DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
C.I.F. A29 507 456

ENSAYOS Nº 51/LE147

Test report No:
NIE: 64800RRF.001A1

Test Report

USA FCC Part 15.247, 15.209
CANADA RSS-247, RSS-Gen

Radio Frequency Devices. Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz.
Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices.
General Requirements and Information for the Certification of Radio Apparatus.

(*) Identification of item tested	Smart Gas Meter
(*) Trademark	Mesura Metering
(*) Model and /or type reference	PRODIGI US1
Other identification of the product	HW version: 1.0 SW version: 1.0 FCC ID: 2AWRB-PRODIGI1 IC ID: 26345-PRODIGI1
(*) Features	LoRa communication
Applicant	Mesura Metering Srl Via Statale 11/13, Ponte San Marco, 25011, Calcinato – Brescia (Italy)
Test method requested, standard	USA FCC Part 15.247 (10-1-19 Edition): Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 (10-1-19 Edition): Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 5 Amendment 1 (March 2019). Guidance for Performing Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid Systems Devices Operating Under Section 15.247 of the FCC Rules. 558074 D01 Meas Guidance v05r02 dated April 2, 2019. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	José Carlos Luque RF Lab. Supervisor Firmado digitalmente por 74841983Y JOSE CARLOS LUQUE (C:A29507456) Fecha: 2021.05.04 15:45:12 +02'00'
Date of issue	2021-05-04
Report template No	FDT08_22 (*) "Data provided by the client"

Index

Competences and guarantees 3
General conditions 3
Uncertainty 3
Data provided by the client 3
Usage of samples 4
Test sample description 4
Identification of the client 6
Testing period and place 6
Document history 6
Environmental conditions 7
Remarks and comments 8
Testing verdicts 9
Summary 9
Appendix A: Test results. LoRa 125 kHz 10
Appendix B: Test results. LoRa 500 kHz 36

Competences and guarantees

DEKRA Testing and Certification S.A.U. is a testing laboratory accredited by the National Accreditation Body (ENAC -Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

DEKRA Testing and Certification is a FCC-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

DEKRA Testing and Certification is an ISED-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification S.A.U. has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification S.A.U. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification S.A.U. at the time of performance of the test.

DEKRA Testing and Certification S.A.U. is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document. **IMPORTANT:** No parts of this report may be reproduced or quoted out of context, in any form or by any means, except in full, without the previous written permission of DEKRA Testing and Certification S.A.U.

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification S.A.U.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification S.A.U. and the Accreditation Bodies.

Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").

2. The sample of the model PRODIGI US1is a Smart Gas Meter. The Smart Gas Meter is able to record gas consumption and send the information remotely.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Usage of samples

Samples undergoing test have been selected by: The client.

- Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
64800B/005	Gas meter	--	--	2020/07/27

Sample S/01 has undergone the test(s): All RADIATED tests indicated in Appendix A and B.

- Sample S/02 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
64800B/006	Gas meter	--	--	2020/07/27

Sample S/02 has undergone the following test(s): All CONDUCTED tests indicated in Appendix A and B.

Test sample description

Ports…… :	Port name and description	Cable			
		Specified max length [m]	Attached during test	Shielded	Coupled to patient(3)
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
Supplementary information to the ports……:					

Rated power supply .....:	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐	AC:	☐	☐	☐	☐	☐
	☐	AC:	☐	☐	☐	☐	☐
	☐	DC: 3.6V					

	☐	DC:
Rated Power .....:	2.7W	
Clock frequencies.....:	10MHz MCU – 32.768KHz RTC	
Other parameters .....:		
Software version .....:	1.0	
Hardware version .....:	1.0	
Dimensions in cm (W x H x D) ....:		
Mounting position .....:	☐	Table top equipment
	☐	Wall/Ceiling mounted equipment
	☐	Floor standing equipment
	☐	Hand-held equipment
	☒	Other: dedicated installation

Modules/parts.....:	Module/parts of test item	Type	Manufacturer
	SX1262	LoRa	Semtech

Accessories (not part of the test item) .....:	Description	Type	Manufacturer

Documents as provided by the applicant.....:	Description	File name	Issue date

(3) Only for Medical Equipment

Identification of the client

Mesura Metering Srl,

Via Statale 11/13, Ponte San Marco, 25011, Calcinato – Brescia (Italy)

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2020-06-03
Date (finish)	2020-08-11

Document history

Report number	Date	Description
64800RRF.001	2020-10-23	First release
64800RRF.001A1	2021-05-04	Second release: - Modification due several typos. - This modification test report cancels and replaces the test report 64800RRF.001.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

Remarks and comments

The tests have been performed by the technical personnel: José Manuel Jiménez, José Gabriel Pendón and Nicolás Salguero.

Used instrumentation:

Conducted Measurements:

		Last Calibration	Due Calibration
1.	Shielded Room ETS LINDGREN S101	N.A.	N.A.
2.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2019/10	2021/10
3.	Signal and Spectrum Analyzer ROHDE AND SCHWARZ FSV 40	2019/09	2021/09

Radiated Measurements:

		Last Calibration	Due Calibration
1.	Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N.A.	N.A.
2.	Shielded Room ETS LINDGREN S101	N.A.	N.A.
3.	Biconical/Log Antenna 30 MHz - 6 GHz ETS LINDGREN 3142E	2020/04	2023/04
4.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2019/10	2021/10
5.	RF Pre-amplifier, 40 dB ,10MHz-6 GHz BONN ELEKTRONIK BLMA 0160-01N	2020/02	2021/02
6.	Broadband Horn antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2019/11	2022/11
7.	Signal and spectrum analyzer 10Hz-40GHz Rhode and Schwarz FSV40	2019/10	2021/10
8.	RF Pre-amplifier, 40 dB ,1-18 GHz BONN ELEKTRONIK BLMA 0118-1M	2020/05	2021/05

Testing verdicts

Not applicable:	N/A
Pass:	P
Fail:	F
Not measured:	N/M

Summary

1. LoRa 125 kHz

FCC PART 15 PARAGRAPH / RSS-247			
Requirement – Test case		**Verdict**	**Remark**
FCC 15.247 (a)(1) / RSS-247 5.1. (b)	20 dB Bandwidth and Carrier frequency separation	P	
FCC 15.247 (a)(1)(i) / RSS-247 5.1 (c)	Number of hopping channels	P	
FCC 15.247 (a)(1)(i) / RSS-247 5.1. (c)	Time of occupancy (Dwell Time)	P	
FCC 15.247 (b) / RSS-247 5.4. (a)	Maximum peak output power and antenna gain	P	
FCC 15.247 (d) / RSS-247 5.5.	Band-edge compliance of conducted emissions (Transmitter)	P	
FCC 15.247 (d) / RSS-247 5.5.	Emission limitations radiated (Transmitter)	P	
Supplementary information and remarks: None.			

2. LoRa 500 kHz

FCC PART 15 PARAGRAPH / RSS-247			
Requirement – Test case		**Verdict**	**Remark**
FCC 15.247 (a)(2) / RSS-247 5.2. (a)	6 dB Bandwidth	P	
FCC 15.247 (b) / RSS-247 5.4. (d)	Maximum peak output power and antenna gain	P	
FCC 15.247 (d) / RSS-247 5.5.	Band-edge emissions compliance (Transmitter)	P	
FCC 15.247 (e) / RSS-247 5.2. (b)	Power spectral density	P	
FCC 15.247 (d) / RSS-247 5.5.	Emission limitations radiated (Transmitter)	P	
Supplementary information and remarks: None.			

Appendix A: Test results. LoRa 125 kHz

INDEX

TEST CONDITIONS 12
FCC 15.247 (a) (1) / RSS-247 5.1. (c) 20 dB Bandwidth and Carrier frequency separation 14
FCC 15.247 (a) (1) (i) / RSS-247 5.1 (c). Number of hopping channels 19
FCC 15.247 (a) (1) (i) / RSS-247 5.1. (c) Time of occupancy (Dwell Time) 21
FCC 15.247 (b) / RSS-247 5.4 (a) Maximum output power and antenna gain 23
FCC 15.247 (d) / RSS-247 5.5. Band-edge compliance of conducted emissions (Transmitter) 26
FCC 15.247 (d) / RSS-247 5.5. Emission limitations radiated (Transmitter) 29

TEST CONDITIONS

POWER SUPPLY (V):

V nonimal:	3.6 Vdc.
Type of power supply:	Battery.

ANTENNA:

Type of Antenna:	Internal.
Maximum Declared Assembly Gain:	+2.31 dBi

TEST FREQUENCIES:

Low Channel:	902.3 MHz
Middle Channel:	908.7 MHz
High Channel:	914.9 MHz

NOTE: The equipment can operate as a frequency hopping system using 64 hopping channels.

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.

RADIATED MEASUREMENTS

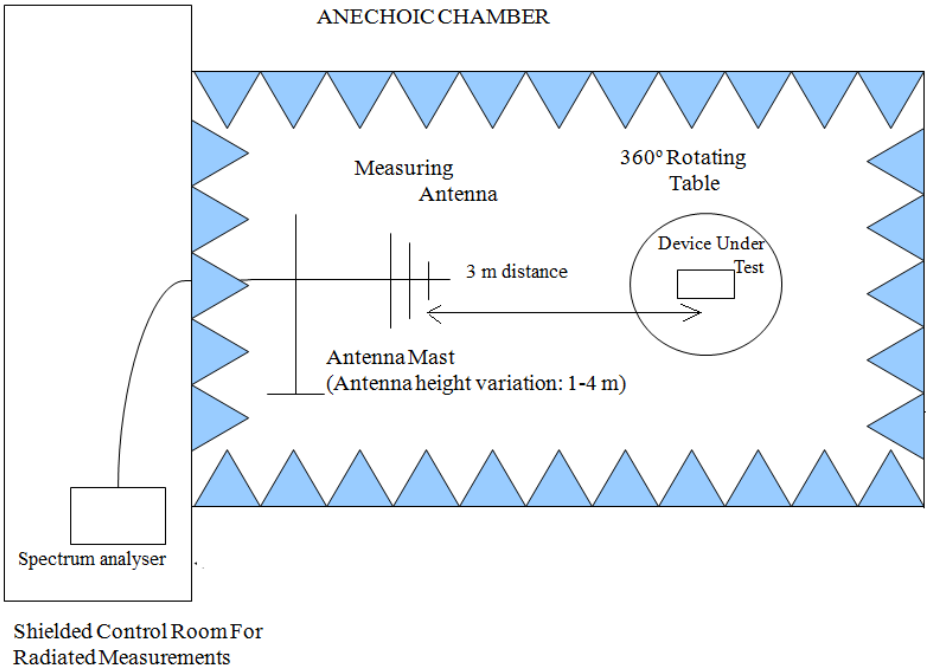
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz and 1 GHz-10 GHz Double ridge horn antenna) is situated at a distance of 3 m.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

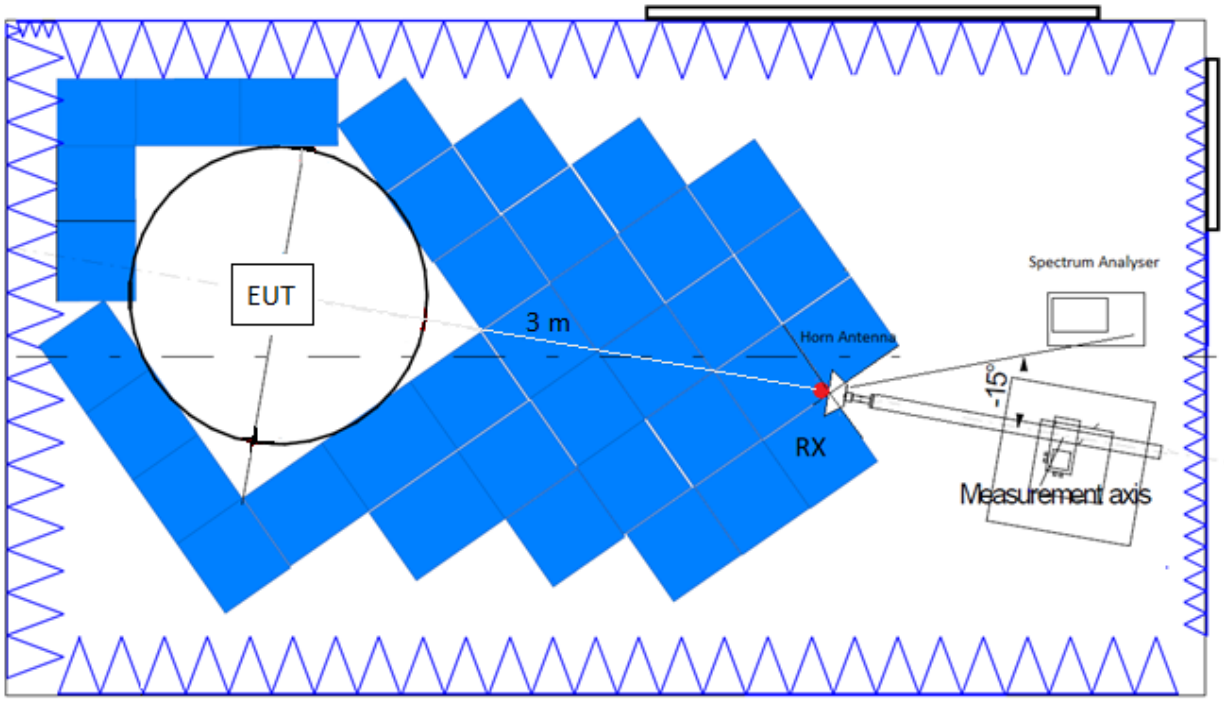
A resolution bandwidth/video bandwidth of 100 kHz/300 kHz was used for frequencies below 1 GHz and 1MHz/3MHz for frequencies above 1 GHz.

Measurements were made in both horizontal and vertical planes of polarization.

Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 10 GHz:



FCC 15.247 (a) (1) / RSS-247 5.1. (c) 20 dB Bandwidth and Carrier frequency separation

SPECIFICATION:

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.

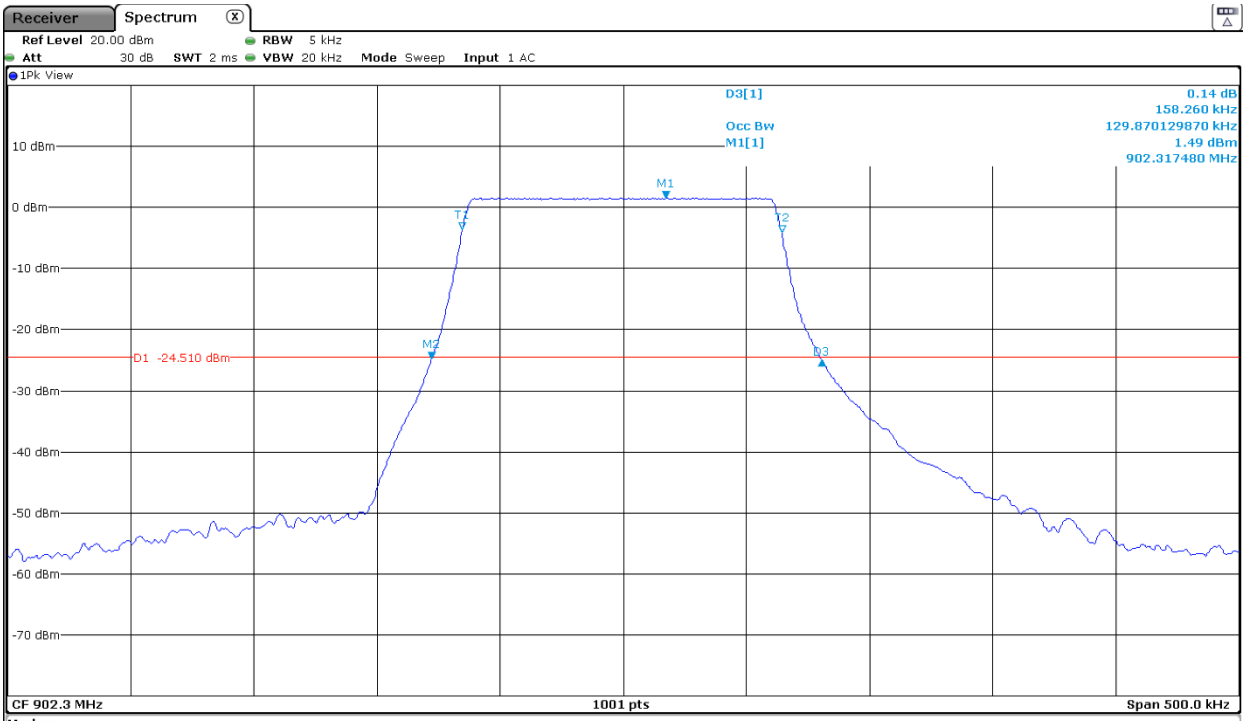
RESULTS:

	Lowest Channel 902.3 MHz	Middle Channel 908.7 MHz	Highest Channel 914.9 MHz
20 dB Spectrum bandwidth (kHz)	148.15	147.65	146.65
99% bandwidth (kHz)	129.87	130.36	129.87
Measurement uncertainty (kHz)	<± 0.87		

Verdict: PASS

99% bandwidth (KHz)

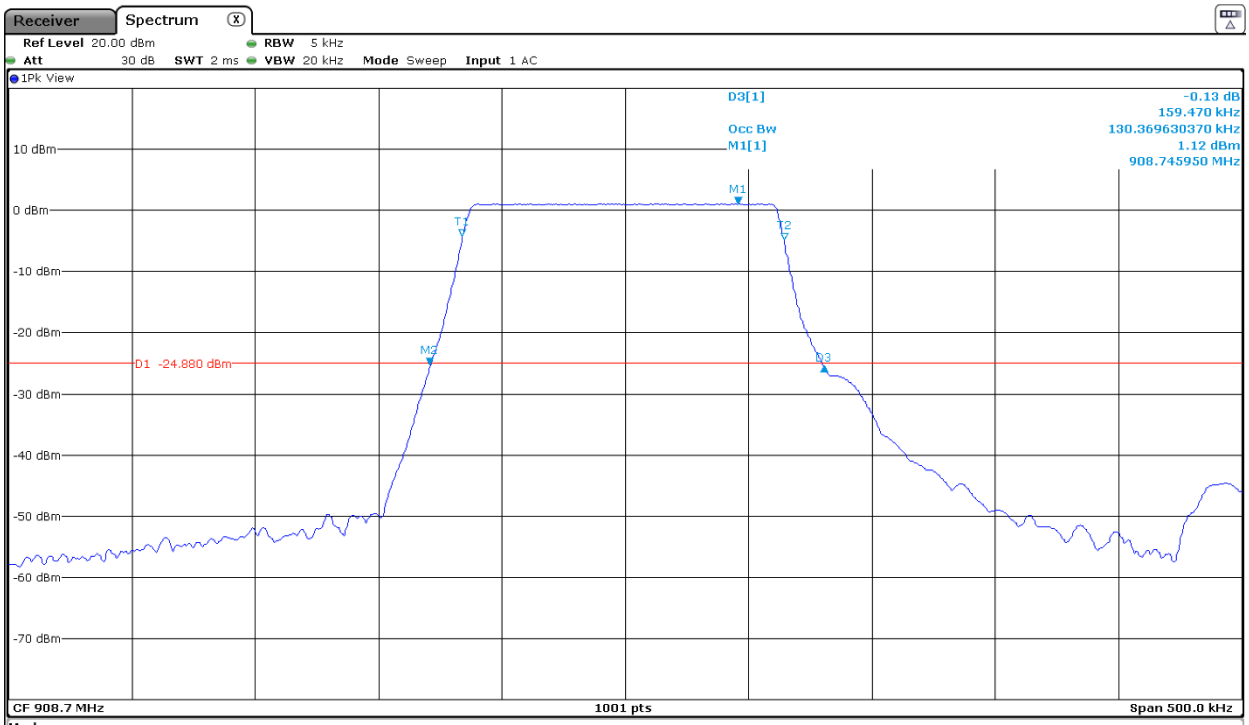
Lowest Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	902.31748 MHz	1.49 dBm		
T1		1	902.234565 MHz	-3.65 dBm	Occ Bw	129.87012987 kHz
T2		1	902.364436 MHz	-4.07 dBm		
M2		1	902.22221 MHz	-24.99 dBm		
D3	M2	1	158.26 kHz	0.14 dB		

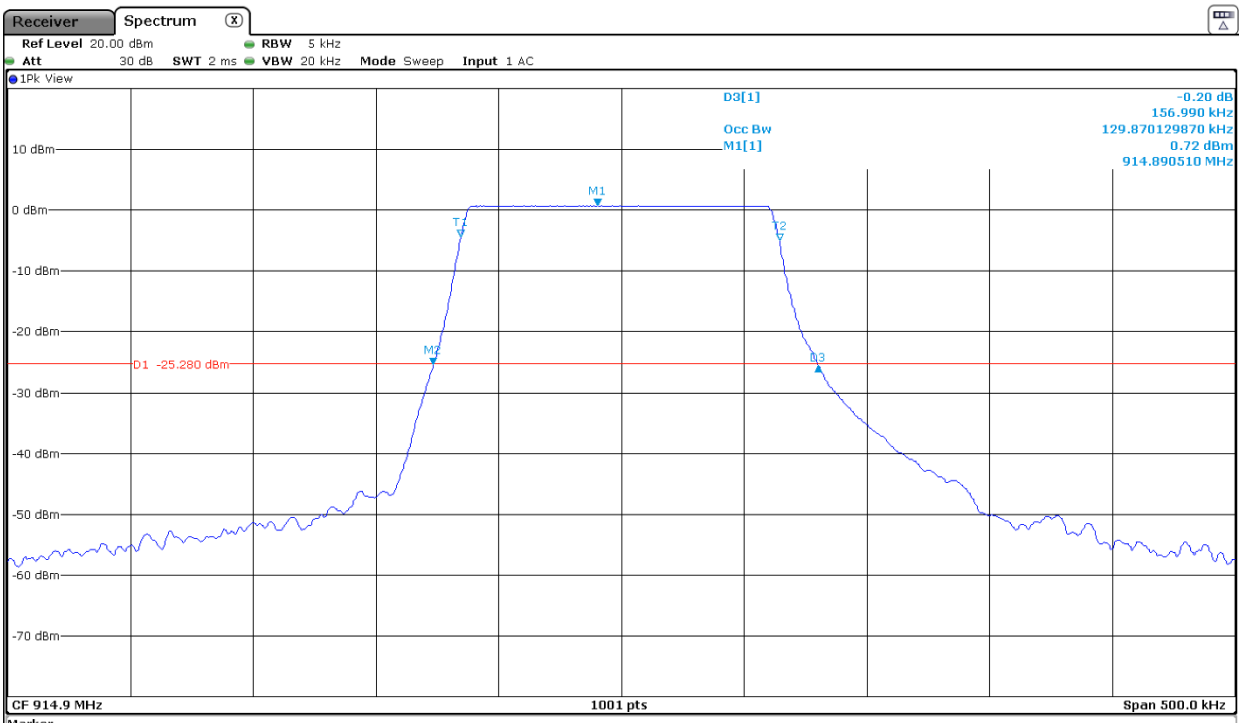
Middle Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	908.74595 MHz	1.12 dBm		
T1		1	908.634066 MHz	-4.27 dBm	Occ Bw	130.36963037 kHz
T2		1	908.764436 MHz	-4.75 dBm		
M2		1	908.62102 MHz	-25.23 dBm		
D3	M2	1	159.47 kHz	-0.13 dB		

High Channel:

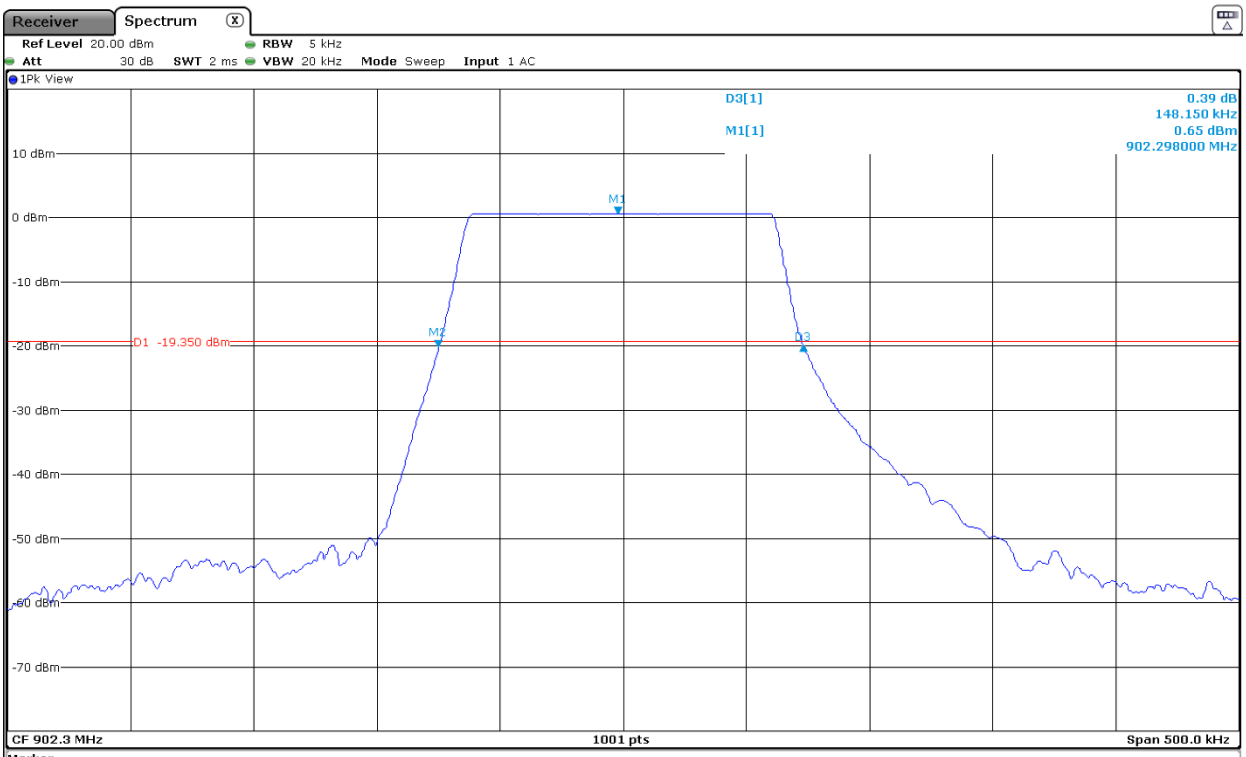


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	914.89051 MHz	0.72 dBm		
T1		1	914.834565 MHz	-4.34 dBm	Occ Bw	129.87012987 kHz
T2		1	914.964436 MHz	-4.98 dBm		
M2		1	914.82343 MHz	-25.38 dBm		
D3	M2	1	156.99 kHz	-0.20 dB		

20 dB Spectrum bandwidth

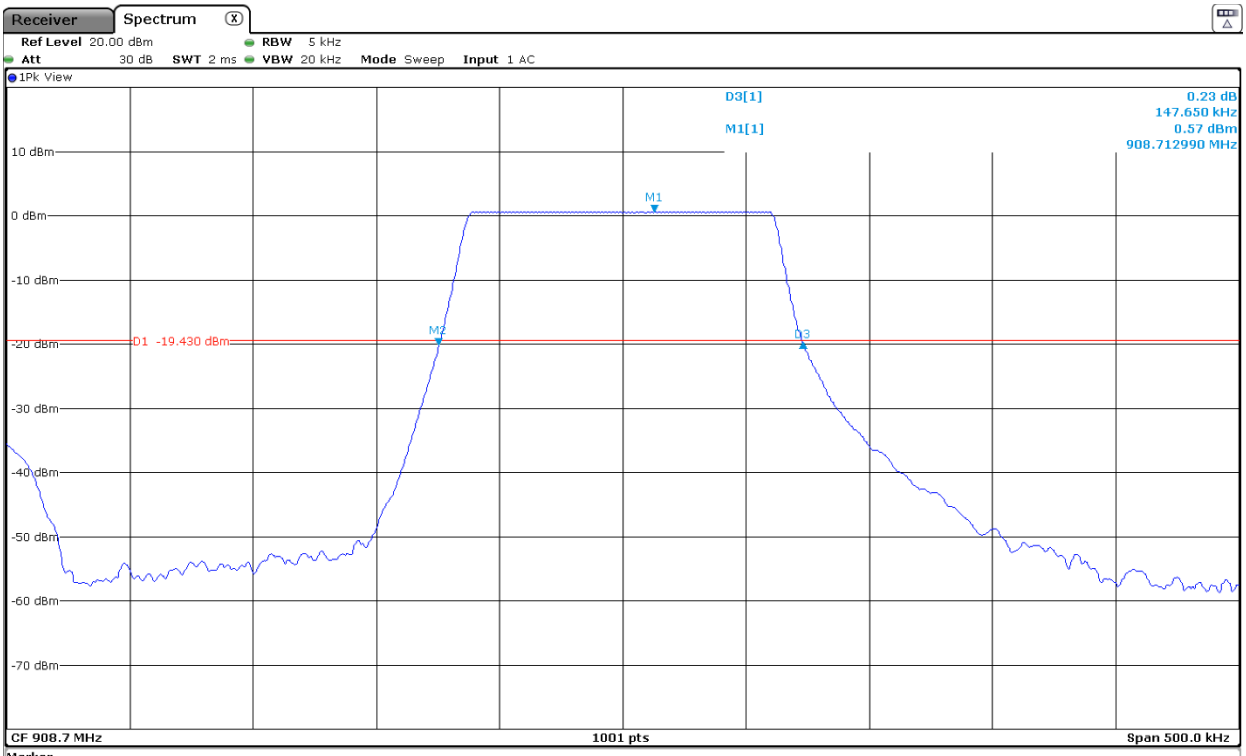
Lowest Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	902.298 MHz	0.65 dBm		
M2		1	902.22502 MHz	-20.09 dBm		
D3	M2	1	148.15 kHz	0.39 dB		

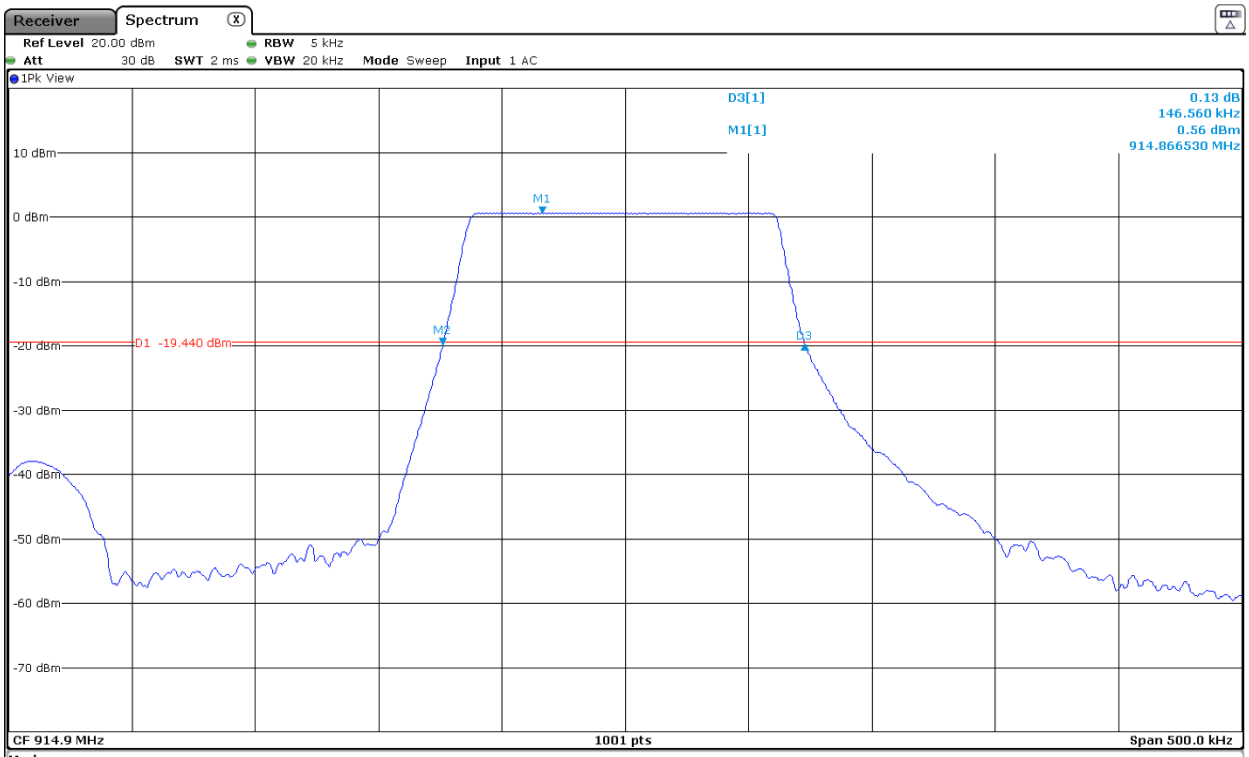
Middle Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	908.71299 MHz	0.57 dBm		
M2		1	908.62538 MHz	-19.84 dBm		
D3	M2	1	147.65 kHz	0.23 dB		

Highest Channel:

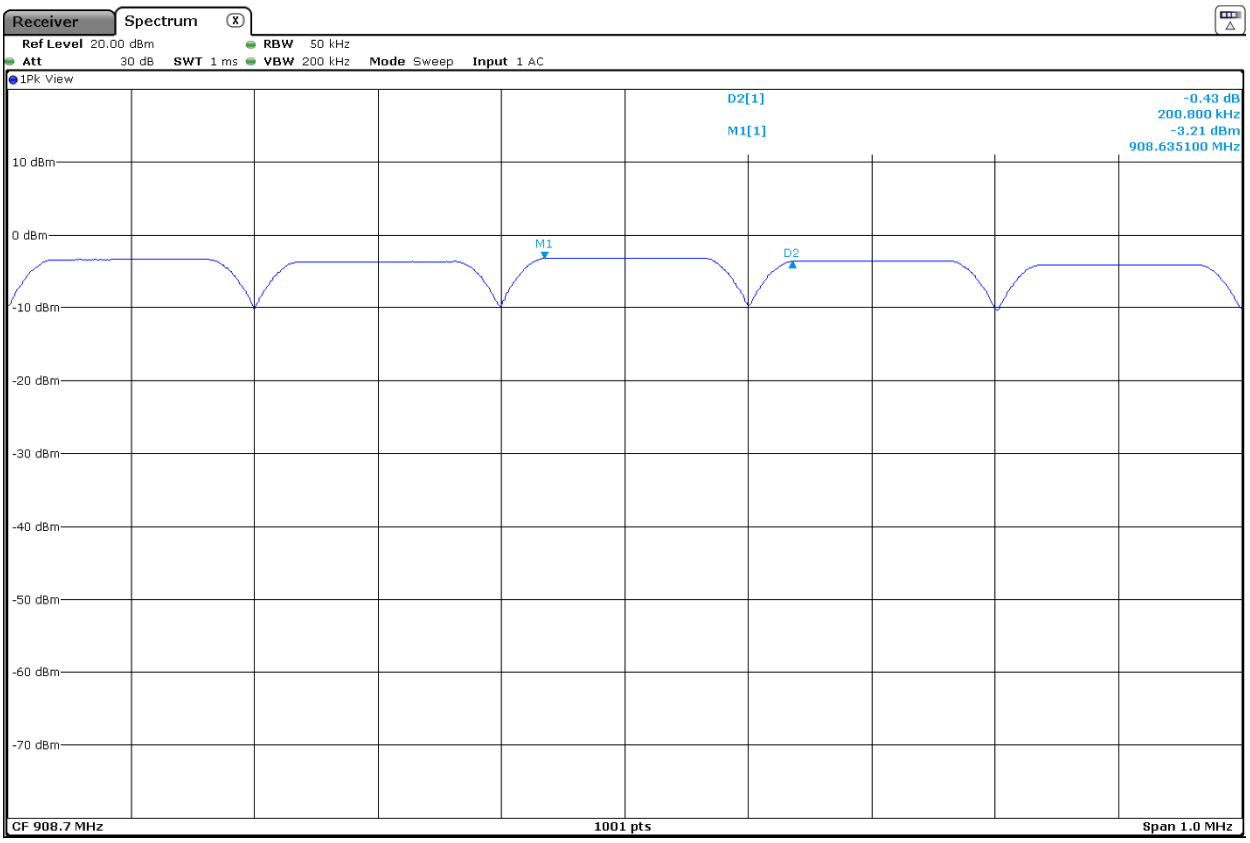


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	914.86653 MHz	0.56 dBm		
M2		1	914.82628 MHz	-19.86 dBm		
D3	M2	1	146.56 kHz	0.13 dB		

Carrier frequency separation

200.8 kHz



The hopping channel carrier frequencies are separated by a minimum of the 20 dB bandwidth of the hopping channel.

Verdict: PASS

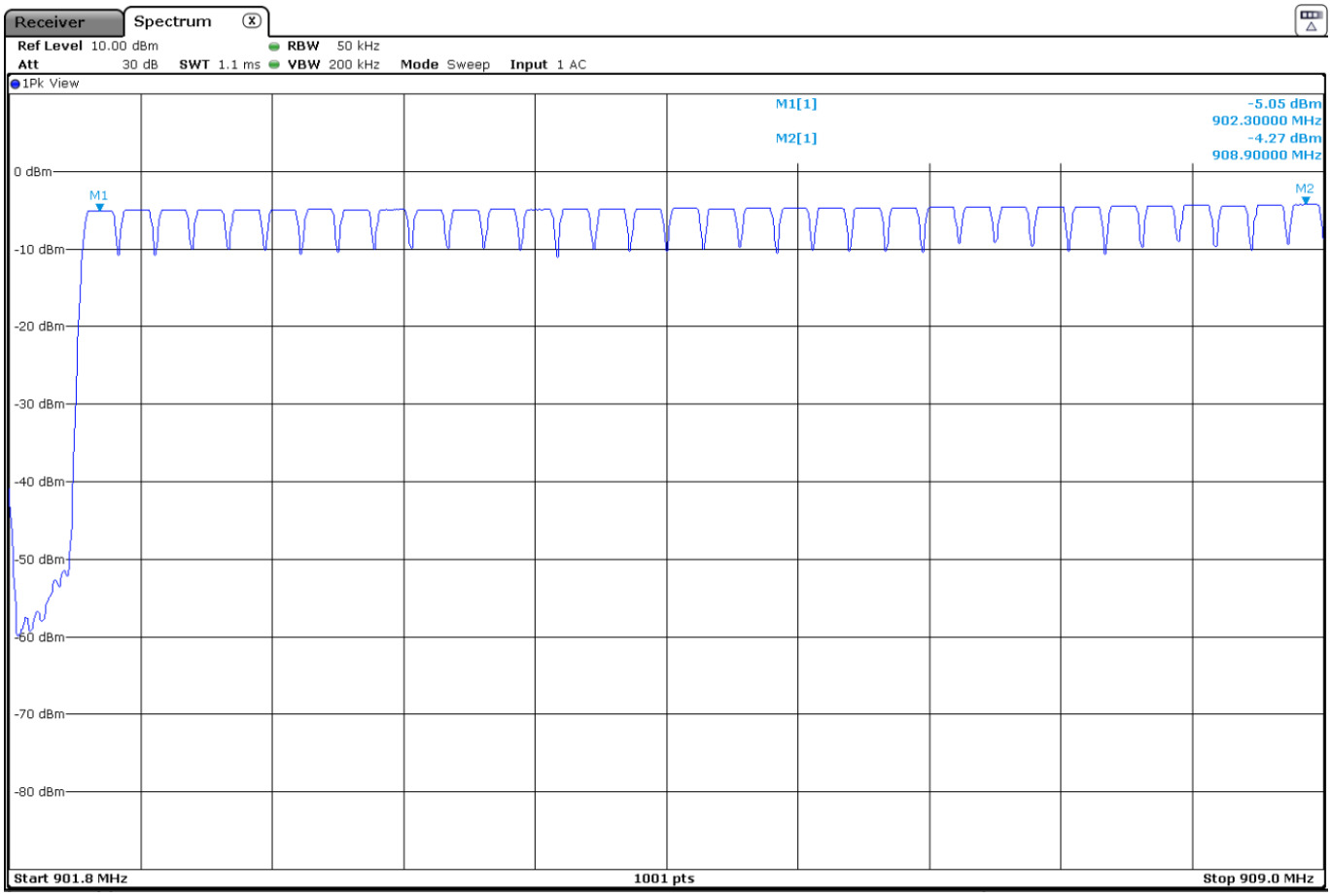
FCC 15.247 (a) (1) (i) / RSS-247 5.1 (c). Number of hopping channels

SPECIFICATION

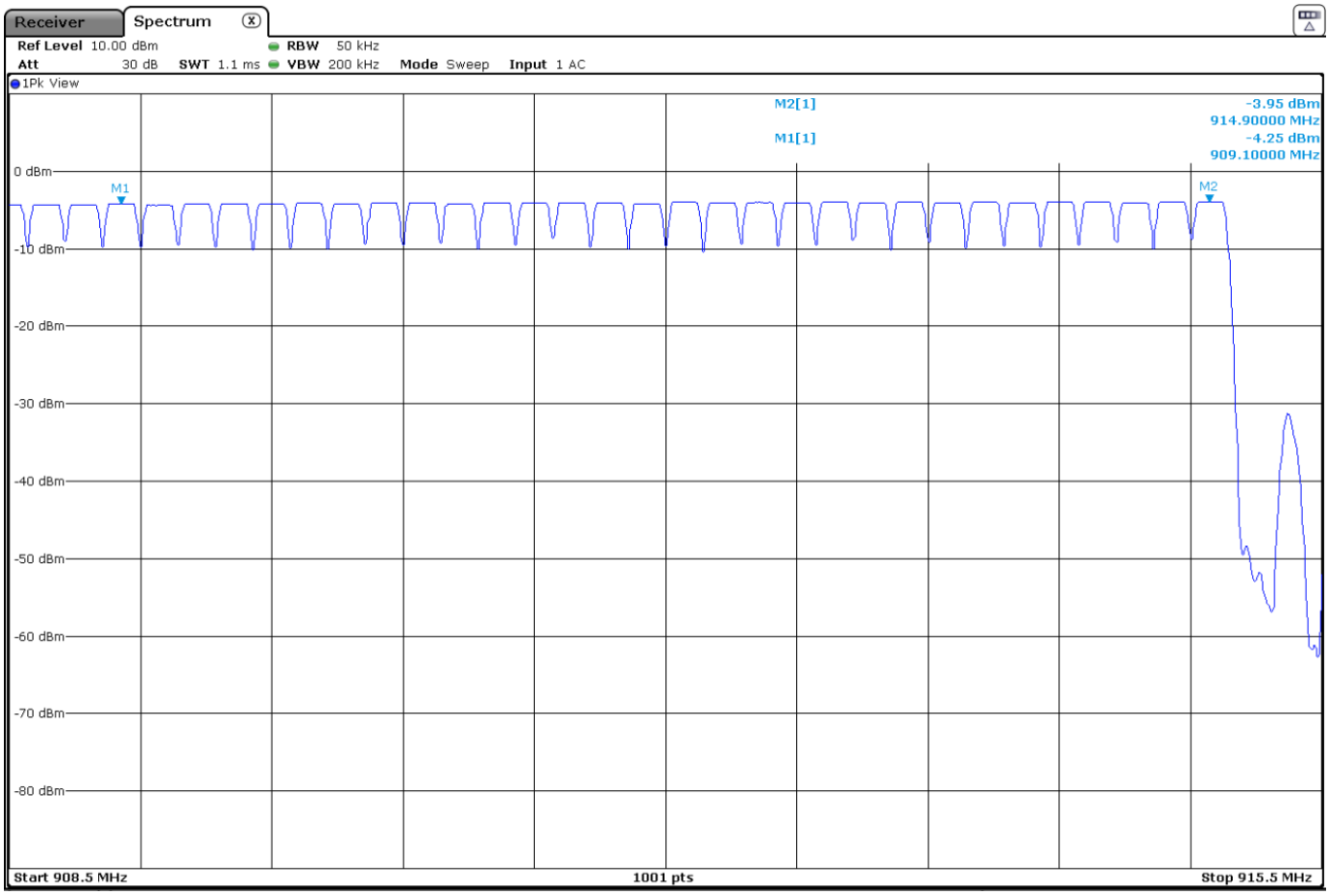
For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period;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

RESULTS

The maximum number of hopping channels is 64 when the equipment operates as a frequency hopping system (see next plots).



Number of hopping frequencies: 34



Number of hopping frequencies: 30

Verdict: PASS

FCC 15.247 (a) (1) (i) / RSS-247 5.1. (c) Time of occupancy (Dwell Time)

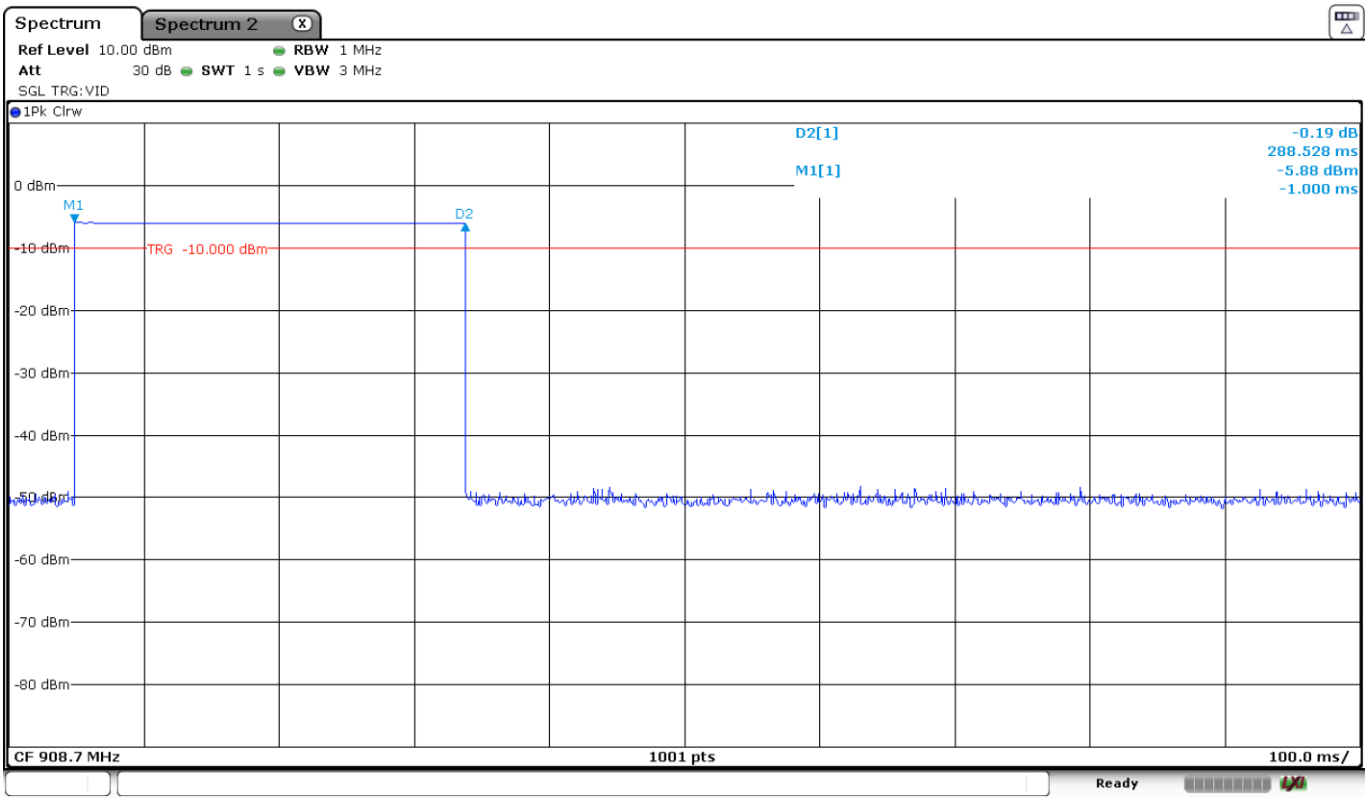
SPECIFICATION:

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.

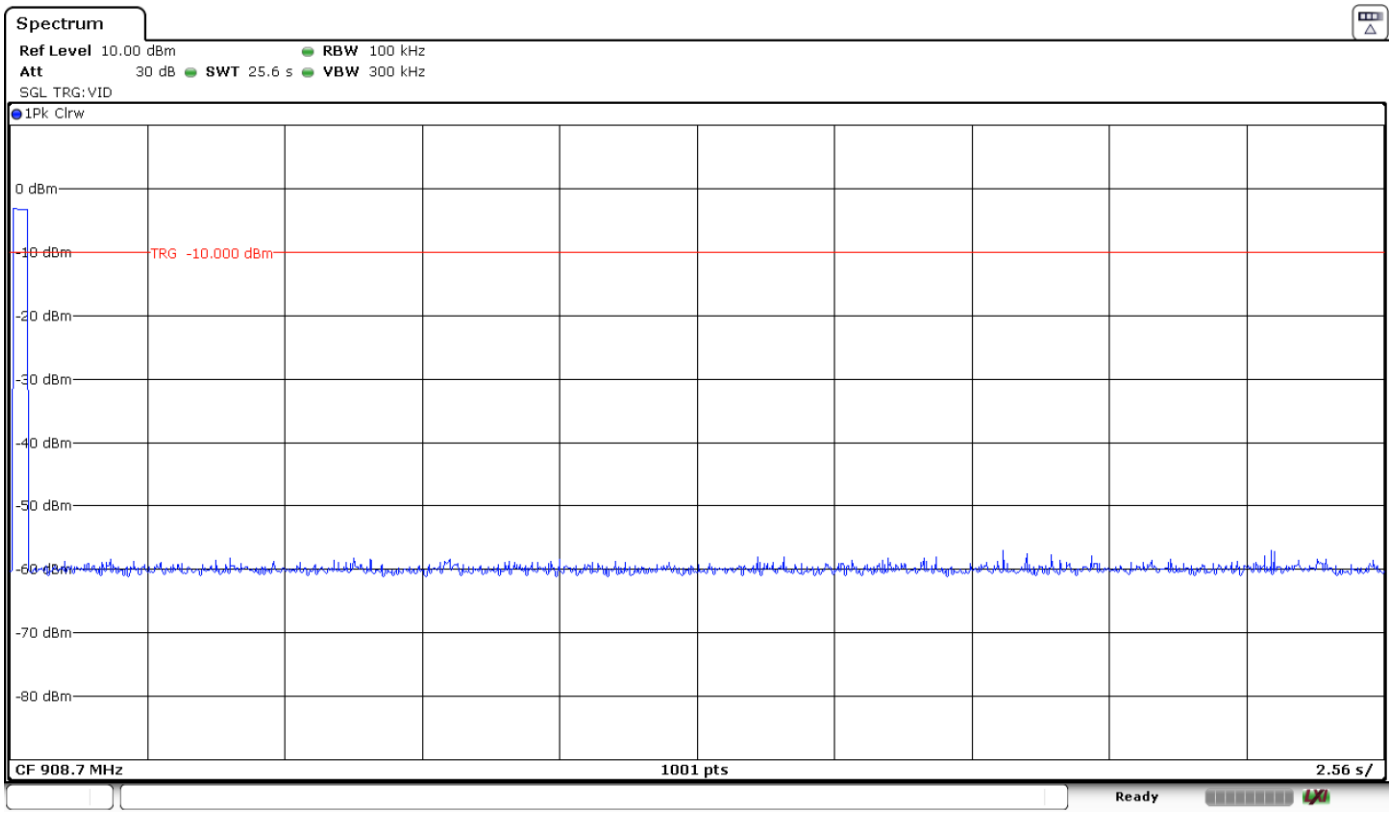
RESULTS:

1. OPERATION AS FREQUENCY HOPPING SYSTEM USING 64 HOPPING CHANNELS:

- TX time per hop: 288.528 ms (see next plots)



- Number of hops over a period of 20 s: 1 (see next plots)



- **Average Time of Occupancy** = 288.528 ms x 1 hops = 288.528 ms per 25.6 s.

  Average Time of Occupancy is <0.4 s per time period in seconds equal to the number of hopping frequencies employed (64) multiplied by 0.4.

Measurement uncertainty (%)	<±0.11

Verdict: PASS

FCC 15.247 (b) / RSS-247 5.4 (a) Maximum output power and antenna gain

SPECIFICATION:

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.

Hybrid systems shall comply with the 1 W limit.

Additionally for RSS-247:

For FHSs operating in the band 902-928 MHz, the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

RESULTS:

The maximum peak conducted output power was measured using the method RBW ≥ DTS bandwidth according to point 11.9.1.1 of ANSI C.63.10-2013".

The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

Maximum Declared Antenna Gain: +2.31 dBi

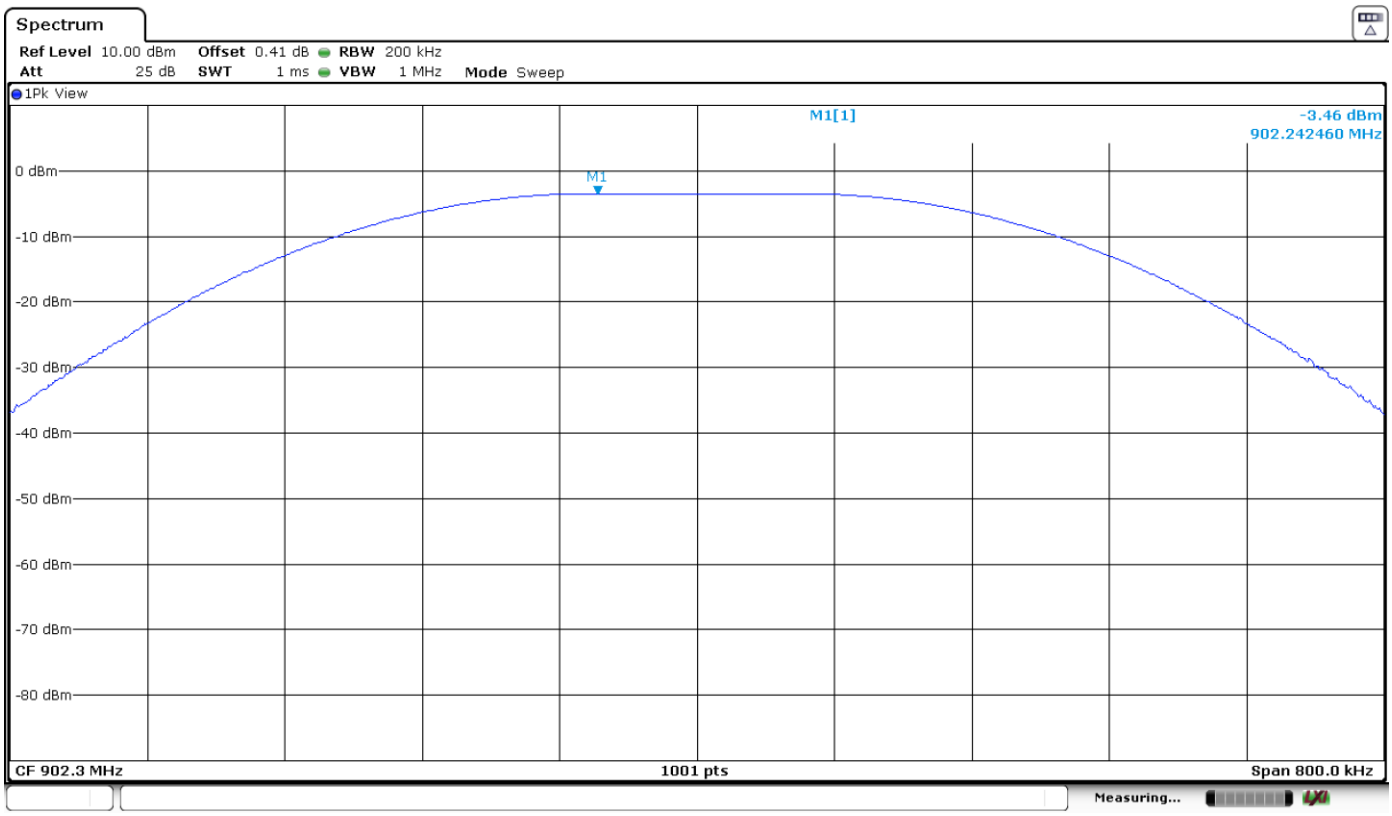
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

	Lowest Channel 902.3 MHz	Middle Channel 908.7 MHz	Highest Channel 914.9 MHz
Maximum Conducted Power (dBm)	-3.46	-5.43	-6.08
Maximum E.I.R.P. power (dBm)	-1.15	-3.12	-3.77
Measurement uncertainty (dB)	<±2.57		

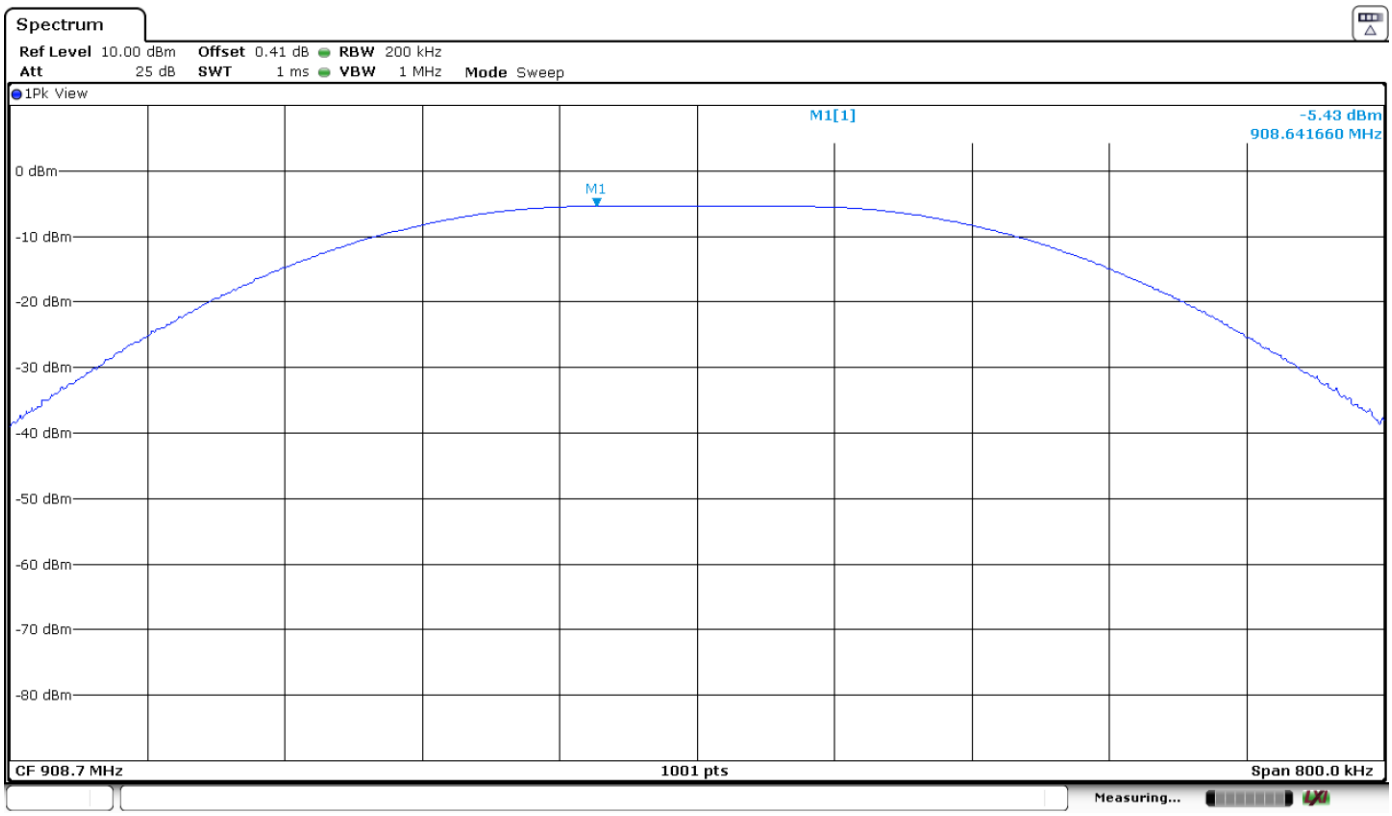
Verdict: PASS

Maximum Peak Output Power:

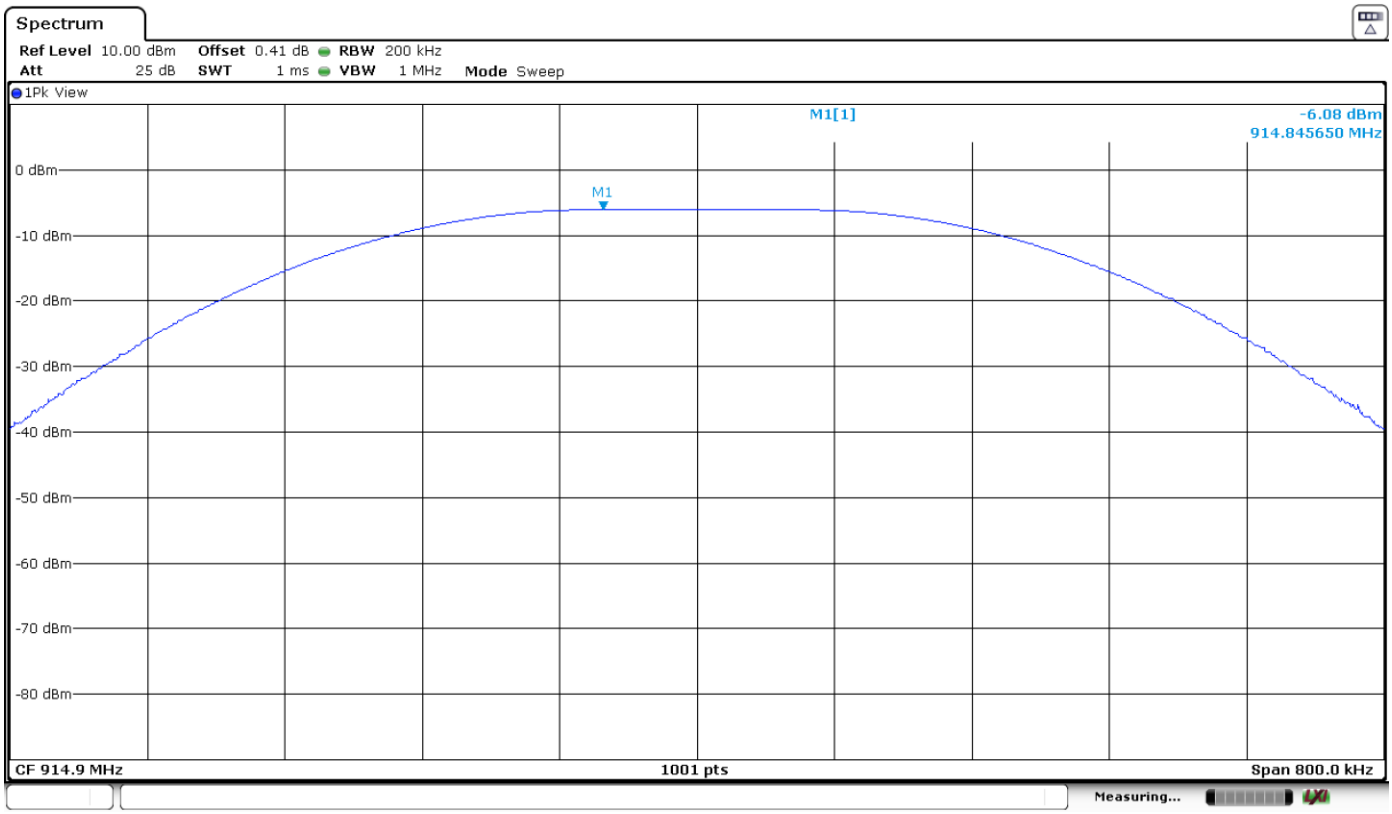
Lowest Channel:



Middle Channel:



Highest Channel:



FCC 15.247 (d) / RSS-247 5.5. Band-edge compliance of conducted emissions (Transmitter)

SPECIFICATION:

In any 100 kHz bandwidths outside the frequency band in which the 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.

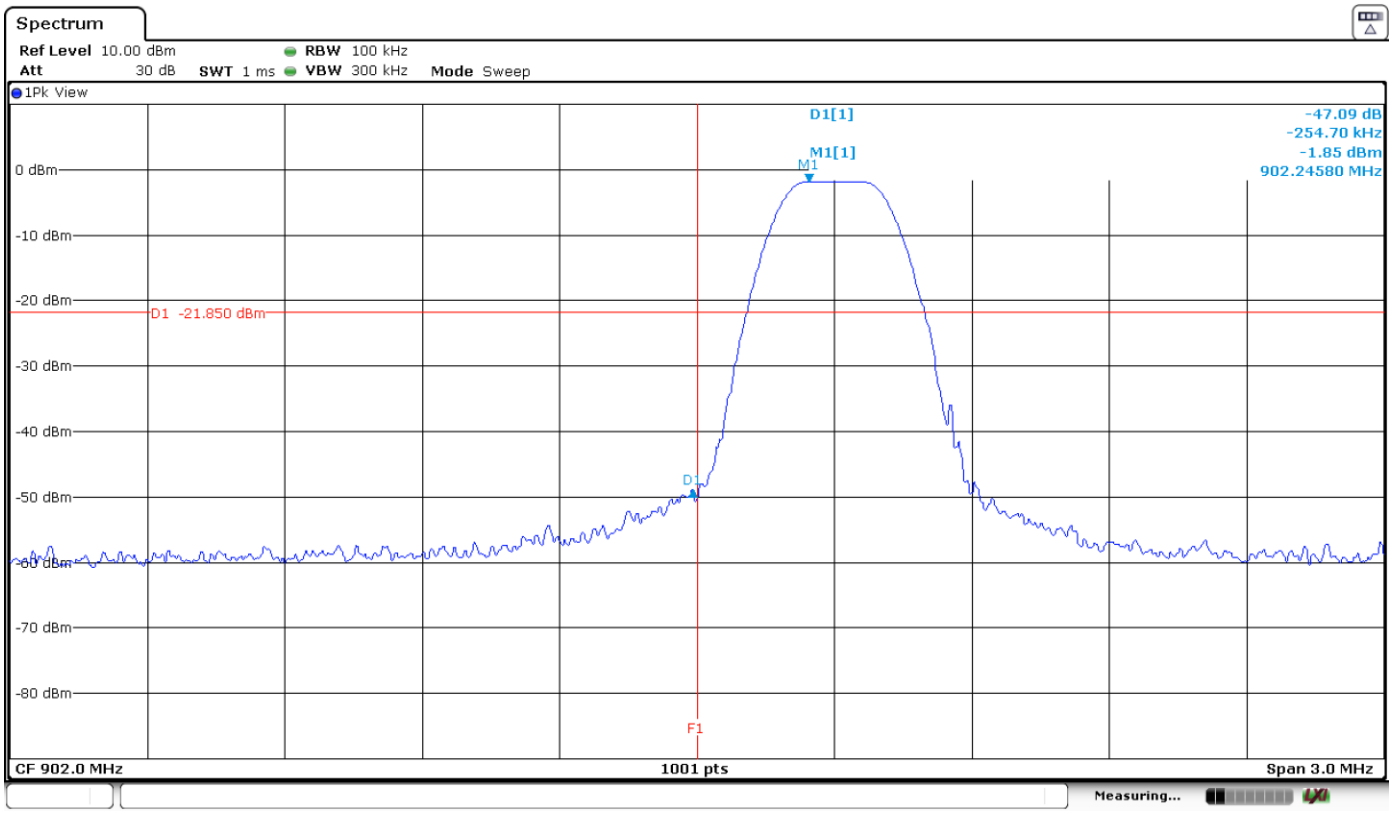
If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

RESULTS:

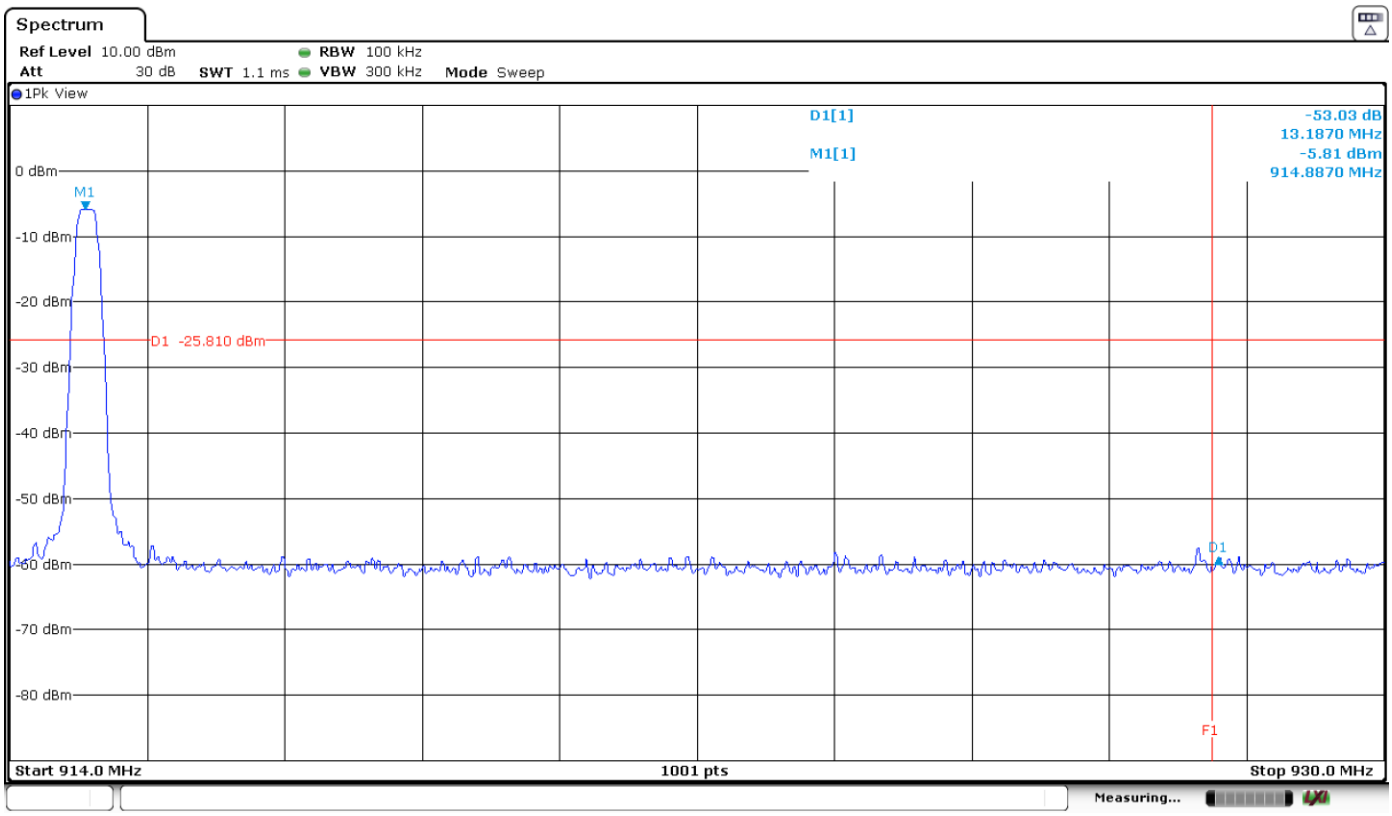
The attenuation of highest emissions at the band-edge is more than 30 dB respect to the highest level of the desired power.

- HOPPING OFF:

  - LOW FREQUENCY SECTION:

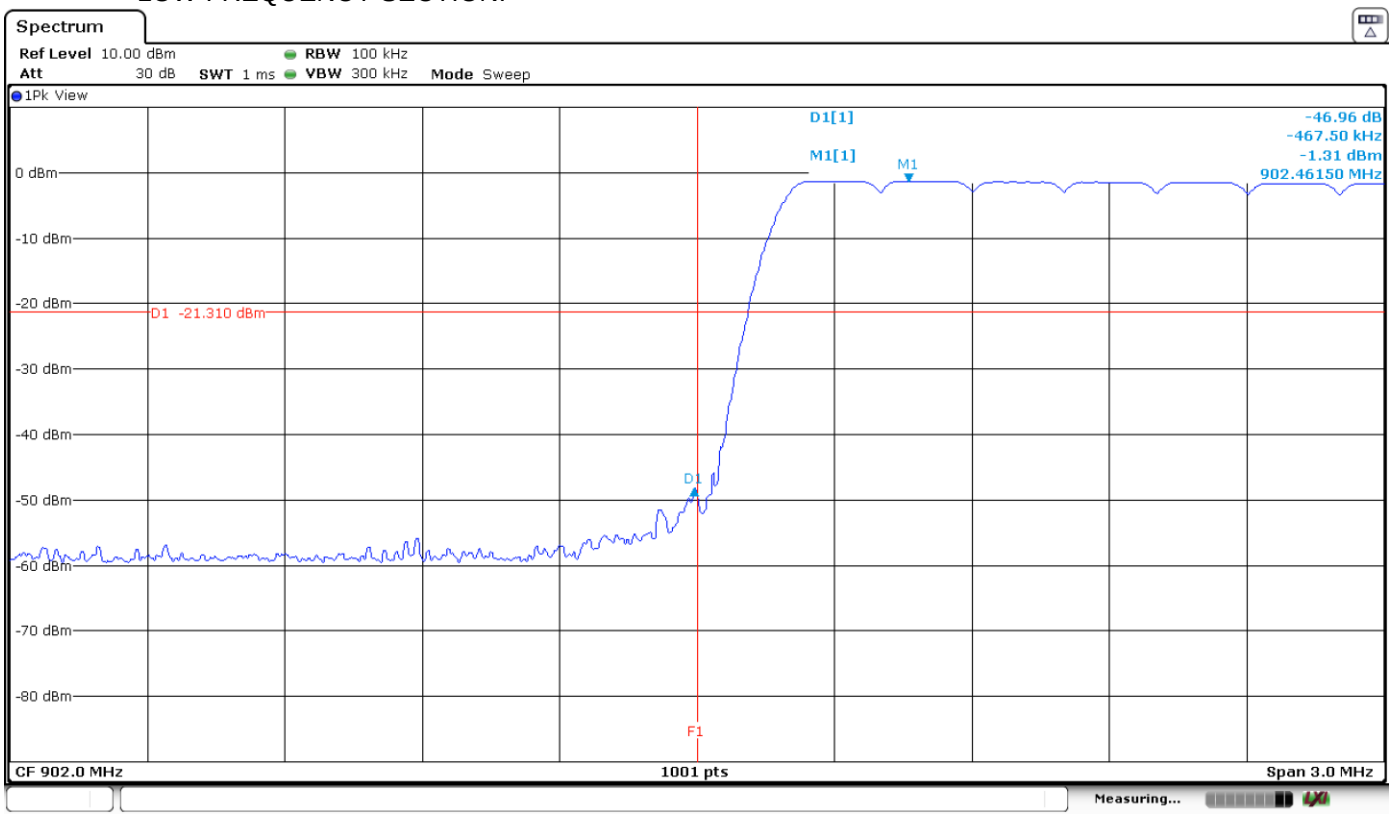


- HIGH FREQUENCY SECTION:

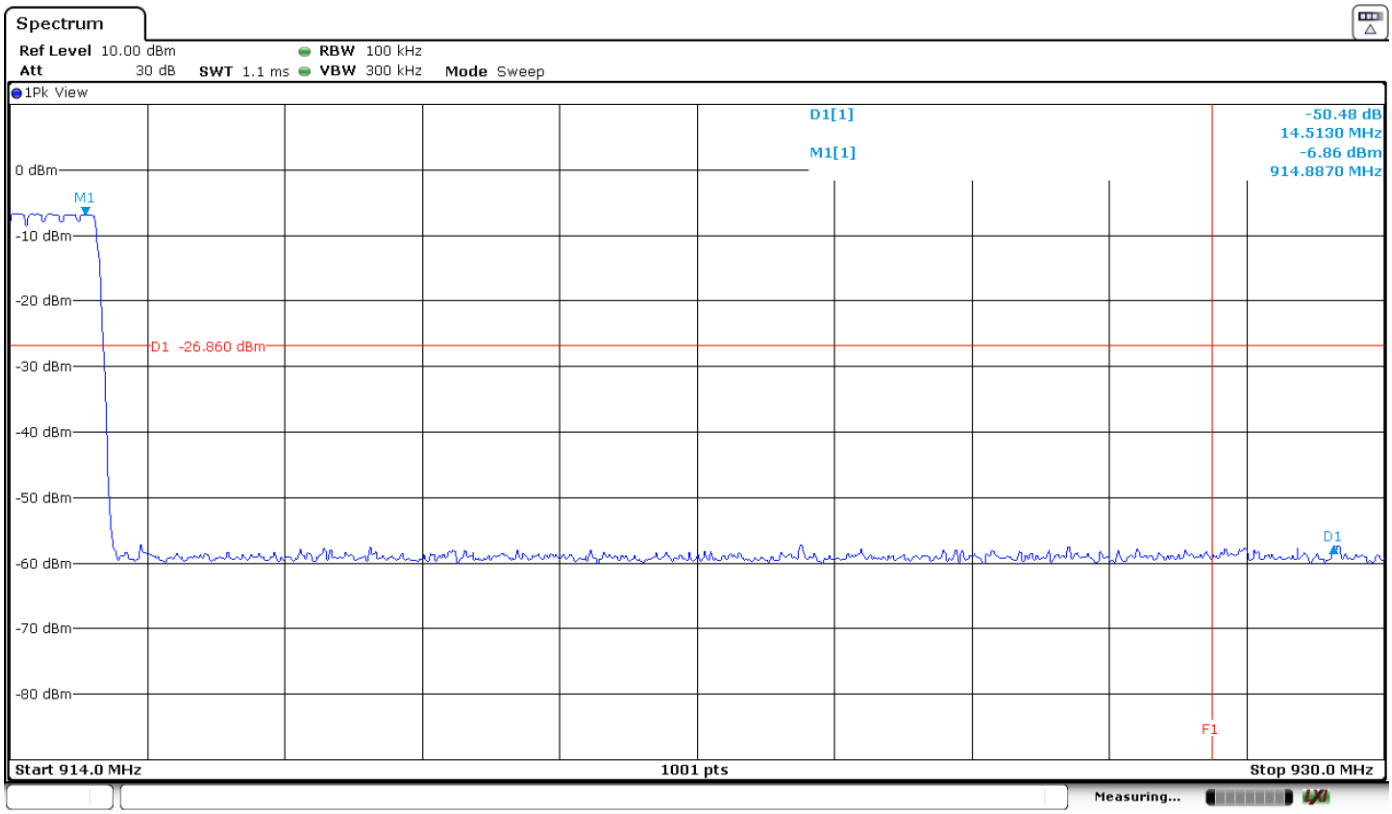


- HOPPING ON:

  - LOW FREQUENCY SECTION:



- HIGH FREQUENCY SECTION:



Verdict: PASS

Measurement uncertainty (dB)	<±2.57

FCC 15.247 (d) / RSS-247 5.5. Emission limitations radiated (Transmitter)

SPECIFICATION:

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)/RSS-Gen):

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 10000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RSS-247. Attenuation below the general field strength limits specified in RSS-Gen is not required.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-10 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

RADIATED:

Frequency range 30 MHz - 1 GHz:

The spurious frequencies do not depend on the operating channel.

Spurious frequencies closest to the limit:

Spurious Frequency (MHz)	Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
893.446	34.40	H	Quasi peak	<± 4.99
943.473	39.40	H	Quasi peak	<± 4.99

Frequency range 1 - 10 GHz:

The results in the next tables show the maximum measured levels in the 1-10 GHz range (see next plots).

Spurious frequencies with peak levels above the average limit (54 dBµV/m at 3 m) are measured with average detector for checking compliance with the average limit.

- LOW CHANNEL. Spurious frequencies closest to the limit:

Spurious Frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
3.609120	50.46	H	Peak	<± 4.98
4.511180	50.84	H	Peak	<± 4.98
5.414180	45.72	V	Peak	<± 4.98
				<± 4.98
6.315550	51.97	H	Peak	<± 4.98
8.120620	54.69	H	Peak	<± 4.98
	53.14		Average	<± 4.98
9.924520	50.86	V	Peak	<± 4.98

- MIDDLE CHANNEL. Spurious frequencies closest to the limit:

Spurious Frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2.726167	39.76	V	Peak	<± 4.98
3.635020	48.68	H	Peak	<± 4.98
4.543620	51.59	H	Peak	<± 4.98
5.452220	45.43	H	Peak	<± 4.98
6.360820	51.45	H	Peak	<± 4.98
8.178480	56.51	H	Peak	<± 4.98
	53.96		Average	<± 4.98
9.086380	49.50	H	Peak	<± 4.98

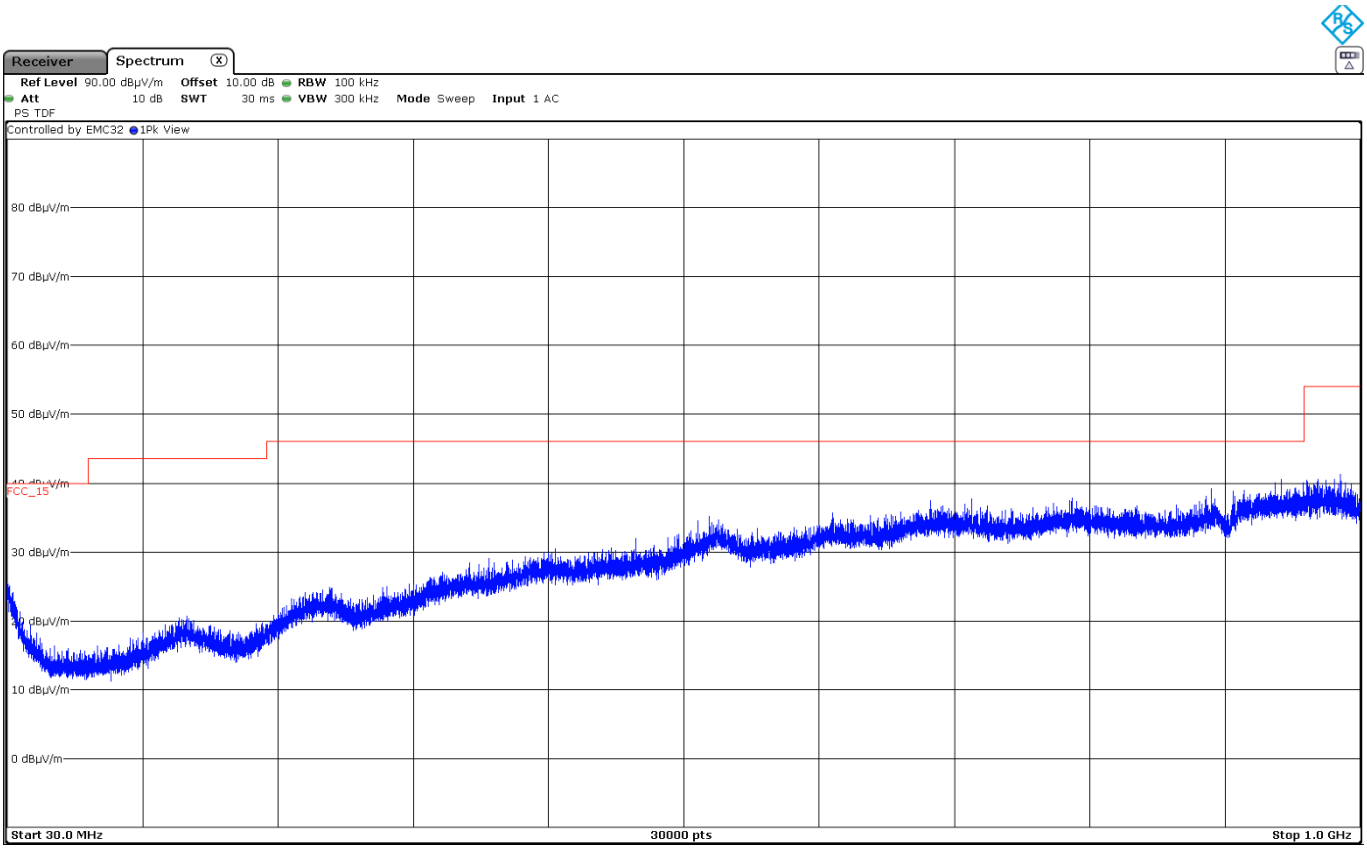
- HIGH CHANNEL. Spurious frequencies closest to the limit:

Spurious Frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
3.659750	48.13	H	Peak	<± 4.98
4.574650	54.73	V	Peak	<± 4.98
	53.91		Average	<± 4.98
5.489780	47.45	V	Peak	<± 4.98
6.404680	52.31	H	Peak	<± 4.98
8.234020	56.06	H	Peak	<± 4.98
	53.94		Average	<± 4.98
9.148680	50.37	H	Peak	<± 4.98

Verdict: PASS

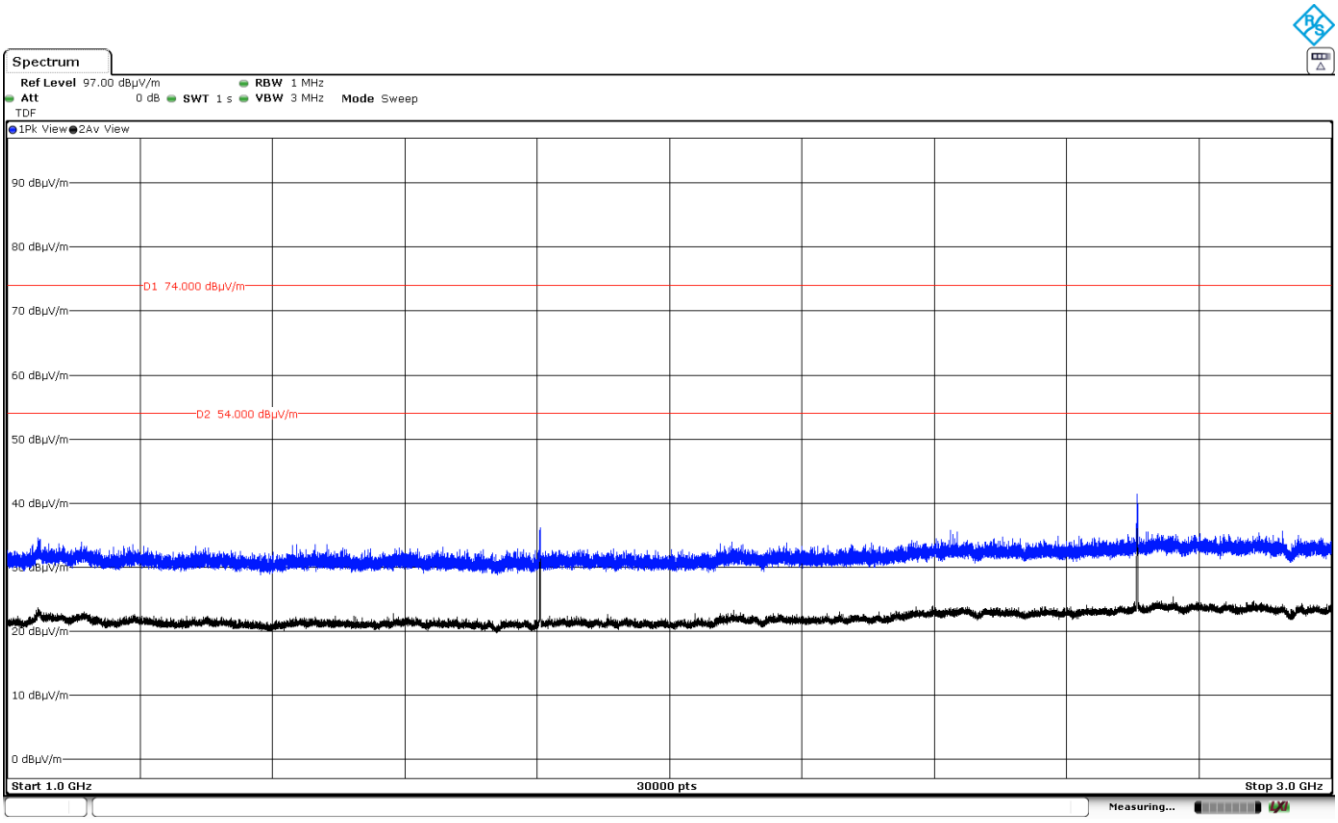
FREQUENCY RANGE 30 MHz - 1 GHz:

This plot is valid for the Low, Middle and High Channels.

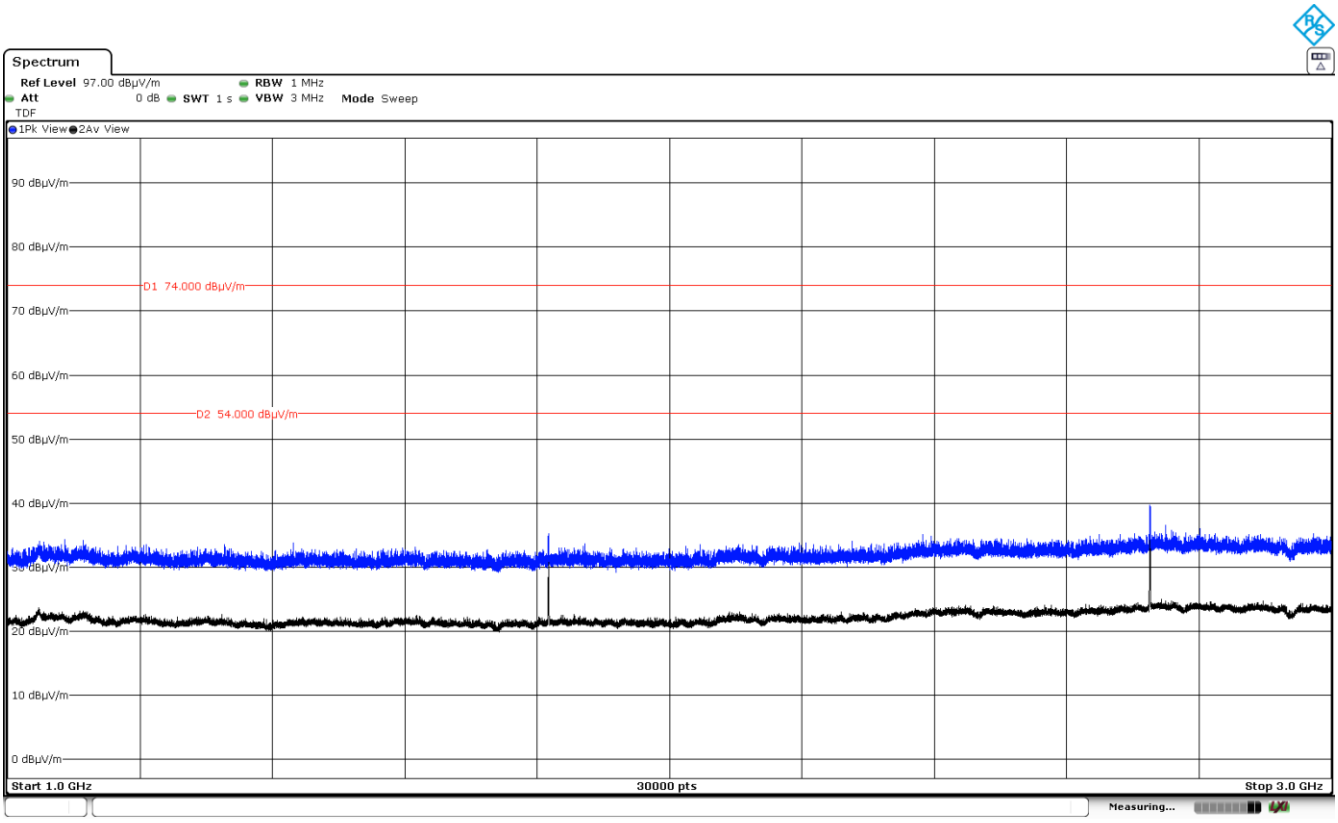


FREQUENCY RANGE 1 - 3 GHz:

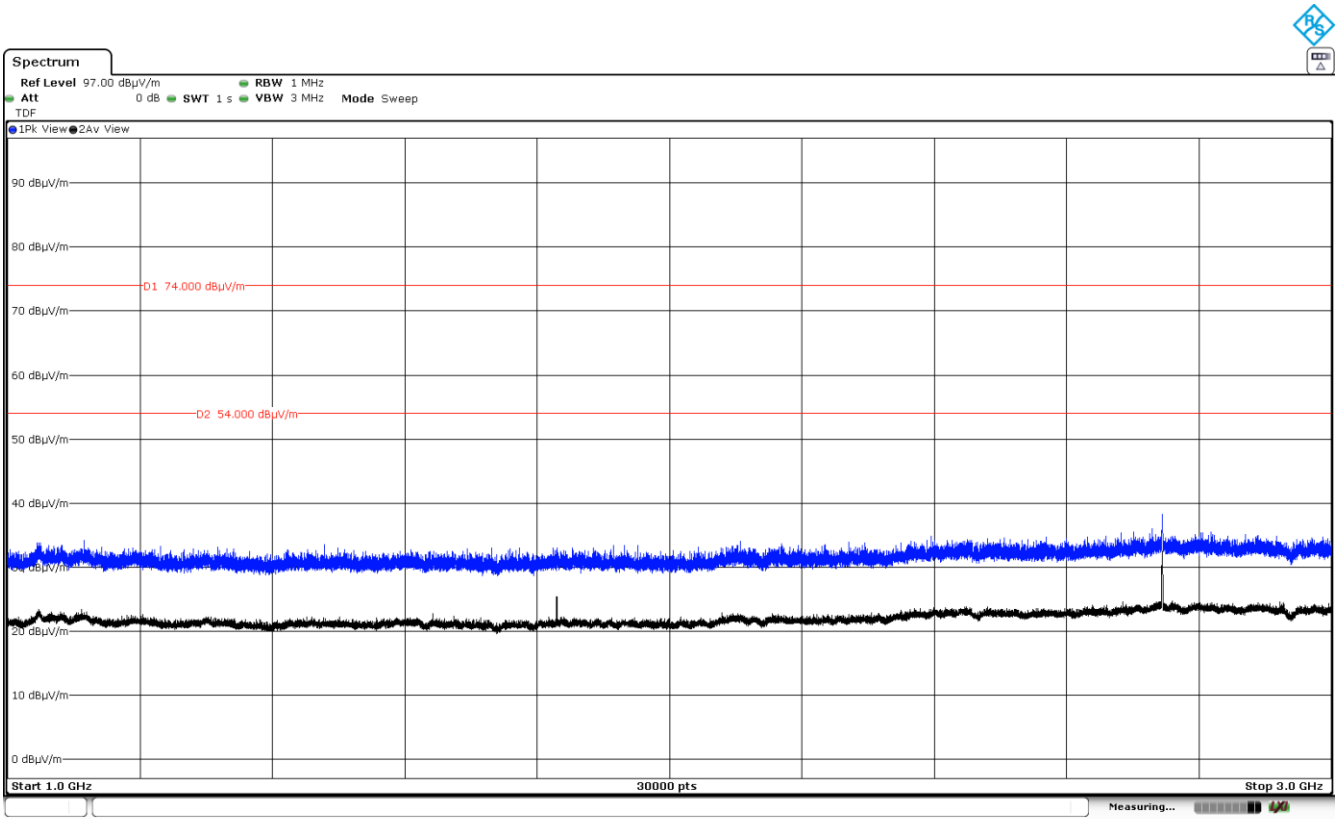
- Low Channel:



- Middle Channel:

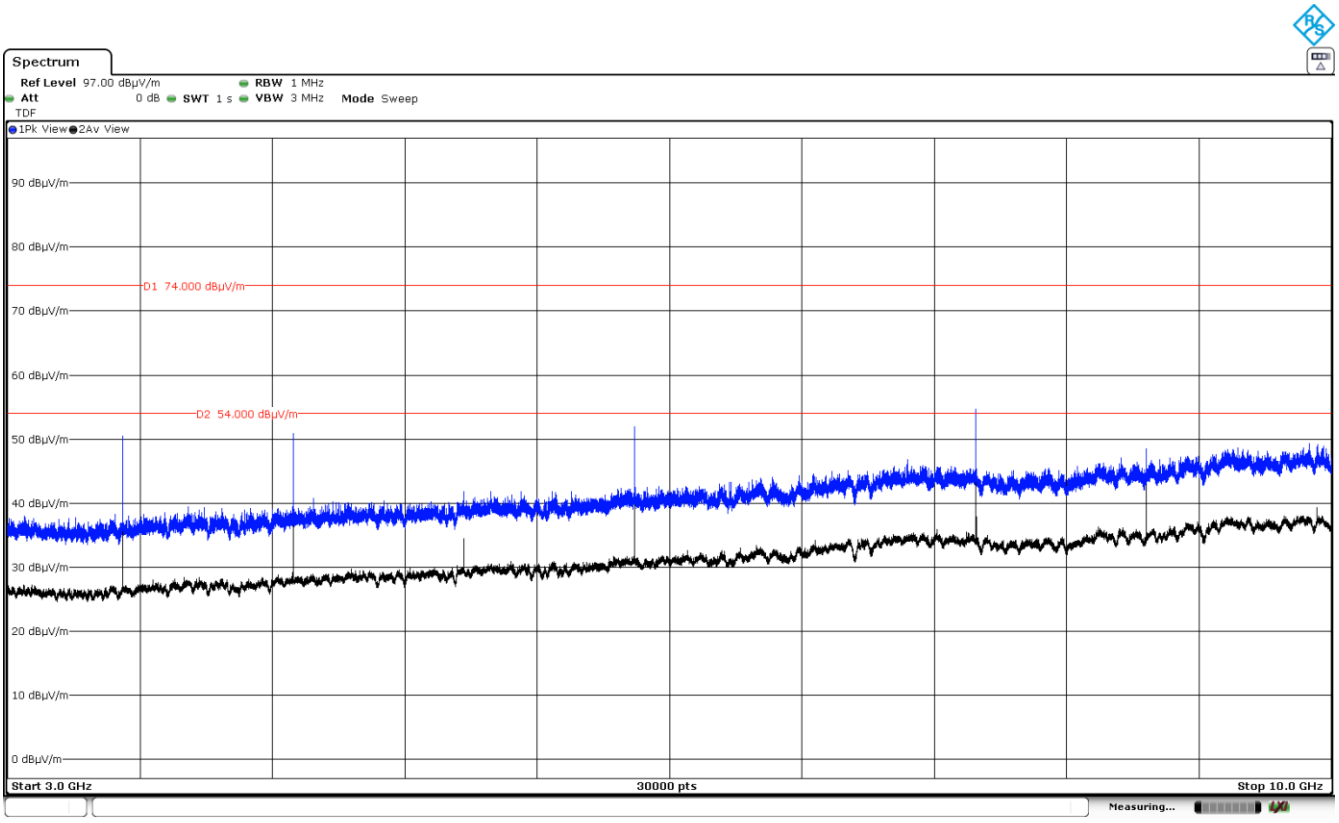


- High Channel:

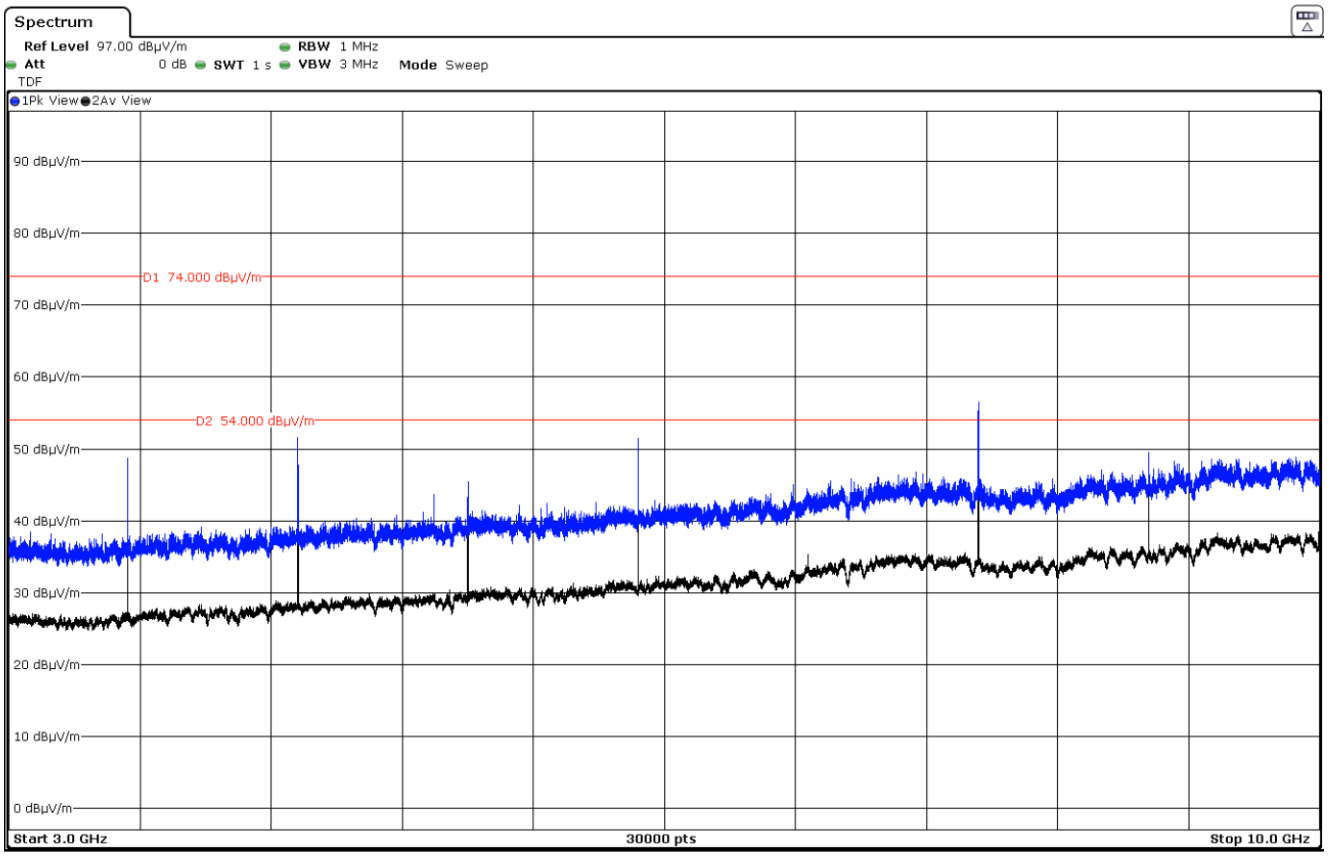


FREQUENCY RANGE 3 - 10 GHz:

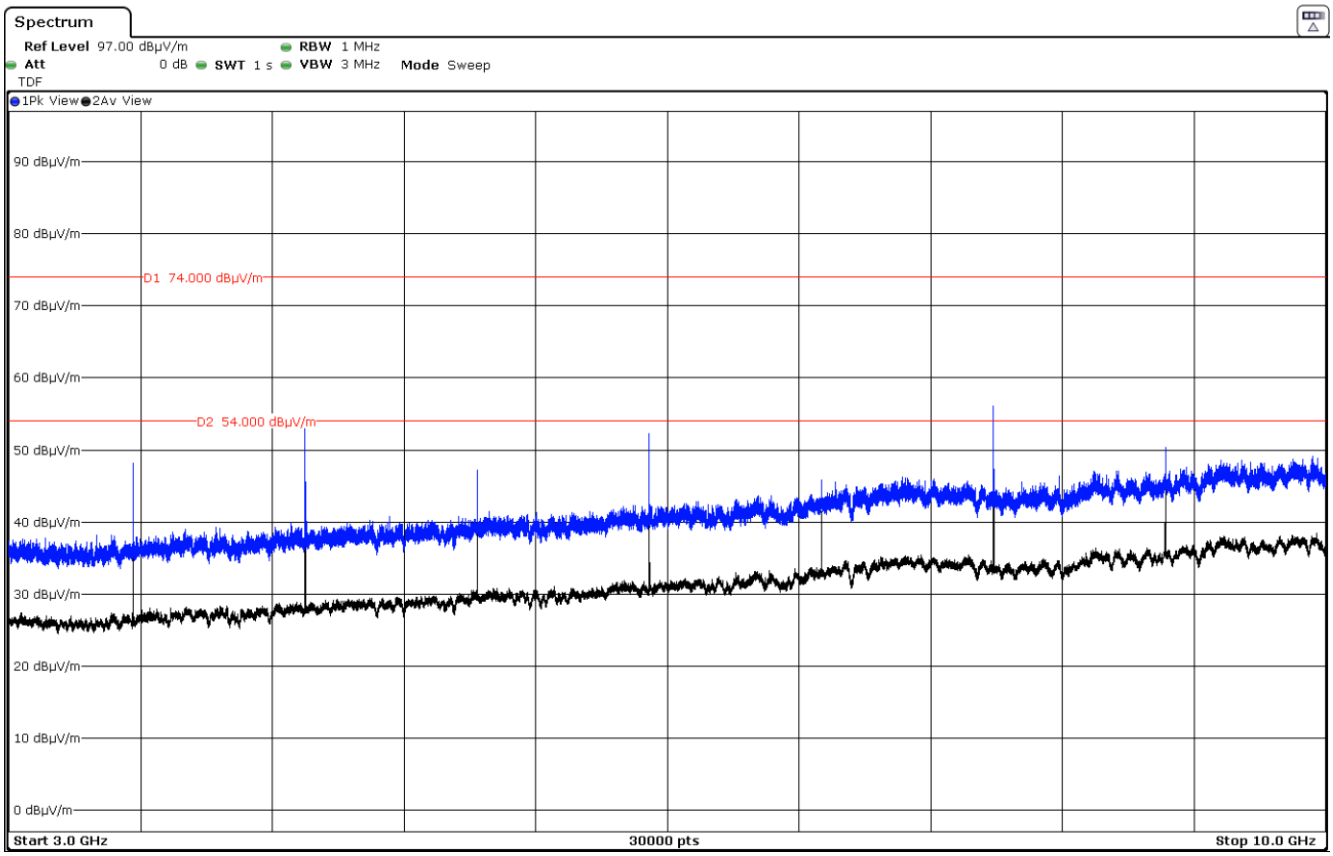
- Low Channel:



- Middle Channel:



- High Channel:



Appendix B: Test results. LoRa 500 kHz

INDEX

TEST CONDITIONS 38
Occupied Bandwidth 40
FCC 15.247 (a)(2) / RSS-247 5.2. (a) 6 dB Bandwidth 42
FCC 15.247 (b) / RSS-247 5.4. (d) Maximum output power and antenna gain 44
FCC 15.247 (d) / RSS-247 5.5. Band-edge emissions compliance (Transmitter) 47
FCC 15.247 (e) / RSS-247 5.2. (b) Power spectral density 49
FCC 15.247 (d) / RSS-247 5.5. Emission limitations radiated (Transmitter) 51

TEST CONDITIONS

POWER SUPPLY (V):

Vnominal:	3.6 Vdc.
Type of Power Supply:	Battery.

ANTENNA:

Type of Antenna:	Internal.
Maximum Declared Antenna Gain:	+2.31 dBi

TEST FREQUENCIES:

Low Channel:	903.0 MHz
Middle Channel:	909.4 MHz
High Channel:	914.2 MHz

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.

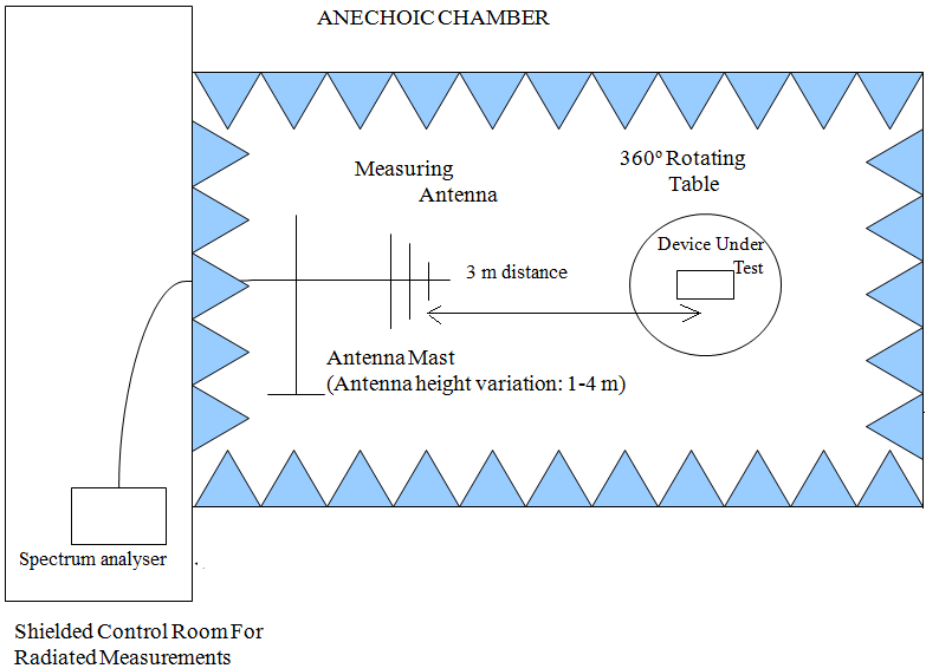
RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz and 1 GHz-10 GHz Double ridge horn antenna) is situated at a distance of 3 m.

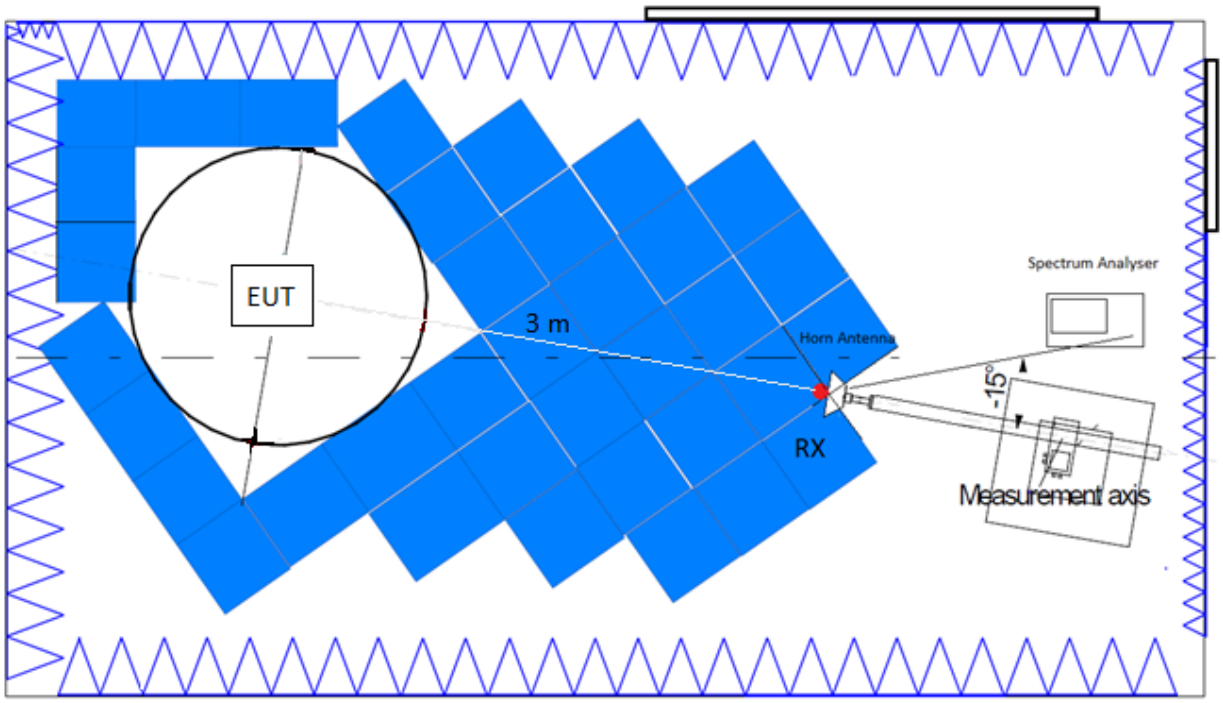
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 10 GHz:

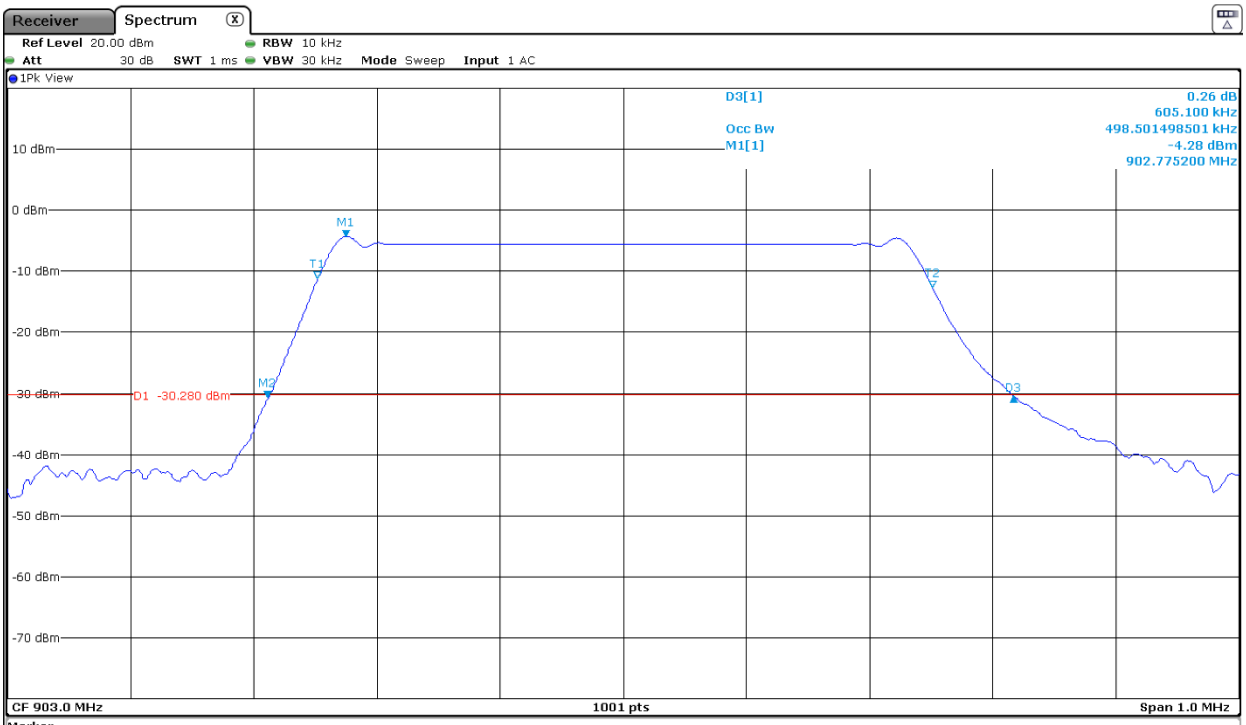


Occupied Bandwidth

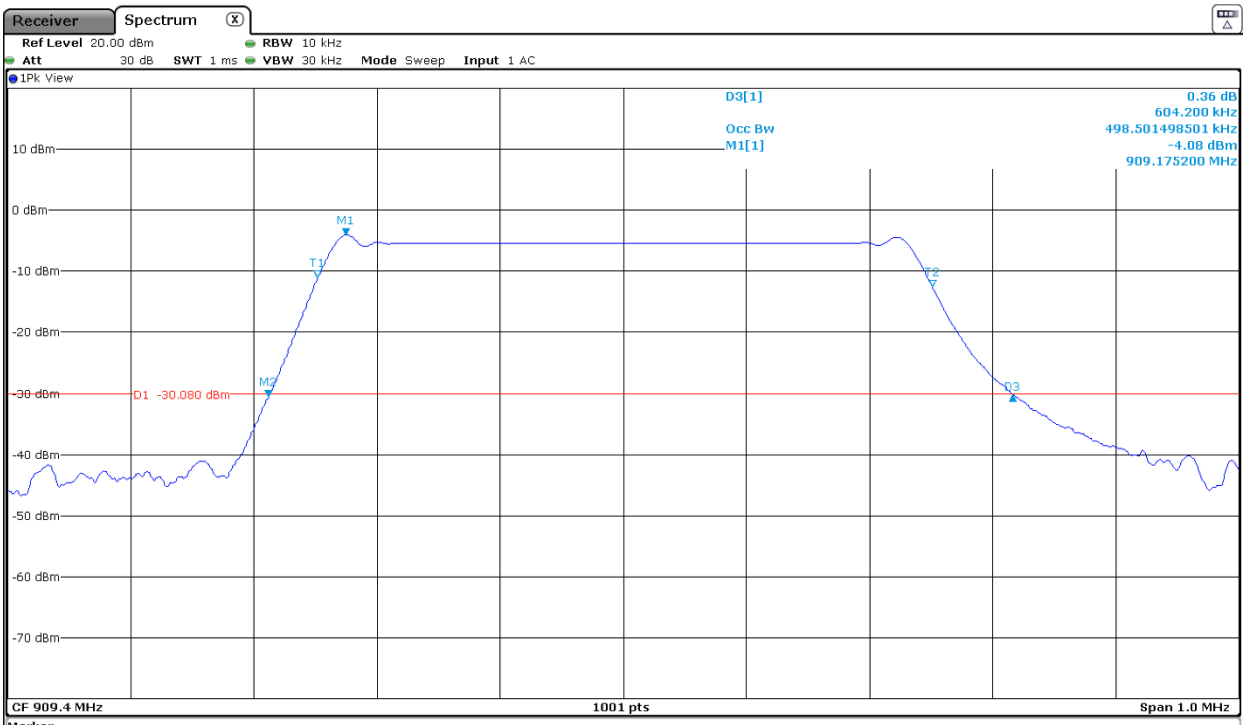
RESULTS:

	Low Channel 903.0 MHz	Middle Channel 909.4 MHz	High Channel 914.2 MHz
99% bandwidth (MHz)	0.4985	0.4985	0.5004
Measurement uncertainty (kHz)	<± 1.73		

- Low Channel:



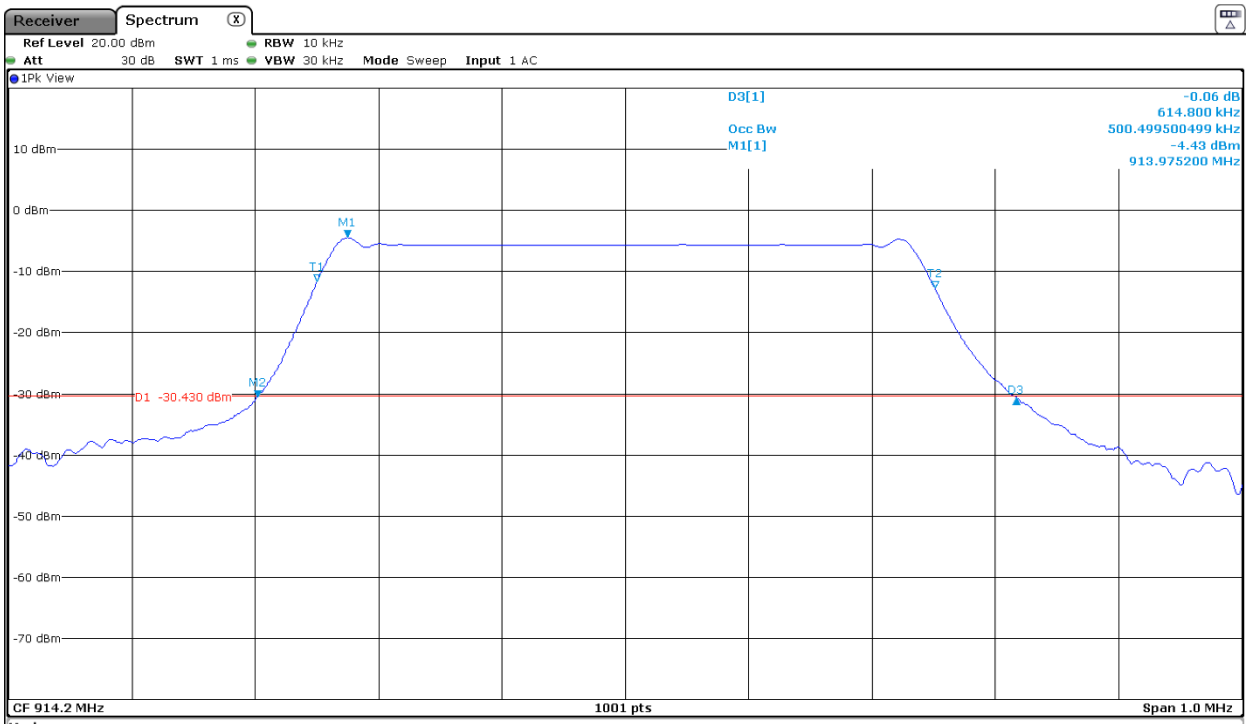
- Middle Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	909.1752 MHz	-4.08 dBm		
T1		1	909.152248 MHz	-10.96 dBm	Occ Bw	498.501498501 kHz
T2		1	909.650749 MHz	-12.51 dBm		
M2		1	909.1122 MHz	-30.52 dBm		
D3	M2	1	604.2 kHz	0.36 dB		

- High Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	913.9752 MHz	-4.43 dBm		
T1		1	913.95025 MHz	-11.68 dBm	Occ Bw	500.499500499 kHz
T2		1	914.450749 MHz	-12.71 dBm		
M2		1	913.9023 MHz	-30.49 dBm		
D3	M2	1	614.8 kHz	-0.06 dB		

FCC 15.247 (a)(2) / RSS-247 5.2. (a) 6 dB Bandwidth

SPECIFICATION:

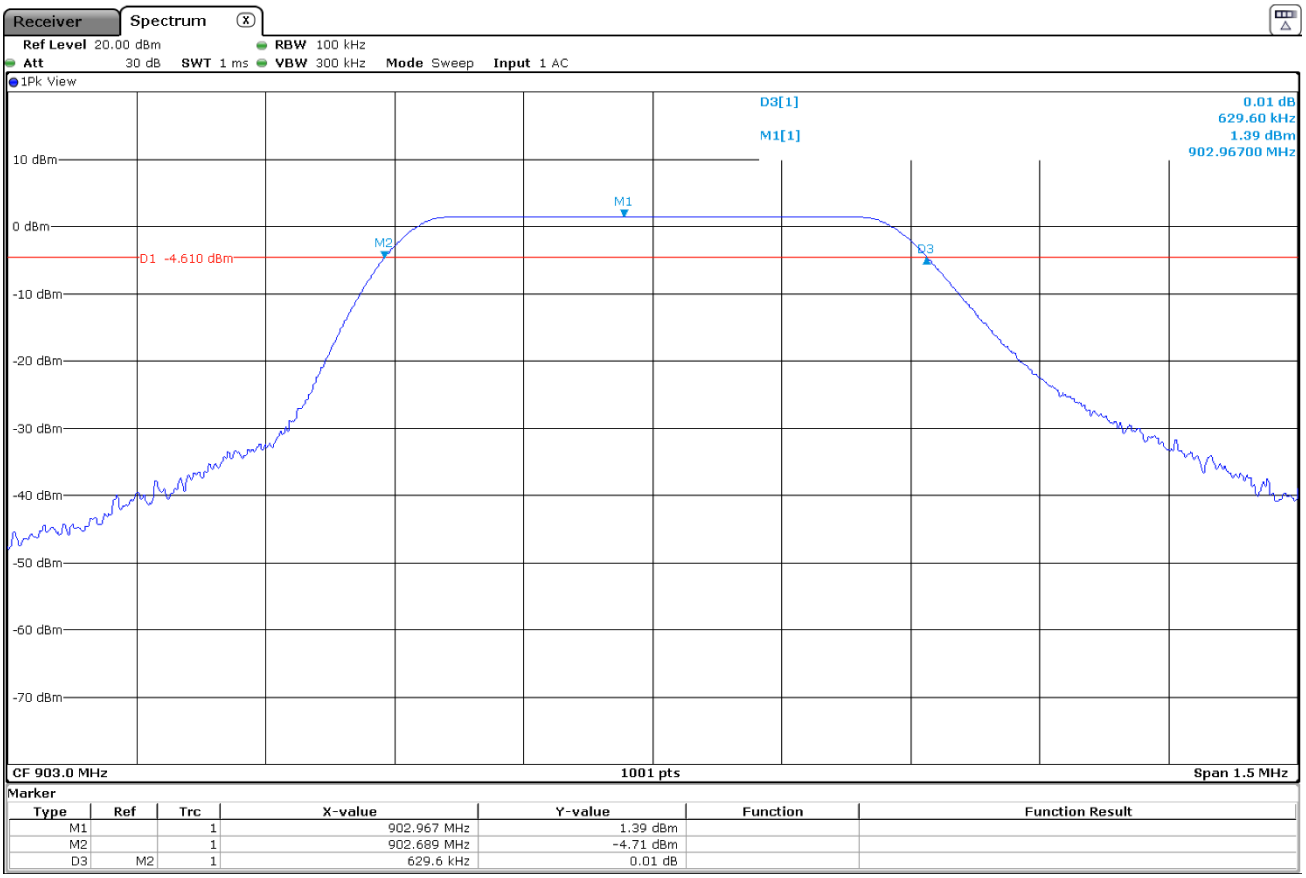
The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS:

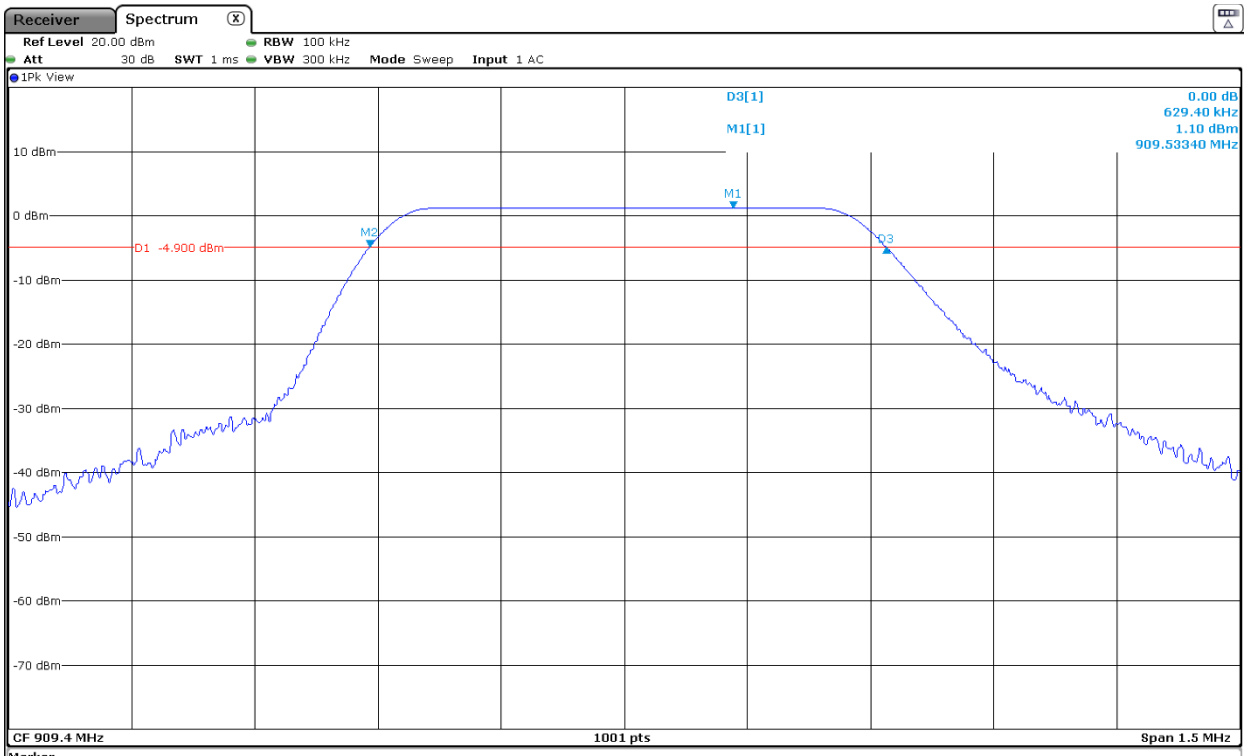
	Low Channel 903.0 MHz	Middle Channel 909.4 MHz	High Channel 914.2 MHz
6 dB Spectrum bandwidth (kHz)	629.60	629.40	629.40
Measurement uncertainty (kHz)	<±12.5		

Verdict: PASS

- Low Channel:



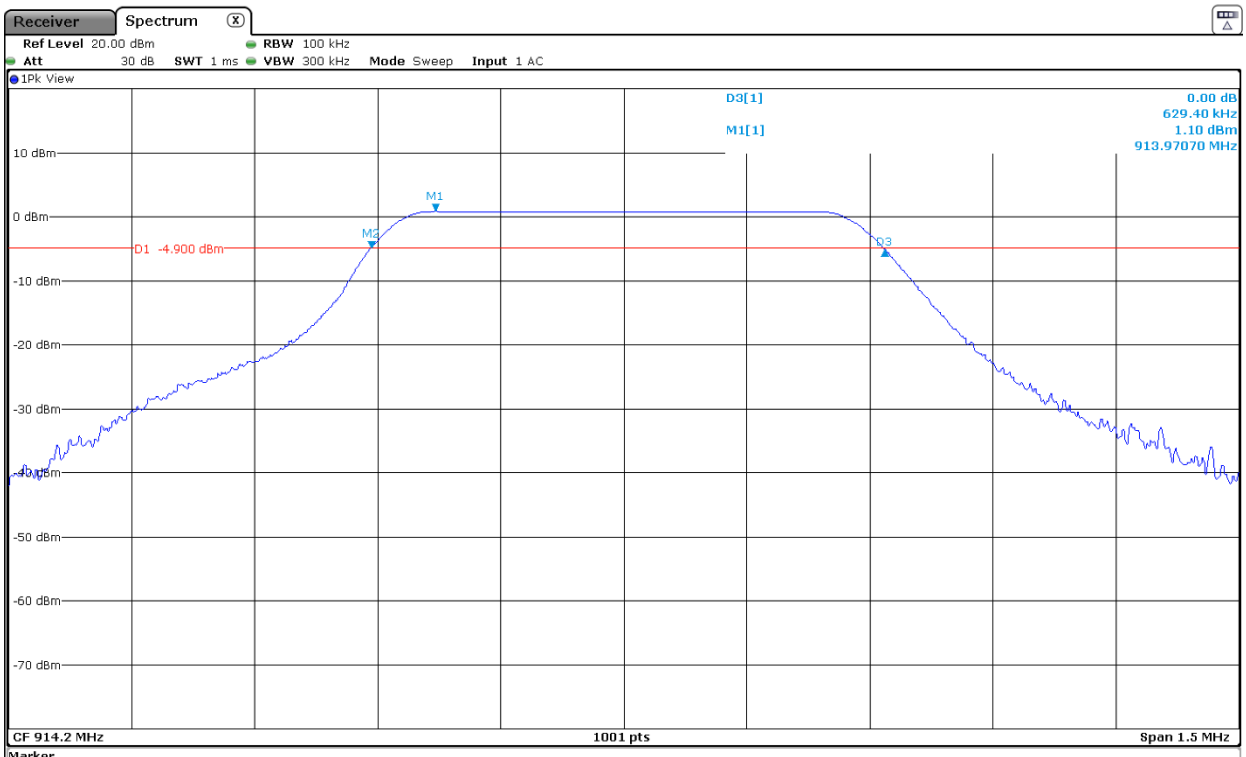
- Middle Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	909.5334 MHz	1.10 dBm		
M2		1	909.0903 MHz	-4.92 dBm		
D3	M2	1	629.4 kHz	-0.00 dB		

- High Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	913.9707 MHz	1.10 dBm		
M2		1	913.893 MHz	-4.92 dBm		
D3	M2	1	629.4 kHz	-0.00 dB		

FCC 15.247 (b) / RSS-247 5.4. (d) Maximum output power and antenna gain

SPECIFICATION:

For systems using digital modulation in the 902-928 MHz band: 1 watt (30 dBm).
The e.i.r.p. shall not exceed 4 W (36 dBm) (Canada).

RESULTS:

The maximum peak conducted output power level in the fundamental emission was measured using the method according to point 11.9.1.1 ”RBW ≥ DTS bandwidth” of ANSI C.63.10-2013.

The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

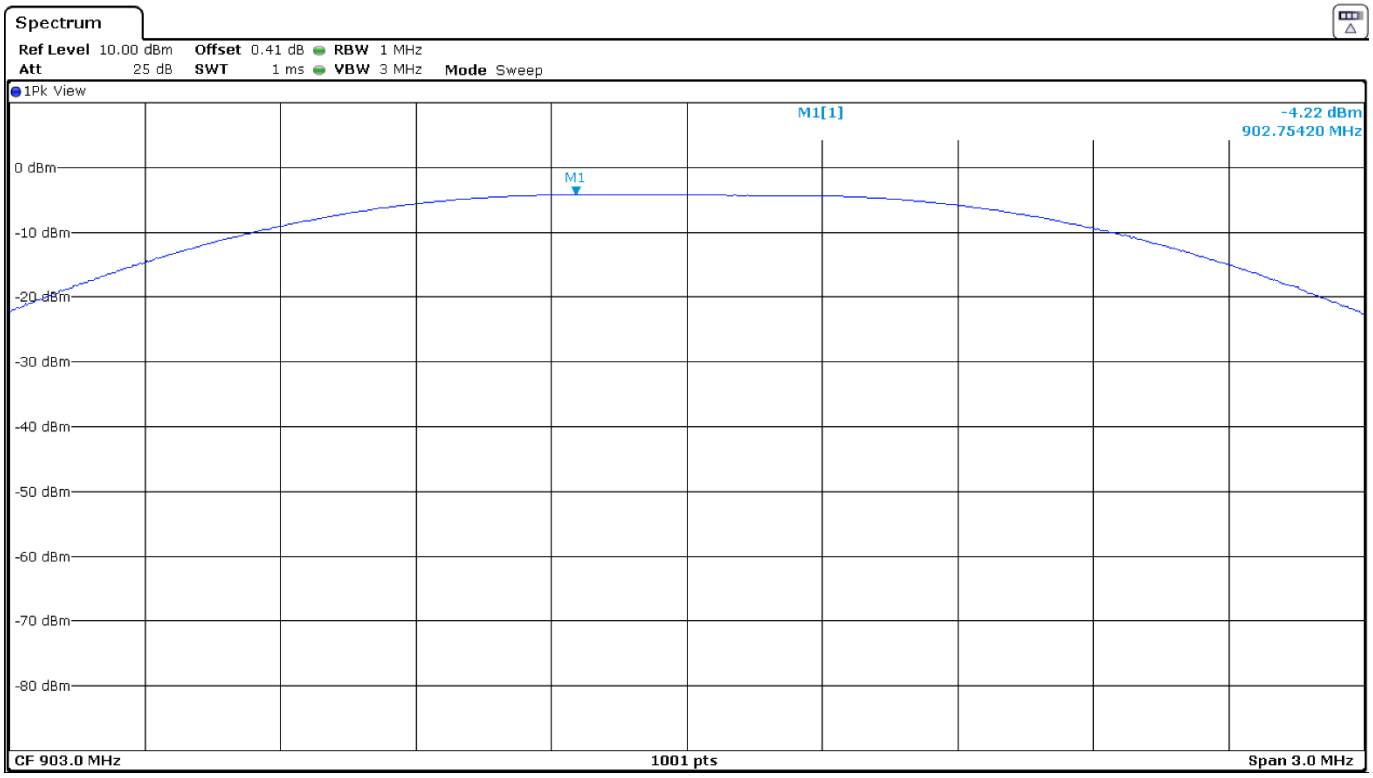
Maximum Declared Antenna Gain: +2.31 dBi

	Low Channel 903.0 MHz	Middle Channel 909.4 MHz	High Channel 914.2 MHz
Maximum Conducted Power (dBm)	-4.22	-6.02	-6.30
Maximum EIRP Power (dBm)	-1.91	-3.71	-3.99
Measurement uncertainty (dB)	<±2.57		

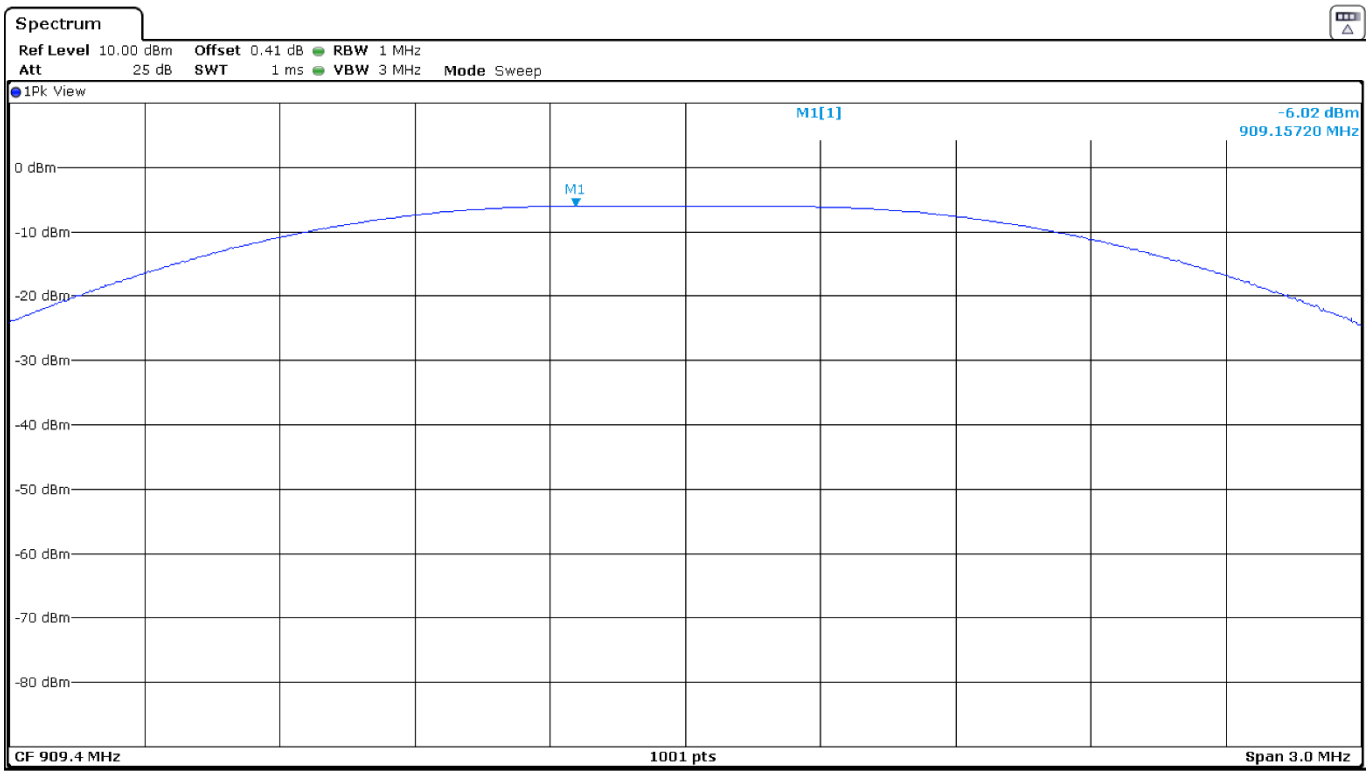
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

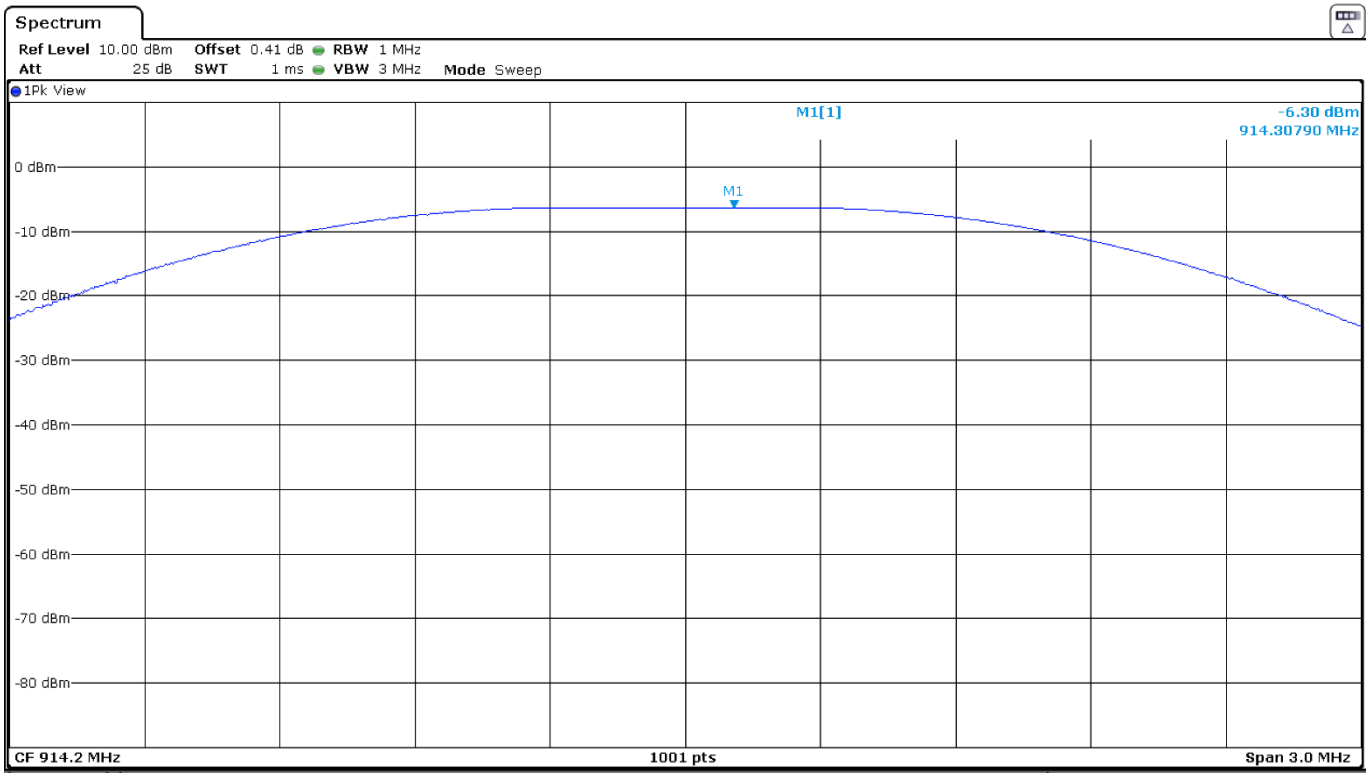
- Low Channel:



- Middle Channel:



- High Channel:



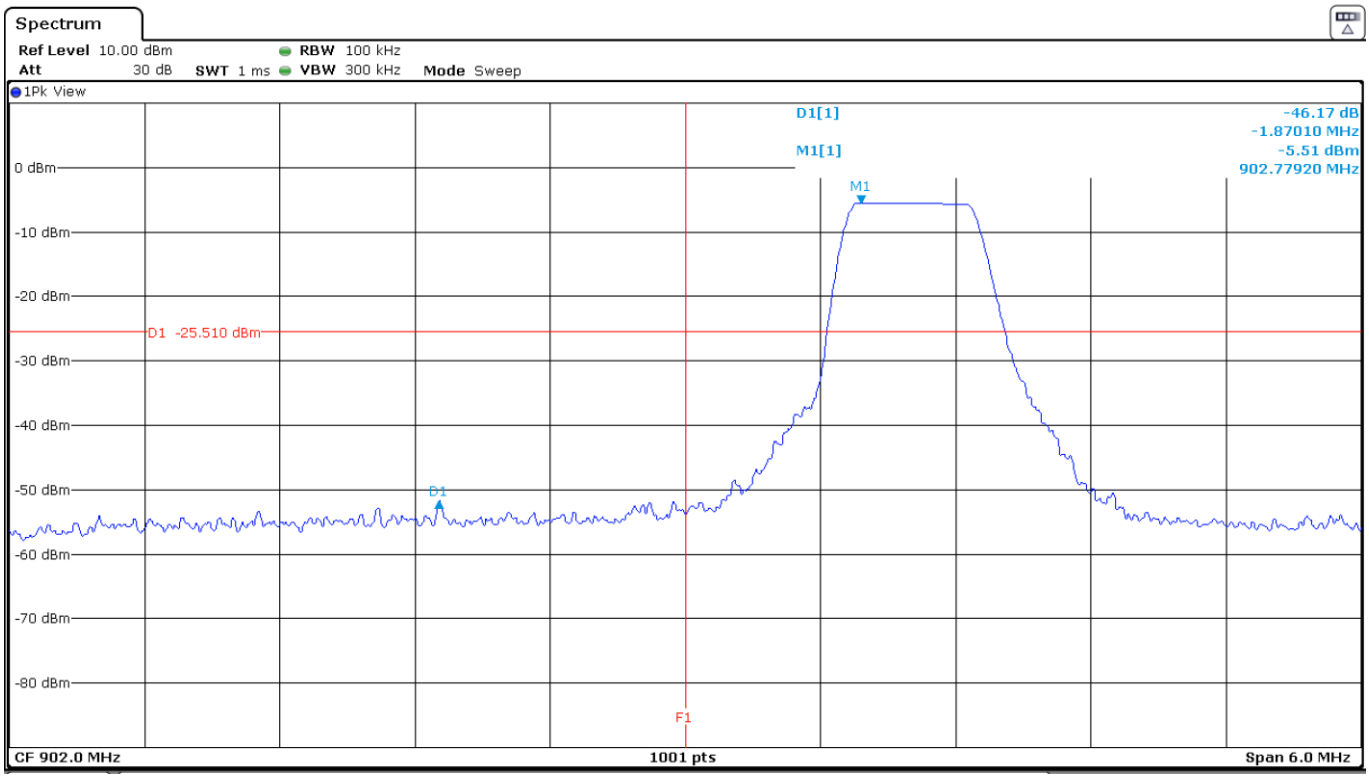
FCC 15.247 (d) / RSS-247 5.5. Band-edge emissions compliance (Transmitter)

SPECIFICATION:

In any 100 kHz bandwidths outside the frequency band in which the 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, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

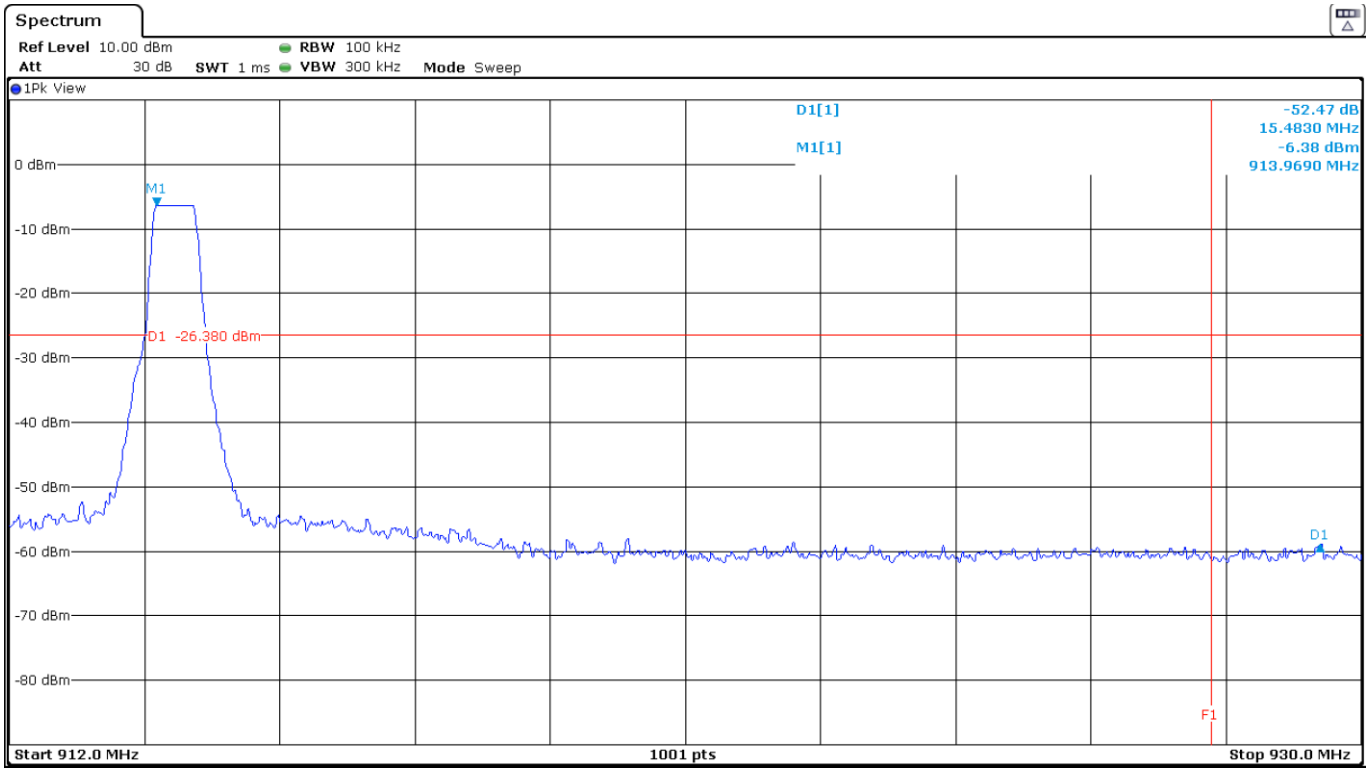
RESULTS:

- Low Channel:



Verdict: PASS

- High Channel:



Verdict: PASS

Measurement uncertainty (dB)	<±2.57

FCC 15.247 (e) / RSS-247 5.2. (b) Power spectral density

SPECIFICATION:

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.

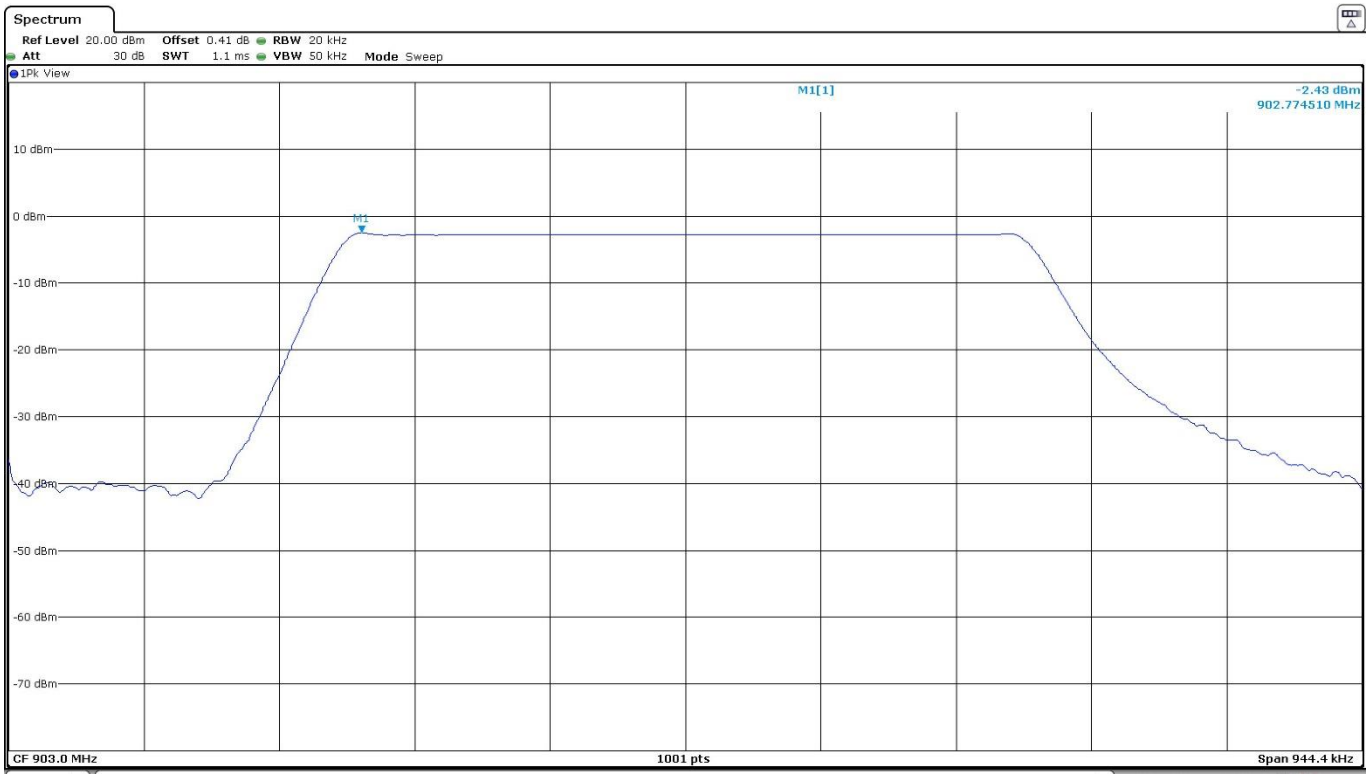
RESULTS:

The maximum power spectral density level in the fundamental emission was measured using the method according to point 11.10.2." Method PKPSD (peak PSD)" of ANSI C.63.10-2013.

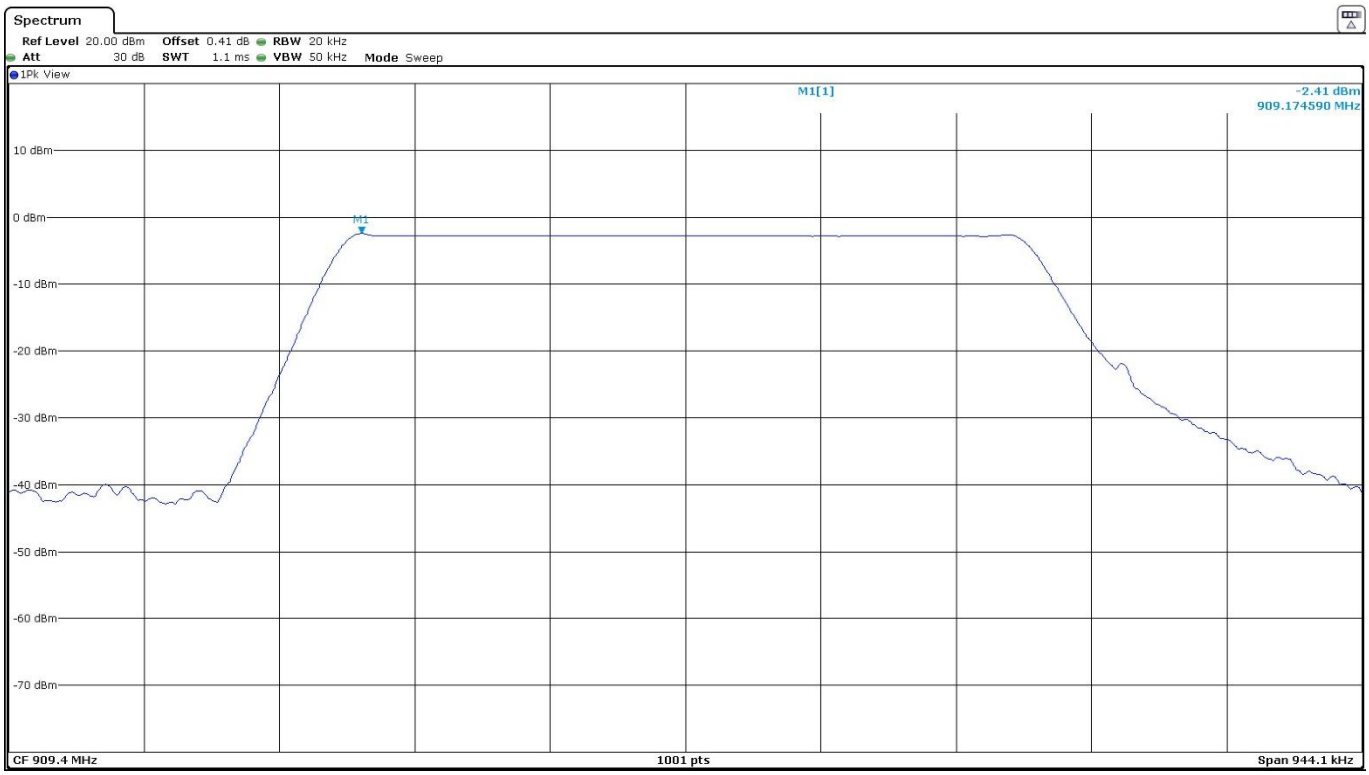
	Low Channel 903.0 MHz	Middle Channel 909.4 MHz	High Channel 914.2 MHz
Power Spectral Density (dBm)	-2.43	-2.41	-2.44
Measurement uncertainty (dB)	<±2.57		

Verdict: PASS

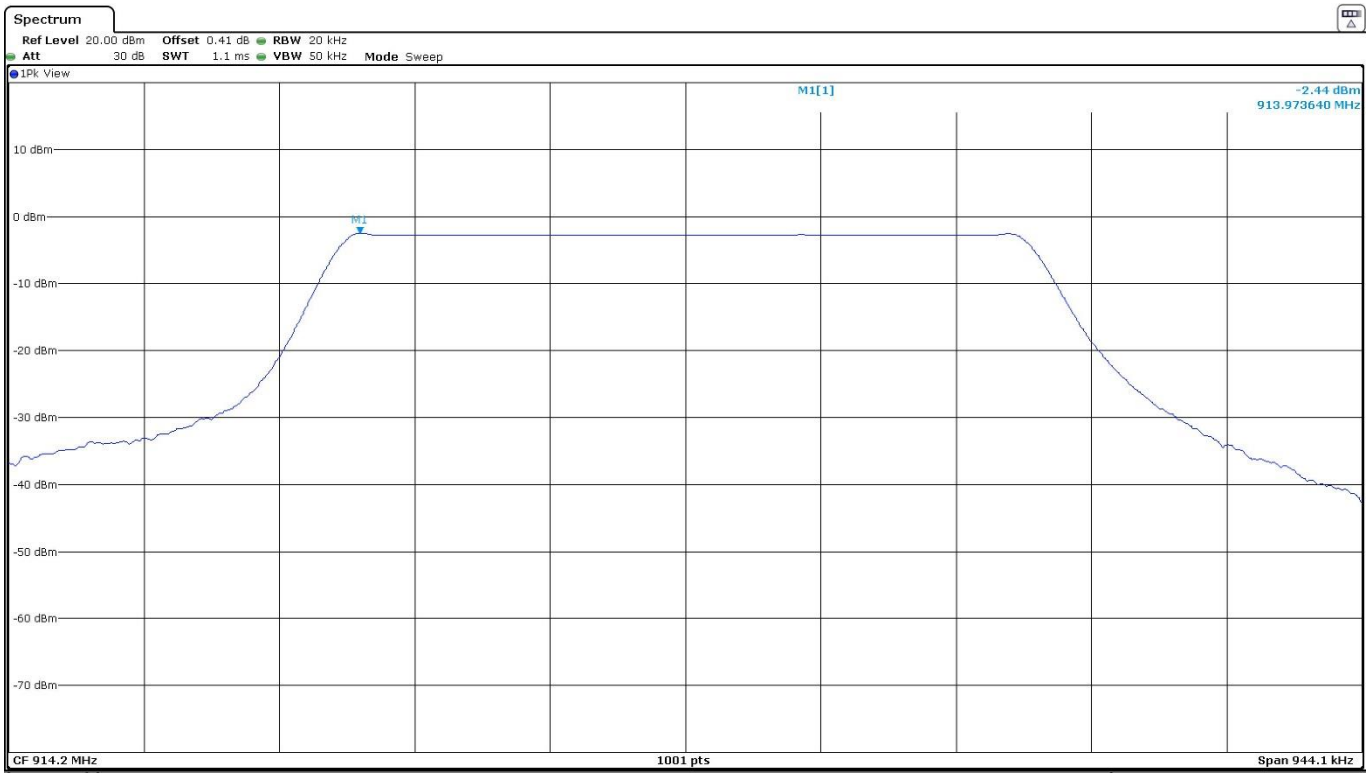
- Low Channel:



- Middle Channel:



- High Channel:



FCC 15.247 (d) / RSS-247 5.5. Emission limitations radiated (Transmitter)

SPECIFICATION:

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)/RSS-Gen):

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 10000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RSS-247: Attenuation below the general field strength limits specified in RSS-Gen is not required.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-10 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Frequency range 30 MHz - 1 GHz:

The spurious frequencies detected do not depend on the operating channel.

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (MHz)	Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
772.9720	30.80	H	Quasi-peak	<± 4.99

Frequency range 1 - 10 GHz:

The results in the next tables show the maximum measured levels in the 1-10 GHz range.

Spurious frequencies with peak levels above the average limit (54 dBµV/m at 3 m) are measured with average detector for checking compliance with the average limit.

- LOW CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2.708500	36.55	V	Peak	<± 4.98
3.611450	50.27	H	Peak	<± 4.98
4.515620	50.15	V	Peak	<± 4.98
5.319220	52.24	H	Peak	<± 4.98
6.319750	50.79	H	Peak	<± 4.98
8.126920	54.62	H	Peak	<± 4.98
	52.29		Average	<± 4.98
8.461980	55.62	H	Peak	<± 4.98
	34.18		Average	<± 4.98

- MIDDLE CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2.727633	36.07	H	Peak	<± 4.98
3.636880	48.63	H	Peak	<± 4.98
4.231180	58.40	V	Peak	<± 4.98
	32.30		Average	<± 4.98
4.546650	51.62	H	Peak	<± 4.98
5.059520	61.74	V	Peak	<± 4.98
	34.67		Average	<± 4.98
5.193220	51.61	H	Peak	<± 4.98
5.302420	52.47	H	Peak	<± 4.98
5.455950	45.52	V	Peak	<± 4.98
6.367120	51.29	H	Peak	<± 4.98
6.973320	50.33	H	Peak	<± 4.98
8.182920	56.26	H	Peak	<± 4.98
	53.98		Average	<± 4.98
9.094080	49.07	H	Peak	<± 4.98

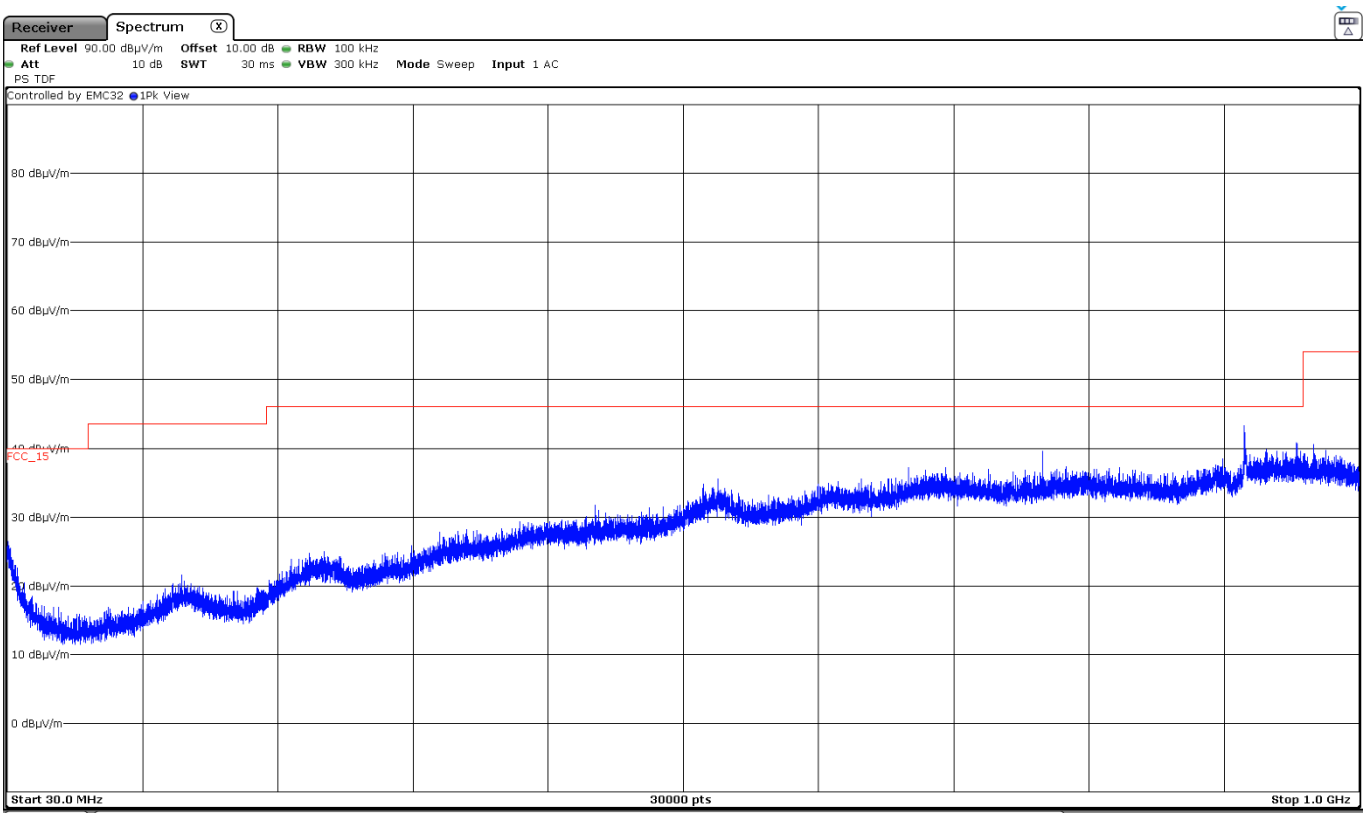
- HIGH CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2.743600	35.23	H	Peak	<± 4.98
3.657650	50.01	H	Peak	<± 4.98
4.571850	52.78	V	Peak	<± 4.98
5.486050	52.05	H	Peak	<± 4.98
6.400250	49.81	V	Peak	<± 4.98
7.315380	48.05	H	Peak	<± 4.98
8.227950	51.19	H	Peak	<± 4.98
9.144480	48.28	H	Peak	<± 4.98

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz:

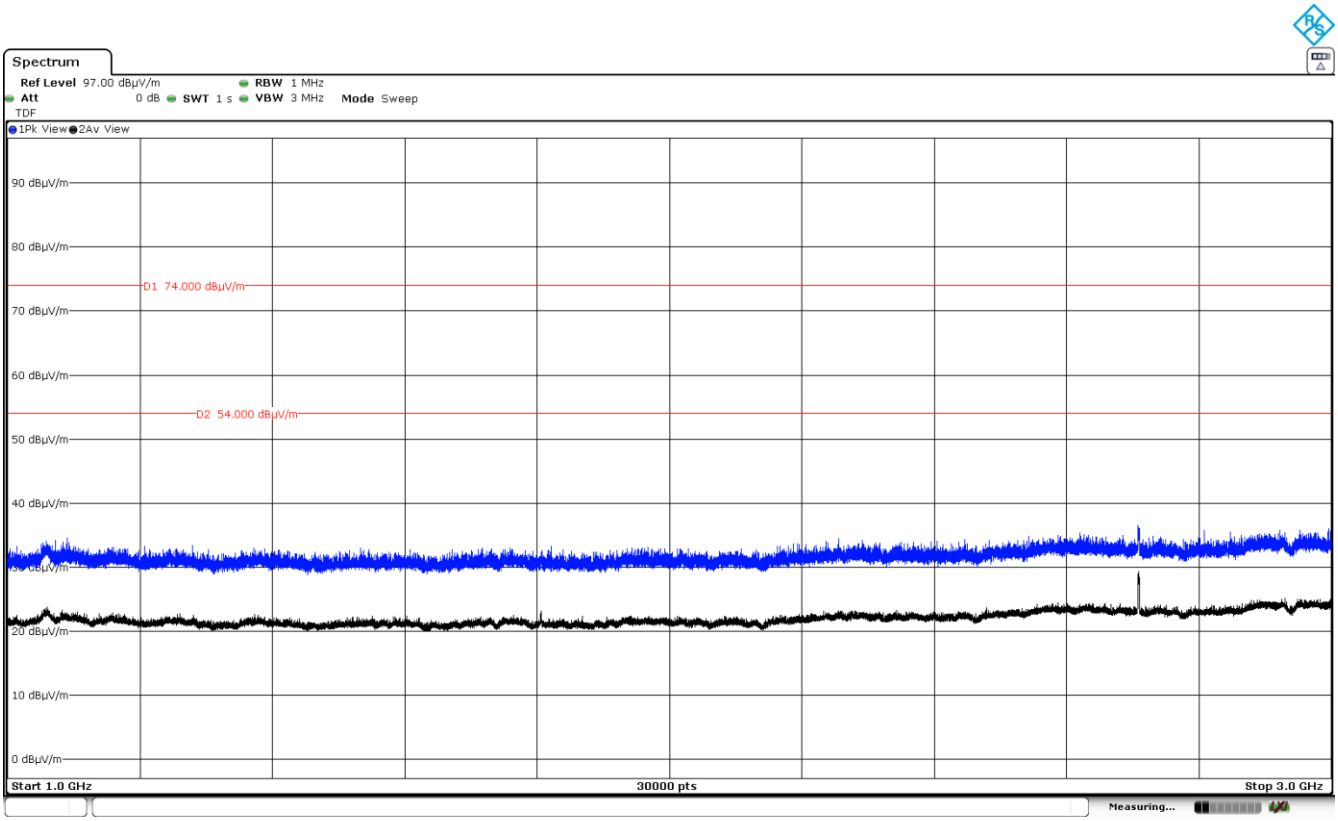
The spurious frequencies detected do not depend on the operating channel.



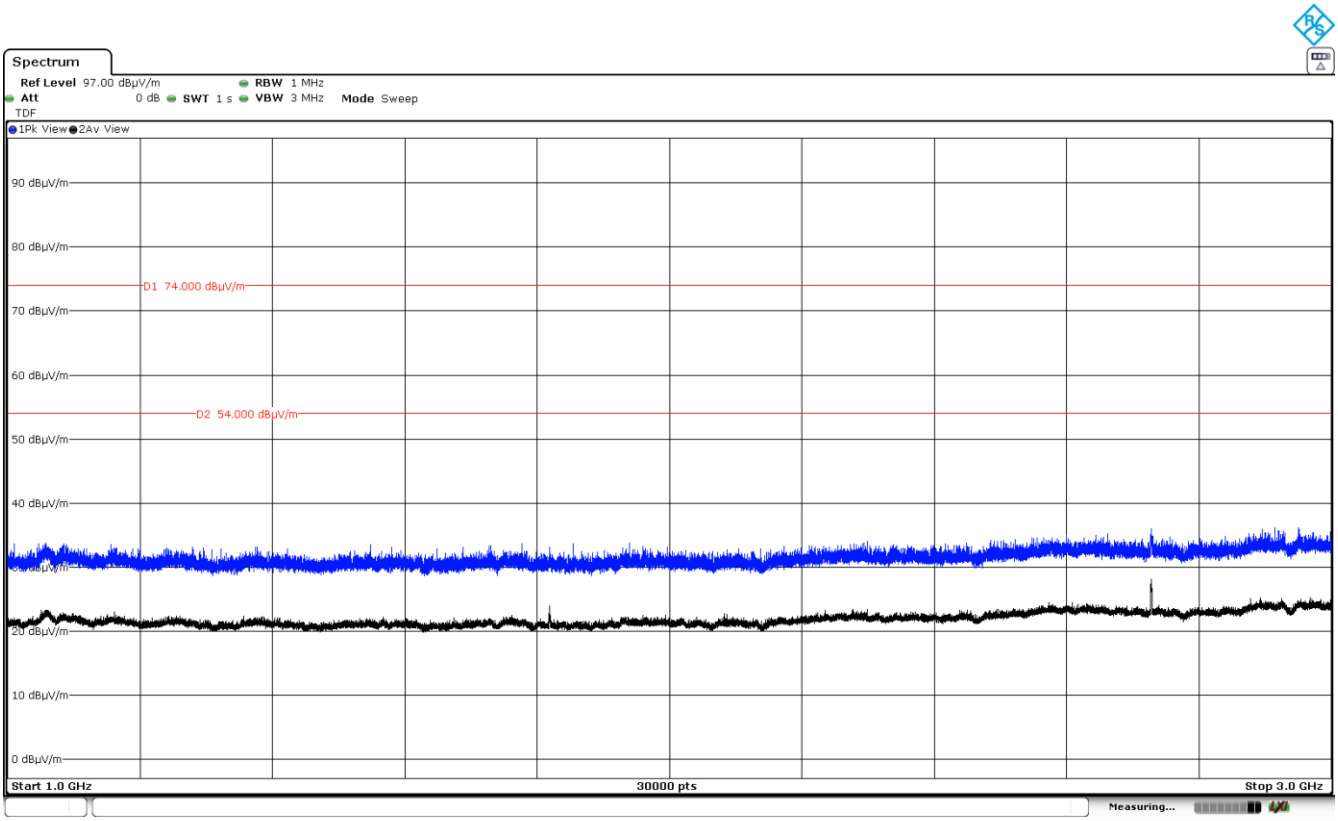
This plot is valid for the Low, Middle and High Channels.

FREQUENCY RANGE 1 - 3 GHz:

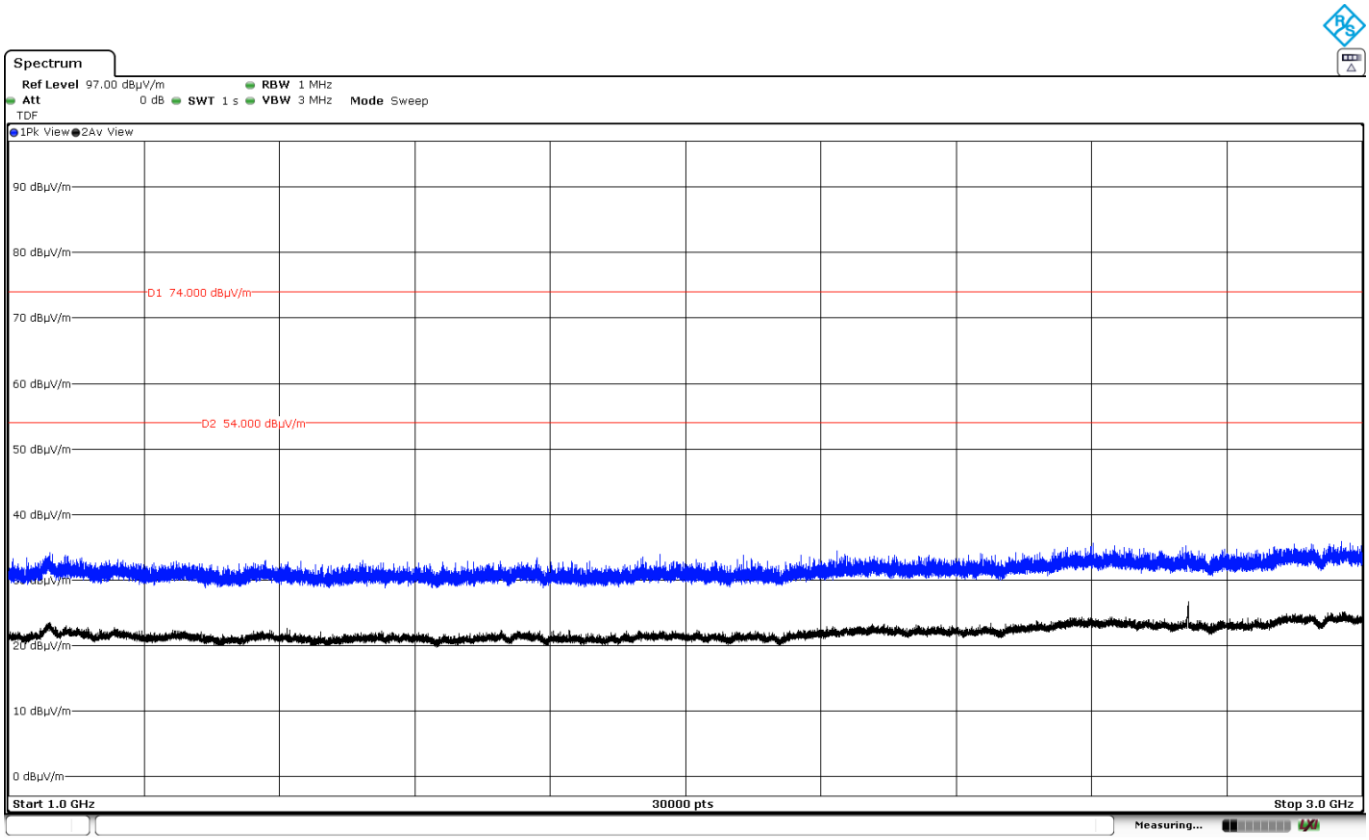
- Low Channel:



- Middle Channel:

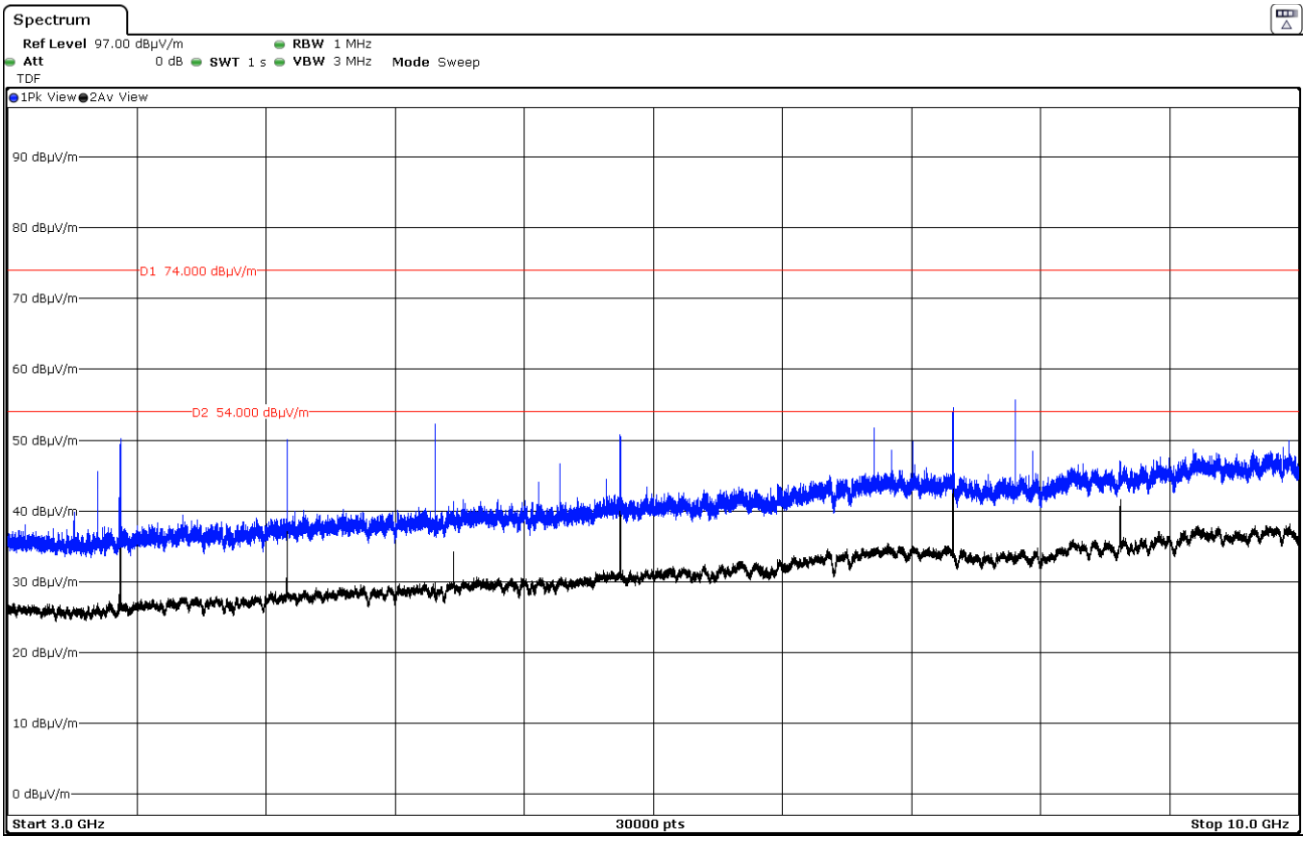


- High Channel:

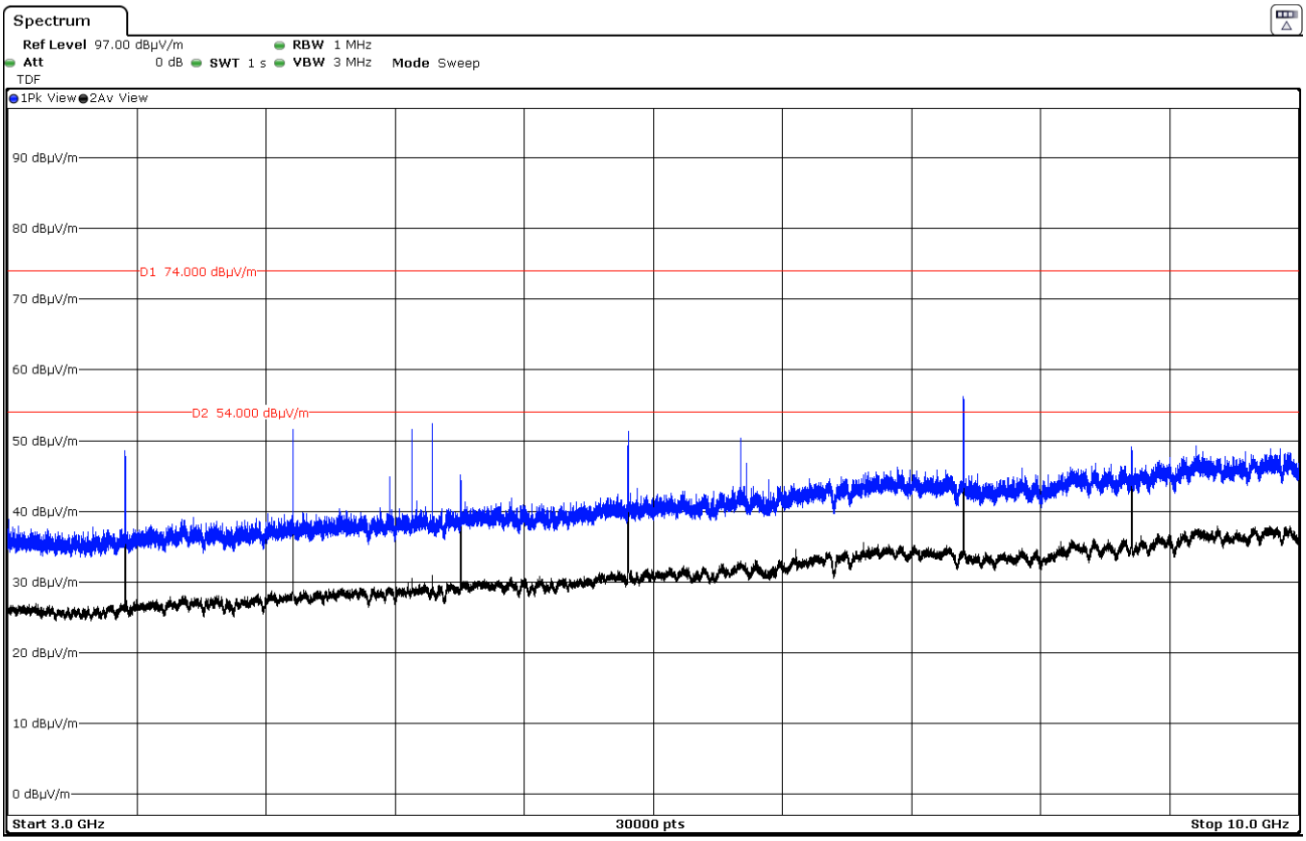
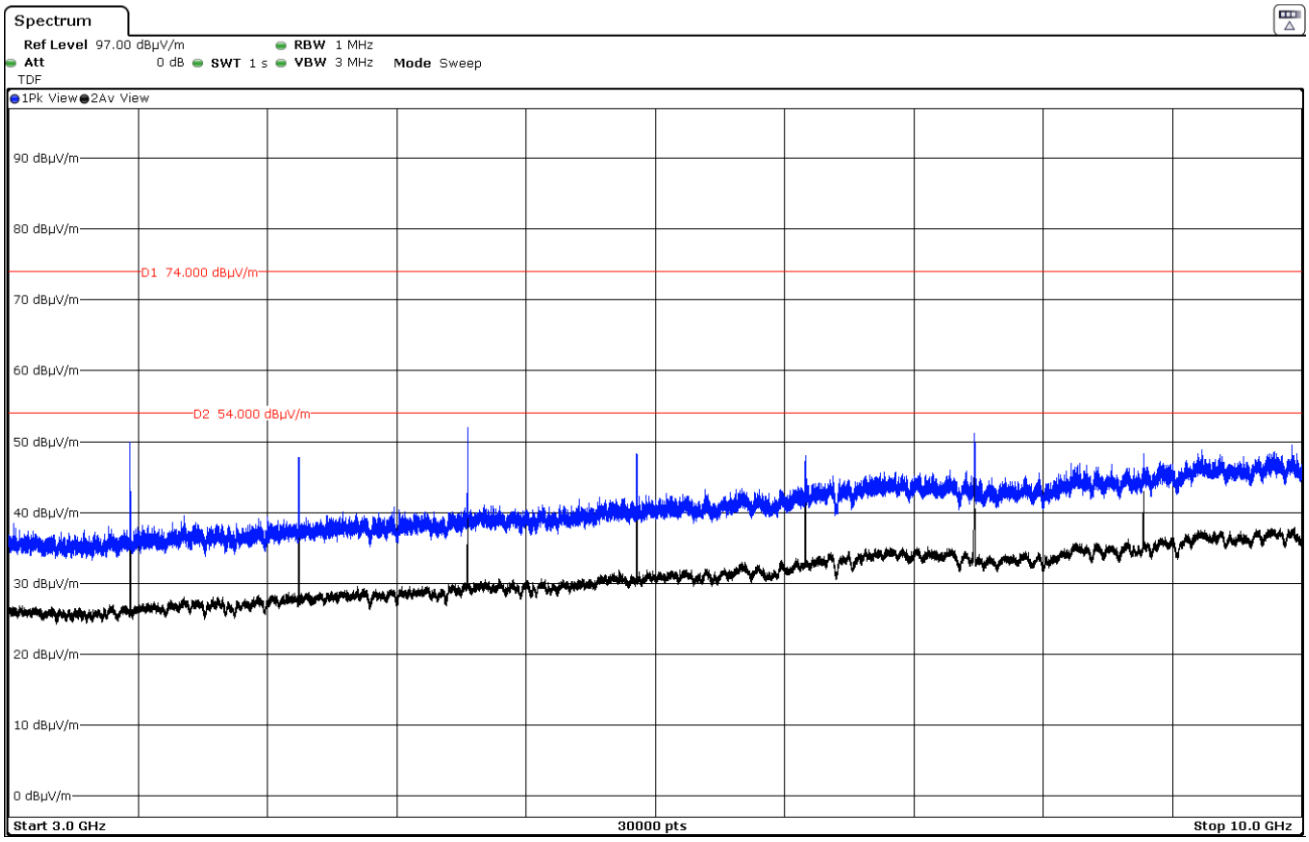


FREQUENCY RANGE 3 - 10 GHz:

- Low Channel:



- Middle Channel:



- High Channel: