

Test Report No.: 8912323629

Page 42 of 65 Pages

Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) Wireless Base Station

Model: WBS-2400

FCC ID: UGM-WBS2400-2S

7.10. Maximum peak output power

7.10.1. Requirements:

The maximum peak output power shall not exceed 1 Watt as required in sec. 15.247 (b). 15.247 (b) (4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi. Applying the restrictions from (c)(2)(ii), the conducted output power is derived as follows:

- The antenna element gain is 10.5 dBi.
- The maximum directional antenna gain is $10.5 + 10 \cdot \log_{10}(3) = 15.3$ dBi.
- The maximum aggregate peak output limit is $30 \text{ dBm} - (15.3 - 6)/3 = 26.9$ dBm.
- The maximum peak output limit for each transmit output and for each beam is $26.9 - 10 \cdot \log_{10}(3) = 22.1$ dBm.

If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.

7.10.2. Test procedure:

The output power measurements were performed at worst case mode, e.g. in multiple (two beams) mode operation.

The measurements were performed in normal (transmitting) mode of operation for carrier (channel) frequency at low, middle and the high of the 2.412 - 2.462 GHz frequency range at each transmit output under two data transfer bit rates that reflect to the worst test results. Additionally, combined maximum peak output power was calculated and presented in table 11.

7.10.3. Test results:

All test results met the requirements.

The summaries of Peak Power measurements (worst case) are shown in Table 10. The reference limit at the measurements in 2 beams mode was taken the same as for the single beam mode.

The aggregate power with two beams not exceeds the limit for one beam (see Table 11). The margin for the aggregate power with two beams is at least 8dB below standard requirements.

Test Report No.: 8912323629

Page 43 of 65 Pages

Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) Wireless Base Station

Model: WBS-2400

FCC ID: UGM-WBS2400-2S

Frequency MHz	Rate Mbps	Output 1 Peak Power [dBm]	Output 2 Peak Power [dBm]	Output 3 Peak Power [dBm]	FCC Limit Per 15.247(b) [dBm]	Calculated Limit [dBm]	Margin [dB] Output 1	Plot number	Margin [dB] Output 2	Plot number	Margin [dB] Output 3	Plot number
2412	1	21.42	20.04	21.00	30	22.1	0.68	75	2.06	81	1.1	87
	6	20.34	20.04	20.20	30	22.1	1.76	76	2.06	82	1.90	88
2437	1	21.48	20.42	20.66	30	22.1	0.62	77	1.68	83	1.44	89
	6	20.72	20.58	20.30	30	22.1	1.38	78	1.52	84	1.80	90
2462	1	20.39	20.66	20.22	30	22.1	1.71	79	1.44	85	1.88	91
	6	19.98	20.01	20.01	30	22.1	2.12	80	2.09	86	2.09	92

Table 10.
Peak Power (Outputs 1-3) test results.

Carrier Frequency MHz	Rate Mbps	Calculated Limit [dBm]	FCC Limit Per 15.247(b) [dBm]/W	Calculated Limit [W]	Calculated Combined (max) Output *, Peak Power [W]	Margin [W]
2412	1	26.9	30/1	0.49	0.37	0.12
	6	26.9	30/1	0.49	0.31	0.18
2437	1	26.9	30/1	0.49	0.37	0.12
	6	26.9	30/1	0.49	0.34	0.15
2462	1	26.9	30/1	0.49	0.33	0.16
	6	26.9	30/1	0.49	0.30	0.19

Table 11.
Peak Power (combined output) test results.

(*) - Calculated Combined (max) Output, Peak Power [W] is the sum of the measured Power from all Output terminals, where each result (output power from separate output terminal) mathematically converted from Logarithm to linear units. The results were present in Watt.

For example, the calculation for 2412 MHz frequency (1 Mbps bit rate) is the following:

1. 21.42dBm = 0.139W; 20.04dBm = 0.101W; 21.00dBm = 0.125W;

2. 0.139+0.101+0.125 = 0.365[W]

Test Report No.: 8912323629

Page 44 of 65 Pages

Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) Wireless Base Station

Model: WBS-2400

FCC ID: UGM-WBS2400-2S



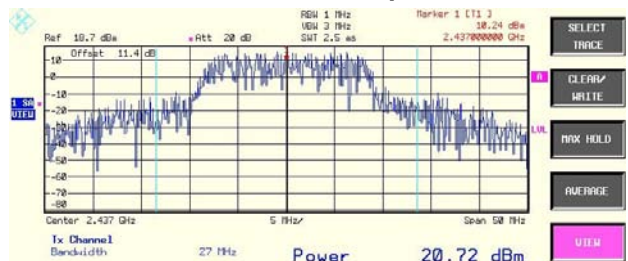
Plot # 75. Tx output 1. Peak power.
Fc-2412 MHz. 1Mbps rate



Plot # 76. Tx output 1. Peak power.
Fc-2412 MHz. 6Mbps rate



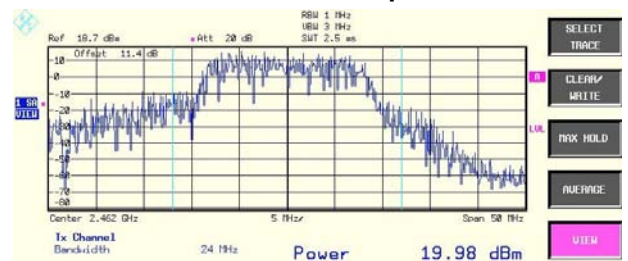
Plot # 77. Tx output 1. Peak power.
Fc-2437 MHz. 1Mbps rate



Plot # 78. Tx output 1. Peak power.
Fc-2437 MHz. 6Mbps rate



Plot # 79. Tx output 1. Peak power.
Fc-2462 MHz. 1Mbps rate



Plot # 80. Tx output 1. Peak power.
Fc-2462 MHz. 6Mbps rate

Test Report No.: 8912323629

Page 45 of 65 Pages

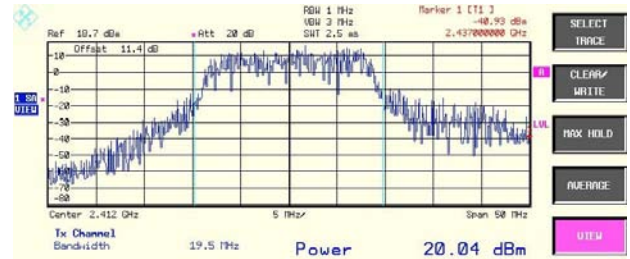
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) Wireless Base Station

Model: WBS-2400

FCC ID: UGM-WBS2400-2S



Plot # 81. Tx output 2. Peak power.
Fc-2412 MHz. 1Mbps rate



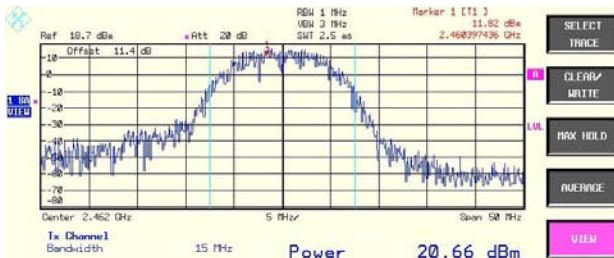
Plot # 82. Tx output 2. Peak power.
Fc-2412 MHz. 6Mbps rate



Plot # 83. Tx output 2. Peak power.
Fc-2437 MHz. 1Mbps rate



Plot # 84. Tx output 2. Peak power.
Fc-2437 MHz. 6Mbps rate



Plot # 85. Tx output 2. Peak power.
Fc-2462 MHz. 1Mbps rate



Plot # 86. Tx output 2. Peak power.
Fc-2462 MHz. 6Mbps rate

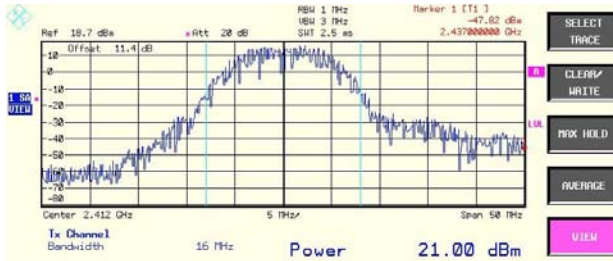
Test Report No.: 8912323629

Page 46 of 65 Pages

Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) Wireless Base Station

Model: WBS-2400

FCC ID: UGM-WBS2400-2S



Plot # 87. Tx output 3. Peak power.
Fc-2412 MHz. 1Mbps rate



Plot # 88. Tx output 3. Peak power.
Fc-2412 MHz. 6Mbps rate



Plot # 89. Tx output 3. Peak power.
Fc-2437 MHz. 1Mbps rate



Plot # 90. Tx output 3. Peak power.
Fc-2437 MHz. 6Mbps rate



Plot # 91. Tx output 3. Peak power.
Fc-2462 MHz. 1Mbps rate



Plot # 92. Tx output 3. Peak power.
Fc-2462 MHz. 6Mbps rate

Test Report No.: 8912323629

Page 47 of 65 Pages

Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) Wireless Base Station

Model: WBS-2400

FCC ID: UGM-WBS2400-2S

7.11. Peak power spectral density of digital modulated systems according to § 15.247(e)

7.11.1. Requirements:

The peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission

7.11.2. Pre-test scanning:

In order to find the “worst case” sample, which can represent all kinds of RF filters, each filter (Murata and Bitel filters) was pre-tested.

After all PSD tests the Bitel model was chosen as the “worst case”, all final measurements were performed with 3 Bitel filters.

7.11.3. Test Procedure:

The measurements were performed in normal (transmitting) mode of operation for carrier (channel) frequency at bottom, middle and the top of the 2.412 - 2.462 GHz frequency range. The EUT RF output was connected to the Spectrum Analyzer and accounted with cable loss in measurement. The maximum level in a 3kHz bandwidth is measured with: RBW=3kHz; VBW>3kHz, sweep time=span/3kHz and video averaging is turned off. The PSD is the highest level found across the emission in any 3kHz band.

Additionally, the peak power spectral density from combined (max.) output was calculated and presented in table 15.

7.11.4. Test Results:

Pre-compliance measurements

The WBS-2400 configurations for preliminary tests were as following: 2 RF filters Murata (outputs 1 & 2), RF filter Bitel (output 3).

The summaries of preliminary PSD measurements are shown in Table 13. The plots of pre-scan for each kind of 2 RF filters (outputs 1&3 accordantly) are presented on the plots 93-104.

Frequency MHz	Rate Mbps	Limit [dBm]	Output 1 PSD [dBm]	Output 3 PSD [dBm]
			Murata	Bitel
2412	1	8	-4.50	-2.67
	6	8	-4.63	-3.85
2437	1	8	-4.62	-3.40
	6	8	-5.98	-3.75
2462	1	8	-4.40	-2.58
	6	8	-7.70	-4.38

Table 12.

Preliminary PSD test results.

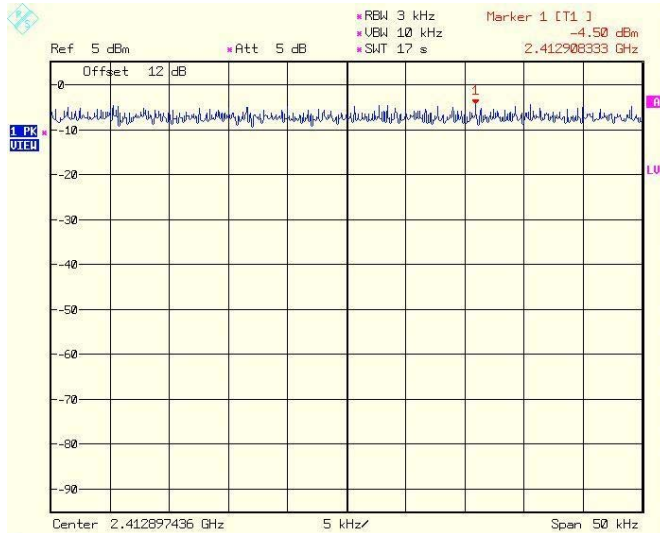
Test Report No.: 8912323629

Page 48 of 65 Pages

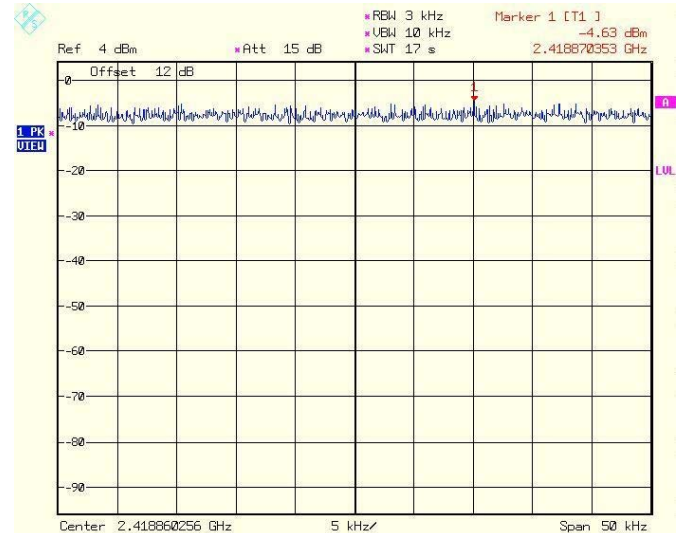
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) Wireless Base Station

Model: WBS-2400

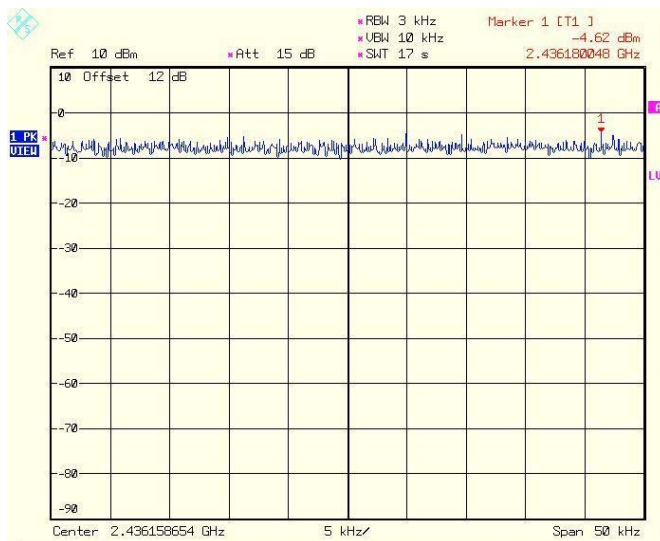
FCC ID: UGM-WBS2400-2S



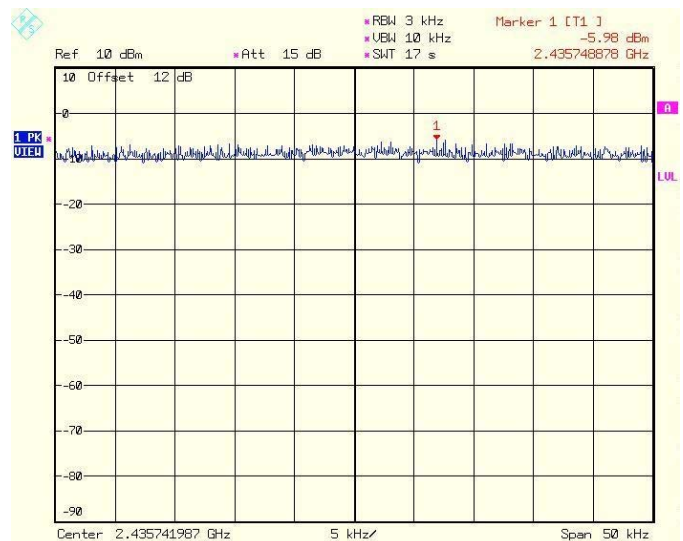
Plot # 93. Transmitter output 1. Peak Power Spectral Density.
Low frequency. 1Mbps rate.



Plot # 94. Transmitter output 1. Peak Power Spectral Density.
Low frequency. 6Mbps rate.



Plot # 95. Transmitter output 1. Peak Power Spectral Density.
Middle frequency. 1Mbps rate.



Plot # 96. Transmitter output 1. Peak Power Spectral Density.
Middle frequency. 6Mbps rate.

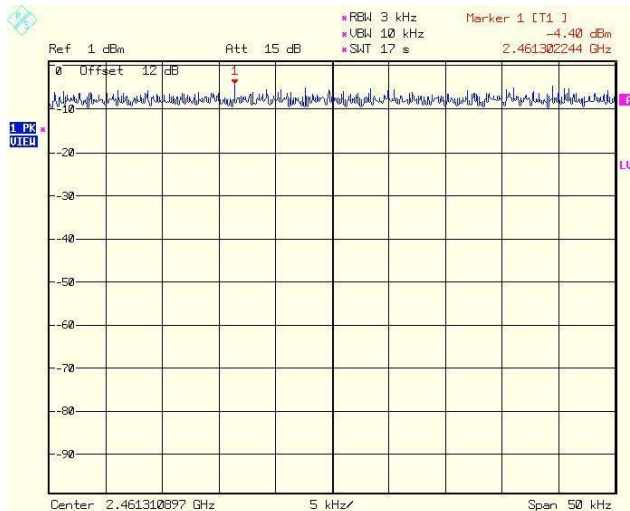
Test Report No.: 8912323629

Page 49 of 65 Pages

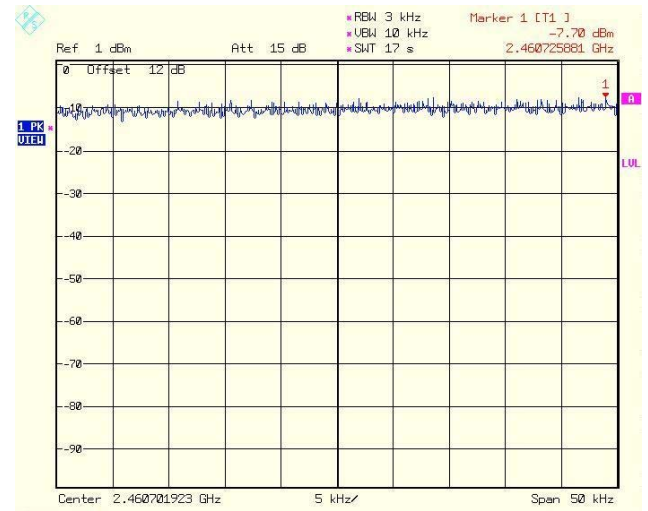
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Model: WBS-2400

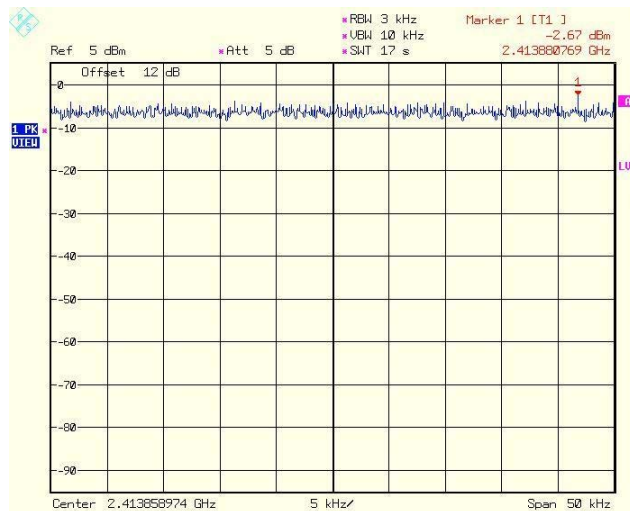
FCC ID: UGM-WBS2400-2S



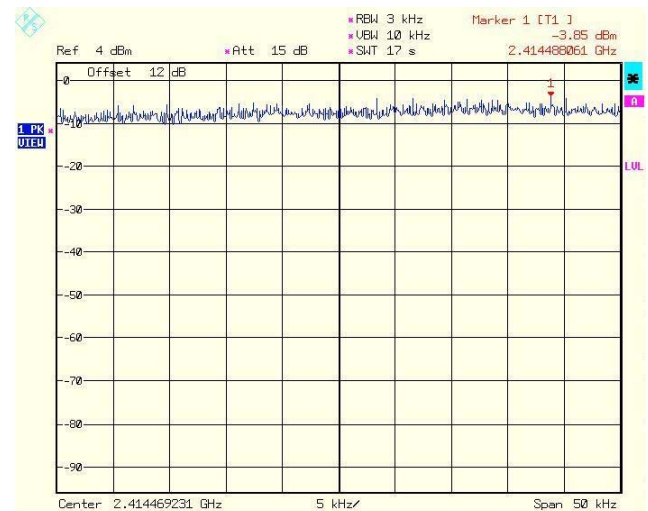
**Plot # 97. Transmitter output 1.
Peak Power Spectral Density.
High frequency. 1Mbps rate.**



**Plot # 98. Transmitter output 1.
Peak Power Spectral Density.
High frequency. 6Mbps rate.**



**Plot # 99. Transmitter output 3.
Peak Power Spectral Density.
Low frequency. 1Mbps rate.**



**Plot # 100. Transmitter output 3.
Peak Power Spectral Density.
Low frequency. 6Mbps rate.**

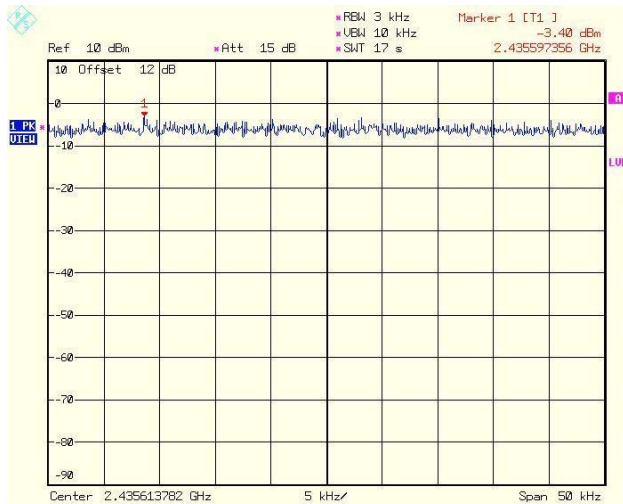
Test Report No.: 8912323629

Page 50 of 65 Pages

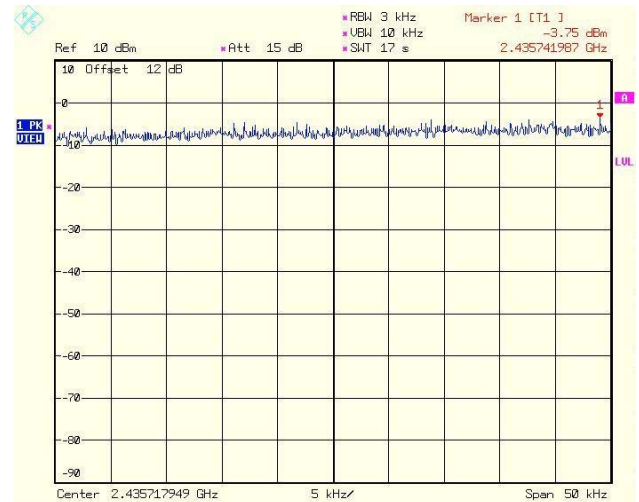
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) Wireless Base Station

Model: WBS-2400

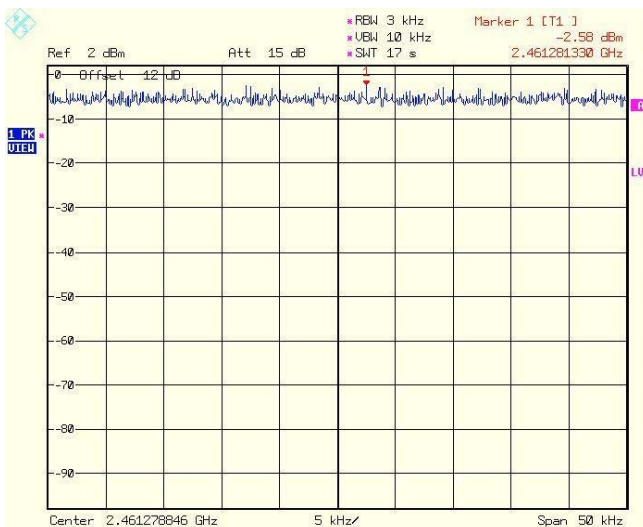
FCC ID: UGM-WBS2400-2S



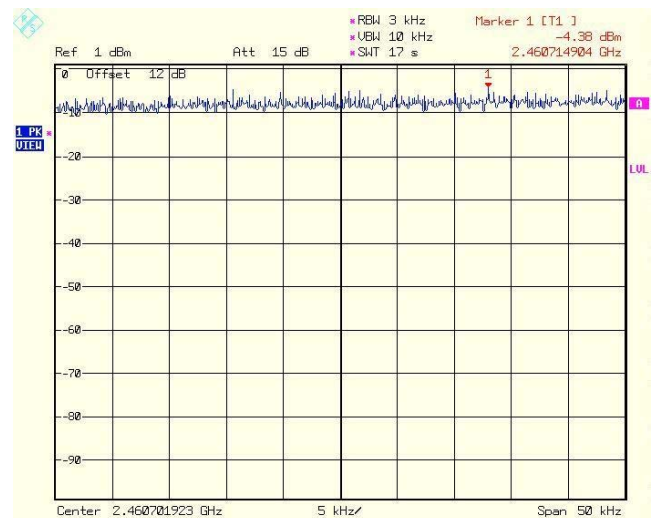
**Plot # 101. Transmitter output 3.
Peak Power Spectral Density.
Middle frequency. 1Mbps rate.**



**Plot # 102. Transmitter output 3.
Peak Power Spectral Density.
Middle frequency. 6Mbps rate.**



**Plot # 103. Transmitter output 3.
Peak Power Spectral Density.
High frequency. 1Mbps rate.**



**Plot # 104. Transmitter output 3.
Peak Power Spectral Density.
High frequency. 6Mbps rate.**

Following pre-scan tests results the "worst case" from the point of view of spurious emissions is Bitel filter.

The final configuration has been built with 3 Bitel RF filters.

All test results met the requirements and presented on the plots 106-140.

Test Report No.: 8912323629

Page 51 of 65 Pages

Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) Wireless Base Station

Model: WBS-2400

FCC ID: UGM-WBS2400-2S

7.11.5. Test Results:

Carrier Frequency MHz	Rate Mbps	Output 1 PSD [dBm]	Output 2 PSD [dBm]	Output 3 PSD [dBm]	Limit [dBm]	Margin [dB] Output 1	Plot number	Margin [dB] Output 2	Plot number	Margin [dB] Output 3	Plot number
2412	1	-4.64	-0.57	-2.17	8	12.64	106	8.57	118	10.17	130
	6	-1.06	-0.31	-6.94	8	9.06	108	8.31	120	14.94	132
2437	1	-0.59	-2.88	-1.34	8	8.59	110	10.88	122	9.34	134
	6	-6.17	-6.87	-5.57	8	14.17	112	14.87	124	12.57	136
2462	1	-1.99	-1.42	-1.09	8	9.99	114	9.42	126	9.09	138
	6	-4.40	-3.00	-5.93	8	12.4	116	11.00	128	13.93	140

Table 13.
PSD (Outputs 1-3) test results.

Carrier Frequency MHz	Rate Mbps	Limit [dBm]	Calculated Combined (max) Output *, PSD [dBm]	Margin [dB]
2412	1	8	2.60	5.4
	6	8	1.91	6.1
2437	1	8	2.11	5.9
	6	8	0.72	7.2
2462	1	8	2.12	5.9
	6	8	1.1	6.9

Table 14.
PSD (Combined Output) test results.

(*)- Calculated Combined (max) Output, PSD [dBm] is the sum of the measured PSD from all Output terminals, where each result (PSD from separate output terminal) mathematically converted from Logarithm to linear units. The results were present in dBm.

For example, the calculation for 2412 MHz frequency (1 Mbps bit rate) is the following:

1. $(-4.64) \text{ dBm} = 0.34 \text{ mW}$; $(-0.57) \text{ dBm} = 0.87 \text{ mW}$; $(-2.17) \text{ dBm} = 0.61 \text{ mW}$;
2. $0.34 + 0.87 + 0.61 = 1.82 \text{ [mW]}$
3. $1.82 \text{ mW} = 2.60 \text{ dBm}$