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Test report

336342-1TRFWL

Date of issue: August 30, 2018

Applicant:

K4 Integration Inc.

Product:

TopVu® eTag® Board

Model:

eTag11

Antenna Model variants:

ET-1244 (Small antenna); ET-3025(Large antenna)

FCC ID:

2APX4ETAGBOARD

IC Registration number:

22620-ETAG11

Specifications:

FCC 47 CFR Part 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

www.nemko.com

Nemko Canada Inc., a testing laboratory, is accredited by the Standards Council of Canada. The tests included in this report are within the scope of this accreditation

FCC 15.225 and RSS-210 B.6.docx; Date: September 2016



Test location

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Province	Ontario
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Country	Canada
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Website	www.nemko.com
Site number	FCC test site registration number: CA2040, IC: 2040A-4 (3 m semi anechoic chamber)

Tested by	Kevin Rose, Wireless/EMC Specialist
Reviewed by	Andrey Adelberg, Senior Wireless/EMC Specialist
Date	August 30, 2018
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 contained 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	K4 Integration Inc.
Address	11 Mary Street Unit A
City	Sudbury
Province/State	Ontario
Postal/Zip code	P3C 1B4
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.225 RSS-210 Issue 9, August 2016, Annex B.6	Operation in the 13.110–14.010 MHz Devices operating in 13.110–14.010 MHz frequency band for any application
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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	Not applicable ³

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 professional installed.

³ N/A for C2PC

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	Not applicable ¹

Notes: ¹ N/A for C2PC

2.3 IC RSS-GEN, Issue 5, test results

Part	Test description	Verdict
7.3	Receiver radiated emission limits	Not applicable
7.4	Receiver conducted emission limits	Not applicable
6.9	Operating bands and selection of test frequencies	Pass
8.8	AC power-line conducted emissions limits	Pass

Notes: ¹ According to sections 5.2 and 5.3 of RSS-Gen, Issue 5 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

EUT is an AC powered device.

2.4 IC RSS-210, Issue 9, test results

Annex	Test description	Verdict
B.6 (a)	The field strength within the band 13.553–13.567 MHz	Pass
B.6 (b)	The field strength within the bands 13.410–13.553 MHz and 13.567–13.710 MHz	Pass
B.6 (c)	The field strength within the bands 13.110–13.410 MHz and 13.710–14.010 MHz	Pass
B.6 (d)	The field strength outside the band 13.110–14.010 MHz	Pass
B.6	Carrier frequency stability	Not applicable ¹

Notes: ¹ N/A for C2PC

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	April 3, 2018
Nemko sample ID number	Item # 1

3.2 EUT information

Product name	TopVu® eTag® board
Model	eTag11
Antenna variant	ET-1244 (Small antenna); ET-3025 (Large antenna)
Serial number	3000

3.3 Technical information

Operating band	13.553–13.567 MHz
Operating frequency	13.56 MHz
Modulation type	OOK
Occupied bandwidth (99 %)	32.4 kHz
Power requirements	120 Vac 60 Hz
Emission designator	32K4A1D
Antenna information	EUT is designed so that the end user may replace a broken antenna. (The antennas are professionally installed.)

3.4 Product description and theory of operation

The eTag® Board system will discover tagged assets placed on these boards – providing location data for tags in strategically identified zones. They provide a mechanism for centrally viewing the location of personnel in real time. Using a passive tag reader interface, the eTag® Boards will locate the tag on the boards and identify which zone or region the tag was placed.

The eTag® Boards consists of two general sizes and can be combined to create a matrix of multiple boards.

TopVu®'s eTag® Board is designed to be used in conjunction with the TopVu® control unit, later described in this manual. This system allows to track production, maintenance and safety personnel as well as contractors without having to change existing behavior. When connected to TopVu® software, the eTag® Board system can provide real time and historical data of the personnel tagged onto the eTag® Board as individual profiles.

A typical diagram of several eTag® Boards' connections to the eTag® Controller is shown below.

3.5 EUT exercise details

The EUT was controlled by software to continuously read tags.

3.6 EUT setup diagram

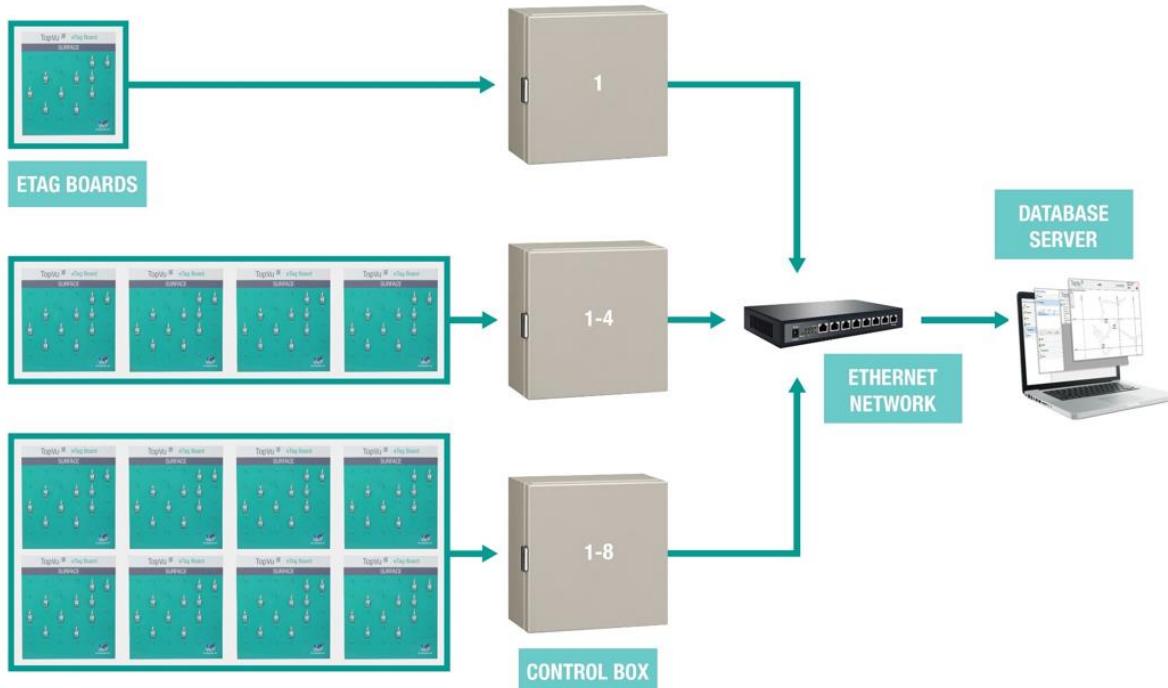


Figure 3.6-1: Setup diagram

3.7 EUT sub assemblies

Table 3.7-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number
Dell Laptop	Dell	-	-

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

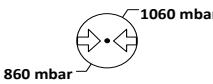
None

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	June 5/19
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
3 Phase AC Power Source	apc AC Power	45 kVA	FA002677	—	VOU
Power Meter	HIOKI	PW3337	FA002727	1 year	July 25/18
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	Sept. 18/18
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	Dec. 6/18
Active loop antenna (9 kHz–30 MHz)	COM-POWER	AL-130	FA002722	1 year	May 8/18
LISN	Rohde & Schwarz	ENV216	FA002515	1 year	April. 30/19
Environmental Chamber	ESPEC	EPX-4H	FA002736	1 year	May 16/18

Note: NCR - no calibration required, VOU - verify on use

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	Quasi-peak	Conducted limit, dB μ V	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

Verdict	Pass		
Test date	April 3, 2018	Temperature	24 °C
Test engineer	Kevin Rose	Air pressure	1006 mbar
Test location	Ottawa	Relative humidity	41 %

8.1.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

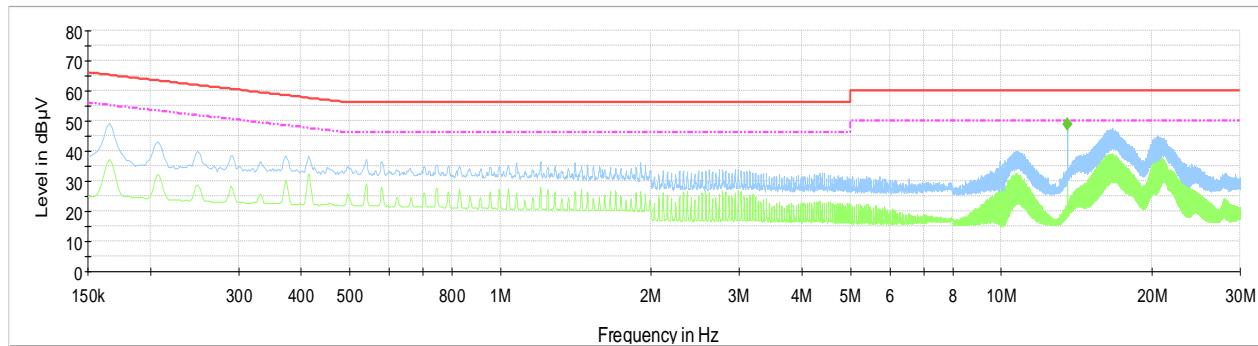
The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

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

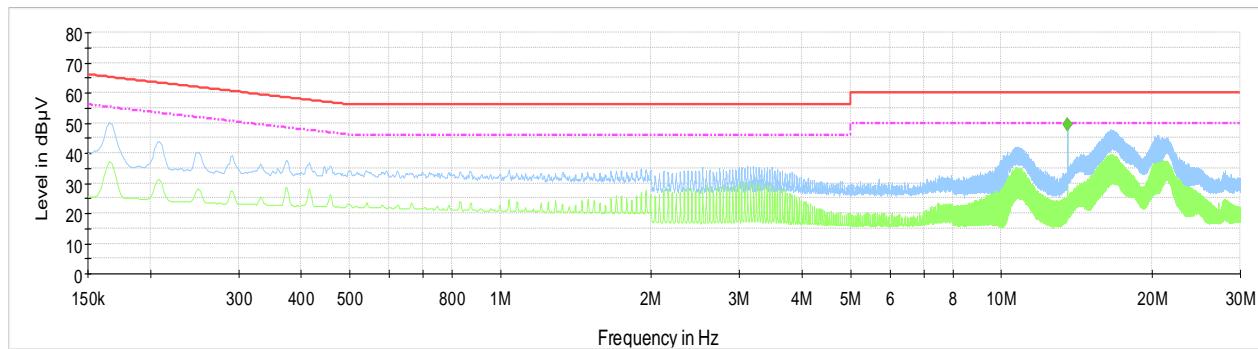
8.1.4 Test data



NEX-327183 Phase 120 Vac 60 Hz A 50 Ohm Load was place at the output of the 13.56 MHz antenna

— Preview Result 2-AVG
— Preview Result 1-PK+
— CISPR 32 Mains Q-Peak Class B Limit
- - - CISPR 32 Mains Average Class B Limit
◆ Final_Result QPK
◆ Final_Result CAV

Plot 8.1-1: Conducted emissions on phase line



NEX-327183 Neutral 120 Vac 60 Hz A 50 Ohm Load was place at the output of the 13.56 MHz antenna

— Preview Result 2-AVG
— Preview Result 1-PK+
— CISPR 32 Mains Q-Peak Class B Limit
- - - CISPR 32 Mains Average Class B Limit
◆ Final_Result QPK
◆ Final_Result CAV

Plot 8.1-2: Conducted emissions on neutral line

Table 8.1-2: Conducted emissions – from AC mains power ports (CAverage) results

Frequency (MHz)	CAverage result ¹ and ³ (dBμV)	CAverage limit (dBμV)	Margin (dB)	Measurement time (ms)	Bandwidth (kHz)	Conductor	Filter	Correction factor ² (dB)
13.560	48.7	50.0	1.27	100	9	L1	ON	10.2
13.560	49.4	50.0	0.63	100	9	N	ON	10.2

Notes:

¹ Result (dBμV) = receiver/spectrum analyzer value (dBμV) + correction factor (dB)

² Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)

³ Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

Sample calculation: 20 dBμV (result) = 10 dBμV (receiver reading) + 10 dB (Correction factor)

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

8.2.1 Definitions and limits

- a) The field strength of any emissions within the band 13.553–13.567 MHz shall not exceed 15848 μ V/m (84 dB μ 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 μ V/m (50.5 dB μ 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 μ V/m (40.5 dB μ V/m) at 30 m.

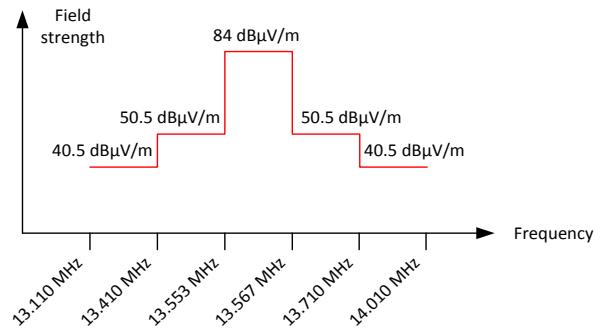


Figure 8.2-1: In-band spurious emissions limit

8.2.2 Test summary

Test date	April 3, 2018	Temperature	24 °C
Test engineer	Kevin Rose	Air pressure	1006 mbar
Verdict	Ottawa	Relative humidity	41 %

8.2.3 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):

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

Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	10 kHz
Video bandwidth	30 kHz
Trace mode	Max Hold

8.2.4 Test data

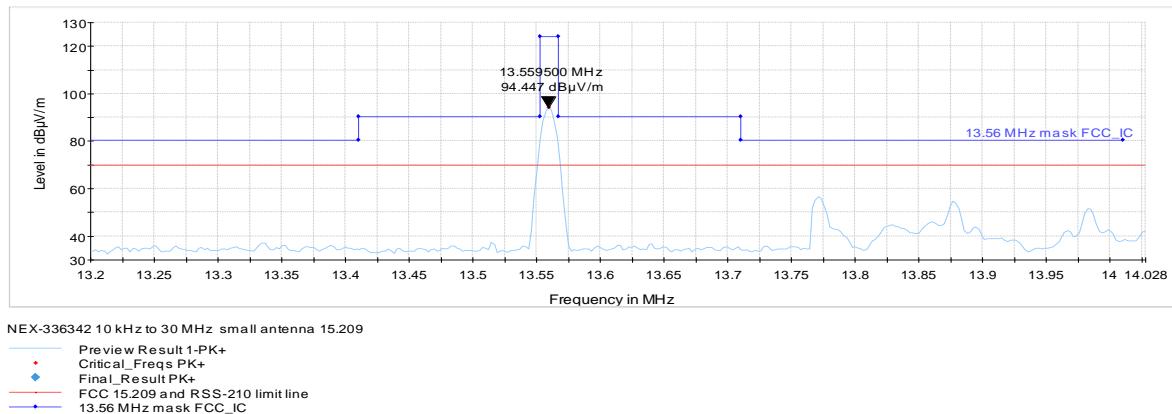


Figure 8.2-2: Field strength within 13.11–14.01 MHz band

Table 8.2-1: Field strength measurement results within 13.11–14.01 MHz band at 3 m distance small antenna

Frequency, MHz	Field strength, dBμV/m	Limit _{3 m} , dBμV/m	Margin, dB
13.561	94.45	124.0	29.55

Table 8.2-2: Field strength measurement results within 13.11–14.01 MHz band at 30 m distance small antenna

Frequency, MHz	Field strength, dBμV/m	Limit _{30 m} , dBμV/m	Margin, dB
13.561	54.45	84.0	29.55

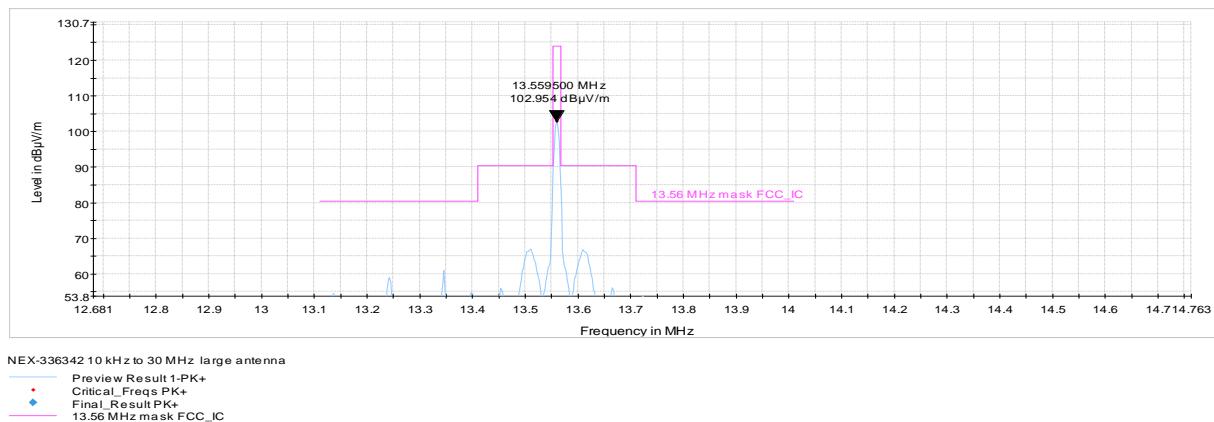


Figure 8.2-3: Field strength within 13.11–14.01 MHz band

Table 8.2-3: Field strength measurement results within 13.11–14.01 MHz band at 3 m distance large antenna

Frequency, MHz	Field strength, dBμV/m	Limit _{3 m} , dBμV/m	Margin, dB
13.561	102.95	124.0	21.08

Table 8.2-4: Field strength measurement results within 13.11–14.01 MHz band at 30 m distance Large antenna

Frequency, MHz	Field strength, dBμV/m	Limit _{30 m} , dBμV/m	Margin, dB
13.561	62.95	84.0	21.08

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

8.3.1 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.

ISED:

RSS-Gen general field strength limits for frequencies outside the band 13.110–14.010 MHz.

Table 8.3-1: 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 × log ₁₀ (F)	300
0.490–1.705	24000/F	87.6 – 20 × 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 8.3-2: ISED restricted frequency bands

MHz	MHz	MHz	GHz
0.090–0.110	12.57675–12.57725	399.9–410	7.25–7.75
0.495–0.505	13.36–13.41	608–614	8.025–8.5
2.1735–2.1905	16.42–16.423	960–1427	9.0–9.2
3.020–3.026	16.69475–16.69525	1435–1626.5	9.3–9.5
4.125–4.128	16.80425–16.80475	1645.5–1646.5	10.6–12.7
4.17725–4.17775	25.5–25.67	1660–1710	13.25–13.4
4.20725–4.20775	37.5–38.25	1718.8–1722.2	14.47–14.5
5.677–5.683	73–74.6	2200–2300	15.35–16.2
6.215–6.218	74.8–75.2	2310–2390	17.7–21.4
6.26775–6.26825	108–138	2483.5–2500	22.01–23.12
6.31175–6.31225	149.9–150.05	2655–2900	23.6–24.0
8.291–8.294	156.52475–156.52525	3260–3267	31.2–31.8
8.362–8.366	156.7–156.9	3332–3339	36.43–36.5
8.37625–8.38675	162.0125–167.17	3345.8–3358	
8.41425–8.41475	167.72–173.2	3500–4400	
12.29–12.293	240–285	4500–5150	Above 38.6
12.51975–12.52025	322–335.4	5350–5460	

Note: Certain frequency bands listed in the table above and above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

Table 8.3-3: FCC 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			

8.3.2 Test summary

Test date	April 3, 2018	Temperature	24 °C
Test engineer	Kevin Rose	Air pressure	1006 mbar
Verdict	Ottawa	Relative humidity	41 %

8.3.3 Observations, settings and special notes

The spectrum was searched from 10 kHz to 1 GHz.

Radiated measurements were performed at a distance of 3 m.

Spectrum analyzer settings for frequencies below 150 kHz:

Detector mode	Quasi-Peak
Resolution bandwidth	300 Hz
Video bandwidth	9 kHz
Trace mode	Max Hold
Measurement time	100 ms

Spectrum analyzer settings for frequencies below 30 MHz:

Detector mode	Quasi-Peak
Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Trace mode	Max Hold
Measurement time	100 ms

Spectrum analyzer settings for frequencies above 30 MHz:

Detector mode	Peak
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Trace mode	Max Hold
Measurement time	100 ms

8.3.4 Test data

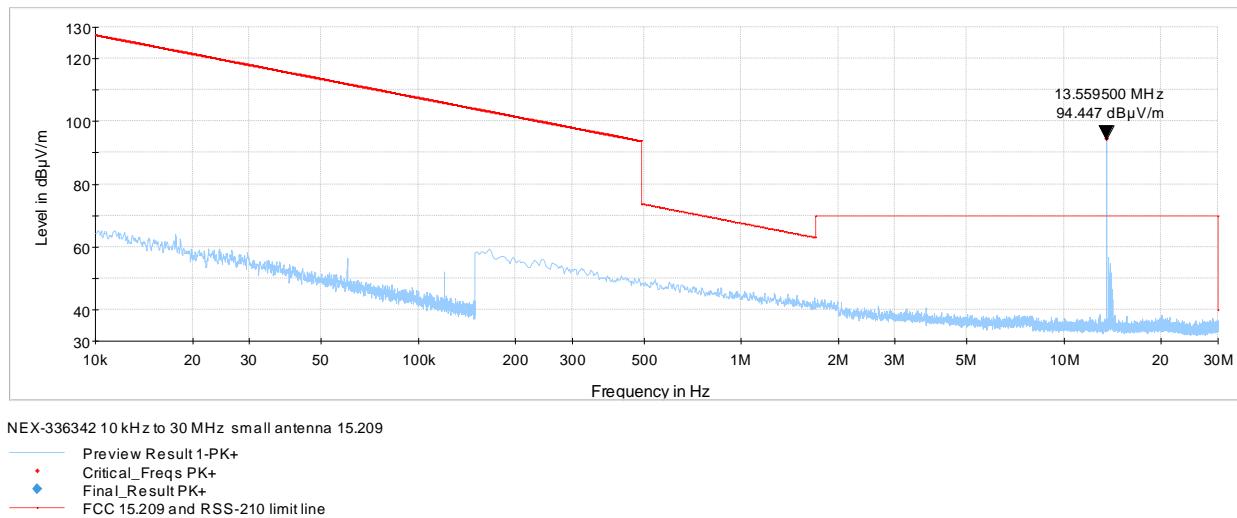


Figure 8.3-1: Field strength of spurious emissions below 30 MHz small antenna

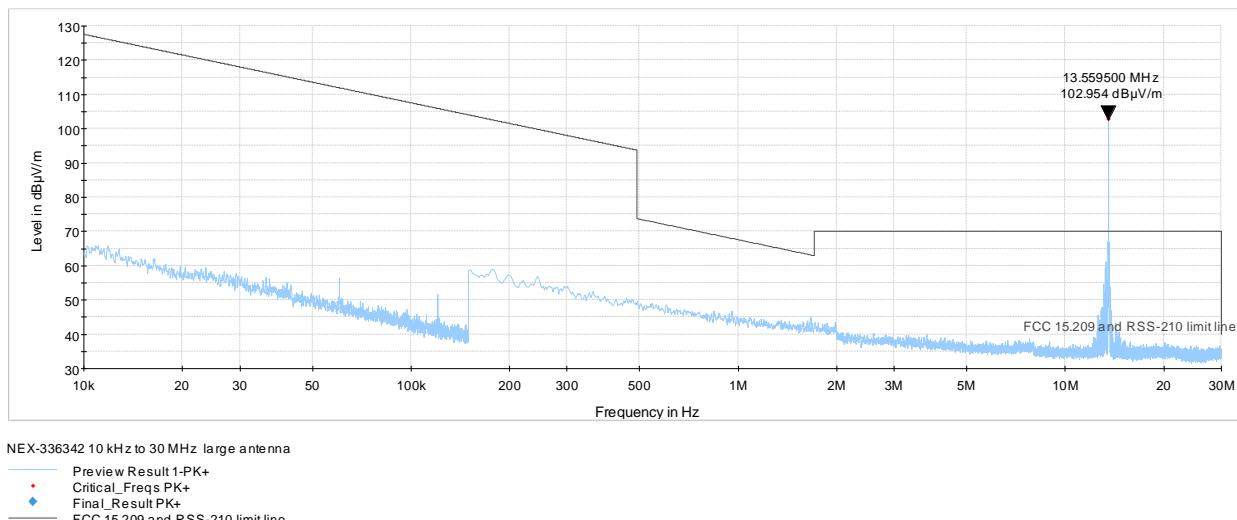


Figure 8.3-2: Field strength of spurious emissions below 30 MHz large antenna

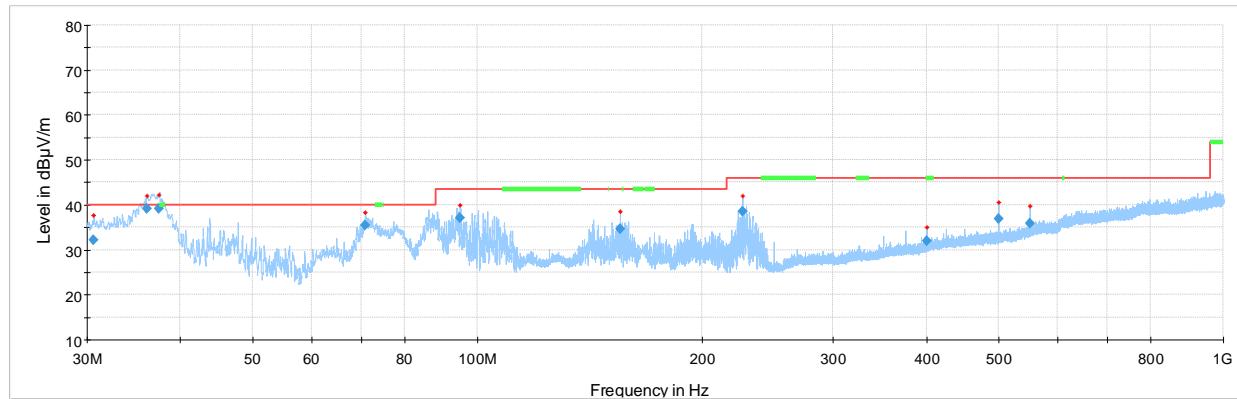


Figure 8.3-3: Field strength of spurious emissions above 30 MHz large antenna

Note: No Transmitter related emission within 10 dB of the 15.209 limit

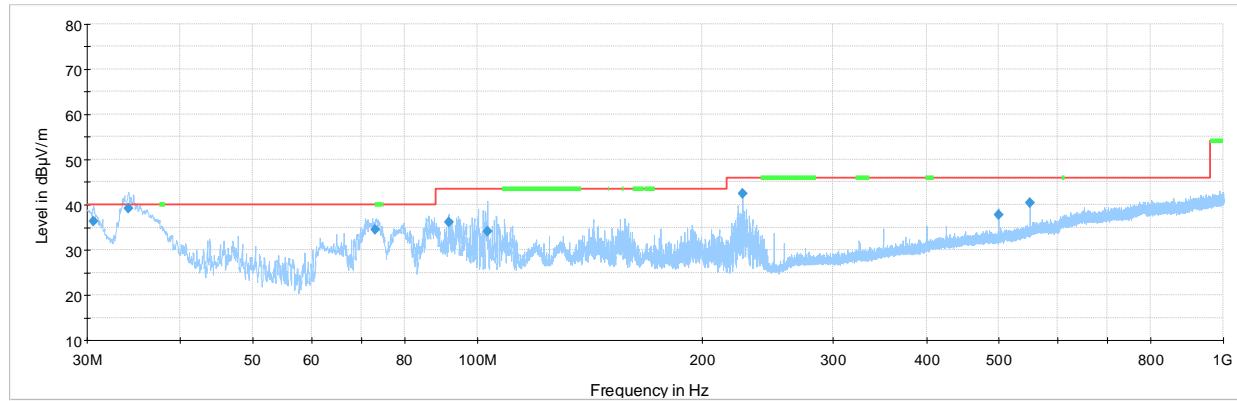
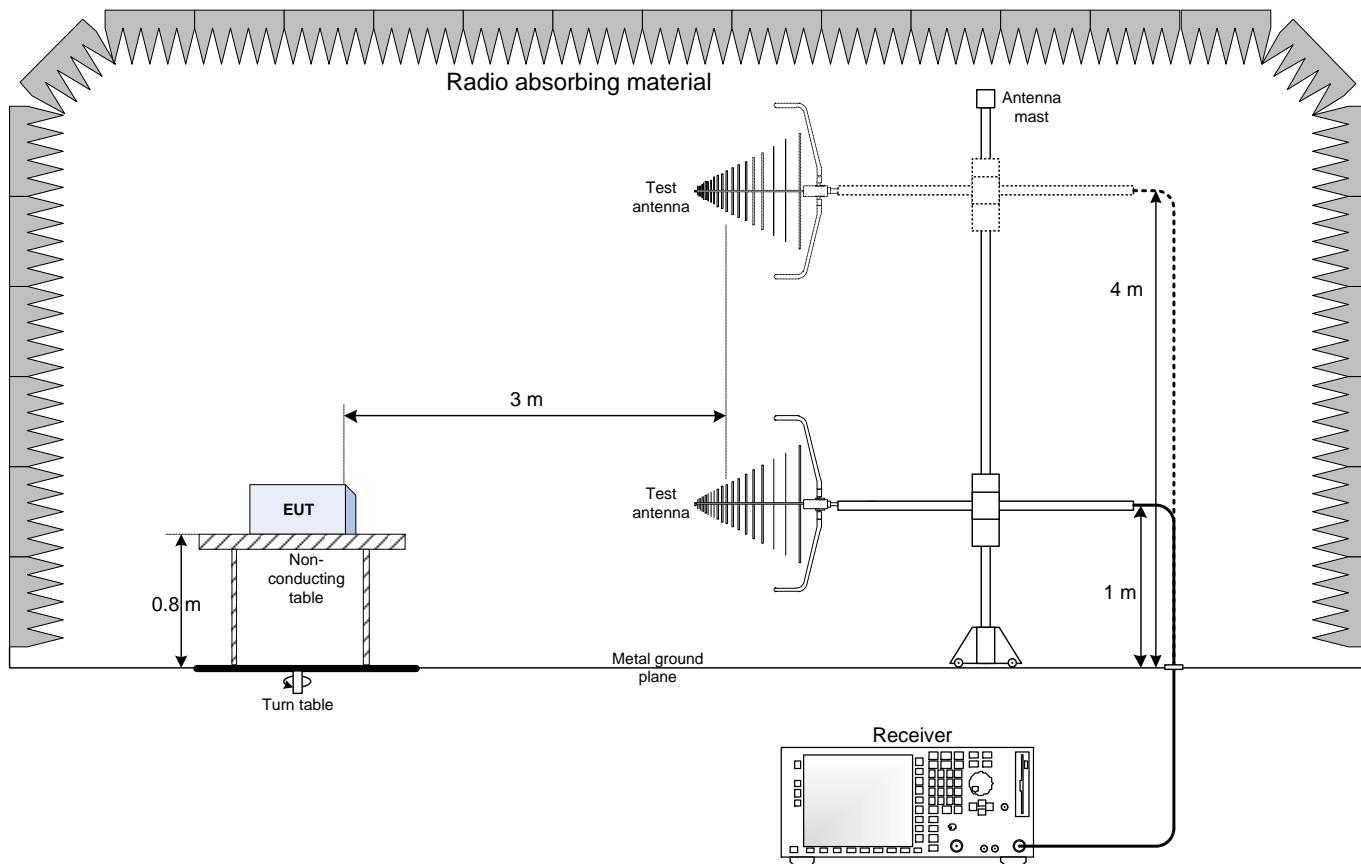


Figure 8.3-4: Field strength of spurious emissions above 30 MHz small antenna

Note: No Transmitter related emission within 10 dB of the 15.209 limit

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up



9.2 Conducted emissions set-up

