

# Test Report

of

DeLaval Herd Navigator™ precision analytics 100

FCC ID: 2AVDM-01

ISED ID: 25745-01

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



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Examined by



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<b>Report no.:</b>	P19-0186-1 rev. 2	<b>Report date:</b>	2021-02-04
<b>Test started:</b>	2019-10-30	<b>Test ended:</b>	2020-01-15
<b>Test laboratory:</b>	EKTOS TRS A/S A. C. Meyers Vænge 15 2450 Copenhagen SV Denmark	<b>Client:</b>	Lattec I/S Blytækkervej 10 3400 Hillerød Denmark
<b>Contact person:</b>	Søren Søltøft	<b>Contact person:</b>	John Slaaby
<b>Facility reg. no.</b>	FCC Designation number: DK0002 ISED CAB identifier: DK0001		
<b>Test specimen:</b>	DeLaval Herd Navigator™ precision analytics 100		
<b>Test specification:</b>	<p>P19-0186-1 rev. 1 supersedes P19-0186-1 issued 2020-01-13. Changes: Added 99% Occupied bandwidth measurement.</p> <p>P19-0186-1 rev. 2 supersedes P19-0186-1 rev. 1 issued 2020-01-15. Changes: Report reissued.</p> <p>FCC 47 CFR Part 15 Subpart C 15.225 Operation within the band 13.11 – 14.01 MHz.</p> <p>ISED RSS-210 Annex B.6 Band 13.110 – 14.010 MHz.</p> <p>The tests relevant for the test specimens are listed in <i>section 1.1</i>.</p>		
<b>Documentation:</b>	<p>This test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory.</p> <p>The complete test documentation is archived for 10 years at the testing laboratory.</p>		
<b>Test results:</b>	<p>The test specimen complies with relevant parts of the test specifications.</p> <p>The test results relate only to the specimen tested.</p>		
<b>Test personnel:</b>	Søren Søltøft	David Busk	

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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 9, Aug 2016 (Amendment)	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	PASSED
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.

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## 1.2 Test specimens

### 1.2.1 NFC module

<b>Manufacturer</b>	Lattec I/S
<b>Name</b>	NFC CLRC663
<b>Model</b>	DeLaval Herd Navigator™ precision analytics 100
<b>Firmware</b>	1.0.0.13D
<b>Revision</b>	3
<b>Supply voltage</b>	5 VDC
<b>Carrier frequency</b>	13.56 MHz
<b>Antenna</b>	Integrated
<b>Antenna size</b>	38 mm x 38 mm
<b>Test duty cycle</b>	50% (5ms on / 5ms off)

During test a special firmware enabling the control of radio parameters was used.

The test specimen is a RF ID module using 13.56 MHz, intended for use in the HN100 analyzer system.

The tests were performed on the RF ID module stand alone and on the HN100 analyzer system with 4 RF ID module mounted. In both cases the test specimens were controlled by special software to ensure maximal duty cycle. Only one power level was available.

To ensure proper function of the module standalone a special control unit, based on a Arduino module “Nano”, was delivered by Lattec. The module and control unit was powered from a typical USB ACDC adaptor.

See photo in appendix 1.

### 1.2.2 HN100

<b>Manufacturer</b>	Lattec I/S
<b>Name</b>	HN100
<b>Model</b>	DeLaval Herd Navigator™ precision analytics 100
<b>Identification</b>	P/N: 60091735, Alias: NFC CLRC663 ADR0, I2C address: 0 P/N: 60091736, Alias: NFC CLRC663 ADR1, I2C address: 1 P/N: 60091737, Alias: NFC CLRC663 ADR2, I2C address: 2 P/N: 60091738, Alias: NFC CLRC663 ADR3, I2C address: 3
<b>Firmware</b>	1.0.0.13D
<b>Revision</b>	3
<b>Supply voltage</b>	24 VDC

See photo in appendix 1.

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## 1.1 Auxiliary Equipment

### 1.1.1 AC/DC power supply

<b>Manufacturer</b>	PULS GmbH
<b>Model</b>	CPS20.241-C1
<b>Serial no.</b>	19332456
<b>Details</b>	-
<b>Supply voltage</b>	AC 100 – 240 V (115 VAC used during tests)
<b>Output voltage</b>	DC 24 V
<b>Operational mode</b>	Used as typical power supply

See photo in appendix 1.

### 1.1.2 Protection Module

<b>Manufacturer</b>	PULS GmbH
<b>Model</b>	PISA11.CLASS2
<b>Input</b>	DC 24 V, 15A
<b>Output</b>	4 channel, DC 24-28V, 3.7-3.2A
<b>Details</b>	-

## 1.2 I/O port to test specimen

I/O Port	Type	Shielding	Cable length
AC power <sup>1</sup>	100 VAC – 240 VAC 50 HZ / 60 Hz	-	-

Note 1: AC power port of AC/DC power supply for HN100.

## 2 TESTS

### 2.1 Field strength of fundamental emission

<b>Test specimen</b>	NFC module
<b>Test specification</b>	47 CFR 15.225 (a) RSS 210 B.6 (a)
<b>Test method</b>	ANSI C63.10:2013 sec. 6.4
<b>Comments</b>	The NFC module was tested in stand-alone configuration
<b>Temperature / Humidity</b>	10°C / 58%RH
<b>Dates of measurements</b>	2019-10-30
<b>Test personnel</b>	David Busk, Søren Søltøft

#### 2.1.1 Test setup

The test was performed on NFC module stand alone.

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

The measurements were performed at a distance of 30 m. The test specimen was rotated for maximal level.

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 dB $\mu$ V/m.

Frequency [MHz]	QP [dB $\mu$ V/m]	BW [kHz]	Corr. Fac. [dB]	Ant Pol.	F.S. [dB $\mu$ V/m]	Margin [dB]	Limit [dB $\mu$ V/m]	Result
13.5600	7.7	9.000	18.64	V	26.34	57.66	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	19966	2022-02-25
Receiver EMI Test 9KHz-2750MHz	Rohde & Schwarz	ESCS30	30114993	2020-07-09

**Table 2. Radiated emission test equipment.**

## 2.2 Field strength of in band emission

<b>Test specimen</b>	NFC module
<b>Test specification</b>	47 CFR 15.225 (a), (b), (c) RSS 210 B.6 (a), (b), (c)
<b>Test method</b>	ANSI C63.10:2013 sec. 6.4
<b>Comments</b>	The NFC module was tested in stand-alone configuration
<b>Temperature / Humidity</b>	21°C / 49%RH
<b>Dates of measurements</b>	2019-10-25
<b>Test personnel</b>	Søren Søltøft

### 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.

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.

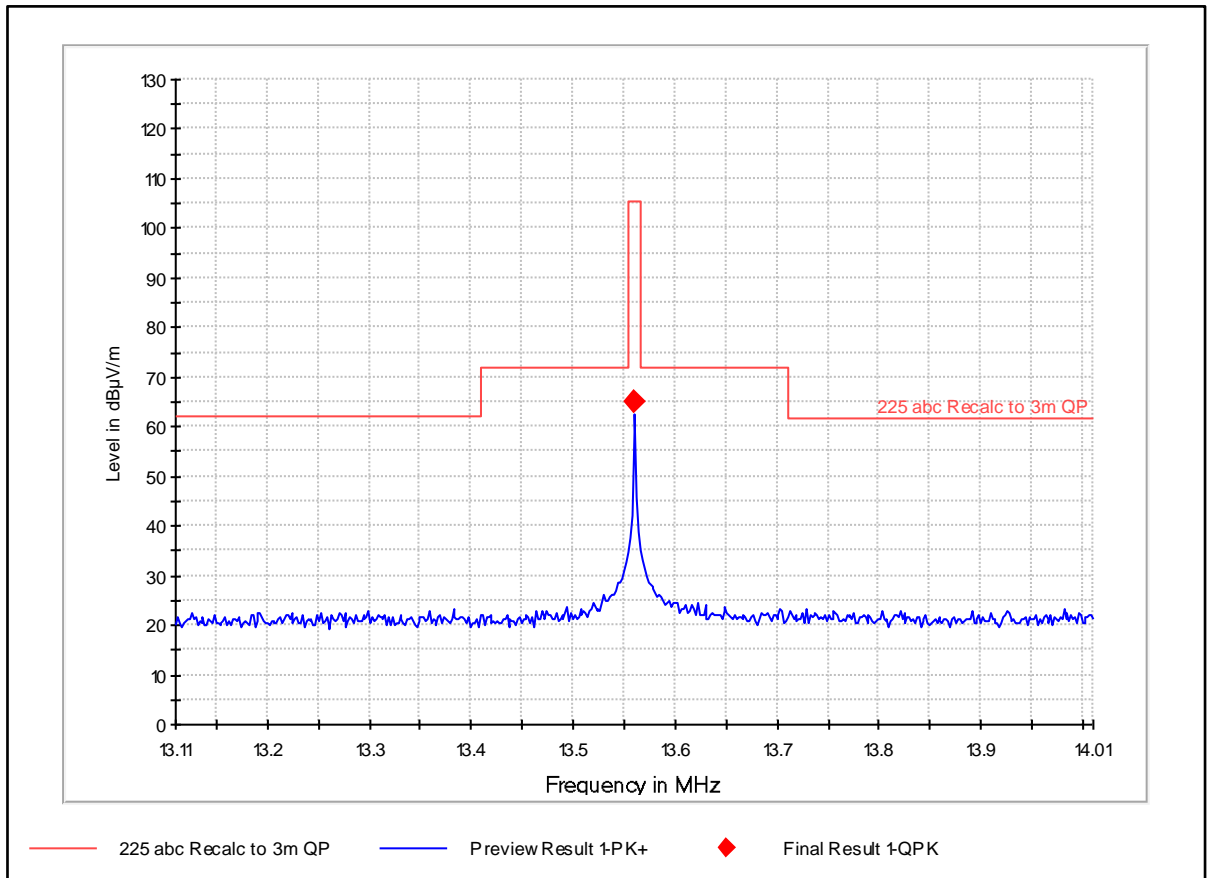
The limits below 30 MHz was recalculated to a 3 m. distance, using the method described in ANSI C63.10-2013 clause 6.4.4.2 Extrapolation from the measurement of a single point.

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]	$d_{\text{limit}}$ [m]	$d_{\text{measure}}$ [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**



**Figure 1. Field strength of fundamental emissions test results. Antenna vertical.**

Frequency [MHz]	QuasiPeak [dBµV/m]	BW [kHz]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBµV/m]	Result
13.560202	65.2	9.000	V	144.0	40.20	105.40	PASSED

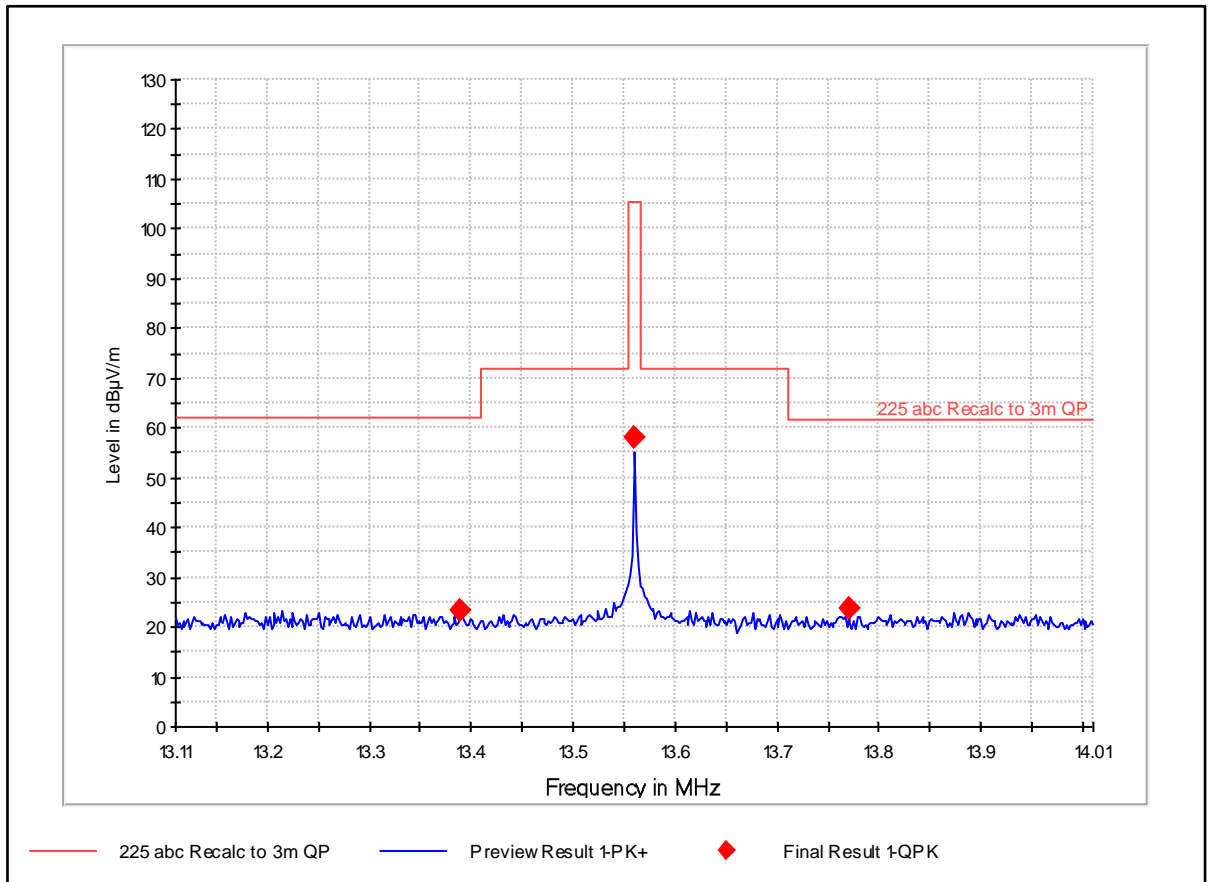
**Table 3. Field strength of fundamental emissions test results. Antenna vertical.**

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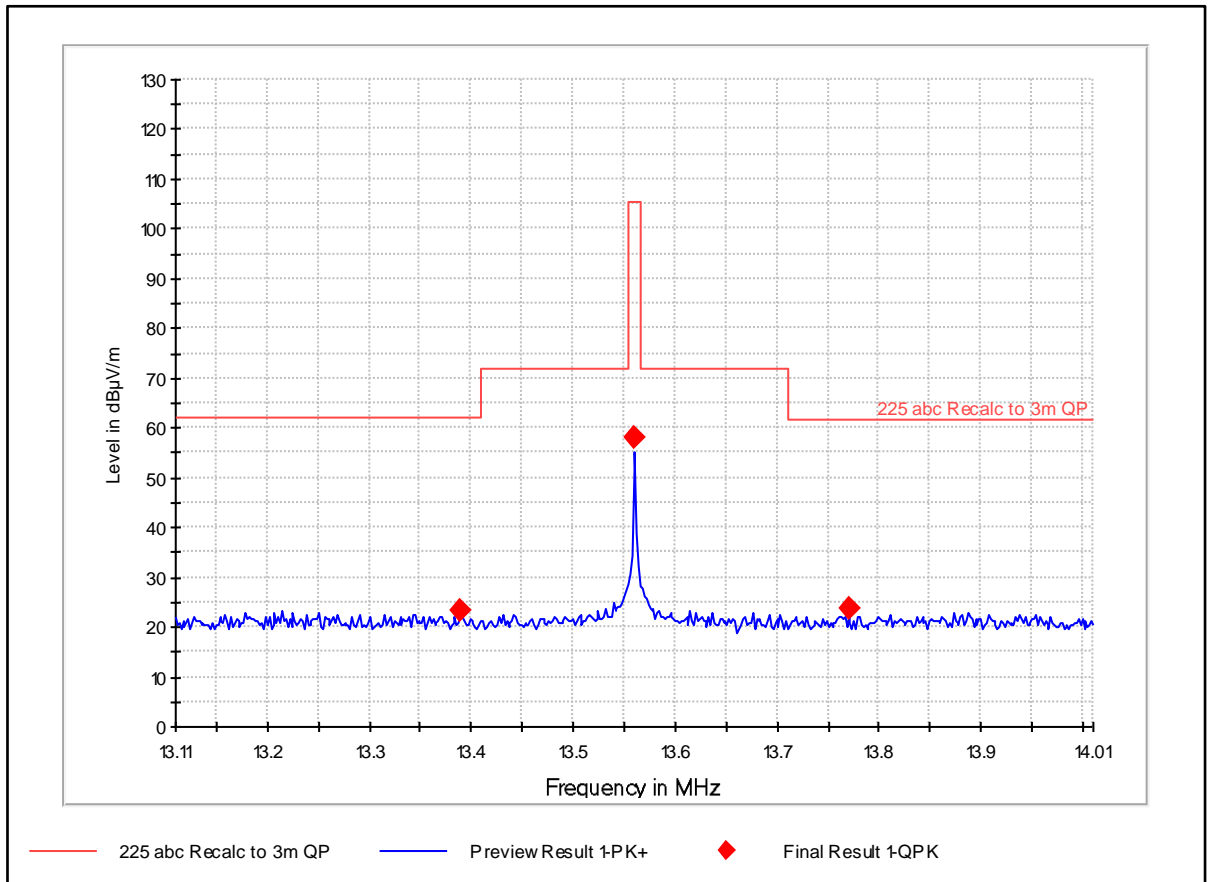
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**Figure 2. Field strength of fundamental emissions test results. Antenna vertical-90.**

Frequency [MHz]	QuasiPeak [dBµV/m]	BW [kHz]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBµV/m]	Result
13.389259	23.6	9.000	V-90	226.0	38.40	62.00	PASSED
13.560202	63.1	9.000	V-90	61.0	42.30	105.40	PASSED
13.730137	23.6	9.000	V-90	193.0	38.20	61.80	PASSED

**Table 4. Field strength of fundamental emissions test results. Antenna vertical-90.**



**Figure 3. Field strength of fundamental emissions test results. Antenna horizontal.**

Frequency [MHz]	QuasiPeak [dBµV/m]	BW [kHz]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBµV/m]	Result
13.389659	23.5	9.000	H	-26.0	38.50	62.00	PASSED
13.560202	58.1	9.000	H	151.0	47.30	105.40	PASSED
13.771020	23.7	9.000	H	151.0	38.10	61.80	PASSED

**Table 5. Field strength of fundamental emissions test results. Antenna horizontal.**

The margin for the fundamental to the recalculated limit is less than the margin for measurement at 30 meters distance at an open area test site.

**2.2.3 Test equipment**

Description	Supplier	Model	Tag no.	Cal. due date
Antenna Magnetic Loop 9 kHz - 30 MHz	Rohde & Schwarz	HFH2-Z2	19966	2022-02-25
Analyzer 20 Hz-26.5 GHz	Rohde & Schwarz	ESI26	20763	2019-12-10

**Table 6. Radiated emission test equipment.**

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

<b>Test specimen</b>	NFC module
<b>Test specification</b>	47 CFR 15.225 (d) RSS 210 B.6 (d)
<b>Test method</b>	ANSI C63.10:2013 sec 6.4
<b>Frequency range</b>	9 kHz – 30 MHz
<b>Limits</b>	FCC 47 CFR Part 15.209 (a)
<b>Comments</b>	The NFC module was tested in stand-alone configuration
<b>Temperature / Humidity</b>	21°C / 49%RH
<b>Dates of measurements</b>	2019-10-25
<b>Test personnel</b>	Søren Søltøft

### 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 RF ID module stand alone.

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.

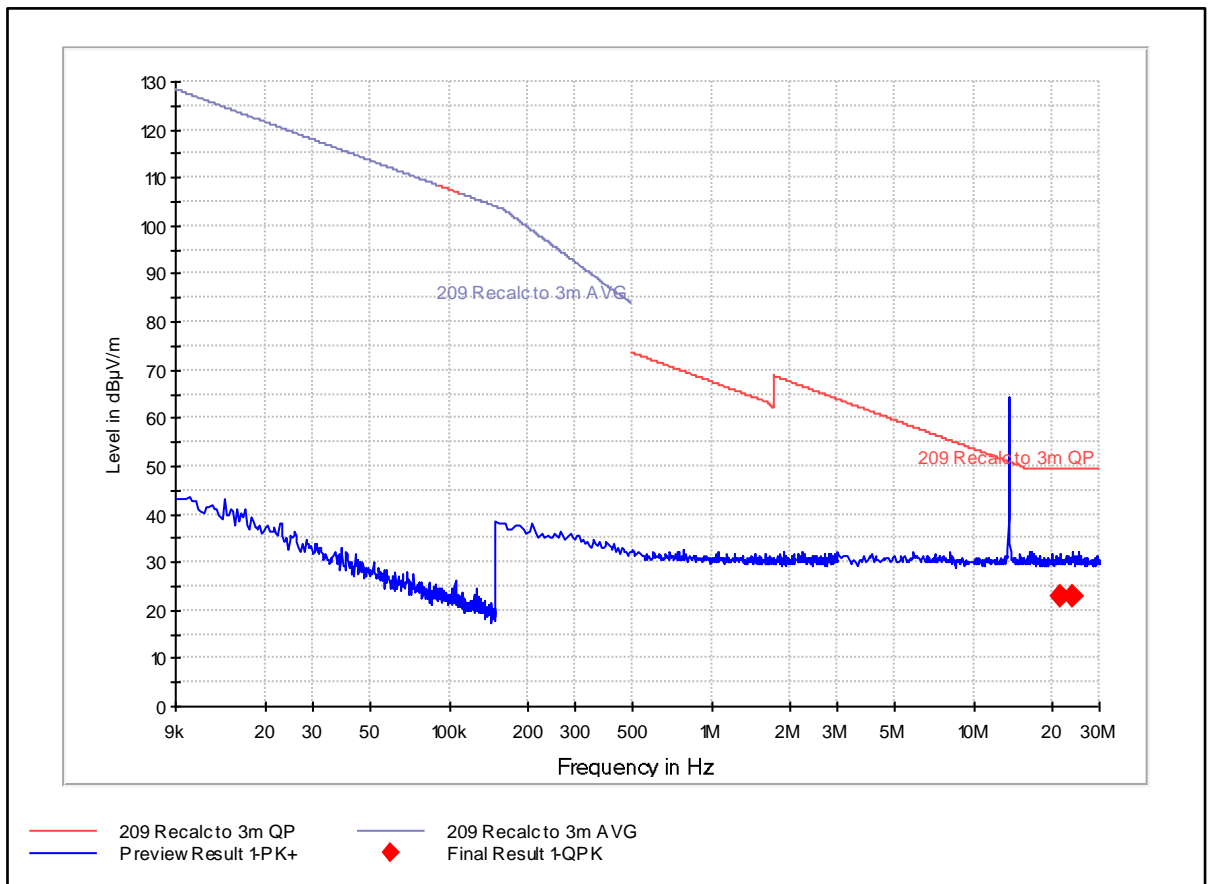
See photo of test set up in appendix 1.

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]	$d_{\text{limit}}$ [m]	$d_{\text{measure}}$ [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**



**Figure 4. 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
21.292077	23.1	9.000	100.0	V	282.0	26.50	49.50	PASSED
23.670839	22.8	9.000	100.0	V	152.0	26.70	49.50	PASSED

**Table 7. Emission outside the frequency band test results, below 30 MHz. Antenna vertical.**

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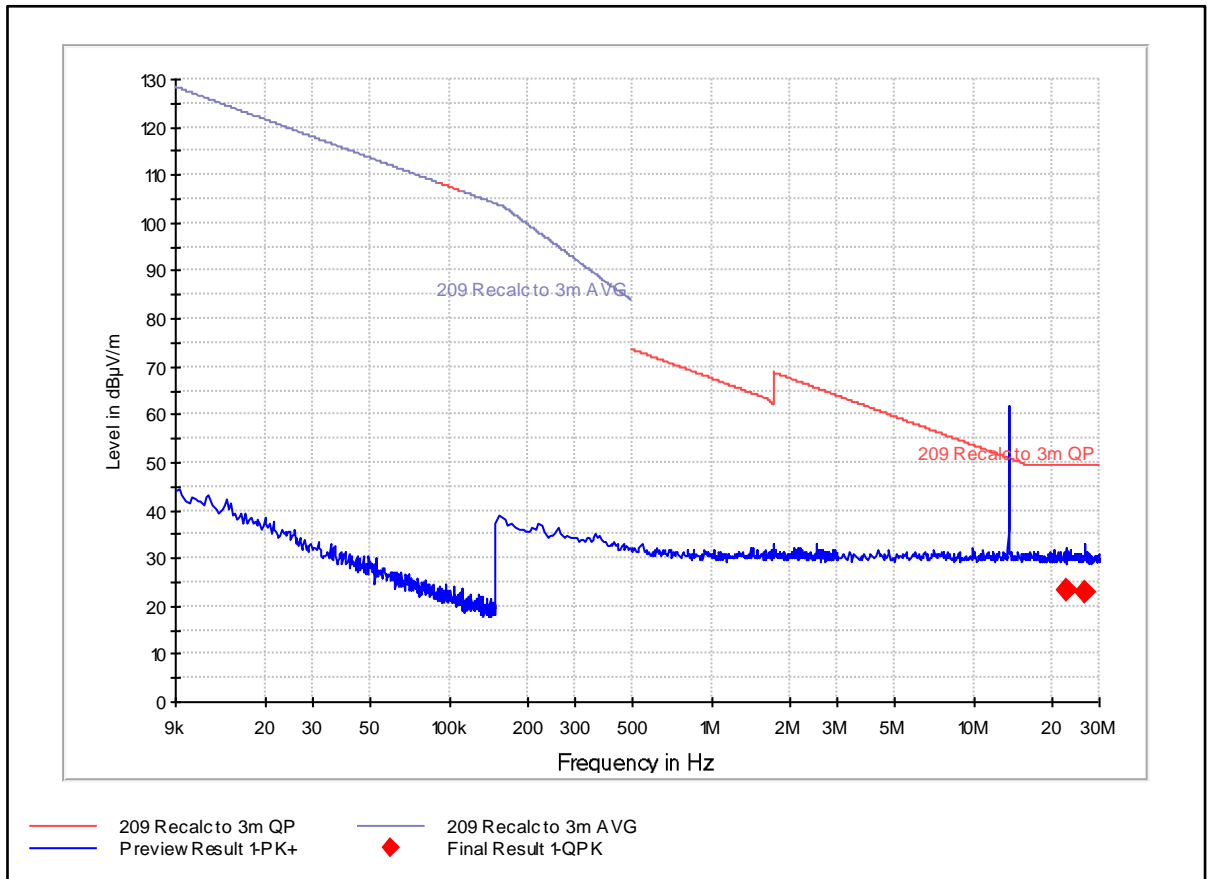


Figure 5. Emission outside the frequency band, below 30 MHz. Antenna vertical -90°.

Frequency [MHz]	QP [dBµV/m]	BW [kHz]	Height [cm]	Ant. Pol.	Azimuth [deg]	Margin [dB]	Limit [dBµV/m]	Result
22.537566	23.08	9.000	100.0	V-90	121.0	26.50	49.50	PASSED
26.541574	23.03	9.000	100.0	V-90	51.0	26.50	49.50	PASSED

Table 8. Emission outside the frequency band test results, below 30 MHz. Antenna vertical -90°.

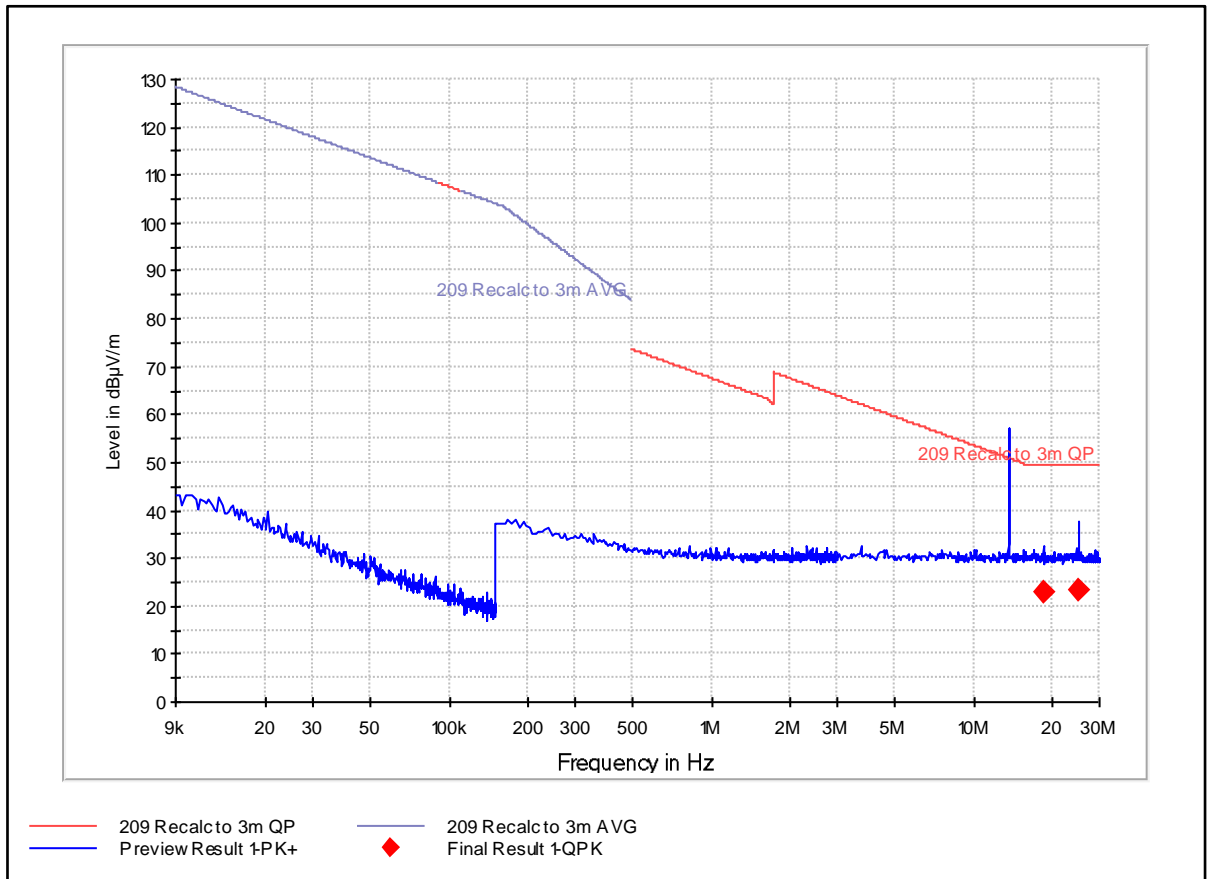


Figure 6. Emission outside the frequency band, below 30 MHz. Antenna horizontal.

Frequency [MHz]	QP [dBµV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBµV/m]	Result
18.312125	22.9	9.000	100.0	H	4.0	26.60	49.50	PASSED
25.074652	23.2	9.000	100.0	H	173.0	26.30	49.50	PASSED

Table 9. Emission outside the frequency band test results, below 30 MHz. Antenna horizontal.

### 2.3.3 Test equipment

Description	Supplier	Model	Tag no.	Cal. due date
Antenna Magnetic Loop 9 kHz - 30 MHz	Rohde & Schwarz	HFH2-Z2	19966	2022-02-25
Analyzer 20 Hz-26.5 GHz	Rohde & Schwarz	ESI26	20763	2019-12-10

Table 10. Radiated emission test equipment.

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

<b>Test specimen</b>	HN100
<b>Test specification</b>	47 CFR 15.225 (d) RSS 210 B.6 (d)
<b>Test method</b>	ANSI C63.10:2013 sec 6.4
<b>Frequency range</b>	30 MHz – 1000 MHz
<b>Limits</b>	FCC 47 CFR Part 15.209 (a)
<b>Comments</b>	The NFC module RFID0, RFID1, RFID2 and RFID3 were individually tested mounted in HN100
<b>Temperature / Humidity</b>	19°C / 48%RH
<b>Dates of measurements</b>	2020-01-08
<b>Test personnel</b>	Søren Søltøft

### 2.4.1 Test setup

The test was performed on a HN 100 analyzer with 4 NFC modules mounted. The NFC modules were 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 was 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, 1.5 m and 2.0 m.

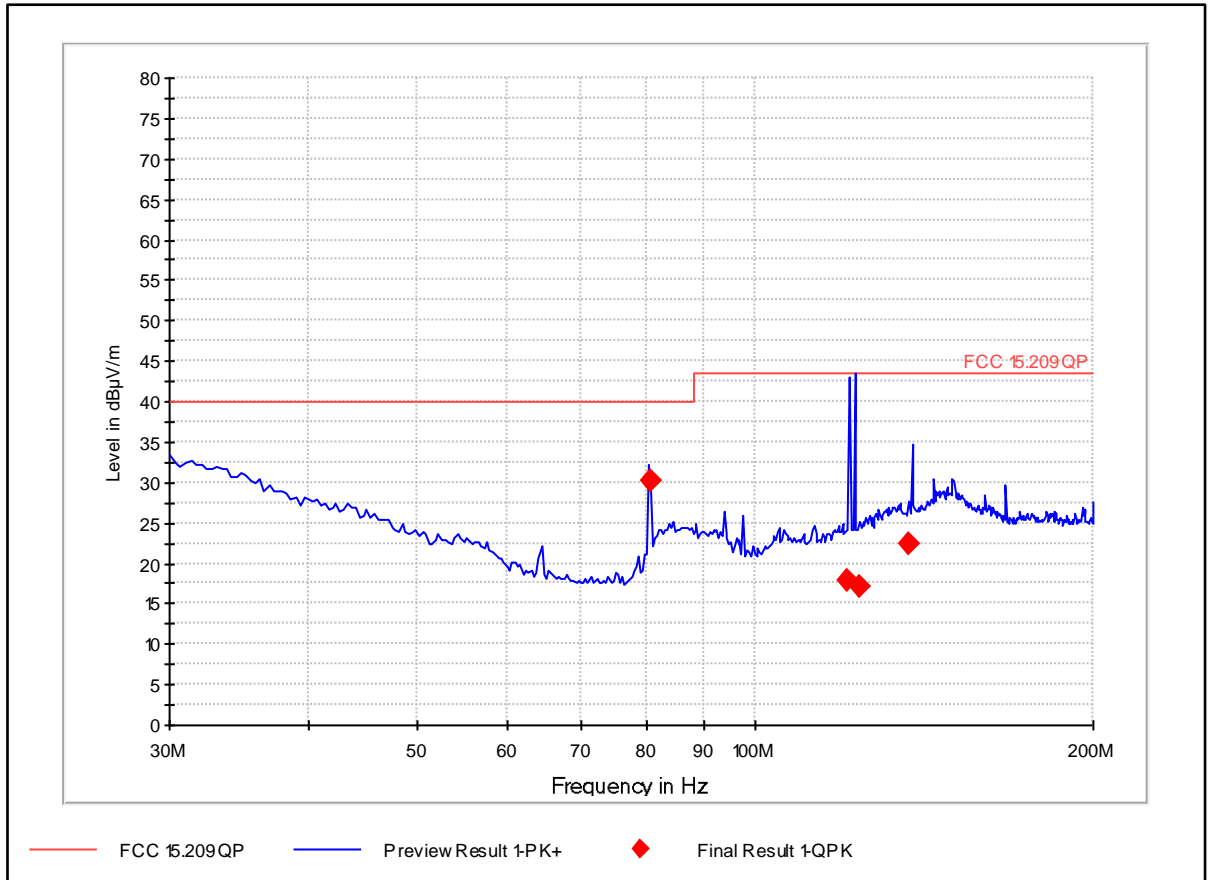
If the emission is close to or above the limit during the pre-measurement, the test object is scanned 360 degrees and the antenna height scanned from 1 to 4 m for maximum response. Then the emission is measured with a quasi-peak detector.

See appendix 1 for photo of test set up



**2.4.2 Test result**

**2.4.2.1 Test result – RFID0**



**Figure 7. Emission outside the frequency band, 30 -200 MHz.**

Frequency [MHz]	QP [dBµV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBµV/m]	Result
80.520842	30.3	120.0	135.0	V	13.0	9.7	40.0	PASSED
120.902605	17.9	120.0	204.0	V	47.0	25.6	43.5	PASSED
123.565331	17.2	120.0	265.0	V	13.0	26.3	43.5	PASSED
136.965992	22.4	120.0	100.0	V	209.0	21.1	43.5	PASSED

**Table 11. Emission outside frequency band test results. 30 - 200 MHz.**

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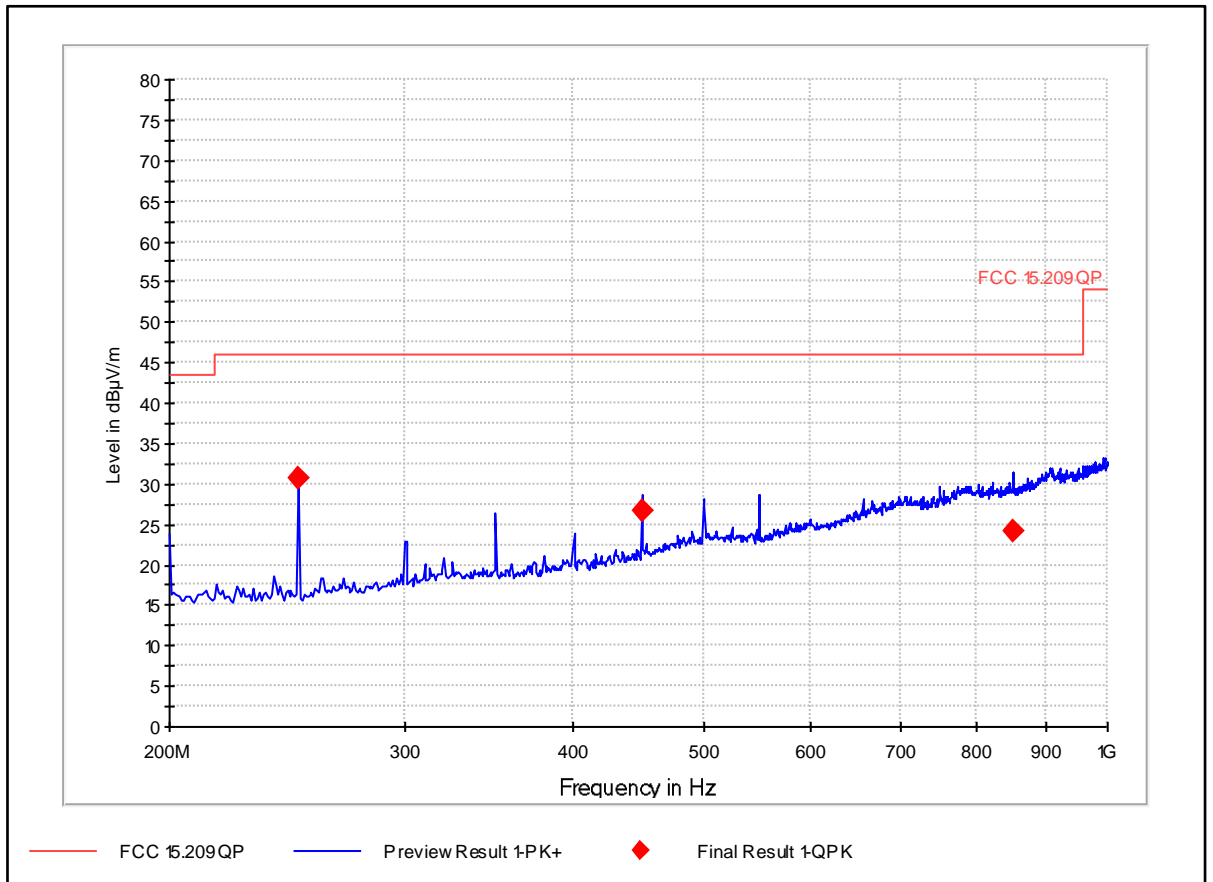


Figure 8. Emission outside frequency band 200 - 1000 MHz.

Frequency [MHz]	QP [dBµV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBµV/m]	Result
249.999399	30.6	120.0	127.0	H	207.0	15.4	46.0	PASSED
450.000200	26.8	120.0	187.0	H	190.0	19.2	46.0	PASSED
849.970200	24.2	120.0	157.0	H	234.0	21.8	46.0	PASSED

Table 12. Emission outside frequency band test results. 200 - 1000 MHz.

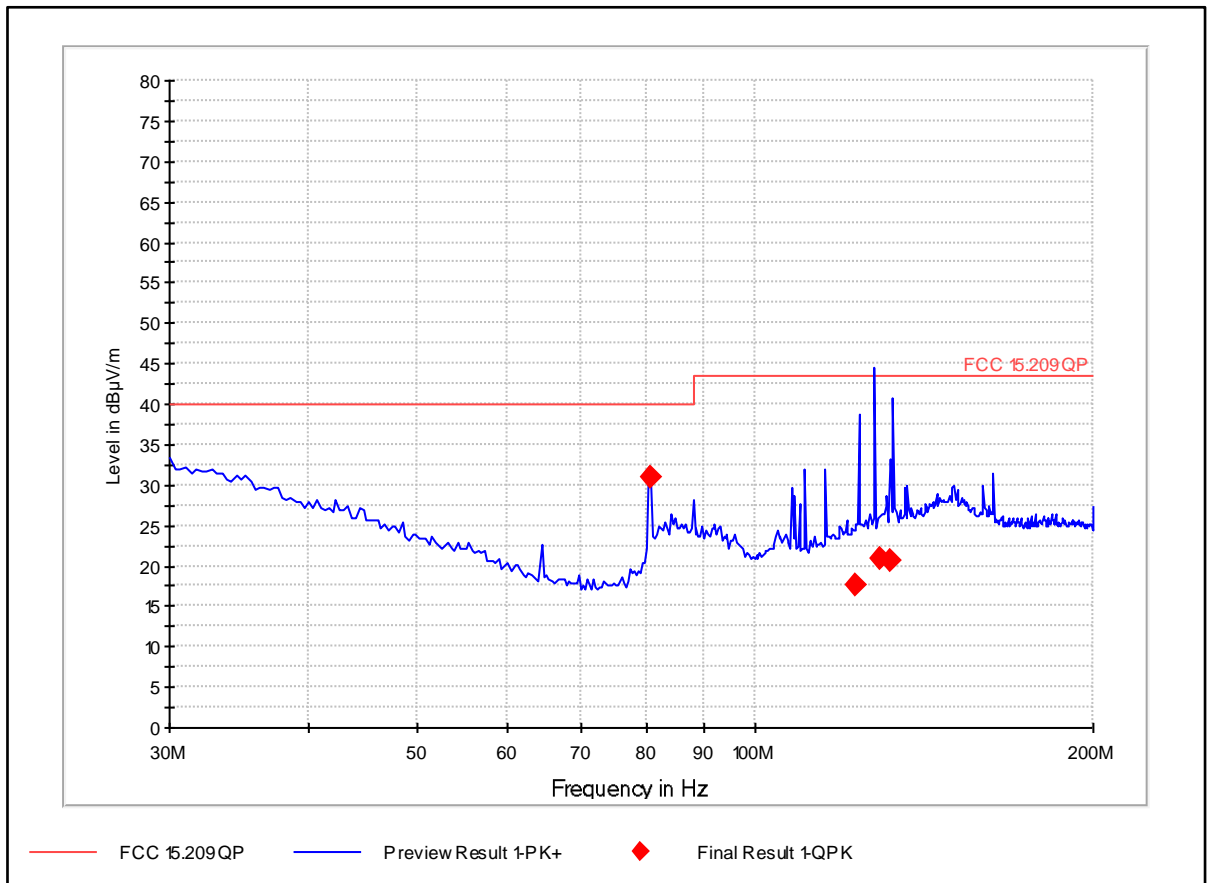
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**2.4.2.2 Test result – RFID1**



**Figure 9. Emission outside frequency band 30 -200 MHz.**

Frequency [MHz]	QP [dBµV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBµV/m]	Result
80.550842	120.000	120.0	V	1.0	120.000	9.1	40.0	PASSED
122.827375	120.000	120.0	H	48.0	120.000	25.8	43.5	PASSED
128.895551	120.000	120.0	V	39.0	120.000	22.7	43.5	PASSED
132.115090	120.000	120.0	V	168.0	120.000	22.9	43.5	PASSED

**Table 13. Emission outside frequency band test results. 30 - 200 MHz.**

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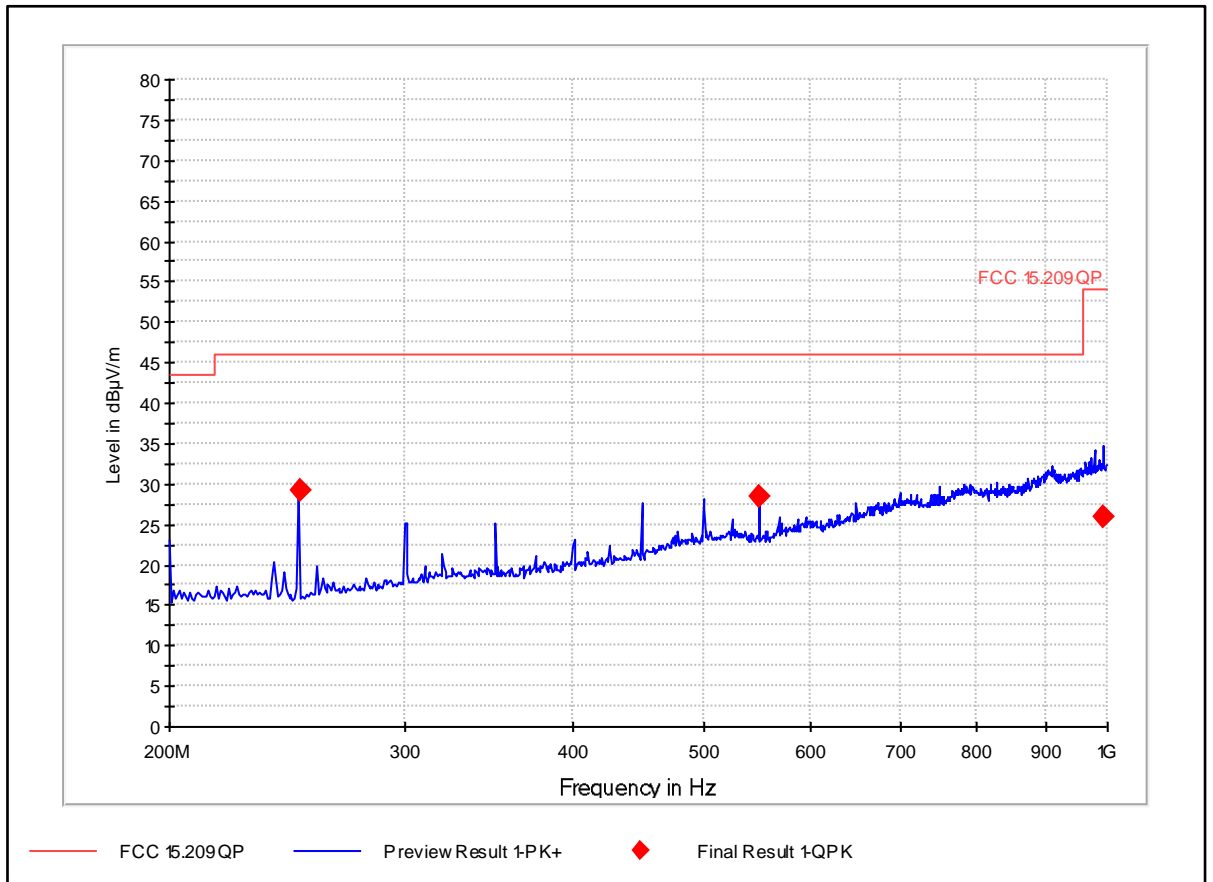
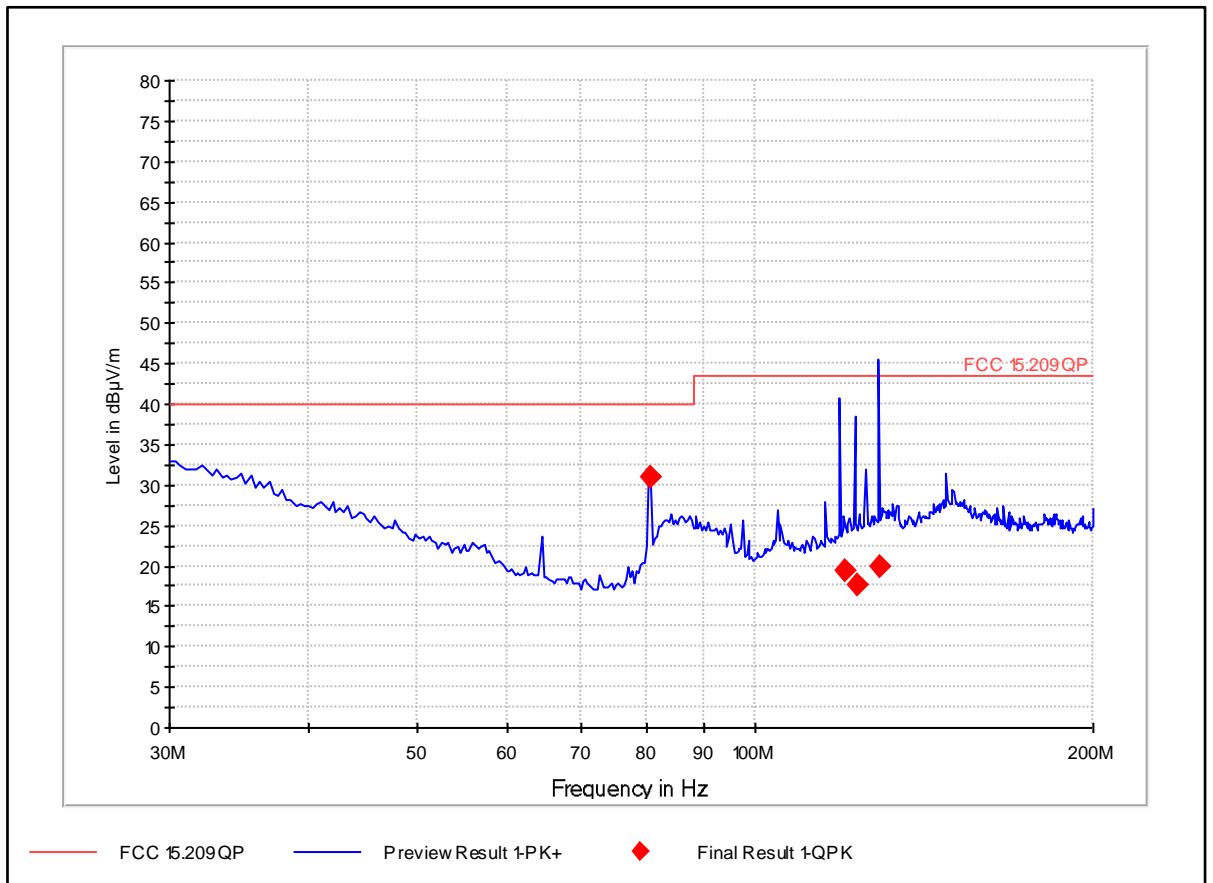


Figure 10. Emission outside frequency band 200-1000 MHz.

Frequency [MHz]	QP [dBµV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBµV/m]	Result
250.009399	29.1	120.0	119.0	H	208.0	16.9	46.0	PASSED
549.970601	28.3	120.0	135.0	H	242.0	17.7	46.0	PASSED
994.337174	26.0	120.0	191.0	H	103.0	28.0	54.0	PASSED

Table 14. Emission outside frequency band test results. 200 - 1000 MHz.

**2.4.2.3 Test result – RFID2**



**Figure 11. Emission outside frequency band 30 -200 MHz.**

Frequency [MHz]	QP [dBµV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBµV/m]	Result
80.600842	31.1	120.0	213.0	H	230.0	8.9	40.0	PASSED
119.997836	19.3	120.0	119.0	V	26.0	24.2	43.5	PASSED
123.085331	17.5	120.0	223.0	H	45.0	26.0	43.5	PASSED
129.267595	19.8	120.0	143.0	V	209.0	23.7	43.5	PASSED

**Table 15. Emission outside frequency band test results. 30 - 200 MHz.**

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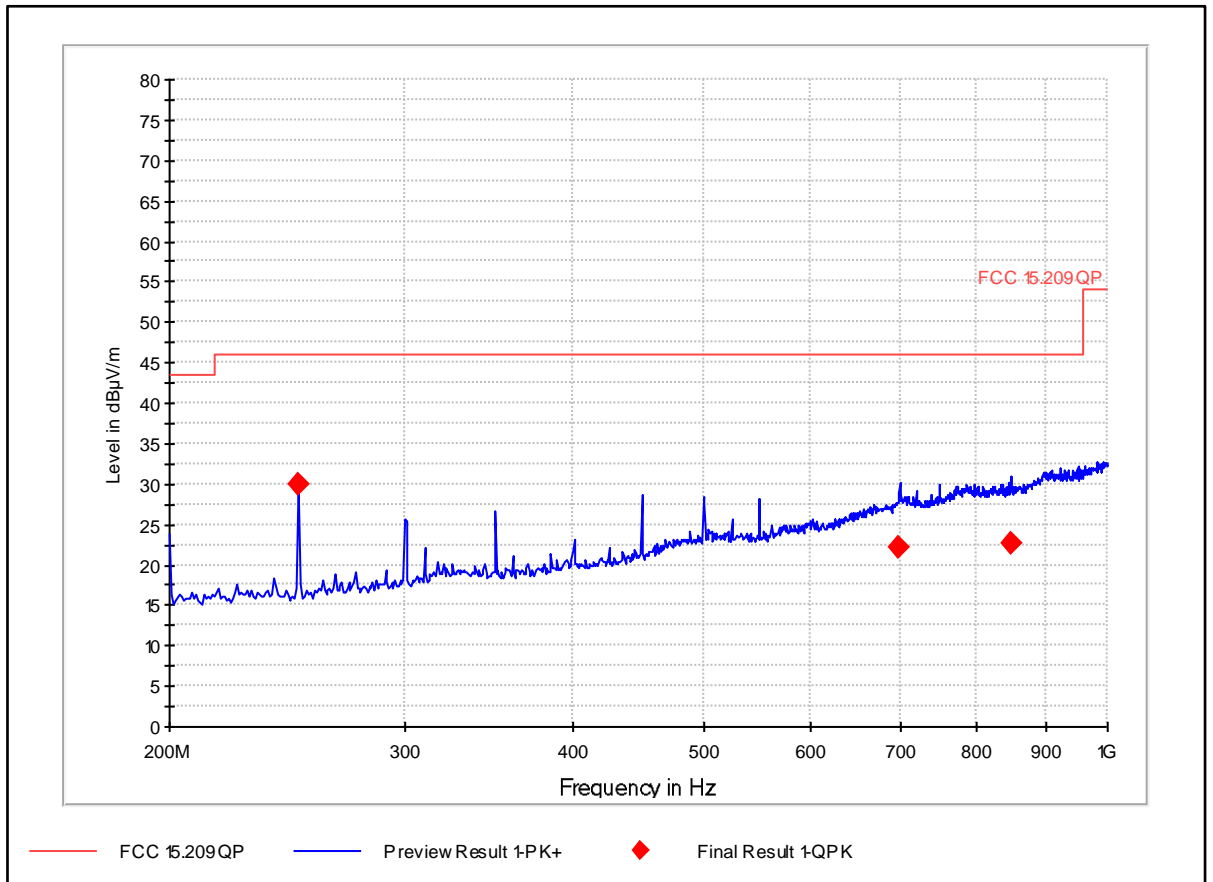
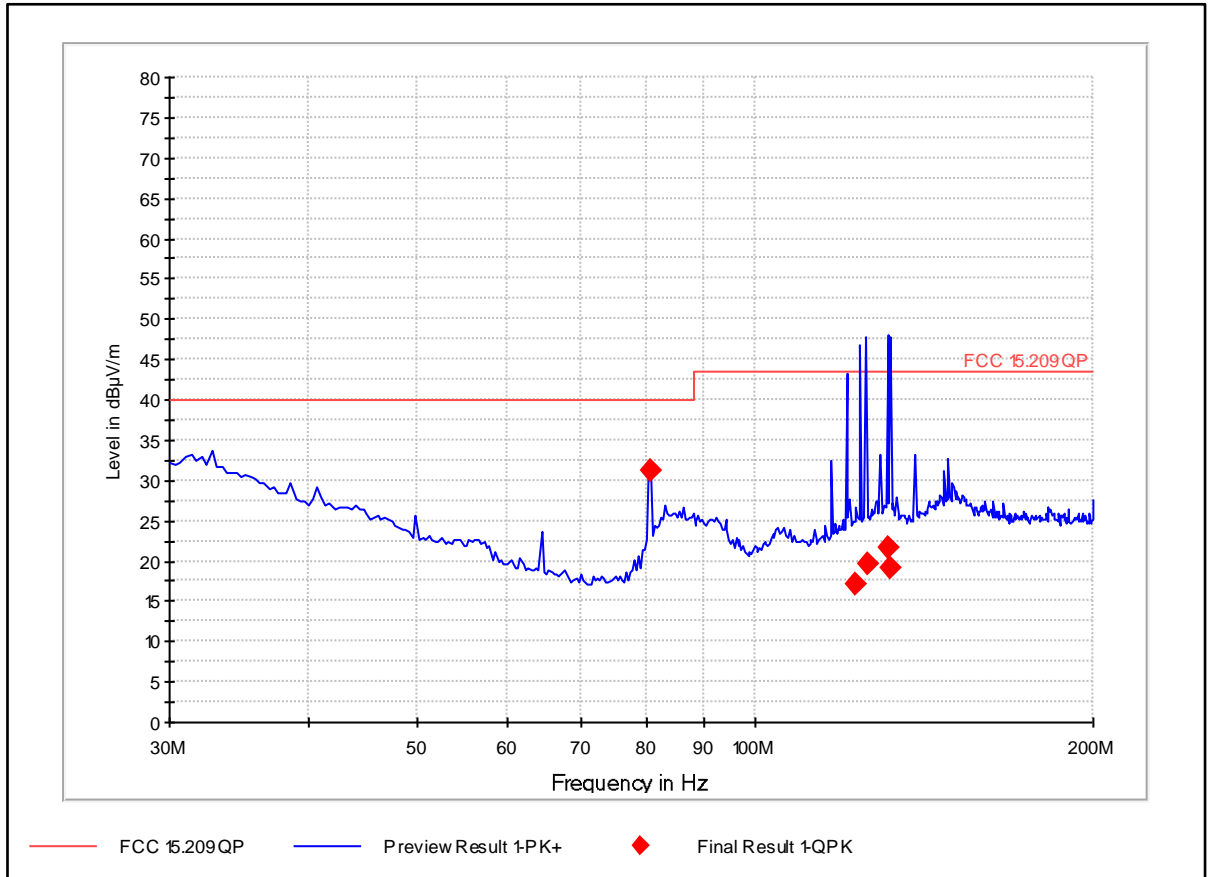


Figure 12. Emission outside frequency band 200-1000 MHz.

Frequency [MHz]	QP [dBµV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBµV/m]	Result
249.999399	29.9	120.0	100.0	H	197.0	16.1	46.0	PASSED
699.700401	22.0	120.0	100.0	V	46.0	24.0	46.0	PASSED
848.675391	22.7	120.0	299.0	V	50.0	23.3	46.0	PASSED

Table 16. Emission outside frequency band test results. 200 - 1000 MHz.

**2.4.2.4 Test result – RFID3**



**Figure 13. Emission outside frequency band 30 -200 MHz.**

Frequency [MHz]	QP [dBµV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBµV/m]	Result
80.640842	31.3	120.0	228.0	H	216.0	8.7	40.0	PASSED
122.978056	17.0	120.0	274.0	V	14.0	26.5	43.5	PASSED
125.720782	19.6	120.0	119.0	V	250.0	23.9	43.5	PASSED
131.593727	21.7	120.0	100.0	V	1.0	21.8	43.5	PASSED
131.672365	19.1	120.0	194.0	V	221.0	24.4	43.5	PASSED

**Table 17. Emission outside frequency band test results. 30 - 200 MHz.**

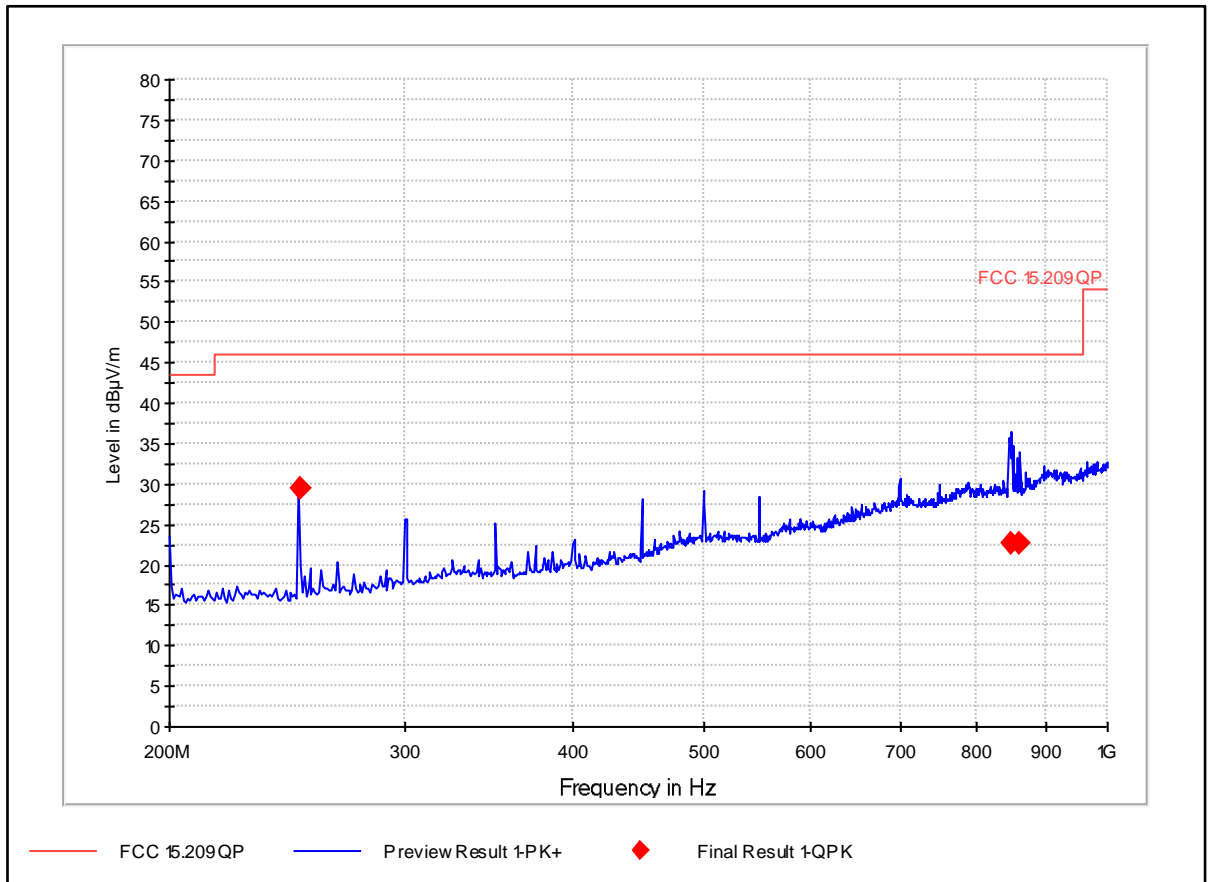


Figure 14. Emission outside frequency band 200-1000 MHz.

Frequency [MHz]	QP [dBµV/m]	BW [kHz]	Height [cm]	Pol.	Azimuth [deg]	Margin [dB]	Limit [dBµV/m]	Result
250.009399	29.3	120.0	135.0	H	199.0	16.7	46.0	PASSED
847.436994	22.6	120.0	127.0	H	1.0	23.4	46.0	PASSED
860.201042	22.7	120.0	264.0	V	72.0	23.3	46.0	PASSED

Table 18. Emission outside frequency band test results. 200 - 1000 MHz.

### 2.4.3 Test equipment

Description	Supplier	Model	Tag no.	Cal. due
Antenna Biconical 25-300MHz	Schwarzbeck	VHA9103 + BBA9106	13835	2022-02-28
Antenna Log Per 0.2 - 1 GHz	ETS-LINDGREN	3148	50023	2022-05-02
Amplifier 30 MHz – 3 GHz	Miteq	AFS3-00100400-18-ULN	50084	-
Analyzer 20 Hz-26.5 GHz	Rohde & Schwarz	ESI26	20763	2019-12-10

Table 19. Radiated emission test equipment.



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## 2.5 Frequency stability versus temperature

<b>Test specimen</b>	NFC module
<b>Test specification</b>	47 CFR 15.225 (e) RSS 210 B.6
<b>Test method</b>	ANSI C63.10:2013 sec. 6.8
<b>Frequency range</b>	13.110 - 14.010 MHz
<b>Limits</b>	47 CFR 15.225 (e) RSS 210 B.6
<b>Comments</b>	The NFC module was tested in stand-alone configuration
<b>Temperature / Humidity</b>	21°C / 33%RH
<b>Dates of measurements</b>	2020-01-09
<b>Test personnel</b>	Søren Søtoft

### 2.5.1 Test setup

The test was performed on NFC module stand alone.

The test specimen was placed in a shielded climatic chamber together with a loop antenna in a fixed position. The antenna was connected to a spectrum analyzer via a feedthrough in the chamber wall.

The frequency count function on the spectrum analyzer was used to improve accuracy.

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

See appendix 1 for photo of test set up

### 2.5.2 Test result

Temperature [°C]	Dev. at power on [%]	Dev. after 2 min. [%]	Dev. after 5 min. [%]	Dev. after 10 min. [%]	Limit [%]	Result
50	-0.0005752	-0.0005826	-0.0005826	-0.0005826	0.01	PASSED
40	-0.0003982	-0.0004203	-0.0004203	-0.0004203	0.01	PASSED
30	-0.0001844	-0.0002065	-0.0002139	-0.0002065	0.01	PASSED
20	0.0000295	0.0000074	0.0000000	0.0000000	0.01	PASSED
10	0.0002360	0.0002139	0.0002139	0.0002139	0.01	PASSED
0	0.0003319	0.0003245	0.0003245	0.0003245	0.01	PASSED
-10	0.0028318	0.0028023	0.0027802	0.0027654	0.01	PASSED
-20	0.0028834	0.0028760	0.0028760	0.0028613	0.01	PASSED

Table 20. Frequency deviation as function of temperature.

### 2.5.3 Test equipment

Description	Supplier	Model	Tag no.	Cal. due date
Climatic chamber	Vötsch	VT4002EMC	19625	2020-08-16
Analyzer 20Hz-26.5GHz	Rohde & Schwarz	ESIB 26	18880	2020-10-15

Table 21. Frequency stability test equipment.

## 2.6 Frequency stability versus supply voltage

<b>Test specimen</b>	HN100
<b>Test specification</b>	47 CFR 15.225 (e) RSS 210 B.6
<b>Test method</b>	ANSI C63.10:2013 sec. 6.8
<b>Frequency range</b>	13.110 - 14.010 MHz
<b>Limits</b>	47 CFR 15.225 (e) RSS 210 B.6
<b>Comments</b>	The NFC module RFID1 was tested mounted in HN100
<b>Temperature / Humidity</b>	19°C / 50%RH
<b>Dates of measurements</b>	2020-01-09
<b>Test personnel</b>	Søren Søtoft

### 2.6.1 Test setup

The test was performed radiated in a semi anachronic chamber. RF ID no 1 mounted in HN 100 was used for test.

The supply voltage variation was performed on HN100 power supply, which is specified to the voltage range 100 V to 240 V.

The voltage level of 85% was calculated from 100 V. the 115% level were calculated from both 115 V and 240 V.

Peak power levels are only analyzer reading not corrected for antenna factor and path antenation.

See appendix 1 for photo of test set up.

Same as Radiated emission test setup in SAC. 9 kHz – 30 MHz.

### 2.6.2 Test result

Voltage [VAC]	Frequency [MHz]	Frequency deviation		Limit [%]	Result
		[MHz]	[%]		
85	13.560394	-0.000004	-0.000029	0.01	PASSED
115	13.560398	-	-	-	-
138	13.560386	-0.000012	-0.000088	0.01	PASSED
276	13.560390	-0.000008	-0.000059	0.01	PASSED

**Table 22. Frequency deviation as function of supply voltage.**

Voltage [VAC]	Peak power [dBμV]	Level deviation [dBμV]	Result
85	64.59	0.03	PASSED
115	64.56	0	-
138	64.56	0	PASSED
276	64.55	-0.01	PASSED

**Table 23. RF power deviation as function of supply voltage.**

### 2.6.3 Test equipment

Description	Supplier	Model	Tag no.	Cal. due date
Multi Meter	Agilent	34401A	14885	2020-06-17
Antenna Magnetic Loop 9 kHz - 30 MHz	Rohde & Schwarz	HFH2-Z2	19966	2022-02-25
Analyzer 20Hz-26.5GHz	Rohde & Schwarz	ESIB 26	20763	2020-10-15

**Table 24. Radiated emission test equipment.**

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## 2.7 Antenna requirement

<b>Test specimen</b>	NFC module
<b>Test specification</b>	47 CFR 15.203 RSS-Gen 6.8
<b>Test method</b>	None
<b>Comments</b>	None
<b>Dates of measurements</b>	2020-01-09
<b>Test personnel</b>	Søren Søltøft

### 2.7.1 Test result

The test specimen has an non detachable internal antenna, which is part of the printed circuit board. Antenna outer dimensions approx.. 38 mm x 38 mm.

See appendix 1 for photo of internal view test specimen.

Requirement	Result
47 CFR 15.203	PASSED
ISED RSS-Gen 6.8	PASSED

**Table 25. Antenna requirements test results.**

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## 2.8 AC Conducted emission

<b>Test specimen</b>	HN100
<b>Test specification</b>	47 CFR 15.207 (a) RSS-Gen 8.8
<b>Test method</b>	ANSI C63.10:2013 sec. 6.2
<b>Frequency range</b>	0.15 - 30 MHz
<b>Limits</b>	47 CFR Part 15.207
<b>Comments</b>	The NFC module RFID0, RFID1, RFID2 and RFID3 were individually tested mounted in HN100
<b>Temperature / Humidity</b>	20°C / 45%RH
<b>Dates of measurements</b>	2020-01-08
<b>Test personnel</b>	Søren Søltøft

### 2.8.1 Test setup

Measurements were performed with the test specimens (RFID0, RFID1, RFID2 and RFID3) mounted in HN100.

The RF ID modules were active one at a time.

See appendix 1 for photo of test set up.

## 2.8.2 Test results

### 2.8.2.1 Test results – RFID0

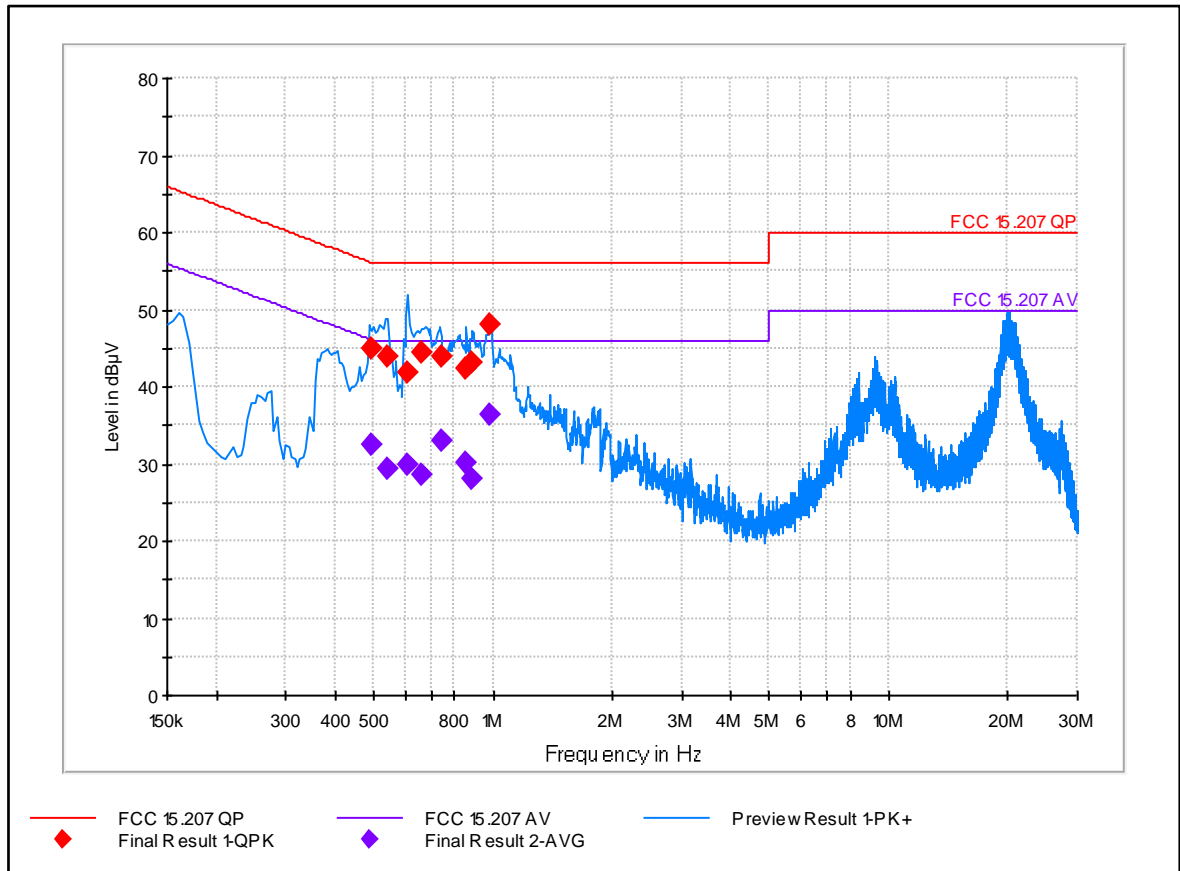


Figure 15. AC Conducted emission.

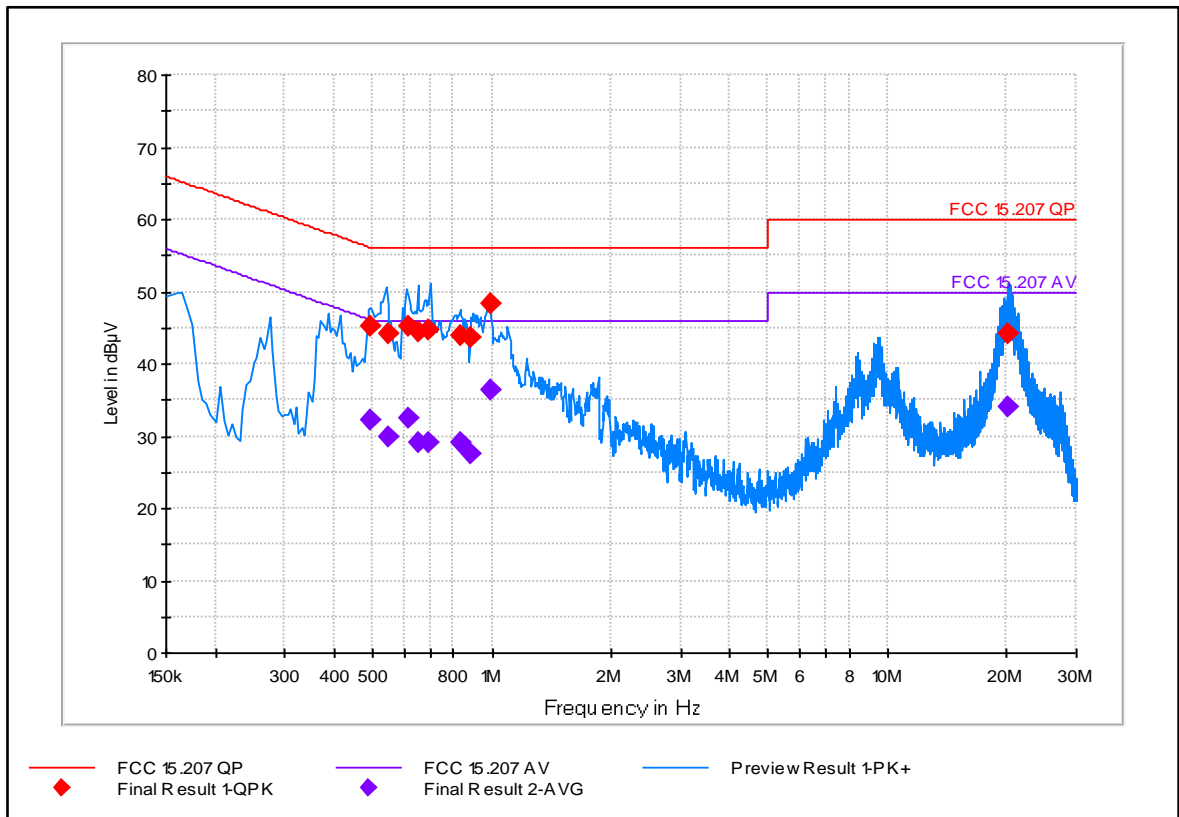
Frequency [MHz]	QuasiPeak [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
0.491800	44.9	9.000	N	11.20	56.10	PASSED
0.541300	43.9	9.000	N	12.10	56.00	PASSED
0.606100	41.9	9.000	N	14.10	56.00	PASSED
0.658500	44.3	9.000	N	11.70	56.00	PASSED
0.738200	43.9	9.000	N	12.10	56.00	PASSED
0.855300	42.3	9.000	N	13.70	56.00	PASSED
0.887400	43.1	9.000	N	12.90	56.00	PASSED
0.987100	48.2	9.000	N	7.80	56.00	PASSED

Table 26. AC Conducted emission. QuasiPeak detector.

Frequency [MHz]	Average [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
0.491800	32.6	9.000	N	13.60	46.10	PASSED
0.541300	29.2	9.000	N	16.80	46.00	PASSED
0.606100	29.9	9.000	N	16.10	46.00	PASSED
0.658500	28.5	9.000	N	17.50	46.00	PASSED
0.738200	33.0	9.000	N	13.00	46.00	PASSED
0.855300	30.2	9.000	N	15.80	46.00	PASSED
0.887400	28.1	9.000	N	17.90	46.00	PASSED
0.987100	36.5	9.000	N	9.50	46.00	PASSED

Table 27. AC Conducted emission. Average detector.

**2.8.2.2 Test results – RFID1**



**Figure 16. AC Conducted emission.**

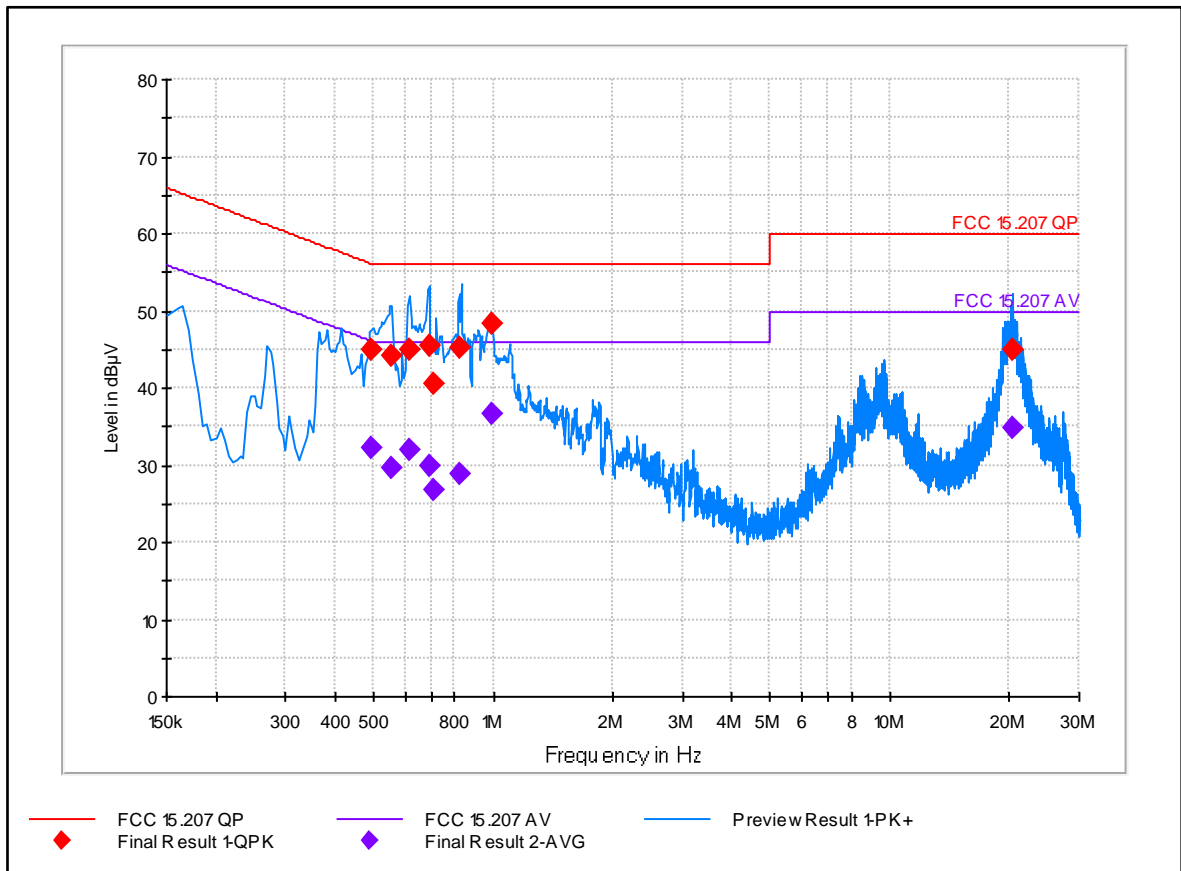
Frequency [MHz]	QuasiPeak [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
0.492200	45.1	9.000	N	11.00	56.10	PASSED
0.544700	44.1	9.000	N	11.90	56.00	PASSED
0.613600	45.2	9.000	N	10.80	56.00	PASSED
0.649200	44.3	9.000	N	11.70	56.00	PASSED
0.691800	44.7	9.000	N	11.30	56.00	PASSED
0.836400	43.9	9.000	N	12.10	56.00	PASSED
0.889000	43.8	9.000	N	12.20	56.00	PASSED
0.989700	48.4	9.000	N	7.60	56.00	PASSED
20.284200	44.2	9.000	L1	15.80	60.00	PASSED

**Table 28. AC Conducted emission. QuasiPeak detector.**

Frequency [MHz]	Average [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
0.492200	32.3	9.000	N	13.80	46.10	PASSED
0.544700	29.9	9.000	N	16.10	46.00	PASSED
0.613600	32.3	9.000	N	13.70	46.00	PASSED
0.649200	29.1	9.000	N	16.90	46.00	PASSED
0.691800	29.2	9.000	N	16.80	46.00	PASSED
0.836400	29.1	9.000	N	16.90	46.00	PASSED
0.889000	27.6	9.000	N	18.40	46.00	PASSED
0.989700	36.5	9.000	N	9.50	46.00	PASSED
20.284200	34.1	9.000	L1	15.90	50.00	PASSED

**Table 29. AC Conducted emission. Average detector.**

**2.8.2.3 Test results – RFID2**



**Figure 17. AC Conducted emission.**

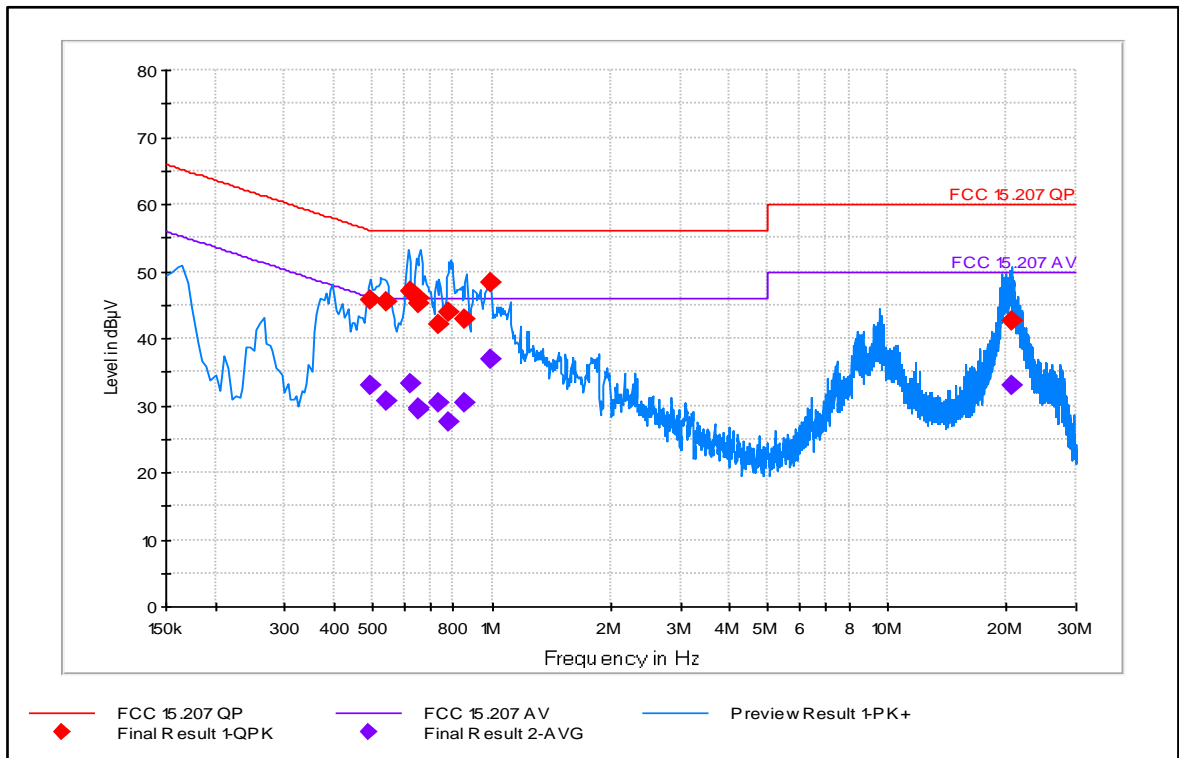
Frequency [MHz]	QuasiPeak [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
0.491000	45.0	9.000	N	11.10	56.20	PASSED
0.551100	44.2	9.000	N	11.80	56.00	PASSED
0.612800	45.0	9.000	N	11.00	56.00	PASSED
0.688700	45.5	9.000	N	10.50	56.00	PASSED
0.710500	40.5	9.000	N	15.50	56.00	PASSED
0.828500	45.3	9.000	N	10.70	56.00	PASSED
0.989300	48.3	9.000	N	7.70	56.00	PASSED
20.456400	44.9	9.000	L1	15.10	60.00	PASSED

**Table 30. AC Conducted emission. QuasiPeak detector.**

Frequency [MHz]	Average [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
0.491000	32.2	9.000	N	13.90	46.20	PASSED
0.551100	29.6	9.000	N	16.40	46.00	PASSED
0.612800	32.0	9.000	N	14.00	46.00	PASSED
0.688700	29.9	9.000	N	16.10	46.00	PASSED
0.710500	26.6	9.000	N	19.40	46.00	PASSED
0.828500	28.8	9.000	N	17.20	46.00	PASSED
0.989300	36.7	9.000	N	9.30	46.00	PASSED
20.456400	34.8	9.000	L1	15.20	50.00	PASSED

**Table 31. AC Conducted emission. Average detector.**

**2.8.2.4 Test results – RFID3**



**Figure 18. AC Conducted emission.**

Frequency [MHz]	QuasiPeak [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
0.492700	45.6	9.000	N	10.50	56.10	PASSED
0.539400	45.5	9.000	N	10.50	56.00	PASSED
0.621300	47.0	9.000	N	9.00	56.00	PASSED
0.652100	45.9	9.000	N	10.10	56.00	PASSED
0.655000	45.1	9.000	N	10.90	56.00	PASSED
0.730500	42.1	9.000	N	13.90	56.00	PASSED
0.778900	43.9	9.000	N	12.10	56.00	PASSED
0.856100	42.8	9.000	N	13.20	56.00	PASSED
0.989400	48.2	9.000	N	7.80	56.00	PASSED
20.573700	42.7	9.000	N	17.30	60.00	PASSED

**Table 32. AC Conducted emission. QuasiPeak detector.**

Frequency [MHz]	Average [dBµV]	BW [kHz]	Line	Margin [dB]	Limit [dBµV]	Result
0.492700	33.0	9.000	N	13.10	46.10	PASSED
0.539400	30.7	9.000	N	15.30	46.00	PASSED
0.621300	33.3	9.000	N	12.70	46.00	PASSED
0.652100	29.5	9.000	N	16.50	46.00	PASSED
0.655000	29.3	9.000	N	16.70	46.00	PASSED
0.730500	30.3	9.000	N	15.70	46.00	PASSED
0.778900	27.6	9.000	N	18.40	46.00	PASSED
0.856100	30.4	9.000	N	15.60	46.00	PASSED
0.989400	36.9	9.000	N	9.10	46.00	PASSED
20.573700	33.0	9.000	N	17.00	50.00	PASSED

**Table 33. AC Conducted emission. Average detector.**



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### 2.8.3 Test equipment

Description	Supplier	Model	Tag no.	Cal. due date
V-network Two Line	R&S	ESH3-Z5	20682	2020-02-25
Receiver EMI Test 20Hz-26.5GHz	Rohde & Schwarz	ESIB 26	18880	2020-10-15

**Table 34. AC Conducted emission test equipment.**

## 2.9 Occupied bandwidth

<b>Test specimen</b>	NFC module
<b>Test specification</b>	47 CFR 15.215 (c) RSS-Gen 6.7
<b>Test method</b>	ANSI C63.10:2013 sec. 6.9.2
<b>Comments</b>	The NFC module was tested in stand-alone configuration
<b>Temperature / Humidity</b>	23°C / 33%RH, 19°C / 40%RH
<b>Dates of measurements</b>	2020-01-09, 2020-01-15
<b>Test personnel</b>	Søren Søltøft

### 2.9.1 Test setup

The test was performed on NFC module stand alone.

The test specimen was placed in a shielded climatic chamber together with a loop antenna in a fixed position. The antenna was connected to a spectrum analyzer via a feedthrough in the chamber wall.

See photo of test set up in appendix 1.

### 2.9.2 Test results

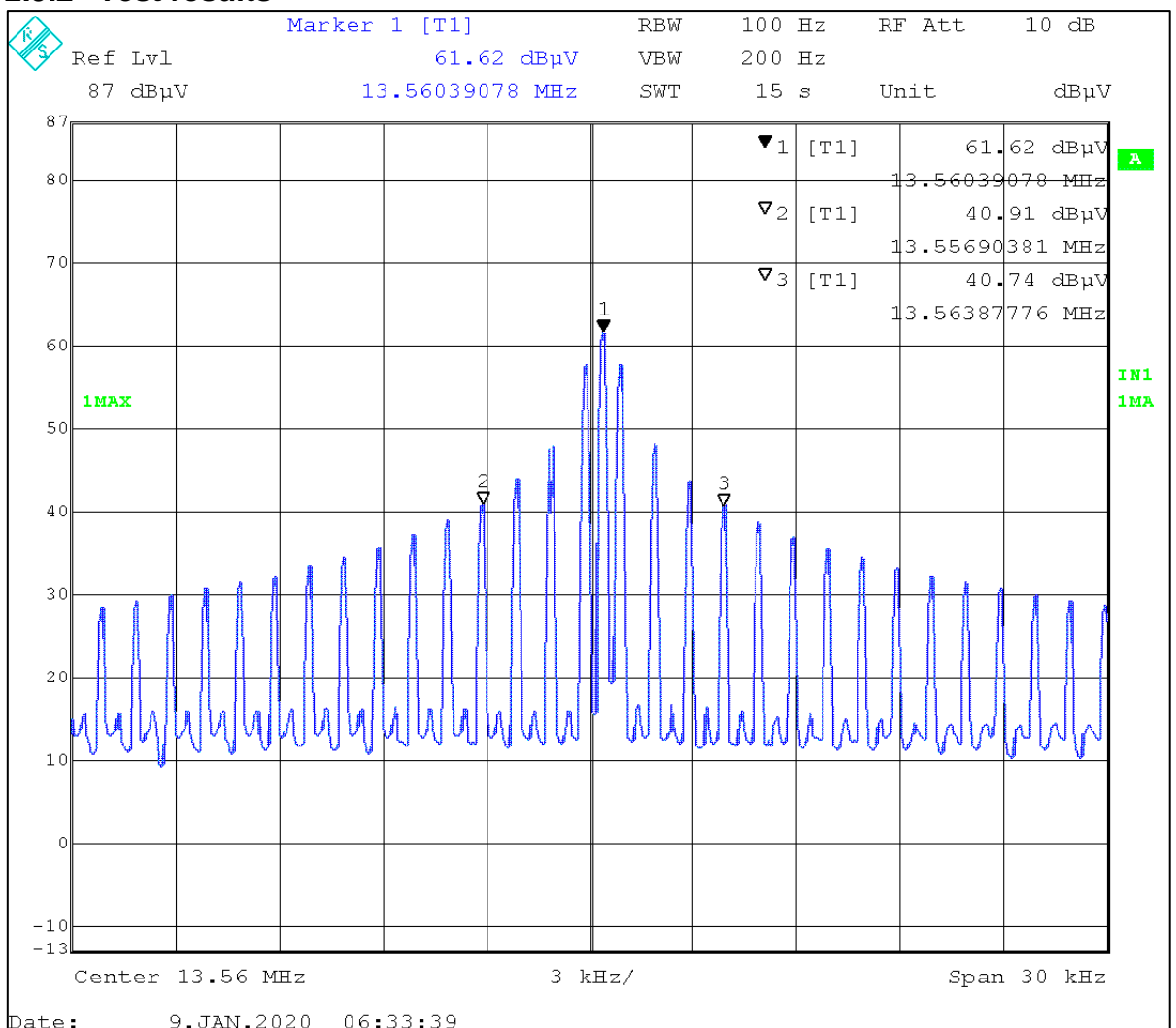
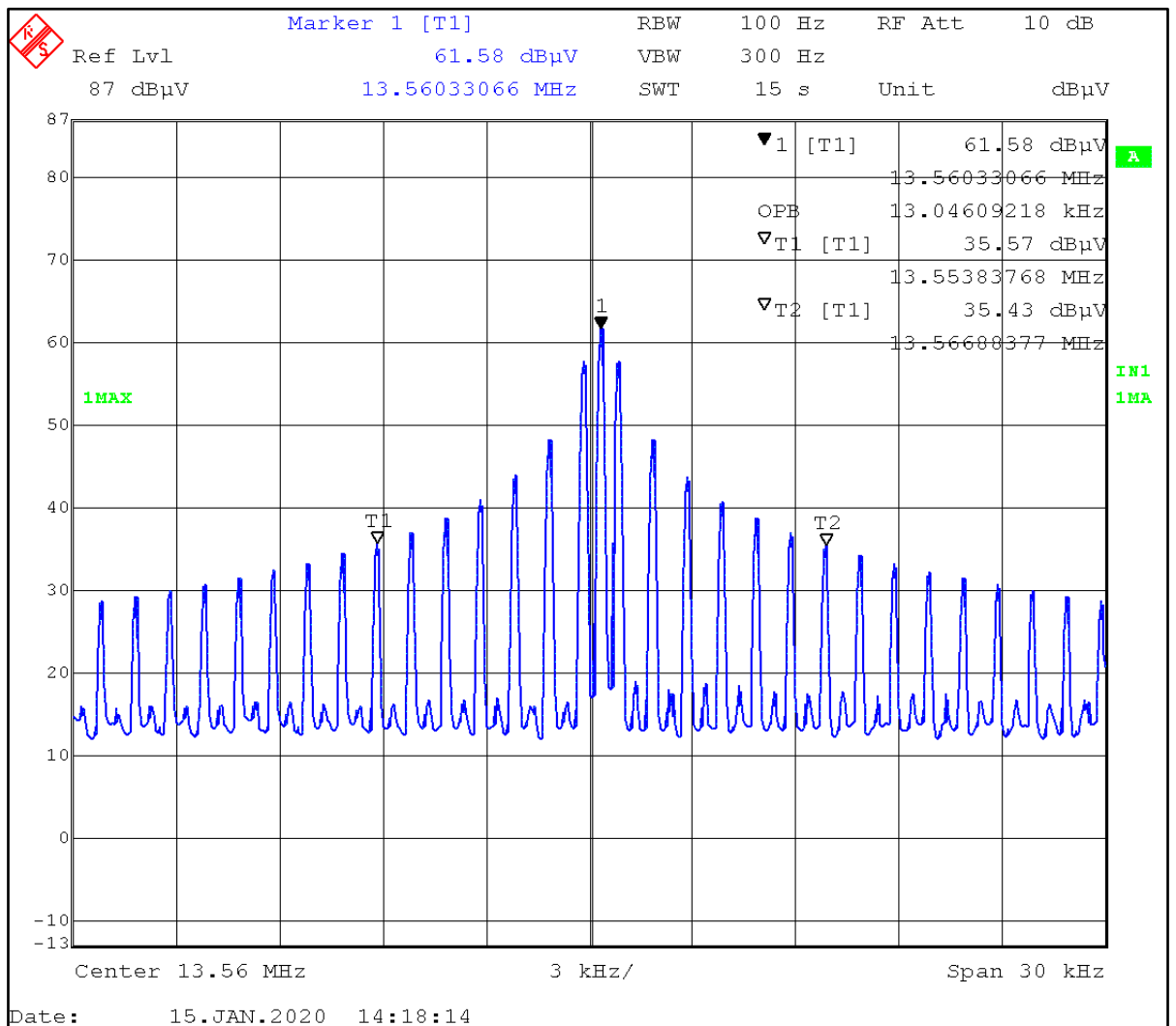


Figure 19. 20 dB Occupied bandwidth.



**Figure 20. 99% Occupied bandwidth. 100% AM.**

Highest frequency deviation detected during frequency stability test was +45 Hz and -79 Hz.

	-20 dB freq. [MHz]	Freq.Stab [MHz]	-20 dB w. Freq. Stab. [MHz]	Band limit [MHz]	Margin [MHz]	Result
Low freq	13.556904	-0.000079	13.556825	14.010	0.4468	PASSED
High freq	13.563878	0.000045	13.563923	13.110	0.4461	PASSED

**Table 35. 20 dB Occupied bandwidth results.**

99% freq. [MHz]	Occupied bandwidth 99% [kHz]	Result
13.56	12.1661	PASSED

**Table 36. 99% Occupied bandwidth results.**

**2.9.3 Test equipment**

Description	Supplier	Model	Tag no.	Cal. due date
Analyzer 20Hz-26.5GHz	Rohde & Schwarz	ESIB 26	18880	2020-10-15

**Table 37. Occupied bandwidth 20 dB 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		<b>3.60 dB</b>
Radiated emission (BiCon – LogPer)	30 - 200	Vertical	<b>4.59 dB</b>
	200 - 1000	Vertical	<b>4.77 dB</b>
	30 - 200	Horizontal	<b>4.57 dB</b>
	200 - 1000	Horizontal	<b>4.86 dB</b>
Conducted emission (CISPR 16-4)	0.009 - 30	-	<b>3.44 dB</b>
Conducted emission (ESIB 26)	<1000	-	<b>2.58 dB</b>
Frequency Error (ESIB)	13.56	-	<b>0.39 ppm</b>