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## RADIO TEST REPORT – 403701-2TRFWL

Type of assessment:

**Final product testing**

Applicant:

**Ring LLC**

Product:

**Motion Detector**

Model:

**5AT2S9**

FCC ID:

**2AEUP5AT2S9**

IC Registration number:

**20271-5AT2S9**

Specifications:

- ◆ FCC 47 CFR Part 15, Subpart C, §15.249
- ◆ RSS-210 Annex B.10, Issue 10, December 2019

Date of issue: January 28, 2021

**Mark Libbrecht, EMC/RF Specialist**

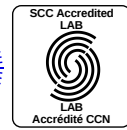
Tested by

Signature

**Andrey Adelberg, Senior EMC/RF Specialist**

Reviewed by

Signature



|                        |                                                                                                                       |                                                                                                                                                      |
|------------------------|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
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| Test site registration | <b>Organization</b><br>FCC/ISED                                                                                       | <b>Recognition numbers and location</b><br>FCC: CA2040; IC: 2040A-4 (Ottawa/Almonte); FCC: CA2041; IC: 2040G-5 (Montreal); <b>CA0101 (Cambridge)</b> |
| Website                | <a href="http://www.nemko.com">www.nemko.com</a>                                                                      |                                                                                                                                                      |

#### 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 Test specifications

|                                              |                                                                                                                                                                              |
|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FCC 47 CFR Part 15, Subpart C, Clause 15.249 | Operation within the bands 902–928 MHz, 2400–2483.5 MHz, 5725–5875 MHz, and 24.0–24.25 GHz.                                                                                  |
| RSS-210 Annex B.10, Issue 10, December 2019  | Licence-Exempt Radio Apparatus: Category I Equipment. Devices operating in 902–928 MHz, 2400–2483.5 MHz, 5725–5875 MHz and 24–24.25 GHz frequency bands for any application. |

### 1.2 Test methods

|                              |                                                                                                |
|------------------------------|------------------------------------------------------------------------------------------------|
| ANSI C63.10 v2013            | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices |
| RSS-Gen, Issue 5, March 2019 | General Requirements for Compliance of Radio Apparatus                                         |

### 1.3 Exclusions

None

### 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 1.3 above. 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 Test report revision history

**Table 1.5-1:** Test report revision history

| Revision # | Date of issue    | Details of changes made to test report |
|------------|------------------|----------------------------------------|
| TRF        | January 28, 2021 | Original report issued                 |

## Section 2. Engineering considerations

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### 2.1 Modifications incorporated in the EUT for compliance

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There were no modifications performed to the EUT during this assessment.

### 2.2 Technical judgment

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Power setting = 0.0 dBm used for all measurements

### 2.3 Deviations from laboratory tests procedures

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No deviations were made from laboratory procedures.

## Section 3. Test conditions

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### 3.1 Atmospheric conditions

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|                   |                                         |
|-------------------|-----------------------------------------|
| Temperature       | 15 °C – 35 °C                           |
| Relative humidity | 20 % – 75 %                             |
| Air pressure      | 86 kPa (860 mbar) – 106 kPa (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.

### 3.2 Power supply range

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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 4. Measurement uncertainty

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### 4.1 Uncertainty of measurement

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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 4.1-1:** Measurement uncertainty calculations

| Test name                         | Measurement uncertainty, $\pm$ dB |
|-----------------------------------|-----------------------------------|
| All antenna port measurements     | 0.55                              |
| Occupied bandwidth                | 4.45                              |
| Conducted spurious emissions      | 1.13                              |
| Radiated spurious emissions       | 3.78                              |
| AC power line conducted emissions | 3.55                              |

## Section 5. Information provided by the applicant

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### 5.1 Disclaimer

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This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results contained within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

### 5.2 Applicant/Manufacture

---

|                     |                                                     |
|---------------------|-----------------------------------------------------|
| Applicant name      | Ring LLC                                            |
| Applicant address   | 1523 26th St, Santa Monica, CA 90404, USA           |
| Manufacture name    | Leedarson Lighting Co.,Ltd.                         |
| Manufacture address | Xingtai industrial zone,Changtai, Zhangzhou Fujian. |

### 5.3 EUT information

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|                                             |                                                                                                                                        |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Product                                     | Motion Detector                                                                                                                        |
| Model                                       | 5AT2S9                                                                                                                                 |
| Serial number                               | None                                                                                                                                   |
| Power supply requirements                   | Battery: $2 \times 1.5 V_{DC}$ (AA)                                                                                                    |
| Product description and theory of operation | When a person walks within the field of view of the Motion Detector, it will active the sensor and send a message to the Base Station. |

### 5.4 Radio technical information

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|                                          |                                                      |
|------------------------------------------|------------------------------------------------------|
| Frequency band                           | 902–928 MHz                                          |
| Frequency Min (MHz)                      | 908.4                                                |
| Frequency Max (MHz)                      | 916.0                                                |
| Channel numbers                          | 3                                                    |
| RF power Max (W), Conducted              | N/A                                                  |
| Field strength, dB $\mu$ V/m @ 3 m       | 92.8 (908.4 MHz), 92.7 (908.42 MHz), 93.5 (916 MHz)  |
| Measured BW (kHz), 99% OBW               | 93.4 (908.4 MHz), 93.5 (908.42 MHz), 113.9 (916 MHz) |
| Type of modulation                       | Enter details                                        |
| Emission classification                  | Z Wave – FSK, GFSK                                   |
| Transmitter spurious, dB $\mu$ V/m @ 3 m | 52.6 (Peak) @ 1830 MHz                               |
| Antenna information                      | Monopole Antenna<br>Peak gain = 0.26 dBi             |

## 5.5 EUT setup details

### 5.5.1 Radio exercise details

|                      |                                                      |
|----------------------|------------------------------------------------------|
| Operating conditions | Firmware Revision V1.9                               |
| Transmitter state    | Transmitter state set to transmit at 100% duty cycle |
| Receiver state       | Receiver state in normal operation                   |

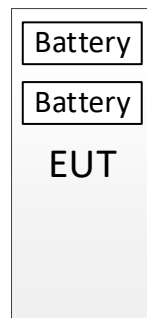
### 5.5.2 EUT setup configuration

**Table 5.5-1: EUT sub assemblies**

| Description         | Brand name | Model, Part number, Serial number, Revision level |
|---------------------|------------|---------------------------------------------------|
| 2 × 1.5 VDC Battery | Duracell   | MN: LR6, SKU: 1004255,                            |

**Table 5.5-2: EUT interface ports**

| Description  | Qty. |
|--------------|------|
| Flying leads | 4    |



**Figure 5.5-1: Testing block diagram**

## Section 6. Summary of test results

### 6.1 Testing location

|                   |           |
|-------------------|-----------|
| Test location (s) | Cambridge |
|-------------------|-----------|

### 6.2 Testing period

|                 |                  |               |                  |
|-----------------|------------------|---------------|------------------|
| Test start date | January 11, 2021 | Test end date | January 15, 2021 |
|-----------------|------------------|---------------|------------------|

### 6.3 Sample information

|              |                 |                           |   |
|--------------|-----------------|---------------------------|---|
| Receipt date | January 5, 2021 | Nemko sample ID number(s) | 1 |
|--------------|-----------------|---------------------------|---|

### 6.4 FCC Part 15 Subpart A and C, general requirements test results

**Table 6.4-1: FCC general requirements results**

| Part       | Test description             | Verdict        |
|------------|------------------------------|----------------|
| §15.207(a) | Conducted limits             | Not applicable |
| §15.31(e)  | Variation of power source    | Not applicable |
| §15.31(m)  | Number of tested frequencies | Pass           |
| §15.203    | Antenna requirement          | Pass           |
| §15.215(c) | Emission bandwidth           | Pass           |
| §15.215(c) | Frequency stability          | Pass           |

Notes: EUT is a battery operated device, the testing was performed using fresh batteries.

### 6.5 FCC Part 15 Subpart C, intentional radiators test results

**Table 6.5-1: FCC requirements results**

| Part          | Test description                                          | Verdict        |
|---------------|-----------------------------------------------------------|----------------|
| §15.249(a)    | Field strength of fundamental and harmonic emissions      | Pass           |
| §15.249(b)(1) | Fixed Point-to-Point operation in the 24.0–24.25 GHz band | Not applicable |
| §15.249(d)    | Radiated emissions except for harmonics                   | Pass           |

Notes: None

## 6.6 ISED RSS-Gen, Issue 5, test results

**Table 6.6-1:** RSS-Gen requirements 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 |
| 6.7  | Occupied bandwidth                                | Pass           |
| 8.11 | Frequency stability                               | Pass           |

Notes: <sup>1</sup>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.

## 6.7 ISED RSS-210, Issue 10, test results

**Table 6.7-1:** ISED requirements results

| Section | Test description                                                                           | Verdict |
|---------|--------------------------------------------------------------------------------------------|---------|
| B.10.a  | The field strength of fundamental and harmonic emissions                                   | Pass    |
| B.10.b  | Emissions radiated outside of the specified frequency bands, except for harmonic emissions | Pass    |

## 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    | Apr. 10/21 |
| 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    | Nov. 12/21 |
| Horn antenna (1–18 GHz)     | ETS Lindgren    | 3117      | FA002911  | 1 year    | Mar. 11/21 |
| Preamp (1–18 GHz)           | ETS Lindgren    | 124334    | FA002956  | 1 year    | Mar. 26/21 |
| Bilog antenna (30–2000 MHz) | SUNAR           | JB1       | FA003010  | 1 year    | Mar. 17/21 |
| 50 $\Omega$ coax cable      | Huber + Suhner  | None      | FA003047  | 1 year    | Mar. 30/21 |
| 50 $\Omega$ coax cable      | Huber + Suhner  | None      | FA003044  | 1 year    | Apr. 7/21  |

Note: NCR - no calibration required

## Section 8. Testing data

### 8.1 Variation of power source

#### 8.1.1 References, definitions and limits

**FCC §15.31:**

- (e) For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

#### 8.1.2 Test summary

|           |                |           |                  |
|-----------|----------------|-----------|------------------|
| Verdict   | Pass           |           |                  |
| Tested by | Mark Libbrecht | Test date | January 13, 2021 |

#### 8.1.3 Observations, settings and special notes

None

#### 8.1.4 Test data

|                                                                                                   |                                         |                             |                                             |
|---------------------------------------------------------------------------------------------------|-----------------------------------------|-----------------------------|---------------------------------------------|
| EUT Power requirements:                                                                           | <input type="checkbox"/> AC             | <input type="checkbox"/> DC | <input checked="" type="checkbox"/> Battery |
| If EUT is an AC or a DC powered, was the noticeable output power variation observed?              | <input type="checkbox"/> YES            | <input type="checkbox"/> NO | <input checked="" type="checkbox"/> N/A     |
| If EUT is battery operated, was the testing performed using fresh batteries?                      | <input checked="" type="checkbox"/> YES | <input type="checkbox"/> NO | <input type="checkbox"/> N/A                |
| If EUT is rechargeable battery operated, was the testing performed using fully charged batteries? | <input type="checkbox"/> YES            | <input type="checkbox"/> NO | <input checked="" type="checkbox"/> N/A     |

## 8.2 Number of frequencies

### 8.2.1 References, definitions and limits

#### FCC §15.31:

- (m) Measurements on intentional radiators or receivers shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table.

#### RSS-Gen, Clause 6.9:

Except where otherwise specified, measurements shall be performed for each frequency band of operation for which the radio apparatus is to be certified, with the device operating at the frequencies in each band of operation shown in table below. The frequencies selected for measurements shall be reported in the test report.

**Table 8.2-1: Frequency Range of Operation**

| Frequency range over which the device operates (in each band) | Number of test frequencies required | Location of measurement frequency inside the operating frequency range |
|---------------------------------------------------------------|-------------------------------------|------------------------------------------------------------------------|
| 1 MHz or less                                                 | 1                                   | Center (middle of the band)                                            |
| 1–10 MHz                                                      | 2                                   | 1 near high end, 1 near low end                                        |
| Greater than 10 MHz                                           | 3                                   | 1 near high end, 1 near center and 1 near low end                      |

Notes: "near" means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

### 8.2.2 Test summary

|           |                |           |                  |
|-----------|----------------|-----------|------------------|
| Verdict   | Pass           |           |                  |
| Tested by | Mark Libbrecht | Test date | January 11, 2021 |

### 8.2.3 Observations, settings and special notes

EUT is limited to 3 channels of operation

### 8.2.4 Test data

**Table 8.2-2: Test channels selection**

| Start of Frequency range, MHz | End of Frequency range, MHz | Frequency range bandwidth, MHz | Low channel, MHz | Mid channel, MHz | High channel, MHz |
|-------------------------------|-----------------------------|--------------------------------|------------------|------------------|-------------------|
| 902                           | 928                         | 26                             | 908.4            | 908.42           | 916               |

## 8.3 Antenna requirement

### 8.3.1 References, definitions and limits

#### FCC §15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

#### RSS-Gen, Clause 6.8:

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list. For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report.

### 8.3.2 Test summary

|           |                |           |                  |
|-----------|----------------|-----------|------------------|
| Verdict   | Pass           |           |                  |
| Tested by | Mark Libbrecht | Test date | January 11, 2021 |

### 8.3.3 Observations, settings and special notes

None

### 8.3.4 Test data

Must the EUT be professionally installed?      ☐ YES      ☒ NO  
Does the EUT have detachable antenna(s)?      ☐ YES      ☒ NO  
If detachable, is the antenna connector(s) non-standard?      ☐ YES      ☐ NO      ☒ N/A

**Table 8.3-1:** Antenna information

| Antenna type     | Manufacturer | Model number | Maximum gain | Connector type |
|------------------|--------------|--------------|--------------|----------------|
| Monopole Antenna | Jucheng      | N/A          | 0.26 dBi     | N/A            |

## 8.4 Field strength of fundamental and harmonics emissions

### 8.4.1 References, definitions and limits

#### FCC §15.249:

- (a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following table.
- (c) Field strength limits are specified at a distance of 3 meters.
- (e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

#### ANSI C63.10, Clause 6.3.3:

##### Radiated total peak emission level

Some wireless devices are subject to a peak limit based on the total peak emission level (i.e., rather than being based on a peak level over a specified bandwidth). Unless otherwise specified, radiated measurements of the fundamental-signal peak field strength shall be made using instrumentation with a bandwidth equal to or greater than the 6 dB bandwidth of the emission.<sup>46</sup> For unlicensed wireless devices with fundamental signals subject to quasi-peak (QP) limits, when the QP detector bandwidth is less than the 6 dB bandwidth of the emission, a peak detector with a bandwidth equal to or greater than the 6 dB bandwidth of the emission shall be used.

#### ANSI C63.10, Clause 4.1.4.2:

Specific detector functions and bandwidths for unlicensed wireless device measurements

##### 4.1.4.2.1 Frequencies less than or equal to 1000 MHz

At any frequency or frequencies less than or equal to 1000 MHz, measurements shall be made with the CISPR quasi-peak detector and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrument using the CISPR quasi-peak detector are given in CISPR 16-1-1:2010. Where average limits are specified, an average detector shall be used. Where peak limits are also specified, the peak emission shall also be measured with instrumentation properly adjusted for factors, such as pulse desensitization. As an alternative to CISPR quasi-peak measurements or average measurements, a test laboratory may demonstrate compliance with the emission limits using measuring equipment employing a peak detector function as long as the equivalent or greater bandwidths as indicated for CISPR quasi-peak measurements or average measurements, as applicable, are employed.

Pulse-modulated devices with a pulse repetition frequency of 20 Hz or less have additional requirements.

##### 4.1.4.2.2 Frequencies above 1000 MHz

Unless otherwise stated, on any frequency or frequencies above 1000 MHz, measurements shall be made with measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz. Peak measurements can apply to the total peak emission level radiated by the device (i.e., the total peak power level) depending on the applicable regulatory requirement. Note that the use of a pulse desensitization correction factor might be needed to determine the total peak emission level.

#### ANSI C63.10, Clause 6.3

Radiated emissions testing—common requirements

##### 6.3.3 Radiated total peak emission level

Some wireless devices are subject to a peak limit based on the total peak emission level (i.e., rather than being based on a peak level over a specified bandwidth). Unless otherwise specified, radiated measurements of the fundamental-signal peak field strength shall be made using instrumentation with a bandwidth equal to or greater than the 6 dB bandwidth of the emission.

#### RSS-210 B.10:

Devices shall comply with the following requirements:

- a. The field strength of fundamental and harmonic emissions measured at 3 m shall not exceed the limits in the following table.  
The field strength shall be measured using an average detector, except for the fundamental emission in the frequency band 902–928 MHz, which is based on measurements using an International Special Committee on Radio Interference (CISPR) quasi-peak detector.

**Table 8.4-1: Field strength limits**

| Fundamental frequency,<br>MHz | Field strength of fundamental, |        | Field strength of spurious emissions, |        |
|-------------------------------|--------------------------------|--------|---------------------------------------|--------|
|                               | mV/m                           | dBμV/m | μV/m                                  | dBμV/m |
| 902–928                       | 50                             | 94     | 500                                   | 54     |
| 2400–2483.5                   | 50                             | 94     | 500                                   | 54     |
| 5725–5875                     | 50                             | 94     | 500                                   | 54     |
| 24000–24250                   | 250                            | 108    | 2500                                  | 68     |

#### 8.4.2 Test summary

---

|           |                |           |                  |
|-----------|----------------|-----------|------------------|
| Verdict   | Pass           |           |                  |
| Tested by | Mark Libbrecht | Test date | January 15, 2021 |

#### 8.4.3 Observations, settings and special notes

---

The spectrum was searched from 30 MHz to the 10<sup>th</sup> harmonic.  
Radiated measurements were performed at a distance of 3 m.  
No transmitter related harmonics observed above the 2<sup>nd</sup> harmonic  
EUT duty cycle  $\geq$  98 %

Spectrum analyser settings for radiated measurements below 1 GHz:

|                      |                            |
|----------------------|----------------------------|
| Resolution bandwidth | > OBW                      |
| Video bandwidth      | $\geq 3 \times \text{RBW}$ |
| Detector mode        | Peak                       |
| Trace mode           | Max Hold                   |

Spectrum analyser settings for radiated measurements above 1 GHz:

|                      |          |
|----------------------|----------|
| Resolution bandwidth | 1 MHz    |
| Video bandwidth      | 3 MHz    |
| Detector mode        | Peak     |
| Trace mode           | Max Hold |

#### 8.4.4 Test data

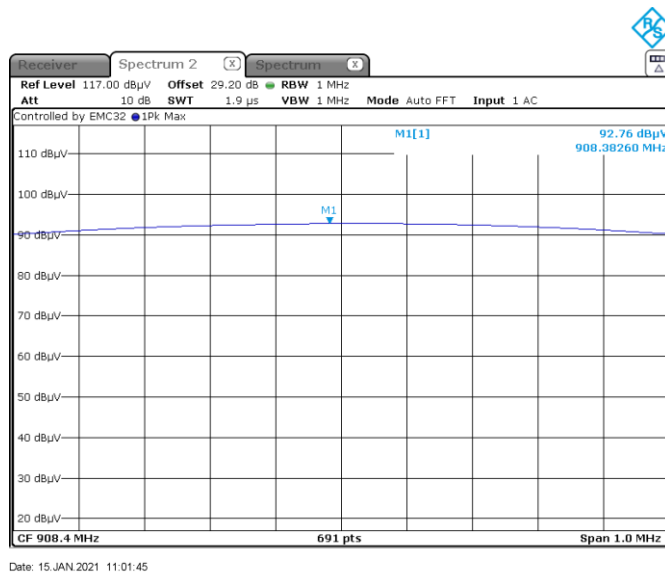
**Table 8.4-2: Radiated field strength measurement results**

| Frequency, MHz | Peak field strength <sup>1</sup> , dBμV/m | Quasi-Peak <sup>2</sup> limit, dBμV/m | Margin, dB |
|----------------|-------------------------------------------|---------------------------------------|------------|
| 908.40         | 92.8                                      | 94.0                                  | 1.2        |
| 908.42         | 92.7                                      | 94.0                                  | 1.3        |
| 916.00         | 93.5                                      | 94.0                                  | 0.5        |

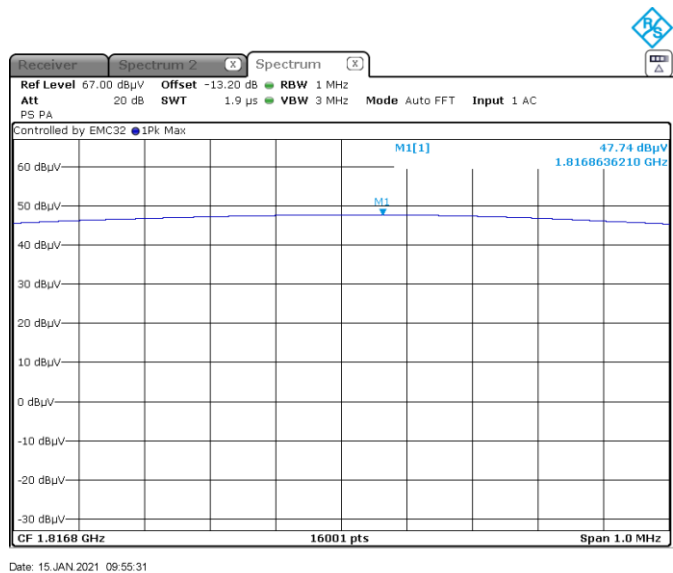
  

| Frequency, MHz | Peak field strength <sup>1</sup> , dBμV/m | Average <sup>3</sup> limit, dBμV/m | Margin, dB |
|----------------|-------------------------------------------|------------------------------------|------------|
| 1816.80        | 47.7                                      | 54.0                               | 6.3        |
| 1816.84        | 47.5                                      | 54.0                               | 6.5        |
| 1832.00        | 52.6                                      | 54.0                               | 1.4        |

Notes: <sup>1</sup>Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.  
<sup>2</sup>At frequencies below 1000 MHz, measurements performed using the quasi-peak measurement procedures must satisfy the quasi-peak limits. However, if the peak-measurement results satisfy the quasi-peak limit, then additional quasi-peak measurements are not required to demonstrate compliance.  
<sup>3</sup>At frequencies above 1000 MHz, measurements performed using the peak and average measurement procedures must satisfy the respective peak and average limits. However, if the peak-measurement results satisfy the average limit, then additional average measurements are not required to demonstrate compliance.

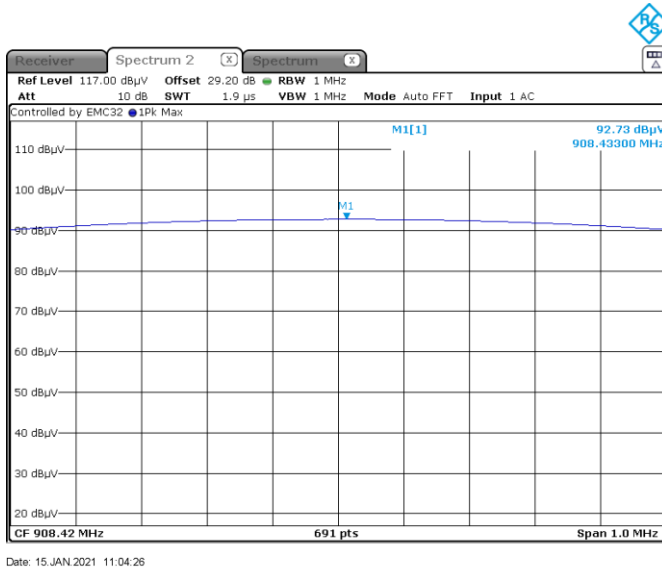


**Figure 8.4-1: Field strength of fundamental emission, 908.4 MHz**

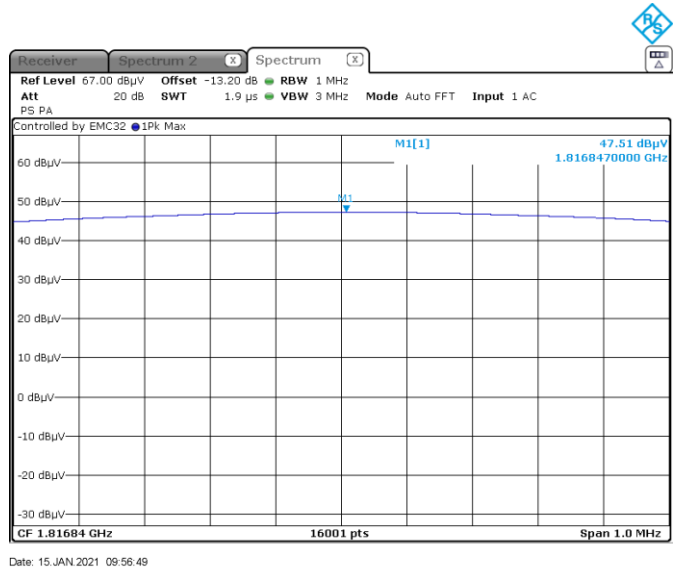


**Figure 8.4-2: Field strength of 2<sup>nd</sup> harmonic emission**

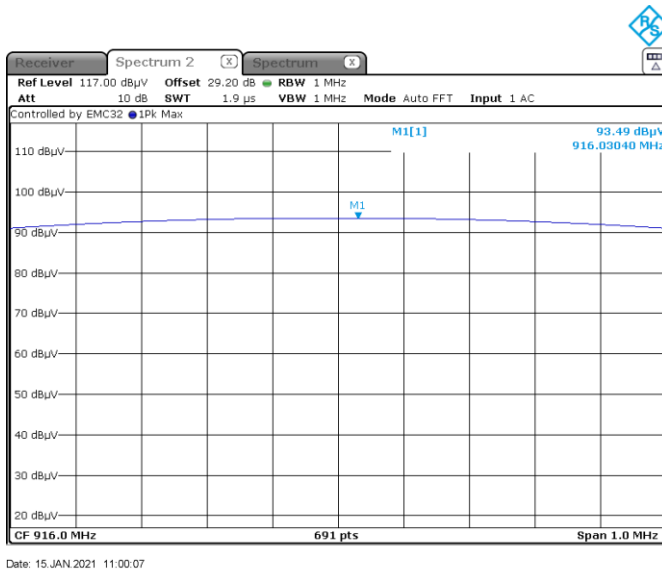
Test data, continued



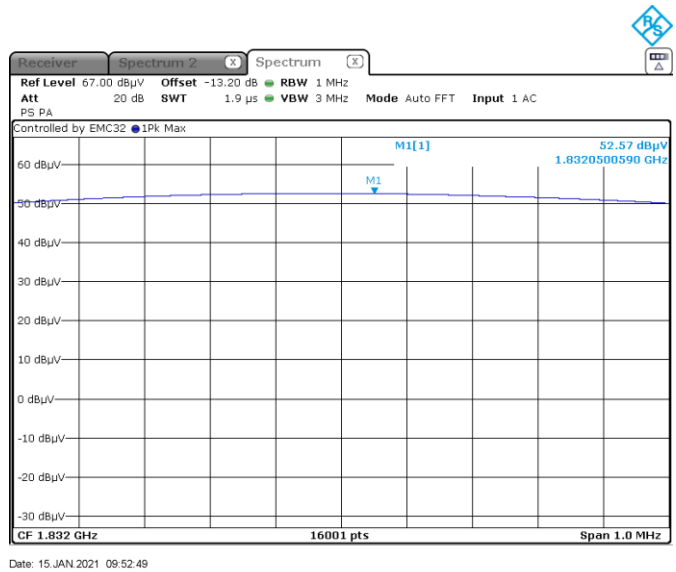
**Figure 8.4-3:** Field strength of fundamental emission, 908.42 MHz



**Figure 8.4-4:** Field strength of 2<sup>nd</sup> harmonic emission



**Figure 8.4-5:** Field strength of fundamental emission, 916.0 MHz



**Figure 8.4-6:** Field strength of 2<sup>nd</sup> harmonic emission

## 8.5 Field strength of spurious emissions (except for harmonics)

### 8.5.1 References, definitions and limits

#### FCC §15.249:

- (d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

#### ANSI C63.10, Clause 4.1.4.2:

Specific detector functions and bandwidths for unlicensed wireless device measurements

##### 4.1.4.2.1 Frequencies less than or equal to 1000 MHz

At any frequency or frequencies less than or equal to 1000 MHz, measurements shall be made with the CISPR quasi-peak detector and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrument using the CISPR quasi-peak detector are given in CISPR 16-1-1:2010. Where average limits are specified, an average detector shall be used. Where peak limits are also specified, the peak emission shall also be measured with instrumentation properly adjusted for factors, such as pulse desensitization. As an alternative to CISPR quasi-peak measurements or average measurements, a test laboratory may demonstrate compliance with the emission limits using measuring equipment employing a peak detector function as long as the equivalent or greater bandwidths as indicated for CISPR quasi-peak measurements or average measurements, as applicable, are employed.

Pulse-modulated devices with a pulse repetition frequency of 20 Hz or less have additional requirements.

##### 4.1.4.2.2 Frequencies above 1000 MHz

Unless otherwise stated, on any frequency or frequencies above 1000 MHz, measurements shall be made with measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz. Peak measurements can apply to the total peak emission level radiated by the device (i.e., the total peak power level) depending on the applicable regulatory requirement. Note that the use of a pulse desensitization correction factor might be needed to determine the total peak emission level.

#### RSS-210 B.10:

Devices shall comply with the following requirements:

- b. Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits listed in RSS-Gen, whichever is less stringent.

**Table 8.5-1: FCC §15.209 and RSS-Gen – Radiated emission limits**

| Frequency,<br>MHz | Field strength of emissions |                                 | Measurement distance, m |
|-------------------|-----------------------------|---------------------------------|-------------------------|
|                   | $\mu\text{V/m}$             | $\text{dB}\mu\text{V/m}$        |                         |
| 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

## References, definitions and limits, continued

**Table 8.5-2: 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     | Above 38.6  |
| 12.29–12.293      | 240–285             | 4500–5150     |             |
| 12.51975–12.52025 | 322–335.4           | 5350–5460     |             |

Note: Certain frequency bands listed in this table 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 8.5-3: 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       |                     |               |             |

## 8.5.2 Test summary

|           |                |           |                  |
|-----------|----------------|-----------|------------------|
| Verdict   | Pass           |           |                  |
| Tested by | Mark Libbrecht | Test date | January 13, 2021 |

### 8.5.3      Observations, settings and special notes

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The spectrum was searched from 30 MHz to the frequency of 10<sup>th</sup> harmonic.  
Radiated measurements were performed at a distance of 3 m.

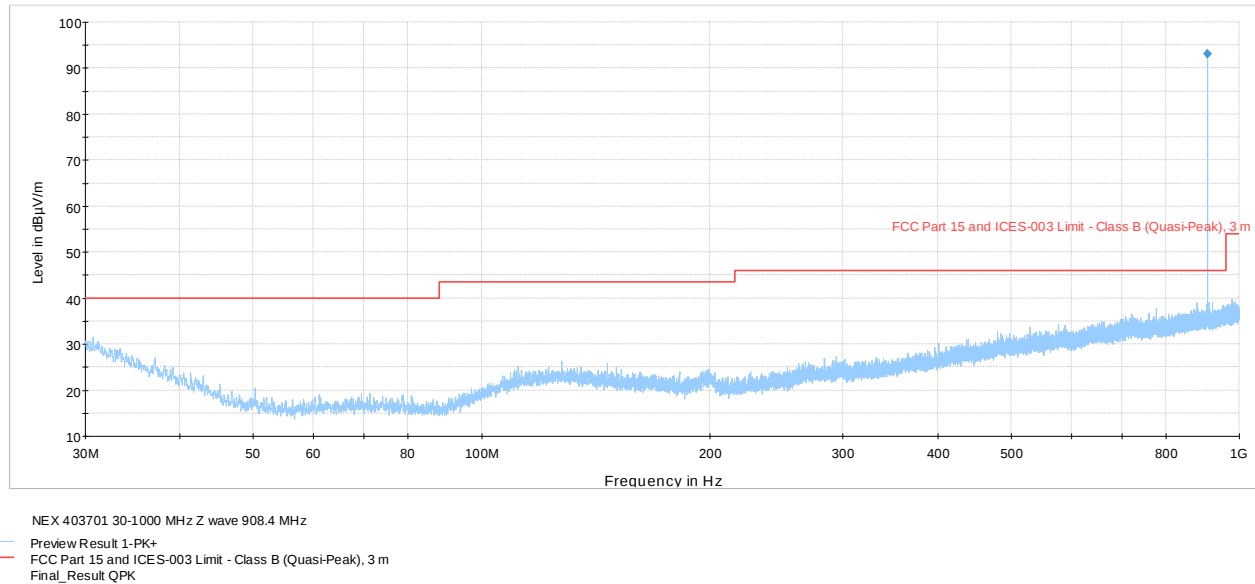
Spectrum analyser settings for radiated measurements within restricted bands below 1 GHz:

|                      |                                    |
|----------------------|------------------------------------|
| Resolution bandwidth | 100 kHz                            |
| Video bandwidth      | 300 kHz                            |
| Detector mode        | Peak (Preview), Quasi-peak (Final) |
| Trace mode           | Max Hold                           |

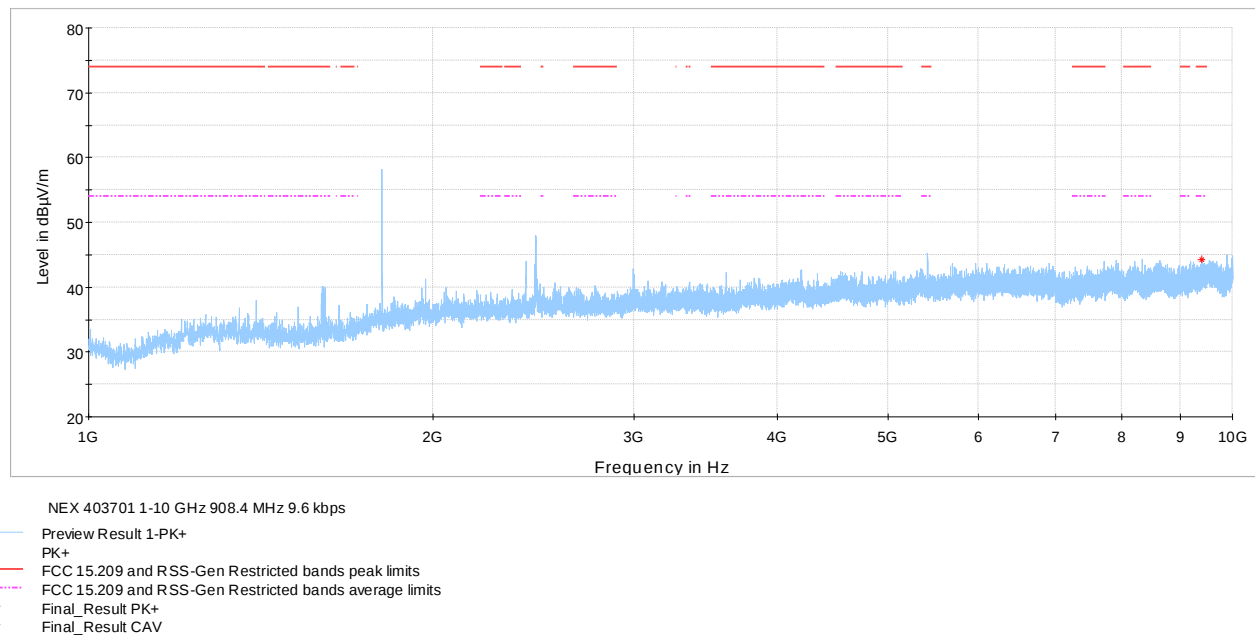
Spectrum analyser settings for radiated measurements within restricted bands above 1 GHz:

|                      |                  |
|----------------------|------------------|
| Resolution bandwidth | 1 MHz            |
| Video bandwidth      | 3 MHz            |
| Detector mode        | Peak and Average |
| Trace mode           | Max Hold         |

#### 8.5.4 Test data

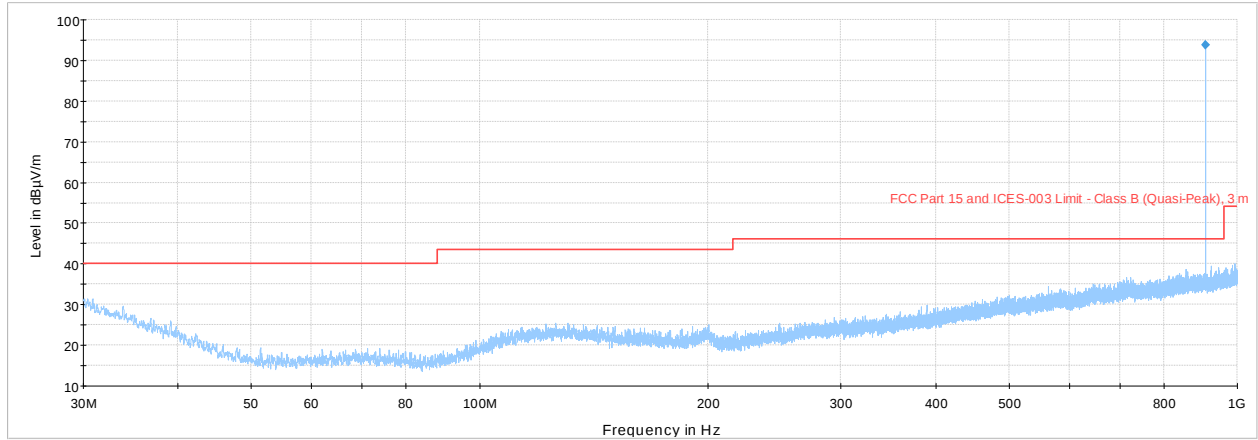


**Figure 8.5-1:** Spurious emissions below 1 GHz, 908.4 MHz

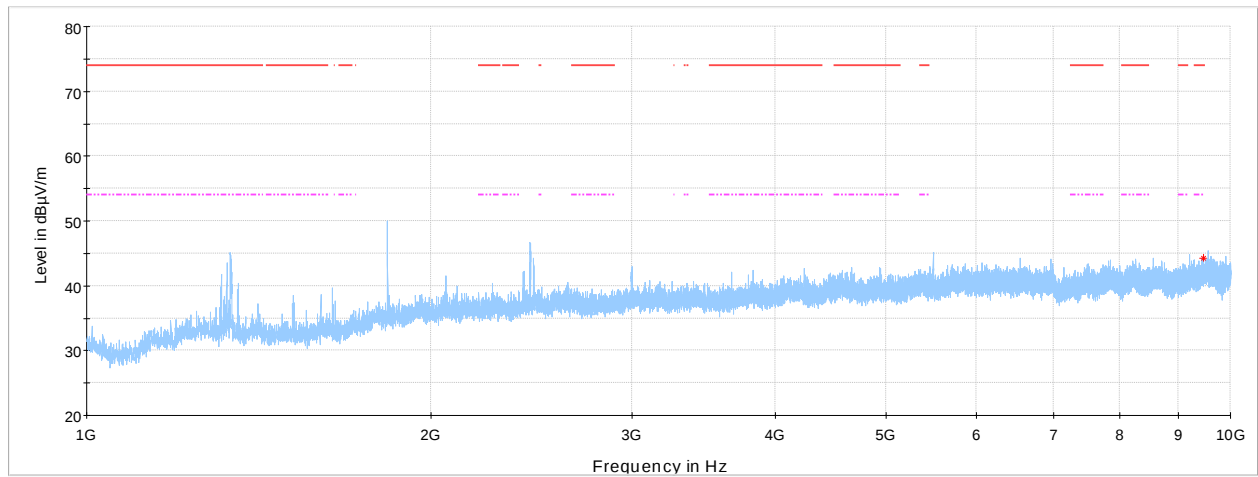


**Figure 8.5-2:** Spurious emissions above 1 GHz, 908.4 MHz

## Test data, continued

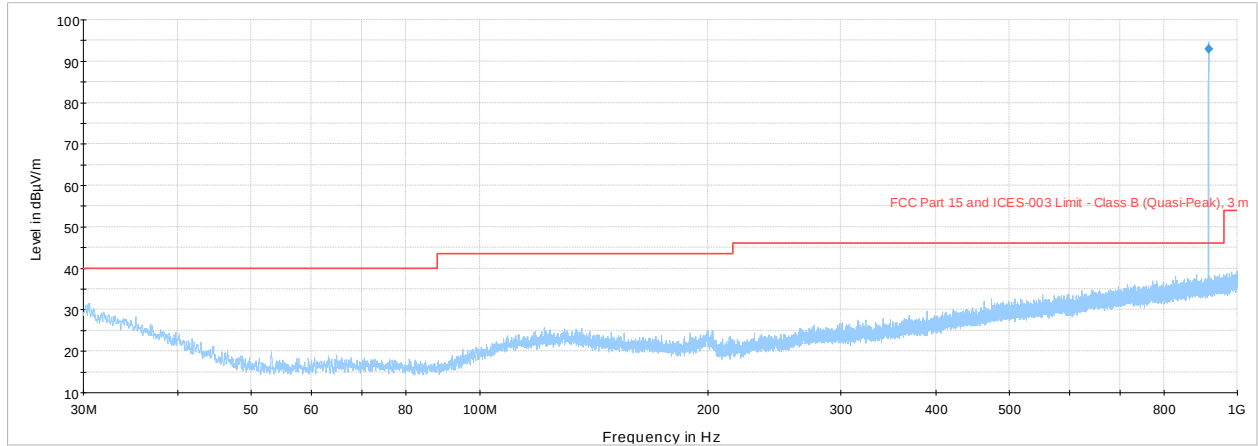


**Figure 8.5-3: Spurious emissions below 1 GHz, 908.42 MHz**



**Figure 8.5-4: Spurious emissions above 1 GHz, 908.42 MHz**

## Test data, continued



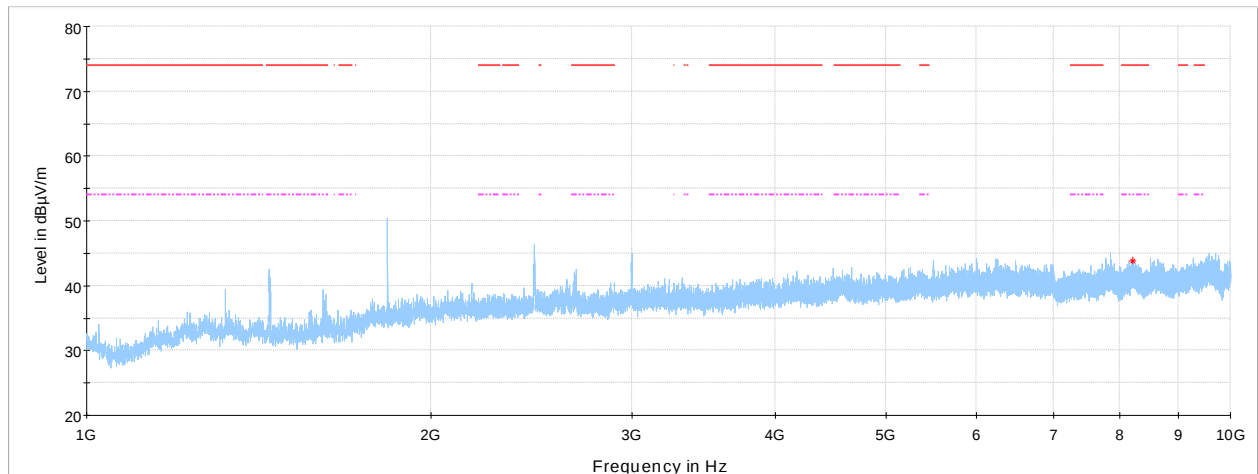
NEX 403701 30-1000 MHz Z wave 916 MHz

Preview Result 1-PK+

FCC Part 15 and ICES-003 Limit - Class B (Quasi-Peak), 3 m

Final\_Result QPK

**Figure 8.5-5: Spurious emissions below 1 GHz, 916 MHz**



NEX 403701 1-10 GHz 916 MHz 100 kbps

Preview Result 1-PK+

PK+

FCC 15.209 and RSS-Gen Restricted bands peak limits

FCC 15.209 and RSS-Gen Restricted bands average limits

Final\_Result PK+

Final\_Result CAV

**Figure 8.5-6: Spurious emissions above 1 GHz, 916 MHz**

## 8.6 Emission bandwidth and frequency stability

### 8.6.1 References, 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.

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, Clause 6.7:

Occupied bandwidth (or 99% emission bandwidth) and x dB bandwidth

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

#### RSS-Gen, Clause 8.11:

Frequency stability

If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable RSS, the fundamental emissions of the radio apparatus should be kept within at least the central 80% of its permitted operating frequency band in order to minimize the possibility of out-of-band operation.

**Table 8.6-1: Frequency stability limit**

| Fundamental frequency band, MHz | Central 80% of permitted operating frequency band, MHz |
|---------------------------------|--------------------------------------------------------|
| 902–928                         | 904.6–925.4                                            |
| 2400–2483.5                     | 2408.35–2475.15                                        |
| 5725–5875                       | 5740–5860                                              |
| 24000–24250                     | 24025–24225                                            |

### 8.6.2 Test summary

|           |                |           |                  |
|-----------|----------------|-----------|------------------|
| Verdict   | Pass           |           |                  |
| Tested by | Mark Libbrecht | Test date | January 15, 2021 |

### 8.6.3 Observations, settings and special notes

Spectrum analyser settings:

|                      |                               |
|----------------------|-------------------------------|
| Resolution bandwidth | ≥ 1 % of emission bandwidth   |
| Video bandwidth      | ≥ 3 × RBW                     |
| Frequency span       | Wider than emission bandwidth |
| Detector mode        | Peak                          |

#### 8.6.4 Test data

**Table 8.6-2:** Occupied bandwidth measurement result

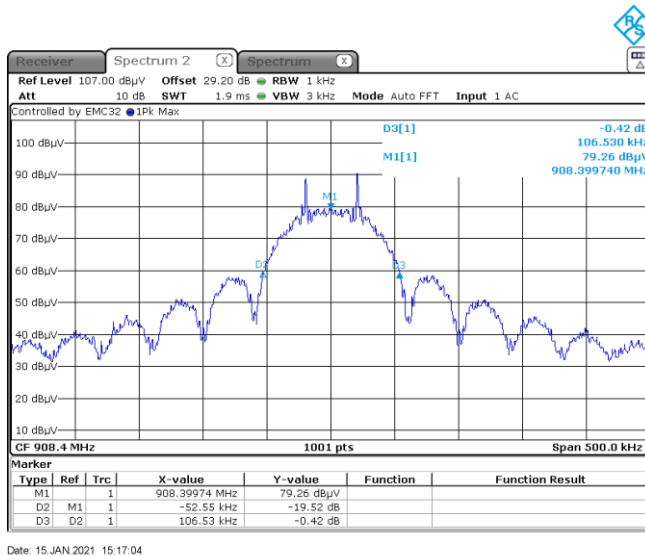
| Frequency, MHz | 20 dB BW, kHz | 99% BW, kHz |
|----------------|---------------|-------------|
| 908.4          | 106.5         | 93.4        |
| 908.42         | 97.7          | 95.5        |
| 916.0          | 121.9         | 113.9       |

**Table 8.6-3:** FCC occupied bandwidth limitations

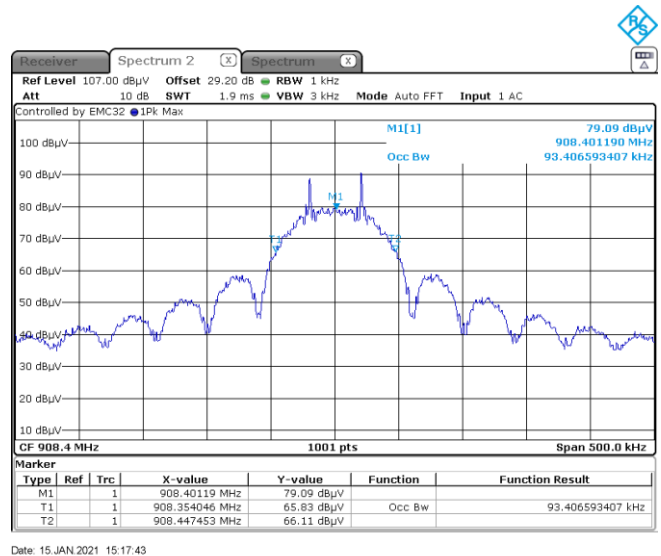
| Fundamental frequency, MHz | Lower -20 dBc frequency cross, MHz | Lower limit, MHz | Margin, MHz | Upper -20 dBc frequency cross, MHz | Upper limit, MHz | Margin, MHz |
|----------------------------|------------------------------------|------------------|-------------|------------------------------------|------------------|-------------|
| 908.4                      | 908.3                              | 904.6            | 3.7         | 908.5                              | 925.4            | 16.9        |
| 908.42                     | 908.3                              | 904.6            | 3.7         | 908.5                              | 925.4            | 16.9        |
| 916.0                      | 915.9                              | 904.6            | 11.3        | 916.1                              | 925.4            | 9.3         |

**Table 8.6-4:** ISED occupied bandwidth limitations

| Fundamental frequency, MHz | Lower 99% BW frequency cross, MHz | Lower limit, MHz | Margin, MHz | Upper 99% BW frequency cross, MHz | Upper limit, MHz | Margin, MHz |
|----------------------------|-----------------------------------|------------------|-------------|-----------------------------------|------------------|-------------|
| 908.4                      | 908.4                             | 904.6            | 3.7         | 908.5                             | 925.4            | 16.9        |
| 908.42                     | 908.3                             | 904.6            | 3.6         | 908.5                             | 925.4            | 16.9        |
| 916.0                      | 915.9                             | 904.6            | 11.3        | 916.1                             | 925.4            | 9.3         |



**Figure 8.6-1:** 20 dB occupied bandwidth, 908.4 MHz



**Figure 8.6-2:** 99 % occupied bandwidth, 908.4 MHz

Test data, continued

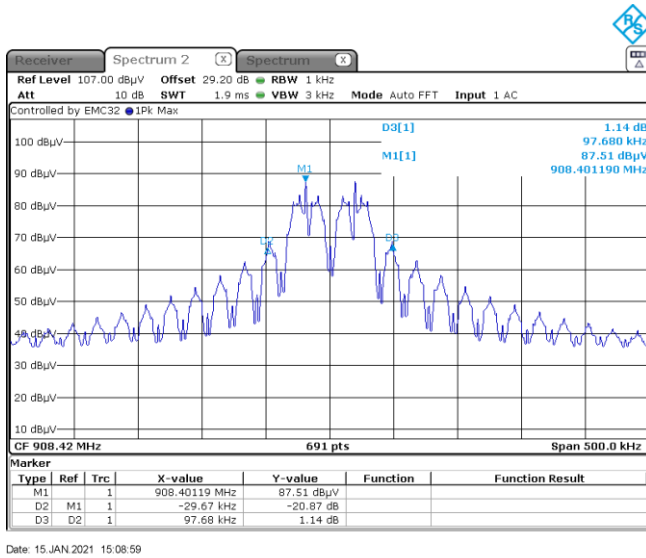


Figure 8.6-3: 20 dB occupied bandwidth, 908.42 MHz

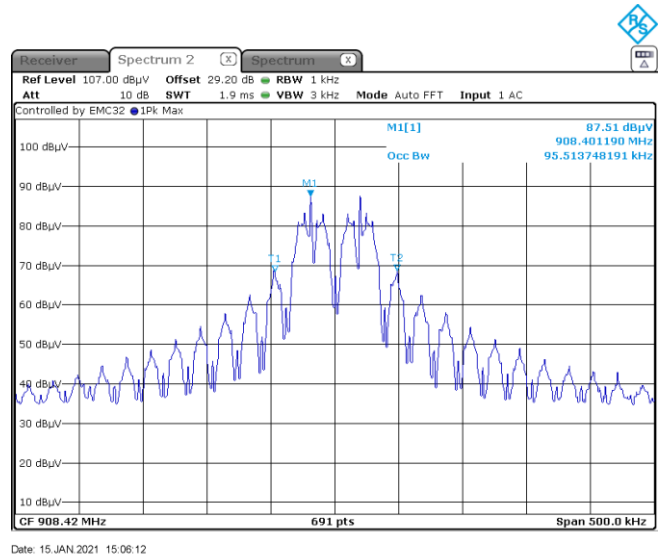


Figure 8.6-4: 99 % occupied bandwidth, 908.42 MHz

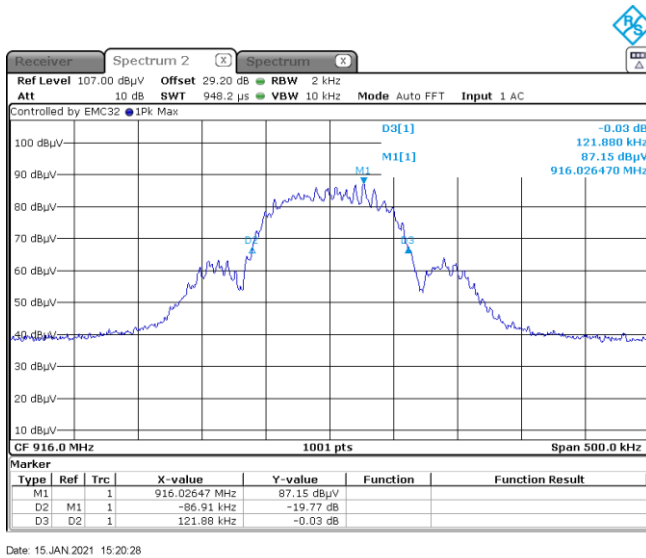


Figure 8.6-5: 20 dB occupied bandwidth, 916 MHz

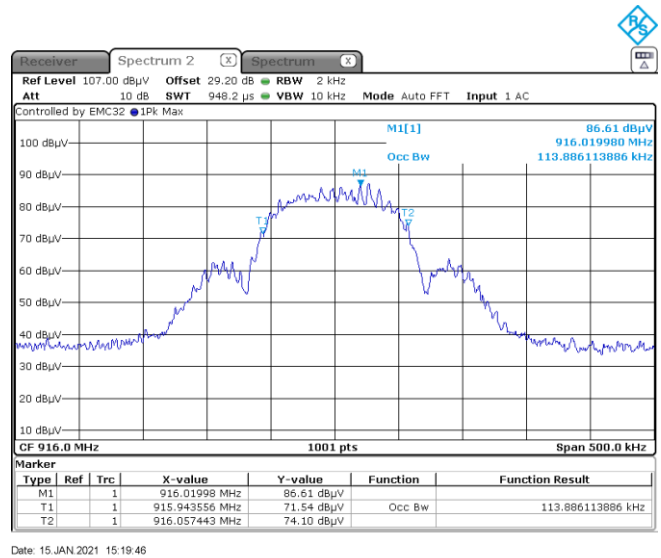
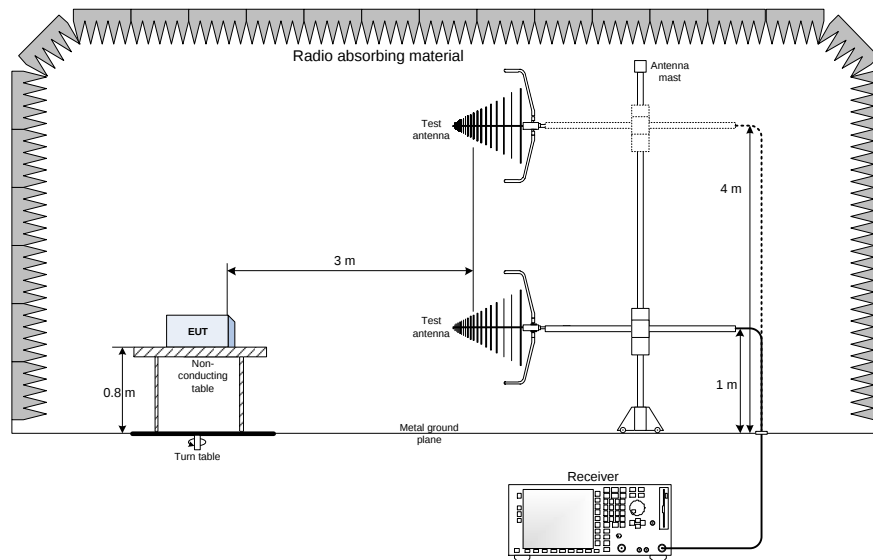


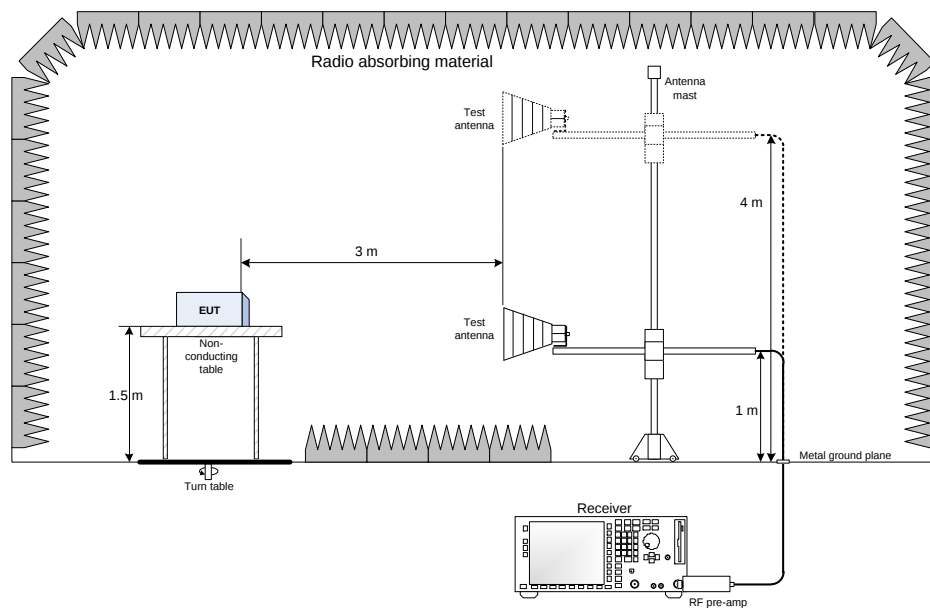
Figure 8.6-6: 99 % occupied bandwidth, 916 MHz

## 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 Test Report