RADIO TEST REPORT – 376843-1R1TRFWL

Applicant:

Kongsberg Automotive

Product:

Wireless automotive key

Model:

1001112579

FCC ID:

2ACER1001112579

ISED Registration Number :

12006A-1001112579

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

Date of issue: April 23, 2020

Redwanul Rasel, Wireless/EMC Specialist	
Tested by	Signature
Yong Huang, EMC/RF Specialist	
Reviewed by	Signature

Test location

Company name	Nemko Canada Inc.			
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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.

Copyright notification

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Kongsberg Automotive
Address	90, 28ieme rue, C.P. 10034 Shawinigan QC, Canada G9T 5K7

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
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

Revision #	Details of changes made to test report
TRF	Original report issued
TRFR1	As per TCB, Software details update for the testing

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	Not applicable
§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 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	Not applicable

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 fresh batteries.

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	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	September 19, 2019
Nemko sample ID number	1

3.2 EUT information

Product name	Wireless automotive key
Model	1001112579
Serial number	225A2561939D

3.3 Technical information

Operating band	13.553–13.567 MHz
Operating frequency	13.56 MHz
Modulation type	ASK/AM
Occupied bandwidth (99 %)	2.24 kHz
Power requirements	12 V_{DC} car battery
Emission designator	K1D
Antenna information	The EUT uses an integrated, non-detachable and not user accessible loop antenna.

3.4 Product description and theory of operation

The product uses a magnetic sensing technology as a Kill-safe device and NFCv RFID signal to identify the driver of the vehicle. The driver of the vehicle should snap a key-like device that uses a passive RFID tag device. During the starting process, the RFID reader will read the tag and give the authorization to the vehicle to start the ignition system.

3.5 EUT exercise details

The EUT was set to transmit continuously within the vicinity of the ignition key.
The RFID DESS Post's contact output serves as a Fail-Safe Cut-off system, based on a non-contact magnetic switch, that send a stop signal to the vehicle engine in case of a key disconnection

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:
Bootloader : S0153E03
Application : S0154A00
Calibration : D01189B00

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

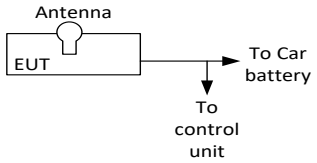


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
Wireless automotive key	Kongsberg Inc	1001112579	225A2561939D

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

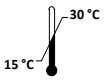
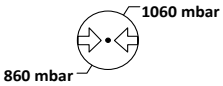
None

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 ±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	January 10, 2020
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
Multimeter	Fluke	26III	FA001261	1 year	November 22, 2020
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	December 9, 2020
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	January 3, 2020
Active loop antenna (0.01–30 MHz)	Com-Power	AL-130	FA002722	1 year	August 30, 2020
Environmental Chamber	Espec	EPX-4H	FA002736	1 year	May 28, 2020
50 Ω coax cable	C.C.A.	None	FA002603	—	VOU
50 Ω coax cable	C.C.A.	None	FA002605	—	VOU
50 Ω coax cable	C.C.A.	None	FA002831	—	VOU

Note: NCR - no calibration required

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
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.

ISED
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 date	September 19, 2019	Temperature	23 °C
Test engineer	Redwanul Rasel	Air pressure	1001 mbar
Verdict	Pass	Relative humidity	37 %

8.1.3 Observations, settings and special notes

Spectrum analyzer settings:

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

8.1.4 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	13.558	13.553	5.0

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	13.561	13.567	6.0

8.1.4 Test data, Continued

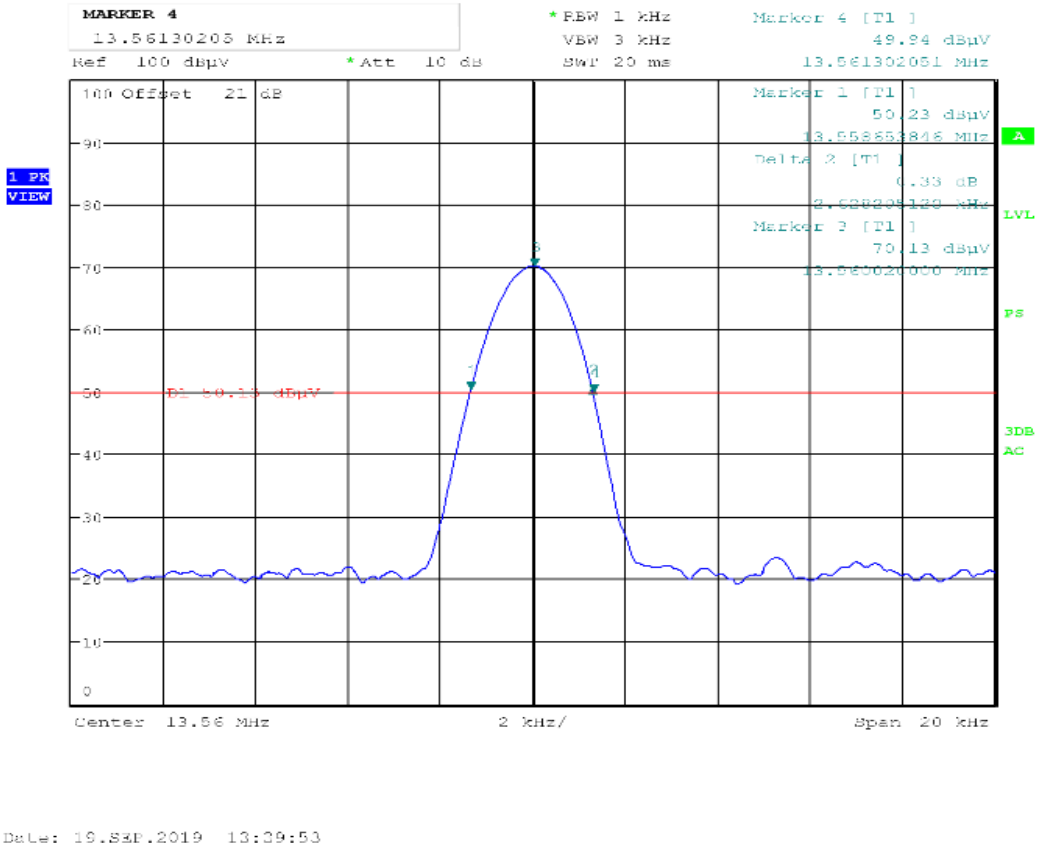


Figure 8.1-1: *20 dB bandwidth*

8.1.4 Test data, Continued

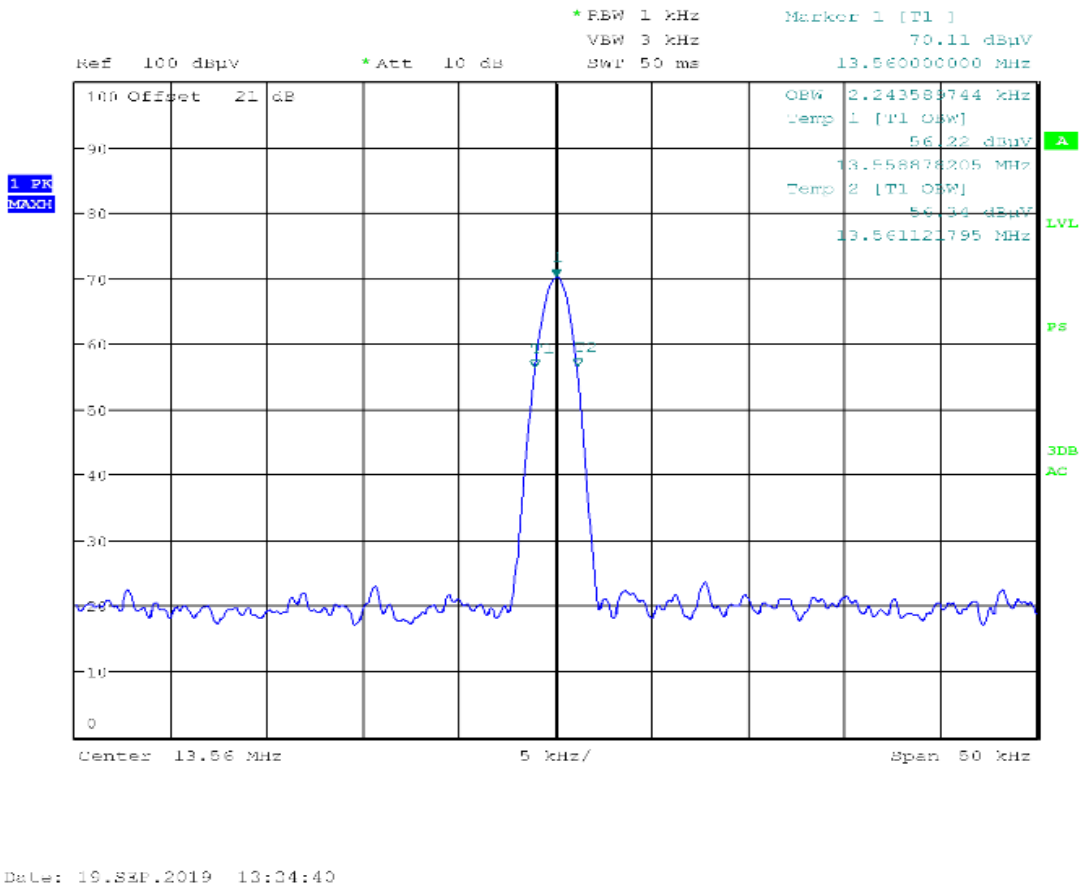


Figure 8.1-2: *99% dB bandwidth*

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 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.

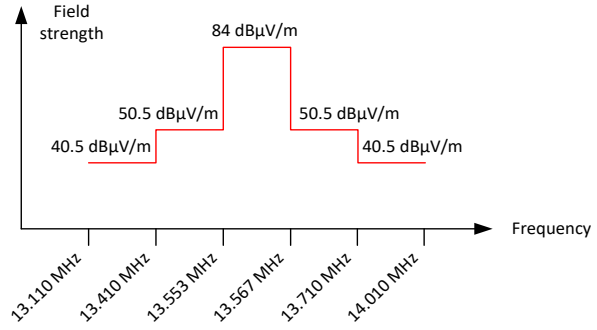


Figure 8.2-1: *In-band spurious emissions limit*

8.2.2 Test summary

Test date	September 19, 2019	Temperature	23 °C
Test engineer	Redwanul Rasel	Air pressure	1001 mbar
Verdict	Pass	Relative humidity	37 %

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):

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

Spectrum analyzer settings:

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

8.2.4 Test data

Table 8.2-1: *Field strength measurements results*

Frequency range, MHz	Frequency, MHz	Field strength at 3 m, dBµV/m	Calculated field strength at 30 m, dBµV/m	Limit, dBµV/m	Margin, dB
13.553–13.567	13.559	72.0	32.0	84.0	52.0
13.410–13.553	13.490	68.0	28.0	50.5	22.5
13.567–13.710	13.587	68.0	28.0	50.5	22.5
13.110–13.410	13.215	41.5	1.5	40.5	39.0
13.710–14.010	13.981	41.5	1.5	40.5	39.0

Note: Calculated field strength at 30 m = Measured field strength at 3 m − 40 dB

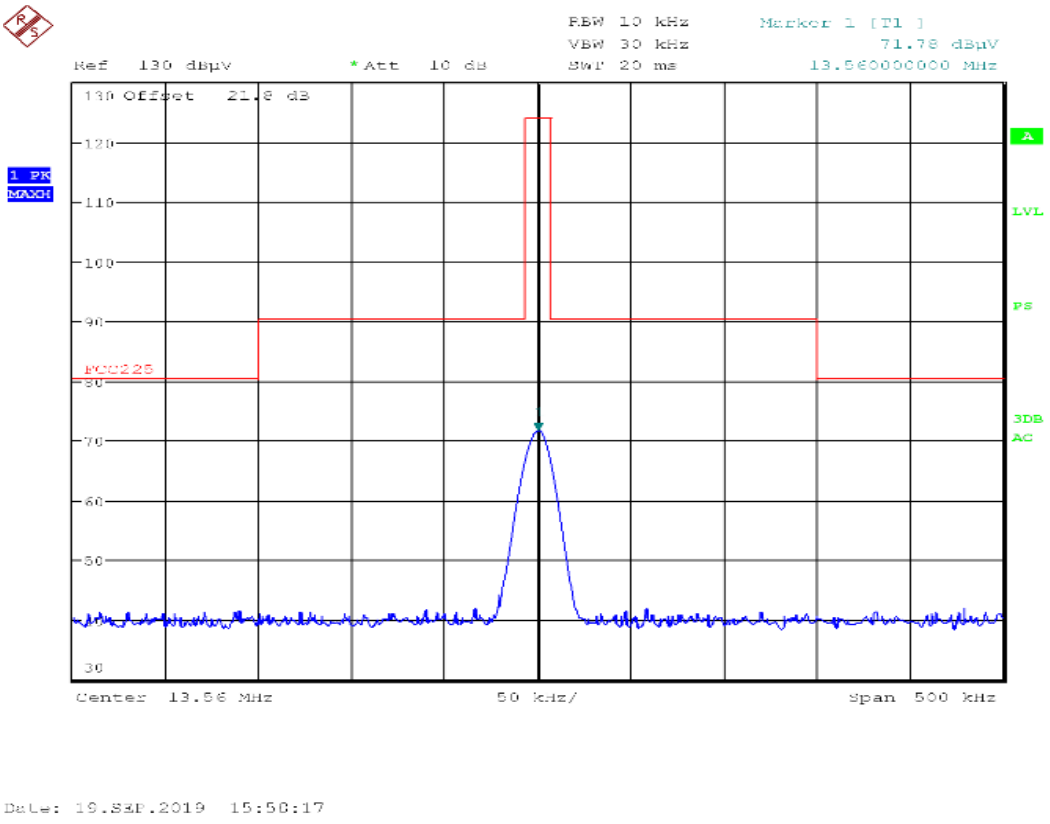


Figure 8.2-2: *Field strength within 13.567–13.710 MHz band*

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	$67.6 - 20 \times \log_{10}(F)$	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 8.3-2: *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	Above 38.6
8.41425–8.41475	167.72–173.2	3500–4400	
12.29–12.293	240–285	4500–5150	
12.51975–12.52025	322–335.4	5350–5460	

Note: Certain frequency bands listed in **Error! Reference source not found.** and above 38.6 GHz are designated for licence-exempt applications. These f requency 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	September 19, 2019	Temperature	23 °C
Test engineer	Redwanul Rasel	Air pressure	1001 mbar
Verdict	Pass	Relative humidity	37 %

8.3.3 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.

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

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

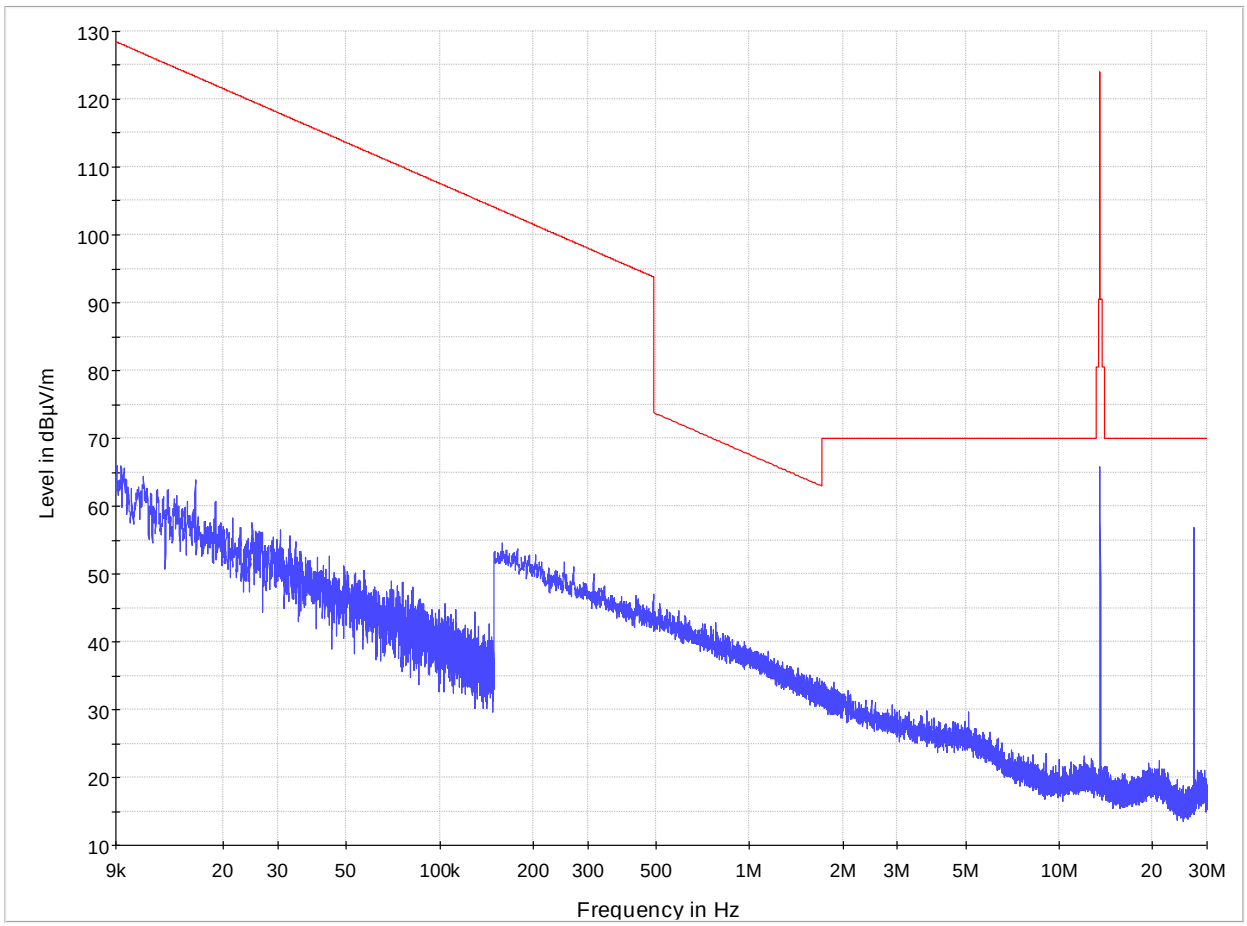


Figure 8.3-1: *Field strength of spurious emissions below 30 MHz, Vertical polarization*

8.3.4 Test data, Continued

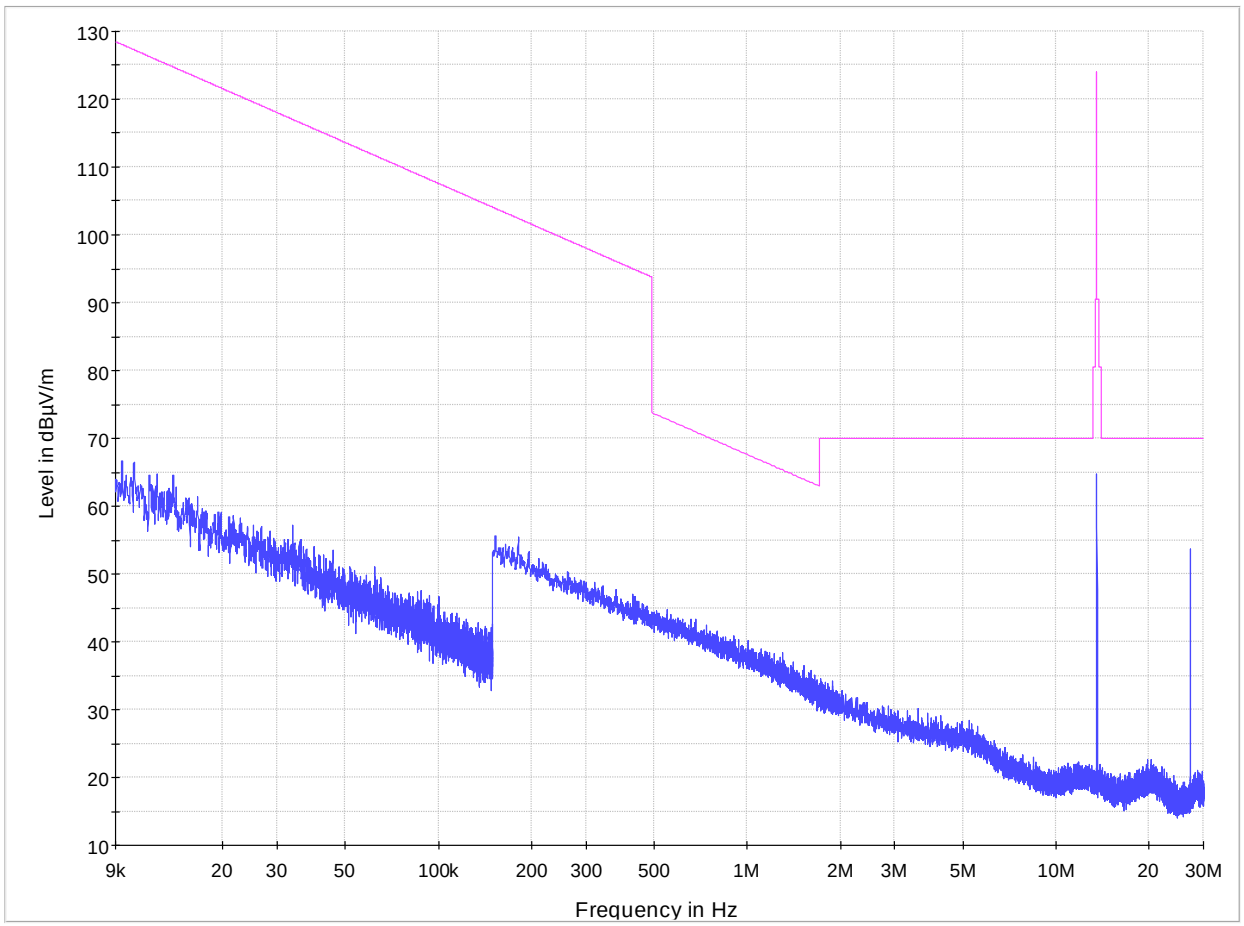


Figure 8.3-2: *Field strength of spurious emissions below 30 MHz, perpendicular polarization*

8.3.4 Test data, Continued

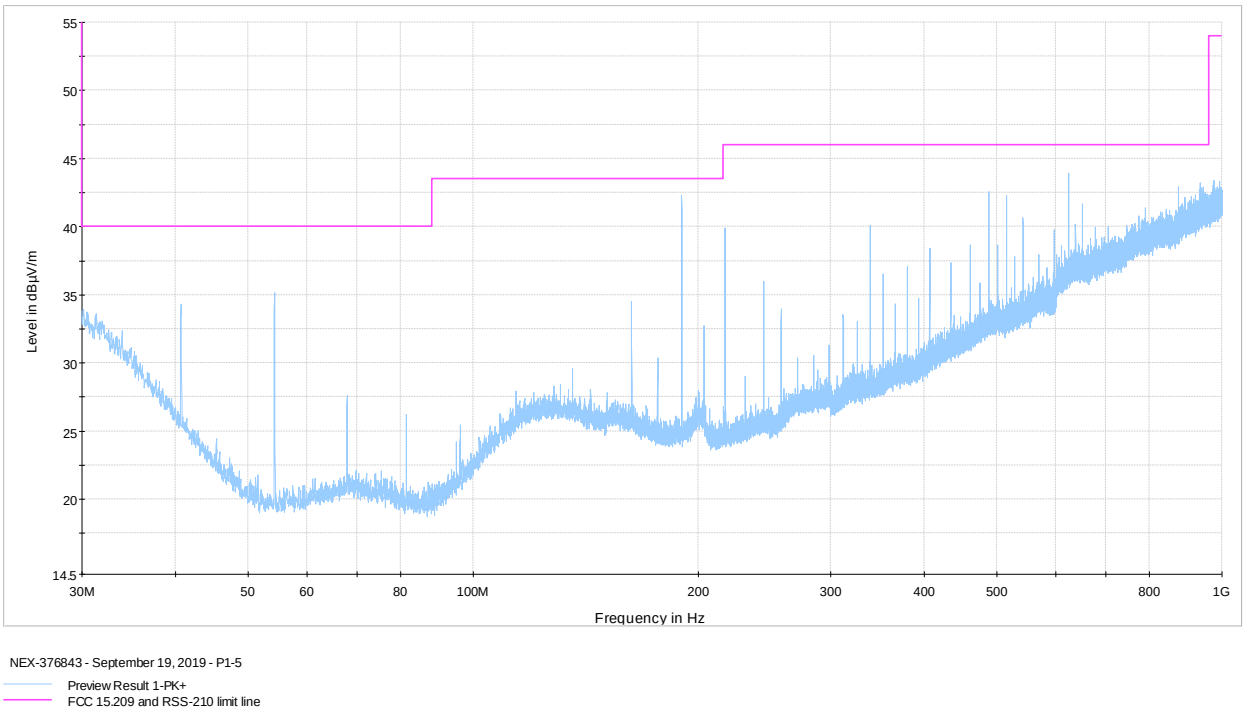


Figure 8.3-3: *Field strength of spurious emissions 30 MHz – 1 GHz*

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 8.3-4: Radiated emissions results-30 MHz to 1 GHz

Frequency (MHz)	Quasi-Peak field strength[1] (dBµV/m)	Quasi-Peak limit [3] (dBµV/m)	Quasi-Peak margin (dB)	Correction factor[2] (dB)
40.68	30.2	40.0	9.8	18.2
54.24	33.5	40.0	6.5	12.1
162.72	32.9	43.5	10.6	17.6
189.84	37.8	43.5	5.7	16.8
216.96	38.3	46.0	7.7	16.5
244.08	35.1	46.0	10.9	17.7
339.00	38.0	46.0	8.0	20.3
488.16	41.2	46.0	4.8	24.6
515.28	40.7	46.0	5.3	24.6
542.40	36.2	46.0	9.8	25.2
623.76	41.8	46.0	4.2	26.6
789.27	28.8	46.0	17.2	29.0
935.43	30.8	46.0	15.2	31.1

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB) − amplifier gain (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: 30.2 dBµV/m (field strength) = 12.0 dBµV (receiver reading) + 18.2 dB (Correction factor)

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

8.4.1 Definitions and limits

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.

8.4.2 Test summary

Test date	September 19, 2019	Temperature	23 °C
Test engineer	Redwanul Rasel	Air pressure	1001 mbar
Verdict	Pass	Relative humidity	37 %

8.4.3 Observations, settings and special notes

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*

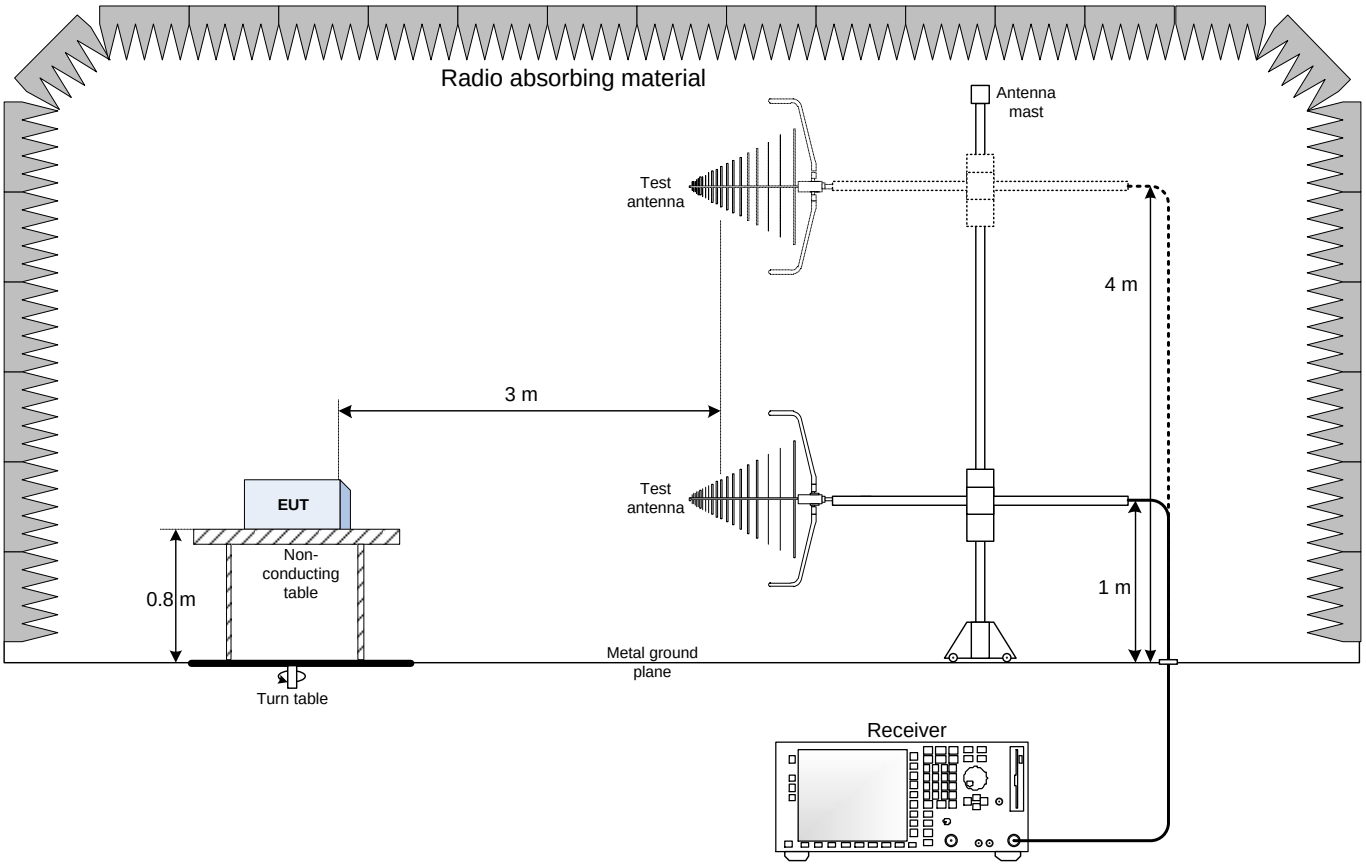
Test conditions	Frequency, MHz	Frequency drift, ±ppm	Limit, ±ppm	Margin, ppm
+50 °C, Nominal	13.56032	12.537	100	87.463
+20 °C, +15 %	13.56007	5.899	100	94.101
+20 °C, Nominal	13.56015	*Reference*	*Reference*	*Reference*
+20 °C, −15 %	13.56005	7.375	100	92.625
−20 °C, Nominal	13.56004	8.112	100	91.888

Note: frequency drift was calculated as follows:

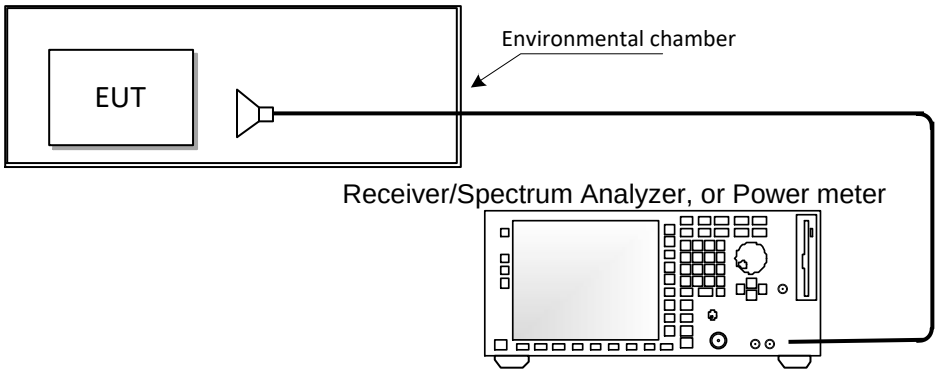
Frequency drift (ppm) = $((F_{measured} - F_{reference}) \div F_{reference}) \times 1 \times 10^6$

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up



9.2 Set-up for non-detachable antennas



(end of report)