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RADIO TEST REPORT – 395590-1TRFWL

Type of assessment:

Final product testing

Applicant:

Kongsberg inc.

Product name (type):

Borne RFID Gen2(RF/Dess post)

Model:

1001105692

Model variant(s):

1001105693

FCC ID:

2ACER1001002222

IC Registration number:

12006A-1001002222

Specifications:

- FCC 47 CFR Part 15.225
- RSS-210 Issue 10,December 2019, Annex B.6

Date of issue: June 11, 2020

Yong Huang, EMC/RF Specialist
Tested by

Signature

David Duchesne, EMC/RF Lab Manager
Reviewed by

Signature

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

Lab locations

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Test site registration	**Organization**	**Recognition numbers and location**		
	FCC/ISED	FCC: CA2040; IC: 2040A-4 (Ottawa/Almonte); FCC: CA2041; IC: 2040G-5 (Montreal); CA0101 (Cambridge)		
Website	www.nemko.com			

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	Kongsberg inc.
Address	90, 28e Rue, C.P. 10034 | Shawinigan | Québec | G9T 5K7 | CA

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 10,December 2019, Annex B.6	Devices operating in 13.110–14.010 MHz frequency band for any application
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.3 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.

1.4 Exclusions

None

1.5 Test report revision history

Table 1.5-1: *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, test results

Table 2.1-1: *FCC Result summary*

Part	Test description	Verdict
§15.207(a)	Conducted limits	Not applicable[1]
§15.31(e)	Variation of power source	Pass[2]
§15.203	Antenna requirement	Pass[3]
§15.215(c)	20 dB bandwidth	Pass
§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: [1] EUT is a battery operated device, the testing was performed using fully charged batterie provided by client.

[2] 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

[3] The antennas are located within the enclosure of EUT and not user accessible.

2.2 ISED, test results

Table 2.2-1: *ISED result summary*

Part	Test description	Verdict
RSS-GEN, 7.3	Receiver radiated emission limits	Not applicable
RSS-GEN, 7.4	Receiver conducted emission limits	Not applicable
RSS-GEN, 6.9	Operating bands and selection of test frequencies	Pass
RSS-GEN, 8.8	AC power-line conducted emissions limits	Not applicable
RSS-210, B.6 (a)(i)	The field strength within the band 13.553–13.567 MHz	Pass
RSS-210, B.6 (a)(ii)	The field strength within the bands 13.410–13.553 MHz and 13.567–13.710 MHz	Pass
RSS-210, B.6 (a)(iii)	The field strength within the bands 13.110–13.410 MHz and 13.710–14.010 MHz	Pass
RSS-210, B.6 (a)(iv)	The field strength outside the band 13.110–14.010 MHz	Pass
RSS-210, B.6 (b)	Carrier frequency stability	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 a battery-operated device, the testing was performed using fully charged batterie provided by client.

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	March 24, 2020
Nemko sample ID number	Item #1

3.2 EUT information

Product name	Borne RFID Gen2
Model	1001105692
Model variants	1001105693
Part number	1001105692
Serial number	855A03620009

3.3 Technical information

Operating band	13.553–13.567 MHz
Operating frequency	13.56 MHz
Modulation type	AM
Occupied bandwidth (99 %)	2.2 kHz
Power requirements	Battery 12 V_{DC}
Emission designator	K1D
Antenna information	The EUT uses a non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

The post detects the presence of the key and allows the vehicle to operate. Without the key, the vehicle can not start and if the key is removed during the vehicle is in operation the engine is shut off.

3.5 EUT exercise details

EUT was configured per client's instruction and set up with client's test firmware, continuous transmit mode was configured during transmitter tests.

Software details

Diagnostic engineering tool (Cadet software) 3.0.5.2

Description of how the exercise the transmitter

In Cadet Software, in Test tab section , set Unit in debug mode, turn On the transmitter in section transmitter,

3.6 EUT setup diagram

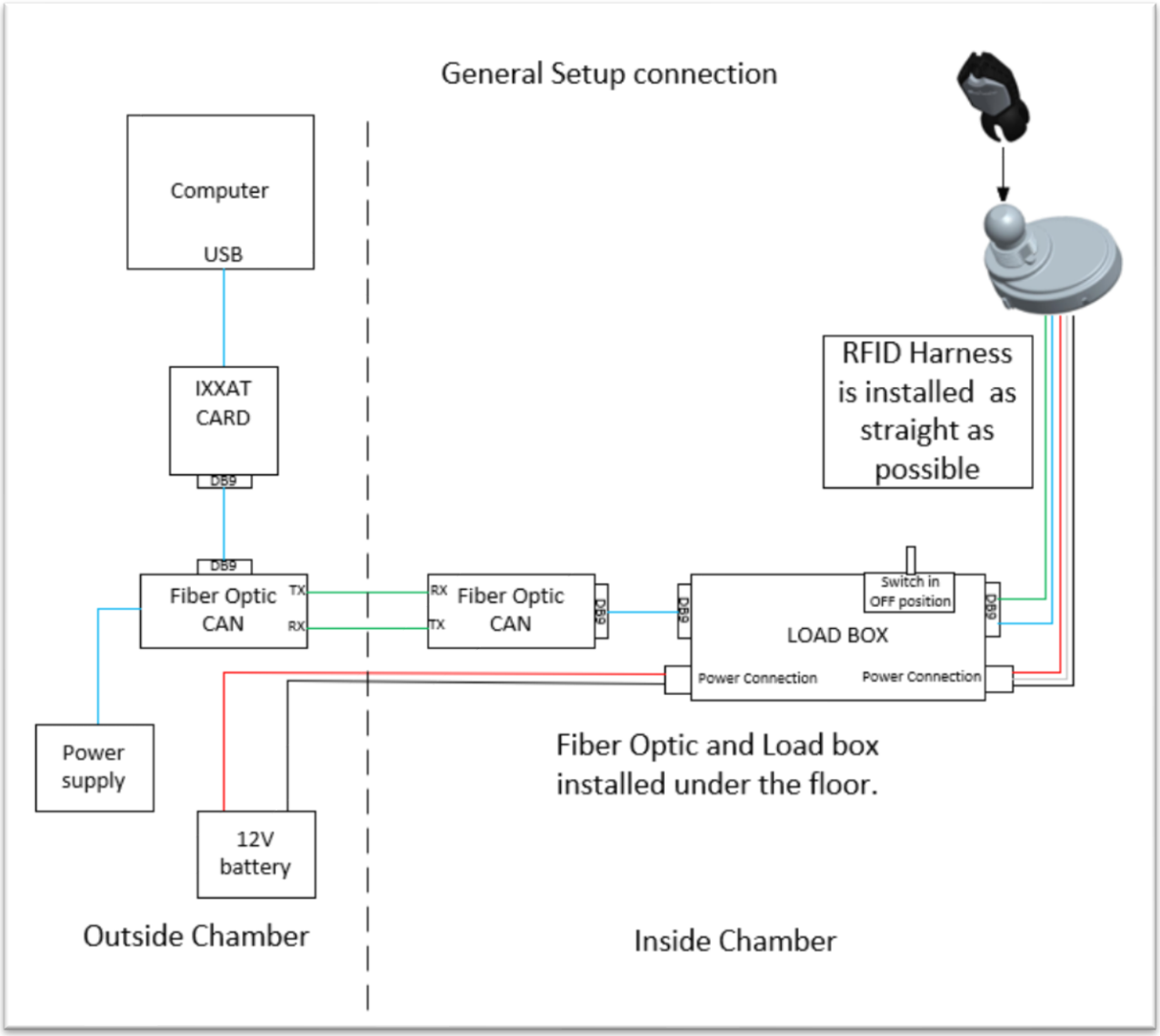


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 1: *EUT sub assemblies*

Description	Brand name	Model, Part number, Serial number, Revision level
RF/Dess post	Kongsberg	MN: 1001105692, PN: 1001105692, SN: 855A03620009, Rev. 05
RFID DESS Key	Kongsberg	MN: 1000634541;PN : 1000645885,SN: 159.120.79.5.80.2.4.224-13.8MHz,Rev: 07

Table 2: *EUT interface ports and cable connections*

Port description	Qty.	Cable connection			
		Cable installed	Cable description	Shielded	Cable length
Main harness	1	☒ yes ☐ no	5 wires red, black, green, blue, gray	☐ yes ☒ no	☒ < 3m ☐ > 3m < 30 m ☐ > 30 m
Power Wire	1	☒ yes ☐ no	1 Red and 1 black from load to battery	☐ yes ☒ no	☐ < 3m ☒ > 3m < 30 m ☐ > 30 m
Can Cable	1	☒ yes ☐ no	Fiber optic	☐ yes ☒ no	☐ < 3m ☒ > 3m < 30 m ☐ > 30 m

Table 3: *Support equipment*

Description	Brand name	Model, Part number, Serial number, Revision level
Load box	Kongsberg	SN:1001196418
Fiber Optic CAN	Michigan Scientific	MN: FO-CAN, SN: 16001
Fiber Optic CAN	Michigan Scientific	MN: FO-CAN, SN: 16000
Power supply	MW	MN: GS06U, SN: 1369307
Battery	AGM	MN: WPHR12-20, SN: 7798601831
IXXAT Card	IXXAT	MN: USB-to CAN, SN: HW030689
Laptop	DELL	MN: Latitude 5400, PN: 21271266110, SN: 9RSD1Z2,

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

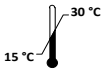
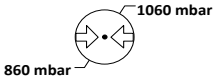
- Product RFID GEN2 (1001002222-05) is a family of product composed of 2 variants: RFID GEN2 CAN (1001105692-03) and RFID GEN2 MOWP (1001105693-02).
- Difference between the 2 products is the communication interface: CAN bus or 1-Wire protocol. Both products use the same PCB and BOM (component on PCB) is >95% the same. The RF circuit (RFID initiator/reader, RF clock, matching circuit, antenna) is 100% the same.
- The RFID GEN2 CAN variant was selected to conduct the FCC/IC certification as preliminary measure performed at NEMKO on both variant have shown that the CAN variant has a higher RF emission in monitored RF range, probably due to the CAN communication.

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 ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

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

Table 6.1-1: Measurement uncertainty calculations for Radio

Test name	Measurement uncertainty, ±dB
All antenna port measurements	0.55
Occupied bandwidth	4.45
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78

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 (Emissions)	TDK	SAC-3	FA002532e	2 year	February 25, 2022
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	December 9, 2020
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	January 28, 2021
Active loop antenna (0.01–30 MHz)	Com-Power	AL-130	FA002722	1 year	August 30, 2020
50 Ω coax cable	C.C.A.	None	FA002603	—	VOU
50 Ω coax cable	Sucoflex	None	FA002563	—	VOU
50 Ω coax cable	C.C.A.	None	FA002831	—	VOU
Environmental Chamber	Espec	EPX-4H	FA002736	1 year	May 28, 2020
Multimeter	AMPPROBE	AM-530	FA002537	1 year	August 20, 2020

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

Section 8. Testing data

8.1 FCC 15.215(c) and RSS-Gen 6.7 Occupied bandwidth (or 99% emission bandwidth) and x dB bandwidth

8.1.1 Definitions and limits

FCC §15.215

c) 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. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80 % of the permitted band in order to minimize the possibility of out-of-band operation.

RSS-GEN, 6.7

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

8.1.2 Test summary

Test start date	March 25, 2020
Verdict	Pass

8.1.3 Observations, settings and special notes

Test methods are as per ANSI 63.10 section 6.9 Occupied bandwidth tests

Spectrum analyzer settings:

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

8.1.4 Test data

Table 8.1-1: *Lower 20 dBc frequency cross result*

Fundamental frequency, MHz	Lower 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.560	13.559	13.553	6

Table 8.1-2: *Upper 20 dBc frequency cross result*

Fundamental frequency, MHz	Upper 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.560	13.560	13.567	7

Table 8.1-3: *99% bandwidth result*

Fundamental frequency, MHz	99% bandwidth, kHz
13.560	2.214

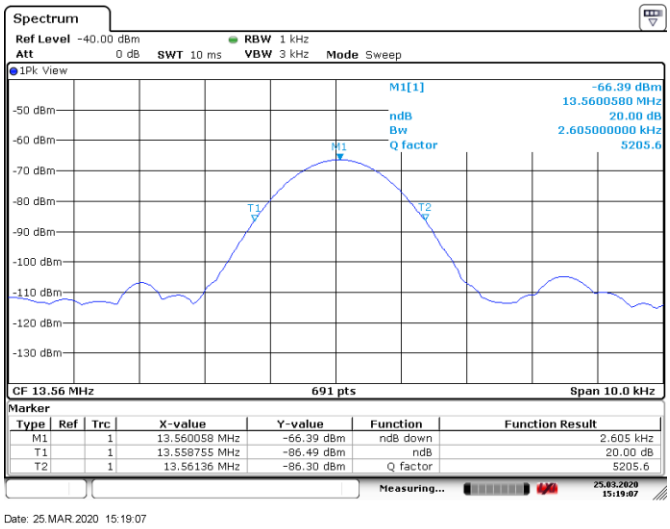


Figure 8.1-1: *20 dB bandwidth*

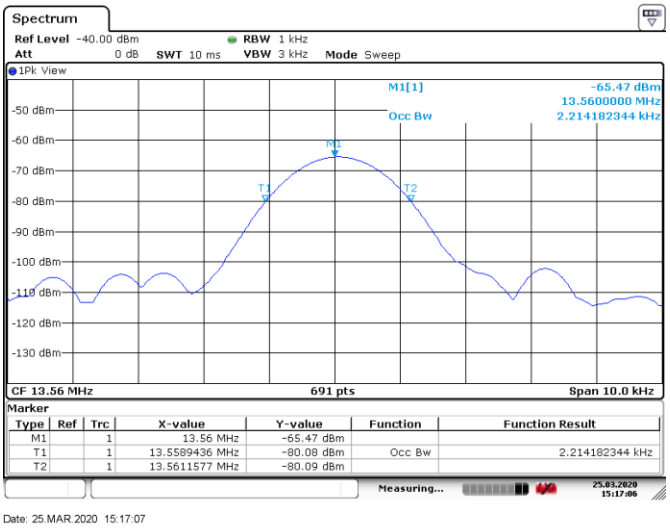


Figure 8.1-2: *99% dB bandwidth*

8.2 FCC 15.225(a–c) and RSS-210 B.6 (a)(i)(ii)(iii) Field strength within band

8.2.1 Definitions and limits

FCC §15.225

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

RSS- 210, B.6

a. the field strength of any emission shall not exceed the following limits:

i. 15.848 mV/m (84 dBµV/m) at 30 m, within the band 13.553-13.567 MHz
ii. 334 µV/m (50.5 dBµV/m) at 30 m, within the bands 13.410-13.553 MHz and 13.567-13.710 MHz
iii. 106 µV/m (40.5 dBµV/m) at 30 m, within the bands 13.110-13.410 MHz and 13.710-14.010 MHz

8.2.2 Test summary

Test start date	March 24, 2020
Verdict	Pass

8.2.3 Observations/special notes

- Test method as per ANSI C63.10 section 6.4 Radiated emissions from unlicensed wireless devices below 30 MHz
- The spectral plot within this section has been corrected with all applicable transducer factors.
- 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

8.2.1 Test data

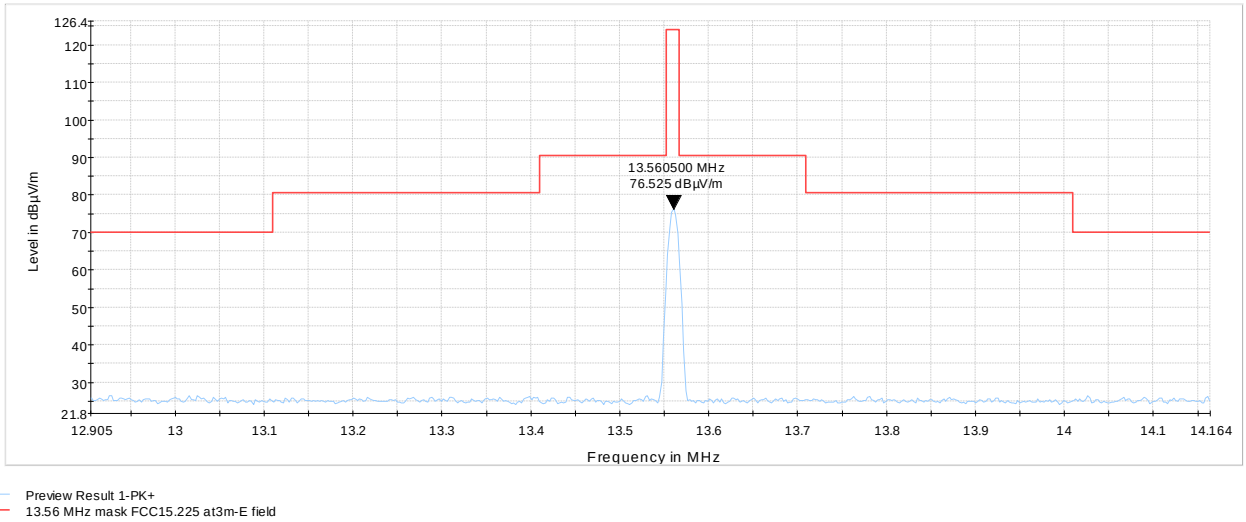


Figure 8.2-1: *Field strength within 13.56 MHz mask*

Note: calculation of extrapolated field strength at 30 m = 76.5 dBµV/m -40 dB = 36.5 dBµV/m,

margin of compliance = limit of 84 dBµV/m - 36.5 dBµV/m,= 47.5 dB

8.3 FCC 15.225(d) and RSS-210 B.6(a)(iv) Field strength of emissions outside band

8.3.1 Definitions and limits

FCC §15.225:

d) 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.

RSS-210, B.6:

iv. 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	$67.6 - 20 \times \log_{10}(F)$	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

8.3.2 Test summary

Test start date	March 24, 2020
Verdict	Pass

8.3.3 Observations, settings and special notes

- Test method is as per ANSI C63.10 section 6.4 Radiated emissions from unlicensed wireless devices below 30 MHz, and section 6.5 Radiated emissions from unlicensed wireless devices in the frequency range of 30 MHz to 1000 MHz
- The spectral plot within this section has been corrected with all applicable transducer factors.
- The spectrum was searched from 9 kHz to 1 GHz.
- Radiated measurements were performed at a distance of 3 m.

Receiver/spectrum analyzer settings.

Resolution bandwidth	Measurements below 150 kHz: 300 Hz, Measurements from 150 kHz to 30 MHz: 9 kHz, Measurements from 30 MHz to 1 GHz: 120 kHz
Video bandwidth	Measurements below 150 kHz: 9 kHz, Measurements from 150 kHz to 30 MHz: 30 kHz, Measurements from 30 MHz to 1 GHz: 300 kHz
Detector mode	Measurements below 150 kHz: Peak (Preview), Quasi-peak (Final) Measurements from 150 kHz to 30 MHz: Peak (Preview), Quasi-peak (Final) Measurements from 30 MHz to 1 GHz: Peak (Preview), Quasi-peak (Final)
Trace mode	Max Hold
Measurement time	100 ms

8.3.4 Test data

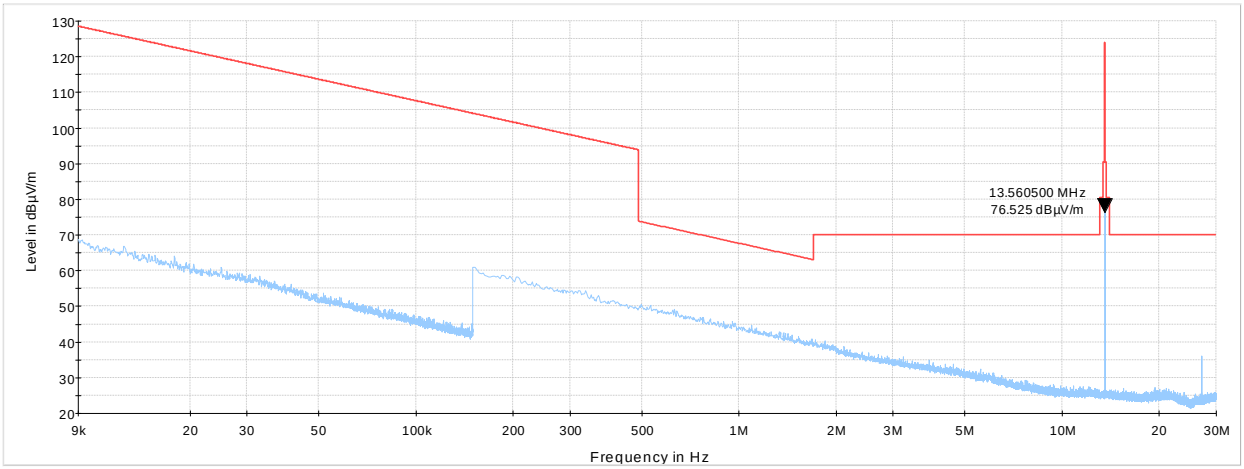


Figure 8.3-1: *Field strength of spurious emissions below 30 MHz*

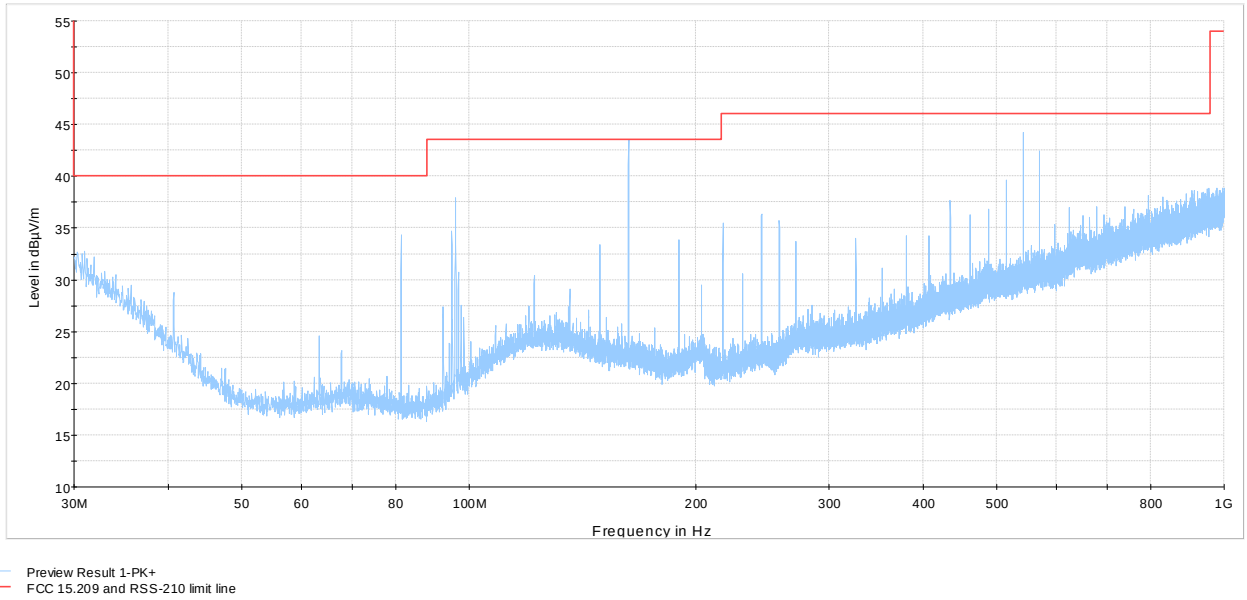


Figure 8.3-2: *Field strength of spurious emissions above 30 MHz*

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.

Table 8.3-2: *Radiated emissions (Quasi-Peak) results*

Frequency (MHz)	Quasi-Peak field strength[1] (dBµV/m)	3 m Quasi-Peak limit [3] (dBµV/m)	Margin (dB)	Measurement time (ms)	Bandwidth (kHz)	Antenna height (cm)	Pol. (V/H)	Turn table position (°)	Correction factor[2] (dB)
31.010	22.91	40.00	17.09	100	120	143	H	172	25
43.620	13.00	40.00	27.00	100	120	211	H	262	16
81.370	34.12	40.00	5.88	100	120	107	V	12	12
94.909	32.50	43.50	11.00	100	120	100	V	182	14
96.000	36.48	43.50	7.02	100	120	110	V	22	14
162.728	41.07	43.50	2.43	100	120	100	V	188	18
189.848	34.29	43.50	9.21	100	120	102	V	194	17
257.627	34.53	46.00	11.47	100	120	201	V	30	17
433.924	36.16	46.00	9.84	100	120	110	V	92	23
515.283	37.84	46.00	8.16	100	120	100	V	30	24
542.403	43.98	46.00	2.02	100	120	149	H	91	25
569.522	41.94	46.00	4.06	100	120	160	H	246	25
955.501	30.17	46.00	15.83	100	120	191	H	90	30

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (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: 32.2 dBµV/m (field strength) = 9.0 dBµV (receiver reading) + 23.2 dB (Correction factor)

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

8.4.1 Definitions and limits

FCC §15.225

e. The frequency tolerance of the carrier signal shall be maintained within ±0.01 % (±100 ppm) of the operating frequency over a temperature variation of −20 °C to +50 °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 °C. For battery operated equipment, the equipment tests shall be performed using a new battery.

RSS-210, B.6

b. the carrier frequency stability shall not exceed ±100 ppm

8.4.2 Test summary

Test start date	March 25, 2020
Verdict	Pass

8.4.3 Observations, settings and special notes

Test method is as per ANSI C63.10, section 6.8 Frequency stability tests

Spectrum analyzer settings:

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

8.4.4 Test data

Table 8.4-1: *Frequency drift measurements results*

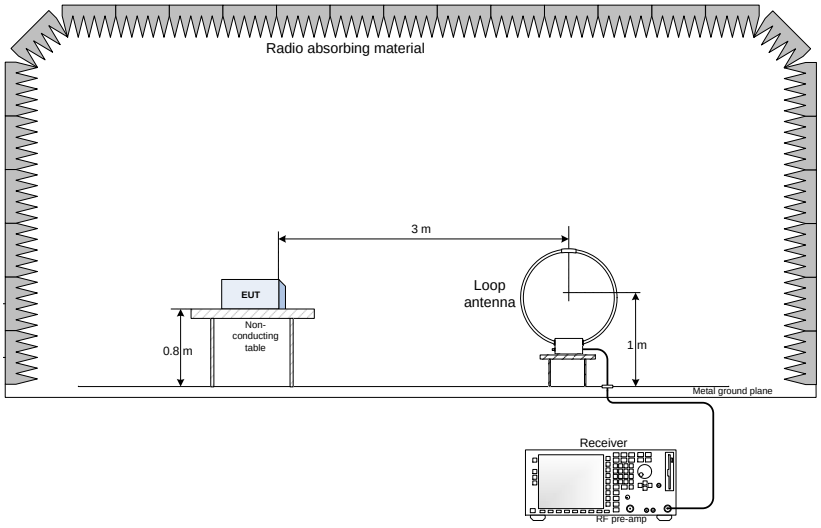
Test conditions	Frequency, MHz	Frequency drift, ±ppm	Limit, ±ppm	Margin, ppm
+50 °C, Nominal	13.56016930	6.83	100	93.17
+20 °C, +15 %	13.56007670	0.00	100	100.00
+20 °C, Nominal	13.56007670	*Reference*	*Reference*	*Reference*
+20 °C, −15 %	13.56007530	-0.10	100	99.90
−20 °C, Nominal	13.56011720	2.99	100	97.01

Note: frequency drift was calculated as follows:

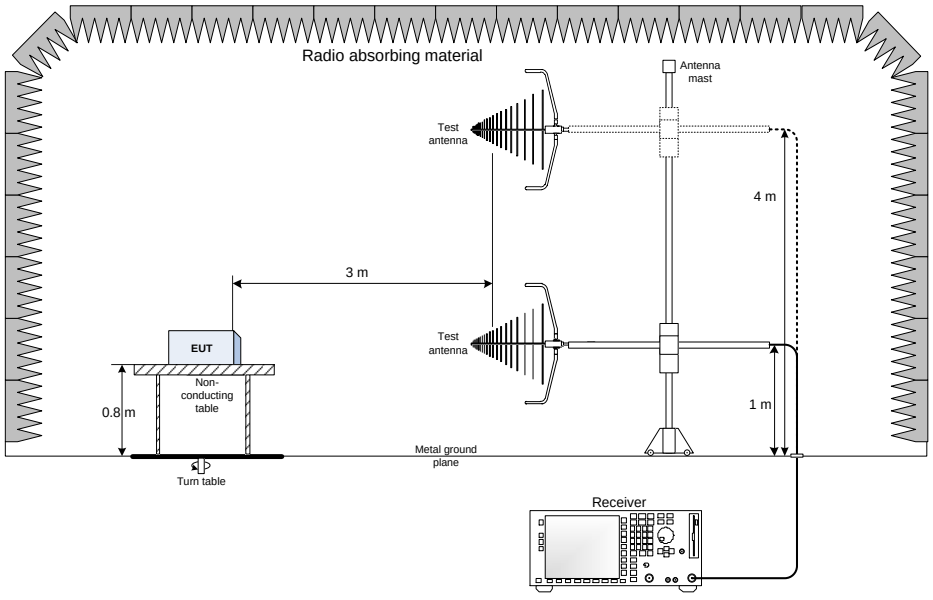
Frequency drift (ppm) = $((F_{measured} - F_{reference}) \div F_{reference}) \times 1 \times 10^6$

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up below 30 MHz



9.2 Radiated emissions set-up above 30 MHz



(End of report)