FCC LISTED, REGISTRATION NUMBER: 905266

IC LISTED REGISTRATION NUMBER IC 4621A-1

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Libro 82, Folio 133, Hoja MA3729

TEST REPORT

REFERENCE STANDARD:

USA FCC Part 15.247, 15.209

CANADA RSS-210, RSS-Gen

Radio Frequency Devices. Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz.

Licence-Exempt Radio Apparatus (All Frequency Bands): Category I Equipment.

General Requirements and Information for the Certification of Radio Apparatus.

NIE ..... :	38880RRF.002
Approved by (name / position & signature) ..... :	A. Llamas / RF Lab. Manager
Elaboration date ..... :	2013-06-13

Alejandro Llamas Rodríguez
Firmado digitalmente por Alejandro Llamas Rodríguez
Fecha: 2013.06.21 08:51:15 +02'00'
.....

Identification of item tested ..... :	3160HMW
Trademark ..... :	INTEL
Model and/or type reference ..... :	3160HMW
Serial number ..... :	TA#: G98549-001 WF MAC:001500BD59CA BD MAC: 001500BD59CE
Other identification of the product ..... :	Commercial name: 3160HMW HW Version: QS SW Version: Test SW: DRTU_1_6_1_628 Op SW: Wifi_ProSet_0340G For OEM factory installation: FCC ID: PD93160H IC: 1000M-3160H For user installation: FCC ID: PD93160HU IC: 1000M-3160H
Features ..... :	802.11 a/b/g/n/ac + BT 4.0
Description ..... :	1x1 PCIe Half Mini-card adapter

Applicant ..... :	INTEL MOBILE COMMUNICATIONS
Address..... :	100 Center Point Circle, Suite 200, Columbia, South Carolina 29210 USA
CIF/NIF/Passport..... :	No provided data
Contact person:	Steven Hackett
Telephone / Fax ..... :	Tel: 803-216-2344/ FAX: 803-216-2176

e-mail: ..... :	steven.c.hackett@intel.com
Test samples supplier ..... :	Same as applicant
Manufacturer ..... :	Same as applicant

Test method requested .....:	See Standard
Standard .....:	USA FCC Part 15.247 10-1-11 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 10-1-11 Edition: Radiated emission limits; general requirements. Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03 dated 08/04/2013. ANSI C63.10-2009: American National Standard for Testing Unlicensed Wireless Devices.
Test procedure .....:	PERF034
Non-standardized test method .....:	N/A
Used instrumentation .....:	Conducted Measurements

		Last Cal. date	Cal. due date
1.	Spectrum Analyzer Agilent E4440A	2012/02	2014/02
2.	EMI Test Receiver R&S ESU40	2012/03	2014/03
3.	Universal Power Meter R&S NRP-Z11	2012/12	2014/12

Radiated Measurements

		Last Cal. date	Cal. due date
1.	Semianechoic Absorber Lined Chamber IR 11. BS	N.A.	N.A.
2.	Control Chamber IR 12.BC	N.A.	N.A.
3.	Hybrid Bilog antenna Sunol Sciences Corporation JB6	2011/05	2014/05
4.	Antenna mast EM 1072 NMT	N.A.	N.A.
5.	Rotating table EM 1084-4. ON	N.A.	N.A.
6.	Double-ridge Guide Horn antenna 1-18 GHz HP 11966E	2011/05	2014/05
7.	Double-ridge Guide Horn antenna 18-40 GHz Agilent 119665J	2011/09	2014/09
8.	EMI Test Receiver R&S ESIB26	2011/11	2013/11
9.	RF pre-amplifier Miteq JS4-12002600-30-5A.	2012/07	2014/07
10.	Multi Device Controller EMCO 2090	N.A.	N.A.
11.	Spectrum Analyzer Agilent E4440A	2012/02	2014/02
12.	RF pre-amplifier Miteq AFS5-04001300-15-10P-6.	2012/07	2014/07
13.	RF pre-amplifier Schaffner CPA 9231.	2011/06	2013/06
14.	EMI Test Receiver R&S ESU40	2012/03	2014/03

Report template No. .....: FDT08_14

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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 conjuction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 905266.

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 programme 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.

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 documents:

PODT000: : Procedimiento para el cálculo de incertidumbres de medida

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
38880B/03	802.11a/b/g/n/ac wireless LAN + BT PCIe half-mini card	3160HMW	TA#: G98549-001 WF MAC:001500BD59CA BD MAC: 001500BD59CE	17/05/2013

Auxiliary elements used with the sample S/01:

Control Nº	Description	Manufacture	Model	Serial Nº	Date of reception
38067/28	Laptop PC	DELL	Latitude E5420	CTFQQL1	08/01/2013
38067/29	Cable of the AC/DC Adapter	DELL	---	---	08/01/2013
38067/30	AC/DC Adapter	DELL	LA90PM111	---	08/01/2013
38880B/11	Reference Antenna	SkyCross	WIMAX/WLAN	---	17/05/2013
38880B/12	Reference Antenna	SkyCross	WIMAX/WLAN	---	17/05/2013
38067/36	M2/NGFF extender cable	---	---	---	08/01/2013
38067/37	HMC/NGFF Testing board	INTEL	PCB00390	3902412-252	11/01/2013
38067/38	Adapter of the AC/DC Board Testing	SINPRO	SPU60-102	07990464 1249	11/01/2013
1302	Board 35mmx35mm	---	---	---	---
---	USB cable	---	---	---	---

Usage of samples

Sample S/02 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
38880B/03	802.11a/b/g/n/ac wireless LAN + BT PCIe half-mini card	3160HMW	TA#: G98549-001 WF MAC:001500BD59CA BD MAC: 001500BD59CE	17/05/2013

Auxiliary elements used with the sample S/02:

Control Nº	Description	Manufacture	Model	Serial Nº	Date of reception
38067/28	Laptop PC	DELL	Latitude E5420	CTFQQL1	08/01/2013
38067/29	Cable of the AC/DC Adapter	DELL	---	---	08/01/2013
38067/30	AC/DC Adapter	DELL	LA90PM111	---	08/01/2013
38067/36	M2/NGFF extender cable	---	---	---	08/01/2013
38067/37	HMC/NGFF Testing board	INTEL	PCB00390	3902412-252	11/01/2013
38067/38	Adapter of the AC/DC Board Testing	SINPRO	SPU60-102	07990464 1249	11/01/2013
---	USB cable	---	---	---	---

1. Sample S/01 has undergone following test(s).
   All radiated tests indicated in appendix A, B and C.

2. Sample S/02 has undergone following test(s).
   All conducted tests indicated in appendix A, B and C.

Testing period

The performed test started on 2013-05-24 and finished on 2013-06-03.

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. = 20.6 ºC Max. = 21.3 ºC
Relative humidity	Min. = 47.8% Max. = 50.3 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω

In the semianechoic chamber (21 meters x 11 meters x 8 meters), the following limits were not exceeded during the test.

Temperature	Min. = 18.7 ºC Max. = 19.9 ºC
Relative humidity	Min. = 46.8 % Max. = 49.1 %
Air pressure	Min. = 1019 mbar Max. = 1020 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 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. = 24.1 ºC Max. = 25.1 ºC
Relative humidity	Min. = 48.5 % Max. = 50.1%
Air pressure	Min. = 1019 mbar Max. = 1020 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω

Summary

Considering the results of the performed test according to standard USA FCC Parts 15.247 / RSS-210, the item under test is **IN COMPLIANCE** with the requested specifications specified in the standard.

NOTE: The results presented in this Test Report apply only to the particular item under test established in page 1 of this document, as presented for test on the date(s) shown in section, "USAGE OF SAMPLES, TESTING PERIOD AND ENVIRONMENTAL CONDITIONS".

Remarks and comments

None.

Testing verdicts

Not applicable .....: NA

Pass.....: P

Fail .....: F

Not measured.....: NM

1. WiFi 2.4 GHz (802.11b/g/n20/n40)

FCC PART 15 PARAGRAPH / RSS-210		VERDICT			
		NA	P	F	NM
Section 15.247 Subclause (a) (2) / RSS-210 A8.2. (a)	6 dB Bandwidth		P		
Section 15.247 Subclause (b) / RSS-210 A8.4. (4)	Maximum output power and antenna gain		P		
Section 15.247 Subclause (d) / RSS-210 A8.5.	Emission limitations conducted (Transmitter)		P		
Section 15.247 Subclause (d) / RSS-210 A8.5.	Band-edge emissions compliance (Transmitter)		P		
Section 15.247 Subclause (e) / RSS-210 A8.2. (b)	Power spectral density		P		
Section 15.247 Subclause (d) / RSS-210 A8.5.	Emission limitations radiated (Transmitter)		P		

2. WiFi 5.725 – 5.825 GHz (802.11a/n20/n40/ac80)

FCC PART 15 PARAGRAPH / RSS-210		VERDICT			
		NA	P	F	NM
Section 15.247 Subclause (a) (2) / RSS-210 A8.2. (a)	6 dB Bandwidth		P		
Section 15.247 Subclause (b) / RSS-210 A8.4. (4)	Maximum output power and antenna gain		P		
Section 15.247 Subclause (d) / RSS-210 A8.5.	Emission limitations conducted (Transmitter)		P		
Section 15.247 Subclause (d) / RSS-210 A8.5.	Band-edge emissions compliance (Transmitter)		P		
Section 15.247 Subclause (e) / RSS-210 A8.2. (b)	Power spectral density		P		
Section 15.247 Subclause (d) / RSS-210 A8.5.	Emission limitations radiated (Transmitter)		P		

3. Bluetooth Low Energy

FCC PART 15 PARAGRAPH / RSS-210		VERDICT			
		NA	P	F	NM
Section 15.247 Subclause (a) (2) / RSS-210 A8.2. (a)	6 dB Bandwidth		P		
Section 15.247 Subclause (b) / RSS-210 A8.4. (4)	Maximum output power and antenna gain		P		
Section 15.247 Subclause (d) / RSS-210 A8.5.	Emission limitations conducted (Transmitter)		P		
Section 15.247 Subclause (d) / RSS-210 A8.5.	Band-edge emissions compliance (Transmitter)		P		
Section 15.247 Subclause (e) / RSS-210 A8.2. (b)	Power spectral density		P		
Section 15.247 Subclause (d) / RSS-210 A8.5.	Emission limitations radiated (Transmitter)		P		

APPENDIX A: Test results
“WiFi 2.4 GHz (802.11b/g/n20/n40)”

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TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 3.3 Vdc

Type of power supply = DC voltage from HMC/NGFC test board.

Type of antenna = External attachable PIFA antenna.

Declared Gain for antenna = 3.2 dBi

TEST FREQUENCIES:

For WiFi 802.11b/g/n20:

Lowest channel (1): 2412 MHz

Middle channel (6): 2437 MHz

Highest channel (11): 2462 MHz

For WiFi 802.11n40:

Lowest channel (3): 2422 MHz

Middle channel (6): 2437 MHz

Highest channel (9): 2452 MHz

The test set-up was made in accordance to the general provisions of ANSI C63.4: 2009 and FCC DTS Measurement KDB 558074 D01 DTS Meas Guidance v03.

For 802.11b/g modes the EUT can only transmit at Main RF output.

For 802.11n modes 802.11n20 (20 MHz channel bandwidth) and 802.11n40 (40MHz channel bandwidth) the EUT can only transmit at Main RF output.

For radio testing purposes the card was installed in a test fixture. The test fixture is connected to a laptop computer and dc power supplied. The laptop computer was used to configure the EUT to continuously transmit at a specified output power with different modes and modulation schemes.

WiFi 2.4 GHz: 802.11b, 802.11g, 802.11n20 (20 MHz channel bandwidth) and 802.11n40 (40MHz channel bandwidth).

The field strength at the band edges was evaluated for each mode individually on the lowest and highest channels at the rated power for the channel under test. Where the power at the edge channels was lower than the power at the center channels additional measurements were made at the adjacent channels.

The PC was using the Intel test utility DRTU Version DRTU 1.6.1.628.

During transmitter test the EUT was being controlled by the Intel DRTU tool 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, HT0 for 802.11n20 and n40 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 at Main RF output was adjusted according to the client's supplied Target values (see following table) using the Intel DRTU tool and measuring the power by using a calibrated average power meter. Measured values for adjustment were within -0.2 dB/+0.3 dB respect to the Target values.

RF conducted output power target values

Mode	BW (MHz)	Channel / Freq.	RF output power at Main RF (dBm)
802.11b	20	1 / 2412	16.5
		6 / 2437	16.5
		11 / 2462	16.5
802.11g	20	1 / 2412	14.5
		2 / 2417	16.5
		6 / 2437	16.5
		10 / 2457	16.5
		11 / 2462	14.5
802.11n	20	1 / 2412	14.5
		2 / 2417	16.5
		6 / 2437	16.5
		10 / 2457	16.5
		11 / 2462	14.5
802.11n*	40	3 / 2422	13
		4 / 2427	13.5
		5 / 2432	15
		6 / 2437	16.5
		7 / 2442	15.5
		8 / 2447	14.5
		9 / 2452	14

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a calibrated low loss RF cable. The reading in the spectrum analyser is compensated with the cable loss at each measurement frequency.

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 one 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.

Occupied Bandwidth

RESULTS

1. WiFi 2.4GHz 802.11 b mode

Occupied Bandwidth (see next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	14.2142	14.1998	14.1882
Measurement uncertainty (kHz)	±21.7		

2. WiFi 2.4GHz 802.11 g mode

Occupied Bandwidth (see next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	17.1456	17.6522	17.1273
Measurement uncertainty (kHz)	±21.7		

3. WiFi 2.4GHz 802.11 n20 mode

Occupied Bandwidth (see next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	18.1903	18.5142	18.1663
Measurement uncertainty (kHz)	±21.7		

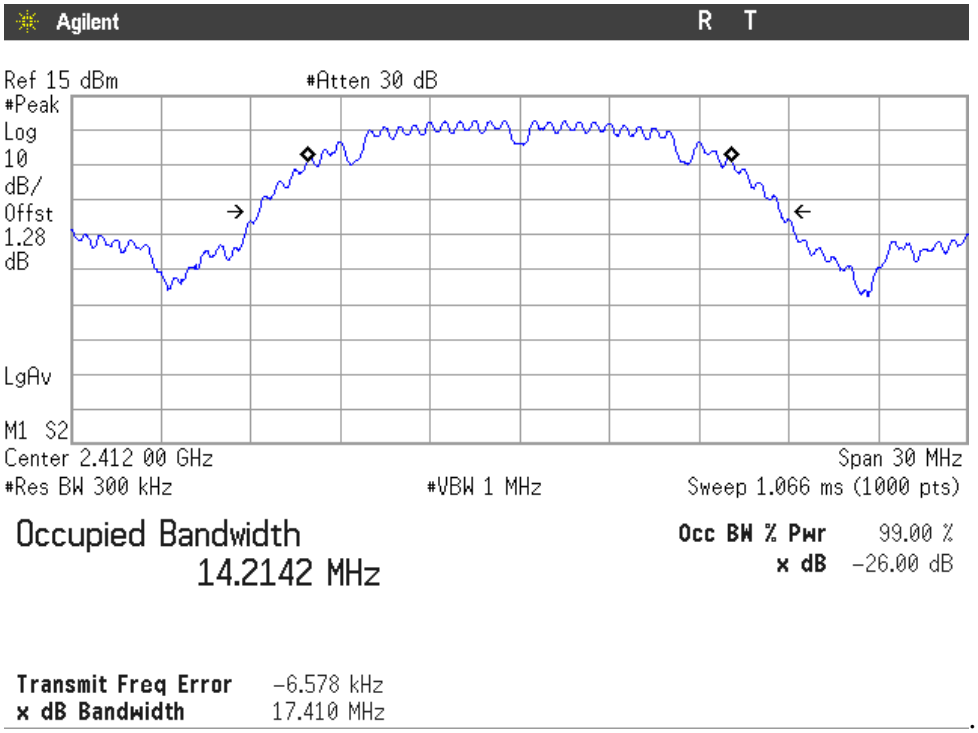
4. WiFi 2.4GHz 802.11 n40 mode

Occupied Bandwidth (see next plots).

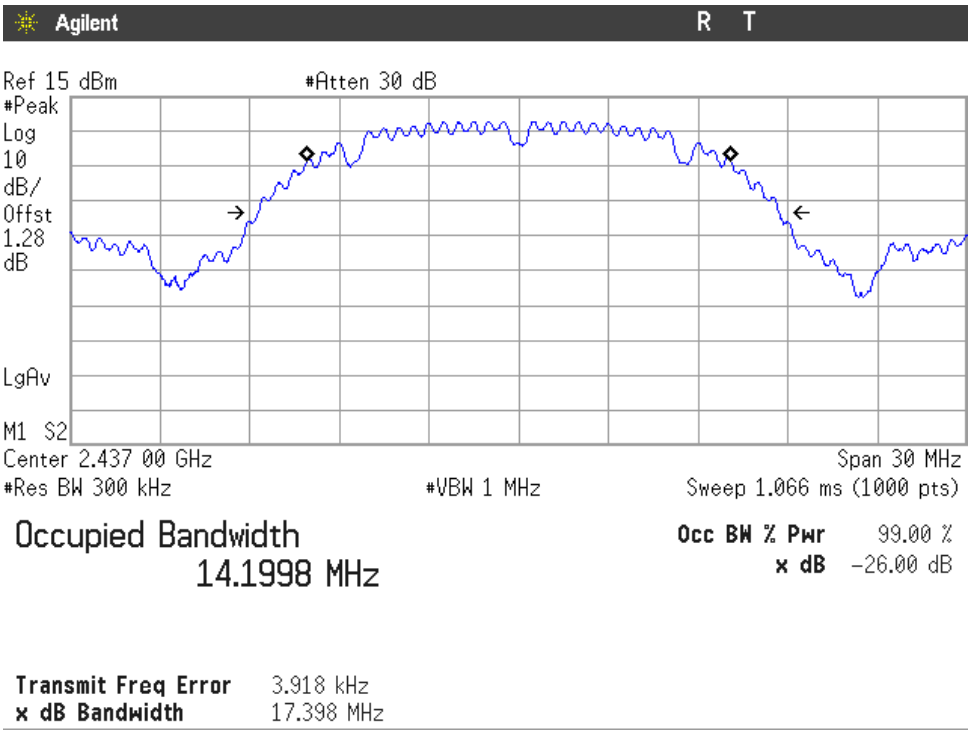
	Lowest frequency 2422 MHz	Middle frequency 2437 MHz	Highest frequency 2452 MHz
99% bandwidth (MHz)	36.0502	36.2044	36.0454
Measurement uncertainty (kHz)	±21.7		

1. WiFi 2.4GHz 802.11 b mode

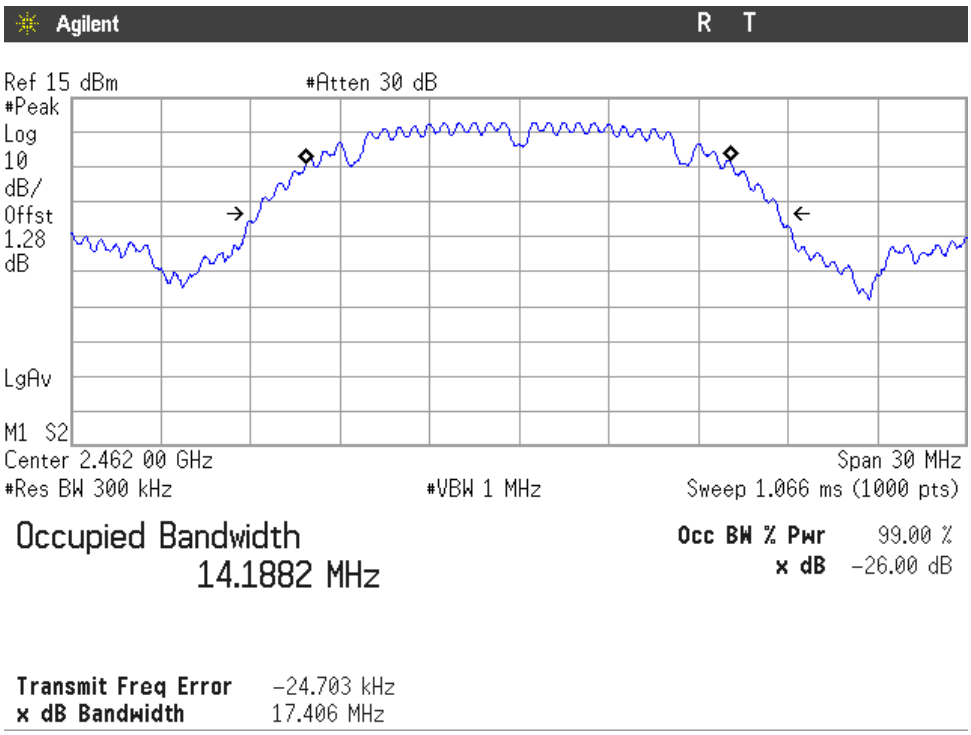
Lowest Channel: 2412 MHz. Chain A



Middle Channel: 2437 MHz. Chain A

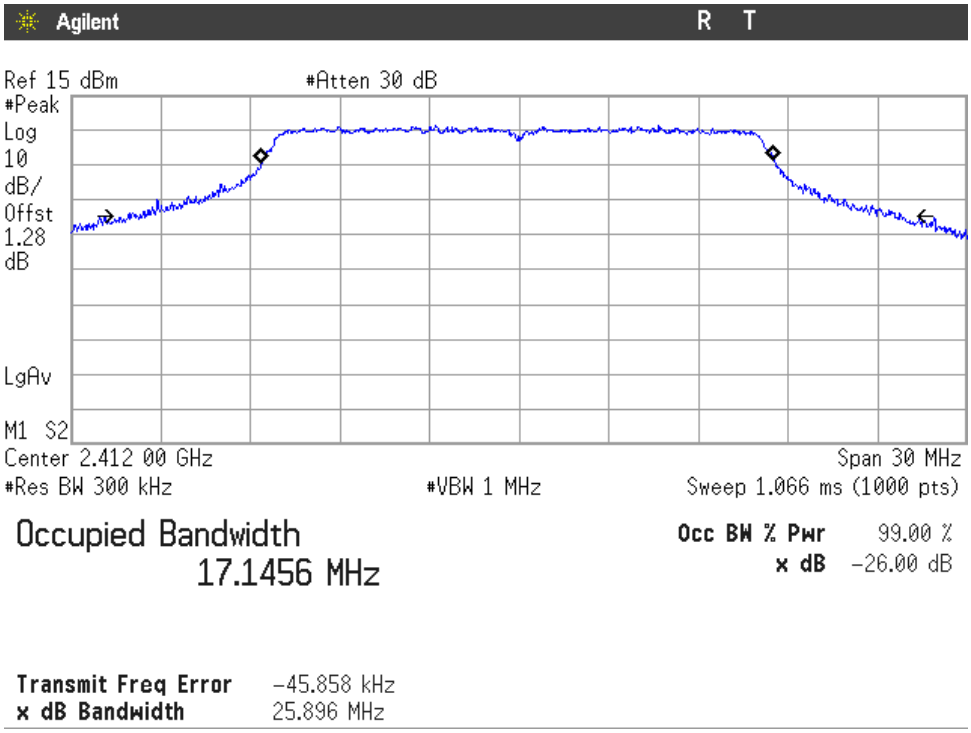


Highest Channel: 2462 MHz. Chain A.

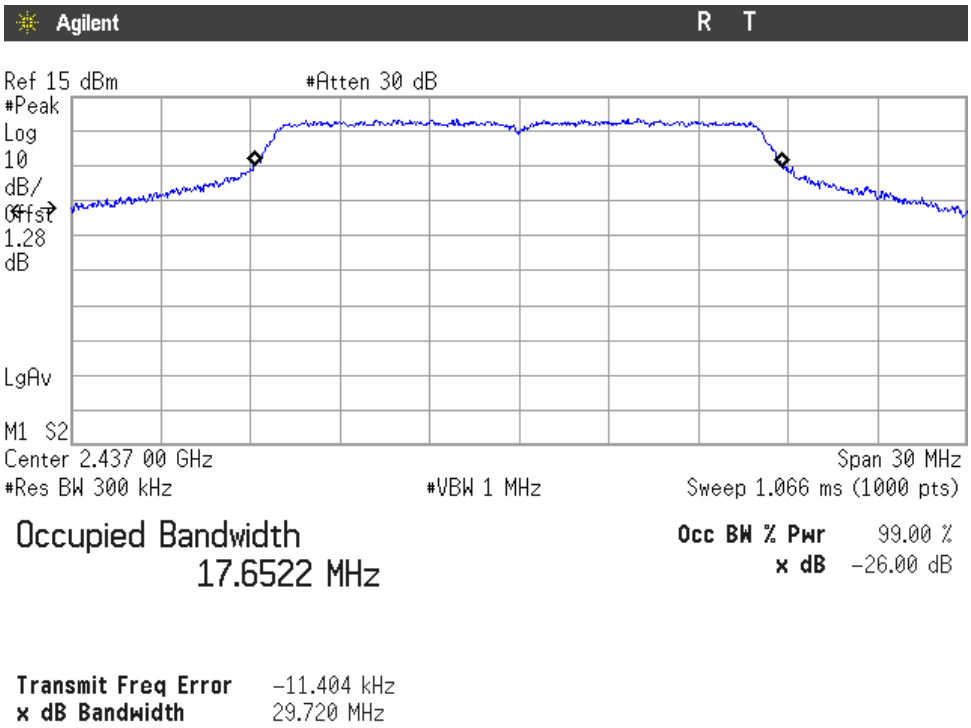


2. WiFi 2.4GHz 802.11 g mode

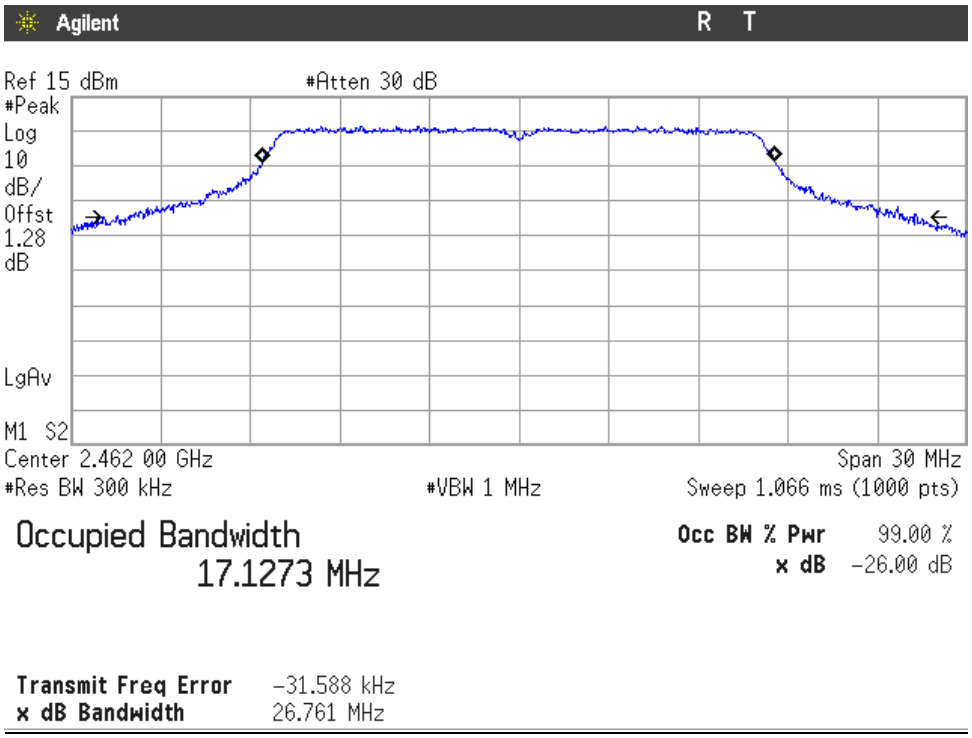
Lowest Channel: 2412 MHz. Chain A



Middle Channel: 2437 MHz. Chain A

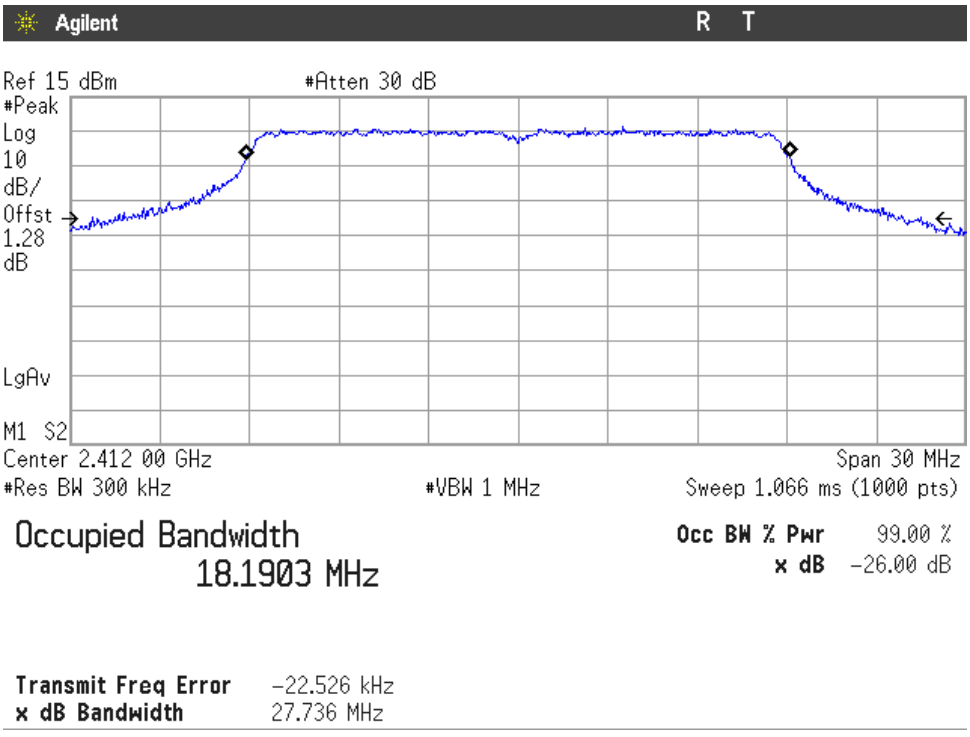


Highest Channel: 2462 MHz. Chain A.

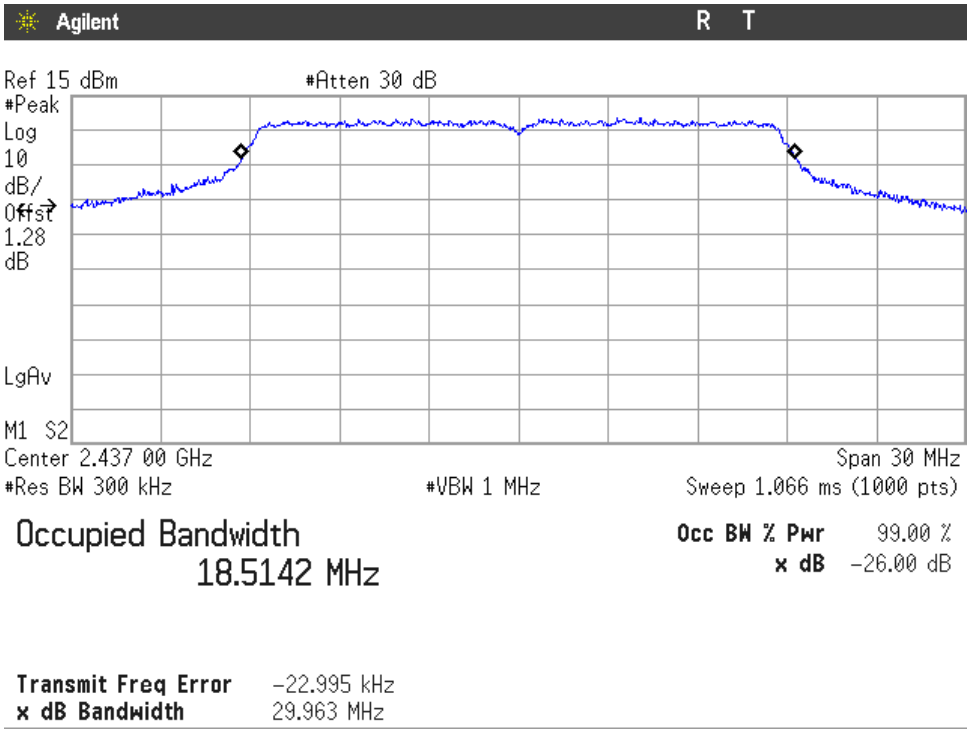


3. WiFi 2.4GHz 802.11 n20 mode

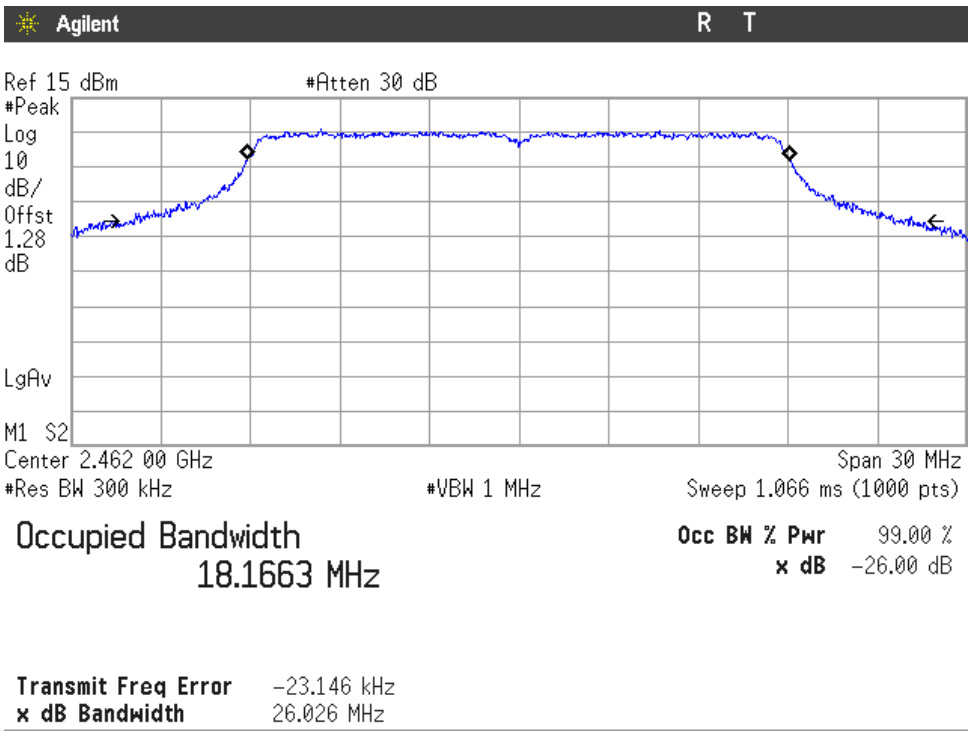
Lowest Channel: 2412 MHz. Chain A



Middle Channel: 2437 MHz. Chain A

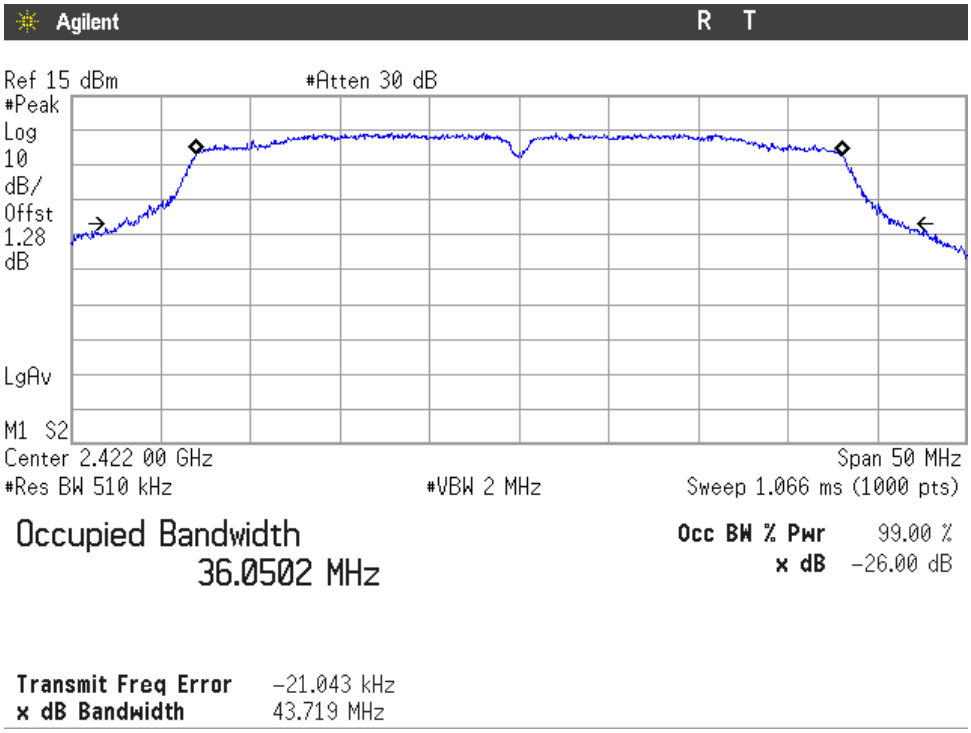


Highest Channel: 2462 MHz. Chain A.

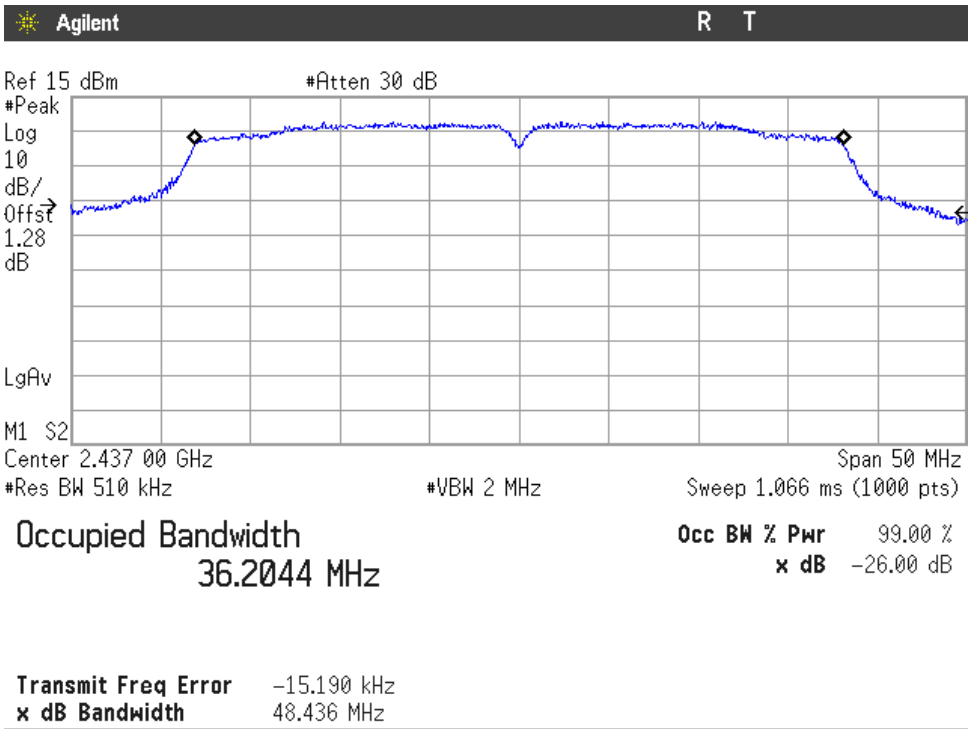


4. WiFi 2.4GHz 802.11 n40 mode

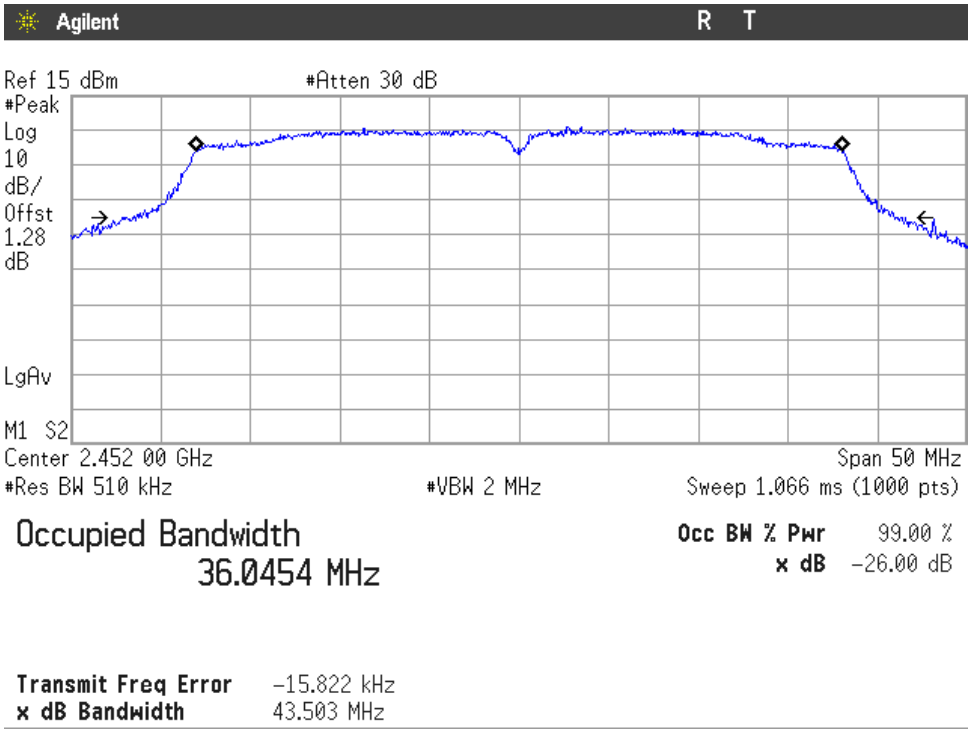
Lowest Channel: 2422 MHz. Chain A



Middle Channel: 2437 MHz. Chain A



Highest Channel: 2452 MHz. Chain A.



Section 15.247 Subclause (a) (2) / RSS-210 A8.2. (a). 6 dB Bandwidth

SPECIFICATION

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

RESULTS

1. WiFi 2.4GHz 802.11 b mode

6 dB Bandwidth (see next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	12.052	12.052	12.052
Measurement uncertainty (kHz)	±89		

Verdict: PASS

2. WiFi 2.4GHz 802.11 g mode

6 dB Bandwidth (see next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	16.416	16.376	16.396
Measurement uncertainty (kHz)	±89		

Verdict: PASS

3. WiFi 2.4GHz 802.11 n20 mode

6 dB Bandwidth (see next plots).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
6 dB Spectrum bandwidth (MHz)	17.618	17.618	17.618
Measurement uncertainty (kHz)	±89		

Verdict: PASS

4. WiFi 2.4GHz 802.11 n40 mode

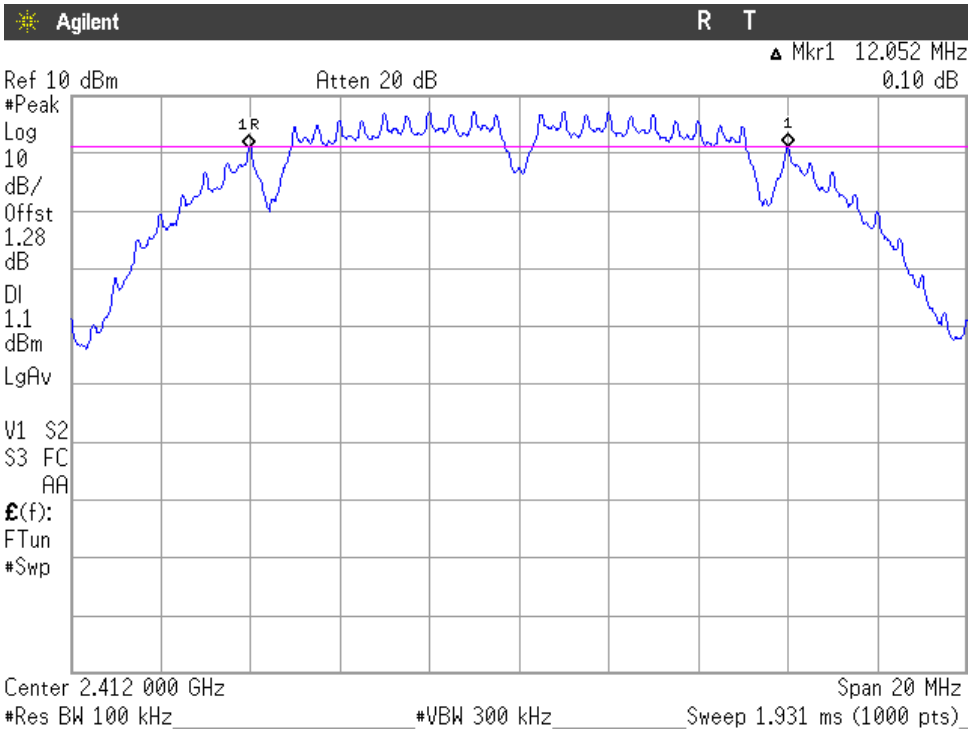
6 dB Bandwidth (see next plots).

	Lowest frequency 2422 MHz	Middle frequency 2437 MHz	Highest frequency 2452 MHz
6 dB Spectrum bandwidth (MHz)	35.16	35.12	35.16
Measurement uncertainty (kHz)	±89		

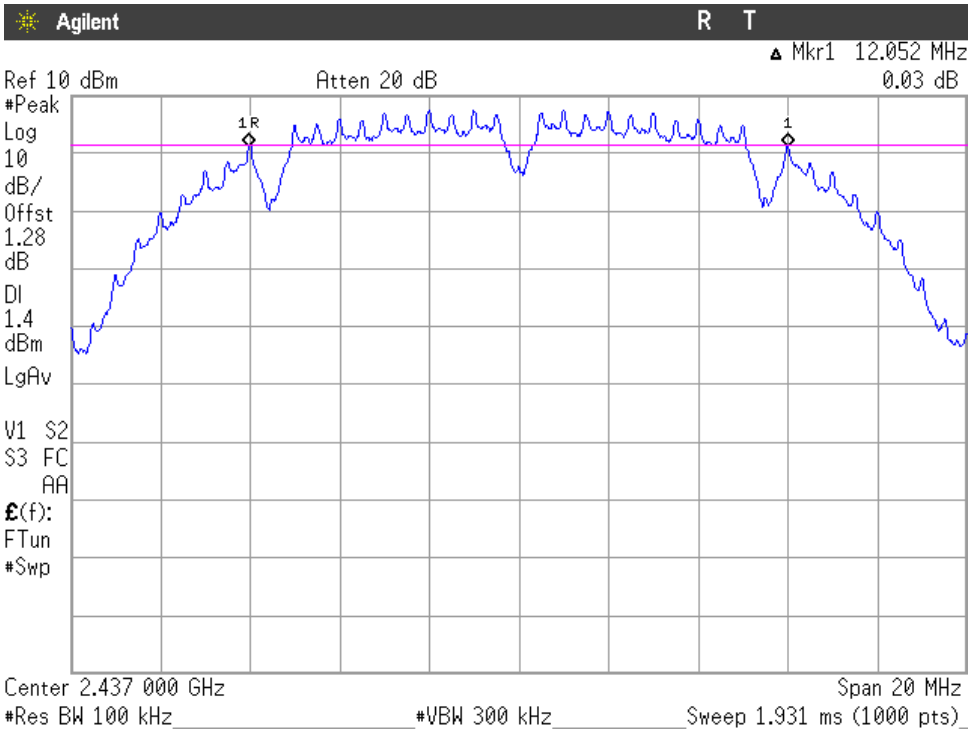
Verdict: PASS

1. WiFi 2.4GHz 802.11 b mode

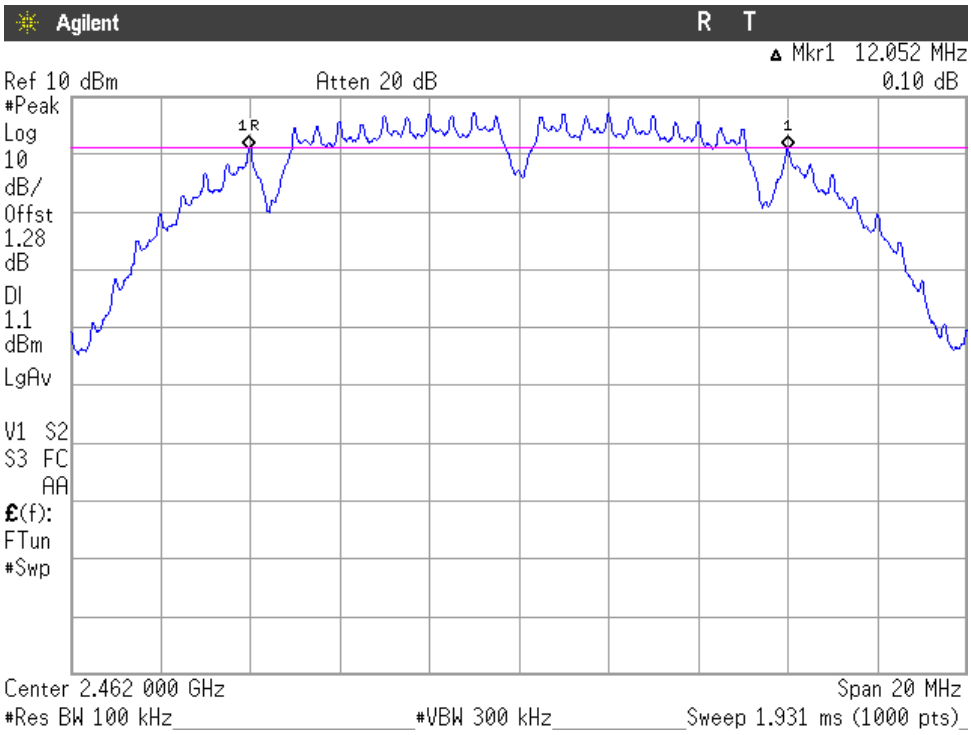
Lowest Channel: 2412 MHz. Chain A.



Middle Channel: 2437 MHz. Chain A

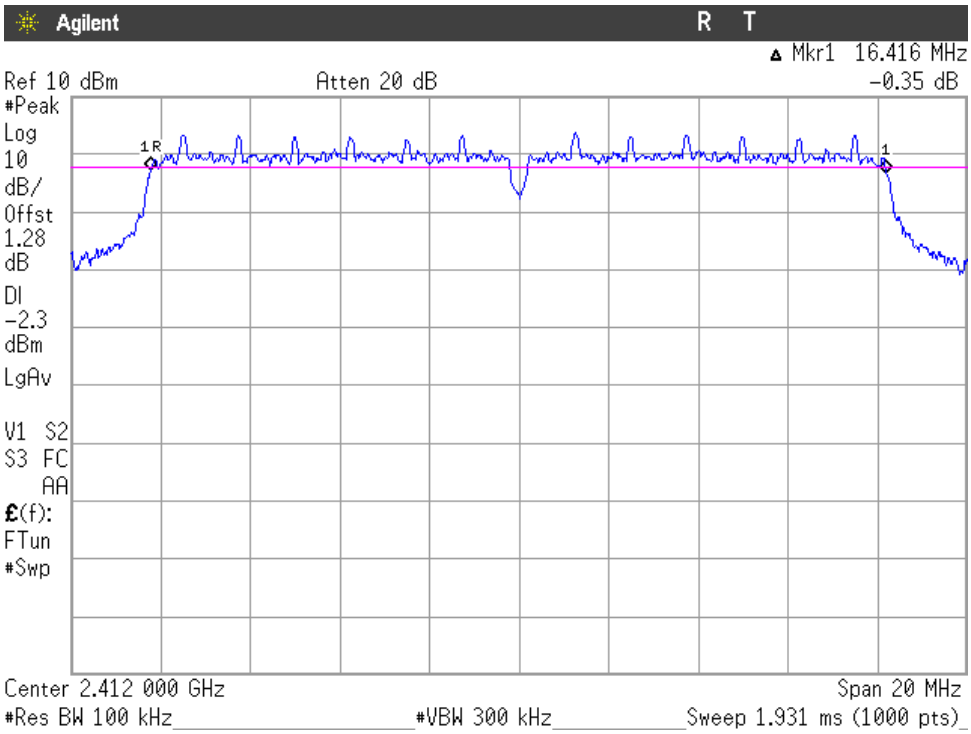


Highest Channel: 2462 MHz. Chain A.

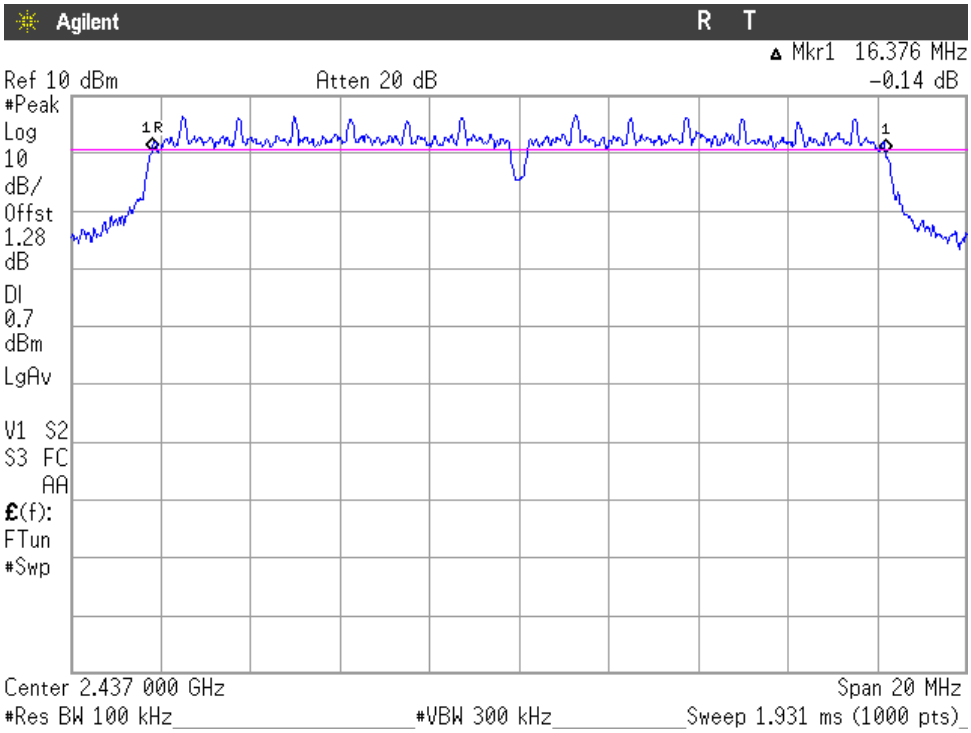


2. WiFi 2.4GHz 802.11 g mode

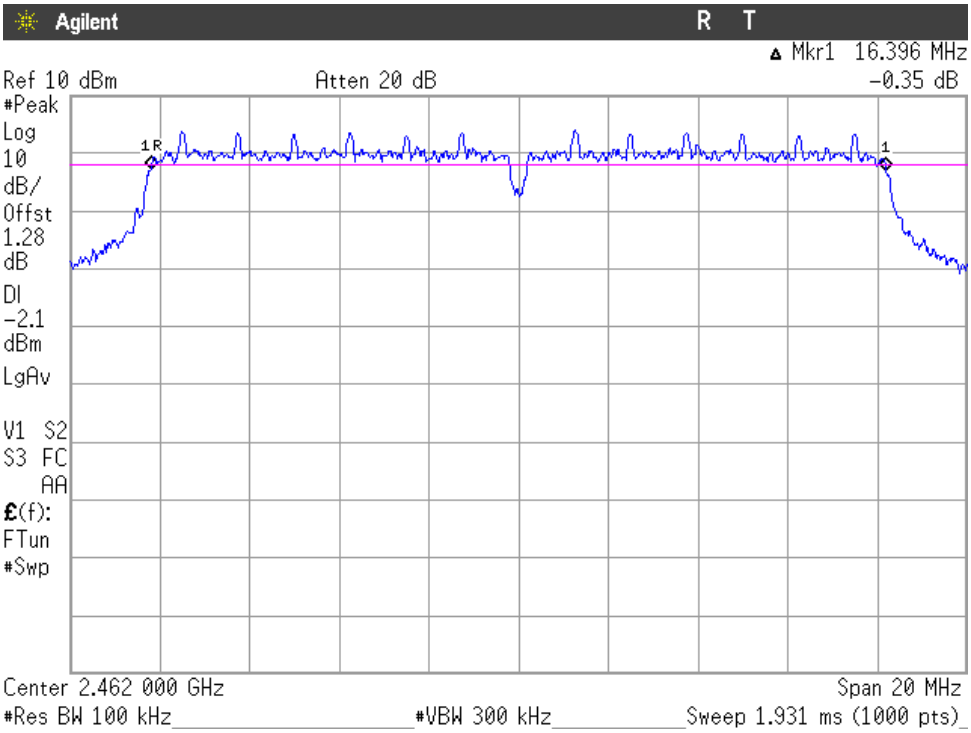
Lowest Channel: 2412 MHz. Chain A



Middle Channel: 2437 MHz. Chain A

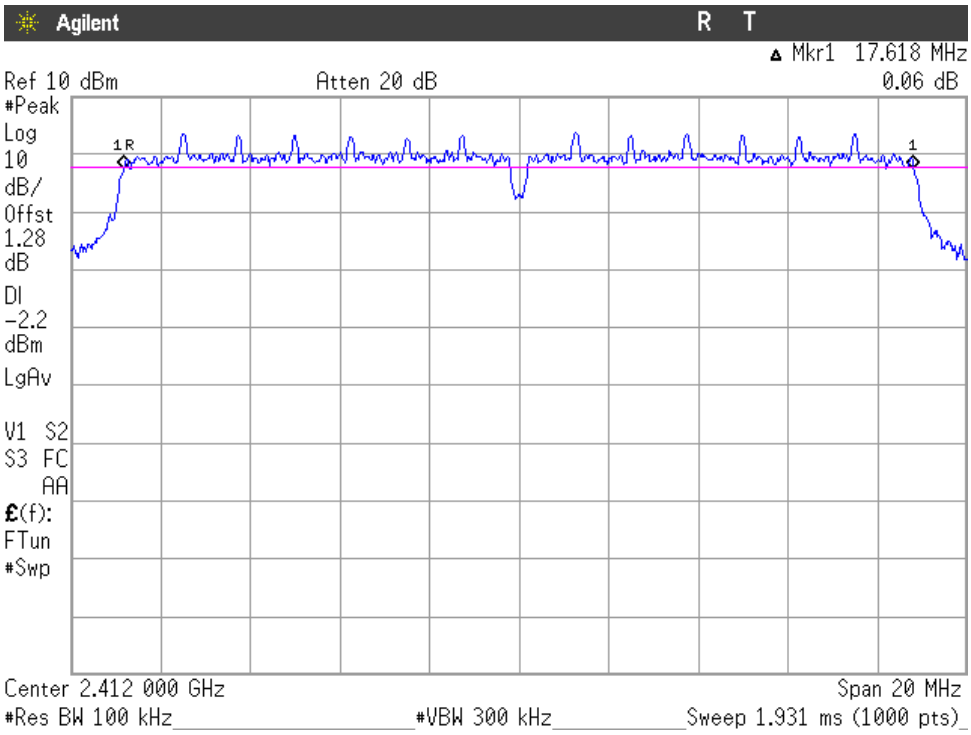


Highest Channel: 2462 MHz. Chain A

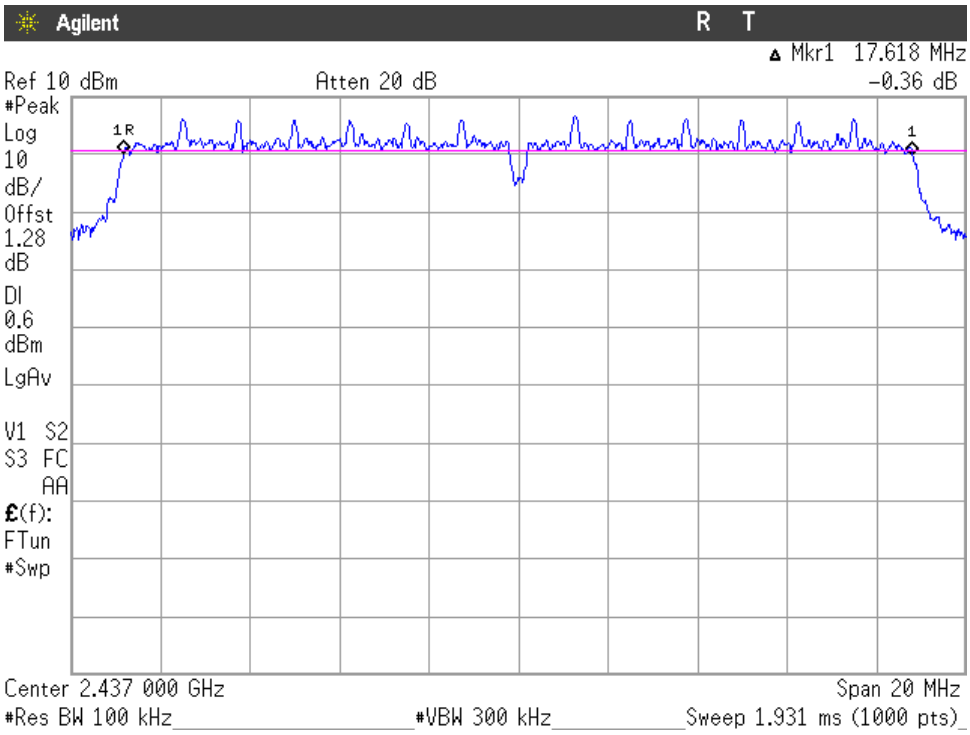


3. WiFi 2.4GHz 802.11 n20 mode

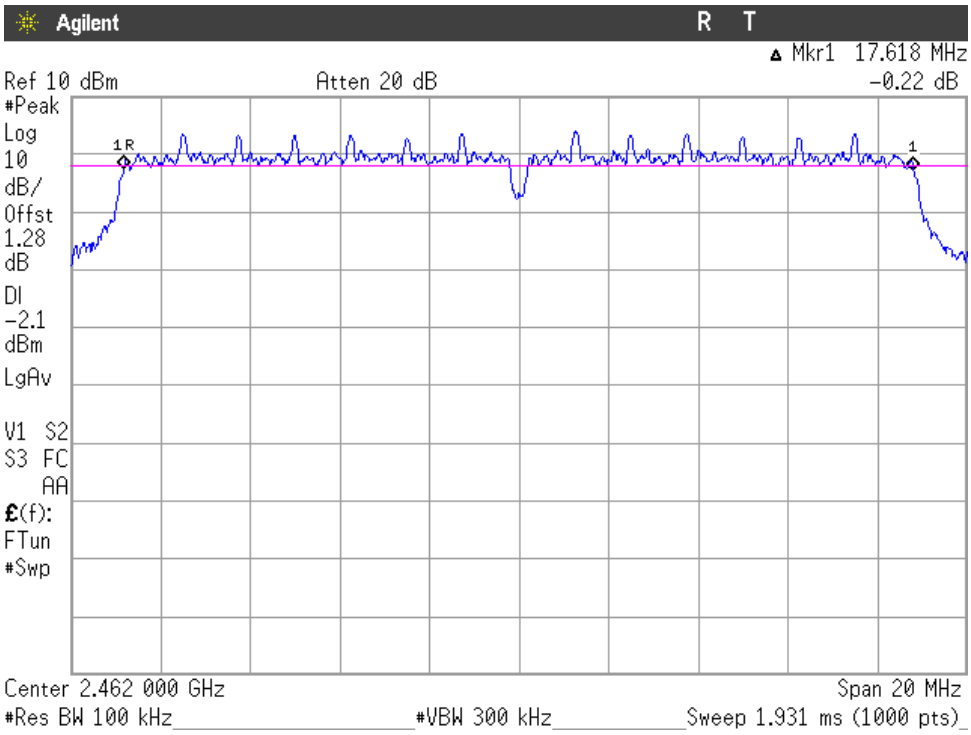
Lowest Channel: 2412 MHz. Chain A



Middle Channel: 2437 MHz. Chain A

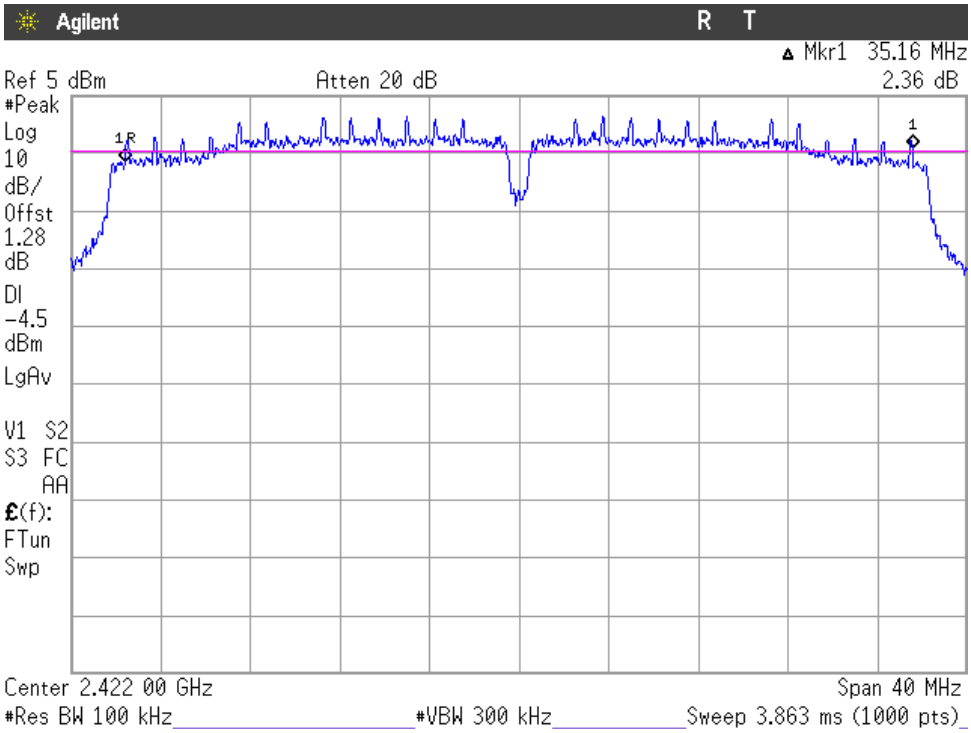


Highest Channel: 2462 MHz. Chain A

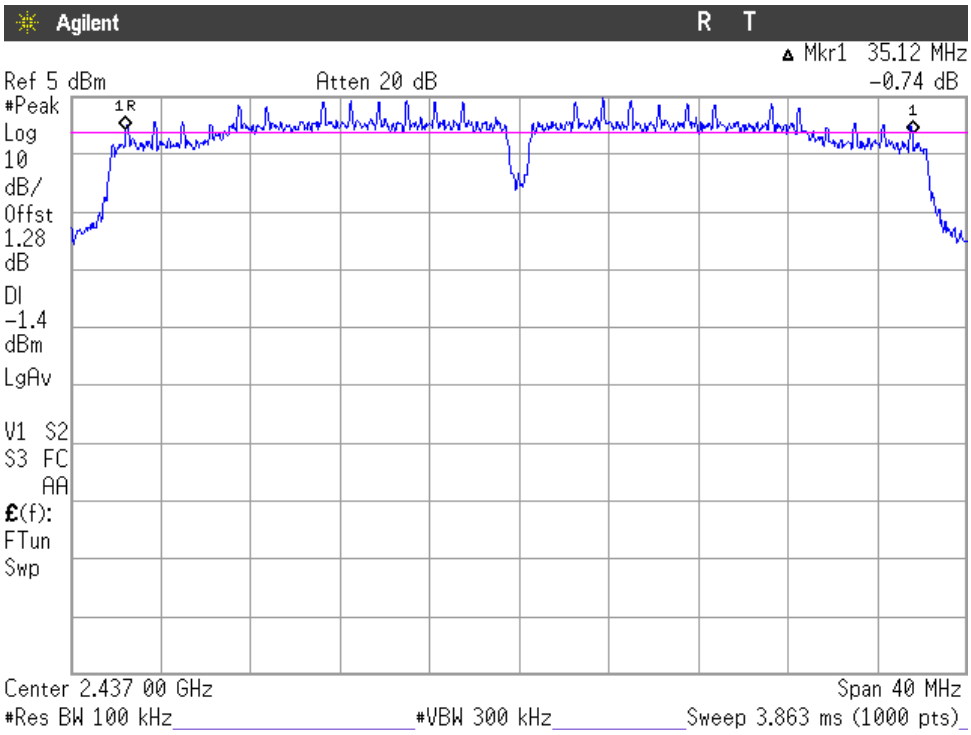


4. WiFi 2.4GHz 802.11 n40 mode

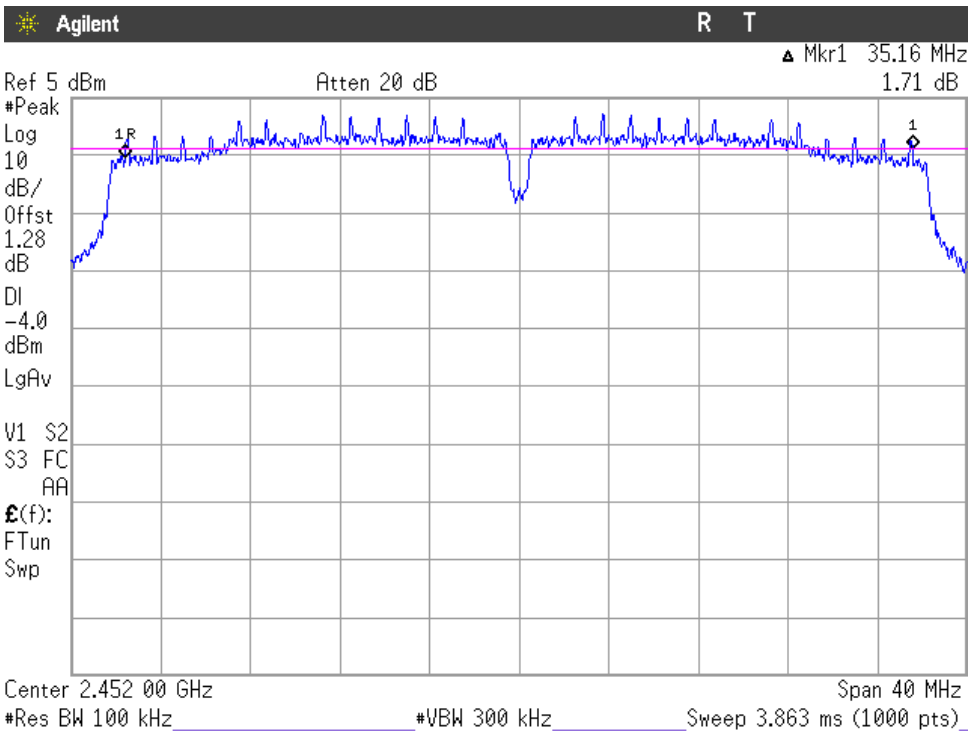
Lowest Channel: 2422 MHz. Chain A



Middle Channel: 2437 MHz. Chain A



Highest Channel: 2452 MHz. Chain A



Section 15.247 Subclause (b) / RSS-210 A8.4. (4). Maximum output power and antenna gain

SPECIFICATION

The maximum peak conducted output power of the intentional radiator shall not exceed 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 9.2.1.1. Option a) of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03 dated 08/04/2013.

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

1. WiFi 2.4GHz 802.11 b mode

MAXIMUM OUTPUT POWER. (See next plot of worst case: Highest power level).

Maximum declared antenna gain: 3.2 dBi.

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	16.38	16.48	16.55
Maximum EIRP power (dBm)	19.58	19.68	19.75
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

2. WiFi 2.4GHz 802.11 g mode

MAXIMUM OUTPUT POWER. (See next plot of worst case: Highest power level).

Maximum declared antenna gain: 3.2 dBi.

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	14.45	16.66	14.51
Maximum EIRP power (dBm)	17.65	19.86	17.71
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

3. WiFi 2.4GHz 802.11 n20 mode

MAXIMUM OUTPUT POWER. (See next plot of worst case: Highest power level).

Maximum declared antenna gain: 3.2 dBi.

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Maximum conducted power (dBm)	14.44	16.65	14.56
Maximum EIRP power (dBm)	17.64	19.85	17.76
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

4. WiFi 2.4GHz 802.11 n40 mode

MAXIMUM OUTPUT POWER. (See next plot of worst case: Highest power level).

Maximum declared antenna gain: 3.2 dBi.

	Lowest frequency 2422 MHz	Middle frequency 2437 MHz	Highest frequency 2452 MHz
Maximum conducted power (dBm)	13.18	16.62	14.33
Maximum EIRP power (dBm)	16.38	19.82	17.53
Measurement uncertainty (dB)	±1.5		

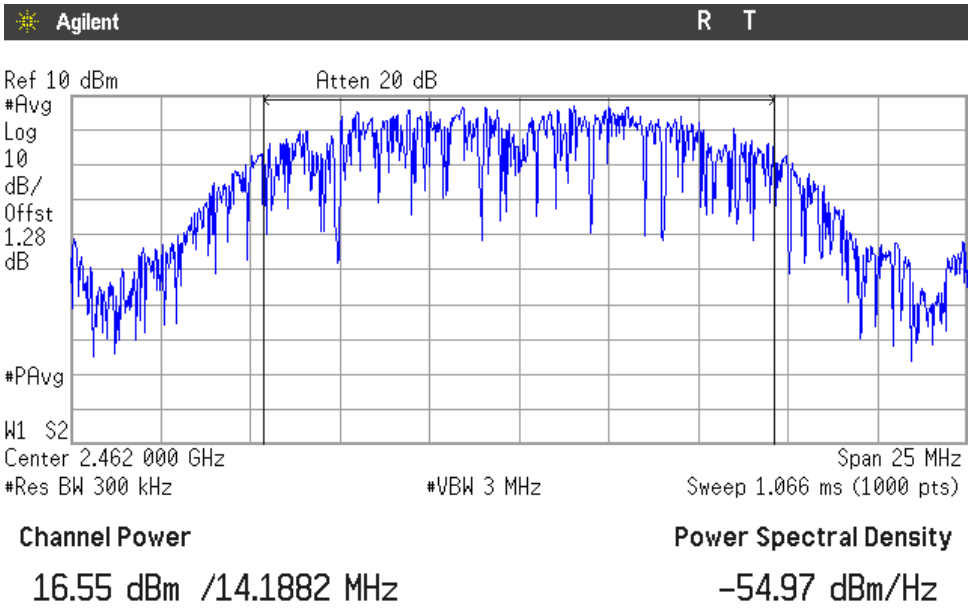
Verdict: PASS

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.

1. CONDUCTED POWER.

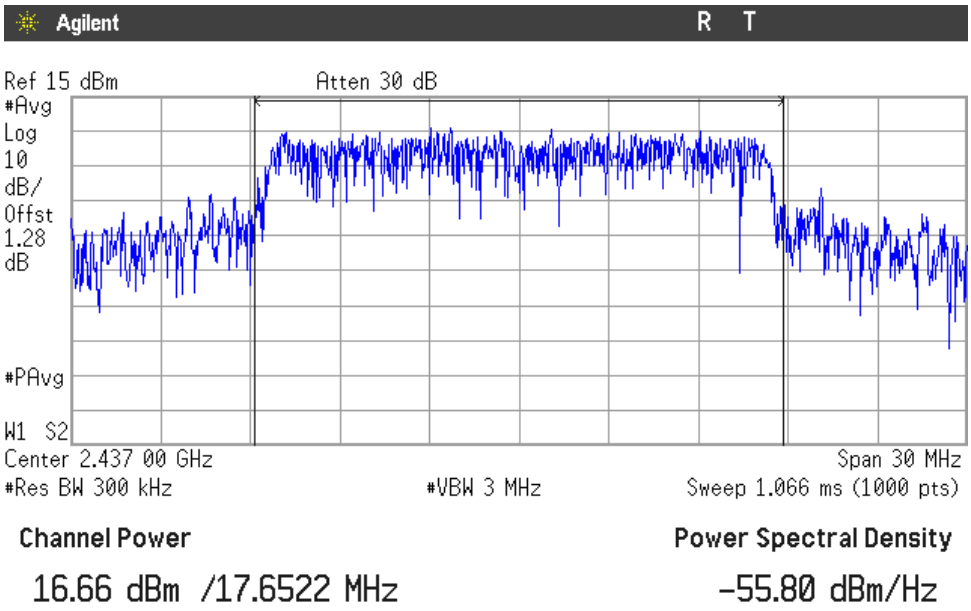
1. WiFi 2.4GHz 802.11 b mode

High frequency 2462 MHz.



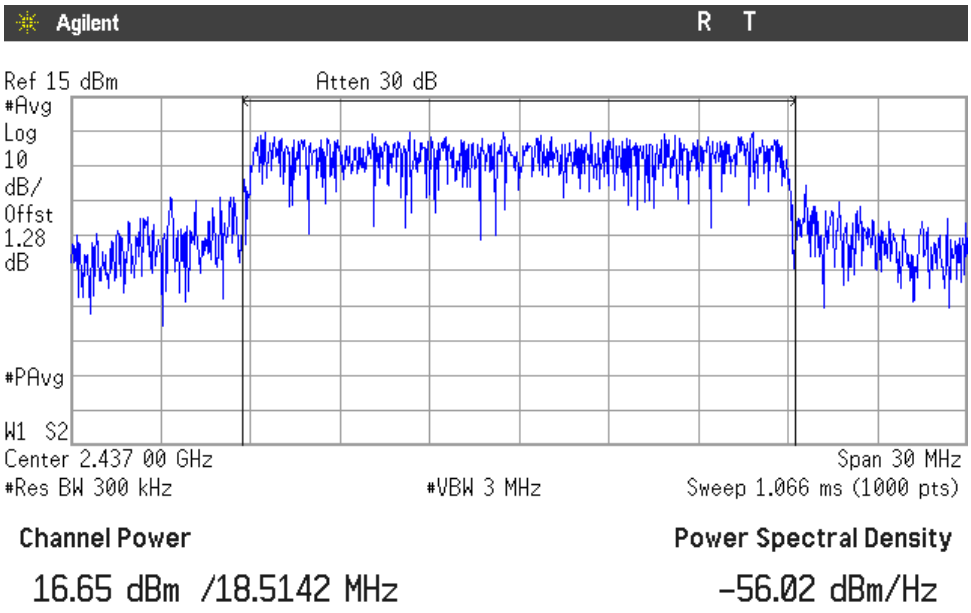
2. WiFi 2.4GHz 802.11 g mode

Middle frequency 2437 MHz.



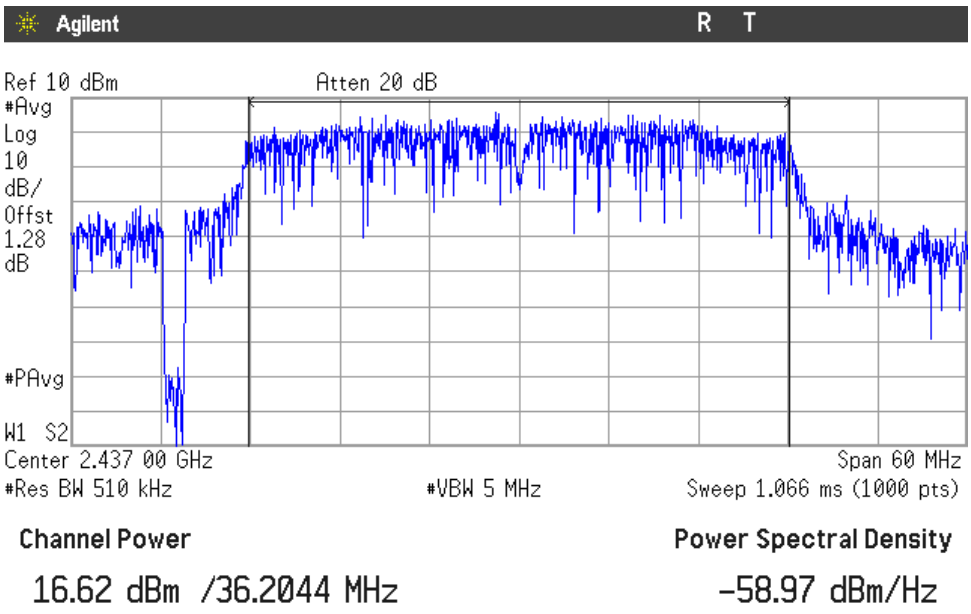
3. WiFi 2.4GHz 802.11 n20 mode

Middle frequency 2437 MHz.



4. WiFi 2.4GHz 802.11 n40 mode

Middle frequency 2437 MHz.



Section 15.247 Subclause (d) / RSS-210 A8.5. 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:

1. WiFi 2.4GHz 802.11 b mode

Reference Level Measurement

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	7.77	7.20	7.18
Measurement uncertainty (dB)	±1.5		

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-22.23

Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-22.80

Highest frequency 2462 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-22.82

Verdict: PASS

2. WiFi 2.4GHz 802.11 g mode

Reference Level Measurement

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	3.70	6.70	4.14
Measurement uncertainty (dB)	±1.5		

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-26.30

Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-23.3

Highest frequency 2462 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-25.86

Verdict: PASS

3. WiFi 2.4GHz 802.11 n20 mode

Reference Level Measurement

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Reference Level Measurement (dBm)	4.28	6.72	4.41
Measurement uncertainty (dB)	±1.5		

Lowest frequency 2412 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-25.72

Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-22.28

Highest frequency 2462 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-25.59

Verdict: PASS

4. WiFi 2.4GHz 802.11 n40 mode

Reference Level Measurement

	Lowest frequency 2422 MHz	Middle frequency 2437 MHz	Highest frequency 2452 MHz
Reference Level Measurement (dBm)	0.80	4.12	1.64
Measurement uncertainty (dB)	±1.5		

Lowest frequency 2422 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-29.20

Middle frequency 2437 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-25.88

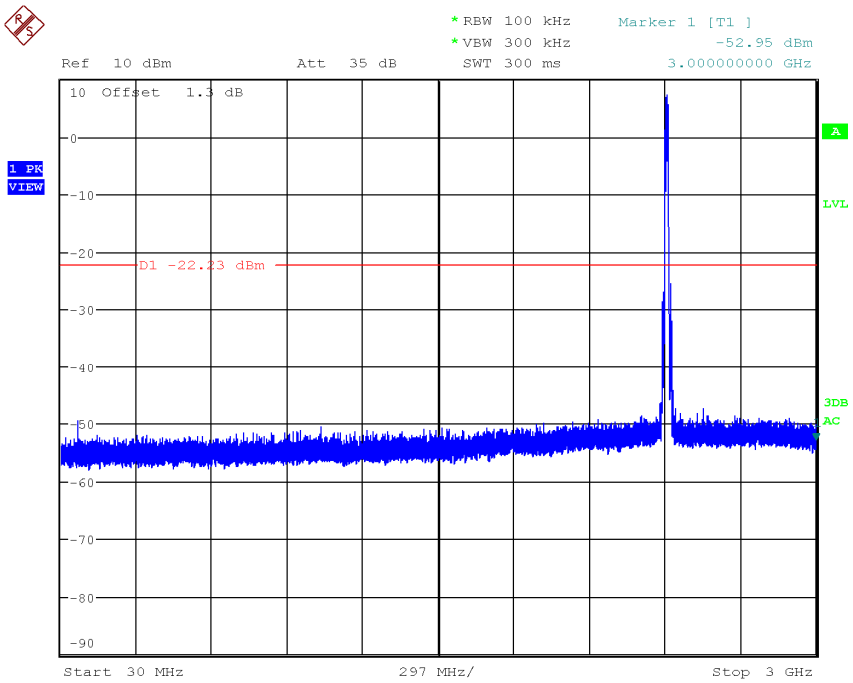
Highest frequency 2452 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-28.36

Verdict: PASS

See next plot of worst case: Mode b. Lowest Channel: 2412 MHz.

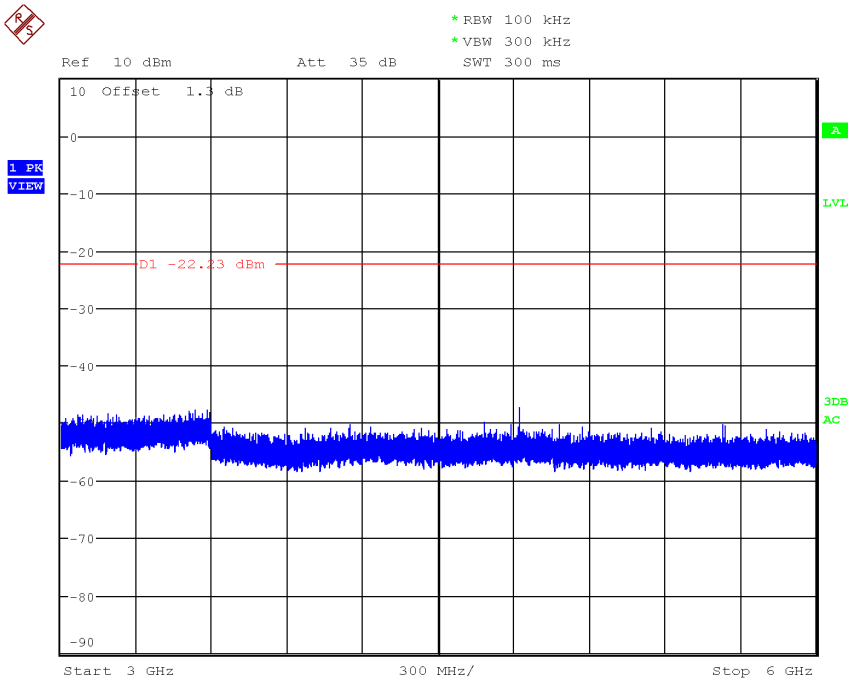
Number of sweep points: 30,001.

Plot 30 MHz to 3 GHz:

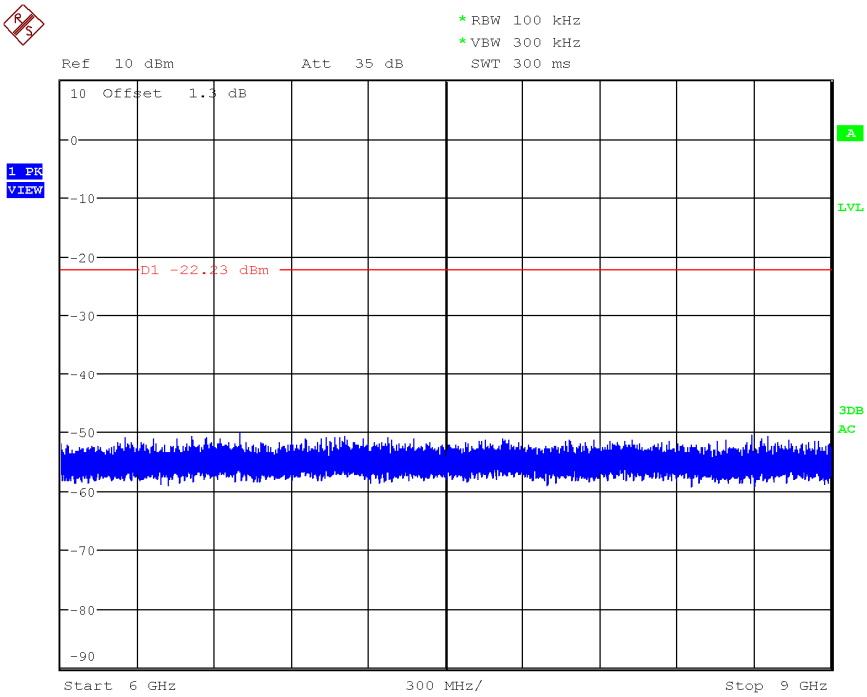


Note: The peak above the limit is the carrier frequency.

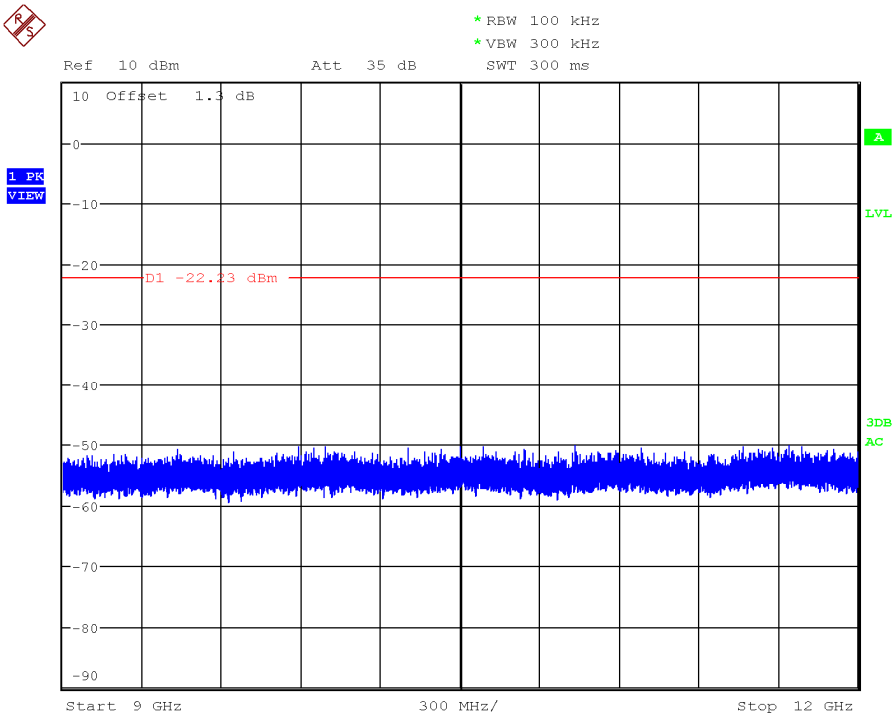
Plot 3 GHz to 6 GHz:



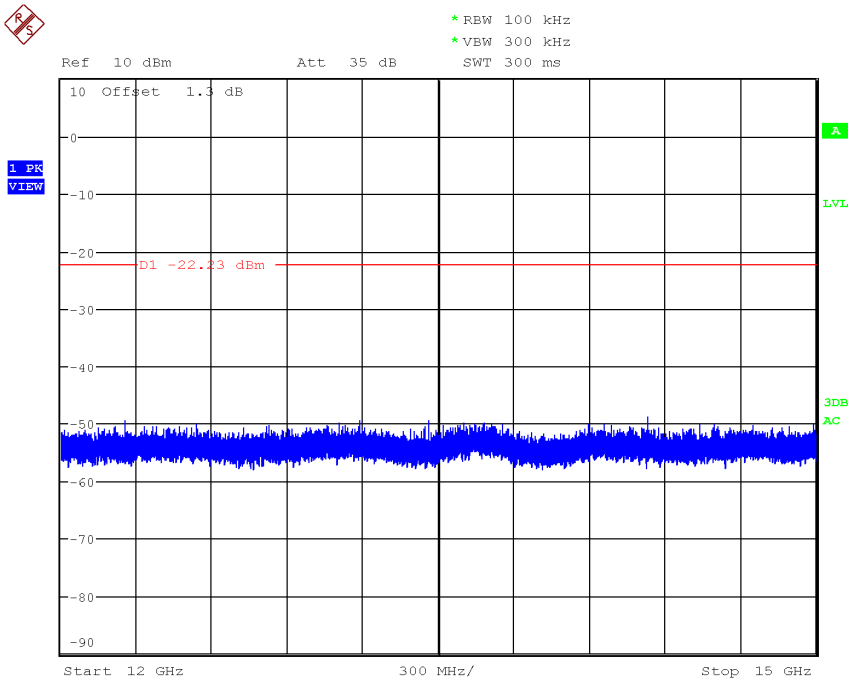
Plot 6 GHz to 9 GHz:



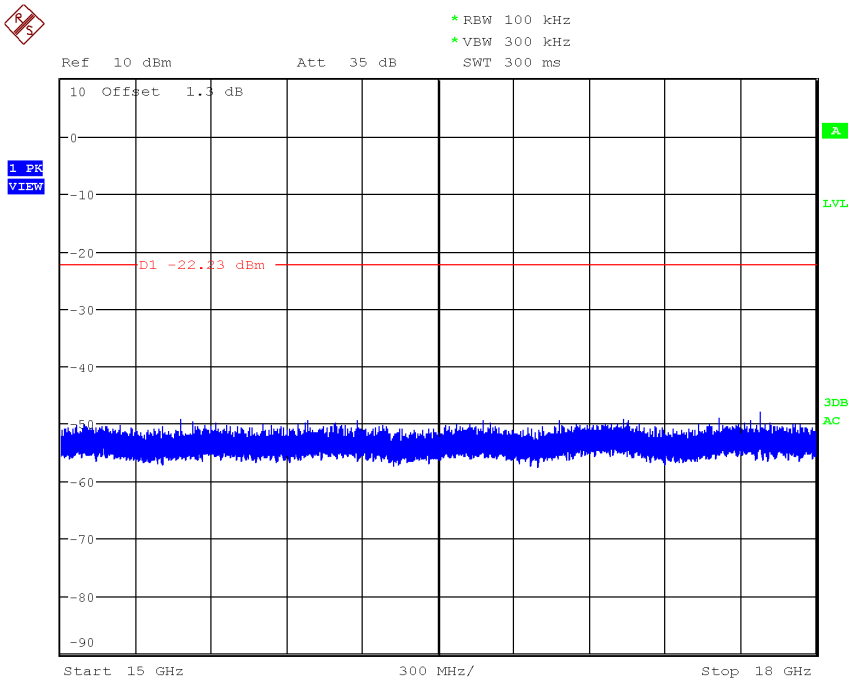
Plot 9 GHz to 12 GHz:



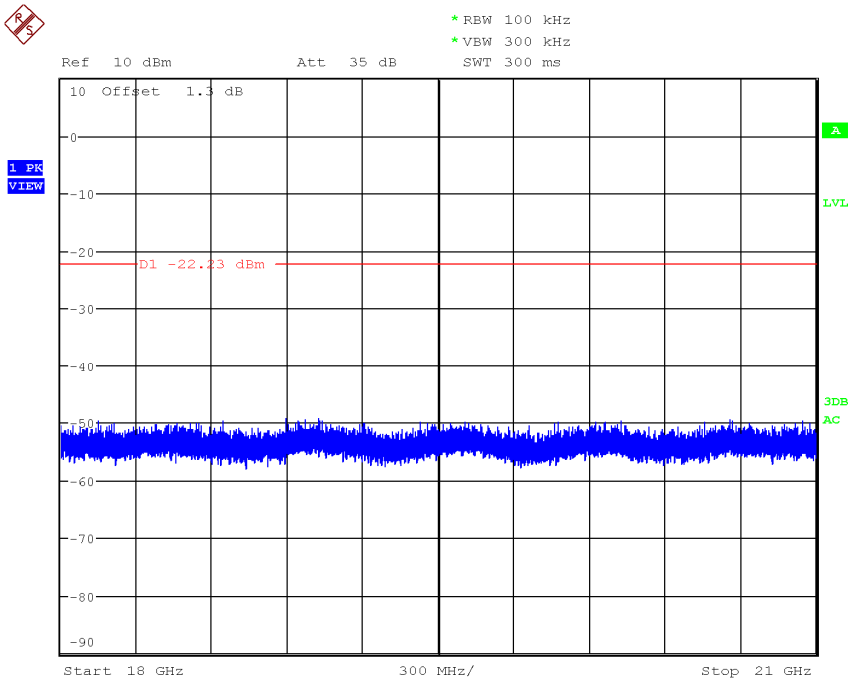
Plot 12 GHz to 15 GHz:



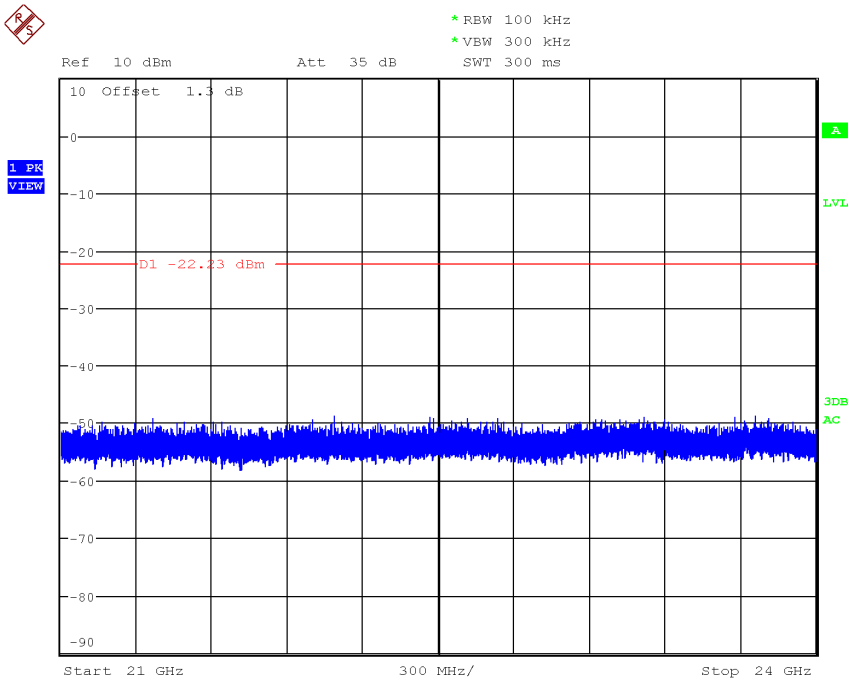
Plot 15 GHz to 18 GHz:



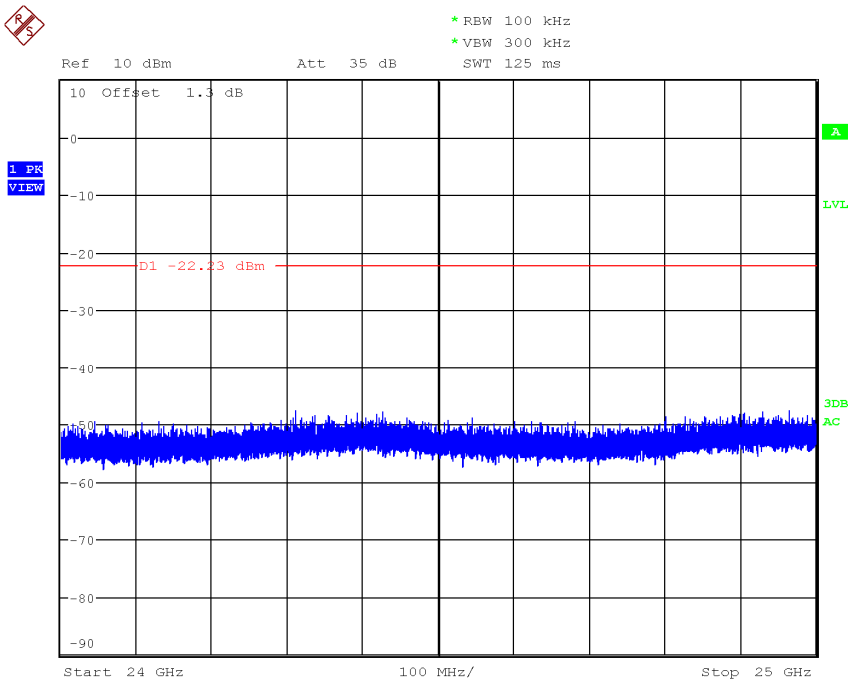
Plot 18 GHz to 21 GHz:



Plot 21 GHz to 24 GHz:



Plot 24 GHz to 25 GHz:



Section 15.247 Subclause (d) / RSS-210 A8.5. Band-edge emissions compliance (Transmitter)

SPECIFICATION

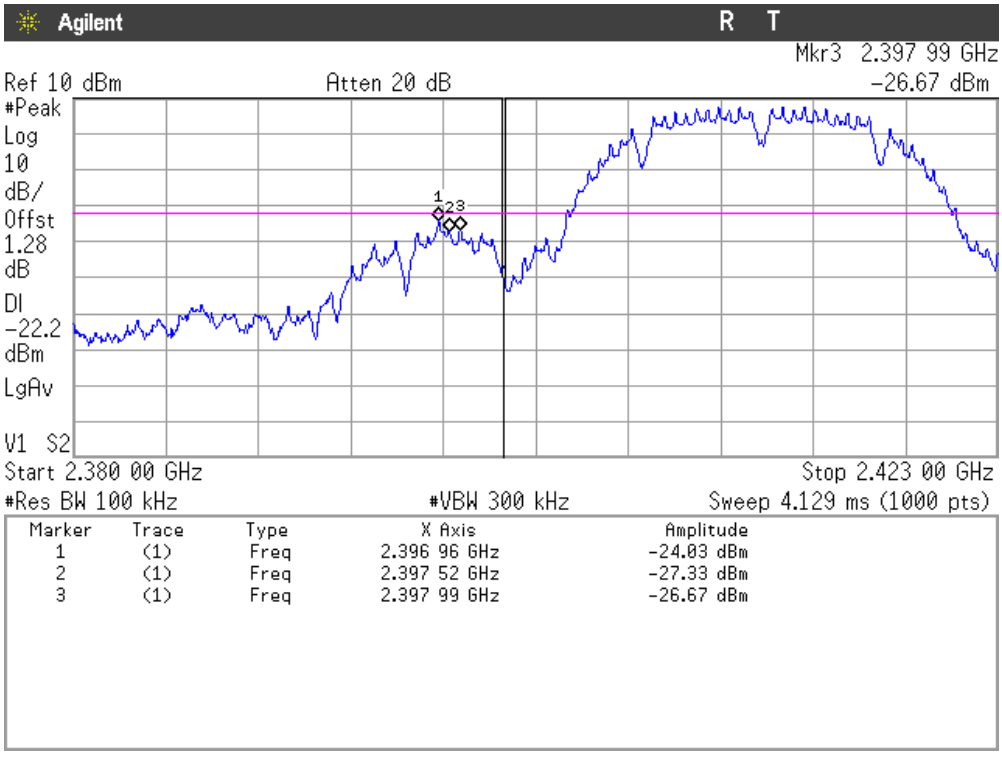
Emissions outside the frequency band in which the intentional radiator is operating shall be at least 20dB below the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 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.

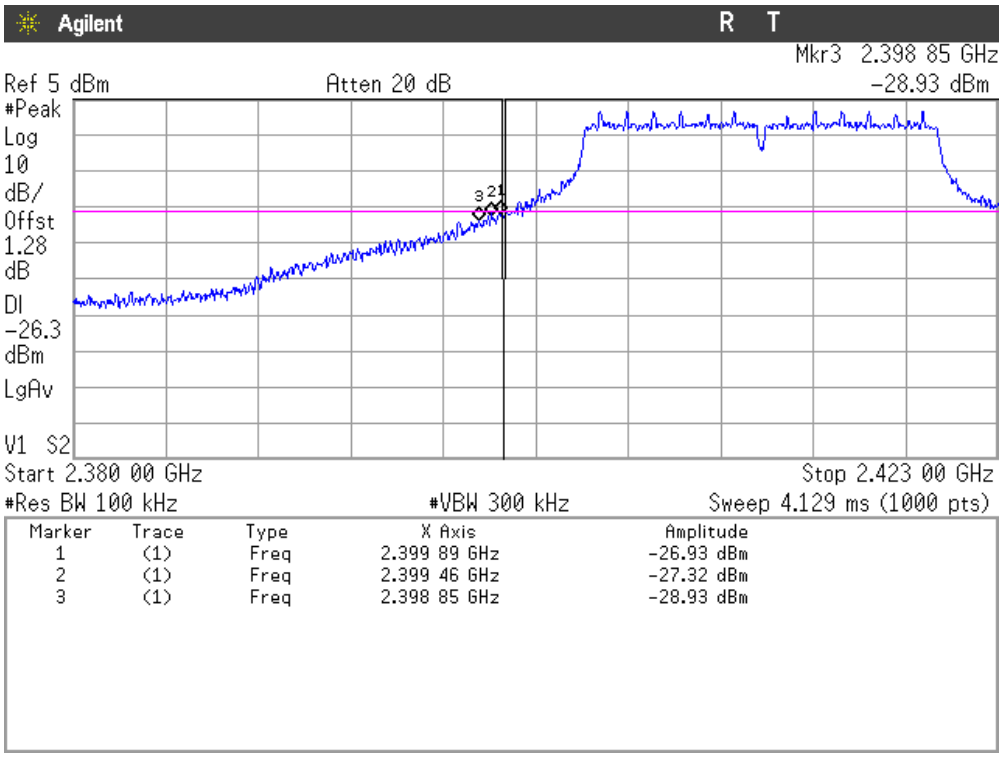
LOW FREQUENCY SECTION 2412 MHz. CONDUCTED.

1. WiFi 2.4GHz 802.11 b mode



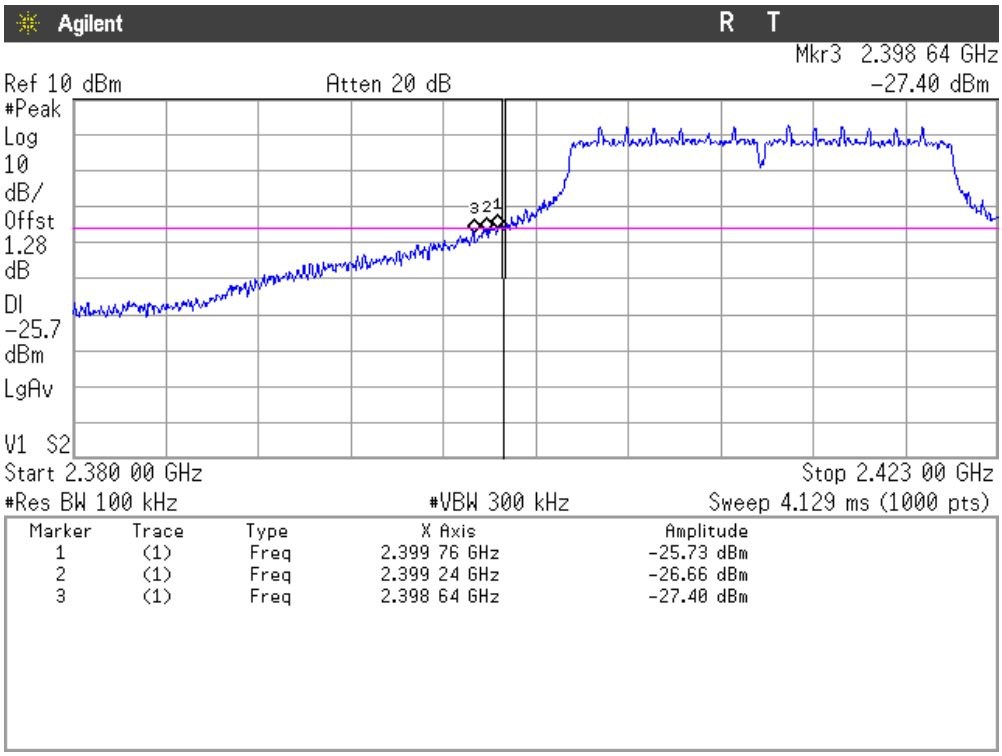
Verdict: PASS

2. WiFi 2.4GHz 802.11 g mode



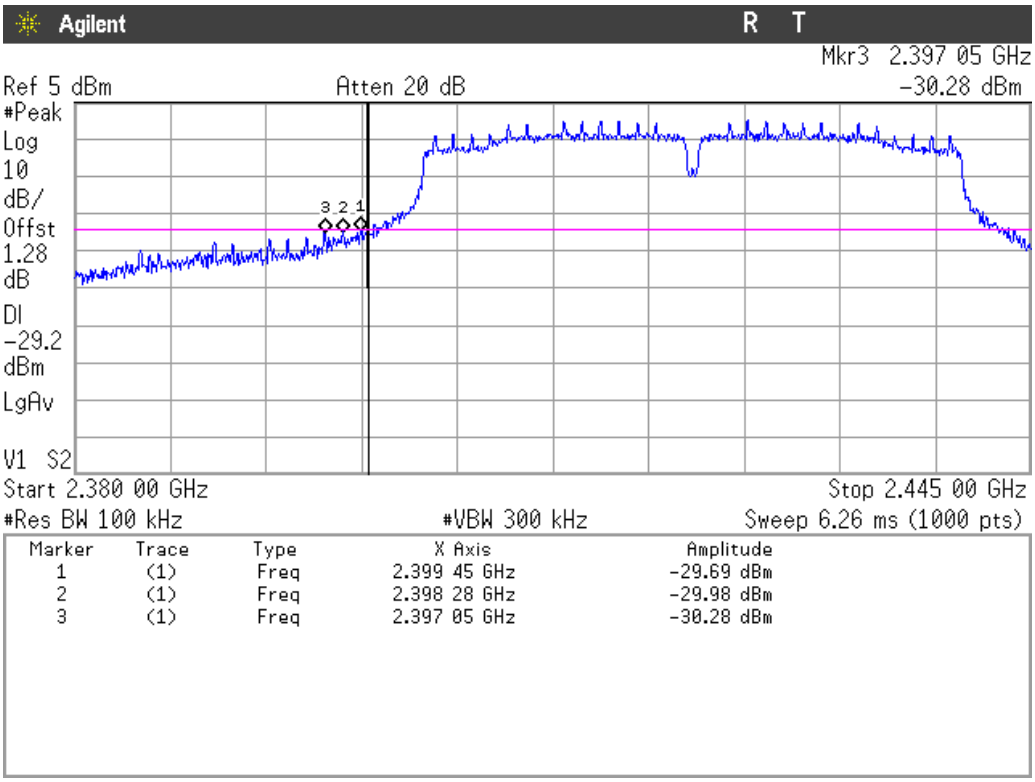
Verdict: PASS

3. WiFi 2.4GHz 802.11 n20 mode



Verdict: PASS

4. WiFi 2.4GHz 802.11 n40 mode



Verdict: PASS

Section 15.247 Subclause (e) / RSS-210 A8.5. 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 of trace averaging with EUT transmitting at full power throughout each sweep 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 v03 dated 08/04/2013.

1. WiFi 2.4GHz 802.11 b mode

Power spectral density (See next plot of worst case = highest level).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-1.23	-1.40	-0.94
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

2. WiFi 2.4GHz 802.11 g mode

Power spectral density (See next plot of worst case = highest level).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-5.52	-3.23	-5.65
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

3. WiFi 2.4GHz 802.11 n20 mode

Power spectral density (See next plot of worst case = highest level).

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
Power spectral density (dBm)	-5.32	-3.20	-5.76
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

4. WiFi 2.4GHz 802.11 n40 mode

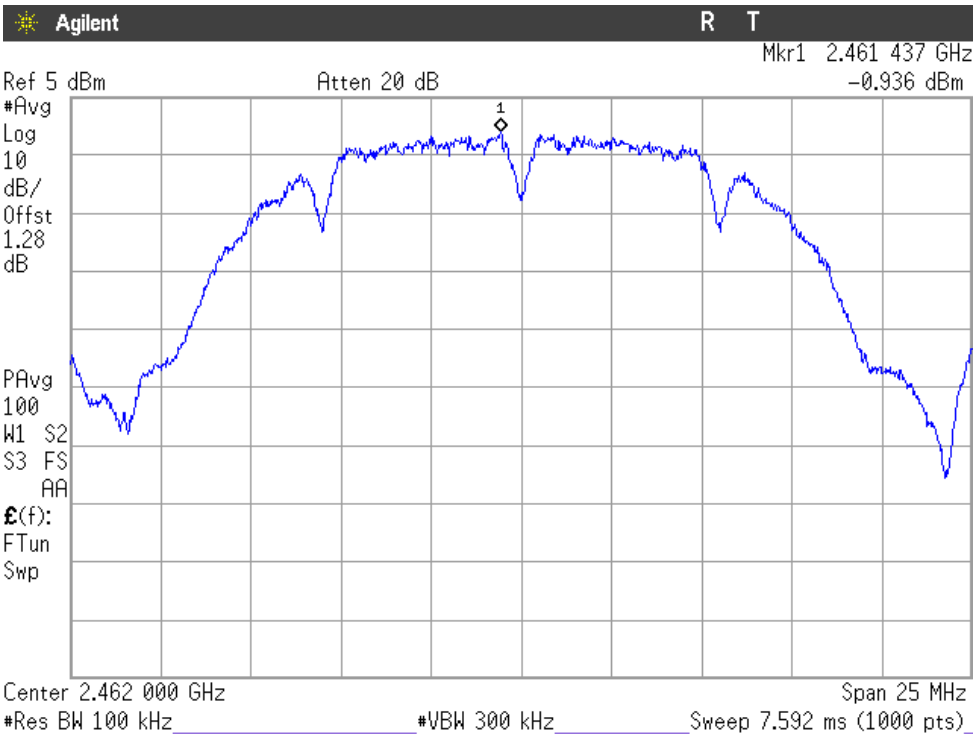
Power spectral density (See next plot of worst case= highest level).

	Lowest frequency 2422 MHz	Middle frequency 2437 MHz	Highest frequency 2452 MHz
Power spectral density (dBm)	-8.81	-5.91	-8.07
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

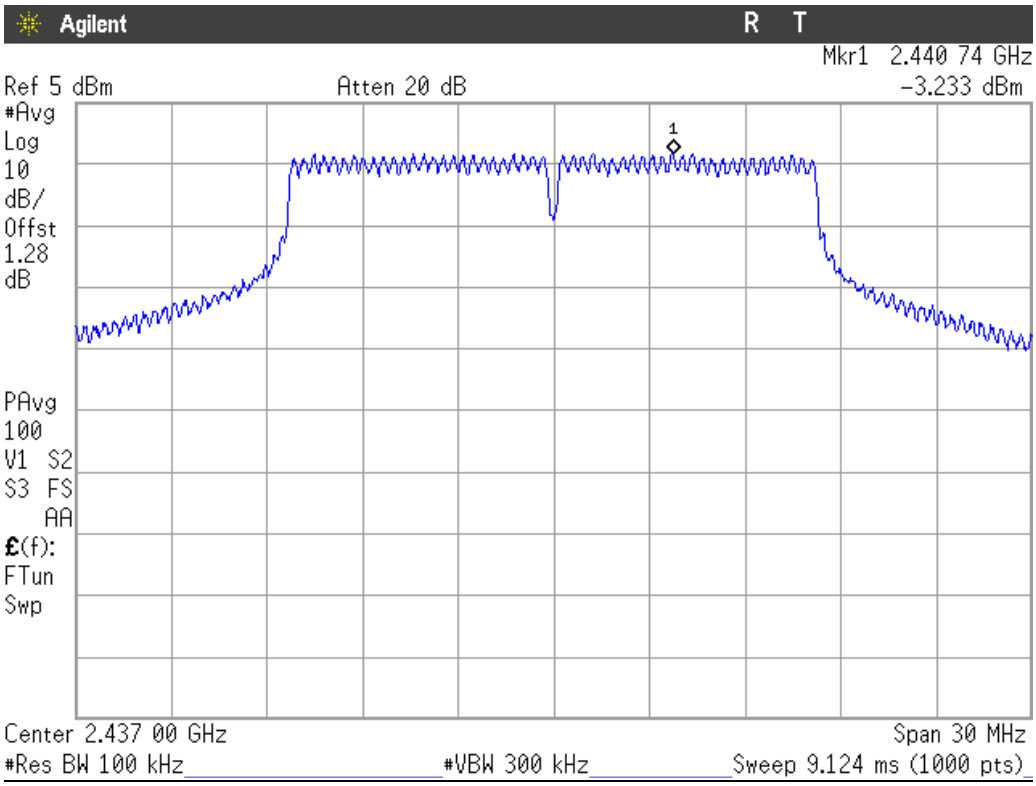
1. WiFi 2.4GHz 802.11 b mode

Highest Channel: 2462 MHz.



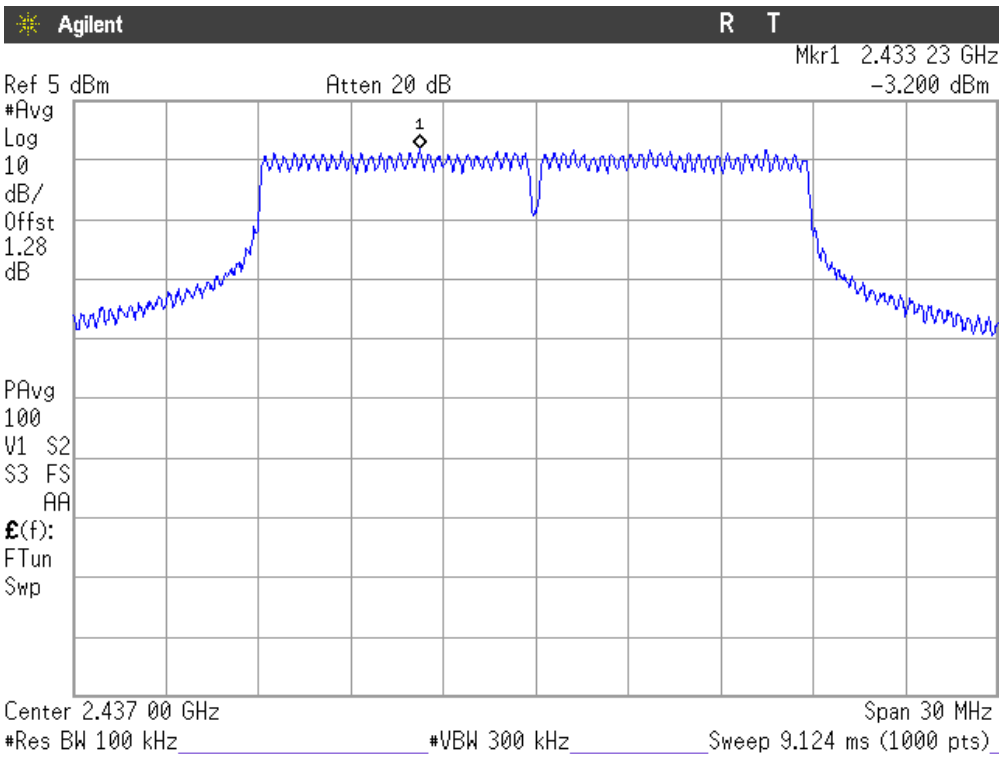
2. WiFi 2.4GHz 802.11 g mode

Middle Channel: 2437 MHz.



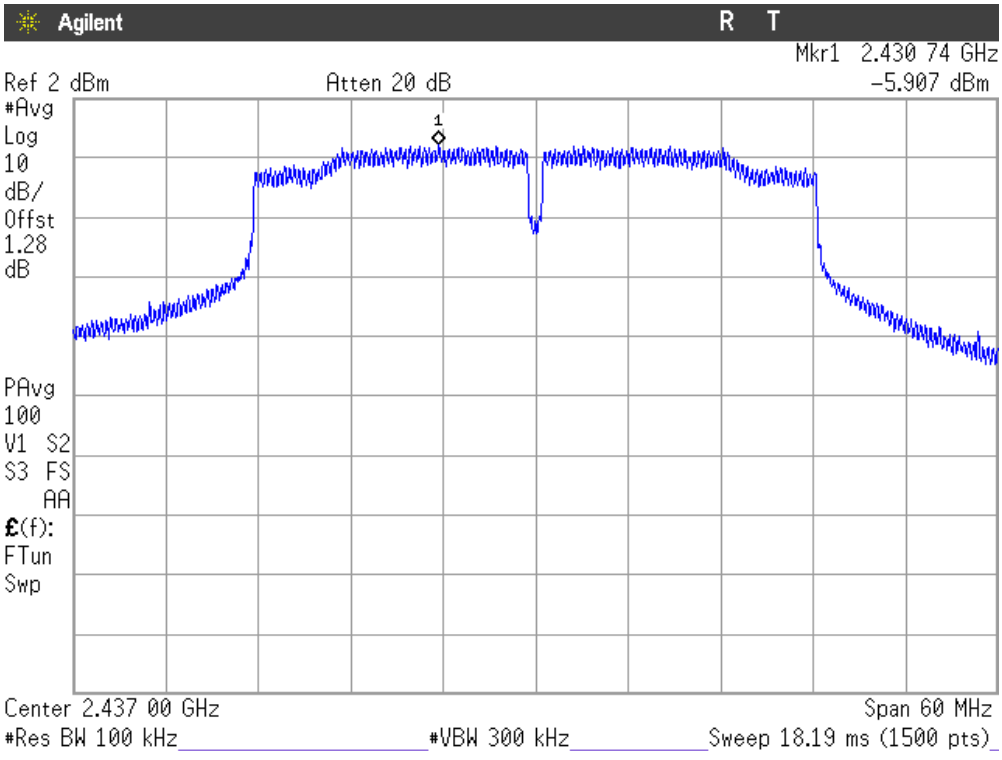
3. WiFi 2.4GHz 802.11 n20 mode

Middle Channel: 2437 MHz.



4. WiFi 2.4GHz 802.11 n40 mode

Middle Channel: 2437 MHz.



Section 15.247 Subclause (d) / RSS-210 A8.5. Emission limitations radiated (Transmitter)

SPECIFICATION

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)):

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
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.

Highest spurious levels:

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
143.4776	V	Quasi-Peak	28.88	± 3.8
166.7949	V	Quasi-Peak	31.28	± 3.8
233.6378	V	Quasi-Peak	29.65	± 3.8
298.9263	V	Quasi-Peak	30.36	± 3.8
588.0609	V	Quasi-Peak	28.03	± 3.8
648.6859	V	Quasi-Peak	28.67	± 3.8

All other 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).

For OFDM modulation modes (802.11g, 802.11n20 and 802.11n40), a preliminary measurement in the central channel in the range 1-12.75 GHz was performed to determine the worst case. The lowest and highest channels were measured for out-of-band emissions for the worst case (802.11g).

The field strength at the band edges was evaluated for each mode and on each chain individually on the lowest and highest channels at the rated power for the channel under test. Where the power at the edge channels was lower than the power at the center channels additional measurements were made at the adjacent channels.

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. 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 bands 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.385440	H	Peak	54.24	± 4.09
		Average	45.06	± 4.09
2.499995	H	Peak	52.62	± 4.09
4.823948	V	Peak	48.34	± 4.09

1.2. CHANNEL 6: MIDDLE (2437 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.357440	H	Peak	52.34	± 4.09
2.494505	H	Peak	52.94	± 4.09
4.873910	V	Peak	49.00	± 4.09

1.3. CHANNEL 11: HIGHEST (2462 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.349440	H	Peak	52.47	± 4.09
2.487906	H	Peak	55.36	± 4.09
		Average	46.18	± 4.09
4.924022	V	Peak	48.79	± 4.09

Verdict: PASS

2. WiFi 2.4GHz 802.11 g mode (worst case OFDM)

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)
2.39000	H	Peak	66.53	± 4.09
		Average	51.22	± 4.09
4.8247596	H	Peak	46.11	± 4.09

2.2. CHANNEL 2 (2417 MHz). Spurious emissions in restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.39000	H	Peak	64.01	± 4.09
		Average	50.00	± 4.09

2.3. CHANNEL 6: MIDDLE (2437 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.38976	H	Peak	56.95	± 4.09
		Average	43.47	± 4.09
2.483533	H	Peak	53.87	± 4.09
4.8742232	V	Peak	47.47	± 4.09

2.4. CHANNEL 10 (2457 MHz). Spurious emissions in restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.483632	H	Peak	58.17	± 4.09
		Average	46.99	± 4.09

2.5. 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)
2.483599	H	Peak	65.45	± 4.09
		Average	48.28	± 4.09
4.924038	H	Peak	48.11	± 4.09

Verdict: PASS

3. WiFi 2.4GHz 802.11 n20 mode

3.1. CHANNEL 1 (2412 MHz). Spurious emissions in restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.39000	H	Peak	66.93	± 4.09
		Average	52.5	± 4.09

3.2. CHANNEL 2 (2417 MHz). Spurious emissions in restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.39000	H	Peak	63.63	± 4.09
		Average	50.24	± 4.09

3.3. CHANNEL 6: MIDDLE (2437 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.38976	H	Peak	55.07	± 4.09
		Average	43.4	± 4.09
2.483599	H	Peak	55.78	± 4.09
		Average	44.17	± 4.09
4.875221	V	Peak	48.59	± 4.09

3.4. CHANNEL 10 (2457 MHz). Spurious emissions in restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.483533	H	Peak	61.91	± 4.09
		Average	48.51	± 4.09

3.5. CHANNEL 11 (2462 MHz). Spurious emissions in restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.483583	H	Peak	67.55	± 4.09
		Average	51.00	± 4.09

4. WiFi 2.4GHz 802.11 n40 mode

4.1. CHANNEL 3 (2422 MHz). Spurious emissions in restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.38960	H	Peak	63.27	± 4.09
		Average	52.84	± 4.09

4.2. CHANNEL 4 (2427 MHz). Spurious emissions in restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.38992	H	Peak	63.28	± 4.09
		Average	51.26	± 4.09

4.3. CHANNEL 5 (2432 MHz). Spurious emissions in restricted band 2.31-2.39 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.38952	H	Peak	66.02	± 4.09
		Average	52.38	± 4.09

4.4. CHANNEL 6: MIDDLE (2437 MHz). Out-of-band spurious emissions in the 1-25 GHz range and inside restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.39000	H	Peak	65.36	± 4.09
		Average	51.91	± 4.09
2.483599	H	Peak	66.01	± 4.09
		Average	50.23	± 4.09
4.874599	H	Peak	46.64	± 4.09

4.5. CHANNEL 7 (2442 MHz). Spurious emissions in restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.4835	H	Peak	65.3	± 4.09
		Average	52.78	± 4.09

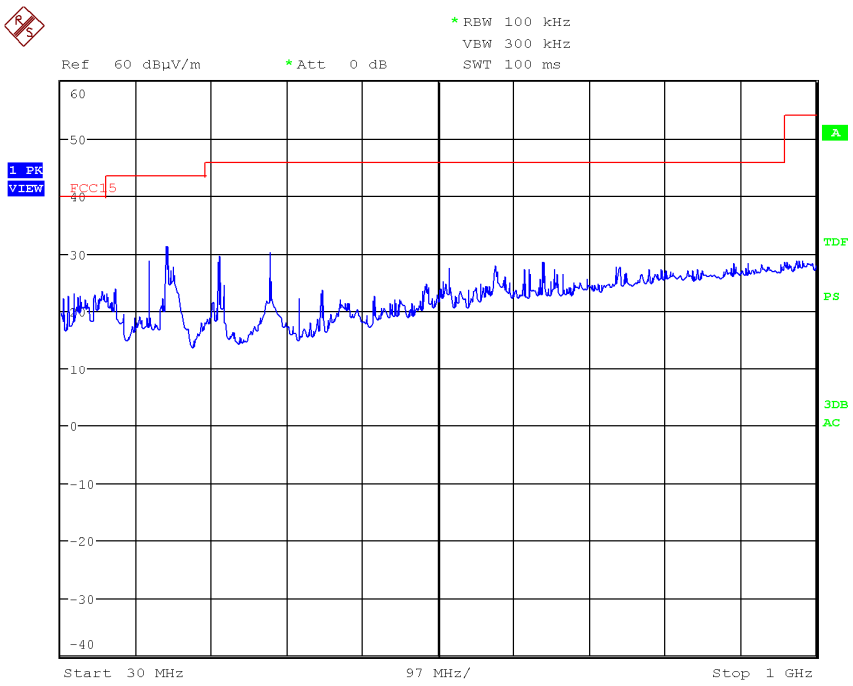
4.6. CHANNEL 8 (2447 MHz). Spurious emissions in restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.4836815	H	Peak	63.76	± 4.09
		Average	51.73	± 4.09

4.7. CHANNEL 9 (2452 MHz). Spurious emissions in restricted band 2.4835-2.5 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.4835	H	Peak	62.7	± 4.09
		Average	50.17	± 4.09

FREQUENCY RANGE 30 MHz-1000 MHz.

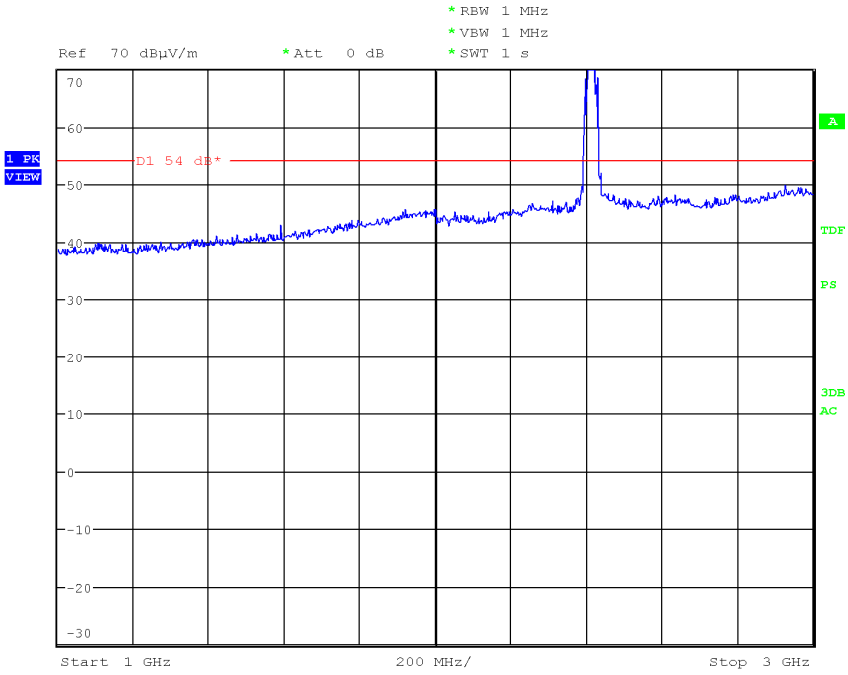


(This plot is valid for all three channels and all modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

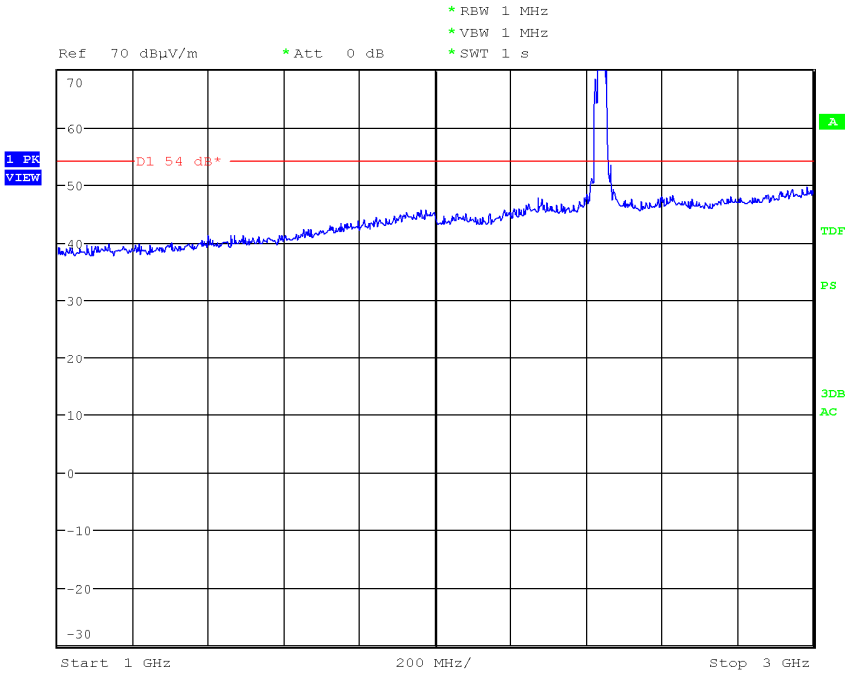
1. WiFi 2.4GHz 802.11 b mode

CHANNEL 1 (2412 MHz).



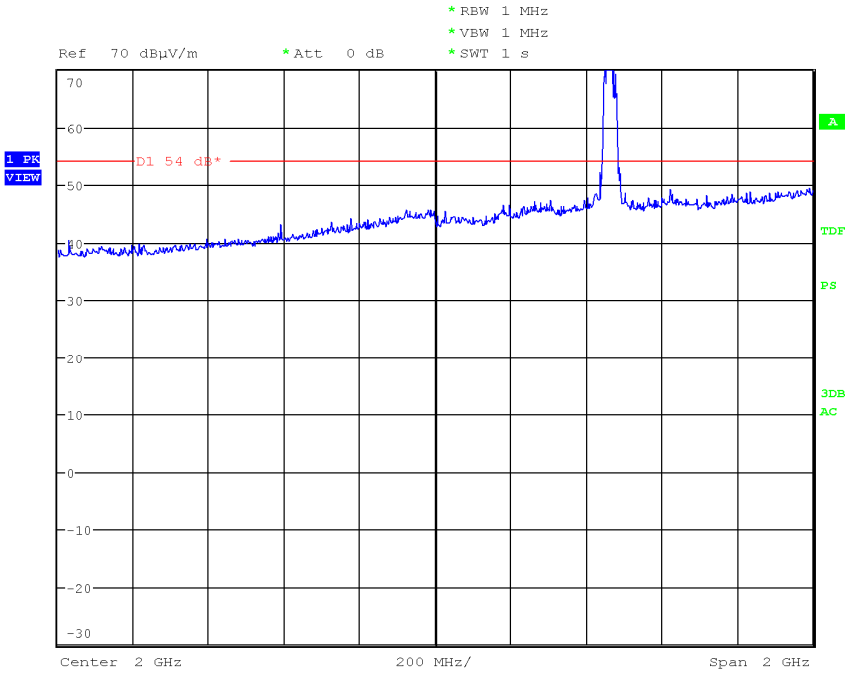
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



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

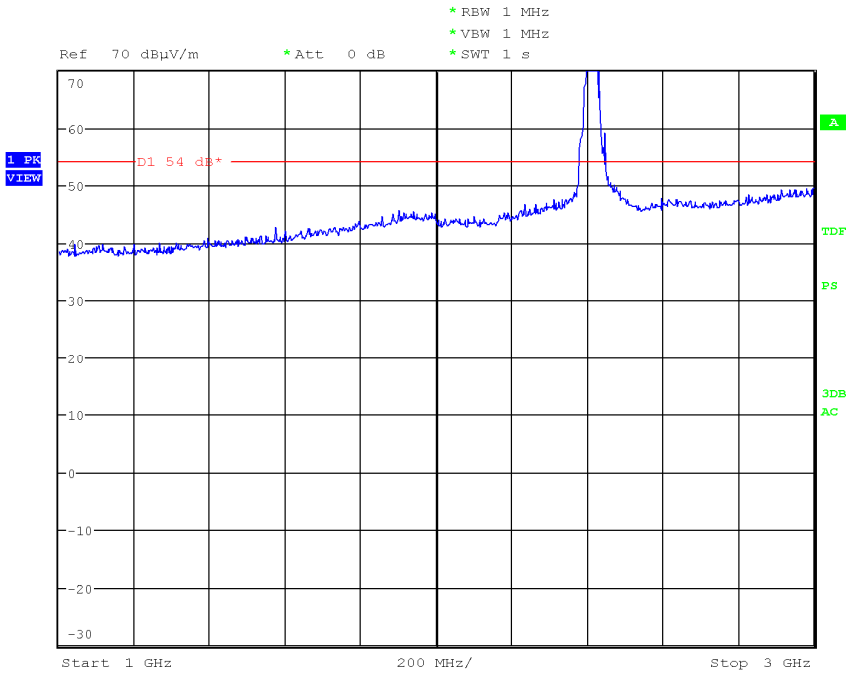
CHANNEL 11 (2462 MHz).



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

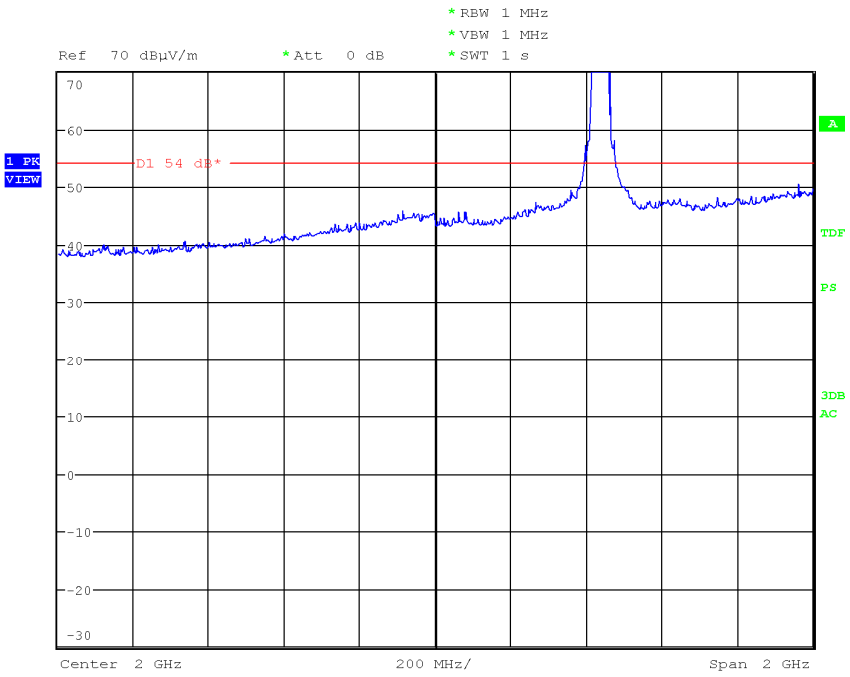
2. WiFi 2.4GHz 802.11 g mode

CHANNEL 1 (2412 MHz).



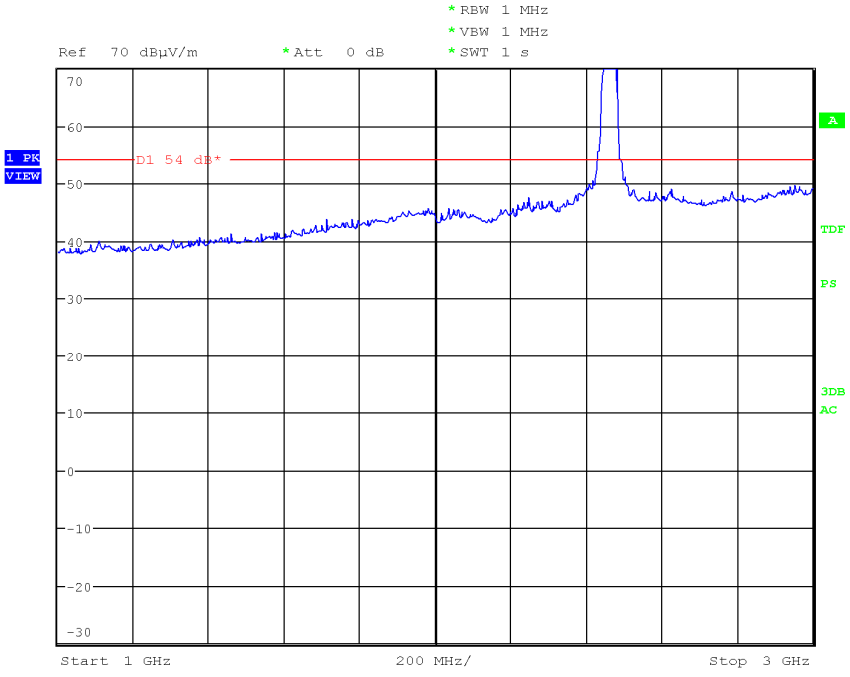
Note: The peak above the limit is the carrier frequency.

CHANNEL 6 (2437 MHz).



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

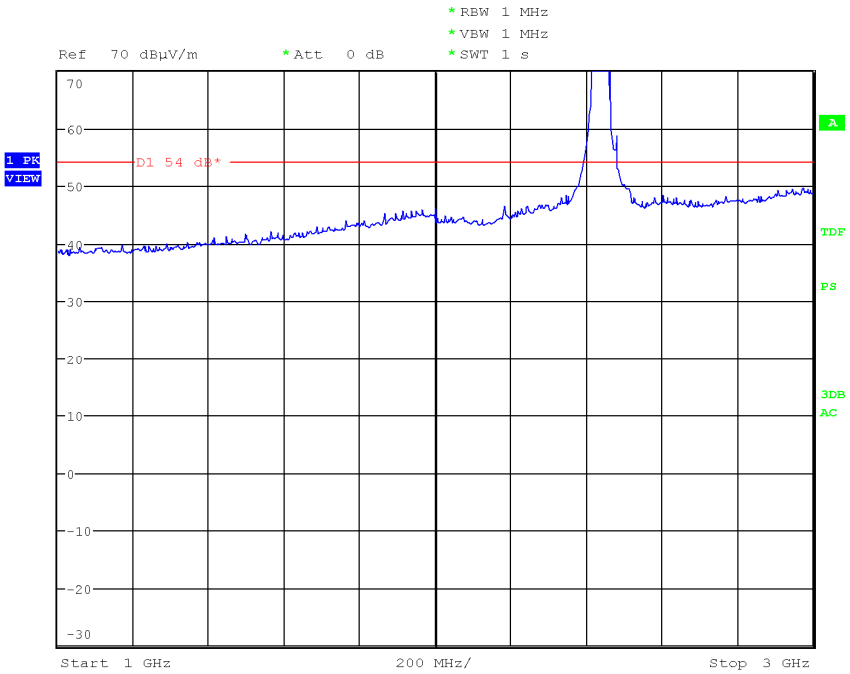
CHANNEL 11 (2462 MHz).



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

3. WiFi 2.4GHz 802.11 n20 mode

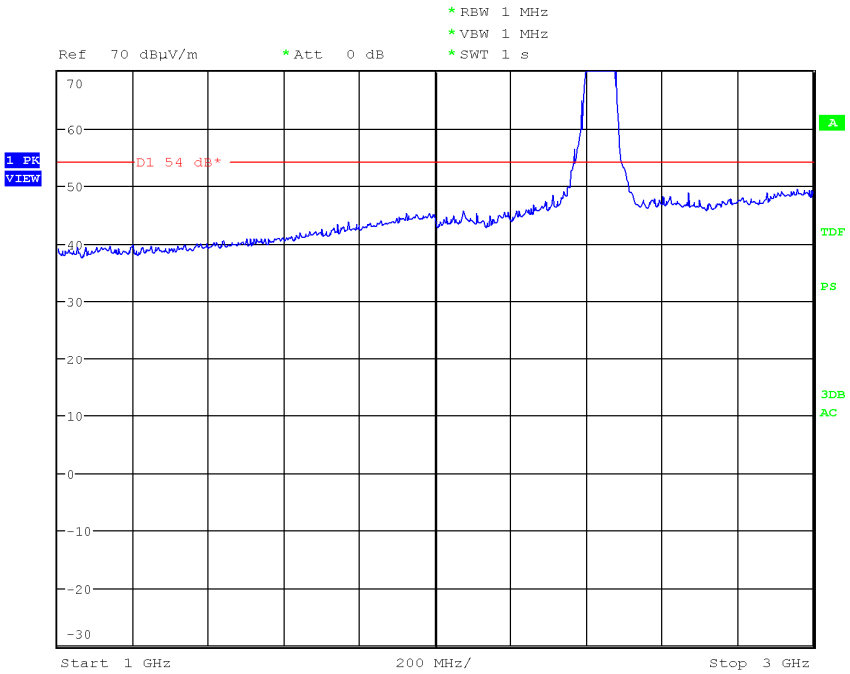
CHANNEL 6 (2437 MHz).



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

4. WiFi 2.4GHz 802.11 n40 mode

CHANNEL 6 (2437 MHz).

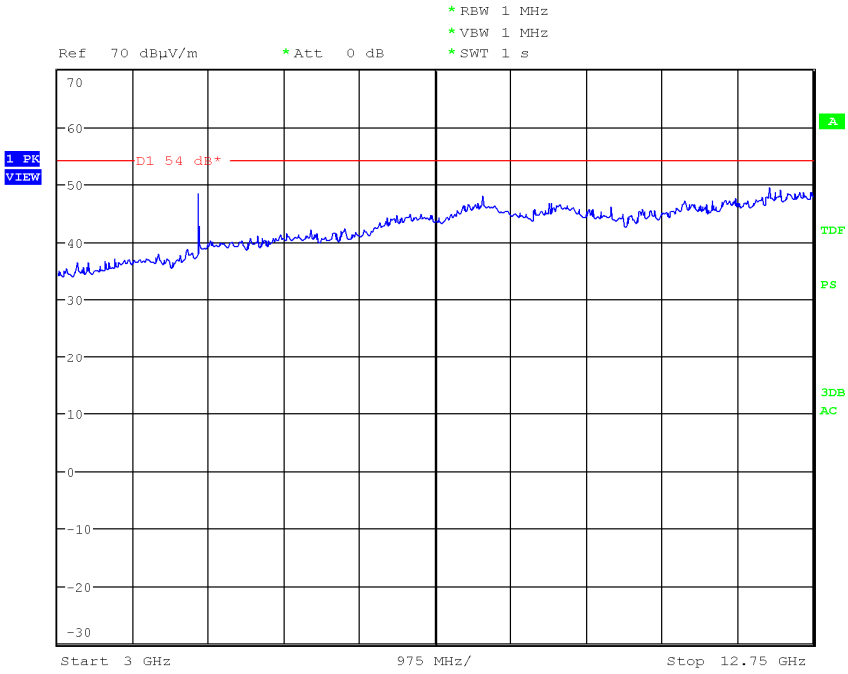


Note: The peak above the limit is the carrier frequency.

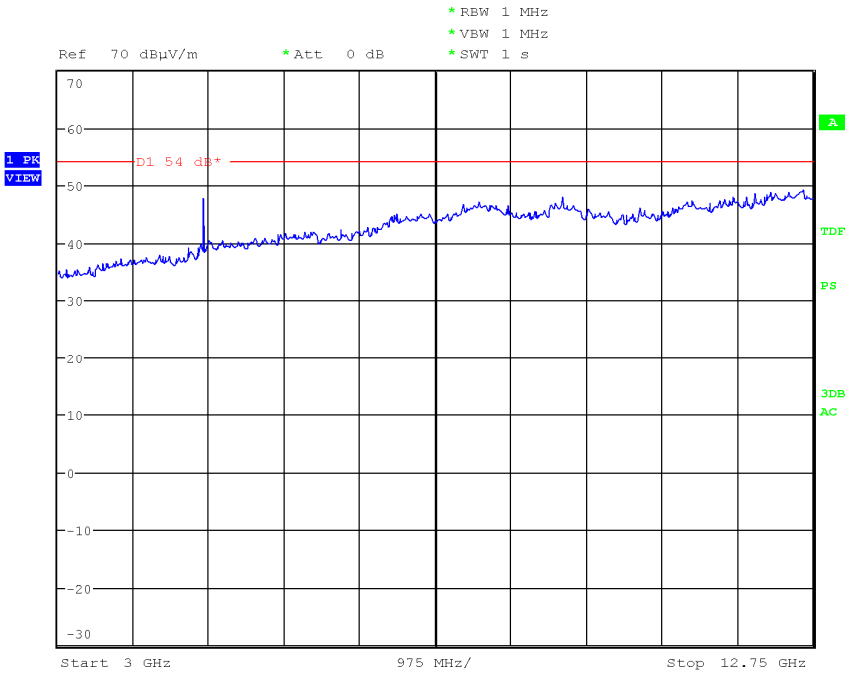
FREQUENCY RANGE 3 GHz to 12.75 GHz.

1. WiFi 2.4GHz 802.11 b mode

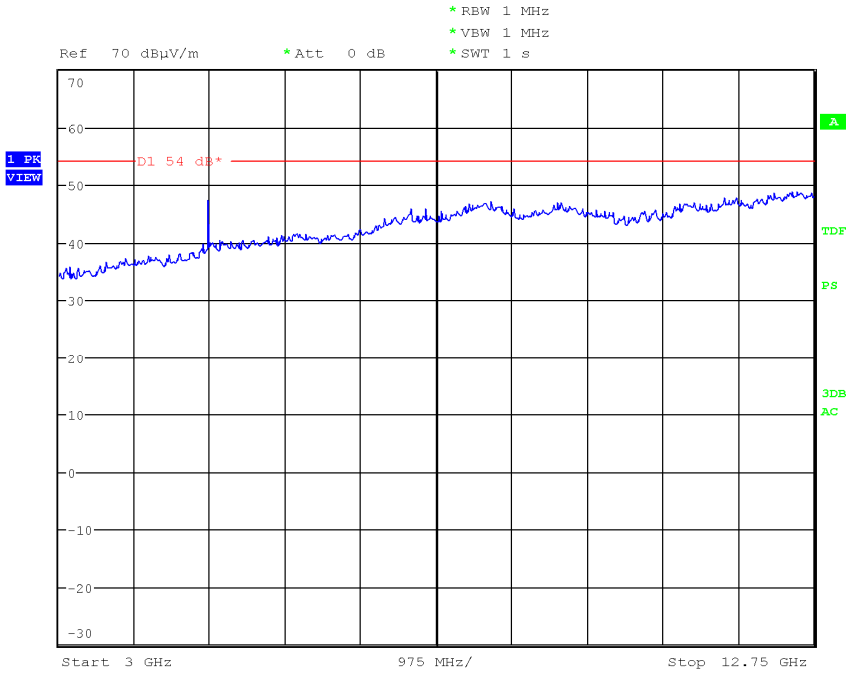
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).



CHANNEL 11 (2462 MHz).



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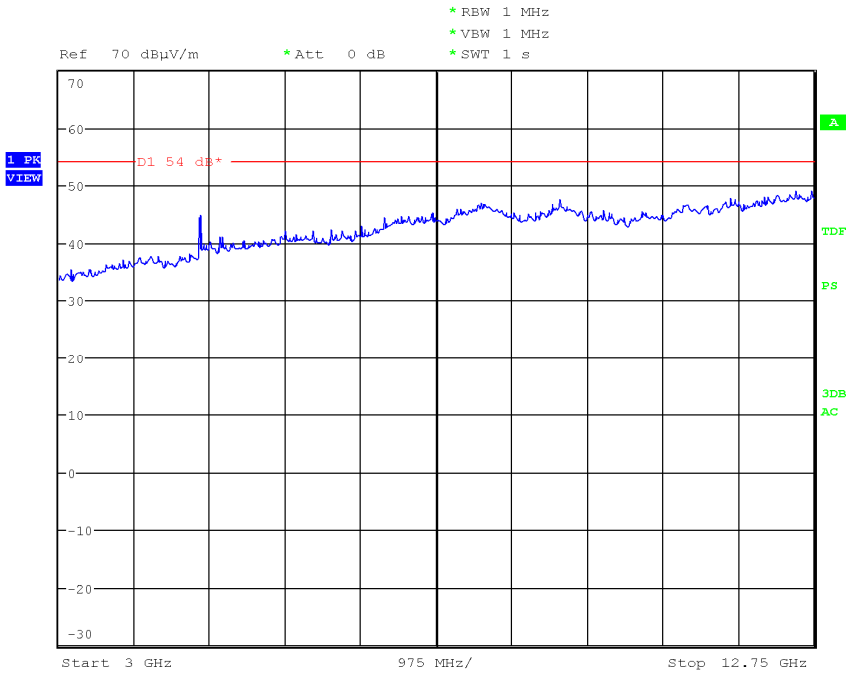
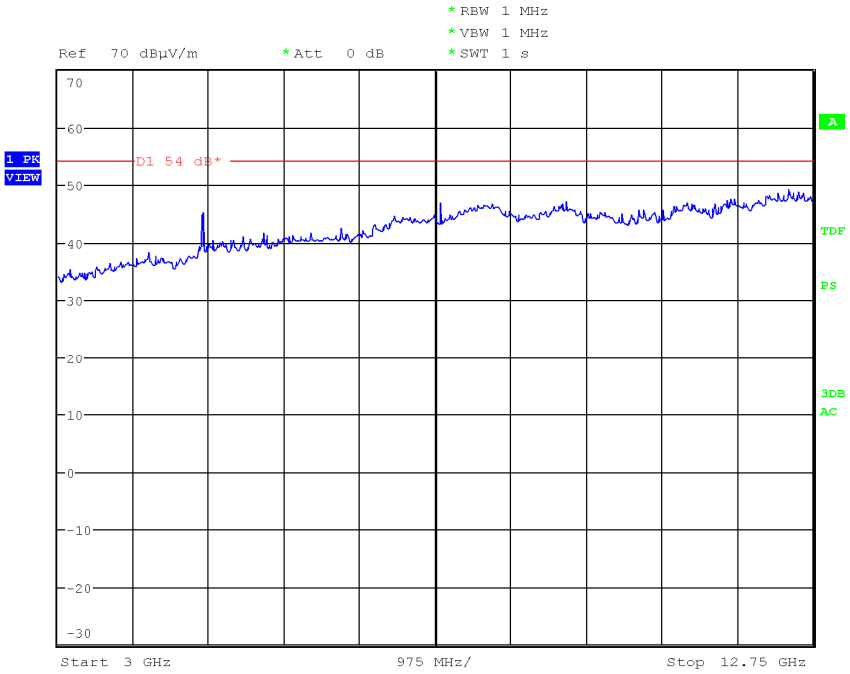
2. WiFi 2.4GHz 802.11 g mode (worst case)

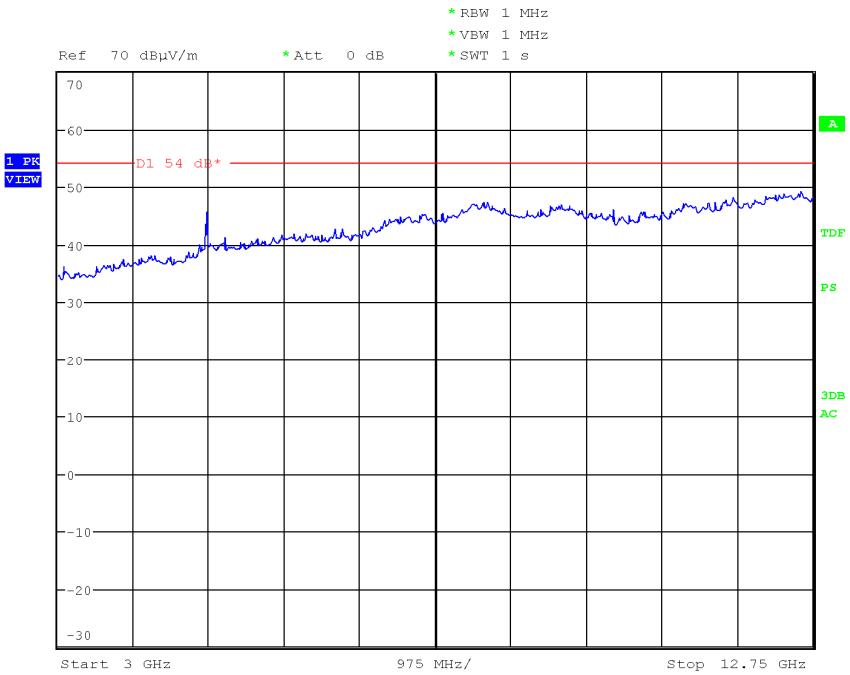
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

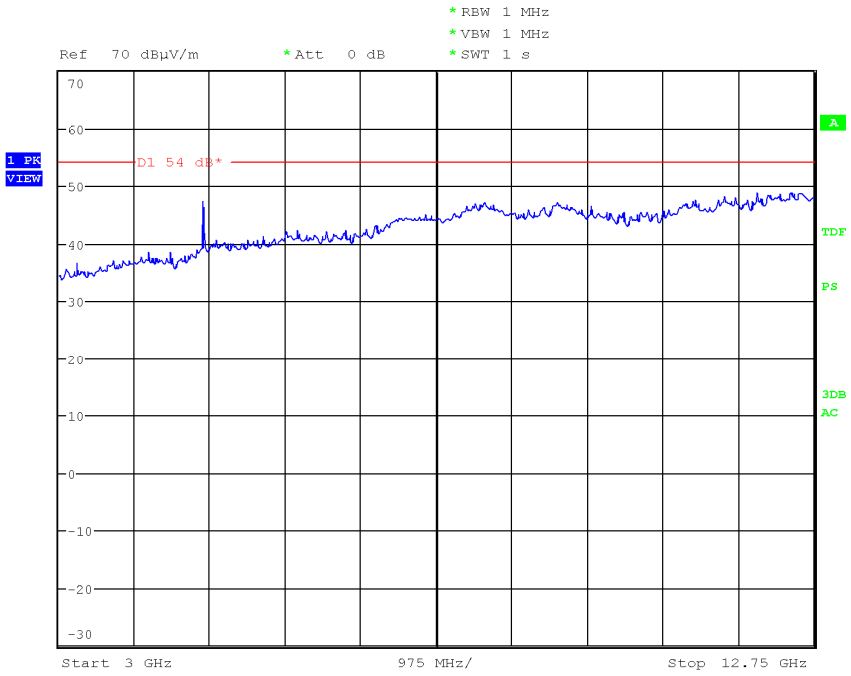


CHANNEL 11 (2462 MHz).



3. WiFi 2.4GHz 802.11 n20 mode

CHANNEL 6 (2437 MHz).



4. WiFi 2.4GHz 802.11 n40 mode

CHANNEL 6 (2437 MHz).

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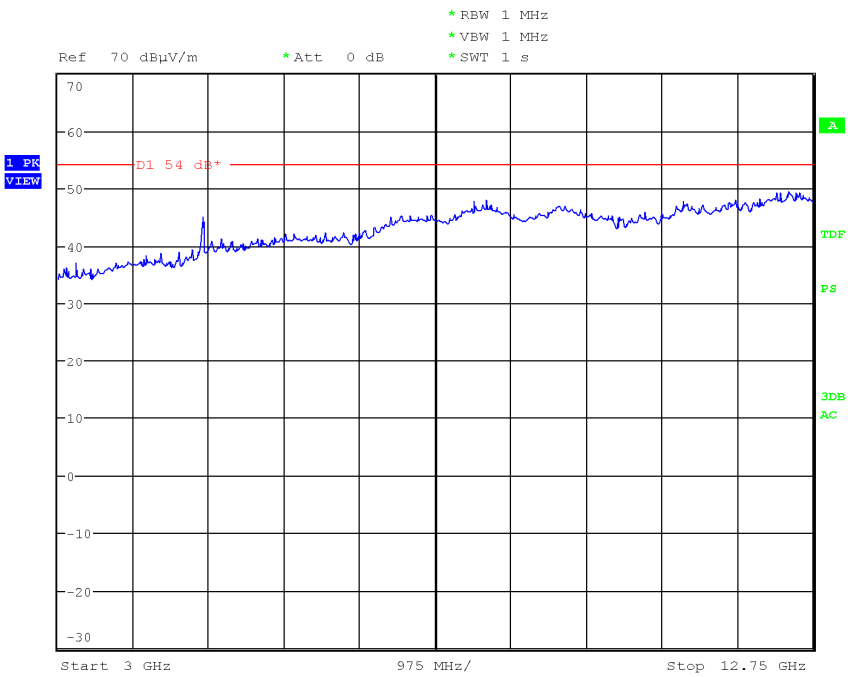
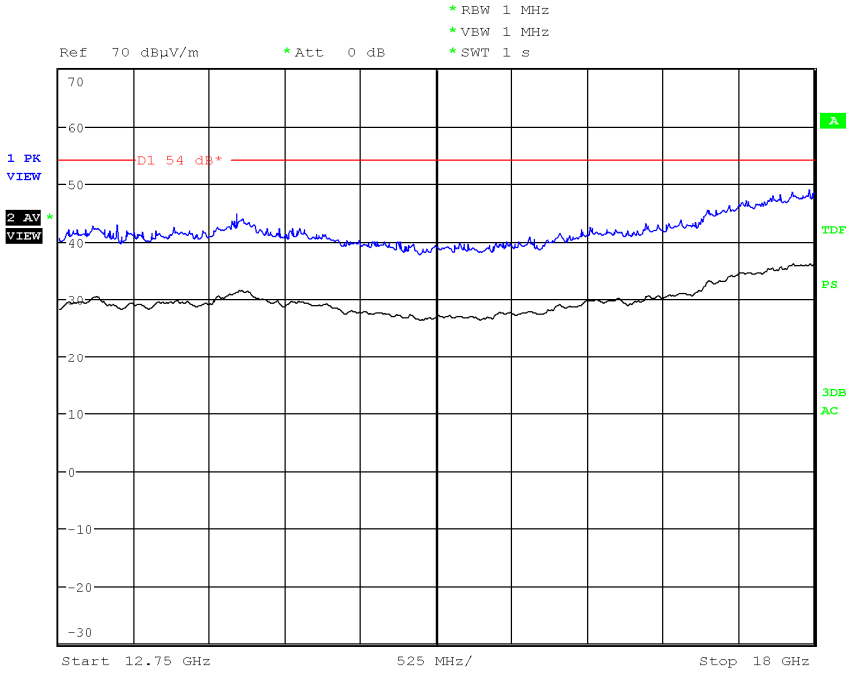
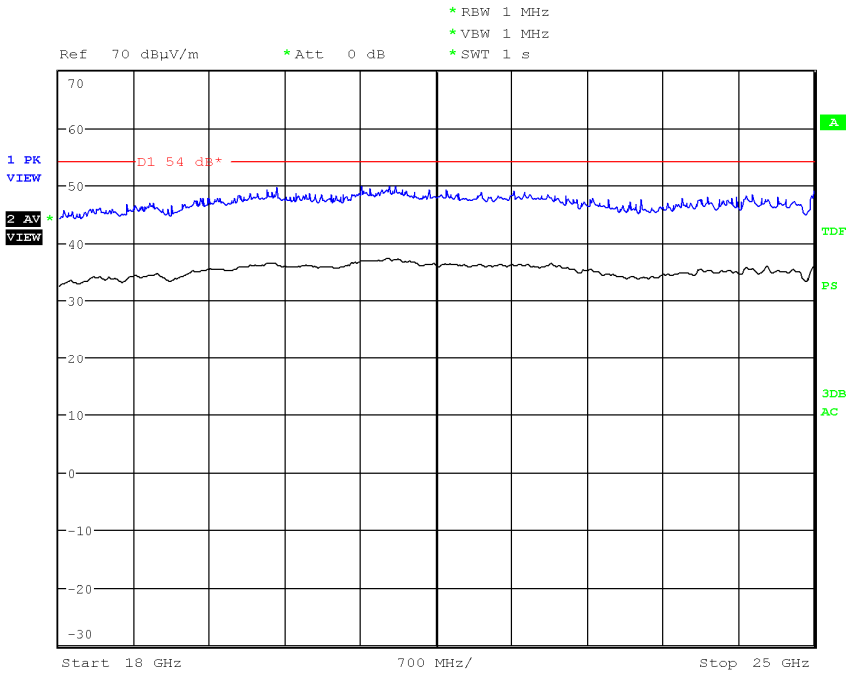


FREQUENCY RANGE 12.75 GHz to 18 GHz. No spurious signals were detected in all modulation modes and channels tested.



FREQUENCY RANGE 18 GHz to 25 GHz. No spurious signals were detected.

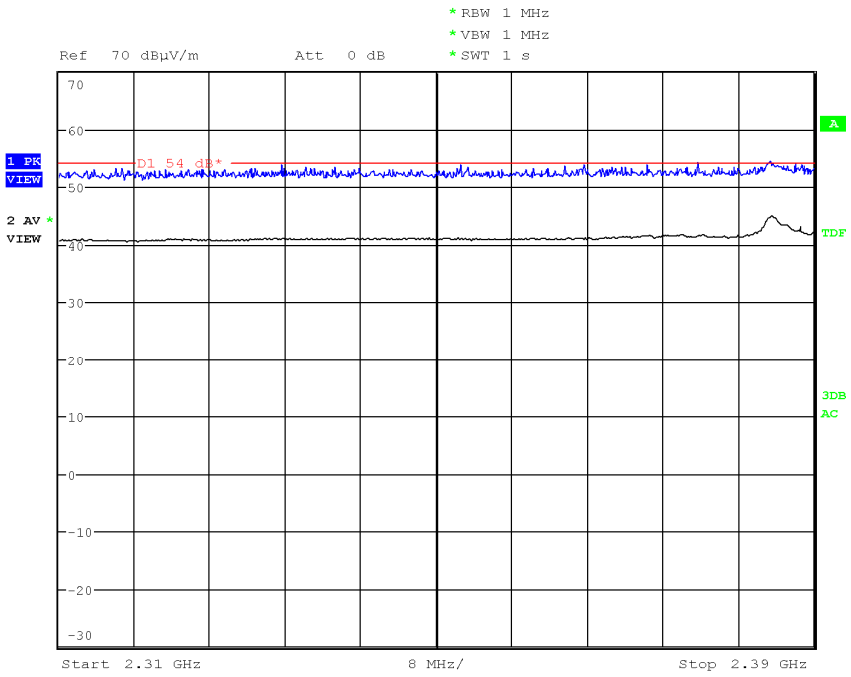


Radiated spurious emissions at band-edges and inside restricted bands 2.31-2.39 GHz and 2.4835 – 2.5 GHz.

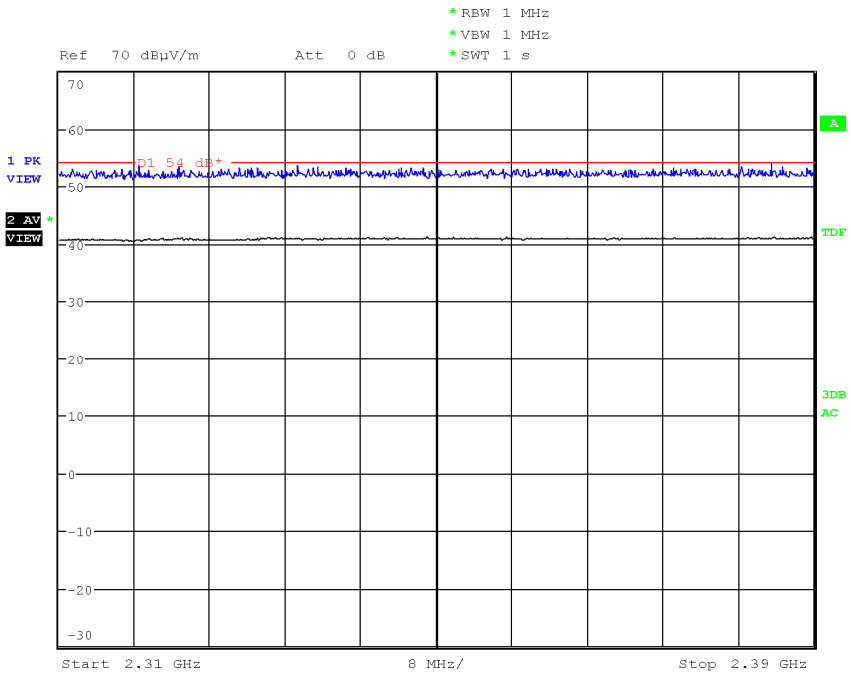
FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

1. WiFi 2.4GHz 802.11 b mode

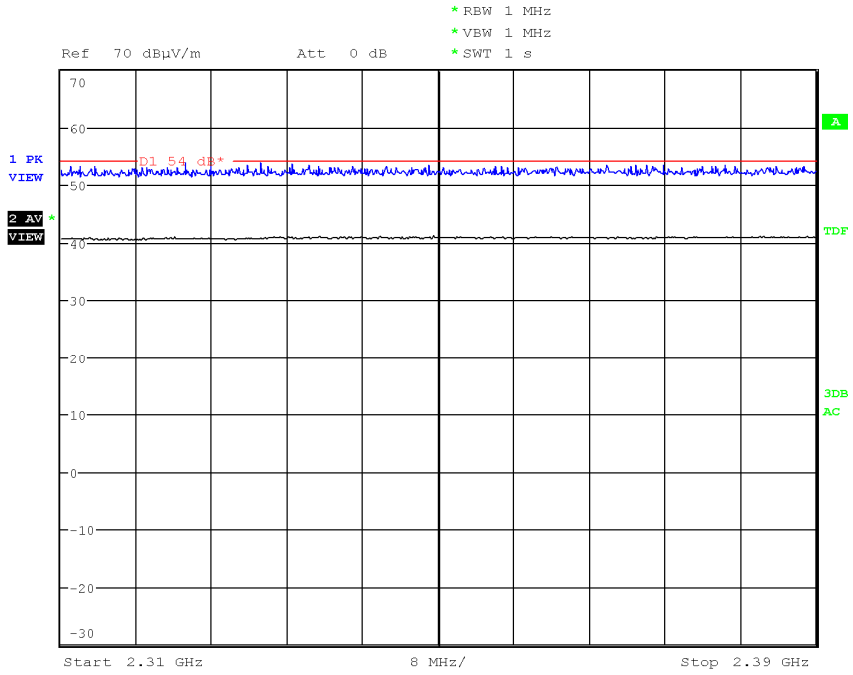
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).



CHANNEL 11 (2462 MHz).



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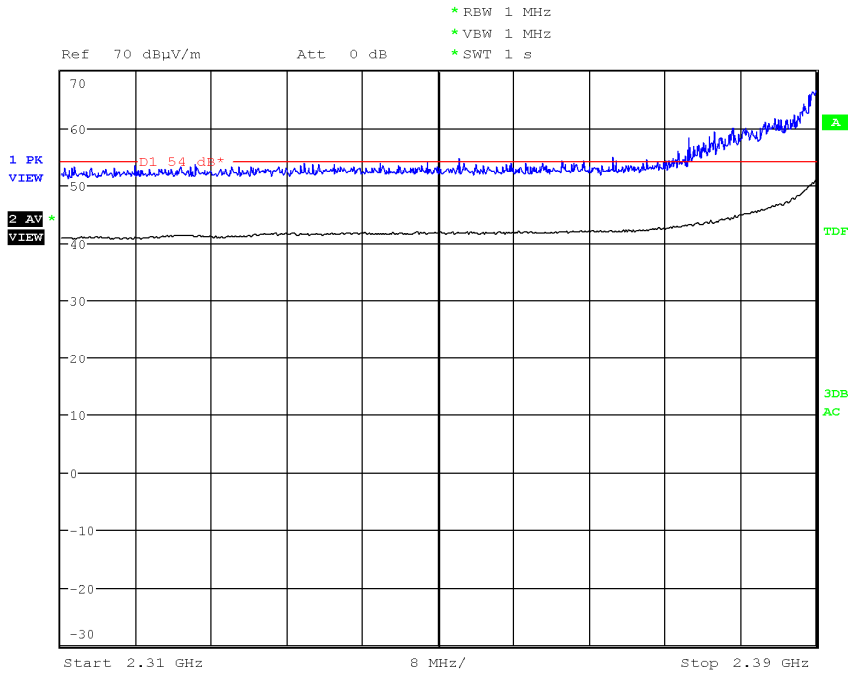
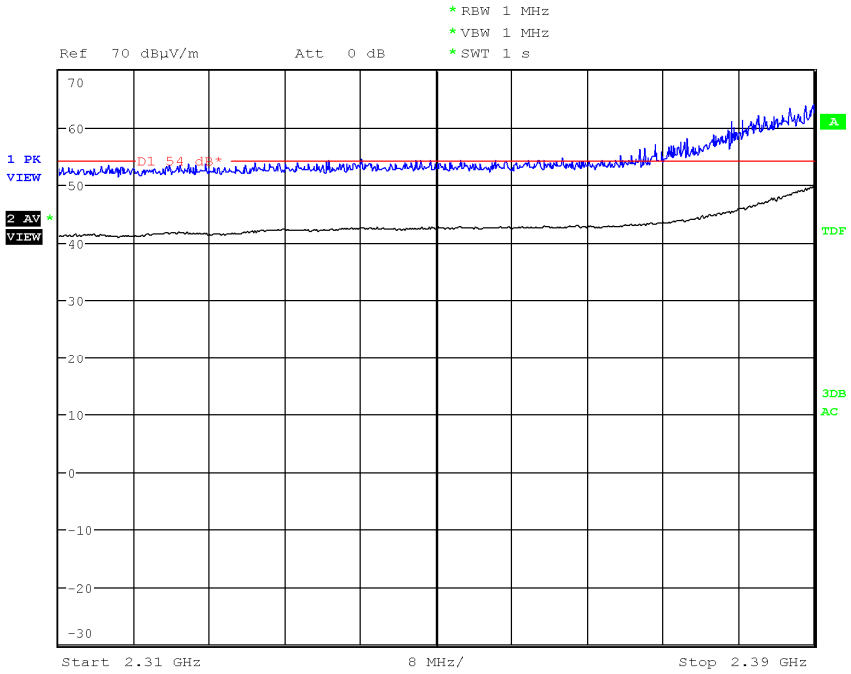
2. WiFi 2.4GHz 802.11 g mode

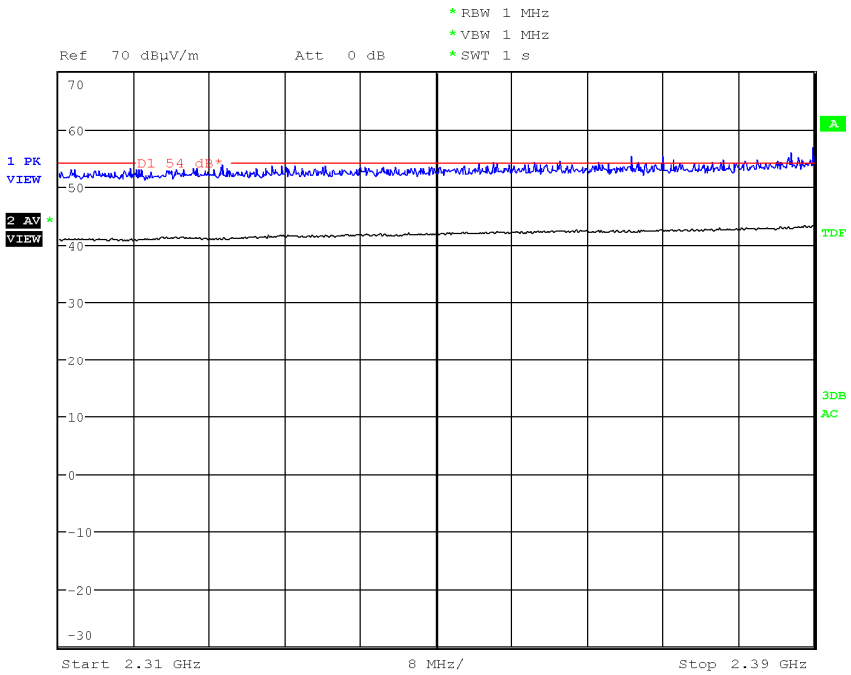
CHANNEL 1 (2412 MHz).



CHANNEL 2 (2417 MHz).

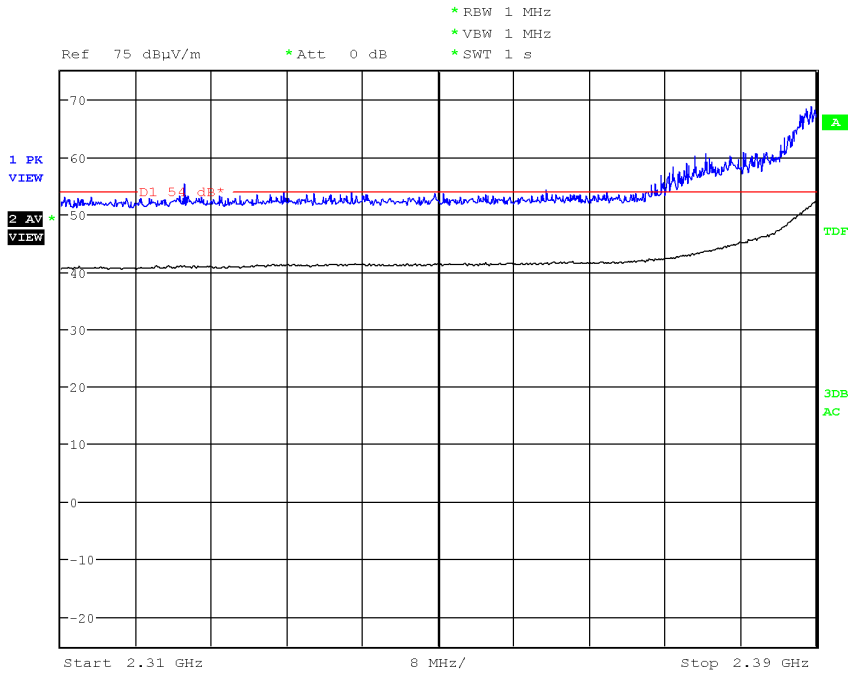


CHANNEL 6 (2437 MHz).

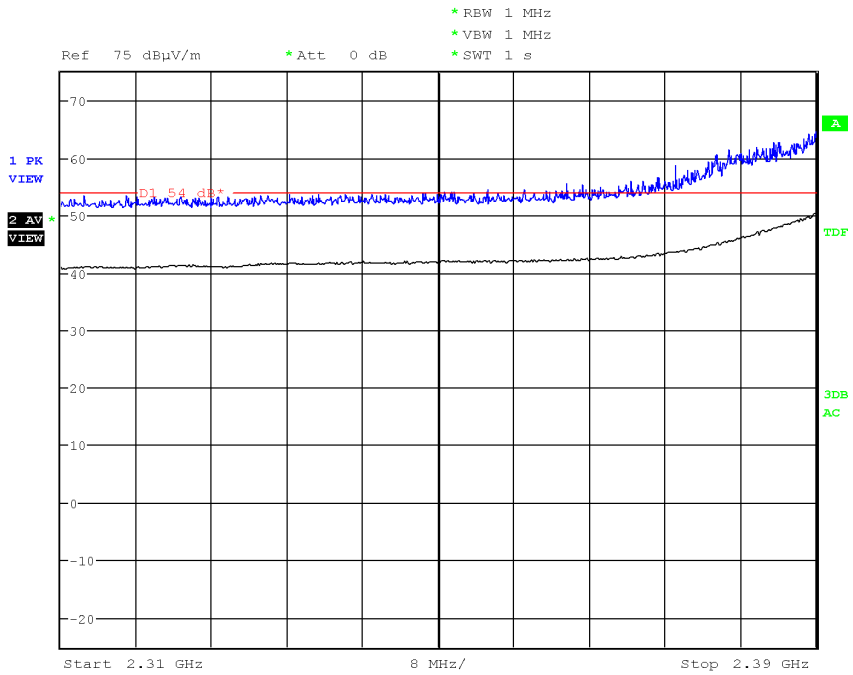


3. WiFi 2.4GHz 802.11 n20 mode

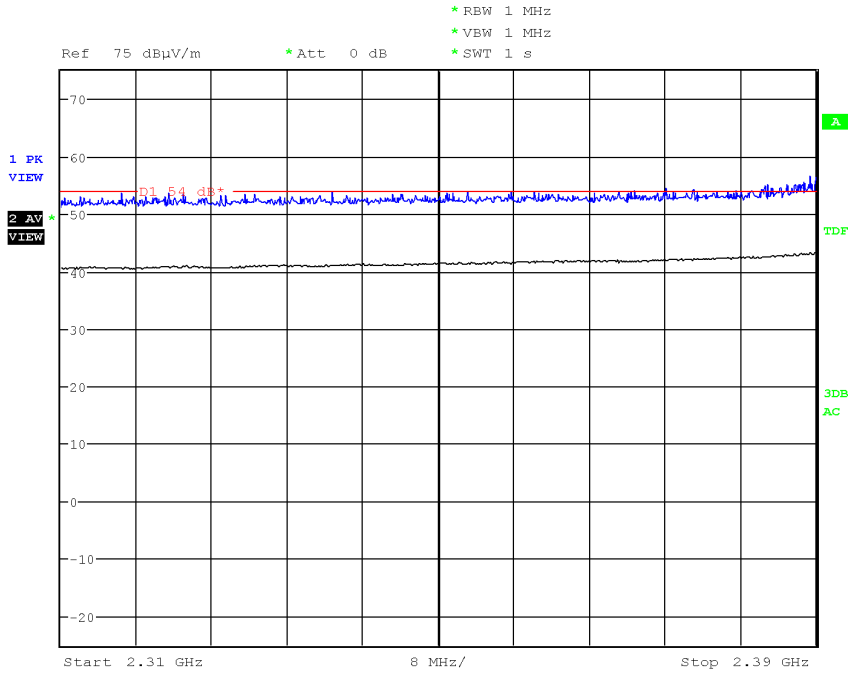
CHANNEL 1 (2412 MHz).



CHANNEL 2 (2417 MHz).



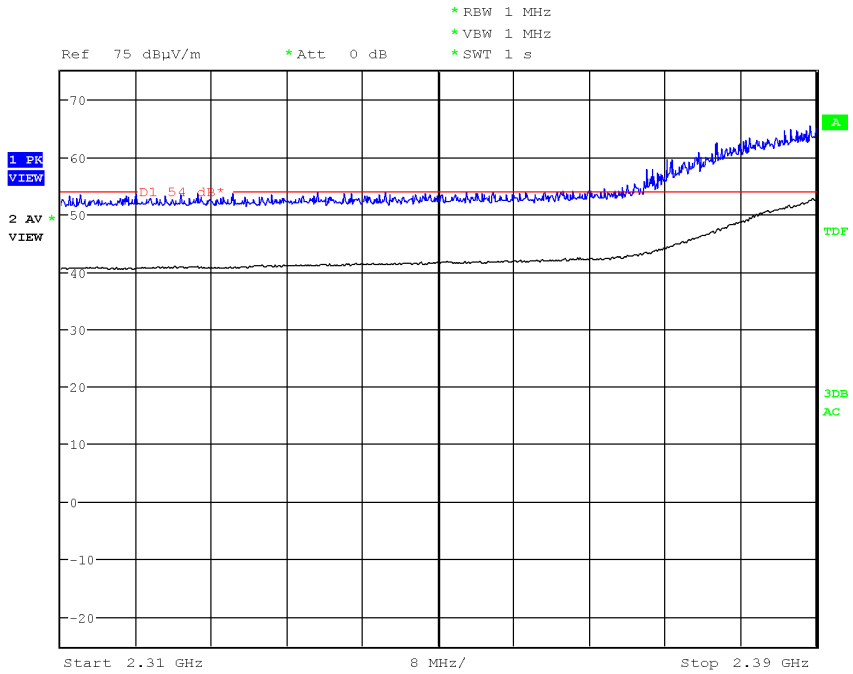
CHANNEL 6 (2437 MHz).



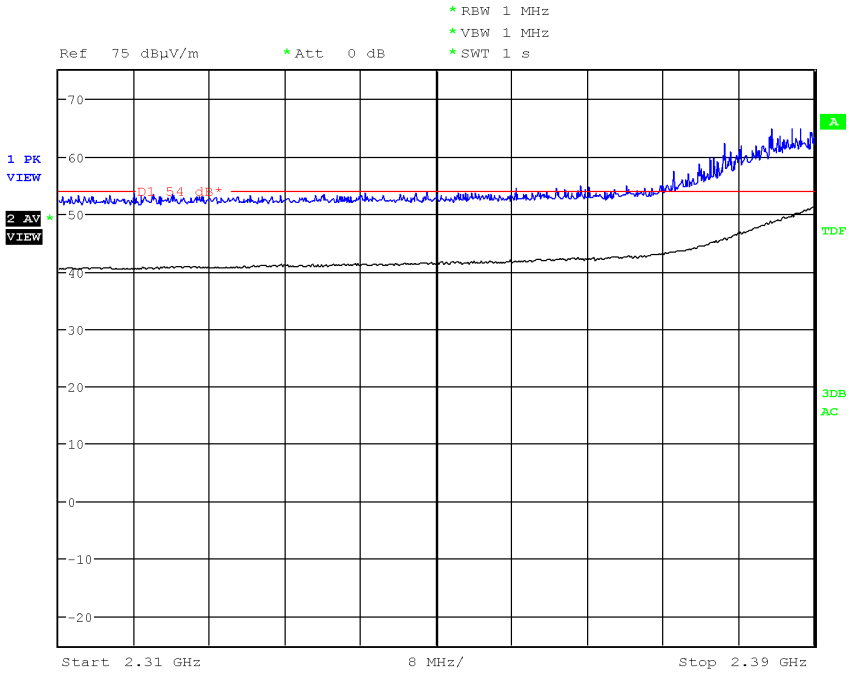
4. WiFi 2.4GHz 802.11 n40 mode

CHANNEL 3 (2422 MHz).

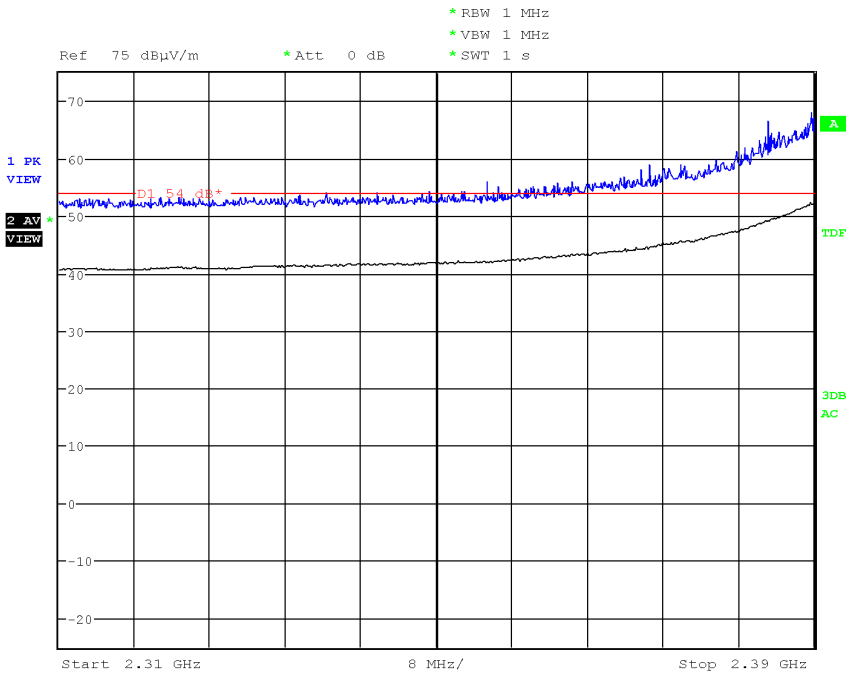
Chain A



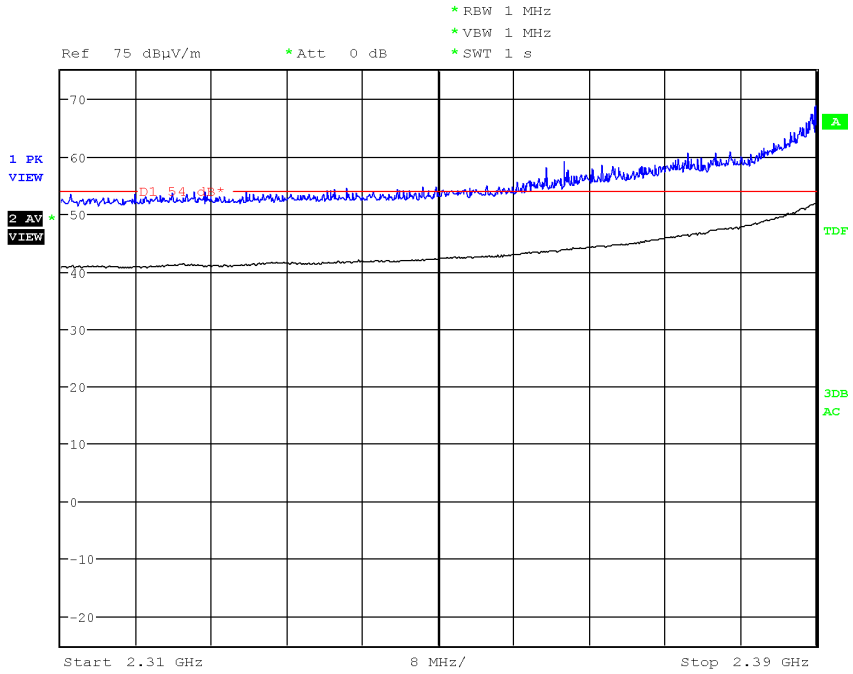
CHANNEL 4 (2427 MHz).



CHANNEL 5 (2432 MHz).



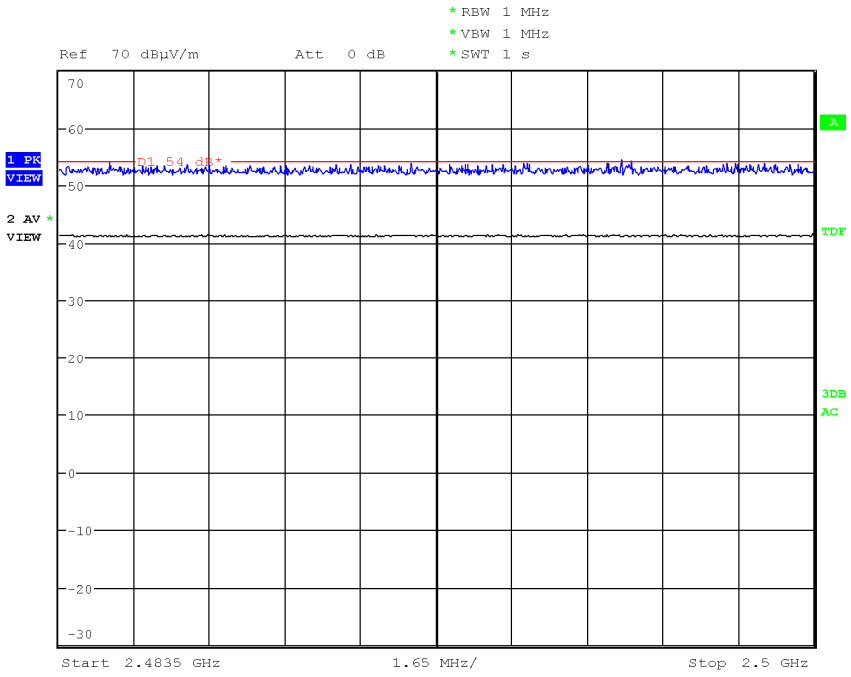
CHANNEL 6 (2437 MHz).



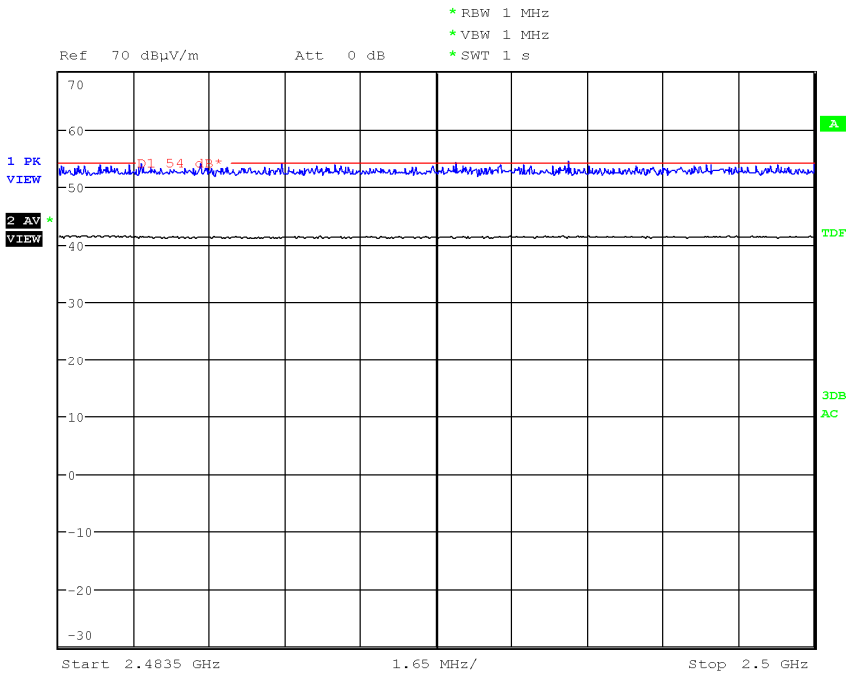
FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

1. WiFi 2.4GHz 802.11 b mode

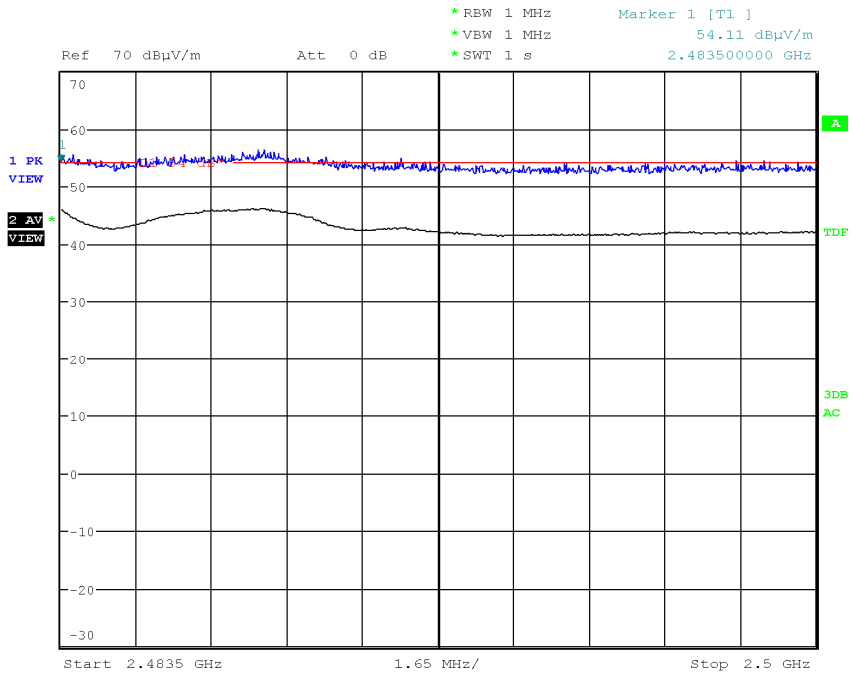
CHANNEL 1 (2412 MHz).



CHANNEL 6 (2437 MHz).

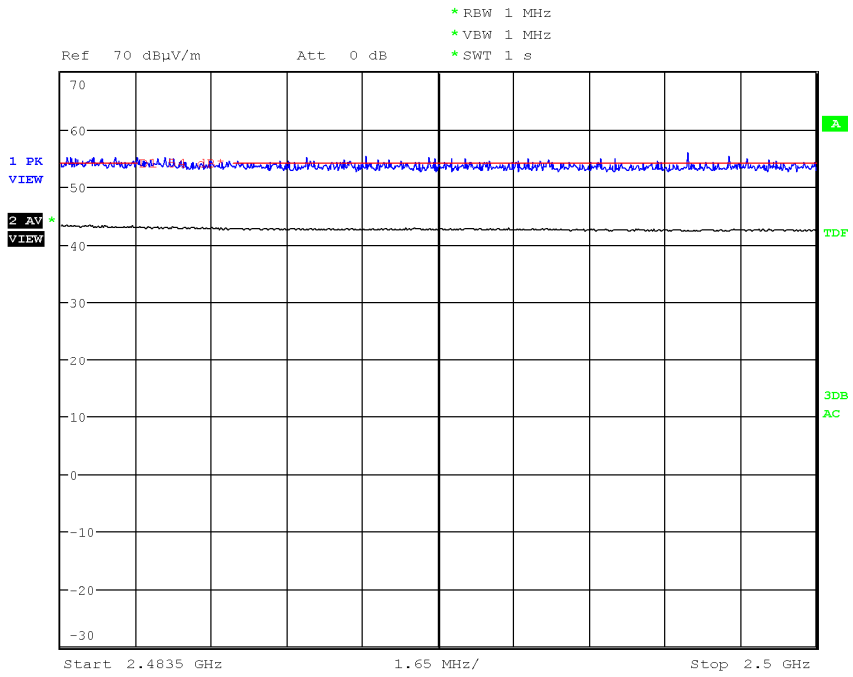


CHANNEL 11 (2462 MHz).

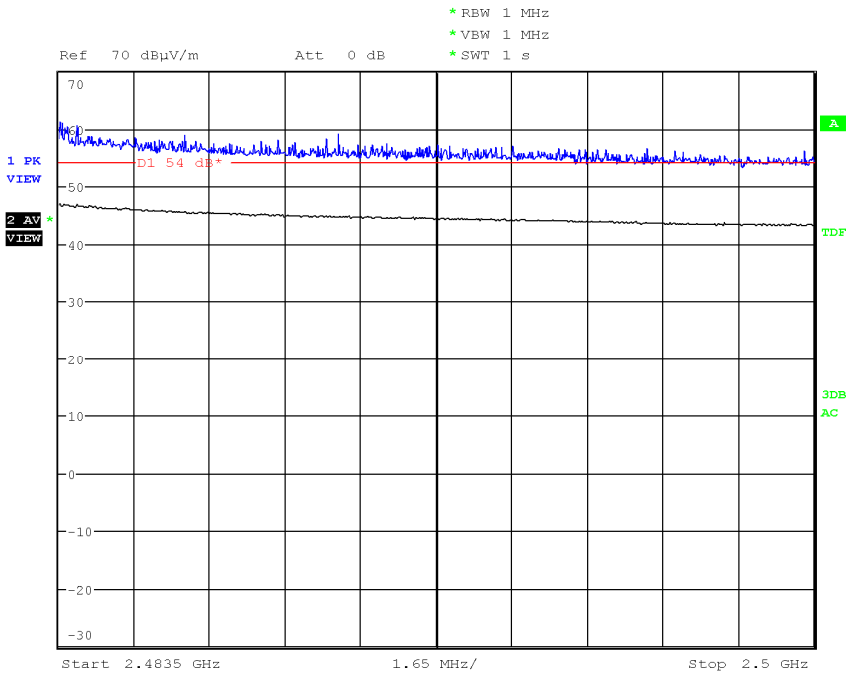


2. WiFi 2.4GHz 802.11 g mode

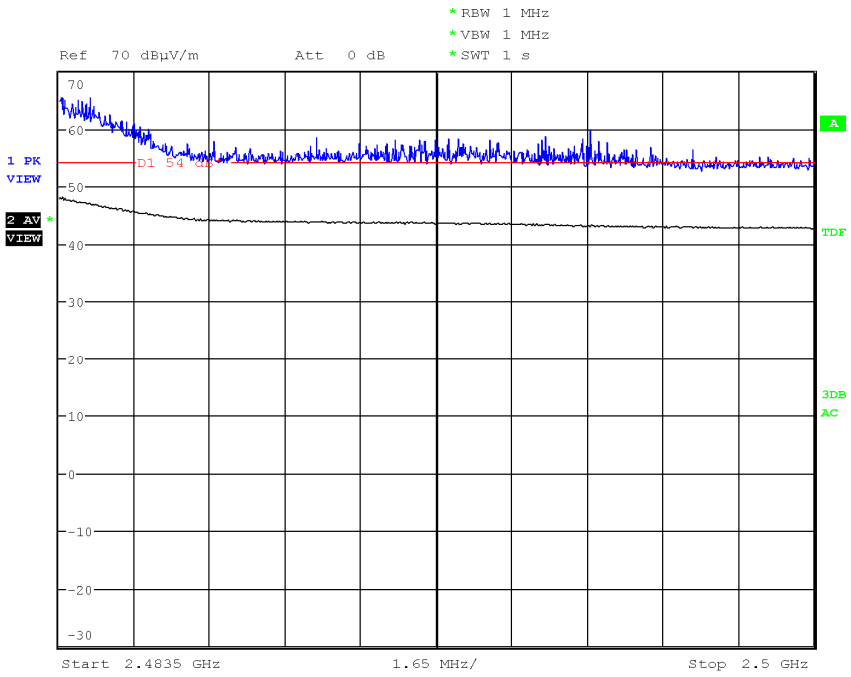
CHANNEL 6 (2437 MHz).



CHANNEL 10 (2457 MHz).

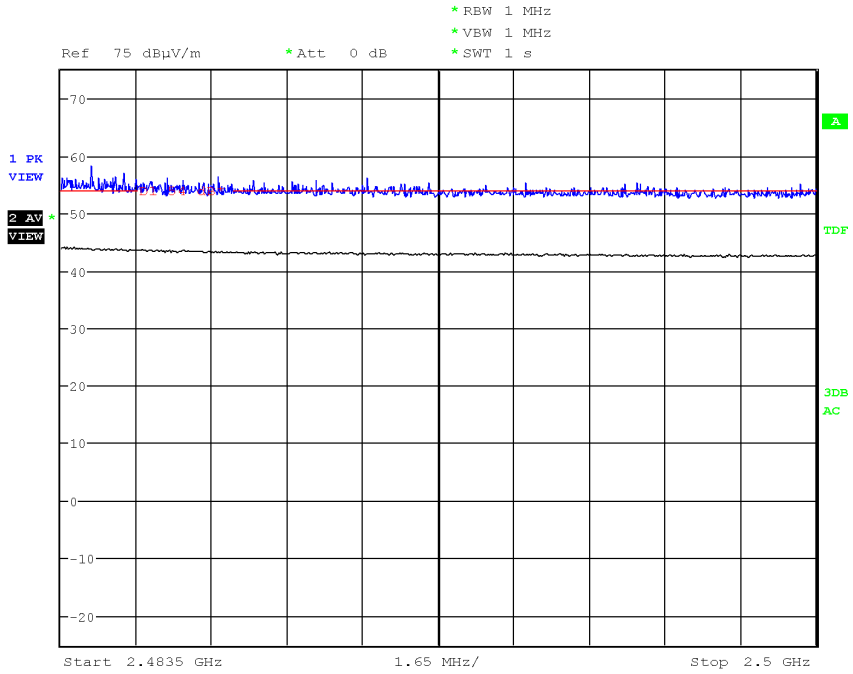


CHANNEL 11 (2462 MHz).

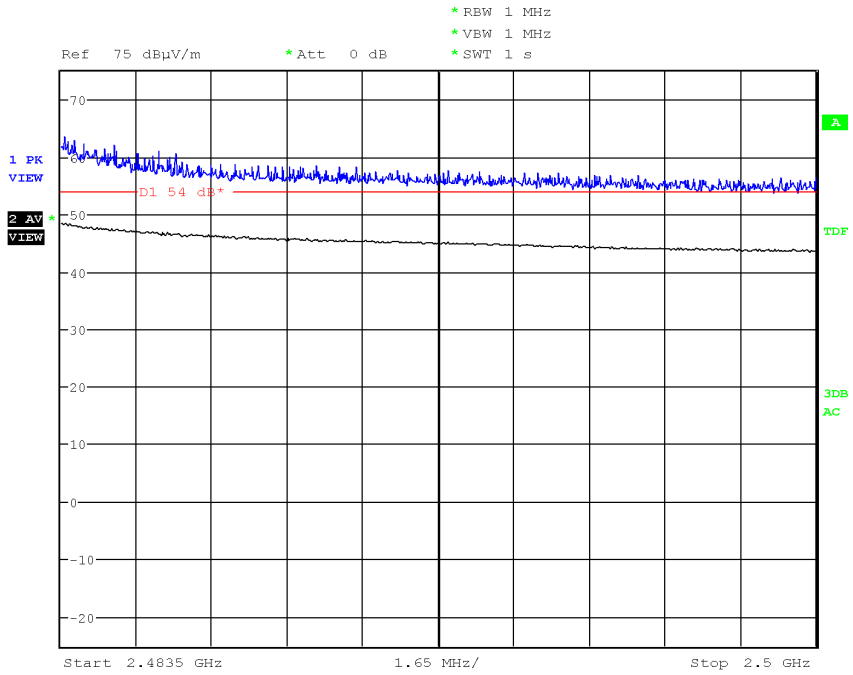


3. WiFi 2.4GHz 802.11 n20 mode

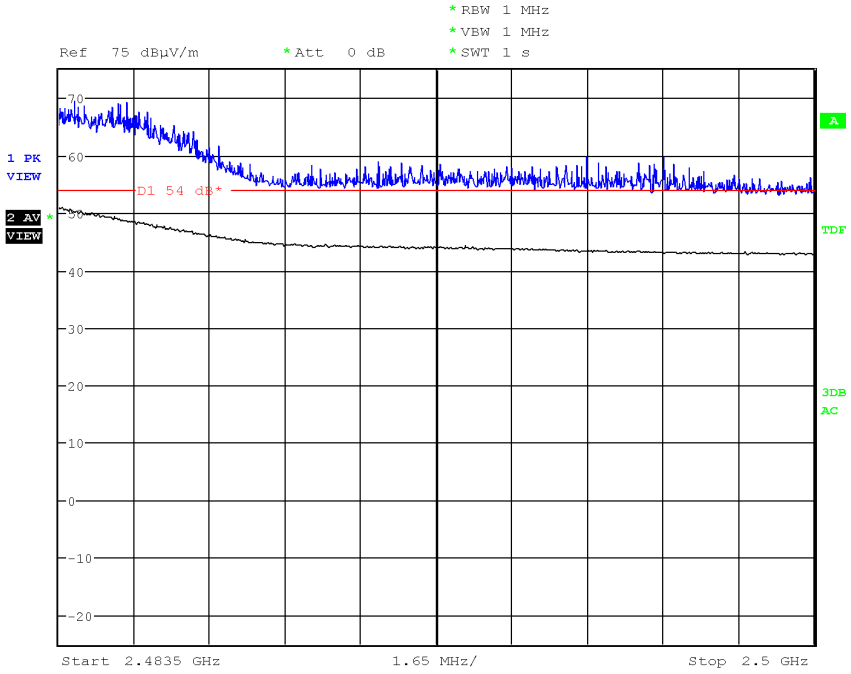
CHANNEL 6 (2437 MHz).



CHANNEL 10 (2457 MHz).

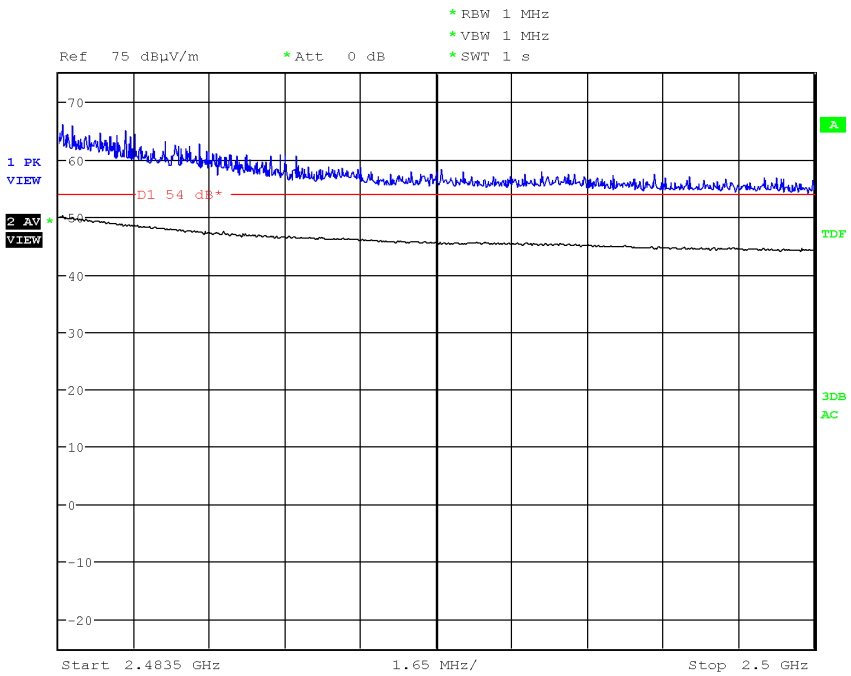


CHANNEL 11 (2462 MHz).

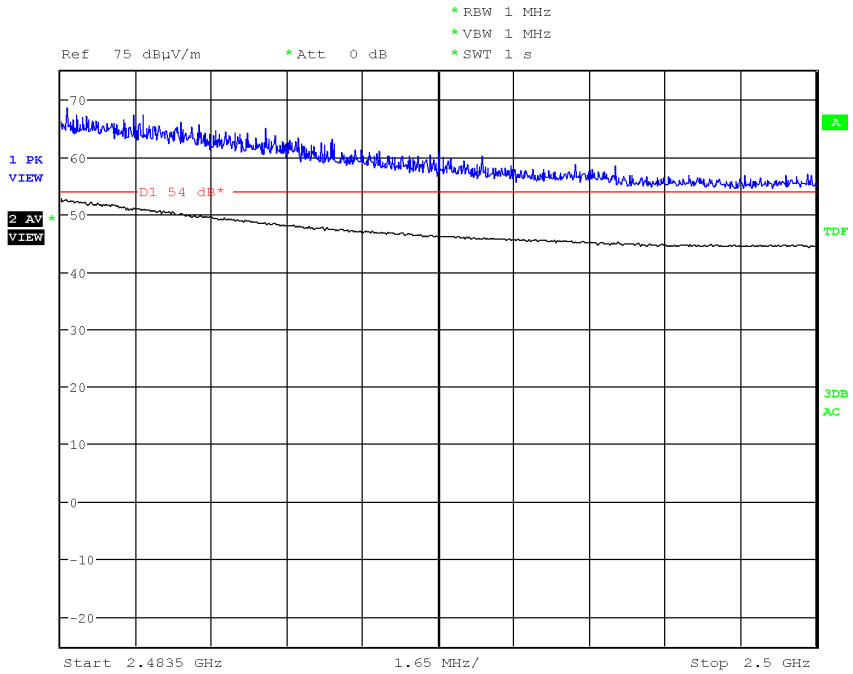


4. WiFi 2.4GHz 802.11 n40 mode

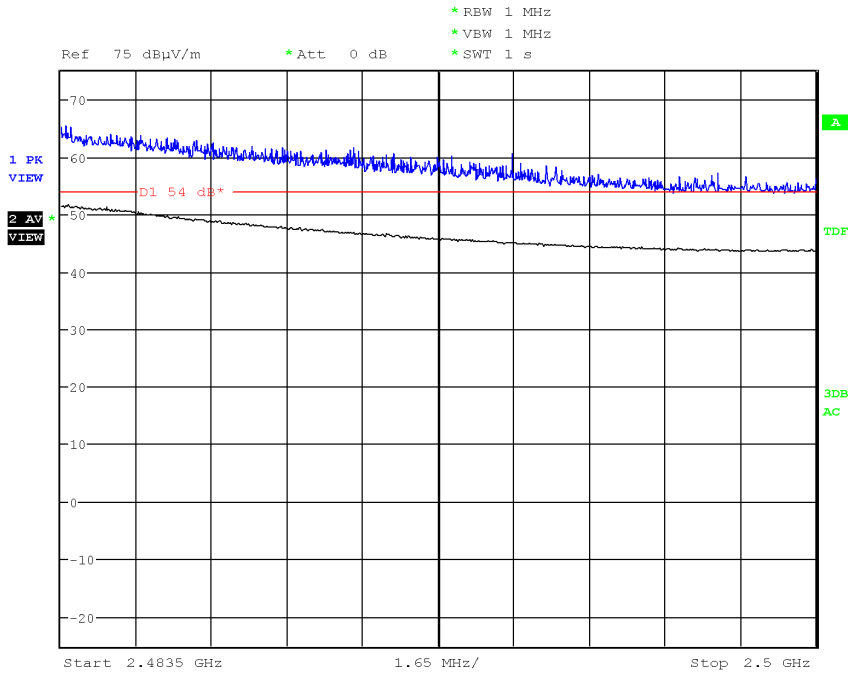
CHANNEL 6 (2437 MHz).



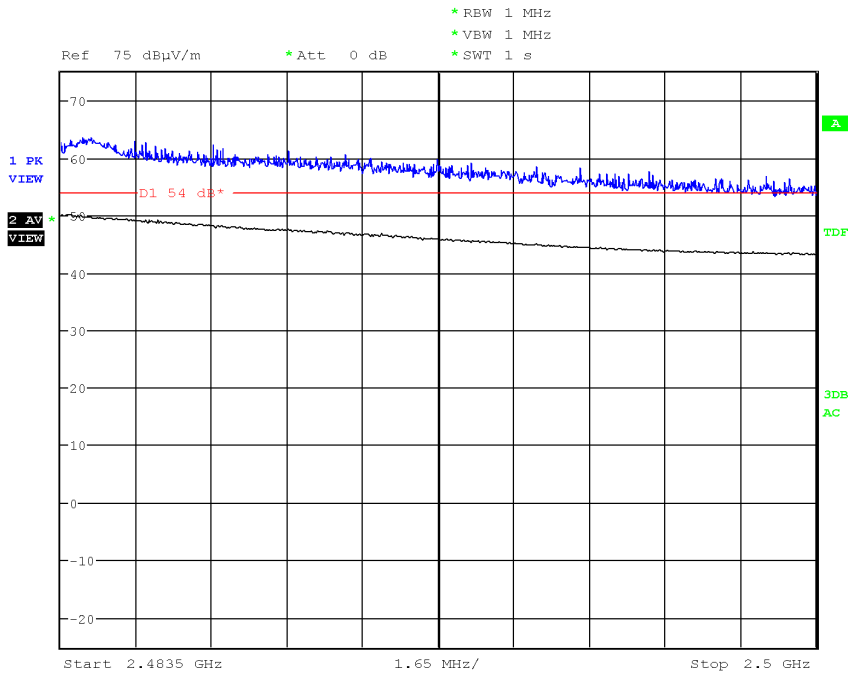
CHANNEL 7 (2442 MHz).



CHANNEL 8 (2447 MHz).



CHANNEL 9 (2452 MHz).



APPENDIX B: Test results

“WiFi 5.725-5.825 GHz (802.11a/n20/n40/ac80)”

INDEX

TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 3.3 Vdc

Type of power supply = DC voltage from HMC/NGFC test board.

Type of antenna = External attachable PIFA antenna.

Declared Gain for antenna = 5 dBi

Operating frequencies in the sub-band 5.725-5.825 GHz.

-For IEEE 802.11a, the equipment uses channels 149,153,157,161,165.

-For IEEE 802.11n, there are two bandwidths:

For 20 MHz bandwidth the equipment uses channels 149,153,157,161,165.
For 40 MHz bandwidth the equipment uses channels 151 and 159.

-For IEEE 802.11ac80 (80 MHz bandwidth) the equipment uses channel 155.

TEST FREQUENCIES:

For WiFi a/n20:

Lowest channel (149): 5745 MHz

Middle channel (157): 5785 MHz

Highest channel (165): 5825 MHz

For WiFi n40:

Lowest channel (151): 5755 MHz

Highest channel (159): 5795 MHz

For WiFi ac80:

Middle channel (155): 5775 MHz

The test set-up was made in accordance to the general provisions of ANSI C63.4: 2009 and FCC DTS Measurement KDB 558074 D01 DTS Meas Guidance v03.

For 802.11a mode the EUT can only transmit at Main RF output.

For 802.11n modes 802.11n20 (20 MHz channel bandwidth), 802.11n40 (40MHz channel bandwidth) and 802.11ac80 (80MHz channel bandwidth) mode the EUT can only transmit at Main RF output.

For radio testing purposes the card was installed in a test fixture. The test fixture is connected to a laptop computer and dc power supplied. The laptop computer was used to configure the EUT to continuously transmit at a specified output power with different modes and modulation schemes.

The PC was using the Intel test utility DRTU Version DRTU 1.6.1.628.

During transmitter test the EUT was being controlled by the Intel DRTU tool 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 6Mb/s for 802.11a, HT0 for 802.11n20 and n40, and VHT0for 802.11 ac80 were selected based on preliminary testing that identified those rates corresponding to the worst cases for output power and spurious levels at the band edges.

The conducted RF output power at Main RF output was adjusted according to the client's supplied Target values (see following table) using the Intel DRTU tool and measuring the power by using a calibrated average power meter. Measured values for adjustment were within -0.2 dB/+0.3 dB respect to the Target values.

RF conducted output power target values

Mode	BW (MHz)	Channel / Freq.	RF output power at Main RF (dBm)
802.11a	20	149 / 5745	16,5
		157 / 5785	16,5
		165 / 5825	16,5
802.11n	20	149 / 5745	16,5
		157 / 5785	16,5
		165 / 5825	16,5
802.11n*	40	151 / 5755	16,5
		159 / 5795	16,5
802.11ac	80	155 / 5775	15

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a calibrated low loss RF cable. The reading in the spectrum analyser is compensated with the cable loss at each measurement frequency.

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

For radiated emissions in the range 1 GHz-40 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 one 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.

Occupied Bandwidth

RESULTS

1. WiFi 5GHz 802.11 a mode

Occupied Bandwidth (see next plots).

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
99% bandwidth (MHz)	17.7895	17.8917	17.6896
Measurement uncertainty (kHz)	±21.7		

2. WiFi 5GHz 802.11 n20 mode

Occupied Bandwidth (see next plots).

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
99% bandwidth (MHz)	18.5061	18.5596	18.4154
Measurement uncertainty (kHz)	±21.7		

3. WiFi 5GHz 802.11 n40 mode

Occupied Bandwidth (see next plots).

	Lowest frequency 5755 MHz	Highest frequency 5795 MHz
99% bandwidth (MHz)	36.2906	36.2305
Measurement uncertainty (kHz)	±21.7	

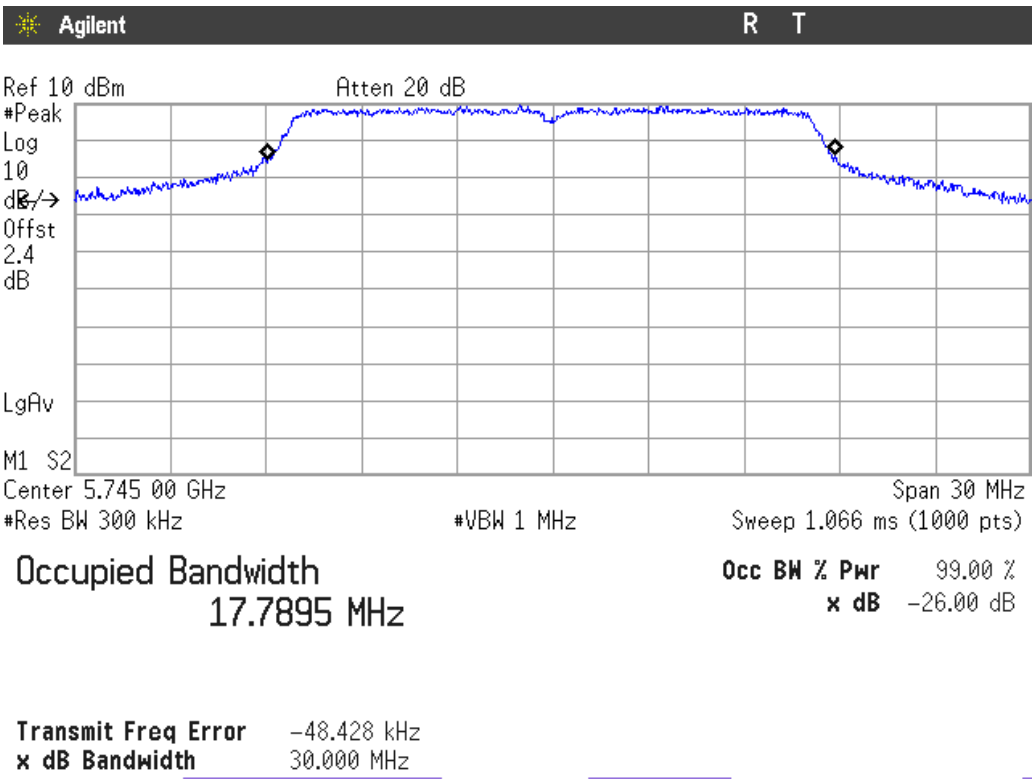
4. WiFi 5GHz 802.11 ac80 mode

Occupied Bandwidth (see next plots).

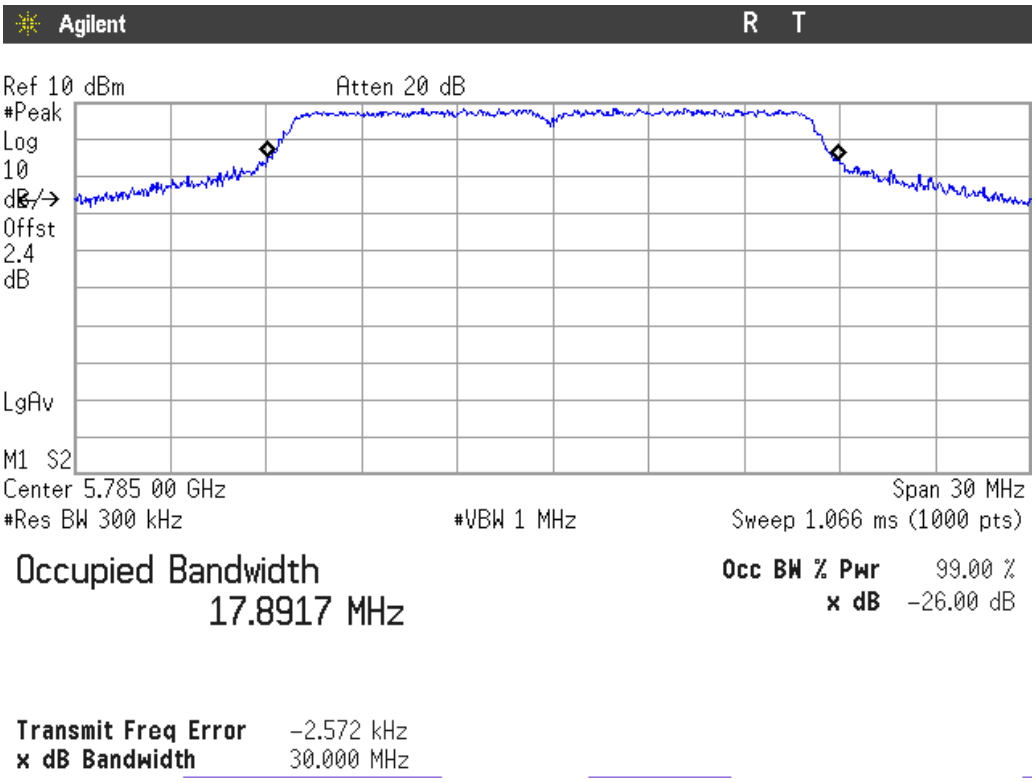
	Middle frequency 5775 MHz
99% bandwidth (MHz)	74.8577
Measurement uncertainty (kHz)	±21.7

1. WiFi 5GHz 802.11 a mode

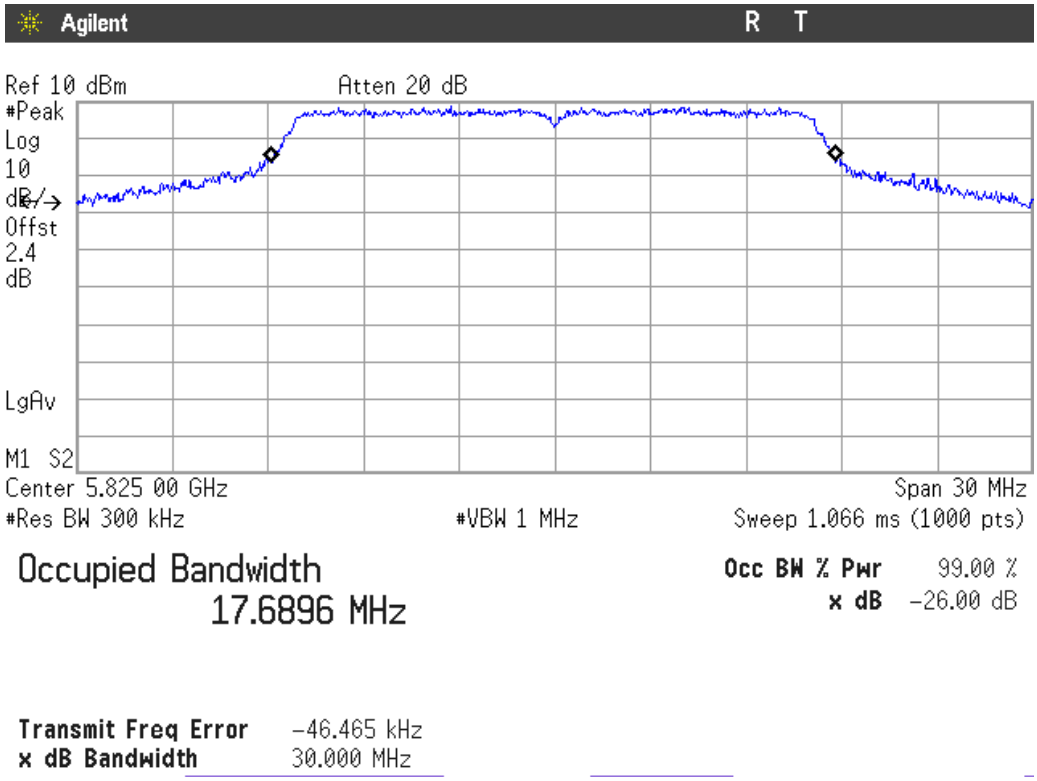
Lowest Channel: 5745 MHz.



Middle Channel: 5785 MHz.

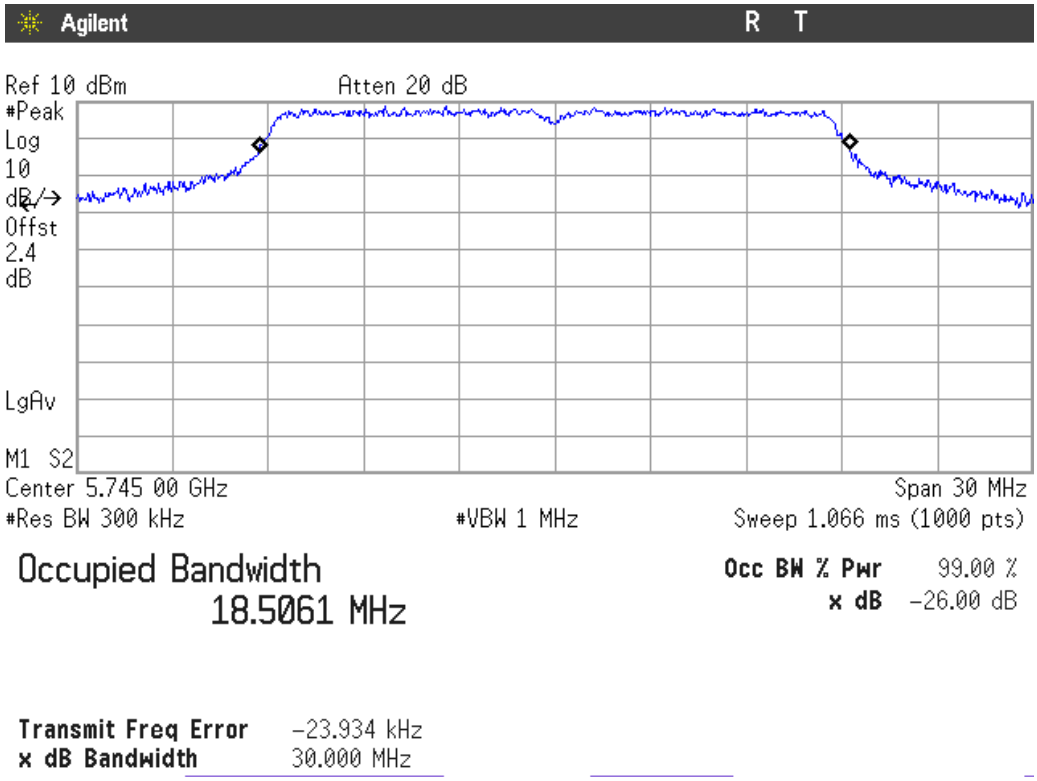


Highest Channel: 5825 MHz.

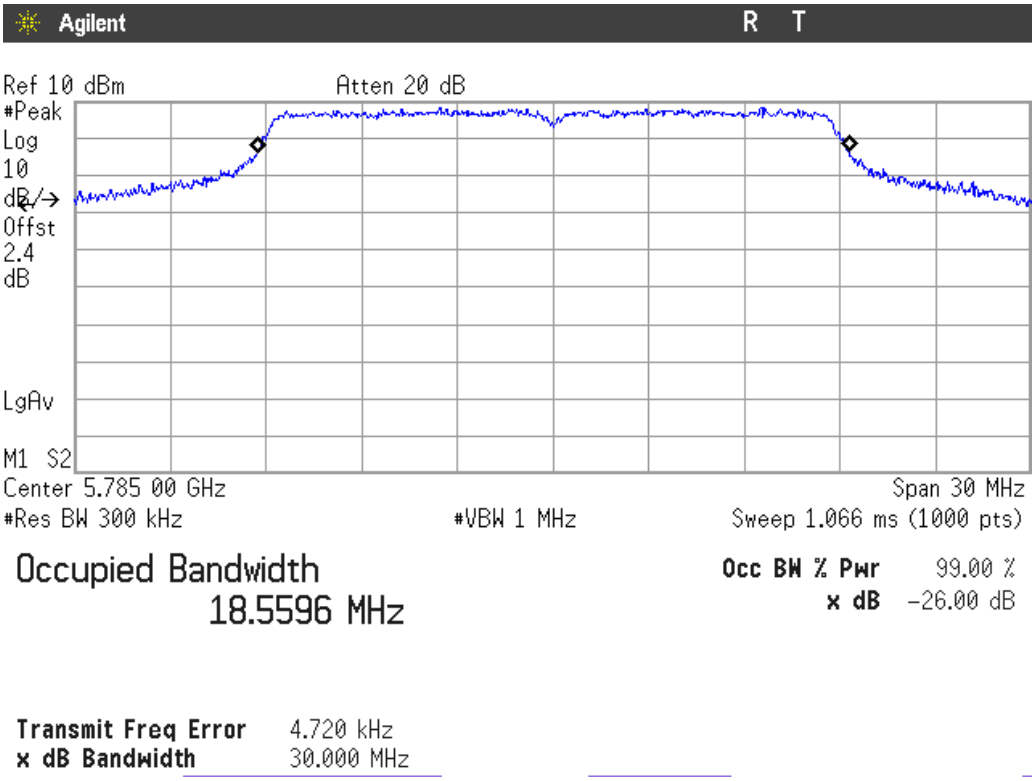


2. WiFi 5GHz 802.11 n20 mode

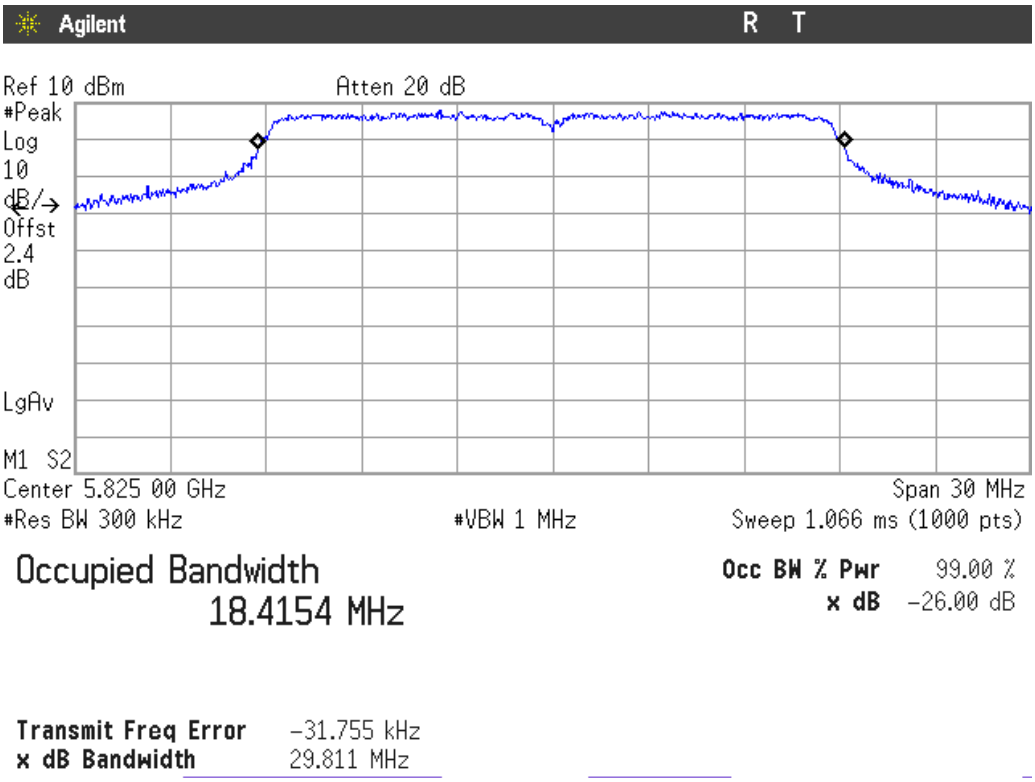
Lowest Channel: 5745 MHz.



Middle Channel: 5785 MHz.

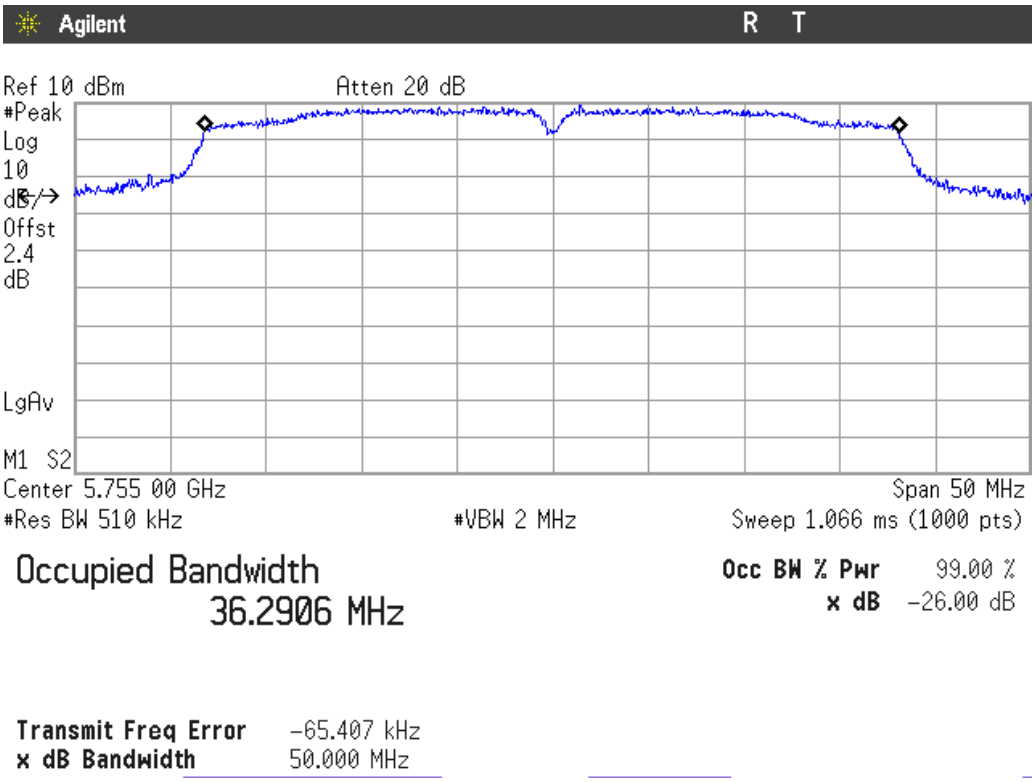


Highest Channel: 5825 MHz.

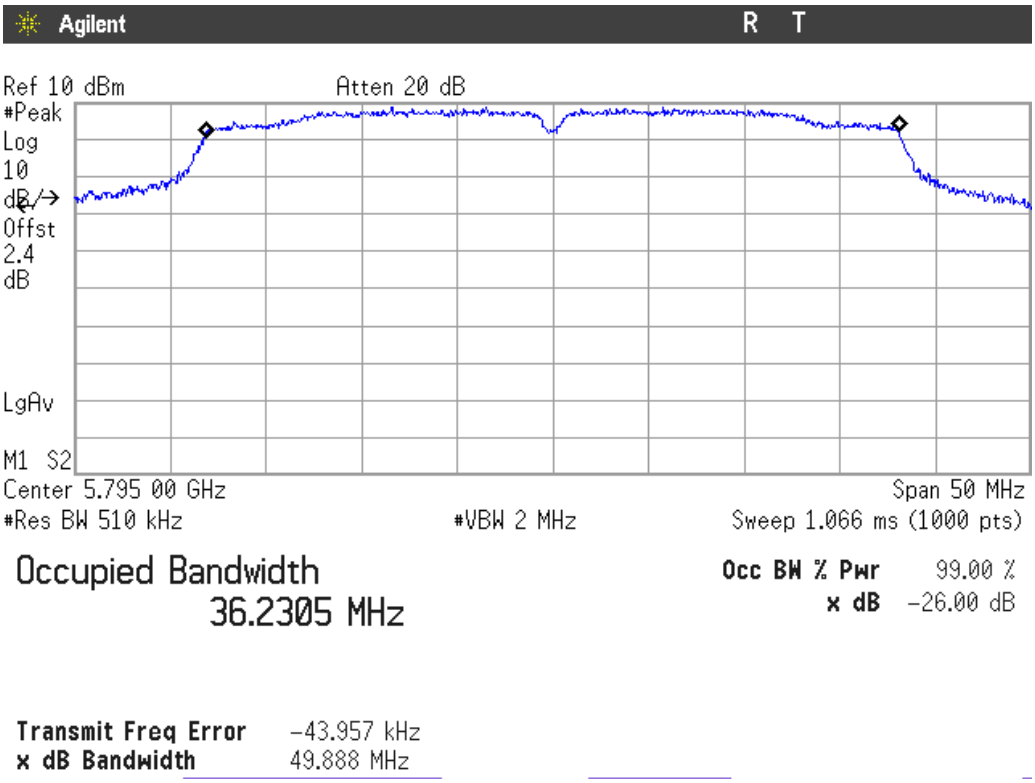


3. WiFi 5GHz 802.11 n40 mode

Lowest Channel: 5755 MHz.

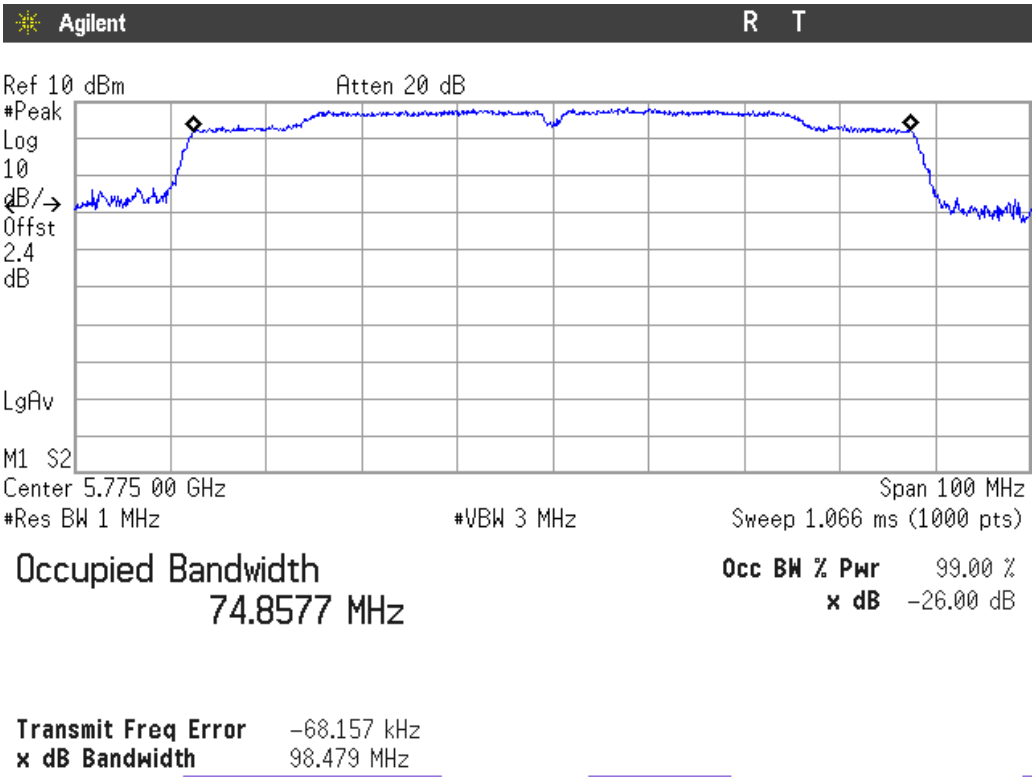


Highest Channel: 5795 MHz.



4. WiFi 5GHz 802.11 ac80 mode

Middle Channel: 5775 MHz.



Section 15.247 Subclause (a) (2) / RSS-210 A8.2. (a). 6 dB Bandwidth

SPECIFICATION

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

RESULTS

6 dB Bandwidth (see next plots).

1. WiFi 5GHz 802.11 a mode

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
6 dB Spectrum bandwidth (MHz)	16.356	16.316	16.356
Measurement uncertainty (kHz)	±89		

2. WiFi 5GHz 802.11 n20 mode

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
6 dB Spectrum bandwidth (MHz)	17.598	17.598	17.598
Measurement uncertainty (kHz)	±89		

3. WiFi 5GHz 802.11 n40 mode

	Lowest frequency 5755 MHz	Highest frequency 5795 MHz
6 dB Spectrum bandwidth (MHz)	35.08	35.16
Measurement uncertainty (kHz)	±21.7	

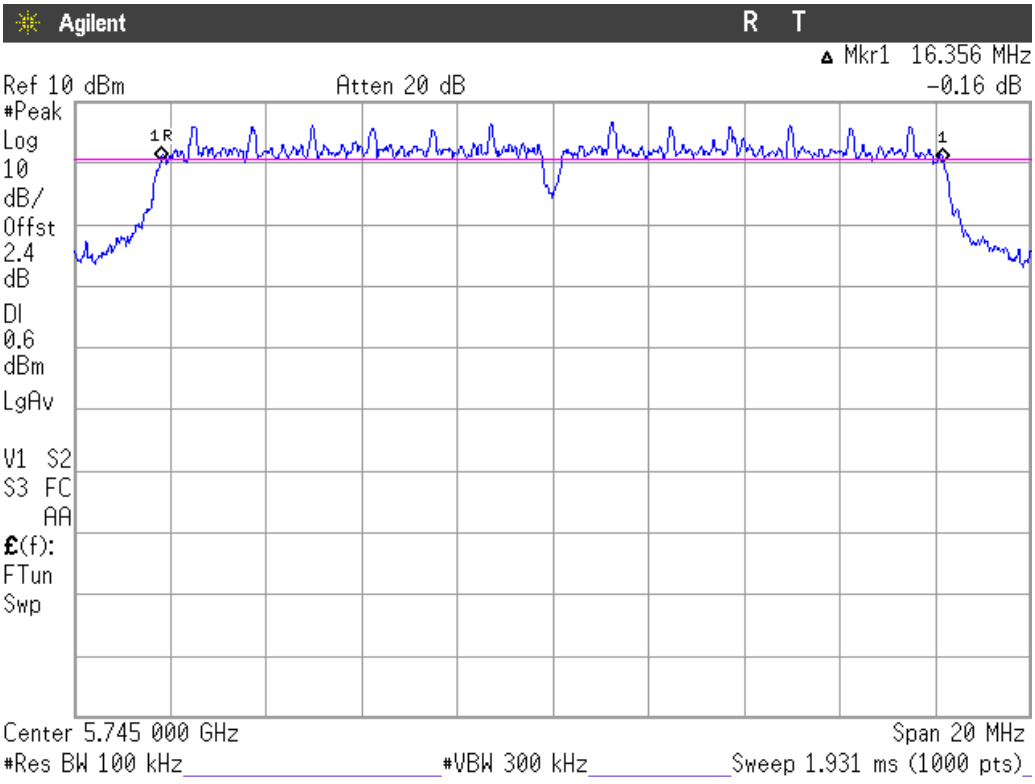
4. WiFi 5GHz 802.11 ac80 mode

	Middle frequency 5775 MHz
6 dB Spectrum bandwidth (MHz)	75.12
Measurement uncertainty (kHz)	±21.7

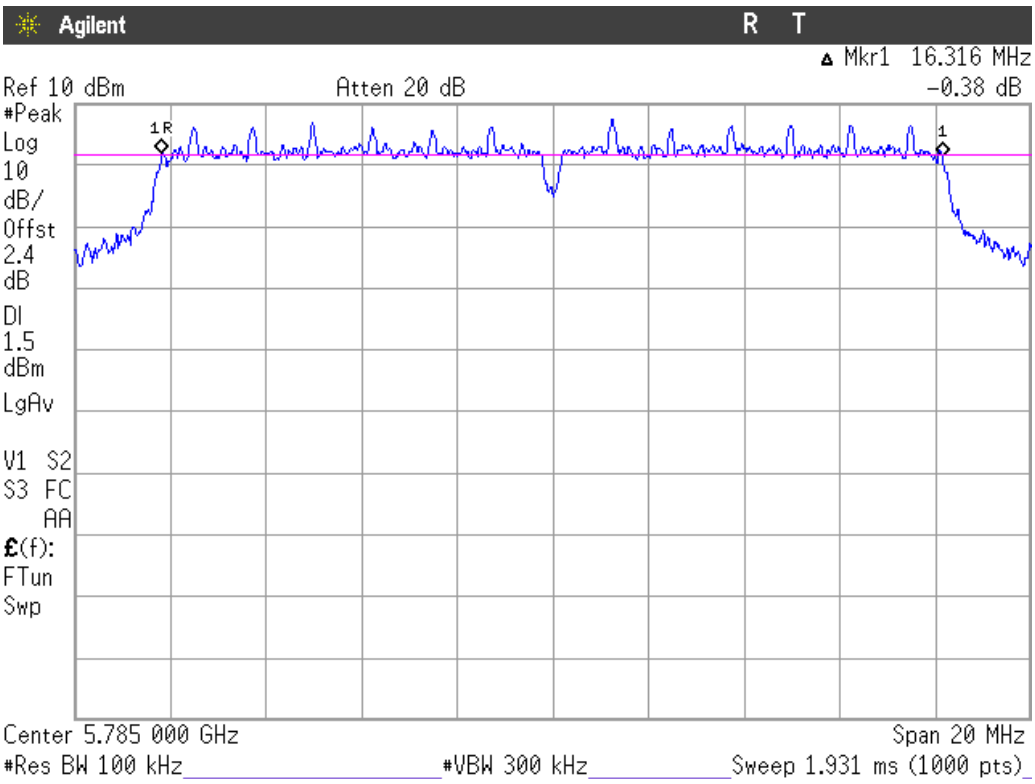
Verdict: PASS

1. WiFi 5GHz 802.11 a mode

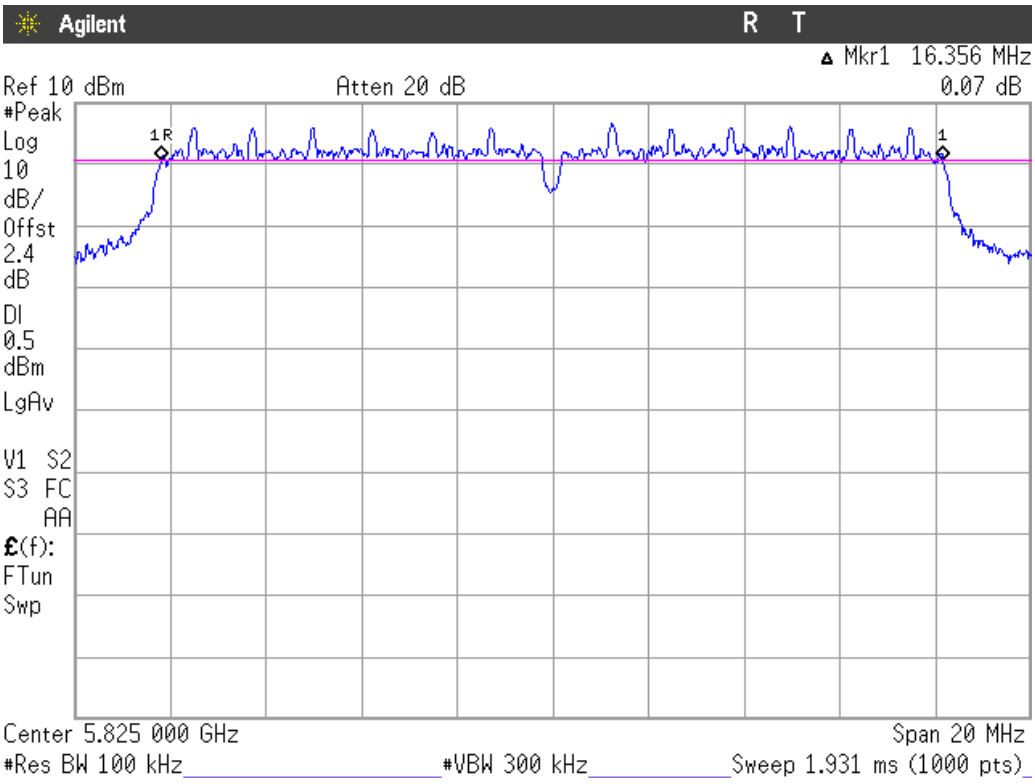
Lowest Channel: 5745 MHz.



Middle Channel: 5785 MHz.

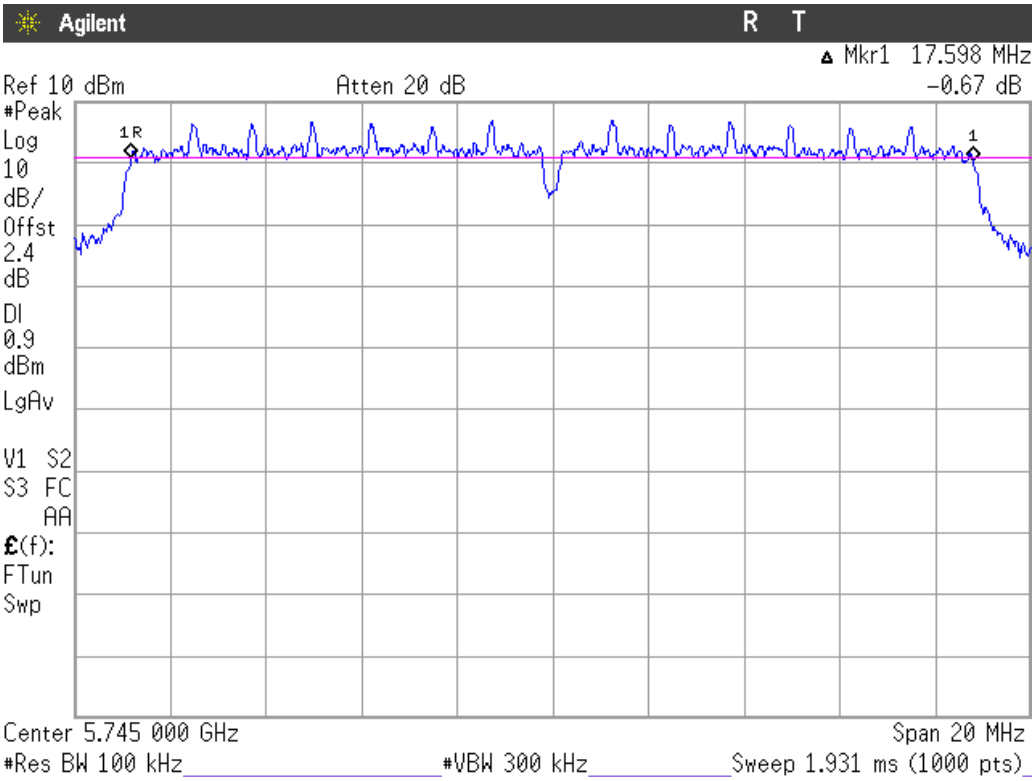


Highest Channel: 5825 MHz.

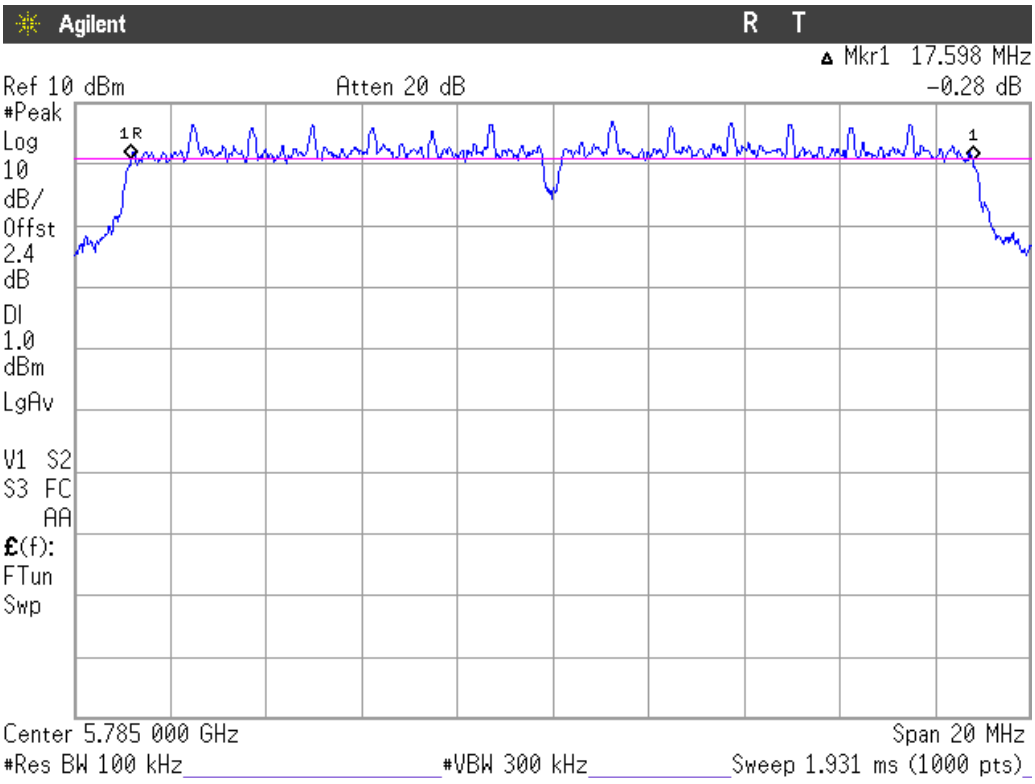


2. WiFi 5GHz 802.11 n20 mode

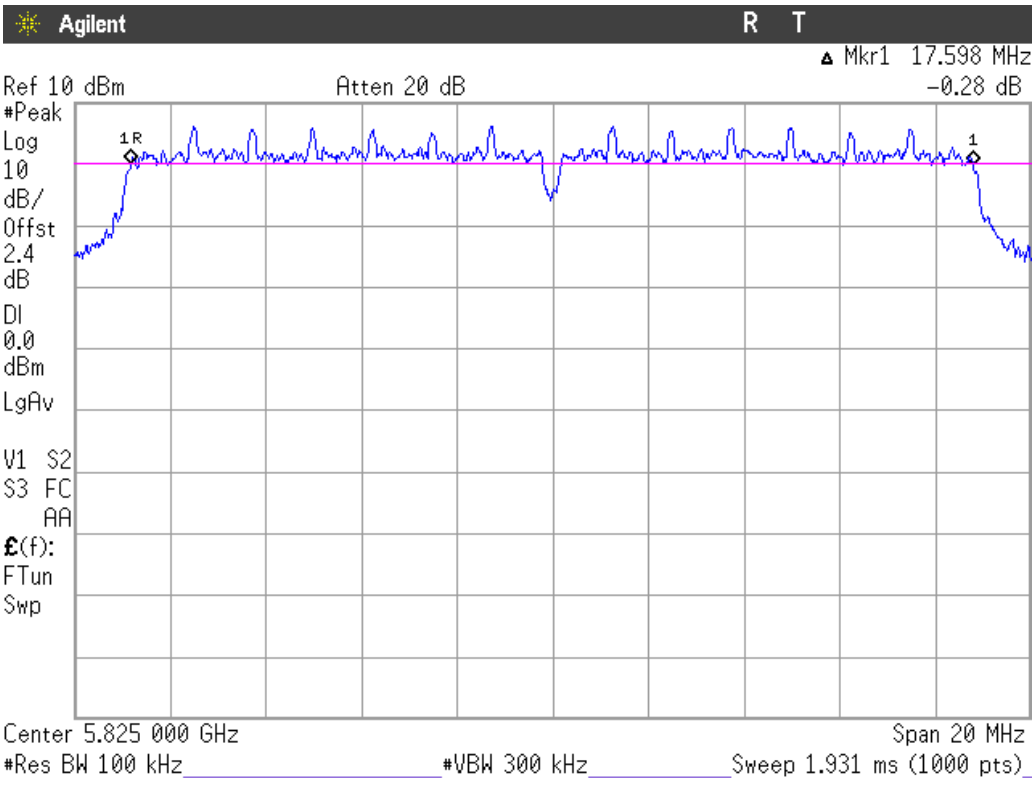
Lowest Channel: 5745 MHz.



Middle Channel: 5785 MHz.

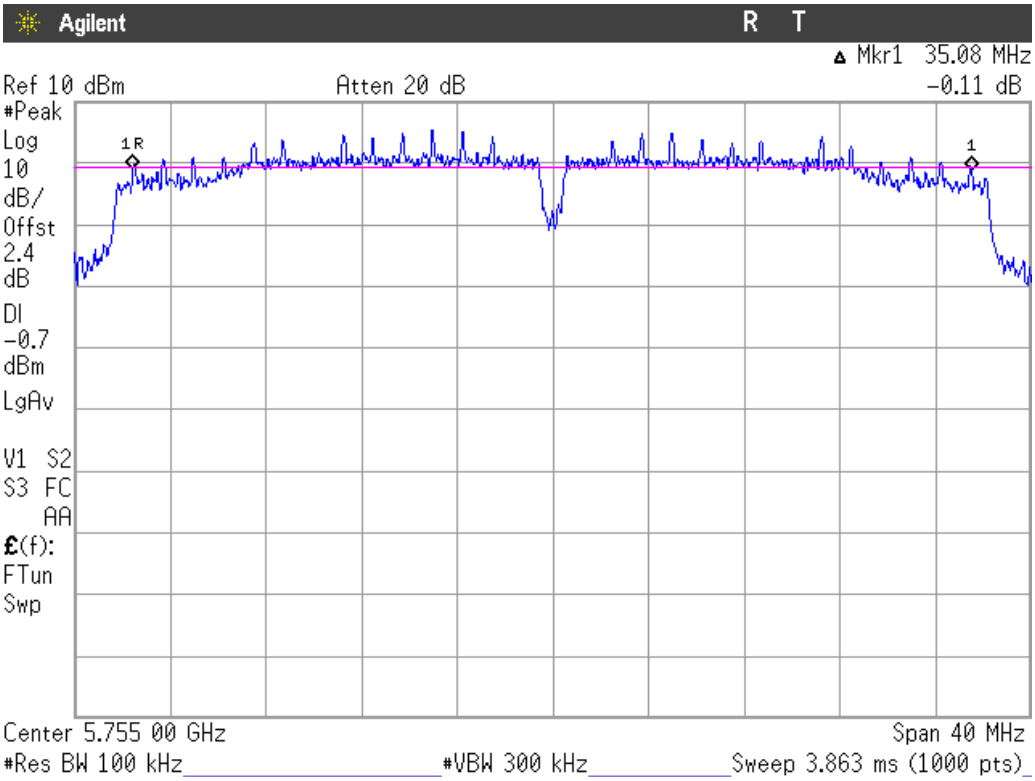


Highest Channel: 5825 MHz.

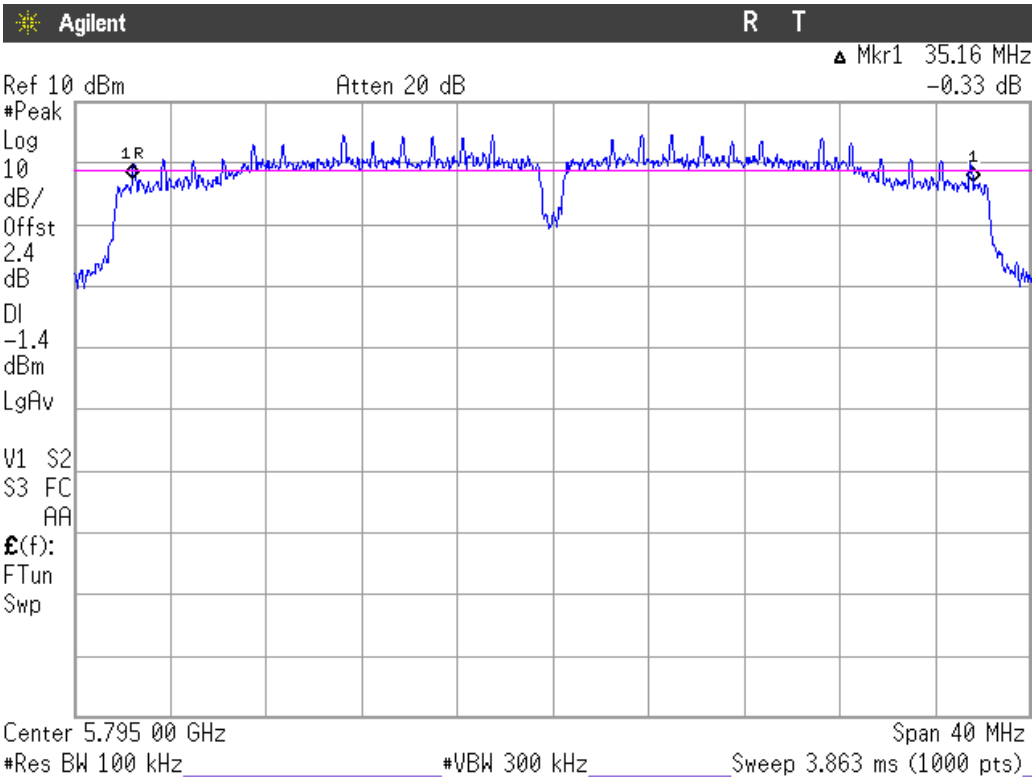


3. WiFi 5GHz 802.11 n40 mode

Lowest Channel: 5755 MHz.

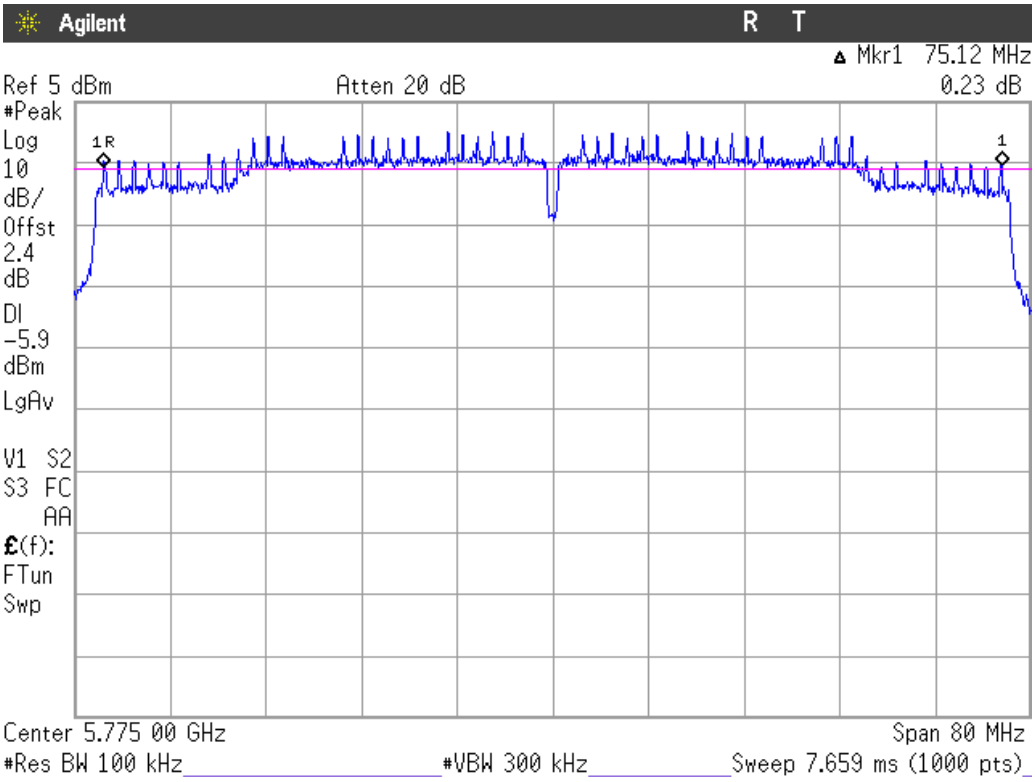


Highest Channel: 5795 MHz. Chain A



4. WiFi 5GHz 802.11 ac80 mode

Middle Channel: 5775 MHz. Chain A



Section 15.247 Subclause (b) / RSS-210 A8.4. (4). Maximum output power and antenna gain

SPECIFICATION

The maximum peak conducted output power of the intentional radiator shall not exceed 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 9.2.1.1. Option a) of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03 dated 08/04/2013.

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

MAXIMUM OUTPUT POWER. (See next plots of worst case: highest power).

Declared maximum antenna gain: 5 dBi.

1. WiFi 5GHz 802.11 a mode

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
Maximum conducted power (dBm)	16.80	16.70	16.64
Maximum EIRP power (dBm)	21.80	21.70	21.64
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

2. WiFi 5GHz 802.11 n20 mode

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
Maximum conducted power (dBm)	16.67	16.65	16.45
Maximum EIRP power (dBm)	21.67	21.65	21.45
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

3. WiFi 5GHz 802.11 n40 mode

	Lowest frequency 5755 MHz	Highest frequency 5795 MHz
Maximum conducted power (dBm)	16.66	16.72
Maximum EIRP power (dBm)	21.66	21.72
Measurement uncertainty (dB)	±1.5	

Verdict: PASS

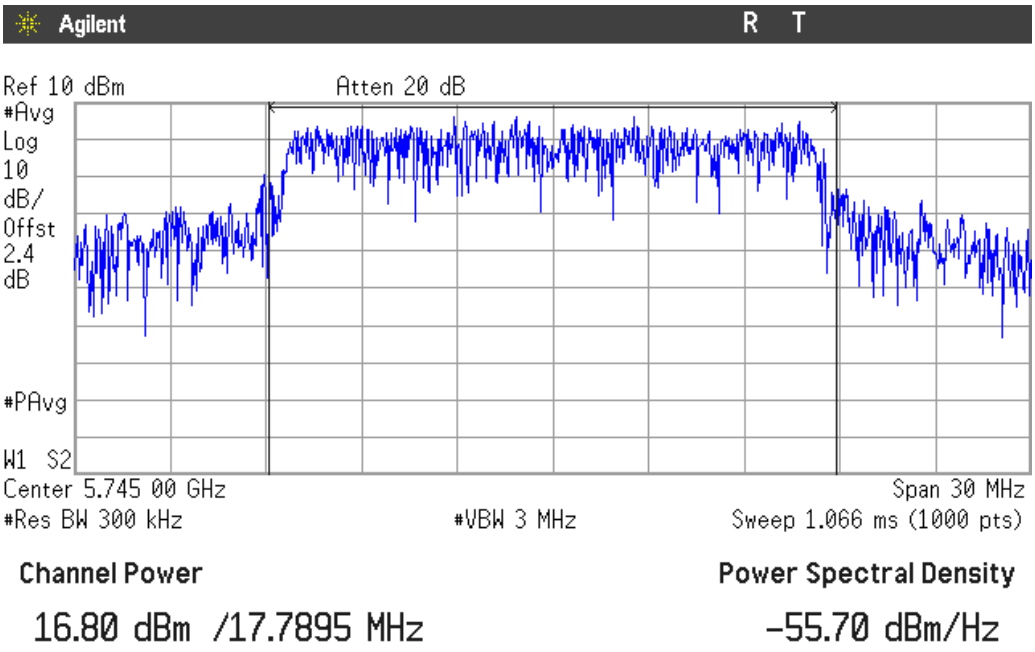
4. WiFi 5GHz 802.11 ac80 mode

	Middle frequency 5775 MHz
Maximum conducted power (dBm)	15.48
Maximum EIRP power (dBm)	20.48
Measurement uncertainty (dB)	±1.5

Verdict: PASS

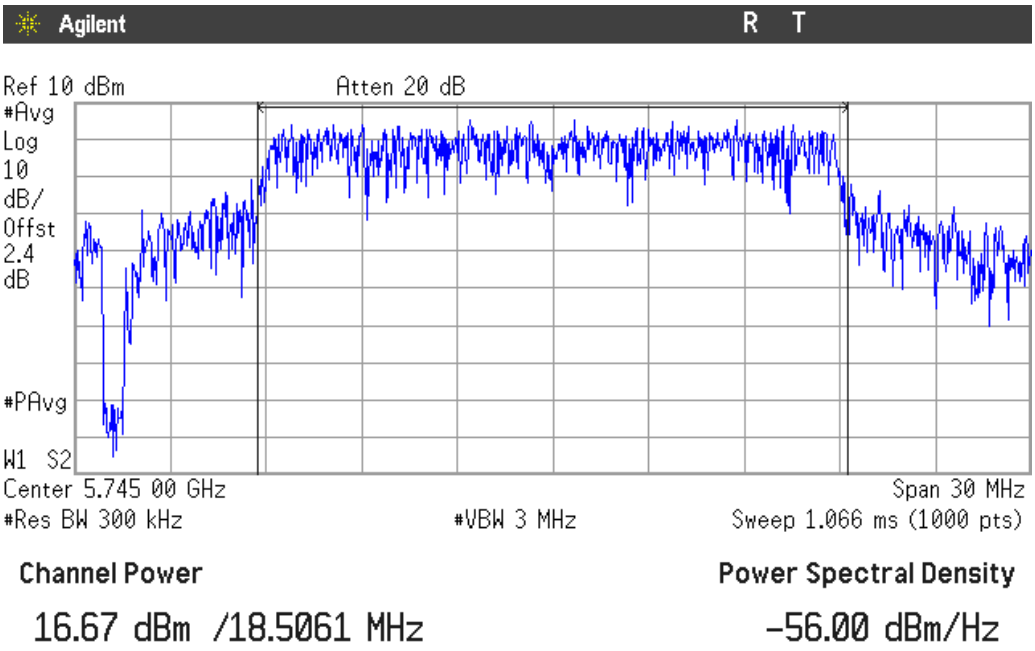
1. WiFi 5GHz 802.11 a mode

Lowest Channel: 5745 MHz.



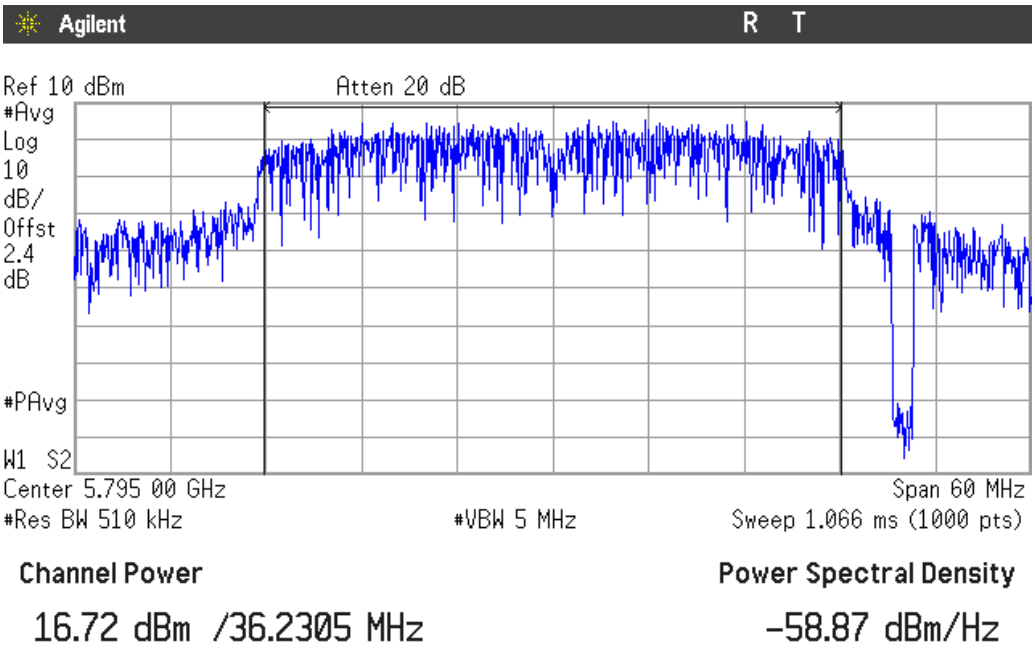
2. WiFi 5GHz 802.11 n20 mode

Lowest Channel: 5745 MHz.



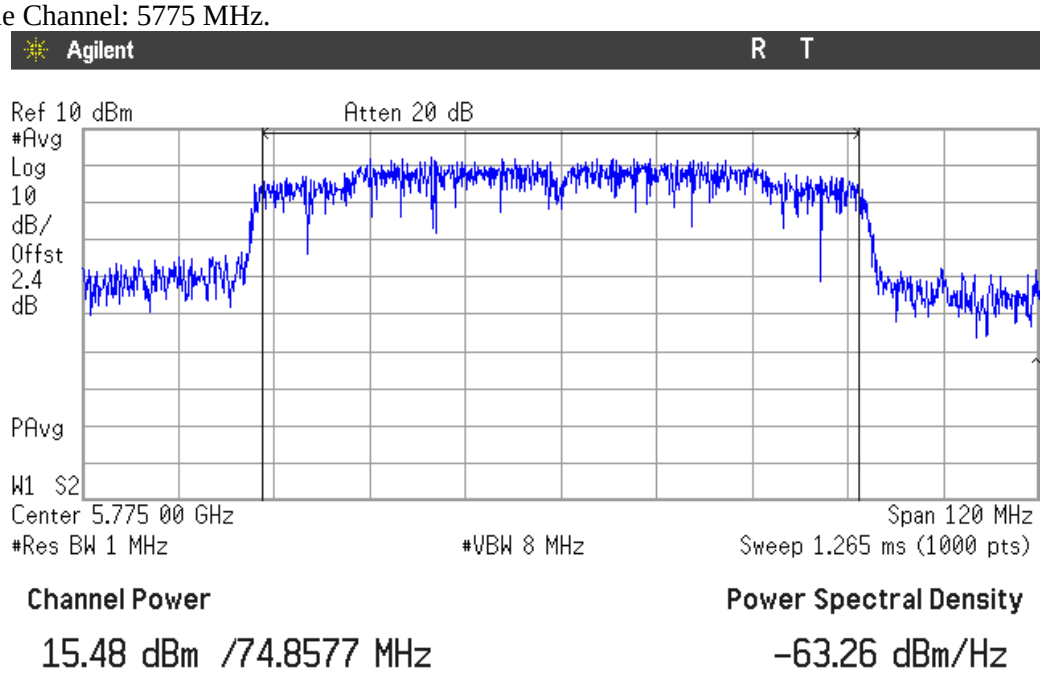
3. WiFi 5GHz 802.11 n40 mode

Highest Channel: 5795 MHz.



4. WiFi 5GHz 802.11 ac80 mode

Middle Channel: 5775 MHz.



Section 15.247 Subclause (d) / RSS-210 A8.5. 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

1. WiFi 5GHz 802.11 a mode

Reference Level Measurement

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
Reference Level Measurement (dBm)	7.74	7.16	6.08
Measurement uncertainty (dB)	±1.5		

Lowest frequency 5745 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-22.26

Middle frequency 5785 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-22.84

Highest frequency 5825 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-23.92

Verdict: PASS

2. WiFi 5GHz 802.11 n20 mode

Reference Level Measurement

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
Reference Level Measurement (dBm)	6.27	6.59	5.62
Measurement uncertainty (dB)	±1.5		

Lowest frequency 5745 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-23.73

Middle frequency 5785 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-23.41

Highest frequency 5825 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-24.38

Verdict: PASS

3. WiFi 5GHz 802.11 n40 mode

Reference Level Measurement

	Lowest frequency 5755 MHz	Highest frequency 5795 MHz
Reference Level Measurement (dBm)	4.14	4.68
Measurement uncertainty (dB)	±1.5	

Lowest frequency 5755 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-25.86

Highest frequency 5795 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-25.32

Verdict: PASS

4. WiFi 5GHz 802.11 ac80 mode

Reference Level Measurement

	Middle frequency 5775 MHz
Reference Level Measurement (dBm)	0.20
Measurement uncertainty (dB)	±1.5

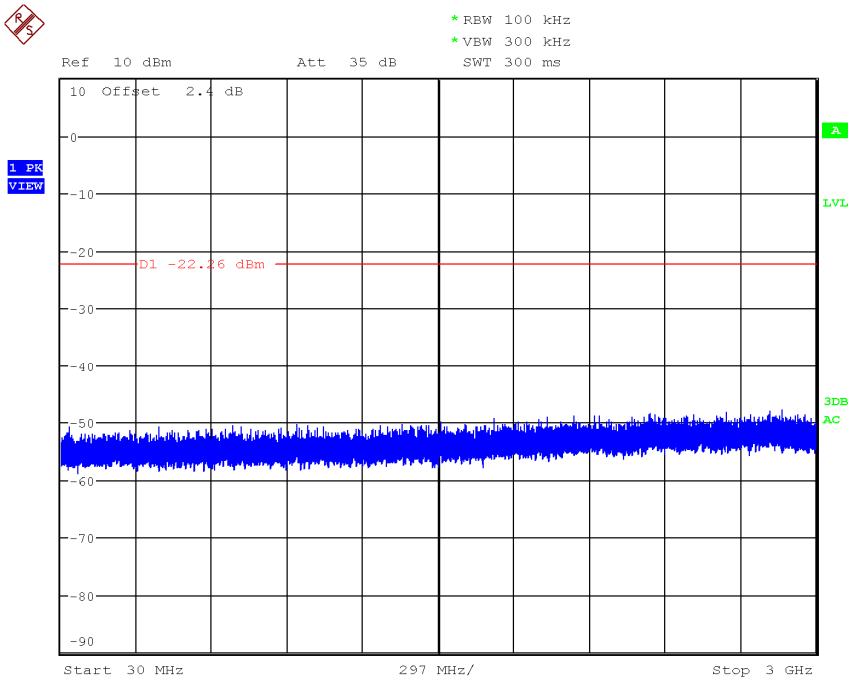
Middle frequency 5775 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-29.8

Verdict: PASS

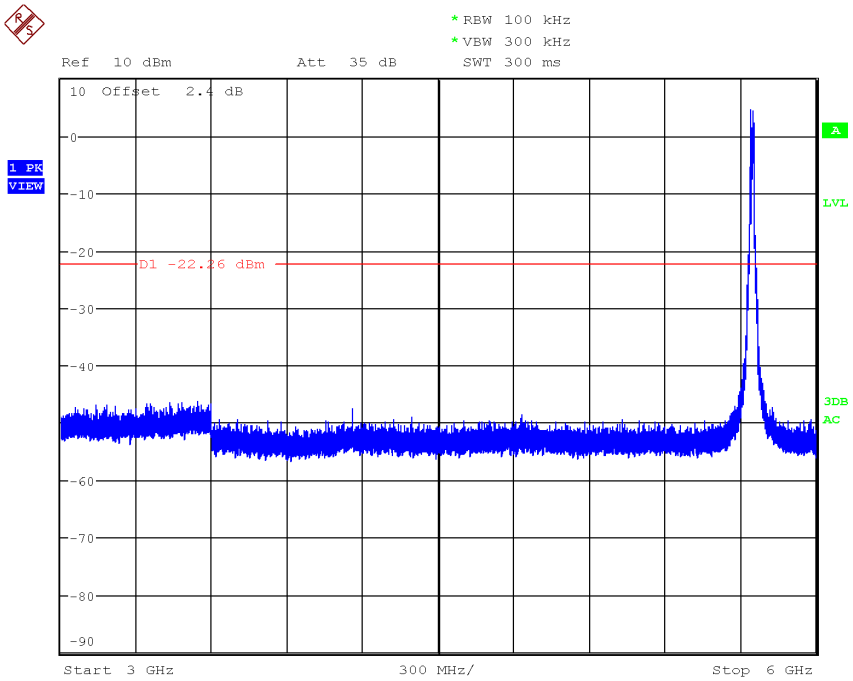
See next plot of worst case: Mode a. Lowest Channel: 5745 MHz.

Number of sweep points: 30,001.

Plot 30 MHz to 3 GHz:

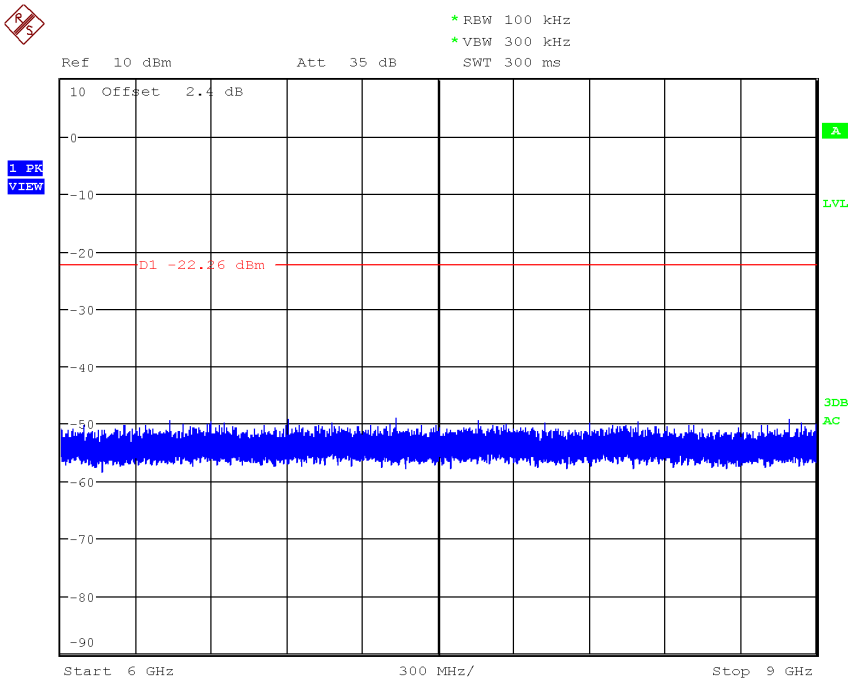


Plot 3 GHz to 6 GHz:

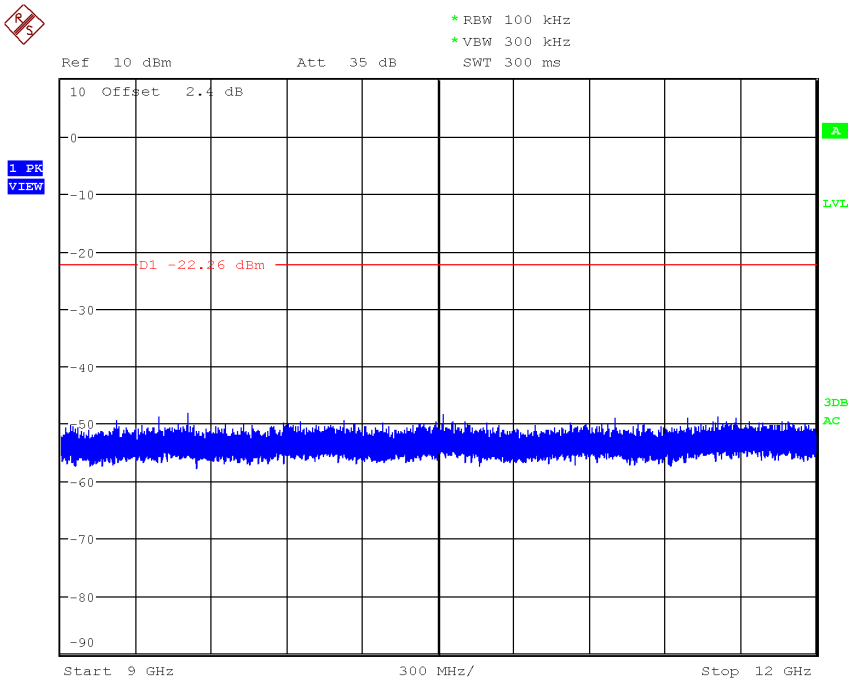


Note: The peak above the limit is the carrier frequency.

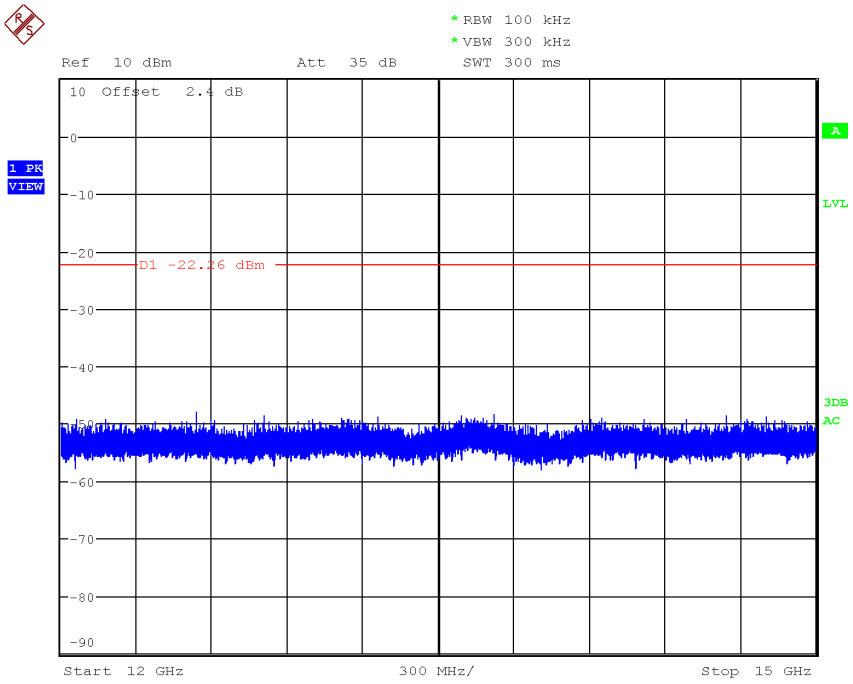
Plot 6 GHz to 9 GHz:



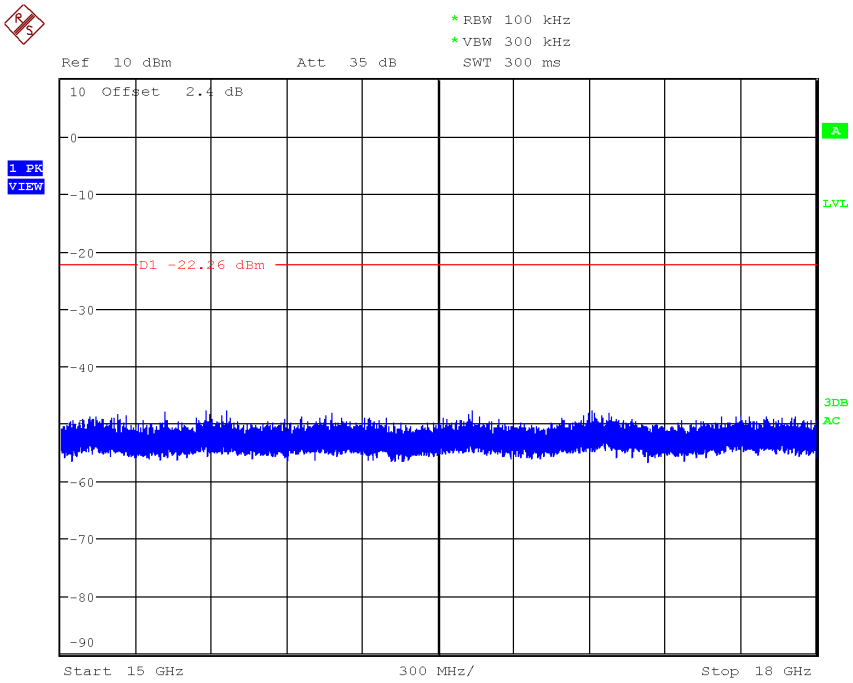
Plot 9 GHz to 12 GHz:



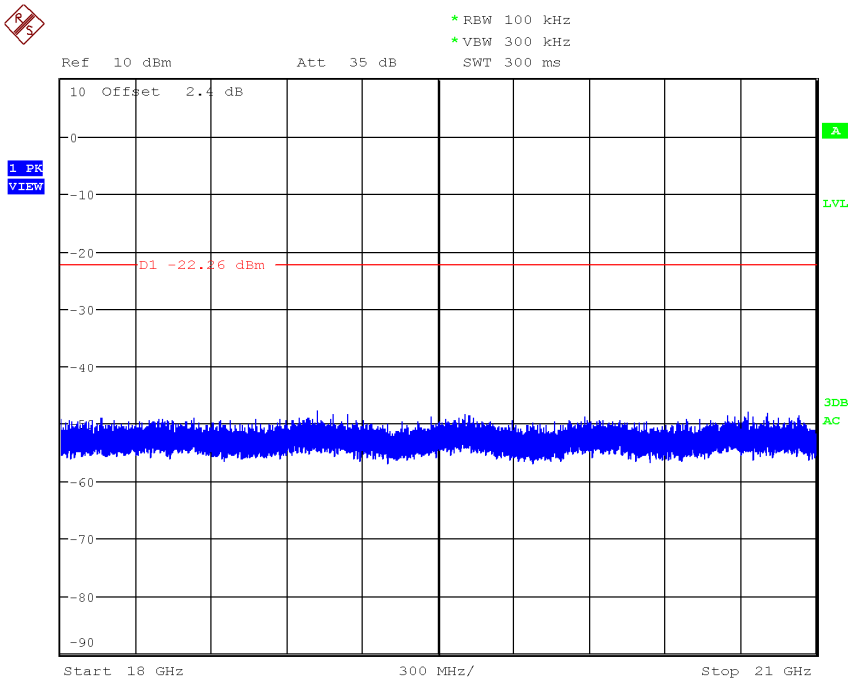
Plot 12 GHz to 15 GHz:



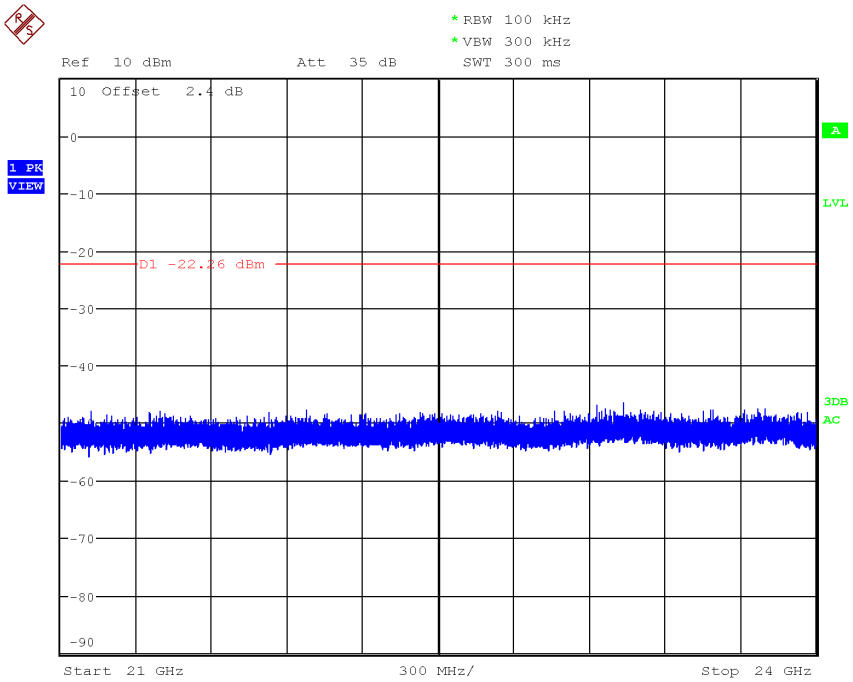
Plot 15 GHz to 18 GHz:



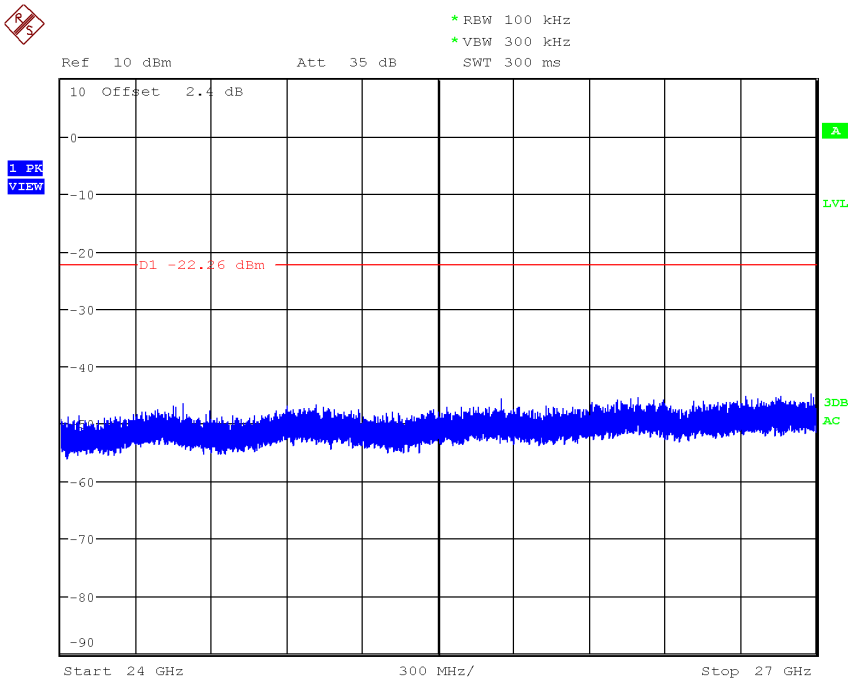
Plot 18 GHz to 21 GHz:



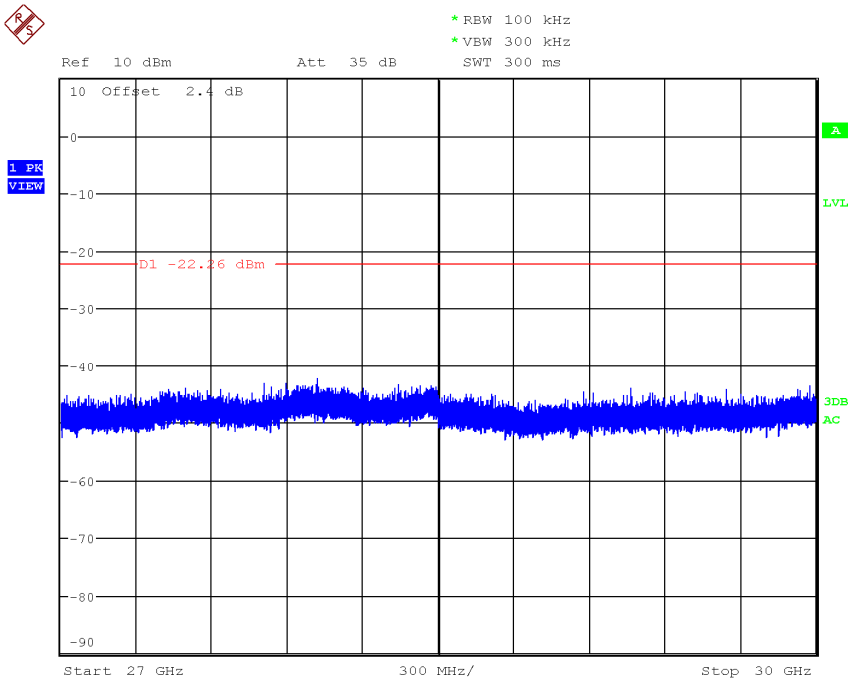
Plot 21 GHz to 24 GHz:



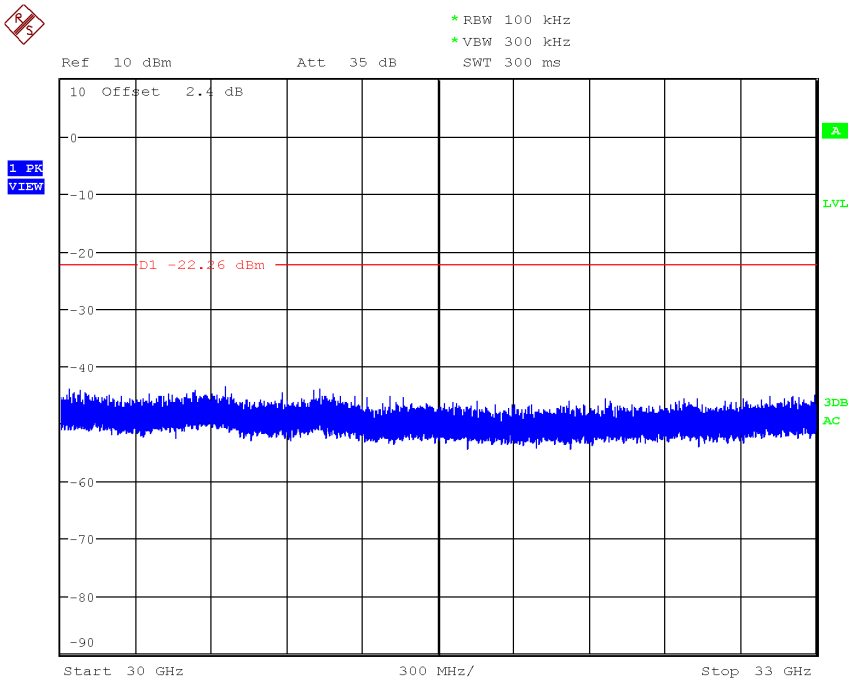
Plot 24 GHz to 27 GHz:



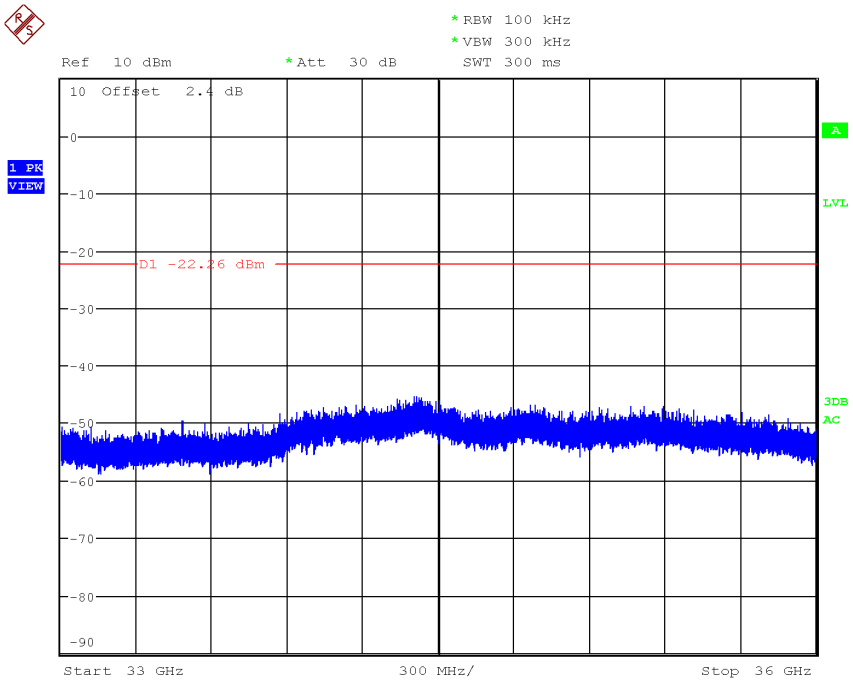
Plot 27 GHz to 30 GHz:



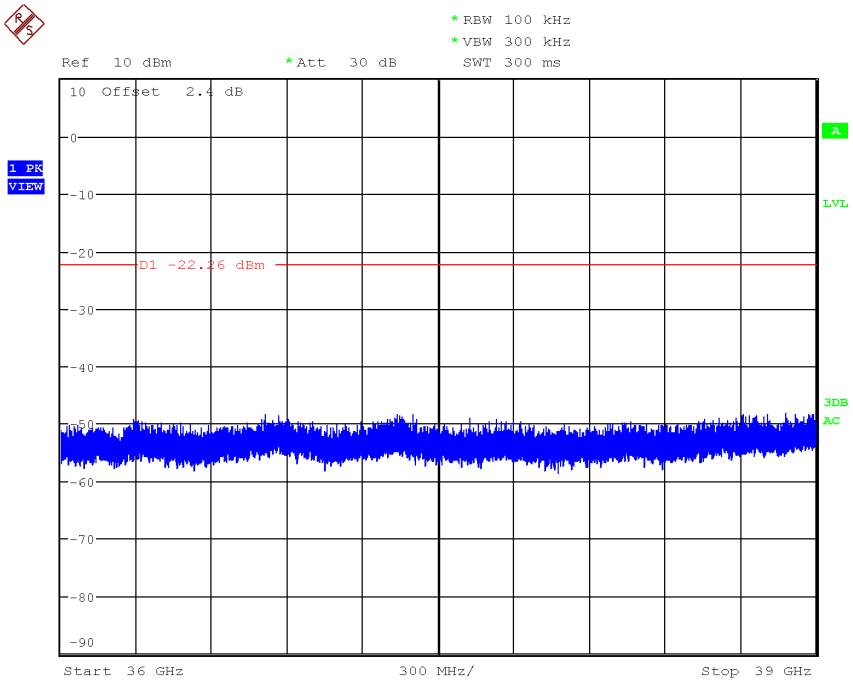
Plot 30 GHz to 33 GHz:



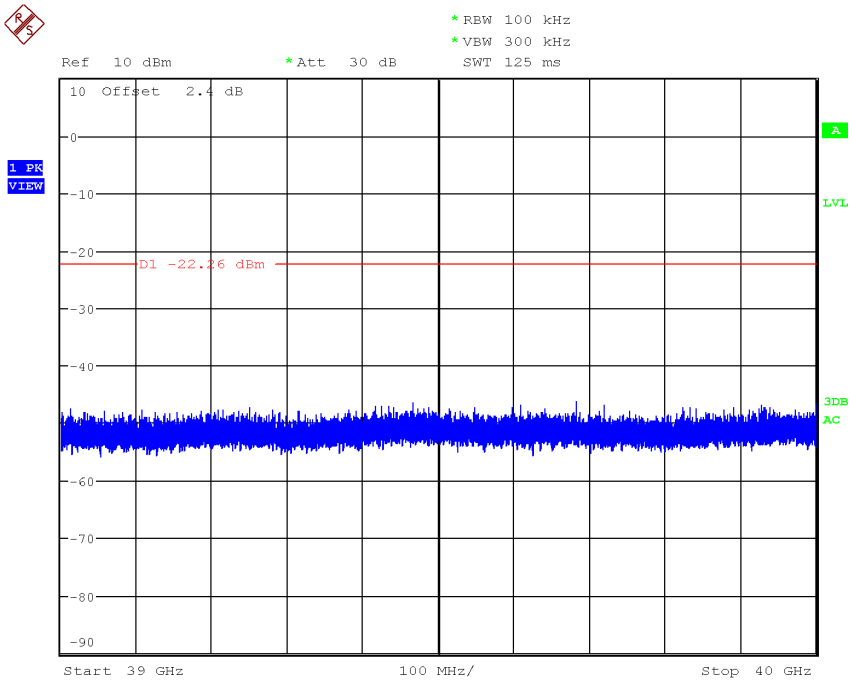
Plot 33 GHz to 36 GHz:



Plot 36 GHz to 39 GHz:



Plot 39 GHz to 40 GHz:



Section 15.247 Subclause (d) / RSS-210 A8.5. Band-edge emissions compliance (Transmitter)

SPECIFICATION

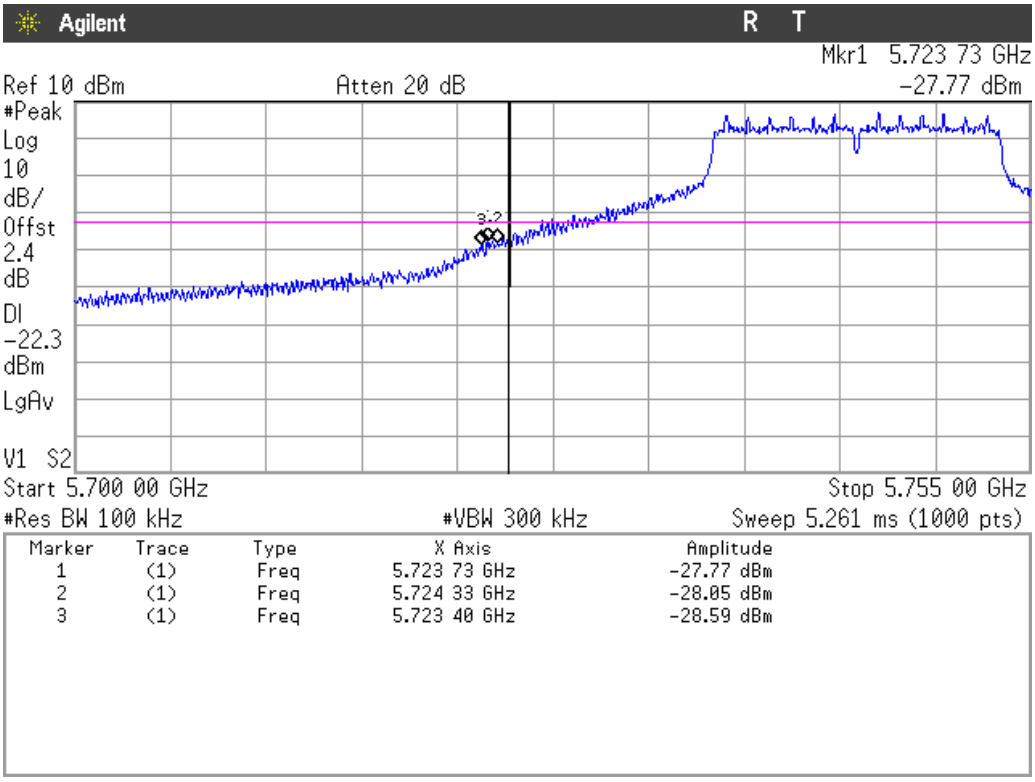
Emissions outside the frequency band in which the intentional radiator is operating shall be at least 20dB below the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be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

RESULTS:

1. WiFi 5GHz 802.11 a mode

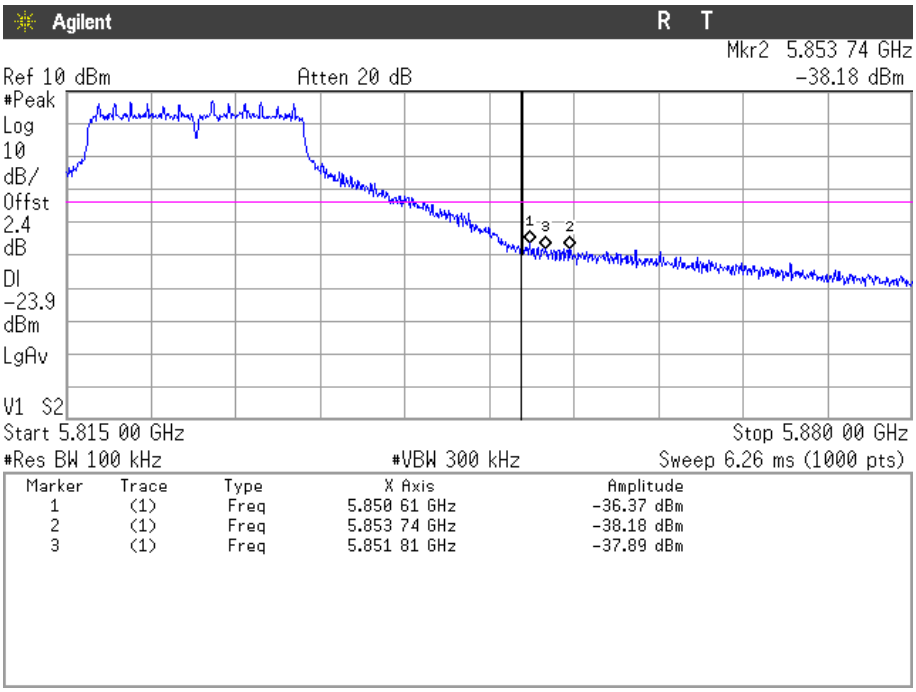
LOW FREQUENCY SECTION 5745 MHz. CONDUCTED.

See next plot.



HIGH FREQUENCY SECTION 5825 MHz. CONDUCTED.

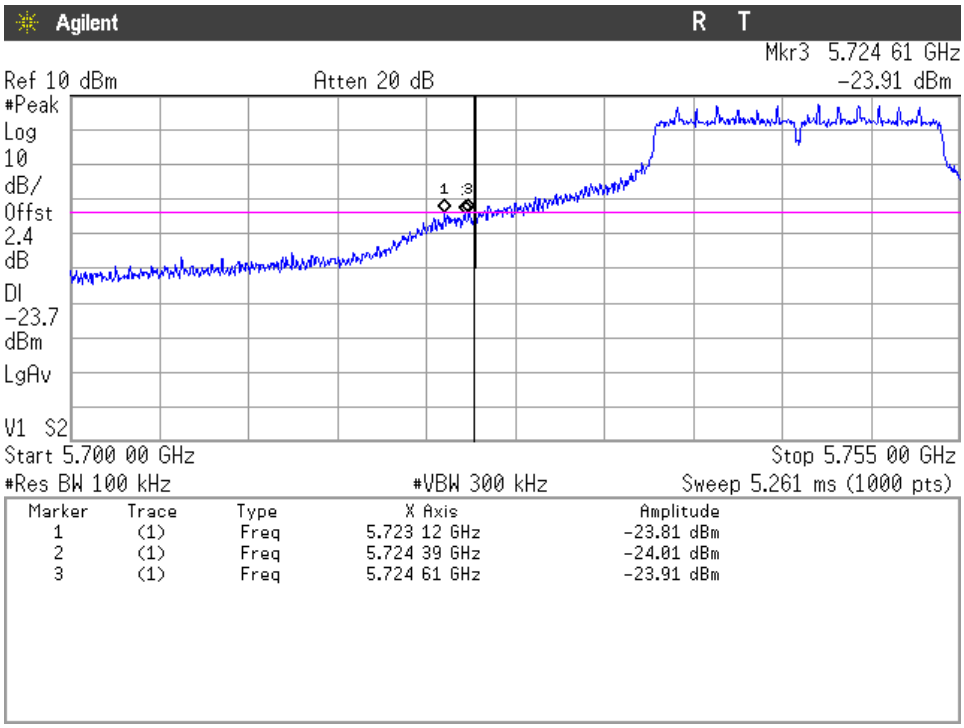
See next plot.



2. WiFi 5GHz 802.11 n20 mode

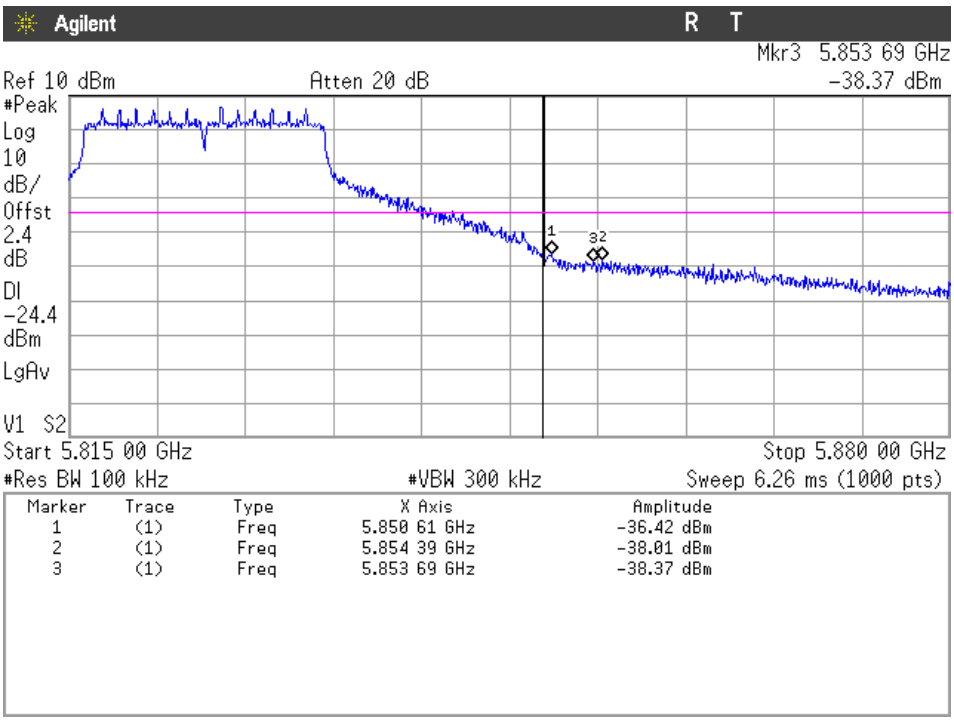
LOW FREQUENCY SECTION 5745 MHz. CONDUCTED.

See next plot.



HIGH FREQUENCY SECTION 5825 MHz. CONDUCTED.

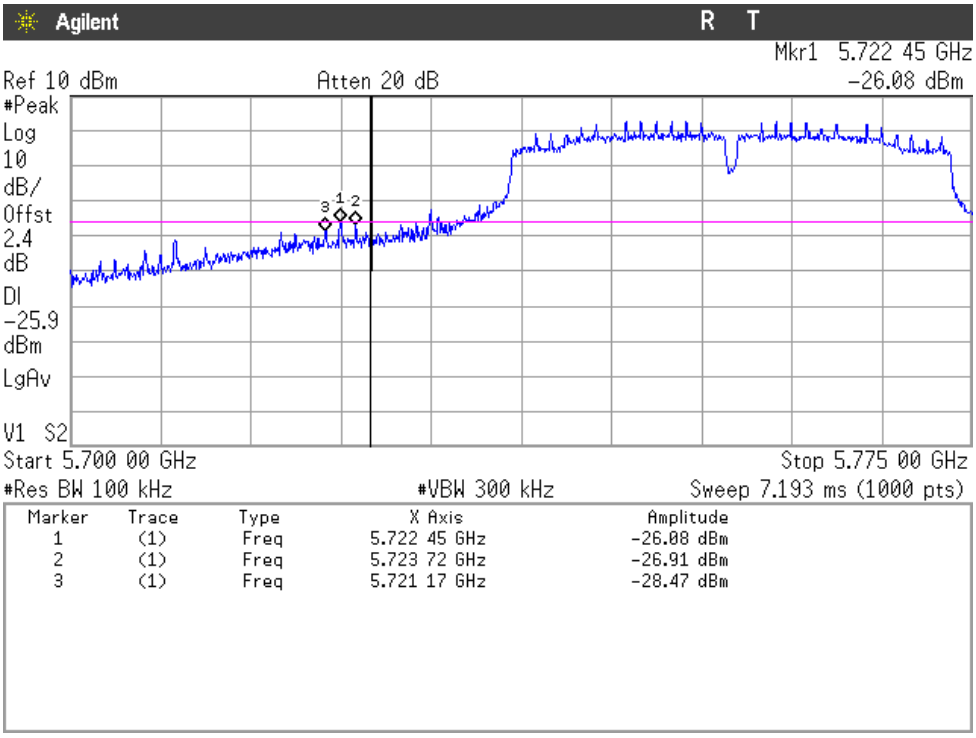
See next plot.



3. WiFi 5GHz 802.11 n40 mode

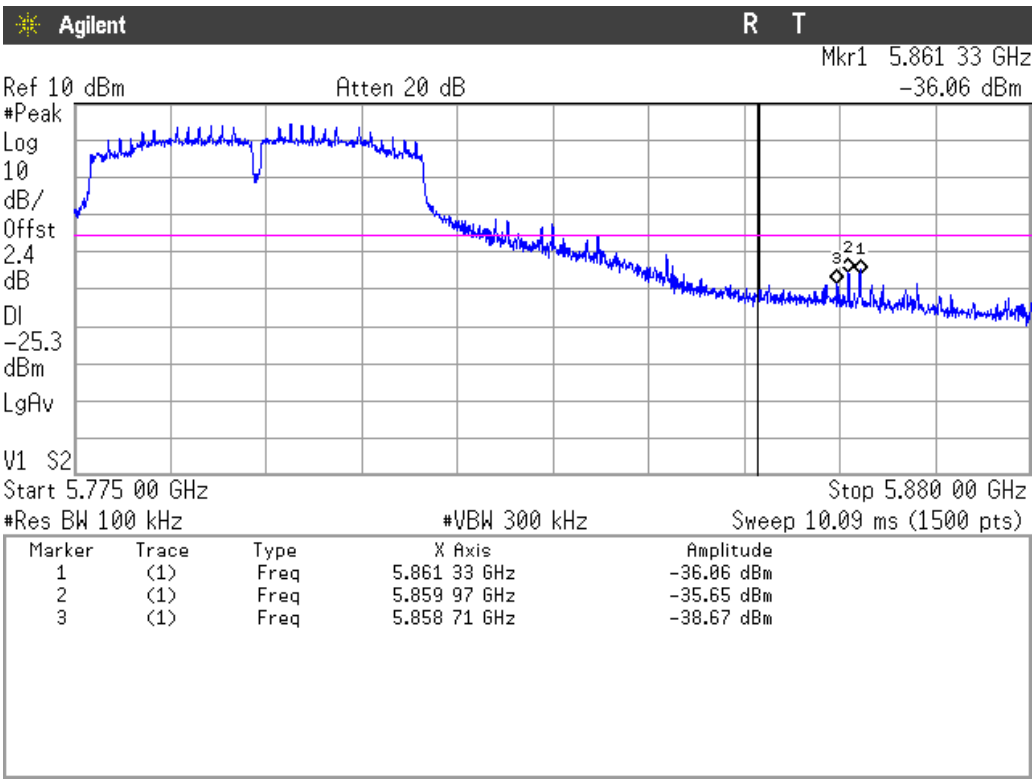
LOW FREQUENCY SECTION 5755 MHz. CONDUCTED.

See next plot.



HIGH FREQUENCY SECTION 5795 MHz. CONDUCTED.

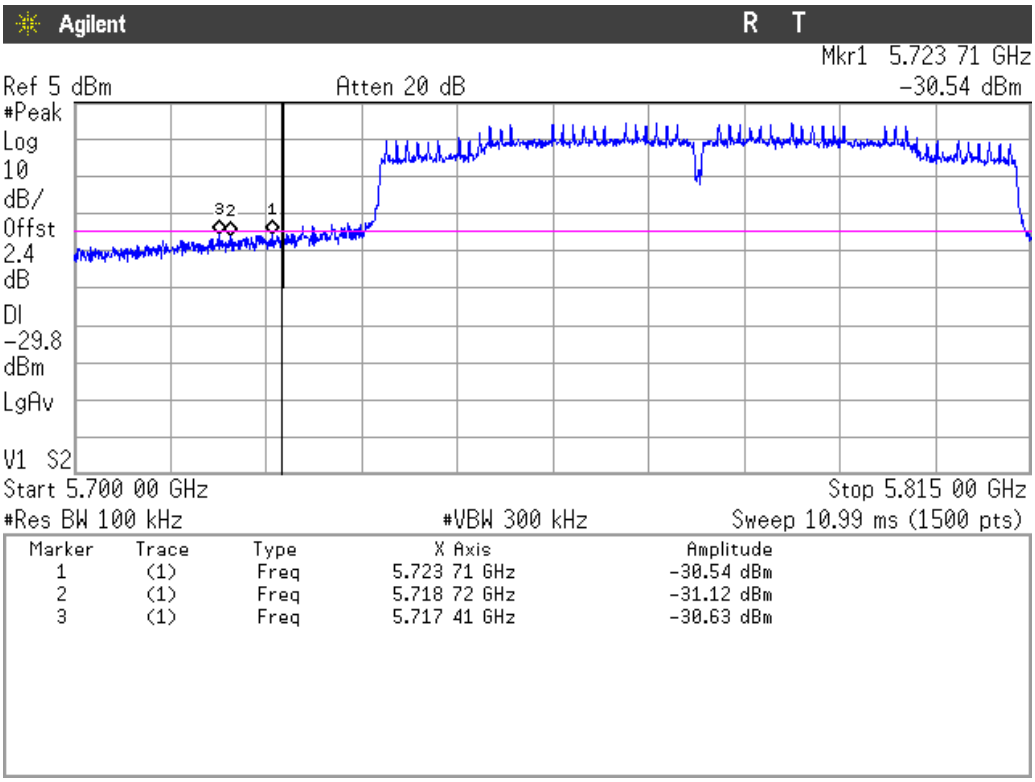
See next plot.



4. WiFi 5GHz 802.11 ac80 mode

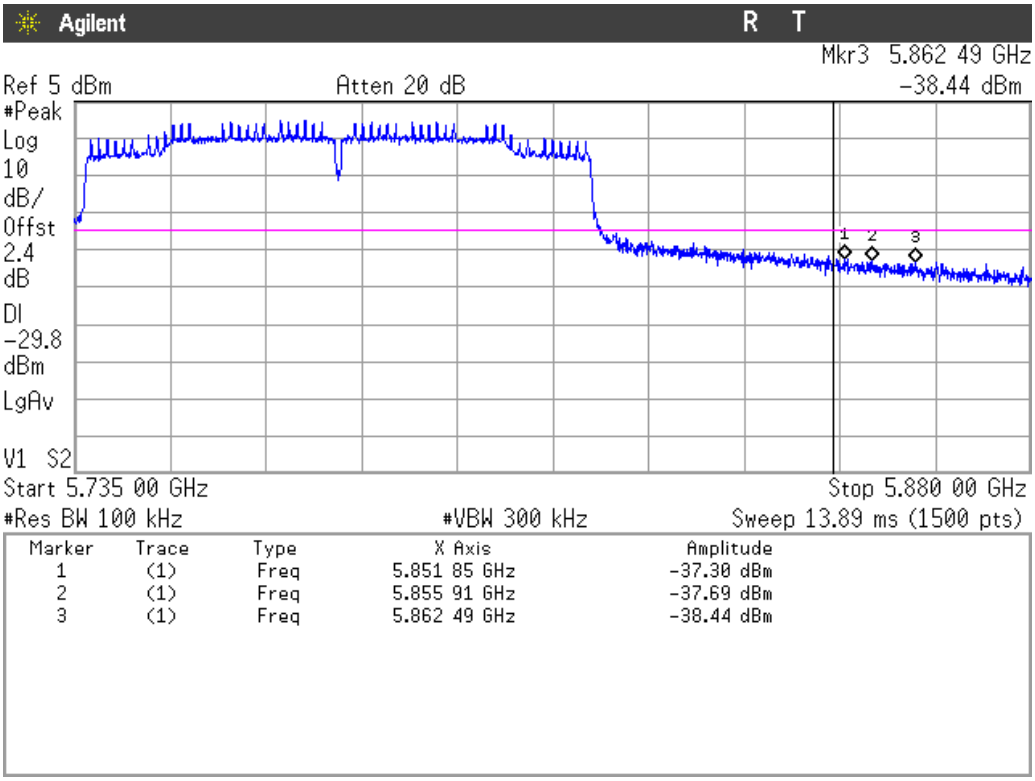
LOW FREQUENCY SECTION 5755 MHz. CONDUCTED.

See next plot.



HIGH FREQUENCY SECTION 5775 MHz. CONDUCTED.

See next plot.



Section 15.247 Subclause (e) / RSS-210 A8.5. 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 of trace averaging with EUT transmitting at full power throughout each sweep 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 v03 dated 08/04/2013.

1. WiFi 5GHz 802.11 a mode

Power spectral density (See next plot of worst case = highest level).

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
Power spectral density (dBm)	-2.92	-3.06	-2.96
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

2. WiFi 5GHz 802.11 n20 mode

Power spectral density (See next plot of worst case = highest level).

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
Power spectral density (dBm)	-3.43	-3.22	-3.64
Measurement uncertainty (dB)	±1.5		

Verdict: PASS

3. WiFi 5GHz 802.11 n40 mode

Power spectral density (See next plot of worst case = highest level).

	Lowest frequency 5755 MHz	Highest frequency 5795 MHz
Power spectral density (dBm)	-5.27	-4.90
Measurement uncertainty (dB)	±1.5	

Verdict: PASS

4. WiFi 5GHz 802.11 ac80 mode

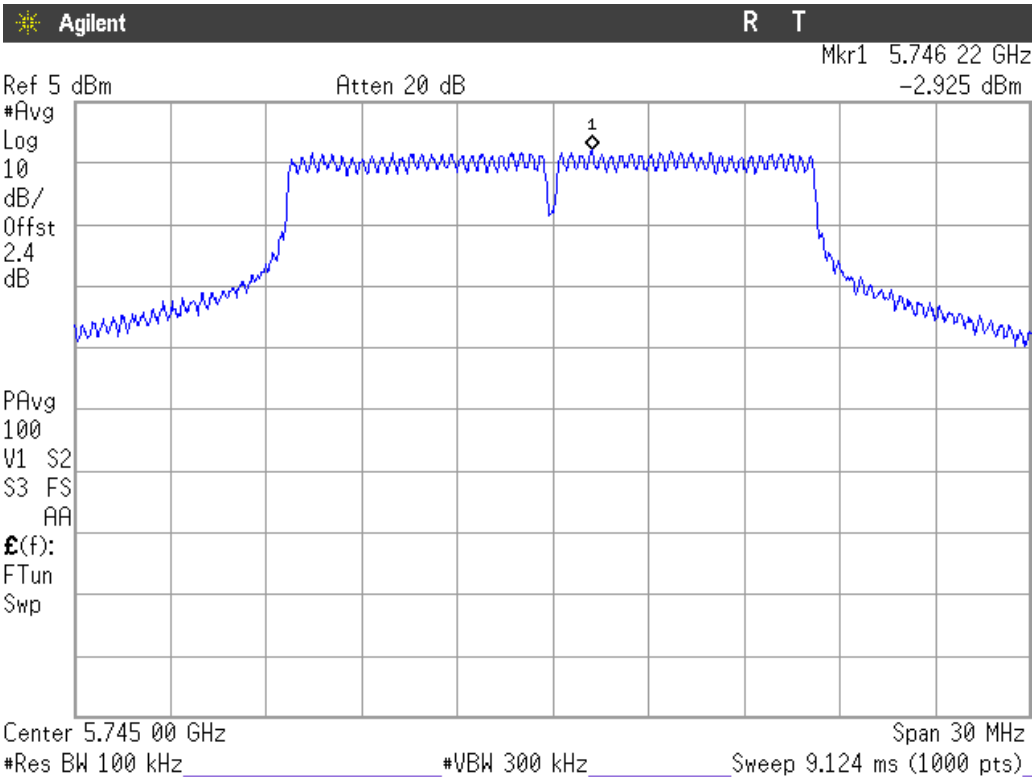
Power spectral density (See next plot of worst case = highest level).

	Middle frequency 5775 MHz
Power spectral density (dBm)	-9.78
Measurement uncertainty (dB)	±1.5

Verdict: PASS

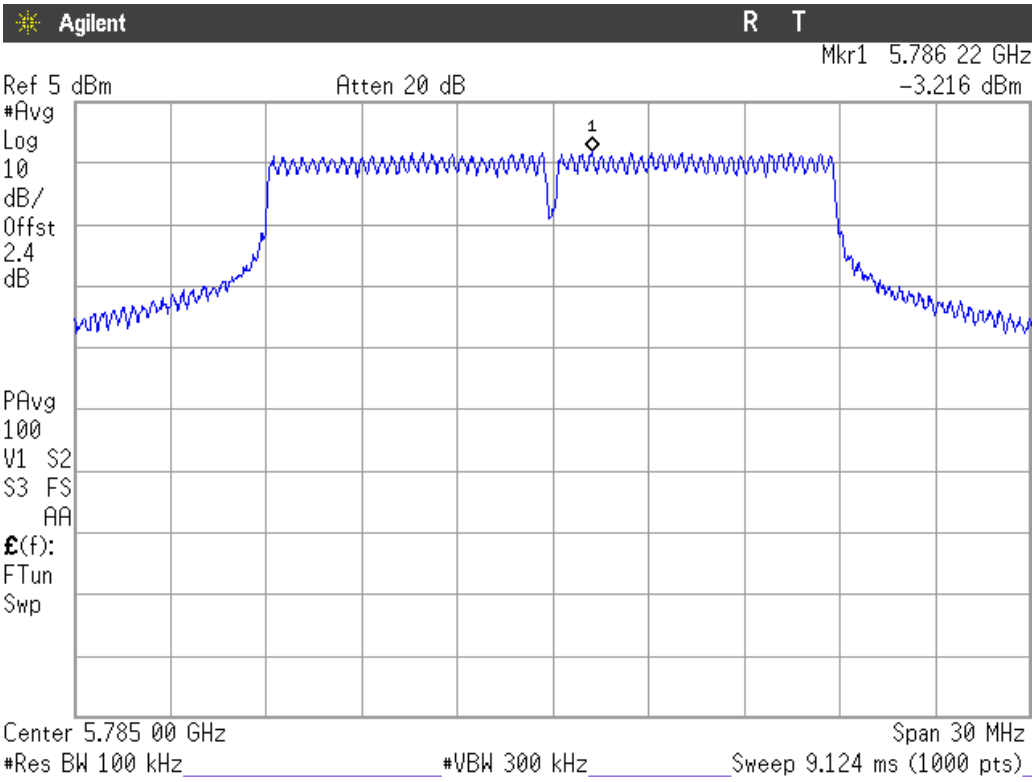
1. WiFi 5GHz 802.11 a mode

Lowest Channel: 5745 MHz.



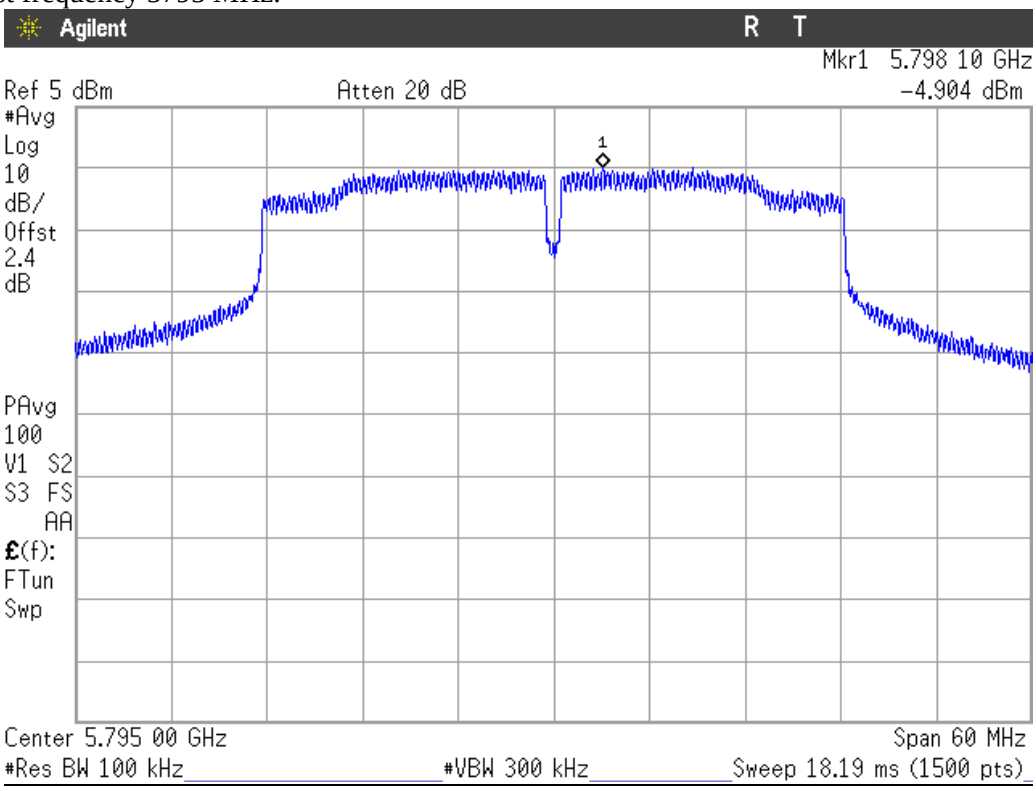
2. WiFi 5GHz 802.11 n20 mode

Middle Channel: 5785 MHz.



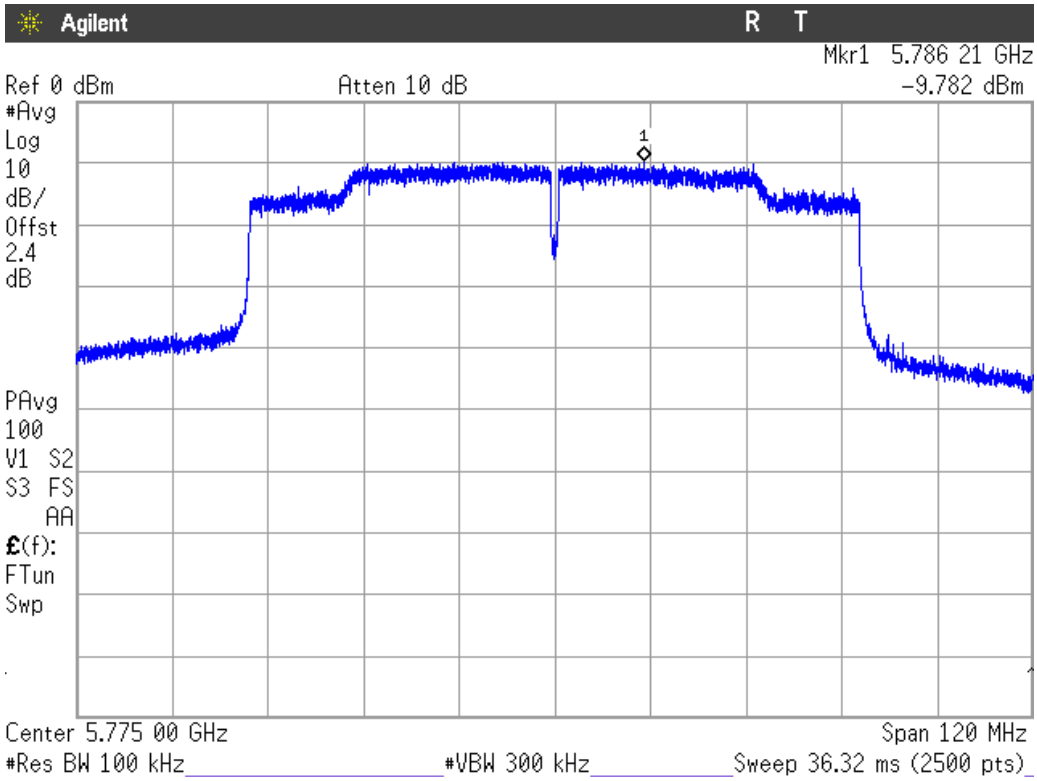
3. WiFi 5GHz 802.11 n40 mode

Highest frequency 5795 MHz.



4. WiFi 5GHz 802.11 ac80 mode

Middle frequency 5775 MHz. Chain A.



Section 15.247 Subclause (d) / RSS-210 A8.5. Emission limitations radiated (Transmitter)

SPECIFICATION

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)):

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 40000	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-40 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.

The equipment transmits continuously in the selected channel so it is not necessary a duty cycle correction factor.

Frequency range 30 MHz-1000 MHz.

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

See test results in Appendix A for details.

Frequency range 1 GHz-40 GHz.

For the 4 OFDM modulation modes (802.11a, 802.11n20, 802.11n40 a 802.11ac80), a preliminary measurement in the central channel was performed in the range 1-26 GHz to determine the worst case. The lowest and highest channels were measured for out-of-band emissions for the worst case (802.11a).

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. WiFi 5GHz 802.11 a mode

Lowest frequency 5745 MHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.49650	V	Peak	48.98	± 4.09

Middle frequency 5785 MHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.57000	V	Peak	50.94	± 4.09
17.35439	V	Peak	47.45	± 4.09
23.14003	V	Peak	48.10	± 4.09

Highest frequency 5825 MHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.65175	V	Peak	53.04	± 4.09

2. WiFi 5GHz 802.11 n20 mode

Middle frequency 5785 MHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.5790	V	Peak	48.43	± 4.09
23.13999	V	Peak	47.93	± 4.09

3. WiFi 5GHz 802.11 n40 mode

Highest frequency 5795 MHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.5885	V	Peak	50.37	± 4.09
23.179955	V	Peak	47.47	± 4.09

4. WiFi 5GHz 802.11 ac80 mode

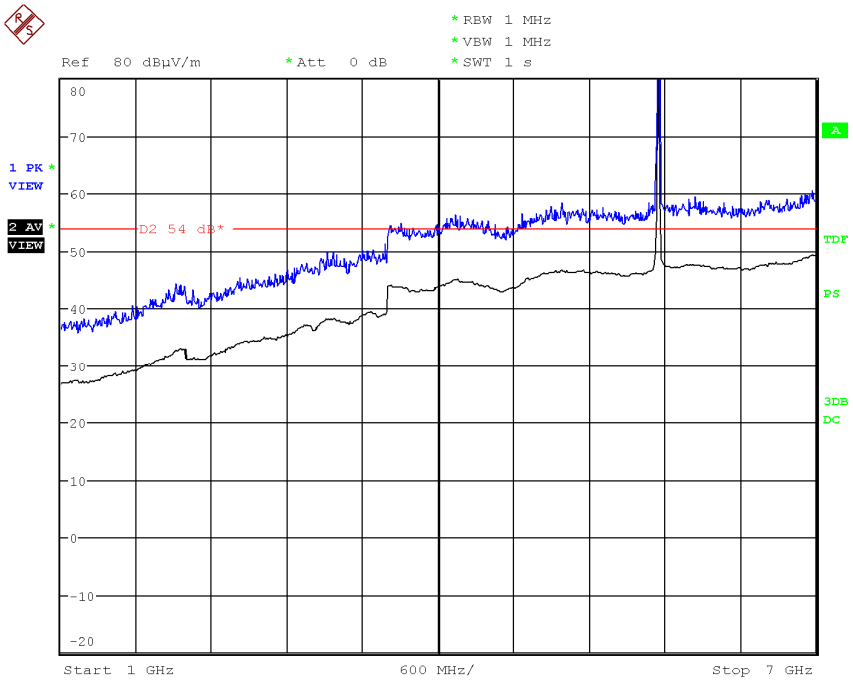
Middle frequency 5775 MHz

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
23.09993	V	Peak	48.22	± 4.09

FREQUENCY RANGE 1 GHz to 7 GHz.

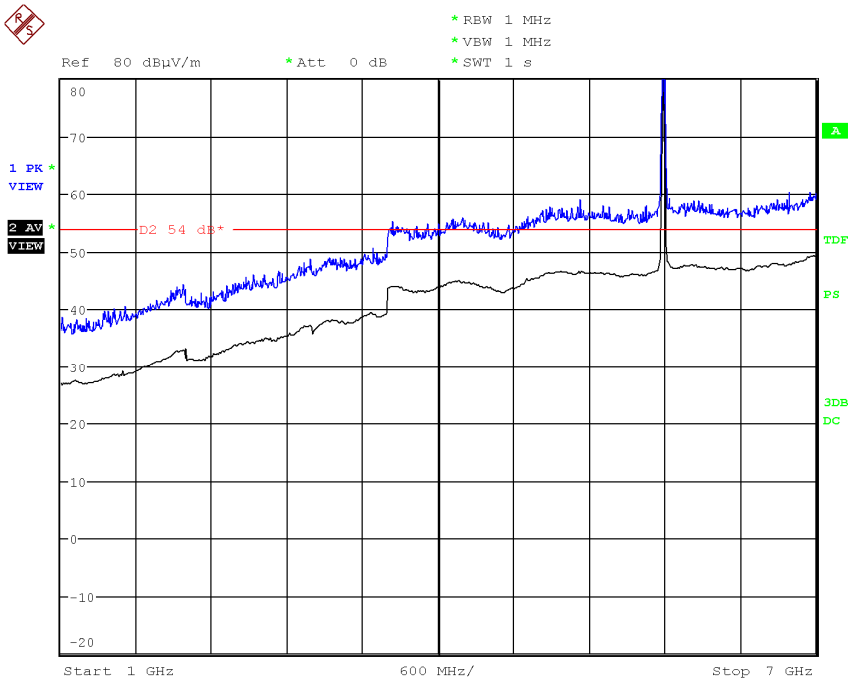
1. WiFi 5GHz 802.11 a mode

Lowest Channel: 5745 MHz.



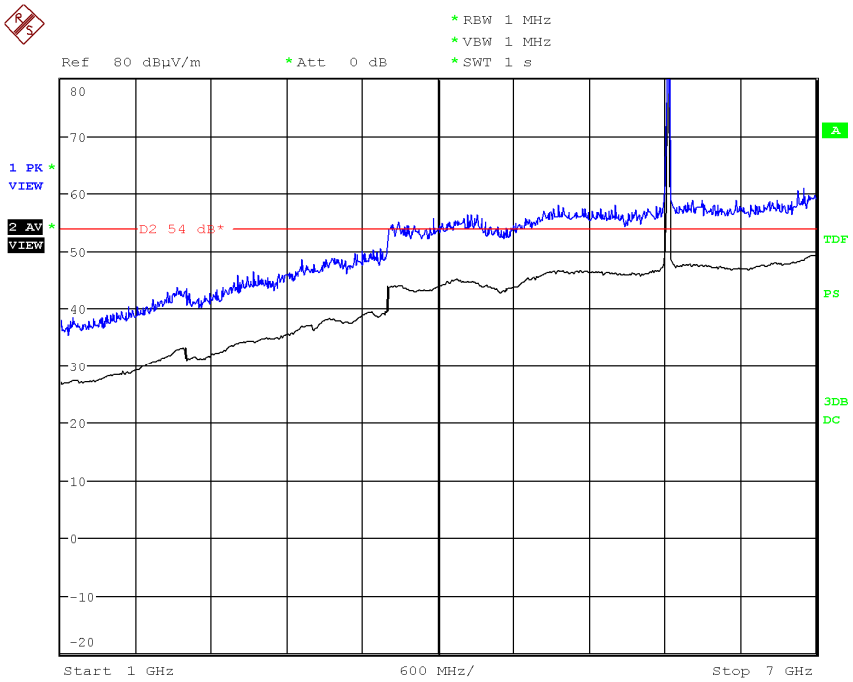
Note: The peak above the limit is the carrier frequency.

Middle Channel: 5785 MHz.



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

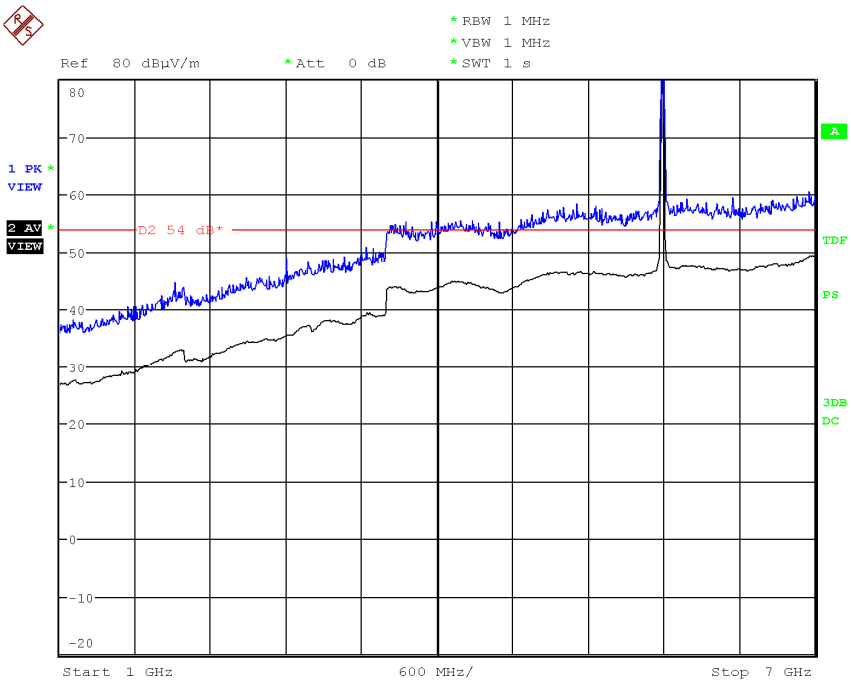
Highest Channel: 5825 MHz.



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

2. WiFi 5GHz 802.11 n20 mode

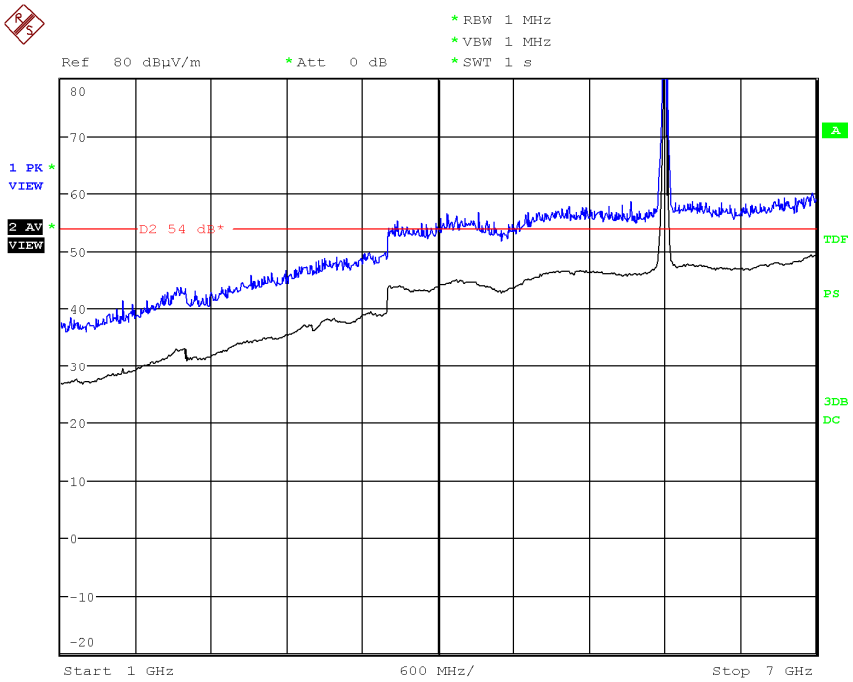
Middle Channel: 5785 MHz.



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

3. WiFi 5GHz 802.11 n40 mode

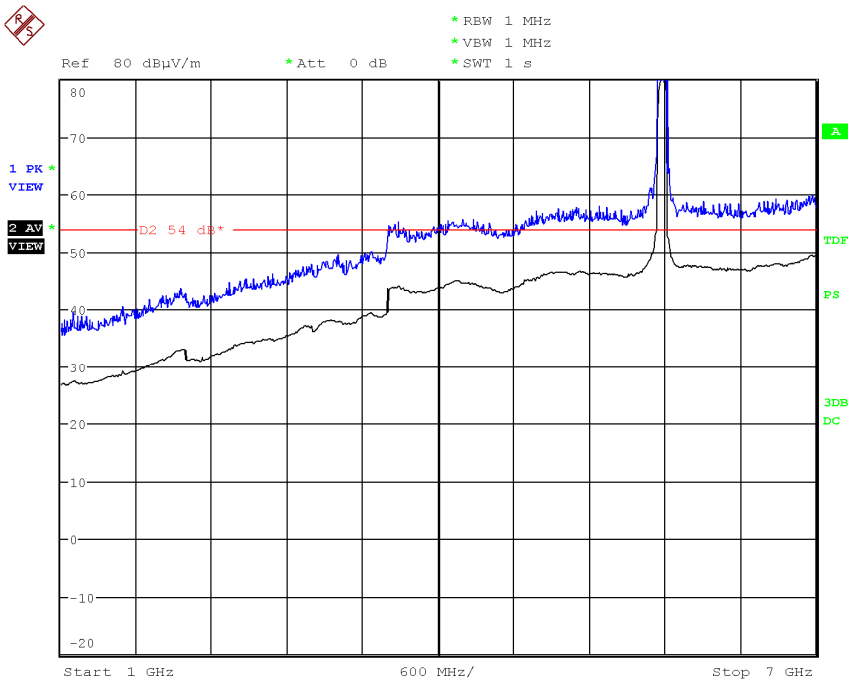
Highest Channel: 5795 MHz.



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

4. WiFi 5GHz 802.11 ac80 mode

Middle Channel: 5775 MHz.

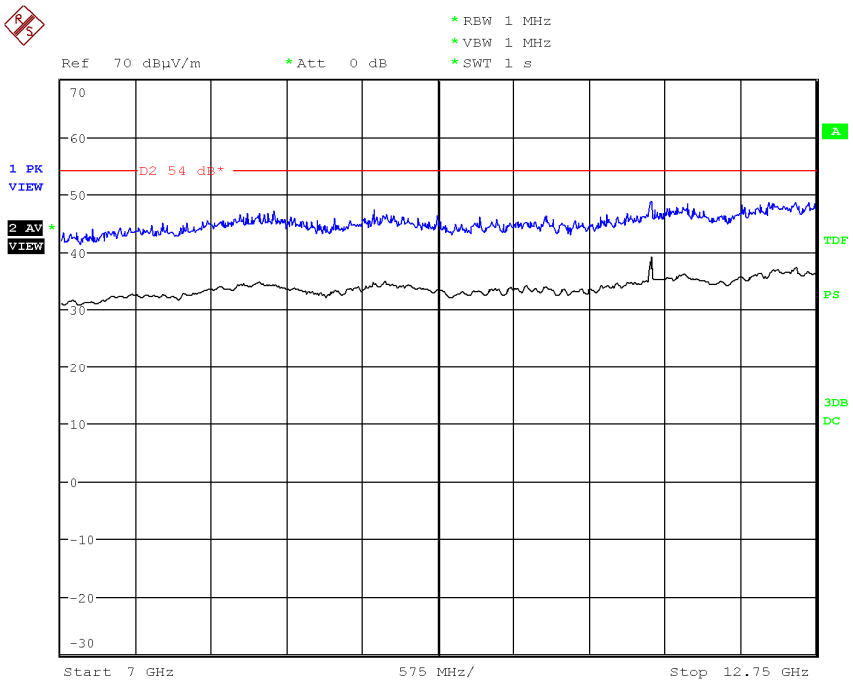


Note: The peak above the limit is the carrier frequency.

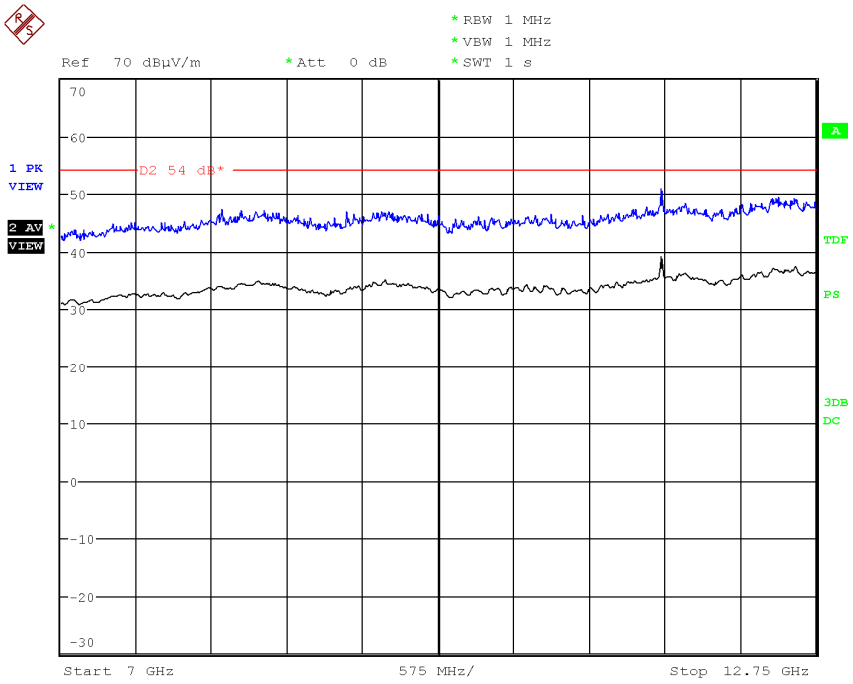
FREQUENCY RANGE 7 GHz to 12 GHz.

1. WiFi 5GHz 802.11 a mode

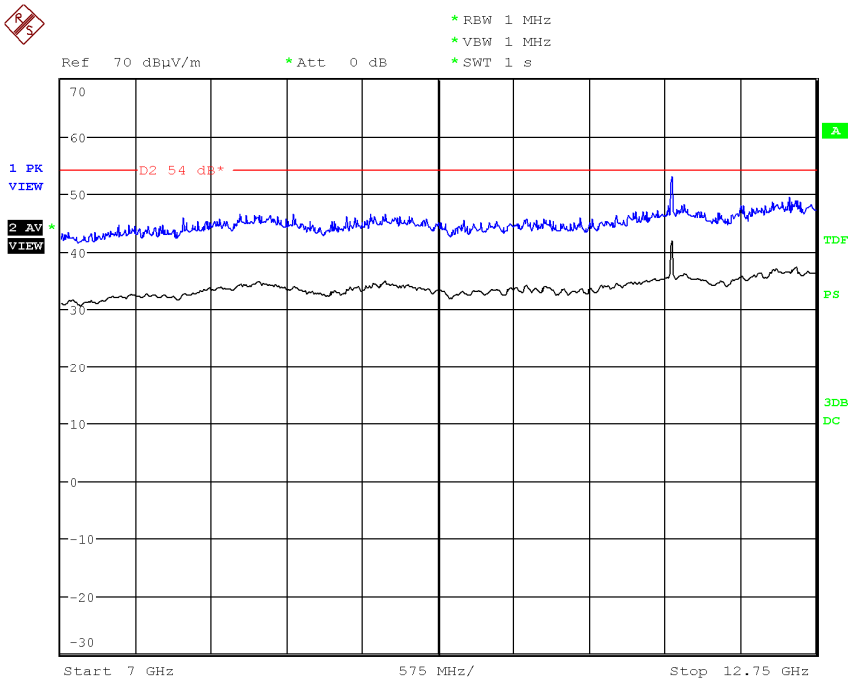
Lowest Channel: 5745 MHz.



Middle Channel: 5785 MHz.

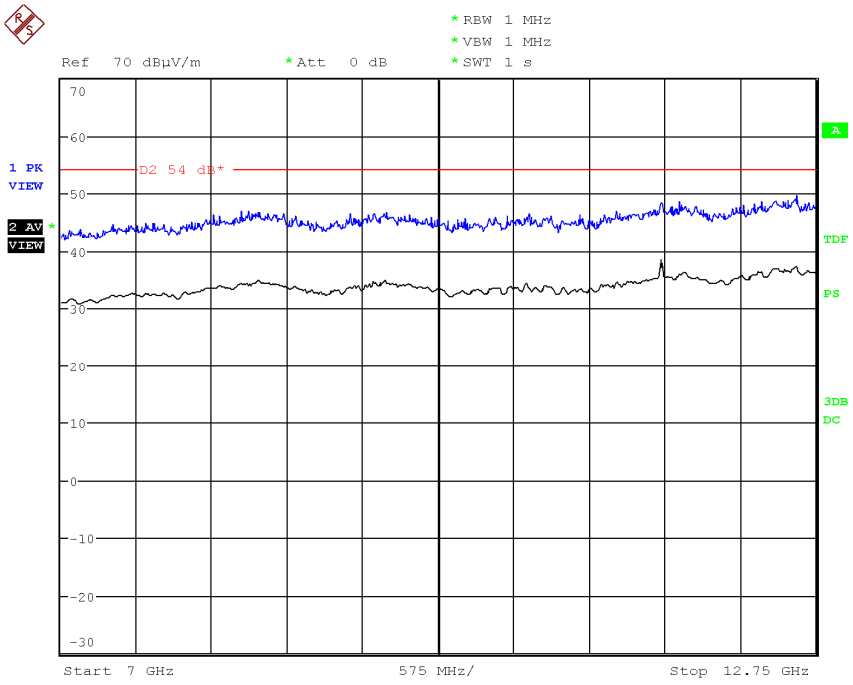


Highest Channel: 5825 MHz.



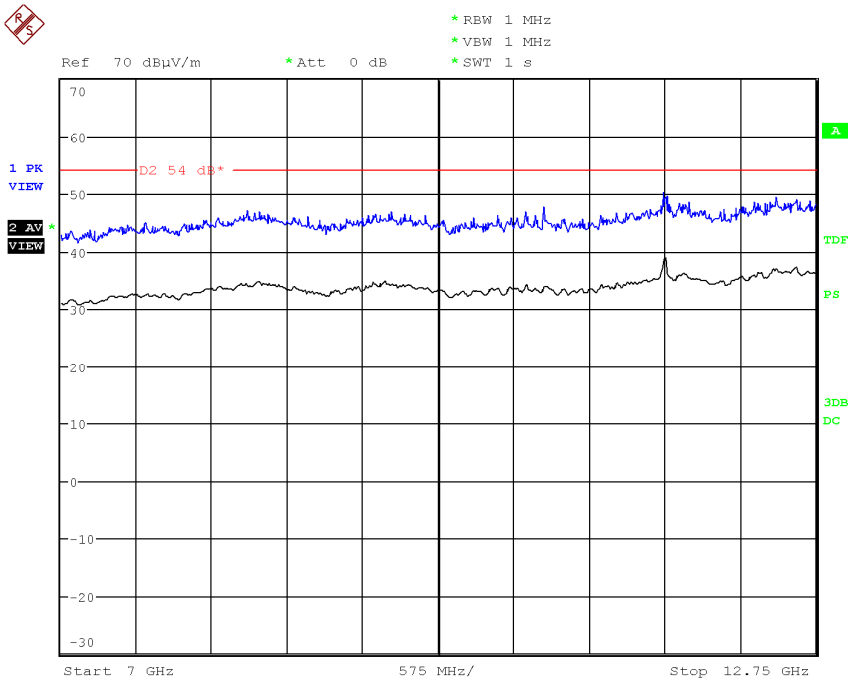
2. WiFi 5GHz 802.11 n20 mode

Middle Channel: 5785 MHz.



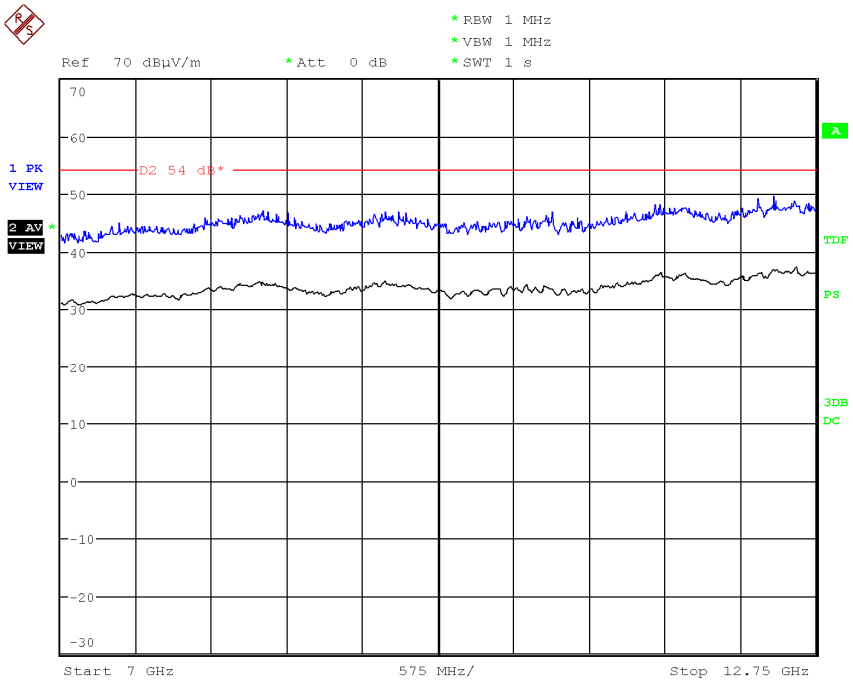
3. WiFi 5GHz 802.11 n40 mode

Highest Channel: 5795 MHz.



4. WiFi 5GHz 802.11 ac80 mode

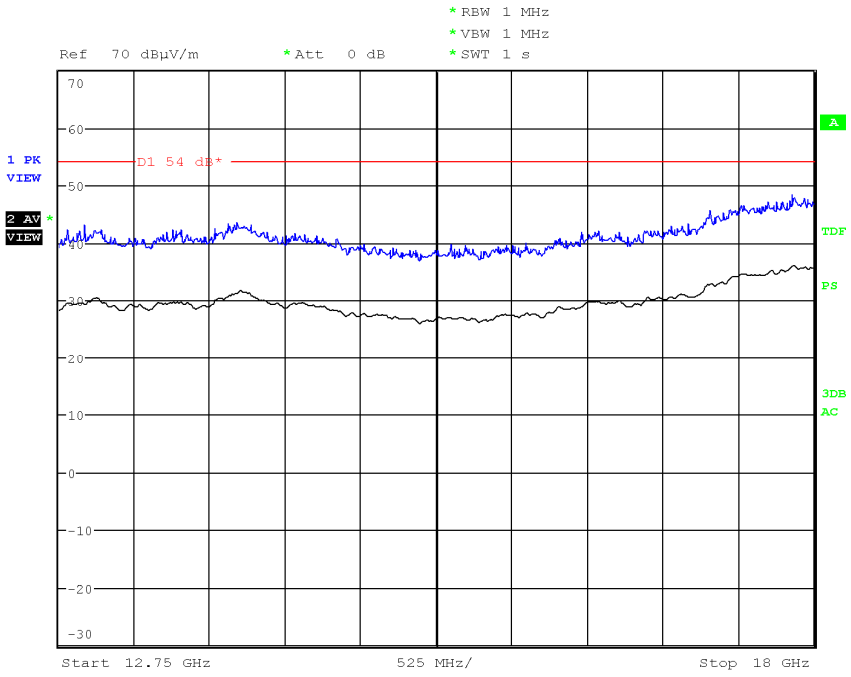
Middle Channel: 5775 MHz.



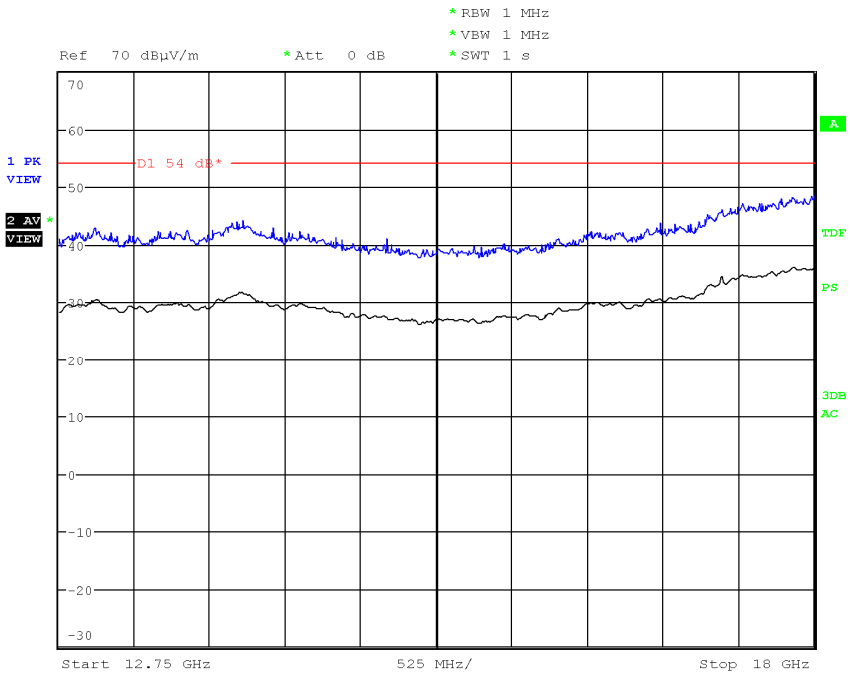
FREQUENCY RANGE 12 GHz to 18 GHz.

1. WiFi 5GHz 802.11 a mode

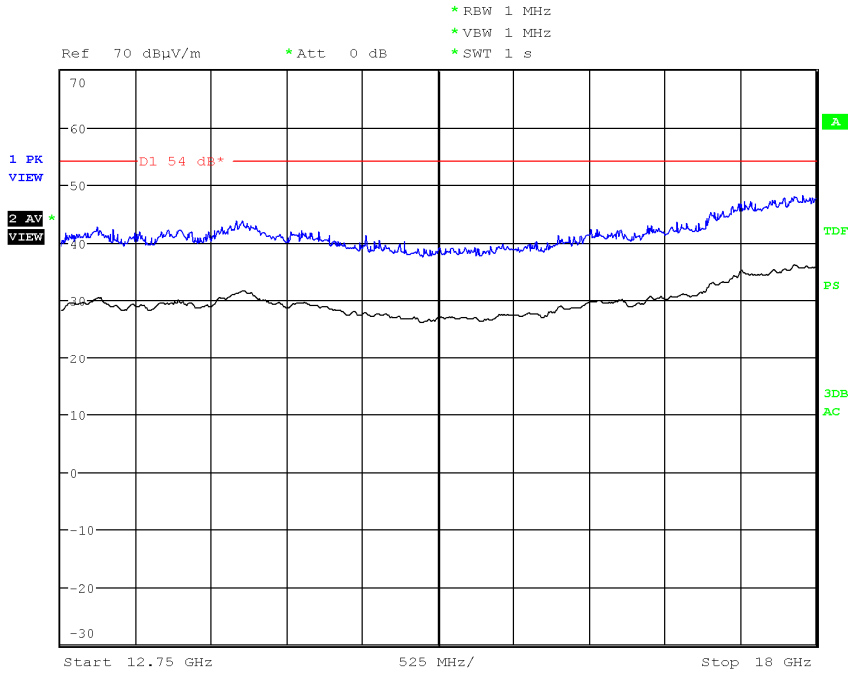
Lowest Channel: 5745 MHz.



Middle Channel: 5785 MHz.

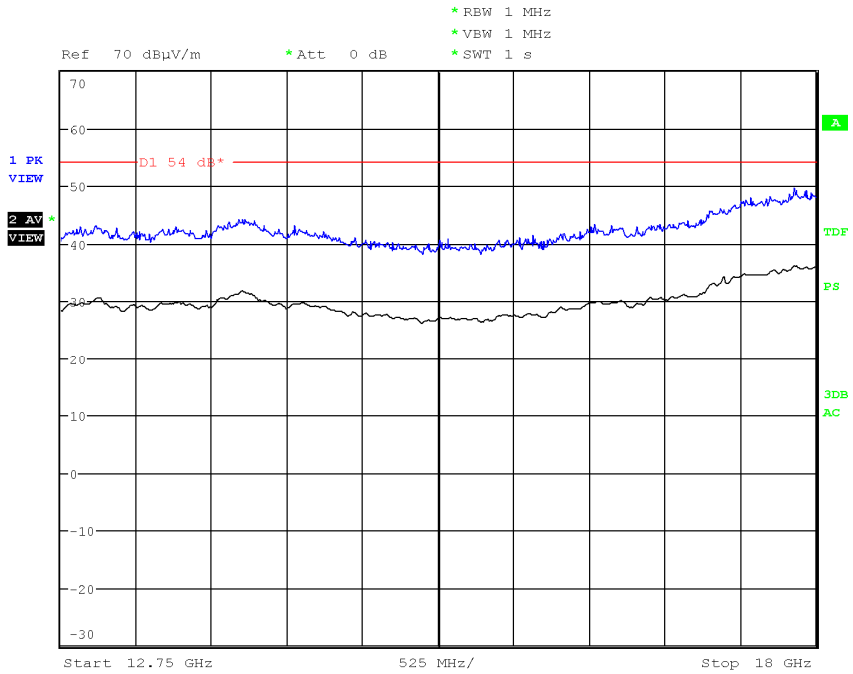


Highest Channel: 5825 MHz.



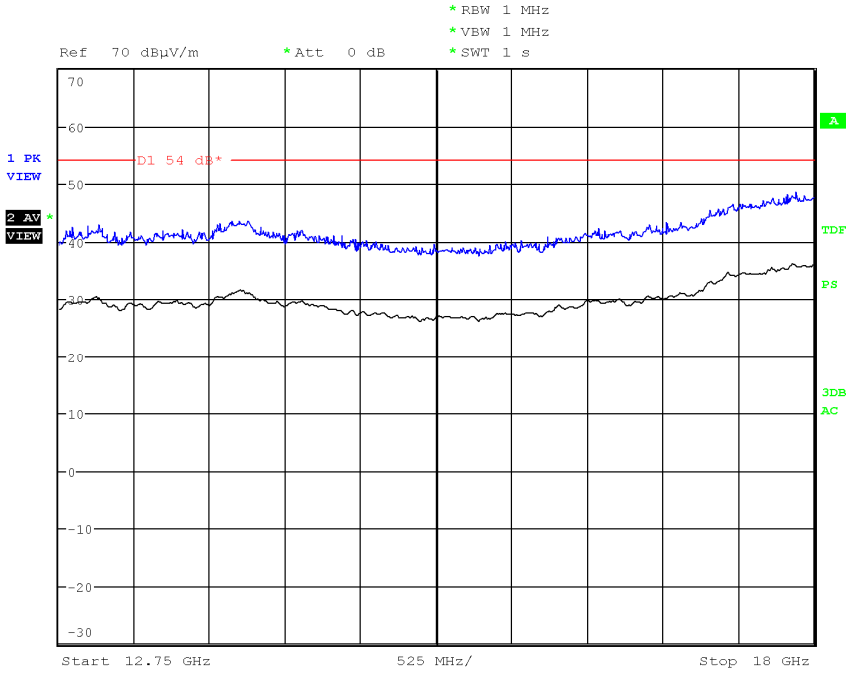
2. WiFi 5GHz 802.11 n20 mode

Middle Channel: 5785 MHz.



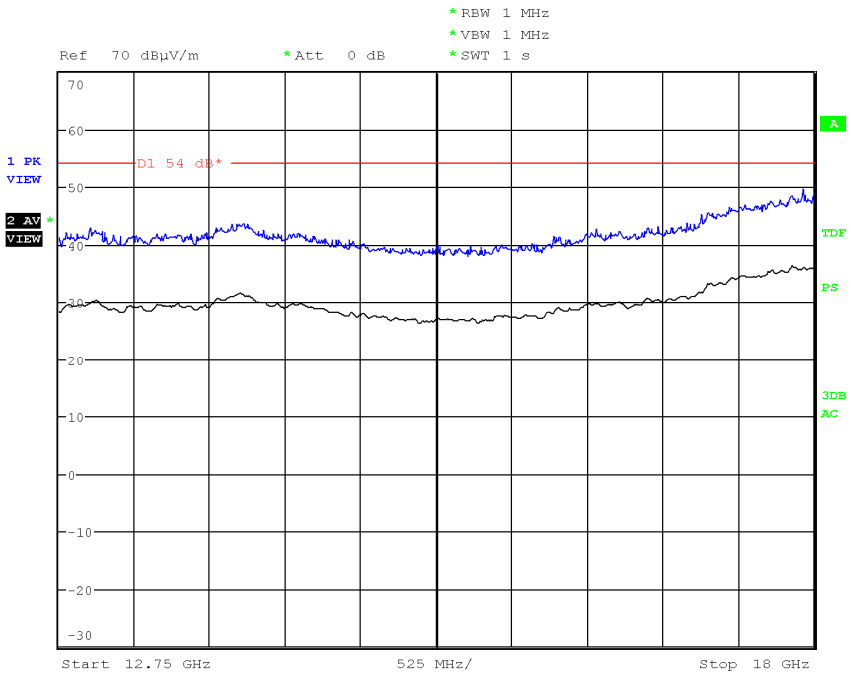
3. WiFi 5GHz 802.11 n40 mode

Highest Channel: 5795 MHz.



4. WiFi 5GHz 802.11 ac80 mode

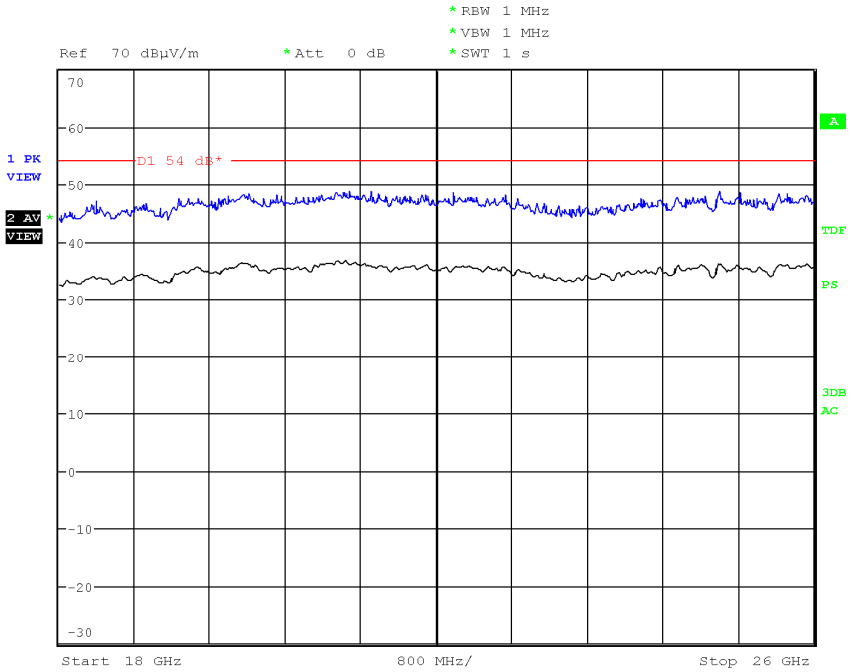
Middle Channel: 5775 MHz.



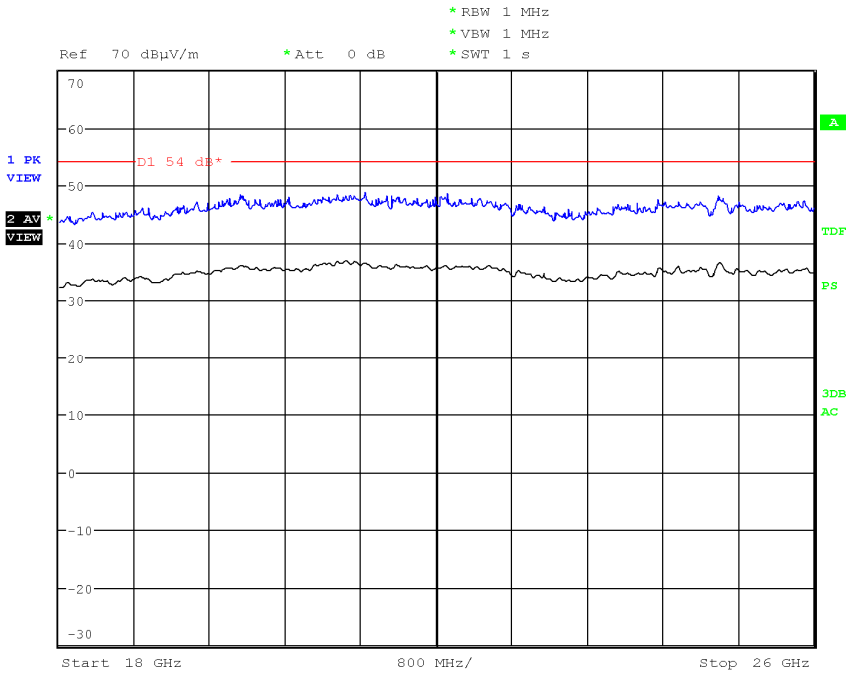
FREQUENCY RANGE 18 GHz to 26 GHz.

1. WiFi 5GHz 802.11 a mode

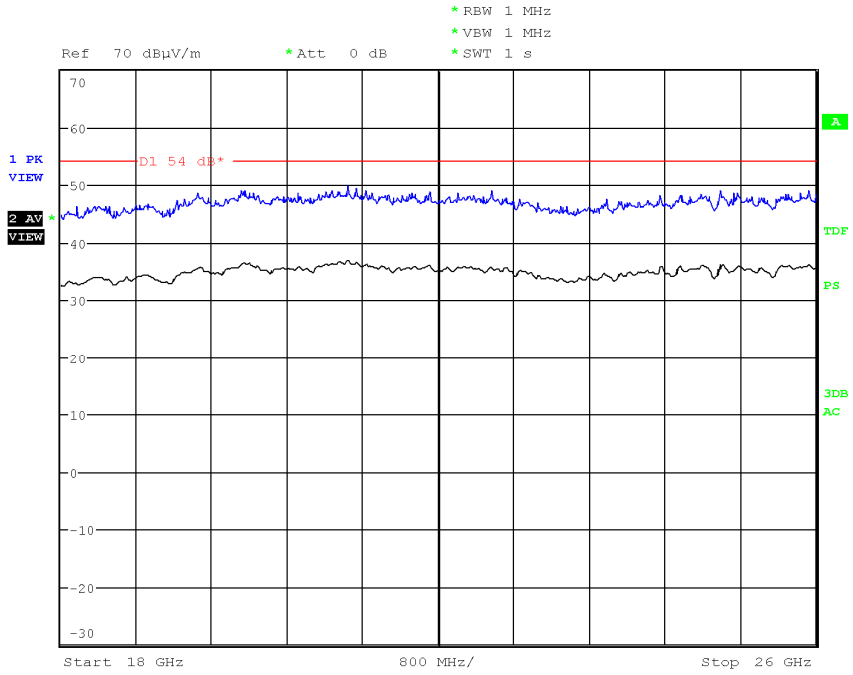
Lowest Channel: 5745 MHz.



Middle Channel: 5785 MHz.

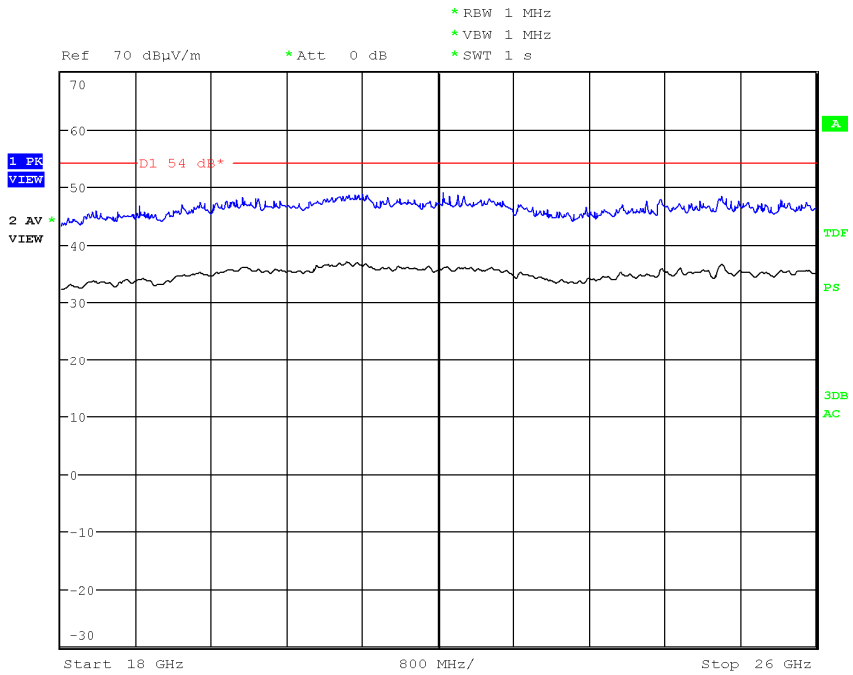


Highest Channel: 5825 MHz.



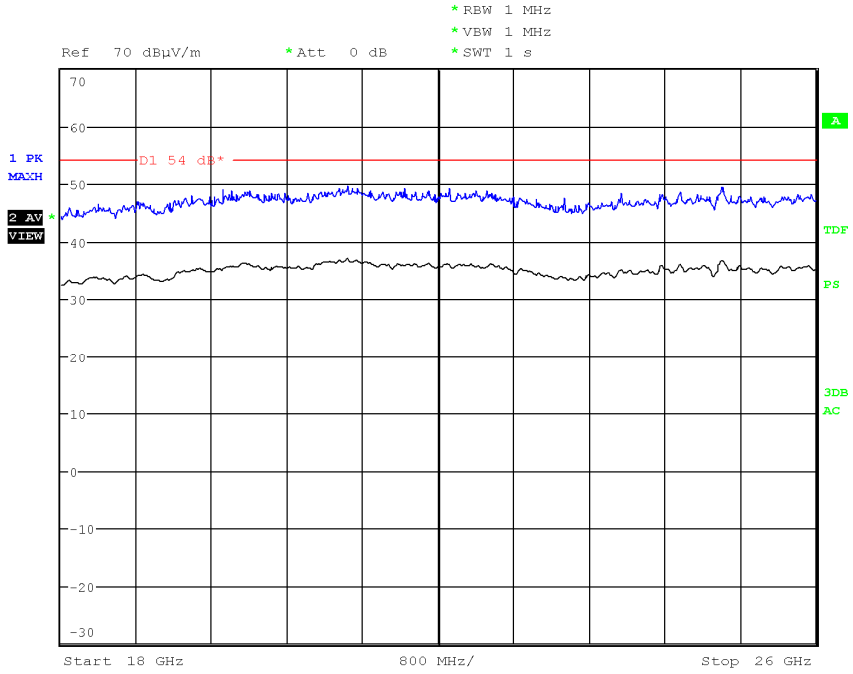
2. WiFi 5GHz 802.11 n20 mode

Middle Channel: 5785 MHz.



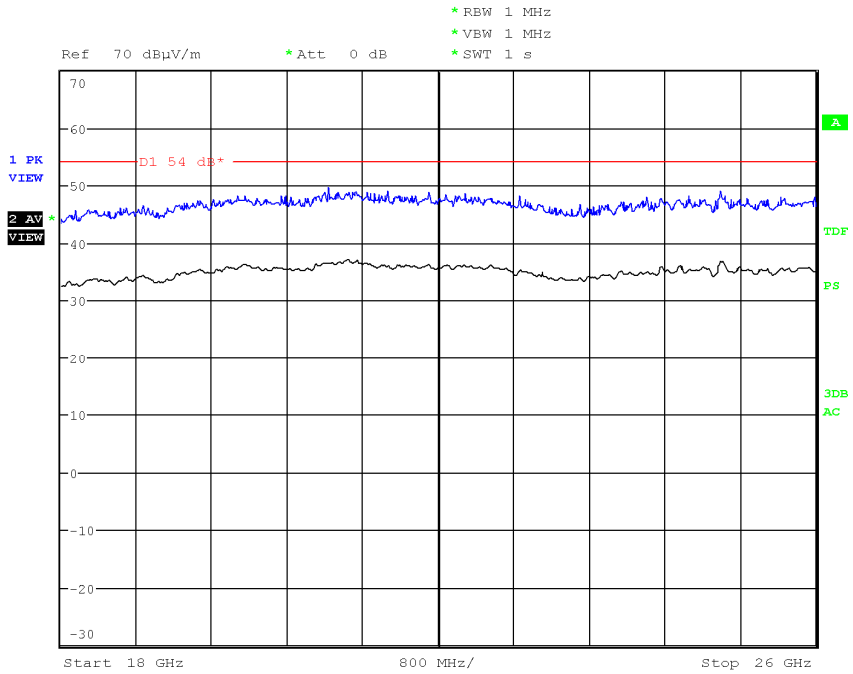
3. WiFi 5GHz 802.11 n40 mode

Highest Channel: 5795 MHz.



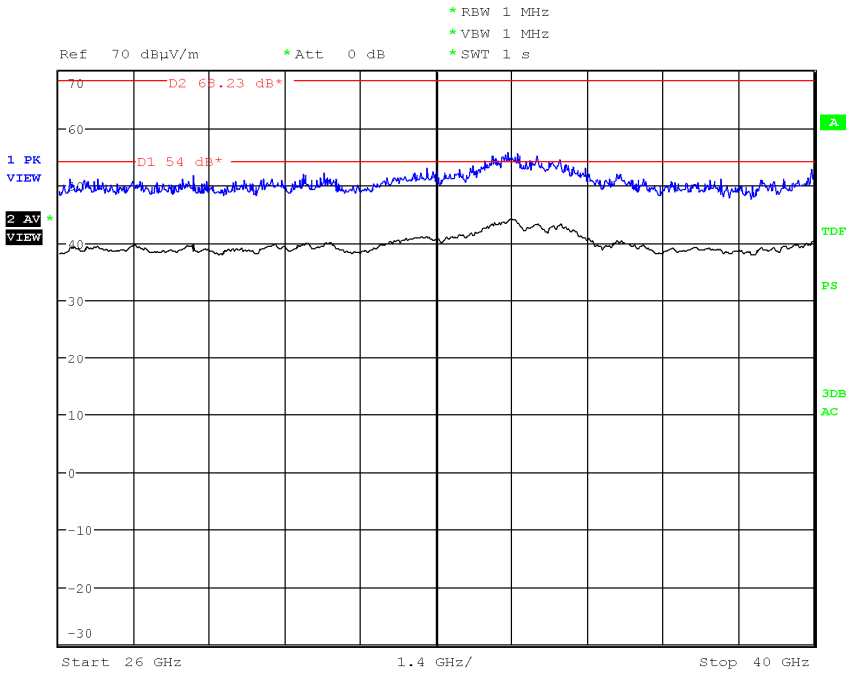
4. WiFi 5GHz 802.11 ac80 mode

Middle Channel: 5775 MHz.



FREQUENCY RANGE 26 GHz to 40 GHz.

No spurious signals were found in all modulations and channels tested.



APPENDIX C: Test results
“Bluetooth Low Energy”

INDEX

TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 3.3 Vdc

Type of power supply = DC voltage from HMC/NGFC test board.

Type of antenna = External attachable PIFA antenna.

Declared Gain for antenna = 3.2 dBi

TEST FREQUENCIES:

Lowest channel: 2402 MHz

Middle channel: 2440 MHz

Highest channel: 2480 MHz

The test set-up was made in accordance to the general provisions of ANSI C63.4: 2009.

For Bluetooth LE operation mode the transmission is at AUX RF output.

For radio testing purposes the card was installed in a test fixture. The test fixture is connected to a laptop computer and dc power supplied. The laptop computer was used to configure the EUT to continuously transmit at a specified output power.

The PC was using the Intel test utility DRTU Version DRTU 1.6.1.628.

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and connected to the spectrum analyzer using a low loss calibrated RF cable. The measurement readings are corrected with the cable loss (dB).

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 one 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.

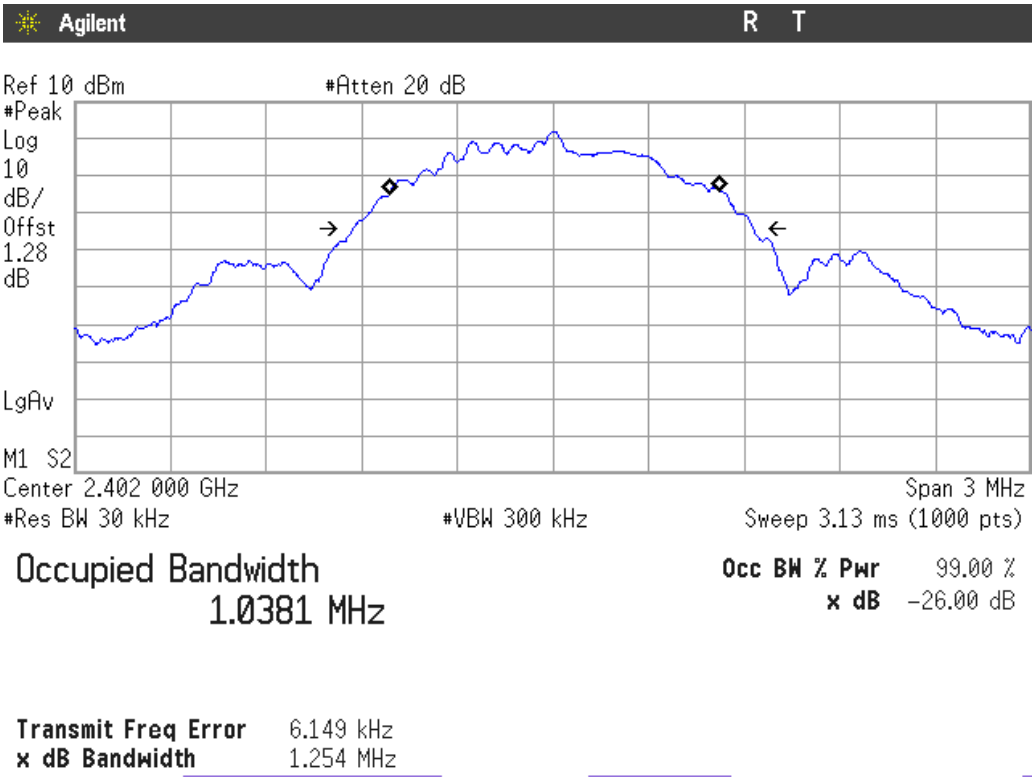
Occupied bandwidth

RESULTS

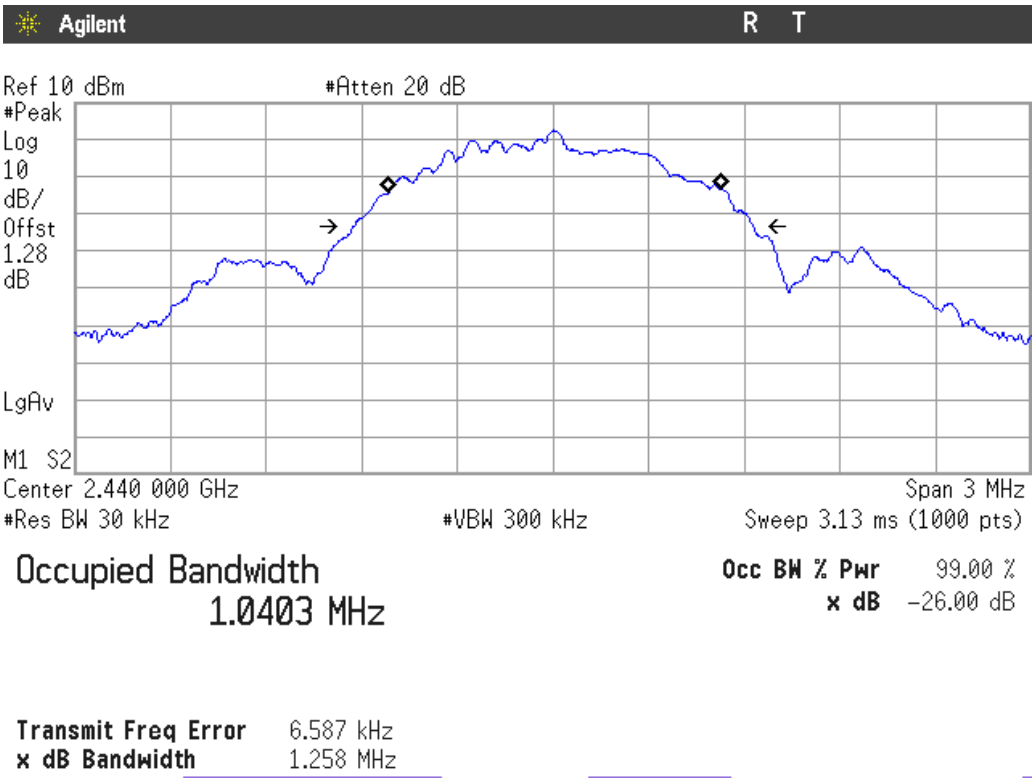
(see next plots).

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
99% bandwidth (MHz)	1.0381	1.0403	1.0377
-26 dBc bandwidth (MHz)	1.254	1.258	1.258
Measurement uncertainty (kHz)	±21.7		

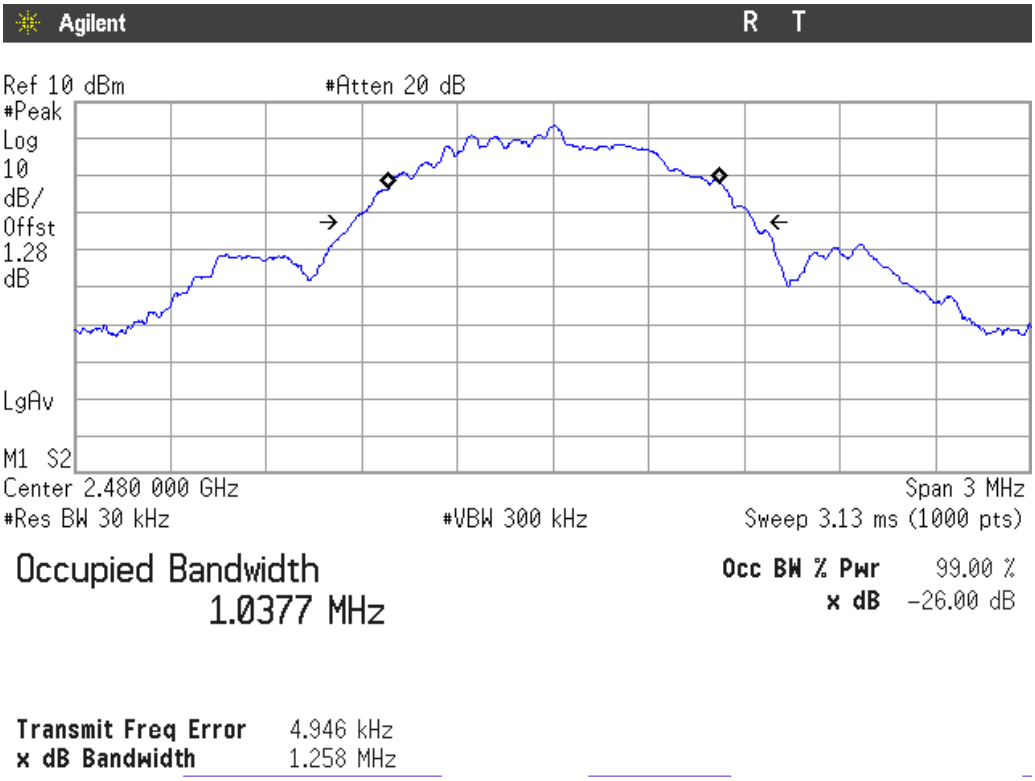
Lowest Channel



Middel Channel



Highest channel



Section 15.247 Subclause (a) (2) / RSS-210 A8.2. (a). 6 dB Bandwidth

SPECIFICATION

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

RESULTS

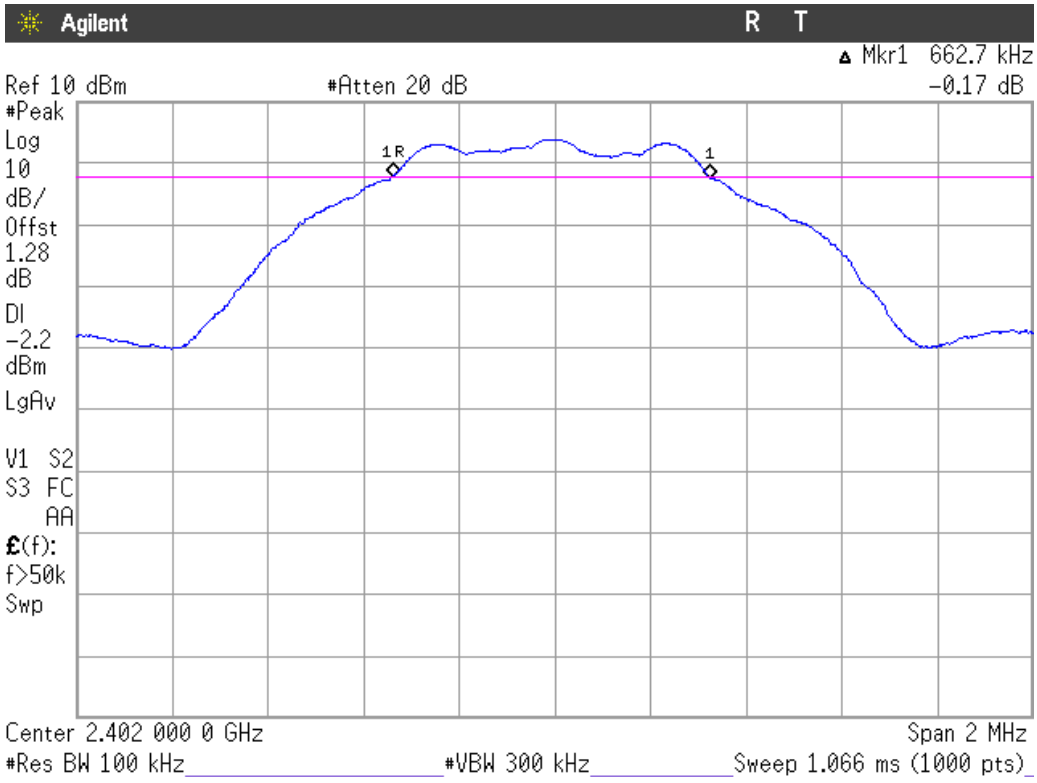
6 dB Bandwidth (see next plots).

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
6 dB Spectrum bandwidth (kHz)	662.7	670.7	672.7
Measurement uncertainty (kHz)	±21.7		

Verdict: PASS

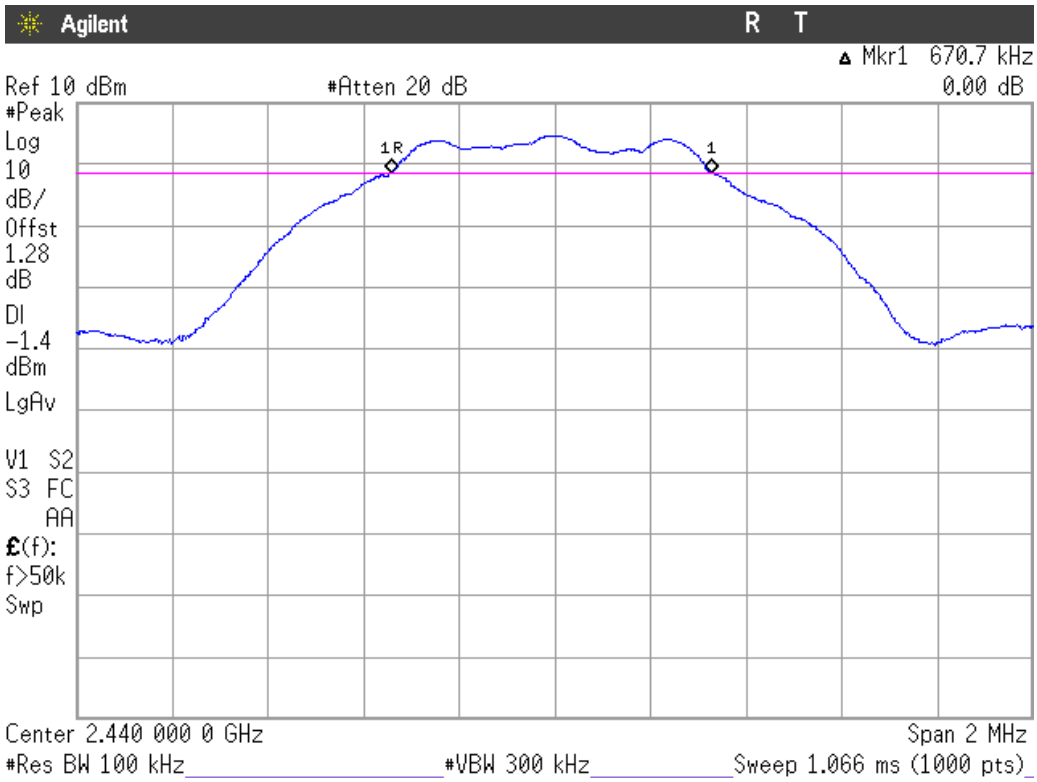
6 dB BANDWIDTH.

Lowest Channel



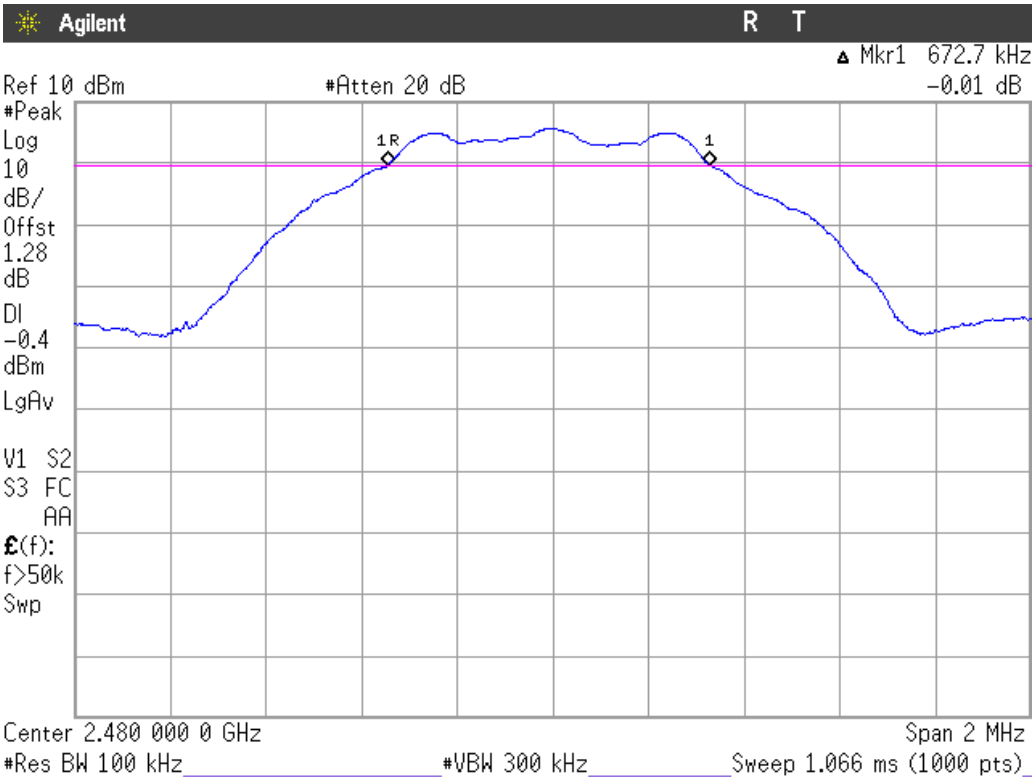
6 dB BANDWIDTH.

Middle Channel



6 dB BANDWIDTH.

Highest Channel



Section 15.247 Subclause (b) / RSS-210 A8.4. (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 9.2.1.1. Option a) of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03 dated 08/04/2013.

MAXIMUM OUTPUT POWER. See next plots.

Maximum declared antenna gain: 3.2 dBi.

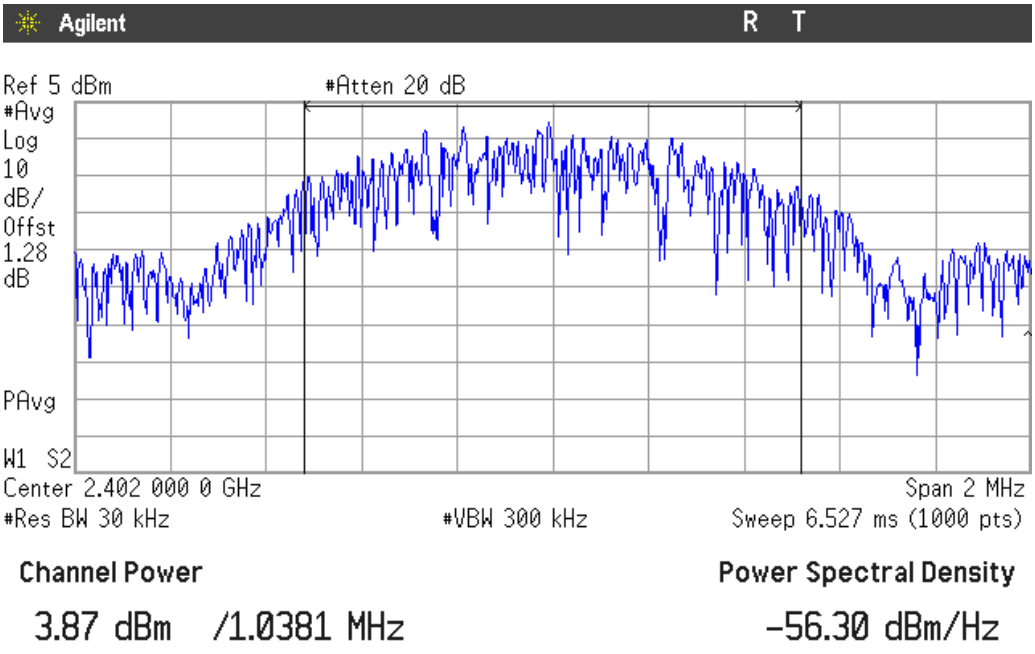
	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Maximum conducted power (dBm)	3.87	4.68	5.61
Maximum EIRP power (dBm)	7.07	7.88	8.81
Measurement uncertainty (dB)	±1.5		

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.

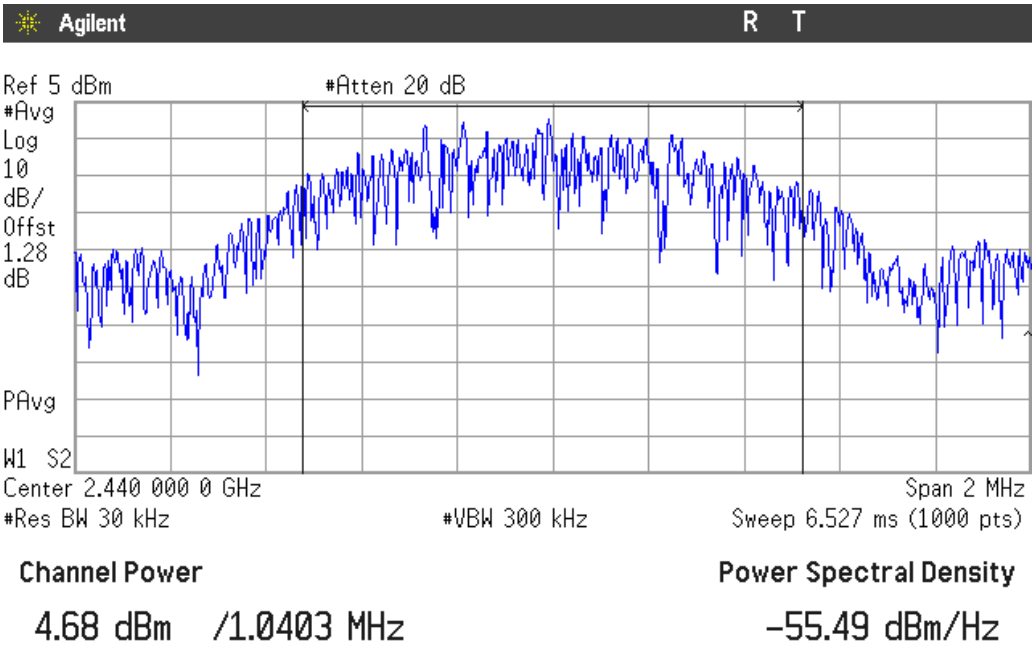
Verdict: PASS

1. CONDUCTED POWER.

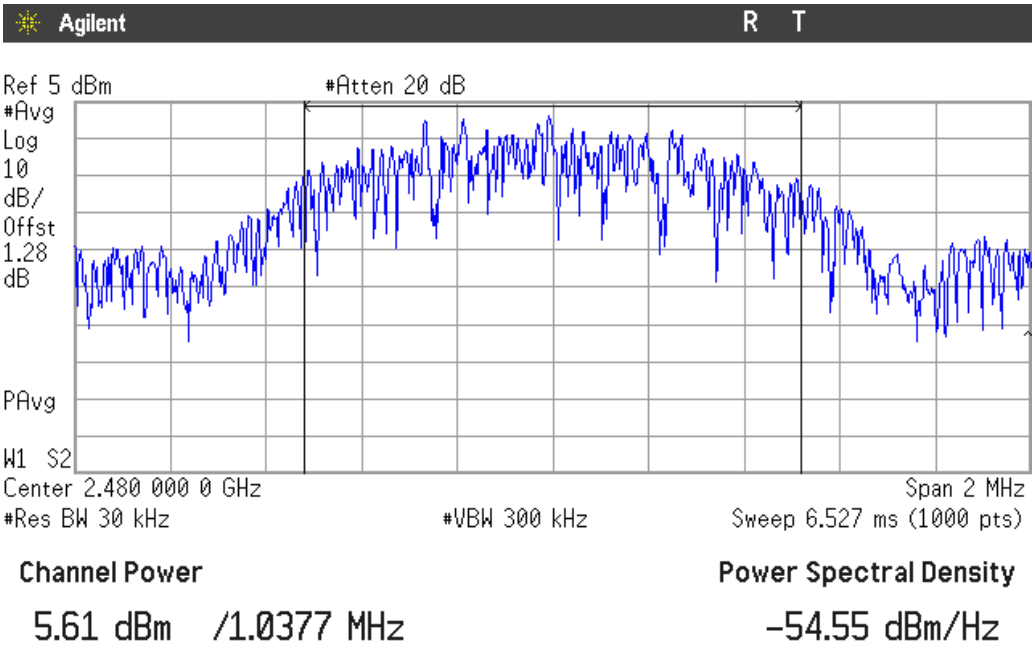
Lowest frequency



Middle frequency



Highest frequency



Section 15.247 Subclause (d) / RSS-210 A8.5. 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 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Reference Level Measurement (dBm)	3.84	4.83	5.56
Measurement uncertainty (dB)	±1.5		

Lowest frequency 2402 MHz			
Spurious frequency (GHz)	Emission Level (dBµV/m)	Limit (dBm)	Measurement Uncertainty (dB)
2.482223	-44.11	-26.16	± 1.50
2.541828	-45.07	-26.16	± 1.50
2.561925	-44.75	-26.16	± 1.50

Middle frequency 2440 MHz			
Spurious frequency (GHz)	Emission Level (dBµV/m)	Limit (dBm)	Measurement Uncertainty (dB)
2.520246	-42.61	-25.17	± 1.50
2.580042	-44.01	-25.17	± 1.50
2.599743	-44.09	-25.17	± 1.50

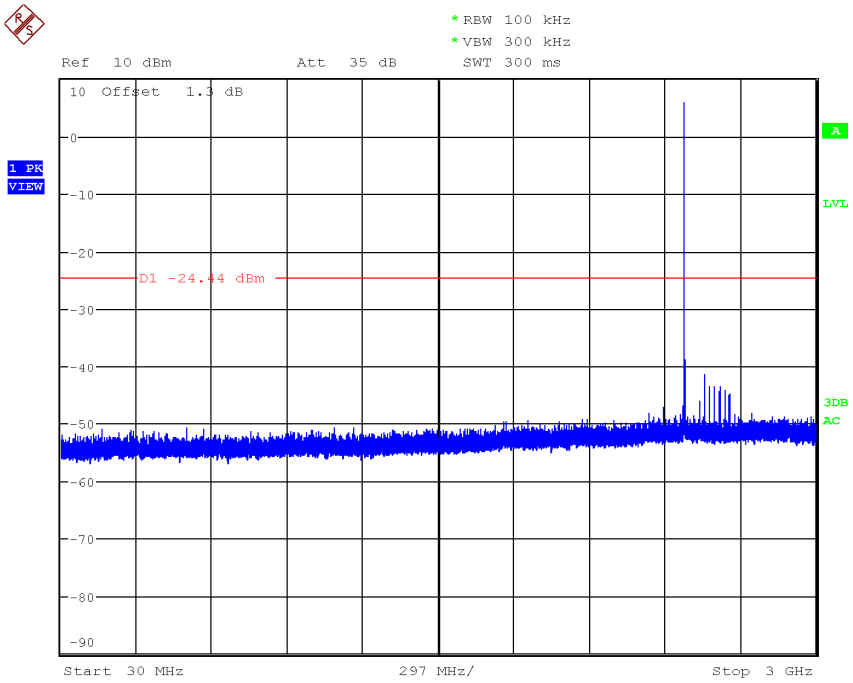
Highest frequency 2480 MHz			
Spurious frequency (GHz)	Emission Level (dBµV/m)	Limit (dBm)	Measurement Uncertainty (dB)
2.559747	-41.39	-24.44	± 1.50
2.599941	-43.43	-24.44	± 1.50
2.620236	-43.42	-24.44	± 1.50

Verdict: PASS

See next plot of worst case: Highest frequency 2480 MHz.

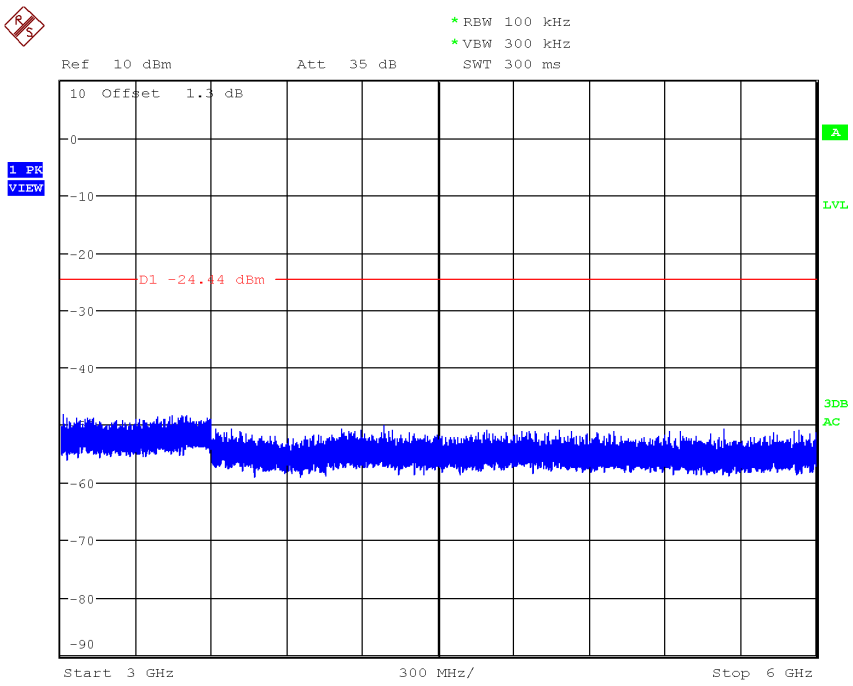
Number of sweep points: 30,001.

Plot 30 MHz to 3 GHz:

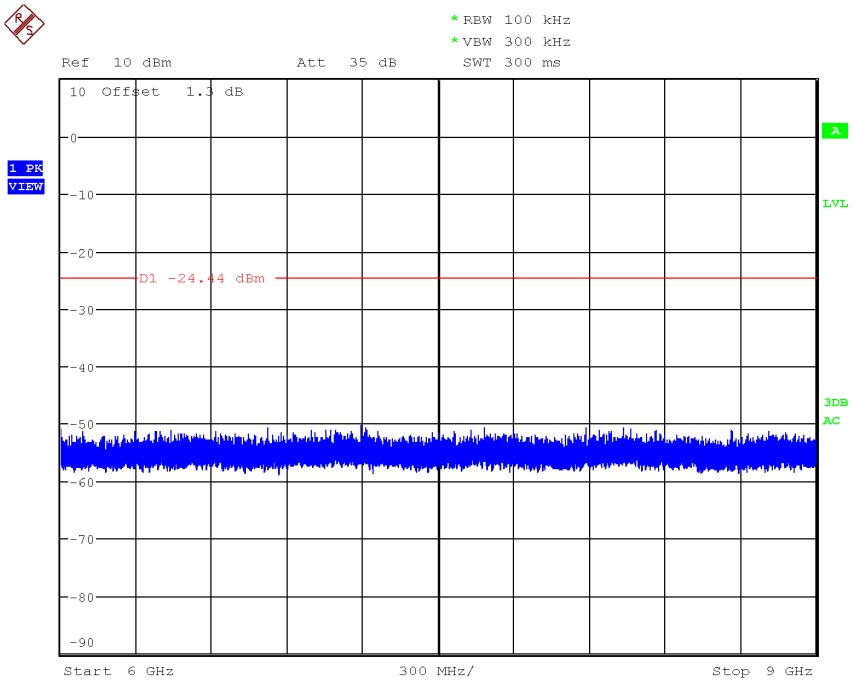


Note: The peak above the limit is the carrier frequency.

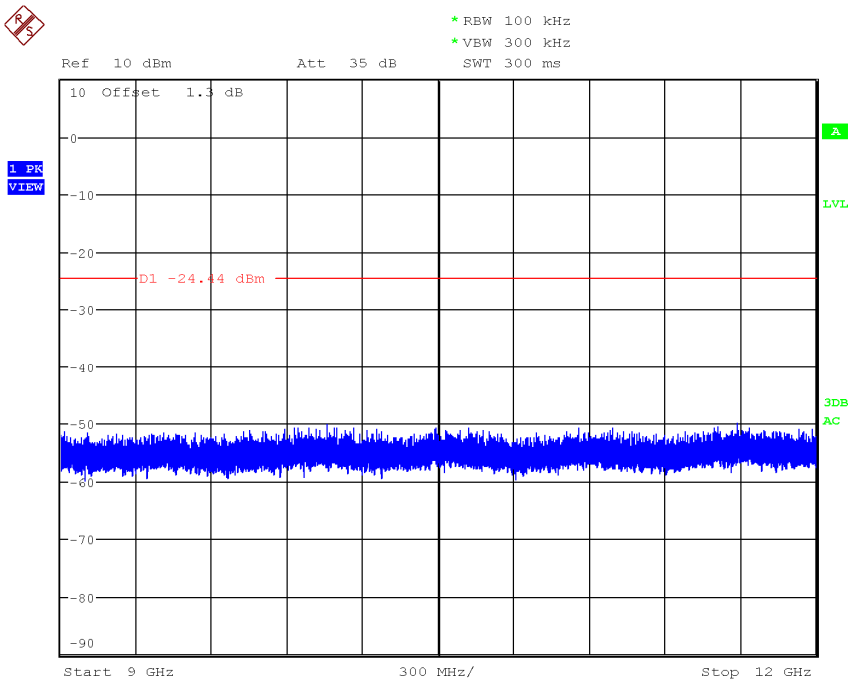
Plot 3 GHz to 6 GHz:



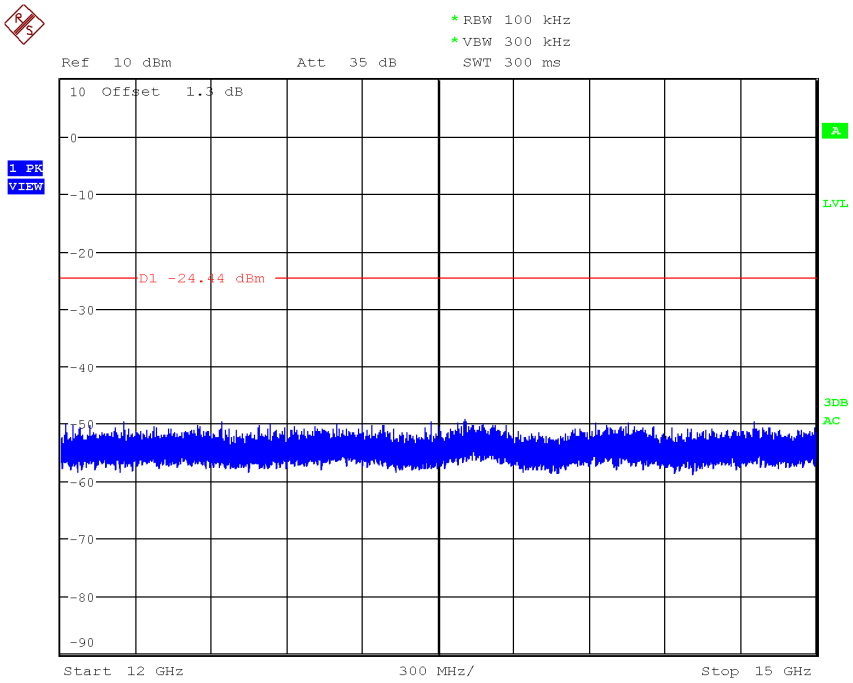
Plot 6 GHz to 9 GHz:



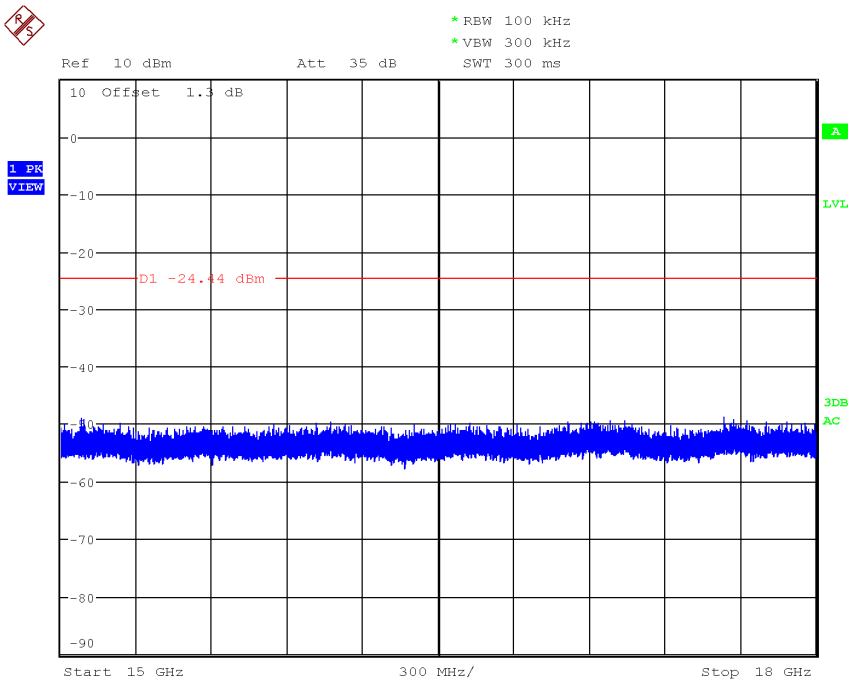
Plot 9 GHz to 12 GHz:



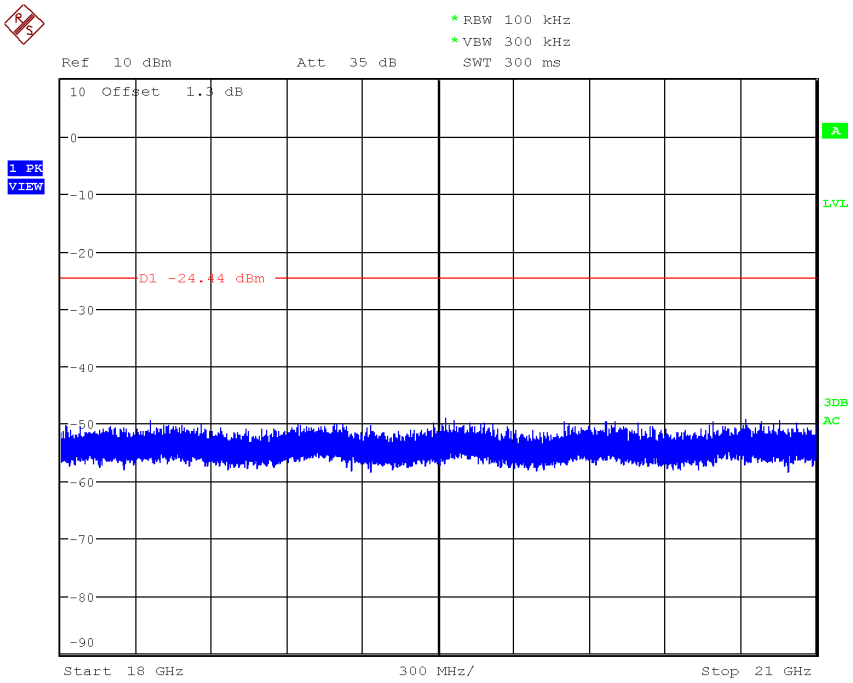
Plot 12 GHz to 15 GHz:



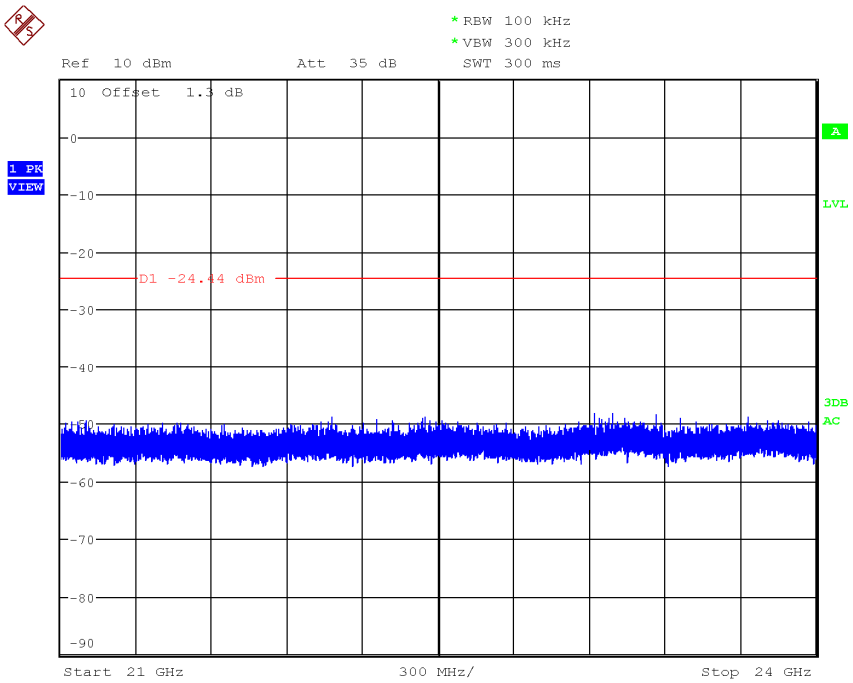
Plot 15 GHz to 18 GHz:



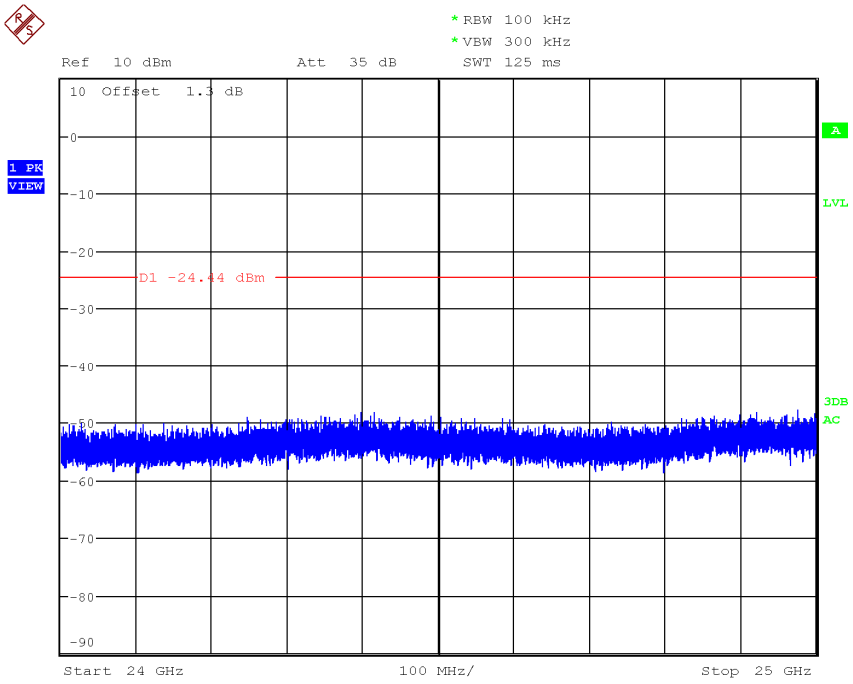
Plot 18 GHz to 21 GHz:



Plot 21 GHz to 24 GHz:



Plot 24 GHz to 25 GHz:



Section 15.247 Subclause (d) / RSS-210 A8.5. Band-edge emissions compliance (Transmitter)

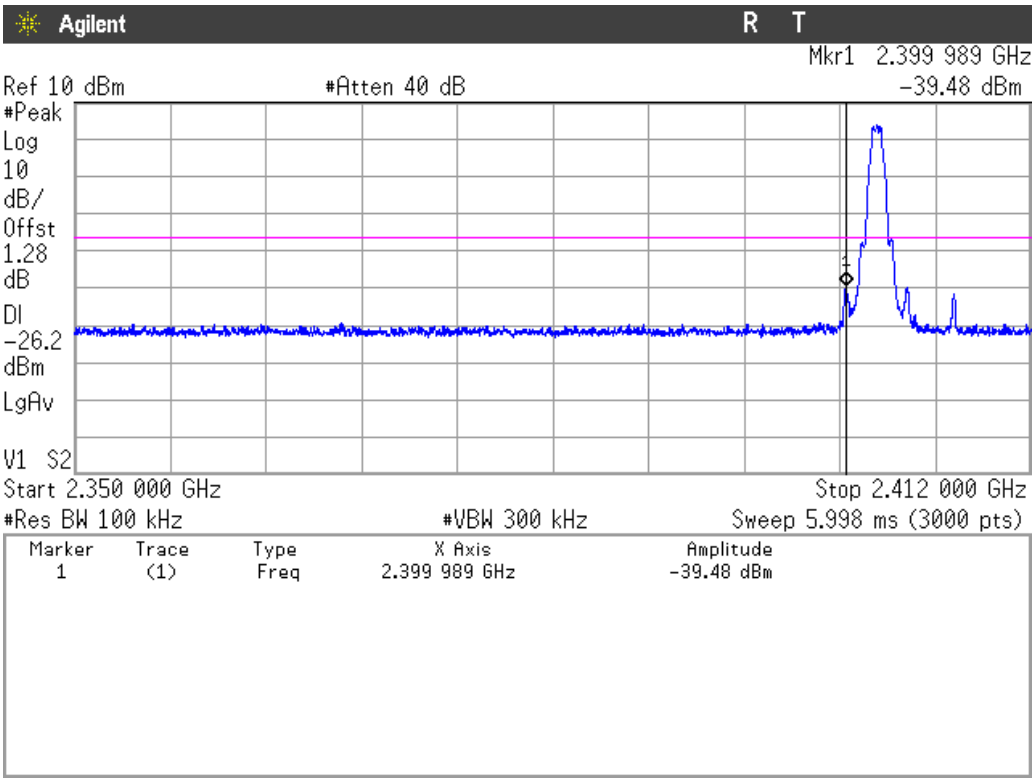
SPECIFICATION

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

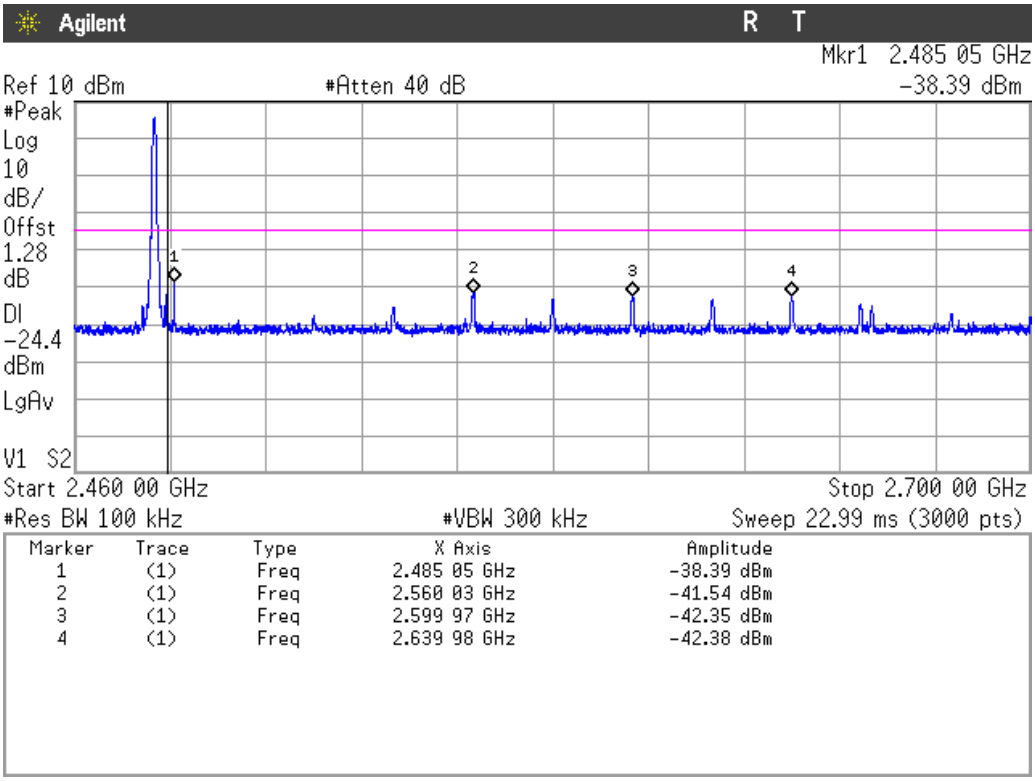
See next plot.



Verdict: PASS

2. HIGH FREQUENCY SECTION. CONDUCTED.

See next plot.



Verdict: PASS

Section 15.247 Subclause (e) / RSS-210 A8.5. 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 Peak PSD (optional if the maximum conducted (average) output power was used to demonstrate compliance) 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 v03 dated 08/04/2013.

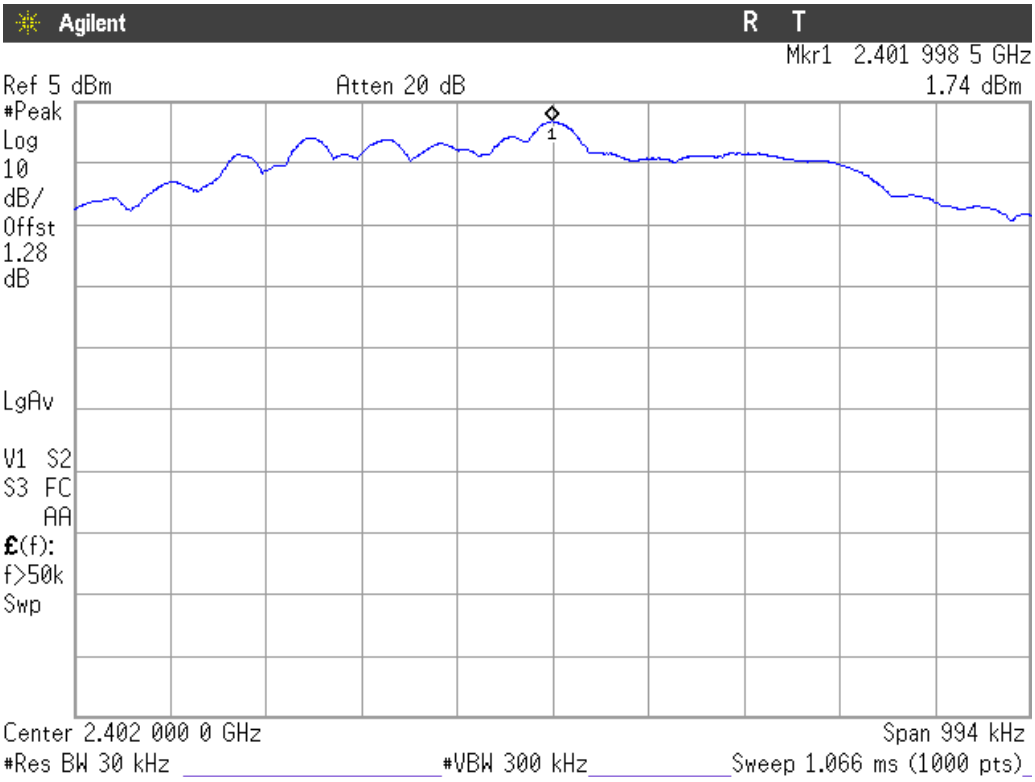
Power spectral density (see next plots).

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Power spectral density (dBm)	1.74	2.40	3.35
Measurement uncertainty (dB)	±1.5		

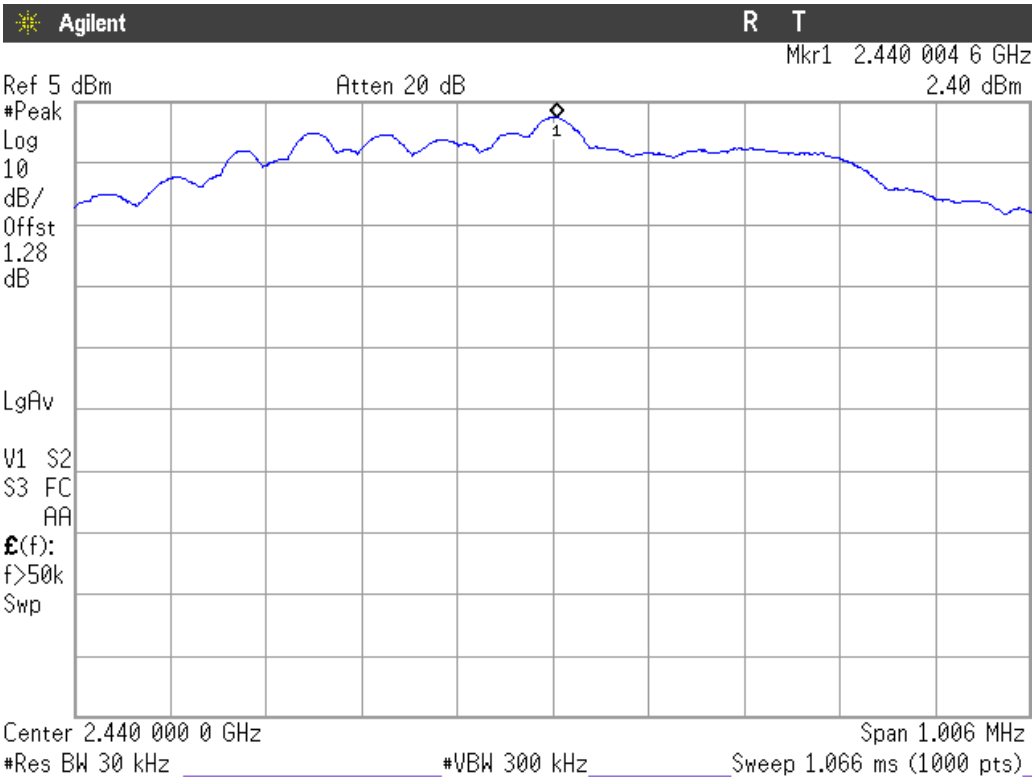
Verdict: PASS

Power spectral density.

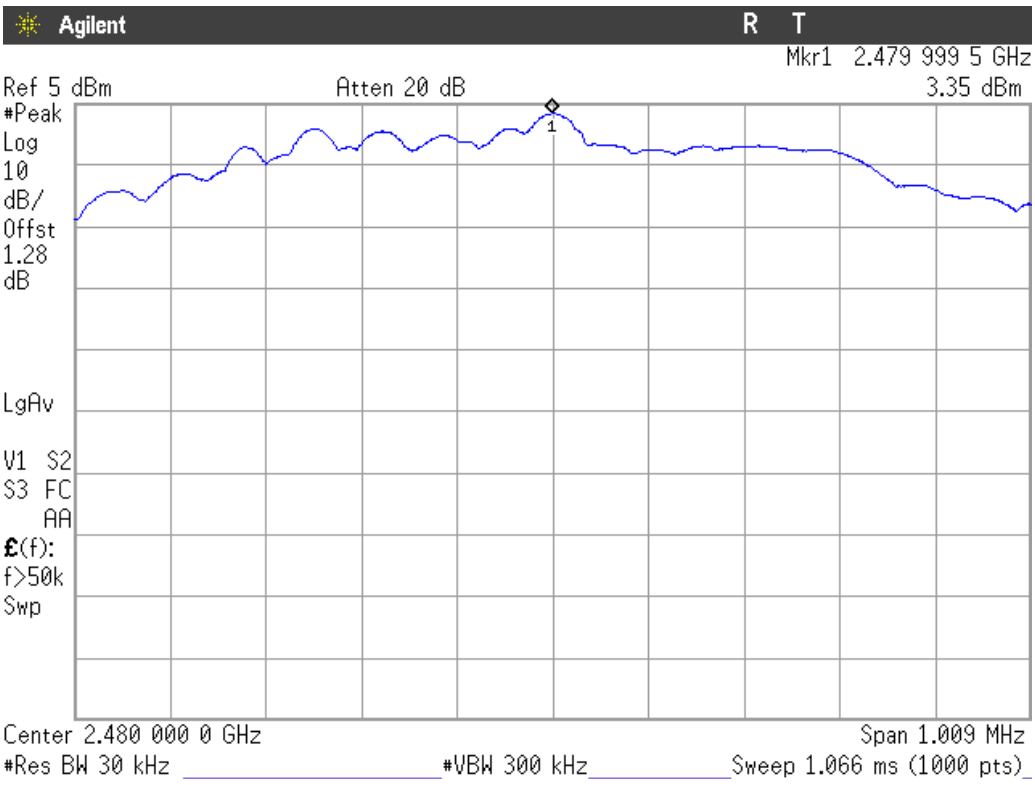
Lowest Channel



Middle Channel



Highest Channel



Section 15.247 Subclause (d) / RSS-210 A8.5. Emission limitations radiated (Transmitter)

SPECIFICATION

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)):

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
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.

See test results in Appendix A for details.

Frequency range 1 GHz-25 GHz

1. CHANNEL: LOWEST (2402 MHz). All maximized peak levels are below the average limit.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.322160	H	Peak	49.18	± 4.09
2.497409	H	Peak	50.50	± 4.09
2.522435	H	Peak	51.38	± 4.09
4.803835	V	Peak	51.38	± 4.09

2. CHANNEL: MIDDLE (2440 MHz). All maximized peak levels are below the average limit.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.360000	H	Peak	51.2	± 4.09
2.499950	H	Peak	50.82	± 4.09
2.520128	H	Peak	53.41	± 4.09
4.879910	V	Peak	43.62	± 4.09

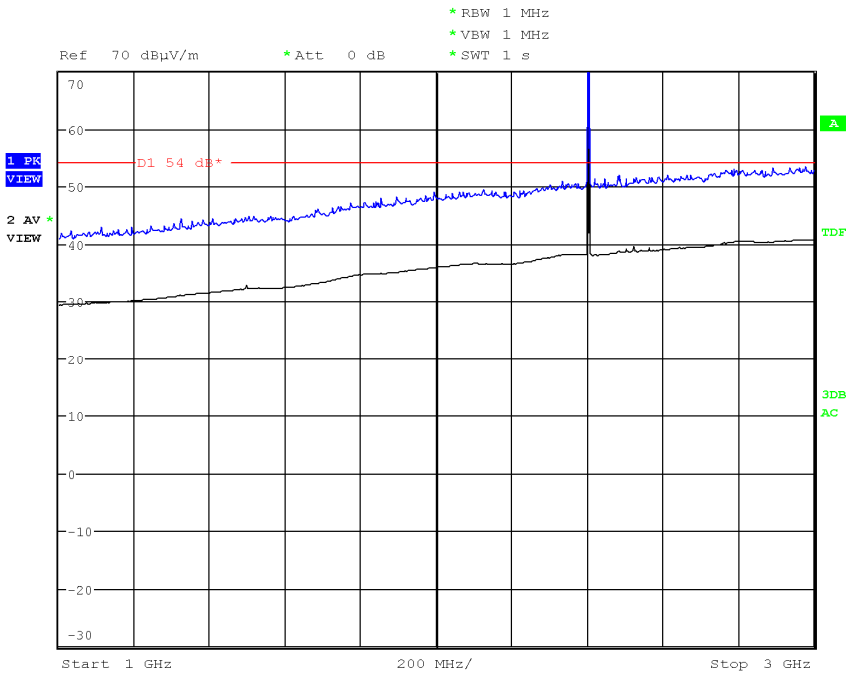
3. CHANNEL: HIGHEST (2480 MHz). All maximized peak levels are below the average limit.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
2.380038	H	Peak	50.99	± 4.09
2.483500	H	Peak	51.58	± 4.09
2.621025	H	Peak	51.49	± 4.09
2.640256	H	Peak	52.39	± 4.09
4.959975	V	Peak	43.48	± 4.09

Verdict: PASS

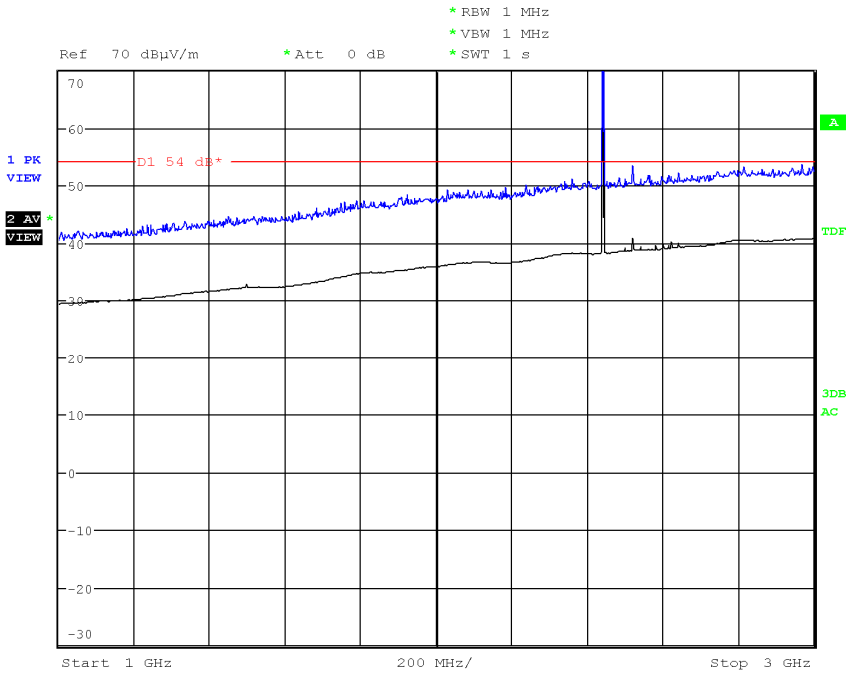
FREQUENCY RANGE 1 GHz to 3 GHz.

CHANNEL: Lowest (2402 MHz).



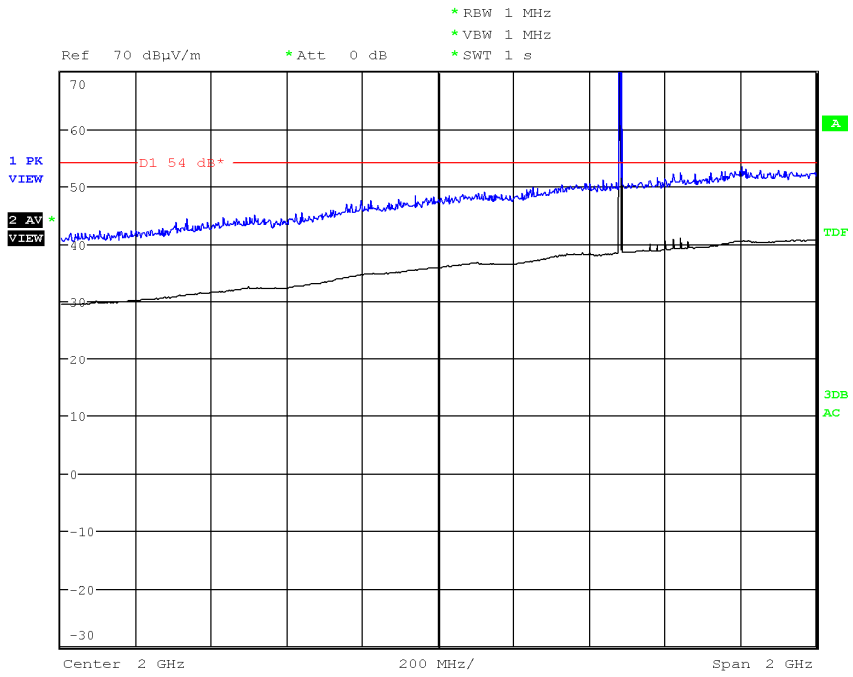
Note: The peak shown in the plot above the limit is the carrier frequency.

CHANNEL: Middle (2440 MHz).



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

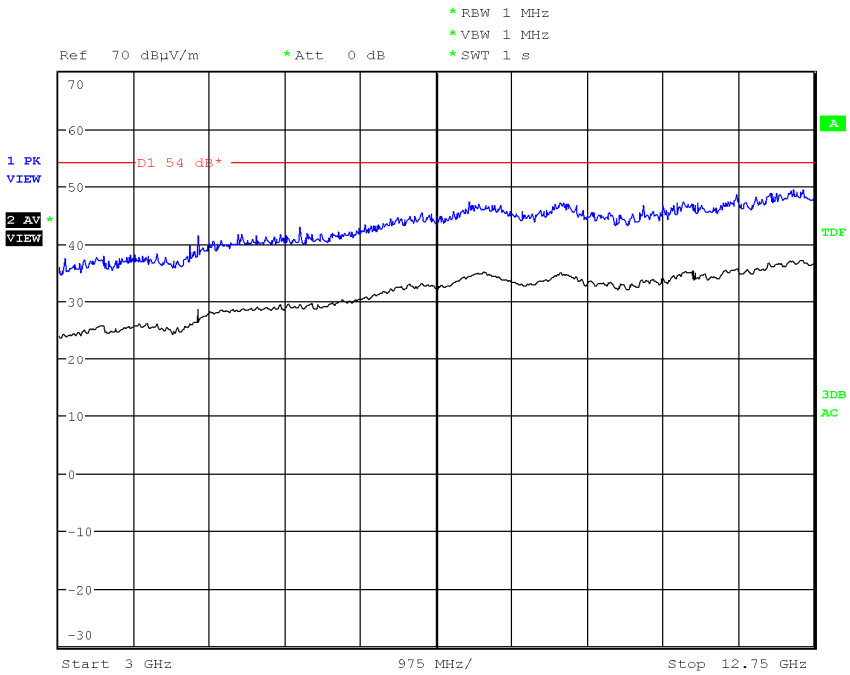
CHANNEL: Highest (2480 MHz).



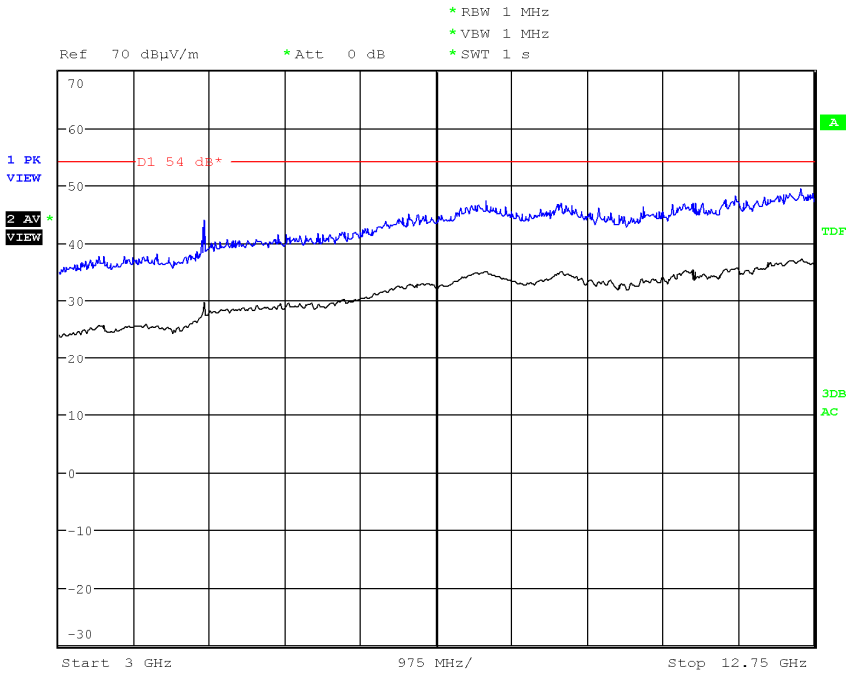
Note: The peak shown in the plot above the limit is the carrier frequency.

FREQUENCY RANGE 3 GHz to 12.75 GHz.

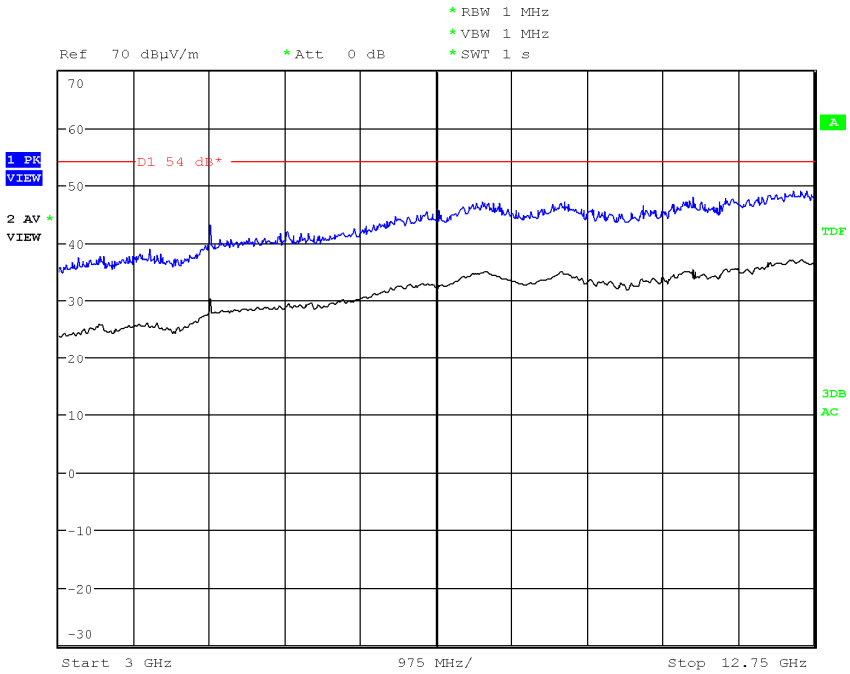
CHANNEL: Lowest (2402 MHz).



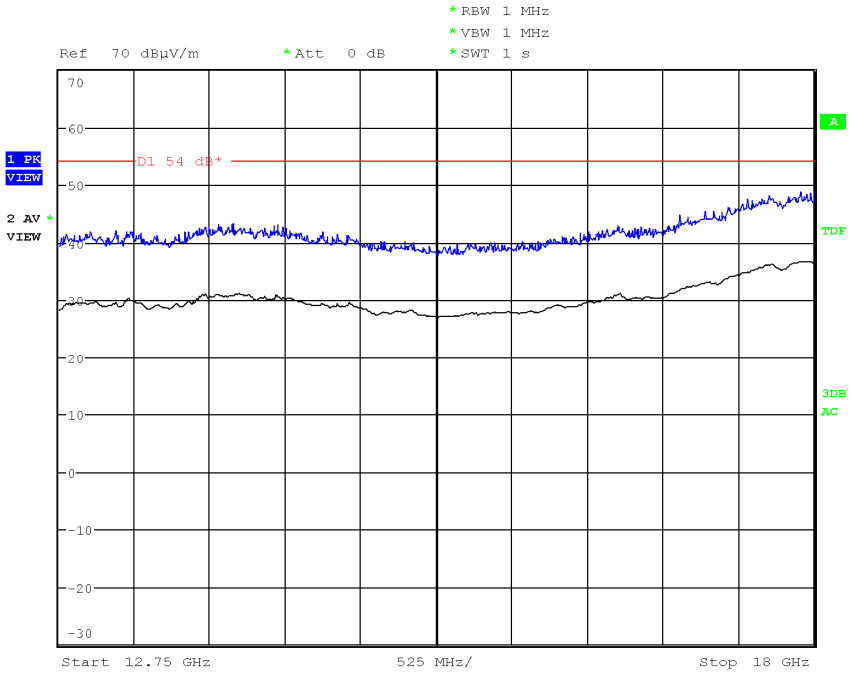
CHANNEL: Middle (2440 MHz).



CHANNEL: Highest (2480 MHz).

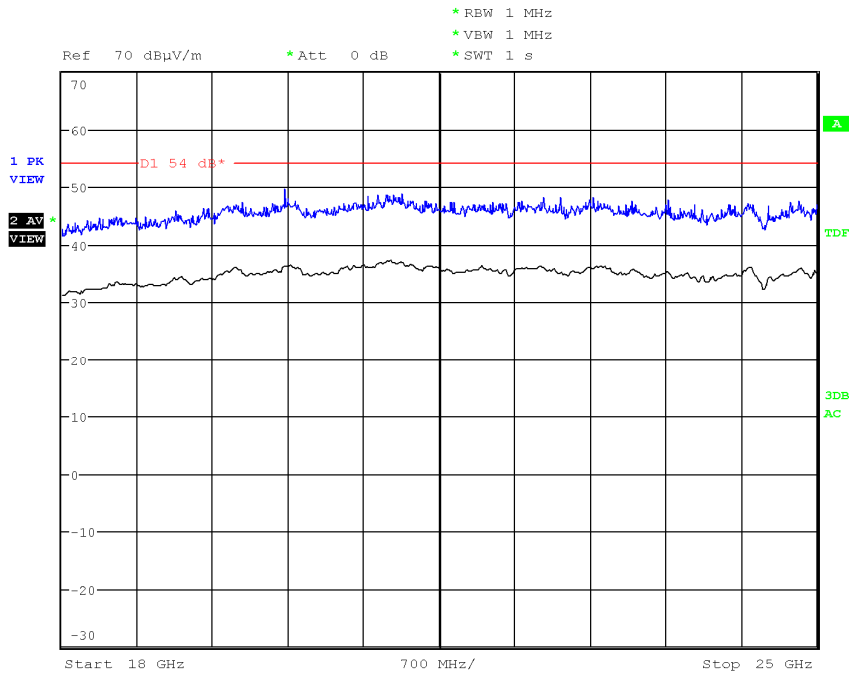


FREQUENCY RANGE 12.75 GHz to 18 GHz.



(This plot is valid for all three channels).

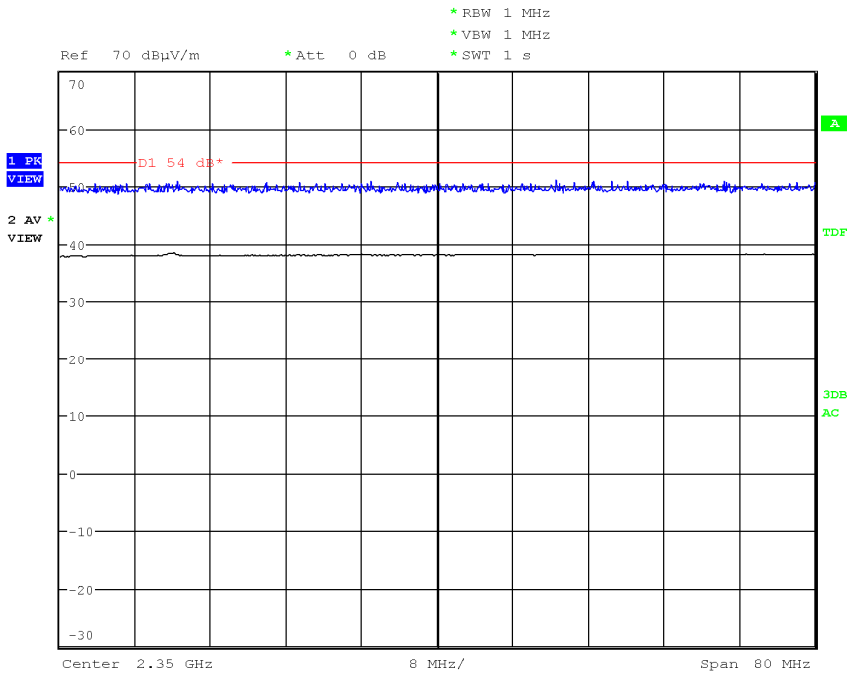
FREQUENCY RANGE 18 GHz to 25 GHz.



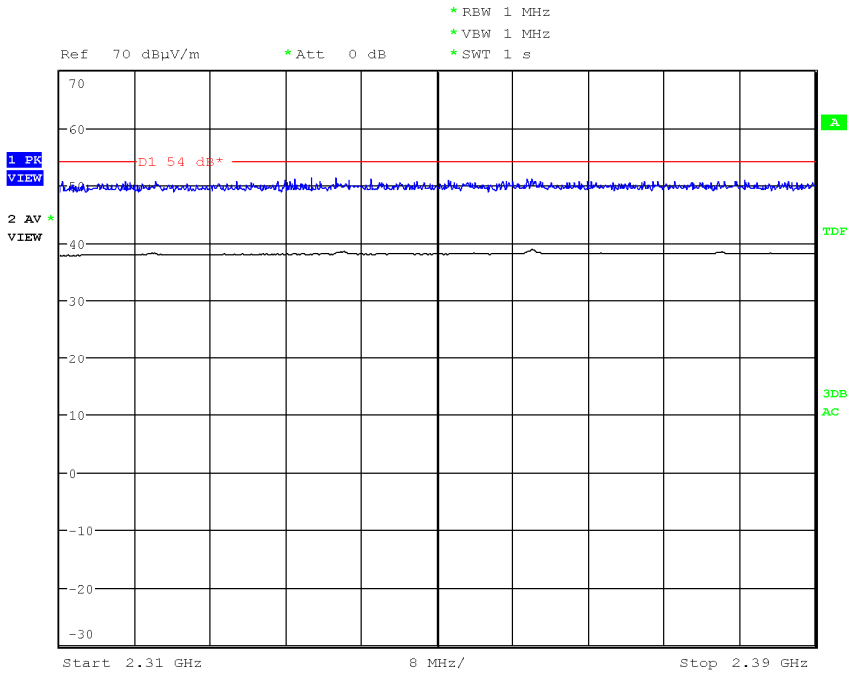
(This plot is valid for all three channels).

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

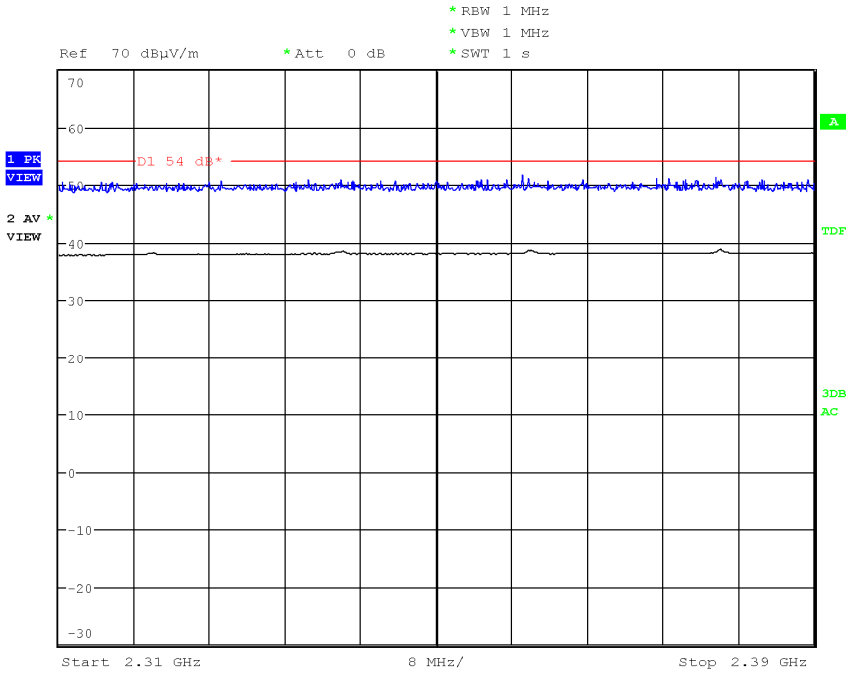
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2440 MHz).

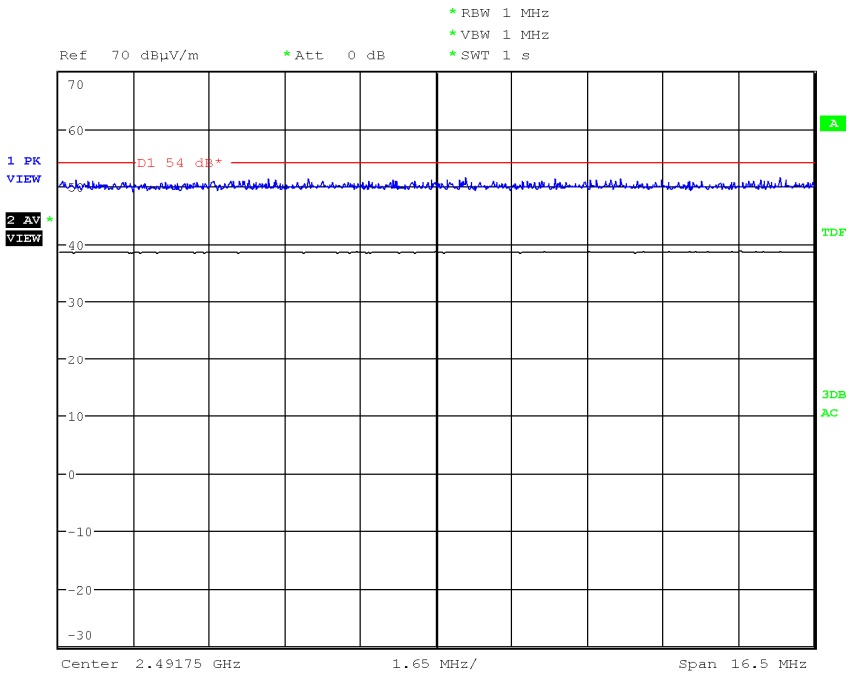


CHANNEL: Highest (2480 MHz).

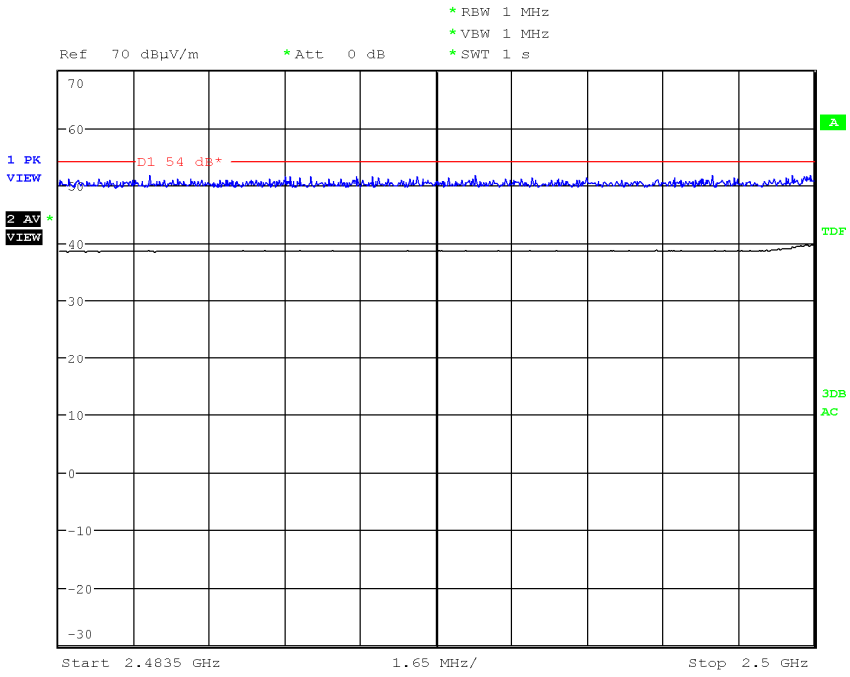


FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2440 MHz).



CHANNEL: Highest (2480 MHz).