ENAC ENSAYOS Nº 51/LE147

FCC LISTED, REGISTRATION NUMBER: 720267

ISED LISTED REGISTRATION NUMBER 4621A-2

Informe de ensayo nº:
Test report No:

NIE: 52641RRF.005

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	Analogic Wireless Datalogger
Marca .....: Trademark	Loadsensing G6
Modelo y/o referencia tipo .....: Model and /or type reference	LS-G6-INC15
Otra identificación del producto.....: Other identification of the product	FCC ID: 2AHN4-LS-G6-INC15 IC: 21260-LSG6INC15
Final HW version .....:	INC15
Final SW version .....:	2.23
Características .....: Features	Module with radio
Fabricante .....: Manufacturer	WORLDSENSING SL c/Viriat, 47, Edificio Numancia 1, 7th floor, 08014 Barcelona, SPAIN
Método de ensayo solicitado, norma.....: Test method requested, standard	USA FCC Part 15.247 10-1-17 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 10-1-17 Edition: Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 4 (November 2014). Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v04 dated 05/04/2017. 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: 2018.03.12 15:47:15 +01'00'
Fecha de realización .....: Date of issue	2018-03-12	
Formato de informe No. .....: Report template No	FDT08_20	

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....6
Testing verdicts....7
Appendix A – Test result....8

Competences and guarantees

DEKRA Testing and Certification 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 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 conjuction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 720267.

DEKRA Testing and Certification 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: ISED 4621A-2.

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

DEKRA Testing and Certification 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 at the time of performance of the test.

DEKRA Testing and Certification 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.

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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.
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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 and the Accreditation Bodies.

Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA Testing and Certification.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
52641/07	Analog wireless datalogger	LS-G6_INC15	5451	2017-06-06
52641/37	Antenna Type N	---	---	2017-06-06

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 Nº	Description	Model	Serial Nº	Date of reception
52641/09	Analog wireless datalogger	LS-G6_INC15	5415	2017-06-06

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 sensor that is capable of measuring changes in preassure by using a vibrating wire.

Identification of the client

WORLDSENSING SL

c/Viriat, 47, Edificio Numancia 1, 7th floor, 08014 Barcelona, SPAIN

Testing period

The performed test started on 2017-06-06 and finished on 2017-09-26.

The tests have been performed at DEKRA Testing and Certification.

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 %
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 ºC Max. = 35 ºC
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 ºC Max. = 35 ºC
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 tests have been performed by the technical personnel: Carlos Alberto Contreras.

2: Used instrumentation:

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Spectruml analyzer Agilent E4440A	2017/10	2019/10
2.	DC power supply R&S NGPE 40/40	2014/11	2017/11

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	2015/06	2018/06
3.	Multi Device Controller EMCO 2090	N.A.	N.A.
4.	Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2016/11	2019/11
5.	EMI Test Receiver R&S ESU 40	2016/03	2018/03
6.	Spectrum analyser Rohde & Schwarz FSW50	2015/12	2017/12
7.	RF pre-amplifier 20 MHz-7 GHz PAM-0207	2016/09	2017/09
8.	RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-1M	2016/02	2018/02

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 (b)	20 dB Bandwidth and Carrier frequency separation		P		
FCC 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (c)	Number of hopping channels	NA			
FCC 15.247 Subclause (f) / RSS-247 Clause 5.3 (a)	Time of occupancy (Dwell Time)		P		
FCC 15.247 Subclause (b) / RSS-247 Clause 5.4 (a)	Maximum peak output power and antenna gain		P		
FCC 15.247 Subclause (d) / RSS-247 Clause 5.5	Emission limitations conducted (Transmitter)		P		
FCC 15.247 Subclause (d) / RSS-247 Clause 5.5.	Band-edge emissions compliance (Transmitter)		P		
FCC 15.247 Subclause (f) / RSS-247 5.3. (b)	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 10

Occupied Bandwidth 12

FCC Section 15.247 Subclause (a) (1) (i)/ RSS-247 Clause 5.1 (b). 20 dB Bandwidth and Carrier frequency separation 14

FCC Section 15.247 Subclause (f)/ RSS-247 Clause 5.3.(a). Time of occupancy (Dwell Time) 17

FCC Section 15.247 Subclause (b) / RSS-247 Clause 5.4 (a). Maximum peak output power and antenna gain 18

FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Band-edge compliance of conducted emissions (Transmitter) 22

FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Emission limitations conducted (Transmitter) 25

FCC Section 15.247 Subclause (f) / RSS-247 5.3. (b) Power spectral density for hybrid systems 28

FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5 Emission limitations radiated (Transmitter) 31

TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 3.7 Vdc

Type of power supply = DC voltage from battery.

Type of antenna = External antenna

Declared Gain for antenna (maximum) = +2.0 dBi

TEST FREQUENCIES:

Lowest channel: 902.3 MHz

Middle channel: 908.7 MHz

Highest channel: 914.9 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).

CONDUCTED MEASUREMENTS

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

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

RADIATED MEASUREMENTS

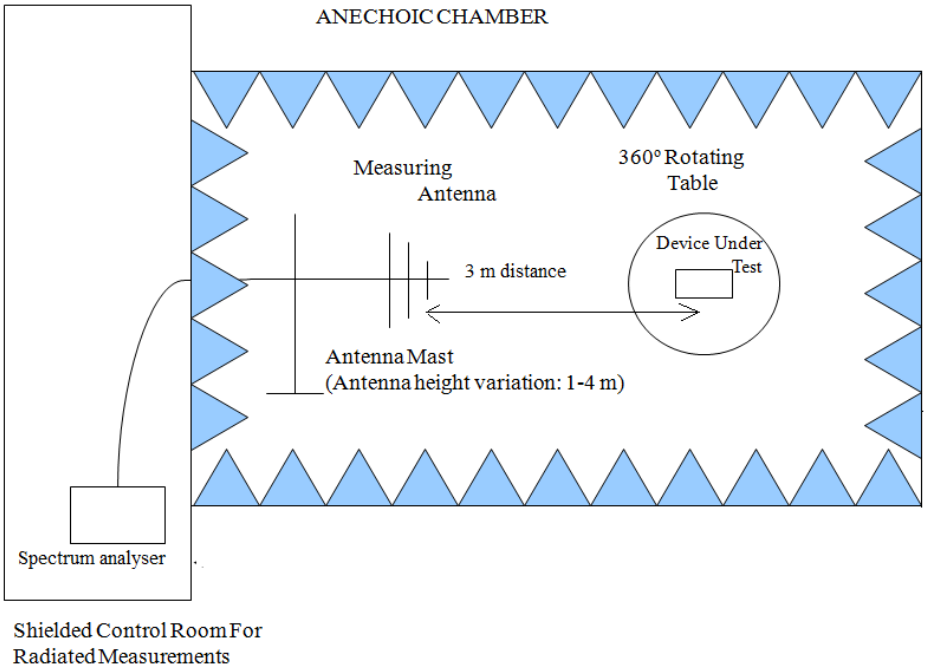
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-10 GHz (1 GHz-18 GHz Double ridge horn antenna).

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.

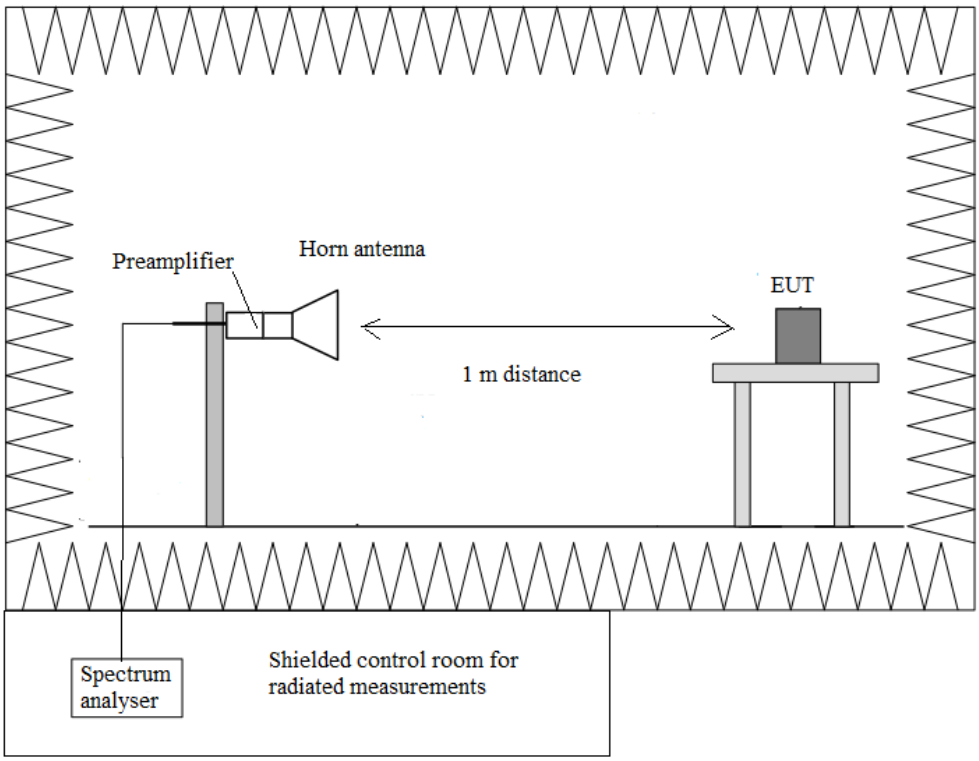
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

Radiated measurements setup f < 1 GHz



Radiated measurements setup f > 1 GHz



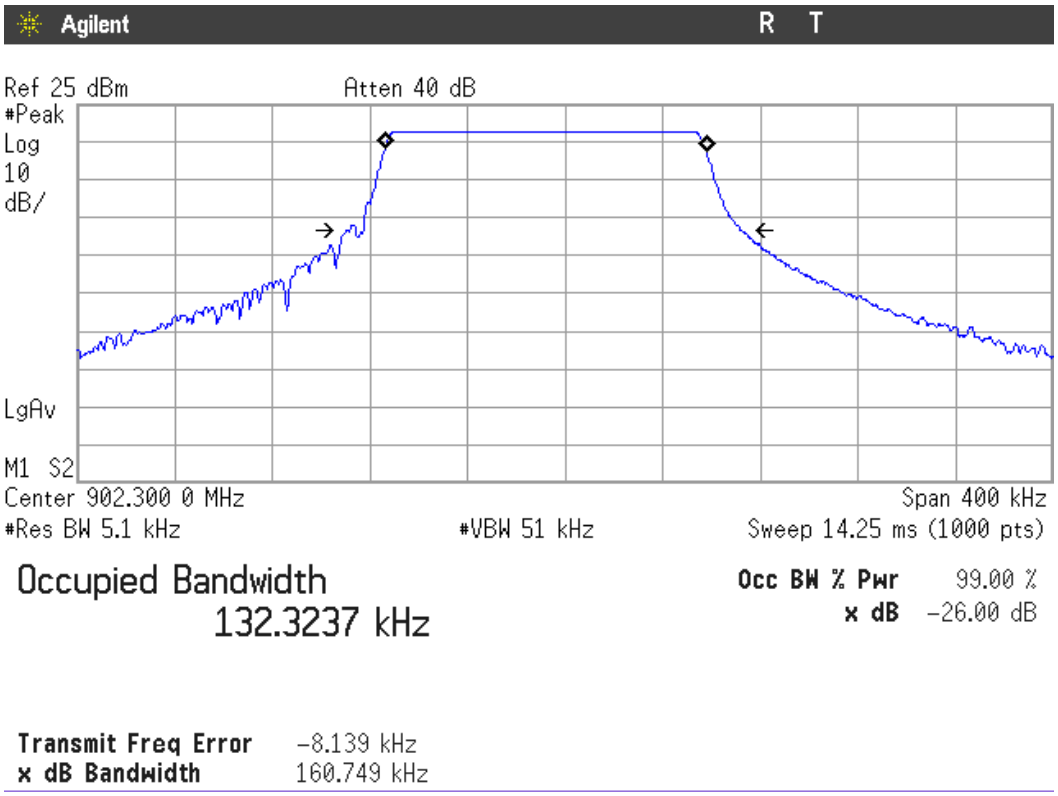
Occupied Bandwidth

RESULTS

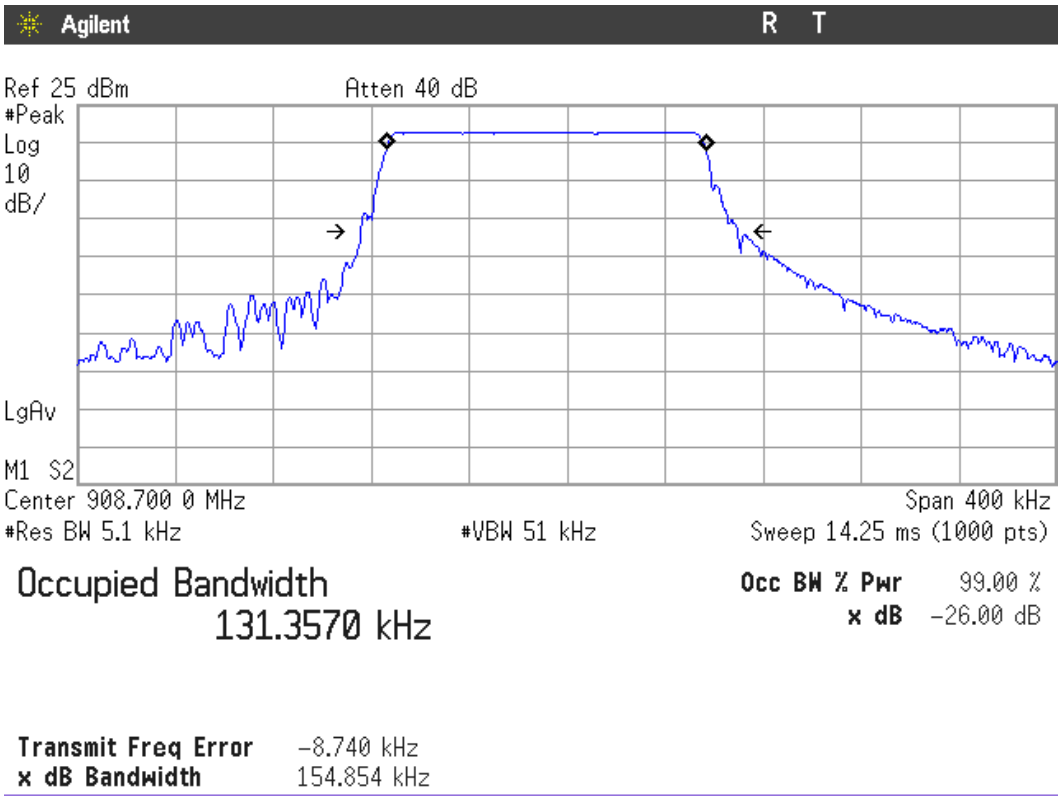
(see next plots).

	Lowest frequency 902.3 MHz	Middle frequency 908.7 MHz	Highest frequency 914.9 MHz
99% bandwidth (kHz)	132.324	131.357	131.499
-26 dBc bandwidth (kHz)	160.749	154.854	154.695
Measurement uncertainty (kHz)	<± 0.67		

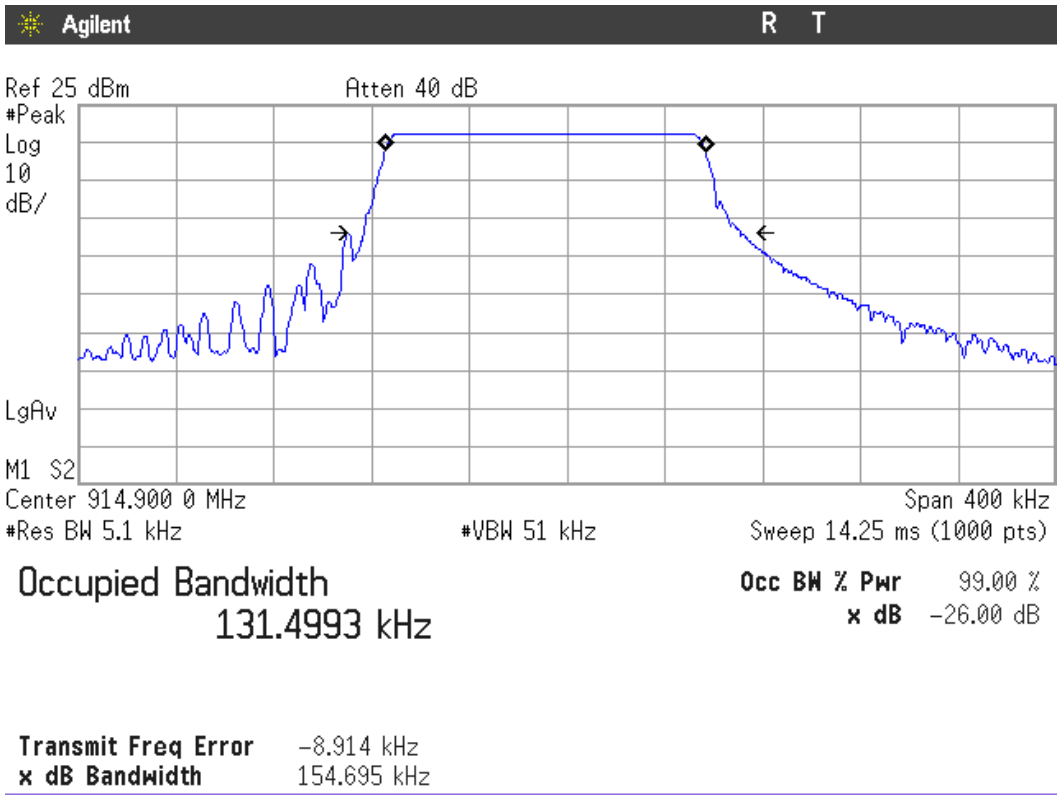
Lowest Channel



Middle Channel



Highest channel



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

SPECIFICATION

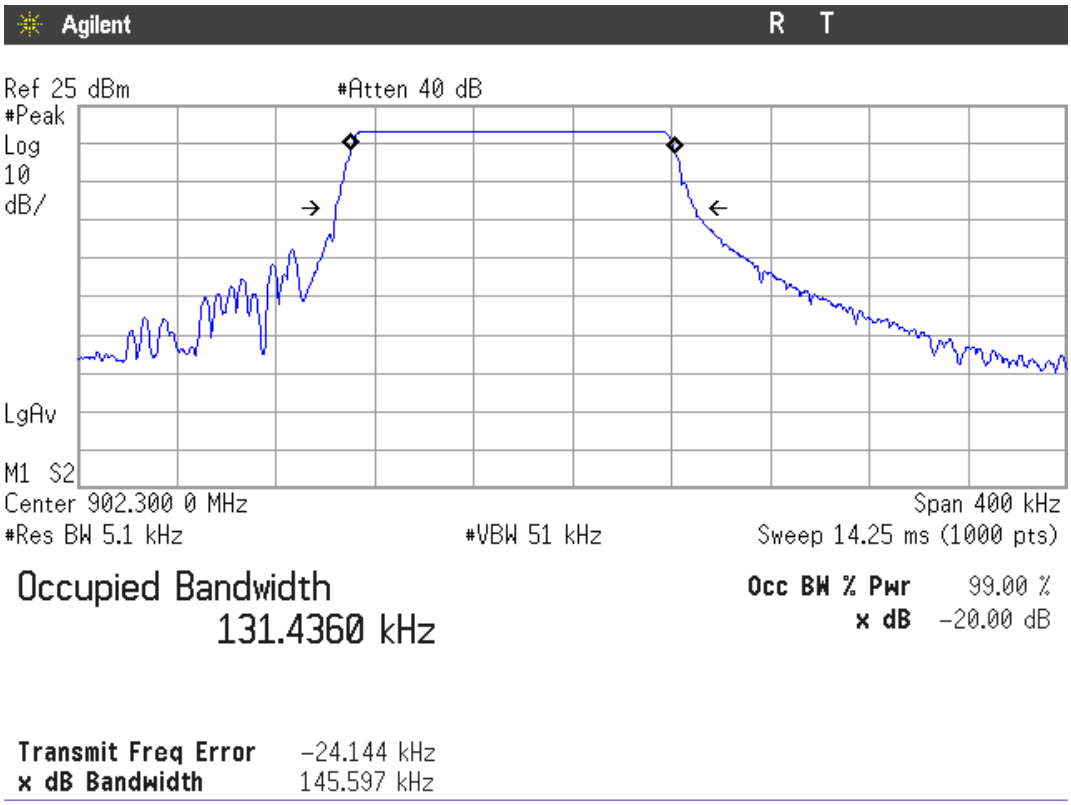
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

RESULTS

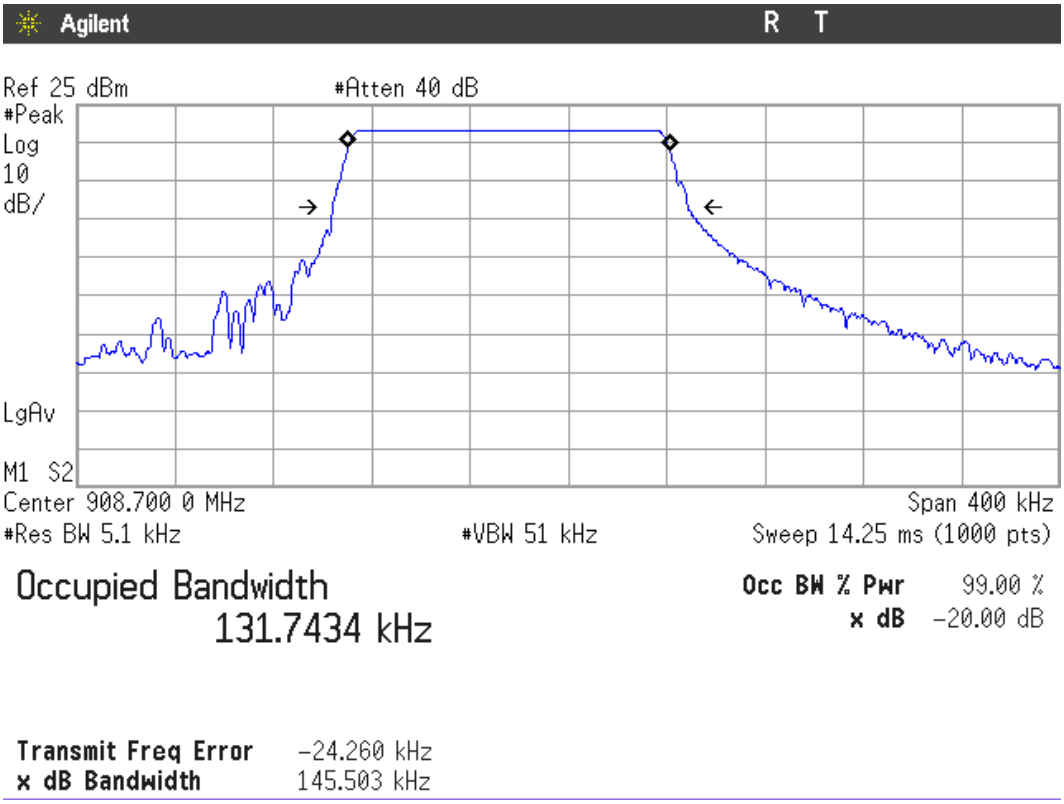
(See next plots)

	Lowest frequency 902.3 MHz	Middle frequency 908.7 MHz	Highest frequency 914.9 MHz
20 dB Spectrum bandwidth (kHz)	145.597	145.503	147.342
Measurement uncertainty (kHz)	<± 0.67		

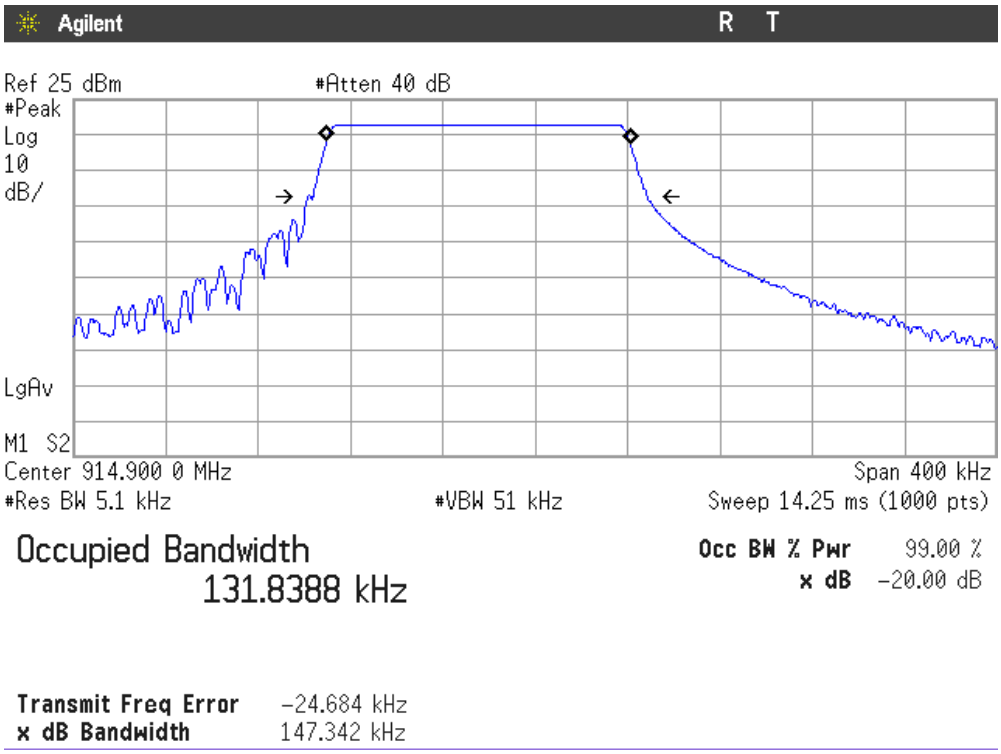
Lowest Channel: 902.3 MHz.



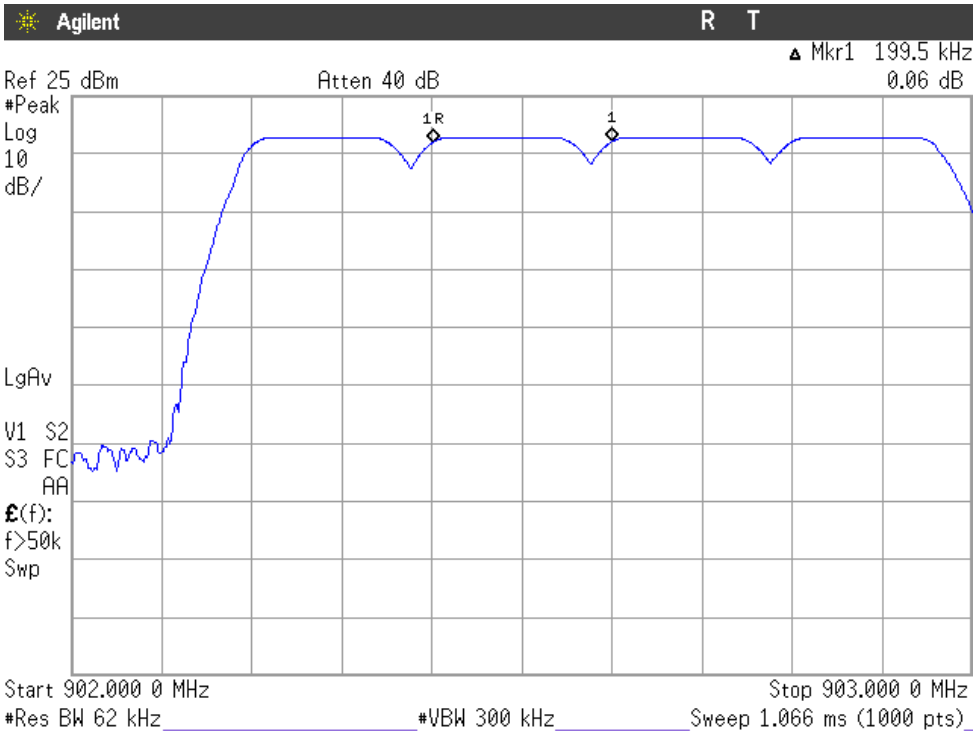
Middle Channel: 908.7 MHz.



Highest Channel: 914.9 MHz.



Carrier frequency separation



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.(a). Time of occupancy (Dwell Time)

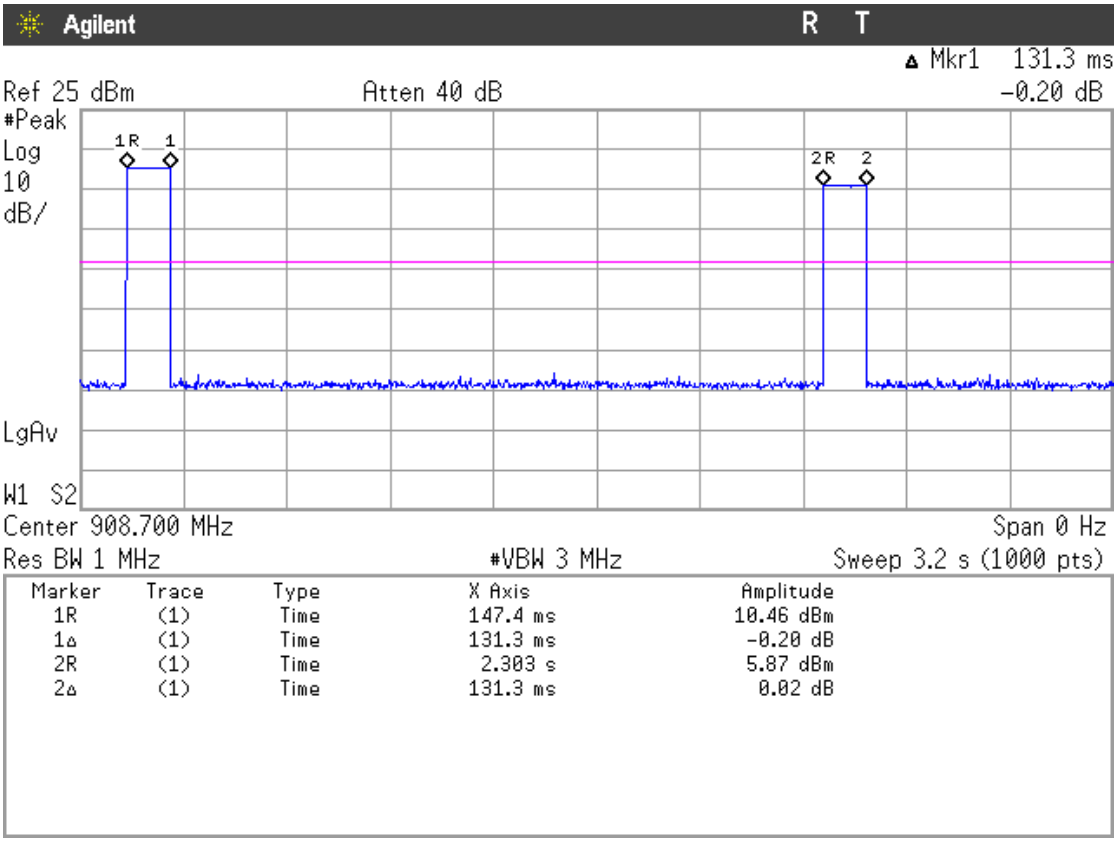
SPECIFICATION

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 (0.4 x 8 = 3.2 seconds).

RESULTS

1. TIME OF OCCUPANCY (DWELL TIME) FOR OPERATION AS FREQUENCY HOPPING SYSTEM USING 8 HOPPING CHANNELS.

- Tx- time per hop = 131.3 ms (see next plot).
- Number of hops over a period of 3.2 seconds = 2 (see next plot).



Averaging time of occupancy = 131.3 ms x 2 hop = 262.6 ms per 3.2 seconds.

Measurement uncertainty (%)	<±0.01

Verdict: PASS

FCC Section 15.247 Subclause (b) / RSS-247 Clause 5.4 (a). Maximum peak 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-2 (trace averaging across on and off times of the EUT transmissions, followed by duty cycle correction) 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 v04 dated 05/04/2017.

MAXIMUM OUTPUT POWER. See next plots.

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

Maximum declared antenna gain: +2.0 dBi.

Measured Duty cycle: x = 0.892. Correction = 10*log (1/x) = 0.50 dB.

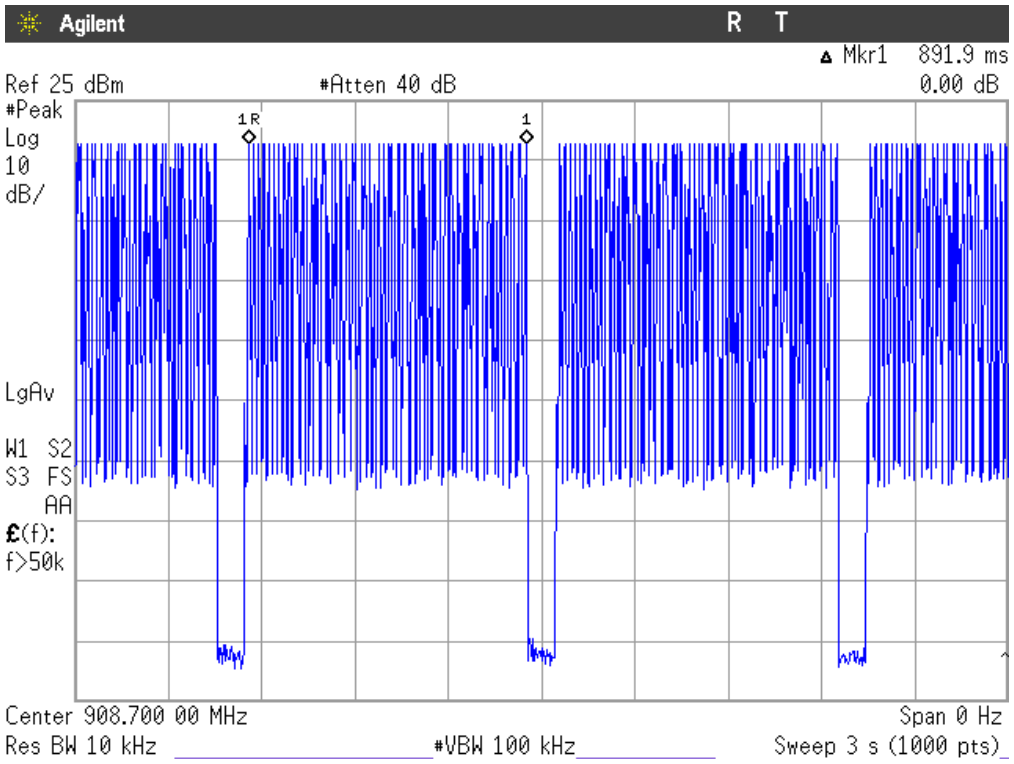
	Lowest frequency 902.3 MHz	Middle frequency 908.7 MHz	Highest frequency 914.9 MHz
Maximum Average conducted power (dBm)	17.45	17.51	17.14
Maximum Average corrected power (dBm)	17.96	18.02	17.65
Maximum Average EIRP power (dBm)	19.96	20.02	19.65
Measurement uncertainty (dB)	<± 0.66		

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.

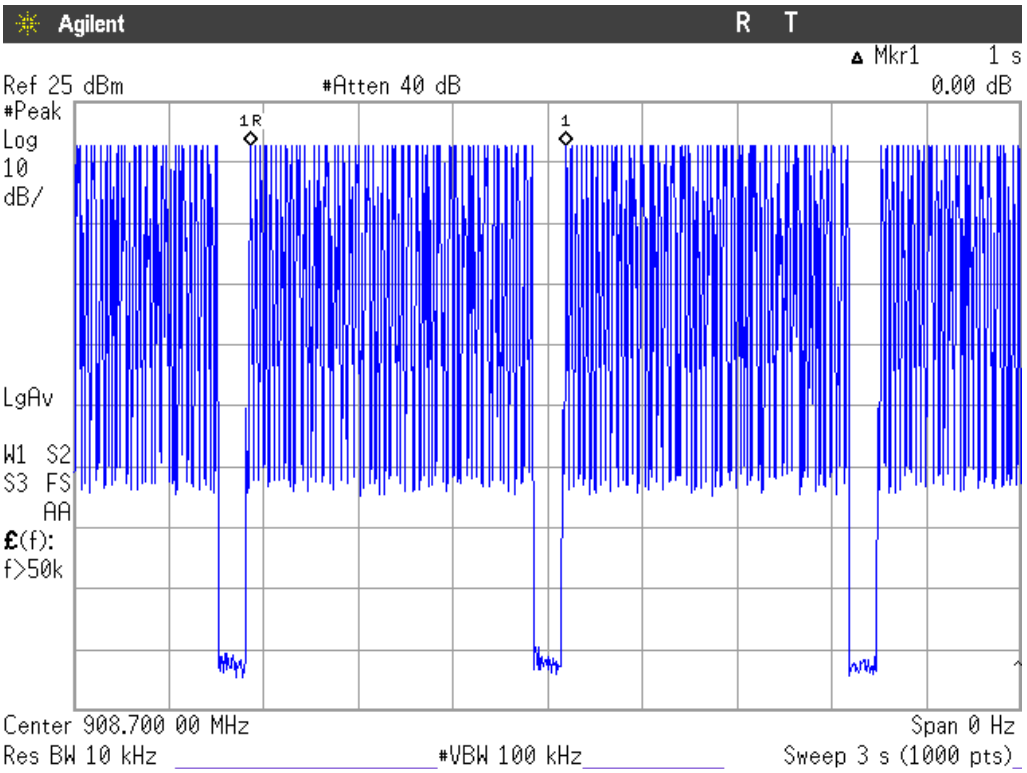
Verdict: PASS

DUTY CYCLE

T ON

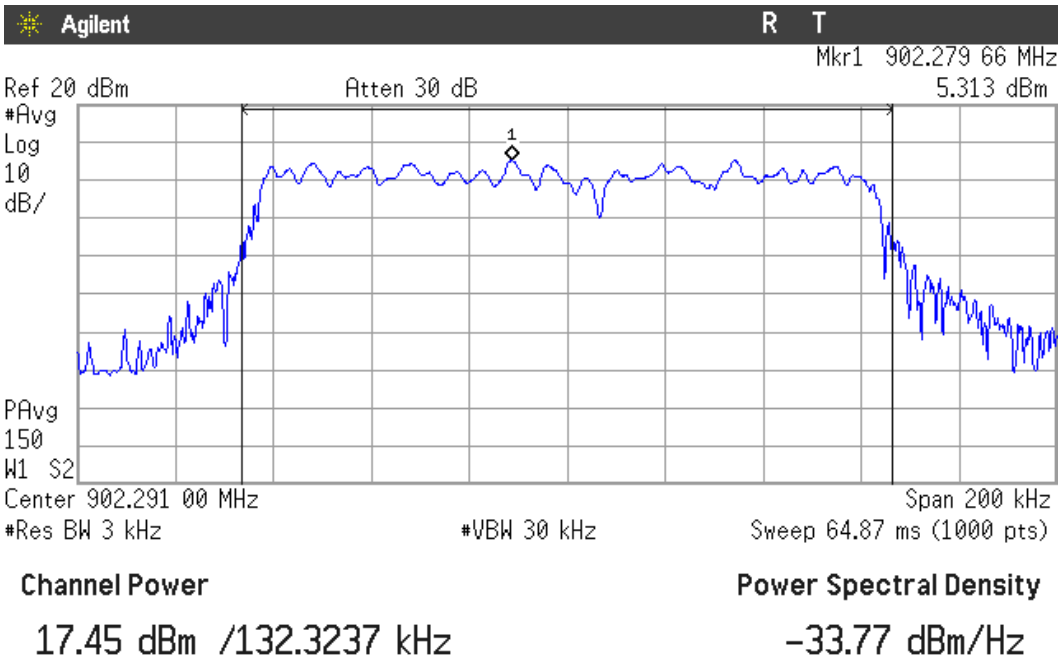


T ON+OFF

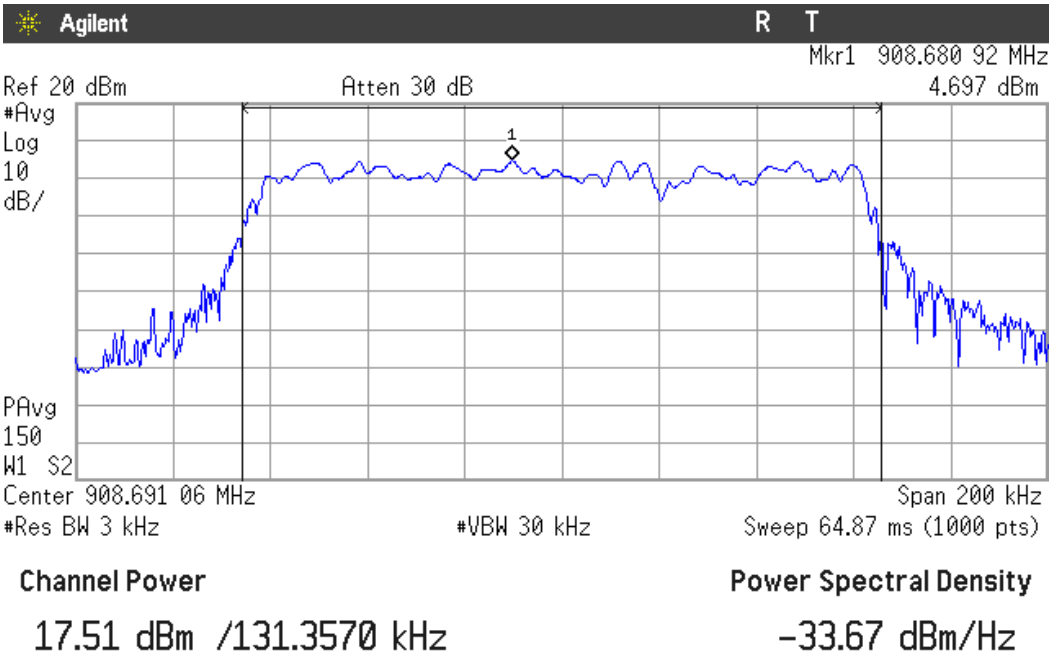


CONDUCTED AVERAGE POWER.

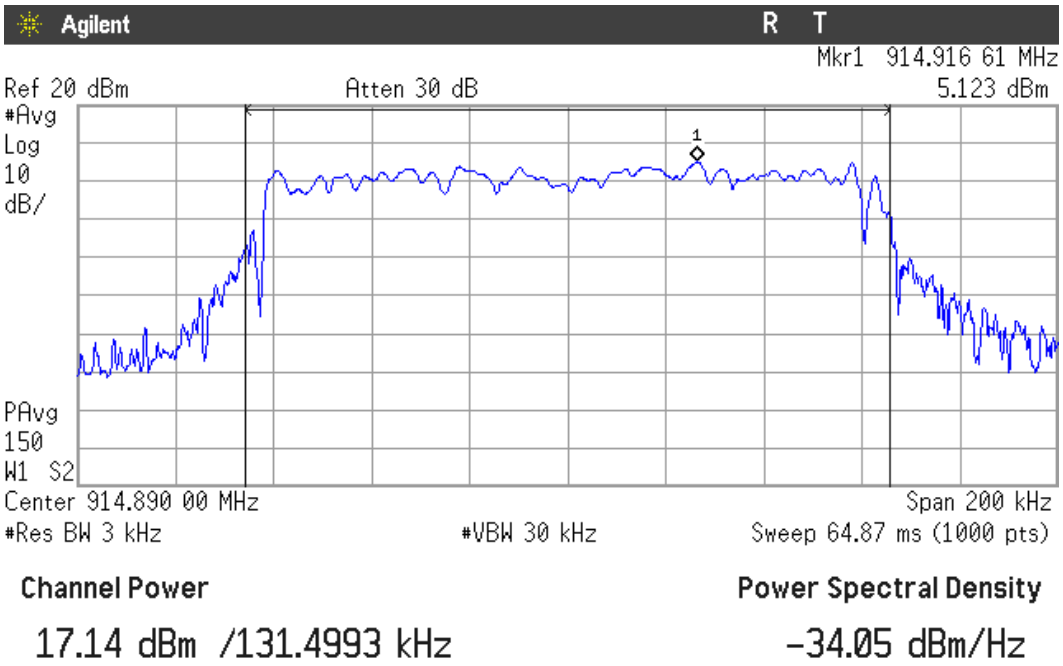
Lowest frequency



Middle frequency



Highest frequency



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

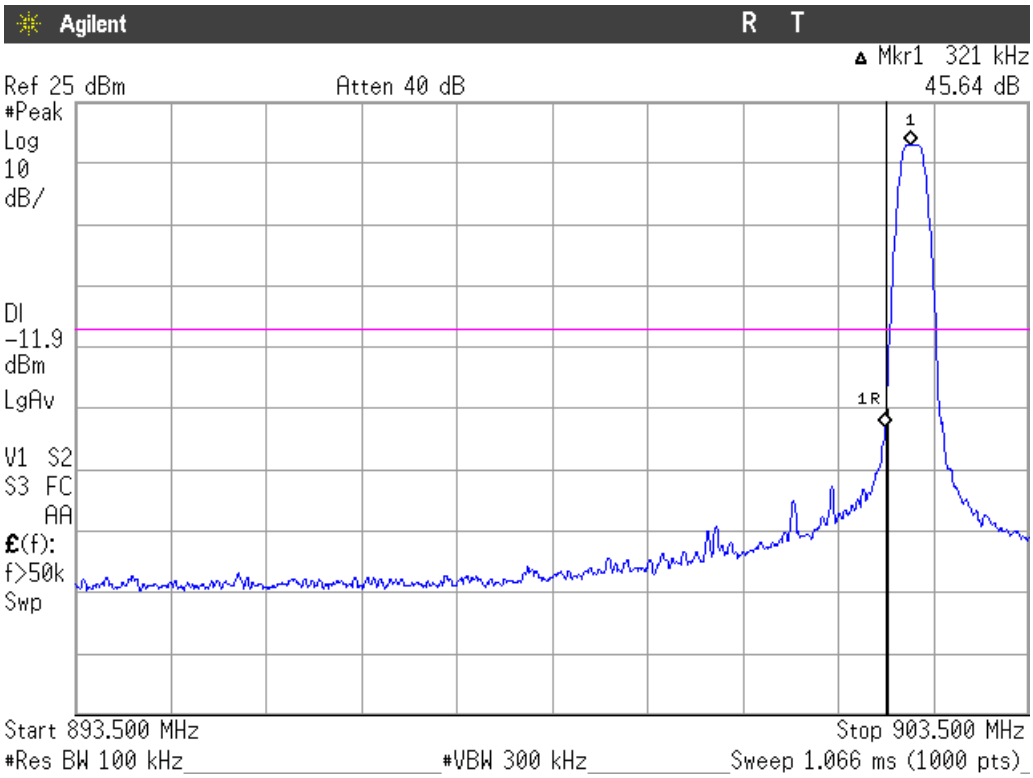
SPECIFICATION

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:

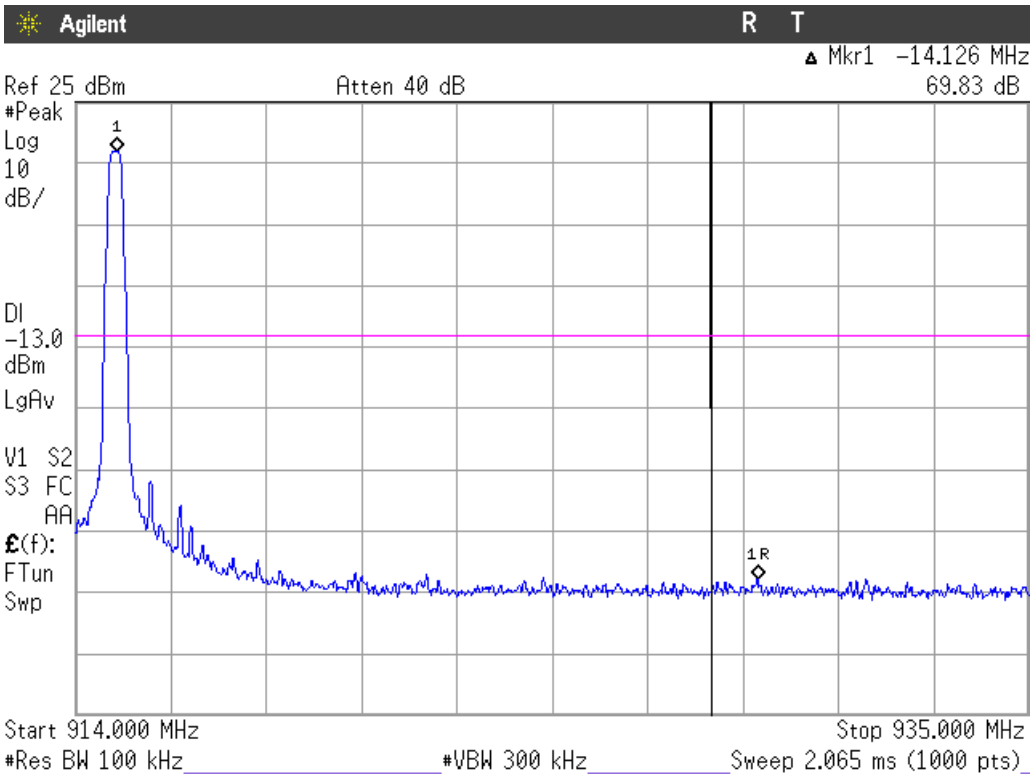
The attenuation of highest emissions at the band-edge is more than 30 dB respect to the highest level of the desired power.

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



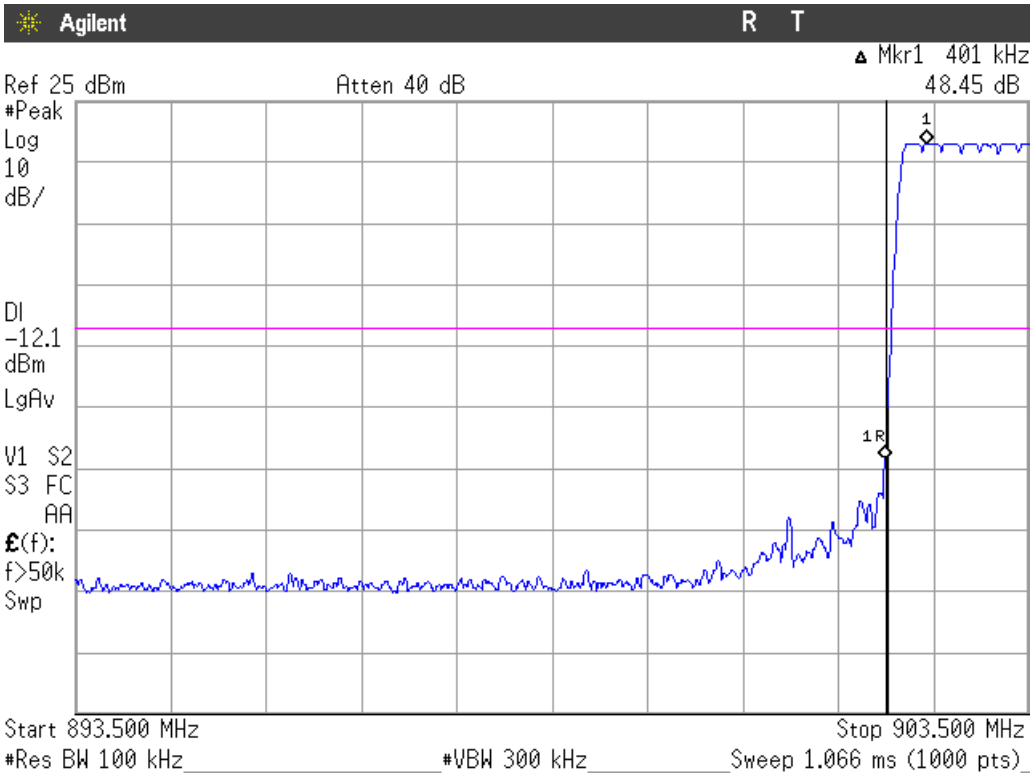
Verdict: PASS

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



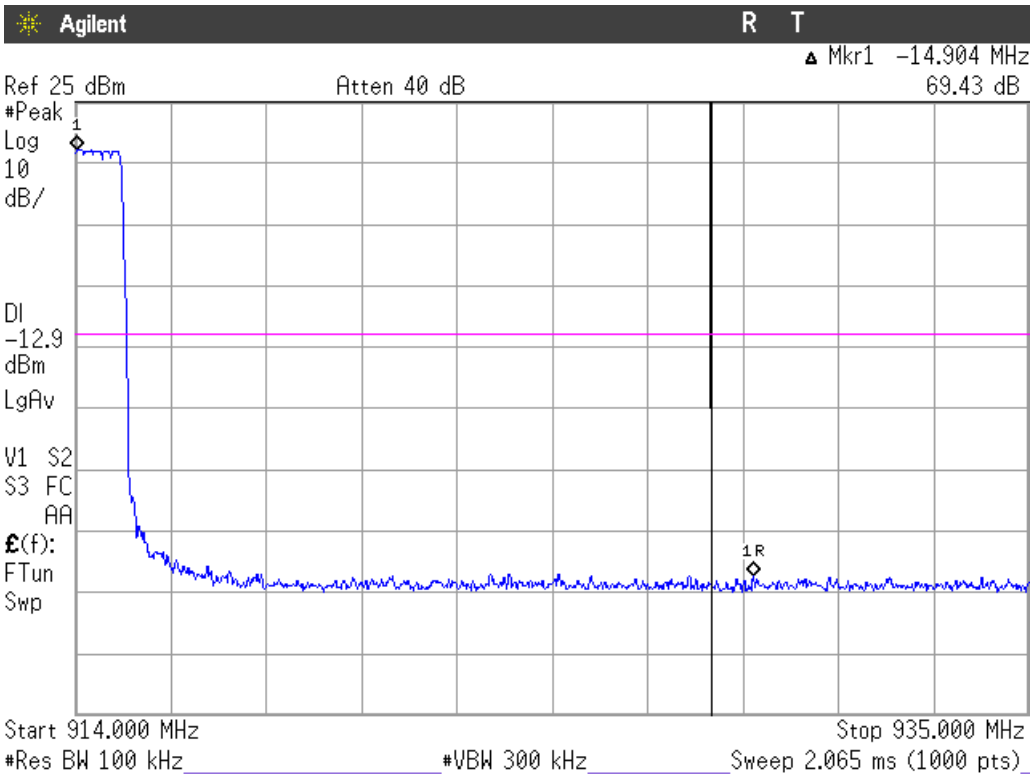
Verdict: PASS

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



Verdict: PASS

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



Verdict: PASS

Measurement uncertainty (dB)	<±2.03

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, 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:

Lowest frequency 902.3 MHz:

All peaks are more than 30 dB below the limit.

Middle frequency 908.7 MHz:

All peaks are more than 30 dB below the limit.

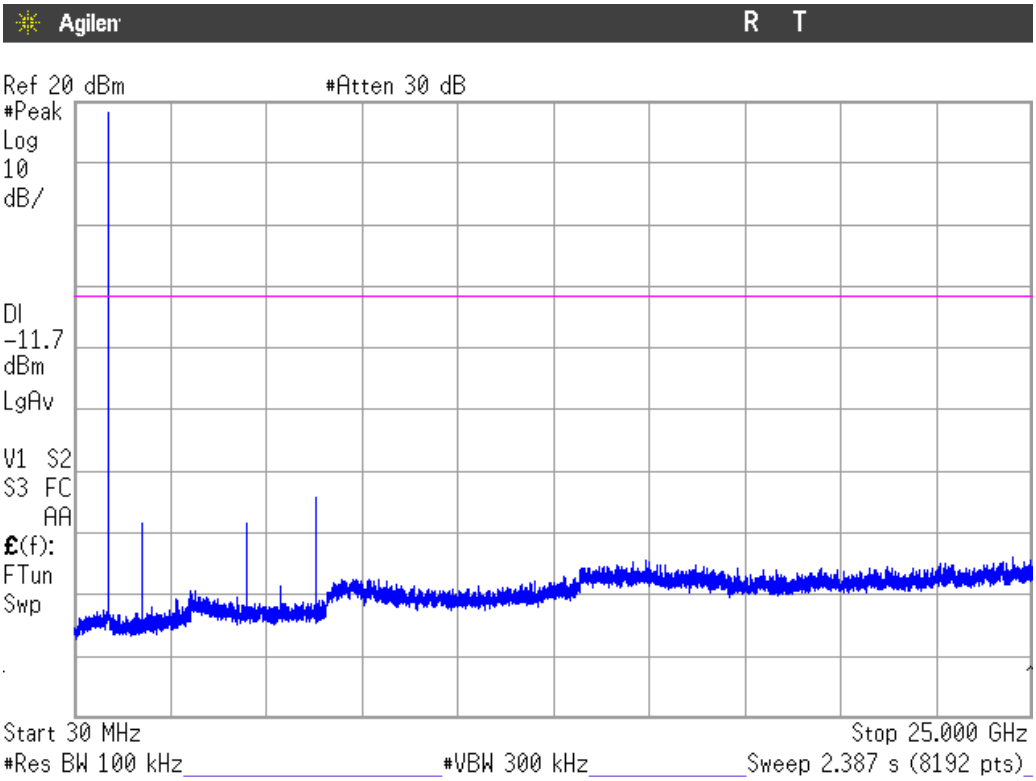
Highest frequency 914.9 MHz:

All peaks are more than 30 dB below the limit.

Measurement uncertainty (dB): < 2.03

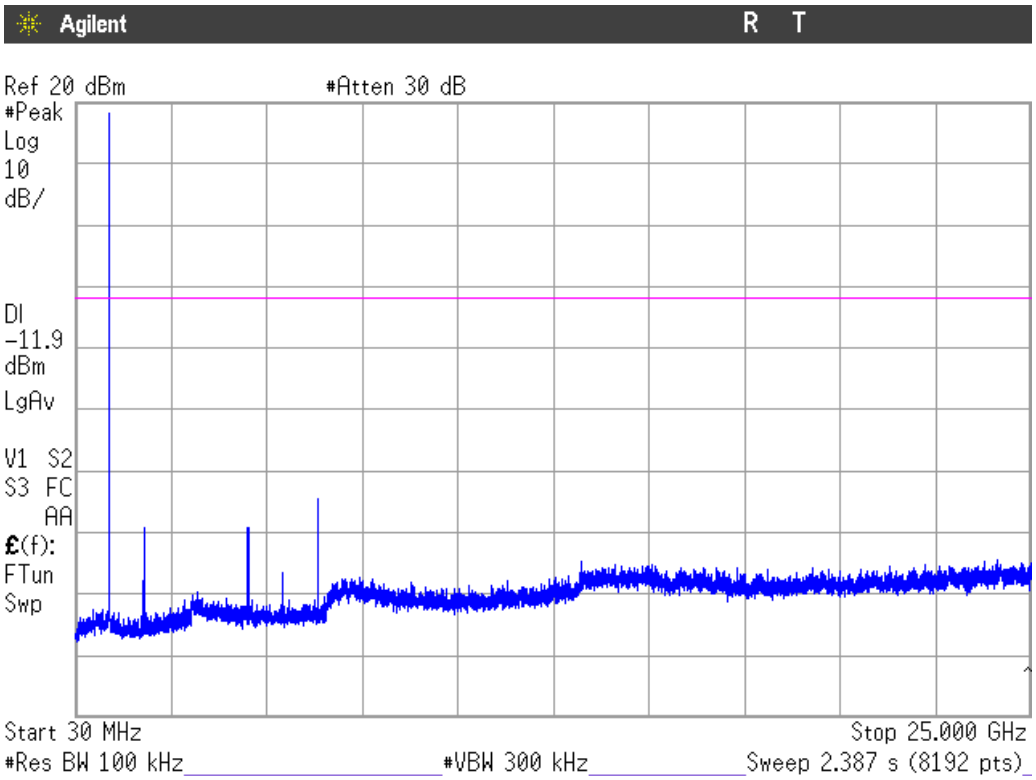
Verdict: PASS

Lowest frequency



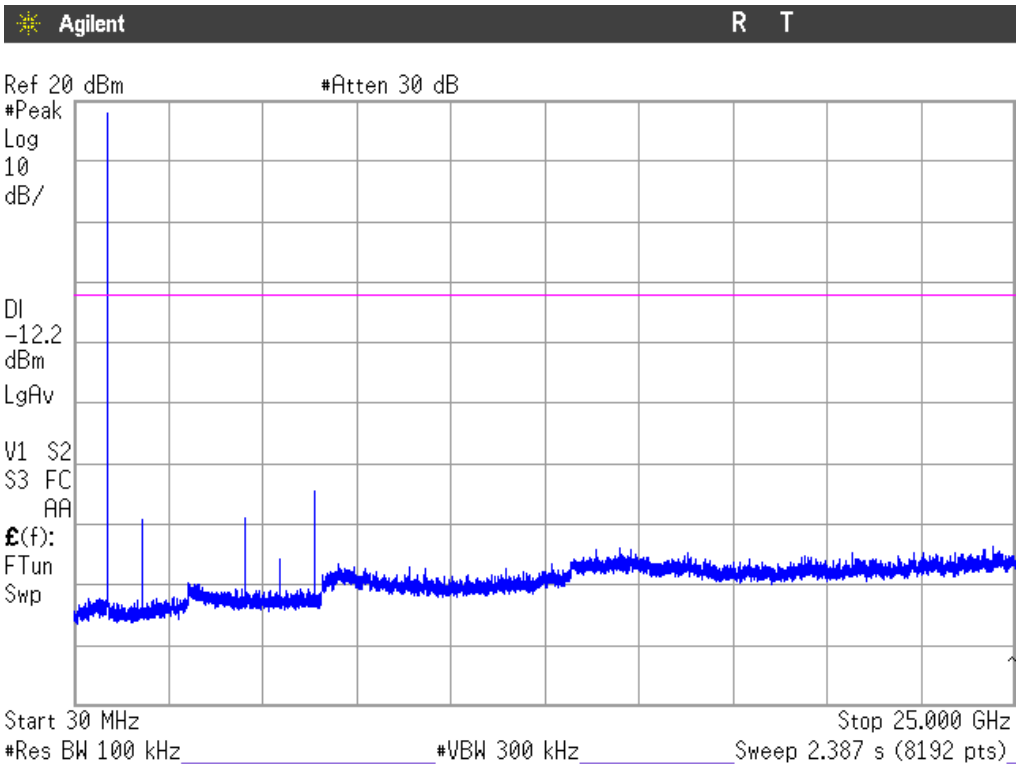
Note: The peak shown in the plot above the limit is the carrier frequency.

Middle frequency



Note: The peak shown in the plot above the limit is the carrier frequency.

Highest frequency



Note: The peak shown in the plot above the limit is the carrier frequency.

FCC Section 15.247 Subclause (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 in the fundamental emission was measured using the method AVGPSD-2 (trace averaging across on and off times of the EUT transmissions, followed by duty cycle correction) 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 v04 dated 05/04/2017.

Power spectral density (see next plots).

Measured Duty cycle: x = 0.892. Correction = 10*log (1/x) = 0.50 dB.

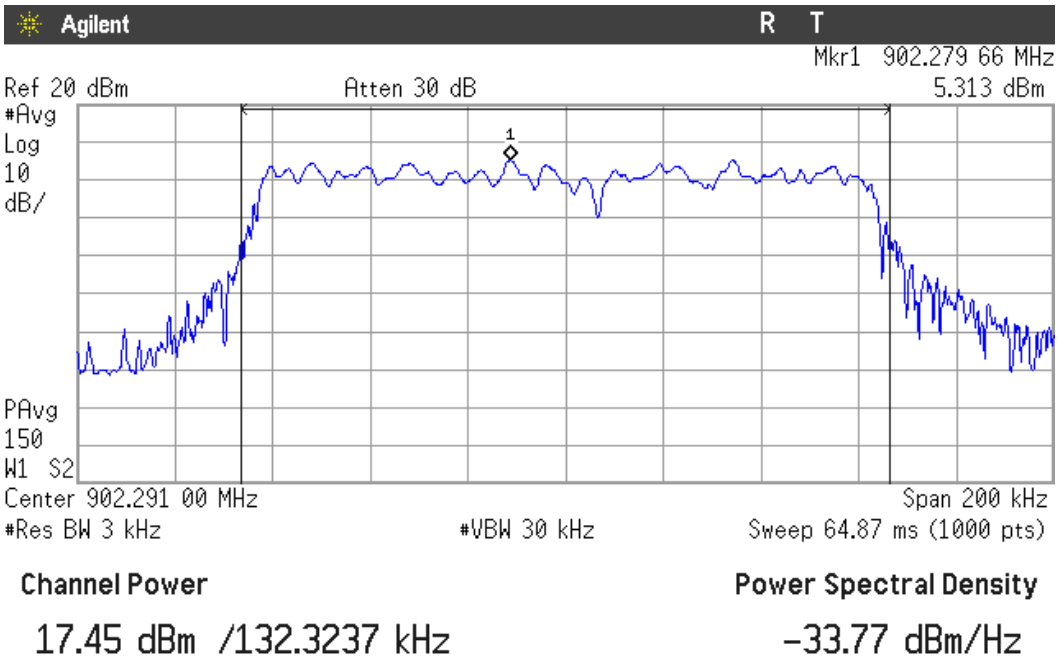
(NOTE: See section “Maximum peak output power and antenna gain”).

	Lowest frequency 902.3 MHz	Middle frequency 908.7 MHz	Highest frequency 914.9 MHz
Power spectral density (dBm)	5.31	4.69	5.12
Average PSD (dBm)	5.81	5.19	5.62
Measurement uncertainty (dB)	<±0.78		

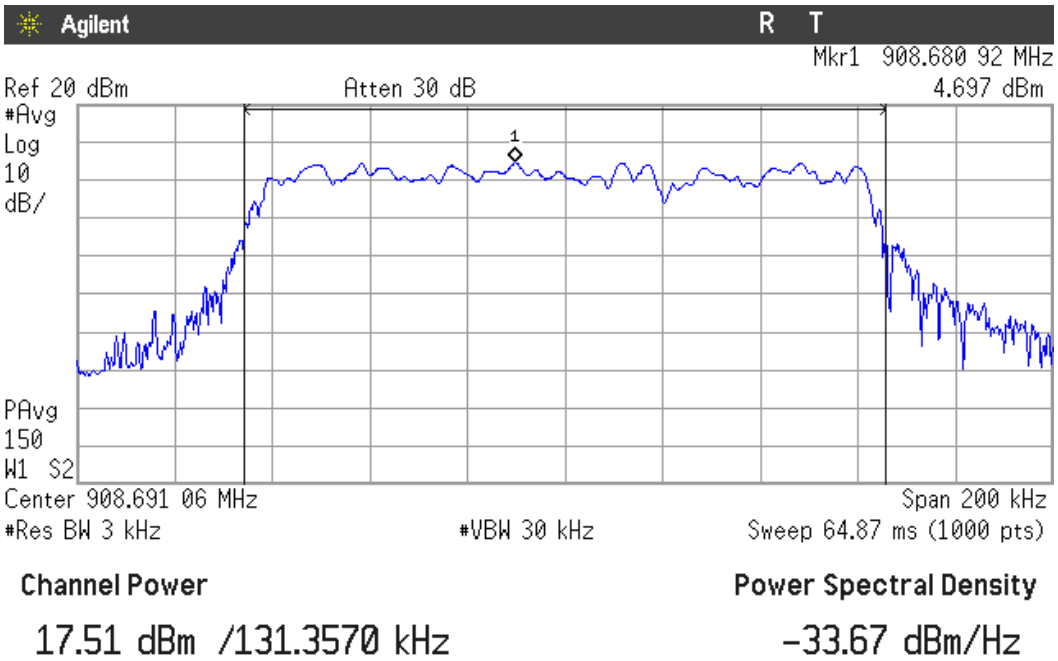
Verdict: PASS

POWER SPECTRAL DENSITY

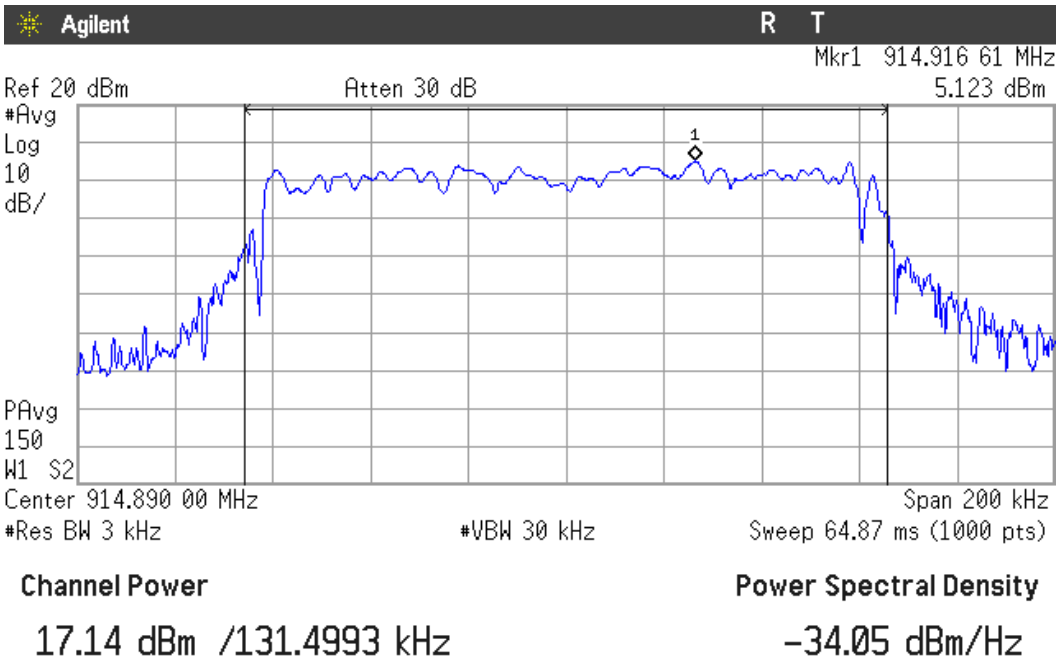
Lowest Channel



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)/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-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

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

Spurious signals 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.

1. CHANNEL: LOWEST (902.3 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.70685	V	Peak	41.89	± 4.87
4.51165	V	Peak	51.44	± 4.87
5.41375	V	Peak	40.86	± 4.87
6.31615	V	Peak	45.24	± 4.87

2. CHANNEL: MIDDLE (908.7 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.81765	V	Peak	39.36	± 4.87
2.72605	V	Peak	45.30	± 4.87
4.54345	V	Peak	51.45	± 4.87
5.45215	V	Peak	42.59	± 4.87
6.36115	V	Peak	48.58	± 4.87

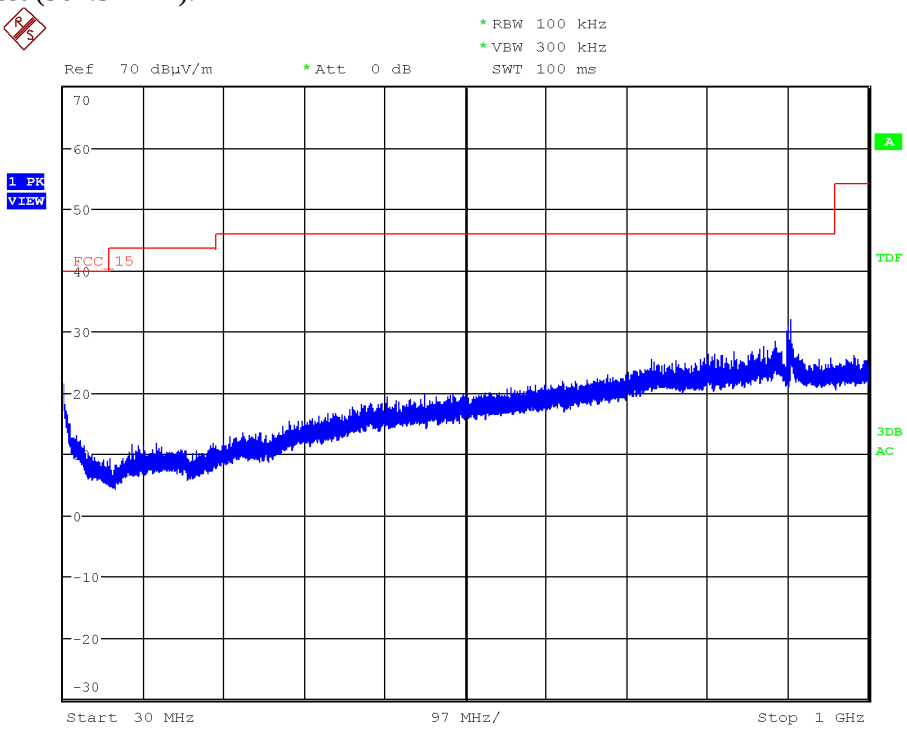
3. CHANNEL: HIGHEST (914.9 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.82965	H	Peak	38.94	± 4.87
2.74465	V	Peak	42.88	± 4.87
4.57435	V	Peak	52.40	± 4.87
5.48965	V	Peak	40.85	± 4.87
6.40465	V	Peak	48.61	± 4.87

Verdict: PASS

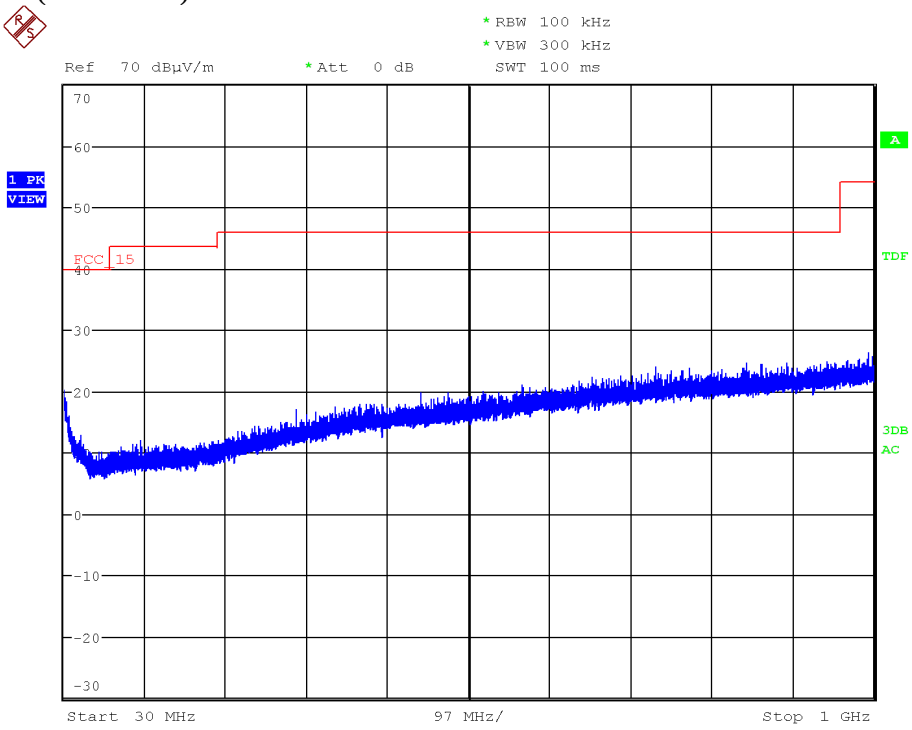
FREQUENCY RANGE 30 MHz-1000 MHz.

CHANNEL: Lowest (902.3 MHz).



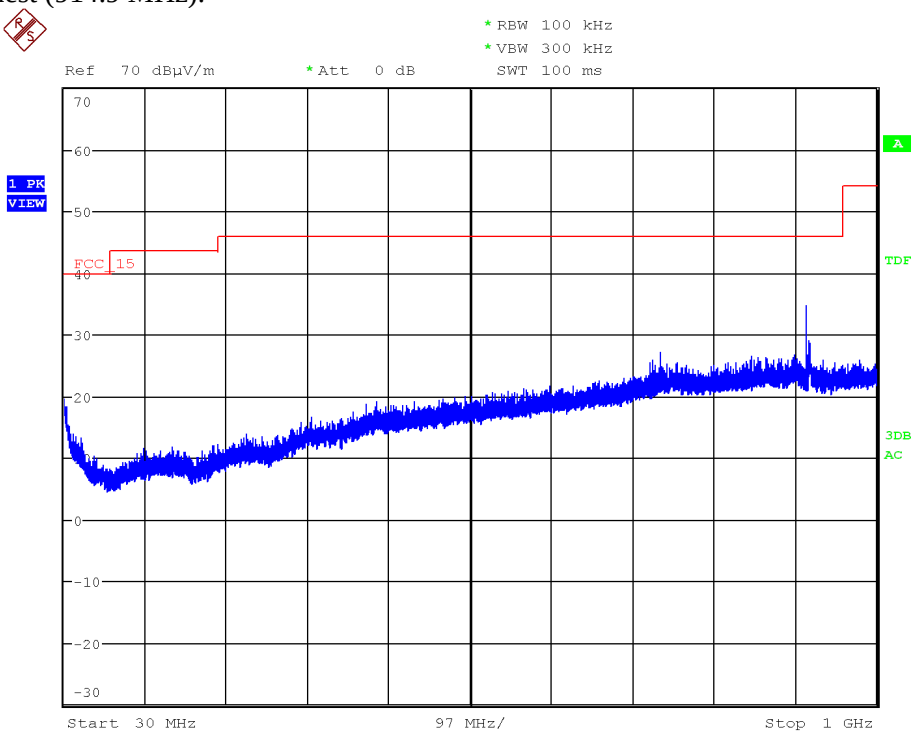
Note: The carrier was attenuated using a notch-filter.

CHANNEL: Middle (908.7 MHz).



Note: The carrier was attenuated using a notch-filter.

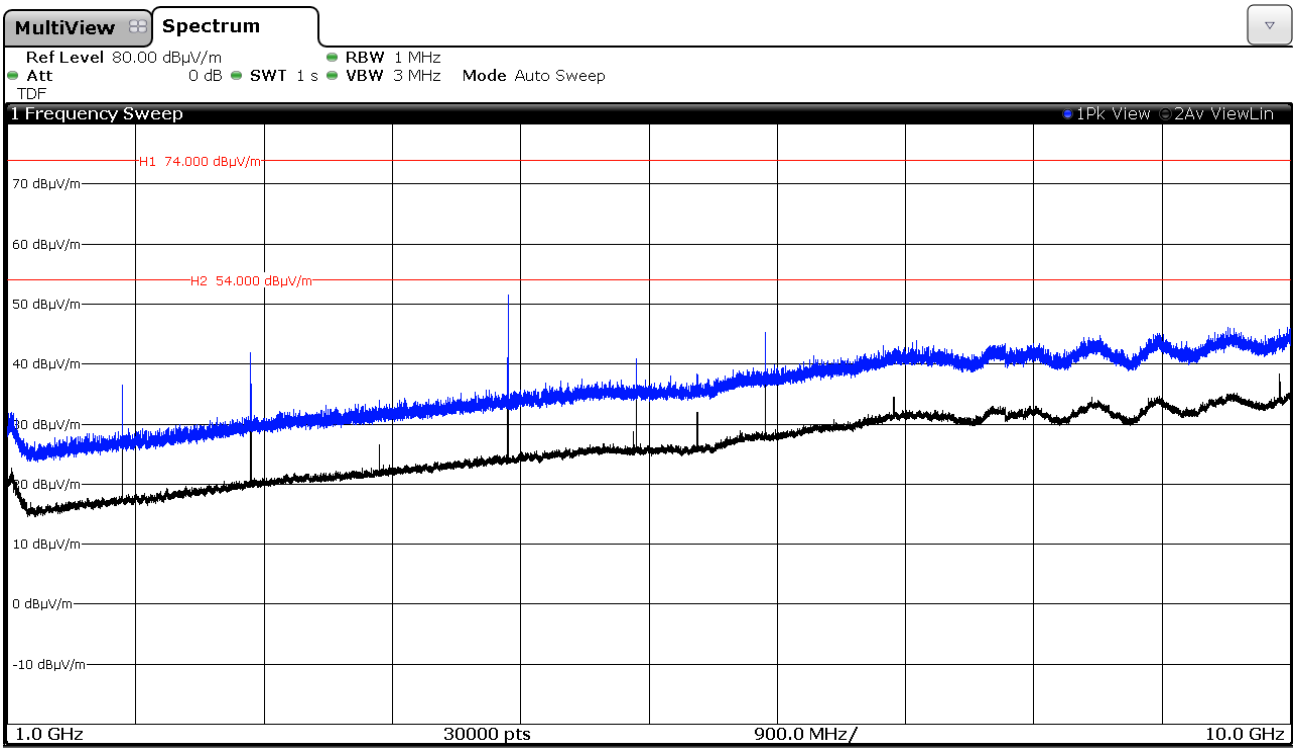
CHANNEL: Highest (914.9 MHz).



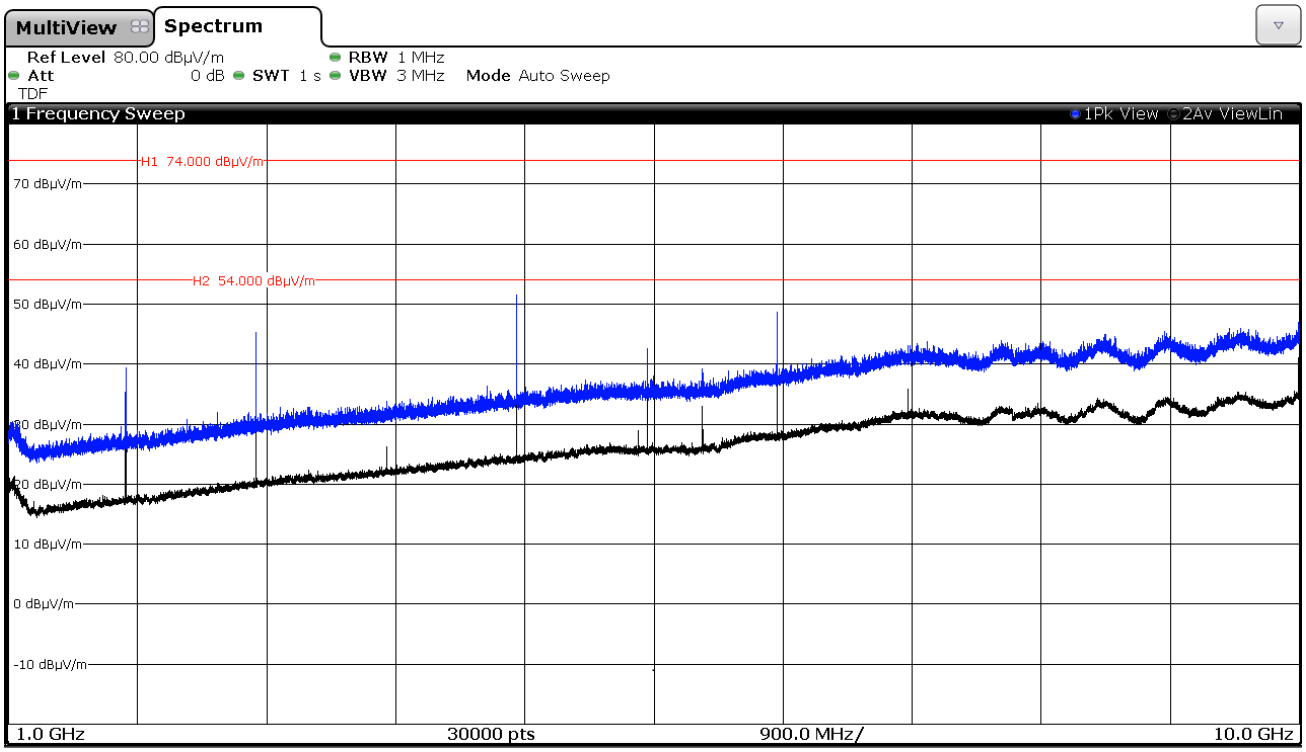
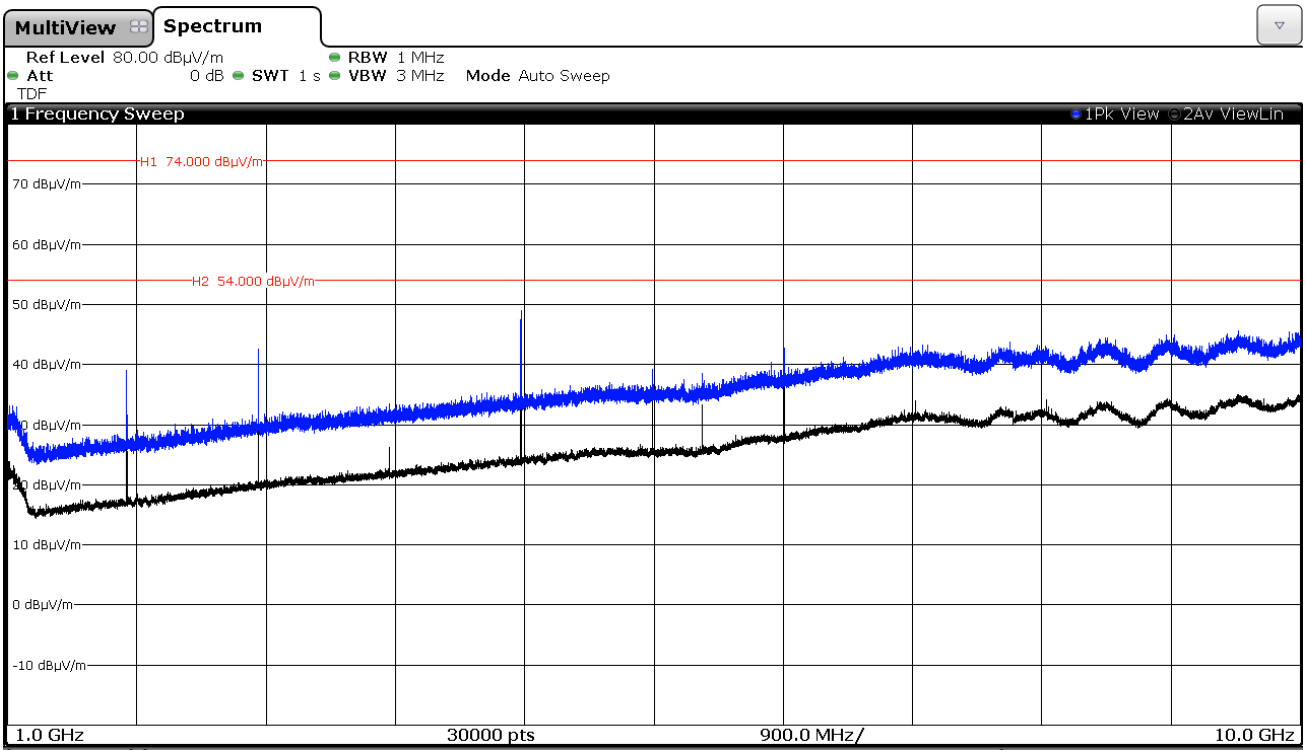
Note: The carrier was attenuated using a notch-filter.

FREQUENCY RANGE 1 GHz to 10 GHz.

CHANNEL: Lowest (902.3 MHz).



CHANNEL: Middle (908.7 MHz).



CHANNEL: Highest (914.9 MHz).