FCC LISTED, REGISTRATION NUMBER: 720267

IC LISTED REGISTRATION NUMBER IC 4621A-2

Informe de ensayo nº:
Test report No:

NIE: 48668RRF.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	Multiprotocol router for the Internet of Things
Marca Trade	Libelium
Modelo y/o referencia tipo Model and /or type reference	Meshlium 4G 802.15.4 AP 900 US
Other identification of the product	Libelium's product FCC ID: XKM-MESHLIUM-V1 Libelium's product IC: 8472A-MESHLIUMV1 Chipsets FCC ID: RI7LE910NA, OUR-XBEEPRO, MCQ-XB900HP and TK4WLE600VX Chipsets IC: 5131A-LE910NA, 4214A-XBEEPRO and 1846A-XB900HP.
Final HW version	1.0
Final SW version	1.0
Características Features	Can communicate with 2G, 3G and 4G/LTE networks. Also equipped with a short-range 802.15.4 module (2.4 GHz ISM band), a long-range RF 900 radio (900 MHz ISM band) and a 802.11a/b/g/n/ac module (2.4 GHz ISM bands). Includes a GNSS (GPS) receiver. USA and Canada version, AT&T. Includes 2 cellular antennas for diversity gain. Contains these radios: WLE600VX, XBee-PRO 802.15.4, LE910 NAG and XBee-PRO 900HP
Fabricante Manufacturer	LIBELIUM COMUNICACIONES DISTRIBUIDAS S.L. C/ Escatrón 16 (Edificio Libelium), CP: 50014, Zaragoza (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. -Emission limitations radiated (Transmitter) 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). Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS

	Meas Guidance v03r05 dated 04/08/2016. 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: 2016.10.04 17:42:41 +02'00'
Fecha de realización ..... Date of issue	2016-10-04
Formato de informe No...... Report template No	FDT08_18

Index

Competences and guarantees....4
General conditions....4
Uncertainty....4
Usage of samples....5
Test sample description....5
Identification of the client....5
Testing period....5
Environmental conditions....6
Remarks and comments....7
Testing verdicts....7
Appendix A – Test result. Zigbee 900 MHz....9
Appendix B – Test result. Zigbee 2.4 GHz....20
Appendix C – Test result. WiFi b/g/n....35

Competences and guarantees

AT4 wireless 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.

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 conjuction 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-2.

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
48668/008	Multiprotocol router for the Internet of Things	Meshlium 4G 802.15.4 AP 900 US	---	2016-06-06
48668/045	Antenna 2.4 GHz	---	---	2016-06-06
48668/047	Antenna 2.4 GHz	---	---	2016-06-06
48668/053	Antenna 900 MHz	---	---	2016-06-06
48668/068	Antenna 4G GPS	---	---	2016-06-06
48668/069	Antenna 4G GPS	---	---	2016-06-06
48668/070	Antenna 4G GPS	---	---	2016-06-06
48668/028	Ethernet crossover cable	---	---	2016-06-06
48668/035	Ethernet cable	---	---	2016-06-06
48668/018	AC/DC Adapter	SAW24-120-2000	---	2016-06-06
48668/020	POE	---	---	2016-06-06

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

   All tests indicated in appendix A, B y C.

Test sample description

The test sample consists of a central node of a Waspmote Plug & Sense! network. It gathers all the data and sends it to the cloud. Meshlium can be deployed outdoors and is quickly configured with its graphic interface.

Identification of the client

LIBELIUM COMUNICACIONES DISTRIBUIDAS S.L.

C/ Escatrón 16 (Edificio Libelium), CP: 50014, Zaragoza (SPAIN)

Testing period

The performed test started on 2016-06-06 and finished on 2016-06-08.

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 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).

Remarks and comments

1: Test not requested. Only radiated spurious emissions tests were requested.

2: Used instrumentation:

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	2016/03	2018/03
7.	Spectrum analyser Rohde & Schwarz FSW50	2015/12	2017/12
8.	RF pre-amplifier 10 MHz-6 GHz SCHWARZBECK BBV9743	2015/09	2016/09
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. Zigbee 900 MHz

FCC PART 15 PARAGRAPH / RSS-247		VERDICT			
		NA	P	F	NM
Section 15.247 Subclause (a) (2) / RSS-247 5.2. (1)	6 dB Bandwidth				NM[1]
Section 15.247 Subclause (b) / RSS-247 5.4. (4)	Maximum output power and antenna gain				NM[1]
Section 15.247 Subclause (d) / RSS-247 5.5	Emission limitations conducted (Transmitter)				NM[1]
Section 15.247 Subclause (d) / RSS-247 5.5. ..	Band-edge emissions compliance (Transmitter)				NM[1]
Section 15.247 Subclause (e) / RSS-247 5.2. (2)	Power spectral density				NM[1]
Section 15.247 Subclause (d) / RSS-247 5.5. ...	Emission limitations radiated (Transmitter)		P		

1: See section “Remarks and comments”.

2. Zigbee 2.4 GHz

FCC PART 15 PARAGRAPH / RSS-247		VERDICT			
		NA	P	F	NM
Section 15.247 Subclause (a) (2) / RSS-247 5.2. (1)	6 dB Bandwidth				NM[1]
Section 15.247 Subclause (b) / RSS-247 5.4. (4)	Maximum output power and antenna gain				NM[1]
Section 15.247 Subclause (d) / RSS-247 5.5	Emission limitations conducted (Transmitter)				NM[1]
Section 15.247 Subclause (d) / RSS-247 5.5. ..	Band-edge emissions compliance (Transmitter)				NM[1]
Section 15.247 Subclause (e) / RSS-247 5.2. (2)	Power spectral density				NM[1]
Section 15.247 Subclause (d) / RSS-247 5.5. ...	Emission limitations radiated (Transmitter)		P		

1: See section “Remarks and comments”.

3. WiFi b/g/n

FCC PART 15 PARAGRAPH / RSS-247		VERDICT			
		NA	P	F	NM
Section 15.247 Subclause (a) (2) / RSS-247 5.2. (1)	6 dB Bandwidth				NM[1]
Section 15.247 Subclause (b) / RSS-247 5.4. (4)	Maximum output power and antenna gain				NM[1]
Section 15.247 Subclause (d) / RSS-247 5.5	Emission limitations conducted (Transmitter)				NM[1]
Section 15.247 Subclause (d) / RSS-247 5.5. ..	Band-edge emissions compliance (Transmitter)				NM[1]
Section 15.247 Subclause (e) / RSS-247 5.2. (2)	Power spectral density				NM[1]
Section 15.247 Subclause (d) / RSS-247 5.5. ...	Emission limitations radiated (Transmitter)		P		

1: See section “Remarks and comments”.

Appendix A – Test result. Zigbee 900 MHz

INDEX

TEST CONDITIONS **11**

Section 15.247 Subclause (d) / RSS-247 5.5. Emission limitations radiated (Transmitter) **13**

TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 115 Vac

Type of power supply = AC/DC adapter.

Type of antenna = External attachable antenna.

TEST FREQUENCIES:

Lowest channel: 902.4 MHz

Middle channel: 915.2 MHz

Highest channel: 927.6 MHz

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v03r05 dated 04/08/2016.

The laptop computer was used to configure the EUT to continuously transmit at a specified output power (17dBm) in all channels.

RADIATED MEASUREMENTS

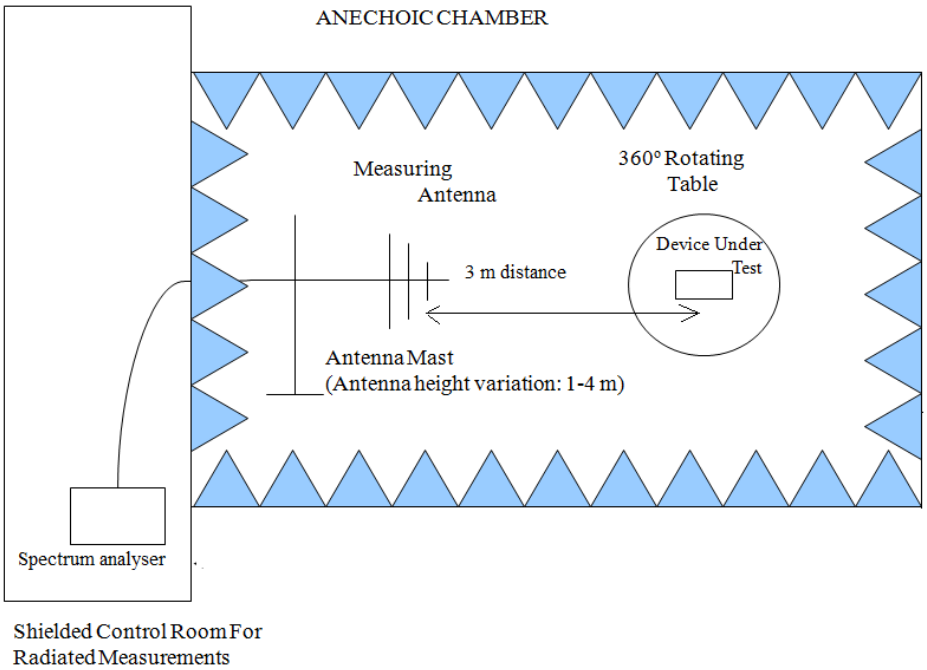
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-10 GHz (1 GHz-18 GHz Double ridge horn antenna).

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.

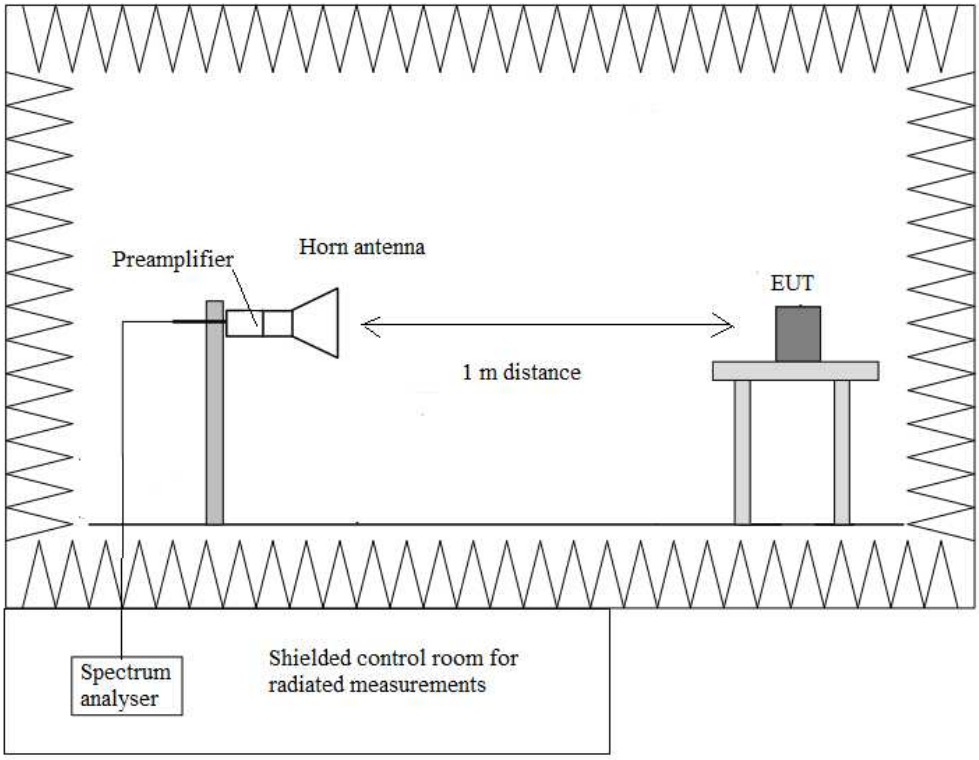
The equipment under test was set up on a non-conductive platform 1.5 meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

Radiated measurements setup f < 1 GHz



Radiated measurements setup f > 1 GHz



Section 15.247 Subclause (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 8.9.:

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 - 18000	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 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.

Spurious levels operating (radiated) closest to limit.

1. CHANNEL: LOWEST (902.4 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
479.983	V	Quasi-Peak	34.52	± 3.88
731.649	V	Quasi-Peak	26.12	± 3.88
872.402	V	Quasi-Peak	41.26	± 3.88
932.389	V	Quasi-Peak	41.69	± 3.88

2. CHANNEL: MIDDLE (915.2 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
479.983	V	Quasi-Peak	32.10	± 3.88
731.649	V	Quasi-Peak	26.12	± 3.88
885.221	V	Quasi-Peak	41.55	± 3.88
945.180	V	Quasi-Peak	40.14	± 3.88

3. CHANNEL: HIGHEST (927.6 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
479.983	V	Quasi-Peak	34.52	± 3.88
731.649	V	Quasi-Peak	26.12	± 3.88
897.601	V	Quasi-Peak	40.18	± 3.88
957.584	V	Quasi-Peak	40.01	± 3.88

Frequency range 1 GHz-10 GHz

The results in the next tables show the maximum measured levels in the 1-10 GHz (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 (902.4 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.80445 (*)	V	Peak	56.98	± 4.87
		AVG	56.77	± 4.87

(*): This spurious frequency is outside the restricted bands as defined in §15.205(a). The measured maximum carrier level at 3 m was 82.39 dBµV/m (Peak) so the spurious level is more than 20 dB below the carrier level.

2. CHANNEL: MIDDLE (915.2 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.83025	V	Peak	54.16	± 4.87
		AVG	53.88	± 4.87

(*): This spurious frequency is outside the restricted bands as defined in §15.205(a). The measured maximum carrier level at 3 m was 82.54 dBµV/m (Peak) so the spurious level is more than 20 dB below the carrier level.

3. CHANNEL: HIGHEST (927.6 MHz).

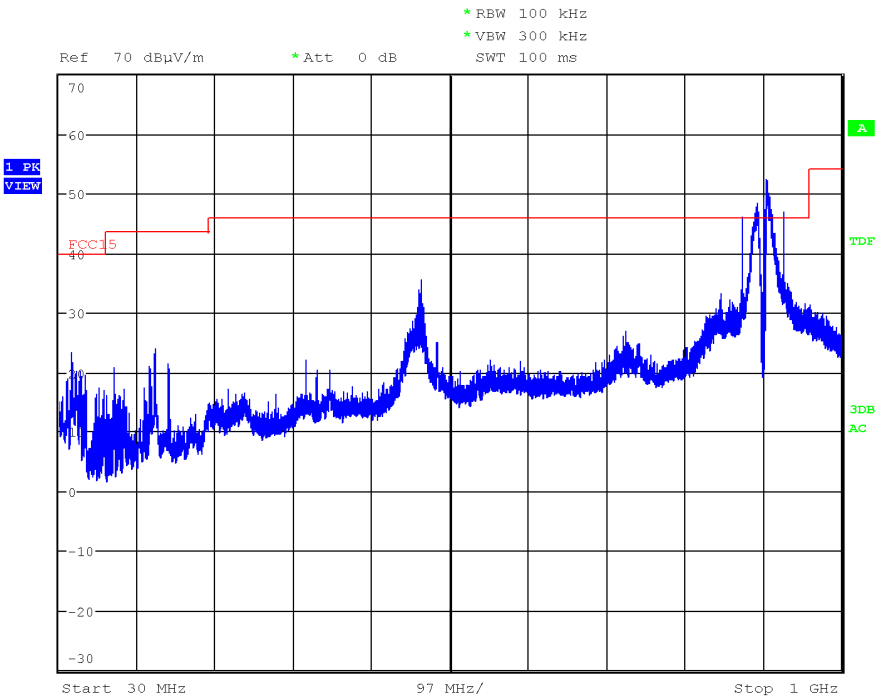
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.85485	V	Peak	52.25	± 4.69
		AVG	51.15	± 4.69

(*): This spurious frequency is outside the restricted bands as defined in §15.205(a). The measured maximum carrier level at 3 m was 83.36 dBµV/m (Peak) so the spurious level is more than 20 dB below the carrier level.

Verdict: PASS

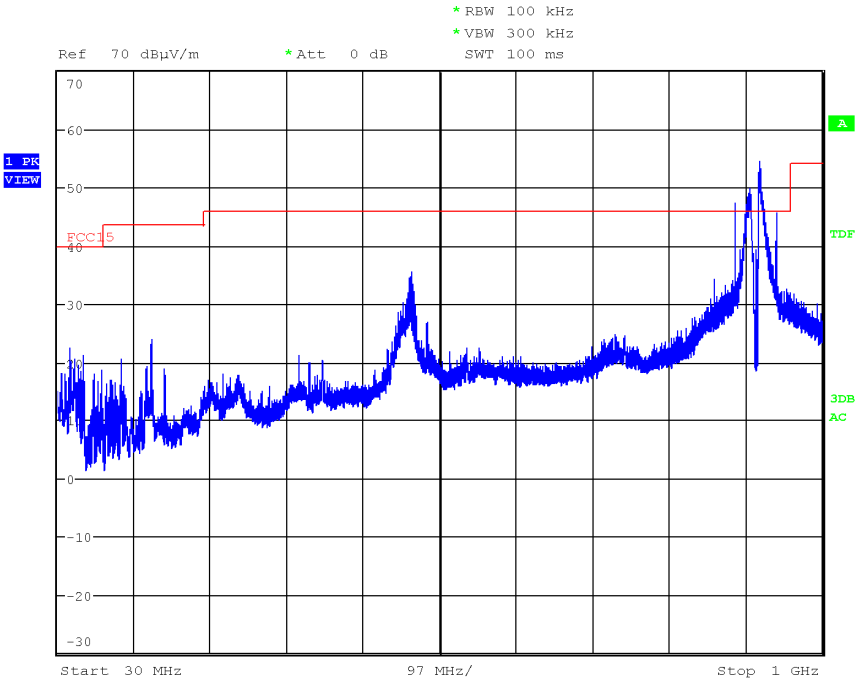
FREQUENCY RANGE 30 MHz-1000 MHz.

CHANNEL: Lowest (902.4 MHz).



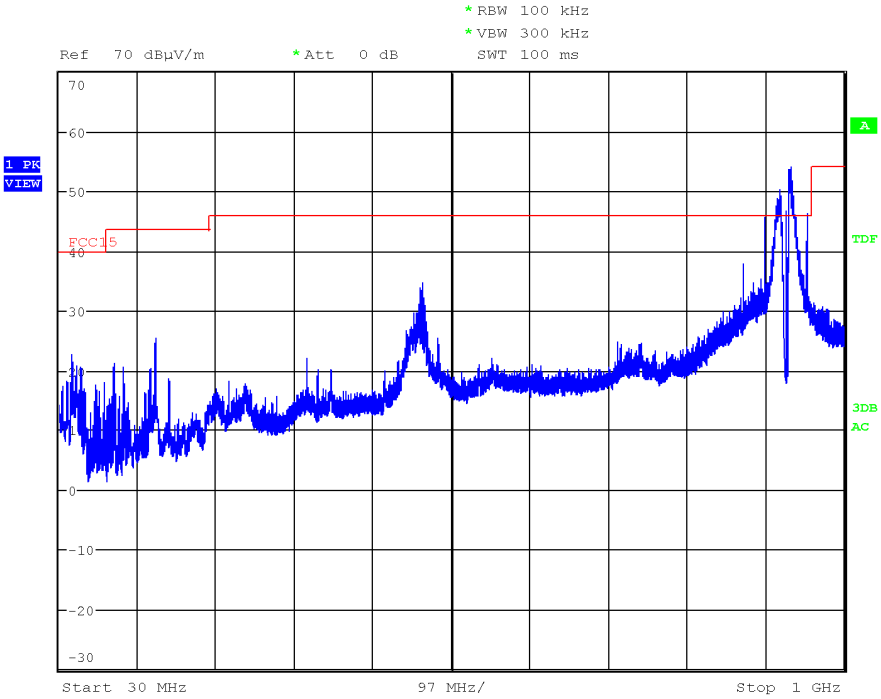
Note: The peak above the limit is the carrier frequency. The carrier was attenuated using a Notch filter.

CHANNEL: Middle (915.2 MHz).



Note: Note: The peak above the limit is the carrier frequency. The carrier was attenuated using a Notch filter.

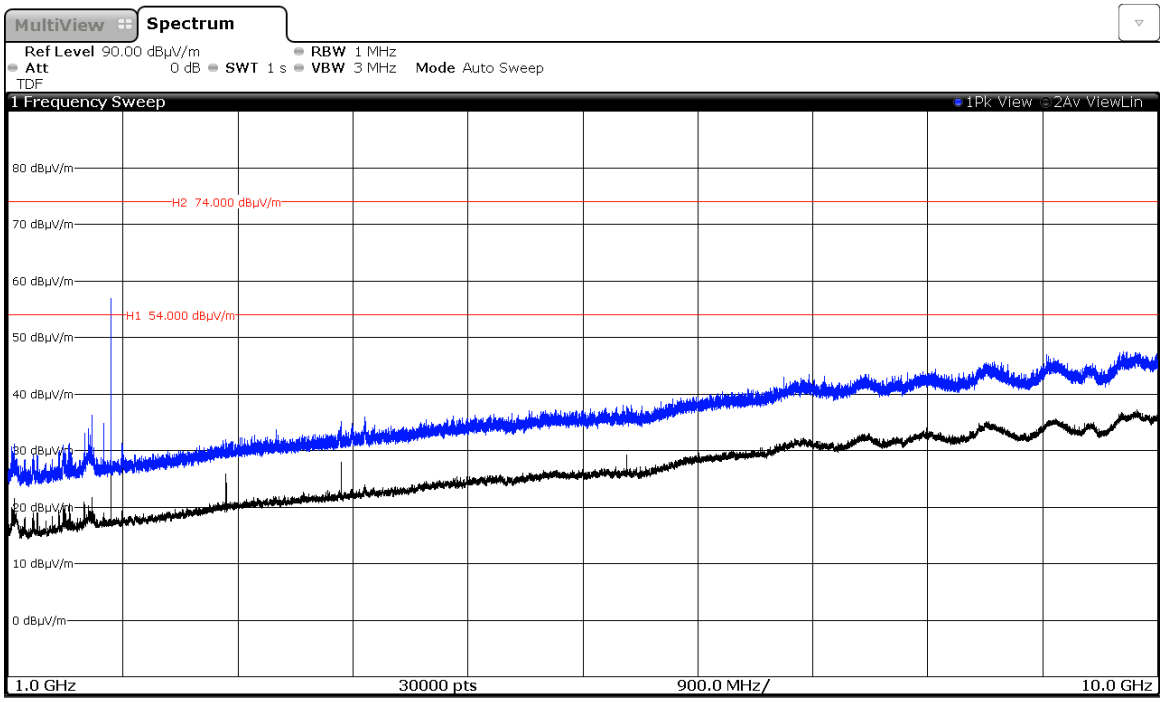
CHANNEL: Highest (927.6 MHz).



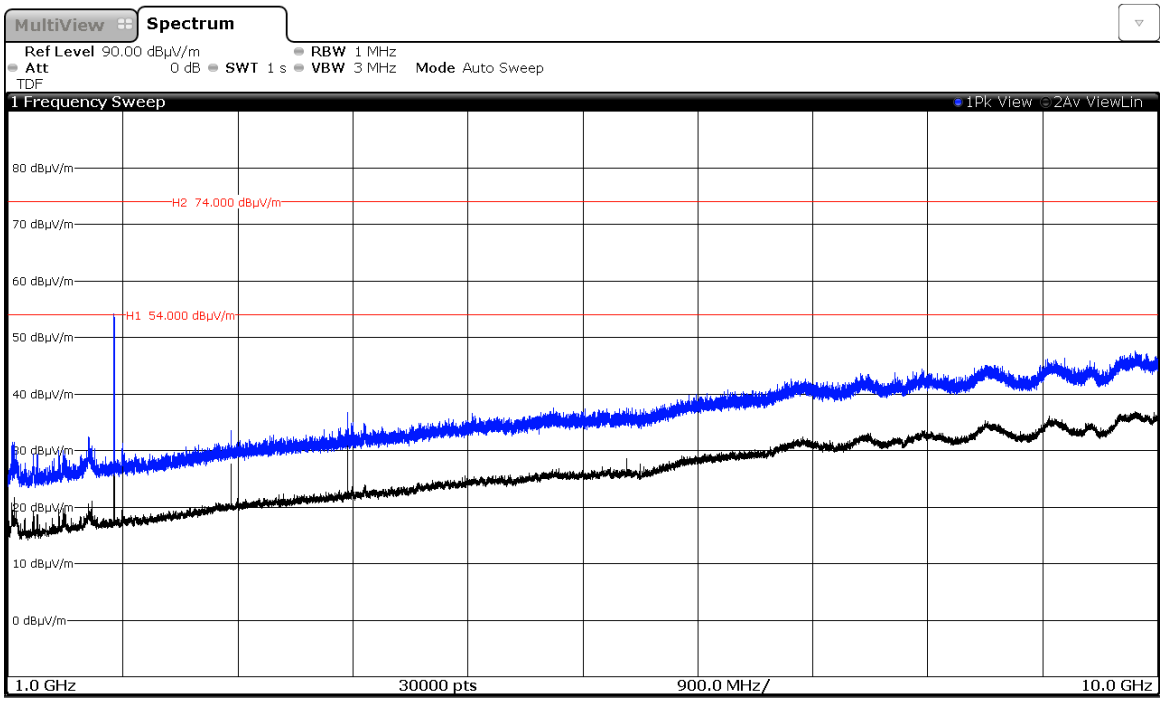
Note: Note: The peak above the limit is the carrier frequency. The carrier was attenuated using a Notch filter.

FREQUENCY RANGE 1 GHz to 10 GHz.

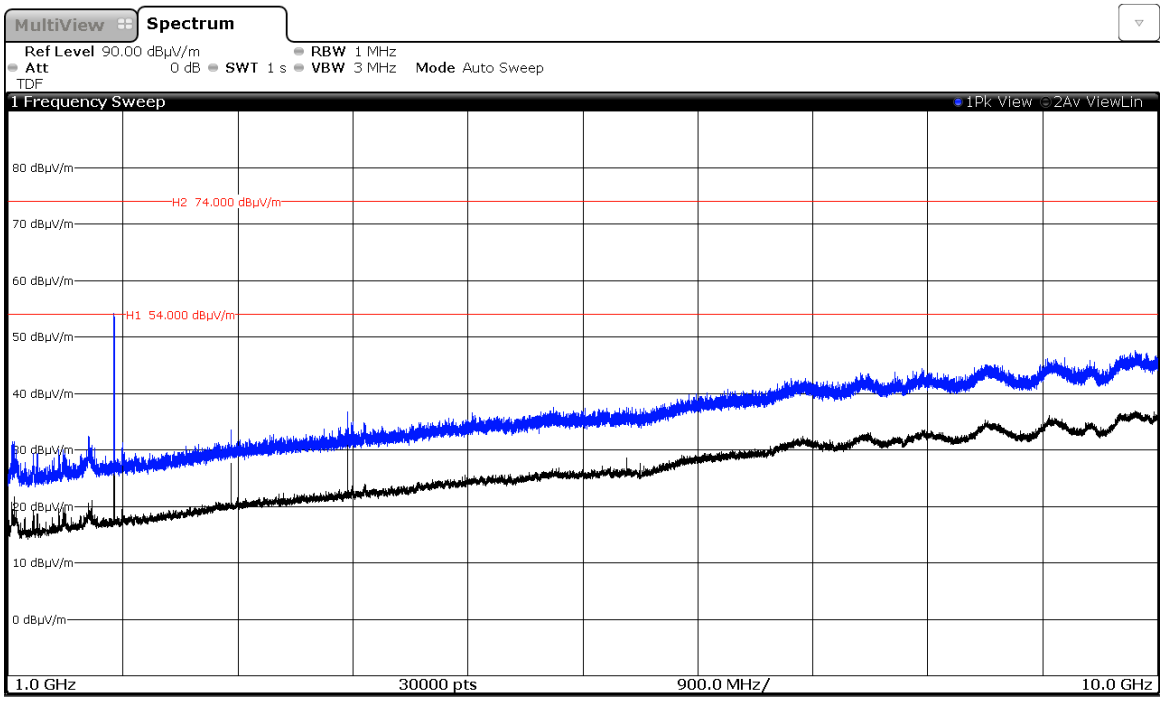
CHANNEL: Lowest (902.4 MHz).



CHANNEL: Middle (915.2 MHz).



CHANNEL: Highest (927.6 MHz).



Appendix B – Test result. Zigbee 2.4 GHz

INDEX

TEST CONDITIONS **22**

Section 15.247 Subclause (d) / RSS-247 5.5. Emission limitations radiated (Transmitter) **24**

TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 115 Vac

Type of power supply = AC/DC adapter.

Type of antenna = External attachable antenna.

TEST FREQUENCIES:

Lowest channel: 2410 MHz

Middle channel: 2440 MHz

Highest channel: 2465 MHz

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v03r05 dated 04/08/2016.

RADIATED MEASUREMENTS

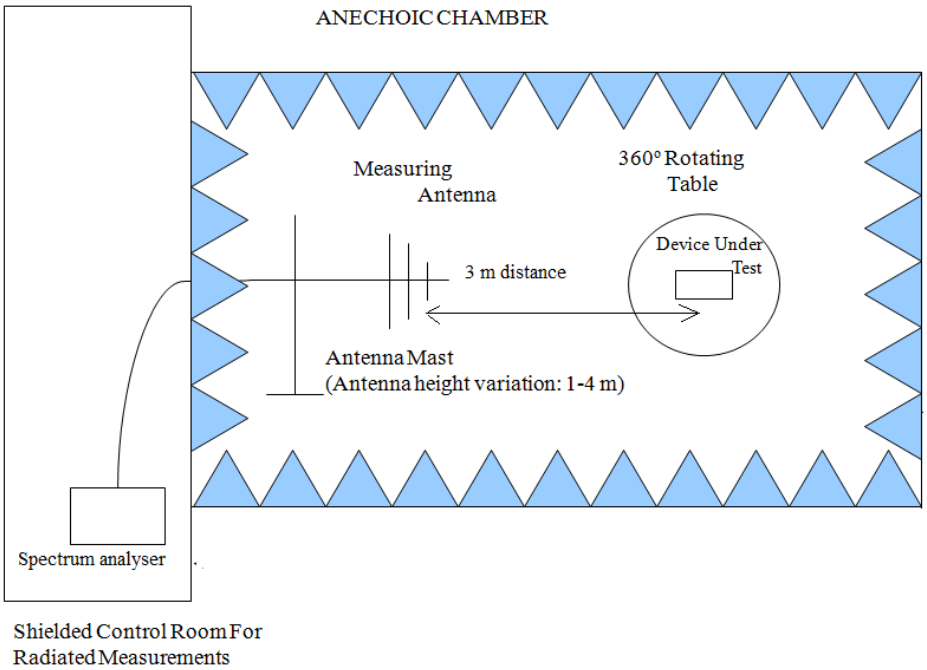
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-25 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 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.

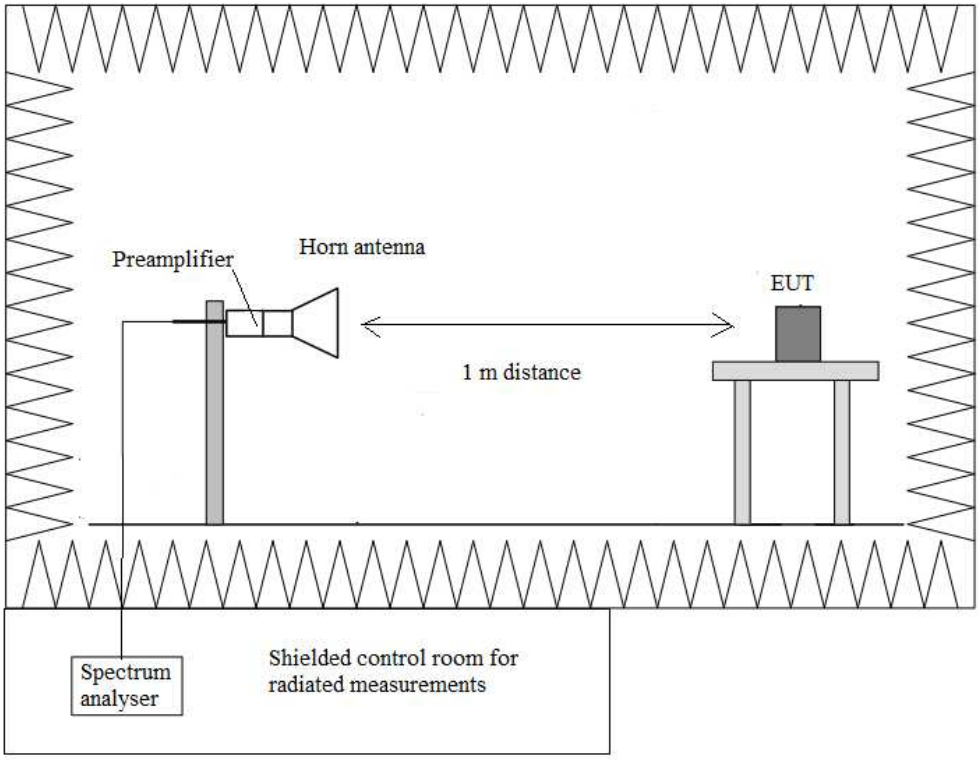
The equipment under test was set up on a non-conductive platform 1.5 meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

Radiated measurements setup f < 1 GHz



Radiated measurements setup f > 1 GHz



Section 15.247 Subclause (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 8.9.:

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 - 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 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-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.

Frequency range 30 MHz-1000 MHz.

Note: The spurious emissions below 1 GHz do not depend on either the operating channel or the modulation mode selected in the EUT.

Spurious levels operating (radiated) closest to limit.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
44.695	V	Quasi-peak	26.98	±3.88
56.384	V	Quasi-peak	24.19	±3.88
78.257	V	Quasi-peak	22.92	±3.88
149.892	V	Quasi-peak	26.04	±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).

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 (2410 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.362500	V	Peak	63.06	± 4.87
		AVG	46.23	± 4.87
2.389620	V	Peak	70.48	± 4.87
		AVG	49.09	± 4.87
2.485905	V	Peak	58.46	± 4.87
		AVG	37.55	± 4.87
7.23125	V	Peak	44.26	± 4.87

2. CHANNEL: MIDDLE (2440 MHz).

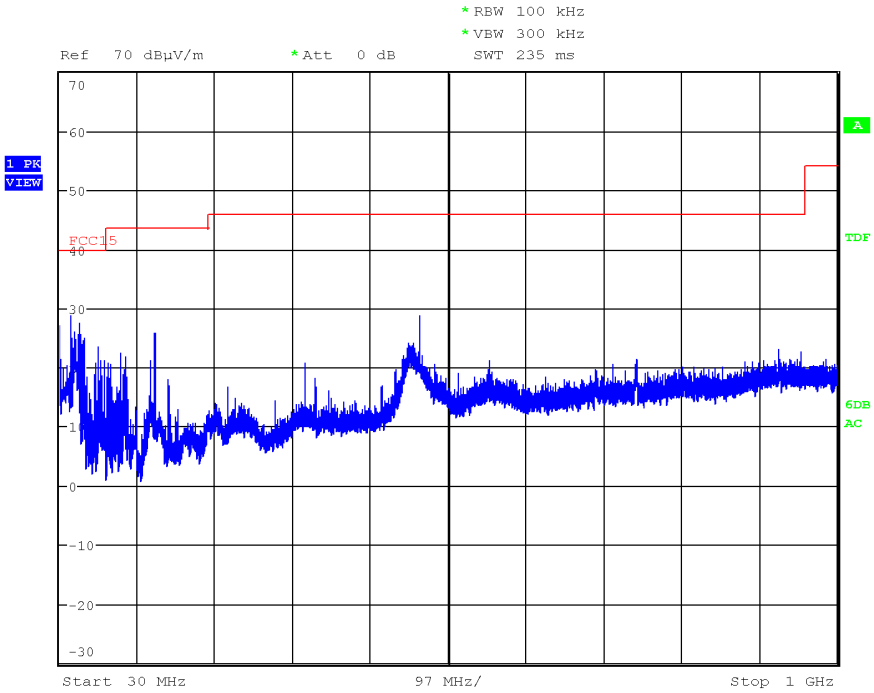
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.38684	V	Peak	61.96	± 4.87
		AVG	42.76	± 4.87
2.48364	V	Peak	62.08	± 4.87
		AVG	38.57	± 4.87
7.32125	V	Peak	44.92	± 4.87

3. CHANNEL: HIGHEST (2465 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.03886	V	Peak	56.06	± 4.87
		AVG	36.14	± 4.87
2.38955	V	Peak	60.92	± 4.87
		AVG	40.03	± 4.87
2.48353	V	Peak	70.92	± 4.87
		AVG	47.16	± 4.87
2.50006	V	Peak	67.98	± 4.87
		AVG	45.46	± 4.87
7.39625	V	Peak	48.49	± 4.87

Verdict: PASS

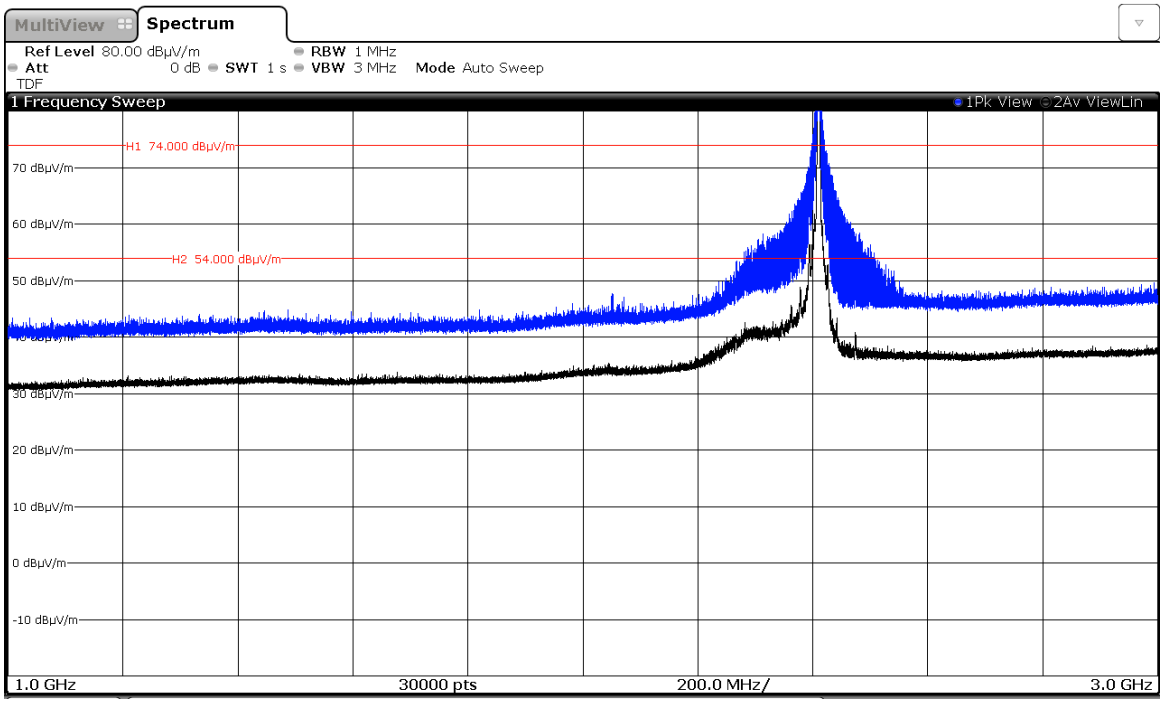
FREQUENCY RANGE 30 MHz-1000 MHz.



(This plot is valid for all three channels and all modulation modes).

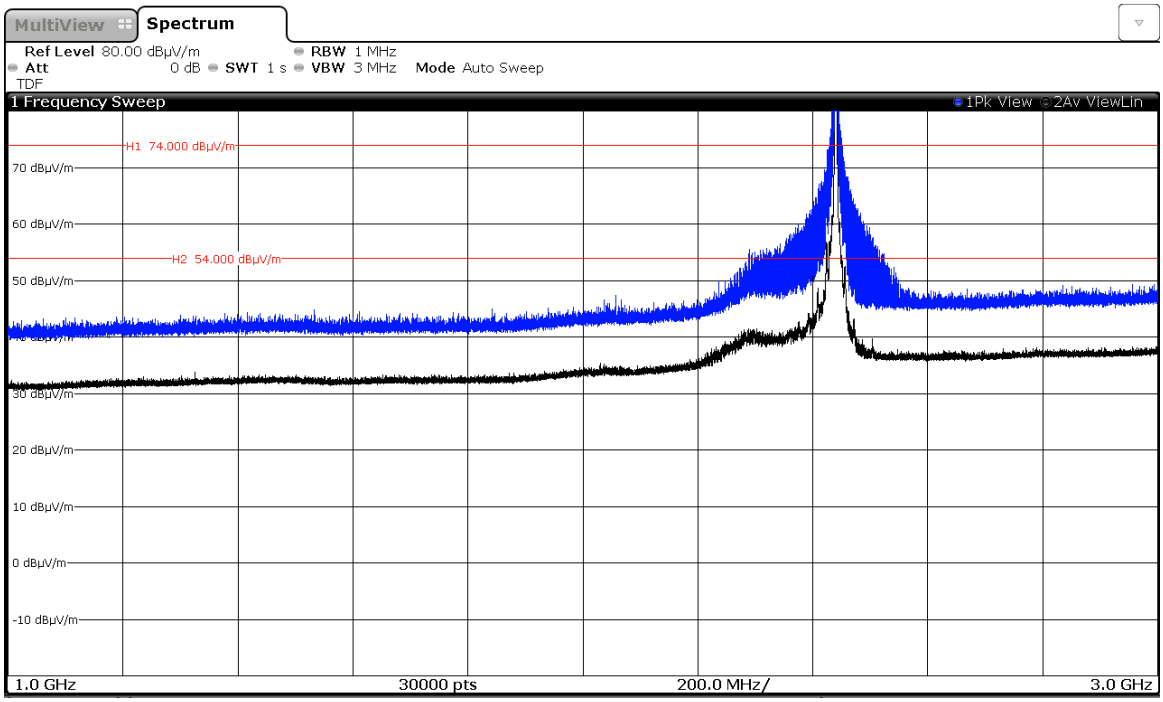
FREQUENCY RANGE 1 GHz to 3 GHz.

CHANNEL: Lowest (2410 MHz).



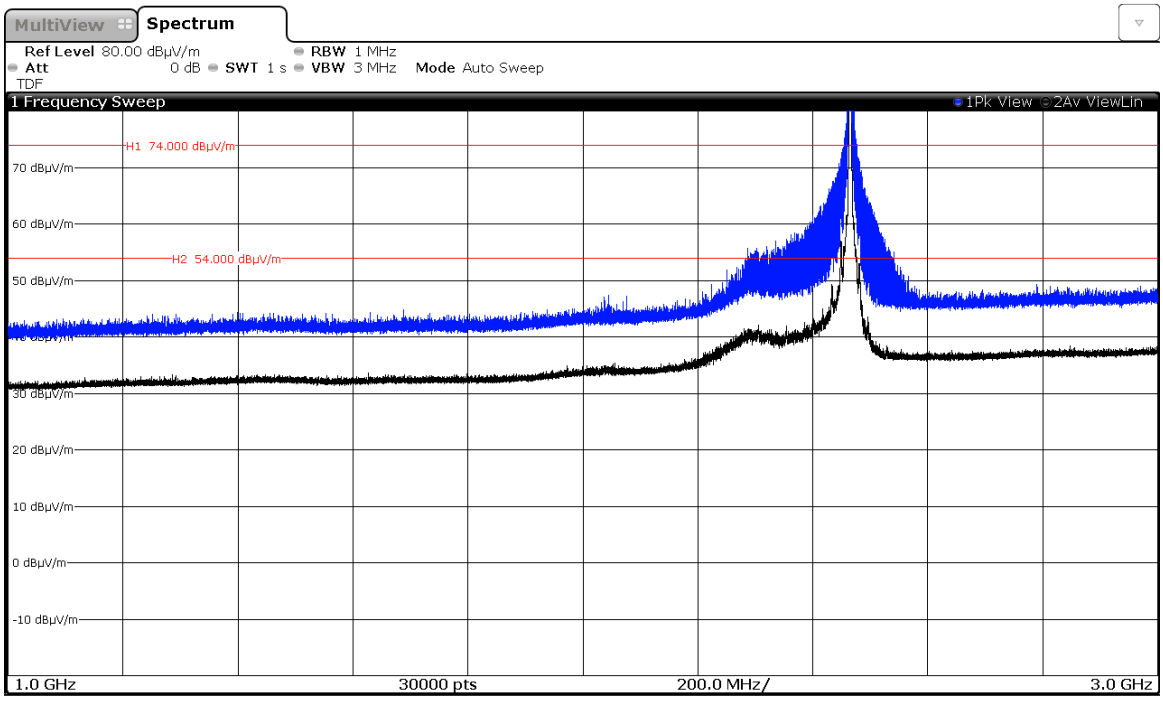
Note: The peak shown in the plot above the limit is the carrier frequency.

CHANNEL: Middle (2440 MHz).



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

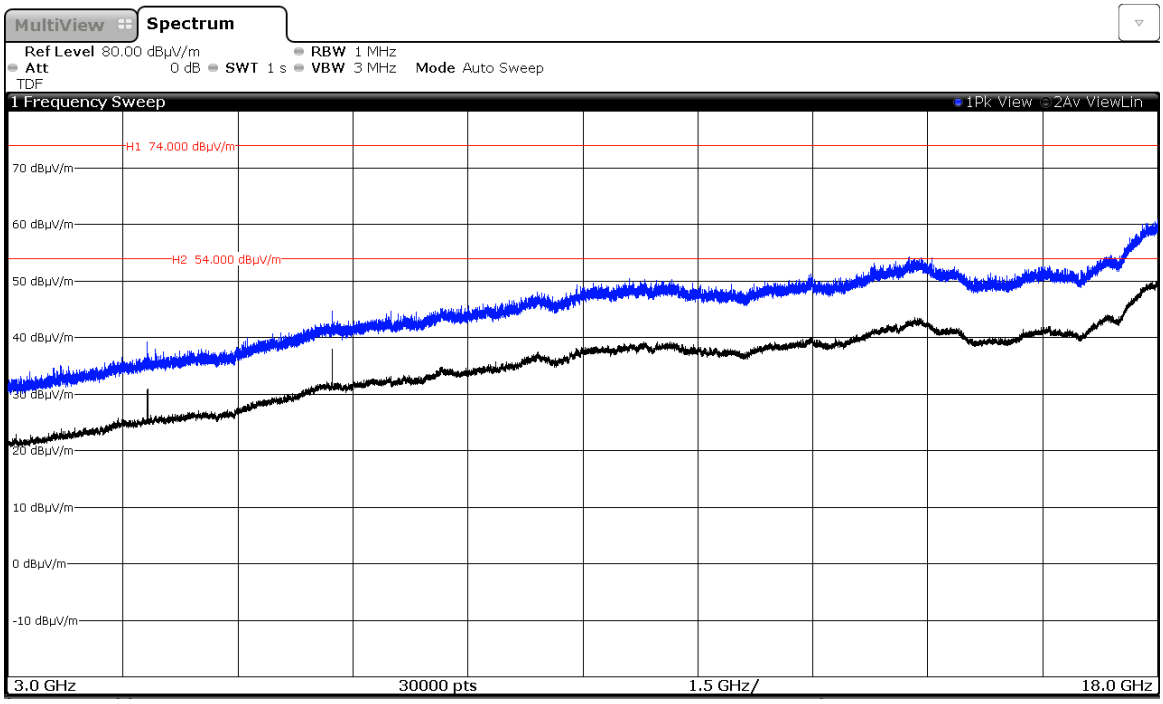
CHANNEL: Highest (2465 MHz).



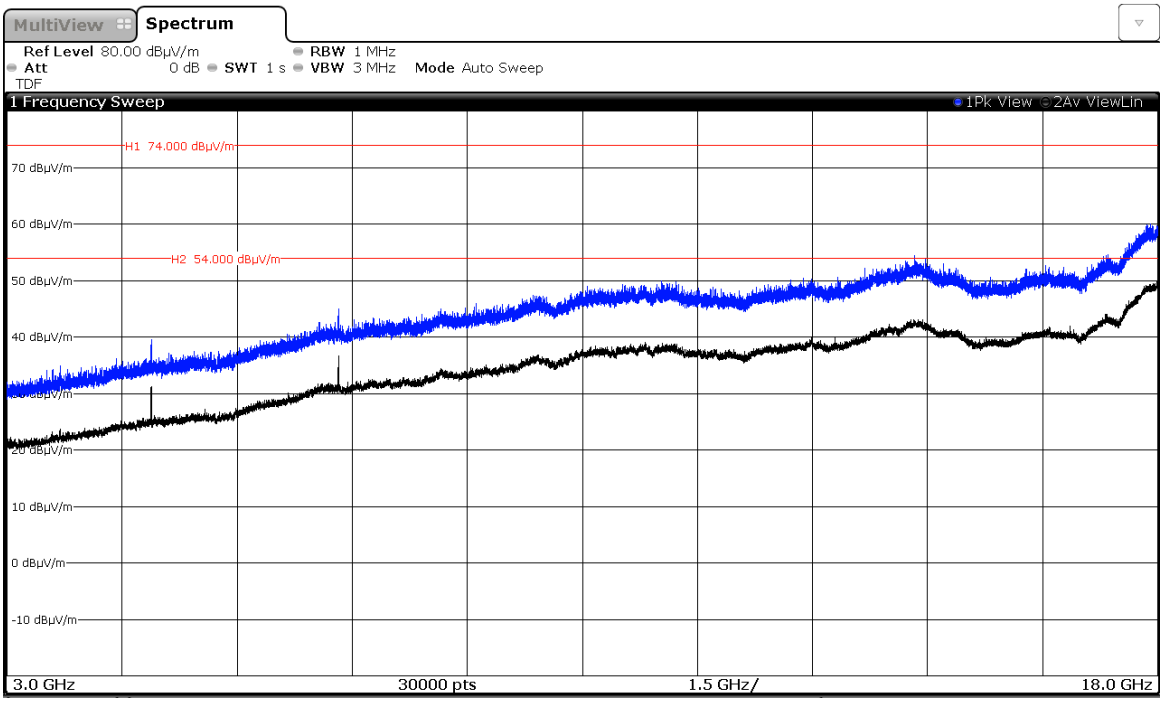
Note: The peak shown in the plot above the limit is the carrier frequency.

FREQUENCY RANGE 3 GHz to 18 GHz.

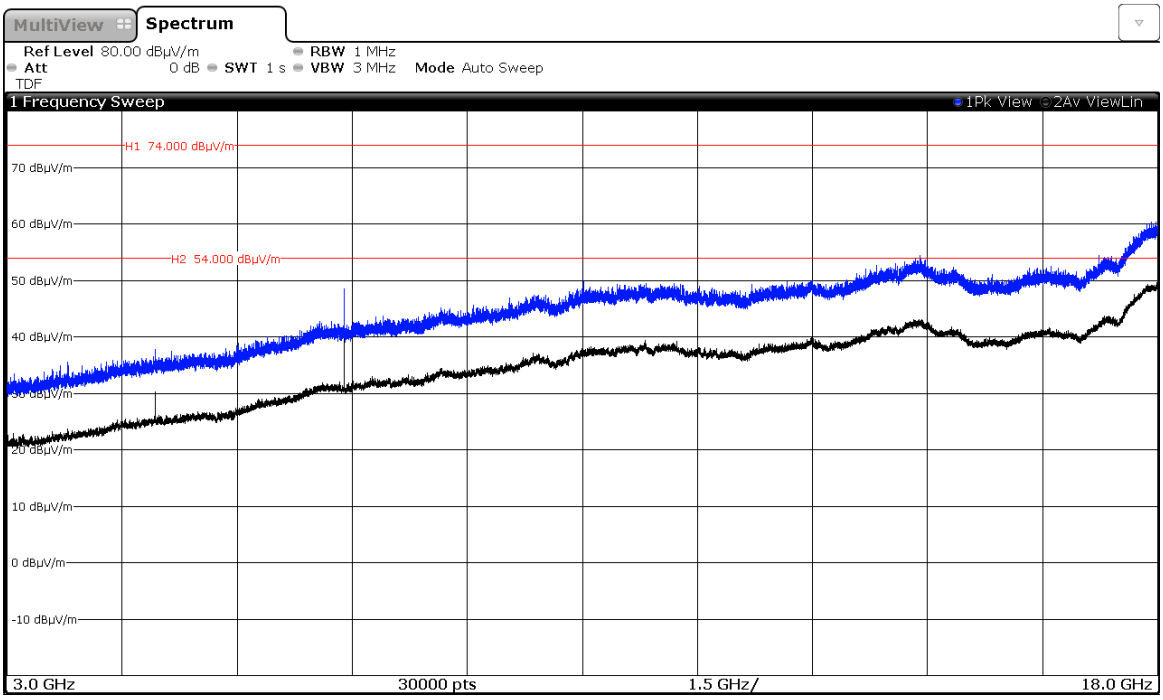
CHANNEL: Lowest (2410 MHz).



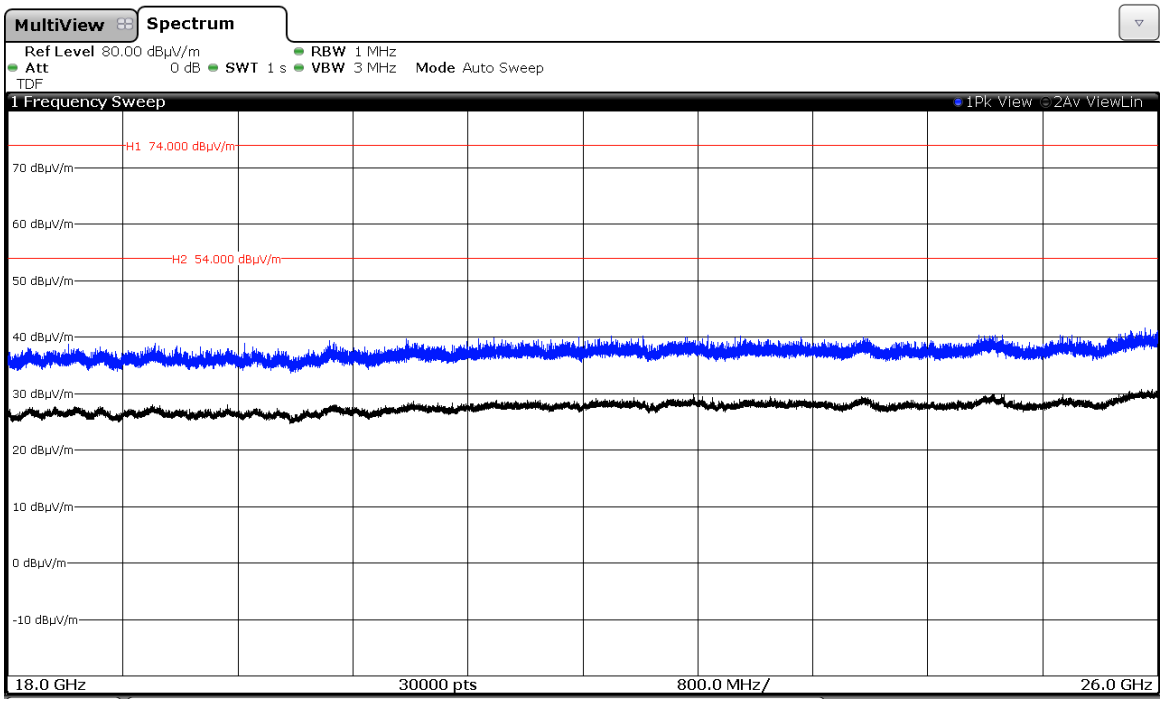
CHANNEL: Middle (2440 MHz).



CHANNEL: Highest (2465 MHz).



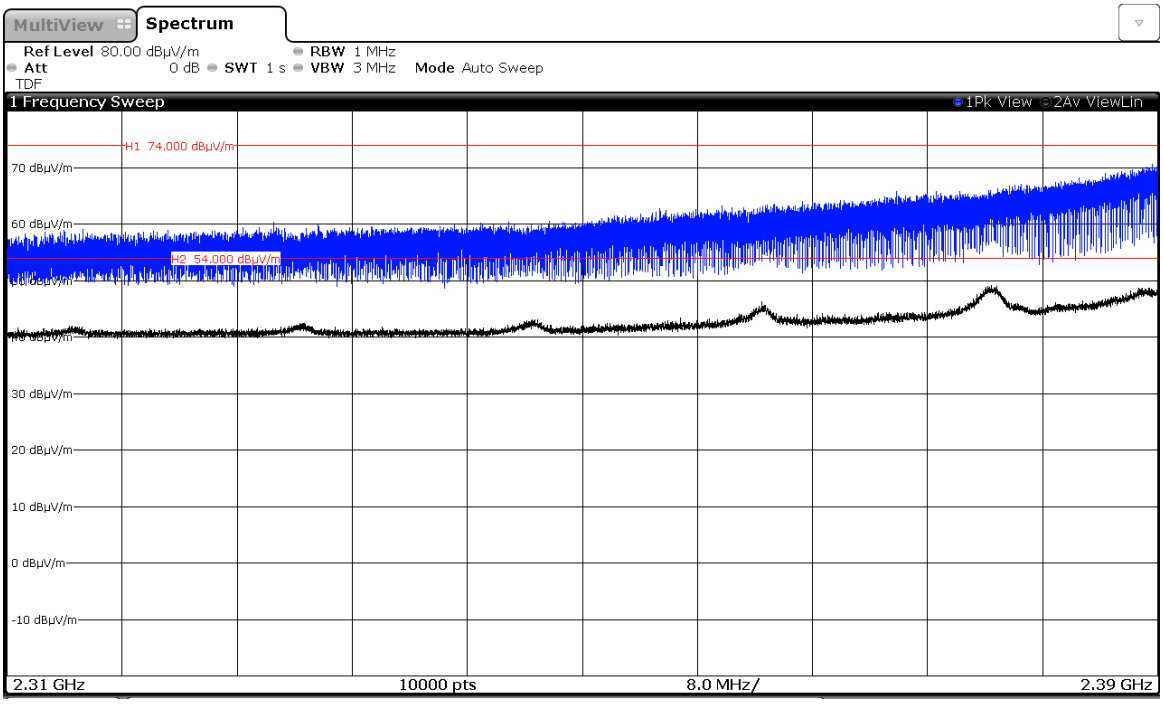
FREQUENCY RANGE 18 GHz to 26 GHz.



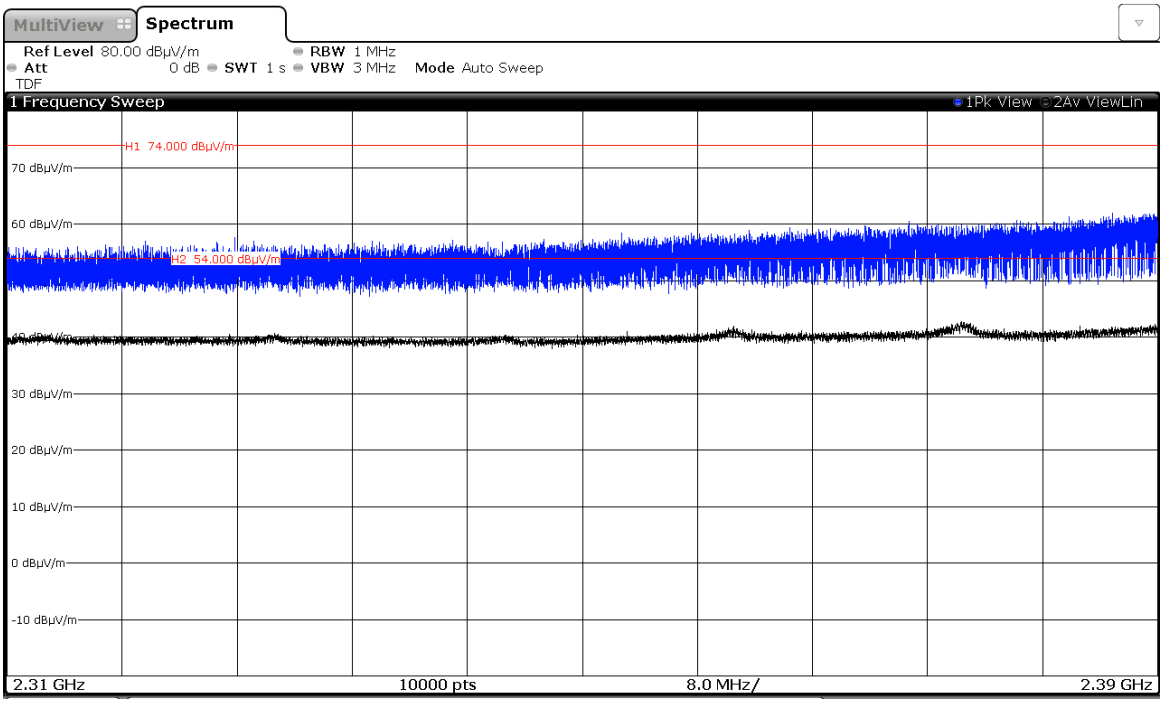
(This plot is valid for all three channels).

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

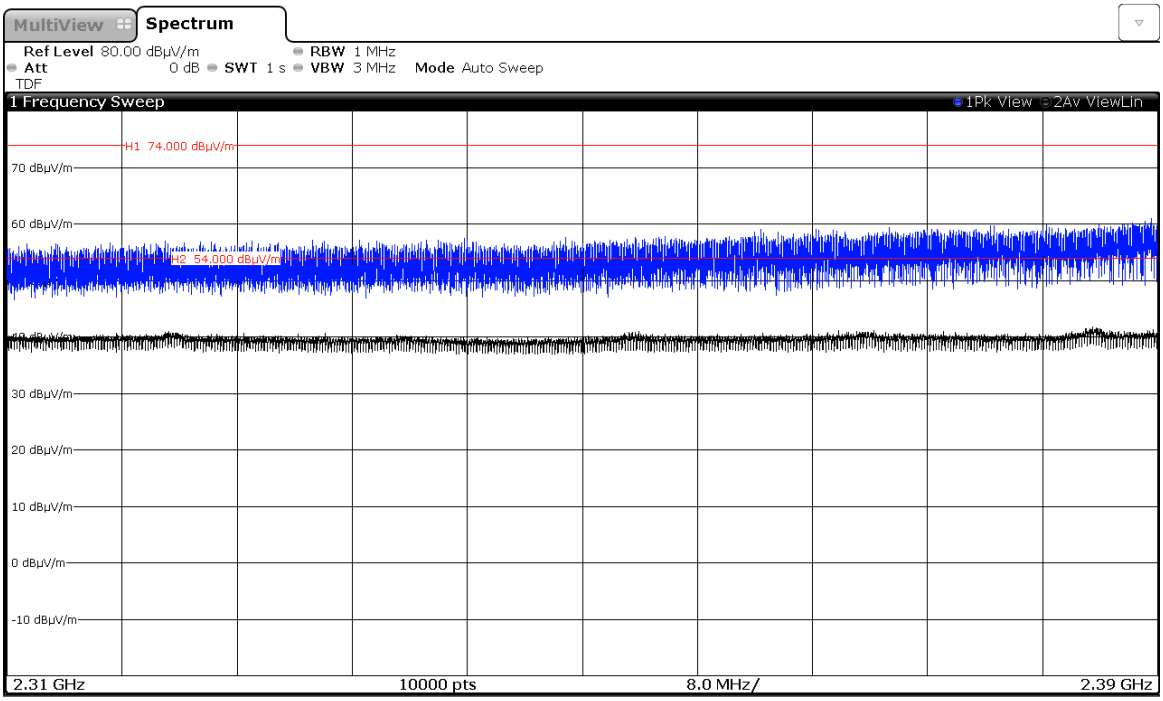
CHANNEL: Lowest (2410 MHz).



CHANNEL: Middle (2440 MHz).

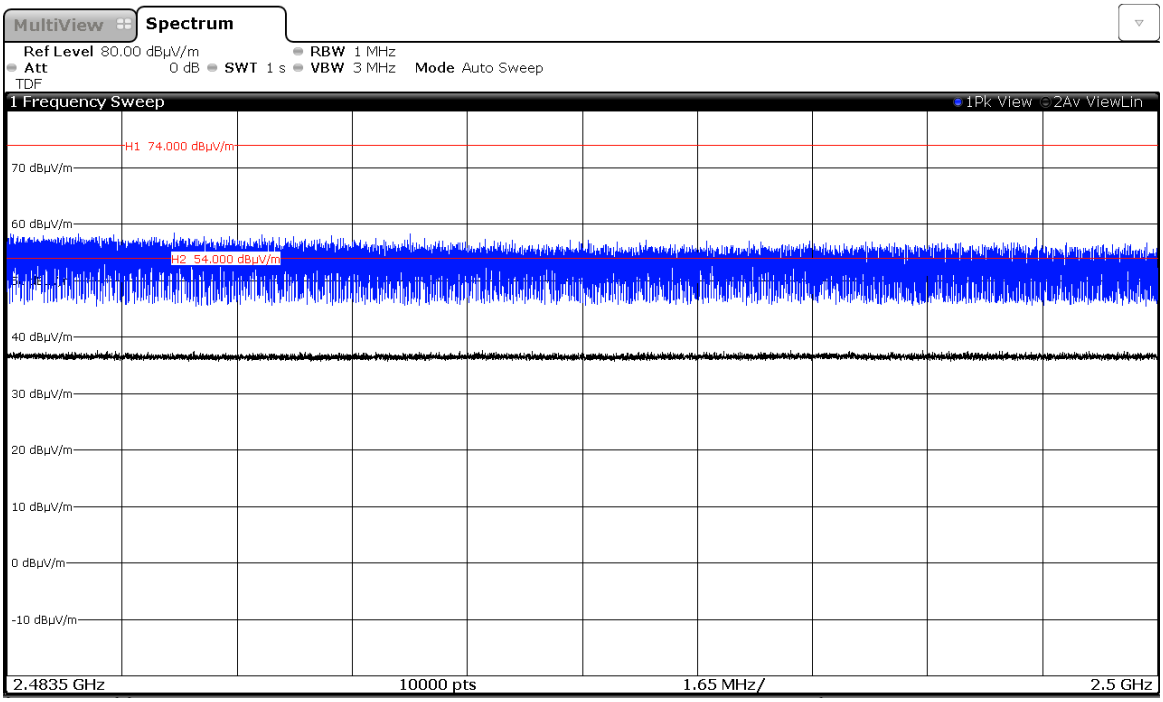


CHANNEL: Highest (2465 MHz).

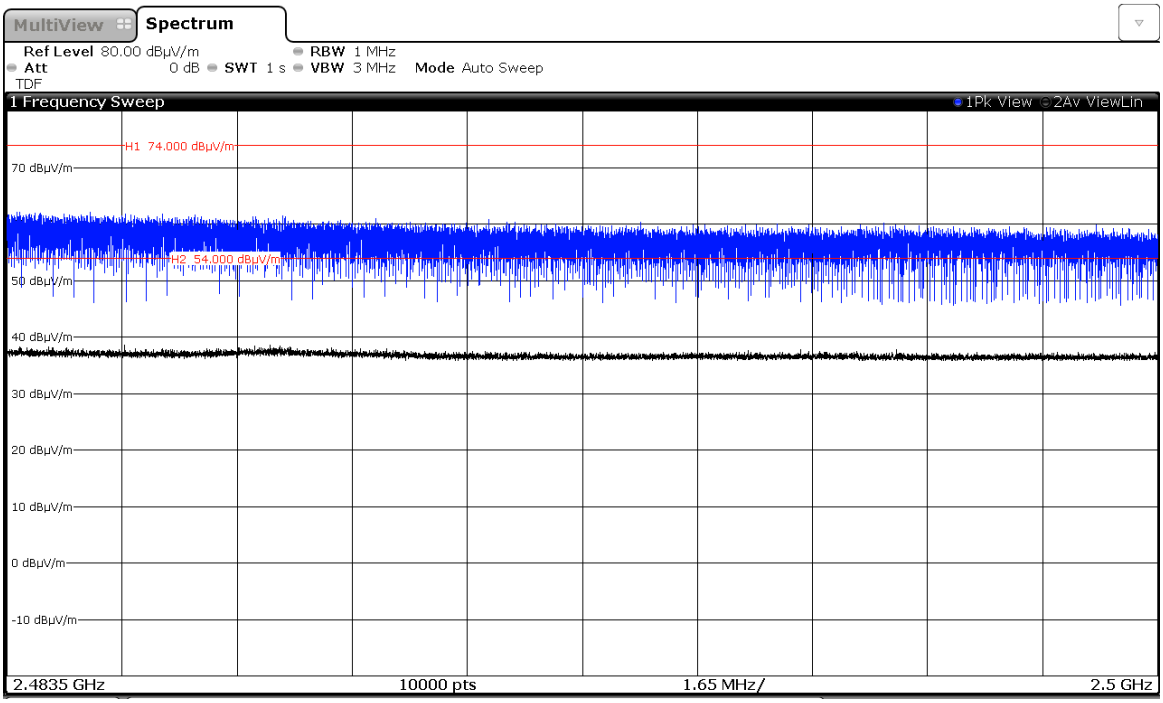


FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

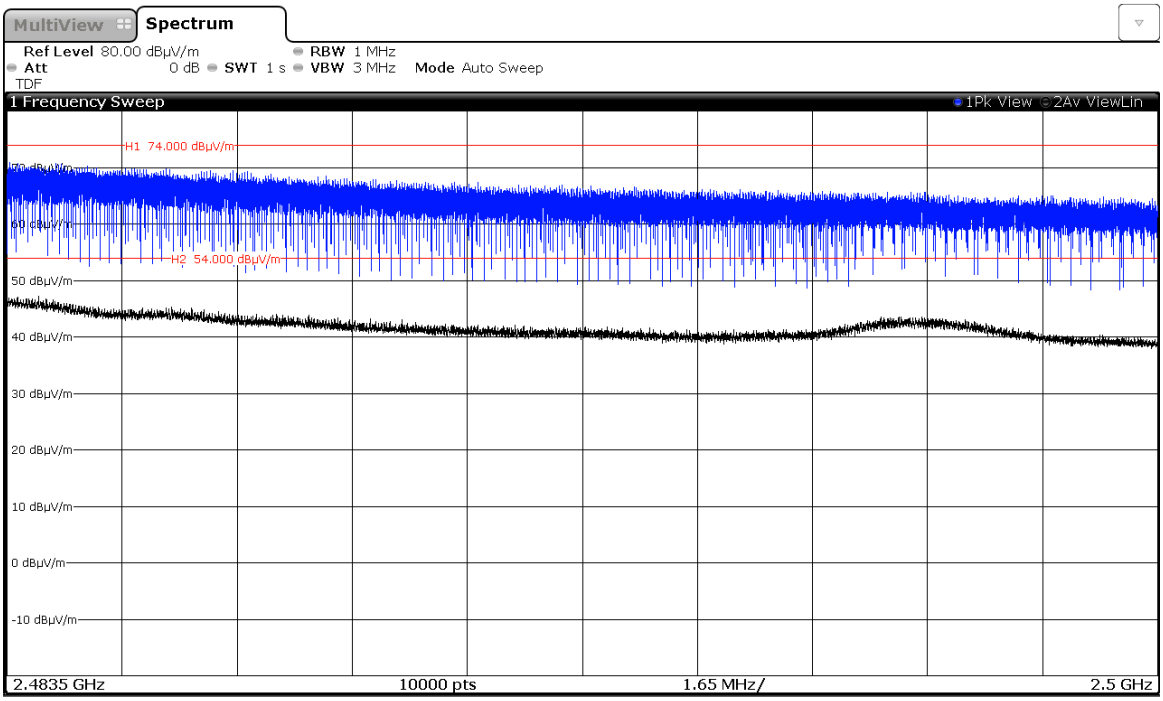
CHANNEL: Lowest (2410 MHz).



CHANNEL: Middle (2440 MHz).



CHANNEL: Highest (2465 MHz).



Appendix C – Test result. WiFi b/g/n

INDEX

TEST CONDITIONS **37**

Section 15.247 Subclause (d) / RSS-247 5.5. Emission limitations radiated (Transmitter) **40**

TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 115 Vac

Type of power supply = AC/DC adapter.

Type of antenna = External attachable antenna.

TEST FREQUENCIES:

For WiFi 802.11b/g/n20:

Lowest channel (1): 2412 MHz

Middle channel (6): 2437 MHz

Highest channel (11): 2462 MHz

WiFi 2.4 GHz: 802.11b, 802.11g, 802.11n20 (20 MHz channel bandwidth).

During transmitter test the EUT was being controlled by the embedded test software to operate in a continuous transmit mode on the test channels as required and in each of the different modulation modes.

The data rates of 1Mb/s for 802.11b, 6Mb/s for 802.11g and 6.5 Mb/s for 802.11n20 were selected based on preliminary testing that identified those rates corresponding to the worst cases for output power and band edge levels at restricted bands.

The conducted RF output power was adjusted according to the client's supplied adjustment values (see following table), which were selected in the test software:

Mode	BW (MHz)	Channel / Freq.	Data Rate	Power adjustment in the test tool
802.11b	20	1 / 2412	1 Mbps	30
		6 / 2437		30
		11 / 2462		30
802.11g	20	1 / 2412	6 Mbps	30
		6 / 2437		30
		11 / 2462		30
802.11n	20	1 / 2412	HT0	25
		6 / 2437		25
		11 / 2462		25

RADIATED MEASUREMENTS

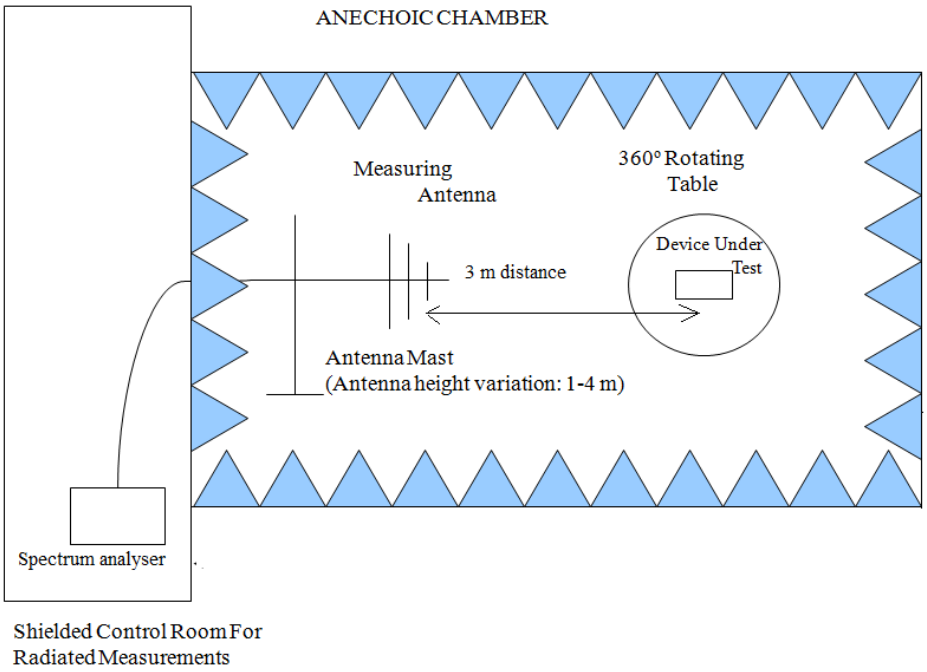
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-25 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 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.

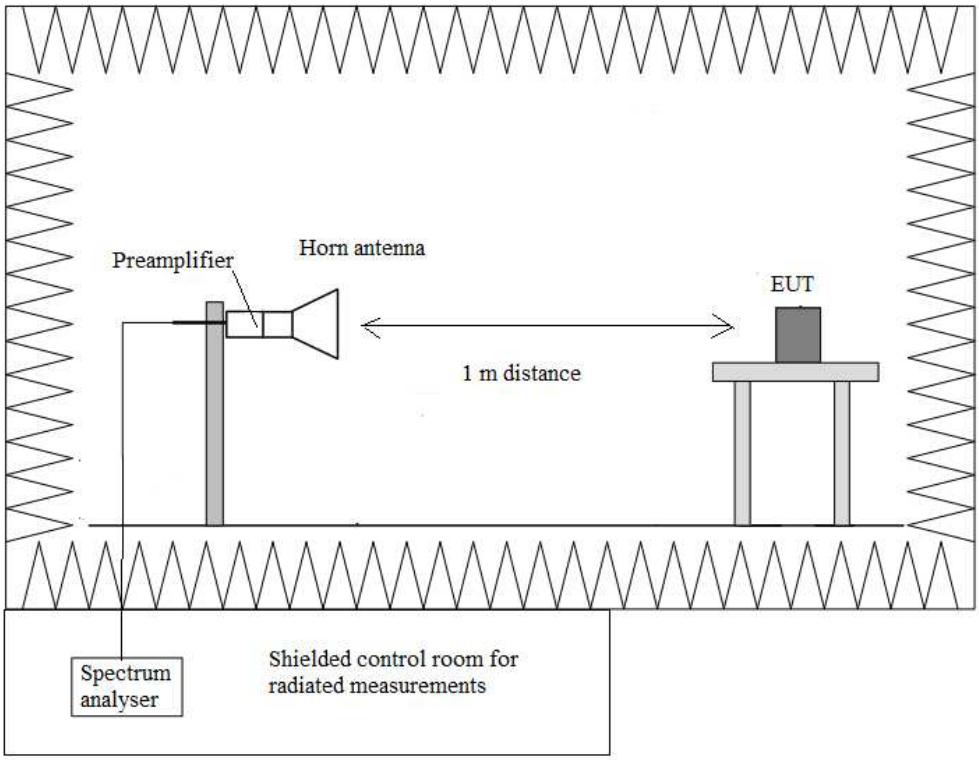
The equipment under test was set up on a non-conductive platform 1.5 meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

Radiated measurements setup f < 1 GHz



Radiated measurements setup f > 1 GHz



Section 15.247 Subclause (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 8.9.:

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 - 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 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-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.

Frequency range 30 MHz-1000 MHz.

The spurious signals detected do not depend on either the operating channel or the modulation mode.

Spurious levels closest to the limit:

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
46.635	PV	Quasi-Peak	30.42	± 3.88
61.767	PV	Quasi-Peak	28.20	± 3.88
122.780	PV	Quasi-Peak	29.51	± 3.88
149.892	PV	Quasi-Peak	25.71	± 3.88
479.983	PV	Quasi-Peak	23.55	± 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).

The field strength at the band edges was evaluated for each mode on the lowest and highest channels at the rated power for the channel under test.

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

1. WiFi 2.4GHz 802.11 b mode.

1.1. CHANNEL 1: LOWEST (2412 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.38801	V	Peak	55.00	± 4.87
		AVG	45.48	± 4.87
4.82425	V	Peak	43.45	± 4.87

1.2. CHANNEL 6: MIDDLE (2437 MHz). Out-of-band spurious emissions in the 1-25 GHz range.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.51383	V	Peak	51.95	± 4.87
4.87375	V	Peak	49.90	± 4.87

1.3. CHANNEL 11: HIGHEST (2462 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.48536	V	Peak	55.99	± 4.87
		AVG	47.76	± 4.87
2.51930	V	Peak	52.32	± 4.87
4.92425	V	Peak	52.67	± 4.87

Verdict: PASS

2. WiFi 2.4GHz 802.11 g mode

2.1. CHANNEL 1: LOWEST (2412 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.38856	V	Peak	54.96	± 4.87
		AVG	46.02	± 4.87
4.82375	V	Peak	39.04	± 4.87
7.23525	V	Peak	45.21	± 4.87

2.2. CHANNEL 6: MIDDLE (2437 MHz). Out-of-band spurious emissions in the 1-25 GHz range.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.48570	V	Peak	51.62	± 4.87
4.87375	V	Peak	46.14	± 4.87
7.31175	V	Peak	45.65	± 4.87

2.3. CHANNEL 11: HIGHEST (2462 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.48654	V	Peak	56.53	± 4.87
		AVG	47.57	± 4.87
2.51837	V	Peak	51.44	± 4.87
4.92375	V	Peak	47.96	± 4.87
7.38725	V	Peak	45.41	± 4.87

Verdict: PASS

3. WiFi 2.4GHz 802.11 n20 mode

3.1. CHANNEL 1: LOWEST (2412 MHz Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.38590	V	Peak	55.02	± 4.87
		AVG	45.90	± 4.87
4.82425	V	Peak	47.67	± 4.87
7.23425	V	Peak	44.78	± 4.87

3.2. CHANNEL 6: MIDDLE (2437 MHz). Out-of-band spurious emissions in the 1-25 GHz range.

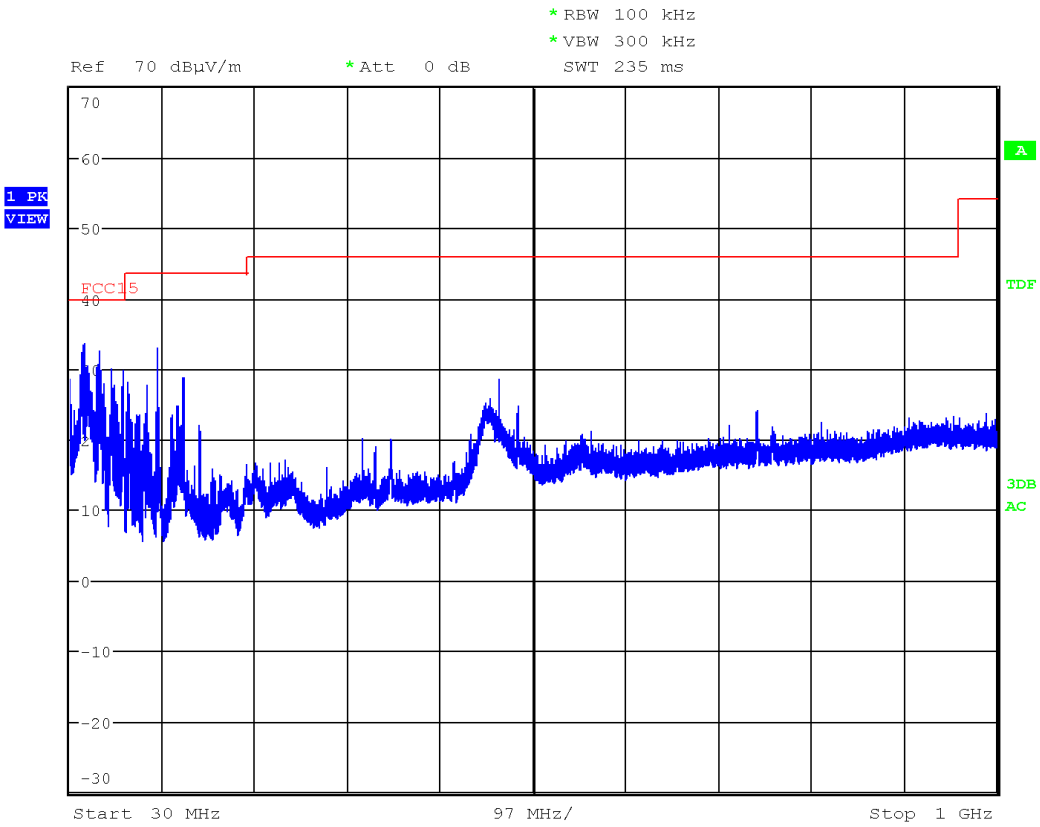
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.50563	V	Peak	51.51	± 4.87
4.87375	V	Peak	44.62	± 4.87
7.31175	V	Peak	44.66	± 4.87

3.3. CHANNEL 11: HIGHEST (2462 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.48648	V	Peak	56.61	± 4.87
		AVG	47.24	± 4.87
4.92406	V	Peak	56.05	± 4.87
		AVG	53.92	± 4.87
7.38475	V	Peak	47.34	± 4.87

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

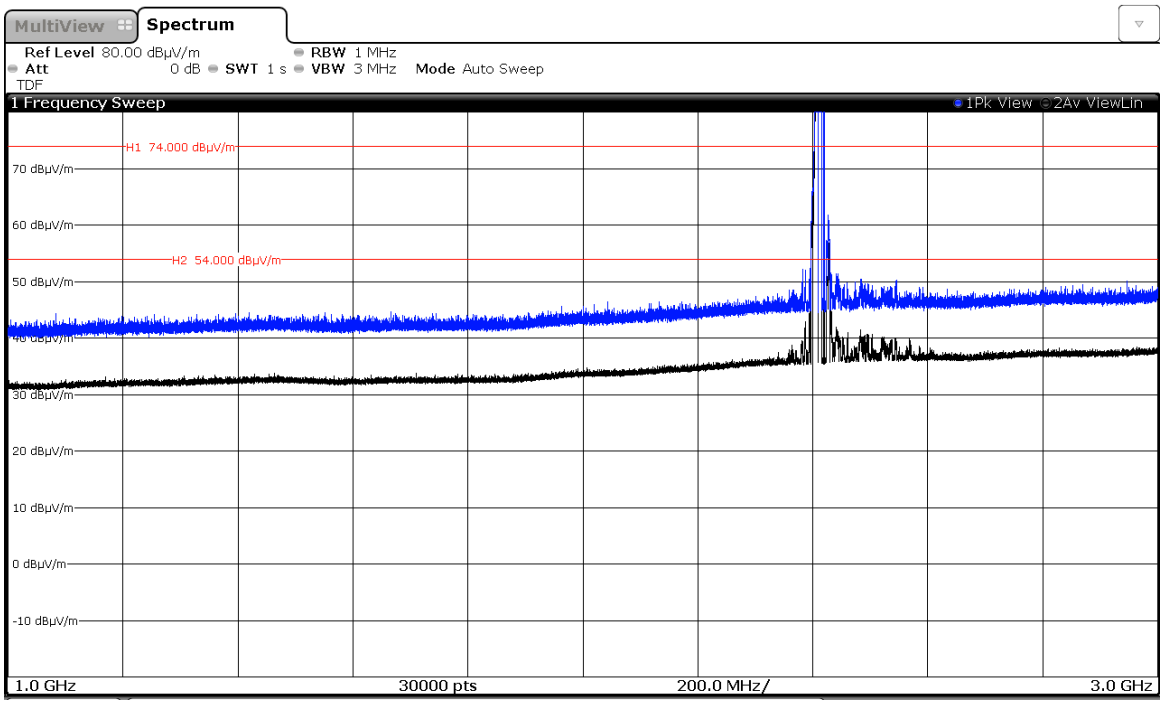


(This plot is valid for all three channels and all modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

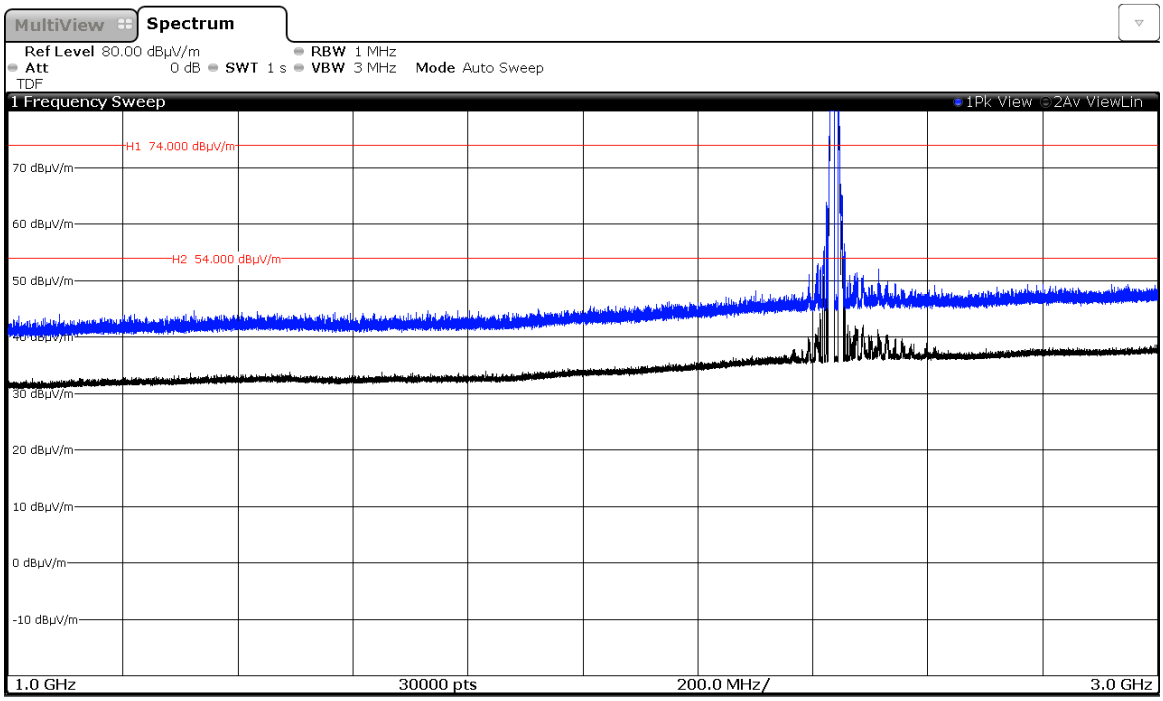
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 1 (2412 MHz).



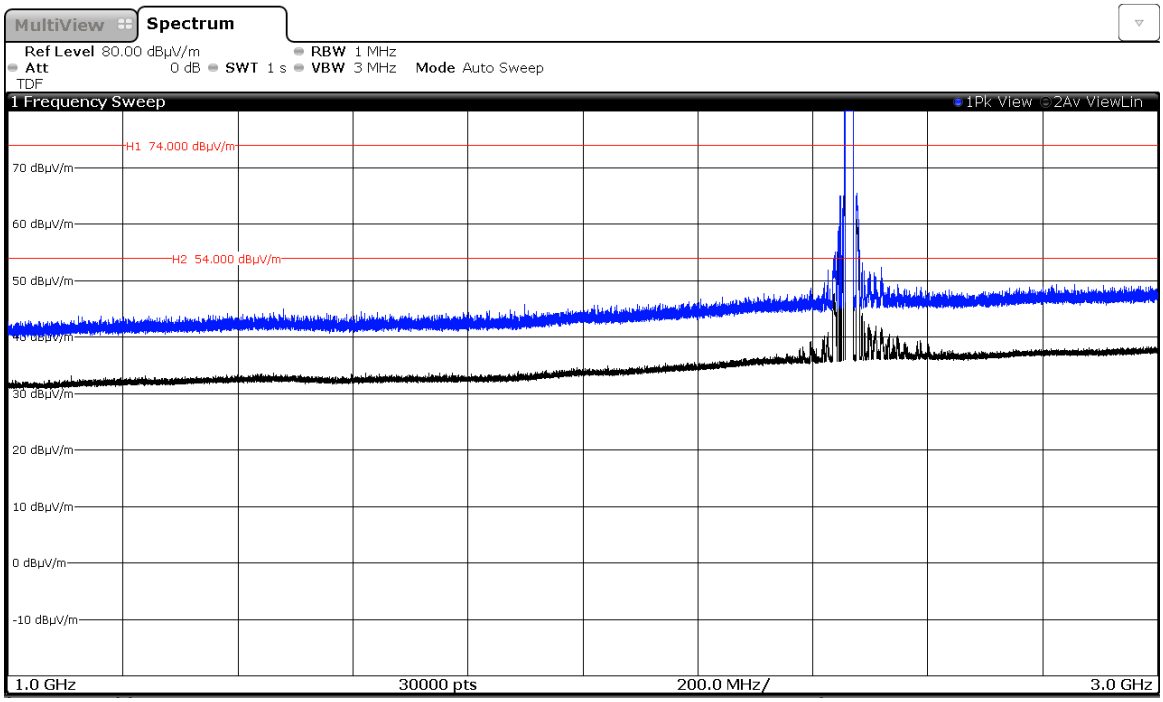
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



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

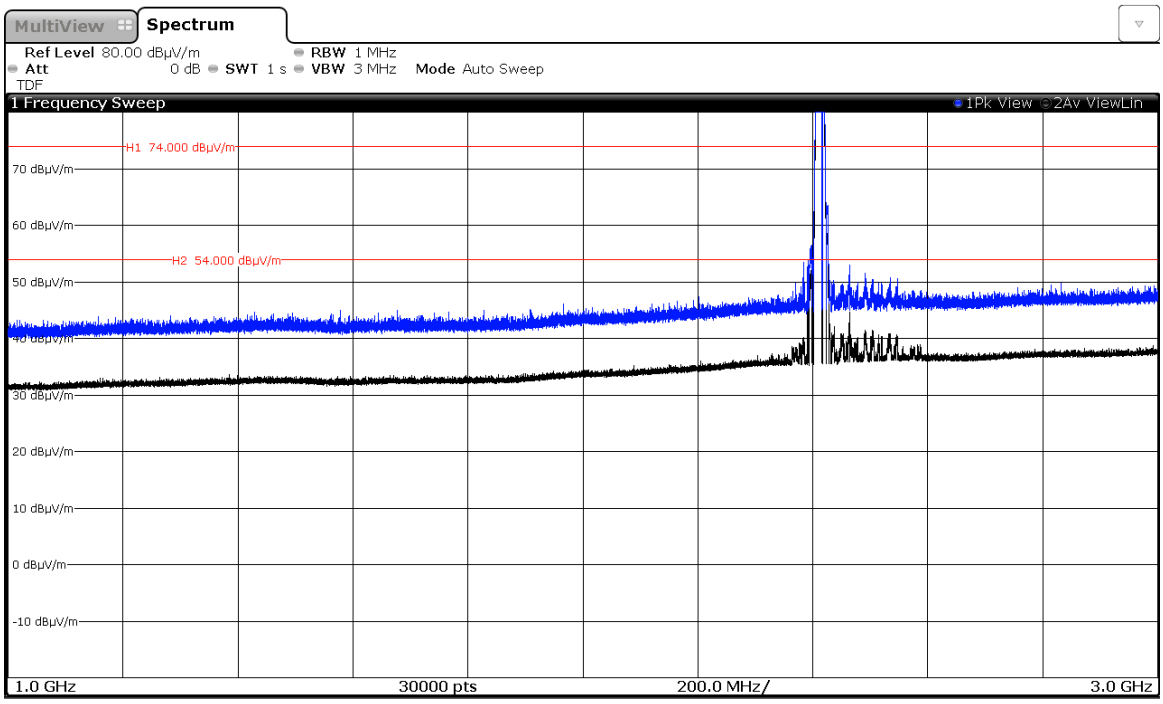
CHANNEL 11 (2462 MHz).



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

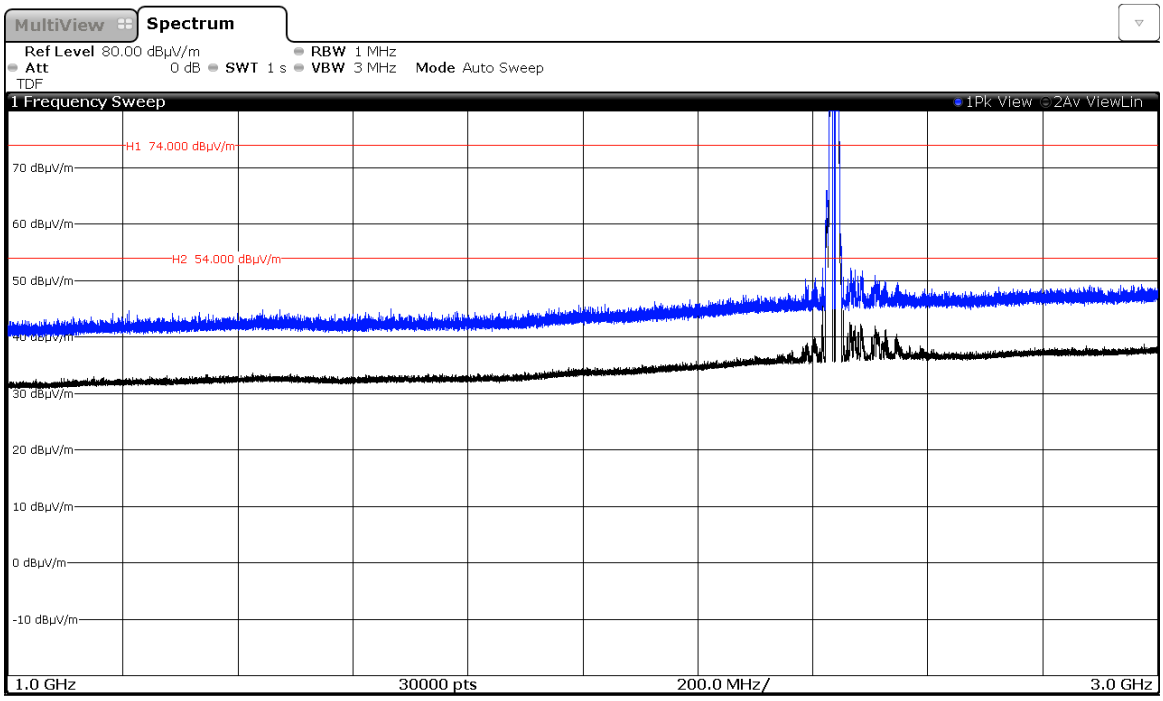
2. WiFi 2.4GHz 802.11 g mode

CHANNEL 1 (2412 MHz).



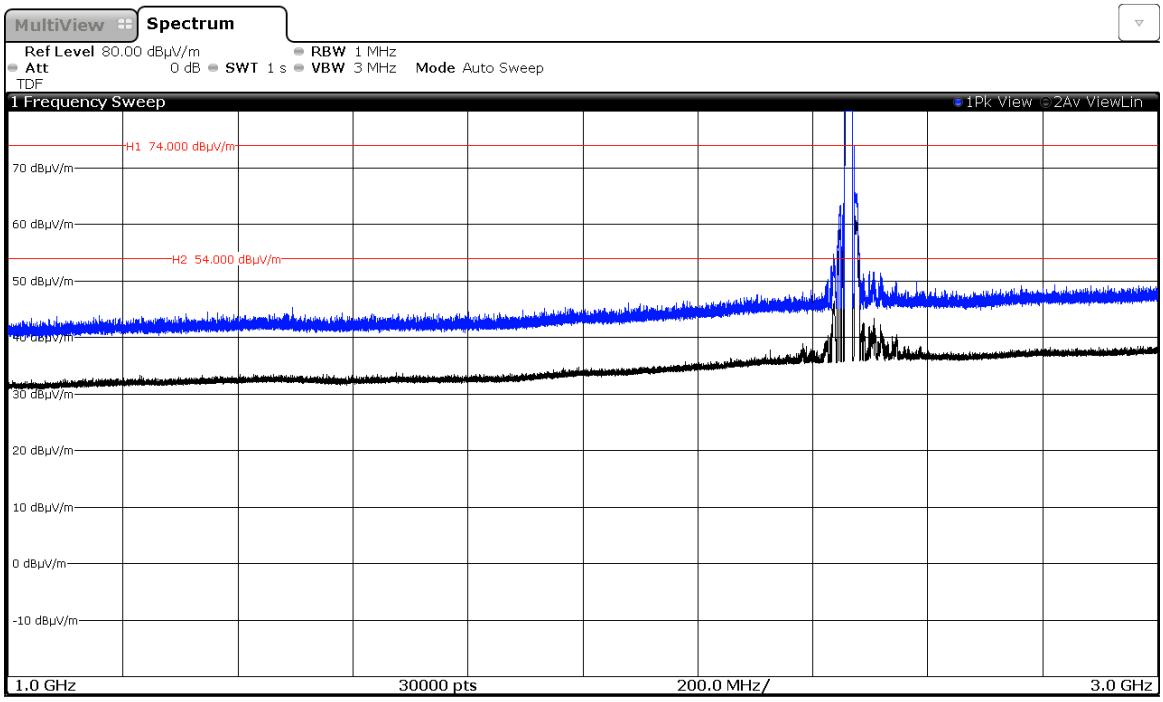
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



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

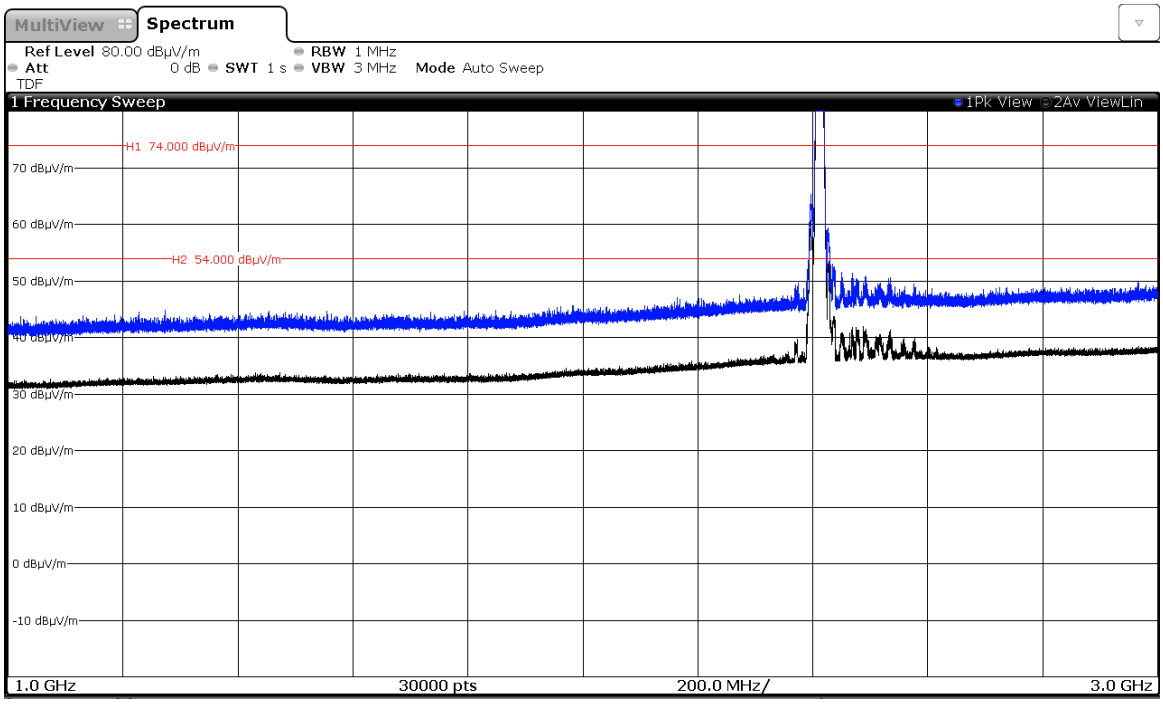
CHANNEL 11 (2462 MHz).



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

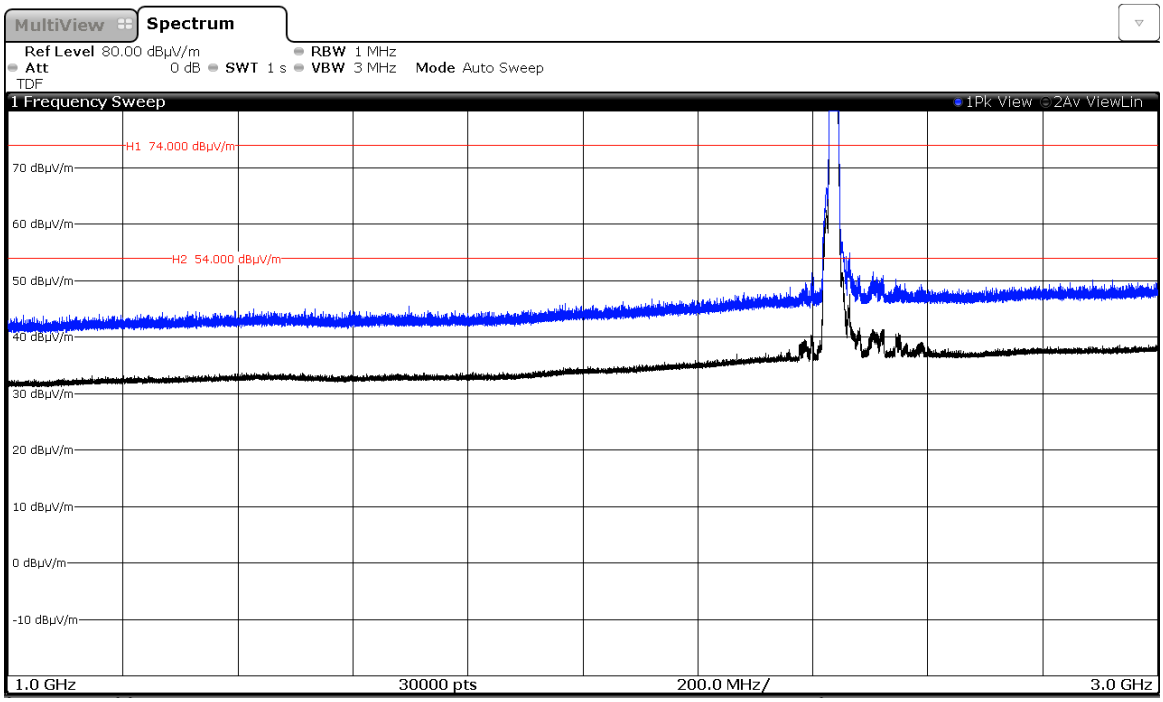
3. WiFi 2.4GHz 802.11 n20 mode

CHANNEL 1 (2412 MHz).



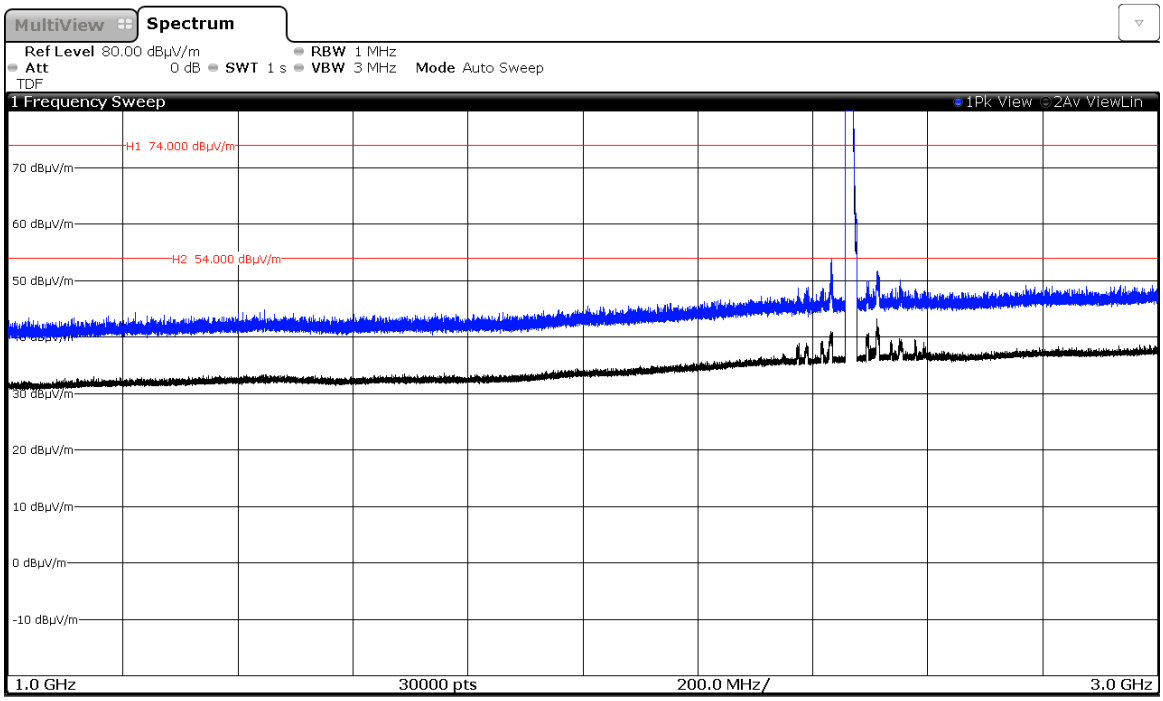
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



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

CHANNEL 11 (2462 MHz).

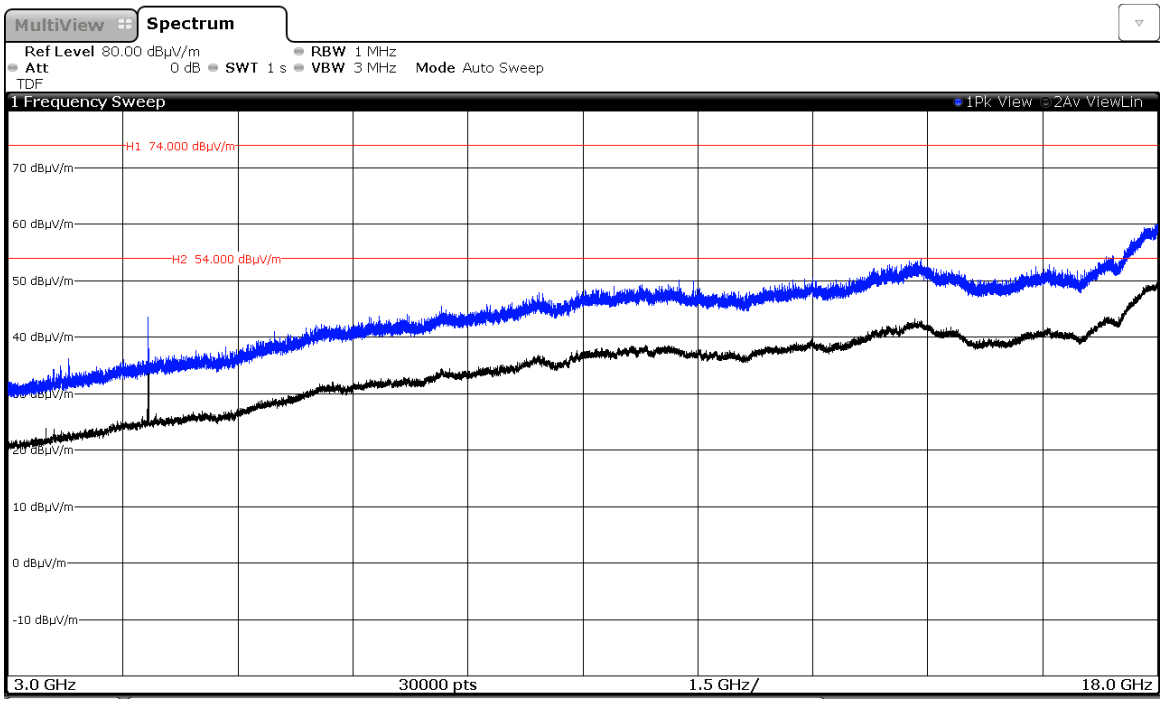


Note: The peak above the limit is the carrier frequency.

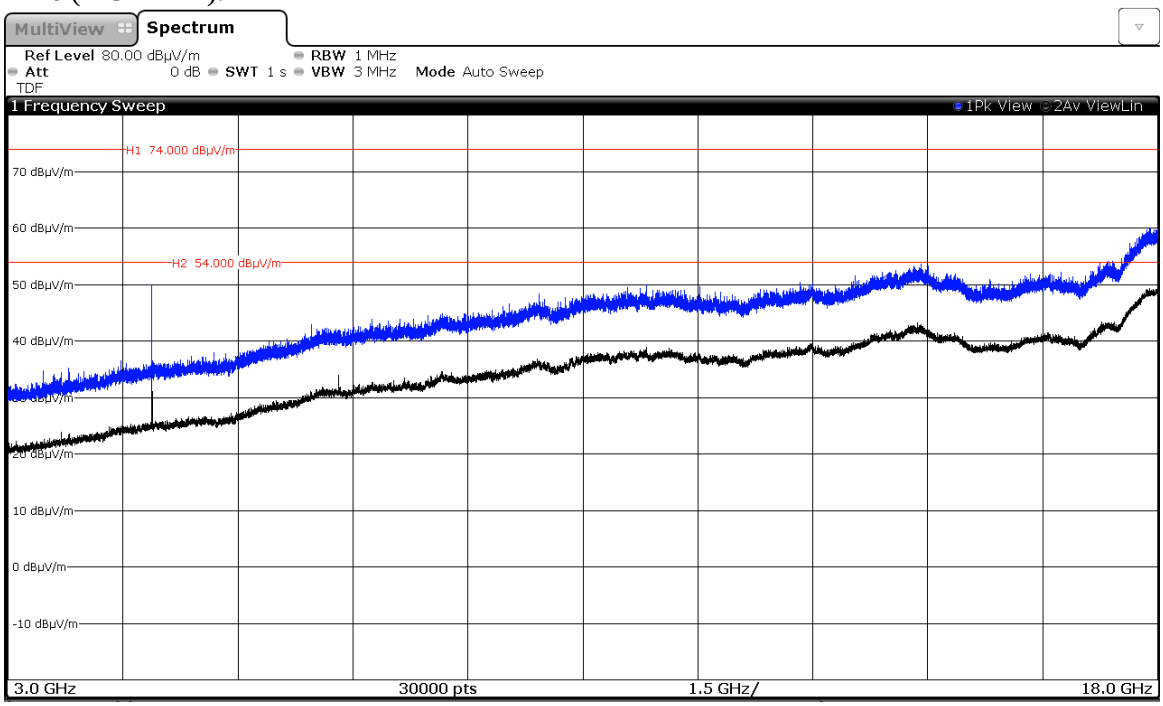
FREQUENCY RANGE 3 GHz to 18 GHz.

1. WiFi 2.4GHz 802.11 b mode

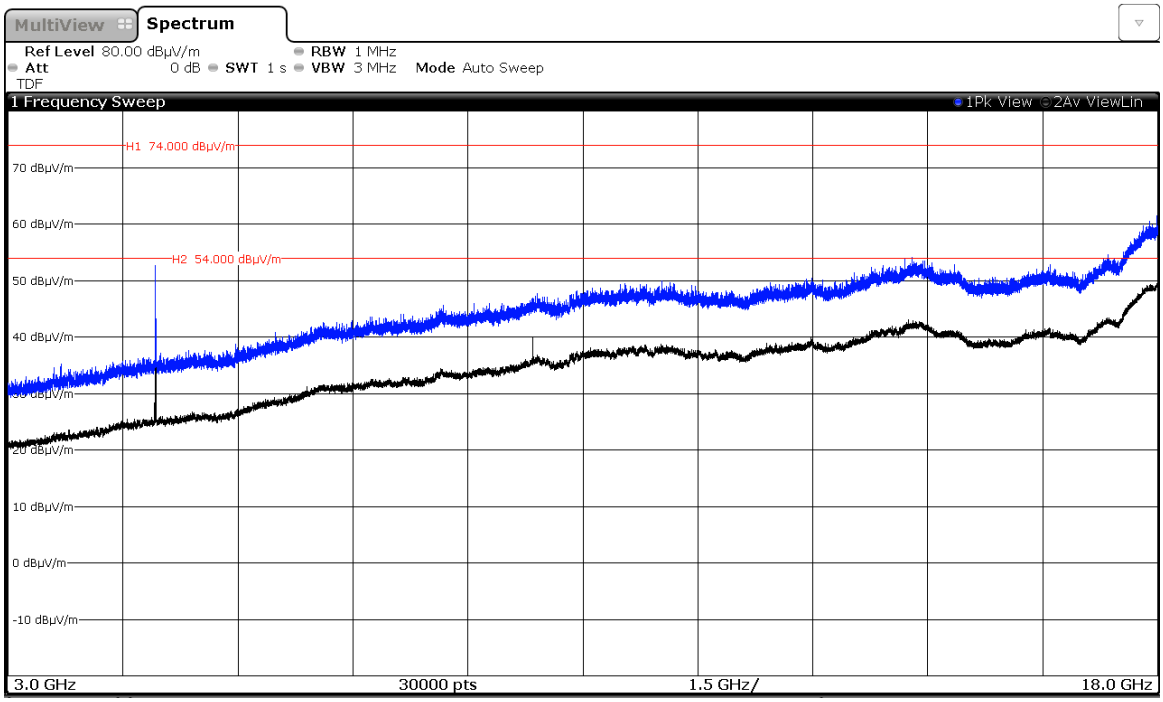
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

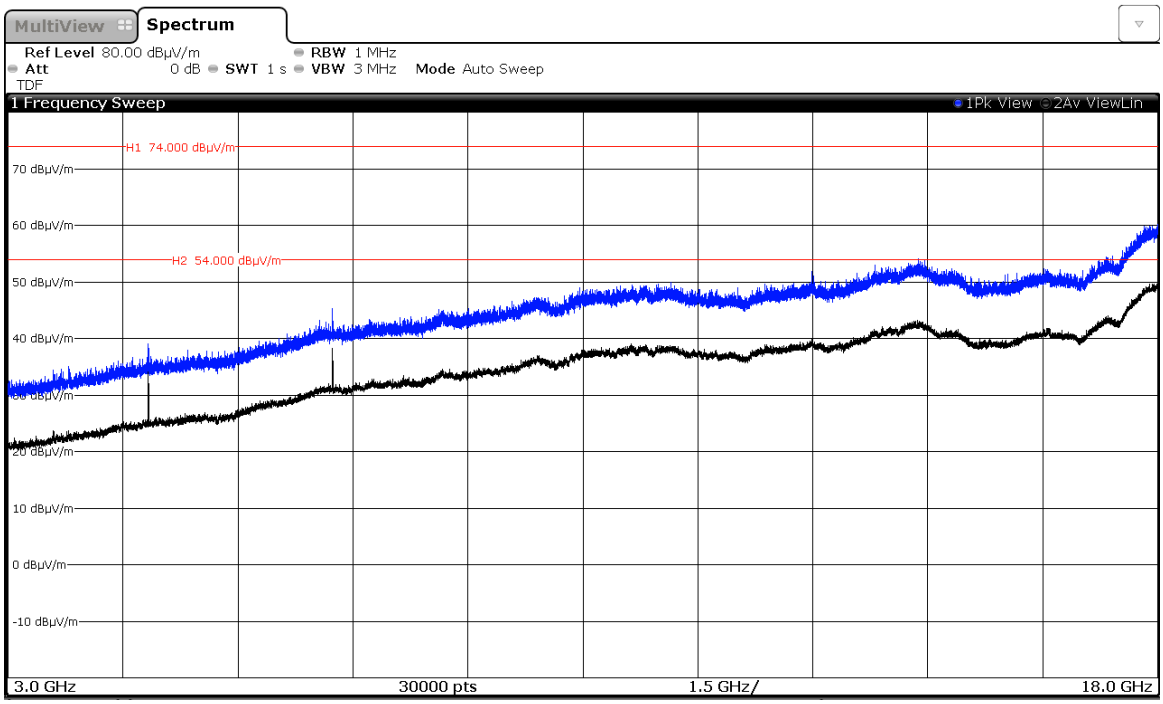


CHANNEL 11 (2462 MHz).

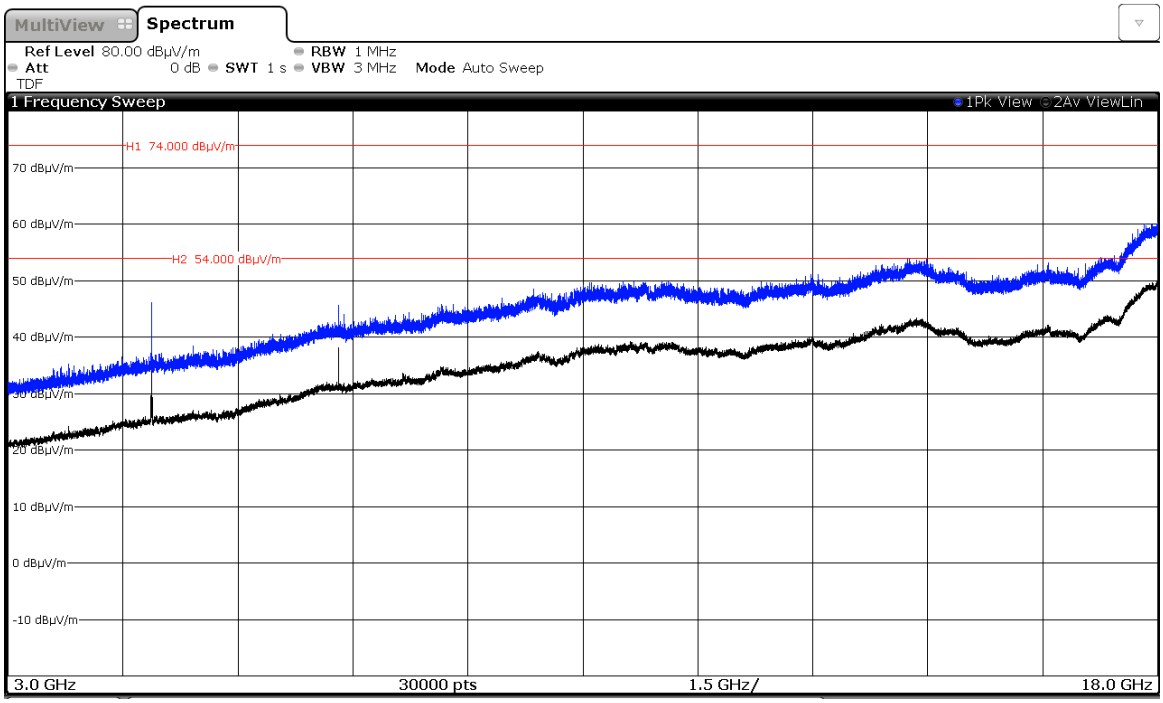


2. WiFi 2.4GHz 802.11 g mode

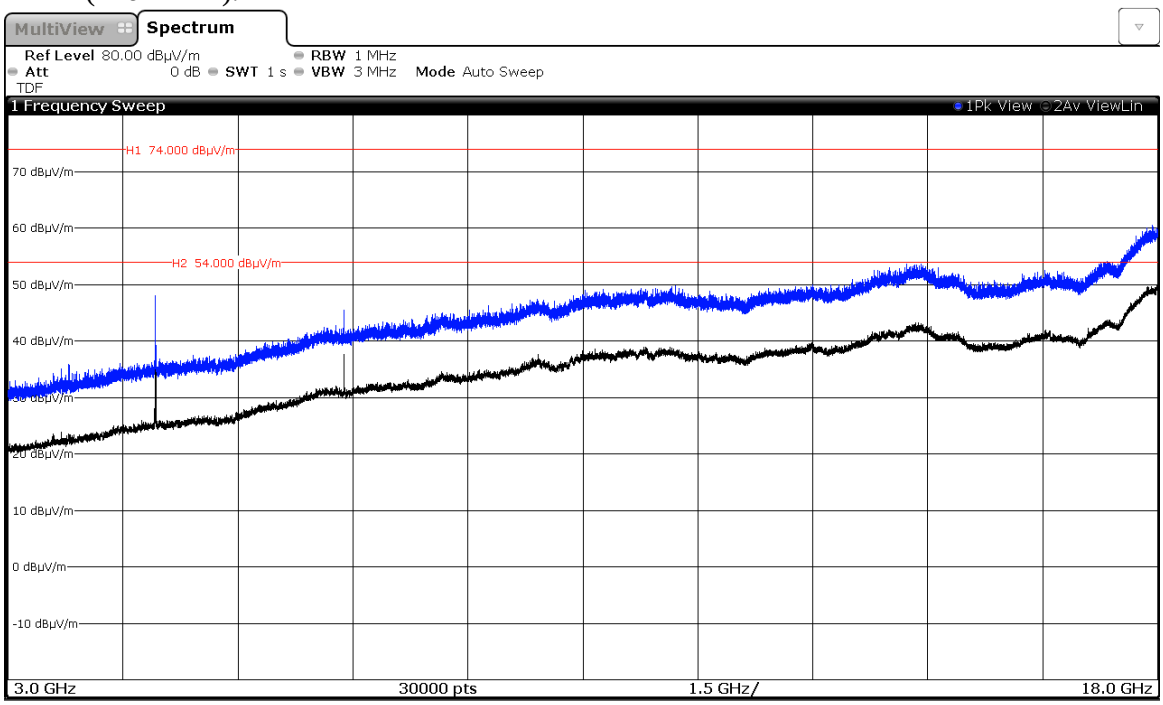
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

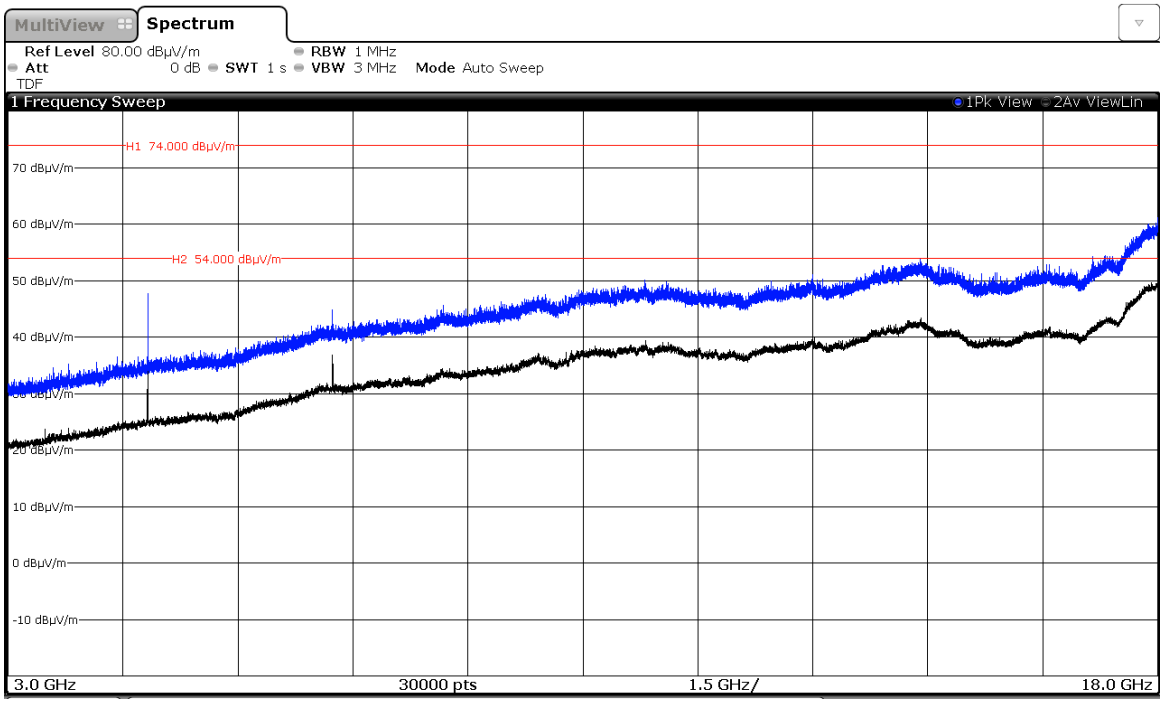


CHANNEL 11 (2462 MHz).

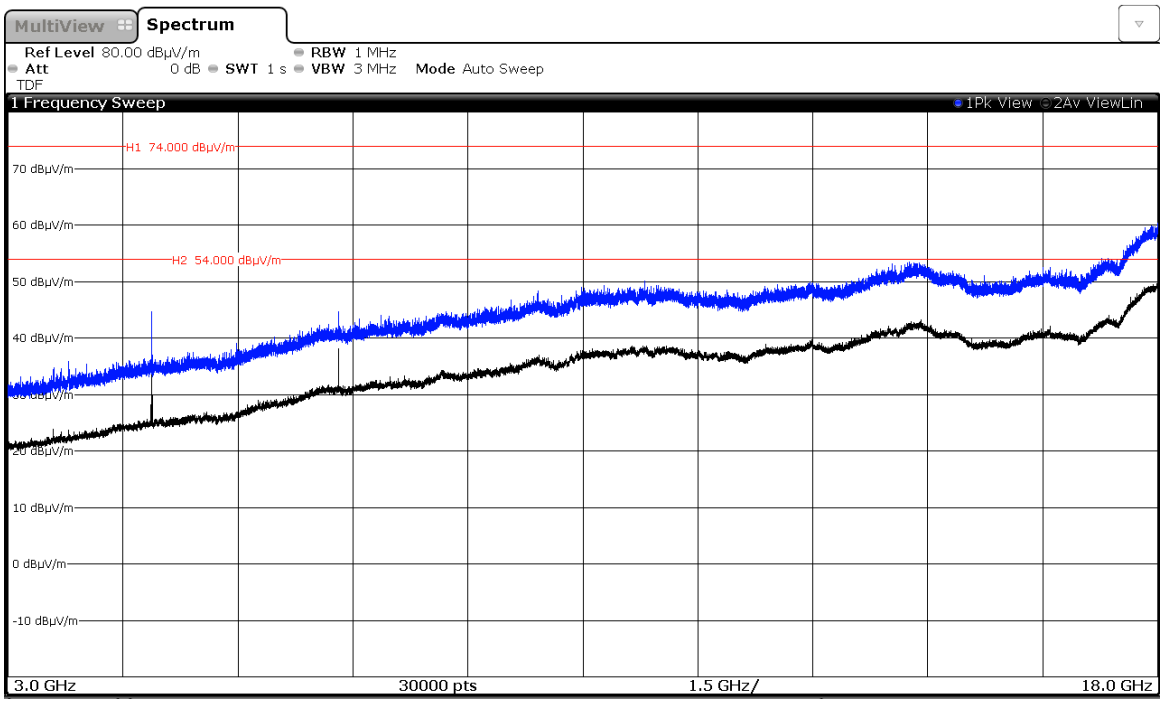


3. WiFi 2.4GHz 802.11 n20 mode

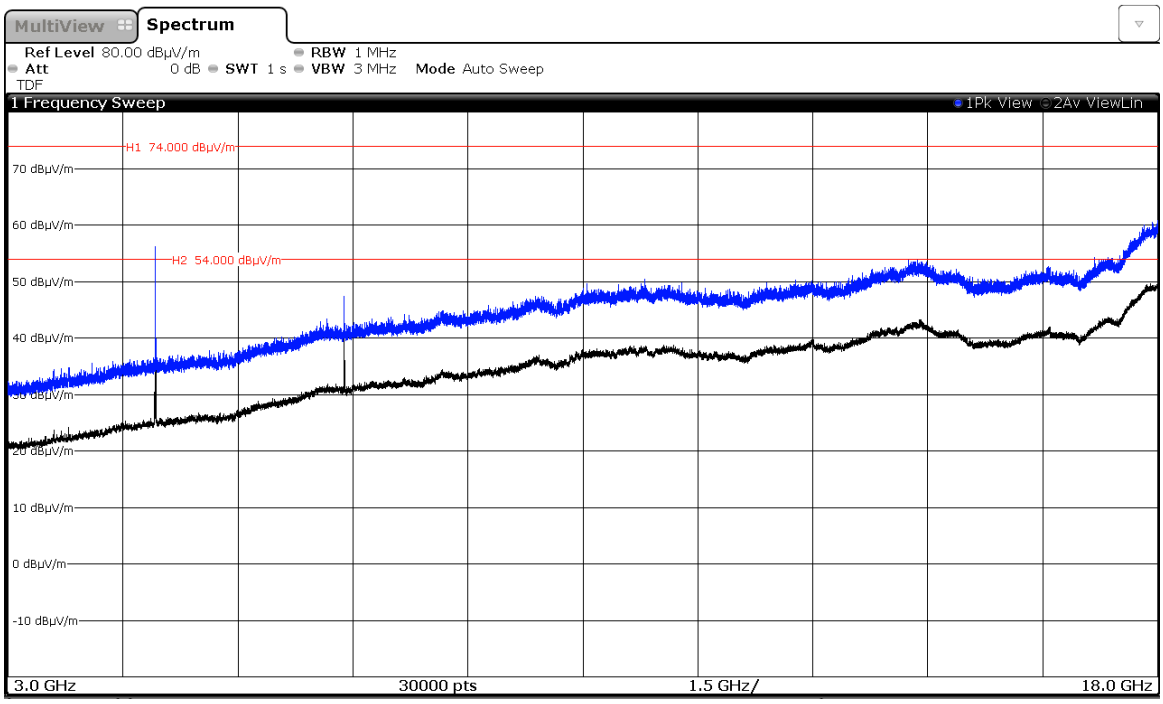
CHANNEL 1 (2412 MHz).



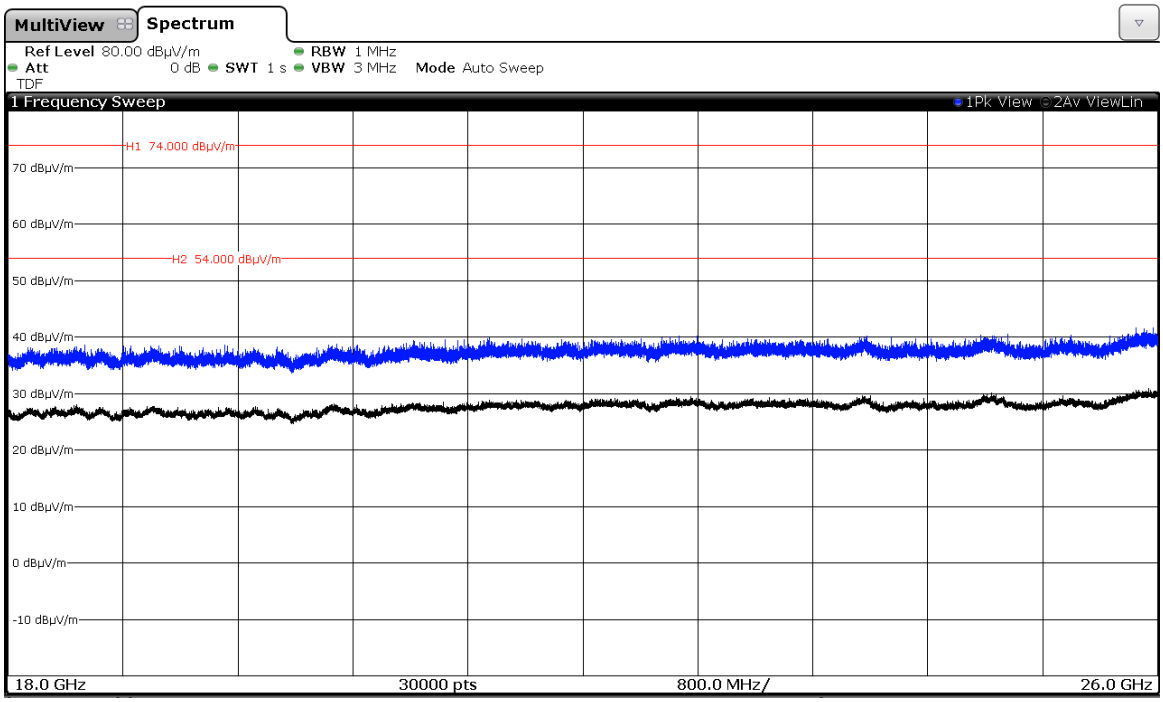
CHANNEL 6 (2437 MHz).



CHANNEL 11 (2462 MHz).



FREQUENCY RANGE 18 GHz to 26 GHz.

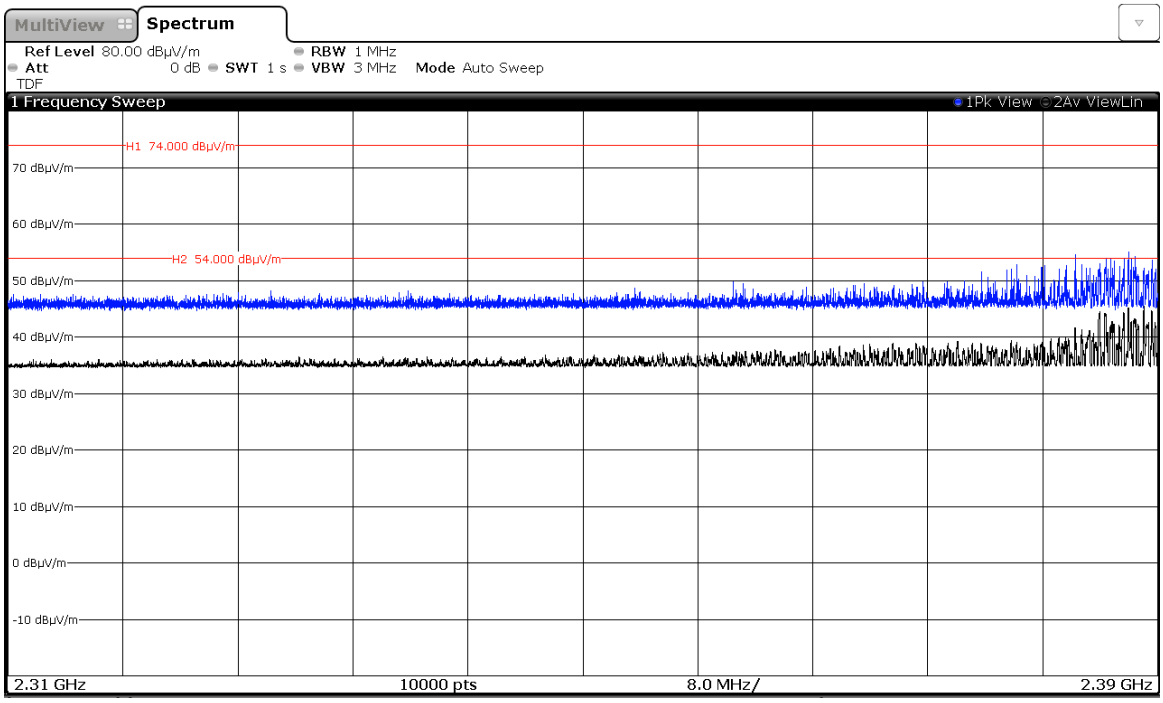


(This plot is valid for all three channels and all modulation modes).

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

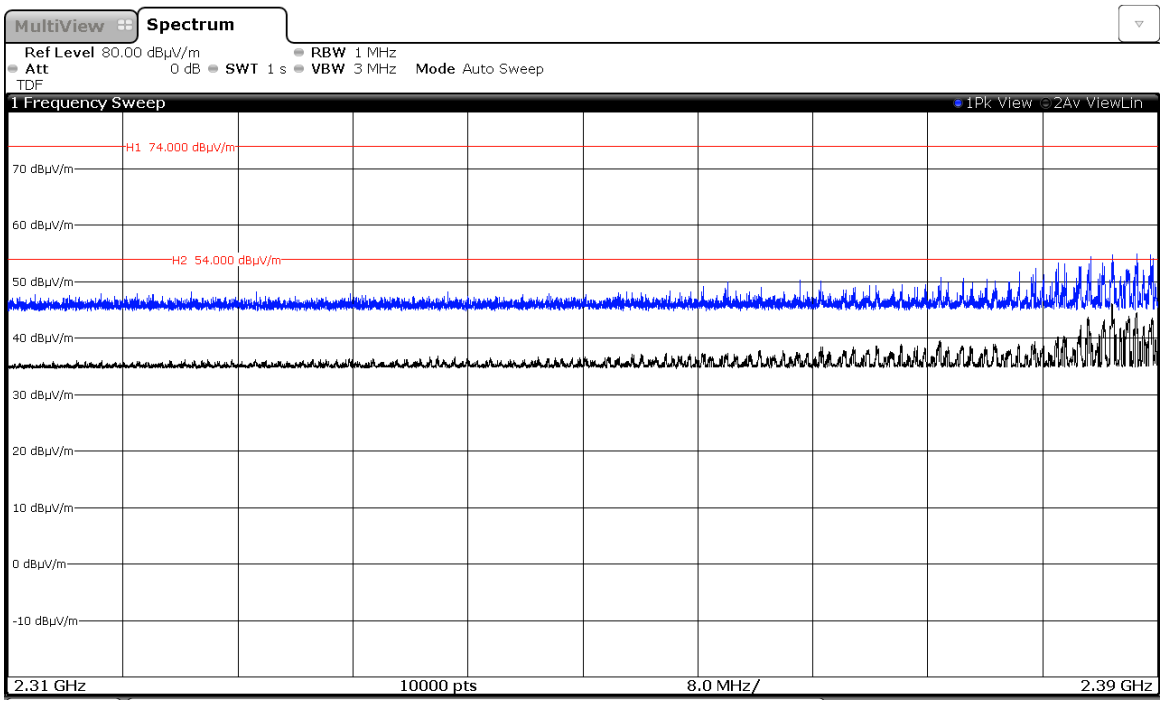
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 1 (2412 MHz).



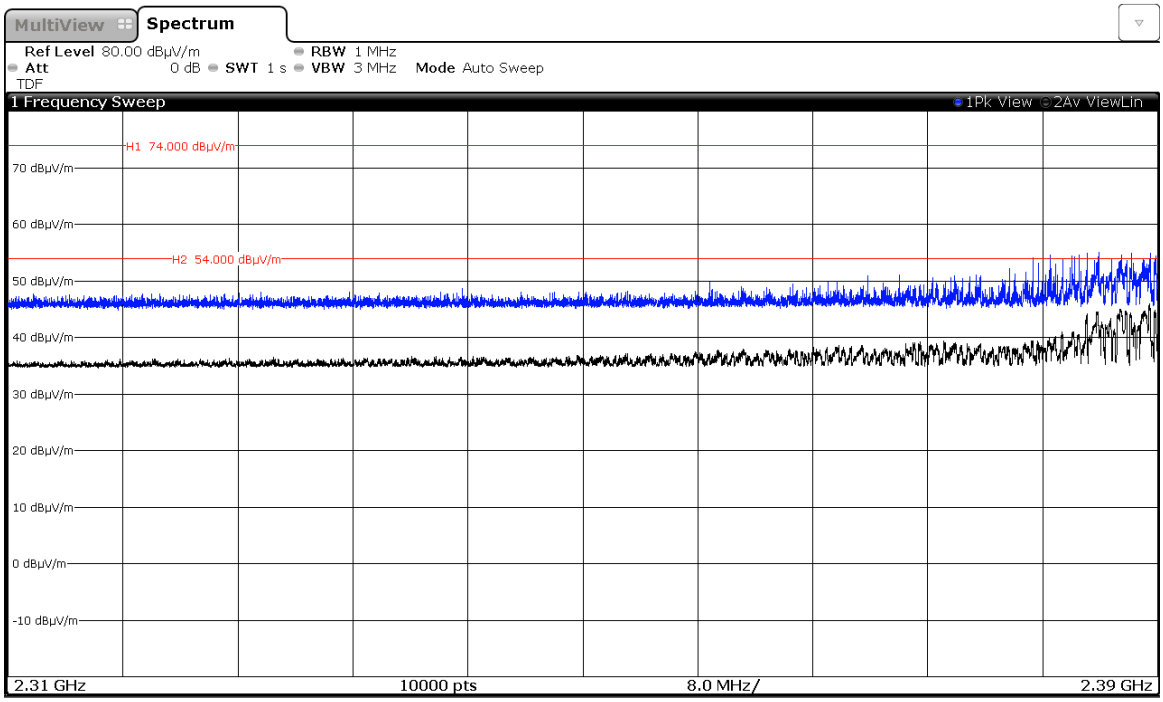
2. WiFi 2.4GHz 802.11 g mode

CHANNEL 1 (2412 MHz).



3. WiFi 2.4GHz 802.11 n20 mode

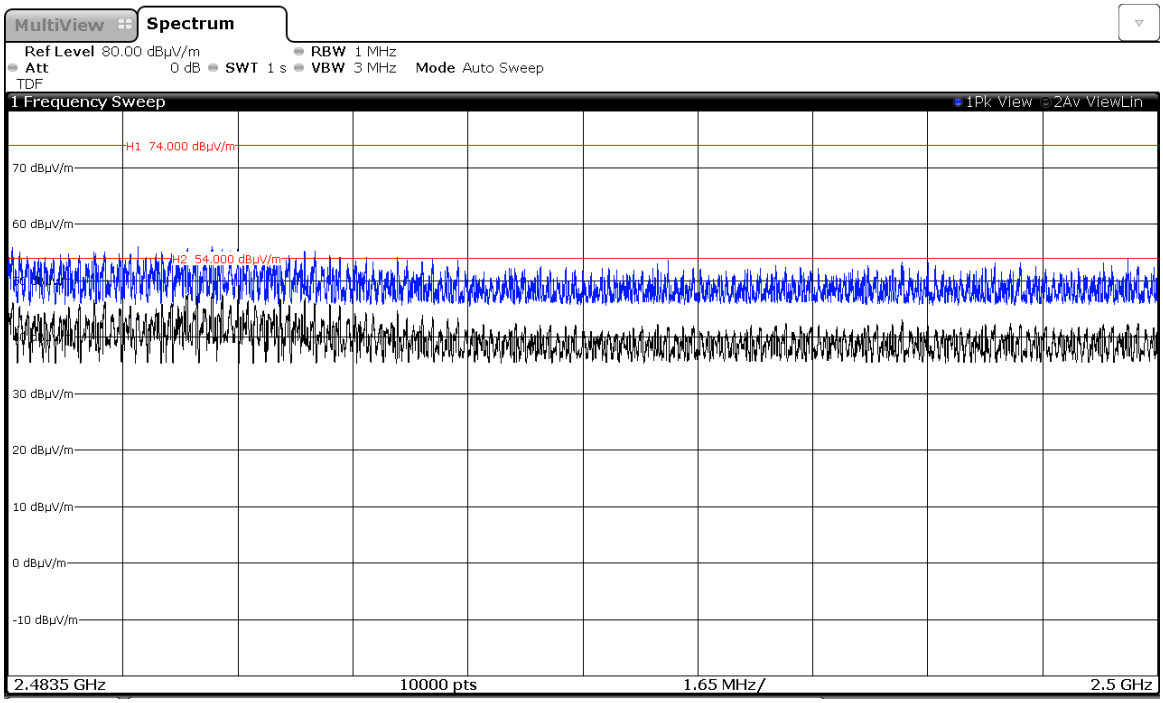
CHANNEL 1 (2412 MHz).



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

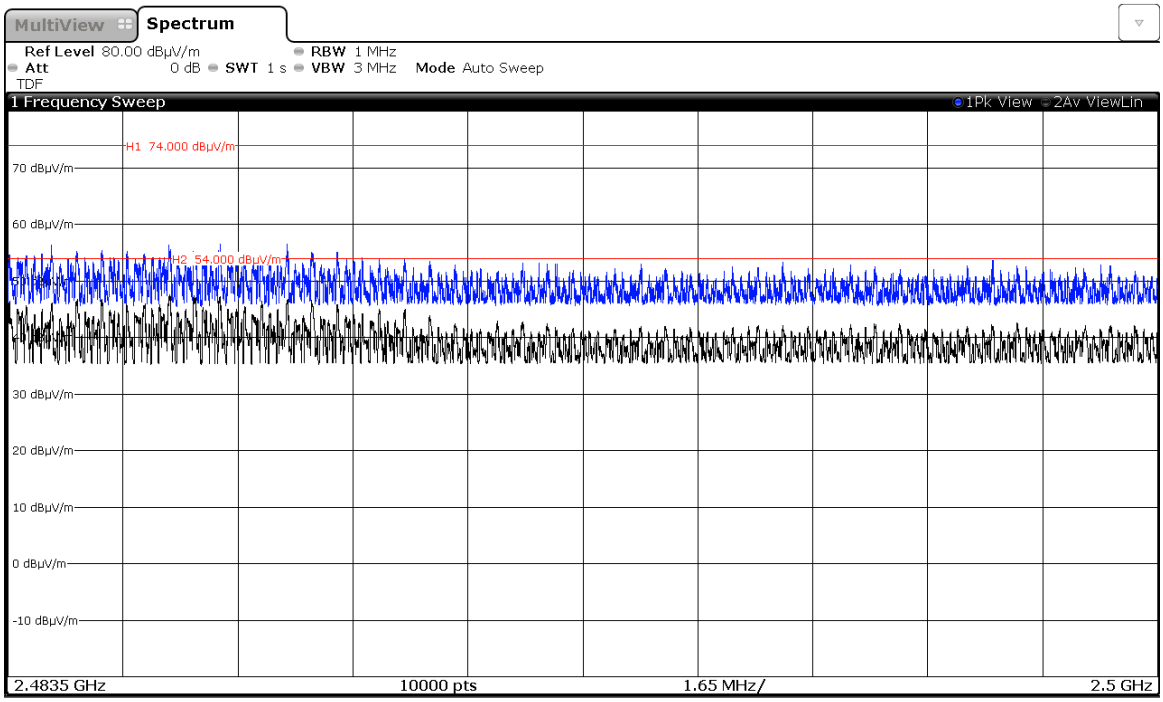
1. WiFi 2.4GHz 802.11 b mode

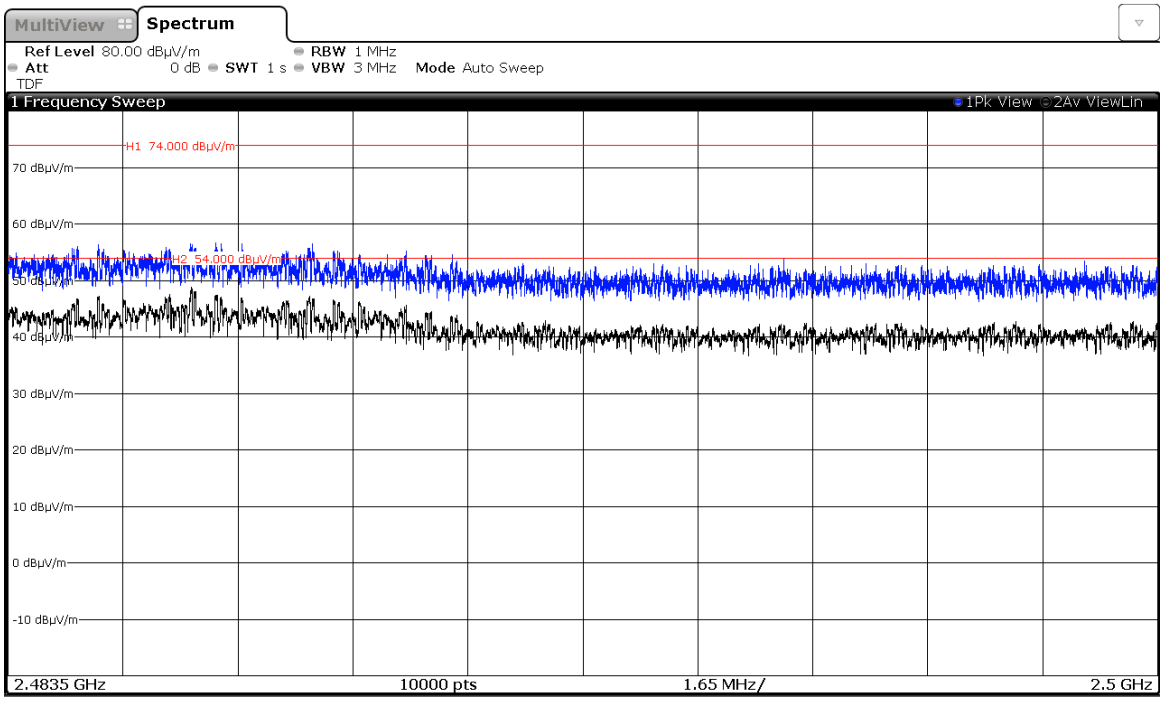
CHANNEL 11 (2462 MHz).



2. WiFi 2.4GHz 802.11 g mode

CHANNEL 11 (2462 MHz).



3. WiFi 2.4GHz 802.11 n20 mode

CHANNEL 11 (2462 MHz).