

Hammerholmen 45A
2650 Hvidovre
Denmark
+45 7070 1499
info@ektos.net

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FCC reg. no.: DK0002
ISED CAB identifier: DK0001

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Test Report

of

Model: NFC MUX Part No.:60091945

according to

FCC 47 CFR, Part 15 Subpart C
15.225 Operation within the band 13.110 – 14.010 MHz
and
ISED RSS-210 Annex B.6 Band 13.110 – 14.010 MHz

Performed by



Søren Søltøft
Senior EMC Engineer

Examined by



Volodymyr Hraivoronskyi
Test Engineer, M. Sc. EE..



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Report no.:	P23-0165-1	Report date:	2024-07-16
Test started:	2024-02-15	Test ended:	2024-06-26
Test laboratory:	EKTOS TRS A/S Hammerholmen 45A 2650 Hvidovre Denmark	Client:	Lattec I/S Gydevang 21 3450 Allerød Denmark
Contact person:	Jens Denborg	Contact person:	John Slaaby
Facility reg. no.	FCC Designation number: DK0002 ISED CAB identifier: DK0001		
Test specimen:	Model: NFC MUX Part No.:60091945		
Test specification:	FCC 47 CFR Part 15 Subpart C 15.225 Operation within the band 13.110 – 14.010 MHz. ISED RSS-210 Annex B.6 Band 13.110 – 14.010 MHz. The tests relevant for the test specimens are listed in <i>section 1.1</i> .		
Documentation:	This test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory. The complete test documentation is archived for 10 years at the testing laboratory.		
Test results:	The test specimen complies with relevant parts of the test specifications. The test results relate only to the specimen tested.		
Test personnel:	Søren Søltøft	Janus Andersen	

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Appendix issued in separate report

- 1 Photos of test setups and equipment.

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1 SUMMARY

See Appendix 1 for photos.

Emission measurements as specified below have been performed.

1.1 Test plan

Standard	Name of the test	Results
FCC 47 CFR Part 15C	15.225 Operation within the band 13.110 – 14.010 MHz	PASSED
RSS 210 Issue 10	B.6 Band 13.110 – 14.010 MHz	PASSED
15.225 (a) RSS 210 B.6 (a)	Field strength of fundamental emission	PASSED
15.225 (b), (c) RSS 210 B.6 (b), (c)	Field strength of in band emission	PASSED
15.225 (d) RSS 210 B.6 (d)	Emission outside frequency band	PASSED
15.225 (e) RSS 210 B.6	Frequency stability	PASSED
15.203 RSS-Gen 6.8	Antenna requirement	No verdict
15.207 (a) RSS-Gen 8.8	AC conducted emission	PASSED
15.215 (c) RSS-Gen 6.7	Occupied bandwidth	PASSED

PASSED The test was performed and the test specimen complies with the essential requirements in the standard.
 FAILED The test was performed and the test specimen does not comply with the essential requirements in the standard.
 REF The test is covered by a test in another report and/or on a similar test specimen.
 NR The test is not relevant for the test specimen or has been waived by the manufacturer.

1.2 Test specimens

1.2.1 NFC MUX

Manufacturer	Lattec I/S
Name	NFC MUX
Part No.	60091945
Supply voltage	5 VDC
Carrier frequency	13.56 MHz
Antenna	External
Supply voltage	5 VDC from Arduino supply or 5 VDC from dedicated input.

NFC MUX and NFC Antenna are an NFC reader/transmitter system operation at 13.56MHz. NFC MUX is designed for the protocol ISO/IEC14443A based on the chip NXP CLRC66301HN (1). The NFC front-end chip CLRC6630 connected to an analog multiplexer TMUX1109 able to switch between 4 antennas. Only one antenna can be active at a time.

NFC MUX must be mounted on a host PCB by the two pin headers with power and I2C communication.

NFC MUX is a common module for further Lattec products, not for third party products.

See photo in appendix 1.

1.2.2 NFC Antenna

Manufacturer	Lattec I/S
Name	NFC Antenna
Part No.	60091966
Identification	PCB 60091965-4
Antenna connector	Molex 5304-70310
Antenna size	29 mm x 29 mm

During tests a NFC Tag was attached to the NFC antenna, to enable normal Read / Write cycle.

See photo in appendix 1.

1.3 Auxiliary Equipment

1.3.1 NFC Mux Base

Manufacturer	Lattec I/S
Name	NFC Mux Base
Model	PCB21-1
Details	-
Supply voltage	USB-C or 6 x 1.5 V AA batteries

See photo in appendix 1.

The NFC Mux Base is a printed circuit board that connects the RJ-45 connector to two row of pin headers for the NFC module. The RJ-45 connector connects to the NFC Mux Controller. No active components are mounted.

1.3.2 NFC Mux Controller

Manufacturer	Lattec I/S
Name	NFC Mux Controller
Model	PCB20-1
Details	-
Supply voltage	Micro-USB or 6 x 1.5 V AA batteries

See photo in appendix 1.

1.3.1 AC/DC power supply

Manufacturer	PULS GmbH
Model	ML15.051
Serial no.	26 876 422
Details	-
Supply voltage	AC 100 – 240 V (120 VAC used during tests)
Output voltage	DC 5-5.5 VDC
Operational mode	Used as typical power supply during conducted emission at 5 VDC

See photo in appendix 1.

2 TESTS

2.1 Field strength of fundamental emission

Test specimen	NFC MUX
Test specification	47 CFR 15.225 (a) RSS 210 B.6 (a)
Test method	ANSI C63.10:2013 sec. 6.4
Comments	The NFC module was tested in stand-alone configuration
Temperature / Humidity	20°C / 38%RH
Dates of measurements	2024-05-17
Test personnel	Bjørn Larsen, Søren Søltøft

2.1.1 Test setup

The test was performed on NFC module with four antennas.

The test specimen was placed 0.8 m above ground at an open area test site without ground plane.

The measurements were performed at a distance of 30 m. The test specimen was rotated for maximal level. The 4 antennas were tested in turns.

See photo of test set up in appendix 1.

2.1.2 Test result

Field strength in the band 13.553 to 13.567 MHz shall not exceed 15848 microvolt / meter at 30m.

The level is converted to dBμV/m.

Antenna	F:S: [dBμV/m]	BW [kHz]	Corr. Fac. [dB]	Ant.	Margin [dB]	Limit [dBμV/m]	Result
0	35.51	9.000	18.64	V	48.49	84.00	PASSED
1	34.61	9.000	18.64	V	49.39	84.00	PASSED
2	35.51	9.000	18.64	V	48.49	84.00	PASSED
3	33.91	9.000	18.64	V	50.09	84.00	PASSED

Table 1. Field strength of fundamental emissions test results.

For result of field strength of fundamental as function of supply voltage see section 2.6 Frequency stability versus supply voltage.

2.1.3 Test equipment

Description	Supplier	Model	Tag no.	Cal. due date
Antenna Magnetic Loop 9 kHz - 30 MHz	Rohde & Schwarz	HFH2-Z2	30119966	2024-07-21
EMI Test Receiver 20Hz-26.5GHz	Rohde & Schwarz	ESI 26	30120763	2025-05-14

Table 2. Radiated emission test equipment.

2.2 Field strength of In band emission

Test specimen	NFC MUX
Test specification	47 CFR 15.225 (a), (b), (c) RSS 210 B.6 (a), (b), (c)
Test method	ANSI C63.10:2013 sec. 6.4
Frequency range	13.110 MHz to 14.010 MHz
Comments	The NFC module was tested in stand-alone configuration
Temperature / Humidity	21°C / 36%RH, 24°C / 35%RH, 24°C / 46%RH
Dates of measurements	2024-02-15, 2024-05-08, 2024-05-23
Test personnel	Søren Søltøft, Janus Andersen

2.2.1 Test setup

Due to high ambient noise level at open area test site the measurements were performed in a semi anechoic chamber.

The test was performed on NFC module stand alone with one antenna active one at a time.

The test specimen was placed in vertical position 0.8 m above ground, and rotated 0 to 360 deg. during measurement. The measurement distance was 3 meters and the antenna height was 1 meter. The measurement was performed with the antenna in parallel (V), perpendicular (V-90) and ground-parallel (H) orientations.

See photo of test set up in appendix 1.

The limits below 30 MHz was recalculated to a 3 m. distance, using the method described in ANSI C63.10-2013 clause 6.4.4.2 Extrapolation from the measurement of a single point.

The largest test specimen, for which this applies, is 0.625 times the wavelength. The smallest wavelength is 10 m. at 30 MHz, which gives a maximal test specimen size of 6.25 meters.

Frequency range	$d_{\text{nearfield}}$ [m]	d_{limit} [m]	d_{measure} [m]	Recalculation formula
9 kHz to 159 kHz	>300	300	3	$-40 \log(d_{\text{limit}} / d_{\text{measure}})$
159 kHz to 490 kHz	97.49 to 300	300	3	$-40 \log(d_{\text{near field}} / d_{\text{measure}}) - 20 \log(d_{\text{limit}} / d_{\text{near field}})$
490 kHz to 1.592 MHz	30 to 97.49	30	3	$-40 \log(d_{\text{limit}} / d_{\text{measure}})$
1.592 MHz to 15.923 MHz	3 to 30	30	3	$-40 \log(d_{\text{near field}} / d_{\text{measure}}) - 20 \log(d_{\text{limit}} / d_{\text{near field}})$
15.923 MHz to 30 MHz	< 3	30	3	$-20 \log(d_{\text{limit}} / d_{\text{measure}})$

2.2.2 Test result

2.2.2.1 Antenna 0

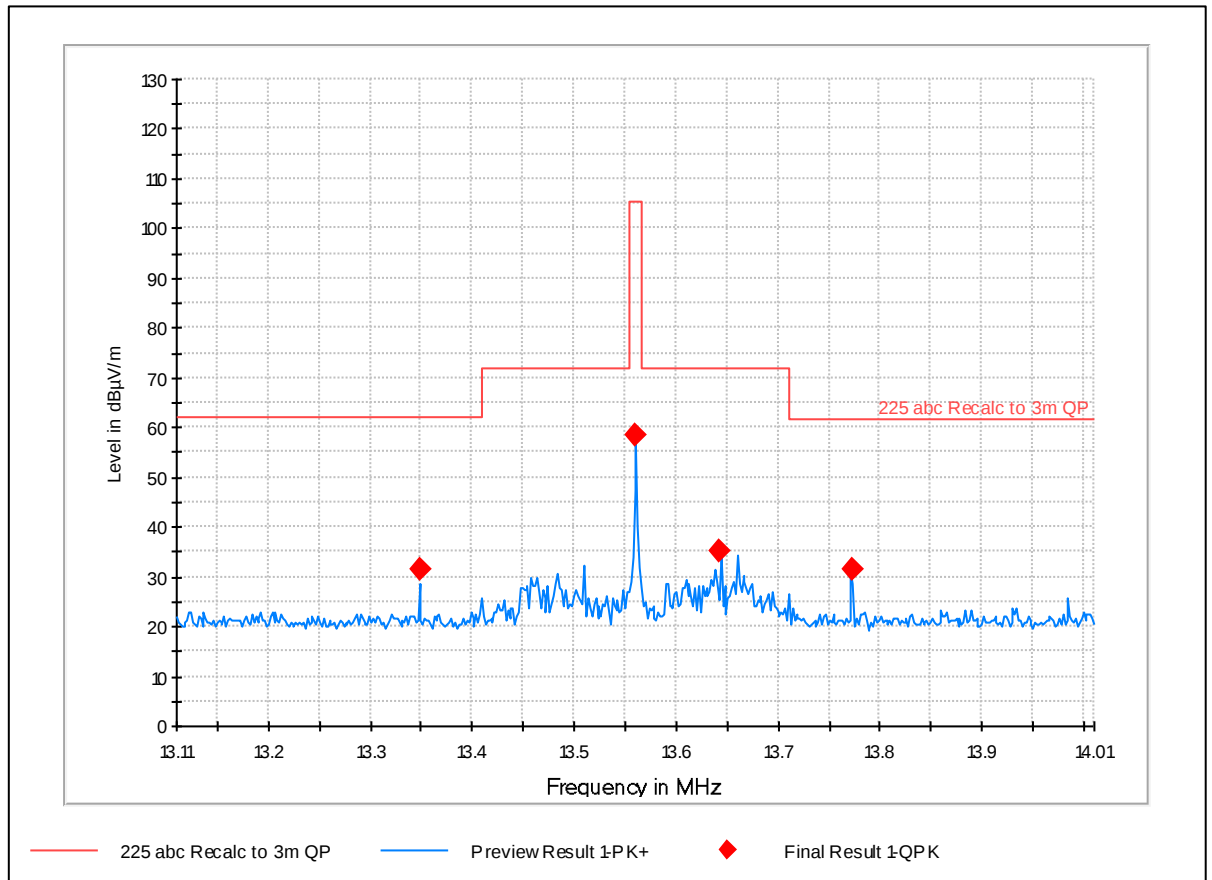


Figure 1. Field strength of In band emissions test results. Antenna vertical.

Frequency [MHz]	QuasiPeak [dBμV/m]	BW [kHz]	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
13.348576	31.7	9.000	144.0	30.40	62.00	PASSED
13.560202	58.5	9.000	162.0	46.90	105.40	PASSED
13.642368	35.0	9.000	141.0	36.90	71.80	PASSED
13.772824	31.7	9.000	180.0	30.10	61.80	PASSED

Table 3. Field strength of In band emissions test results. Antenna vertical.

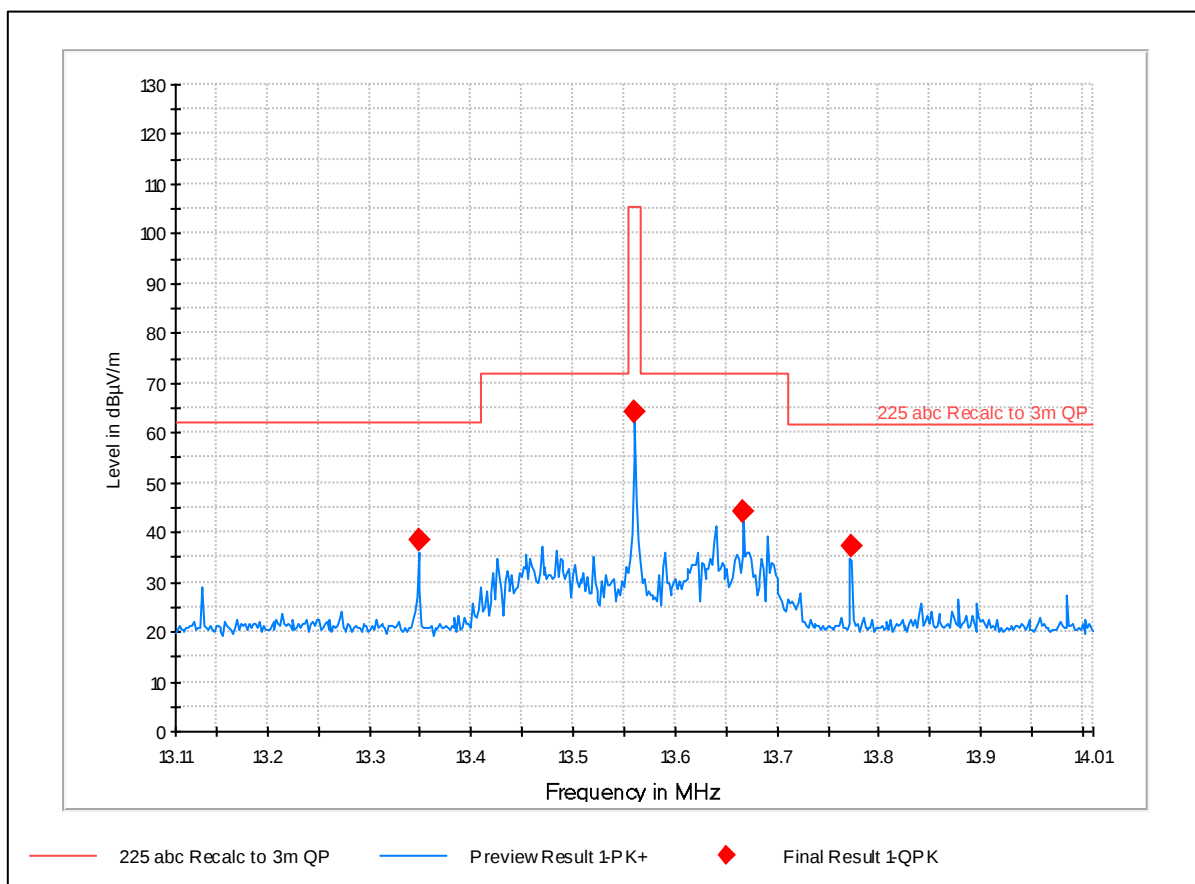


Figure 2. Field strength of In band emissions test results. Antenna vertical-90.

Frequency [MHz]	QuasiPeak [dBμV/m]	BW [kHz]	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
13.348576	38.4	9.000	61.0	23.60	62.00	PASSED
13.560202	64.1	9.000	65.0	41.30	105.40	PASSED
13.666615	44.1	9.000	45.0	27.70	71.80	PASSED
13.772024	37.1	9.000	84.0	24.60	61.80	PASSED

Table 4. Field strength of In band emissions test results. Antenna vertical-90.

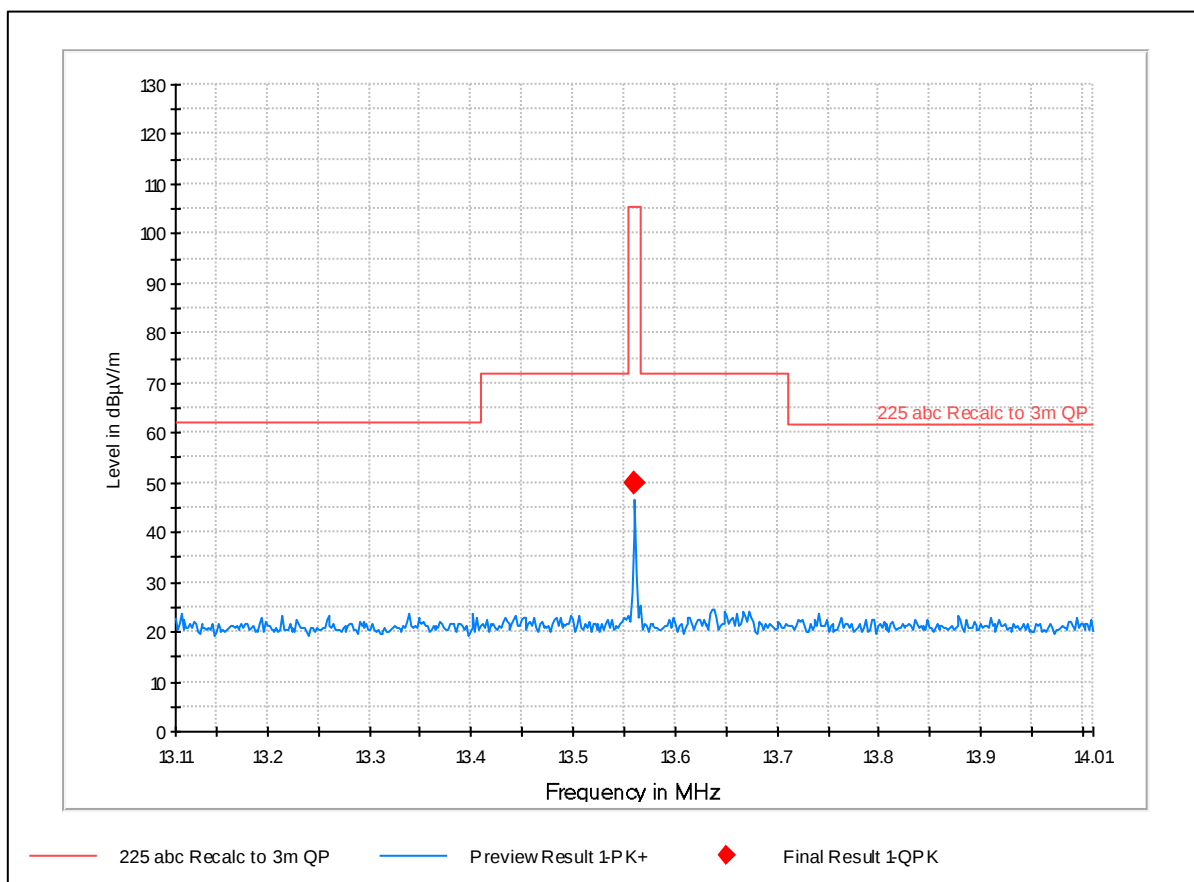


Figure 3. Field strength of In band emissions test results. Antenna horizontal.

Frequency [MHz]	QuasiPeak [dBμV/m]	BW [kHz]	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
13.560202	50.1	9.000	-33.0	55.30	105.40	PASSED

Table 5. Field strength of In band emissions test results. Antenna horizontal.

2.2.2.2 Antenna 1

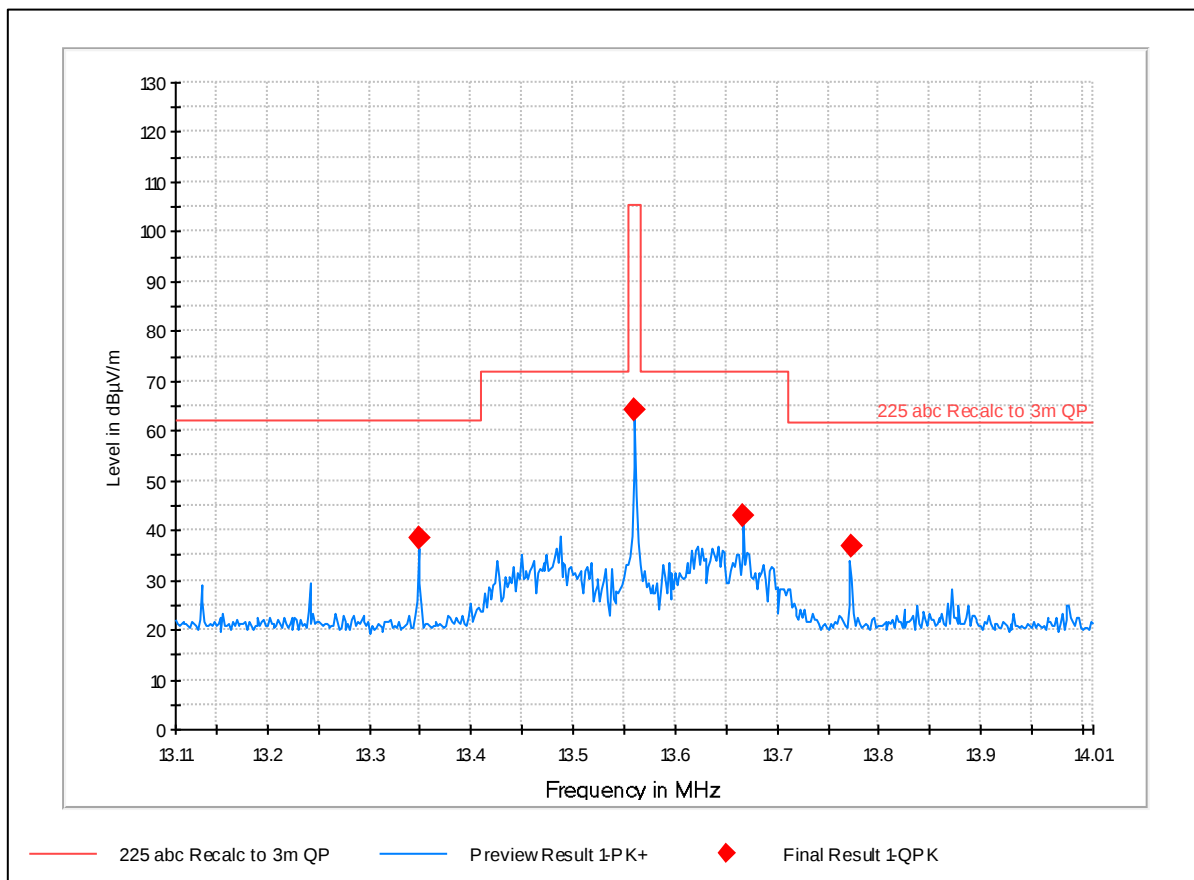


Figure 4. Field strength of In band emissions test results. Antenna vertical.

Frequency [MHz]	QuasiPeak [dBμV/m]	BW [kHz]	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
13.348176	38.3	9.000	229.0	23.70	62.00	PASSED
13.560202	64.4	9.000	245.0	41.00	105.40	PASSED
13.667015	43.1	9.000	267.0	28.70	71.80	PASSED
13.772424	36.8	9.000	233.0	24.90	61.80	PASSED

Table 6. Field strength of In band emissions test results. Antenna vertical.

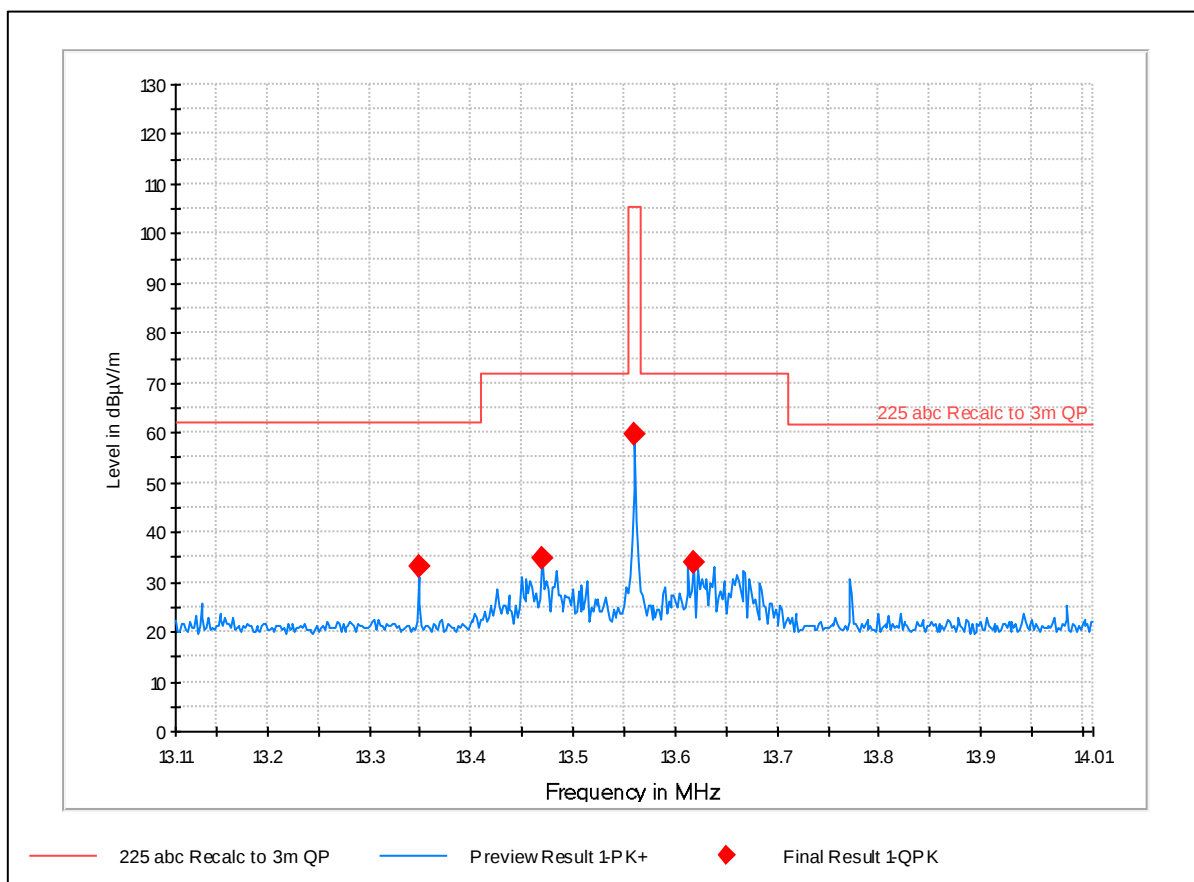


Figure 5. Field strength of In band emissions test results. Antenna vertical-90.

Frequency [MHz]	QuasiPeak [dBμV/m]	BW [kHz]	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
13.348576	33.1	9.000	-22.0	28.90	62.00	PASSED
13.470218	34.8	9.000	312.0	37.10	71.90	PASSED
13.560202	59.7	9.000	-25.0	45.70	105.40	PASSED
13.619117	34.0	9.000	136.0	37.90	71.80	PASSED

Table 7. Field strength of In band emissions test results. Antenna vertical-90.

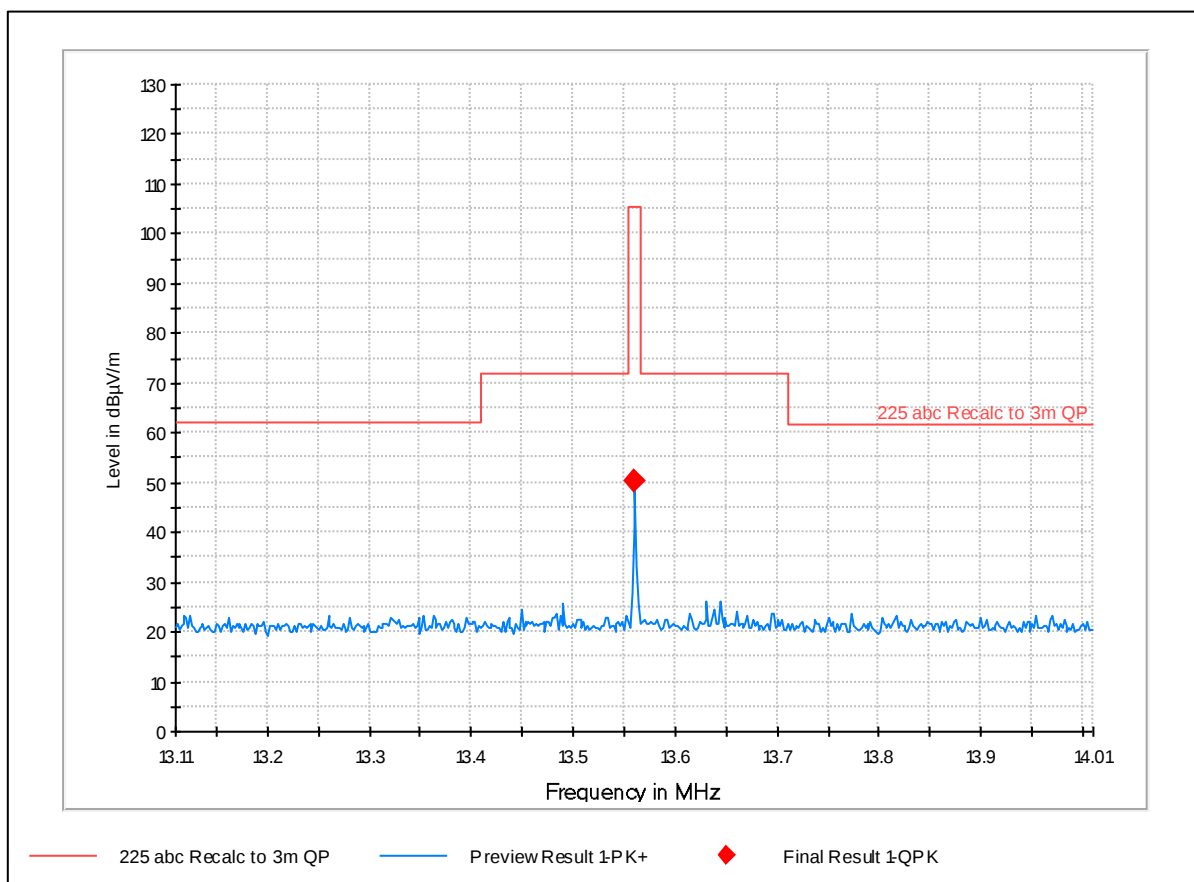


Figure 6. Field strength of In band emissions test results. Antenna horizontal.

Frequency [MHz]	QuasiPeak [dBμV/m]	BW [kHz]	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
13.560202	50.4	9.000	-25.0	55.00	105.40	PASSED

Table 8. Field strength of In band emissions test results. Antenna horizontal.

2.2.2.3 Antenna 2

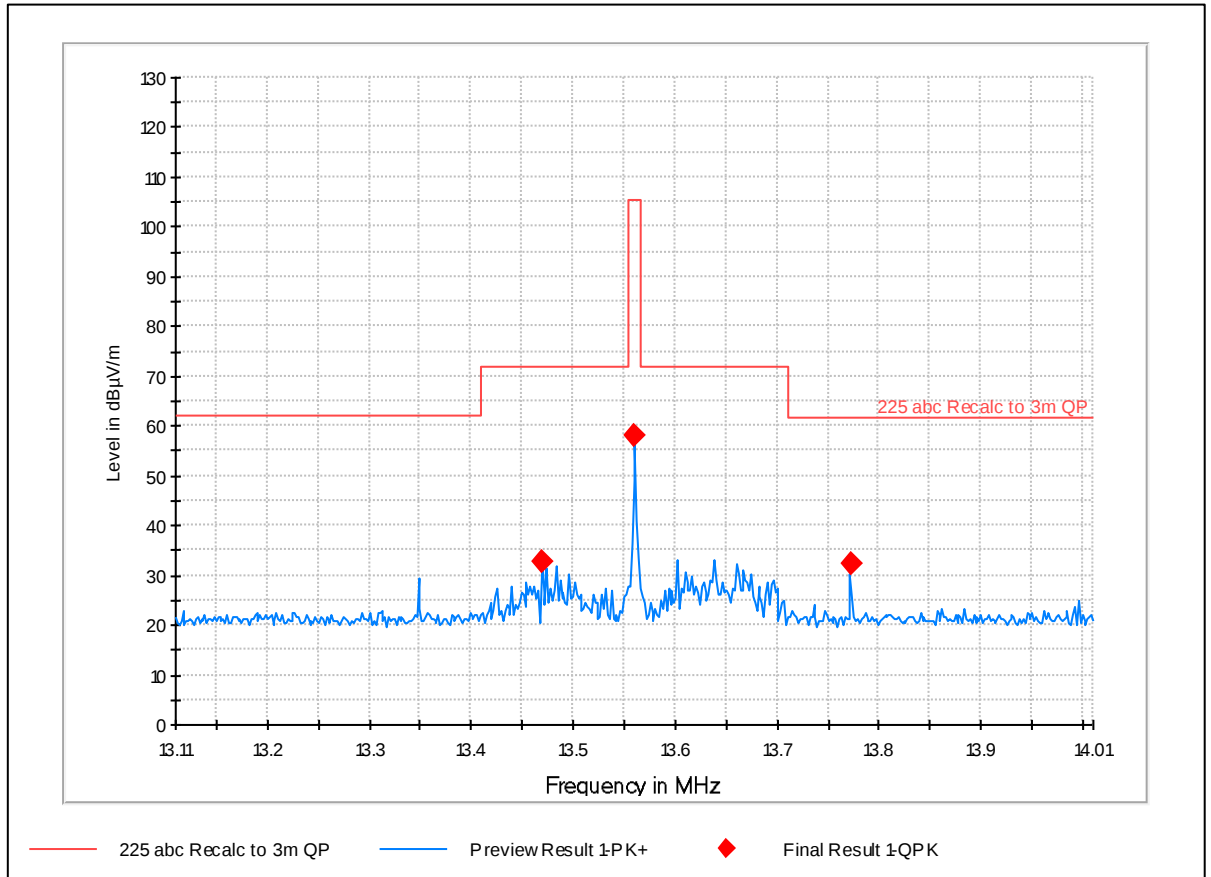


Figure 7. Field strength of In band emissions test results. Antenna vertical.

Frequency [MHz]	QuasiPeak [dBμV/m]	BW [kHz]	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
13.469818	32.6	9.000	180.0	39.30	71.90	PASSED
13.560202	58.2	9.000	155.0	47.20	105.40	PASSED
13.772424	32.3	9.000	144.0	29.40	61.80	PASSED

Table 9. Field strength of In band emissions test results. Antenna vertical.

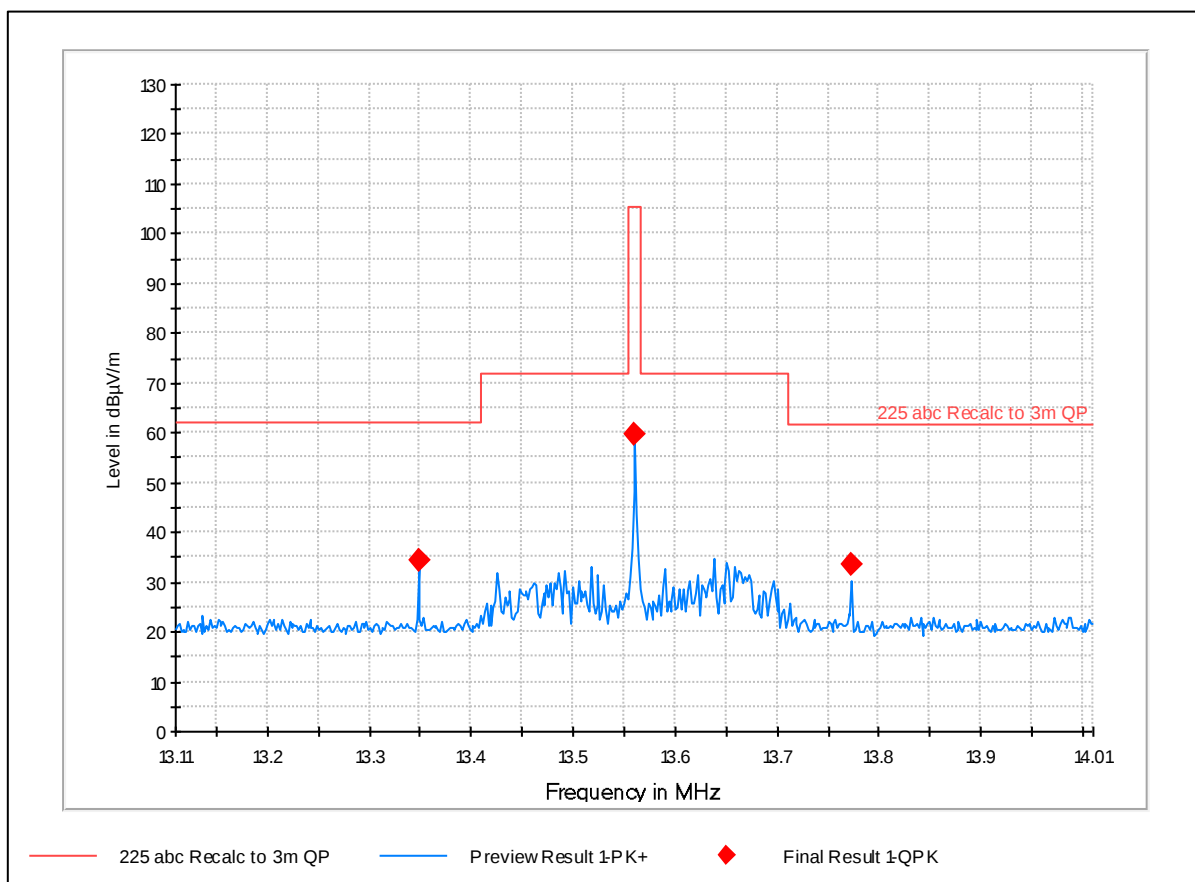


Figure 8. Field strength of In band emissions test results. Antenna vertical-90.

Frequency [MHz]	QuasiPeak [dBμV/m]	BW [kHz]	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
13.348576	34.4	9.000	57.0	27.70	62.00	PASSED
13.560602	59.8	9.000	57.0	45.60	105.40	PASSED
13.772227	33.4	9.000	61.0	28.40	61.80	PASSED

Table 10. Field strength of In band emissions test results. Antenna vertical-90.

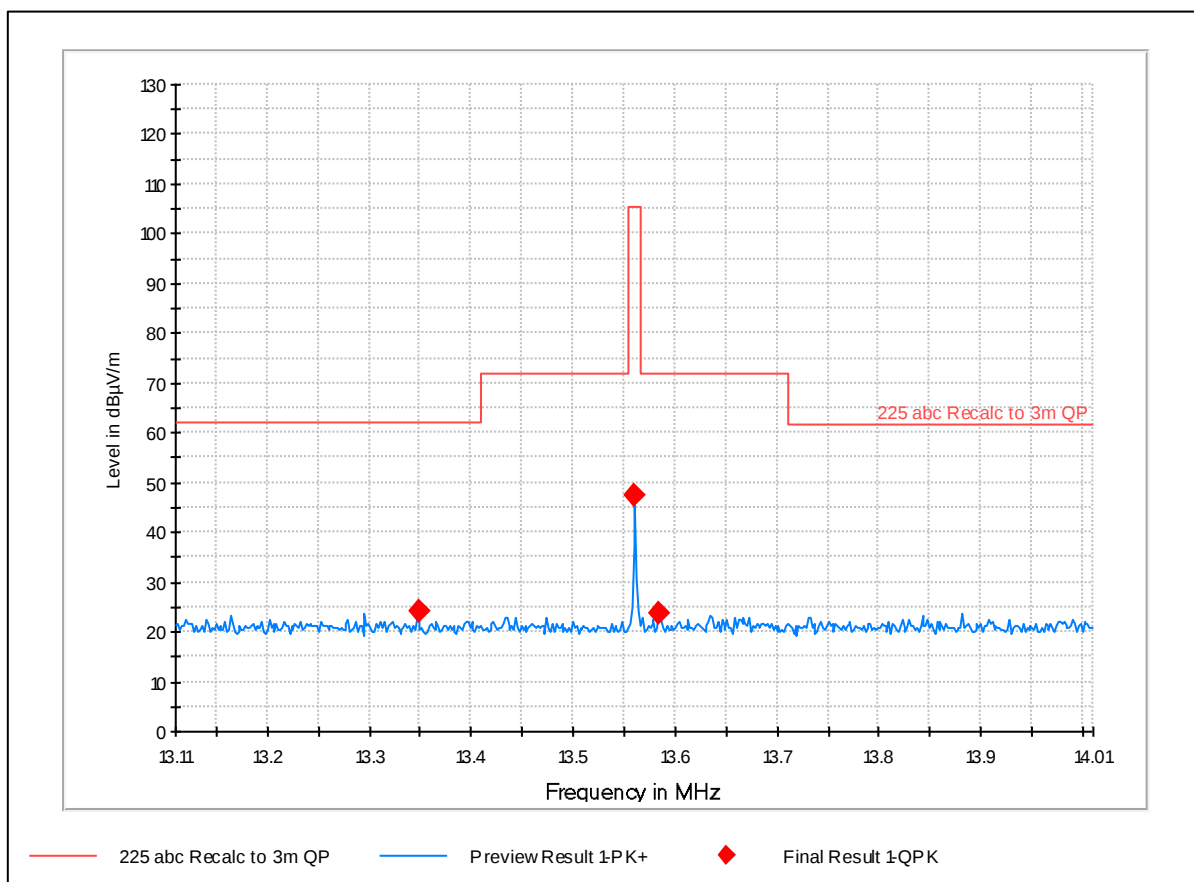


Figure 9. Field strength of In band emissions test results. Antenna horizontal.

Frequency [MHz]	QuasiPeak [dBμV/m]	BW [kHz]	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
13.348176	24.2	9.000	-22.0	37.80	62.00	PASSED
13.560202	47.6	9.000	315.0	57.80	105.40	PASSED
13.584849	23.5	9.000	237.0	48.40	71.90	PASSED

Table 11. Field strength of In band emissions test results. Antenna horizontal.

2.2.2.4 Antenna 3

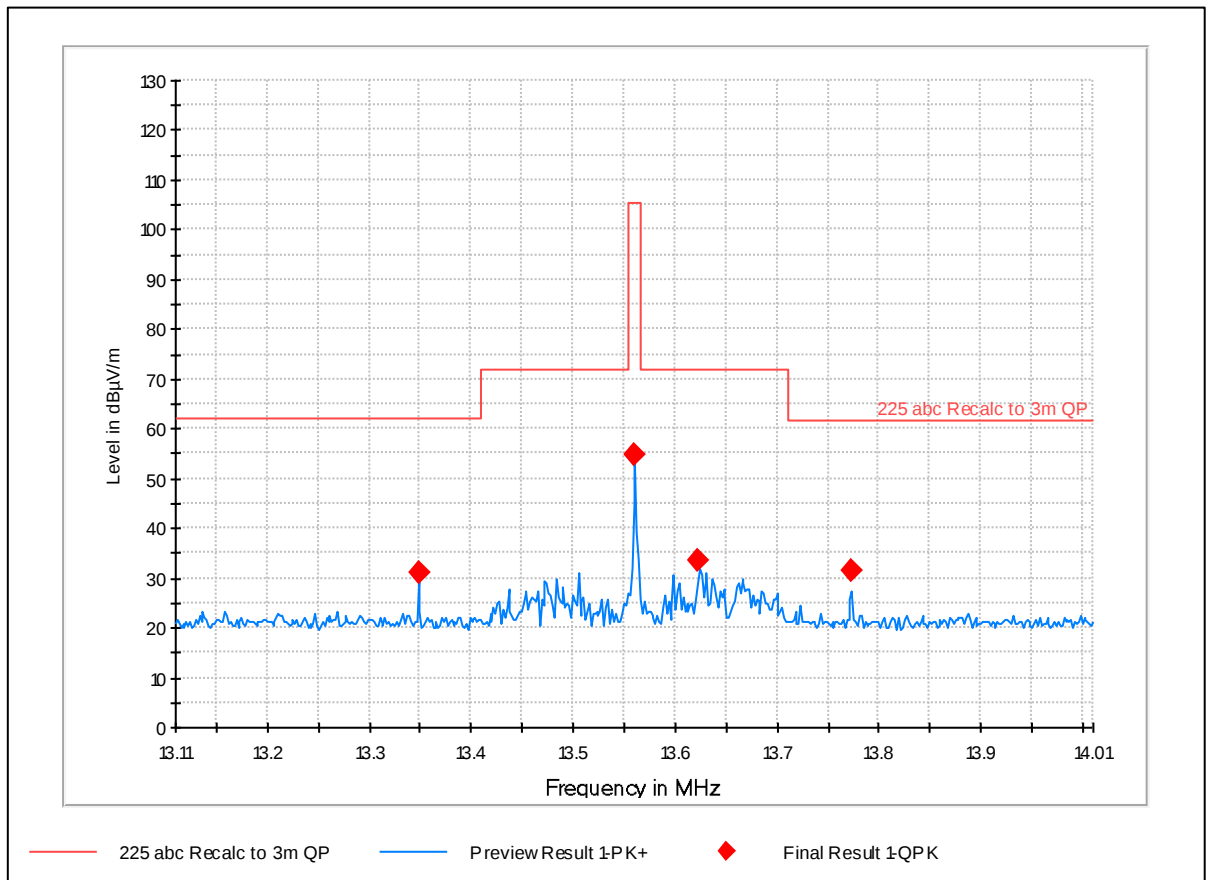


Figure 10. Field strength of In band emissions test results. Antenna vertical.

Frequency [MHz]	QuasiPeak [dBμV/m]	BW [kHz]	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
13.348176	31.1	9.000	141.0	30.90	62.00	PASSED
13.560202	54.7	9.000	331.0	50.70	105.40	PASSED
13.622928	33.5	9.000	129.0	38.30	71.80	PASSED
13.772227	31.3	9.000	157.0	30.50	61.80	PASSED

Table 12. Field strength of In band emissions test results. Antenna vertical.

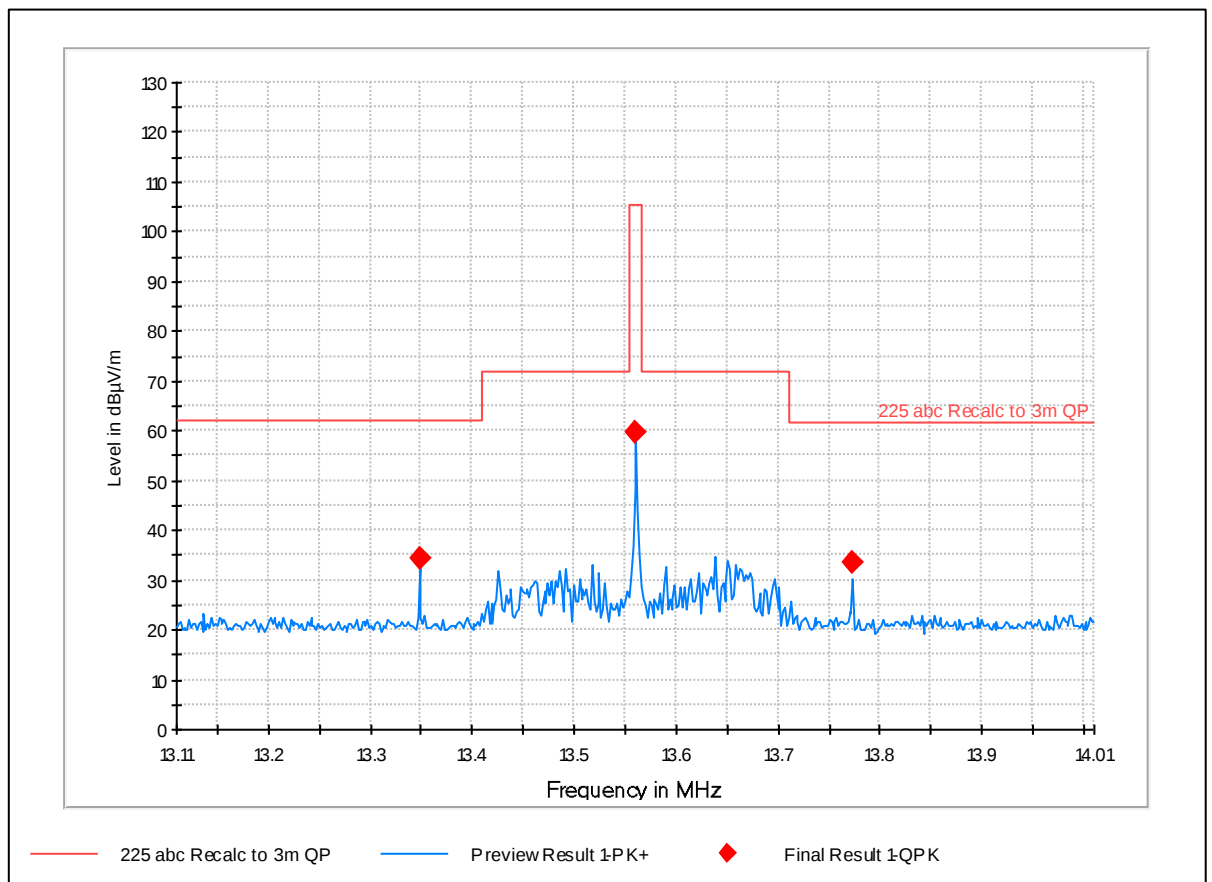


Figure 11. Field strength of In band emissions test results. Antenna vertical-90.

Frequency [MHz]	QuasiPeak [dBμV/m]	BW [kHz]	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
13.348576	34.4	9.000	57.0	27.70	62.00	PASSED
13.560602	59.8	9.000	57.0	45.60	105.40	PASSED
13.772227	33.4	9.000	61.0	28.40	61.80	PASSED

Table 13. Field strength of In band emissions test results. Antenna vertical-90.

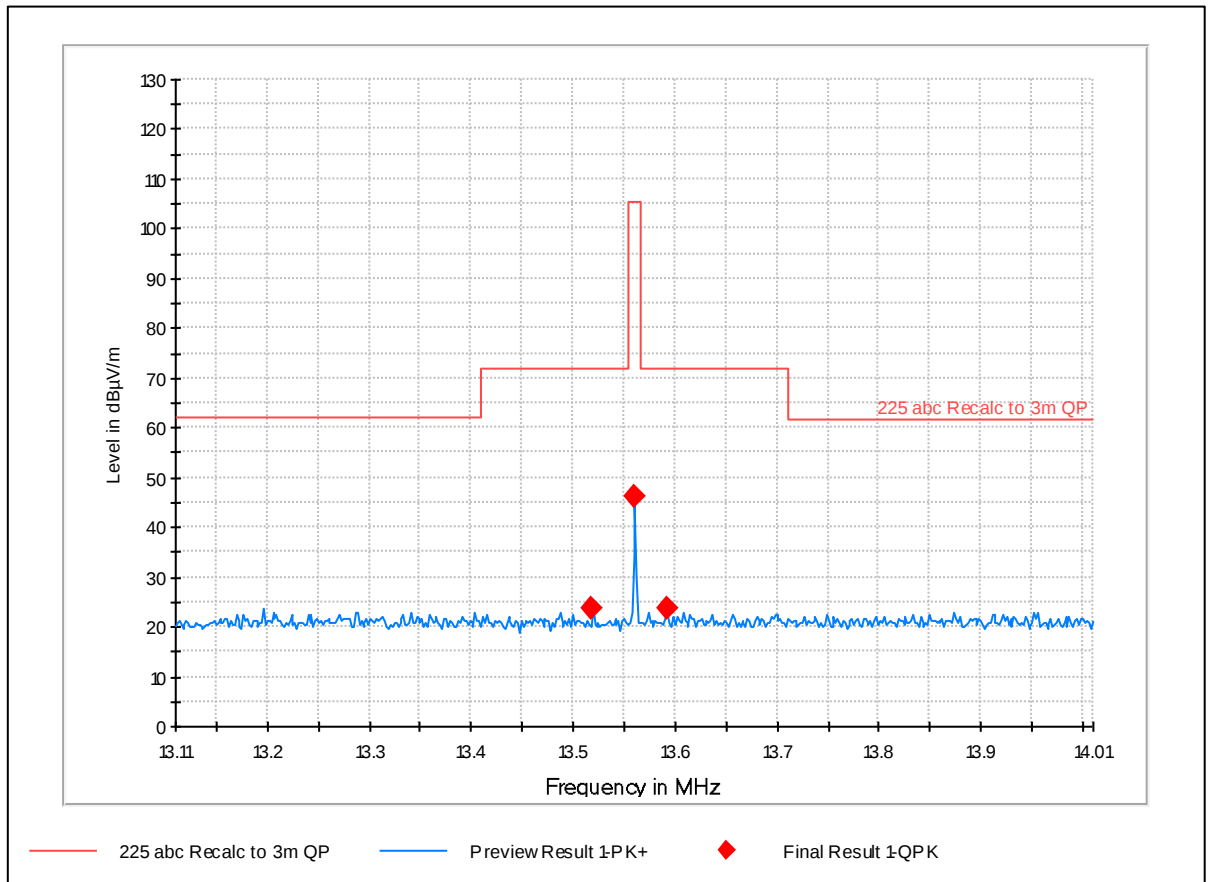


Figure 12. Field strength of In band emissions test results. Antenna horizontal.

Frequency [MHz]	QuasiPeak [dBμV/m]	BW [kHz]	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
13.518719	23.8	9.000	135.0	48.10	71.90	PASSED
13.560602	46.1	9.000	313.0	59.30	105.40	PASSED
13.592863	23.7	9.000	139.0	48.20	71.90	PASSED

Table 14. Field strength of In band emissions test results. Antenna horizontal.

2.2.3 Test equipment

Description	Supplier	Model	Tag no.	Cal. due date
Antenna Magnetic Loop 9 kHz - 30 MHz	Rohde & Schwarz	HFH2-Z2	30119966	2024-07-21
EMI Test Receiver 20Hz-26.5GHz	Rohde & Schwarz	ESIB26	30118880	2025-01-25

Table 15. Radiated emission test equipment.

2.3 Emission outside the 13.110-14.010 MHz band (below 30 MHz)

Test specimen	NFC MUX
Test specification	47 CFR 15.225 (d) RSS 210 B.6 (d)
Test method	ANSI C63.10:2013 sec 6.4
Frequency range	9 kHz – 30 MHz
Limits	FCC 47 CFR Part 15.209 (a) RSS Gen 8.9
Comments	The NFC module was tested in stand-alone configuration
Temperature / Humidity	22°C / 37%RH, 24°C / 35%RH, 24°C / 46%RH, 28°C / 49%RH
Dates of measurements	2024-02-27, 2024-05-08, 2024-05-23, 2024-06-26
Test personnel	Søren Søltøft, Janus Andersen

2.3.1 Test setup

Due to high ambient noise level at open area test site the measurements were performed in a semi anechoic chamber.

The test was performed on NFC module stand alone with one antenna active one at a time.

The test specimen was placed in vertical position 0.8 m above ground, and rotated 0 to 360 deg. during measurement. The measurement distance was 3 meters and the antenna height was 1 meter. The measurement was performed with the antenna in parallel (V), perpendicular (V-90) and ground-parallel (H) orientations.

See photo of test set up in appendix 1.

The limits below 30 MHz was recalculated to a 3 m. distance, using the method described in ANSI C63.10-2013 clause 6.4.4.2 Extrapolation from the measurement of a single point.

The largest test specimen, for which this applies, is 0.625 times the wavelength. The smallest wavelength is 10 m. at 30 MHz, which gives a maximal test specimen size of 6.25 meters.

Frequency range	$d_{\text{nearfield}}$ [m]	d_{limit} [m]	d_{measure} [m]	Recalculation formula
9 kHz to 159 kHz	>300	300	3	$-40 \log(d_{\text{limit}} / d_{\text{measure}})$
159 kHz to 490 kHz	97.49 to 300	300	3	$-40 \log(d_{\text{near field}} / d_{\text{measure}}) - 20 \log(d_{\text{limit}} / d_{\text{near field}})$
490 kHz to 1.592 MHz	30 to 97.49	30	3	$-40 \log(d_{\text{limit}} / d_{\text{measure}})$
1.592 MHz to 15.923 MHz	3 to 30	30	3	$-40 \log(d_{\text{near field}} / d_{\text{measure}}) - 20 \log(d_{\text{limit}} / d_{\text{near field}})$
15.923 MHz to 30 MHz	< 3	30	3	$-20 \log(d_{\text{limit}} / d_{\text{measure}})$

2.3.2 Test results

2.3.2.1 Antenna 0

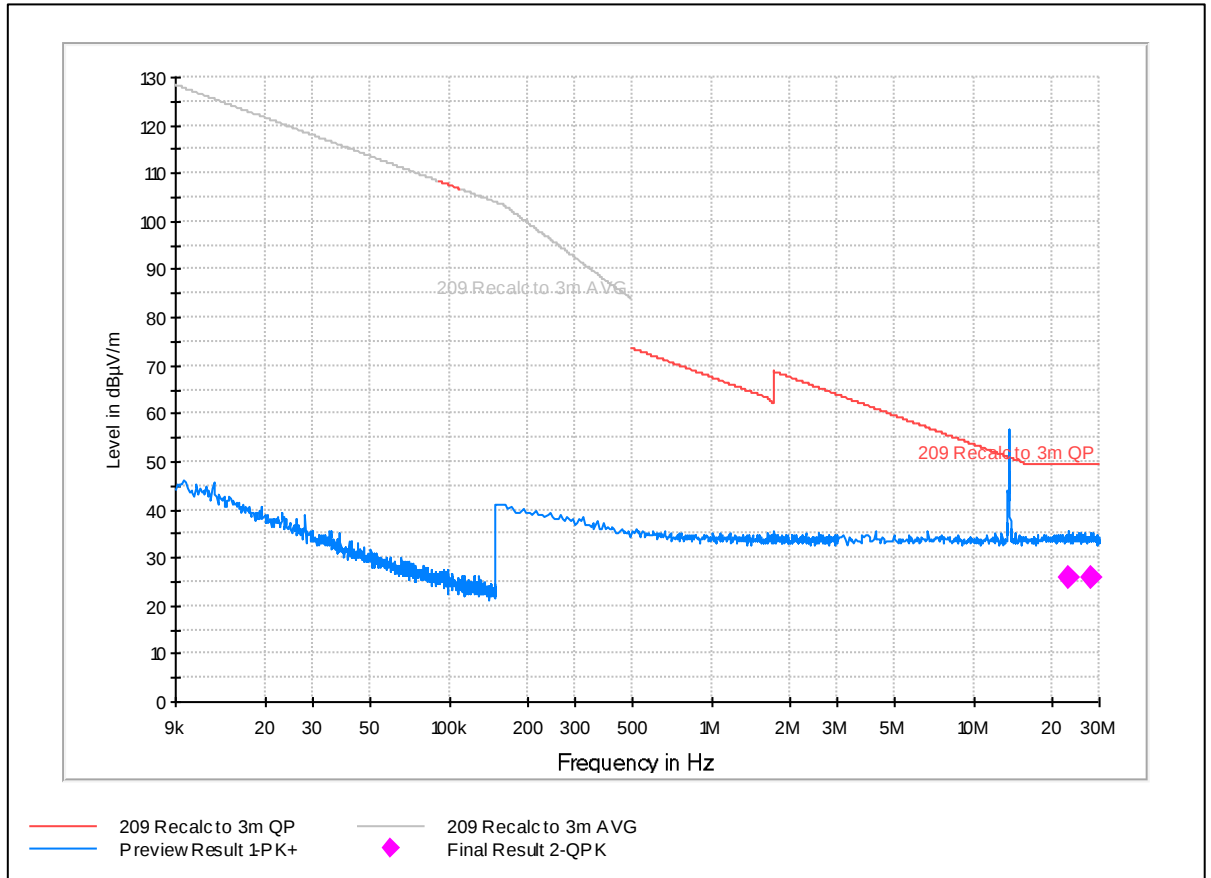


Figure 13. Emission outside the frequency band, below 30 MHz. Antenna vertical.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Ant. Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
22.95193	23.9	9	100	V	126	25.6	49.5	PASSED
27.93978	23.8	9	100	V	30	25.7	49.5	PASSED

Table 16. Emission outside the frequency band test results, below 30 MHz. Antenna vertical.

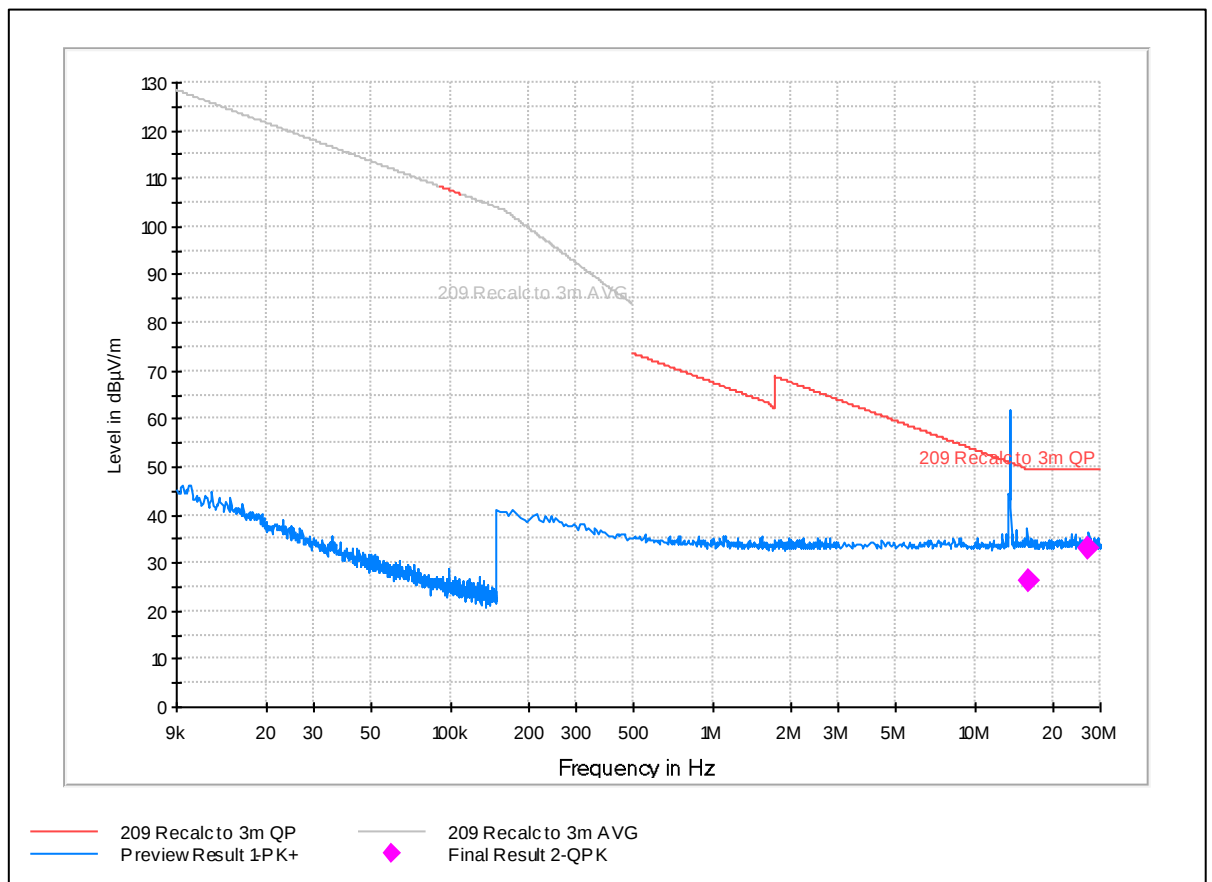


Figure 14. Emission outside the frequency band, below 30 MHz. Antenna vertical -90°.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Ant. Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
15.87365	23.9	9	100	V	180	25.6	49.5	PASSED
27.12227	28.0	9	100	V	203	21.5	49.5	PASSED

Table 17. Emission outside the frequency band test results, below 30 MHz. Antenna vertical -90°.

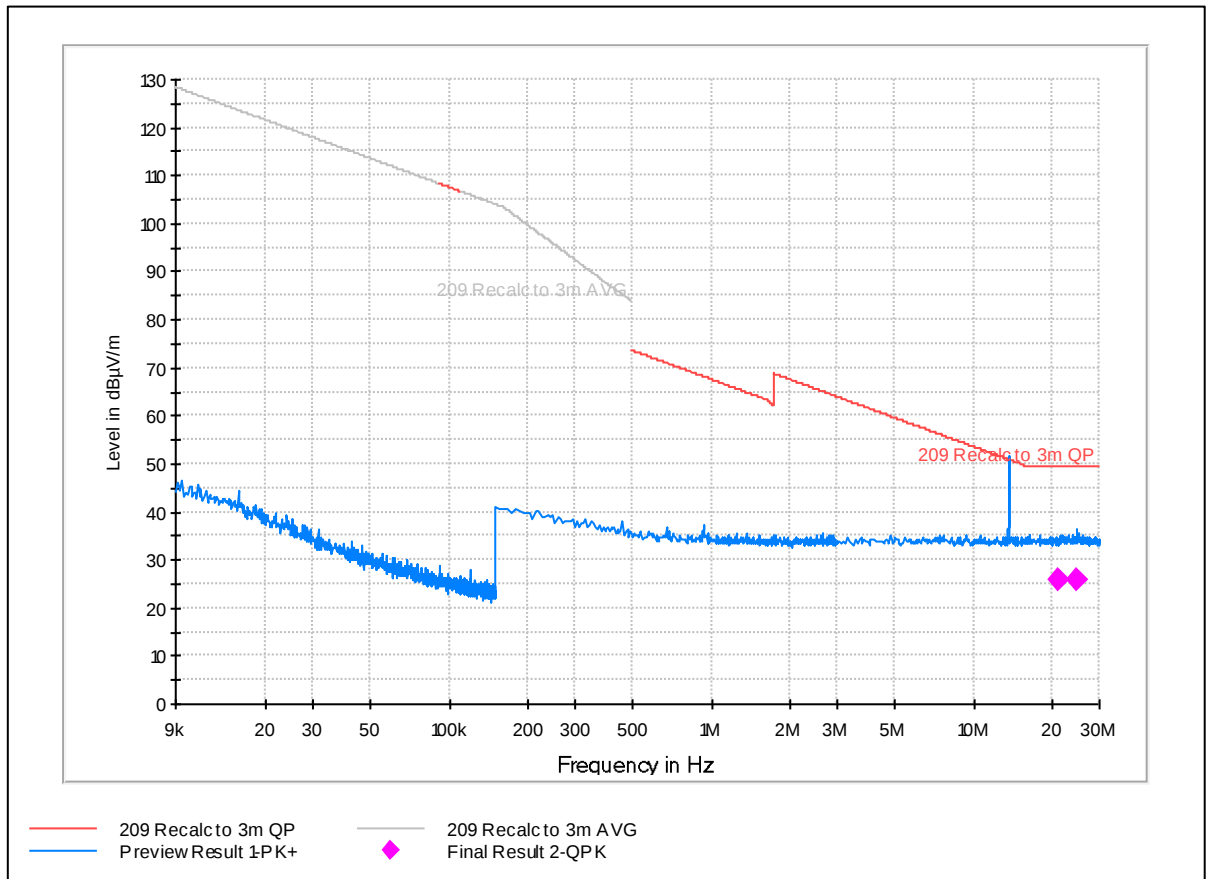


Figure 15. Emission outside the frequency band, below 30 MHz. Antenna horizontal.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
21.12025	24.0	9	100	H	126	25.5	49.5	PASSED
24.61329	24.5	9	100	H	252	25.0	49.5	PASSED

Table 18. Emission outside the frequency band test results, below 30 MHz. Antenna horizontal.

2.3.2.2 Antenna 1

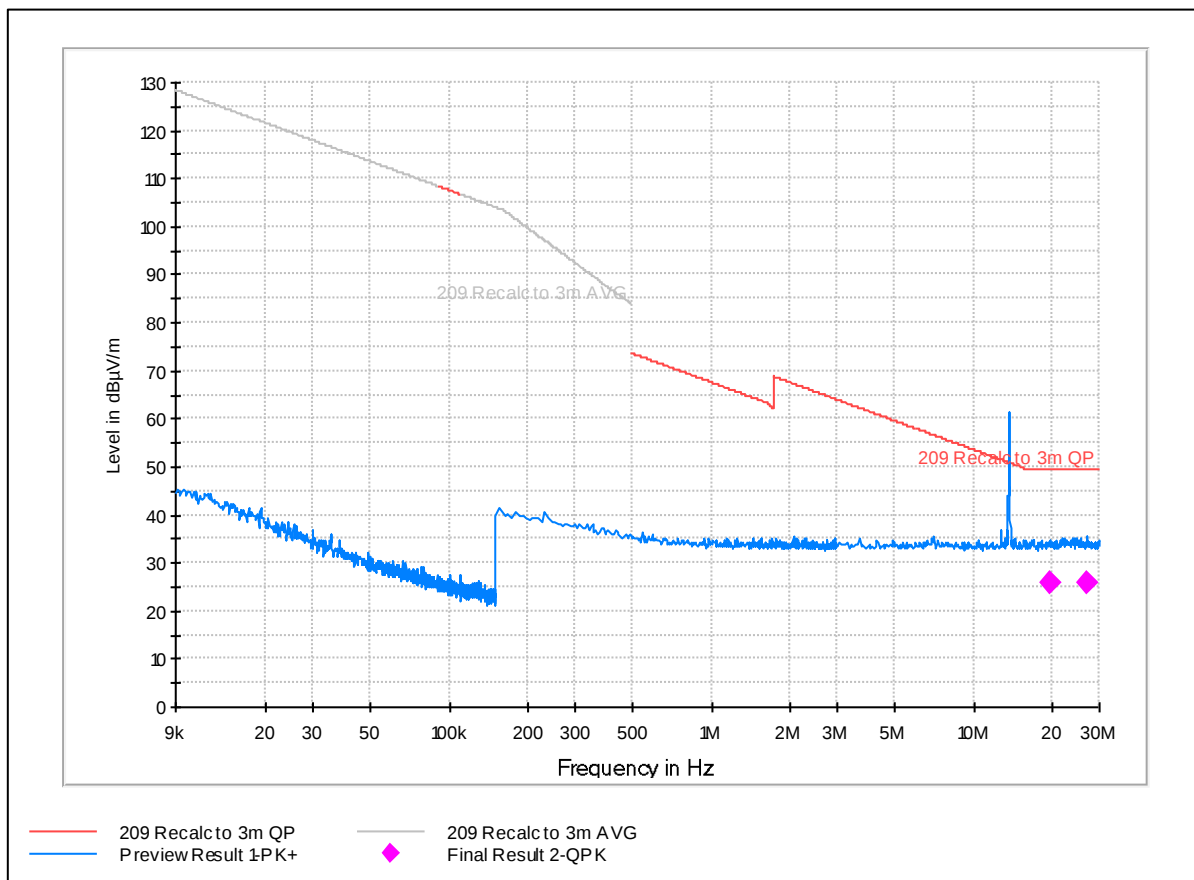


Figure 16. Emission outside the frequency band, below 30 MHz. Antenna vertical.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Ant. Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
19.42479	23.8	9	100	V	167	25.7	49.5	PASSED
27.05405	23.9	9	100	V	162	25.6	49.5	PASSED

Table 19. Emission outside the frequency band test results, below 30 MHz. Antenna vertical.

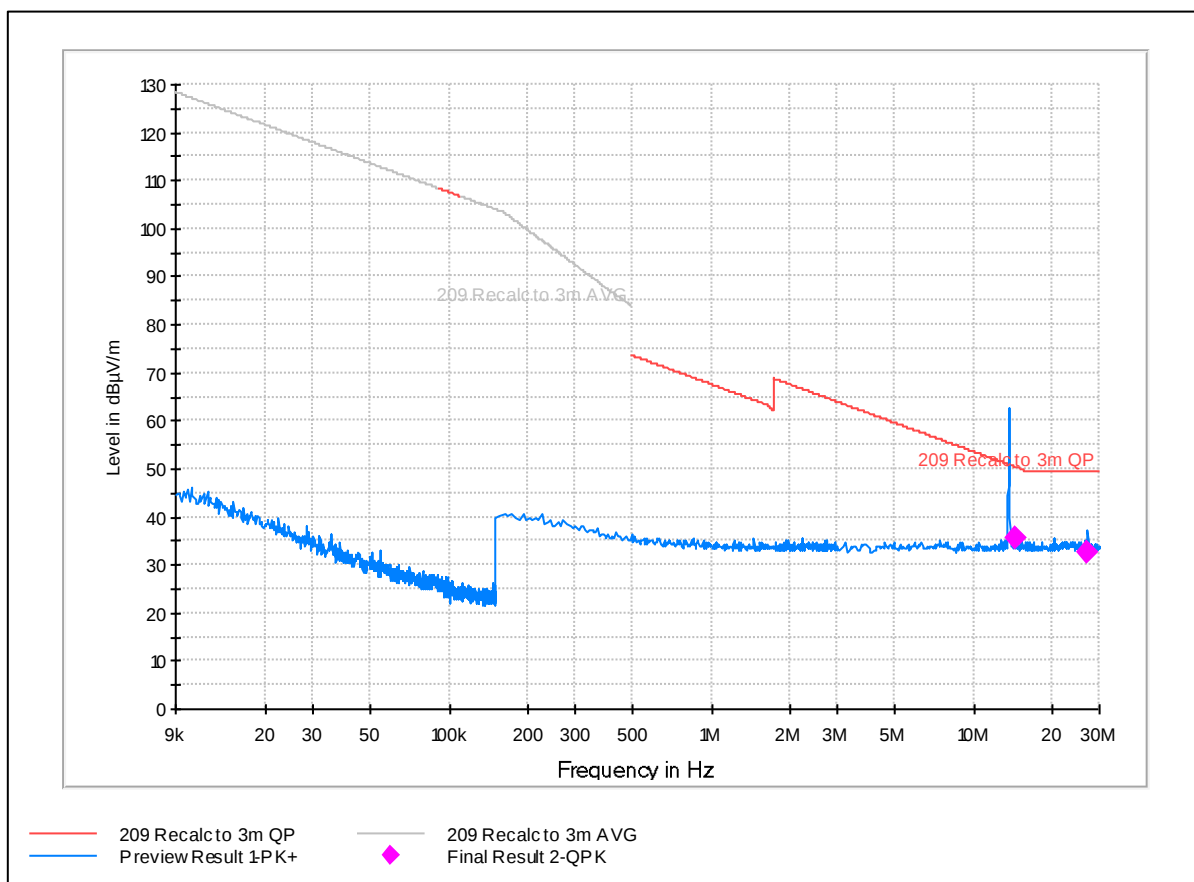


Figure 17. Emission outside the frequency band, below 30 MHz. Antenna vertical -90°.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Ant. Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
14.40683	33.5	9	100	V	252	16.9	50.4	PASSED
27.11827	27.6	9	100	V	144	21.9	49.5	PASSED

Table 20. Emission outside the frequency band test results, below 30 MHz. Antenna vertical -90°.

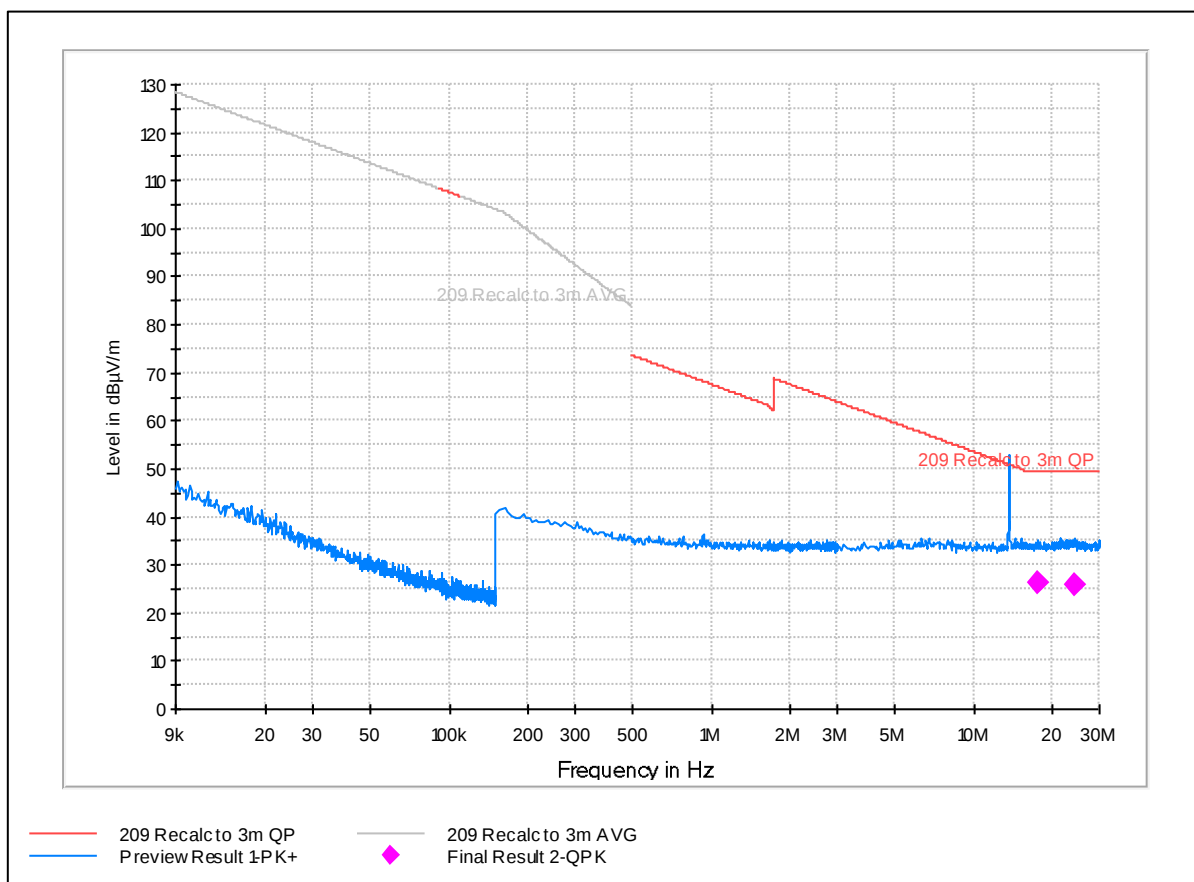


Figure 18. Emission outside the frequency band, below 30 MHz. Antenna horizontal.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
17.40679	23.9	9	100	H	175	25.6	49.5	PASSED
24.0701	24.2	9	100	H	315	25.3	49.5	PASSED

Table 21. Emission outside the frequency band test results, below 30 MHz. Antenna horizontal.

2.3.2.3 Antenna 2

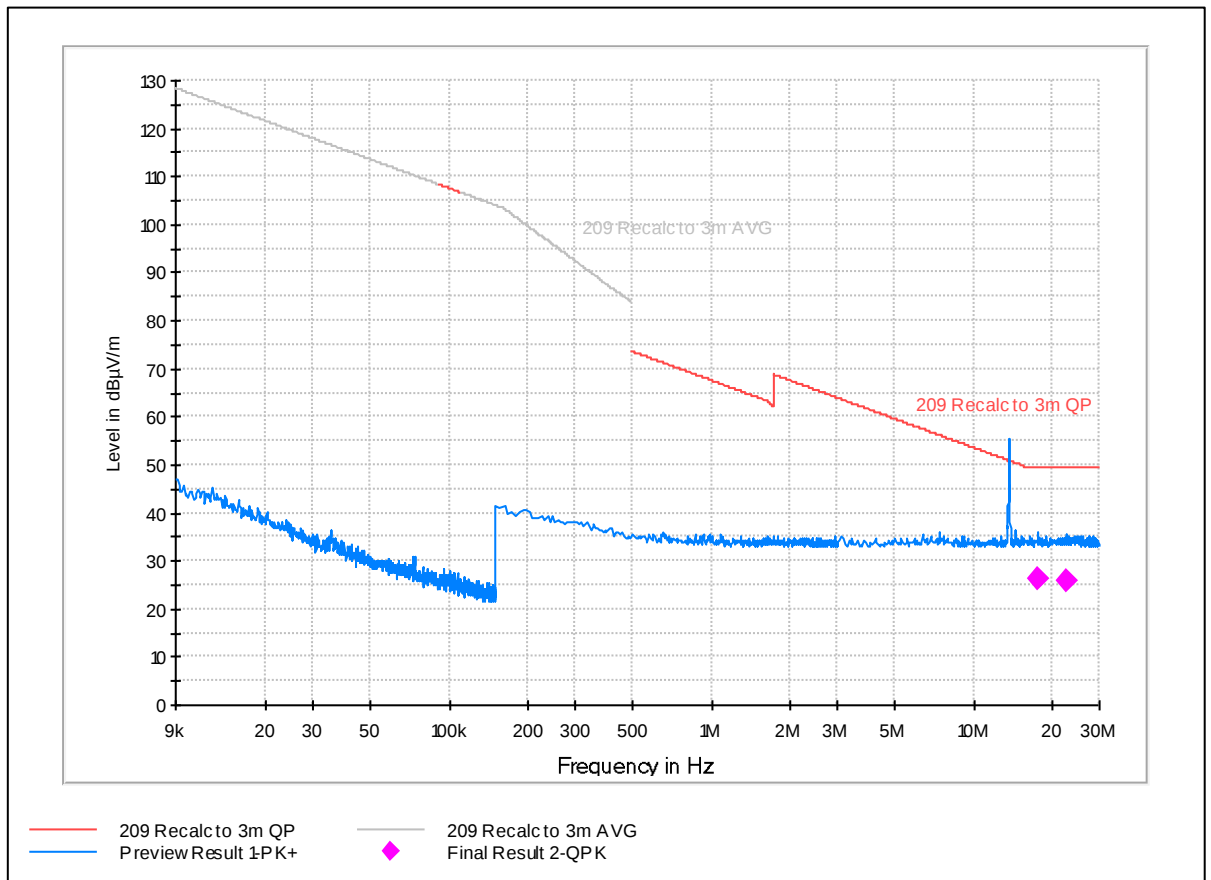


Figure 19. Emission outside the frequency band, below 30 MHz. Antenna vertical.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Ant. Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
17.44489	23.9	9	100	V	165	25.6	49.5	PASSED
22.57107	24.1	9	100	V	319	25.4	49.5	PASSED

Table 22. Emission outside the frequency band test results, below 30 MHz. Antenna vertical.

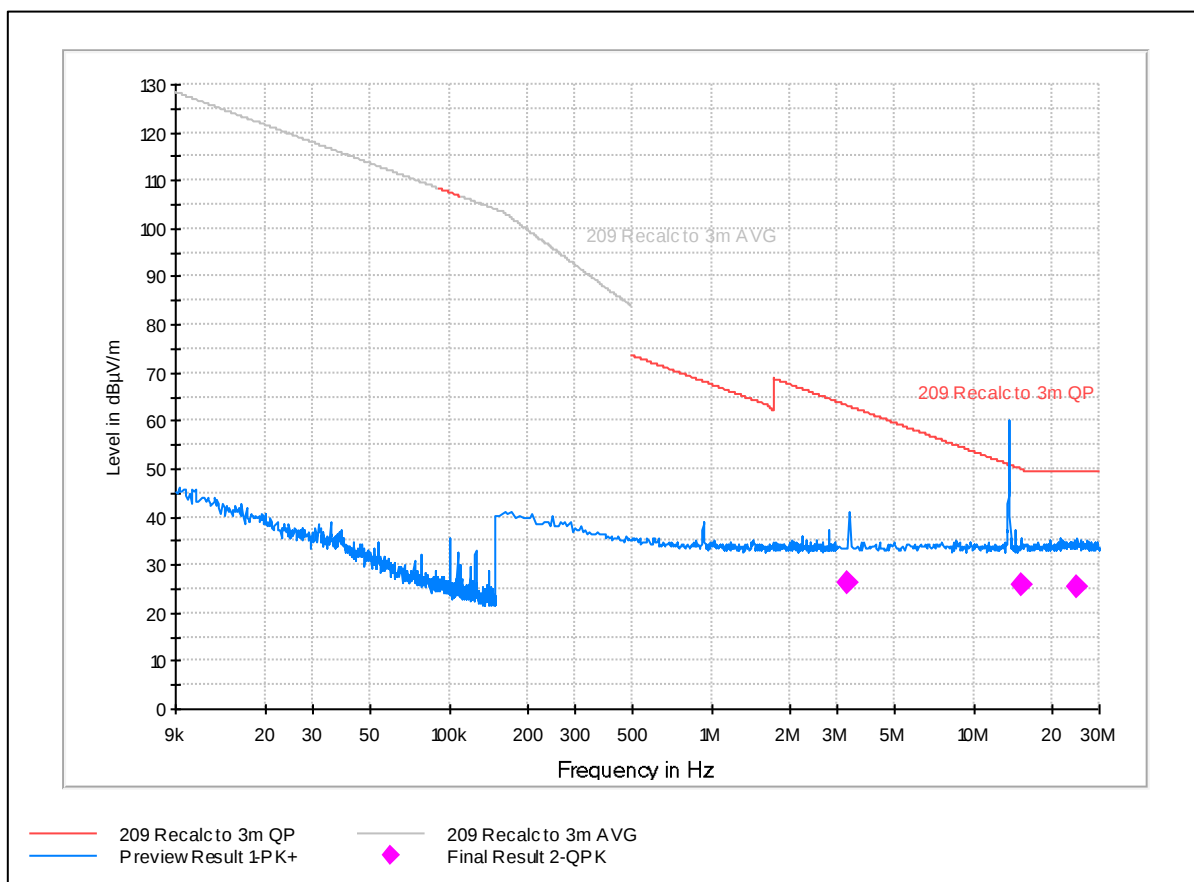


Figure 20. Emission outside the frequency band, below 30 MHz. Antenna vertical -90°.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Ant. Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
3.278649	24.0	9	100	V	30	39.3	63.3	PASSED
15.21446	23.9	9	100	V	-27	26.0	49.9	PASSED
24.82361	24.2	9	100	V	54	25.3	49.5	PASSED

Table 23. Emission outside the frequency band test results, below 30 MHz. Antenna vertical -90°.

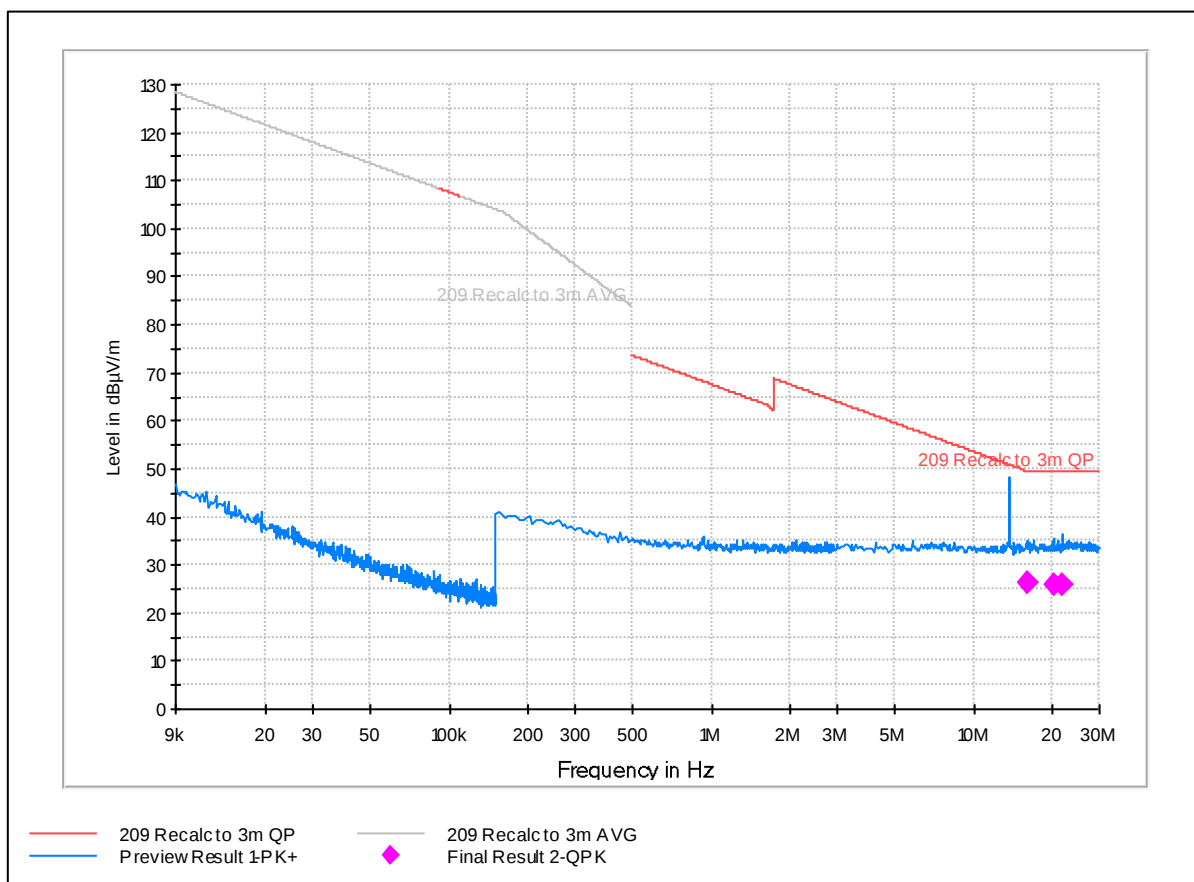


Figure 21. Emission outside the frequency band, below 30 MHz. Antenna horizontal.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
15.91176	24.2	9	100	H	37	25.4	49.5	PASSED
20.07409	23.9	9	100	H	135	25.6	49.5	PASSED
21.71734	24.0	9	100	H	135	25.5	49.5	PASSED

Table 24. Emission outside the frequency band test results, below 30 MHz. Antenna horizontal.

2.3.2.4 Antenna 3

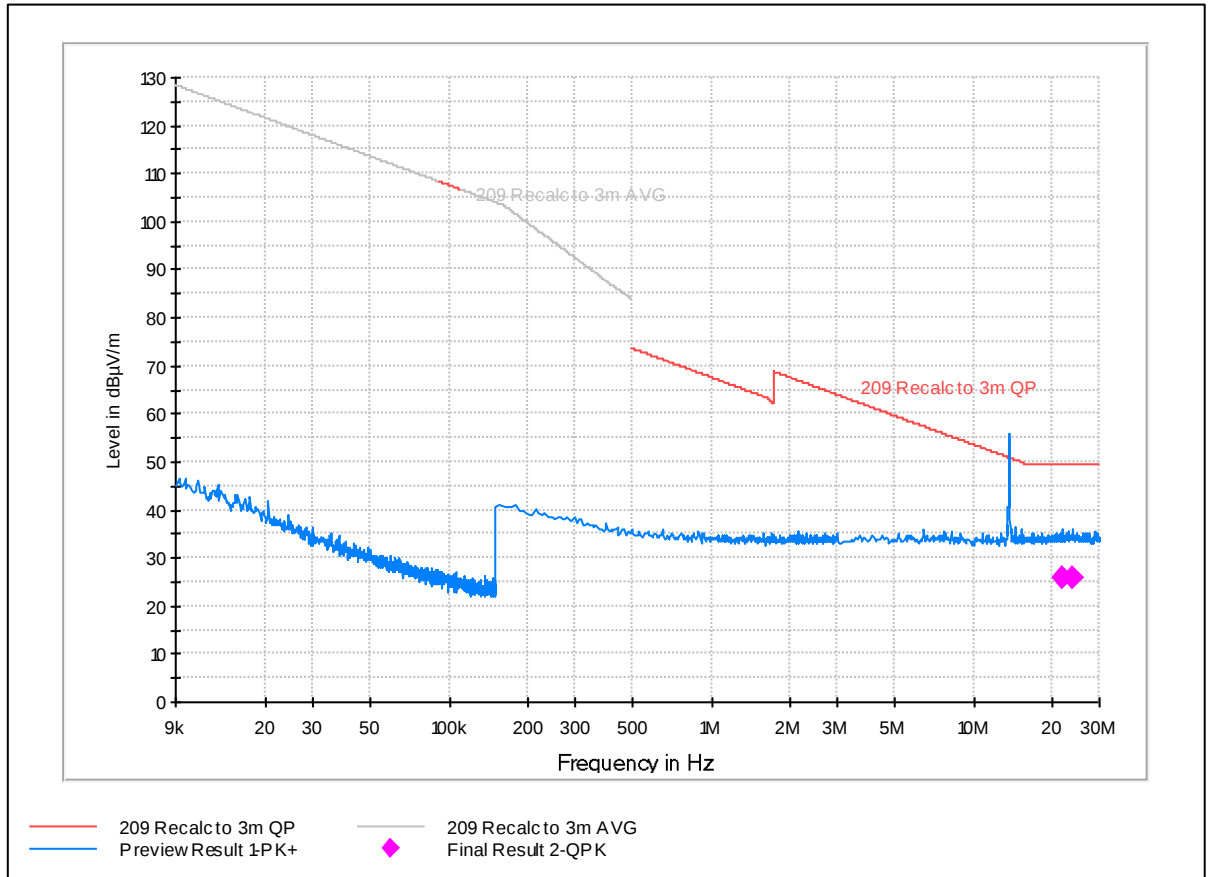


Figure 22. Emission outside the frequency band, below 30 MHz. Antenna vertical.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Ant. Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
21.59523	24.0	9	100	V	192	25.5	49.5	PASSED
23.60923	24.2	9	100	V	283	25.3	49.5	PASSED

Table 25. Emission outside the frequency band test results, below 30 MHz. Antenna vertical.

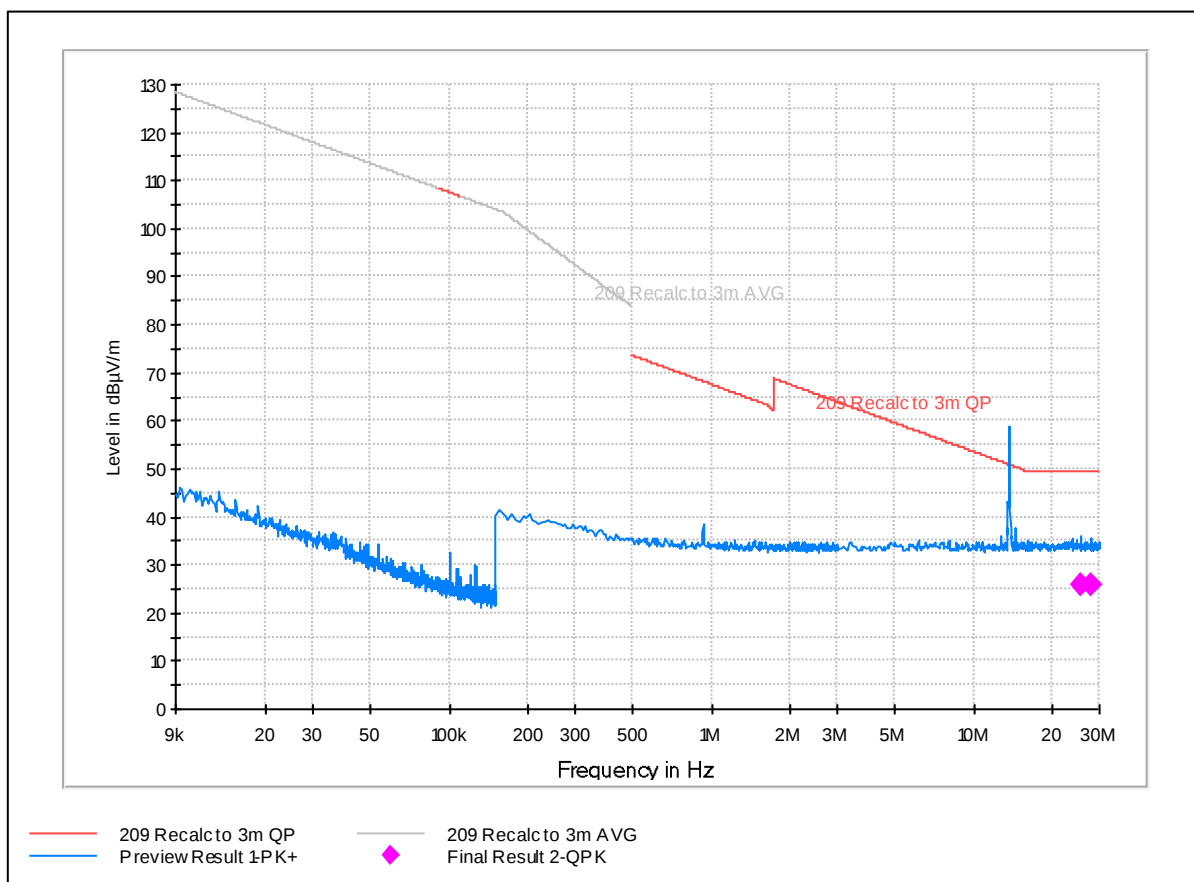


Figure 23. Emission outside the frequency band, below 30 MHz. Antenna vertical -90°.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Ant. Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
25.39669	23.9	9	100	V	112	25.6	49.5	PASSED
28.0461	24.0	9	100	V	107	25.5	49.5	PASSED

Table 26. Emission outside the frequency band test results, below 30 MHz. Antenna vertical -90°.

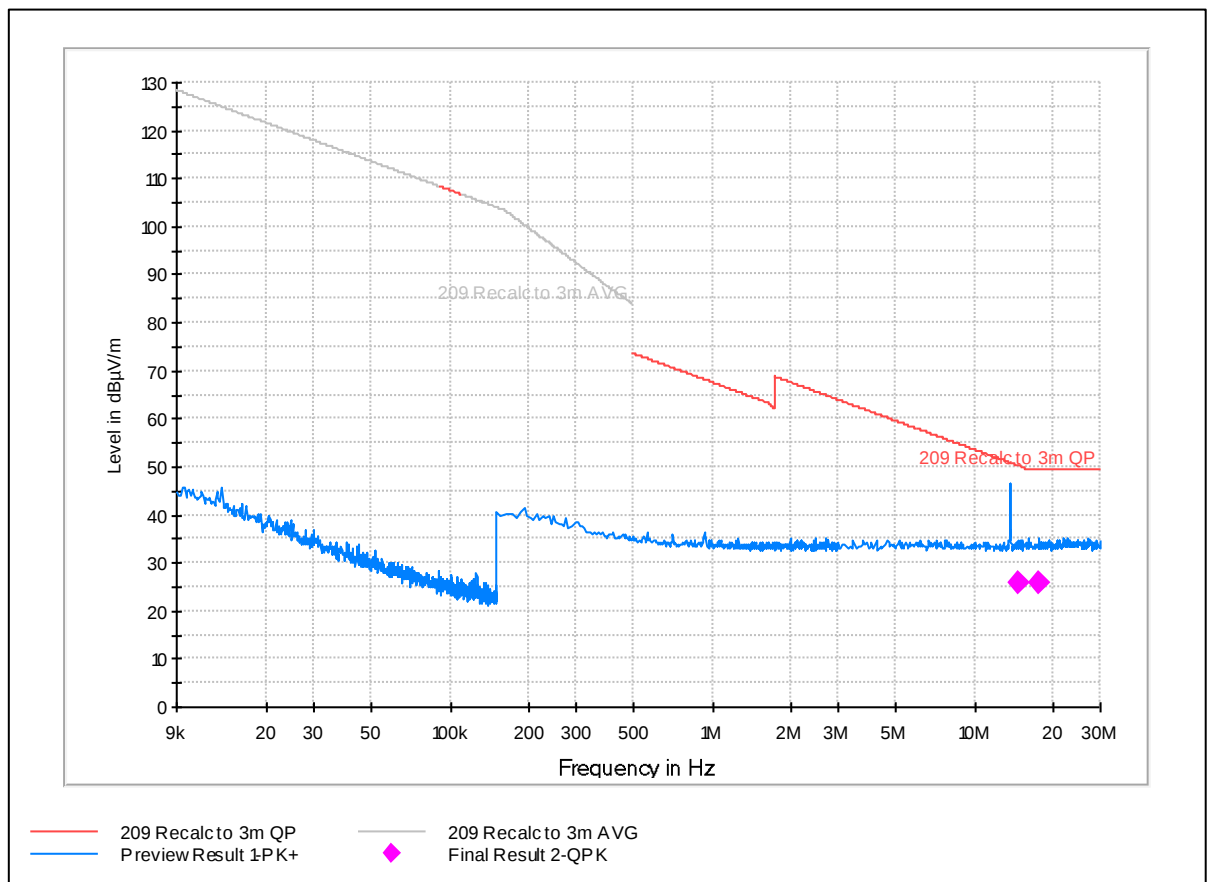


Figure 24. Emission outside the frequency band, below 30 MHz. Antenna horizontal.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
14.53505	23.9	9	100	H	223	25.6	49.5	PASSED
17.37479	23.9	9	100	H	-27	25.6	49.5	PASSED

Table 27. Emission outside the frequency band test results, below 30 MHz. Antenna horizontal.

Date
2024-07-16Reference
P23-0165-1Page
34 (67)**2.3.3 Test equipment**

Description	Supplier	Model	Tag no.	Cal. due date
Antenna Magnetic Loop 9 kHz - 30 MHz	Rohde & Schwarz	HFH2-Z2	30119966	2024-07-21
EMI Test Receiver 20Hz-26.5GHz	Rohde & Schwarz	ESIB26	30118880	2025-01-25

Table 28. Radiated emission test equipment.

2.4 Emission outside the 13.110-14.010 MHz band (above 30 MHz)

Test specimen	NFC MUX
Test specification	47 CFR 15.225 (d) RSS 210 B.6 (d)
Test method	ANSI C63.10:2013 sec 6.4
Frequency range	30 MHz – 1000 MHz
Limits	FCC 47 CFR Part 15.209 (a) RSS Gen 8.9
Comments	The NFC module was tested in stand-alone configuration
Temperature / Humidity	22°C / 37%RH, 24°C / 35%RH, 24°C / 46%RH
Dates of measurements	2024-02-27, 2024-05-08, 2024-05-23
Test personnel	Søren Søltøft, Janus Andersen

2.4.1 Test setup

The test was performed on NFC module stand alone with one antenna active one at a time.

The test of radiated emission was performed in a semi anechoic chamber. The measurements were performed with both horizontal and vertical antenna polarization.

The measuring distance was 3 m.

The test specimen and antennas were placed in vertical and horizontal position 0.8 m above ground, and rotated 0 to 360 deg. during measurement.

A pre-measurement is performed with peak detector. The test object is measured in eight directions with the antenna in the frequency range 30-1000 MHz, with the antenna at three heights, 1.0 m, 2.0 m and 3.0 m.

Based on the preliminary measurements the frequencies with the highest emissions are selected for final radiated emission measurements. Final measurements were made by rotating the turntable and changing the height of the antenna to maximize the emission level.

See appendix 1 for photo of test setup.

2.4.2 Test result

2.4.2.1 Antenna 0

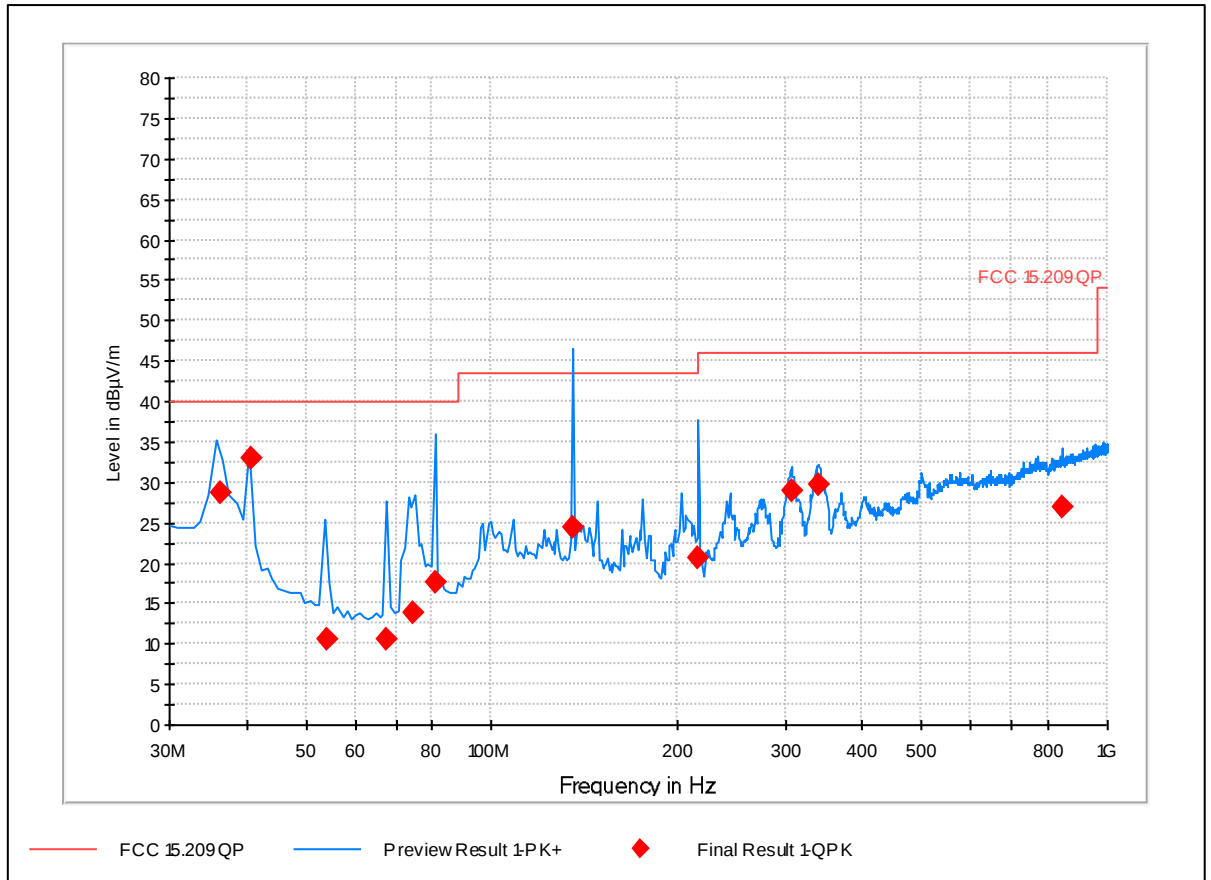


Figure 25. Emission outside the frequency band, 30 -1000 MHz. Test specimen vertical.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
36.451303	28.8	120	99.9	V	0.0	11.2	40.0	PASSED
40.680721	32.9	120	99.9	V	72.0	7.1	40.0	PASSED
54.227094	10.5	120	325.0	H	235.0	29.5	40.0	PASSED
67.795351	10.5	120	315.1	H	331.0	29.5	40.0	PASSED
74.490421	13.9	120	140.9	V	45.0	26.1	40.0	PASSED
81.381723	17.6	120	100.1	V	73.0	22.4	40.0	PASSED
135.610982	24.3	120	100.1	V	331.0	19.2	43.5	PASSED
216.932986	20.6	120	99.9	V	-22.0	25.4	46.0	PASSED
307.677595	28.9	120	99.9	H	331.0	17.1	46.0	PASSED
339.039760	29.6	120	132.8	H	185.0	16.4	46.0	PASSED
843.687375	26.8	120	179.2	H	184.0	19.2	46.0	PASSED

Table 29. Emission outside frequency band results. 30 - 1000 MHz. Test specimen vertical.

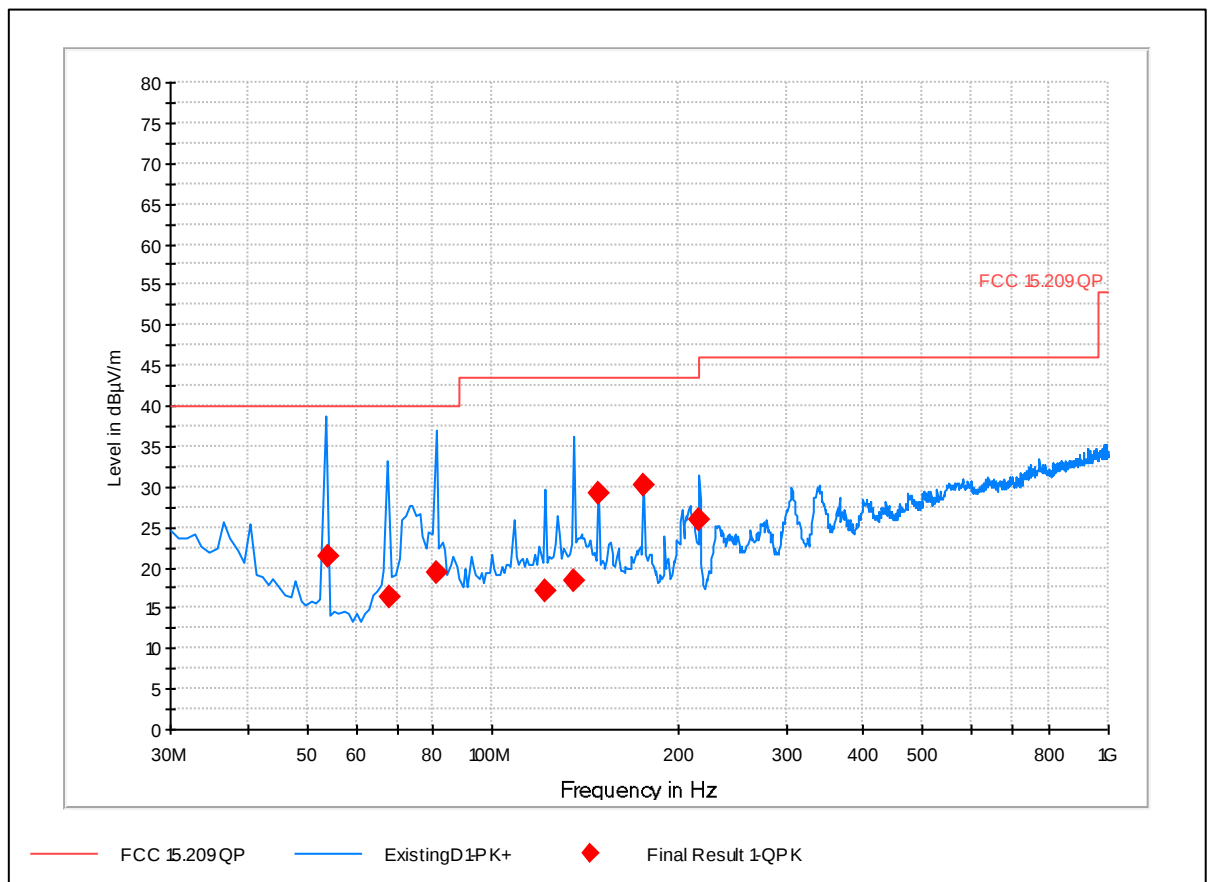


Figure 26. Emission outside frequency band 30 - 1000 MHz. Test specimen horizontal.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
54.227094	21.4	120	100.1	V	95.0	18.6	40.0	PASSED
67.835351	16.2	120	128.0	V	270.0	23.8	40.0	PASSED
81.381723	19.4	120	135.8	V	270.0	20.6	40.0	PASSED
122.042725	17.1	120	200.0	H	305.0	26.4	43.5	PASSED
135.610982	18.3	120	210.1	H	151.0	25.2	43.5	PASSED
149.157355	29.2	120	222.1	H	0.0	14.3	43.5	PASSED
176.271984	30.2	120	224.8	H	148.0	13.3	43.5	PASSED
216.972986	26.0	120	159.0	H	-44.0	20.0	46.0	PASSED

Table 30. Emission outside frequency band results. 30 - 1000 MHz. Test specimen horizontal.

2.4.2.2 Antenna 1

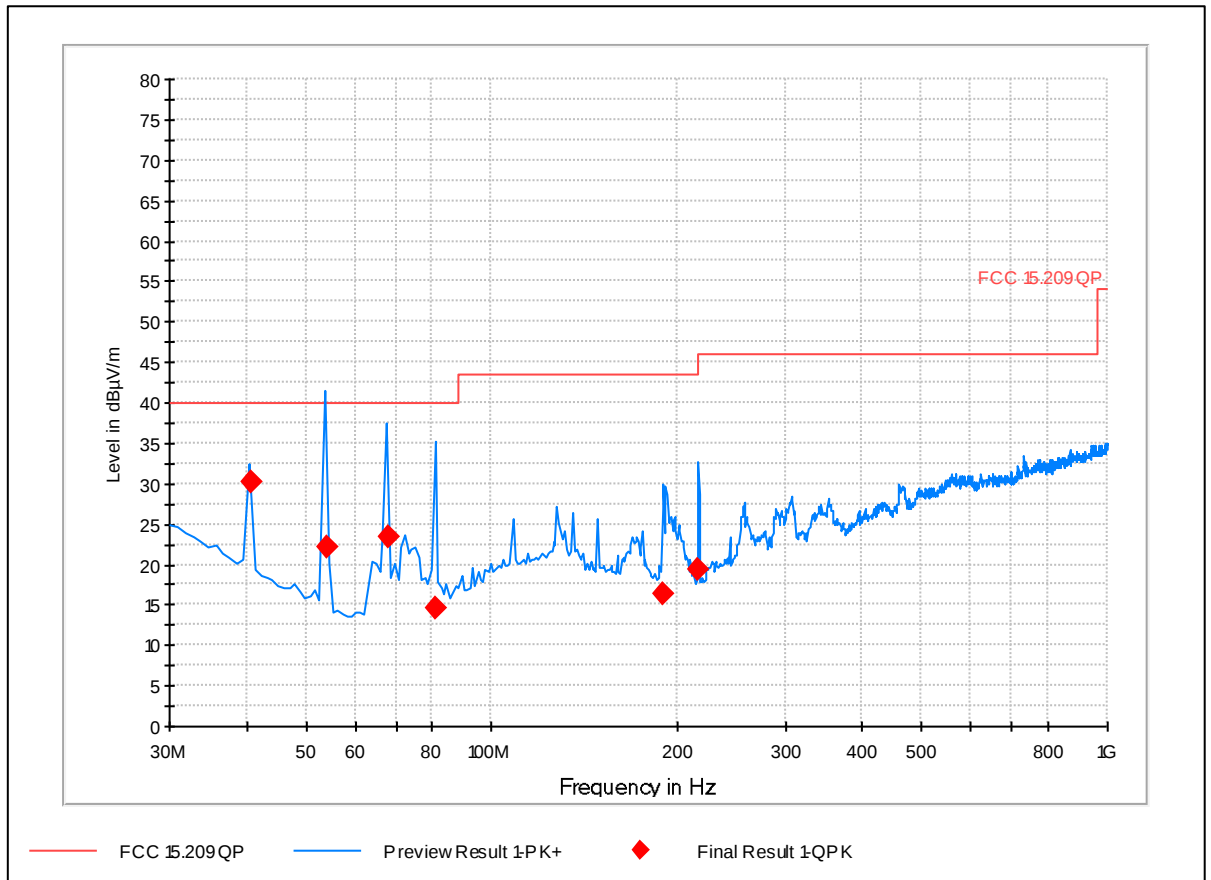


Figure 27. Emission outside the frequency band, 30 -1000 MHz. Test specimen vertical.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
40.680721	30.1	120	100.2	V	297.0	9.9	40.0	PASSED
54.227094	22.2	120	100.2	V	68.0	17.8	40.0	PASSED
67.835351	23.3	120	100.1	V	0.0	16.7	40.0	PASSED
81.381723	14.5	120	128.0	V	27.0	25.5	40.0	PASSED
189.840240	16.4	120	99.9	V	45.0	27.1	43.5	PASSED
216.932986	19.4	120	147.4	H	-44.0	26.6	46.0	PASSED

Table 31. Emission outside frequency band results. 30 - 1000 MHz. Test specimen vertical.

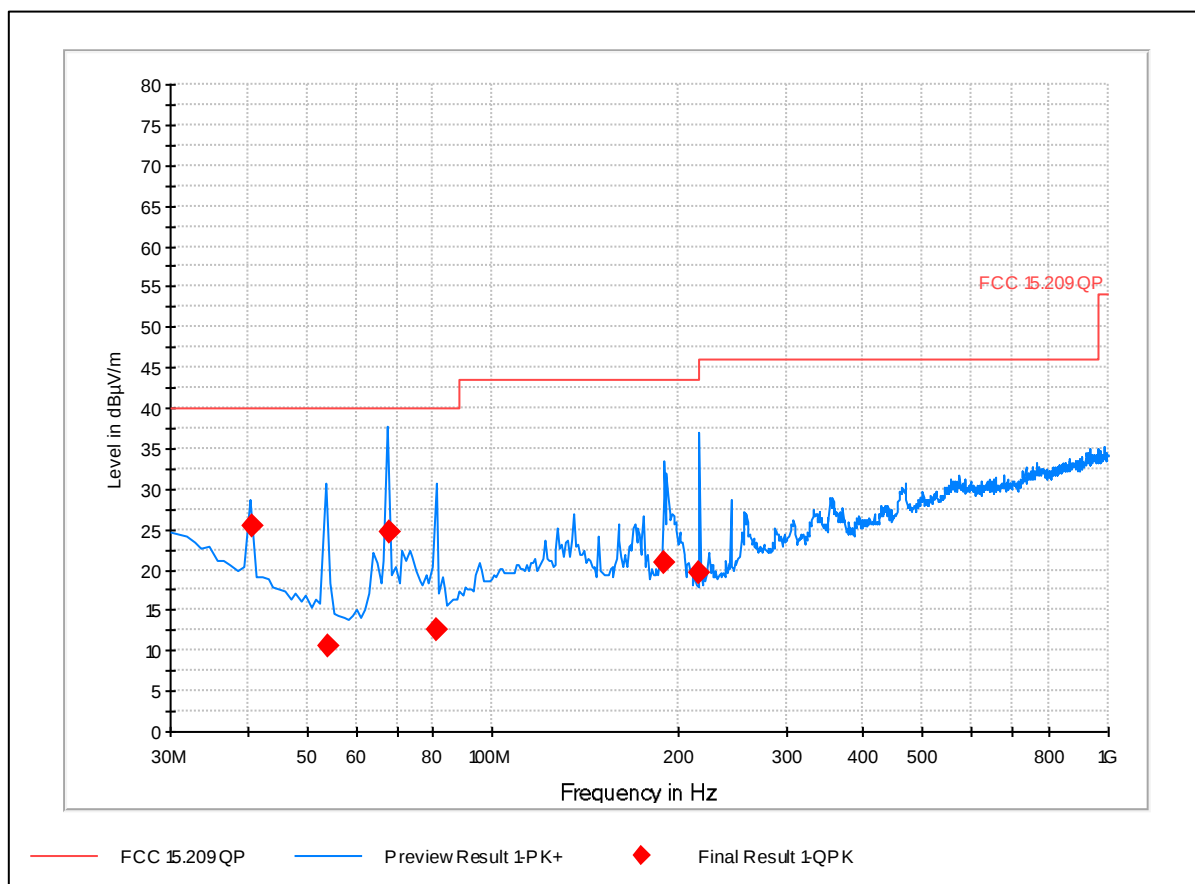


Figure 28. Emission outside frequency band 30 - 1000 MHz. Test specimen horizontal.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
40.720721	25.5	120	99.6	V	260.0	14.5	40.0	PASSED
54.267094	10.6	120	338.1	H	-33.0	29.4	40.0	PASSED
67.835351	24.6	120	100.2	V	-40.0	15.4	40.0	PASSED
81.381723	12.7	120	147.1	V	106.0	27.3	40.0	PASSED
189.880240	21.0	120	100.1	V	-10.0	22.5	43.5	PASSED
216.932986	19.6	120	146.9	H	293.0	26.4	46.0	PASSED

Table 32. Emission outside frequency band results. 30 - 1000 MHz. Test specimen horizontal.

2.4.2.3 Antenna 2

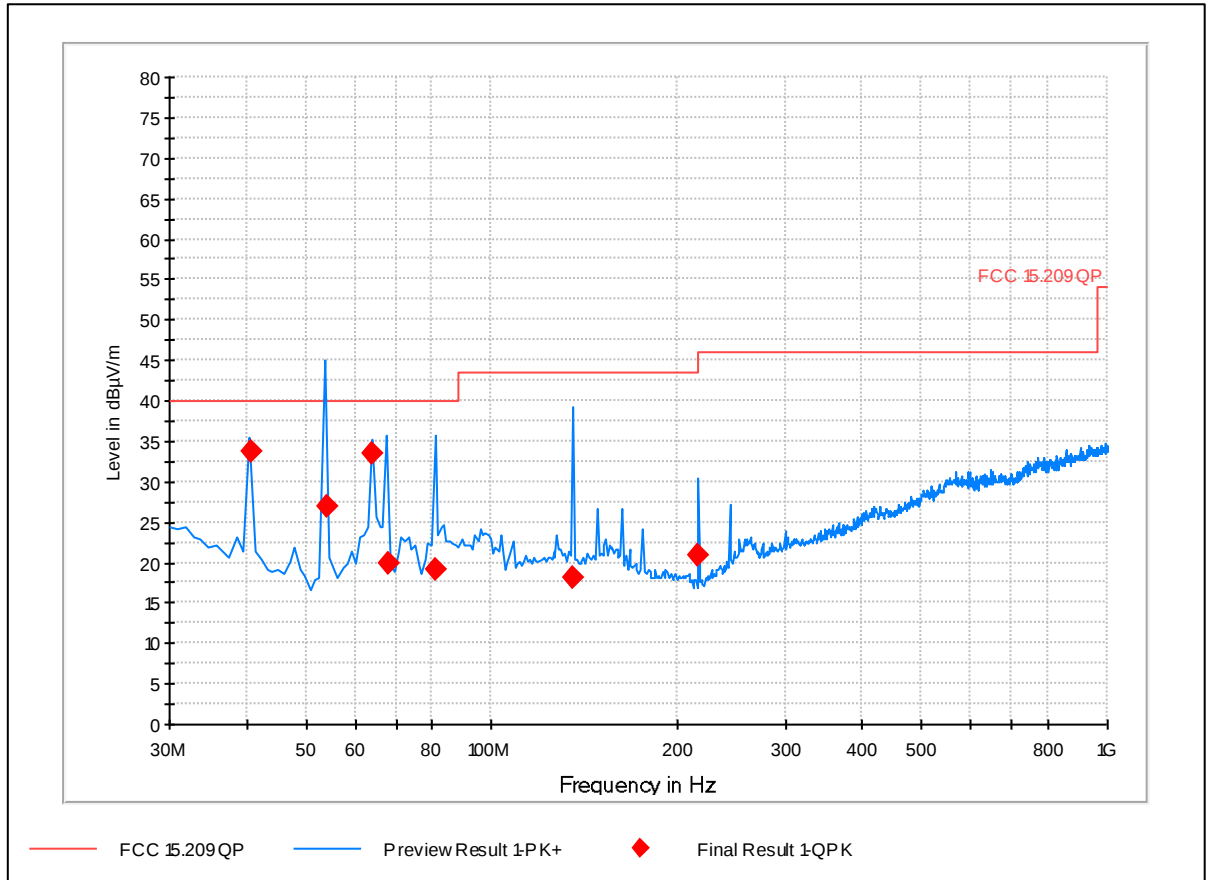


Figure 29. Emission outside the frequency band, 30 -1000 MHz. Test specimen vertical.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
40.680721	33.6	120	100.0	V	46.0	6.4	40.0	PASSED
54.227094	27.0	120	100.0	V	135.0	13.0	40.0	PASSED
64.147816	33.5	120	157.0	V	270.0	6.5	40.0	PASSED
67.835351	19.9	120	155.0	V	135.0	20.1	40.0	PASSED
81.341723	19.1	120	175.0	V	136.0	21.0	40.0	PASSED
135.610982	18.2	120	240.0	H	16.0	25.3	43.5	PASSED
216.932986	20.8	120	135.0	H	90.0	25.2	46.0	PASSED

Table 33. Emission outside frequency band results. 30 - 1000 MHz. Test specimen vertical.

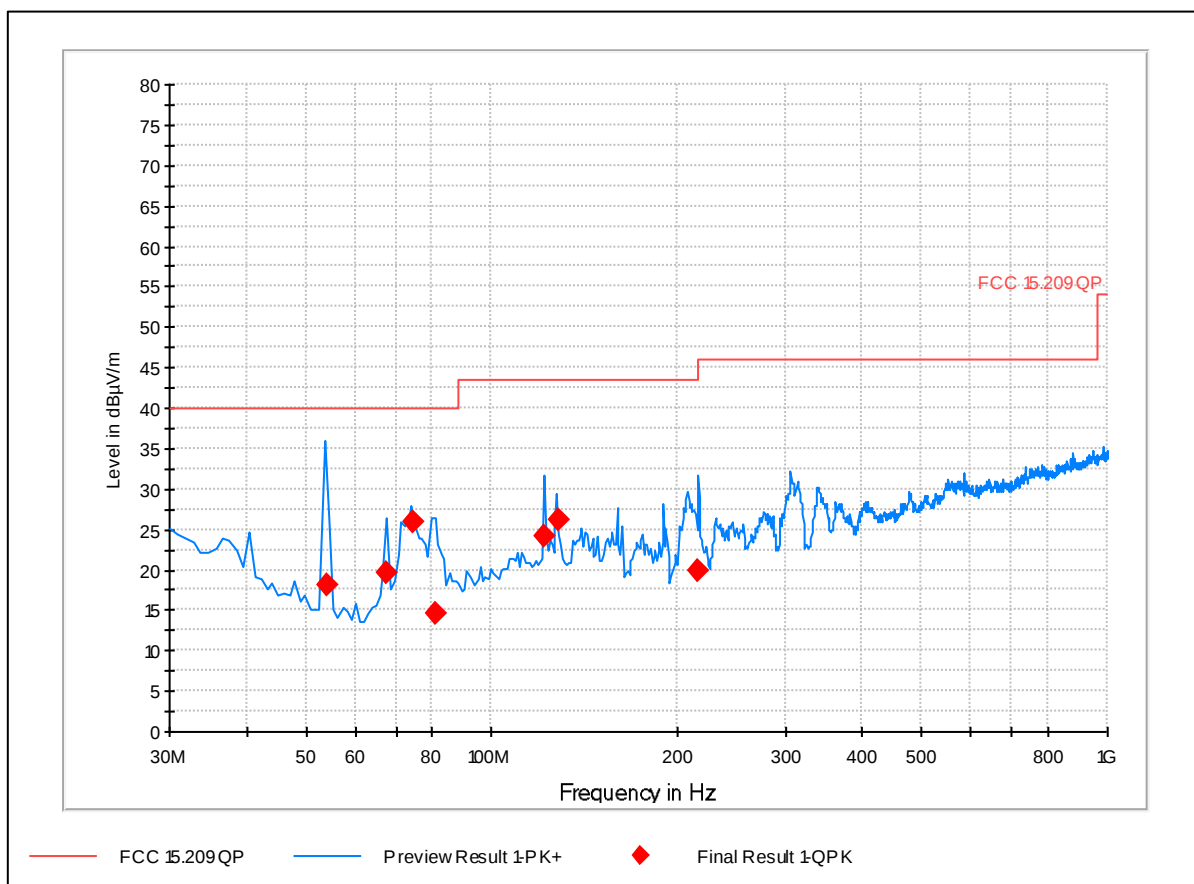


Figure 30. Emission outside frequency band 30 - 1000 MHz. Test specimen horizontal.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
54.227094	18.0	120	100.1	V	135.0	22.0	40.0	PASSED
67.795351	19.7	120	100.1	V	5.0	20.3	40.0	PASSED
74.868537	25.8	120	127.1	V	-10.0	14.2	40.0	PASSED
81.381723	14.5	120	175.0	V	144.0	25.5	40.0	PASSED
122.082725	24.3	120	247.1	H	-30.0	19.2	43.5	PASSED
128.275912	26.3	120	206.1	H	242.0	17.2	43.5	PASSED
216.932986	19.9	120	174.9	H	305.0	26.1	46.0	PASSED

Table 34. Emission outside frequency band results. 30 - 1000 MHz. Test specimen horizontal.

2.4.2.4 Antenna 3

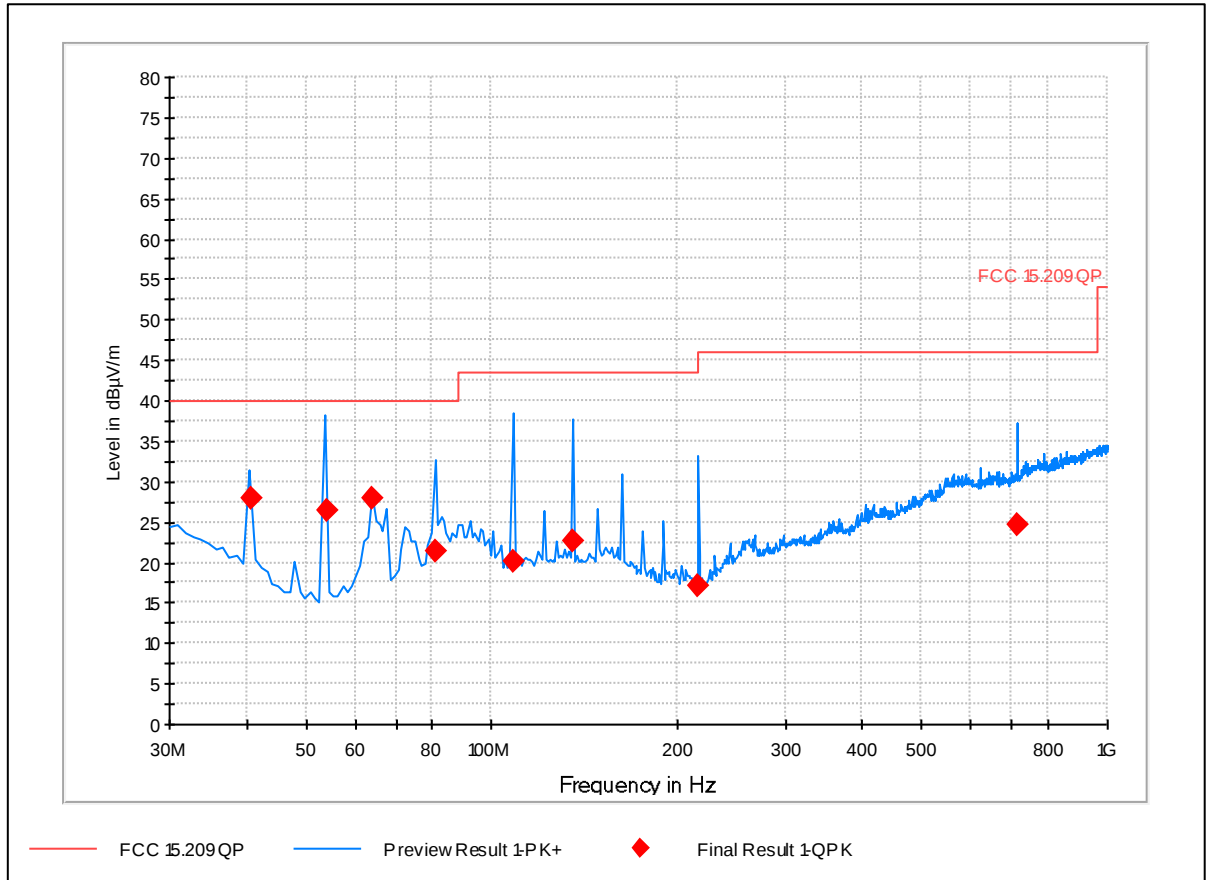


Figure 31. Emission outside the frequency band, 30 -1000 MHz. Test specimen vertical.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
40.680721	27.9	120	100.0	V	192.0	12.1	40.0	PASSED
54.227094	26.5	120	175.0	V	270.0	13.5	40.0	PASSED
64.147816	28.0	120	141.0	V	278.0	12.0	40.0	PASSED
81.341723	21.4	120	100.0	V	353.0	18.6	40.0	PASSED
108.456353	20.0	120	100.0	V	90.0	23.5	43.5	PASSED
135.610982	22.6	120	100.0	V	135.0	20.9	43.5	PASSED
216.892986	17.2	120	149.0	H	90.0	28.8	46.0	PASSED
713.426854	24.7	120	225.0	H	283.0	21.3	46.0	PASSED

Table 35. Emission outside frequency band results. 30 - 1000 MHz. Test specimen vertical.

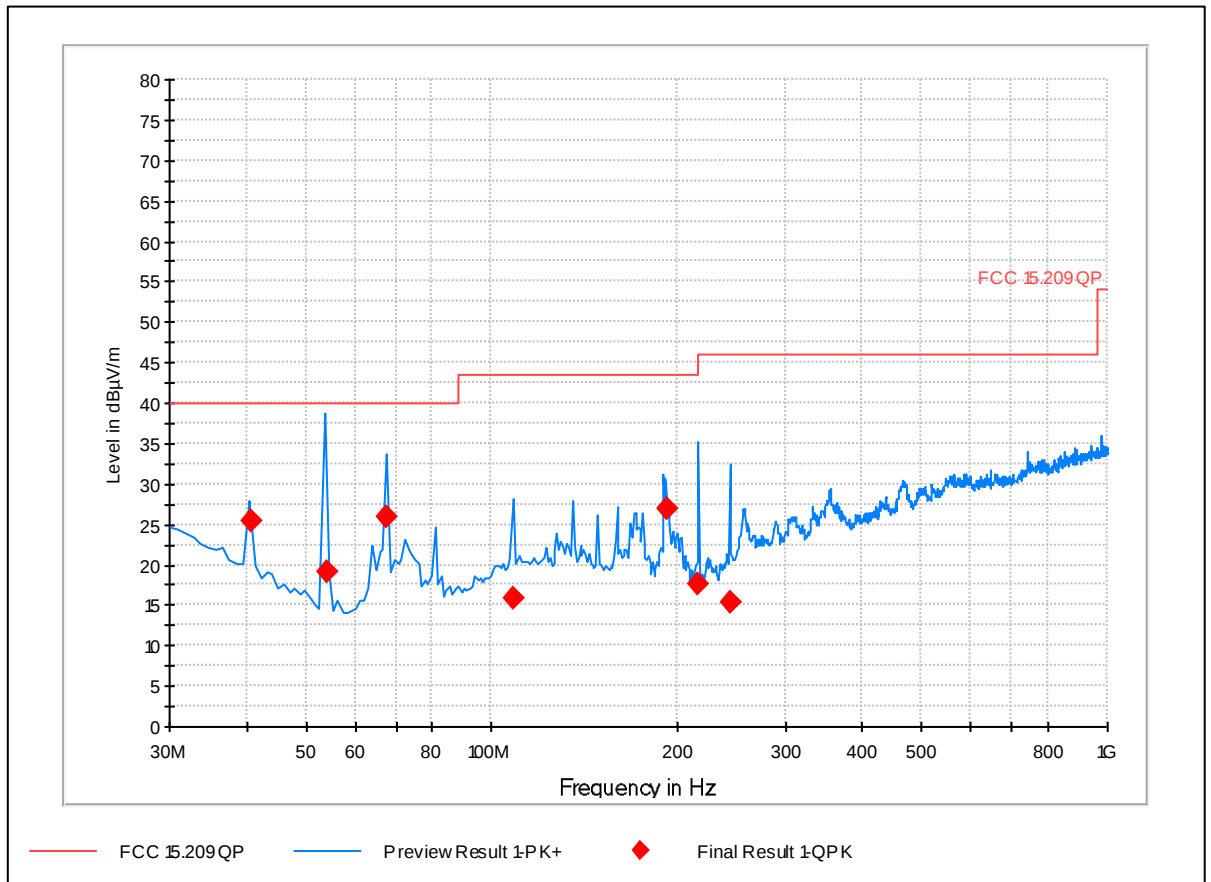


Figure 32. Emission outside frequency band 30 - 1000 MHz. Test specimen horizontal.

Frequency [MHz]	QP [dBμV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBμV/m]	Result
40.680721	25.3	120	99.6	V	26.0	14.7	40.0	PASSED
54.227094	19.2	120	99.6	V	237.0	20.8	40.0	PASSED
67.795351	25.8	120	174.9	V	229.0	14.2	40.0	PASSED
108.496353	15.8	120	286.2	H	42.0	27.7	43.5	PASSED
192.324008	26.9	120	100.1	V	91.0	16.6	43.5	PASSED
216.892986	17.7	120	127.1	H	274.0	28.3	46.0	PASSED
244.047615	15.4	120	125.0	H	53.0	30.6	46.0	PASSED

Table 36. Emission outside frequency band results. 30 - 1000 MHz. Test specimen horizontal.

2.4.3 Test equipment

Description	Supplier	Model	Tag no.	Cal. due
Antenna Bilog 30MHz - 2GHz	Chase	CBL6112B	30114397	2025-12-15
LNA amplifier 1 - 26 GHz	Miteq	JS4-01002600-36-5P	30150081	2024-11-14
EMI Test Receiver 20Hz-26.5GHz	Rohde & Schwarz	ESIB26	30118880	2025-01-25

Table 37. Radiated emission test equipment.

2.5 Frequency stability versus temperature

Test specimen	NFC MUX
Test specification	47 CFR 15.225 (e) RSS 210 B.6
Test method	ANSI C63.10:2013 sec. 6.8
Frequency range	13.110 - 14.010 MHz
Limits	47 CFR 15.225 (e) RSS 210 B.6
Comments	The NFC module was tested in stand-alone configuration
Temperature / Humidity	22°C / 34%RH
Dates of measurements	2024-02-21
Test personnel	Søren Søltøft

2.5.1 Test setup

The test was performed on NFC module stand alone with one antenna active one at a time. The test specimen was placed in a shielded climatic chamber together with a loop antenna in a fixed position. The loop antenna was connected to a spectrum analyzer outside the chamber. The frequency count function on the spectrum analyzer was used to improve accuracy. The controller board was placed outside the chamber and connected to NFC module by a Ethernet cable.

The temperature variation was performed between 50°C and -20°C

See appendix 1 for photo of test setup.

2.5.2 Test result

The deviation is calculated with the frequency at 20°C after 10 min. as reference.

Temp. °C	Ant. no.	Pwr On %	2 min. %	5 min. %	10 min. %	Limit %	Result
50	0	-0.000686	-0.000686	-0.000686	-0.000686	0.01	PASSED
	1	-0.000686	-0.000686	-0.000686	-0.000686	0.01	PASSED
	2	-0.000686	-0.000686	-0.000686	-0.000686	0.01	PASSED
	4	-0.000686	-0.000686	-0.000686	-0.000686	0.01	PASSED
40	0	-0.000501	-0.000509	-0.000509	-0.000509	0.01	PASSED
	1	-0.000501	-0.000509	-0.000509	-0.000509	0.01	PASSED
	2	-0.000501	-0.000509	-0.000509	-0.000509	0.01	PASSED
	4	-0.000501	-0.000509	-0.000509	-0.000509	0.01	PASSED
30	0	-0.000251	-0.000258	-0.000265	-0.000265	0.01	PASSED
	1	-0.000251	-0.000258	-0.000265	-0.000265	0.01	PASSED
	2	-0.000258	-0.000258	-0.000265	-0.000265	0.01	PASSED
	4	-0.000258	-0.000258	-0.000265	-0.000265	0.01	PASSED
20	0	0.000022	0.000007	0.000000	0.000000	0.01	PASSED
	1	0.000007	0.000007	0.000000	0.000000	0.01	PASSED
	2	0.000007	0.000007	0.000000	0.000000	0.01	PASSED
	4	0.000007	0.000007	0.000000	0.000000	0.01	PASSED
10	0	0.000177	0.000170	0.000170	0.000170	0.01	PASSED
	1	0.000177	0.000170	0.000170	0.000170	0.01	PASSED
	2	0.000177	0.000170	0.000170	0.000170	0.01	PASSED
	4	0.000177	0.000170	0.000170	0.000170	0.01	PASSED
0	0	0.000243	0.000243	0.000243	0.000243	0.01	PASSED
	1	0.000243	0.000243	0.000243	0.000243	0.01	PASSED
	2	0.000243	0.000243	0.000243	0.000243	0.01	PASSED
	4	0.000243	0.000243	0.000243	0.000243	0.01	PASSED
-10	0	0.000133	0.000155	0.000155	0.000155	0.01	PASSED
	1	0.000147	0.000155	0.000155	0.000155	0.01	PASSED
	2	0.000147	0.000155	0.000155	0.000155	0.01	PASSED
	4	0.000147	0.000155	0.000155	0.000155	0.01	PASSED
-20	0	-0.000177	-0.000147	-0.000147	-0.000147	0.01	PASSED
	1	-0.000170	-0.000147	-0.000147	-0.000147	0.01	PASSED
	2	-0.000162	-0.000147	-0.000147	-0.000147	0.01	PASSED
	4	-0.000162	-0.000147	-0.000147	-0.000147	0.01	PASSED

2.5.3 Test equipment

Description	Supplier	Model	Tag no.	Cal. due date
Climatic chamber	ESPEC	ARL-1100-AE	30091345	2026-09-22
Analyzer 20Hz-26.5GHz	Rohde & Schwarz	FSV 13	30150092	2024-11-29

Table 38. Frequency stability test equipment.

2.6 Frequency stability versus supply voltage

Test specimen	NFC MUX
Test specification	47 CFR 15.225 (e) RSS 210 B.6
Test method	ANSI C63.10:2013 sec. 6.8
Frequency range	13.110 - 14.010 MHz
Limits	47 CFR 15.225 (e) RSS 210 B.6
Comments	The NFC module was tested in stand-alone configuration
Temperature / Humidity	23°C / 33%RH
Dates of measurements	2024-02-23
Test personnel	Søren Søltøft

2.6.1 Test setup

The normal supply voltage is 5 VDC. The test was performed at 85% and 115% of normal supply voltage.

See appendix 1 for photo of test setup.

2.6.2 Test result

Voltage [VDC]	Frequency deviation [%]				Limit [%]	Result
	Antenna 0	Antenna 1	Antenna 2	Antenna 3		
4.25	0.000	0.000	0.000	0.000	0.01	PASSED
5.75	0.000	0.000	0.000	0.000	0.01	PASSED

Table 39. Frequency deviation as function of supply voltage.

2.6.3 Test equipment

Description	Supplier	Model	Tag no.	Cal date	Cal. due date
Multi Meter	Agilent	34401A	30114118	2024-01-22	2025-01-22
Analyzer 20Hz-26.5GHz	Rohde & Schwarz	FSV 13	30150092	2023-11-29	2024-11-29

Table 40. Radiated emission test equipment.

Date
2024-07-16

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2.7 Antenna requirement

Test specimen	NFC MUX
Test specification	47 CFR 15.203 RSS-Gen 6.8
Test method	None
Comments	None
Dates of measurements	2020-02-23
Test personnel	Søren Søltøft

2.7.1 Test result

All four antennas are using the same connector.

Description: CONN HEADER VERT 3POS 1.25MM

Manufacturer: Molex

Manufacturer Product Number: 0530470310

Antenna outer dimensions 29 mm x 29 mm.

See appendix 1 for photo of test specimen.

Not able to decide if the antenna connector complies with the unique antenna connector requirement.

Requirement	Result
47 CFR 15.203	No verdict
ISED RSS-Gen 6.8	No verdict

Table 41. Antenna requirements test results.

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2024-07-16

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2.8 AC Conducted emission

Test specimen	NFC MUX
Test specification	47 CFR 15.207 (a) RSS-Gen 8.8
Test method	ANSI C63.10:2013 sec. 6.2
Frequency range	0.15 - 30 MHz
Limits	47 CFR Part 15.207 RSS-Gen 8.8
Comments	None
Temperature / Humidity	23°C / 35%RH, 25°C / 39%RH
Dates of measurements	2024-04-24, 2024-05-03
Test personnel	Søren Søltøft

2.8.1 Test setup

The test was performed on NFC module stand alone with one antenna active one at a time.
The NFC MUX was powered through an AC / DC adaptor. The AC / DC adapter was powered by 120 VAC through the AMN.
The NFC Mux Controller was powered by 6 times 1.5 V batteries.

The tests was repeated with a terminations instead of the antennas in the frequency band 13.11 MHz to 14.01 MHz.

According to Q5 of KDB 174176 D01 v01r01 it is permissible to do a retest of the transmitter's fundamental emission band with a dummy load instead of the normal antenna to show compliance with the limits.

See appendix 1 for photo of test setup.

2.8.2 Test results

2.8.2.1 Antenna 0

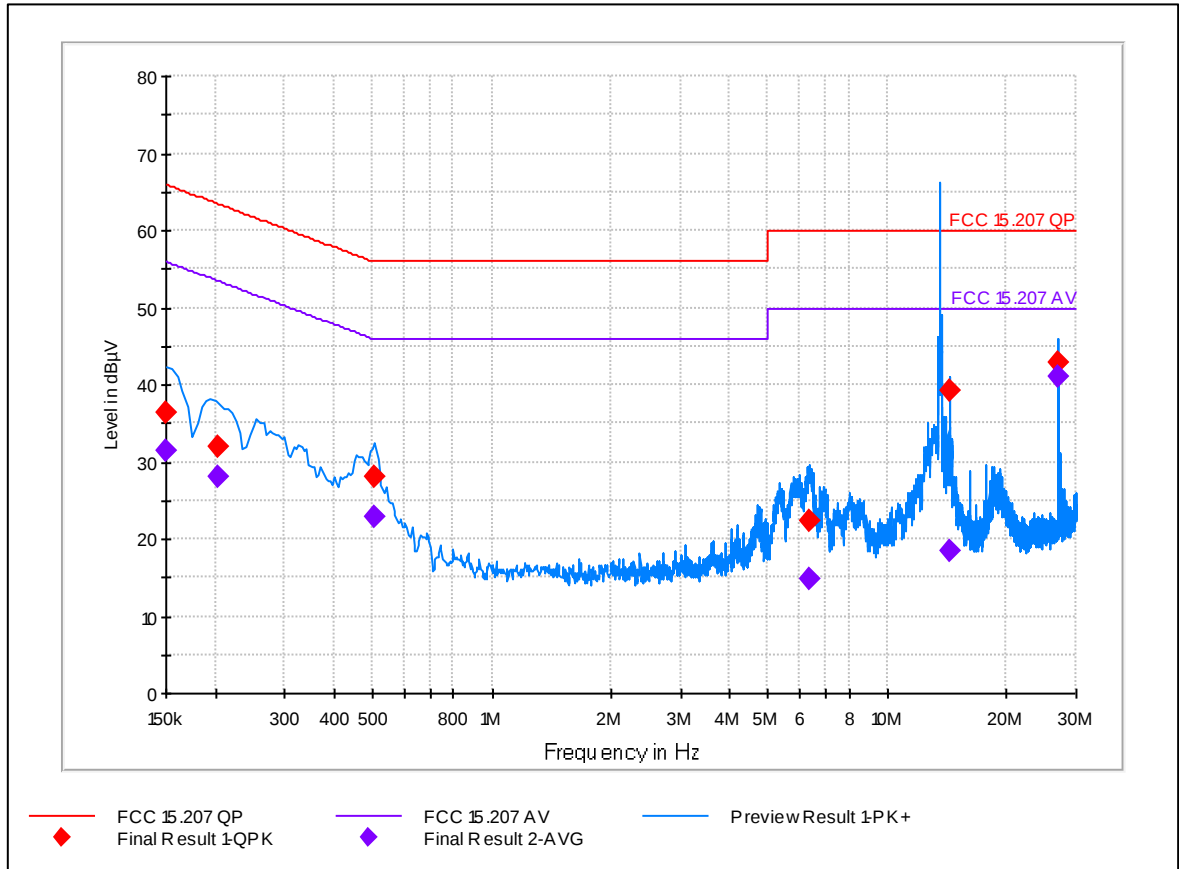


Figure 33. AC Conducted emission.

Frequency [MHz]	QuasiPeak [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
0.150300	36.5	9.000	N	29.50	66.00	PASSED
0.204100	32.0	9.000	N	31.50	63.40	PASSED
0.503400	28.0	9.000	N	28.00	56.00	PASSED
6.389900	22.2	9.000	N	37.80	60.00	PASSED
14.408500	39.2	9.000	L1	20.80	60.00	PASSED
27.120000	42.8	9.000	N	17.20	60.00	PASSED

Table 42. AC Conducted emission. QuasiPeak detector.

Frequency [MHz]	Average [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
0.150300	31.4	9.000	N	24.60	56.00	PASSED
0.204100	28.0	9.000	N	25.50	53.40	PASSED
0.503400	22.9	9.000	N	23.10	46.00	PASSED
6.389900	14.7	9.000	N	35.30	50.00	PASSED
14.408500	18.5	9.000	L1	31.50	50.00	PASSED
27.120000	41.0	9.000	N	9.00	50.00	PASSED

Table 43. AC Conducted emission. Average detector.

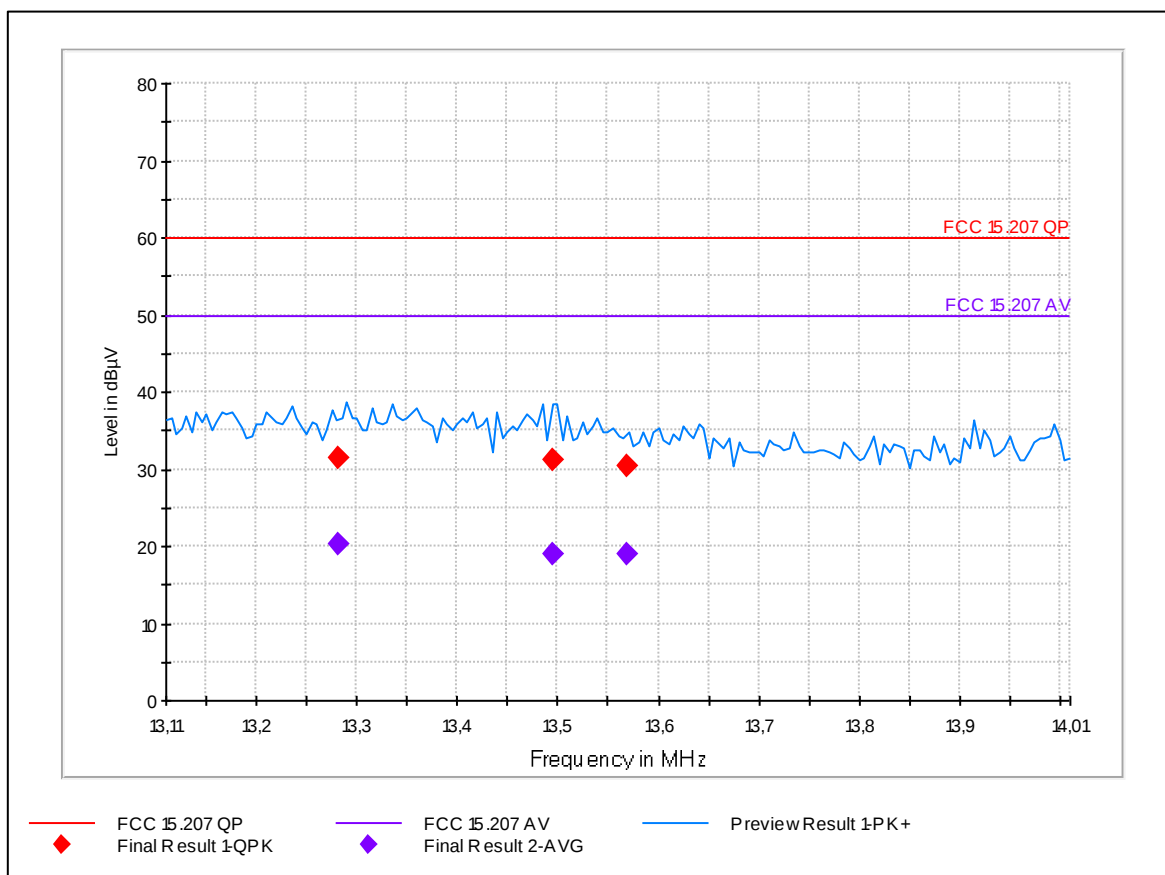


Figure 34. AC Conducted emission in band 13.11 MHz to 14.01 MHz.

Frequency [MHz]	QuasiPeak [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
13.282600	31.4	9.000	L1	28.60	60.00	PASSED
13.496000	31.1	9.000	L1	28.90	60.00	PASSED
13.568000	30.4	9.000	L1	29.60	60.00	PASSED

Table 44. AC Conducted emission in band 13.11 MHz to 14.01 MHz. QuasiPeak detector.

Frequency [MHz]	Average [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
13.282600	20.3	9.000	L1	29.70	50.00	PASSED
13.496000	19.1	9.000	L1	30.90	50.00	PASSED
13.568000	19.0	9.000	L1	31.00	50.00	PASSED

Table 45. AC Conducted emission in band 13.11 MHz to 14.01 MHz. Average detector.

2.8.2.2 Antenna 1

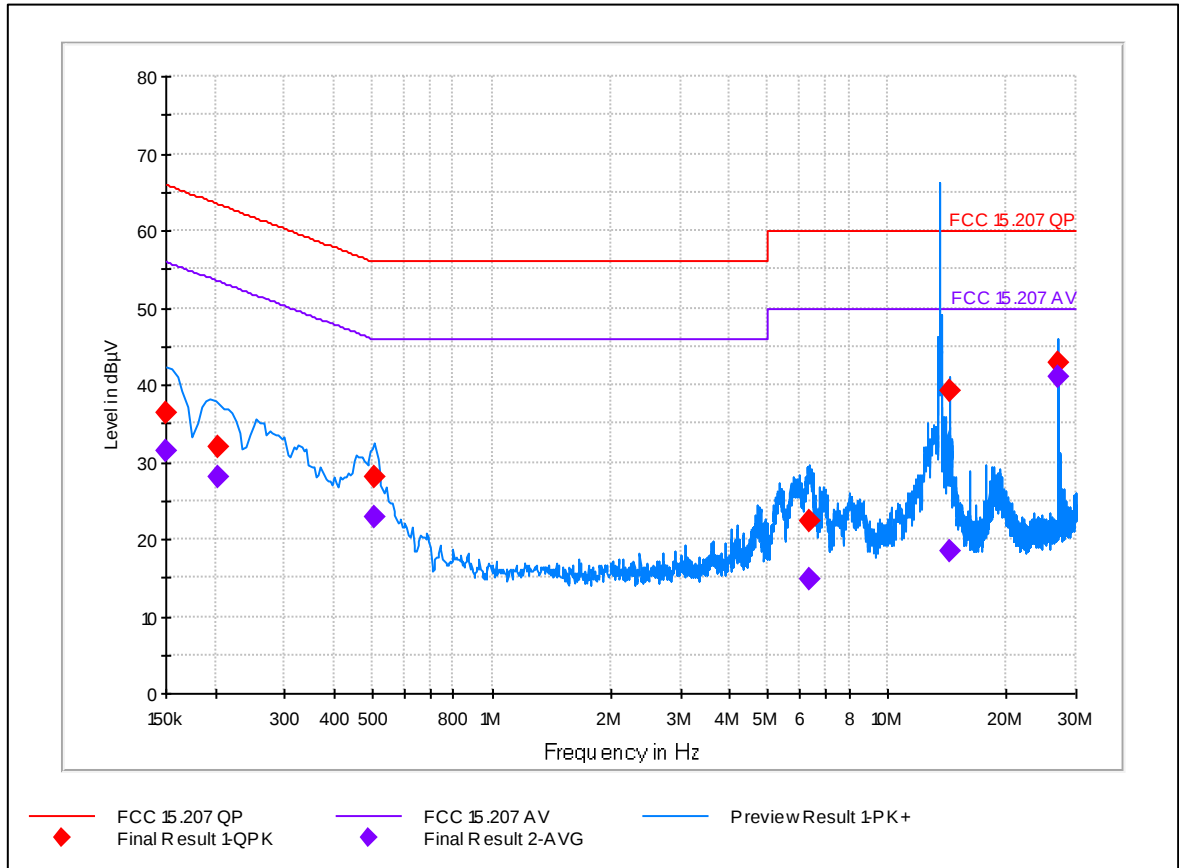


Figure 35. AC Conducted emission.

Frequency [MHz]	QuasiPeak [dBμV]	BW [kHz]	Line	Margin [dB]	Limit [dBμV]	Result
0.151400	36.2	9.000	N	29.80	65.90	PASSED
0.194600	32.2	9.000	N	31.60	63.80	PASSED
0.506800	27.9	9.000	N	28.10	56.00	PASSED
6.293600	22.2	9.000	N	37.80	60.00	PASSED
14.407700	40.2	9.000	L1	19.80	60.00	PASSED
27.119400	43.7	9.000	N	16.30	60.00	PASSED

Table 46. AC Conducted emission. QuasiPeak detector.

Frequency [MHz]	Average [dBμV]	BW [kHz]	Line	Margin [dB]	Limit [dBμV]	Result
0.151400	31.0	9.000	N	24.90	55.90	PASSED
0.194600	27.4	9.000	N	26.40	53.80	PASSED
0.506800	23.6	9.000	N	22.40	46.00	PASSED
6.293600	13.6	9.000	N	36.40	50.00	PASSED
14.407700	19.2	9.000	L1	30.80	50.00	PASSED
27.119400	41.9	9.000	N	8.10	50.00	PASSED

Table 47. AC Conducted emission. Average detector.

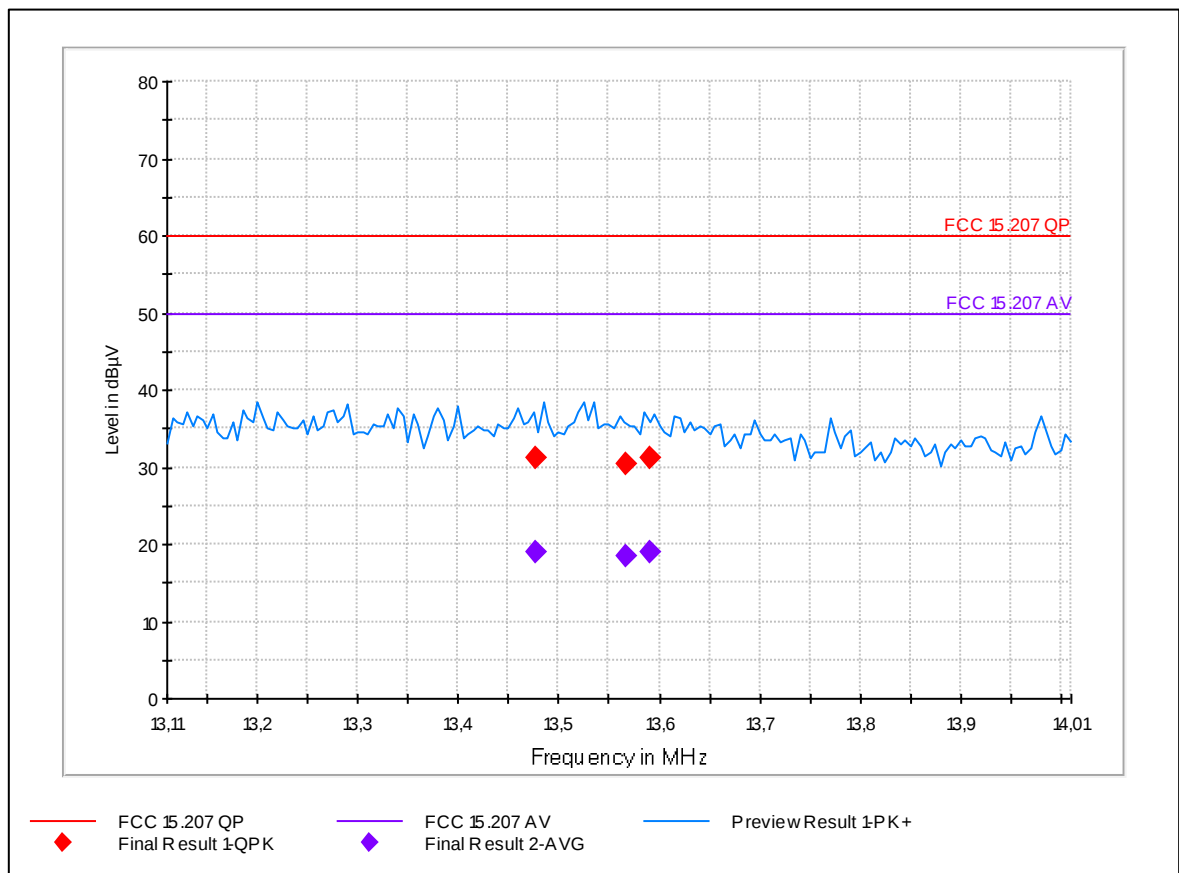


Figure 36. AC Conducted emission in band 13.11 MHz to 14.01 MHz.

Frequency [MHz]	QuasiPeak [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
13.478000	31.3	9.000	L1	28.70	60.00	PASSED
13.567300	30.3	9.000	L1	29.70	60.00	PASSED
13.590500	31.1	9.000	L1	28.90	60.00	PASSED

Table 48. AC Conducted emission in band 13.11 MHz to 14.01 MHz. QuasiPeak detector.

Frequency [MHz]	Average [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
13.478000	19.0	9.000	L1	31.00	50.00	PASSED
13.567300	18.4	9.000	L1	31.60	50.00	PASSED
13.590500	19.0	9.000	L1	31.00	50.00	PASSED

Table 49. AC Conducted emission in band 13.11 MHz to 14.01 MHz. Average detector.

2.8.2.3 Antenna 2

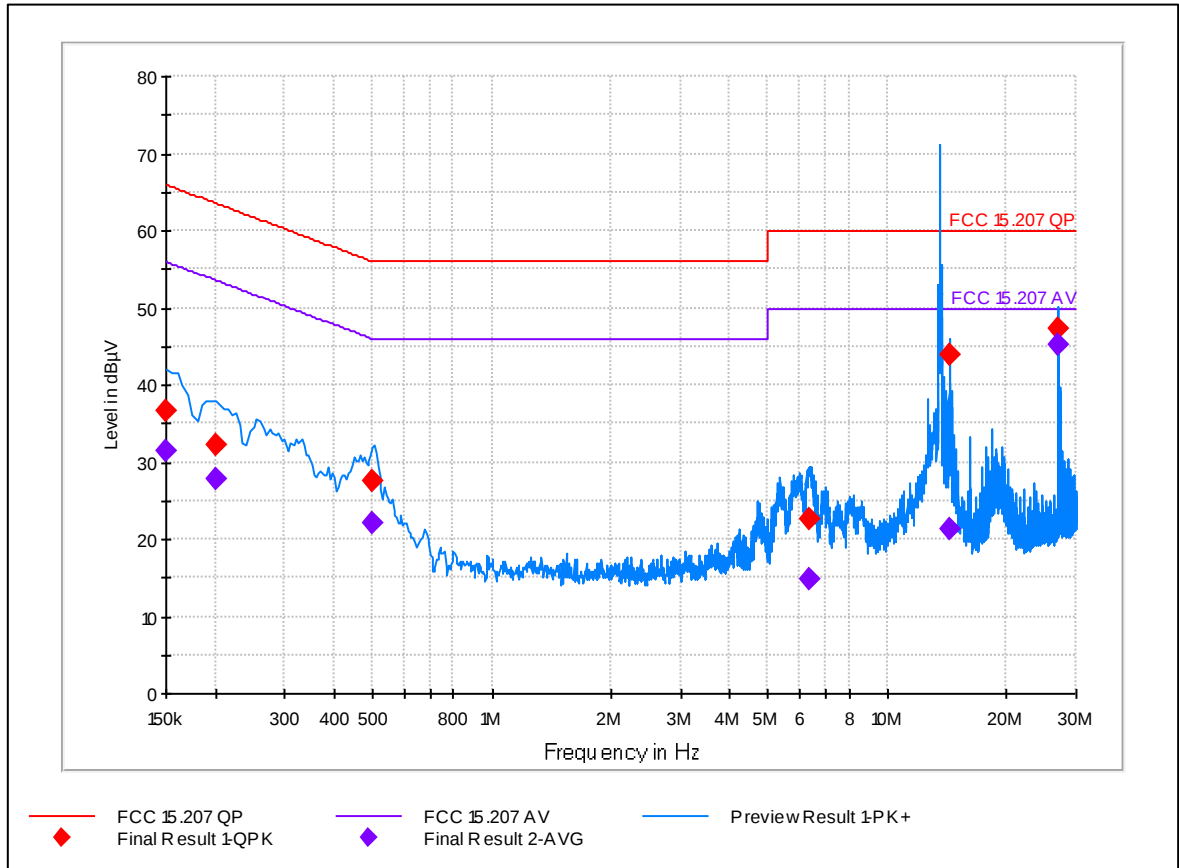


Figure 37. AC Conducted emission.

Frequency [MHz]	QuasiPeak [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
0.150300	36.5	9.000	N	29.50	66.00	PASSED
0.200100	32.2	9.000	N	31.40	63.60	PASSED
0.499900	27.4	9.000	N	28.60	56.00	PASSED
6.374000	22.7	9.000	N	37.30	60.00	PASSED
14.408700	43.9	9.000	L1	16.10	60.00	PASSED
27.118900	47.2	9.000	N	12.80	60.00	PASSED

Table 50. AC Conducted emission. QuasiPeak detector.

Frequency [MHz]	Average [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
0.150300	31.3	9.000	N	24.60	56.00	PASSED
0.200100	27.8	9.000	N	25.80	53.60	PASSED
0.499900	22.1	9.000	N	23.90	46.00	PASSED
6.374000	14.8	9.000	N	35.20	50.00	PASSED
14.408700	21.3	9.000	L1	28.70	50.00	PASSED
27.118900	45.3	9.000	N	4.70	50.00	PASSED

Table 51. AC Conducted emission. Average detector.

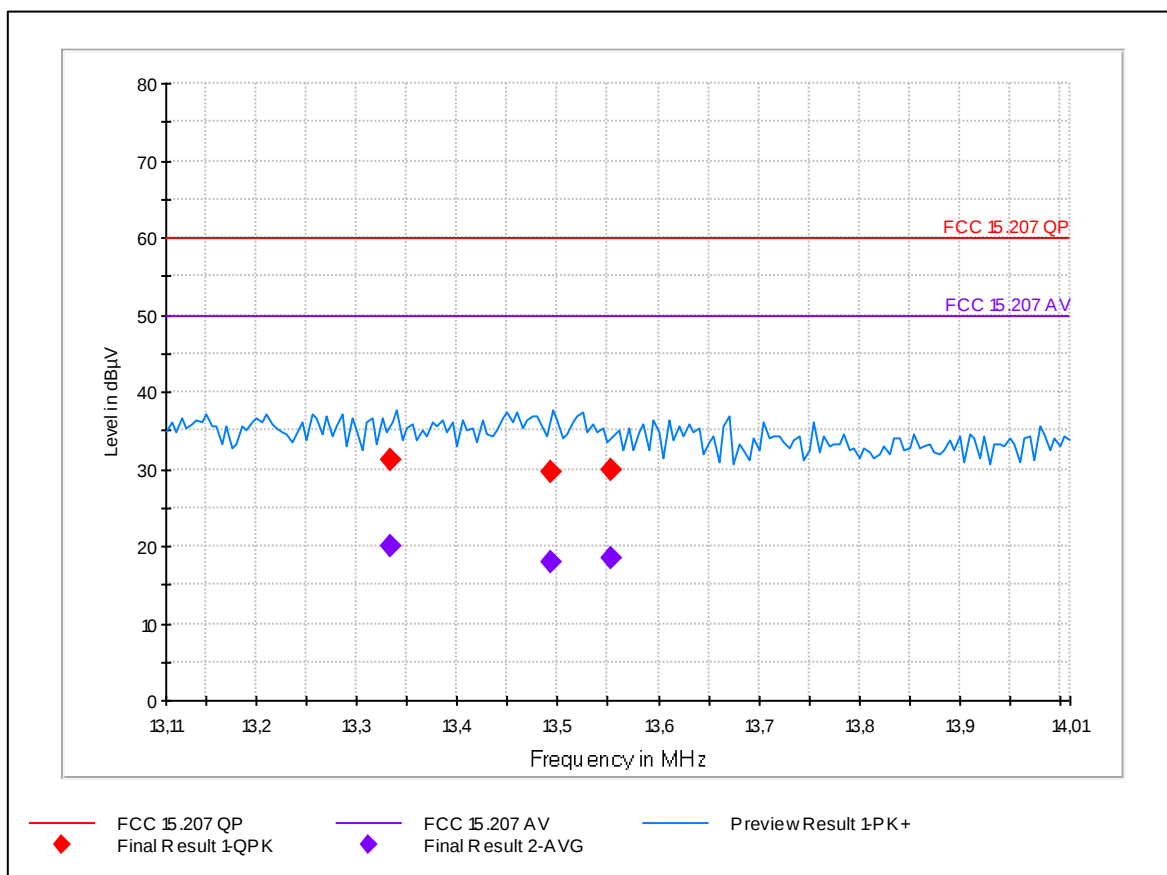


Figure 38. AC Conducted emission in band 13.11 MHz to 14.01 MHz.

Frequency [MHz]	QuasiPeak [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
13.333900	31.2	9.000	L1	28.80	60.00	PASSED
13.492800	29.6	9.000	L1	30.40	60.00	PASSED
13.553300	29.9	9.000	L1	30.10	60.00	PASSED

Table 52. AC Conducted emission in band 13.11 MHz to 14.01 MHz. QuasiPeak detector.

Frequency [MHz]	Average [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
13.333900	20.1	9.000	L1	29.90	50.00	PASSED
13.492800	18.0	9.000	L1	32.00	50.00	PASSED
13.553300	18.5	9.000	L1	31.50	50.00	PASSED

Table 53. AC Conducted emission in band 13.11 MHz to 14.01 MHz. Average detector.

2.8.2.4 Antenna 3

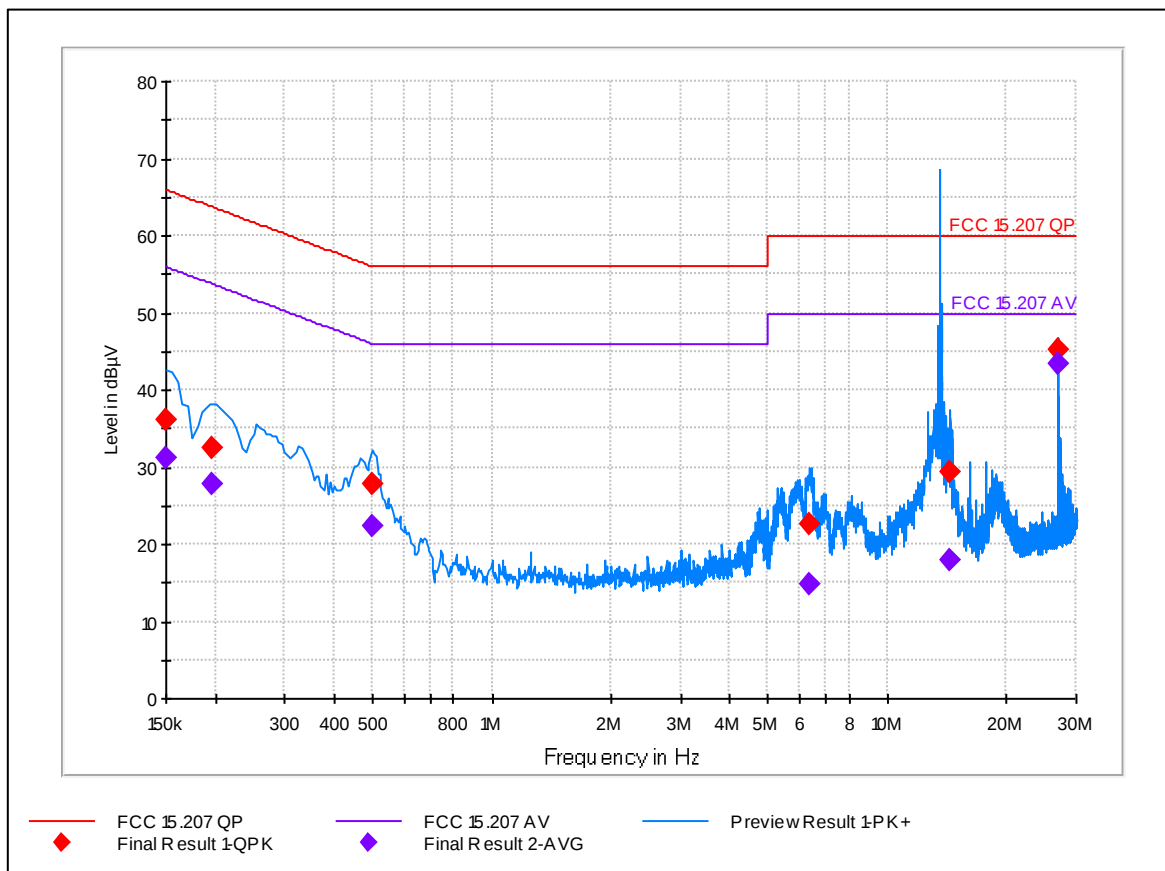


Figure 39. AC Conducted emission.

Frequency [MHz]	QuasiPeak [dBμV]	BW [kHz]	Line	Margin [dB]	Limit [dBμV]	Result
0.150800	36.2	9.000	N	29.80	66.00	PASSED
0.195900	32.3	9.000	N	31.40	63.80	PASSED
0.501400	27.9	9.000	N	28.20	56.00	PASSED
6.377100	22.6	9.000	N	37.40	60.00	PASSED
14.307700	29.3	9.000	N	30.70	60.00	PASSED
27.121000	45.1	9.000	N	14.90	60.00	PASSED

Table 54. AC Conducted emission. QuasiPeak detector.

Frequency [MHz]	Average [dBμV]	BW [kHz]	Line	Margin [dB]	Limit [dBμV]	Result
0.150800	31.2	9.000	N	24.70	56.00	PASSED
0.195900	27.8	9.000	N	26.00	53.80	PASSED
0.501400	22.2	9.000	N	23.80	46.00	PASSED
6.377100	14.9	9.000	N	35.10	50.00	PASSED
14.307700	17.9	9.000	N	32.10	50.00	PASSED
27.121000	43.5	9.000	N	6.50	50.00	PASSED

Table 55. AC Conducted emission. Average detector.

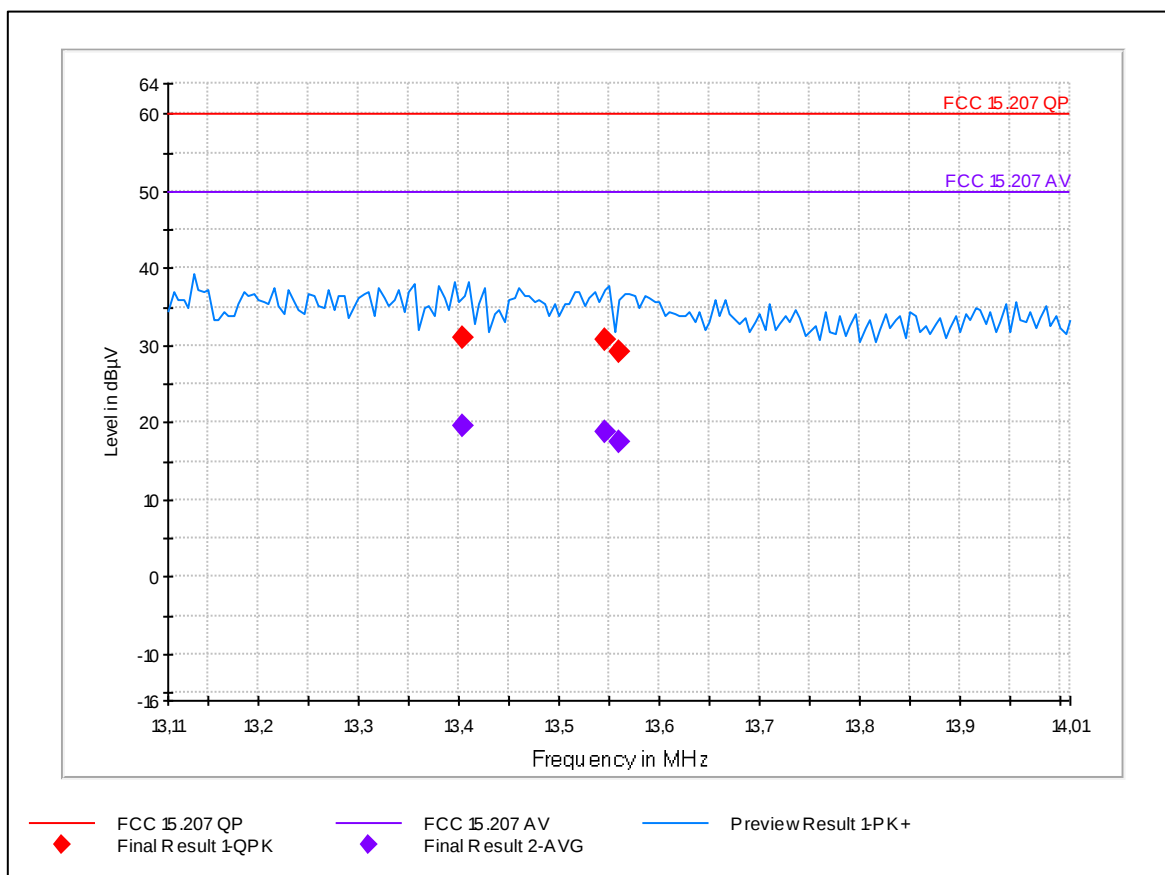


Figure 40. AC Conducted emission in band 13.11 MHz to 14.01 MHz.

Frequency [MHz]	QuasiPeak [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
13.404600	31.0	9.000	N	29.00	60.00	PASSED
13.545900	30.7	9.000	N	29.30	60.00	PASSED
13.560600	29.2	9.000	N	30.80	60.00	PASSED

Table 56. AC Conducted emission in band 13.11 MHz to 14.01 MHz. QuasiPeak detector.

Frequency [MHz]	Average [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
13.404600	19.5	9.000	N	30.50	50.00	PASSED
13.545900	18.9	9.000	N	31.10	50.00	PASSED
13.560600	17.6	9.000	N	32.40	50.00	PASSED

Table 57. AC Conducted emission in band 13.11 MHz to 14.01 MHz. Average detector.

2.8.3 Test equipment

Description	Supplier	Model	Tag no.	Cal. due date
V-network Two Line	Rohde & Schwarz	ESH3-Z5	30120682	2025-02-05
Pulse Limiter	Rohde & Schwarz	ESH-Z2	30113513	2024-05-15
Receiver EMI Test 20Hz-26.5GHz	Rohde & Schwarz	ESIB 26	30118880	2025-01-24

Table 58. AC Conducted emission test equipment.

2.9 Occupied bandwidth

Test specimen	NFC MUX
Test specification	47 CFR 15.215 (c) RSS-Gen 6.7
Test method	ANSI C63.10:2013 sec. 6.9.2
Comments	The NFC module was tested in stand-alone configuration
Temperature / Humidity	24°C / 34%RH
Dates of measurements	2024-04-25
Test personnel	Søren Søltøft

2.9.1 Test setup

The test was performed on NFC module stand alone with one antenna active one at a time A loop antenna was placed below the 4 antennas. The loop antenna was connected to a spectrum analyzer.

See photo of test set up in appendix 1.

2.9.2 Test results

2.9.2.1 20 dB OBW

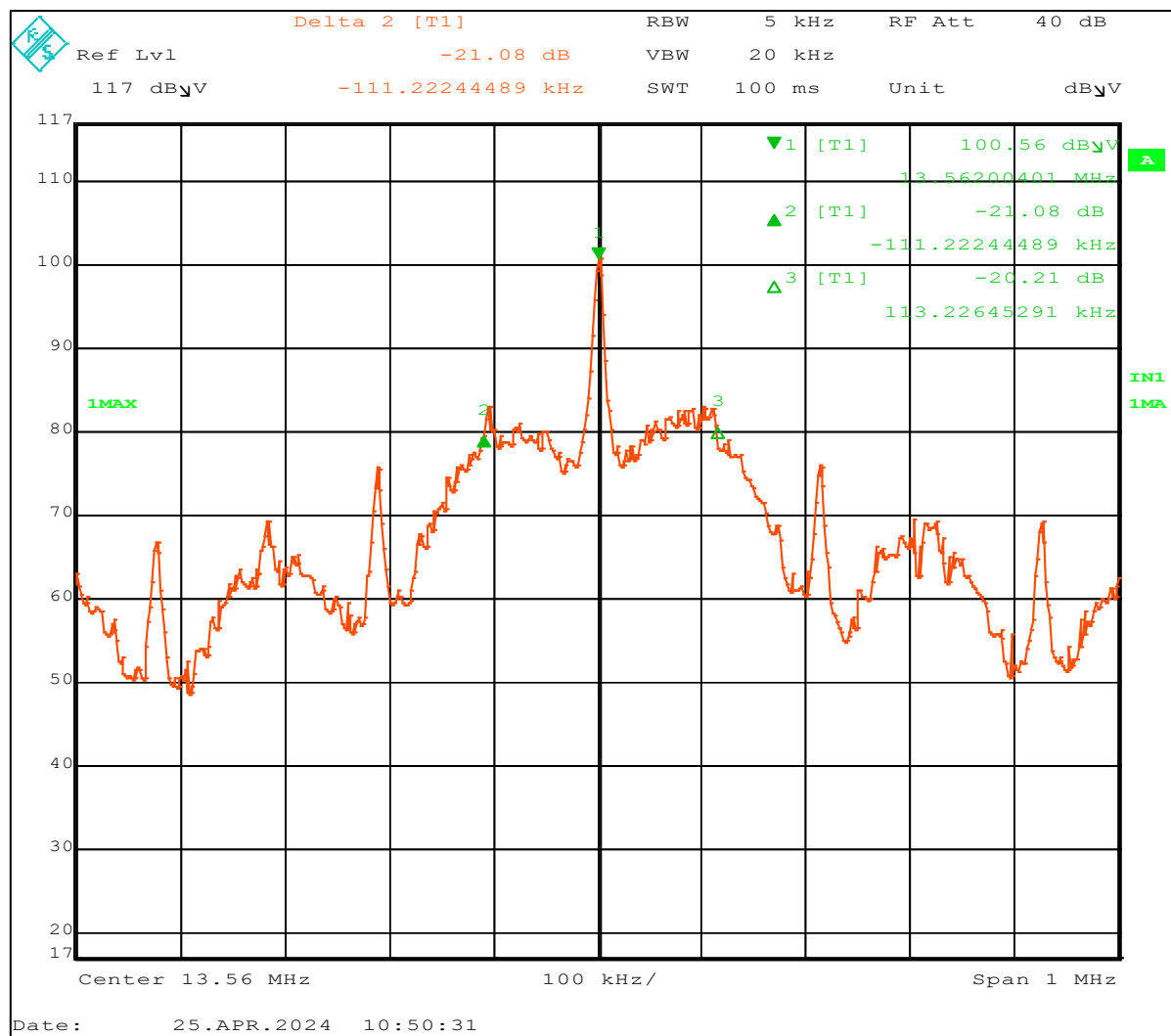


Figure 41. Antenna 0. 20 dB Occupied bandwidth.

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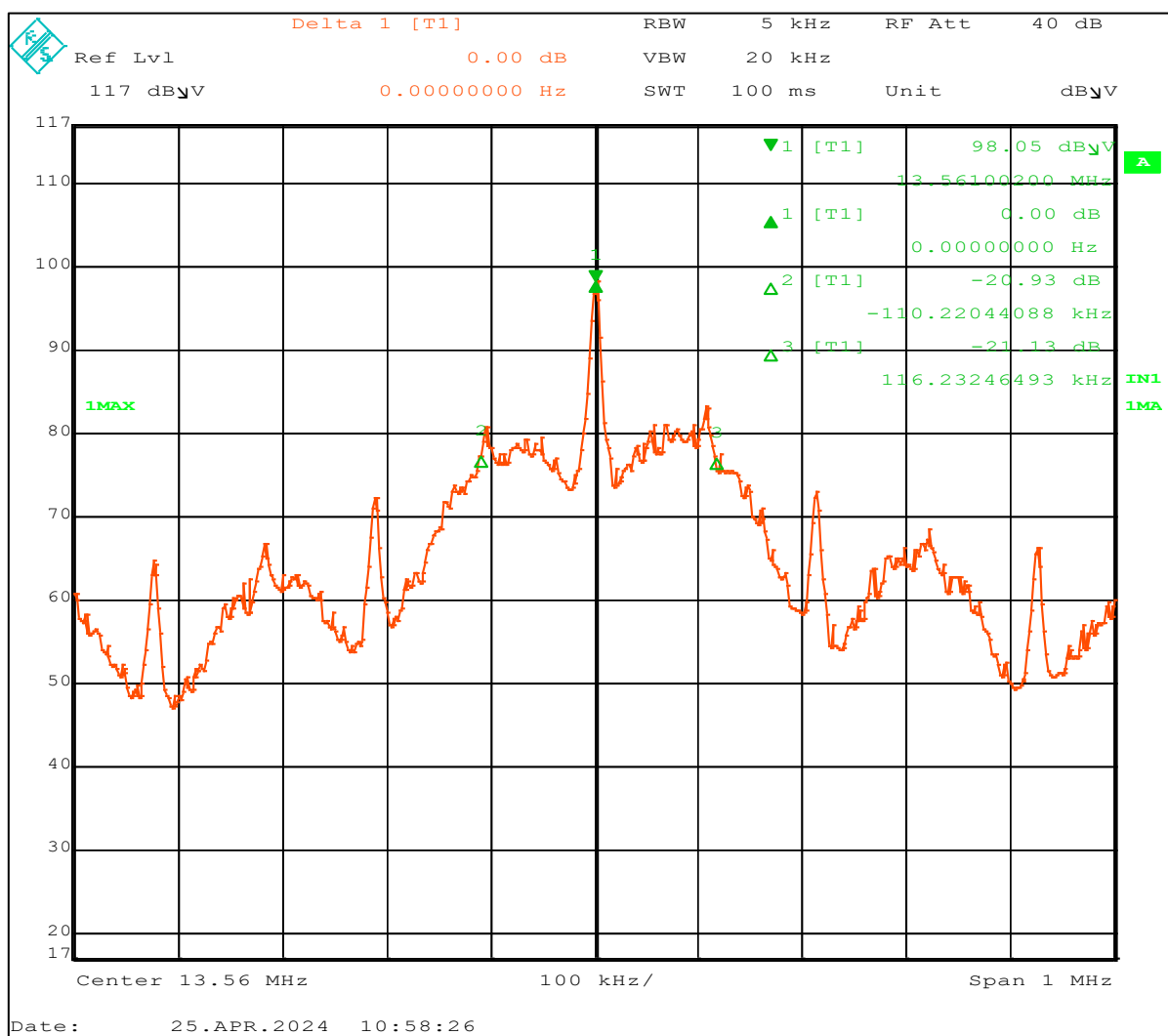


Figure 42. Antenna 1. 20 dB Occupied bandwidth.

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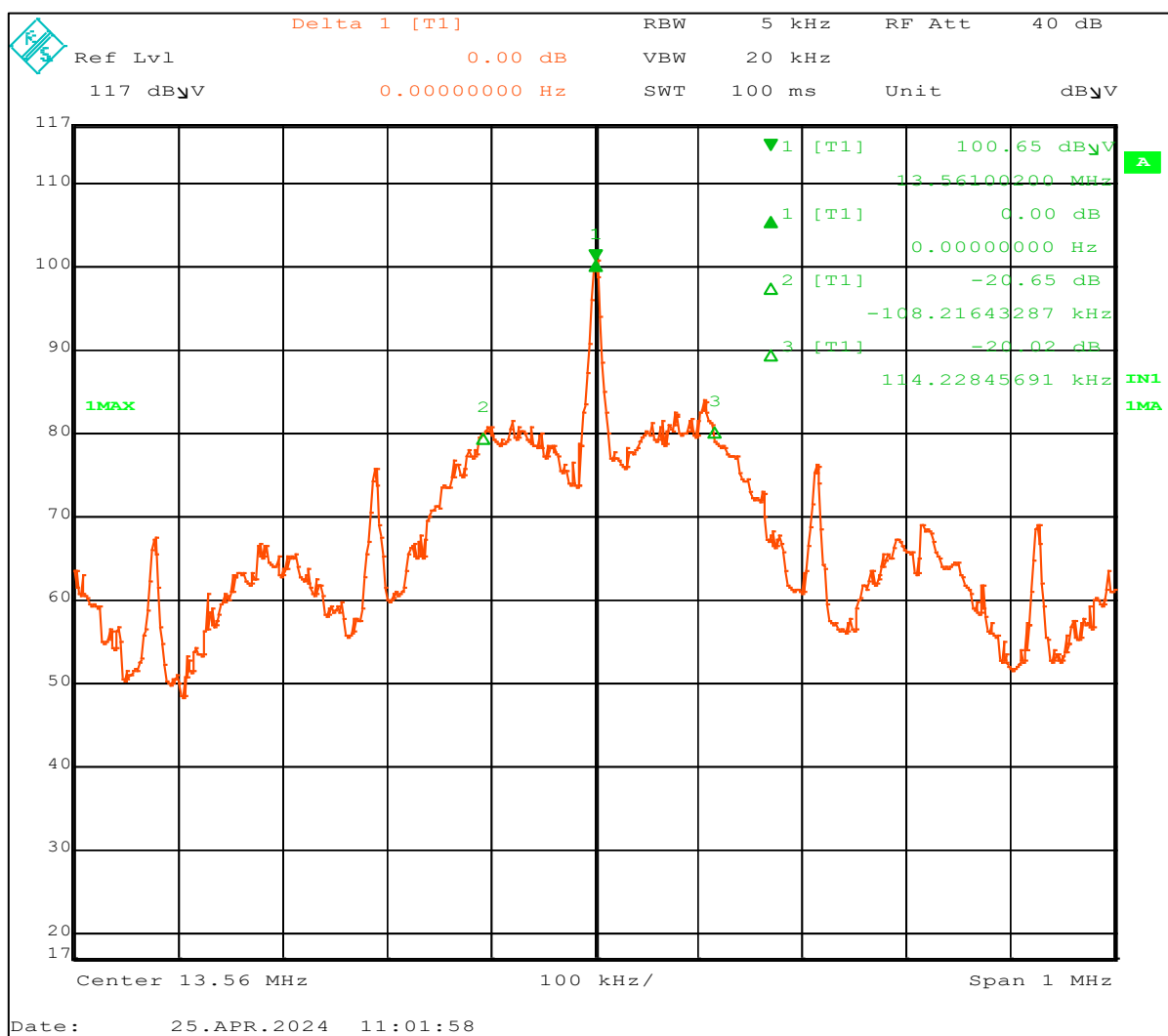


Figure 43. Antenna 2. 20 dB Occupied bandwidth.

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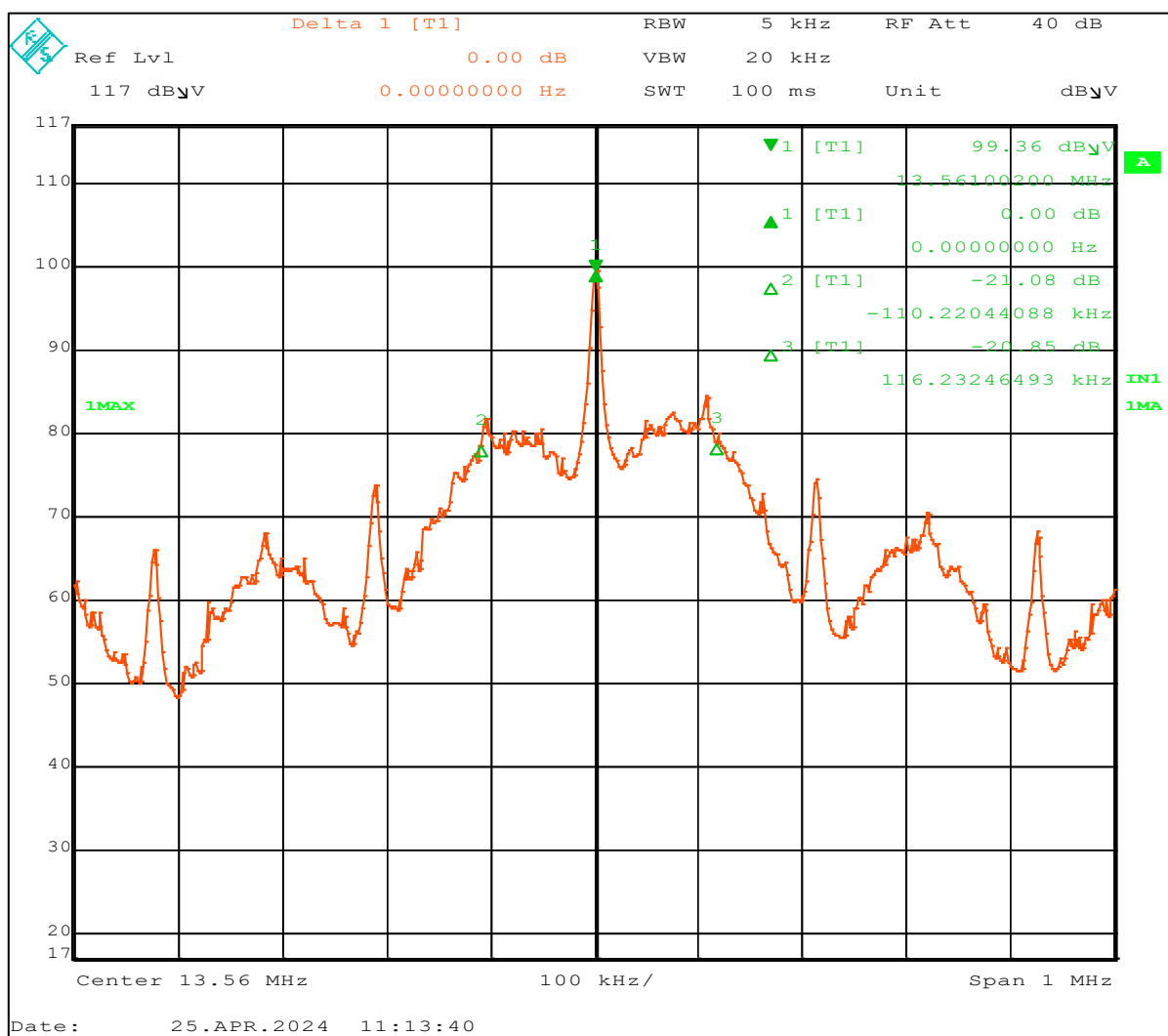


Figure 44. Antenna 3. 20 dB Occupied bandwidth.

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2.9.2.2 99% OBW

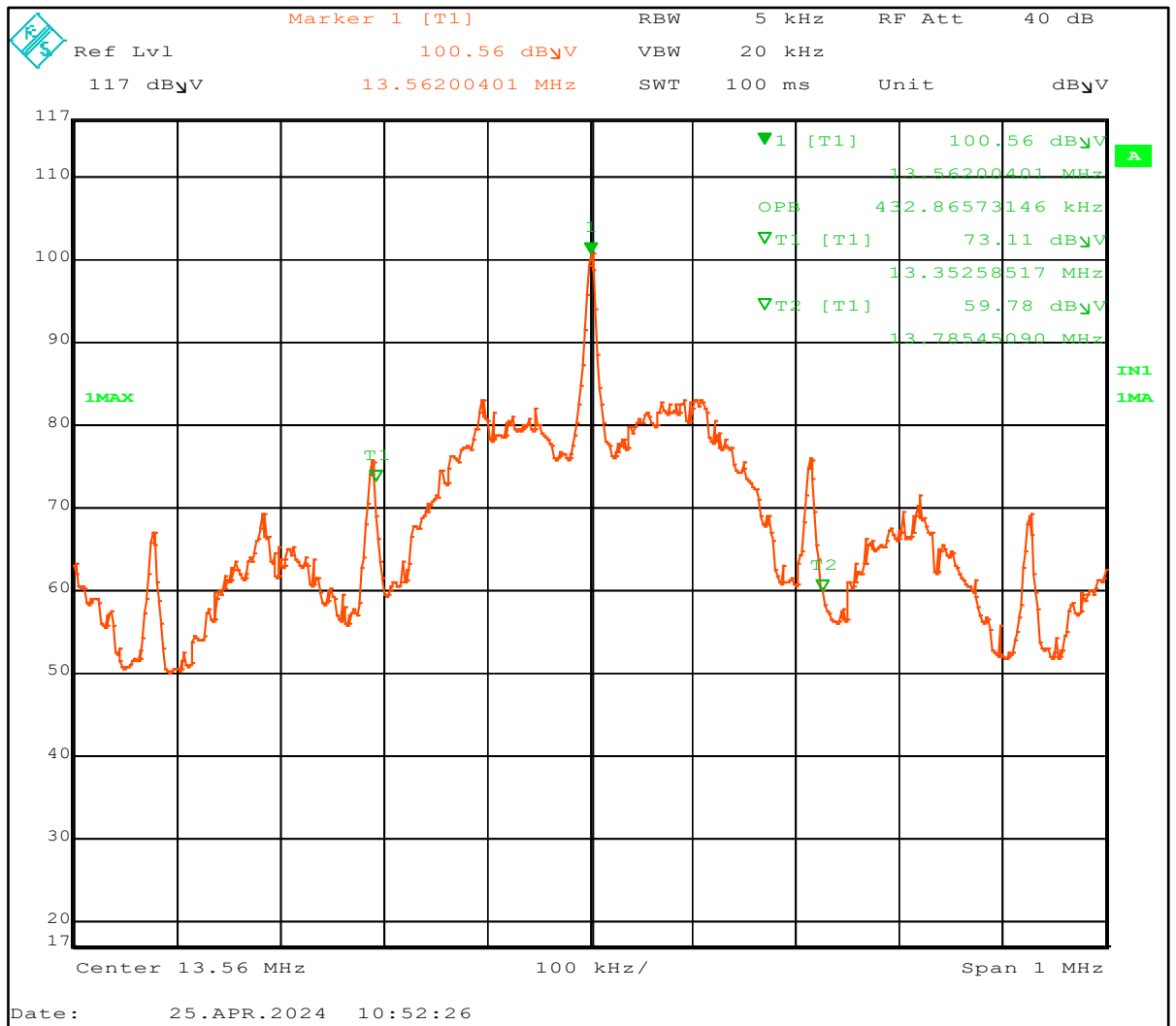


Figure 45. Antenna 0. 99% Occupied bandwidth.

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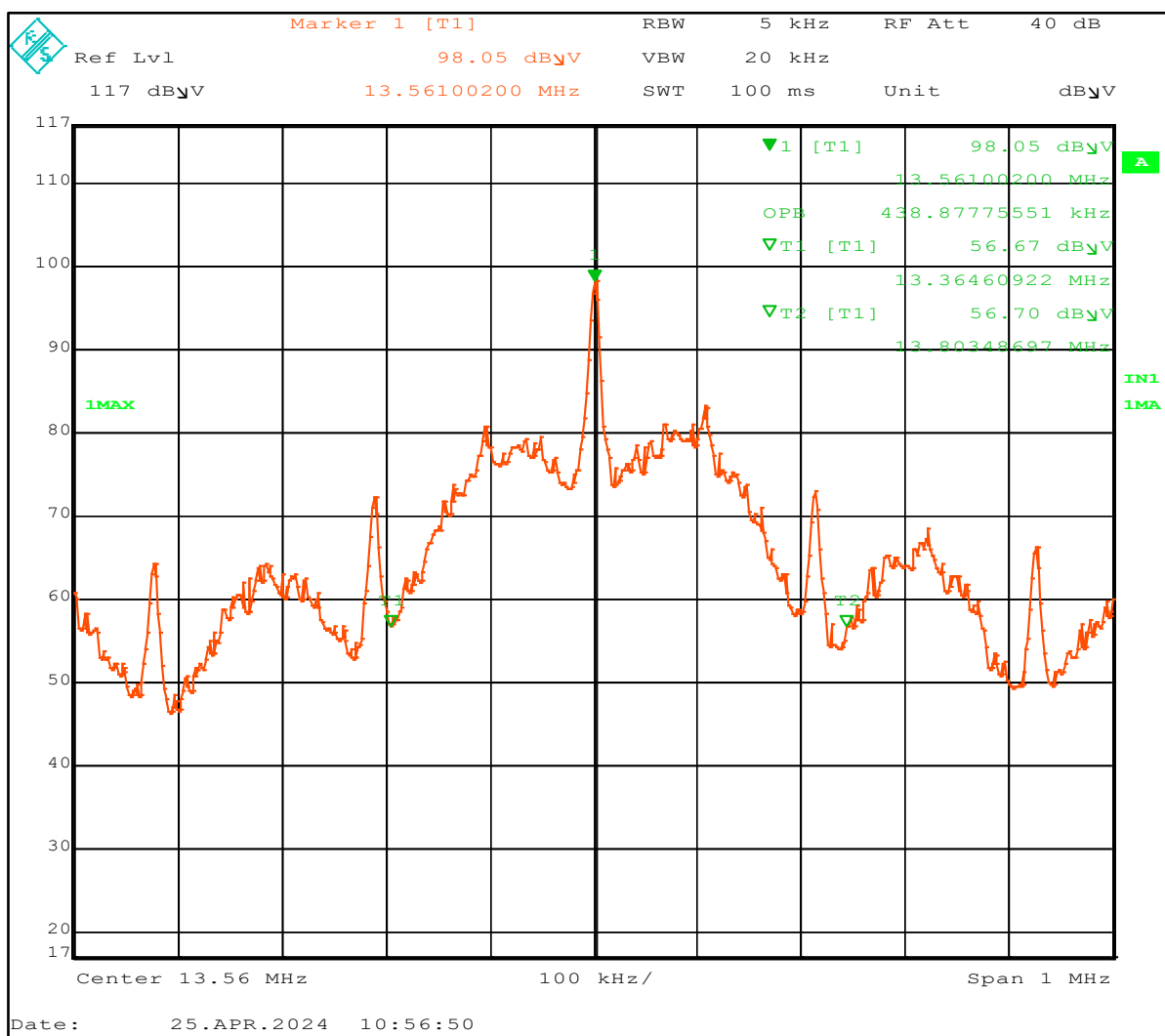


Figure 46. Antenna 1. 99% Occupied bandwidth.

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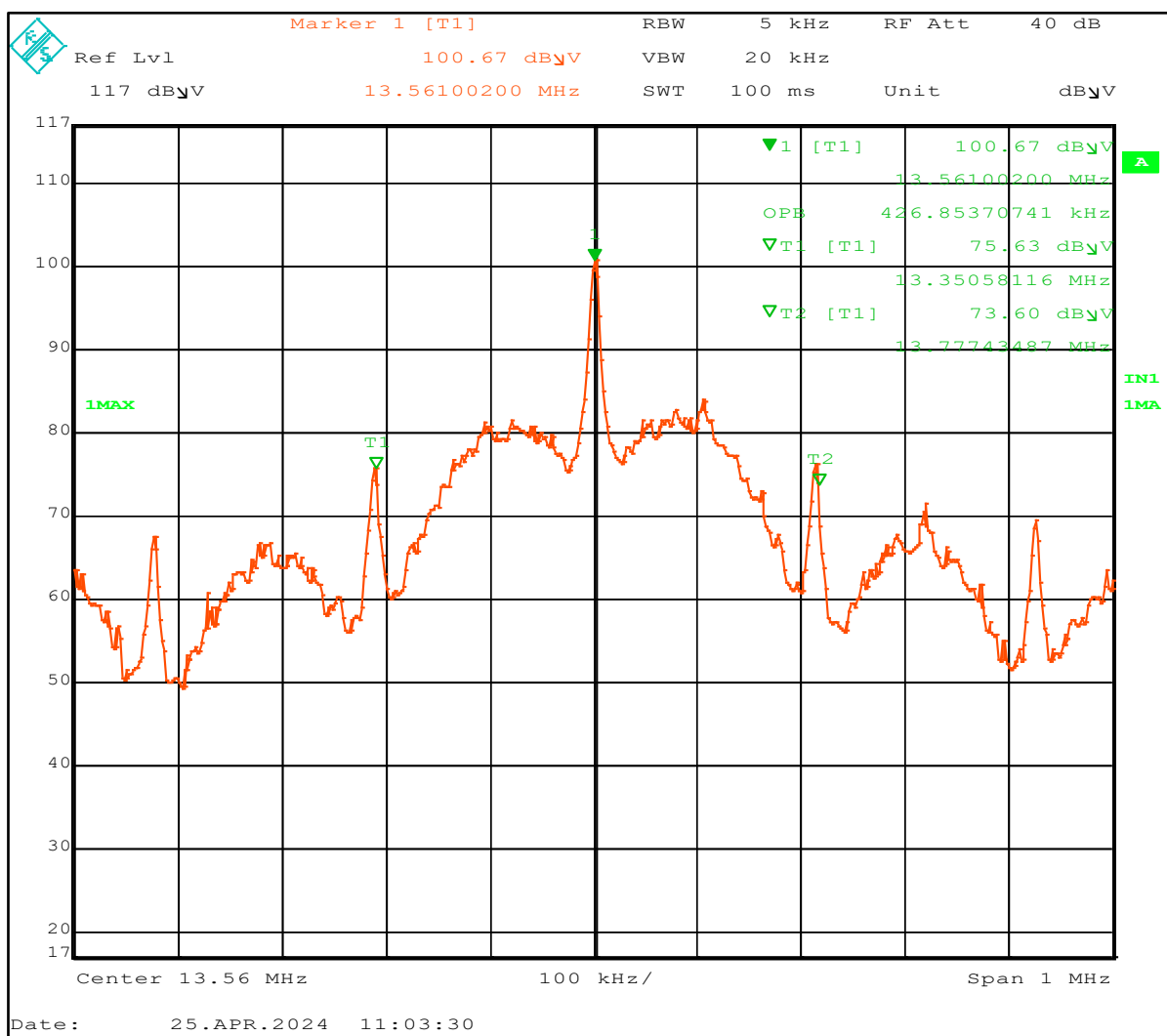


Figure 47. Antenna 2. 99% Occupied bandwidth.

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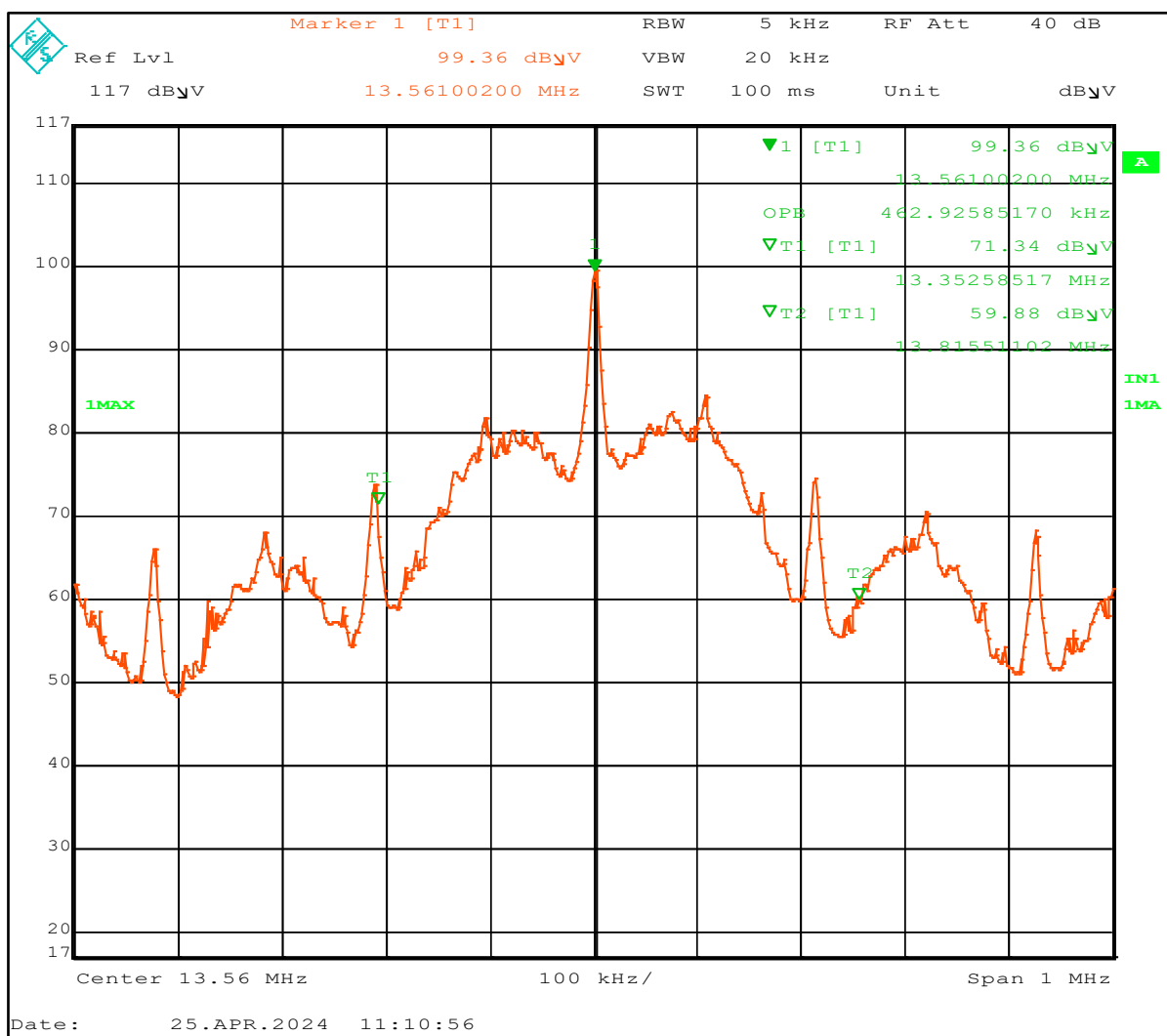


Figure 48. Antenna 3. 99% Occupied bandwidth.

Highest frequency deviation detected during frequency stability test was +33 Hz and -95 Hz.

	OBW freq.. [MHz]	Freq. Stab. [MHz]	OBW w. Freq. Stab. [MHz]	Band limit [MHz]	Margin [MHz]	Result
Low freq.	13.450782	-0.000095	13.450687	13.11	0.341	PASSED
High freq.	13.675230	0.000033	13.675263	14.01	0.335	PASSED

Table 59. Antenna 0. 20 dB Occupied bandwidth results.

	OBW freq.. [MHz]	Freq. Stab. [MHz]	OBW w. Freq. Stab. [MHz]	Band limit [MHz]	Margin [MHz]	Result
Low freq.	13.450782	-0.000095	13.450687	13.11	0.341	PASSED
High freq.	13.677234	0.000033	13.677267	14.01	0.333	PASSED

Table 60. Antenna 1. 20 dB Occupied bandwidth results.

	OBW freq.. [MHz]	Freq. Stab. [MHz]	OBW w. Freq. Stab. [MHz]	Band limit [MHz]	Margin [MHz]	Result
Low freq.	13.452786	-0.000095	13.452691	13.11	0.343	PASSED
High freq.	13.675230	0.000033	13.675263	14.01	0.335	PASSED

Table 61. Antenna 2. 20 dB Occupied bandwidth results.

	OBW freq.. [MHz]	Freq. Stab. [MHz]	OBW w. Freq. Stab. [MHz]	Band limit [MHz]	Margin [MHz]	Result
Low freq.	13.450782	-0.000095	13.450687	13.11	0.341	PASSED
High freq.	13.675230	0.000033	13.675263	14.01	0.335	PASSED

Table 62. Antenna 3. 20 dB Occupied bandwidth results.

	OBW freq.. [MHz]	Freq. Stab. [MHz]	OBW w. Freq. Stab. [MHz]	Band limit [MHz]	Margin [MHz]	Result
Low freq.	13.352585	-0.000095	13.35249	13.11	0.242	PASSED
High freq.	13.705451	0.000033	13.705484	14.01	0.305	PASSED

Table 63. Antenna 0. 99% Occupied bandwidth results.

	OBW freq.. [MHz]	Freq. Stab. [MHz]	OBW w. Freq. Stab. [MHz]	Band limit [MHz]	Margin [MHz]	Result
Low freq.	13.364609	-0.000095	13.364514	13.11	0.255	PASSED
High freq.	13.803487	0.000033	13.80352	14.01	0.206	PASSED

Table 64. Antenna 1. 99% Occupied bandwidth results.

	OBW freq.. [MHz]	Freq. Stab. [MHz]	OBW w. Freq. Stab. [MHz]	Band limit [MHz]	Margin [MHz]	Result
Low freq.	13.350581	-0.000095	13.350486	13.11	0.240	PASSED
High freq.	13.777435	0.000033	13.777468	14.01	0.233	PASSED

Table 65. Antenna 2. 99% Occupied bandwidth results.

	OBW freq.. [MHz]	Freq. Stab. [MHz]	OBW w. Freq. Stab. [MHz]	Band limit [MHz]	Margin [MHz]	Result
Low freq.	13.352385	-0.000095	13.35229	13.11	0.242	PASSED
High freq.	13.815511	0.000033	13.815544	14.01	0.194	PASSED

Table 66. Antenna 3. 99% Occupied bandwidth results.

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2024-07-16

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2.9.3 Test equipment

Description	Supplier	Model	Tag no.	Cal. due date
Receiver EMI Test 20Hz-26.5GHz	Rohde & Schwarz	ESIB 26	30118880	2025-01-24

Table 67. Occupied bandwidth 20 dB and 99% test equipment.

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3 MEASURING UNCERTAINTIES

Compliance evaluation is based on a shared risk principle with respect to the measurement uncertainty.

	Frequency [MHz]	Polarization	Expanded Uncertainty [dB] (k=2)
Radiated emission (HFH2-Z2)	0.009 - 30		3.60 dB
Radiated emission	30 - 200	Vertical	4.73 dB
	200 - 1000	Vertical	4.97 dB
	30 - 200	Horizontal	4.72 dB
	200 - 1000	Horizontal	5.08 dB
Conducted emission (CISPR 16-4)	0.009 - 30	-	3.44 dB
Conducted emission (ESIB 26)	<1000	-	2.58 dB
Frequency Error (ESIB)	13.56	-	0.39 ppm