TEST REPORT

1. Applicant

Name : Handheld Group AB

Address : Kinnegatan 17A S-531 33 Lidköping, Sweden

2. Products

Name : Mobile Computer

Model : NAUTIZ X4

Manufacturer : POINTMOBILE CO.,LTD

3. Test Standard : FCC CFR 47 Part 15C, section 15.247 / IC RSS-210 Issue 8

4. Test Method : KDB 558074 D01 v03r01, ANSI C63.4-2009

5. Test Results : Positive

6. Date of Application : January 16, 2014

7. Date of Issue : June 20, 2014

Tested by

Jong-gon Ban
ICT Infrastructure
Technology Center
Senior Engineer

Approved by

Jeong-min Kim
ICT Infrastructure
Technology Center
Manager

Korea Testing Laboratory

Test Report revision History

Revision	Date	Comments
00	2014-06-20	Initial Version

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1. Administrative Information

1.1. Applicant (Client)

Company Name	Handheld Group AB
Address	Kinnegatan 17A S-531 33 Lidköping, Sweden
Contact Person	
Name	Jerker Hellstrom
E-mail	j.hellstrom@handheldgroup.com
Phone	+46(0)510-54 7170

1.2. Manufacturer Data (only if different from Applicant)

Company Name	POINTMOBILE CO.,LTD
Address	Gasan-dong, B-9F Kabul Great Valley 32, Digital-ro9-gil, Geumcheon-gu, Seoul, Korea
Contact Person	
Name	Chloe Kim
E-mail	chloe.kim@pointmobile.co.kr
Phone	+82 70 7090 2642

1.3. Testing Laboratory Data

The following list shows all places and laboratories involved for test result generation.

Company Name	Korea Testing Laboratory
Address	723 Haean-ro, Sangnok-Gu, Ansan-Si, Gyeounggi-Do, 426-901 KOREA
Contact Person	
Name	Jong-gon Ban
E-mail	banjg@ktl.re.kr
Phone	+82-31-500-0133
Fax	+82-31-500-0149

2.EUT Information

2.1. General Description of the EUT

The following section lists all specifications of EUT (Equipment Under Test) involved in test. Additionally, KTL has received sufficient documentation from the client and/or manufacturer to perform the tests

General Information		
FCC ID & Model Number		FCC ID: **YY3-14244R**, Model Number: **NAUTIZ X4**
IC Number & Model Number		IC Number: **11695A-14244R**, Model Number: **14244-GSM-R**
SKUs	NX4-2DGQ-R-E	BT, WiFi, GSM, UMTS, RFID, GPS, Camera, 2D scanner, Qwerty Key
	NX4-2DGN-R-E	BT, WiFi, GSM, UMTS, RFID, GPS, Camera, 2D scanner, Numeric Key
Antenna Type		Internal Antenna
Type of Radio transmission		DSSS/CCK(802.11b), OFDM(802.11g/ 802.11n_HT20)
Frequency Range		2,412 ~ 2,462 MHz
Channel Numbers		11
Antenna Gain		2.2 dBi
Battery options		Li-ion, 3.7 V (4000 mAh)
Date(s) tested		2014.01.16 ~ 2014.06.05

3. SUMMARY OF TEST RESULTS

The following table represents the list of measurements required under the FCC CFR47 Part 15.247

FCC Rules	IC Rules	Test Items	Results	Remarks
15.247(a)(2)	A8.2(a)	6dB Bandwidth	Pass	-
-	RSS-Gen 4.6.1	99% Bandwidth	Pass	-
15.247(b)(3)	A8.4(4)	Maximum Peak Power	Pass	-
15.247(e)	A8.2(b)	Power Spectral Density	Pass	-
15.247(d)	A8.5	Band Edges Emissions	Pass	-
15.247(d)	A8.5	Tx spurious emissions conducted	Pass	-
15.205, 15.209, 15.247(d)	A8.5	Radiated Spurious Emissions	Pass	-
15.207	RSS-Gen 7.2.2	AC Line Conducted Emission	Pass	-
-	RSS-Gen 6.1	Receiver Spurious Emissions	Pass	

4. ANTENNA REQUIREMENTS

According to FCC 47 CFR part 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.”

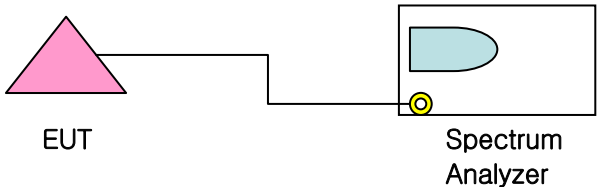
* The antennas of this E.U.T are permanently attached.

*The E.U.T Complies with the requirement of §15.203

5. Measurement & Results

5.1. Duty Cycle

5.1.1. Test Setup Layout



5.1.2. Test Condition

According to KDB 558074)6)b), issued 04/09/2013)

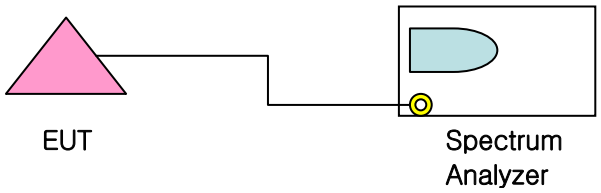
- The transmitter output is connected to the Spectrum Analyzer. We tested according to the zero span measurement method, 6.0)b) in KDB 558074 (issued 04/09/2013)
- The largest available value of RBW is 8 MHz and VBW is 50 MHz. The zero-span method of measuring duty cycle shall not be used if T ≤ 6.25 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.

Mode	Data Rate	Duty Cycle	Duty Cycle Factor (dB)
802.11b	1 Mbps	0.896	0.48
	2 Mbps	0.815	0.89
	5.5 Mbps	0.630	2.00
	11 Mbps	0.487	3.12
802.11g	6 Mbps	0.582	2.35
	9 Mbps	0.492	3.08
	12 Mbps	0.412	3.85
	18 Mbps	0.320	4.95
	24 Mbps	0.267	5.73
	36 Mbps	0.205	6.89
	48 Mbps	0.156	8.07
	54 Mbps	0.153	8.17
802.11n (20MHz)	6.5 Mbps	0.574	2.41
	13 Mbps	0.404	3.94
	19.5 Mbps	0.322	4.92
	26 Mbps	0.265	5.77
	39 Mbps	0.204	6.90
	52 Mbps	0.167	7.78
	58.5 Mbps	0.156	8.07
	65 Mbps	0.145	8.38

Note: Duty Cycle Factor Calculation: 10*log(1/Duty Cycle). where, Duty Cycle = T_{on} / T_{total}
- Sample calculation 802.11b (1Mbps), Duty Cycle Factor (dB) = 10*log(1/0.896) = 0.48

5.2. 6 dB Bandwidth

5.2.1. Test Setup Layout



5.2.2. Test Condition & Limit

- Set Spectrum analyzer as RBW = 100 kHz, VBW ≥3xRBW according to KDB 558074
- 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

5.2.3. Test result

* Operation Mode: 802.11b

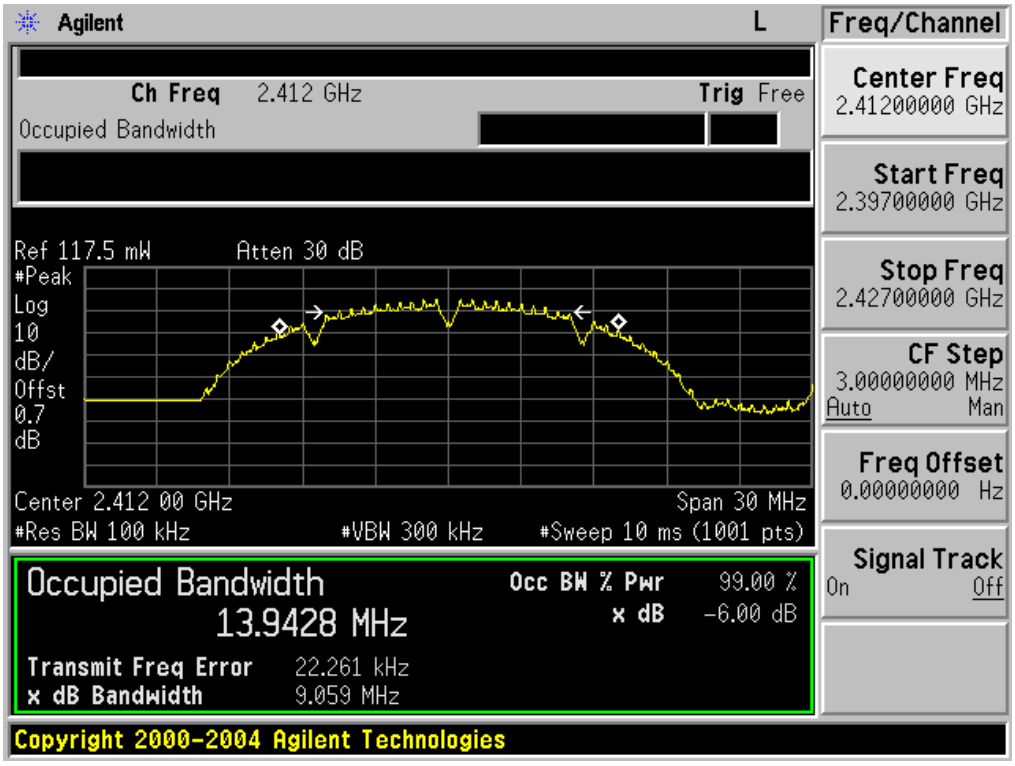
Channels	Frequency (MHz)	6dB Bandwidth (MHz)	99% Bandwidth (MHz)	Verdict
Low	2412	9.06	13.94	Pass
Middle	2437	9.07	13.96	Pass
High	2462	10.00	13.98	Pass

* Operation Mode : 802.11g

Channels	Frequency (MHz)	6dB Bandwidth (MHz)	99% Bandwidth (MHz)	Verdict
Low	2412	15.32	16.36	Pass
Middle	2437	15.32	16.46	Pass
High	2462	15.48	16.52	Pass

* Operation Mode : 802.11n

Channels	Frequency (MHz)	6dB Bandwidth (MHz)	99% Bandwidth (MHz)	Verdict
Low	2412	15.35	17.54	Pass
Middle	2437	15.54	17.63	Pass
High	2462	15.33	17.70	Pass



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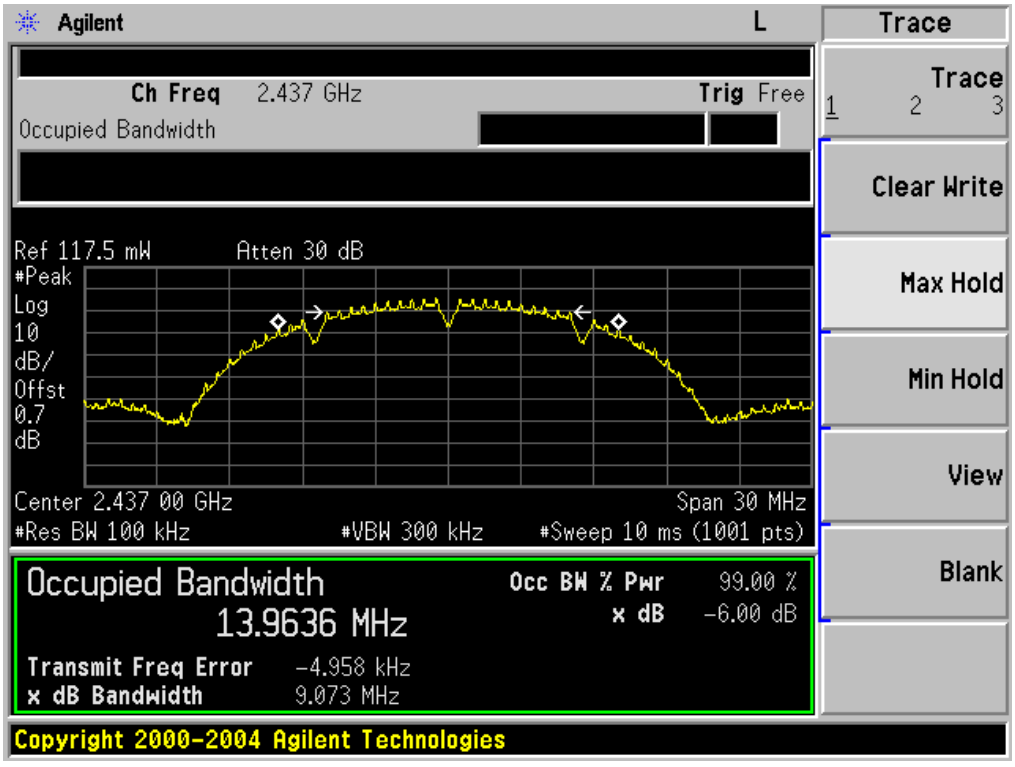

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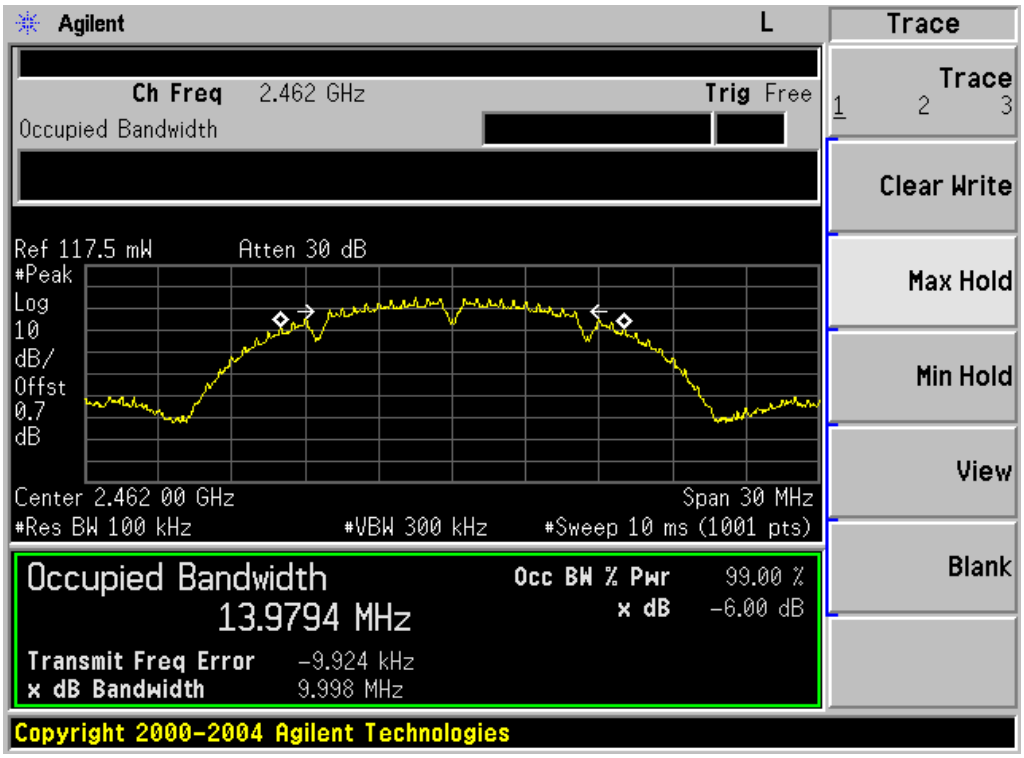

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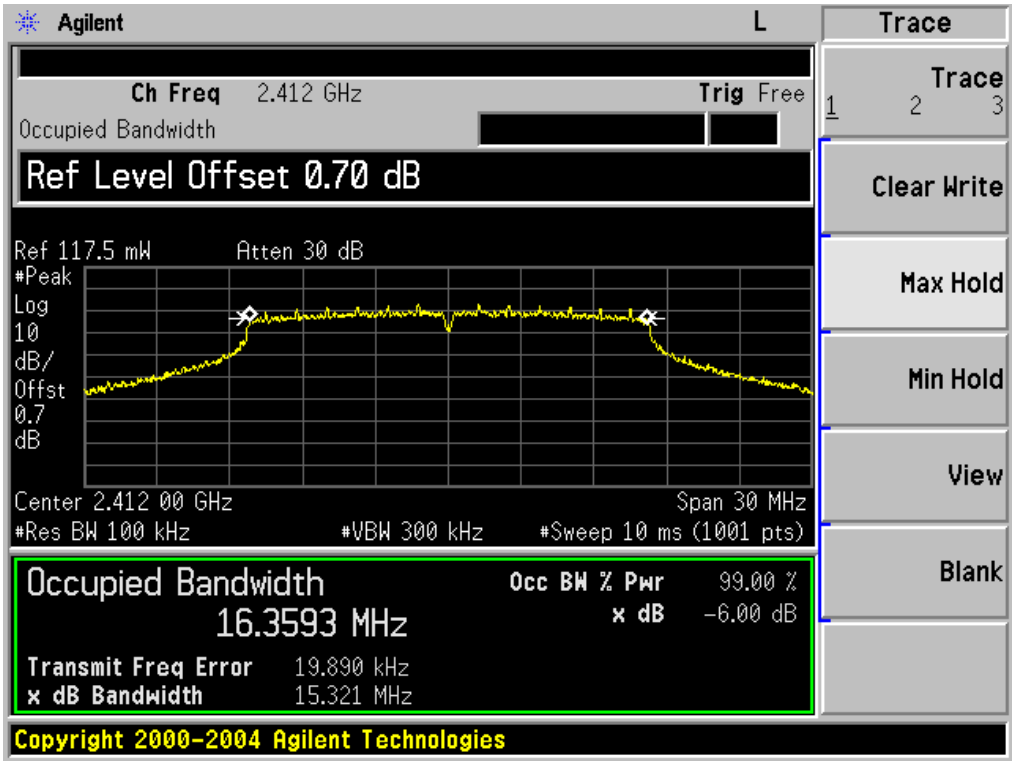

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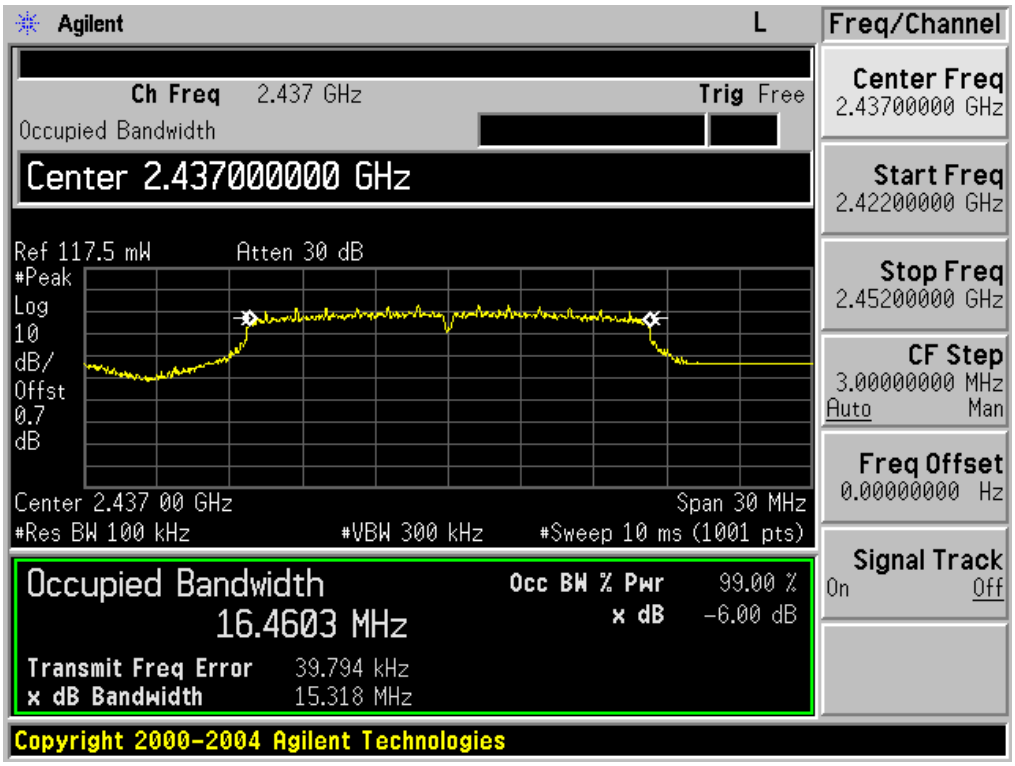

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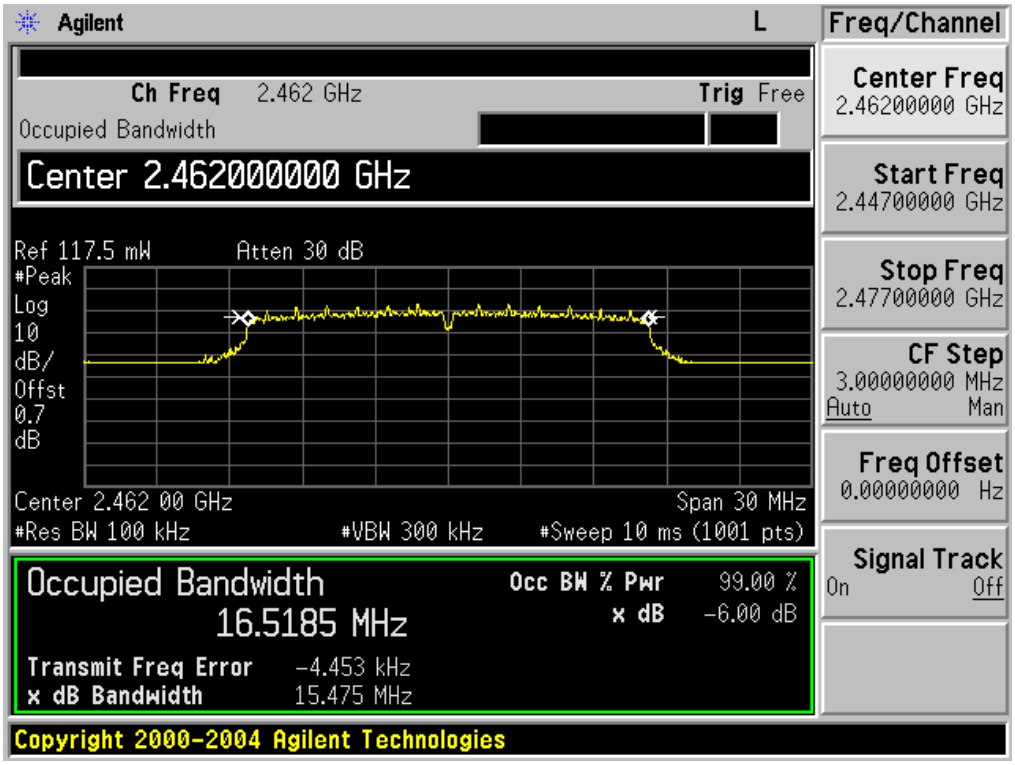

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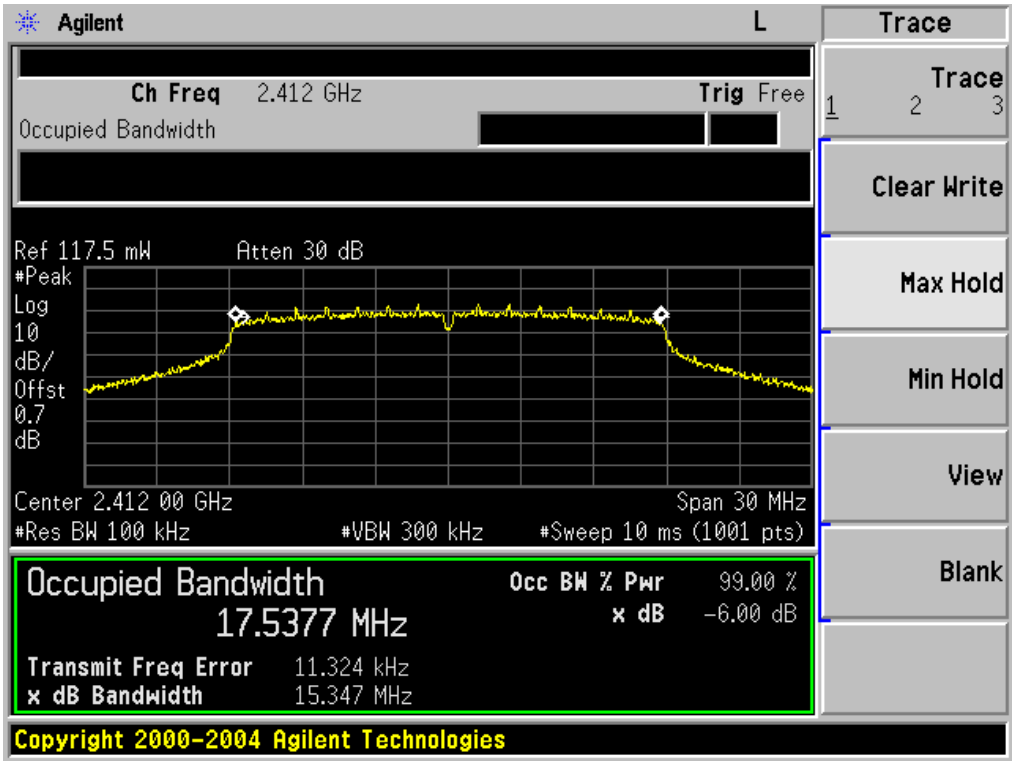

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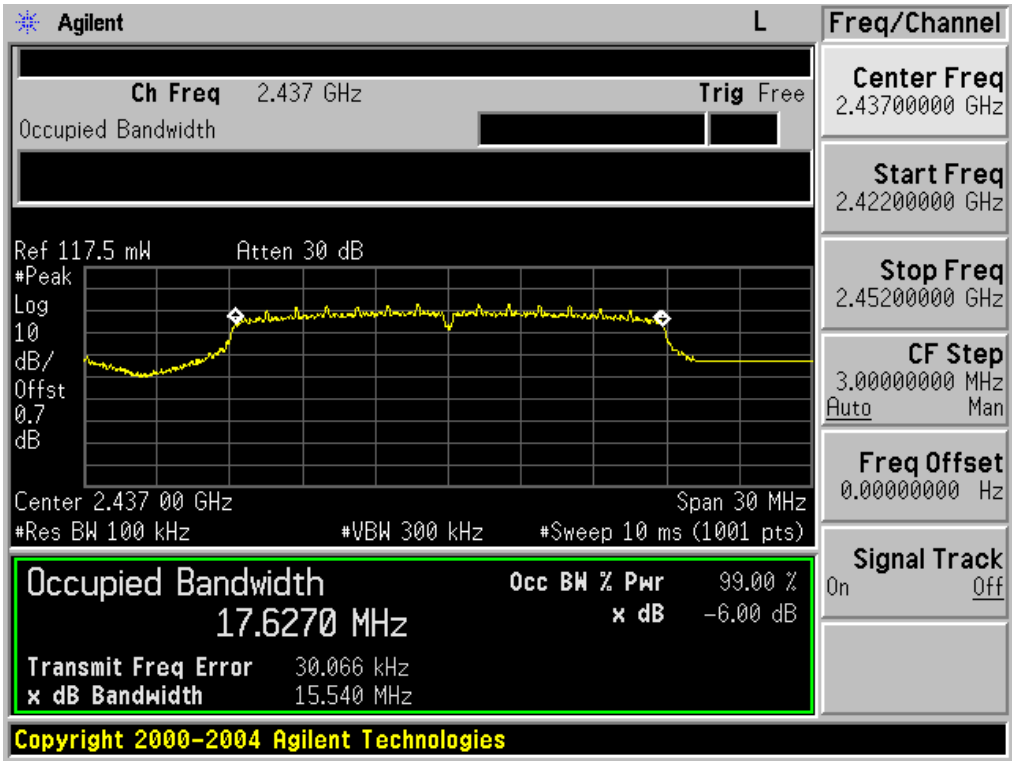

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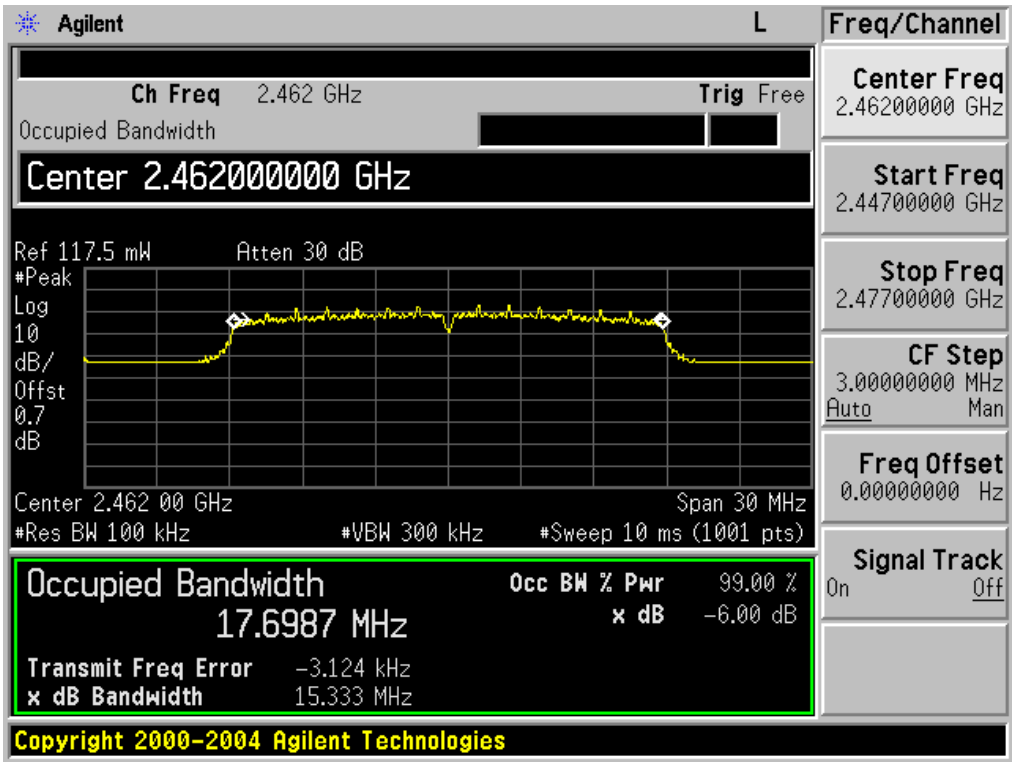
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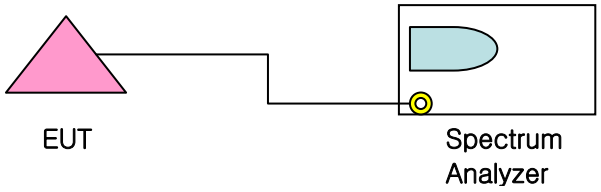
– 802.11n 11CH –

5.3. Maximum Peak Power

5.3.1. Test Setup Layout



5.3.2. Test Condition & Limit

- A transmitter antenna terminal of EUT is connected to the input of a Spectrum Analyzer as above.
- Measurement is made while the EUT is operating in transmission mode at the appropriate frequencies.
- Peak Power: Procedure 9.1.2 in IDB 558074, issued 04/09/2013

The spectrum analyzer is set as integrated band power measurement function.

a) RBW = 1MHz
b) BW≥3 x RBW
c) SPAN ≥1.5 x DTS bandwidth
d) Detector Mode = Peak
e) Sweep = auto couple
f) Trace Mode = max hold
g) Allow trace to fully stabilize.
h) Use the instrument's band/channel power measurement function with the band limits set equal to the DTS bandwidth edges (for some instruments, this may require a manual override to select peak detector).

- Average Power: Procedure 9.2.2.4 in IDB 558074, issued 04/09/2013

a) Measure the duty cycle
b) Set span to at least 1.5 times the OBW
c) Set RBW = 1-5% of the OBW, not to exceed 1 MHz
d) Set VBW ≥ 3 x RBW
e) Number of points in sweep ≥ 2 x span / RBW. (This gives bin-to-bin spacing ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
f) Sweep time = auto.
g) Detector = RMS (i.e., power averaging)
h) Don't use sweep triggering. Allow the sweep to "free run".
i) Trace average at least 100 traces in power averaging(RMS) mode.
j) Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function with band limits set equal to the OBW band edges.

k) 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.

- **The Maximum permissible conducted output power is 1Watt.**

※ **Sample calculation**

Output Power = Reading Value + Cable loss + Duty Cycle Factor

= 14.88 + 0.7 + 0.45 = 16.03

(Cable loss is already included in the Reading value.)

5.3.3. Test result

* Peak Power

Test Mode	Data Rate (Mbps)	2412MHz (dBm)	2437MHz (dBm)	2462MHz (dBm)
802.11b	1	16.23	16.32	16.66
	2	16.26	16.33	16.70
	5.5	16.49	16.61	17.03
	11	16.94	16.94	17.24

*Average Power

Test Mode	Data Rate (Mbps)	2412MHz (dBm)	2437MHz (dBm)	2462MHz (dBm)
802.11b	1	13.93	14.12	14.03
	2	14.01	13.95	13.93
	5.5	13.90	13.82	14.08
	11	13.95	13.96	14.08

-Average Power = Measured Power (dBm) + Duty Cycle Factor
-Sample Calculation = 13.45 + 0.48 = 13.93 dBm

* Peak Power

Test Mode	Data Rate (Mbps)	2412MHz (dBm)	2437MHz (dBm)	2462MHz (dBm)
802.11g	6	19.45	19.54	19.61
	9	19.02	19.11	19.29
	12	18.38	18.40	18.58
	18	17.86	17.97	18.10
	24	17.71	17.79	17.99
	36	17.29	17.32	17.53
	48	16.70	16.77	16.96
	54	16.41	16.49	16.76

*Average Power

Test Mode	Data Rate (Mbps)	2412MHz (dBm)	2437MHz (dBm)	2462MHz (dBm)
802.11g	6	14.08	14.08	14.09
	9	13.94	14.20	13.95
	12	13.96	14.71	14.16
	18	14.12	14.97	14.25
	24	13.95	13.99	14.32
	36	14.08	14.28	14.06
	48	13.88	13.87	13.87
	54	13.51	13.80	13.71

- Average Power = Measured Power (dBm) + Duty Cycle Factor
-Sample Calculation = 11.73 +2.35 = 14.08 dBm

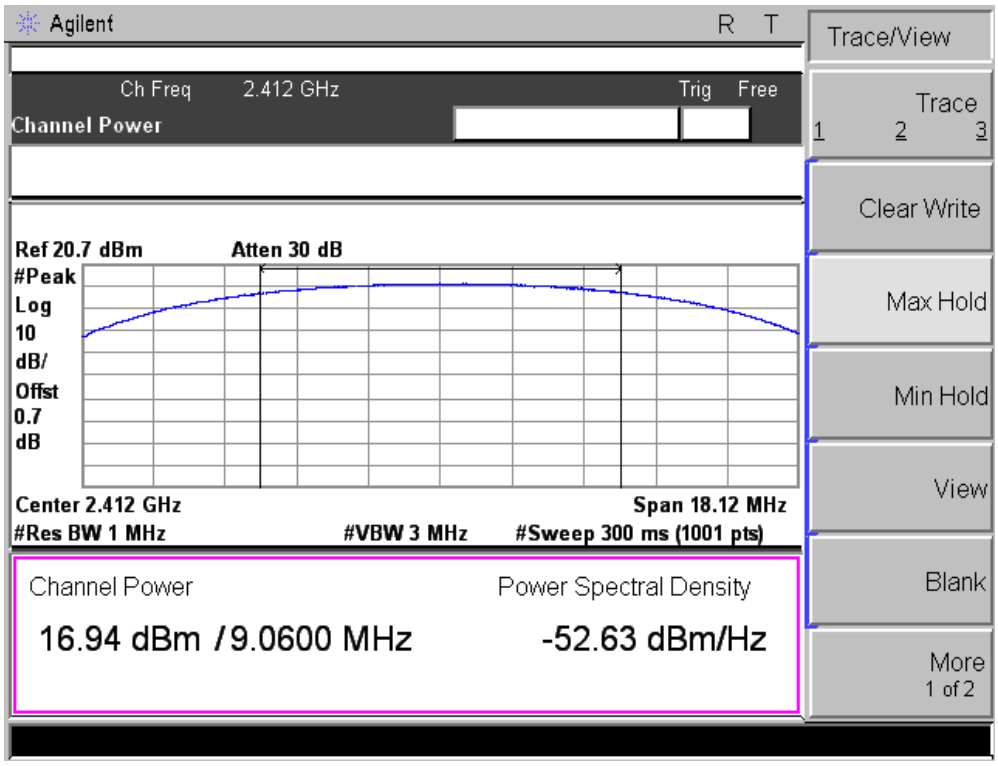
* Peak Power

Test Mode	Data Rate (Mbps)	2412MHz (dBm)	2437MHz (dBm)	2462MHz (dBm)
802.11n	6.5	19.20	19.27	19.33
	13	17.97	18.06	18.15
	19.5	17.61	17.60	17.80
	26	17.57	17.58	17.76
	39	17.08	17.24	17.36
	52	16.19	16.33	16.41
	58.5	16.12	16.29	16.39
	65	15.19	15.26	15.41

*Average Power

Test Mode	Data Rate (Mbps)	2412MHz (dBm)	2437MHz (dBm)	2462MHz (dBm)
802.11n	6.5	13.61	13.82	13.80
	13	13.96	13.98	13.98
	19.5	13.85	13.97	13.85
	26	13.61	14.25	13.90
	39	13.94	13.87	13.99
	52	13.47	13.33	13.54
	58.5	15.53	13.35	13.36
	65	12.50	12.75	12.62

- Average Power = Measured Power (dBm) + Duty Cycle Factor
-Sample Calculation = 11.20 +2.41= 13.61dBm



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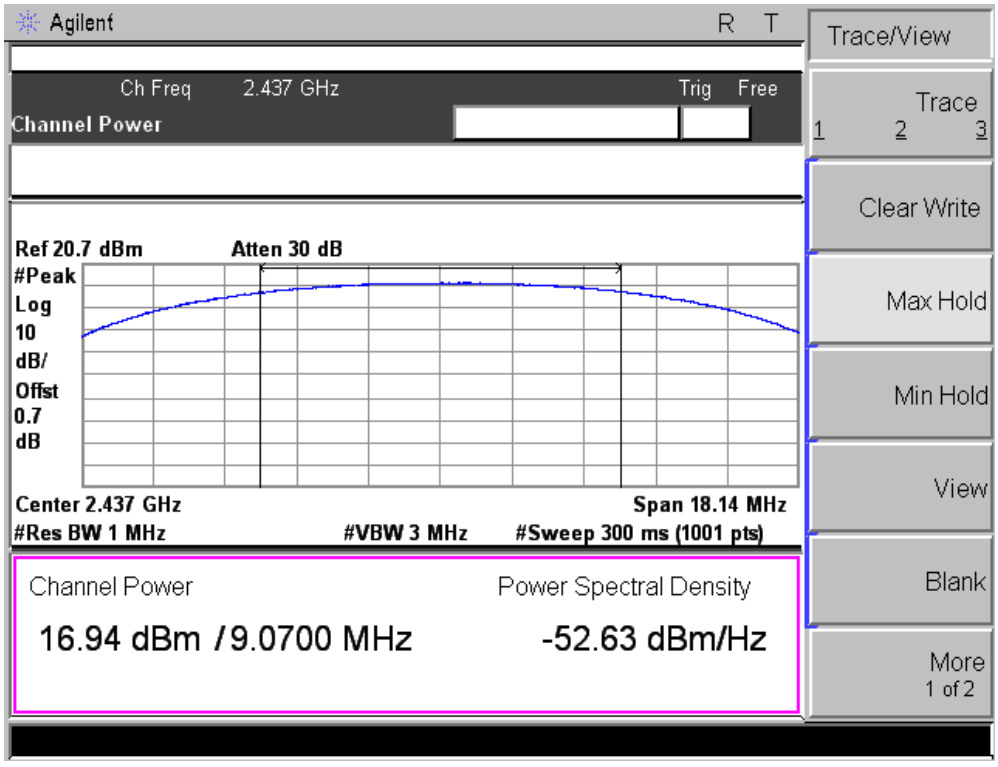

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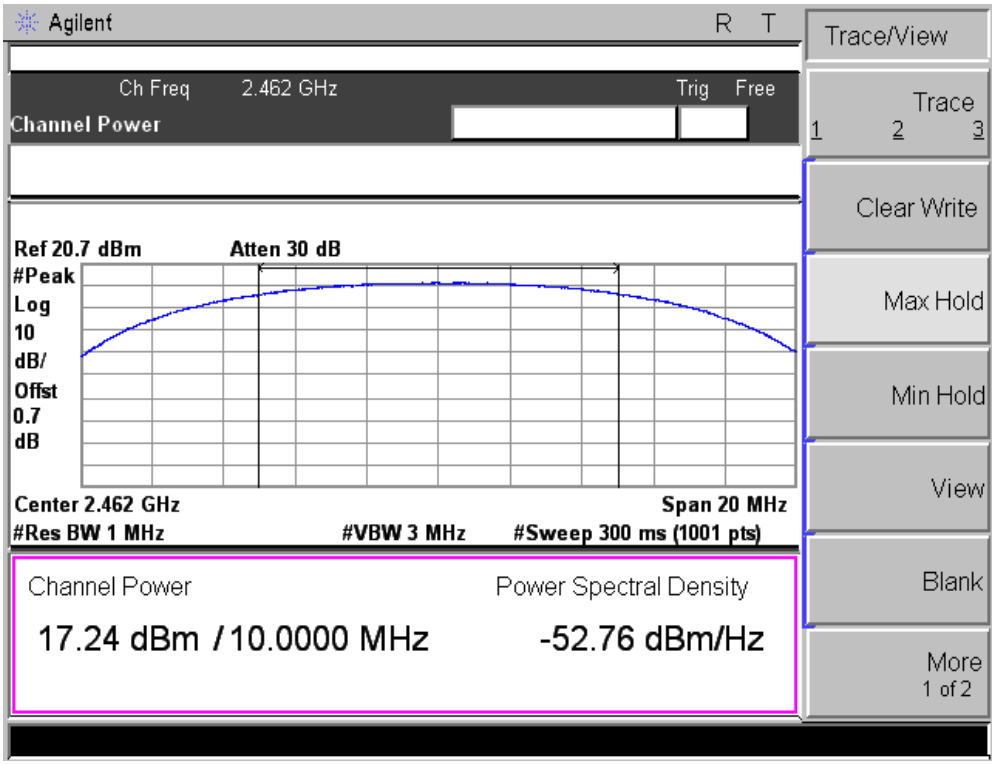

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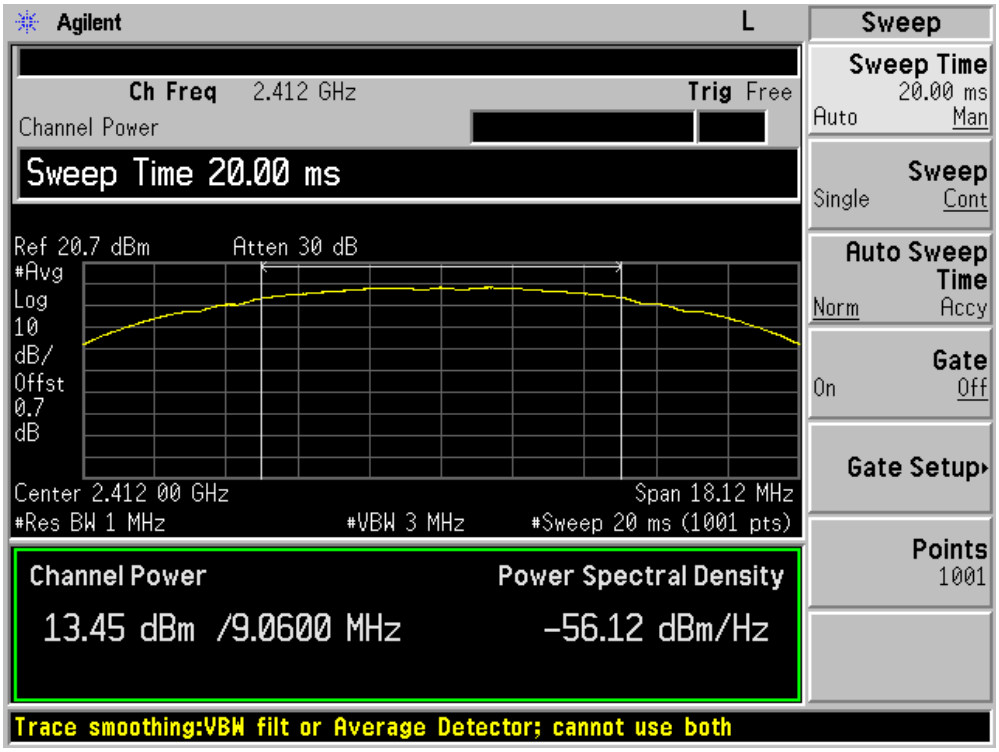

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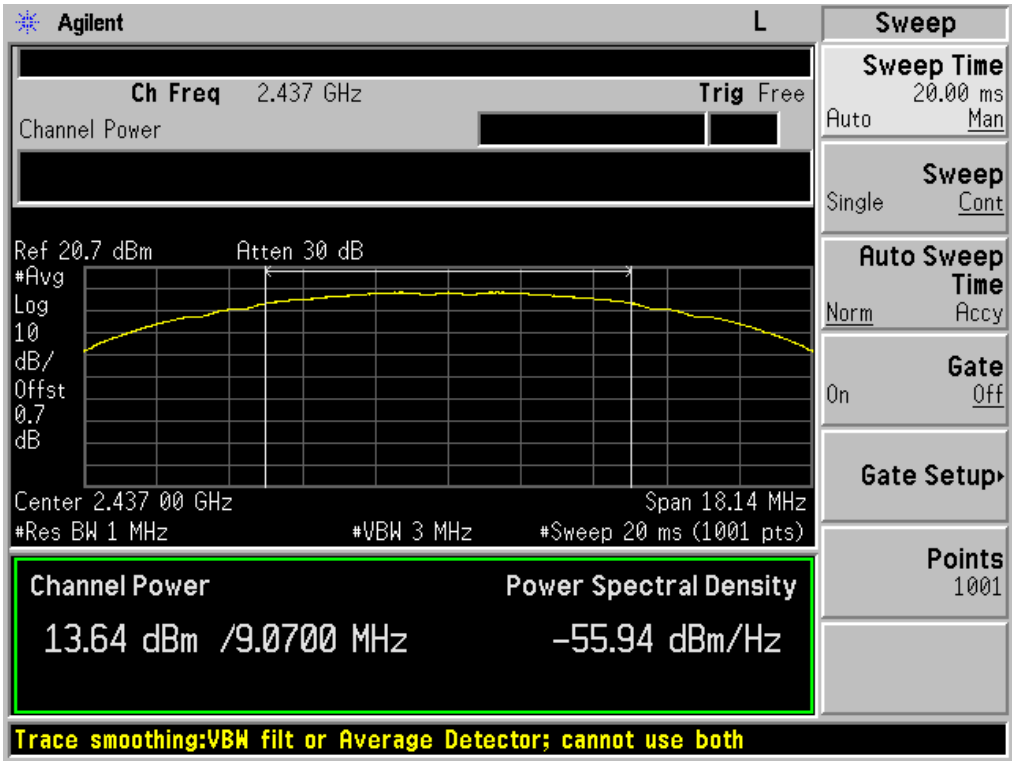

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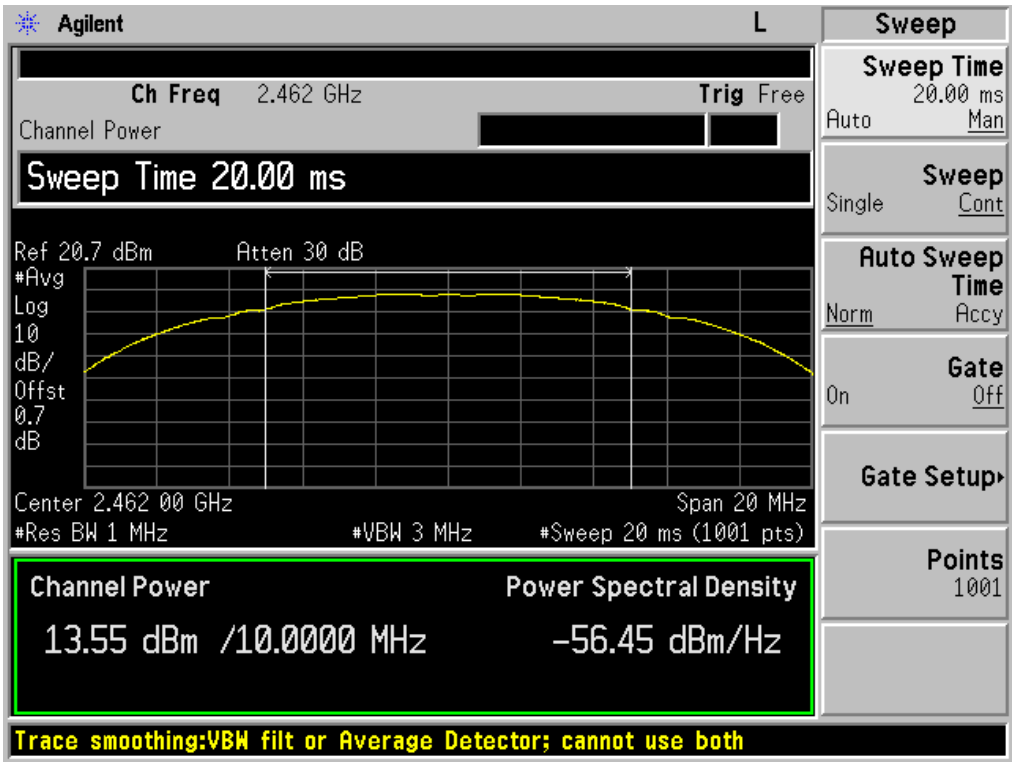

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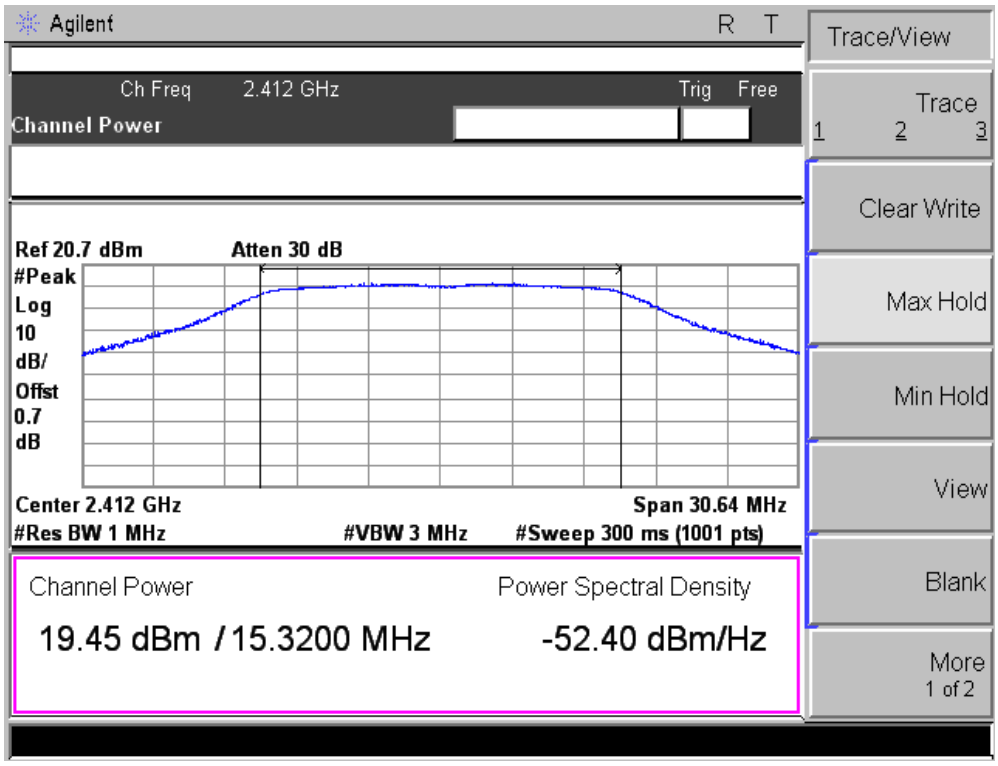

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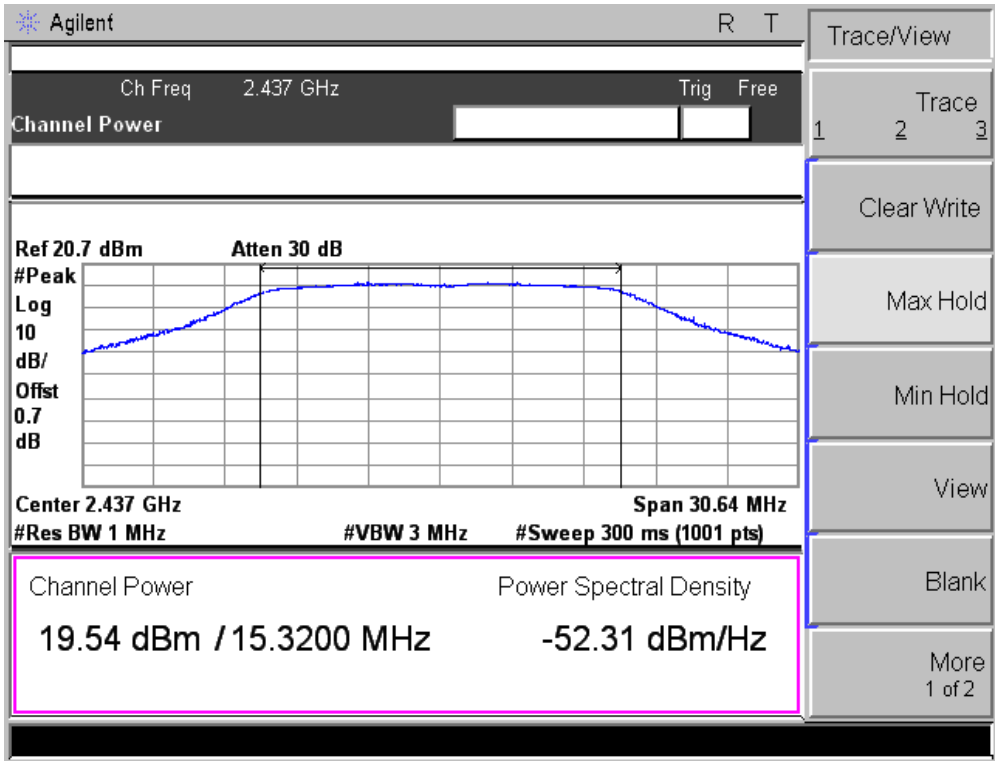

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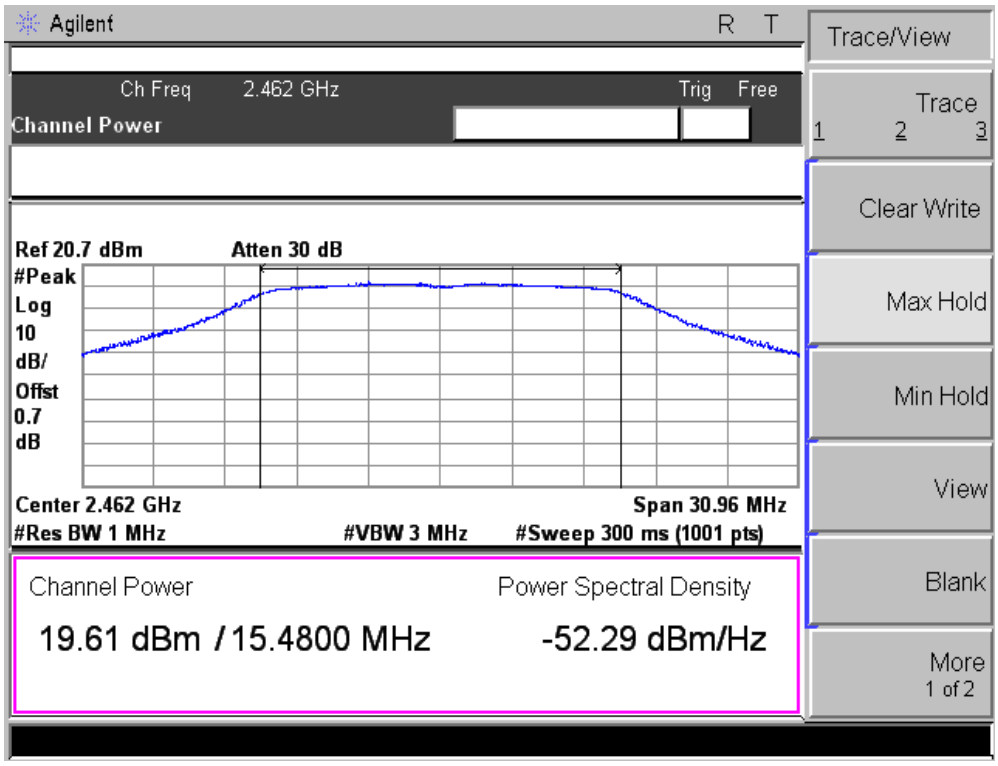

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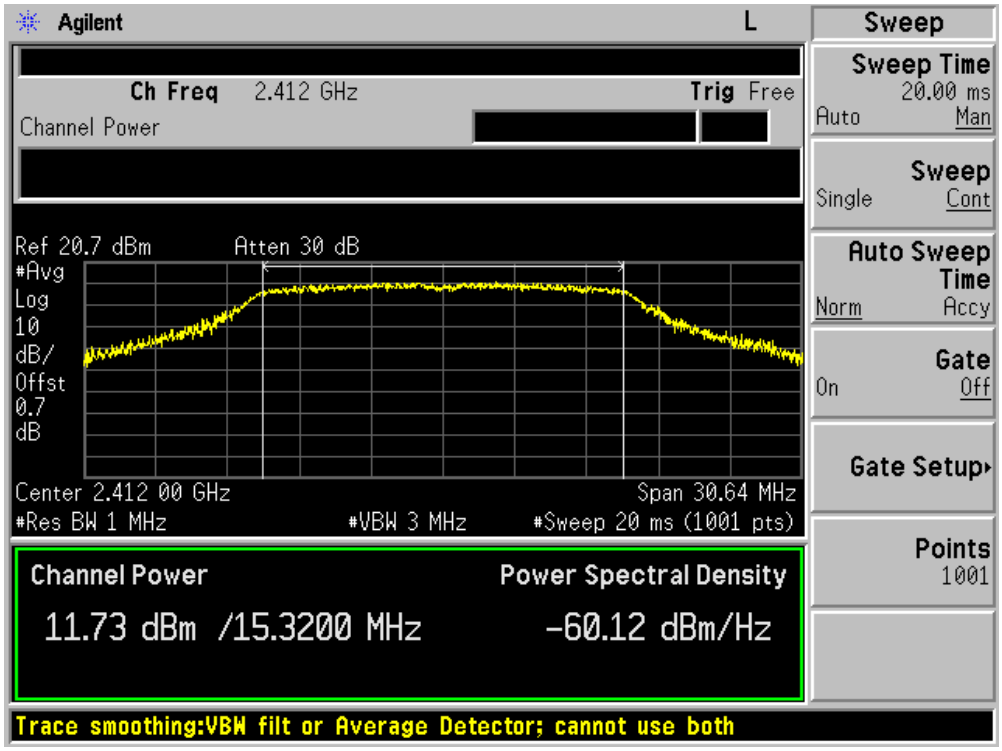

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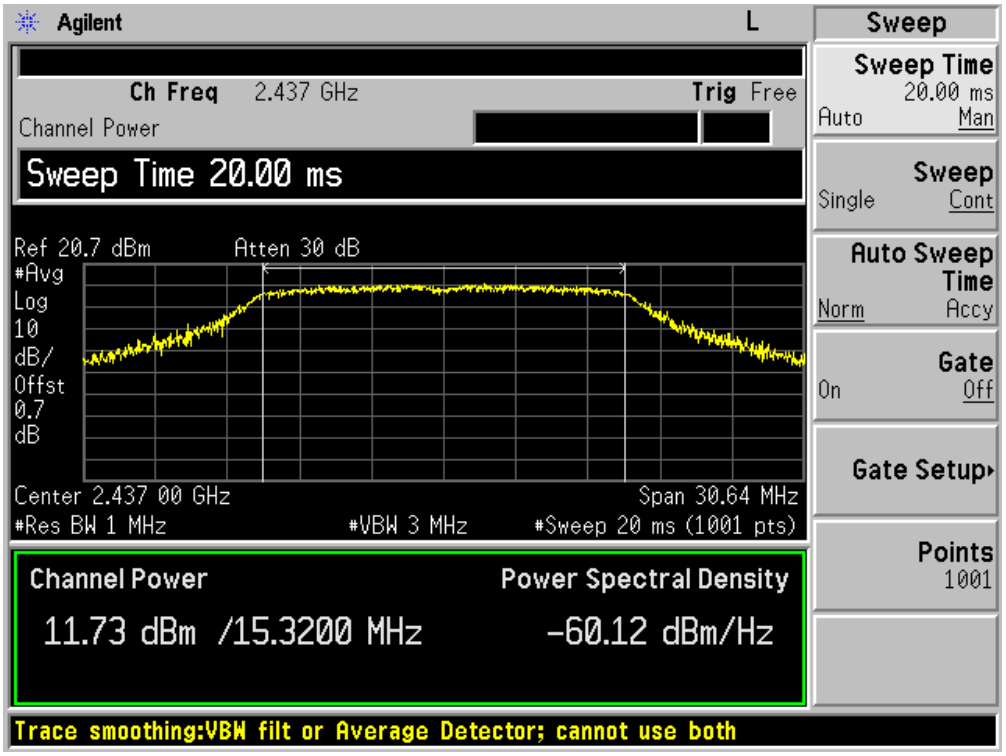

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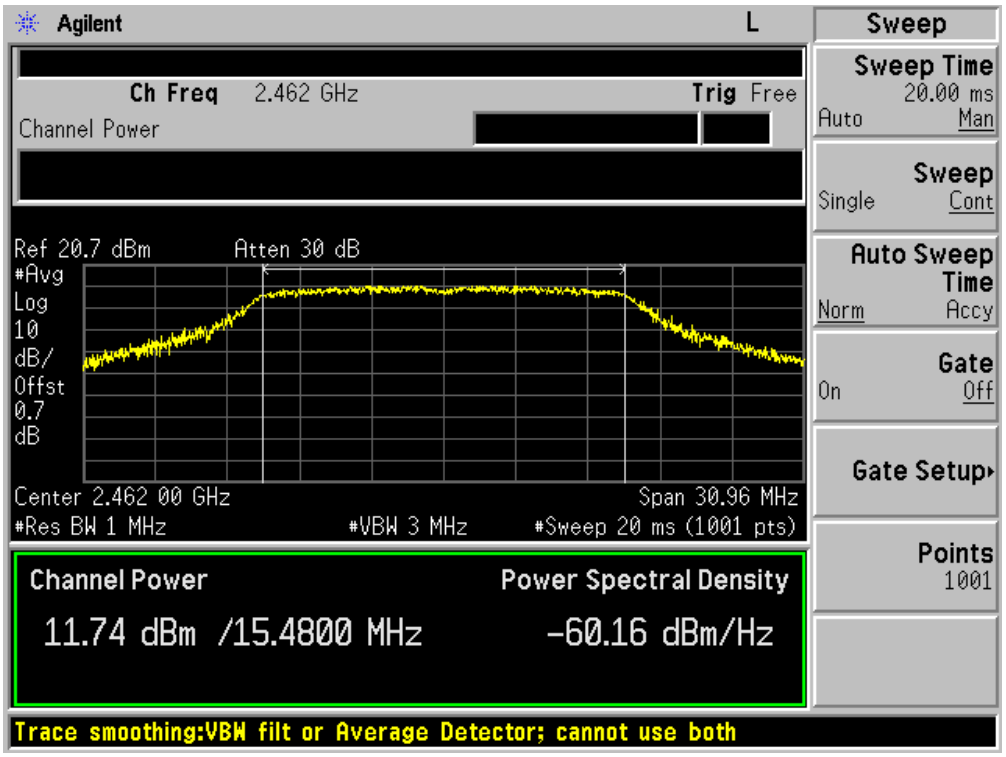

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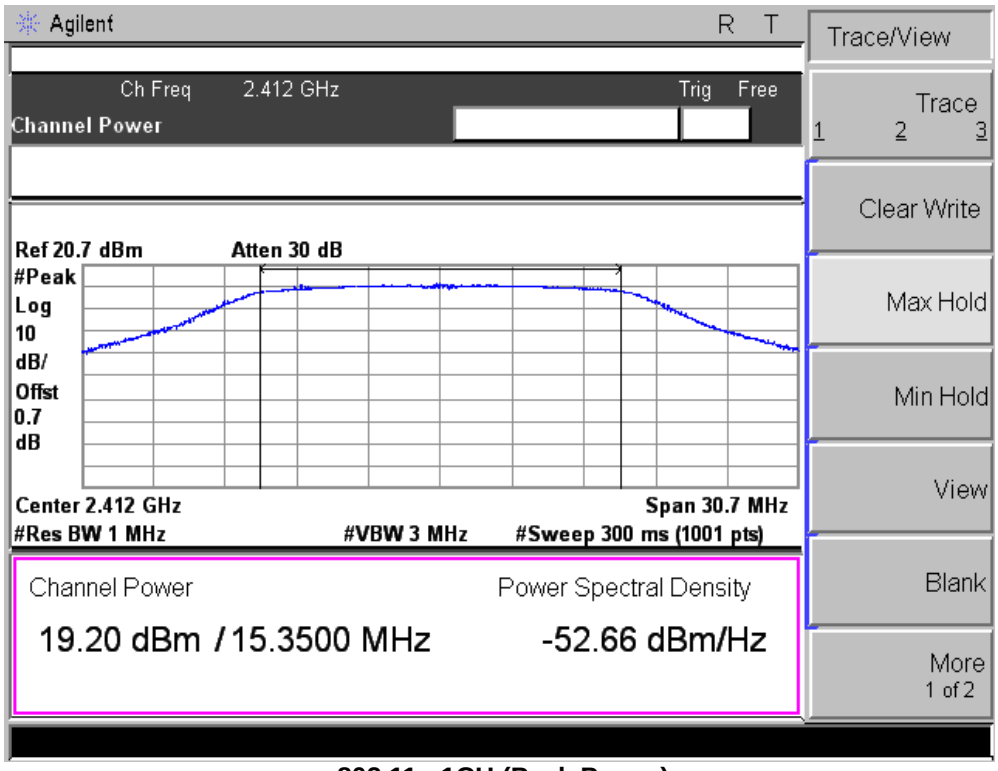

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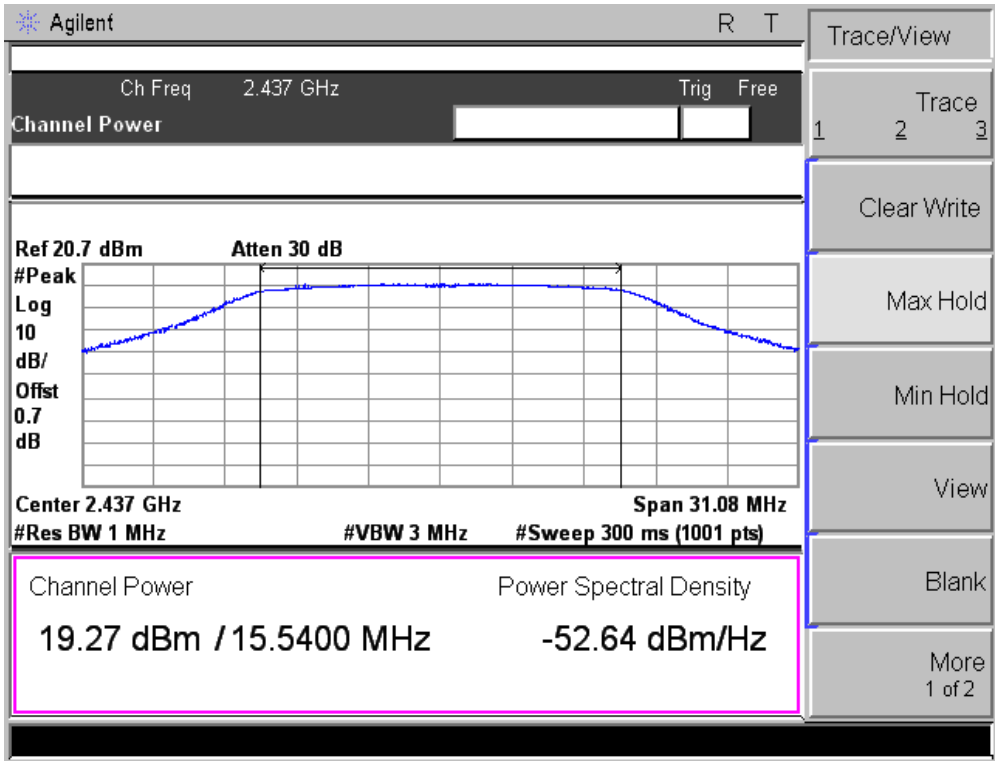

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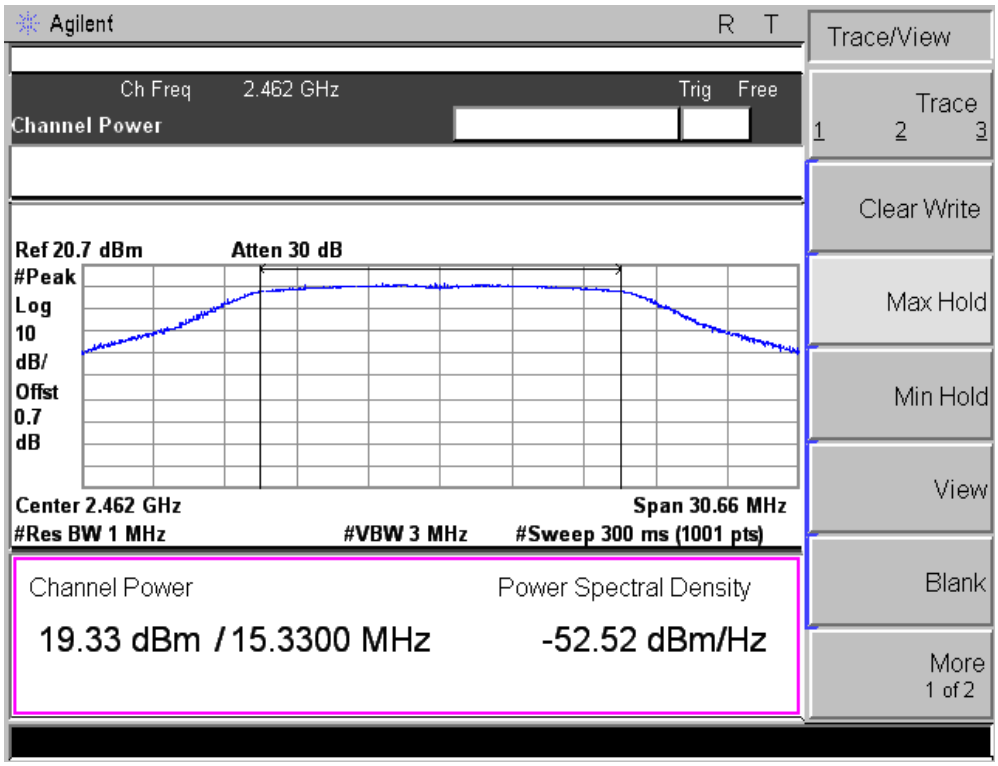

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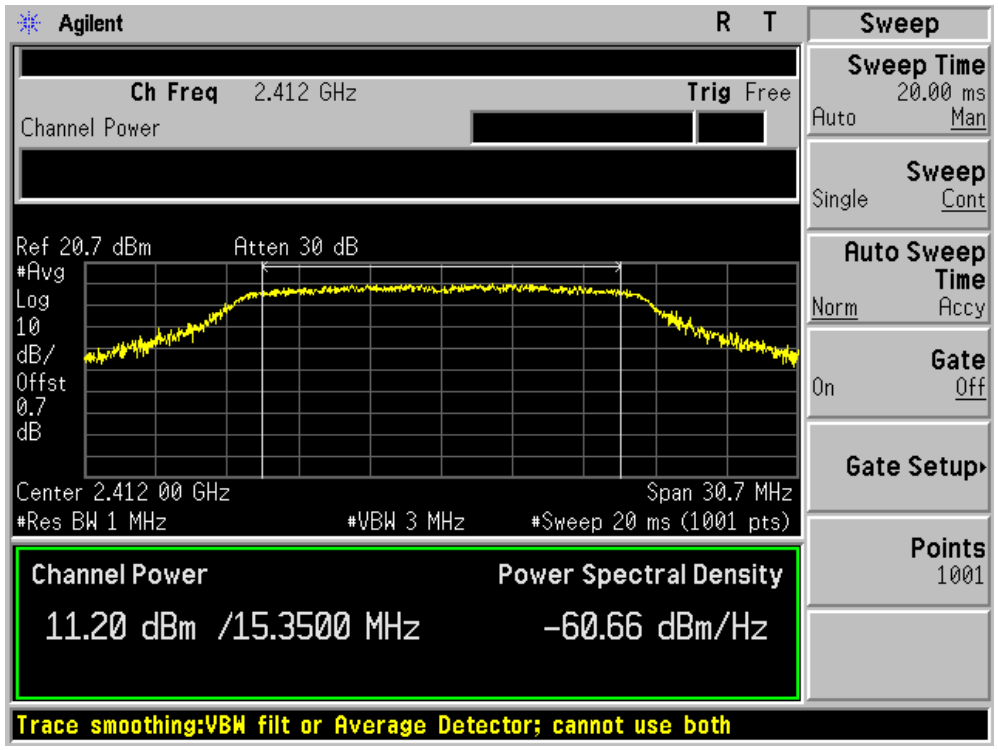

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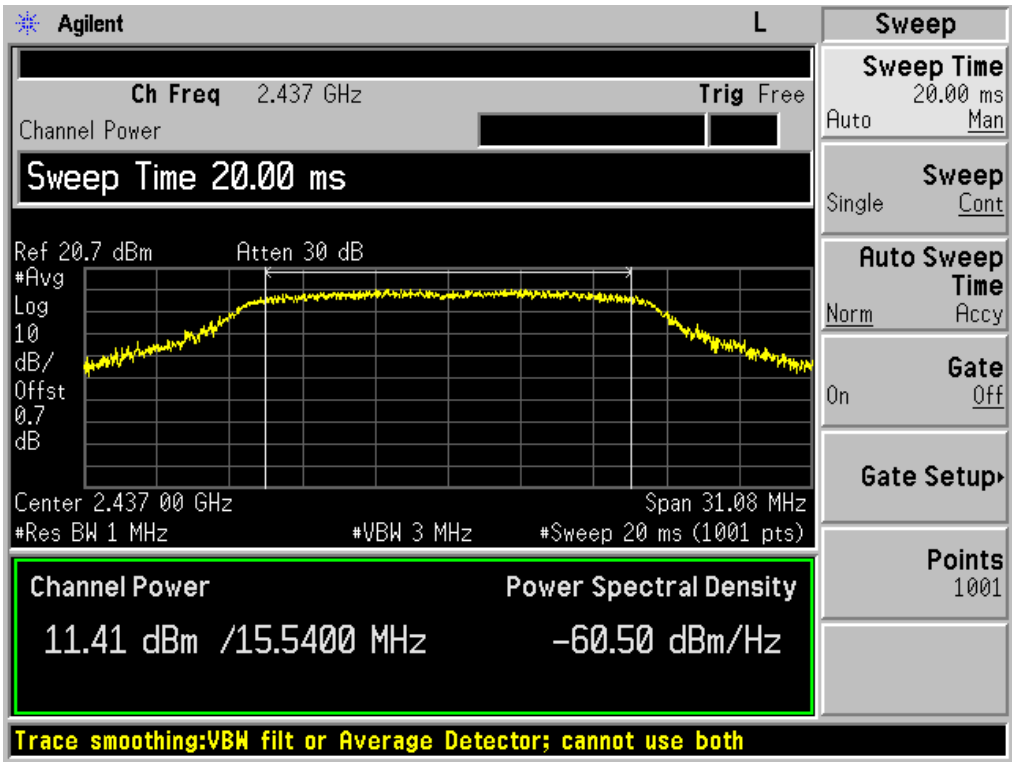
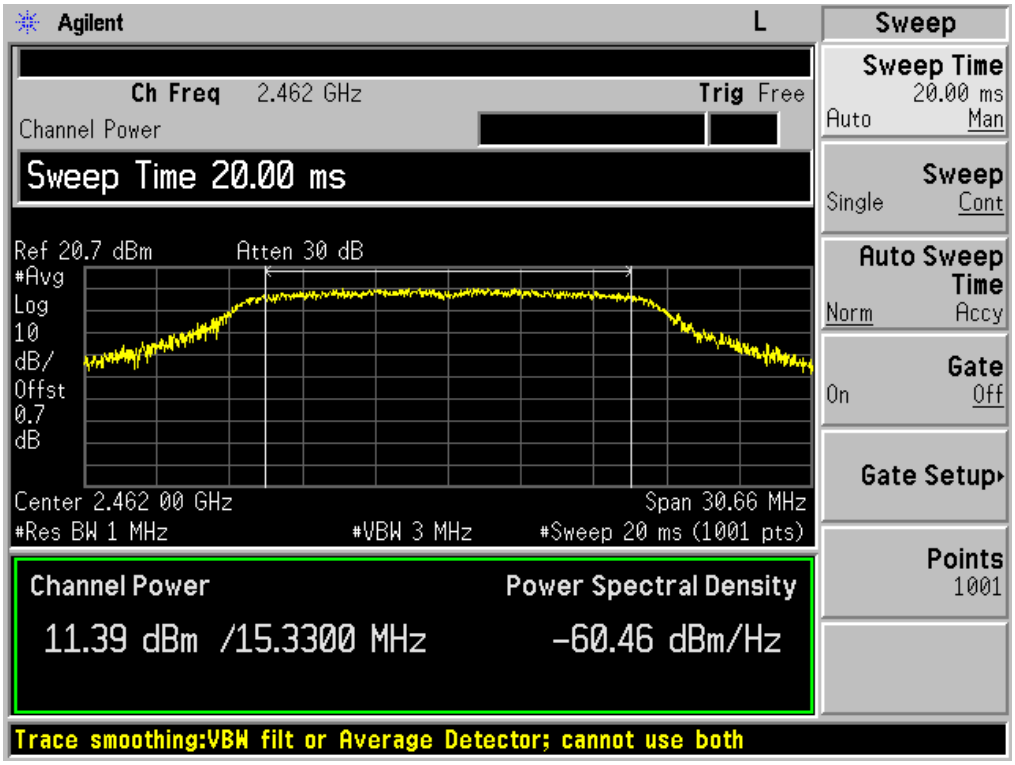


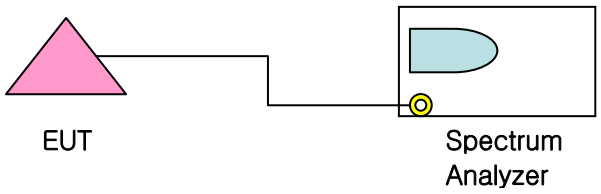
– 802.11n 6CH (Average Power)–



– 802.11n 11CH (Average Power)–

5.4. Power Spectral Density

5.4.1. Test Setup Layout



5.4.2. Test Condition & Limit

-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.

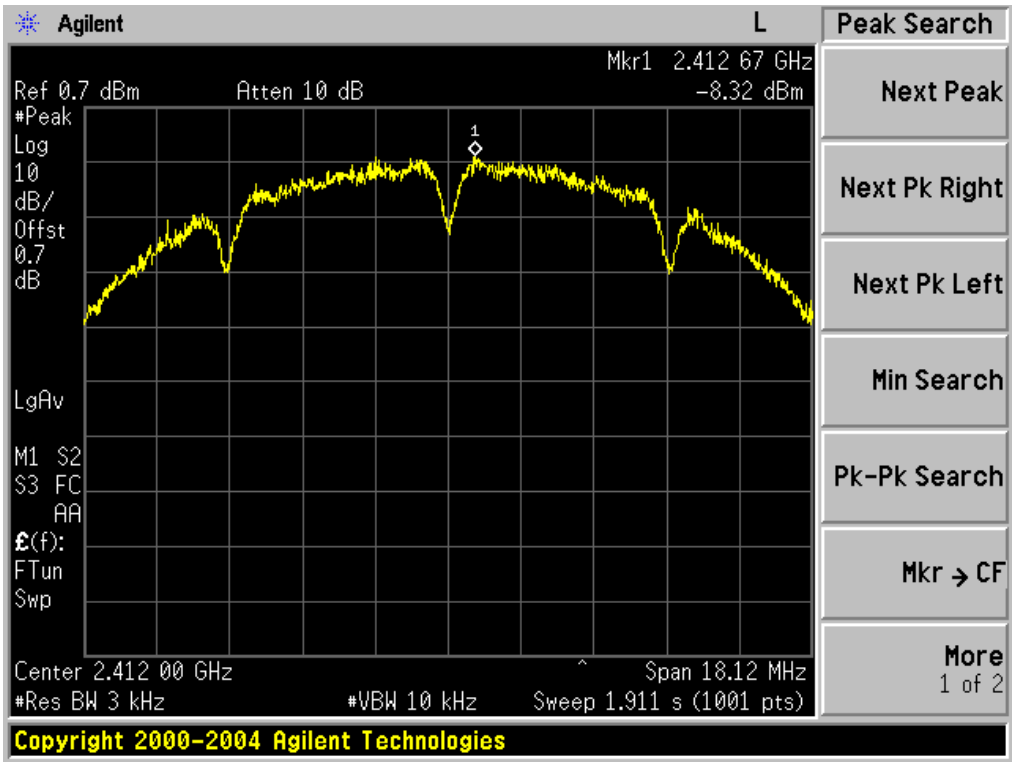
- **The Maximum permissible power spectral density is 8 dBm in any 3 kHz band.**
- Test was performed according to Procedure 10.2 in KDB 558074, issued 04/09/2013

The Spectrum analyzer is set to:

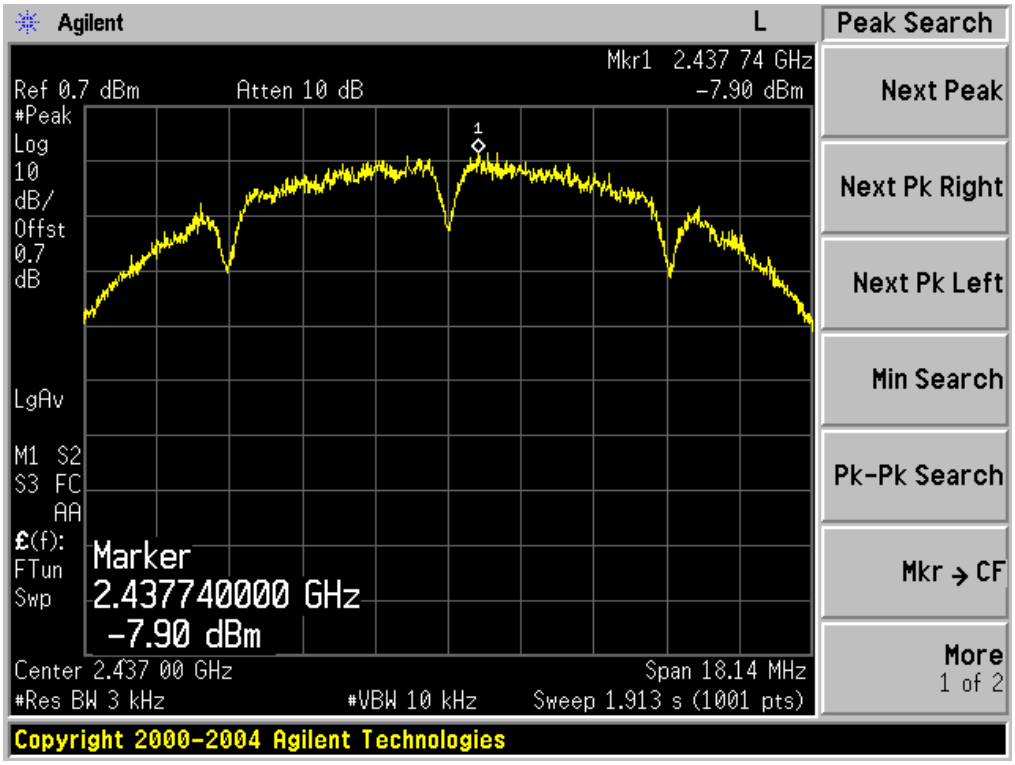
a) Set analyzer center frequency to DTS channel center frequency.
b) Span =1.5 times the DTS channel bandwidth
c) RBW = 3kHz ≤RBW ≤100kHz
d) VBW≥3 x RBW
e) Sweep = auto couple
f) Detector = peak
g) Trace Mode = max hold
h) Allow trace to fully stabilize
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
If measured value exceeds limit, reduce RBW (no less than 3kHz) and repeat.

5.4.3. Test result

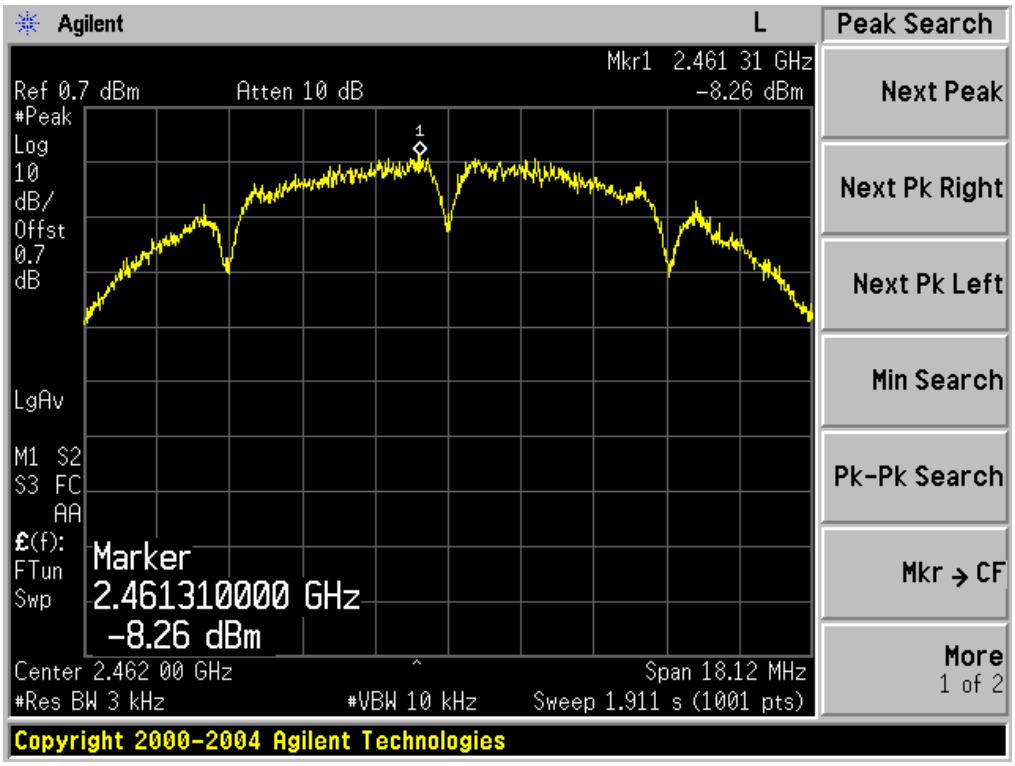
Test Mode	Power Spectral Density			Limit
	2412MHz (dBm)	2437MHz (dBm)	2462MHz (dBm)	
802.11b	-8.32	-7.90	-8.26	8dBm
802.11g	-11.29	-11.03	-10.09	8dBm
802.11n	-13.29	-13.06	-14.06	8dBm



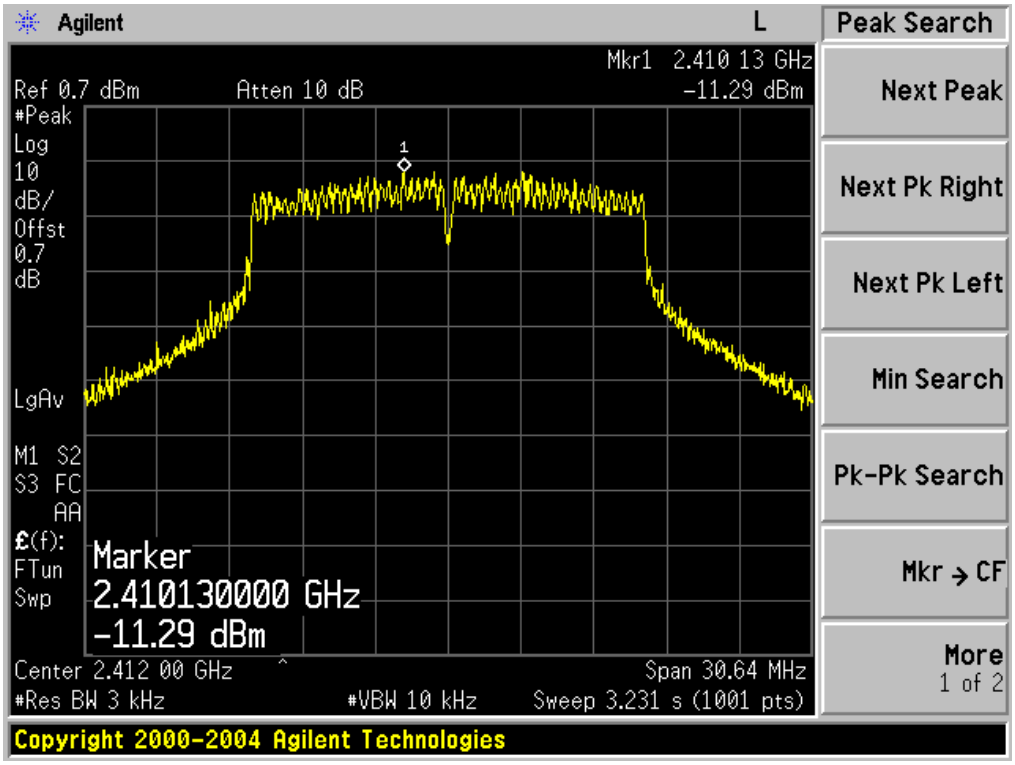
– 802.11b 1CH (Power Spectral Density)–



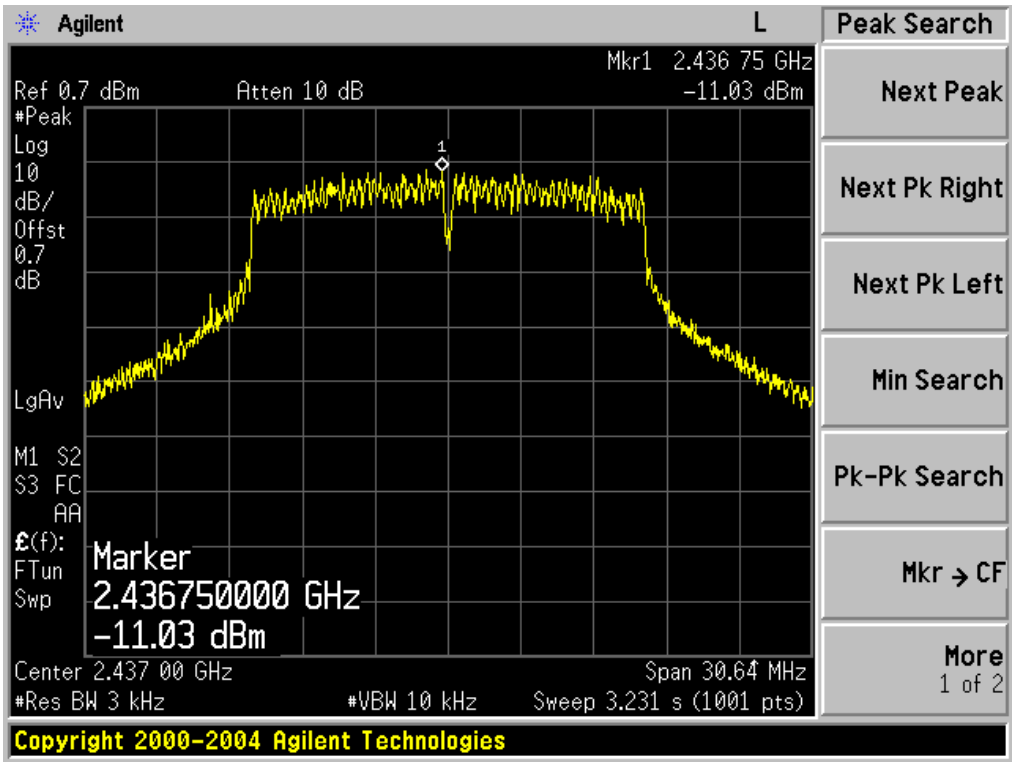
– 802.11b 6CH (Power Spectral Density)–



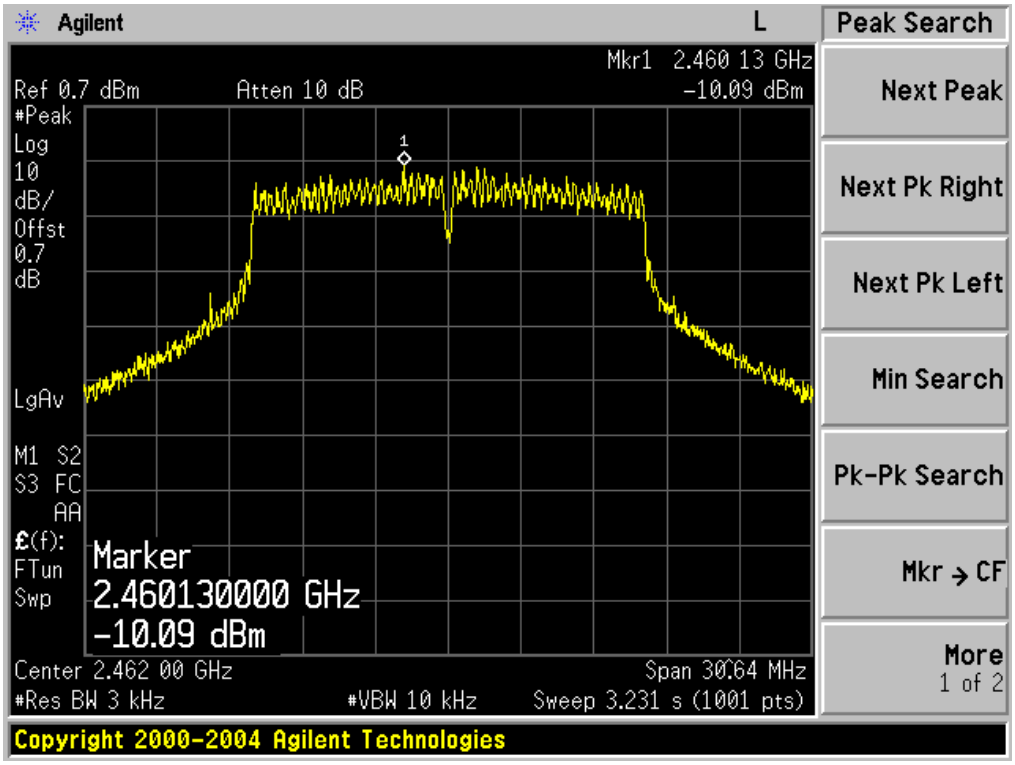
– 802.11b 11CH (Power Spectral Density)–



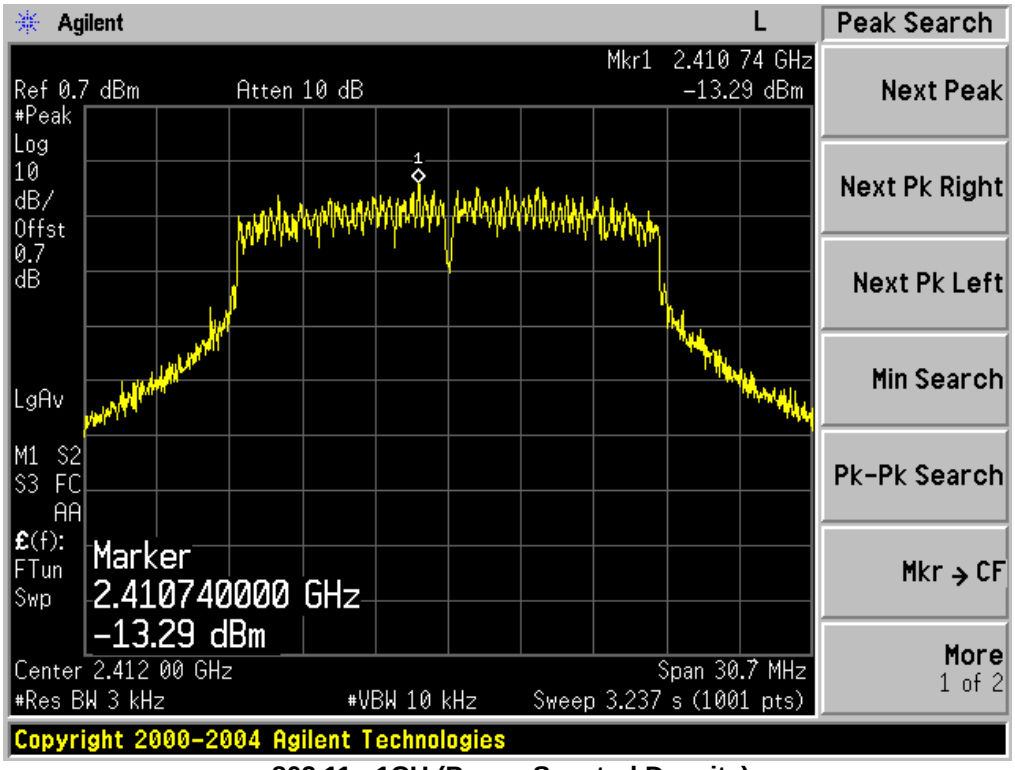
– 802.11g 1CH (Power Spectral Density)–



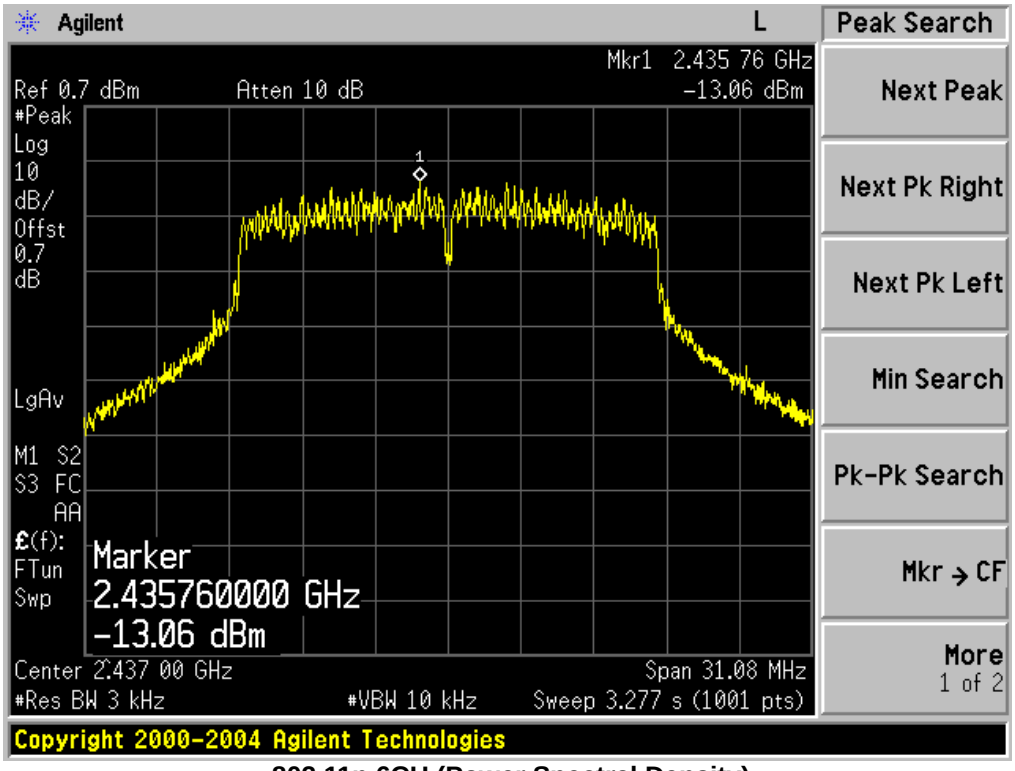
– 802.11g 6CH (Power Spectral Density)–



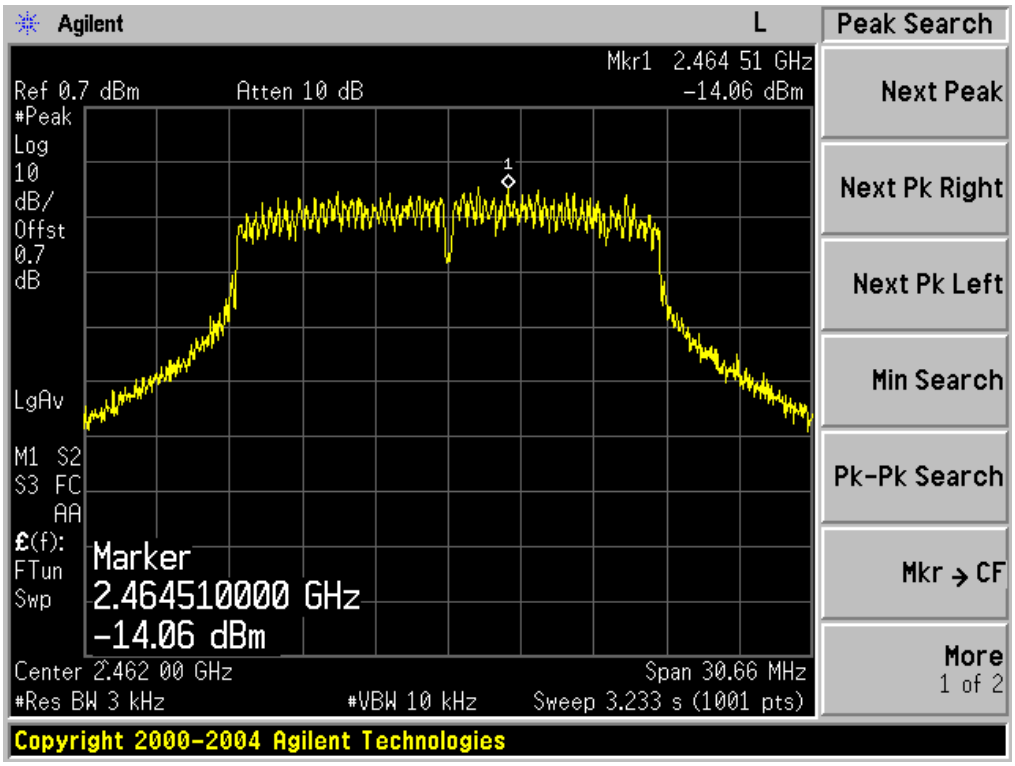
– 802.11g 11CH (Power Spectral Density)–



– 802.11n 1CH (Power Spectral Density)–



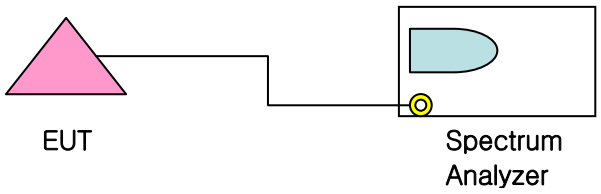
– 802.11n 6CH (Power Spectral Density)–



802.11n 11CH (Power Spectral Density)–

5.5. 100 KHz Bandwidth of Frequency Band Edges

5.5.1. Test Setup Layout



5.5.2. Test Condition & Limit

- Set RBW & VBW of Spectrum analyzer to 100 kHz
- 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.
- The maximum frequency range measuring with the spectrum from 30 MHz to 25 GHz is investigated with the transmitter

5.5.3. Test result

Operation Mode: 802.11b

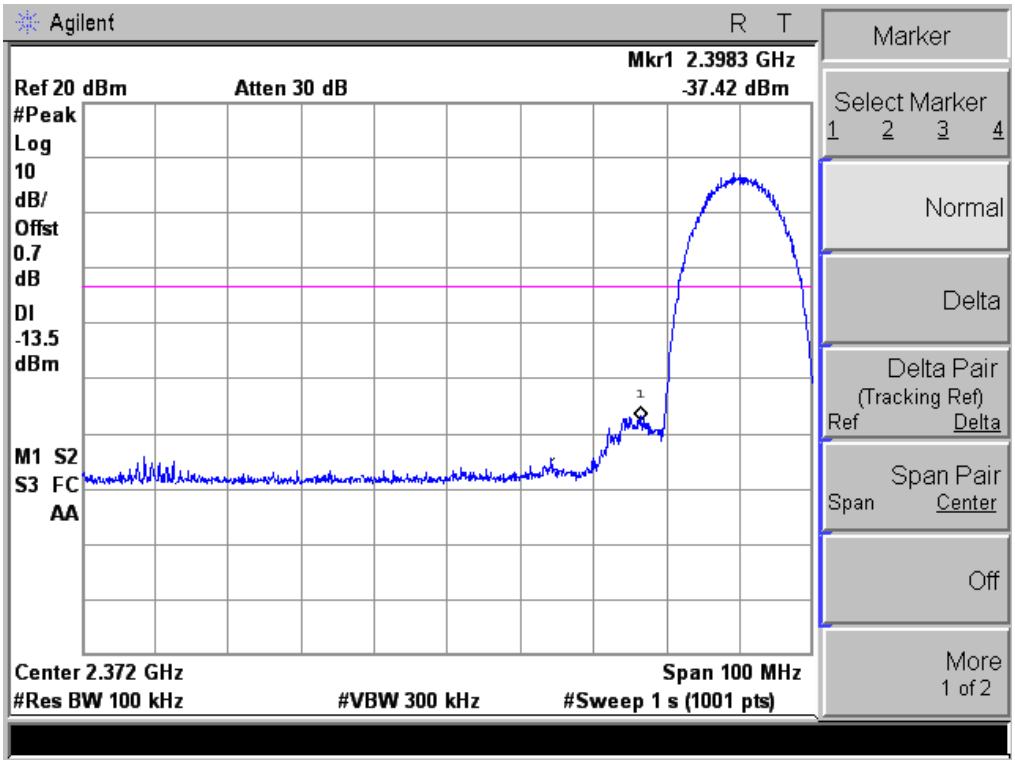
Channels	Frequency (MHz)	Result (dBc)	Limit (dBc)	Verdict
Low	2412	40 >	20	Pass
High	2462	40 >	20	Pass

* Operation Mode: 802.11g

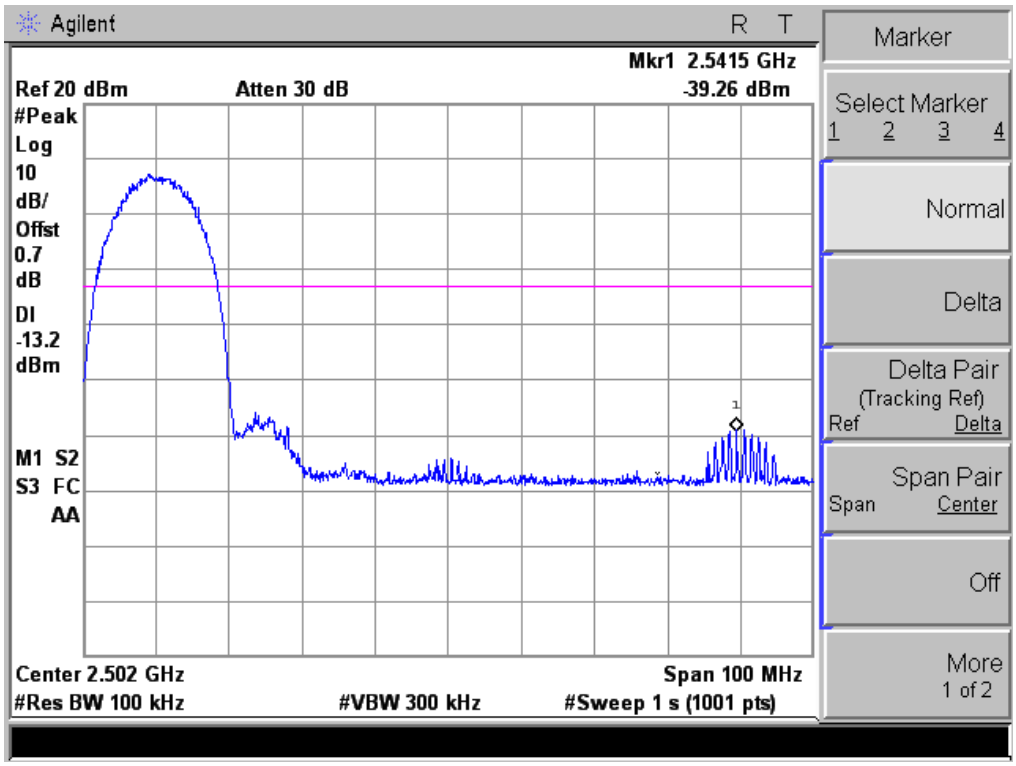
Channels	Frequency (MHz)	Result (dBc)	Limit (dBc)	Verdict
Low	2412	40 >	20	Pass
High	2462	40 >	20	Pass

* Operation Mode: 802.11n

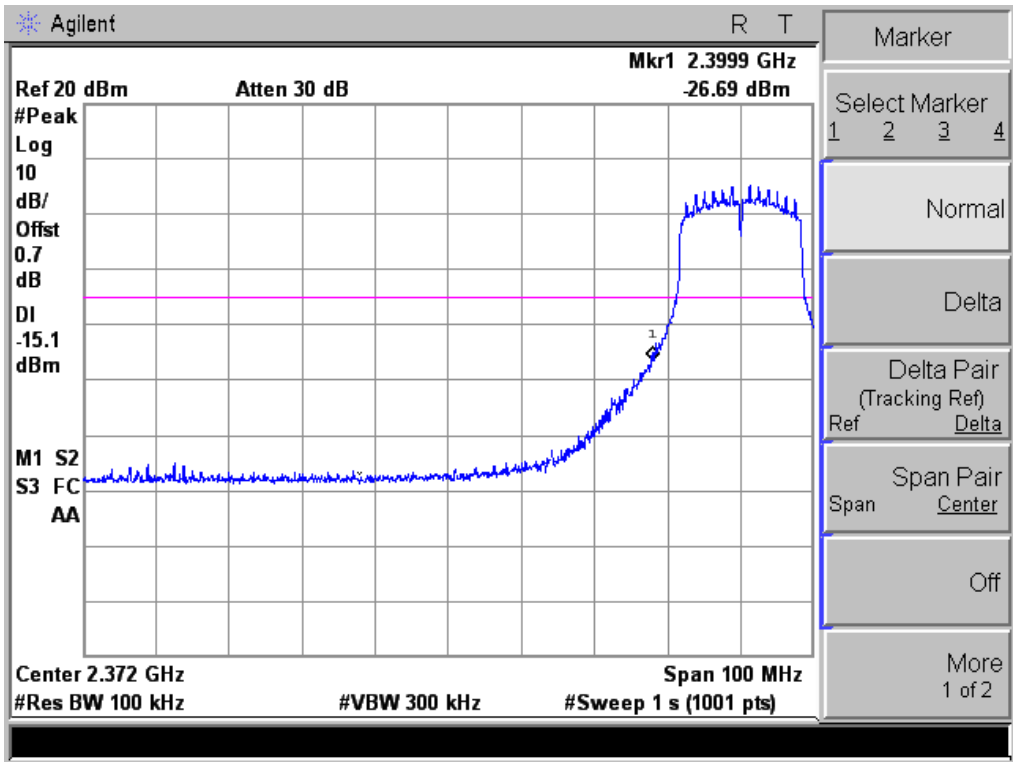
Channels	Frequency (MHz)	Result (dBc)	Limit (dBc)	Verdict
Low	2412	40 >	20	Pass
High	2462	40 >	20	Pass



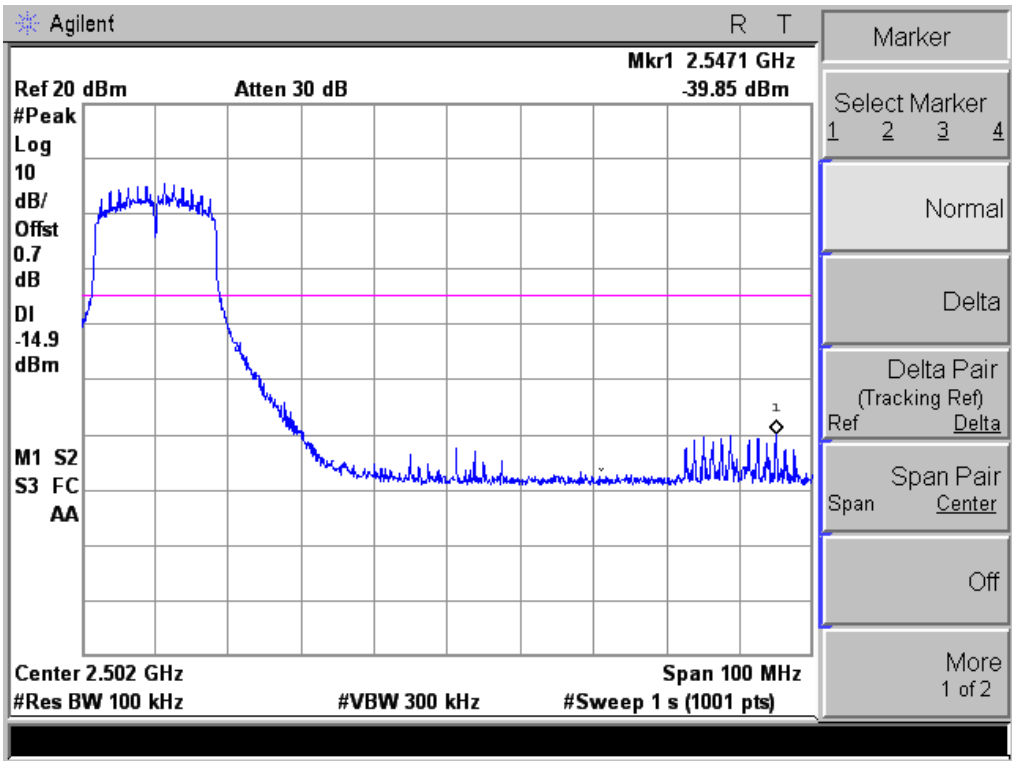
– 802.11b (Band edge lower side) –



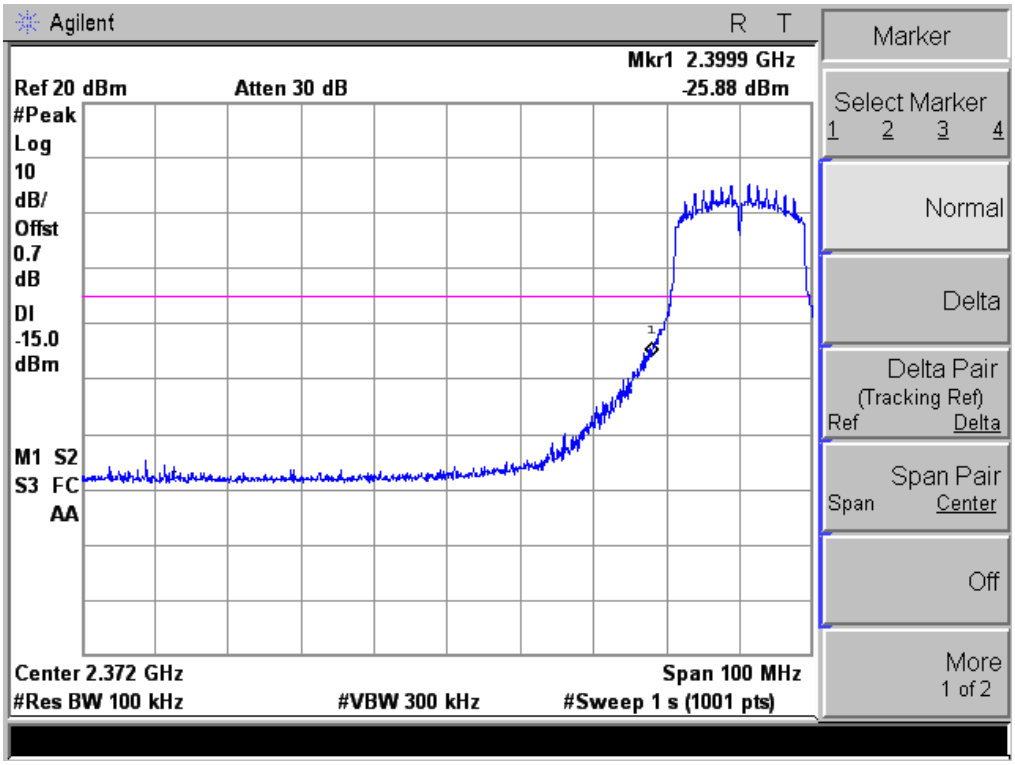
– 802.11b (Band edge higher side) –



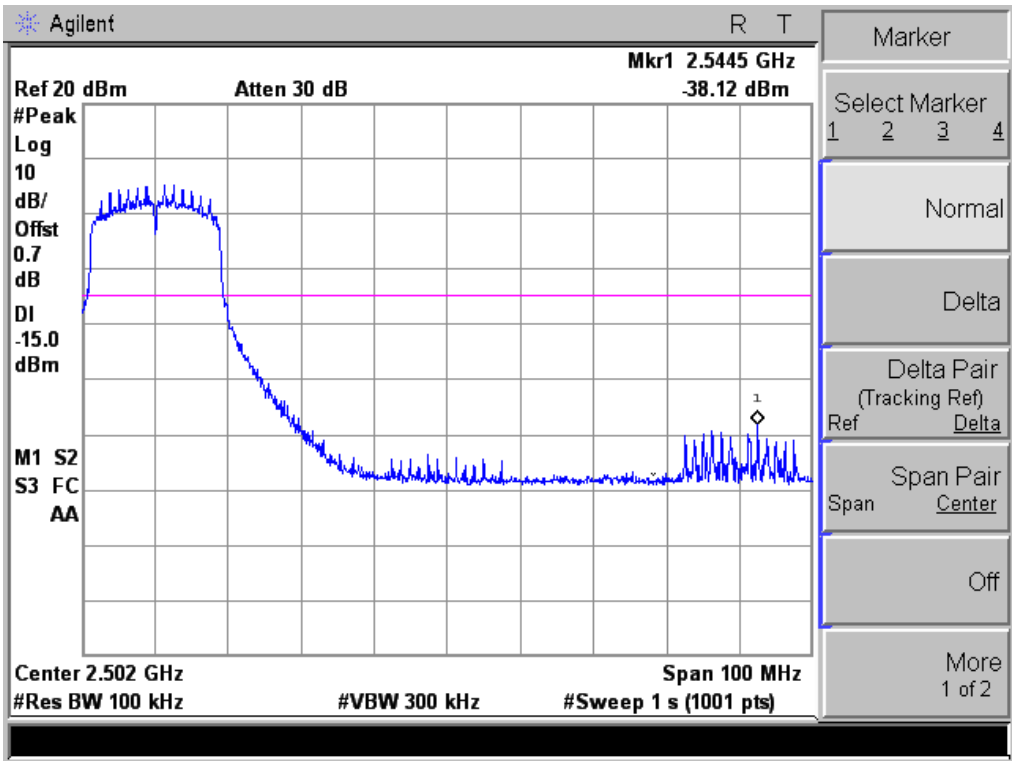
– 802.11g (Band edge lower side) –



– 802.11g (Band edge higher side) –



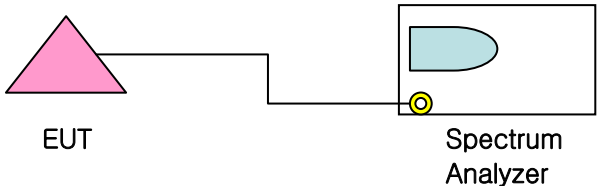
– 802.11n (Band edge lower side) –



– 802.11n (Band edge higher side) –

5.6. Conducted Spurious Emission

5.6.1. Test Setup Layout



5.6.2. Test Condition & Limit

- Set the spectrum analyzer as RBW, VBW = 100 kHz
- The reference value for the measurement of the spurious RF conducted emissions is determined during the test “band edge compliance” (cf. chapter 4.5). This value is used to calculate the 20 dBc limit.
- 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.

5.6.3. Test result

Operation Mode: 802.11b

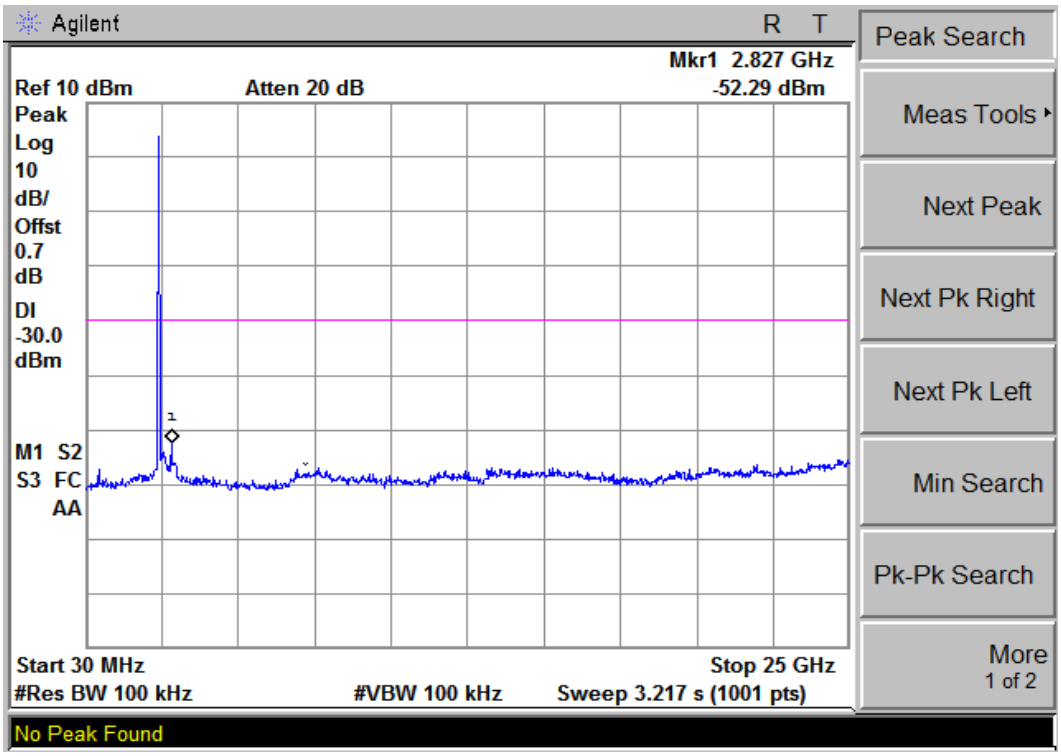
Channels	Frequency (MHz)	Result (dBc)	Limit (dBc)	Verdict
Low	2412	50 >	20	Pass
Mid	2437	50 >	20	Pass
High	2462	50 >	20	Pass

* Operation Mode: 802.11g

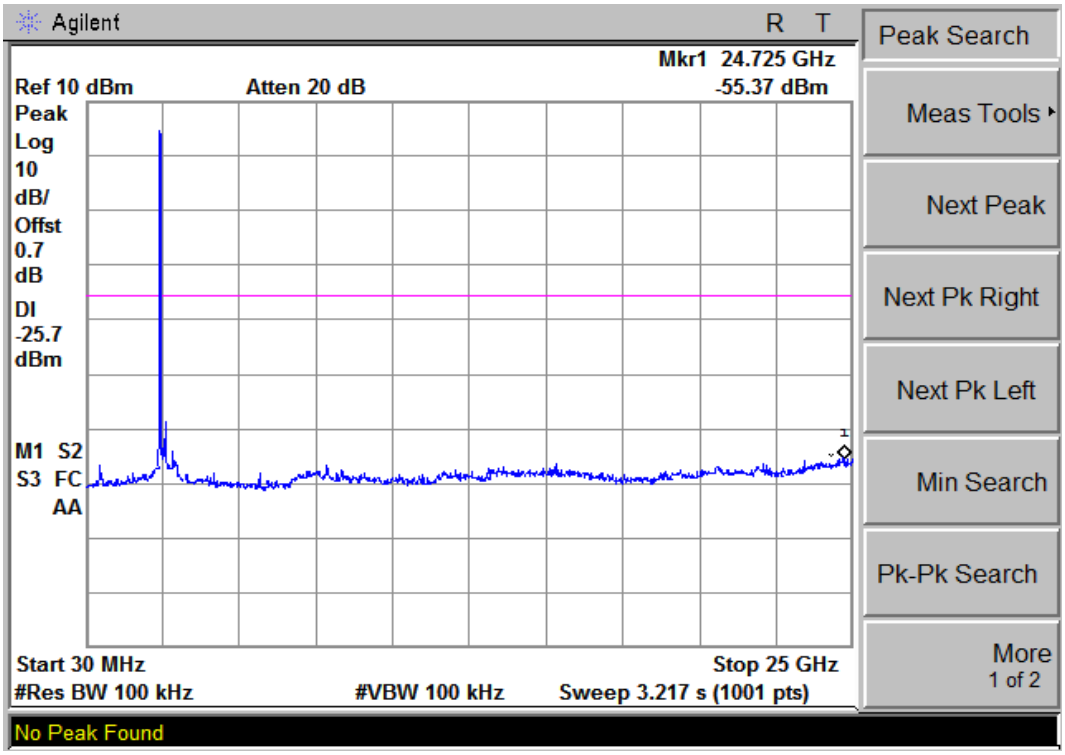
Channels	Frequency (MHz)	Result (dBc)	Limit (dBc)	Verdict
Low	2412	50 >	20	Pass
Mid	2437	50 >	20	Pass
High	2462	50 >	20	Pass

* Operation Mode: 802.11n

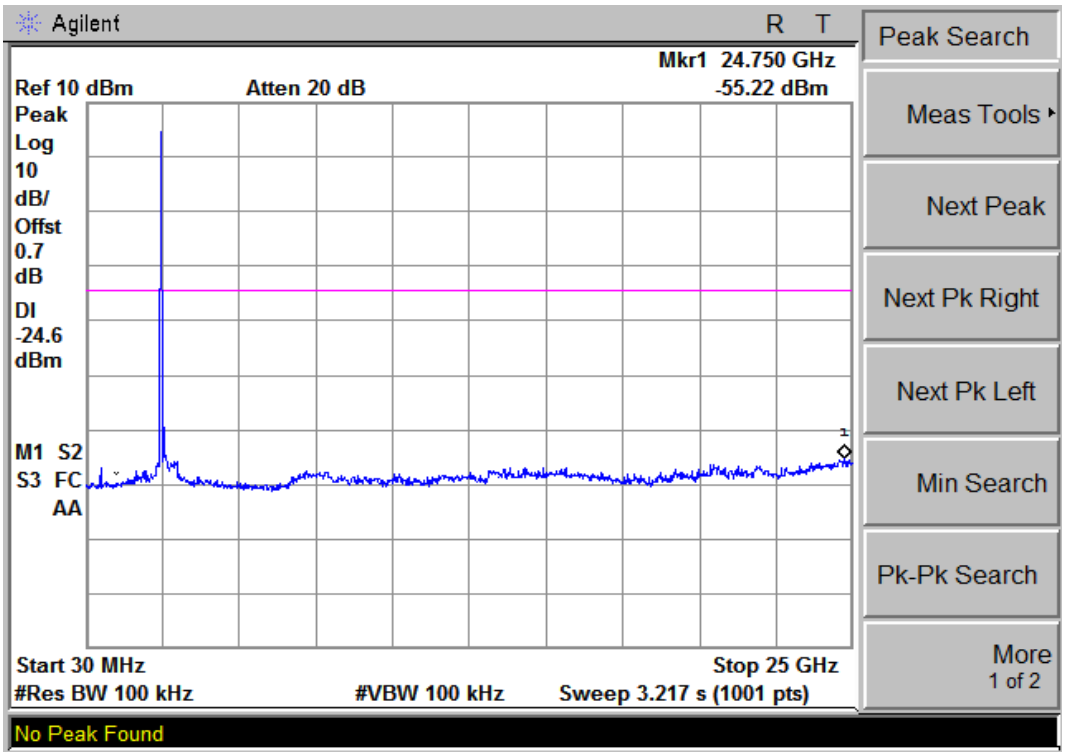
Channels	Frequency (MHz)	Result (dBc)	Limit (dBc)	Verdict
Low	2412	50 >	20	Pass
Mid	2437	50 >	20	Pass
High	2462	50 >	20	Pass



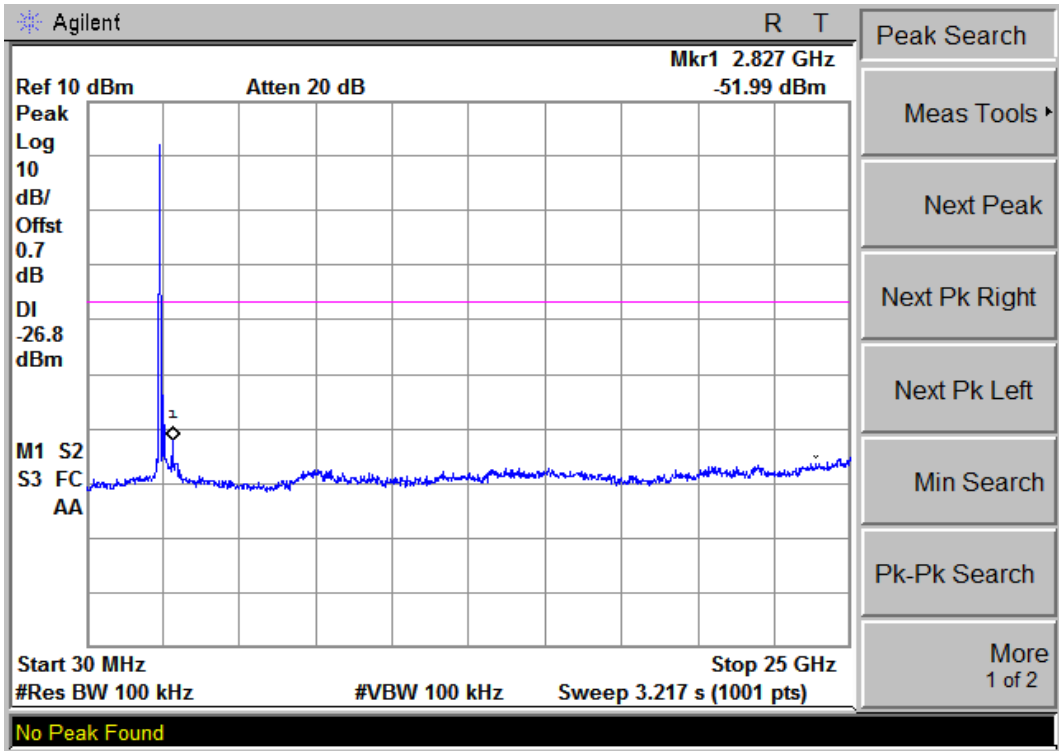
-802.11b CH1-



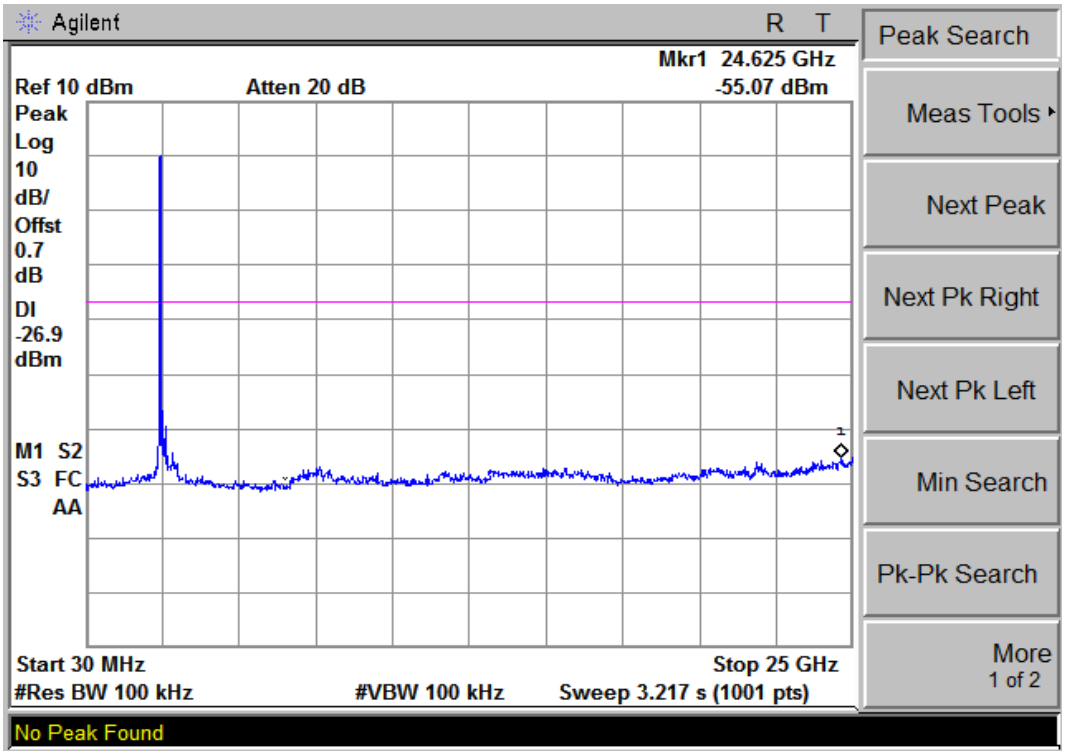
-802.11b CH6-



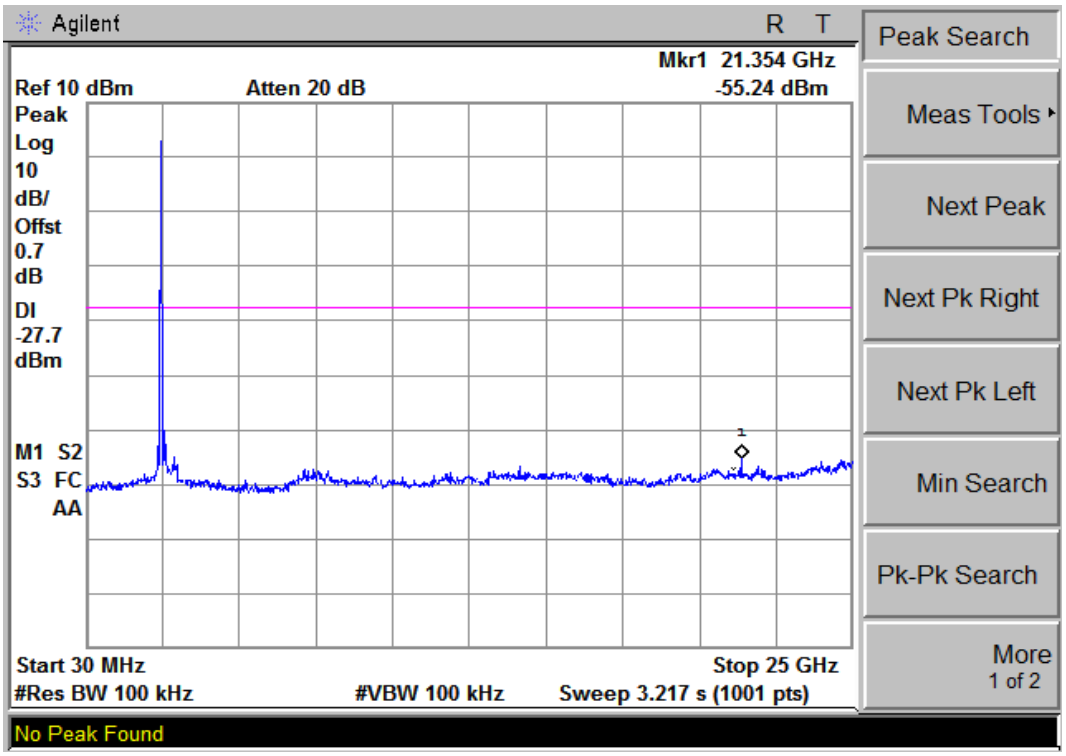
-802.11b CH11-



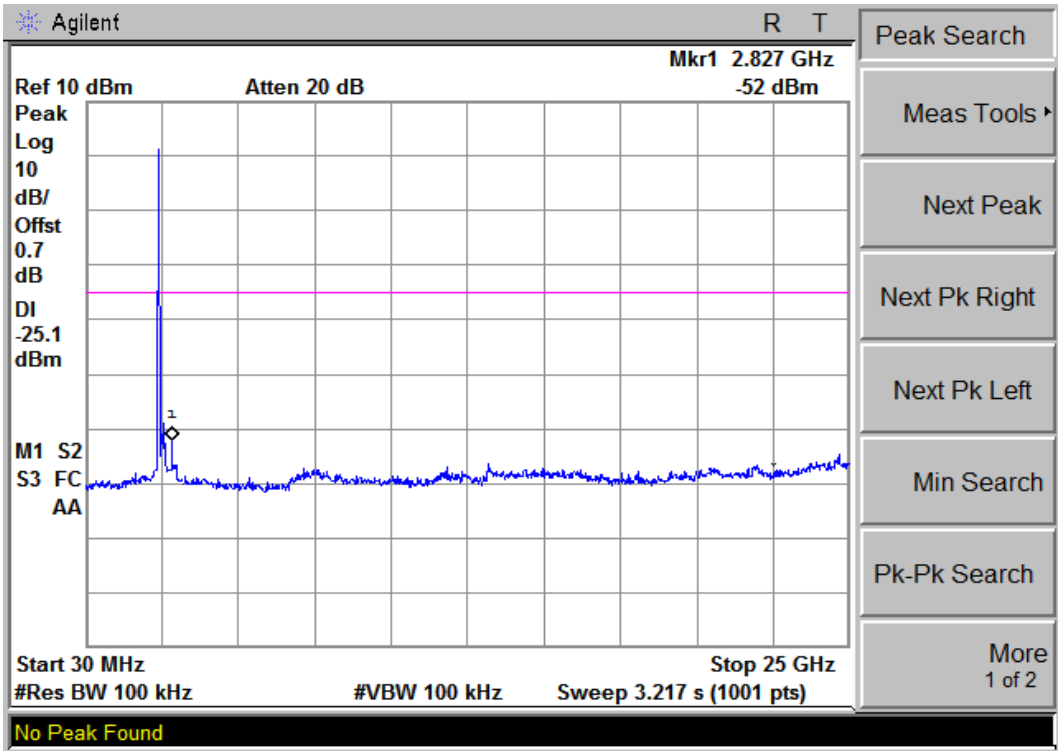
-802.11g CH1-



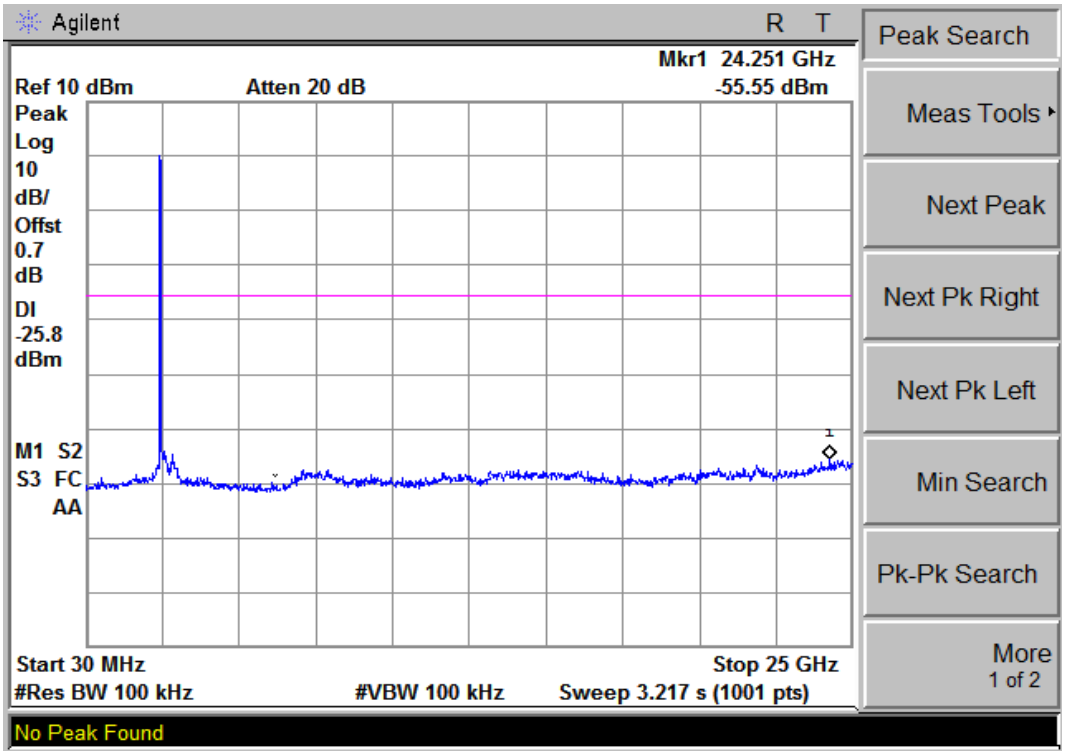
-802.11g CH6-



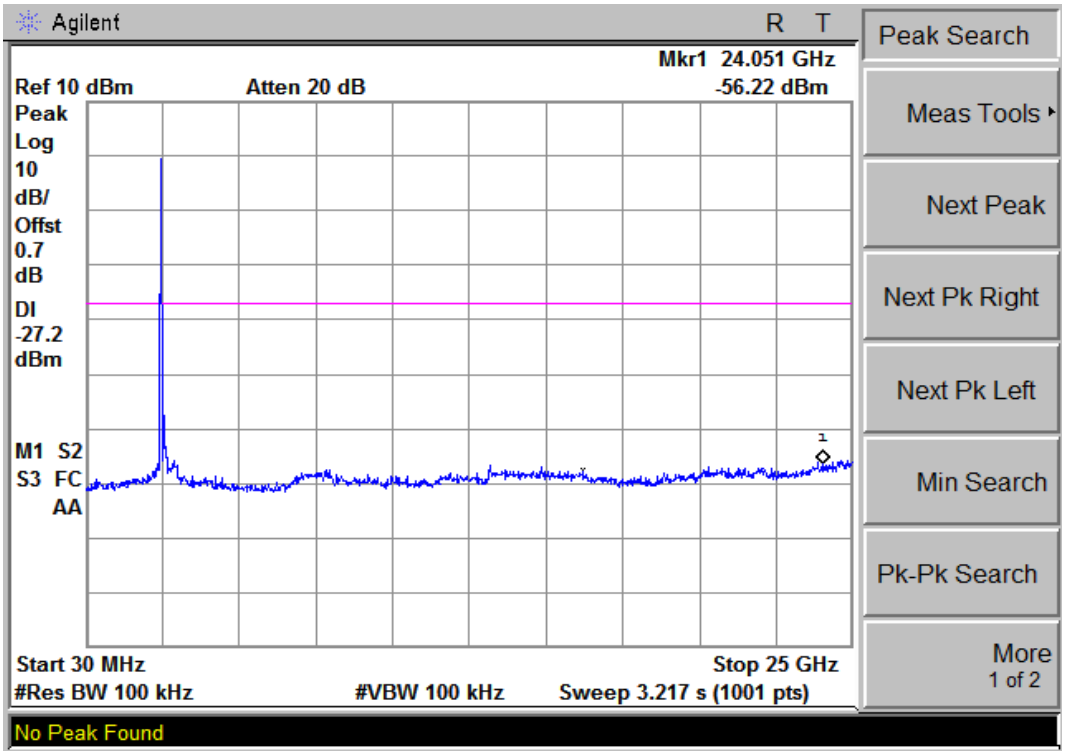
-802.11g CH11-



-802.11n CH1-



-802.11n CH6-


Agilent
R T
Mkr1 24.051 GHz
-56.22 dBm
Ref 10 dBm
Atten 20 dB
Peak
Log
10
dB/
Offst
0.7
dB
Dl
-27.2
dBm
M1 S2
S3 FC
AA
Start 30 MHz
#Res BW 100 kHz
#VBW 100 kHz
Stop 25 GHz
Sweep 3.217 s (1001 pts)
No Peak Found
Peak Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
More
1 of 2

-802.11n CH11-

5.7. Radiated Spurious Emissions

5.7.1. Test Procedure

5.7.1.1 Preliminary Testing for Reference

Preliminary testing was performed in a KTL absorber-lined room to determine the emission characteristics of the EUT. The EUT was placed on the wooden table which has dimensions of 0.8 meters in height, 1 meter in length and 1.5 meters in width. Receiving antenna (Biconi-Log antenna : 30 to 1000 MHz or Horn Antenna : 1 to 40 GHz) was placed at the distance of 3 meter from the EUT.

An attempt was made to maximize the emission level with the various configurations of the EUT. Emission levels from the EUT with various configurations were examined on a spectrum analyzer connected with a RF amplifier and graphed.
The emission was within the illumination area of the 3 dB beam width of the antenna so that the maximum emission from the EUT is measured.

5.7.1.2 Final Radiated Emission Test at an Absorber-Lined Room

The final measurement of radiated field strength was carried out in a KTL Absorber-Lined Room that was listed up at FCC according to the "Radiated Emissions Testing" procedure specified by ANSI C63.4.

Based on the test results in preliminary test, measurement was made in same test set up and configuration which produced maximum emission level. Receiving antenna was installed at 3-meter distance from the EUT, and was connected to an EMI receiver.

Turntable was rotated through 360 degrees and receiving antenna height was varied from 1 to 4 meters above the ground plane to read maximum emission level. Receiving antenna polarization was changed vertical and horizontal. The worst value was recorded.

If necessary, the radiated emission measurements could be performed at a closer distance than specified distance to ensure higher accuracy and their results were extrapolated to the specified distance using an inverse linear distance extrapolation factor (20 dB/decade) as per Section 15.31(f).

The maximum emission level from the EUT occurred in such configuration as shown in the following photograph.

Tested in x, y, z axis and worst case results are reported

The maximum frequency range measuring with the spectrum from 30 MHz to 40 GHz is investigated with the transmitter

5.7.2. Limits

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

[1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
[2] Above 38.6

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:
Frequency Field Strength Measurement Distance (MHz) (microvolts/meter) (meters)

Frequency (MHz)	Field Strength (microvolts/meter)	Distance (Meters)
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200**	3
above 960	500	3

** 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 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

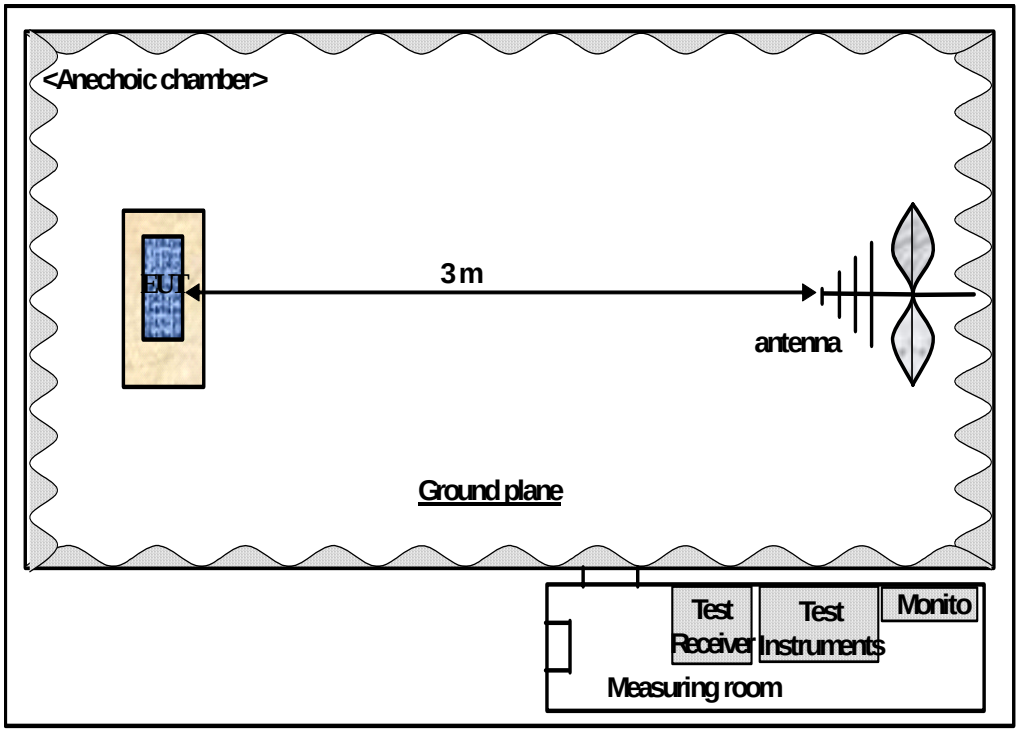
5.7.3. Sample Calculation

The emission level measured in decibels above one microvolt (dBμV) was following sample calculation.

For example ;

	Measured Value at 2388.00 MHz	37.71 dBμV
	Antenna Factor, Cable loss & Preamplifier	26.37 dB
=	Radiated Emission	64.08 dBμV/m

5.7.4. Measurement Configuration



5.7.5. Test Procedure Used

- ANSI C63.10 (2009)
-Method 12.2.4 in KDB 558074, issued 04/09/2013 (Peak)
-Method 12.2.5.3 in KDB 558074, issued 04/09/2013 (Average Case 2)
: Duty Cycle ≥ 98 % is considered for 802.11b/g/n mode Average measurements

The spectrum analyzer is set as below.

-Peak Measurement

a) RBW = 1 MHz

b) VBW ≥3 MHz

c) Detector = Peak

d) Sweep Time = Auto

e) Trace mode = Max hold

f) Allow sweeps to continue until the trace stabilizes.(Note that the required measurement time may be longer for low duty cycle applications).

-Average Measurement (Case 2)

If continuous transmission of the EUT (i.e., duty cycle ≥ 98 percent) cannot be achieved and the duty cycle is not constant (i.e., duty cycle variations exceed ± 2 percent), then the following procedure shall be used:

a) RBW = 1 MHz

b) VBW ≥ 1/T

c) Video bandwidth mode or display mode

1) The instrument shall be set to ensure that video filtering is applied in the power domain. Typically, this requires setting the detector mode to RMS and setting the Average-VBW Type to Power (RMS).

2) As an alternative, the instrument may be set to linear detector mode. Ensure that video filtering is applied in linear voltage domain (rather than in a log or dB domain). Some instruments require linear display mode in order to accomplish this. Others have a setting for Average-VBW Type, which can be set to “Voltage” regardless of the display mode.

d) Detector = Peak

e) Sweep Time = Auto

f) Trace mode = Max hold

g) Allow max hold to run for at least 50 times (1/duty cycle) traces.

Note: The actual setting value of VBW

Mode	Worst Data rate (Mbps)	T_{on} (ms)	T_{total} (ms)	Duty cycle (%)	VBW (1/T) (Hz)	Actual VBW setting
b	1	8.42	9.40	0.895	119	120
g	6	1.38	2.37	0.582	724	750
n	6.5	1.32	2.30	0.573	757	910

5.7.6. Restricted Band-edge Test Results (802.11b/g/n)

Test distance : 3m

Frequency (MHz)	Antenna Pol.	Reading level	Correction factor (dB)	Level Corrected (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark	Plane X/Y/Z
802.11b Lower side band-edge – 2412 MHz								
2375.33	H	38.32	26.37	64.69	74.0	9.31	Peak	X
2375.33	H	15.83	26.37	42.20	54.0	11.80	Average	X
802.11b Higher side band-edge – 2462 MHz								
2487.10	H	36.59	26.71	63.30	74.0	10.70	Peak	X
2487.10	H	17.53	26.71	44.24	54.0	9.76	Average	X
802.11g Lower side band-edge – 2412 MHz								
2389.87	H	35.63	26.37	62.00	74.0	12.00	Peak	X
2389.87	H	20.96	26.37	47.33	54.0	6.67	Average	X
802.11g Higher side band-edge – 2462 MHz								
2483.80	H	44.73	26.71	71.44	74.0	2.56	Peak	Y
2483.80	H	25.91	26.71	52.62	54.0	1.38	Average	Y
802.11n Lower side band-edge – 2412 MHz								
2389.73	H	42.57	26.37	65.22	74.0	8.78	Peak	Y
2389.73	H	26.42	26.62	50.03	54.0	3.97	Average	Y
802.11n Higher side band-edge – 2462 MHz								
2483.86	H	41.53	26.71	68.24	74.0	5.76	Peak	X
2483.86	H	26.13	26.71	52.84	54.0	1.16	Average	X

Level Corrected = Reading level + Correction factor (dB/m)
Correction factor = Antenna factor + Cable loss – Pre-amplifier (when using a pre-amplifier)

Note
1. Measurement was done over the Restricted Bands. The EUT was rotated and the antenna was changed to a range of height of from 1 m to 4 m above the ground plane for maximum response.
2. Pre-amplifier was used.
3. Test results include the rotation of the EUT through three orthogonal axes to determine the maximum emission.
4. If the peak measured values are lower than average limits, average measurements are not performed.

Remark
1. Noise floor of 30 ~ 1000 MHz : <20 dBuV at 3m distance
2. Noise floor of 1000 ~ 5000 MHz : <40 dBuV at 3m distance
3. Noise floor of 5000 ~ 25000 MHz : <50 dBuV at 3m distance

5.7.7. Spurious Emission Test Results

5.7.7.1 Spurious Radiated Emission (Worst case configuration, 30 MHz ~ 1 GHz)

Test mode: 802.11b/g/n

Frequency (MHz)	Antenna Pol.	Reading level [Quasi-Peak]	Correction factor (dB)	Level Corrected (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Plane X/Y/Z
-							
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-

Level Corrected = Reading level + Correction factor (dB/m)
Correction factor = Antenna factor + Cable loss – Pre-amplifier (when using a pre-amplifier)

Note 1. Measurement was done over the frequency range from 30 MHz to 1 GHz. The EUT was rotated and the antenna was changed to a range of height of from 1 m to 4 m above the ground plane for maximum response.
2. Testing is include the rotation of the EUT through three orthogonal axes to determine the maximum emission.
3. Any emission values 20dB lower than the limit are not recorded.

Remark 1. Noise floor of 30 ~ 1000 MHz : <20 dBuV at 3m distance
2. Noise floor of 1000 ~ 5000 MHz : <40 dBuV at 3m distance
3. Noise floor of 5000 ~ 25000 MHz : <45 dBuV at 3m distance

5.7.7.2 Spurious Radiated Emission (1 GHz ~ 25 GHz)

Test mode: 802.11b

Frequency (MHz)	Antenna Pol.	Reading level	Correction factor (dB)	Level Corrected (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark	Plane X/Y/Z
Lowest channel Ch. 1 (2412 MHz)								
4824	H	37.89	17.02	54.91	74.0	19.09	Peak	Y
4824	V	26.37	17.02	43.39	54.0	10.61	Average	Y
Middle channel Ch. 6 (2437 MHz)								
4874	H	40.14	15.74	55.88	74.0	18.12	Peak	Y
4874	V	30.47	15.74	46.21	54.0	7.79	Average	Y
Highest channel Ch. 11 (2462 MHz)								
4924	H	38.25	16.54	54.79	74.0	19.21	Peak	Y
4924	H	26.04	16.54	42.58	54.0	11.42	Average	Y

Level Corrected = Reading level + Correction factor (dB/m)
Correction factor = Antenna factor + Cable loss – Pre-amplifier (when using a pre-amplifier)

Note
1. Measurement was done over the frequency range from 1GHz to 10th harmonic. The EUT was rotated and the antenna was changed to a range of height of from 1 m to 4 m above the ground plane for maximum response.
2. Pre-amplifier was used in the range between 1 ~ 25 GHz.
3. Test results include the rotation of the EUT through three orthogonal axes to determine the maximum emission.
4. If the peak measured values are lower than average limits, average measurements are not performed.
5. Any emission values 20dB lower than the limit are not recorded.

Remark
1. Noise floor of 30 ~ 1000 MHz : <20 dBuV at 3m distance
2. Noise floor of 1000 ~ 5000 MHz : <40 dBuV at 3m distance
3. Noise floor of 5000 ~ 25000 MHz : <50 dBuV at 3m distance

Test mode: 802.11g

Frequency (MHz)	Antenna Pol.	Reading level	Correction factor (dB)	Level Corrected (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark	Plane X/Y/Z
Lowest channel Ch. 1 (2412 MHz)								
-	-	-	-	-	-	-	-	-
Middle channel Ch. 6 (2437 MHz)								
-	-	-	-	-	-	-	-	-
Highest channel Ch. 11 (2462 MHz)								
4924	H	35.03	16.54	51.57	74.0	22.43	Peak	Y

Level Corrected = Reading level + Correction factor (dB/m)
Correction factor = Antenna factor + Cable loss – Pre-amplifier (when using a pre-amplifier)

Note
1. Measurement was done over the frequency range from 1GHz to 10th harmonic. The EUT was rotated and the antenna was changed to a range of height of from 1 m to 4 m above the ground plane for maximum response.
2. Pre-amplifier was used in the range between 1 ~ 25 GHz.
3. Test results include the rotation of the EUT through three orthogonal axes to determine the maximum emission.
4. If the peak measured values are lower than average limits, average measurements are not performed.
5. Any emission values 20dB lower than the limit are not recorded.

Remark
1. Noise floor of 30 ~ 1000 MHz : <20 dBuV at 3m distance
2. Noise floor of 1000 ~ 5000 MHz : <40 dBuV at 3m distance
3. Noise floor of 5000 ~ 25000 MHz : <50 dBuV at 3m distance

Test mode: 802.11n

Frequency (MHz)	Antenna Pol.	Reading level	Correction factor (dB)	Level Corrected (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark	Plane X/Y/Z
Lowest channel Ch. 1 (2412 MHz)								
4824	H	38.44	17.02	55.46	74.0	18.54	Peak	Y
4824	V	27.47	17.02	44.49	54.0	9.51	Average	Y
Middle channel Ch. 6 (2437 MHz)								
-	-	-	-	-	-	-	-	-
Highest channel Ch. 11 (2462 MHz)								
-	-	-	-	-	-	-	-	-

Level Corrected = Reading level + Correction factor (dB/m)
Correction factor = Antenna factor + Cable loss – Pre-amplifier (when using a pre-amplifier)

Note
1. Measurement was done over the frequency range from 1GHz to 10th harmonic. The EUT was rotated and the antenna was changed to a range of height of from 1 m to 4 m above the ground plane for maximum response.
2. Pre-amplifier was used in the range between 1 ~ 25 GHz.
3. Test results include the rotation of the EUT through three orthogonal axes to determine the maximum emission.
4. If the peak measured values are lower than average limits, average measurements are not performed.
5. Any emission values 20dB lower than the limit are not recorded.

Remark
1. Noise floor of 30 ~ 1000 MHz : <20 dBuV at 3m distance
2. Noise floor of 1000 ~ 5000 MHz : <40 dBuV at 3m distance
3. Noise floor of 5000 ~ 25000 MHz : <50 dBuV at 3m distance

5.8. Receiver Radiated Spurious Emissions

5.8.1. Test Procedure

Same as 5.7.1 Test procedure

5.8.2. Limits

Same as 5.7.2 Limits

5.8.3. Receiver Spurious Emission Test Results

5.8.3.1 Receiver Radiated Spurious Emission (Worst case configuration, 30 MHz ~ 1 GHz)

Test mode: 802.11 b/g/n

Frequency (MHz)	Antenna Pol.	Reading level	Correction factor (dB)	Level Corrected (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark	Plane X/Y/Z
-	-	-	-	-	-	-	-	-

Level Corrected = Reading level + Correction factor (dB/m)
Correction factor = Antenna factor + Cable loss – Pre-amplifier (when using a pre-amplifier)

Note 1. Measurement was done over the frequency range from 30 MHz to 1 GHz. The EUT was rotated and the antenna was changed to a range of height of from 1 m to 4 m above the ground plane for maximum response.
2. Testing is include the rotation of the EUT through three orthogonal axes to determine the maximum emission.
3. Any emission values below more than 20dB are not recorded.

Remark 1. Noise floor of 30 ~ 1000 MHz : <20 dBuV at 3m distance
2. Noise floor of 1000 ~ 5000 MHz : <40 dBuV at 3m distance
3. Noise floor of 5000 ~ 25000 MHz : <45 dBuV at 3m distance

5.8.3.2 Receiver Radiated Spurious Emission (1 GHz ~ 25 GHz)

Test mode: 802.11 b/g/n

Frequency (MHz)	Antenna Pol.	Reading level	Correction factor (dB)	Level Corrected (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark	Plane X/Y/Z
-	-	-	-	-	-	-	-	-

Level Corrected = Reading level + Correction factor (dB/m)
Correction factor = Antenna factor + Cable loss – Pre-amplifier (when using a pre-amplifier)

Note
1. Measurement was done over the frequency range from 1GHz to 10th harmonic. The EUT was rotated and the antenna was changed to a range of height of from 1 m to 4 m above the ground plane for maximum response.
2. Pre-amplifier was used in the range between 1 ~ 25 GHz.
3. Test results include the rotation of the EUT through three orthogonal axes to determine the maximum emission.
4. If the peak measured values are lower than average limits, average measurements are not performed.
5. Any emission values below more than 20 dB are not recorded.

Remark
1. Noise floor of 30 ~ 1000 MHz : <20 dBuV at 3m distance
2. Noise floor of 1000 ~ 5000 MHz : <40 dBuV at 3m distance
3. Noise floor of 5000 ~ 25000 MHz : <50 dBuV at 3m distance

5.9. AC Conducted Emissions

5.9.1. Test Procedure

Conducted emission measurements on the EUT were performed by "AC Power Line Conducted Emissions Testing" procedure as per ANSI C63.4. The EUT was set up on a wooden table 0.8 meters height, 1.0 by 1.5 meters in size, placed in the shielded enclosed with a side of wall of which constituted a vertical conducting surface of 2.2 m x 3.1 m in size to maintain 40 cm from the rear of EUT

LISN(Line Impedance Stabilization Network, ROHDE & SCHWARZ, ESH3-Z5, 50 ohm / 50 μH) was installed and electrically boned to the conducting ground plane. The EUT was connected to the LISN using a typical power adapter.
One of two 50 ohm output terminals of the LISN was connected to the EMI Receiver (ROHDE & SCHWARZ, ESCI, 9 kHz to 3 GHz) and the other was terminated in 50 ohms. Measurements were again performed after interchanging such a connection oppositely.
The frequency range from 150 kHz to 30 MHz was examined and the remarkable frequencies were measured with Quasi-peak and Average values using the EMI receiver instrument (ROHDE & SCHWARZ, ESI, 9 kHz to 3 GHz ; Detector Function ; CISPR Quasi-Peak & Average). The 6 dB bandwidth of the Receiver was set to 9 kHz

The position of connecting cables of the EUT was changed to find the worst case configuration during measurements. The maximum emission level from the EUT occurred in such configuration as shown in the following photograph.

5.9.2. Limits

Except as shown in paragraphs (b) and (c) of this section, 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 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency (MHz)	Conducted Limits (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

- Decreases with the logarithm of the frequency.

5.9.3. Sample calculation

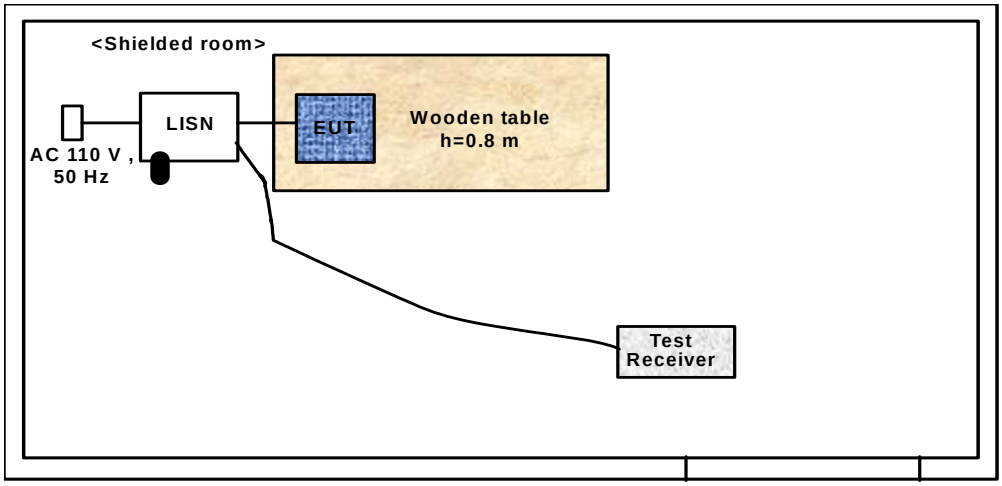
The emission level measured in decibels above one microvolt (dBμV) was converted into microvolt (μV) as shown in following sample calculation.

For example :

Measured Value at	0.1635 MHz	33.9 dBμV	@ Q-Peak mode
+ Correct factor *		9.9 dB	
= Conducted Emission		43.8 dBμV	

* Correct factor is adding RF cable loss and Attenuation

5.9.4. Photograph for the test configuration



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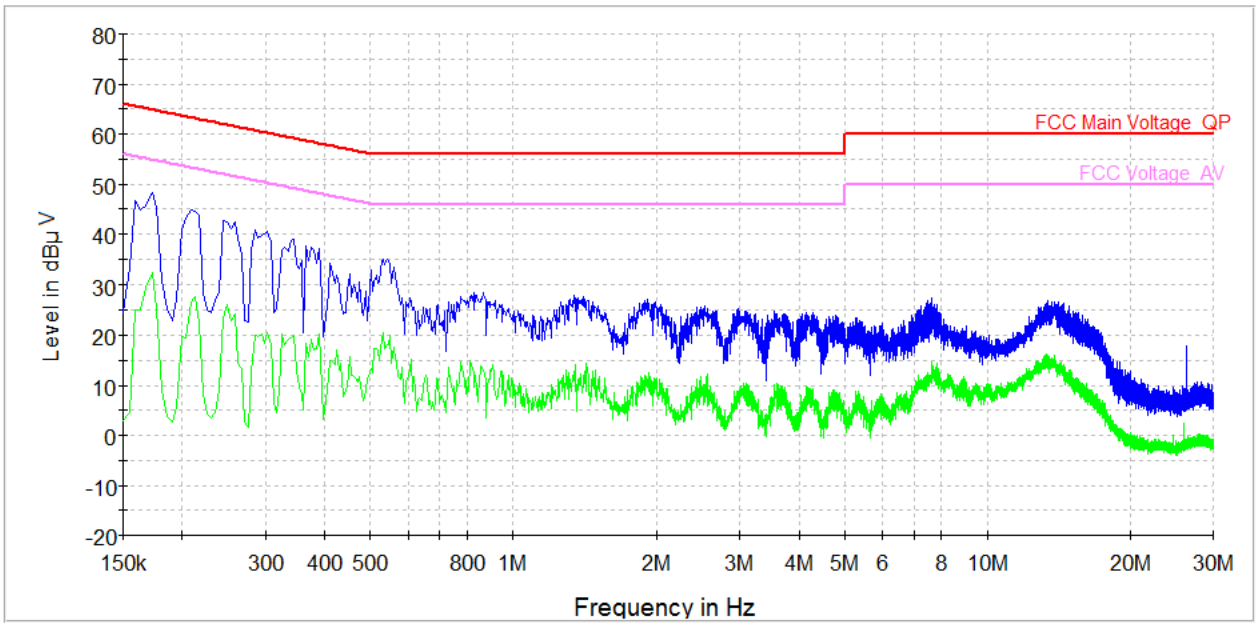
5.9.5. Test Results

<L1>



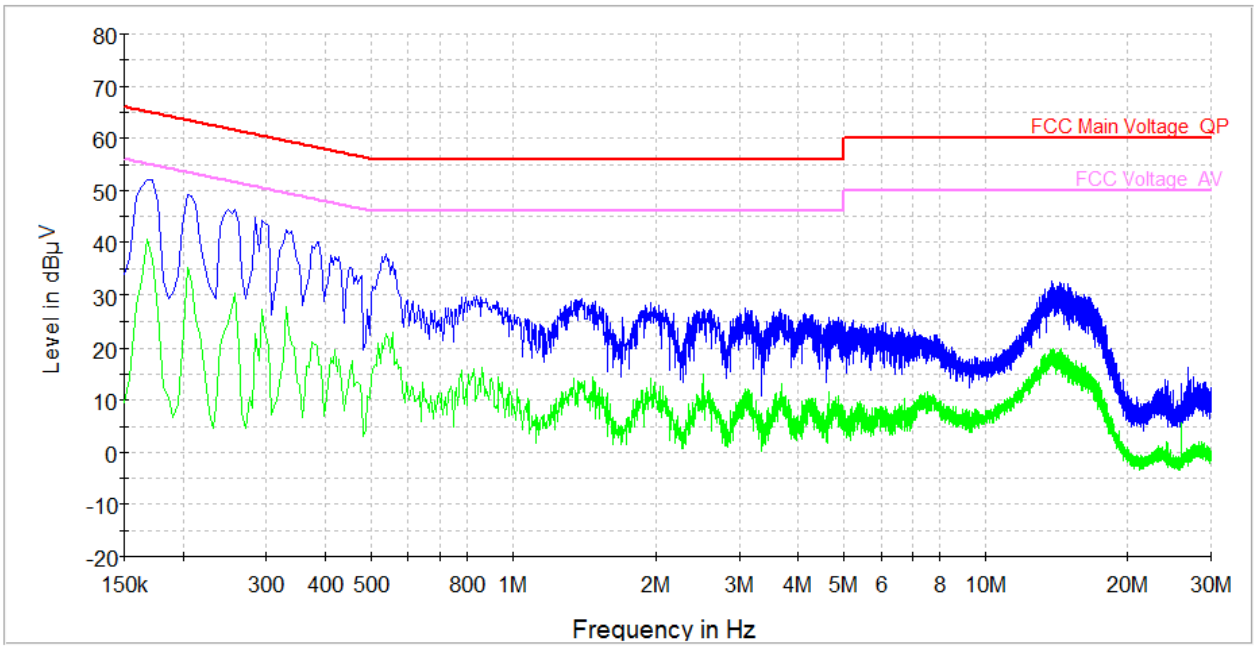
Final Result 1(L1-Quasi-Peak)

Frequency (MHz)	Quasi Peak (dBuV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)	Comment
0.172500	49.4	1000.0	9.000	L1	10.0	15.5	64.9	-
0.208500	47.3	1000.0	9.000	L1	9.9	15.9	63.2	-
0.532500	34.0	1000.0	9.000	L1	10.0	22.0	56.0	-
0.825000	25.8	1000.0	9.000	L1	9.9	30.2	56.0	-
7.615500	19.6	1000.0	9.000	L1	9.8	40.4	60.0	-
13.375500	21.3	1000.0	9.000	L1	9.9	38.7	60.0	-

Final Result 2(L1-Average)

Frequency (MHz)	Average (dBuV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)	Comment
0.172500	31.4	1000.0	9.000	L1	10.0	23.6	55.0	-
0.532500	20.4	1000.0	9.000	L1	10.0	33.1	53.5	-
0.775500	14.0	1000.0	9.000	L1	9.9	32.0	46.0	-
7.813500	12.6	1000.0	9.000	L1	9.8	37.4	50.0	-
13.285500	14.5	1000.0	9.000	L1	9.9	35.5	50.0	-

<N>



Final Result 1(N-Quasi-Peak)

Frequency (MHz)	Quasi Peak (dBuV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)	Comment
0.168000	50.2	1000.0	9.000	N	10.1	14.8	65.0	-
0.204000	47.2	1000.0	9.000	N	9.9	16.3	63.5	-
0.537000	34.9	1000.0	9.000	N	10.0	21.1	56.0	-
0.838500	26.2	1000.0	9.000	N	9.9	29.8	56.0	-
5.230500	19.5	1000.0	9.000	N	9.9	36.5	56.0	-
13.803000	27.0	1000.0	9.000	N	10.0	33.0	60.0	-

Final Result 2(N-Average)

Frequency (MHz)	Average (dBuV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)	Comment
0.168000	37.8	1000.0	9.000	N	10.1	17.2	55.0	-
0.204000	30.2	1000.0	9.000	N	9.9	23.3	53.5	-
0.555000	21.0	1000.0	9.000	N	10.0	25.0	46.0	-
0.861000	14.6	1000.0	9.000	N	9.9	31.4	46.0	-
7.440000	9.8	1000.0	9.000	N	9.9	40.2	50.0	-
13.870500	18.4	1000.0	9.000	N	10.0	31.6	50.0	-

6. TEST EQUIPMENTS

No.	Equipment	Manufacturer	Model	S/N	Calibration Due date
1	Spectrum Analyzer	Agilent	E4407B	US41443316	03-11-2015
2	Synthesized Sweeper	HP	83620A	3250A01653	03-03-2015
3	Digital RF Signal Generator	Agilent	E4438C	US41460859	02-18-2015
4	Signal Generator	R&S	SMIQ O3	DE22348	02-14-2015
5	PSA Series Spectrum Analyzer	Agilent	E4448A	US44300484	02-19-2015
6	DC Power Supply	Agilent	E4356A	MY41000296	02-11-2015
7	DC Power Supply	Agilent	E3645A	MY40000851	02-11-2015
8	AC Power Supply	Agilent	6811B	MY41000446	02-07-2015
9	Oscilloscope	Agilent	DSO6054A	MY44001104	01-22-2015
10	Directional Coupler	Agilent	87300C	MY44300126	03-04-2015
11	Directional Coupler	Agilent	773D	MY28390213	03-04-2015
12	VHF Attenuator	HP	355D	2522A45959	03-04-2015
13	Coaxial Attenuator	Weinschel	56-20	N8527	03-04-2015
14	Coaxial Attenuator	Agilent	8491B	50109	03-04-2015
15	Power Divider	HP	11636A	09084	03-07-2015
16	Power Spliter	HP	11667A	21063	03-04-2015
17	Temp/Humidity Chamber	ESPEC	SH-641	92007482	01-14-2015
18	Function/Arbitrary Waveform Generator	Agilent	33250A	MY40015758	04-24-2015
19	EMI Receiver	R&S	ESIB26	100280	03-12-2015
20	Pre-Amplifier	HP	83017A	MY39500982	02-19-2015
21	Pre-Amplifier	SONA INSTRUMENT	310	284609	01-08-2015
22	Biconi-Log Antenna	Schwarzbeck	VULB9168	9168-181	05-14-2015
24	Double Ridge Wave Guide	ETS-Lindgren	3115	9012-3595	10-21-2014
25	Double Ridge Wave Guide	ETS-Lindgren	3116	2664	10-15-2014