

## TEST REPORT

Test report no.: 1-8881-24-01-17\_TR1-R03



### Testing laboratory

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#### **Accredited Testing Laboratory:**

The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS).

The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number:

D-PL-12047-01-00.

ISED Testing Laboratory Recognized Listing Number: DE0001

FCC designation number: DE0002

### Applicant

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### Manufacturer

#### **endiio Engineering GmbH**

Georges-Köhler-Allee 302

79110 Freiburg im Breisgau / GERMANY

### Test standard/s

|                                                                                   |                                                                                                                                   |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| FCC - Title 47 CFR Part 15                                                        | FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices                                   |
| RSS - 247 Issue 3                                                                 | Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices      |
| RSS - Gen Issue 5 incl. Amendment 1 & 2                                           | Spectrum Management and Telecommunications Radio Standards Specification - General Requirements for Compliance of Radio Apparatus |
| For further applied test standards please refer to section 3 of this test report. |                                                                                                                                   |

### Test Item

|                                   |                                        |
|-----------------------------------|----------------------------------------|
| <b>Kind of test item:</b>         | <b>RF Modul for IoT Sensorplatform</b> |
| <b>Model name:</b>                | <b>endiio Retrofit-Box V2</b>          |
| <b>FCC ID:</b>                    | <b>2BL4CEN-WM2</b>                     |
| <b>ISED certification number:</b> | <b>33310-ENWM2</b>                     |
| Frequency:                        | 915.4 MHz – 916 MHz                    |
| Technology tested:                | proprietary                            |
| Antenna:                          | internal antenna                       |
| Power supply:                     | 2.9 V to 3.6 V DC, by internal battery |
| Temperature range:                | -20°C to +120°C                        |

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

### Test report authorized:

Christoph Schneider  
Lab Manager  
Radio Labs

### Test performed:

Hans-Joachim Wolsdorfer  
Lab Manager  
Radio Labs

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## 2 General information

### 2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. cetecom advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

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**This test report replaces the test report with the number 1-8881-24-01-17\_TR1-R02 and dated 2025-05-09.**

### 2.2 Application details

|                                    |            |
|------------------------------------|------------|
| Date of receipt of order:          | 2024-11-11 |
| Date of receipt of test item:      | 2025-03-12 |
| Start of test:*                    | 2025-03-19 |
| End of test:*                      | 2025-04-09 |
| Person(s) present during the test: | -/-        |

\*Date of each measurement, if not shown in the plot, can be requested. Dates are stored in the measurement software.

### 2.3 Test laboratories sub-contracted

None

### 3 Test standard/s, references and accreditations

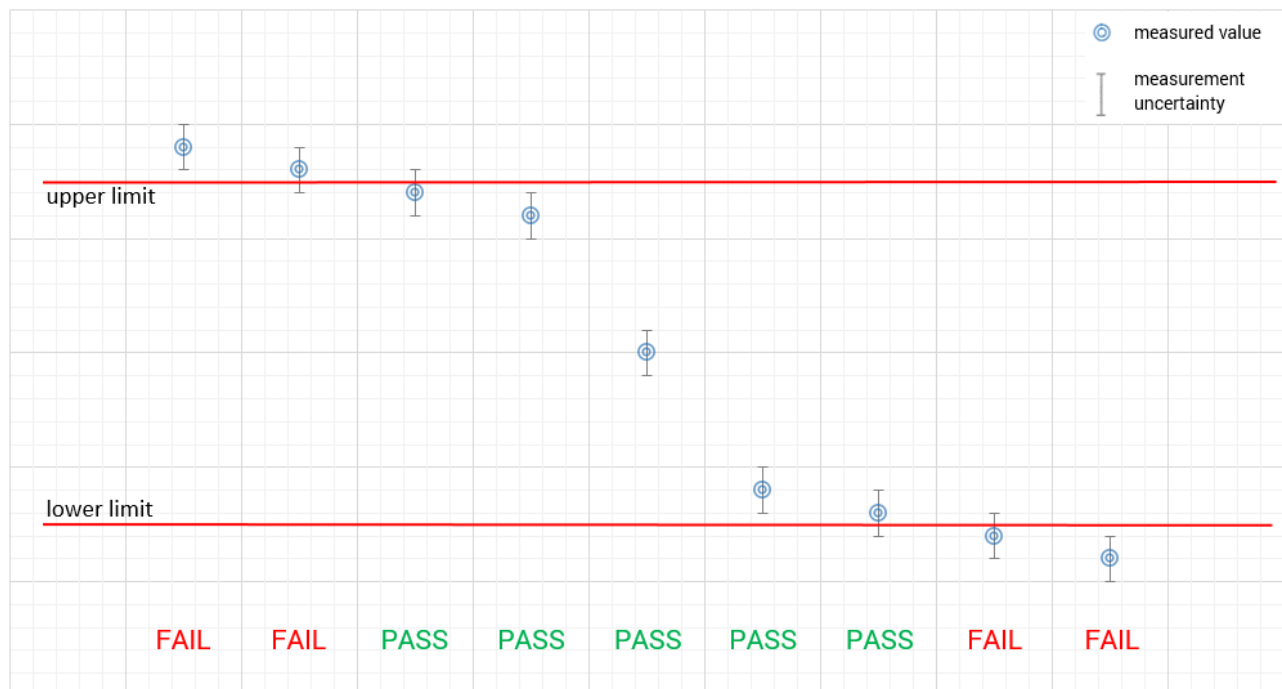
| Test standard                           | Date          | Description                                                                                                                                                                              |
|-----------------------------------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FCC - Title 47 CFR Part 15              |               | FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices                                                                                          |
| RSS - 247 Issue 3                       | August 2023   | Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices                                                             |
| RSS - Gen Issue 5 incl. Amendment 1 & 2 | February 2021 | Spectrum Management and Telecommunications Radio Standards Specification<br>- General Requirements for Compliance of Radio Apparatus                                                     |
| Guidance                                | Version       | Description                                                                                                                                                                              |
| KDB 558074 D01                          | v05r02        | GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES |
| KDB 996369 D04                          | v02           | MODULAR TRANSMITTER INTEGRATION GUIDE GUIDANCE FOR HOST PRODUCT MANUFACTURERS                                                                                                            |
| ANSI C63.4a-2017                        | -/-           | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz                      |
| ANSI C63.10-2020                        | -/-           | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices                                                                                           |

#### 4 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.

The measurement uncertainty is mentioned in this test report, see chapter 9, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."

measured value, measurement uncertainty, verdict



## 5 Test environment

|                             |                                                          |                                                                                                                                                                                    |
|-----------------------------|----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Temperature :               | T <sub>nom</sub><br>T <sub>max</sub><br>T <sub>min</sub> | +22 °C during room temperature tests<br>+120 °C during high temperature tests<br>-20 °C during low temperature tests<br>Testing under extreme temperature conditions not required. |
| Relative humidity content : |                                                          | 55 %                                                                                                                                                                               |
| Barometric pressure :       |                                                          | 1021 hpa                                                                                                                                                                           |
| Power supply :              | V <sub>nom</sub><br>V <sub>max</sub><br>V <sub>min</sub> | 3.2 V DC, by internal battery<br>3.6 V DC<br>2.9 V DC<br>Testing under extreme voltage conditions not required.                                                                    |

## 6 Test item

### 6.1 General description

|                              |                                        |
|------------------------------|----------------------------------------|
| Kind of test item :          | RF Modul for IoT Sensorplatform        |
| Model name :                 | endiio Retrofit-Box V2                 |
| HMN :                        | endiio Retrofit-Box V2                 |
| PMN :                        | endiio WM                              |
| HVIN :                       | V2.21                                  |
| FVIN :                       | -/-                                    |
| S/N serial number :          | prototype                              |
| Hardware status :            | N.A.                                   |
| Software status :            | N.A.                                   |
| Firmware status :            | v2.0.9.c                               |
| Frequency band :             | 915.4 MHz – 916 MHz                    |
| Type of radio transmission : | modulated carrier                      |
| Use of frequency spectrum :  |                                        |
| Type of modulation :         | FSK                                    |
| Number of channels :         | 4                                      |
| Antenna :                    | internal antenna                       |
| Power supply :               | 2.9 V to 3.6 V DC, by internal battery |
| Temperature range :          | -20°C to +120°C                        |

### 6.2 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup and EUT photos are included in test report:

1-8881-24-01-17\_TR1-A101-R01  
1-8881-24-01-17\_TR1-A102-R01  
1-8881-24-01-17\_TR1-A103-R01

## 7 Description of the test setup

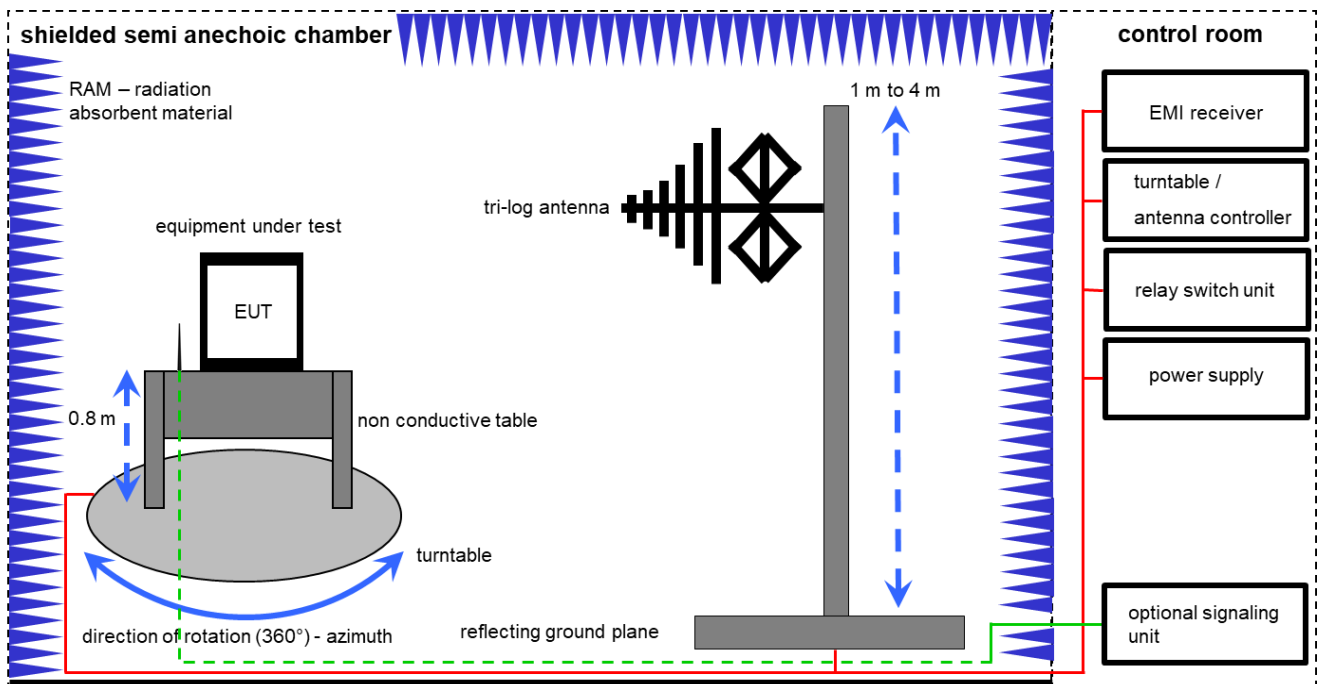
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Each block diagram listed can contain several test setup configurations. All devices belonging to a test setup are identified with the same letter syntax. For example: Column Setup and all devices with an A.

## 7.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 30 MHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are conform to specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: tri-log antenna 10 meter  
EMC32 software version: 10.59.00

FS = UR + CL + AF  
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

### Example calculation:

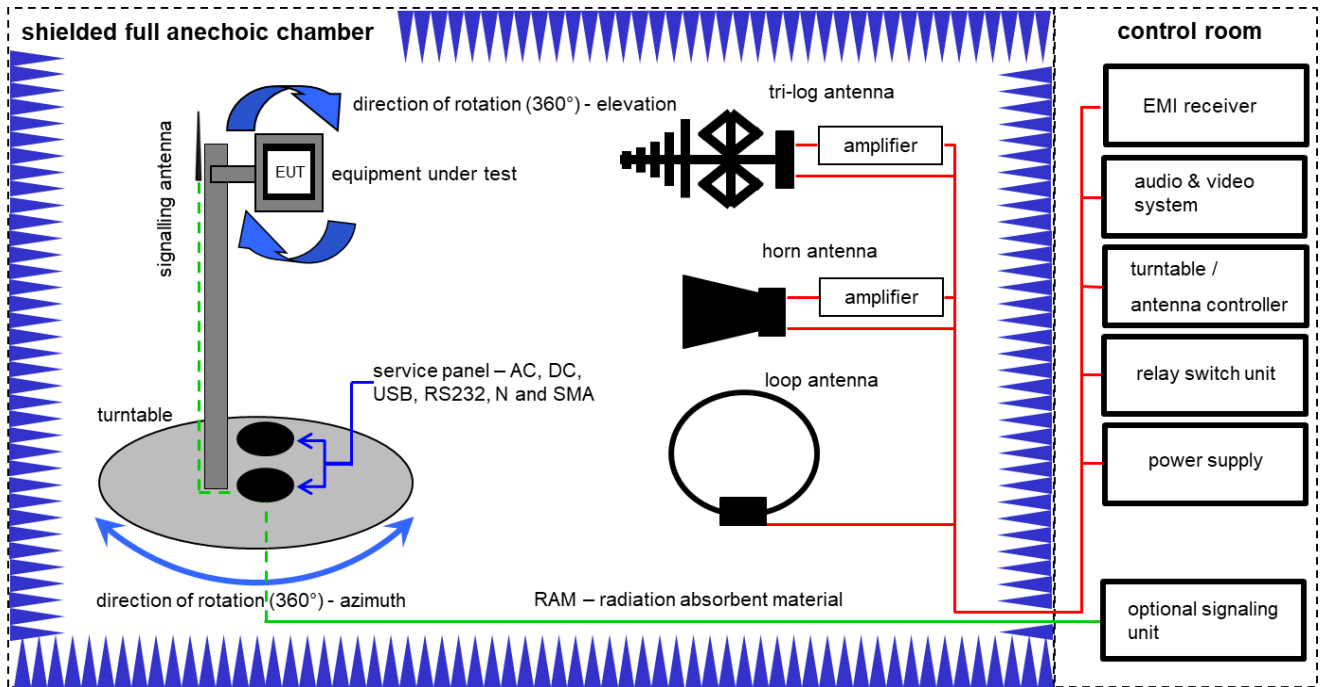
FS [dB $\mu$ V/m] = 12.35 [dB $\mu$ V/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dB $\mu$ V/m] (35.69  $\mu$ V/m)



**Equipment table:**

| No. | Setup | Equipment                                    | Type         | Manufacturer                  | Serial No. | INV. No.  | Kind of Calibration | Last Calibration | Next Calibration |
|-----|-------|----------------------------------------------|--------------|-------------------------------|------------|-----------|---------------------|------------------|------------------|
| 1   | A     | Switch-Unit                                  | 3488A        | HP                            | 2719A14505 | 300000368 | ev                  | -/-              | -/-              |
| 2   | A     | Semi anechoic chamber                        | 3000023      | MWB AG                        | -/-        | 300000551 | ne                  | -/-              | -/-              |
| 3   | A     | Antenna Tower                                | Model 2175   | ETS-Lindgren                  | 64762      | 300003745 | izw                 | -/-              | -/-              |
| 4   | A     | Positioning Controller                       | Model 2090   | ETS-Lindgren                  | 64672      | 300003746 | izw                 | -/-              | -/-              |
| 5   | A     | Turntable Interface-Box                      | Model 105637 | ETS-Lindgren                  | 44583      | 300003747 | izw                 | -/-              | -/-              |
| 6   | A     | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163     | Schwarzbeck Mess - Elektronik | 318        | 300003696 | vIKI!               | 31.01.2024       | 30.01.2026       |
| 7   | A     | Turntable                                    | 2089-4.0     | EMCO                          | -/-        | 300004394 | ne                  | -/-              | -/-              |
| 8   | A     | PC                                           | TecLine      | F+W                           | -/-        | 300004388 | ne                  | -/-              | -/-              |
| 9   | A     | EMI Test Receiver                            | ESR3         | Rohde & Schwarz               | 102587     | 300005771 | k                   | 06.12.2024       | 31.12.2025       |

## 7.2 Shielded fully anechoic chamber



Measurement distance: tri-log antenna and horn antenna 3 meter; loop antenna 3 meter / 1 meter

$$FS = UR + CA + AF$$

(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

### Example calculation:

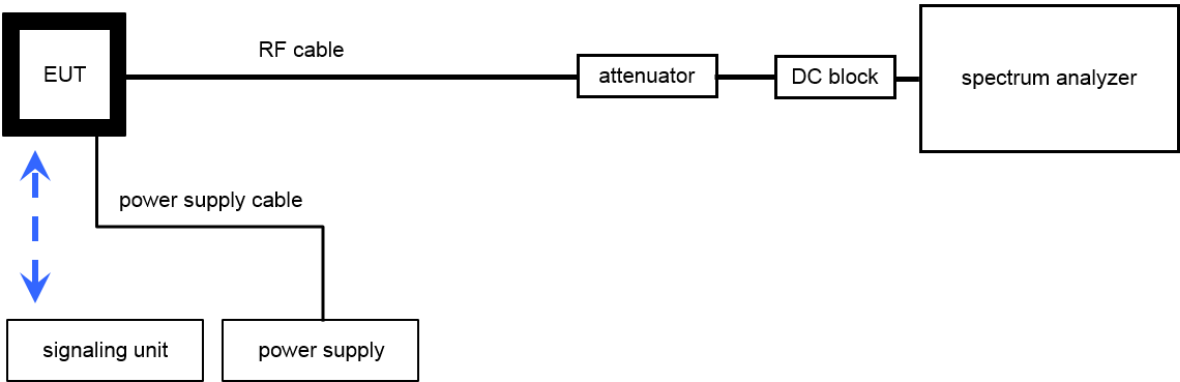
$$FS [dB\mu V/m] = 40.0 [dB\mu V/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dB\mu V/m] (71.61 \mu V/m)$$

### Equipment table:

| No. | Setup | Equipment                                      | Type                 | Manufacturer                  | Serial No. | INV. No.  | Kind of Calibration | Last Calibration | Next Calibration |
|-----|-------|------------------------------------------------|----------------------|-------------------------------|------------|-----------|---------------------|------------------|------------------|
| 1   | A,B,C | Anechoic chamber                               | FAC 3/5m             | MWB / TDK                     | 87400/02   | 300000996 | ev                  | -/-              | -/-              |
| 2   | A,B,C | EMI Test Receiver 20Hz- 26,5GHz                | ESU26                | R&S                           | 100037     | 300003555 | k                   | 11.12.2024       | 31.12.2025       |
| 3   | A,B,C | 4U RF Switch Platform                          | L4491A               | Agilent Technologies          | MY50000037 | 300004509 | ne                  | -/-              | -/-              |
| 4   | A,B,C | NEXIO EMV-Software                             | BAT EMC V2022.0.32.0 | Nexio                         |            | 300004682 | ne                  | -/-              | -/-              |
| 5   | C     | Double-Ridged Waveguide Horn Antenna 1-18.0GHz | 3115                 | EMCO                          | 8812-3088  | 300001032 | vIKI!               | 10.10.2023       | 31.10.2025       |
| 6   | C     | Highpass Filter                                | WHK1.1/15G-10SS      | Wainwright                    | 3          | 300003255 | ev                  | -/-              | -/-              |
| 7   | C     | Broadband Amplifier 0.5-18 GHz                 | CBLU5184540          | CERNEX                        | 22049      | 300004481 | ev                  | -/-              | -/-              |
| 8   | B     | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz   | VULB9163             | Schwarzbeck Mess - Elektronik | 01029      | 300005379 | vIKI!               | 09.10.2023       | 31.10.2025       |
| 9   | A     | Active Loop Antenna 9 kHz to 30 MHz            | 6502                 | EMCO                          | 2210       | 300001015 | vIKI!               | 02.08.2023       | 31.07.2025       |

7.3 Conducted measurements

Conducted measurements normal conditions



OP = AV + CA  
(OP-output power; AV-analyzer value; CA-loss signal path)

Example calculation:  
OP [dBm] = 6.0 [dBm] + 11.7 [dB] = 17.7 [dBm] (58.88 mW)

**Equipment table:**

| No. | Setup | Equipment       | Type  | Manufacturer    | Serial No. | INV. No.  | Kind of Calibration | Last Calibration | Next Calibration |
|-----|-------|-----------------|-------|-----------------|------------|-----------|---------------------|------------------|------------------|
| 1   | A     | Signal analyzer | FSW26 | Rohde & Schwarz | 101455     | 300004528 | k                   | 09.12.2024       | 31.12.2025       |

## 8 Sequence of testing

### 8.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

#### Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, it is placed on a table with 0.8 m height.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

#### Premeasurement\*

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

#### Final measurement

- Identified emissions during the pre-measurement are maximized by the software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated about its vertical axis for maximum response at each azimuth about the EUT. (For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT)
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

\*)Note: The sequence will be repeated three times with different EUT orientations.

## 8.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

### Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

### Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

### Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position  $\pm 45^\circ$  and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

### 8.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

#### Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

#### Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height is 1.5 m.
- At each turntable position and antenna polarization the analyzer sweeps with positive peak detector to find the maximum of all emissions.

#### Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximizes the peaks by rotating the turntable from 0° to 360°. This measurement is repeated for different EUT-table positions (0° to 150° in 30°-steps) and for both antenna polarizations.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

## 9 Measurement uncertainty

| Measurement uncertainty                               |                                                  |
|-------------------------------------------------------|--------------------------------------------------|
| Test case                                             | Uncertainty                                      |
| Antenna gain                                          | $\pm 3$ dB                                       |
| Carrier frequency separation                          | $\pm 21.5$ kHz                                   |
| Number of hopping channels                            | -/-                                              |
| Spectrum bandwidth                                    | $\pm 21.5$ kHz absolute; $\pm 15.0$ kHz relative |
| Maximum output power                                  | $\pm 1$ dB                                       |
| Detailed conducted spurious emissions @ the band edge | $\pm 1$ dB                                       |
| Band edge compliance radiated                         | $\pm 3$ dB                                       |
| Spurious emissions conducted                          | $\pm 3$ dB                                       |
| Spurious emissions radiated below 30 MHz              | $\pm 3$ dB                                       |
| Spurious emissions radiated 30 MHz to 1 GHz           | $\pm 3$ dB                                       |
| Spurious emissions radiated 1 GHz to 12.75 GHz        | $\pm 3.7$ dB                                     |

## 10 Summary of measurement results

|                                     |                                                                                                                       |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| <input type="checkbox"/>            | No deviations from the technical specifications were ascertained                                                      |
| <input type="checkbox"/>            | There were deviations from the technical specifications ascertained                                                   |
| <input checked="" type="checkbox"/> | This test report is only a partial test report. The content and verdict of the performed test cases are listed below. |

### 10.1 Hybrid mode (915.4 MHz - 916 MHz)

| Test specification clause            | Test case                                               | Temperature conditions | Power source voltages | Mode              | C                                   | NC                       | NA                                  | NP                                  | Remark          |
|--------------------------------------|---------------------------------------------------------|------------------------|-----------------------|-------------------|-------------------------------------|--------------------------|-------------------------------------|-------------------------------------|-----------------|
| §15.247(b)(4)<br>RSS - 247 / 5.4 (d) | Antenna gain                                            | Nominal                | Nominal               | TX single channel | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/>            | -/-             |
| §15.247(a)(1)<br>RSS - 247 / 5.1 (b) | Carrier frequency separation                            | Nominal                | Nominal               | TX hopping        | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/>            | <input checked="" type="checkbox"/> | -/-             |
| §15.247(a)(1)<br>RSS - 247 / 5.1 (a) | Spectrum bandwidth                                      | Nominal                | Nominal               | TX single channel | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/>            | <input checked="" type="checkbox"/> | -/-             |
| §15.247(f)<br>RSS - 247 / 5.2 (b)    | Power spectral density                                  | Nominal                | Nominal               | TX single channel | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/>            | <input checked="" type="checkbox"/> | -/-             |
| §15.247(b)(3)<br>RSS - 247 / 5.4 (b) | Maximum output power                                    | Nominal                | Nominal               | TX single channel | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/>            | -/-             |
| §15.247(d)<br>RSS - 247 / 5.5        | Detailed spurious emissions @ the band edge - conducted | Nominal                | Nominal               | TX single channel | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/>            | <input checked="" type="checkbox"/> | -/-             |
| §15.247(d)<br>RSS - 247 / 5.5        | Spurious emissions conducted                            | Nominal                | Nominal               | TX single channel | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/>            | <input checked="" type="checkbox"/> | -/-             |
| §15.247(f)<br>RSS - 247 / 5.1 (d)    | Time of occupancy (dwell time)                          | Nominal                | Nominal               | TX single channel | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/>            | -/-             |
| §15.247(d)<br>RSS-210 / A8.5         | TX spurious emissions radiated                          | Nominal                | Nominal               | TX single channel | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/>            | -/-             |
| §15.107<br>§15.207                   | Conducted emissions                                     | Nominal                | Nominal               | TX single channel | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/>            | battery powered |
| §15.209(a)<br>RSS-Gen                | TX spurious emissions radiated < 30 MHz                 | Nominal                | Nominal               | TX single channel | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/>            | -/-             |

**Note:** C = Compliant; NC = Not compliant; NA = Not applicable; NP = Not performed



## 11 RF measurements

### 11.1 Additional comments

Reference documents: none

Special test descriptions: all tests have been performed using the software SmartRF Studio v7  
Version 2.24.0, cap array Delta setting: 00, power setting: +13dBm

Configuration descriptions: Hybrid: 915.4 MHz 915.4 MHz,  
916.0 MHz 916.0 MHz;  
these channels were tested in this test report.

nominal operating frequencies: 915.4 MHz, 915.6 MHz, 915.8 MHz and 916.0 MHz

Test mode: ☒ Special software is used.  
EUT is transmitting pseudo random data by itself

## 11.2 Antenna gain

### Description:

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.

### Measurement:

| Measurement parameters  |                                                               |
|-------------------------|---------------------------------------------------------------|
| Detector                | Peak                                                          |
| Sweep time              | Auto                                                          |
| Resolution bandwidth    | 1 MHz                                                         |
| Video bandwidth         | 3 MHz                                                         |
| Span                    | 5 MHz                                                         |
| Trace mode              | Max hold                                                      |
| Test setup              | see chapter 7.2 B (radiated)<br>see chapter 7.3 A (conducted) |
| Measurement uncertainty | see sub clause 9                                              |

### Limits:

| FCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | IC |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Antenna gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |    |
| The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi. |    |

### Results:

|                           | 915.4 MHz | middle channel | 916.0 MHz |
|---------------------------|-----------|----------------|-----------|
| Conducted power           | 6.63 dBm  | -/-            | 6.64 dBm  |
| Radiated power (e.i.r.p.) | 8.40 dBm  | -/-            | 8.83 dBm  |
| Gain calculated           | 1.77 dBi  | -/-            | 2.19 dBi  |

### 11.3 Average Time of Occupancy (dwell time)

**Measurement:**

The measurement is performed in zero span mode to show that none of the 4 used channels is allocated more than 0.4 seconds within a 1.6 seconds interval (4 channels times 0.4s).

**Limits:**

| FCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Average time of occupancy                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4 |

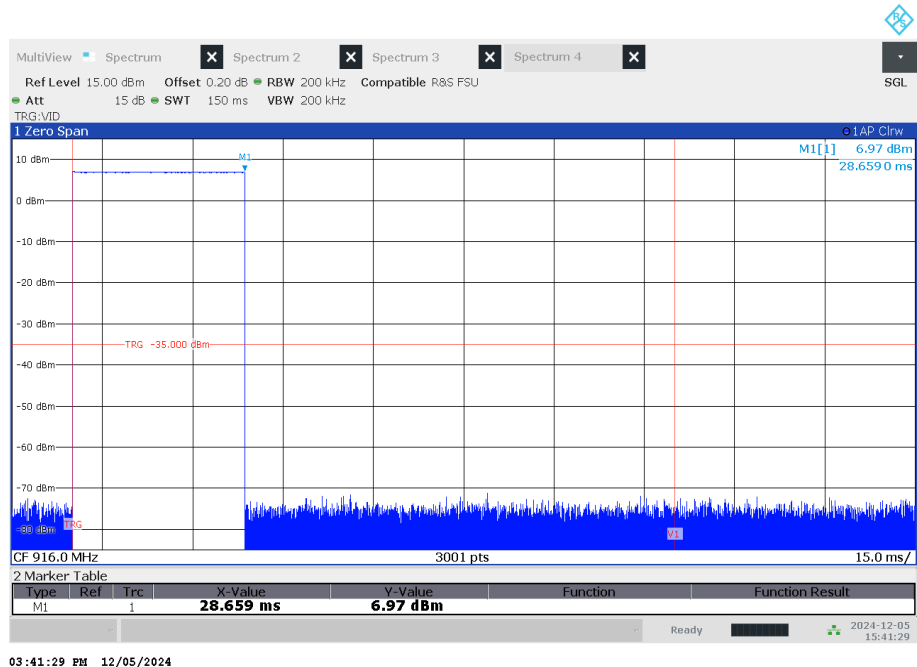
**Result:** The time slot length is = 28.7 ms

Within 1.6 s period, the maximum time of occupancy is 28.7 ms

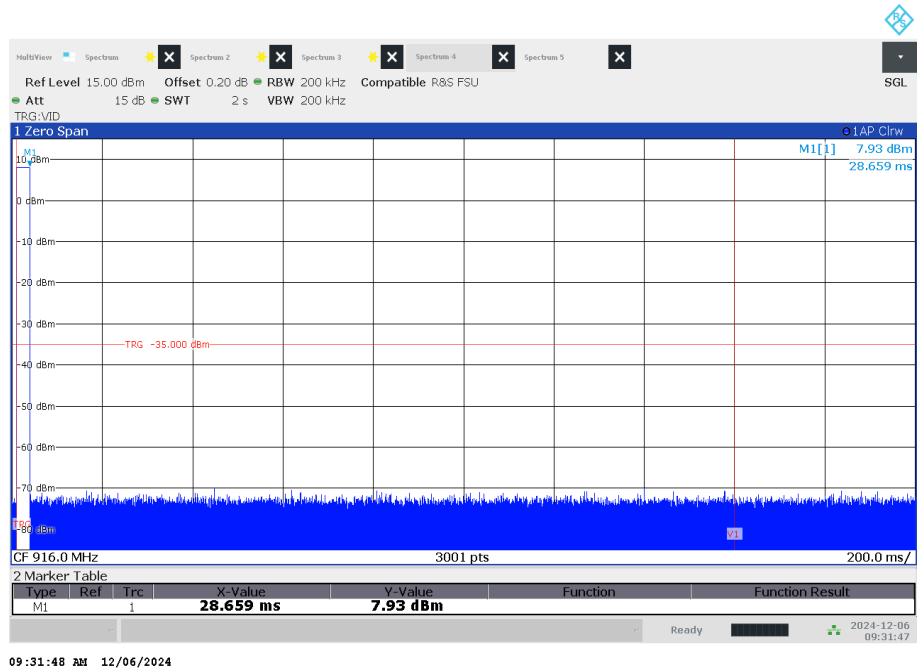
→ The max time of occupancy = 28.7 ms

**Plots:**

Plot 1: Time slot length = 28.65 ms



Plot 2: hops / channel @ 1.6s = 1



## 11.4 Maximum Output Power

### Measurement:

| Measurement parameter    |                                                                            |
|--------------------------|----------------------------------------------------------------------------|
| Detector:                | Peak                                                                       |
| Sweep time:              | See plots                                                                  |
| Resolution bandwidth:    | 200 kHz                                                                    |
| Video bandwidth:         | 500 kHz                                                                    |
| Span:                    | 1 MHz                                                                      |
| Trace-Mode:              | Single sweep                                                               |
| Measurement method       | According to ANSI C63.10-2020<br>11.9.1 Method peak conducted output power |
| Used equipment:          | see chapter 7.3 A                                                          |
| Measurement uncertainty: | see chapter 9                                                              |

### Limits:

| FCC                                                                                                                                                                                                                                                                                                          | IC |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Maximum Output Power Conducted                                                                                                                                                                                                                                                                               |    |
| For frequency hopping systems operating in the 902–928 MHz band: 1 watt (30 dBm) for systems employing at least 50 hopping channels; and, 0.25 watts (24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section. |    |

### Result:

| Test Conditions |           | Maximum Output Power Conducted |           |
|-----------------|-----------|--------------------------------|-----------|
|                 |           | 915.4 MHz                      | 916.0 MHz |
| $T_{nom}$       | $V_{nom}$ | 6.63 dBm                       | 6.64 dBm  |

## 11.5 Spurious Emissions Radiated < 30 MHz

### Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode. The measurement is performed in the mode with the highest output power. The limits are recalculated to a measurement distance of 3 m according the ANSI C63.10.

### Measurement:

| Measurement parameter    |                                            |
|--------------------------|--------------------------------------------|
| Detector:                | Peak / Quasi Peak                          |
| Sweep time:              | Auto                                       |
| Video bandwidth:         | F < 150 kHz: 1 kHz<br>F > 150 kHz: 100 kHz |
| Resolution bandwidth:    | F < 150 kHz: 200 Hz<br>F > 150 kHz: 9 kHz  |
| Span:                    | 9 kHz to 30 MHz                            |
| Trace-Mode:              | max Hold                                   |
| Used equipment:          | see chapter 7.2 A                          |
| Measurement uncertainty: | see chapter 9                              |

### Limits:

| FCC             |                                    |                          |
|-----------------|------------------------------------|--------------------------|
| Frequency (MHz) | Field strength ( $\mu\text{V/m}$ ) | Measurement distance (m) |
| 0.009 – 0.490   | 2400/(F/kHz)                       | 300                      |
| 0.490 – 1.705   | 24000/(F/kHz)                      | 30                       |
| 1.705 – 30      | 30 (29.5 dB $\mu\text{V/m}$ )      | 30                       |

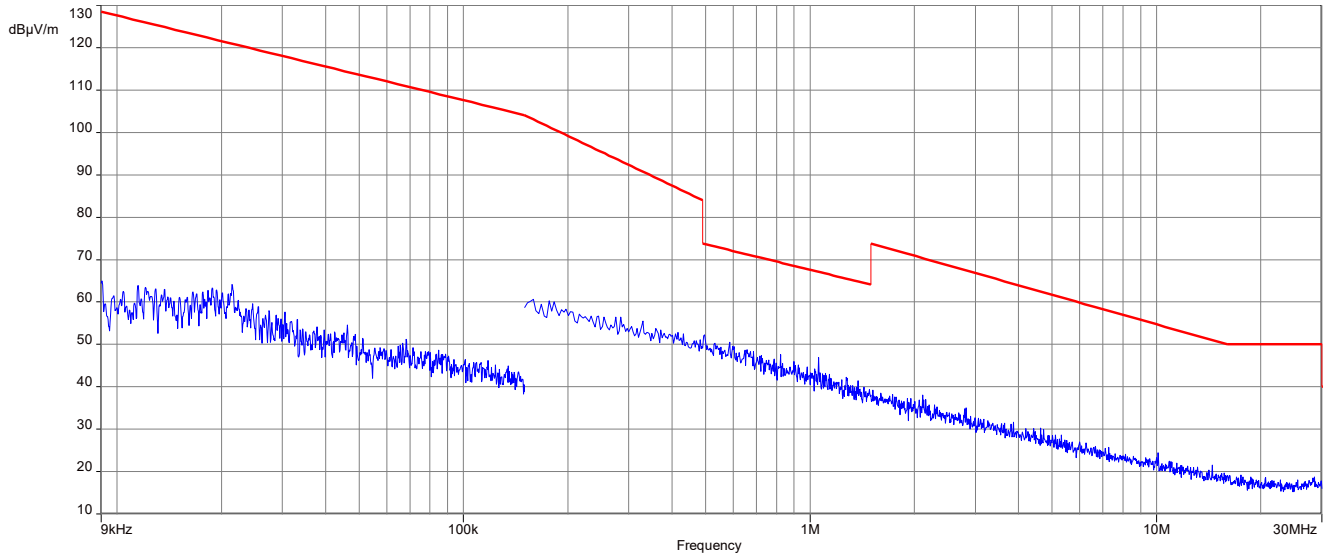
| IC              |                                    |                          |
|-----------------|------------------------------------|--------------------------|
| Frequency (MHz) | Field strength ( $\mu\text{A/m}$ ) | Measurement distance (m) |
| 0.009 – 0.490   | 6.37/F (F in kHz)                  | 300                      |
| 0.490 – 1.705   | 63.7/F (F in kHz)                  | 30                       |
| 1.705 – 30      | 0.08 (-22 dB $\mu\text{A/m}$ )     | 30                       |

### Result:

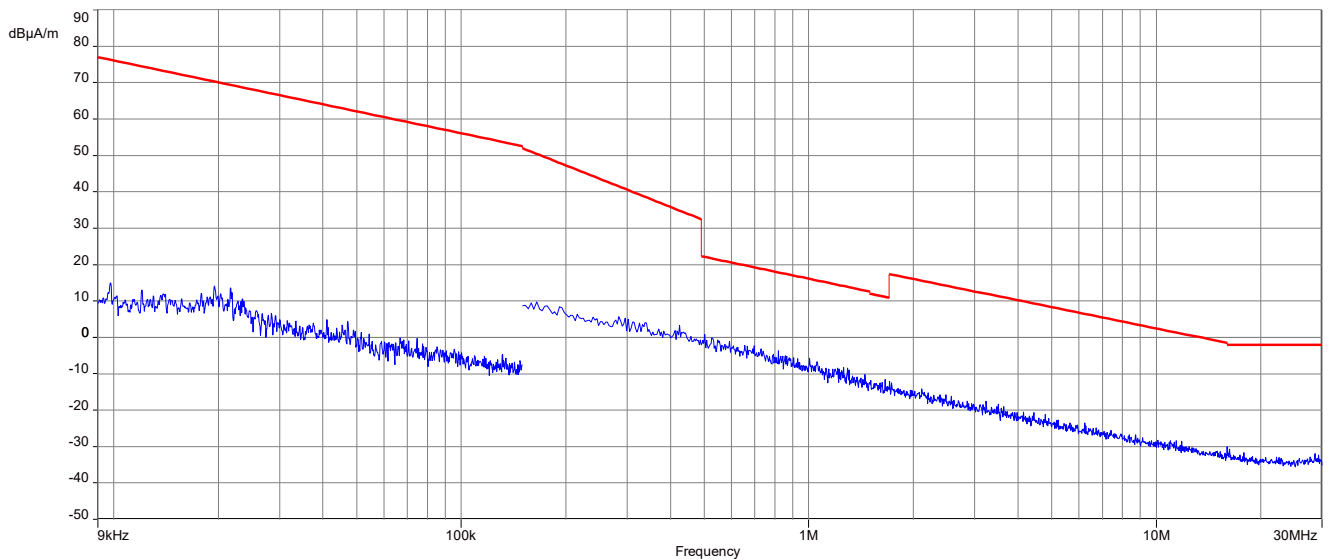
| SPURIOUS EMISSIONS LEVEL |          |                               |                 |          |                               |                   |          |                               |
|--------------------------|----------|-------------------------------|-----------------|----------|-------------------------------|-------------------|----------|-------------------------------|
| 915.4 MHz                |          |                               | middle channel  |          |                               | 916.0 MHz         |          |                               |
| Frequency / MHz          | Detector | Level / (dB $\mu\text{V/m}$ ) | Frequency / MHz | Detector | Level / (dB $\mu\text{V/m}$ ) | Frequency / MHz   | Detector | Level / (dB $\mu\text{V/m}$ ) |
| no peaks detected        |          |                               | -/-             | -/-      | -/-                           | no peaks detected |          |                               |
| -/-                      | -/-      | -/-                           | -/-             | -/-      | -/-                           | -/-               | -/-      | -/-                           |

**Plots:**

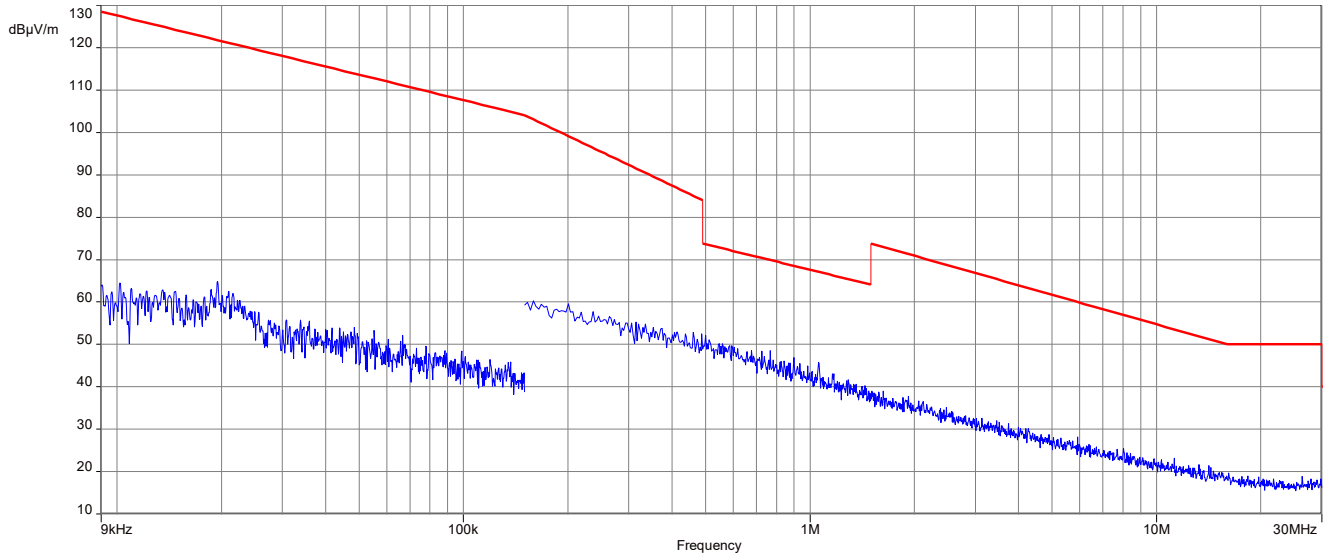
Plot 1: TX-Mode 915.4 MHz FCC



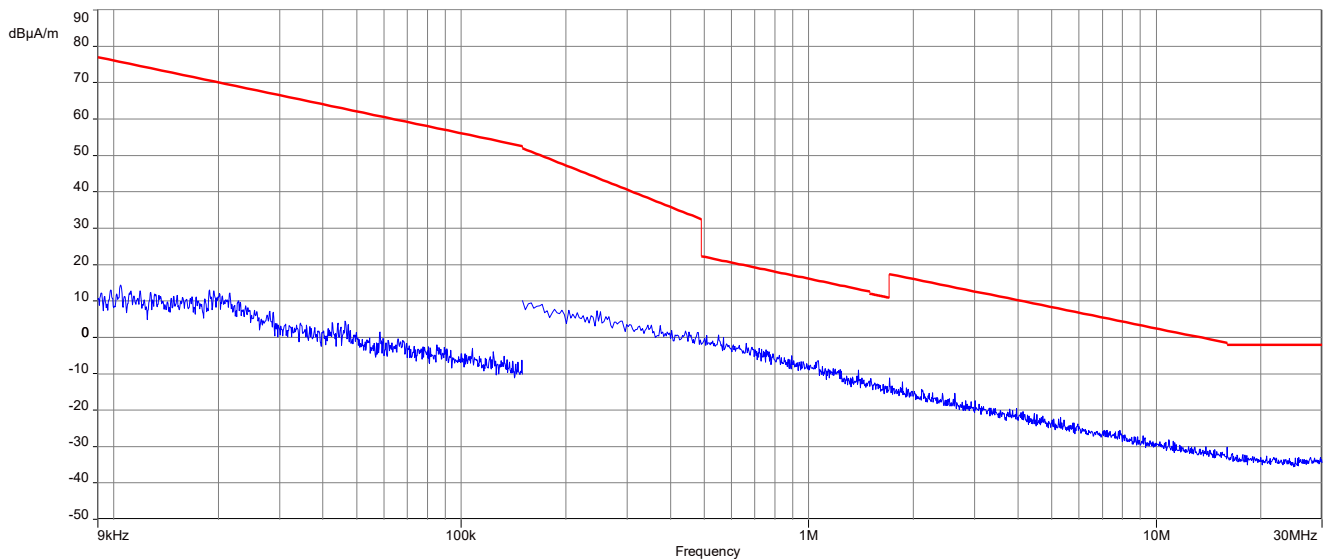
Plot 2: TX-Mode 915.4 MHz IC



Plot 3: TX-Mode 916.0 MHz FCC



Plot 4: TX-Mode 916.0 MHz IC





## 11.6 Spurious Emissions Radiated > 30 MHz

### 11.6.1 Spurious emissions radiated 30 MHz to 1 GHz

#### **Description:**

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed at channel low and high.

#### **Measurement:**

| Measurement parameters  |                   |
|-------------------------|-------------------|
| Detector                | Peak / Quasi Peak |
| Sweep time              | Auto              |
| Resolution bandwidth    | 3 x VBW           |
| Video bandwidth         | 120 kHz           |
| Span                    | 30 MHz to 1 GHz   |
| Trace mode              | Max hold          |
| Measured modulation     | Hybrid            |
| Test setup              | see chapter 7.1 A |
| Measurement uncertainty | see chapter 9     |

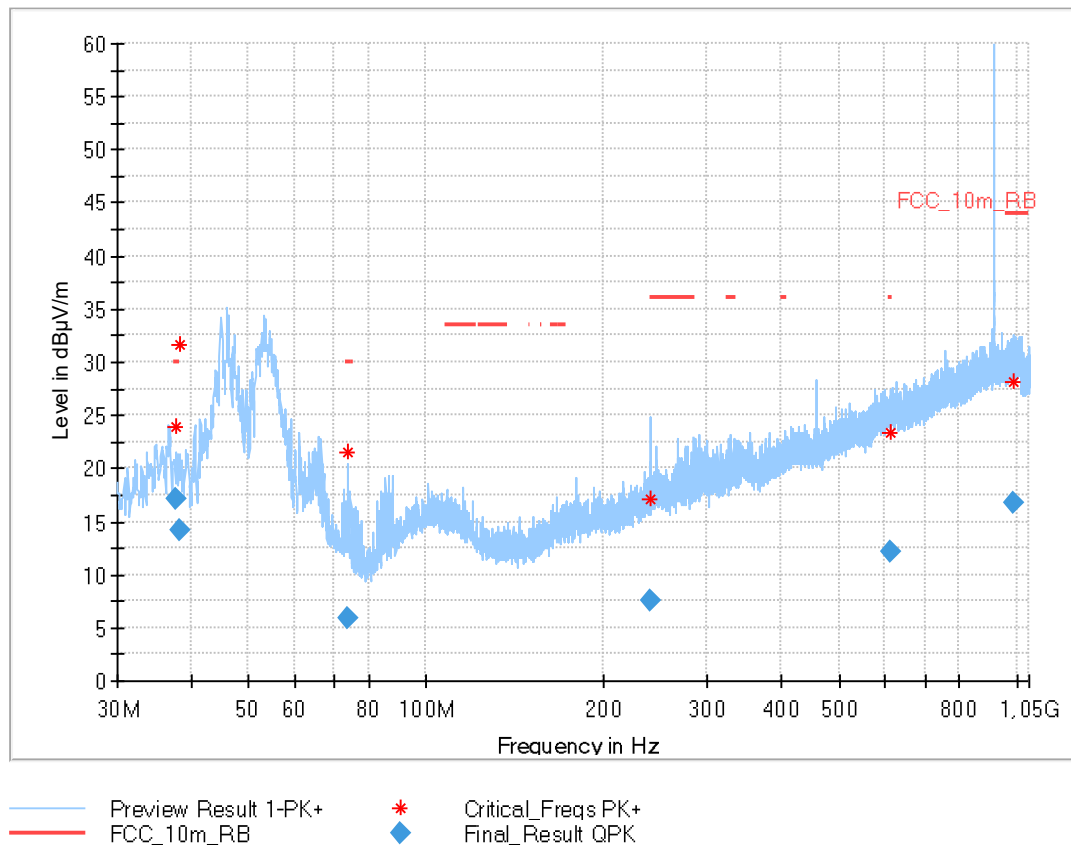
#### **Limits:**

| FCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                           | IC                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------------------------|
| Band-edge Compliance of conducted and radiated emissions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                           |                          |
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)). |                           |                          |
| Frequency / MHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Field Strength / (dBμV/m) | Measurement distance / m |
| 30 - 88                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 30.0                      | 10                       |
| 88 - 216                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 33.5                      | 10                       |
| 216 - 960                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 36.0                      | 10                       |
| Above 960                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 54.0                      | 3                        |

**Result:** See result table below the plots

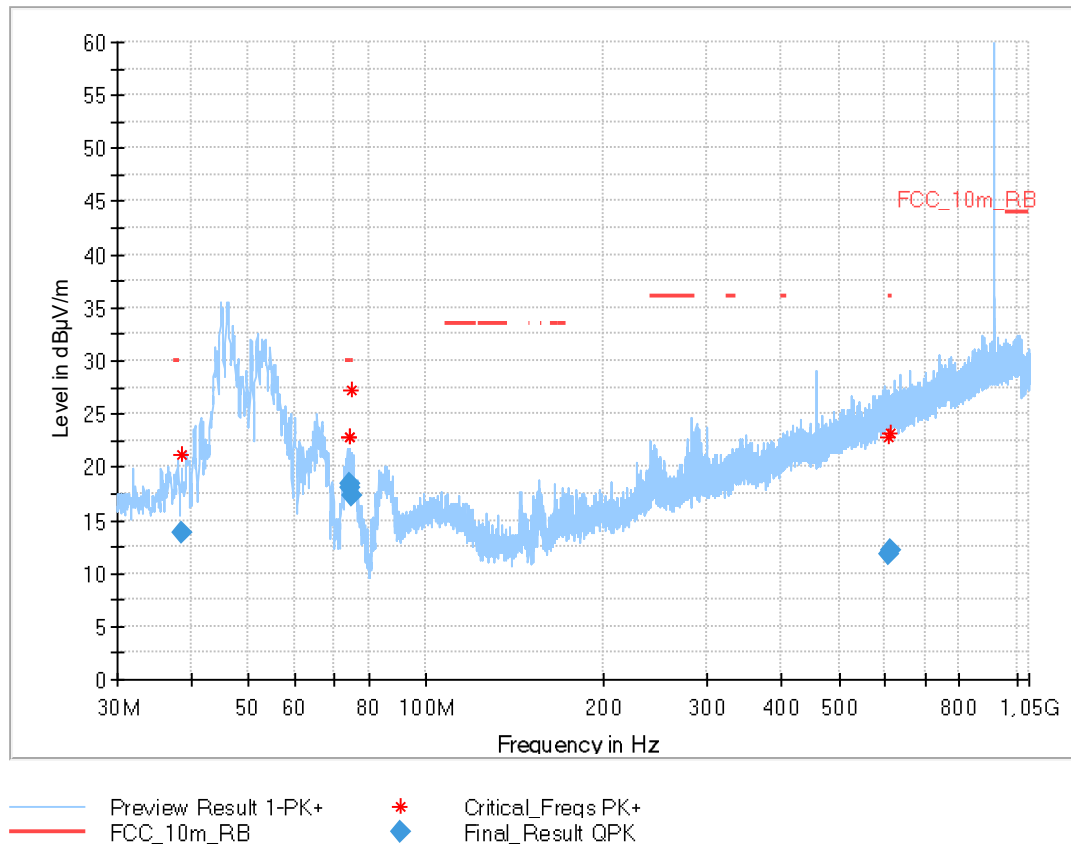
**Plots:**

Plot 1: TX 915.4 MHz, 30 MHz – 1 GHz, horizontal &amp; vertical polarisation



| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 37.820          | 17.15              | 30.0           | 12.9        | 1000            | 120.0           | 115.0       | V   | 180           | 14           |
| 38.370          | 14.09              | ---            | ---         | 1000            | 120.0           | 400.0       | V   | 175           | 14           |
| 73.938          | 5.90               | 30.0           | 24.1        | 1000            | 120.0           | 200.0       | V   | 231           | 9            |
| 240.388         | 7.57               | 36.0           | 28.4        | 1000            | 120.0           | 130.0       | V   | 247           | 14           |
| 611.460         | 12.16              | 36.0           | 23.8        | 1000            | 120.0           | 237.0       | V   | 202           | 22           |
| 987.006         | 16.72              | 44.0           | 27.3        | 1000            | 120.0           | 138.0       | V   | 45            | 26           |

Plot 2: TX 916.0 MHz, 30 MHz – 1 GHz, horizontal &amp; vertical polarisation



| Frequency (MHz) | QuasiPeak (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|--------------------------|----------------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 38.466          | 13.74                    | ---                  | ---         | 1000            | 120.0           | 200.0       | V   | 225           | 14           |
| 73.975          | 18.08                    | 30.0                 | 11.9        | 1000            | 120.0           | 250.0       | V   | 164           | 9            |
| 73.975          | 18.37                    | 30.0                 | 11.6        | 1000            | 120.0           | 269.0       | V   | 232           | 9            |
| 74.969          | 17.27                    | 30.0                 | 12.7        | 1000            | 120.0           | 353.0       | V   | 24            | 9            |
| 608.567         | 11.69                    | 36.0                 | 24.3        | 1000            | 120.0           | 324.0       | V   | 225           | 22           |
| 611.511         | 12.08                    | 36.0                 | 23.9        | 1000            | 120.0           | 371.0       | H   | -8            | 22           |

### 11.6.2 Spurious emissions radiated above 1 GHz

#### Description:

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed in the mode with the highest output power.

#### Measurement:

| Measurement parameters  |                                       |
|-------------------------|---------------------------------------|
| Detector                | Peak / RMS                            |
| Sweep time              | Auto                                  |
| Resolution bandwidth    | 1 MHz                                 |
| Video bandwidth         | 3 x RBW                               |
| Span                    | 1 GHz to 12 GHz                       |
| Trace mode              | Max hold                              |
| Measured modulation     | Hybrid                                |
| Test setup              | see chapter 7.2 C (1 GHz – 12.75 GHz) |
| Measurement uncertainty | see chapter 9                         |

The modulation with the highest output power was used to perform the transmitter spurious emissions. If spurious were detected a re-measurement was performed on the detected frequency with each modulation.

#### Limits:

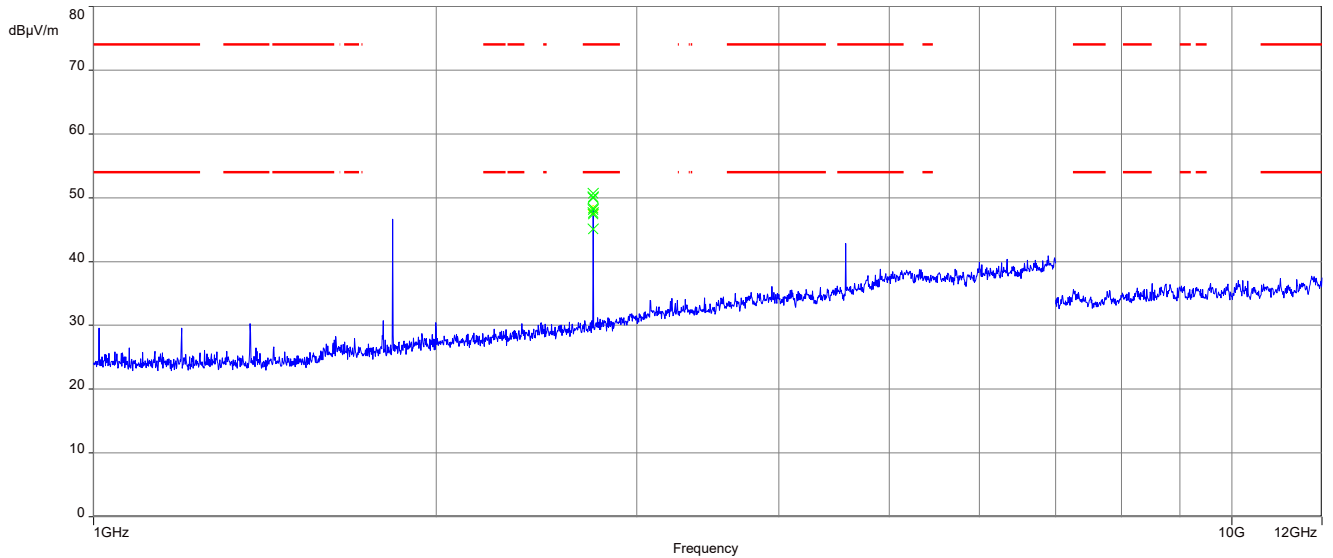
| FCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                           | IC                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------------------------|
| TX spurious emissions radiated                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                           |                          |
| In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)). |                           |                          |
| §15.209                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                           |                          |
| Frequency / MHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Field strength / (dBμV/m) | Measurement distance / m |
| Above 960                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 54.0                      | 3                        |

**Result:**

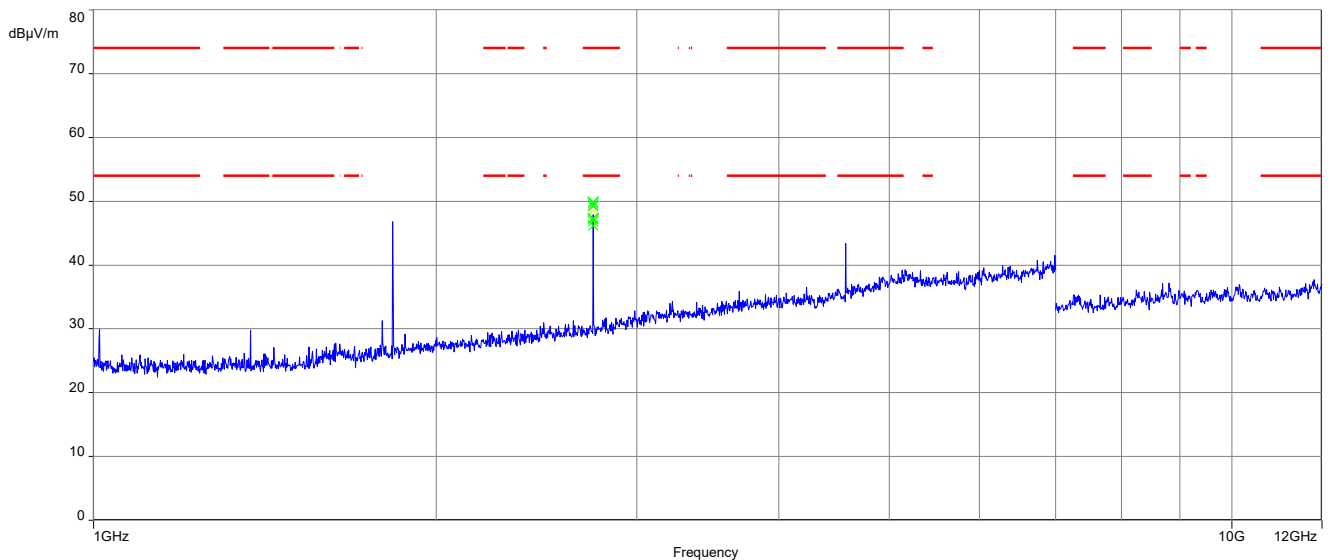
| TX spurious emissions radiated |          |                        |                 |          |                        |                 |          |                        |
|--------------------------------|----------|------------------------|-----------------|----------|------------------------|-----------------|----------|------------------------|
| 915.4 MHz                      |          |                        | -/-             |          |                        | 916.0 MHz       |          |                        |
| Frequency / MHz                | Detector | Level / (dB $\mu$ V/m) | Frequency / MHz | Detector | Level / (dB $\mu$ V/m) | Frequency / MHz | Detector | Level / (dB $\mu$ V/m) |
| 2746.0                         | Peak     | 50.70                  | -/-             | Peak     | -/-                    | 2747.8          | Peak     | 49.93                  |
|                                | AVG      | 48.10                  |                 | AVG      | -/-                    |                 | AVG      | 47.32                  |
| -/-                            | Peak     | -/-                    | -/-             | Peak     | -/-                    | -/-             | Peak     | -/-                    |
|                                | AVG      | -/-                    |                 | AVG      | -/-                    |                 | AVG      | -/-                    |
| -/-                            | Peak     | -/-                    | -/-             | Peak     | -/-                    | -/-             | Peak     | -/-                    |
|                                | AVG      | -/-                    |                 | AVG      | -/-                    |                 | AVG      | -/-                    |

### Plots:

Plot 1: TX 915.4 MHz, 1 GHz – 12 GHz, horizontal & vertical polarisation



Plot 2: TX 916.0 MHz, 1 GHz – 12 GHz, horizontal & vertical polarisation



## 12 Glossary

|                        |                                                    |
|------------------------|----------------------------------------------------|
| <b>AVG</b>             | Average                                            |
| <b>C</b>               | Compliant                                          |
| <b>C/N<sub>0</sub></b> | Carrier to noise-density ratio, expressed in dB-Hz |
| <b>CAC</b>             | Channel availability check                         |
| <b>CW</b>              | Clean wave                                         |
| <b>DC</b>              | Duty cycle                                         |
| <b>DFS</b>             | Dynamic frequency selection                        |
| <b>DSSS</b>            | Dynamic sequence spread spectrum                   |
| <b>DUT</b>             | Device under test                                  |
| <b>EN</b>              | European Standard                                  |
| <b>ETSI</b>            | European Telecommunications Standards Institute    |
| <b>EMC</b>             | Electromagnetic Compatibility                      |
| <b>EUT</b>             | Equipment under test                               |
| <b>FCC</b>             | Federal Communications Commission                  |
| <b>FCC ID</b>          | Company Identifier at FCC                          |
| <b>FHSS</b>            | Frequency hopping spread spectrum                  |
| <b>FVIN</b>            | Firmware version identification number             |
| <b>GNSS</b>            | Global Navigation Satellite System                 |
| <b>GUE</b>             | GNSS User Equipment                                |
| <b>HMN</b>             | Host marketing name                                |
| <b>HVIN</b>            | Hardware version identification number             |
| <b>HW</b>              | Hardware                                           |
| <b>IC</b>              | Industry Canada                                    |
| <b>Inv. No.</b>        | Inventory number                                   |
| <b>MC</b>              | Modulated carrier                                  |
| <b>NA</b>              | Not applicable                                     |
| <b>NC</b>              | Not compliant                                      |
| <b>NOP</b>             | Non occupancy period                               |
| <b>NP</b>              | Not performed                                      |
| <b>OBW</b>             | Occupied bandwidth                                 |
| <b>OC</b>              | Operating channel                                  |
| <b>OCW</b>             | Operating channel bandwidth                        |
| <b>OFDM</b>            | Orthogonal frequency division multiplexing         |
| <b>OOB</b>             | Out of band                                        |
| <b>OP</b>              | Occupancy period                                   |
| <b>PER</b>             | Packet error rate                                  |
| <b>PMN</b>             | Product marketing name                             |
| <b>PP</b>              | Positive peak                                      |
| <b>QP</b>              | Quasi peak                                         |
| <b>RLAN</b>            | Radio local area network                           |
| <b>S/N or SN</b>       | Serial number                                      |
| <b>SW</b>              | Software                                           |
| <b>UUT</b>             | Unit under test                                    |
| <b>WLAN</b>            | Wireless local area network                        |

13 Document history

| Version | Applied changes                            | Date of release |
|---------|--------------------------------------------|-----------------|
| R01     | Initial release                            | 2025-05-07      |
| R02     | update HVIN field                          | 2025-05-09      |
| R03     | update antenna information and chapter 6.1 | 2025-06-25      |

##### END OF TEST REPORT #####