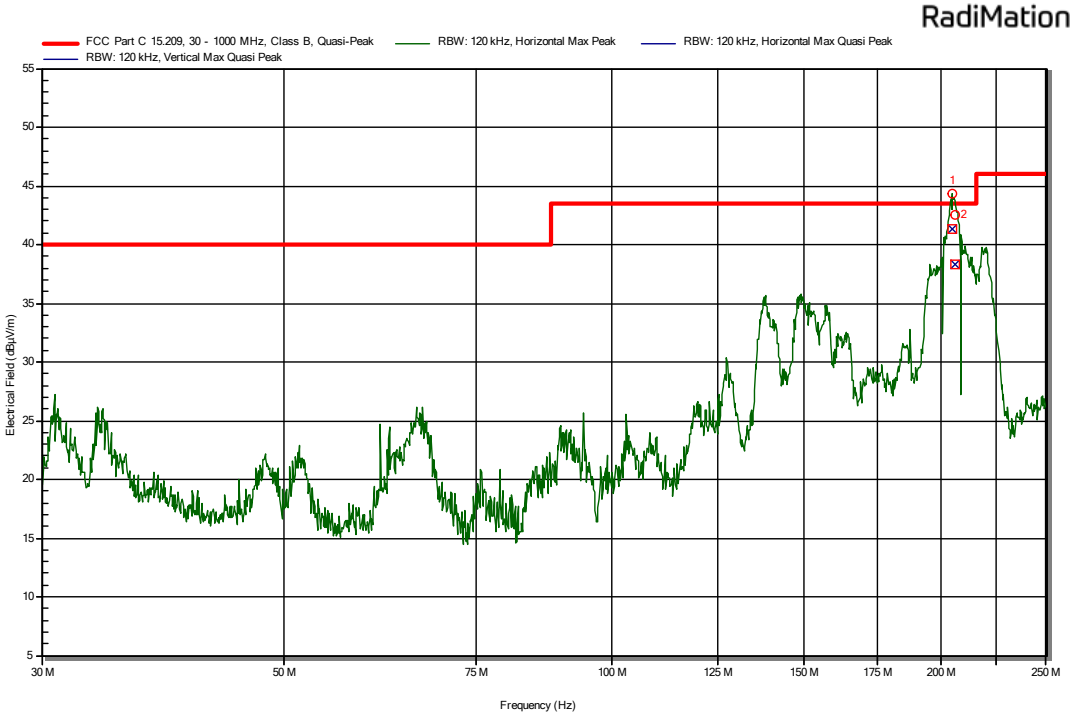
Plot 10f: radiated emissions of the EUT variant 2v8, Antenna horizontal, in the range 1 – 10 GHz
(peak and average values shown)
High channel

Verification results with EUT in host 2.

30 – 250 MHz

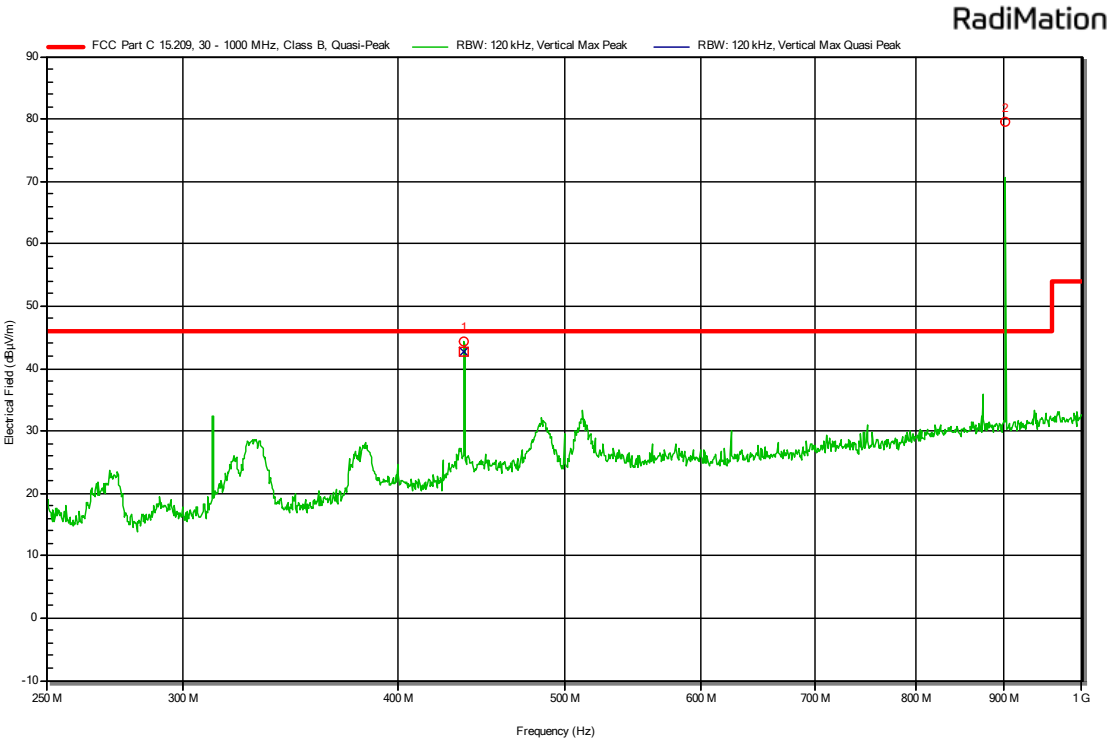


Plot 11: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 30 – 250 MHz (pre-scan peak values shown)
Low channel

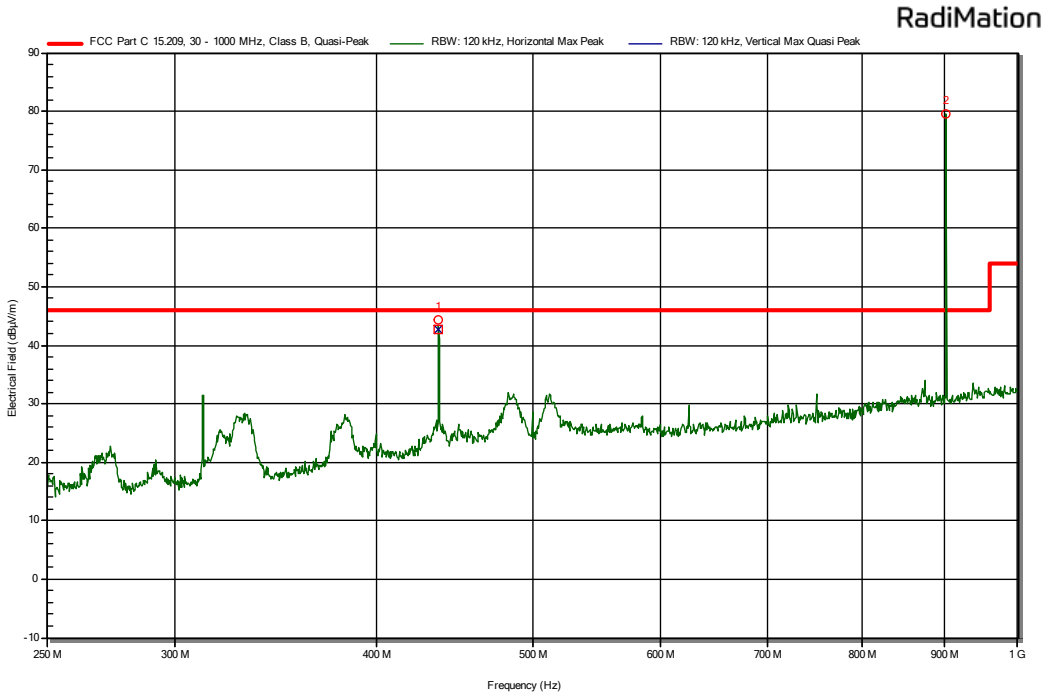


Plot 12: radiated emissions of the EUT variant 3v1, Antenna Horizontal, in the range 30 – 250 MHz (pre-scan peak values shown)
Low channel

250 – 1000 MHz

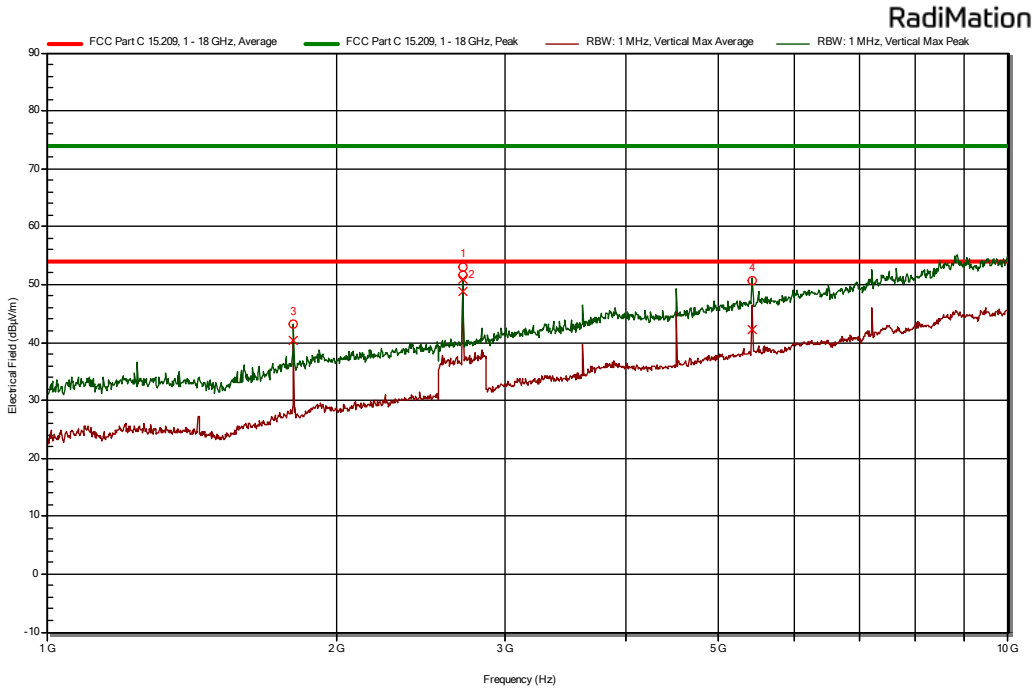


Plot 13: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 250 – 1000 MHz
(pre-scan peak values shown)
Low channel

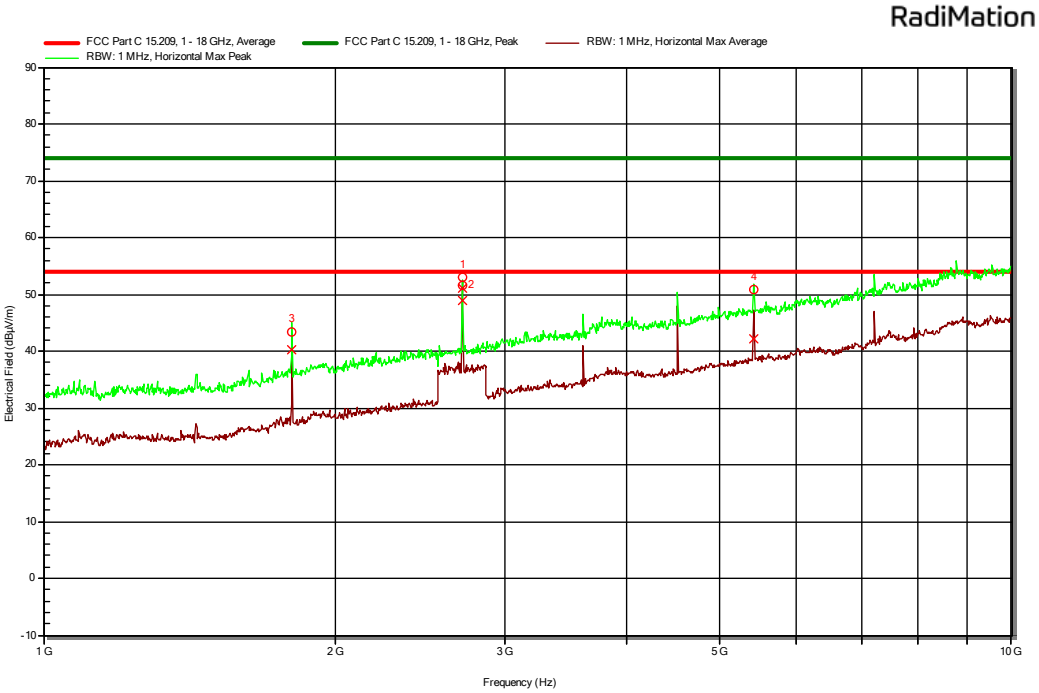


Plot 14: radiated emissions of the EUT variant 3v1, Antenna Horizontal, in the range 250 – 1000 MHz
(pre-scan peak values shown)
Low channel

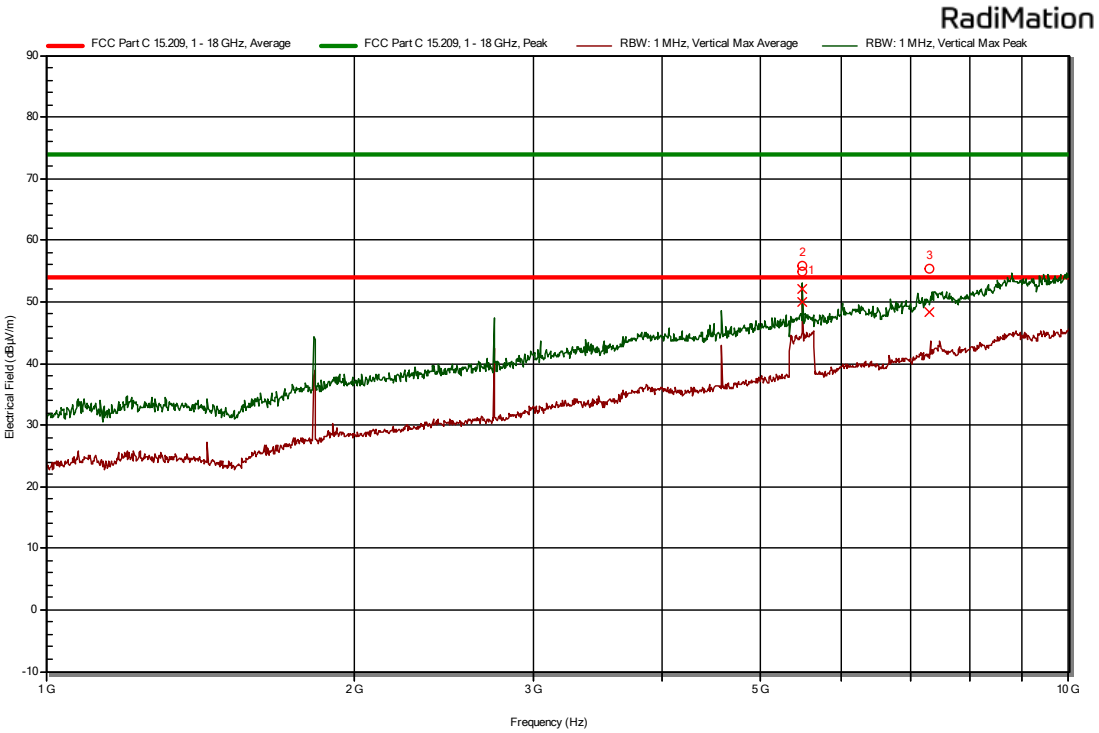
1 – 10 GHz



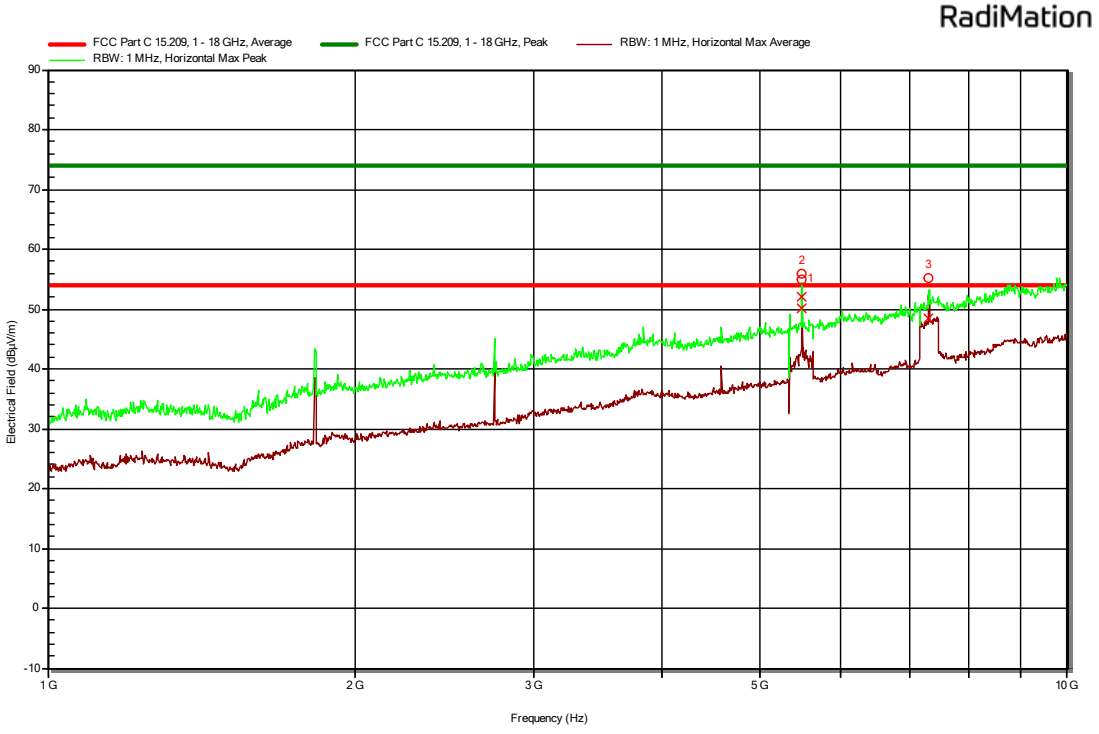
Plot 15: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 1 – 10 GHz (peak and average values shown)
Low channel



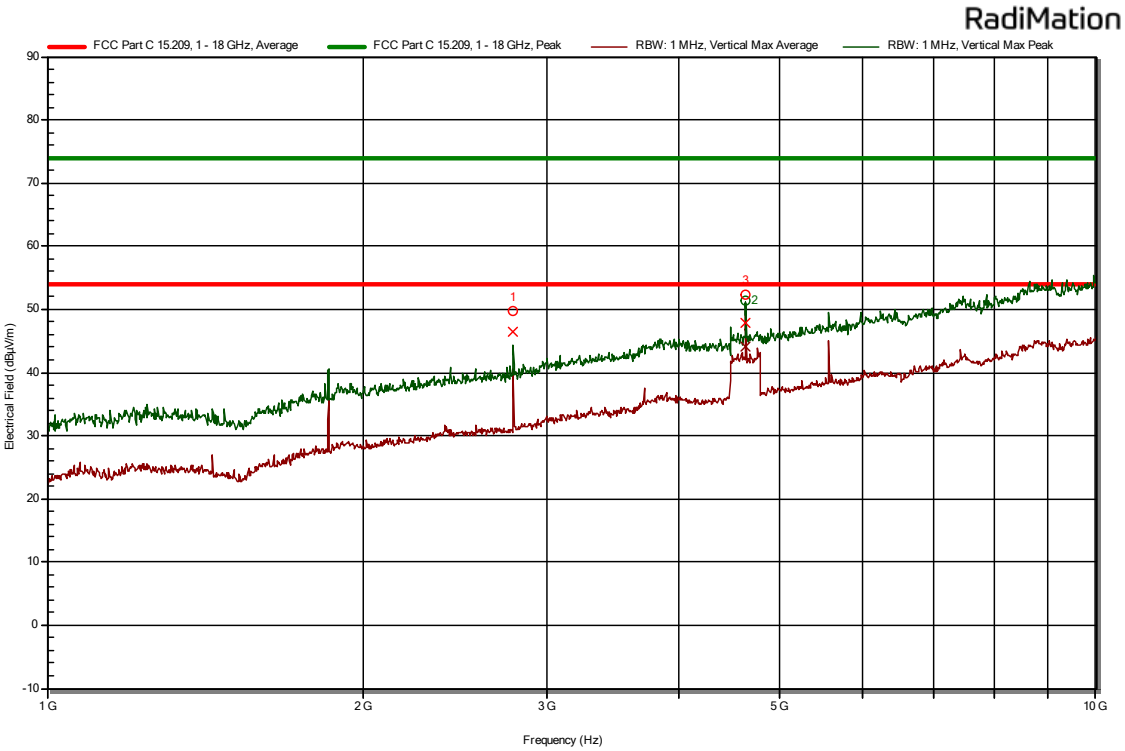
Plot 16: radiated emissions of the EUT variant 3v1, Antenna Horizontal, in the range 1 – 10 GHz (peak and average values shown)
Low channel



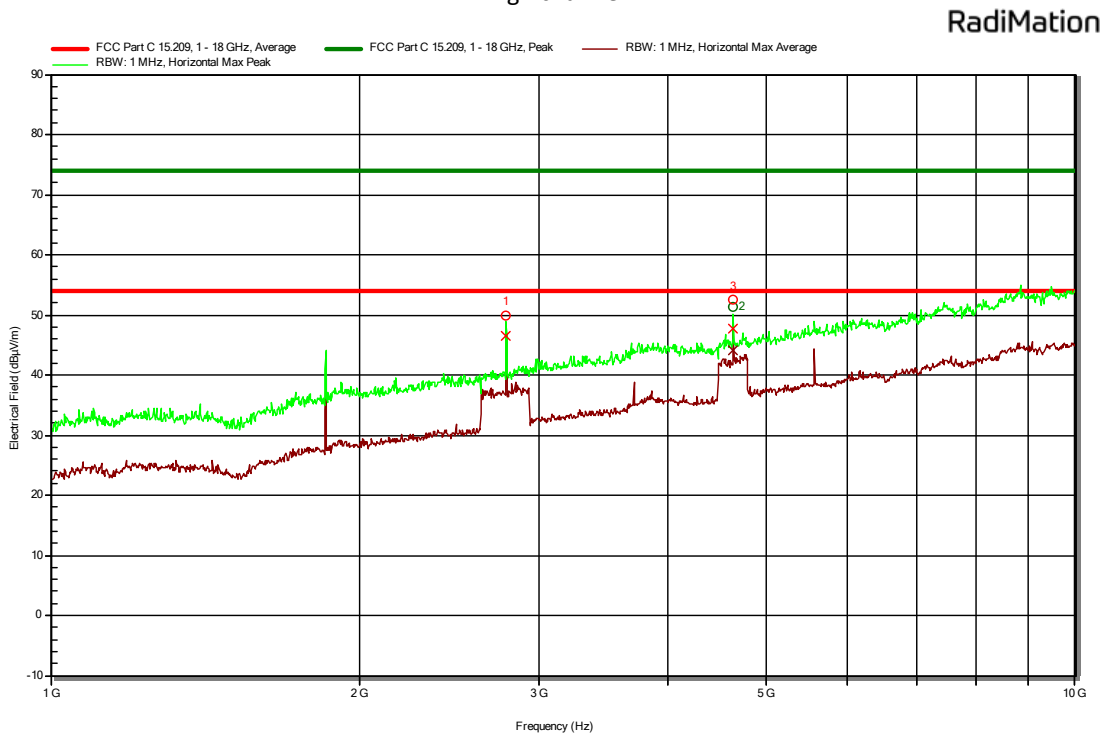
Plot 17: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 1 – 10 GHz (peak and average values shown)
Mid channel



Plot 18: radiated emissions of the EUT variant 3v1, Antenna Horizontal, in the range 1 – 10 GHz (peak and average values shown)
Mid channel



Plot 19: radiated emissions of the EUT variant 3v1, Antenna vertical, in the range 1 – 10 GHz
(peak and average values shown)
High channel



Plot 20: radiated emissions of the EUT variant 3v1, Antenna Horizontal, in the range 1 – 10 GHz
(peak and average values shown)
High channel

3.2 20 dB bandwidth Measurement

3.2.1 Limit

The maximum 20 dB Bandwidth shall be 500 kHz.

3.2.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.2.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.2.4 Test procedure

According to ANSI C63.10, section 6.9
IRN 404 - Occupied bandwidth (Hz) Method 4 – DTS Bandwidth.

3.2.5 Test Results of the 20 dB bandwidth Measurement

Variant 3v1:

Technology Std.	Channel	Frequency (MHz)	Data rate	20 dB bandwidth (kHz)
Proprietary	1	902.5	50 kbps	82.03
	25	914.5	50 kbps	82.42
	50	927.0	50 kbps	85.71
Uncertainty	± 4.4 kHz			

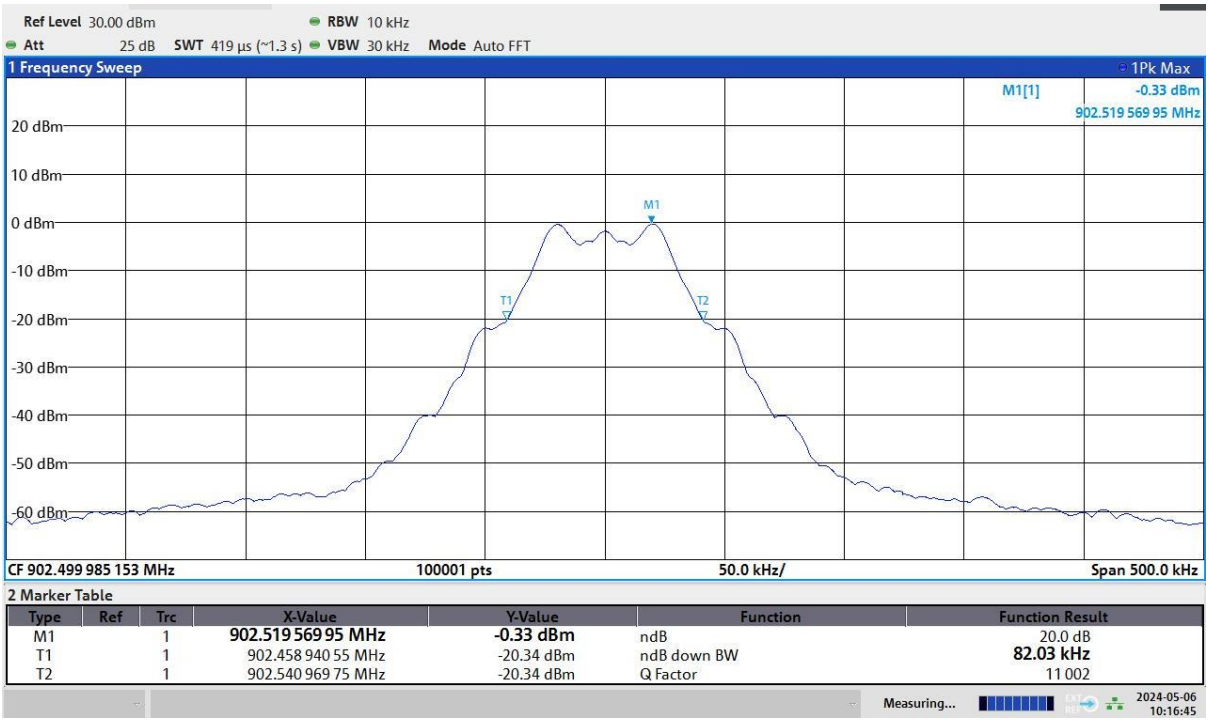
Note: plots are provided on the next page.

Variant 2v8:

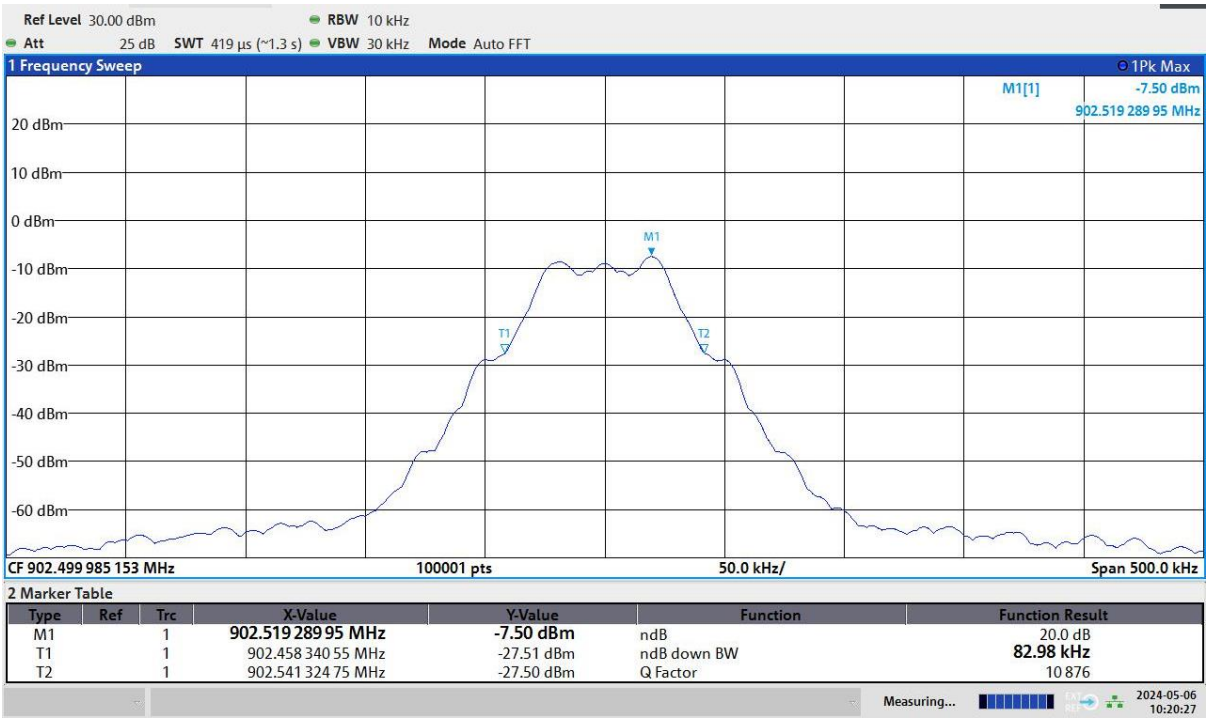
Technology Std.	Channel	Frequency (MHz)	Data rate	20 dB bandwidth (kHz)
Proprietary	1	902.5	50 kbps	82.98
	25	914.5	50 kbps	82.88
	50	927.0	50 kbps	85.30
Uncertainty	± 4.4 kHz			

Note: plots are provided on the next page.

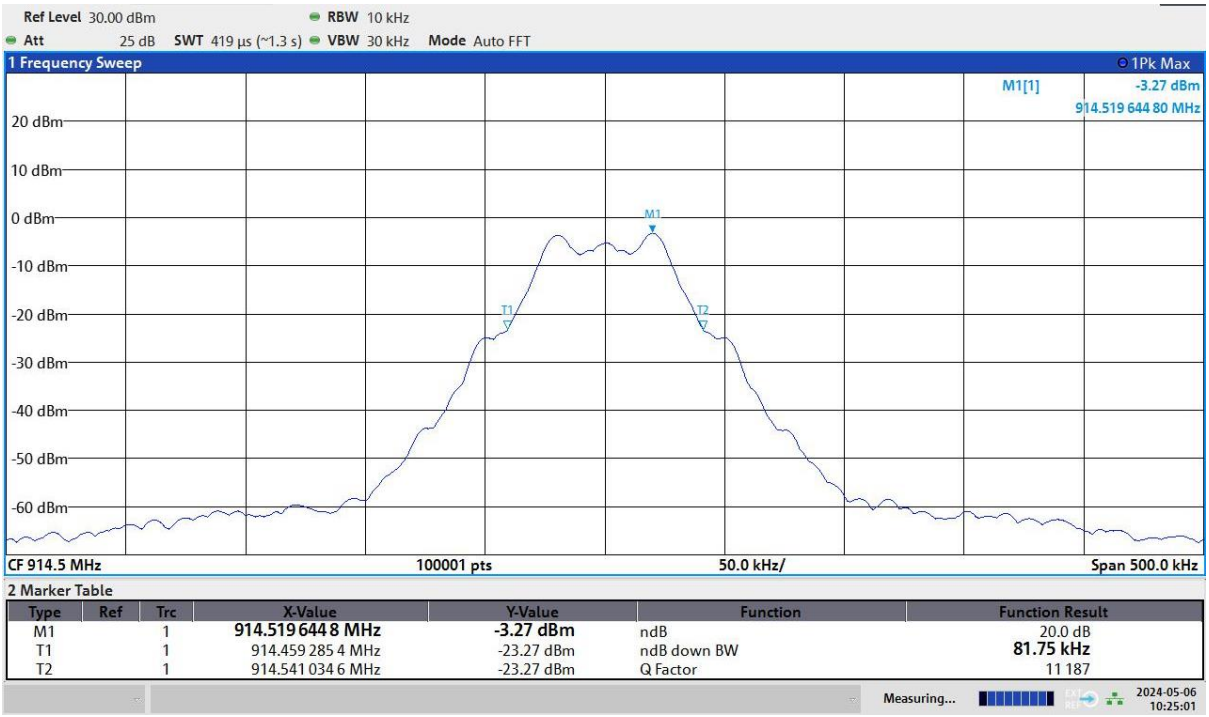
3.2.6 Plots of the 20 dB bandwidth



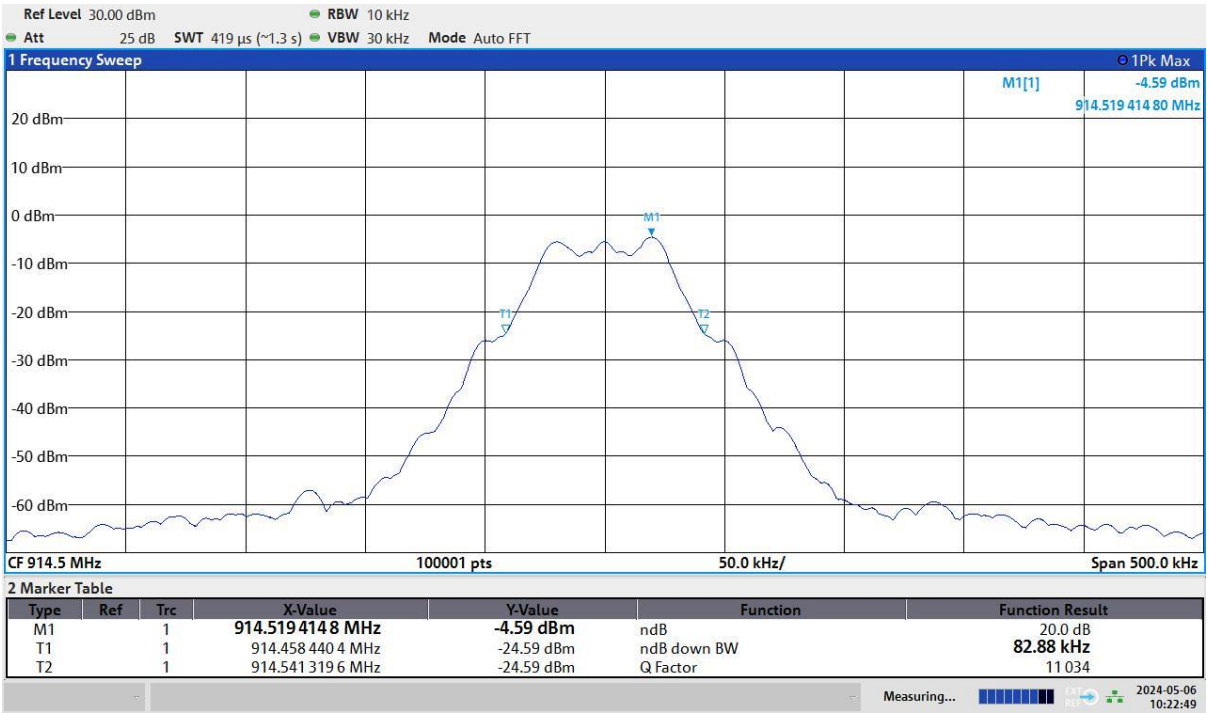
Plot 11: Occupied Bandwidth of the EUT variant 3v1
Low channel



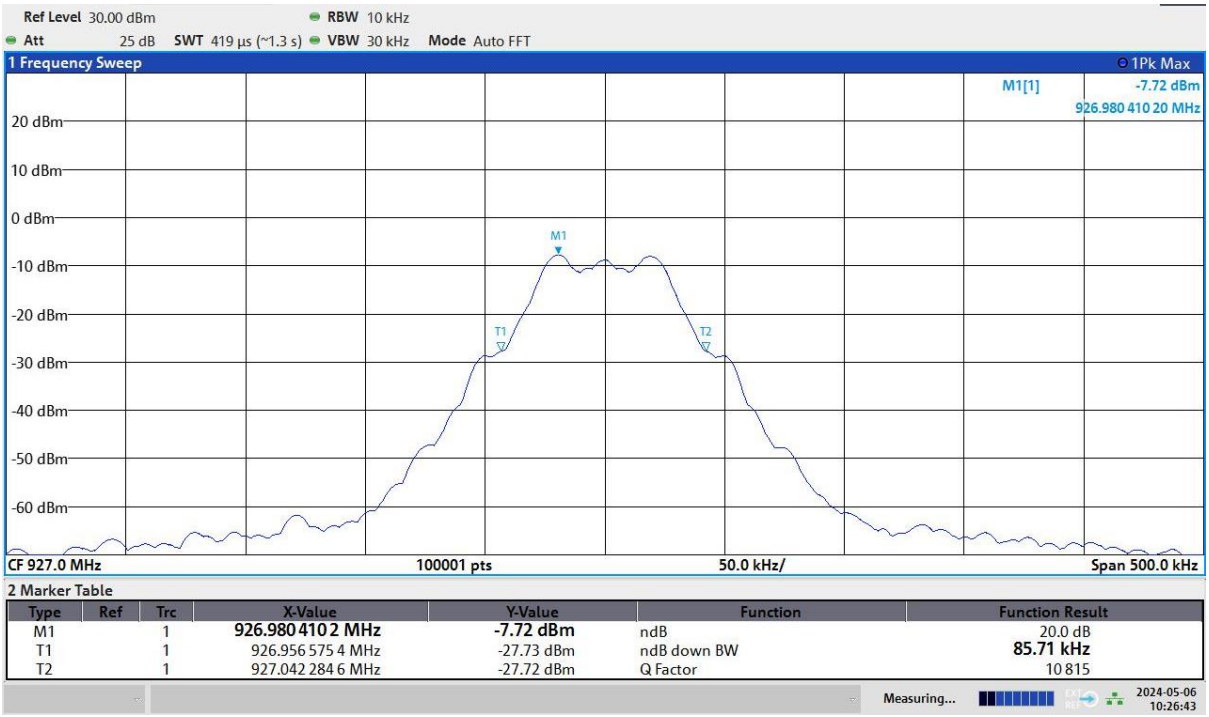
Plot 12: Occupied Bandwidth of the EUT variant 2v8
Low channel



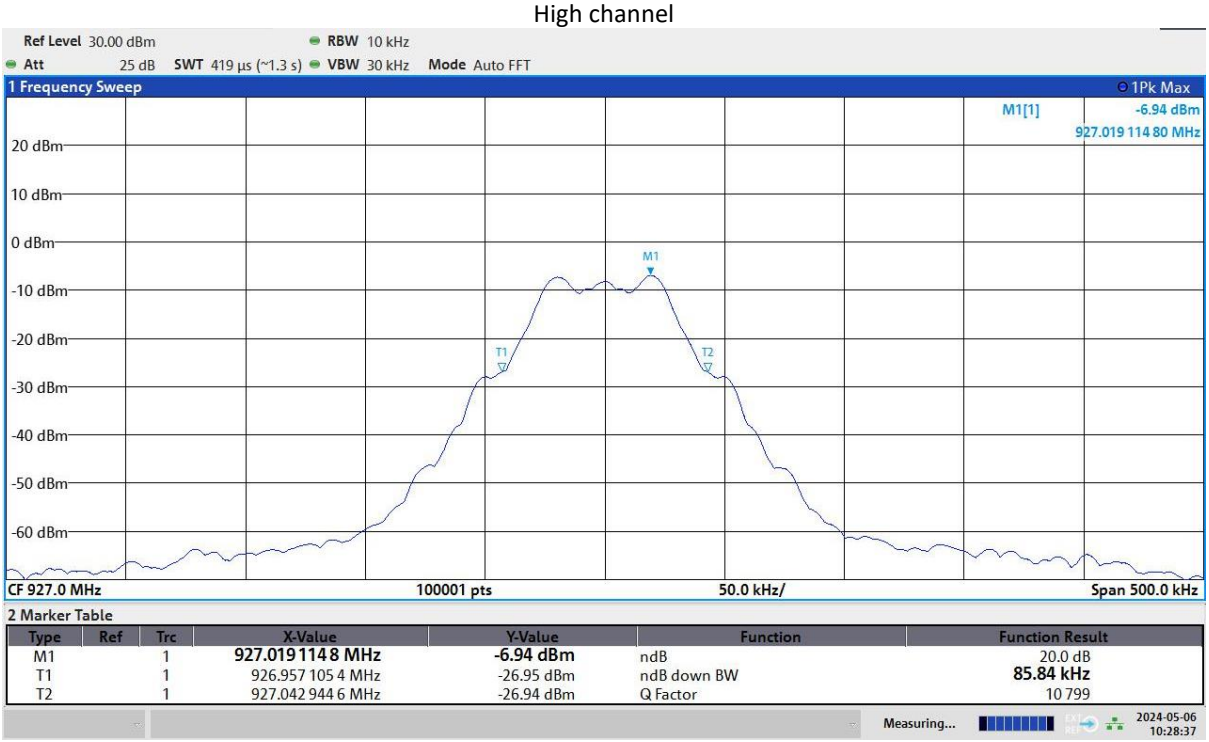
Plot 13: Occupied Bandwidth of the EUT variant 3v1
Mid channel



Plot 14: Occupied Bandwidth of the EUT variant 2v8
Mid channel



Plot 15: Occupied Bandwidth of the EUT variant 3v1
High channel



Plot 16: Occupied Bandwidth of the EUT variant 2v8
High channel

3.3 99% Occupied Bandwidth

3.3.1 Limit

According to RSS-Gen 6.7

3.3.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.3.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.3.4 Test procedure

According to ANSI C63.10, section 6.9
IRN 404 - Occupied bandwidth (Hz) Method 1 – XX % power bandwidth.

3.3.5 Test results of the 99% occupied bandwidth measurement

Variant 3v1:

Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (kHz)
Proprietary	1	902.5	50 kbps	73.90
	25	914.5	50 kbps	73.74
	50	927.0	50 kbps	74.08
Uncertainty	± 4.4 kHz			

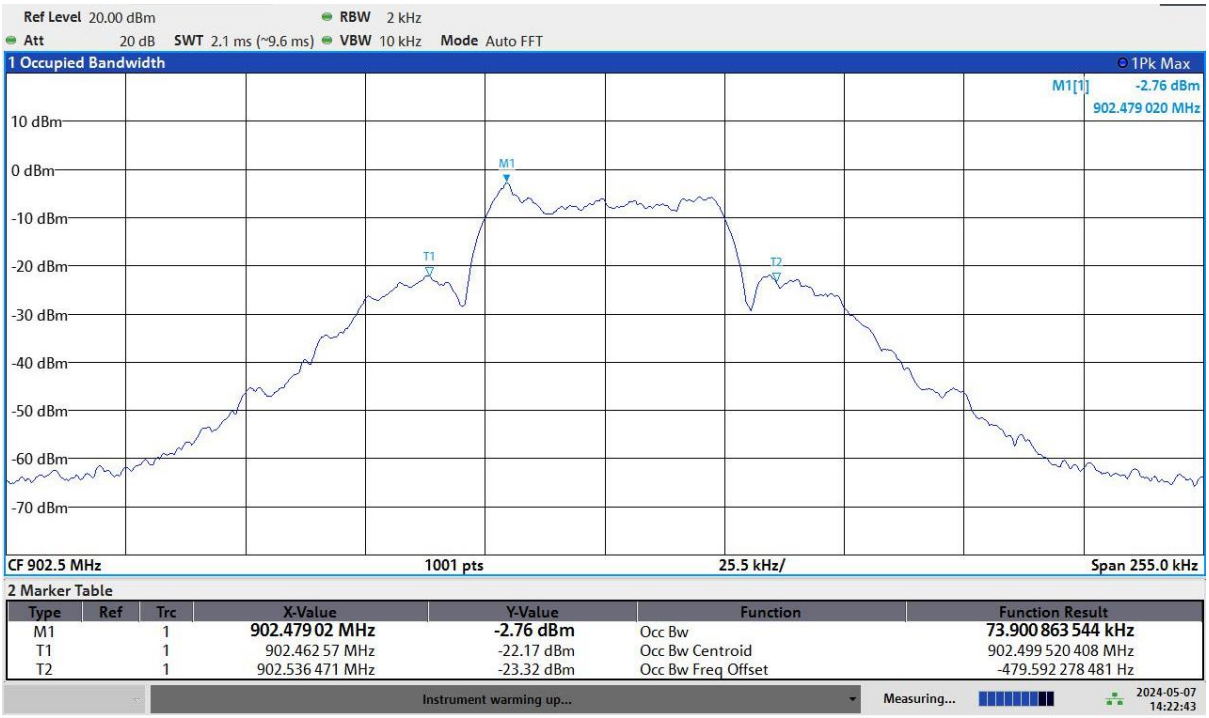
Note: plots are provided on the next page.

Variant 2v8:

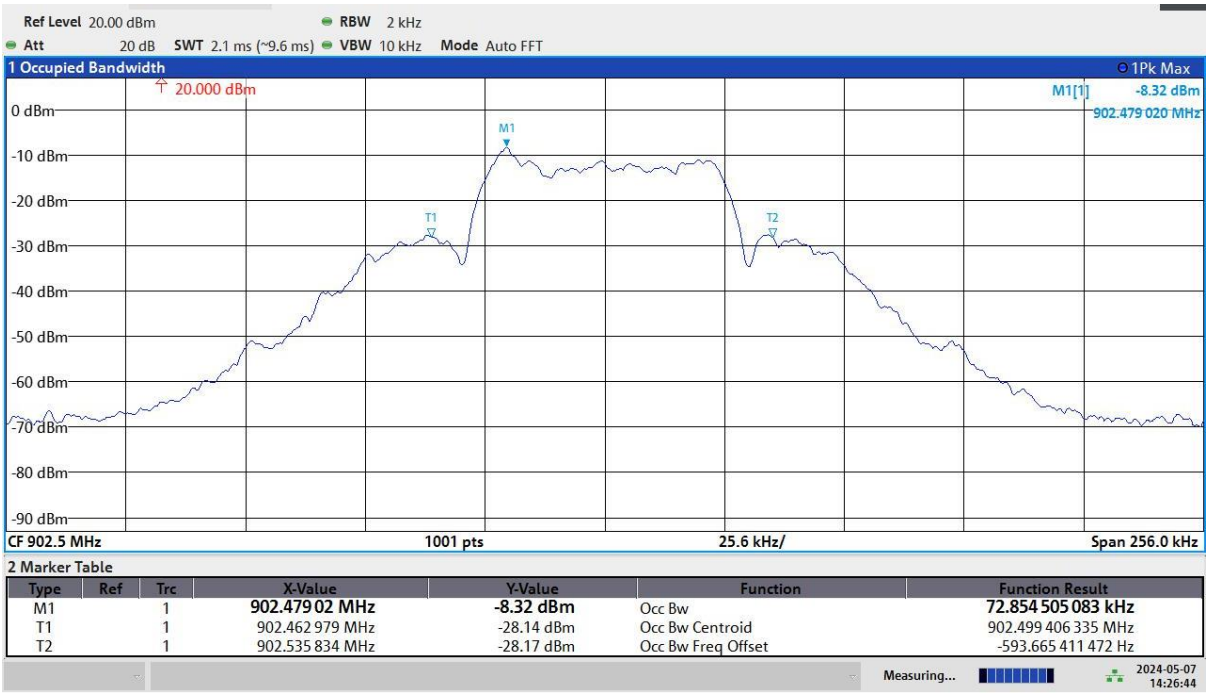
Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (kHz)
Proprietary	1	902.5	50 kbps	72.73
	25	914.5	50 kbps	73.24
	50	927.0	50 kbps	74.23
Uncertainty	± 4.4 kHz			

Note: plots are provided on the next page.

3.3.6 Plots of the 99% occupied bandwidth measurement

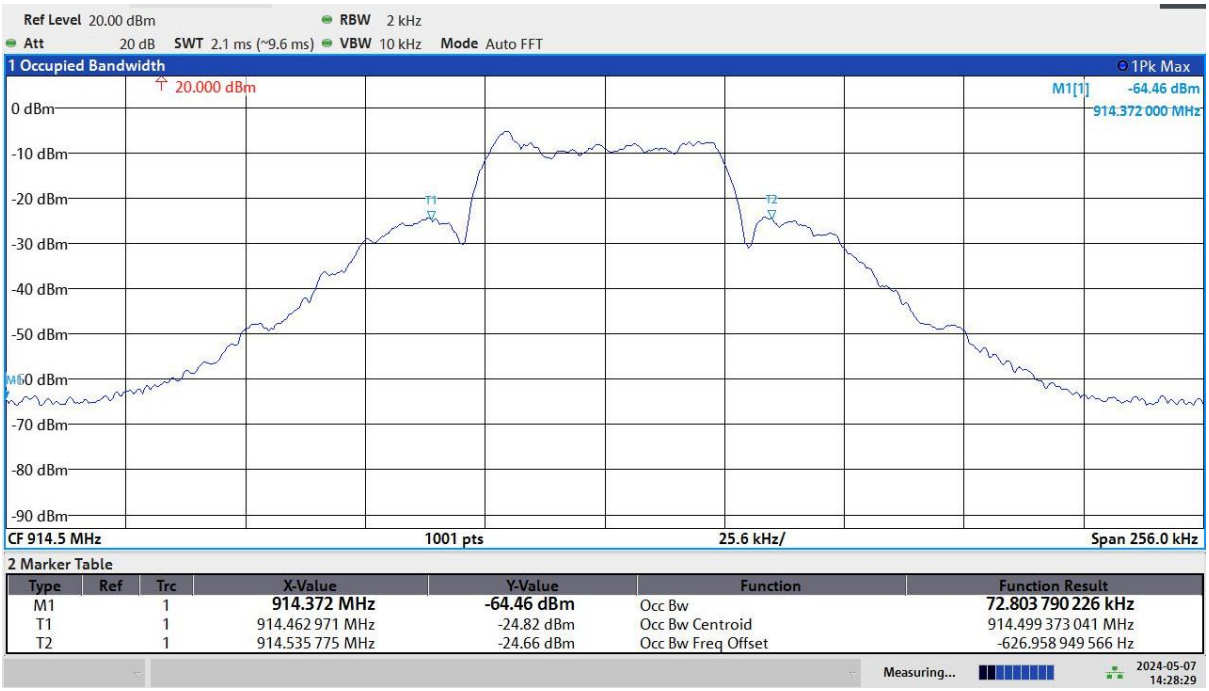


Plot 17: 99% Occupied Bandwidth of the EUT variant 3v1
Low channel

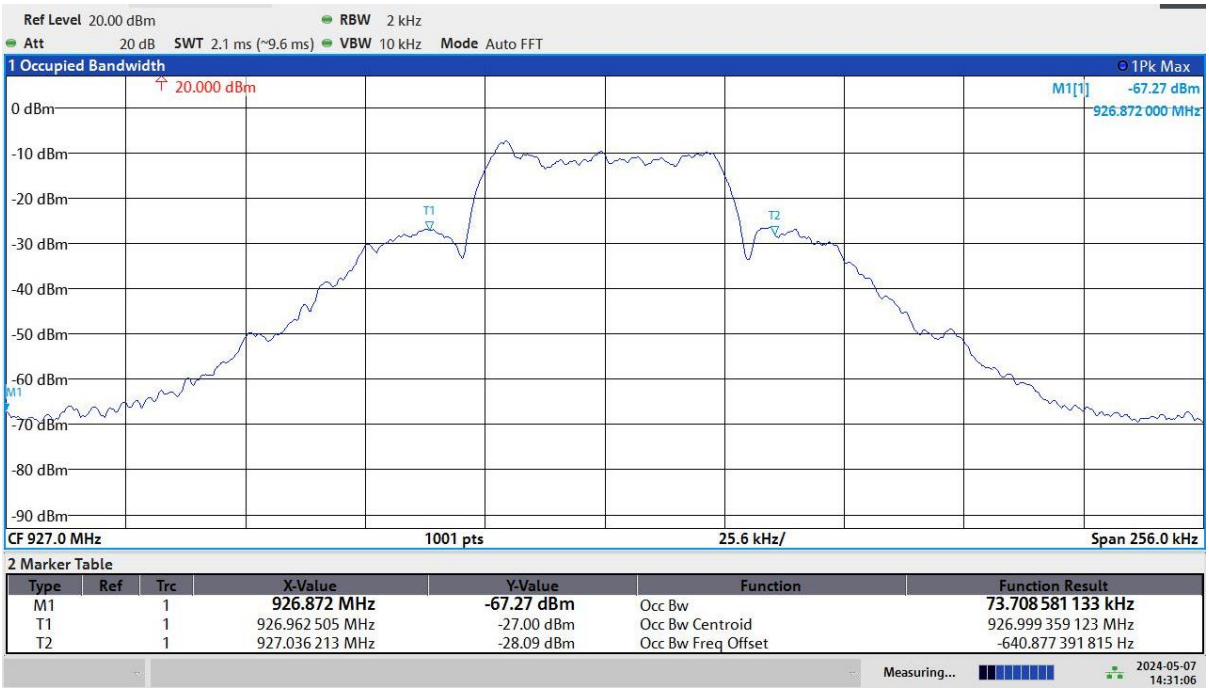


Plot 18: 99% Occupied Bandwidth of the EUT variant 2v8
Low channel

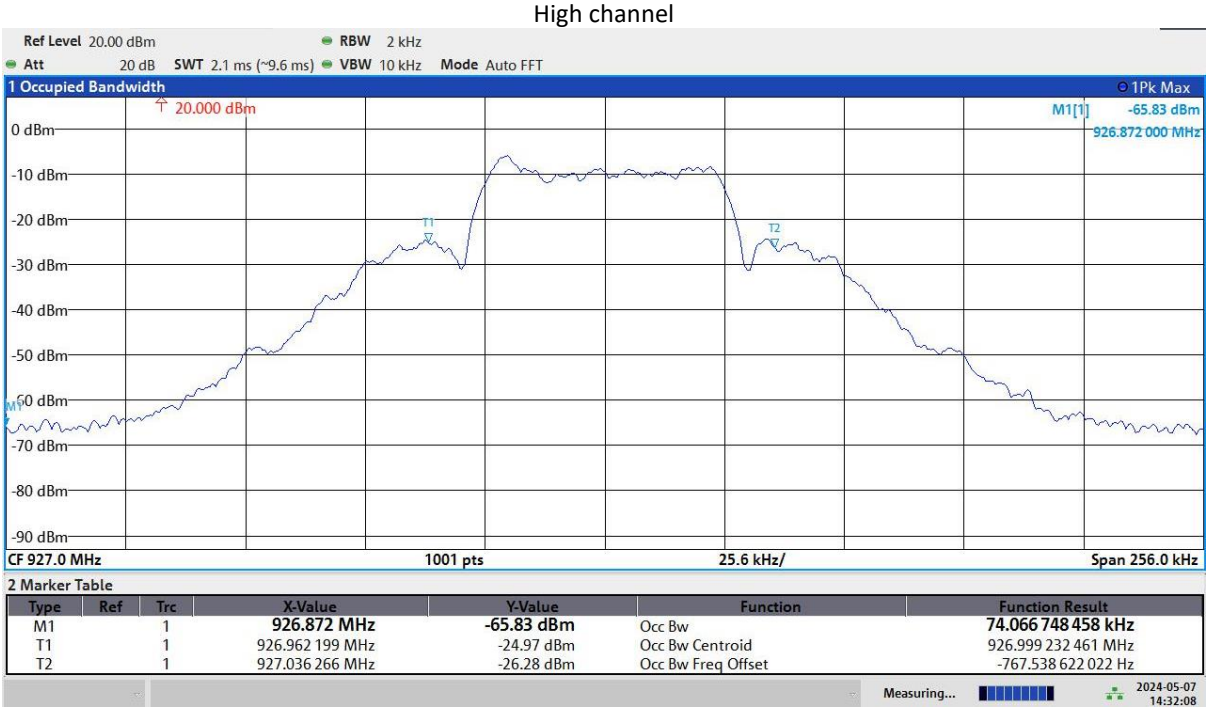
Plot 19: 99% Occupied Bandwidth of the EUT variant 3v1
Mid channel



Plot 20: 99% Occupied Bandwidth of the EUT variant 2v8
Mid channel



Plot 21: 99% Occupied Bandwidth of the EUT variant 3v1
High channel



Plot 22: 99% Occupied Bandwidth of the EUT variant 2v8
High channel

3.4 Output Power Measurement

3.4.1 Limit

FCC: For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section. The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3.4.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.4.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.4.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02.

IRN 402 - RF power (W) - Method 12 – Peak Method according to ANSI C63.10.

3.4.5 Test results of Output Power Measurement

Variant 3v1:

Peak method

Technology Std.	Channel	Frequency (MHz)	Data rate	Peak output power conducted (dBm)	Peak output power conducted (W)	Peak output power EIRP (W)
Proprietary	1	902.5	50 kbps	0.22	0.0011	0.0014
	25	914.5	50 kbps	-4.56	0.0003	0.0005
	50	927.0	50 kbps	-6.89	0.0002	0.0003
Uncertainty				±0.71 dB		

Note: plots are provided on the next page

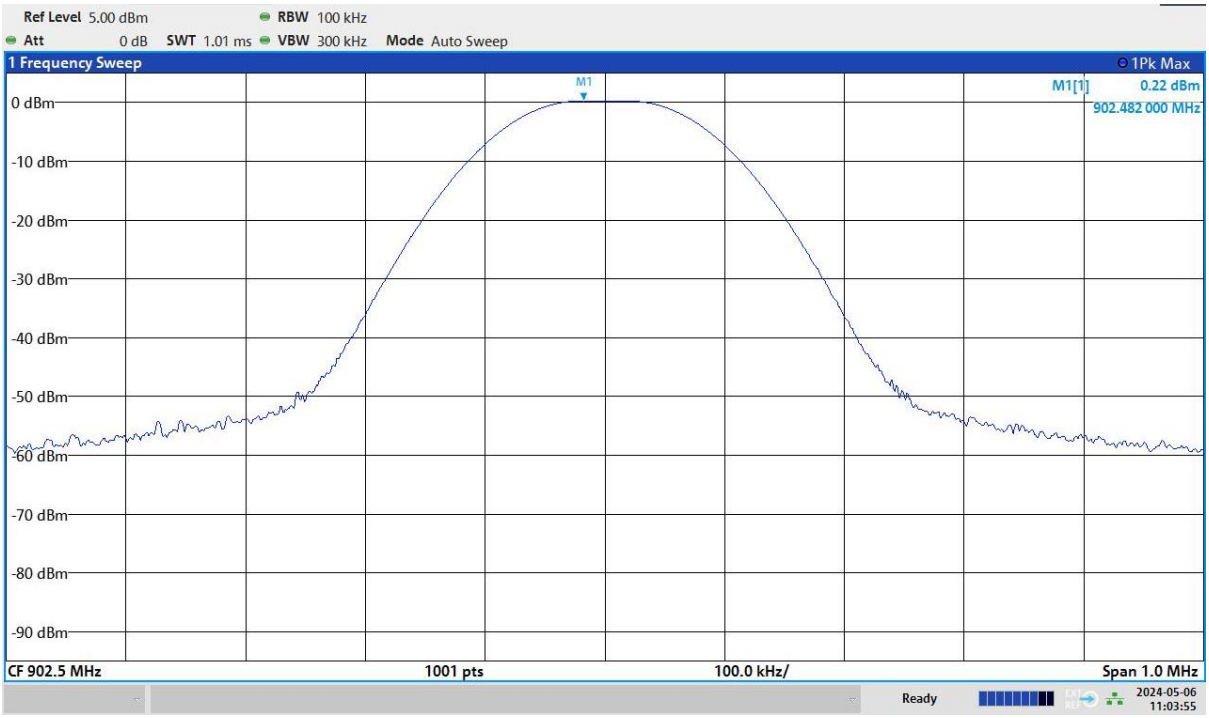
Variant 2v8:

Peak method

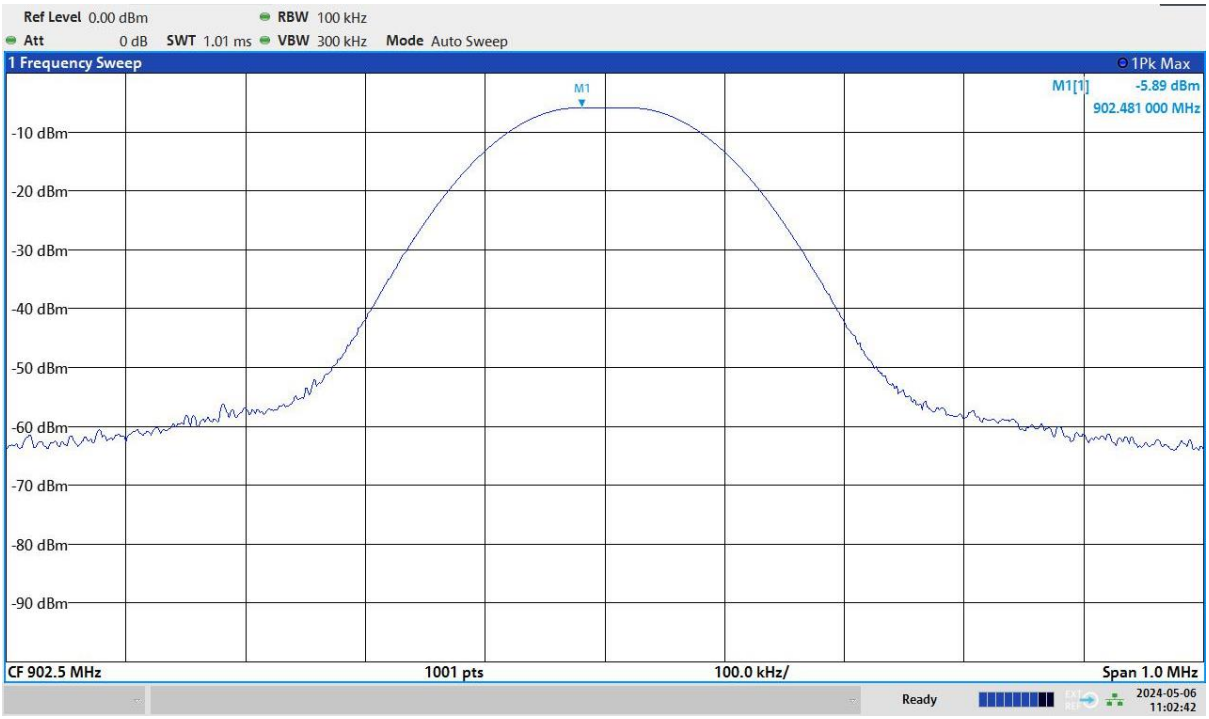
Technology Std.	Channel	Frequency (MHz)	Data rate	Peak output power conducted (dBm)	Peak output power conducted (W)	Peak output power EIRP (W)
Proprietary	1	902.5	50 kbps	-5.89	0.0003	0.0003
	25	914.5	50 kbps	-4.80	0.0003	0.0004
	50	927.0	50 kbps	-6.94	0.0002	0.0003
Uncertainty				±0.71 dB		

Note: plots are provided on the next page

3.4.6 Plots of the Output power



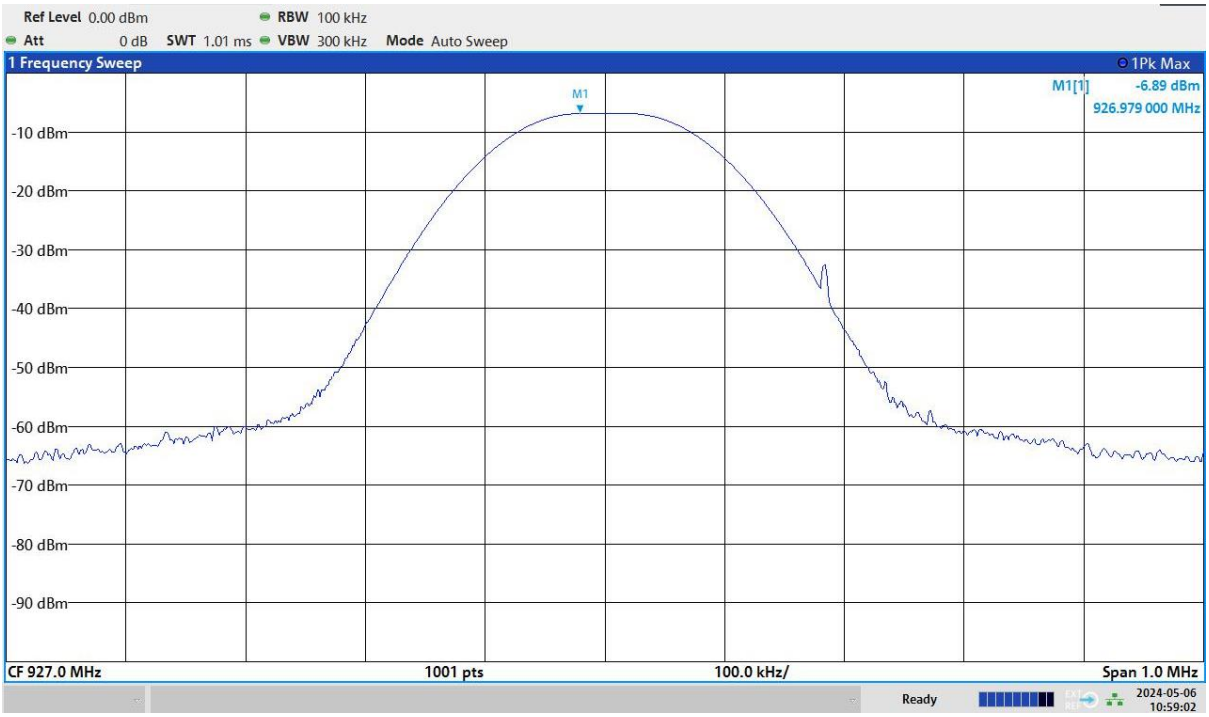
Plot 23: Conducted Output Power of the EUT variant 3v1
Low channel



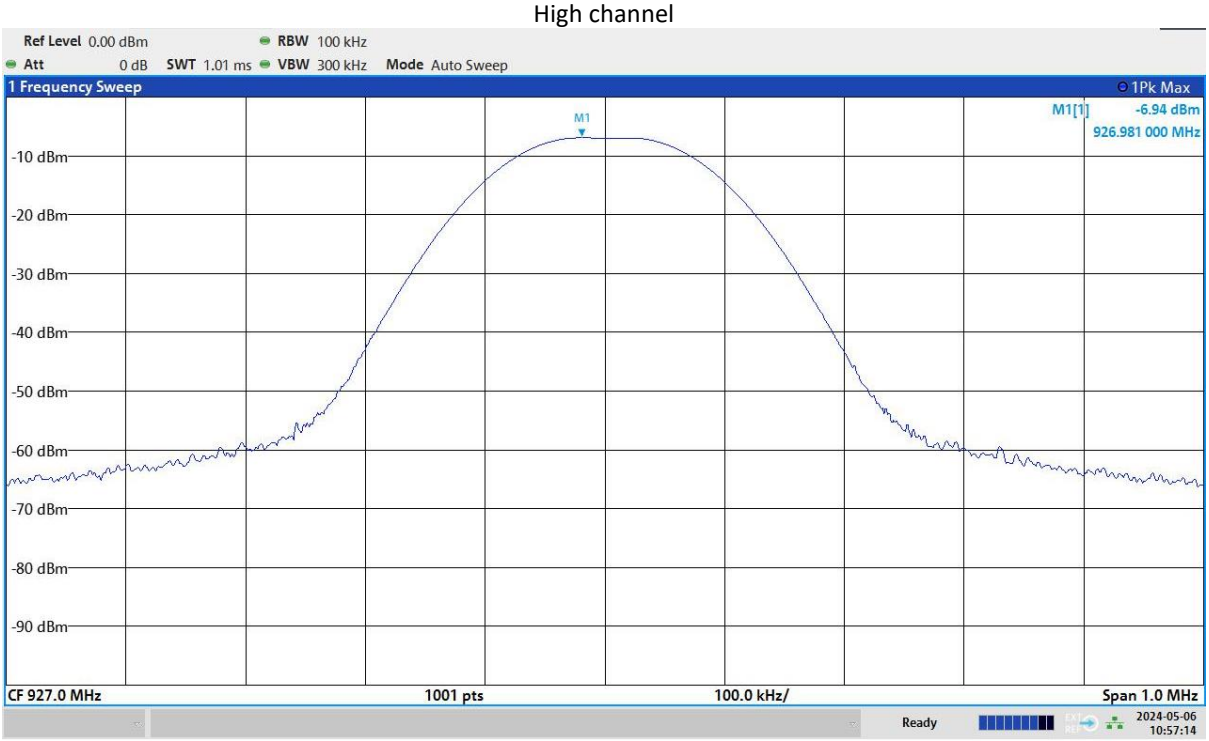
Plot 24: 99% Occupied Bandwidth of the EUT variant 2v8
Low channel

Plot 25: 99% Occupied Bandwidth of the EUT variant 3v1
Mid channel

Plot 26: 99% Occupied Bandwidth of the EUT variant 2v8
Mid channel



Plot 27: 99% Occupied Bandwidth of the EUT variant 3v1
High channel



Plot 28: 99% Occupied Bandwidth of the EUT variant 2v8
High channel

3.5 Band edge Measurement

3.5.1 Limit

Band edge:
At the edge of the authorized band the RF power shall be at least 20 dB down.

3.5.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.5.3 Test setup

The test setup is as shown in chapter 2.2 of this report. Antenna port conducted.

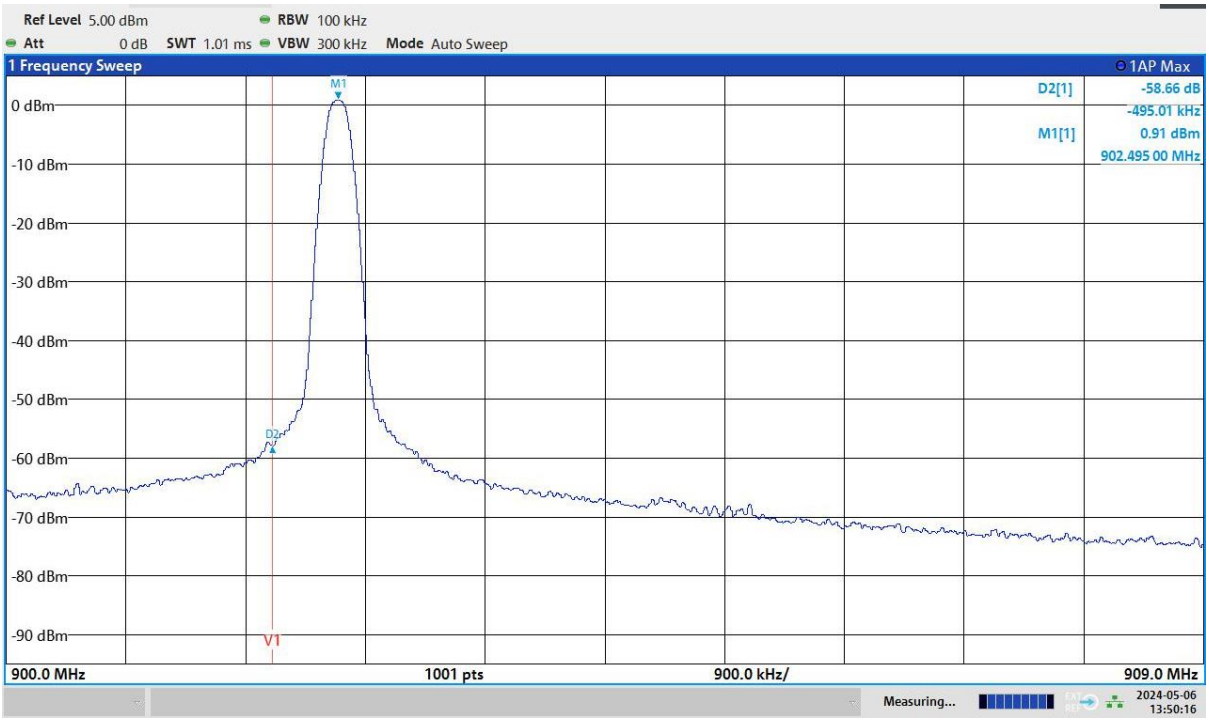
3.5.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02, section 8.7.
IRN 415 – Method 13 – Spurious emissions at the Authorized band edge (relative method).

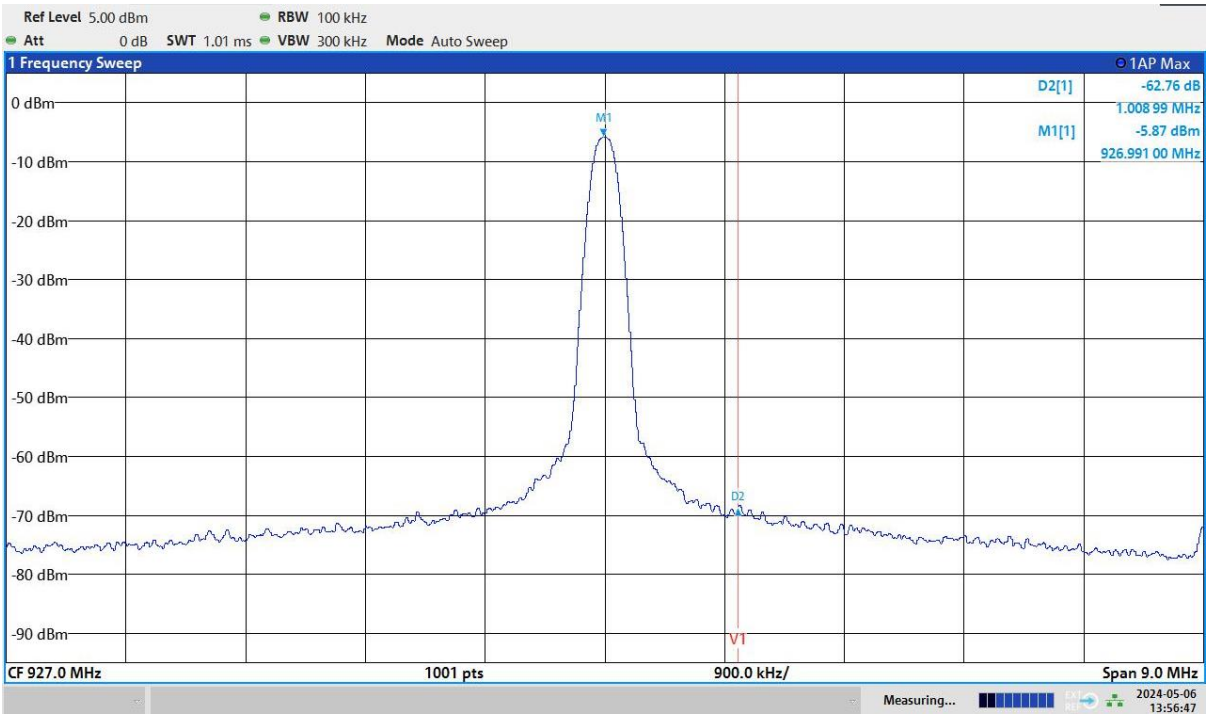
3.5.5 Measurement Uncertainty

± 5.7 dB.(radiated)

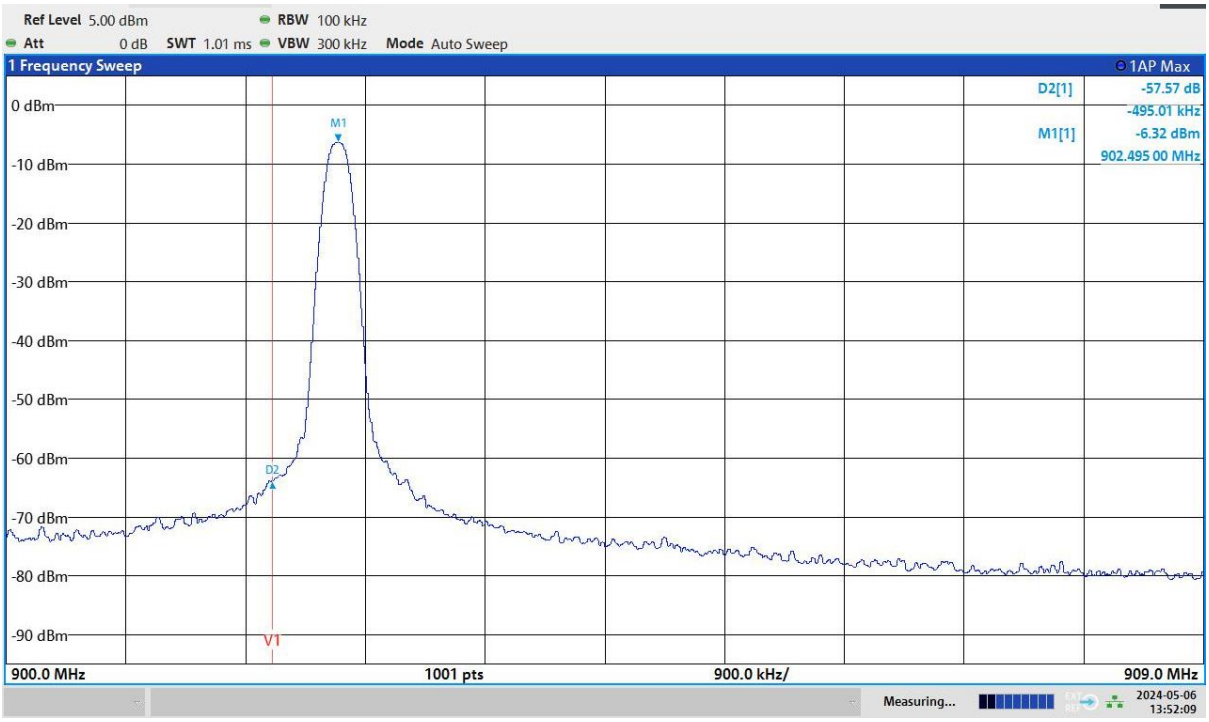
3.5.6 Plots of the Band edge Measurements



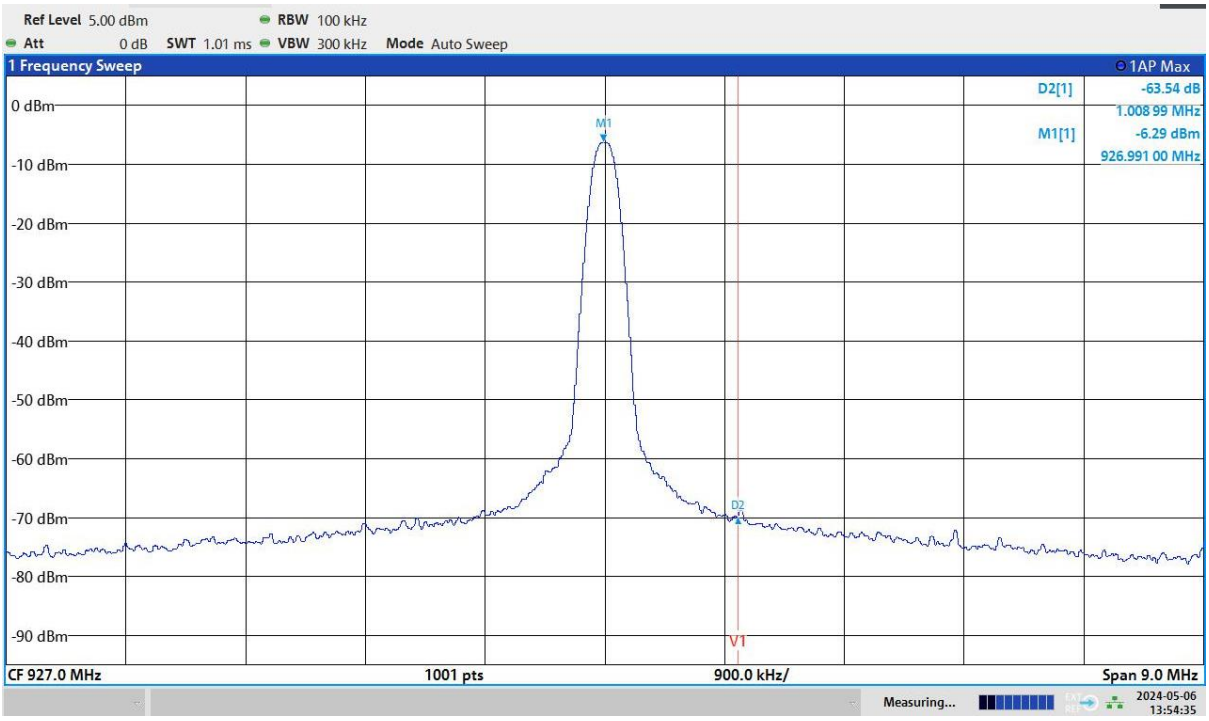
Plot 29: Variant 3v1 Lower band edge (Channel 1)



Plot 30: Variant 3v1 Upper band edge (Channel 50)



Plot 31: Variant 2v8 Lower band edge (Channel 1)



Plot 32: Variant 2v8 Upper band edge (Channel 50)

3.6 AC Power-line conducted emissions

3.6.1 Limit

According to 15.207 (a), (c)

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, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN).

Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

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.

3.6.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.6.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.6.4 Test procedure

According to ANSI C63.10-2020 Section 6.2
IRN 439 – Method 1

3.6.5 Measurement uncertainty

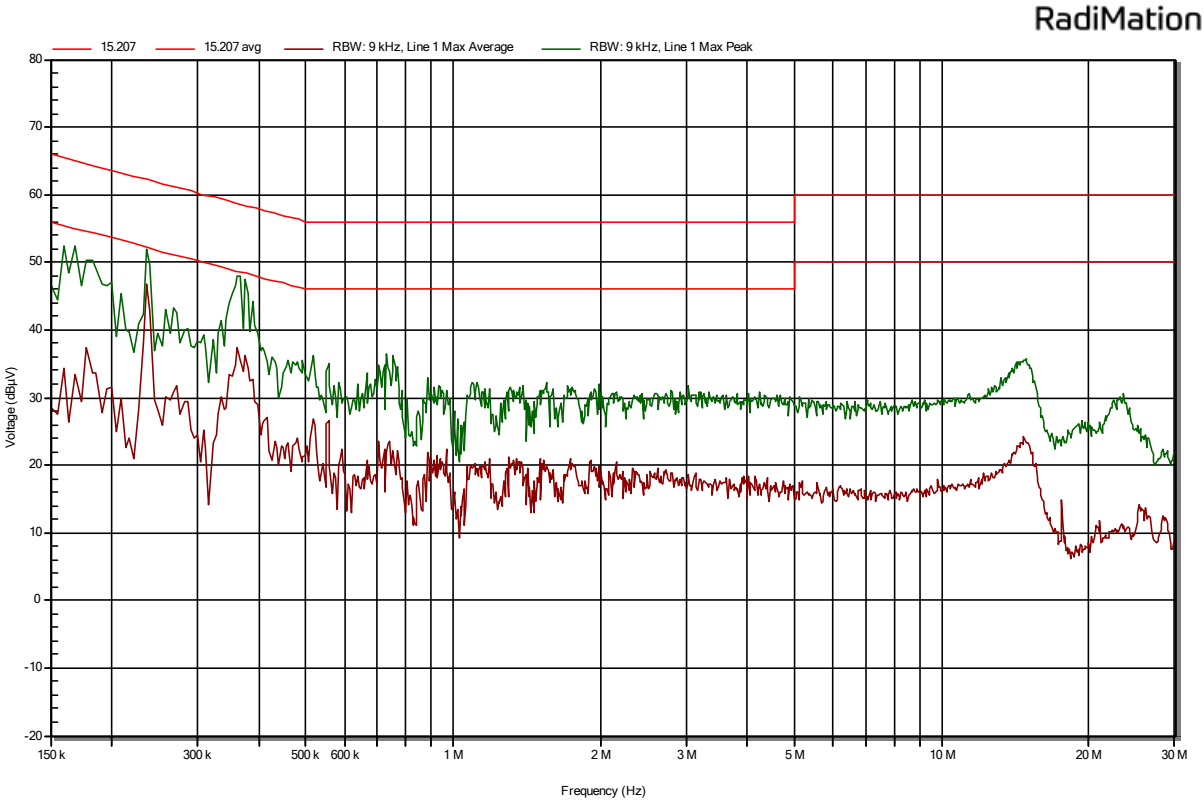
+/- 3.6 dB

3.6.6 AC Power Line Conducted emission data of the EUT, results

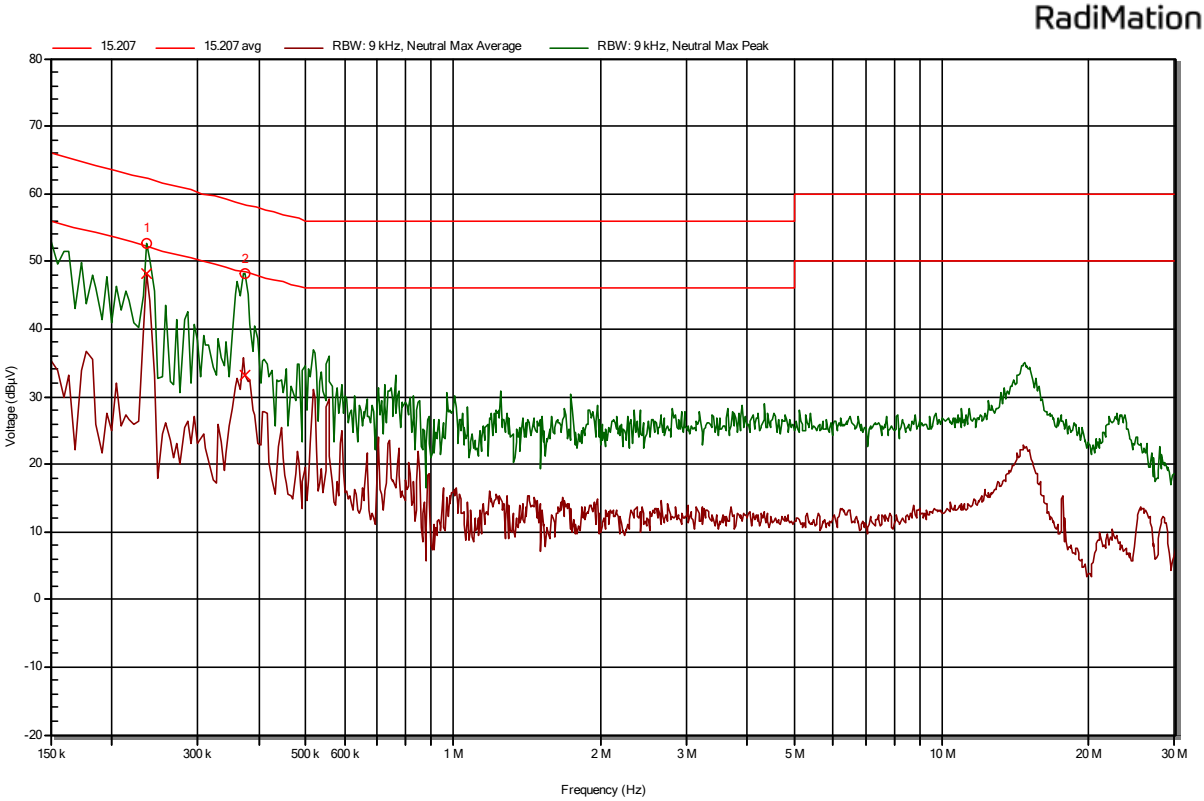
Variant 3v1:

Frequency (kHz)	Peak (dBµV)	QP Limit (dBµV)	Average (dBµV)	AVG Limit (dBµV)	Line	Status
235.5	52.7	62.3	48.2	52.3	Neutral	Pass
375	48.2	58.4	33.2	48.4	Neutral	Pass

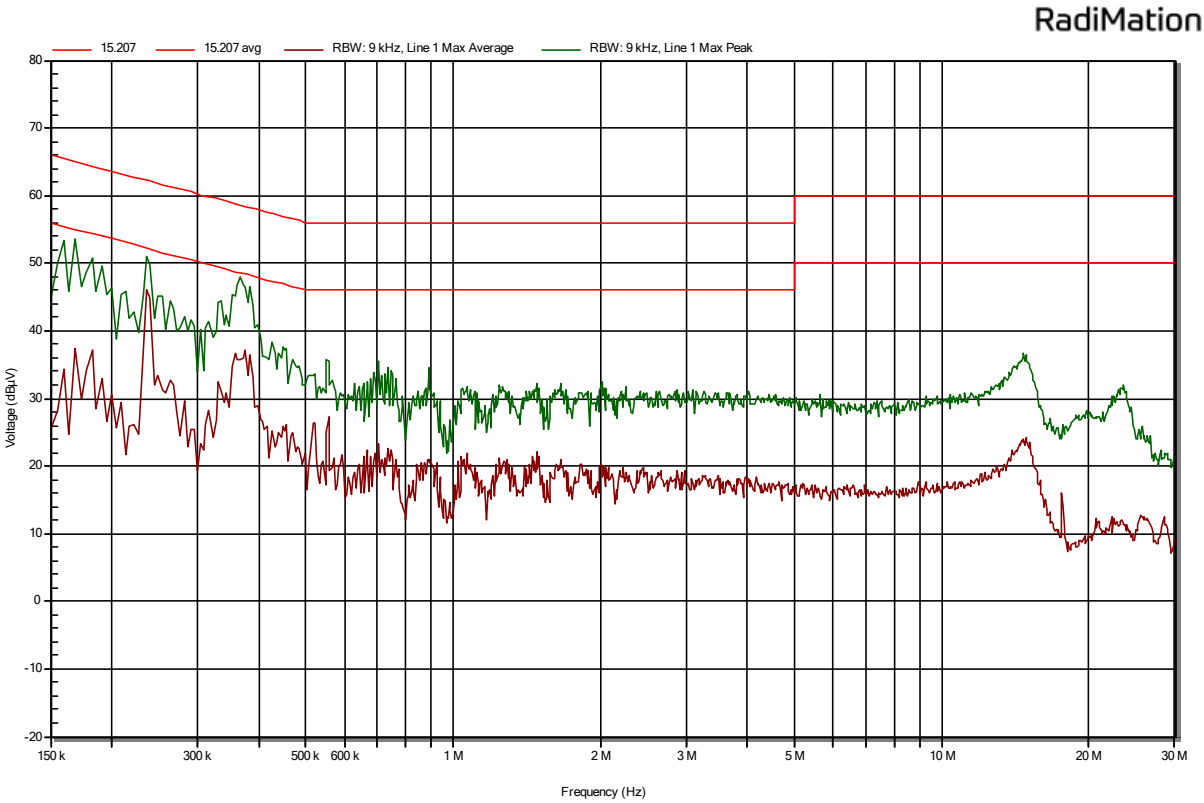
3.6.7 Plots of the AC mains conducted spurious measurement



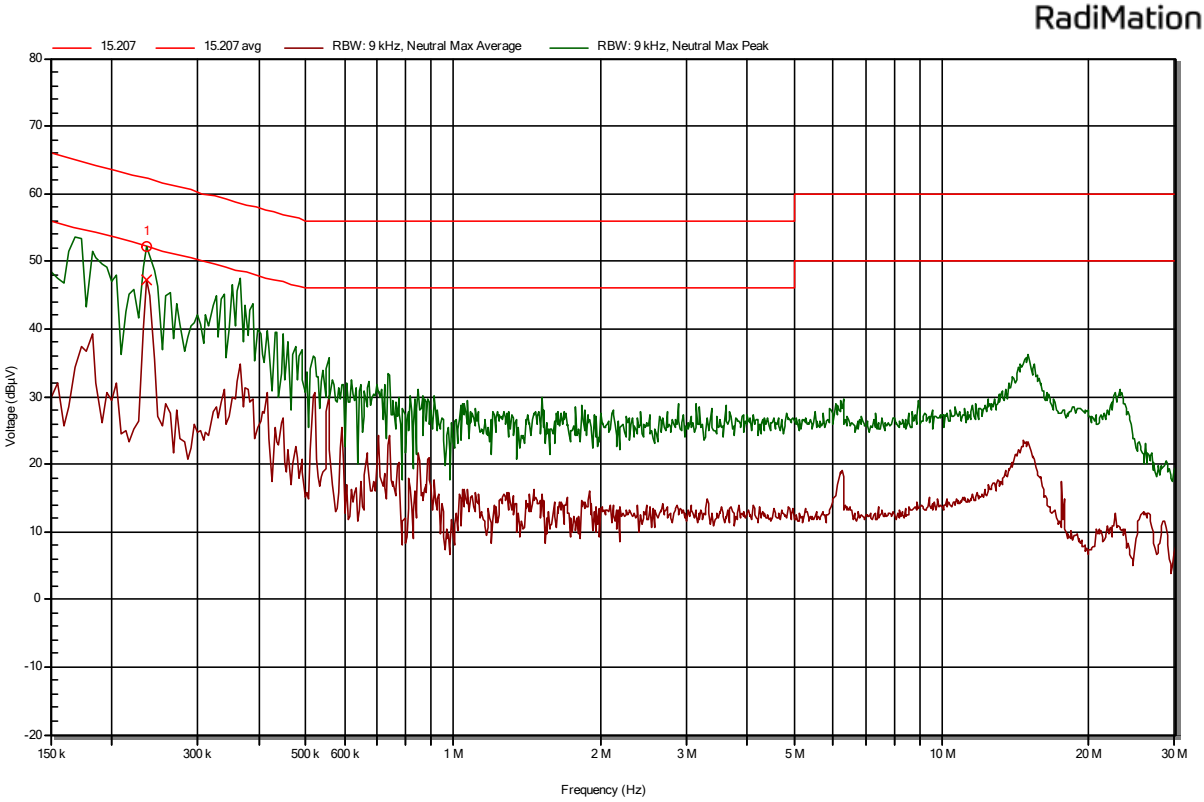
Pre-scan plot with peak detector of the AC Power-line Conducted emissions Variant 3v1 on **Phase**



Pre-scan plot with peak detector of the AC Power-line Conducted emissions Variant 3v1 on **Neutral**



Pre-scan plot with peak detector of the AC Power-line Conducted emissions Variant 2v8 on **Phase**



Pre-scan plot with peak detector of the AC Power-line Conducted emissions Variant 2v8 on **Neutral**

3.7 Dwell Time

3.7.1 Limit

For frequency hopping systems operating in the 902 – 928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

3.7.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.7.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

3.7.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05.
IRN 401 - Method 1

3.7.5 Uncertainty

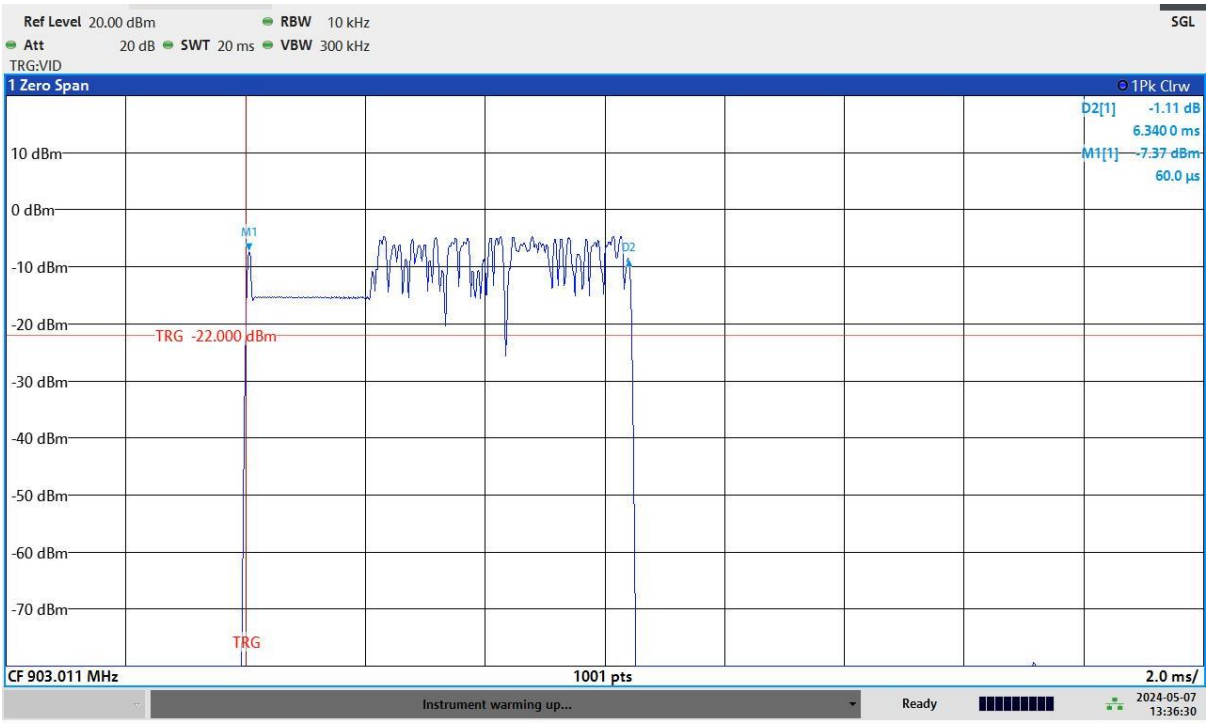
+/- 2.85 %

3.7.6 Test results of Dwell time Measurement

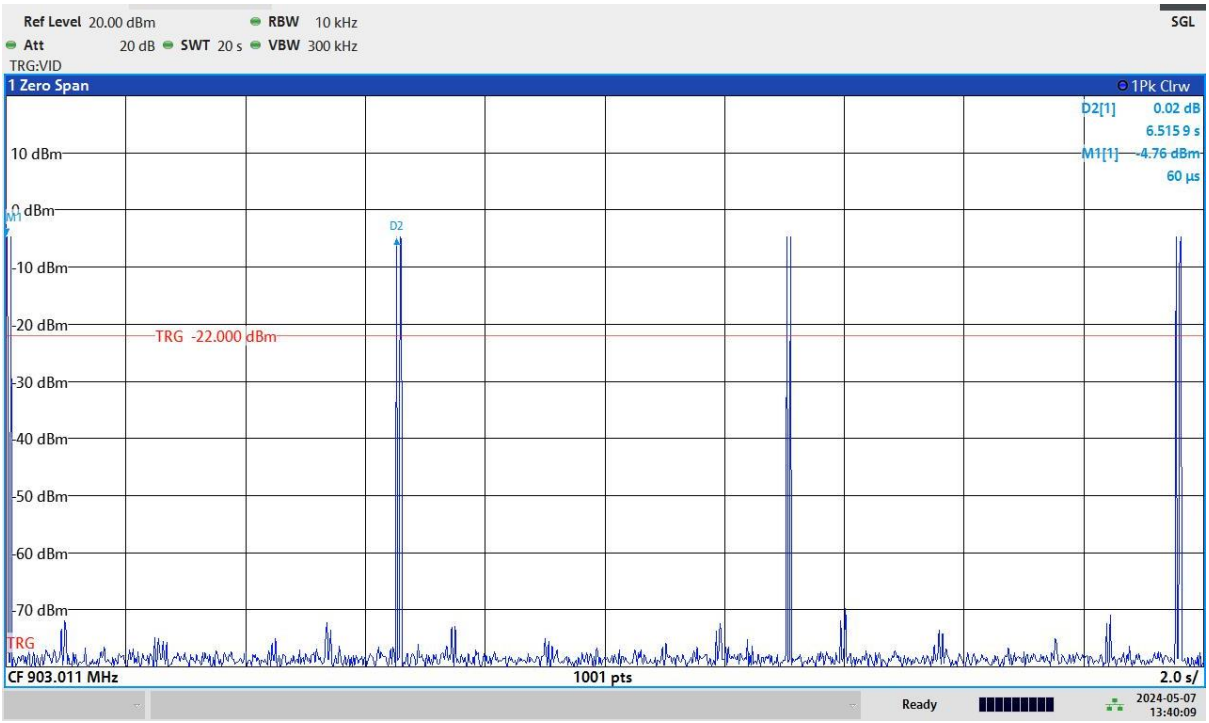
Ton = 6.34 ms
Toff = 6.516 s

In 20 seconds the Ton time = 6.34 x 4 = 25.36 ms.

3.7.7 Plots for the Dwell time measurement



Ton time



Ton time in 20 seconds

3.8 Channel separation

3.8.1 Limit

Frequency hopping systems operating in the 902 – 928 MHz shall have hopping frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

3.8.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.8.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

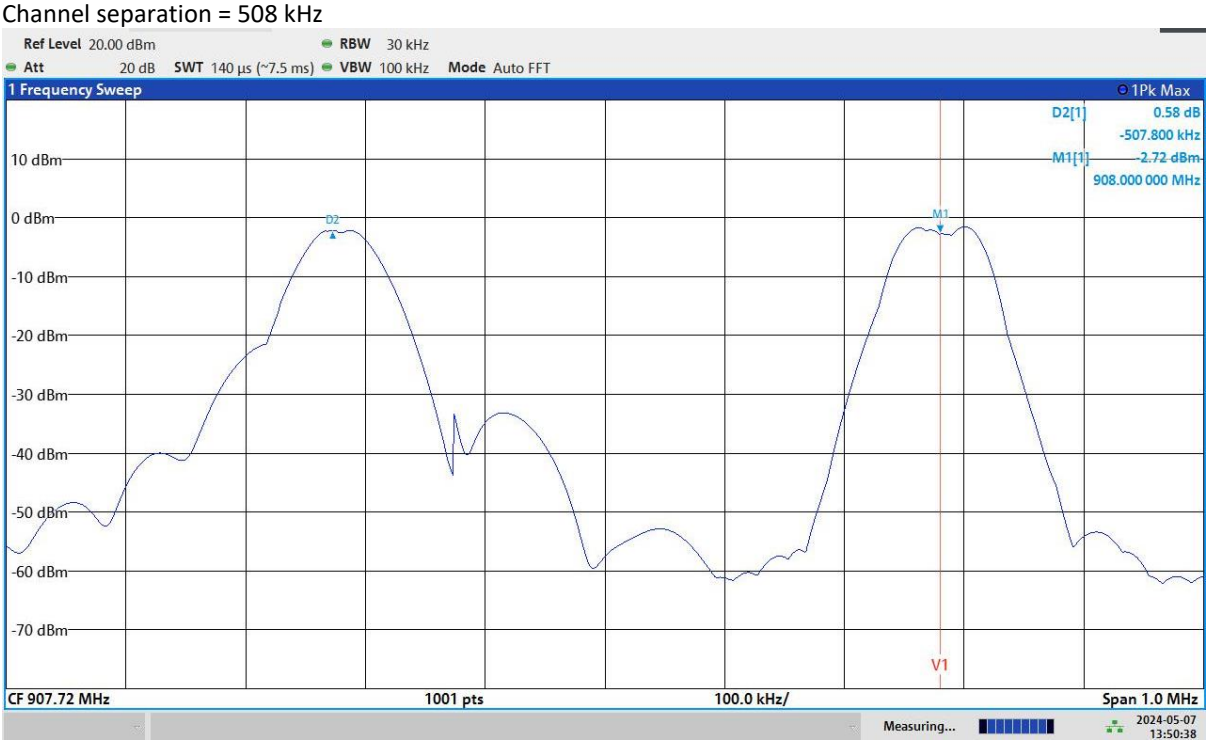
3.8.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05.
IRN 400 - Method 3

3.8.5 Test results of Channel separation Measurement

F1 = 907.492 MHz
F2 = 908 MHz

Channel separation = 508 kHz



3.9 Number of hopping channels

3.9.1 Limit

For frequency hopping systems operating in the 902 – 928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.

3.9.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.9.3 Test setup

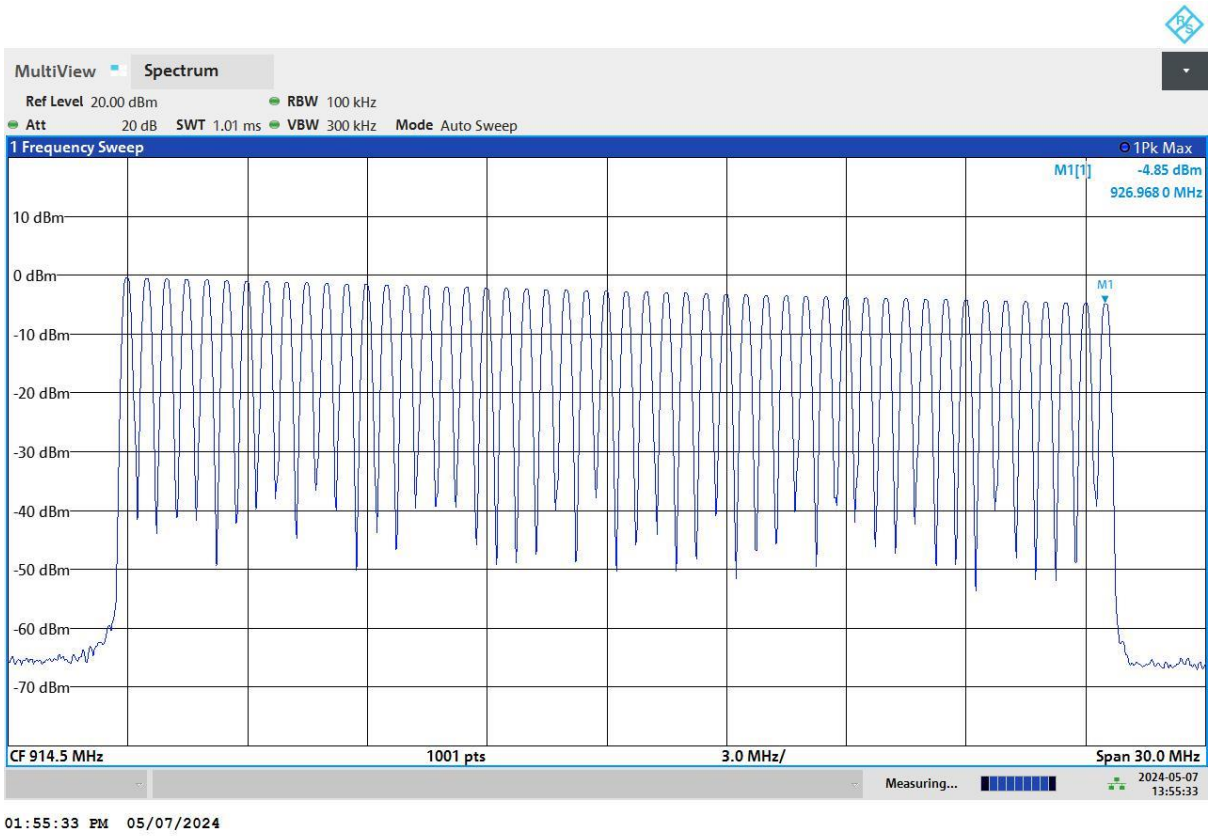
The test setup is as shown in chapter 2.3 of this report.

3.9.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05.
IRN 400 - Method 2

3.9.5 Test results of Dwell time Measurement

The EUT uses 50 hopping channels



4 Sample calculations

All formulas for data conversions and conversion factors are reported in this chapter.

Conducted emission Measurement:

U_{lisn} (dBµV) = U (dBµV) + Corr. (dB)

Where:
U = Measuring receiver voltage
LISN insertion loss = Voltage division factor of LISN
Corr. = sum of single correction factors of used LISN, cables and pulse limiter.
Linear interpolation will be used for frequencies in between the values in the table.

Frequency (MHz)	**Voltage division LISN (db)**	**Cable loss (dB)**	**Corr. (dB)**
	114379 SN: 230000813 Rohde & Schwarz ENV 216	**TE 11134**	
0,15	9.7	0.02	9.72
0,2	9.68	0.03	9.71
0,3	9.68	0.03	9.71
0,5	9.69	0.08	9.77
0,7	9.69	0.25	9.94
0,8	9.69	0.25	9.94
1	9.68	0.11	9.79
2	9.7	0.15	9.85
3	9.71	0.21	9.92
5	9.72	0.21	9.93
7	9.76	0.25	10.01
8	9.77	0.25	10.02
10	9.77	0.29	10.06
15	9.84	0.34	10.18
20	9.88	0.37	10.25
25	9.97	0.43	10.4
30	10.08	0.45	10.53

Magnetic field strength measurement:

$$H\left[dB\left(\mu\frac{A}{m}\right)\right] = V[dB(\mu V)] + L_c[dB] + AF^H[\frac{dB}{\Omega m}]$$

Where:
H is the magnetic field strength (to be compared to the limit)
V is the voltage level measured by the receiver or spectrum analyzer
L_C is the cable loss
AF^H is the magnetic antenna factor

Frequency (MHz)	AF (dB/Ωm) 114515 EMCO 6505 S/N:9112-2710	CL (dB) SAR cable	Corr. (dB)
0,009	-32,35	0,7	-31,65
0,01	-33,16	0,05	-33,11
0,02	-37,56	0,07	-37,49
0,03	-39,29	0,1	-39,19
0,04	-40,11	0,1	-40,01
0,1	-41,27	0,1	-41,17
0,2	-41,48	0,1	-41,38
0,5	-41,58	0,1	-41,48
1	-41,62	0,2	-41,42
3	-41,6	0,2	-41,4
5	-41,65	0,3	-41,35
10	-42,11	0,6	-41,51
15	-42,88	0,9	-41,98
20	-43,78	1	-42,78
25	-44,85	0,7	-44,15
27	-45,36	1,2	-44,16
30	-46,25	1	-45,25

Field Strength Measurement:

E (dBµV/m) = U(dBµV) + AF (dB/m) + Corr. (dB)

Where:
E = Electric field strength
U = Measuring receiver voltage
AF = Antenna factor
CL = Cable loss

Corr. = sum of single correction factors of used cable and amplifier (if applicable).
Linear interpolation will be used for frequencies in between the values in the table.
Tables shows an extract of the values.

Frequency (MHz)	**AF (dB/m)** **ID: 114436** **VHA 9103 + BBA 9106** **SN: 9856**	**Cable loss (dB)** **Id: SAR cable**	**Corr. (dB)**
30	18.6	0.68	19.28
100	10.4	1.15	11.55
150	14.8	1.41	16.21
200	16.0	1.63	17.63
250	16.9	1.93	18.83

Frequency (MHz)	**Gain (dBi)** **ID: 114385** **EMCO LPDA** **SN: 9856**	**Cable loss (dB)** **Id: SAR cable**	**Corr. (dB)**
250	11.8	1.93	13.73
300	13	2.12	15.12
350	15.6	2.2	17.8
400	17.1	2.29	19.39
450	17.3	2.53	19.83
500	17.7	2.67	20.37
550	18.4	2.9	21.3
600	19.2	3.02	22.22
650	19.7	3.09	22.79
700	20.3	3.22	23.52
750	21.4	3.56	24.96
800	22	3.69	25.69
900	22.1	3.81	25.91
950	22.6	3.91	26.51
1000	22.5	4.3	26.8

Frequency (MHz)	AF (dB/m) Kiwa ID: 114607 Emco 3115 SN: 9412-4377	Gain (dB) Kiwa ID: 114693 Miteq JS4-18004000-30-8P-A1	Cable loss (dB) TE 01315	Corr. (dB)
1000	23,6	40,4	2,0	66
1500	25,1	40,5	2,4	68
2000	27,1	40,5	2,7	70,3
2500	28,6	40,7	3,2	72,5
3000	30,5	40,7	3,2	74,4
3500	31,2	40,7	3,4	75,3
4000	32,7	40,9	4,9	78,5
4500	32,4	40,9	4,4	77,7
5000	33,2	40,7	4,6	78,5
5500	34,0	40,5	4,5	79
6000	34,6	40,0	5,2	79,8
6500	34,3	39,4	5,9	79,6
7000	35,2	38,6	5,7	79,5
7500	36,4	39,2	5,9	81,5
8000	37,0	38,9	6,3	82,2
8500	37,5	38,4	6,4	82,3
9000	38,1	37,4	6,5	82
9500	37,8	37,0	7,1	81,9
10000	38,2	36,5	7,3	82
10500	38,1	36,7	7,6	82,4
11000	38,3	36,9	8,3	83,5
11500	38,5	37,6	8,1	84,2
12000	39,1	38,3	8,4	85,8
12500	38,7	38,5	8,3	85,5
13000	39,2	38,9	9,2	87,3
13500	40,5	40,2	8,3	89
14000	41,1	40,0	8,2	89,3
14500	41,4	40,1	8,2	89,7
15000	40,2	41,4	8,3	89,9
15500	37,9	41,4	8,6	87,9
16000	37,5	42,8	9,2	89,5
16500	38,6	42,3	8,8	89,7
17000	41,1	43,1	9,4	93,6
17500	42,7	43,2	9,4	95,3
18000	44,0	44,2	9,8	98

Frequency (MHz)	AF (dB/m) Kiwa ID: 114518 Flann 20240-25 SN: 163703	Gain (dB) Kiwa ID:114693 Miteq JS4-18004000-30-8P-A1	Cable loss (dB) TE 01315	Corr. (dB)
18000	31,3	26,2	9,8	67,3
19000	31,5	26,1	9,6	67,2
20000	31,7	25,9	11	68,6
21000	31,9	24,3	10,7	66,9
22000	32,1	18,3	10,5	60,9
23000	32,2	18,9	10,8	61,9
24000	32,3	23,6	11,4	67,3
25000	32,4	24,5	11,6	68,5
26000	32,5	25,3	11,7	69,5

<< END OF REPORT>>