RF TEST REPORT

Test item	:	Wi-Fi Module
Model No.	:	TWFM-B005D
Order No.	:	DEMC1205-00579, DEMC1205-00580
Date of receipt	:	2012-05-08
Test duration	:	2012-06-12 ~ 2012-06-29
Date of issue	:	2012-07-12
Use of report	:	Class II Permissive Change

Applicant : LG Innotek Co., Ltd.
#978-1, Jangduk-dong, Gwangsan-gu, Gwangju, 506-731, Korea

Test laboratory : Digital EMC Co., Ltd.
683-3, Yubang-Dong, Cheoin-Gu, Yongin-Si, Kyunggi-Do, 449-080, Korea

Test specification	:	FCC Part 15.407 Subpart E & RSS-210 Issue 8 ANSI C63.4-2003, KDB 789033
Test environment	:	See appended test report
Test result	:	☒ Pass ☐ Fail

Tested by:	Witnessed by:	Reviewed by:
Engineer J.J.LEE	N/A	Technical Director Harvey sung

CONTENTS

1. EUT information

1.1 EUT description

FCC Equipment Class	Unlicensed National Information Infrastructure (UNII)
Product	Wi-Fi Module
Model Name	TWFM-B005D
Add Model Name	TWFM-B015D, TWFM-B025D
Equipment serial no.	Identical prototype
Frequency Range	802.11a/n(20MHz) : 5180 ~ 5240MHz 802.11n(40MHz) : 5190 ~ 5230 MHz
Channel number	802.11a/n(20MHz): 4 802.11n(40MHz): 2
Modulation type	802.11a/n : OFDM
Data rate	802.11a/g: 6, 9, 12, 18, 24, 36, 48, 54 Mbps 802.11n(20MHz): 6.5, 13, 19.5, 26, 39, 52, 58.5, 65 Mbps 802.11n(40MHz): 13.5, 27, 40.5, 54, 81, 108, 121.5, 135 Mbps
Antenna Specification	PIFA Antenna (2TX 2RX) 5.1GHz Band Max. peak gain Chain 0 : 3.32dBi, Chain 1 : 4.14dBi
Power Supply	DC 5.0 V

1.2 Ancillary equipment

Equipment	Model No.	Serial No.	Manufacturer	Note
-	-	-	-	-
-	-	-	-	-

2. Information about test items

2.1 Test mode

Band	Mode	Single Transmitting		Multiple Transmitting (2 TX / 2 RX)
		Chain 0	Chain 1	
5GHz	802.11a	6Mbps	6Mbps	N/A
	802.11n(20MHz)	N/A	N/A	6.5Mbps
	802.11n(40MHz)	N/A	N/A	13.5Mbps

For all test items, the low, middle and high channels of the modes were tested respectively by choosing the highest RF out power chain and transmission rate from preliminary testing.

2.2 Auxiliary equipment

Equipment	Model No.	Serial No.	Manufacturer	Note
Notebook	X51RL	85N0AS318314227	ASUSTeK Computer Inc.	-
-	-	-	-	-
-	-	-	-	-

2.3 Frequency / Channel Operations

▪ **Frequency / Channel information**

Band	Mode	Channel No.	Freq. [MHz]	Channel No.	Freq. [MHz]	Channel No.	Freq. [MHz]
5GHz	802.11a/n(20MHz)	36	5180	44	5220	-	-
		40	5200	48	5240	-	-
	802.11n(40MHz)	38	5190	46	5230	-	-

▪ **Supported Antenna Configuration**

Band	Mode	Single Transmitting		Multiple Transmitting (2 TX / 2 RX)
		Chain 0	Chain 1	
5GHz	802.11a	Yes	Yes	No
	802.11n(20MHz)	No	No	Yes
	802.11n(40MHz)	No	No	Yes

2.4 Tested environment

Temperature	:	22 ~ 25 °C
Relative humidity content	:	35 ~ 45 % R.H.
Details of power supply	:	DC 5.0 V

2.5 EMI Suppression Device(s)/Modifications

EMI suppression device(s) added and/or modifications made during testing
→ None

3. Test Report

3.1 Summary of tests

FCC Part Section(s)	RSS Section(s)	Parameter	Limit	Test Condition	Status Note 1
I. Transmitter Mode (TX)					
15.407(a)	N/A	26 dB Bandwidth for FCC	N/A	Conducted	C
15.407(a)	RSS-210 [A9.2]	Maximum Conducted Output Power	< 4 + 10log$_{10}$(B) dBm (5150-5250) < 11 + 10log$_{10}$(B) dBm (5250-5350) < 11 + 10log$_{10}$(B) dBm (5470-5725)		C
15.407(a)	RSS-210 [A9.2]	Peak Power Spectral Density	< 4 dBm/MHz (5150-5250) < 11 dBm/MHz (5250-5350) < 11 dBm/MHz (5470-5725)		NT Note.2
15.407(a)	N/A	Peak Excursion	< 13 dB/MHz maximum difference		NT Note.2
15.407(g)	N/A	Frequency Stability	N/A		NT Note.2
-	RSS Gen [4.6.1]	Occupied Bandwidth (99%)	N/A		NT Note.2
15.407(b)	RSS-210 [A9.2]	Undesirable Emissions	< -27 dBm/MHz EIRP (5150-5725)	Radiated	C Note.3
15.205 15.209 15.407(b)	RSS-Gen [7.2.5]	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209		C Note.3
15.207	RSS-Gen [7.2.4]	AC Conducted Emissions	FCC 15.207	AC Line Conducted	C
15.203	RSS-Gen [7.1.2]	Antenna Requirements	FCC 15.203	-	C

Note 1: **C**=Comply **NC**=Not Comply **NT**=Not Tested **NA**=Not Applicable

Note 2: According to the manufacturer's declaration, these items were not tested since changes shall not affect to these test items. Please refer to manufacturer's declaration letter for detail changes.

Note 3: These test items were performed in each axis and the worst case data was reported.

3.2 Transmitter requirements

3.2.1 26 dB Bandwidth

Test Requirements

The bandwidth at 26 dB down from the highest in-band 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 26dB bandwidth is used to determine the conducted output power limit.

▣ TEST CONFIGURATION

Refer to the APPENDIX I.

▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer and used following test procedure of **KDB789033**.

1. Set resolution bandwidth (RBW) = approximately **1 %** of the EBW
2. Set the video bandwidth **(VBW) > RBW**.
3. Detector = **Peak**.
4. Trace mode = **max hold**.
   Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

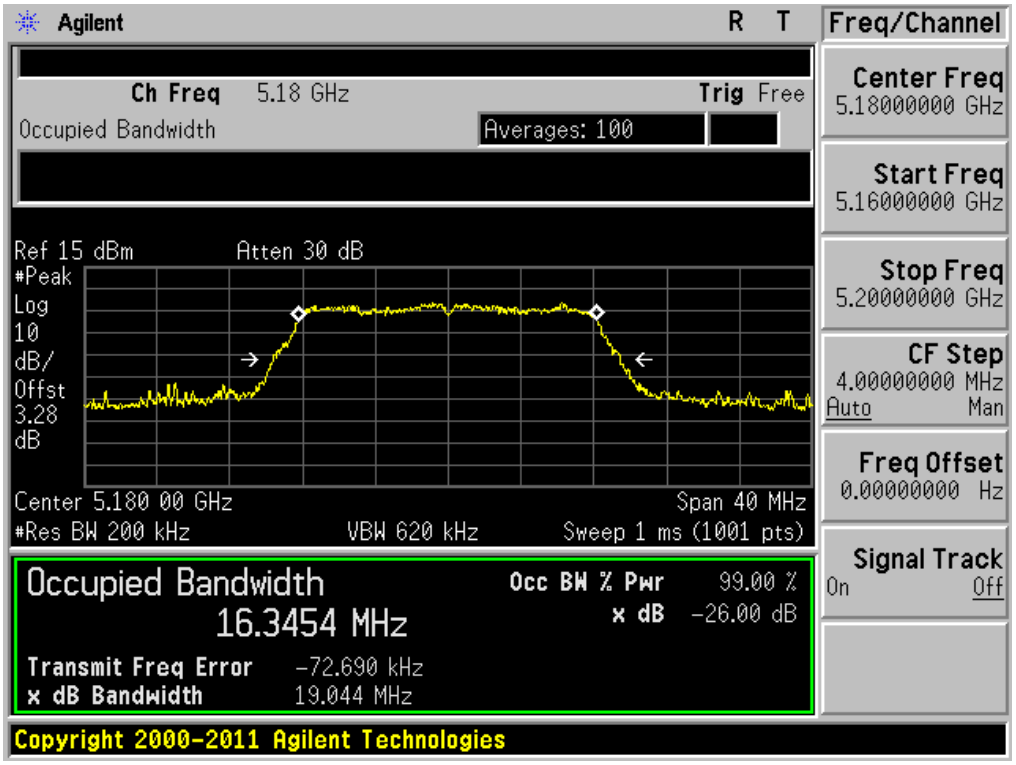
▣ TEST RESULTS: Comply

Mode	Channel	Frequency [MHz]	Test Result [MHz]	
			Chain 0	Chain 1
802.11a	36	5180	19.044	19.037
	40	5200	19.035	19.131
	48	5240	18.942	18.954
802.11n (20MHz)	36	5180	19.153	19.216
	40	5200	19.231	19.275
	48	5240	19.129	19.269
802.11n (40MHz)	38	5190	38.767	39.211
	46	5230	39.103	39.082

▣ RESULT PLOTS

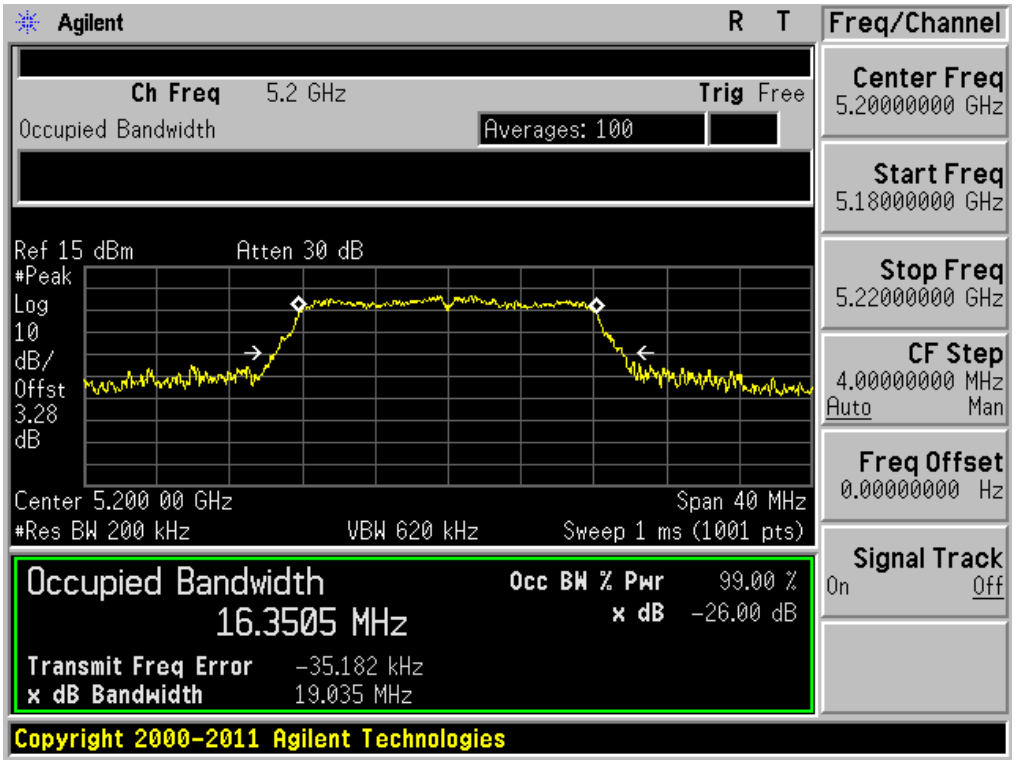
26 dB Bandwidth

Test Mode: 802.11a & Ch.36 & Chain 0

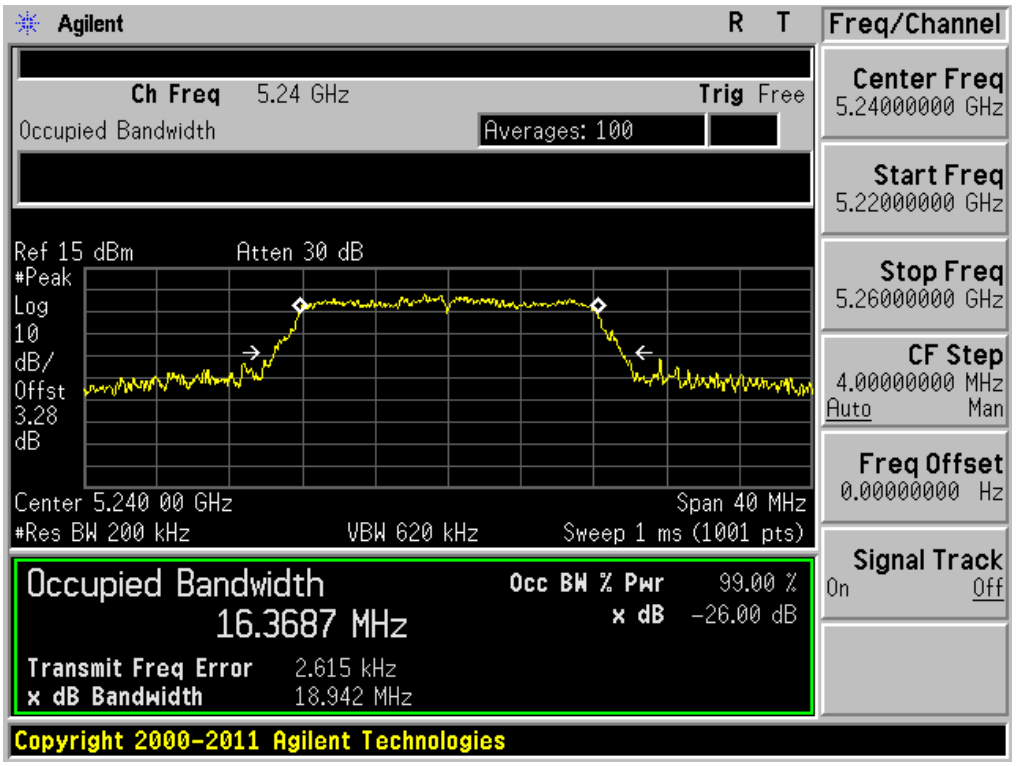


26 dB Bandwidth

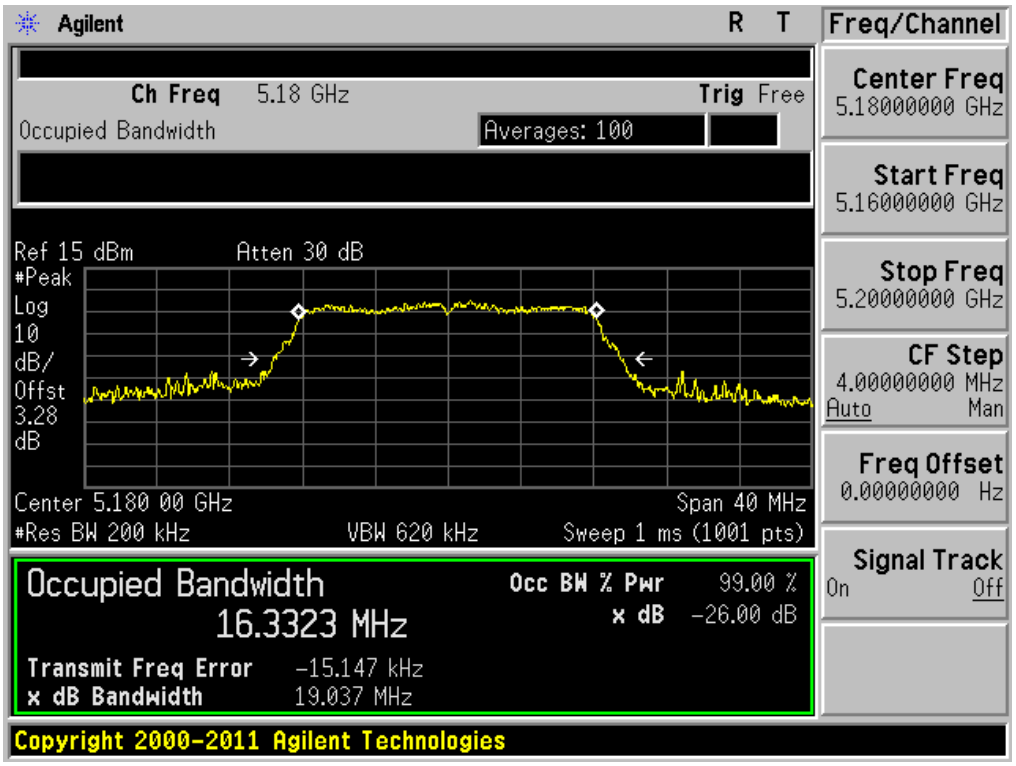
Test Mode: 802.11a & Ch.40 & Chain 0



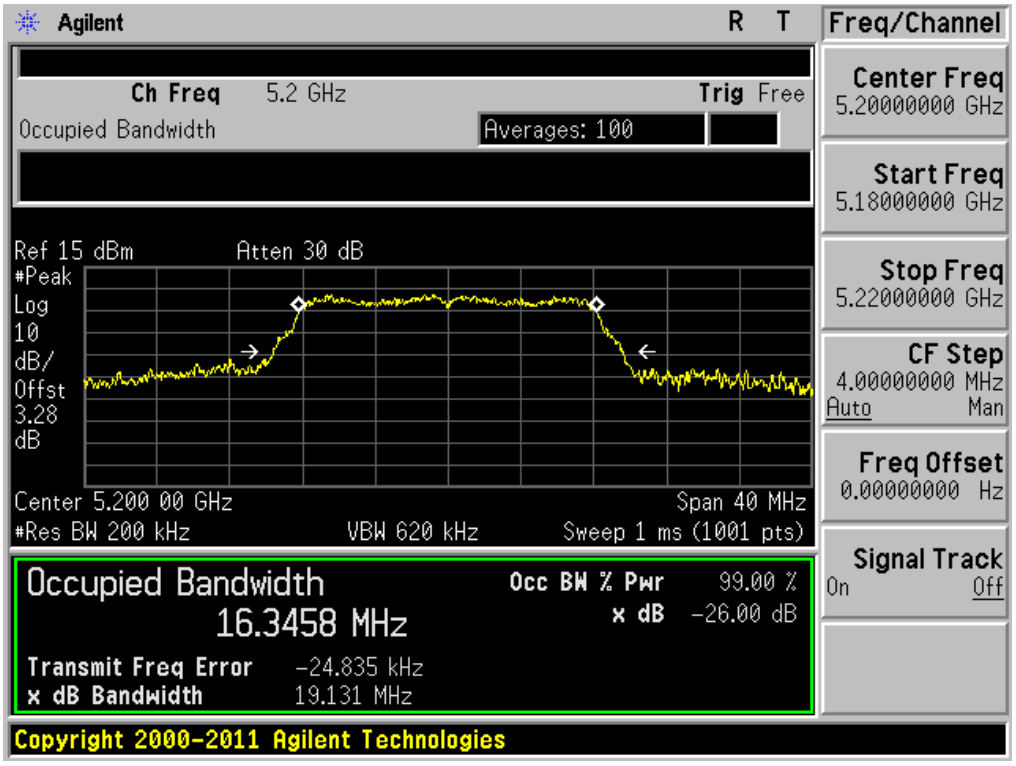
26 dB Bandwidth Test Mode: 802.11a & Ch.48 & Chain 0



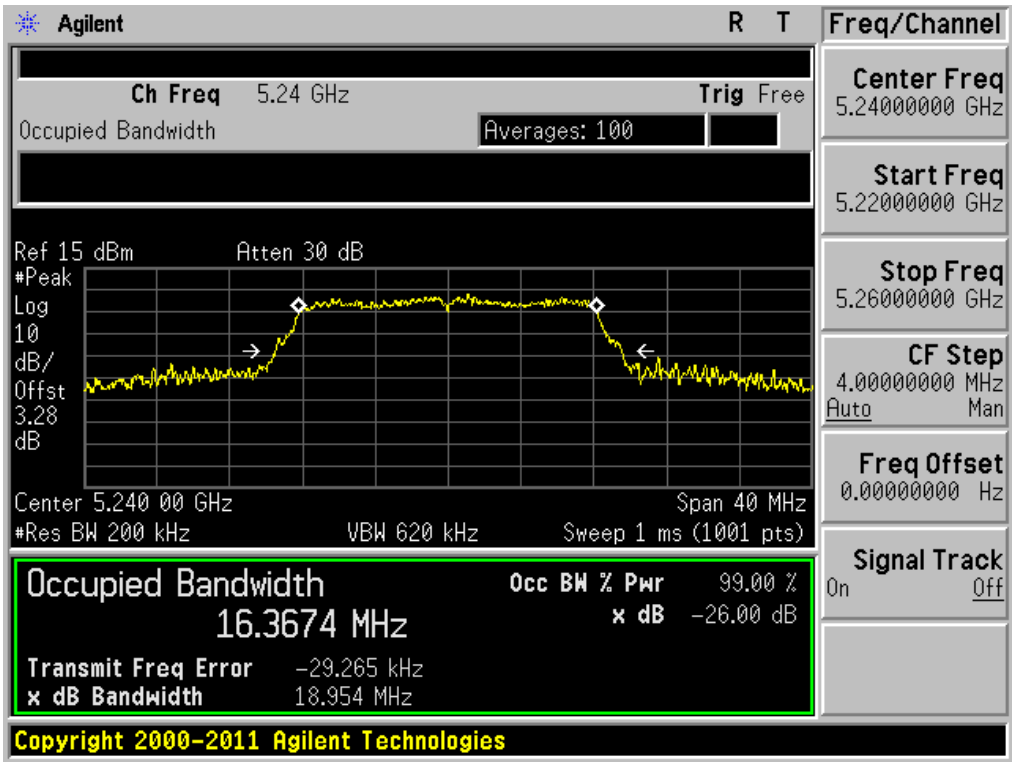
26 dB Bandwidth Test Mode: 802.11a & Ch.36 & Chain 1



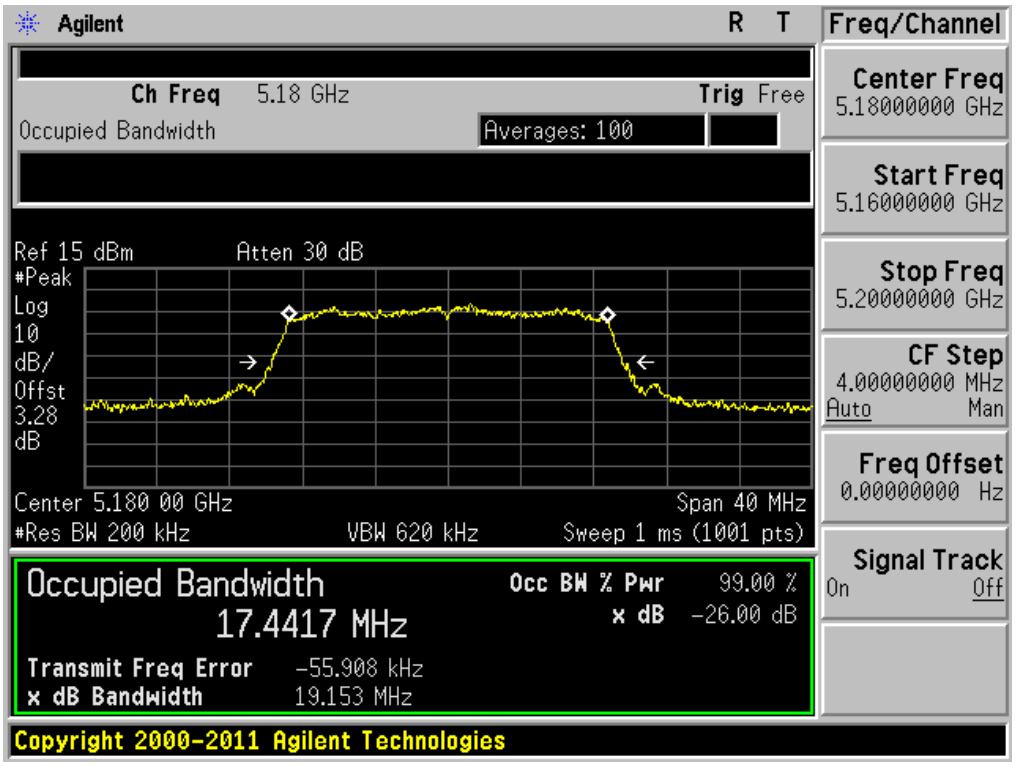
26 dB Bandwidth Test Mode: 802.11a & Ch.40 & Chain 1



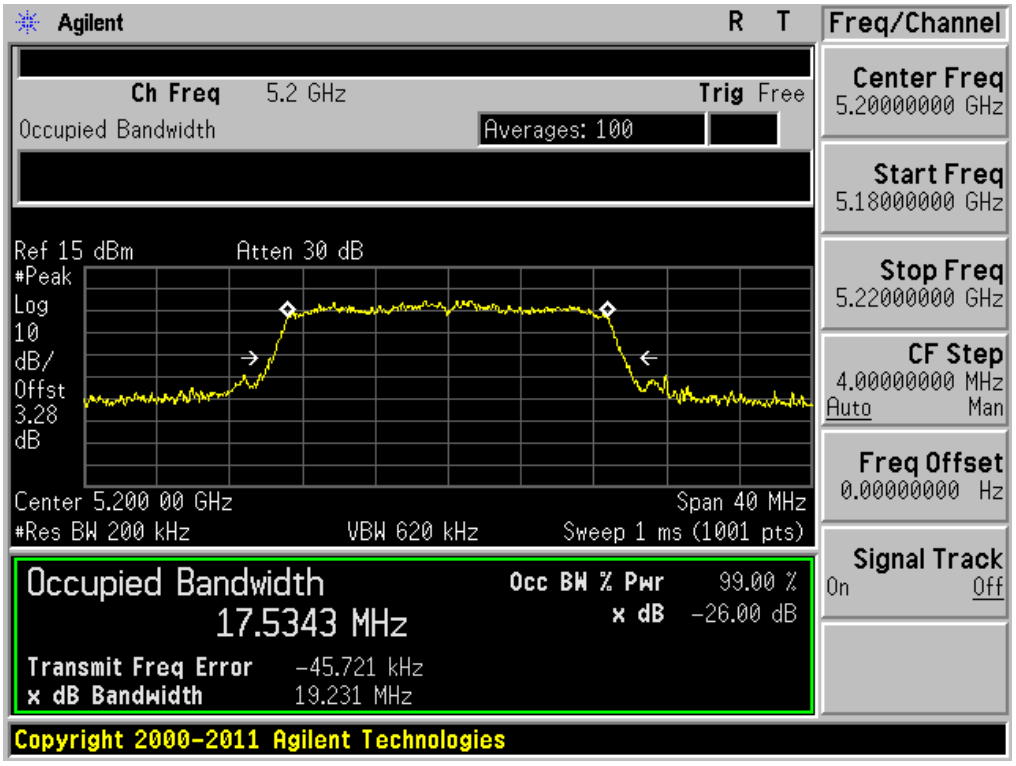
26 dB Bandwidth Test Mode: 802.11a & Ch.48 & Chain 1



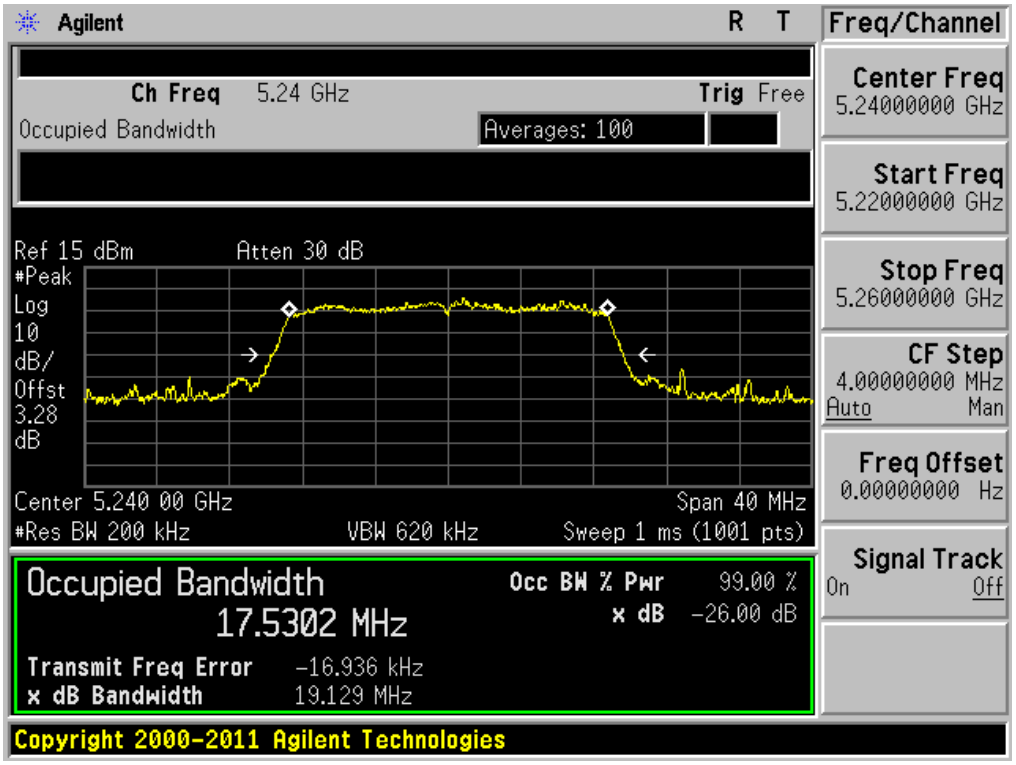
26 dB Bandwidth Test Mode: 802.11n-HT20 & Ch.36 & Chain 0



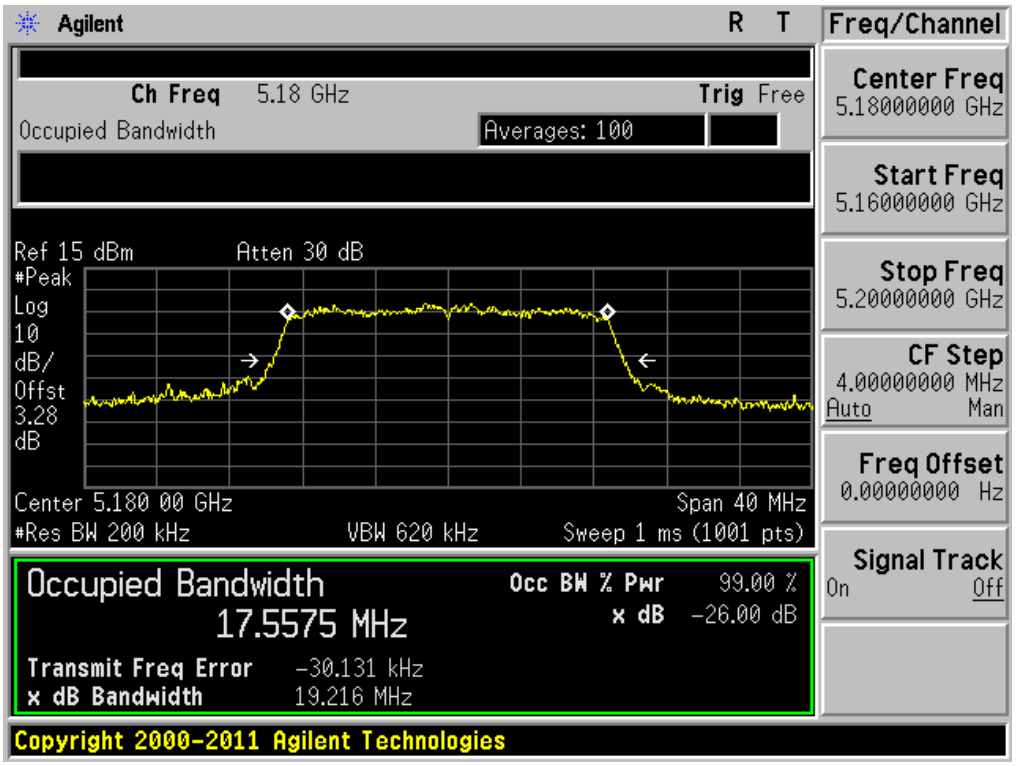
26 dB Bandwidth Test Mode: 802.11n-HT20 & Ch.40 & Chain 0



26 dB Bandwidth Test Mode: 802.11n-HT20 & Ch.48 & Chain 0



26 dB Bandwidth Test Mode: 802.11n-HT20 & Ch.36 & Chain 1



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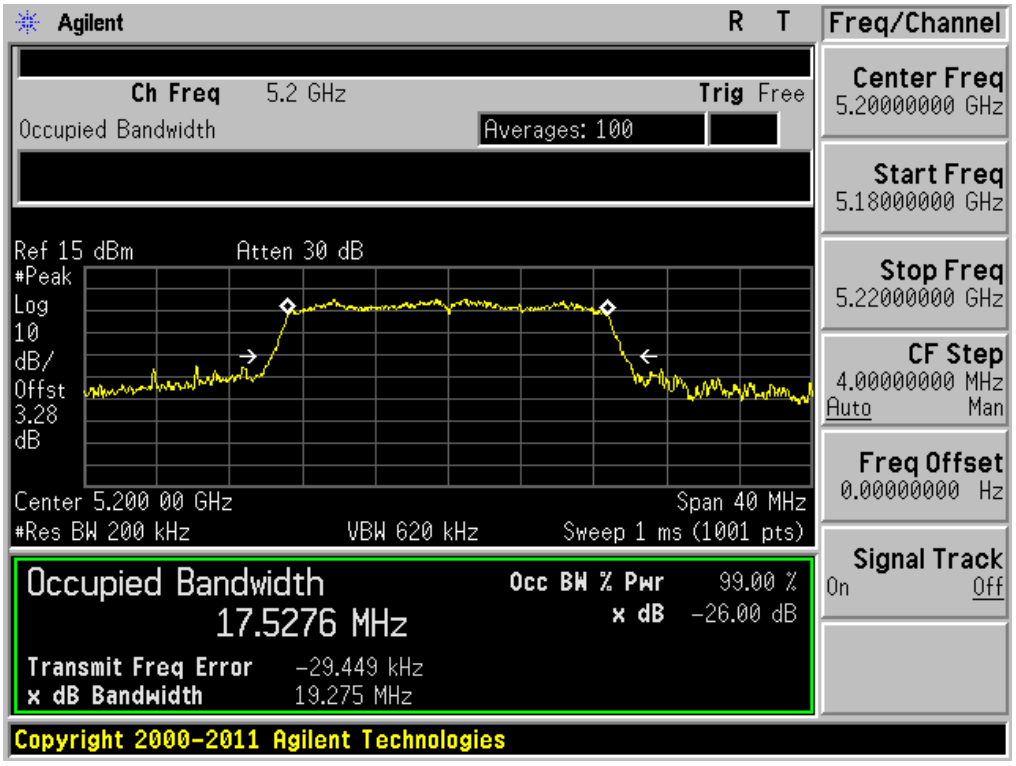
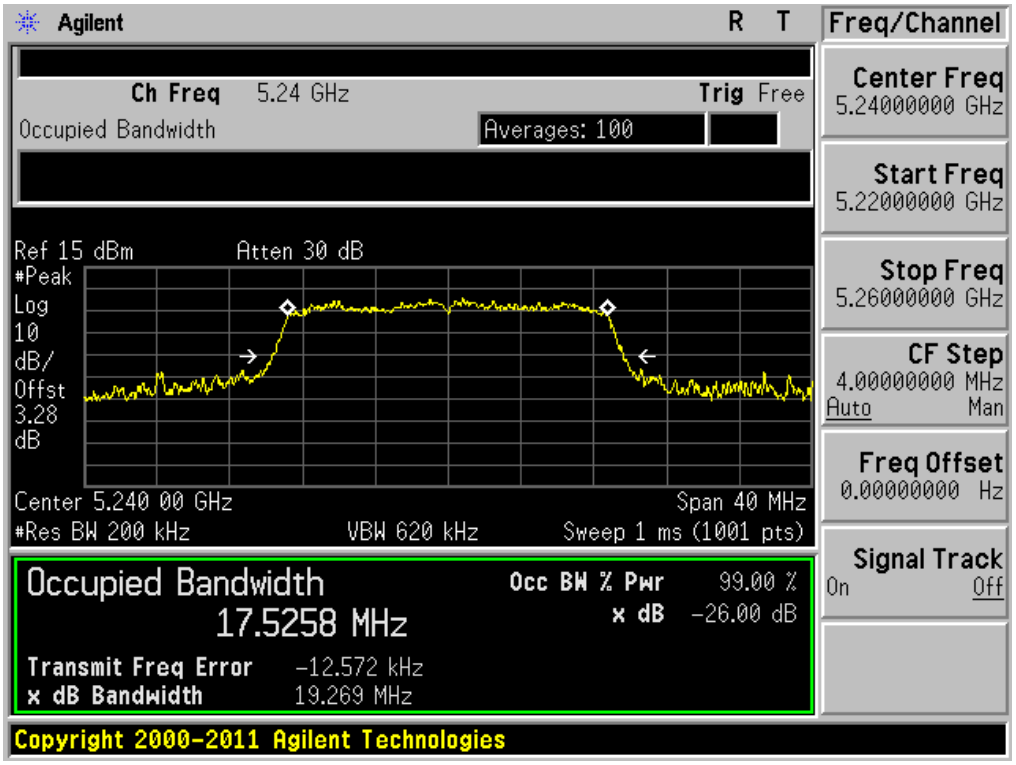
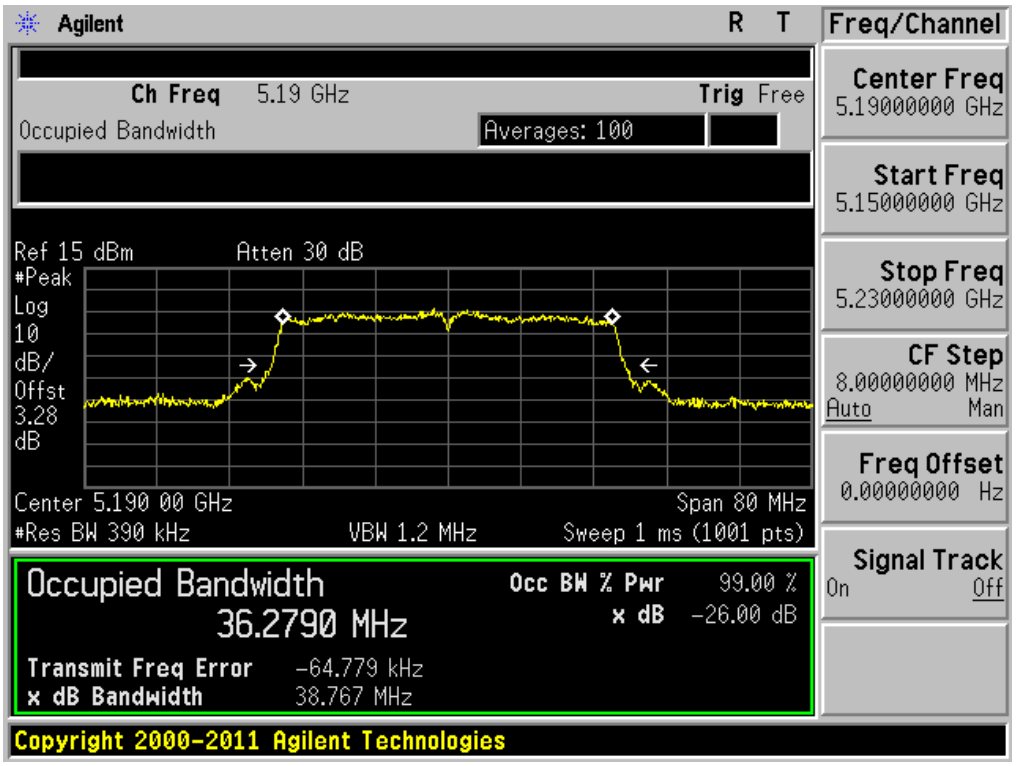


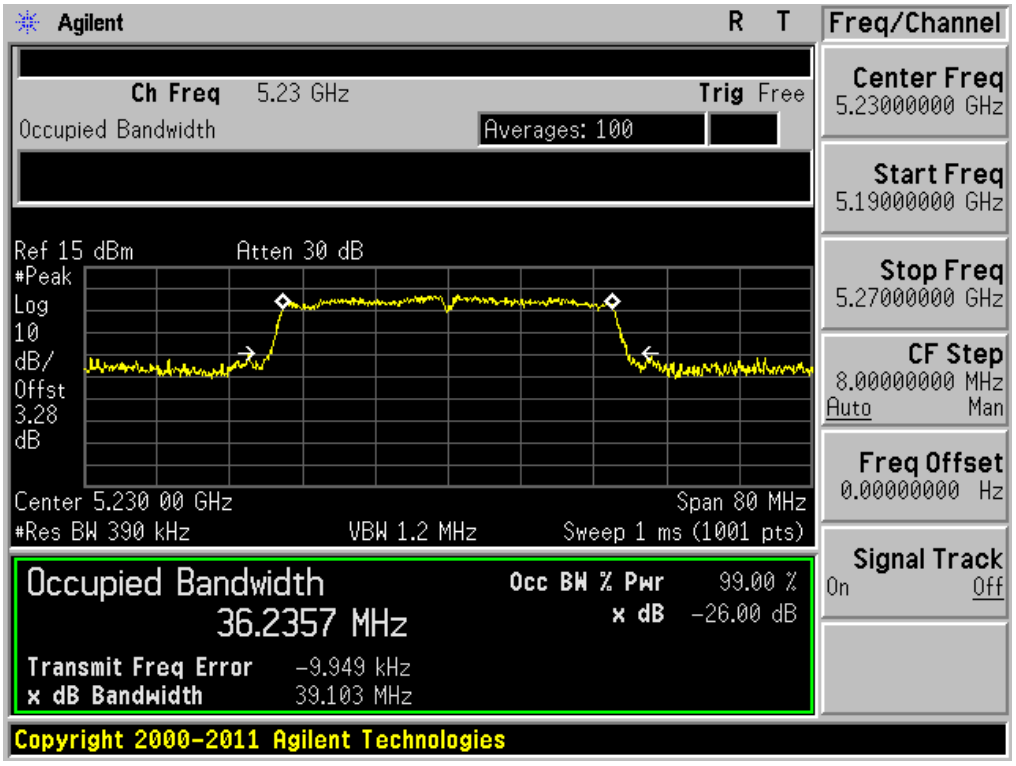
26 dB Bandwidth Test Mode: 802.11n-HT20 & Ch.48 & Chain 1



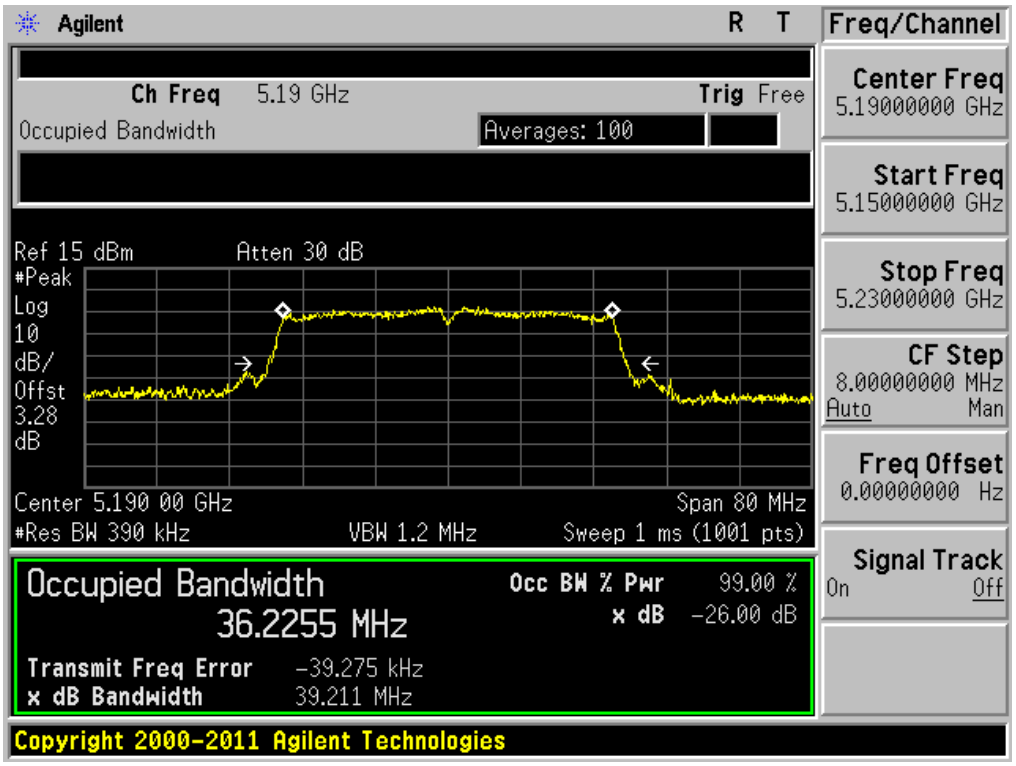
26 dB Bandwidth Test Mode: 802.11n-HT40 & Ch.38 & Chain 0



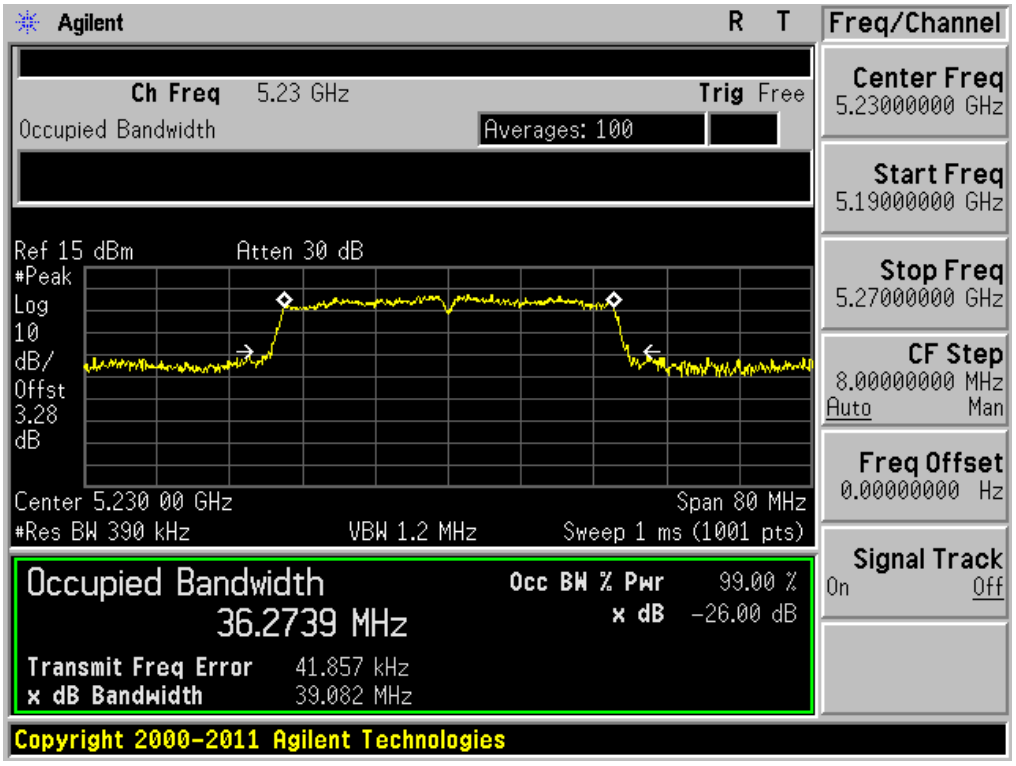
26 dB Bandwidth Test Mode: 802.11n-HT40 & Ch.46 & Chain 0



26 dB Bandwidth Test Mode: 802.11n-HT40 & Ch.38 & Chain 1



26 dB Bandwidth Test Mode: 802.11n-HT40 & Ch.46 & Chain 1



3.2.2 Output Power

Test Requirements

(1) For the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 50 mW or 4 dBm + 10log B, where B is the 26 dB emission bandwidth in MHz. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(2) For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10log B, where B is the 26 dB emission bandwidth in megahertz. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

- Output power Limit Calculation

Bands [GHz]	Mode	Power Limit [mW] / Least 26dBC BW [MHz]	Calculation Limit [dBm]	ANT Gain Note1			Determined Limit[dBm]
				ANT0 [dBi]	ANT1 [dBi]	MIMO Directional Gain[dBi]	
5.15 ~ 5.25	802.11a	50	16.99	3.32	4.14	Non MIMO	16.77
		18.942	16.77			Non MIMO	
	802.11n HT20	50	16.99			6.75	16.07
		19.129	16.82			6.75	
	802.11n HT40	50	16.99			6.75	16.24
		38.767	19.88			6.75	

Note 1 : Using Correlated Directional Gain = 10 log[$(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2$ /N] dBi
Note 2 : Using Uncorrelated Directional Gain = 10 log[$(10^{G1/10} + 10^{G2/10} + \ldots + 10^{GN/10})$/N] dBi

▣ TEST CONFIGURATION

Refer to the APPENDIX I.

▣ TEST PROCEDURE (Case 1) :

Reference purpose only for comparing output powers with original certified equipment.

The test is performed in accordance with FCC Public Notice: APPENDIX A Guidelines for assessing Unlicensed National Information Infrastructure (U-NII) Devices – Part 15, Subpar E, August 2002.

▣ **TEST RESULTS : Comply**

-Changed Device

Mode	Channel	Frequency [MHz]	Test Result			
			Chain 0		Chain 1	
			[dBm]	[W]	[dBm]	[W]
802.11a	36	5180	6.46	0.004	7.92	0.006
	40	5200	9.47	0.009	**10.49**	**0.011**
	48	5240	10.26	0.011	10.05	0.010

Mode	Channel	Frequency [MHz]	Test Result			
			Chain 0 [dBm]	Chain 1 [dBm]	Aggregate Power[Note1]	
					[dBm]	[W]
802.11n HT20	36	5180	5.60	6.94	9.33	0.009
	40	5200	7.56	8.34	10.98	0.013
	48	5240	8.36	7.81	**11.10**	**0.013**
802.11n HT40	38	5190	3.86	4.89	7.42	0.006
	46	5230	10.34	10.28	**13.32**	**0.021**

Note 1: Aggregate power = $10\log(10^{(\frac{\text{chain }0}{10})} + 10^{(\frac{\text{chain }1}{10})})$

-Original Device

Mode	Channel	Frequency [MHz]	Test Result			
			Chain 0		Chain 1	
			[dBm]	[W]	[dBm]	[W]
802.11a	36	5180	7.90	0.006	8.45	0.007
	40	5200	11.28	0.013	11.33	0.014
	48	5240	11.91	0.016	**12.08**	**0.016**

Mode	Channel	Frequency [MHz]	Test Result			
			Chain 0 [dBm]	Chain 1 [dBm]	Aggregate Power[Note1]	
					[dBm]	[W]
802.11n HT20	36	5180	6.54	7.17	9.88	0.010
	40	5200	9.00	9.43	12.23	0.017
	48	5240	9.84	10.15	**13.01**	**0.019**
802.11n HT40	38	5190	5.04	5.34	8.20	0.007
	46	5230	11.84	12.10	**14.98**	**0.031**

Note 1: Aggregate power = $10\log(10^{(\frac{\text{chain }0}{10})} + 10^{(\frac{\text{chain }1}{10})})$

▣ **TEST PROCEDURE (Case 2):**

Maximum Conducted Output Power is measured using Measurement Procedure **Method SA-2 of KDB789033**

1. Set the **RBW = 1 MHz**.
2. Set the **VBW ≥ 3 MHz**.
3. Set **SPAN to encompass the entire EBW** of signal.
4. Detector = **RMS (power averaging)**
5. Sweep time = **auto couple**.
6. **Trace average at least 100 traces in power averaging**.
7. **Compute power by integrating the spectrum across the 26 dB EBW** of the signal using the spectrum analyzer's band power measurement function with band limits set equal to the EBW band edges.
8. **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 (because the measurement represents an average over both the on and off times of the transmission)

▣ **TEST RESULTS : Comply**

Mode	Channel	Frequency [MHz]	Duty Cycle(x)	DCF [dB] = 10*log(1/x)	Test Result			
					Chain 0		Chain 1	
					[dBm]	[W]	[dBm]	[W]
802.11a	36	5180	0.94	0.27	7.07	0.005	**8.48**	0.007
	40	5200			10.03	0.010	**10.89**	0.012
	48	5240			**11.01**	0.013	10.73	0.012

Note 1 : Chain 0 and Chain 1 Test Result = Measurement Data + DCF

Mode	Channel	Frequency [MHz]	Duty Cycle(x)	DCF [dB] = 10*log(1/x)	Test Result			
					Chain 0 [dBm]	Chain 1 [dBm]	Aggregate Power[Note2]	
							[dBm]	[W]
802.11n HT20	36	5180	0.93	0.32	6.08	7.88	**10.08**	***0.010***
	40	5200			8.09	9.08	**11.62**	***0.015***
	48	5240			8.81	8.48	**11.66**	***0.015***
802.11n HT40	38	5190	0.87	0.60	4.39	6.13	**8.36**	***0.007***
	46	5230			11.30	11.16	**14.24**	***0.027***

Note 1 : Chain 0 and Chain 1 Test Result = Measurement Data + DCF

Note 2: Aggregate power = $10\log(10^{(\frac{\text{chain 0}}{10})} + 10^{(\frac{\text{chain 1}}{10})})$

▣ Measurement Data PLOTS

Output Power Test Mode: 802.11a & Ch.36 & Chain 0

Output Power Test Mode: 802.11a & Ch.40 & Chain 0

Output Power Test Mode: 802.11a & Ch.48 & Chain 0

Output Power Test Mode: 802.11a & Ch.36 & Chain 1

Output Power Test Mode: 802.11a & Ch.40 & Chain 1

Output Power Test Mode: 802.11a & Ch.48 & Chain 1

Output Power Test Mode: 802.11n HT20 & Ch.36 & Chain 0

Output Power Test Mode: 802.11n HT20 & Ch.40 & Chain 0

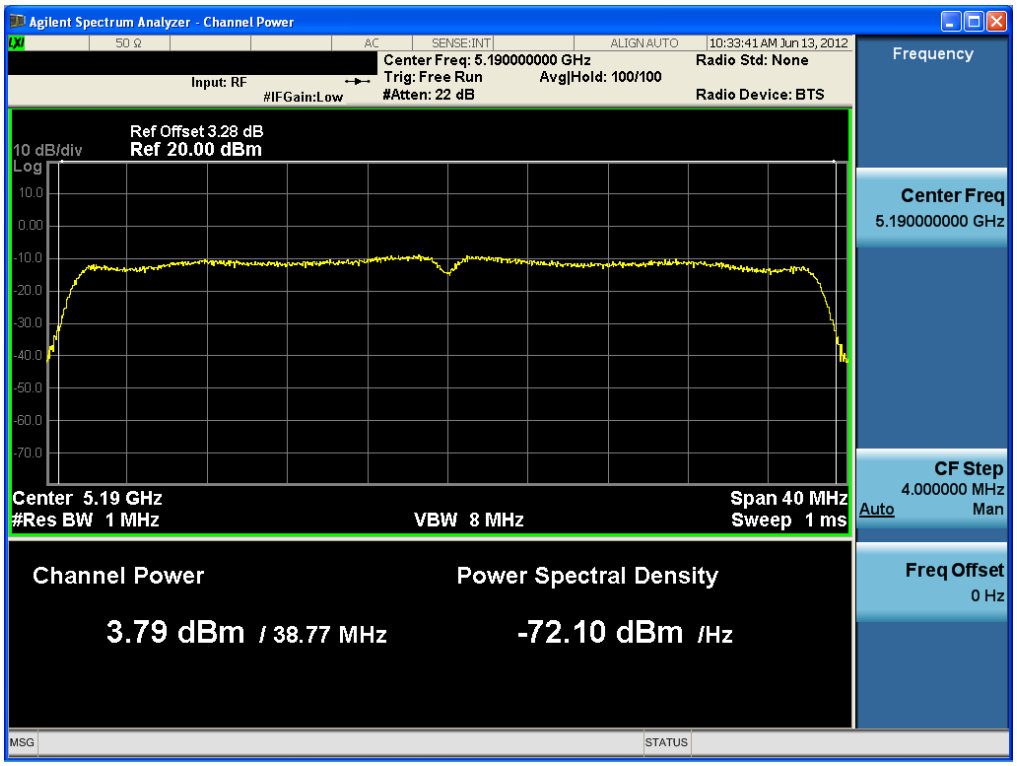
Output Power Test Mode: 802.11n HT20 & Ch.48 & Chain 0

Output Power Test Mode: 802.11n HT20 & Ch.36 & Chain 1

Output Power Test Mode: 802.11n HT20 & Ch.40 & Chain 1

Output Power Test Mode: 802.11n HT20 & Ch.48 & Chain 1

Output Power Test Mode: 802.11n HT40 & Ch.38 & Chain 0



Output Power Test Mode: 802.11n HT40 & Ch.46 & Chain 0

Output Power Test Mode: 802.11n HT40 & Ch.38 & Chain 1

Output Power Test Mode: 802.11n HT40 & Ch.46 & Chain 1

3.2.3 Peak Power Spectral Density

Test requirements

The peak power spectral density shall not exceed 4 dBm in any 1MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

- Peak Power Spectral Density Limit Calculation

Bands [GHz]	Mode	Limit [dBm]	ANT Gain Note1			Determined Limit [dBm]
			ANT0 [dBi]	ANT1 [dBi]	MIMO Directional Gain [dBi]	
5.15 ~ 5.25	802.11a	4	3.32	4.14	Non MIMO	4
	802.11n HT20				6.75	3.25
	802.11n HT40				6.75	

Note 1 : Using Correlated Directional Gain = 10 log[$(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2$ /N] dBi
Note 2 : Using Uncorrelated Directional Gain = 10 log[$(10^{G1/10} + 10^{G2/10} + \ldots + 10^{GN/10})$/N] dBi

▣ **TEST CONFIGURATION**

Refer to the APPENDIX I.

▣ **TEST PROCEDURE**

Peak Power Spectral Density is measured using Measurement Procedure **of KDB789033**

1) Create an average power spectrum for the EUT operating mode being tested by following the instructions in section C)3) for measuring maximum conducted output power using a spectrum analyzer: select the appropriate test method (SA-1, SA-2, SA-3, or alternatives to each) and apply it up to, but not including, the step labeled, “Compute power…”. (This procedure is required even if the maximum conducted output power measurement was performed using a power meter, method PM.)
2) Use the peak search function on the spectrum analyzer to find the peak of the spectrum.
3) Make the following adjustments to the peak value of the spectrum, if applicable:
   a) If Method SA-2 or SA-2 Alternative was used, add 10 log(1/x), where x is the duty cycle, to the peak of the spectrum.
   b) If Method SA-3 Alternative was used and the linear mode was used in step C)3)g)(viii), add 1 dB to the final result to compensate for the difference between linear averaging and power averaging.
4) The result is the PPSD.

▣ **TEST RESULT : N/T**

▣ **Measurement Data : N/T**

3.2.4 Peak Excursion Ratio

Test requirements

The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the maximum conducted output power (measured as specified above) shall not exceed **13 dB/MH**z.

▣ **TEST CONFIGURATION**

Refer to the APPENDIX I.

▣ **TEST PROCEDURE**

Peak Excursion Ratio is measured using Measurement Procedure **of KDB789033**

1) Compliance with the peak excursion requirement of Section 15.407(a)(6) shall be demonstrated by confirming that the ratio of the maximum of the peak-max-hold spectrum to the maximum of the average spectrum for continuous transmission does not exceed 13 dB. (Earlier procedures that required computing the ratio of the two spectra at each frequency across the emission bandwidth can lead to unintended failures at band edges and will no longer be required.)
2) Set the spectrum analyzer span to view the entire emission bandwidth.
3) Find the maximum of the peak-max-hold spectrum.
   a) Set **RBW = 1 MHz.**
   b) **VBW ≥ 3 MHz**.
   c) **Detector = peak.**
   d) **Trace mode = max-hold.**
   e) Allow the sweeps to continue until the trace stabilizes.
   f) Use the peak search function to find the peak of the spectrum.
4) **Use the procedure found under E) to measure the PPSD.**
5) Compute the ratio of the maximum of the peak-max-hold spectrum to the PPSD.

▣ **TEST RESULT : N/T**

▣ **Measurement Data : N/T**

3.2.5 Frequency Stability

Test requirements

Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

▣ **TEST PROCEDURE**

The EUT was placed inside of an environmental chamber as the temperature in the chamber was varied between -10℃ and +60℃. The temperature was incremented by 10℃ intervals and the unit was allowed to stabilize at each measurement. The center frequency of the transmitting channel was evaluated at each temperature and the frequency deviation from the channel's center frequency was recorded.

▣ **TEST RESULT : N/T**

3.2.6 Radiated Spurious Emission Measurements

▣ **TEST PROCEDURE**

The EUT was placed on a 0.8m high wooden table inside a shielded enclosure. An antenna was placed near the EUT and measurements of frequencies and amplitudes of field strengths were recorded for reference during final measurements. For final radiated testing, measurements were performed in semi anechoic chamber. Measurements were performed with the EUT oriented in 3 orthogonal axis and rotated 360 degrees to determine the worst-case orientation for maximum emissions.

Radiated spurious emission measured using following Measurement Procedure **of KDB789033**

- **Measurements Below 1000MHz**
  a) Follow the requirements in section G)3), "General Requirements for Unwanted Emissions Measurements"
  b) Compliance shall be demonstrated using **CISPR quasi-peak detection**; however, **peak detection** is permitted as an alternative to quasi-peak detection.

G)3), General Requirements for Unwanted Emissions Measurements. The following requirements apply to all unwanted emissions measurements, both in and outside of the restricted bands:

a) EUT Duty Cycle

(1) The EUT shall be configured or modified to **transmit continuously** except as stated in (ii), below. The intent is to test at 100 percent duty cycle; however a small reduction in duty cycle (**to no lower than 98 percent**) is permitted if required by the EUT for amplitude control purposes. Manufacturers are expected to provide software to the test lab to permit such continuous operation.

(2) If **continuous transmission (or at least 98 percent duty cycle) cannot be achieved** due to hardware limitations of the EUT (e.g., overheating), the following additions to the measurement and reporting procedures are required:

- The EUT shall be configured to operate at the maximum achievable duty cycle.
- Measure the duty cycle, x, of the transmitter output signal.
- Adjustments to measurement procedures (e.g., increasing test time and number of traces averaged) shall be performed as described in the procedures below.
- The test report shall include the following additional information:
  - The reason for the duty cycle limitation.
  - The duty cycle achieved for testing and the associated transmit duration and interval between transmissions.
  - The sweep time and the amount of time used for trace stabilization during max-hold measurements for peak emission measurements.

(3) **Reduction of the measured emission amplitude levels to account for operational duty factor is not permitted. Compliance is based on emission levels occurring during transmission - not on an average across on and off times of the transmitter.**

- **Measurements Above 1000MHz(Peak)**
  a) Follow the requirements in section G)3), "General Requirements for Unwanted Emissions Measurements".
  b) Peak emission levels are measured by setting the analyzer as follows:
  (1) **RBW = 1 MHz**.
  (2) VBW ≥ 3 MHz.
  (3) Detector = Peak.
  (4) Sweep time = auto.
  (5) Trace mode = max hold.
  (6) Allow sweeps to continue until the trace stabilizes. Note that if the transmission is not continuous, the time required for the trace to stabilize will increase by a factor of approximately 1/x, where x is the duty cycle. For example, at 50 percent duty cycle, the measurement time will increase by a factor of two relative to measurement time for continuous transmission.

- **Measurements Above 1000MHz(Method AD)**
  (1) RBW = 1 MHz.
  (2) VBW ≥ 3 MHz.
  (3) Detector = RMS, if span/(# of points in sweep) ≤ RBW/2. Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, the detector mode shall be set to peak.
  (4) Averaging type = power (i.e., RMS)
  • As an alternative, the detector and averaging type may be set for linear voltage averaging. Some analyzers require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.
  (5) Sweep time = auto.
  (6) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, the number of traces shall be increased by a factor of 1/x, where x is the duty cycle. For example, with 50 percent duty cycle, at least 200 traces should be averaged.
  (7) If tests are performed with the EUT transmitting at a duty cycle less than 98 percent, a correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:
  • If power averaging (RMS) mode was used in step (iv) above, the correction factor is 10 log(1/x), where x is the duty cycle. For example, if the transmit duty cycle was 50 percent, then 3 dB must be added to the measured emission levels.
  • If linear voltage averaging mode was used in step (iv) above, the correction factor is 20 log(1/x), where x is the duty cycle. For example, if the transmit duty cycle was 50 percent, then 6 dB must be added to the measured emission levels.

▣ **Minimum Standard:**

▪ **FCC Part 15.209(a) and (b)**

Frequency (MHz)	Limit (uV/m) @ 3m
30 ~ 88	100 **
88 ~ 216	150 **
216 ~ 960	200 **
Above 960	500

** Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88MHz, 174-216MHz or 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

▪ **FCC Part 15.205 (a):** Only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz	GHz	GHz
0.009 ~ 0.110	8.41425 ~ 8.41475	108 ~ 121.94	1300 ~ 1427	3600 ~ 4400	14.47 ~ 14.5
0.495 ~ 0.505	12.29 ~ 12.293	123 ~ 138	1435 ~ 1626.5	4.5 ~ 5.15	15.35 ~ 16.2
2.1735 ~ 2.1905	12.51975 ~	149.9 ~ 150.05	1645.5 ~ 1646.5	5.35 ~ 5.46	17.7 ~ 21.4
4.125 ~ 4.128	12.52025	156.52475 ~	1660 ~ 1710	7.25 ~ 7.75	22.01 ~ 23.12
4.17725 ~ 4.17775	12.57675 ~	156.52525	1718.8 ~ 1722.2	8.025 ~ 8.5	23.6 ~ 24.0
4.20725 ~ 4.20775	12.57725	156.7 ~ 156.9	2200 ~ 2300	9.0 ~ 9.2	31.2 ~ 31.8
6.215 ~ 6.218	13.36 ~ 13.41	162.0125 ~ 167.17	2310 ~ 2390	9.3 ~ 9.5	36.43 ~ 36.5
6.26775 ~ 6.26825	16.42 ~ 16.423	167.72 ~ 173.2	2483.5 ~ 2500	10.6 ~ 12.7	Above 38.6
6.31175 ~ 6.31225	16.69475 ~	240 ~ 285	2655 ~ 2900	13.25 ~ 13.4	
8.291 ~ 8.294	16.69525	322 ~ 335.4	3260 ~ 3267		
8.362 ~ 8.366	16.80425 ~	399.90 ~ 410	3332 ~ 3339		
8.37625 ~ 8.38675	16.80475	608 ~ 614	3345.8 ~ 3358		
	25.5 ~ 25.67	960 ~ 1240			
	37.5 ~ 38.25				
	73 ~ 74.6				
	74.8 ~ 75.2				

▪ **FCC Part 15.205(b):** The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

▪ **FCC Part 15.407(b)(2)**

For transmitters operating in the 5.25–5.35 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of –27dBm/MHz.

▣ **Measurement Data:**

30MHz ~ 40GHz Radiated Spurious Emissions: *802.11a & Chain 0 & 5180MHz(Ch. 36)*

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector	Reading (dBuV)	T.F (dB/m)	DUTY Correction Factor (dB)	Distance Correction Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
199.225	H	X	QP	46.25	-11.80	-	-	34.45	43.50	9.05
265.237	H	X	QP	48.68	-8.50	-	-	40.18	46.00	5.82
5149.550	V	Z	PK	56.40	7.45	-	-	63.85	74.00	10.15
5149.970	V	Z	AV	44.10	7.45	0.54	-	52.09	54.00	1.91
10366.400	V	X	PK	43.39	16.17	-	-6.02	53.54	68.20	14.66

30MHz ~ 40GHz Radiated Spurious Emissions: *802.11a & Chain 0 & 5200MHz(Ch. 40)*

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector	Reading (dBuV)	T.F (dB/m)	DUTY Correction Factor (dB)	Distance Correction Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
199.210	H	X	QP	46.32	-11.80	-	-	34.52	43.50	8.98
265.325	H	X	QP	48.69	-8.50	-	-	40.19	46.00	5.81
10398.850	H	Y	PK	49.94	16.59	-	-6.02	60.51	68.20	7.69

30MHz ~ 40GHz Radiated Spurious Emissions: *802.11a & Chain 0 & 5240MHz(Ch. 48)*

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector	Reading (dBuV)	T.F (dB/m)	DUTY Correction Factor (dB)	Distance Correction Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
199.170	H	X	QP	46.50	-11.80	-	-	34.70	43.50	8.80
265.213	H	X	QP	48.72	-8.50	-	-	40.22	46.00	5.78
5368.050	V	Z	PK	45.84	8.46	-	-	54.30	74.00	19.70
5361.150	V	Z	AV	34.16	8.46	0.54	-	42.89	54.00	10.84
10480.560	H	Y	PK	48.49	17.60	-	-6.02	60.07	68.20	8.13

Note.

1. This test item was performed in each axis and the worst case data were reported.
2. Sample Calculation.
   Margin = Limit – Result
   Result = Reading + T.F + DUTY Correction Factor + Distance Correction Factor
   T.F = AF + CL – AG
   DUTY Correction Factor : 0.54 dB = 20*log(1/0.94)
3. Measurement Distance above 10 GHz = 1.5 m So Distance Correction Factor : -6.02dB = 20*log(1.5m/3m)

▣ **Measurement Data:**

30MHz ~ 40GHz Radiated Spurious Emissions: *802.11a & Chain 1 & 5180MHz(Ch. 36)*

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector	Reading (dBuV)	T.F (dB/m)	DUTY Correction Factor (dB)	Distance Correction Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
199.194	H	X	QP	46.10	-11.80	-	-	34.30	43.50	9.20
265.295	H	X	QP	48.79	-8.50	-	-	40.29	46.00	5.71
5147.570	V	Z	PK	56.82	7.45	-	-	64.27	74.00	9.73
5148.890	V	Z	AV	43.59	7.45	0.54	-	51.58	54.00	2.42
10359.200	V	X	PK	41.97	16.17	-	-6.02	52.12	68.20	16.08

30MHz ~ 40GHz Radiated Spurious Emissions: *802.11a & Chain 1 & 5200MHz(Ch. 40)*

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector	Reading (dBuV)	T.F (dB/m)	DUTY Correction Factor (dB)	Distance Correction Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
199.205	H	X	QP	46.39	-11.80	-	-	34.59	43.50	8.91
265.362	H	X	QP	48.67	-8.50	-	-	40.17	46.00	5.83
10402.400	H	Y	PK	45.38	16.59	-	-6.02	55.95	68.20	12.25

30MHz ~ 40GHz Radiated Spurious Emissions: *802.11a & Chain 1 & 5240MHz(Ch. 48)*

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector	Reading (dBuV)	T.F (dB/m)	DUTY Correction Factor (dB)	Distance Correction Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
199.155	H	X	QP	47.00	-11.80	-	-	35.20	43.50	8.30
265.365	H	X	QP	47.97	-8.50	-	-	39.47	46.00	6.53
5392.900	V	Z	PK	46.52	8.46	-	-	54.98	74.00	19.02
5366.300	V	Z	AV	34.07	8.46	0.54	-	43.07	54.00	10.93
10481.020	H	Y	PK	47.21	17.60	-	-6.02	58.79	68.20	9.41

Note.

1. This test item was performed in each axis and the worst case data were reported.
2. Sample Calculation.
   Margin = Limit – Result
   Result = Reading + T.F + DUTY Correction Factor + Distance Correction Factor
   T.F = AF + CL – AG
   DUTY Correction Factor : 0.54 dB = 20*log(1/0.94)
3. Measurement Distance above 10 GHz = 1.5 m So Distance Correction Factor : -6.02dB = 20*log(1.5m/3m)

▣ **Measurement Data:**

30MHz ~ 40GHz Radiated Spurious Emissions: *802.11n HT20 & 2TX & 5180MHz(Ch. 36)*

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector	Reading (dBuV)	T.F (dB/m)	DUTY Correction Factor (dB)	Distance Correction Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
199.215	H	X	QP	46.27	-11.80	-	-	34.47	43.50	9.03
264.795	H	X	QP	48.64	-8.50	-	-	40.14	46.00	5.86
5149.700	V	Z	PK	55.36	7.45	-	-	62.81	74.00	11.19
5149.220	V	Z	AV	44.01	7.45	0.63	-	52.09	54.00	1.91
10358.450	H	Y	PK	43.28	16.17	-	-6.02	53.43	68.20	14.77

30MHz ~ 40GHz Radiated Spurious Emissions: *802.11n HT20 & 2TX & 5200MHz(Ch. 40)*

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector	Reading (dBuV)	T.F (dB/m)	DUTY Correction Factor (dB)	Distance Correction Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
199.334	H	X	QP	46.13	-11.80	-	-	34.33	43.50	9.17
265.120	H	X	QP	48.71	-8.50	-	-	40.21	46.00	5.79
5123.840	V	Z	PK	54.67	8.46	-	-	63.13	74.00	10.87
5126.950	V	Z	AV	42.22	8.46	0.63	-	51.31	54.00	2.69
10400.900	H	Y	PK	45.72	16.59	-	-6.02	56.29	68.20	11.91

30MHz ~ 40GHz Radiated Spurious Emissions: *802.11n HT20 & 2TX & 5240MHz(Ch. 48)*

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector	Reading (dBuV)	T.F (dB/m)	DUTY Correction Factor (dB)	Distance Correction Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
199.000	H	X	QP	46.60	-11.80	-	-	34.80	43.50	8.70
265.168	H	X	QP	48.74	-8.50	-	-	40.24	46.00	5.76
5350.050	V	Z	PK	47.53	8.46	-	-	55.99	74.00	18.01
5351.600	V	Z	AV	36.77	8.46	0.63	-	45.86	54.00	8.14
10480.700	H	Y	PK	46.12	17.60	-	-6.02	57.70	68.20	10.50

Note.

1. This test item was performed in each axis and the worst case data were reported.
2. Sample Calculation.
   Margin = Limit – Result
   Result = Reading + T.F + DUTY Correction Factor + Distance Correction Factor
   T.F = AF + CL – AG
   DUTY Correction Factor : 0.63 dB = 20*log(1/0.93)
3. Measurement Distance above 10 GHz = 1.5 m So Distance Correction Factor : -6.02dB = 20*log(1.5m/3m)

▣ **Measurement Data:**

30MHz ~ 40GHz Radiated Spurious Emissions: *802.11n HT40 & 2TX & 5190MHz(Ch. 38)*

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector	Reading (dBuV)	T.F (dB/m)	DUTY Correction Factor (dB)	Distance Correction Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
199.356	H	X	QP	45.56	-11.80	-	-	33.76	43.50	9.75
265.212	H	X	QP	47.95	-8.50	-	-	39.45	46.00	6.55
5149.650	V	Z	PK	58.02	7.45	-	-	65.47	74.00	8.53
5149.050	V	Z	AV	43.88	7.45	1.21	-	52.54	54.00	1.46
10382.460	V	Z	PK	45.22	16.17	-	-6.02	55.37	68.20	12.83

30MHz ~ 40GHz Radiated Spurious Emissions: *802.11n HT40 & 2TX & 5230MHz(Ch. 46)*

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector	Reading (dBuV)	T.F (dB/m)	DUTY Correction Factor (dB)	Distance Correction Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
199.380	H	X	QP	45.66	-11.80	-	-	33.86	43.50	9.64
265.237	H	X	QP	48.24	-8.50	-	-	39.74	46.00	6.26
5363.300	V	Z	PK	48.18	8.46	-	-	56.64	74.00	17.36
5350.500	V	Z	AV	37.57	8.46	1.21	-	47.24	54.00	6.76
10465.200	H	Y	PK	46.04	16.59	-	-6.02	56.61	68.20	11.59

Note.

1. This test item was performed in each axis and the worst case data were reported.
2. Sample Calculation.
   Margin = Limit – Result
   Result = Reading + T.F + DUTY Correction Factor + Distance Correction Factor
   T.F = AF + CL – AG
   DUTY Correction Factor : 1.21dB = 20*log(1/0.87)
3. Measurement Distance above 10 GHz = 1.5 m So Distance Correction Factor : -6.02dB = 20*log(1.5m/3m)

3.2.7 AC Conducted Emissions

▣ **TEST PROCEDURE :**

The conducted emissions are measured in the shielded room with a spectrum analyzer in peak hold. Emissions closest to the limit are measured in the quasi-peak mode (QP) and average mode (AV) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation and Exerciser operation. The highest emissions relative to the limit are listed.

▣ **Measurement Data: Comply**

Note 1: See next pages for actual measured spectrum plots and data.

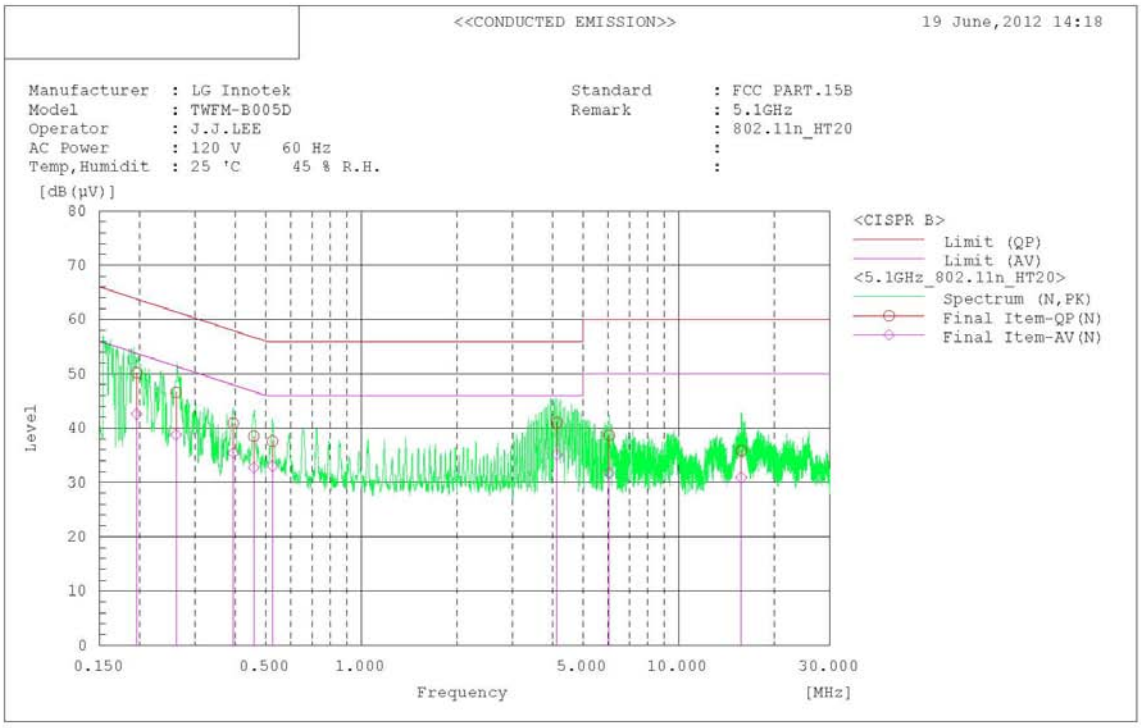
▣ **Minimum Standard: FCC Part 15.207(a)/EN 55022**

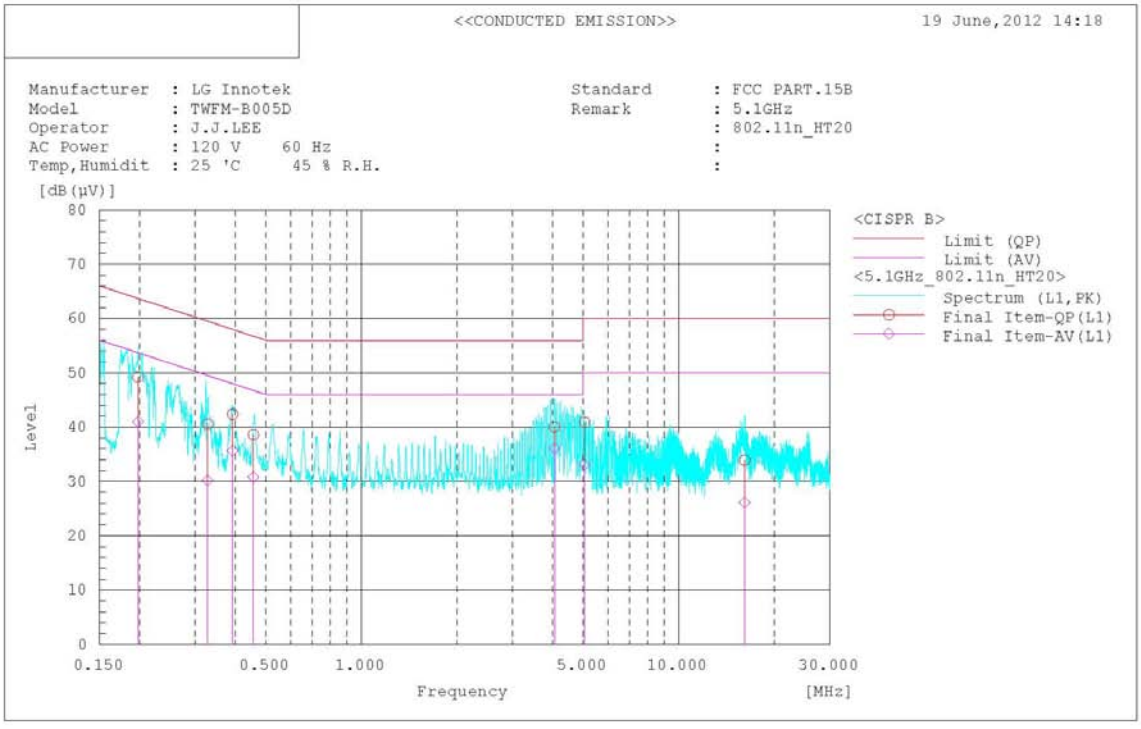
Frequency Range (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15 ~ 0.5	66 to 56 *	56 to 46 *
0.5 ~ 5	56	46
5 ~ 30	60	50

* Decreases with the logarithm of the frequency

AC Line Conducted Emissions (Graph)

Test Mode: 802.11n HT40





AC Line Conducted Emissions (Data List)

Test Mode: 802.11n HT40

<<CONDUCTED EMISSION>>

19 June, 2012 14:18

Standard : FCC PART.15B
Manufacturer : LG Innotek
Model : TWFM-B005D
Operator : J.J.LEE
AC Power : 120 V 60 Hz
Temp,Humidit : 25 'C 45 % R.H.
Remark : 5.1GHz
: 802.11n_HT20
:
:

Final Result

--- N Phase ---

No.	Frequency [MHz]	Reading QP [dB(μV)]	Reading AV [dB(μV)]	c.f [dB]	Result QP [dB(μV)]	Result AV [dB(μV)]	Limit QP [dB(μV)]	Limit AV [dB(μV)]	Margin QP [dB]	Margin AV [dB]	Remark
1	0.196	40.2	32.6	10.0	50.2	42.6	63.8	53.8	13.6	11.2	
2	0.261	36.6	28.8	10.0	46.6	38.8	61.4	51.4	14.8	12.6	
3	0.395	30.9	25.4	10.0	40.9	35.4	58.0	48.0	17.1	12.6	
4	0.459	28.5	22.7	10.0	38.5	32.7	56.7	46.7	18.2	14.0	
5	0.525	27.6	23.0	10.0	37.6	33.0	56.0	46.0	18.4	13.0	
6	4.128	30.9	25.0	10.1	41.0	35.1	56.0	46.0	15.0	10.9	
7	6.035	28.5	21.5	10.2	38.7	31.7	60.0	50.0	21.3	18.3	
8	15.735	25.5	20.5	10.4	35.9	30.9	60.0	50.0	24.1	19.1	

--- L1 Phase ---

No.	Frequency [MHz]	Reading QP [dB(μV)]	Reading AV [dB(μV)]	c.f [dB]	Result QP [dB(μV)]	Result AV [dB(μV)]	Limit QP [dB(μV)]	Limit AV [dB(μV)]	Margin QP [dB]	Margin AV [dB]	Remark
1	0.198	39.2	31.0	10.0	49.2	41.0	63.7	53.7	14.5	12.7	
2	0.328	30.6	20.2	10.0	40.6	30.2	59.5	49.5	18.9	19.3	
3	0.393	32.4	25.7	10.0	42.4	35.7	58.0	48.0	15.6	12.3	
4	0.457	28.6	20.8	10.0	38.6	30.8	56.7	46.7	18.1	15.9	
5	4.061	29.8	25.9	10.2	40.0	36.1	56.0	46.0	16.0	9.9	
6	5.050	30.7	22.9	10.2	40.9	33.1	60.0	50.0	19.1	16.9	
7	16.135	23.6	15.8	10.3	33.9	26.1	60.0	50.0	26.1	23.9	

3.2.8 Antenna Requirements

▣ **Procedure:**

Describe how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT.

▣ **Conclusion: Comply**

The antenna is permanently attached by soldering. (Refer to Internal Photo file.)

▣ **Minimum Standard:**

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall 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.

3.2.9 Occupied Bandwidth

▣ **TEST Requirements**

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured

▣ **TEST CONFIGURATION**

▣ **TEST PROCEDURE :**

The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual

▣ **TEST RESULT : N/T**

Minimum Standard : N/A

▣ **RESULT PLOT : N/T**

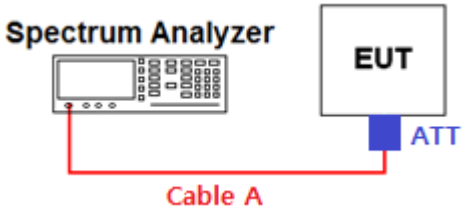
4. LIST OF TEST EQUIPMENT

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent	E4440A	11/09/30	12/09/30	MY45304199
Spectrum Analyzer	Rohde Schwarz	FSQ26	12/01/09	13/01/09	200445
Digital Multimeter	H.P	34401A	12/03/05	13/03/05	3146A13475, US36122178
Spectrum Analyzer	Agilent	N9020A	12/01/09	13/01/09	MY49100833
Signal Generator	Rohde Schwarz	SMR20	12/03/05	13/03/05	101251
Vector Signal Generator	Rohde Schwarz	SMJ100A	12/01/09	13/01/09	100148
Thermo hygrometer	BODYCOM	BJ5478	12/01/13	13/01/13	090205-2
DC Power Supply	HP	6622A	12/03/05	13/03/05	3448A03760
High-Pass Filter	Wainwright	WHKX8.5	11/09/19	12/09/19	1
BILOG ANTENNA	SCHAFFNER	CBL6112D	10/12/21	12/12/21	2737
HORN ANT	ETS	3115	12/02/20	13/02/20	6419
HORN ANT	A.H.Systems	SAS-574	11/03/25	13/03/25	154
Attenuator (3dB)	WEINSCHEL	56-3	11/09/30	12/09/30	Y2342
Amplifier (22dB)	H.P	8447E	12/01/09	13/01/09	2945A02865
Amplifier (30dB)	Agilent	8449B	12/03/05	13/03/05	3008A01590
EMI TEST RECEIVER	R&S	ESU	12/03/05	13/03/05	100014
RFI/Field intensity Meter	KYORITSU	KNM-2402	12/07/02	13/07/02	4N-170-3
Spectrum Analyzer	H/P	8591E	12/03/05	13/03/05	3649A05889
CVCF	NF	4420	11/09/15	12/09/15	3049354420023
Artificial Mains Network	Narda S.T.S. / PMM	PMM L2-16B	12/03/13	13/03/13	000WX20305
10dB Attenuator	Aeroflex/Weinschel	86-10-11	11/09/30	12/09/30	408

APPENDIX I

Test set Diagram & Offset value information

- **Conducted Test** (6dB Bandwidth & Maximum Peak Conducted Output Power)



Path Loss information

Frequency (GHz)	Offset Value (dB)	Frequency (GHz)	Offset Value (dB)
5.180 ~ 5.240	3.28	-	-

Note. 1: The path loss from EUT to Spectrum analyzer was measured and used for test.
S/A's offset value = Cable A + Attenuator (ATT)