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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

www.nemko.com

## 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.

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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

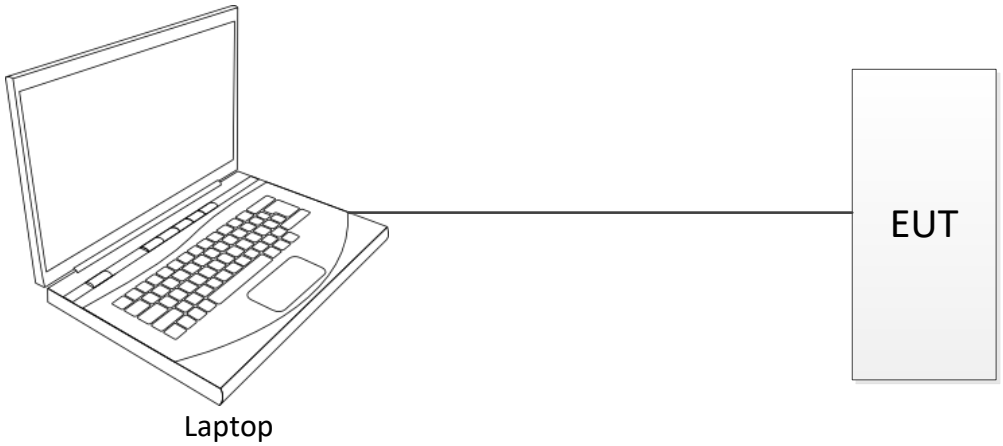



***Figure 3.4-1:*** *Setup diagram*

## 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 |

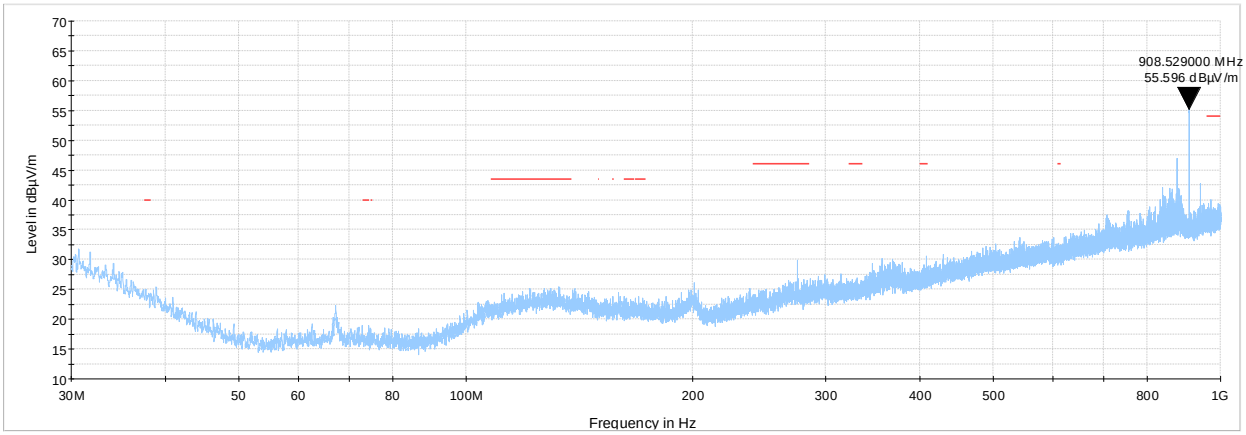
### 8.1.3 Observations, settings and special notes

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.

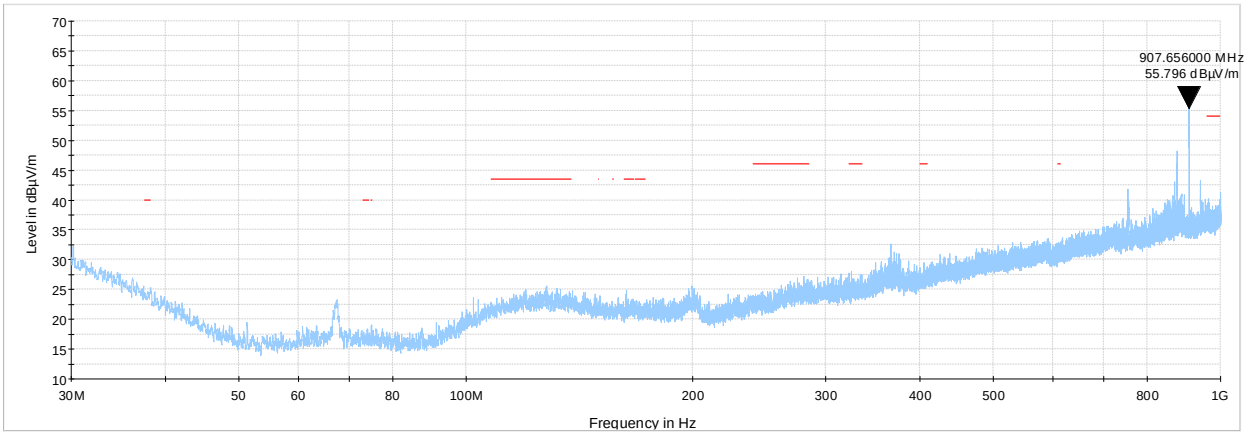
| | |
|---|---|
| Resolution bandwidth | Measurements below 1 GHz: 120 kHz, Measurements above 1 GHz: 1 MHz |
| Video bandwidth | Measurements below 1 GHz: 300 kHz, Measurements above 1 GHz:3 MHz |
| Detector mode | Measurements below 1 GHz: Peak (Preview), Quasi-peak (Final)<br>Measurements above 1GHz: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

### 8.1.4 Test data




NEX391342 30 MHz -1 GHz, 908.5 MHz LORA 125 kHz BW, BLE mid channel, 902 - 928 MHz Notch filter
Preview Result 1-PK+
FCC 15.209 and RSS-Gen Restricted bands quasi-peak limits

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

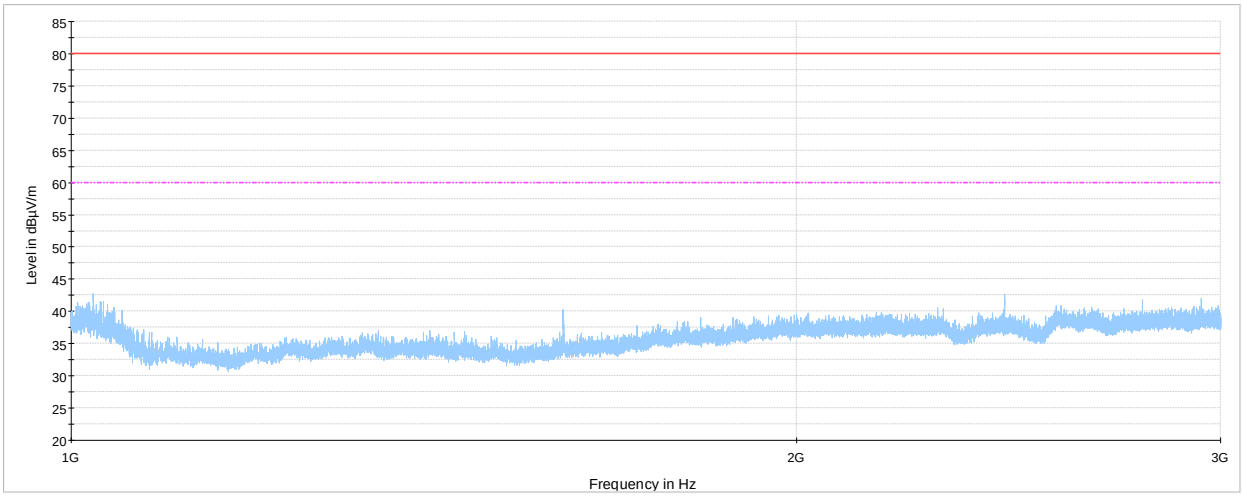



NEX391342 30 MHz -1 GHz, 907.8 MHz LORA 500 kHz BW, BLE mid channel, 902 - 928 MHz Notch filter
Preview Result 1-PK+
FCC 15.209 and RSS-Gen Restricted bands quasi-peak limits

***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

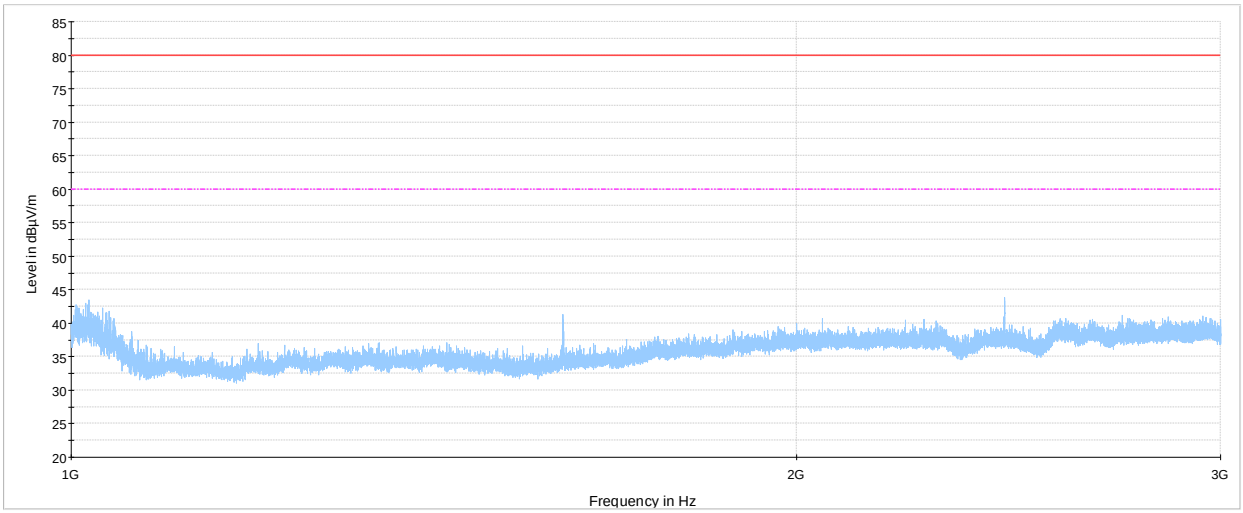
### 8.1.5 Test data, continued




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

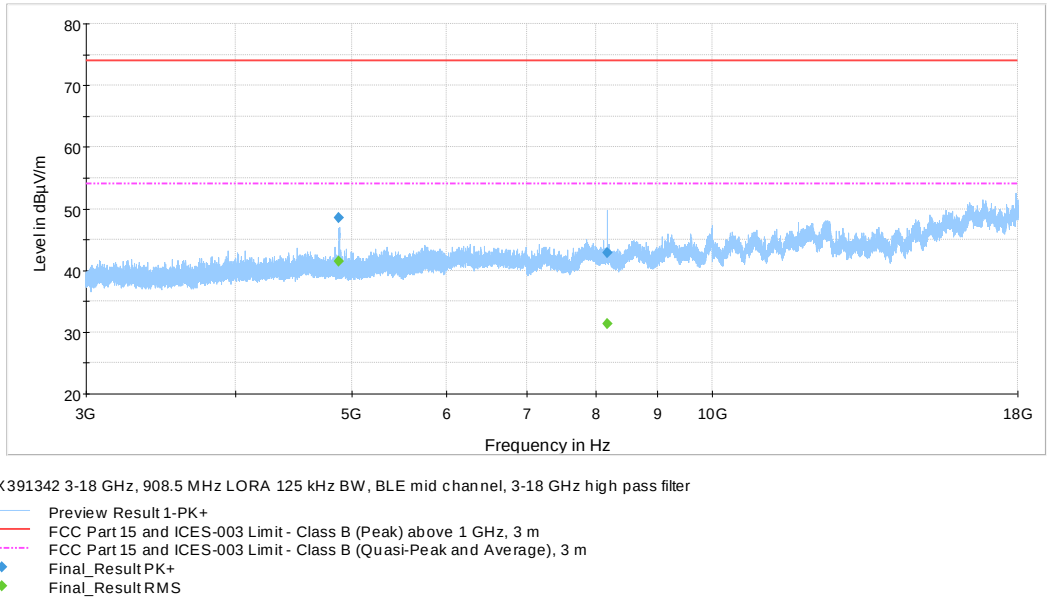



***Figure 8.1-5:*** *Radiated spurious emissions 3 - 18 GHz, BLE Tx at 2440 MHz, LoRa 125 kHz BW at 908.5 MHz*

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

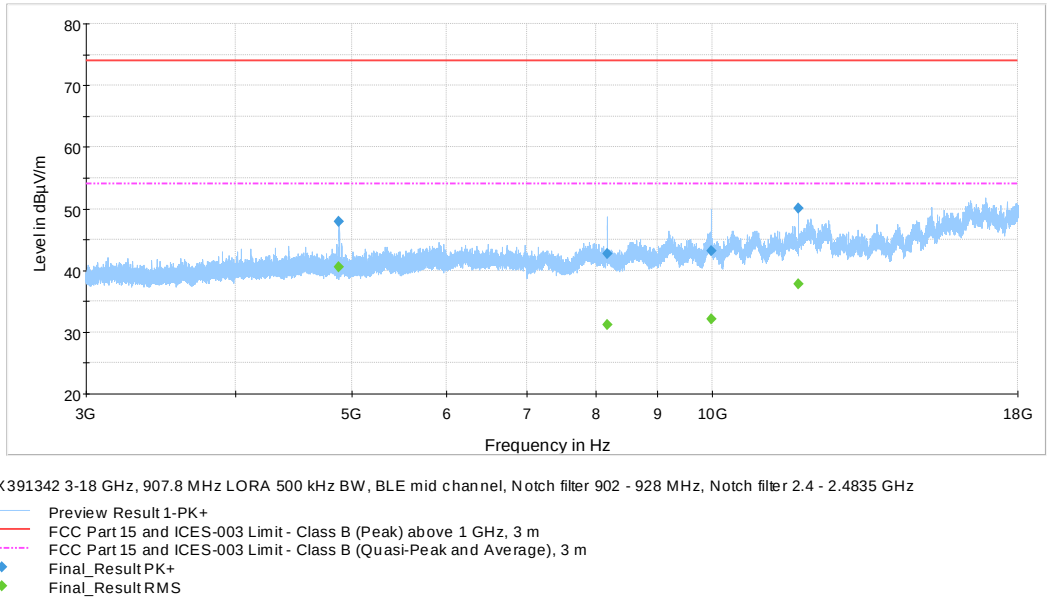



***Figure 8.1-6:*** *Radiated spurious emissions 3 - 18 GHz, BLE Tx at 2440 MHz, LoRa 500 kHz BW at 907.8 MHz*

***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 |

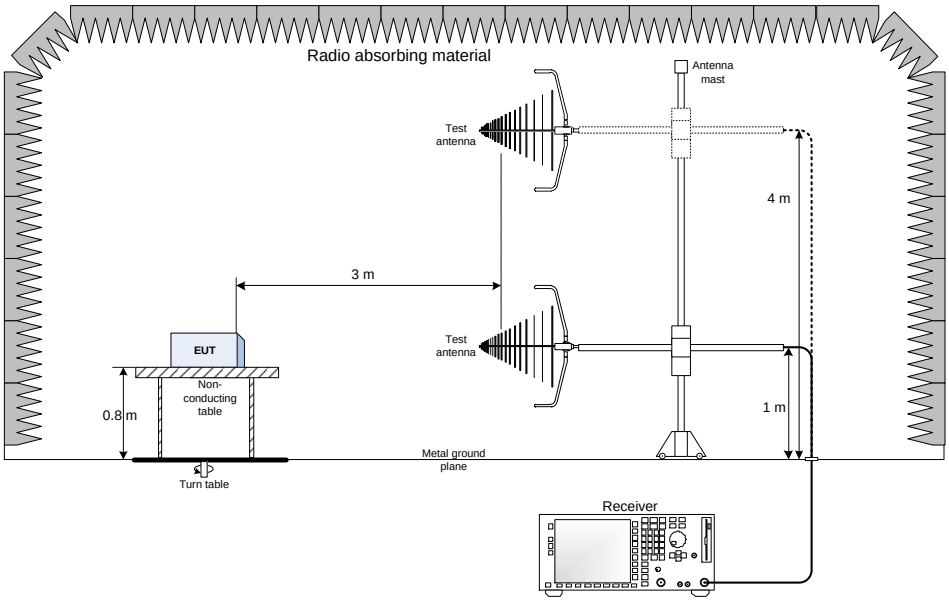
| Frequency (MHz) | Peak field strength[1 and 3] (dBµV/m) | Peak limit (dB⍰V/m) | Peak margin (dB) | Correction factor[2] (dB) |
|---|---|---|---|---|
| 4879.9 | 47.9 | 74.0 | 26.1 | -7.5 |
| 8173.0 | 42.7 | 74.0 | 31.3 | -0.8 |
| 9981.5 | 43.2 | 74.0 | 30.8 | 1.4 |
| 11800.5 | 50.0 | 74.0 | 24.0 | 1.2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

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.

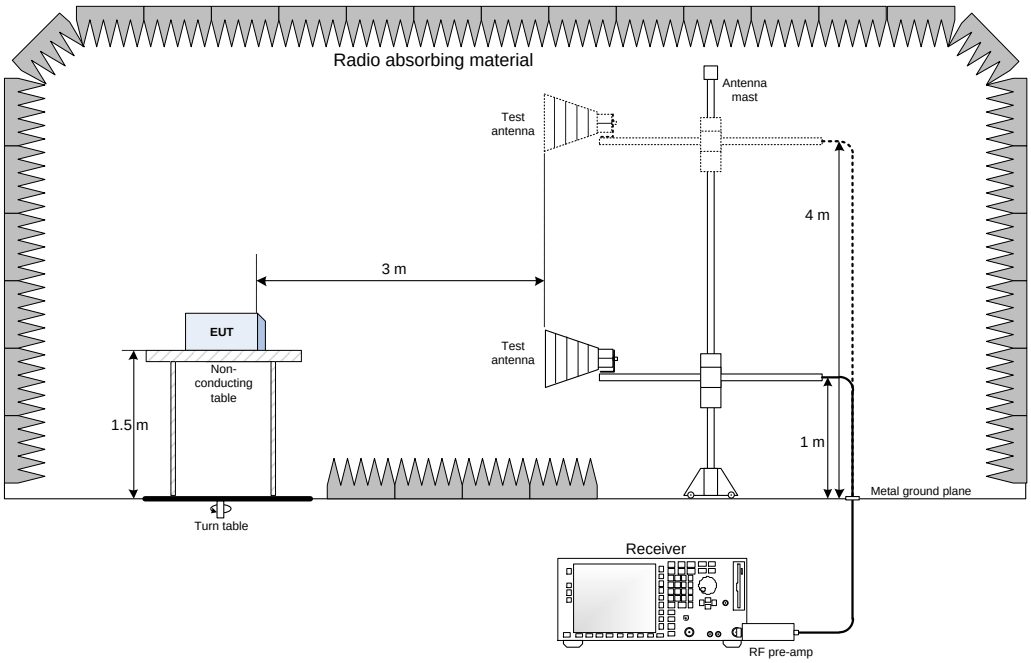
Sample calculation: 40.5 dBµV/m (field strength) = 48.0 dBµV (receiver reading) + (-7.5 dB) (Correction factor)

# 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)**