DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España

DEKRA

ilac-MRA ENAC ENSAYOS Nº 51/LE147

FCC LISTED, REGISTRATION NUMBER: 720267

ISED LISTED REGISTRATION NUMBER 4621A-2

Informe de ensayo nº:
Test report No:

NIE: 53613RRF.006A2

Test report (Modification II)
REFERENCE STANDARD:
USA FCC Part 15.225 and Part 15.209 & CANADA RSS-210

Identificación del objeto ensayado.....: Identification of item tested	Electronic Lock Series including all mechanical variants
Marca .....: Trademark	AElement Fusion
Modelo y/o referencia tipo .....: Model and /or type reference	AF0D (Type reference: E1723)
Other identification of the product .....:	FCC ID: UKCAF0B IC: 10088A-AF0B
Final HW version .....:	1.0
Final SW version .....:	0146 (Control Firmware) + 0136 (BGM111 Firmware)
Características .....: Features	Contains 2 certified Bluetooth modules (BGM111 & DirectKey)
Solicitante.....: Applicant	SALTO Systems, S.L. Arkotz 9, Polígono Lanbarren 20180, Oiartzun, Gipuzkoa, SPAIN
Método de ensayo solicitado, norma.....: Test method requested, standard	USA FCC Part 15.225 (10–1–17 Edition): Operation within the band 13.110 -14.010. USA FCC Part 15.209 (10–1–17 Edition): Radiated emission limits, general requirements. CANADA RSS-210 Issue 9 (August 2016). CANADA RSS-Gen Issue 4 (November 2014). ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Resultado.....: Summary	IN COMPLIANCE
Aprobado por (nombre / cargo y firma) .....: Approved by (name / position & signature)	A. Llamas RF Lab. Manager Firmado digitalmente por ALEJANDRO LLAMAS RODRIGUEZ Fecha: 2018.04.24 14:38:02 +02'00'
Fecha de realización .....: Date of issue	2018-04-20
Formato de informe No. .....: Report template No	FDT11_20

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DEKRA Testing and Certification is a laboratory with a measurement site in compliance with the requirements of RSS 212, Issue 1 (Provisional) and has been added to the list of filed sites of the Canadian Certification and Engineering Bureau. Reference File Number: ISED 4621A-2.

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Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA Testing and Certification internal document PODT000.

Usage of samples

Samples undergoing test have been selected by: **the client**

Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
53613B/017	PCB with antenna conector	---	---	2017-10-23
53613B/018	Module	---	---	2017-10-23

1. Sample S/01 has undergone following test(s).

   All conducted tests indicated in appendix A (mode NFC-A).

Sample S/02 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
53613B/013	Electronic lock	AF0D	---	2017-09-28

1. Sample S/02 has undergone following test(s).

   All radiated tests indicated in appendix A (mode NFC-A).

Sample S/03 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
53613B/029	Electronic lock	AF0D	---	2018-03-22
53613B/001	Lock case	---	---	2017-07-20

1. Sample S/02 has undergone following test(s).

   All radiated and conducted tests indicated in appendix A (mode NFC-V).

Test sample description

The test sample consists of a new AElement reader with Mifare/NFC-V and Bluetooth Smart (BGM111 & DirectKey) technology. Electronic and batteries inside the door.

Identification of the client

SALTO Systems, S.L.
Arkotz 9, Polígono Lanbarren
20180, Oiartzun, Gipuzkoa, SPAIN

Testing period

The performed test started on 2017-10-20 and finished on 2018-04-19.

The tests have been performed at DEKRA Testing and Certification.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Shielding effectiveness	> 100 dB

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Normal site attenuation (NSA)	< ±4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz)
Field homogeneity	More than 75% of illuminated surface is between 0 and 6 dB (26 MHz to 1000 MHz).

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB

Modifications to the reference test report

It was introduced the following modifications in respect to the test report number 53613RRF.006A1 related with the same samples, in the next clauses and sub-clauses:

Clauses / Sub-clauses	Modification	Justification
Usage of Samples	Added sample S/03	New measurements for NFC-V mode
Testing period	Modified finish date	New measurements for NFC-V mode
Remarks and comments/Used instrumentation	Added instrumentation	New measurements for NFC-V mode
Appendix A – Test result	Added mode NFC-V results	New measurements for NFC-V mode
Appendix B – Photographs	Added photographs of mode NFC-V samples	New measurements for NFC-V mode

This modification test report cancels and replaces the test report 53613RRF.006A1.

Remarks and comments

1: Tests have been performed by the technical personnel: Carlos Alberto Contreras, Gonzalo Rueda and José Alberto Aranda.

2: Used instrumentation.

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Spectrum analyser Agilent E4440A	2017/10	2019/10
2.	Climatic chamber HERAEUS VM 04/35	2016/03	2018/03
3.	DC power supply R&S NGPE 40/40	2018/02	2021/02
4.	Vector Signal analyser R&S FSQ8	2016/06	2018/06
5.	Spectrum analyser Rohde & Schwarz FSV40	2017/07	2019/07

Radiated Measurements

		Last Cal. date	Cal. due date
1.	Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2.	BiconicalLog antenna ETS LINDGREN 3142E	2015/09	2018/09
3.	Multi Device Controller EMCO 2090	N.A.	N.A.
4.	EMI Test Receiver R&S ESU 26	2018/02	2020/02
5.	RF pre-amplifier 30 MHz-6 GHz Bonn Elektronik BLNA 0360-01N	2017/07	2018/07
6.	Loop antenna HP 1196 A.	2016/05	2018/05
7.	Antenna tripod EMCO 11968C.	N.A.	N.A.

Testing verdicts

Not applicable ..... :	N/A
Pass ..... :	P
Fail ..... :	F
Not measured ..... :	N/M

FCC PART 15/RSS-210 PARAGRAPH	VERDICT			
	NA	P	F	NM
15.225 Subclause (a) / RSS-210 Clause B.6 (a). Field strength of emissions within the band 13.553 MHz -13.567 MHz		P		
15.225 Subclause (b) / RSS-210 Clause B.6 (b). Field strength of emissions within the band 13.410 - 13.553 MHz and 13.567 – 13.710 MHz		P		
15.225 Subclause (c) / RSS-210 Clause B.6 (c). Field strength of emissions within the band 13.110 - 13.410 MHz and 13.710 – 14.010 MHz		P		
15.225 Subclause (d) / RSS-210 Clause B.6 (d). Field strength of emissions outside of the band 13.110 MHz -14.010 MHz		P		
15.225 Subclause (e) / RSS-210 Clause B.6. Frequency tolerance of the carrier signal		P		

Appendix A – Test result

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TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 4.5 Vdc

Vmin = 3.825 Vdc

Vmax = 5.175 Vdc

The subscripts nom, min and max indicate voltage test conditions (nominal, minimum and maximum respectively, as declared by the applicant).

Type of power supply = DC voltage from batteries.

Type of antenna = Integral antenna

Operating Temperature Range (ºC):

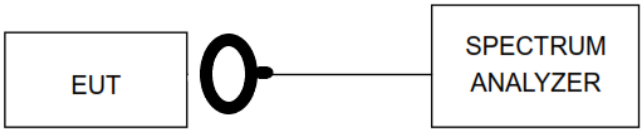
T_{nom} = +15 to + 35

TEST FREQUENCIES:

Nominal Operating frequency: 13.56 MHz

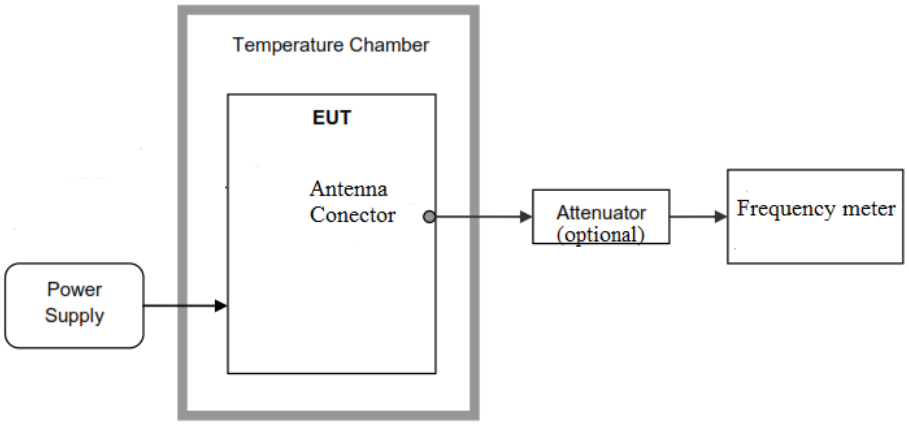
CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is directly connected to the spectrum analyser or using a coupling device.



Coupling device

For frequency stability test the EUT was placed inside a climatic chamber and connected to a frequency meter using a low loss cable. An external DC power supply was connected to the EUT for voltage variation test.



RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Loop antenna for the range between 9 kHz to 30 MHz and Bilog antenna for the range between 30 MHz to 200 MHz) is situated at a distance of 3 m.

For radiated emissions in the range 9 kHz to 30 MHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 40 dB per decade is used to normalize the measured data for determining compliance.

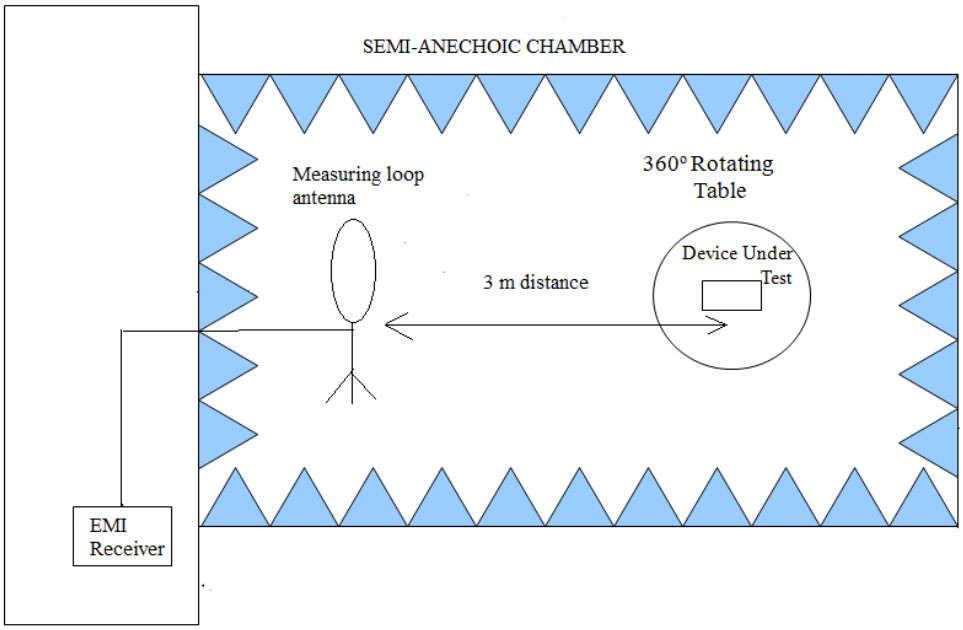
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and in the range between 30 MHz and 200 MHz the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

In the range between 9 kHz and 30 MHz the measurements were made in the three different orientation planes of the loop antenna to determine the maximum received field.

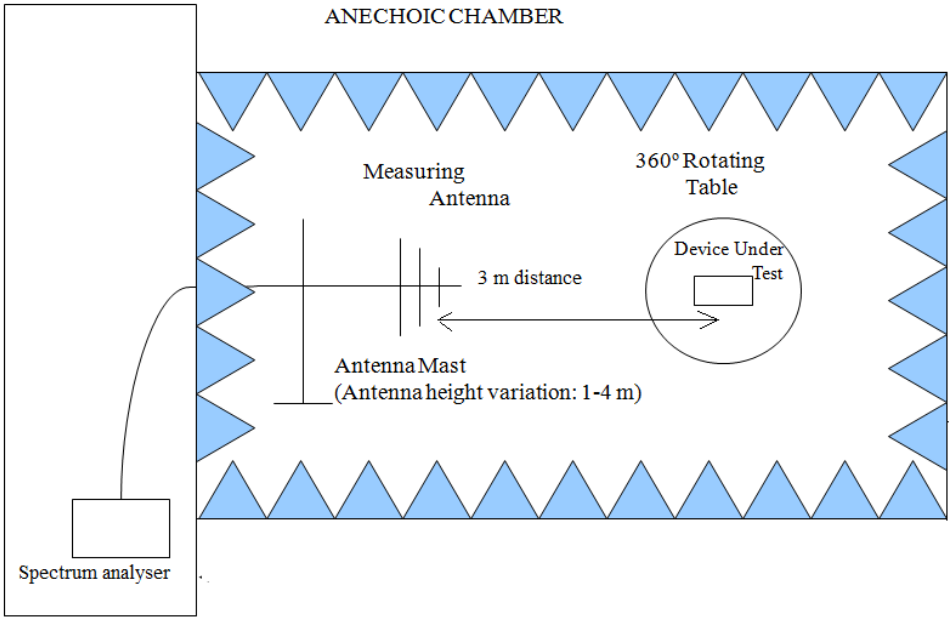
In the range between 30 MHz and 200 MHz the measurements were made in both horizontal and vertical planes of polarization.

The test was performed with the equipment transmitting first with only the 13.56 MHz radio and repeated with the 2.4 GHz BT LE radio transmitting simultaneously to check the impact of the co-location of the other radio interfaces. The results and plots below show the worst results obtained.

Radiated measurements setup 9 kHz to 30 MHz.



Radiated measurements setup 30 MHz to 200 MHz.



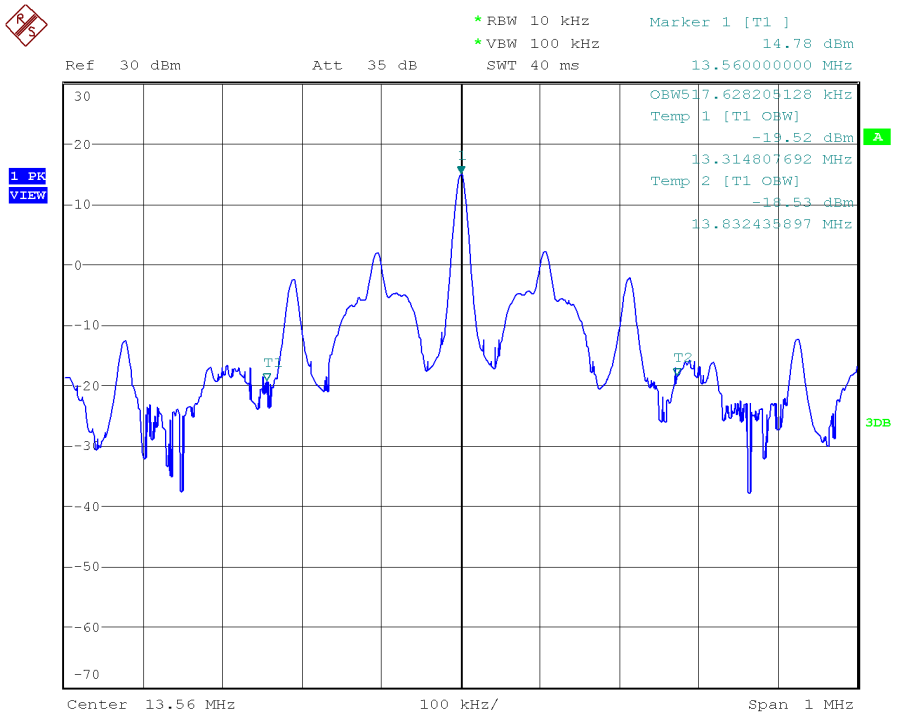
Occupied Bandwidth

RESULTS

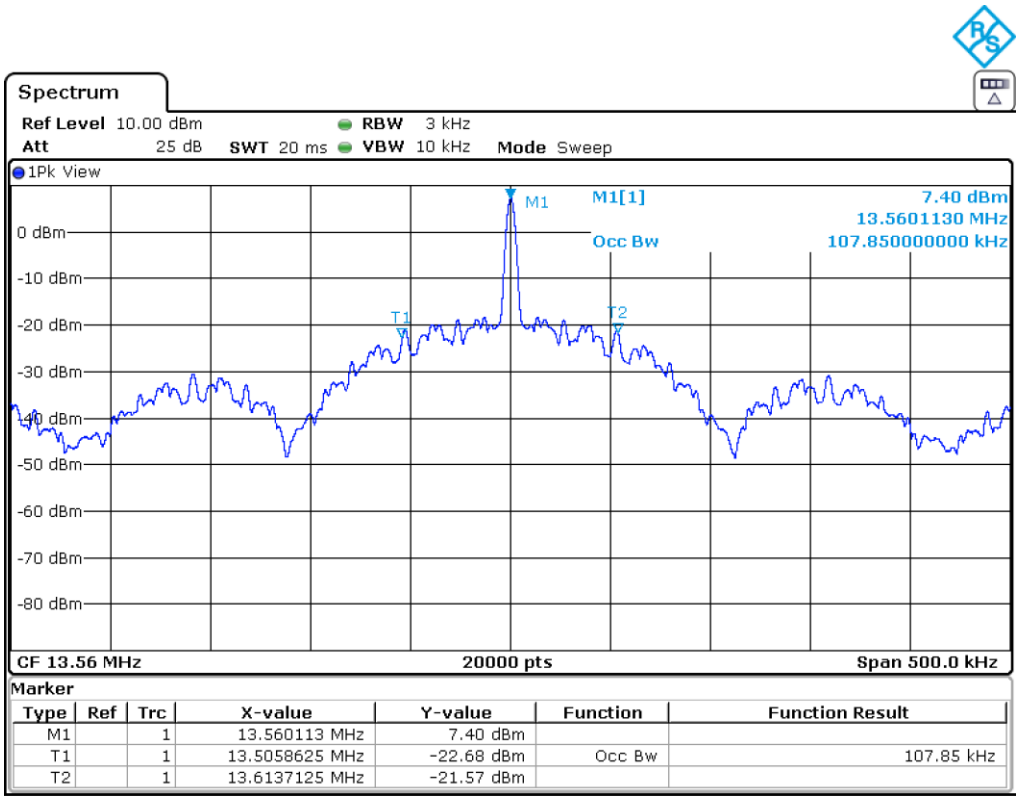
99 % Occupied Bandwidth (see next plots).

Operation mode	99% occupied bandwith (kHz)
NFC-A	517.628
NFC-V	107.850
Measurement uncertainty (kHz)	<±6.01

NFC-A



NFC-V


Spectrum
Ref Level 10.00 dBm
RBW 3 kHz
Att 25 dB
SWT 20 ms
VBW 10 kHz
Mode Sweep
1Pk View
M1
M1[1]
7.40 dBm
13.5601130 MHz
Occ Bw
107.850000000 kHz
T1
T2
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 13.56 MHz
20000 pts
Span 500.0 kHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 13.560113 MHz 7.40 dBm
T1 1 13.5058625 MHz -22.68 dBm Occ Bw 107.85 kHz
T2 1 13.6137125 MHz -21.57 dBm

Section 15.225 Subclause (a) / RSS-210 Clause B.6 (a). Field strength of emissions within the band 13.553 MHz -13.567 MHz

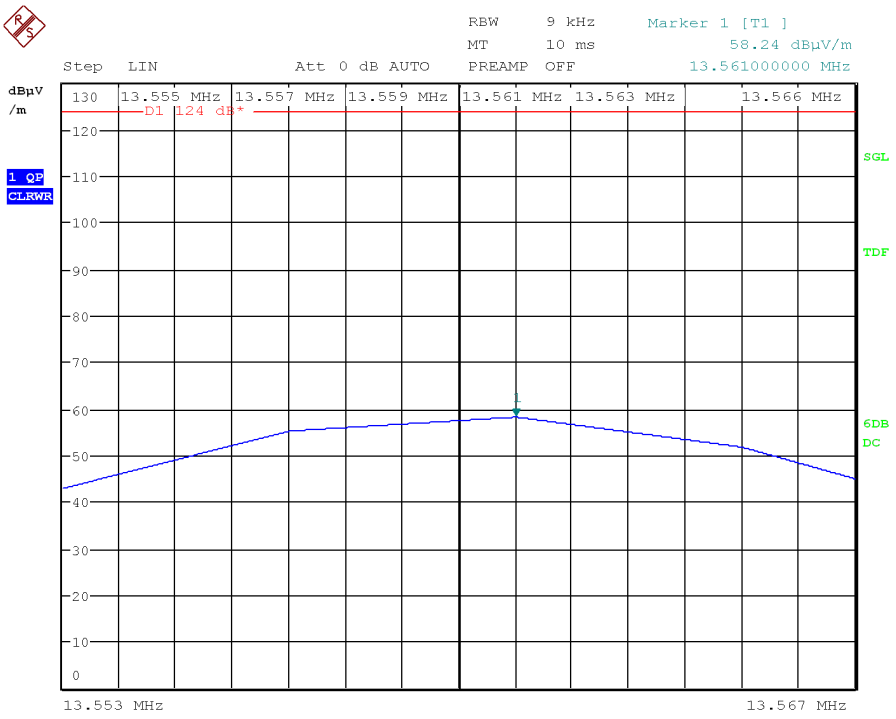
SPECIFICATION

The field strength of any emissions within the band 13.553 – 13.567 MHz shall not exceed 15,848 microvolts/meter (84 dBµV/m) at 30 meters.

RESULTS

Measurement distance: 3 meters

NFC-A

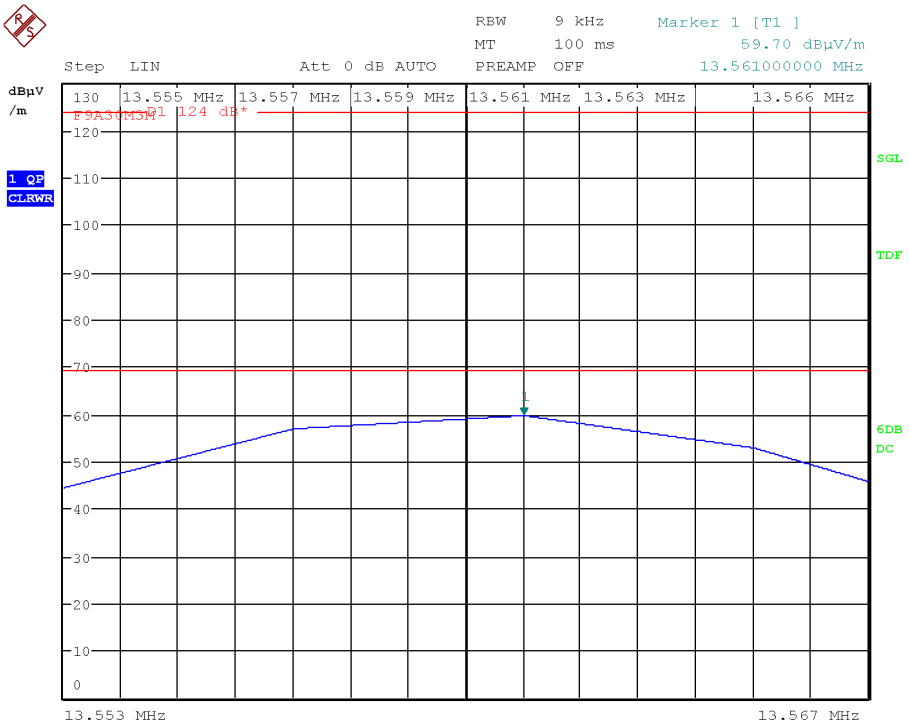


Note: The limit shown in the above plot is extrapolated to 3 meters

Frequency (MHz)	Maximum field strength (dBµV/m) measured at 3 m (quasi-peak detector)	Maximum field strength (dBµV/m) extrapolated to 30 m (40 dB/decade)
13.561	58.24	18.24
Measurement uncertainty (dB)	<±3.61	

Verdict: PASS

NFC-V



Note: The limit shown in the above plot is extrapolated to 3 meters

Frequency (MHz)	Maximum field strength (dBµV/m) measured at 3 m (quasi-peak detector)	Maximum field strength (dBµV/m) extrapolated to 30 m (40 dB/decade)
13.561	59.70	19.70
Measurement uncertainty (dB)	<±3.61	

Verdict: PASS

Section 15.225 Subclause (b) / RSS-210 Clause B.6 (b). Field strength of emissions within the band 13.410 MHz -13.553 MHz and 13.567 MHz -13.710 MHz

SPECIFICATION

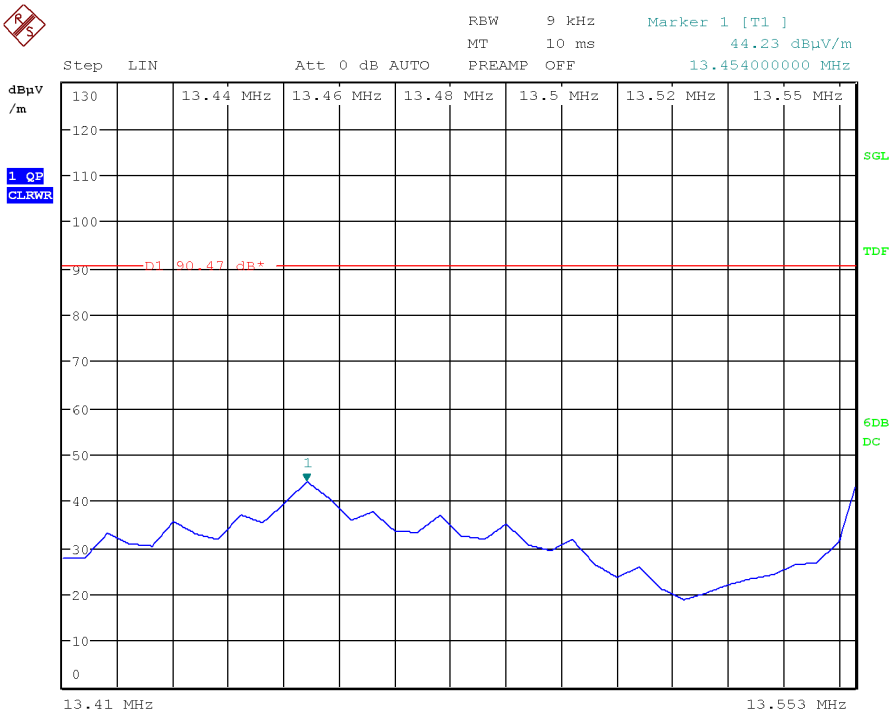
Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter (50.47 dBµV/m) at 30 meters.

RESULTS

Band 13.410-13.553 MHz

Measurement distance: 3 meters.

NFC-A

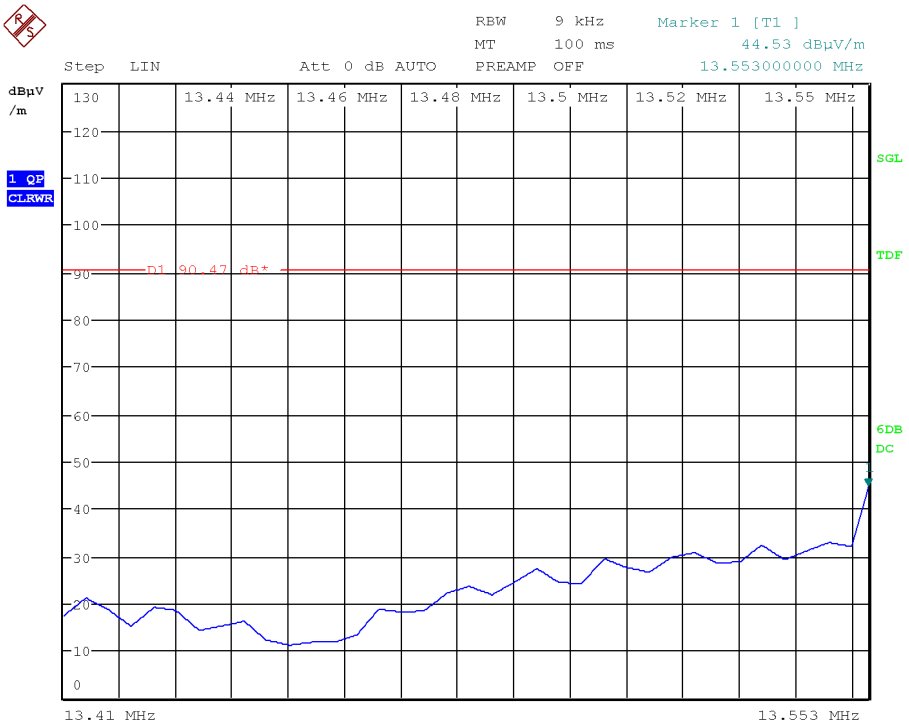


Note: The limit shown in the above plot is extrapolated to 3 meters

Frequency (MHz)	Maximum field strength (dBµV/m) measured at 3 m (quasi-peak detector)	Maximum field strength (dBµV/m) extrapolated to 30 m (40 dB/decade)
13.454	44.23	4.23
Measurement uncertainty (dB)	<±3.61	

Verdict: PASS

NFC-V



Note: The limit shown in the above plot is extrapolated to 3 meters

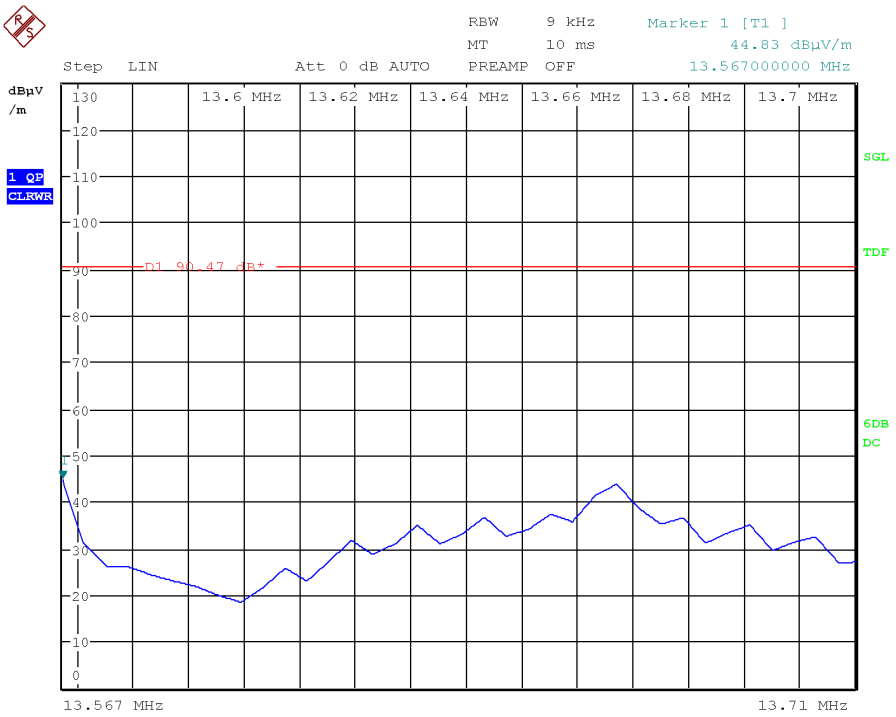
Frequency (MHz)	Maximum field strength (dBµV/m) measured at 3 m (quasi-peak detector)	Maximum field strength (dBµV/m) extrapolated to 30 m (40 dB/decade)
13.553	44.53	4.53
Measurement uncertainty (dB)	<±3.61	

Verdict: PASS

Band 13.567-13.710 MHz

Measurement distance: 3 meters.

NFC-A

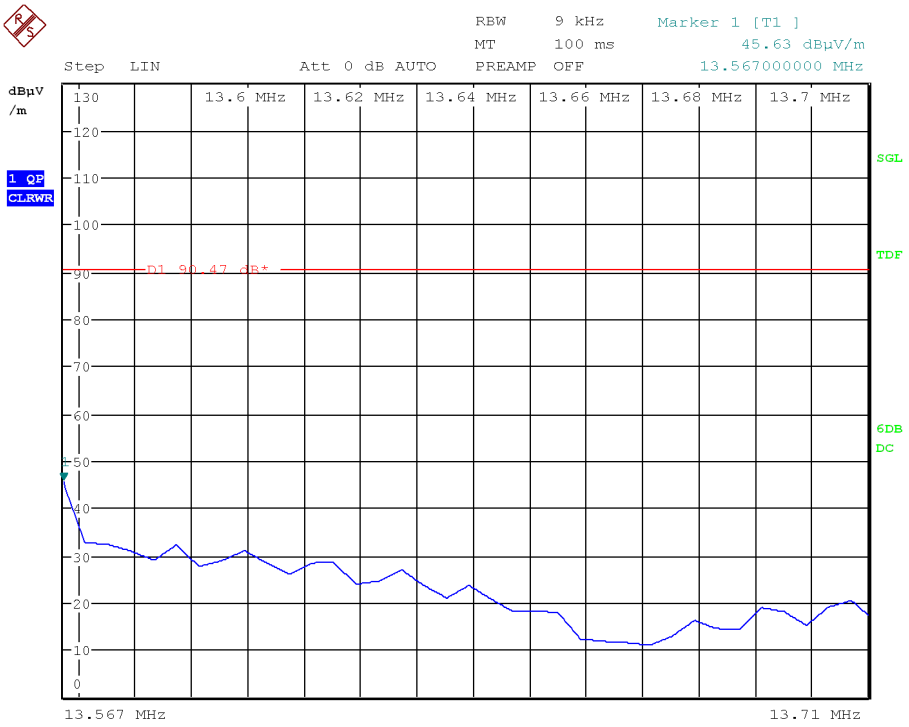


Note: The limit shown in the above plot is extrapolated to 3 meters

Frequency (MHz)	Maximum field strength (dBµV/m) measured at 3 m (quasi-peak detector)	Maximum field strength (dBµV/m) extrapolated to 30 m (40 dB/decade)
13.567	44.83	4.83
Measurement uncertainty (dB)	<±3.61	

Verdict: PASS

NFC-V



Note: The limit shown in the above plot is extrapolated to 3 meters

Frequency (MHz)	Maximum field strength (dBµV/m) measured at 3 m (quasi-peak detector)	Maximum field strength (dBµV/m) extrapolated to 30 m (40 dB/decade)
13.567	45.63	5.63
Measurement uncertainty (dB)	<±3.61	

Verdict: PASS

Section 15.225 Subclause (c) / RSS-210 Clause B.6 (c). Field strength of emissions within the band 13.110 MHz -13.410 MHz and 13.710 MHz -14.010 MHz

SPECIFICATION

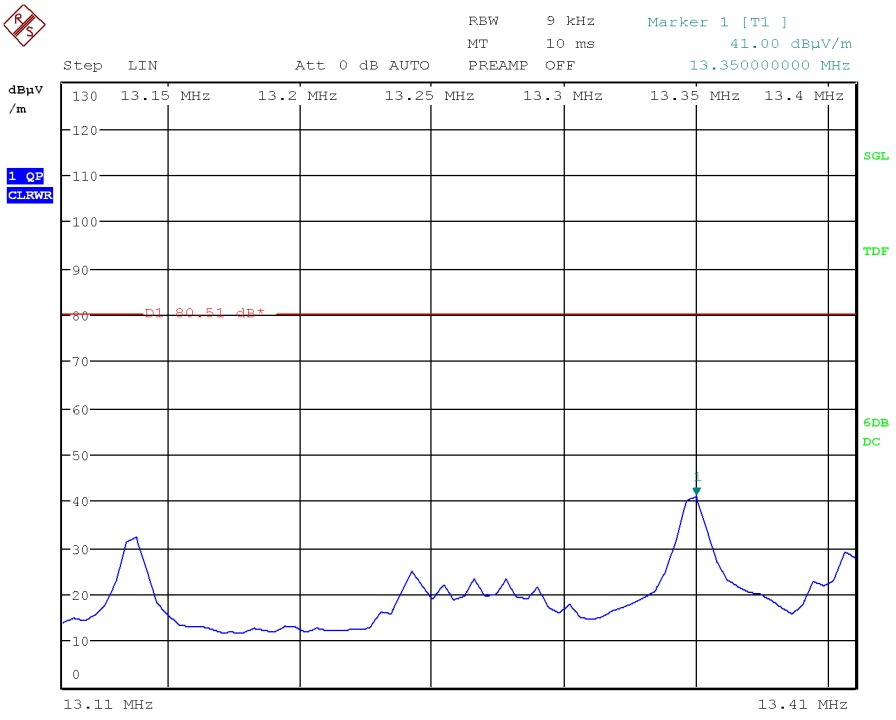
Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz, the field strength of any emissions shall not exceed 106 microvolts/meter (40.51 dBµV/m) at 30 meters.

RESULTS

Band 13.110-13.410 MHz

Measurement distance: 3 meters.

NFC-A

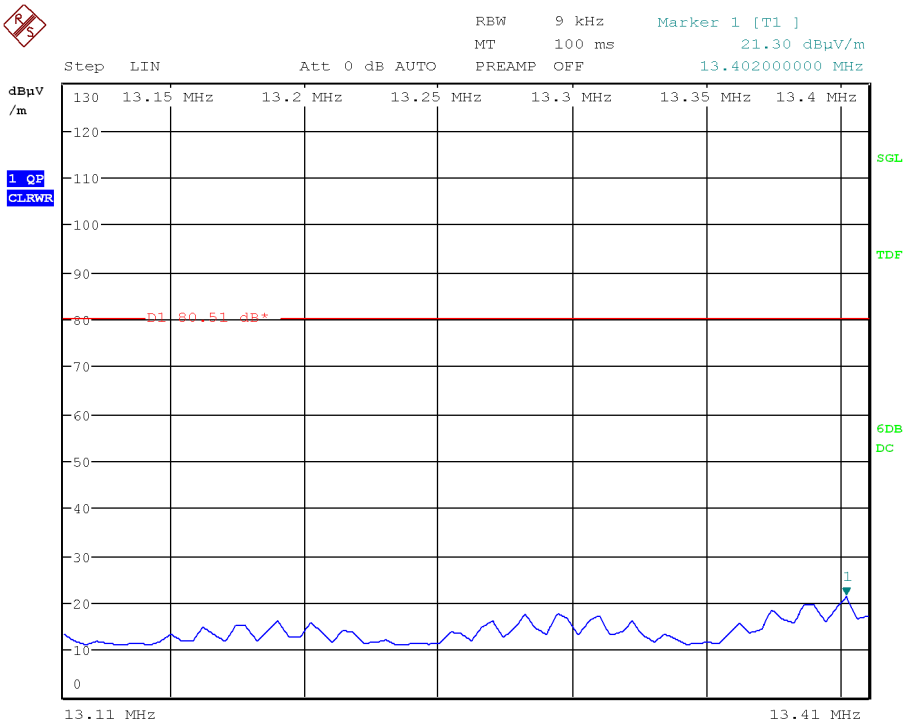


Note: The limit shown in the above plot is extrapolated to 3 meters

Frequency (MHz)	Maximum field strength (dBµV/m) measured at 3 m (quasi-peak detector)	Maximum field strength (dBµV/m) extrapolated to 30 m (40 dB/decade)
13.350	41.00	1.00
Measurement uncertainty (dB)	<±3.61	

Verdict: PASS

NFC-V



Note: The limit shown in the above plot is extrapolated to 3 meters

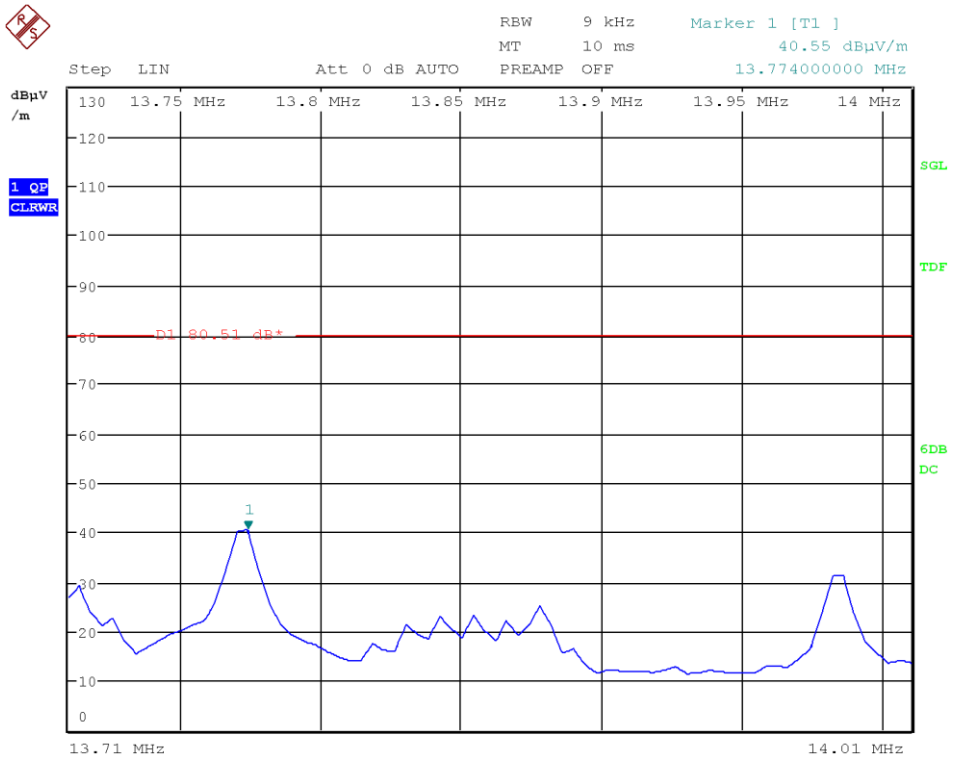
Frequency (MHz)	Maximum field strength (dBµV/m) measured at 3 m (quasi-peak detector)	Maximum field strength (dBµV/m) extrapolated to 30 m (40 dB/decade)
13.402	21.30	-18.70
Measurement uncertainty (dB)	<±3.61	

Verdict: PASS

Band 13.710-14.010 MHz

Measurement distance: 3 meters.

NFC-A

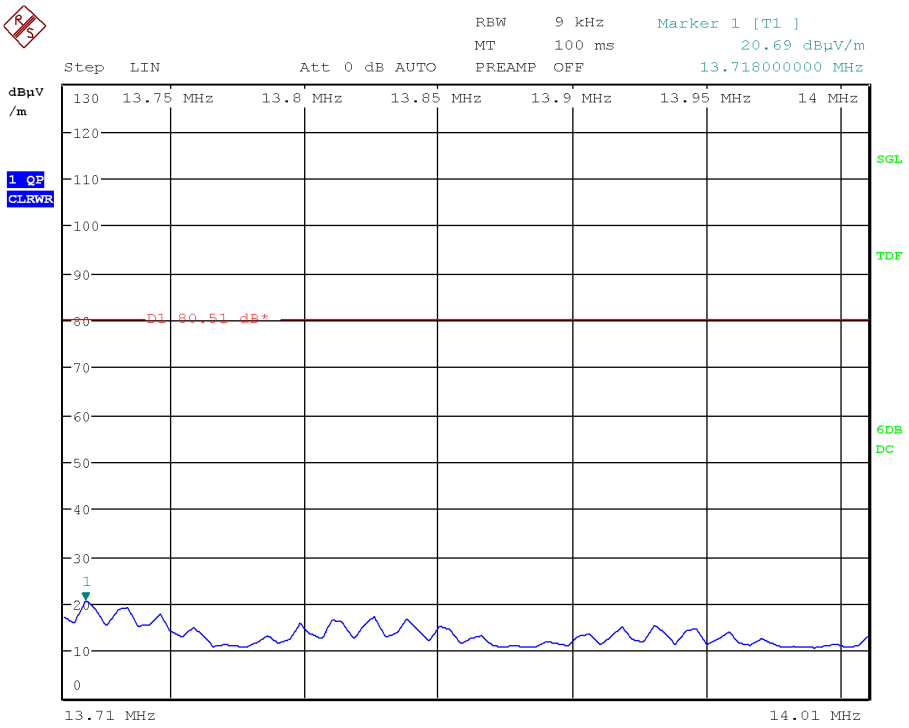


Note: The limit shown in the above plot is extrapolated to 3 meters

Frequency (MHz)	Maximum field strength (dBµV/m) measured at 3 m (quasi-peak detector)	Maximum field strength (dBµV/m) extrapolated to 30 m (40 dB/decade)
13.774	40.55	0.55
Measurement uncertainty (dB)	±3.61	

Verdict: PASS

NFC-V



Note: The limit shown in the above plot is extrapolated to 3 meters

Frequency (MHz)	Maximum field strength (dBµV/m) measured at 3 m (quasi-peak detector)	Maximum field strength (dBµV/m) extrapolated to 30 m (40 dB/decade)
13.718	20.69	-19.31
Measurement uncertainty (dB)	±3.61	

Verdict: PASS

Section 15.225 Subclause (d) / RSS-210 Clause B.6 (d). Field strength of emissions outside of the band 13.110 MHz -14.010 MHz

SPECIFICATION

Field strength of any emissions appearing outside of the band 13.110 MHz - 14.010 MHz band shall not exceed the general radiated emission limits in 15.209/RSS-Gen:

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705 - 30.0	30	29.54	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

RESULTS:

All tests were performed in a semi-anechoic chamber at a distance of 3 m.

The spectrum was inspected from 9 kHz up to at least the 10th harmonic searching for spurious signals.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifier gain.

NFC-A

Frequency range 9 kHz-30 MHz.

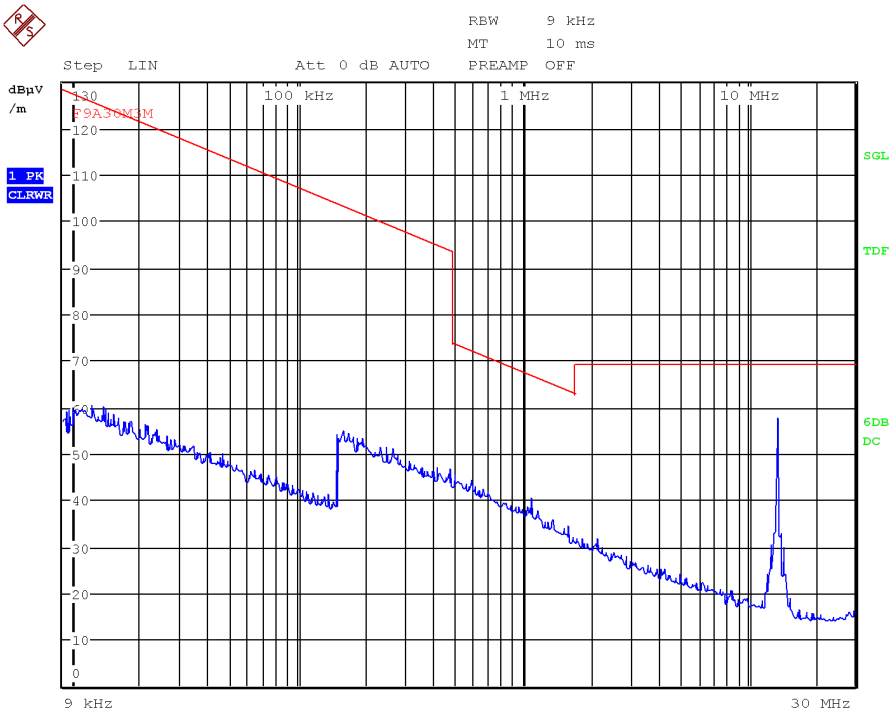
No spurious signals were found at less than 20 dB below the limit.

Frequency range 30 MHz-200 MHz

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
67.80	V	Quasi-peak	24.74	± 3.88
81.37	V	Quasi-peak	27.33	± 3.88

Verdict: PASS

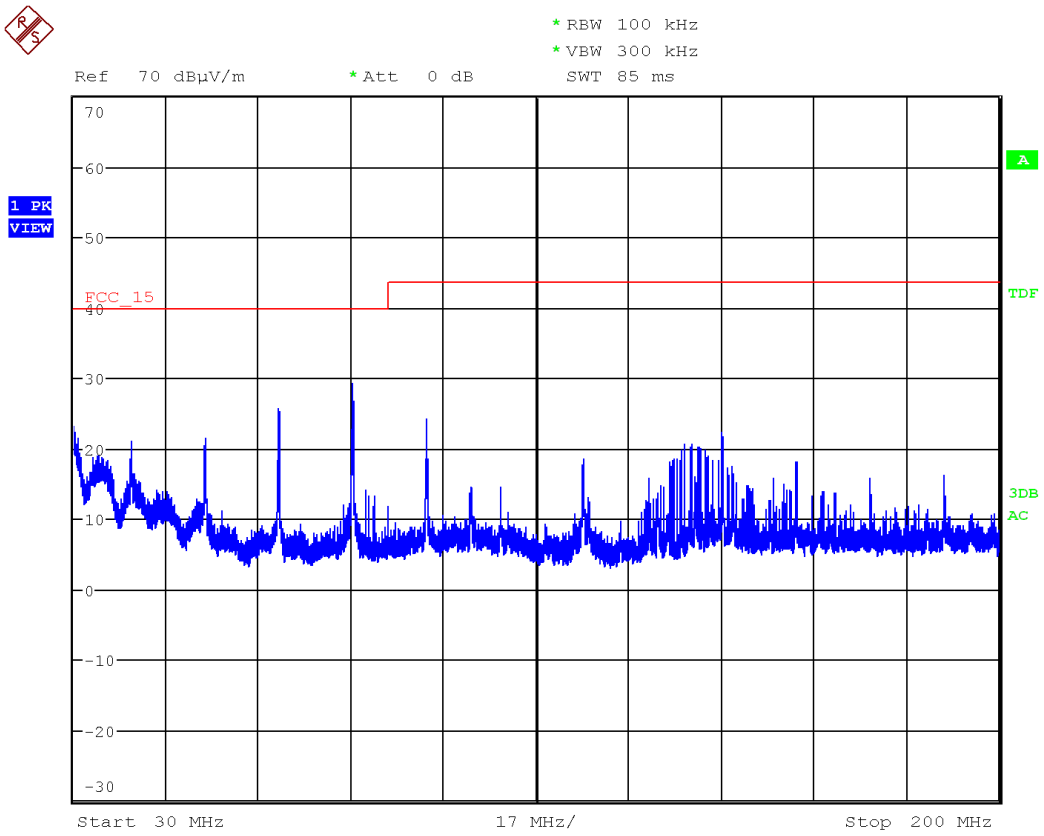
FREQUENCY RANGE 9 kHz-30 MHz.



Note: The limits shown in the above plot are extrapolated to 3 meters. The highest peak corresponds to the carrier level.

Resolution bandwidth:
200 Hz for 9 kHz ≤ f ≤ 150 kHz
9 kHz for 150 kHz ≤ f ≤ 30 MHz

FREQUENCY RANGE 30 MHz to 200 MHz.



Note: The above plot shows the results of the scan using peak detector.

NFC-V

Frequency range 9 kHz-30 MHz.

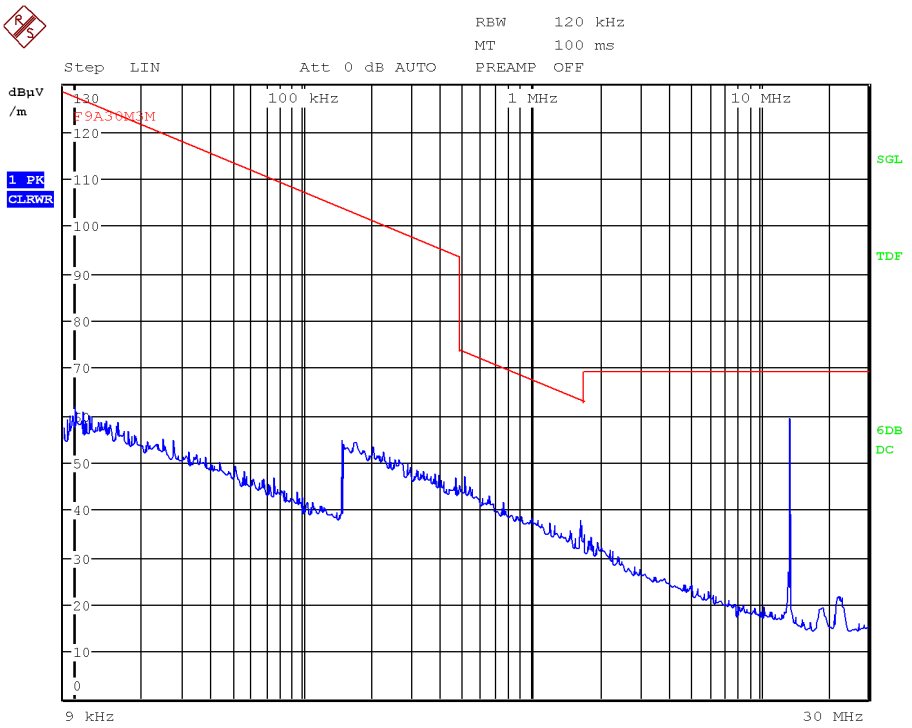
No spurious signals were found at less than 20 dB below the limit.

Frequency range 30 MHz-140 MHz

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
30.308	V	Quasi-peak	19.80	± 3.88
34.455	V	Quasi-peak	19.10	± 3.88

Verdict: PASS

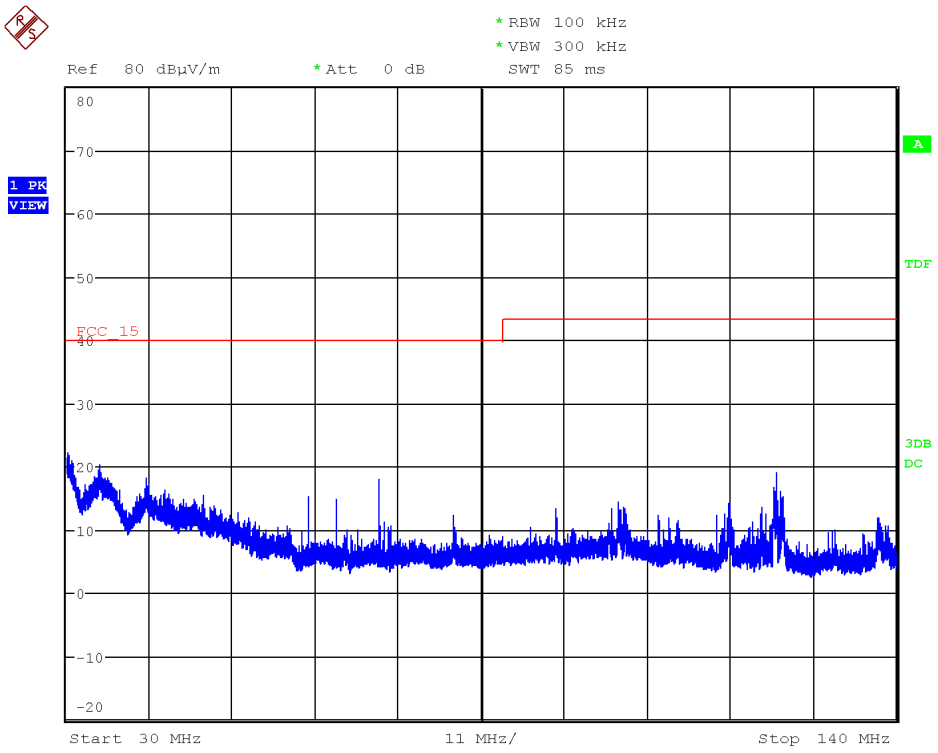
FREQUENCY RANGE 9 kHz-30 MHz.



Note: The limits shown in the above plot are extrapolated to 3 meters. The highest peak corresponds to the carrier level.

Resolution bandwidth:
200 Hz for 9 kHz ≤ f ≤ 150 kHz
9 kHz for 150 kHz ≤ f ≤ 30 MHz

FREQUENCY RANGE 30 MHz to 140 MHz.



Note: The above plot shows the results of the scan using peak detector.

Section 15.225 Subclause (e) / RSS-210 Clause B.6. Frequency tolerance of the carrier signal

SPECIFICATION

The frequency tolerance of the carrier signal shall be maintained within +/- 0.01% of the operating frequency over a temperature variation of –20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.

RESULTS

Nominal operating frequency: 13.56 MHz

Mode: unmodulated carrier

Frequency stability over temperature variations.

Temperature (ºC)	Frequency Error (Hz)	Frequency Error (%)
+50	174	0.001286
+40	190	0.001402
+30	205	0.001513
+20	276	0.002036
+10	266	0.001963
0	275	0.002025
-10	270	0.001992
-20	276	0.002036

Frequency stability over voltage variations.

DC Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (%)
Vmax	5.175	312	0.002298
Vmin	3.825	175	0.001287

Verdict: PASS