

FCC LISTED, REGISTRATION
NUMBER: 720267

Informe de ensayo nº:
Test report No:

IC LISTED REGISTRATION
NUMBER IC 4621A-1

NIE: 44623RRF.001

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	Automotive headunit
Marca Trademark	Daimler
Modelo y/o referencia tipo Model and /or type reference	NTG5 HU (J6)
Other identification of the product	FCC ID: T8GNTG5HU IC: 6434A-NTG5HU
Final HW version	D-Sample
Final SW version	Serial SW
Características Features	BT, WLAN, Kleer, GPS Drive, Tuner, Navigation
Fabricante Manufacturer	Harman Becker Automotive Systems GmbH Becker-Görling-Str. 16, 76307 Karlsbad (Germany)
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). Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r04 dated 01/07/2016. 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: 2016.04.13 10:03:10 +02'00'
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Competences and guarantees

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

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

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

AT4 wireless guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at AT4 wireless at the time of performance of the test.

AT4 wireless is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

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

IMPORTANT: No parts of this report may be reproduced or quoted out of context, in any form or by any means, except in full, without the previous written permission of AT4 wireless.

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of AT4 wireless.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of AT4 wireless and the Accreditation Bodies.

Uncertainty

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

Usage of samples

Samples undergoing test have been selected by: **the client**

Sample S/01 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
44623/002	Automotive headunit	NTG5 HU (J6)	527 BEM062FS000863 2	2016-02-10
44623/003	Connection cable	---	---	2016-02-10
44623/004	Connection cable	---	---	2016-02-10
44623/005	Connection cable	---	---	2016-02-10
44623/006	Kleer antenna	---	---	2016-02-10
44623/007	BT EDR antenna	---	---	2016-02-10
44623/008	WiFi antenna	---	---	2016-02-10
44623/009	GPS antenna	---	---	2016-02-10

Auxiliary elements used with the sample S/01:

Control N°	Description	Model	Serial N°	Date of reception
44623/010	PCB	---	---	2016-02-10
44623/011	USB cable	---	---	2016-02-10
38058/272	Multiple connector	---	---	2013-02-19

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

All radiated tests indicated in appendix A and appendix B.

Sample S/02 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
44623/002	Automotive headunit	NTG5 HU (J6)	527 BEM062FS000863 2	2016-02-10
44623/003	Connection cable	---	---	2016-02-10
44623/005	Connection cable	---	---	2016-02-10
44623/006	Kleer antenna	---	---	2016-02-10
44623/007	BTEDR antenna	---	---	2016-02-10
44623/009	GPS antenna	---	---	2016-02-10

Auxiliary elements used with the sample S/02:

Control N°	Description	Model	Serial N°	Date of reception
44623/010	PCB	---	---	2016-02-10
44623/011	USB cable	---	---	2016-02-10
38058/272	Multiple connector	---	---	2013-02-19

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

All conducted tests indicated in appendix A.

Sample S/03 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
44623/002	Automotive headunit	NTG5 HU (J6)	527 BEM062FS000863 2	2016-02-10
44623/003	Connection cable	---	---	2016-02-10
44623/004	Connection cable	---	---	2016-02-10
44623/005	Connection cable	---	---	2016-02-10
44623/007	BT EDR antenna	---	---	2016-02-10
44623/008	WiFi antenna	---	---	2016-02-10
44623/009	GPS antenna	---	---	2016-02-10

Auxiliary elements used with the sample S/03:

Control N°	Description	Model	Serial N°	Date of reception
44623/010	PCB	---	---	2016-02-10
44623/011	USB cable	---	---	2016-02-10
38058/272	Multiple connector	---	---	2013-02-19

1. Sample S/03 has undergone following test(s).

All conducted tests indicated in appendix B.

Test sample description

The test sample consists of an automotive headunit with BT, WLAN, Kleer, GPS Drive, Tuner and Navigation.

Identification of the client

Harman Becker Automotive Systems GmbH.
Becker-Göring-Str. 16, 76307 Karlsbad (Germany).

Testing period

The performed test started on 2016-02-18 and finished on 2016-02-23.

The tests have been performed at AT4 wireless.

Environmental conditions

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

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

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

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

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

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

Remarks and comments

1: Used instrumentation:

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Spectrum analyser Agilent PSA E4440A	2014/05	2016/05
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	2014/03	2017/03
3.	Multi Device Controller EMCO 2090	N.A.	N.A.
4.	Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2013/11	2016/11
5.	Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2014/03	2017/03
6.	EMI Test Receiver R&S ESU 40	2014/02	2016/02
7.	Spectrum analyser Rohde & Schwarz FSW50	2015/12	2017/12
8.	RF pre-amplifier 10 MHz-6 GHz SCHWARZBECK BBV9743	2015/03	2016/03
9.	RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-3A	2015/05	2016/05
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. WiFi 2.4 GHz (802.11b/g).

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	P			
Section 15.247 Subclause (b) / RSS-247 5.4. (4)	Maximum output power and antenna gain	P			
Section 15.247 Subclause (d) / RSS-247 5.5	Emission limitations conducted (Transmitter)	P			
Section 15.247 Subclause (d) / RSS-247 5.5. ..	Band-edge conducted emissions compliance (Transmitter)	P			
Section 15.247 Subclause (e) / RSS-247 5.2. (2)	Power spectral density	P			
Section 15.247 Subclause (d) / RSS-247 5.5. ...	Emission limitations radiated (Transmitter)	P			

2. Kloor.

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	P			
Section 15.247 Subclause (b) / RSS-247 5.4. (4)	Maximum output power and antenna gain	P			
Section 15.247 Subclause (d) / RSS-247 5.5	Emission limitations conducted (Transmitter)	P			
Section 15.247 Subclause (d) / RSS-247 5.5. ..	Band-edge conducted emissions compliance (Transmitter)	P			
Section 15.247 Subclause (e) / RSS-247 5.2. (2)	Power spectral density	P			
Section 15.247 Subclause (d) / RSS-247 5.5. ...	Emission limitations radiated (Transmitter)	P			

Appendix A – Test result “WiFi 2.4 GHz (802.11b/g)”

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TEST CONDITIONS

Power supply (V):

$V_{\text{nominal}} = 12.6 \text{ Vdc}$

Type of power supply = External power supply (Battery).

Type of antenna: External OEM antenna

Declared Gain for antenna (maximum) = 2.4 dBi

TEST FREQUENCIES:

For WiFi 802.11b/g:

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v03r04 dated 01/07/2016.

The laptop computer was used to configure the EUT to continuously transmit at a specified output power “15dBm” in all channels with different modes and modulation schemes.

WiFi 2.4 GHz: 802.11b, 802.11g.

The field strength at the band edges was evaluated for each mode for the channel under test.

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

The data rates of 5.5Mb/s for 802.11b, 6Mb/s for 802.11g 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.

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to the spectrum analyzer using a low loss RF cable. The measurements are corrected taking into account the cable loss.



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).

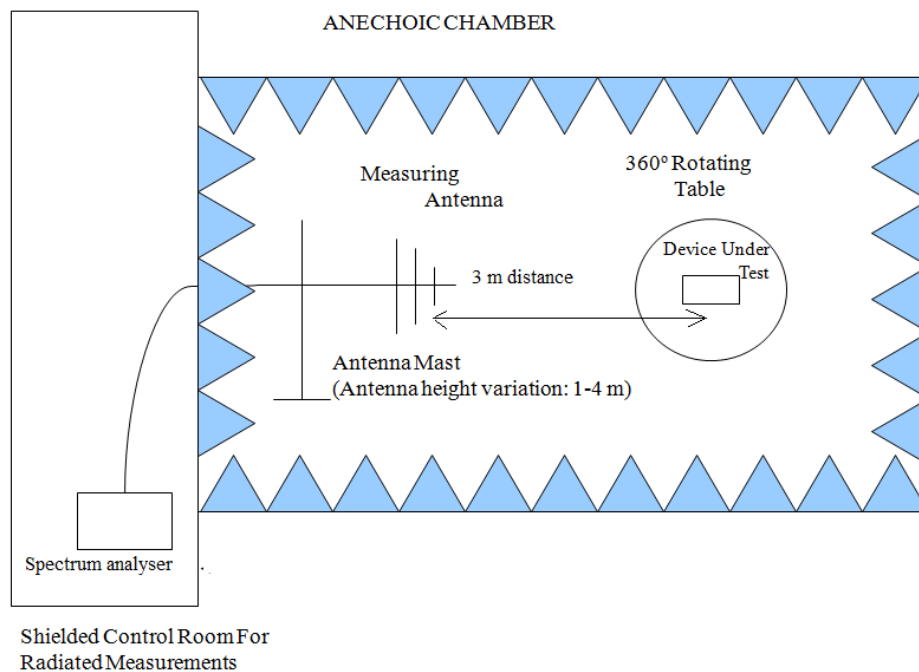
For radiated emissions in the range 1 GHz-25 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive (wooden) platform 1.5 meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission.

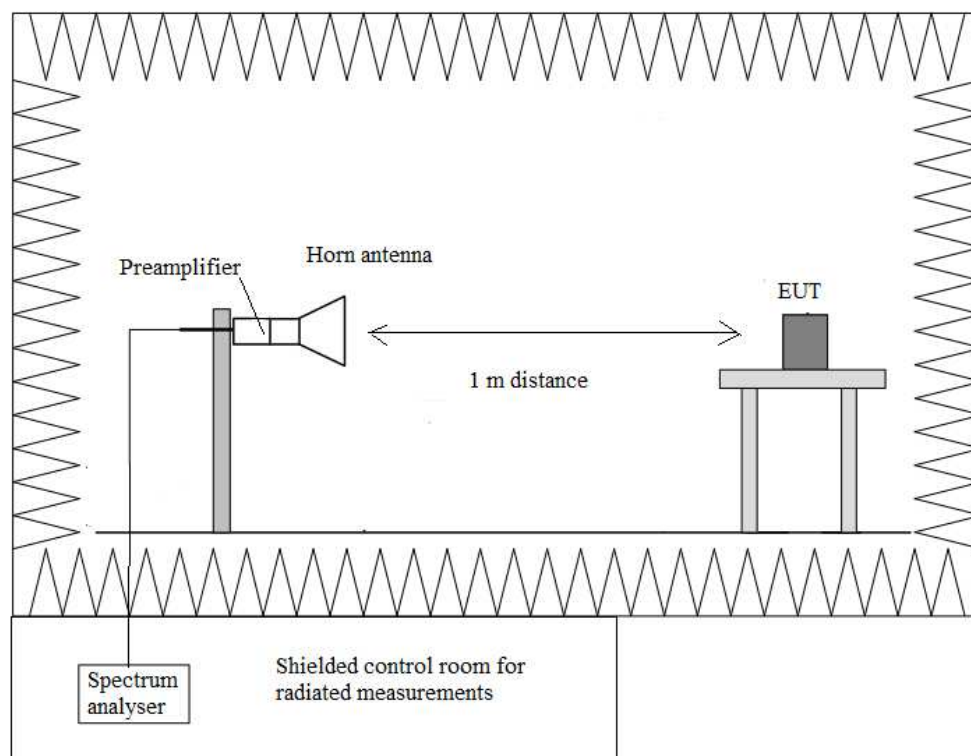
It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

Radiated measurements setup $f < 1$ GHz



Radiated measurements setup $f > 1$ GHz



Occupied Bandwidth

RESULTS

(see next plots)

Mode B

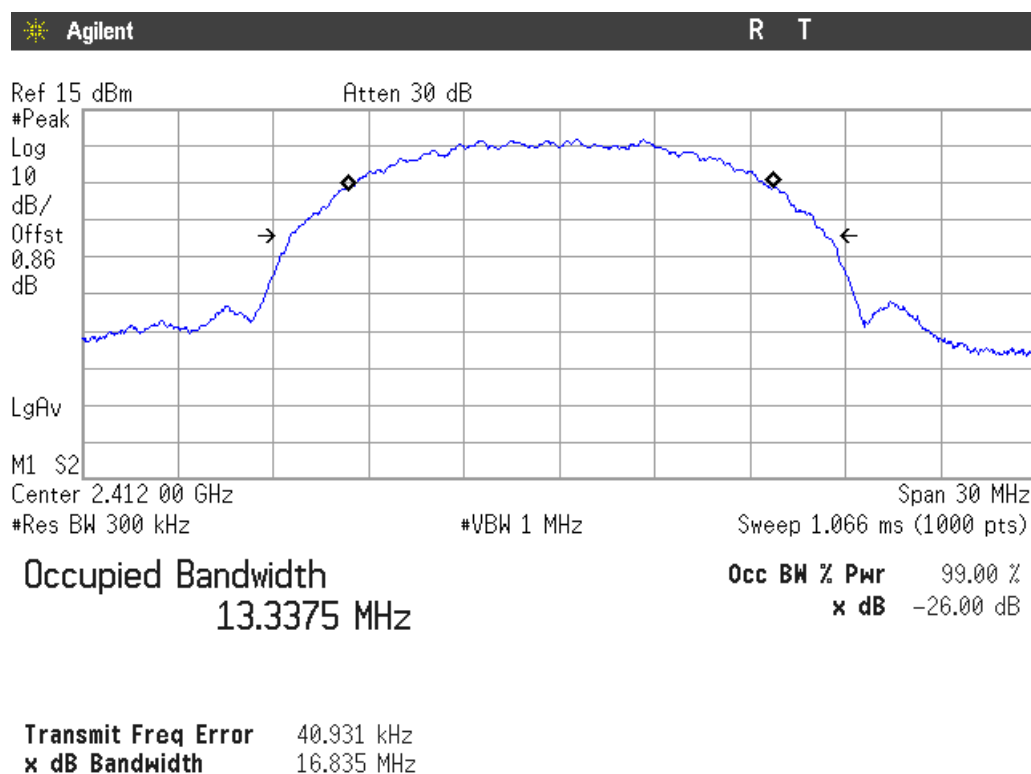
	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	13.337	13.343	13.343
-26 dBc bandwidth (MHz)	16.835	16.840	16.843
Measurement uncertainty (kHz)	<±50		

Mode G

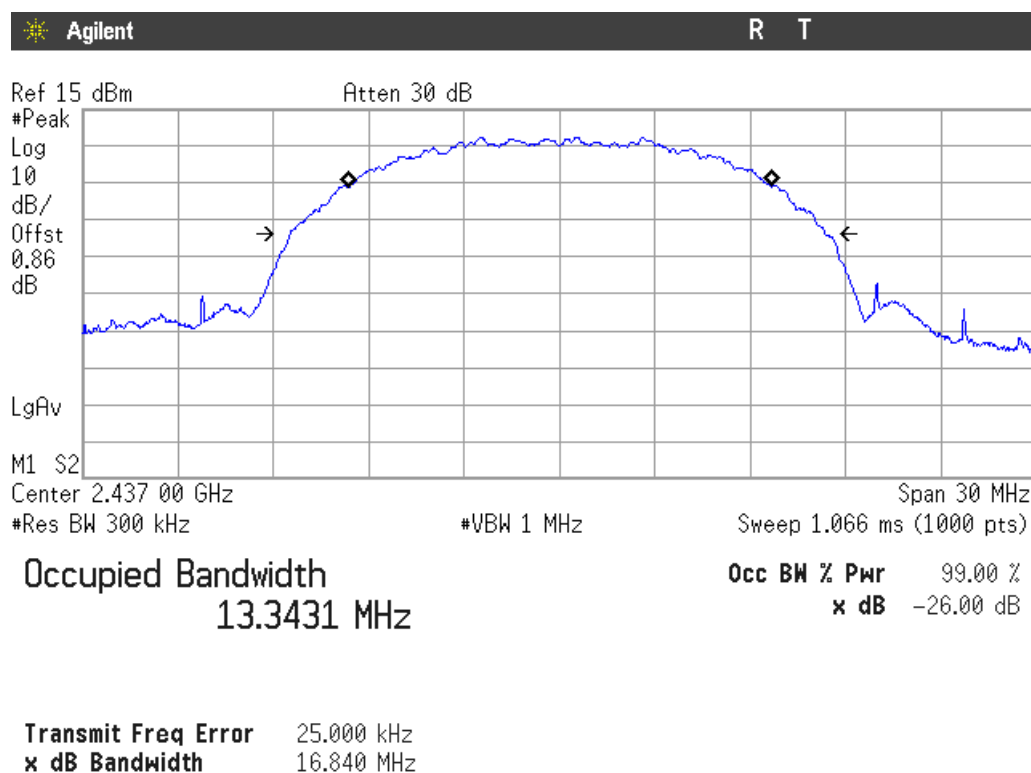
	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	16.794	16.784	16.815
-26 dBc bandwidth (MHz)	20.129	20.141	20.172
Measurement uncertainty (kHz)	<±50		

Mode B

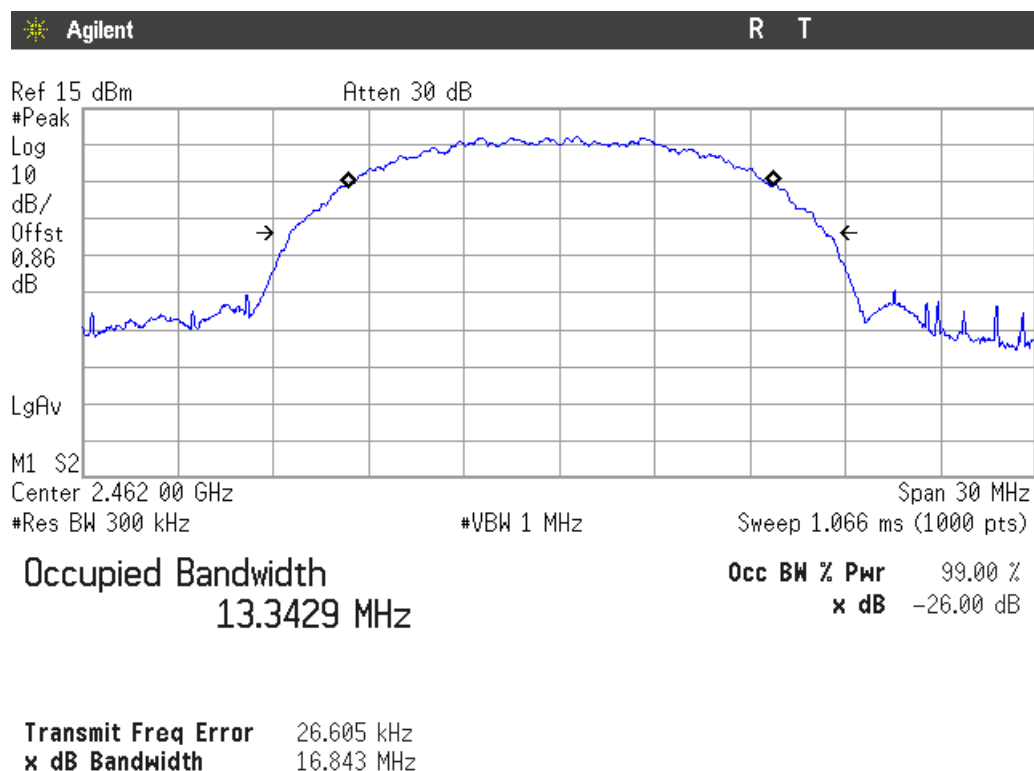
Lowest Channel



Middle Channel

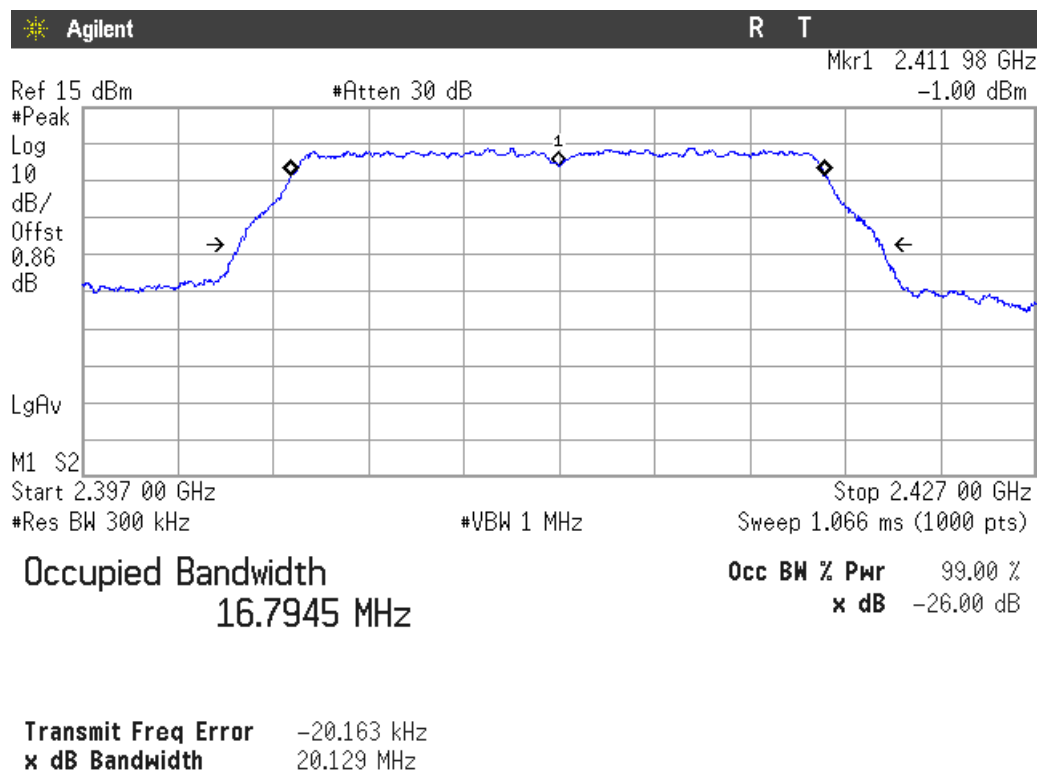


Highest channel

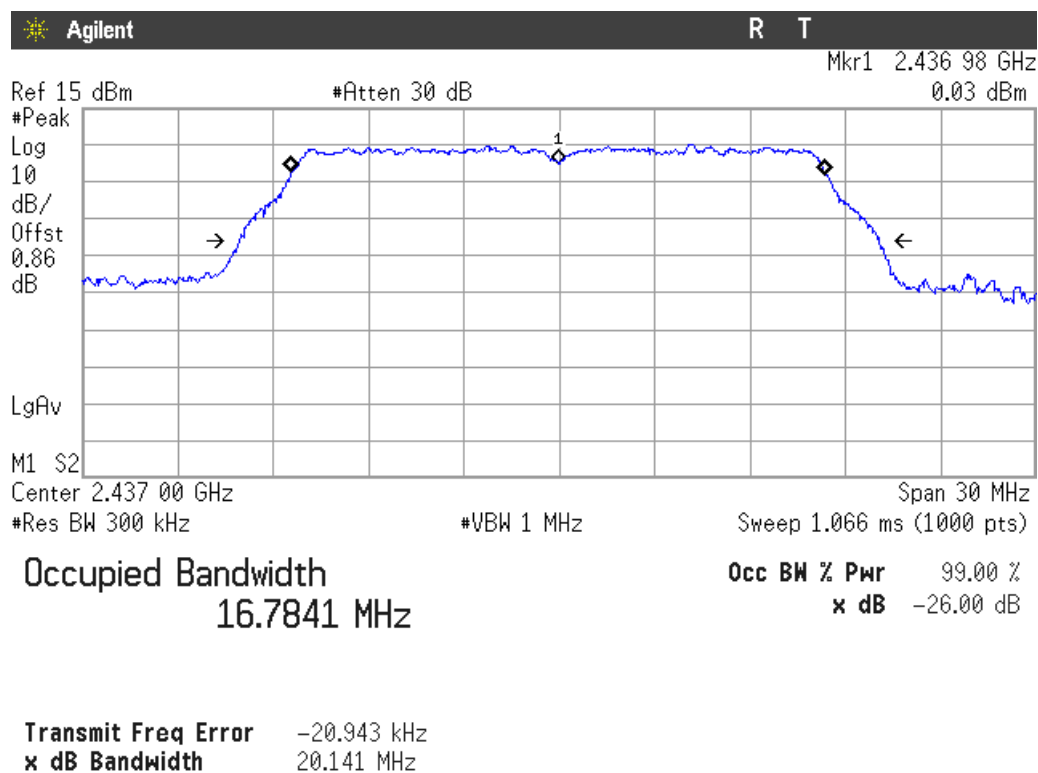


Mode G

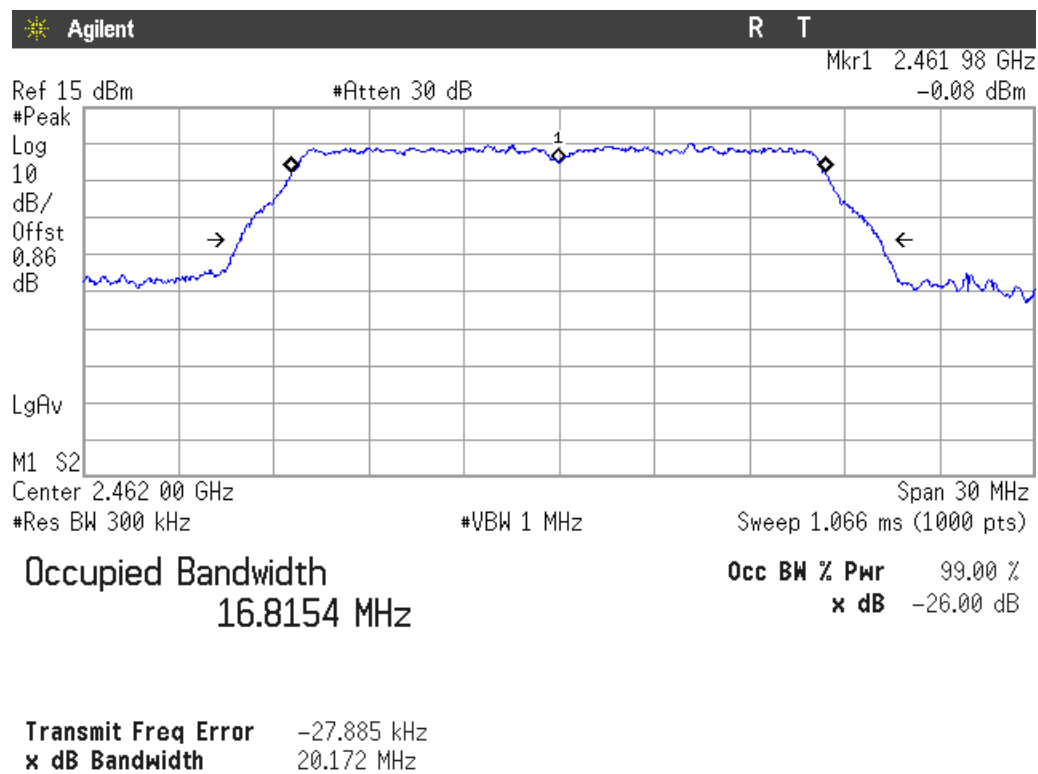
Lowest Channel



Middle Channel



Highest channel



Section 15.247 Subclause (a) (2) / RSS-247 5.2. (1). 6 dB Bandwidth

SPECIFICATION

The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

6 dB Bandwidth (see next plots).

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	10.290	10.290	10.430
Measurement uncertainty (kHz)	<±65.0		

Mode G

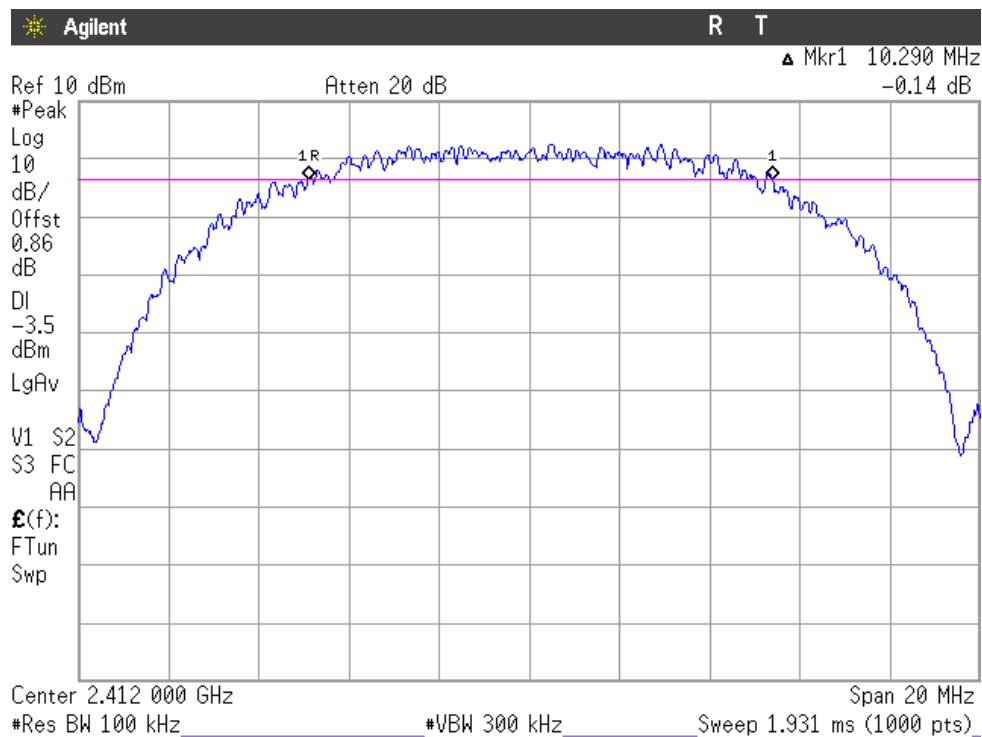
	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	16.597	16.597	16.557
Measurement uncertainty (kHz)	<±65.0		

Verdict: PASS

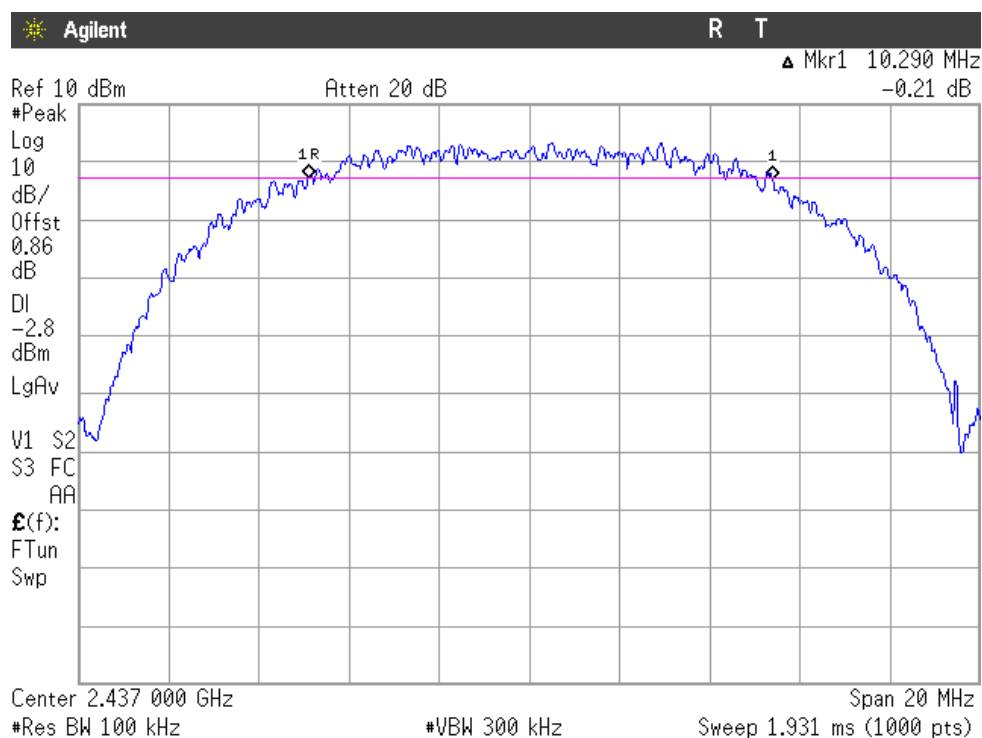
6 dB BANDWIDTH.

Mode B

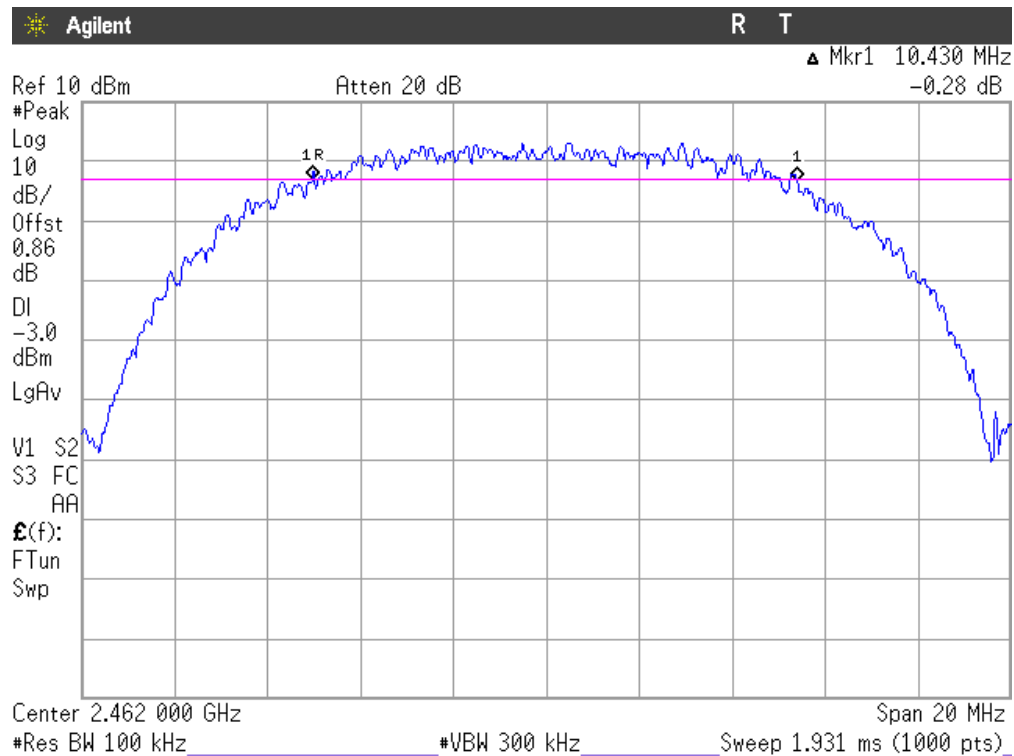
Lowest Channel



Middle Channel

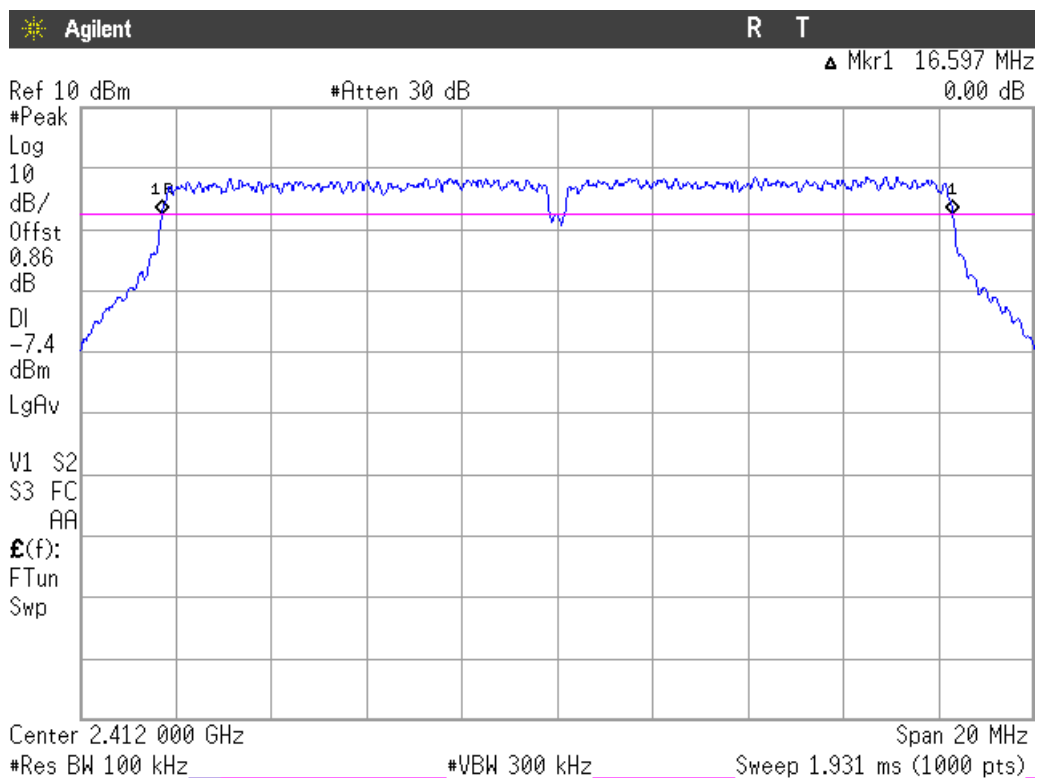


Highest channel

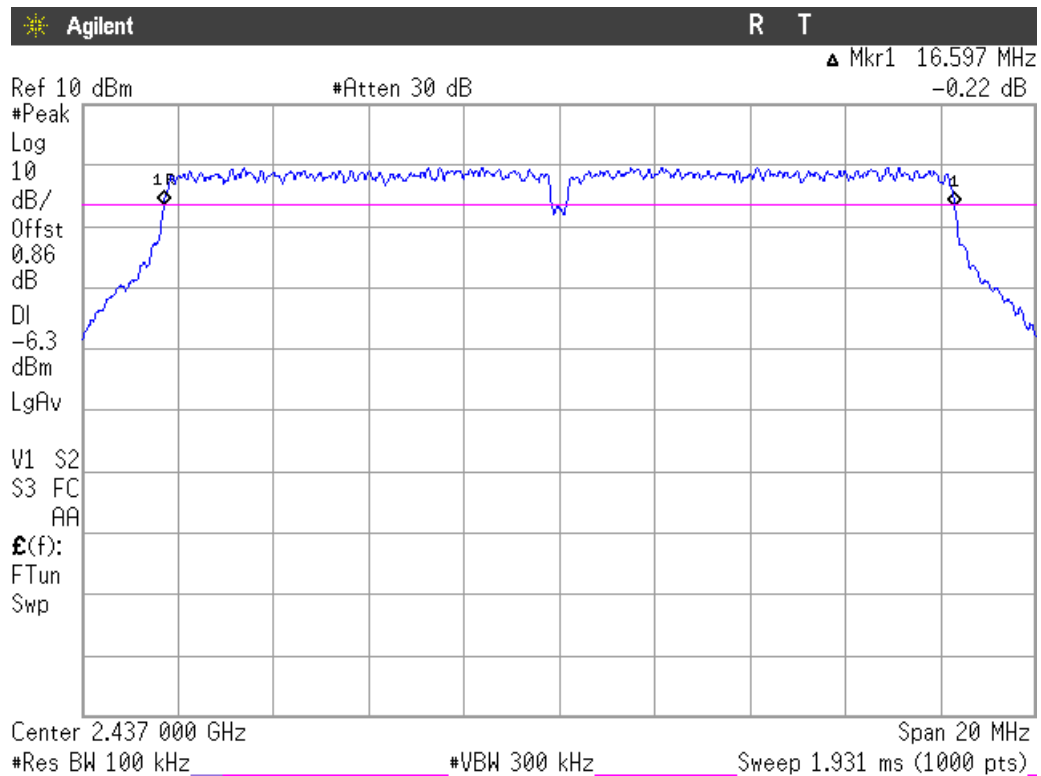


Mode G

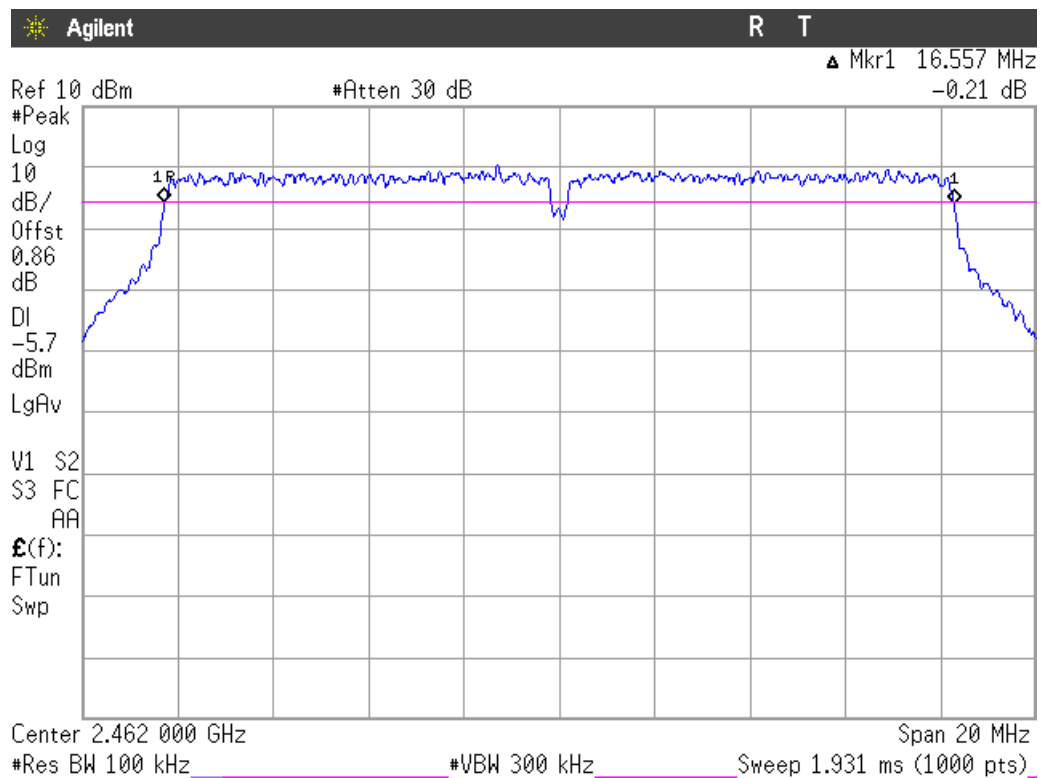
Lowest Channel



Middle Channel



Highest channel



Section 15.247 Subclause (b) / RSS-247 5.4. (4). Maximum output power and antenna gain

SPECIFICATION

For systems using digital modulation in the 2400-2483.5 MHz band: 1 watt (30 dBm).
The e.i.r.p. shall not exceed 4 W (36 dBm) (Canada).

RESULTS

The maximum conducted (average) output power was measured using the method according to point 9.2.2.2. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247 558074 D01 DTS Meas Guidance v03r04 dated 01/07/2016.

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

MAXIMUM OUTPUT POWER. See next plots.

Maximum declared antenna gain: 2.4 dBi.

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	13.02	13.53	13.43
Maximum EIRP power (dBm)	15.42	15.93	15.83
Measurement uncertainty (dB)	<±0.79		

Mode G

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	12.74	13.79	13.64
Maximum EIRP power (dBm)	15.14	16.19	16.04
Measurement uncertainty (dB)	<±0.79		

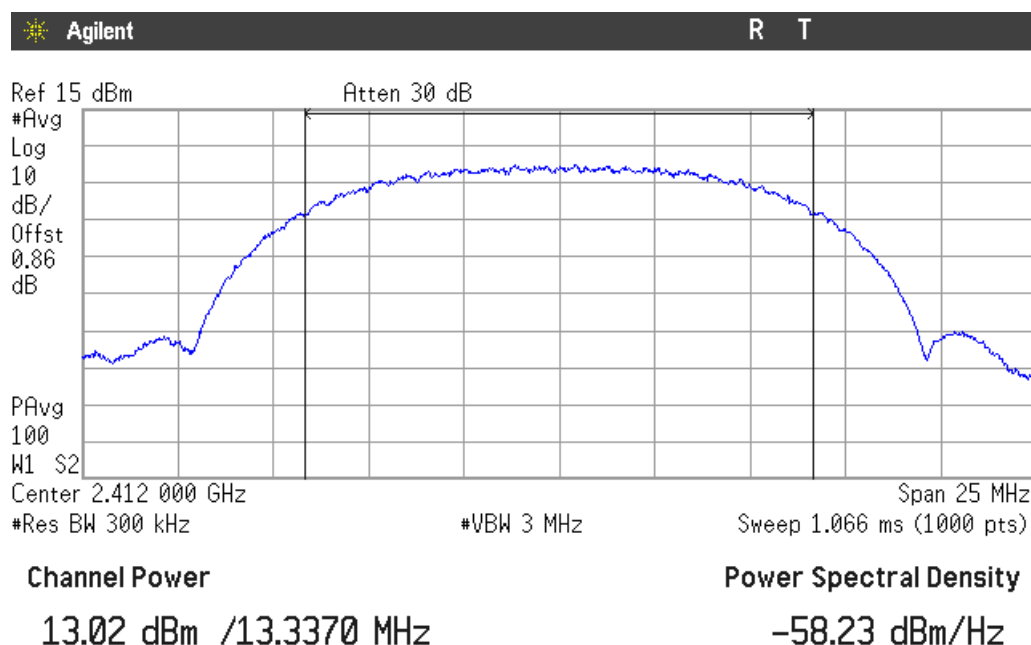
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

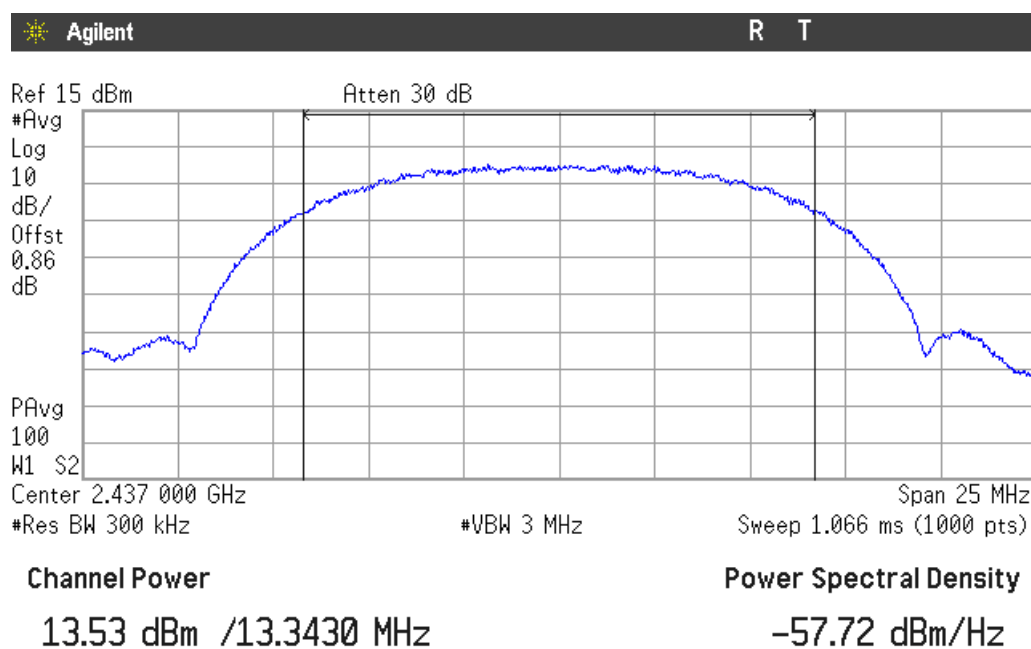
CONDUCTED AVERAGE POWER.

Mode B

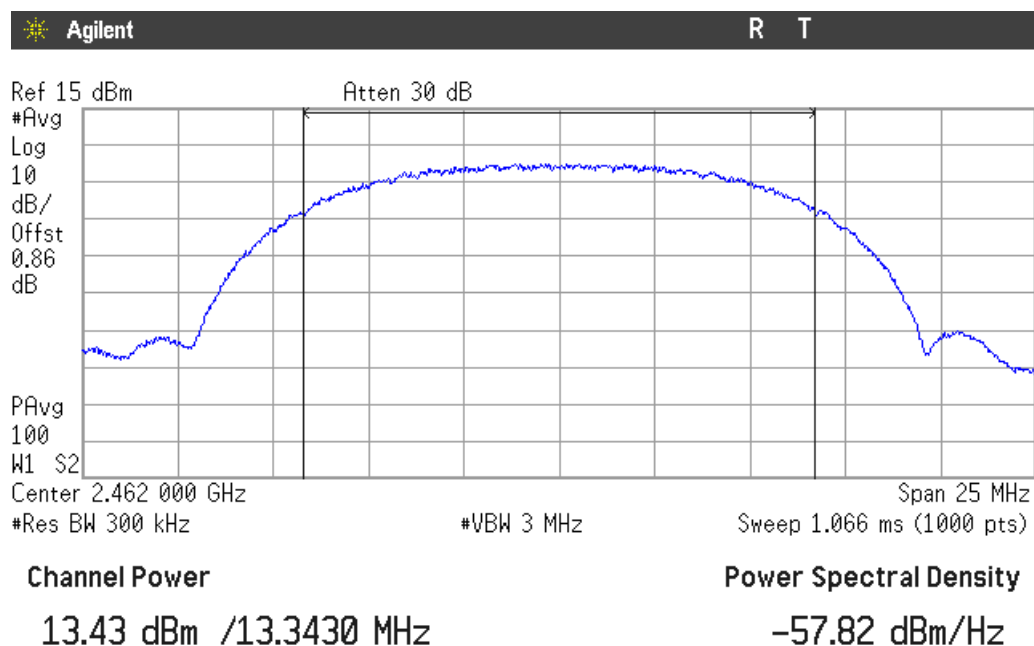
Lowest Channel



Middle Channel

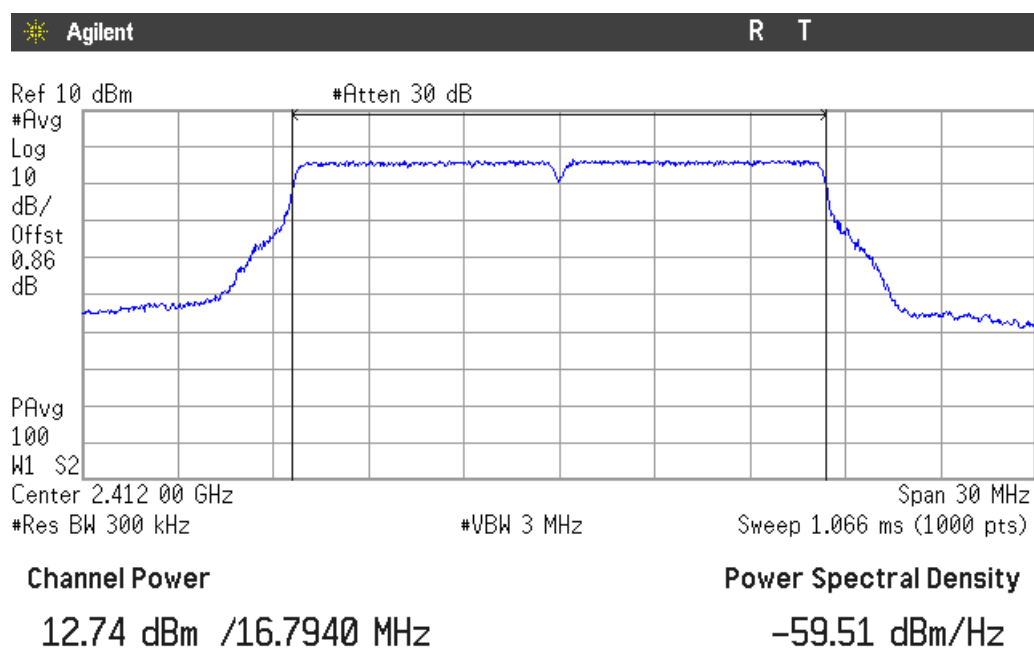


Highest channel

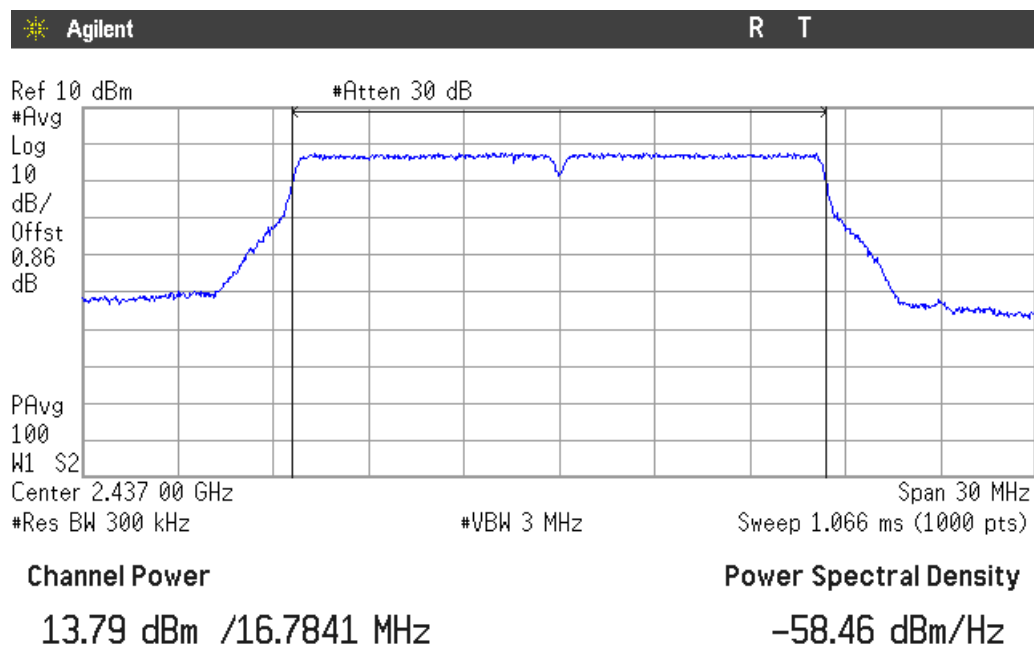


Mode G

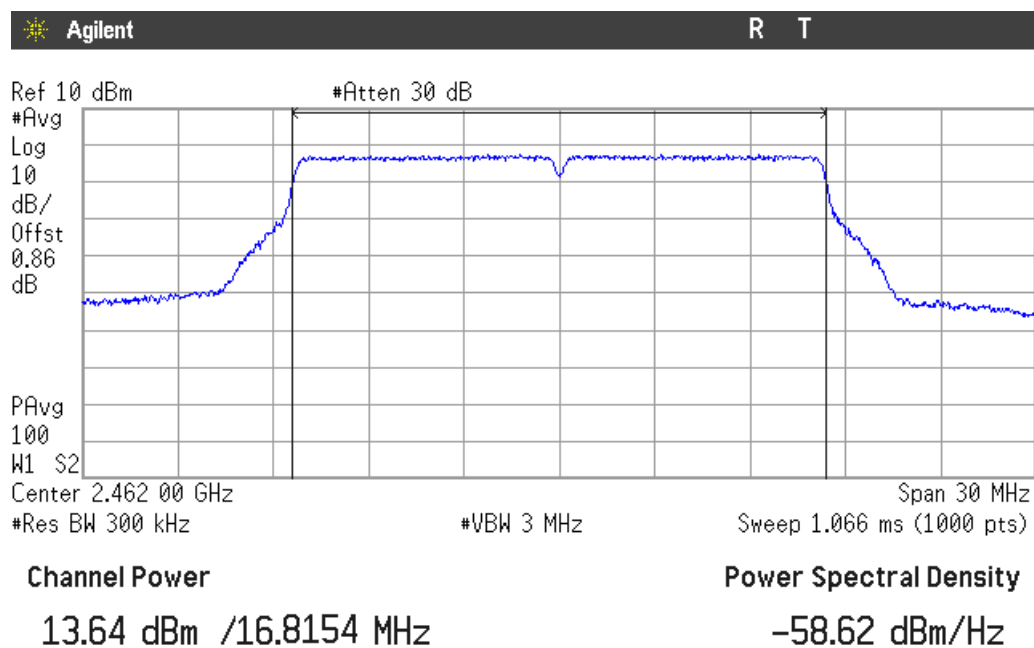
Lowest Channel



Middle Channel



Highest channel



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

SPECIFICATION

In any 100 kHz bandwidth outside the frequency band in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

RESULTS:

Reference Level Measurement

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	2.53	3.24	2.94
Measurement uncertainty (dB)	<±0.78		

Mode G

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	-1.34	-0.38	-0.49
Measurement uncertainty (dB)	<±0.78		

Mode B

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-27.47

Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-26.76

Highest frequency 2462 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-27.06

Mode G

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-31.34

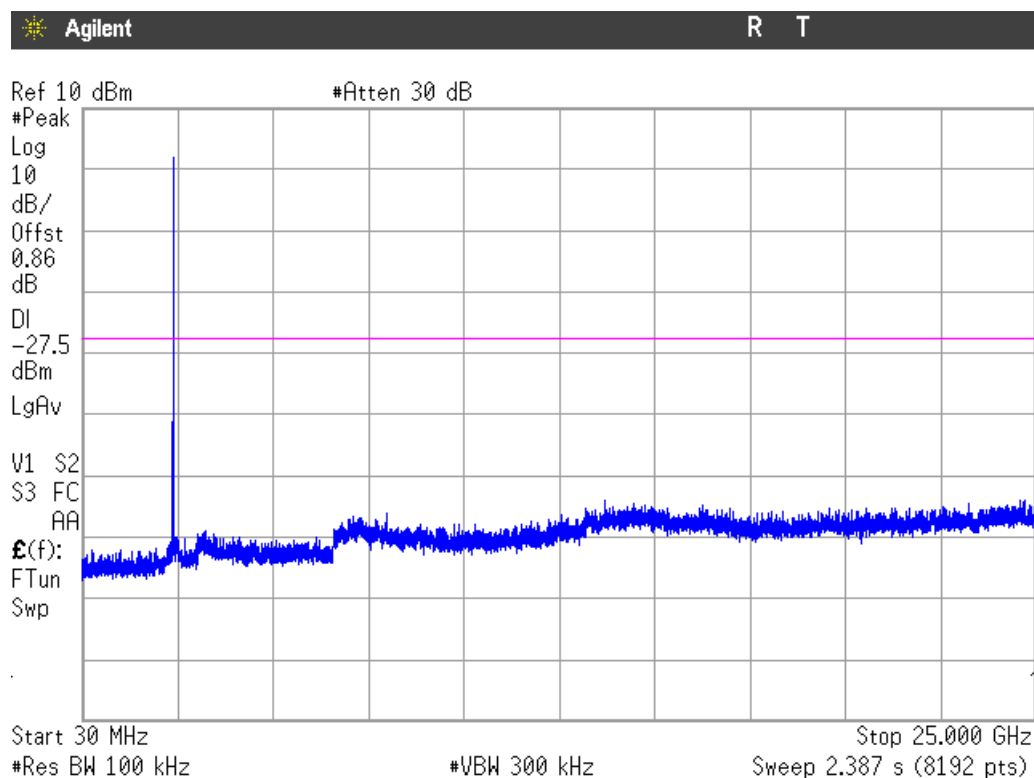
Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-30.38

Highest frequency 2462 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-30.49

Verdict: PASS

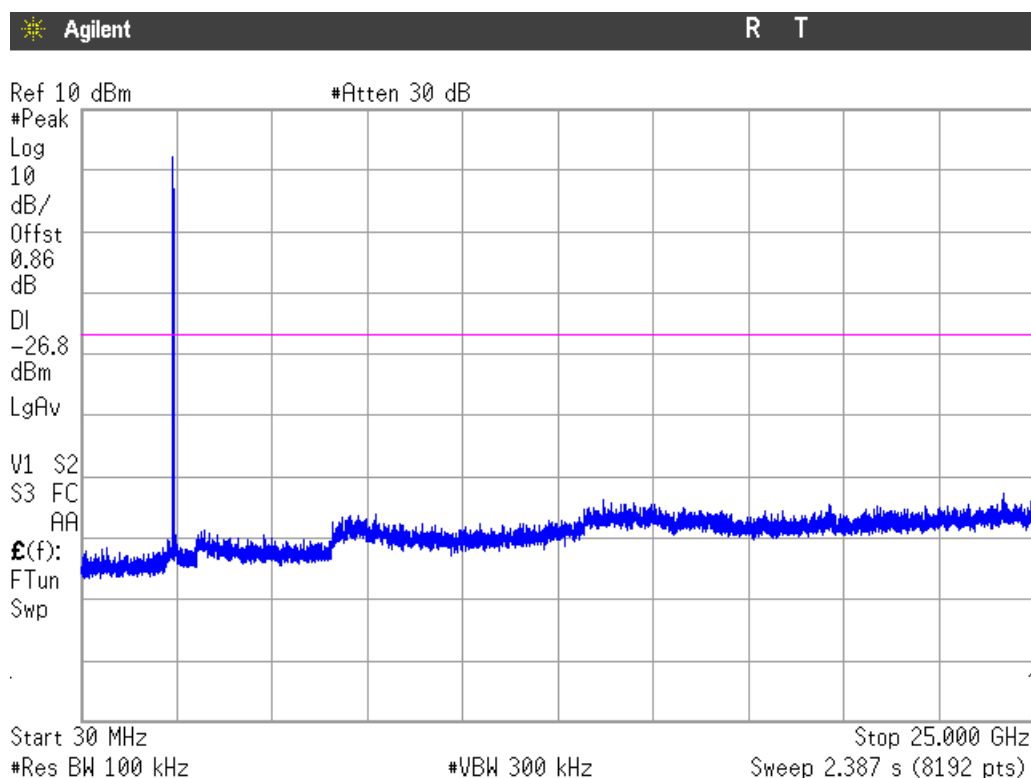
Mode B

Lowest Channel



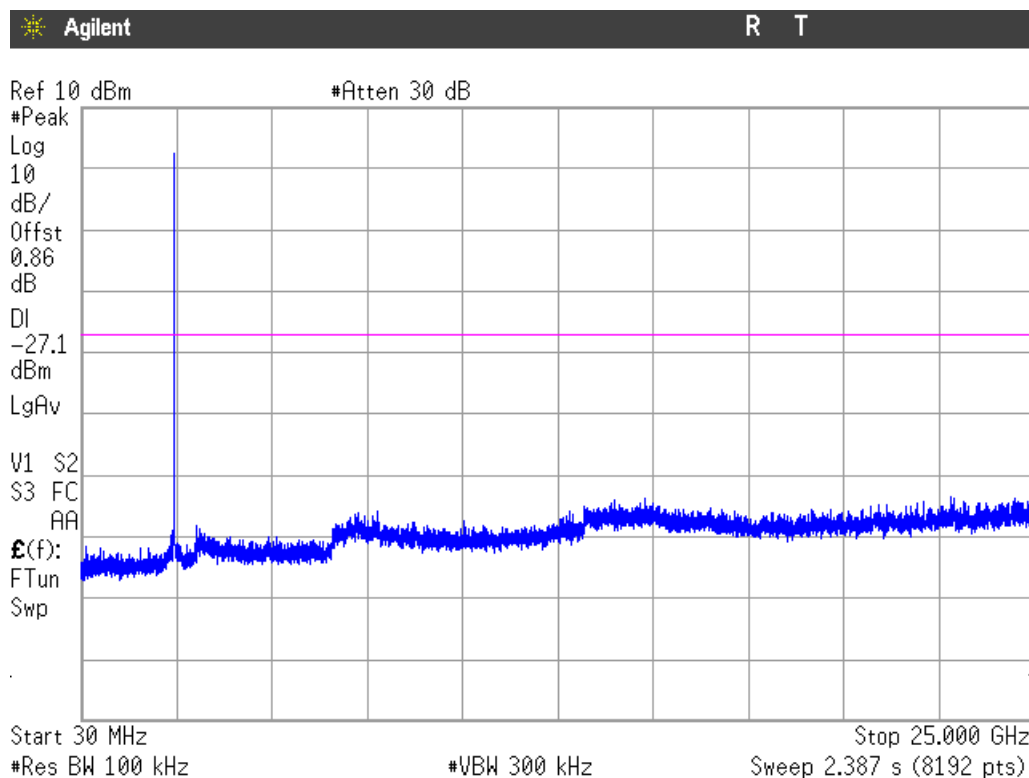
Note: The peak shown in the plot above the limit is the carrier frequency.

Middle Channel



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

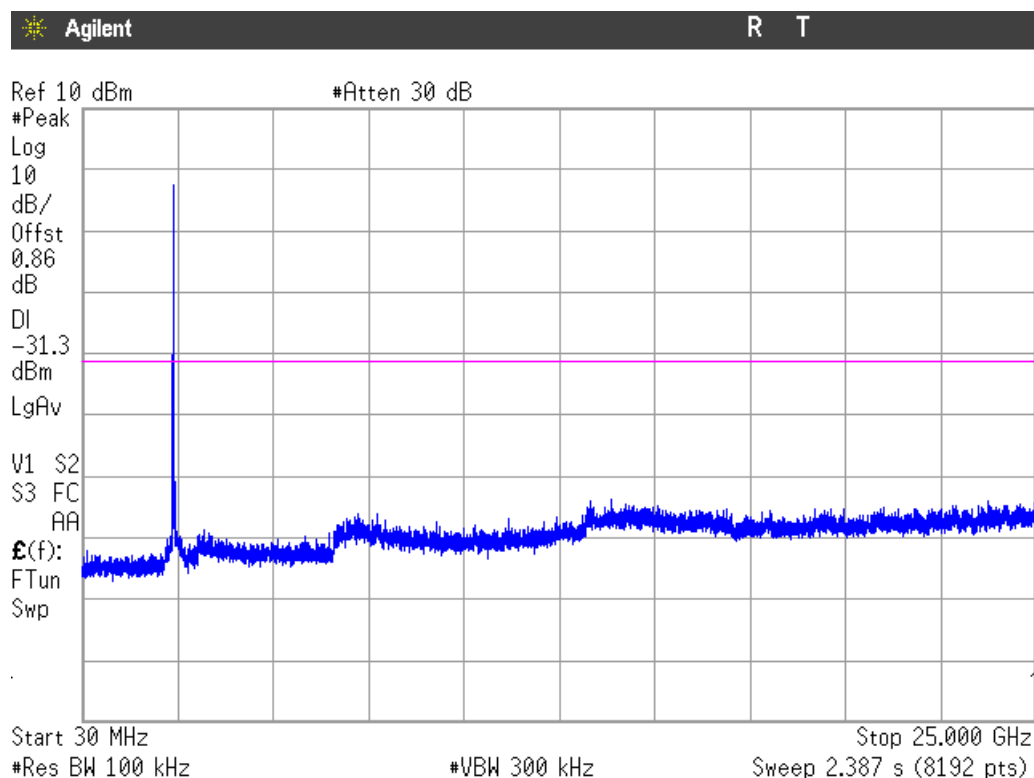
Highest channel



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

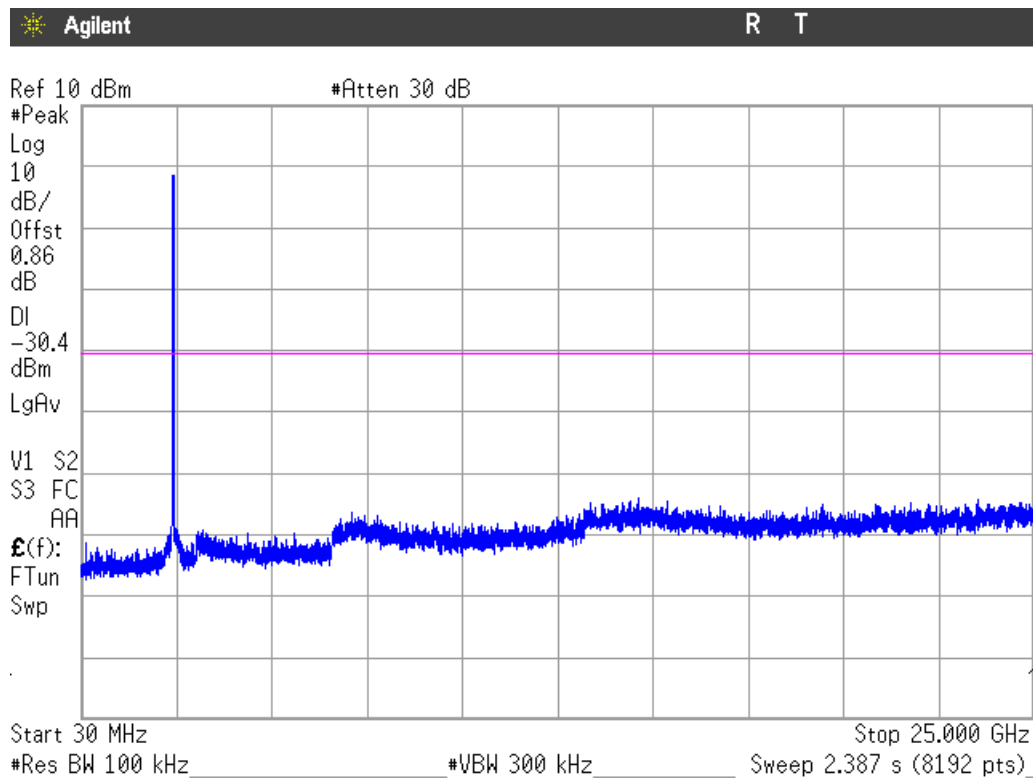
Mode G

Lowest Channel



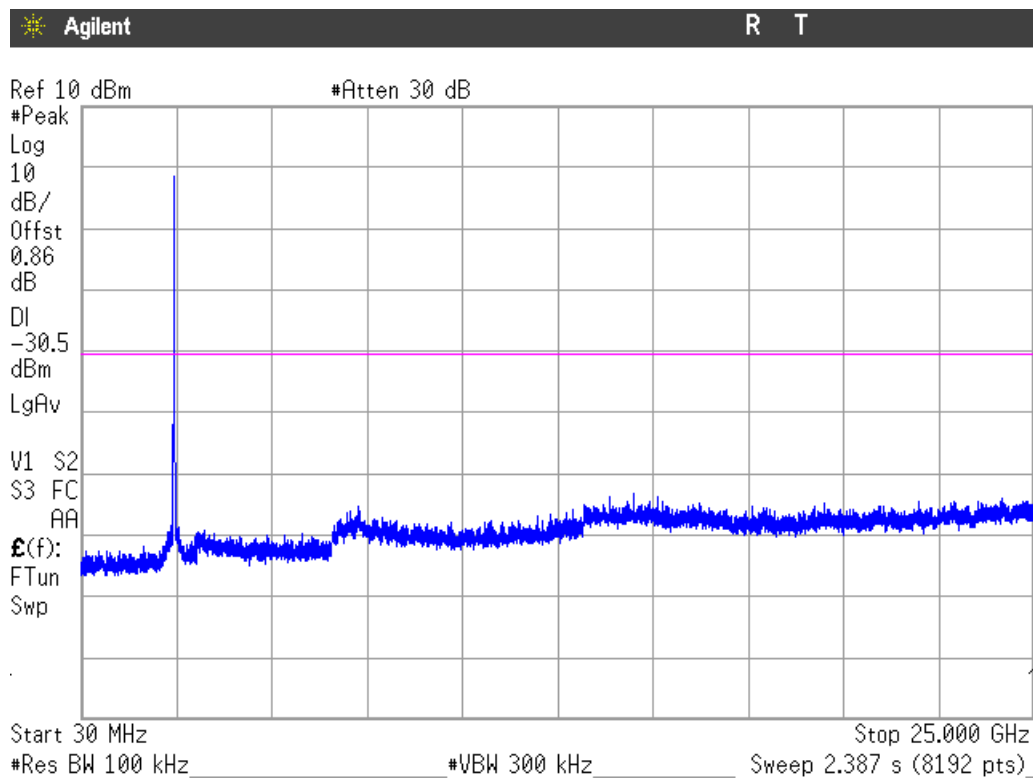
Note: The peak shown in the plot above the limit is the carrier frequency.

Middle Channel



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

Highest channel



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

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

SPECIFICATION

In any 100 kHz bandwidth outside the frequency band in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

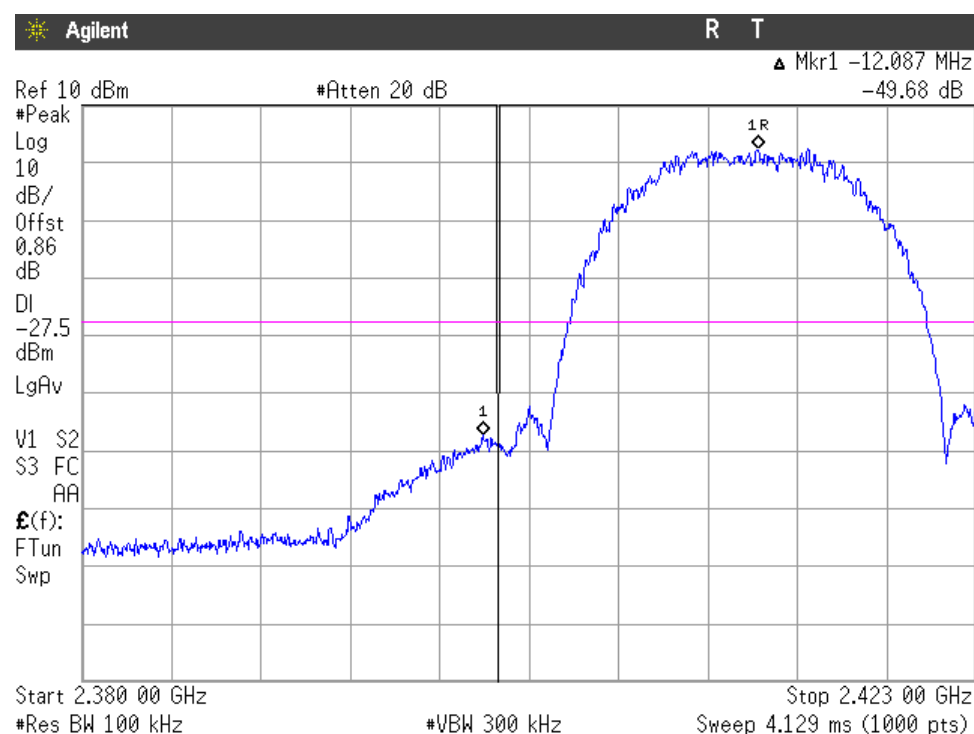
RESULTS:

Note: Radiated measurements were used to show compliance with the limits in the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

LOW FREQUENCY SECTION 2412 MHz. CONDUCTED.

Mode B

See next plots.

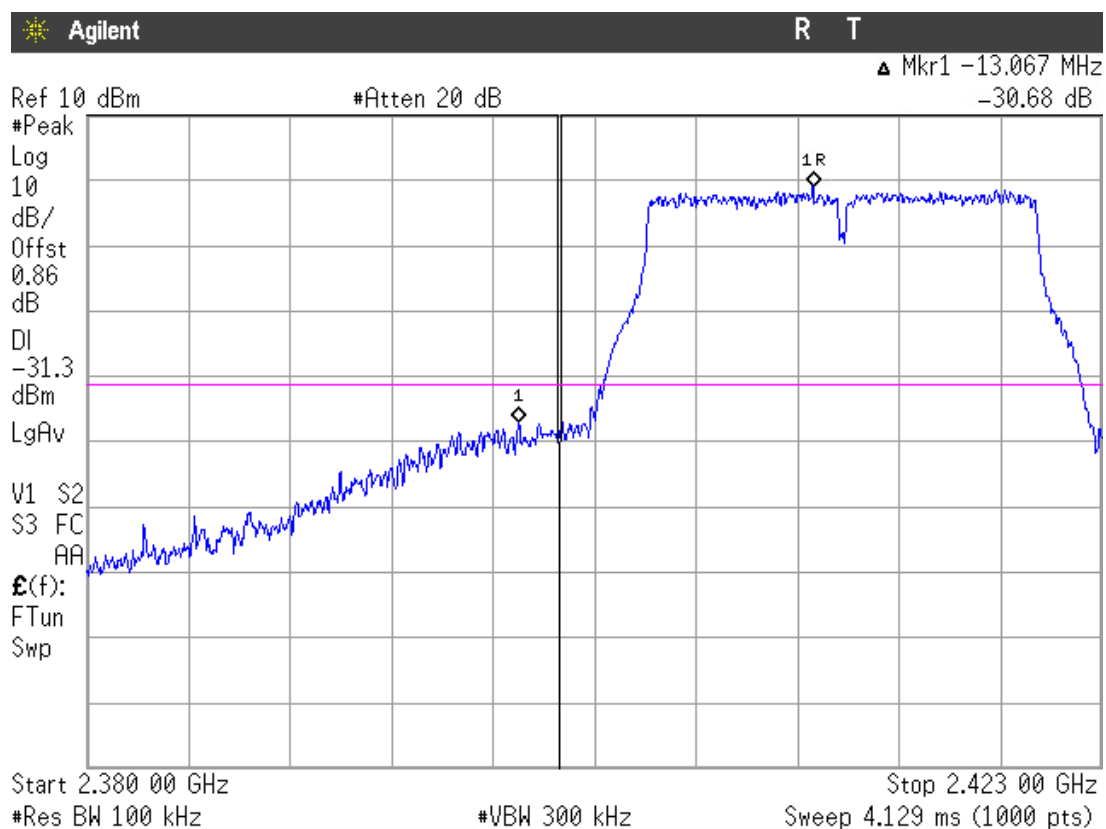


Measurement uncertainty (dB)	< ±2.03
------------------------------	---------

Verdict: PASS

Mode G

See next plot.



Measurement uncertainty (dB)	< ±2.03
------------------------------	---------

Verdict: PASS

Section 15.247 Subclause (e) / RSS-247 5.2. (2) Power spectral density

SPECIFICATION

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna 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 AVGPS-1 (AVG PSD) according to point 10.3. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r04 dated 01/07/2016.

Power spectral density (see next plots).

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-4.190	-3.773	-3.812
Measurement uncertainty (dB)	<±0.78		

Mode G

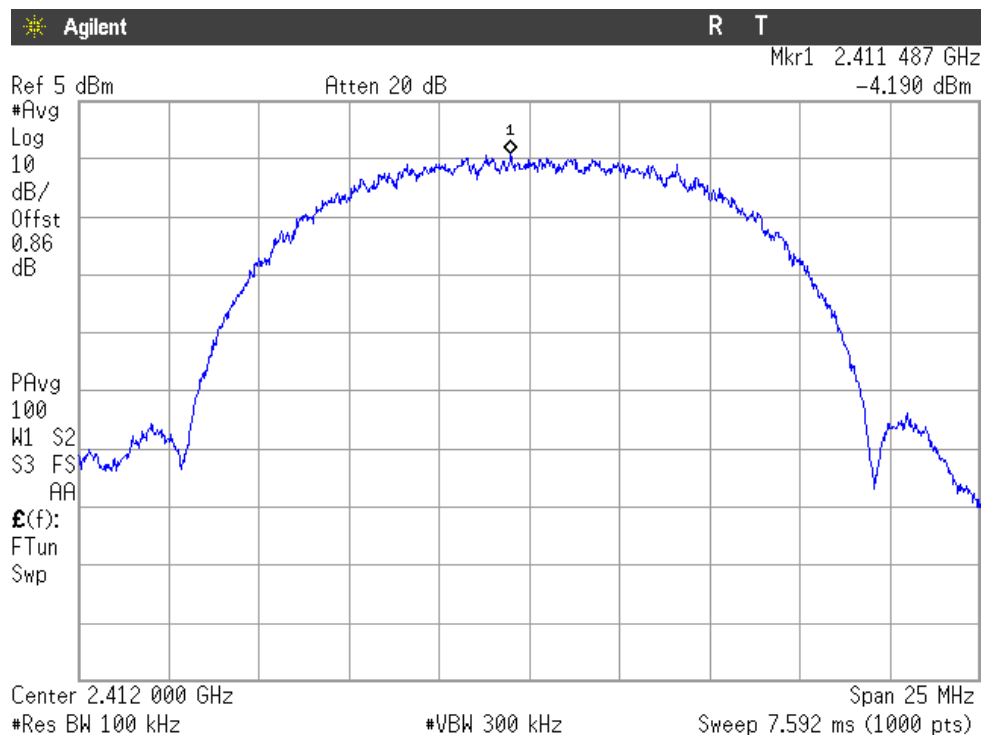
	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-7.083	-6.181	-6.237
Measurement uncertainty (dB)	<±0.78		

Verdict: PASS

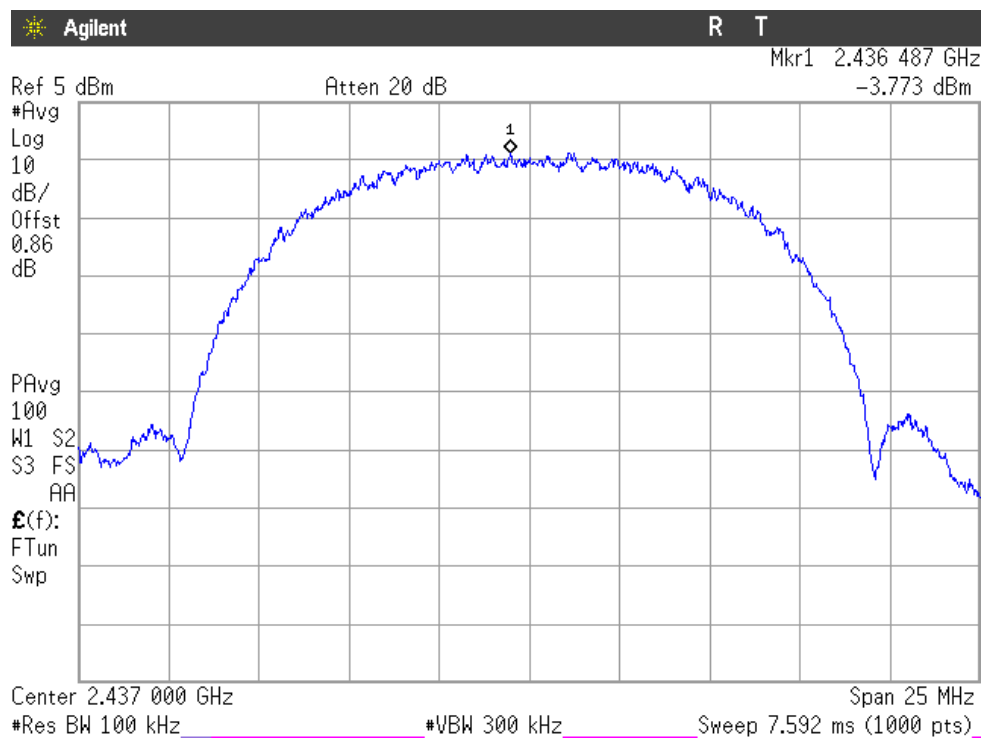
Power spectral density.

Mode B

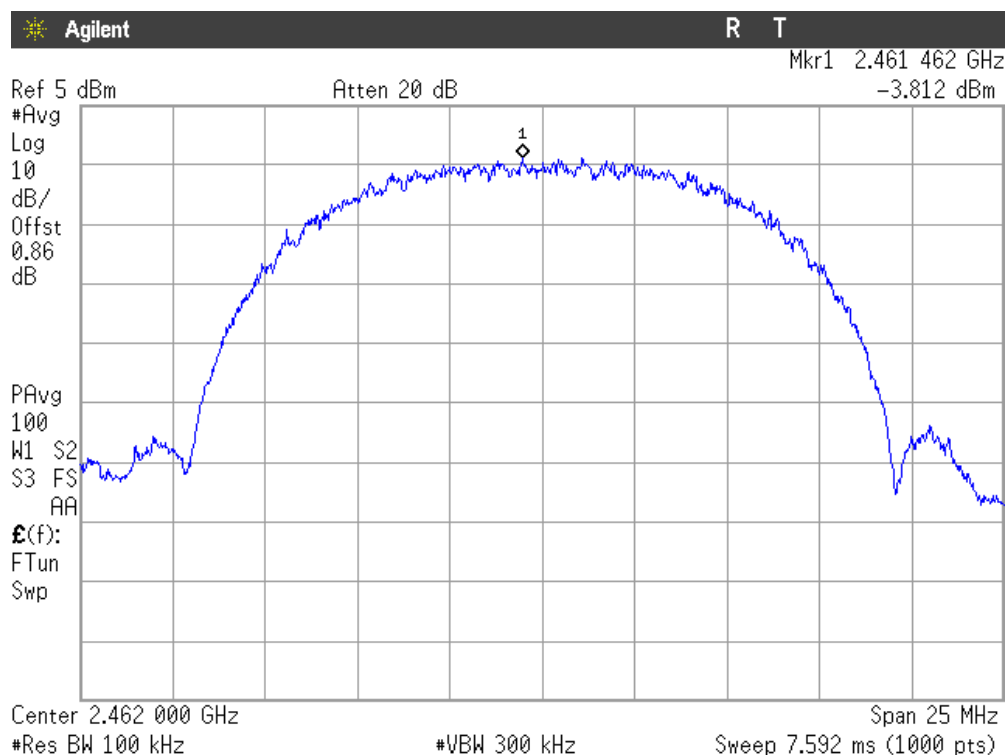
Lowest Channel



Middle Channel

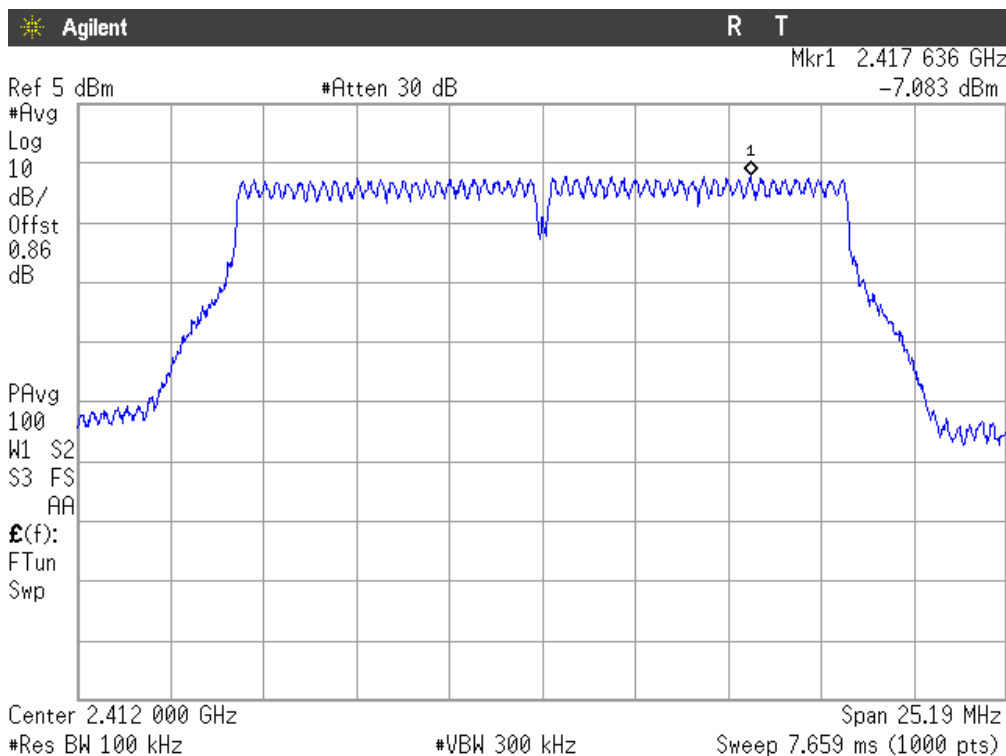


Highest channel

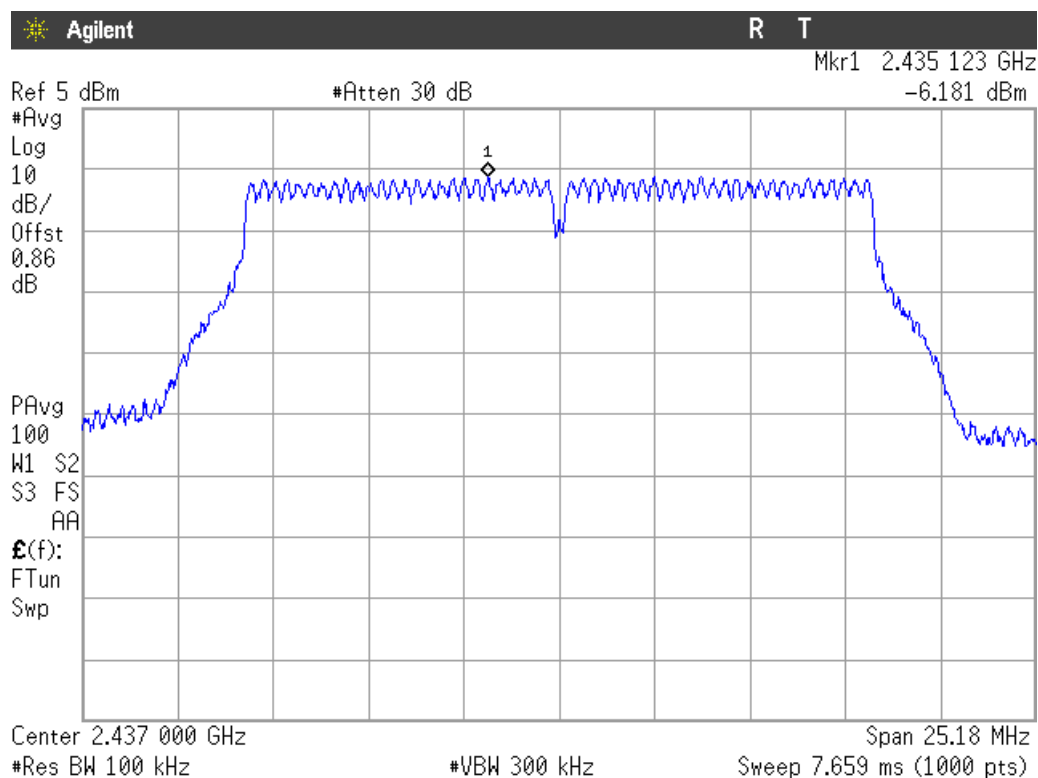


Mode G

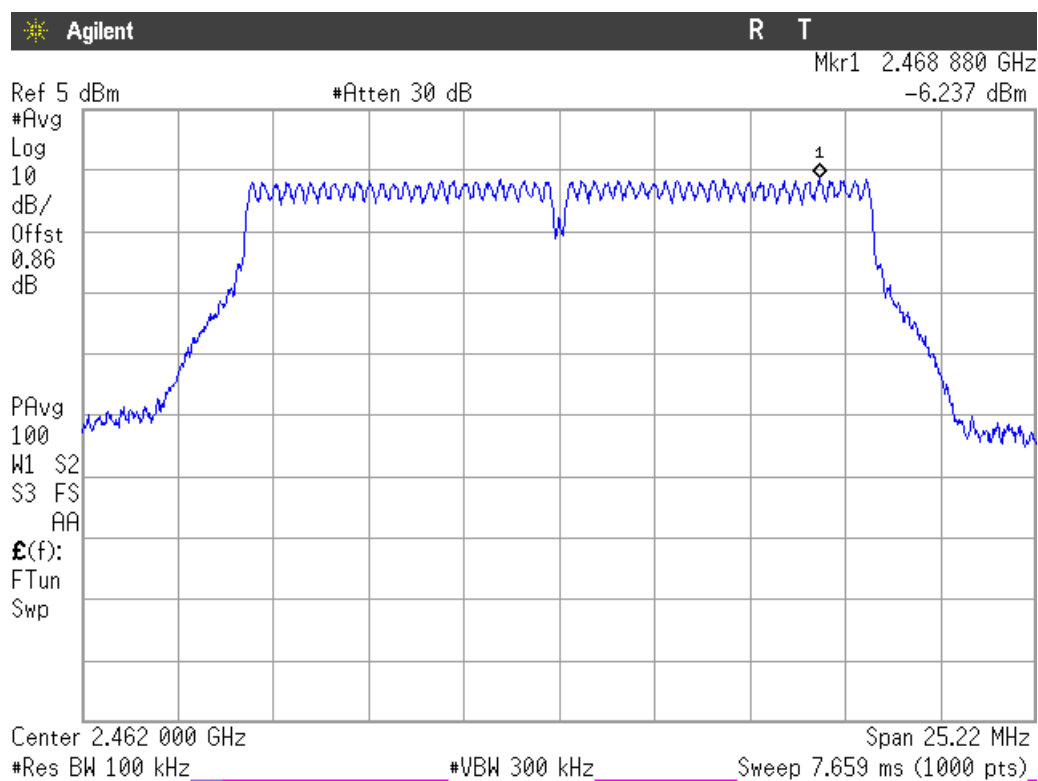
Lowest Channel



Middle Channel



Highest channel



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 ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RESULTS:

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

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

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-1000 MHz and at distance of 1m for the frequency range 1 GHz-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.

All peaks are more than 20 dB below the limit.

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 for the channel under test.

Spurious signals with peak levels above the average limit (54 dB μ V/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 (dB μ V/m)	Measurement Uncertainty (dB)
2.06443	PH	Peak	48.75	± 4.69
4.82925	PV	Peak	38.25	± 4.69

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

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
2.0647	PV	Peak	47.88	± 4.69
4.86875	PV	Peak	35.92	± 4.69
6.49875	PV	Peak	40.17	± 4.69

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)
2.06443	PV	Peak	47.90	± 4.69
2.48364	PV	Peak	62.26	± 4.69
		Average	38.37	± 4.69
2.48371	PV	Peak	62.14	± 4.69
		Average	37.77	± 4.69
2.48404	PV	Peak	62.65	± 4.69
		Average	38.34	± 4.69

Verdict: PASS

2. WiFi 2.4GHz 802.11 g 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)
2.06466	PH	Peak	48.16	± 4.69
2.34392	PV	Peak	57.06	± 4.69
		Average	36.24	± 4.69
2.34897	PV	Peak	55.42	± 4.69
		Average	36.39	± 4.69
2.35205	PV	Peak	57.38	± 4.69
		Average	36.57	± 4.69
2.35756	PV	Peak	54.88	± 4.69
		Average	36.04	± 4.69
2.38994	PV	Peak	57.38	± 4.69
		Average	45.96	± 4.69

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

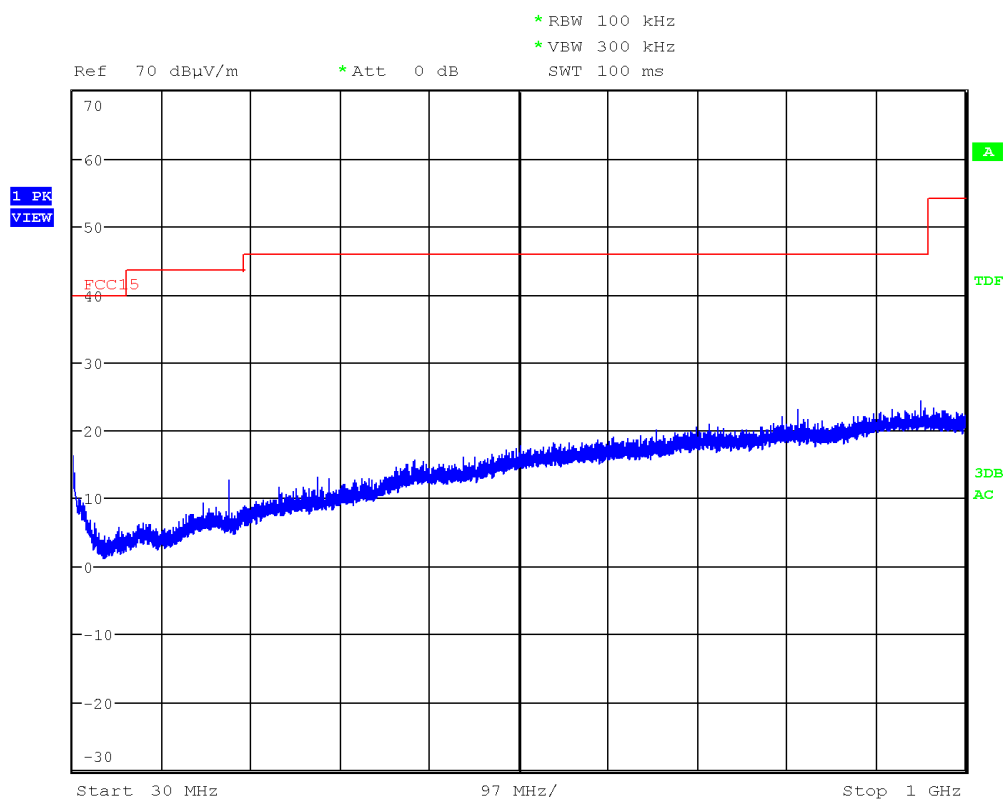
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
2.06457	PV	Peak	48.32	± 4.69
6.49875	PV	Peak	40.38	± 4.69

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)
2.06450	PV	Peak	48.00	± 4.69
2.48383	PV	Peak	62.24	± 4.69
		Average	43.45	± 4.69
2.49380	PV	Peak	61.74	± 4.69
		Average	39.01	± 4.69
2.49474	PV	Peak	61.48	± 4.69
		Average	38.73	± 4.69
2.49542	PV	Peak	63.74	± 4.69
		Average	39.50	± 4.69
2.49548	PV	Peak	61.11	± 4.69
		Average	38.64	± 4.69
2.51270	PV	Peak	58.00	± 4.69
		Average	38.18	± 4.69
6.56525	PV	Peak	41.54	± 4.69

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

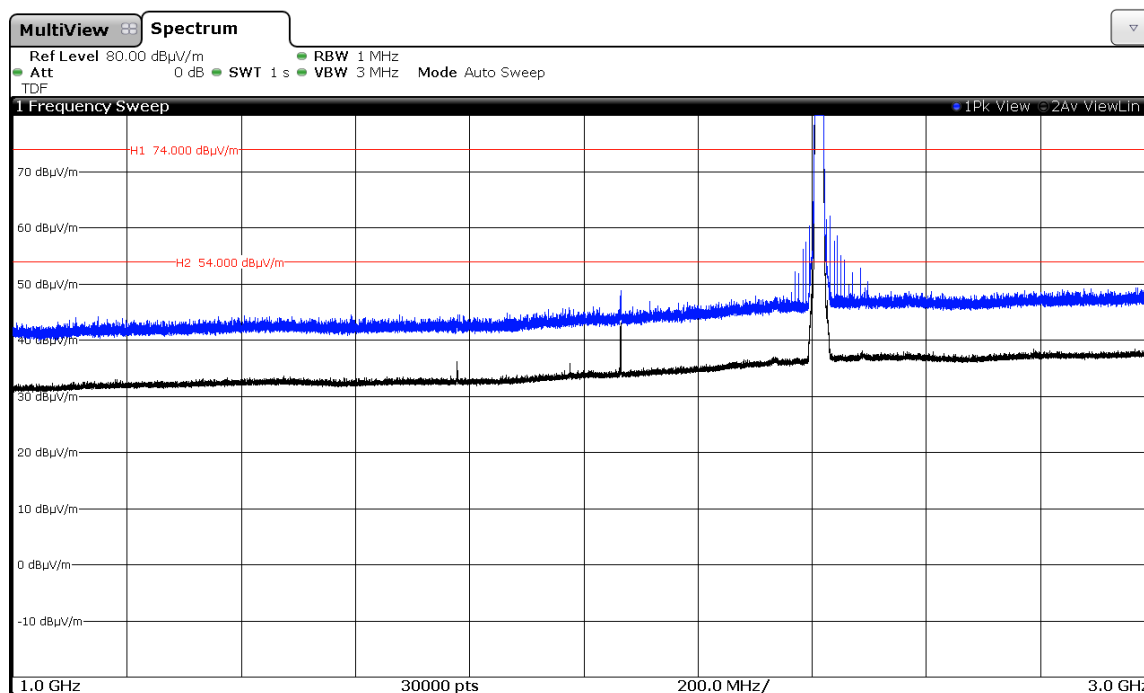


(This plot is valid for all modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

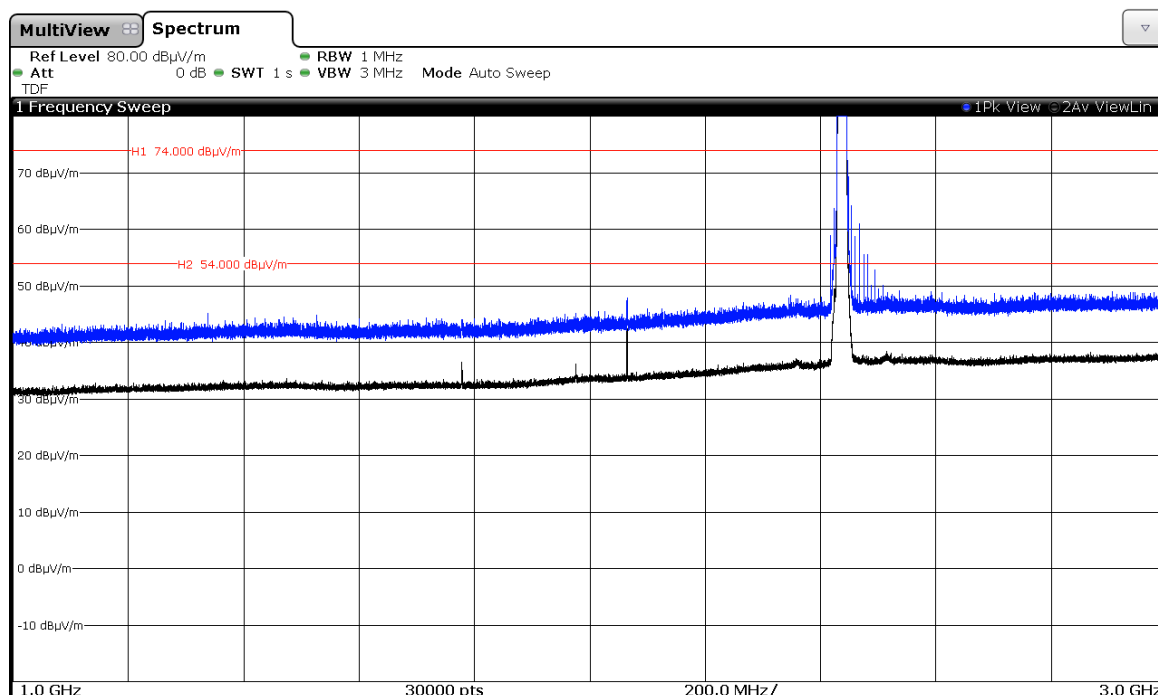
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 1 (2412 MHz).



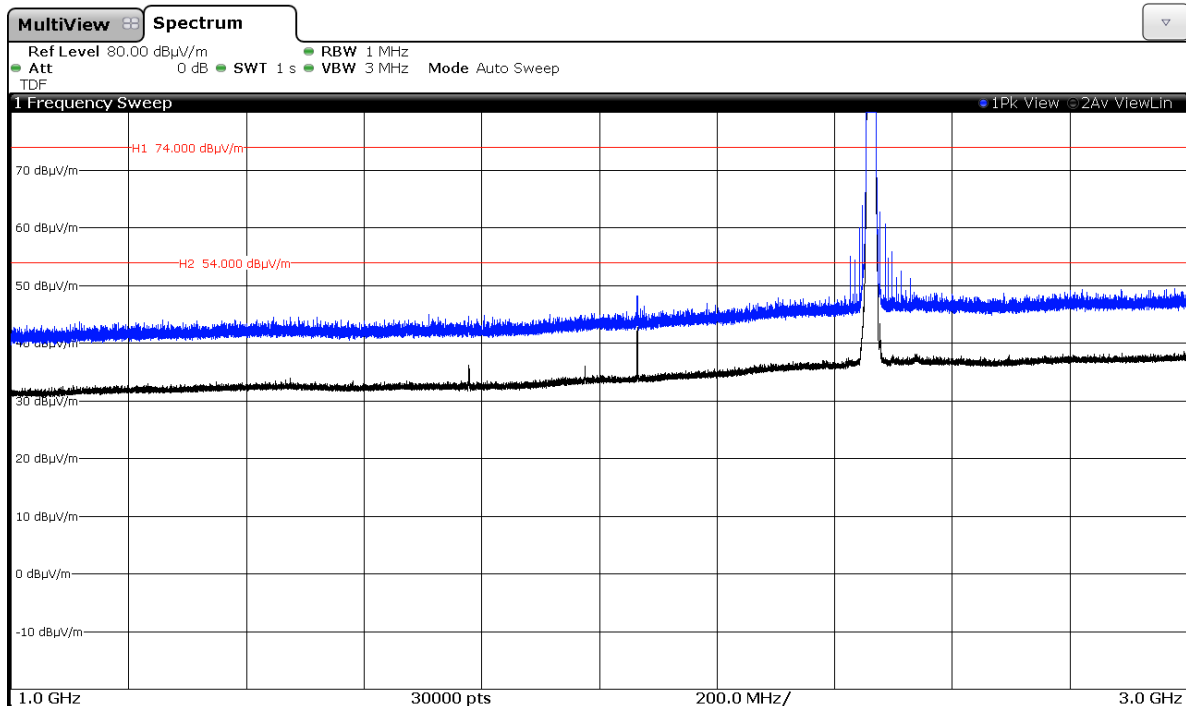
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



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

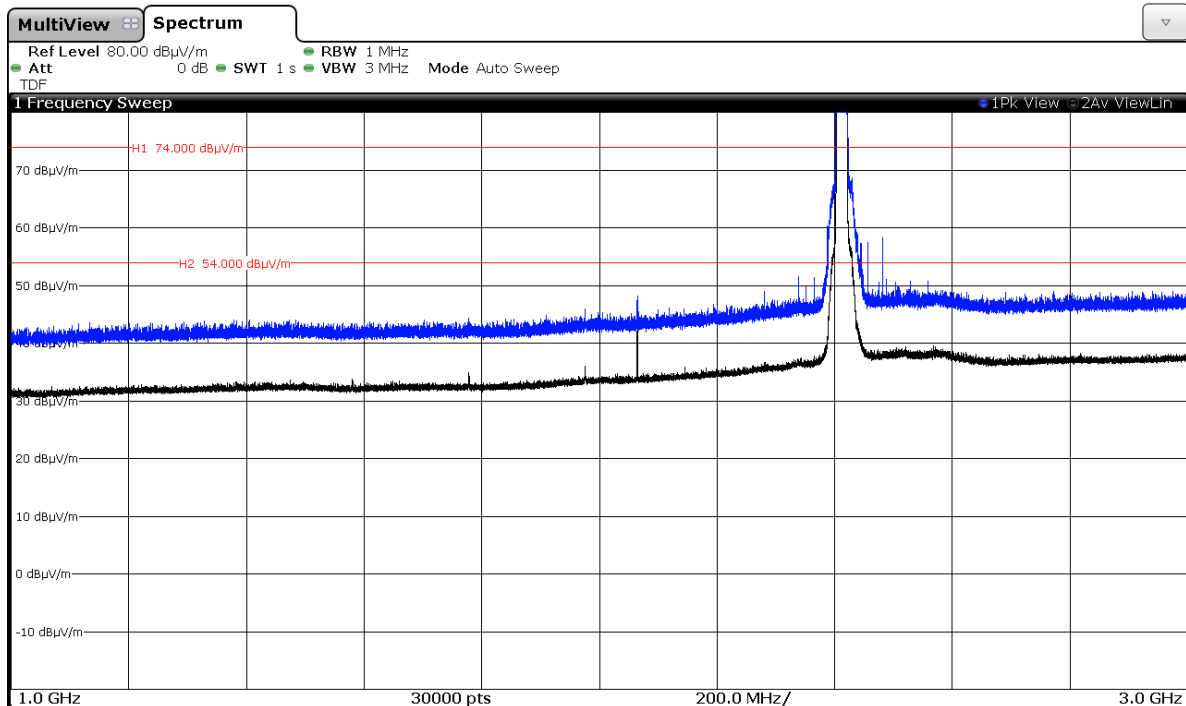
CHANNEL 11 (2462 MHz).



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

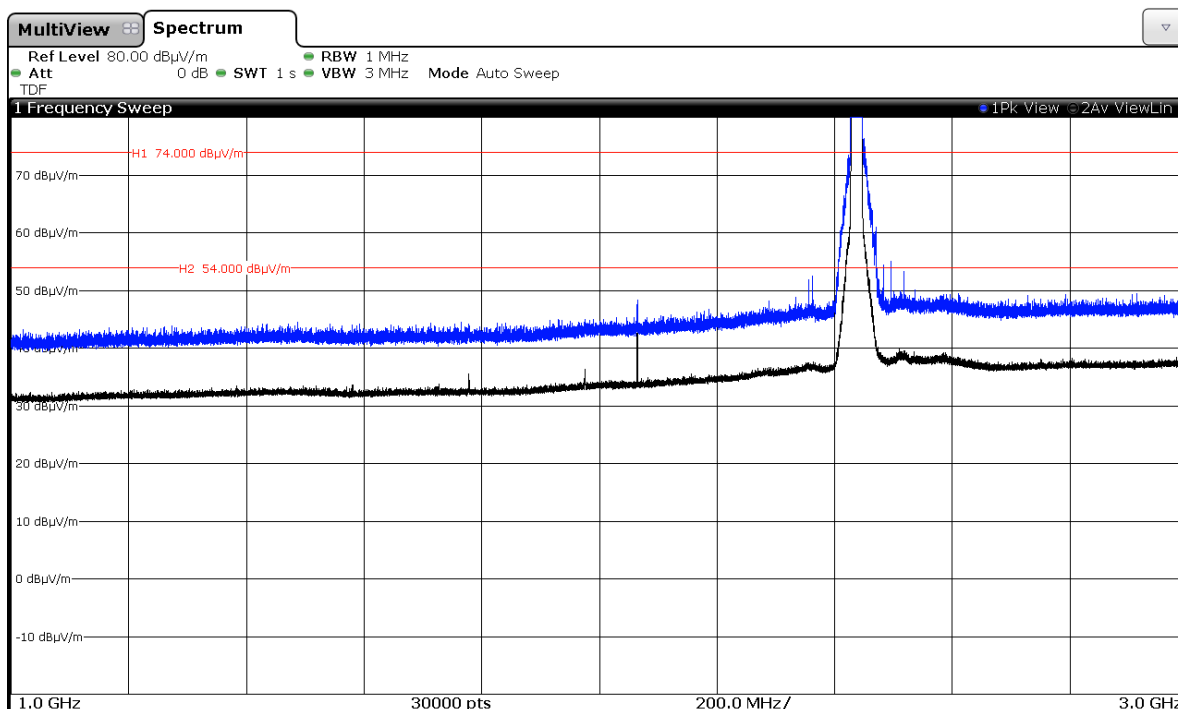
2. WiFi 2.4GHz 802.11 g mode

CHANNEL 1 (2412 MHz).



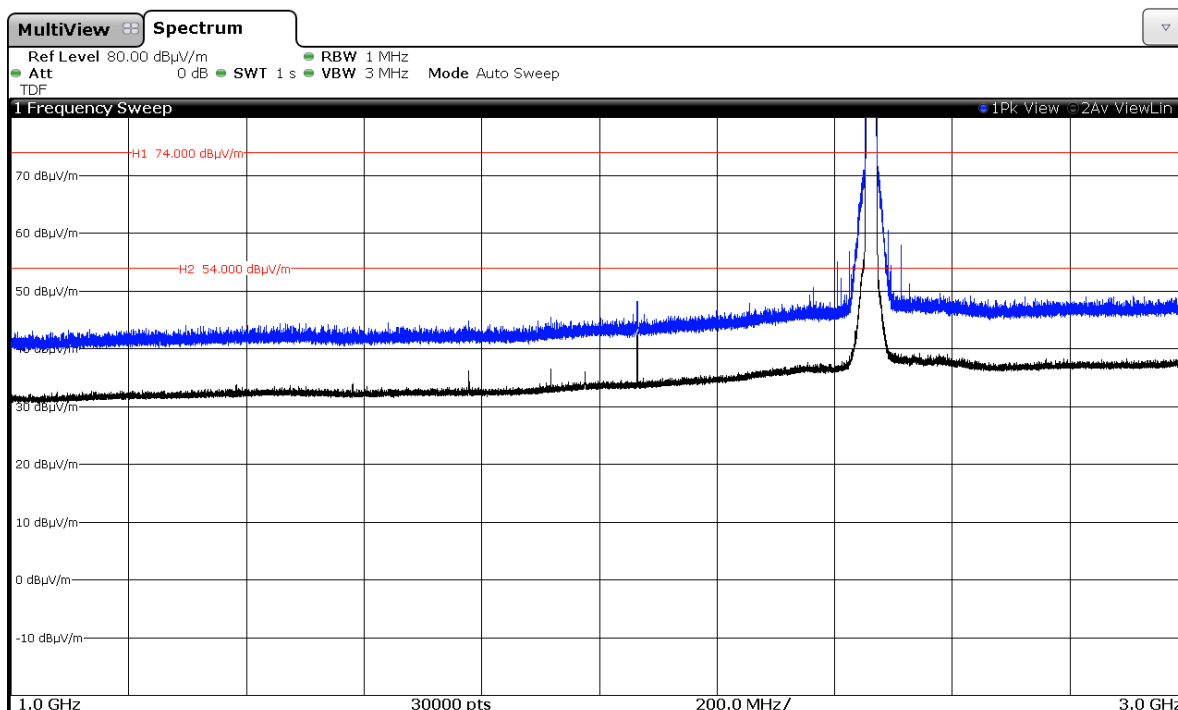
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



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

CHANNEL 11 (2462 MHz).

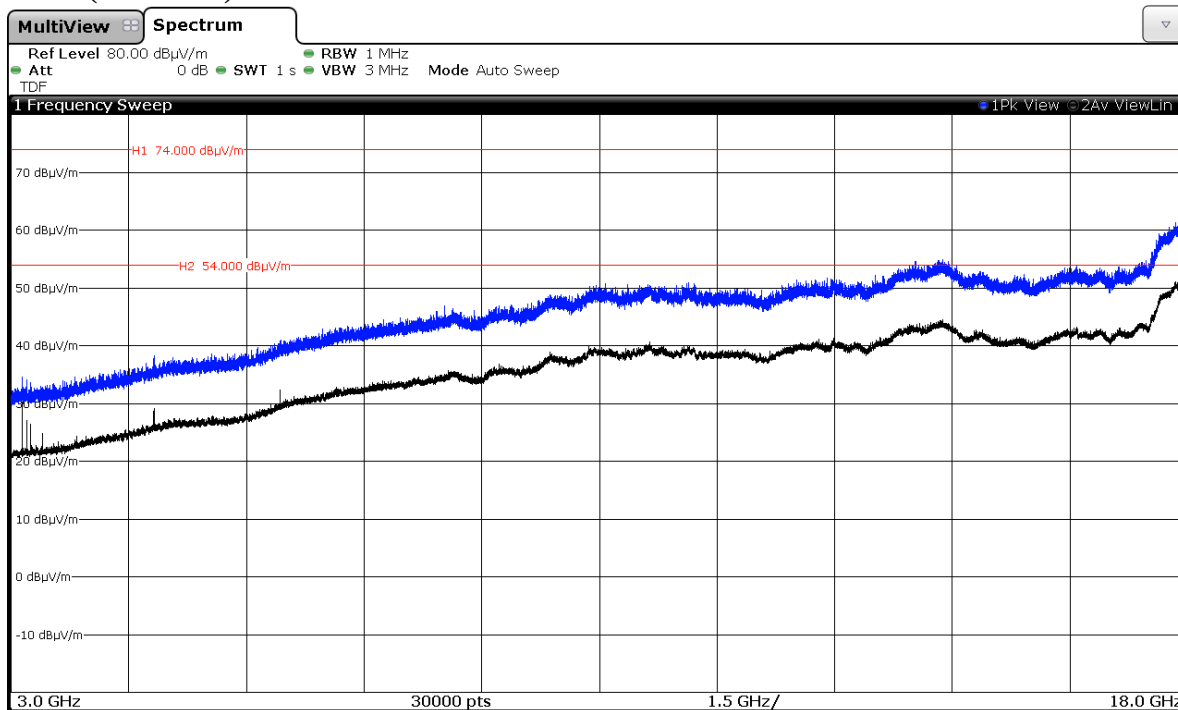


Note: The peak above the limit is the carrier frequency.

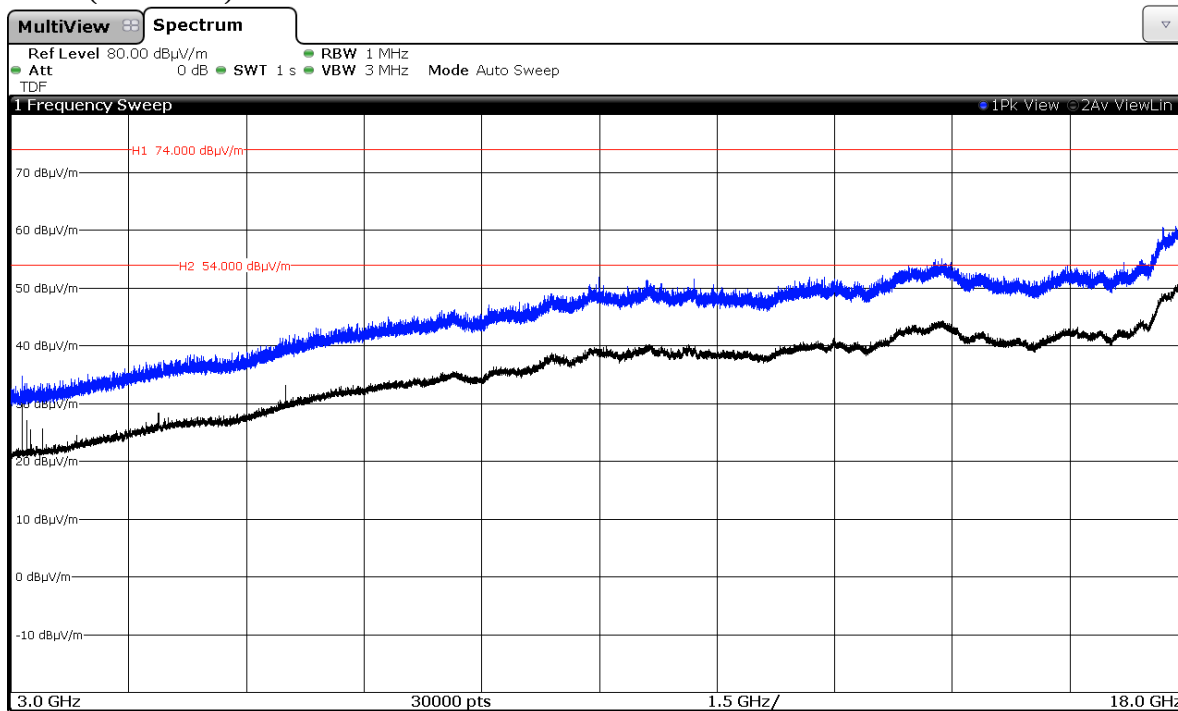
FREQUENCY RANGE 3 GHz to 18 GHz.

1. WiFi 2.4GHz 802.11 b mode

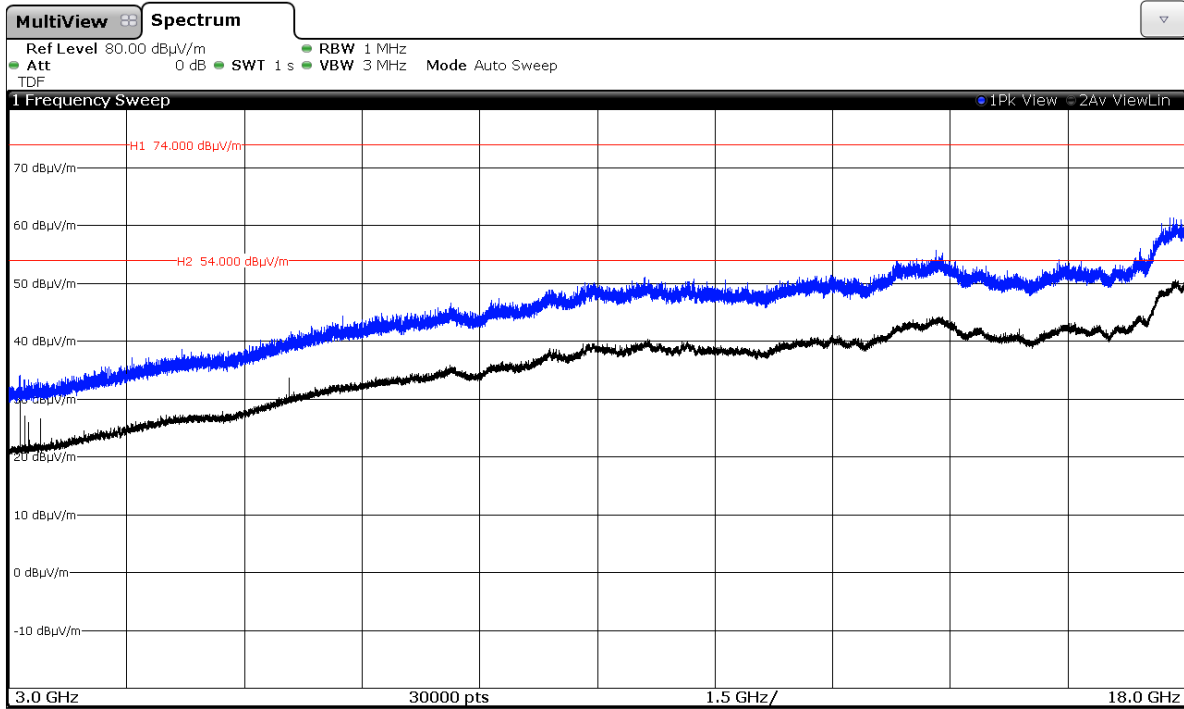
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

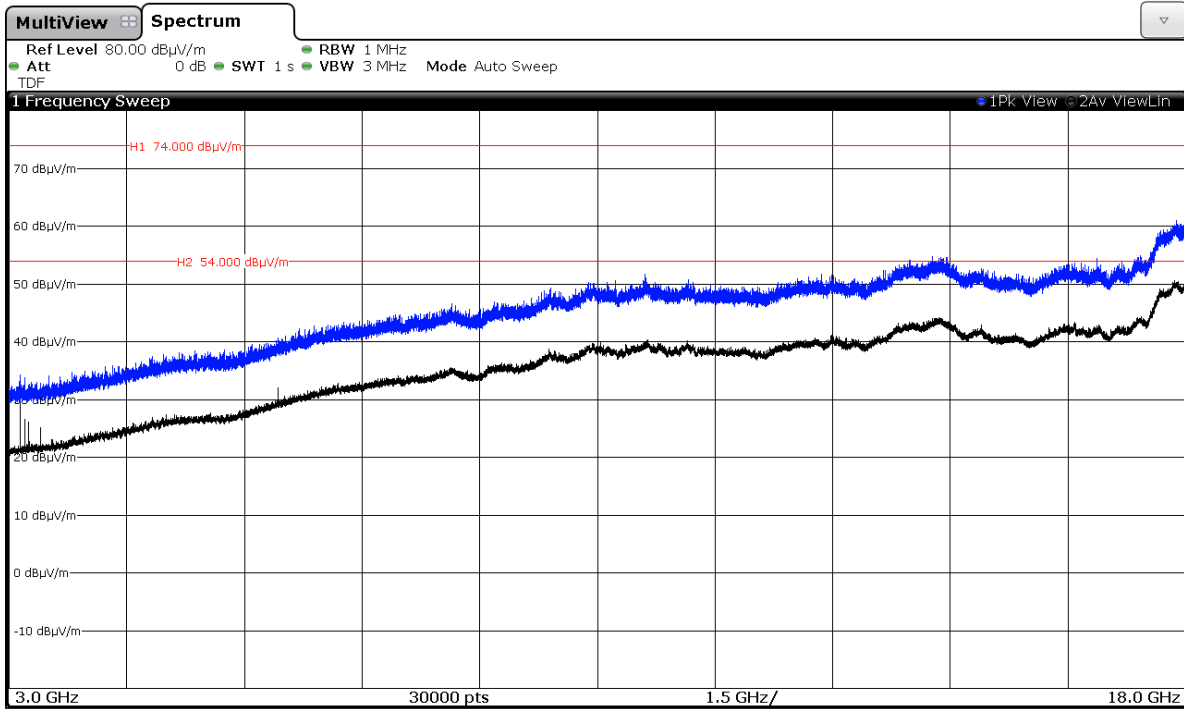


CHANNEL 11 (2462 MHz).

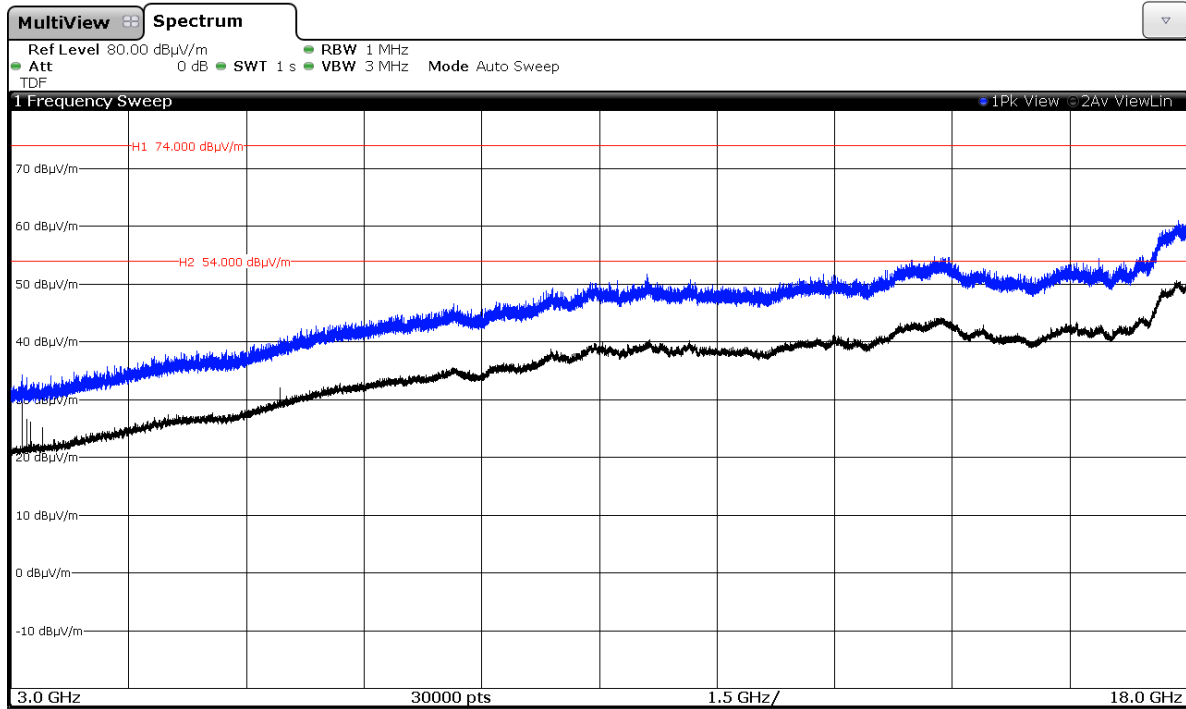


2. WiFi 2.4GHz 802.11 g mode

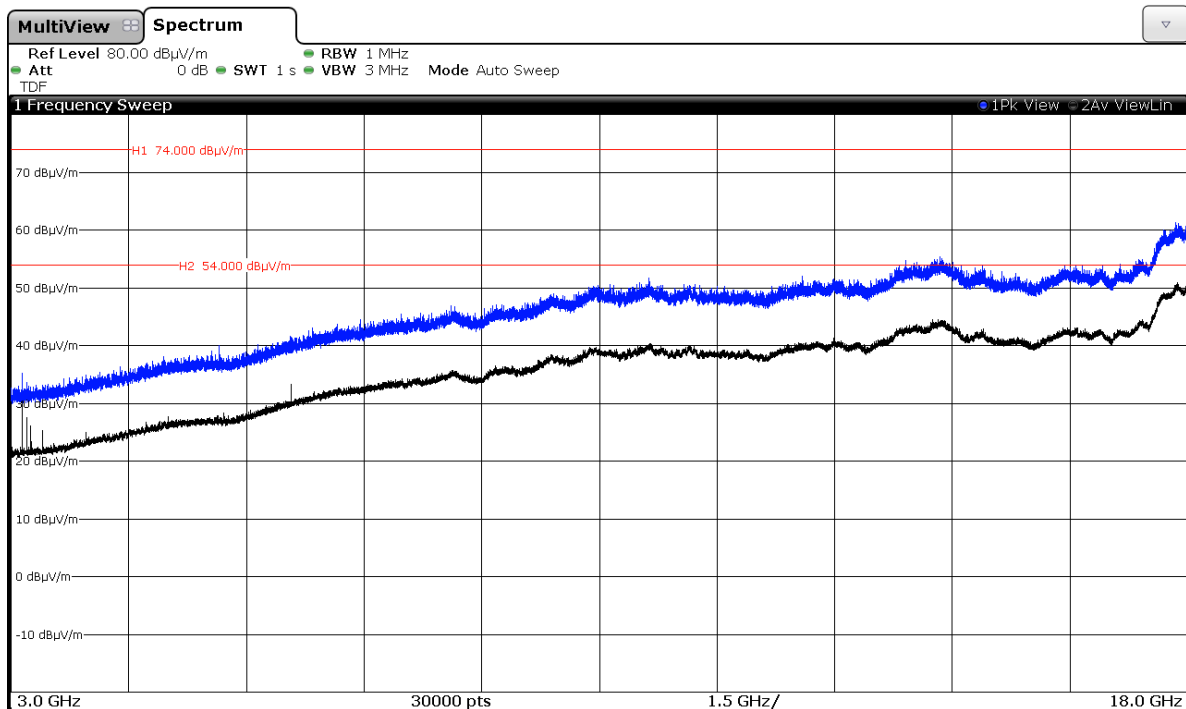
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

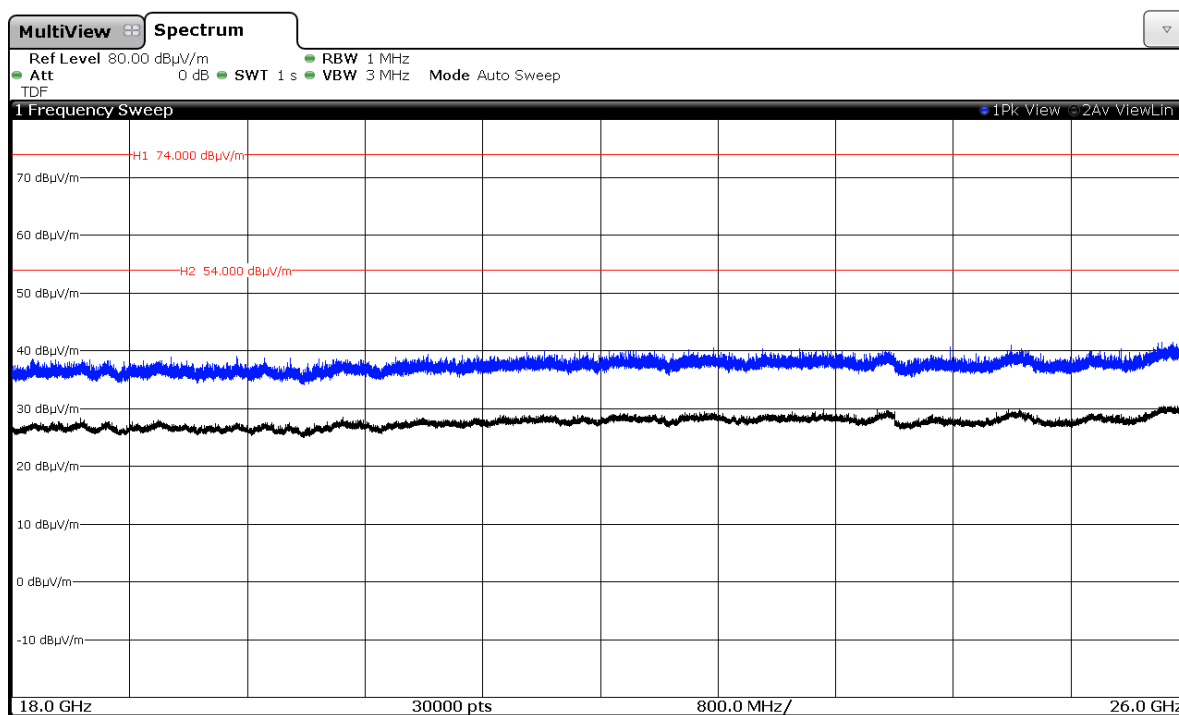


CHANNEL 11 (2462 MHz).



FREQUENCY RANGE 18 GHz to 26 GHz.

No spurious signals were detected.

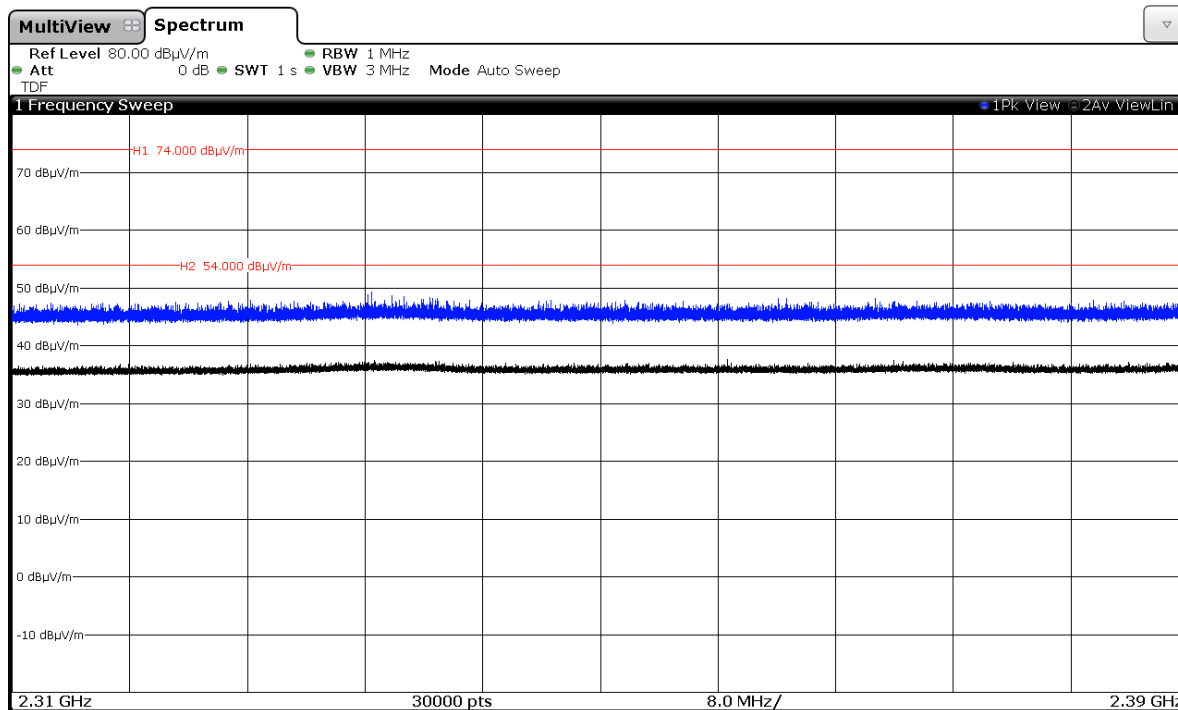


(This plot is valid for all channels and all modulation modes).

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

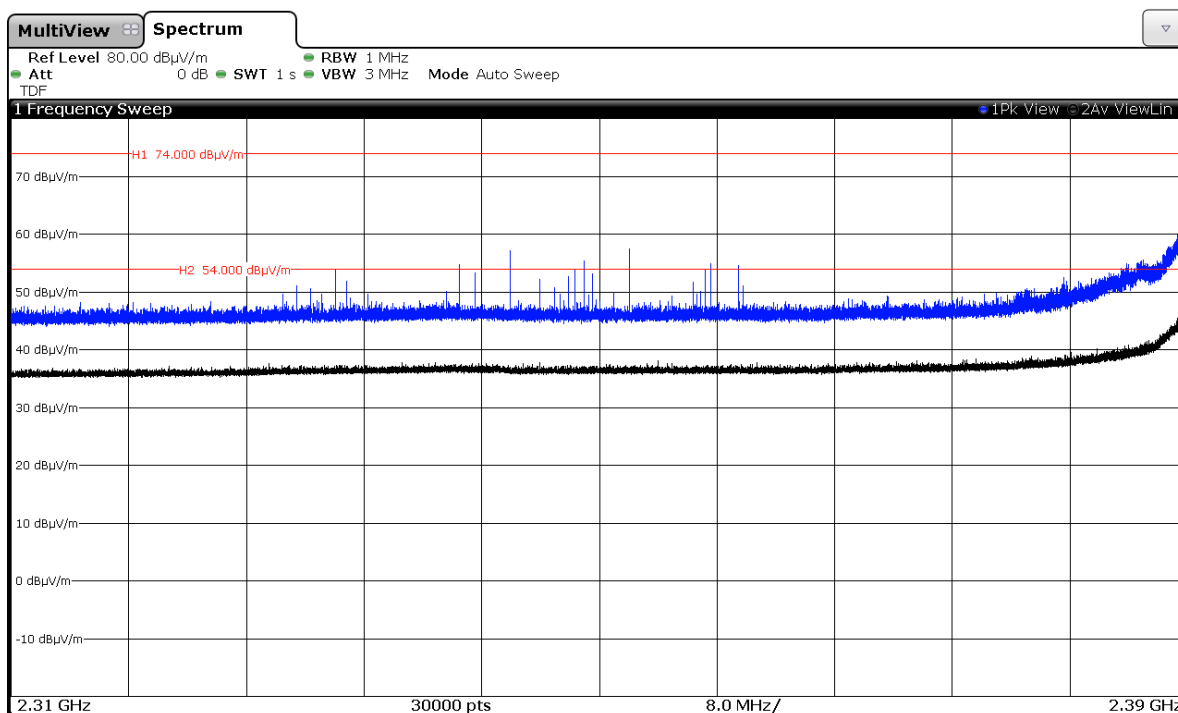
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 1 (2412 MHz).



2. WiFi 2.4GHz 802.11 g mode

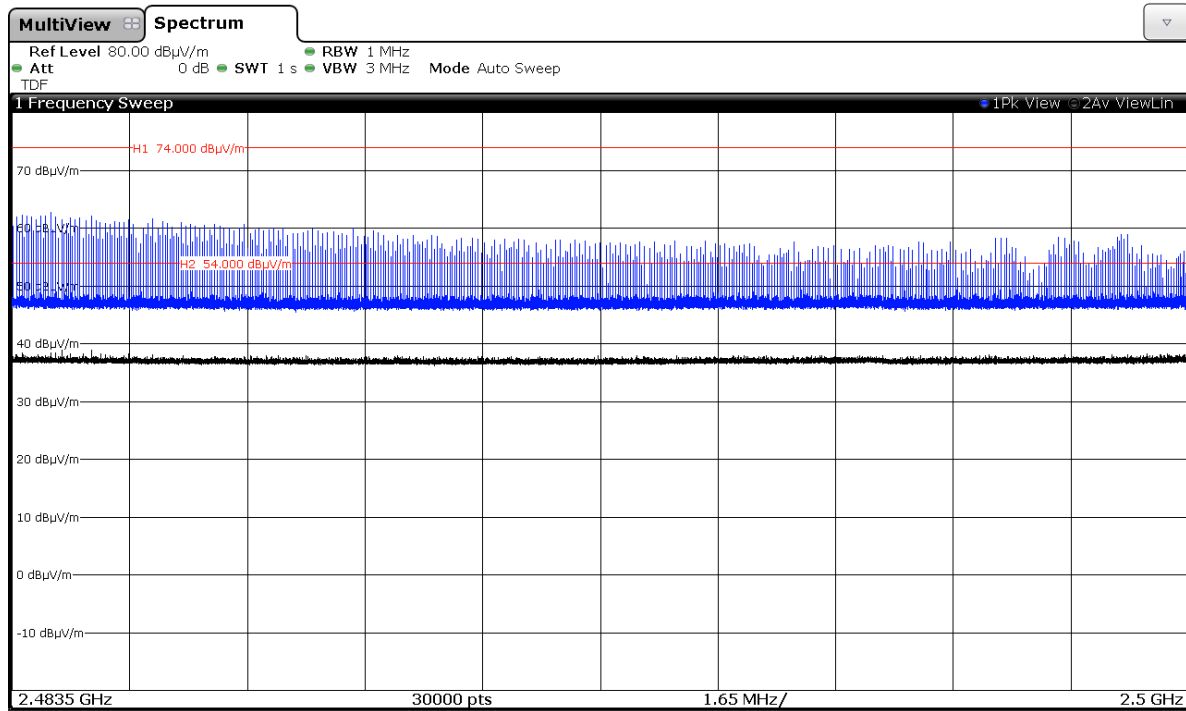
CHANNEL 1 (2412 MHz).



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

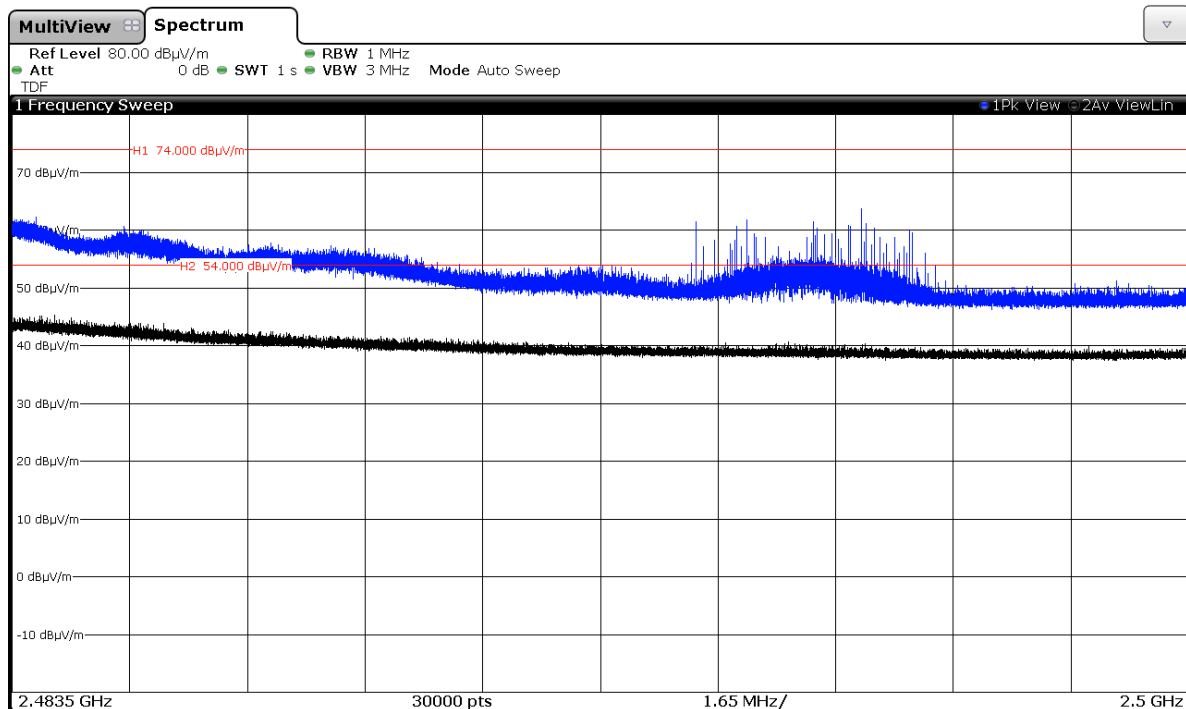
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 11 (2462 MHz).



2. WiFi 2.4GHz 802.11 g mode

CHANNEL 11 (2462 MHz).



Appendix B – Test result “Kleer”

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TEST CONDITIONS

Power supply (V):

$V_{\text{nominal}} = 12.6 \text{ Vdc}$

Type of power supply = External power supply (Battery).

Type of antenna: External OEM antenna

Declared Gain for antenna (maximum) = 1.5 dBi

TEST FREQUENCIES:

Lowest channel: 2403 MHz

Middle channel: 2438 MHz

Highest channel: 2478 MHz

The test set-up was made in accordance to the general provisions of FCC DTS Measurement KDB 558074 D01 DTS Meas Guidance v03r04 dated 01/07/2016.

The laptop computer was used to configure the EUT to continuously transmit at a maximum output power.

The field strength at the band edges was evaluated for the channel under test.

During transmitter test the EUT was being controlled by the SW tool to operate in a continuous transmit mode on the test channel as required.

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to the spectrum analyzer using a low loss RF cable. The measurements are corrected taking into account the cable loss.



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).

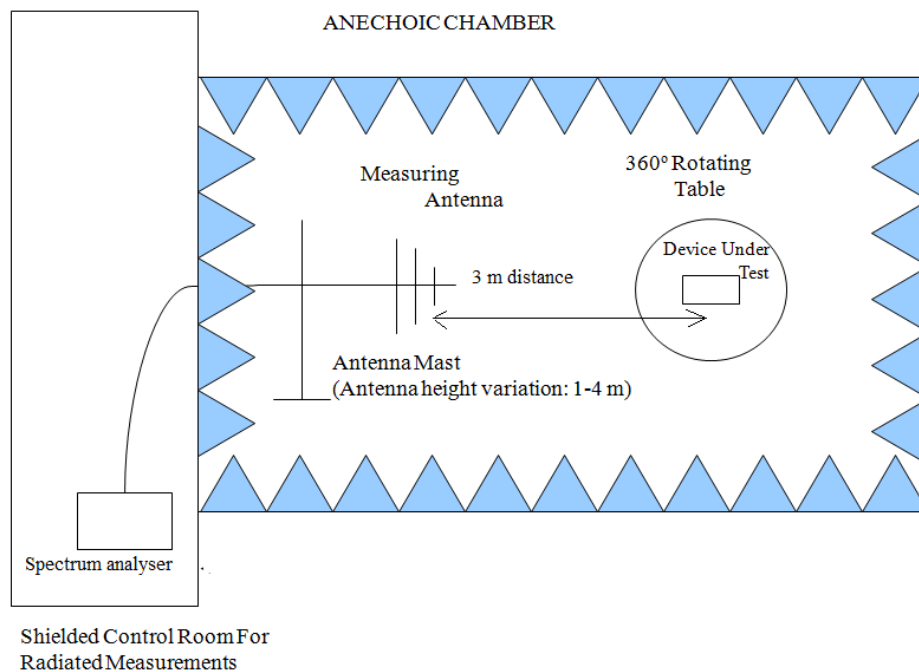
For radiated emissions in the range 1 GHz-25 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive (wooden) platform 1.5 meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission.

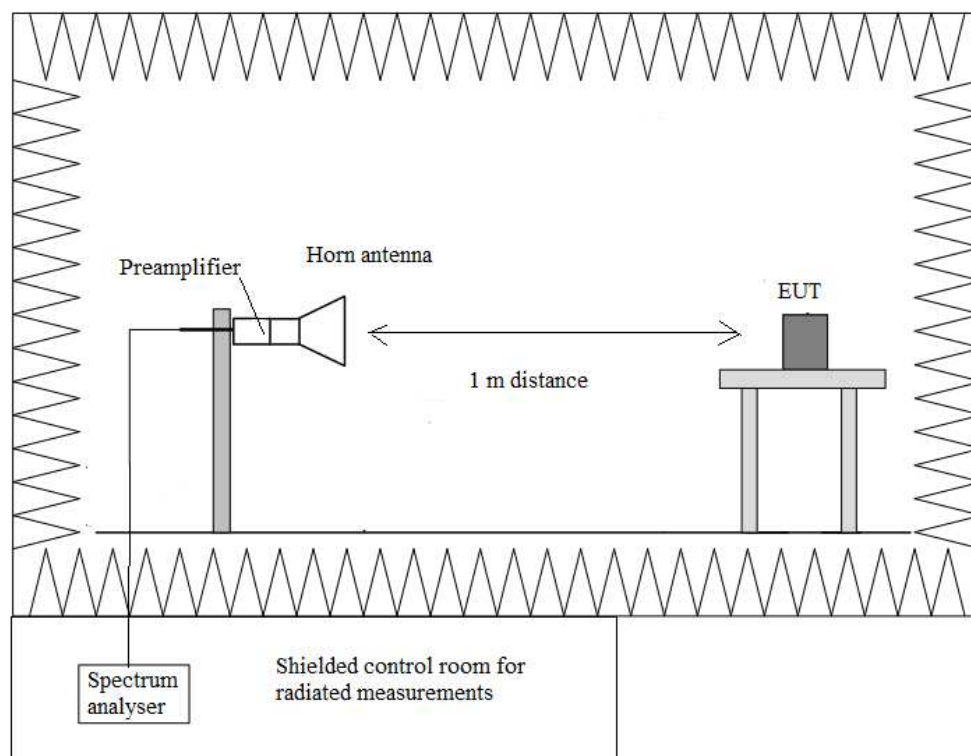
It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

Radiated measurements setup $f < 1$ GHz



Radiated measurements setup $f > 1$ GHz



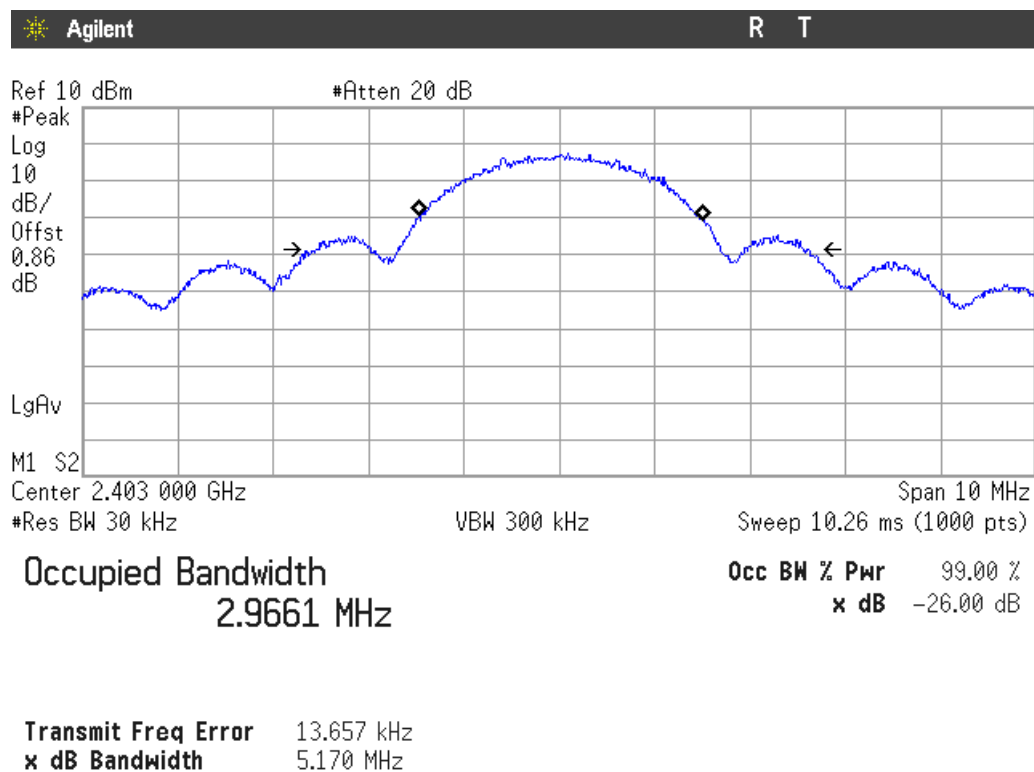
Occupied Bandwidth

RESULTS

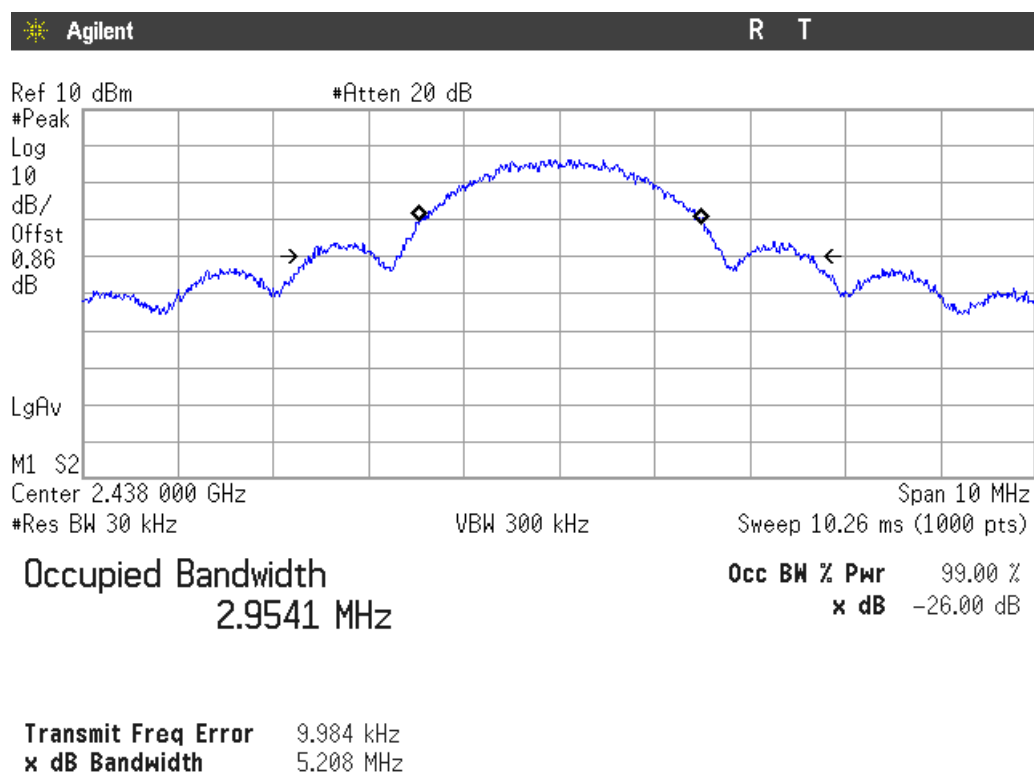
(see next plots).

	Lowest frequency 2403 MHz	Middle frequency 2438 MHz	Highest frequency 2478 MHz
99% bandwidth (MHz)	2.966	2.954	2.942
-26 dBc bandwidth (MHz)	5.170	5.208	5.082
Measurement uncertainty (kHz)	<±16.67		

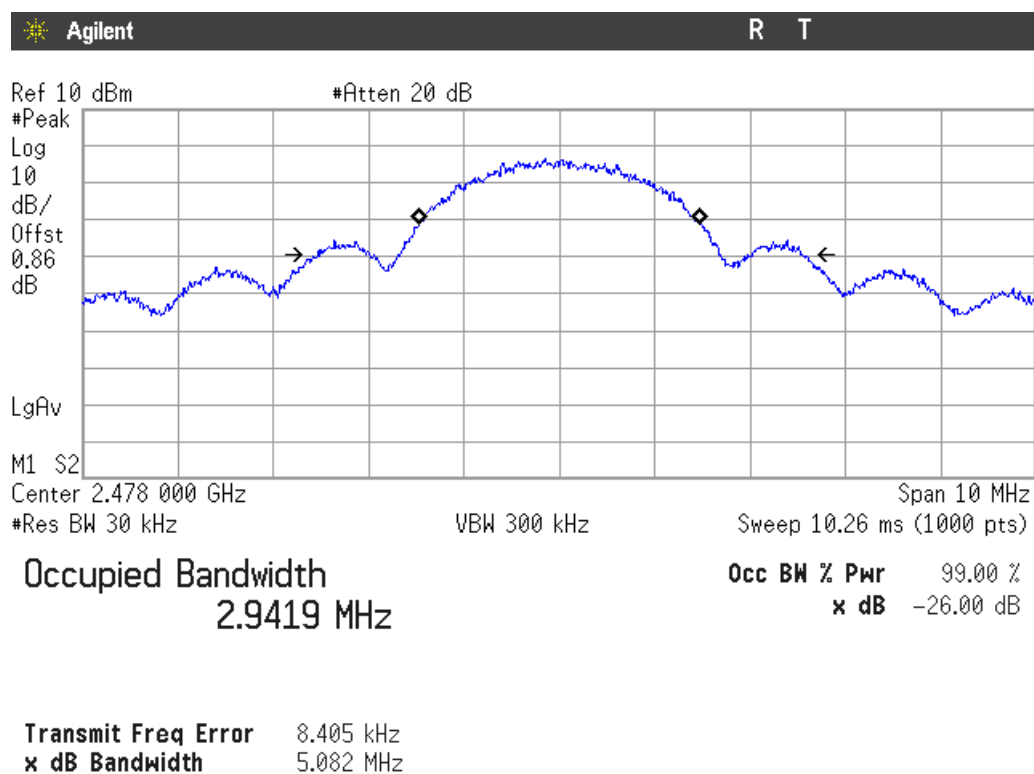
Lowest Channel



Middle Channel



Highest channel



Section 15.247 Subclause (a) (2) / RSS-247 5.2. (1). 6 dB Bandwidth

SPECIFICATION

The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

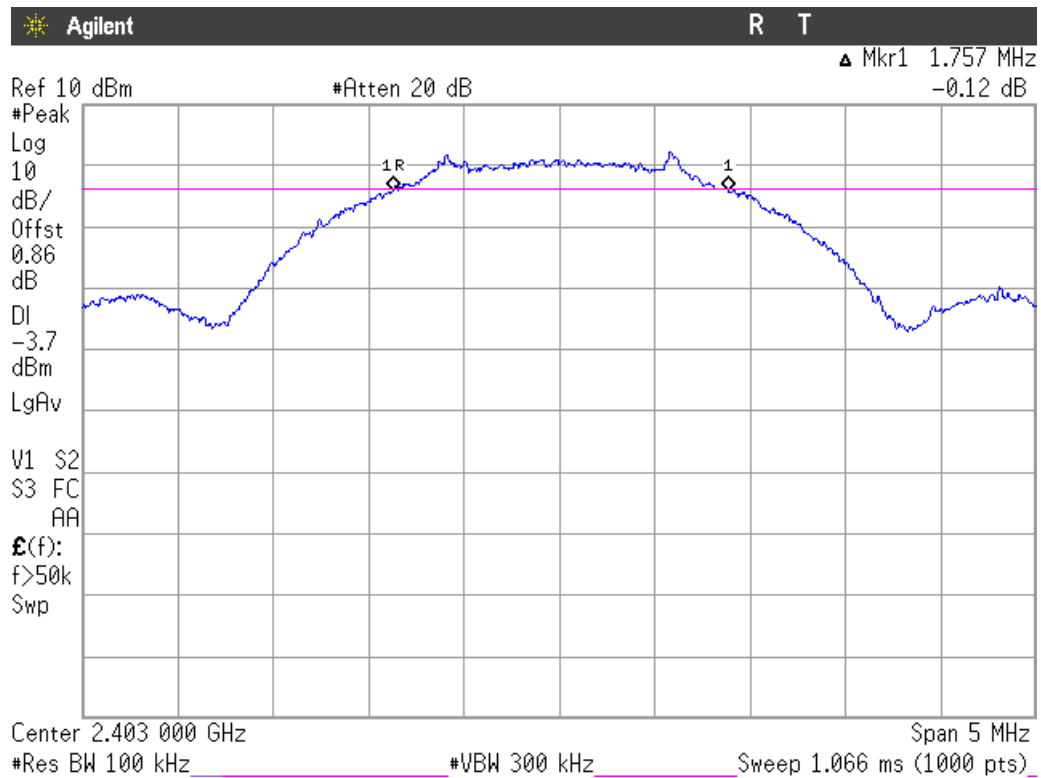
6 dB Bandwidth (see next plots).

	Lowest frequency 2403 MHz	Middle frequency 2438 MHz	Highest frequency 2478 MHz
6 dB Spectrum bandwidth (MHz)	1.757	1.867	1.842
Measurement uncertainty (kHz)	<±20		

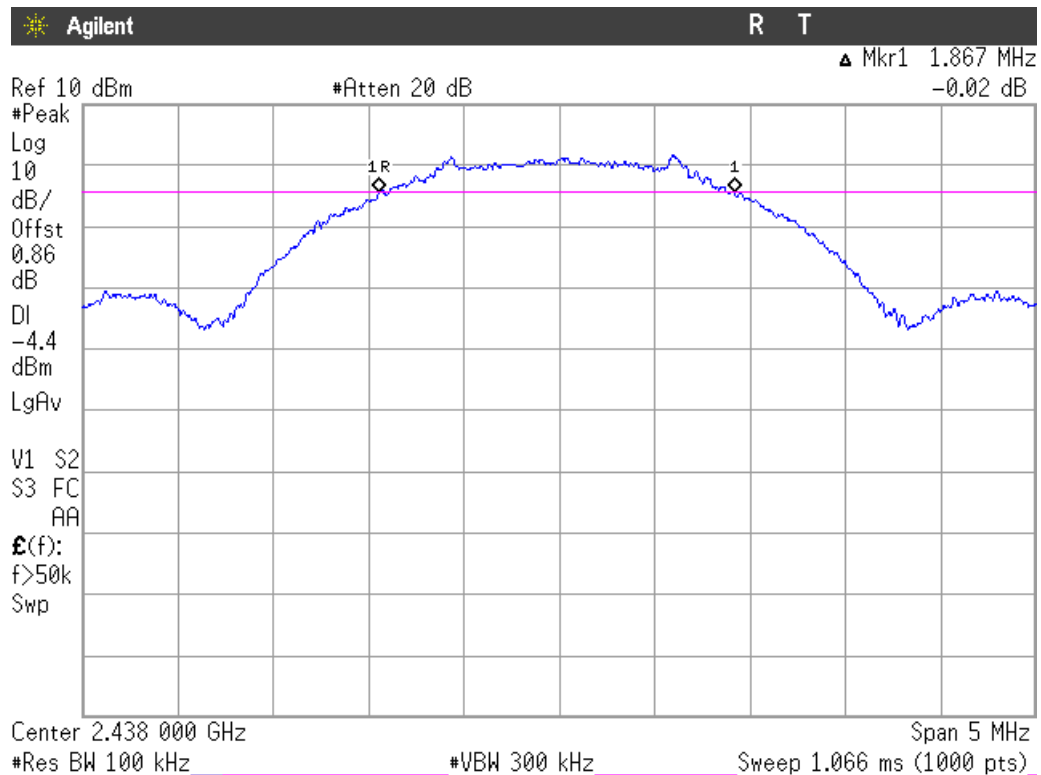
Verdict: PASS

6 dB BANDWIDTH.

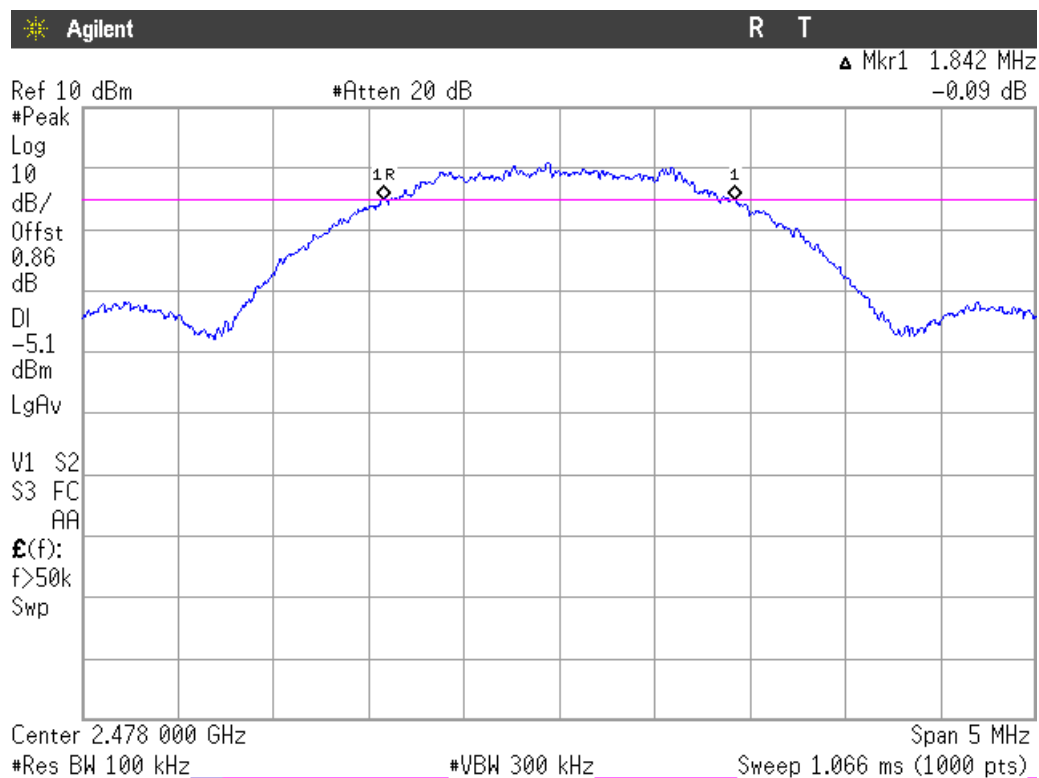
Lowest Channel



Middle Channel



Highest Channel



Section 15.247 Subclause (b) / RSS-247 5.4. (4). Maximum output power and antenna gain

SPECIFICATION

For systems using digital modulation in the 2400-2483.5 MHz band: 1 watt (30 dBm).

The e.i.r.p. shall not exceed 4 W (36 dBm) (Canada).

RESULTS

The maximum peak conducted output power was measured using the method according to point 9.1.1. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r04 dated 01/07/2016.

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

MAXIMUM OUTPUT POWER. See next plots.

Maximum declared antenna gain: 1.5dBi.

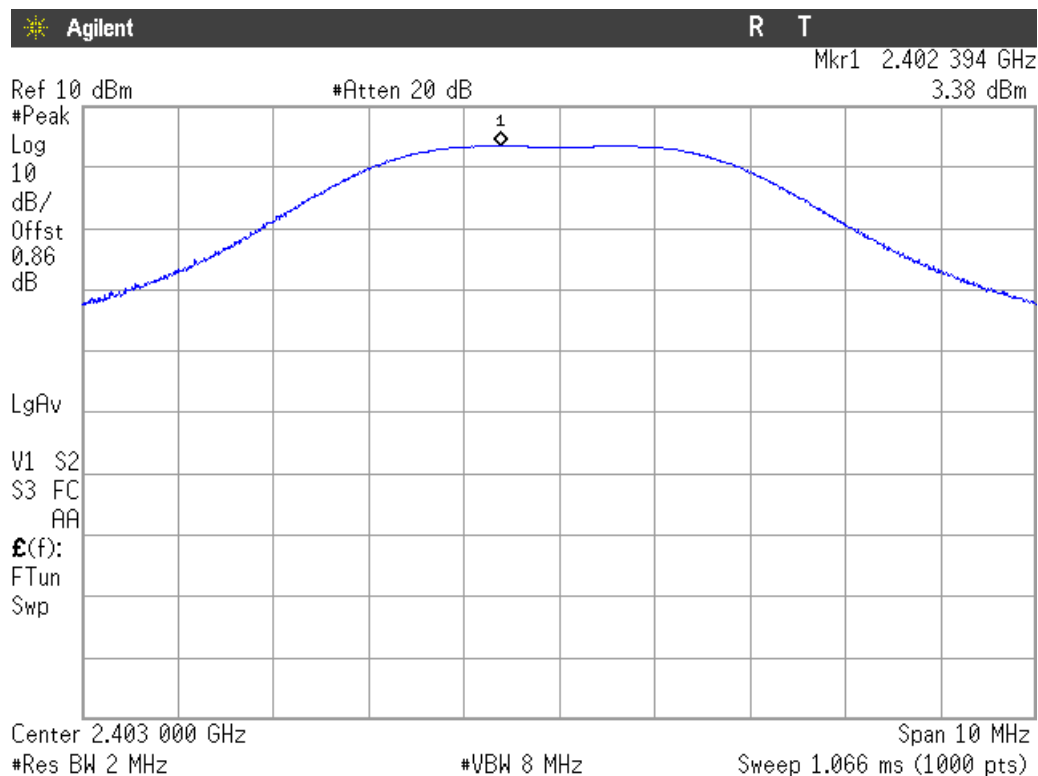
	Lowest frequency 2403 MHz	Middle frequency 2438 MHz	Highest frequency 2478 MHz
Maximum conducted power (dBm)	3.38	3.29	2.83
Maximum EIRP power (dBm)	4.88	4.79	4.33
Measurement uncertainty (dB)	<±0.78		

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.

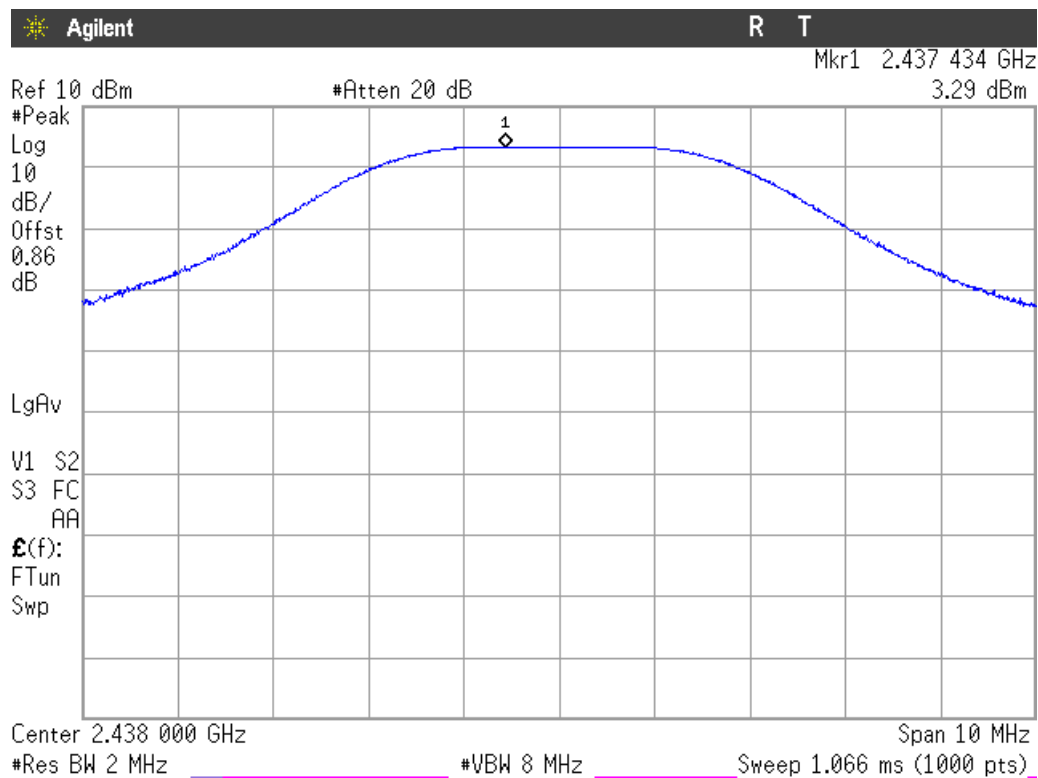
Verdict: PASS

CONDUCTED PEAK POWER.

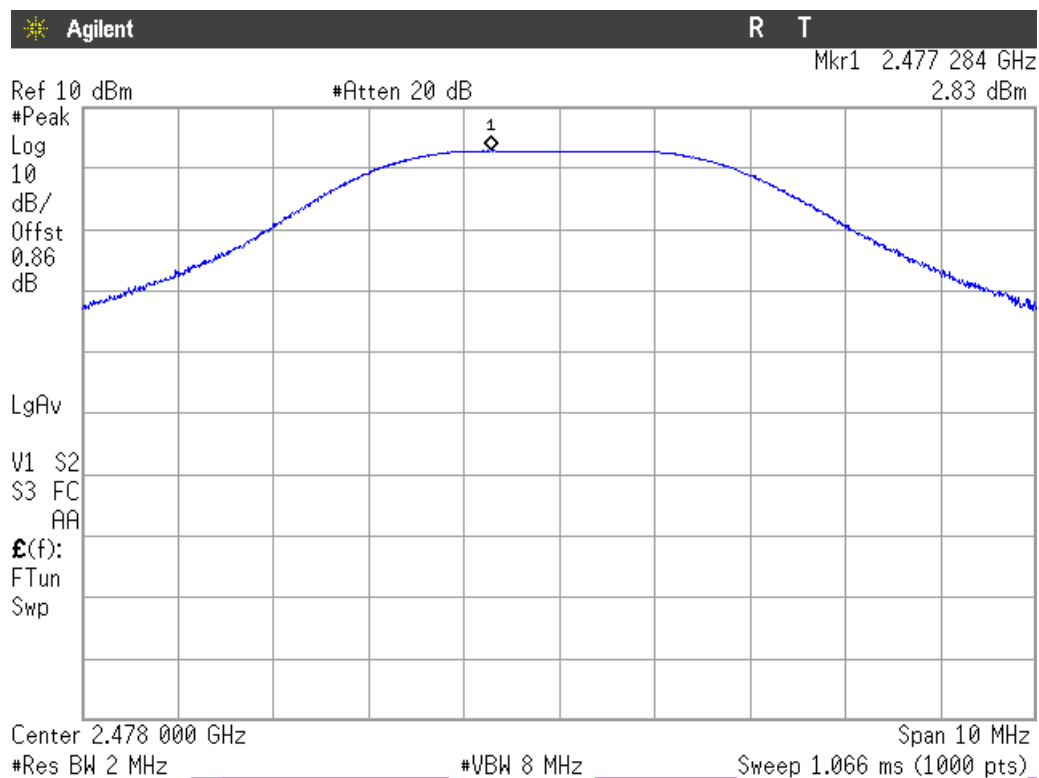
Lowest frequency



Middle frequency



Highest frequency



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

SPECIFICATION

In any 100 kHz bandwidth outside the frequency band in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

RESULTS:

Reference Level Measurement

	Lowest frequency 2403 MHz	Middle frequency 2438 MHz	Highest frequency 2478 MHz
Reference Level Measurement (dBm)	1.83	2.21	1.15
Measurement uncertainty (dB)	<±0.78		

Lowest frequency 2402 MHz

All peaks are more than 20 dB below the limit.

Middle frequency 2440 MHz

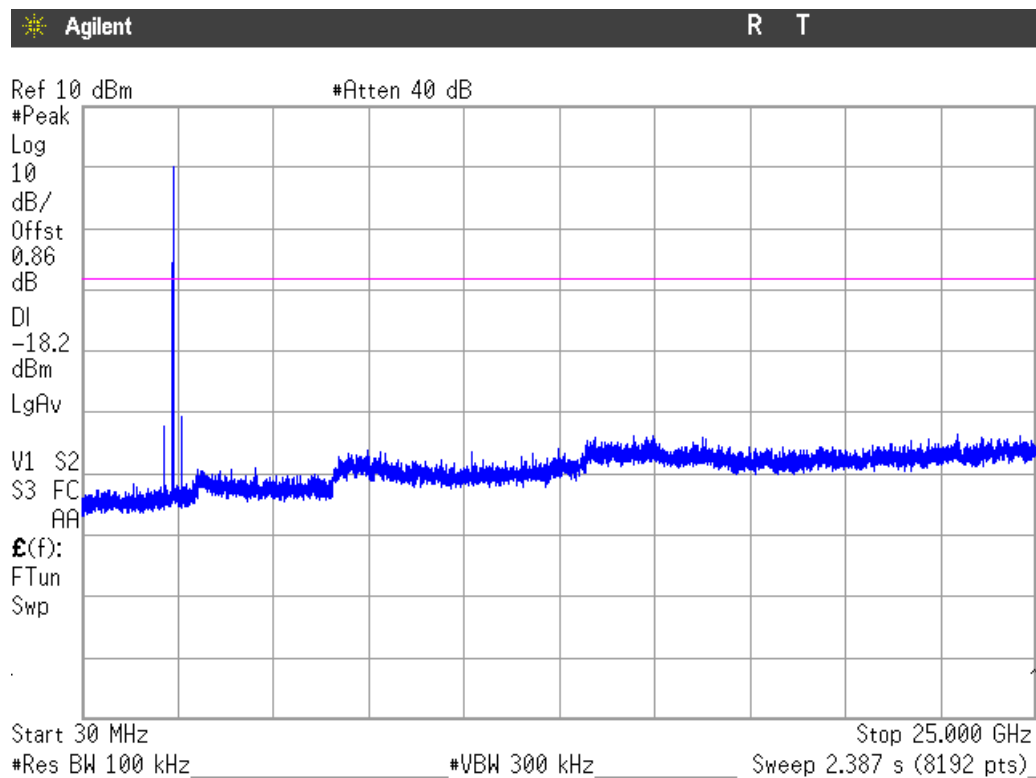
All peaks are more than 20 dB below the limit.

Highest frequency 2480 MHz

All peaks are more than 20 dB below the limit.

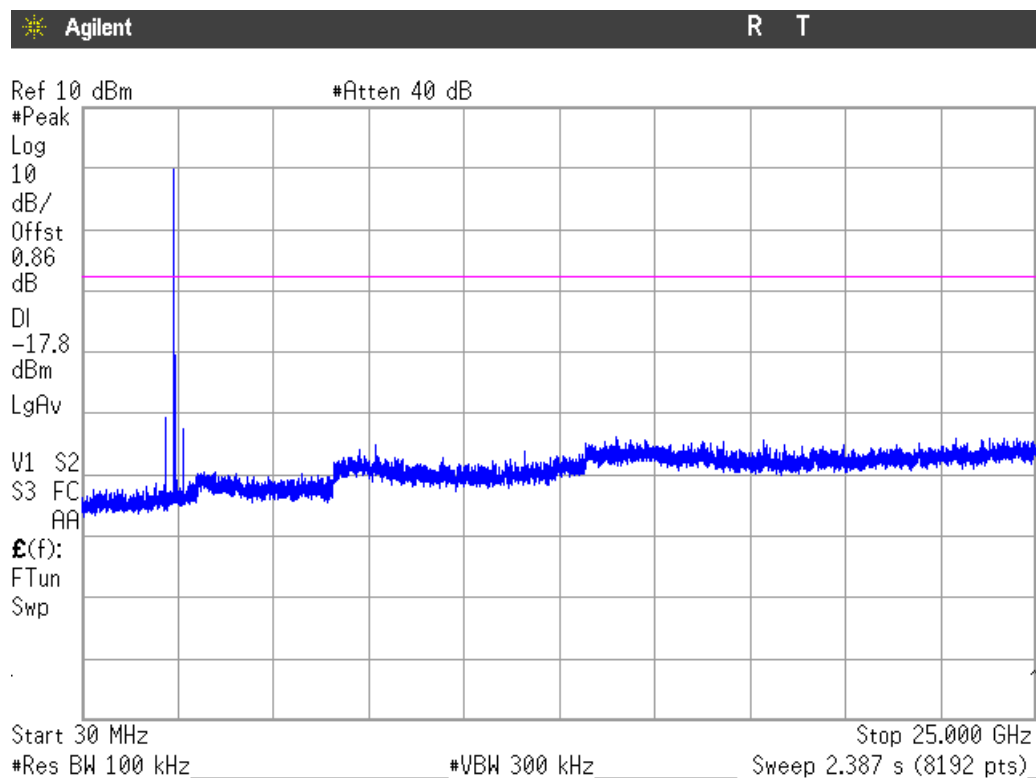
Verdict: PASS

CH LOW:



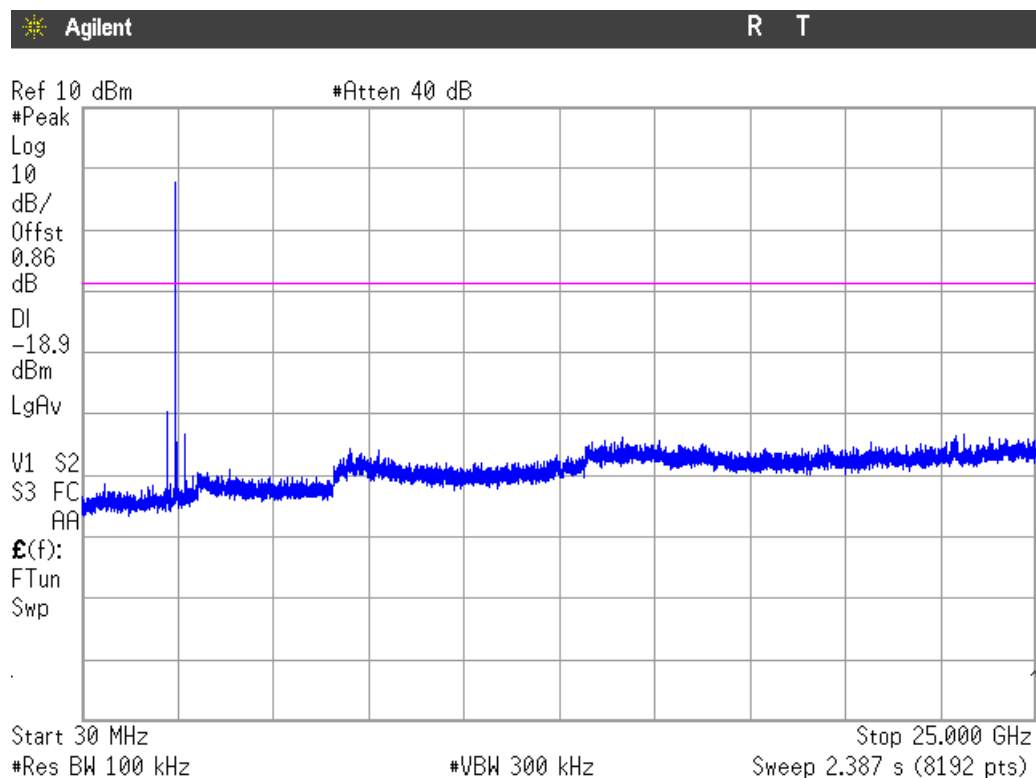
Note: The peak above the limit is the carrier frequency.

CH MIDDLE:



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

CH HIGH:



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

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

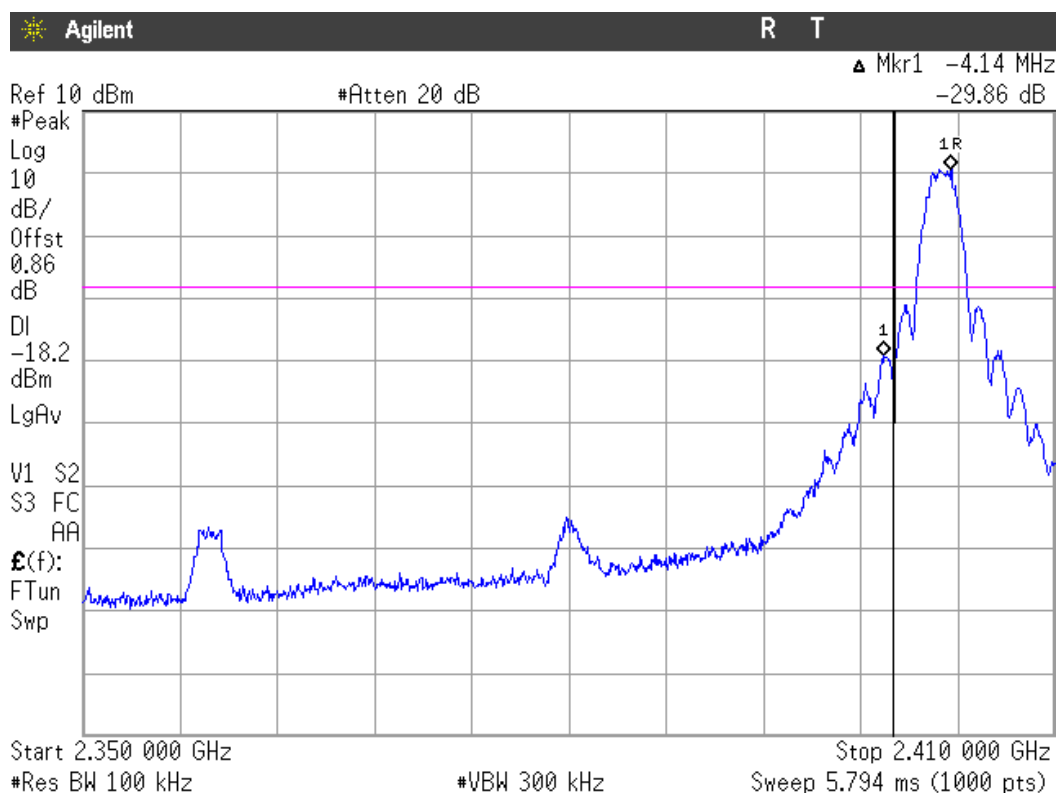
SPECIFICATION

In any 100 kHz bandwidth outside the frequency band in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

RESULTS:

1. LOW FREQUENCY SECTION. CONDUCTED.

See next plot.



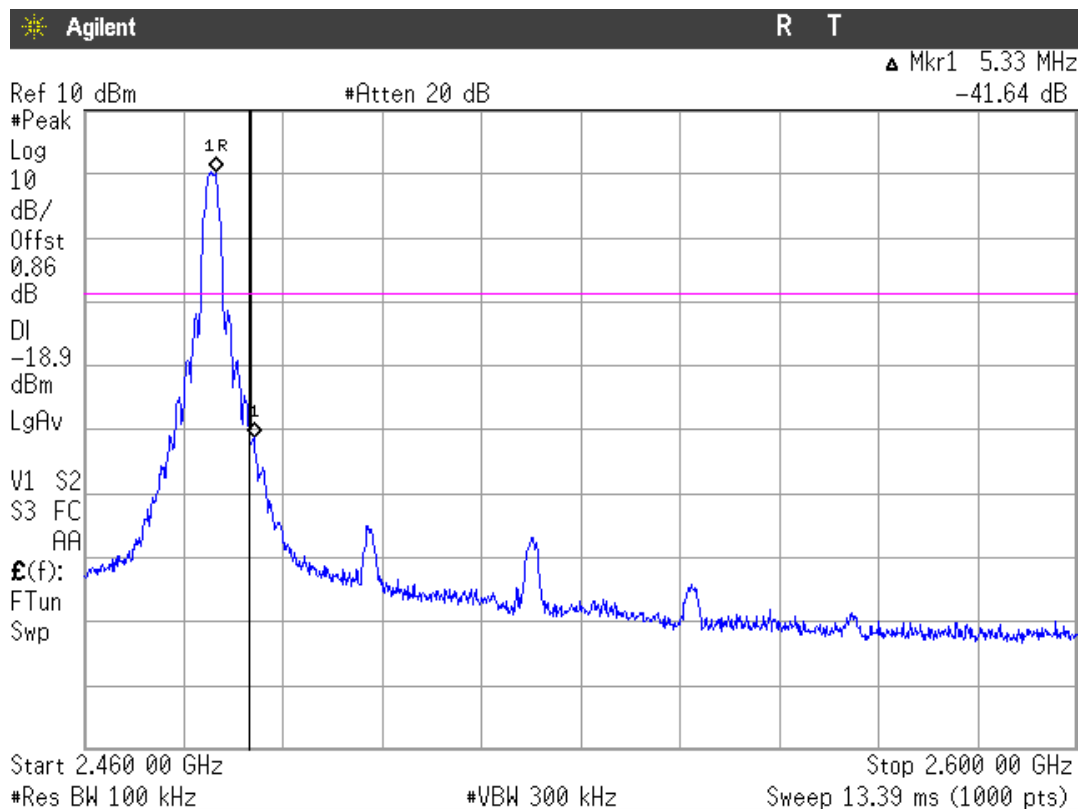
Measurement uncertainty (dB)

< ±2.03

Verdict: PASS

2. HIGH FREQUENCY SECTION. CONDUCTED.

See next plot.



Measurement uncertainty (dB)	< ±2.03
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Verdict: PASS

Section 15.247 Subclause (e) / RSS-247 5.2. (2) Power spectral density

SPECIFICATION

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna 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 PKPSD (Peak PSD) according to point 10.2. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r04 dated 01/07/2016.

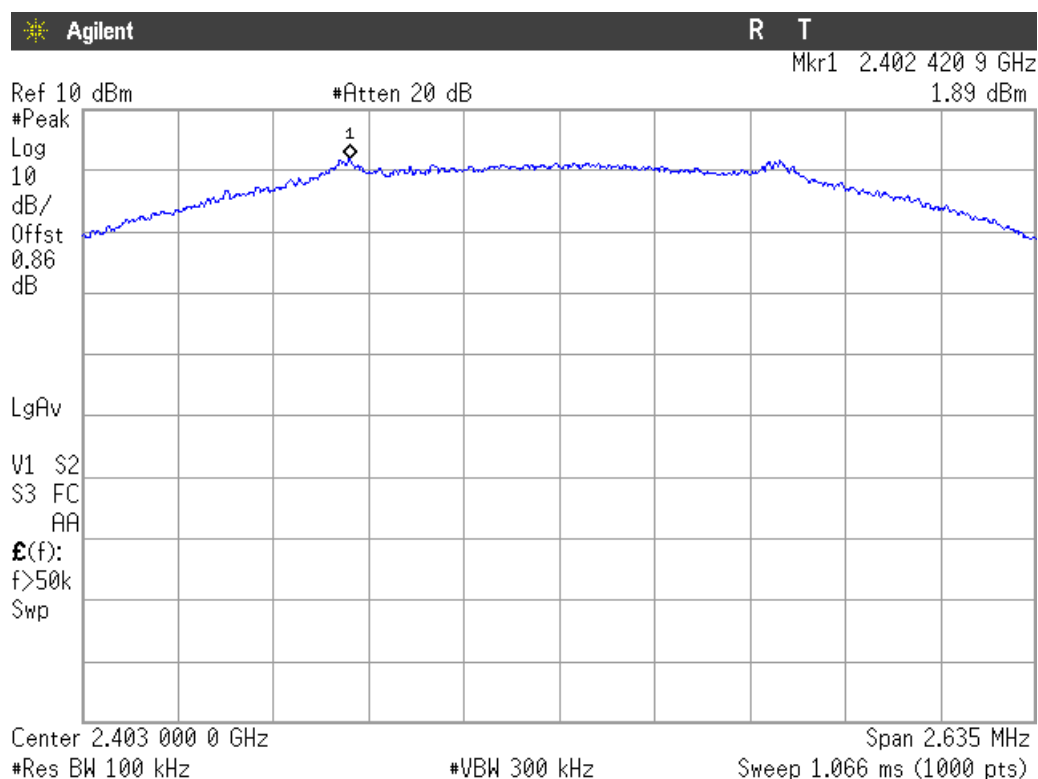
Power spectral density (see next plots).

	Lowest frequency 2403 MHz	Middle frequency 2438 MHz	Highest frequency 2478 MHz
Power spectral density (dBm)	1.89	2.10	1.59
Measurement uncertainty (dB)	<±0.78		

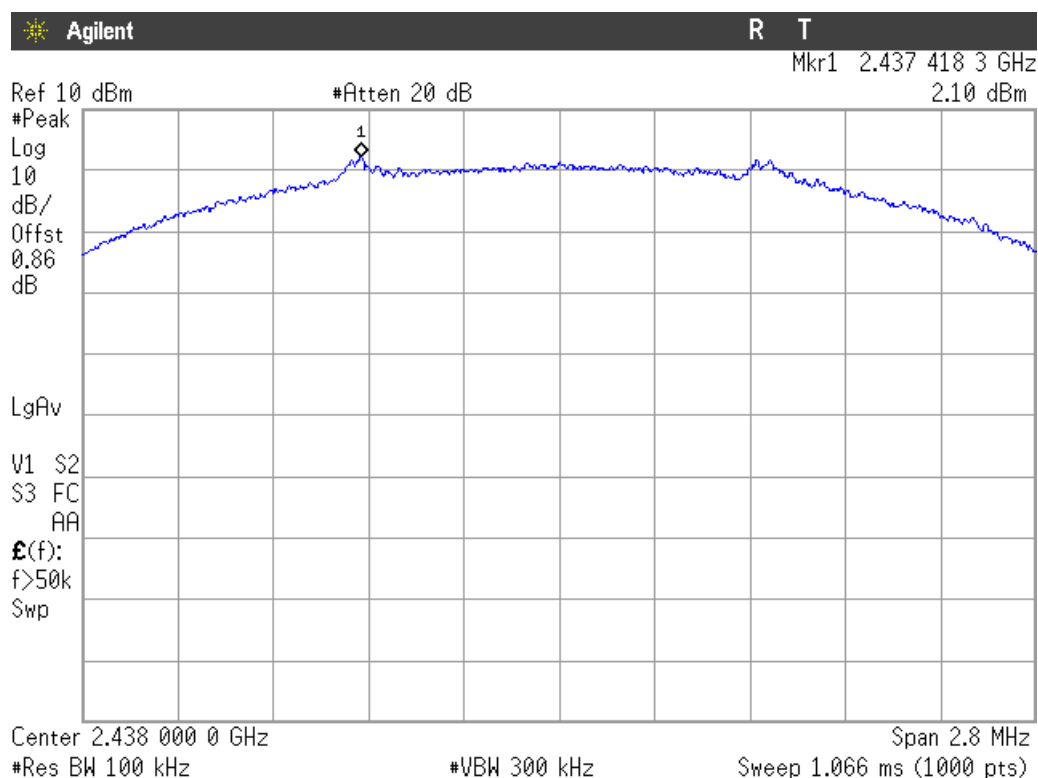
Verdict: PASS

Power spectral density.

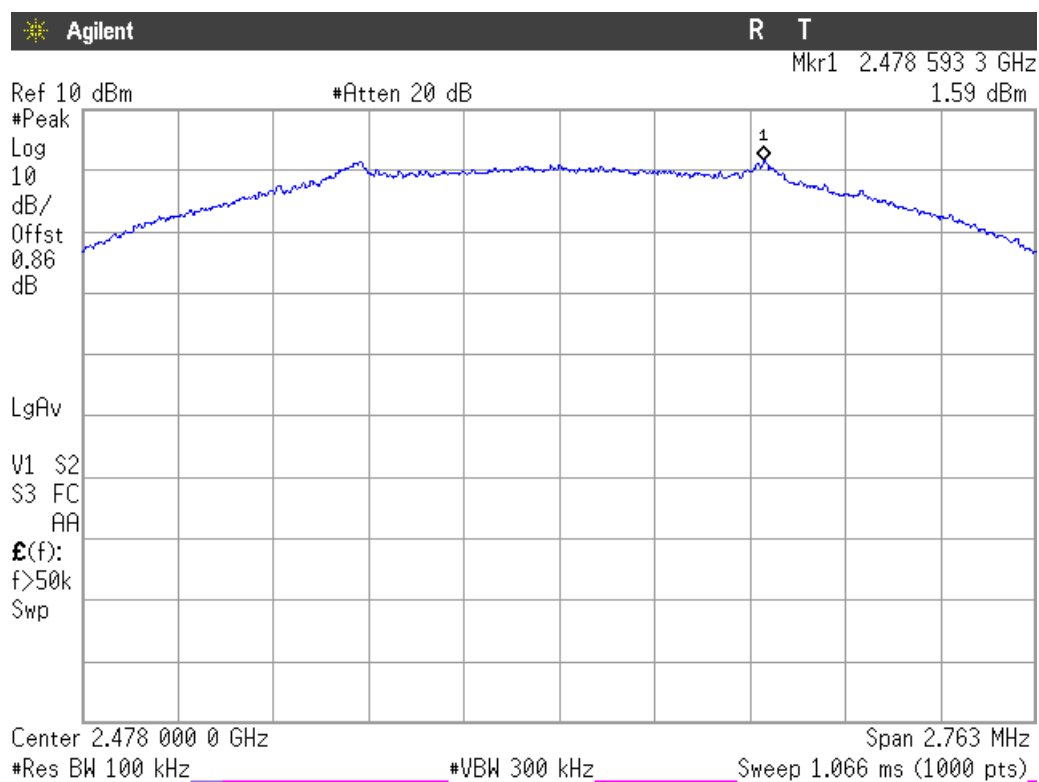
Lowest Channel



Middle Channel



Highest Channel



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 ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RESULTS:

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

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

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-1000 MHz and at distance of 1m for the frequency range 1 GHz-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 the operating channel.

All peaks are more than 20 dB below the limit.

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 dB μ V/m at 3 m) are measured with AVG detector for checking compliance with the average limit.

1. CHANNEL: LOWEST (2403 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
2.18450	V	Peak	51.06	± 4.69
2.38015	V	Peak	47.56	± 4.69
2.62150	V	Peak	54.98	± 4.69
		Average	52.43	± 4.69
4.80625	V	Peak	43.00	± 4.69
7.20925	H	Peak	44.97	± 4.69
9.61225	V	Peak	56.07	± 4.69
		Average	53.92	± 4.69

2. CHANNEL: MIDDLE (2438 MHz).

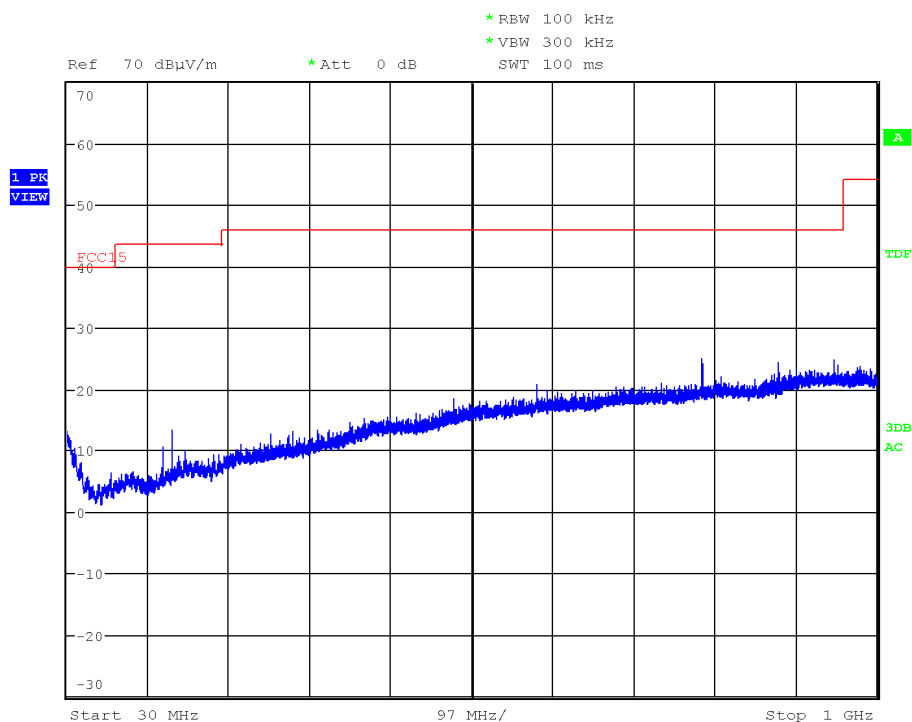
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
1.97557	V	Peak	44.93	± 4.69
2.21650	V	Peak	51.98	± 4.69
2.48359	H	Peak	48.86	± 4.69
2.65903	V	Peak	56.98	± 4.69
		Average	51.65	± 4.69
4.99975	H	Peak	37.34	± 4.69
6.49875	V	Peak	40.75	± 4.69
9.75025	H	Peak	53.73	± 4.69

3. CHANNEL: HIGHEST (2478 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
2.06430	V	Peak	48.38	± 4.69
2.25297	V	Peak	53.37	± 4.69
2.48350	V	Peak	61.03	± 4.69
		Average	51.87	± 4.69
2.70300	V	Peak	55.49	± 4.69
			50.64	± 4.69
4.95475	H	Peak	41.05	± 4.69
9.90925	H	Peak	57.05	± 4.69
		Average	48.06	± 4.69

Verdict: PASS

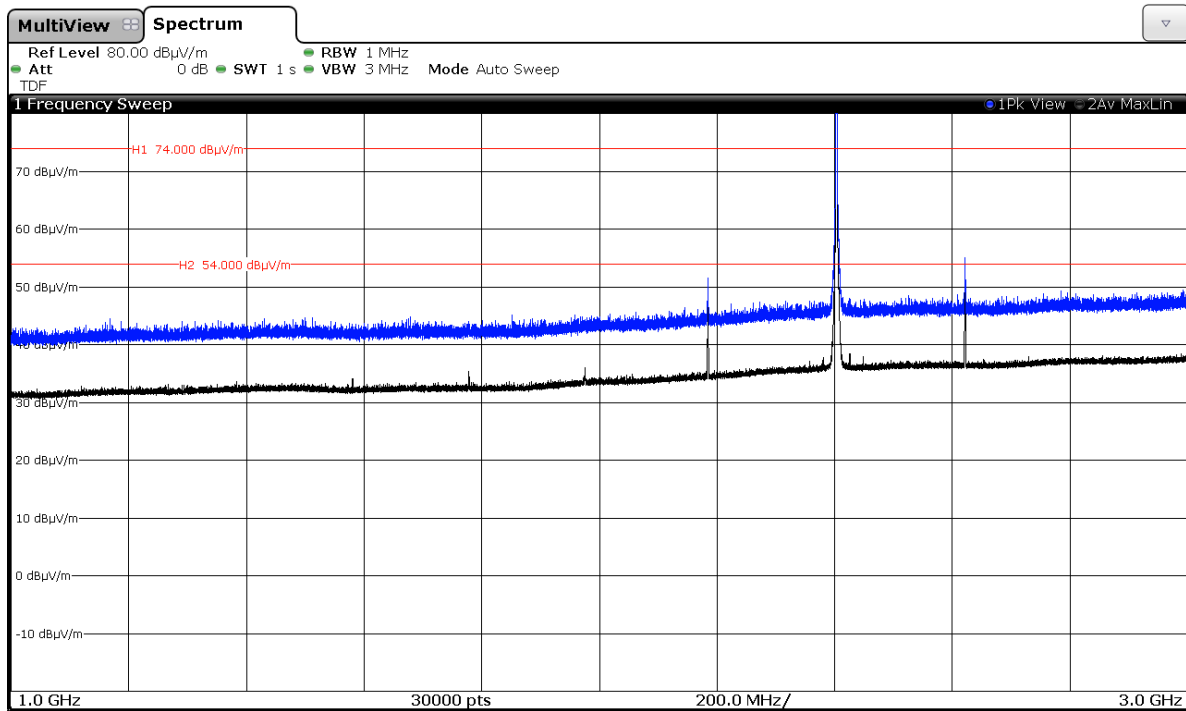
FREQUENCY RANGE 30 MHz-1000 MHz.



(This plot is valid for all three channels).

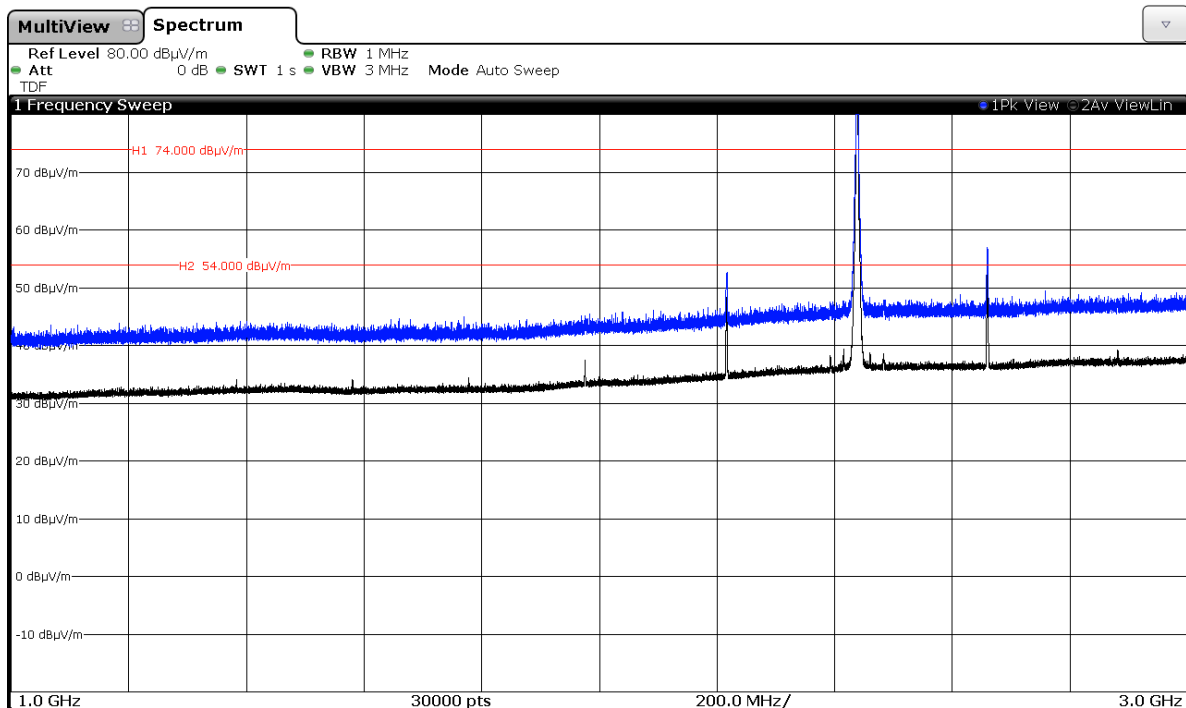
FREQUENCY RANGE 1 GHz to 3 GHz.

CHANNEL: Lowest (2403 MHz).



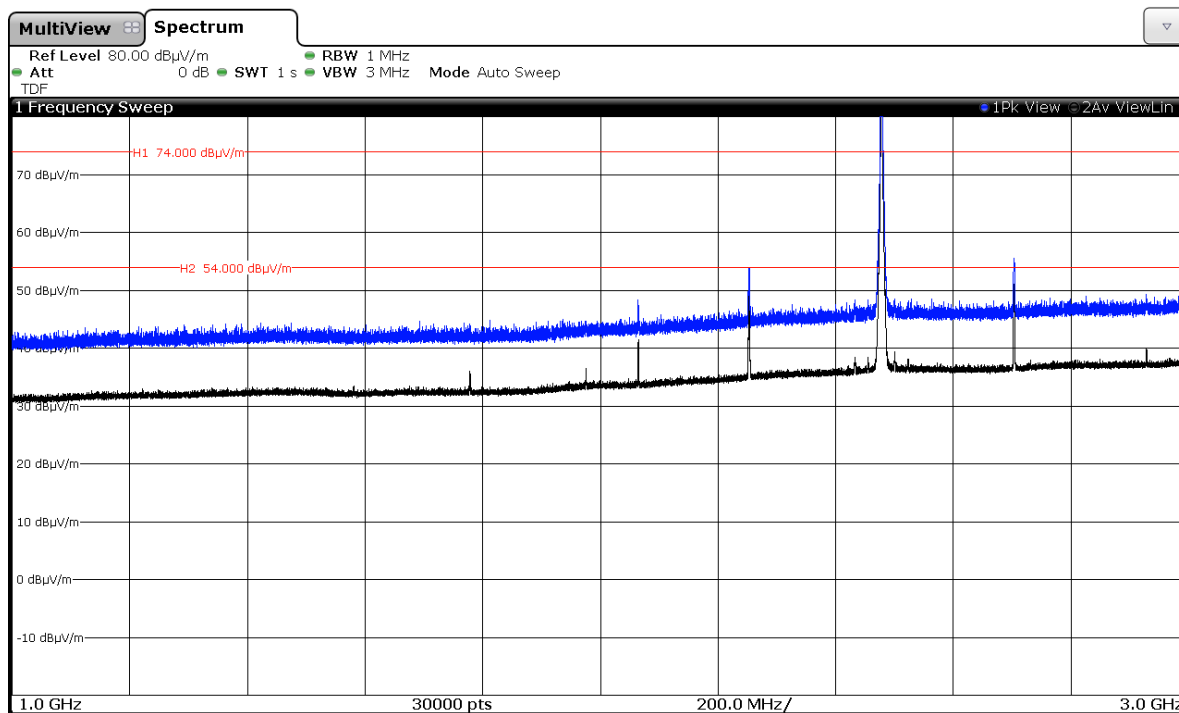
Note: The peak shown in the plot above the limit is the carrier frequency.

CHANNEL: Middle (2438 MHz).



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

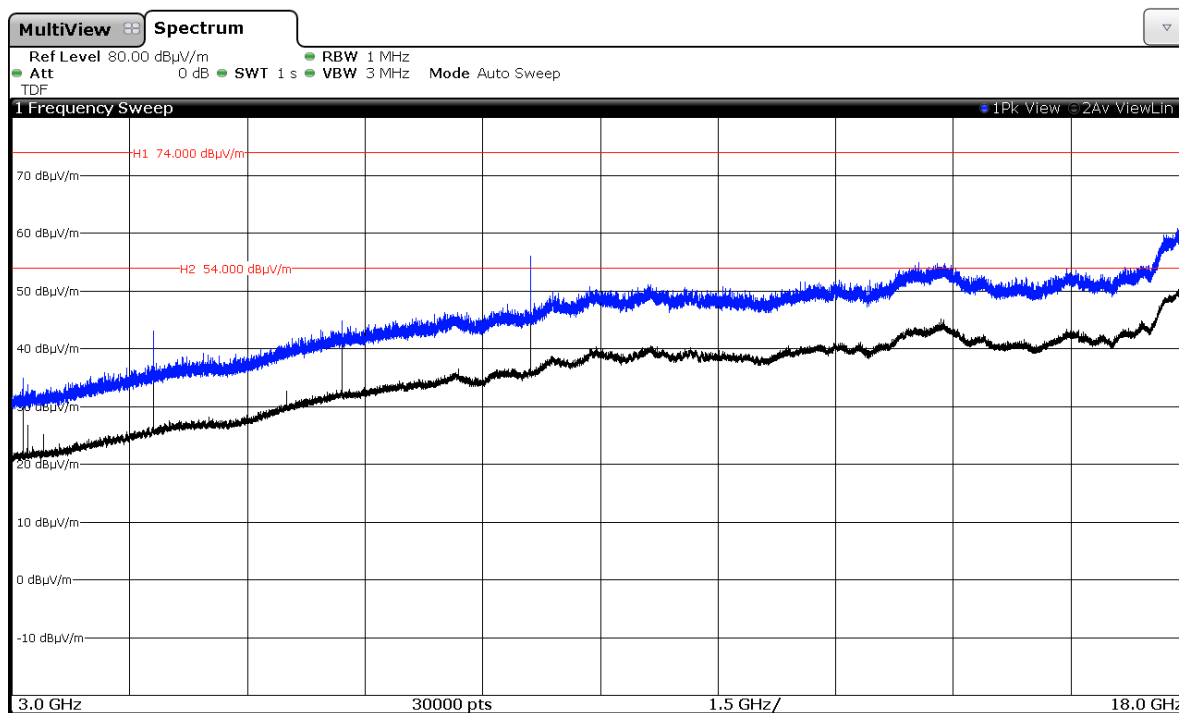
CHANNEL: Highest (2478 MHz).



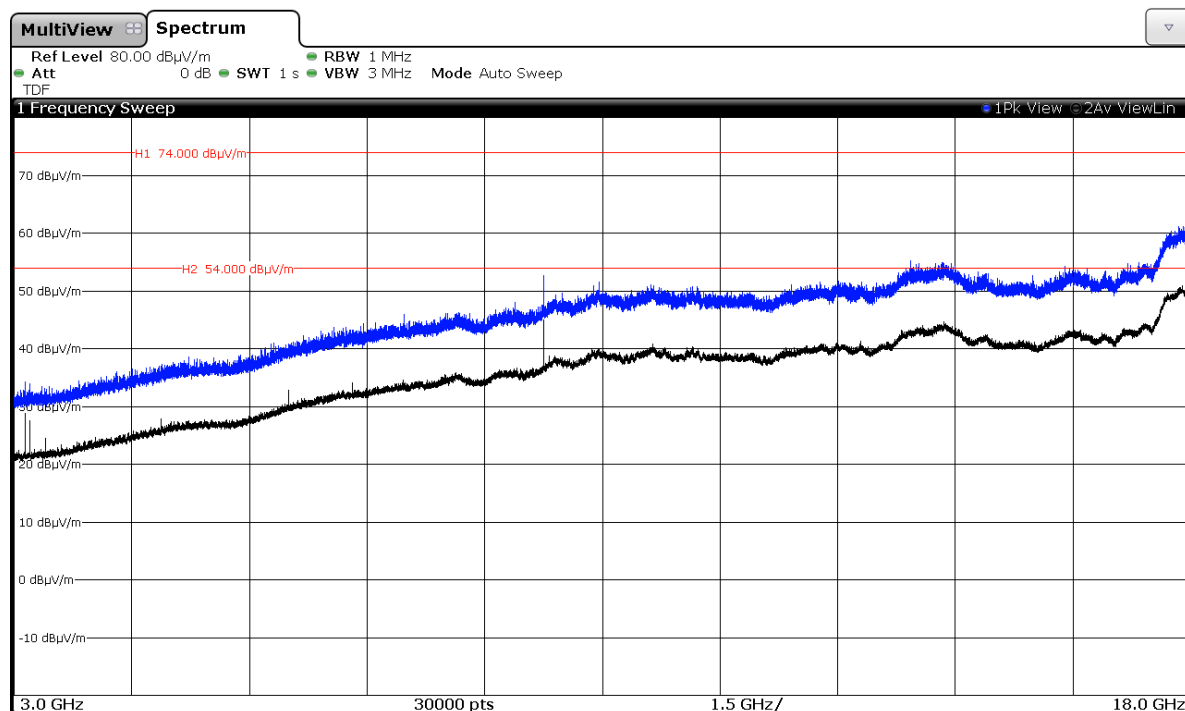
Note: The peak shown in the plot above the limit is the carrier frequency.

FREQUENCY RANGE 3 GHz to 18 GHz.

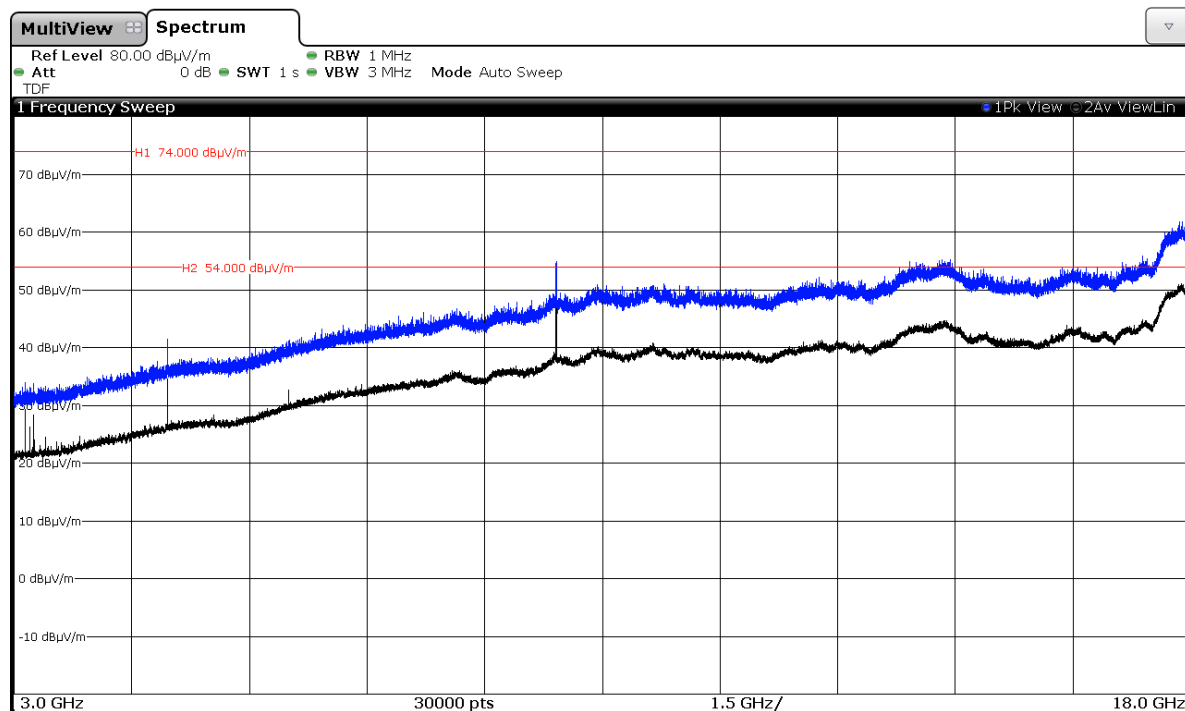
CHANNEL: Lowest (2403 MHz).



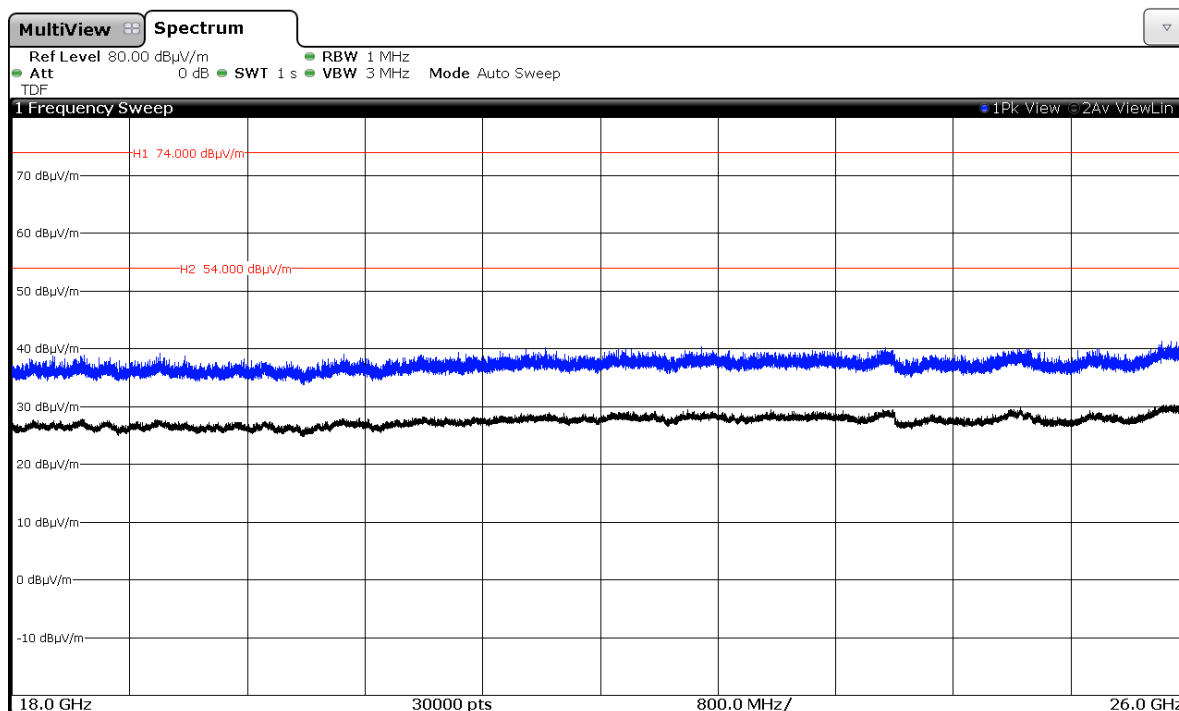
CHANNEL: Middle (2438 MHz).



CHANNEL: Highest (2478 MHz).



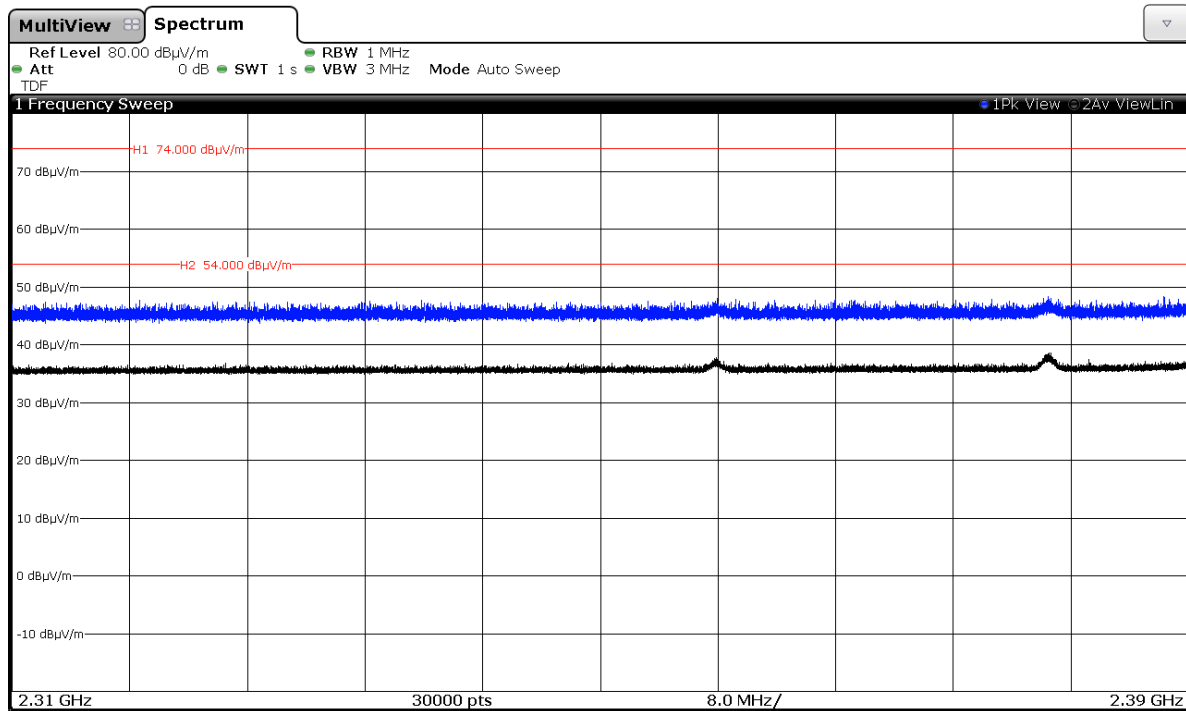
FREQUENCY RANGE 18 GHz to 26 GHz.



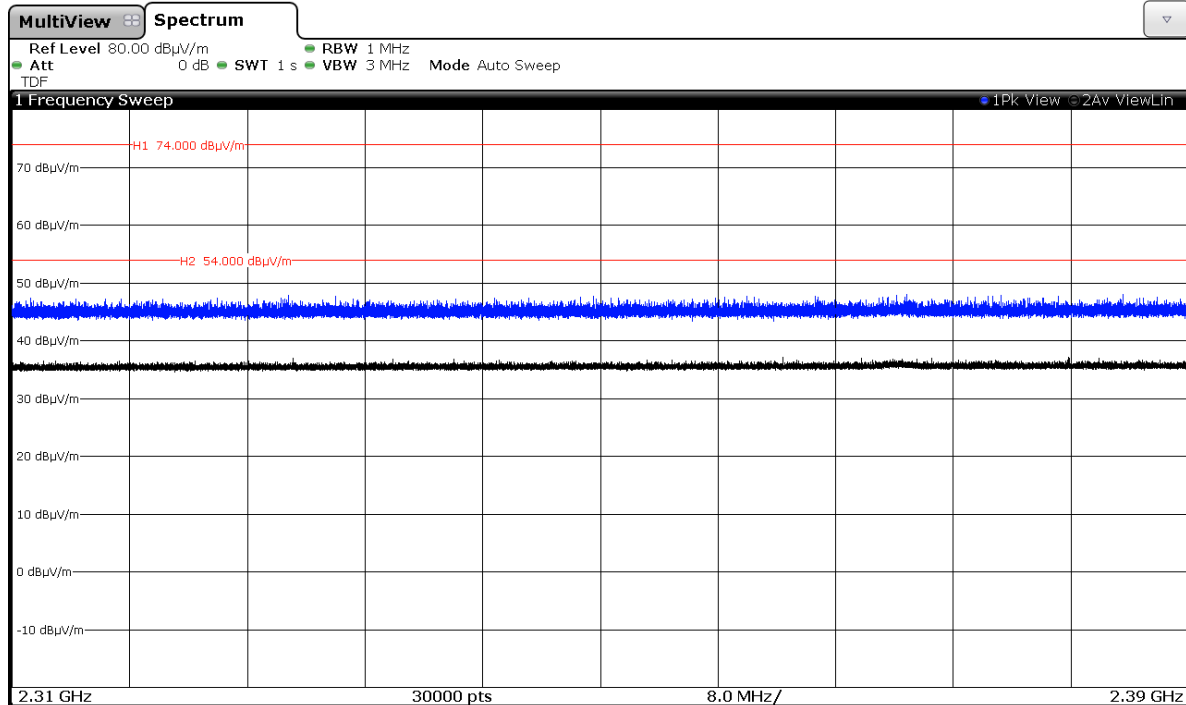
(This plot is valid for all three channels).

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

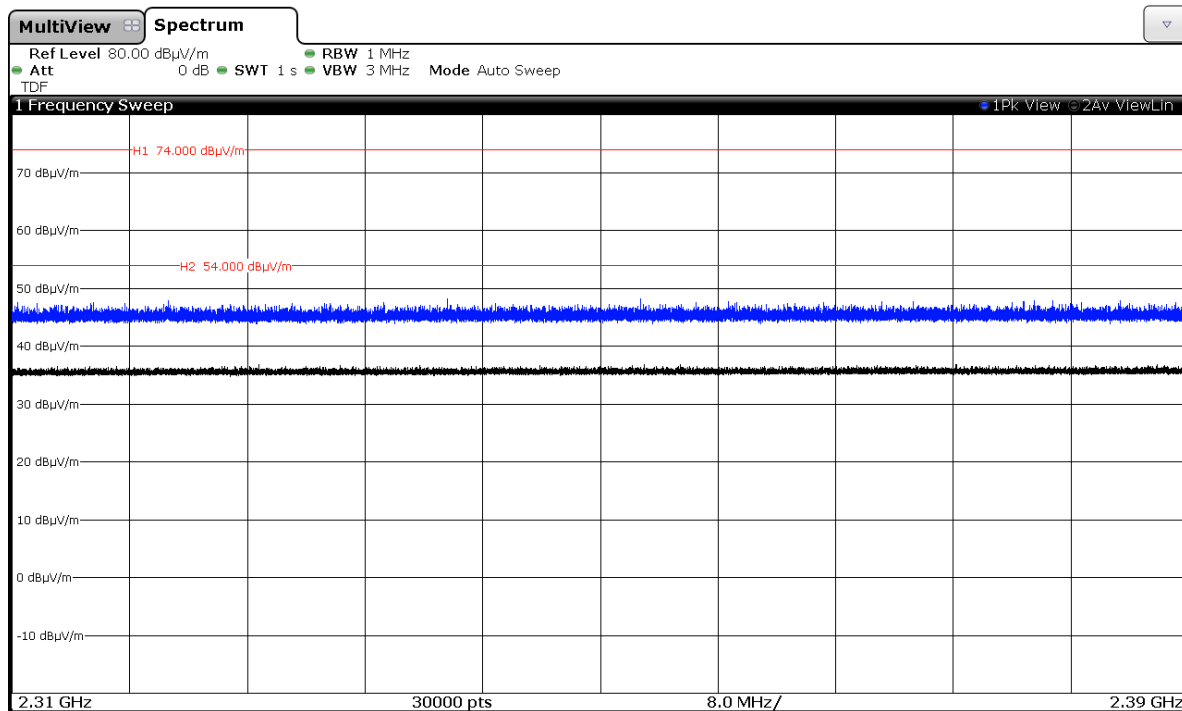
CHANNEL: Lowest (2403 MHz).



CHANNEL: Middle (2438 MHz).

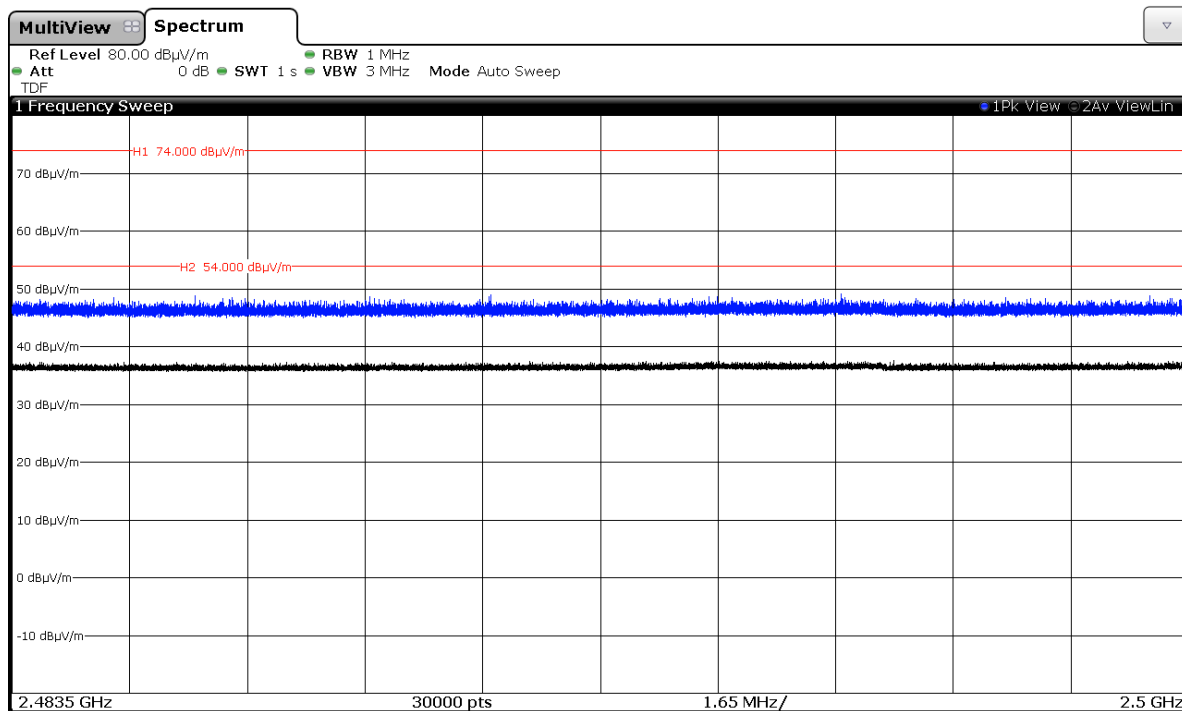


CHANNEL: Highest (2478 MHz).

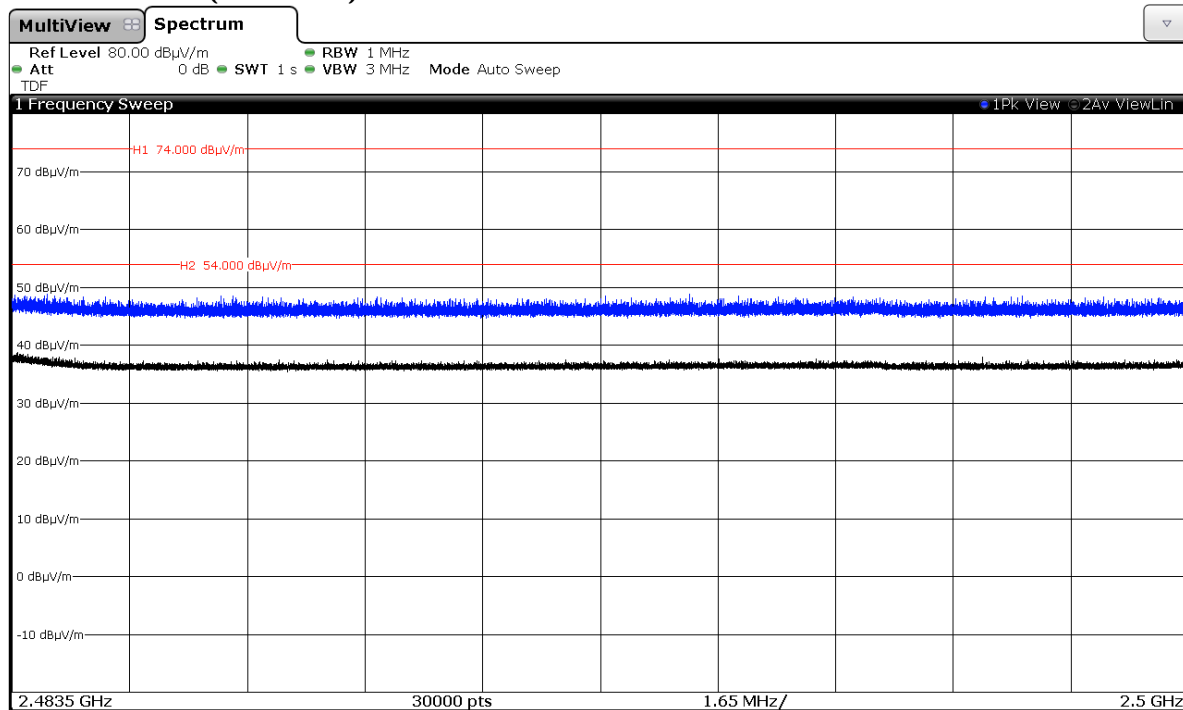


FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

CHANNEL: Lowest (2403 MHz).



CHANNEL: Middle (2438 MHz).



CHANNEL: Highest (2478 MHz).

