

Test report

323875-1TRFWL

Date of issue: March 23, 2017

Applicant:

Aromaestro Inc.

Product:

Aromaestro

Model:

Model 105

FCC ID:

2AKE3-ARO105

IC Reg. Number

21410-ARO105

Specifications:

FCC 47 CFR Part 15 Subpart C, §15.225

Operation within the band 13.110–14.010 MHz

RSS-210 Issue 9, August 2016

Annex B.6 Devices operating in 13.110–14.010 MHz frequency band for any application

Test location

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Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC: 722545; IC: 2040G-5 (3 m semi anechoic chamber)

Tested by	Avul Nzenza, EMC/Wireless Specialist and Yong Huang, Wireless/EMC Specialist
Reviewed by	Andrey Adelberg, Senior Wireless/EMC Specialist
Date	March 23, 2017
Signature	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Aromaestro Inc.
Address	40, Émilien-Marcoux street, Suite 100
City	Blainville
Province/State	Quebec
Postal/Zip code	J7C 0B5
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.225	Operation in the 13.110–14.010 MHz
RSS-210 Issue 9, August 2016, Annex B.6	Devices operating in 13.110–14.010 MHz frequency band for any application

1.3 Test methods

ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
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1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See “Summary of test results” for full details.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass ¹
§15.203	Antenna requirement	Pass ²
§15.215(c)	20 dB bandwidth	Pass

Notes: ¹ Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

² The Antennas are located within the enclosure of EUT and not user accessible.

2.2 FCC Part 15 Subpart C, intentional radiators test results

Part	Test description	Verdict
§15.225(a)	Field strength within 13.553–13.567 MHz band	Pass
§15.225(b)	Field strength within 13.410–13.553 MHz and 13.567–13.710 MHz bands	Pass
§15.225(c)	Field strength within 13.110–13.410 MHz and 13.710–14.010 MHz bands	Pass
§15.225(d)	Field strength outside 13.110–14.010 MHz band	Pass
§15.225(e)	Frequency tolerance of carrier signal	Pass

Notes: None

2.3 IC RSS-GEN, Issue 4, test results

Part	Test description	Verdict
6.6	Occupied bandwidth	Pass
6.11	Transmitter frequency stability	Pass ¹
7.1.2	Receiver radiated emission limits	Not applicable ²
7.1.3	Receiver conducted emission limits	Not applicable ²
8.8	Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus	Pass

Notes: ¹ Frequency stability covered in RSS-210.

² According to sections 5.2 and 5.3 of RSS-Gen, Issue 4 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

2.4 IC RSS-210, Issue 9, test results

Part	Test description	Verdict
A B.6 (a)	The field strength within the band 13.553–13.567 MHz.	Pass
A B.6 (b)	The field strength within the bands 13.410–13.553 MHz and 13.567–13.710 MHz	Pass
A B.6 (c)	The field strength within the bands 13.110–13.410 MHz and 13.710–14.010 MHz.	Pass
A B.6 (d)	The field strength outside the band 13.110–14.010 MHz.	Pass
A B.6	Carrier frequency stability	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	January 24, 2017
Nemko sample ID number	Item # 1

3.2 EUT information

Product name	Aromaestro
Model	Model 105
Serial number	a8404115c7bf

3.3 Technical information

Operating band	13.553–13.567 MHz
Operating frequency	13.56 MHz
Modulation type	WIFI:OFDM RFID: Readers to card 100 % ASK, Miller encoded, transfer speed 106 kBd to 848 kBd; Card to reader subcarrier load modulation, Manchester encoded or BPSK, transfer speed 106 kBd to 848 kBd
Occupied bandwidth (99 %)	59.1 kHz
Power requirements	100-120 Vac (adaptor) for 5 Vdc
Emission designator	59K0M1D
Antenna information	The EUT has an integrated, non-detachable antenna.

3.4 Product description and theory of operation

This RFID module is designed based on MFRC522. It is a highly integrated reader/writer for contactless communication at 13.56MHz. It supports ISO 14443A/MIFARE mode and MIFARE Classic (e.g. MIFARE Standard) products. Contactless communication using MIFARE higher transfer speeds up to 848kbit/s in both directions.

3.5 EUT exercise details

In the "AroRFID" software window, click on "Test RFID" to place the RFID reader in RFID tag read mode with continuous RFID 13.56 MHz carrier transmission and continuous RFID tag detection. The status bar at the bottom of the software window should display "Success". On the RFID reader, a red "MODE" LED should turn on

3.6 EUT setup diagram



Figure 3.6-1: Setup diagram

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages $\pm 5\%$, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of $K = 2$ with 95% certainty.

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002532	2 year	May 25/17
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
Power source	California Instruments	5001ix	FA002494	1 year	April 29/17
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	March 23/17
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	March 8/17
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	Oct. 5/17
Active loop antenna (9 kHz–30 MHz)	COM-POWER	AL-130	FA002722	1 year	March 31/17
Environmental Chamber	ESPEC	EPX-4H	FA002736	1 year	March 18/17

Note: NCR - no calibration required

Section 8. Testing data

8.1 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits

8.1.1 Definitions and limits

FCC:

Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

IC:

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in table below. The more stringent limit applies at the frequency range boundaries.

Table 8.1-1: Conducted emissions limit

Frequency of emission, MHz	Conducted limit, dB μ V	
	Quasi-peak	Average**
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

Note: * - The level decreases linearly with the logarithm of the frequency.

** - A linear average detector is required.

8.1.2 Test summary

Test date	January 26, 2017	Temperature	24.9 °C
Test engineer	Avul Nzenza	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	34 %

8.1.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

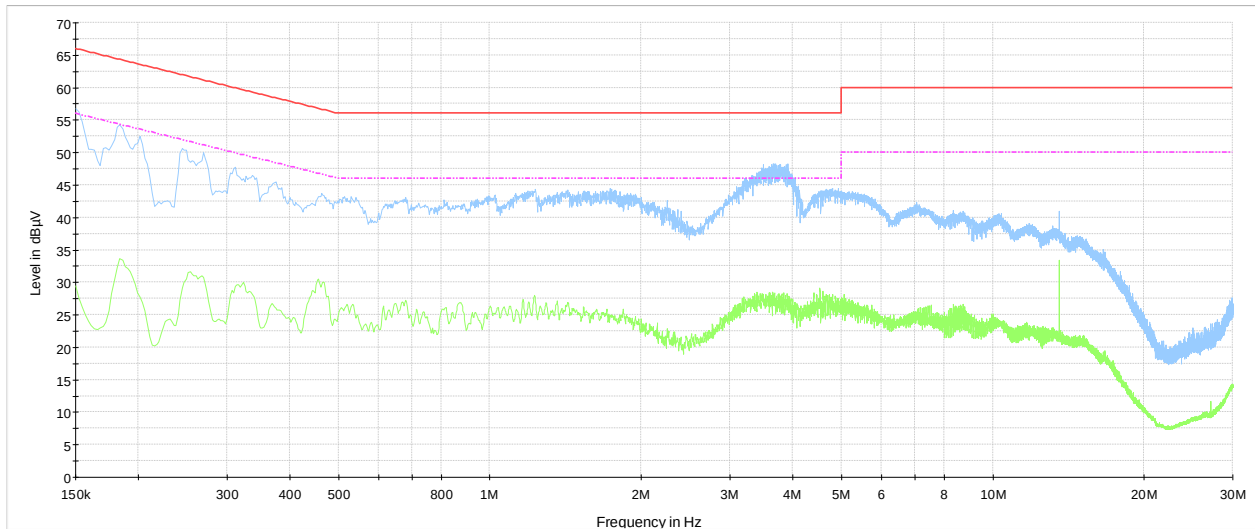
The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Test receiver settings:

Frequency span	150 kHz to 30 MHz
Detector mode	Peak and Average (preview mode); Quasi-Peak (final measurements)
Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Trace mode	Max Hold
Measurement time	1000 ms

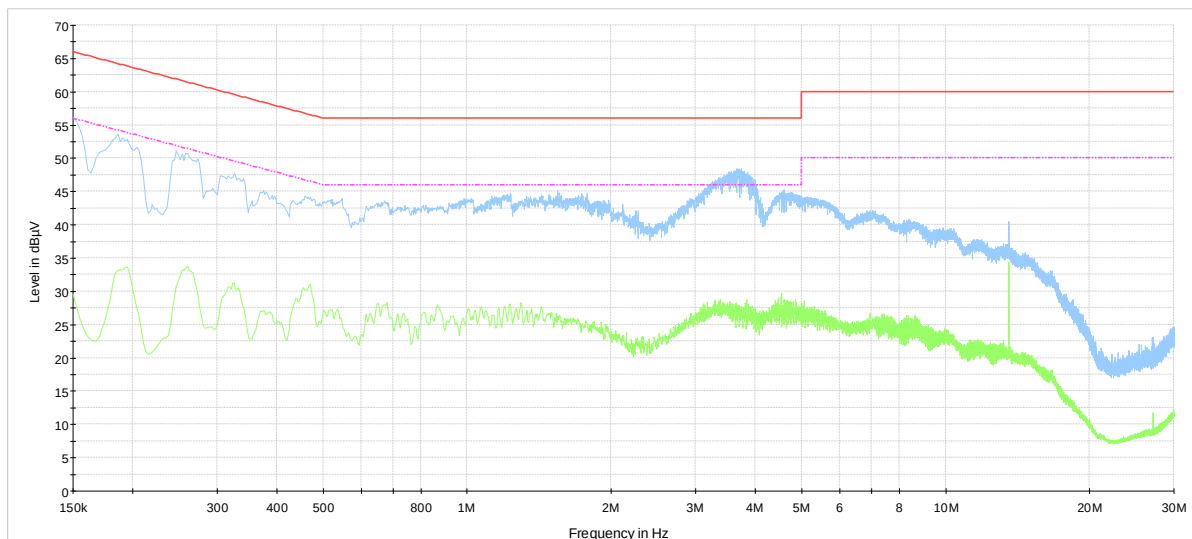
8.1.4 Test data



308692 _ Conducted Emissions_120 Vac_Phase_TX ON_January 26, 2017

Preview Result 2-AVG
Preview Result 1-PK+
Critical_Freqs AVG
Critical_Freqs PK+
CISPR 22 Limit - Class B, Mains (Quasi-Peak)
CISPR 22 Limit - Class B, Mains (Average)
Final_Result QPK
Final_Result CAV

Plot 8.1-1: Conducted emissions on phase line – 120 V_{AC} power input



308692 _ Conducted Emissions_120 Vac_Neutral_TX ON_January 26, 2017

Preview Result 2-AVG
Preview Result 1-PK+
MaxPeak-PK+
Average-AVG
CISPR 22 Limit - Class B, Mains (Quasi-Peak)
CISPR 22 Limit - Class B, Mains (Average)
Final_Result QPK
Final_Result CAV

Plot 8.1-2: Conducted emissions on neutral line – 120 V_{AC} power input

8.2 FCC 15.215(c) 20 dB bandwidth

8.2.1 Definitions and limits

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage.

8.2.2 Test summary

Test date	January 26, 2017	Temperature	24.9 °C
Test engineer	Avul Nzenza	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	34 %

8.2.3 Observations, settings and special notes

Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	≥1 % of span
Video bandwidth	RBW × 3
Trace mode	Max Hold

8.2.4 Test data

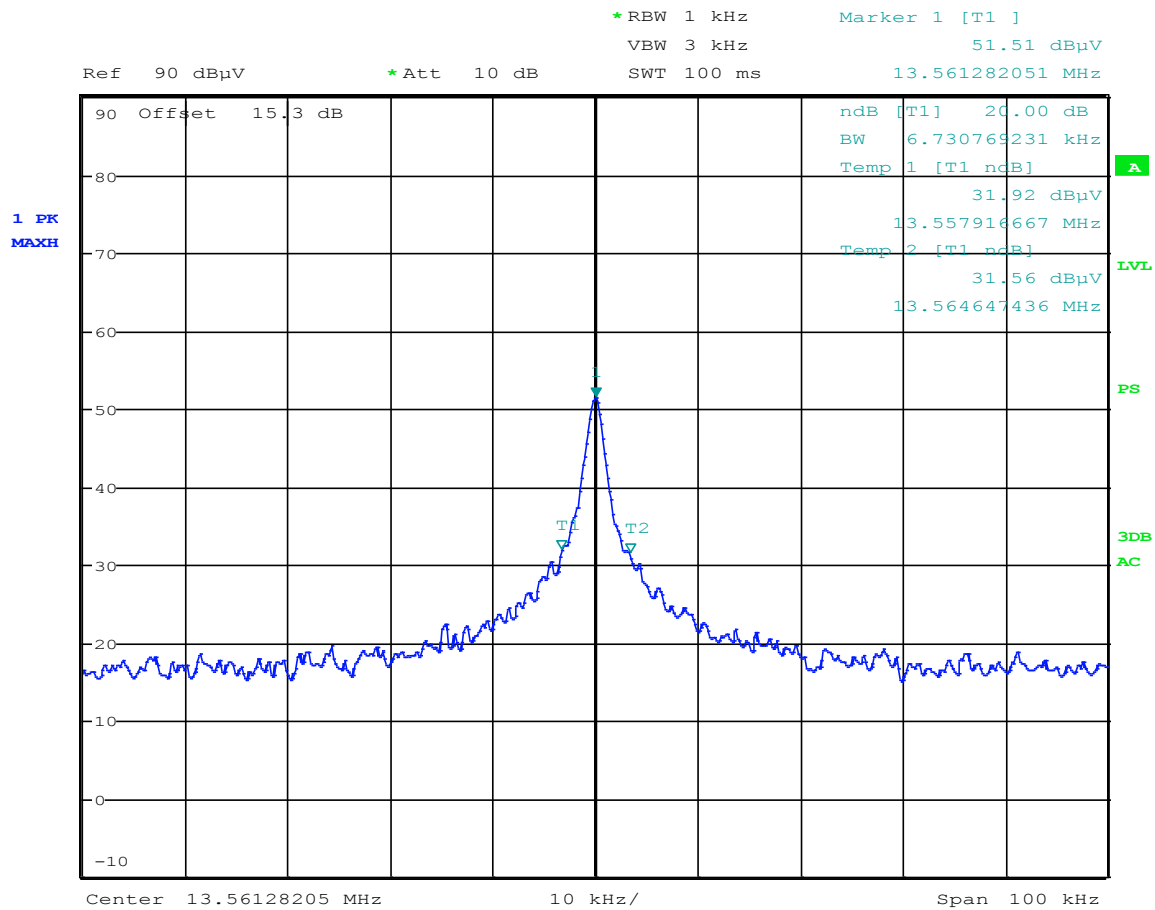
Table 8.2-1: Lower 20 dBc frequency cross result

Fundamental frequency, MHz	Lower 20 dBc frequency cross, MHz	Minimum limit, MHz	Margin, kHz
13.561	13.558	13.553	5

Table 8.2-2: Upper 20 dBc frequency cross result

Fundamental frequency, MHz	Upper 20 dBc frequency cross, MHz	Maximum limit, MHz	Margin, kHz
13.561	13.565	13.567	2

8.2.4 Test data, continued



Date: 26.JAN.2017 16:11:01

Figure 8.2-1: 20 dB bandwidth spectrum plot

8.3 RSS-Gen 6.6 Occupied bandwidth

8.3.1 Definitions and limits

The emission bandwidth (×dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated × dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3× the resolution bandwidth.

8.3.2 Test summary

Test date	January 26, 2017	Temperature	24.9 °C
Test engineer	Avul Nzenza	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	34 %

8.3.3 Observations, settings and special notes

Spectrum analyzer settings:

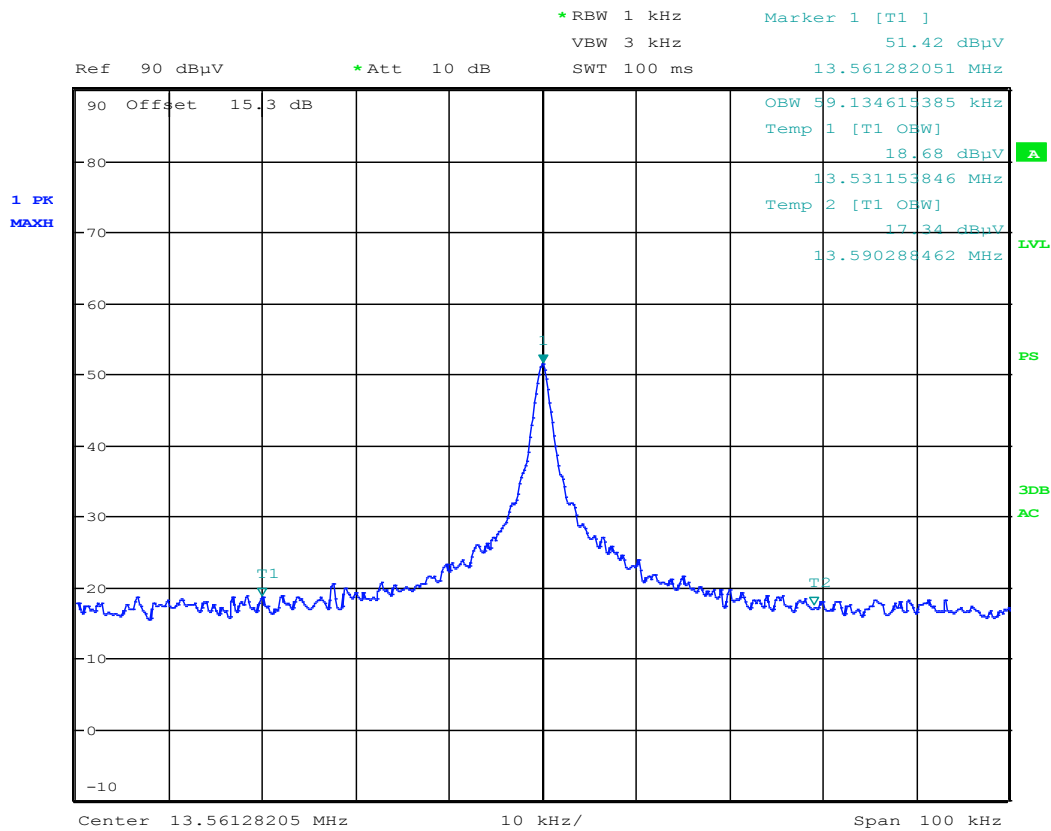
Detector mode	Peak
Resolution bandwidth	≥1 % of span
Video bandwidth	RBW × 3
Trace mode	Max Hold

8.3.4 Test data

Table 8.3-1: 99 % occupied bandwidth result

Fundamental frequency, MHz	99 % occupied bandwidth, kHz
13.561	59.1

8.3.5 Test data, continued



Date: 26.JAN.2017 16:13:37

Figure 8.3-1: 99 % occupied bandwidth

8.4 FCC 15.225(a–c) and RSS-210 A B.6 (a–c) Field strength within the 13.110–14.010 MHz band

8.4.1 Definitions and limits

- a) The field strength of any emissions within the band 13.553–13.567 MHz shall not exceed 15848 $\mu\text{V/m}$ (84 dB $\mu\text{V/m}$) at 30 m.
- b) Within the bands 13.410–13.553 MHz and 13.567–13.710 MHz, the field strength of any emissions shall not exceed 334 $\mu\text{V/m}$ (50.5 dB $\mu\text{V/m}$) at 30 m.
- c) Within the bands 13.110–13.410 MHz and 13.710–14.010 MHz the field strength of any emissions shall not exceed 106 $\mu\text{V/m}$ (40.5 dB $\mu\text{V/m}$) at 30 m.

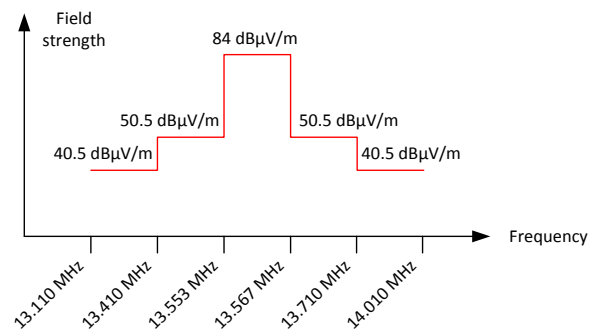


Figure 8.4-1: In-band spurious emissions limit @ 30 m

8.4.2 Test summary

Test date	January 26, 2017	Temperature	24.9 °C
Test engineer	Avul Nzenza	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	34 %

8.4.3 Observations/special notes

The measurements were performed at the distance of 3 m. 40 dB distance correction factor* was applied to the measurement result in order to comply with 30 m limits.

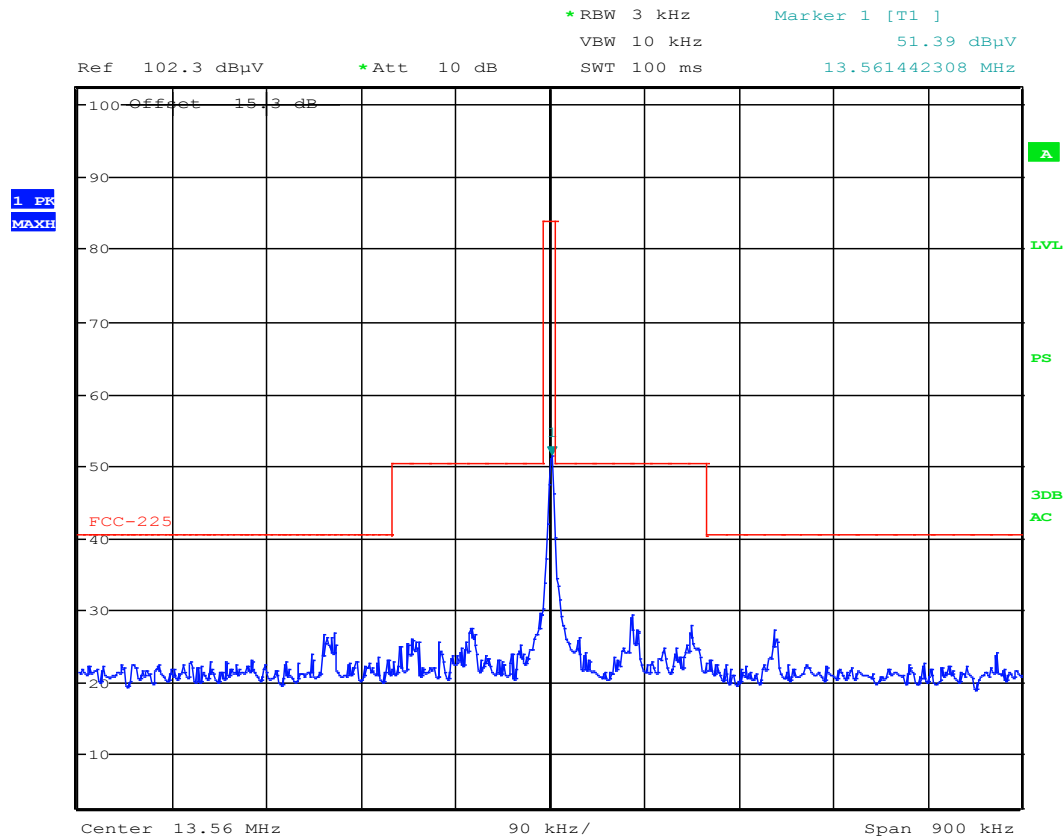
* 30 m to 3 m distance correction factor calculation (for 13 MHz band):

$$40 \times \log_{10} (3 \text{ m}/30 \text{ m}) = 40 \times \log_{10} (0.1) = -40 \text{ dB}$$

Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	3 kHz
Video bandwidth	10 kHz
Trace mode	Max Hold

8.4.4 Test data



Date: 26.JAN.2017 16:07:13

Figure 8.4-2: Emission mask @ 3 m

Note: 30 m limit line is depicted on the plot above at 3 m measurement distance for comparison reasons. 30 m limit line would be 40 dB higher than 3 m one.

Table 8.4-1: Field strength measurement results within 13.11–14.01 MHz band at 3 m distance

Frequency, MHz	Field strength, dBμV/m	Limit _{3 m} , dBμV/m	Margin, dB
13.561	51.39	124.0	72.61

Table 8.4-2: Field strength measurement results within 13.11–14.01 MHz band at 30 m distance

Frequency, MHz	Field strength, dBμV/m	Limit _{30 m} , dBμV/m	Margin, dB
13.561	11.39	84.0	72.61

8.5 FCC 15.225(d) and RSS-210 A B.6(d) Field strength of emissions outside 13.110–14.010 MHz band

8.5.1 Definitions and limits

FCC: The field strength of any emissions appearing outside of the 13.110–14.010 MHz band shall not exceed the general radiated emission limits in §15.209

The field strength of emissions appearing within restricted bands (as specified in §15.205) shall not exceed the limits from §15.209.

IC: The field strength of any emission outside the band 13.110–14.010 MHz shall not exceed the 30 µV/m (29.5 dBµV/m) limit.

Table 8.5-1: FCC §15.209 and RSS-Gen – Radiated emission limits

Frequency, MHz	Field strength of emissions		Measurement distance, m
	µV/m	dBµV/m	
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges. For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

Table 8.5-2: Restricted frequency bands

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

8.5.2 Test summary

Test date	January 26, 2017	Temperature	24.9 °C
Test engineer	Avul Nzenza	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	34 %

8.5.3 Observations, settings and special notes

The spectrum was searched from 9 kHz to 1 GHz.

Radiated measurements were performed at a distance of 3 m.

Limit line for frequencies below 490 kHz was re-calculated to 3 m measurements distance: $40 \times \log_{10}(300 \text{ m}/3 \text{ m}) = 40 \times \log_{10}(100) = +80 \text{ dB}$

Limit line for frequencies within 490 kHz to 30 MHz was re-calculated to 3 m measurements distance: $40 \times \log_{10}(30 \text{ m}/3 \text{ m}) = 40 \times \log_{10}(10) = +40 \text{ dB}$

Spectrum analyzer settings:

Frequency ranges	9 kHz to 490 kHz	490 kHz to 30 MHz	30 MHz to 1000 MHz
Detector mode	Quasi-Peak	Quasi-Peak	Peak
Resolution bandwidth	200 Hz	9 kHz	100 kHz
Video bandwidth	300 Hz	30 kHz	300 kHz
Trace mode	Max Hold	Max Hold	Max Hold
Measurement time	100 ms	100 ms	100 ms

8.5.4 Test data

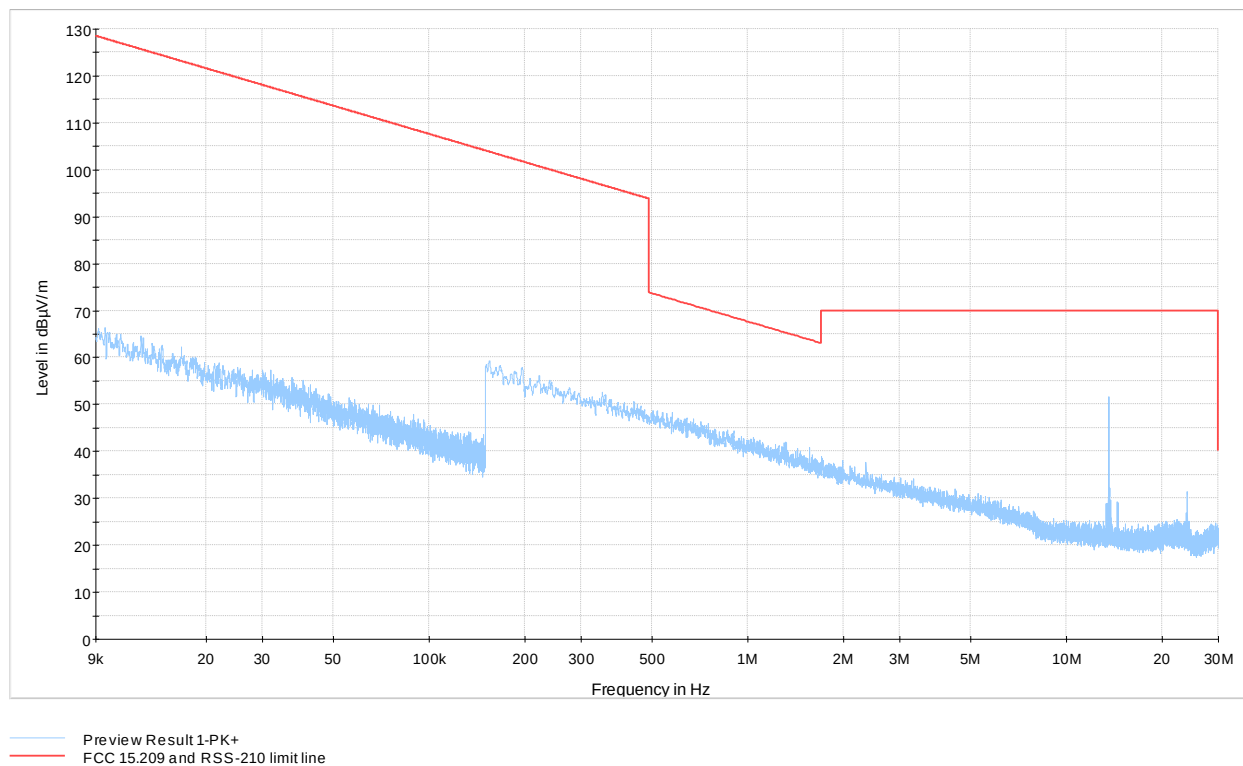
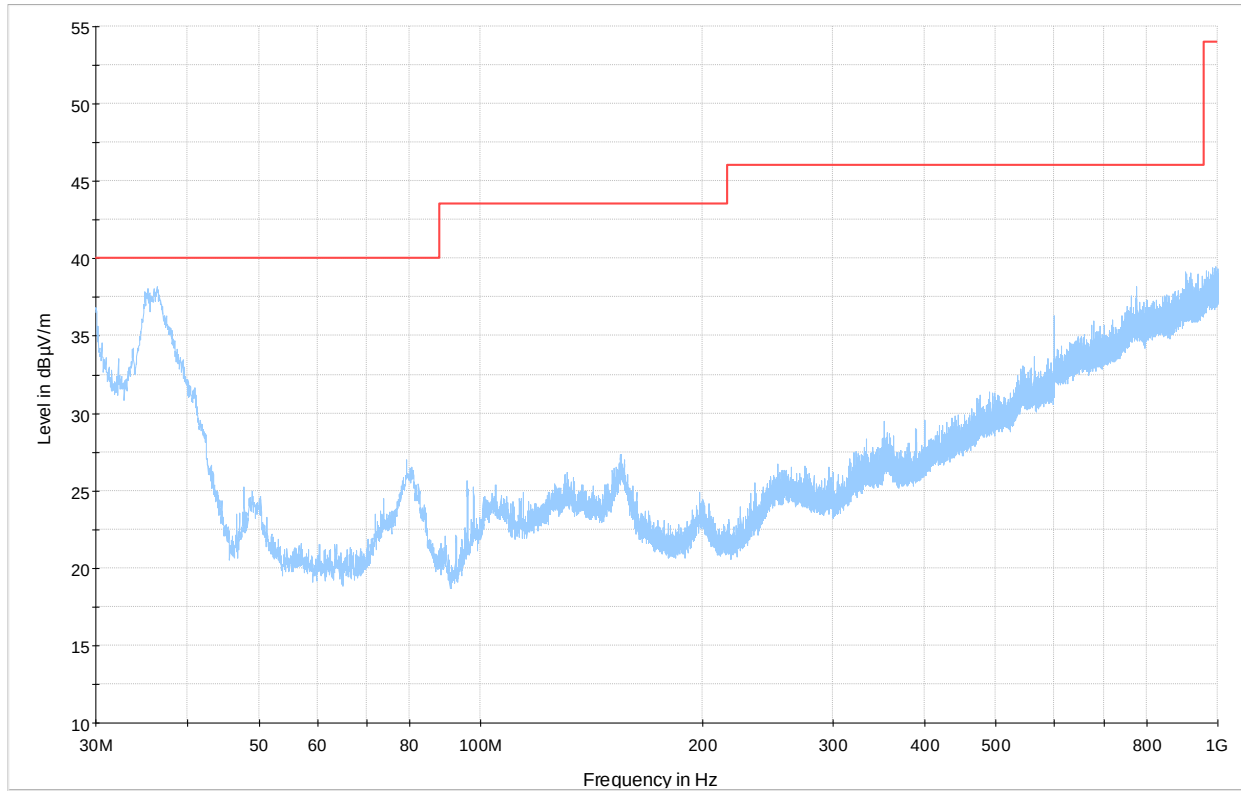


Figure 8.5-1: Field strength of spurious emissions below 30 MHz

8.5.4 Test data, continued



323875 _ Radiated Emissions_1 GHz_ January 26, 2017

Preview Result 1-PK+

FCC Part 15 and ICES-003 Limit - Class B (Quasi-Peak and Average), 3 m

Figure 8.5-2: Field strength of spurious emissions above 30 MHz

Note: all measurement results indicated in the plot were taken with a peak detector, which is more stringent measurement, and still comply with quasi-peak limit.

8.6 FCC 15.225(e) and RSS-210 A B.6 Frequency tolerance of the carrier signal

8.6.1 Definitions and limits

The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ (± 100 ppm) of the operating frequency over a temperature variation of $-20\text{ }^{\circ}\text{C}$ to $+50\text{ }^{\circ}\text{C}$ 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 $20\text{ }^{\circ}\text{C}$. For battery operated equipment, the equipment tests shall be performed using a new battery.

8.6.2 Test summary

Test date	January 31, 2017 and February 3, 2017	Temperature	23 $^{\circ}\text{C}$
Test engineer	Yong Huang	Air pressure	1010 mbar
Verdict	Pass	Relative humidity	35 %

8.6.3 Observations, settings and special notes

Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	1 Hz
Video bandwidth	1 Hz
Trace mode	Max Hold

8.6.4 Test data

Table 8.6-1: Frequency drift measurements results

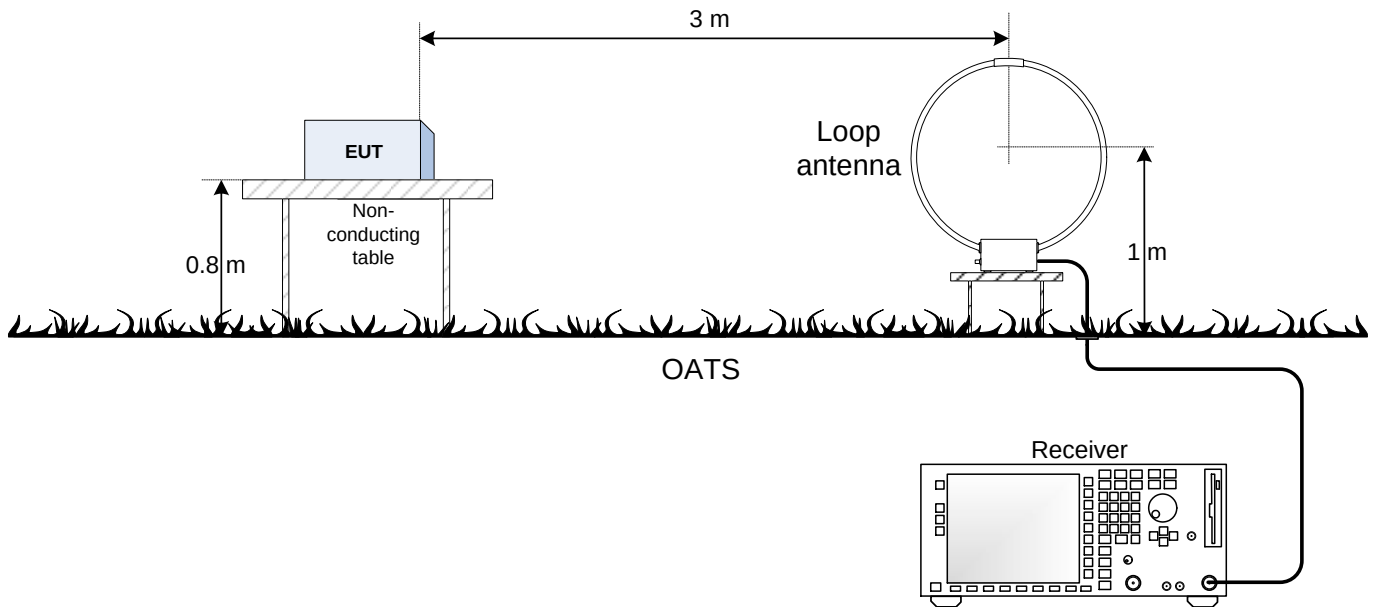
Test conditions	Frequency, MHz	Frequency drift, $\pm$ ppm	Limit, $\pm$ ppm	Margin, ppm
+50 $^{\circ}\text{C}$, Nominal	13.5611335	5.456741223	100	94.5432588
+20 $^{\circ}\text{C}$, +15 %	13.5612065	0.073739746	100	99.9262603
+20 $^{\circ}\text{C}$, Nominal	13.5612075	Reference	Reference	Reference
+20 $^{\circ}\text{C}$, -15 %	13.5611955	0.884876955	100	99.115123
-20 $^{\circ}\text{C}$, Nominal	13.5613255	8.701290058	100	91.2987099

Note: frequency drift was calculated as follows:

$$\text{Frequency drift (ppm)} = ((F_{\text{measured}} - F_{\text{reference}}) \div F_{\text{reference}}) \times 1 \times 10^6$$

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 30 MHz



9.2 Radiated emissions set-up

