

FCC LISTED, REGISTRATION
NUMBER: 720267

Informe de ensayo nº:
Test report No:

IC LISTED REGISTRATION
NUMBER IC 4621A-1

NIE: 47788RRF.002

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.

Identificación del objeto ensayado.....: Identification of item tested	Vibrating wire wireless datalogger
Marca Trademark	Loadsensing G6
Modelo y/o referencia tipo Model and /or type reference	LS-G6-VW
Other identification of the product	FCC ID: 2AHN4-LS-G6-VW IC: 21260-LSG6VW
Final HW version	4
Final SW version	2.15
Características Features	---
Fabricante Manufacturer	WORLDSENSING SL c/Aragó, 383, 4t, 08013 Barcelona. SPAIN
Método de ensayo solicitado, norma.....: Test method requested, standard	USA FCC Part 15.247 10-1-15 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 10-1-15 Edition: Radiated emission limits; general requirements. CANADA RSS-247 Issue 1 (May 2015). CANADA RSS-Gen Issue 4 (November 2014). FCC part 15.247 and Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum System DA 00-705 Released March 30, 2000. Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r03 dated 06/09/2015. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Resultado.....: Summary	IN COMPLIANCE

Aprobado por (nombre / cargo y firma) Approved by (name / position & signature)	A. Llamas RF Lab. Manager		Firmado digitalmente por ALEJANDRO LLAMAS RODRIGUEZ Fecha: 2016.05.12 10:29:59 +02'00'
Fecha de realización Date of issue	2016-05-12		
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Index

Competences and guarantees.....	4
General conditions.....	4
Uncertainty	4
Usage of samples.....	4
Test sample description	5
Identification of the client	5
Testing period.....	5
Environmental conditions.....	5
Remarks and comments.....	7
Testing verdicts	8
Appendix A – Test result.....	9

Competences and guarantees

AT4 wireless is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 720267.

AT4 wireless is a laboratory with a measurement site in compliance with the requirements of RSS 212, Issue 1 (Provisional) and has been added to the list of filed sites of the Canadian Certification and Engineering Bureau. Reference File Number: IC 4621A-1.

In order to assure the traceability to other national and international laboratories, AT4 wireless has a calibration and maintenance program for its measurement equipment.

AT4 wireless 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 AT4 wireless at the time of performance of the test.

AT4 wireless 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 AT4 wireless.

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 AT4 wireless.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of AT4 wireless and the Accreditation Bodies.

Uncertainty

Uncertainty (factor $k=2$) was calculated according to the AT4 wireless internal document PODT000.

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
47788E/002	Vibrating wire datalogger	LS-G6-VW	1681	2015-12-09
47788E/029	Antenna	---	---	2015-12-09
47788E/023	Vibrating wire sensor	EPP-30V	---	2015-12-09
47788E/025	Vibrating wire sensor	EPP-30V	---	2015-12-09
47788E/026	Vibrating wire sensor	EPP-30V	---	2015-12-09
47788E/027	Vibrating wire sensor	EPP-30V	---	2015-12-09
47788E/028	Vibrating wire sensor	EPP-30V	---	2015-12-09

1. Sample S/01 has undergone following test(s).

All radiated tests indicated in appendix A.

Sample S/02 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
47788E/001	Vibrating wire datalogger	LS-G6-VW	1888	2015-12-09
47788E/016	Connection cable	---	---	2015-12-09

1. Sample S/02 has undergone following test(s).

All conducted tests indicated in appendix A.

Test sample description

The test sample consists of a equipment for data collection from vibrating wire sensor for industrial, geotechnical and scientific applications. The data are taken at regular intervals, are stored locally, and transmitted using a wireless long-range radio.

Identification of the client

WORLDSENSING SL
c/Aragó, 383, 4t, 08013 Barcelona. SPAIN.

Testing period

The performed test started on 2015-12-10 and finished on 2015-12-29.

The tests have been performed at AT4 wireless.

Environmental conditions

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

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

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

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω
Normal site attenuation (NSA)	< ±4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz)
Field homogeneity	More than 75% of illuminated surface is between 0 and 6 dB (26 MHz to 1000 MHz).

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

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

Remarks and comments

1: The equipment under test is a hybrid system which uses both digital modulation and frequency hopping techniques at the same time on the same carrier.

2: Used instrumentation:

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Spectrum analyser Agilent E4440A	2015/10	2017/10
2.	DC power supply R&S NGPE 40/40	2014/11	2017/11
3.	Signal Analyser Rohde FSQ8	2014/05	2016/05

Radiated Measurements

		Last Cal. date	Cal. due date
1.	Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2.	BiconicalLog antenna ETS LINDGREN 3142E	2014/03	2017/03
3.	Multi Device Controller EMCO 2090	N.A.	N.A.
4.	Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2013/11	2016/11
5.	Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2014/03	2017/03
6.	EMI Test Receiver R&S ESU 40	2014/02	2016/02
7.	EMI Test Receiver R&S ESU 26	2015/11	2017/11
8.	RF pre-amplifier 10 MHz-6 GHz SCHWARZBECK BBV9743	2015/03	2016/03
9.	RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-3A	2015/05	2016/05

Testing verdicts

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

FCC PART 15 PARAGRAPH / RSS-247		VERDICT			
		NA	P	F	NM
FCC 15.247 Subclause (a) (1) / RSS-247 Clause 5.1 (2)	20 dB Bandwidth and Carrier frequency separation		P		
FCC 15.247 Subclause (f) / RSS-247 Clause 5.3 (1)	Time of occupancy (Dwell Time)		P		
FCC 15.247 Subclause (b) (2) / RSS-247 Clause 5.4 (1)	Maximum output power and antenna gain		P		
FCC 15.247 Subclause (d) / RSS-247 Clause 5.5	Band-edge compliance of conducted (Transmitter)		P		
FCC 15.247 Subclause (d) / RSS-247 Clause 5.5	Emission limitations conducted (Transmitter)		P		
FCC 15.247 Subclause (f) / RSS-247 5.3. (2)	Power spectral density		P		
FCC 15.247 Subclause (d) / RSS-247 Clause 5.5	Emission limitations radiated (Transmitter)		P		

Appendix A – Test result

INDEX

TEST CONDITIONS	11
FCC Section 15.247 Subclause (a) (1) / RSS-247 Clause 5.1 (2). 20 dB Bandwidth and Carrier frequency separation.....	15
FCC Section 15.247 Subclause (f) / RSS-247 Clause 5.3 (1). Time of occupancy (Dwell Time)	18
FCC Section 15.247 Subclause (b) (2) / RSS-247 Clause 5.4 (1). Maximum output power and antenna gain	19
FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Band-edge compliance of conducted emissions (Transmitter)	23
FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Emission limitations conducted (Transmitter).....	26
FCC Section 15.247 Subclause (f) / RSS-247 5.3. (2) Power spectral density.....	28
FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Emission limitations radiated (Transmitter)	31

TEST CONDITIONS

Power supply (V):

$V_{\text{nominal}} = 3.6 \text{ Vdc}$

Type of power supply = DC voltage from internal battery.

Type of antenna = External attachable antenna.

Declared Gain for antenna (maximum) = 3 dBi

TEST FREQUENCIES:

Lowest channel: 902.3 MHz

Middle channel: 908.7 MHz

Highest channel: 914.9 MHz

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is directly connected to the spectrum analyzer.



RADIATED MEASUREMENTS

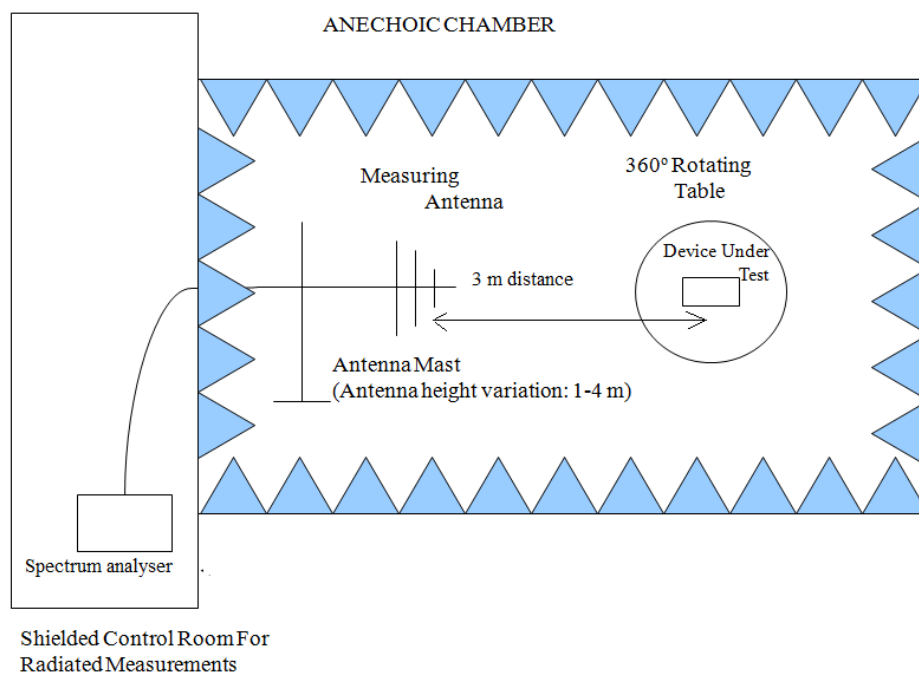
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-10 GHz (1 GHz-18 GHz Double ridge horn antenna).

For radiated emissions in the range 1 GHz-10 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

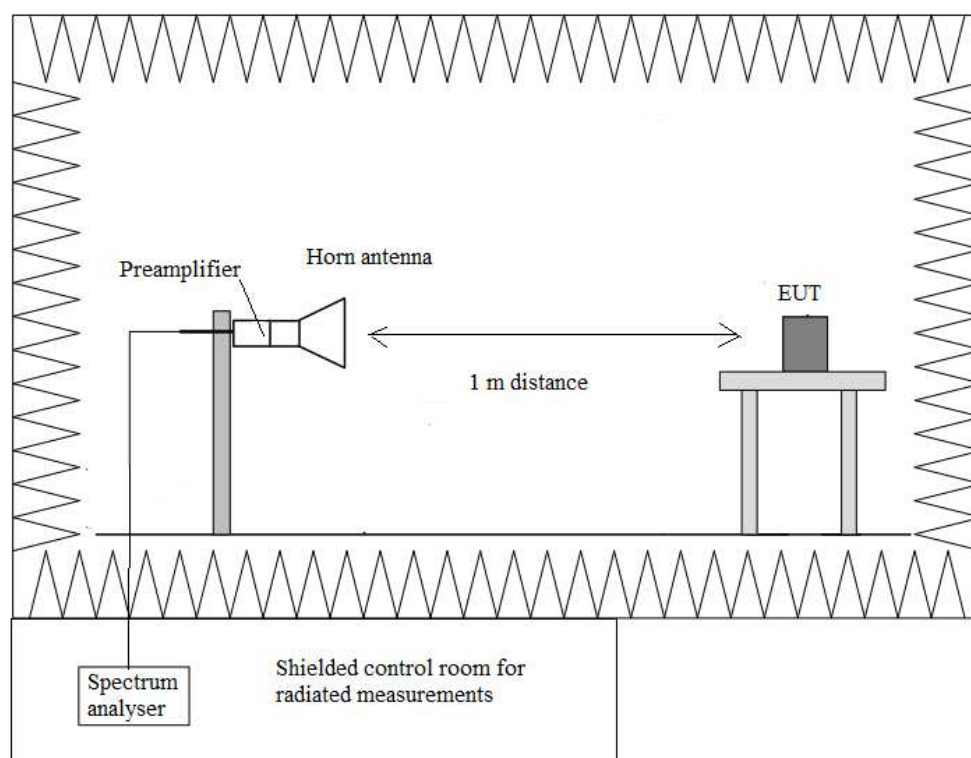
The equipment under test was set up on a non-conductive (wooden) platform 1.5 meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

Radiated measurements setup $f < 1$ GHz



Radiated measurements setup $f > 1$ GHz



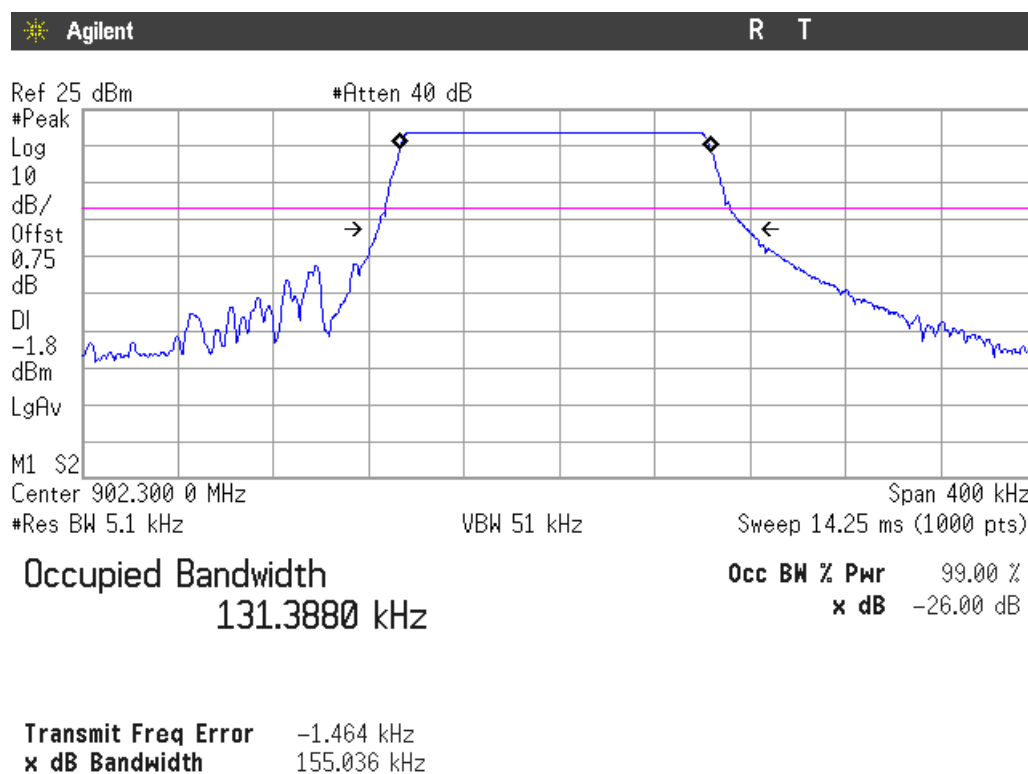
Occupied bandwidth

RESULTS

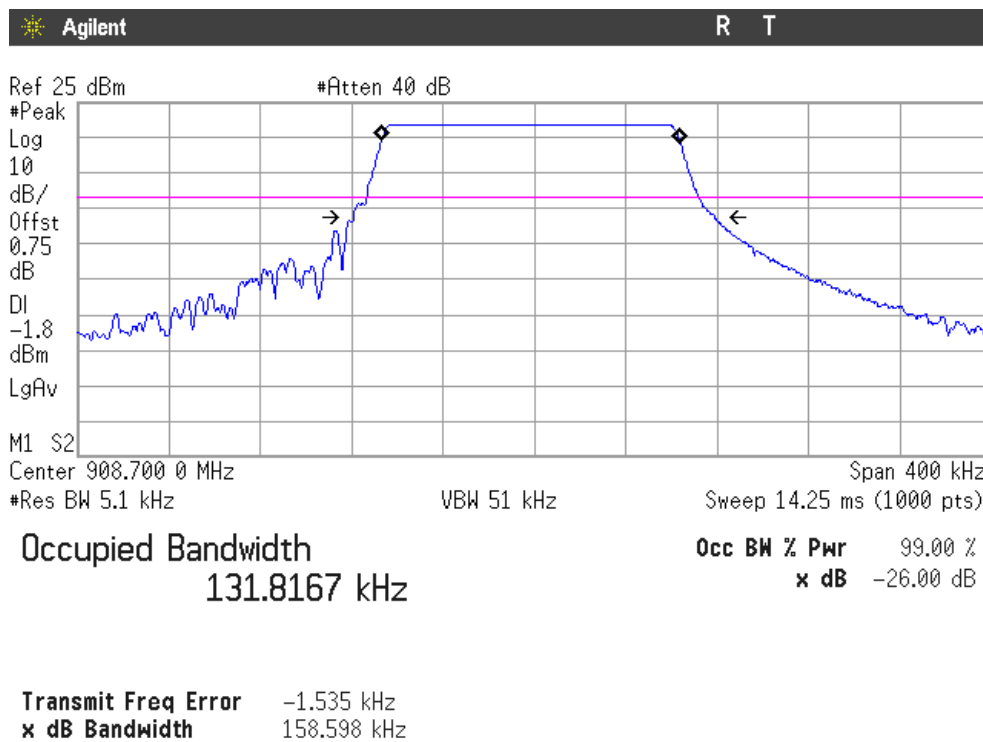
(See next plots)

	Lowest frequency 902.3 MHz	Middle frequency 908.7 MHz	Highest frequency 914.9 MHz
Occupied bandwidth (kHz)	131.3880	131.8167	131.6296
Measurement uncertainty (kHz)	<±0.67		

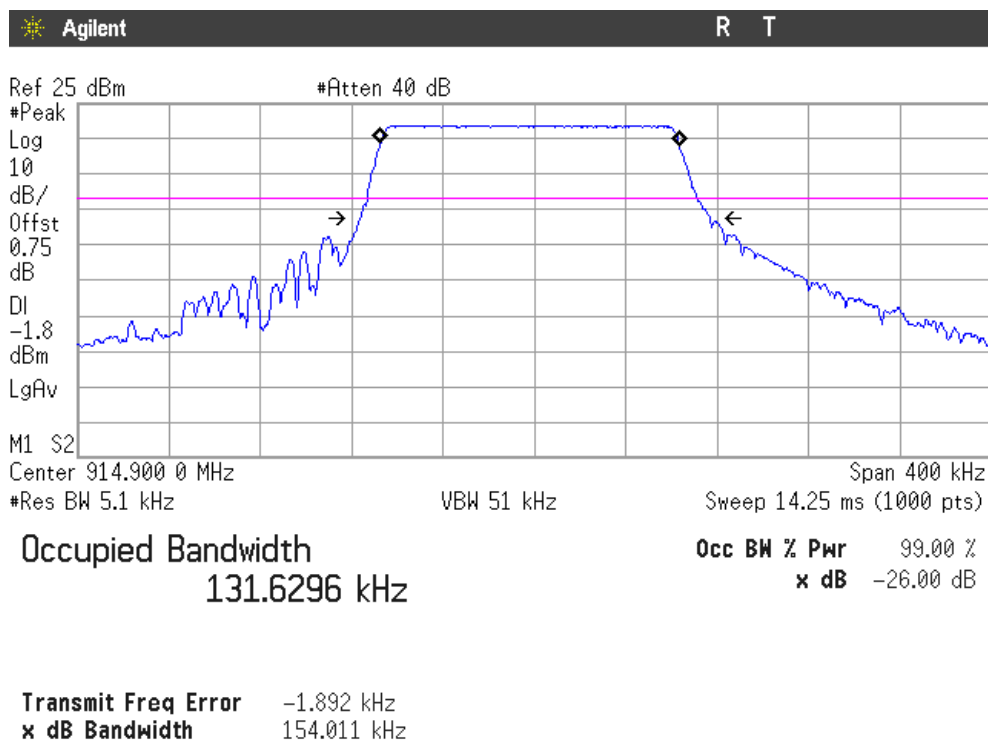
Lowest Channel: 902.3 MHz.



Middle Channel: 908.7 MHz.



Highest Channel: 914.9 MHz.



FCC Section 15.247 Subclause (a) (1) / RSS-247 Clause 5.1 (2). 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.

For frequency hopping systems operating in the 902–928 MHz band the maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

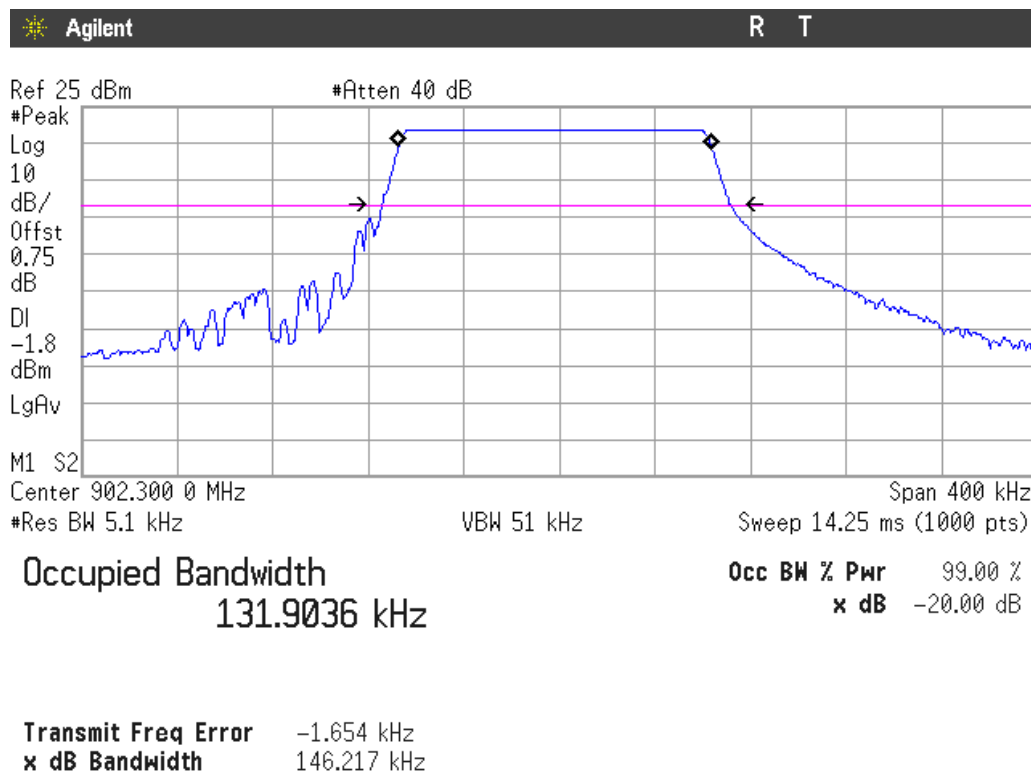
RESULTS

(See next plots)

	Lowest frequency 902.3 MHz	Middle frequency 908.7 MHz	Highest frequency 914.9 MHz
20 dB Spectrum bandwidth (kHz)	146.217	145.909	145.742
Measurement uncertainty (kHz)	<±0.67		

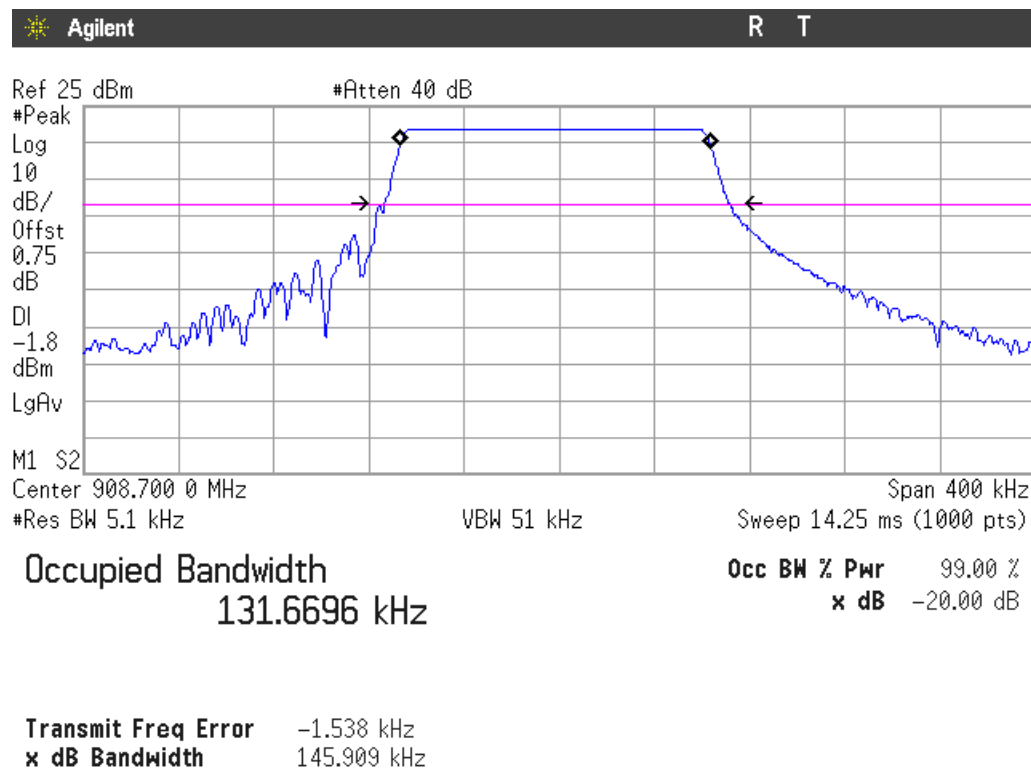
20 dB BANDWIDTH.

Lowest Channel: 902.3 MHz.



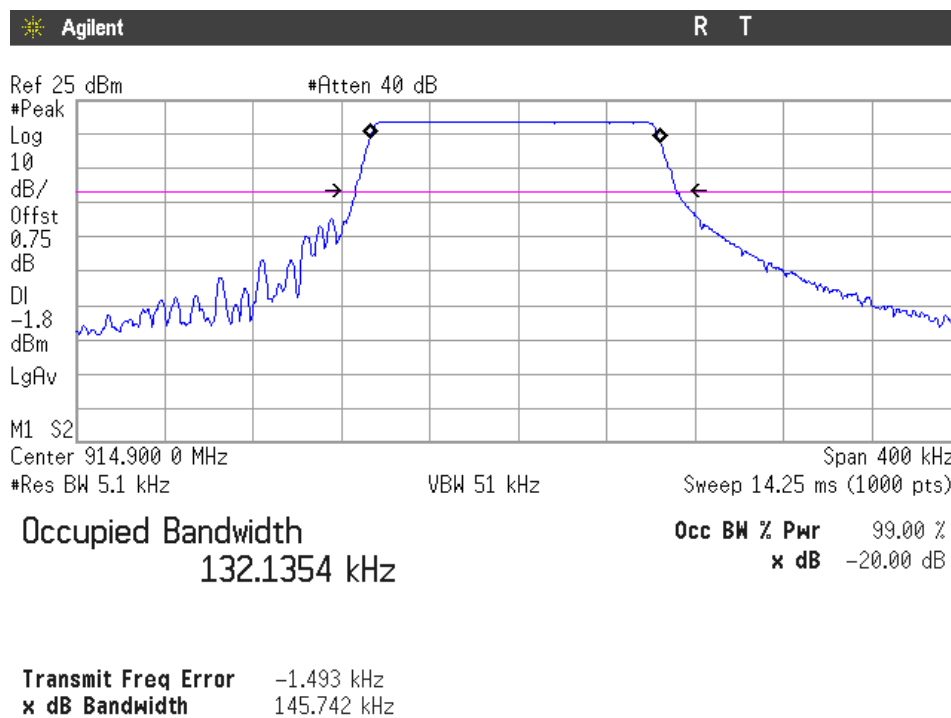
20 dB BANDWIDTH

Middle Channel: 908.7 MHz.

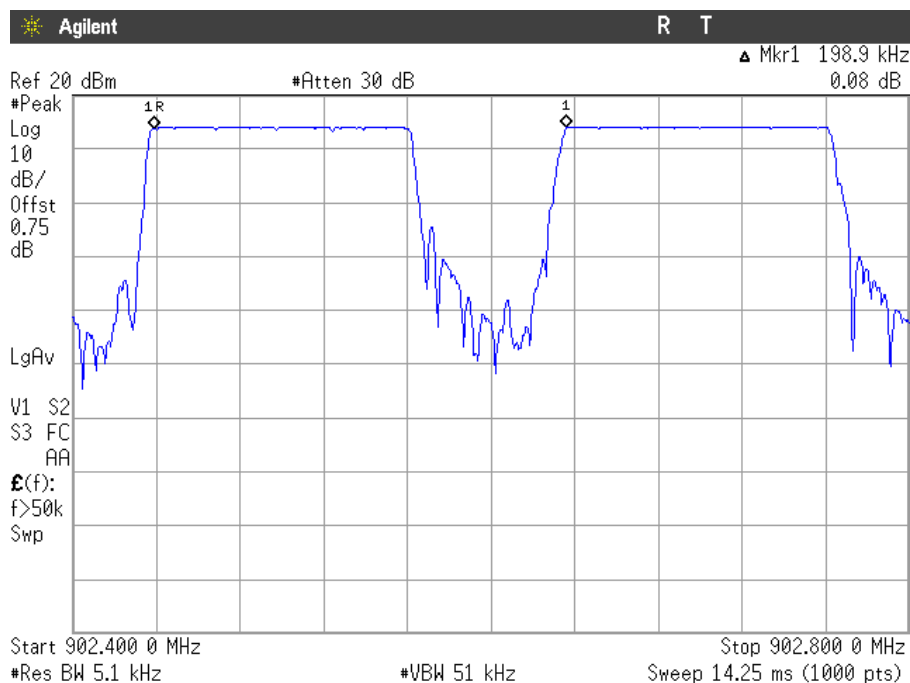


20 dB BANDWIDTH

Highest Channel: 914.9 MHz.



Carrier frequency separation



Measurement uncertainty (kHz)

<±1.46

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

Verdict: PASS

FCC Section 15.247 Subclause (f) / RSS-247 Clause 5.3 (1). 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 ($0.4 \times 8 = 3.2$ seconds).

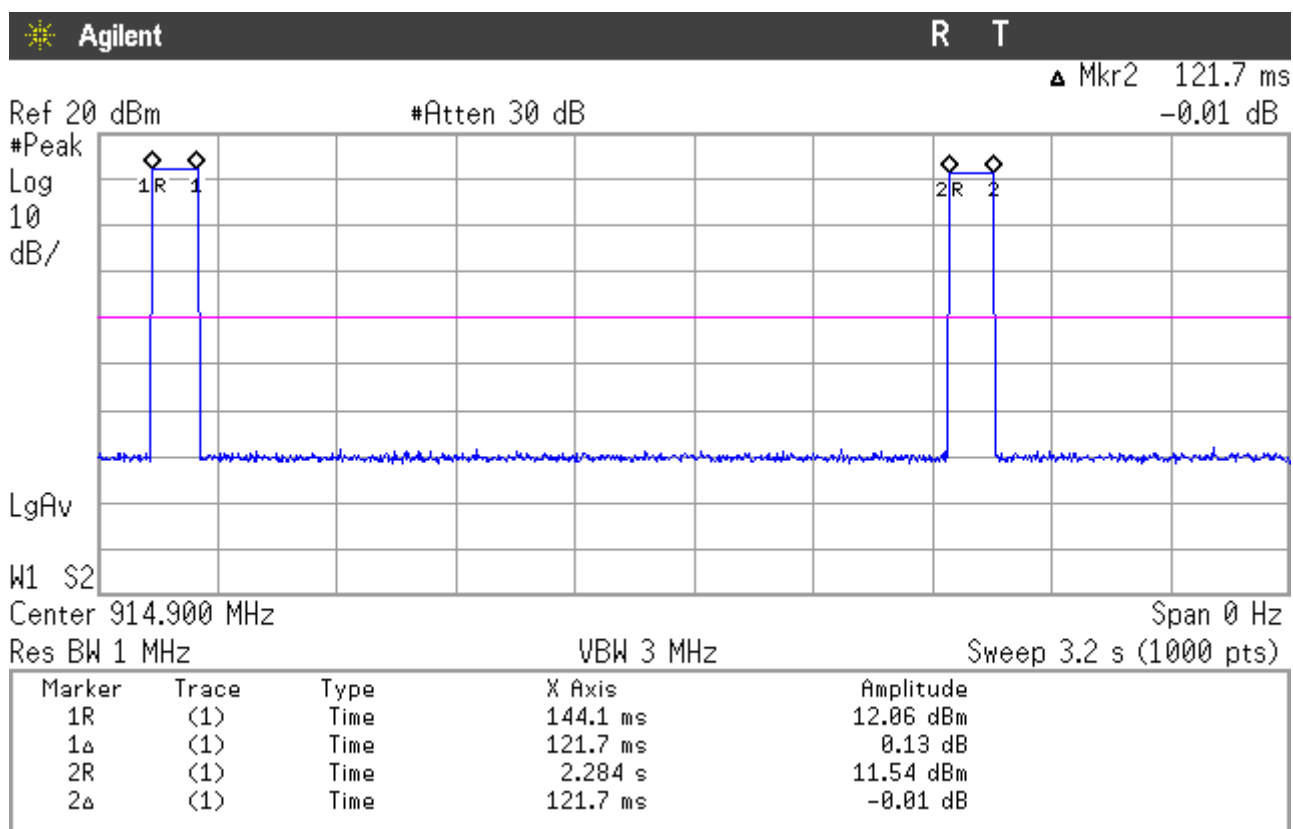
RESULTS

1. TIME OF OCCUPANCY (DWEELL TIME).

The system makes worst case 2 hops in each channel in a period of $0.4 \times 8 = 3.2$ seconds (see next plots).

Each Tx-time is 121.7 ms (see next plots).

So we have $2 \times 121.7 \text{ ms} = 243.4 \text{ ms}$ per 3.2 seconds.



Measurement uncertainty (%)

<±0.01

Verdict: PASS

FCC Section 15.247 Subclause (b) (2) / RSS-247 Clause 5.4 (1). 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: 1 watt.

The e.i.r.p. shall not exceed 4 W (36 dBm) if the hopset uses 50 or more hopping channels (RSS-247).

RESULTS

Type of equipment: Hybrid system in the 902–928 MHz band.

The maximum output power level in the fundamental emission was measured using the method AVGSA-2 (Average Power) according to point 9.2.2.4 of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r03 dated 06/09/2015.

MAXIMUM AVERAGE OUTPUT POWER. See next plots.

Declared maximum antenna gain: 3 dBi.

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

Measured Duty cycle: $x = 0.89$. Correction = $10 \cdot \log(1/x) = 0.51$ dB.

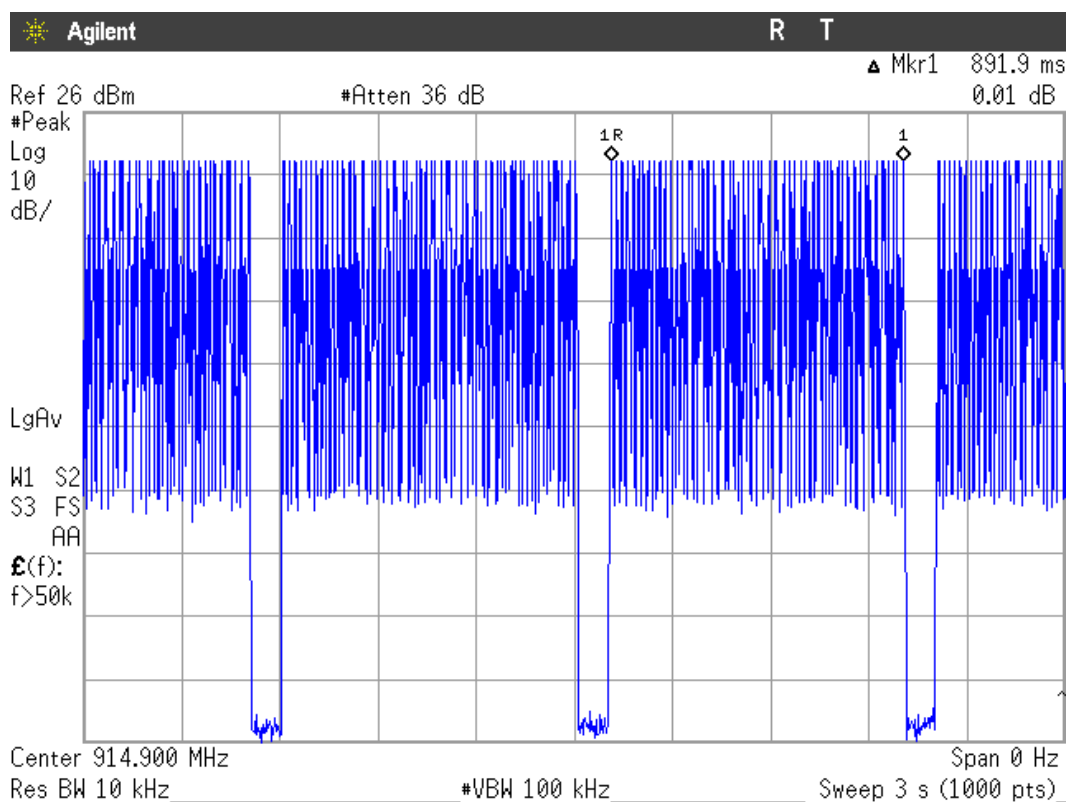
	Lowest frequency 902.3 MHz	Middle frequency 908.7 MHz	Highest frequency 914.9 MHz
Maximum Average conducted power (dBm)	17.49	17.53	17.66
Maximum Average corrected power (dBm)	18.00	18.04	18.17
Maximum Average EIRP power (dBm)	21.00	21.04	21.17
Measurement uncertainty (dB)	<± 0.66		

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.

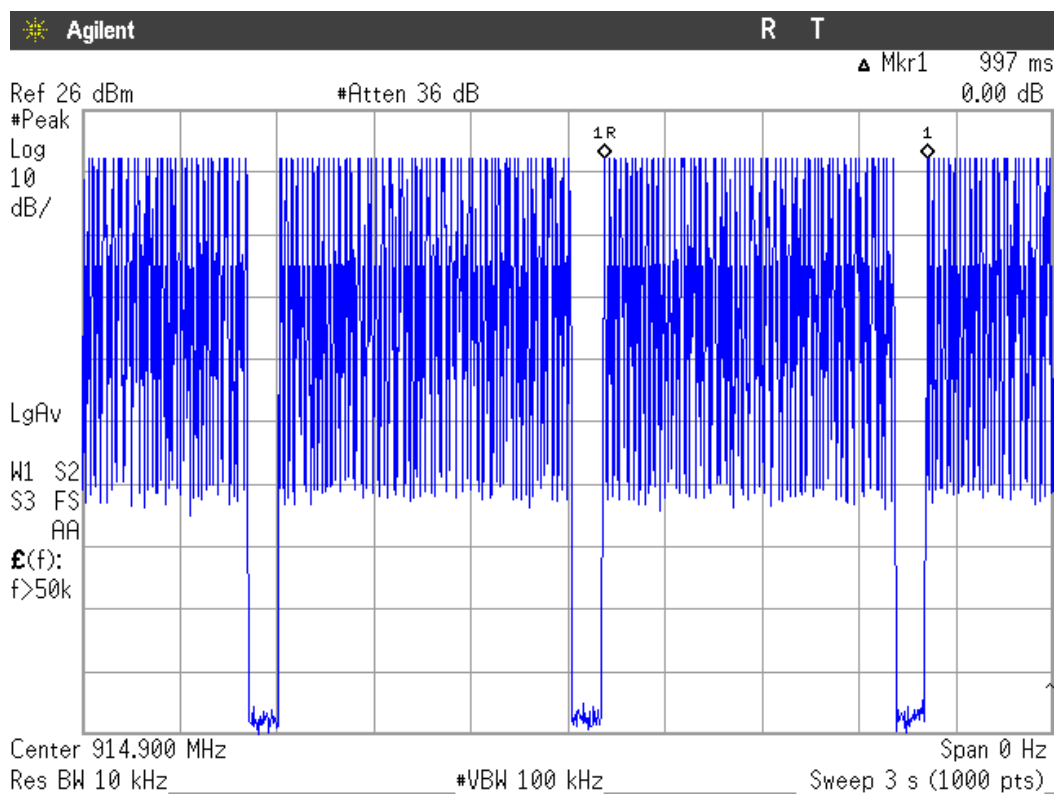
Verdict: PASS

DUTY CYCLE

T ON

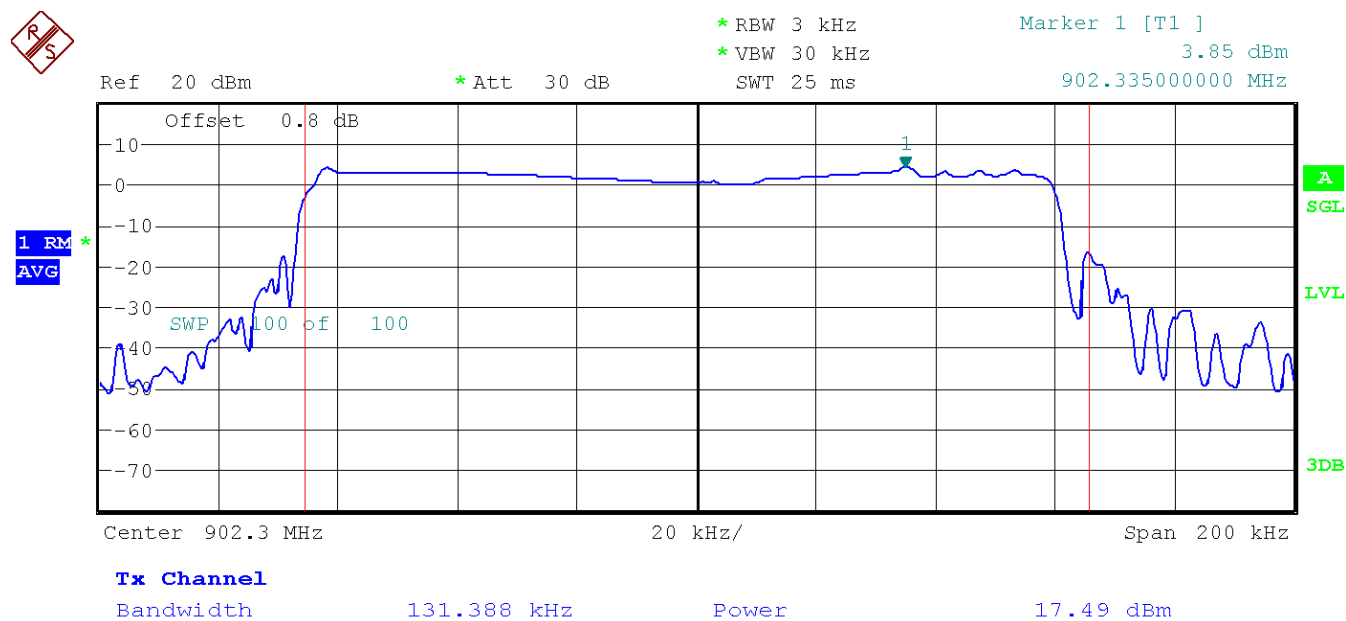


T ON+OFF

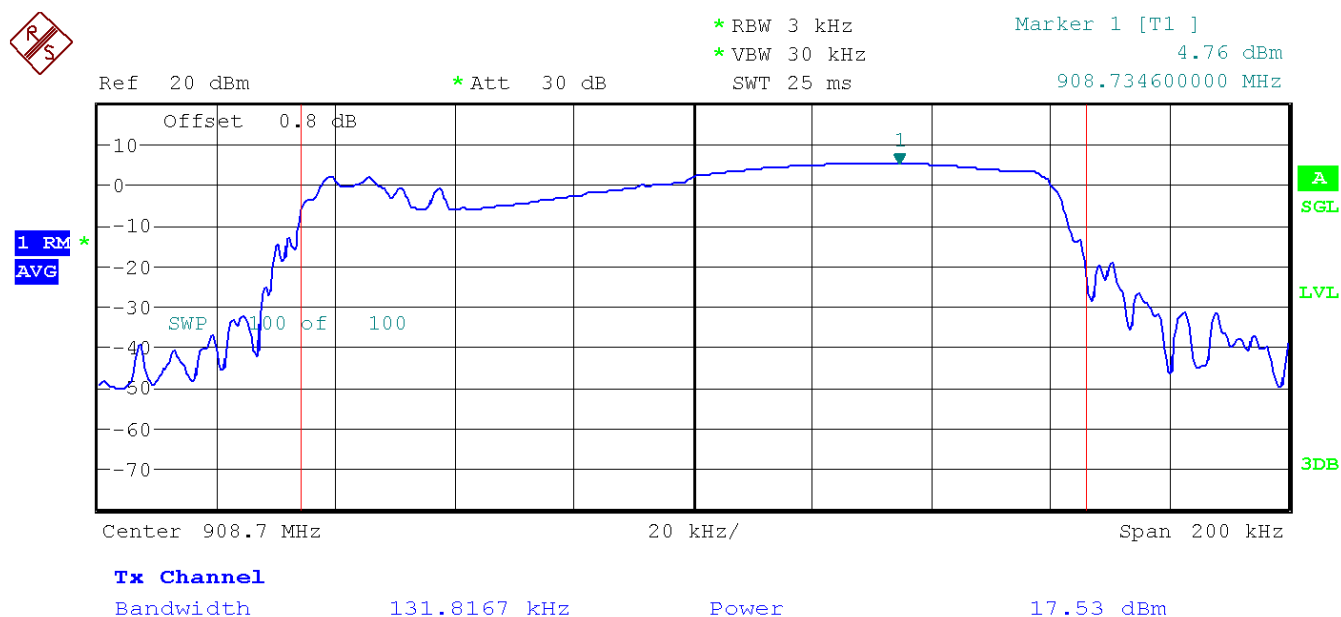


AVERAGE OUTPUT POWER (CONDUCTED).

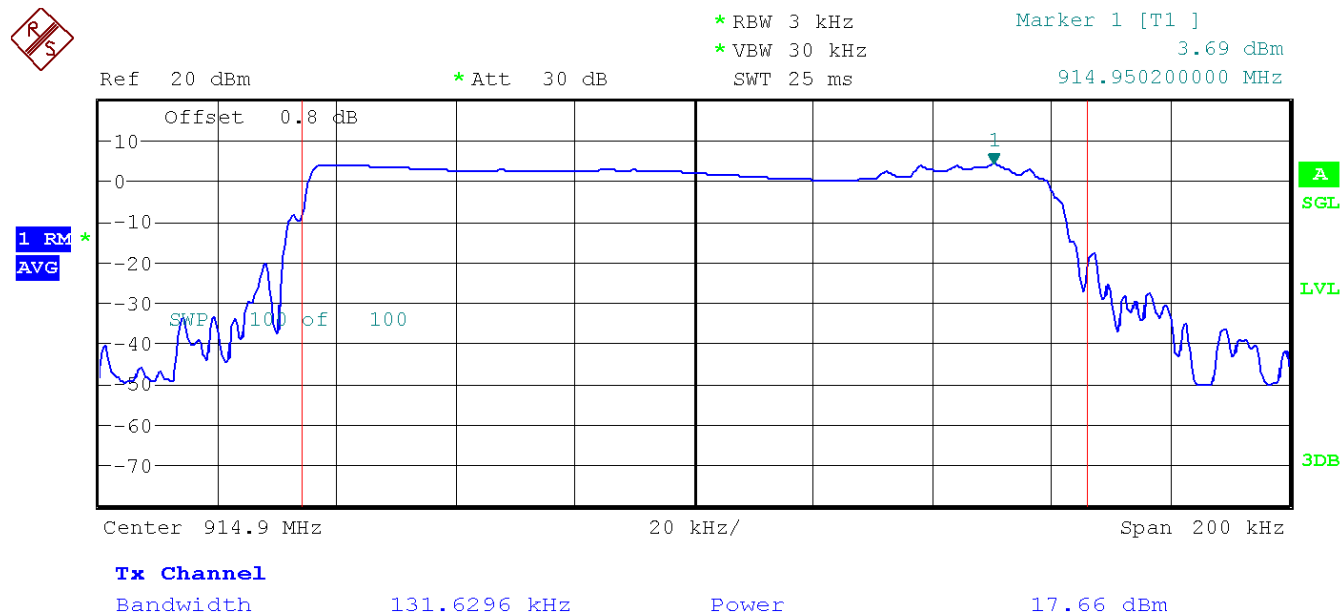
Lowest Channel: 902.3 MHz



Middle Channel: 908.7 MHz



Highest Channel: 914.9 MHz



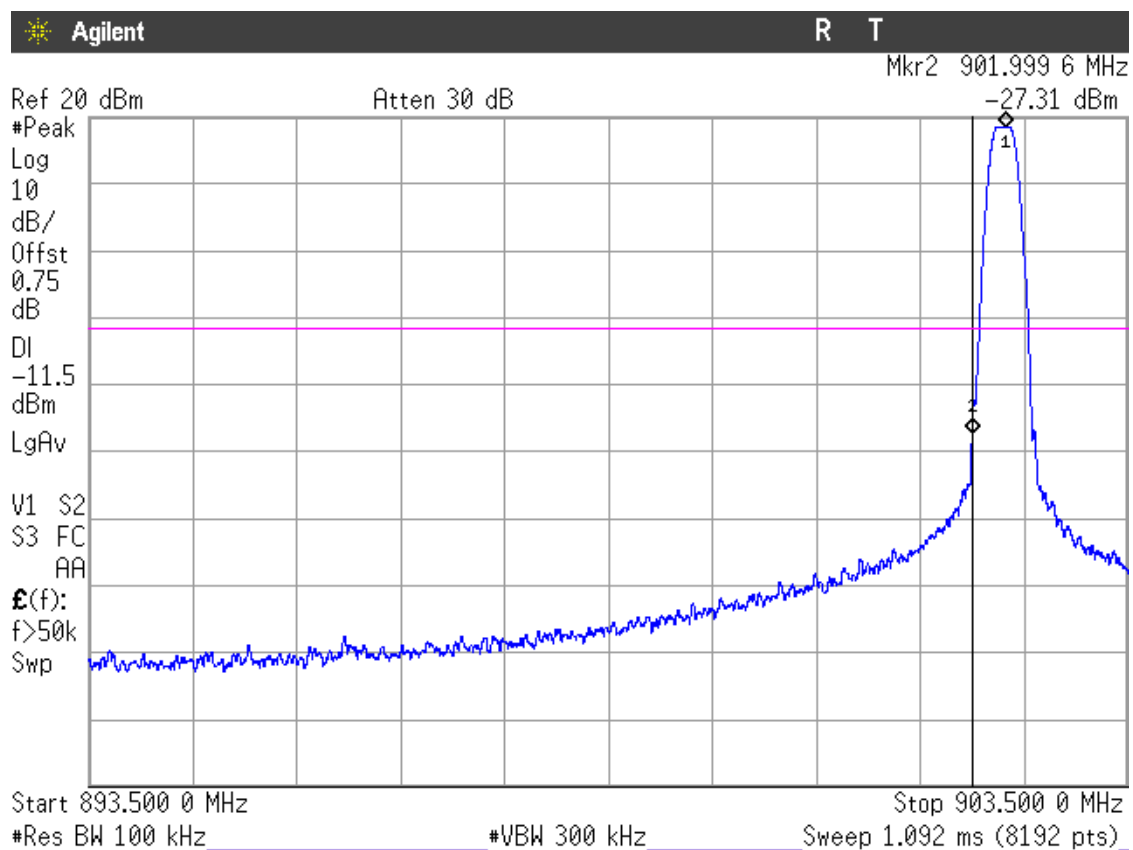
FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Band-edge compliance of conducted emissions (Transmitter)

SPECIFICATION

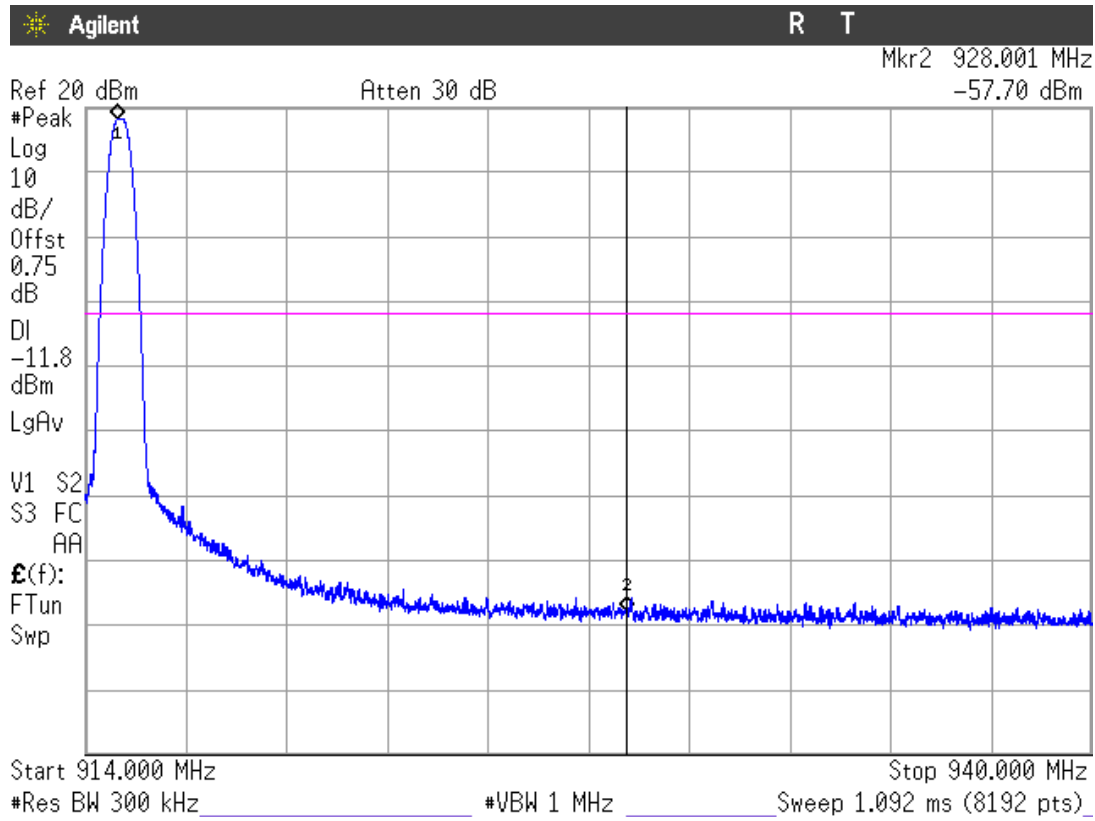
Emissions outside the frequency band in which the intentional radiator is operating shall be at least 20 dB below the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

RESULTS:

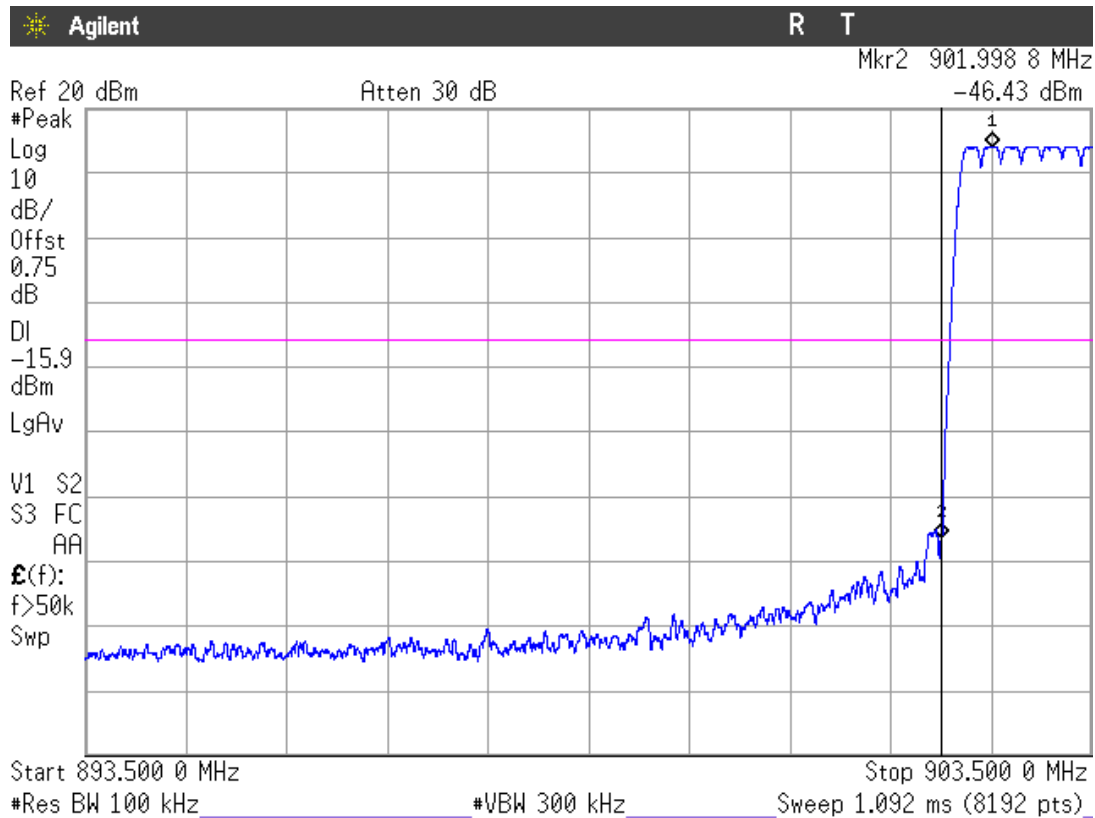
1. LOW FREQUENCY SECTION 902.3 MHz (HOPPING OFF). See next plot.



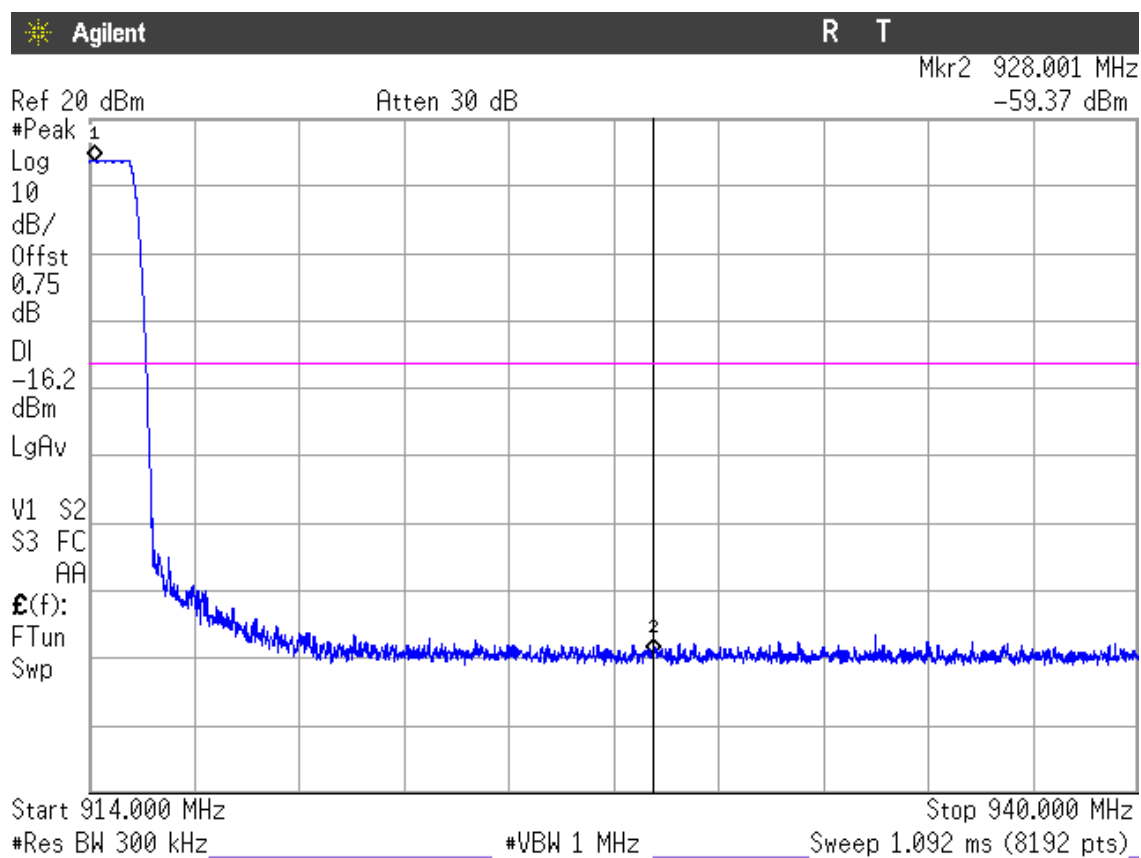
2. HIGH FREQUENCY SECTION 914.9 MHz (HOPPING OFF). See next plot.



3. LOW FREQUENCY SECTION 902.3 MHz (HOPPING ON). See next plot.



4. HIGH FREQUENCY SECTION 914.9 MHz (HOPPING ON). See next plot.



Measurement uncertainty (dB)	<±2.03
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Verdict: PASS

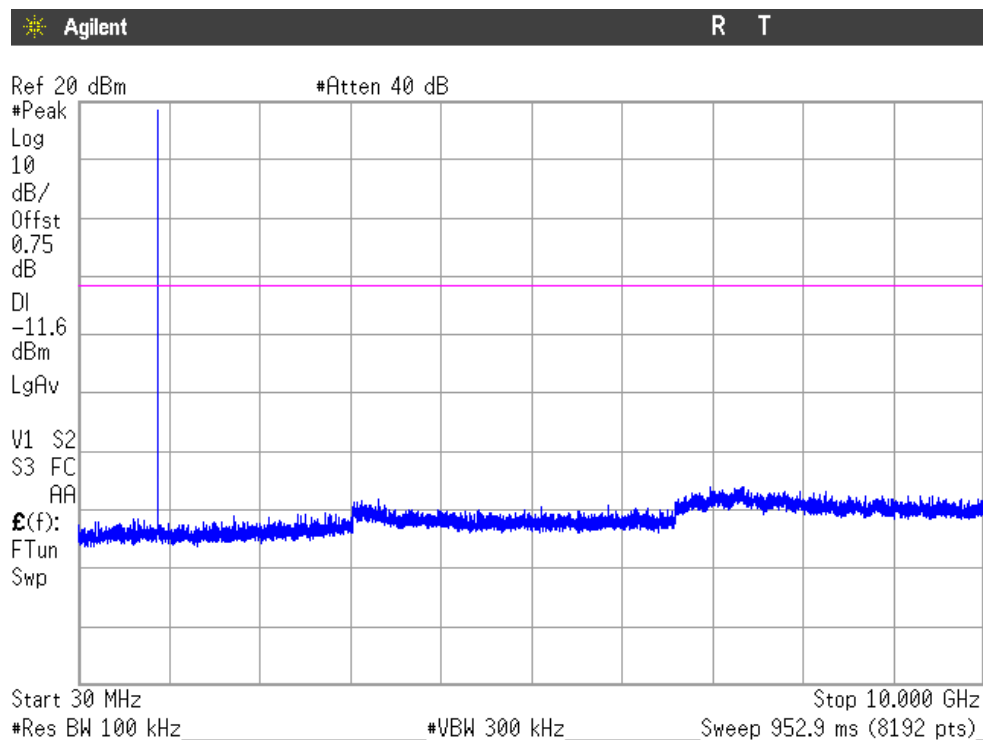
FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Emission limitations conducted (Transmitter)

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. 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.

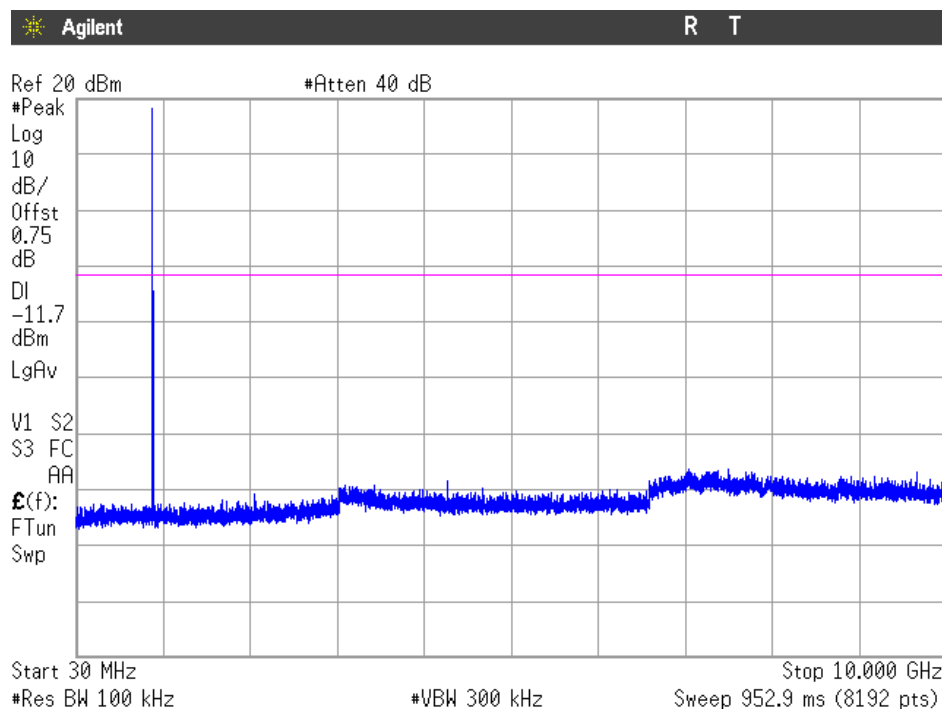
RESULTS:

1. LOWEST CHANNEL (902.3 MHz): 30 MHz-10 GHz (see next plot).



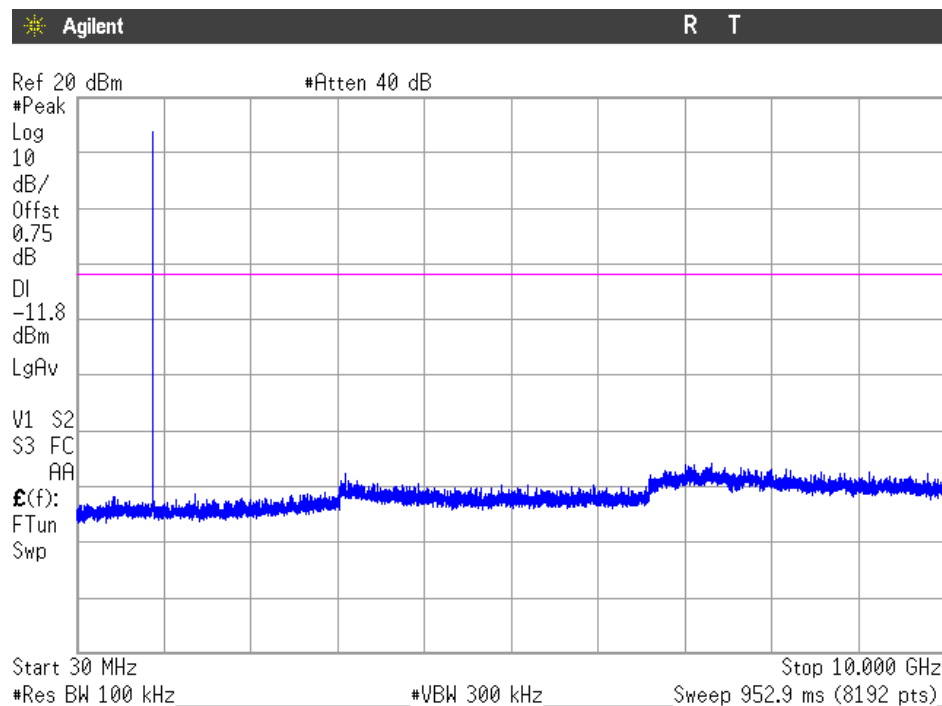
Note: The peak above the limit is the carrier frequency.

2. MIDDLE CHANNEL (908.7 MHz): 30 MHz-10 GHz (see next plot).



Note: The peak above the limits is the carrier frequency.

3. HIGH CHANNEL (914.9 MHz): 30 MHz-10 GHz (see next plot).



Note: The peak above the limits is the carrier frequency.

Measurement uncertainty (dB)	<±2.03
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Verdict: PASS

FCC Section 15.247 Subclause (f) / RSS-247 5.3. (2) Power spectral density

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

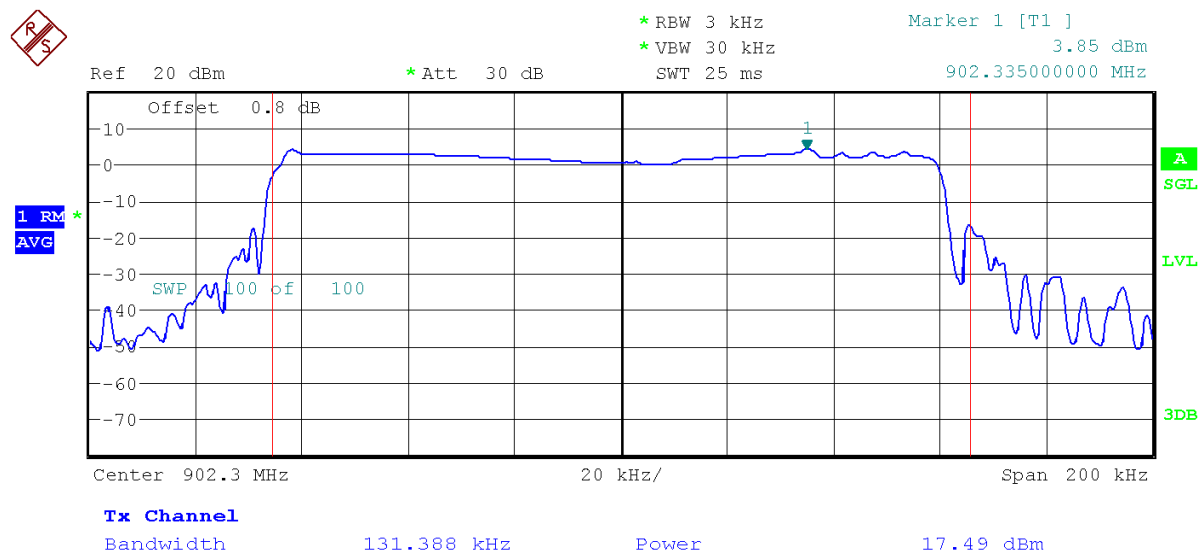
The maximum power spectral density level in the fundamental emission was measured using the method AVGPSD (Average PSD) according to point 10.5. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r03 dated 06/09/2015.

Power spectral density (see next plots).

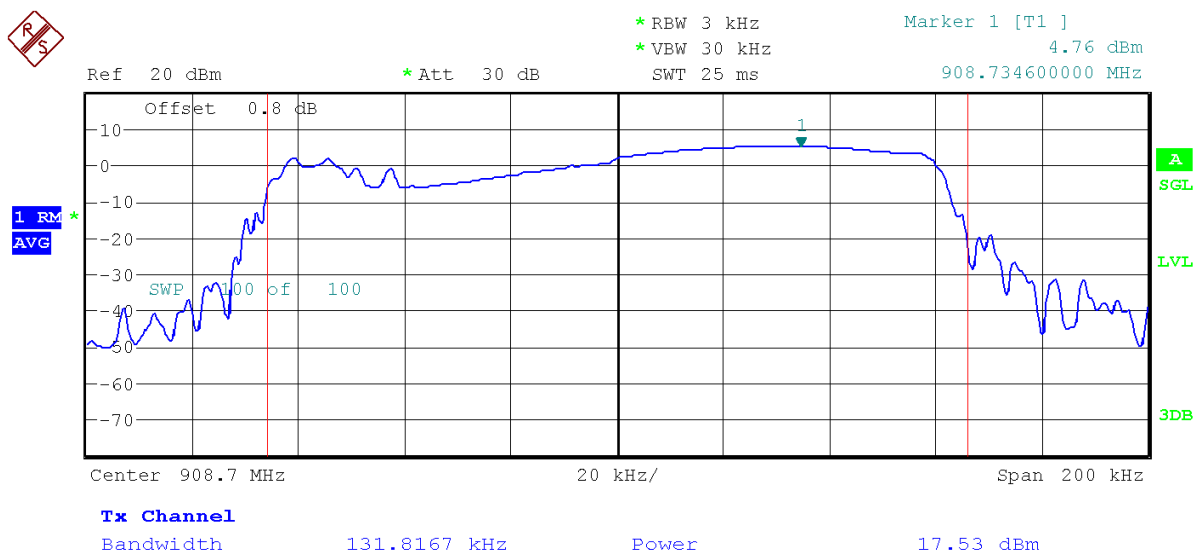
Measured Duty cycle: $x = 0.89$. Correction = $10 \cdot \log(1/x) = 0.51$ dB.

	Lowest frequency 902.3 MHz	Middle frequency 908.7 MHz	Highest frequency 914.9 MHz
Power spectral density (dBm)	3.85	4.76	3.69
Average PSD (dBm)	4.36	5.27	4.20
Measurement uncertainty (kHz)	<±0.66		

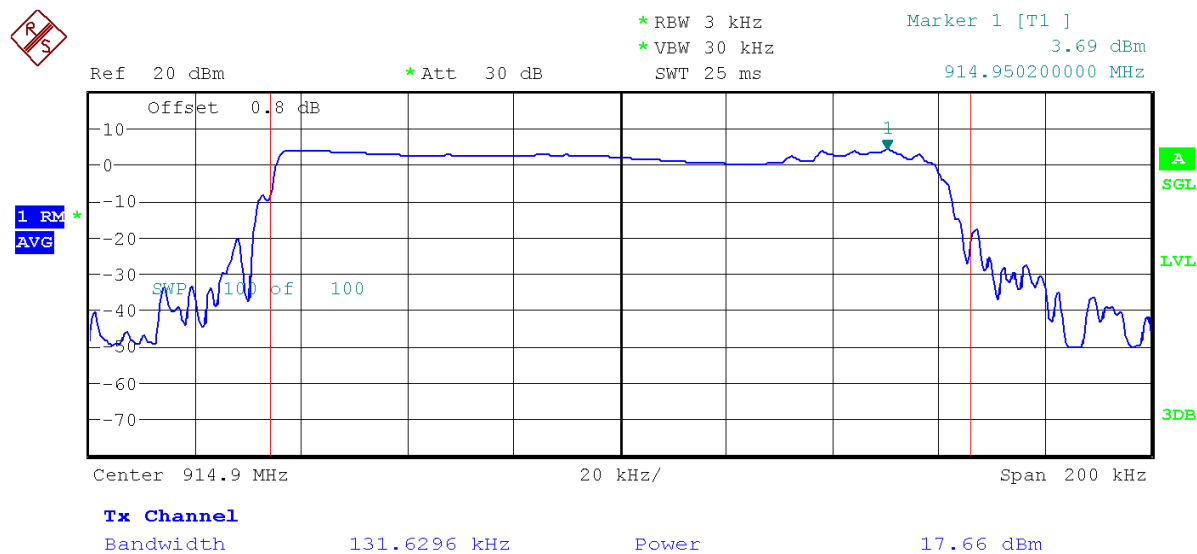
Power spectral density. Lowest Channel



Middle Channel



Highest Channel



FCC Section 15.247 Subclause (d) / RSS-247 Clause 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)):

Frequency Range (MHz)	Field strength ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	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 - 25000	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.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° 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-1000 MHz and at distance of 1m for the frequency range 1 GHz-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-1000 MHz.

No spurious signals were found at less than 20 dB respect to the limit.

Frequency range 1 GHz-10 GHz

1. CHANNEL: LOWEST (902.3 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμ V/m)	Measurement Uncertainty (dB)
1.80430	V	Peak	42.95	± 4.69
		AVG	42.11	± 4.69
2.70670	H	Peak	45.62	± 4.69
		AVG	44.59	± 4.69
3.60910	V	Peak	42.77	± 4.69
		AVG	41.76	± 4.69
4.51150	V	Peak	51.28	± 4.69
		AVG	50.37	± 4.69
5.41420	V	Peak	46.50	± 4.69
		AVG	44.72	± 4.69
6.31630	V	Peak	45.49	± 4.69
		AVG	42.17	± 4.69
7.21870	V	Peak	43.05	± 4.69
		AVG	39.11	± 4.69
8.12080	V	Peak	45.13	± 4.69
		AVG	41.40	± 4.69
9.02380	V	Peak	42.44	± 4.69
		AVG	36.03	± 4.69

2. CHANNEL: MIDDLE (908.7 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
1.81720	V	Peak	44.40	± 4.69
		AVG	43.66	± 4.69
2.72590	V	Peak	46.14	± 4.69
		AVG	45.35	± 4.69
3.63490	V	Peak	44.83	± 4.69
		AVG	43.57	± 4.69
4.54360	V	Peak	51.09	± 4.69
		AVG	50.62	± 4.69
5.45200	V	Peak	47.83	± 4.69
		AVG	46.70	± 4.69
6.36100	V	Peak	46.22	± 4.69
		AVG	43.49	± 4.69
7.26940	V	Peak	42.90	± 4.69
		AVG	38.83	± 4.69
8.17900	V	Peak	46.37	± 4.69
		AVG	42.93	± 4.69

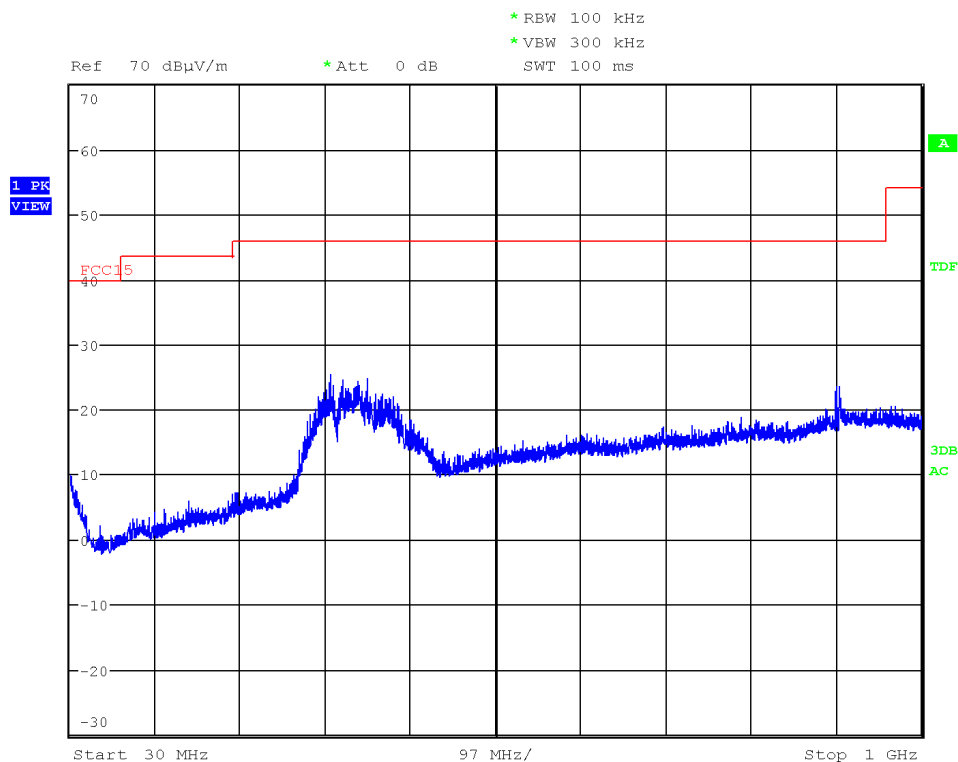
3. CHANNEL: HIGHEST (914.9 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμ V/m)	Measurement Uncertainty (dB)
1.82980	V	Peak	45.98	± 4.69
		AVG	45.44	± 4.69
2.74480	V	Peak	44.57	± 4.69
		AVG	43.74	± 4.69
3.65980	V	Peak	45.16	± 4.69
		AVG	44.25	± 4.69
4.57450	V	Peak	50.70	± 4.69
		AVG	50.04	± 4.69
5.48920	V	Peak	47.32	± 4.69
		AVG	45.84	± 4.69
6.40480	V	Peak	45.31	± 4.69
		AVG	43.22	± 4.69
7.31920	V	Peak	42.42	± 4.69
		AVG	37.52	± 4.69
8.23420	V	Peak	46.11	± 4.69
		AVG	42.20	± 4.69

Verdict: PASS

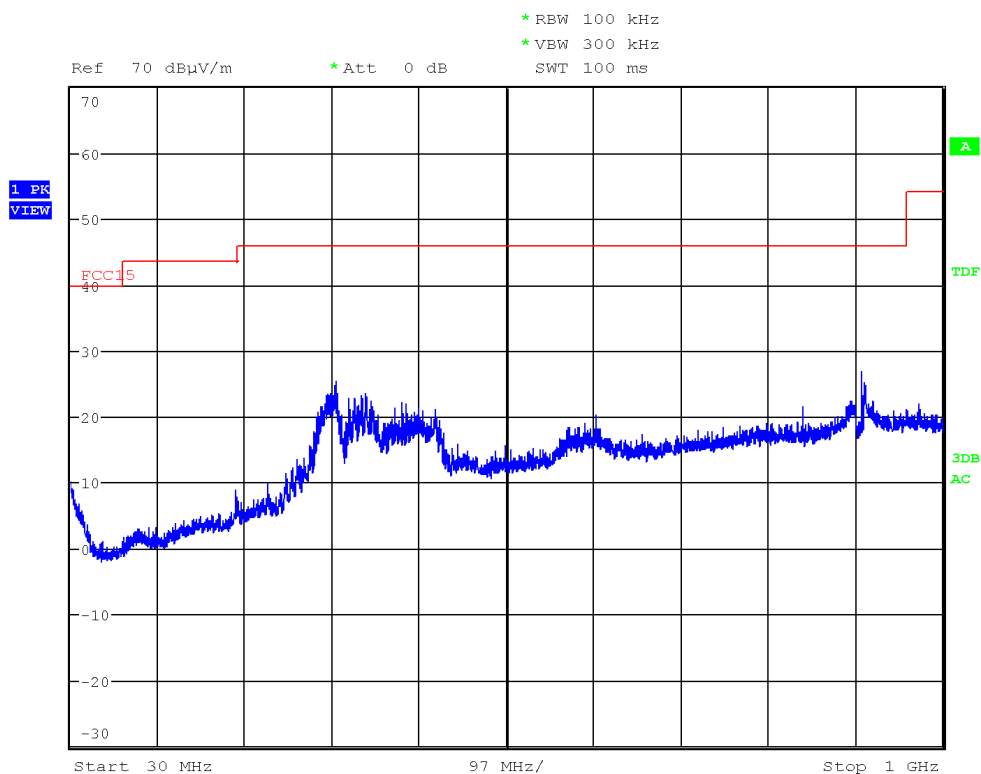
FREQUENCY RANGE 30 MHz-1000 MHz.

CHANNEL: Lowest (902.3 MHz).



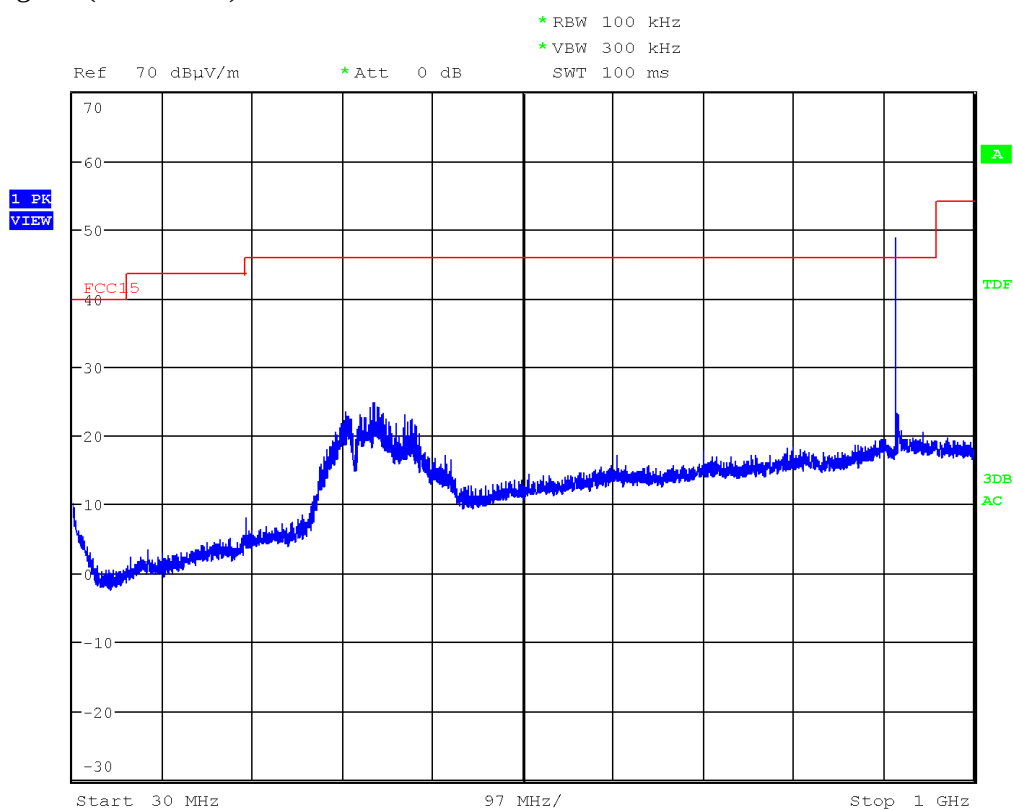
Note: The carrier was attenuated using a Notch filter.

CHANNEL: Middle (908.7 MHz).



Note: The carrier was attenuated using a Notch filter.

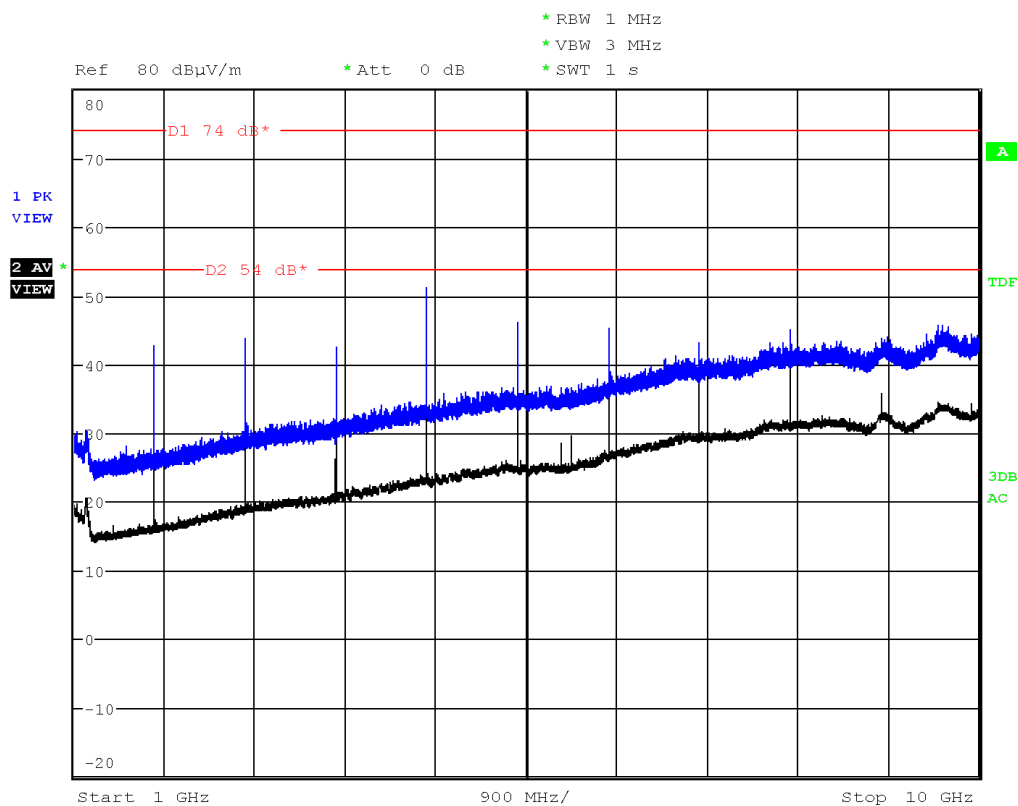
CHANNEL: Highest (914.9 MHz).



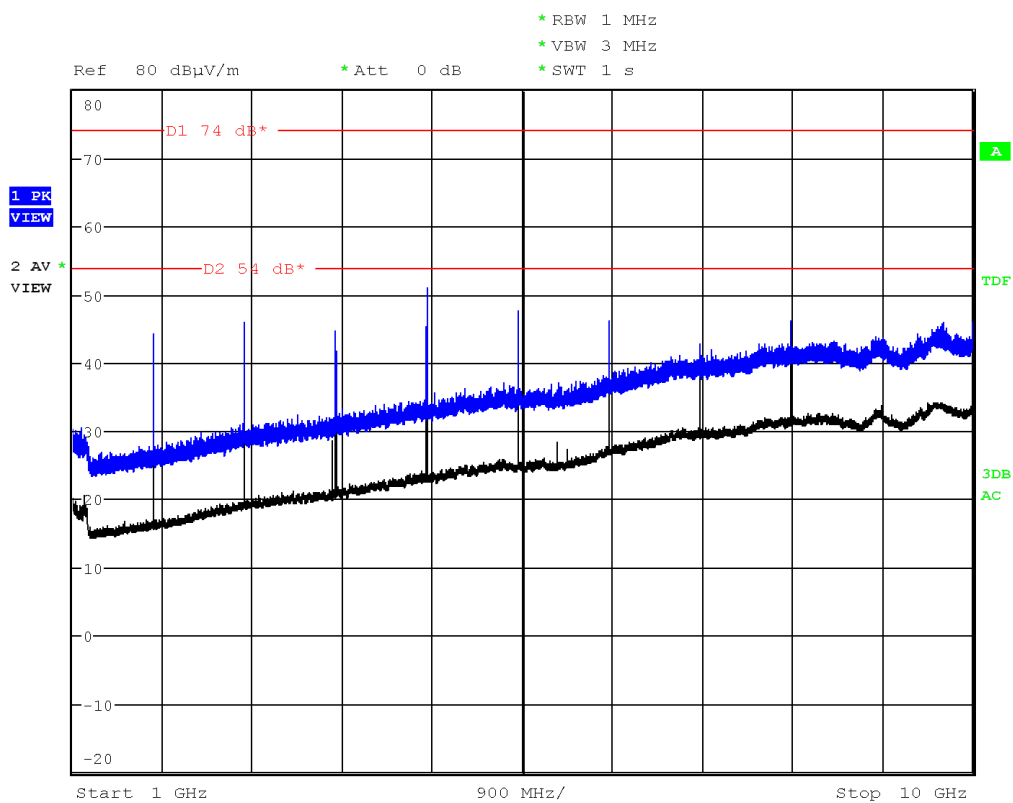
Note: The carrier was attenuated using a Notch filter.

FREQUENCY RANGE 1 GHz to 10 GHz.

CHANNEL: Lowest (902.3 MHz).



CHANNEL: Middle (908.7 MHz).



CHANNEL: Highest (914.9 MHz).

