



EMI – TEST REPORT

- FCC Part 15.247, RSS-247 -

Type / Model Name : smaXtec climate sensor SX.2.1

Product Description : Climate sensor

Applicant : smaXtec animal care GmbH

Address : Sandgasse 36/2

8010 GRAZ, AUSTRIA

Manufacturer : smaXtec animal care GmbH

Address : Sandgasse 36/2

8010 GRAZ, AUSTRIA

Test Result according to the standards
listed in clause 1 test standards:

POSITIVE

Test Report No. : **80164398-00 Rev_0**

05. December 2023

Date of issue



Deutsche
Akkreditierungsstelle
D-PL-12030-01-03
D-PL-12030-01-04

Contents

1	<u>TEST STANDARDS</u>	<u>3</u>
2	<u>EQUIPMENT UNDER TEST</u>	<u>4</u>
2.1	Information provided by the Client	4
2.2	Sampling	4
2.3	Photo documentation of the EUT – Detailed photos see ATTACHMENT A	4
2.4	Equipment type	4
2.5	Short description of the equipment under test (EUT)	4
2.6	Variants of the EUT	4
2.7	Operation frequency and channel plan	5
2.8	Transmit operating modes	6
2.9	Antenna	6
2.10	Power supply system utilised	6
2.11	Peripheral devices and interface cables	6
2.12	Determination of worst-case conditions for final measurement	7
3	<u>TEST RESULT SUMMARY</u>	<u>8</u>
3.1	Revision history of test report	8
3.2	Final assessment	8
4	<u>TEST ENVIRONMENT</u>	<u>9</u>
4.1	Address of the test laboratory	9
4.2	Environmental conditions	9
4.3	Statement of the measurement uncertainty	9
4.4	Conformity Decision Rule	10
4.5	Measurement protocol for FCC and ISSED	10
5	<u>TEST CONDITIONS AND RESULTS</u>	<u>13</u>
5.1	Conducted emissions	13
5.2	Emission bandwidth	13
5.3	Maximum peak output power conducted	19
5.4	Power spectral density	22
5.5	Spurious emissions	26
5.6	Band edge compliance	27
5.7	Radiated emissions in restricted bands	29
5.8	Dwell time	36
5.9	Number of hopping channels	38
5.10	Carrier frequency separation	41
5.11	Antenna application	43
6	<u>USED TEST EQUIPMENT AND ACCESSORIES</u>	<u>44</u>

ATTACHMENT A as separate supplement

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September 2021)

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements
Part 15, Subpart A, Section 15.35	Measurement detector functions and bandwidths

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (September 2021)

Part 15, Subpart C, Section 15.203	Antenna requirement
Part 15, Subpart C, Section 15.204	External radio frequency power amplifiers and antenna modifications
Part 15, Subpart C, Section 15.205	Restricted bands of operation
Part 15, Subpart C, Section 15.207	Conducted limits
Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements
Part 15, Subpart C, Section 15.247	Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz and 5725 - 5850 MHz

ANSI C63.10: 2013	Testing Unlicensed Wireless Devices
-------------------	-------------------------------------

ETSI TR 100 028 V1.3.1: 2001-03,	Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the Measurement of Mobile Radio Equipment Characteristics—Part 1 and Part 2
----------------------------------	--

KDB 558074 D01 v05r02	Guidance for compliance measurements on DTS; FHSS and hybrid system devices operating under Section 15.247 of the FCC rules, April 2, 2019.
-----------------------	---

2 EQUIPMENT UNDER TEST

2.1 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

2.2 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according to his/her instructions.

2.3 Photo documentation of the EUT – Detailed photos see ATTACHMENT A

2.4 Equipment type

LoRa device

2.5 Short description of the equipment under test (EUT)

The EUT is a Climate Sensor with RF interface. The climate sensor is an electronic device which provides real time data about ambient temperature, humidity and air pressure.

Number of tested samples: 2
Radiated Sample:
Serial number: 0C10000007
Firmware version: 19

Conducted Sample
Serial number: 0C10000008
Firmware version: 19

EUT configuration:

(The CDF filled by the applicant can be viewed at the test laboratory.)

2.6 Variants of the EUT

There are no variants:

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

2.7 Operation frequency and channel plan

US:

Upstream LoRa 125 kHz BW, DR0-DR3

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	902,3	16	905,5	32	908,7	48	911,9
1	902,5	17	905,7	33	908,9	49	912,1
2	902,7	18	905,9	34	909,1	50	912,3
3	902,9	19	906,1	35	909,3	51	912,5
4	903,1	20	906,3	36	909,5	52	912,7
5	903,3	21	906,5	37	909,7	53	912,9
6	903,5	22	906,7	38	909,9	54	913,1
7	903,7	23	906,9	39	910,1	55	913,3
8	903,9	24	907,1	40	910,3	56	913,5
9	904,1	25	907,3	41	910,5	57	913,7
10	904,3	26	907,5	42	910,7	58	913,9
11	904,5	27	907,7	43	910,9	59	914,1
12	904,7	28	907,9	44	911,1	60	914,3
13	904,9	29	908,1	45	911,3	61	914,5
14	905,1	30	908,3	46	911,5	62	914,7
15	905,3	31	908,5	47	911,7	63	914,9

Note: the marked frequencies are determined for final testing.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

2.8 Transmit operating modes

DataRate	Configuration	Indicative physical bit rate (bit/sec)
0	LoRa: SF10 / 125 kHz	250
1	LoRa: SF9 / 125 kHz	1760
2	LoRa: SF8 / 125 kHz	3125
3	LoRa: SF7 / 125 kHz	5470
5:7	RFU	

2.9 Antenna

The following antenna shall be used with the EUT:

Number	Characteristic	Model number	Plug	Frequency range (MHz)	Gain (dBi)	Cable loss (dB)	Effective gain (dBi)
1	Omni	PCB	-	902 - 928	-25,1	0	-25.1

2.10 Power supply system utilised

Power supply voltage, V_{nom} : 3.0V (2x AA 1.5V Battery)

2.11 Peripheral devices and interface cables

The following peripheral devices and interface cables are connected during the measurements:

- -Power supply Model : -Hameg HM8143

2.12 Determination of worst-case conditions for final measurement

Preliminary tests are performed in all three orthogonal axes of the EUT to locate at which position and at what setting of the EUT produce the maximum of the emissions. For the further measurement the EUT is set in Y position.

The tests are carried out in the following frequency band:

902 MHz – 928 MHz

For the final test the following channels and test modes are selected:

Available channel	Tested channels	Power setting	Modulation	Modulation type	Data rate
0 to 63	0, 32, 63	Pmax	DSSS	FSK	DR0-3

2.12.1 Test jig

No test jig is used.

2.12.2 Test software

The test software for the EUT provides max power setting and the special test mode TX continuous, modulated. The EUT was set with test modulation to transmit data during the tests with a maximum duty cycle (x) from an internal packet generator. Only for the test the appropriate test software is available.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

3 TEST RESULT SUMMARY

FCC Rule Part	RSS Rule Part	Description	Result
15.207(a)	RSS-Gen, 8.8	AC power line conducted emissions	not applicable
15.247(a)(1)	RSS-247, 5.1(a)	20 dB EBW, 99% EBW	passed
15.247(a)(2)	RSS-247, 5.1(b)	6 dB EBW, OBW	passed
15.247(a)(1)	RSS-247, 5.1(d)	Dwell time	passed
15.247(b)(1)	RSS-247, 5.4(b)	Peak power	passed
15.247(f)		Power Spectral Density	passed
15.247(d)	RSS-247, 5.5	Out-of-band emission	passed
15.247(d)	RSS-Gen, 8.10	Emissions in restricted bands	passed
15.247(a)	RSS-247, 5.4(b)	Number of hopping channels	passed
15.35(c)	RSS-Gen, 6.10	Pulsed operation	passed
15.203	RSS-247, 5.4(b)	Antenna requirement	passed

The mentioned RSS Rule Parts in the above table are related to:
RSS-Gen, Issue 5 + Amendment 1 + Amendment 2, March 2019
RSS-247, Issue 2, February 2017

3.1 Revision history of test report

Test report No	Rev.	Issue Date	Changes
80164398-00	0	05 December 2023	Initial test report US Channels

The test report with the highest revision number replaces the previous test reports.

3.2 Final assessment

The equipment under test fulfills the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 23 May 2023

Testing concluded on : 07 June 2023

Checked by:

Tested by:

Klaus Gegenfurtner
Teamleader Radio

Laurin Roth
Radio Team

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

**CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY**

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15-35 ° C

Humidity: 30-60 %

Atmospheric pressure: 86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor $k = 2$. The true value is located in the corresponding interval with a probability of 95 %. The measurement uncertainty was calculated for all measurements listed in this test report on basis of the ETSI Technical Report TR 100 028 Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1 and Part 2. The results are documented in the quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Measurement Type	Range	Confidence Level	Calculated Uncertainty
AC power line conducted emissions	0.15 MHz to 30 MHz	95%	± 3.29 dB
EBW and OBW	2400 MHz to 3000 MHz	95%	$\pm 2.5 \times 10^{-7}$
Maximum peak conducted output power	2400 MHz to 3000 MHz	95%	± 0.62 dB
Power spectral density	2400 MHz to 3000 MHz	95%	± 0.62 dB
Conducted Spurious Emissions	9 kHz to 10000 MHz	95%	± 2.15 dB
Conducted Spurious Emissions	10000 MHz to 40000 MHz	95%	± 3.47 dB
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	± 3.53 dB
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	± 3.71 dB
Radiated Spurious Emissions	1000 MHz to 30000 MHz	95%	± 2.34 dB
Field strength of the fundamental	100 kHz to 100 MHz	95%	± 3.53 dB

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

4.4 Conformity Decision Rule

The applied conformity decision rule is based on ILAC G8:09/2019 clause 4.2.1 Binary Statement for Simple Acceptance Rule ($w = 0$).
Details can be found in the procedure CSA_B_V50_29.

4.5 Measurement protocol for FCC and ISCED

4.5.1 General information

CSA Group Bayern GmbH is recognized as wireless testing laboratory under the CAB identifier:

FCC: DE 0011
ISED: DE0009

4.5.2 General Standard information

The test methods used comply with ANSI C63.10 - "Testing Unlicensed Wireless Devices".

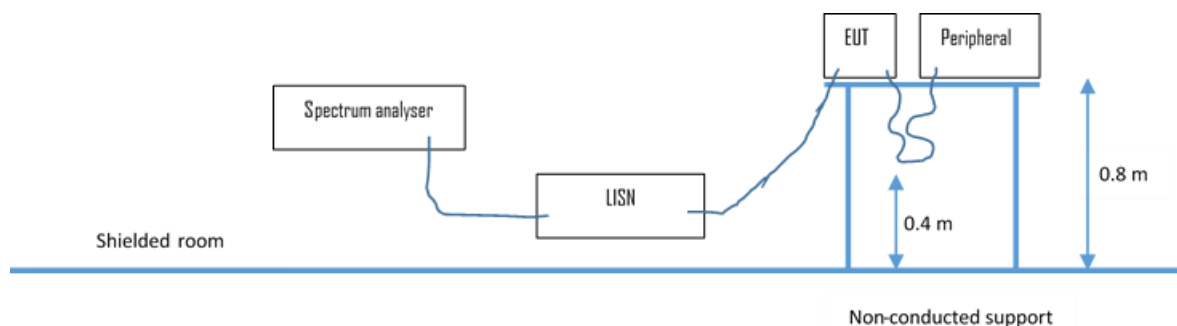
4.5.2.1 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions.

4.5.3 Details of test procedures

4.5.3.1 Conducted emission

Test setup according ANSI C63.10



The final level, expressed in dB μ V, is arrived at by taking the reading directly from the Spectrum analyser. This level is compared to the limit.

To convert between dB μ V and μ V, the following conversions apply:

$$\text{dB}\mu\text{V} = 20(\log \mu\text{V})$$

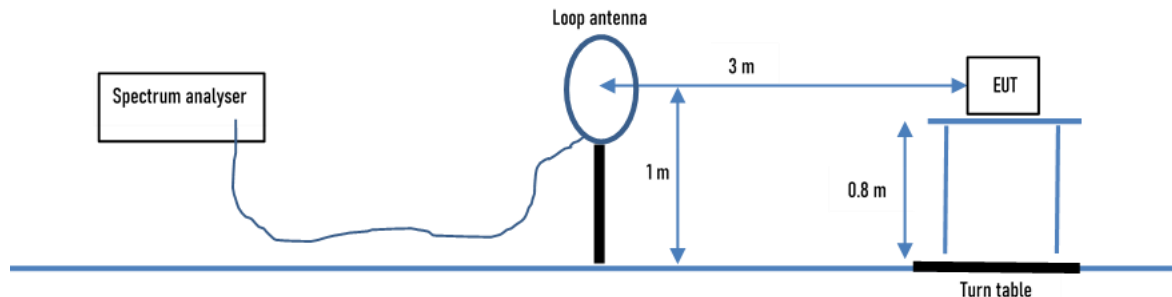
$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with 50 Ω / 50 μ H (CISPR 16) characteristics. The receiver is protected by means of an impedance matched pulse limiter connected directly to the RF input. Table top equipment is placed on a non-conducting table 80 centimetres above the floor and is positioned 40 centimetres from the vertical ground plane (wall) of the screen room. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emission is re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

4.5.3.2 Radiated emission

4.5.3.2.1 OATS1 test site (9 kHz - 30 MHz):

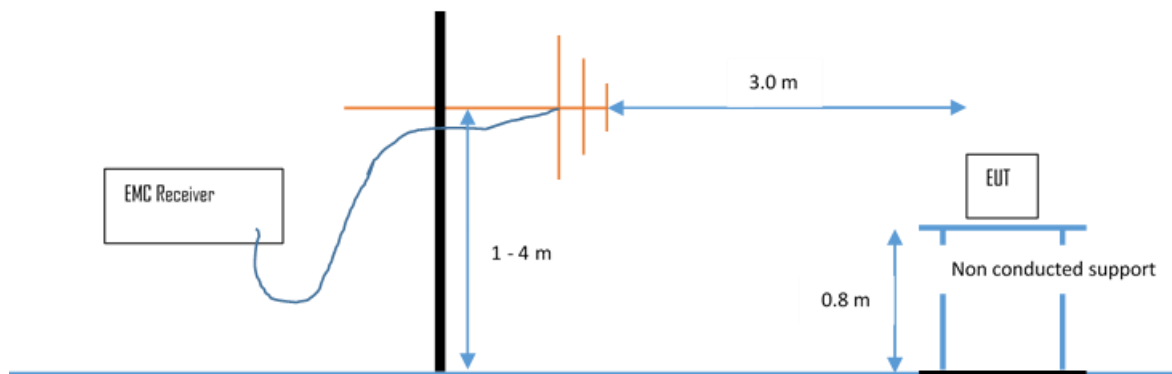
Test setup according ANSI C63.10



Emissions from the EUT are measured in the frequency range of 9 MHz to 30 MHz using a tuned receiver and a calibrated loop antenna. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. The antenna is positioned 3, 10 or 30 metres horizontally from the EUT and is repeated vertically. To locate maximum emissions from the test sample the antenna is varied along the site axis and the EUT is rotated 360 degrees.

4.5.3.2.2 OATS1 test site (30 MHz - 1 GHz):

Test setup according ANSI C63.10.



Spurious emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees. The final level in dBµV/m is calculated by taking the reading from the EMI receiver (Level dBµV) and adding the correction factors and cable loss factor (dB). The FCC limit is subtracted from this result in order to provide the limit margin listed in the measurement protocol.

The resolution bandwidth setting:

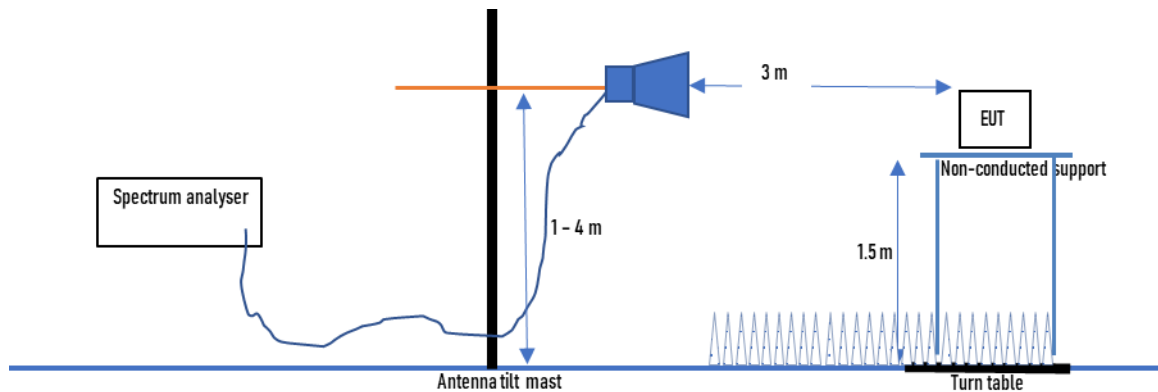
30 MHz – 1000 MHz: RBW: 120 kHz

Example:

Frequency (MHz)	Level (dBµV)	+	Factor (dB)	=	Level (dBµV/m)	-	Limit (dBµV/m)	=	Delta (dB)
719.0	75.0	+	32.6	=	107.6	-	110.0	=	-2.4

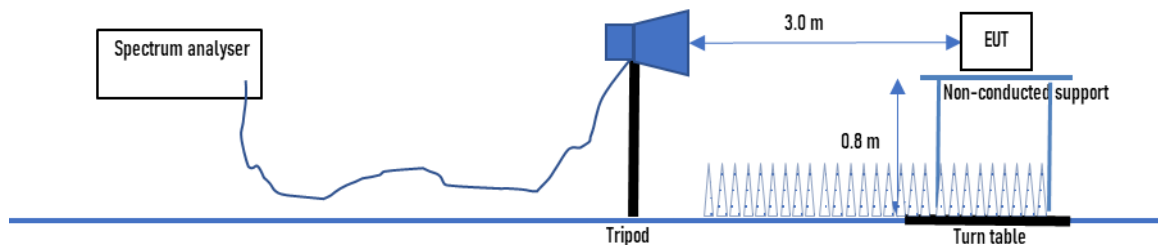
4.5.3.2.3 Anechoic chamber 1 (1000 MHz – 18000 MHz)

Test setup according ANSI C63.10.



Radiated emissions from the EUT are measured in the frequency range 1 GHz up to 18 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 1.5 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the center, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements.

4.5.3.2.4 Anechoic chamber 1 (18 GHz – 40 GHz)



Emissions from the EUT are measured in the frequency range 18 GHz up to 40 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 0.8 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the center, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty. The limits are adopted.

5 TEST CONDITIONS AND RESULTS

5.1 Conducted emissions

For test instruments and accessories used see section 6 Part A 4.

5.1.1 Description of the test location

Test location: NONE

Remarks: The measurement is not applicable the EUT has no AC mains connection.

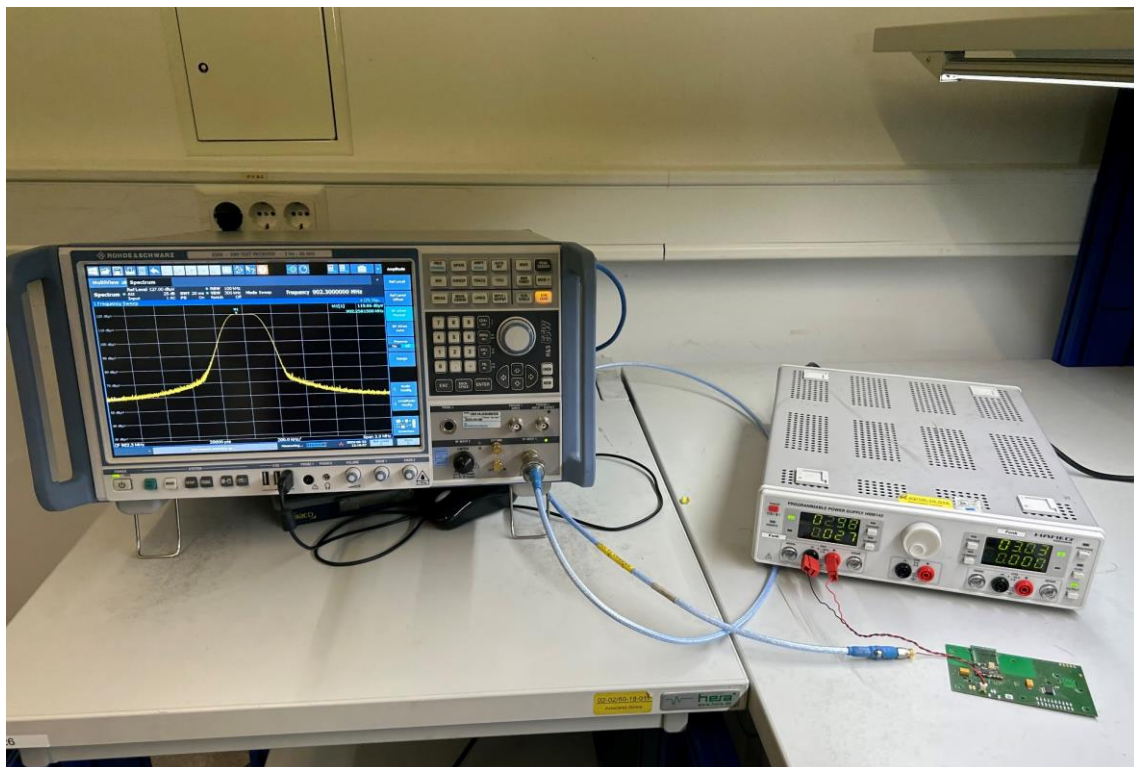
5.2 Emission bandwidth

For test instruments and accessories used see section 6 Part MB.

5.2.1 Description of the test location

Test location: Shielded Room S6

5.2.2 Photo documentation of the test set-up



5.2.3 Applicable standard

According to FCC Part 15C, Section 15.247(a):

(a)(1i) Frequency hopping systems shall have hopping carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

(a)(2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

5.2.4 Description of Measurement

The bandwidth is measured at an amplitude level reduced from the seeence level by a specified ratio of -20 dB. The seeence level is the level of the highest signal amplitude observed from the transmitter at either the fundamental frequency or the first-order modulation products in all typical modes of operation including the unmodulated carrier, even if atypical.

Analyser settings for 125 kHz:

RBW: 3 kHz, VBW: 10 kHz, Sweep time: auto, Detector: Peak, Trace mode: Max hold

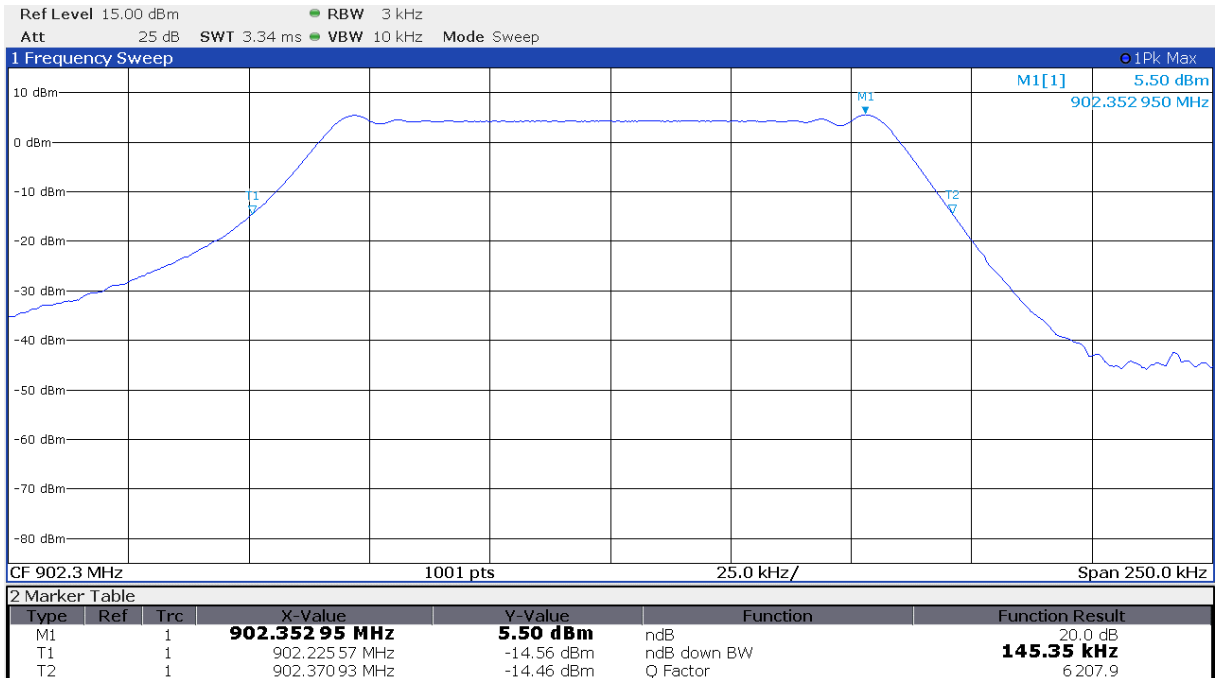
The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.2.5 Test result

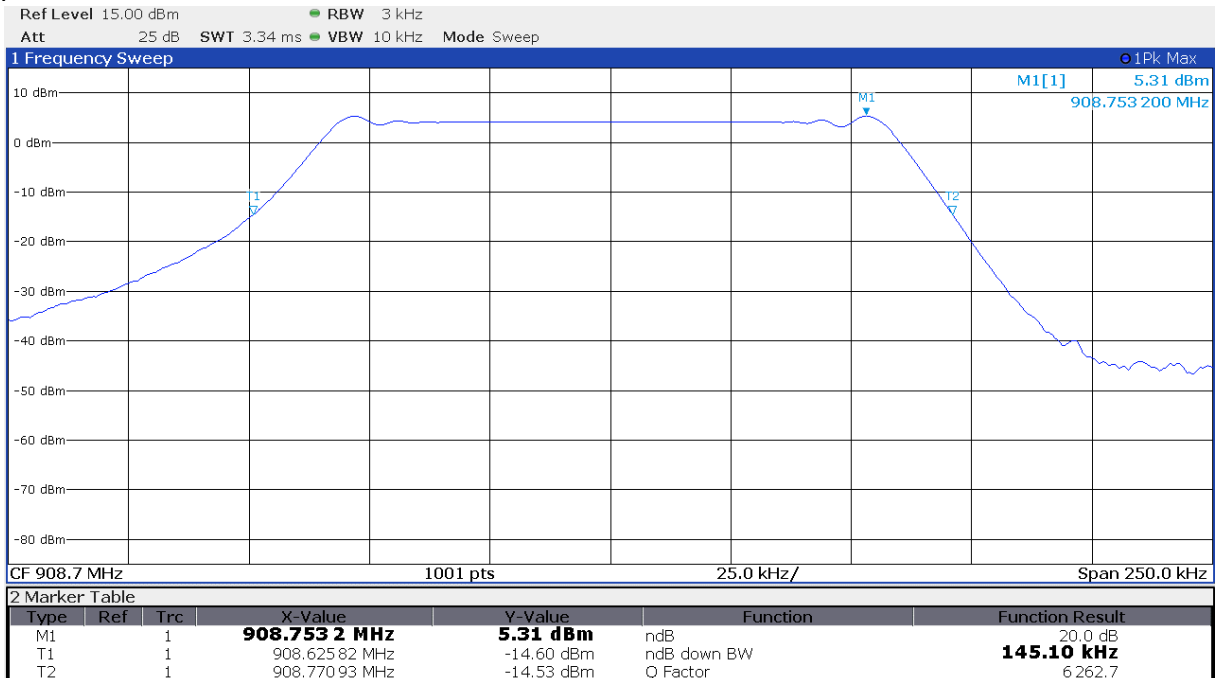
Channels 125 kHz Bandwidth:

20dB down:

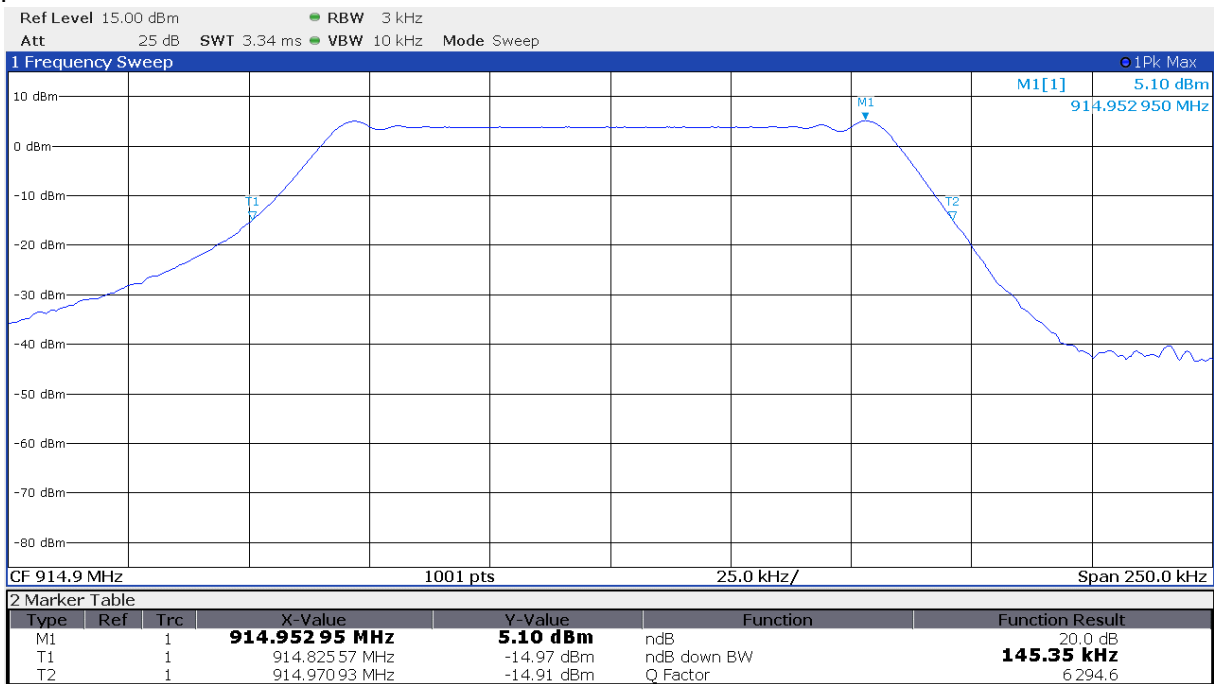
CH 0:



CH 32:

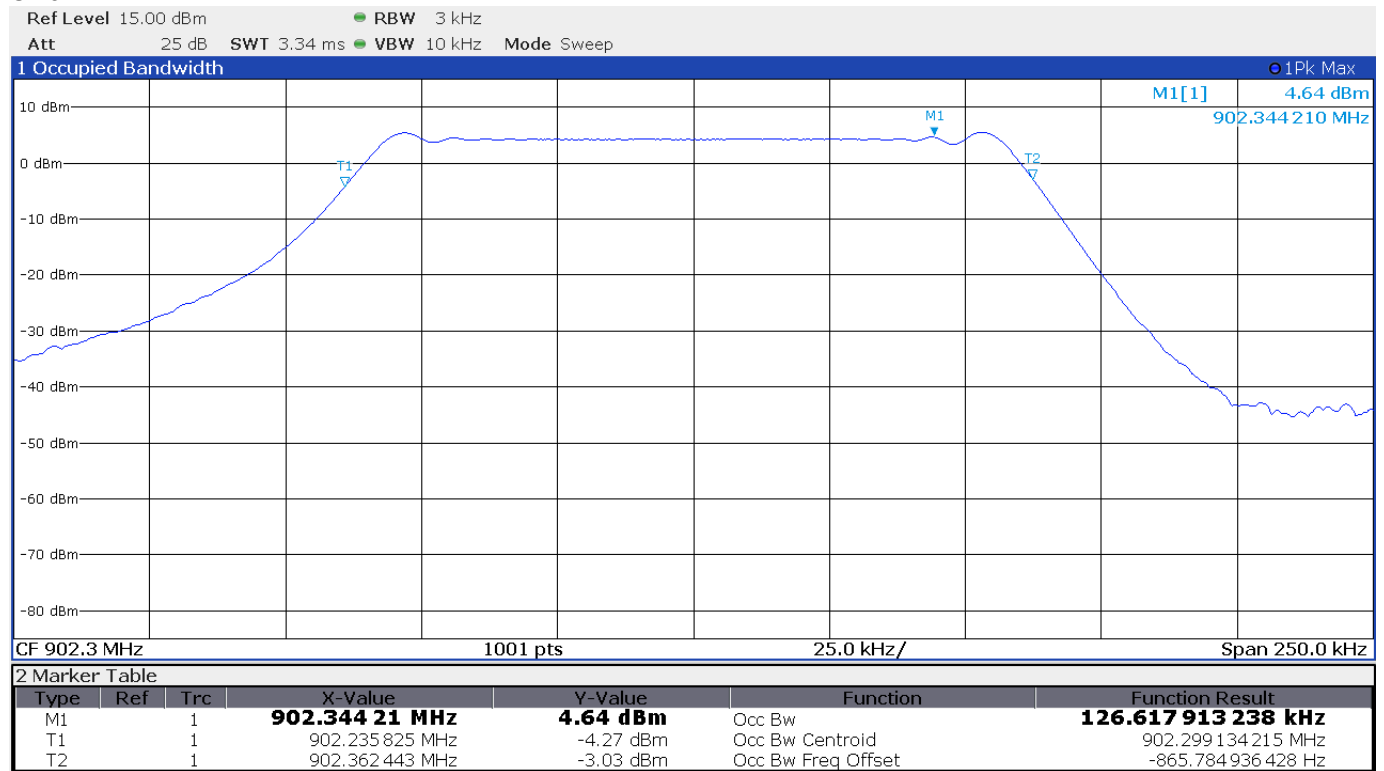


CH 63:

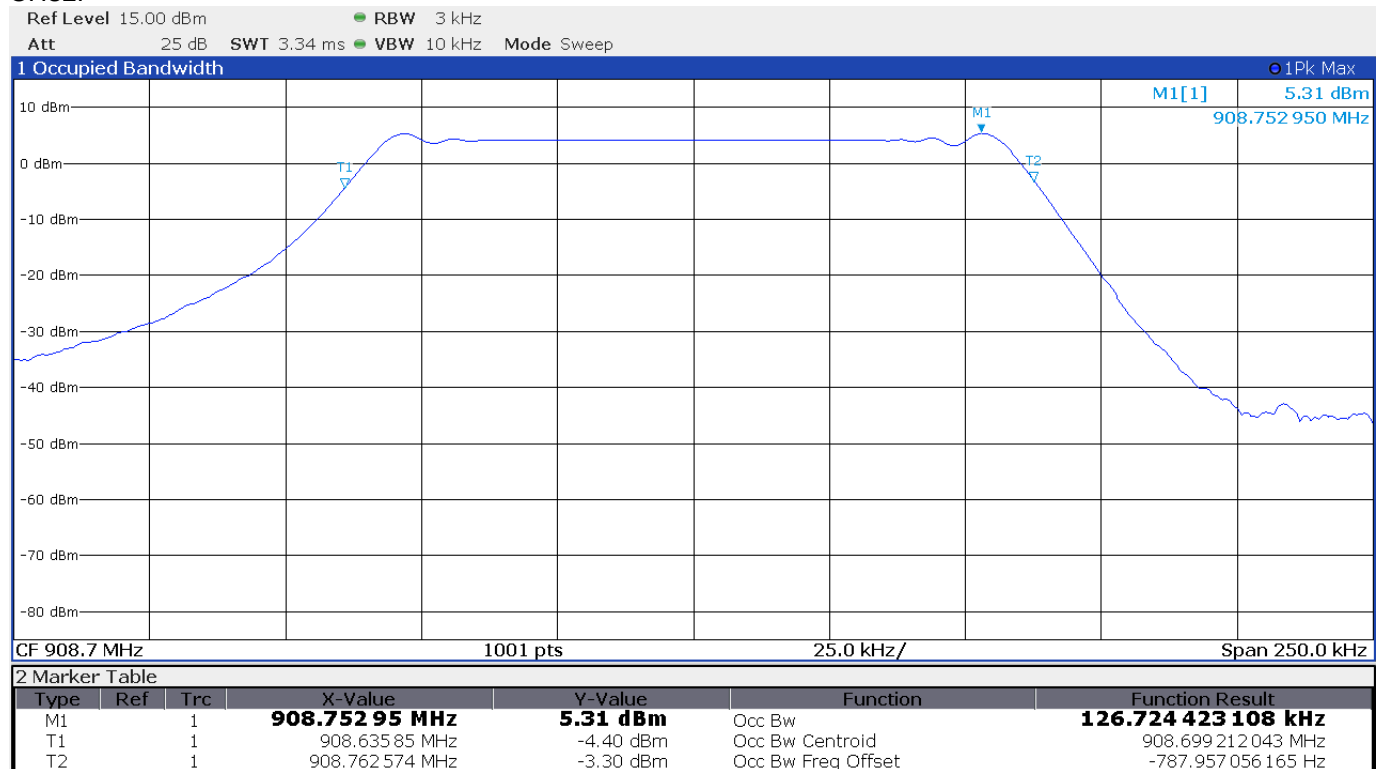


99% EBW:

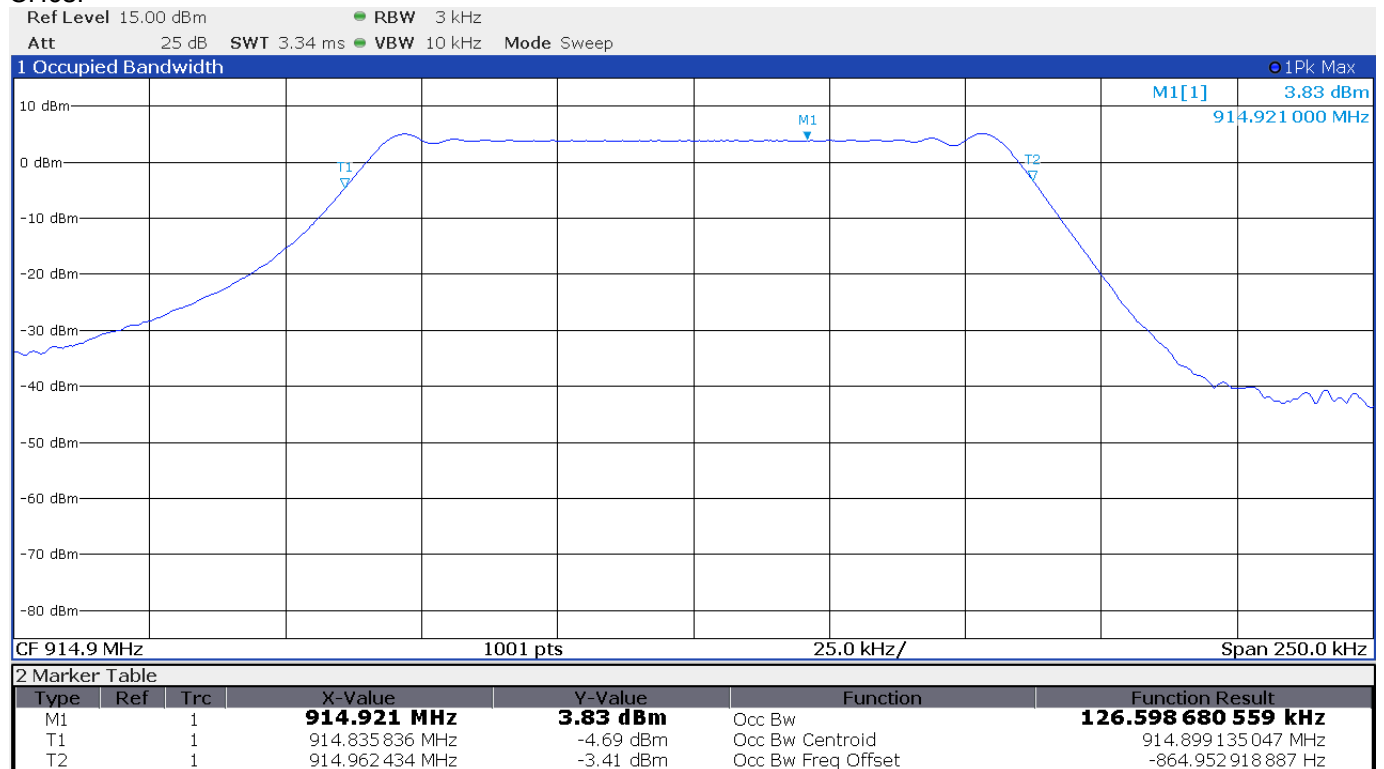
CH0:



CH32:



CH63:



There is no bandwidth limit according to FCC Part15C, Section 15.247(a).

The requirements are **FULFILLED**.

Remarks: None.

-

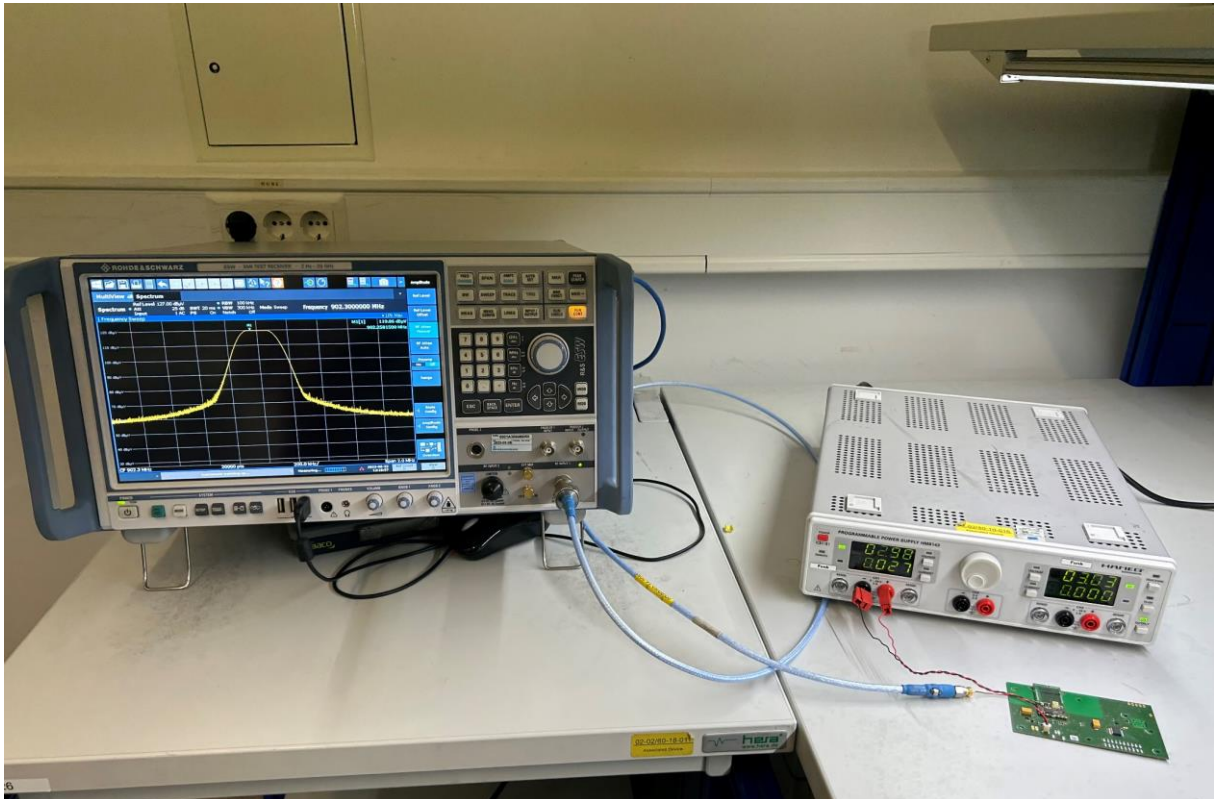
5.3 Maximum peak output power conducted

For test instruments and accessories used see section 6 Part **CPC 2**.

5.3.1 Description of the test location

Test location: Shielded Room S6

5.3.2 Photo documentation of the test set-up



5.3.3 Applicable standard

According to FCC Part 15C, Section 15.247(b)(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.

5.3.4 Description of Measurement

A spectrum analyser is connected to the output of the transmitter via a suitable attenuator while EUT is operating in transmit mode using the assigned frequency according to ANSI C63.10, 7.8.5.

Analyser settings:

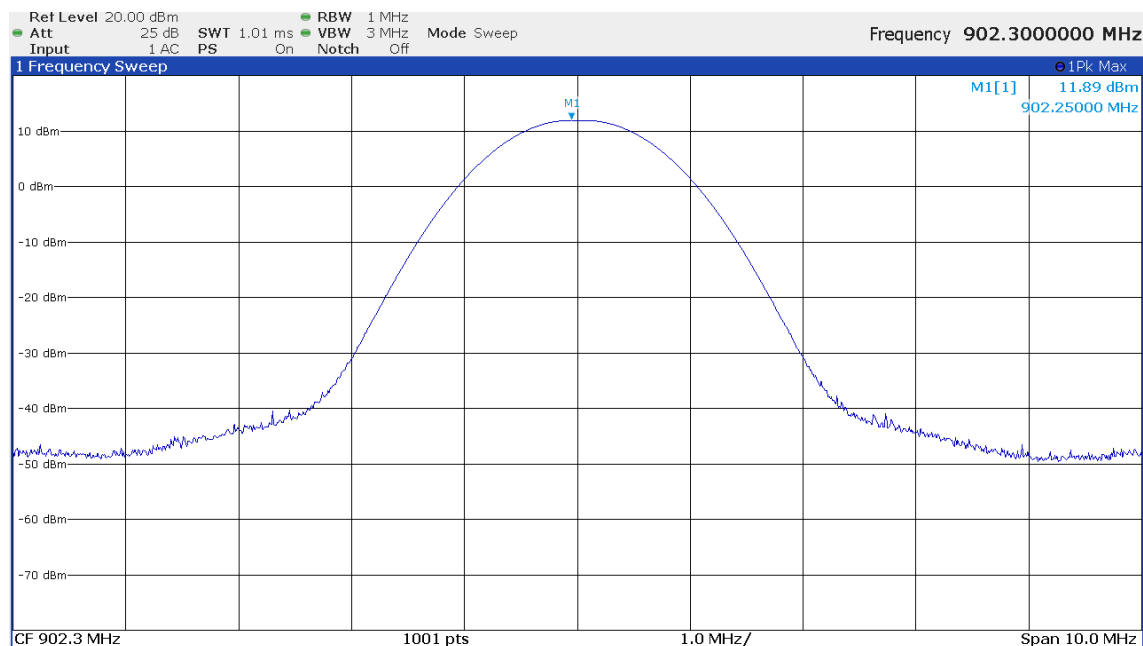
RBW: 3 MHz, VBW $\geq$ RBW, Detector: Max peak, Trace: Max hold, Sweep time: auto

5.3.5 Test result

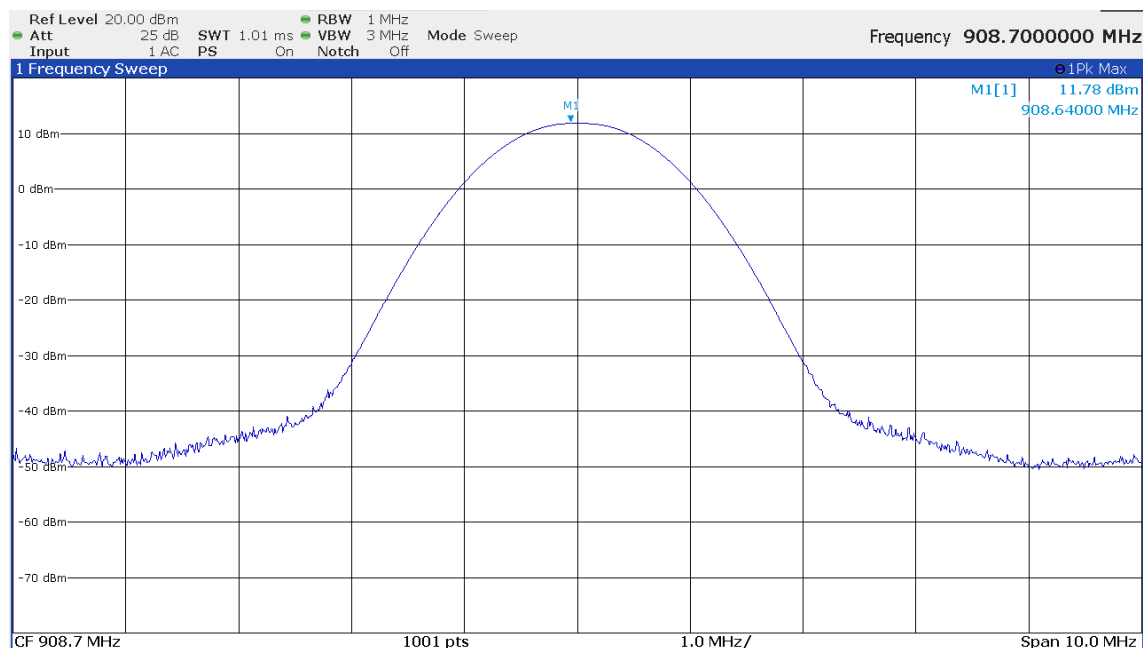
US:

125 kHz Channels, Pmax				
Channel	f	A	Limit	Delta
	(MHz)	(dBm)	(dBm)	(dB)
CH0	902,3	11,9	30	-18,1
CH32	908,7	11,8	30	-18,2
CH63	914,9	11,7	30	-18,3

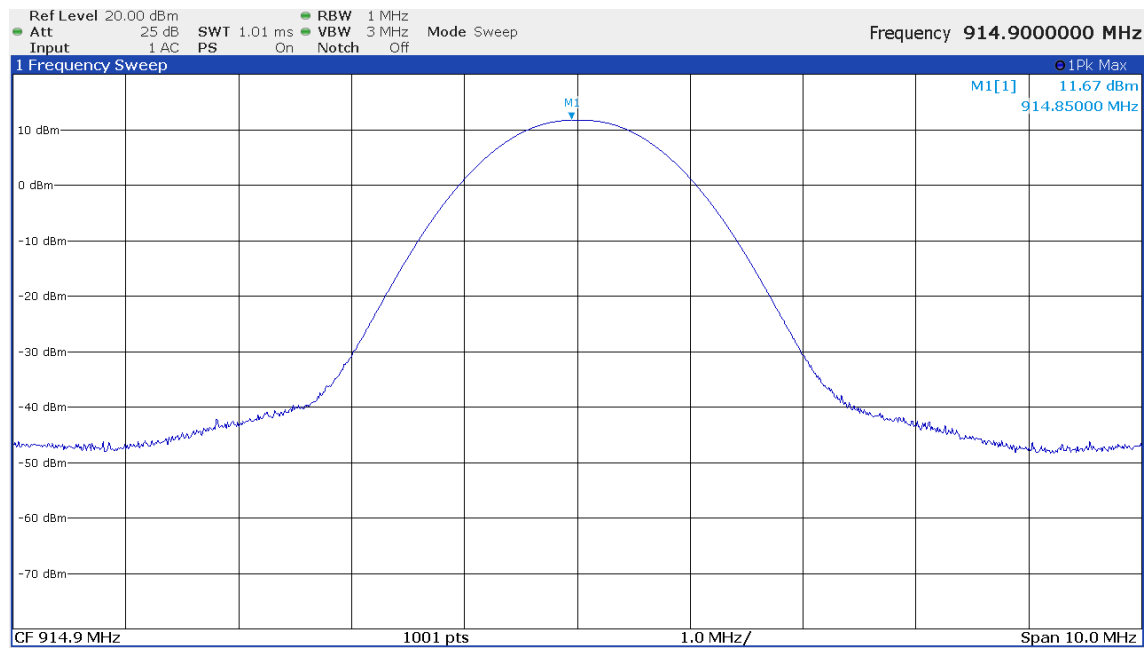
CH0:



CH32:



CH63:



Peak Power Limit according to FCC Part 15C, Section 15.247(b)(2):

Frequency (MHz)	Peak power limit	
	(dBm)	(Watt)
902 - 928	30	1

The requirements are **FULFILLED**.

Remarks: None.

-

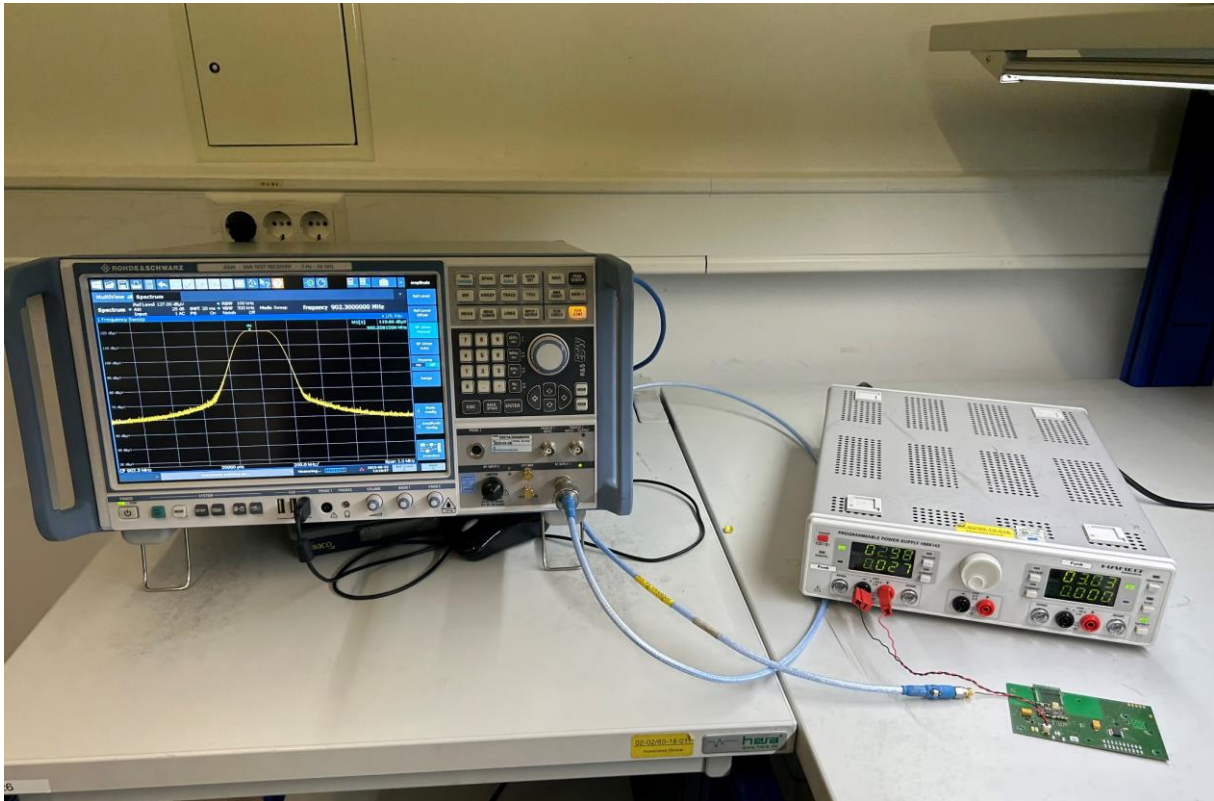
5.4 Power spectral density

For test instruments and accessories used see section 6 Part **CPC 2**.

5.4.1 Description of the test location

Test location: Shielded Room S6

5.4.2 Photo documentation of the test set-up



5.4.3 Applicable standard

According to FCC Part 15, Section 15.247(e):

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

5.4.4 Description of Measurement

The measurement is performed using the procedure set out in 11.10 of ANSI C63.10. The power measurement was done as peak power measurement. Therefore, the PKPSD is measured. The max peak was located and with the spectrum analyser and a marker set to peak.

Spectrum analyser settings:

RBW: 3 kHz, VBW: 10 kHz, Detector: Peak, Sweep time: auto

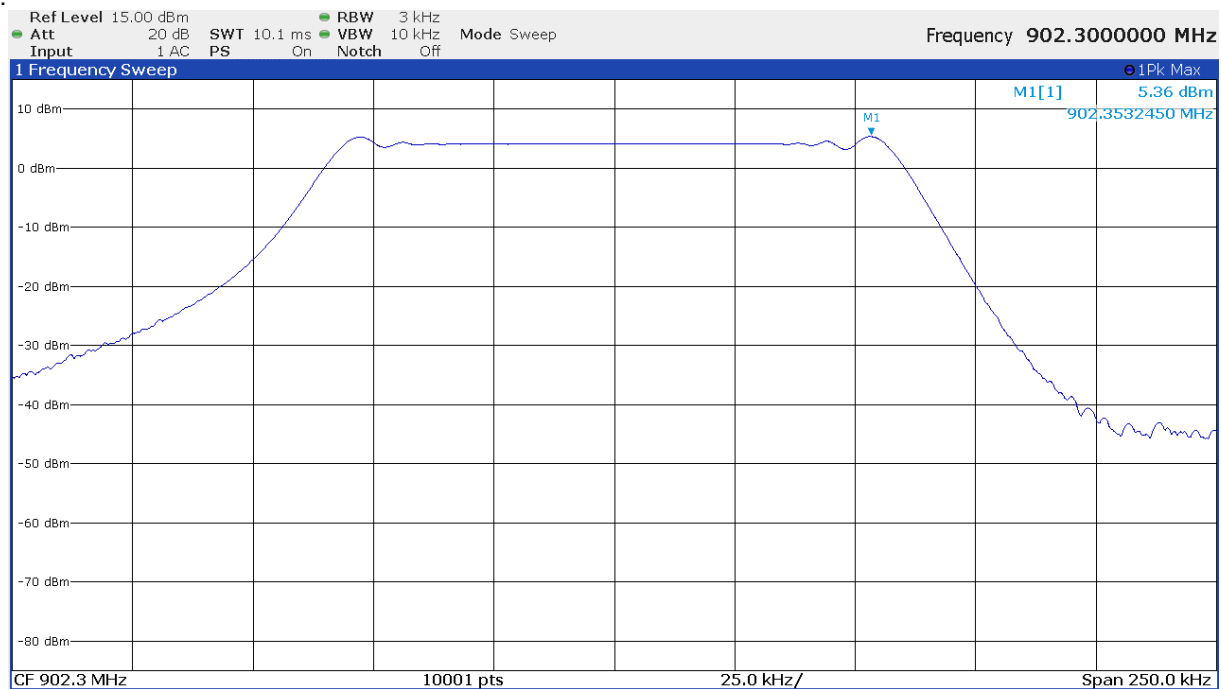
5.4.5 Test result

US:

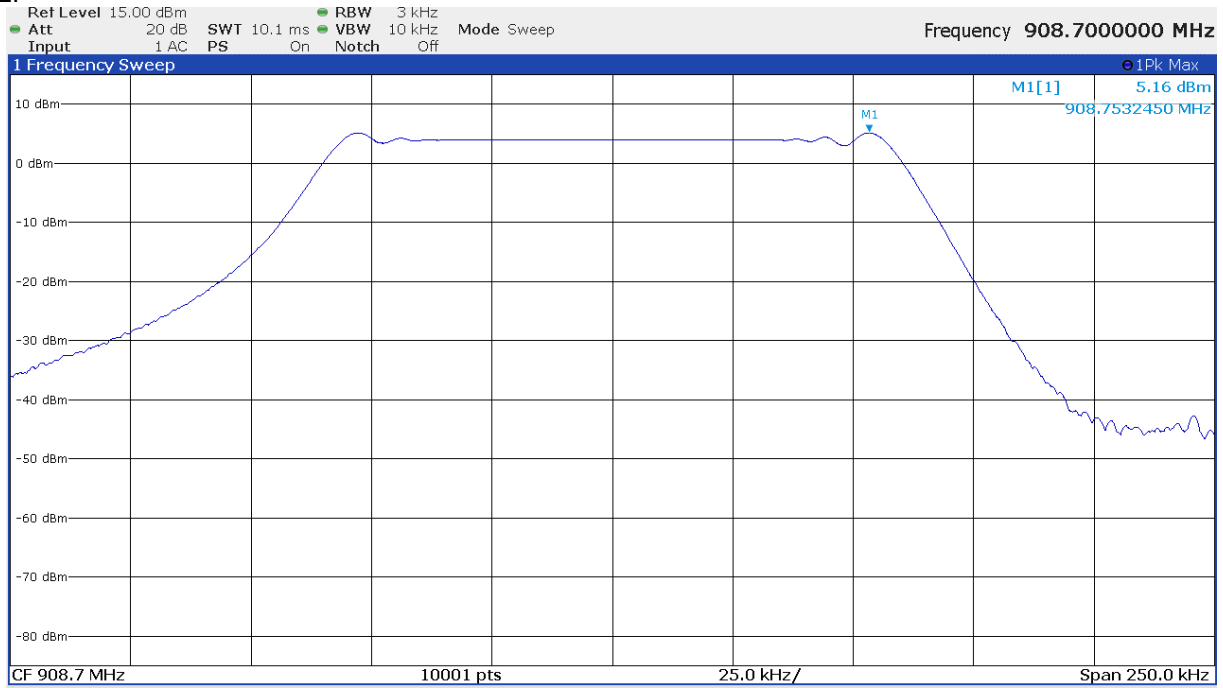
125kHz Channels Pmax				
Channel	f	PSD	Limit	Delta
	(MHz)	(dBm)	(dBm/3kHz)	(dB)
CH0	902,3	5,4	8,0	-2,6
CH32	908,7	5,2	8,0	-2,8
CH63	914,9	5,0	8,0	-3,0

US 125 kHz:

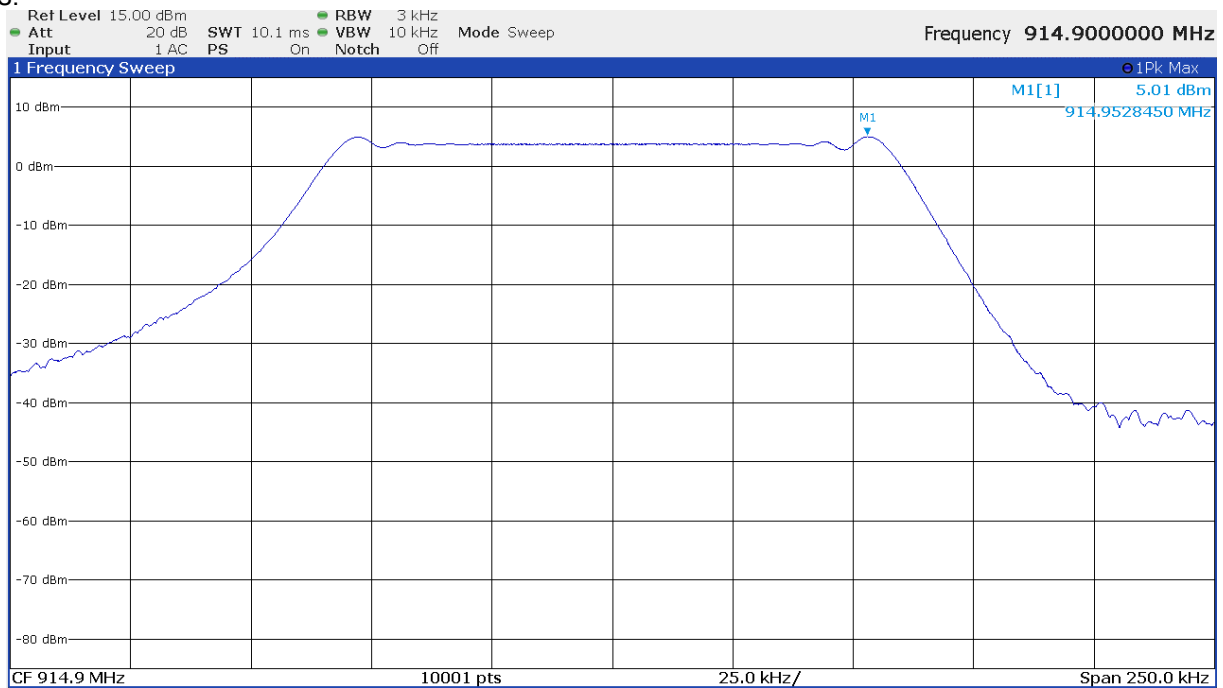
CH 0:



CH 32:



CH 63:



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

Power spectral density limit according to FCC Part 15, Section 15.247©:

Frequency (MHz)	Power spectral density limit
	(dBm/3 kHz)
902 – 928	8

The requirements are **FULFILLED**.

Remarks: None.

-

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.5 Spurious emissions

For test instruments and accessories used see section 6 Part **SEC1, SEC2 and SEC3**.

5.5.1 Description of the test location

Test location: NONE

5.5.2 Applicable standard

According to FCC Part 15C, Section 15.247(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.

Remarks: Not applicable, the EUT holds the general limits.

-

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

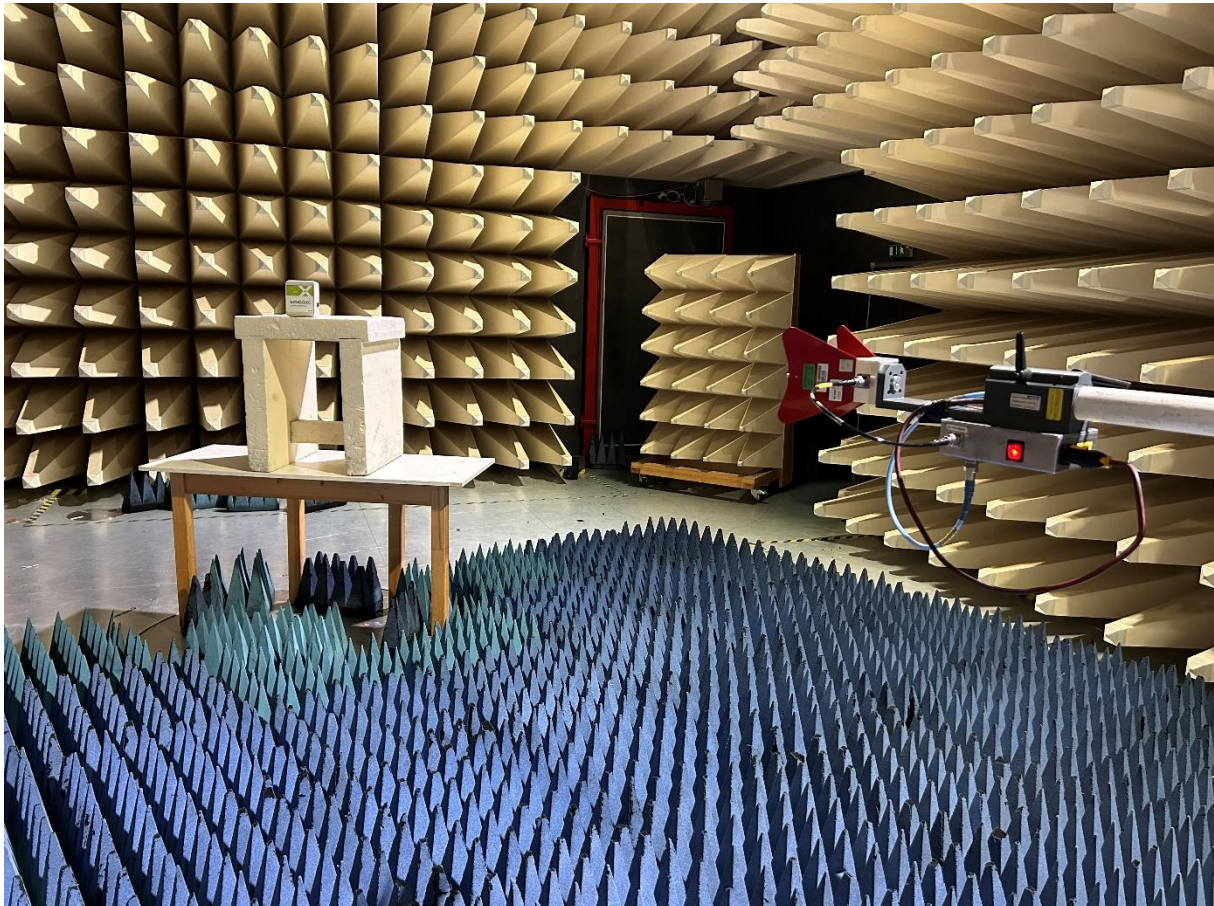
5.6 Band edge compliance

For test instruments and accessories used see section 6 Part **SER3**.

5.6.1 Description of the test location

Test location: Anechoic chamber 1

5.6.2 Photo documentation of the test set-up



5.6.3 Applicable standard

According to FCC Part 15C, Section 15.247(d):

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)).

ANSI C63.10, 7.8.6: For band-edge measurements, use the band-edge procedure in 6.10. Band-edge measurements shall be tested both on single channels, and with the EUT hopping.

5.6.4 Description of Measurement

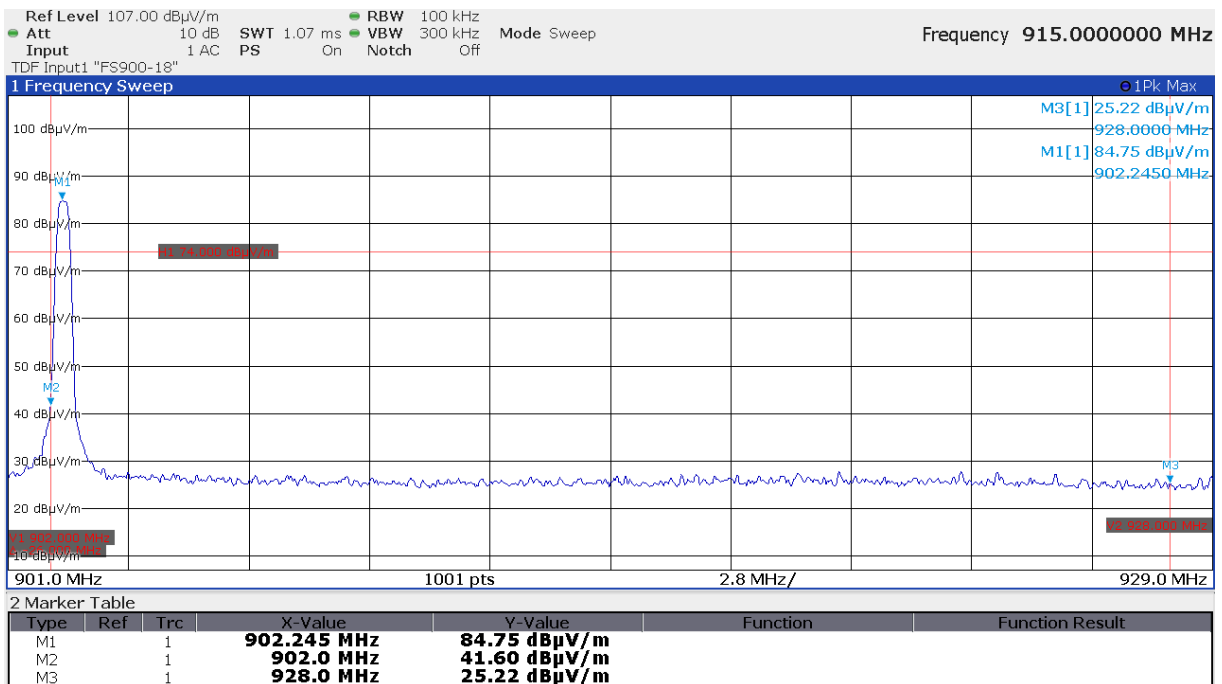
A spectrum analyser is connected to the output of the transmitter via a suitable attenuator while EUT was operating in transmit mode at the assigned frequency according ANSI C63.10, 6.10.

Spectrum analyser settings:

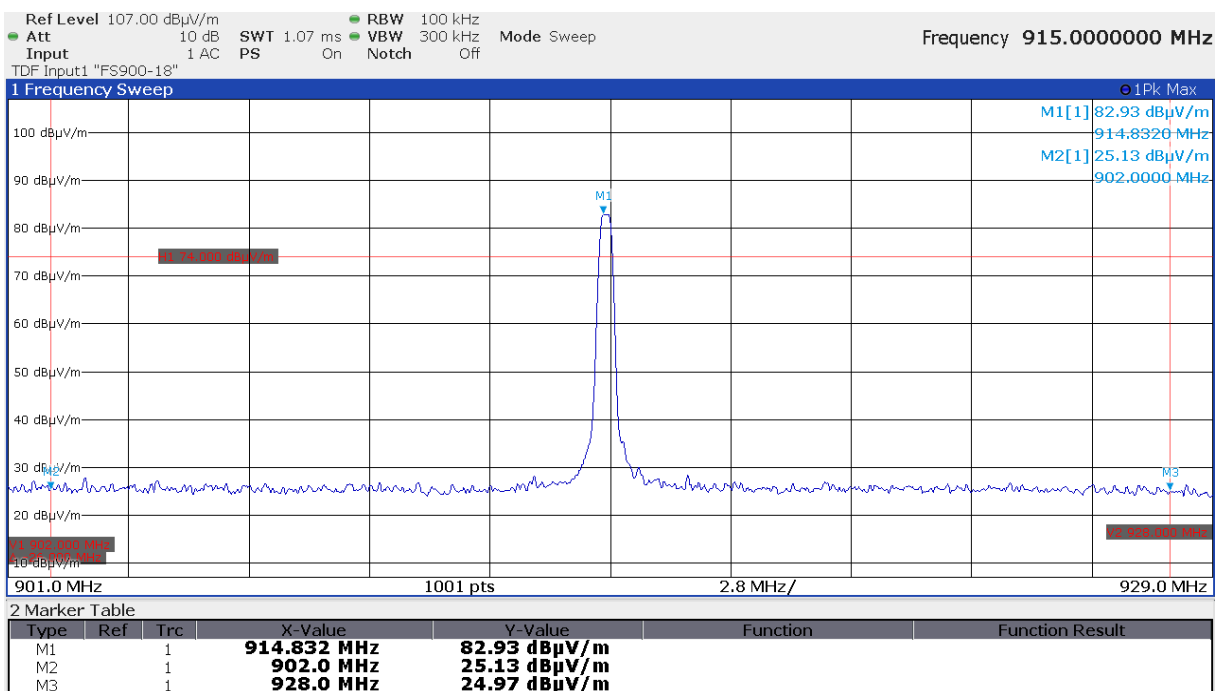
RBW: 100 kHz, VBW: 300 kHz, Detector: Peak, Trace: Max hold, Sweep: auto

5.6.5 Test result

Channels 125 kHz Bandwidth:
CH0



CH63



The requirements are **FULFILLED**.

Remarks:

-

5.7 Radiated emissions in restricted bands

For test instruments and accessories used see section 6 Part **SER1, SER2, SER3**.

5.7.1 Description of the test location

Test location: OATS 1
Test distance: 3 m

Test location: Anechoic chamber 1
Test distance: 3 m

5.7.2 Photo documentation of the test set-up

Test setup 9 kHz – 30 MHz



Test setup 30 – 1000 MHz

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

Test setup 1 – 10 GHz



5.7.3 Applicable standard

According to FCC Part 15, Section 15.205(a):

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

5.7.4 Description of Measurement

The restricted bands are measured radiated. The span of the spectrum analyser was set wide enough to capture the restricted band and measure the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.

Spectrum analyser settings:

RBW: 1 MHz,

VBW: 3 MHz,

Sweep: Auto,

Detector function: Peak

5.7.5 Test result

9kHz – 30MHz

FCC Part 15.209 Radiated emission limits; general requirements (< 30 MHz)									
f [kHz]	PK reading [dBμV]	QP reading [dBμV]	Duty cycle corr. [dB]	Ant. factor [dB]	Distance corr. [dB]	corr. AV level [dBμV/m]	QP level [dBμV/m]	Limit [dBμV/m]	Margin [dB]
10,000	46,7	40,7	0,0	20,0	-80,0	-13,3	-19,3	47,6	-60,9
50,000	37,5	35,3	0,0	20,0	-80,0	-22,5	-24,7	33,6	-56,1
200,000	40,2	39,1	0,0	20,0	-80,0	-19,8	-20,9	21,6	-41,4
5000,000	25,0	23,3	0,0	20,0	-40,0	5,0	3,3	29,5	-26,2
20000,000	20,3	19,9	0,0	20,0	-40,0	0,3	-0,1	29,5	-29,6

30 - 1000 MHz

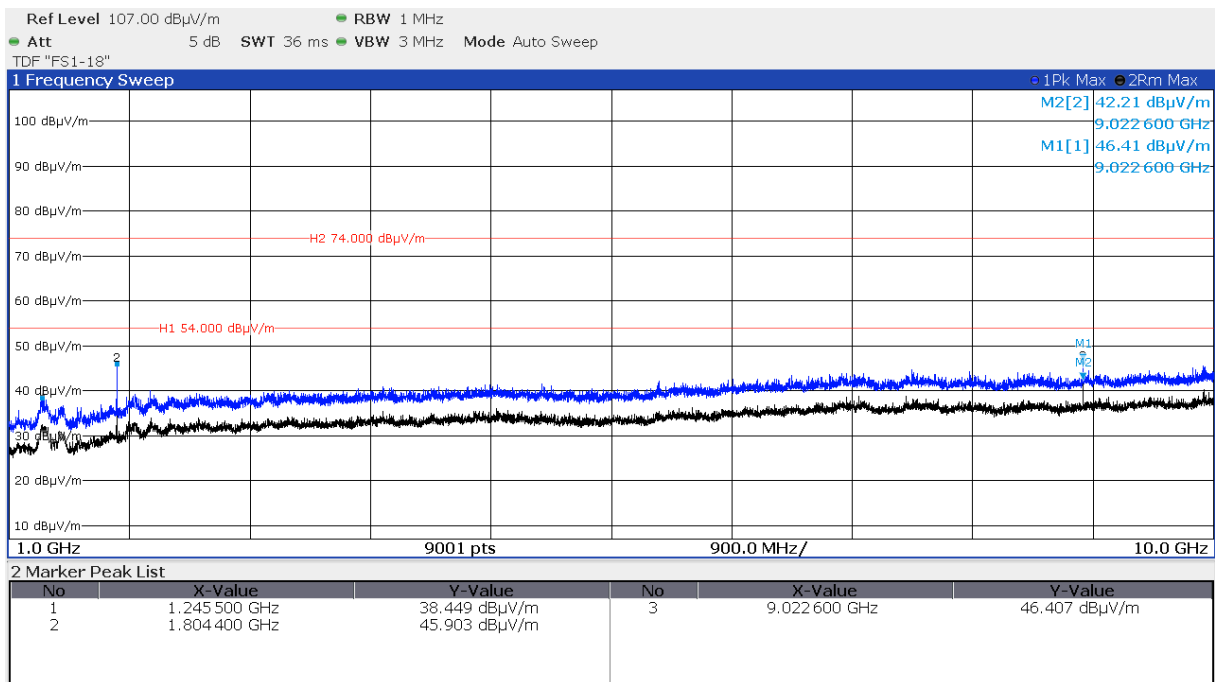
Frequency (MHz)	Reading Vert. (dBμV)	Reading Hor. (dBμV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBμV/m)	Level Hor. (dBμV/m)	Limit (dBμV/m)	Dlimit (dB)
35,10	9,9	4,4	16,1	17,2	26,0	21,6	40,0	-14,0
84,30	4,0	-1,5	13,8	13,7	17,8	12,2	40,0	-22,2
142,00	-0,9	-0,3	19,4	18,5	18,5	18,2	43,5	-25,0
244,10	0,9	1,1	18,5	18,4	19,4	19,5	46,0	-26,5
832,60	8,2	5,1	31,8	32,2	40,0	37,3	46,0	-6,0

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

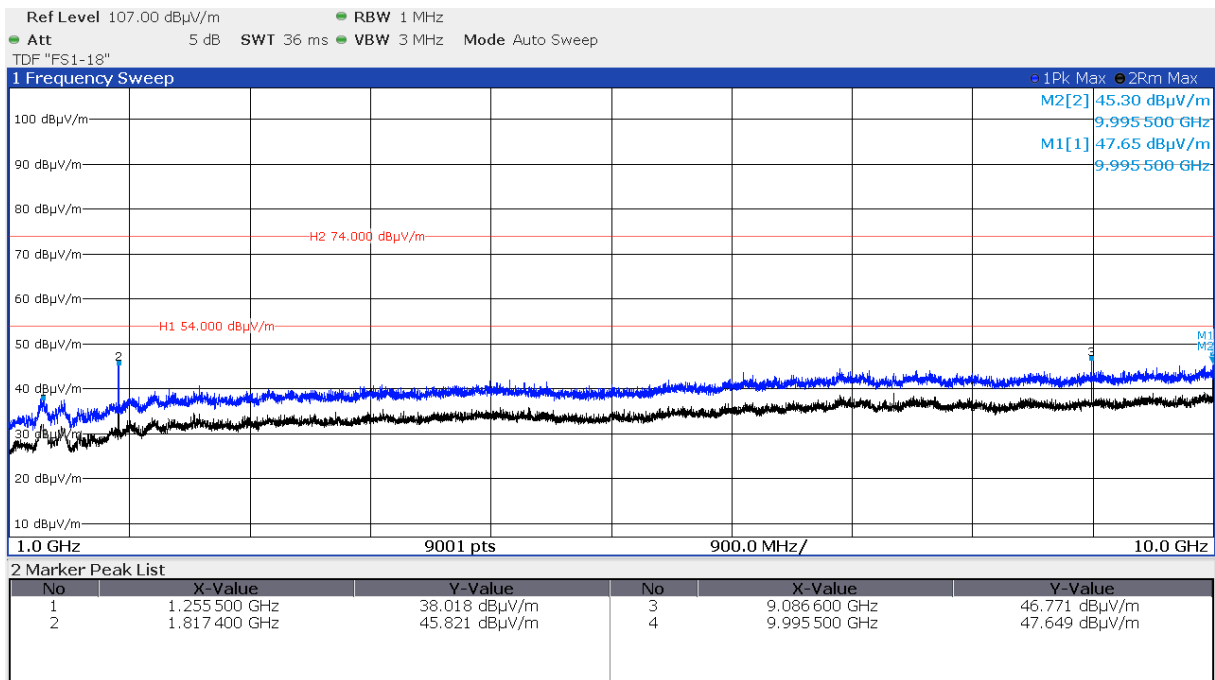
f > 1000 MHz

5.7.5.1 125 kHz Bandwidth:

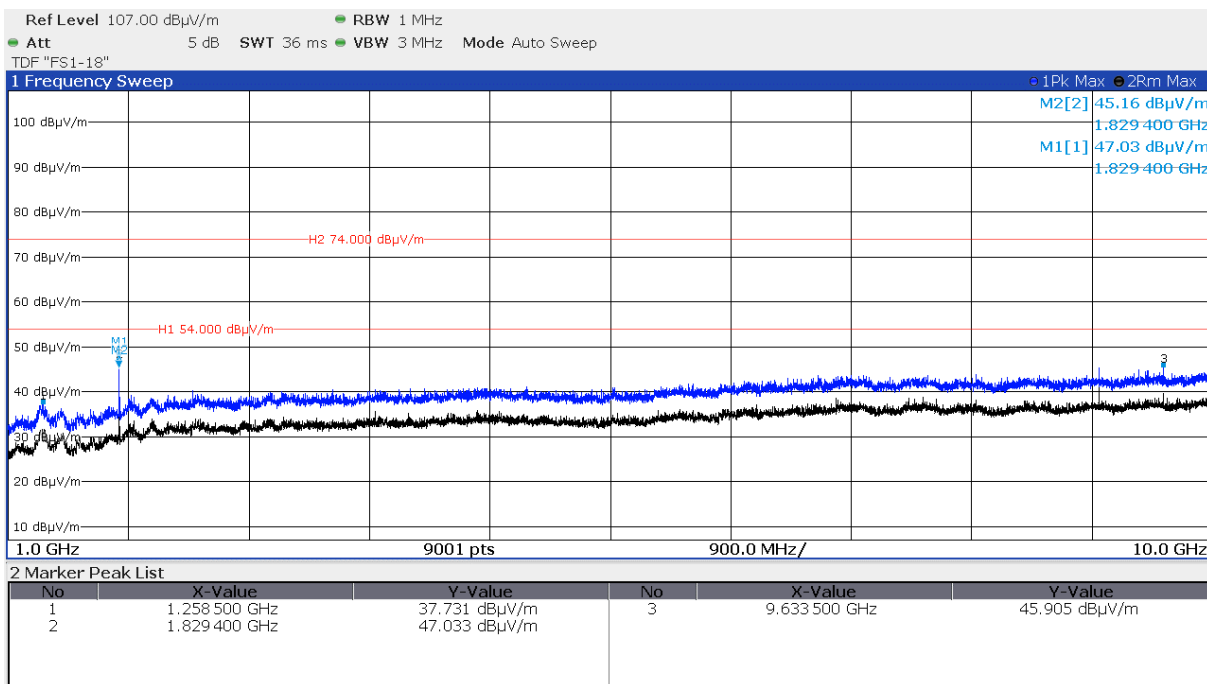
CH0



CH32



CH63



Peak-Limit according to FCC Part 15C, Section 15.205(a):

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

Frequency (MHz)	Limits acc. 15.209		Measurement distance (m)
	PK dB(μV/m)	AV dB(μV/m)	
Above 960	74	54	3

Restricted bands of operation:

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2690 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3345.8 – 3358	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4	3600 – 4400	Above 38.6

RSS-Gen, Table 6 – Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 – 0.110	12.57675 – 12.57725	399.9 – 410	7.250 – 7.750
0.495 – 0.505	13.36 – 13.41	608 – 614	8.025 – 8.500
2.1735 – 2.1905	16.42 – 16.423	960 – 1427	9.0 – 9.2
3.020 – 3.026	16.69475 – 16.69525	1435 – 1626.5	9.3 – 9.5
4.125 – 4.128	16.80425 – 16.80475	1645.5 – 1646.5	10.6 – 12.7
4.17725 – 4.17775	25.5 – 25.67	1660 – 1710	13.25 – 13.4
4.20725 – 4.20775	37.5 – 38.25	1718.8 – 1722.2	14.47 – 14.5
5.677 – 5.683	73 – 74.6	2200 – 2300	15.35 – 16.2
6.215 – 6.218	74.8 – 75.2	2310 – 2390	17.7 – 21.4
6.26775 – 6.26825	108 – 138	2483.5 – 2500	22.01 – 23.12
6.31175 – 6.31225	149.9 – 150.05	2655 – 2900	23.6 – 24.0
8.291 – 8.294	156.52475 – 156.52525	3260 – 3267	31.2 – 31.8
8.362 – 8.366	156.7 – 156.9	3332 – 3339	36.43 – 36.5
8.37625 – 8.38675	162.0125 – 167.17	3345.8 – 3358	Above 38.6
8.41425 – 8.41475	167.72 – 173.2	3500 – 4400	
12.29 – 12.293	240 – 285	4500 – 5150	
12.51975 – 12.52025	322 – 335.4	5350 – 5460	

The requirements are **FULFILLED**.

Remarks: From 9 kHz – 1000MHz only noise was detected.

Only the worst-case plots are listed.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

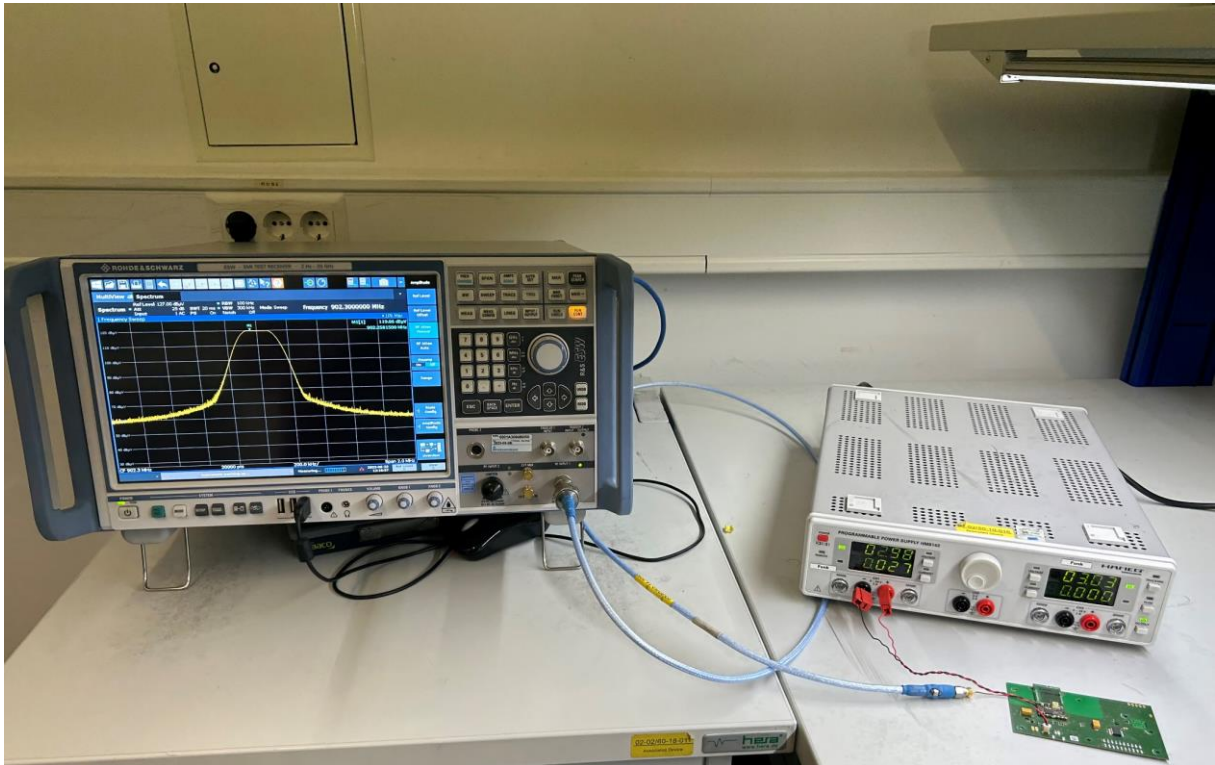
5.8 Dwell time

For test instruments and accessories used see section 6 Part MB.

5.8.1 Description of the test location

Test location: Shielded Room S6

5.8.2 Photo documentation of the test set-up



5.8.3 Applicable standard

According to FCC Part 15, Section 15.247(a):

In Section 15.247(a)(1)(i) are dwell times defined for the special frequency ranges should not exceed by a frequency hopping system.

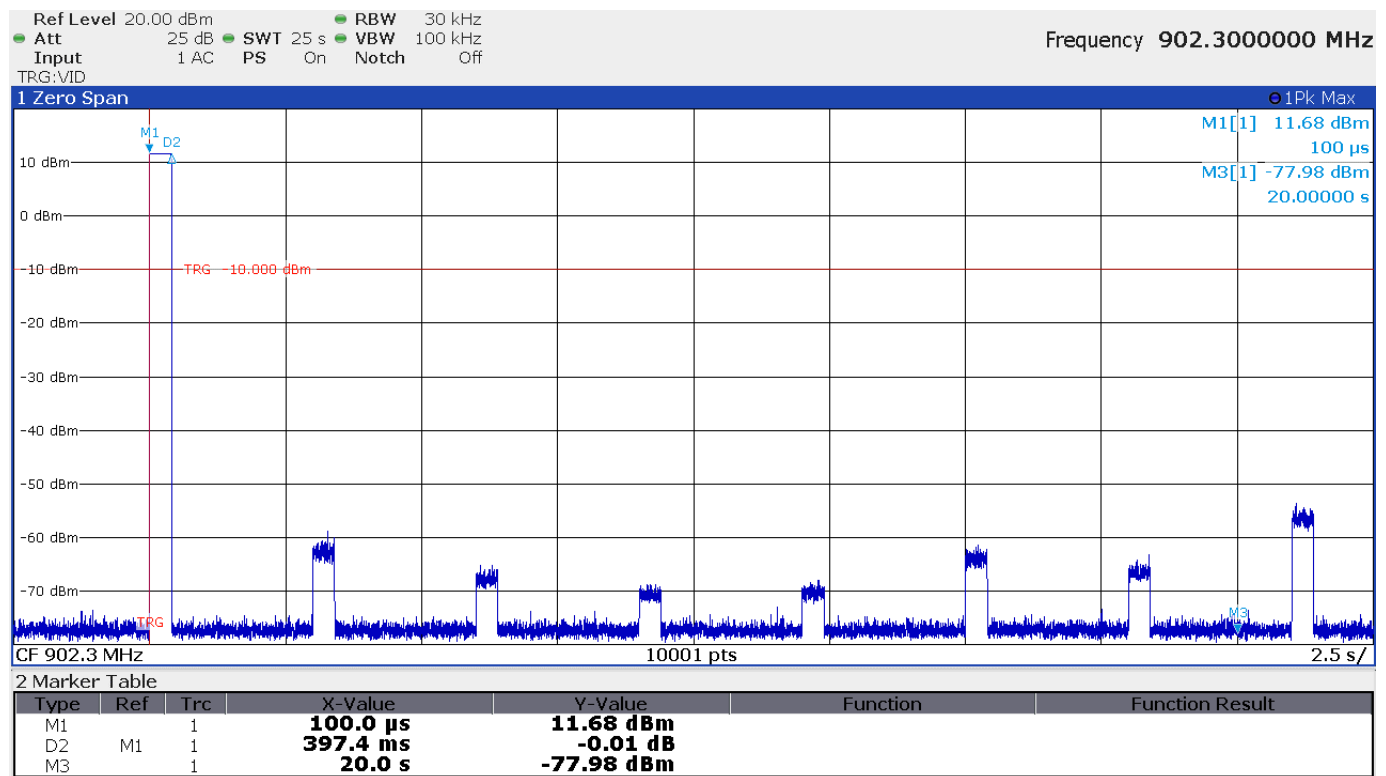
5.8.4 Test result

Dwell time = time slot length * hop rate

397.5 ms * 1 = 397.4 ms

Limit according to FCC Part 15C, Section 15.247(a)(1)(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.



Limit according to FCC Part 15C, Section 15.247(1)(i):

For frequency hopping systems operating in the 902-928 MHz band:

The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period;

The requirements are **FULFILLED**.

Remarks: -

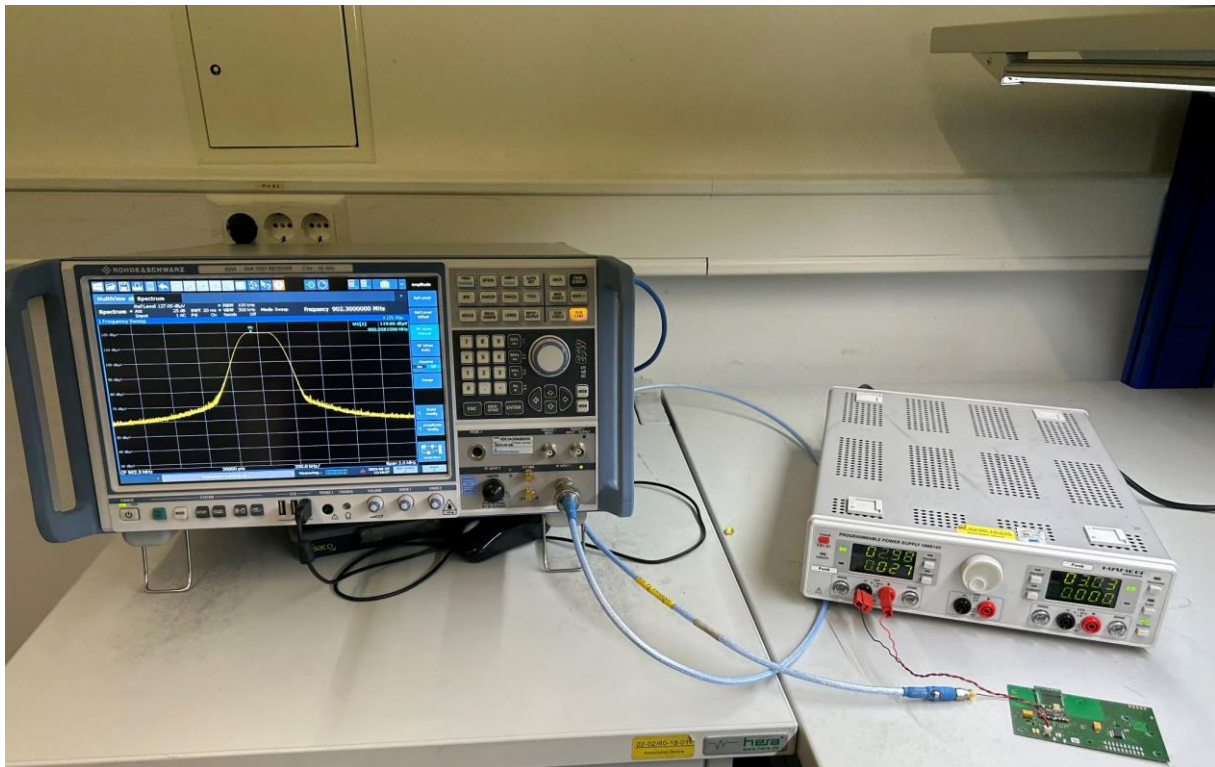
5.9 Number of hopping channels

For test instruments and accessories used see section 6 Part MB.

5.9.1 Description of the test location

Test location: Shielded Room S6

5.9.2 Photo documentation of the test set-up



5.9.3 Applicable standard

According to FCC Part 15, Section 15.247(a)(1)(i):

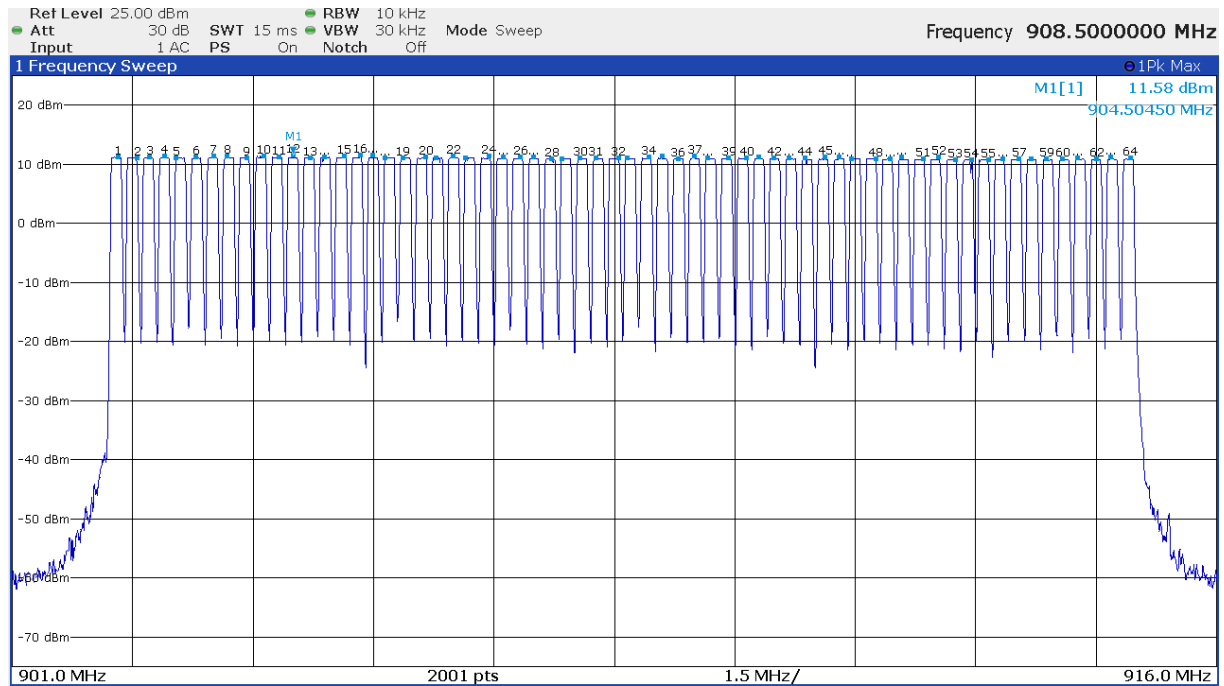
For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period;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

5.9.4 Description of Measurement

The method of measurement is used set out in ANSI C63.10, 7.8.3.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.9.5 Test result



Ref Level 20.00 dBm Att 25 dB Input 1 AC SWT 15 ms PS On RBW 10 kHz VBW 30 kHz Mode Sweep Notch Off

Frequency 908.500000 MHz

2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	902.315600 MHz	11.282 dBm	33	908.664900 MHz	11.082 dBm
2	902.555500 MHz	11.087 dBm	34	908.934800 MHz	11.172 dBm
3	902.712900 MHz	11.273 dBm	35	909.092200 MHz	11.374 dBm
4	902.900300 MHz	11.447 dBm	36	909.294600 MHz	10.993 dBm
5	903.042700 MHz	11.077 dBm	37	909.497000 MHz	11.447 dBm
6	903.290100 MHz	11.216 dBm	38	909.661900 MHz	11.152 dBm
7	903.507500 MHz	11.407 dBm	39	909.924300 MHz	11.050 dBm
8	903.679900 MHz	11.452 dBm	40	910.149200 MHz	11.109 dBm
9	903.919800 MHz	11.116 dBm	41	910.291600 MHz	11.209 dBm
10	904.137200 MHz	11.466 dBm	42	910.486500 MHz	11.035 dBm
11	904.324600 MHz	11.218 dBm	43	910.673900 MHz	11.137 dBm
12	904.504500 MHz	11.583 dBm	44	910.876300 MHz	11.124 dBm
13	904.706900 MHz	11.154 dBm	45	911.123700 MHz	11.243 dBm
14	904.886800 MHz	11.197 dBm	46	911.303600 MHz	11.316 dBm
15	905.141700 MHz	11.341 dBm	47	911.446000 MHz	10.928 dBm
16	905.336600 MHz	11.550 dBm	48	911.753400 MHz	10.899 dBm
17	905.494000 MHz	11.507 dBm	49	911.933300 MHz	10.918 dBm
18	905.643900 MHz	11.131 dBm	50	912.075700 MHz	11.242 dBm
19	905.868800 MHz	11.160 dBm	51	912.345600 MHz	10.941 dBm
20	906.153700 MHz	11.185 dBm	52	912.540500 MHz	11.165 dBm
21	906.273600 MHz	11.155 dBm	53	912.742900 MHz	10.792 dBm
22	906.491000 MHz	11.394 dBm	54	912.952800 MHz	10.755 dBm
23	906.648400 MHz	11.037 dBm	55	913.155200 MHz	10.741 dBm
24	906.940800 MHz	11.335 dBm	56	913.342600 MHz	10.858 dBm
25	907.120700 MHz	11.238 dBm	57	913.537500 MHz	10.874 dBm
26	907.330600 MHz	11.297 dBm	58	913.694900 MHz	10.908 dBm
27	907.495500 MHz	11.163 dBm	59	913.882300 MHz	10.976 dBm
28	907.720400 MHz	10.907 dBm	60	914.084700 MHz	10.949 dBm
29	907.847800 MHz	10.960 dBm	61	914.272100 MHz	11.033 dBm
30	908.072700 MHz	11.013 dBm	62	914.504500 MHz	10.900 dBm
31	908.267600 MHz	11.099 dBm	63	914.676900 MHz	11.209 dBm
32	908.552500 MHz	11.016 dBm	64	914.924300 MHz	11.105 dBm

Hopping channel frequency range	Number of all available hopping channels
902 – 928	64

Limit according to FCC Part 15C, Section 15.247(1):

Frequency range (MHz)	LIMIT (Number of Hopping Channels)			
	20dB Bandwidth < 250kHz	20dB Bandwidth > 250kHz	20dB Bandwidth < 1 MHz	20dB Bandwidth > 1MHz
902 – 928	-	50	-	-

The requirements are **FULFILLED**.

Remarks: -

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

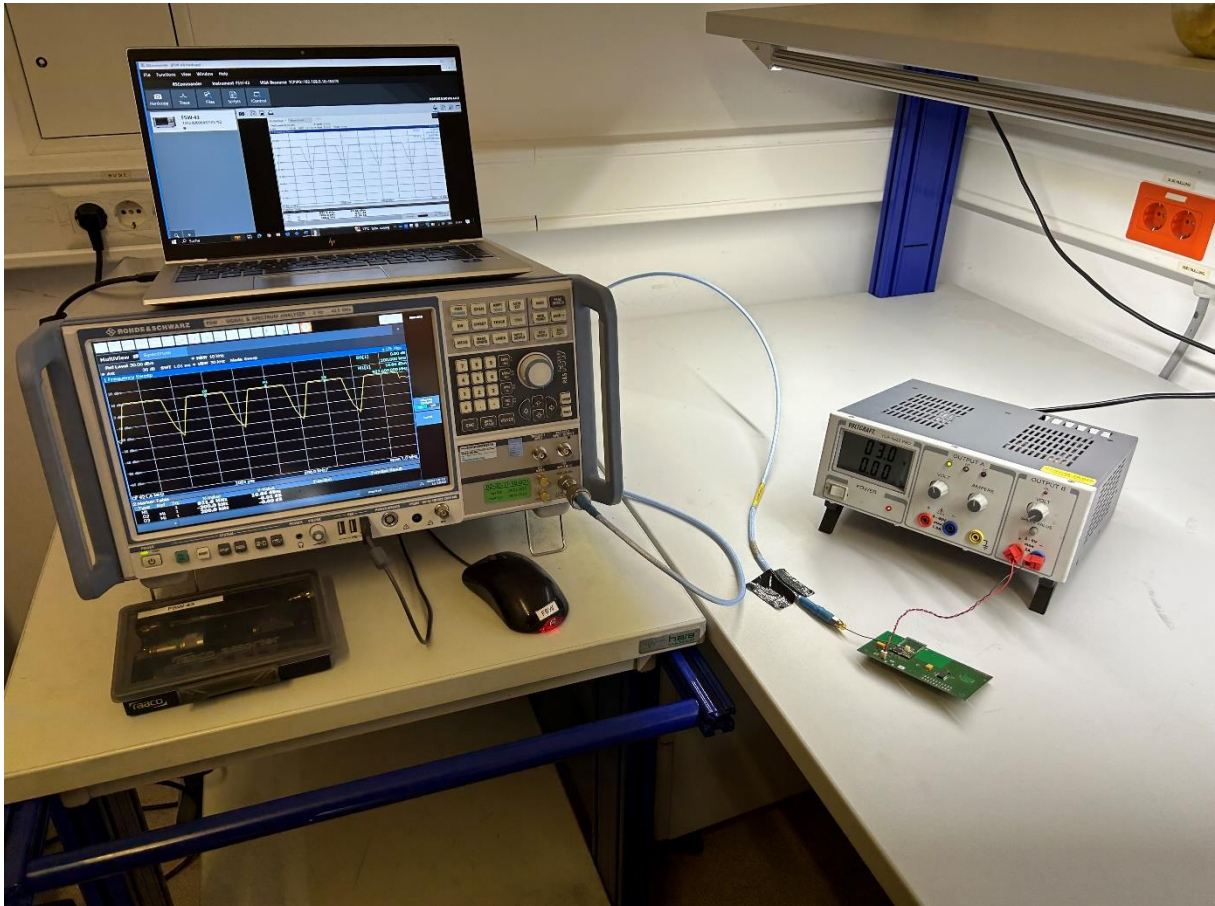
5.10 Carrier frequency separation

For test instruments and accessories used see section 6 Part MB.

5.10.1 Description of the test location

Test location: Shielded Room S6

5.10.2 Photo documentation of the test set-up



5.10.3 Applicable standard

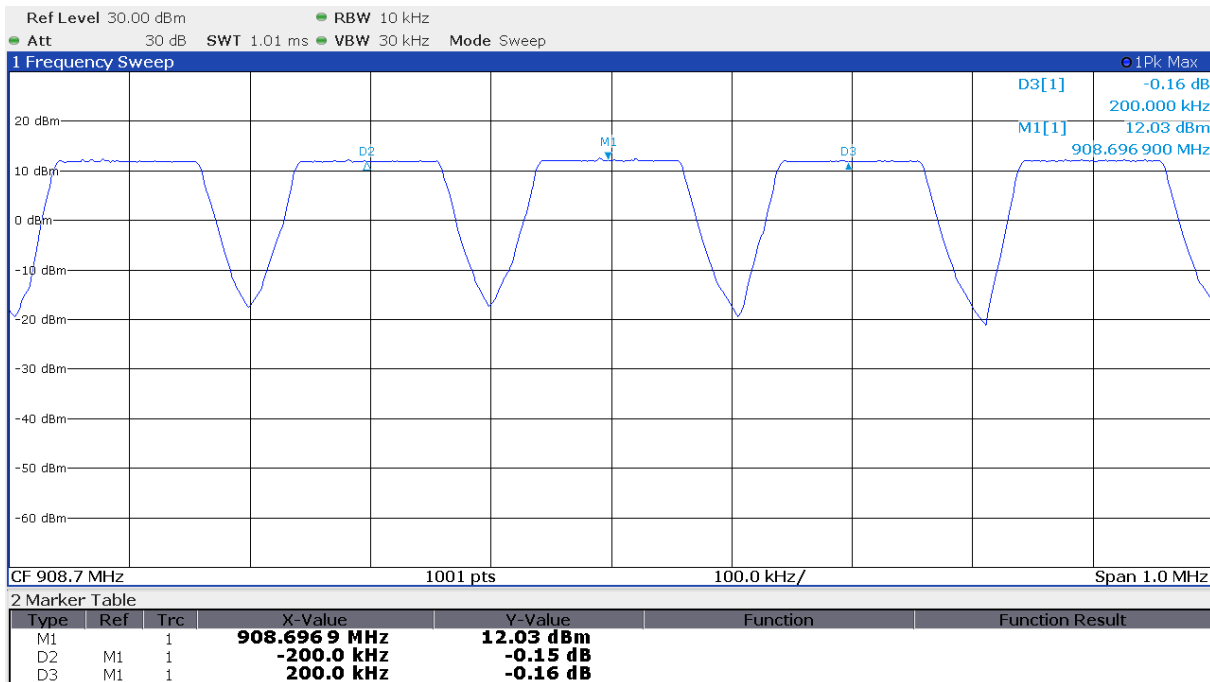
According to FCC Part 15, Section 15.247(a):

Frequency hopping systems shall have hopping channel carrier frequencies that are separated by 25 kHz or the 20 dB bandwidth of the hopping channel , whichever is greater.

5.10.4 Description of Measurement

The method of measurement is used set out in ANSI C63.10, 7.8.2.

5.10.5 Test result



Limit according to FCC Part 15C, Section 15.247(a):

Frequency (MHz)	Hopping channels	Limit channel separation
902 - 928	≥ 50	> 25 kHz or 20 dB bandwidth, whichever is greater

The requirements are **FULFILLED**.

Remarks: For detailed test results please see the following test protocols.

5.11 Antenna application

5.11.1 Applicable standard

According to FCC Part 15C, Section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit that broken antennas can be replaced by the user, but the use of a standard antenna jack is prohibited.

The EUT has an integrated PCB antenna; no replacing of the antenna is possible that prevents manipulation by a user. No external power amplifier can be connected. The requirements of part 15.203 and 15.204 are met.

5.11.2 Antenna requirements

According to FCC Part 15C, Section 15.247 (b)(4):

The conducted output power limit specified in paragraph (b) of 15.247 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 intentional radiator shall be reduced below the stated values in paragraph (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.

Defacto EIRP-Limit:

$$P_{out} = 30 - (G_x - 6);$$

Remarks: The antenna is < 6 dBi gain, no Defacto limit results.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
CPC 2	FSW43	02-02/11-21-001	22/05/2024	22/05/2023		
MB	FSW43	02-02/11-21-001	22/05/2024	22/05/2023		
SER 1	FSW43	02-02/11-21-001	22/05/2024	22/05/2023		
	HFH 2 - Z 2	02-02/24-05-020	01/06/2025	01/06/2022	05/09/2024	05/09/2023
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
SER 2	ESVS 30	02-02/03-05-006	27/07/2023	27/07/2022		
	VULB 9168	02-02/24-05-005	20/04/2024	20/04/2023	03/07/2023	03/07/2022
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
	50F-003 N 3 dB	02-02/50-21-010				
SER 3	FSW43	02-02/11-21-001	22/05/2024	22/05/2023		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	23/06/2023	23/06/2022		
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				
	BAT-EMC 2022.0.23.0	02-02/68-13-001				

- End of test report -

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.