



FCC LISTED, REGISTRATION
NUMBER: 720267

ISED LISTED REGISTRATION
NUMBER 4621A-2

Informe de ensayo nº:
Test report No:

NIE: 52481RRF.004

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 (DTs), 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	Radio Transceiver for industrial application
Marca Trademark	IKUSI
Modelo y/o referencia tipo Model and /or type reference	PVTTR2400-MCX (Module with antenna connectors) R11 (Host equipment with external attachable antennas)
Other identification of the product	FCC ID: PVTTR2400-MCX IC: 4166A-TR2400MCX
Final HW version	PVTTR2400-MCX : 123662 R11: 123704D
Final SW version	PVTTR2400-MCX: V2.4.0 R11 with external antenna: V3.0.1
Características Features	---
Solicitante Applicant	IKUSI ELECTRONICA SL Paseo Miramón, 170, 20014, San Sebastián, Guipúzcoa (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). 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

Fecha de realización	2017-07-17
Date of issue	
Formato de informe No.	FDT08_20
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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 conjunction 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.

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.

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The results presented in this Test Report apply only to the particular item under test established in this document.

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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 N°	Description	Model	Serial N°	Date of reception
52481B/015	Radio module 2.4GHz with antenna connectors	PVTTR2400-MCX	01-17	2017-02-07

Auxiliary elements used with samples S/01:

Control N°	Description	Model	Serial N°	Date of reception
52481B/002	Transceiver R11 with external antenna connector	R11	01170187	2017-01-31

1. Sample S/01 has undergone following test(s).
All conducted tests indicated in appendix A.

Sample S/02 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
52481B/002	Receiver for industrial application with external antennas	R11	01170187	2017-01-31

1. Sample S/02 has undergone following test(s).
Radiated tests for R11 model with external antennas indicated in appendix A.

Test sample description

PVTTR2400-MCX: Radio module in the 2.4 GHz band with external antenna, included in a host for the communication between two or more hosts.

R11: The test sample consists of a receiver for industrial application with 11 digital output (11manoeuvres / 1 safety / 1 start-klaxon).2 Relays in serial circuit mode with forced mechanics guide. Multi voltage power supply (48-230Vac).

Identification of the client

IKUSI ELECTRONICA SL

Paseo Miramón, 170, 20014, San Sebastián, Guipúzcoa (SPAIN)

Testing period

The performed test started on 2017-01-31 and finished on 2017-03-16.

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

Remarks and comments

1: Tests have been performed by the technical personnel: Carlos Alberto Contreras, Pedro Parada & Carolina Postigo.

2: Used instrumentation:

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Spectrum analyser Agilent E4440A	2015/10	2017/10
2.	AC power supply ELGAR CS-AC35(351SL)	2016/05	2019/05

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	2016/11	2019/11
5.	Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2017/03	2020/03
6.	EMI Test Receiver R&S ESU 40	2016/03	2018/03
7.	Spectrum analyser Rohde & Schwarz FSW50	2015/12	2017/12
8.	RF pre-amplifier 10 MHz-6 GHz SCHWARZBECK BBV9743	2016/04	2017/04
9.	RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-1M	2016/02	2018/02
10.	RF pre-amplifier 18-40 GHz BONN ELEKTRONIK BLMA 1840-1M	2015/12	2017/12

Testing verdicts

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

1. – Proprietary radio

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 (a)(1)(iii) / RSS-247 Clause 5.1 (4)	Number of hopping channels		P		
FCC 15.247 Subclause (a)(1)(iii) / RSS-247 Clause 5.1 (4)	Time of occupancy (Dwell Time)		P		
FCC 15.247 Subclause (b) / RSS-247 Clause 5.4 (2)	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	Emission limitations radiated (Transmitter)		P		

Appendix A – Test result

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TEST CONDITIONS

PVTTR2400-MCX:

Power supply (V):

Vnominal = 3.3 Vdc

Type of power supply = DC voltage from an auxiliary equipment “R11”.

Type of antenna: External antenna.

Declared Gain for antenna (maximum) = +0.5 dBi (external antenna).

R11:

Power supply (V):

Vnominal = 115 Vac

R11 includes module PVTTR2400-MCX.

Type of power supply = AC mains.

Type of antenna: External antenna.

Declared Gain for antennas (maximum) = +0.5 dBi (external antennas).

Note: The device has two diversity antennas but only one antenna active at any moment in time. There is no simultaneous transmission over both antennas.

TEST FREQUENCIES:

Lowest channel: 2405 MHz

Middle channel: 2445 MHz

Highest channel: 2475 MHz

CONDUCTED MEASUREMENTS

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



The AC 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-25 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

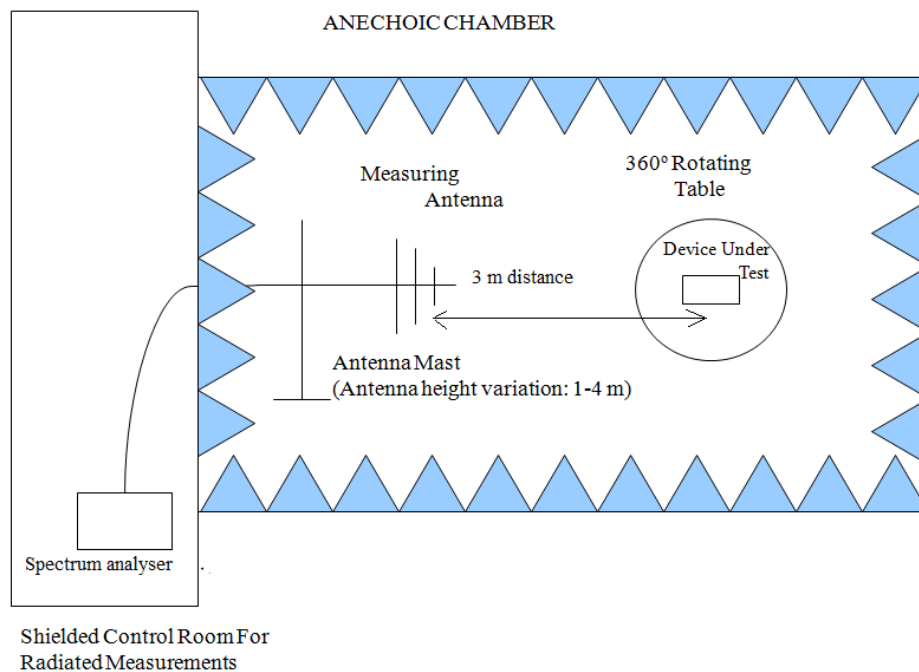
For radiated emissions in the range 1 GHz-25 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

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.

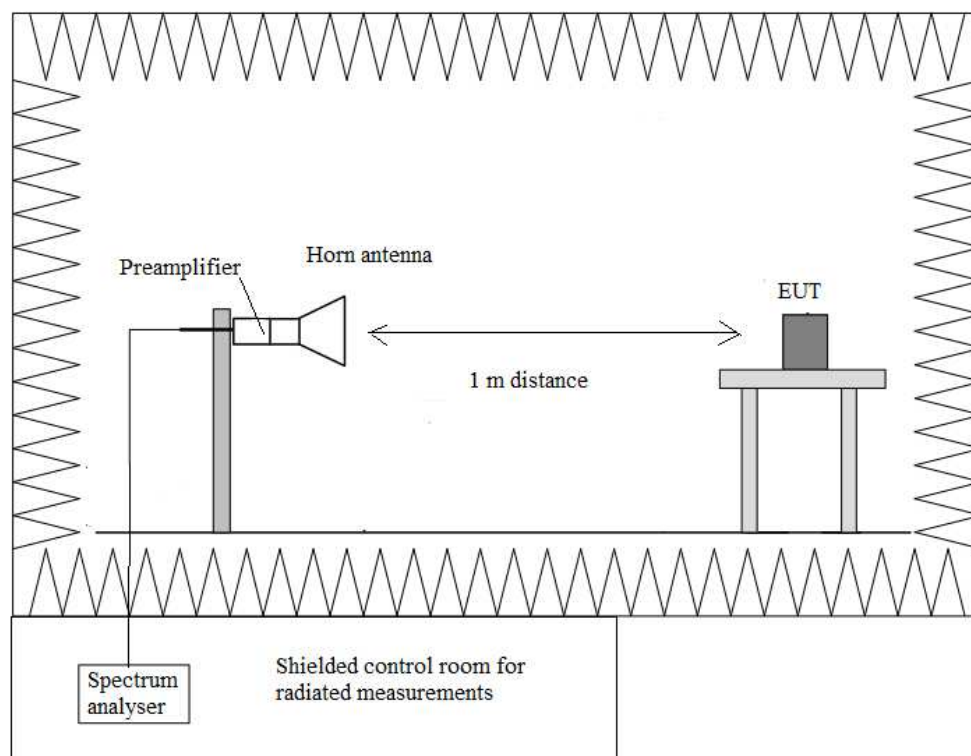
It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

Radiated measurements setup $f < 1$ GHz



Radiated measurements setup $f > 1$ GHz



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. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

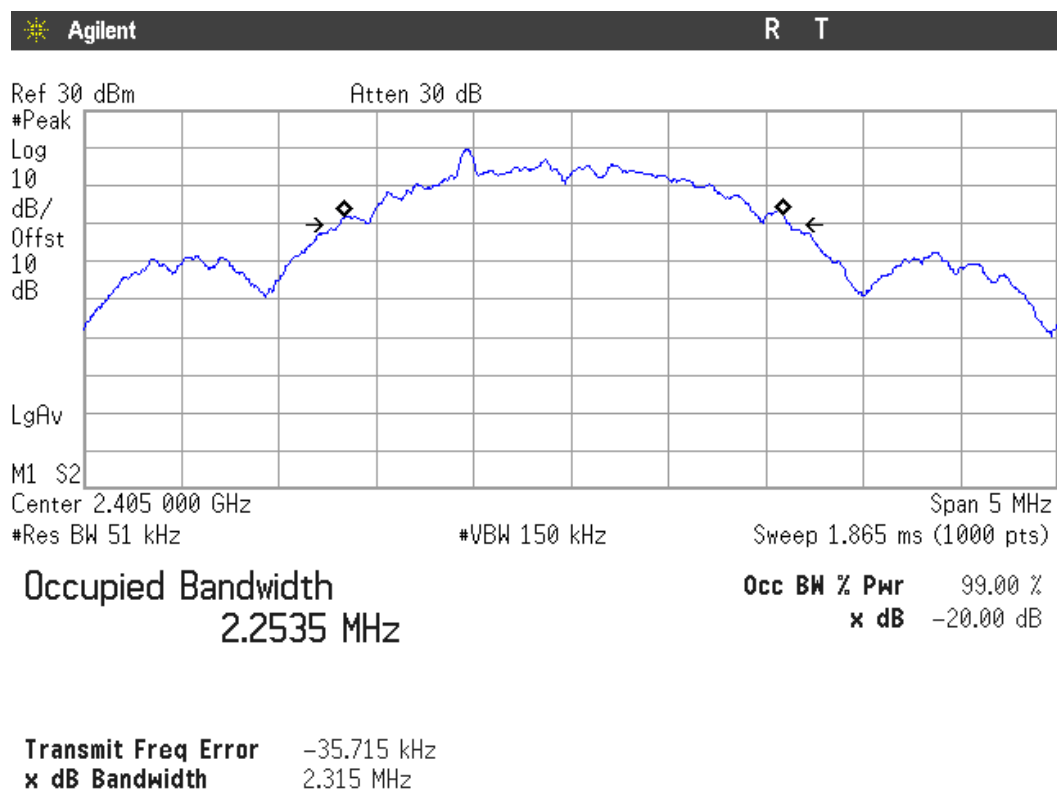
RESULTS

(See next plots)

	Lowest frequency 2405 MHz	Middle frequency 2445 MHz	Highest frequency 2475 MHz
20 dB Spectrum bandwidth (kHz)	2315	2574	2578
Measurement uncertainty (kHz)	<±5.00		

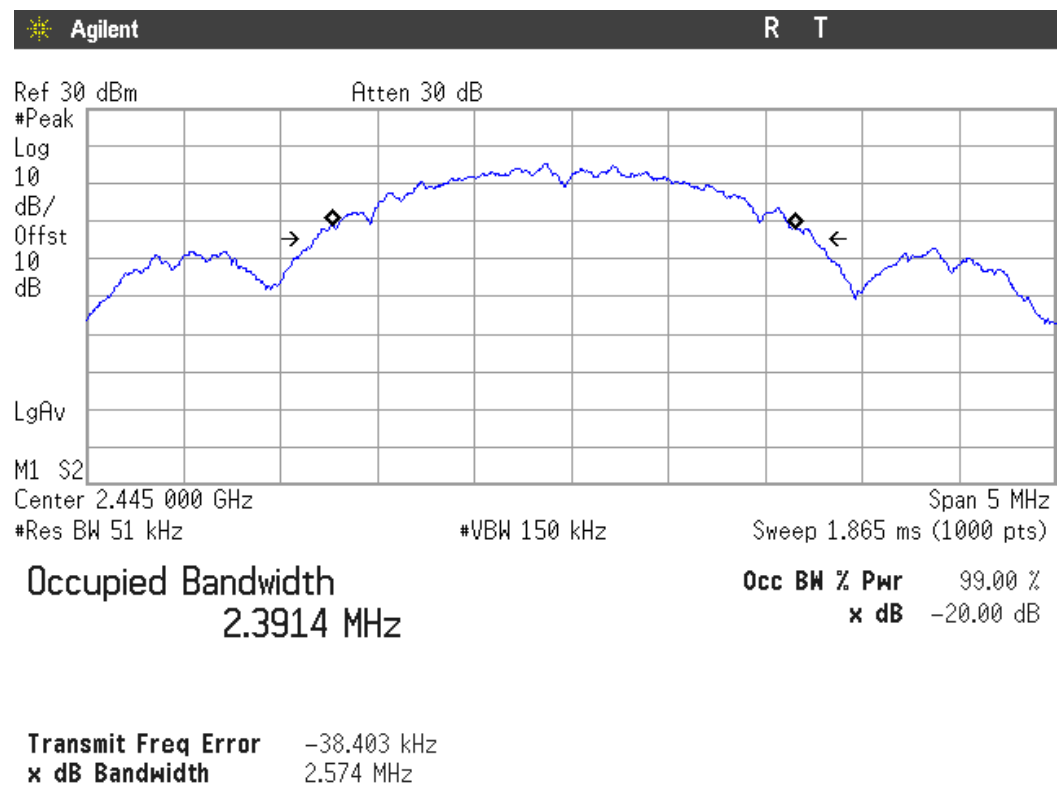
20 dB BANDWIDTH.

Lowest Channel: 2405 MHz.



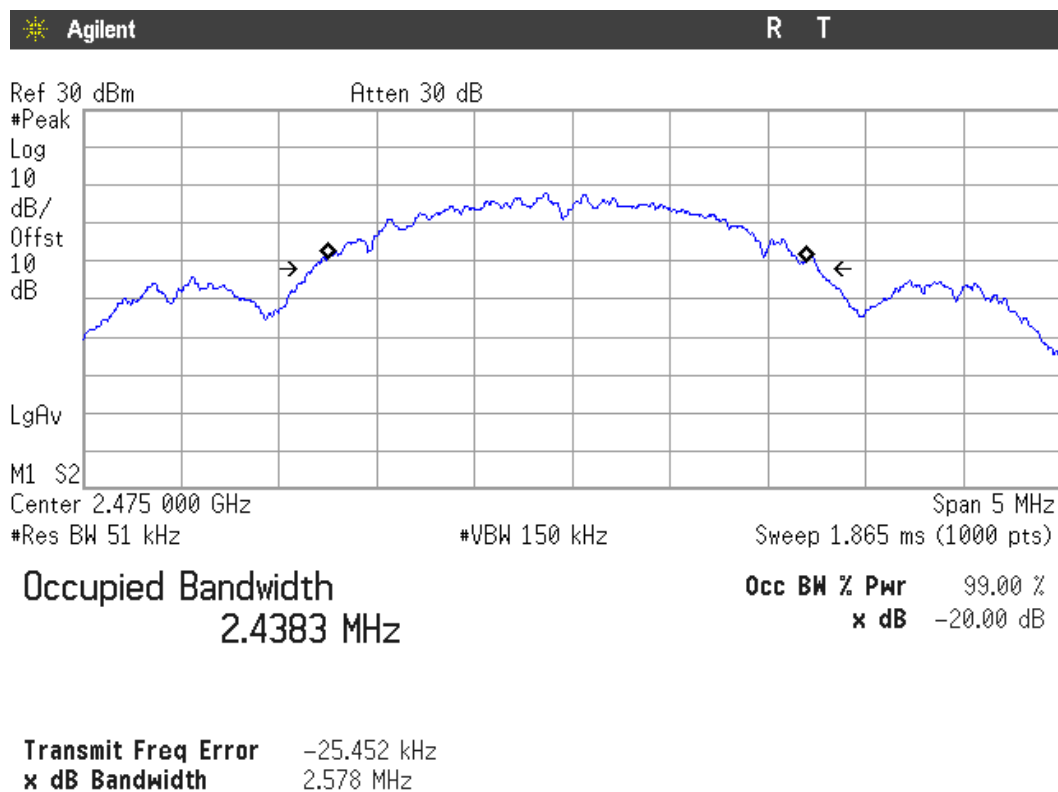
20 dB BANDWIDTH

Middle Channel: 2445 MHz.

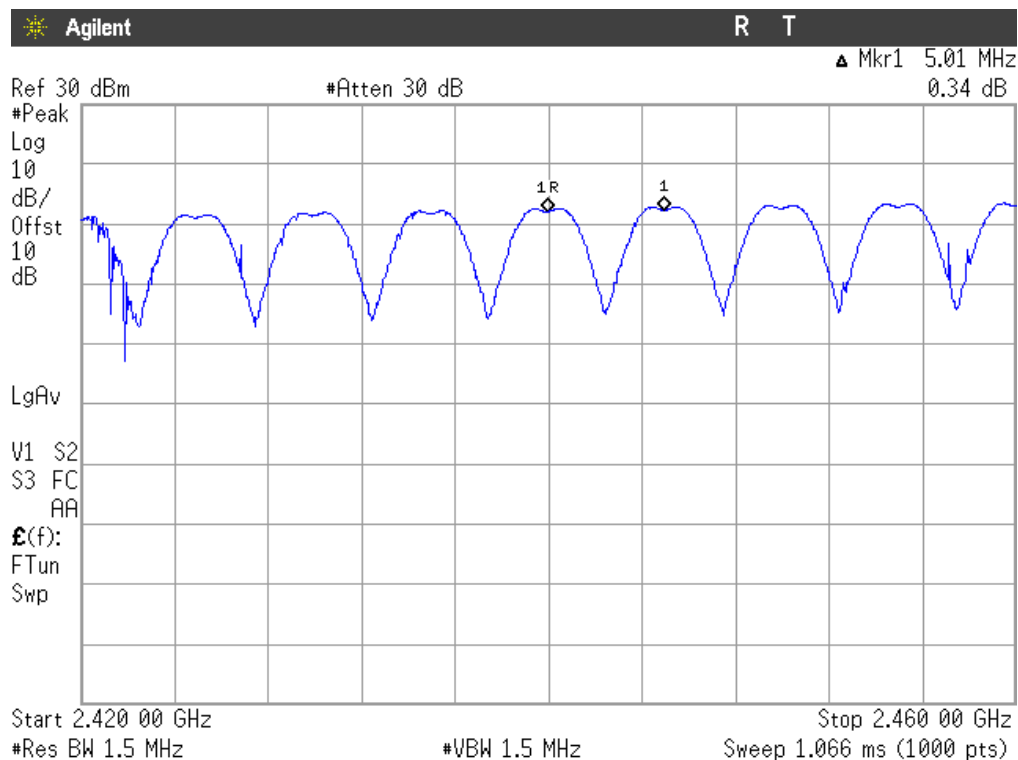


20 dB BANDWIDTH

Highest Channel: 2475 MHz.



Carrier frequency separation



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

Verdict: PASS

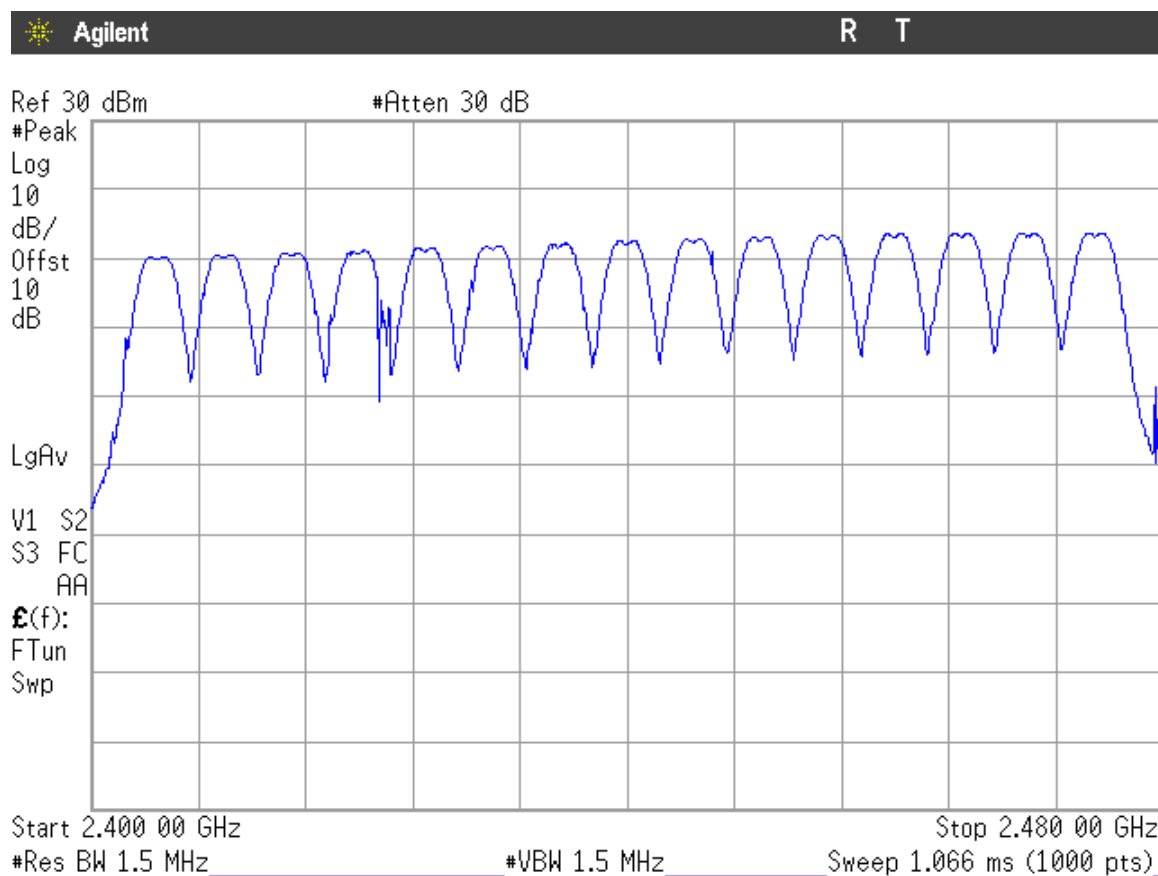
FCC Section 15.247 Subclause (a) (1) (iii) / RSS-247 Clause 5.1 (4). Number of hopping channels

SPECIFICATION

Frequency hopping system in the 2400-2483.5 MHz band shall use at least 15 channels.

RESULTS

The number of hopping channels is 15 (see next plot).



Number of hopping frequencies: 15

Verdict: PASS

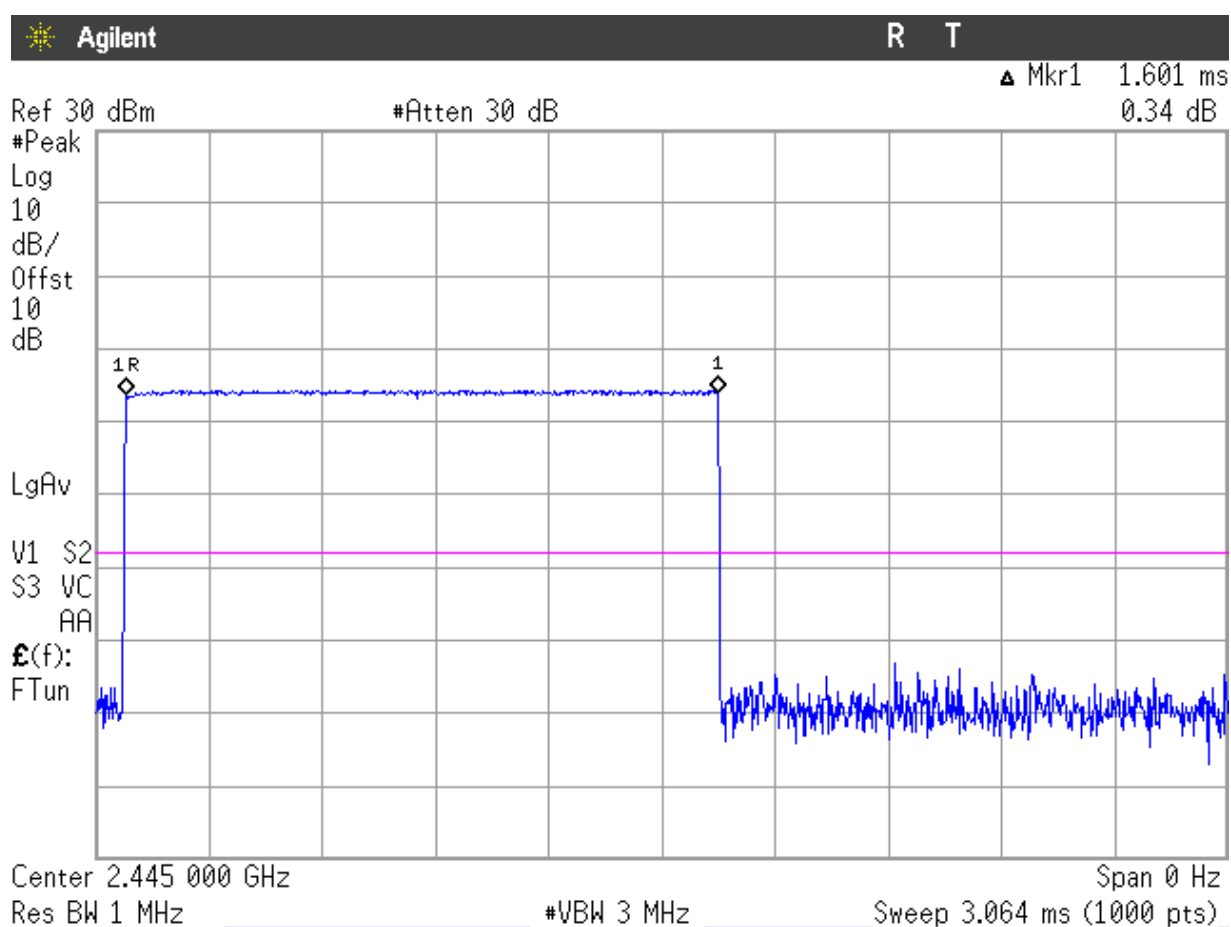
FCC Section 15.247 Subclause (a) (1) (iii) / RSS-247 Clause 5.1 (4). Time of occupancy (Dwell Time)

SPECIFICATION

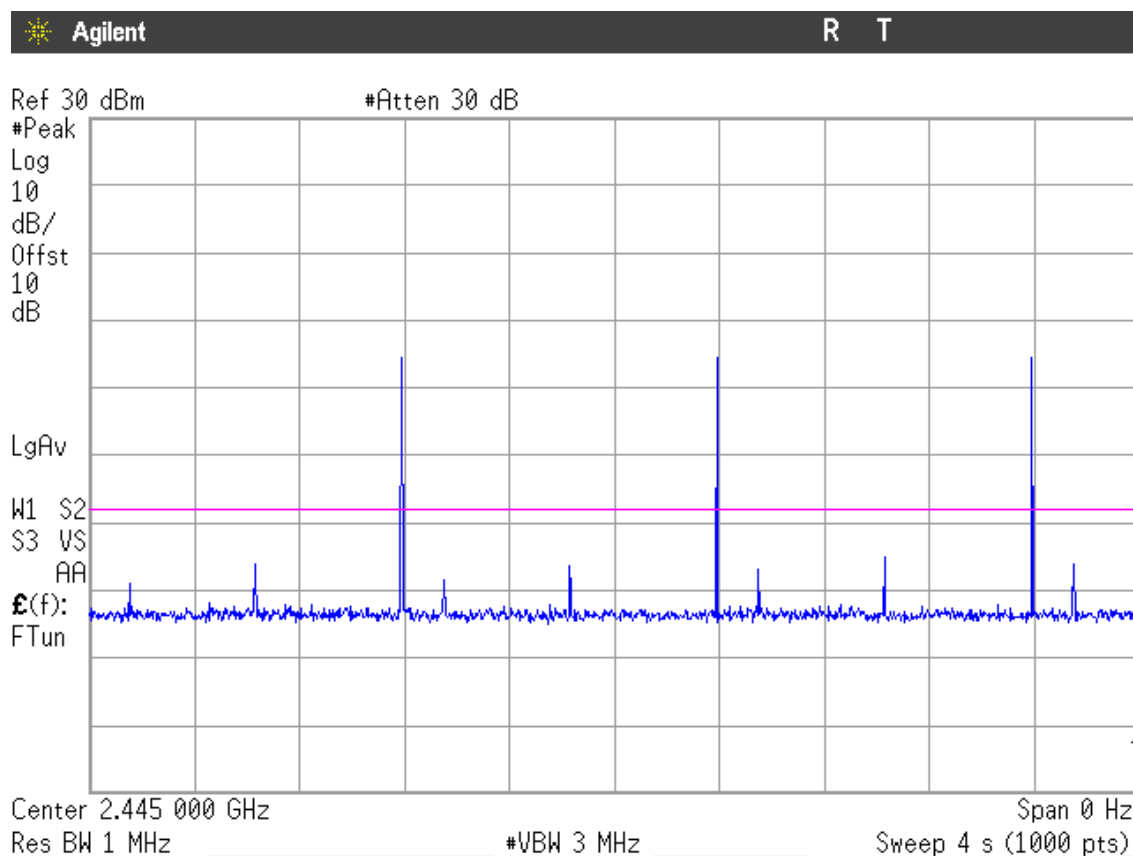
The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed = $0.4 \times 15 = 6$ seconds.

RESULTS

- Tx- time per hop = 1.601 ms (see next plot).



- Number of hops over a period of 4 seconds = 3 (see next plot).



Number of hops in the period specified in the requirements = (3 hops) x (6 s / 4 s) = 4.5 hops.

Averaging time of occupancy = 1.601 ms x 4.5 hops = 7.2045 ms per 6 seconds.

Measurement uncertainty (%)	<±0.01
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Verdict: PASS

FCC Section 15.247 Subclause (b) / RSS-247 Clause 5.4 (2). Maximum peak output power and antenna gain

SPECIFICATION

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels: 1 watt (30 dBm). For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts (20.97 dBm).

The e.i.r.p. shall not exceed 0.5 W (27 dBm) if the hopset uses less than 75 hopping channels (RSS-247).

MAXIMUM OUTPUT POWER. See next plots.

Declared maximum antenna gain: +0.5 dBi (external antenna)

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

External antenna:

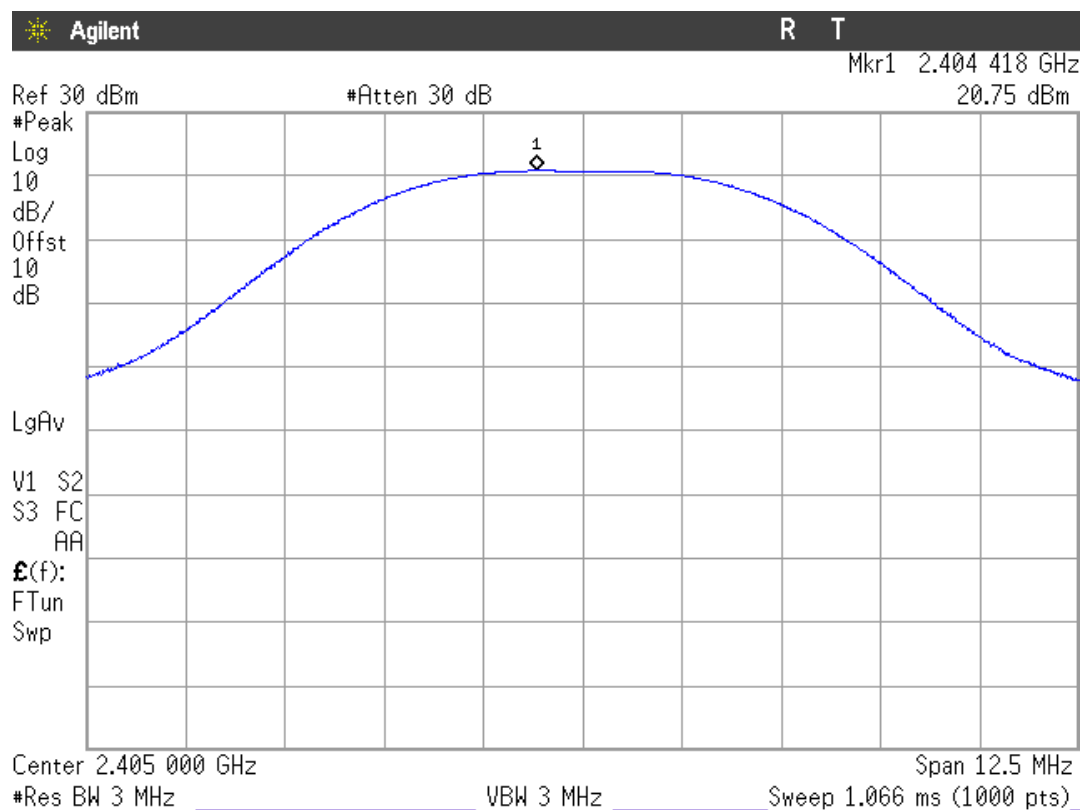
	Lowest frequency 2405 MHz	Middle frequency 2445 MHz	Highest frequency 2475 MHz
Maximum peak power (dBm)	20.75	19.49	12.49
Maximum EIRP power (dBm)	21.25	19.99	12.99
Measurement uncertainty (dB)	<±0.78		

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.

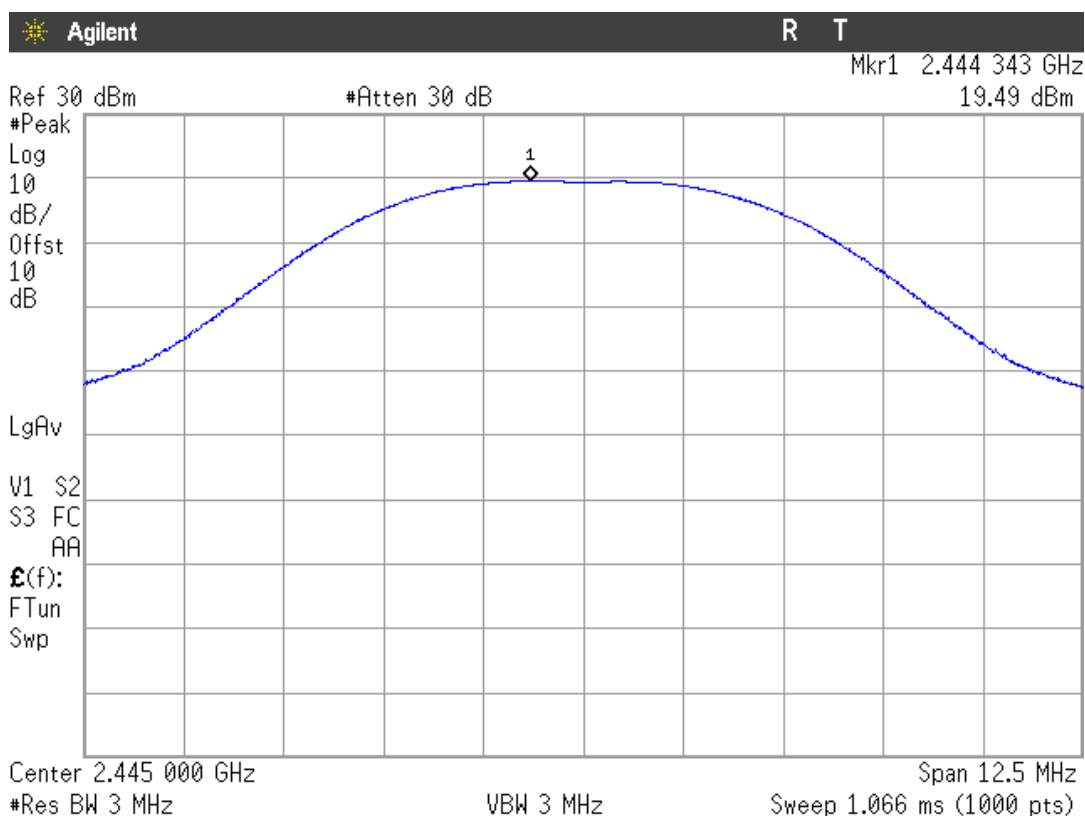
Verdict: PASS

PEAK OUTPUT POWER (CONDUCTED).

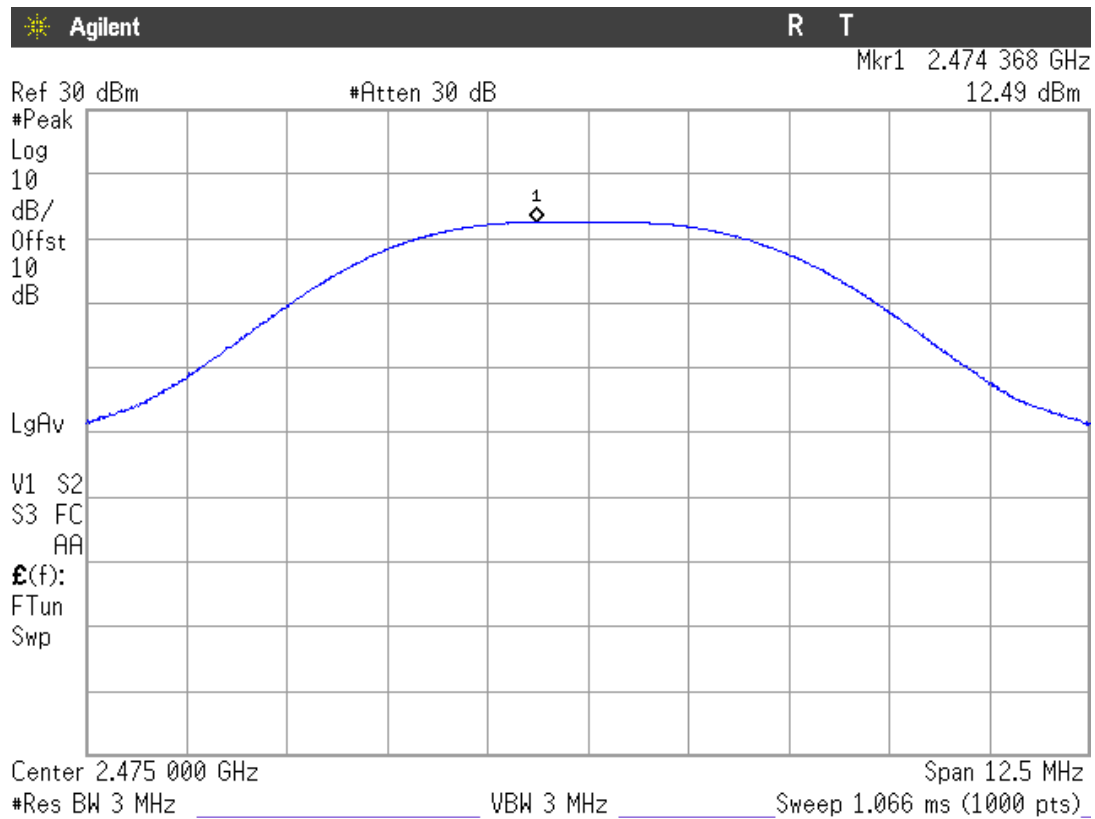
Lowest Channel: 2405 MHz.



Middle Channel: 2445 MHz.



Highest Channel: 2475 MHz.



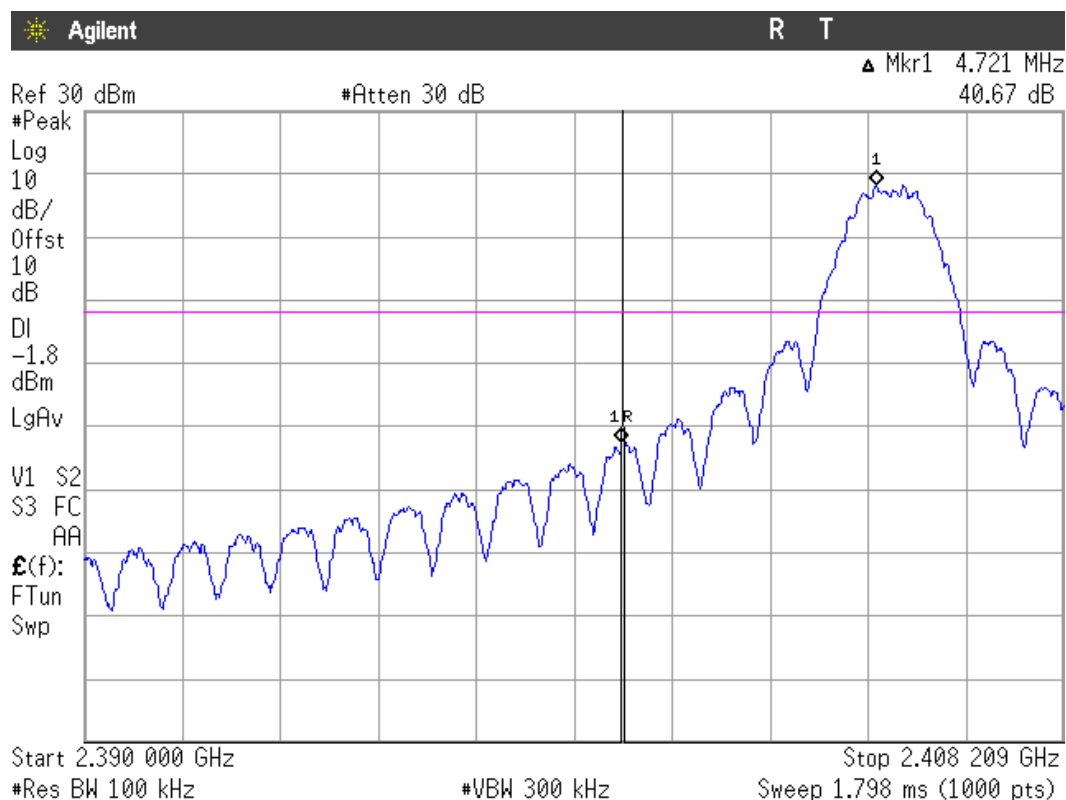
FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Band-edge compliance of conducted emissions (Transmitter)

SPECIFICATION

Emissions outside the frequency band in which the intentional radiator is operating shall be at least 20dB below the highest level of the desired power.

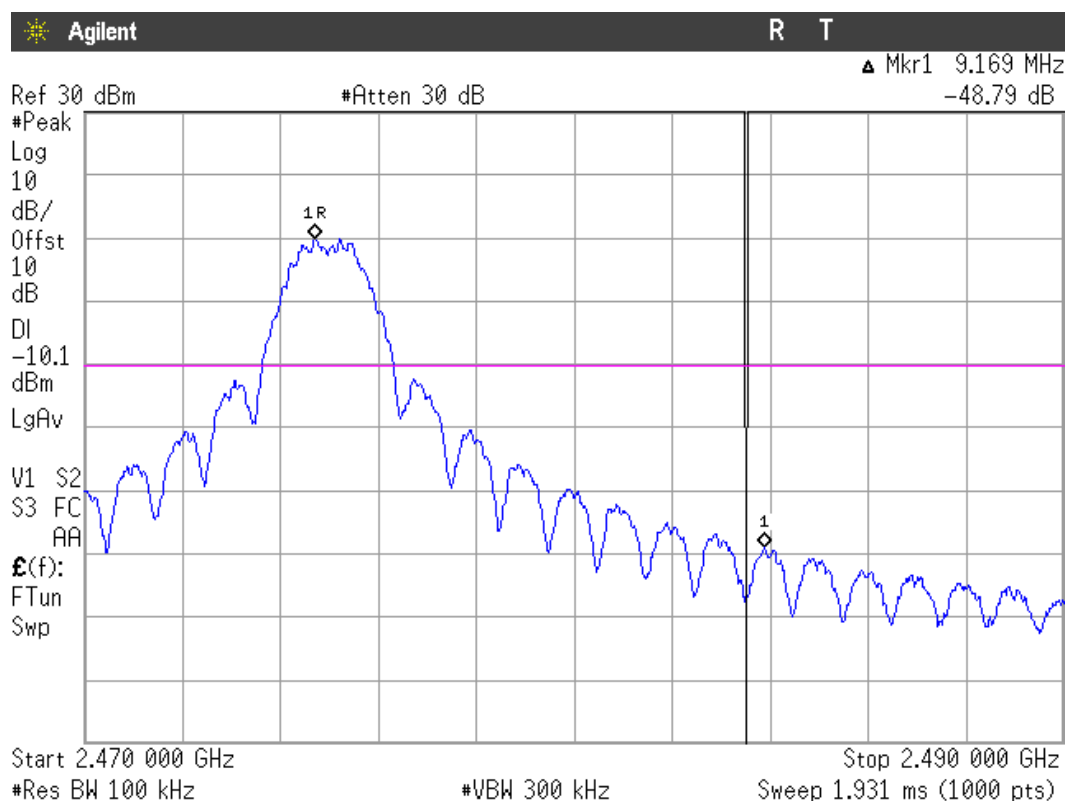
RESULTS:

1. LOW FREQUENCY SECTION 2405 MHz (HOPPING OFF). See next plot.



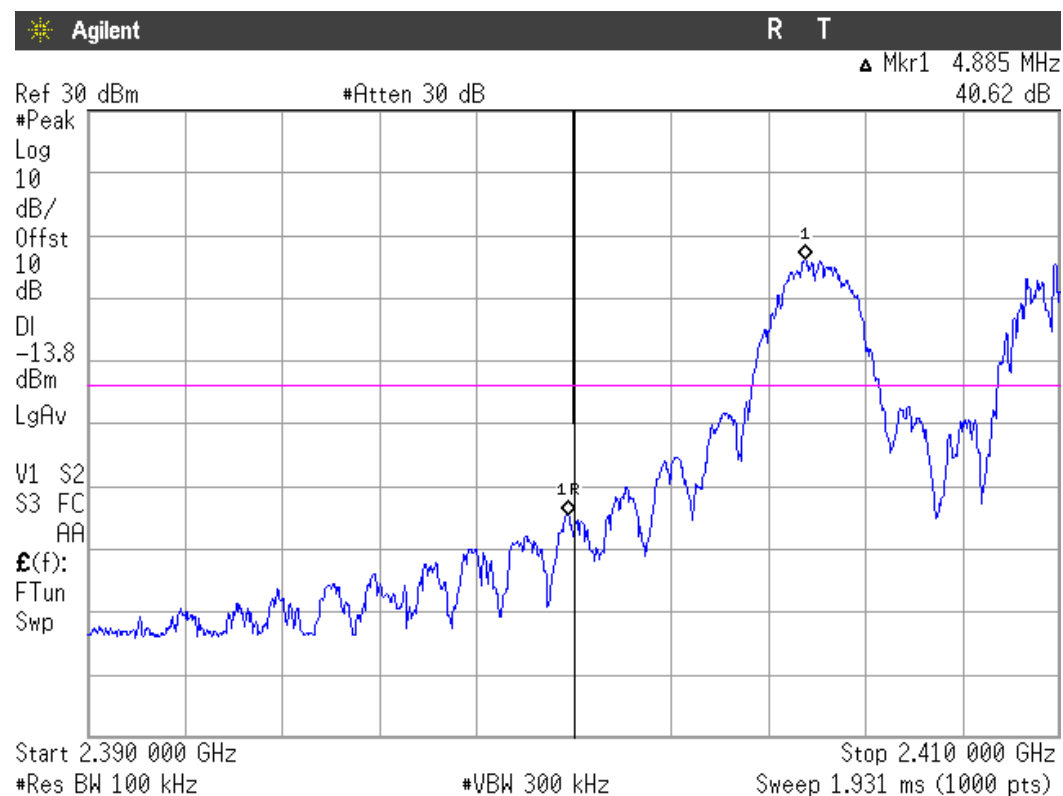
Verdict: PASS

2. HIGH FREQUENCY SECTION 2475 MHz (HOPPING OFF). See next plot.



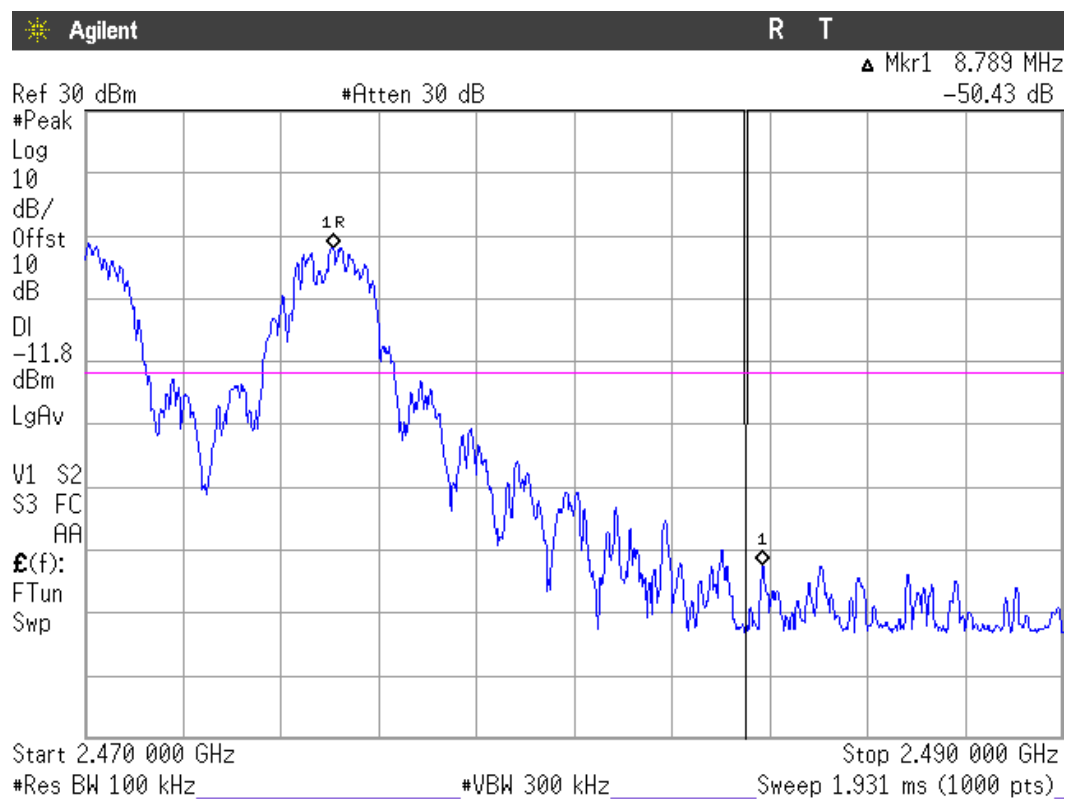
Verdict: PASS

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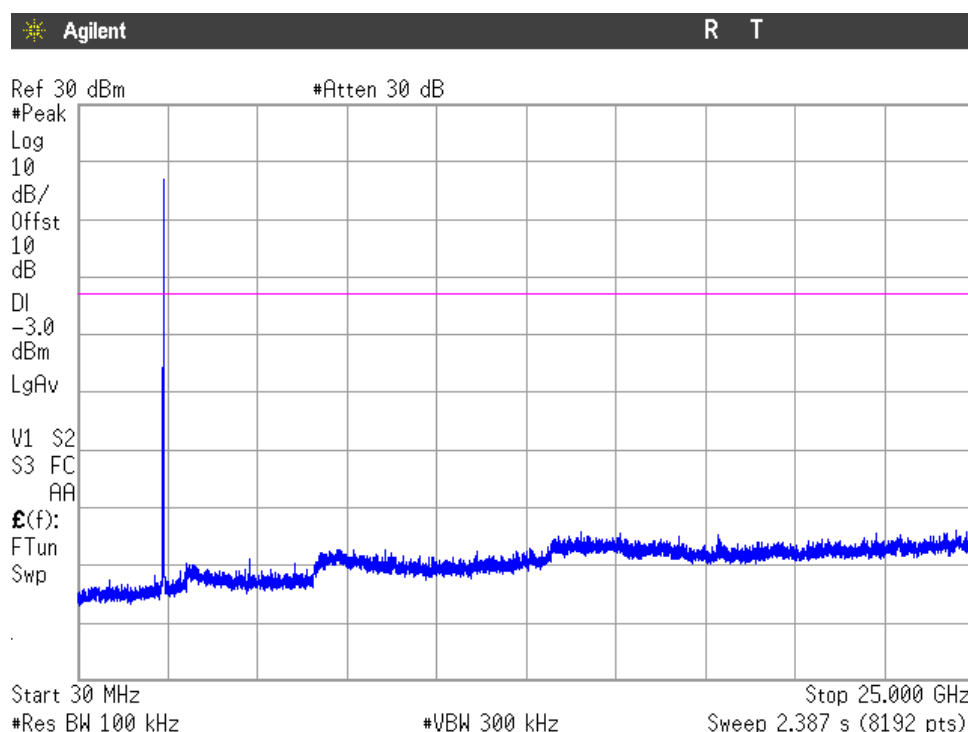
FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5. Emission limitations conducted (Transmitter)

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 20dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

RESULTS:

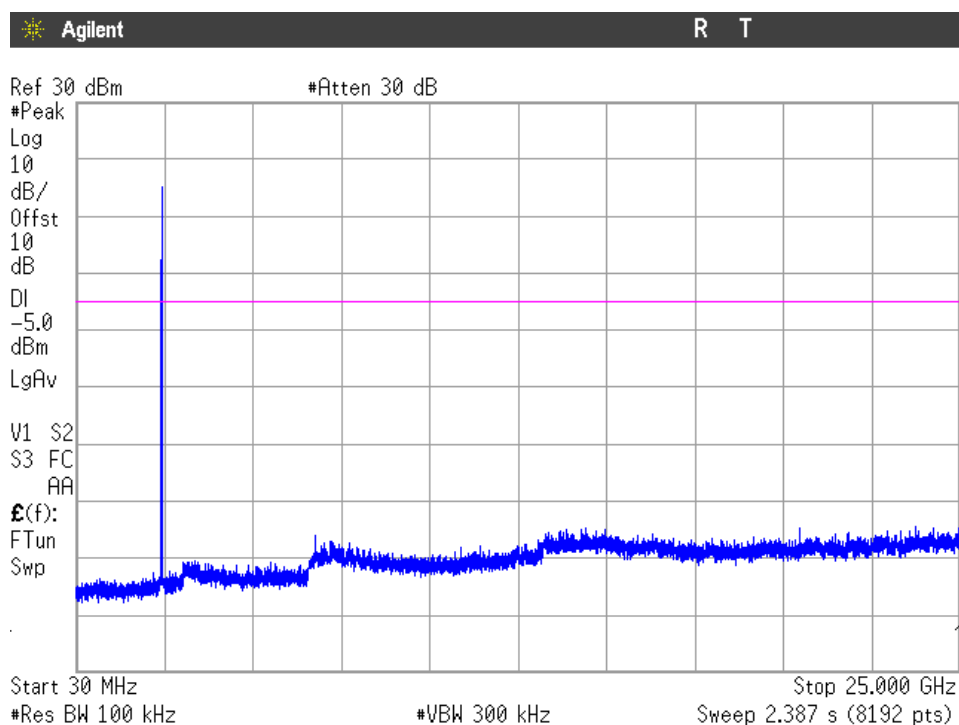
1. LOWEST CHANNEL (2405 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

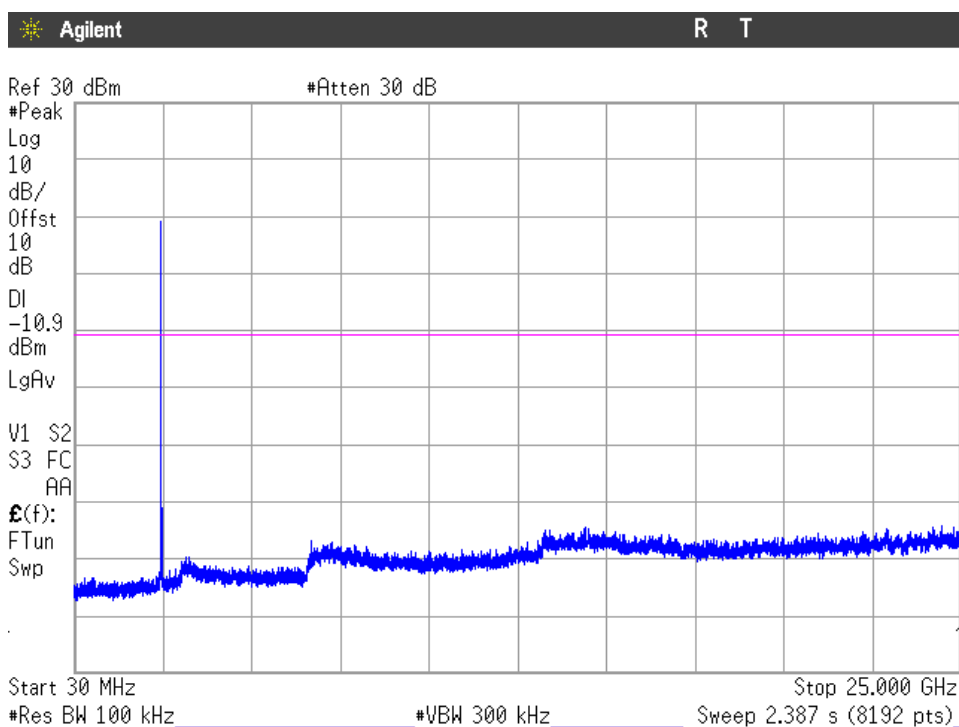
2. MIDDLE CHANNEL (2445 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

3. HIGH CHANNEL (2475 MHz): 30 MHz-25 GHz (see next plot).



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

Verdict: PASS

Measurement uncertainty (dB)

<±2.03

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 ($\mu\text{V/m}$)	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.

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 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-25 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.

Note: The device has two diversity antennas, but there is no simultaneous transmission over both antennas.

R11 with external antennas (Worst case: Antenna port 1)

Frequency range 30 MHz-1000 MHz.

Note: The spurious emissions below 1 GHz do not depend on the operating channel.

Spurious levels operating (radiated) closest to limit.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
91.20700	H	Quasi-Peak	34.15	± 3.88
288.02000	V	Quasi-Peak	31.12	± 3.88
431.96800	V	Quasi-Peak	29.80	± 3.88
576.01300	V	Quasi-Peak	24.20	± 3.88
722.05800	V	Quasi-Peak	31.10	± 3.88

Frequency range 1 GHz-25 GHz

The results in the next tables show the maximum measured levels in the 1-25 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz (see next plots).

1. CHANNEL: LOWEST (2405 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
2.38971	V	Peak	60.13	± 4.87
		AVG	52.40	± 4.87
4.81075	V	Peak	59.45	± 4.87
		AVG	54.16	± 4.87
7.21625	H	Peak	48.32	± 4.87
9.622225	H	Peak	57.09	± 4.87
		AVG	51.17	± 4.87

2. CHANNEL: MIDDLE (2445 MHz).

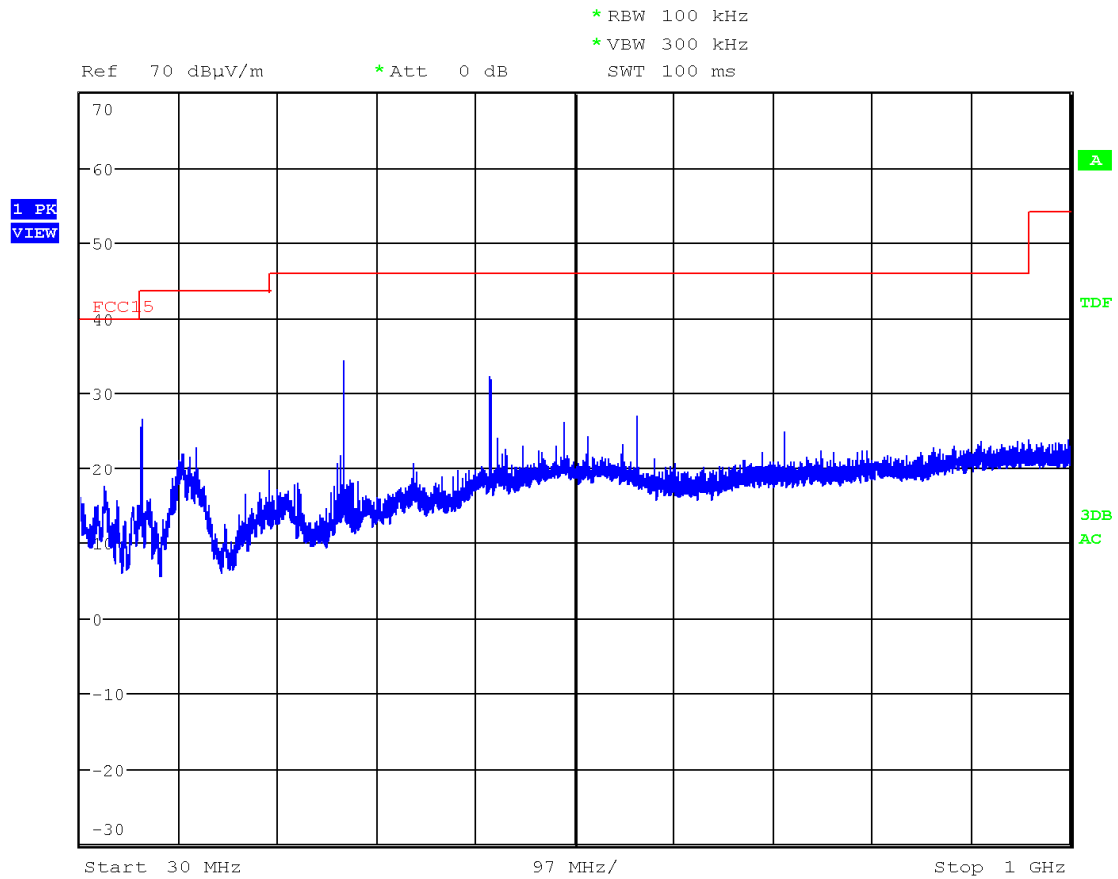
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
4.89075	H	Peak	60.77	± 4.87
		AVG	54.30	± 4.87
7.33325	H	Peak	59.97	± 4.87
		AVG	50.33	± 4.87
9.78225	H	Peak	56.70	± 4.87
		AVG	49.53	± 4.87

3. CHANNEL: HIGHEST (2475 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
2.48357	V	Peak	62.24	± 4.87
		AVG	54.00	± 4.87
4.94875	H	Peak	56.01	± 4.87
		AVG	50.64	± 4.87
7.42325	H	Peak	47.53	± 4.87
9.89825	V	Peak	51.21	± 4.87

Verdict: PASS

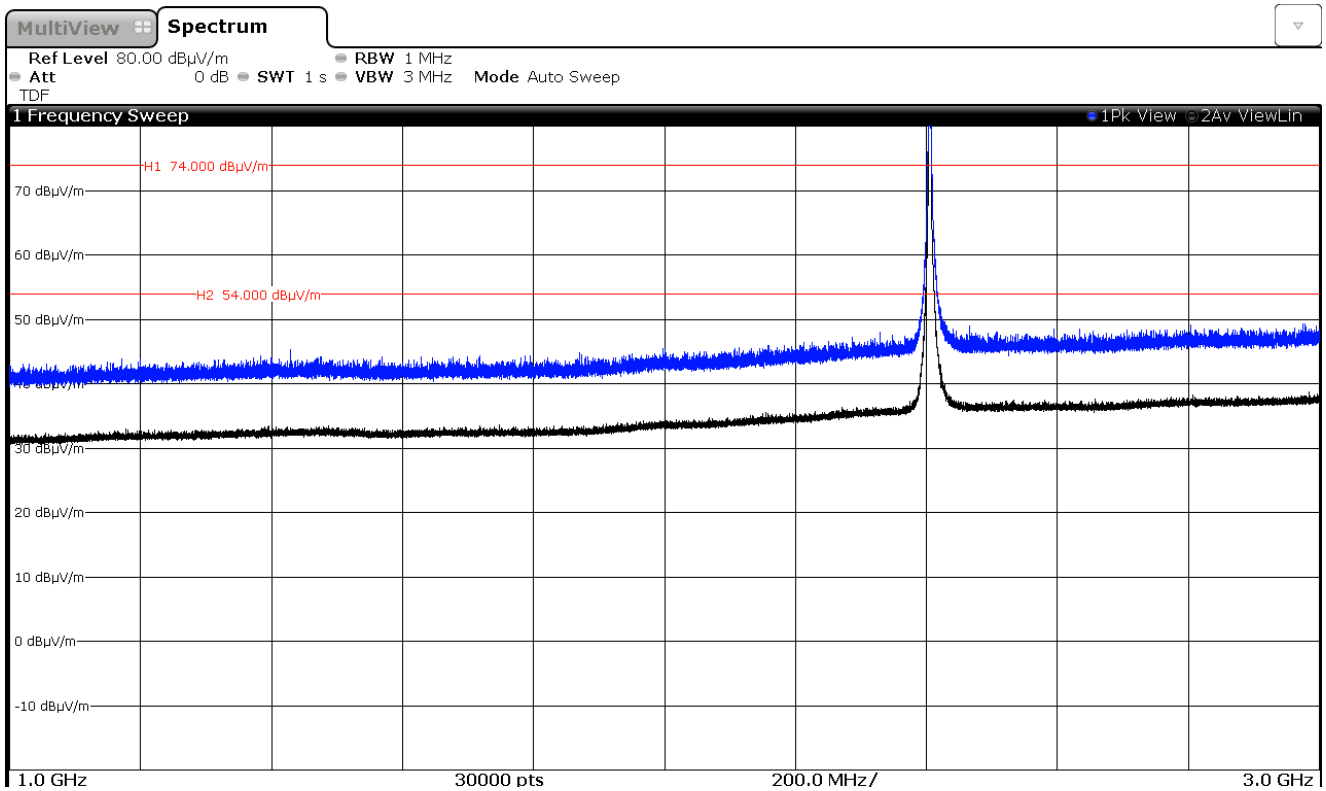
FREQUENCY RANGE 30 MHz-1000 MHz.



(This plot is valid for all three channels).

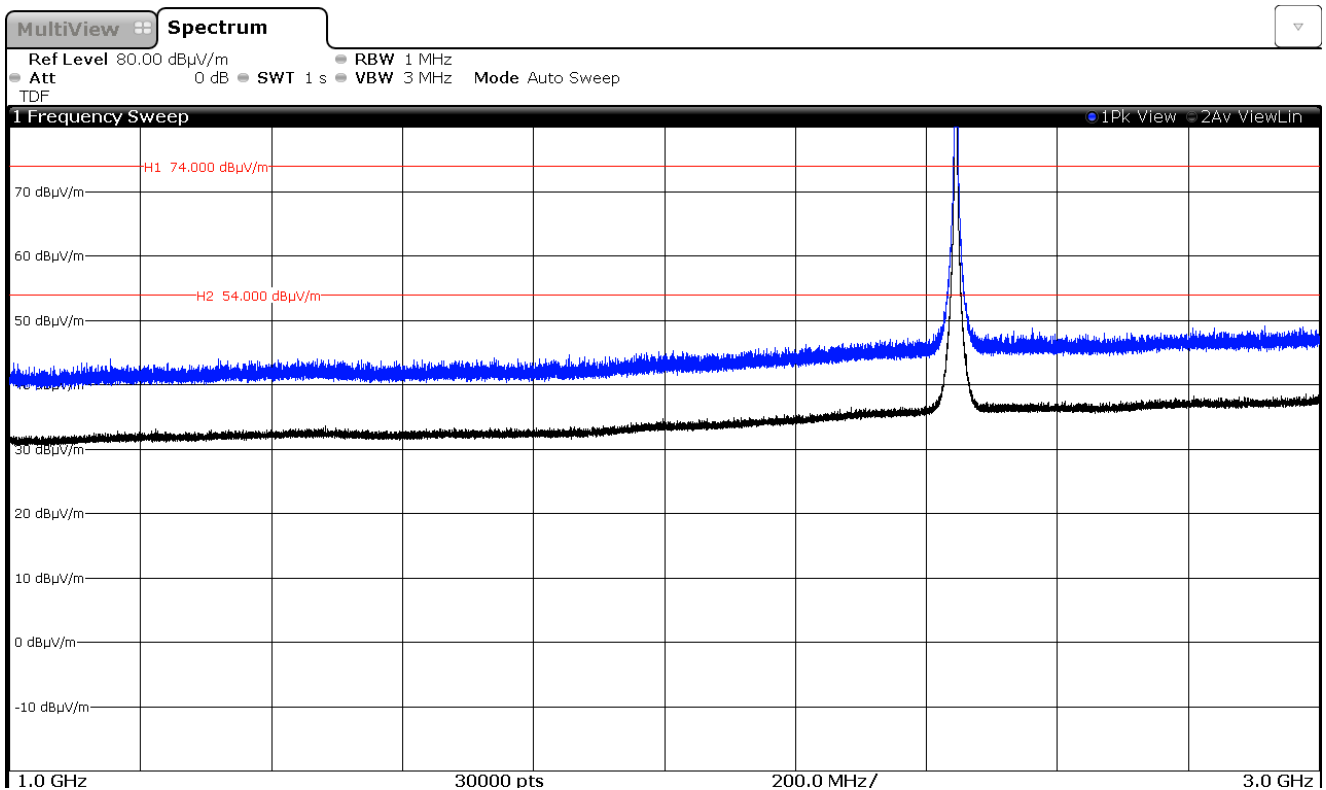
FREQUENCY RANGE 1 GHz to 3 GHz.

CHANNEL: Lowest (2405 MHz).



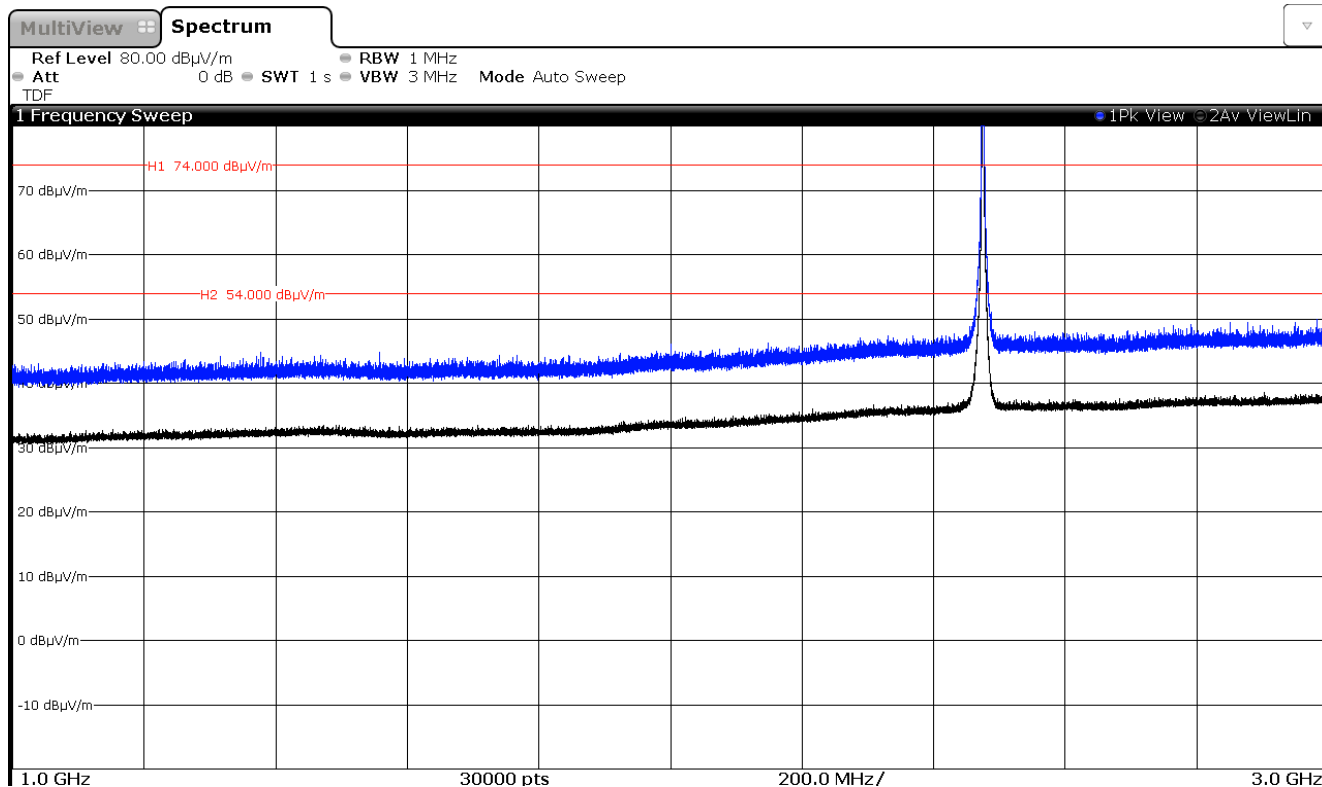
Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Middle (2445 MHz).



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

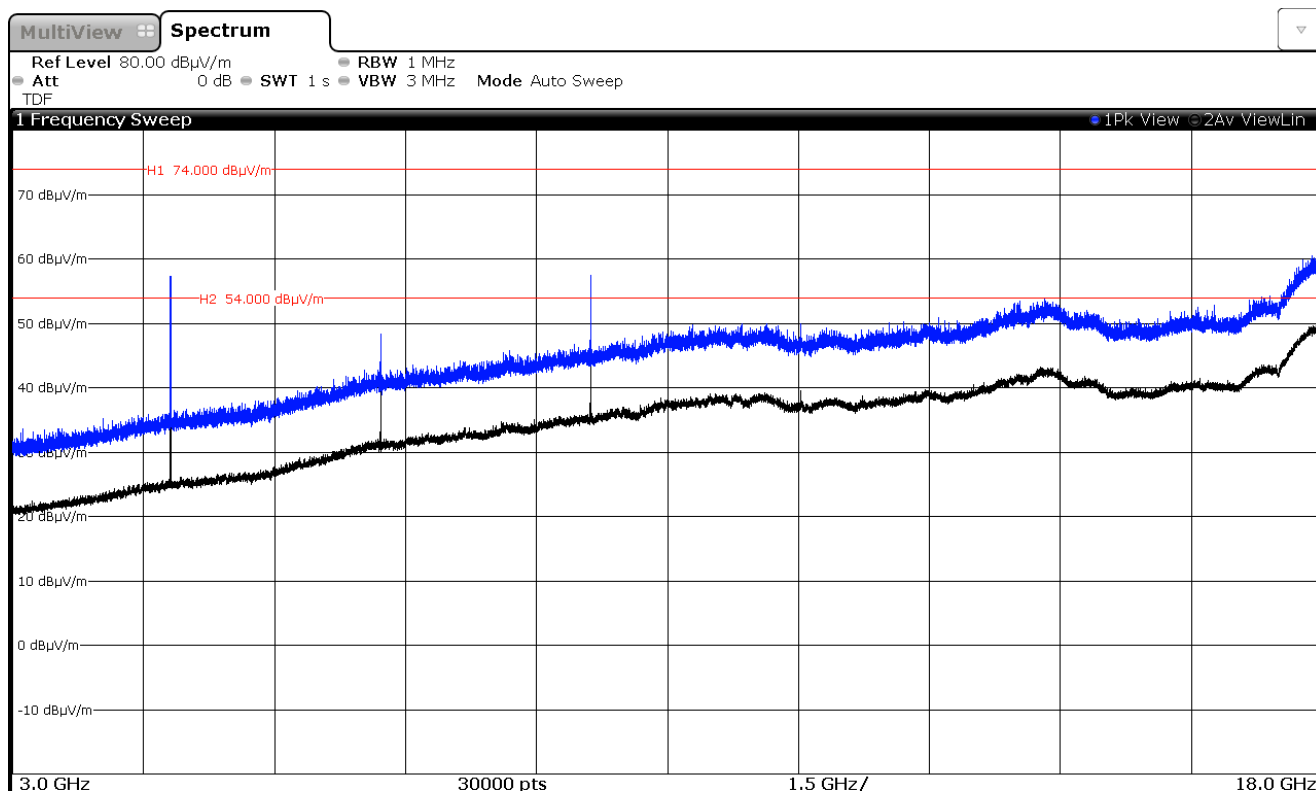
CHANNEL: Highest (2475 MHz).



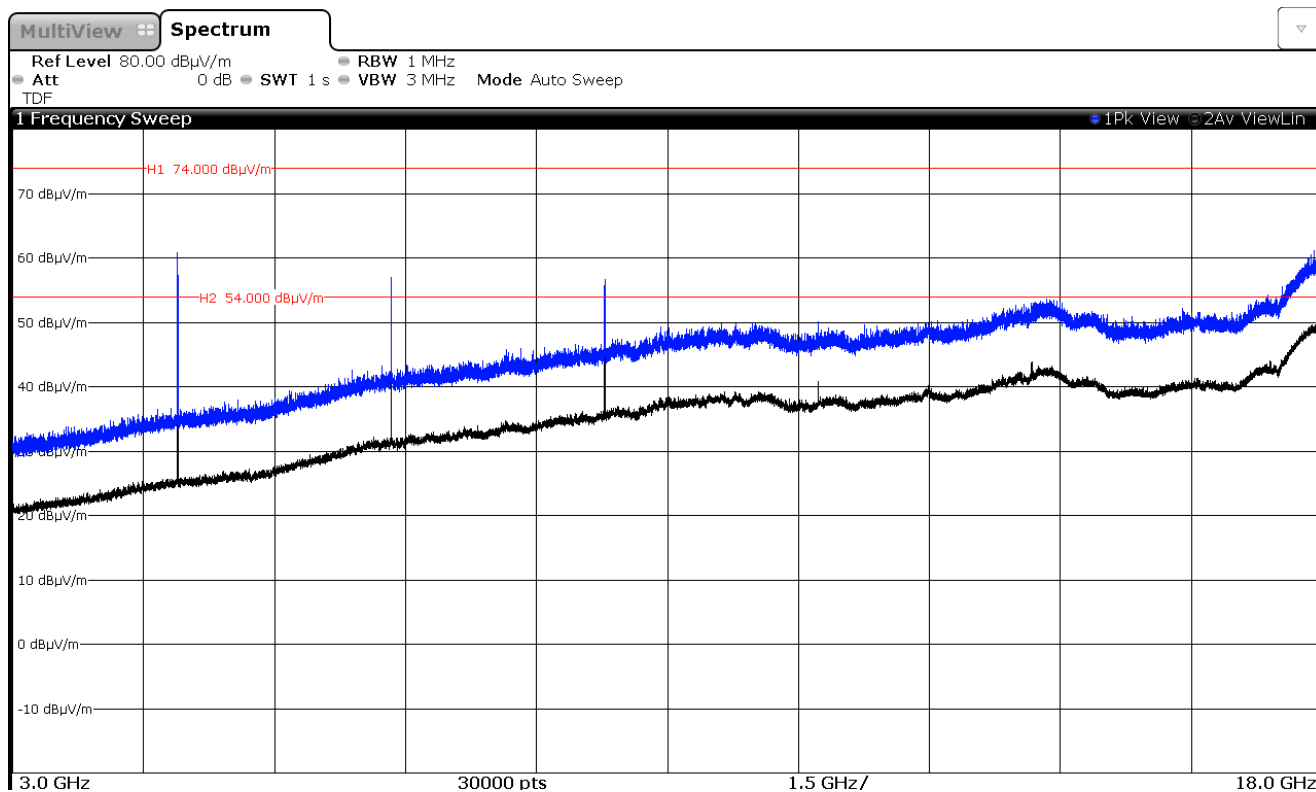
Note: The peak shown in the plot above the limits is the carrier frequency.

FREQUENCY RANGE 3 GHz to 18 GHz.

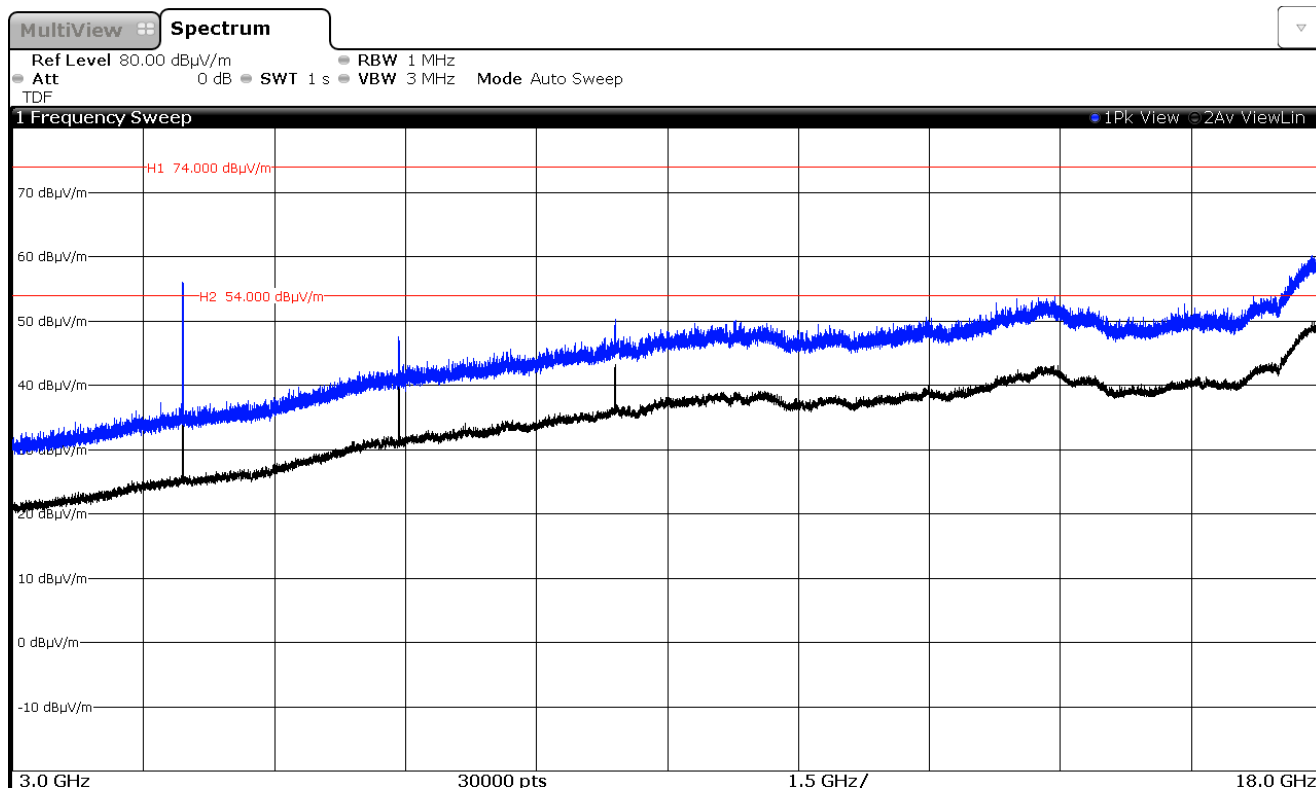
CHANNEL: Lowest (2405 MHz).



CHANNEL: Middle (2445 MHz).

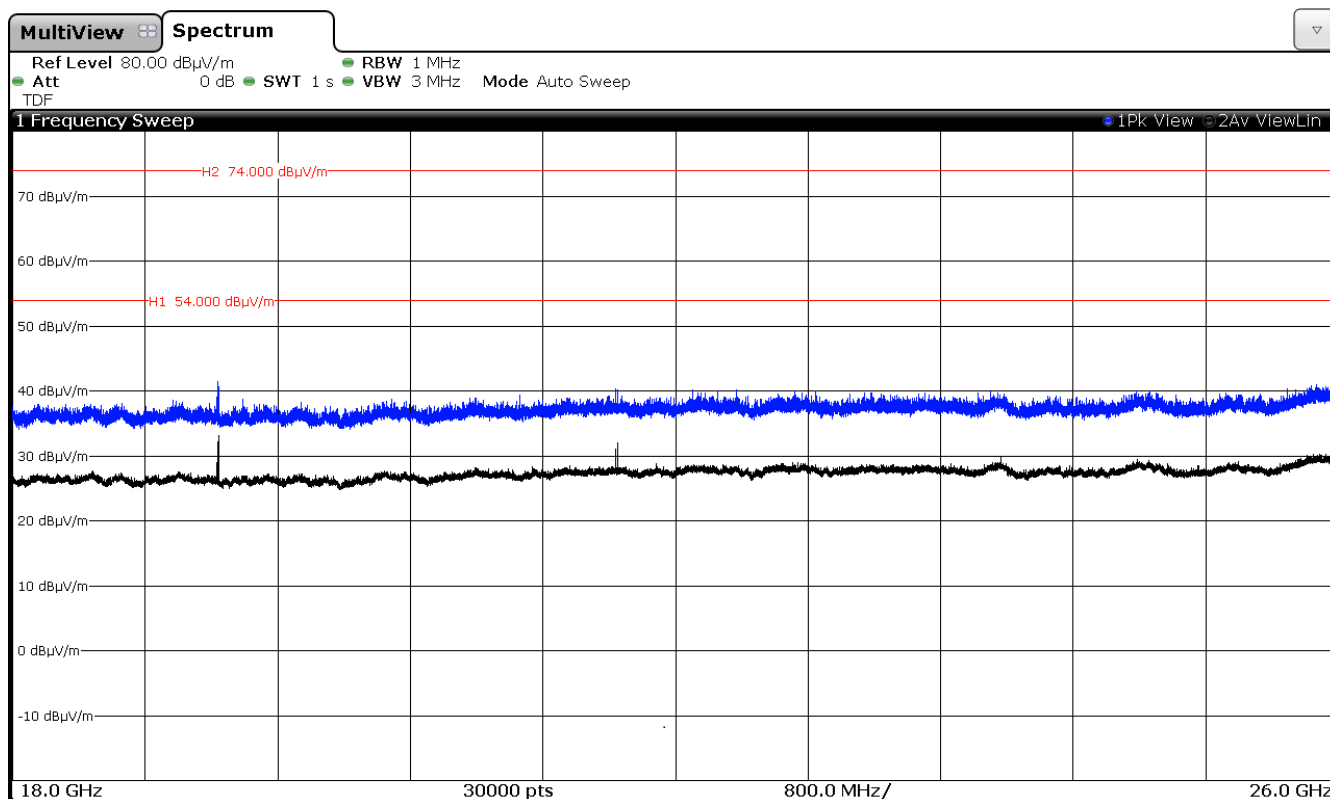


CHANNEL: Highest (2475 MHz).

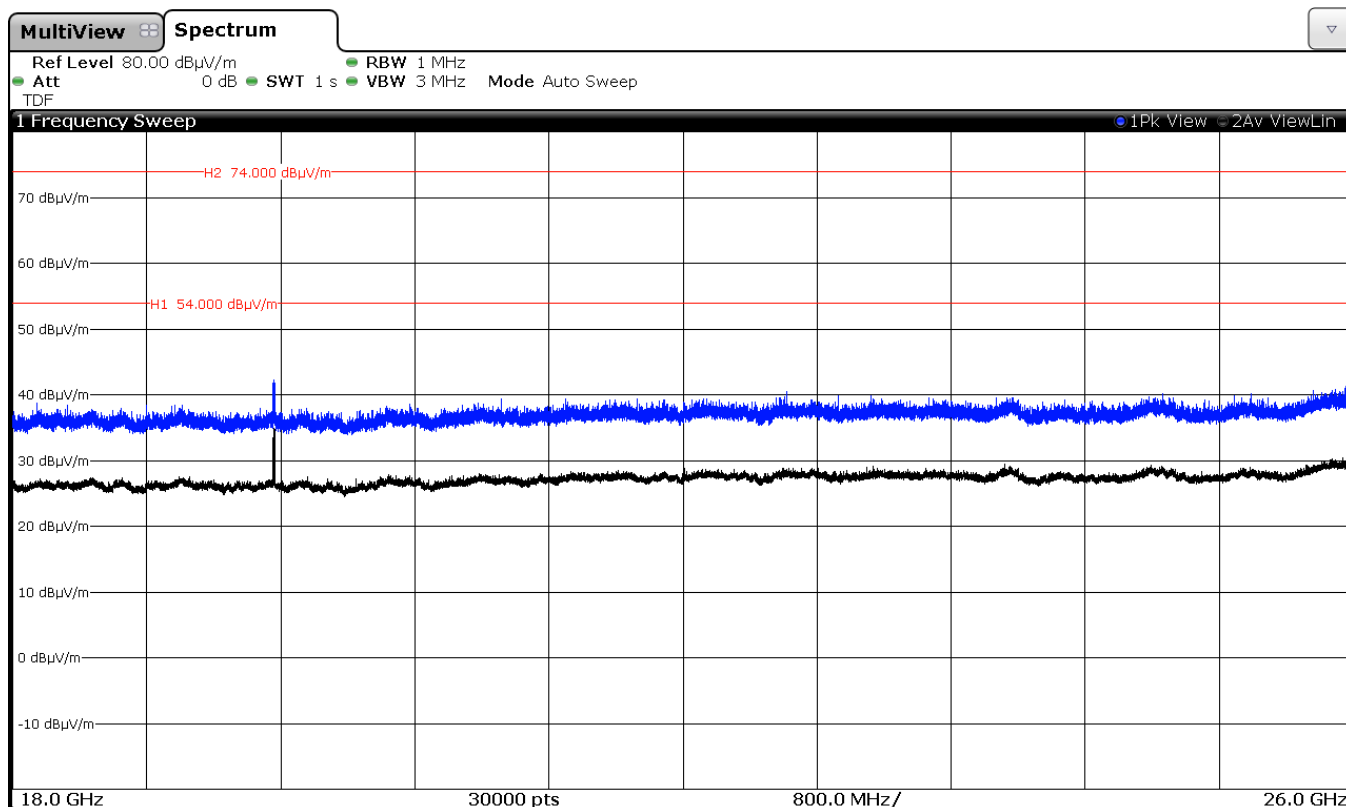


FREQUENCY RANGE 18 GHz to 26 GHz.

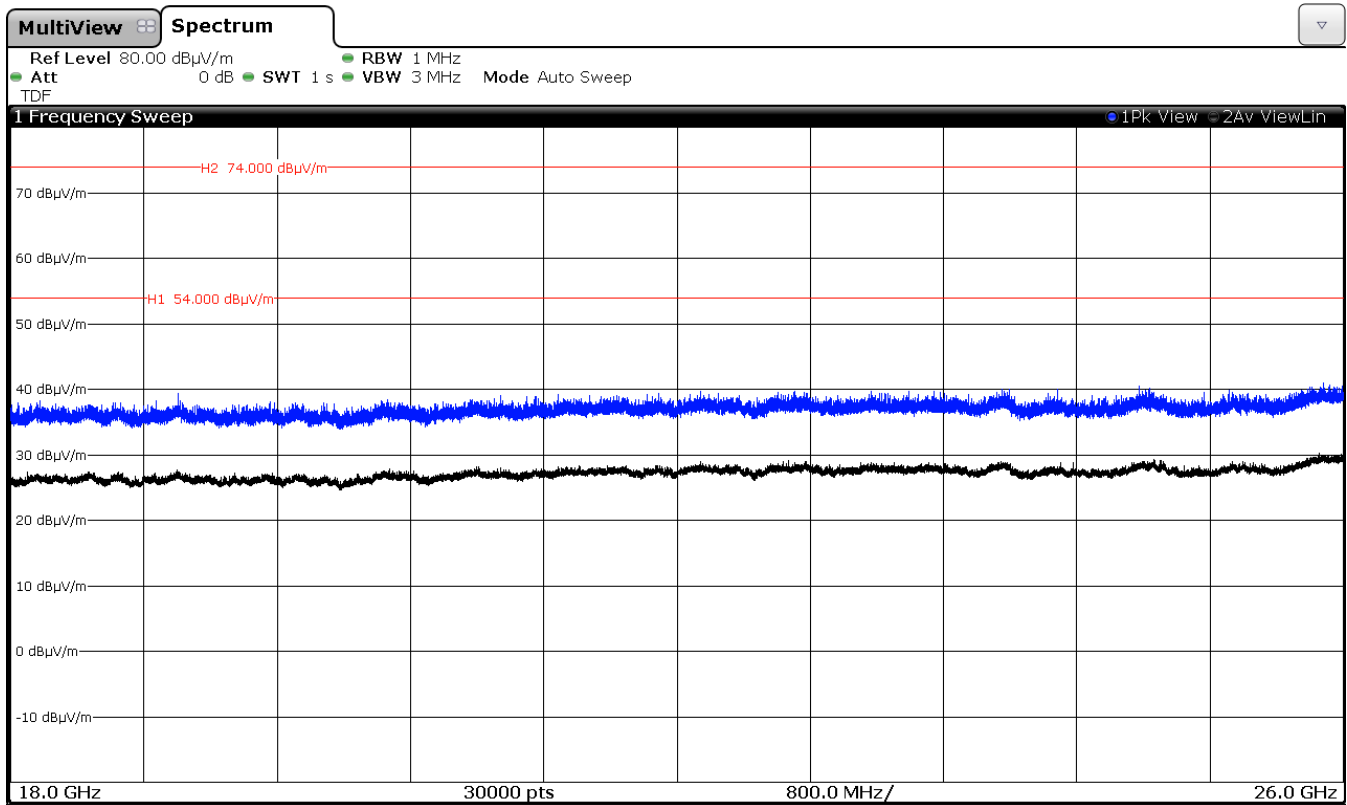
CHANNEL: Lowest (2405 MHz).



CHANNEL: Middle (2445 MHz).

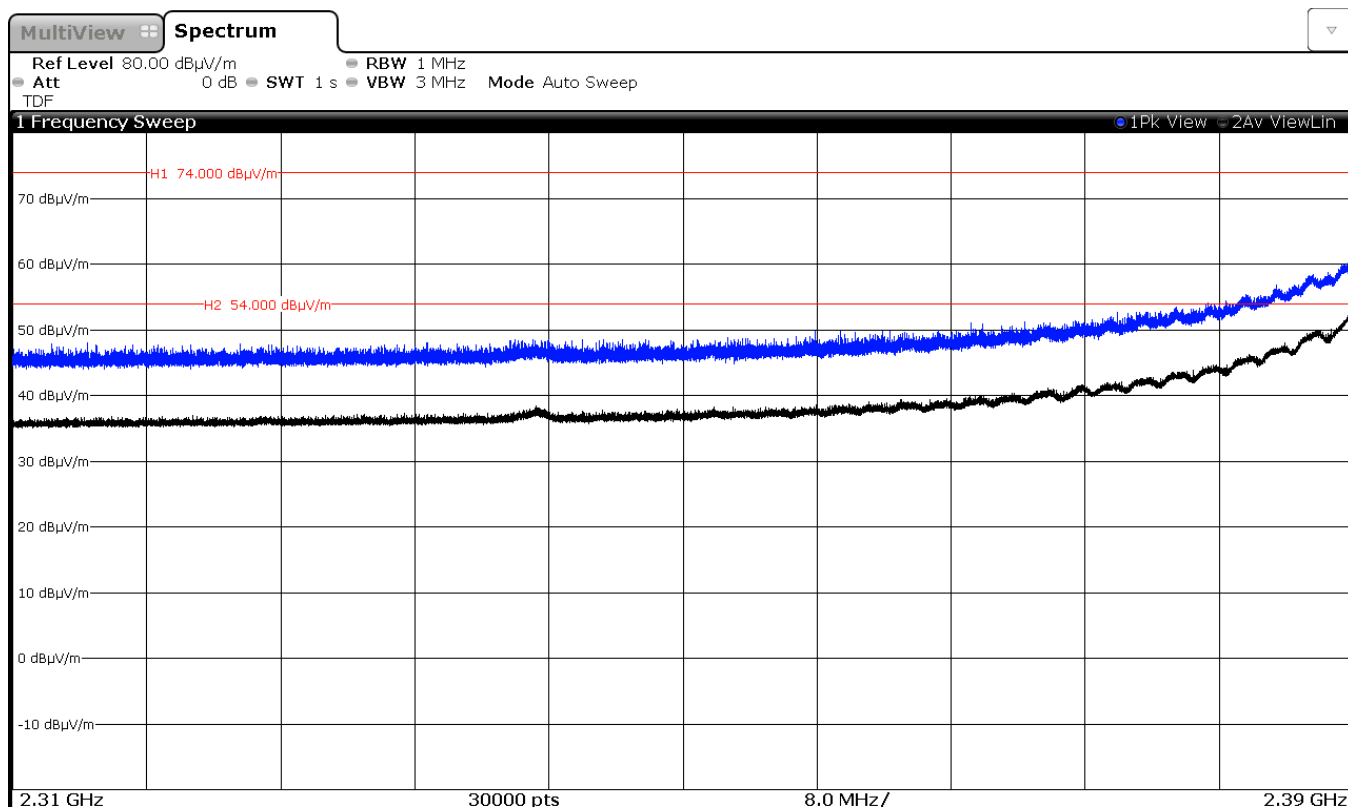


CHANNEL: Highest (2475 MHz).

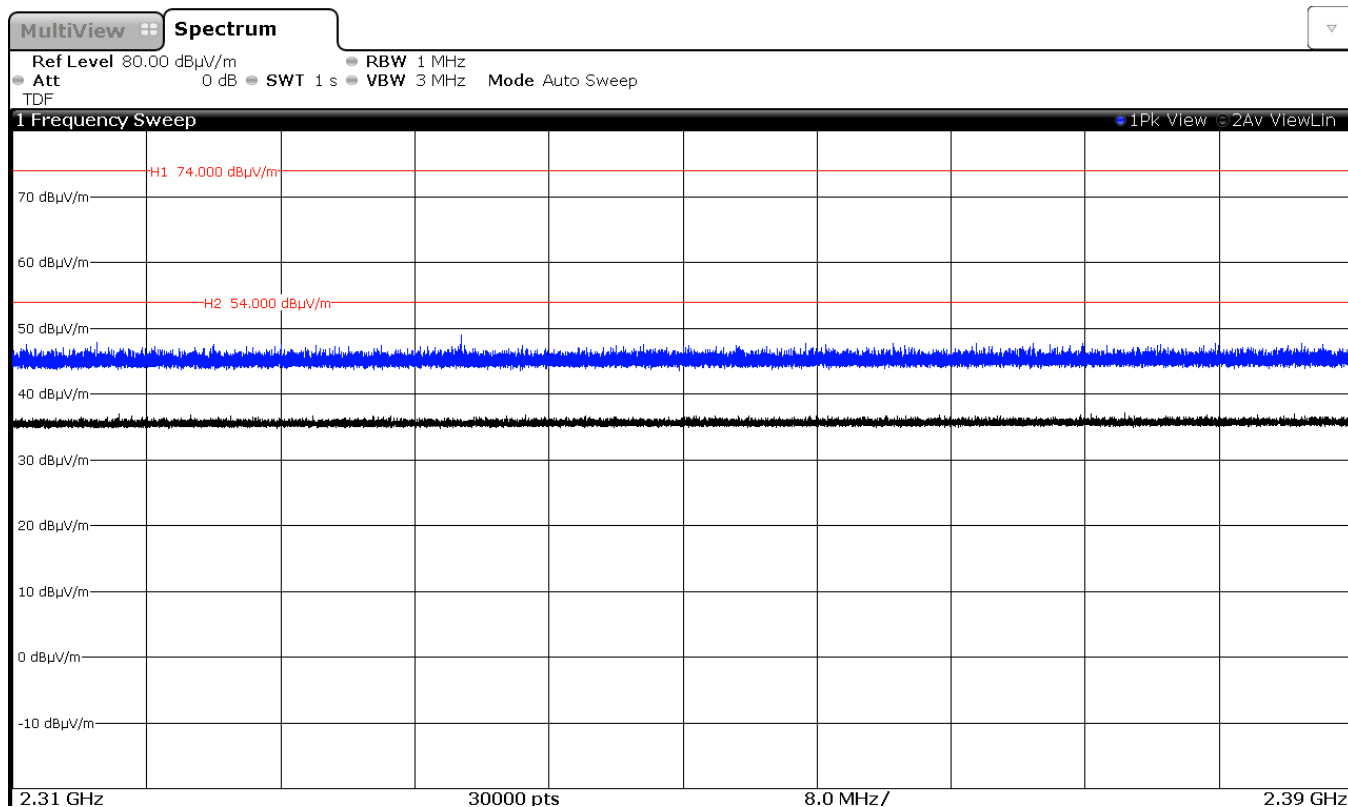


FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

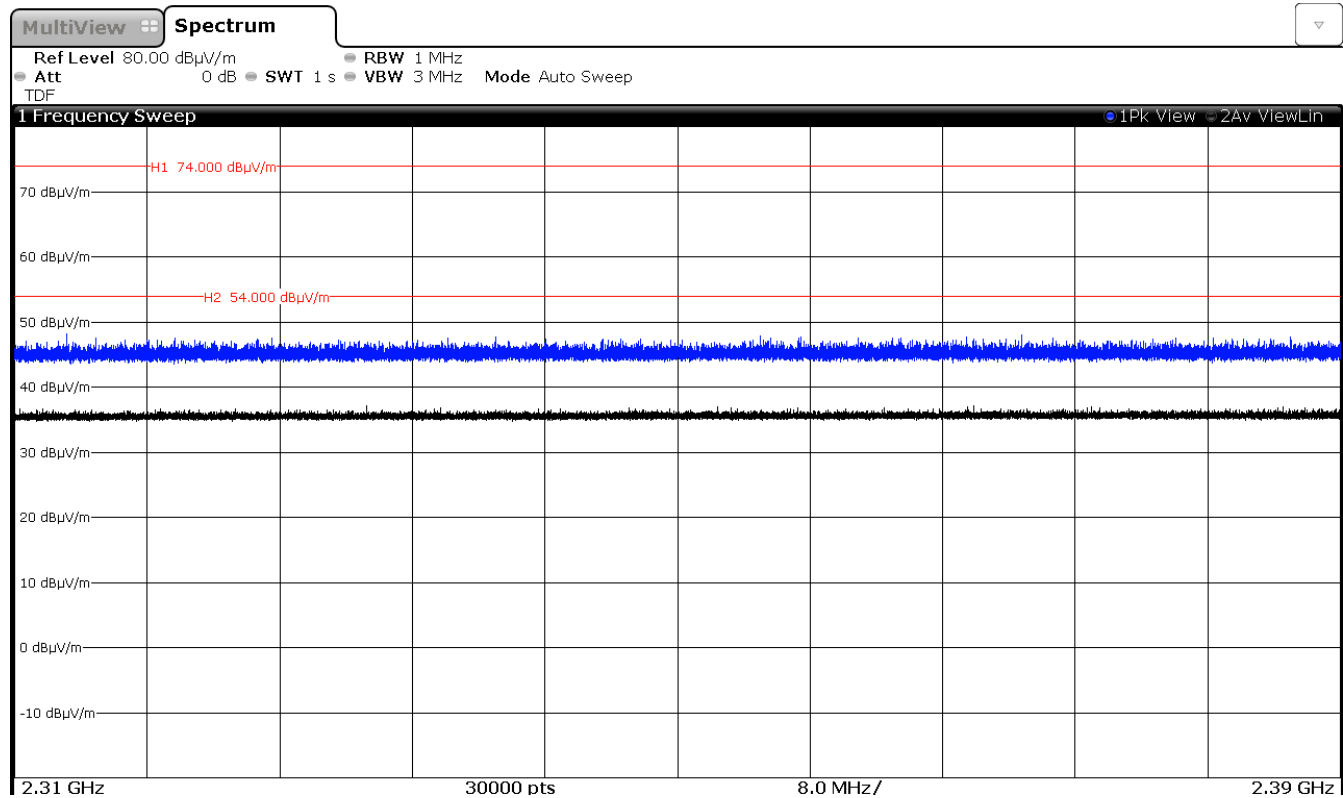
CHANNEL: Lowest



CHANNEL: Middle

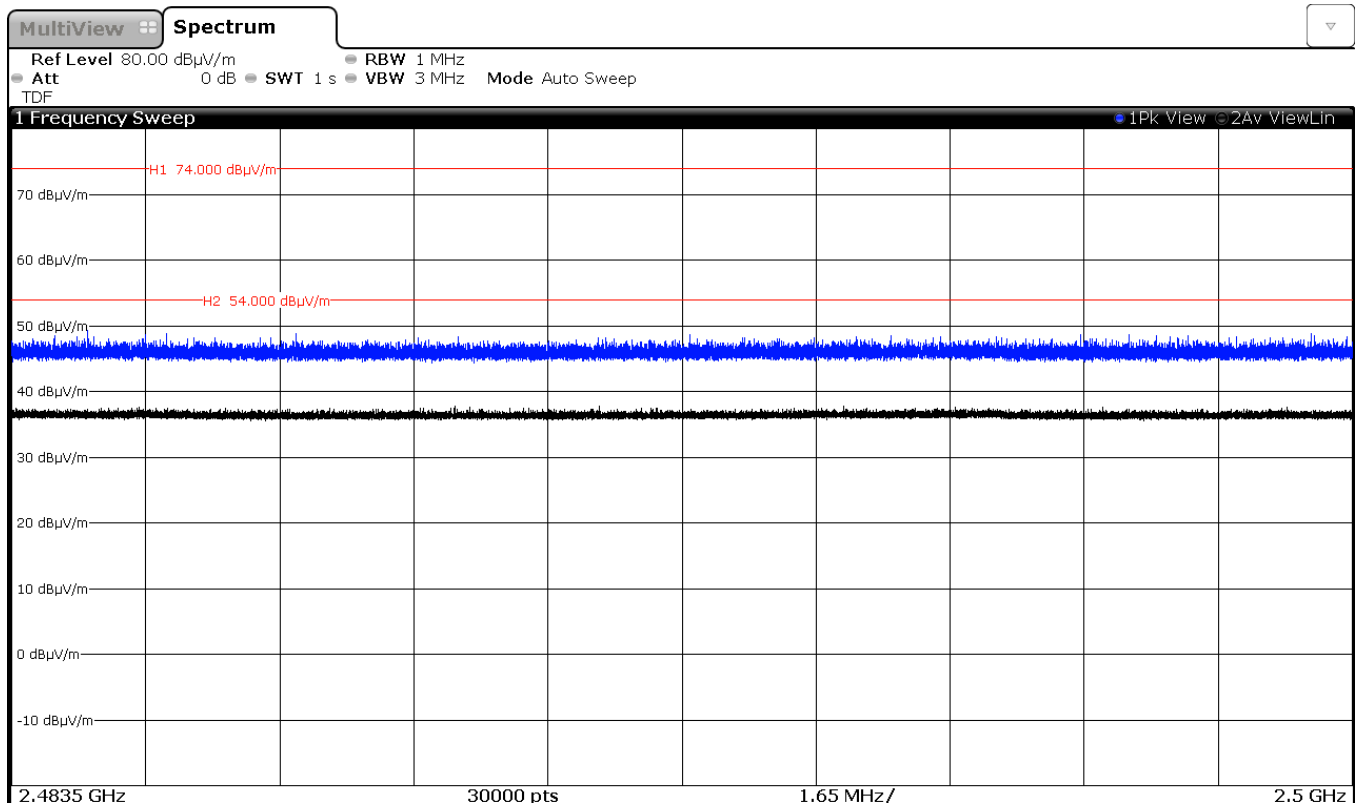


CHANNEL: Highest

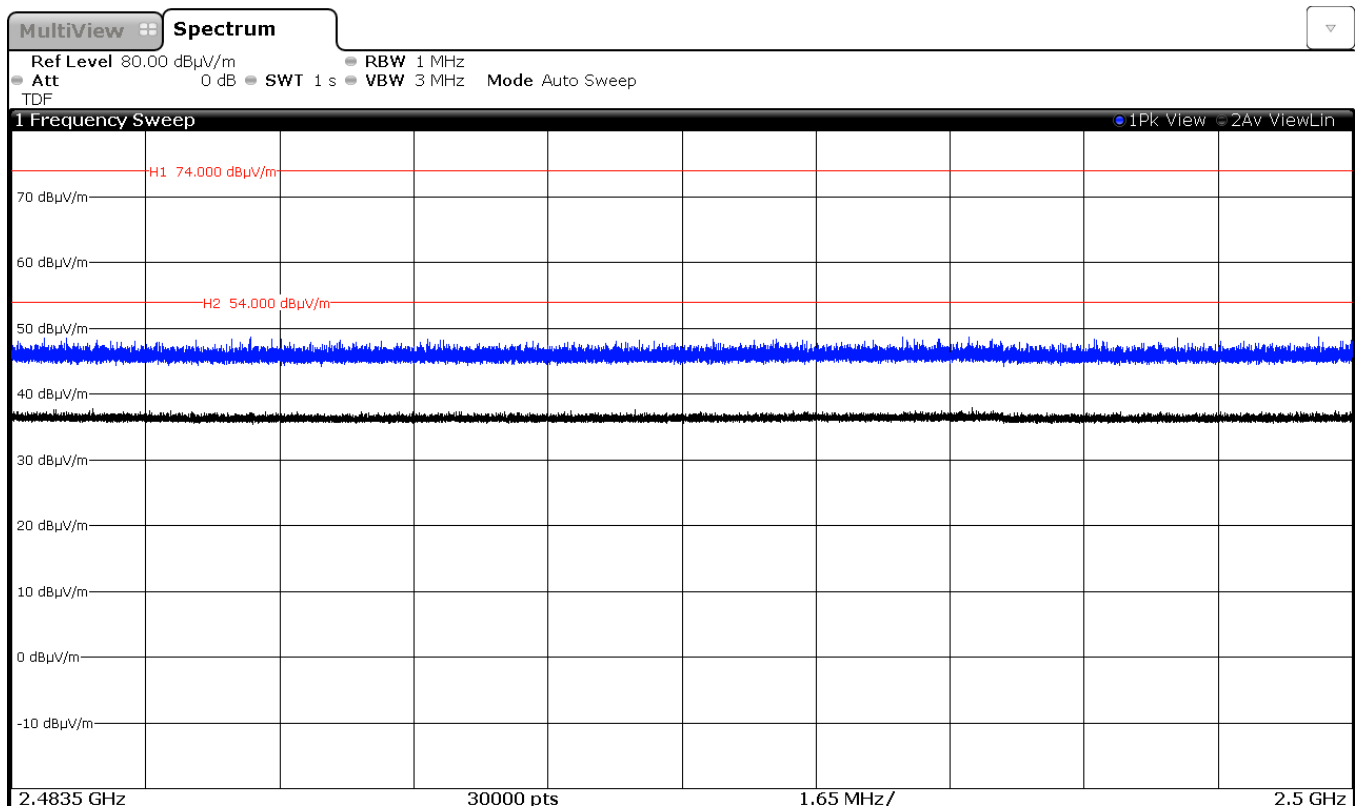


FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

CHANNEL: Lowest



CHANNEL: Middle



CHANNEL: Highest

