



# Wireless test report – 455375-1TRFWL

Type of assessment:

**Final product testing**

Applicant:

**Sensor ID Srl**

**Corso Amatuzio 122, Bojano (CB) - Italy**

Product:

**Portable RFID reader**

Model:

**U27 BTW 11**

Model variant:

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FCC ID:

**2AVDNU27BTW11**

IC Registration number:

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Specifications:

- ◆ **FCC 47 CFR Part 15 Subpart C, §15.247**

Radiated emission limits; general requirements.

Date of issue: **19 September, 2022**

**D. Guarnone**

◆ Tested by

*Domenico Guarnone*

Signature

**P. Barbieri**

◆ Reviewed by

*Barbieri*

Signature

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Doc. n. TRF001; Rev. 0; Date: 2020-11-30

## Table of contents

<b>Section 1: Report summary .....</b>	<b>3</b>
1.1    Test specification .....	3
1.2    Statement of compliance .....	3
1.3    Exclusions .....	3
1.4    Registration number .....	3
1.5    Test report revision history .....	3
1.6    Limits of responsibility.....	3
<b>Section 2: Summary of test results .....</b>	<b>4</b>
2.1    FCC Part 15 Subpart C – Intentional Radiators, test results.....	4
<b>Section 3: Equipment under test (EUT) and application details .....</b>	<b>5</b>
3.1    Applicant details.....	5
3.2    Modular equipment.....	5
3.3    Product details .....	5
3.4    Application purpose .....	5
3.5    Composite/related equipment.....	5
3.6    Sample information.....	6
3.7    EUT technical specifications.....	6
3.8    Operation of the EUT during testing .....	6
3.9    EUT setup diagram.....	6
<b>Section 4: Engineering considerations.....</b>	<b>7</b>
4.1    Modifications incorporated in the EUT .....	7
4.2    Deviations from laboratory tests procedures .....	7
4.3    Technical judgment.....	7
<b>Section 5: Test conditions .....</b>	<b>8</b>
5.1    Power source and ambient temperatures .....	8
<b>Section 6: Measurement uncertainty .....</b>	<b>9</b>
<b>Section 7: Test equipment .....</b>	<b>10</b>
<b>Section 8: Testing data.....</b>	<b>11</b>
8.1    Clause 15.31(e) Variation of power source.....	11
8.2    Clause 15.31(m) Number of operating frequencies .....	12
8.3    Clause 15.203 Antenna requirement .....	13
8.4    Clause 15.207(a) Conducted limits.....	14
8.5    Clause 15.247(a)(1) Frequency hopping requirements .....	17
8.6    Clause 15.247(b) Maximum peak conducted output power.....	21
8.7    Clause 15.247(d) Spurious emissions .....	26
<b>Section 9: Block diagrams of test set-ups.....</b>	<b>38</b>
<b>Section 10: EUT photos.....</b>	<b>39</b>
<b>Section 10: EUT photos.....</b>	<b>40</b>

## Section 1: Report summary

### 1.1 Test specification

<b>Specifications</b>	<b>FCC Part 15 Subpart C, 15.247</b> Operation within the bands 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz.
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### 1.2 Statement of compliance

<b>Compliance</b>	In the configuration tested the EUT was found compliant Yes <input type="checkbox"/> No <input type="checkbox"/> This report contains an assessment of apparatus against specifications based upon tests carried out on samples submitted at Nemko Canada Inc. These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15; Subpart C. Radiated tests were conducted in accordance with ANSI C63.4-2003.
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### 1.3 Exclusions

<b>Exclusions</b>	None
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### 1.4 Registration number

<b>Test site FCC ID number</b>	682159 (3 m Semi anechoic chamber)
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### 1.5 Test report revision history

Revision #	Details of changes made to test report
455375-1TRF	Original report issued

### 1.6 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 2: Summary of test results

### 2.1 FCC Part 15 Subpart C – Intentional Radiators, test results

#### General requirements for FCC Part 15

Part	Test description	Verdict
§15.31(e)	Variation of power source	Pass
§15.31(m)	Number of operating frequencies	Pass
§15.203	Antenna requirement	Pass
§15.207(a)	Conducted limits	Pass

#### Specific requirements for FCC Part 15 Subpart C, 15.247

Part	Test description	Verdict
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	Pass
§15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	N/A
§15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	N/A
§15.247(a)(2)	Minimum 6 dB bandwidth for systems using digital modulation techniques	N/A
§15.247(b)(1)	Maximum peak output power of frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band	N/A
§15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	Pass
§15.247(b)(3)	Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	N/A
§15.247(b)(4)	Maximum peak output power	Pass
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	N/A
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	N/A
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density for digitally modulated devices	N/A
§15.247(f)	Time of occupancy for hybrid systems	N/A
Notes: None		

## Section 3: Equipment under test (EUT) and application details

3.1 Applicant details		
<b>Applicant complete business name</b>	Name:	Sensor ID Srl
	Federal Registration Number (FRN):	0029045184
	Grantee code	2AVDNU27BTW11
<b>Mailing address</b>	Address: City: Province/State: Post code: Country:	Via Don G. Mucciardi 5 Campochiaro CB 86020 Italy

3.2 Modular equipment		
<b>a) Single modular approval</b>	Single modular approval Yes <input type="checkbox"/> No <input type="checkbox"/>	
<b>b) Limited single modular approval</b>	Limited single modular approval Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	

3.3 Product details		
<b>FCC ID</b>	Grantee code:	2AVDN
	Product code:	U27BTW11
<b>Equipment class</b>	DSS – Spread spectrum transmitter (FHSS) or DTS – Digital Transmission system	
<b>Description of product as it is marketed</b>	Portable RFID reader	
	Model name/number:	U27 BTW 11
	Serial number:	455375002 assigned by Nemko

3.4 Application purpose		
<b>Type of application</b>	<input checked="" type="checkbox"/> Original certification <input type="checkbox"/> Change in identification of presently authorized equipment Original FCC ID: <input type="text"/> Grant date: <input type="text"/> <input type="checkbox"/> Class II permissive change or modification of presently authorized equipment	

3.5 Composite/related equipment		
<b>a) Composite equipment</b>	The EUT is a composite device subject to an additional equipment authorization Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	
<b>b) Related equipment</b>	The EUT is part of a system that operates with, or is marketed with, another device that requires an equipment authorization Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	
<b>c) Related FCC ID</b>	If either of the above is "yes": <input type="checkbox"/> has been granted under the FCC ID(s) listed below: <input type="checkbox"/> is in the process of being filled under the FCC ID(s) listed below: <input type="checkbox"/> is pending with the FCC ID(s) listed below: <input type="checkbox"/> has a mix of pending and granted statuses under the FCC ID(s) listed below: i <input type="text"/> FCC ID: ii <input type="text"/> FCC ID:	

**3.6 Sample information**

<b>Receipt date:</b>	2022-02-14
<b>Nemko sample ID number:</b>	4553750002

**3.7 EUT technical specifications**

<b>Operating band:</b>	902–928 MHz
<b>Operating frequency:</b>	902.75 MHz to 927.25 MHz
<b>Modulation type:</b>	ASK
<b>Occupied bandwidth:</b>	0.134 MHz
<b>Channel spacing:</b>	0.5 MHz
<b>Emission designator:</b>	1340KF1D
<b>Antenna type:</b>	Integral Permanent fixed antenna, which may be built-in, (Equipment does not have an external 50 Ω RF connector)
<b>Power source:</b>	Battery integrated 2000mAh LiPo. Battery charging 5V with micro USB connector. RF Power max 100mW (20dBm)

**3.8 Operation of the EUT during testing**

<b>Details:</b>	Forced to transmit at low, middle and high channel.
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**3.9 EUT setup diagram**

## Section 4: Engineering considerations

### 4.1 Modifications incorporated in the EUT

<b>Modifications</b>	Modifications performed to the EUT during this assessment None <input checked="" type="checkbox"/> Yes <input type="checkbox"/> , performed by Client <input type="checkbox"/> or Nemko <input type="checkbox"/> Details:
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### 4.2 Deviations from laboratory tests procedures

<b>Deviations</b>	Deviations from laboratory test procedures None <input checked="" type="checkbox"/> Yes <input type="checkbox"/> - details are listed below:
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### 4.3 Technical judgment

<b>Judgment</b>	None
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## Section 5: Test conditions

5.1 Power source and ambient temperatures	
<b>Normal temperature, humidity and air pressure test conditions</b>	Temperature: 15–30 °C Relative humidity: 20–75 % Air pressure: 86–106 kPa  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.
<b>Power supply range:</b>	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 6: Measurement uncertainty

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of  $K = 2$  with 95% certainty.

**Table 1-1: Measurement uncertainty**

EUT	Type	Test	Range	Measurement Uncertainty	Notes
Transmitter	Conducted	Frequency error	0.001 MHz ÷ 40 GHz	0.08 ppm	(1)
			0.009 MHz ÷ 30 MHz	1.1 dB	(1)
		Carrier power	30 MHz ÷ 18 GHz	1.5 dB	(1)
		RF Output Power	18 MHz ÷ 40 GHz	3.0 dB	(1)
			40 MHz ÷ 140 GHz	5.0 dB	(1)
		Adjacent channel power	1 MHz ÷ 18 GHz	1.4 dB	(1)
			0.009 MHz ÷ 18 GHz	3.0 dB	(1)
		Conducted spurious emissions	18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 dB	(1)
		Intermodulation attenuation	1 MHz ÷ 18 GHz	2.2 dB	(1)
		Attack time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Attack time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Release time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Release time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Transient behaviour of the transmitter – Transient frequency behaviour	1 MHz ÷ 18 GHz	0.2 kHz	(1)
		Transient behaviour of the transmitter – Power level slope	1 MHz ÷ 18 GHz	9%	(1)
		Frequency deviation - Maximum permissible frequency deviation	0.001 MHz ÷ 18 GHz	1.3%	(1)
		Frequency deviation - Response of the transmitter to modulation frequencies above 3 kHz	0.001 MHz ÷ 18 GHz	0.5 dB	(1)
	Radiated	Dwell time	-	3%	(1)
		Hopping Frequency Separation	0.01 MHz ÷ 18 GHz	1%	(1)
		Occupied Channel Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
		Modulation Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
		Radiated spurious emissions	0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
Receiver	Radiated		66 GHz ÷ 220 GHz	10 dB	(1)
			10 kHz ÷ 26.5 GHz	6.0 dB	(1)
		Effective radiated power transmitter	26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
		Radiated spurious emissions	0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
	Conducted	Sensitivity measurement	1 MHz ÷ 18 GHz	6.0 dB	(1)
		Conducted spurious emissions	0.009 MHz ÷ 18 GHz	3.0 dB	(1)
			18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 dB	(1)

NOTES:

(1) The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k = 2$ , which for a normal distribution corresponds to a coverage probability of approximately 95 %

## Section 7: Test equipment

Description	Manufacturer	Model	Identifier	Cal Date	Due Date
EMI Receiver	Rohde & Schwarz	ESW44	101620	2022-08	2023-08
EMI Receiver	Rohde & Schwarz	ESU8	100202	2022-09	2023-09
Antenna Trilog 25MHz - 8GHz	Schwarzbeck Mess-Elektronik	VULB9162	9162-025	2021-07	2024-07
Antenna Trilog 25-2000 MHz	Schwarzbeck Mess-Elektronik	VULB9168	9168-242	2021-06	2024-06
Antenna 1 - 18 GHz	Schwarzbeck Mess-Elektronik	STLP9148	STLP 9148-152	2021-09	2024-09
Antenna 1 - 18 GHz	Schwarzbeck Mess-Elektronik	STLP9148	STPL 9148-123	2021-06	2024-06
Double Ridge Horn Antenna	RFSpin	DRH40	061106A40	2020-04	2023-04
Broadband Bench Top Amplifier	Sage	STB-1834034030-KFKF-L1	18490-01	2022-04	2023-04
Preamplifier	Schwarzbeck Mess-Elektronik	BBV9718	BBV9718-137	2022-04	2023-04
Semi-anechoic chamber	Nemko S.p.a.	10m semi-anechoic chamber	530	2021-09	2023-09
Common Mode Absorption Device	Schwarzbeck Mess-Elektronik	CMAD1614	00041	2022-05	2023-05
LISN	Rohde & Schwarz	ESH2-Z5	881 362/006	2022-03	2023-03
LISN	Rohde & Schwarz	ESH2-Z5	872 460/041	2022-09	2023-09
V-network	Rohde & Schwarz	ESH3-Z5	840 731/004	2022-09	2023-09
Oscilloscope	Agilent	54846A	MY40000254	2022-11	2024-11
Multimeter	Rohde & Schwarz	HMC8012	101577	2022-06	2023-06
Barometer	Castle	GBP 3300	072015	2022-04	2023-04
Data logger con diagnosi in campo	Testo	175-H2	20012380/305	2022-12	2024-12
Data logger con diagnosi in campo	Testo	175-H2	38203337/703	2022-12	2024-12
Attenuator	Aeroflex / Weinschel	2	CC8577	2022-07	2023-07

Section 8	Testing data
Test name	FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements
Specification	FCC Part 15 Subpart C

## Section 8: Testing data

### 8.1 Clause 15.31(e) Variation of power source

#### § 15.31 Measurement standards.

(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.

#### Special notes

None

#### Test data

- All tests were performed with new battery.
-

## 8.2 Clause 15.31(m) Number of operating frequencies

### § 15.31 Measurement standards.

(m) Measurements on intentional radiators or receivers, other than TV broadcast 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:

Frequency range over which device operates	Number of frequencies	Location in the range of operation
1 MHz and less	1	Middle
1 to 10 MHz	2	1 near top and 1 near bottom
More than 10 MHz	3	1 near top, 1 near middle and 1 near bottom

### Special notes

None

### Test data

The frequency band is 902–928 MHz therefore number of operating frequencies is

Low frequency / channel	902.75 MHz
Mid frequency / channel	915.2'5 MHz
High frequency / channel	927.25 MHz

Section 8	Testing data
Test name	FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements
Specification	FCC Part 15 Subpart C

### 8.3 Clause 15.203 Antenna requirement

#### § 15.203 Antenna requirement.

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 carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, 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.

#### Special notes

None

#### Test data

- (The EUT has a non-standard antenna jack or electrical connector.)

:

Insert photo here

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

Specification FCC Part 15 Subpart C

## 8.4 Clause 15.207(a) Conducted limits

### § 15.207 Conducted limits.

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50  $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (MHz)	Conducted limit (dB $\mu$ V)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

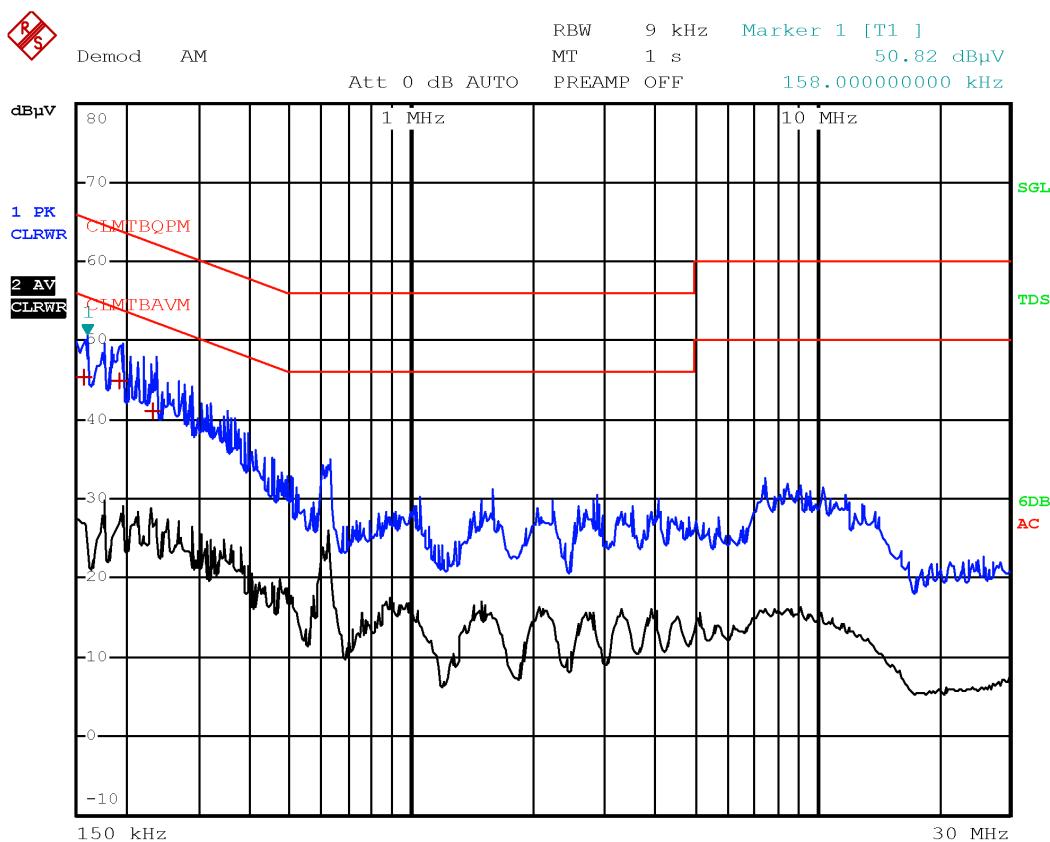
\*-Decreases with the logarithm of the frequency.

### Special notes

None

**Section 8**
**Testing data**

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

**Test data**
**Phase line**


Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
0.1580	45.4	65.6	-20.2	QP
0.1940	45.0	63.9	-18.9	QP
0.2340	41.2	62.3	-21.1	QP

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

**Receiver/Spectrum analyzer settings:**

0.15 MHz to 30 MHz

**Preview measurements**

Receiver: 9 kHz RBW, Peak and Average detector, max hold

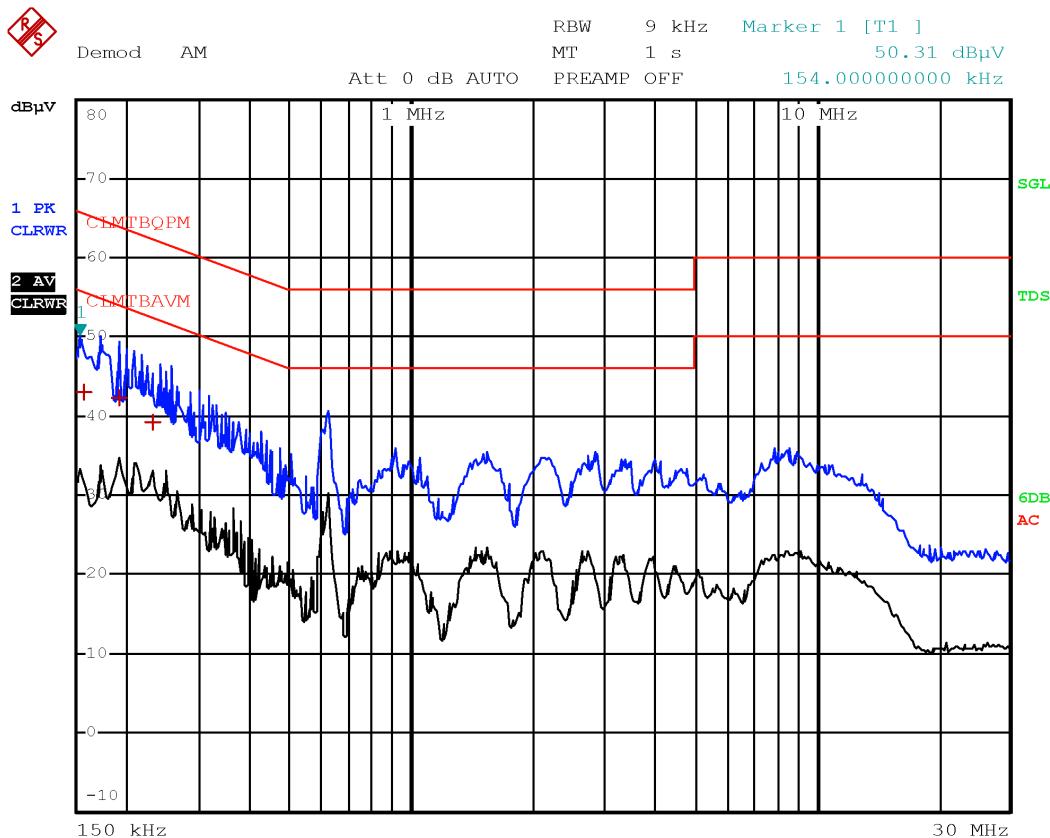
**Final measurement**

Receiver: 9 kHz RBW, Quasi-peak and Average detector

Measurement time 100 ms

**Section 8**
**Testing data**

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

**Test data, continued**
**Neutral line**


Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Detector
0.1580	43.0	65.6	-22.6	QP
0.1940	42.3	63.9	-21.6	QP
0.2340	39.4	62.3	-22.9	QP

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

**Receiver/Spectrum analyzer settings:**

0.15 MHz to 30 MHz

**Preview measurements**

Receiver: 9 kHz RBW, Peak and Average detector, max hold

**Final measurement**

Receiver: 9 kHz RBW, Quasi-peak and Average detector

Measurement time 100 ms

Test name	FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements
Specification	FCC Part 15 Subpart C

## 8.5 Clause 15.247(a)(1) Frequency hopping requirements

### § 15.247 Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz.

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

- (1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.
  - (i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
  - (ii) Frequency hopping systems operating in the 5725–5850 MHz band shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.
  - (iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

### Special notes

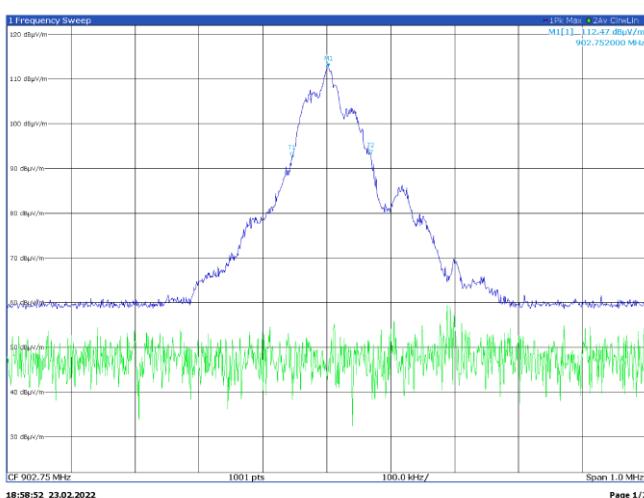
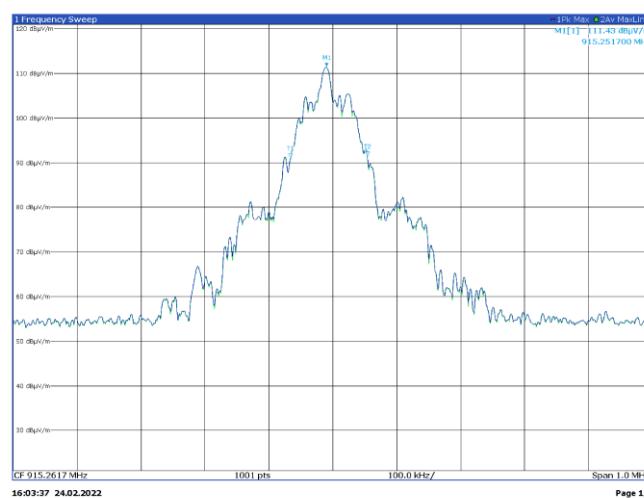
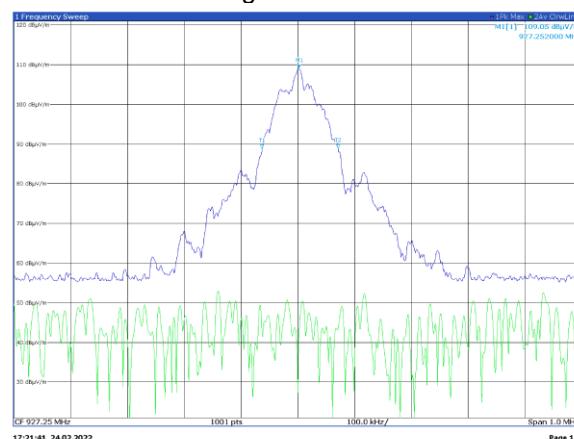
The peak detector was used with 100 kHz/300 kHz RBW/VBW

**Section 8**
**Testing data**

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

**Test data**
**Section (1) Results**

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

**Low channel:**

**Mid channel:**

**High channel:**


Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1	1	902.75000 MHz	112.47 dBµV/m	ndB	20.0 dB	<b>123.90 kHz</b>
T1	1	902.6951 MHz	92.56 dBµV/m	ndB down BW		
T2	1	902.8169 MHz	93.14 dBµV/m	Q Factor	7267.5	

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1	1	915.261700 MHz	111.43 dBµV/m	ndB	20.0 dB	<b>119.90 kHz</b>
T1	1	915.1956 MHz	91.08 dBµV/m	ndB down BW		
T2	1	915.3156 MHz	91.31 dBµV/m	Q Factor	7634.7	

Frequency (MHz)	20 dB bandwidth (MHz)
902.75	0.1239

**Section 8** Testing data

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements

**Specification** FCC Part 15 Subpart C

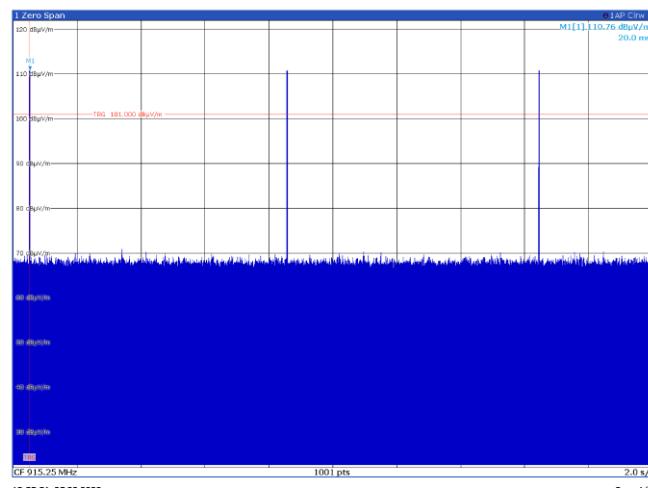
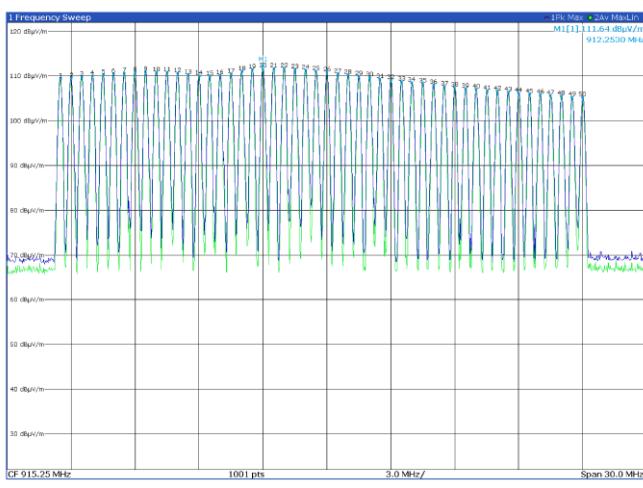
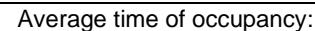
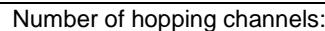
915.25	0.1199
927.25	0.1339

<b>Test name</b>	FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements
<b>Specification</b>	FCC Part 15 Subpart C

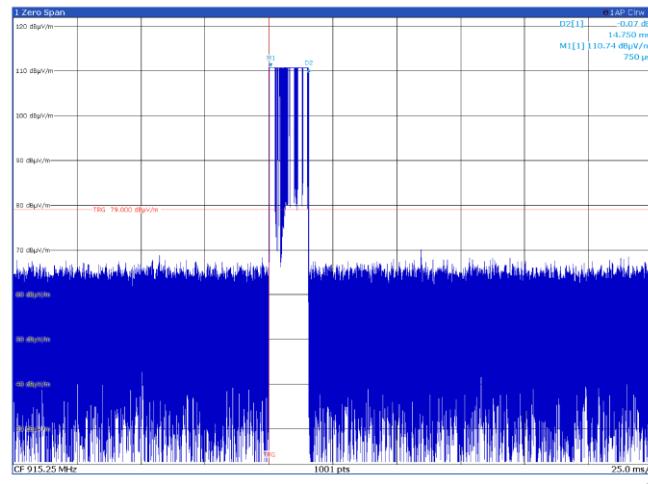
## Test data, continued

## Section (i) Results

For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.



Marker Peak List		X-Value	Y-Value	No	X-Value	Y-Value
1	900.752000 MHz	109.359 dB/uM	26	915.250000 MHz	110.789 dB/uM	
2	903.740000 MHz	109.789 dB/uM	27	916.250000 MHz	110.800 dB/uM	
3	903.740000 MHz	109.789 dB/uM	28	916.250000 MHz	110.250 dB/uM	
4	904.210000 MHz	110.034 dB/uM	29	916.749000 MHz	109.889 dB/uM	
5	904.210000 MHz	110.034 dB/uM	30	917.249000 MHz	109.900 dB/uM	
6	905.240000 MHz	110.455 dB/uM	31	917.738000 MHz	109.330 dB/uM	
7	905.240000 MHz	110.455 dB/uM	32	918.236000 MHz	109.500 dB/uM	
8	905.239000 MHz	110.816 dB/uM	33	918.756000 MHz	109.788 dB/uM	
9	906.739000 MHz	109.861 dB/uM	34	919.236000 MHz	109.504 dB/uM	
10	907.737000 MHz	109.861 dB/uM	35	919.756000 MHz	109.504 dB/uM	
11	907.737000 MHz	110.772 dB/uM	36	920.250000 MHz	109.970 dB/uM	
12	908.237000 MHz	110.575 dB/uM	37	920.764000 MHz	109.717 dB/uM	
13	908.237000 MHz	110.575 dB/uM	38	921.278000 MHz	109.970 dB/uM	
14	909.256000 MHz	110.010 dB/uM	39	921.753000 MHz	107.161 dB/uM	
15	909.256000 MHz	110.010 dB/uM	40	922.250000 MHz	107.161 dB/uM	
16	910.245000 MHz	110.102 dB/uM	41	923.252000 MHz	106.735 dB/uM	
17	910.754000 MHz	110.437 dB/uM	42	923.252000 MHz	106.568 dB/uM	
18	911.744000 MHz	111.043 dB/uM	43	924.214000 MHz	106.987 dB/uM	
19	911.744000 MHz	111.043 dB/uM	44	924.214000 MHz	106.120 dB/uM	
20	912.253000 MHz	111.636 dB/uM	45	924.750000 MHz	105.954 dB/uM	
21	912.253000 MHz	111.636 dB/uM	46	925.250000 MHz	105.954 dB/uM	
22	913.240000 MHz	111.640 dB/uM	47	925.740000 MHz	105.630 dB/uM	
23	914.231000 MHz	112.056 dB/uM	48	926.250000 MHz	105.891 dB/uM	
24	914.231000 MHz	112.056 dB/uM	49	926.758000 MHz	105.891 dB/uM	
25	914.741000 MHz	111.051 dB/uM	50	927.238000 MHz	105.205 dB/uM	



Average time = 14.750 ms X 3 = 44 ms

Section 8	Testing data
Test name	FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements
Specification	FCC Part 15 Subpart C

## 8.6 Clause 15.247(b) Maximum peak conducted output power

### § 15.247 Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz.

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

- (1) For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.
- (2) **For frequency hopping systems operating in the 902–928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.**
- (3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.
- (4) 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.
  - (i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.
  - (ii) Systems operating in the 5725–5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.
  - (iii) Fixed, point-to-point operation, as used in paragraphs (b)(3)(i) and (b)(3)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

### Special notes

None

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

**Test data, continued**
**Section (3) Results, continued**
**Radiated measurements horizontal polarization**

Radiated measurements were performed:

- The EUT was measured on three orthogonal axis.
- All measurements were performed at a distance of 3 m.
- All measurements were performed:
  - using a peak detector with RBW wider than emission bandwidth
  - Only the worst data presented in the test report.
  - Fresh battery was used throughout the test.

Frequency (MHz)	Field strength (dB $\mu$ V/m)	Output power (dBm)	Limit (dBm)	Margin (dBm)
902.752	113.66	18.43	30	-11.57
915.25	108.87	13.64	30	-16.36
927.52	109.35	14.12	30	-15.88

Note: The limit was reduced from 30 dBm by amount in dB that the directional gain of the antenna exceeds 6 dBi.

Theoretical conversion from Field Strength measured at 3 m to power conducted from the intentional radiator to the antenna:

$$P (W) = \frac{E^2 R^2}{30G}$$

*E* = Measured field strength value (V/m)

*R* = Measurement distance (m)

*G* = Antenna Gain (numeric)

Therefore  $dBW = dB\mu V/m + 20\log(3) - 10\log(30) - 10\log(G)$

From which we obtain

$$\begin{aligned} dBmW &= dB\mu V/m - 120 + 20\log(3) - 10\log(30) - 10\log(G) + 30 \\ &= dB\mu V/m - 95.23 - 10\log(G) \end{aligned}$$

Output power [dBm] = Field Strength [dB $\mu$ V/m] – 95.23 [dB] – Antenna gain [dBi]

Frequency (MHz)	EIRP (dBm)	Limit (dBm)	Margin (dBm)
902.752	18.43	36	-17.57
915.25	13.64	36	-22.36
927.52	14.12	36	-21.88

EIRP [dBm] = Output power [dBm] + Antenna gain [dBi]

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

## Test data, continued

Section (3) Results, continued

### Radiated measurements vertical polarization

Radiated measurements were performed:

- The EUT was measured on three orthogonal axis.
- All measurements were performed at a distance of 3 m.
- All measurements were performed:
  - using a peak detector with RBW wider than emission bandwidth
  - Only the worst data presented in the test report.
  - Fresh battery was used throughout the test.

Frequency (MHz)	Field strength (dB $\mu$ V/m)	Output power (dBm)	Limit (dBm)	Margin (dBm)
902.752	109.56	14.33	30	-15.67
915.25	111.22	15.99	30	-14.01
927.25	105.72	10.49	30	-19.51

Note: The limit was reduced from 30 dBm by amount in dB that the directional gain of the antenna exceeds 6 dBi.

Theoretical conversion from Field Strength measured at 3 m to power conducted from the intentional radiator to the antenna:

$$P (W) = \frac{E^2 R^2}{30G}$$

*E* = Measured field strength value (V/m)

*R* = Measurement distance (m)

*G* = Antenna Gain (numeric)

Therefore  $dBW = dB\mu V/m - 120 + 20\log(3) - 10\log(30) - 10\log(G) + 30$

From which we obtain

$$dBmW = dB\mu V/m - 120 + 20\log(3) - 10\log(30) - 10\log(G) + 30 \\ = dB\mu V/m - 95.23 - 10\log(G)$$

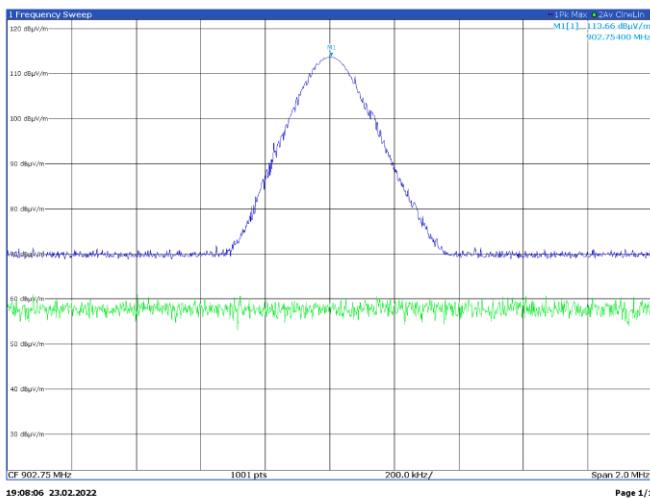
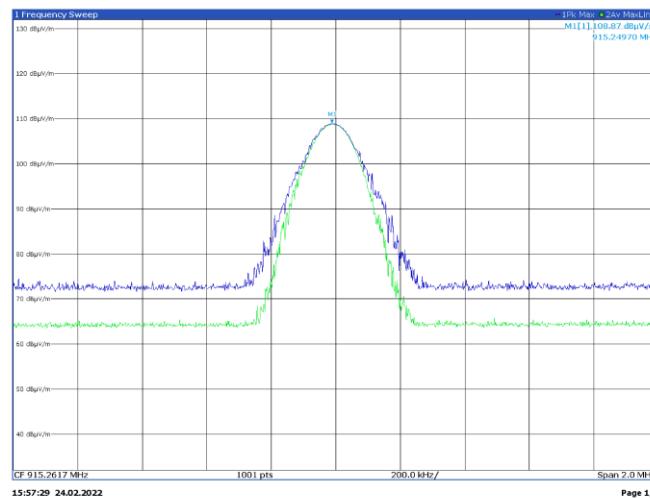
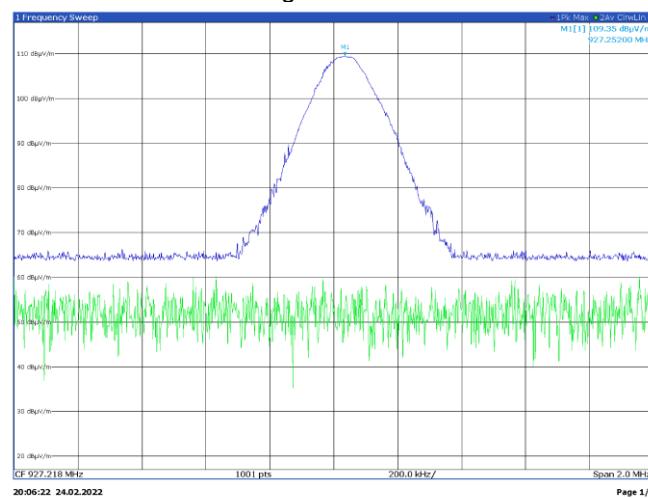
Output power [dBm] = Field Strength [dB $\mu$ V/m] – 95.23 [dB] – Antenna gain [dBi]

Frequency (MHz)	EIRP (dBm)	Limit (dBm)	Margin (dBm)
902.752	14.33	36	-21.67
915.25	15.99	36	-20.01
927.25	10.49	36	-25.51

EIRP [dBm] = Output power [dBm] + Antenna gain [dBi]

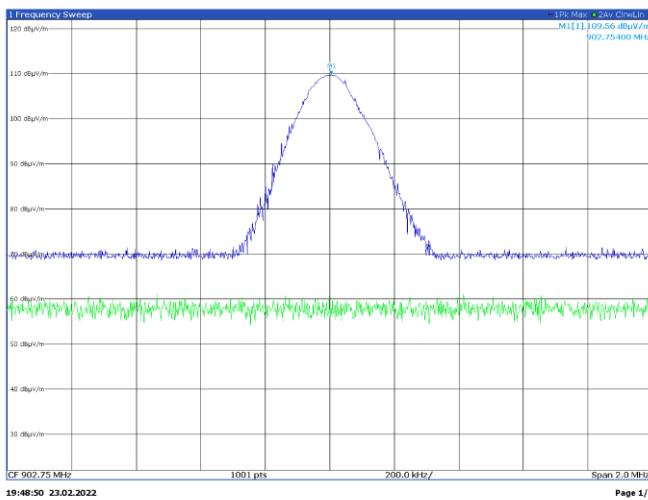
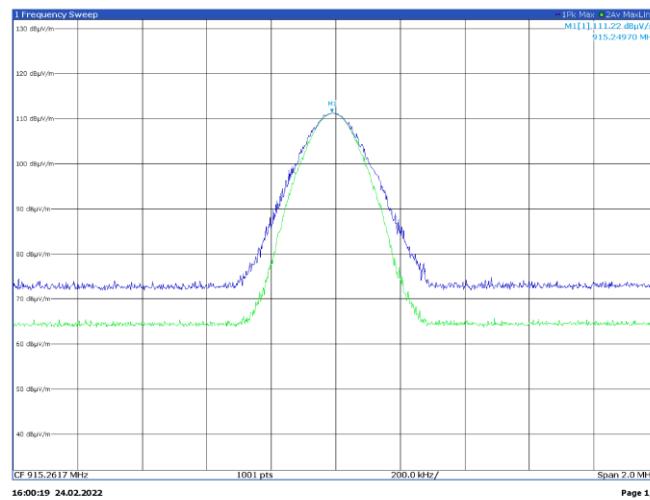
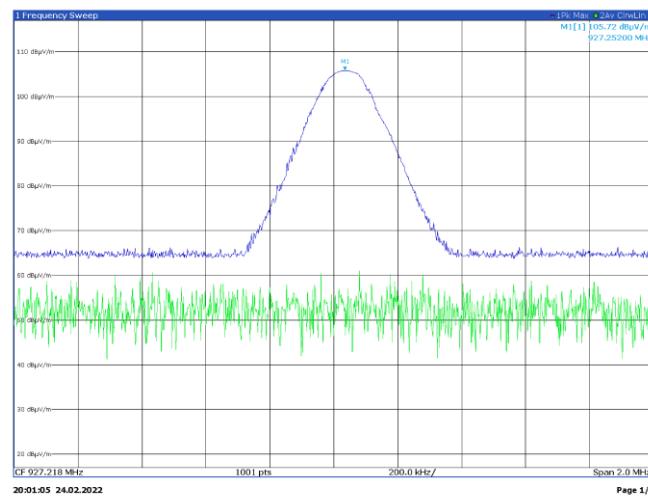
**Section 8**
**Testing data**

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

**Test data, continued**
**Section (3) Results, continued**
**Radiated spectral plots: horizontal polarization**
**Low channel**

**Mid channel**

**High channel**


**Section 8**
**Testing data**

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

**Test data, continued**
**Section (3) Results, continued**
**Radiated spectral plots: vertical polarization**
**Low channel**

**Mid channel**

**High channel**


Section 8	Testing data
Test name	FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements
Specification	FCC Part 15 Subpart C

## 8.7 Clause 15.247(d) Spurious emissions

### § 15.247 Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz.

(d) 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)).

**Section 8**

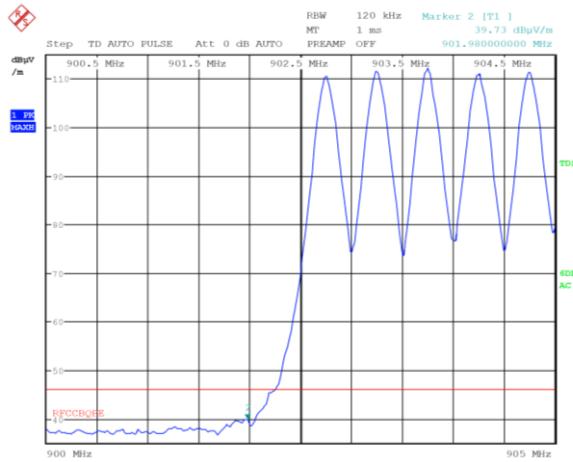
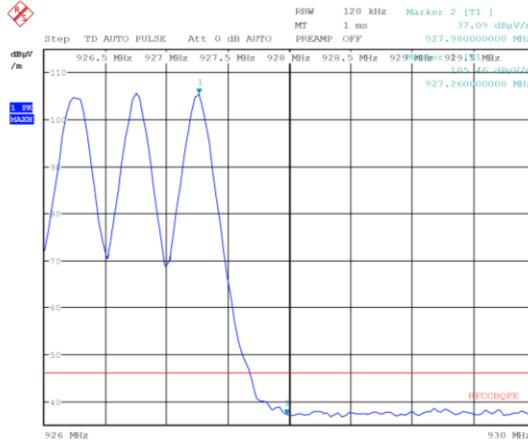
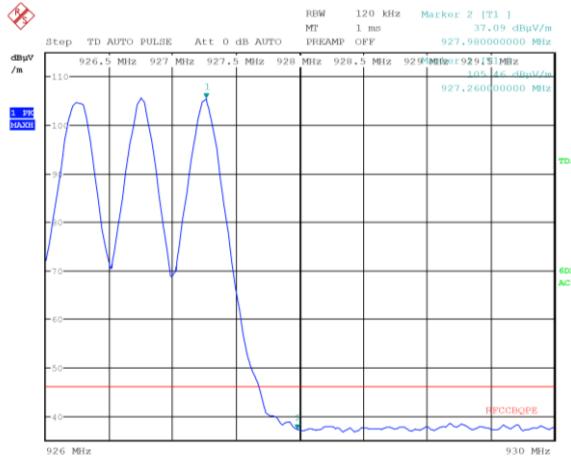
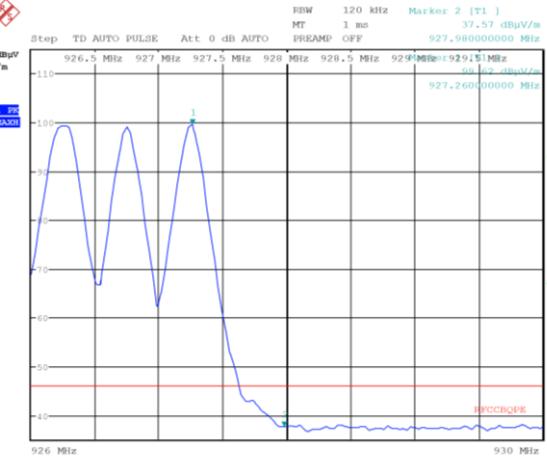
Testing data

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

Special notes																																					
<b>§15.209 – Radiated emission limits</b>																																					
<table border="1"> <thead> <tr> <th rowspan="2">Frequency (MHz)</th><th colspan="2">Field strength</th><th rowspan="2">Measurement distance (m)</th></tr> <tr> <th>(<math>\mu</math>V/m)</th><th>(dB<math>\mu</math>V/m)</th></tr> </thead> <tbody> <tr> <td>0.009–0.490</td><td>2400/F</td><td>67.6–20log(F)</td><td>300</td></tr> <tr> <td>0.490–1.705</td><td>24000/F</td><td>87.6–20log(F)</td><td>30</td></tr> <tr> <td>1.705–30.0</td><td>30</td><td>29.5</td><td>30</td></tr> <tr> <td>30–88</td><td>100</td><td>40.0</td><td>3</td></tr> <tr> <td>88–216</td><td>150</td><td>43.5</td><td>3</td></tr> <tr> <td>216–960</td><td>200</td><td>46.0</td><td>3</td></tr> <tr> <td>above 960</td><td>500</td><td>54.0</td><td>3</td></tr> </tbody> </table>				Frequency (MHz)	Field strength		Measurement distance (m)	( $\mu$ V/m)	(dB $\mu$ V/m)	0.009–0.490	2400/F	67.6–20log(F)	300	0.490–1.705	24000/F	87.6–20log(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
Frequency (MHz)	Field strength		Measurement distance (m)																																		
	( $\mu$ V/m)	(dB $\mu$ V/m)																																			
0.009–0.490	2400/F	67.6–20log(F)	300																																		
0.490–1.705	24000/F	87.6–20log(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																																		
<p>Notes:</p> <ul style="list-style-type: none"> <li>– F = fundamental frequency in kHz</li> <li>– In the emission table above, the tighter limit applies at the band edges.</li> <li>– 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.</li> </ul>																																					
<b>§15.205 – Restricted bands of operation</b>																																					
<b>MHz</b>	<b>MHz</b>	<b>MHz</b>	<b>GHz</b>																																		
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																																					
<ul style="list-style-type: none"> <li>– The spectrum was searched from 30 MHz to the 10<sup>th</sup> harmonic.</li> <li>– The EUT was measured on three orthogonal axis.</li> <li>– All measurements were performed at a distance of 3 m.</li> <li>– All measurements were performed:           <ul style="list-style-type: none"> <li>– below 30 MHz: using a quasi-peak detector with 9 kHz/30 kHz RBW/VBW,</li> <li>– within 30–1000 MHz range: using a quasi-peak detector with 120 kHz/300 kHz RBW/VBW,</li> <li>– within 30–1000 MHz range: using a peak detector with 100 kHz/300 kHz RBW/VBW,</li> <li>– above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results               <ul style="list-style-type: none"> <li>– and using peak detector with 1 MHz/10 Hz RBW/VBW for average results</li> <li>– or using average detector with 1 MHz/3 MHz RBW/VBW for average results</li> <li>– or using a duty cycle/average factor for average results calculations.</li> </ul> </li> </ul> </li> </ul>																																					

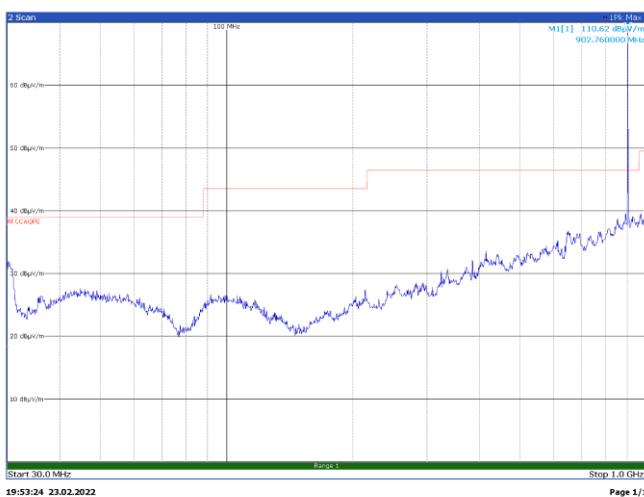
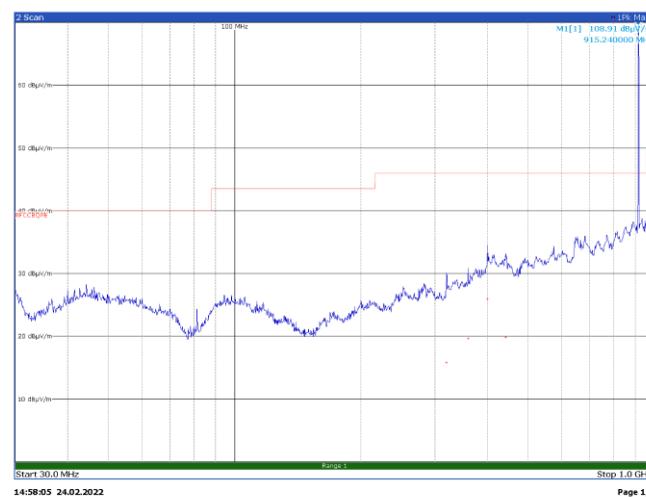
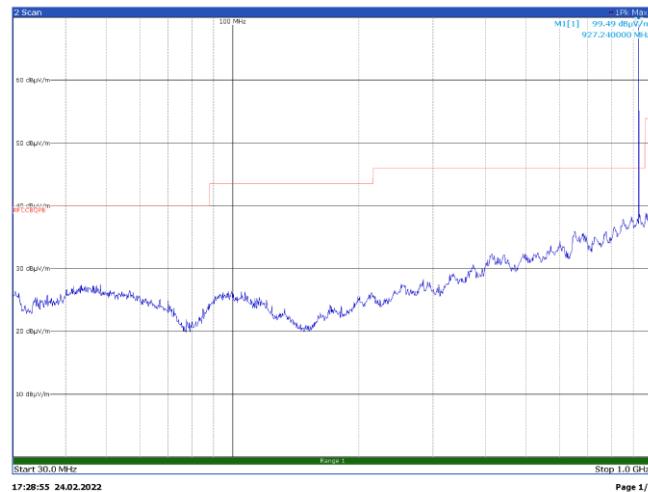
**Section 8**
**Testing data**

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

**Test data, continued**
**Lower band edge check with frequency hopping**  
**Horizontal**

**Vertical**

**Upper band edge check with frequency hopping**
**Horizontal**

**Vertical**


**Section 8**
**Testing data**

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

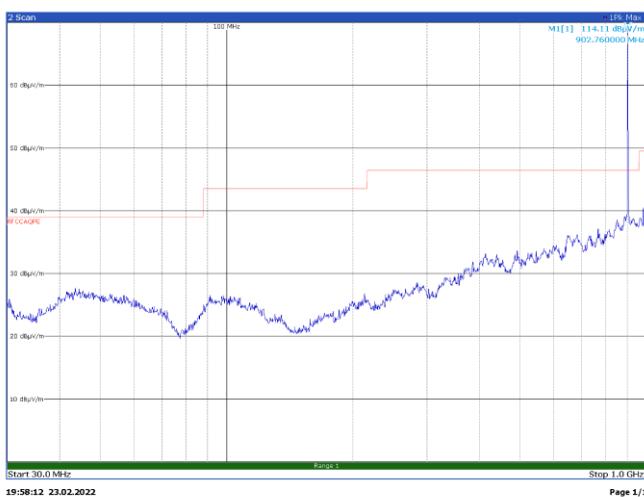
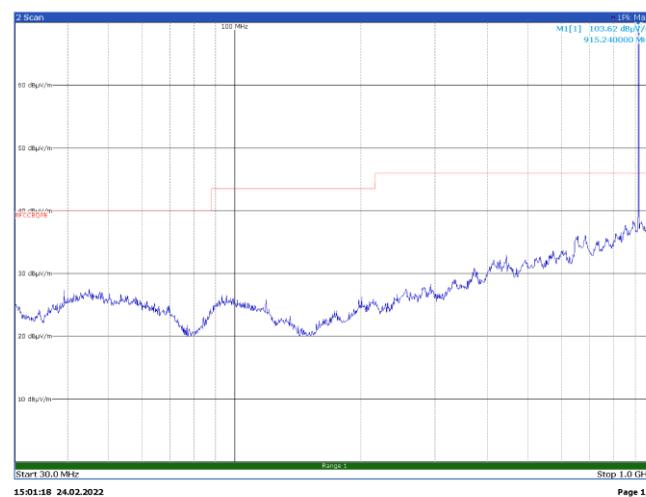
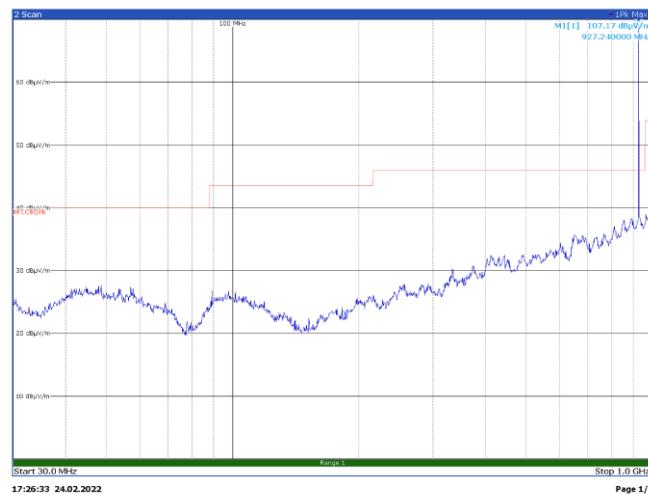
**Test data, continued**
**Radiated measurement vertical**
**Low channel**

**Mid channel**

**High channel**

**Limits exceeded by carrier**
**Radiated Measurements**

No emissions were detected within 10 dB of limit inside the 15.205 Restricted bands.

- All measurements were performed at a distance of 3 m.
- All measurements performed:
  - within 30–1000 MHz range: using a peak detector with 100 kHz/300 kHz RBW/VBW,
  - above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results
  - and using average detector with 1 MHz/3 MHz RBW/VBW for average results

**Section 8**
**Testing data**

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

**Test data, continued**
**Radiated measurement horizontal**
**Low channel**

**Mid channel**

**High channel**

**Limit exceeded by carrier**
**Radiated Measurements**

No emissions were detected within 10 dB of limit inside the 15.205 Restricted bands.

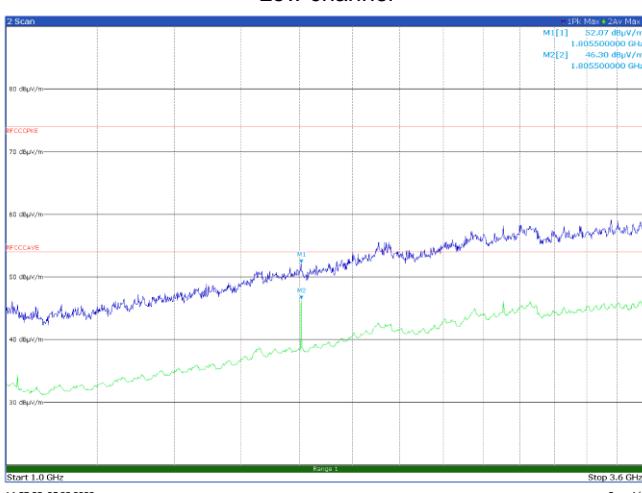
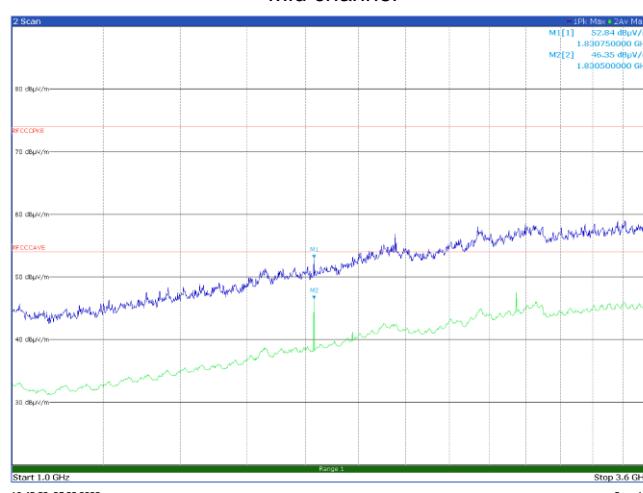
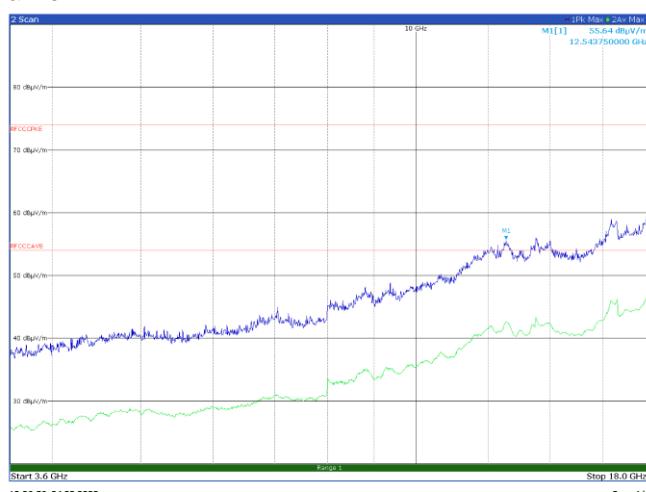
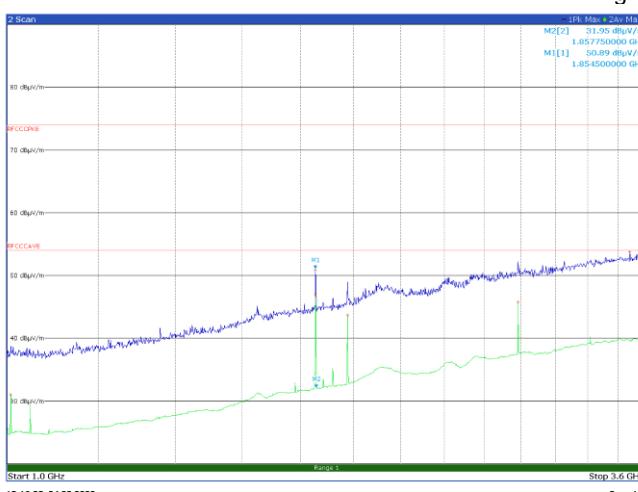
- All measurements were performed at a distance of 3 m.
- All measurements performed:
  - within 30–1000 MHz range: using a peak detector with 100 kHz/300 kHz RBW/VBW,
  - above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results
  - and using average detector with 1 MHz/3 MHz RBW/VBW for average results



<b>Section 8</b>	Testing data
<b>Test name</b>	FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements
<b>Specification</b>	FCC Part 15 Subpart C

**Section 8**
**Testing data**

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

**Test data, continued**
**Radiated measurement horizontal**
**Low channel**

**Mid channel**

**High channel**


Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Detector
--	--	--	--	--

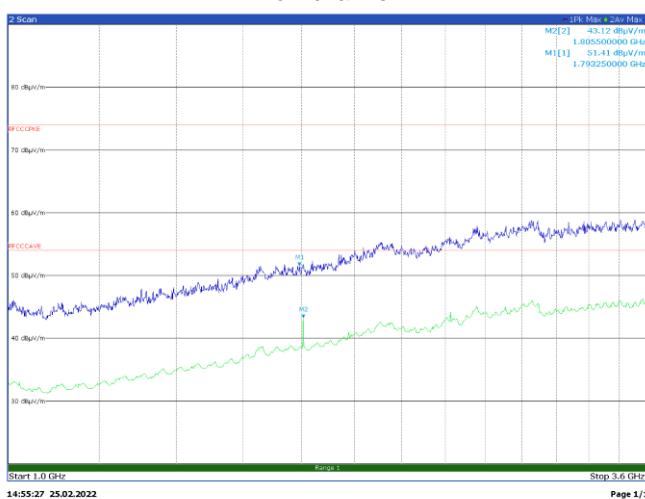
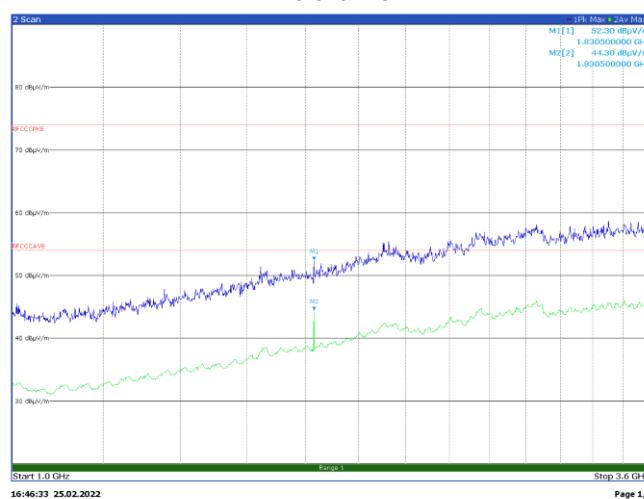
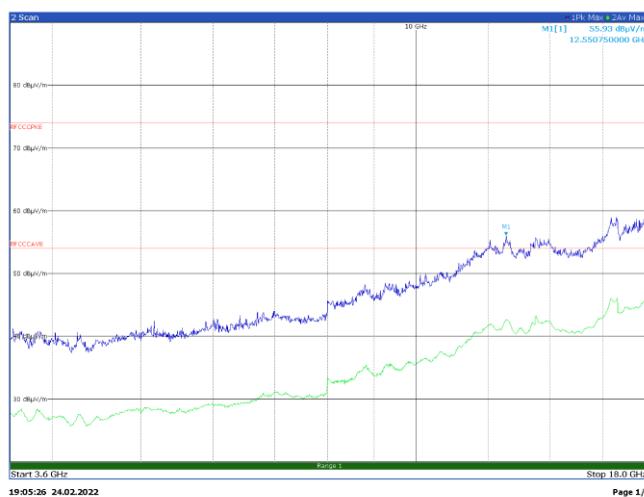
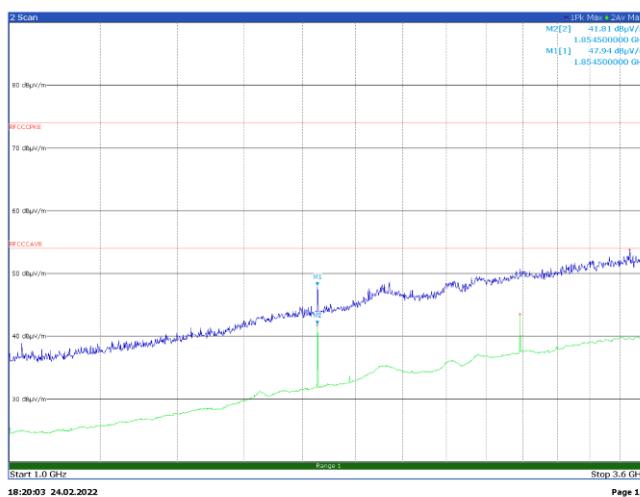
**Radiated Measurements**

No emissions were detected within 10 dB of limit inside the 15.205 Restricted bands.

- All measurements were performed at a distance of 3 m.
- All measurements performed:
  - within 30–1000 MHz range: using a peak detector with 100 kHz/300 kHz RBW/VBW,
  - above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results
  - and using average detector with 1 MHz/3 MHz RBW/VBW for average results

**Section 8**
**Testing data**

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

**Test data, continued**
**Radiated measurement vertical**
**Low channel**

**Mid channel**

**High channel**


Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Detector
--	--	--	--	--

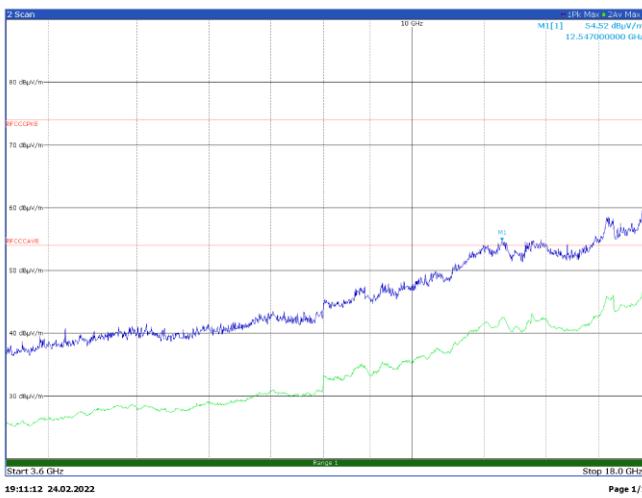
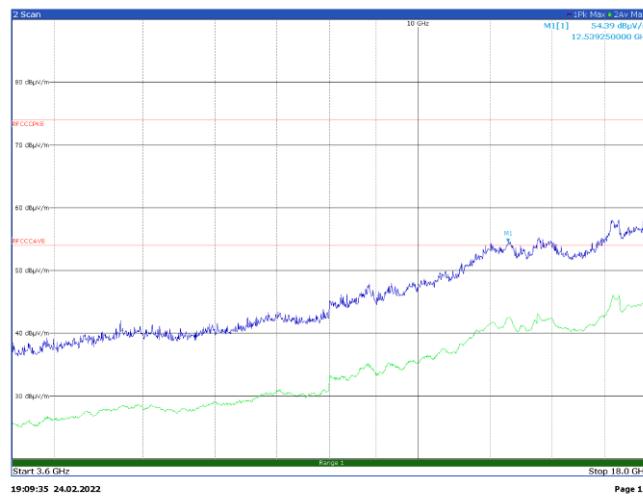
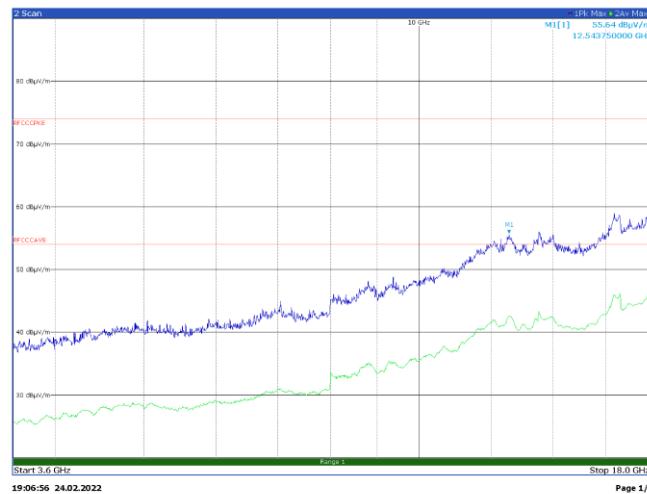
**Radiated Measurements**

No emissions were detected within 10 dB of limit inside the 15.205 Restricted bands.

- All measurements were performed at a distance of 3 m.
- All measurements performed:
  - within 30–1000 MHz range: using a peak detector with 100 kHz/300 kHz RBW/VBW,
  - above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results
  - and using average detector with 1 MHz/3 MHz RBW/VBW for average results

**Section 8**
**Testing data**

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
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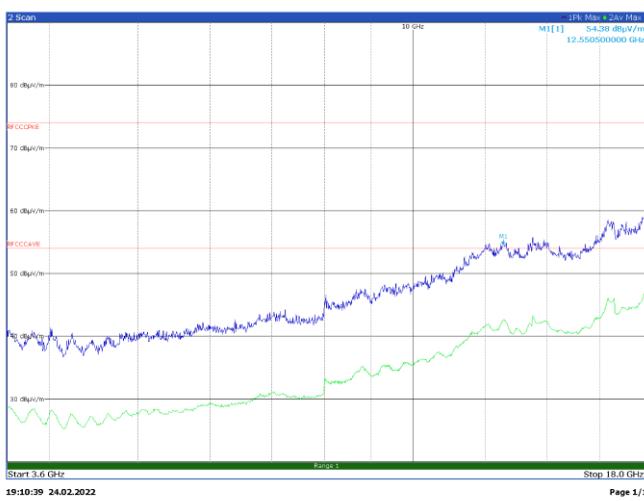
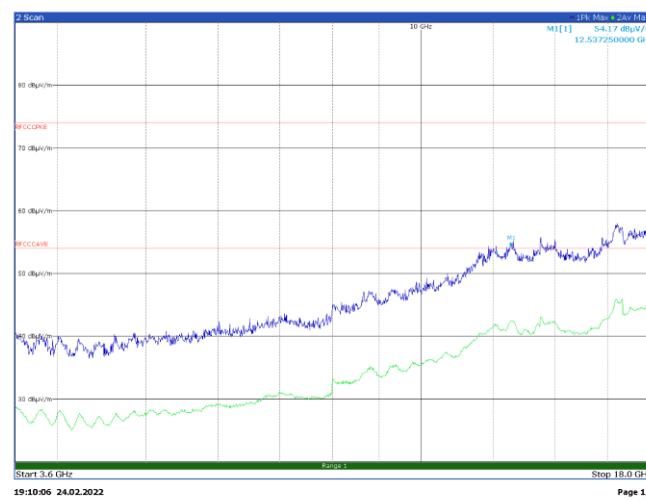
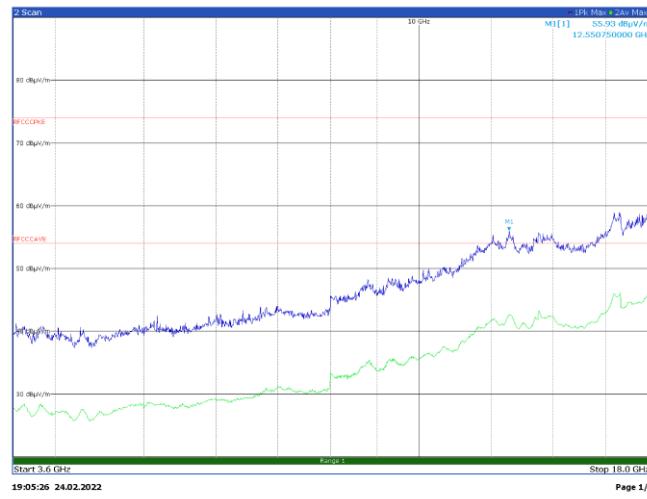
**Test data, continued**
**Radiated measurement horizontal**
**Low channel**

**Mid channel**

**High channel**

**Radiated Measurements**

No emissions were detected within 10 dB of limit inside the 15.205 Restricted bands.

- All measurements were performed at a distance of 3 m.
- All measurements performed:
  - within 30–1000 MHz range: using a peak detector with 100 kHz/300 kHz RBW/VBW,
  - above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results
  - and using average detector with 1 MHz/3 MHz RBW/VBW for average results

**Section 8** Testing data

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements  
**Specification** FCC Part 15 Subpart C

**Test data, continued**
**Radiated measurement vertical**
**Low channel**

**Mid channel**

**High channel**

**Radiated Measurements**

No emissions were detected within 10 dB of limit inside the 15.205 Restricted bands.

- All measurements were performed at a distance of 3 m.
- All measurements performed:
  - within 30–1000 MHz range: using a peak detector with 100 kHz/300 kHz RBW/VBW,
  - above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results
  - and using average detector with 1 MHz/3 MHz RBW/VBW for average results

**Section 8****Testing data****Test name**

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

**Specification**

FCC Part 15 Subpart C

**Setup photos**

**Section 8**

Testing data

**Test name**

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

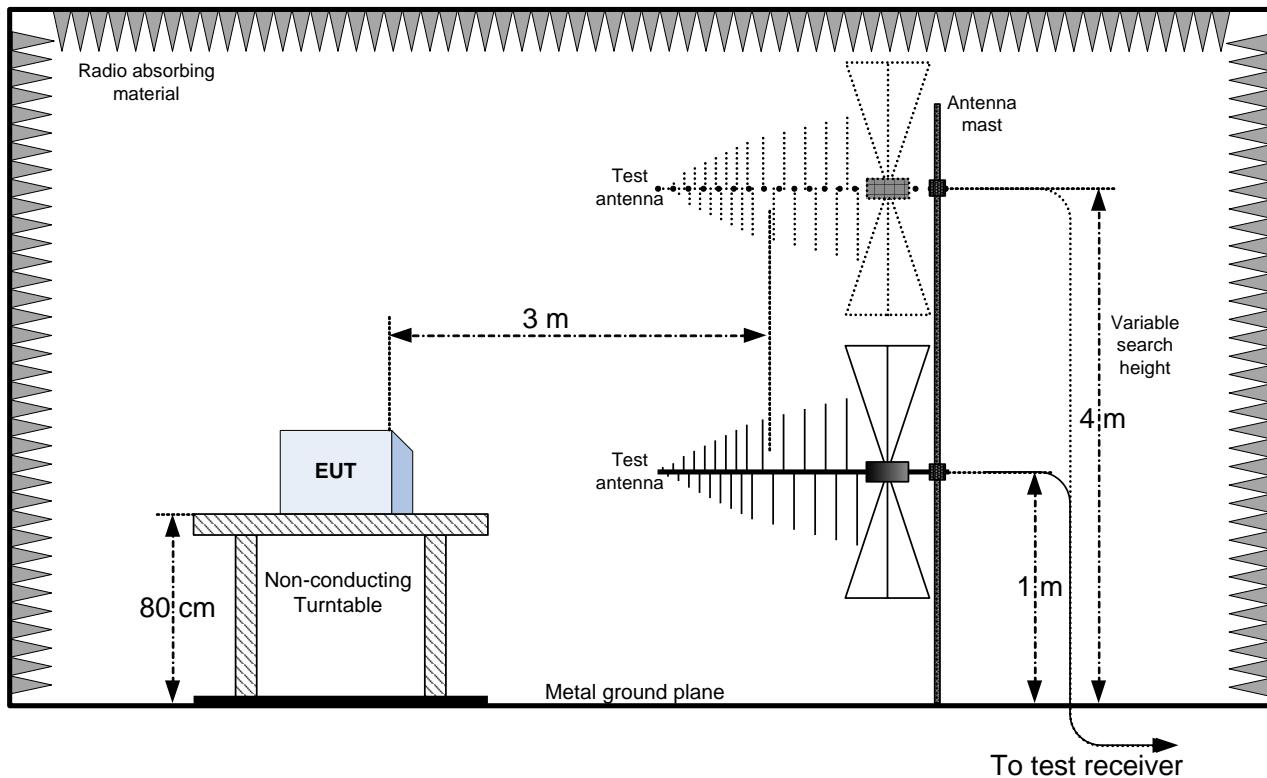
**Specification**

FCC Part 15 Subpart C

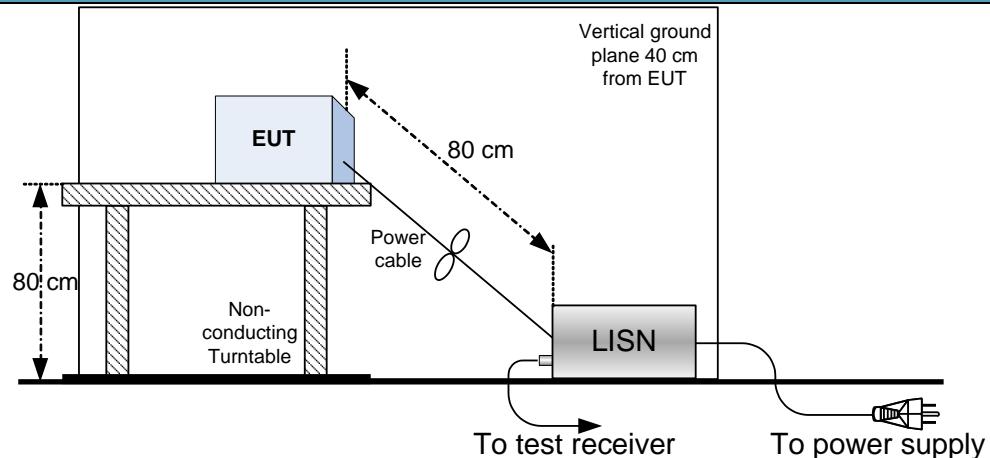
**Setup photos**

## Section 9: Block diagrams of test set-ups

### Radiated emissions set-up



### Conducted emissions set-up



**Section 10** EUT photos

**Test name** FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements

**Specification** FCC Part 15 Subpart C

## Section 10: EUT photos

### EUT



Section 10 EUT photos

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

Specification FCC Part 15 Subpart C

## Section 10: EUT photos

### EUT

