DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
C.I.F. A29507456

Test report No:

NIE: 67125RRF.001

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

(*) Identification of item tested	Wireless datalogger
(*) Trademark	Loadsensing G6
(*) Model and /or type reference	LS-G6-TIL90-I
Other identification of the product	HW version: LS-G6-TIL90-I-1 rev2 SW version: 2.54 FCC ID: 2AHN4-LS-G6-TIL90-I IC: 21260-LSG6TIL90I
(*) Features	LoRa communication
Applicant	Worldsensing S.L. Calle Viriat 47, planta 10, 08014, Barcelona, Spain
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)	Rafael López Martín EMC Consumer & RF Lab. Manager 2021.06.21 12:33:27 +02'00'
Date of issue	2021-06-21
Report template No	FDT08_23 (*) "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 5
Testing period and place 5
Document history 5
Environmental conditions 6
Remarks and comments 7
Testing verdicts 8
Summary 8
Appendix A: Test results. 9

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 LS-G6-TIL90-I is a wireless inclinometer to measure angle variation in 3 axis. It sends the data via radio through an internal antenna.

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 M/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
67125/040	Wireless datalogger	LS-G6-TIL90-I	51165	2021/03/19

Sample M/01 has undergone the following test(s): The Conducted tests indicated in the Appendix A.

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

Control Nº	Description	Model	Serial Nº	Date of reception
67125/035	Wireless datalogger	LS-G6-TIL90-I	40760	2021/02/08

Sample M/02 has undergone the following test(s): The Radiated tests indicated in the Appendix A.

Test sample description

Ports…… :	Port name and description		Cable				
			Specified max length [m]	Attached during test	Shielded	Coupled to patient(3)	
	Miniusb port for configuration			☐	☐	☐	
	-			☐	☐	☐	
Supplementary information to the ports…… :	-						
Rated power supply ……:	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐	AC:	☐	☐	☐	☐	☐
	☐	AC:	☐	☐	☐	☐	☐
	☒	DC: DC lithium battery. Saft LSH 14. 3.6V					
	☐	DC:					
Rated Power ……:	1300mA at 3.6V recommended continuous current by manufacturer.						
Clock frequencies ……:	-						
Other parameters……:	-						
Software version ……:	2.54						
Hardware version……:	LS-G6-TIL90-I-1 rev2						
Dimensions in cm (W x H x D)….:	103 x 100 x 61 mm						
Mounting position……:	☒	Table top equipment					
	☒	Wall/Ceiling mounted equipment					
	☒	Floor standing equipment					

	☐	Hand-held equipment		
	☐	Other:		
Modules/parts .....:	Module/parts of test item		Type	Manufacturer
	-			
Accessories (not part of the test item) .....:	Description		Type	Manufacturer
	2 x Saft batteries		Battery	Saft
	-			
Documents as provided by the applicant.....:	Description		File name	Issue date
	-			

(3) Only for Medical Equipment

Identification of the client

Worldsensing S.L.

Calle Viriat 47, planta 10, 08014, Barcelona, Spain

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2021-02-08
Date (finish)	2021-06-09

Document history

Report number	Date	Description
67125RRF.001	2021-06-21	First release.

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: Alfonso Gutiérrez, José Manuel Jiménez, Cristina Calle, Pablo Redondo and Rosa María Gallardo.

Used instrumentation:

Conducted Measurements:

		Last Calibration	Due Calibration
1.	Shielded Room ETS LINDGREN S101	N.A.	N.A.
2.	Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2020/03	2022/03
3.	DC Power Supply 30V/5A 150W AGILENT TECHNOLOGIES U8002A	N.A.	N.A.
4.	Digital Multimeter FLUKE 175	2020/11	2021/11

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 30MHz - 6GHz ETS LINDGREN 3142E	2020/10	2023/10
4.	RF Preamplifier 40 dB, 10 MHz - 6 GHz BONN ELEKTRONIK BLNA 0160-01N	2021/03	2022/03
5.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2019/10	2021/10
6.	Digital Multimeter, FLUKE 175	2020/11	2021/11
7.	Horn Antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2019/11	2022/11
8.	RF Preamplifier, 40 dB ,1-18 GHz BONN ELEKTRONIK BLMA 0118-1M	2020/05	2021/05
9.	Spectrum Analyzer ROHDE AND SCHWARZ FSW50	2020/07	2022/07

Testing verdicts

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

Summary

1. LoRa 915 MHz

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)(iii) / RSS-247 5.1. (c)	Number of hopping channels	N/A	
FCC 15.247 (f) / RSS-247 5.3. (a)	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 (f) / RSS-247 5.3. (b)	Power spectral density for hybrid systems	P	
FCC 15.247 (d) / RSS-247 5.5.	Emission limitations radiated (Transmitter)	P	
Supplementary information and remarks: None.			

Appendix A: Test results

INDEX

TEST CONDITIONS 11
Occupied Bandwidth 13
FCC 15.247 (a) (1) / RSS-247 5.1. (b) 20 dB Bandwidth and Carrier frequency separation. 15
FCC 15.247 (a) (1) (iii) / RSS-247 5.1. (c) Number of hopping channels..... **¡Error! Marcador no definido.**
FCC 15.247 (f) / RSS-247 5.3. (a) Time of occupancy (Dwell Time) 18
FCC 15.247 (b) / RSS-247 5.4 (a) Maximum output power and antenna gain 20
FCC 15.247 (d) / RSS-247 5.5. Band-edge compliance of conducted emissions (Transmitter).....24
FCC 15.247 (f) / RSS-247 5.3. (b) Power spectral density for hybrid systems 27
FCC 15.247 (d) / RSS-247 5.5. Emission limitations radiated (Transmitter).....30

TEST CONDITIONS

POWER SUPPLY:

V nonimal: 3.6 Vdc

Type of Power Supply: Lithium Battery (Saft LSH 14 Battery).

ANTENNA:

Type of Antenna: Internal (Omnidirectional)

Maximum Declared Assembly Gain: +1.9 dBi

TEST FREQUENCIES:

Conducted Tests:

Low Channel: 902.3 MHz

Middle Channel: 914.9 MHz

High Channel: 927.7 MHz

Radiated Tests:

Low Channel: 902.3 MHz

Middle Channel: 914.9 MHz

High Channel: 927.7 MHz

- The equipment can operate as a hybrid system using 8 hopping channels.

The sample was used to configure the EUT to transmit at a specified output power in all channels (Power Setting in DUT = 20 and shielded model).

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.

The DC supply voltage is applied using an external power supply calibrated by multimeter.

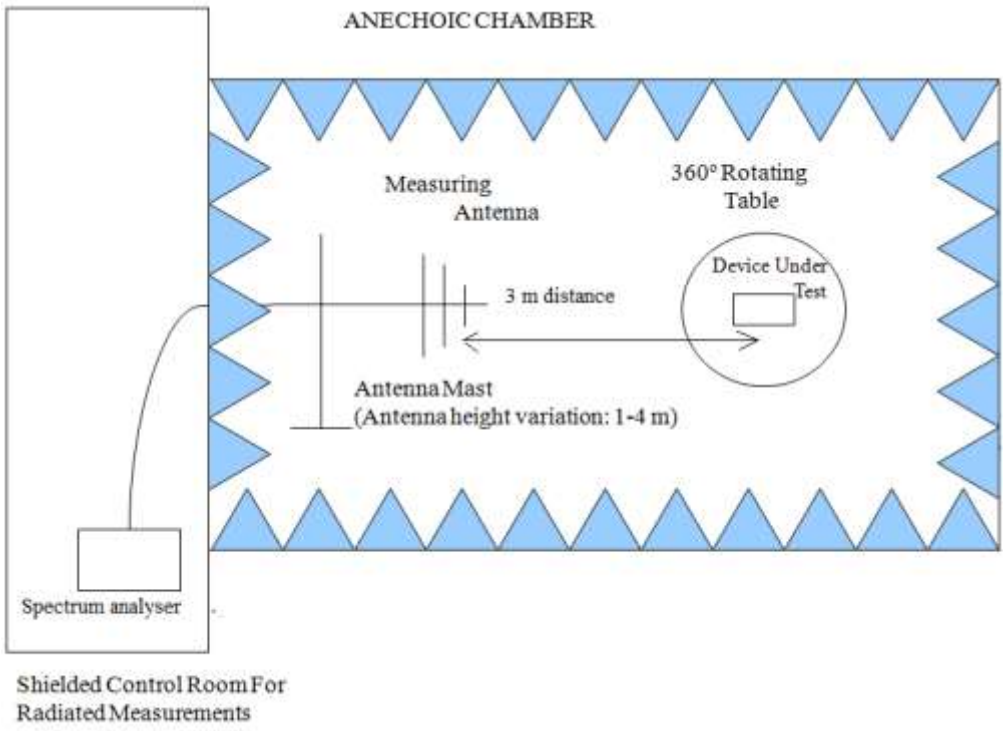
RADIATED MEASUREMENTS

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.

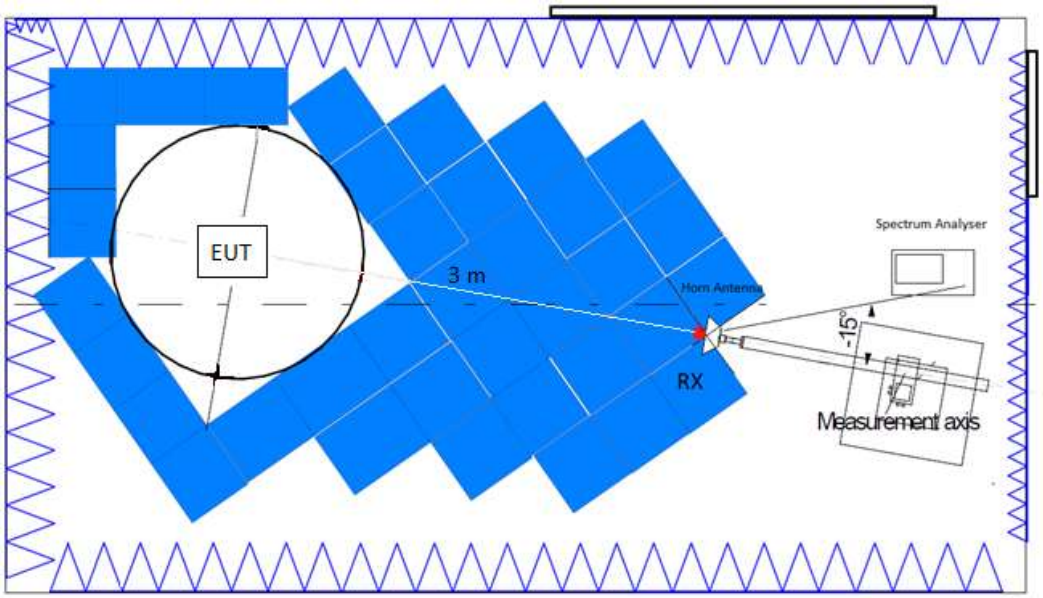
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find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

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

Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 10 GHz:



Occupied Bandwidth

SPECIFICATION:

FCC §2.1049. Measurements required: Occupied bandwidth.

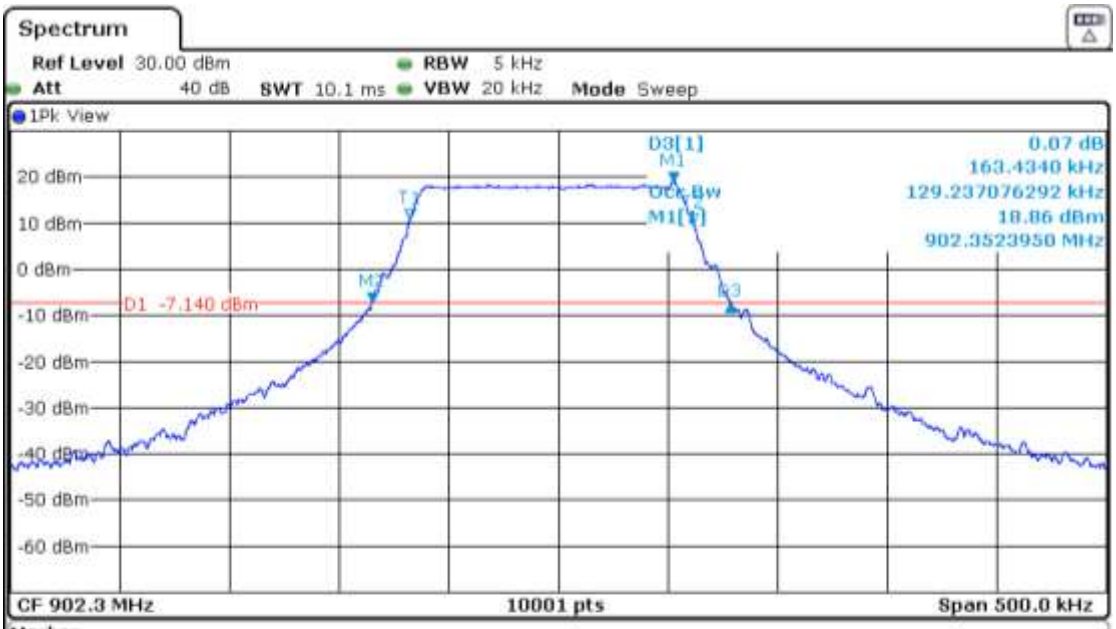
RSS-Gen Clause 6.7.

RESULTS:

	Low Channel	Middle Channel	High Channel
99% Bandwidth (kHz)	129.237	129.087	129.187
-26 dBc Bandwidth (kHz)	163.434	163.234	162.434
Measurement uncertainty (kHz)	<± 0.52		

Verdict: PASS

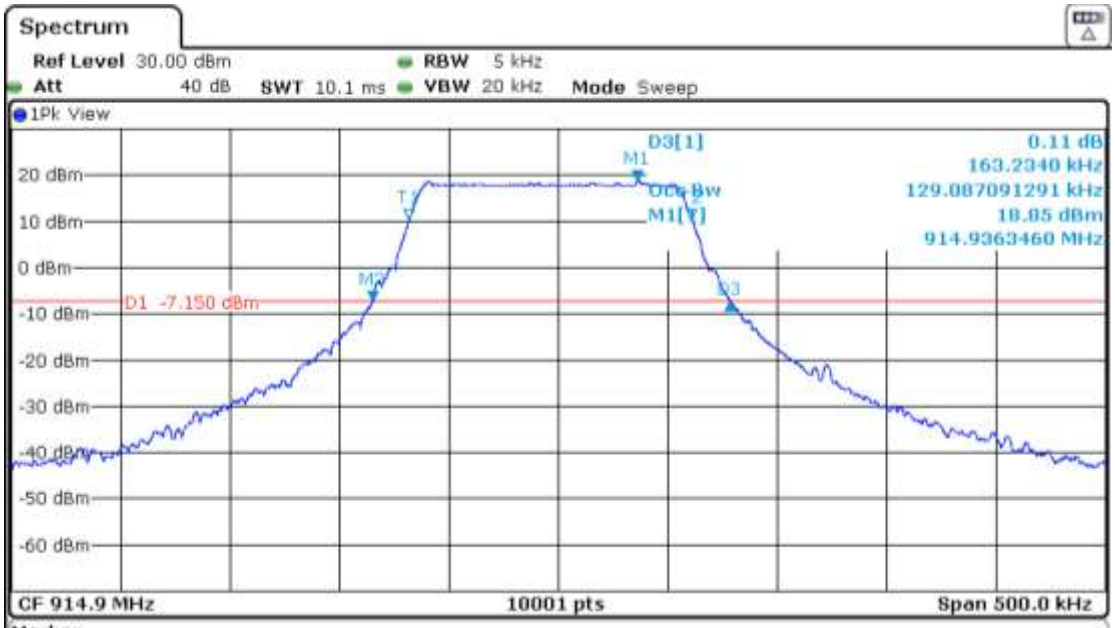
Low Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	902.352395 MHz	18.86 dBm		
T1		1	902.2320568 MHz	10.70 dBm	Occ Bw	129.237076292 kHz
T2		1	902.3612939 MHz	9.80 dBm		
M2		1	902.214909 MHz	-7.23 dBm		
D3	M2	1	163.434 kHz	0.07 dB		

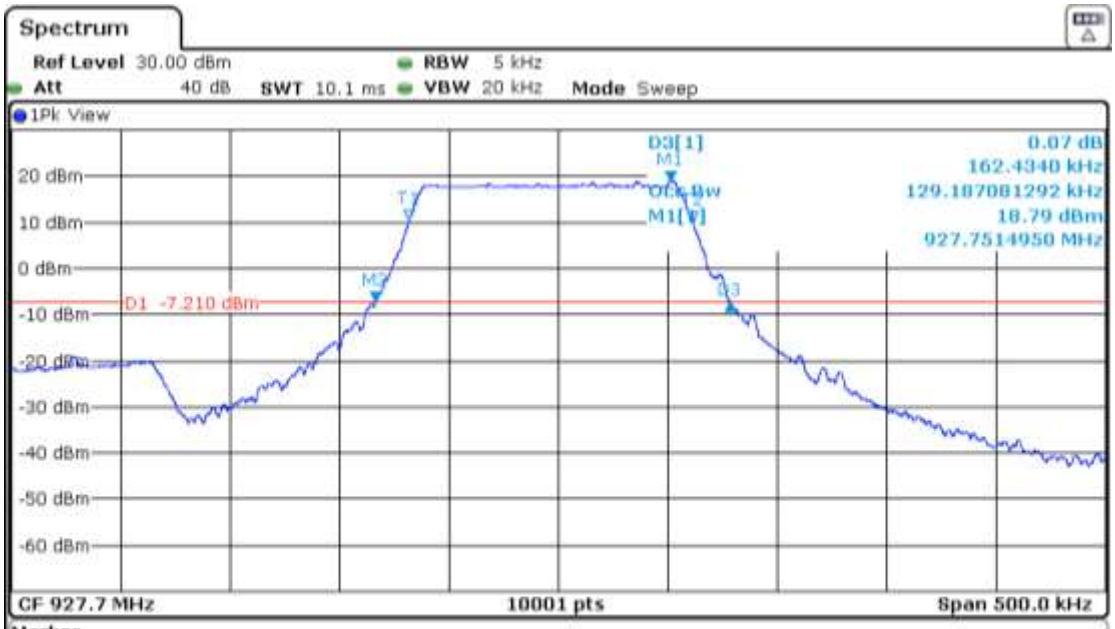
Middle Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	914.936346 MHz	18.85 dBm		
T1		1	914.8319068 MHz	10.40 dBm	Occ Bw	129.087091291 kHz
T2		1	914.9609939 MHz	10.39 dBm		
M2		1	914.815108 MHz	-7.28 dBm		
D3	M2	1	163.234 kHz	0.11 dB		

High Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	927.751495 MHz	18.79 dBm		
T1		1	927.6319068 MHz	10.56 dBm	Occ Bw	129.187081292 kHz
T2		1	927.7610939 MHz	10.10 dBm		
M2		1	927.616308 MHz	-7.30 dBm		
D3	M2	1	162.434 kHz	0.07 dB		

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

SPECIFICATION:

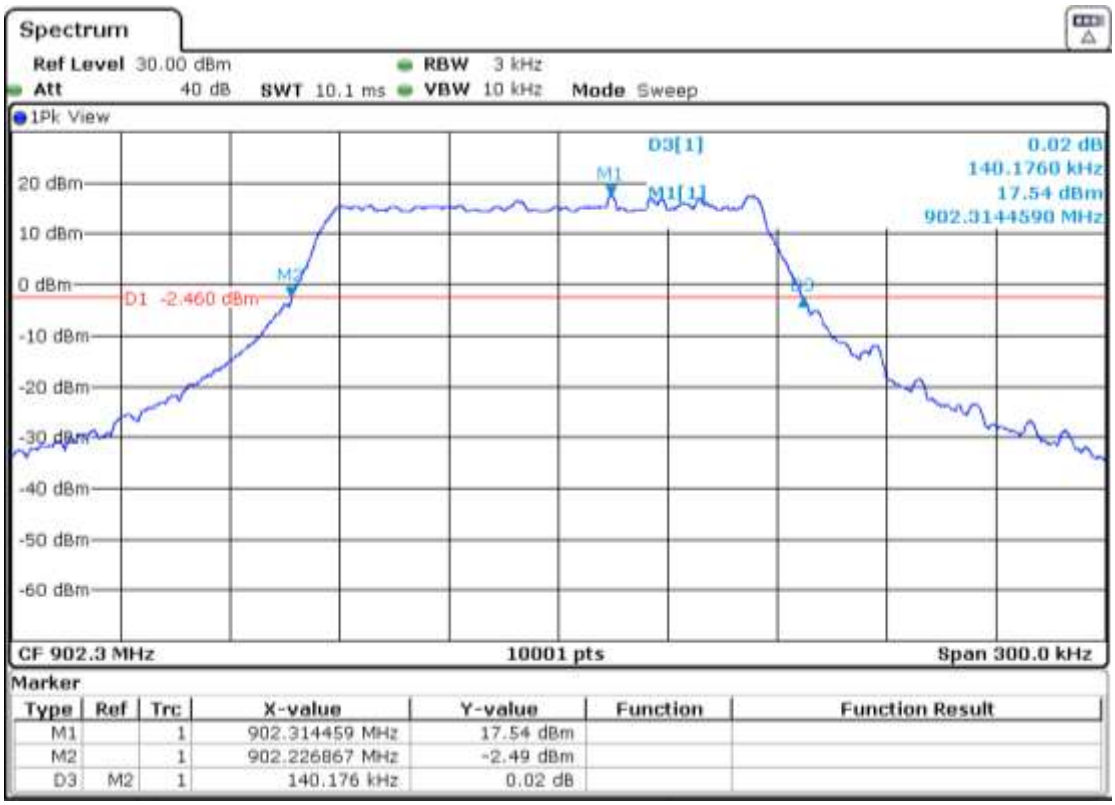
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

RESULTS:

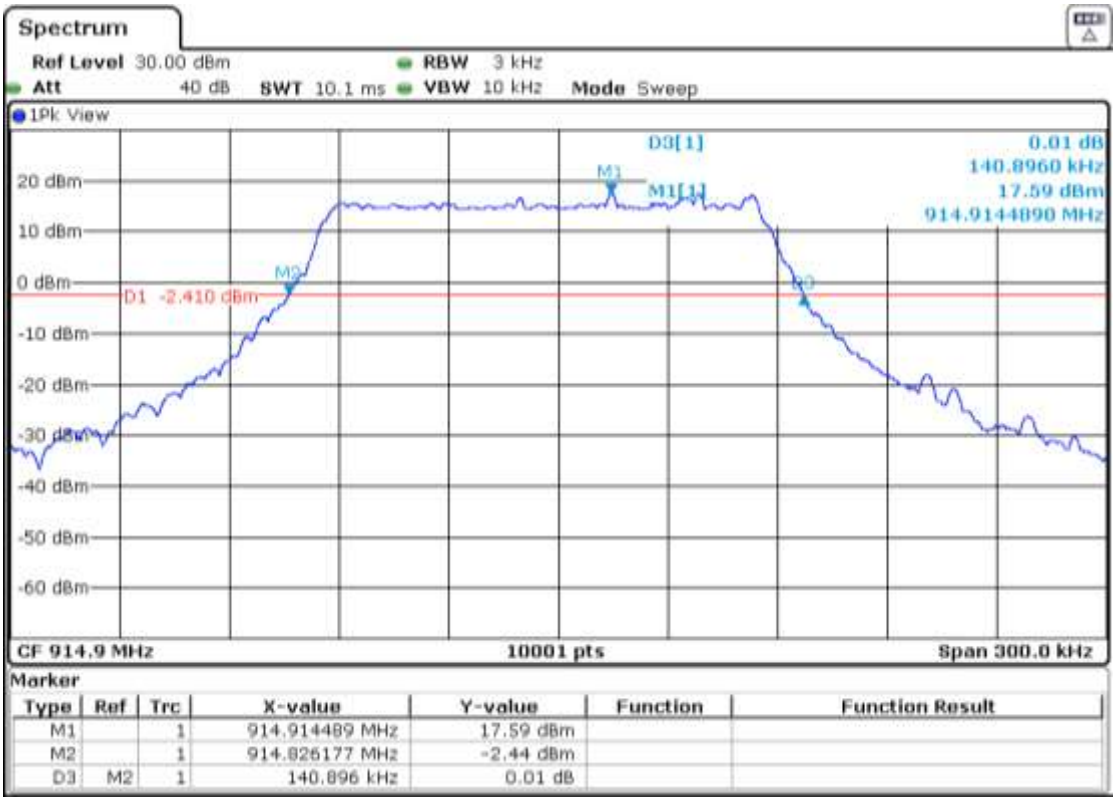
	Low Channel	Middle Channel	High Channel
20 dB Spectrum bandwidth (kHz)	140.176	140.896	139.906
Measurement uncertainty (kHz)	<± 0.52		

Verdict: PASS

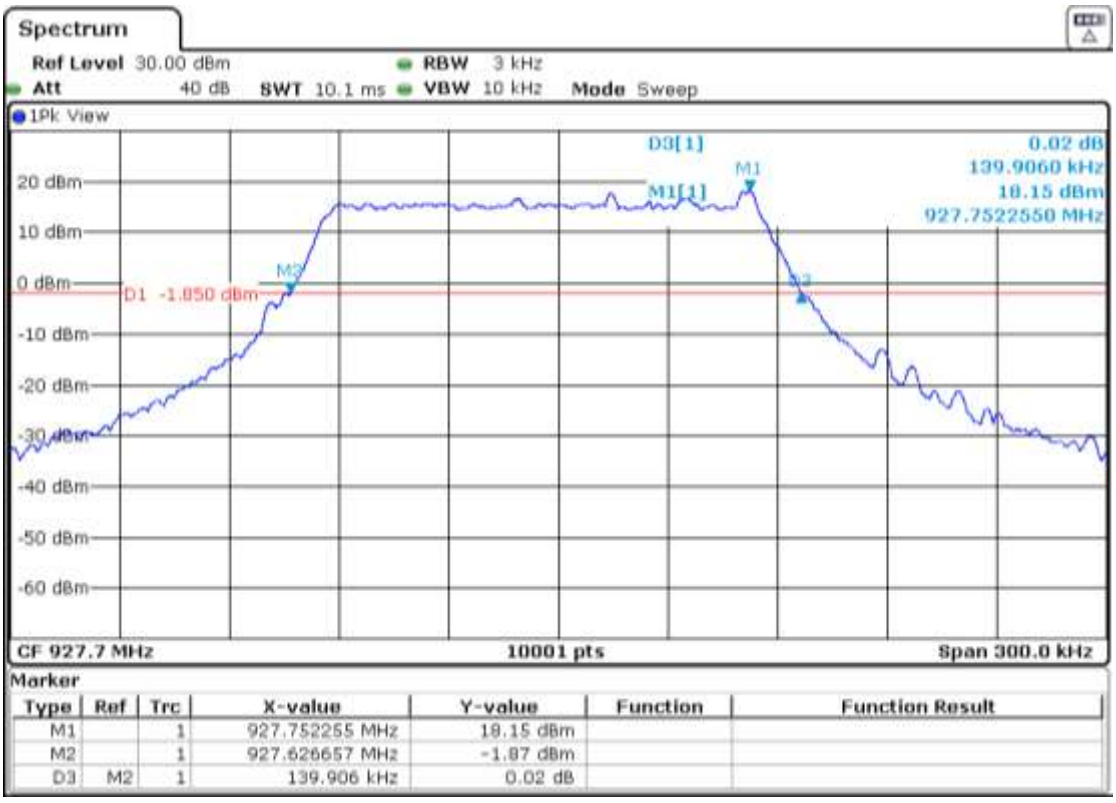
Low Channel:



Middle Channel:

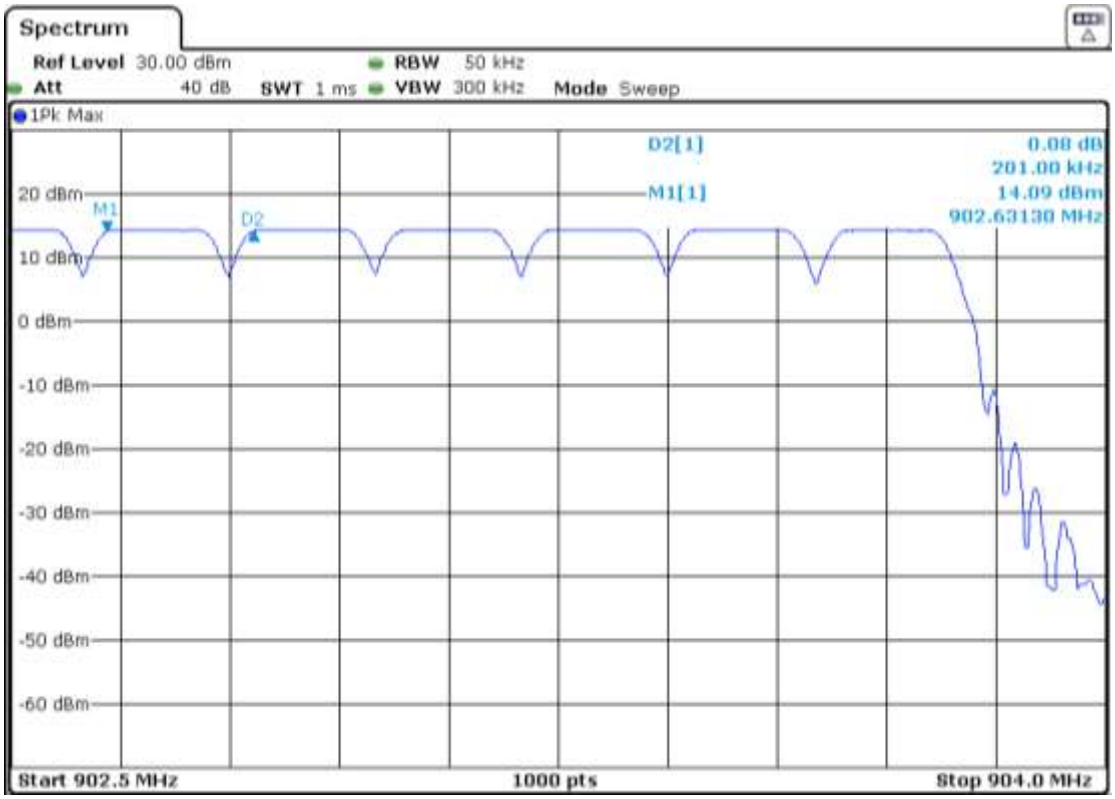


High Channel:



Carrier frequency separation

201 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 (f) / RSS-247 5.3. (a) Time of occupancy (Dwell Time)

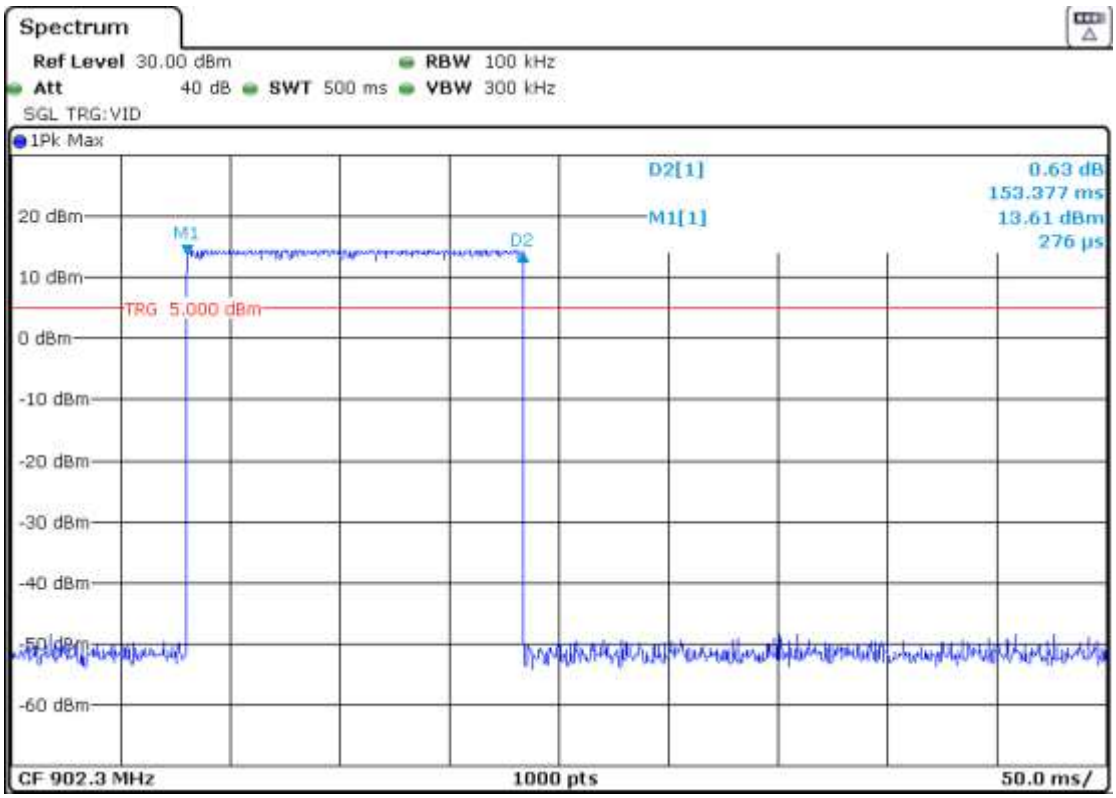
SPECIFICATION:

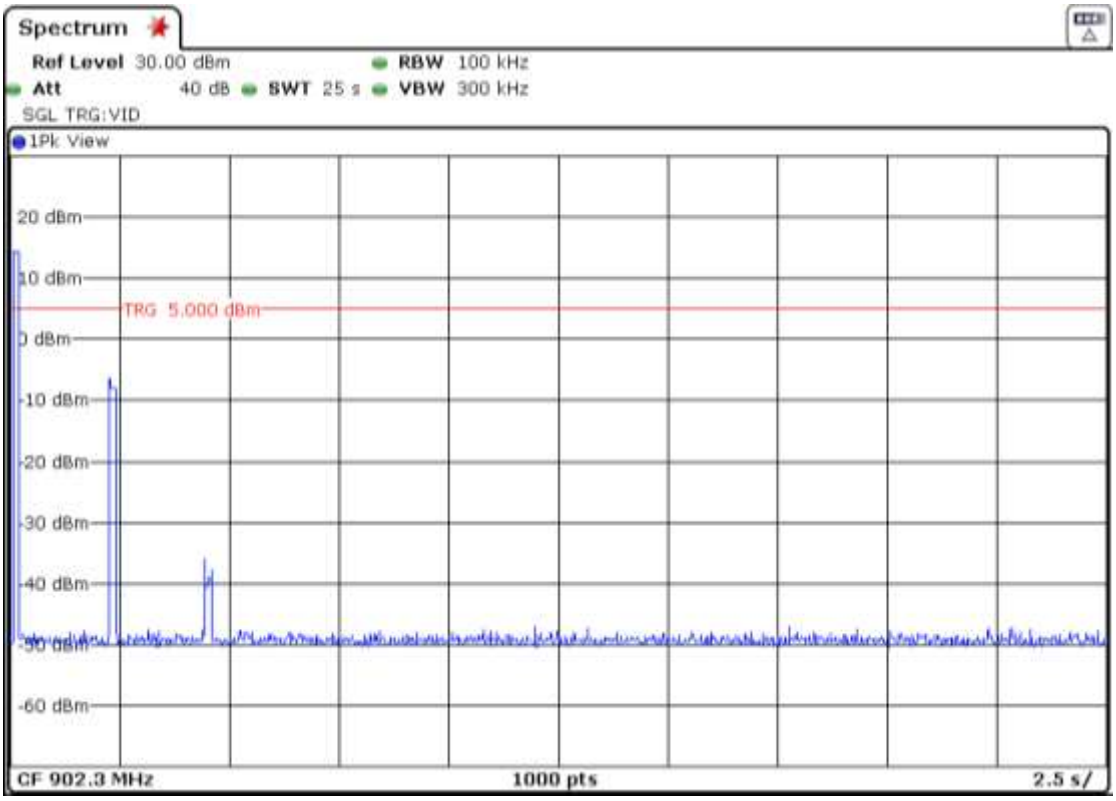
For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4.

RESULTS:

1. OPERATION AS A FREQUENCY HOPPING SYSTEM USING 8 HOPPING CHANNELS:

- TX time per hop: 153.377 ms (see next plots)
- Number of hops over a period of 2.5 s: 1 (see next plots)





- **Average Time of Occupancy** = 153.377 ms x 1 hops = 153.377 ms per 2.5 s.

  Average Time of Occupancy is < 0.4 s per time period in seconds equal to the number of hopping frequencies employed (1) multiplied by 0.4.

Measurement uncertainty (ms)	<±1.02

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 conducted (average) output power was measured using the method AVGSA-1 (trace averaging across on and off times of the EUT transmissions) according to point 11.9.2.2.2 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: +1.9 dBi

Measured Duty cycle: x = 0.616. Correction = 10*log (1/x) = 2.10 dB.

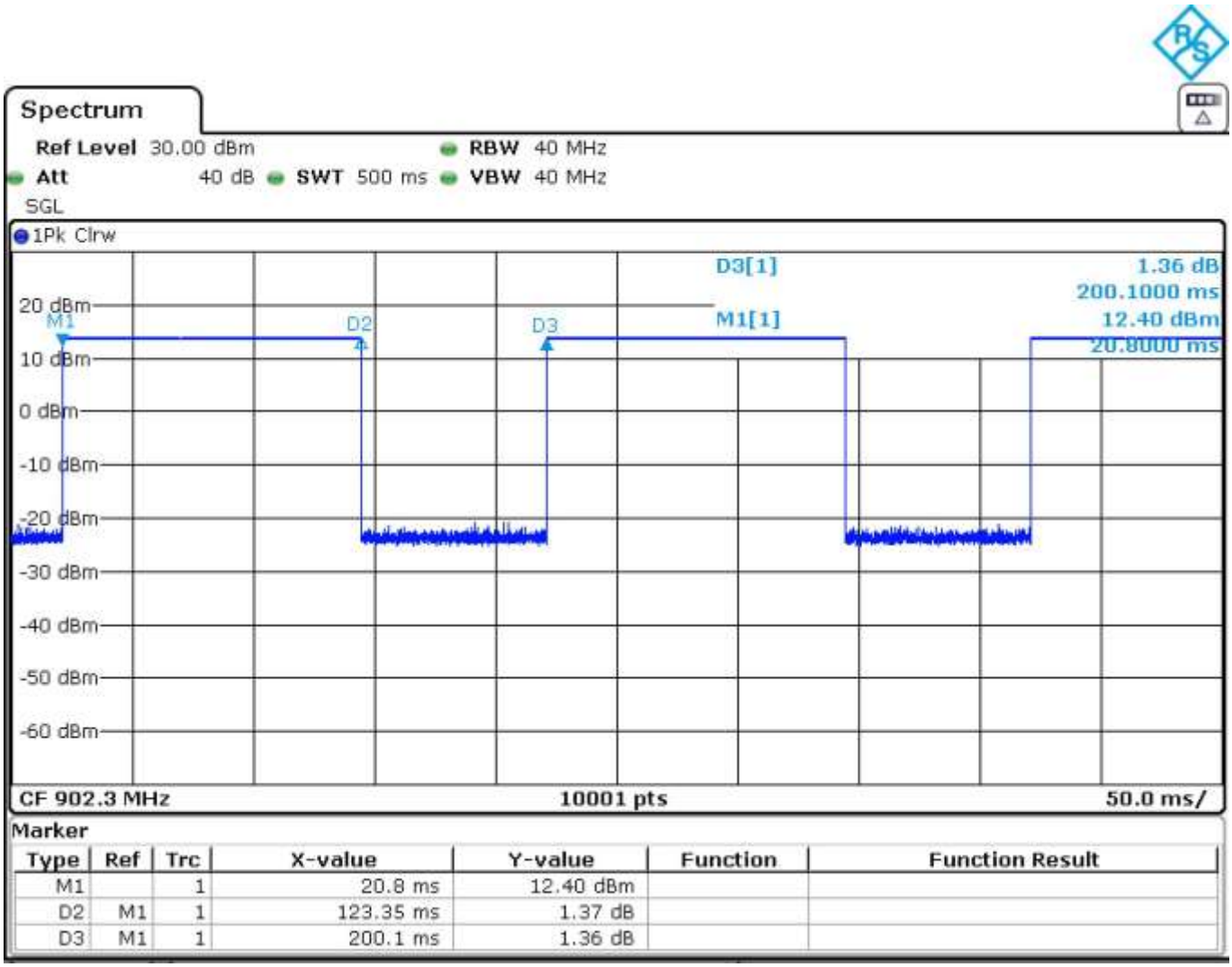
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

	Low Channel	Middle Channel	High Channel
Maximum Average Conducted Power (dBm)	16.89	17.12	16.99
Duty Cycle Correction (dB)	2.10		
Corrected Maximum Average Conducted Power (dBm)	18.99	19.22	19.09
Corrected Maximum EIRP Average Conducted Power (dBm)	20.89	21.12	20.99
Measurement uncertainty (dB)	<±2.57		

Verdict: PASS

DUTY CYCLE

T (ON) and T (ON+OFF)

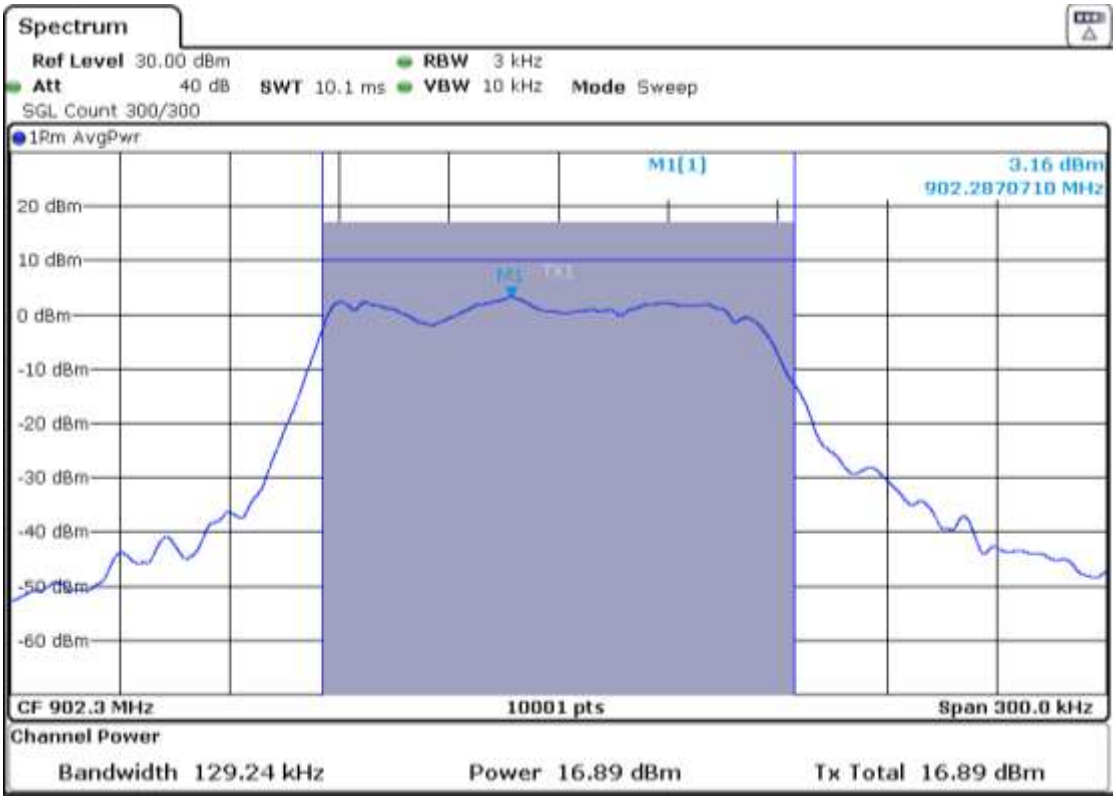


Marker

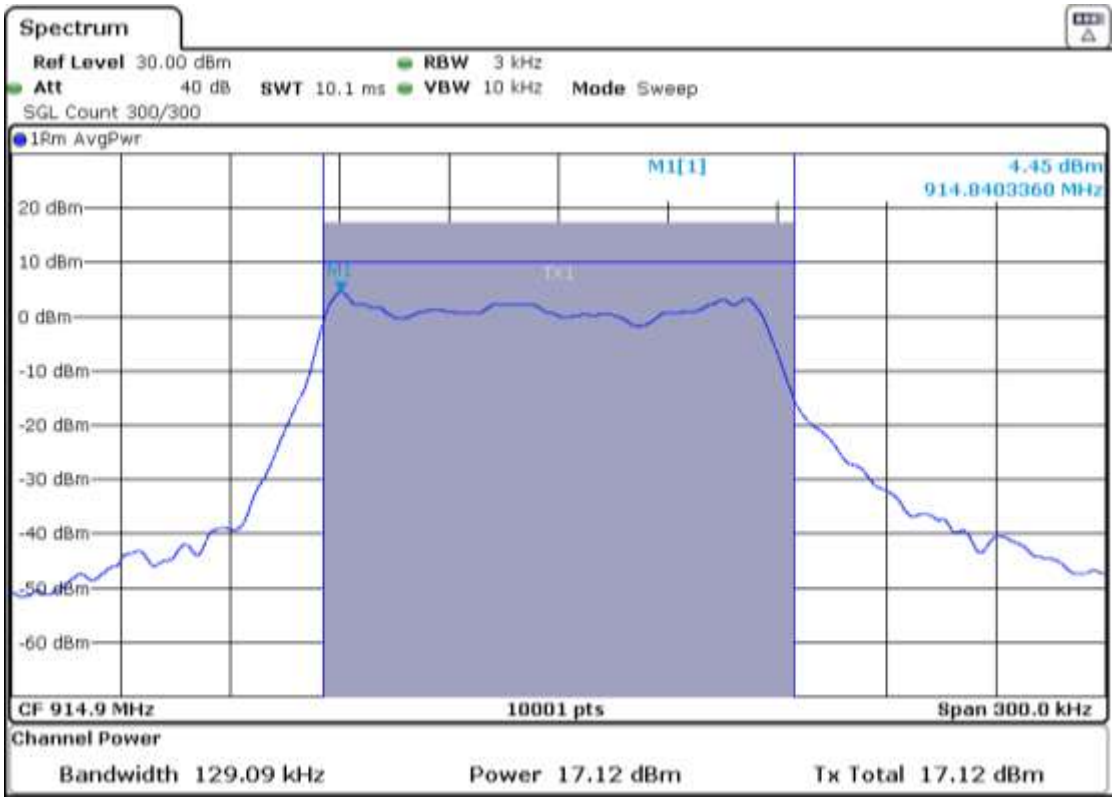
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	20.8 ms	12.40 dBm		
D2	M1	1	123.35 ms	1.37 dB		
D3	M1	1	200.1 ms	1.36 dB		

Maximum Average Output Power:

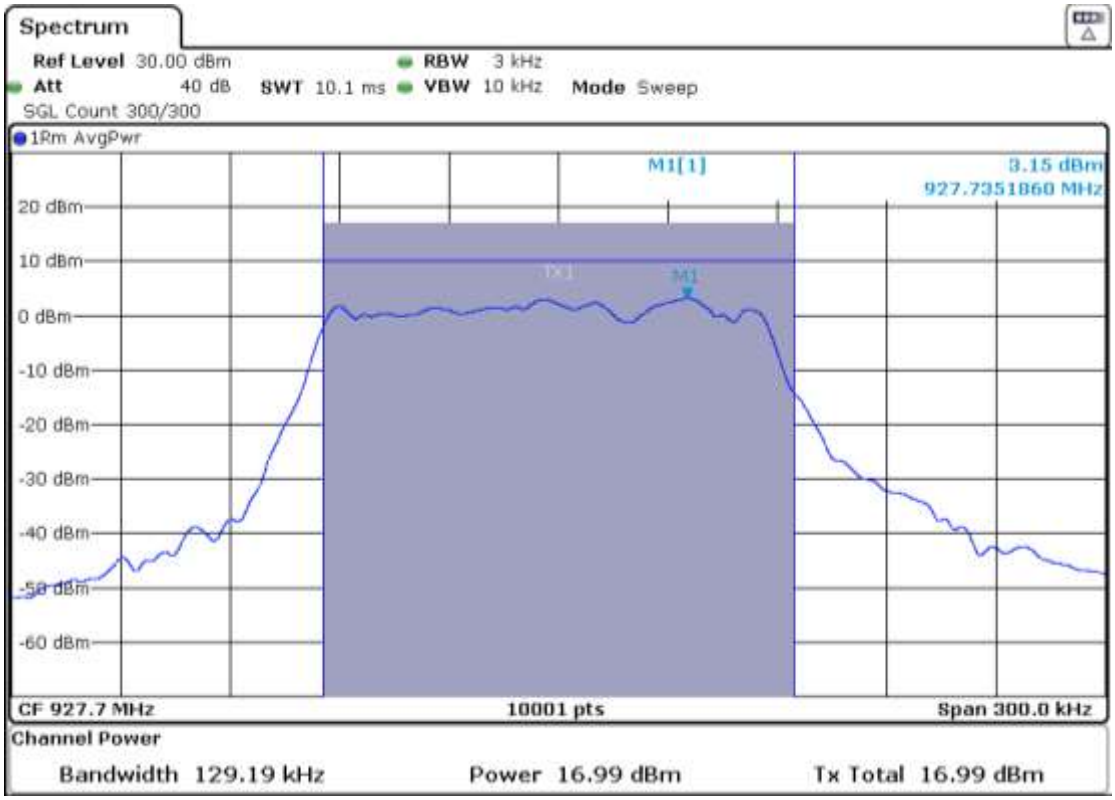
Low Channel:



Middle Channel:



High 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.

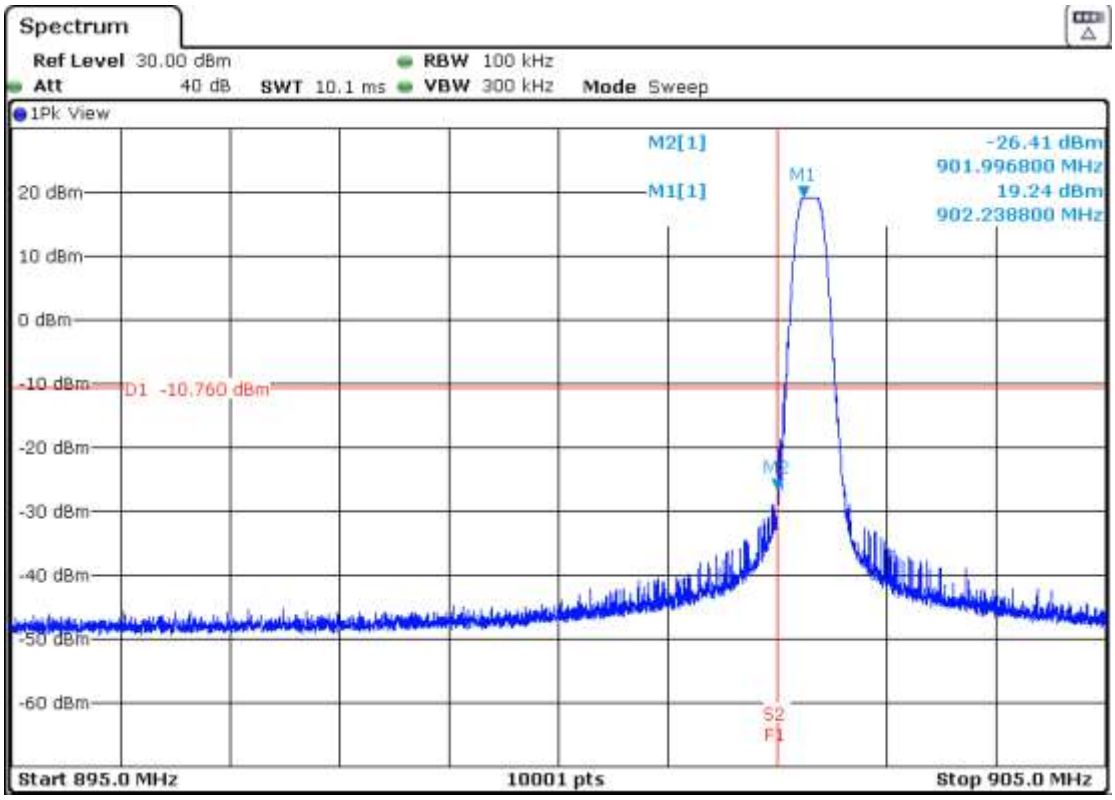
If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

RESULTS:

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

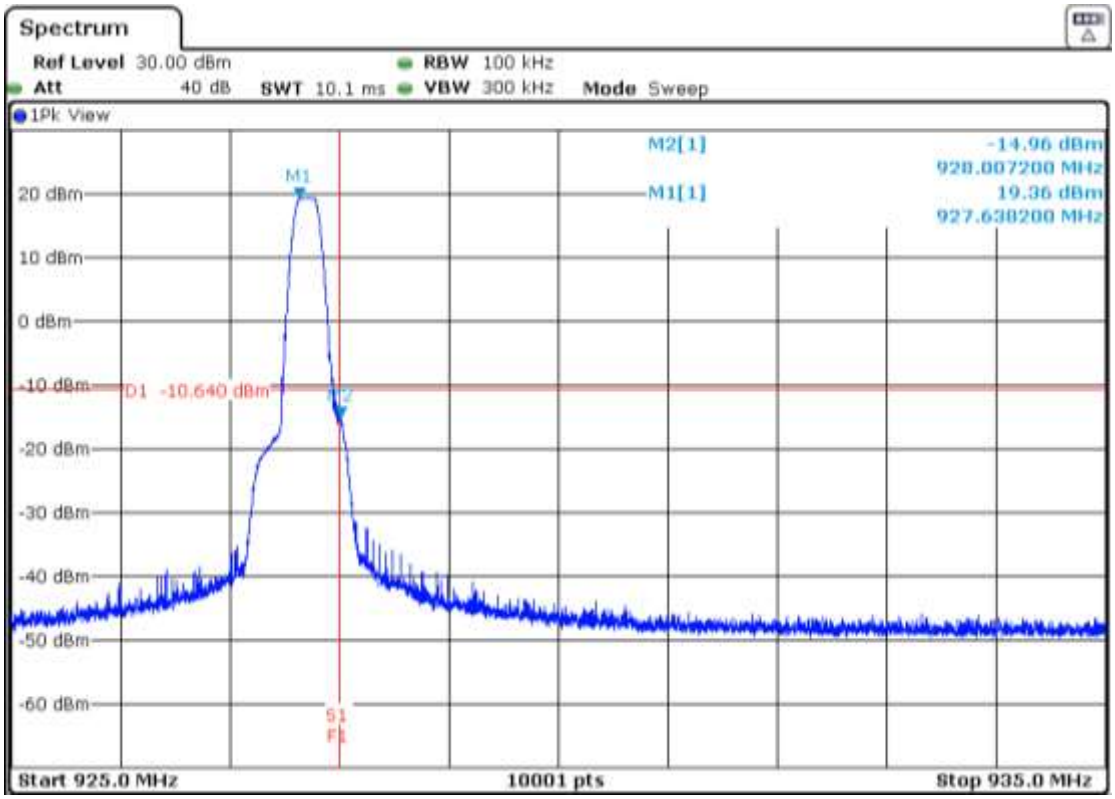
- HOPPING OFF:

  - LOW FREQUENCY SECTION:



Verdict: PASS

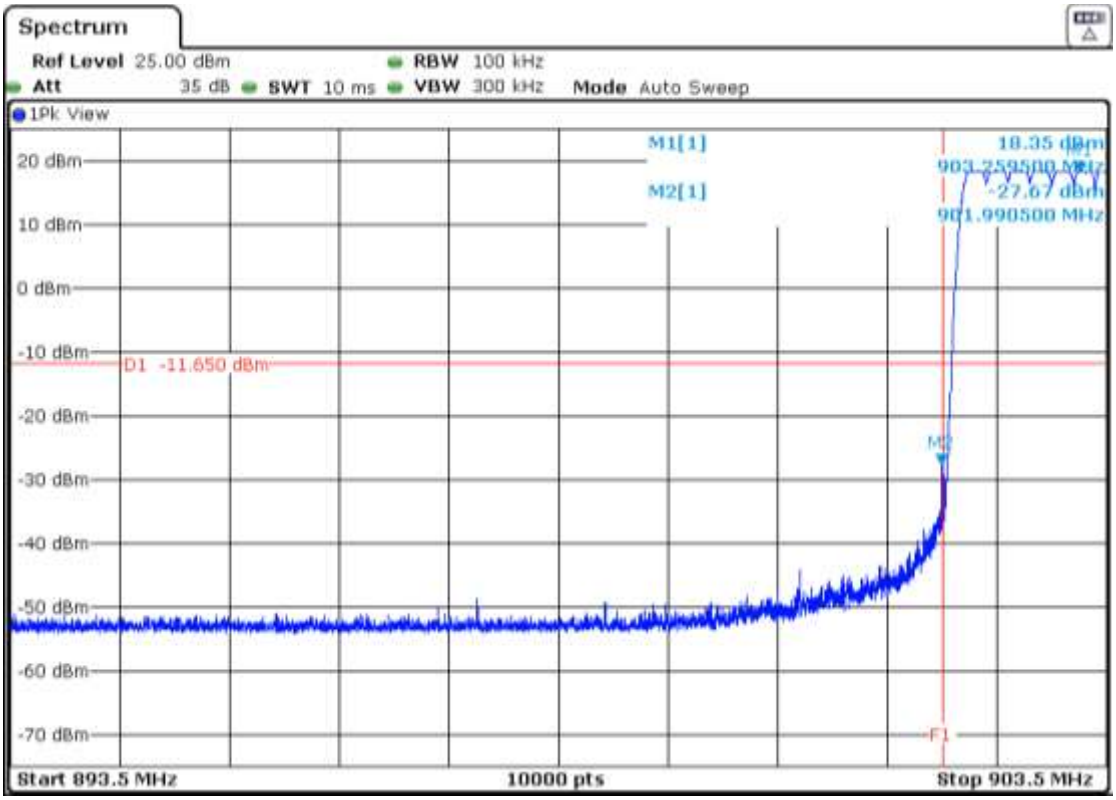
- HIGH FREQUENCY SECTION:



Verdict: PASS

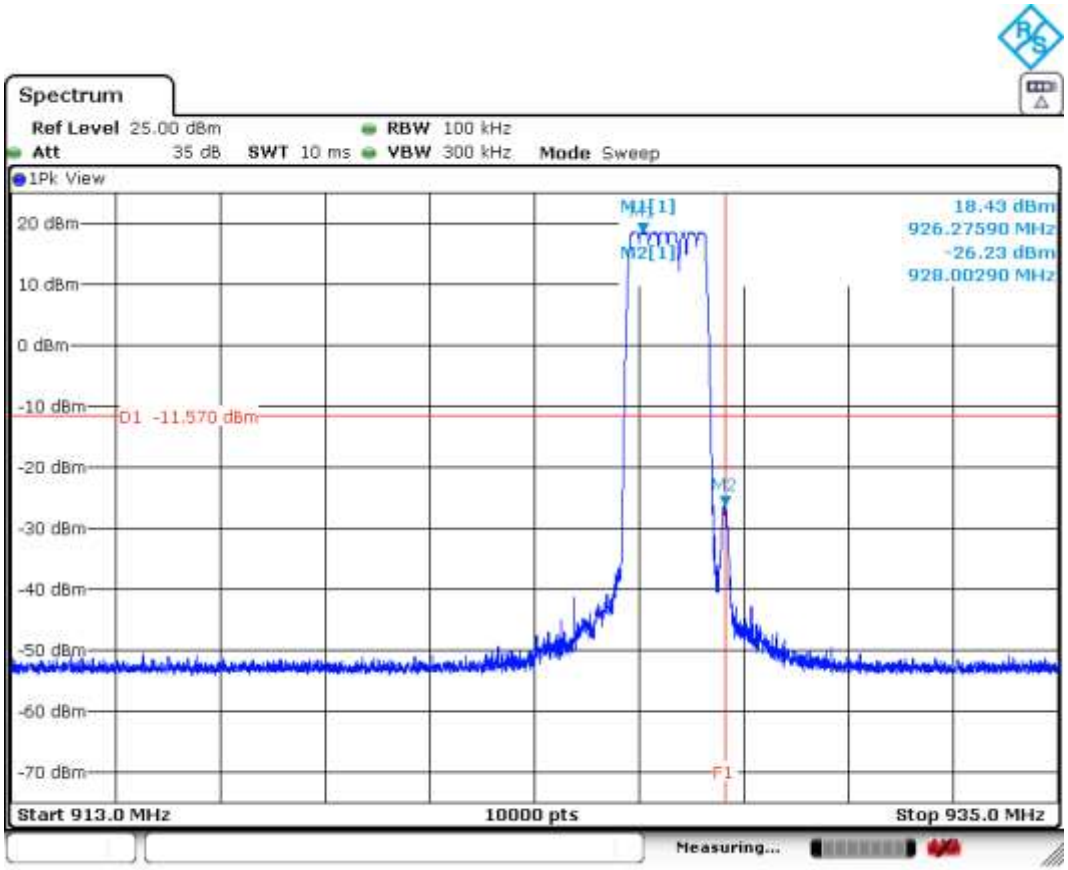
- HOPPING ON:

- LOW FREQUENCY SECTION:



Verdict: PASS

- HIGH FREQUENCY SECTION:



Verdict: PASS

Measurement uncertainty (dB)	<±2.57

FCC 15.247 (f) / RSS-247 5.3. (b) Power spectral density for hybrid systems

SPECIFICATION:

For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques.

The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, 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 was measured using the method AVGPSD-1 according to point 11.10.3 of ANSI C.63.10-2013.

	Low Channel	Middle Channel	High Channel
Average Power Spectral Density (dBm)	4.13	4.22	3.73
Duty Cycle Correction (dB)	2.10		
Corrected Average Power Spectral Density (dBm)	6.231	6.321	5.831
Measurement uncertainty (dB)	<±2.57		

Verdict: PASS

Power Spectral Density:

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 §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)
863.8605	27.09	H	Quasi-Peak	<± 5.08

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)
2.707	46.86	V	Peak	<± 4.98
3.609	49.52	H	Peak	<± 4.98
5.414	50.95	H	Peak	<± 4.98
6.31625 (*)	61.77	V	Peak	<± 4.98
	57.48		Average	<± 4.98
8.121	57.62	V	Peak	<± 4.98
	52.59		Peak	<± 4.98

(*): This Spurious Frequency is outside the restricted bands as defined in §15.205(a). The measured maximum carrier level at 3 m was 106.45 dBµV/m (Peak) so the spurious level is more than 20 dB below the carrier level.

- MIDDLE CHANNEL. Spurious frequencies closest to the limit:

Spurious Frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2.744466667	48.58	V	Peak	<± 4.98
4.5745	48.01	V	Peak	<± 4.98
5.489	48.93	H	Peak	<± 4.98
6.40425	53.35	V	Peak	<± 4.98
7.31925	52.94	H	Peak	<± 4.98
8.23425	57.90	V	Peak	<± 4.98
	52.83		Average	<± 4.98

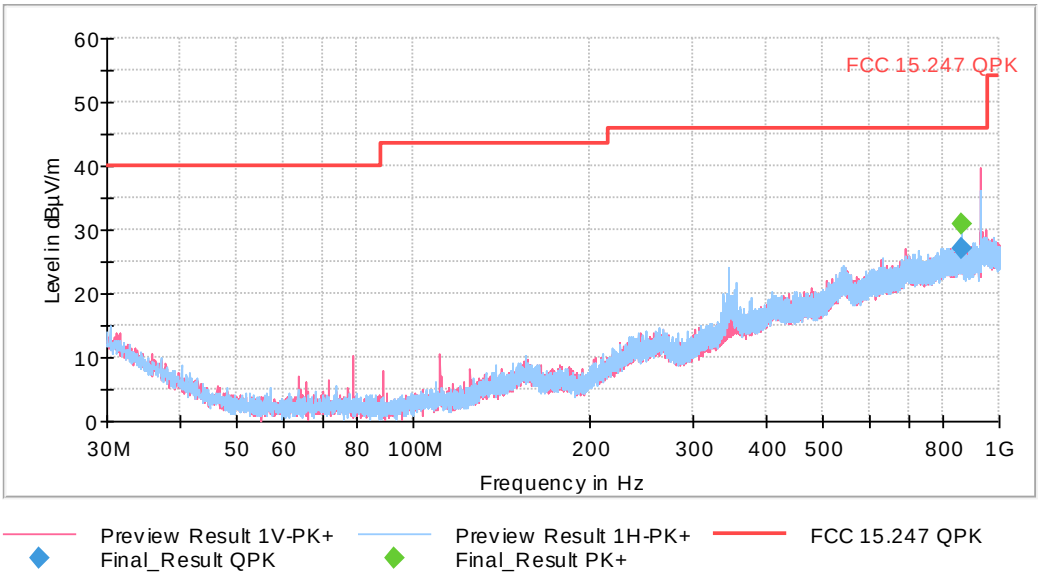
- HIGH CHANNEL. Spurious frequencies closest to the limit:

Spurious Frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2.78313	44.50	V	Peak	<± 4.98
4.6382	42.25	V	Peak	<± 4.98
7.42275	52.35	V	Peak	<± 4.98
8.34975	48.45	V	Peak	<± 4.98

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz:

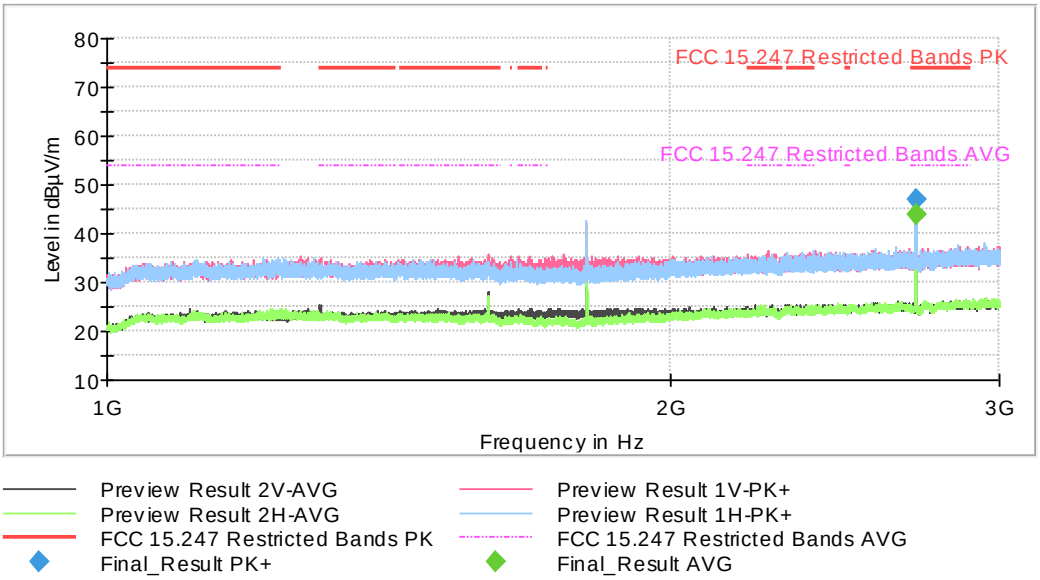
This plot is valid for all channels.



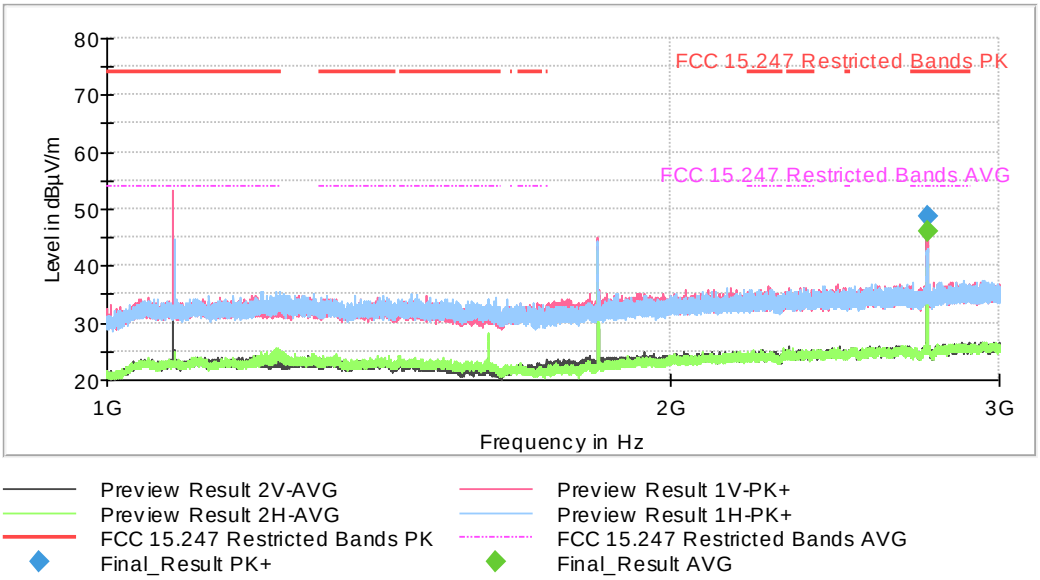
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 1 - 3 GHz:

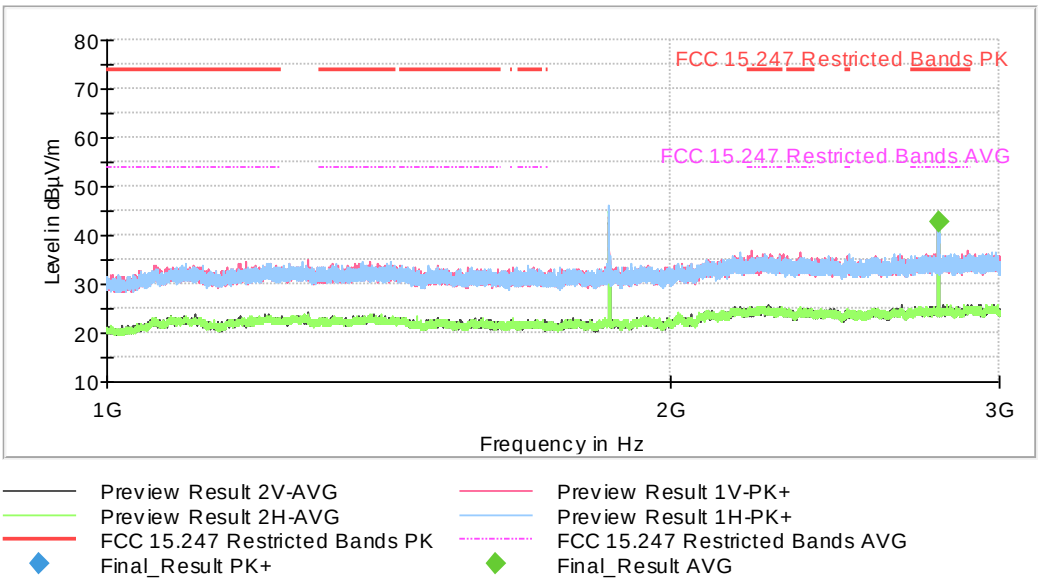
- Low Channel:



- Middle Channel:

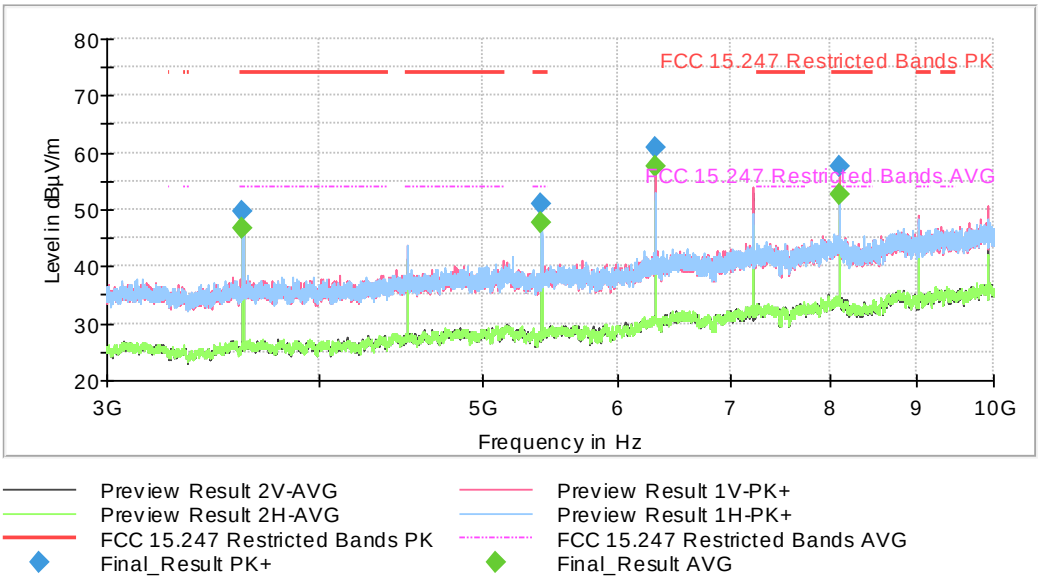


- High Channel:

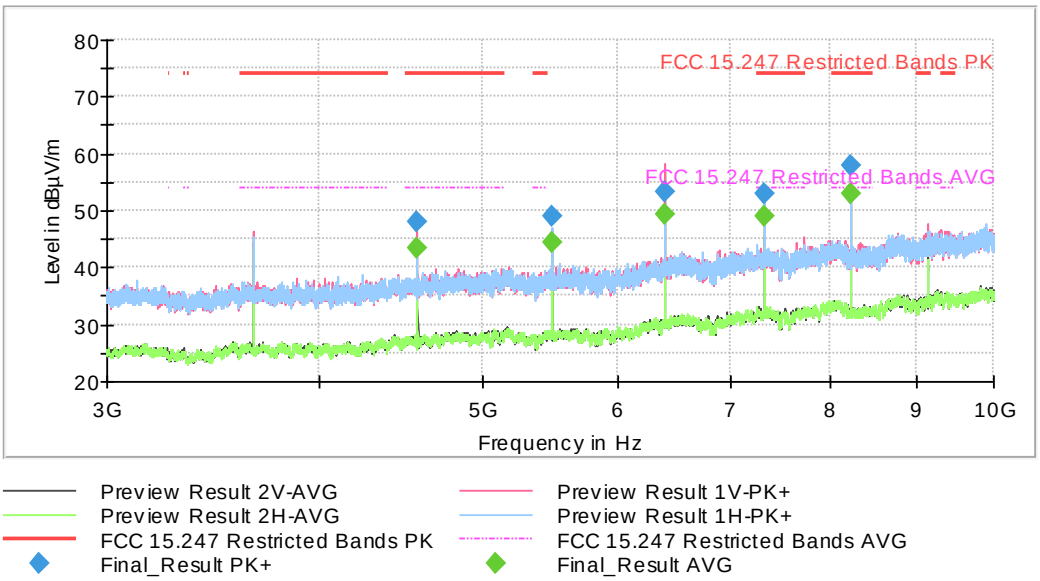
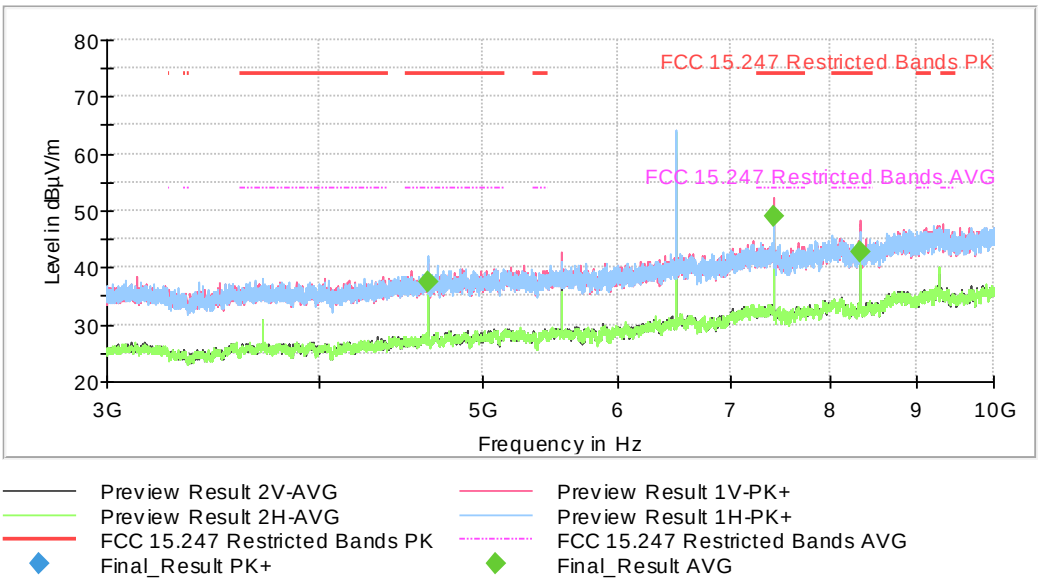


FREQUENCY RANGE 3 - 10 GHz:

- Low Channel:



- Middle Channel:



- High Channel: