Test Report No. 8612332644

Applicant: *Wavion Ltd.*

Equipment Under Test:
2.4 GHz Band Outdoor WiFi (802.11b/g) access point

Model: *WS410*

From The Standards Institution
Of Israel
Industry Division
Electronics & Telematics Laboratory
EMC Section

ACCREDITED
Certificate No.1487-01

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Test Report No.: 8612332644 **Page 1 of 103 Pages**
Title: Test on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point
Model: WS410 **FCC ID: UGMWS410**

Applicant:	Wavion Ltd.
Address:	6 Ha'yetsira Street, Yoqne'am-Illit, 20692, Israel
Sample for test selected by:	The customer
The date of test:	22,23/05, 06/2006, 07/2006

Description of Equipment

Under Test (EUT):	2.4 GHz Band Outdoor WiFi (802.11b/g) access point
Model:	WS410
Manufactured by:	Wavion Ltd.

Reference Documents:

- **CFR 47 FCC:** Rules and Regulations; Part 15. “Radio frequency devices”; Subpart C: “Intentional radiators” (2006).

- **Test Results:** The EUT was found meeting with the relevant requirements of CFR 47 FCC Part 15 Sections: 15.205, 15.207, 15.209, 15.247.

Table of Contents

1. Applicant information

Company: Wavion Ltd.
Address : 6 Ha'yetsira Street
P.O.B.: 580
City: Yoqneam
Country : Israel

2. Test performance

Location: SII EMC Section
Wavion Ltd.
Purpose of test: Apparatus compliance verification in according with CFR 47 FCC Requirement
Test specification: CFR 47 FCC Part 15 Sections: 15.205, 15.207, 15.209, 15.247

Test	FCC Part 15	Test result
Radiated emissions in restricted bands	Sec.15.205	Complies
Radiated Emission on Radio Unit: spurious	Sec.15.209	Complies
Conducted emission	Sec.15.207	Complies
Radiated emission – general requirements	Sec.15.209	Complies
Minimum bandwidth	Sec. 15.247 (a) (2)	Complies
Maximum peak output power	Sec.15.247 (b)	Complies
Peak power spectral density	Sec.15.247 (d)	Complies
Conducted spurious emissions	Sec.15.247 (c)	Complies

Electronics and Telematics Laboratory

7 August 2006

Test performed by: Name: Albert Herzenshtein

Test report prepared by: Name: Albert Herzenshtein

Position: Engineer

3. Scope

This test report contains results measured on 2.4 GHz Band Outdoor WiFi (802.11b/g) access point (FCC ID: UGMWS410) according to the relevant requirements of CFR 47 FCC Part 15 Subpart C.

4. EUT (equipment under test) description.

4.1. General Description

The WS410 is a new category of Wi-Fi Access Point designed from the ground up for metro-Wi-Fi deployments. It is based on six antennas and radios and custom-built ASICs, utilizes Wavion's powerful multi-antenna signal processing technologies, and provides significant performance gains to off-the-shelf 802.11 standards-based Wi-Fi clients.
The WS410 Wi-Fi Access Point uses six omni-directional antennas and beam-forming technology in order to provide significant performance gains to off-the-shelf 802.11 standards-based Wi-Fi clients.

The EUT's block diagram is shown in Figure 1.

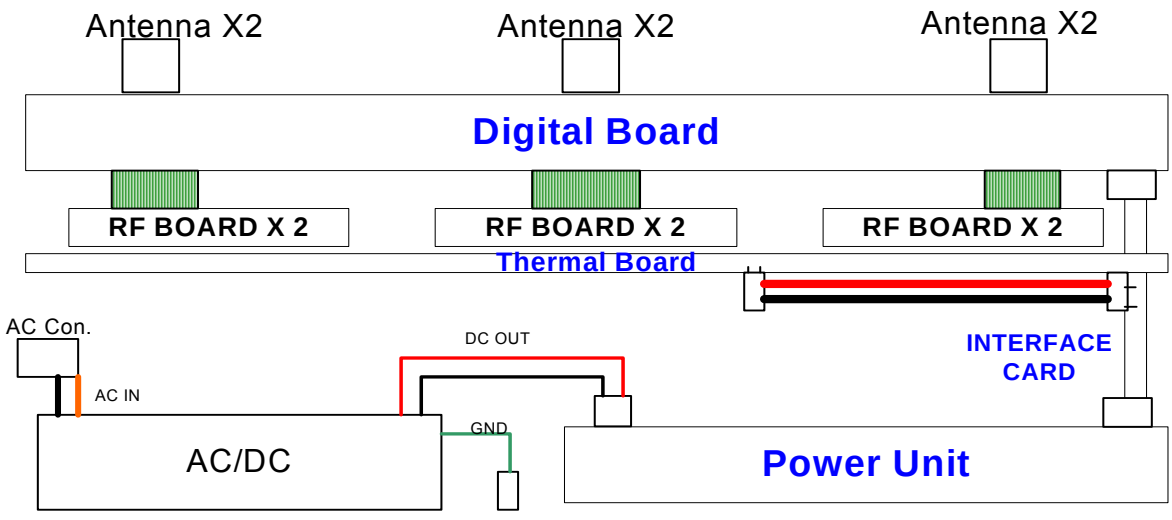


Figure 1. EUT's block diagram

4.2. EUT's sub-assemblies list.

The EUT ports and lines are detailed in Table 1.

No.	Description	Model	Manufacturer
1	Digital Board	PC00018	Wavion
2	RF Board	Tornado- PC00028	Wavion
3	Thermal Board	PC00029	Wavion
4	Interface card	PC00023	Wavion
5	AC/DC	HWS150-48	Nemic Lambda
6	AC Connector	50909	Remke
7	Antenna	SF-245W	Comet
8	Power Unit	PC00019	Wavion

Table 1. Sub-assemblies list

4.3. EUT ports and lines.

The EUT ports and lines are detailed in Table 2.

Port Type	Port Description	Connected from / to	Connector type	Qty.	Cable Type	Cable Length
AC Power	AC inlet	Wall outlet/Power TAP-inlet	Standard	1	Unshielded	20fit
Data	Data/HPoE	HPoE injector	RJ-45 shielded	1	CAT-5e	Up to 100m
Data	Data/PoE	PD-Client	RJ-45 shielded	1	CAT-5e	Up to 100m

Table 2. The EUT ports and lines

4.4. Potential emission source:

The potential emission sources are detailed in Table 3.

Frequency	Location	Remarks
40 MHz	On board	Crystal Oscillator

Table 3. Potential emission sources

4.5. EUT technical characteristic

Type of equipment								
	Stand-alone (Equipment with or without its own control provisions)							
Intended use		**Condition of use**						
	Fixed	Always at a distance more than 2 m from all people						
Assigned frequency range		2402MHz to 2472MHz						
Operating frequency range		2412MHz to 2462MHz (WLAN channels 1 to 11)						
RF channel spacing		5MHz						
Maximum rated output power		At transmitter 50 Ω RF output connector		15dBm@2412MHz				
				19dBm@2437MHz				
				16dBm@2462MHz				
Is transmitter output power variable?								
			Yes	minimum RF power	4dBm			
				maximum RF power	19dBm			
Antenna connection								
	unique coupling	V (N-Type)	standard connector		integral		with temporary RF connector	
						V	without temporary RF connector	

External antenna/s technical characteristics

Type	Manufacturer	Model number	Gain
7.4dBi	Comet	SF-245W	7.4dBi
7.4dBi	MTI	MT-342015/NV/A	7.4dBi

Transmitter 99% power bandwidth	12000kHz to 16000kHz				
Transmitter aggregate data rate/s (min-maximum)	1Mbps to 54Mbps				
Type of modulation	OFDM, DSSS, CCK				
Type of multiplexing	CSMA/CA				
Modulating test signal (baseband)	Random data				
Maximum transmitter duty cycle in normal use	90.%	Tx ON time	…X….msec	Period	…X….msec
Transmitter duty cycle supplied for test	100%	Tx ON time	…X….msec	Period	…X….msec

Transmitter power source						
V	DC	**Nominal rated voltage**	HPoE 58VDC			
V	AC mains	**Nominal rated voltage**	90-480VAC	Frequency: 50/60Hz	90-265VAC: 50-60Hz 480VAC: 60Hz	

Spread spectrum technique used	Frequency hopping (FHSS)	
	Digital transmission system (DTS)	V
	Hybrid	

Spread spectrum parameters for transmitters tested per FCC 15.247 only		
DSSS	chip sequence length	11bits
	spectrum width	12MHz

5. Test configuration:

1. For Radiated emission measurements per sec. 15.209 requirements the EUT was configured for tests as shown in Figure 2.
2. For transmitter measurements per sec. 15.247 requirements the EUT was configured for tests as shown in Figure 3.
3. For Radiated emission measurements per sec. 15.205 requirements the Radio unit was tested with integral antenna, detailed in Table 4.

Mnuf.	Freq. Range GHz	Gain dBi	Model	Type
Comet	2.4-2.4835	7.4	SF-245W	Omni-directional

Table 4. Details of antenna used in WS410.

5.1. Support and test equipment

The potential emission sources are detailed in Table 5.

Description	Manufacturer	Model
AC/DC adaptor	Nemic Lambda	HWS150-48
Lap top	IBM	2648-KU2
Power Splitter (Combiner)	ZB8PD-4-S	Micro-Circuits

Table 5. Potential emission sources

RF output terminated by 50Ω

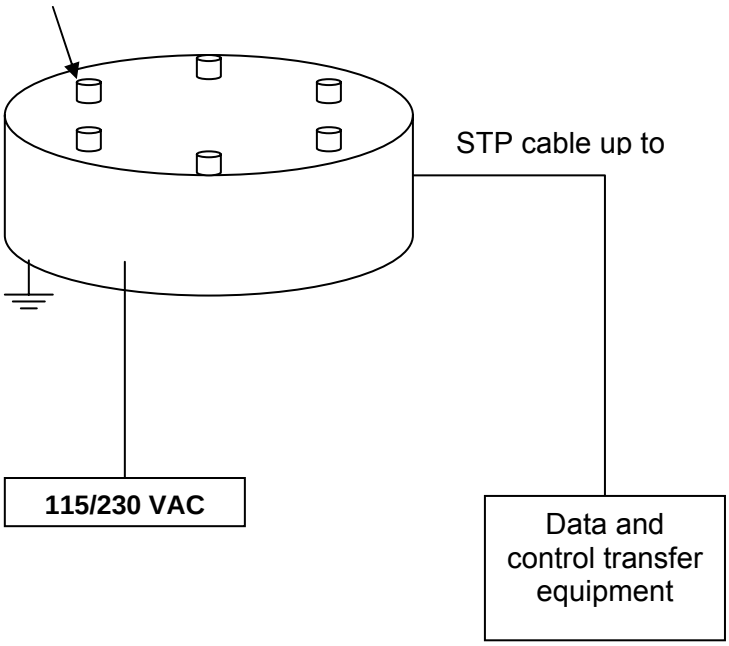


Figure 2. Radiated emission test setup

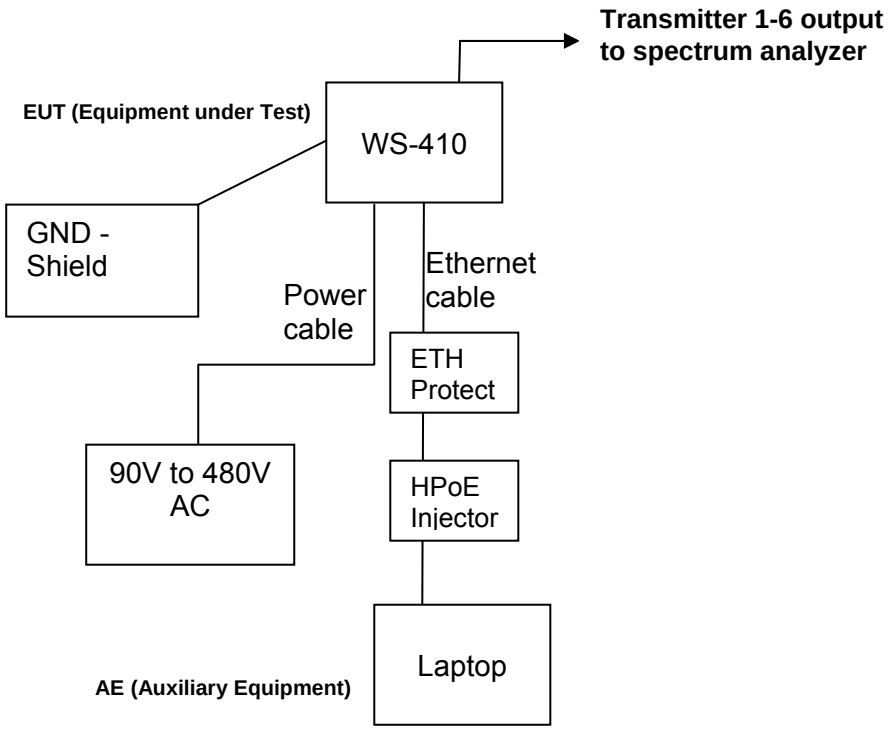


Figure 3. Transmitter measurements test setup

5.2. ***Environmental evaluation and exposure limit according to FCC CFR 47 part 1, §1.1307, §1.1310***

Limit for power density for general population/uncontrolled exposure is 1 mW/cm^2.

The power density P (mW/cm^2) = Pt /4π r^2.

Where:

Pt - The transmitted power (EIRP) (mW)

Pt- the transmitted power whish is equal to the output power 19 dBm plus maximum antenna gain – 7.4 dBi

r - The distance from the unit. (cm)

The 1(mW/cm^2) limit can be calculated from the above based on the following data:

The maximum EIRP for each transmit output = 26.4 dBm = 436 mW

r = sqrt(436/4π) = 5.9 cm

For aggregate Pt- the transmitted power whish is equal to the output power 26.9 dBm plus maximum directional antenna gain – 15.2 dBi

The maximum aggregate EIRP = 42.1 dBm = 16218 mW:

r = sqrt(16218/4π) = 35.9 cm

The allowed distance “r”, where RF exposure limits may not be exceeded, is 35.9 cm from the unit antenna main lobe.

The EUT with the attached antenna are mounted only outside the building on the high level pole or wall, which are above general public, see the manufacturer instructions for installation provided in attached documentation.

6. Test specification, Methods and Procedures

Test Specification:

- CFR 47 FCC: Rules and Regulations; Part 15. “Radio frequency devices”;
  Subpart C: “Intentional radiators” (2006).

Methods and Procedures:

- ANSI C63/4/2003: "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz”.

7. Measurements, examinations and derived results

7.1. *Location of the Test Site:*

The tests were conducted in the EMC laboratory of the Standards Institution of Israel in Tel-Aviv, in Wavion's laboratory and at open test site located at Kibbutz Native Halamed Hai in Emek HaEla, Israel.

7.2. *Normal test condition:*

Temperature: 22 °C
Humidity: 50 %

7.3. Conducted emission test (per Section 15.207):

7.3.1. Requirements:

The EUTs conducted emission within the band 150 kHz to 30 MHz shall not exceed value required in section 15.207 (a).

Frequency of emission (MHz)	Conducted limit (dBµV)	
	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.

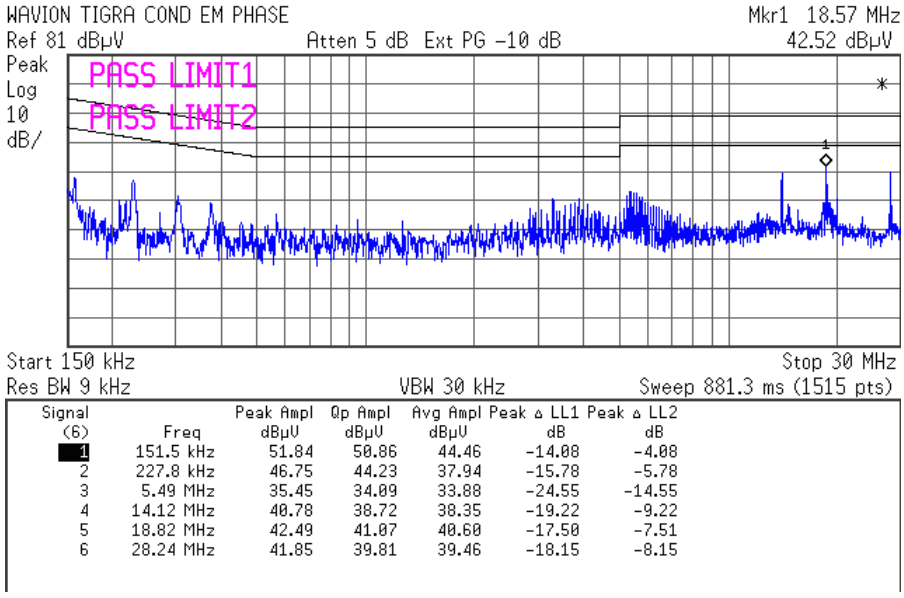
7.3.2. Test procedure:

Each EUT was placed on a non-metallic table in a shielded chamber at a height of 80 cm from the floor and 40 cm from the nearest wall.
The EUT was operated to transmitting through the customer software.
First, initial scans 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 4 data transfer bit rates. The worst results from all measurements (2437MHz frequency, 1Mbps bit rate) are presented at the plots 1 and 2.
Test equipment (EMI receiver) setup was as follow:

Initial scan:	
Detector type	Peak
Mode	Max hold
Bandwidth	9 kHz
Step size	Continuous sweep
Sweep time	>100 msec
Measurements	
Detector type	Quasi-peak, Avg (CISPR)
Bandwidth	9 kHz
Measurement time	200 seconds/MHz
Observation	>15 seconds

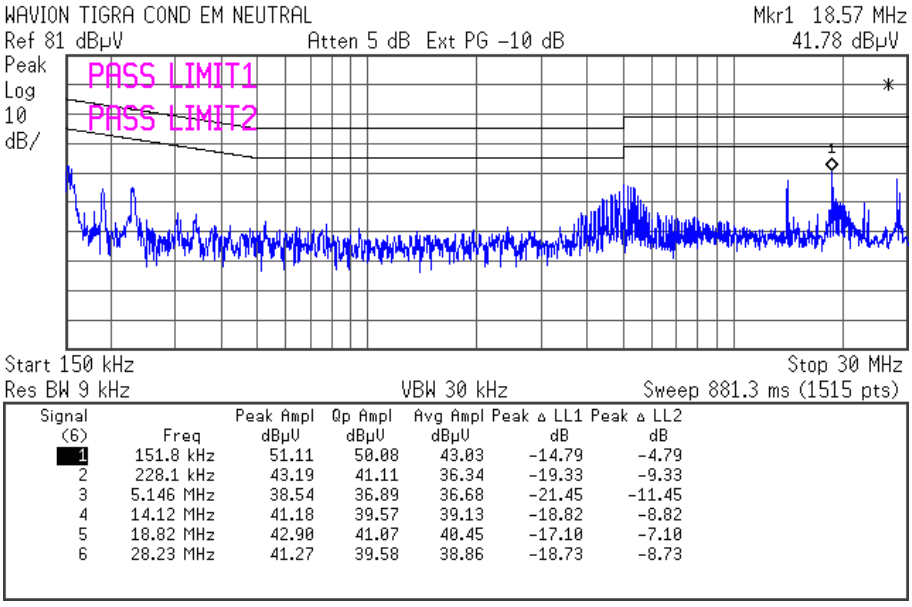
7.3.3. Test results:

The test results were found complies with relevant standard requirements.
Test results are shown in Plots #1, 2.



Signal (6)	Freq	Peak Ampl dBµV	Qp Ampl dBµV	Avg Ampl dBµV	Peak Δ LL1 dB	Peak Δ LL2 dB
1	151.5 kHz	51.84	50.86	44.46	-14.08	-4.08
2	227.8 kHz	46.75	44.23	37.94	-15.78	-5.78
3	5.49 MHz	35.45	34.09	33.88	-24.55	-14.55
4	14.12 MHz	40.78	38.72	38.35	-19.22	-9.22
5	18.82 MHz	42.49	41.07	40.60	-17.50	-7.51
6	28.24 MHz	41.85	39.81	39.46	-18.15	-8.15

Plot # 1. Conducted emissions measurement result on 110 VAC power line: phase



Signal (6)	Freq	Peak Ampl dBµV	Qp Ampl dBµV	Avg Ampl dBµV	Peak Δ LL1 dB	Peak Δ LL2 dB
1	151.8 kHz	51.11	50.08	43.03	-14.79	-4.79
2	228.1 kHz	43.19	41.11	36.34	-19.33	-9.33
3	5.146 MHz	38.54	36.89	36.68	-21.45	-11.45
4	14.12 MHz	41.18	39.57	39.13	-18.82	-8.82
5	18.82 MHz	42.90	41.07	40.45	-17.10	-7.10
6	28.23 MHz	41.27	39.58	38.86	-18.73	-8.73

Plot # 2. Conducted emissions measurement result on 110 VAC power line: neutral

7.4. Radiated emission test, general requirements (per section 15.209):

7.4.1. Requirements:

The EUT's radiated emission shall not exceed value required in section 15.209.

7.4.2. Test description:

The measurements were performed at the Open Area Test Site.
The test configuration is shown in Fig.2.
The EUT was arranged on a non-metallic table 0.8 m placed on the turn-table.
The measurements were performed at a 10 m measurement distance.
The Biconilog 30 MHz-2 GHz antenna was used.
The frequency range was investigated from 30 MHz to 2 GHz.
The measurements were performed at each frequency at which the signal was 10 dB below the limit or less.
The level were maximized by initially rotating turntable through 360°, varying the antenna height between 1 m and 4 m, rerouting EUT cables and changing antenna polarization from vertical to horizontal. The measuring equipment settings were:

Initial scan:	
Detector type	Peak
Mode	Max hold
Bandwidth	120 kHz
Step size	Continuous sweep
Sweep time	>1 seconds/MHz
Measurements:	
Detector type	Quasi-peak (CISPR 16)
Bandwidth	120 kHz
Measurement time	20 seconds/MHz
Observation	>15 seconds

7.4.3. Radiated emission test results:

The test results were found complies with relevant standard requirements.
Test results are presented in Table 6.

Table 6. Radiated emission test results
FCC Part 15 section 15.209

Frequency (MHz)	Turn-table Angle (°)	Antenna Polariz.	Antenna Height (m)	Emission Level Note 1 (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin Note 2 (dB)	Results
37.7	217	V	1.95	38.7	40	1.3	Complies
41.3	165	V	1.65	37.8	40	2.2	Complies
44.0	244	V	2.44	37.7	40	2.3	Complies
148.3	202	V	1.21	37.0	43.5	6.5	Complies
216.5	141	H	1.76	36.6	46	9.4	Complies
268.4	122	H	3.84	39.5	46	6.5	Complies
284.0	5	H	1.41	38.3	46	7.7	Complies

Note 1: Emission level = E Reading (dBμV) + Cable loss (dB) + Antenna Factor (dB/m) + 10 dB

Where 10 dB is an extrapolation distance factor.
For Cable Loss and Antenna Factor refer to Appendix 2.

Note 2: Margin (dB) = Limit (dBμV/m) – Emission level (dBμV/m)

7.5. Radiated emission test on Radio Unit – spurious (per Section 15.209):

7.5.1. Requirements:

The levels of any unwanted emission shall not exceed value required in section 15.209.

7.5.2. EUT configuration:

The radio unit was tested with Omni-directional antenna model SF-245W.

7.5.3. 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.
The emission levels of the EUT more than 20 dB lower than the specified limit were not recorded in the tables. For the test results refer to relevant Plots.
Test results found in 30 – 2000 MHz are brought in section 7.4 of this test report.

Antenna height = 1 m.
Polarization: Vertical/Horizontal
Measurement distance = 3m.
The frequency range was investigated up to 40 GHz.
The measurements were performed in vertical and horizontal polarization, the maximum reading recorded.
Measuring detector function and bandwidths:

Detector type	Peak
Resolution bandwidth	1MHz
Video bandwidth	1 MHz
Detector type	Average
Resolution bandwidth	1MHz
Video bandwidth	3 kHz

7.5.4. Radiated emission test results and calculation ratio:

The test results are shown in Table 7.
The emission level was calculated as:
E Reading (dBμV) + measuring cable loss (dB) + measuring antenna factor (dB/m) + Distance correction factor
For measuring cable loss and measuring antenna factor refer to Appendix 2.
Distance correction factor = -9.5 dB (an extrapolation reading from 1 m measuring distance to 3m specified distance)

Table 7. Spurious emissions test results

Antenna P/N: SF-245W

Frequency (GHz)	Emission Level (dBμV/m)		Limit @ 3m (dBμV/m)		Margin (dB)		Results
	Average	Peak	Average	Peak	Average	Peak	
LOW 2.412 GHz							
4.824	Noise floor	Noise floor	54	74	20dB at least	20dB at least	Complies
12.06	Noise floor	Noise floor			20dB at least	20dB at least	Complies
14.47	Noise floor	Noise floor			20dB at least	20dB at least	Complies
19.3	Noise floor	Noise floor			20dB at least	20dB at least	Complies
MIDDLE 2.437 GHz							
4.874	Noise floor	Noise floor	54	74	20dB at least	20dB at least	Complies
7.311	Noise floor	Noise floor			20dB at least	20dB at least	Complies
12.19	Noise floor	Noise floor			20dB at least	20dB at least	Complies
19.5	Noise floor	Noise floor			20dB at least	20dB at least	Complies
HIGH 2.462 GHz							
4.924	Noise floor	Noise floor	54	74	20dB at least	20dB at least	Complies
7.386	Noise floor	Noise floor			20dB at least	20dB at least	Complies
12.1	Noise floor	Noise floor			20dB at least	20dB at least	Complies
19.7	Noise floor	Noise floor			20dB at least	20dB at least	Complies
22.16	Noise floor	Noise floor			20dB at least	20dB at least	Complies

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

7.6.1. Requirements:

Radiated emission in restricted bands should meet the requirements sec. 15.205.
The following frequency bands should be measured:
Operating Frequency Range 2.412 – 2.462 GHz

7.6.2. EUT configuration:

The radio unit was tested with all six Omni-directional antennas (model SF-245W) connected to EUT, as it shown on the photos 3-4.

7.6.3. 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.
Measuring antennas used: Up to 18 GHz - Double Ridge EMCO model 3115
First, initial scans were performed in normal (transmitting) mode of operation for carrier (channel) frequency at low, middle and the high of the 2412 - 2462 MHz frequency range under 4 data transfer bit rates. The Output Power (15dBm for the 2412MHz frequency; 19dBm for the 2437MHz frequency; 16dBm for the 2462MHz frequency) 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 7.6.4 and at the plots 3-18.

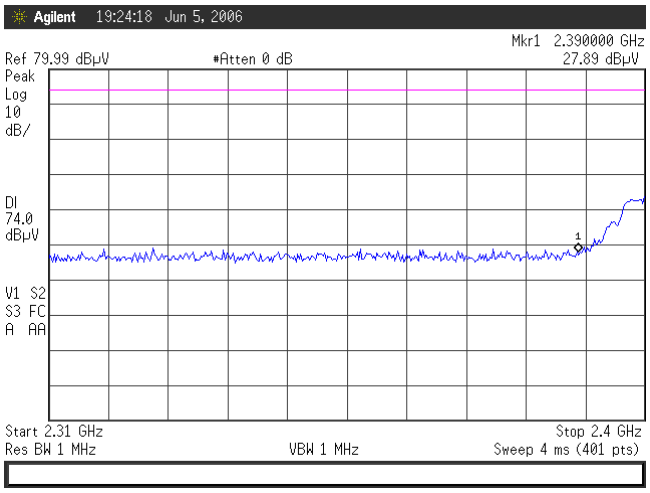
Antenna height = 1 m.
Measurement distance = 3m.
Measuring detector function and bandwidths:

Detector type	Peak	Average
RBW	1MHz	1MHz
VBW	1 MHz	30 Hz

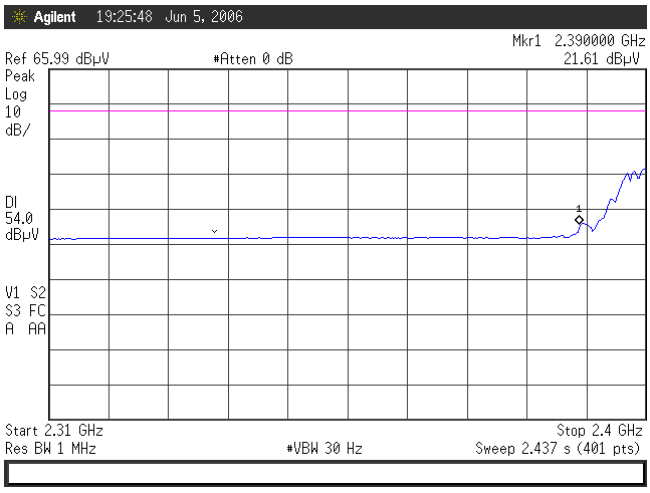
7.6.4. Test results and calculation ratio:

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

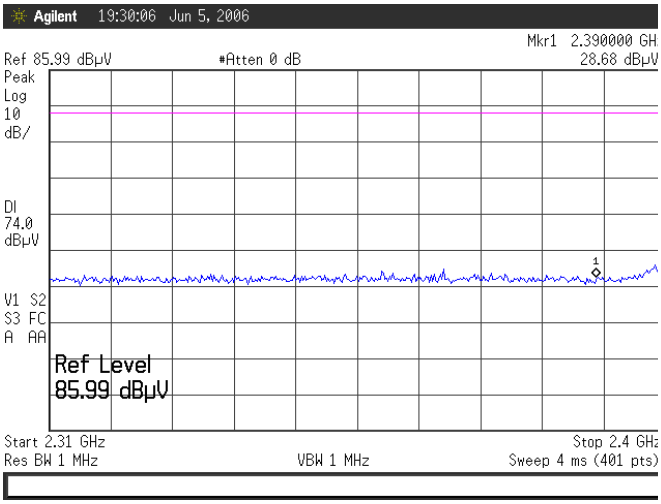
Band edge Freq. MHz	Pol V/H	Rate, Mbps	Read Pk, dBµV	Read Avg, dBµV	AF, dB	Peak, dBµV/m	Avg, dBµV/m	Peak Limit, dB(µV/m)	Avg Limit, dB(µV/m)	Peak Margin dB	Avg Margin dB	Verdict	Plot Number
Transmitting on Low (2.412GHz) frequency.													
2390	V	1	27.89	21.61	30	57.89	51.61	74	54	16.11	2.39	Pass	3,4
2390	H	1	28.68	17.8	30	58.68	47.8	74	54	15.32	6.2	Pass	5,6
2390	V	6	38.7	23.07	30	68.7	53.07	74	54	5.3	0.93	Pass	7,8
2390	H	6	29.51	17.36	30	59.51	47.36	74	54	14.49	6.64	Pass	9,10
Transmitting on High (2.462GHz) frequency.													
2483.5	V	1	35.14	22.82	30	65.14	52.82	74	54	8.86	1.18	Pass	11,12
2483.5	H	1	29.78	18.12	30	59.78	48.12	74	54	14.22	5.88	Pass	13,14
2483.5	V	6	34.28	22.51	30	64.28	52.51	74	54	9.72	1.49	Pass	15,16
2483.5	H	6	29.12	17.74	30	59.12	47.74	74	54	14.88	6.26	Pass	17,18



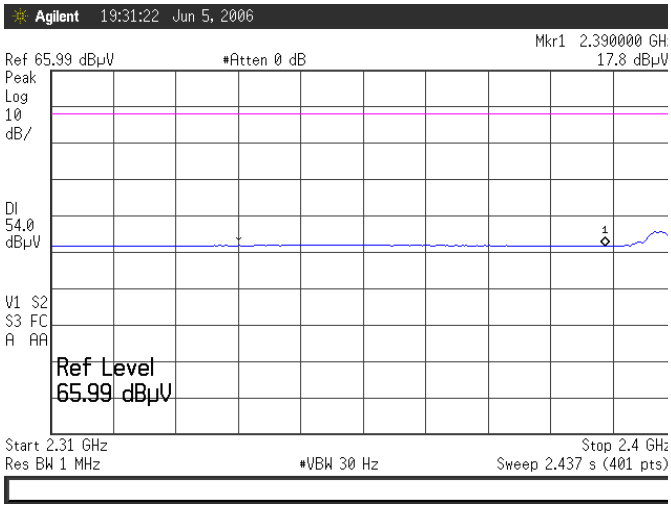
Plot # 3. Low frequency 1Mbps rate. 802.11b;Peak;Vertical.



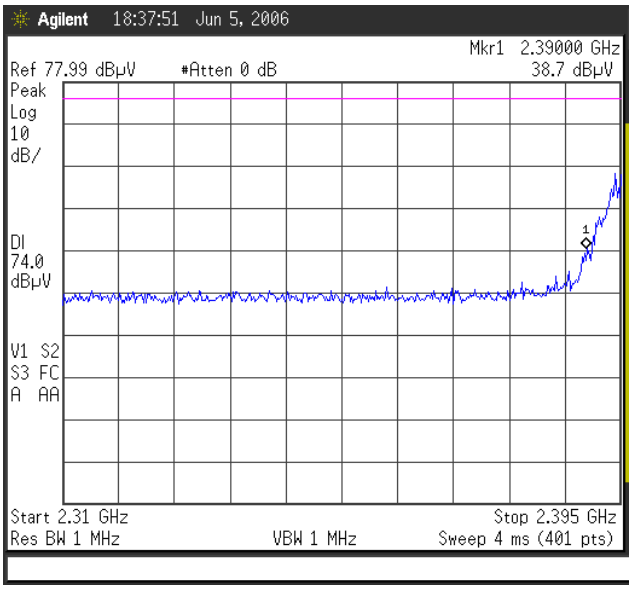
Plot # 4. Low frequency 1Mbps rate. 802.11b;AVG;Vertical.



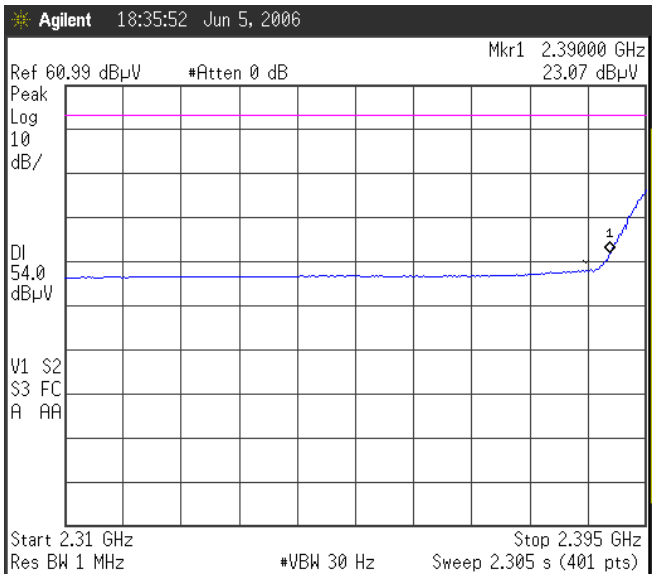
Plot # 5. Low frequency 1Mbps rate. 802.11b;Peak; Horizontal.



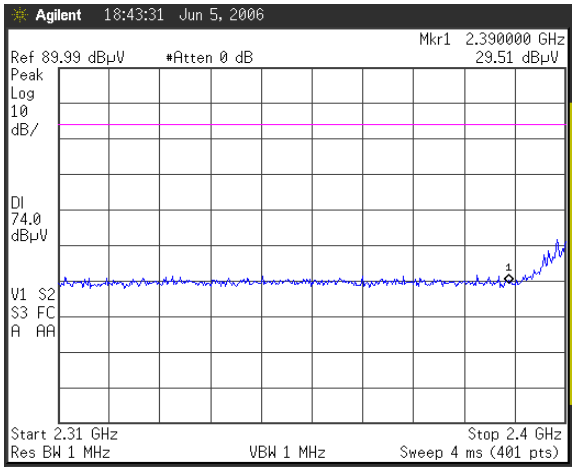
Plot # 6. Low frequency 1Mbps rate. 802.11b;AVG; Horizontal.



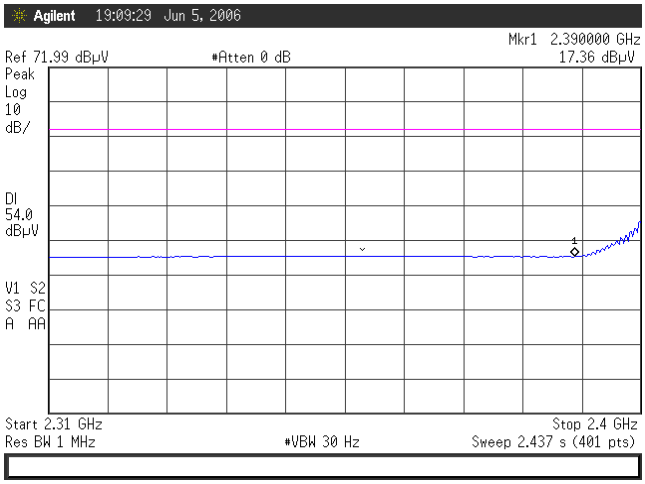
Plot # 7. Low frequency 6Mbps rate. 802.11g; Peak; Vertical.



Plot # 8. Low frequency 6Mbps rate. 802.11g; AVG; Vertical.



Plot # 9. Low frequency 6Mbps rate. 802.11g; Peak; Horizontal.



Plot # 10. Low frequency 6Mbps rate. 802.11g; AVG; Horizontal.

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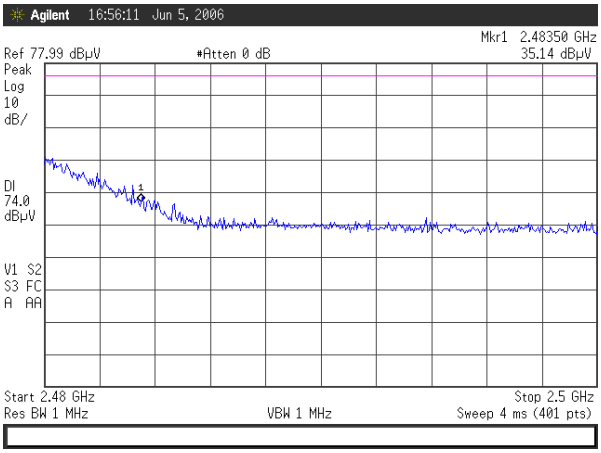
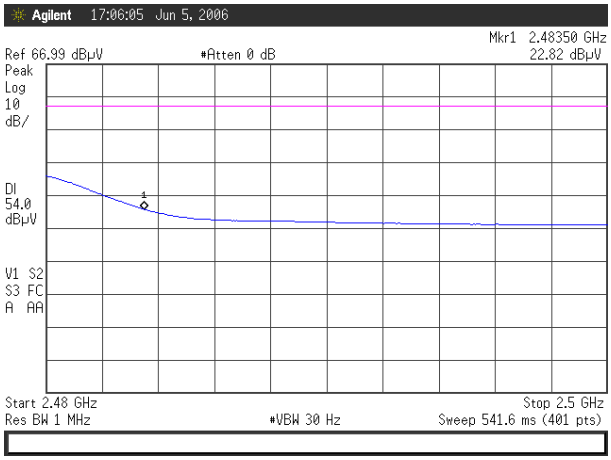
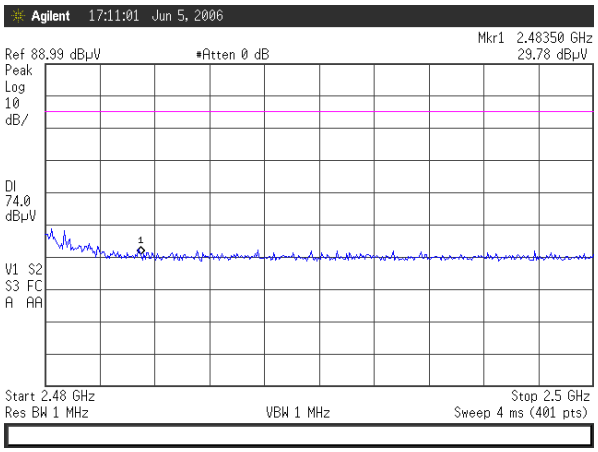
Model: WS410 **FCC ID: UGMWS410**



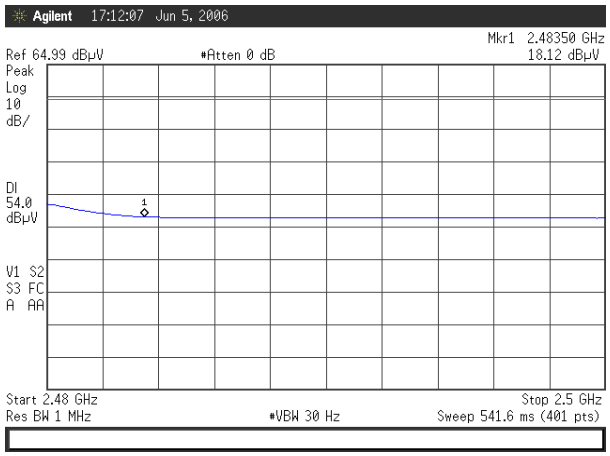
Plot # 11. High frequency 1Mbps rate. 802.11b;Peak; Vertical.



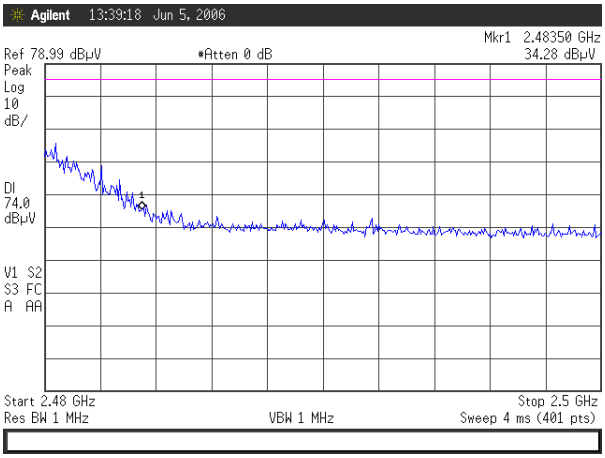
Plot # 12. High frequency 1Mbps rate. 802.11b;AVG; Vertical.



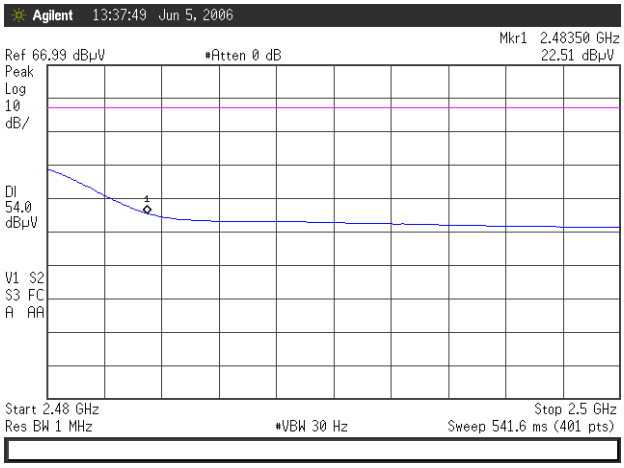
Plot # 13. High frequency 1Mbps rate. 802.11b;Peak; Horizontal.



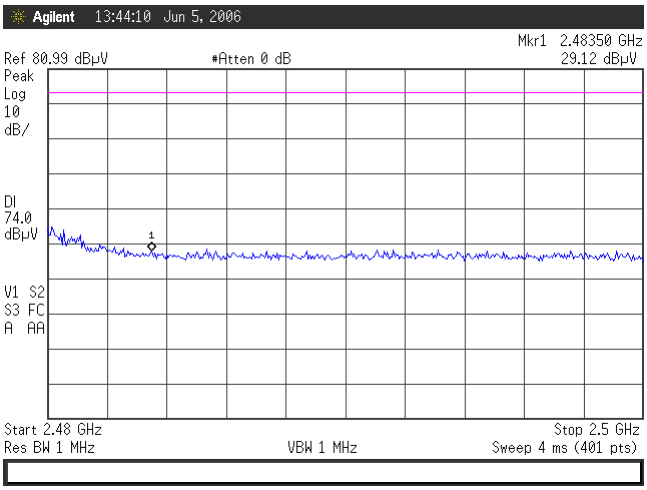
Plot # 14. High frequency 1Mbps rate. 802.11b;AVG; Horizontal.



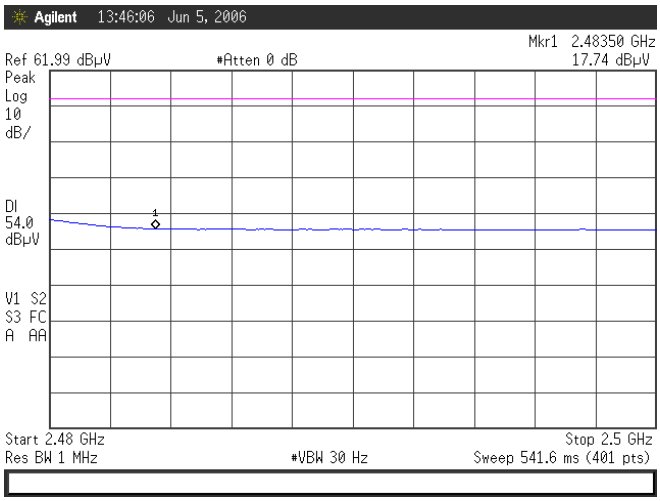
Plot # 15. High frequency 6Mbps rate. 802.11g; Peak; Vertical.



Plot # 16. High frequency 6Mbps rate. 802.11g; AVG; Vertical.



Plot # 17. High frequency 6Mbps rate. 802.11g; Peak; Horizontal.



Plot # 18. High frequency 6Mbps rate. 802.11g; AVG; Horizontal.

8. Transmitter characteristics.

8.1. Minimum bandwidth

8.1.1. Requirements:

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

8.1.2. 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 4 data transfer bit rates, that reflect to the worst test results.
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.

8.1.3. Test results:

The summaries of minimum bandwidth measurements are shown in Table 8.
The minimum measured bandwidth for all configurations is 8077 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	9038	500	Pass	27
	11	802.11b	9263	500	Pass	28
	6	802.11g	15722	500	Pass	29
	54	802.11g	15962	500	Pass	30
2437	1	802.11b	8077	500	Pass	23
	11	802.11b	9135	500	Pass	24
	6	802.11g	16346	500	Pass	25
	54	802.11g	16442	500	Pass	26
2462	1	802.11b	9471	500	Pass	19
	11	802.11b	9800	500	Pass	20
	6	802.11g	16106	500	Pass	21
	54	802.11g	16240	500	Pass	22

Table 8. 6dB bandwidth results

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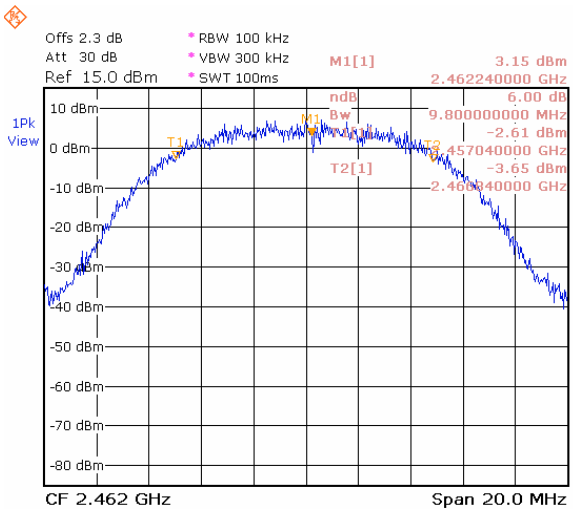
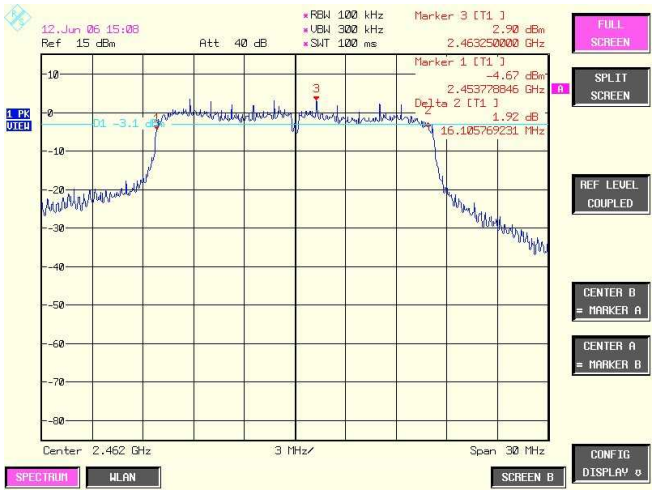
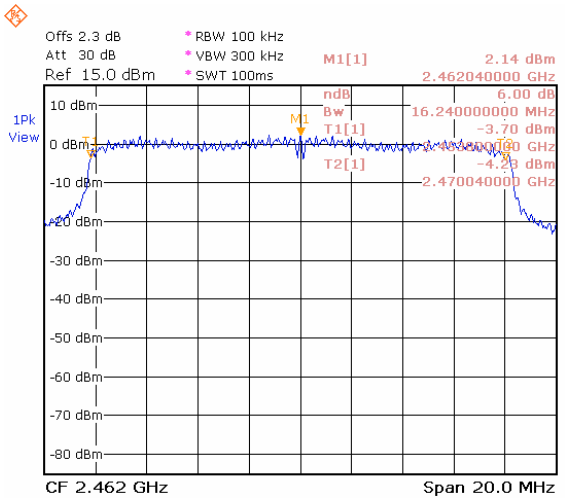
Plot # 19. 6 dB Bandwidth. High frequency. 1Mbps rate.



Plot # 20. 6 dB Bandwidth. High frequency. 11Mbps rate.

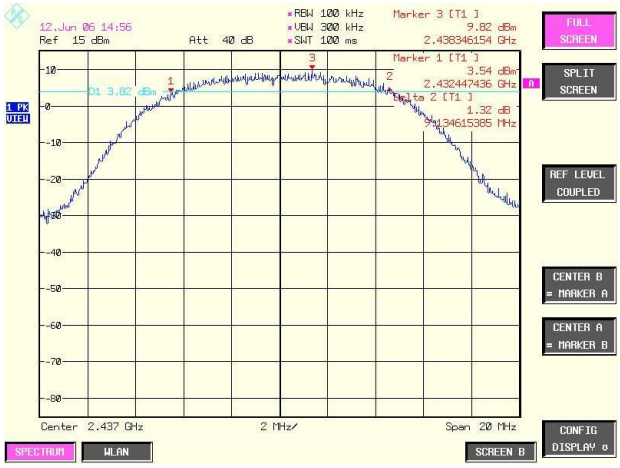


Plot # 21. 6 dB Bandwidth. High frequency. 6Mbps rate.

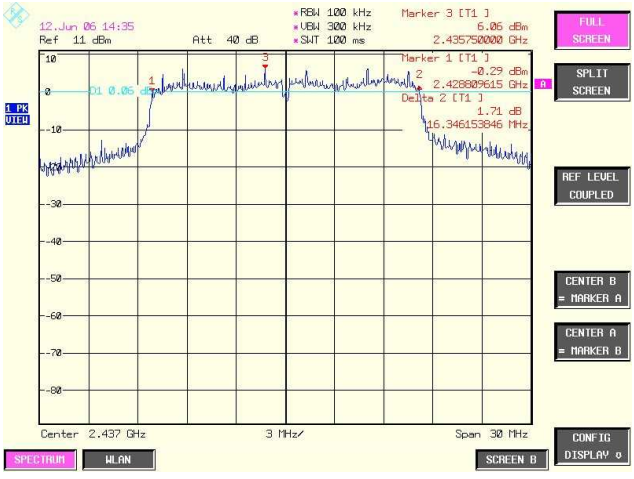


Plot # 22. 6 dB Bandwidth. High frequency. 54 Mbps rate.

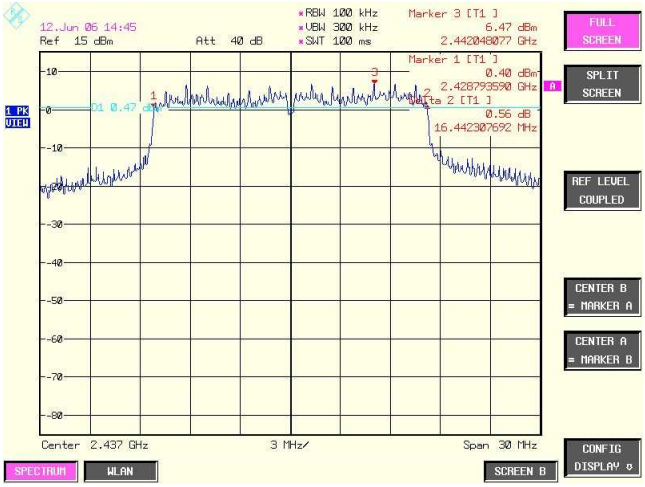
Plot # 23. 6 dB Bandwidth. Middle frequency. 1Mbps rate.



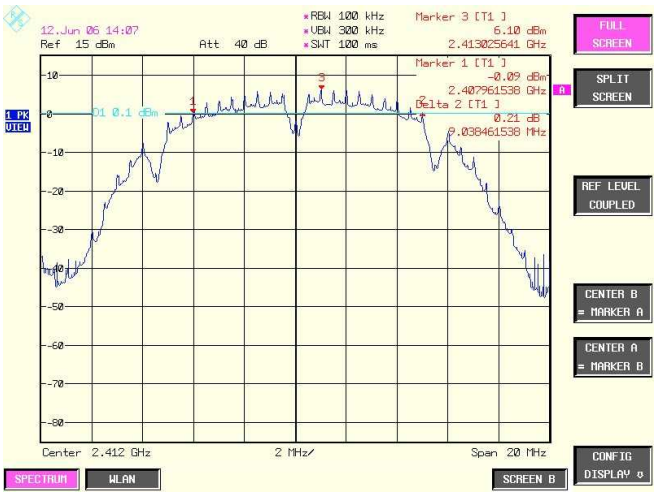
Plot # 24. 6 dB Bandwidth. Middle frequency. 11Mbps rate.



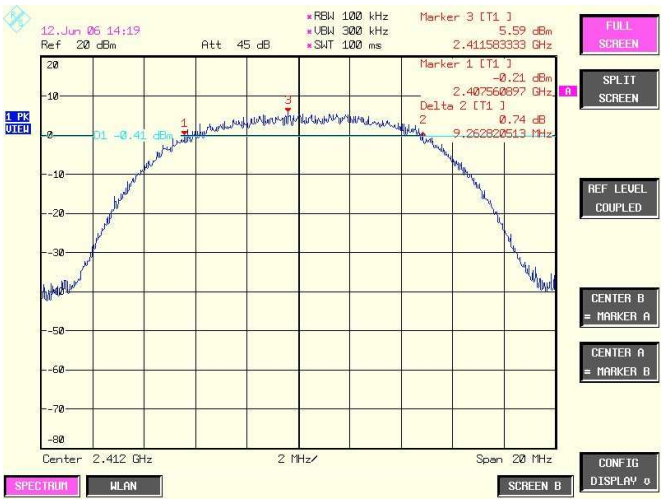
Plot # 25. 6 dB Bandwidth. Middle frequency. 6Mbps rate.



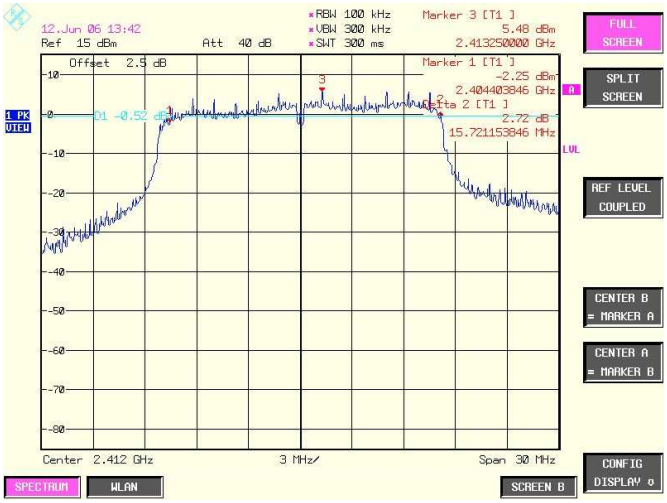
Plot # 26. 6 dB Bandwidth. Middle frequency. 54 Mbps rate.



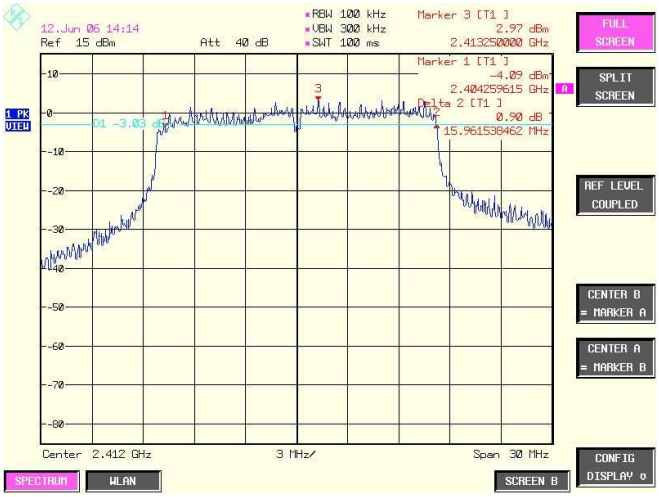
Plot # 27. 6 dB Bandwidth. Low frequency. 1Mbps rate.



Plot # 28. 6 dB Bandwidth. Low frequency. 11Mbps rate.



Plot # 29. 6 dB Bandwidth. Low frequency. 6Mbps rate.



Plot # 30. 6 dB Bandwidth. Low frequency. 54 Mbps rate.

8.2. Maximum peak output power

8.2.1. 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.

- 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 peak output limit is 30 dBm – (15.2-6)/3 =26.9 dBm.
- The maximum peak output limit for each transmit output is $26.9-10*\log_{10}(6)=19.1$ dBm.

8.2.2. 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 at each transmit output under 4 data transfer bit rates, that reflect to the worst test results. Additionally, all transmitter outputs were aggregated through a combiner, and the combined output was tested.

Detector type	Sample
RBW	1MHz
VBW	3 MHz

8.2.3. Test results:

All test results met the requirements.
The summary 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 [dBm] Output 1	Plot number	Margin [dBm] Output 2	Plot number	Margin [dBm] Output 3	Plot number
2412	1	802.11b	14.33	14.46	14.53	30	15	0.67	31	0.54	43	0.47	55
	11	802.11b	14.29	14.52	14.53	30	15	0.71	32	0.48	44	0.47	56
	6	802.11g	14.85	14.95	14.84	30	15	0.15	33	0.05	45	0.16	57
	54	802.11g	14.68	14.73	14.77	30	15	0.32	34	0.27	46	0.23	58
2437	1	802.11b	18.34	18.58	18.49	30	19	0.66	35	0.42	47	0.51	59
	11	802.11b	18.42	18.74	18.56	30	19	0.58	36	0.26	48	0.44	60
	6	802.11g	18.38	18.52	18.57	30	19	0.62	37	0.48	49	0.43	61
	54	802.11g	18.32	18.60	18.39	30	19	0.68	38	0.4	50	0.61	62
2462	1	802.11b	15.82	15.60	15.32	30	16	0.18	39	0.4	51	0.68	63
	11	802.11b	15.81	15.50	15.38	30	16	0.19	40	0.5	52	0.62	64
	6	802.11g	15.94	15.79	15.77	30	16	0.06	41	0.21	53	0.23	65
	54	802.11g	15.79	15.65	15.49	30	16	0.21	42	0.35	54	0.51	66

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

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 [dBm] Output 4	Plot number	Margin [dBm] Output 5	Plot number	Margin [dBm] Output 6	Plot number
2412	1	802.11b	14.43	14.4	14.48	30	15	0.57	67	0.6	79	0.52	91
	11	802.11b	14.4	14.23	14.47	30	15	0.6	68	0.77	80	0.53	92
	6	802.11g	14.7	14.64	14.82	30	15	0.3	69	0.36	81	0.18	93
	54	802.11g	14.7	14.49	14.58	30	15	0.3	70	0.51	82	0.42	94
2437	1	802.11b	18.7	18.79	18.53	30	19	0.3	71	0.21	83	0.47	95
	11	802.11b	18.78	18.69	18.59	30	19	0.22	72	0.31	84	0.41	96
	6	802.11g	18.71	18.88	18.77	30	19	0.29	73	0.12	85	0.23	97
	54	802.11g	18.57	18.62	18.50	30	19	0.43	74	0.38	86	0.5	98
2462	1	802.11b	15.58	15.34	15.72	30	16	0.42	75	0.66	87	0.28	99
	11	802.11b	15.80	15.40	15.69	30	16	0.2	76	0.6	88	0.31	100
	6	802.11g	15.84	15.68	15.84	30	16	0.16	77	0.32	89	0.16	101
	54	802.11g	15.77	15.54	15.72	30	16	0.23	78	0.46	90	0.28	102

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

Frequency MHz	Rate Mbps	Modulation mode	Combined Output Peak Power [dBm]	FCC Limit Per 15.247(b) [dBm]	Calculated Limit [dBm]	Margin [dBm]	Combined Output Peak Power [W]	FCC Limit Per 15.247(b) [W]	Calculated Limit [W]	Margin [W]	Plot number	Calculated Combined (max) Output *, Peak Power [W]	Margin [W]
2412	1	802.11b	24.38	30	26.9	2.52	0.27	1	0.49	0.22	103	0.17	0.32
	11	802.11b	24.42	30	26.9	2.48	0.28	1	0.49	0.21	104	0.17	0.32
	6	802.11g	23.58	30	26.9	3.32	0.23	1	0.49	0.26	105	0.18	0.31
	54	802.11g	23.41	30	26.9	3.49	0.22	1	0.49	0.27	106	0.18	0.31
2437	1	802.11b	26.90	30	26.9	0	0.49	1	0.49	0.00	107	0.43	0.06
	11	802.11b	26.71	30	26.9	0.19	0.47	1	0.49	0.02	108	0.44	0.05
	6	802.11g	26.77	30	26.9	0.13	0.48	1	0.49	0.01	109	0.44	0.05
	54	802.11g	26.54	30	26.9	0.36	0.45	1	0.49	0.04	110	0.43	0.06
2462	1	802.11b	24.45	30	26.9	2.45	0.28	1	0.49	0.21	111	0.22	0.27
	11	802.11b	24.46	30	26.9	2.44	0.28	1	0.49	0.21	112	0.22	0.27
	6	802.11g	23.50	30	26.9	3.4	0.22	1	0.49	0.27	113	0.23	0.26
	54	802.11g	23.31	30	26.9	3.59	0.21	1	0.49	0.28	114	0.22	0.27

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

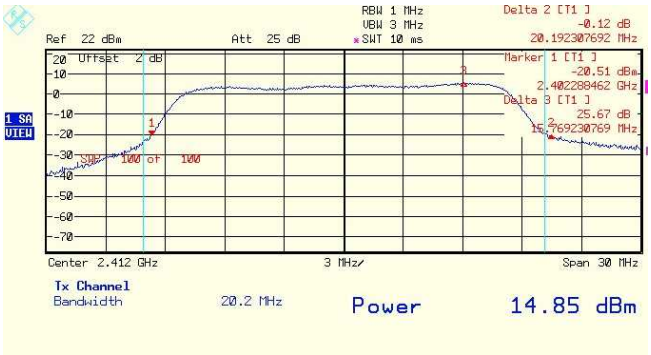
(*) - Calculated Combined (max) Output, Peak Power [W] is the sum of the measured Power from all Output terminals, where each result (output power from separate output terminal) mathematically conversed from Logarithm to linear units. The results were present in Watt.
For example, the calculation for 2412 MHz frequency (1 Mbps bit rate, 802.11b modulation) is the following:

1. 14.33dBm = 0.027W; 14.46dBm = 0.028W; 14.53dBm = 0.028W; 14.43dBm = 0.028W; 14.4dBm = 0.028W; 14.48dBm = 0.028W.
2. 0.027+0.028+0.284+0.028+0.028+0.028=0.17 [W]

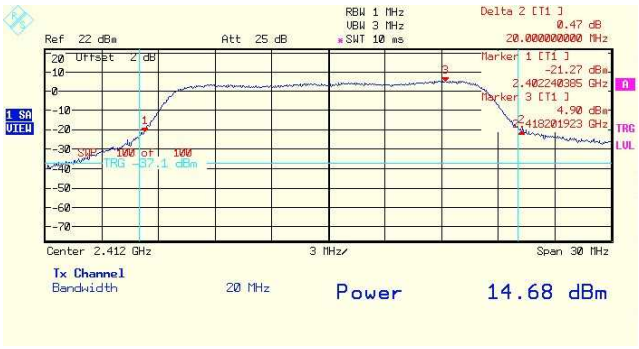
3.

Plot # 31. Output 1 peak power. Lower frequency. 1Mbps rate.

Plot # 32. Output 1 peak power. Lower frequency. 11Mbps rate.

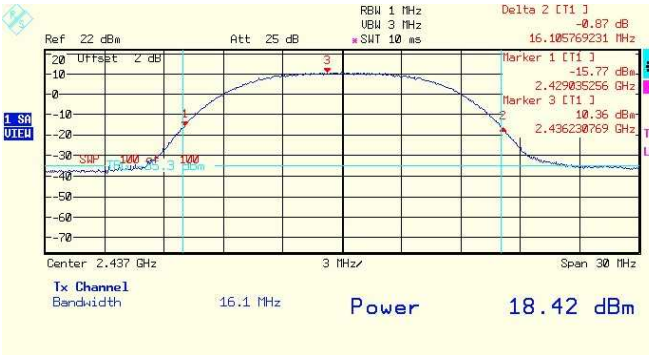


Plot # 33. Output 1 peak power. Lower frequency. 6Mbps rate.

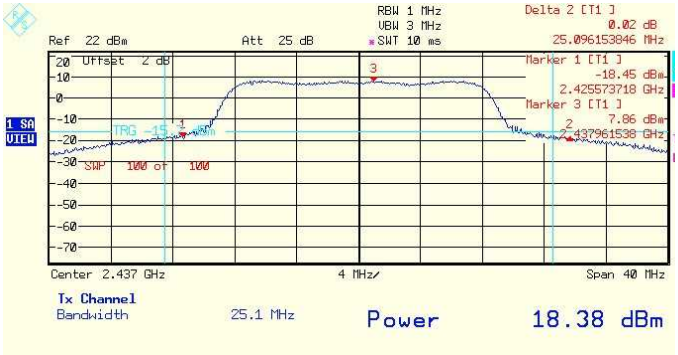


Plot # 34. Output 1 peak power. Lower frequency. 54Mbps rate.

Plot # 35. Output 1 peak power. Middle frequency. 1Mbps rate.

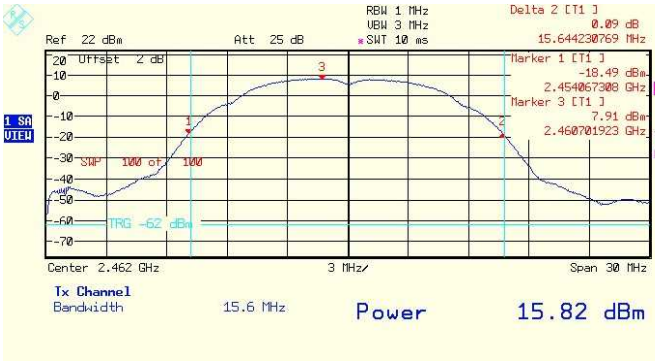


Plot # 36. Output 1 peak power. Middle frequency. 11Mbps rate.

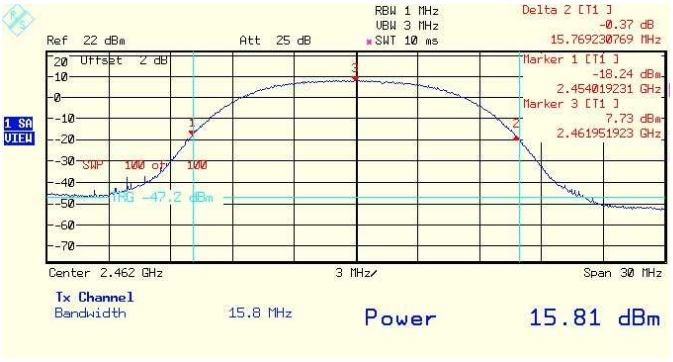


Plot # 37. Output 1 peak power. Middle frequency. 6Mbps rate.

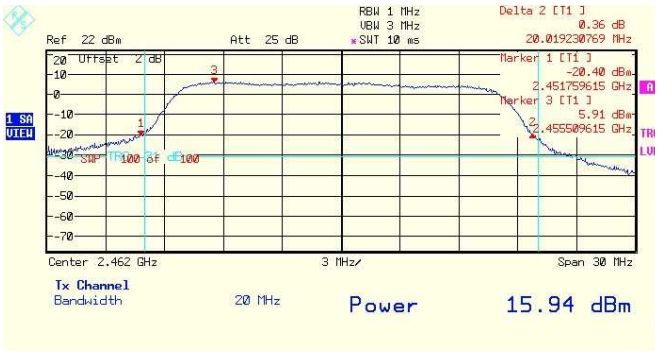
Plot # 38. Output 1 peak power. Middle frequency. 54Mbps rate.



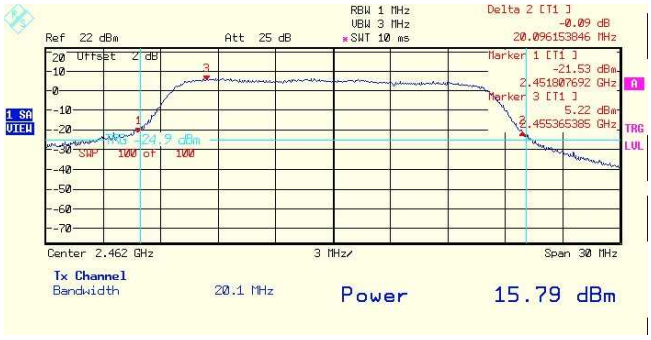
Plot # 39. Output 1 peak power. High frequency. 1Mbps rate.



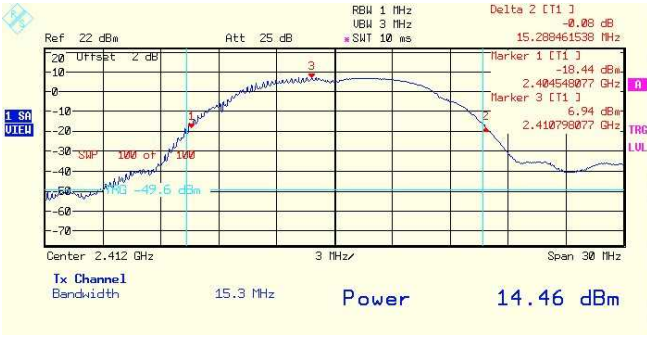
Plot # 40. Output 1 peak power. High frequency. 11Mbps rate.



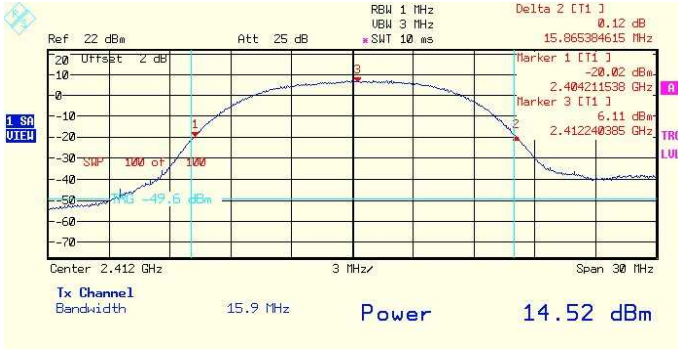
Plot # 41. Output 1 peak power. High frequency. 6Mbps rate.



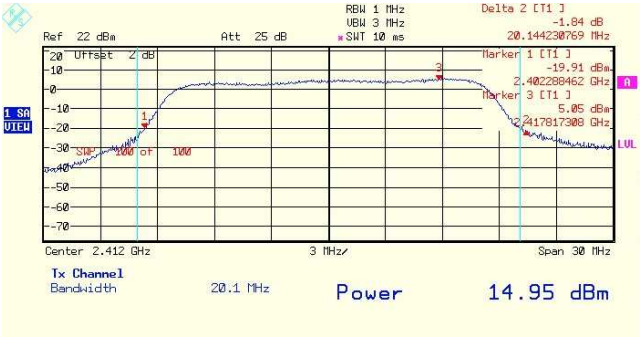
Plot # 42. Output 1 peak power. High frequency. 54Mbps rate.



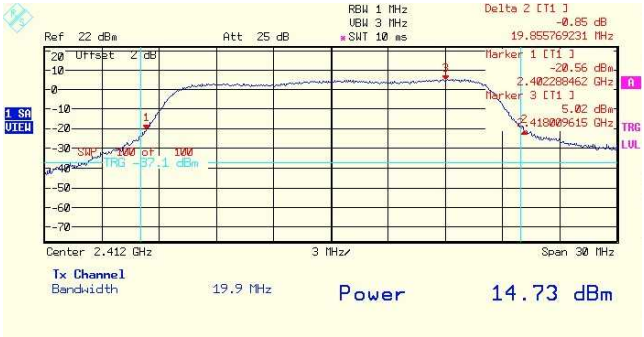
Plot # 43. Output 2 peak power. Lower frequency. 1Mbps rate.



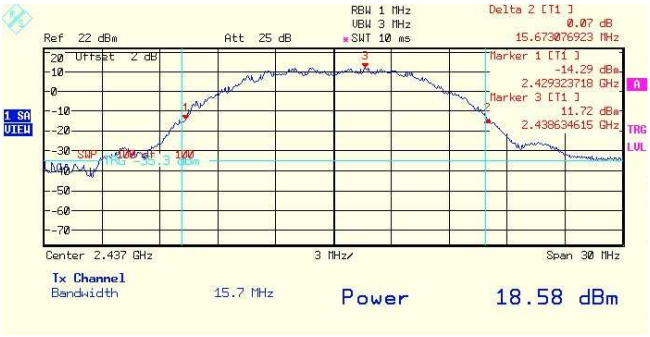
Plot # 44. Output 2 peak power. Lower frequency. 11Mbps rate.



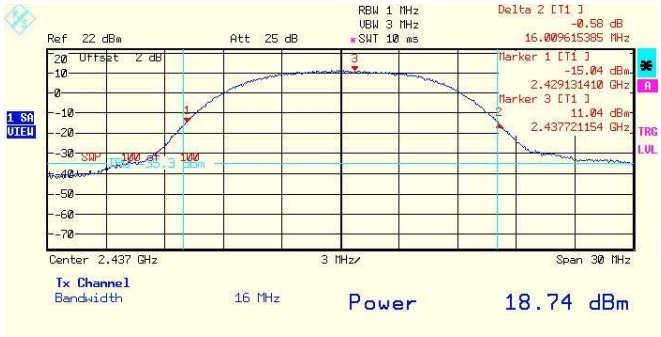
Plot # 45. Output 2 peak power. Lower frequency. 6Mbps rate.



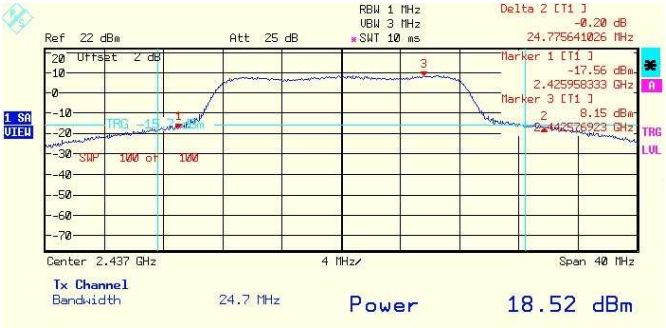
Plot # 46. Output 2 peak power. Lower frequency. 54Mbps rate.



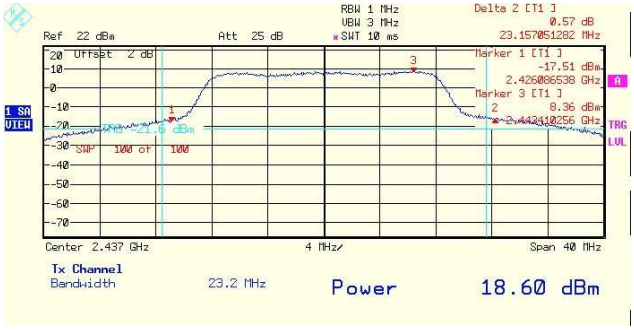
Plot # 47. Output 2 peak power. Middle frequency. 1Mbps rate.



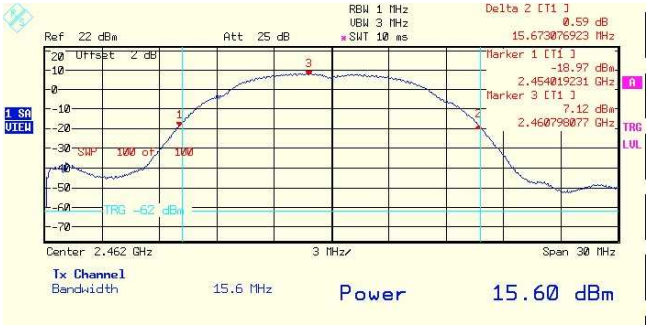
Plot # 48. Output 2 peak power. Middle frequency. 11Mbps rate.



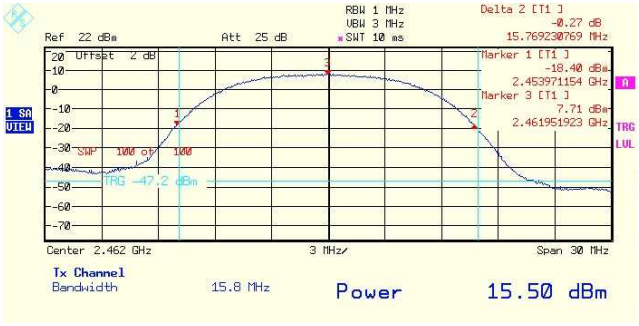
Plot # 49. Output 2 peak power. Middle frequency. 6Mbps rate.



Plot # 50. Output 2 peak power. Middle frequency. 54Mbps rate.

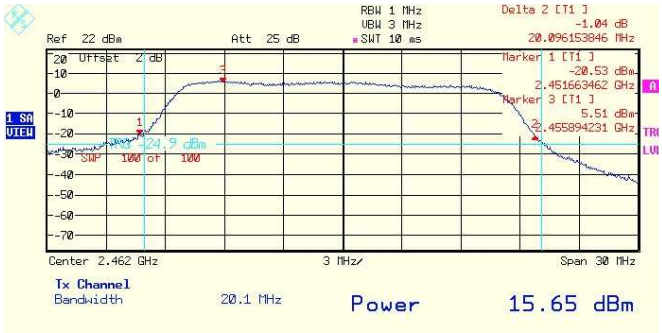


Plot # 51. Output 2 peak power. High frequency. 1Mbps rate.



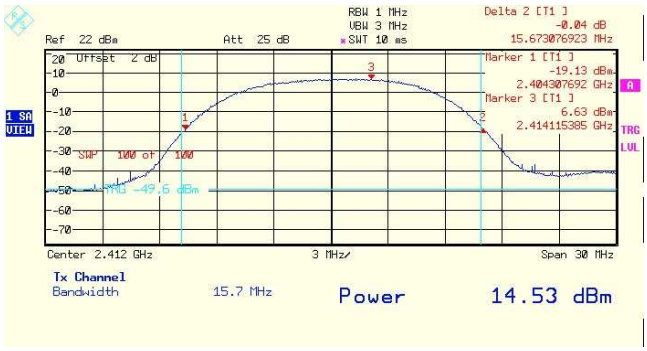
Plot # 52. Output 2 peak power. High frequency. 11Mbps rate.

Plot # 53. Output 2 peak power. High frequency. 6Mbps rate.

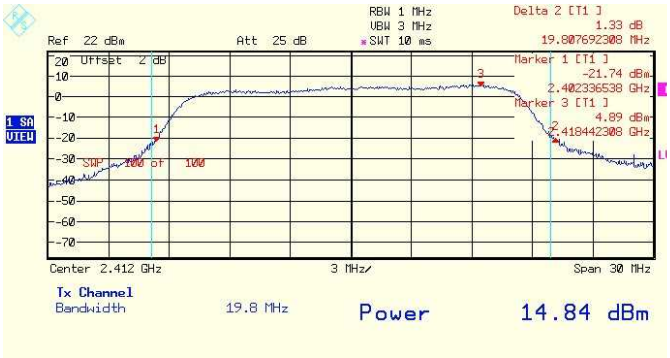


Plot # 54. Output 2 peak power. High frequency. 54Mbps rate.

Plot # 55. Output 3 peak power. Lower frequency. 1Mbps rate.

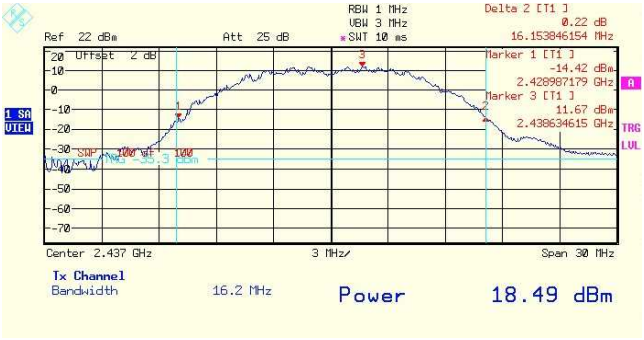


Plot # 56. Output 3 peak power. Lower frequency. 11Mbps rate.

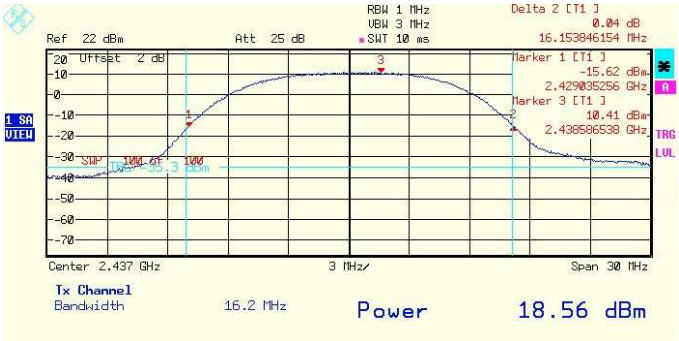


Plot # 57. Output 3 peak power. Lower frequency. 6Mbps rate.

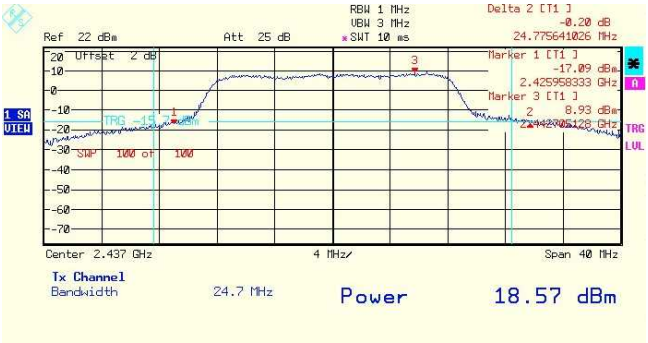
Plot # 58. Output 3 peak power. Lower frequency. 54Mbps rate.



Plot # 59. Output 3 peak power. Middle frequency. 1Mbps rate.

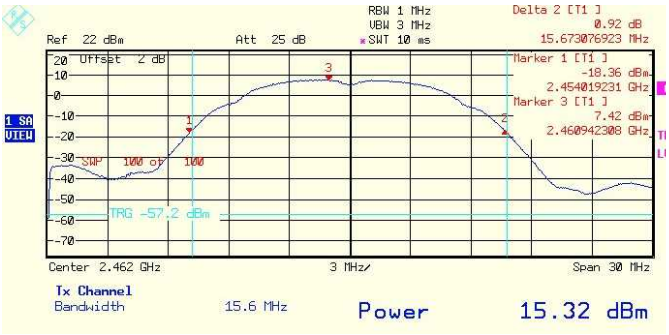


Plot # 60. Output 3 peak power. Middle frequency. 11Mbps rate.

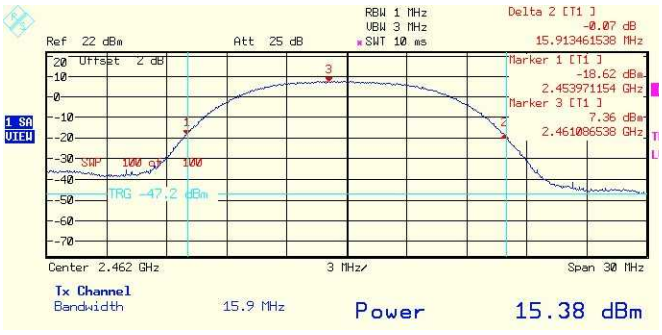


Plot # 61. Output 3 peak power. Middle frequency. 6Mbps rate.

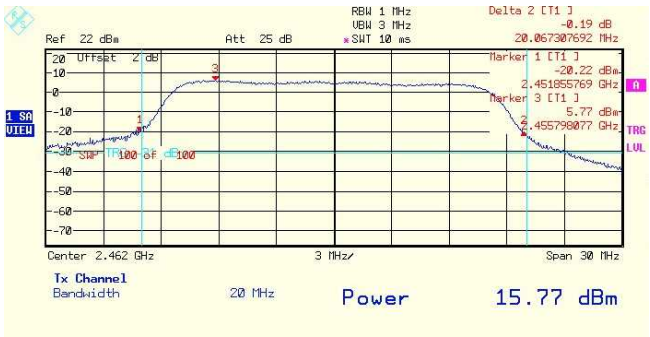
Plot # 62. Output 3 peak power. Middle frequency. 54Mbps rate.



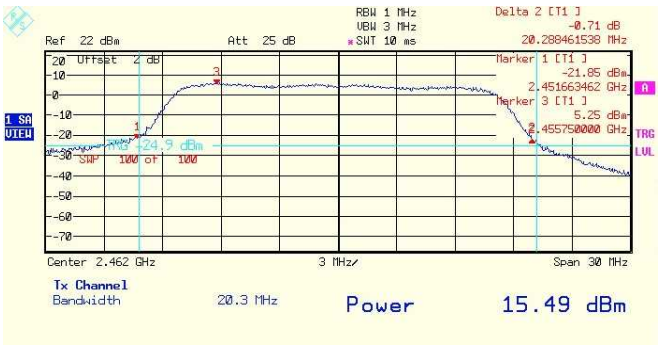
Plot # 63. Output 3 peak power. High frequency. 1Mbps rate.



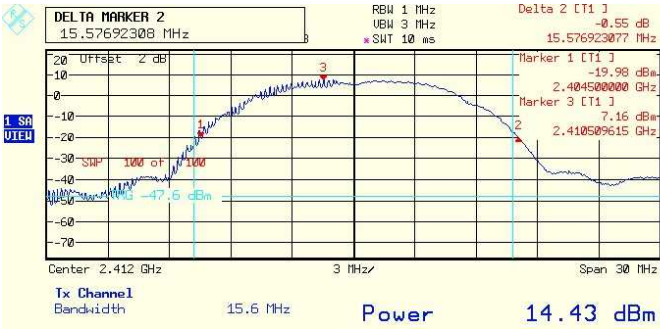
Plot # 64. Output 3 peak power. High frequency. 11Mbps rate.



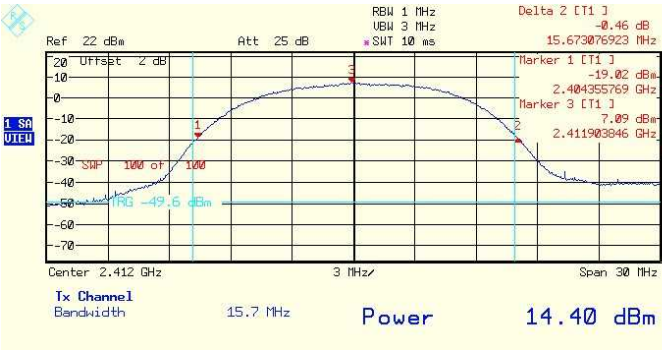
Plot # 65. Output 3 peak power. High frequency. 6Mbps rate.



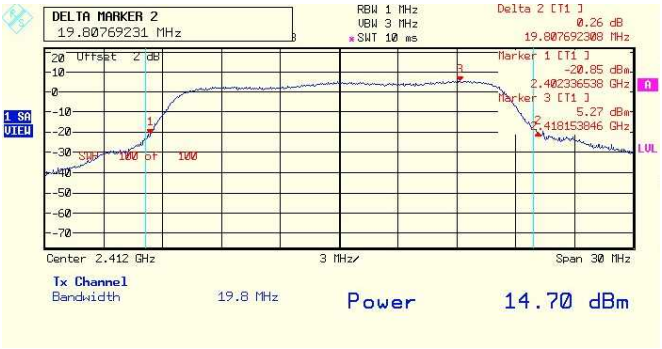
Plot # 66. Output 3 peak power. High frequency. 54Mbps rate.



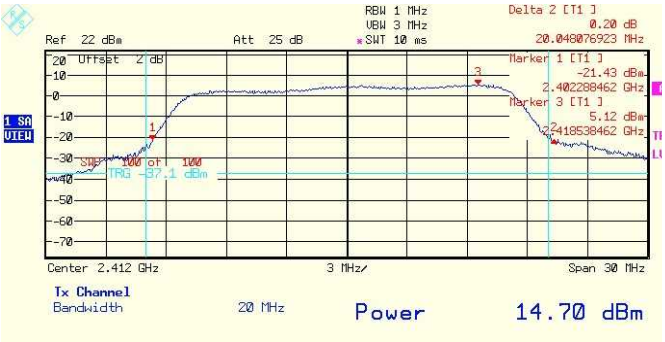
Plot # 67. Output 4 peak power. Lower frequency. 1Mbps rate.



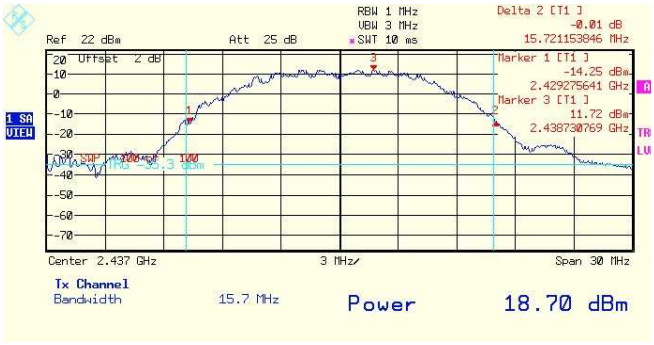
Plot # 68. Output 4 peak power. Lower frequency. 11Mbps rate.



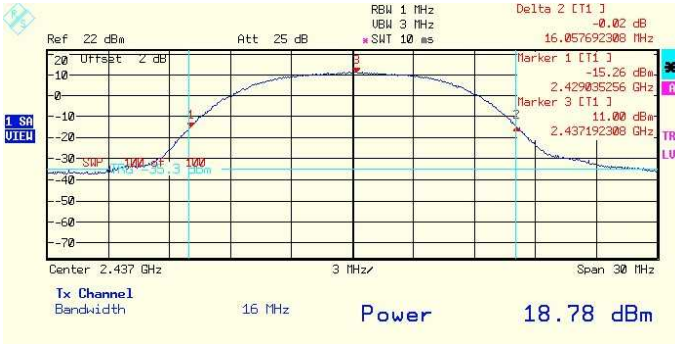
Plot # 69. Output 4 peak power. Lower frequency. 6Mbps rate.



Plot # 70. Output 4 peak power. Lower frequency. 54Mbps rate.

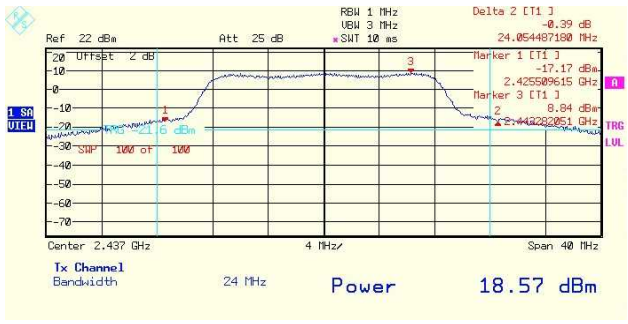


Plot # 71. Output 4 peak power. Middle frequency. 1Mbps rate.



Plot # 72. Output 4 peak power. Middle frequency. 11Mbps rate.

Plot # 73. Output 4 peak power. Middle frequency. 6Mbps rate.



Plot # 74. Output 4 peak power. Middle frequency. 54Mbps rate.