HCT CO.,LTD. 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA
TEL: +82-31-645-6300 **FAX: +82-31-645-6401**

FCC / ISED DTS REPORT

Certification

Applicant Name:
WISOL CO., LTD

Address:
531-7, Gajang-ro, Osan-si Gyeonggi-do, 18103, Korea

Date of Issue:
July 18, 2017
Test Site/Location:
HCT CO., LTD., 74,Seoicheon-ro 578beon-gil,Majang-myeo,Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA
Report No.: HCT-R-1706-F048-3
HCT FRN: 0005866421
ISED Registration Number: 5944A-5

FCC ID	**: 2ABA2SFM20R4**
IC	**: 11534A-SFM20R4**
APPLICANT	**: WISOL CO., LTD**

Model:	SFM20R4
EUT Type:	Sigfox Quad-mode module
Peak Output Power:	Wi-Fi 802.11b (17.40 dBm) / Wi-Fi 802.11g (21.36 dBm) / Wi-Fi 802.11n_HT20 (21.09 dBm)
Frequency Range:	2412 MHz - 2462 MHz (2.4 GHz Band)
Modulation type:	CCK/DSSS/OFDM
FCC Classification:	Digital Transmission System(DTS)
FCC Rule Part(s):	Part 15.247
ISED Rule Part(s):	RSS-247 Issue 2(February 2017), RSS-Gen Issue 4(November 2014)

Engineering Statement:

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them.

HCT CO., LTD. Certifies that no party to this application has subject to a denial of Federal benefits that includes FCC benefits pursuant to section 5301 of the Anti-Drug Abuse Act of 1998,21 U.S. C.853(a)

Report prepared by : Jung Lae Cho
Engineer of Telecommunication testing center

Approved by : Yong Hyun Lee
Manager of Telecommunication testing center

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Version

TEST REPORT NO.	DATE	DESCRIPTION
HCT-R-1706-F048	June 12, 2017	- First Approval Report
HCT-R-1706-F048-1	July 10, 2017	- Revised the Section 6 Antenna requirements on Page 6
HCT-R-1706-F048-2	July 12, 2017	- Revised the Output power
HCT-R-1706-F048-3	July 18, 2017	- Revised the Section 2 Antenna specification on Page 4 - Revised the Section 6 Antenna requirements on Page 6

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1. GENERAL INFORMATION

Applicant:	WISOL CO., LTD
Address:	531-7, Gajang-ro, Osan-si Gyeonggi-do, 18103, Korea
FCC ID:	2ABA2SFM20R4
IC:	11534A-SFM20R4
EUT Type:	Sigfox Quad-mode module
Model:	SFM20R4
Date(s) of Tests:	April 17, 2017 ~ May 26, 2017
	HCT Co., Ltd.
Place of Tests:	74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea

2. EUT DESCRIPTION

Model	SFM20R4	
EUT Type	Sigfox Quad-mode module	
Power Supply	DC 3.3 V	
Frequency Range	TX: 2412 MHz ~ 2462 MHz RX: 2412 MHz ~ 2462 MHz	
Max. RF Output Power	Peak	Wi-Fi 802.11b (17.40 dBm) / Wi-Fi 802.11g (21.36 dBm) / Wi-Fi 802.11n_HT20 (21.09 dBm)
	Average	Wi-Fi 802.11b (13.06 dBm) / Wi-Fi 802.11g (13.44 dBm) / Wi-Fi 802.11n_HT20 (13.20 dBm)
Modulation Type	DSSS/CCK(802.11b), OFDM(802.11g, 802.11n)	
Antenna Specification	Manufacturer: INNO-LINK Antenna type: External dipole antenna Peak Gain : 4.44 dBi	

3. TEST METHODOLOGY

FCC KDB 558074 D01 DTS Meas Guidance v04 dated April 05, 2017 entitled "Guidance for Performing Compliance Measurements on Digital Transmission Systems(DTS) and the measurement procedure described in ANSI C63.10(Version : 2013) 'the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices'.

3.1 EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

3.2 EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C/ RSS-Gen issue 4, RSS-247 issue 2.

3.3 GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10. (Version :2013) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peak and average detector modes.

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1GHz. Above 1GHz with 1.5m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3.75 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 8 of ANSI C63.10. (Version: 2013)

Conducted Antenna Terminal

See Section from 9.1 to 9.2.(KDB 558074 v04)

3.4 DESCRIPTION OF TEST MODES

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

Channel low, mid and high with highest data rate (worst case) is chosen for full testing.

4. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipments, which is traceable to recognized national standards.
Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2006).

5. FACILITIES AND ACCREDITATIONS

5.1 FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea. The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22. Detailed description of test facility was submitted to the Commission and accepted dated July 07, 2015 (Registration Number: 90661)

5.2 EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements. Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.
All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

6. ANTENNA REQUIREMENTS

According to FCC 47 CFR §15.203:

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.”

*This module has SMA type antenna connector, not unique coupling. So it`s subject to Limited singl e-modular transmitter.
*The OEM manufacturer who will install this module into their device must not give an access to an tenna and connector by end-user in compliance with FCC Section 15.203.

7. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4:2014.

All measurement uncertainty values are shown with a coverage factor of *k* = 2 to indicate a 95 % level of confidence.

Parameter	Expanded Uncertainty (±dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.82
Radiated Disturbance (9 kHz ~ 30 MHz)	3.40
Radiated Disturbance (30 MHz ~ 1 GHz)	4.80
Radiated Disturbance (1 GHz ~ 18 GHz)	5.70

8. SUMMARY TEST OF RESULTS

8.1 FCC Part

Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	§15.247(a)(2)	> 500 kHz	CONDUCTED	PASS
Conducted Maximum Peak Output Power	§15.247(b)(3)	< 1 Watt		PASS
Power Spectral Density	§15.247(e)	< 8 dBm / 3 kHz Band		PASS
Band Edge(Out of Band Emissions)	§15.247(d)	Conducted > 30 dBc		PASS
AC Power line Conducted Emissions	§15.207	cf. Section 9.8		PASS
Radiated Spurious Emissions	§15.205, 15.209	cf. Section 9.7.1	RADIATED	PASS
Radiated Restricted Band Edge	§15.247(d), 15.205, 15.209	cf. Section 9.7.2		PASS

8.2 ISED Part

Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	RSS-247, 5.2	> 500 kHz	CONDUCTED	PASS
99% Bandwidth	RSS-GEN, 6.6	NA		NA
Conducted Maximum Peak Output Power And e.i.r.p.	RSS-247, 5.4.4	< 1 Watt <4 Watt(e.i.r.p.)		PASS
Power Spectral Density	RSS-247, 5.2	< 8 dBm / 3 kHz Band		PASS
Band Edge(Out of Band Emissions)	RSS-247, 5.5	Conducted > 20 dBc		PASS
AC Power line Conducted Emissions	RSS-GEN, 8.8	cf. Section 8.7		PASS
Radiated Spurious Emissions	RSS-GEN, 8.9	RSS-GEN section 8.9 table 4, 5	RADIATED	PASS
Receiver Spurious Emissions	RSS-GEN, 5 RSS-GEN, 7.1.2	RSS-GEN section 7.1.2 table 2		PASS
Radiated Restricted Band Edge	RSS-GEN, 8.10	RSS-GEN section 8.10 table 6		PASS

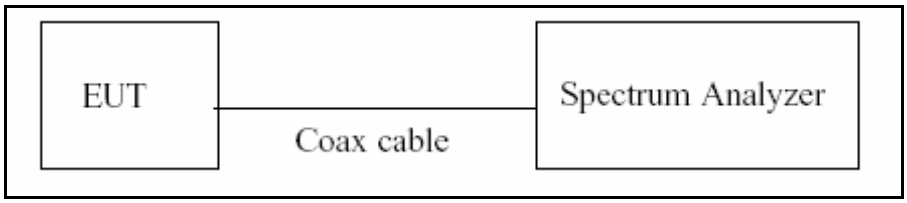
9. TEST RESULT

9.1 DUTY CYCLE

According to Section 6.0)b) in KDB 558074 v04

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ RBW. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer. We tested according to the zero-span measurement method, 6.0)b) in KDB 558074 v04.

The largest available value of RBW is 8 MHz and VBW is 50 MHz. The zero-span method of measuring duty cycle shall not be used if T ≤ 6.25 microseconds. (50/6.25 = 8)

The zero-span method was used because all measured T data are > 6.25 microseconds and both RBW and VBW are > 50/*T*.

1. RBW = 8 MHz (the largest available value)
2. VBW = 8 MHz (≥ RBW)
3. SPAN = 0 Hz
4. Detector = Peak
5. Number of points in sweep > 100
6. Trace mode = Clear write
7. Measure T_{total} and T_{on}
8. Calculate Duty Cycle = T_{on}/ T_{total} and Duty Cycle Factor = 10*log(1/Duty Cycle)

▣ Duty Cycle Factor

Mode	Data Rate	T_{on} (ms)	T_{total} (ms)	Duty Cycle	Duty Cycle Factor (dB)
b	1 Mbps	1.000	1.000	1.00000000	1.000
	2 Mbps	1.000	1.000	1.00000000	1.000
	5.5 Mbps	1.000	1.000	1.00000000	1.000
	11 Mbps	1.000	1.000	1.00000000	1.000
g	6 Mbps	1.000	1.000	1.00000000	1.000
	9 Mbps	1.000	1.000	1.00000000	1.000
	12 Mbps	1.000	1.000	1.00000000	1.000
	18 Mbps	1.000	1.000	1.00000000	1.000
	24 Mbps	1.000	1.000	1.00000000	1.000
	36 Mbps	1.000	1.000	1.00000000	1.000
	48 Mbps	1.000	1.000	1.00000000	1.000
	54 Mbps	1.000	1.000	1.00000000	1.000
n_HT20	MCS Index 0	1.000	1.000	1.00000000	1.000
	MCS Index 1	1.000	1.000	1.00000000	1.000
	MCS Index 2	1.000	1.000	1.00000000	1.000
	MCS Index 3	1.000	1.000	1.00000000	1.000
	MCS Index 4	1.000	1.000	1.00000000	1.000
	MCS Index 5	1.000	1.000	1.00000000	1.000
	MCS Index 6	1.000	1.000	1.00000000	1.000
	MCS Index 7	1.000	1.000	1.00000000	1.000

Note : Duty Cycle Factor = 10*log(1/Duty Cycle). where, Duty Cycle = T_{on} / T_{total}

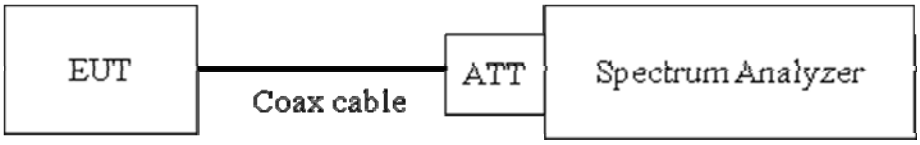
9.2 6dB BANDWIDTH

Test Requirements and limit, §15.247(a)(2) / RSS-247(Issue 2) Section 5.2.

The bandwidth at 6dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequencies.

The minimum permissible 6dB bandwidth is 500 kHz.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to (Procedure 8.1 in KDB 558074 v04)

RBW = 100 kHz

VBW ≥ 3 x RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

Note : We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

▣ TEST RESULTS

Conducted 6dB Bandwidth Measurements for 802.11b

802.11b Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]	Pass / Fail
Frequency [MHz]	Channel No.			
2412	1	8.580	0.5	Pass
2437	6	8.571	0.5	Pass
2462	11	8.166	0.5	Pass

Conducted 6dB Bandwidth Measurements for 802.11g

802.11g Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]	Pass / Fail
Frequency [MHz]	Channel No.			
2412	1	15.85	0.5	Pass
2437	6	15.79	0.5	Pass
2462	11	15.87	0.5	Pass

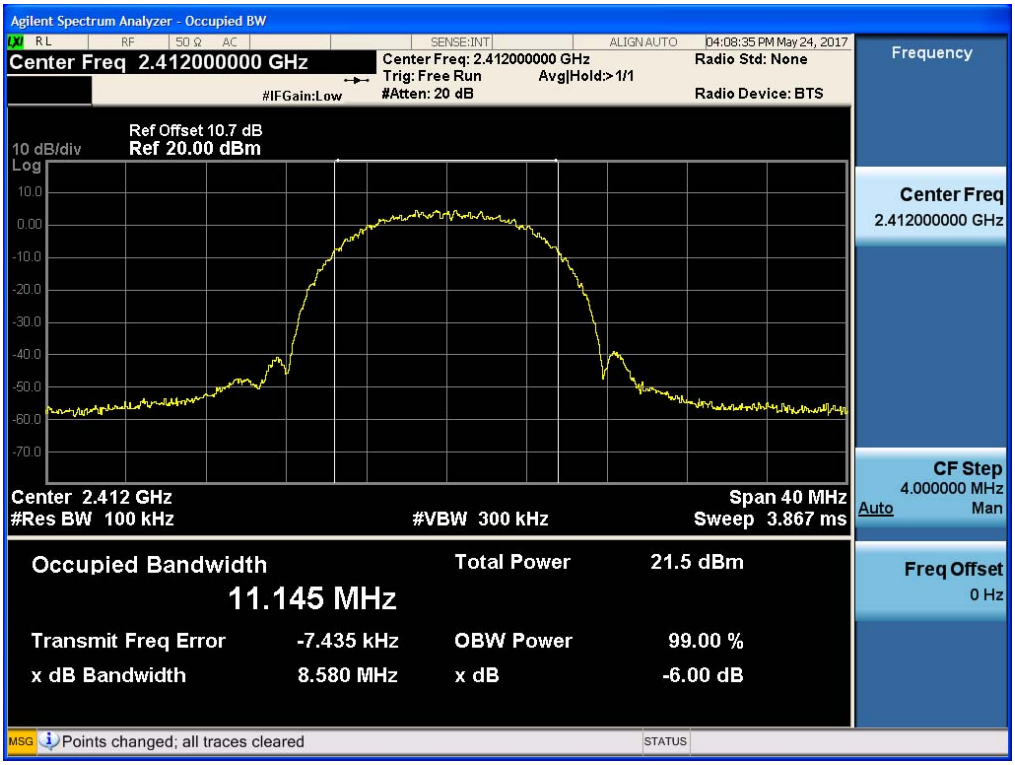
Conducted 6dB Bandwidth Measurements for 802.11n_HT20

802.11n Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]	Pass / Fail
Frequency [MHz]	Channel No.			
2412	1	15.84	0.5	Pass
2437	6	15.74	0.5	Pass
2462	11	15.83	0.5	Pass

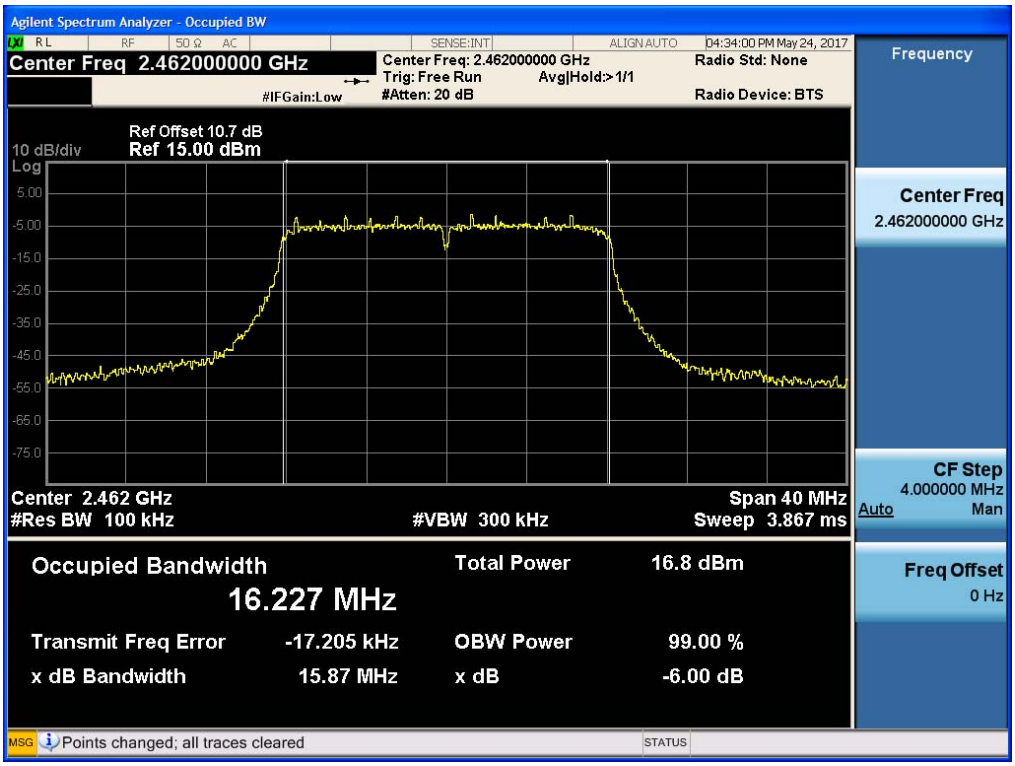
Note : In order to simplify the report, attached plots were only the most wide 6 dB BW channel.

▣ RESULT PLOTS

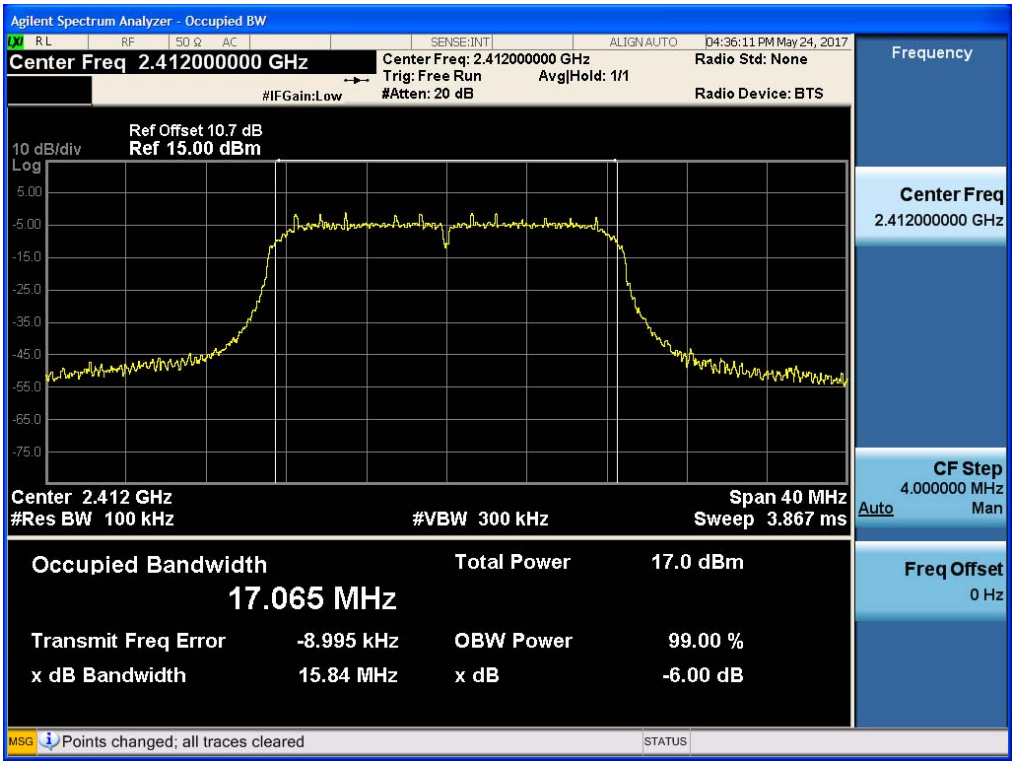
6dB Bandwidth plot (802.11b-CH 1)



6dB Bandwidth plot (802.11g-CH 11)



6dB Bandwidth plot (802.11n_HT20-CH 1)

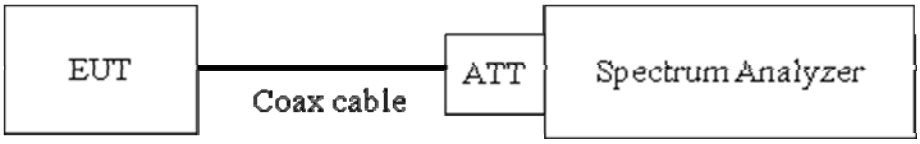


9.3 99% BANDWIDTH

Limit, RSS-Gen(Issue 4) Section 6.6

The 99 % bandwidth is used to determine the conducted power limits.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer.

RBW = 1% ~ 5% of the occupied bandwidth

VBW ≒ 3 x RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

Note : We tested OBW using the automatic bandwidth measurement capability of a spectrum analyzer.

▣ TEST RESULTS

Conducted 99% Bandwidth Measurements for 802.11b

802.11b Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]
Frequency [MHz]	Channel No.		
2412	1	11.19	N/A
2437	6	11.18	N/A
2462	11	11.17	N/A

Conducted 99% Bandwidth Measurements for 802.11g

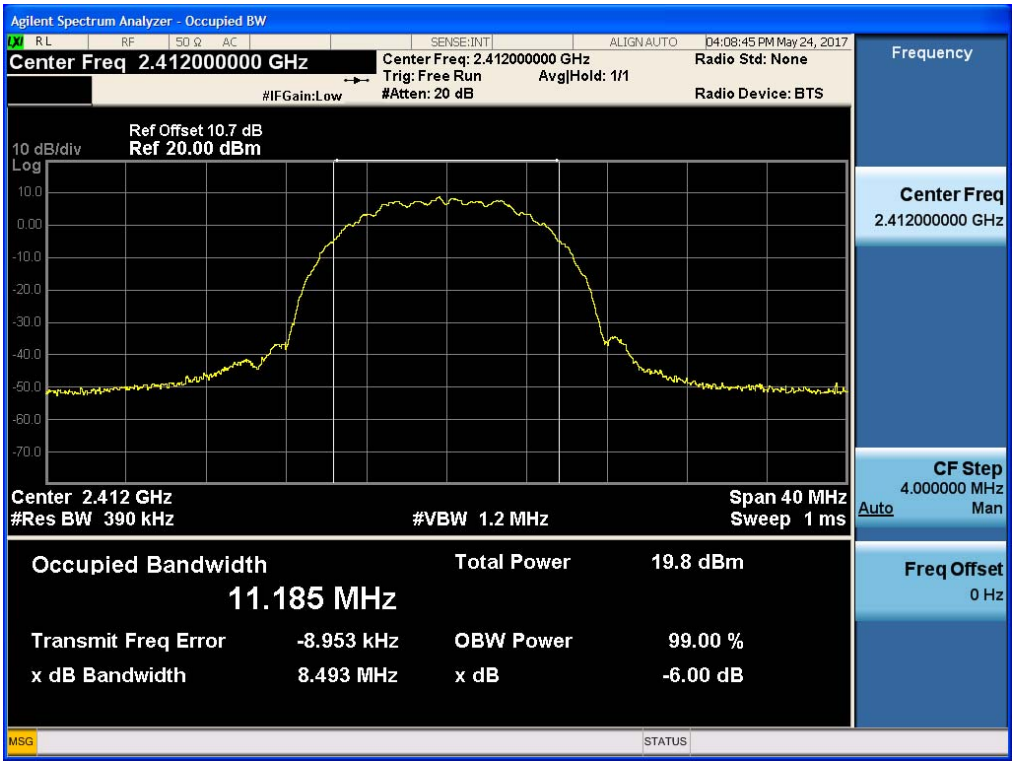
802.11b Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]
Frequency [MHz]	Channel No.		
2412	1	16.34	N/A
2437	6	16.42	N/A
2462	11	16.34	N/A

Conducted 99% Bandwidth Measurements for 802.11n_HT20

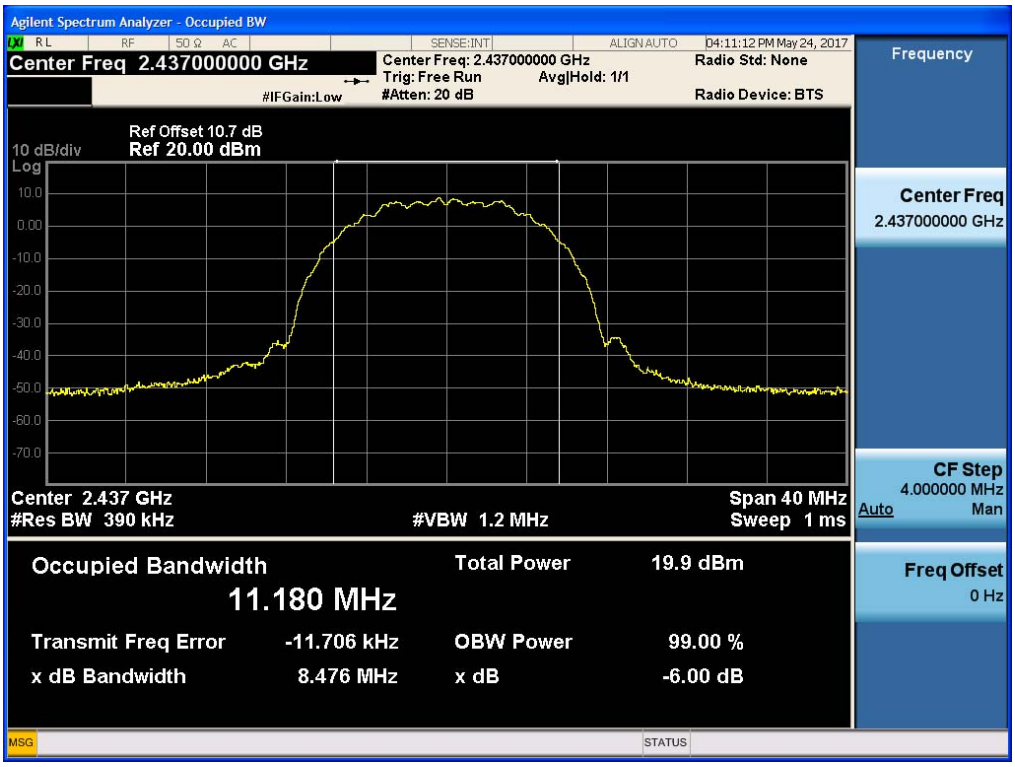
802.11b Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]
Frequency [MHz]	Channel No.		
2412	1	17.12	N/A
2437	6	17.17	N/A
2462	11	17.11	N/A

▣ RESULT PLOTS

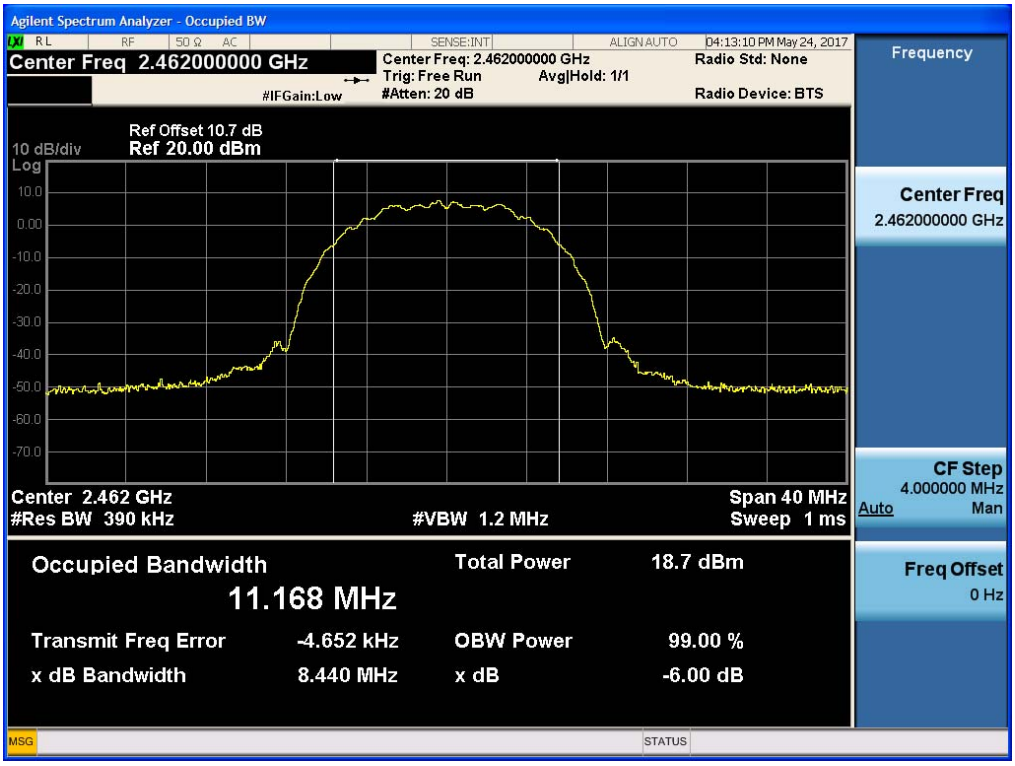
99% Bandwidth plot (802.11b - CH 1)



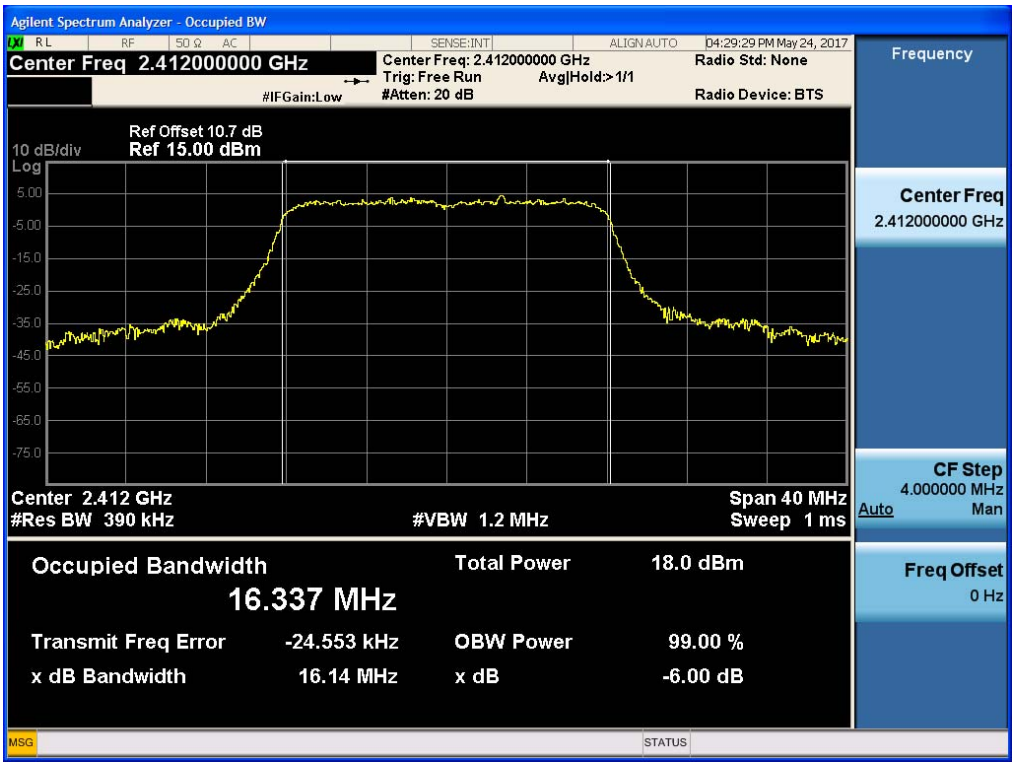
99% Bandwidth plot (802.11b - CH 6)



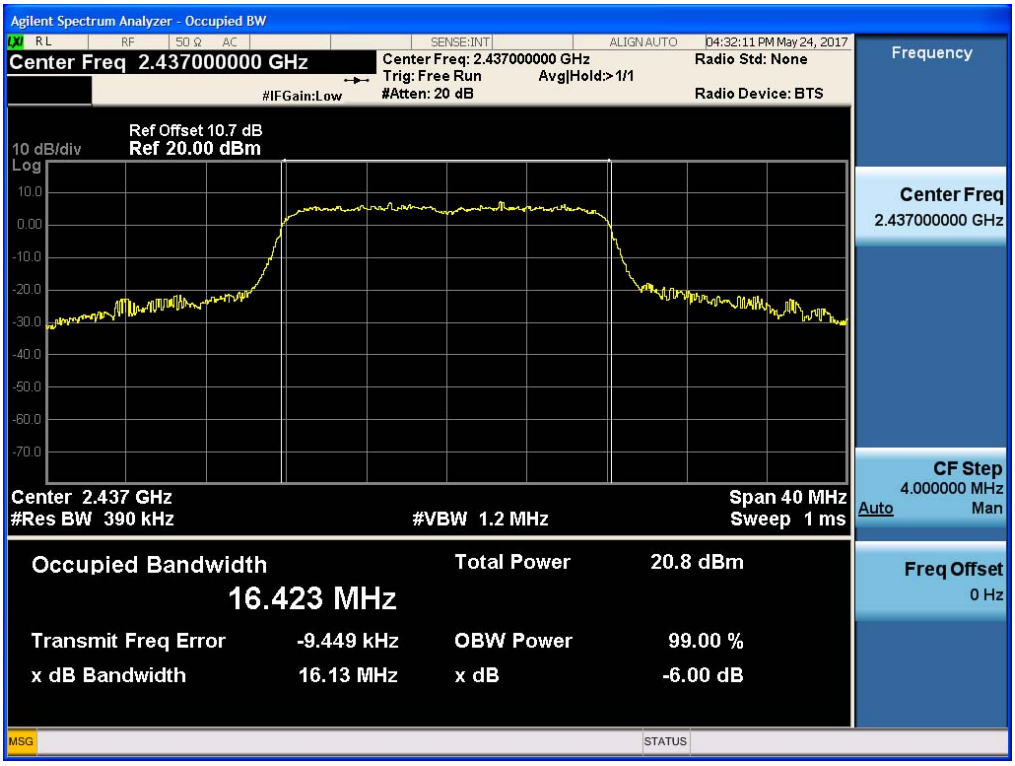
99% Bandwidth plot (802.11b - CH 11)



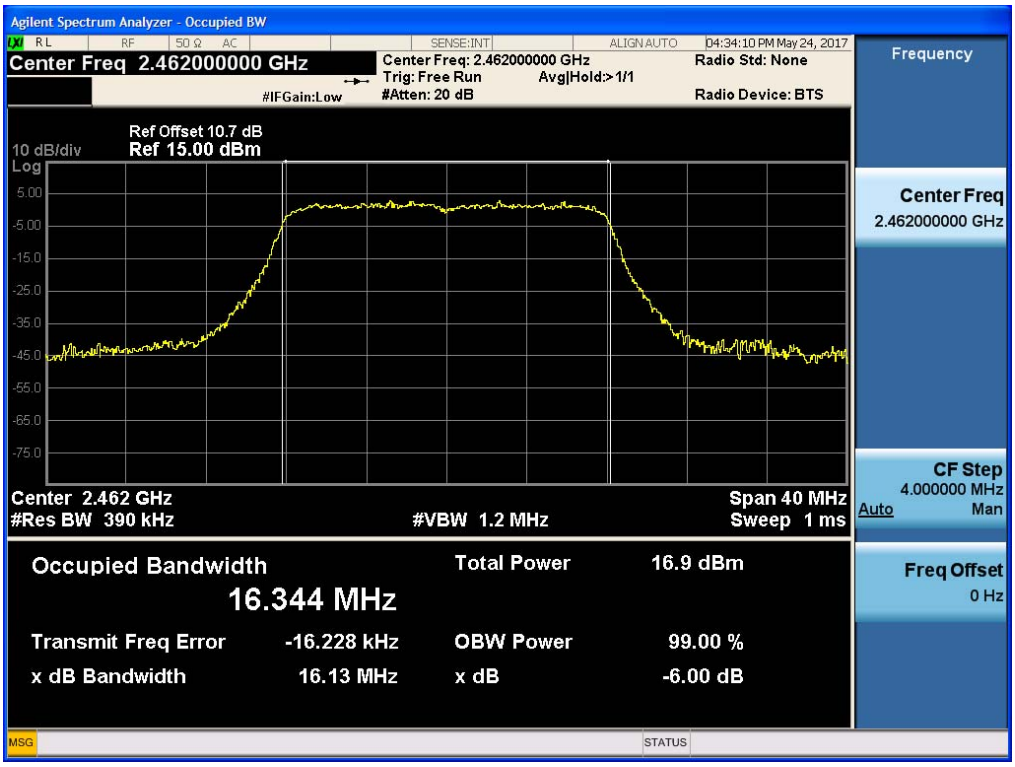
99% Bandwidth plot (802.11g - CH 1)



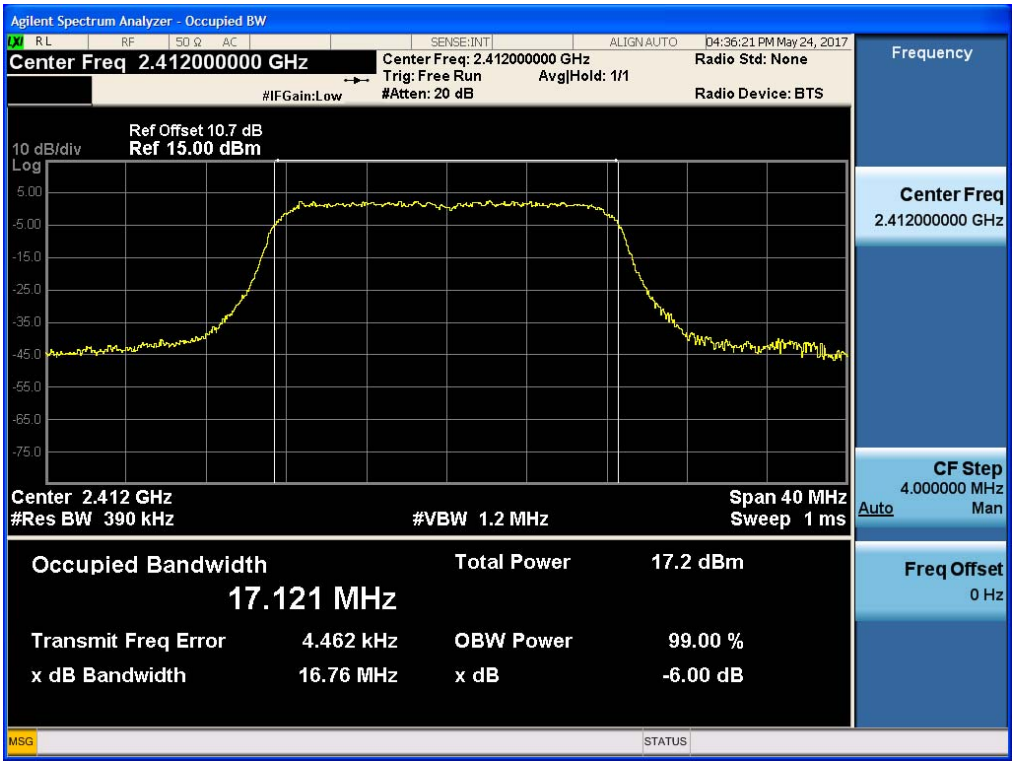
99% Bandwidth plot (802.11g - CH 6)



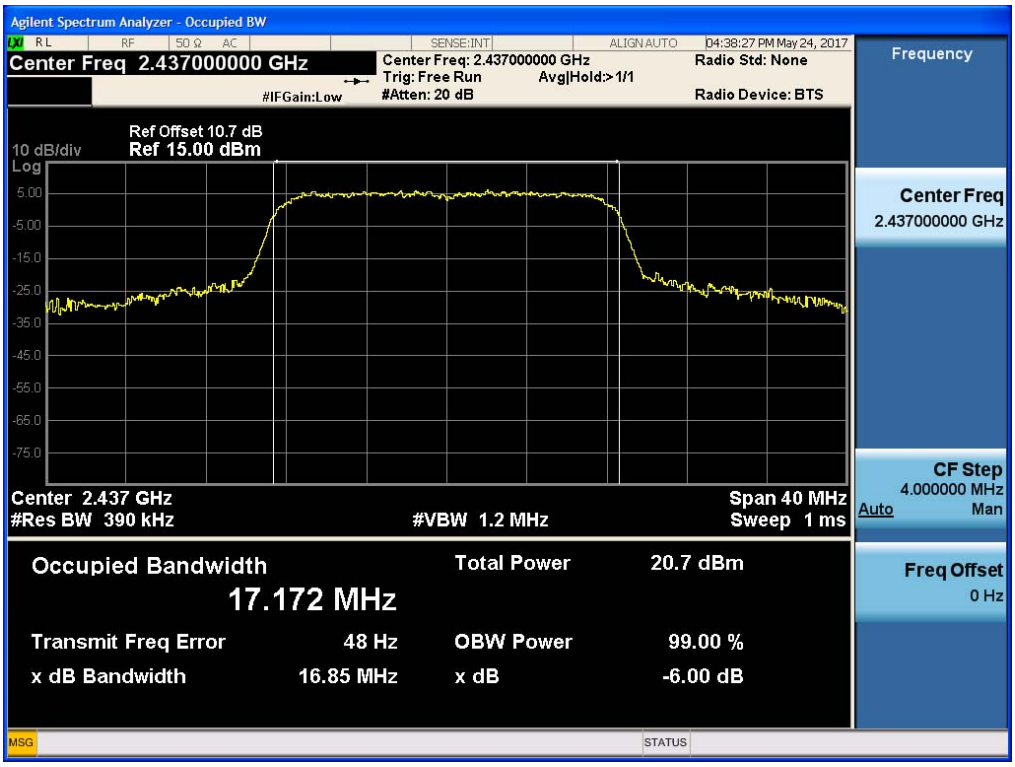
99% Bandwidth plot (802.11g - CH 11)



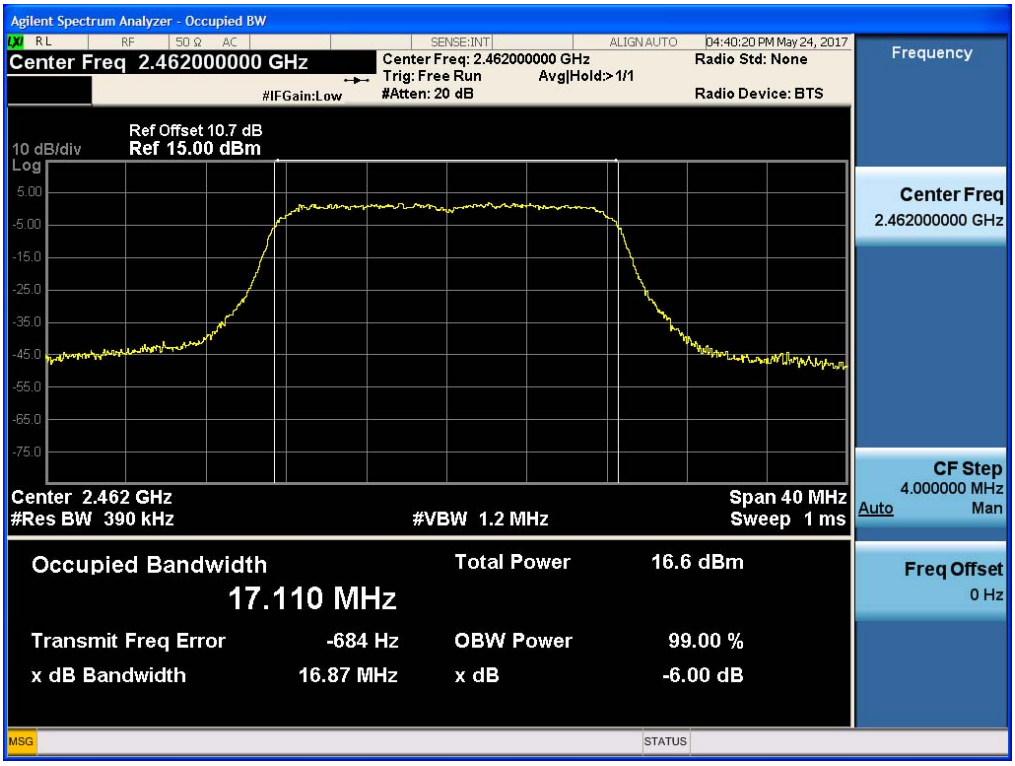
99% Bandwidth plot (802.11n_HT20 - CH 1)



99% Bandwidth plot (802.11n_HT20 - CH 6)



99% Bandwidth plot (802.11n_HT20 - CH 11)



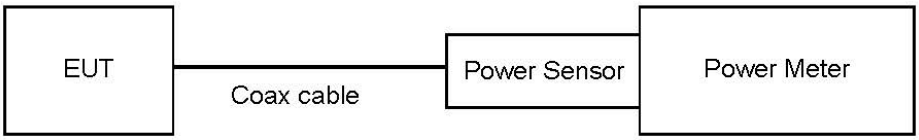
9.4 OUTPUT POWER (802.11b/g/n)

Test Requirements and limit, §15.247(b)(3) / RSS-247(Issue 2) Section 5.4.4.

The transmitter output is connected to the input of an RF power sensor. Measurement is made using a broadband power meter capable of making peak and average measurements while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies.

The maximum permissible conducted output power is 1 Watt.

▣ TEST CONFIGURATION(20 MHz BW)



▣ TEST PROCEDURE(20 MHz BW)

- Peak Power (Procedure 9.1.2 in KDB 558074 v04)
  1. Measure the peak power of the transmitter.
- Average Power (Procedure 9.2.3.1 in KDB 558074 v04)
  1. Measure the duty cycle.
  2. Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
  3. Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times.

Note :

1. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So, 10.7 dB is offset for 2.4 GHz Band.
   Actual value of loss for the attenuator and cable combination is below table.

Band	Frequency[MHz]	Loss[dB]
2.4 GHz	2412	10.65
	2437	10.65
	2462	10.66

(Actual value of loss for the attenuator and cable combination)

▣ TEST RESULTS-Peak

Conducted Output Power Measurements (802.11b Mode)

802.11b Mode		Rate [Mbps]	Measured Power[dBm]	Limit [dBm]
Frequency[MHz]	Channel No.			
2412	1	1 Mbps	15.85	30
		2 Mbps	15.86	30
		5.5 Mbps	15.86	30
		11 Mbps	16.52	30
2437	6	1 Mbps	17.15	30
		2 Mbps	17.15	30
		5.5 Mbps	17.33	30
		11 Mbps	17.40	30
2462	11	1 Mbps	14.98	30
		2 Mbps	15.02	30
		5.5 Mbps	15.08	30
		11 Mbps	15.72	30

Conducted Output Power Measurements (802.11g Mode)

802.11g Mode		Rate [Mbps]	Measured Power[dBm]	Limit [dBm]
Frequency[MHz]	Channel No.			
2412	1	6 Mbps	19.82	30
		9 Mbps	19.98	30
		12 Mbps	19.92	30
		18 Mbps	19.53	30
		24 Mbps	19.55	30
		36 Mbps	19.10	30
		48 Mbps	17.35	30
		54 Mbps	17.29	30
2437	6	6 Mbps	21.36	30
		9 Mbps	20.89	30
		12 Mbps	20.89	30
		18 Mbps	20.69	30
		24 Mbps	20.63	30
		36 Mbps	20.41	30
		48 Mbps	19.17	30
		54 Mbps	19.12	30
2462	11	6 Mbps	19.34	30
		9 Mbps	19.33	30
		12 Mbps	19.37	30
		18 Mbps	18.25	30
		24 Mbps	18.37	30
		36 Mbps	17.70	30
		48 Mbps	15.66	30
		54 Mbps	15.60	30

Conducted Output Power Measurements (802.11n_HT20 Mode)

802.11n Mode		MCS	Measured	Limit
Frequency[MHz]	Channel No.	Index	Power[dBm]	[dBm]
2412	1	0	19.66	30
		1	19.76	30
		2	19.32	30
		3	19.48	30
		4	18.78	30
		5	16.72	30
		6	15.82	30
		7	14.40	30
2437	6	0	21.09	30
		1	20.88	30
		2	20.72	30
		3	20.74	30
		4	20.49	30
		5	19.11	30
		6	18.45	30
		7	17.24	30
2462	11	0	19.03	30
		1	19.31	30
		2	18.26	30
		3	18.25	30
		4	17.65	30
		5	15.26	30
		6	14.45	30
		7	12.88	30

▣ TEST RESULTS-Average

Conducted Output Power Measurements (802.11b Mode)

802.11b Mode		Rate [Mbps]	Measured Power[dBm]	Duty Cycle Factor [dB]	Measured Power(dBm) + Duty Cycle Factor[dB]	Limit [dBm]
Frequency [MHz]	Channel No.					
2412	1	1 Mbps	12.76	0.000	12.76	30
		2 Mbps	12.75	0.000	12.75	30
		5.5 Mbps	12.72	0.000	12.72	30
		11 Mbps	12.73	0.000	12.73	30
2437	6	1 Mbps	13.03	0.000	13.03	30
		2 Mbps	13.04	0.000	13.04	30
		5.5 Mbps	13.05	0.000	13.05	30
		11 Mbps	13.06	0.000	13.06	30
2462	11	1 Mbps	11.81	0.000	11.81	30
		2 Mbps	11.82	0.000	11.82	30
		5.5 Mbps	11.86	0.000	11.86	30
		11 Mbps	11.89	0.000	11.89	30

Conducted Output Power Measurements (802.11g Mode)

802.11g Mode		Rate [Mbps]	Measured Power[dBm]	Duty Cycle Factor [dB]	Measured Power(dBm) + Duty Cycle Factor[dB]	Limit [dBm]
Frequency [MHz]	Channel No.					
2412	1	6 Mbps	10.69	0.000	10.69	30
		9 Mbps	11.65	0.000	11.65	30
		12 Mbps	11.67	0.000	11.67	30
		18 Mbps	10.77	0.000	10.77	30
		24 Mbps	10.77	0.000	10.77	30
		36 Mbps	9.51	0.000	9.51	30
		48 Mbps	8.19	0.000	8.19	30
		54 Mbps	7.17	0.000	7.17	30
2437	6	6 Mbps	13.38	0.000	13.38	30
		9 Mbps	13.40	0.000	13.40	30
		12 Mbps	13.44	0.000	13.44	30
		18 Mbps	12.93	0.000	12.93	30
		24 Mbps	12.89	0.000	12.89	30
		36 Mbps	11.96	0.000	11.96	30
		48 Mbps	10.38	0.000	10.38	30
		54 Mbps	9.43	0.000	9.43	30
2462	11	6 Mbps	9.98	0.000	9.98	30
		9 Mbps	9.96	0.000	9.96	30
		12 Mbps	10.00	0.000	10.00	30
		18 Mbps	8.75	0.000	8.75	30
		24 Mbps	8.72	0.000	8.72	30
		36 Mbps	7.69	0.000	7.69	30
		48 Mbps	6.37	0.000	6.37	30
		54 Mbps	5.38	0.000	5.38	30

Conducted Output Power Measurements (802.11n_HT20 Mode)

802.11n Mode		MCS Index	Measured Power[dBm]	Duty Cycle Factor [dB]	Measured Power(dBm) + Duty Cycle Factor[dB]	Limit [dBm]
Frequency [MHz]	Channel No.					
2412	1	0	11.00	0.000	11.00	30
		1	10.99	0.000	10.99	30
		2	10.12	0.000	10.12	30
		3	10.11	0.000	10.11	30
		4	8.85	0.000	8.85	30
		5	7.38	0.000	7.38	30
		6	6.40	0.000	6.40	30
		7	4.52	0.000	4.52	30
2437	6	0	13.20	0.000	13.20	30
		1	13.16	0.000	13.16	30
		2	12.88	0.000	12.88	30
		3	12.88	0.000	12.88	30
		4	11.98	0.000	11.98	30
		5	10.30	0.000	10.30	30
		6	9.38	0.000	9.38	30
		7	7.52	0.000	7.52	30
2462	11	0	9.67	0.000	9.67	30
		1	9.65	0.000	9.65	30
		2	8.44	0.000	8.44	30
		3	8.44	0.000	8.44	30
		4	7.38	0.000	7.38	30
		5	5.89	0.000	5.89	30
		6	5.01	0.000	5.01	30
		7	3.07	0.000	3.07	30

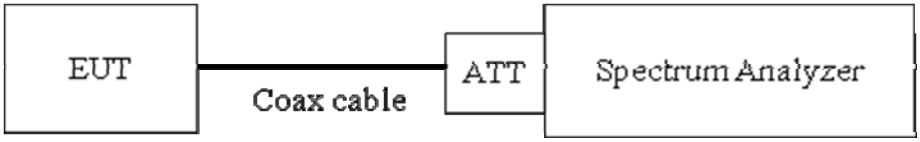
9.5 POWER SPECTRAL DENSITY (802.11b/g/n)

Test Requirements and limit, §15.247(e) / RSS-247(Issue 2) Section 5.2.

The peak power spectral density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

Minimum Standard – 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.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

We tested according to Procedure 10.2 in KDB 558074 v04

The spectrum analyzer is set to :

Set analyzer center frequency to DTS channel center frequency.

Span = 1.5 times the DTS channel bandwidth.

RBW = 3 kHz ≤ RBW ≤ 100 kHz.

VBW ≥ 3 x RBW.

Sweep = auto couple

Detector = peak

Trace Mode = max hold

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level within the RBW.

If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

▣ Sample Calculation

PSD = Reading Value + ATT loss + Cable loss(1 ea)

Output Power = -5 dBm + 10 dB + 0.8 dB = 5.8 dBm

Note :

1. Spectrum reading values are not plot data. The PSD results in plot is already including the actual values of loss for the attenuator and cable combination.
2. Spectrum offset = Attenuator loss + Cable loss
3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So, 10.7 dB is offset for 2.4 GHz Band.

   Actual value of loss for the attenuator and cable combination is below table.

Band	Frequency(MHz)	Loss(dB)
2.4 GHz	2412	10.65
	2437	10.65
	2462	10.66

(Actual value of loss for the attenuator and cable combination)

▣ TEST RESULTS

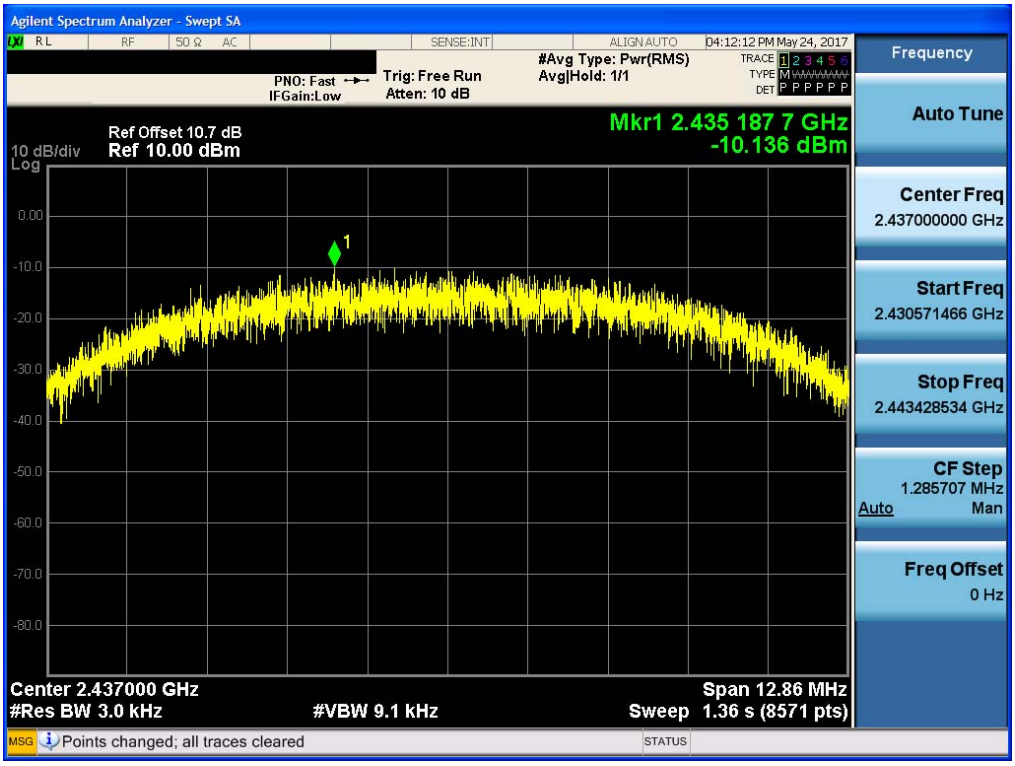
Conducted Power Density Measurements

Frequency [MHz]	Channel No.	Mode	Test Result		
			PSD [dBm]	Limit [dBm]	Pass/Fail
2412	1	802.11b	-10.470	8	Pass
2437	6		-10.136	8	Pass
2462	11		-10.692	8	Pass
2412	1	802.11g	-14.051	8	Pass
2437	6		-12.076	8	Pass
2462	11		-14.996	8	Pass
2412	1	802.11n _HT20	-15.349	8	Pass
2437	6		-11.647	8	Pass
2462	11		-16.655	8	Pass

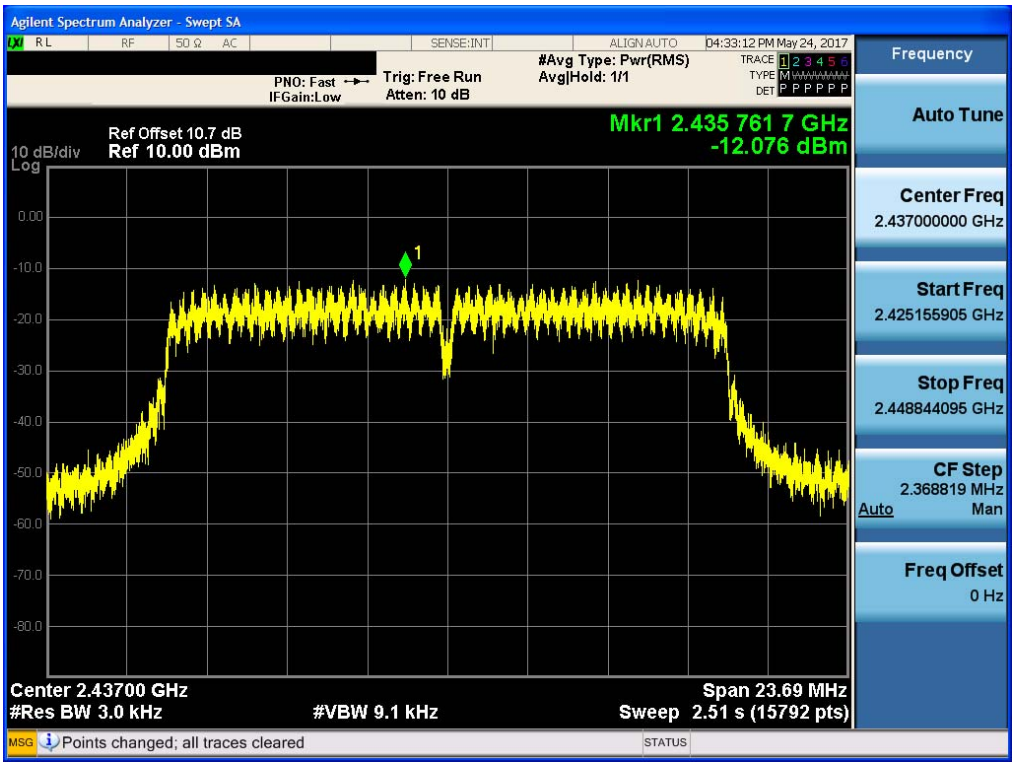
Note : In order to simplify the report, attached plots were only the highest PSD channel.

▣ RESULT PLOTS

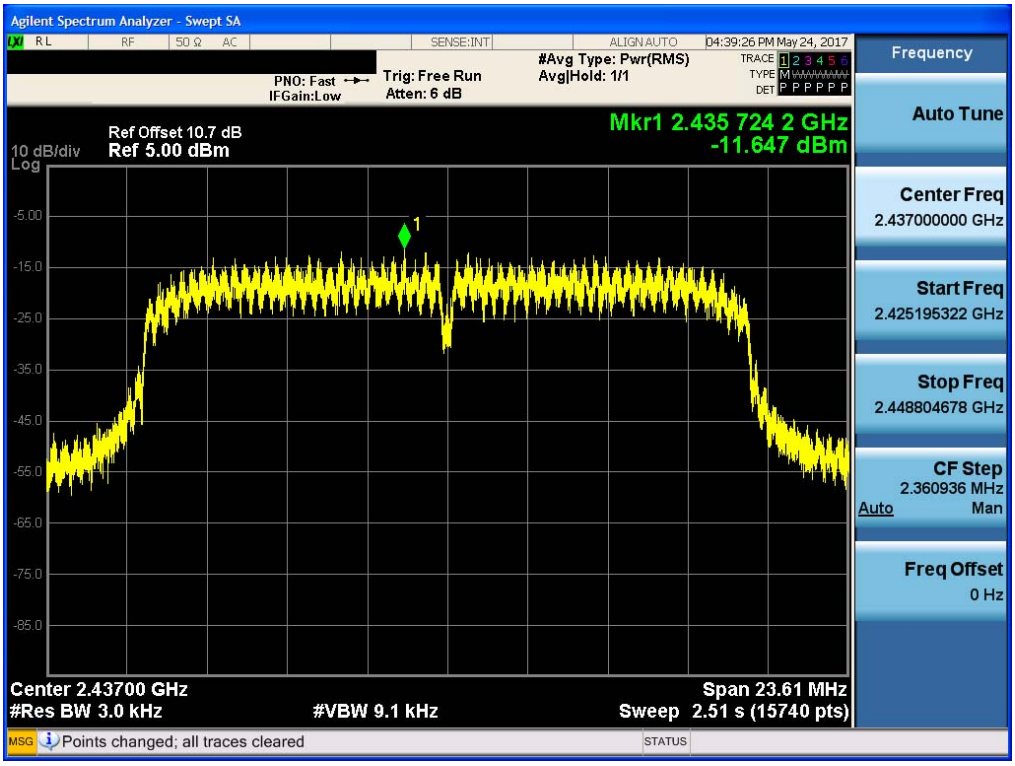
Power Spectral Density (802.11b-CH 6)



Power Spectral Density (802.11g-CH 6)



Power Spectral Density (802.11n_HT20 -CH 6)



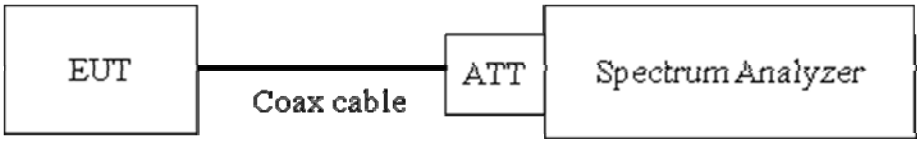
9.6 OUT OF BAND EMISSIONS AT THE BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS

Test Requirements and limit, §15.247(d) / RSS-247(Issue 2) Section 5.5.

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) / RSS-Gen is not required. In addition, 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)).

Limit : 20 dBc

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. (Procedure 11.0 in KDB 558074 v04)

RBW = 100 kHz

VBW ≥ 3 x RBW

Set span to encompass the spectrum to be examined

Detector = Peak

Trace Mode = max hold

Sweep time = auto couple

Ensure that the number of measurement points ≥ Span/RBW

Allow trace to fully stabilize.

Use peak marker function to determine the maximum amplitude level.

Measurements are made over the 30 MHz to 10th harmonic range with the transmitter set to the lowest, middle, and highest channels.

Note :

1. The maximum peak conducted output power procedure was used to demonstrate compliance as described in 9.1(KDB558074 v04), so the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc).

2. The band edge results in plot is already including the actual values of loss for the attenuator and cable combination.
3. Spectrum offset = Attenuator loss + Cable loss
4. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So, 10.7 dB is offset for 2.4 GHz Band. Actual value of loss for the attenuator and cable combination is below table.

Band	Frequency(MHz)	Loss(dB)
2.4 GHz	2412	10.65
	2437	10.65
	2462	10.66

(Actual value of loss for the attenuator and cable combination)

5. In case of conducted spurious emissions test, please check factors blow table.
6. In order to simplify the report, attached plots were only the worst case channel.

▣ FACTORS FOR FREQUENCY

Freq(MHz)	Factor(dB)
30	11.30
100	9.83
200	10.19
300	10.13
400	10.23
500	10.25
600	10.32
700	10.35
800	10.35
900	10.34
1000	10.39
2000	10.64
2400*	10.65
2500*	10.67
3000	10.68
4000	10.89
5000	11.07
6000	11.06
7000	11.35
8000	11.32
9000	11.48

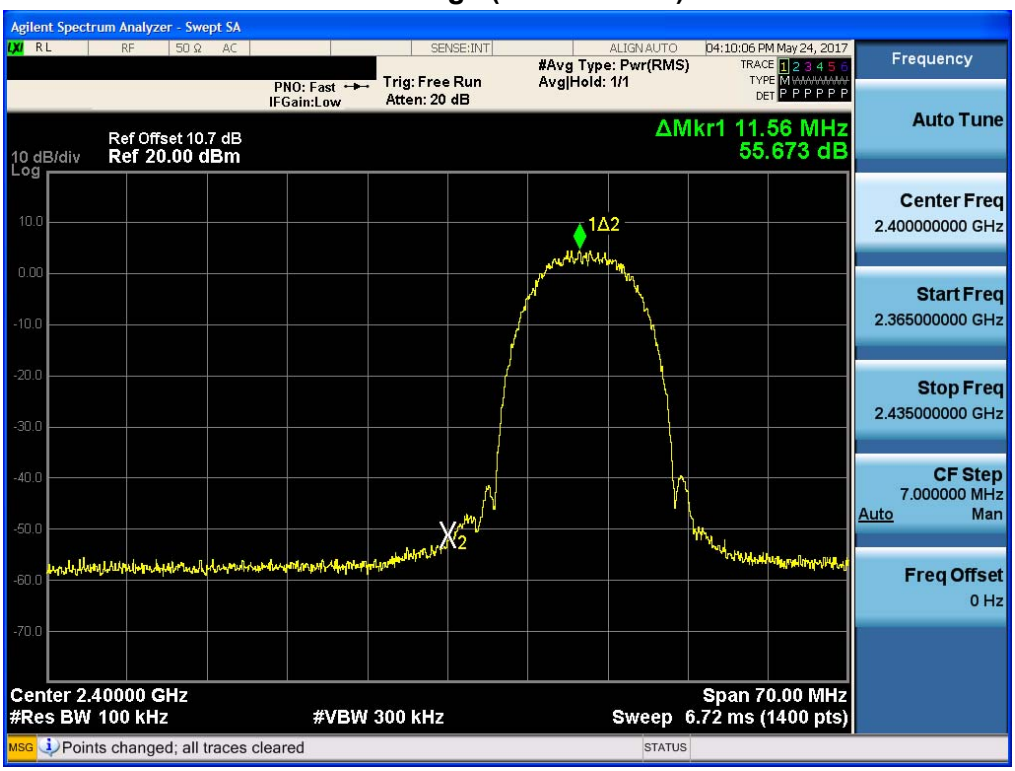
10000	11.56
11000	11.56
12000	11.68
13000	11.83
14000	11.90
15000	11.98
16000	12.04
17000	12.02
18000	12.08
19000	12.07
20000	12.14
21000	12.17
22000	12.31
23000	12.60
24000	12.34
25000	12.53

Note : 1. '*' is fundamental frequency range.

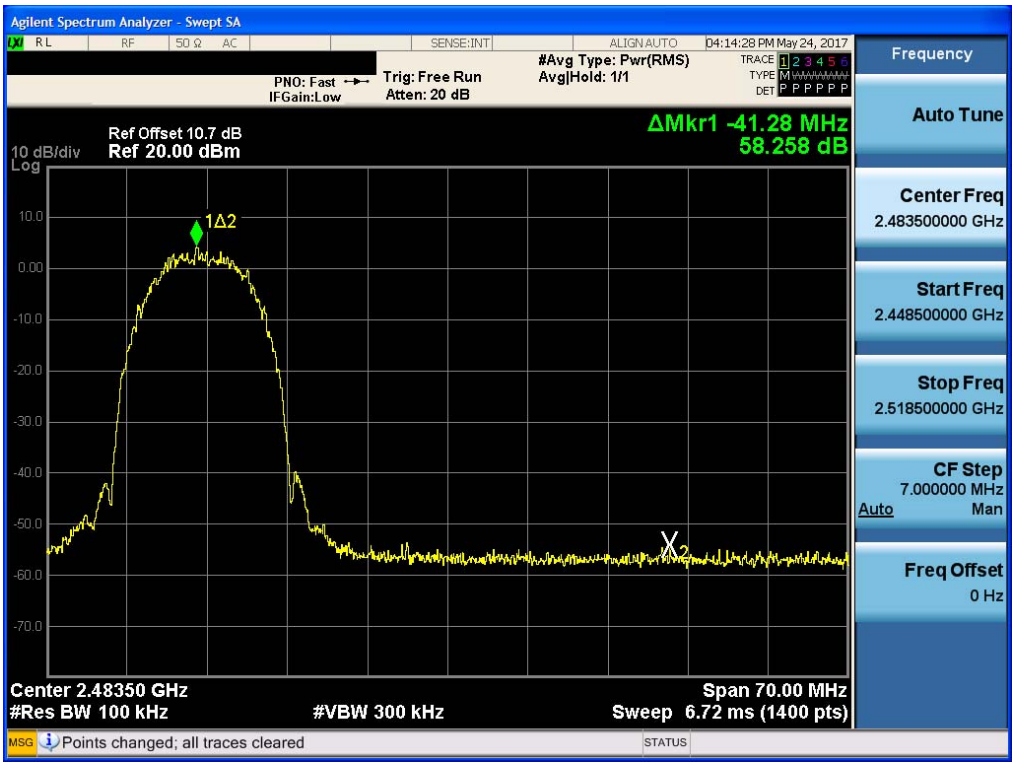
2. Factor = Cable loss + Attenuator loss

▣ RESULT PLOTS

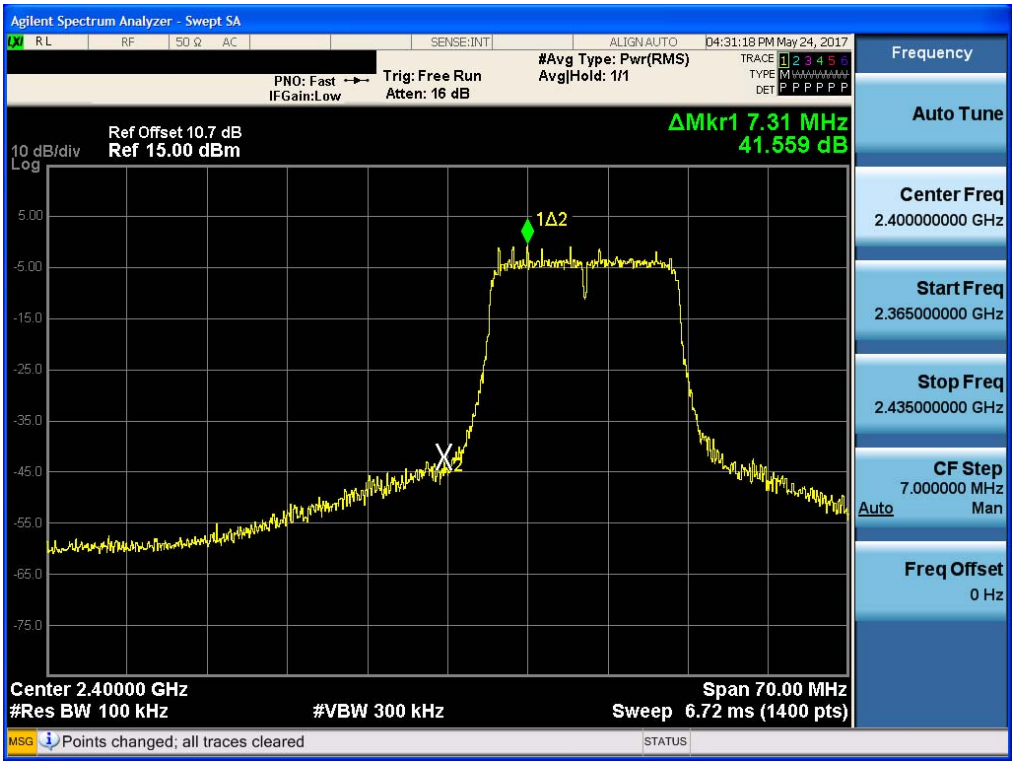
Band Edge (802.11b-CH1)



Band Edge (802.11b-CH11)

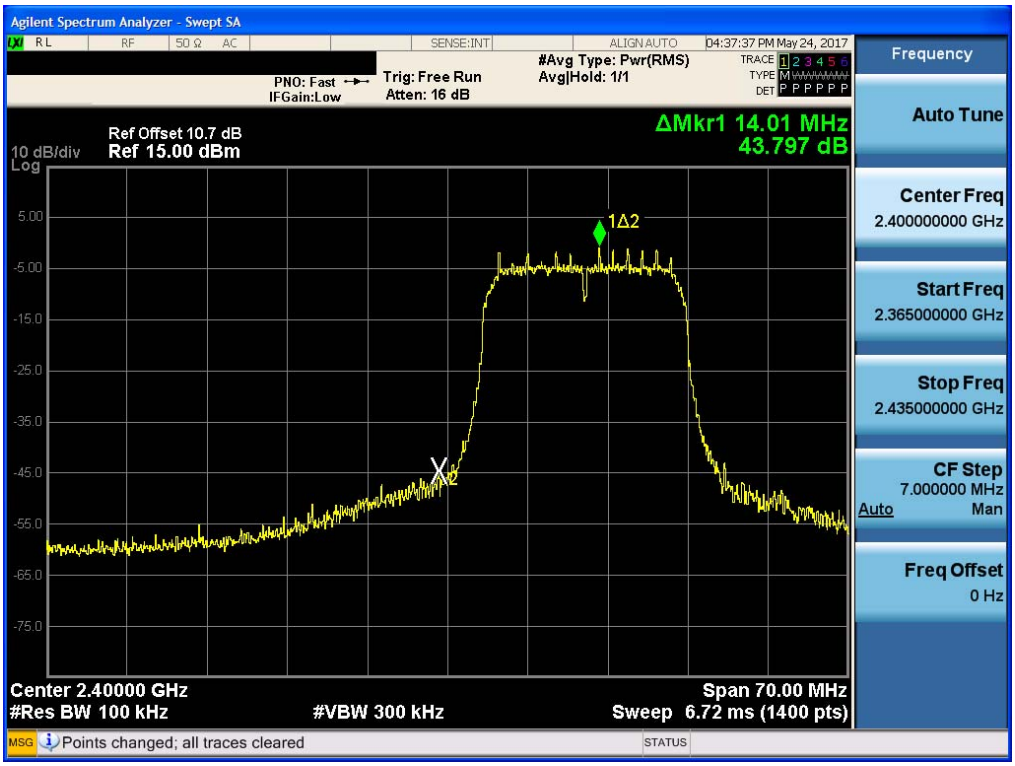


Band Edge (802.11g-CH1)

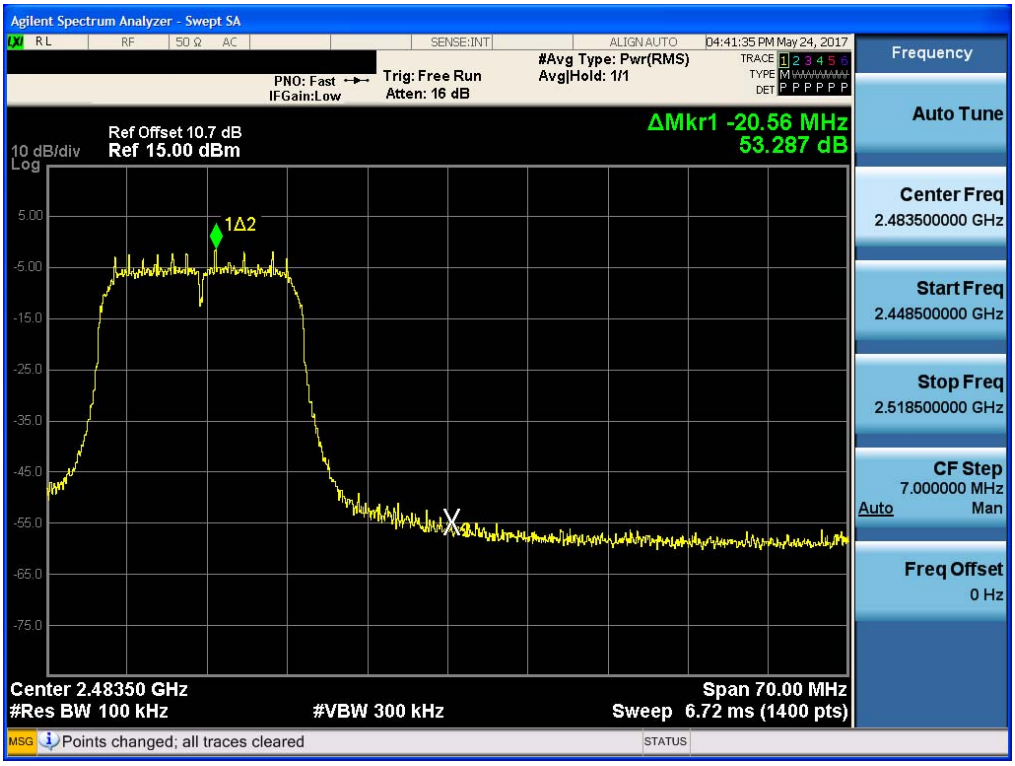


Band Edge (802.11g-CH11)

Band Edge (802.11n_HT20-CH1)

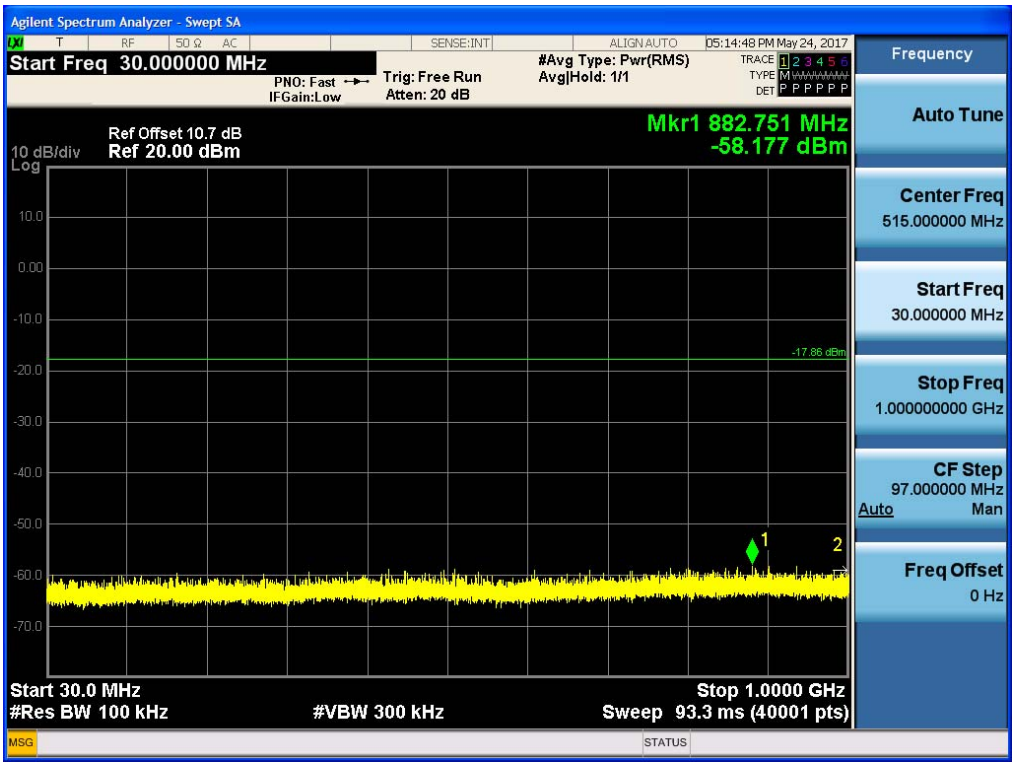


Band Edge (802.11n_HT20-CH11)



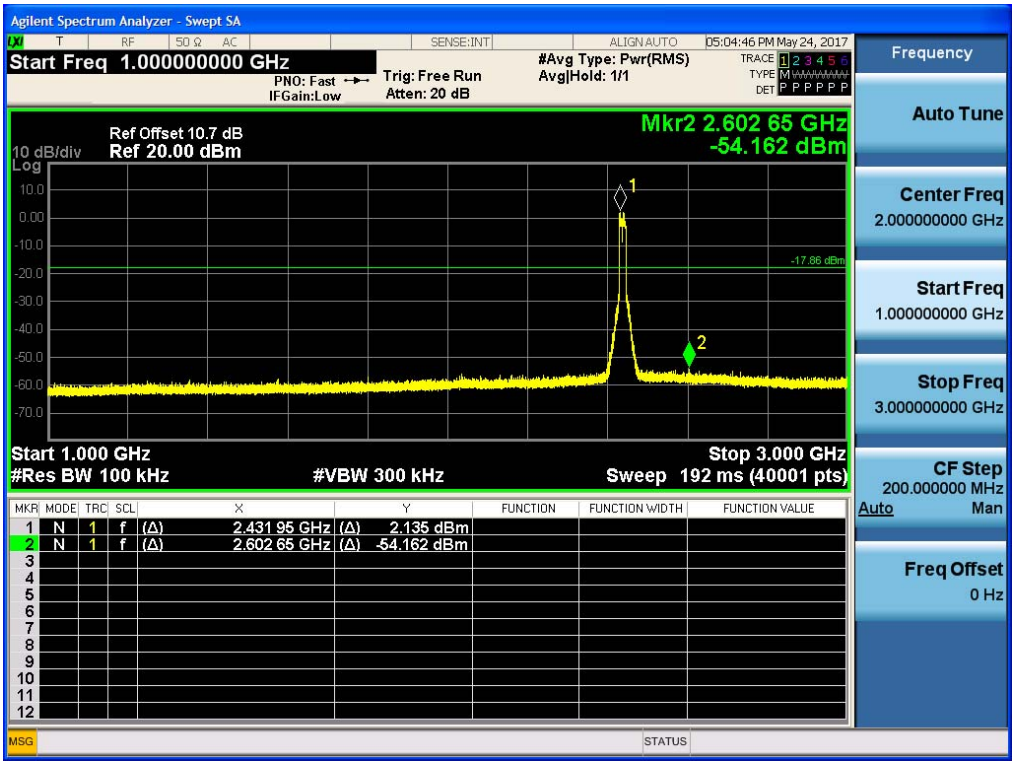
30 MHz ~ 1 GHz

Conducted Spurious Emission (802.11g_Ch.06_6 Mbps)



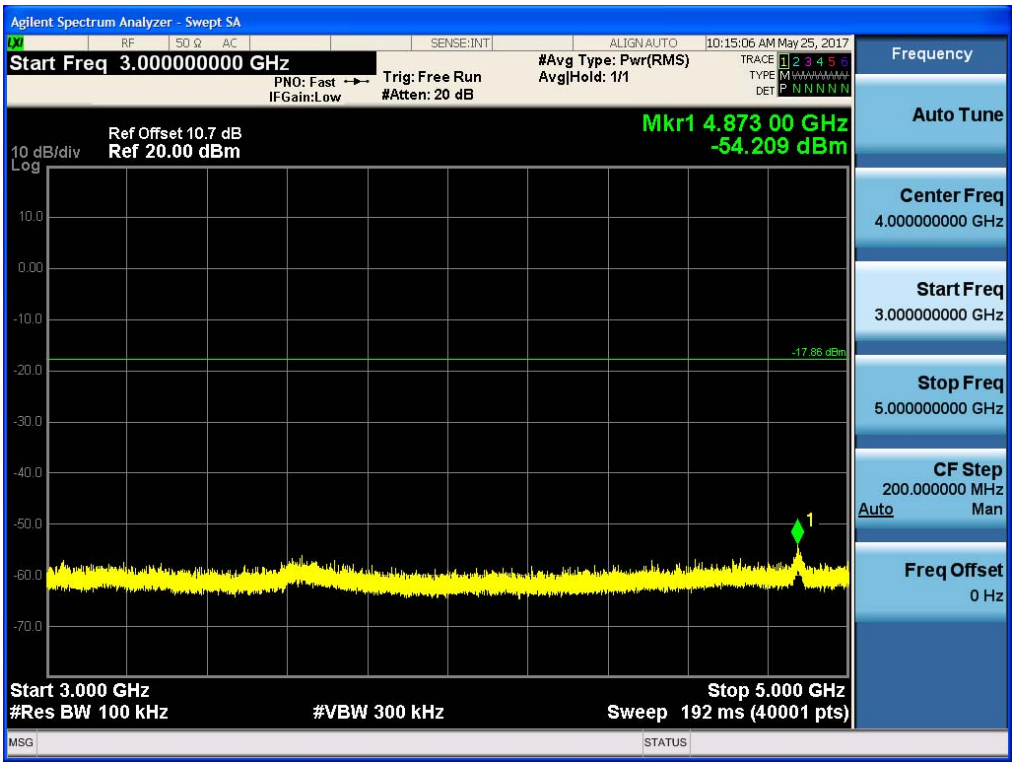
1 GHz ~ 3 GHz

Conducted Spurious Emission (802.11g_Ch.06_6 Mbps)



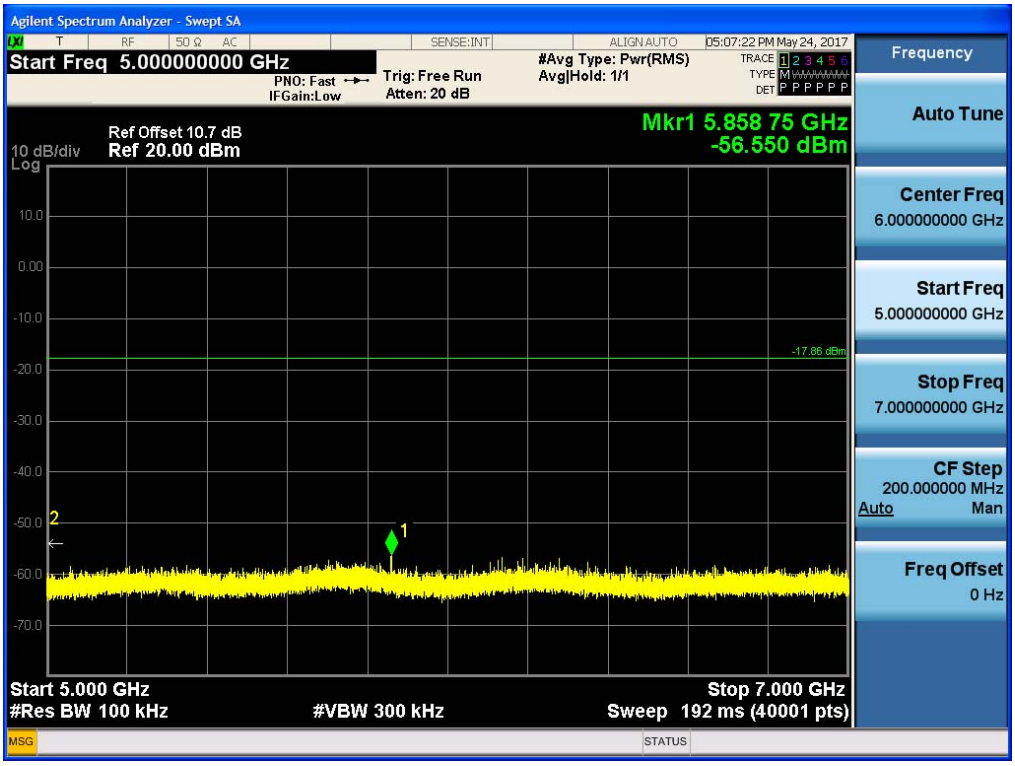
3 GHz ~ 5 GHz

Conducted Spurious Emission (802.11g_Ch.06_6 Mbps)



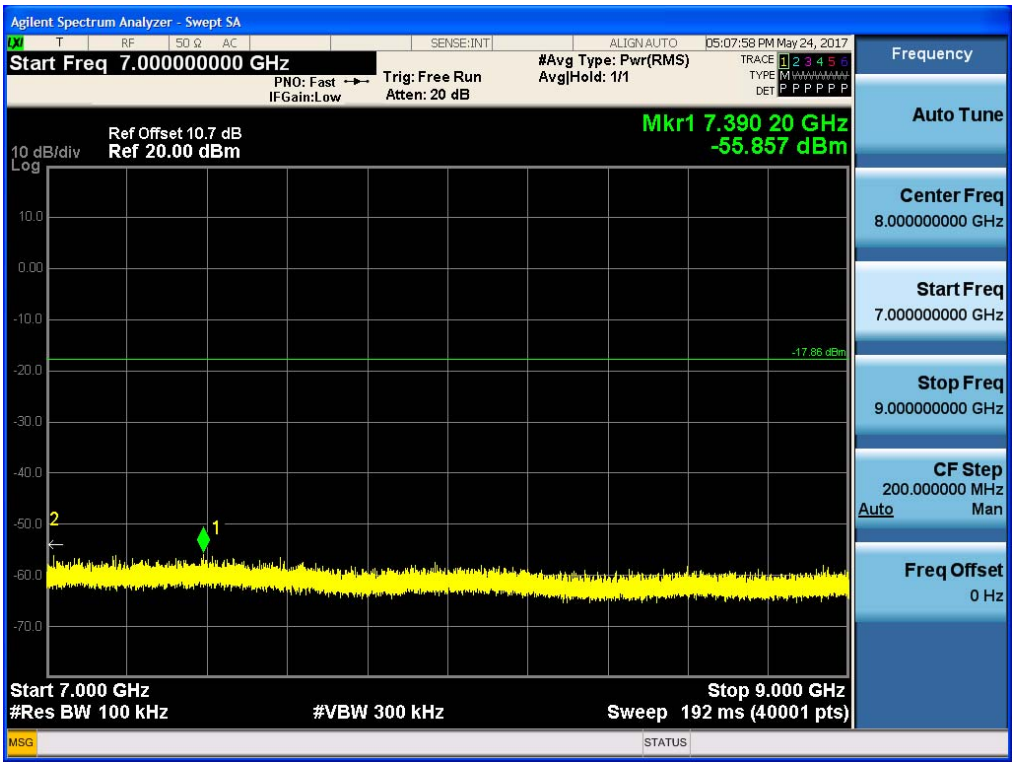
5 GHz ~ 7 GHz

Conducted Spurious Emission (802.11g_Ch.06_6 Mbps)



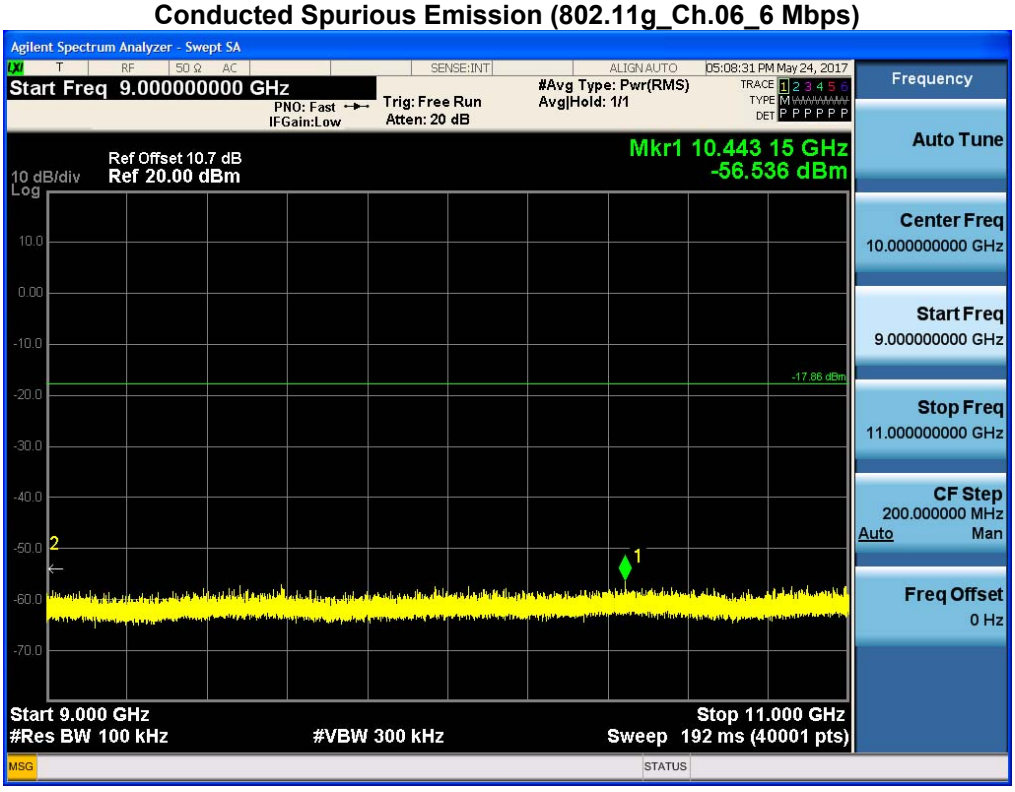
7 GHz ~ 9 GHz

Conducted Spurious Emission (802.11g_Ch.06_6 Mbps)



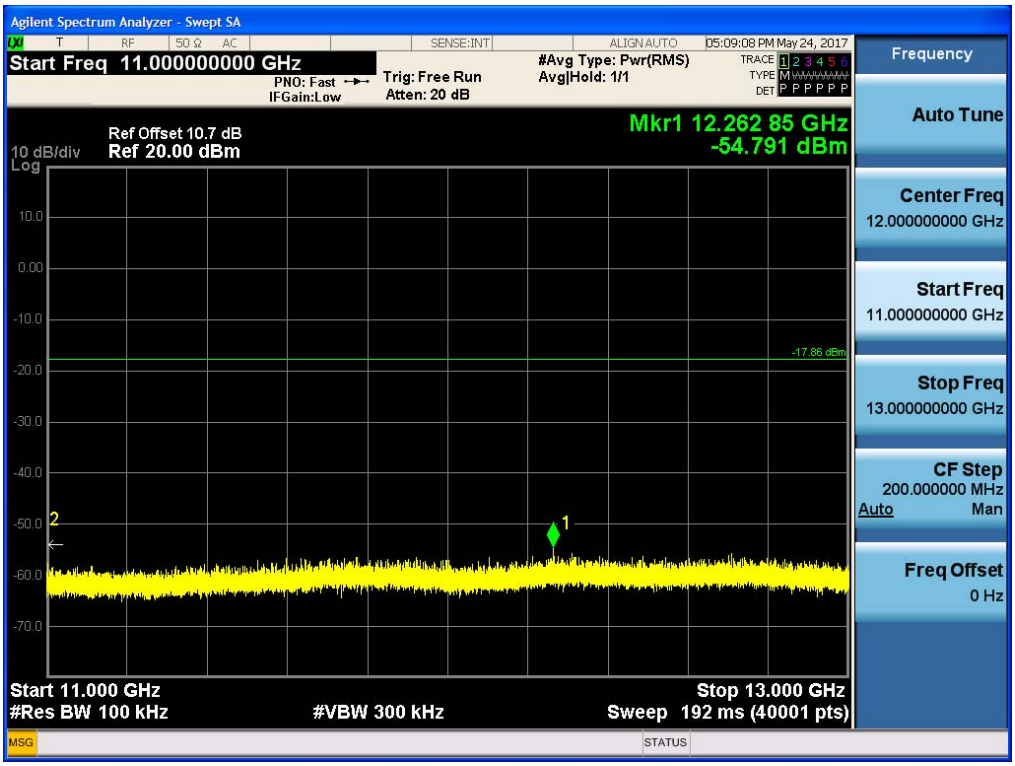
9 GHz ~ 11 GHz

Conducted Spurious Emission (802.11g_Ch.06_6 Mbps)



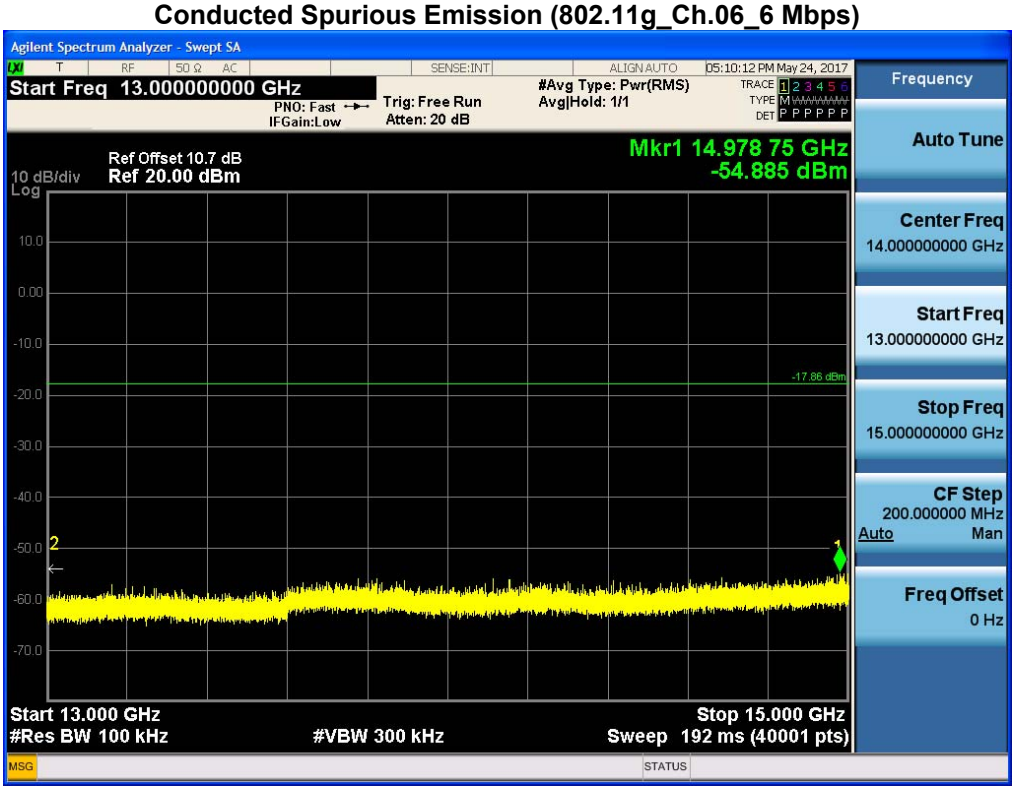
11 GHz ~ 13 GHz

Conducted Spurious Emission (802.11g_Ch.06_6 Mbps)



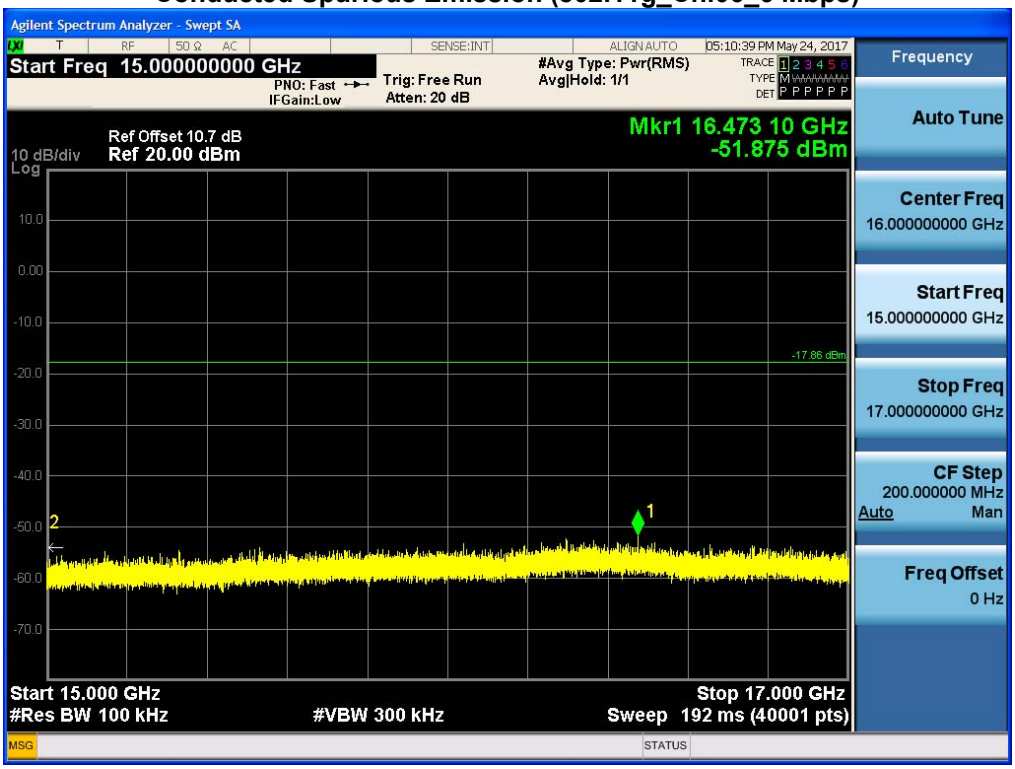
13 GHz ~ 15 GHz

Conducted Spurious Emission (802.11g_Ch.06_6 Mbps)



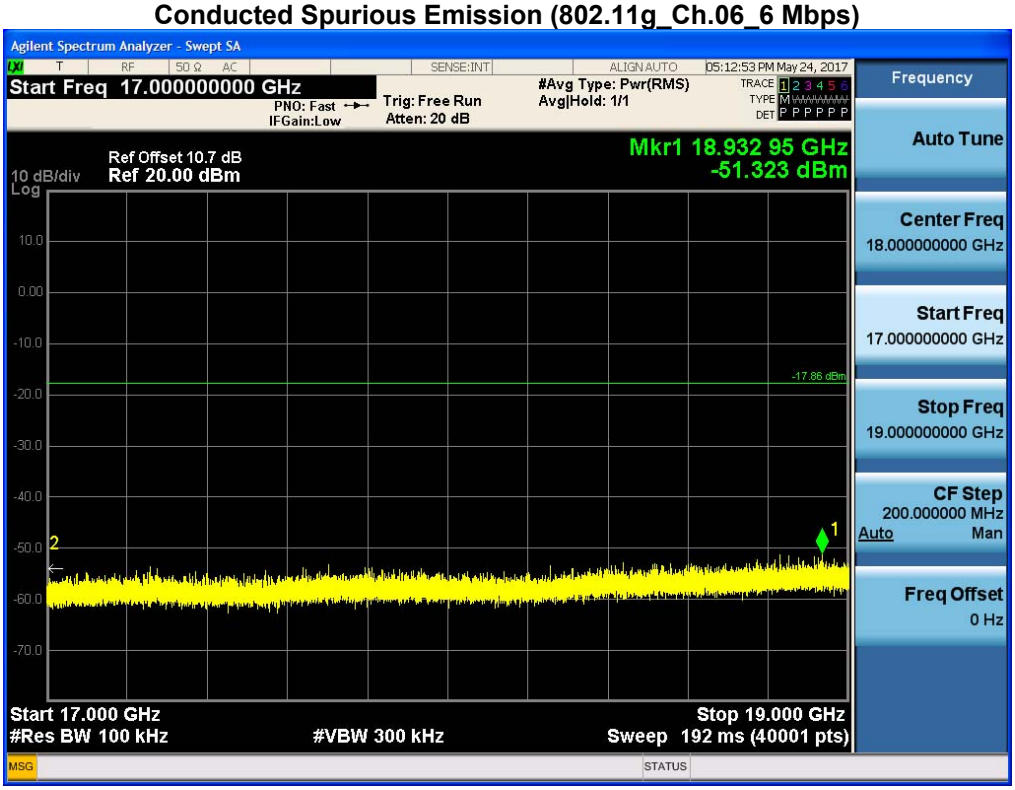
15 GHz ~ 17 GHz

Conducted Spurious Emission (802.11g_Ch.06_6 Mbps)



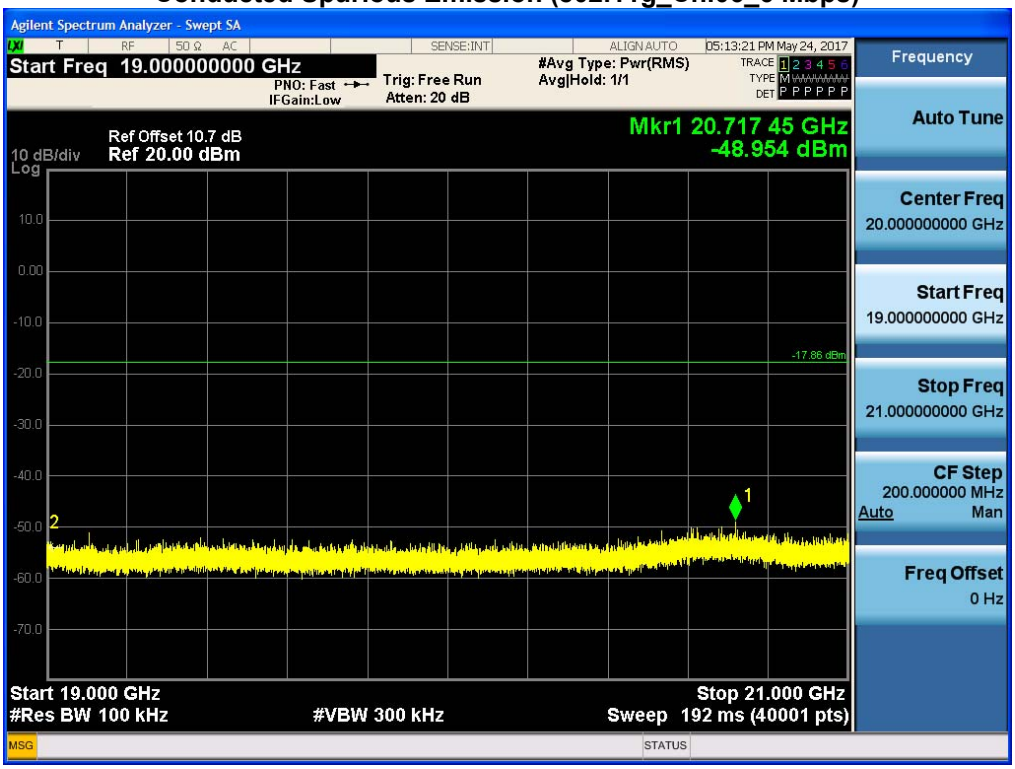
17 GHz ~ 19 GHz

Conducted Spurious Emission (802.11g_Ch.06_6 Mbps)



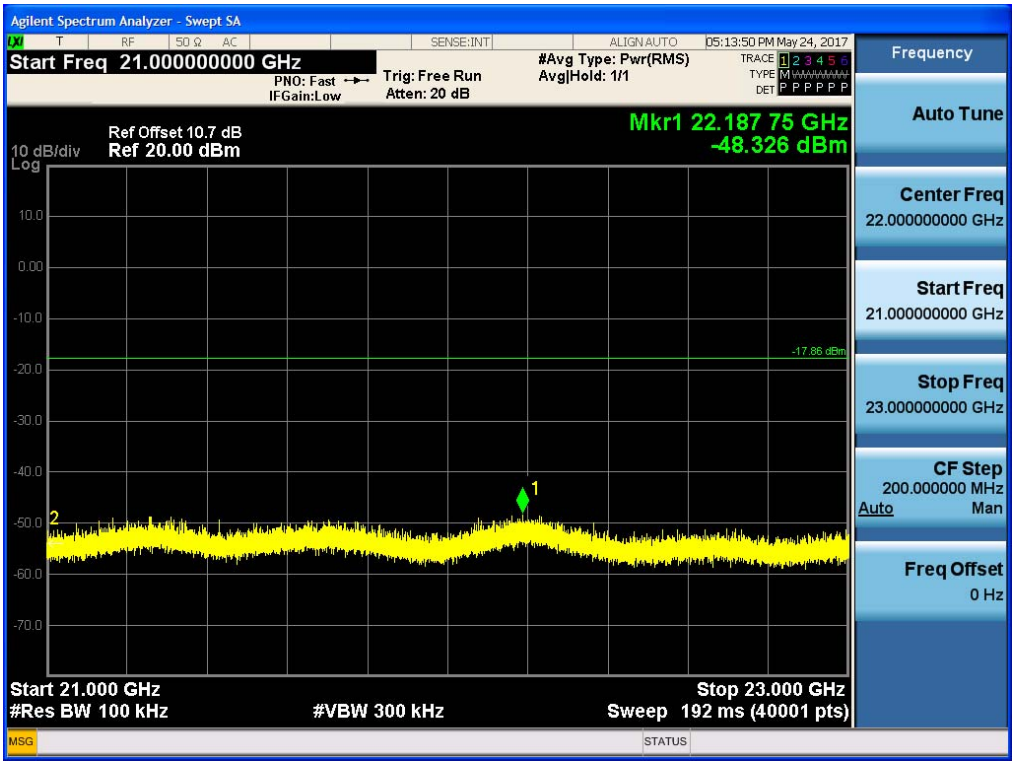
19 GHz ~ 21 GHz

Conducted Spurious Emission (802.11g_Ch.06_6 Mbps)



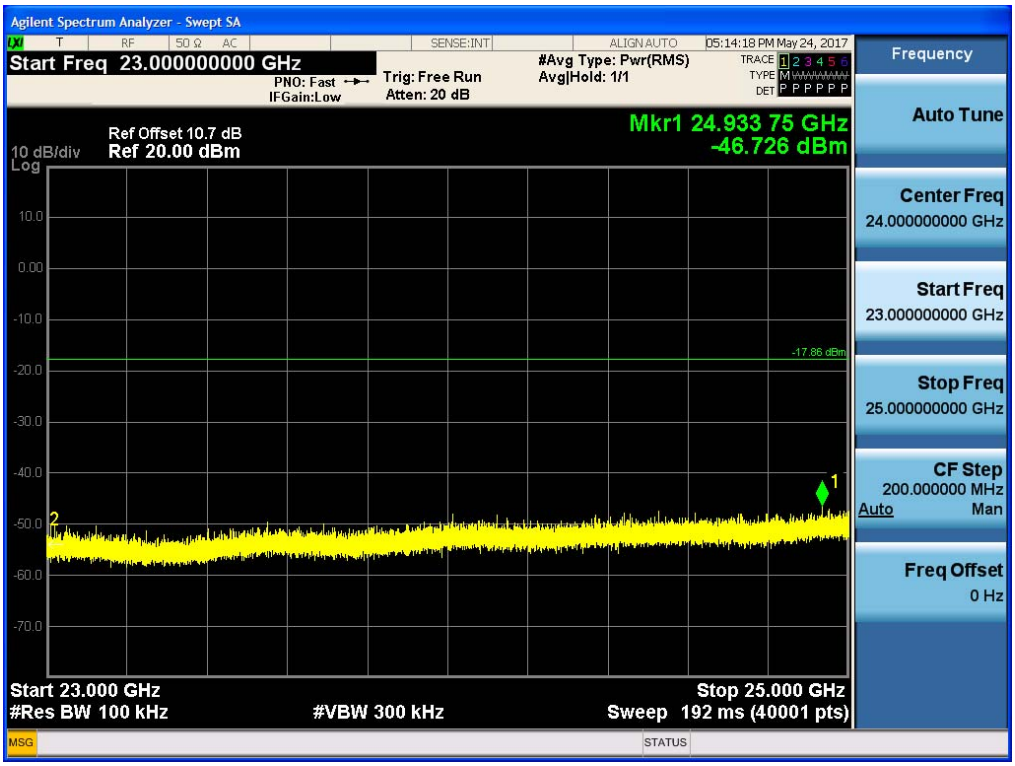
21 GHz ~ 23 GHz

Conducted Spurious Emission (802.11g_Ch.06_6 Mbps)



23 GHz ~ 25 GHz

Conducted Spurious Emission (802.11g_Ch.06_6 Mbps)



9.7 RADIATED MEASUREMENT.

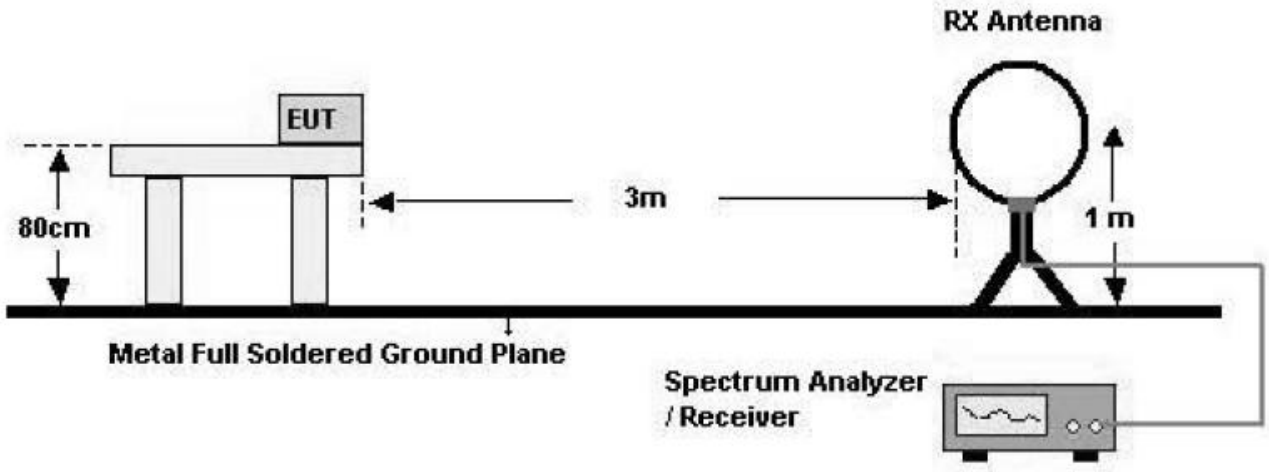
9.7.1 RADIATED SPURIOUS EMISSIONS.

Test Requirements and limit, §15.205, §15.209/ RSS-Gen(Issue 4) Section 8.9.

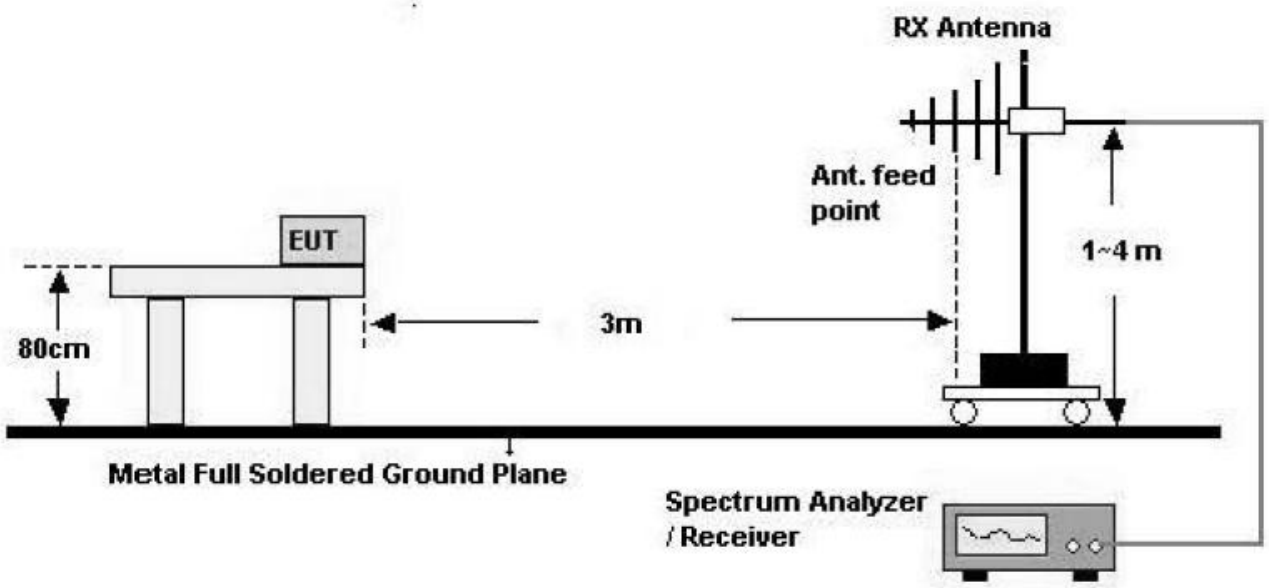
Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Test Configuration

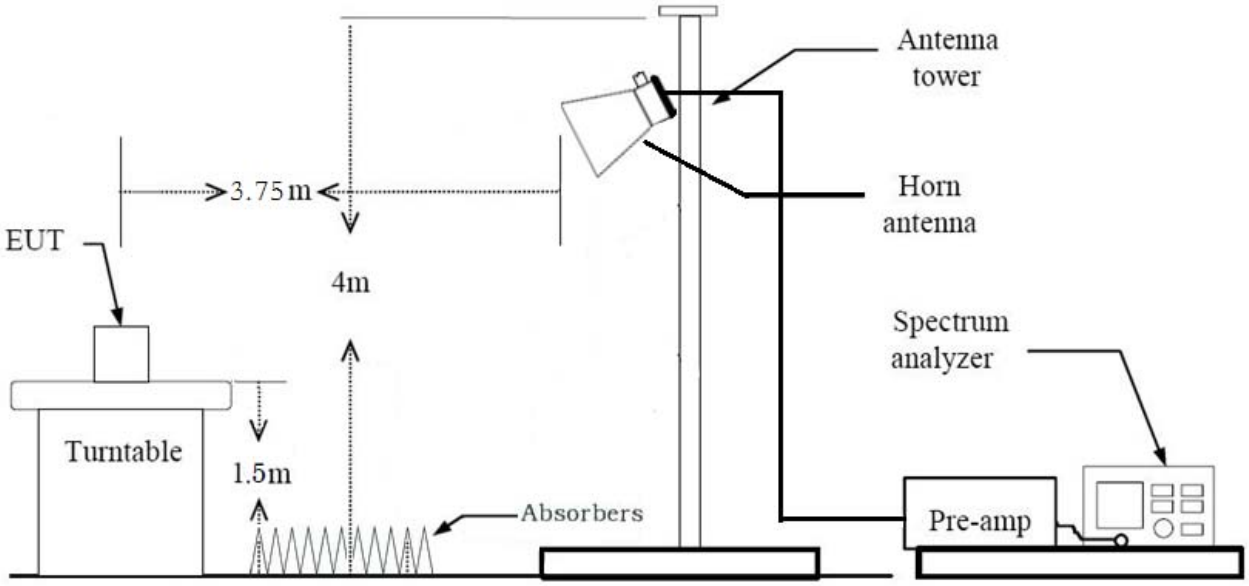
Below 30 MHz



30 MHz - 1 GHz



Above 1 GHz



TEST PROCEDURE USED

Method 12.1 in KDB 558074 v04

Spectrum Setting

- Peak

Peak emission levels are measured by setting the instrument as follows:

RBW = cf. Table 1.

VBW ≥ 3 x RBW.

Detector = Peak.

Sweep time = auto.

Trace mode = max hold.

Allow sweeps to continue until the trace stabilizes.

(Note that the required measurement time may be longer for low duty cycle applications).

Table 1 —RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

- Average (duty cycle ≥ 98%)

Set RBW = 1 MHz

Set VBW ≥ 3 x RBW

Detector = RMS

Averaging type = power (*i.e.*, RMS).

Sweep time = auto.

Trace mode = average (at least 100 traces).

- Average (duty cycle < 98%, duty cycle variations are less than ±2%)

Set RBW = 1 MHz

Set VBW ≥ 3 x RBW

Detector = RMS.

Averaging type = power (*i.e.*, RMS).

Sweep time = auto.

Trace mode = average (at least 100 traces).

A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle.

Note :

1. We are performed the RSE and radiated band edge using standard radiated method(RMS).
2. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor(reference distance : 3 m).
3. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
4. The duty cycle factor for 802.11 b/g/n_HT20

Mode	Worst Data rate (Mbps)	T_{on} (ms)	T_{total} (ms)	Duty Cycle (%)	Duty Cycle Factor (dB)
b	1	-	-	-	-
g	6	-	-	-	-
n_HT20	MCS Index 0	-	-	-	-

TEST RESULTS

9 kHz – 30MHz

Operation Mode: Normal Mode

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 9 kHz to the 30MHz.
2. The reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
3. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
4. Limit line = specific Limits (dBuV) + Distance extrapolation factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
6. The test results for below 30 MHz is correlated to an open site.
   The result on OATS is about 2 dB higher than semi-anechoic chamber (10 m chamber)

TEST RESULTS

Below 1 GHz

Operation Mode: Normal Mode

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 30 MHz to the 1 GHz.
2. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Above 1 GHz [Antenna 90°]

Operation Mode: 802.11 b
Transfer Rate: 1 Mbps
Operating Frequency 2412
Channel No. 01 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.-A.G+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4824	62.78	-6.51	V	56.27	73.98	17.71	PK
4824	53.89	-6.51	V	47.38	53.98	6.60	AV
7236	53.21	-0.62	V	52.59	73.98	21.39	PK
7236	41.08	-0.62	V	40.46	53.98	13.52	AV
4824	64.81	-6.51	H	58.30	73.98	15.68	PK
4824	55.38	-6.51	H	48.87	53.98	5.11	AV
7236	53.28	-0.62	H	52.66	73.98	21.32	PK
7236	41.13	-0.62	H	40.51	53.98	13.47	AV

Operation Mode: 802.11 g
Transfer Rate: 6 Mbps
Operating Frequency 2412
Channel No. 01 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.-A.G+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4824	61.57	-6.51	V	55.06	73.98	18.92	PK
4824	48.21	-6.51	V	41.70	53.98	12.28	AV
7236	52.24	-0.62	V	51.62	73.98	22.36	PK
7236	41.00	-0.62	V	40.38	53.98	13.60	AV
4824	63.64	-6.51	H	57.13	73.98	16.85	PK
4824	50.28	-6.51	H	43.77	53.98	10.21	AV
7236	52.81	-0.62	H	52.19	73.98	21.79	PK
7236	41.09	-0.62	H	40.47	53.98	13.51	AV

Operation Mode:	802.11 n_HT20
Transfer MCS Index:	0
Operating Frequency	2412
Channel No.	01 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.-A.G+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4824	61.53	-6.51	V	55.02	73.98	18.96	PK
4824	47.95	-6.51	V	41.44	53.98	12.54	AV
7236	53.10	-0.62	V	52.48	73.98	21.50	PK
7236	40.52	-0.62	V	39.90	53.98	14.08	AV
4824	63.09	-6.51	H	56.58	73.98	17.40	PK
4824	49.66	-6.51	H	43.15	53.98	10.83	AV
7236	53.23	-0.62	H	52.61	73.98	21.37	PK
7236	41.06	-0.62	H	40.44	53.98	13.54	AV

*A.F. : Antenna Factor / C.L. : Cable Loss / A.G. : Amplifier Gain / D.F. : Distance Factor

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain + Distance Factor
5. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
6. We have done 802.11b/g/n mode and all data rate. Worst data rate is the lowest data of each mode.
7. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Operation Mode: 802.11 b
Transfer Rate: 1 Mbps
Operating Frequency 2437
Channel No. 06 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.-A.G+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4874	61.51	-6.14	V	55.37	73.98	18.61	PK
4874	54.99	-6.14	V	48.85	53.98	5.13	AV
7311	53.46	-0.34	V	53.12	73.98	20.86	PK
7311	41.18	-0.34	V	40.84	53.98	13.14	AV
4874	63.11	-6.14	H	56.97	73.98	17.01	PK
4874	56.94	-6.14	H	50.80	53.98	3.18	AV
7311	53.51	-0.34	H	53.17	73.98	20.81	PK
7311	41.22	-0.34	H	40.88	53.98	13.10	AV

Operation Mode: 802.11 g
Transfer Rate: 6 Mbps
Operating Frequency 2437
Channel No. 06 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.-A.G+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4874	63.15	-6.14	V	57.01	73.98	16.97	PK
4874	52.08	-6.14	V	45.94	53.98	8.04	AV
7311	53.11	-0.34	V	52.77	73.98	21.21	PK
7311	41.08	-0.34	V	40.74	53.98	13.24	AV
4874	65.05	-6.14	H	58.91	73.98	15.07	PK
4874	54.00	-6.14	H	47.86	53.98	6.12	AV
7311	53.37	-0.34	H	53.03	73.98	20.95	PK
7311	41.19	-0.34	H	40.85	53.98	13.13	AV

Operation Mode:	802.11 n_HT20
Transfer MCS Index:	0
Operating Frequency	2437
Channel No.	06 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.-A.G+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4874	63.49	-6.14	V	57.35	73.98	16.63	PK
4874	51.28	-6.14	V	45.14	53.98	8.84	AV
7311	53.61	-0.34	V	53.27	73.98	20.71	PK
7311	40.83	-0.34	V	40.49	53.98	13.49	AV
4874	65.49	-6.14	H	59.35	73.98	14.63	PK
4874	53.62	-6.14	H	47.48	53.98	6.50	AV
7311	53.77	-0.34	H	53.43	73.98	20.55	PK
7311	41.15	-0.34	H	40.81	53.98	13.17	AV

*A.F. : Antenna Factor / C.L. : Cable Loss / A.G. : Amplifier Gain / D.F. : Distance Factor

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain + Distance Factor
5. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
6. We have done 802.11b/g/n mode and all data rate. Worst data rate is the lowest data of each mode.
7. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Operation Mode: 802.11 b
Transfer Rate: 1 Mbps
Operating Frequency 2462
Channel No. 11 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.-A.G+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4924	60.06	-5.71	V	54.35	73.98	19.63	PK
4924	53.77	-5.71	V	48.06	53.98	5.92	AV
7386	53.20	0.02	V	53.22	73.98	20.76	PK
7386	41.11	0.02	V	41.13	53.98	12.85	AV
4924	61.89	-5.71	H	56.18	73.98	17.80	PK
4924	55.56	-5.71	H	49.85	53.98	4.13	AV
7386	53.25	0.02	H	53.27	73.98	20.71	PK
7386	41.25	0.02	H	41.27	53.98	12.71	AV

Operation Mode: 802.11 g
Transfer Rate: 6 Mbps
Operating Frequency 2462
Channel No. 11 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.-A.G+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4924	55.68	-5.71	V	49.97	73.98	24.01	PK
4924	44.69	-5.71	V	38.98	53.98	15.00	AV
7386	53.24	0.02	V	53.26	73.98	20.72	PK
7386	41.19	0.02	V	41.21	53.98	12.77	AV
4924	57.32	-5.71	H	51.61	73.98	22.37	PK
4924	46.22	-5.71	H	40.51	53.98	13.47	AV
7386	53.36	0.02	H	53.38	73.98	20.60	PK
7386	41.43	0.02	H	41.45	53.98	12.53	AV

Operation Mode:	802.11 n_HT20
Transfer MCS Index:	0
Operating Frequency	2462
Channel No.	11 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.-A.G+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4924	58.91	-5.71	V	53.20	73.98	20.78	PK
4924	45.52	-5.71	V	39.81	53.98	14.17	AV
7386	52.98	0.02	V	53.00	73.98	20.98	PK
7386	41.16	0.02	V	41.18	53.98	12.80	AV
4924	60.71	-5.71	H	55.00	73.98	18.98	PK
4924	47.51	-5.71	H	41.80	53.98	12.18	AV
7386	53.11	0.02	H	53.13	73.98	20.85	PK
7386	41.31	0.02	H	41.33	53.98	12.65	AV

*A.F. : Antenna Factor / C.L. : Cable Loss / A.G. : Amplifier Gain / D.F. : Distance Factor

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain + Distance Factor
5. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
6. We have done 802.11b/g/n mode and all data rate. Worst data rate is the lowest data of each mode.
7. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

[Antenna 0°] – Worst case

Operation Mode:	802.11 b
Transfer Rate:	1 Mbps
Operating Frequency	2437
Channel No.	06 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.-A.G+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4874	59.87	-6.14	V	53.73	73.98	20.25	PK
4874	48.56	-6.14	V	42.42	53.98	11.56	AV
4874	61.38	-6.14	H	55.24	73.98	18.74	PK
4874	50.15	-6.14	H	44.01	53.98	9.97	AV

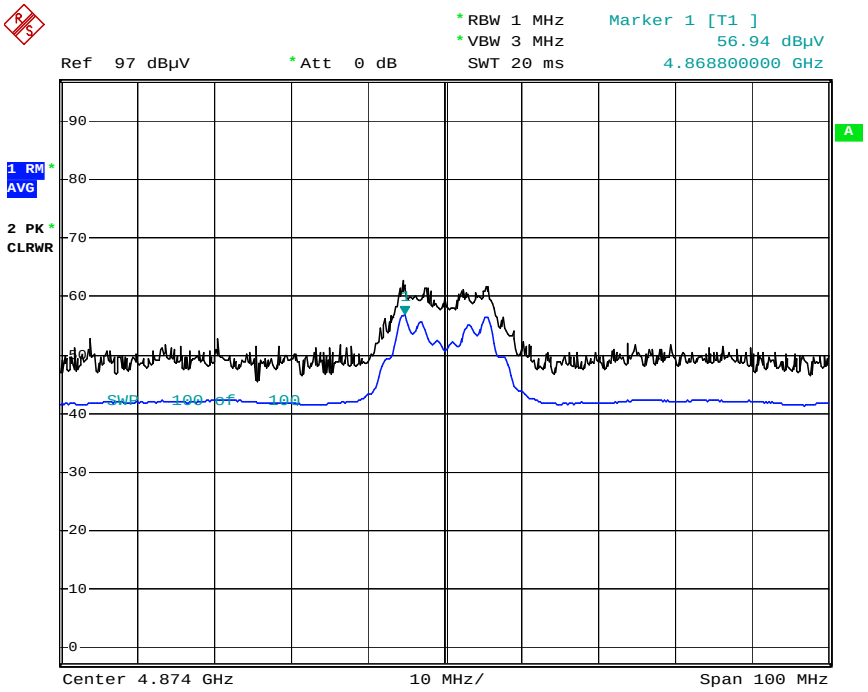
*A.F. : Antenna Factor / C.L. : Cable Loss / A.G. : Amplifier Gain / D.F. : Distance Factor

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain + Distance Factor
5. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
6. We have done 802.11b/g/n mode and all data rate. Worst data rate is the lowest data of each mode.
7. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

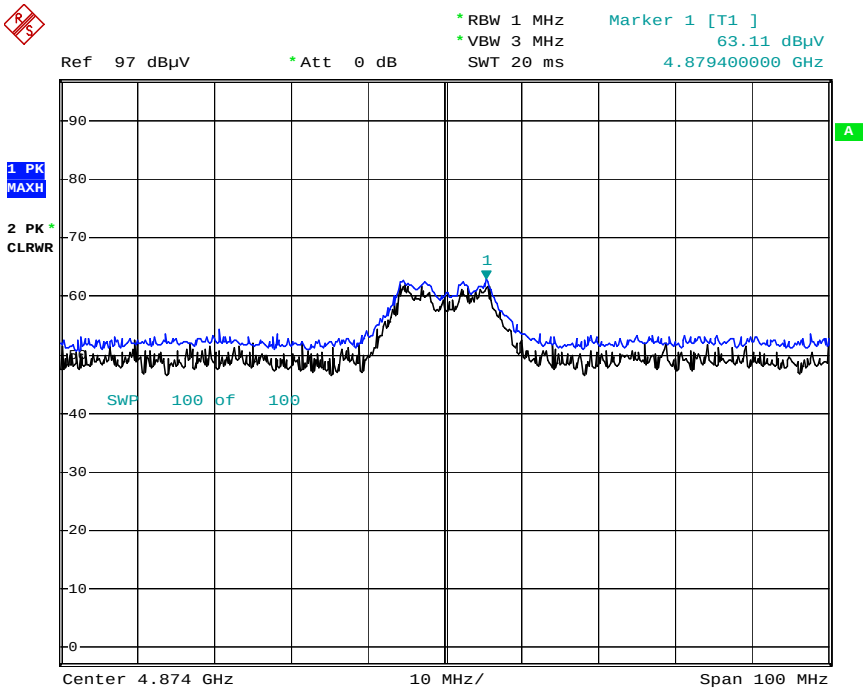
▣ RESULT PLOTS (Worst case : Z-H)

Radiated Spurious Emissions plot – Average Reading (802.11b, Ch.6 2nd Harmonic)



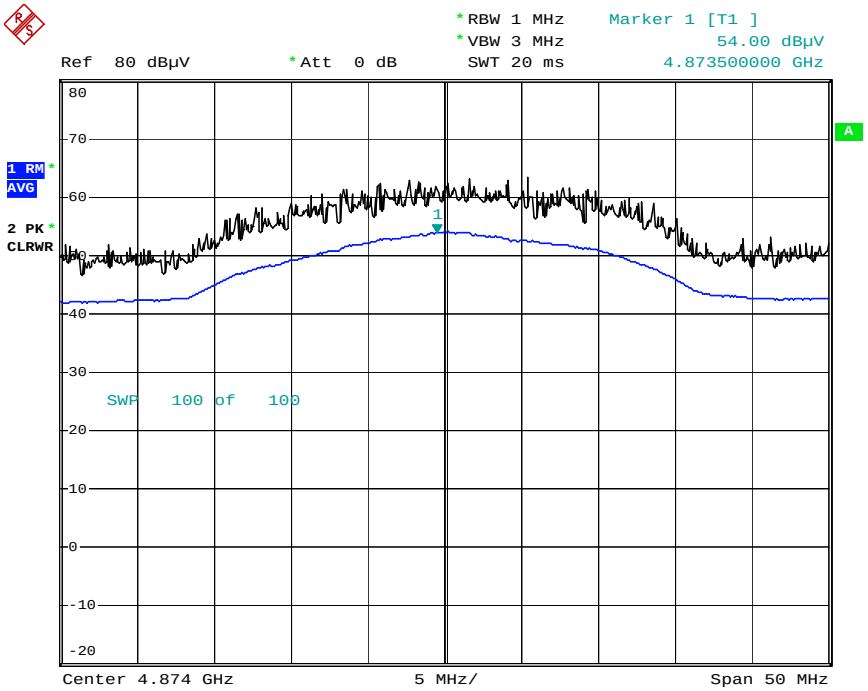
Date: 23.MAY.2017 13:30:09

Radiated Spurious Emissions plot – Peak Reading (802.11b, Ch.6 2nd Harmonic)



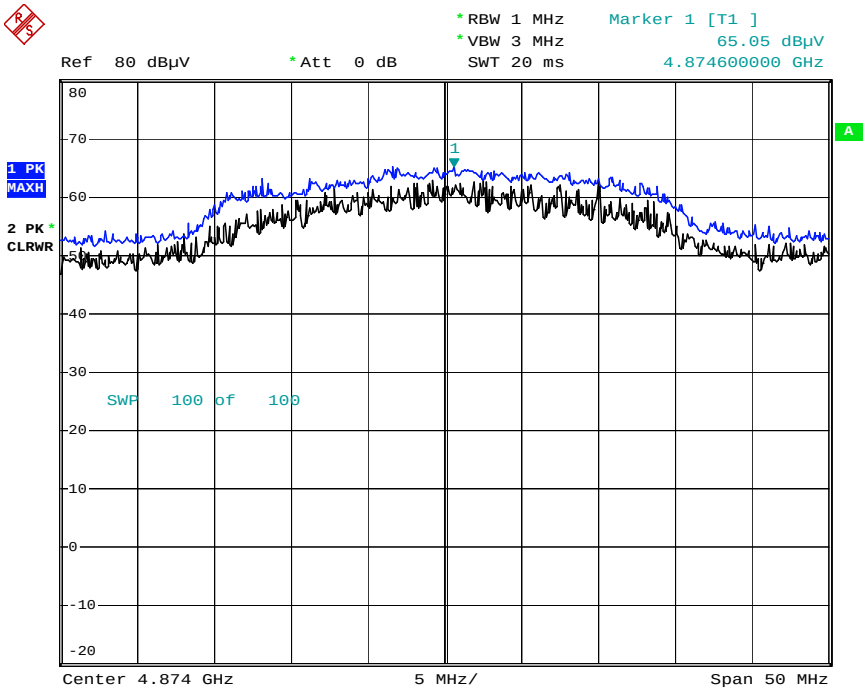
Date: 23.MAY.2017 13:30:40

Radiated Spurious Emissions plot – Average Reading (802.11g, Ch.6 2nd Harmonic)



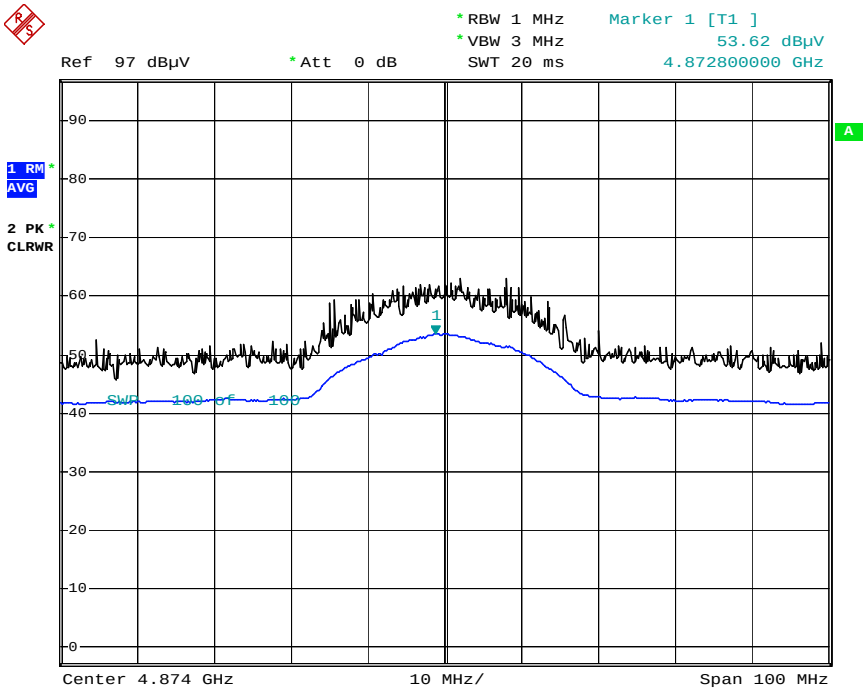
Date: 23.MAY.2017 13:20:02

Radiated Spurious Emissions plot – Peak Reading (802.11g, Ch.6 2nd Harmonic)



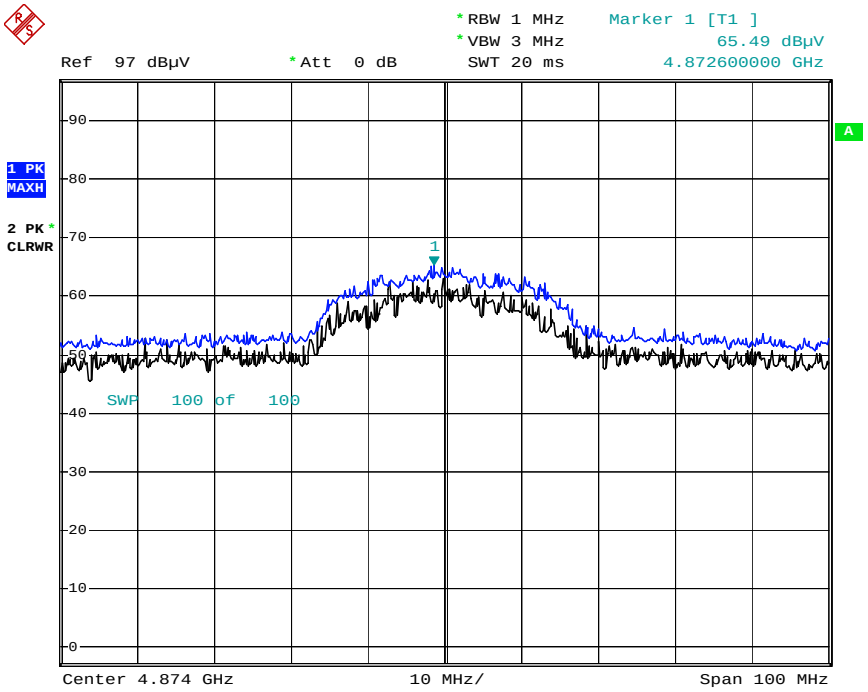
Date: 23.MAY.2017 13:21:33

Radiated Spurious Emissions plot – Average Reading (802.11n_HT20, Ch.6 2nd Harmonic)



Date: 23.MAY.2017 13:26:11

Radiated Spurious Emissions plot – Peak Reading (802.11n_HT20, Ch.6 2nd Harmonic)



Date: 23.MAY.2017 13:26:36

Note : Only the worst case plots for Radiated Spurious Emissions.

9.6.2 RADIATED RESTRICTED BAND EDGES

Test Requirements and limit, §15.247(d) §15.205, §15.209, RSS-Gen(Issue 4) 8.10

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a) (See section 15.205(c)).

[Antenna 90°]

Operation Mode:	802.11g
Transfer Rate:	6 Mbps
Operating Frequency	2412 MHz, 2462 MHz
Channel No.	01 Ch, 11 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
2390.0	63.73	-3.91	H	59.82	73.98	14.16	PK
2390.0	54.27	-3.91	H	50.36	53.98	3.62	AV
2390.0	63.12	-3.91	V	59.21	73.98	14.77	PK
2390.0	53.98	-3.91	V	50.07	53.98	3.91	AV
2483.5	63.81	-3.62	H	60.19	73.98	13.79	PK
2483.5	54.24	-3.62	H	50.62	53.98	3.36	AV
2483.5	63.15	-3.62	V	59.53	73.98	14.45	PK
2483.5	54.00	-3.62	V	50.38	53.98	3.60	AV

*A.F. : Antenna Factor / C.L. : Cable Loss / D.F. : Distance Factor

Operation Mode: 802.11b
Transfer Rate: 1 Mbps
Operating Frequency 2412 MHz, 2462 MHz
Channel No. 01 Ch, 11 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
2390.0	53.54	-3.91	H	49.63	73.98	24.35	PK
2390.0	44.91	-3.91	H	41.00	53.98	12.98	AV
2390.0	53.03	-3.91	V	49.12	73.98	24.86	PK
2390.0	44.28	-3.91	V	40.37	53.98	13.61	AV
2483.5	57.82	-3.62	H	54.20	73.98	19.78	PK
2483.5	49.05	-3.62	H	45.43	53.98	8.55	AV
2483.5	57.22	-3.62	V	53.60	73.98	20.38	PK
2483.5	48.56	-3.62	V	44.94	53.98	9.04	AV

Operation Mode: 802.11n_HT20
Transfer MCS Index: 0
Operating Frequency 2412 MHz, 2462 MHz
Channel No. 01 Ch, 11 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
2390.0	63.77	-3.91	H	59.86	73.98	14.12	PK
2390.0	54.21	-3.91	H	50.30	53.98	3.68	AV
2390.0	63.15	-3.91	V	59.24	73.98	14.74	PK
2390.0	53.84	-3.91	V	49.93	53.98	4.05	AV
2483.5	63.63	-3.62	H	60.01	73.98	13.97	PK
2483.5	54.15	-3.62	H	50.53	53.98	3.45	AV
2483.5	63.08	-3.62	V	59.46	73.98	14.52	PK
2483.5	53.84	-3.62	V	50.22	53.98	3.76	AV

Notes:

1. Total = Reading Value + Antenna Factor + Cable Loss + Distance Factor
2. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
3. We have done 802.11b/g/n mode and all data rate. Worst data rate is the lowest data of each mode.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

[Antenna 0°] – Worst case

Operation Mode:	802.11g
Transfer Rate:	6 Mbps
Operating Frequency	2462 MHz
Channel No.	11 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.+D.F. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
2483.5	73.07	-3.62	H	69.45	73.98	4.53	PK
2483.5	54.03	-3.62	H	50.41	53.98	3.57	AV
2483.5	72.16	-3.62	V	68.54	73.98	5.44	PK
2483.5	53.65	-3.62	V	50.03	53.98	3.95	AV

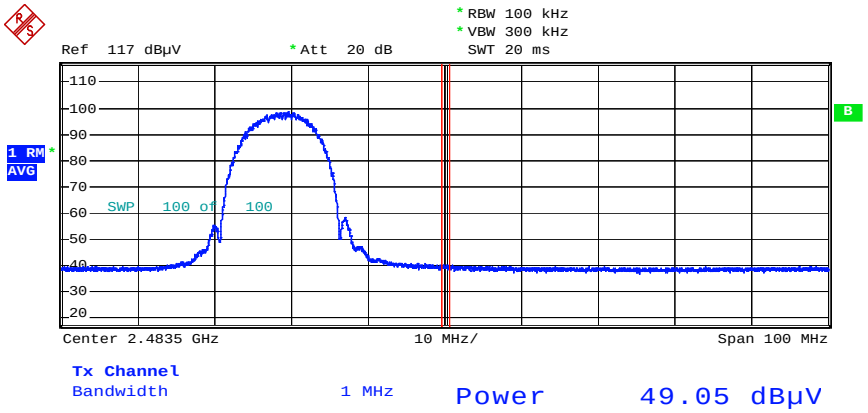
*A.F. : Antenna Factor / C.L. : Cable Loss / D.F. : Distance Factor

Notes:

1. Total = Reading Value + Antenna Factor + Cable Loss + Distance Factor
2. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
3. We have done 802.11b/g/n mode and all data rate. Worst data rate is the lowest data of each mode.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

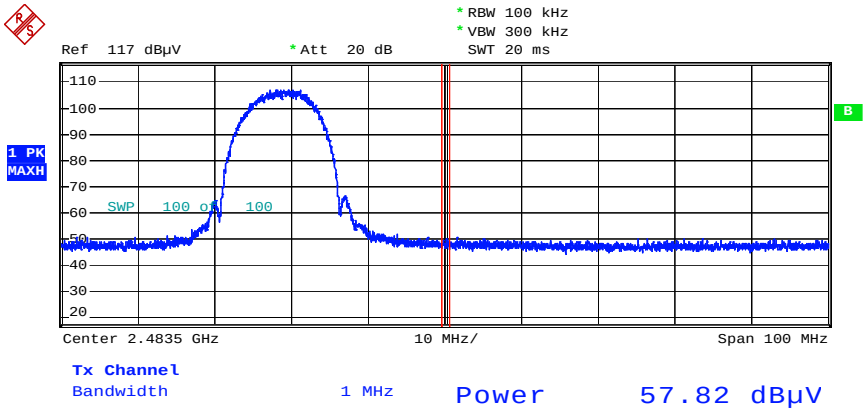
▣ RESULT PLOTS (Worst case Y-H)

Radiated Restricted Band Edges plot – Average Reading (802.11b, Ch.11)



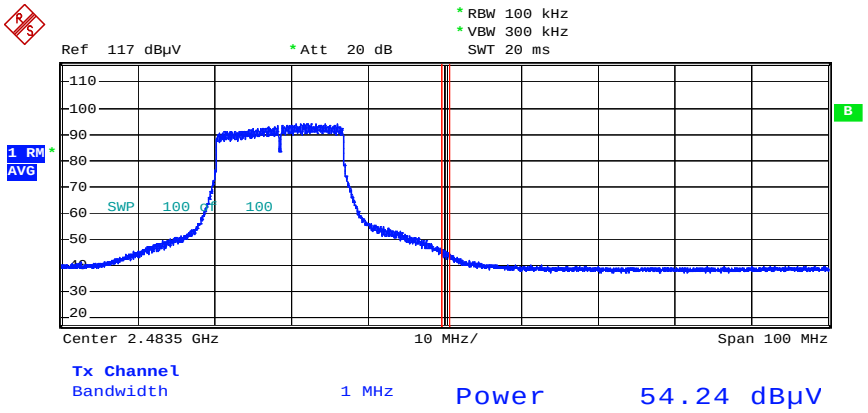
Date: 23.MAY.2017 03:28:37

Radiated Restricted Band Edges plot – Peak Reading (802.11b, Ch.11)



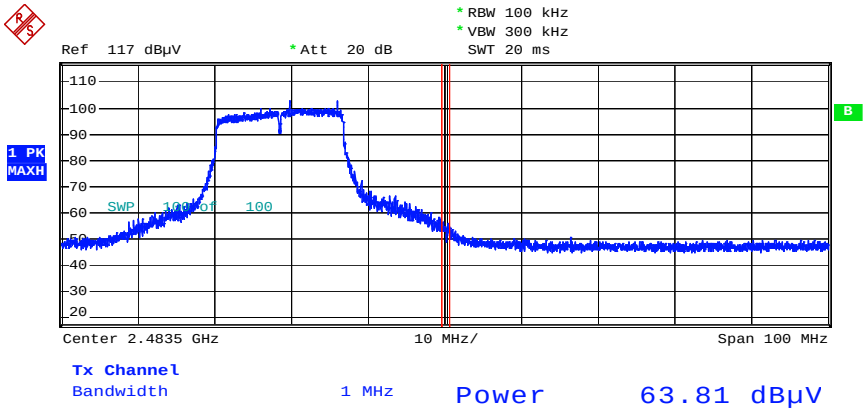
Date: 23.MAY.2017 03:27:49

Radiated Restricted Band Edges plot – Average Reading (802.11g, Ch.11)



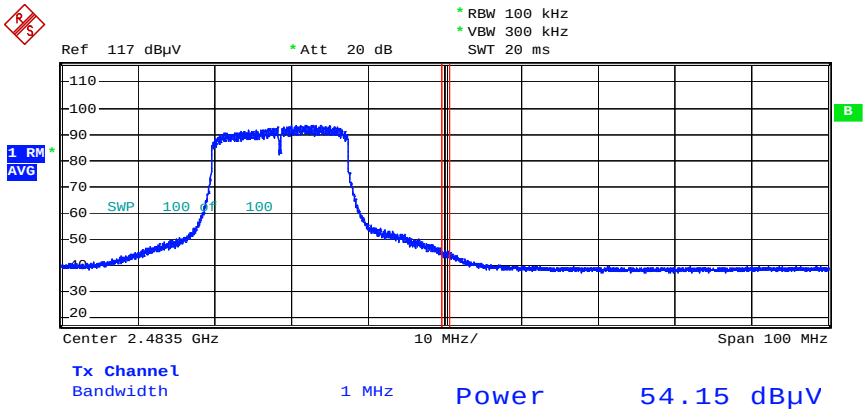
Date: 23.MAY.2017 03:32:25

Radiated Restricted Band Edges plot – Peak Reading (802.11g, Ch.11)



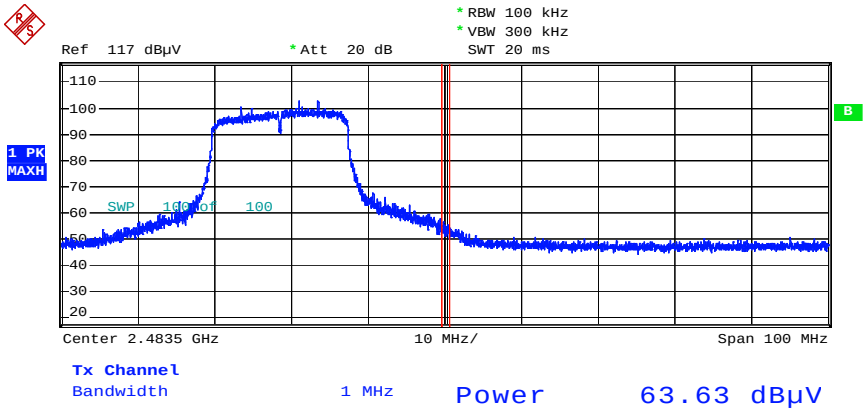
Date: 23.MAY.2017 03:32:53

Radiated Restricted Band Edges plot – Average Reading (802.11n_HT20, Ch.11)



Date: 23.MAY.2017 03:30:37

Radiated Restricted Band Edges plot – Peak Reading (802.11n_HT20, Ch.11)



Date: 23.MAY.2017 03:31:10

Note : Only the worst case plots for Radiated Restricted Band Edges.

9.7.3 RECEIVER SPURIOUS EMISSIONS

ISED Rule(s)	**RSS-Gen**
Test Requirements:	**Blow the table**
Operating conditions:	**Under normal test conditions**
Method of testing:	**Radiated**
S/A. Settings:	**F < 1 GHz: RBW: 120 kHz, VBW: 300 kHz (Quasi Peak)** **F > 1 GHz: RBW: 1 MHz, VBW: 3 MHz (Peak)**
Mode of operation:	**Receive**

Frequency (MHz)	Field Strength (microvolts/m at 3 meters)
30 – 88	100
88 - 216	150
216 – 960	200
Above 960	500

Operation Mode: Receive:

30 MHz ~ 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBμV	dB /m	dB	(H/V)	dBμV/m	dBμV/m	dB
No critical peaks found							

Above 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBμV	dB /m	dB	(H/V)	dBμV/m	dBμV/m	dB
No critical peaks found							

9.8 POWERLINE CONDUCTED EMISSIONS

Test Requirements and limit, §15.207, RSS-Gen(Issue 4) Section 8.8

For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range is listed as follows:

Frequency Range (MHz)	Limits (dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

Test Configuration

See test photographs attached in Appendix 1 for the actual connections between EUT and support equipment.

TEST PROCEDURE

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors – Quasi Peak and Average Detector.
5. We are performed the AC Power Line Conducted Emission test for worst data rate, channel, operation mode.

Sample Calculation

Quasi-peak(Final Result) = Reading Value + Correction Factor

▣ RESULT PLOTS

Conducted Emissions (Line 1)

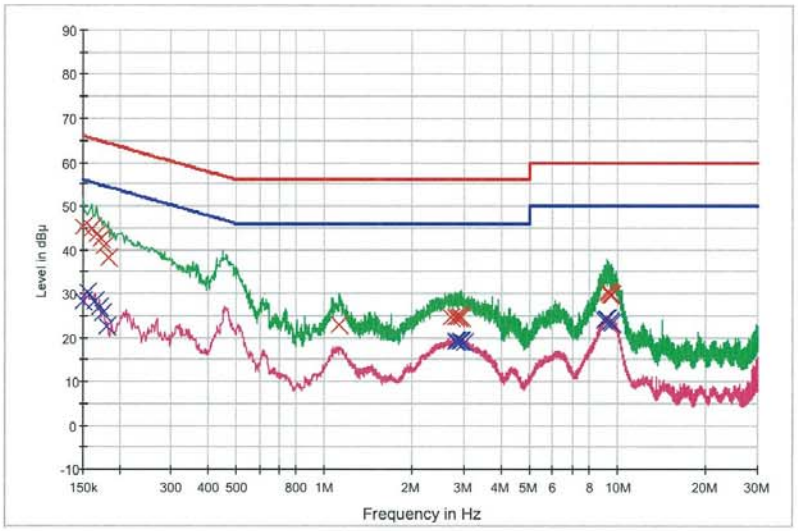
EMI Auto Test(12) 1 / 2

HCT TEST Report

Common Information

EUT:	SFN20R4
Manufacturer:	WISOL
Test Site:	SHIELD ROOM
Operating Conditions:	WLAN MODE_L1

FCC CLASS B



Final Result 1

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.150000	45.3	9.000	Off	L1	9.6	20.7	66.0
0.160000	45.1	9.000	Off	L1	9.6	20.4	65.5
0.166000	43.6	9.000	Off	L1	9.6	21.5	65.2
0.172000	42.5	9.000	Off	L1	9.6	22.4	64.9
0.176000	40.9	9.000	Off	L1	9.6	23.8	64.7
0.184000	38.2	9.000	Off	L1	9.6	26.1	64.3
1.128000	22.8	9.000	Off	L1	9.7	33.2	56.0
2.692000	24.6	9.000	Off	L1	9.8	31.4	56.0
2.786000	24.5	9.000	Off	L1	9.8	31.5	56.0
2.868000	24.7	9.000	Off	L1	9.8	31.3	56.0
2.886000	24.8	9.000	Off	L1	9.8	31.2	56.0
2.942000	24.7	9.000	Off	L1	9.8	31.3	56.0
9.182000	30.4	9.000	Off	L1	10.1	29.6	60.0
9.244000	30.2	9.000	Off	L1	10.1	29.8	60.0
9.308000	30.0	9.000	Off	L1	10.1	30.0	60.0
9.330000	29.9	9.000	Off	L1	10.1	30.1	60.0
9.370000	29.7	9.000	Off	L1	10.1	30.3	60.0
9.518000	29.8	9.000	Off	L1	10.1	30.2	60.0

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EMI Auto Test(12) 2 / 2

Final Result 2

Frequency (MHz)	CAverage (dBuV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.150000	28.4	9.000	Off	L1	9.6	27.6	56.0
0.156000	30.5	9.000	Off	L1	9.6	25.2	55.7
0.164000	28.3	9.000	Off	L1	9.6	27.0	55.3
0.170000	27.1	9.000	Off	L1	9.6	27.9	55.0
0.174000	25.6	9.000	Off	L1	9.6	29.1	54.8
0.180000	22.5	9.000	Off	L1	9.6	32.0	54.5
2.782000	19.0	9.000	Off	L1	9.8	27.0	46.0
2.786000	19.0	9.000	Off	L1	9.8	27.0	46.0
2.822000	19.1	9.000	Off	L1	9.8	26.9	46.0
2.888000	19.3	9.000	Off	L1	9.8	26.7	46.0
2.942000	19.1	9.000	Off	L1	9.8	26.9	46.0
3.006000	18.8	9.000	Off	L1	9.8	27.2	46.0
8.968000	24.0	9.000	Off	L1	10.1	26.0	50.0
9.048000	24.4	9.000	Off	L1	10.1	25.6	50.0
9.174000	24.3	9.000	Off	L1	10.1	25.7	50.0
9.182000	24.3	9.000	Off	L1	10.1	25.7	50.0
9.370000	23.7	9.000	Off	L1	10.1	26.3	50.0
9.518000	23.2	9.000	Off	L1	10.1	26.8	50.0

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Conducted Emissions (Line 2)

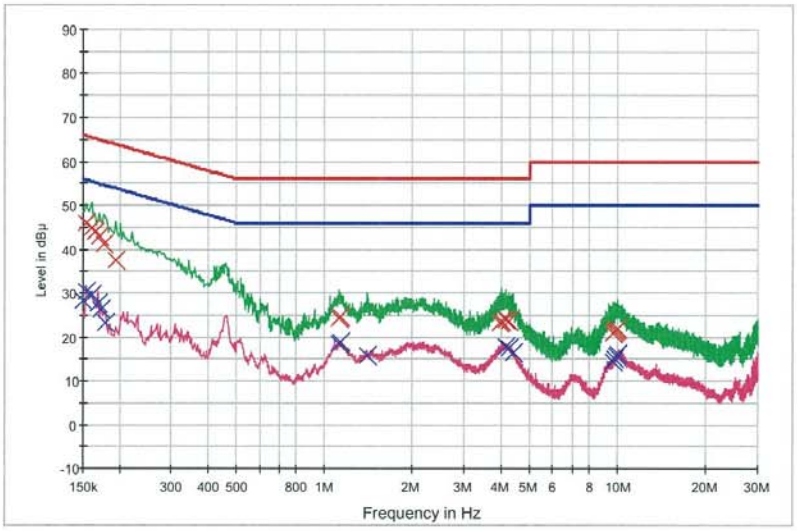
EMI Auto Test(12) 1 / 2

HCT TEST Report

Common Information

EUT:	SFN20R4
Manufacturer:	WISOL
Test Site:	SHIELD ROOM
Operating Conditions:	WLAN MODE_N

FCC CLASS B



FCC CLASS B_QP
Preview Result 2-AVG
FCC CLASS B_ AV
Final Result 1-QPK
Preview Result 1-PK+
Final Result 2-CAV

Final Result 1

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.154000	45.9	9.000	Off	N	9.6	19.8	65.8
0.160000	44.8	9.000	Off	N	9.6	20.6	65.5
0.164000	43.8	9.000	Off	N	9.6	21.5	65.3
0.170000	42.8	9.000	Off	N	9.6	22.2	65.0
0.176000	41.1	9.000	Off	N	9.6	23.6	64.7
0.194000	37.6	9.000	Off	N	9.6	26.3	63.9
1.124000	24.3	9.000	Off	N	9.7	31.7	56.0
1.138000	24.6	9.000	Off	N	9.7	31.4	56.0
3.954000	23.2	9.000	Off	N	9.8	32.8	56.0
4.036000	23.6	9.000	Off	N	9.8	32.4	56.0
4.168000	24.0	9.000	Off	N	9.8	32.0	56.0
4.236000	23.7	9.000	Off	N	9.9	32.3	56.0
9.600000	20.8	9.000	Off	N	10.1	39.2	60.0
9.744000	21.2	9.000	Off	N	10.1	38.8	60.0
9.900000	21.6	9.000	Off	N	10.1	38.4	60.0
9.978000	21.7	9.000	Off	N	10.1	38.3	60.0
10.000000	22.0	9.000	Off	N	10.1	38.0	60.0
10.048000	21.8	9.000	Off	N	10.1	38.2	60.0

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EMI Auto Test(12) 2 / 2

Final Result 2

Frequency (MHz)	CAverage (dBuV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.150000	28.4	9.000	Off	N	9.6	27.6	56.0
0.154000	30.2	9.000	Off	N	9.6	25.6	55.8
0.160000	29.5	9.000	Off	N	9.6	25.9	55.5
0.168000	27.6	9.000	Off	N	9.6	27.5	55.1
0.172000	26.3	9.000	Off	N	9.6	28.6	54.9
0.178000	23.2	9.000	Off	N	9.6	31.4	54.6
1.124000	18.5	9.000	Off	N	9.7	27.5	46.0
1.138000	18.7	9.000	Off	N	9.7	27.3	46.0
1.408000	15.9	9.000	Off	N	9.7	30.1	46.0
4.168000	17.9	9.000	Off	N	9.8	28.1	46.0
4.264000	17.4	9.000	Off	N	9.9	28.6	46.0
4.390000	16.5	9.000	Off	N	9.9	29.5	46.0
9.600000	14.4	9.000	Off	N	10.1	35.6	50.0
9.744000	14.9	9.000	Off	N	10.1	35.1	50.0
9.902000	15.9	9.000	Off	N	10.1	34.1	50.0
9.978000	15.9	9.000	Off	N	10.1	34.1	50.0
10.000000	16.1	9.000	Off	N	10.1	33.9	50.0
10.048000	16.2	9.000	Off	N	10.1	33.8	50.0

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10. LIST OF TEST EQUIPMENT

10.1 LIST OF TEST EQUIPMENT(Conducted Test)

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Rohde & Schwarz	ENV216 / LISN	12/23/2016	Annual	100073
Rohde & Schwarz	ESCI / Test Receiver	12/23/2016	Annual	100584
Agilent	N9020A / Signal Analyzer	06/24/2016	Annual	MY51110085
Agilent	N9030A / Signal Analyzer	11/30/2016	Annual	MY49431210
Agilent	N1911A / Power Meter	04/17/2017	Annual	MY45100523
Agilent	N1921A / Power Sensor	04/17/2017	Annual	MY52260025
Agilent	87300B / Directional Coupler	11/23/2016	Annual	3116A03621
Hewlett Packard	11667B / Power Splitter	06/14/2016	Annual	05001
Hewlett Packard	E3632A / DC Power Supply	07/07/2016	Annual	KR75303960
Agilent	8493C / Attenuator(10 dB)	07/15/2016	Annual	07560

10.2 LIST OF TEST EQUIPMENT(Radiated Test)

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Innco system	MA4000-EP / Antenna Position Tower	N/A	N/A	N/A
Innco system	CT0800 / Turn Table	N/A	N/A	N/A
Innco system	CO3000 / Controller(Antenna mast)	N/A	N/A	CO3000-4p
ETS	2090 / Controller(Turn table)	N/A	N/A	1646
Rohde & Schwarz	Loop Antenna	04/19/2017	Biennial	1513-175
Schwarzbeck	VULB 9168 / Hybrid Antenna	04/06/2017	Biennial	760
Schwarzbeck	BBHA 9120D / Horn Antenna	12/11/2015	Biennial	9120D-1191
Schwarzbeck	BBHA9170 / Horn Antenna(15 GHz ~ 40 GHz)	09/04/2015	Biennial	BBHA9170541
Rohde & Schwarz	FSP / Spectrum Analyzer	09/29/2016	Annual	836650/016
Rohde & Schwarz	FSV40-N / Spectrum Analyzer	09/23/2016	Annual	101068-SZ
Wainwright Instruments	WHKX10-2700-3000-18000-40SS / High Pass Filter	08/11/2016	Annual	4
Wainwright Instruments	WHKX8-6090-7000-18000-40SS / High Pass Filter	07/15/2016	Annual	5
Wainwright Instruments	WRCJV2400/2483.5-2370/2520-60/12SS / Band Reject Filter	07/06/2016	Annual	2
Wainwright Instruments	WRCJV5100/5850-40/50-8EEK / Band Reject Filter	01/24/2017	Annual	2
H.P.	8491A / Attenuator(10 dB)	08/11/2016	Annual	18593
CERNEX	CBLU1183540 / Power Amplifier	01/25/2017	Annual	24614
CERNEX	CBL06185030 / Power Amplifier	01/25/2017	Annual	24615
CERNEX	CBL18265035 / Power Amplifier	01/23/2017	Annual	22966
CERNEX	CBL26405040 / Power Amplifier	07/11/2016	Annual	25956