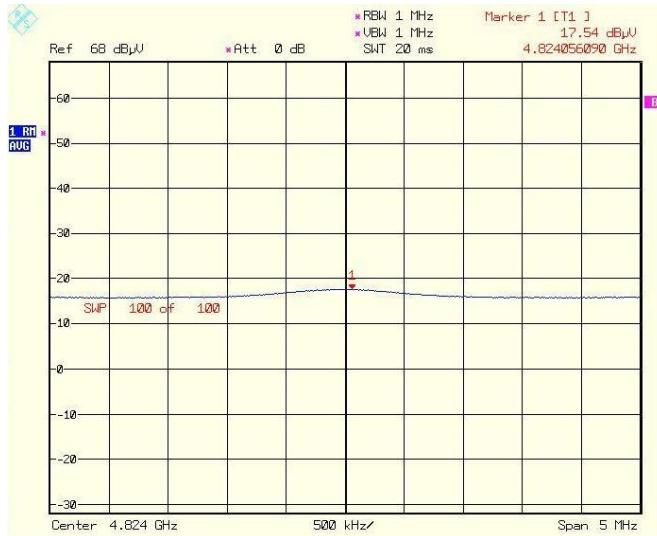


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7.7. Radiated emission test on Outdoor Radio Unit - restricted bands (per Section 15.205):

7.7.1. Requirements:

Radiated emission in restricted bands should meet the requirements sec. 15.205 Subpart C.

Operating Frequency Range 2.412 – 2.462 GHz

7.7.2. EUT configuration:

The tested configuration has been built with 6 Bitel RF filters.

The EUT was tested with all six Omni-directional antennas (model MT-341017/N/A) connected to EUT, as it shown on the photo 3.

7.7.3. Test procedure:

The measurements were performed in the anechoic chamber.

The EUT was arranged on a non-metallic table 0.8 m placed on the turntable.

Cable loss (in dB) is included in SA measurement calculation.

First, initial scans were performed in normal (transmitting) mode of operation for carrier (channel) frequency at the low and the high of the 2412 - 2462 MHz frequency range under 2 data transfer bit rates. The Output Power (19dBm) was adjusted from the data and control transfer equipment with the system integrator access only (following to Important Safety Instruction of Installation Guide). The worst results from all measurements (Low band edge frequency-2390MHz frequency, and High band edge frequency-2483.5MHz) are presented in summary table of clause 7.7.4 and at the plots 104-119.

Measuring antennas used: Double Ridge EMCO model 3115

Antenna height = 1 m.

Measurement distance = 3m.

Measuring detector function and bandwidths:

Detector type	Peak	Average
Resolution bandwidth	1MHz	1MHz
Video bandwidth	1 MHz	30 Hz



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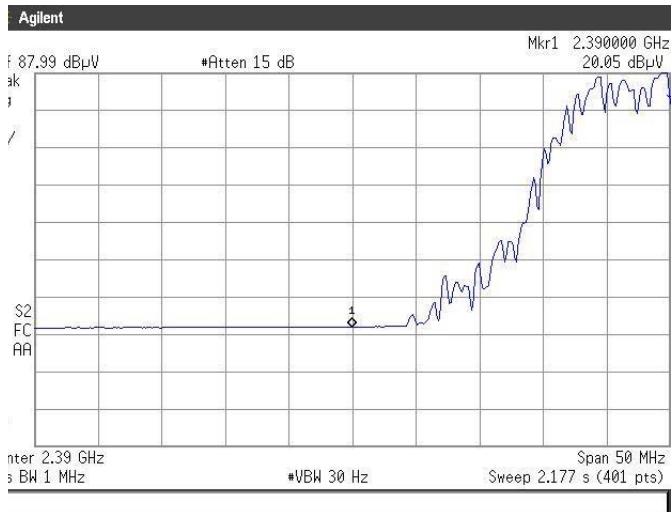
Model: WBS-2400

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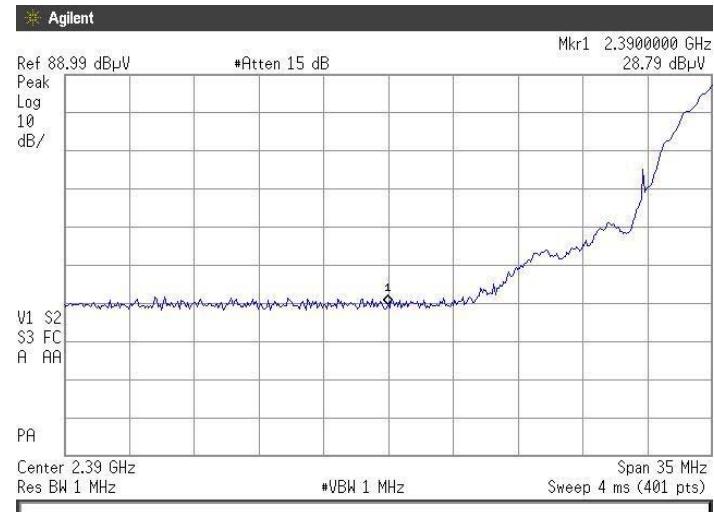
7.7.4. Test results and calculation ratio:

The test results are shown in Plots - as detailed in Table below.

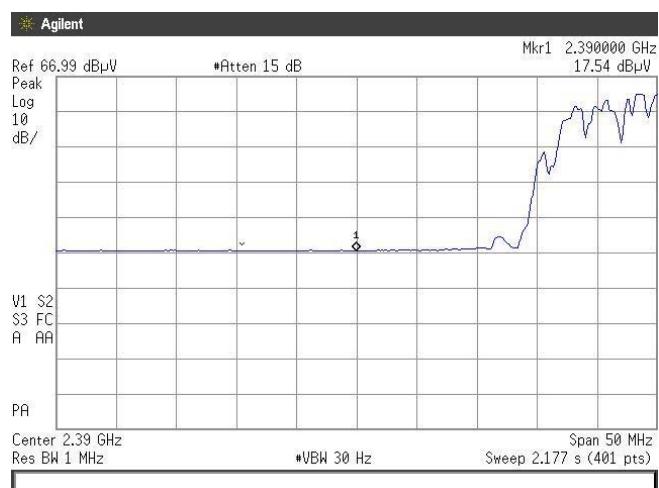
Band edge Freq. MHz	Pol V/H	Rate, Mbps	Read Pk, dB μ V	Read Avg, dB μ V	AF, dB	Peak, dB μ V/m	Avg, dB μ V/m	Peak Limit, dB(μ V/m)	Avg Limit, dB(μ V/m)	Peak Margin dB	Avg Margin dB	Verdict	Plot Number
Transmitting on Low (2.412GHz) frequency.													
2390	V	1	28.79	20.05	28.8	57.59	48.85	74	54	16.41	5.15	Pass	105,104
2390	H	1	27.48	17.54	28.8	56.28	46.34	74	54	17.72	7.66	Pass	107,106
2390	V	6	30.11	21.27	28.8	58.91	50.07	74	54	15.09	3.93	Pass	109,108
2390	H	6	27.98	17.67	28.8	56.78	46.47	74	54	17.22	7.53	Pass	111,112
Transmitting on High (2.462GHz) frequency.													
2483.5	V	1	28.87	20.34	28.8	57.67	49.14	74	54	16.33	4.86	Pass	113,112
2483.5	H	1	27.66	17.39	28.8	56.46	46.19	74	54	17.54	7.81	Pass	115,114
2483.5	V	6	34.81	19.18	28.8	63.61	47.98	74	54	10.39	6.02	Pass	117,116
2483.5	H	6	27.67	17.35	28.8	56.47	46.15	74	54	17.53	7.85	Pass	119,118

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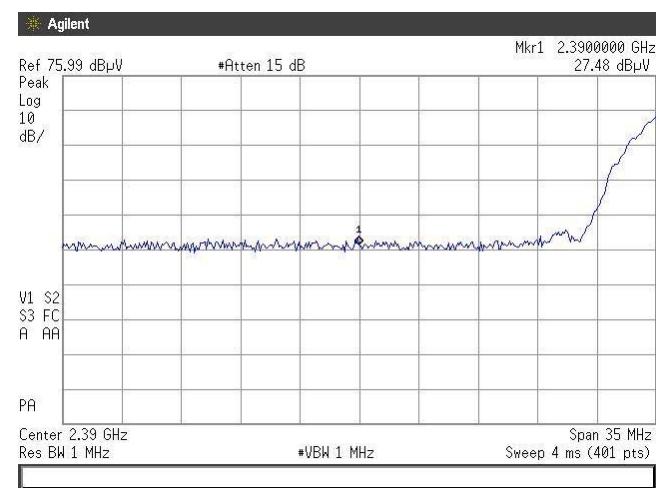
**Plot # 104. Low frequency 1Mbps rate.
802.11b; AVG; Vertical.**



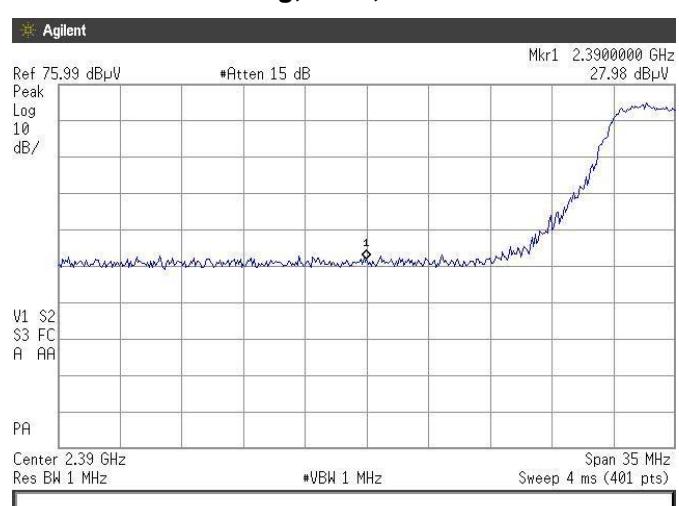
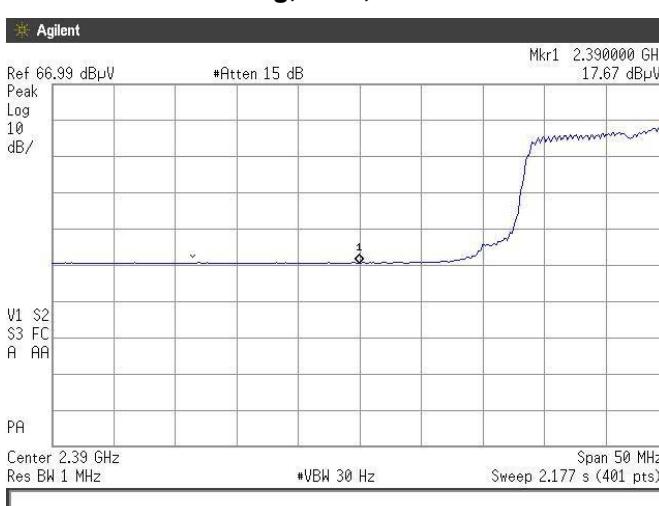
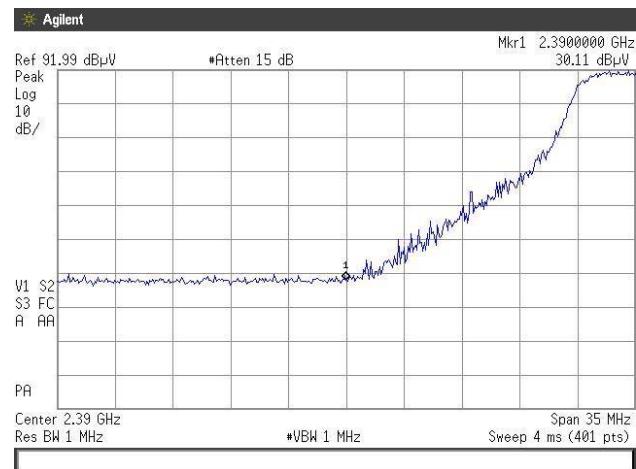
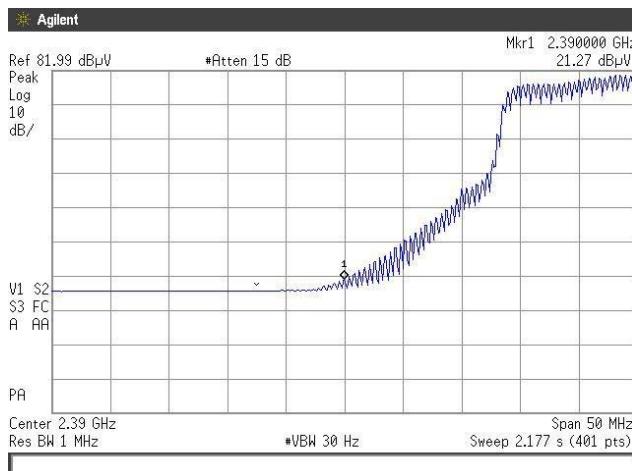
**Plot # 105. Low frequency 1Mbps rate.
802.11b; Peak; Vertical.**

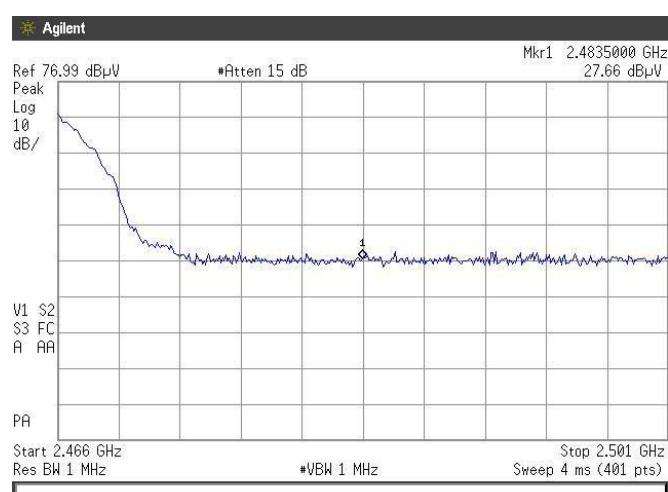
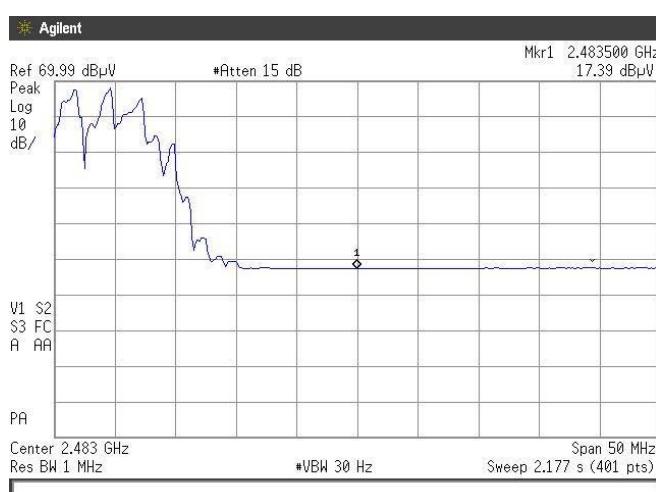
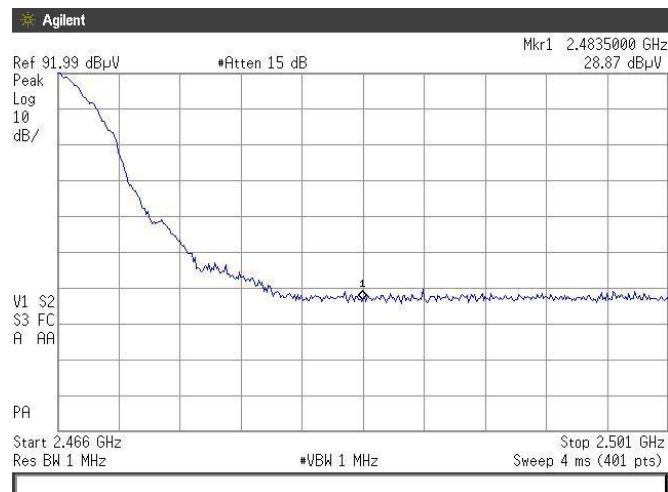
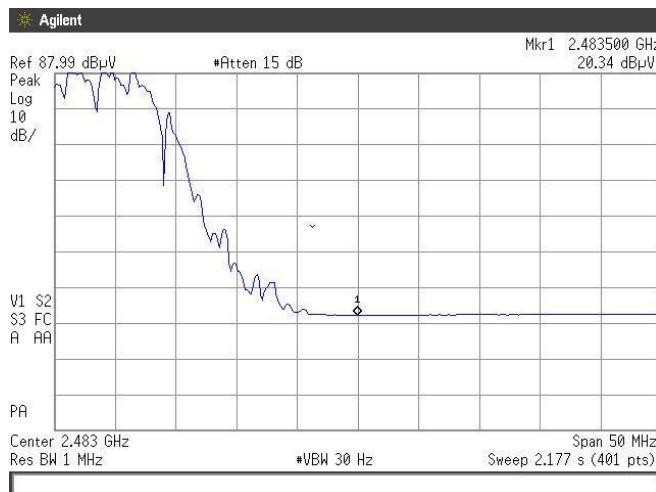


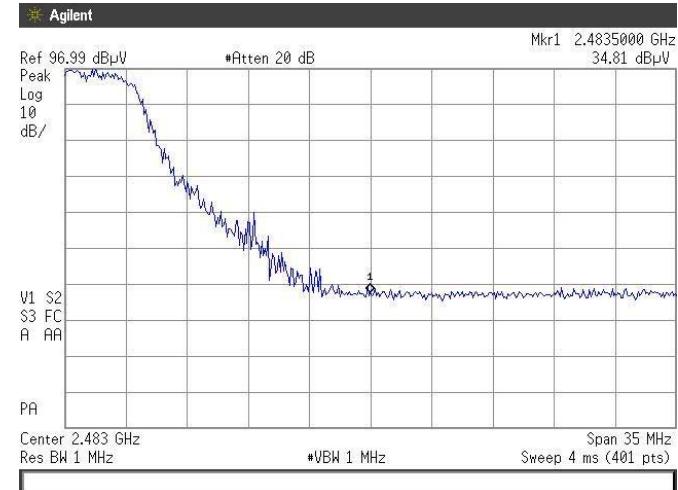
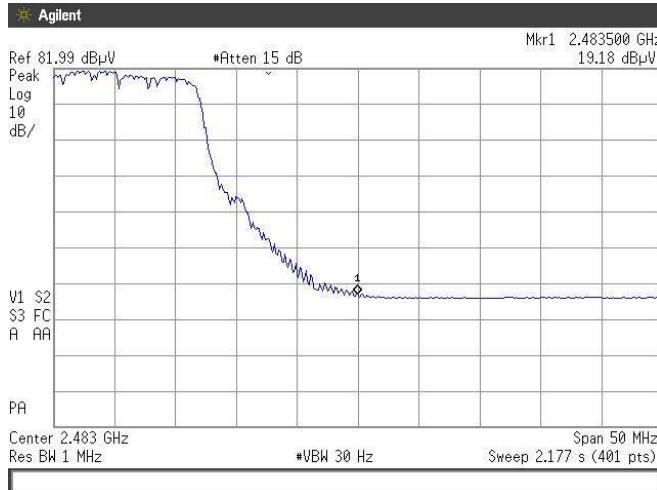
**Plot # 106. Low frequency 1Mbps rate.
802.11b; AVG; Horizontal.**



**Plot # 107. Low frequency 1Mbps rate.
802.11b; Peak; Horizontal.**

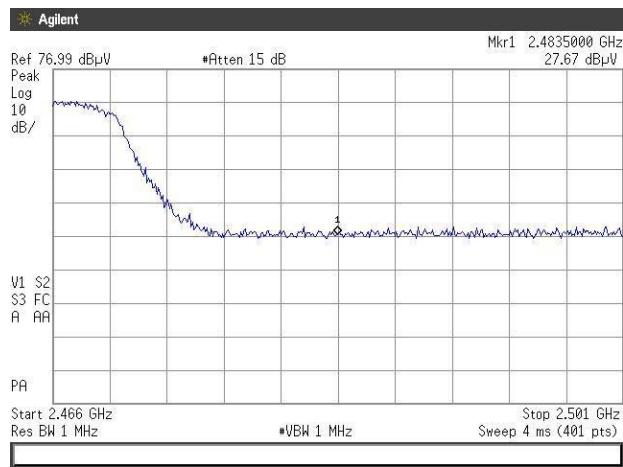
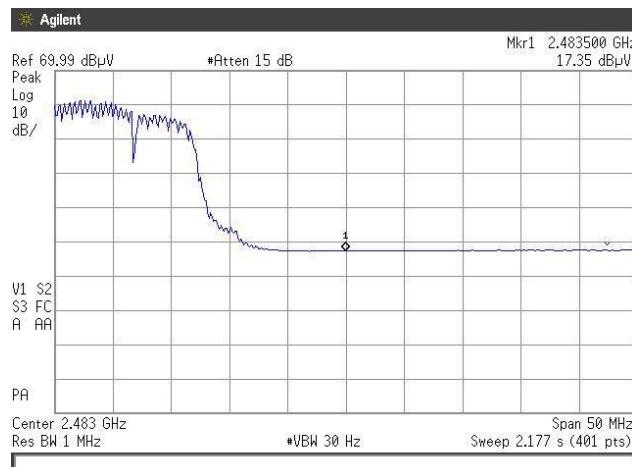
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**Plot # 116. High frequency 6Mbps rate.
802.11g; AVG; Vertical.**

**Plot # 117. High frequency 6Mbps rate.
802.11g; Peak; Vertical.**



**Plot # 118. High frequency 6Mbps rate.
802.11g; AVG; Horizontal.**

**Plot # 119. High frequency 6Mbps rate.
802.11g; Peak; Horizontal.**



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7.8. Minimum bandwidth

7.8.1. Requirements:

The minimum 6dB bandwidth shall be at least 500 KHz as required in sec. 15.247 (a)(2).

7.8.2. 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 min. bandwidth tests the Bitel models were chosen as the “worst case”, all final measurements were performed with 6 Bitel filters.

7.8.3. Test procedure:

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 under 2 data transfer bit rates that reflect to the worst test results. All final tests were performed on Output 4 that is the worst case between all outputs.

The EUT RF output was connected to the Spectrum Analyzer accounted with cable loss in SA settings.

The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

7.8.4. Test results:

Pre-compliance measurements

The WBS-2400 configurations for preliminary tests were as following: 2 RF filters Murata (outputs 1 & 2), 4 RF filter Bitel (outputs 3 -6).

The summaries of preliminary minimum bandwidth measurements are shown in Table 7 and were found with large margin. The plots of pre-scan for each kind of 2 RF filters (outputs 1&6 accordantly) are presented on the plots 120-131.

			Output1	Output6
Freq.	Rate	Modulation	Murata	Bitel
MHz	Mbps	mode	kHz	kHz
2412	1	802.11b	9519	8526
	6	802.11g	15673	15337
2437	1	802.11b	10000	8526
	6	802.11g	16346	15000
2462	1	802.11b	10064	9006
	6	802.11g	15785	15304

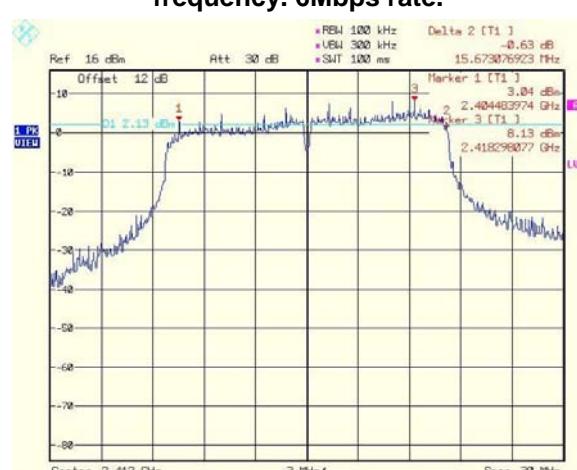
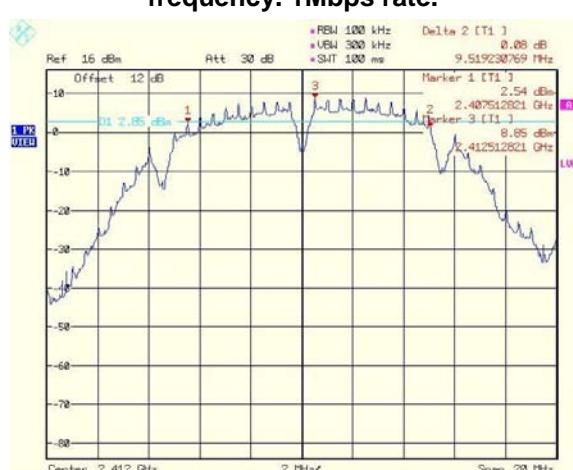
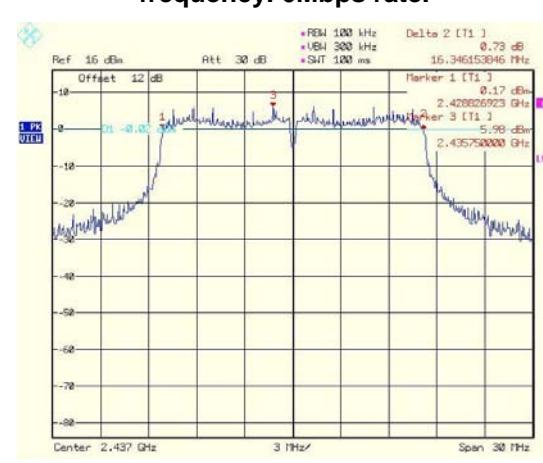
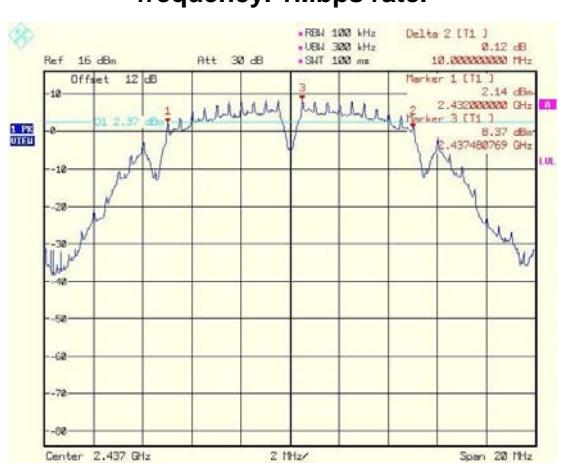
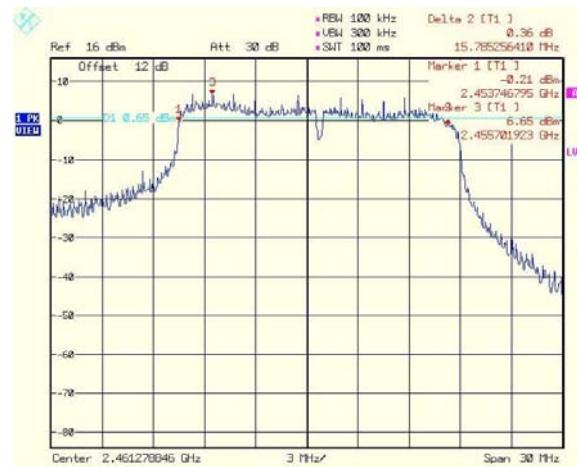
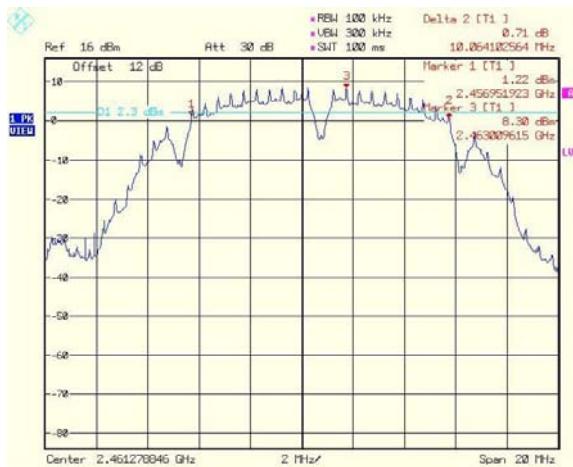
Table 7. 6dB bandwidth results

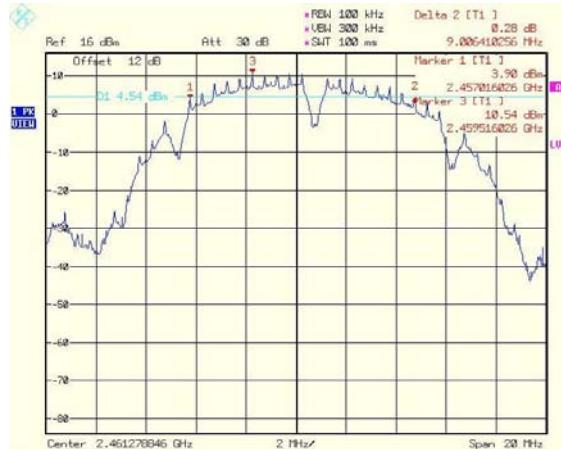
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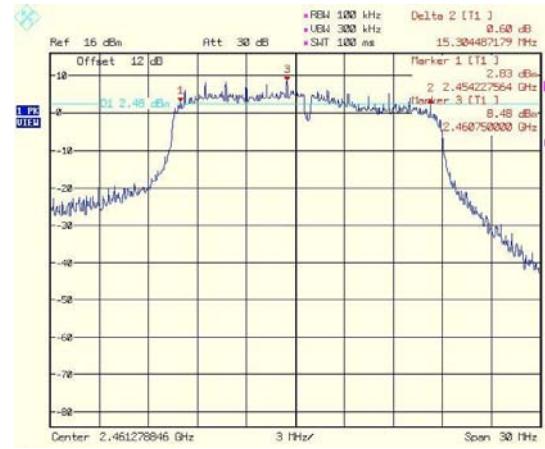
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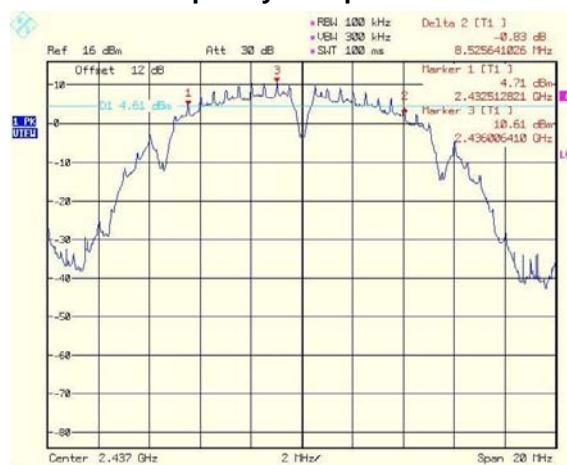


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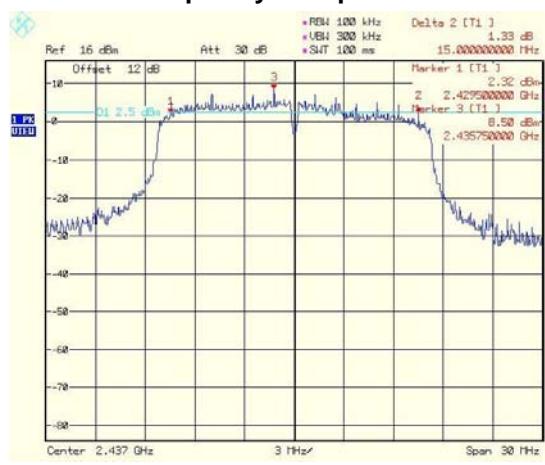
Plot # 126. Output 6. 6 dB Bandwidth. High frequency. 1Mbps rate.



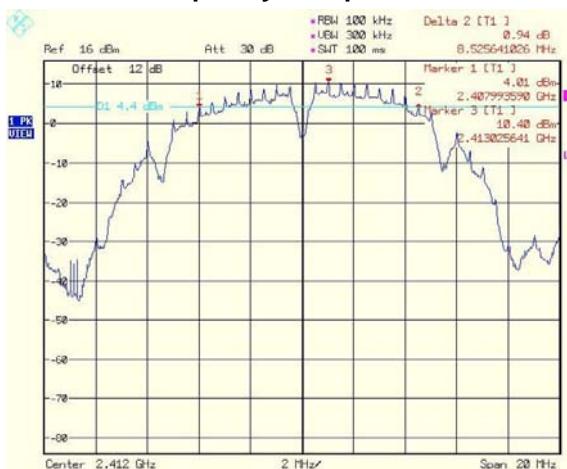
Plot # 127. Output 6. 6 dB Bandwidth. High frequency. 6Mbps rate.



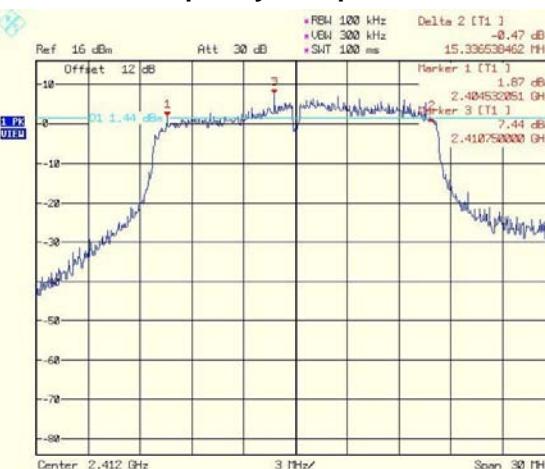
Plot # 128. Output 6. 6 dB Bandwidth. Middle frequency. 1Mbps rate.



Plot # 129. Output 6. 6 dB Bandwidth. Middle frequency. 6Mbps rate.



Plot # 130. Output 6. 6 dB Bandwidth. Low frequency. 1Mbps rate.



Plot # 131. Output 6. 6 dB Bandwidth. Low frequency. 6Mbps rate.



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Final measurements

In a reason of large margin received in pre-compliance testing the final configuration was yet based on clause 7.5.4.

The final configuration has been built with 6 Bitel RF filters.

The summaries of final minimum bandwidth measurements from output 5 are shown in Table 8.

The minimum measured bandwidth for all configurations is 9006 kHz that is comply with standard required bandwidth.

Frequency MHz	Rate Mbps	Modulation Mode	6dB Bandwidth [kHz]	Minimum Limit [kHz]	Verdict	Plot number
2412	1	802.11b	8554	500	Pass	132
	6	802.11g	15638	500	Pass	133
2437	1	802.11b	9006	500	Pass	134
	6	802.11g	14487	500	Pass	135
2462	1	802.11b	9006	500	Pass	136
	6	802.11g	15673	500	Pass	137

Table 8. 6dB bandwidth results

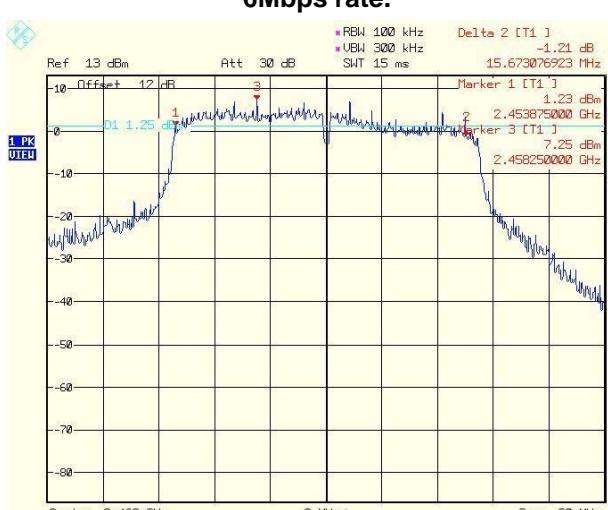
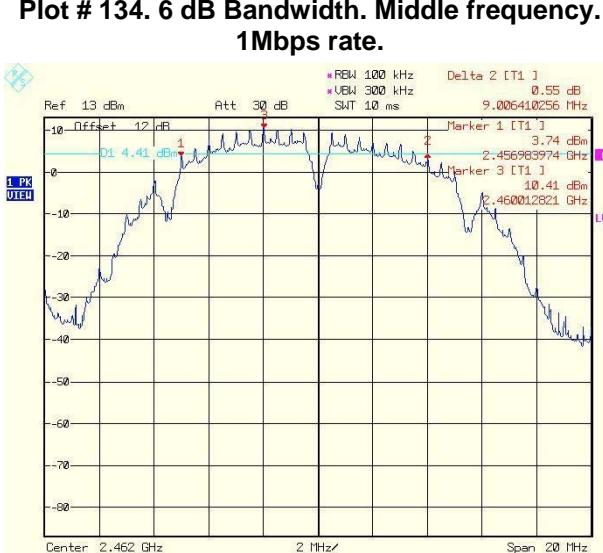
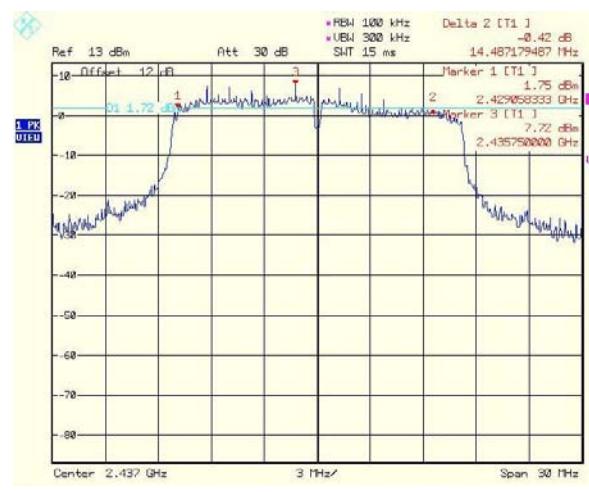
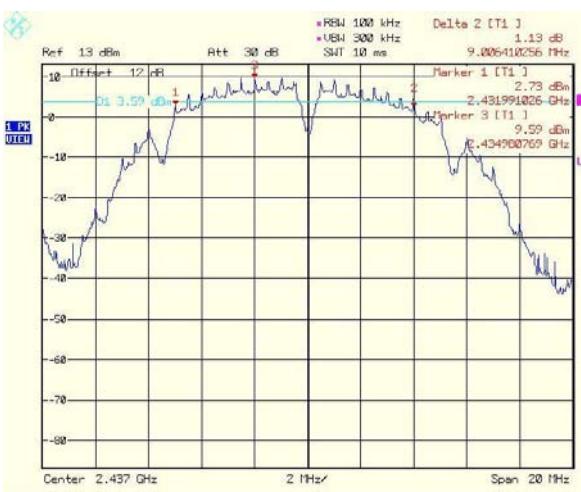
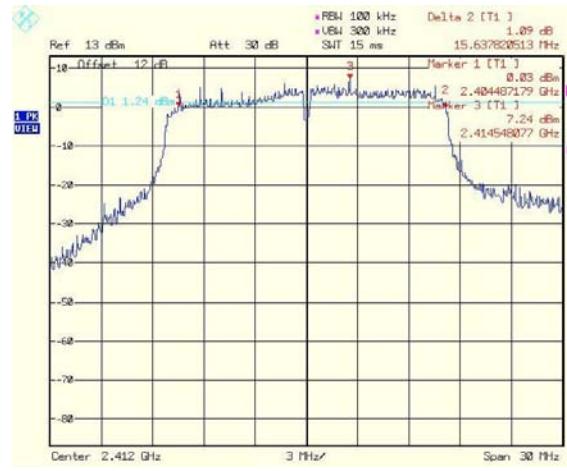
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7.9. Maximum peak output power

7.9.1. 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 7.4 dBi.
- The maximum directional antenna gain is $7.4 + 10 \log_{10}(6) = 15.2$ dBi.
- The maximum aggregate peak output limit is $30 \text{ dBm} - (15.2 - 6)/3 = 26.9$ dBm.
- The maximum peak output limit for each transmit output for each beam is $26.9 - 10 \log_{10}(6) = 19.1$ dBm.

7.9.2. Test procedure:

The tested configuration has been built with 6 Bitel RF filters.

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 2 data transfer bit rates that reflect to the worst test results.

Additionally, combined maximum peak output power was calculated and presented in table 10.

7.9.3. Test results:

All test results met the requirements.

The summaries of Peak Power measurements are shown in Tables 9-11.

Frequency MHz	Rate Mbps	Modulation mode	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	802.11b	18.34	18.44	18.28	30	19.1	0.76	138	0.66	144	0.82	150
	6	802.11g	17.16	17.34	18.18	30	19.1	1.94	139	1.76	145	0.92	151
2437	1	802.11b	18.24	18.44	18.33	30	19.1	0.86	140	0.66	146	0.77	152
	6	802.11g	18.41	18.22	18.01	30	19.1	0.69	141	0.88	147	1.09	153
2462	1	802.11b	18.01	18.28	18.39	30	19.1	1.09	142	0.82	148	0.71	154
	6	802.11g	18.20	18.25	17.83	30	19.1	0.90	143	0.85	149	1.27	155

Table 9.
Peak Power (Outputs 1-3) test results.



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Frequency MHz	Rate Mbps	Modulation mode	Output 4 Peak Power [dBm]	Output 5 Peak Power [dBm]	Output 6 Peak Power [dBm]	FCC Limit Per 15.247(b) [dBm]	Calculated Limit [dBm]	Margin [dB] Output 4	Plot number	Margin [dB] Output 5	Plot number	Margin [dB] Output 6	Plot number
2412	1	802.11b	17.97	18.59	18.46	30	19.1	1.13	156	0.51	162	0.64	168
	6	802.11g	17.16	17.26	17.45	30	19.1	1.94	157	1.84	163	1.65	169
2437	1	802.11b	18.35	15.16	18.39	30	19.1	0.75	158	3.94	164	0.71	170
	6	802.11g	18.01	15.42	18.18	30	19.1	1.09	159	3.68	165	0.92	171
2462	1	802.11b	18.37	18.73	18.83	30	19.1	0.73	160	0.37	166	0.27	172
	6	802.11g	17.99	18.35	18.56	30	19.1	1.11	161	0.75	167	0.54	173

Table 10.
Peak Power (Outputs 4-6) test results.

Frequency MHz	Rate Mbps	Modulation mode	Calculated Limit [dBm]	FCC Limit Per 15.247(b) [dBm]	FCC Limit Per 15.247(b) [W]	Calculated Limit [W]	Calculated Combined (max) Output *, Peak Power [W]	Margin [W]
2412	1	802.11b	26.9	30	1	0.49	0.41	0.08
	6	802.11g	26.9	30	1	0.49	0.33	0.16
2437	1	802.11b	26.9	30	1	0.49	0.37	0.12
	6	802.11g	26.9	30	1	0.49	0.36	0.13
2462	1	802.11b	26.9	30	1	0.49	0.42	0.07
	6	802.11g	26.9	30	1	0.49	0.40	0.09

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

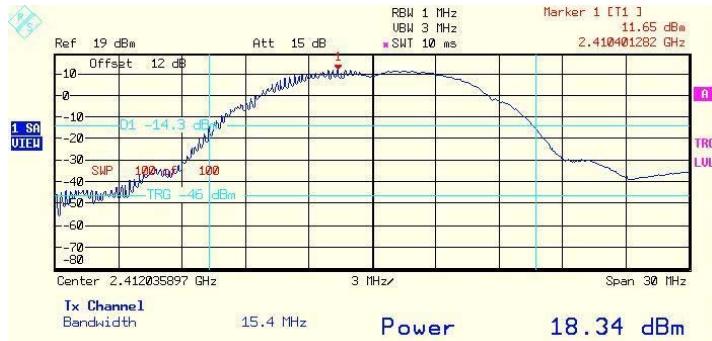
(*) - Calculated Combined (max) Output, Peak Power [W] is the sum of the measured Power from all Output terminals, where each result (output power from separate output terminal) mathematically converted from Logarithm to linear units. The results were present in Watt.

For example, the calculation for 2412 MHz frequency (1 Mbps bit rate, 802.11b modulation) is the following:

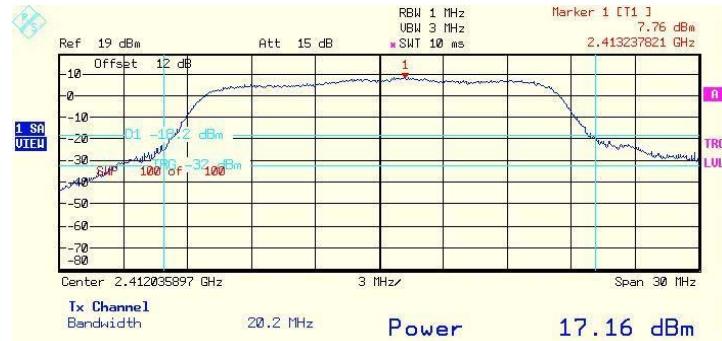
1. $18.34\text{dBm} = 0.068\text{W}$; $18.44\text{dBm} = 0.070\text{W}$; $18.28\text{dBm} = 0.067\text{W}$; $17.97\text{dBm} = 0.063\text{W}$;

$18.59\text{dBm} = 0.072\text{W}$; $18.46\text{dBm} = 0.070\text{W}$.

2. $0.068+0.070+0.067+0.063+0.072+0.070=0.41\text{[W]}$

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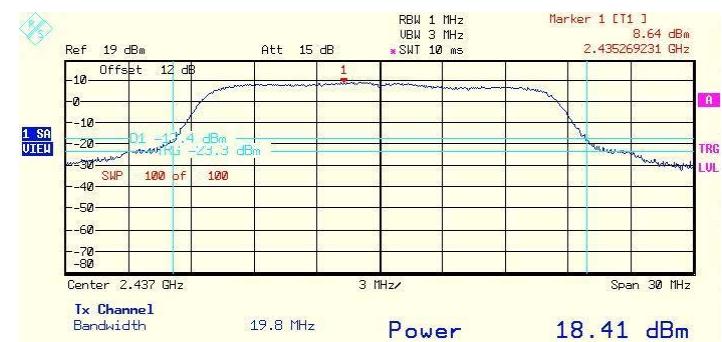
Plot # 138. Output 1 peak power. Lower frequency. 1Mbps rate.



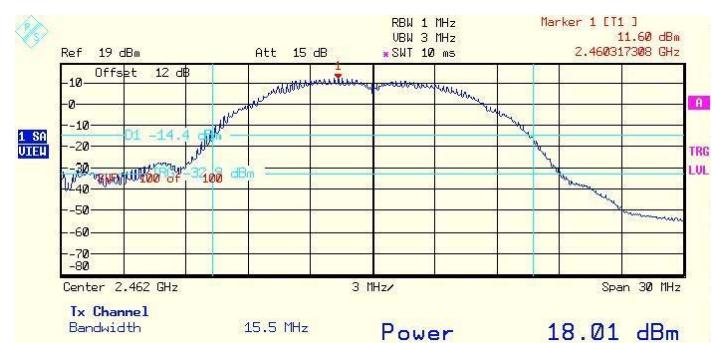
Plot # 139. Output 1 peak power. Lower frequency. 6Mbps rate.



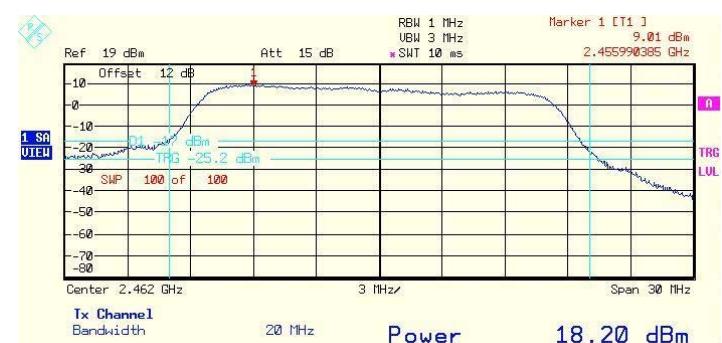
Plot # 140. Output 1 peak power. Middle frequency. 1Mbps rate.



Plot # 141. Output 1 peak power. Middle frequency. 6Mbps rate.



Plot # 142. Output 1 peak power. High frequency. 1Mbps rate.



Plot # 143. Output 1 peak power. High frequency. 6Mbps rate.