TEST REPORT

Part 15 Subpart C 15.247

Equipment under test	WiFi Module
Model name	SWL-Q93T
Derivative Model	SWL-CQ93
FCC ID	NLMSWLQ93T
Applicant	Hanwha Techwin Co., Ltd.
Manufacturer	Hanwha Techwin Co., Ltd.
Date of test(s)	2015.11.16 ~ 2015.12.15
Date of issue	2015.12.17

Issued to

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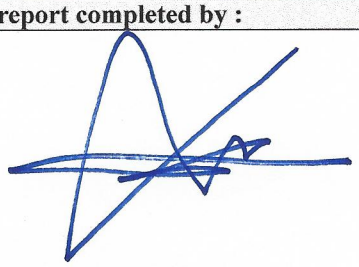
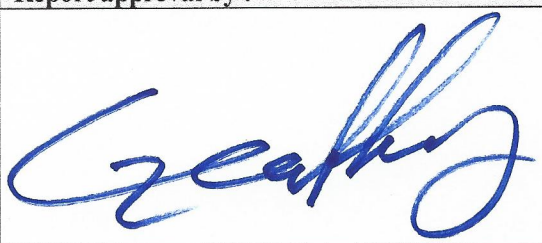
Test and report completed by :	Report approval by :
	
Kwon-se Kim / Test engineer	Jeff Do / Technical manager

Revision history

Revision	Date of issue	Test report No.	Description
-	2015.12.17	KES-RF-15T0093	Initial

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1. General information

Applicant:	Hanwha Techwin Co., Ltd.
Applicant address:	1204, Changwon-daero, Seongsan-gu, Changwon-si Gyeongsangnam-do, South Korea
Test site:	KES Co., Ltd.
Test site address:	C-3701, Simin-daero 365-40, Dongan-gu, Anyang-si, Gyeonggi-do,14057, Korea 473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, 12658, Korea
FCC rule part(s):	15.247
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering
Application purpose:	☒ Original grant ☐ Class I permissive change ☐ Class II permissive change

1.1. EUT description

Equipment under test	WiFi Module
Frequency range	2 412 ㎒ ~ 2 462 ㎒(802.11b/g/n_HT20) 5 745 ㎒ ~ 5 825 ㎒(802.11a/n_HT20), 5 755 ㎒ ~ 5 795 ㎒(802.11n_HT40) 5 180 ㎒ ~ 5 240 ㎒(802.11a/n_HT20), 5 190 ㎒ ~ 5 230 ㎒(802.11n_HT40) 5 260 ㎒ ~ 5 320 ㎒(802.11a/n_HT20), 5 270 ㎒ ~ 5 310 ㎒(802.11n_HT40) 5 500 ㎒ ~ 5 700 ㎒(802.11a/n_HT20), 5 510 ㎒ ~ 5 670 ㎒(802.11n_HT40)
Model:	SWL-Q93T(Basic), SWL-CQ93(Derivative model)
Modulation technique	DSSS, OFDM
Number of channels	2 412 ㎒ ~ 2 462 ㎒(802.11 b/g/n_HT20) : 11ch 5 745 ㎒ ~ 5 825 ㎒(802.11a/n_HT20) : 5ch 5 755 ㎒ ~ 5 795 ㎒(802.11n_HT40) : 2ch 5 180 ㎒ ~ 5 240 ㎒(802.11a/n_HT20) : 4ch 5 190 ㎒ ~ 5 230 ㎒(802.11n_HT40) : 2ch 5 260 ㎒ ~ 5 320 ㎒(802.11a/n_HT20) : 4ch 5 270 ㎒ ~ 5 310 ㎒(802.11n_HT40) : 2ch 5 500 ㎒ ~ 5 700 ㎒(802.11a/n_HT20) : 11ch 5 510 ㎒ ~ 5 670 ㎒(802.11n_HT40) : 5ch
Antenna specification	Antenna type: FIPA Antenna
Power source	DC 5 V

1.2. Frequency/channel operations

Ch.	Frequency (㎒)	Mode
1	2 412	11b/g/n_HT20
. .	. .	. .
6	2 437	11b/g/n_HT20
. .	. .	. .
11	2 462	11b/g/n_HT20

1.3 Information about derivative model

This is to notify that SWL-CQ93 are same Hardware, Software and components.

1.4 Directional antenna gain for MIMO

Model : SWL-CQ93 (Airlink)

ANT1 Gain (dBi)	ANT2 Gain (dBi)	Total Gain (dBi)	Note
-2.69	-2.22	1.78	For 2.4 ㎓

-Ant Gain = 10 log[$10^{G1/20}$+$10^{G2/20}$+…+$10^{GN/20}$]^2/N_{ANT}

2. Summary of tes

Reference	Test description	Test results
15.205, 15.209	Radiated restricted band and emission	Pass
15.207(d)	Conducted band edge and out of band emissions	Pass
15.247(a)(2)	6 dB bandwidth	Pass
15.247(b)(3)	Peak output power	Pass
15.247(e)	Power spectral density	Pass
15.207	AC conducted emissions	Pass

Test procedures;
The EUT was tested per the guidance of ANSI C63.10-2009 was used to reference the appropriate EUT setup for radiated spurious emissions testing, the guidance provided in KDB 558074_v03r03 and KDB 662911 D01 v02r01 were used in the measurement of the EUT.

Pre-scanned maximum output power

Preliminary tests were performed in different data rate as below table and the highest power data rates(802.11b, 802.11g, 802.11n_HT20) were chosen for full test in the following section to demonstrate compliance to the FCC limit line.

Antenna 0

802.11b

channel	Detector mode	Conducted power(dB m)			
		Data rate(Mbps)			
		1	2	5.5	11
Low	Peak	13.45	13.31	13.03	12.69
Middle		12.82	12.81	12.76	12.44
High		12.86	12.85	12.79	12.12

802.11g

channel	Detector mode	Conducted power(dB m)							
		Data rate(Mbps)							
		6	9	12	18	24	36	48	54
Low	Peak	11.64	11.33	10.71	10.56	10.53	10.47	10.30	10.03
Middle		12.59	12.22	12.11	12.10	12.09	12.05	12.00	11.99
High		12.51	12.41	12.19	12.14	12.13	12.12	12.10	11.93

802.11n(HT20)

Test mode	Detector mode	Conducted power(dB m)							
		Data rate(Mbps)							
		MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
Low	Peak	13.09	13.00	12.71	12.55	12.33	12.17	12.01	11.96
Middle		12.68	12.58	12.25	12.19	12.17	11.92	11.81	11.75
High		12.40	12.37	12.23	12.13	12.04	11.98	11.97	11.80

Antenna 1

802.11b

channel	Detector mode	Conducted power(dB m)			
		Data rate(Mbps)			
		1	2	5.5	11
Low	Peak	13.45	13.31	13.03	12.69
Middle		12.82	12.81	12.76	12.44
High		12.86	12.85	12.79	12.12

802.11g

channel	Detector mode	Conducted power(dB m)							
		Data rate(Mbps)							
		6	9	12	18	24	36	48	54
Low	Peak	13.14	12.73	12.67	12.50	12.50	12.50	12.26	12.14
Middle		12.24	12.04	11.97	11.89	11.86	11.71	11.56	11.25
High		11.91	11.65	11.43	11.38	11.28	11.23	11.16	11.15

802.11n(HT20)

Test mode	Detector mode	Conducted power(dB m)							
		Data rate(Mbps)							
		MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
Low	Peak	12.66	12.63	12.55	12.49	12.48	12.34	12.21	11.90
Middle		12.34	12.16	12.05	11.95	11.85	11.76	11.62	11.45
High		12.18	11.74	11.53	11.52	11.51	11.49	11.33	11.23

Antenna 0 +Antenna 1

802.11n(HT20)

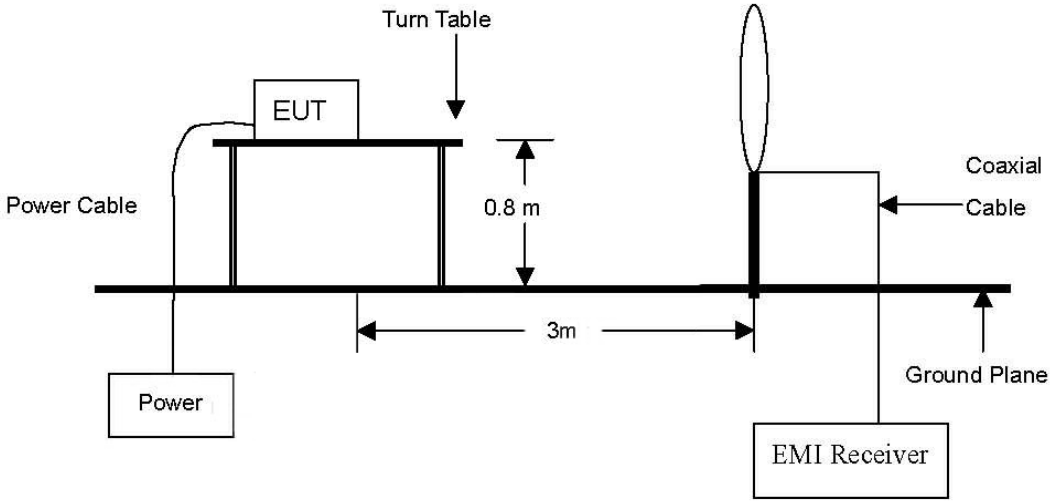
Test mode	Detector mode	Conducted power(dB m)							
		Data rate(Mbps)							
		MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
Low	Peak	15.89	15.83	15.64	15.53	15.42	15.27	15.12	14.97
Middle		15.52	15.39	15.16	15.08	15.02	14.85	14.73	14.61
High		15.30	15.08	14.90	14.85	14.79	14.75	14.67	14.53

3. Test results

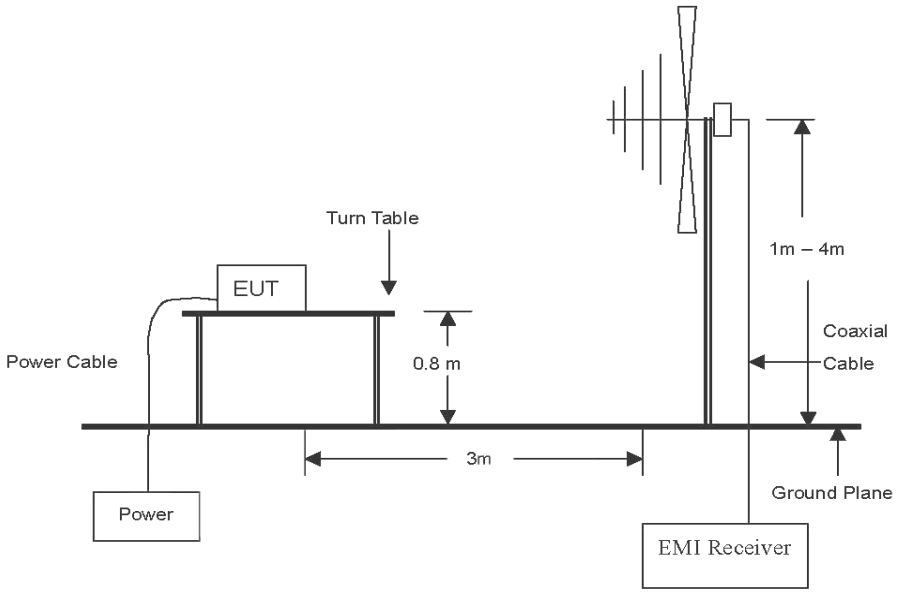
3.1. Radiated restricted band and emissions

Test setup

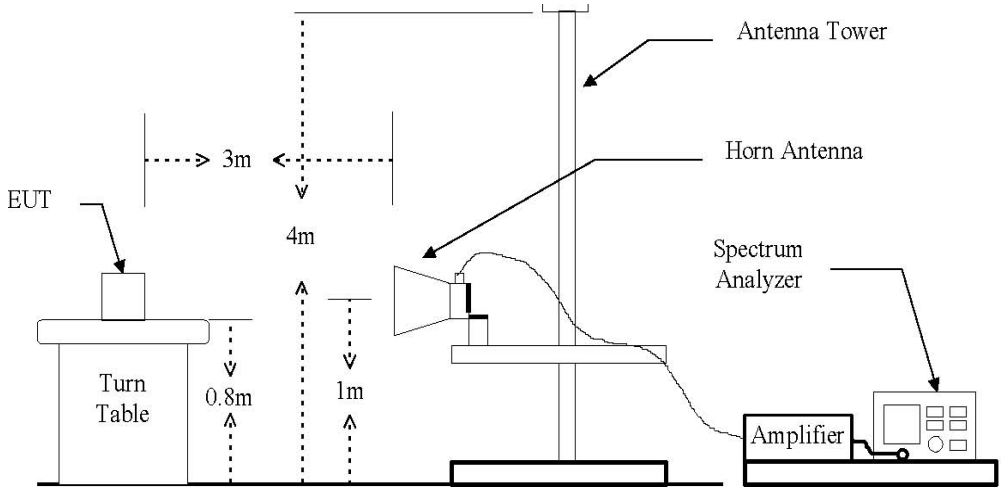
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to 24 ㎓ emissions.



Test procedure
Radiated emissions from the EUT were measured according to the dictates in section 11.0 & 12.0 of KDB 558074_v03r03 and ANSI C63.4-2009

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site or open area test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1㎓, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable height antenna tower. During performing radiated emission above 1 ㎓, the EUT was set 3 meter away from the interference receiving antenna.
3. The antenna is a broadband antenna, and its height is varied from 1 meter to 4 meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test receiver system was set to peak detect function and specified bandwidth with maximum hold mode.
6. If the emission level of the EUT in peak mode was 10 ㏈lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have10 ㏈ margin would be retested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

Note.
All data rates and modes were investigated for radiated spurious emissions. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

1. Average Field Strength Measurements per Section 12.2.5.1
Analyzer center frequency was set to the frequency of the radiated spurious emission of interest.
Set RBW = 1 ㎒.
Set VBW = 3 ㎒ (≥ 3 x RBW).
Set detector = power average(RMS).
Set sweep time = auto.
Trace (RMS) averaging was performed over at least 100 traces.

2. Peak Field Strength Measurements per Section 12.2.4
Analyzer center frequency was set to the frequency of the radiated spurious emission of interest.
Set RBW = 1 ㎒.
Set VBW = 3 ㎒ (≥ 3 x RBW).
Set detector = Peak.
Set sweep time = auto.
Trace mode = max hold.
Allow sweeps to continue until the trace stabilizes.

Limit

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values：

Frequency (㎒)	Distance (Meters)	Radiated (㎶/m)
0.009 ~ 0.490	300	2 400 / F(㎑)
0.490 ~ 1.705	30	24 000 / F(㎑)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 ~ 72 ㎒, 76 ~ 88 ㎒, 174 ~ 216 ㎒ or 470 ~ 806 ㎒. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

Test results (Below 30 ㎒)

Mode:	802.11 n_HT20(MIMO)
Transfer rate:	6 Mbps
Distance of measurement:	3 meter
Operating frequency:	2 412 ㎒ (Worst case)
Channel:	01

Frequency (㎒)	Level (dB㎶)	Ant. Pol.	Correction factors (dB/m)	F_d (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No signal detected							

Test results (Below 1 000 ㎒)

Mode:	802.11 n_HT20(MIMO)
Transfer rate:	6 Mbps
Distance of measurement:	3 meter
Operating frequency:	2 412 ㎒ (Worst case)
Channel:	01

Radiated emissions		Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
100.810	27.68	H	8.93	0.79	37.40	43.52	6.12
144.460	20.95	V	12.88	0.92	34.75	43.52	8.77
173.560	24.30	V	11.75	1.09	37.14	43.52	6.38
214.300	24.36	H	10.67	1.32	36.35	43.52	7.17
240.490	24.53	H	11.63	1.37	37.53	46.02	8.49
264.740	20.12	H	12.52	1.46	34.10	46.02	11.92
346.220	21.04	H	14.86	1.65	37.55	46.02	8.47
451.950	17.45	H	17.23	2.01	36.69	46.02	9.33

Note.

1. All spurious emission at channels are almost the same below 1 ㎓, so that low channel was chosen at representative in final test.
2. Actual = Reading + Ant. factor + Cable loss
3. Detector mode: Quasi peak
4. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

Test results (Above 1 000 ㎒)

-Antenna port 0

Mode: 802.11b
Transfer rate: 1 Mbps
Operating frequency: 2 412 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2397.21	61.84	Peak	H	-0.91	60.93	74.00	13.07
2398.69	45.35	Avg	H	-0.90	44.45	54.00	9.55
2397.21	52.55	Peak	V	-0.91	51.64	74.00	22.36
2398.69	40.67	Avg	V	-0.90	39.77	54.00	14.23

Mode: 802.11b
Transfer rate: 1 Mbps
Operating frequency: 2 437 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Emission levels are not reported much lower than the limits by over 20 dB							

Mode: 802.11b
Transfer rate: 1 Mbps
Operating frequency: 2 462 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2484.37	49.00	Peak	H	-0.44	48.56	74.00	25.44
2483.86	48.24	Peak	V	-0.45	47.79	74.00	26.21

Mode: 802.11g
Transfer rate: 6 Mbps
Operating frequency: 2 412 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2399.68	72.80	Peak	H	-0.90	71.90	74.00	2.10
2399.90	42.31	Avg	H	-0.90	41.41	54.00	12.59
2399.36	67.41	Peak	V	-0.90	66.51	74.00	7.49
2399.90	36.12	Avg	V	-0.90	35.22	54.00	18.78

Mode: 802.11g
Transfer rate: 6 Mbps
Operating frequency: 2 437 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4884.00	36.00	Peak	H	8.64	44.64	74.00	29.36

Mode: 802.11g
Transfer rate: 6 Mbps
Operating frequency: 2 462 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2485.74	58.12	Peak	H	-0.44	57.68	74.00	16.32
2483.55	31.62	Avg	H	-0.45	31.17	54.00	22.83
2484.37	57.40	Peak	V	-0.44	56.96	74.00	17.04
2483.55	29.63	Avg	V	-0.45	29.18	54.00	24.82

-Antenna port 1

Mode: 802.11b
Transfer rate: 1 Mbps
Operating frequency: 2 412 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2397.61	62.57	Peak	H	-0.91	61.66	74.00	12.34
2398.14	51.63	Avg	H	-0.91	50.72	54.00	3.28
2397.93	58.34	Peak	V	-0.91	57.43	74.00	16.57
2398.14	46.33	Avg	V	-0.91	45.42	54.00	8.58
4829.00	38.84	Peak	H	8.25	47.09	74.00	26.91

Mode: 802.11b
Transfer rate: 1 Mbps
Operating frequency: 2 437 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4884.00	37.76	Peak	H	8.64	46.40	74.00	27.60

Mode: 802.11b
Transfer rate: 1 Mbps
Operating frequency: 2 462 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2484.59	58.56	Peak	H	-0.44	58.12	74.00	15.88
2483.55	35.71	Avg	H	-0.45	35.26	54.00	18.74
2484.73	57.89	Peak	V	-0.44	57.45	74.00	16.55
2483.55	36.15	Avg	V	-0.45	35.70	54.00	18.30
4924.00	39.13	Peak	H	8.93	48.06	74.00	25.94

Mode: 802.11g
Transfer rate: 6 Mbps
Operating frequency: 2 412 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2399.84	71.78	Peak	H	-0.90	70.88	74.00	3.12
2399.68	42.21	Avg	H	-0.90	41.31	54.00	12.69
2399.84	69.99	Peak	V	-0.90	69.09	74.00	4.91
2399.79	46.12	Avg	V	-0.90	45.22	54.00	8.78

Mode: 802.11g
Transfer rate: 6 Mbps
Operating frequency: 2 437 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Emission levels are not reported much lower than the limits by over 20 dB							

Mode: 802.11g
Transfer rate: 6 Mbps
Operating frequency: 2 462 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2484.15	57.33	Peak	H	-0.45	56.88	74.00	17.12
2483.55	35.65	Avg	H	-0.45	35.20	54.00	18.80
2487.41	58.38	Peak	V	-0.43	57.95	74.00	16.05
2483.56	35.42	Avg	V	-0.45	34.97	54.00	19.03

Antenna 0 + Antenna 1

Mode: 802.11n (HT20)
Transfer rate: MCS8
Operating frequency: 2 412 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2399.04	72.10	Peak	H	-0.90	71.20	74.00	2.80
2399.68	47.42	Avg	H	-0.90	46.52	54.00	7.48
2399.68	69.59	Peak	V	-0.90	68.69	74.00	5.31
2399.68	44.20	Avg	V	-0.90	43.30	54.00	10.70

Mode: 802.11n (HT20)
Transfer rate: MCS8
Operating frequency: 2 437 ㎒

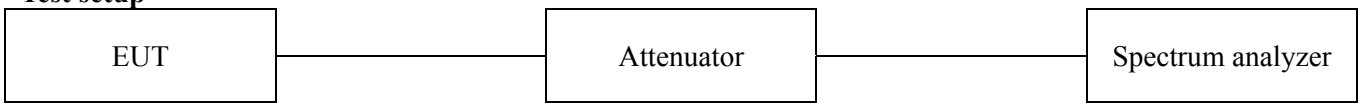
Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Emission levels are not reported much lower than the limits by over 20 dB							

Mode: 802.11n (HT20)
Transfer rate: MCS8
Operating frequency: 2 462 ㎒

Frequency (㎒)	Level (dBμV)	Detect	Ant. Pol.	Correction factors (dB/m)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2484.15	58.37	Peak	H	-0.45	57.92	74.00	16.08
2483.61	36.75	Avg	H	-0.45	36.30	54.00	17.70
2484.59	57.44	Peak	V	-0.44	57.00	74.00	17.00
2483.55	35.56	Avg	V	-0.45	35.11	54.00	18.89

3.2. Conducted spurious emissions & band edge

Test setup



Test procedure

All data rates and modes were investigated for conducted spurious emissions. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.

Per the guidance of KDB 558074_v03r03, section 11.2&11.3,

1. Use the following spectrum analyzer setting
   Center frequency: Low and high channel.
   Set the span to encompass frequency range to be measured.
   Set the RBW = 100 ㎑.
   Set the VBW = 300 ㎑ (≥3x RBW).
   Detector = peak.
   Sweep time = auto couple.
   Trace mode= max hold.
   Allow trace to fully stabilize.
   Use the peak market function to determine the maximum PSD level.

2. Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in 11.1 a) or 11.1 b). Report the three highest emissions relative to the limit.

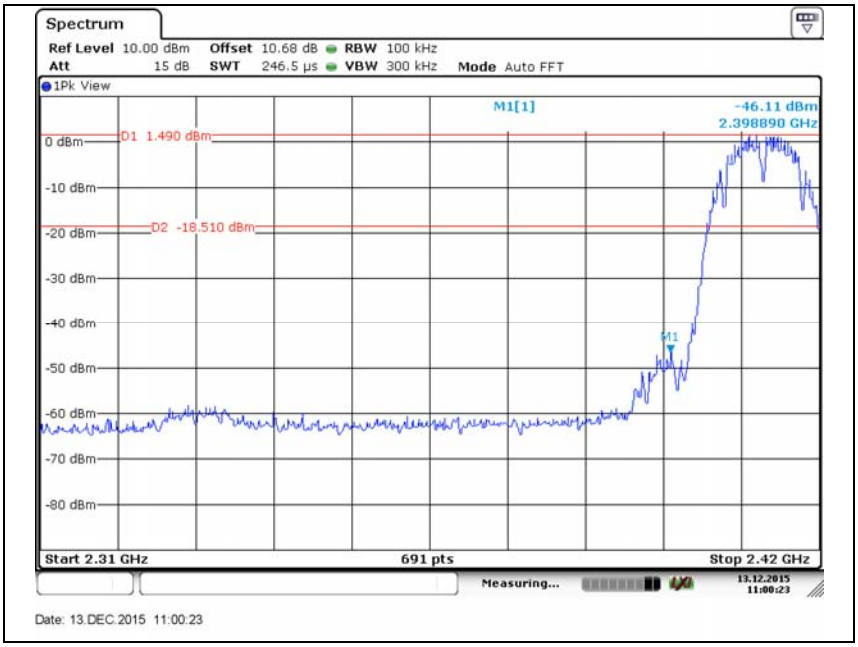
Limit

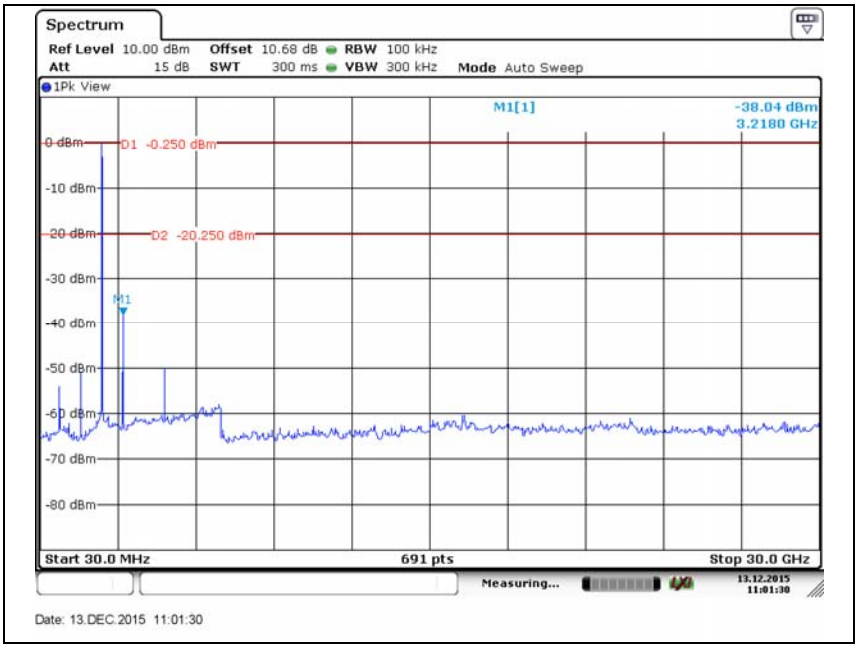
According to 15.247(d), in any 100 ㎑ bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 ㏈ below that in the 100 ㎑ bandwidth within the band 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 ㏈ instead of 20 ㏈. Attenuation below the general limits specified in section 15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section 15.205(a), must also comply the radiated emission limits specified in section 15.209(a) (see section 15.205(c))

Test results for conducted spurious emission

-Antenna port 0

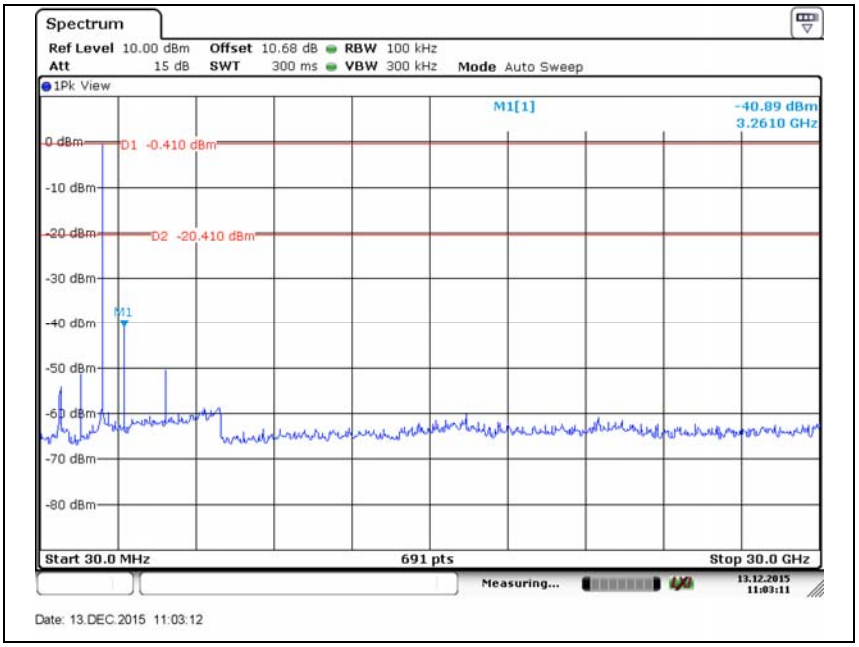
802.11b // Low channel



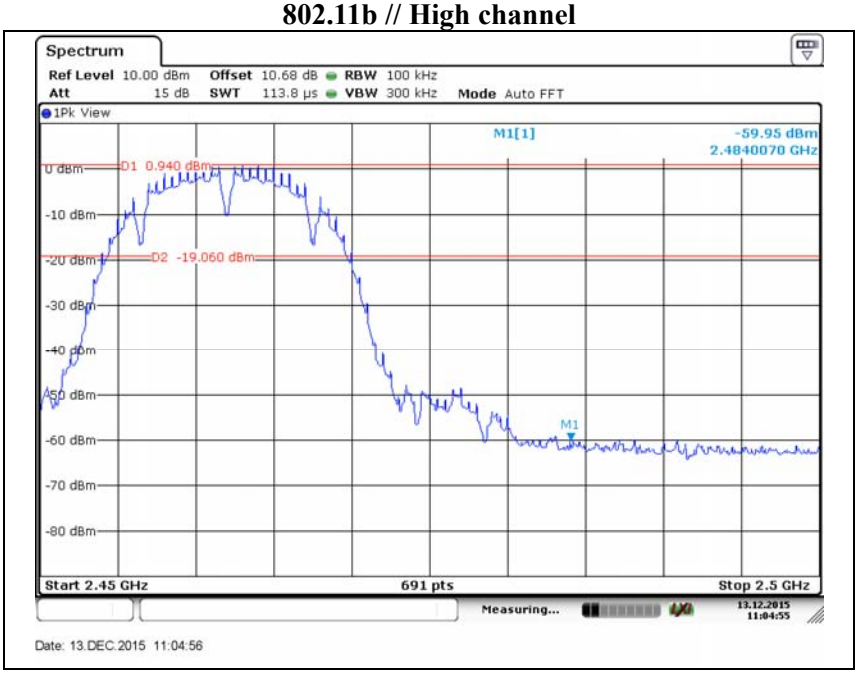


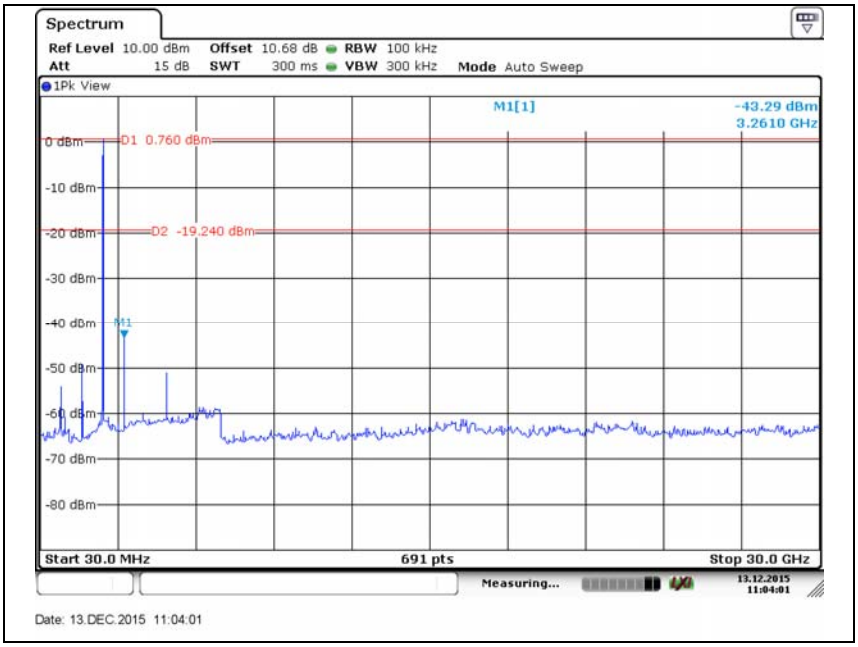
802.11b // Middle channel

N/A

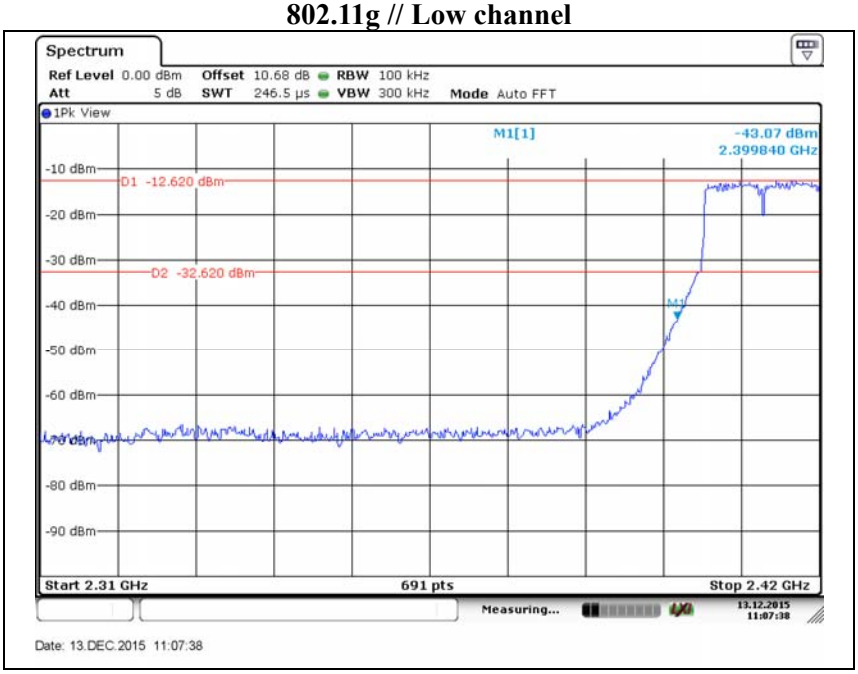


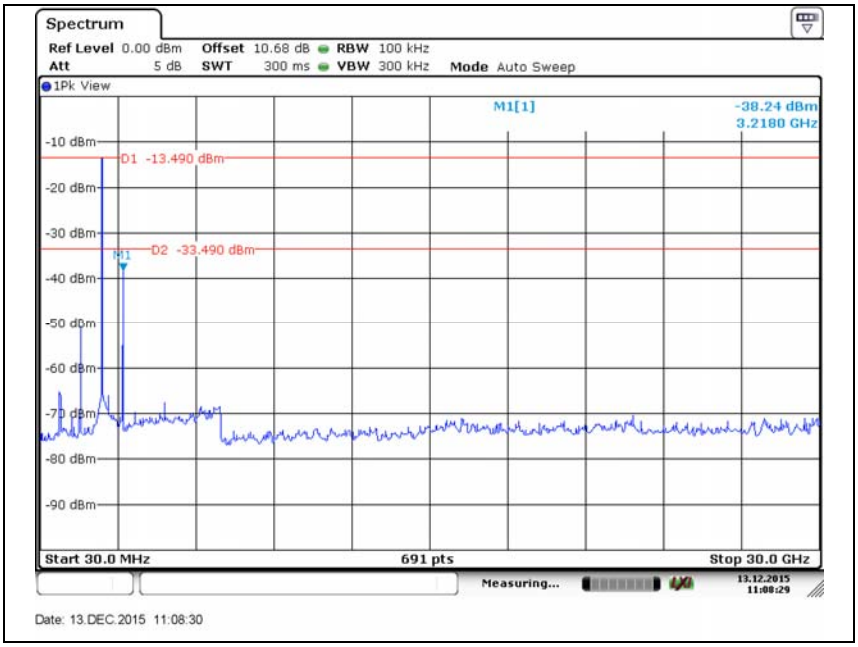
802.11b // High channel





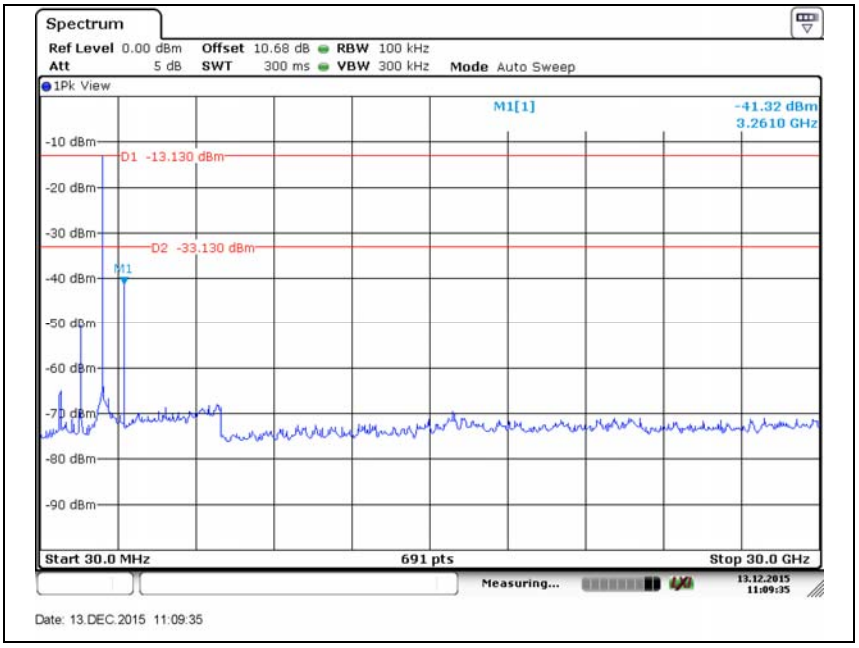
802.11g // Low channel



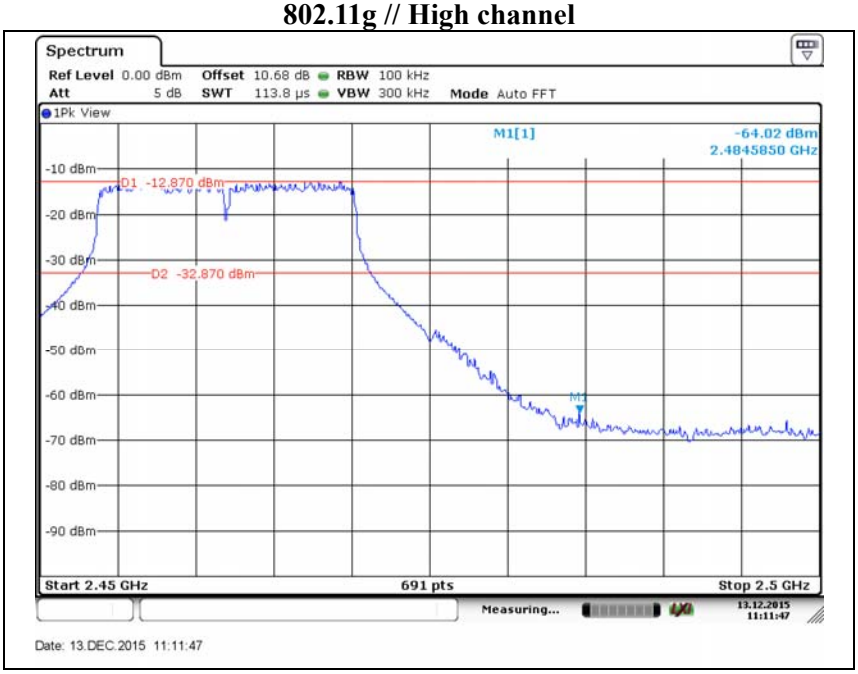


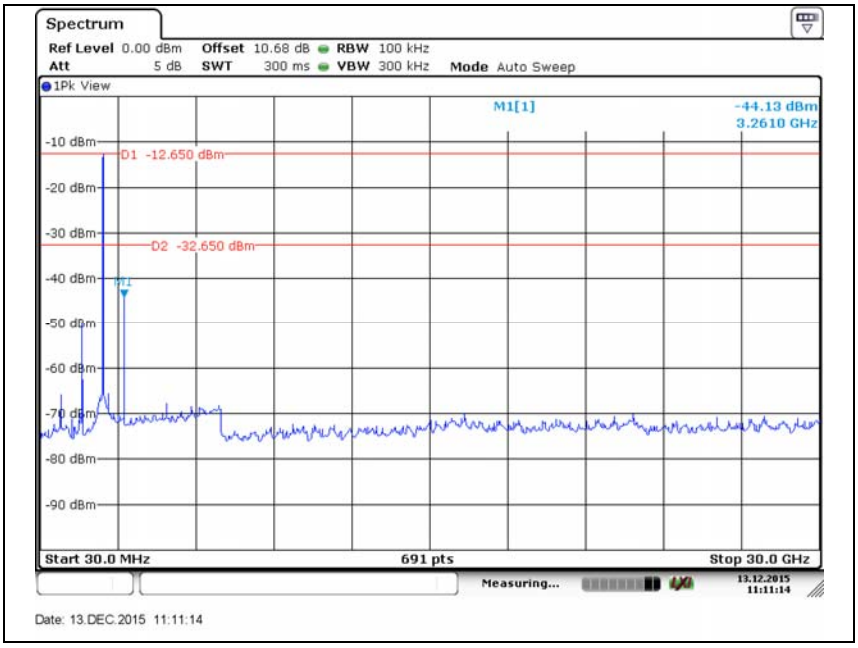
802.11g // Middle channel

N/A

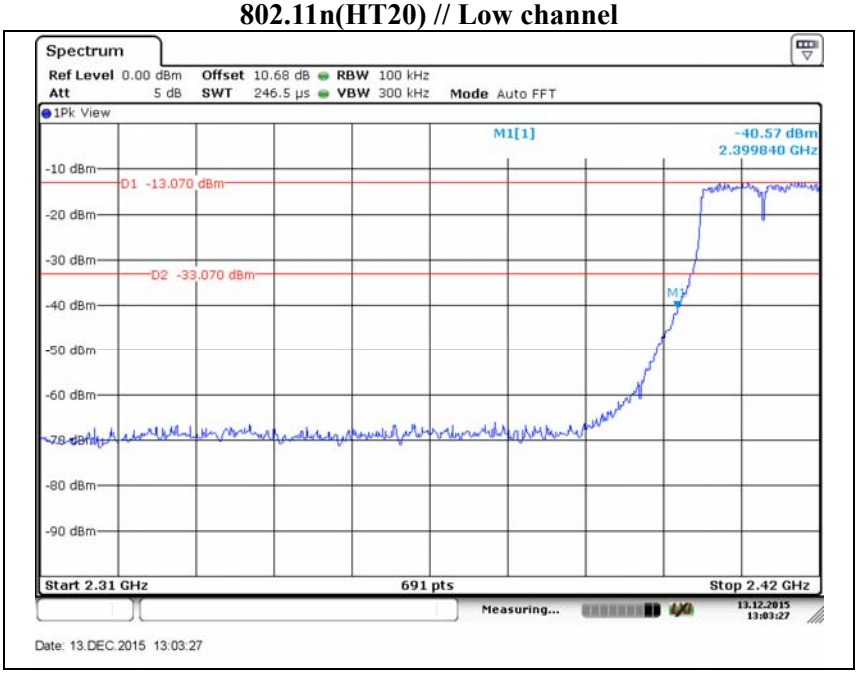


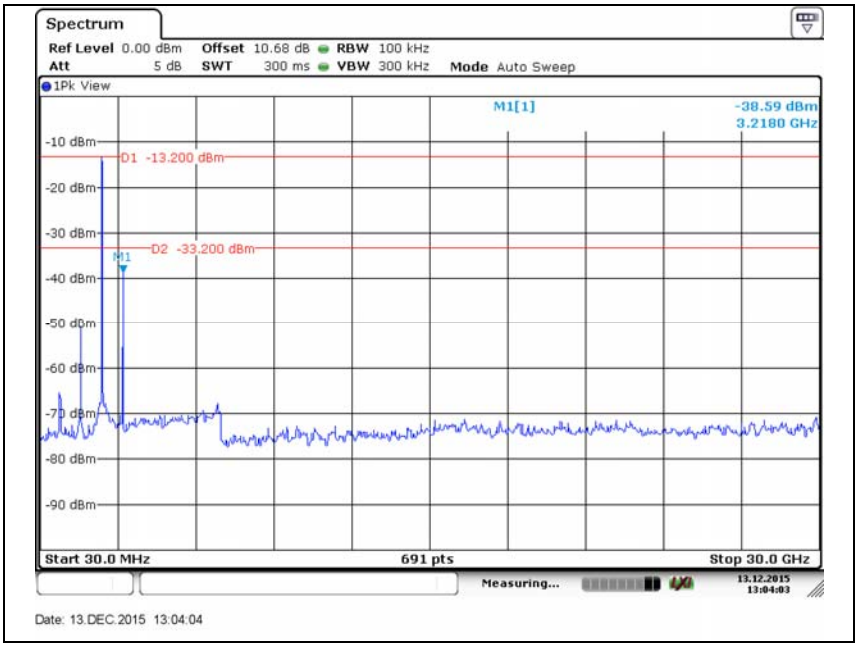
802.11g // High channel





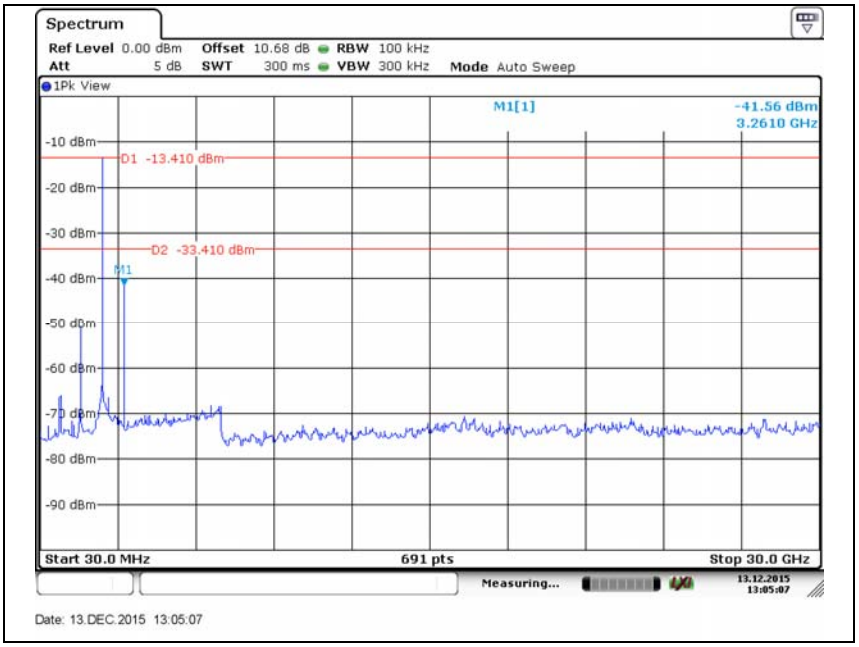
802.11n(HT20) // Low channel



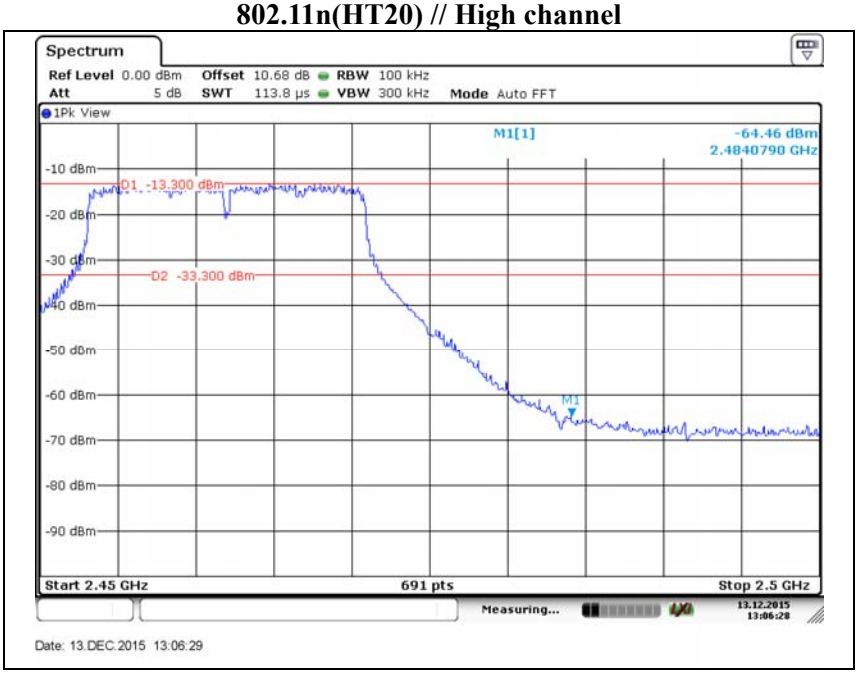


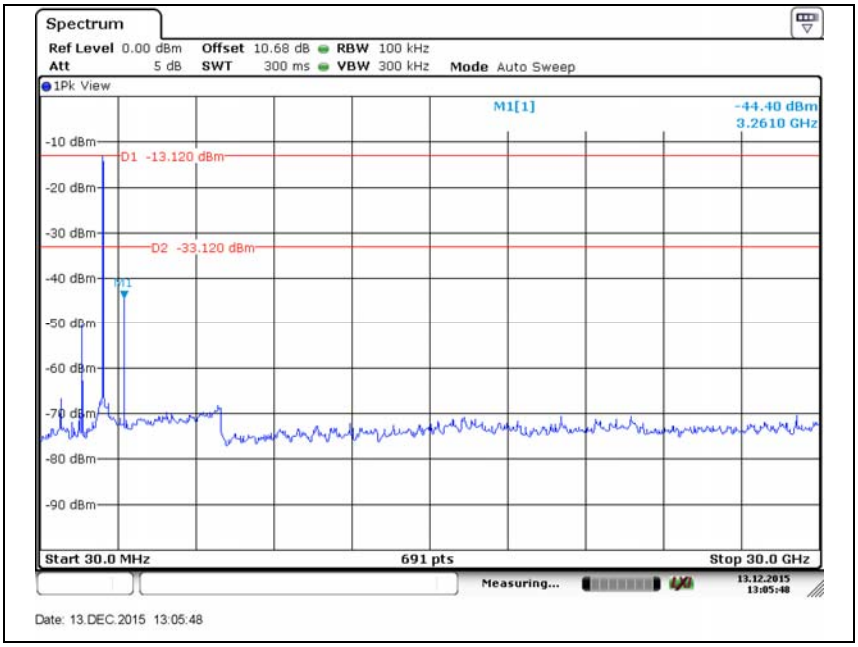
802.11n(HT20) // Middle channel

N/A



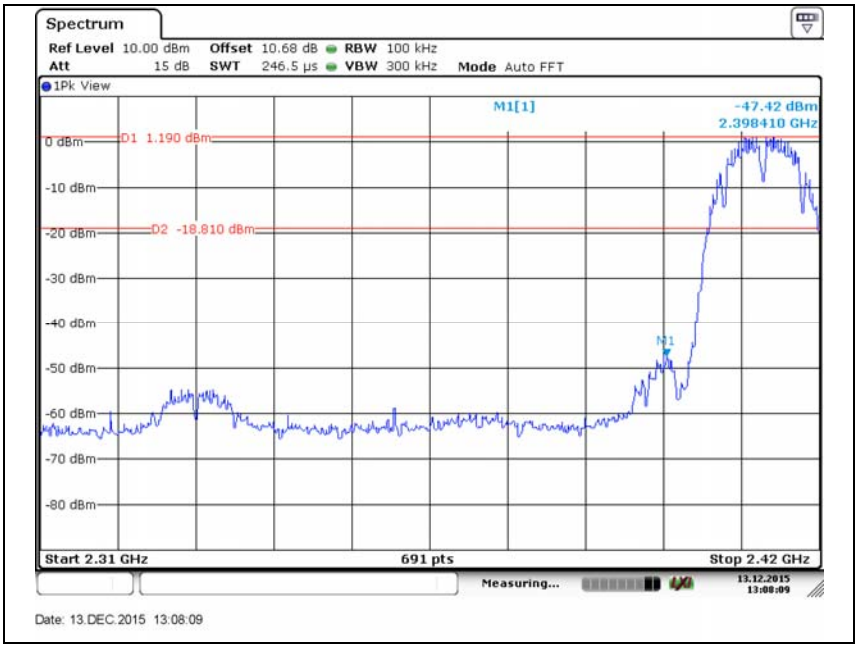
802.11n(HT20) // High channel

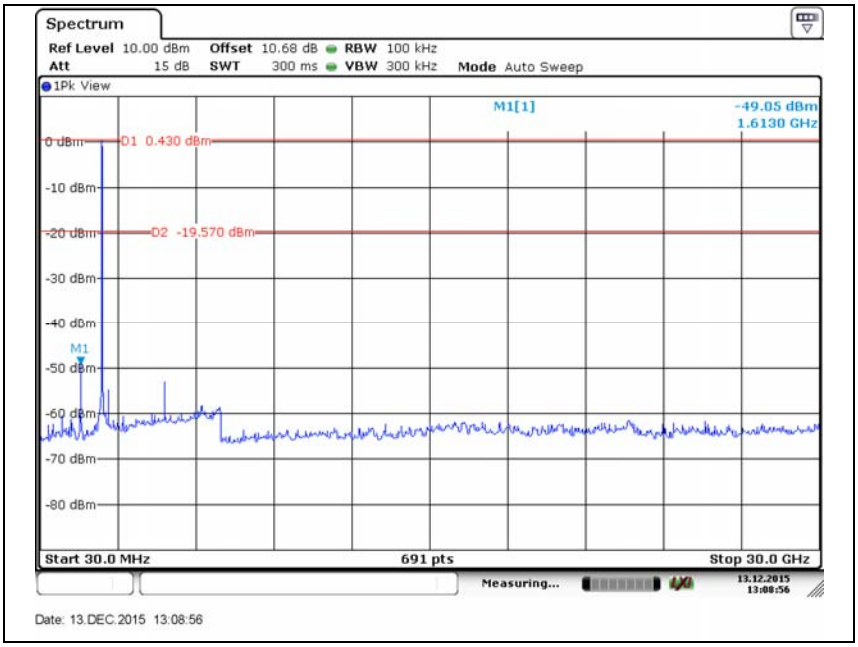




-Antenna port 1

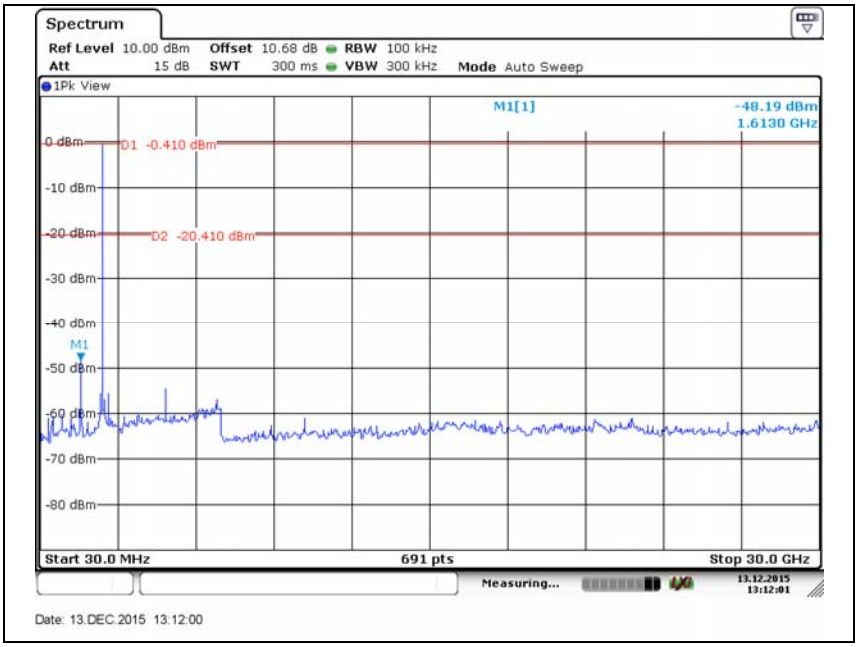
802.11b // Low channel



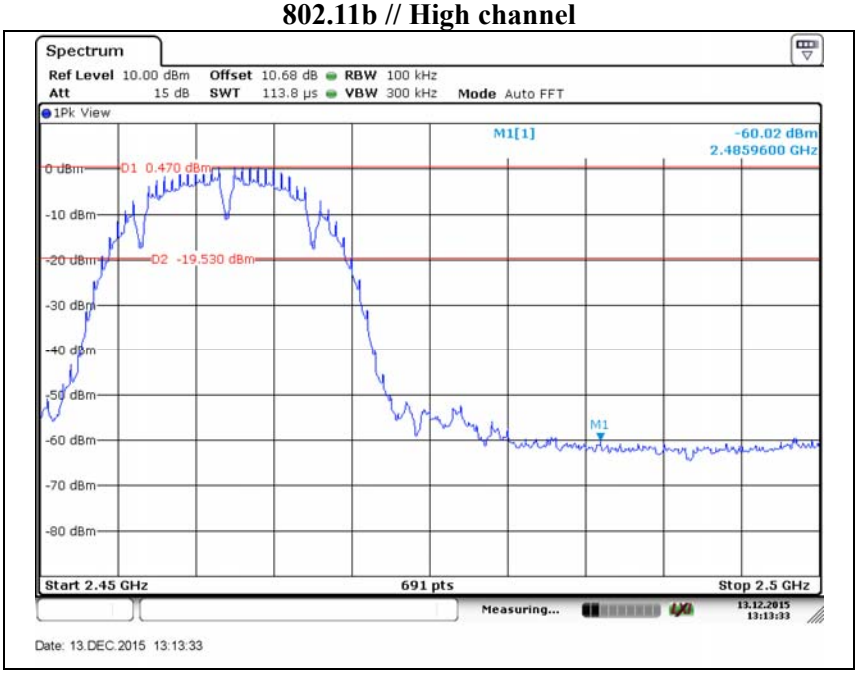


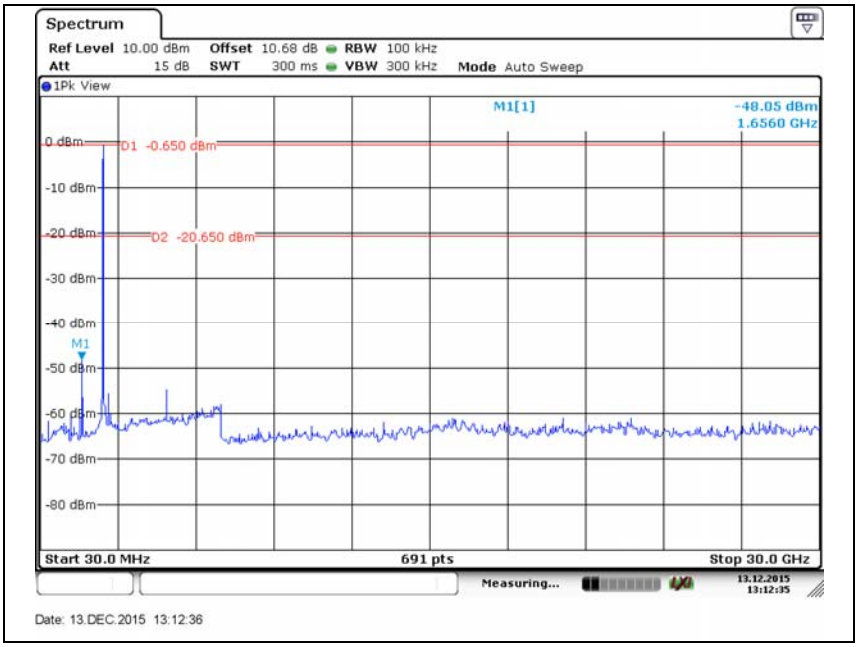
802.11b // Middle channel

N/A

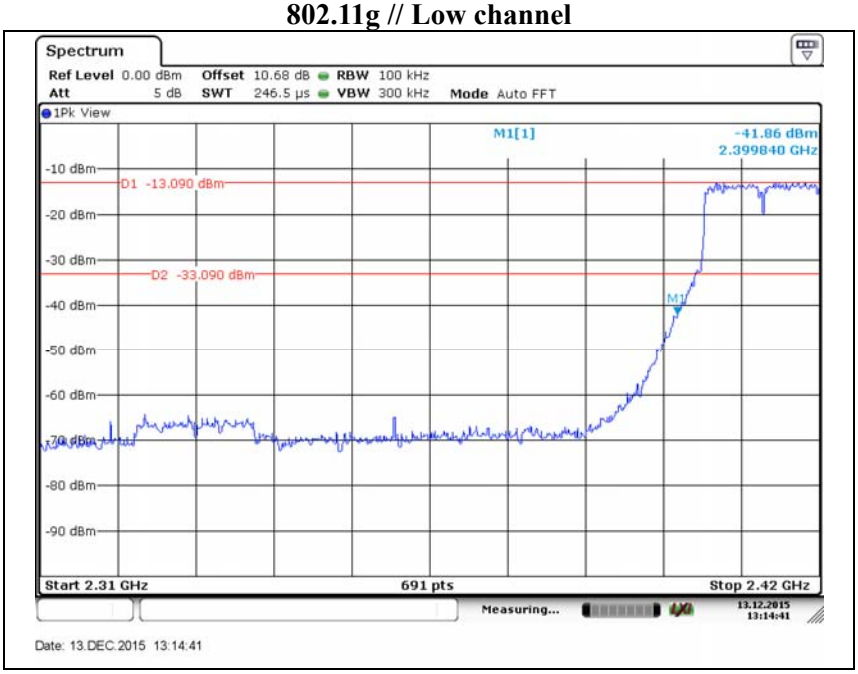


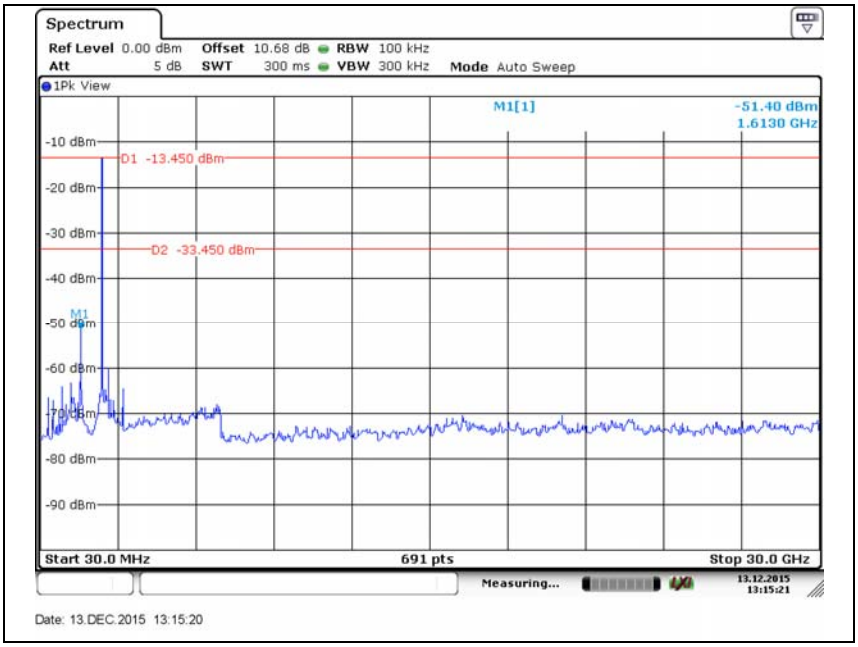
802.11b // High channel





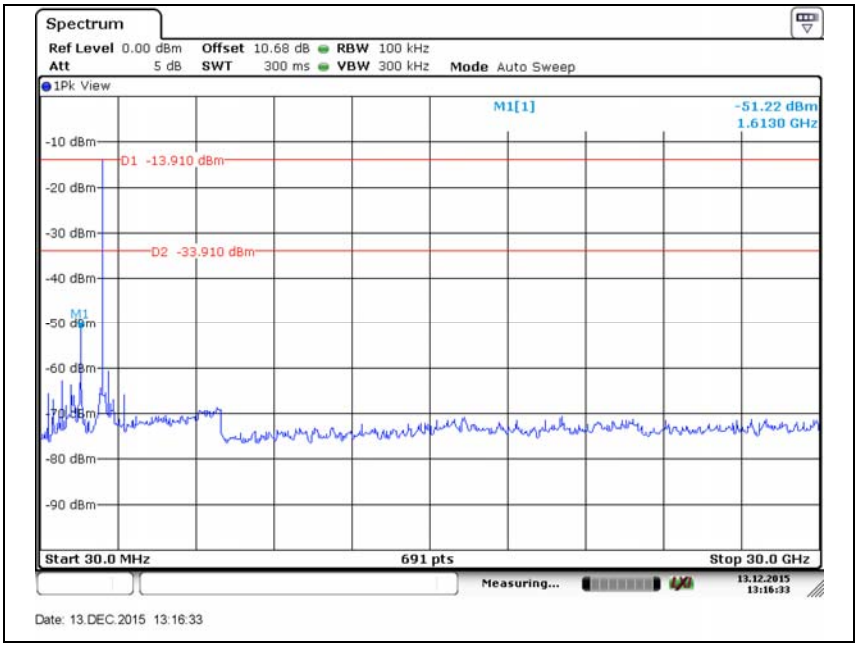
802.11g // Low channel



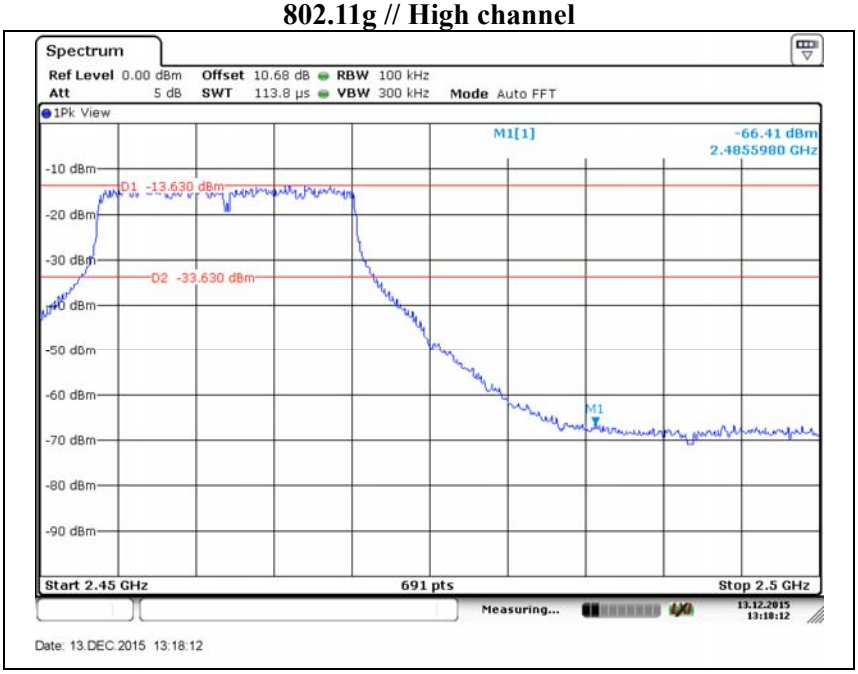


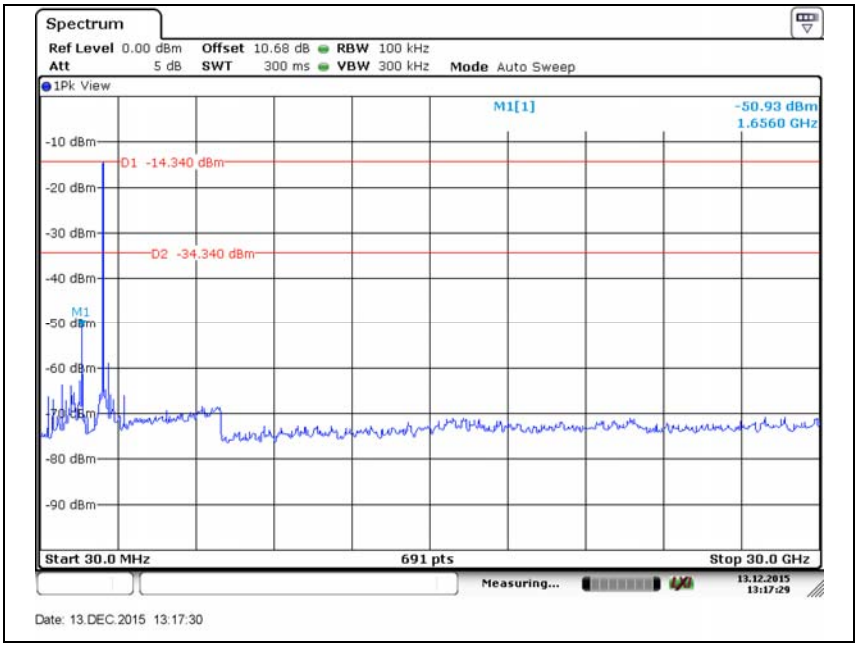
802.11g // Middle channel

N/A

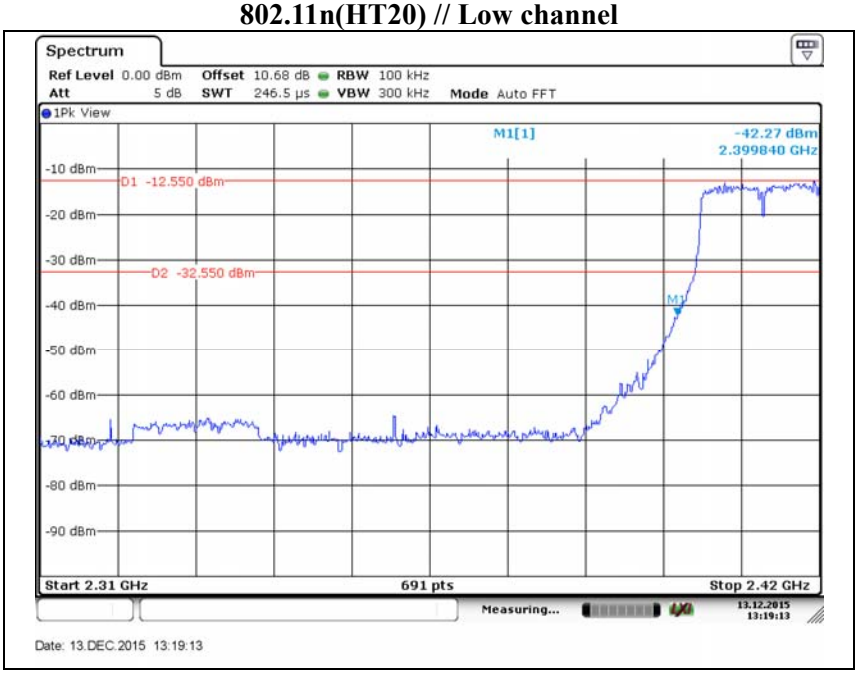


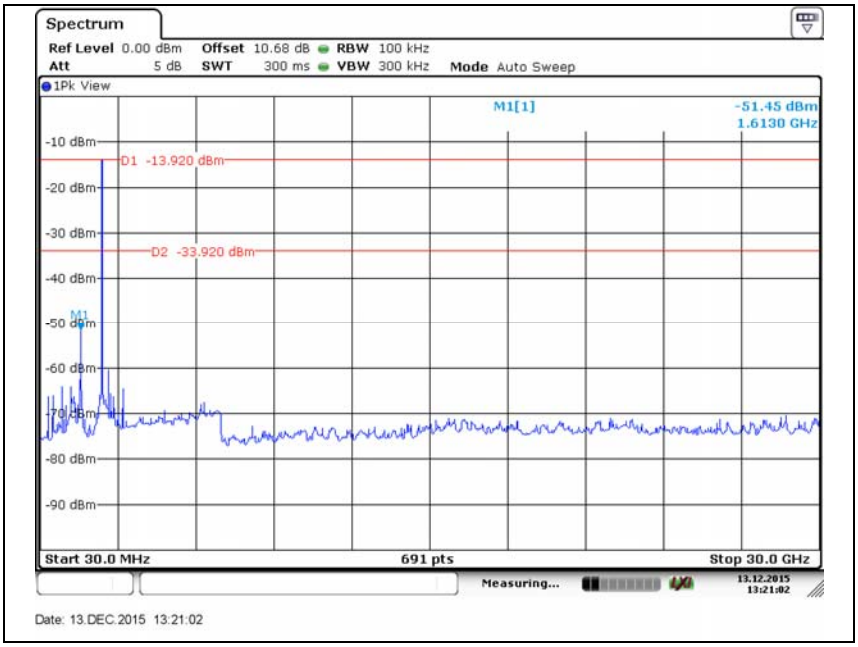
802.11g // High channel





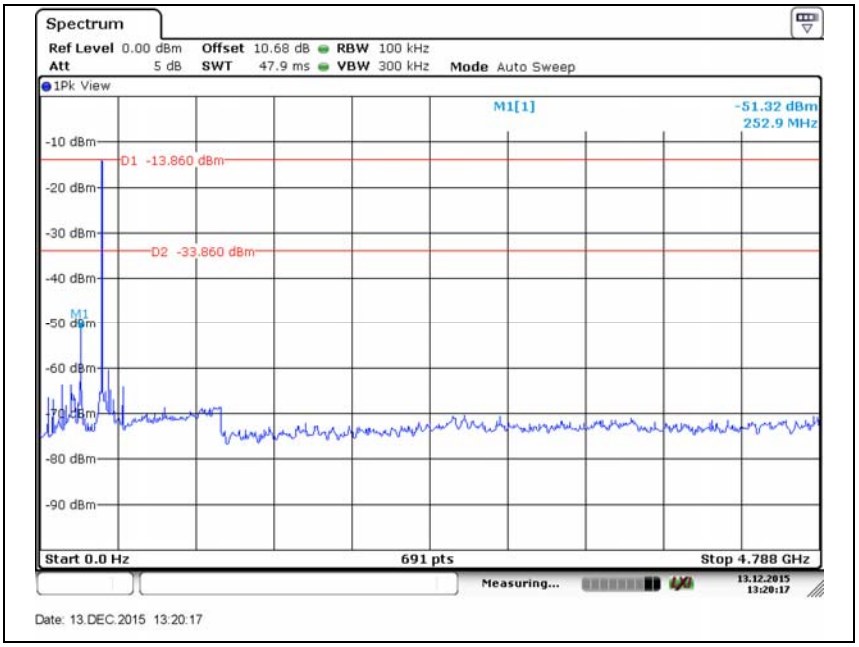
802.11n(HT20) // Low channel



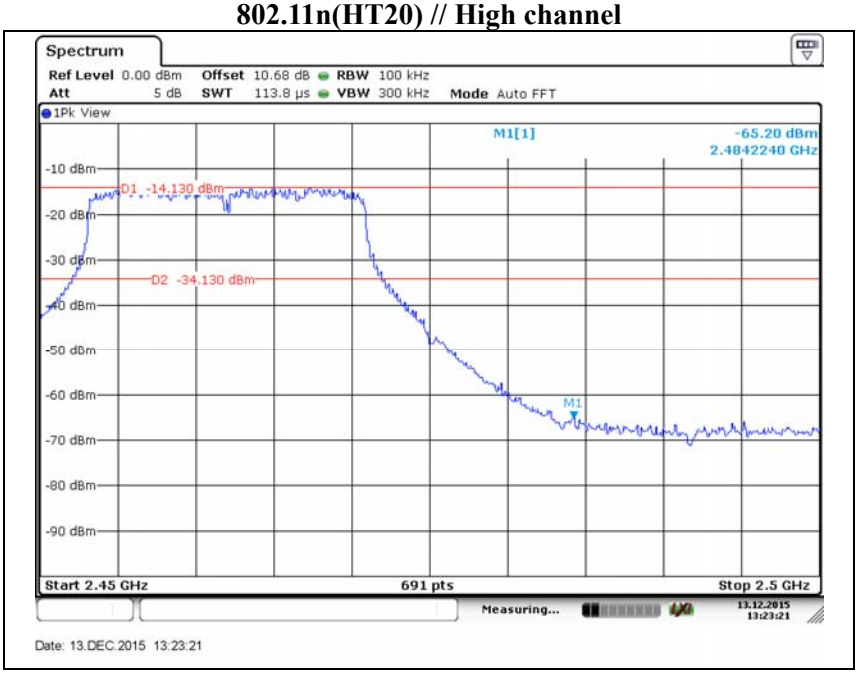


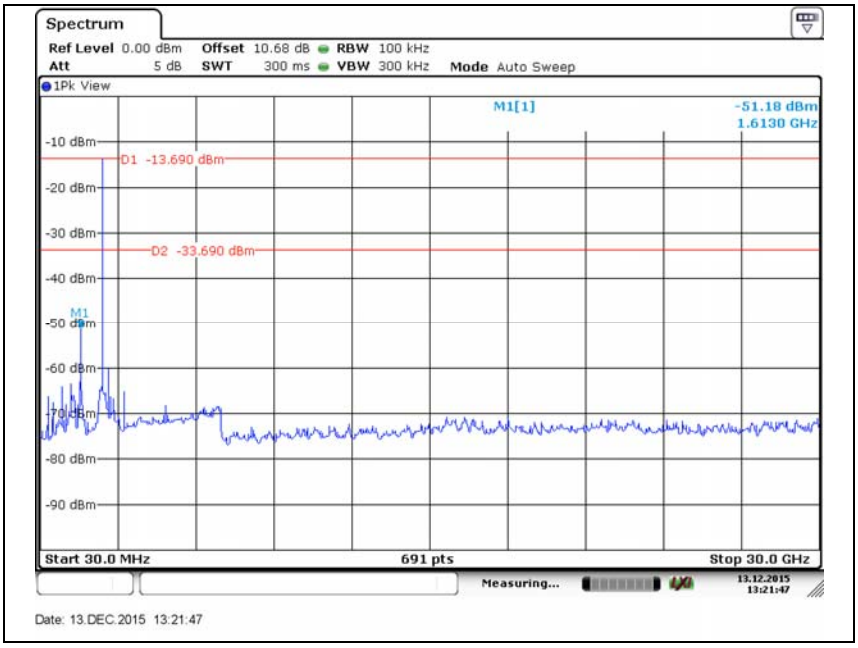
802.11n(HT20) // Middle channel

N/A



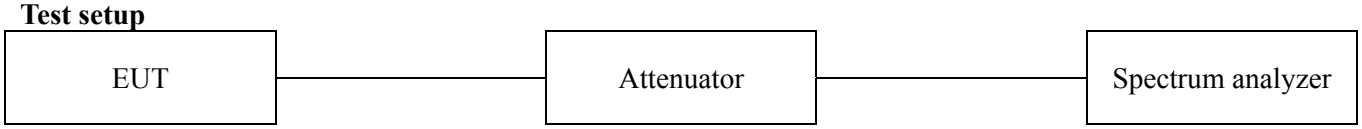
802.11n(HT20) // High channel





3.3. 6 dB bandwidth

Test setup



Test procedure

KDB 558074_v03r03 – section 8.1 option 1 or section 8.2 option 2.

Option 1:

a) Set RBW = 100 ㎑.
b) Set the video bandwidth(VBW) ≥ 3 × RBW.
c) Detector = peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 ㏈ relative to the maximum level measured in the fundamental emission.

Option 2:

The automatic bandwidth measurement capability of an instrument may be employed using the X bandwidth mode with X set to 6 ㏈, if the functionality described above (i.e., RBW = 100 ㎑, VBW ≥ 3 × RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 ㏈.

Limit

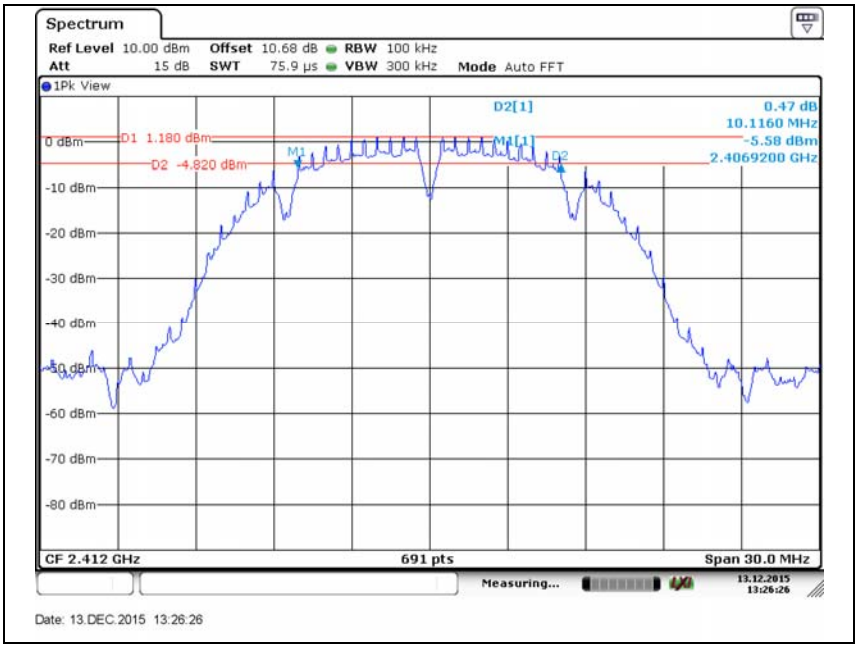
According to §15.247(a)(2), systems using digital modulation techniques may operate 902 ~ 928 ㎒, 2 400 ~ 2 483.5 ㎒, and 5 725 ~ 5 850 ㎒ bands. The minimum 6 ㏈ bandwidth shall be at least 500 ㎑.

Test results

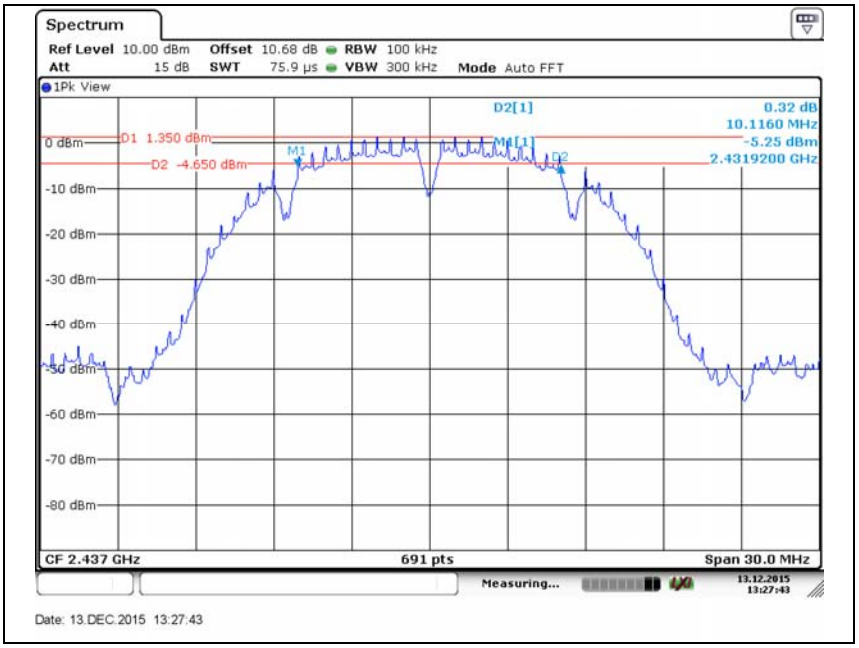
Antenna port	Operation mode	Frequency(㎒)	6 dB bandwidth(㎒)	Limit(㎒)
0	802.11b	2 412	10.12	0.5
		2 437	10.12	
		2 462	10.12	
	802.11g	2 412	16.54	
		2 437	16.59	
		2 462	16.59	
	802.11n (HT20)	2 412	17.84	
		2 437	17.84	
		2 462	17.84	
1	802.11b	2 412	10.12	
		2 437	10.12	
		2 462	10.12	
	802.11g	2 412	16.59	
		2 437	16.59	
		2 462	16.59	
	802.11n (HT20)	2 412	17.80	
		2 437	17.84	
		2 462	17.80	

- Antenna port 0

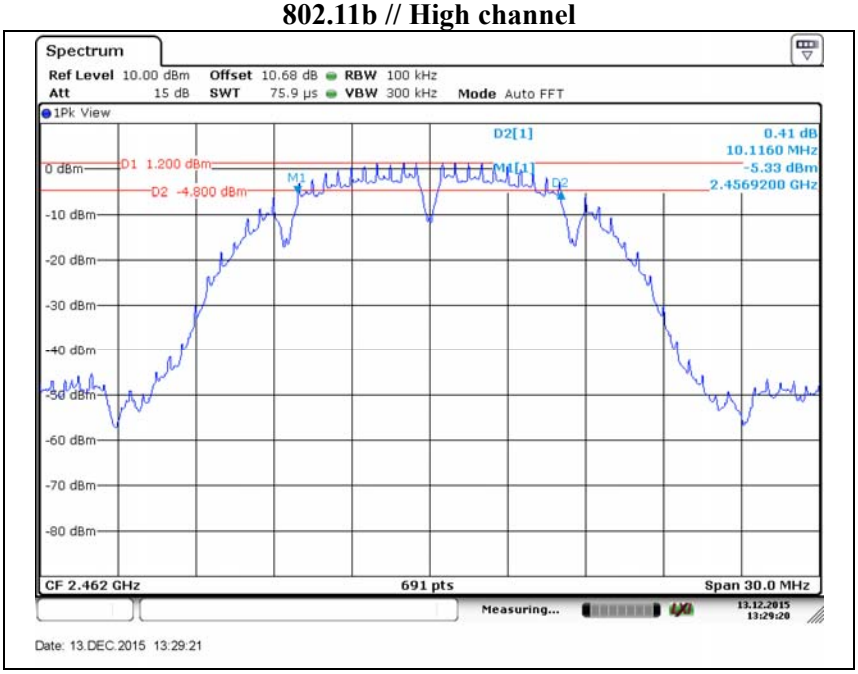
802.11b // Low channel



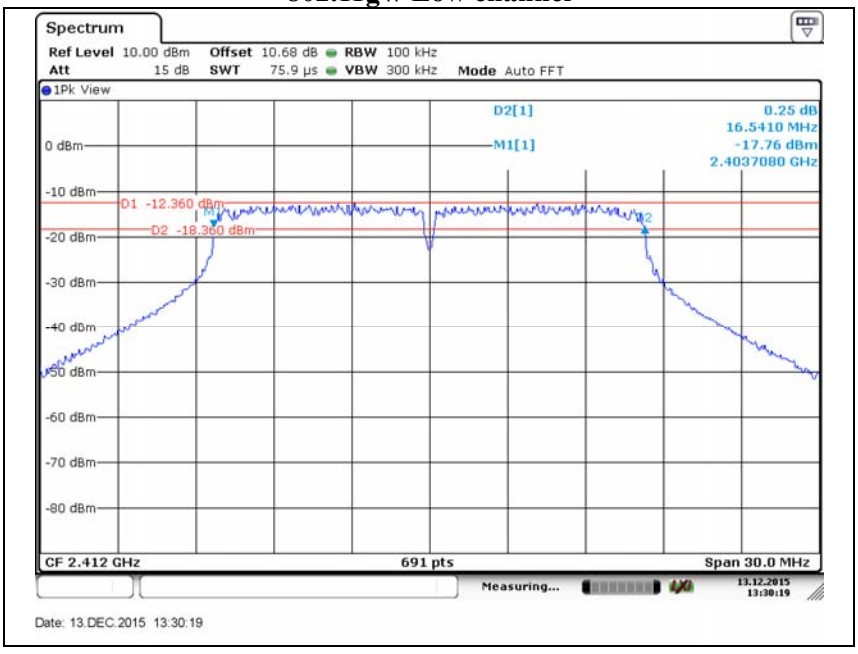
802.11b // Middle channel



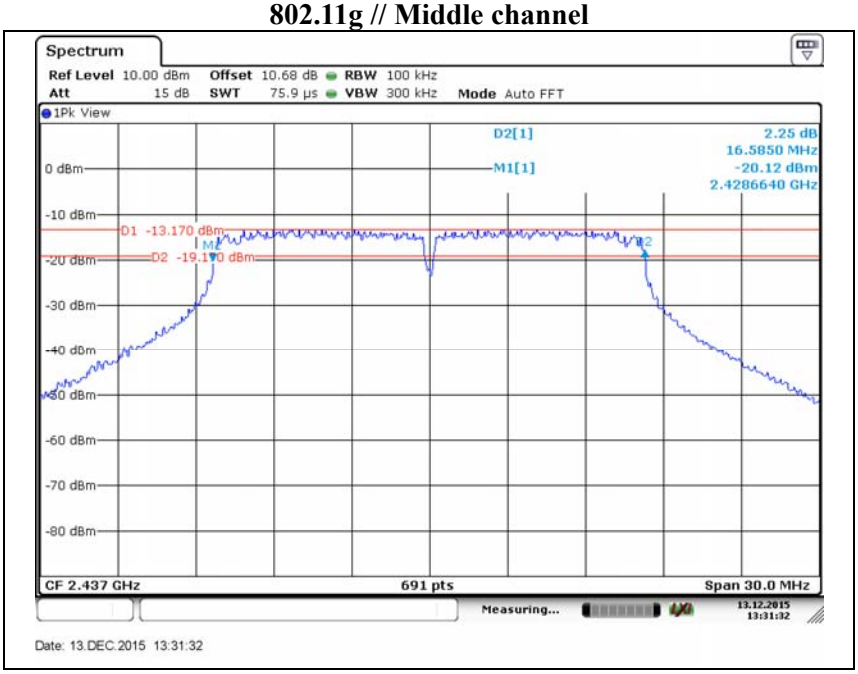
802.11b // High channel



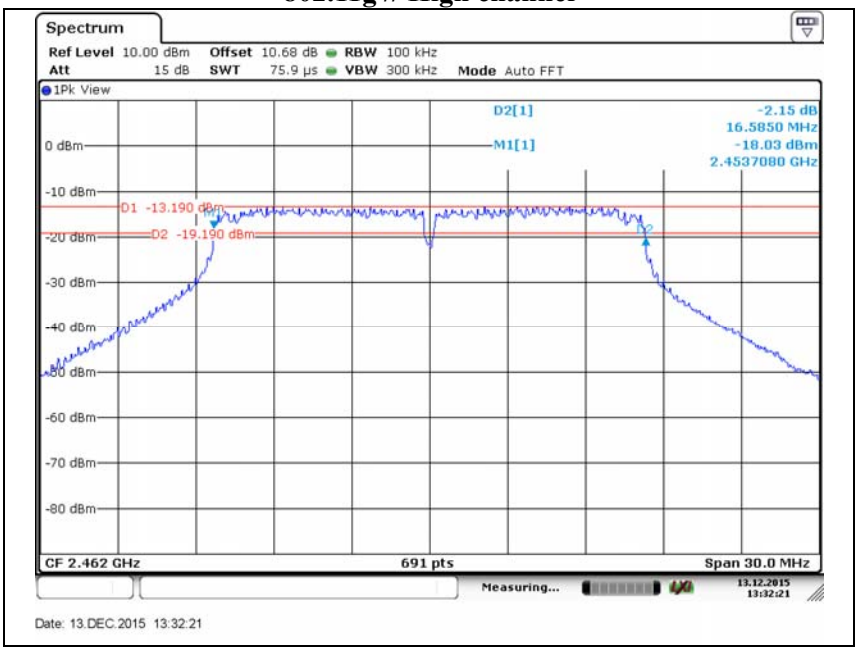
802.11g // Low channel



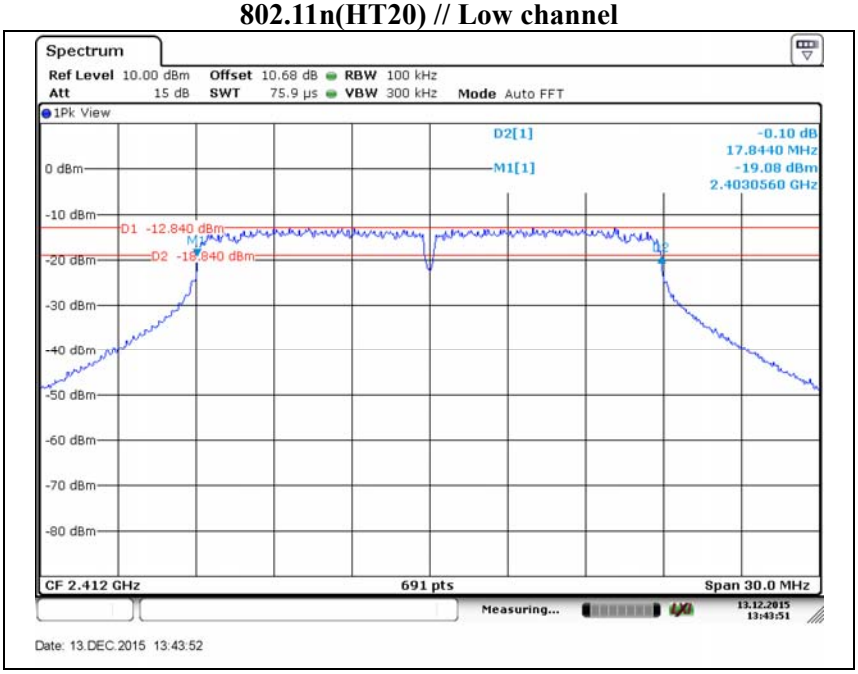
802.11g // Middle channel



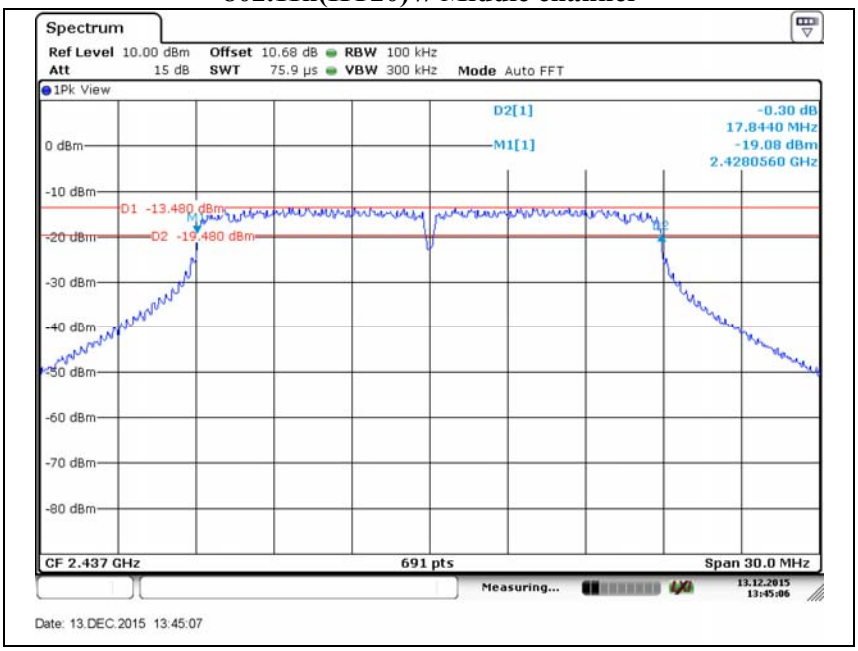
802.11g // High channel



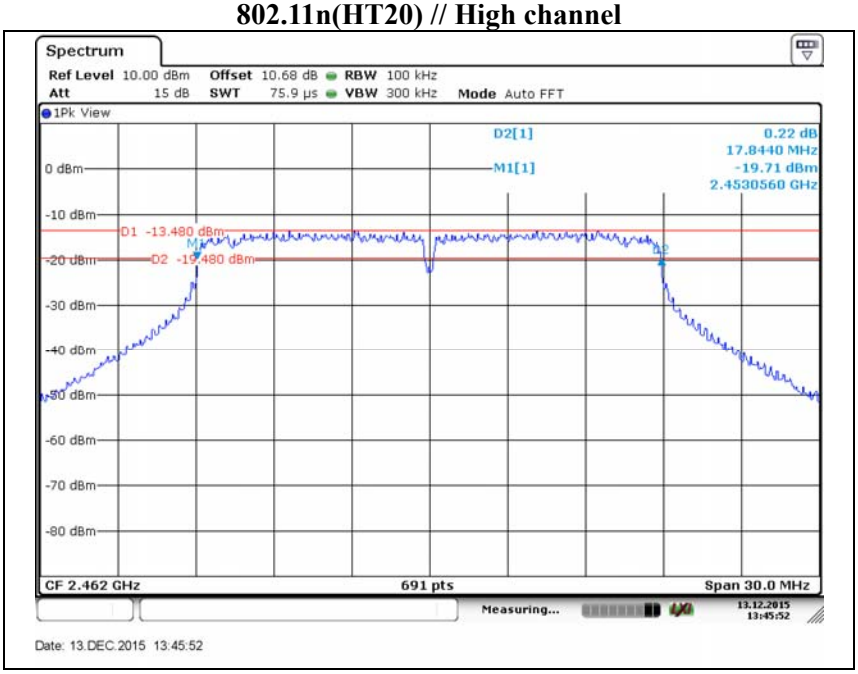
802.11n(HT20) // Low channel



802.11n(HT20) // Middle channel

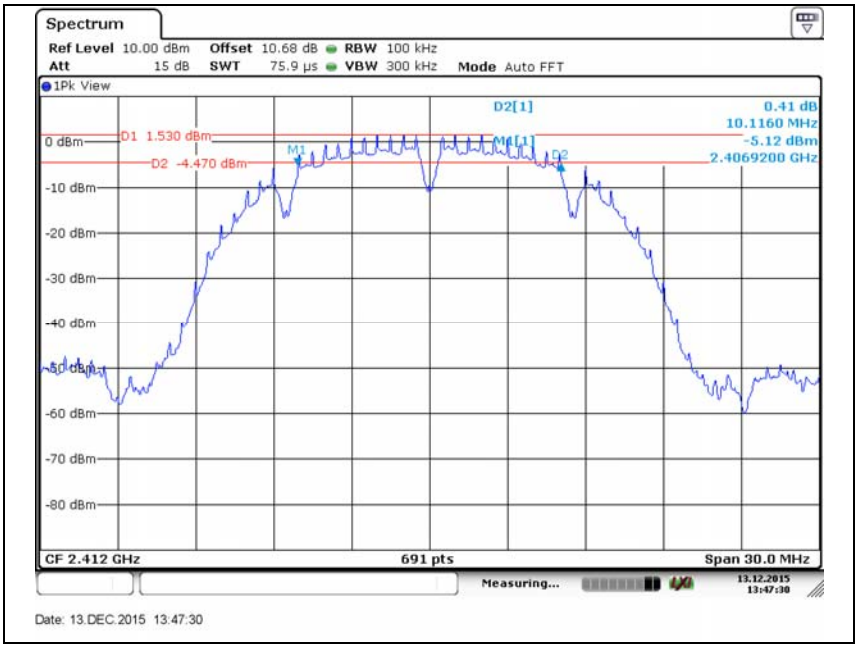


802.11n(HT20) // High channel

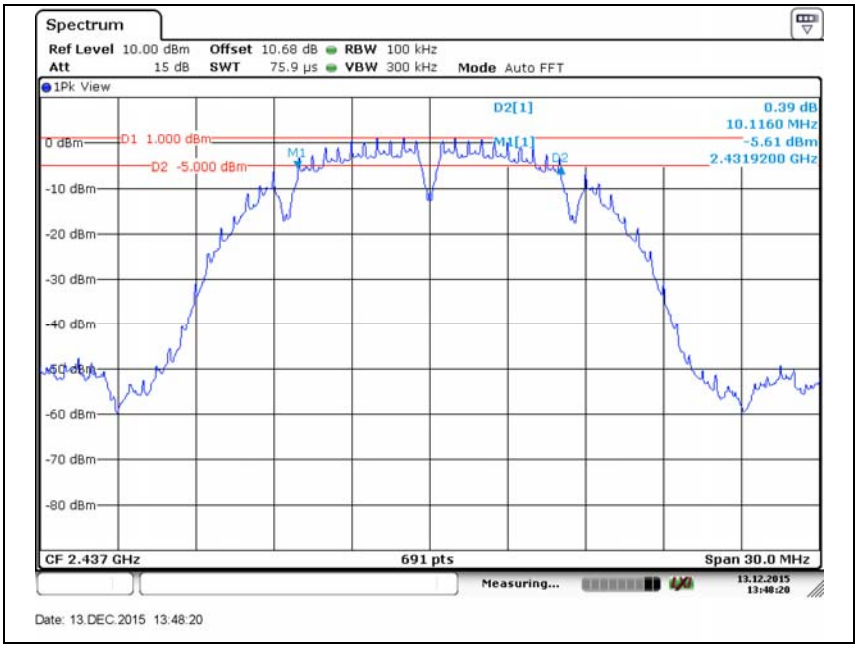


- Antenna port 1

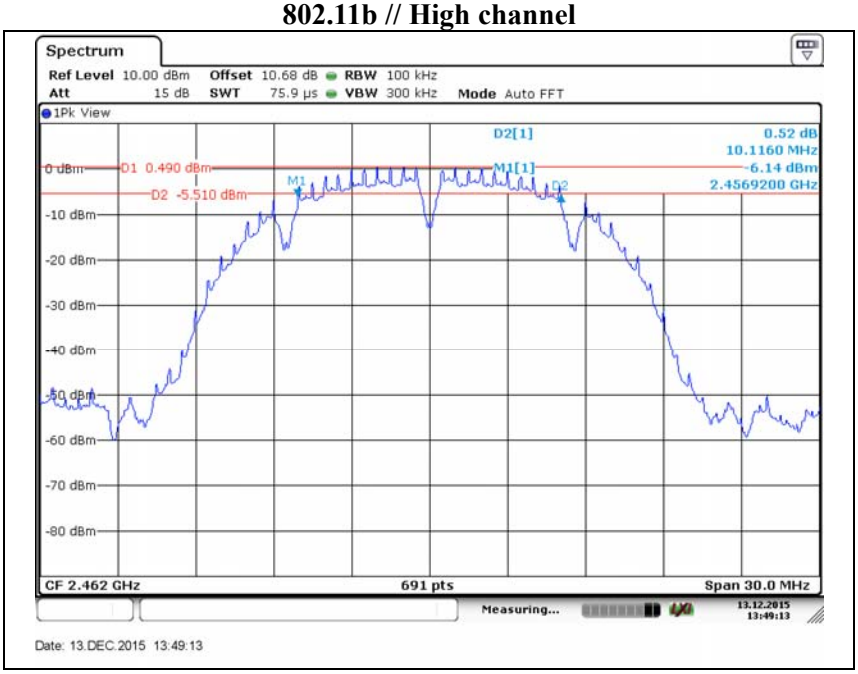
802.11b // Low channel



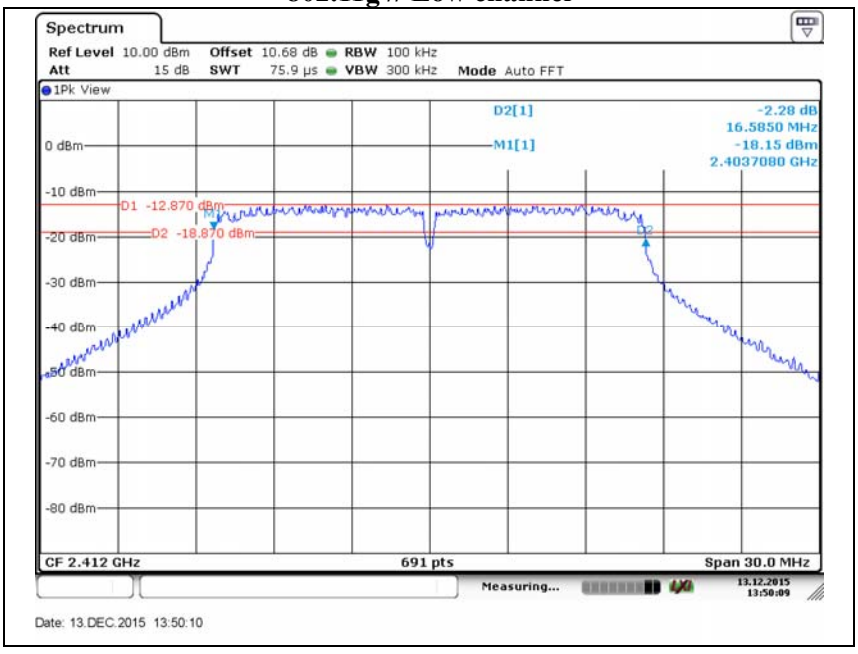
802.11b // Middle channel



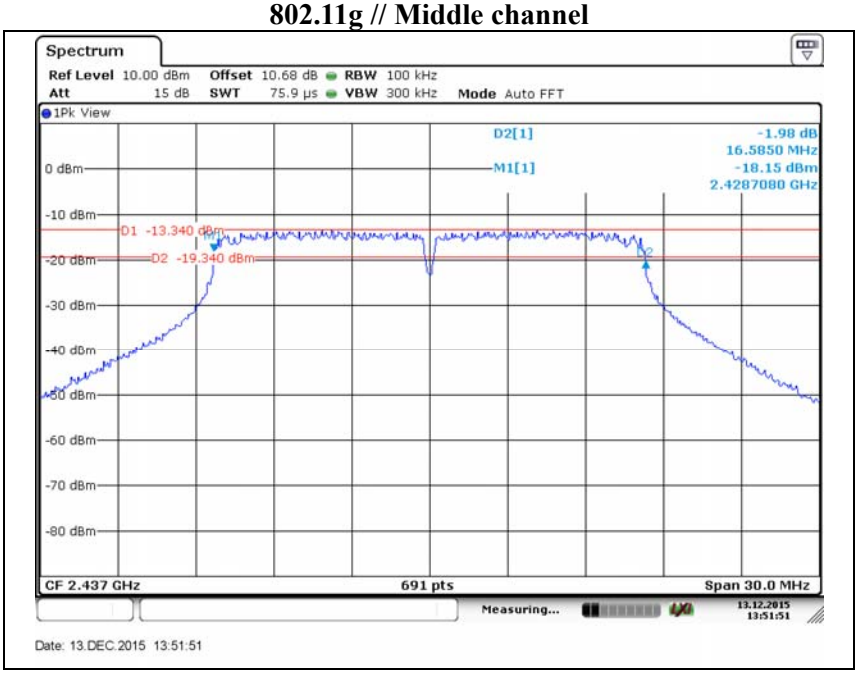
802.11b // High channel



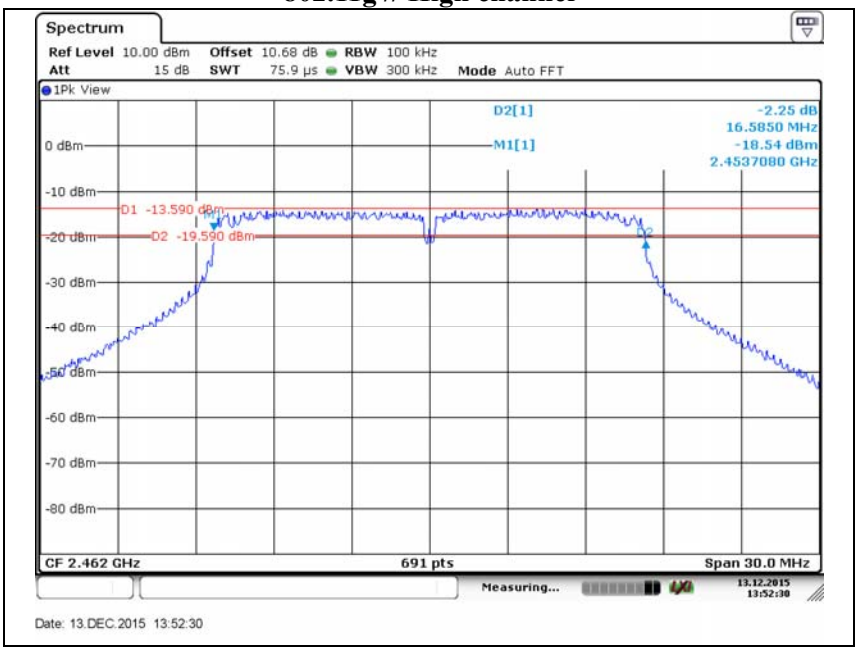
802.11g // Low channel



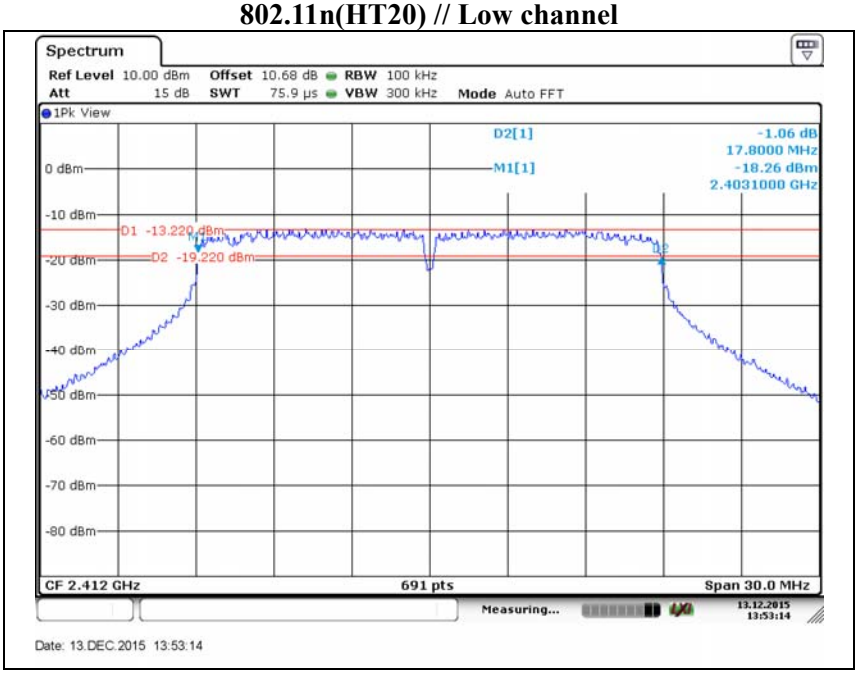
802.11g // Middle channel



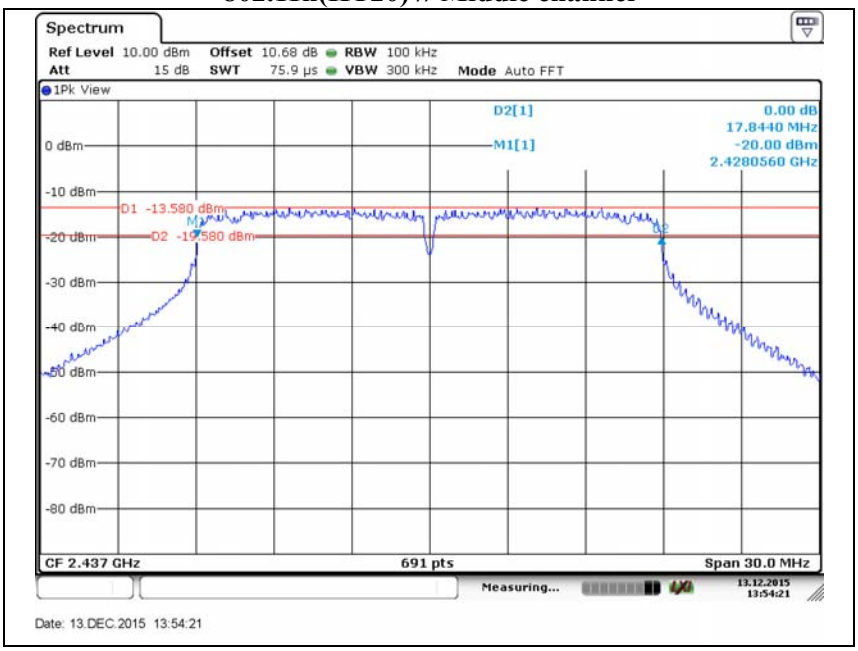
802.11g // High channel



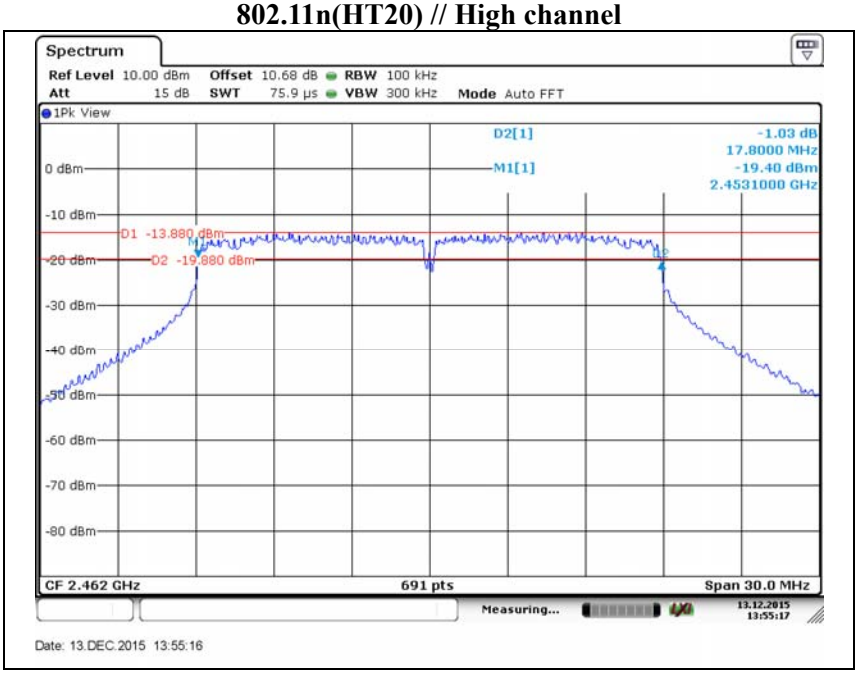
802.11n(HT20) // Low channel



802.11n(HT20) // Middle channel

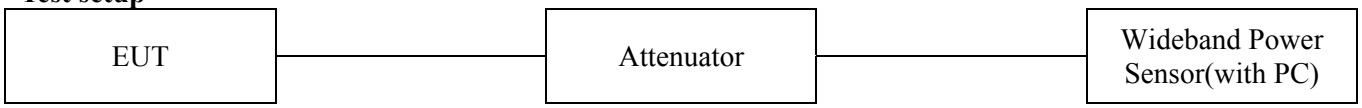


802.11n(HT20) // High channel



3.4. Peak output power

Test setup



Test procedure

All data rates and modes were investigated for conducted spurious emissions. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.

KDB 558074_v03r03 – section 9.1.2

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

Limit

According to §15.247(b)(3), For systems using digital modulation in the 902~928 ㎒, 2 400~2 483.5 ㎒, and 5 725~5 850 ㎒ bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted out-put power. Maximum Conducted Out-put Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to §15.247(b)(4), The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 ㏈i. Except as shown in paragraph (c) of this section, if transmit-ting antennas of directional gain greater than 6 ㏈i are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 ㏈i.

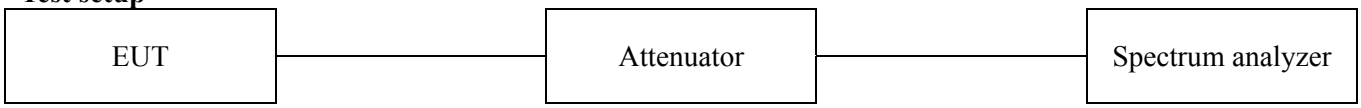
Test results

Operation mode	Frequency(㎒)	Conducted power (dBm)			Limit(dBm)
		Ant0	Ant1	Ant0 + Ant1	
802.11b	2 412	13.45	13.50	-	30
	2 437	12.82	12.66	-	
	2 462	12.86	12.32	-	
802.11g	2 412	11.64	13.14	-	
	2 437	12.59	12.24	-	
	2 462	12.51	11.91	-	
802.11n(HT20)	2 412	13.09	12.66	15.89	
	2 437	12.68	12.34	15.52	
	2 462	12.40	12.18	15.30	

Ant Gain = 10 log[$10^{G1/20}$+$10^{G2/20}$+…+$10^{GN/20}$]^2/N_{ANT} = 1.78 dBi < 6 dBI, so no need to reduce the limit

3.5. Power spectral density

Test setup



Test procedure

KDB 558074_v03r03– section 10.2

Measurement procedure

a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS channel bandwidth.
c) Set the RBW to: 3 ㎑ ≤ RBW ≤ 100 ㎑
d) Set the VBW ≥ 3 × RBW.
e) Detector = power averaging (RMS) or sample detector(when RMS not available).
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Employ trace averaging (RMS) mode over a minimum of 100 traces.
i) Use the peak marker function to determine the maximum amplitude level.
j) If measured value exceeds limit, reduce RBW(no less than 3 ㎑) and repeat.

Limit

According to §15.247€, For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 ㏈m in any 3 ㎑ band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

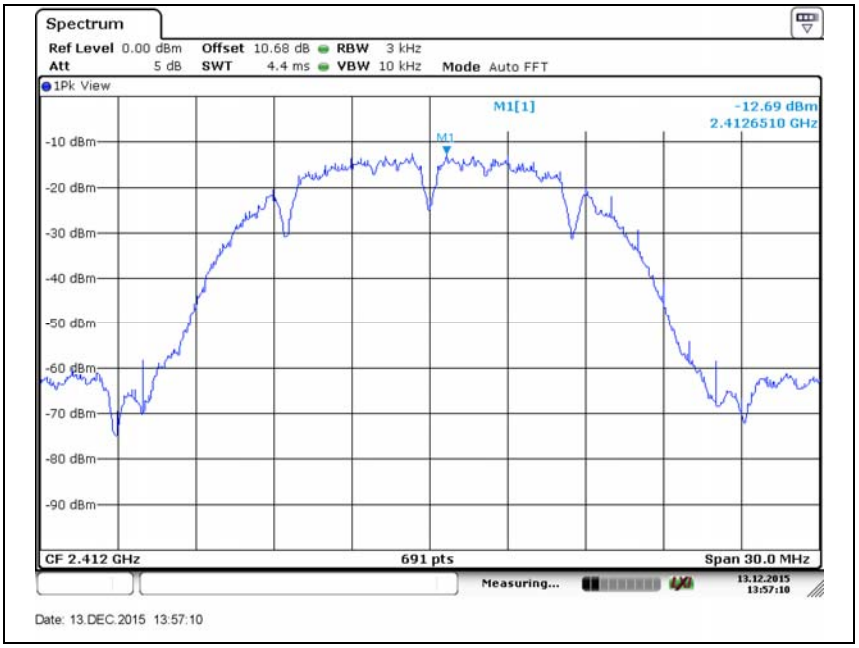
Test results

Operation mode	Frequency(㎒)	Measured PSD(dBm)			Limit(dBm)
		Ant0	Ant1	Ant0 + Ant1	
802.11b	2 412	-12.69	-12.46	-	8
	2 437	-13.32	-12.78	-	
	2 462	-12.30	-12.92	-	
802.11g	2 412	-22.04	-22.62	-	
	2 437	-22.71	-22.81	-	
	2 462	-22.66	-22.85	-	
802.11n(HT20)	2 412	-23.42	-23.66	-20.53	
	2 437	-22.46	-23.47	-19.93	
	2 462	-23.35	-24.36	-20.82	

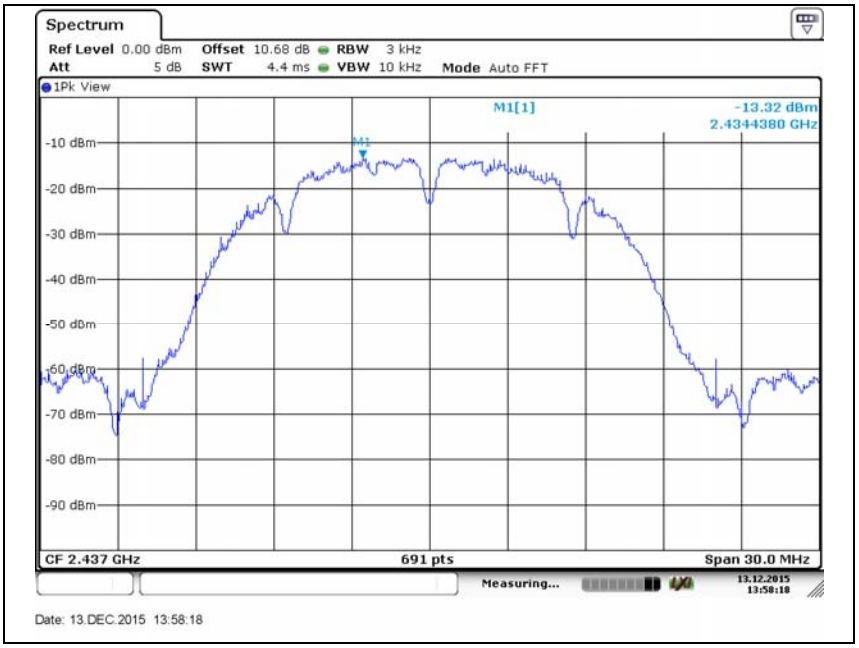
Ant Gain = 10 log[$10^{G1/20}$+$10^{G2/20}$+…+$10^{GN/20}$]^2/N_{ANT} = 1.78 dBi < 6 dBI, so no need to reduce the limit

-Antenna port 0

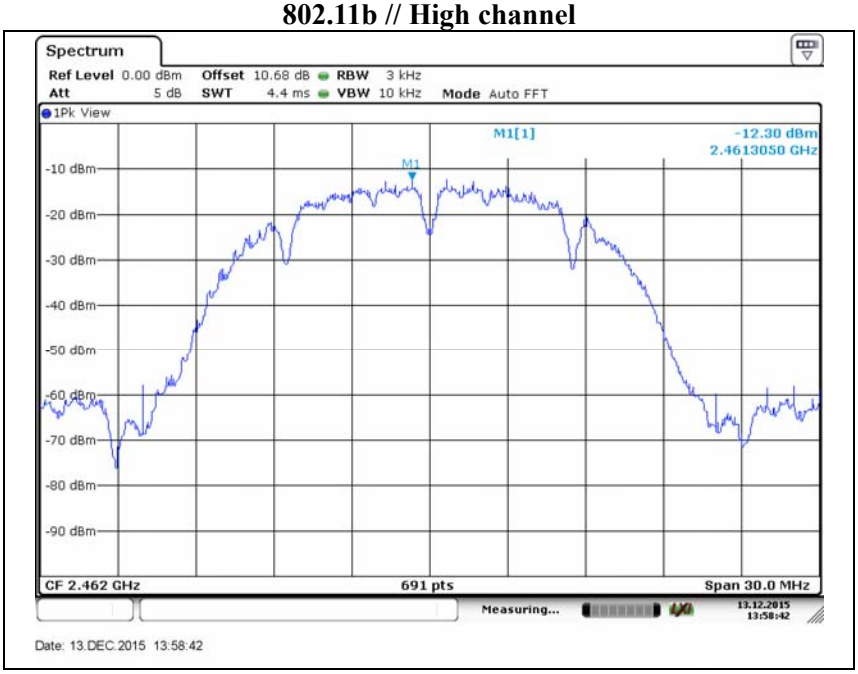
802.11b // Low channel



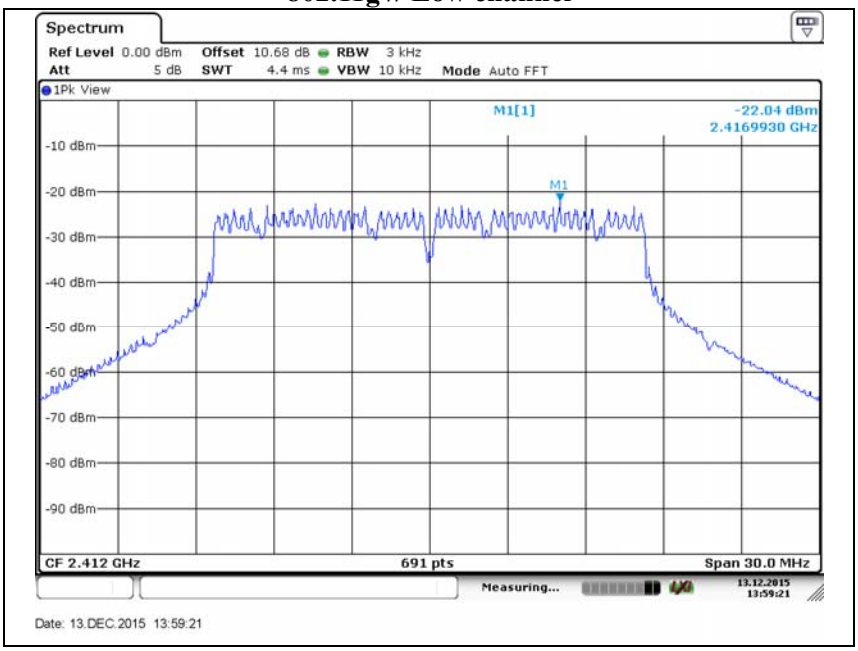
802.11b // Middle channel



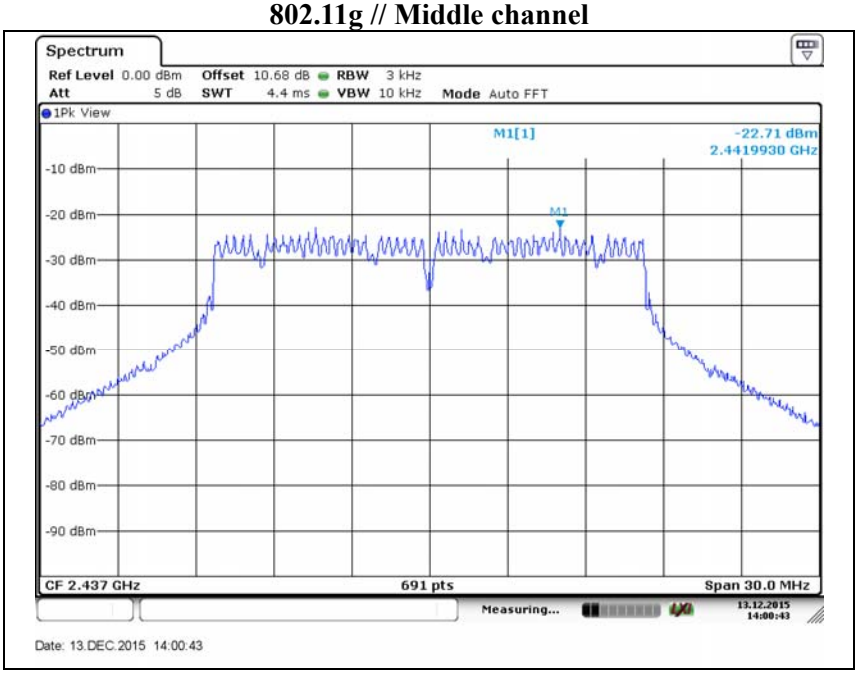
802.11b // High channel



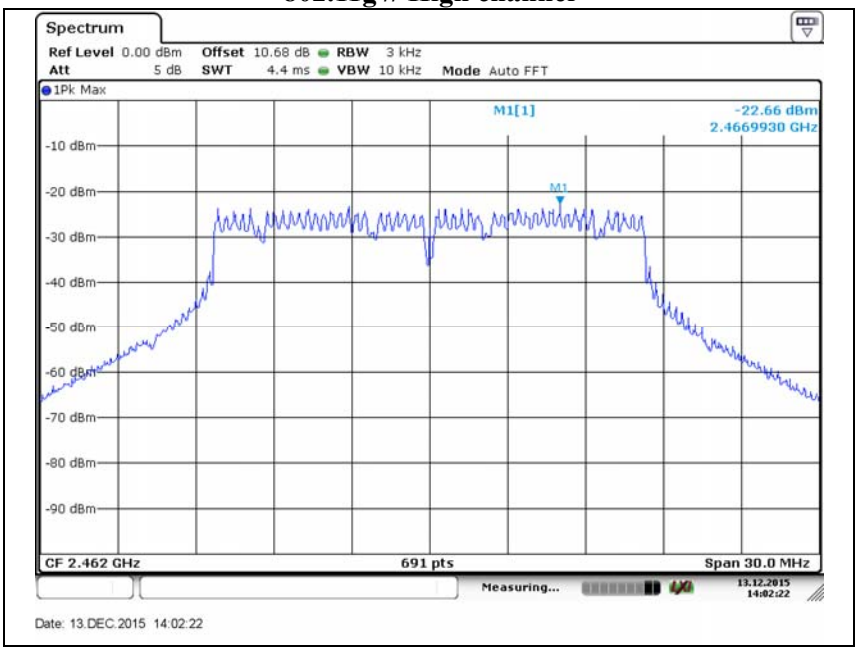
802.11g // Low channel



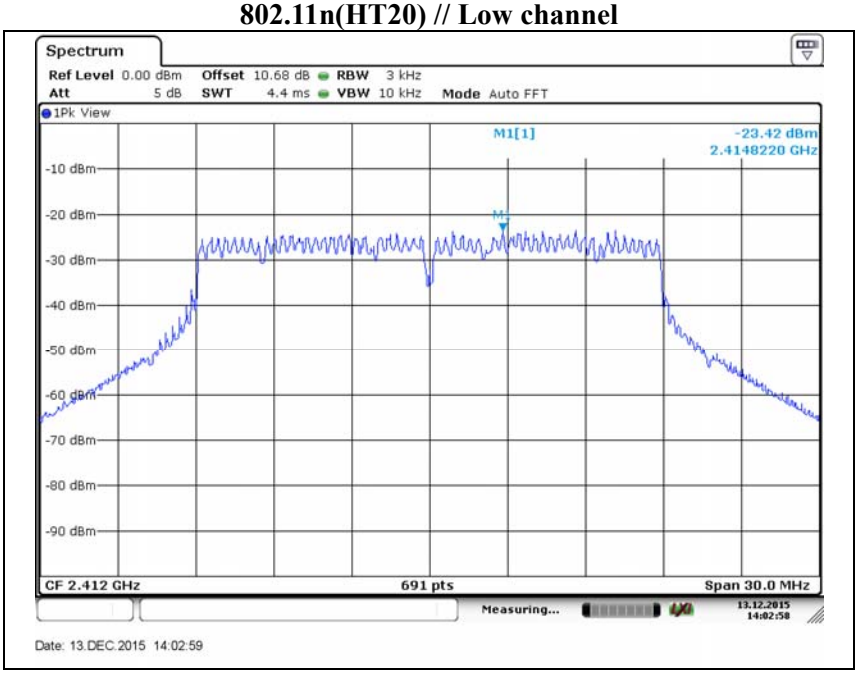
802.11g // Middle channel



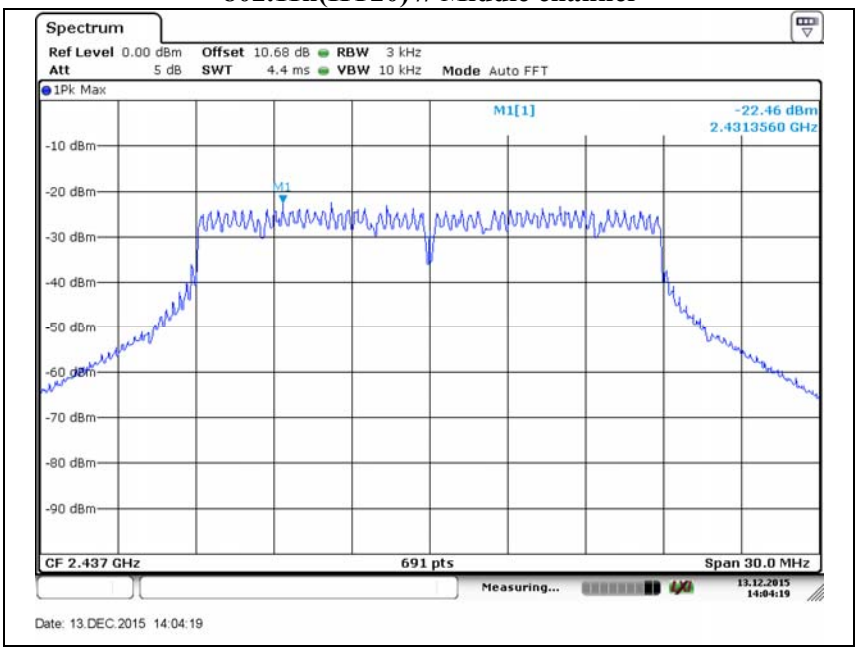
802.11g // High channel



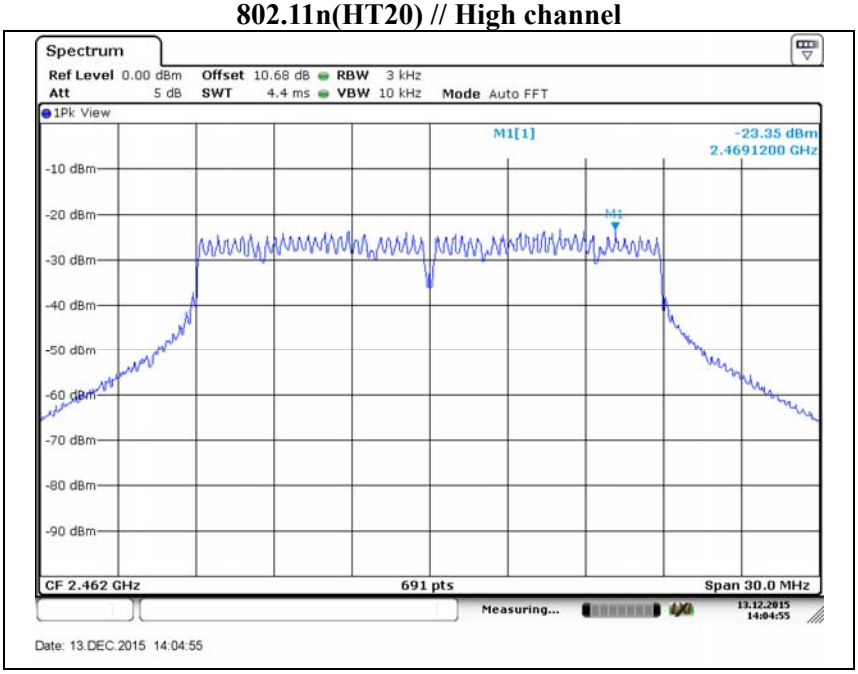
802.11n(HT20) // Low channel



802.11n(HT20) // Middle channel

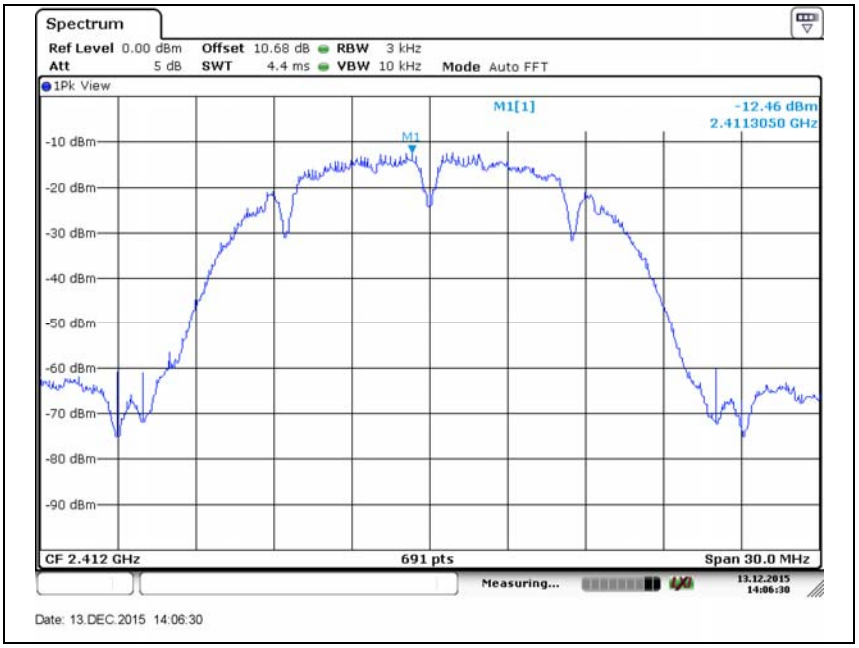


802.11n(HT20) // High channel

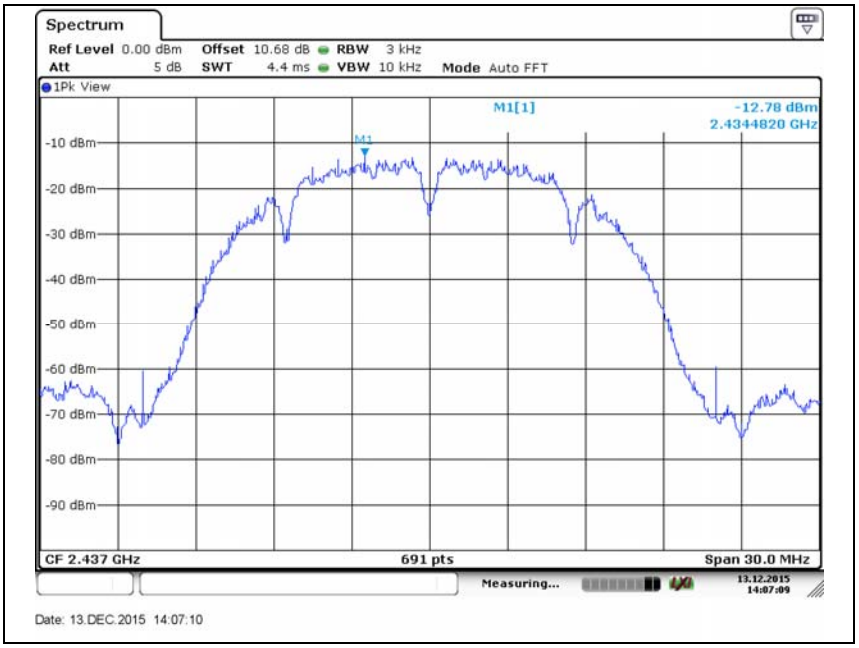


-Antenna port 1

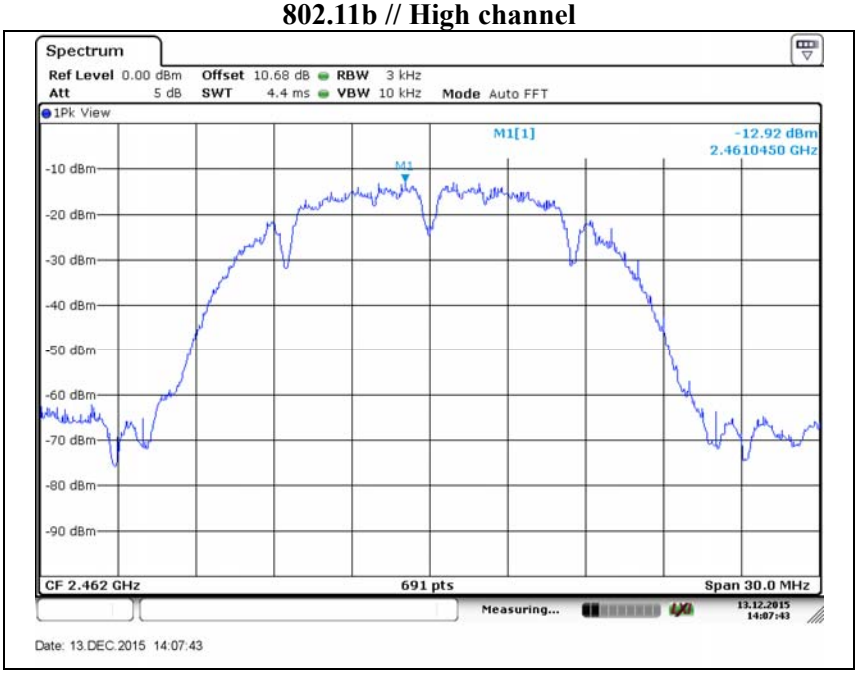
802.11b // Low channel



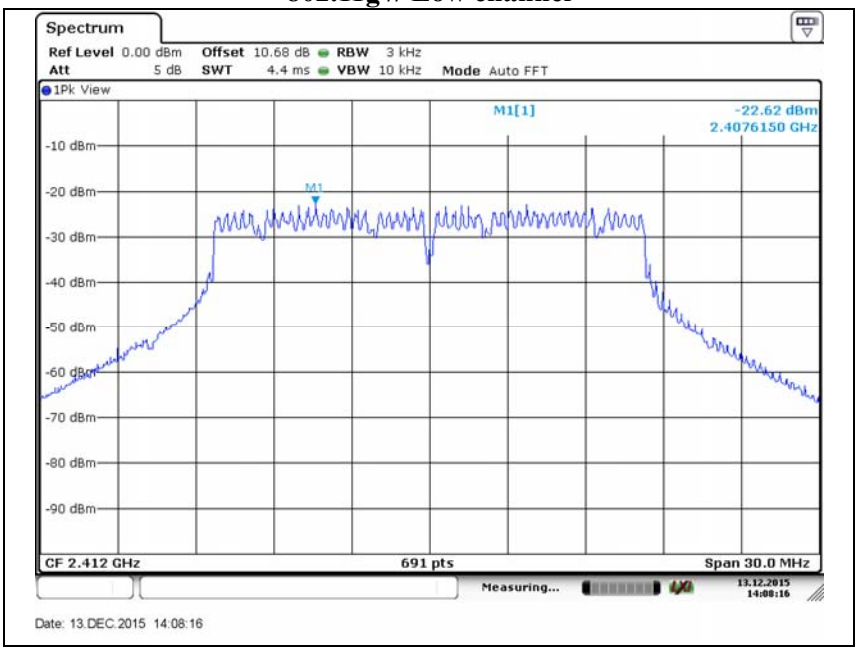
802.11b // Middle channel



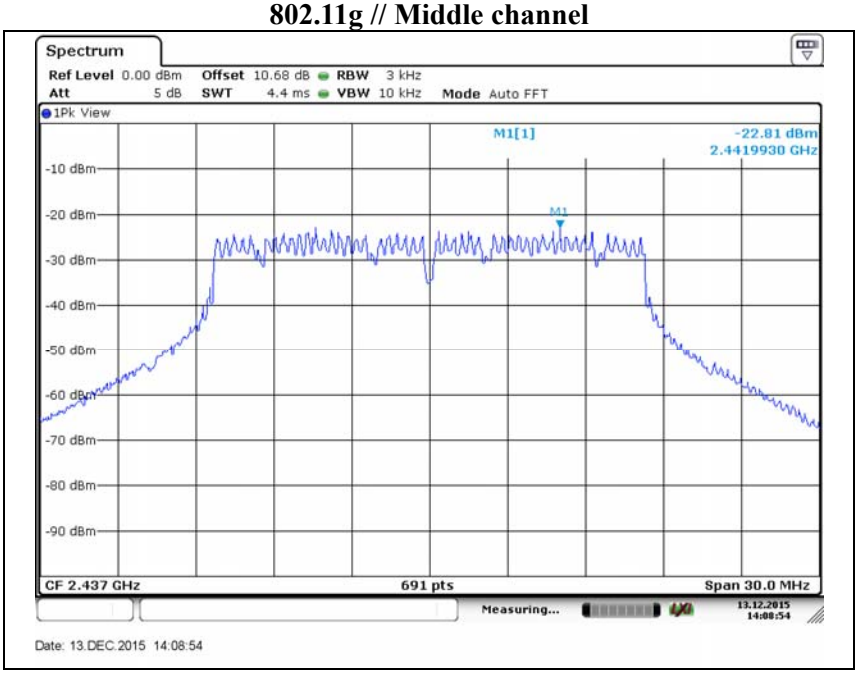
802.11b // High channel



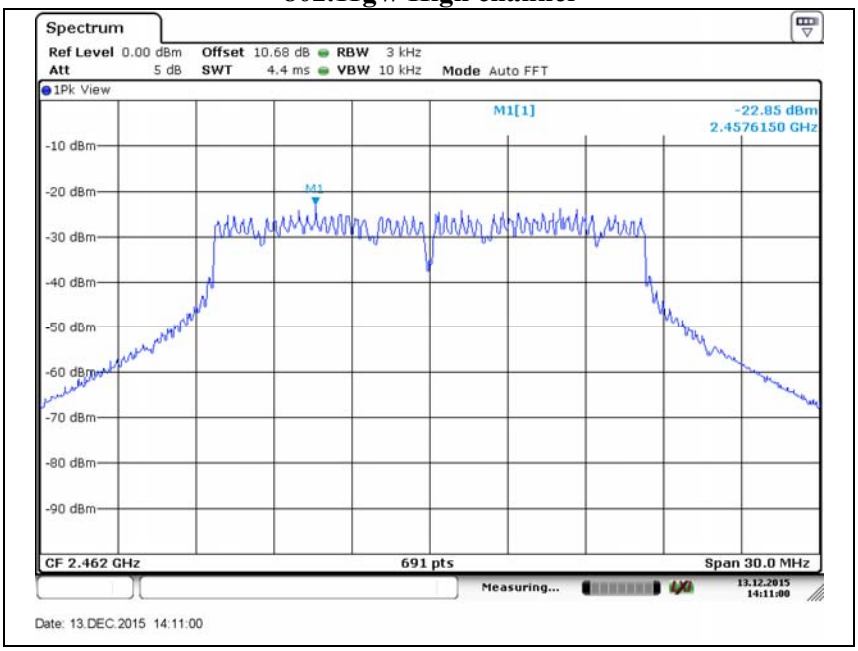
802.11g // Low channel



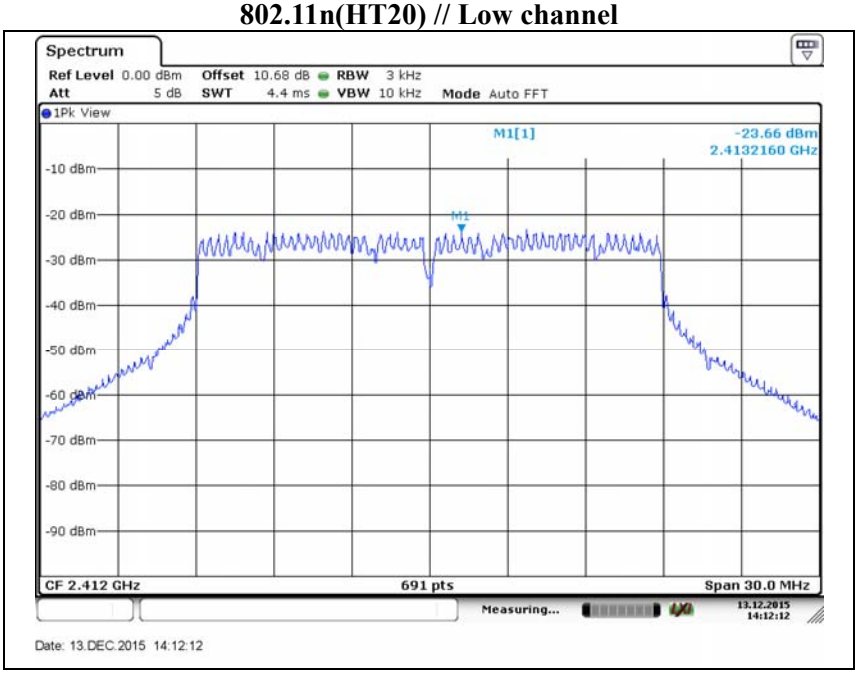
802.11g // Middle channel



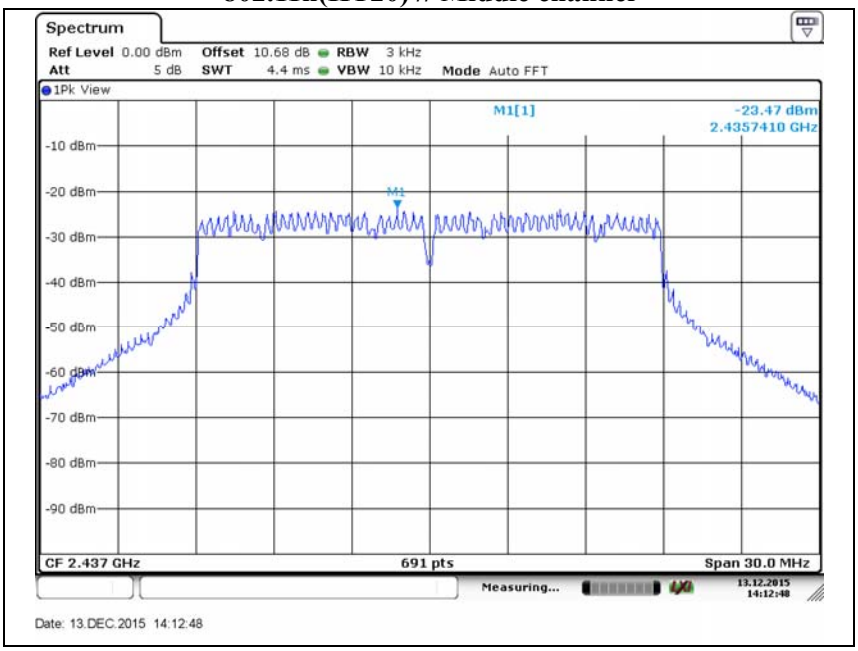
802.11g // High channel



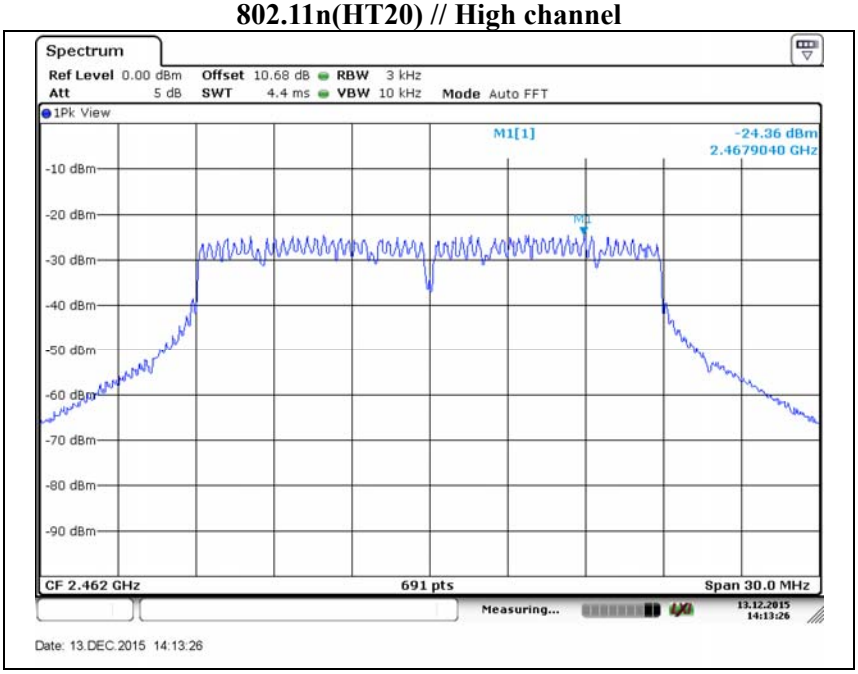
802.11n(HT20) // Low channel



802.11n(HT20) // Middle channel



802.11n(HT20) // High channel



3.6. AC conducted emission

Frequency range of measurement
150 ㎑ to 30 ㎒

Instrument settings
IF Band Width: 9 ㎑

Test procedures
The EUT was placed on a non-metallic table 0.8m above the metallic, grounded floor and 0.4m from the reference ground plane wall. The distance to other metallic surfaces was at least 0.8m. Amplitude measurements were performed with a quasi-peak detector and an average detector.

Limit
According to 15.207(a), for an intentional radiator that 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 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

Frequency of Emission (㎒)	Conducted limit (dB㎶/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

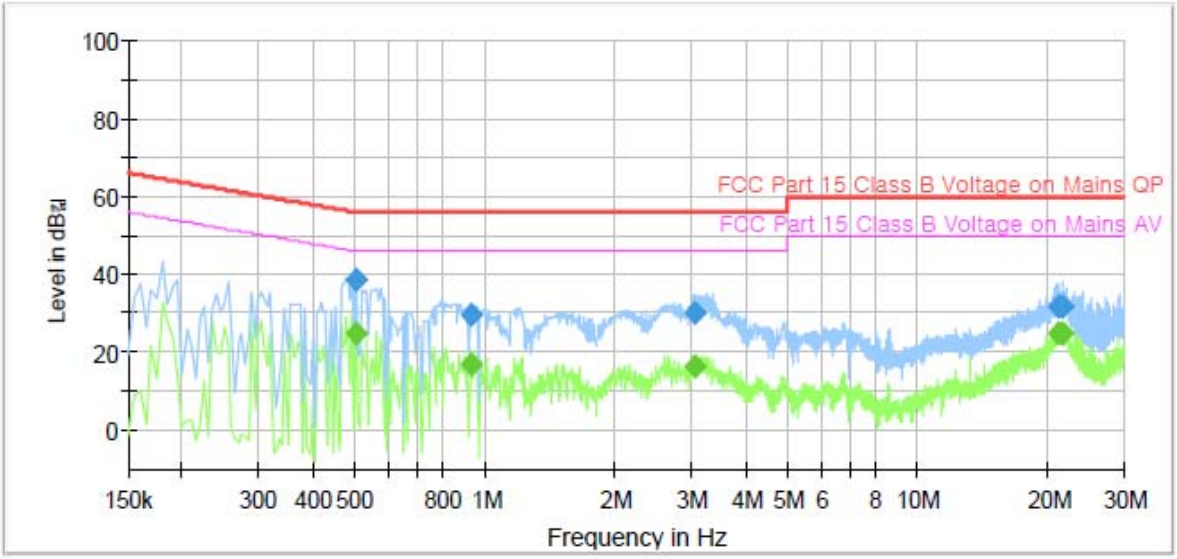
Note.
a) Decreases with the logarithm of the frequency.
b) All AC Conducted emission at channels are almost the same, so that 802.11b High channel was chosen at representative in final test.

Test results – TX_H

Test Report

Common Information

Test Description:	Conducted Emission
Model No.:	SWL-Q93T
Mode	TX
Operator Name:	KES



Final_Result

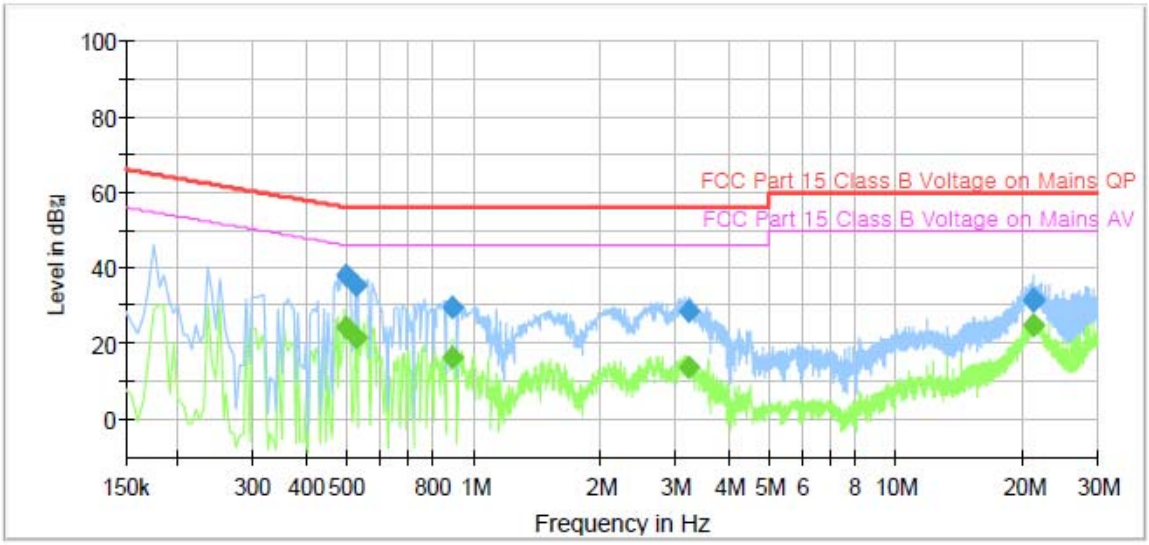
Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.505000	---	25.07	46.00	20.93	1000.0	9.000	L1	9.7
0.505000	38.78	---	56.00	17.22	1000.0	9.000	L1	9.7
0.930000	---	16.88	46.00	29.12	1000.0	9.000	L1	9.7
0.930000	29.79	---	56.00	26.21	1000.0	9.000	L1	9.7
3.060000	---	16.18	46.00	29.82	1000.0	9.000	L1	9.8
3.060000	30.10	---	56.00	25.90	1000.0	9.000	L1	9.8
21.080000	---	25.07	50.00	24.93	1000.0	9.000	L1	10.2
21.080000	31.85	---	60.00	28.15	1000.0	9.000	L1	10.2
21.595000	---	25.14	50.00	24.86	1000.0	9.000	L1	10.2
21.595000	31.80	---	60.00	28.20	1000.0	9.000	L1	10.2

Test results – TX_N

Test Report

Common Information

Test Description:	Conducted Emission
Model No.:	SWL-Q93T
Mode	TX
Operator Name:	KES



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.500000	---	24.49	46.00	21.51	1000.0	9.000	N	9.7
0.500000	37.92	---	56.00	18.08	1000.0	9.000	N	9.7
0.525000	---	21.94	46.00	24.06	1000.0	9.000	N	9.7
0.525000	35.73	---	56.00	20.27	1000.0	9.000	N	9.7
0.890000	---	16.33	46.00	29.67	1000.0	9.000	N	9.7
0.890000	29.71	---	56.00	26.29	1000.0	9.000	N	9.7
3.225000	---	13.83	46.00	32.17	1000.0	9.000	N	9.8
3.225000	28.38	---	56.00	27.62	1000.0	9.000	N	9.8
21.170000	---	25.03	50.00	24.97	1000.0	9.000	N	10.0
21.170000	31.89	---	60.00	28.11	1000.0	9.000	N	10.0
21.235000	---	24.68	50.00	25.32	1000.0	9.000	N	10.0
21.235000	31.37	---	60.00	28.63	1000.0	9.000	N	10.0

Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum Analyzer	R&S	FSV40	101002	1 year	2016.07.25
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2016.01.23
Attenuator	KEYSIGHT	8493C	82506	1 year	2016.04.02
Power Meter	Anritsu	ML2495A	1438001	1 year	2016.01.22
Pulse Power Sensor	Anritsu	MA2411B	1339205	1 year	2016.01.26
Loop Antenna	R&S	HFH2-Z2.335.4711.52	826532	2 years	2017.03.03
Trilog-Broadband Antenna	SCHWARZBECK	VULB 9168	9168-461	2 years	2017.04.03
Horn Antenna	A.H. SYSTEMS	SAS-571	414	2 years	2017.02.09
Horn Antenna	Schwarzbeck	BBHA9170	BBHA9170550	2 years	2017.04.30
High Pass Filter	Wainwright Instrument	WHJS3000-10TT	1	1 year	2016.07.24
Low Pass Filter	Wainwright Instrument	WLK1.0/18G-10T	1	1 year	2016.07.24
Preamplifier	SCHWARZBECK	BBV-9718	9718-246	1 year	2016.10.23
Broadband Amplifier	SCHWARZBECK	BBV-9721	PS9721-003	1 year	2016.04.03
EMI Test Receiver	R & S	ESR3	101781	1 year	2016.05.06
EMI Test Receiver	R & S	ESR3	101783	1 year	2016.05.06
LISN	R & S	ENV216	101137	1 year	2016.02.10

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook Computer	Samsung Electronics Co., Ltd.	RV518	HTK991NC600207R
Mouse	Moneual	MSU0846	0910020101086E