

Test Report

HELEM2111000483-2



INTENTIONAL RADIATOR TESTS ACCORDING TO FCC PART 15 C AND ISED CANADA REQUIREMENTS

Equipment Under Test: Temperature probe with SRD

Model: Tango XN 1m

Manufacturer: Quanturi Oy
Lars Sonckin kaari 10
FI-02600 Espoo
FINLAND

Customer: Quanturi Oy
Lars Sonckin kaari 10
FI-02600 Espoo
FINLAND

FCC Rule Part: 15.247

IC Rule Part: RSS-247, Issue 2, 2017

RSS-GEN Issue 5 Amendment 2, 2021

KDB: 558074 D01 15.247 Meas Guidance v05r02

Guidance for Compliance Measurements on Digital Transmission Systems,
Frequency Hopping Spread Spectrum System, and Hybrid System Devices
Operating Under §15.247 of the FCC rules (April 2, 2019)

Date: 2 December 2022

Issued by:

A handwritten signature in blue ink, appearing to read 'R. Repo'.

Rauno Repo
Senior EMC Specialist

Date: 2 December 2022

Checked by:

A handwritten signature in blue ink, appearing to read 'Henri Mäki'.

Henri Mäki
Testing Engineer

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GENERAL REMARKS**Disclaimer**

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Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 30 days only.

RELEASE HISTORY

Version	Changes	Issued
1.0	Initial release	14 February 2022
1.1	Added the antenna port results from the test report HELEM2111000483-3 v1.0.	8 September 2022
1.2	Type errors corrected	20 October 2022
1.3	All FCC required measurements were also made as radiated.	2 December 2022

PRODUCT DESCRIPTION

Equipment Under Test

Equipment Under Test: Temperature probe with SRD
 Model: Tango XN 1m
 Trademark: 
 Serial no: -
 SRD radio module or chip: ON Semiconductor AX8052F143-D
 FCC ID: -
 IC: -
 Parallel models: Tango XN 2m, Tango XN 2m, Tango M 2m, Tango M 3m, Tango M 4m

General Description

The Tango M probes are for measuring temperatures at every meter inside stored goods such as grains, loose hay, woodchips, or other fermentable materials. The Tango XN probes are extra robust probes specifically designed for highly corrosive environments, such as those found in the composting industry.

The probe transmits a packet once per hour. If the Base Station and/or repeater are in the receiving range they will proceed the message and reply to the probe.

Classification

Fixed device	☐
Mobile Device (Human body distance > 20cm)	☒
Portable Device (Human body distance < 20cm)	☐

Modifications Incorporated in the EUT

No modifications.

Ratings and declarations

Operating Frequency Range (OFR):	902 - 928 MHz
Modulation:	FSK
Antenna type:	Integral PCB antenna

Power Supply

Operating voltage range: 3.6 V- 2.2 Ah, Lithium Battery

Mechanical Size of the EUT

Height: 130 mm	Width: 38 mm	Length: 1355 mm
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SUMMARY OF TESTING

Test Specification	Description of Test	Result
§15.203	Antenna requirement	PASS
§15.207(a) / RSS-GEN 8.8	Conducted Emissions on Power Supply Lines	PASS ¹⁾
§15.247(b)(3) / RSS-247 5.4(d)	Maximum Peak Conducted Output Power	PASS ^{1) 2)}
§15.247(a)(2) / RSS-247 5.2(a)	6 dB Bandwidth	PASS ^{1) 2)}
§15.247(e) / RSS-247 5.2(b)	Power Spectral Density	PASS ^{1) 2)}
RSS-GEN 6.7	99% Occupied Bandwidth	PASS ¹⁾
§15.247(d) / RSS-247 5.5	100 kHz Bandwidth of Frequency Band Edges and Conducted Spurious Emissions	PASS ^{1) 2)}
§15.209(a), §15.247(d) / RSS-247 5.5	Radiated Emissions Within the Restricted Bands	PASS

The decision rule applied for the tests results stated in this test report is according to the requirements of section 1.3 of ANSI C63.10-2013.

- ¹⁾ Antenna port measurements were made with Repeater unit with the same SRD-circuit.
- ²⁾ Tests were made also as radiated.

EUT Test Conditions during Testing

The EUT was in continuous modulated transmit mode during the tests. Tests were made with low, mid and high frequencies. The pre-measurements were performed with the EUT being in three orthogonal positions (X, Y, Z). Final measurements were done in worst position.



Figure 1: Test setup block diagram

Conducted tests from the antenna port were measured with the Repeater unit containing the same SRD circuit (FCC Test Report HELEM2111000483-3).

Table 1: Test frequencies

Channel	Frequency (MHz)
Low	903
Mid	915
High	927

Test Facility

Testing Laboratory / address: FCC designation number: FI0002 ISED CAB identifier: T004	SGS Fimko Ltd Takomotie 8 FI-00380, HELSINKI FINLAND
Test Site:	☐ K10LAB, ISED Canada registration number: 8708A-1 ☒ K5LAB, ISED Canada registration number: 8708A-2 ☐ T10LAB

TEST RESULTS

Antenna Requirement

Standard: FCC Rule §15.203
Tested by: RRE
Date:

FCC Rule: 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.

Specification	Requirement (at least one of the following shall be applied)	Conclusion
§15.203	1. Permanently attached antenna 2. Unique coupling to the intentional radiator 3. Professionally installed radio. The installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.	PASS
Note	Option 1 is used	

Maximum Peak Conducted Output Power

Maximum Peak Conducted Output Power

Standard: ANSI C63.10 (2013)
Tested by: RRE
Date: 24 February 2022, 1 December 2022
Temperature: $23 \pm 3^\circ\text{C}$
Humidity: 20 - 75 % RH
Measurement uncertainty: $\pm 2.87\text{dB}$ Level of confidence 95 % ($k = 2$)

FCC Rule: 15.247(b)(3)
RSS-247 5.4(d)

For systems using digital modulation in the 902-928 MHz bands the limit is 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power.

Measured values are peak values.

Results:

Conducted measurements:

Table 2: Maximum conducted output power

Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
Low	11.53	30	18.47	PASS
Mid	11.77	30	18.23	PASS
High	11.88	30	18.12	PASS

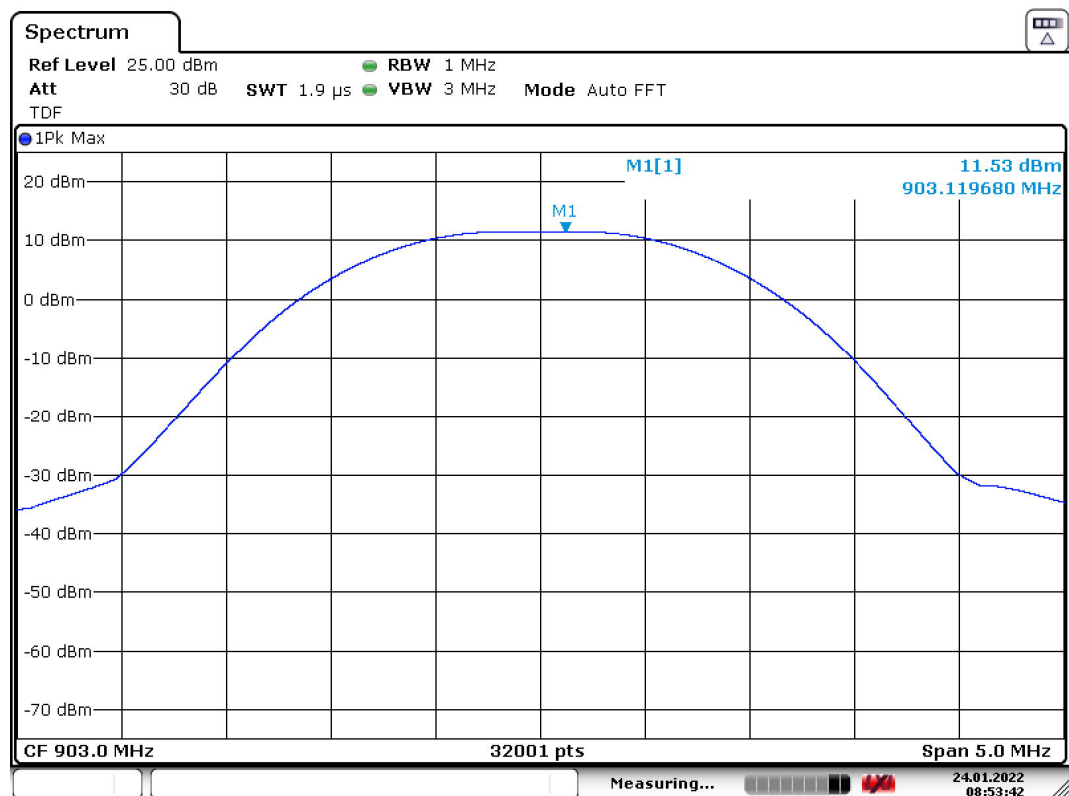


Figure 2: Conducted power, Channel LOW

Maximum Peak Conducted Output Power

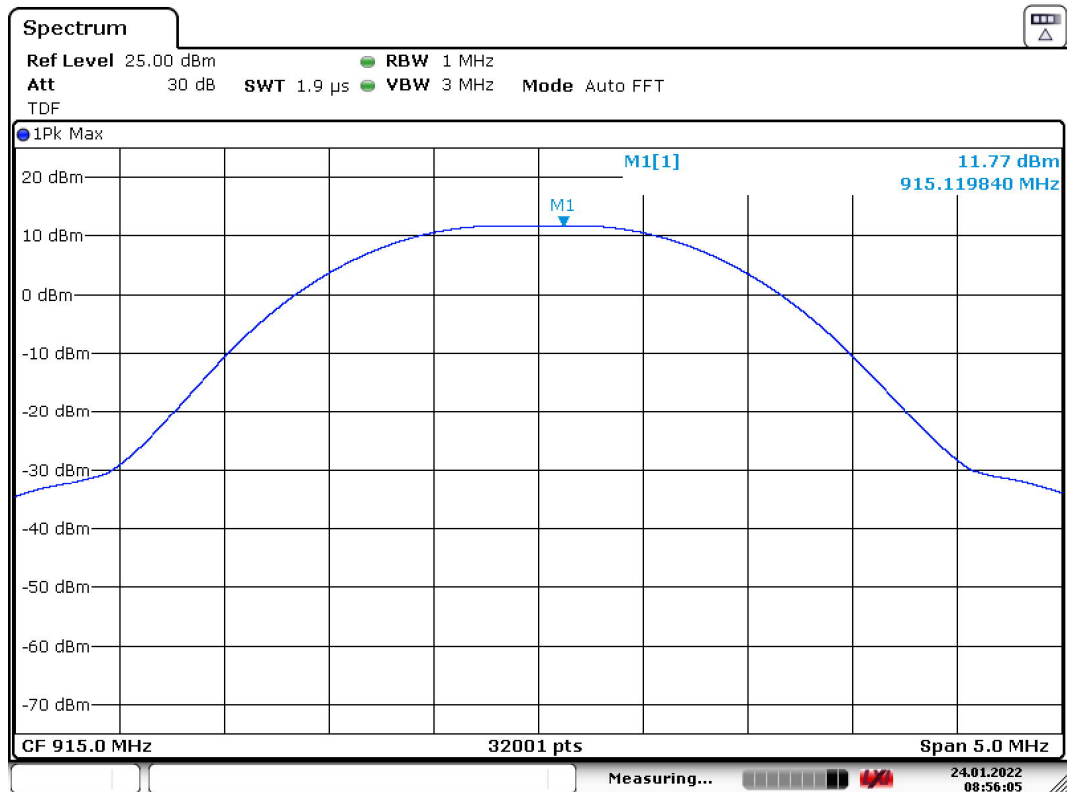


Figure 3: Conducted power, Channel MID

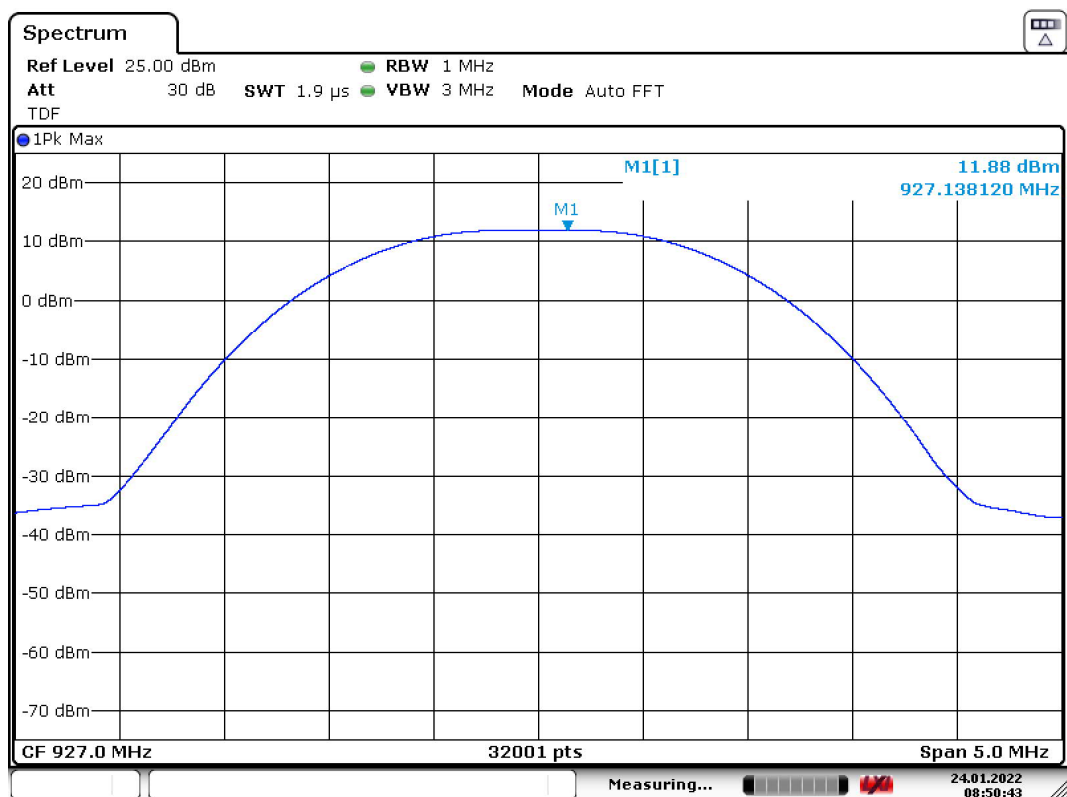


Figure 4: Conducted power, Channel HIGH

Maximum Peak Conducted Output Power

Radiated measurements:

Measurements were made as electric field strength measurement in dB μ V/m and the results are converted to EIRP (dBm) according to the formulas presented in ANSI C63.10-2013 Clause 11.12.2.2.

$$\text{EIRP (dBm)} = \text{E (dB}\mu\text{V/m)} + 20\log(3) - 104.8 - 4.7$$

The EUT was in position which generates the highest emissions. The final measurements were performed by rotating the turntable 0° to 360° and antenna from 1.0 m to 4.0 m.

Table 3: Maximum power (radiated method, BW=1 MHz)

Channel	E [dB μ V/m]	EIRP [dBm]	Limit [dBm]	Margin [dBm]	Result
Low	107.14	7.18	30	22.82	PASS
Mid	109.74	9.78	30	20.22	PASS
High	110.94	10.98	30	19.02	PASS

The electric field strength values (E) contain the cable attenuations and the measurement antenna gain.

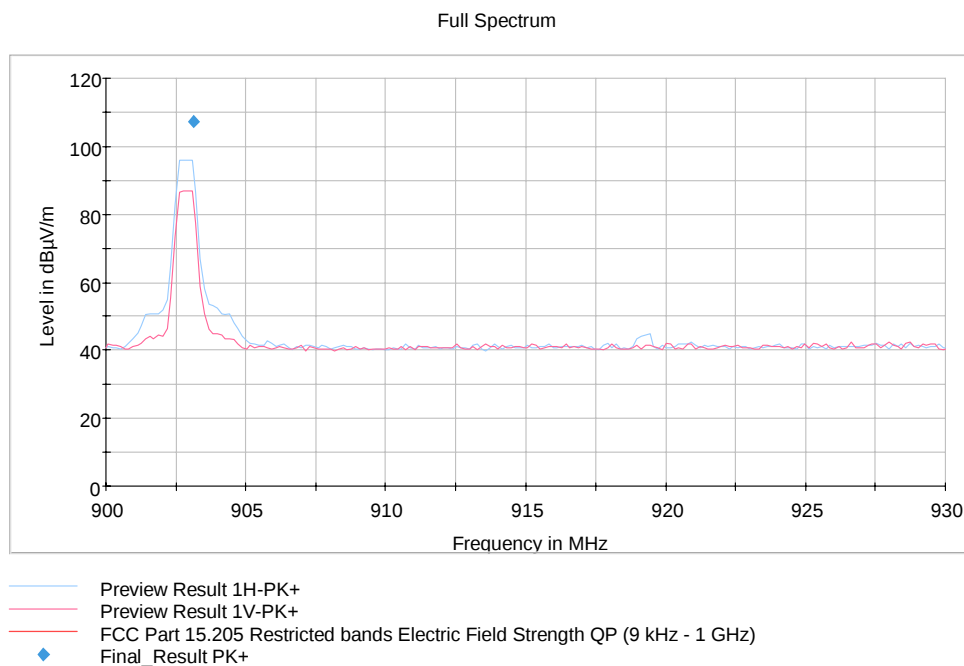


Figure 5: Measured power (903 MHz)

Maximum Peak Conducted Output Power

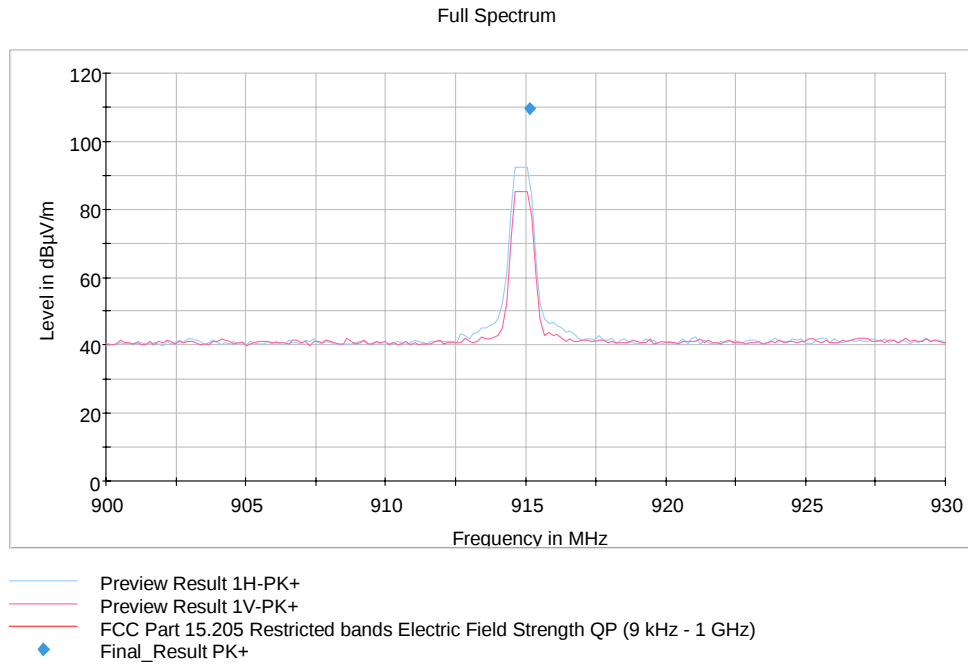


Figure 6: Measured power (915 MHz)

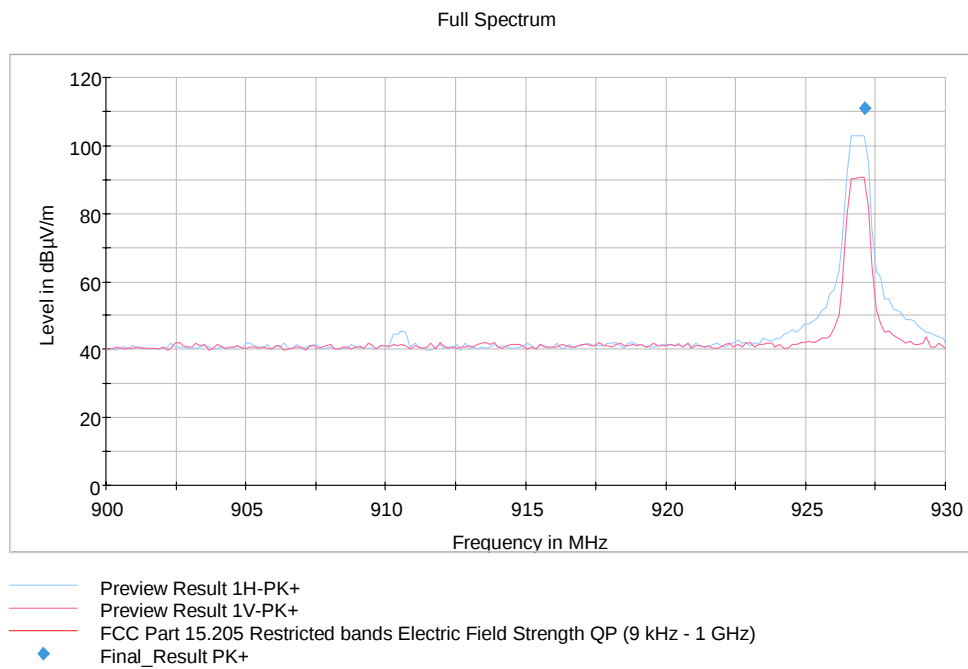


Figure 7: Measured power (927 MHz)

Transmitter Radiated Spurious Emissions 9 kHz - 10 GHz

Transmitter Radiated Spurious Emissions 9 kHz - 10 GHz

Standard: ANSI C63.10 (2013)
Tested by: RRE
Date: 8 December 2021, 10 February 2022
Temperature: 23 ± 3 °C
Humidity: 20 - 75 % RH
Measurement uncertainty: ± 4.51 dB Level of confidence 95 % (k = 2)

FCC Rule: 15.247(d), 15.209(a)

RSS-247 5.5

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

The correction factor in the final result table contains the sum of the transducers (antenna + amplifier + cables).

Peak values of emissions below 1000 MHz measured for reference as well as transmitter fundamental.

The pre-measurements were performed with the EUT being in three orthogonal positions (X, Y, Z). Final measurements were done in worst position.

All frequencies (low, mid and high) were measured but the worst case is presented in this document.

Frequency range [MHz]	Limit [$\mu\text{V/m}$]	Limit [$\text{dB}\mu\text{V/m}$]	Detector
0.009-0.490	$2400/F(\text{kHz})$	48.5-13.8	Quasi-peak
0.490-1.705	$24000/F(\text{kHz})$	33.8-22.97	Quasi-peak
1.705-30.0	30	29.54	Quasi-peak
30 - 80	100	40.0	Quasi-peak
88 - 216	150	43.5	Quasi-peak
216 - 960	200	46.0	Quasi-peak
960 - 1000	500	53.9	Quasi-peak
Above 1000	500	53.9	Average
Above 1000	5000	73.9	Peak

Transmitter Radiated Spurious Emissions 9 kHz - 10 GHz

Results High channel

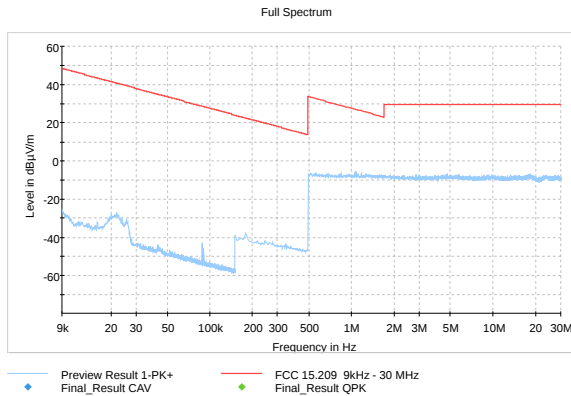


Figure 8: High channel (9 kHz – 30 MHz)

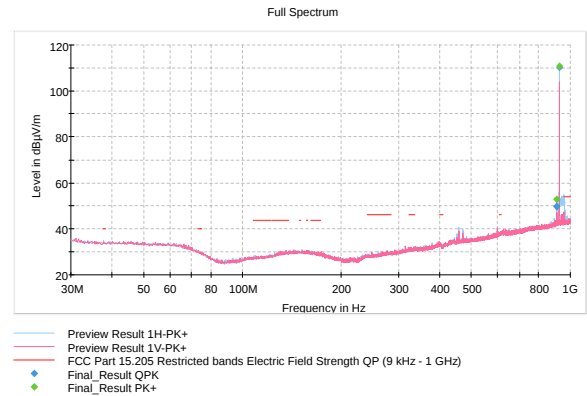


Figure 9: High channel (30 MHz – 1000 MHz)

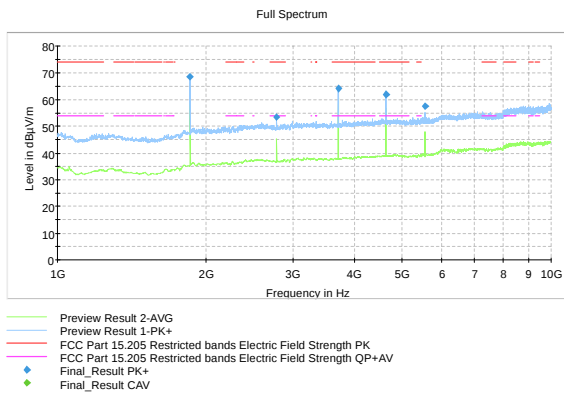


Figure 10: High channel (1 GHz – 10 GHz)

Table 4: High channel results (30 MHz to 1000 MHz)

Frequency (MHz)	QuasiPeak (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
910.775000	---	52.76	90.81**	38.76	15x1000.0	120.000	100.0	H	118.0	41.5
910.775000	49.75	---	---	---	15x1000.0	120.000	100.0	H	118.0	41.5
926.865000*	---	110.81	---	---	15x1000.0	120.000	100.0	H	116.0	41.9
926.865000*	110.42	---	---	---	15x1000.0	120.000	100.0	H	116.0	41.9

*Fundamental frequency

**Limit is 20 dB less than the fundamental peak value

Table 5: High channel peak results (1 GHz to 10 GHz)

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Notes
1853.775000	68.49	90.81*	22.32	15x1000.0	1000.000	237.0	H	197.0	12.5	dBc
2781.425000	53.51	74.00	20.49	15x1000.0	1000.000	147.0	H	280.0	13.9	-
3707.525000	64.14	74.00	9.86	15x1000.0	1000.000	131.0	H	44.0	15.3	-
4635.625000	61.91	74.00	12.09	15x1000.0	1000.000	134.0	H	136.0	16.6	-
5561.275000	57.41	90.81*	33.40	15x1000.0	1000.000	100.0	H	127.0	17.8	dBc

*Limit is 20 dB less than the fundamental peak value

Transmitter Radiated Spurious Emissions 9 kHz - 10 GHz

Table 6: High channel average results (1 GHz to 10 GHz)

Frequency (MHz)	Average* (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Notes
2781.425000	33.46	54.00	20.54	15x1000.0	1000.000	147.0	H	280.0	13.9	-
3707.525000	44.09	54.00	9.91	15x1000.0	1000.000	131.0	H	44.0	15.3	-
4635.625000	41.86	54.00	12.14	15x1000.0	1000.000	134.0	H	136.0	16.6	-

* Average values for the harmonics are calculated from the peak results using duty cycle correction factor (look at section "Duty cycle correction factor, Transmit time in 100 ms").

Transmitter Band Edge Measurement and Conducted Spurious Emissions

Transmitter Band Edge Measurement and Conducted Spurious Emissions

Standard: ANSI C63.10 (2013)
Tested by: RRE
Date: 24 January 2022, 1 December 2022
Temperature: 23 ± 3 °C
Humidity: 20 - 75 % RH
Measurement uncertainty: ± 2.87 dB Level of confidence 95 % (k = 2)

FCC Rule: 15.247(d), 15.209(a)

RSS-247 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

Table 7: Band edge attenuation

Band Edge Attenuation	
Lower Band Edge	Upper Band Edge
-43.68 dBc (conducted)	-50.36 dBc (conducted)
-33.32 dBc (radiated)	-35.40 dBc (radiated)
Limit: -20 dBc	

Transmitter Band Edge Measurement and Conducted Spurious Emissions

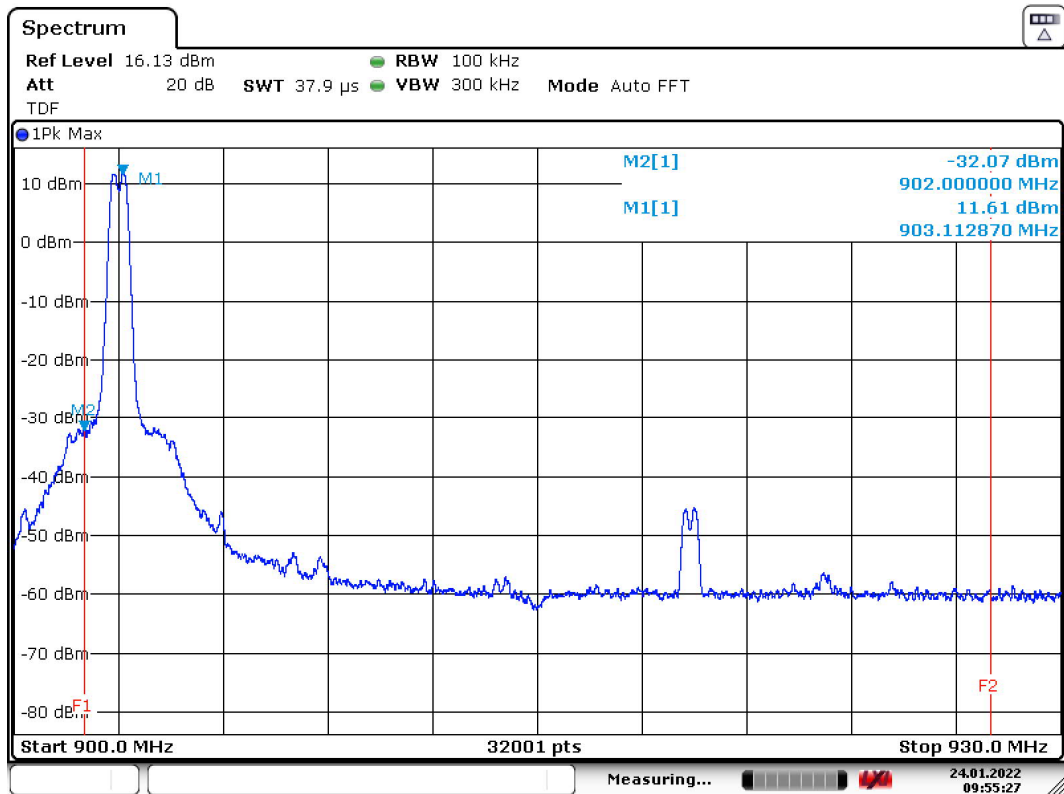


Figure 11: Lower Band Edge

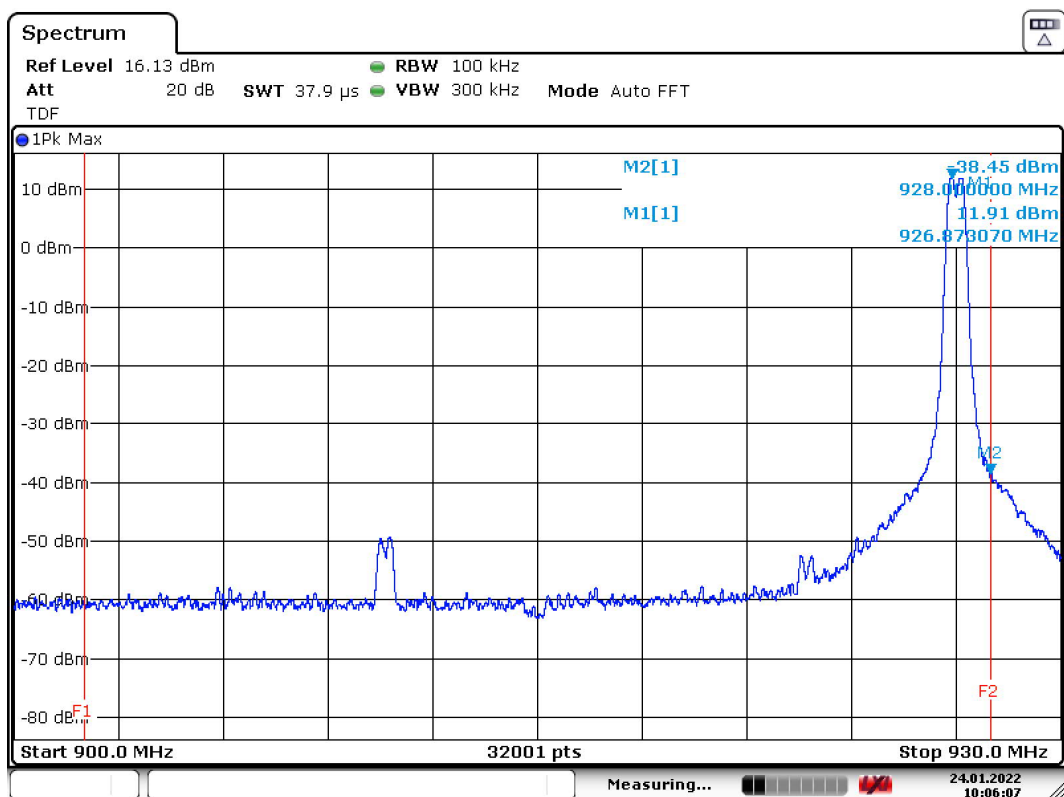
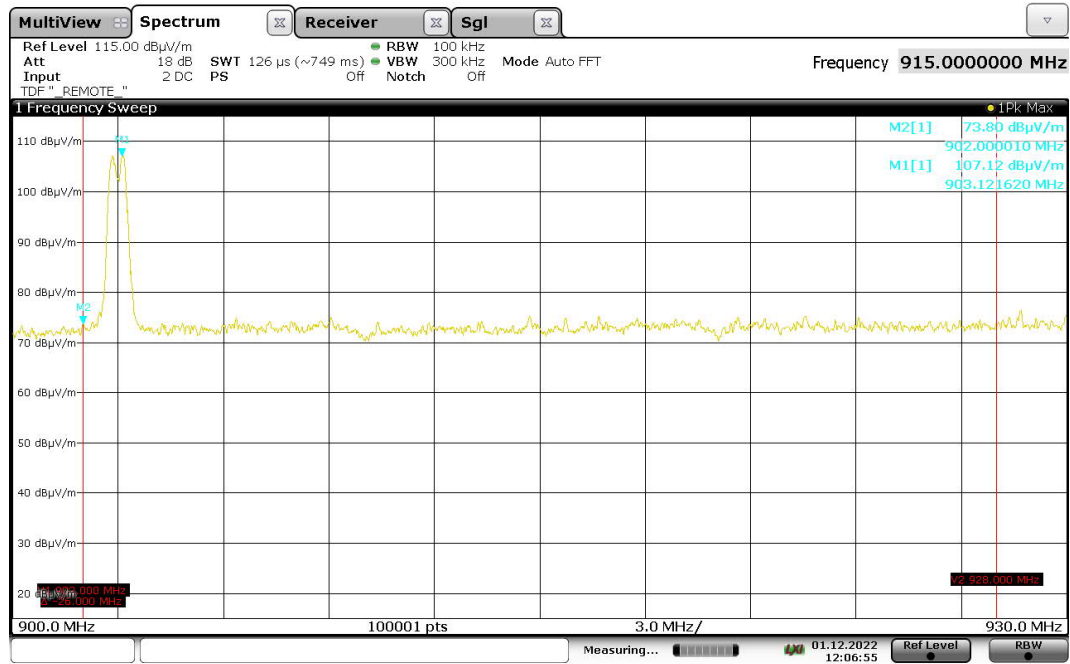


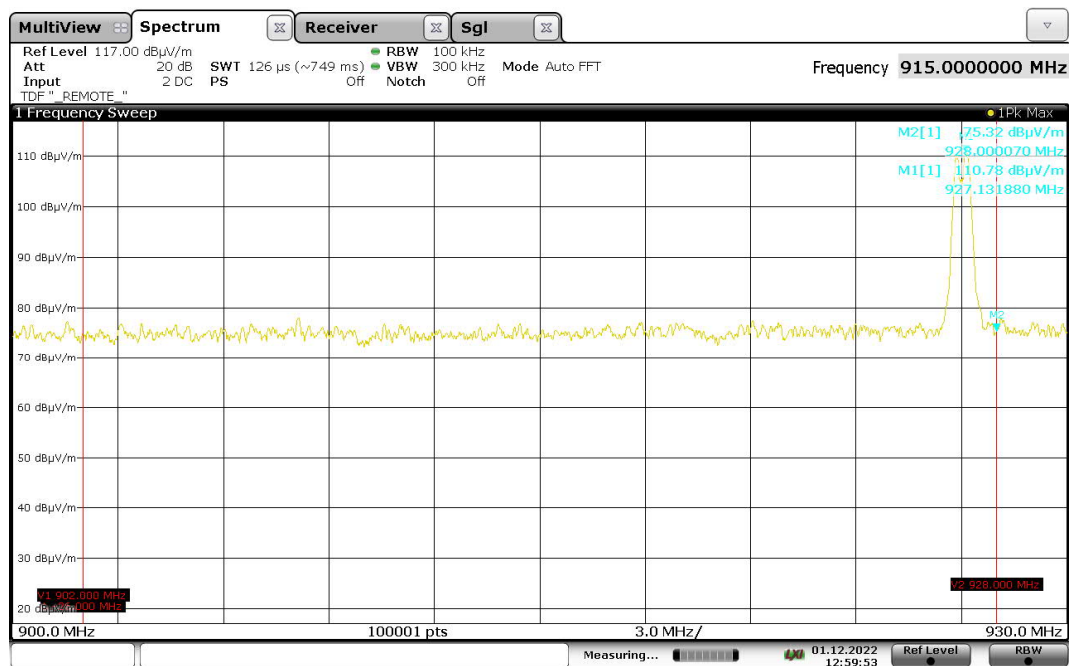
Figure 12: Upper Band Edge

Transmitter Band Edge Measurement and Conducted Spurious Emissions



12:06:55 01.12.2022

Figure 13: Lower Band Edge (radiated)



12:59:53 01.12.2022

Figure 14: Upper Band Edge (radiated)

Transmitter Band Edge Measurement and Conducted Spurious Emissions

Conducted spurious emissions results LOW channel

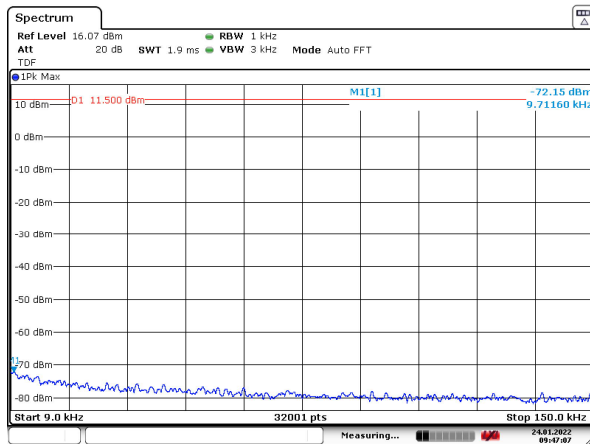


Figure 15: Conducted spurious emissions 9-150 kHz LOW channel

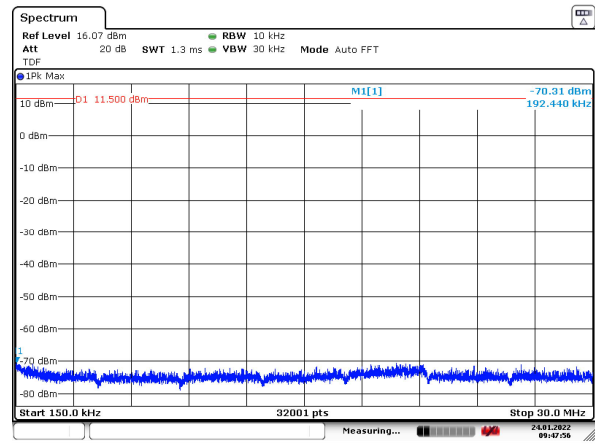


Figure 16: Conducted spurious emissions 150 kHz – 30 MHz LOW channel

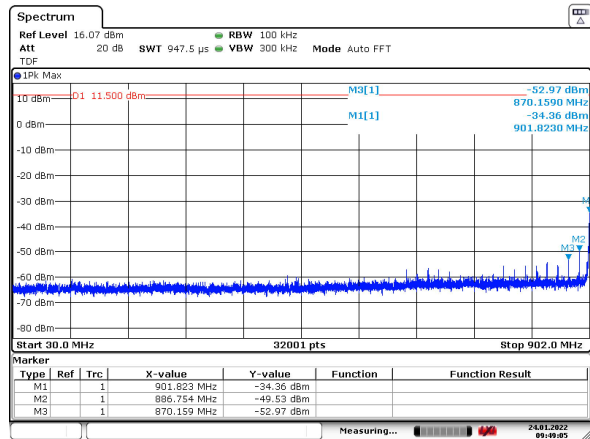


Figure 17: Conducted spurious emissions 30 MHz – 902 MHz LOW channel

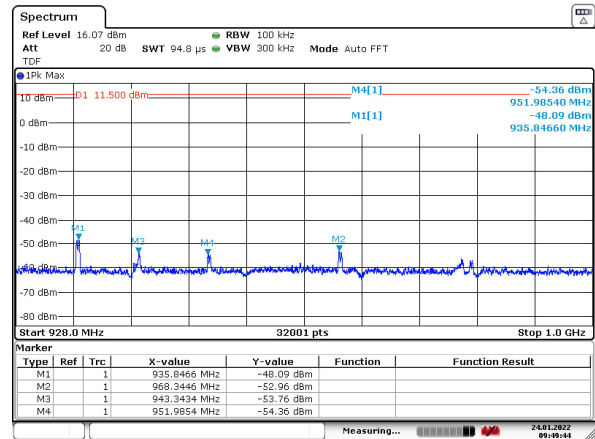


Figure 18: Conducted spurious emissions 928 MHz – 1 GHz LOW channel

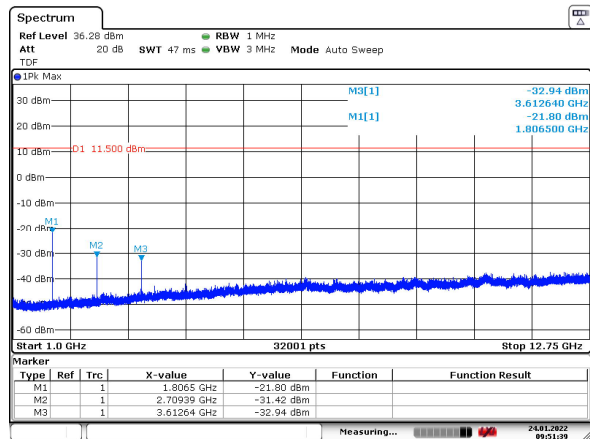


Figure 19: Conducted spurious emissions 1 GHz – 12.75 GHz LOW channel

Transmitter Band Edge Measurement and Conducted Spurious Emissions

Conducted spurious emissions results MID channel

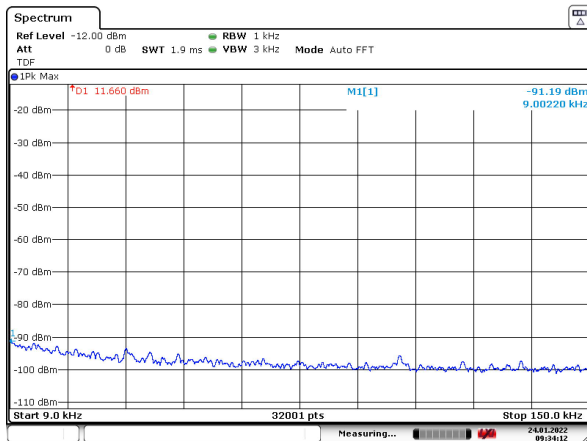


Figure 20: Conducted spurious emissions 9-150 kHz MID channel

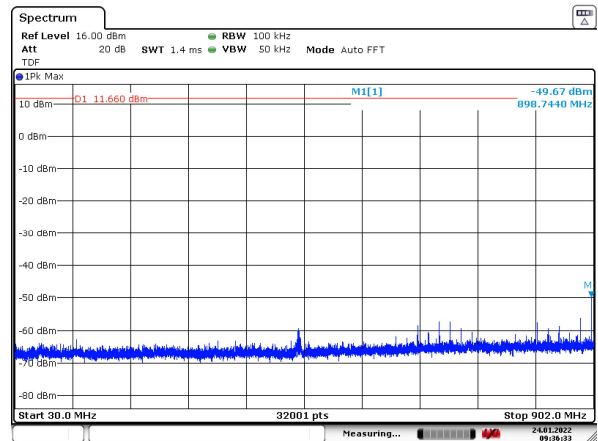


Figure 21: Conducted spurious emissions 150 kHz – 30 MHz MID channel

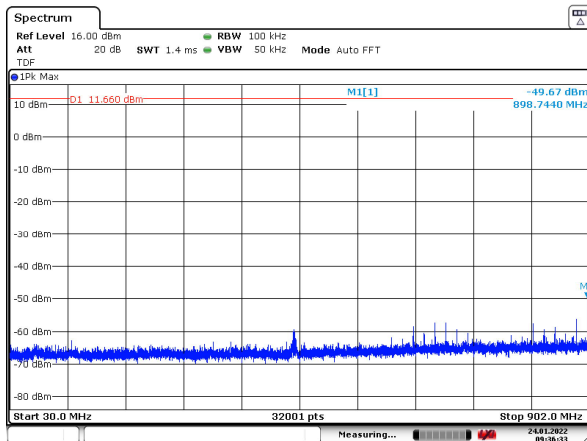


Figure 22: Conducted spurious emissions 30 MHz – 902 MHz MID channel

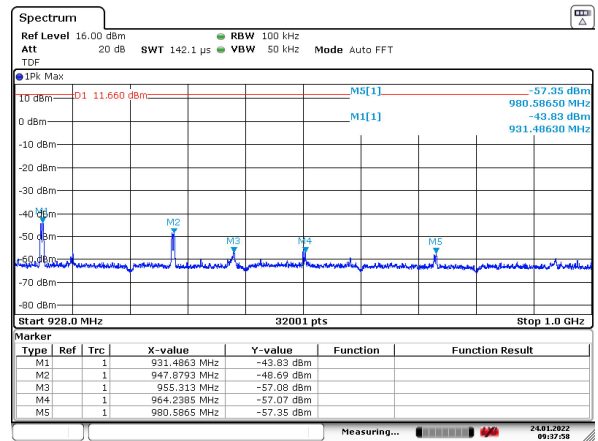


Figure 23: Conducted spurious emissions 928 MHz – 1 GHz MID channel

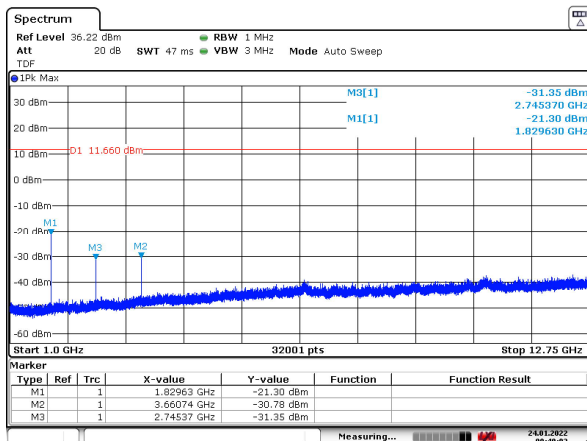


Figure 24: Conducted spurious emissions 1 GHz – 12.75 GHz MID channel

Transmitter Band Edge Measurement and Conducted Spurious Emissions

Conducted spurious emissions results HIGH channel

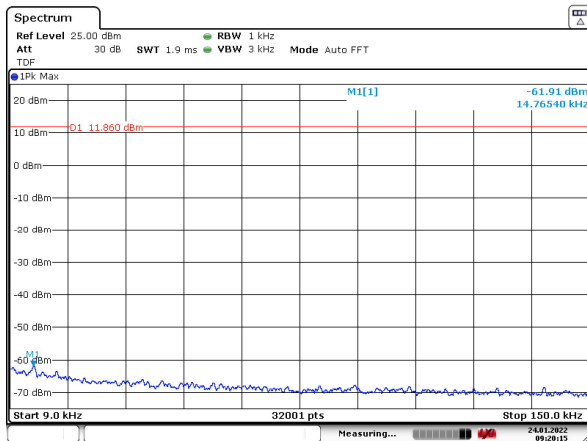


Figure 25: Conducted spurious emissions 9-150 kHz HIGH channel

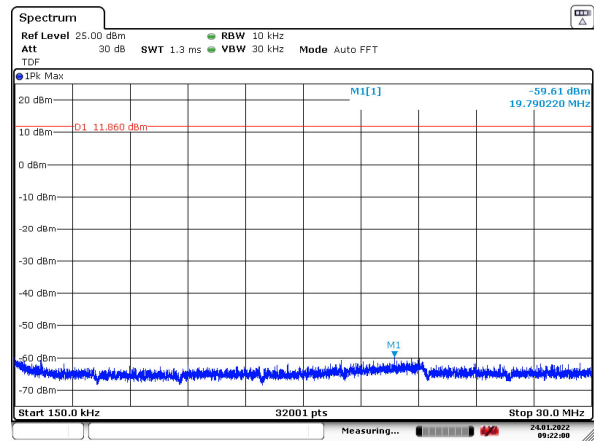


Figure 26: Conducted spurious emissions 150 kHz – 30 MHz HIGH channel

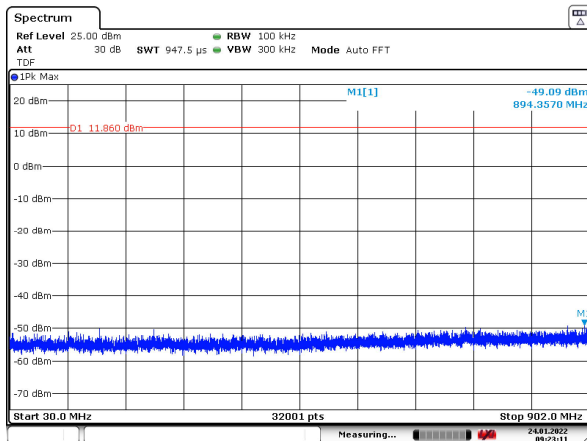


Figure 27: Conducted spurious emissions 30 MHz – 902 MHz HIGH channel

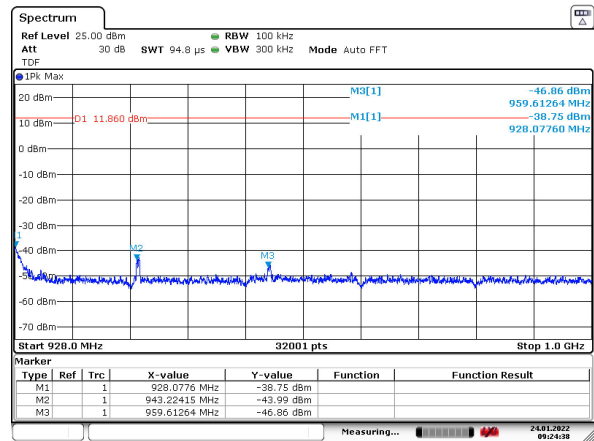


Figure 28: Conducted spurious emissions 928 MHz – 1 GHz HIGH channel

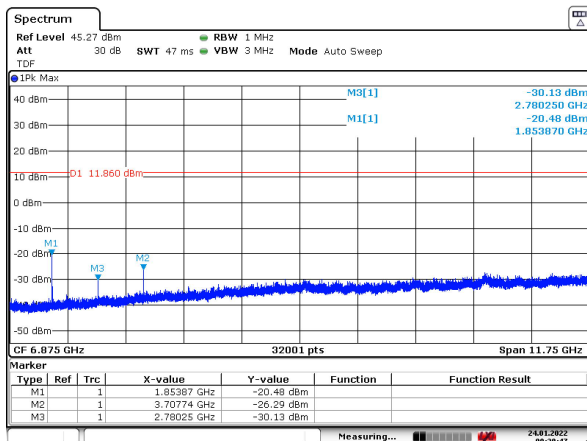


Figure 29: Conducted spurious emissions 1 GHz – 12.75 GHz HIGH channel

6 dB Bandwidth of the Channel

Standard: ANSI C63.10 (2013)
Tested by: RRE
Date: 24 January 2022, 1 December 2022
Temperature: 23 ± 3 °C
Humidity: 20 - 75 % RH

FCC Rule: 15.247(a)(2)
RSS-247 5.2(a)

Results

Table 8: 6 dB bandwidth test results

Channel	6 dB BW [kHz] conducted	6 dB BW [kHz] radiated	Minimum limit [kHz]
Low	517.8	502.0	500
Mid	518.6	527.3	
High	518.1	527.7	

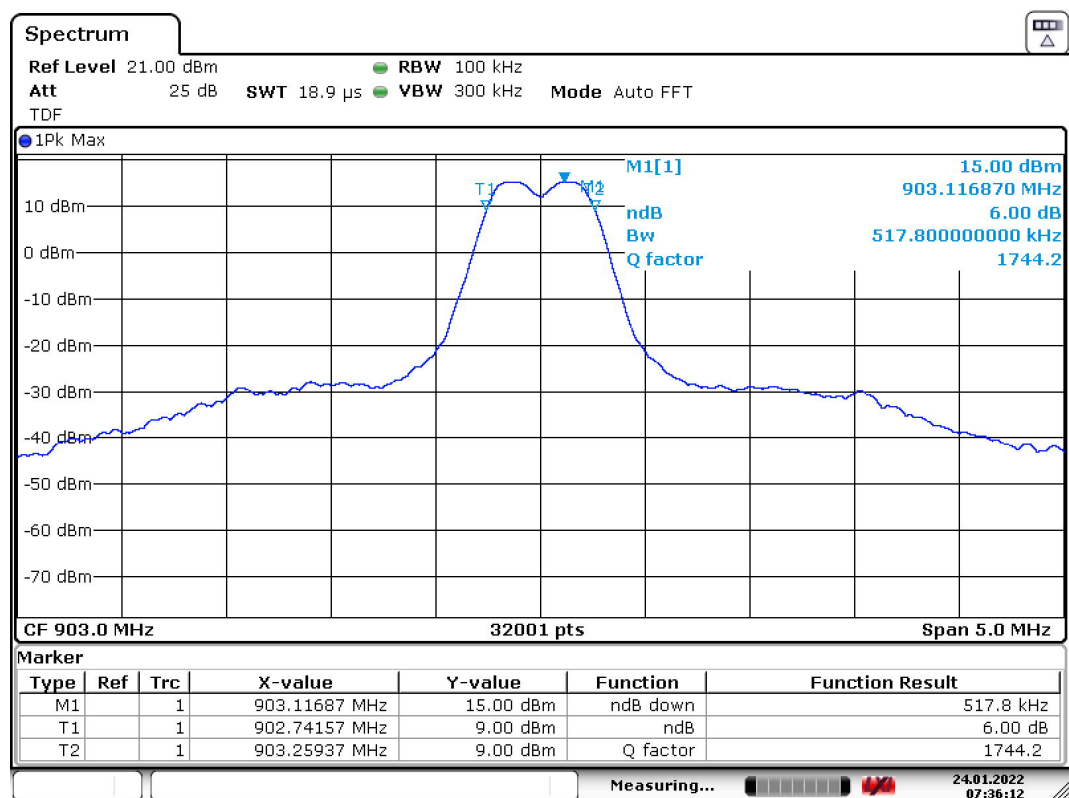


Figure 30: 6 dB bandwidth, channel LOW

6 dB Bandwidth of the Channel

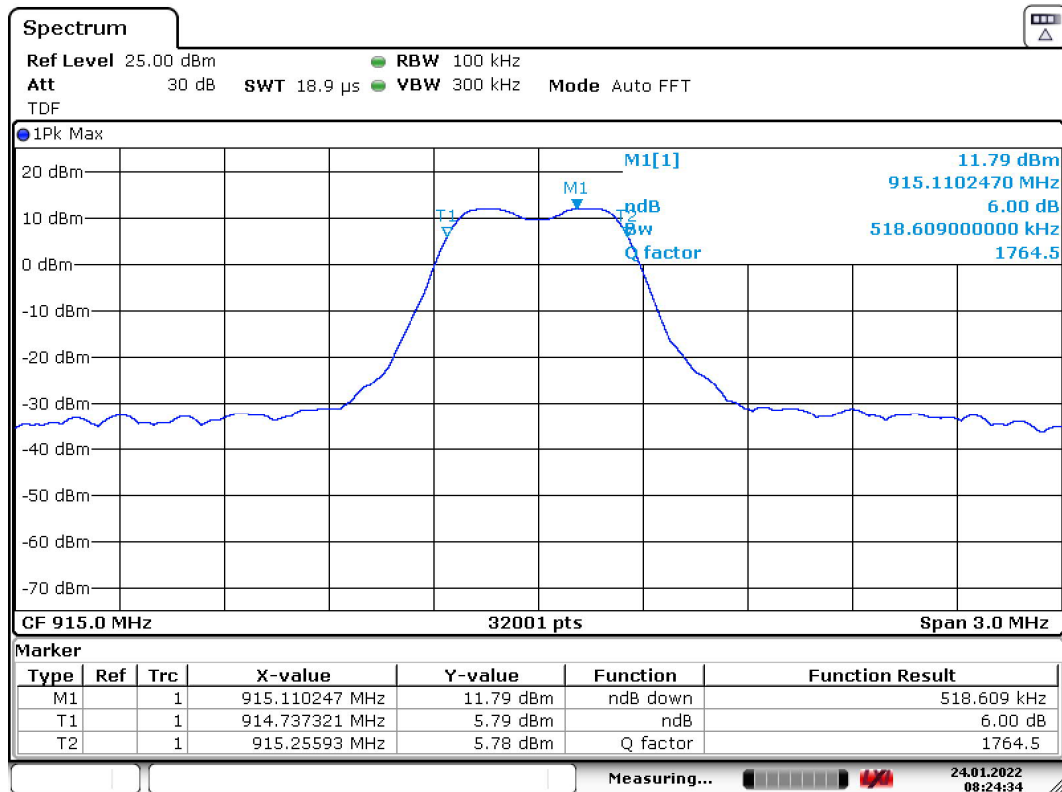


Figure 31: 6 dB bandwidth, channel MID

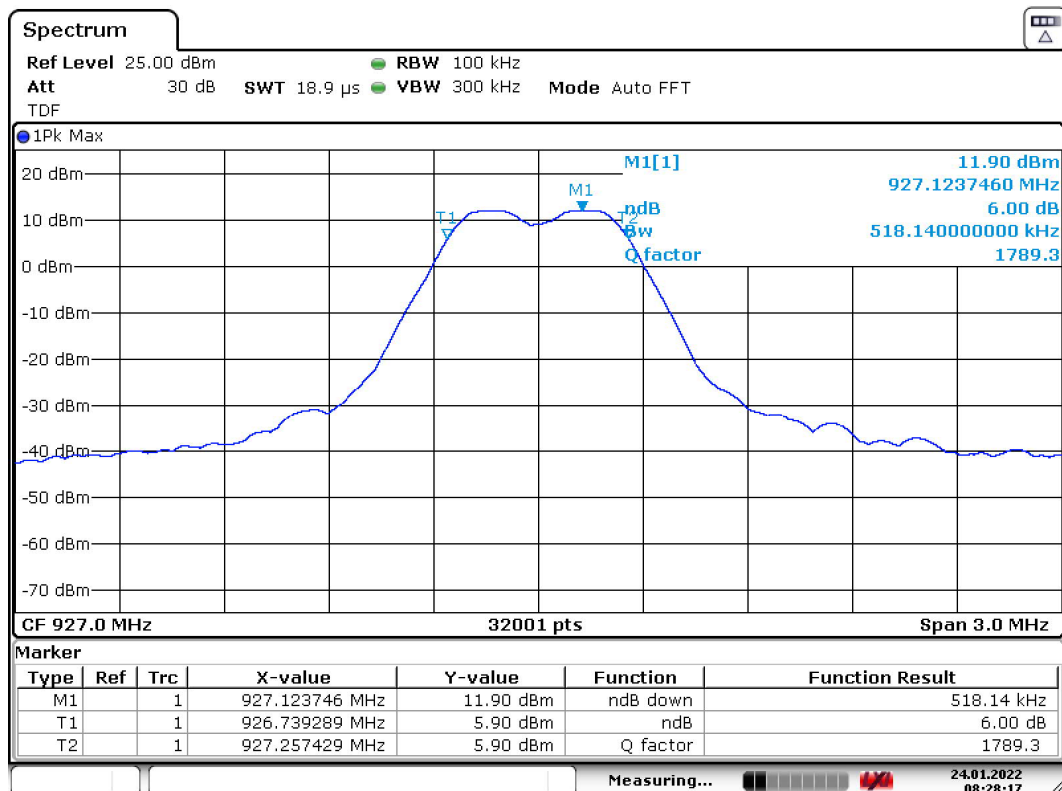


Figure 32: 6 dB bandwidth, channel HIGH

6 dB Bandwidth of the Channel

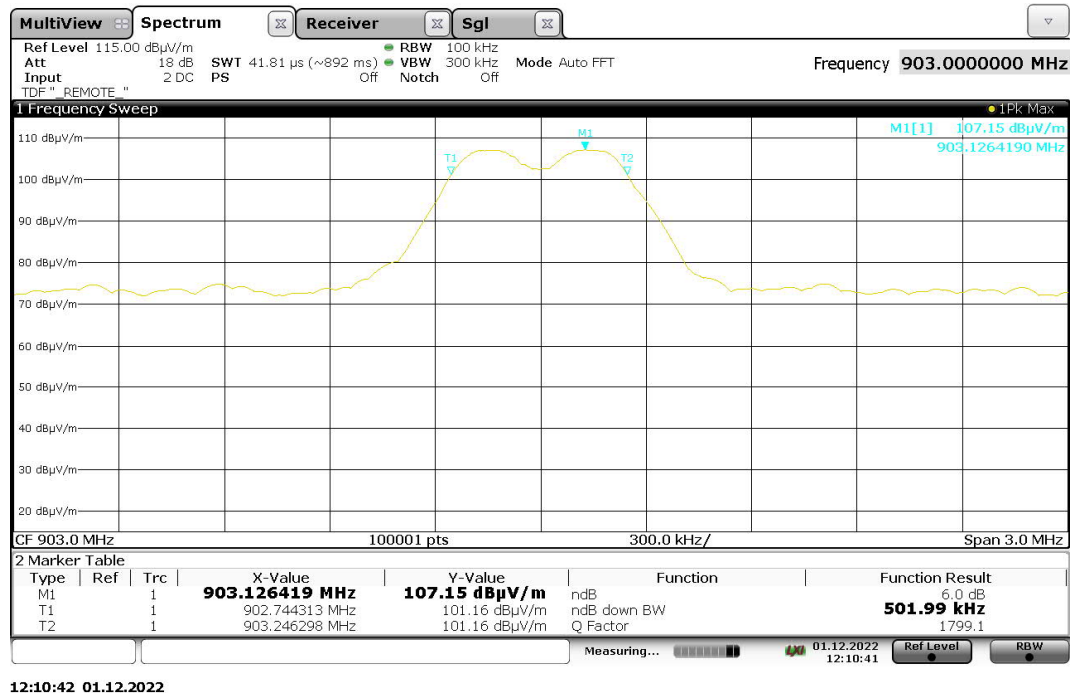


Figure 33: 6 dB bandwidth, channel LOW (radiated)

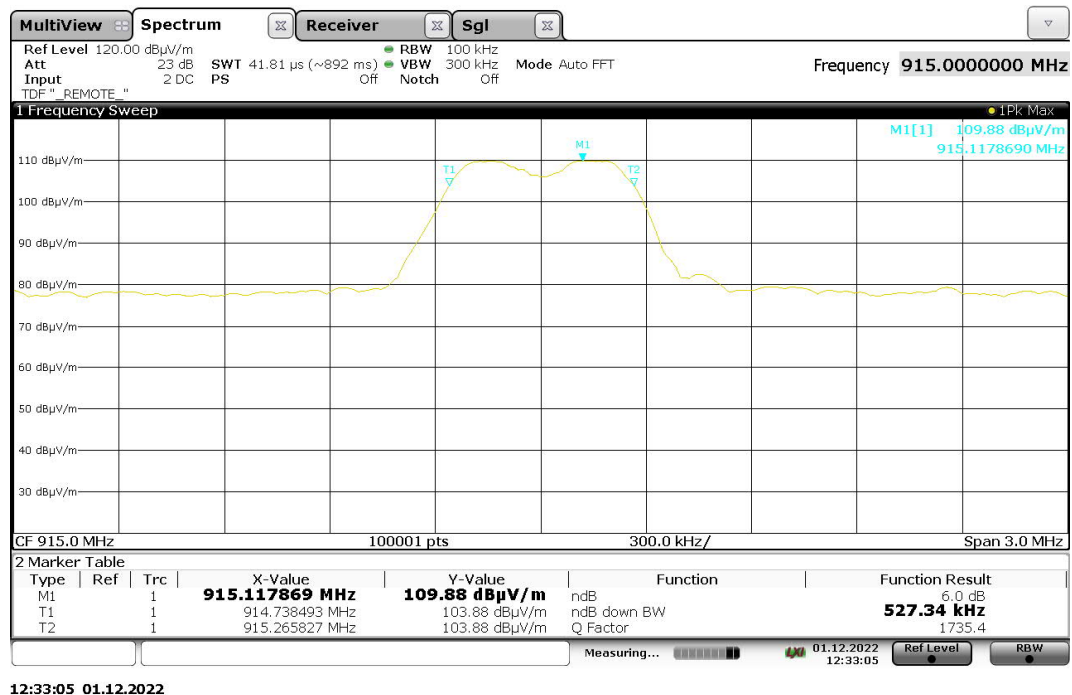
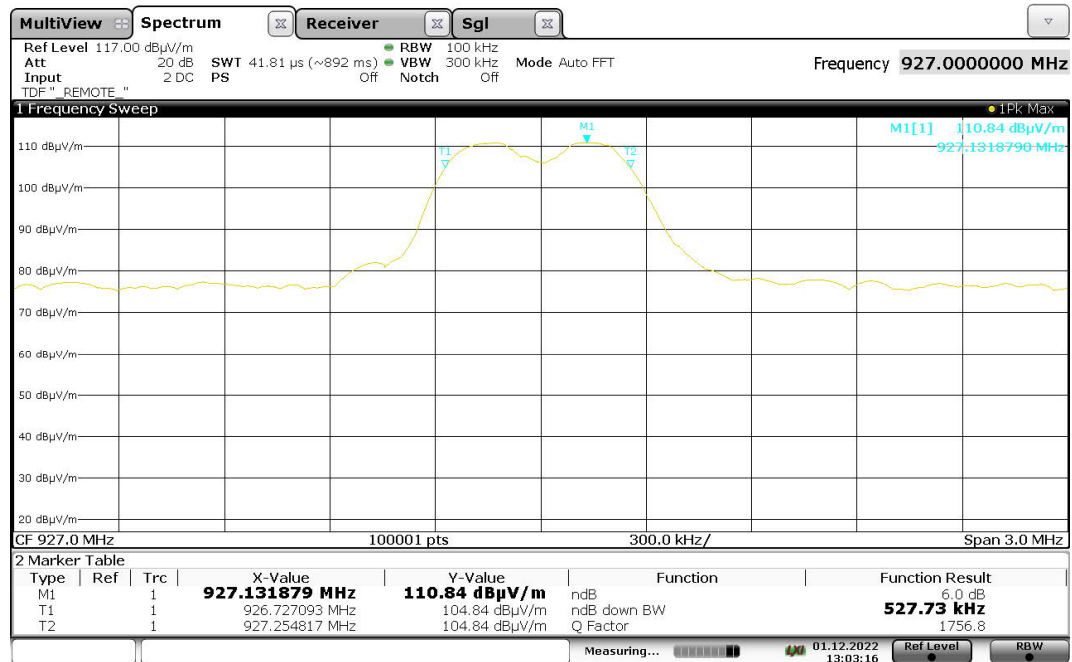


Figure 34: 6 dB bandwidth, channel MID (radiated)

6 dB Bandwidth of the Channel



13:03:17 01.12.2022

Figure 35: 6 dB bandwidth, channel HIGH (radiated)

Power Spectral Density

Standard: ANSI C63.10 (2013)
Tested by: RRE
Date: 24 January 2022, 1 December 2022
Temperature: 23 ± 3 °C
Humidity: 20 - 75 % RH

FCC Rule: 15.247(e)
RSS-247 5.2(b)

Results

Table 9: Power spectral density test results (conducted)

Channel	PSD dBm/3 kHz	Maximum limit [dBm/3kHz]
Low	7.18	+8.00
Mid	6.36	
High	7.61	

Table 10: Power spectral density test results (radiated)

Channel	Radiated PSD dBμV/m /3 kHz	Radiated PSD dBm/3 kHz	Maximum limit [dBm/3kHz]
Low	102.62	6.66	+8.00
Mid	105.06	5.10	
High	106.37	6.41	

Radiated measurements were made as electric field strength measurement in dBμV/m and the results are converted to EIRP (dBm) according to the formulas presented in ANSI C63.10-2013 Clause 11.12.2.2.

$$\text{EIRP (dBm)} = E (\text{dB}\mu\text{V/m}) + 20\log(3) - 104.8 - 4.7$$

The measurement was performed at a point (turntable and mast) where the highest radiated emissions were detected. The measurement distance was 3.0 m.

Power Spectral Density

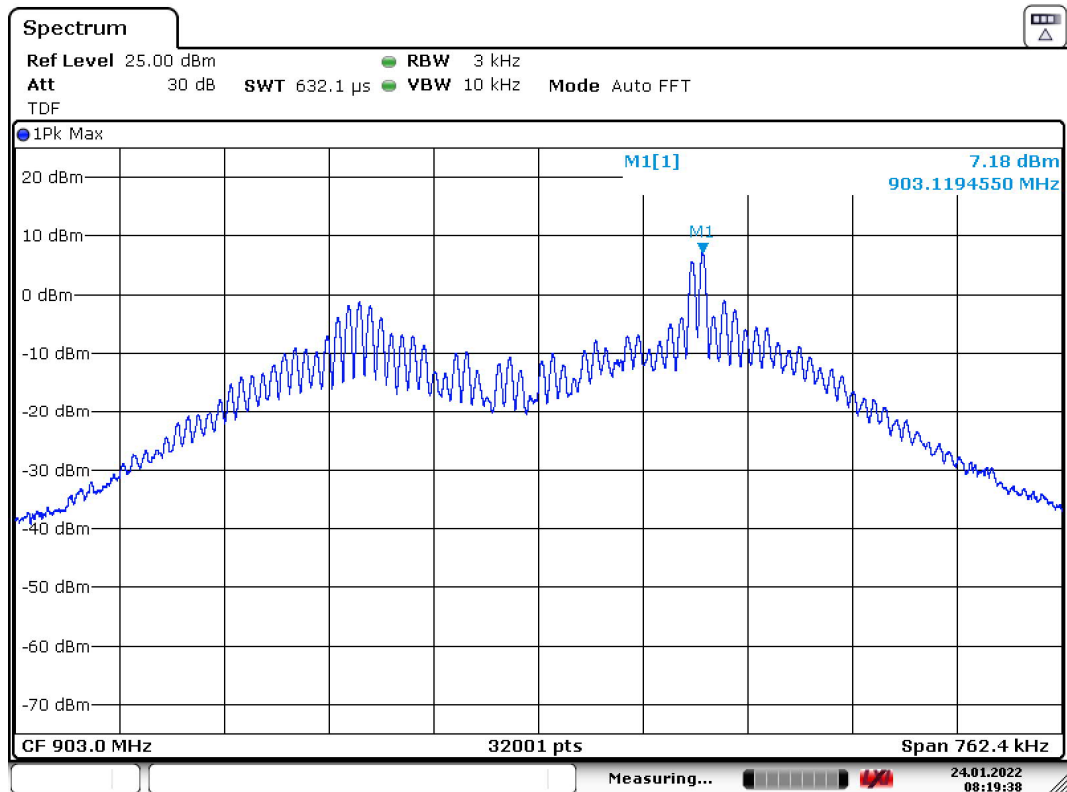


Figure 36: Power spectral density, channel LOW

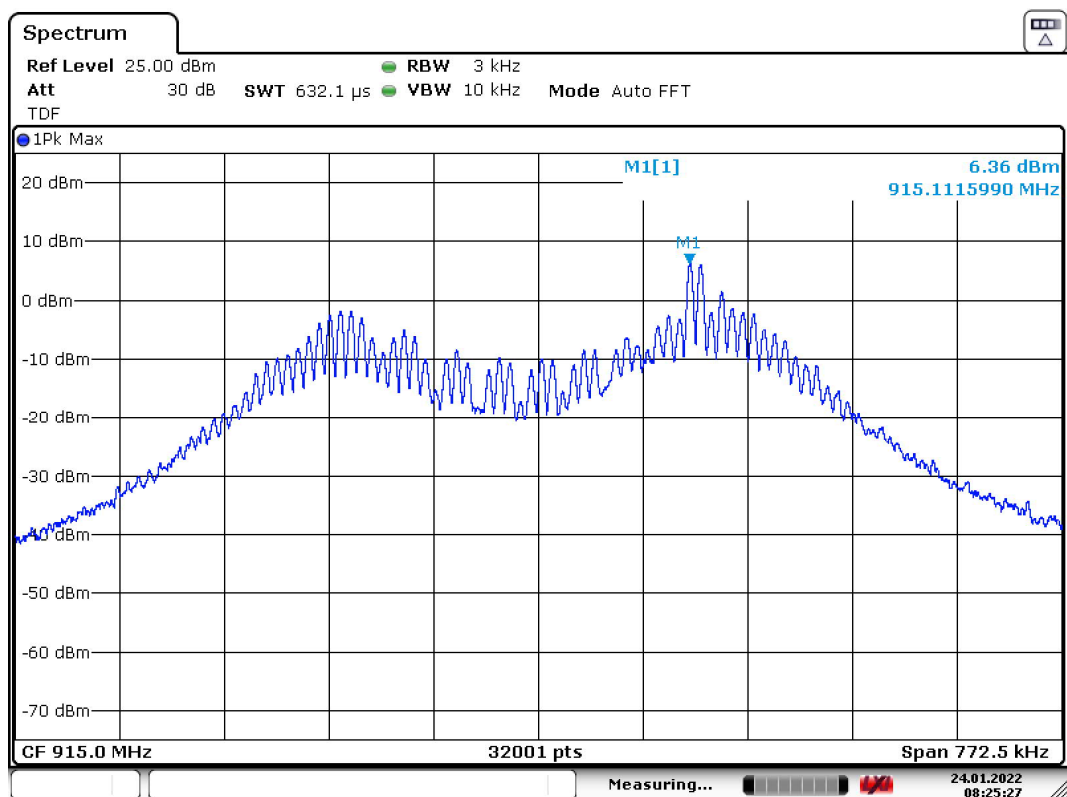


Figure 37: Power spectral density, channel MID

Power Spectral Density

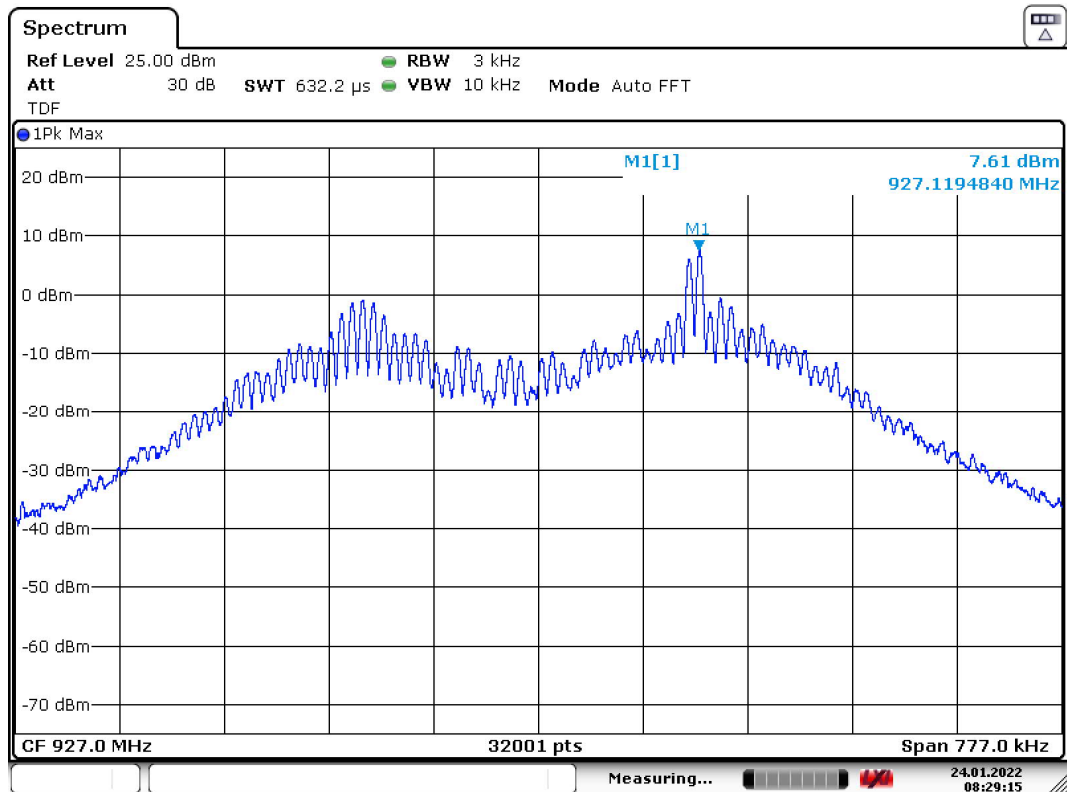


Figure 38: Power spectral density, channel HIGH

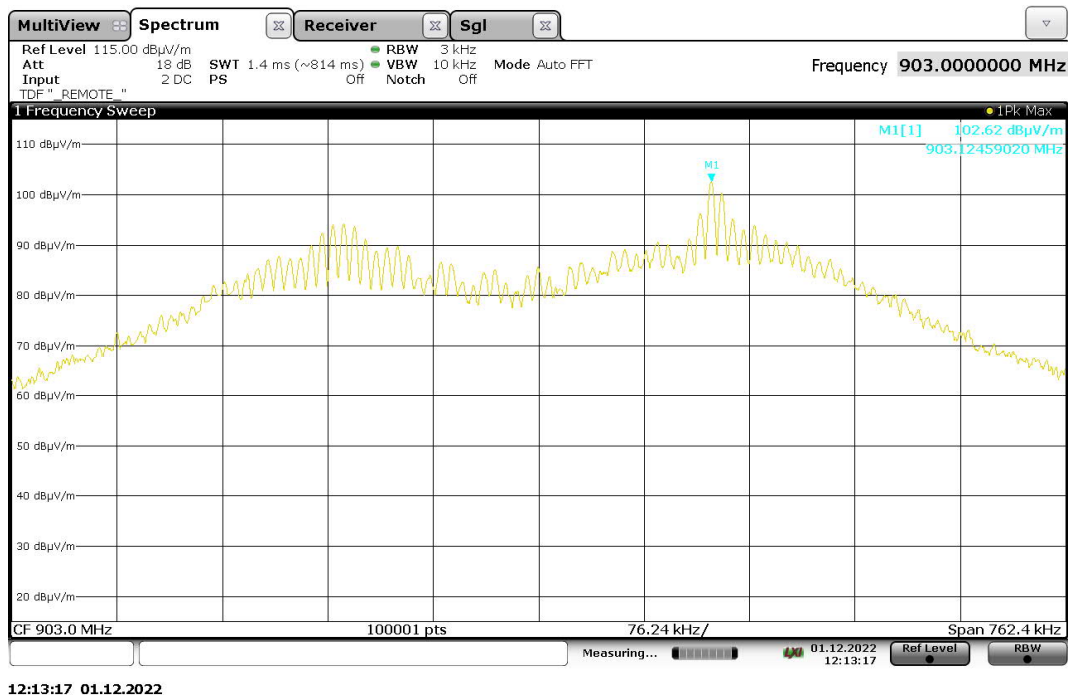


Figure 39: Power spectral density, channel LOW (radiated)

Power Spectral Density

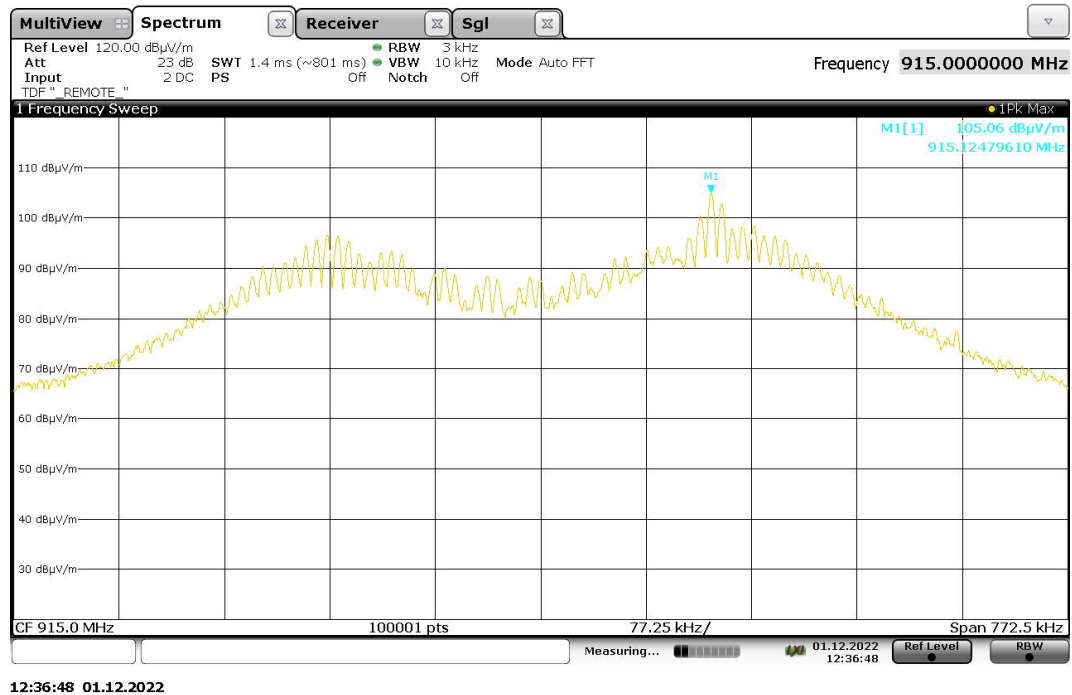


Figure 40: Power spectral density, channel MID (radiated)

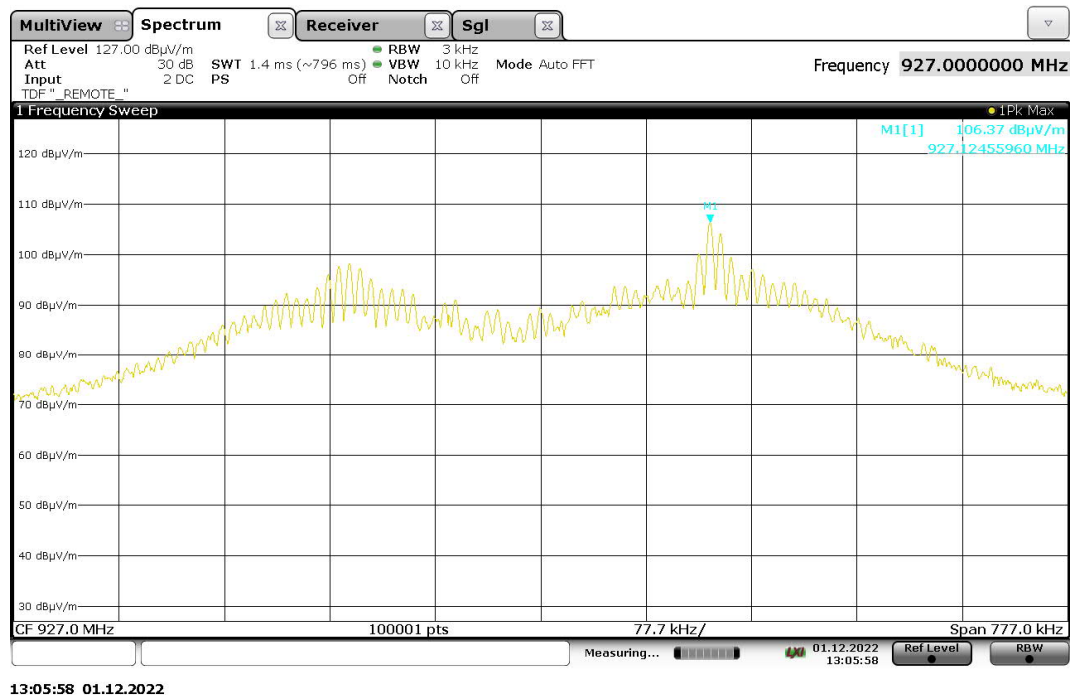


Figure 41: Power spectral density, channel HIGH (radiated)

99% Occupied Bandwidth

Standard: RSS-GEN (2019)
Tested by: RRE
Date: 24 January 2022
Temperature: 23 ± 3 °C
Humidity: 20 - 75 % RH

RSS-GEN 6.6

Results

Table 11: 99% occupied bandwidth test results

Channel	Limit	99 % BW [kHz]	Result
Low	-	468.110371551	PASS
Mid	-	452.485859817	PASS
High	-	472.953970188	PASS

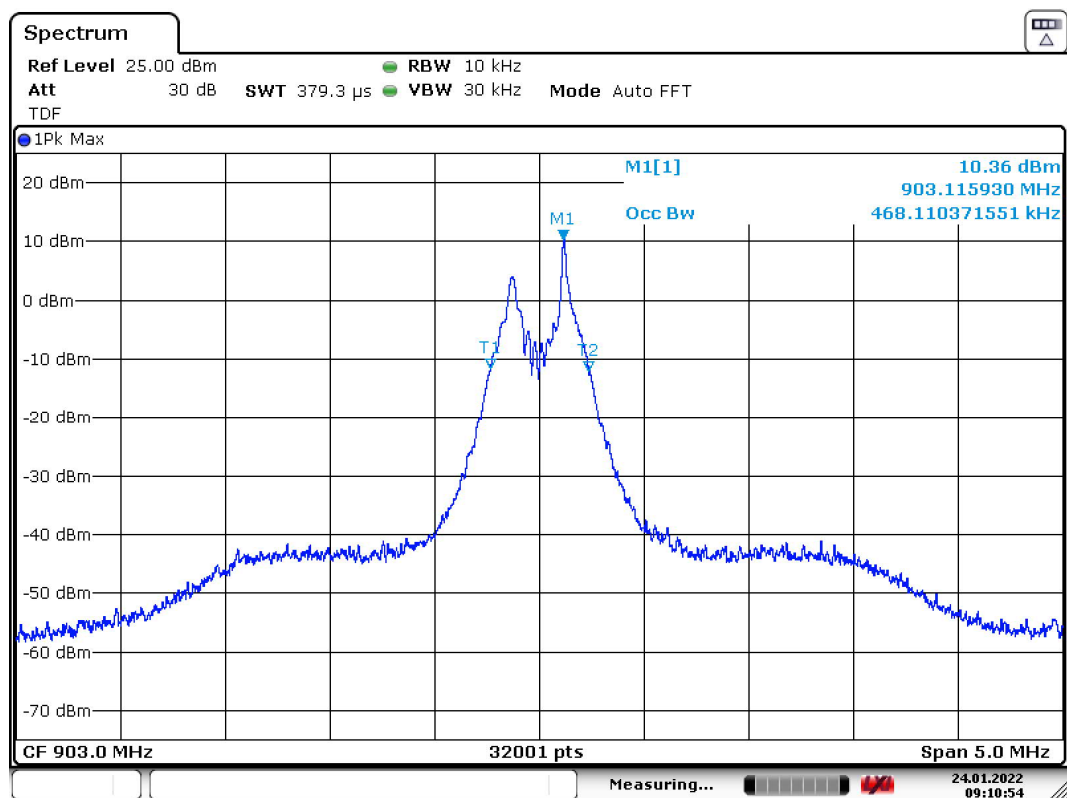


Figure 42: 99% OBW, channel LOW

99% Occupied Bandwidth

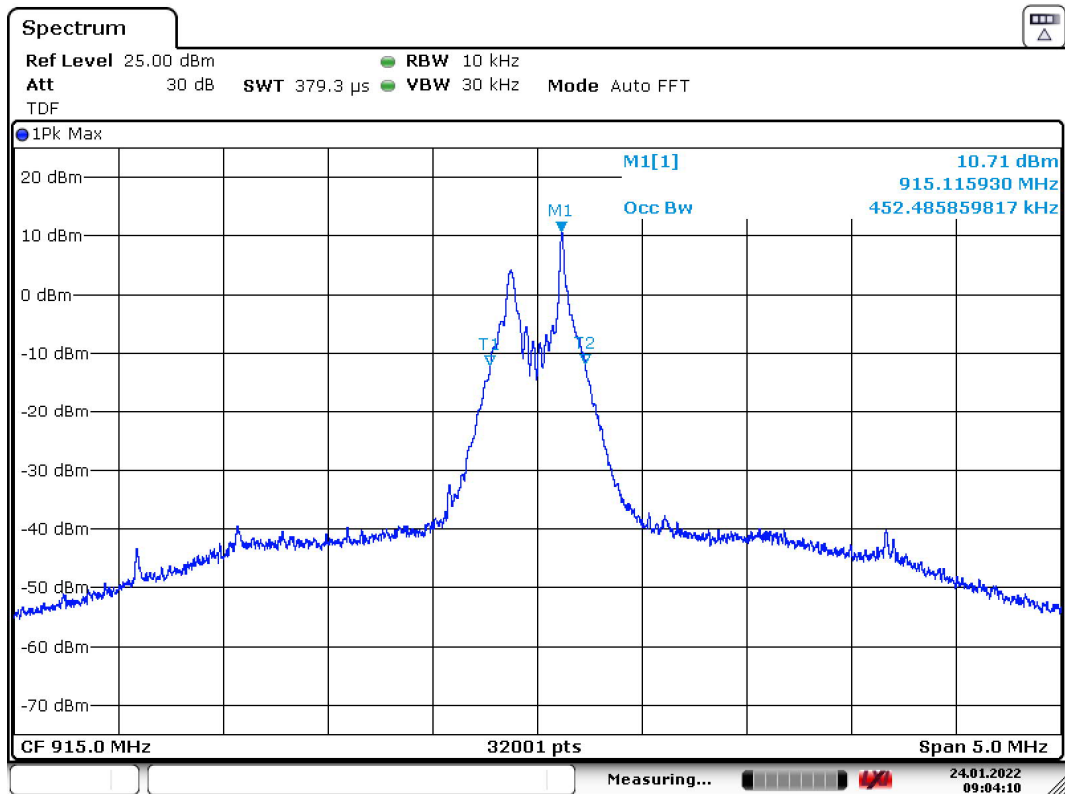


Figure 43: 99% OBW, channel MID

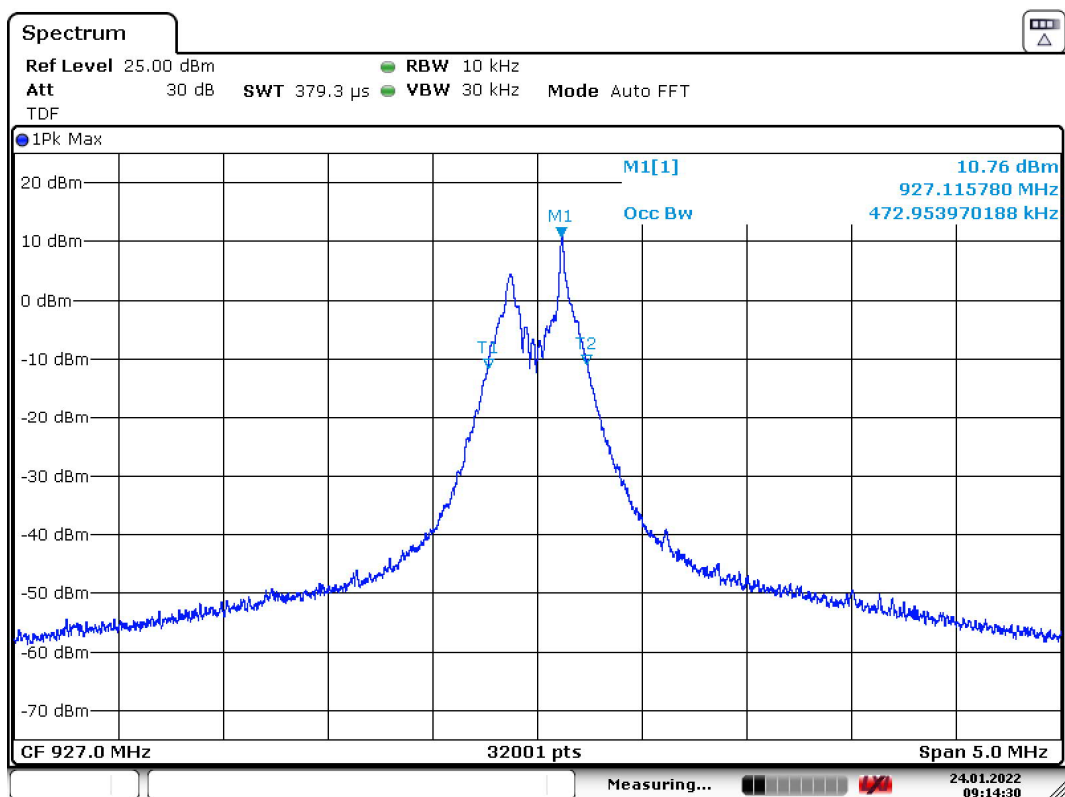


Figure 44: 99% OBW, channel HIGH

Duty cycle correction factor, Transmit time in 100 ms

Standard: ANSI C63.10 (2013)
Tested by: RRE
Date: 17 December 2021
Temperature: 23 ± 3 °C
Humidity: 20 - 75 % RH

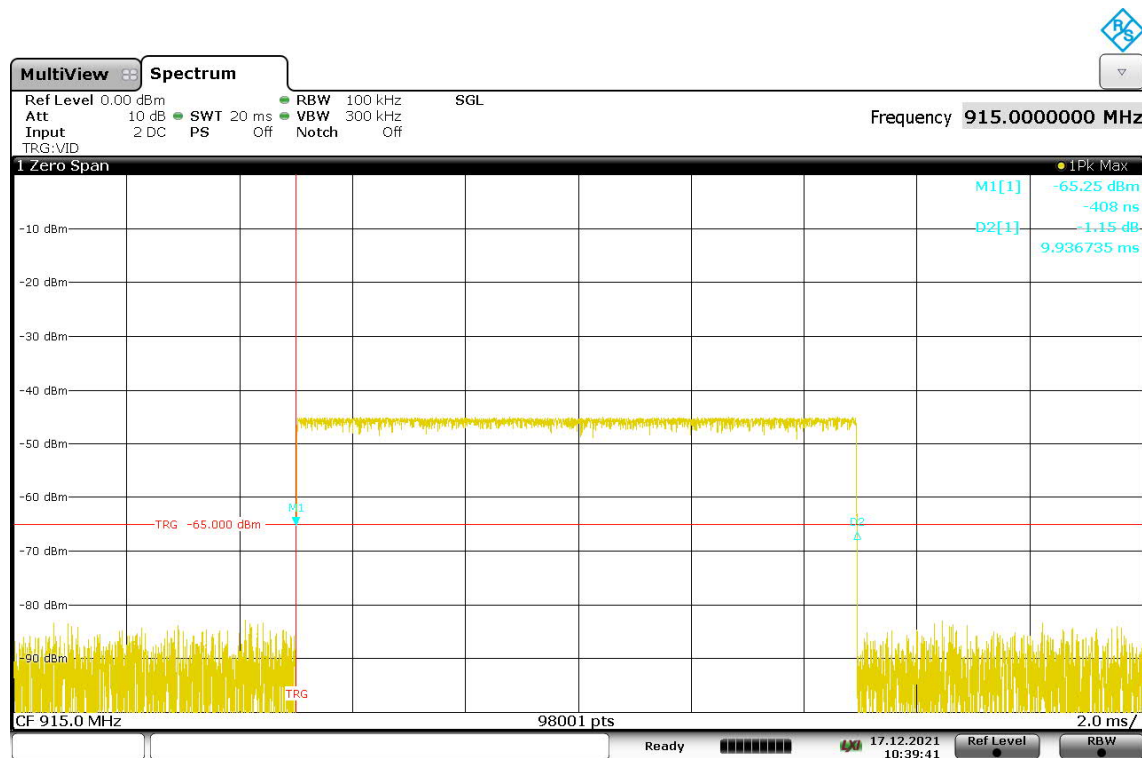
Spectrum analyzer with zero span was used to investigate spectrum.

15.35(c) Unless otherwise specified, e.g. § 15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

Pulses / 100 ms = 1

Length of one pulse = 9.936735 ms

Duty Cycle Correction Factor = $20 \cdot \log(\text{Tocc}/100) = 20 \cdot \log(1 \cdot 9.936735 / 100) = -20.05$ dB



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Figure 45. Pulse length

TEST EQUIPMENT

Equipment	Manufacturer	Type	Inv or serial	Prev Calib	Next Calib
ATTENUATOR	HUBER&SUHNER	6810.17.B (10dB)	inv:10390	2021-01-25	2023-01-25
ATTENUATOR	INMET	10 dB, DC-40 GHz	inv:10347	2021-04-20	2023-04-20
ANTENNA	A.H. SYSTEMS	SAS-200/518	inv:7873	NCR	NCR
SPECTRUM ANALYZER	AGILENT	E7405A, monitoring	inv:9746	NCR	NCR
RF PREAMPLIFIER	CIAO	CA118-3123	inv:10278	2021-10-05	2022-10-05
TEMPERATURE/ HUMIDITY SENSOR	EDS	OW-ENV-TH, K5 SAC	inv:10517	2021-10-22	2022-10-22
				2022-10-27	2023-10-27
ANTENNA	EMCO	3117, emi 1-18GHz	inv:7293	2020-03-11	2022-03-11
TURNTABLE	MATURO	DS430 UPGRADED	inv:10182	NCR	NCR
MAST & TURNTABLE CONTROLLER	MATURO	NCD	inv:10183	NCR	NCR
ANTENNA MAST	MATURO	TAM 4.0E	inv:10181	NCR	NCR
ATTENUATOR	PASTERNAK	PE 7004-4 (4dB)	inv:10126	2021-03-26	2022-03-26
				2022-03-30	2023-03-30
GPS REFERENCE	PENDELUM	GPS-88	inv:8032	NCR	NCR
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	NCR	NCR
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv:10679	2021-06-21	2022-06-21
				2022-06-20	2023-06-20
SPECTRUM ANALYZER	ROHDE & SCHWARZ	FSV40	inv:9093	2021-12-06	2022-12-06
ANTENNA	SCHWARZBECK	VULB 9168	inv:8911	2020-11-04	2022-11-04
ANTENNA	SCHWARZBECK	VULB 9168	inv:8885	2022-05-05	2024-05-05
FILTER	WAINWRIGHT	HP, WHKX1.0/15G-10SS	inv:8267	2021-01-29	2023-01-29

NCR = No calibration required

END OF REPORT