Report on the FCC and IC Testing of the GWF AG

Model: ERH

In accordance with FCC 47 CFR Part 15 C and ISED RSS-247 and ISED RSS-GEN

Product Service

Add value.
Inspire trust.

Prepared for: GWF AG
Obergrundstrasse 119
CH-6005 Lucerne
Switzerland

FCC ID: 2A4F7-ERH
IC: 28165-ERH

COMMERCIAL-IN-CONFIDENCE

Date: 2023-09-26
Document Number: TR-713292918-02 | Revision 2

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Alexander Deese	2023-09-26	SIGN-ID 835341
Authorised Signatory	Matthias Stumpe	2023-09-28	SIGN-ID 835773

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

Engineering Statement:

This measurement shown in this report were made in accordance with the procedures described on test pages.
All reporded testing was carried out on a sample equipment to demonstrate limited compilance with with FCC 47 CFR Part 15 C and ISED RSS-247 and RSS-GEN.
The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Alexander Deese	2023-09-26	SIGN-ID 835341

Laboratory Accreditation	Laboratory recognition	Industry Canada test site registration
DAkkS Reg. No. D-PL-11321-11-03 DAkkS Reg. No. D-PL-11321-11-04	Registration No. BNetzA-CAB-16/21-15	3050A-2

Executive Statement:

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15 C:2021 and ISED RSS-247:2017 and RSS-GEN:2021

Trade Register Munich
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Information pursuant to Section 2(1)
DL-InfoV (Germany) at
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Germany

Product Service

Content

Product Service

1 Report Summary

1.1 Modification Report

Alternations and additions of this report will be issued to the holders of each copy in the form of a complete document.

Issue	*Description of changes*	*Date of Issue*
0	First Issue	2023-02-24
1	Section 2.2.7: Smaller RBW for Bandwidth measurement. Section 2.6.7: Conducted output power added. Section 2.7.7: Marker at Band edges added. Section: 2.8: Header changed to “Non-Restricted”. Section 2.8.7: Measurement up to 9.3 GHz	2023-09-04
2	Hopping mode added to Frequency Band Edge and Non-Restricted Band of operation measurements	2023-09-26

Table 1: Report of Modifications

1.2 Introduction

Applicant	GWF AG Obergrundstrasse 119 CH-6005 Lucerne Switzerland
Manufacturer	ESCATEC Mechatronics Sdn. Bhd. 8 Jalan Firma 2/1 Kawasan Perindustrian Tebrau 1 81100 Johor Bahru Johor Malaysia
Model Number(s)	ERH
Serial Number(s)	---
Hardware Version(s)	---
Software Version(s)	---
Number of Samples Tested	1
Test Specification(s) / Issue / Date	FCC 47 CFR Part 15 C: 2021 ISED RSS-247, Issue 2: 2017 ISED RSS-GEN, Issue 5, Amd. 1, Amd. 2: February 2021
Test Plan/Issue/Date	N/A
Order Number	5753425 REV 3.0
Date	2023-01-31
Date of Receipt of EUT	2023-02-20
Start of Test	2023-02-20
Finish of Test	2023-02-22
Name of Engineer(s)	Alexander Deese
Related Document(s)	ANSI C63.4: 2014 ANSI C63.10: 2013 KDB 558074 D01 V05R02

Product Service

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15 C, ISED RSS-247 and ISED RSS-GEN is shown below.

Section	*Specification Clause*	*Test Description*	*Result*
2.1	15.203, 15.247(b)	Antenna requirement	Pass
2.2	15.247(a)(1)(i)	Emission Bandwidth	Pass
2.3	15.247(a)(1)	Hopping Channel Separation	Pass
2.4	15.247(a)(1)(i)	Number of Hopping Channels	Pass
2.5	15.247(a)(1)(i)	Time Occupancy on any Channel	Pass
2.6	15.247(b)(3)	Output Power	Pass
2.7	15.247(d)	Frequency Band Edge	Pass
2.8	15.209, 15.247(d)	Non-Restricted Bands of operation	Pass
2.9	15.247(d), 15.205, 15.209	Spurious Emissions	Pass
---	15.207	Conducted Emissions on Mains Terminals	Not Applicable

Table 2: Results according to FCC 47 CFR Part 15 C

Section	*Specification Clause*	*Test Description*	*Result*
2.2	5.1.c	Emission Bandwidth	Pass
2.3	5.1.b	Hopping Channel Separation	Pass
2.4	5.1.c	Number of Hopping Channels	Pass
2.5	5.1.c	Time Occupancy on any Channel	Pass
2.6	5.4 d.	Output Power	Pass
2.7	5.5	Frequency Band Edge	Pass
2.8	5.5	Non-Restricted Bands of operation	Pass
2.9	5.5	Spurious Emissions	Pass

Table 3: Results according to ISED RSS-247

Section	*Specification Clause*	*Test Description*	*Result*
2.2	6.7	Emission Bandwidth	Pass
2.8	8.10	Restricted Bands of operation	Pass
2.9	8.9, 8.10	Spurious Emissions	Pass
2.10	8.11	Frequency Stability	Pass
--	8.8	Conducted Emissions on Mains Terminals	Not applicable

Table 4: Results according to RSS-Gen

Product Service

1.4 Product Information

1.4.1 Technical Description

The ERH is an external LoRaWAN radio module for water and gas meters.

Frequency Band	902 – 928 MHz
Frequency range	902.3 MHz to 914.9 MHz
Number of frequency channels:	64
Power supply:	Lithium Ion Battery
Supply Voltage nominal:	3 V
Supply Voltage maximum:	3.5 V
Supply Voltage minimum:	2.2 V
Supply Frequency:	DC

1.5 Test Configuration

The EUT was configured as standalone device.

1.6 Modes of Operation

Mode 1:
Continuously transmitting, Carrier frequency 902.3 MHz

Mode 2:
Continuously transmitting, Carrier frequency 908.5 MHz

Mode 3:
Continuously transmitting, Carrier frequency 914.9 MHz

Mode 4:
Continuously transmitting, Hopping mode

Product Service

1.7 EUT Modifications Record

The table below details modifications made to the EUT during the test program.
The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
0	As supplied by the customer	Not Applicable	Not Applicable

Table 5

1.8 Test Location

TÜV SÜD Product Service conducted the following tests at our Straubing test laboratory:

Test Name	*Name of Engineer(s)*
Antenna requirement	Alexander Deese
Emission Bandwidth	Alexander Deese
Hopping Channel Separation	Alexander Deese
Number of Hopping Channel	Alexander Deese
Output Power	Alexander Deese
Frequency Band Edge	Alexander Deese
Non-Restricted Bands of Operation	Alexander Deese
Spurious emissions	Alexander Deese
Temperature Stability	Alexander Deese

Office Address:
Äußere Frühlingstraße 45
94315 Straubing
Germany

Product Service

2 Test Details

2.1 Antenna requirement

2.1.1 Specification Reference

FCC 47 CFR Part 15 C, Clauses 15.203, 15.247(b)

2.1.2 Equipment under Test and Modification State

ERH; S/N ---; Modification State 0

2.1.3 Date of Test

2023-02-20

2.1.4 Specification Limits

FCC 47 CFR 15.203
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or 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. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some fields disturbance sensors, or to other intentional radiators which 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 are not exceeded.

FCC 47 CFR 15.247(b)
Except for point-to-point operation and multiple directional beams, if the transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

2.1.5 Test Results

Pass: The EUT uses an integrated antenna on the PCB.

Product Service

2.2 Emission Bandwidth

2.2.1 Specification Reference

FCC 47 CFR Part 15 C, Clause 15.247(a)(1)(i)
ISED RSS-247, Clause 5.1 c.
ISED RSS-Gen, Clause 6.7

2.2.2 Equipment under Test and Modification State

ERH; S/N ---; Modification State 0

2.2.3 Date of Test

2023-02-20 to 2023-02-21

2.2.4 Environmental Conditions

Ambient Temperature	19 °C
Relative Humidity	40 %

2.2.5 Specification Limits

The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

ISED RSS-GEN:
The occupied (99 %) bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSS.

2.2.6 Test Method

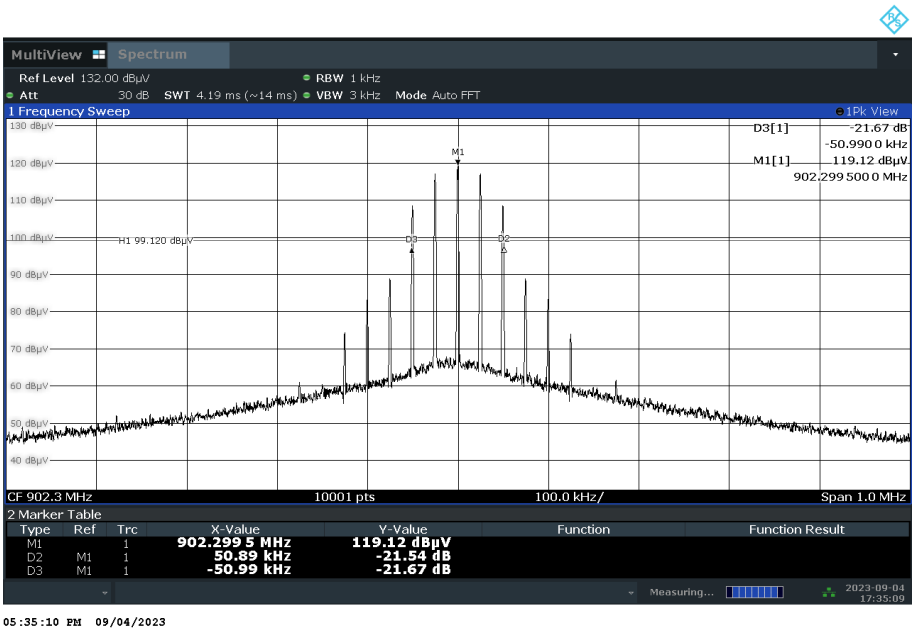
The test was performed according to ANSI C63.10, clauses 6.9.3 and 11.8.1

Product Service

2.2.7 Test Results

Frequency Channel	*20 dB Bandwidth*	*Limit*	*Band Edge Left*	*Band Edge Right*	*Result*
902.3 MHz	101.9 kHz	500 kHz	902.249 MHz	902.350 MHz	Pass
908.5 MHz	101.9 kHz	500 kHz	908.448 MHz	908.550 MHz	Pass
914.9 MHz	101.9 kHz	500 kHz	914.848 MHz	914.950 MHz	Pass

Table 6: 20 dB bandwidth



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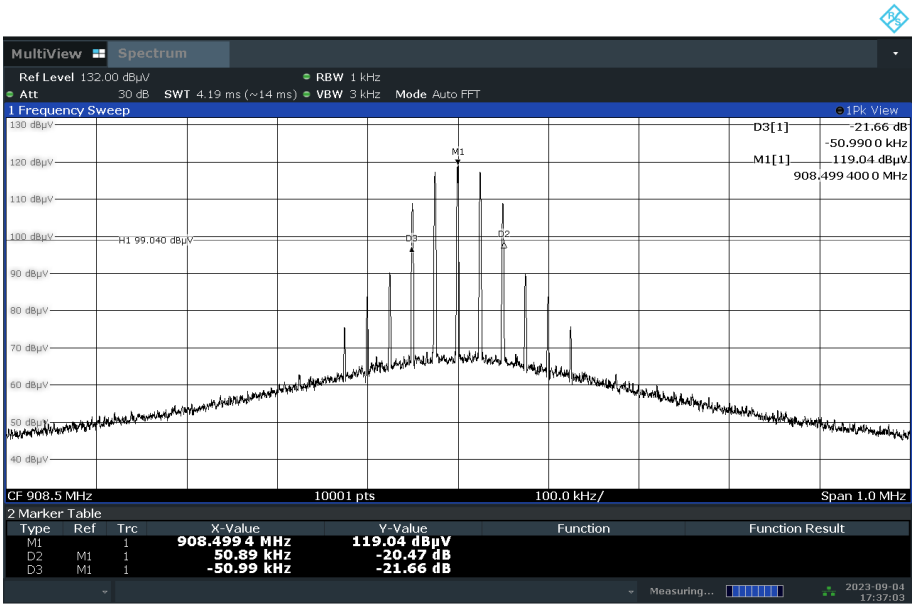
Product Service



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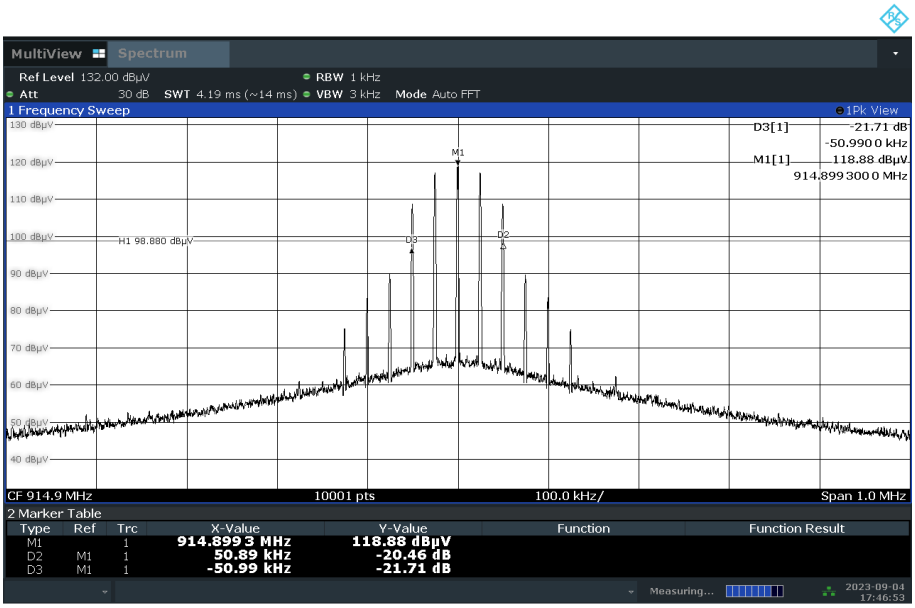

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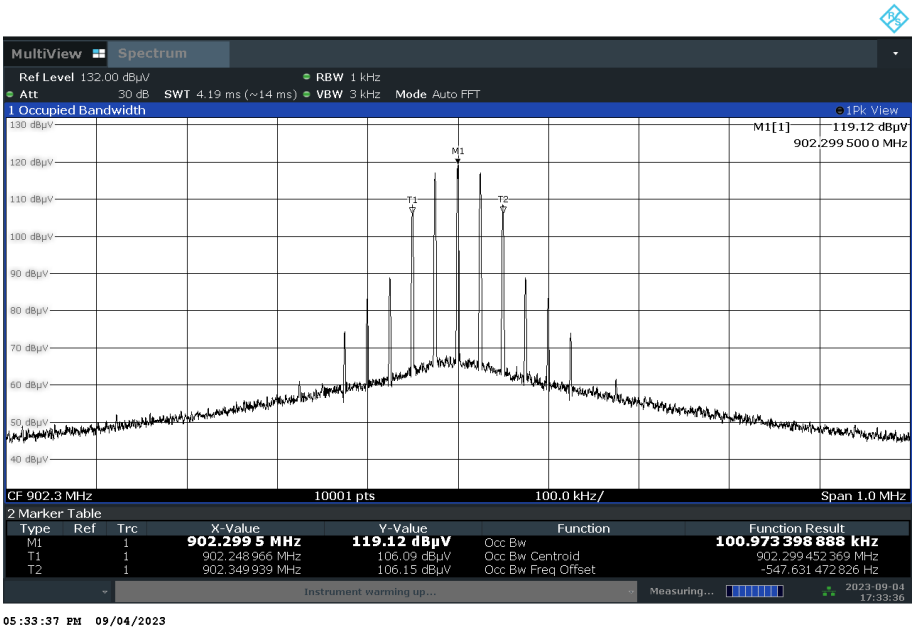
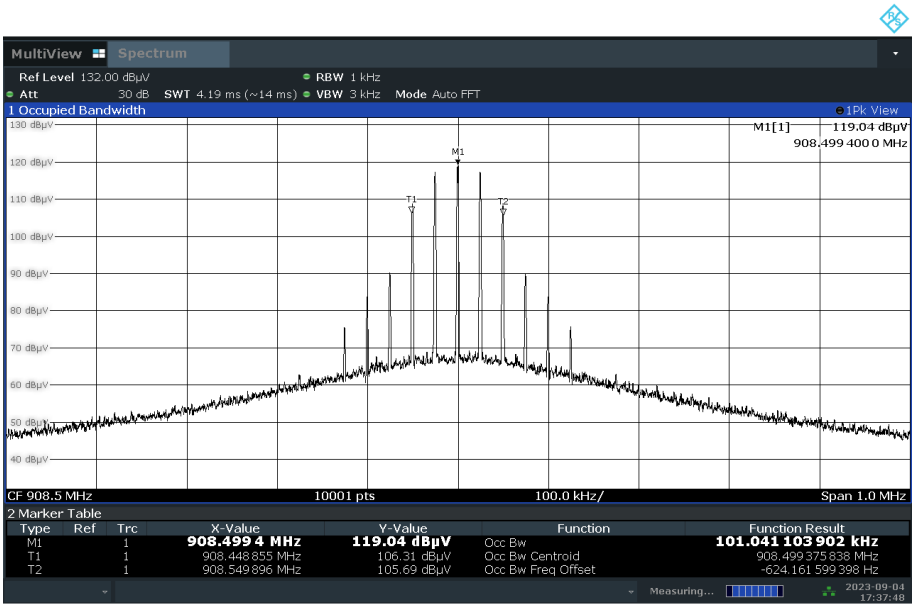
Frequency Channel	*99% Bandwidth*	*Band Edge Left*	*Band Edge Right*
902.3 MHz	101.0 kHz	902.249 MHz	902.350 MHz
908.5 MHz	101.0 kHz	908.449 MHz	908.550 MHz
914.9 MHz	101.0 kHz	914.849 MHz	914.950 MHz

Table 7: 99% bandwidth



Product Service



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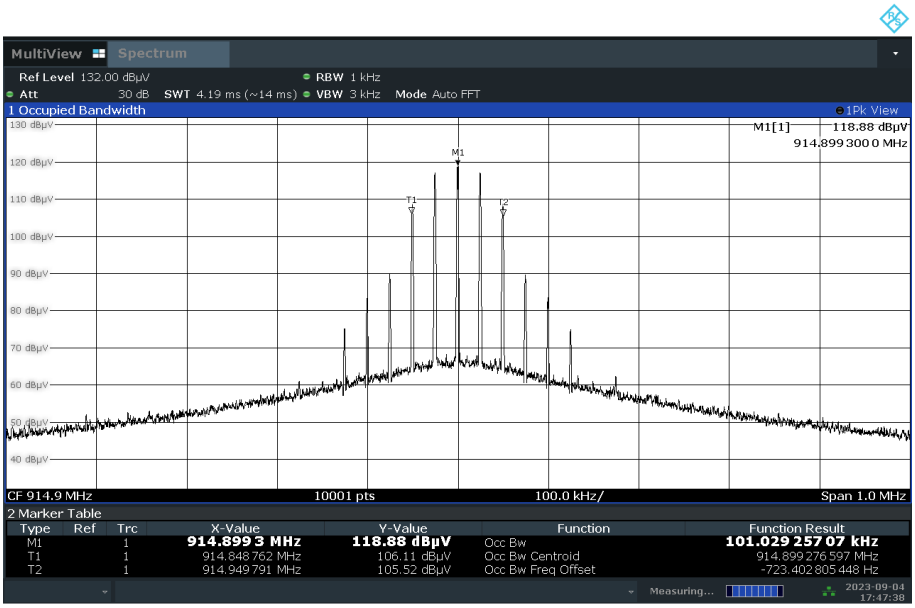

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Product Service

2.2.8 Test Location and Test Equipment

The test was carried out in semi anechoic room No. 11

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rohde & Schwarz	ESW44	39897	12	2023-04-30
ULTRALOG Antenna	Rohde & Schwarz	HL562E	39969	36	2025-03-31
Fixed attenuator	Aeroflex	Model 1: 6 dB	39632	36	2025-03-31
Semi anechoic room	Frankonia	Cabin No. 11	42961	36	2024-09-30
Signal and Spectrum Analysator	Rohde & Schwarz	FSV40	20219	24	2024-02-29
Signal and Spectrum Analyser	Rohde & Schwarz	FSW43	53496	12	2024-04-30

Table 8

Product Service

2.3 Hopping Channel Separation

2.3.1 Specification Reference

FCC 47 CFR Part 15 C, Clause 15.247(a)(1)
ISED RSS-247, Clause 5.1.b.

2.3.2 Equipment under Test and Modification State

ERH; S/N ---; Modification State 0

2.3.3 Date of Test

2023-02-21

2.3.4 Environmental Conditions

Ambient Temperature	19 °C
Relative Humidity	40 %

2.3.5 Specification Limits

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.

2.3.6 Test Method

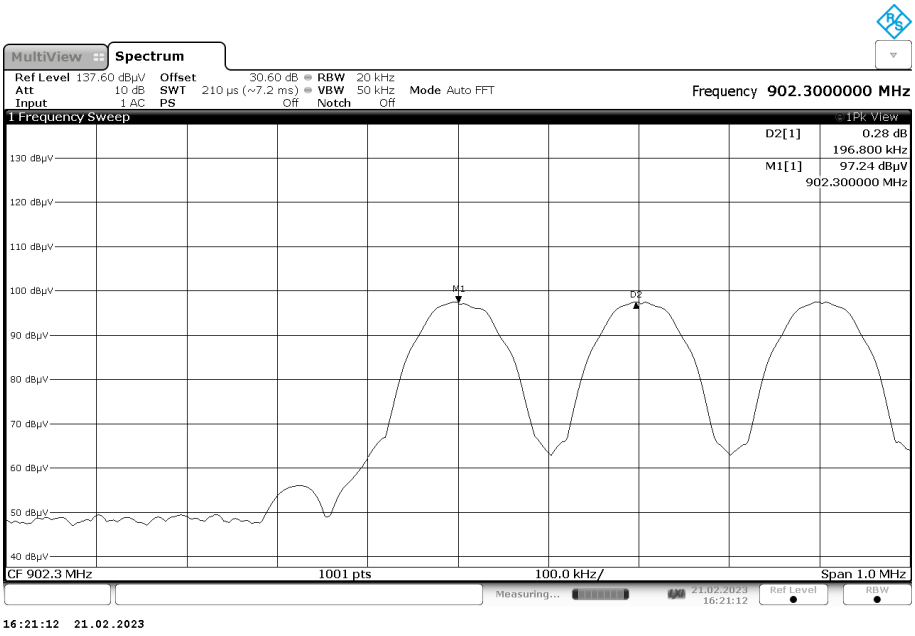
The test was performed according to ANSI C63.10, clauses 6.9.3 and 11.8.1

Product Service

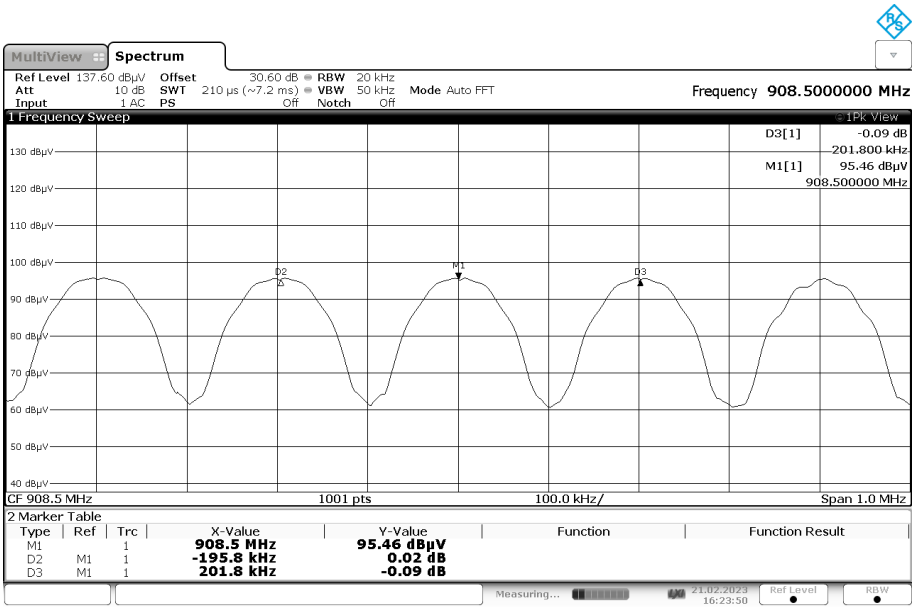
2.3.7 Test Results

Frequency Channel	*Band Separation*	*Limit*	*Result*
902.3 MHz	196.8 kHz	≥ 118.8 kHz	Pass
908.5 MHz	195.8 kHz	≥ 118.9 kHz	Pass
914.9 MHz	200.8 kHz	≥ 118.9 kHz	Pass

Table 9: Hopping Channel separation



Product Service



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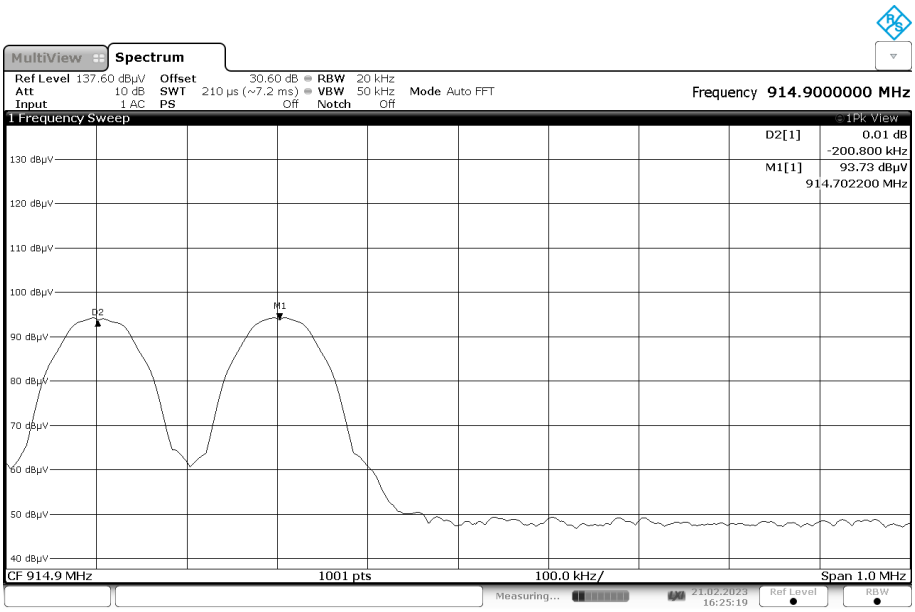

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Product Service

2.3.8 Test Location and Test Equipment

The test was carried out in semi anechoic room No. 11

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rohde & Schwarz	ESW44	39897	12	2023-04-30
ULTRALOG Antenna	Rohde & Schwarz	HL562E	39969	36	2025-03-31
Fixed attenuator	Aeroflex	Model 1: 6 dB	39632	36	2025-03-31
Semi anechoic room	Frankonia	Cabin No. 11	42961	36	2024-09-30

Table 10

Product Service

2.4 Number of Hopping Channels

2.4.1 Specification Reference

FCC 47 CFR Part 15 C, Clause 15.247(a)(1)(i)
ISED RSS-247, Clause 5.1.c.

2.4.2 Equipment under Test and Modification State

ERH; S/N ---; Modification State 0

2.4.3 Date of Test

2023-02-21

2.4.4 Environmental Conditions

Ambient Temperature	19 °C
Relative Humidity	40 %

2.4.5 Specification Limits

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 and any frequency shall not be greater than 0.4 s within a 20 s 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 s with a 10 s period.

2.4.6 Test Method

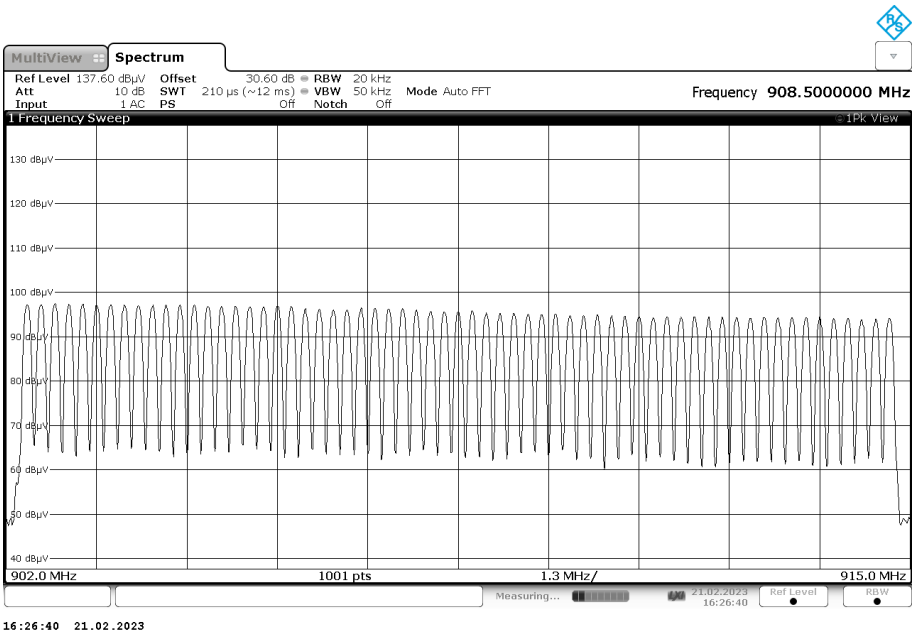
The test was performed according to ANSI C63.10, clauses 6.9.3 and 11.8.1

Product Service

2.4.7 Test Results

Frequency Channels	*Band Separation*	*Limit*	*Result*
64	< 250 kHz	≥ 50	Pass

Table 11:



Product Service

2.4.8 Test Location and Test Equipment

The test was carried out in semi anechoic room No. 11

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rohde & Schwarz	ESW44	39897	12	2023-04-30
ULTRALOG Antenna	Rohde & Schwarz	HL562E	39969	36	2025-03-31
Fixed attenuator	Aeroflex	Model 1: 6 dB	39632	36	2025-03-31
Semi anechoic room	Frankonia	Cabin No. 11	42961	36	2024-09-30

Table 12

Product Service

2.5 Time Occupancy on any Channel

2.5.1 Specification Reference

FCC 47 CFR Part 15 C, Clause 15.247(a)(1)(i)
ISED RSS-247, Clause 5.1.c.

2.5.2 Equipment under Test and Modification State

ERH; S/N ---; Modification State 0

2.5.3 Date of Test

2023-02-21

2.5.4 Environmental Conditions

Ambient Temperature	19 °C
Relative Humidity	40 %

2.5.5 Specification Limits

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 and any frequency shall not be greater than 0.4 s within a 20 s 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 s with a 10 s period.

2.5.6 Test Method

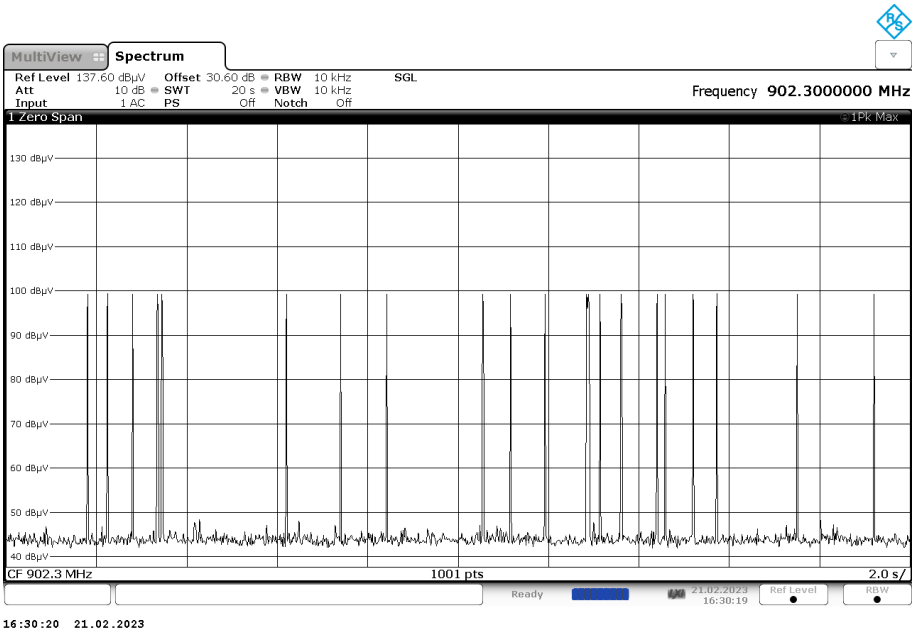
The test was performed according to ANSI C63.10, clauses 6.9.3 and 11.8.1

Product Service

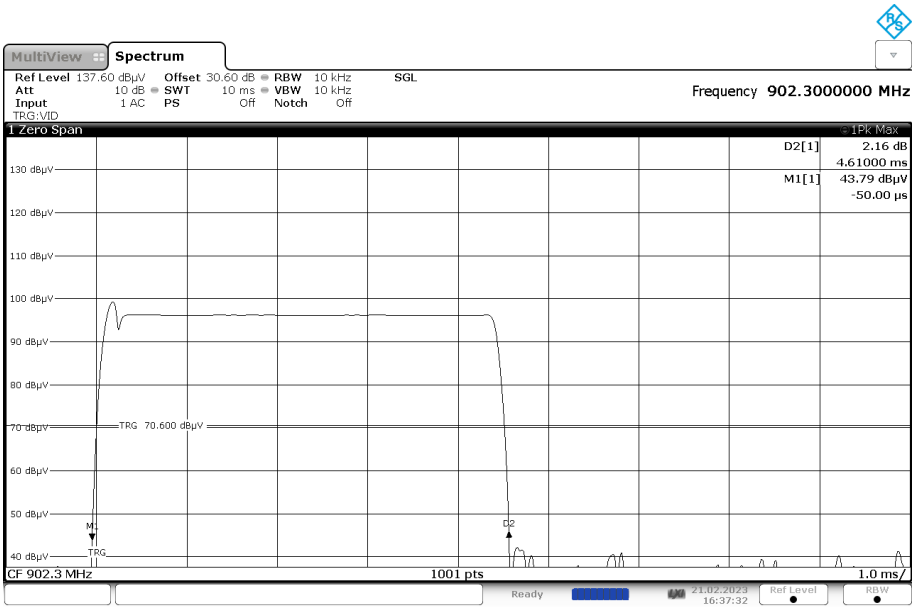
2.5.7 Test Results

Frequency Channel	*Time occupancy*	*Limit*	*Result*
902.3 MHz	24 x 4.610 ms = 110.640 ms	< 400 ms	Pass
908.5 MHz	23 x 4.620 ms = 106.260 ms	< 400 ms	Pass
914.9 MHz	36 x 4.620 ms = 166.320 ms	< 400 ms	Pass

Table 13: Time Occupancy



Product Service



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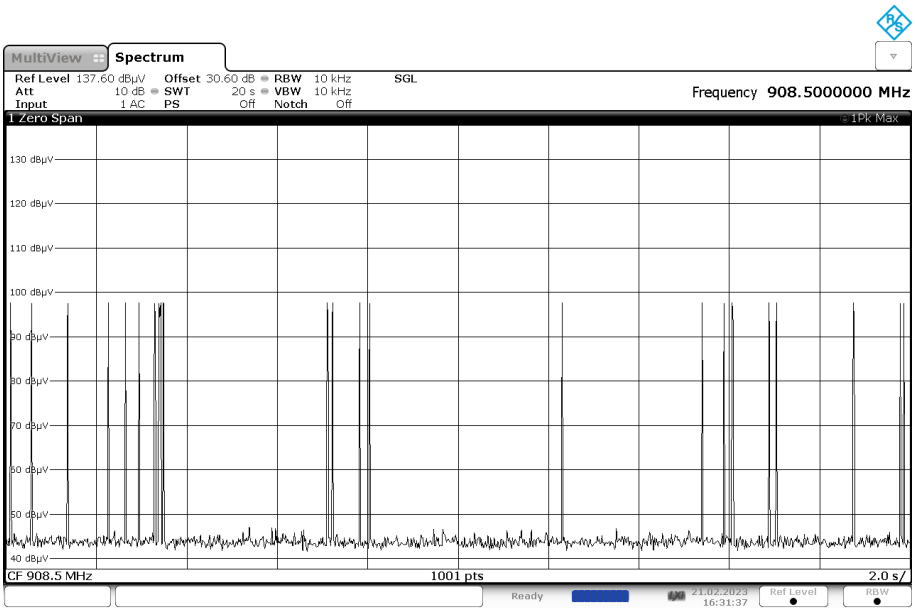

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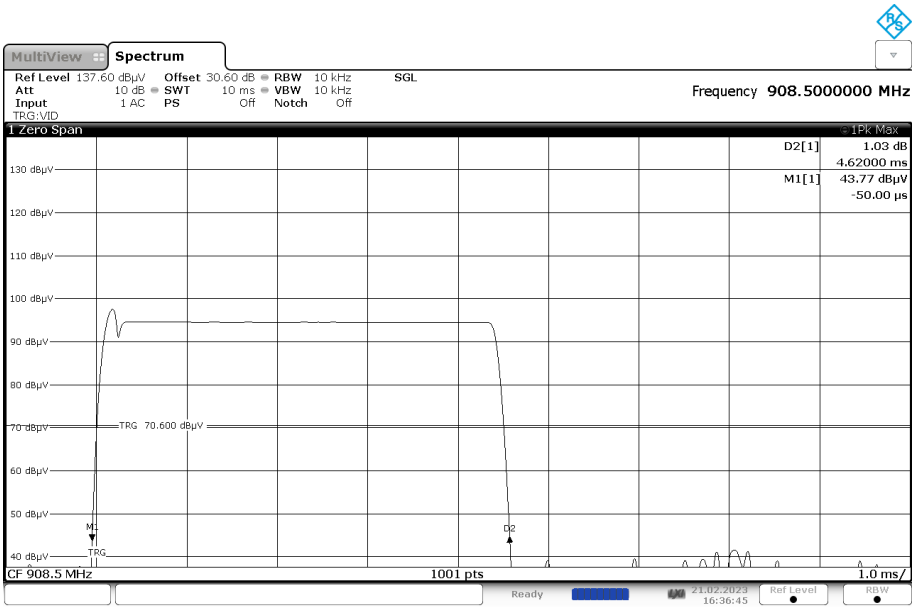

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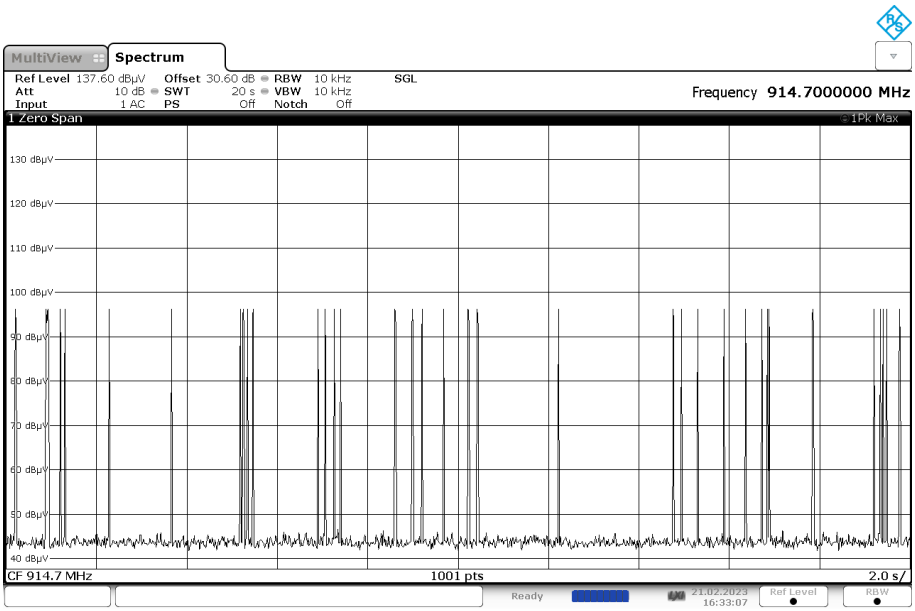

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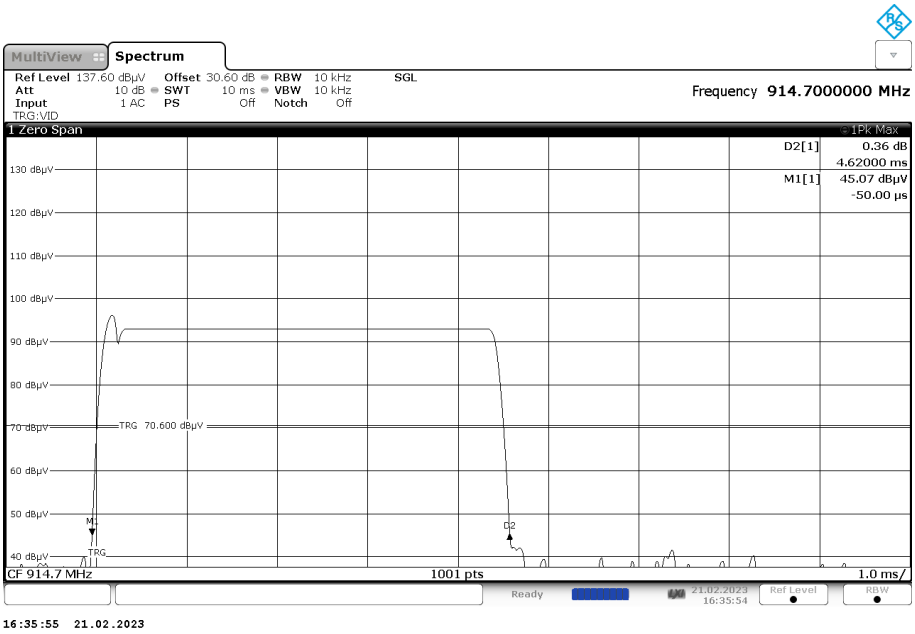


Product Service

2.5.8 Test Location and Test Equipment

The test was carried out in semi anechoic room No. 11

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rohde & Schwarz	ESW44	39897	12	2023-04-30
ULTRALOG Antenna	Rohde & Schwarz	HL562E	39969	36	2025-03-31
Fixed attenuator	Aeroflex	Model 1: 6 dB	39632	36	2025-03-31
Semi anechoic room	Frankonia	Cabin No. 11	42961	36	2024-09-30

Table 14

Product Service

2.6 Output Power

2.6.1 Specification Reference

FCC 47 CFR Part 15 C, Clause 15.247(b)(3)
ISED RSS-247, Clause 5.4 d.

2.6.2 Equipment under Test and Modification State

ERH; S/N ---; Modification State 0

2.6.3 Date of Test

2023-02-20 to 2023-02-21

2.6.4 Environmental Conditions

Ambient Temperature	19 °C
Relative Humidity	40 %

2.6.5 Specification Limits

The maximum conducted output power shall not exceed 1 W (30 dBm).
The e.i.r.p. shall not exceed 4 W (36 dBm).

2.6.6 Test Method

The test was performed according to ANSI C63.10, section 11.9
EIRP value was calculated according to ANSI C63.10, section 9.5:

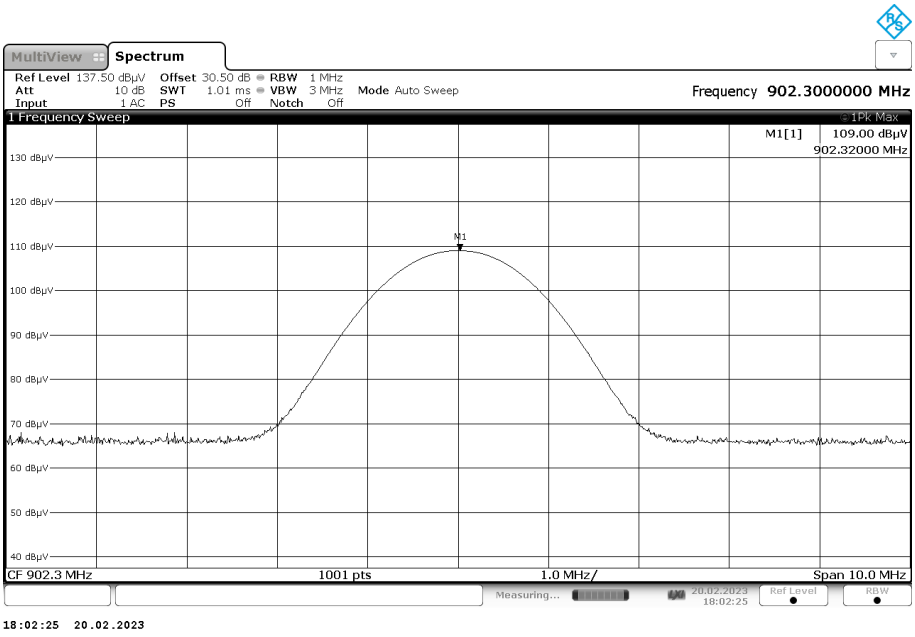
$$EIRP = E_{Meas} + 20\ log(d_{Meas}) - 104.7\ dB$$

Product Service

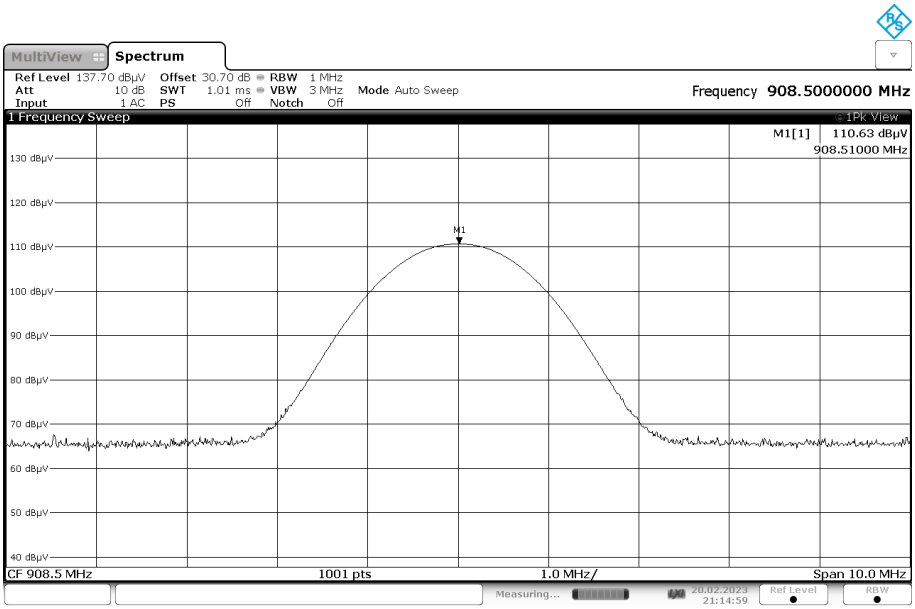
2.6.7 Test Results

Frequency Channel	*3 m Fieldstrength*	*EIRP*	*Limit*	*Result*
902.3 MHz	109.00 dBµV/m	13.77 dBm	36.0 dBm	Pass
908.5 MHz	110.63 dBµV/m	15.40 dBm	36.0 dBm	Pass
914.9 MHz	110.20 dBµV/m	14.97 dBm	36.0 dBm	Pass

Table 15: Output Power



Product Service



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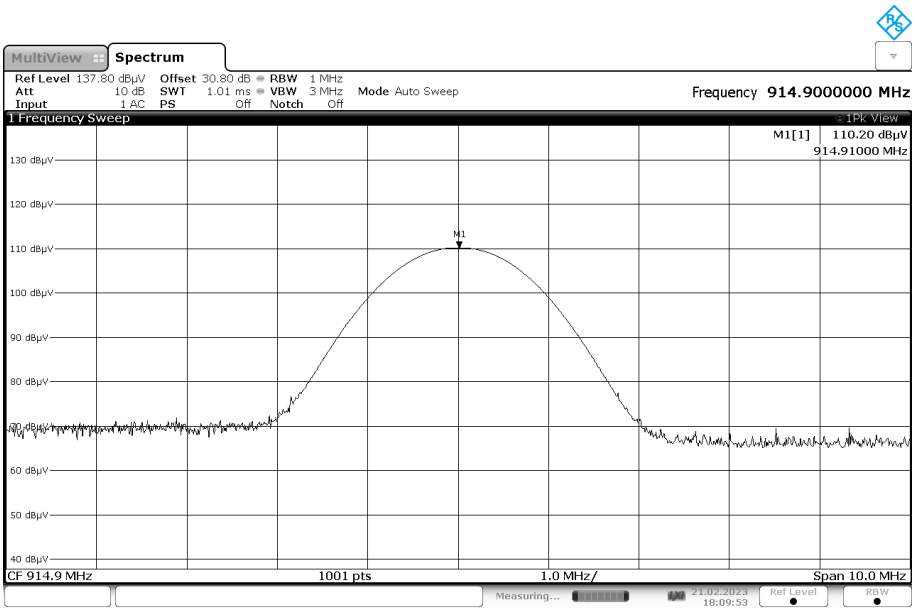

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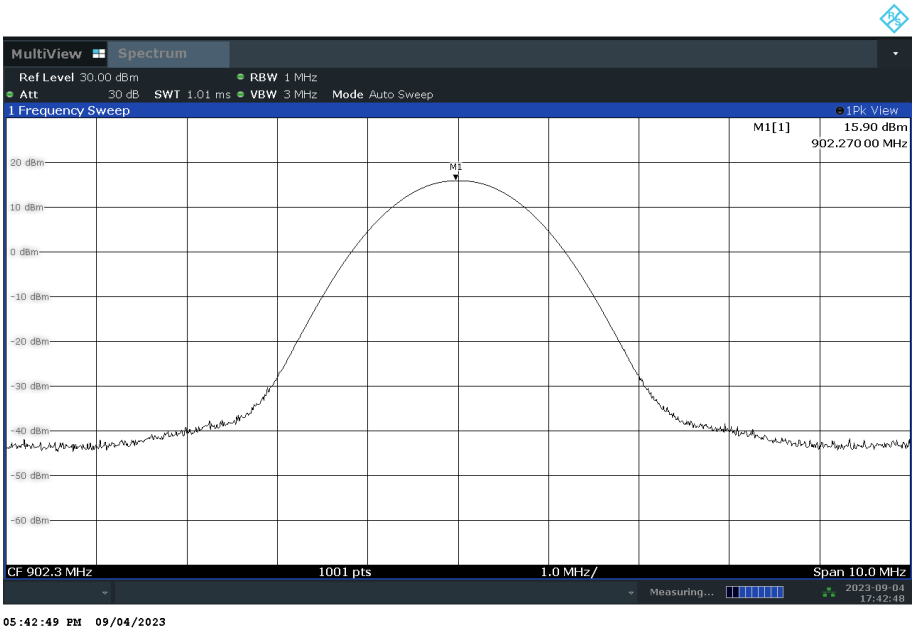
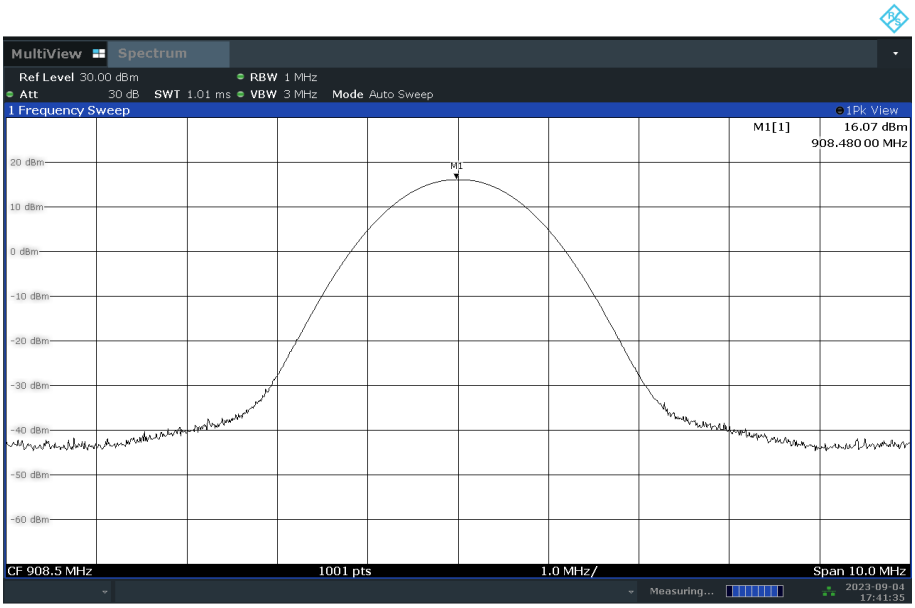
Frequency Channel	*Conducted Output Power*	*Limit*	*Result*
902.3 MHz	15.90 dBm	30.0 dBm	Pass
908.5 MHz	16.07 dBm	30.0 dBm	Pass
914.9 MHz	15.99 dBm	30.0 dBm	Pass

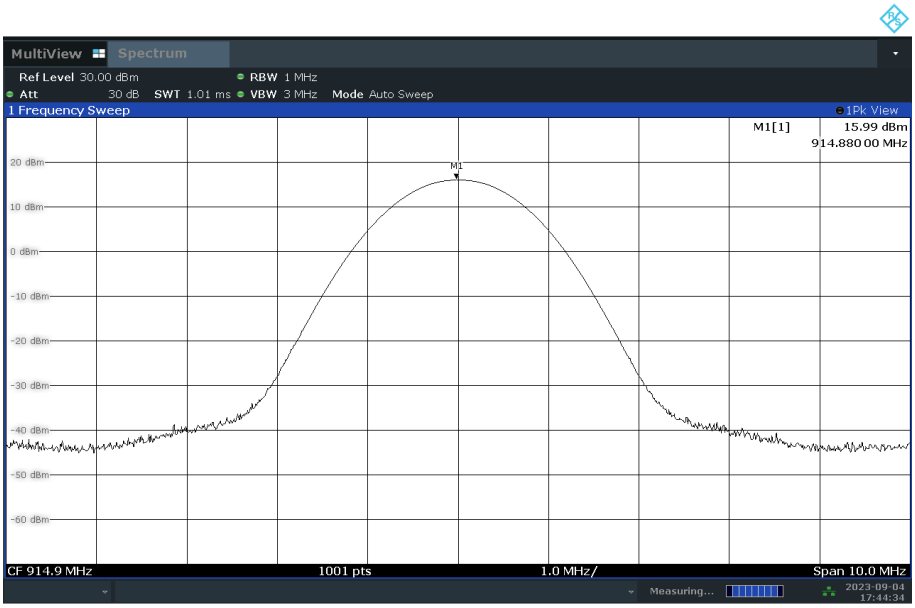
Table 16: Output Power



Product Service



05:41:36 PM 09/04/2023



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Product Service

2.6.8 Test Location and Test Equipment

The test was carried out in semi anechoic room No. 11

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rohde & Schwarz	ESW44	39897	12	2023-04-30
ULTRALOG Antenna	Rohde & Schwarz	HL562E	39969	36	2025-03-31
Fixed attenuator	Aeroflex	Model 1: 6 dB	39632	36	2025-03-31
Semi anechoic room	Frankonia	Cabin No. 11	42961	36	2024-09-30
Signal and Spectrum Analyser	Rohde & Schwarz	FSW43	53496	12	2024-04-30

Table 17

Product Service

2.7 Frequency Band Edge

2.7.1 Specification Reference

FCC 47 CFR Part 15 C, Clause 15.247(d)
ISED RSS-247, Clause 5.5

2.7.2 Equipment under Test and Modification State

ERH; S/N ---; Modification State 0

2.7.3 Date of Test

2023-02-20 to 2023-02-21

2.7.4 Environmental Conditions

Ambient Temperature	19 °C
Relative Humidity	40 %

2.7.5 Specification Limits

In any 100 kHz bandwidth outside the frequency band in which the device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power, based on either conducted or radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted, the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits is not required.
In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

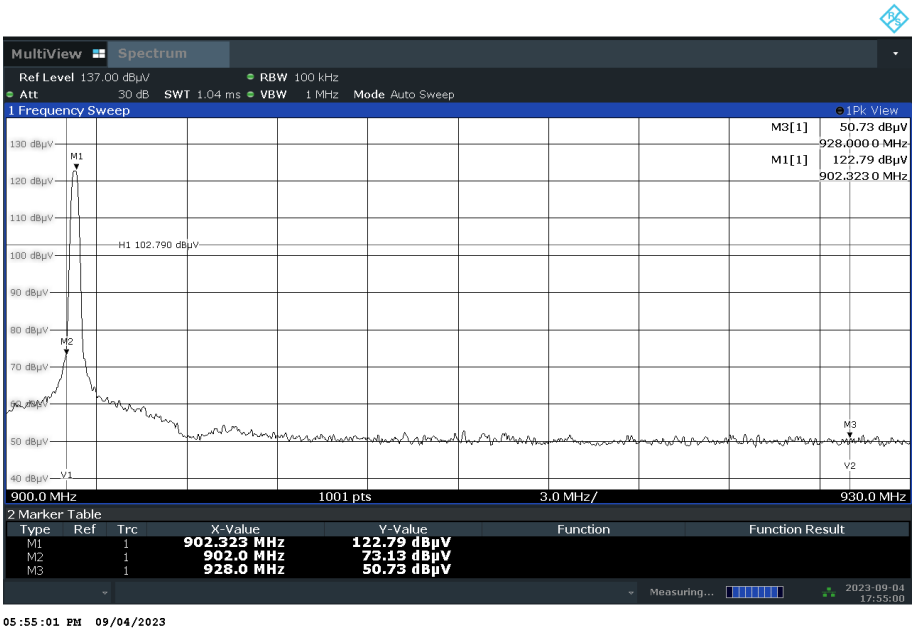
2.7.6 Test Method

The test was performed according to ANSI C63.10, sections 11.11

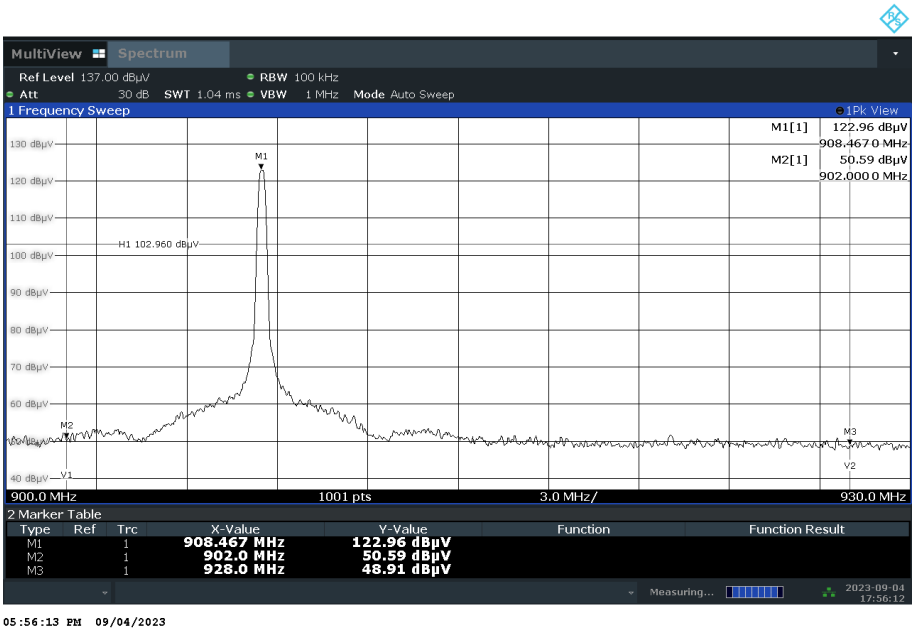
Product Service

2.7.7 Test Results

See plots for restricted band for further details.
Pass

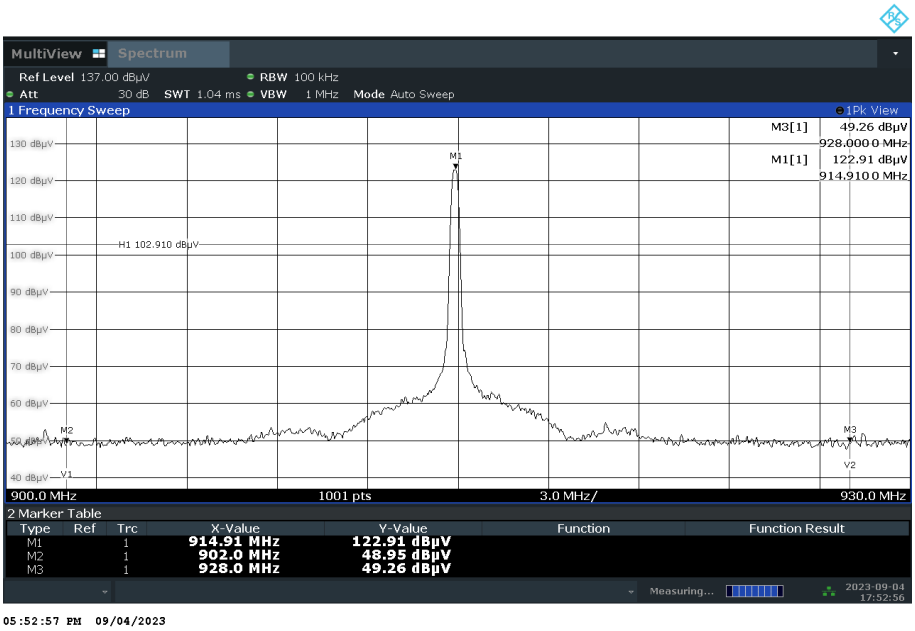


Lowes channel: pass

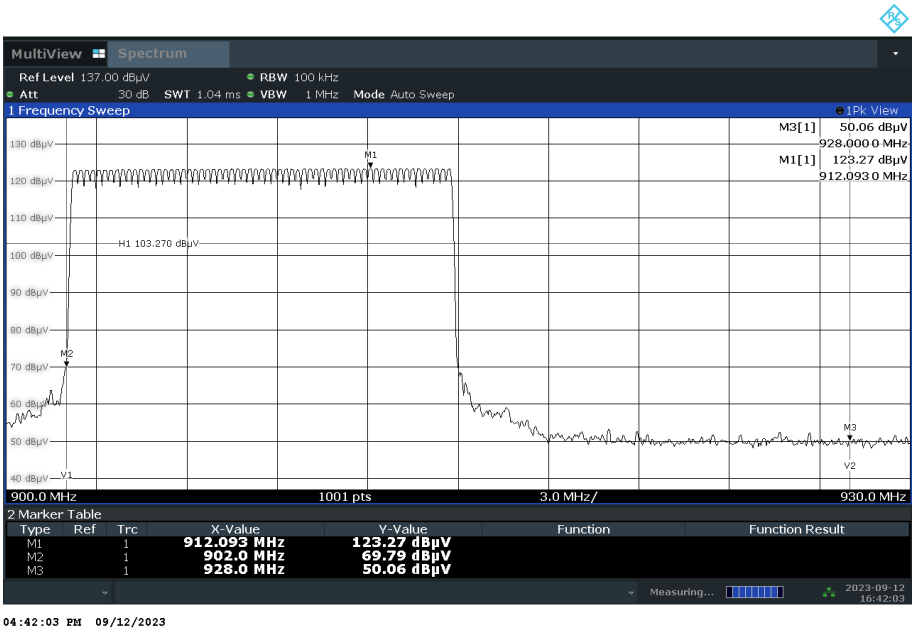


Middle channel: pass

Product Service



Highest channel: pass



Hopping mode: pass

Product Service

2.7.8 Test Location and Test Equipment

The test was carried out in semi anechoic room No. 11

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rohde & Schwarz	ESW44	39897	12	2023-04-30
ULTRALOG Antenna	Rohde & Schwarz	HL562E	39969	36	2025-03-31
Fixed attenuator	Aeroflex	Model 1: 6 dB	39632	36	2025-03-31
Semi anechoic room	Frankonia	Cabin No. 11	42961	36	2024-09-30
Signal and Spectrum Analyser	Rohde & Schwarz	FSW43	53496	12	2024-04-30

Table 18

Product Service

2.8 Non-Restricted Bands of operation

2.8.1 Specification Reference

FCC 47 CFR Part 15 C, Clauses 15.209 and 15.247(d)
ISED RSS-247, Clause 5.5
ISED RSS-GEN, Clause 8.10

2.8.2 Equipment under Test and Modification State

ERH; S/N ---; Modification State 0

2.8.3 Date of Test

2023-02-20 to 2023-02-21

2.8.4 Environmental Conditions

Ambient Temperature	19 °C
Relative Humidity	40 %

2.8.5 Specification Limits

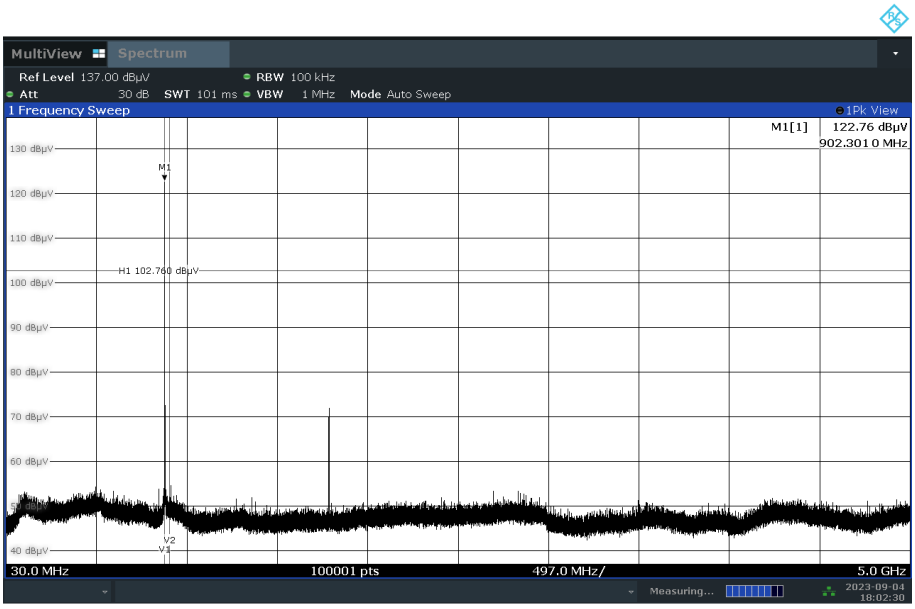
In any 100 kHz bandwidth outside the frequency band in which the device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power, based on either conducted or radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted, the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits is not required.
In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

2.8.6 Test Method

The test was performed according to ANSI C63.10, sections 11.11

Product Service

2.8.7 Test Results



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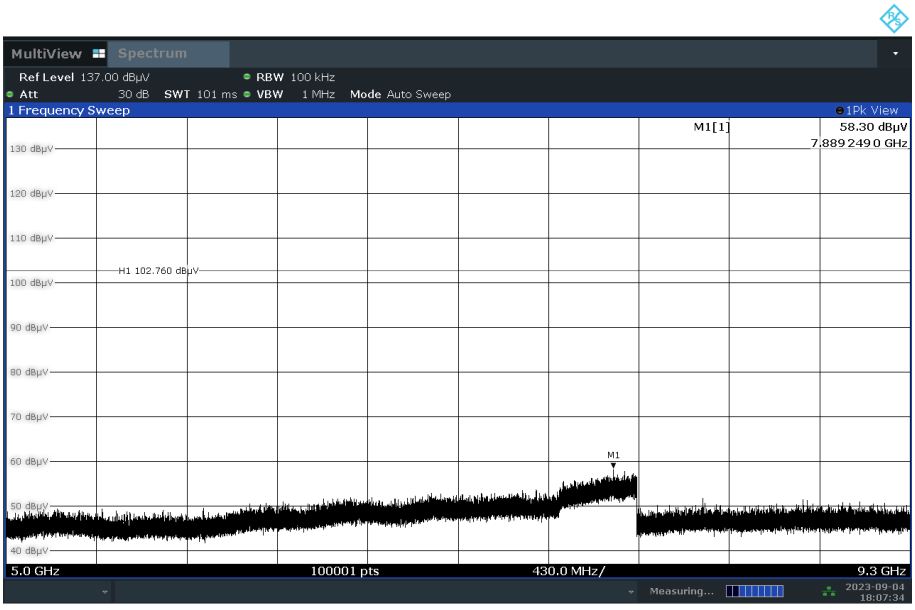

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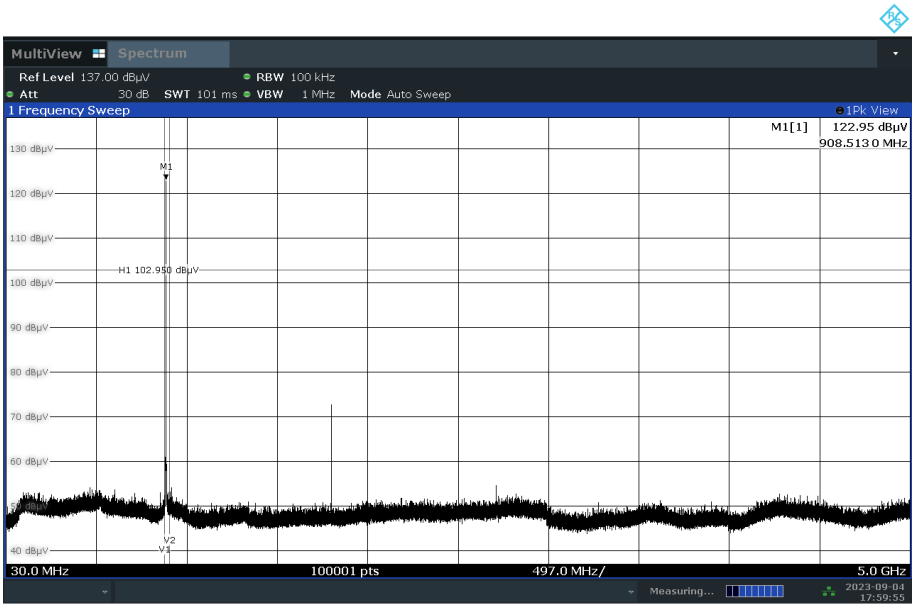
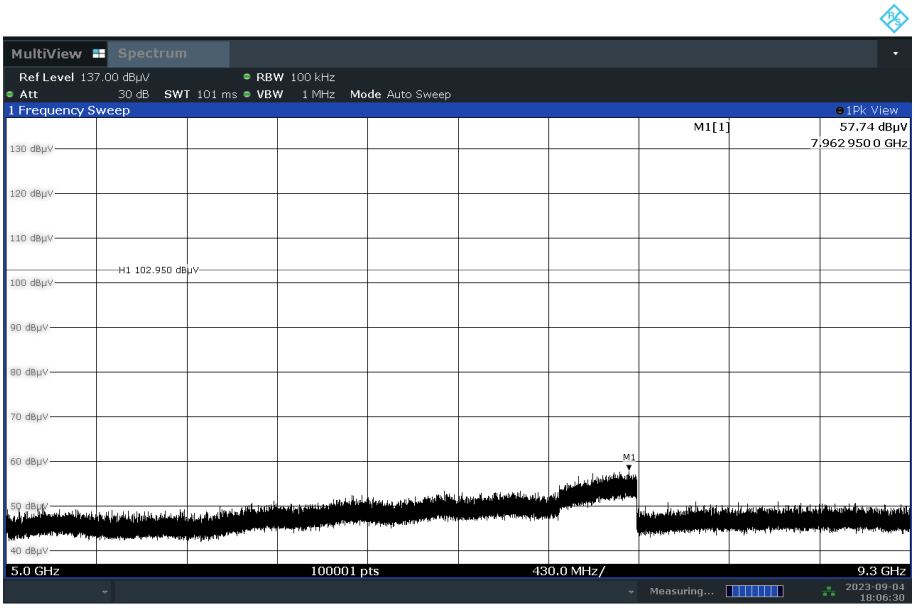
Lowest channel: Pass

Product Service



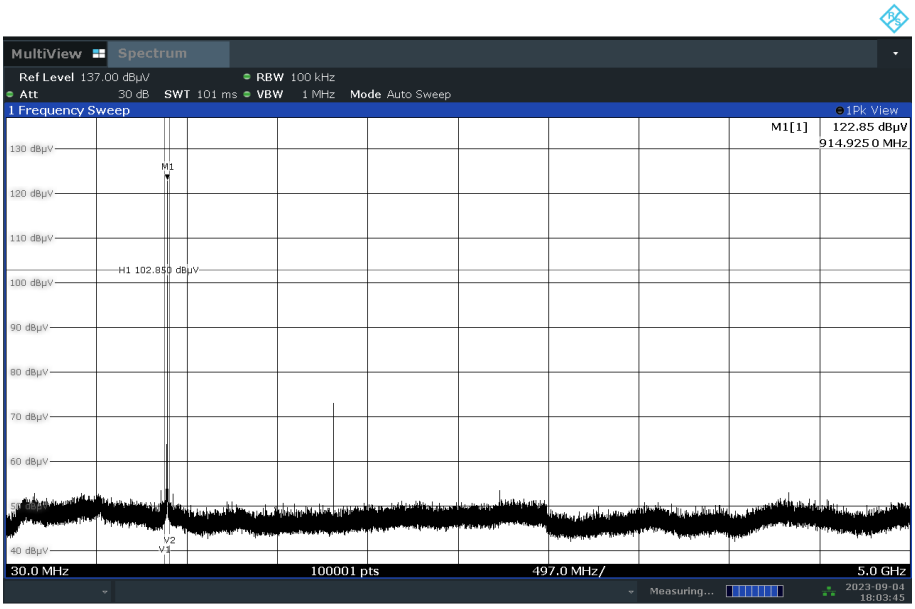
05:59:56 PM 09/04/2023



06:06:30 PM 09/04/2023

Middle channel: Pass

Product Service



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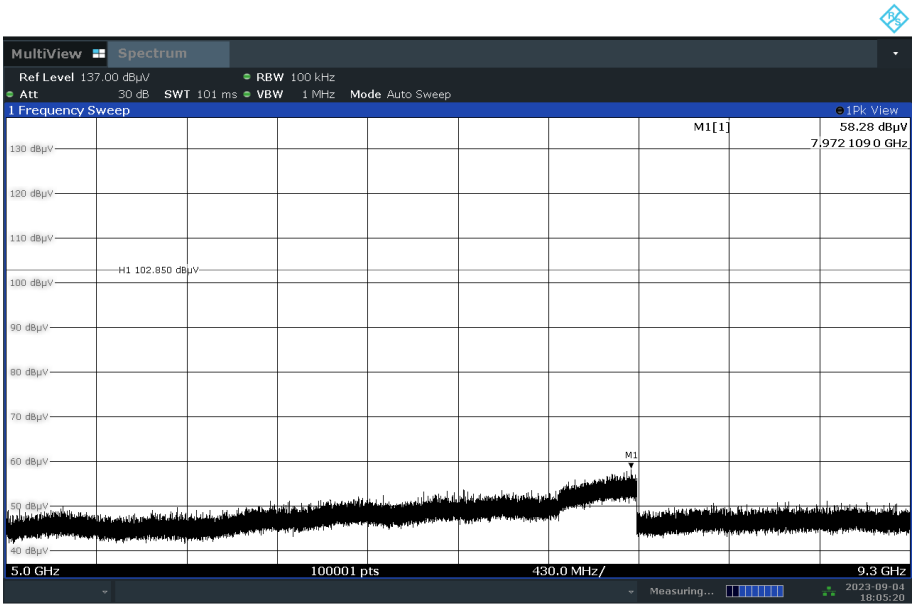

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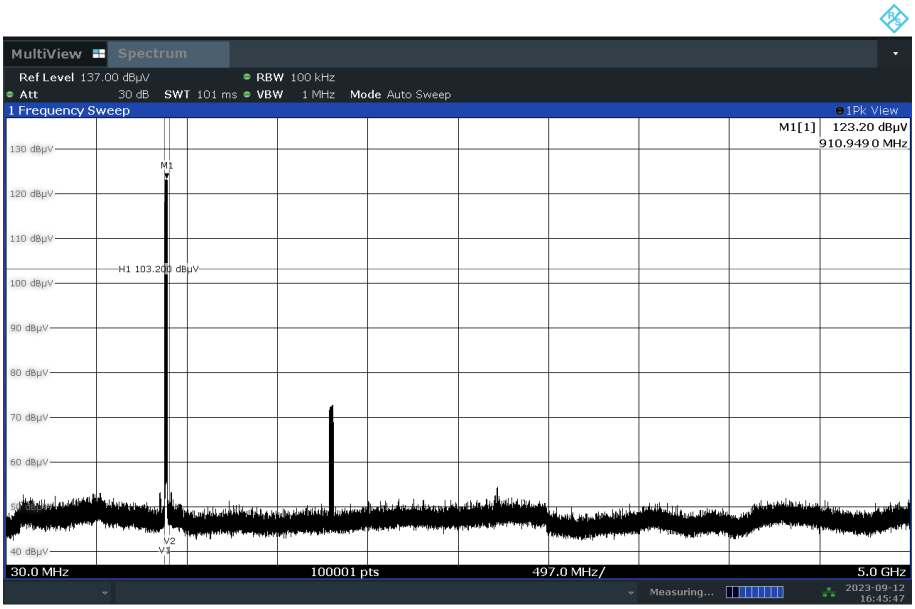
Highest channel: Pass

Product Service



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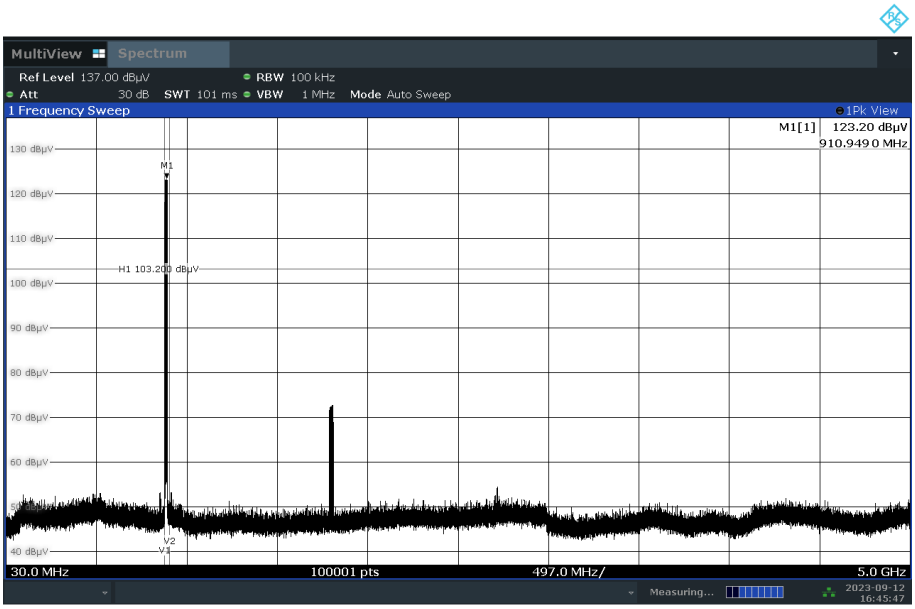

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Hopping mode: pass

Product Service

2.8.8 Test Location and Test Equipment

The test was carried out in semi anechoic room No. 11

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rohde & Schwarz	ESW44	39897	12	2023-04-30
ULTRALOG Antenna	Rohde & Schwarz	HL562E	39969	36	2025-03-31
Fixed attenuator	Aeroflex	Model 1: 6 dB	39632	36	2025-03-31
Semi anechoic room	Frankonia	Cabin No. 11	42961	36	2024-09-30
Signal and Spectrum Analyser	Rohde & Schwarz	FSW43	53496	12	2024-04-30

Table 19

Product Service

2.9 Spurious emissions

2.9.1 Specification Reference

FCC 47 CFR Part 15 C, Clause 15.205, 15.209, 15.247(d)
ISED RSS-247, Clause 5.5
ISED RSS-Gen, Clauses 8.9 and 8.10

2.9.2 Equipment under Test and Modification State

ERH; S/N ---; Modification State 0

2.9.3 Date of Test

2023-02-20 and 2023-02-22

2.9.4 Environmental Conditions

Ambient Temperature	19 °C
Relative Humidity	40 %

Product Service

2.9.5 Specification Limits

In any 100 kHz bandwidth outside the frequency band in which the device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power, based on either conducted or radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted, the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits is not required.
In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

General radiated emission limits:					
Frequency Range	*Test distance*	*Field strength*		*Field strength*	
(MHz)	*(m)*	*(µA/m)*	*(dBµA/m)*	*(µV/m)*	*(dBµV/m)*
0.009 – 0.49	300	6.37 / *f*	20*lg(6.37 / *f*)	2400 / *f*	20*lg(2400 / *f*)
0.49 – 1.705	30	63.7 / *f*	20*lg(63.7 / *f*)	24000 / *f*	20*lg(24000 / *f*)
1.705 - 30	30	0.08	20*lg(0.08 / *f*)	30	20*lg(30 / *f*)
30 – 88	3	---	--	100	40
88 – 216	3	--	--	150	43.5
126 – 960	3	--	--	200	46
above 960	3	--	--	500	54
Note 1: *f* in kHz					

Table 20 General radiated emission limits

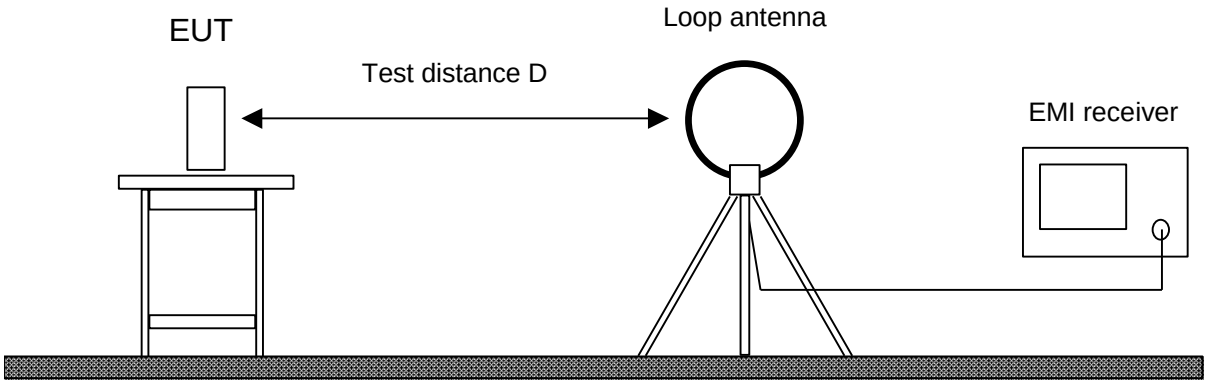
Product Service

2.9.6 Test Method

The test was performed according to ANSI C63.10, sections 11.11 and 11.12

Prescans are performed in six positions of the EUT to get the full spectrum of emission caused by the EUT with the measuring antenna raised and lowered from 1 m to 4 m with vertical and horizontal polarisation to find the combination of table position, antenna height and antenna polarisation for the maximum emission levels.
Data reduction is applied to these results to select those levels having less margin than 10 dB or exceeding the limit using subranges and limited number of maximums.
Further maximisation for adjusting the maximum position is following.
Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

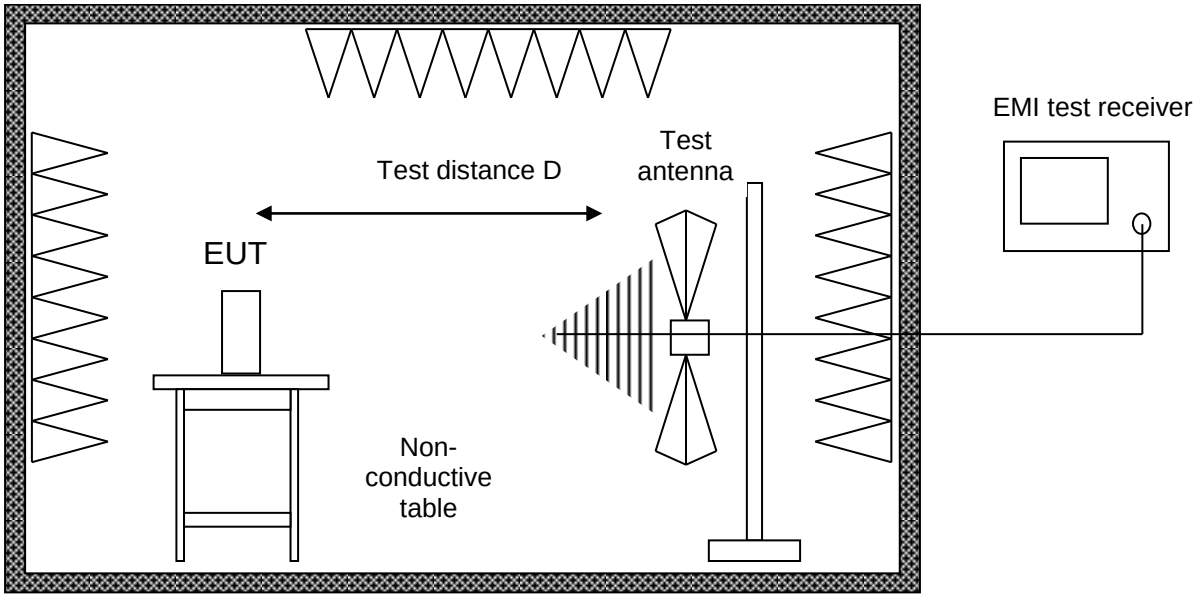
2.9.6.1 Frequency range 9 kHz – 30 MHz



The EUT was placed on a non-conductive table, 0.8 m above the ground.
Radiated emissions in the frequency 9 kHz – 30 MHz is measured within a semi-anechoic room with an active loop antenna with the measurement detector set to peak. In addition in the frequency range 9 kHz to 490 kHz also an average detector was used. The measurement bandwidth of the receiver was set to 300 Hz in the frequency range 9 kHz to 150 kHz and 10 kHz in the frequency range 150 kHz to 30 MHz. Prescans were performed in six positions of the EUT.
For final measurements the detector was set to CISPR quasi-peak and in addition to CISPR average in the frequency range 9 kHz to 490 kHz with a resolution bandwidth 200 Hz in the frequency range 9 kHz to 150 kHz and 9 kHz in the frequency range 150 kHz to 30 MHz. Final tests were performed immediately after a final frequency and zoom (for drifting disturbances) and maximum adjustment.

Product Service

2.9.6.2 Frequency range 30 MHz – 1 GHz

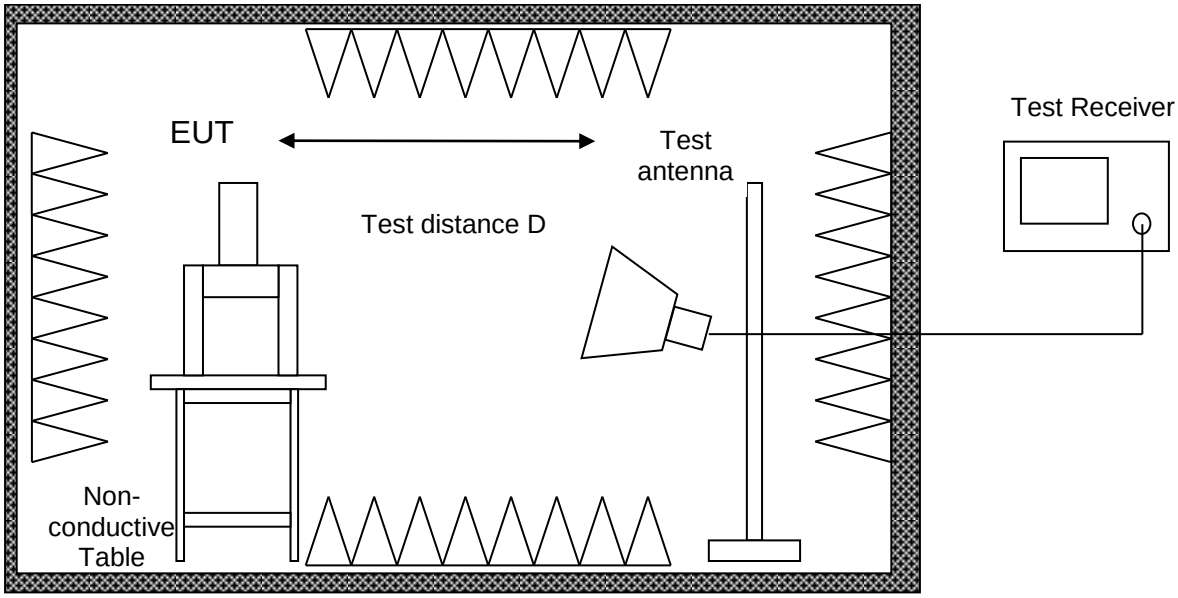


Alternate test site (semi anechoic room)

The EUT was placed on a non-conductive table, 0.8 m above the ground plane
Radiated emissions in the frequency range 30 MHz – 1 GHz is measured within a semi-anechoic room with groundplane complying with the NSA requirements of ANSI C63.4. for alternative test sites. A linear polarised logarithmic periodic antenna combined with a 4:1 broadband dipole (“Trilog broadband antenna”) is used.
For prescan tests the test receiver is set to peak-detector with a bandwidth of 120 kHz.
With the measurement bandwidth of the test receiver set to 120 kHz CISPR quasi-peak detector is selected for final measurements following immediately after a final frequency zoom (for drifting disturbances) and maximum adjustment.

Product Service

2.9.6.3 Frequency range above 1 GHz



Fully anechoic room

The EUT was placed on a non-conductive table, 1.5 m above the ground plane
Radiated emission tests above 1 GHz are performed in a fully anechoic room with the S_{VSWR} requirements of ANSI C63.4. Measurements are performed both in the horizontal and vertical planes of polarisation using a test receiver with the detector function set to peak and average and the resolution bandwidth set to 1 MHz. Testing above 1 GHz is performed with horn antennas with the EUT in boresight of the antenna.
For prescan tests the test receiver is set to peak- and average-detector with a bandwidth of 1 MHz. With the measurement bandwidth of the test receiver set to 1 MHz and peak- and CISPR average-detector is selected for final measurements following immediately after a final frequency zoom (for drifting disturbances) and maximum adjustment.

Product Service

2.9.7 Test Results

Frequency range	*Limit applied*	*Test distance*	*Test site*
9 kHz – 30 MHz	15.209	3 m	Cabin No. 11
30 MHz – 1 GHz	15.209, 15.247	3 m	Cabin No. 11
1 GHz – 4 GHz	15.209, 15.247	3 m	Cabin No. 11
4 GHz – 10 GHz	15.209, 15.247	1 m	Cabin No. 11

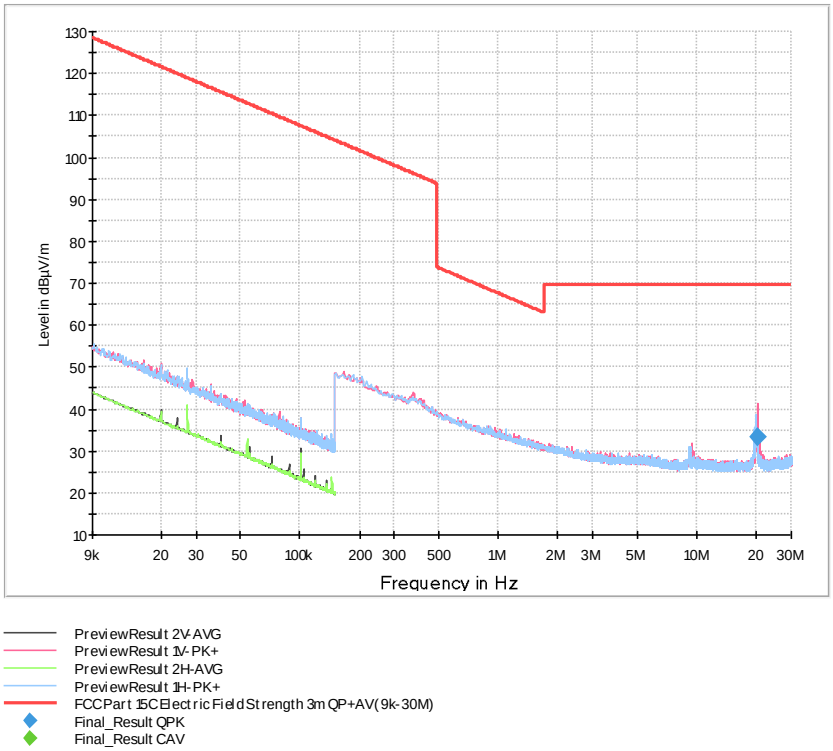
Table 21: Description of performed tests

Sample calculation:

Final Value (dBµV/m) = Reading Value (dBµV) + (Cable attenuation (dB) + Antenna Transducer (dB(1/m)))

Product Service

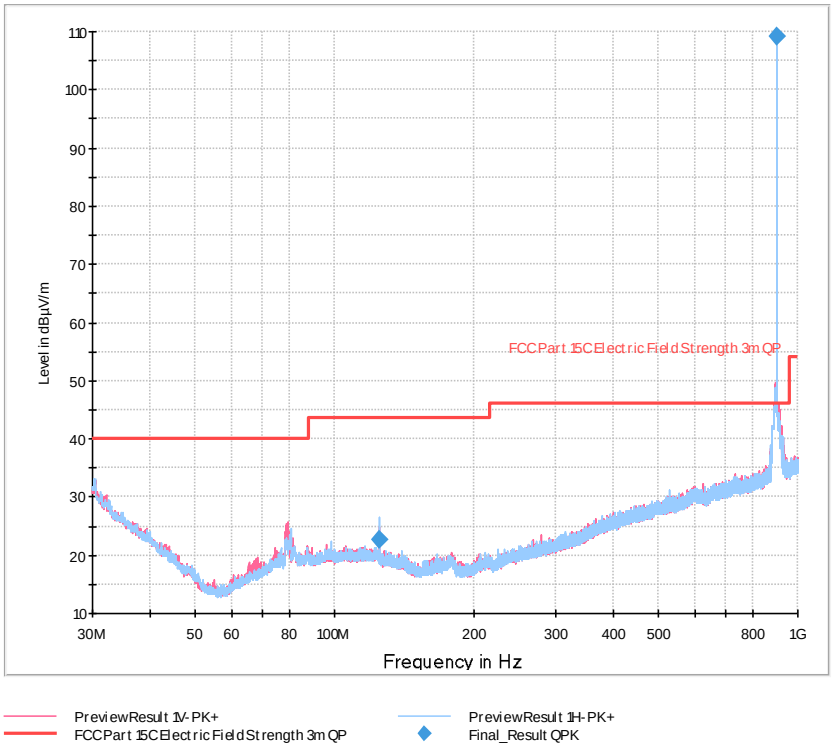
2.9.7.1 Mode 1



Final Results:

Frequency MHz	*Qua-siPeak dBµV/m*	*CAver-age dBµV/m*	*Limit dBµV/m*	*Mar-gin dB*	*Meas. Time ms*	*Band-width kHz*	*Height cm*	*Pol*	*Azi-muth deg*	*Corr. dB/m*
20.190750	33.16	---	69.54	36.38	1000.0	9.000	100.0	V	0.0	18.9

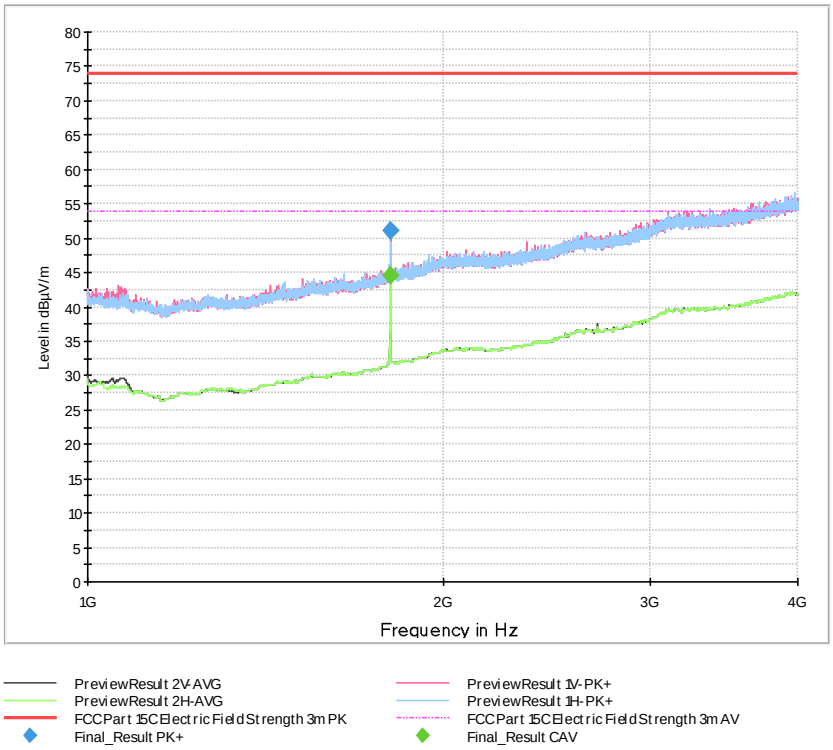
Product Service



Final Results:

Frequency MHz	*QuasiPeak dBµV/m*	*Limit dBµV/m*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB/m*
124.980000	22.54	43.50	20.96	1000.0	120.000	243.0	H	45.0	17.1
902.280000	109.11	#	#	1000.0	120.000	100.0	H	48.0	30.5

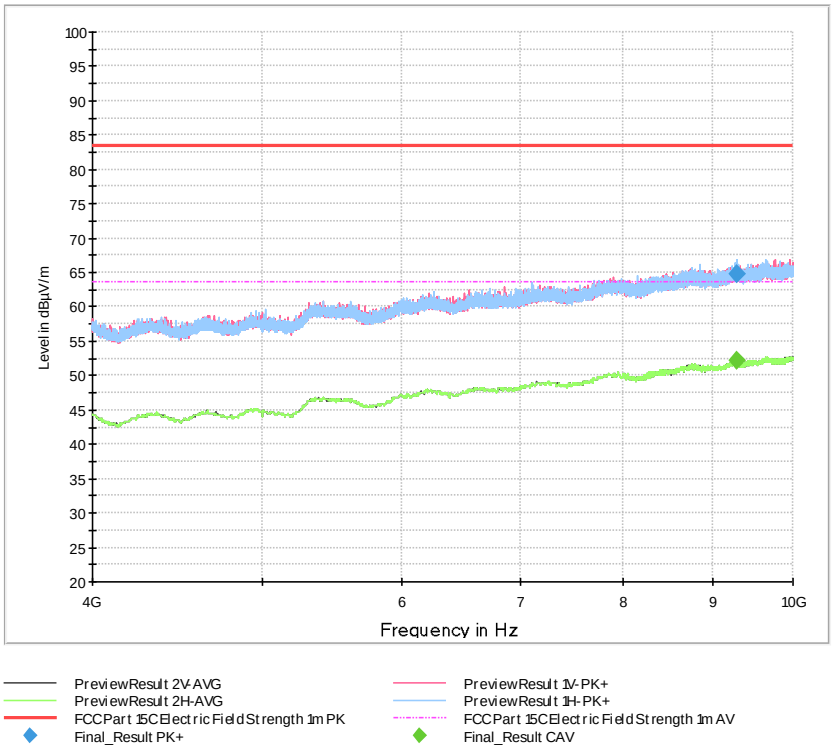
#: Intentional radiation not evaluated.



Final Results:

Frequency MHz	*Max-Peak dBµV/m*	*CAver-age dBµV/m*	*Limit dBµV/m*	*Mar-gin dB*	*Meas. Time ms*	*Band-width kHz*	*Height cm*	*Pol*	*Azi-muth deg*	*Corr. dB/m*
1804.750000	---	44.44	53.98	9.54	1000.0	1000.000	116.0	V	20.0	31.3
1804.750000	51.08	---	73.98	22.90	1000.0	1000.000	116.0	V	20.0	31.3

Product Service

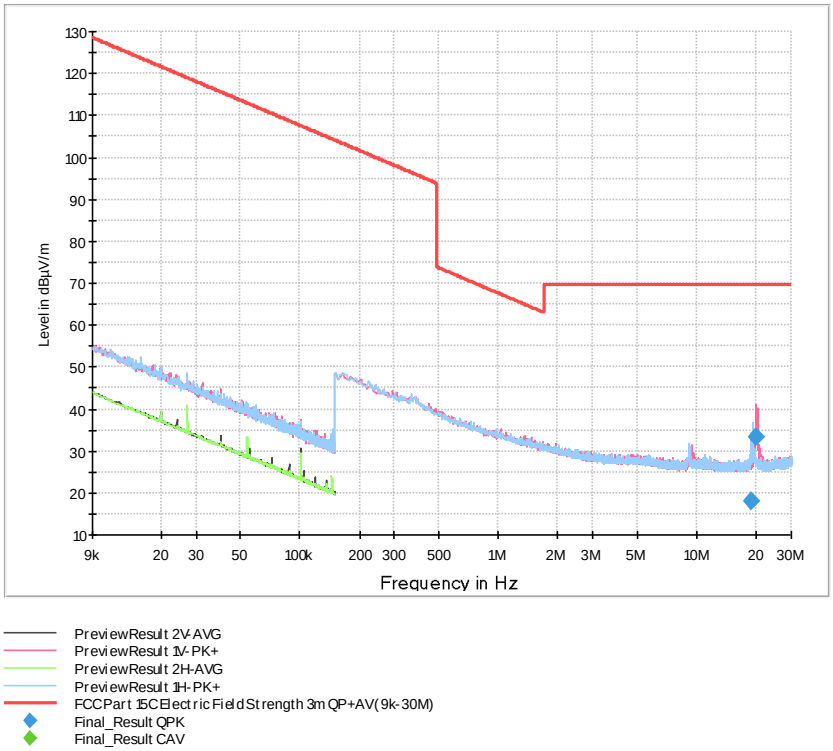


Final Results:

Frequency MHz	*Max-Peak dBµV/m*	*CAver-age dBµV/m*	*Limit dBµV/m*	*Mar-gin dB*	*Meas. Time ms*	*Band-width kHz*	*Height cm*	*Pol*	*Azi-muth deg*	*Corr. dB/m*
9285.000000	---	52.09	63.50	11.41	1000.0	1000.000	150.0	H	-114.0	50.5
9285.000000	64.81	---	83.50	18.69	1000.0	1000.000	150.0	H	-114.0	50.5

Product Service

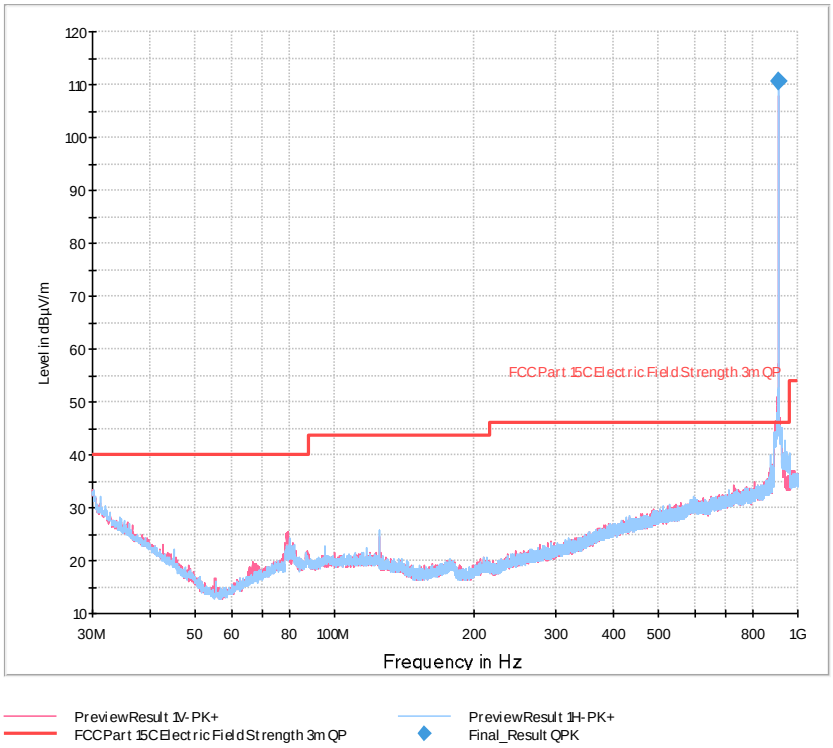
2.9.7.2 Mode 2



Final Results:

Frequency MHz	Qua-siPeak dBµV/m	CAver-age dBµV/m	Limit dBµV/m	Mar-gin dB	Meas. Time ms	Band-width kHz	Height cm	Pol	Azi-muth deg	Corr. dB/m
19.005000	18.14	---	69.54	51.40	1000.0	9.000	100.0	H	29.0	18.9
20.080500	33.28	---	69.54	36.26	1000.0	9.000	100.0	V	122.0	18.9

Product Service

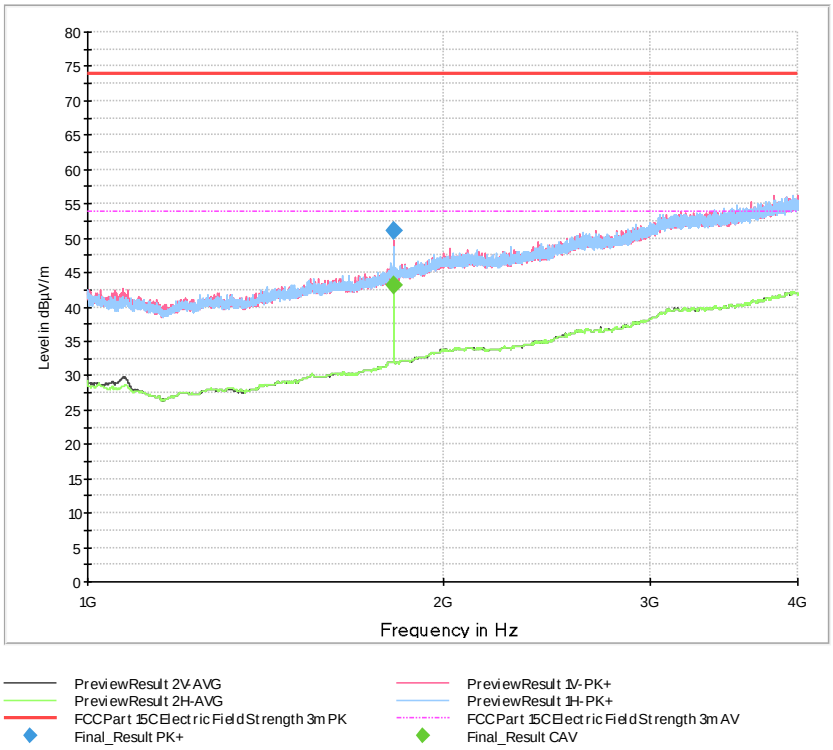


Final Results:

Frequency MHz	*QuasiPeak dBµV/m*	*Limit dBµV/m*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB/m*
908.520000	110.71	#	#	1000.0	120.000	146.0	H	56.0	30.7

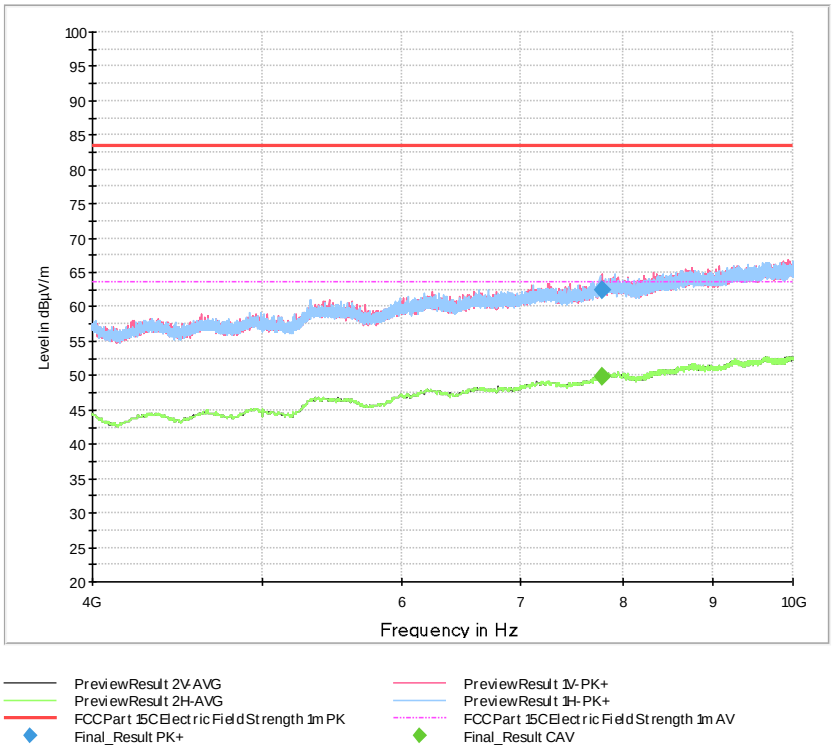
#: Intentional radiation not evaluated.

Product Service



Final Results:

Frequency MHz	*Max-Peak dBµV/m*	*CAver-age dBµV/m*	*Limit dBµV/m*	*Mar-gin dB*	*Meas. Time ms*	*Band-width kHz*	*Height cm*	*Pol*	*Azi-muth deg*	*Corr. dB/m*
1817.000000	---	43.10	53.98	10.88	1000.0	1000.000	100.0	V	-5.0	31.4
1817.000000	51.11	---	73.98	22.87	1000.0	1000.000	100.0	V	-5.0	31.4

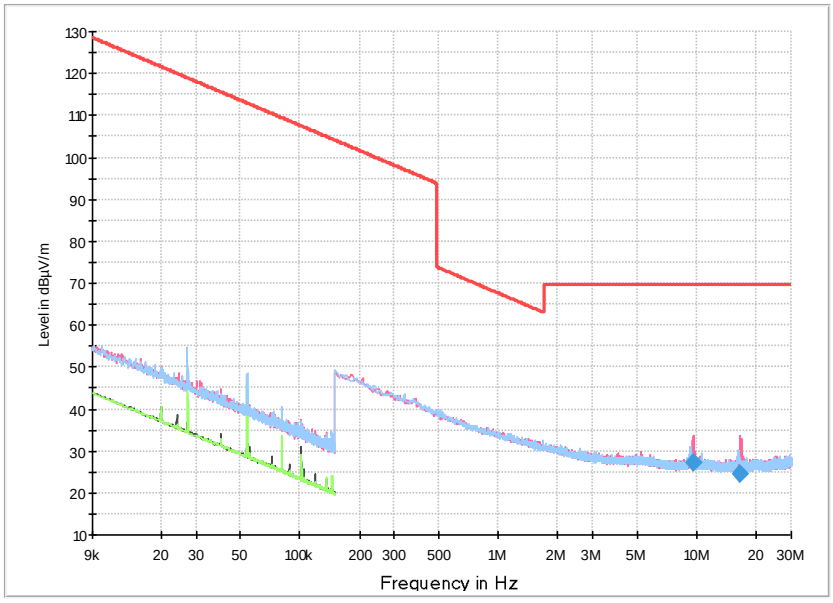


Final Results:

Frequency MHz	*Max-Peak dBµV/m*	*CAver-age dBµV/m*	*Limit dBµV/m*	*Mar-gin dB*	*Meas. Time ms*	*Band-width kHz*	*Height cm*	*Pol*	*Azi-muth deg*	*Corr. dB/m*
7792.250000	---	49.74	63.50	13.76	1000.0	1000.000	200.0	V	176.0	48.4
7792.250000	62.52	---	83.50	20.98	1000.0	1000.000	200.0	V	176.0	48.4

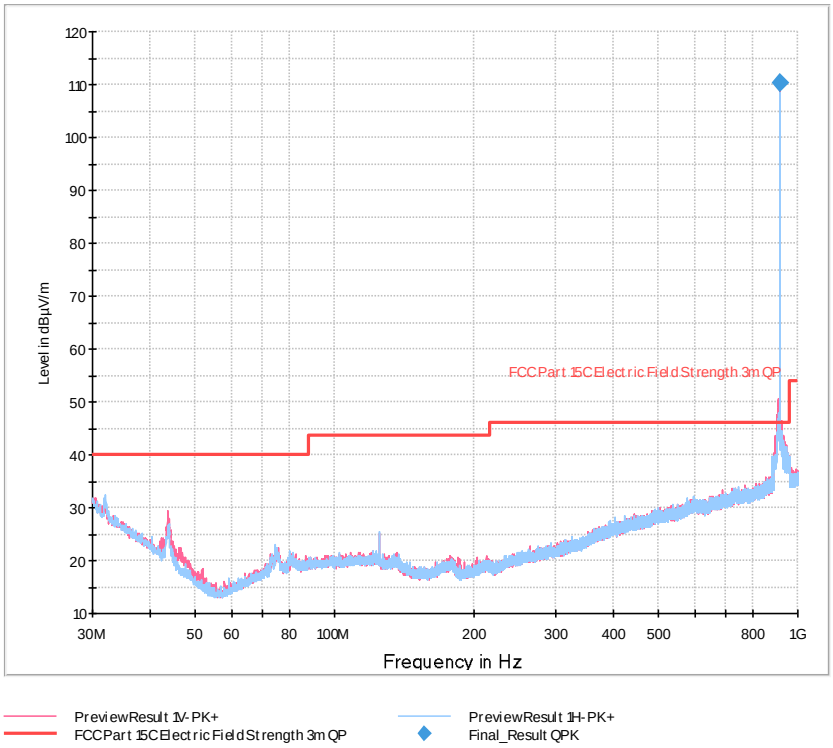
Product Service

2.9.7.3 Mode 3



Final Results:

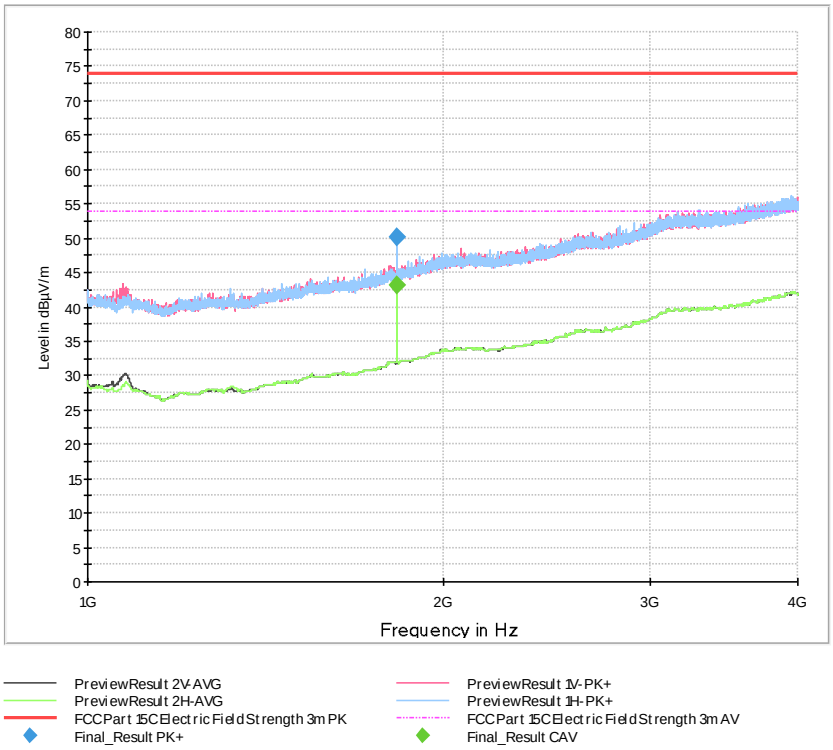
Frequency MHz	Qua-siPeak dBµV/m	CAver-age dBµV/m	Limit dBµV/m	Mar-gin dB	Meas. Time ms	Band-width kHz	Height cm	Pol	Azi-muth deg	Corr. dB/m
9.595500	27.23	---	69.54	42.31	1000.0	9.000	100.0	V	236.0	19.1
16.687500	24.42	---	69.54	45.12	1000.0	9.000	100.0	V	171.0	18.9



Final Results:

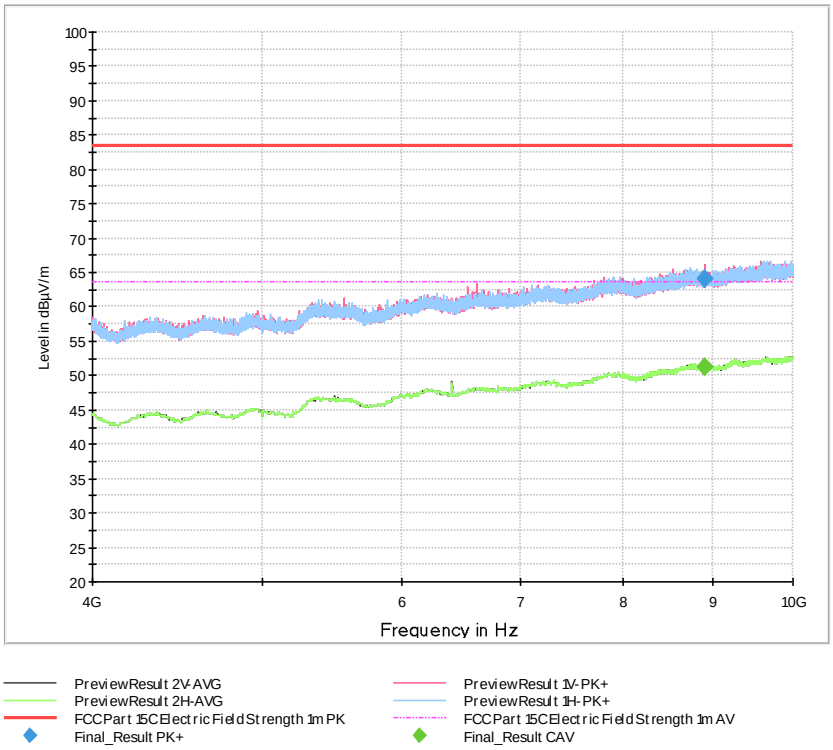
Frequency MHz	*QuasiPeak dBµV/m*	*Limit dBµV/m*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB/m*
914.880000	110.27	#	#	1000.0	120.000	107.0	V	83.0	30.8

#: Intentional radiation not evaluated.



Final Results:

Frequency MHz	*Max-Peak dBµV/m*	*CAver-age dBµV/m*	*Limit dBµV/m*	*Mar-gin dB*	*Meas. Time ms*	*Band-width kHz*	*Height cm*	*Pol*	*Azi-muth deg*	*Corr. dB/m*
1829.750000	---	43.13	53.98	10.85	1000.0	1000.000	400.0	H	120.0	31.4
1829.750000	50.05	---	73.98	23.93	1000.0	1000.000	400.0	H	120.0	31.4



Final Results:

Frequency MHz	*Max-Peak dBµV/m*	*CAver-age dBµV/m*	*Limit dBµV/m*	*Mar-gin dB*	*Meas. Time ms*	*Band-width kHz*	*Height cm*	*Pol*	*Azi-muth deg*	*Corr. dB/m*
8914.750000	---	51.19	63.50	12.31	1000.0	1000.000	250.0	V	117.0	49.9
8914.750000	64.04	---	83.50	19.46	1000.0	1000.000	250.0	V	117.0	49.9

Product Service

2.9.8 Test Location and Test Equipment

The test was carried out in semi anechoic rooms No. 11

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Loop Antenna	Schwarzbeck	FMZB 1519B	44334	36	2023-02-28
ULTRALOG antenna	Rohde & Schwarz	HL562E	39969	36	2025-03-31
Double ridged horn antenna	Rohde & Schwarz	HF907	19933	24	2023-08-31
EMI test receiver	Rohde & Schwarz	ESW 44	19897	12	2023-04-30
EMI measurement software	Rohde & Schwarz	EMC32 Emission V10.60.20	42986	---	---
Semi anechoic room	Frankonia	Cabin No. 11	42961	36	2024-09-30

Table 22

Product Service

2.10 Temperature Stability

2.10.1 Specification Reference

ISED RSS-Gen, Clause 6.11, 8.11

2.10.2 Equipment under Test and Modification State

ERH; S/N ---; Modification State 0

2.10.3 Date of Test

2023-02-22

2.10.4 Environmental Conditions

Ambient Temperature	21 °C
Relative Humidity	39 %

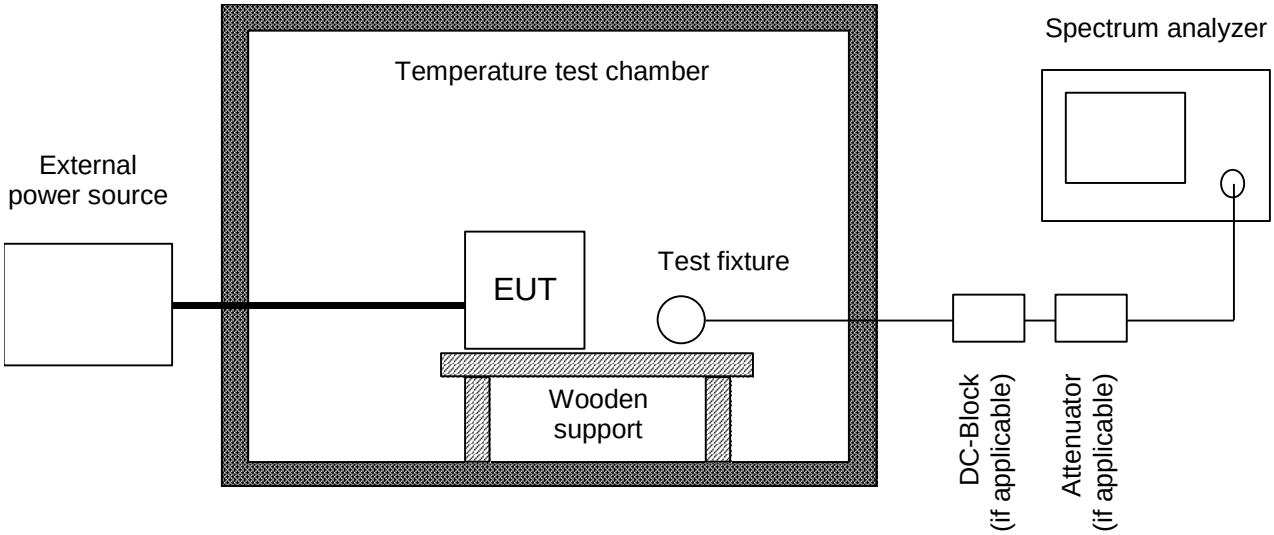
2.10.5 Specification Limits

If the stability of the license-exempt radio apparatus is not specified in the applicable RSS, the fundamental emissions of the radio apparatus should be kept within at least the central 80 % of its permitted operating frequency band in order to minimize the possibility of out-of-band operation. In additions, its occupied bandwidth shall be entirely outside the restricted bands and the prohibited TV bands of 85 MHz – 72 MHz, 76 MHz – 88 MHz, 174 MHz – 216 MHz, and 470 MHz – 602 MHz, unless otherwise indicated.

Product Service

2.10.6 Test Method

The test was performed according to ANSI C63.10, section 6.8.



The frequency tolerance of the carrier signal is measured over a temperature variation of -20 °C to +50 °C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rates supply voltage at a temperature of 20 °C. Temperature and voltage range may vary if the manufacturer states another temperature or voltage range.
If the EUT provides an antenna connector the spectrum analyzer is connected to this port. If required, a resistive matching network equal to the impedance specified or employed for the antenna is used as well as a DC block and appropriate (50 Ω) attenuators. In case where the EUT does not provide an antenna connector or a test fixture is used.
For battery operated equipment, the test is performed using a new battery. Alternatively, an external supply voltage can be used and is at least set to:

- The maximum battery voltage as delivered by a new battery or 115 % of the battery nominal voltage;
- The battery nominal voltage
- 85 % of the battery nominal voltage
- The battery operating end point voltage which shall be specified by the equipment manufacturer.

The EUT is operating providing an unmodulated carrier for frequency error tests. The peak detector of the spectrum analyzer is selected and resolution as well as video bandwidth are set to values appropriate to shape of the spectrum of the EUT. The frequency counter mode of the spectrum analyzer is used to maximize the accuracy of the measured frequency tolerance.
If an unmodulated carrier is not available a significant and stable point of the spectrum is selected and the span is reduced to a value that delivers an accuracy which shall be better than 1 % of the maximum frequency tolerance allowed for the carrier signal. This method may be performed as long as the margin to the frequency tolerance is larger than the uncertainty of the measured frequency tolerance.

The test was performed with an unmodulated carrier signal

Product Service

2.10.7 Test Results

Temperature	*Supply Voltage*	*Frequency*	*Frequency drift*
-15 °C	3.0 V	902.30430 MHz	4.30 kHz
20 °C	2.2 V	902.30000 MHz	0.00 kHz
20 °C	3.0 V	902.30140 MHz	1.40 kHz
20 °C	3.5 V	902.30000 MHz	0.00 kHz
65 °C	3.0 V	902.29710 MHz	-2.90 kHz

Table 23: Temperature Stability Mode 1

Temperature	*Supply Voltage*	*Frequency*	*Frequency drift*
-15 °C	3.0 V	908.50430 MHz	4.30 kHz
20 °C	2.2 V	908.50000 MHz	0.00 kHz
20 °C	3.0 V	908.50140 MHz	1.40 kHz
20 °C	3.5 V	908.50000 MHz	0.00 kHz
65 °C	3.0 V	908.49710 MHz	-2.90 kHz

Table 24: Temperature Stability Mode 2

Temperature	*Supply Voltage*	*Frequency*	*Frequency drift*
-15 °C	3.0 V	914.90430 MHz	4.30 kHz
20 °C	2.2 V	914.90140 MHz	1.40 kHz
20 °C	3.0 V	914.90140 MHz	1.40 kHz
20 °C	3.5 V	914.90000 MHz	0.00 kHz
65 °C	3.0 V	914.89710 MHz	-2.90 kHz

Table 25: Temperature Stability Mode 3

Product Service

2.10.8 Test Location and Test Equipment

The test was carried out in Radio Test Laboratory

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Spectrum Analysator	Rohde & Schwarz	FSV40	20219	24	2024-02-29
Temperature test chamber	Feutron	KPK200-2	19868	18	2023-02-28

Table 26

Product Service

3 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

The measurement uncertainty in the laboratory is less than or equal to the maximum measurement uncertainty according to CISPR16-4-2: 2011 + A1 + A2 + Cor1 (U_{CISPR}). This normative regulation means that the measured value is also the value to be assessed in relation to the limit value.

Radio Interference Emission Testing		
Test Name	*kp*	*Expanded Uncertainty*
Conducted Voltage Emission		
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB
100 kHz to 200 MHz (50Ω/5µH AMN)	2	± 3.6 dB
Discontinuous Conducted Emission		
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB
Conducted Current Emission		
9 kHz to 200 MHz	2	± 3.5 dB
Magnetic Fieldstrength		
9 kHz to 30 MHz (with loop antenna)	2	± 3.9 dB
9 kHz to 30 MHz (large-loop antenna 2 m)	2	± 3.5 dB
Radiated Emission		
30 MHz to 300 MHz	2	± 4.9 dB
300 MHz to 1 GHz	2	± 5.0 dB
1 GHz to 6 GHz	2	± 4.6 dB
Test distance 10 m		
30 MHz to 300 MHz	2	± 4.9 dB
300 MHz to 1 GHz	2	± 4.9 dB
The expanded uncertainty reported according to to CISPR16-4-2: 2011 + A1 + A2 + Cor1 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%		

Table 27 Measurement uncertainty based on CISPR 16-4-2

Product Service

Radio Interference Emission Testing		
Test Name	*kp*	*Expanded Uncertainty*
Occupied Bandwdith	2	± 5 %
Conducted Power		
9 kHz ≤ f < 30 MHz	2	± 1.0 dB
30 MHz ≤ f < 1 GHz	2	± 1.5 dB
1 GHz ≤ f ≤ 40 GHz	2	± 2.5 dB
1 MS/s power sensor (TS8997)	2	± 1.5 dB
Occupied Bandwidth	2	± 5 %
Power Spectral Density	2	± 3.0 dB
Radiated Power		
9 kHz ≤ f < 26.5 GHz	2	± 5.6 dB
26.5 GHz ≤ f < 60 GHz	2	± 8.0 dB
60 GHz ≤ f < 325 GHz	2	± 10 dB
Conducted Spurious Emissions	2	± 3.0 dB
Radiated Spurious Emissions	2	± 6.0 dB
Voltage		
DC	2	± 1.0 %
AC	2	± 2.0 %
Time (automatic)	2	± 5 %
Frequency	2	± 10^{-7}
The expanded uncertainty reported according to to ETSI TR 100 028:2001 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%		

Table 28 Measurement uncertainty based on ETSI TR 100 028