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Wireless test report – 391342-3TRFWL

Applicant:

Northern Mechatronics Inc.

Product name:

LoRa® Bluetooth® 5 Low Energy Module

Model:

NM180100

FCC ID:

2AL5J-180100

IC Registration number:

22729-180100

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.209
  Radiated emission limits; general requirements.
- RSS-GEN, Issue 5, March 2019, section 8.9
  Transmitter Emission Limits

Date of issue: February 6, 2020

Test engineer(s): Mark Libbrecht

Signature: 

Reviewed by: Kevin Rose, Wireless/EMC Specialist

Test location(s)

Company name	Nemko Canada Inc.
Site name	Cambridge
Address	130 Saltsman Drive, Unit #1
City	Cambridge
Province	Ontario
Postal code	N3E 0B2
Country	Canada
Telephone	Tel: +1 519 680 4811
Website	www.nemko.com
Site number	FCC/IC: CA0101

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.

Copyright notification

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Northern Mechatronics Inc.
Address	92 King Street South, Suite 203
City	Waterloo
Province/State	Ontario
Postal/Zip code	N2J 1P5
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15 Subpart C, §15.209	Radiated emission limits; general requirements.
RSS-GEN, Issue 5, March 2019, section 8.9	Transmitter Emission Limits for Licence-Exempt Radio Apparatus

1.3 Test methods

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

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.5 below. 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

As per quote, the purpose of this report is verification of transmitters colocation. Only inter-modulation products within restricted bands were assessed, other requirements were excluded from the scope of this report.

1.6 Test report revision history

Revision #	Date of issue	Details of changes made to test report
TRF	February 6, 2020	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.209	Radiated emission limits; general requirements.	Pass

2.2 ISED RSS-GEN, Issue 5, test results

Part	Test description	Verdict
8.9	Transmitter Emission Limits for Licence-Exempt Radio Apparatus	Pass

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	January 15, 2020
Nemko sample ID number	1

3.2 EUT information

Product name	LoRa® Bluetooth® 5 Low Energy Module
Model	NM180100
Model variant	None
Serial number	None

3.3 Technical information

Applicant IC company number	22729
IC UPN number	180100
All used IC test site(s) Reg. number	2040A-4
RSS number and Issue number	RSS-247 Issue 2, Feb 2017
Frequency band	2400-2483.5 MHz (BLE), 902-928 MHz (LoRa)
Type of modulation	GFSK (BLE), LoRa (LoRa)
Emission classification (F1D, G1D, D1D)	F1D
Transmitter spurious, dBµV/m @ 3 m	47.9 (Peak), 40.5 (Average) @ 4880 MHz
Power requirements	2.8 – 3.6 V_{DC}
Antenna information	Tri-band, max gain 2.26 dBi (BLE), 2.27 dBi (LoRa)

3.4 EUT setup diagram

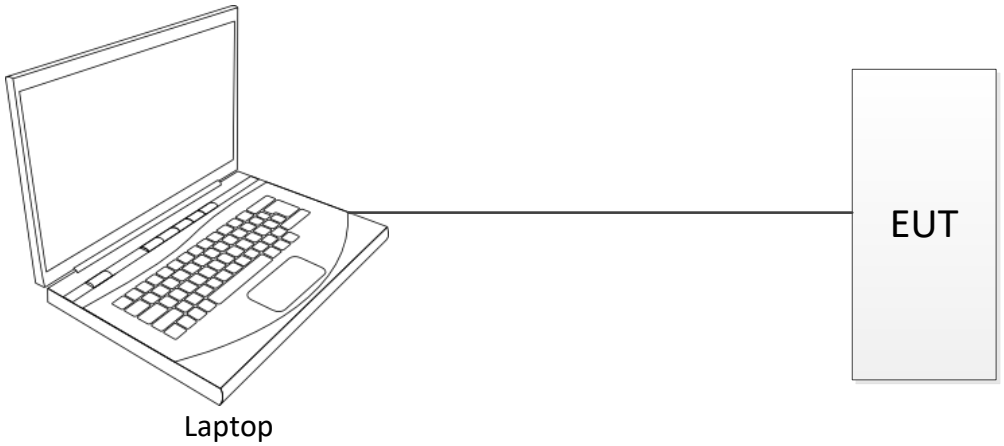


Figure 3.4-1: *Setup diagram*

3.5 EUT sub assemblies

Table 3.5-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
Laptop	Lenovo N22	806S	YD00LVMN

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

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.

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	FA003012	1 year	Oct. 10/20
Flush mount turntable	SUNAR	FM2022	FA003006	—	NCR
Controller	SUNAR	SC110V	FA002976	—	NCR
Antenna mast	SUNAR	TLT2	FA003007	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESR26	FA002969	1 year	June 4/20
Horn antenna (1–18 GHz)	ETS Lindgren	3117	FA002911	1 year	Sept. 11/20
Preamp (1–18 GHz)	ETS Lindgren	124334	FA002956	1 year	Sept. 26/20
Bilog antenna (30–2000 MHz)	SUNAR	JB1	FA003010	1 year	Sept. 17/20
50 Ω coax cable	Huber + Suhner	None	FA003047	1 year	Sept. 30/20
50 Ω coax cable	Huber + Suhner	None	FA003044	1 year	Oct. 7/20
Notch filter 902-928 MHz	Microwave circuits	N03916M1	FA003032	1 year	Oct. 9/20
High Pass filter 3 – 18 GHz	Microwave circuits	H3G020G8	FA003026	1 year	Oct. 8/20
Notch filter 2.4 – 2.4835 GHz	Microwave circuits	N0324413	FA003027	1 year	Oct. 8/20

Note: NCR - no calibration required

Section 8. Testing data

8.1 FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements

8.1.1 Definitions and limits

FCC:
(f) In accordance with §15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in §15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in §15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit.
Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in §15.109 that are applicable to the incorporated digital device.

ISED:
Except when the requirements applicable to a given device state otherwise, emissions from licence‑exempt transmitters shall comply with the field strength limits shown in Table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 8.1-1: *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 8.1-2: *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 Table 8.1-2 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 8.1-3: *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			

8.1.2 Test summary

Test start date	January 31, 2020
Test engineer	Mark Libbrecht

8.1.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to 18 GHz.
EUT's BLE and LoRa (125 kHz and 500 kHz BW) transmitters were set to transmit continuously on middle channel.
Radiated measurements were performed at a distance of 3 m.

Receiver/spectrum analyzer settings.

Resolution bandwidth	Measurements below 1 GHz: 120 kHz, Measurements above 1 GHz: 1 MHz
Video bandwidth	Measurements below 1 GHz: 300 kHz, Measurements above 1 GHz:3 MHz
Detector mode	Measurements below 1 GHz: Peak (Preview), Quasi-peak (Final) Measurements above 1GHz: Peak (Preview), Peak and RMS Average (Final)
Trace mode	Max Hold
Measurement time	100 ms

8.1.4 Test data

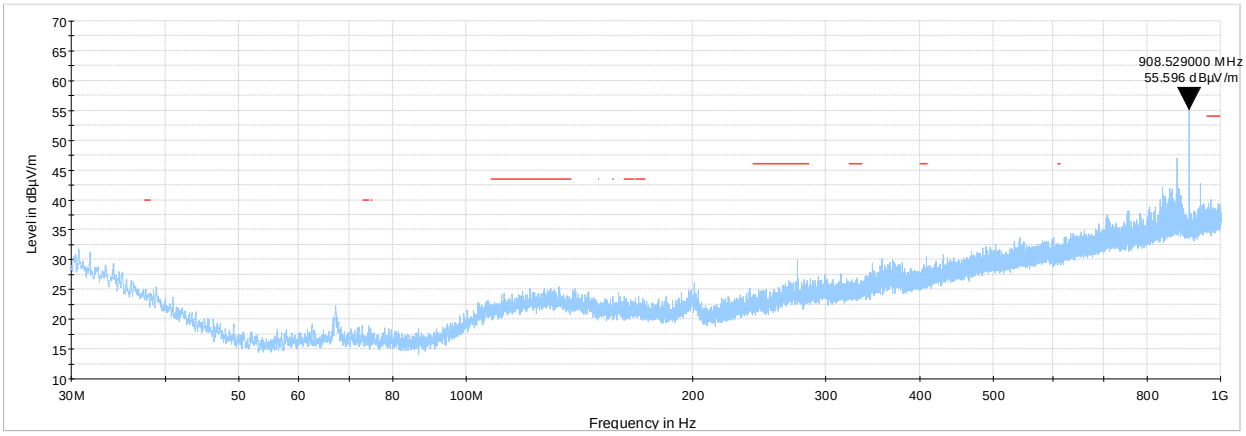


Figure 8.1-1: *Radiated spurious emissions 30 MHz – 1 GHz, BLE Tx at 2440 MHz, LoRa 125 kHz BW at 908.5 MHz*

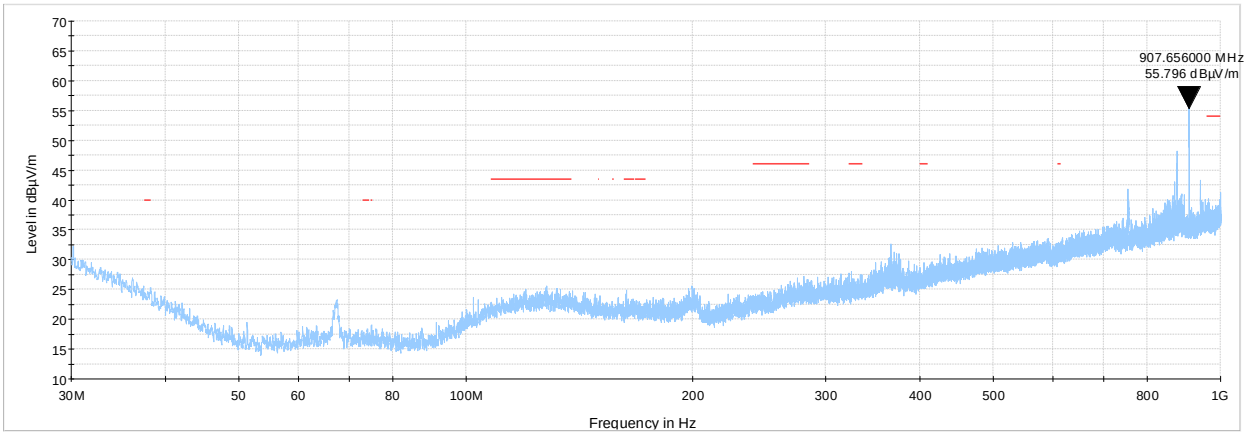
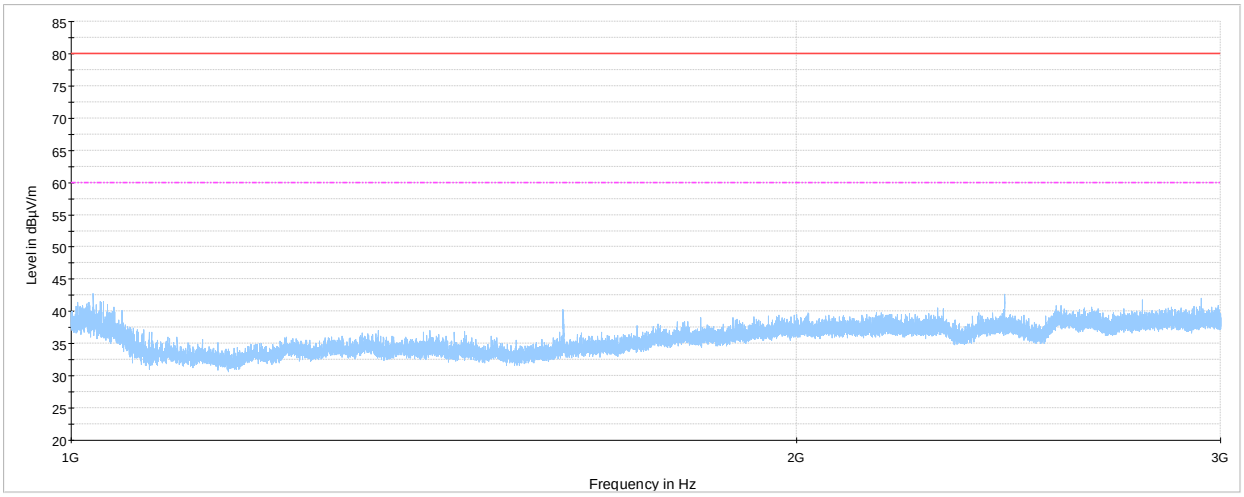


Figure 8.1-2: *Radiated spurious emissions 30 MHz – 1 GHz, BLE Tx at 2440 MHz, LoRa 500 kHz BW at 907.8 MHz*

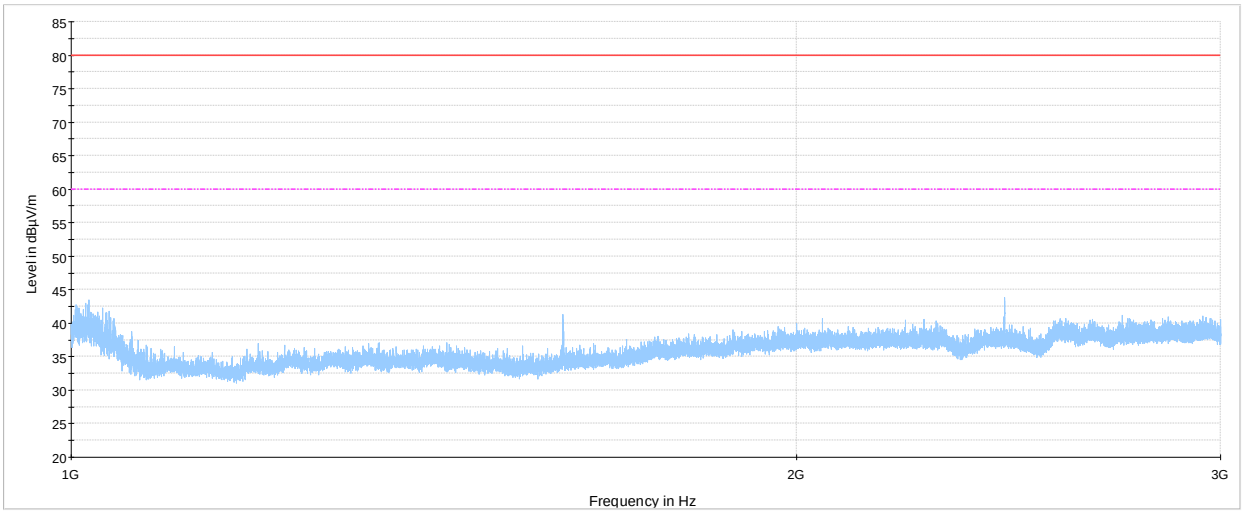
Note: Emissions above the limit were from intentional emissions. no intermodulation emissions were detected

8.1.5 Test data, continued



NEX391342 1 - 3 GHz, 908.5 MHz LORA 125 kHz BW, BLE mid channel, Notch filter 902 - 928 MHz, Notch filter 2.4 - 2.4835 GHz
Preview Result 1-PK+
FCC Part 15 and ICES-003 Limit - Class A (Peak) above 1 GHz, 3m
FCC Part 15 and ICES-003 Limit - Class A (Quasi-Peak and Average), 3 m

Figure 8.1-3: *Radiated spurious emissions 1 - 3 GHz, BLE Tx at 2440 MHz, LoRa 125 kHz BW at 908.5 MHz*



NEX391342 1 - 3 GHz, 907.8 MHz LORA 500 kHz BW, BLE mid channel, Notch filter 902 - 928 MHz, Notch filter 2.4 - 2.4835 GHz
Preview Result 1-PK+
FCC Part 15 and ICES-003 Limit - Class A (Peak) above 1 GHz, 3m
FCC Part 15 and ICES-003 Limit - Class A (Quasi-Peak and Average), 3 m

Figure 8.1-4: *Radiated spurious emissions 1 - 3 GHz, BLE Tx at 2440 MHz, LoRa 500 kHz BW at 907.8 MHz*

8.1.6 Test data, continued

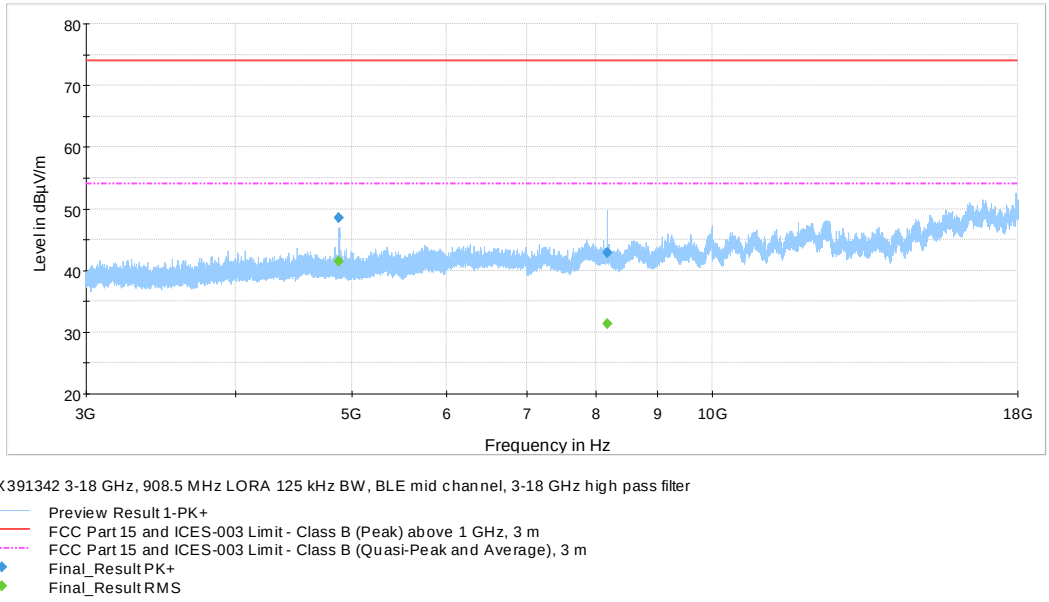


Figure 8.1-5: *Radiated spurious emissions 3 - 18 GHz, BLE Tx at 2440 MHz, LoRa 125 kHz BW at 908.5 MHz*

Note: Emissions above the limit were from intentional emissions or their harmonic, no intermodulation emissions were detected

Table 8.1-4: *Radiated emissions results 3 - 18 GHz, BLE Tx at 2440 MHz, LoRa 125 kHz BW at 908.5 MHz*

Frequency (MHz)	RMS Average field strength[1 and 3] (dBµV/m)	RMS Average limit (dBµV/m)	RMS Average margin (dB)	Correction factor[2] (dB)
4879.8	41.5	54.0	12.5	-7.5
8179.5	31.4	54.0	22.6	-0.8

Frequency (MHz)	Peak field strength[1 and 3] (dBµV/m)	Peak limit (dB□V/m)	Peak margin (dB)	Correction factor[2] (dB)
4879.8	48.5	74.0	25.5	-7.5
8179.5	42.9	74.0	31.1	-0.8

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: 41.5 dBµV/m (field strength) = 49.0 dBµV (receiver reading) + (-7.5 dB) (Correction factor)

8.1.7 Test data, continued

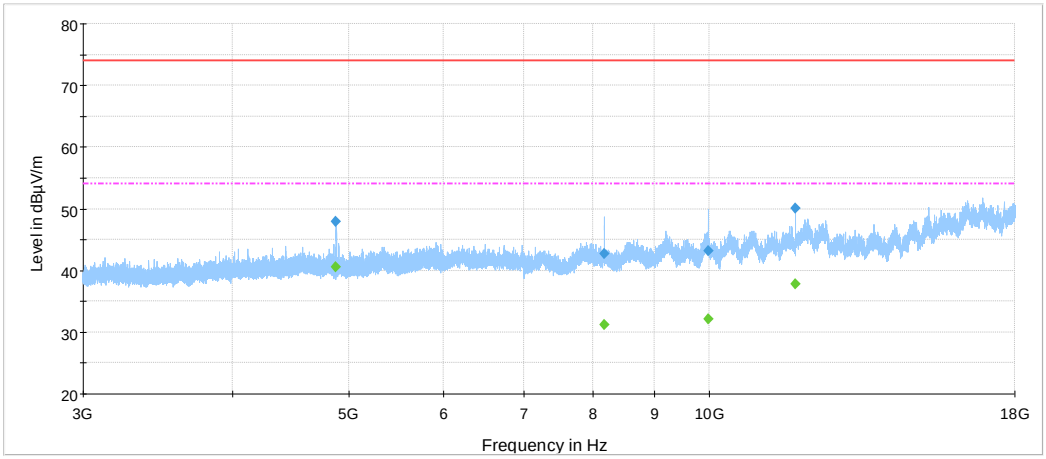


Figure 8.1-6: *Radiated spurious emissions 3 - 18 GHz, BLE Tx at 2440 MHz, LoRa 500 kHz BW at 907.8 MHz*

Table 8.1-5: *Radiated emissions results 3 - 18 GHz, BLE Tx at 2440 MHz, LoRa 125 kHz BW at 908.5 MHz*

Frequency (MHz)	RMS Average field strength[1 and 3] (dBµV/m)	RMS Average limit (dBµV/m)	RMS Average margin (dB)	Correction factor[2] (dB)
4879.9	40.5	54.0	13.5	-7.5
8173.0	31.2	54.0	22.8	-0.8
9981.5	32.1	54.0	21.9	1.4
11800.5	37.9	54.0	16.1	1.2

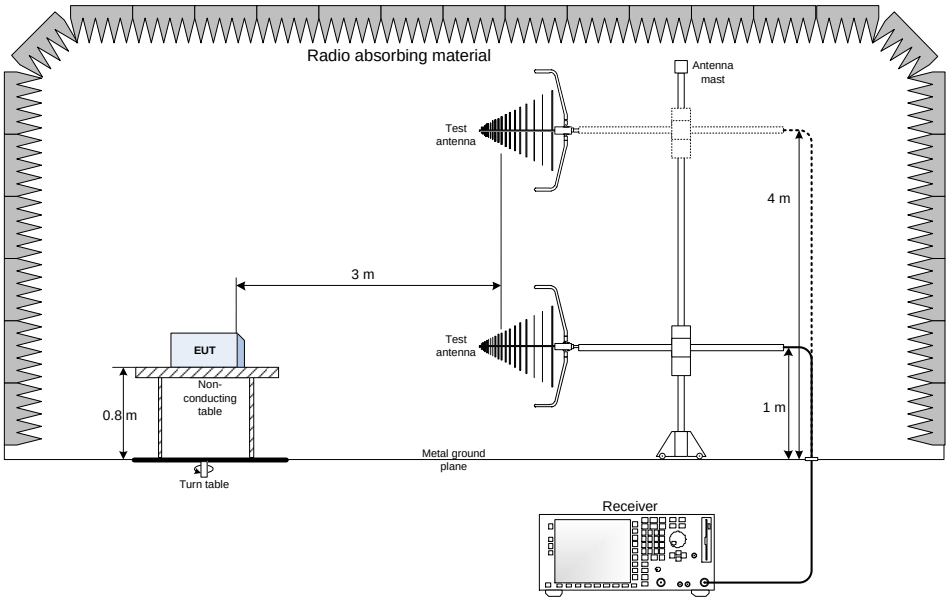
Frequency (MHz)	Peak field strength[1 and 3] (dBµV/m)	Peak limit (dB□V/m)	Peak margin (dB)	Correction factor[2] (dB)
4879.9	47.9	74.0	26.1	-7.5
8173.0	42.7	74.0	31.3	-0.8
9981.5	43.2	74.0	30.8	1.4
11800.5	50.0	74.0	24.0	1.2

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.

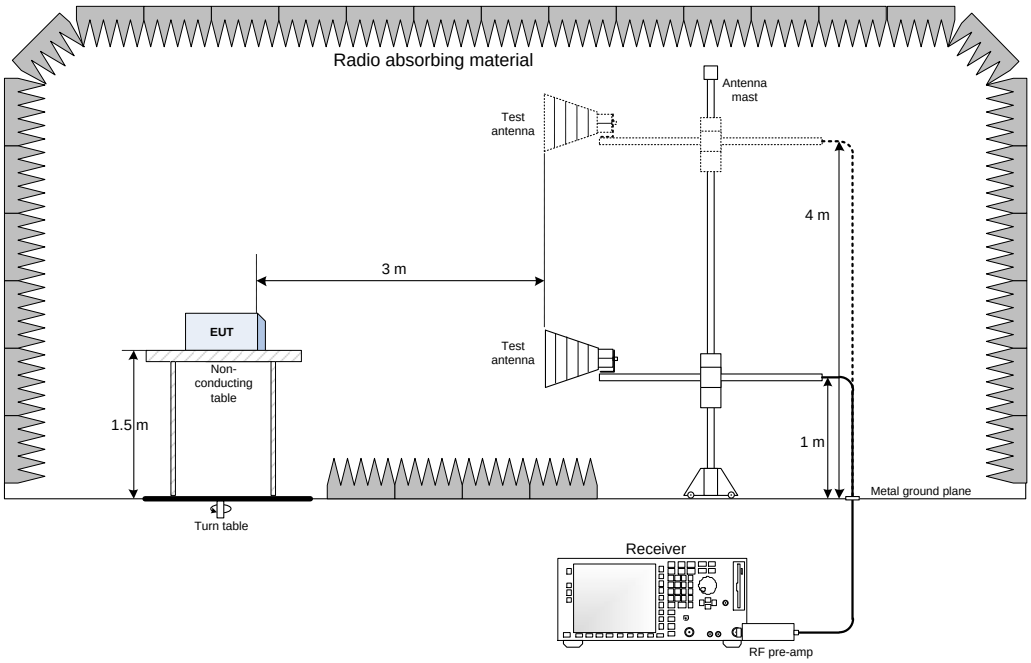
Sample calculation: 40.5 dBµV/m (field strength) = 48.0 dBµV (receiver reading) + (-7.5 dB) (Correction factor)

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



(End of report)