

Test Report



INTENTIONAL RADIATOR TESTS ACCORDING TO FCC PART 15 C and INDUSTRY CANADA REQUIREMENTS

Equipment Under Test: Electrocardiogram (ECG) Transmitter

Model: OW-ECG1

Type: -

Manufacturer: Omegawave Oy Sinikalliontie 5 A
Tekniikantie 14
FI-02150 Espoo
FINLAND

Customer: Omegawave Oy Sinikalliontie 5 A
Tekniikantie 14
FI-02150 Espoo
FINLAND

FCC Rule Part: 15.247: 2011
IC Rule Part: RSS-210, Issue 8, 2010
RSS-GEN Issue 3, 2010

Date: 6.11.2012

Issued by:

A handwritten signature in blue ink, appearing to read "R. Repo".

Rauno Repo
Testing Engineer

Date: 6.11.2012

Checked by:

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Jari Merikari
Technical Manager

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Equipment Under Test (EUT)

Electrocardiogram (ECG) Transmitter
Model: OW-ECG1

The EUT has an internal antenna.

Description of the EUT

The EUT is an ECG Bluetooth transmitter connected to human body with a chest belt. ECG pulses are transmitted via Bluetooth for example to a cell phone.

Classification of the device

Fixed device	☐
Mobile Device (Human body distance > 20cm)	☐
Portable Device (Human body distance < 20cm)	☒

Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing

Ratings and declarations

Operating Frequency Range (OFR):	2402 – 2480 MHz
Channels:	79
Channel separation:	1 MHz
Channel bandwidth:	1 MHz
Transmission technique:	FHSS
Modulation:	GFSK, $\pi/4$ DQPSK, 8DPSK
Antenna gain:	0 dBi

Power Supply

Battery operated
Normal input voltage: 3.7 V (Lithium polymer 330 mAh)

Mechanical Size of the EUT

Height: 38 mm Width: 76 mm Depth: 15 mm

Peripherals

-ECG Generator: HEЙPOTECT 7B, SN:0608

Samples

Sample 1: including a socket to configure the EUT

Sample 2: including a socket to configure the EUT and an antenna port SMA connector to perform the conducted measurements

Disclaimer

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SUMMARY OF TESTING

Test Specification	Description of Test	Result
15.247(a)(1) / RSS-210 A8.1	Hopping Channel Carrier Frequency Separation	PASS
§15.247(a)(1)(iii) / RSS-210 A8.1	Number of Hopping Frequencies	PASS
§15.247(a)(1)(iii) / RSS-210 A8.1	Average Time of Occupancy of Hopping Frequency	PASS
§15.247(b)(1) / RSS-210 A8.4	Maximum Peak Conducted Output Power	PASS
§15.247(a)(1) / RSS-210 A8.1	20 dB Bandwidth	PASS
RSS-GEN 4.6.1	99% Occupied Bandwidth	PASS
§15.247(d) / RSS-210 A8.5	100 kHz Bandwidth of Frequency Band Edges and Conducted Spurious Emissions	PASS
§15.209(a) §15.247(d) / RSS-210 A8.5	Radiated Emissions Within The Restricted Bands	PASS
§15.109 RSS-GEN 7.2.3.2	Unintentional Radiated Emissions	PASS
§15.207 RSS-GEN 7.2.2	Conducted emissions	N/A

EUT Test Conditions during Testing

The EUT was in continuous transmit mode during all the tests.

The hopping was stopped and the EUT was configured into the wanted channel. Normal modulation and duty cycle was applied in all the tests.

In the radiated emission test the EUT was tested in three different orthogonal axes (X, Y and Z) in order to find the worst direction. The worst direction result was reported.

Following channels were used during the tests when the hopping was stopped:

Channel LOW (CH 1) = 2402 MHz

Channel MID (CH 40) = 2441 MHz

Channel HIGH (CH 79) = 2480 MHz

Test Facility

☐ Testing Location / address: FCC registration number: 90598	SGS Fimko Ltd Särkiniementie 3 FI-00210, HELSINKI FINLAND
☒ Testing Location / address: FCC registration number: 178986 Industry Canada registration number: 8708A-2	SGS Fimko Ltd Karakaarenkuja 4 FI-02610, ESPOO FINLAND

Maximum Peak Conducted Output Power

Standard: ANSI C63.10 (2009)
Tested by: RRE
Date: 22.10.2012
Humidity: 47 %
Temperature: 19 °C
Measurement uncertainty $\pm 2.87\text{dB}$ Level of confidence 95 % (k = 2)

FCC Rule: 15.247(b) (1)

For frequency hopping systems operating in the 2400-2483.5 MHz, employing at least 75 channels limit is 1.0 Watt. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

Results:

1 Mbps

Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
Low	0.90	30	29.10	PASS
Mid	0.26	30	29.74	PASS
High	-2.12	30	32.12	PASS

2 Mbps

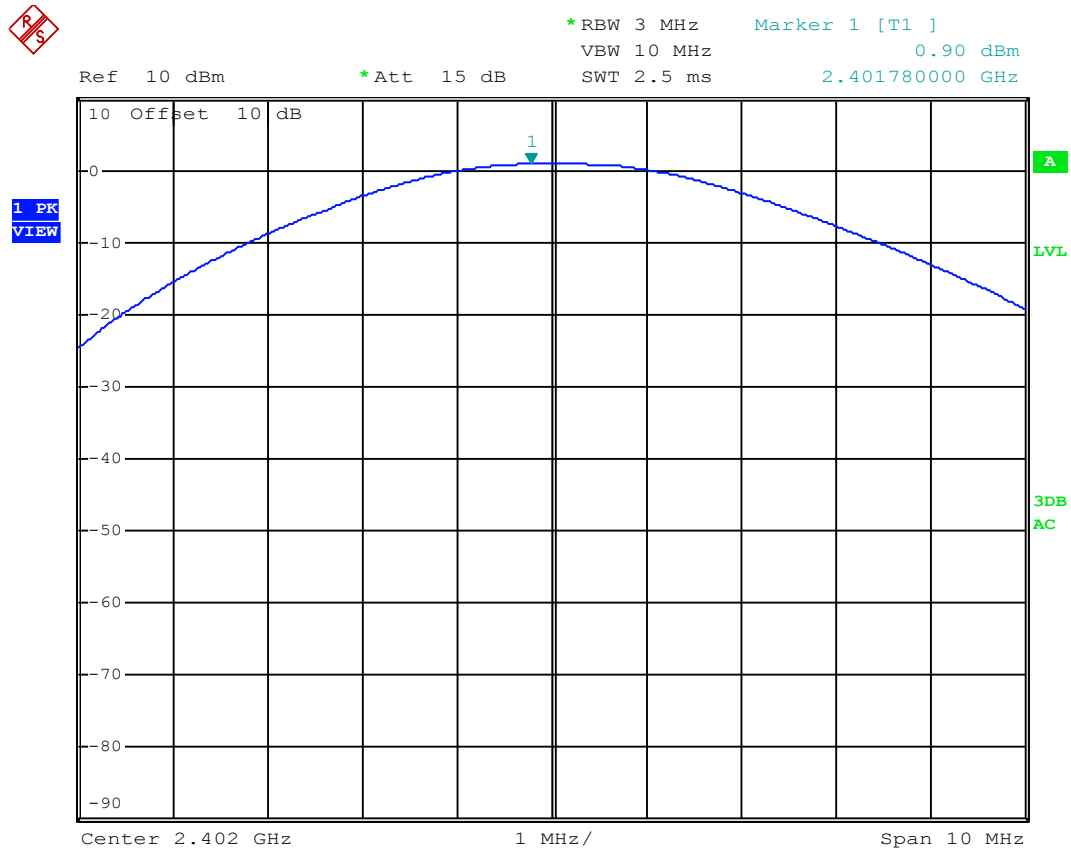
Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
Low	-0.68	30	30.68	PASS
Mid	-1.51	30	31.51	PASS
High	-4.16	30	34.16	PASS

3 Mbps

Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
Low	-0.47	30	30.47	PASS
Mid	-1.26	30	31.26	PASS
High	-3.92	30	33.92	PASS

The attenuation of the measurement cable and the attenuator was added as an offset 10.0 dB to correct the measurement result.

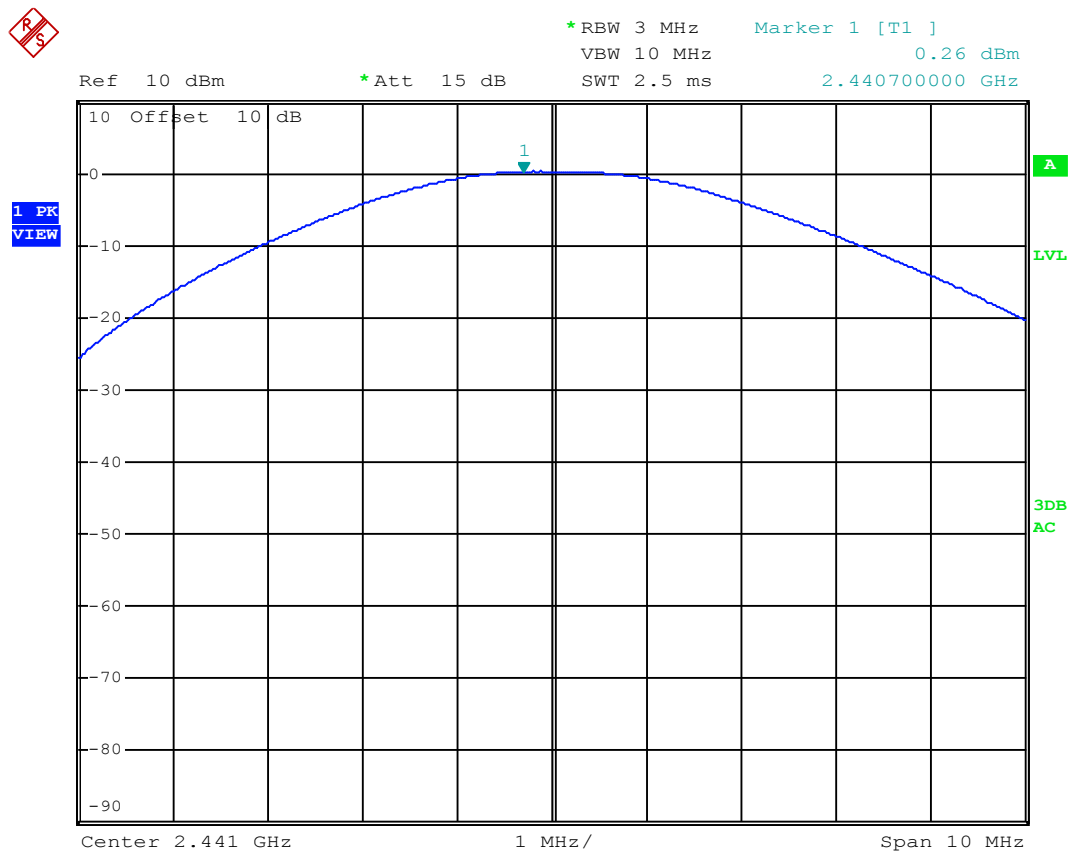
Conducted Output Power Test



Date: 22.OCT.2012 13:00:54

Figure 1. 1 Mbps Channel LOW.

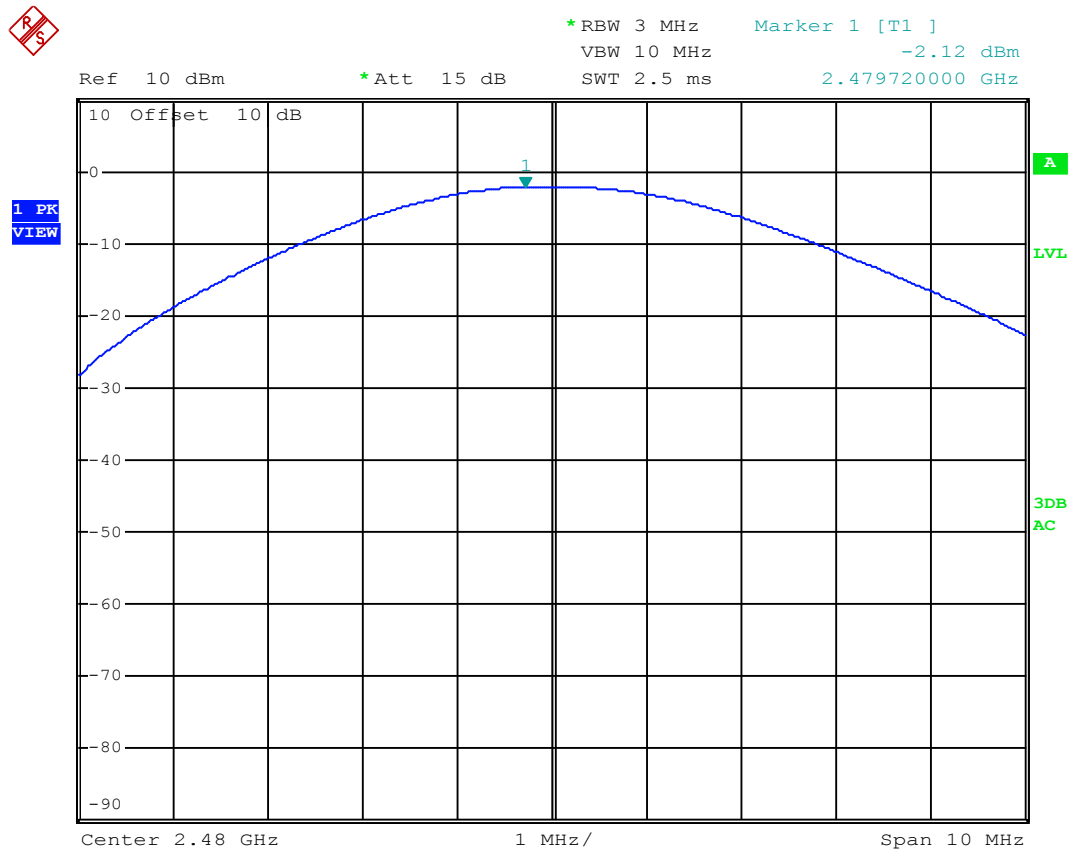
Conducted Output Power Test



Date: 22.OCT.2012 13:02:11

Figure 2. 1 Mbps Channel MID.

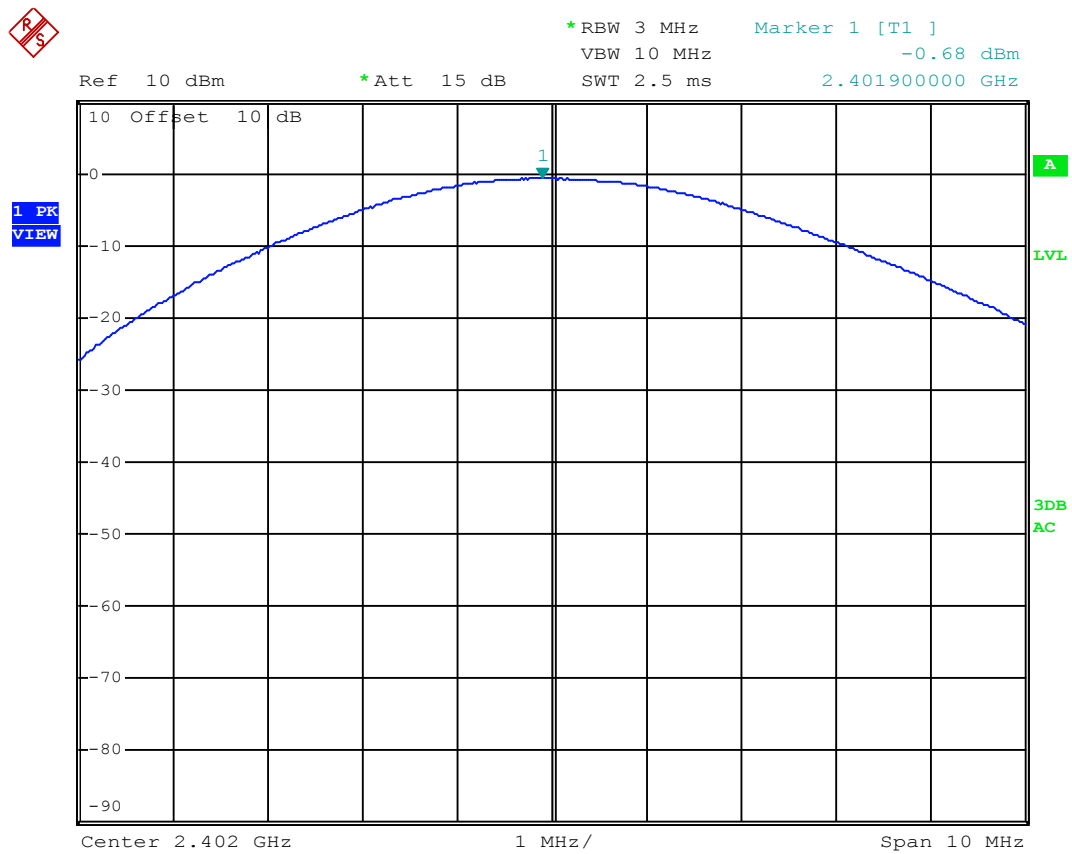
Conducted Output Power Test



Date: 22.OCT.2012 13:03:21

Figure 3. 1 Mbps Channel HIGH.

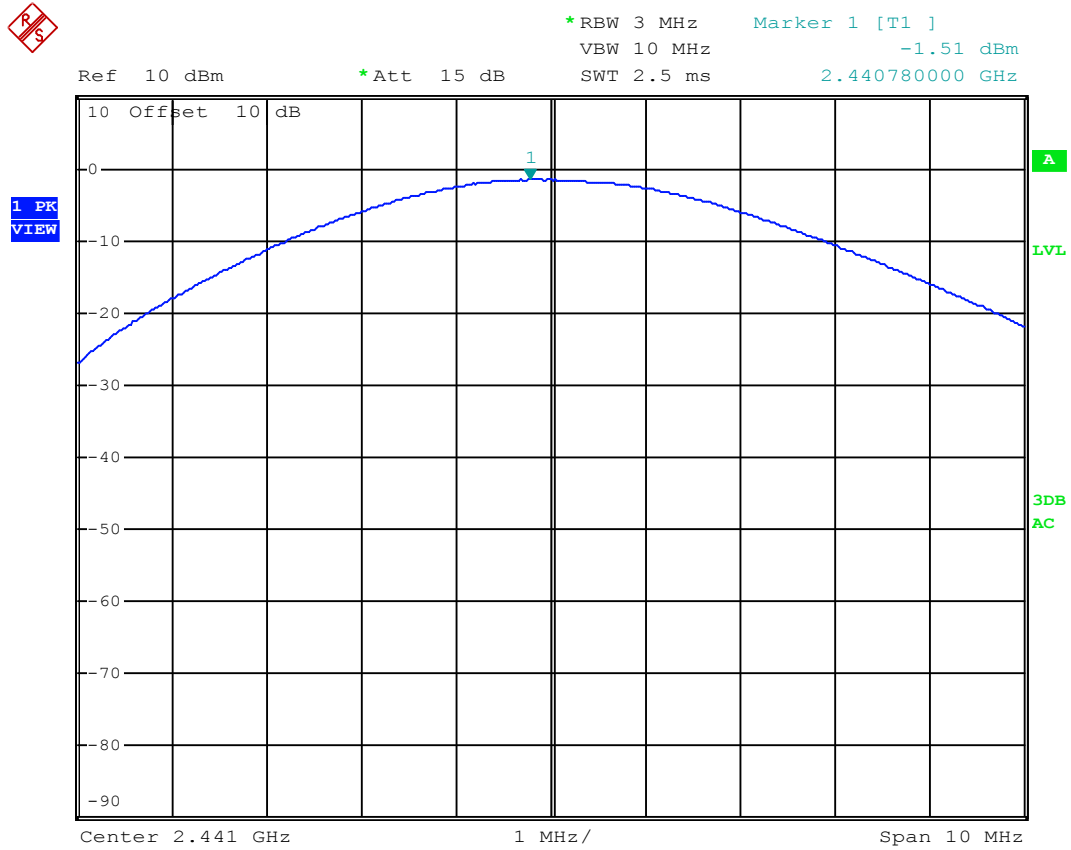
Conducted Output Power Test



Date: 22.OCT.2012 13:04:52

Figure 4. 2 Mbps Channel LOW.

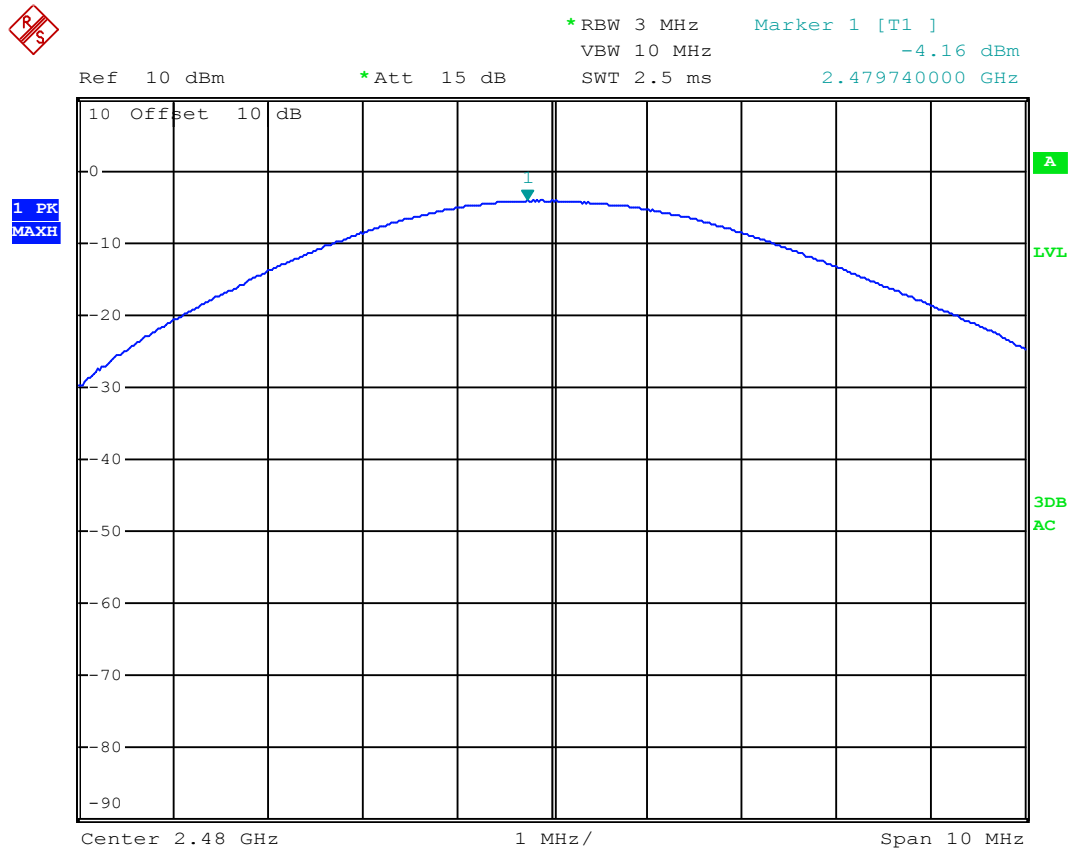
Conducted Output Power Test



Date: 22.OCT.2012 13:05:53

Figure 5. 2 Mbps Channel MID.

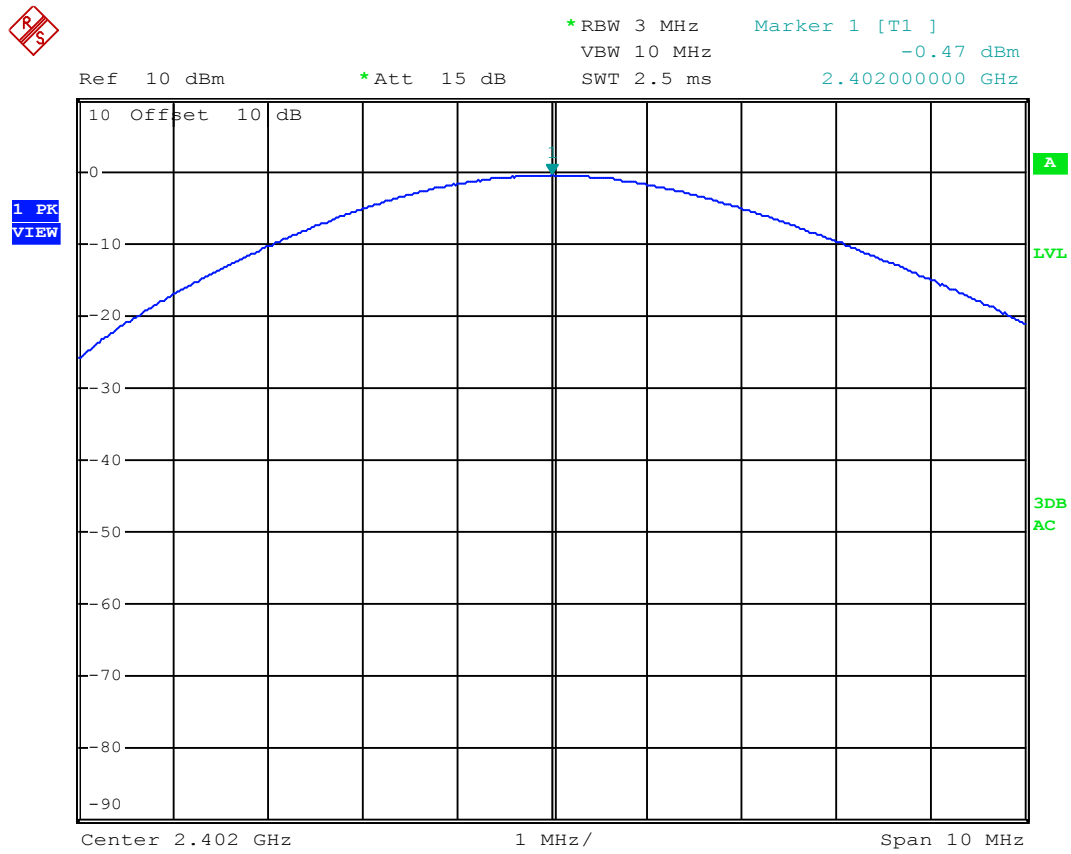
Conducted Output Power Test



Date: 22.OCT.2012 13:07:00

Figure 6. 2 Mbps Channel HIGH.

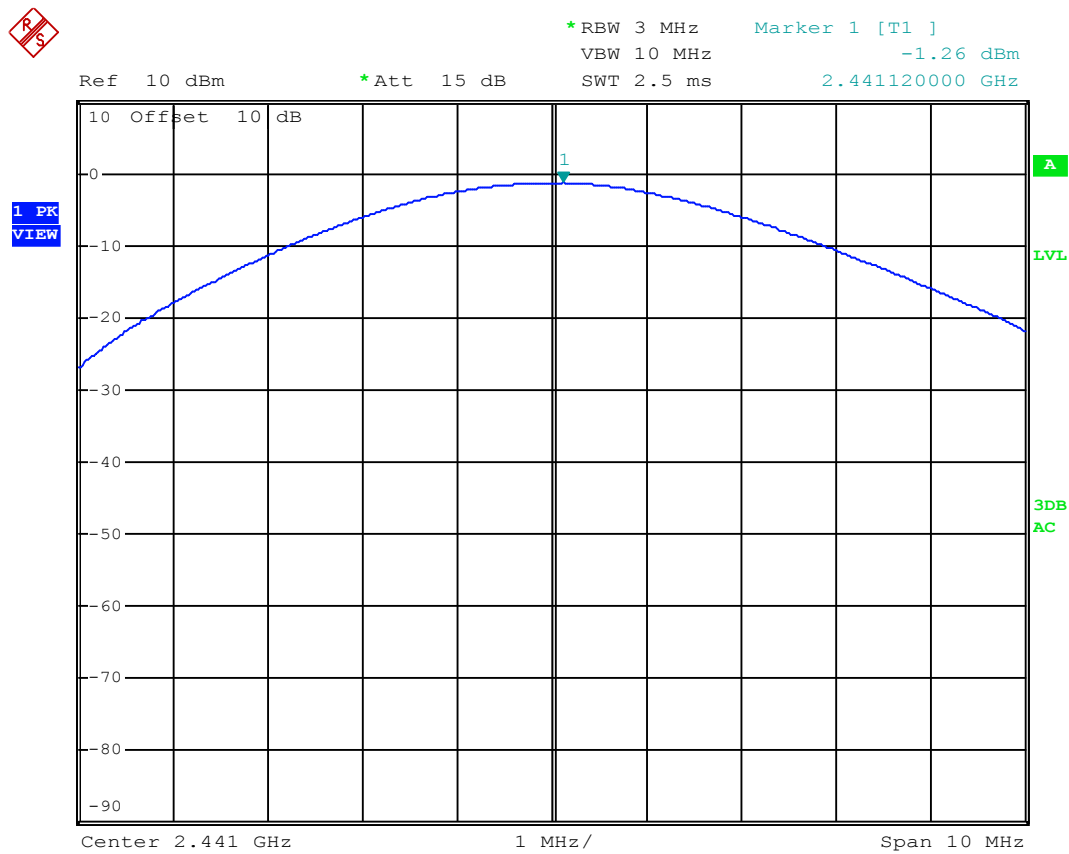
Conducted Output Power Test



Date: 22.OCT.2012 13:07:52

Figure 7. 3 Mbps Channel LOW.

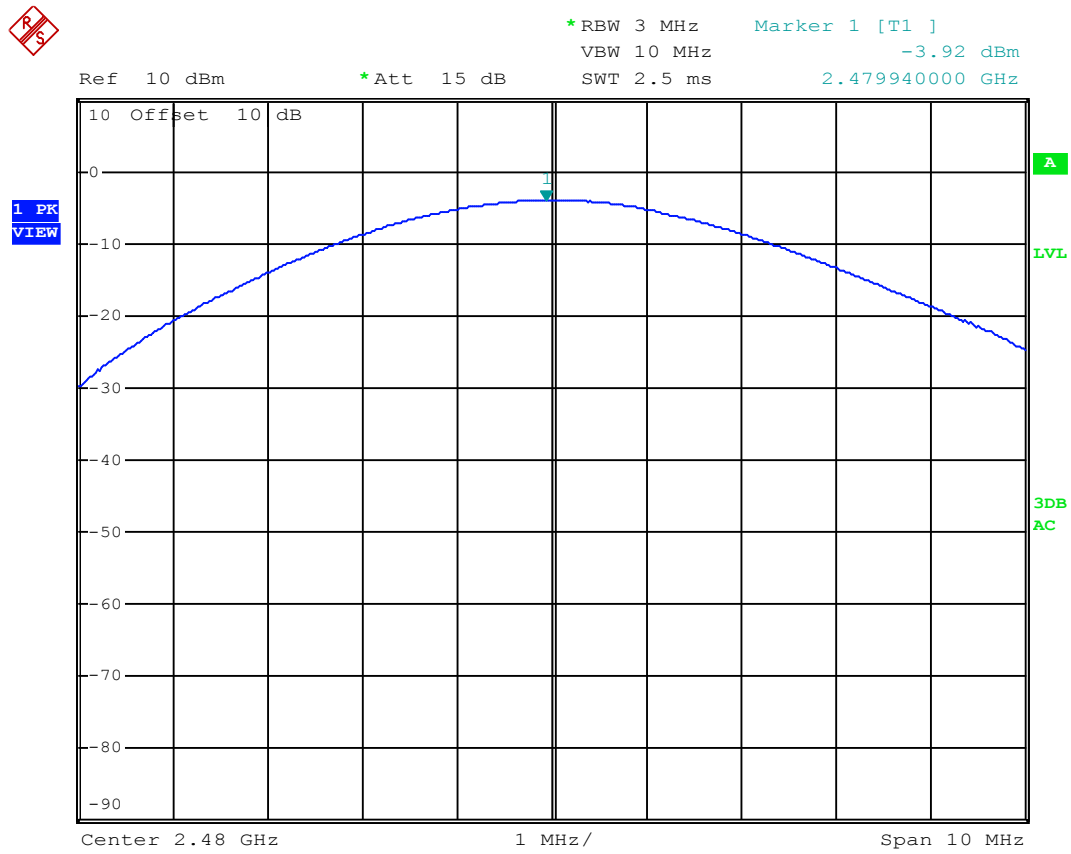
Conducted Output Power Test



Date: 22.OCT.2012 13:10:06

Figure 8. 3 Mbps Channel MID.

Conducted Output Power Test



Date: 22.OCT.2012 13:11:12

Figure 9. 3 Mbps Channel HIGH.

Transmitter Radiated Emissions 30 – 1000 MHz

Standard:	ANSI C63.10	(2009)
Tested by:	RRE	
Date:	19.- 22.10.2011	
Temperature:	18 - 19 °C	
Humidity:	47 - 60 % RH	
Measurement uncertainty	± 4.51 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.247(d), 15.209(a)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a).

The correction factor in the final result table contains the sum of the transducers (antenna + amplifier + cables). The QuasiPeak value is the measured value corrected with the correction factor.

Measurements were done with 1 Mbps (worst case).

Measured Peak Values In The Frequency Range 30 MHz - 1000 MHz.

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m

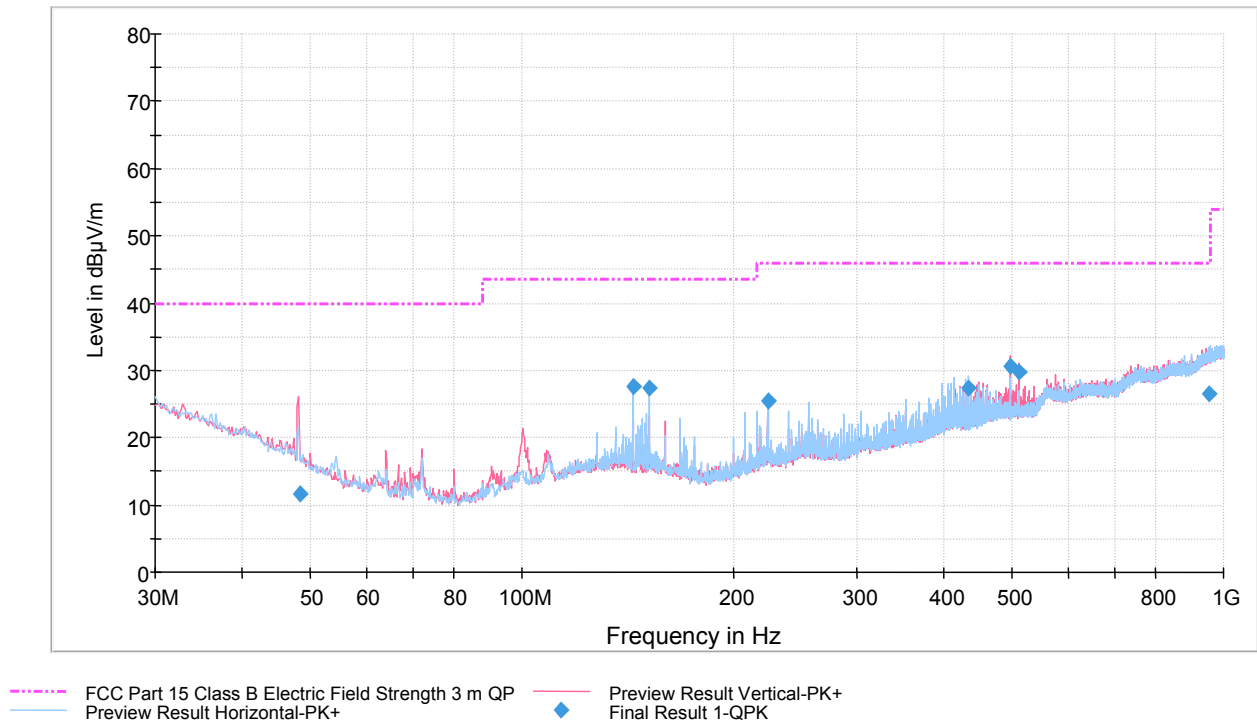


Figure 10. Measured curve with peak-detector. 1 Mbps Channel LOW.

Final measurements from the worst frequencies

Table 1. Final results.

Frequency (MHz)	QuasiPeak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
48.235000	11.6	120.000	100.0	V	3.0	15.1	28.4	40.0	
144.015000	27.6	120.000	266.0	H	79.0	13.0	15.9	43.5	
152.005000	27.4	120.000	160.0	H	249.0	12.7	16.1	43.5	
224.005000	25.5	120.000	149.0	H	108.0	13.9	20.6	46.0	
432.015000	27.4	120.000	100.0	H	204.0	18.9	18.6	46.0	
496.015000	30.6	120.000	100.0	V	71.0	20.2	15.4	46.0	
512.025000	29.8	120.000	100.0	V	76.0	20.3	16.2	46.0	
955.665000	26.6	120.000	189.0	H	57.0	27.8	19.4	46.0	

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m

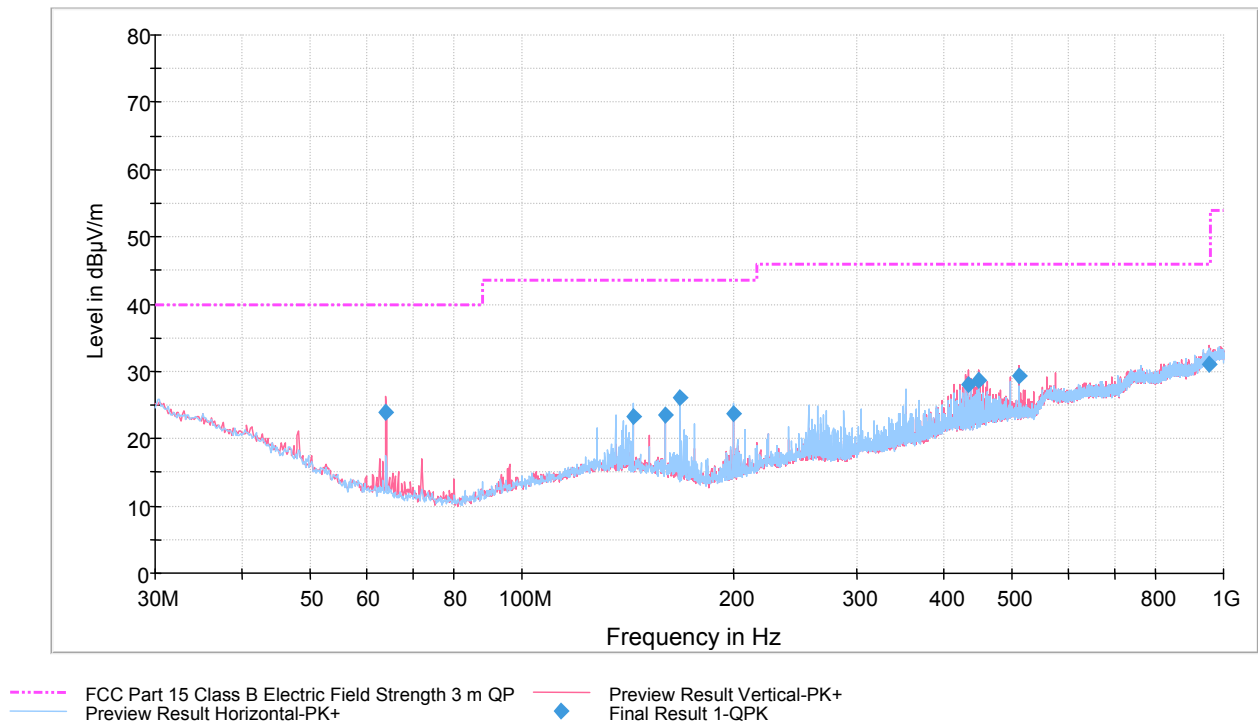


Figure 11. Measured curve with peak-detector. 1 Mbps Channel MID.

Final measurements from the worst frequencies

Table 2. Final results.

Frequency (MHz)	QuasiPeak (dBμV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)	Comment
63.995000	23.9	120.000	192.0	V	213.0	10.0	16.1	40.0	
144.015000	23.2	120.000	222.0	H	105.0	13.0	20.3	43.5	
160.015000	23.5	120.000	209.0	H	114.0	12.5	20.0	43.5	
168.015000	26.0	120.000	188.0	H	258.0	12.2	17.5	43.5	
200.005000	23.8	120.000	127.0	H	241.0	12.1	19.7	43.5	
432.015000	28.1	120.000	100.0	V	195.0	18.9	17.9	46.0	
448.015000	28.6	120.000	100.0	V	178.0	19.3	17.4	46.0	
512.005000	29.3	120.000	100.0	V	266.0	20.3	16.7	46.0	
954.645000	31.0	120.000	161.0	V	185.0	27.8	15.0	46.0	

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m

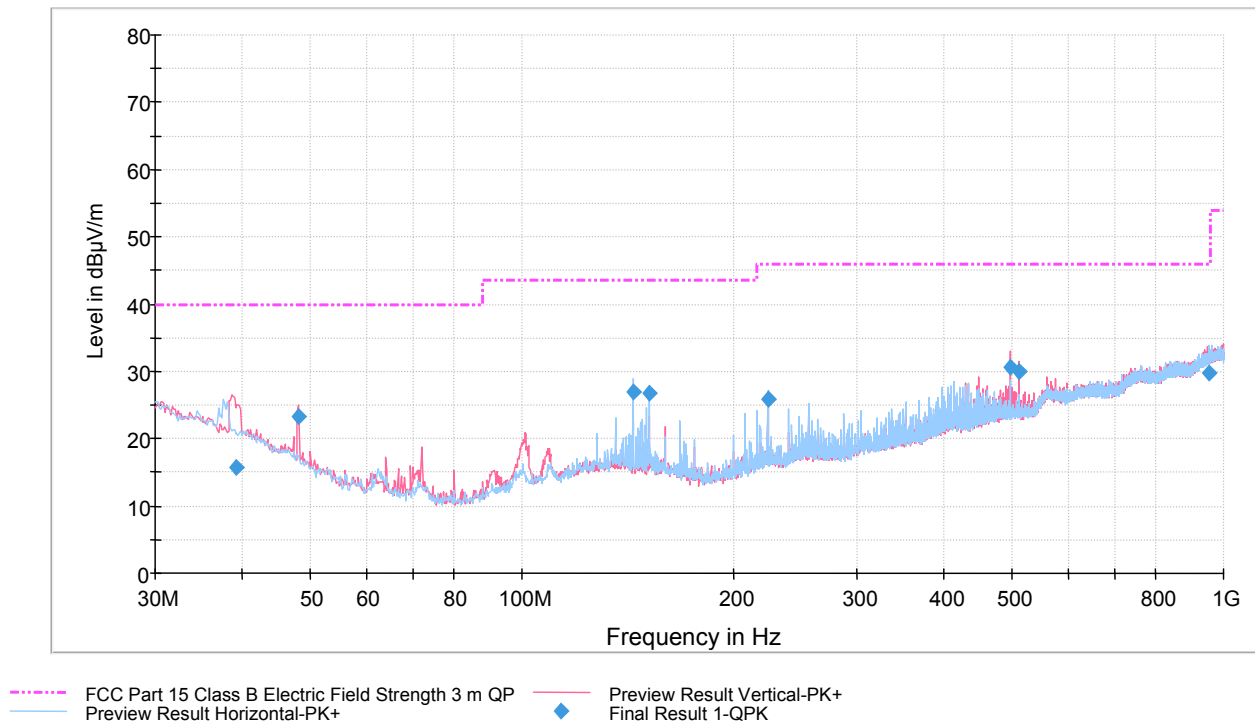


Figure 12. Measured curve with peak-detector. 1 Mbps Channel HIGH.

Final measurements from the worst frequencies

Table 3. Final results.

Frequency (MHz)	QuasiPeak (dBμV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)	Comment
39.225000	15.7	120.000	144.0	V	285.0	19.4	24.3	40.0	
47.995000	23.3	120.000	110.0	V	324.0	15.2	16.7	40.0	
144.015000	27.1	120.000	297.0	H	91.0	13.0	16.4	43.5	
152.005000	26.7	120.000	183.0	H	75.0	12.7	16.8	43.5	
224.005000	25.9	120.000	161.0	H	257.0	13.9	20.1	46.0	
496.015000	30.6	120.000	100.0	V	75.0	20.2	15.4	46.0	
512.025000	29.9	120.000	100.0	V	79.0	20.3	16.1	46.0	
954.545000	29.7	120.000	160.0	H	147.0	27.8	16.3	46.0	

Transmitter Radiated Emissions 1 000 – 26 500 MHz

Measured Peak and Average Values In The Frequency Range 1 000 MHz – 4 000 MHz.

The correction factor in the final result tables contains the sum of the transducers (antenna + amplifier + cables).
The Max Peak and Average values are measured values corrected with the correction factor.

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

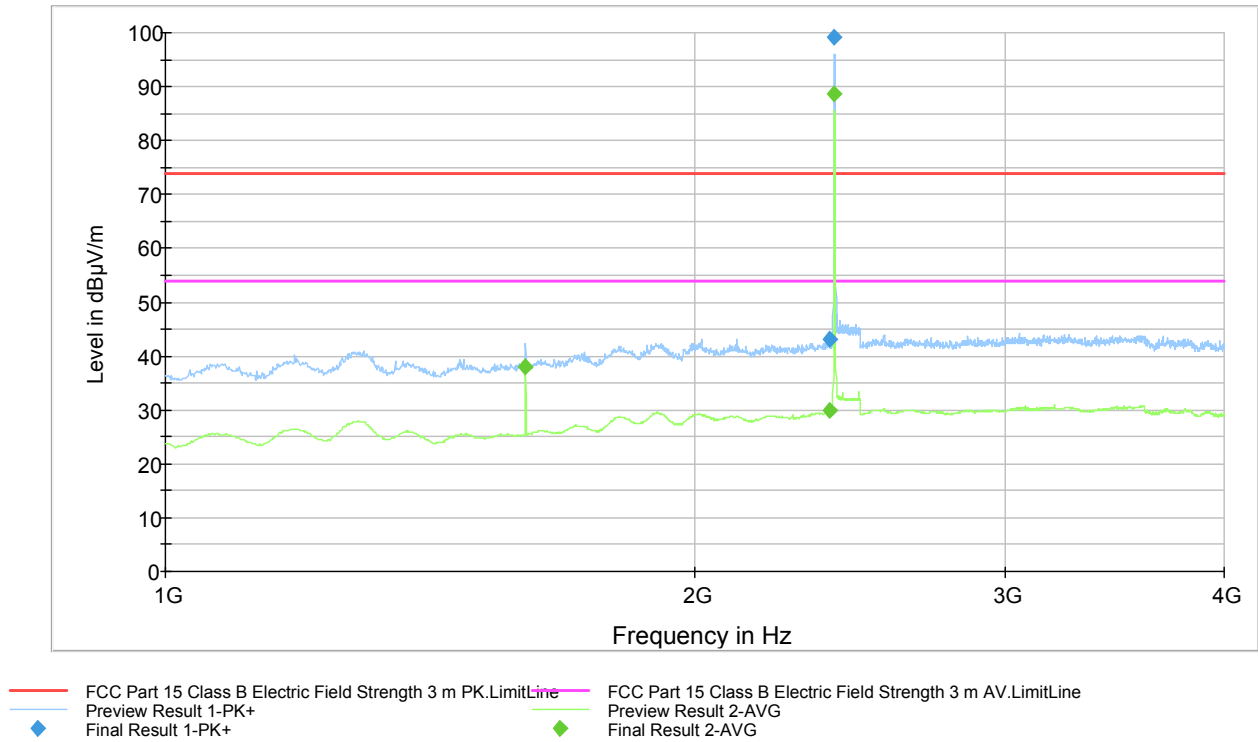


Figure 13. Measured curve with peak- and average detector. 1 Mbps Channel LOW.

Table 4. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
2386.800000	43.2	1000.000	155.0	V	46.0	4.3	30.7	73.9	
2402.000000	99.1	1000.000	219.0	V	65.0	4.4	-25.2	73.9	*

* Out of the restricted bands 15.205(a)

Table 5. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1602.075000	38.0	1000.000	100.0	V	210.0	-1.3	15.9	53.9	
2386.000000	30.0	1000.000	187.0	V	84.0	4.3	23.9	53.9	
2402.000000	88.7	1000.000	181.0	V	68.0	4.4	-34.8	53.9	*

* Out of the restricted bands 15.205(a)

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

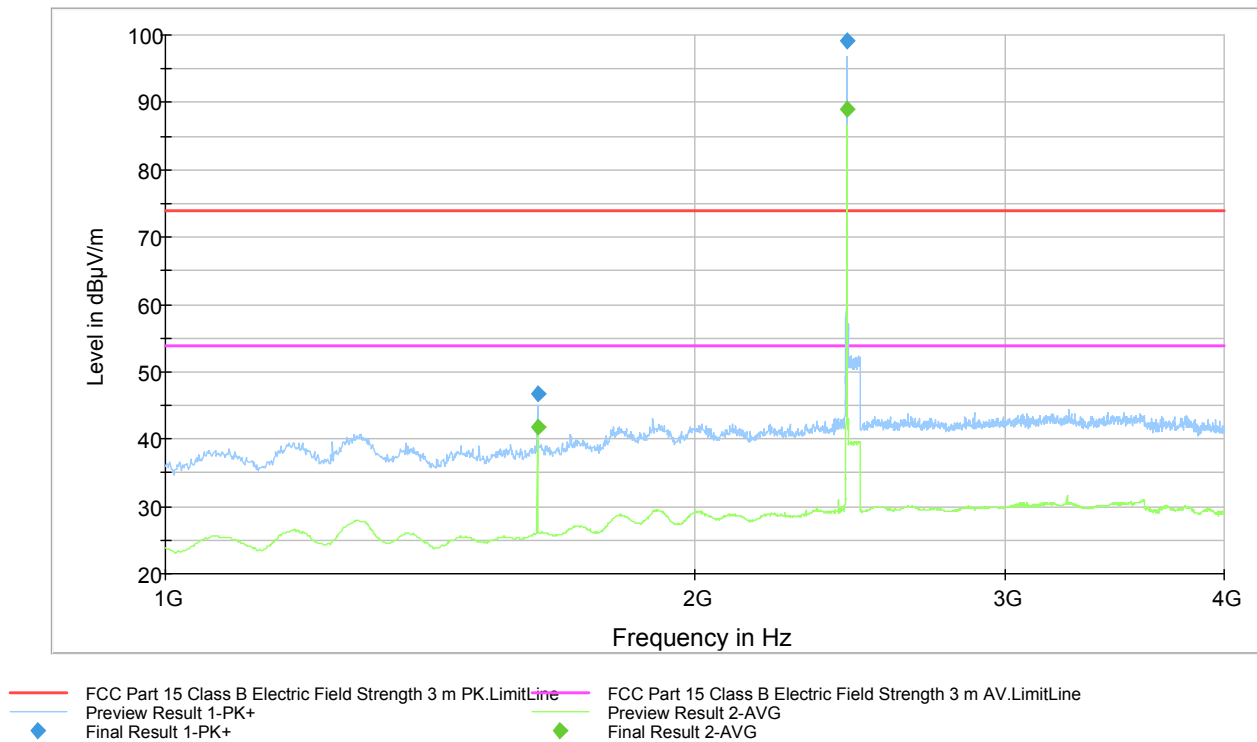


Figure 14. Measured curve with peak- and average detector. 1 Mbps Channel MID.

Table 6. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1627.925000	46.7	1000.000	100.0	V	305.0	-0.9	27.2	73.9	
2441.200000	99.2	1000.000	211.0	V	89.0	4.1	-25.3	73.9	*

* Out of the restricted bands 15.205(a)

Table 7. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1627.925000	41.7	1000.000	100.0	V	308.0	-0.9	12.2	53.9	
2441.000000	88.9	1000.000	211.0	V	89.0	4.1	-35.0	53.9	*

* Out of the restricted bands 15.205(a)

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

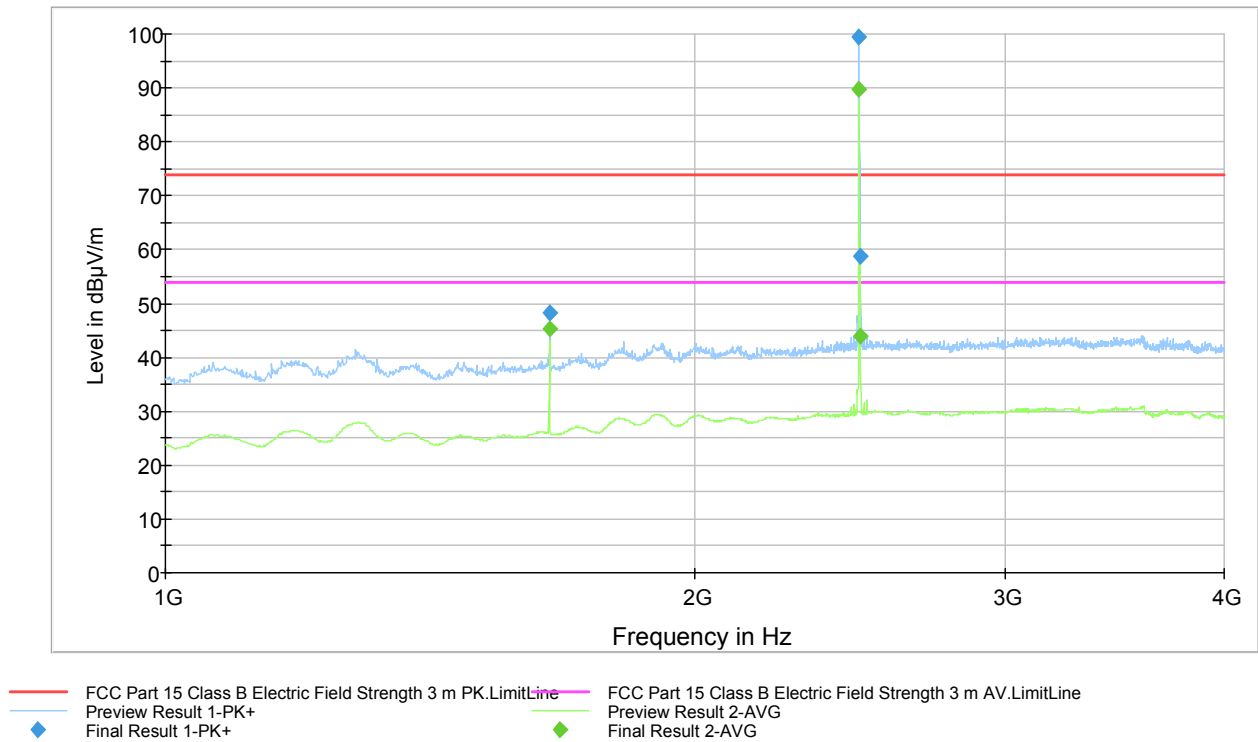


Figure 15. Measured curve with peak- and average detector. 1 Mbps Channel HIGH.

Final measurements from the worst frequencies

Table 8. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1654.175000	48.2	1000.000	122.0	H	194.0	-0.4	25.7	73.9	
2480.200000	99.6	1000.000	211.0	V	114.0	4.4	-25.7	73.9	*
2483.500000	58.7	1000.000	205.0	V	104.0	4.4	15.2	73.9	

* Out of the restricted bands 15.205(a)

Table 9. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1653.975000	45.2	1000.000	122.0	H	194.0	-0.5	8.7	53.9	
2480.000000	89.8	1000.000	208.0	V	116.0	4.3	-35.9	53.9	*
2484.100000	43.9	1000.000	209.0	V	89.0	4.4	10.0	53.9	

* Out of the restricted bands 15.205(a)

Measured Peak and Average Values In The Frequency Range 4 000 MHz – 18 000 MHz.

FCC Part 15 Class B Spurious Emission 4-18GHz 3m

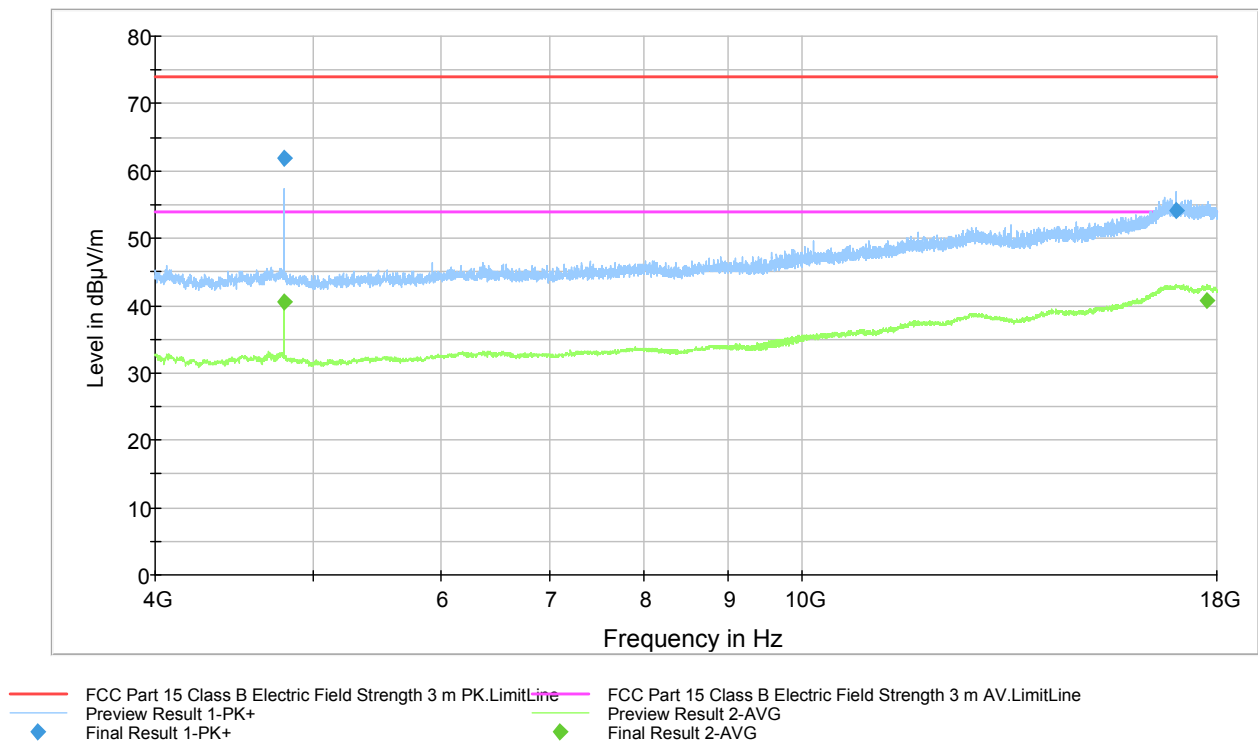


Figure 16. Measured curve with peak- and average detector. 1 Mbps Channel LOW.

Final measurements from the worst frequencies

Table 10. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBμV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)	Comment
4804.125000	61.8	1000.000	154.0	H	301.0	10.5	12.1	73.9	
17008.725000	54.2	1000.000	168.0	V	105.0	25.5	19.7	73.9	

Table 11. Final Average results.

Frequency (MHz)	Average (dBμV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)	Comment
4804.125000	40.6	1000.000	133.0	V	350.0	10.5	13.3	53.9	
17747.575000	40.9	1000.000	131.0	V	305.0	25.6	13.0	53.9	

FCC Part 15 Class B Spurious Emission 4-18GHz 3m

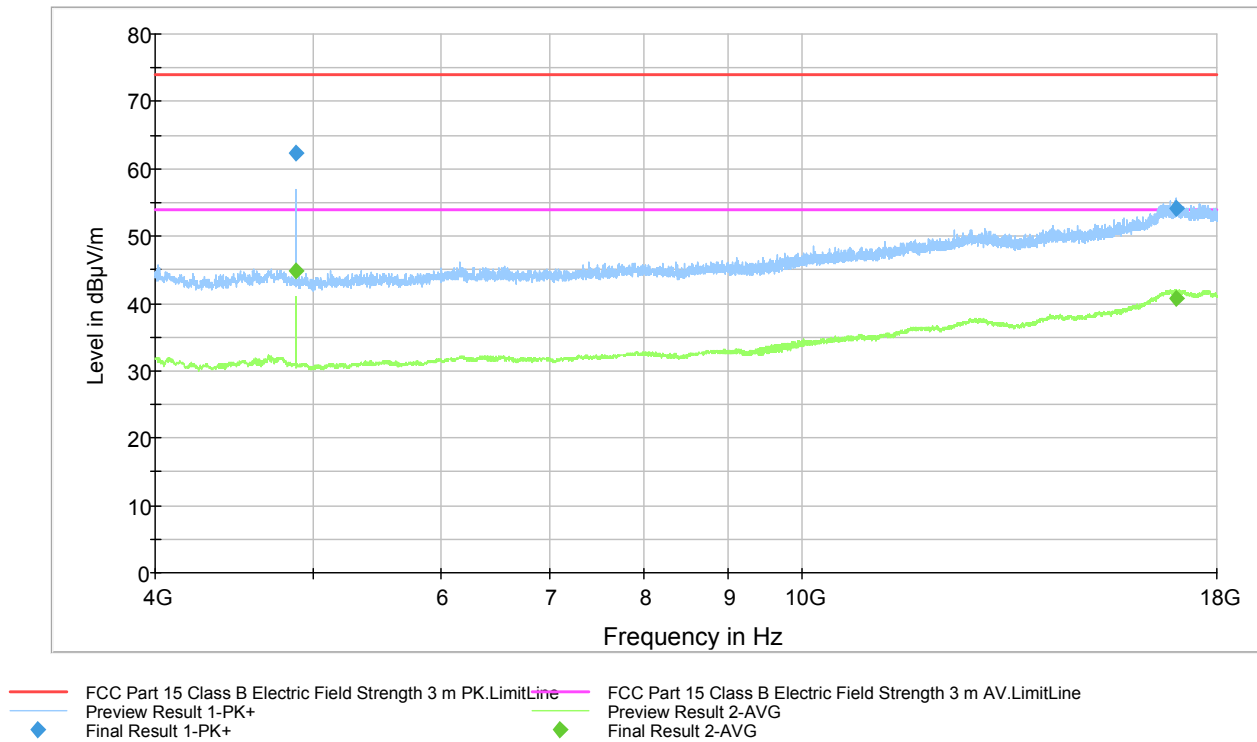


Figure 17. Measured curve with peak- and average detector. 1 Mbps Channel MID.

Final measurements from the worst frequencies

Table 12. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4882.075000	62.3	1000.000	154.0	H	138.0	10.4	11.6	73.9	
17005.075000	54.1	1000.000	254.0	V	16.0	25.5	19.8	73.9	

Table 13. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4882.075000	44.9	1000.000	154.0	H	139.0	10.4	9.0	53.9	
16995.875000	40.8	1000.000	100.0	V	297.0	25.5	13.1	53.9	

FCC Part 15 Class B Spurious Emission 4-18GHz 3m

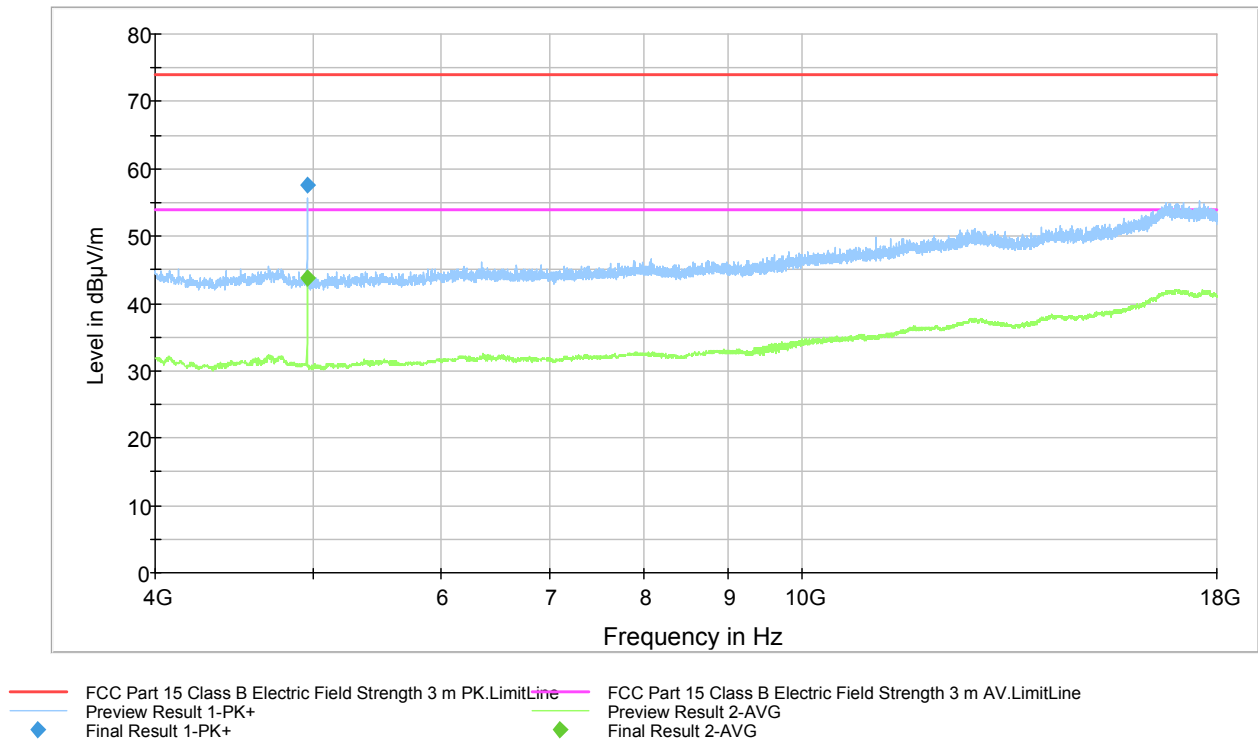


Figure 18. Measured curve with peak- and average detector. 1 Mbps Channel HIGH.

Final measurements from the worst frequencies

Table 14. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4959.975000	57.5	1000.000	194.0	V	332.0	10.3	16.4	73.9	

Table 15. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4960.175000	43.7	1000.000	146.0	V	333.0	10.3	10.2	53.9	

Measured Peak and Average Values In The Frequency Range 18 000 MHz – 26 500 MHz.

FCC Part 15 Class B Spurious Emission 18-26.5GHz 3m

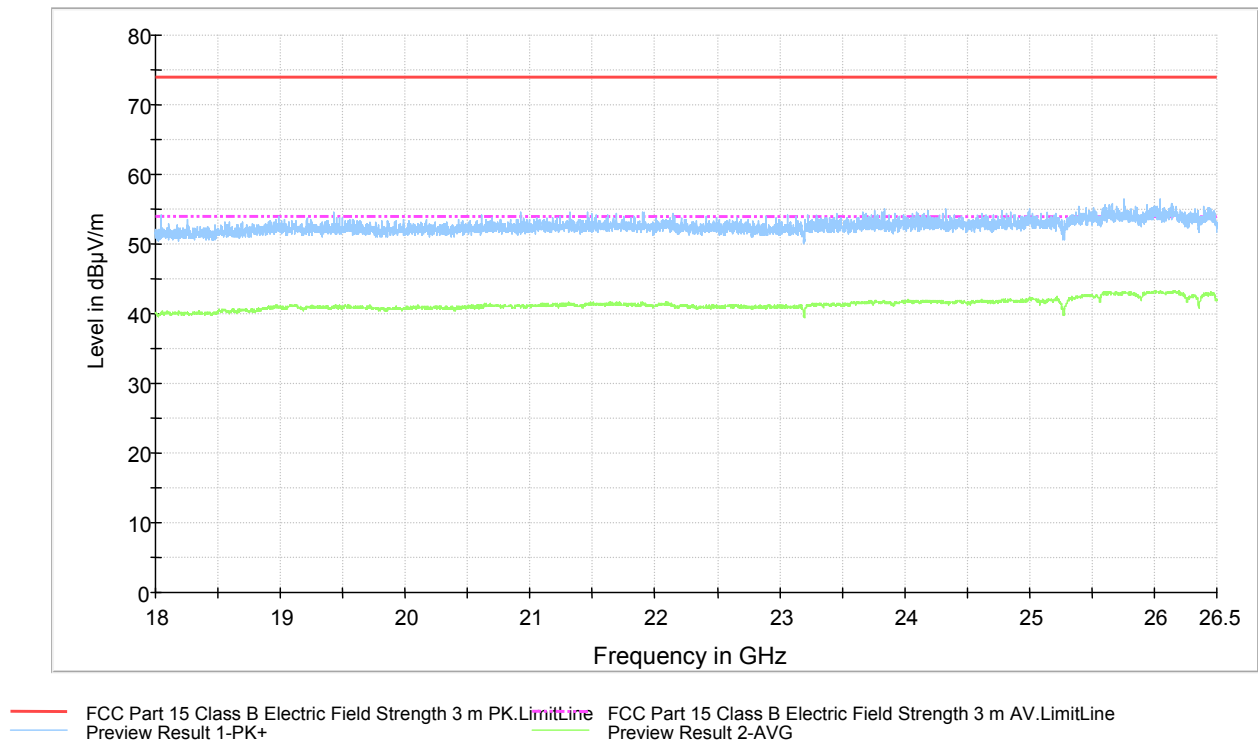


Figure 19. Measured curve with peak- and average detector. 1 Mbps Channel LOW.

FCC Part 15 Class B Spurious Emission 18-26.5GHz 3m

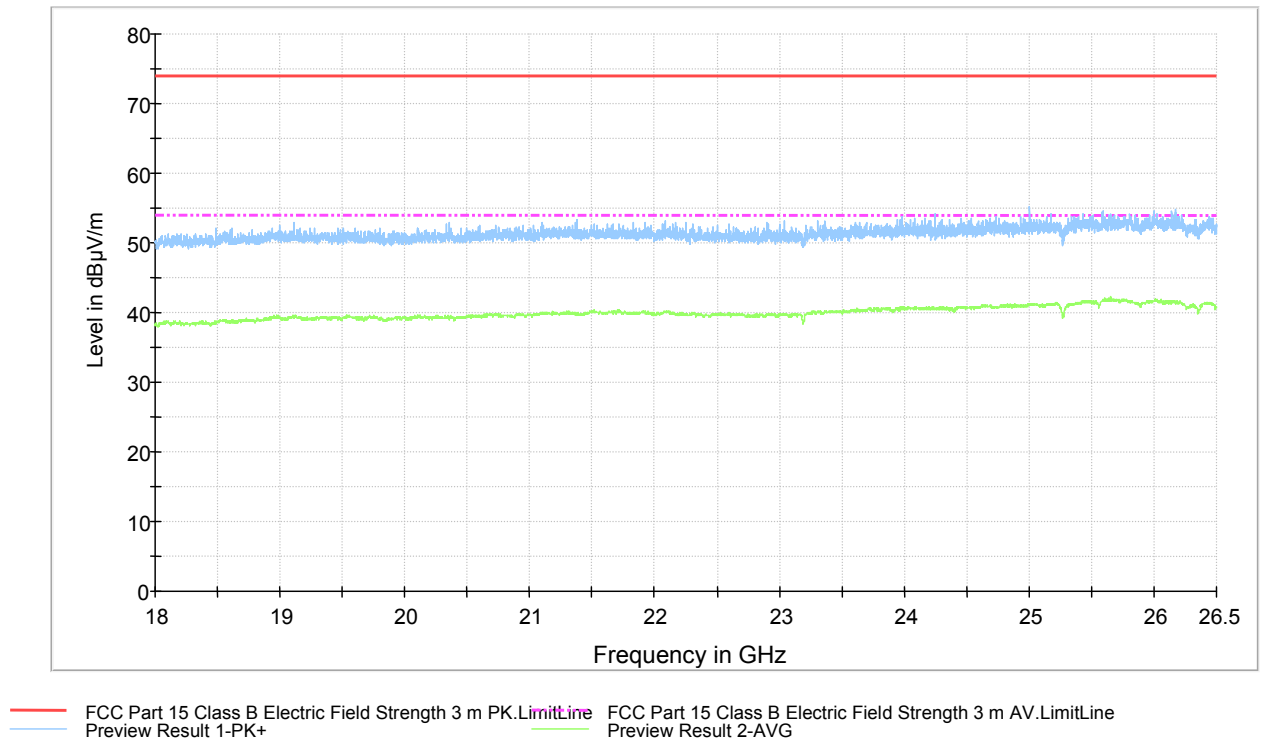


Figure 20. Measured curve with peak- and average detector. 1 Mbps Channel MID.

FCC Part 15 Class B Spurious Emission 18-26.5GHz 3m

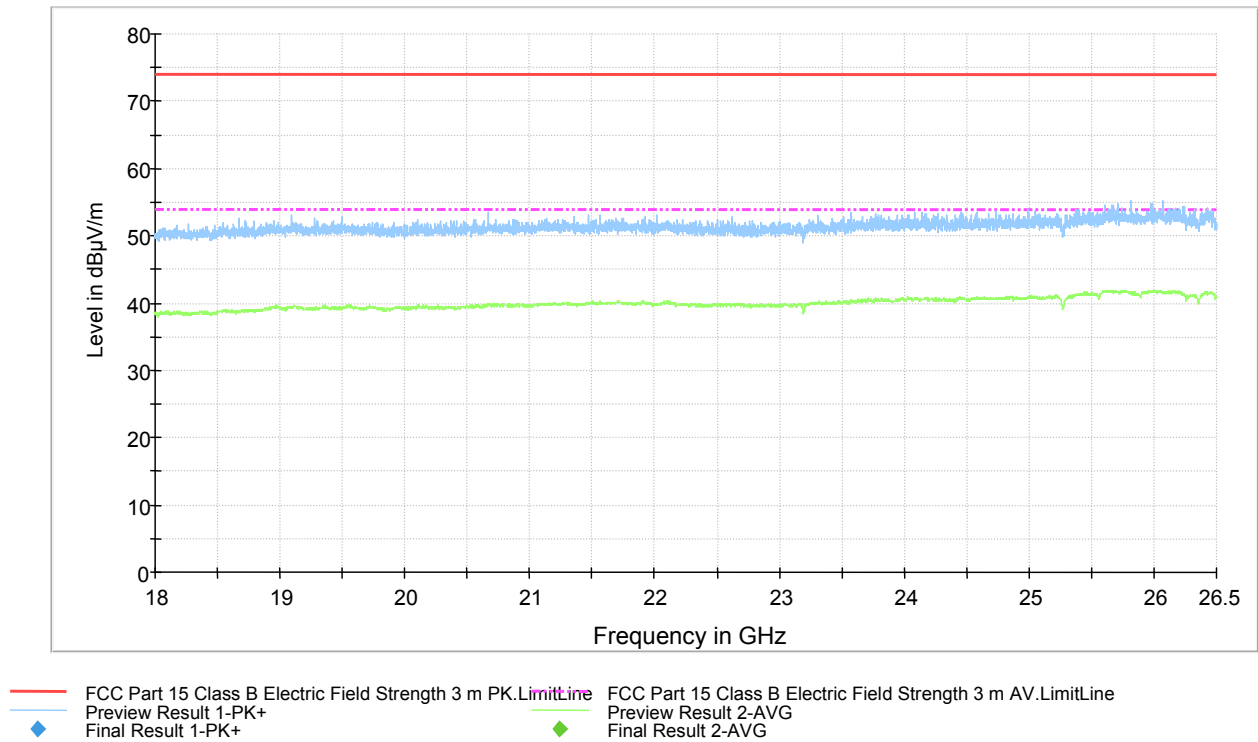


Figure 21. Measured curve with peak- and average detector. 1 Mbps Channel HIGH.

Radiated Band Edge Measurement results

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

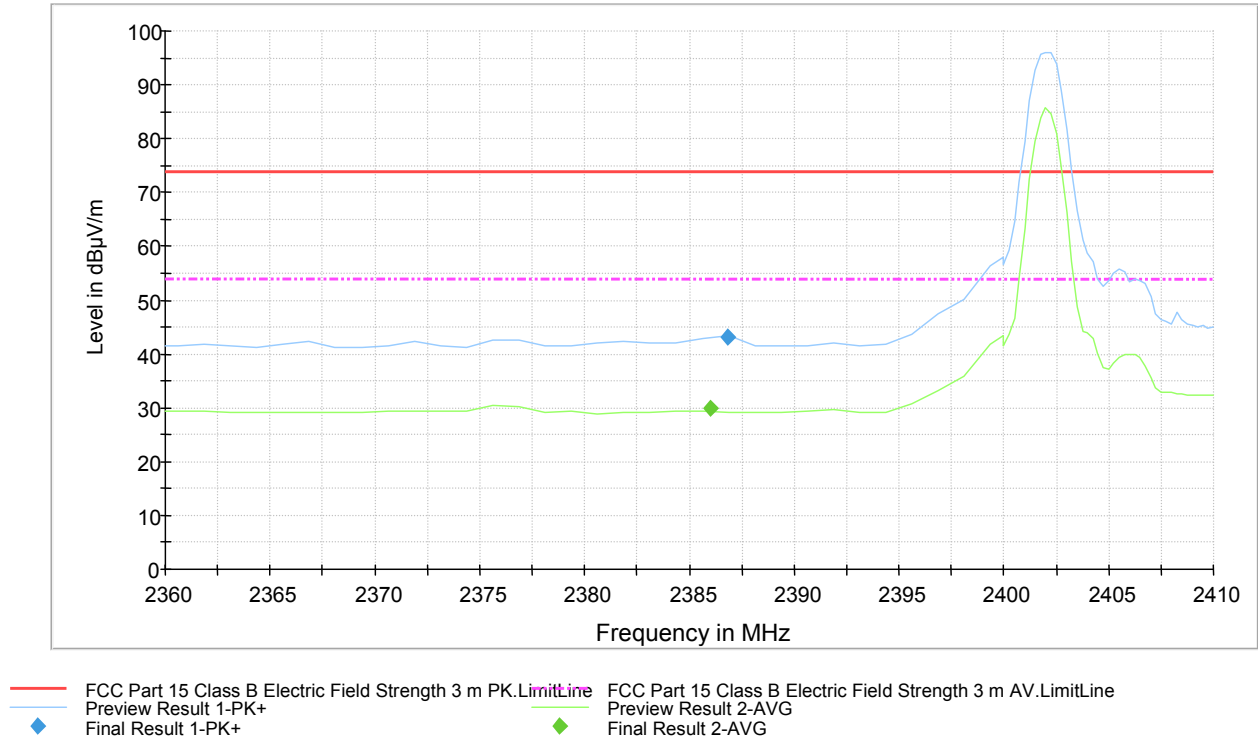


Figure 22. Measured curve with peak and average detectors. 1 Mbps Lower band edge.

Table 16. Final measurement with peak detector.

Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)	Comment
2386.800000	43.2	1000.0	1000.000	155.0	V	46.0	4.3	30.7	73.9	

Table 17. Final measurement with average detector.

Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)	Comment
2386.000000	30.0	1000.0	1000.000	187.0	V	84.0	4.3	23.9	53.9	

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

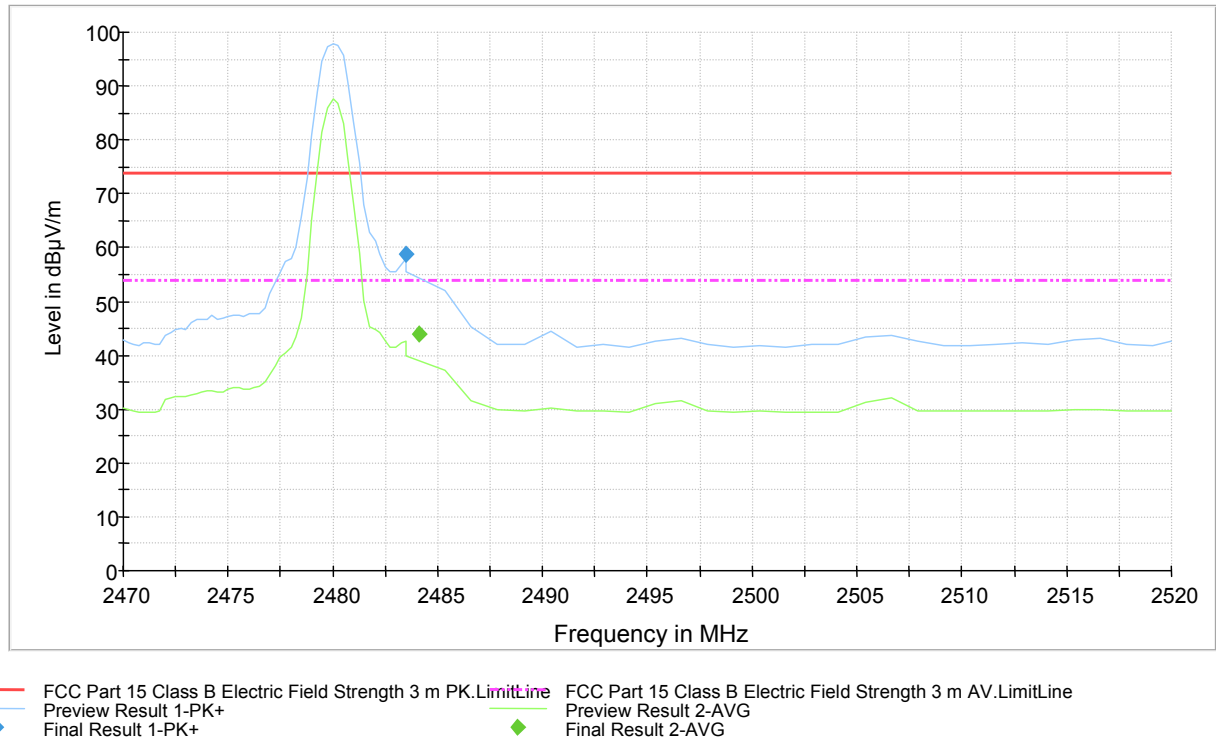


Figure 23. Measured curve with peak and average detectors. 1 Mbps Upper band edge.

Table 18. Final measurement with peak detector.

Frequency (MHz)	MaxPeak (dBμV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)	Comment
2483.500000	58.7	1000.000	205.0	V	104.0	4.4	15.2	73.9	

Table 19. Final measurement with average detector.

Frequency (MHz)	Average (dBμV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)	Comment
2484.100000	43.9	1000.000	209.0	V	89.0	4.4	10.0	53.9	

Transmitter Band Edge Measurement and Conducted Spurious Emissions

Standard: ANSI C63.10 (2009)
Tested by: RRE
Date: 23.10.2012
Temperature: 20 °C
Humidity: 30 %
Measurement uncertainty: ± 2.87 dB Level of confidence 95 % (k = 2)

FCC Rule: 15.247(d), 15.209(a)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

Table 20. Band edge attenuation.

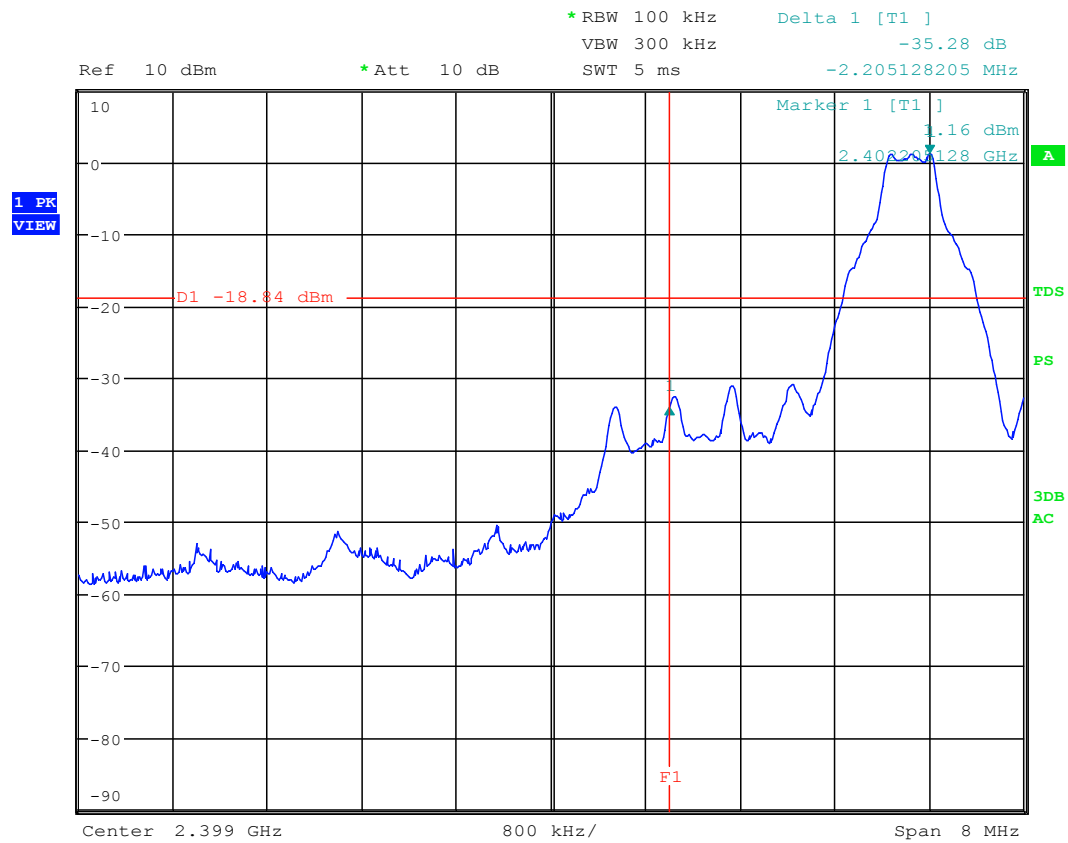
Data rate	Band Edge Attenuation	
	Lower Band Edge	Upper Band Edge
1Mbps	-35.28 dBc	-44.94 dBc
2Mbps	-39.18 dBc	-41.72 dBc
3Mbps	-39.56 dBc	-41.88 dBc
Limit: -20dBc		

Table 21. Conducted spurious emissions 1Mbps (worst case)

Conducted Spurious Emissions				
Channel	Measured Attenuation [dB]	Limit [dBc]	Margin [dB]	Result
Low	-	-20.0	-	-
Mid	-	-20.0	-	-
High	-	-20.0	-	-

No significant emissions were detected close to the limit.

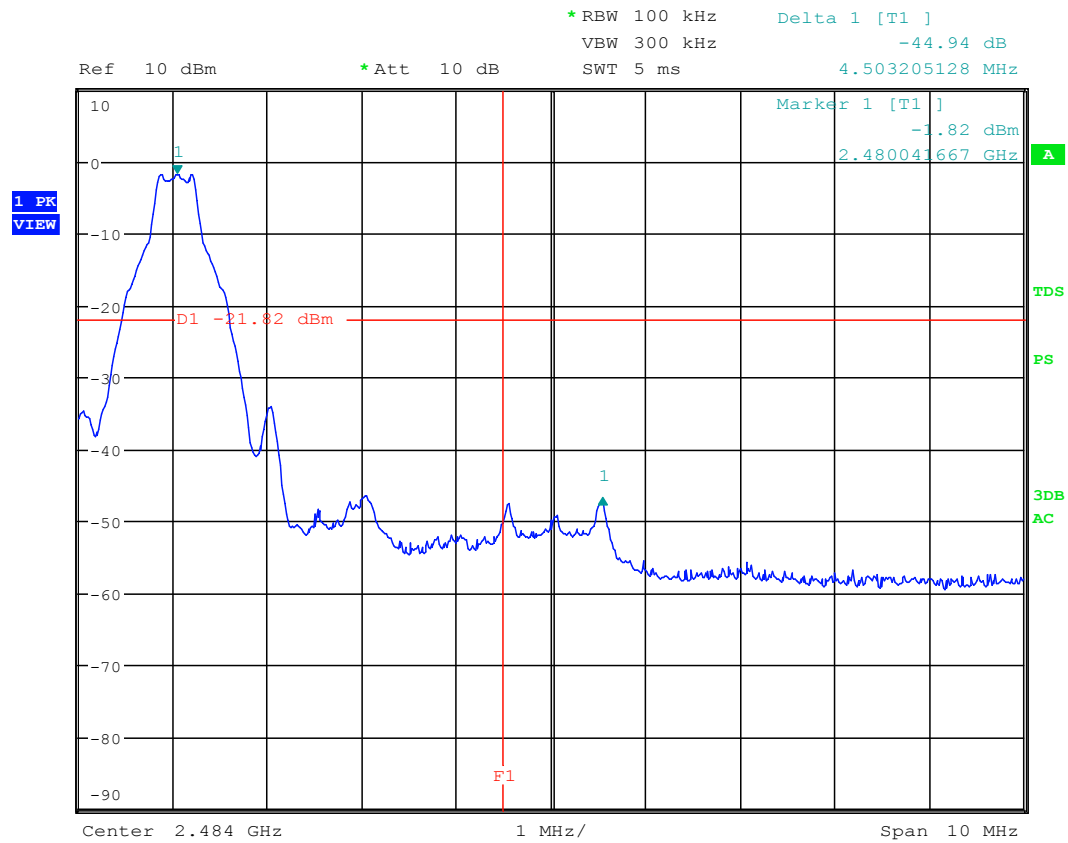
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 07:36:04

Figure 24. Lower Band Edge 1Mbps.

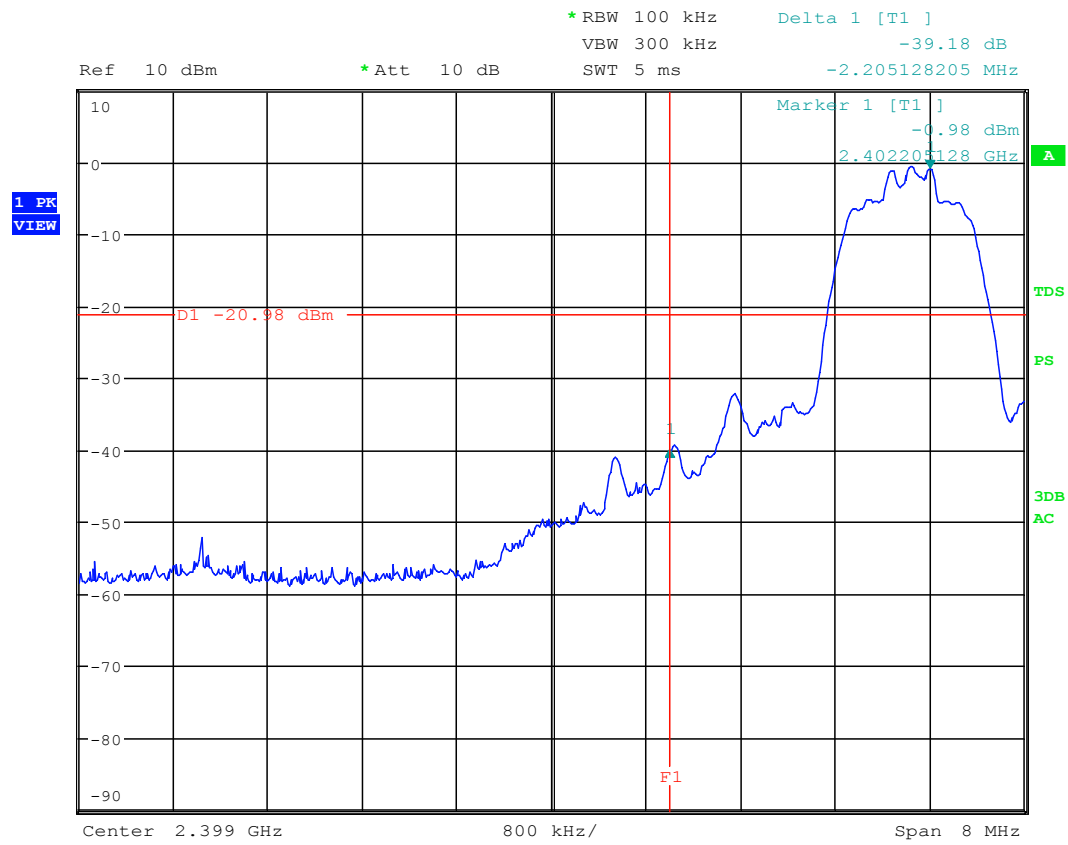
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 07:47:43

Figure 25. Upper Band Edge 1Mbps.

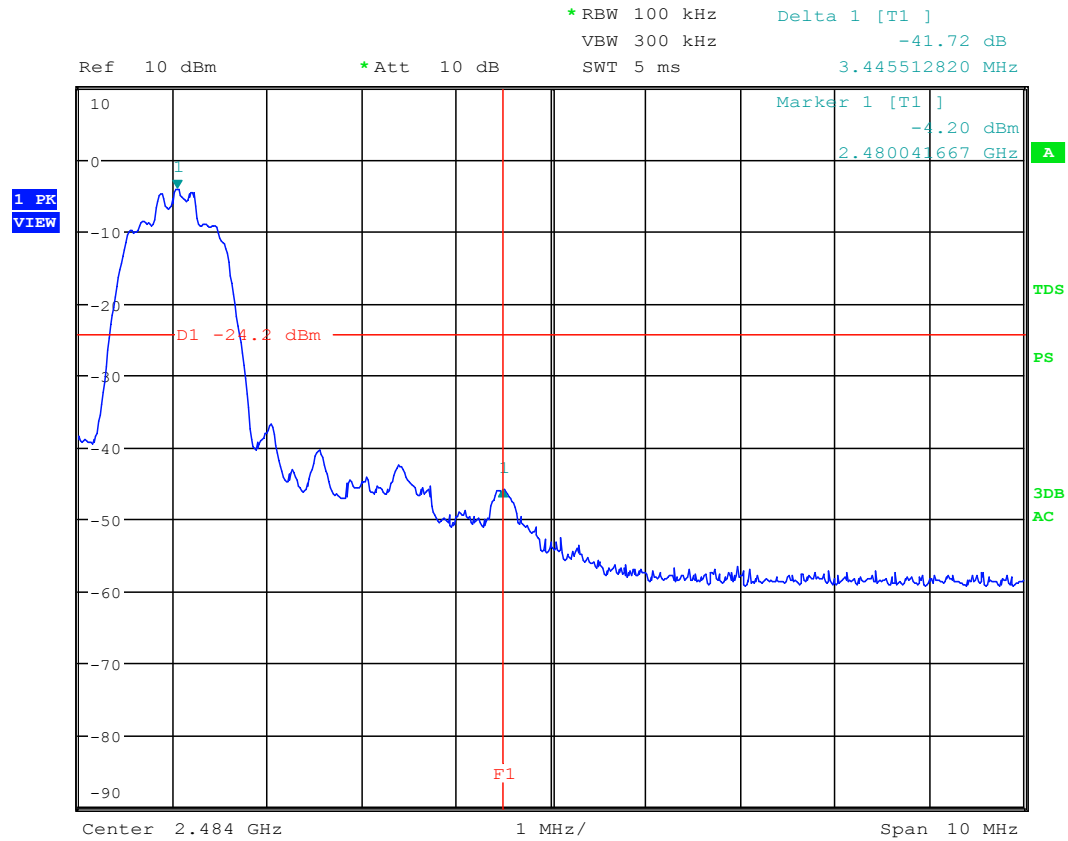
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 07:39:16

Figure 26. Lower Band Edge 2Mbps.

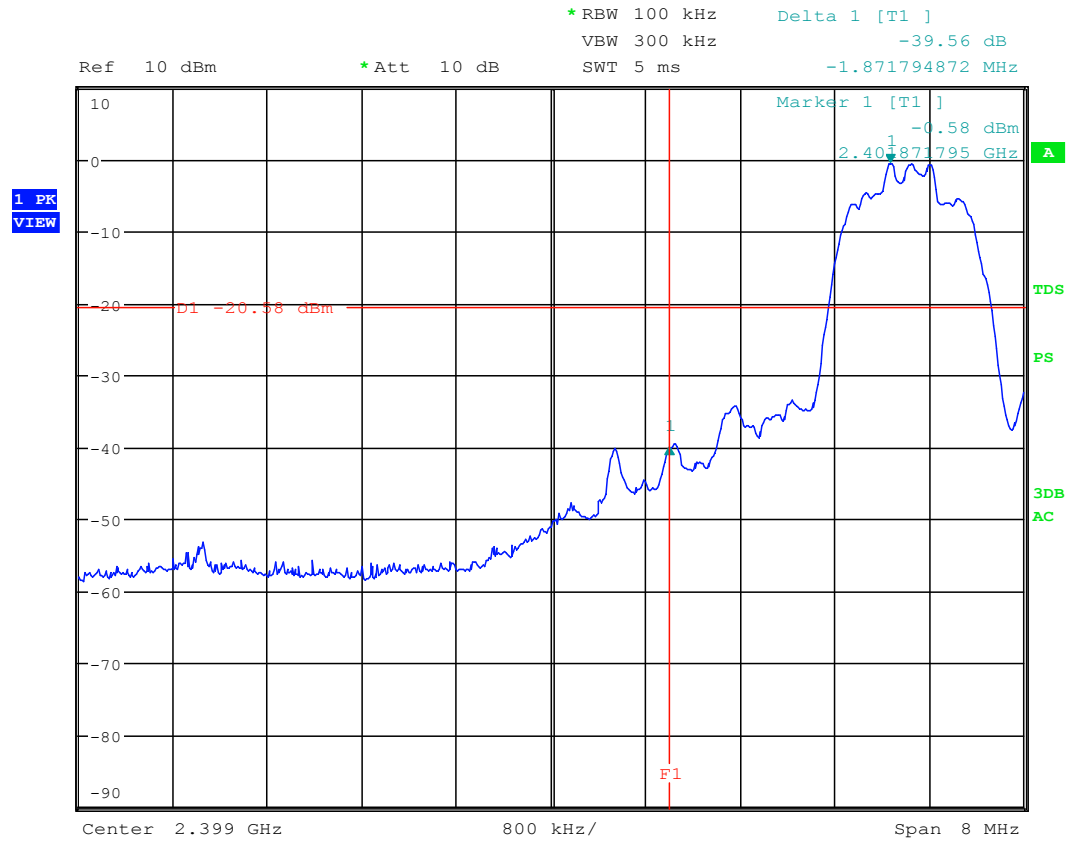
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 07:51:35

Figure 27. Upper Band Edge 2Mbps.

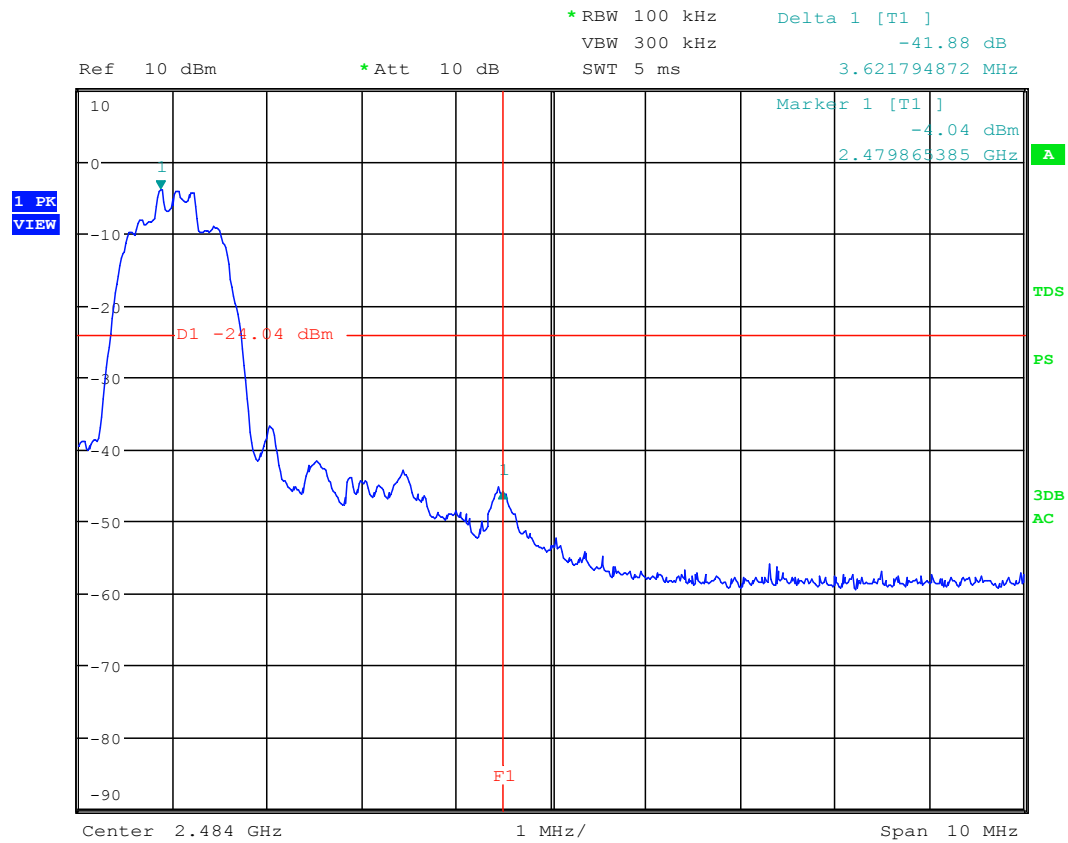
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 07:32:20

Figure 28. Lower Band Edge 3Mbps.

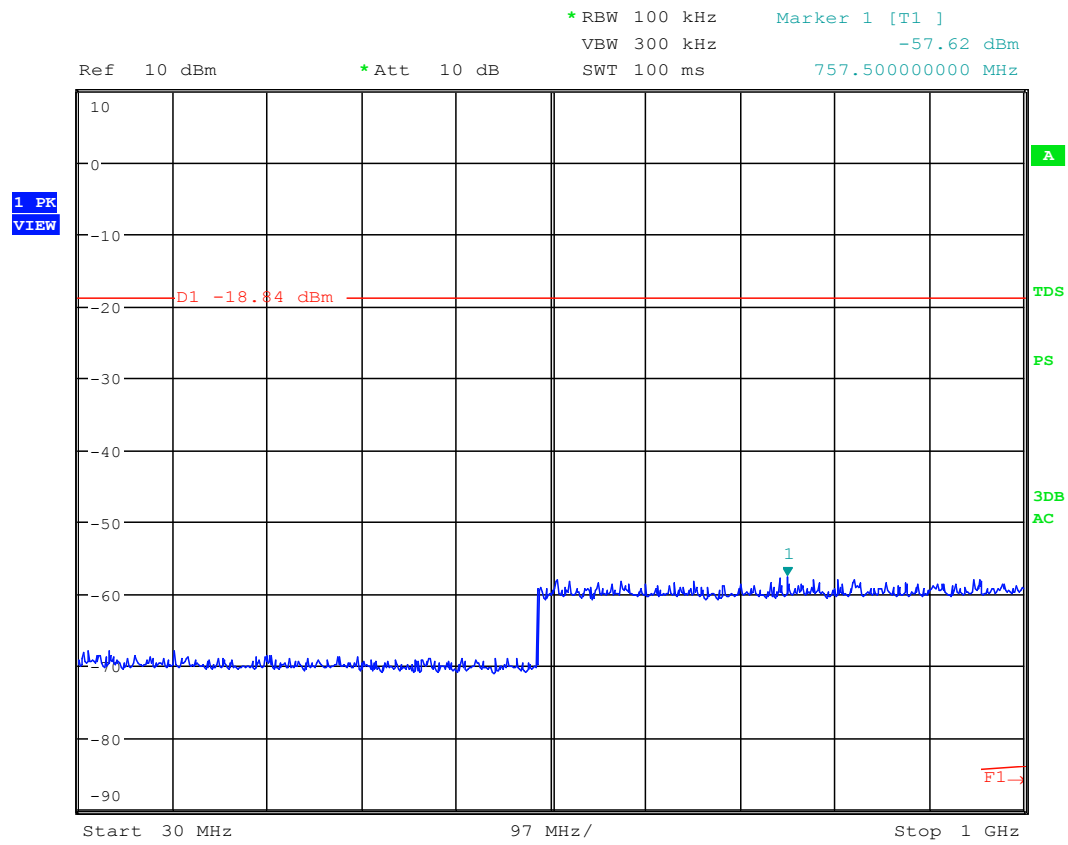
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 07:55:12

Figure 29. Upper Band Edge 3Mbps.

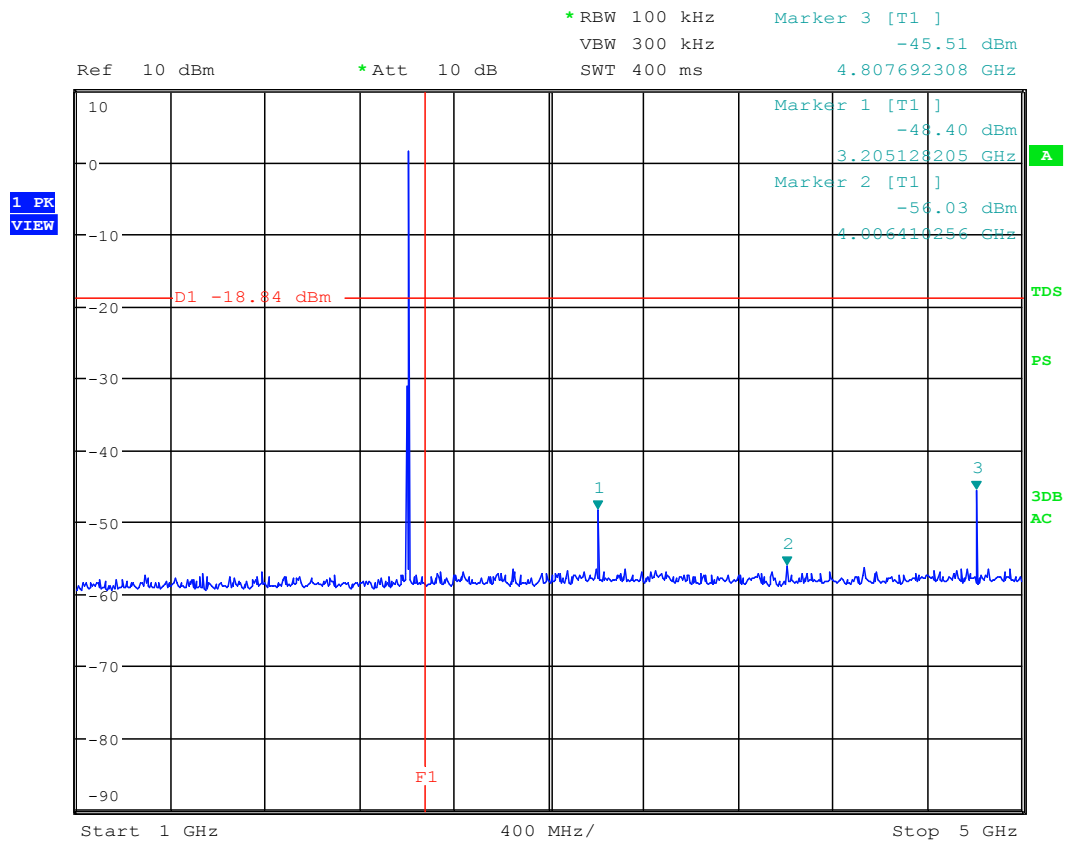
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 08:05:29

Figure 30. Conducted Spurious Emissions 30 – 1 000 MHz. 1 Mbps Channel LOW.

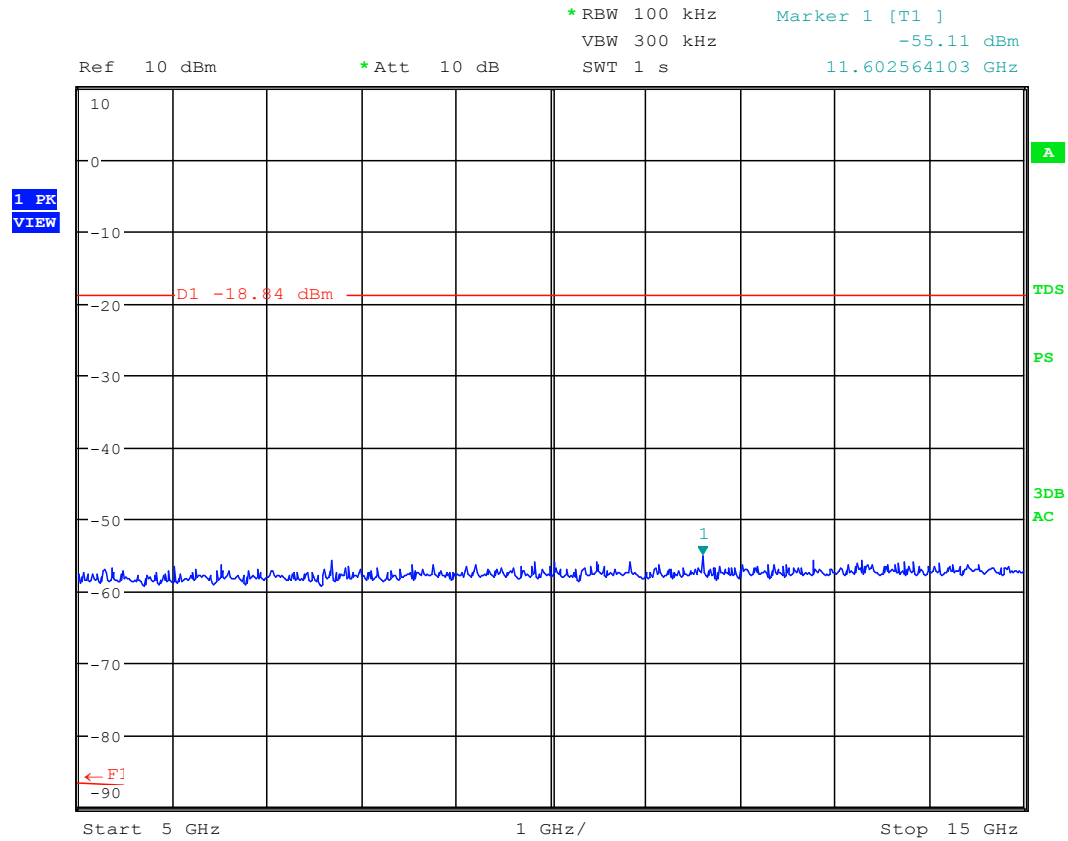
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 08:10:02

Figure 31. Conducted Spurious Emissions 1 000 – 5 000 MHz. 1 Mbps Channel LOW.

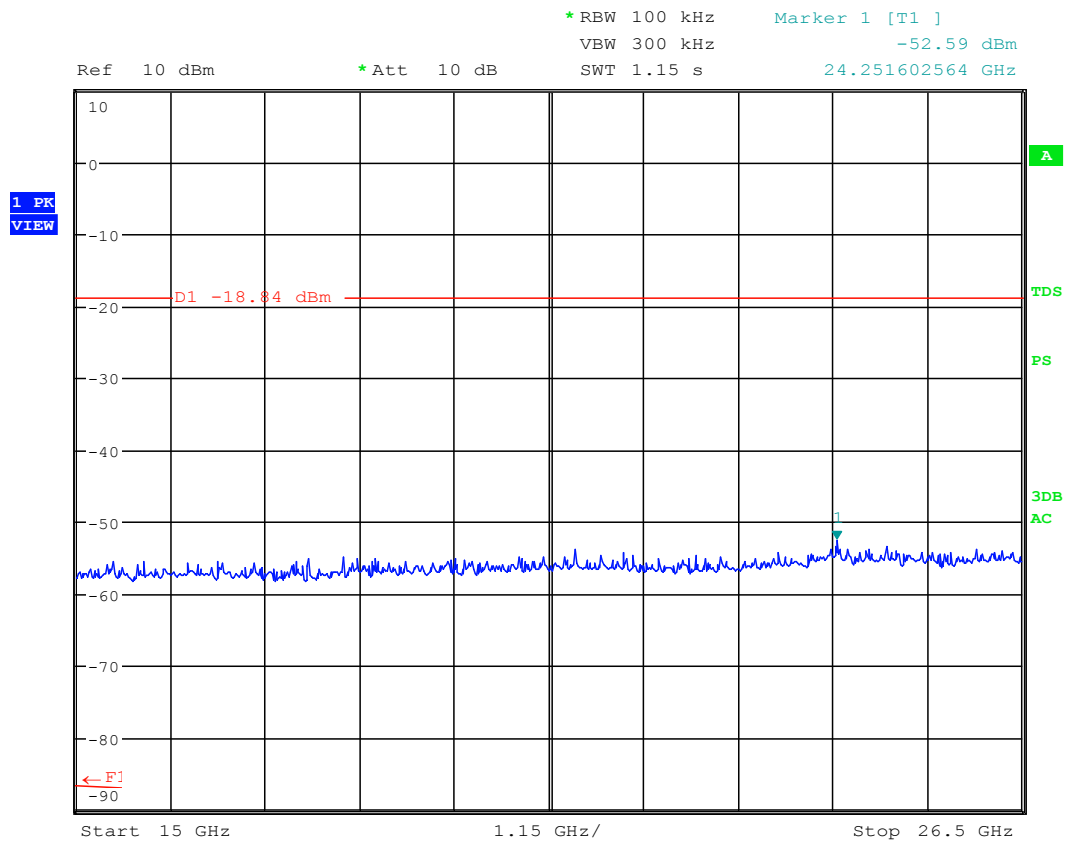
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 08:11:49

Figure 32. Conducted Spurious Emissions 5 000 – 15 000 MHz. 1 Mbps Channel LOW.

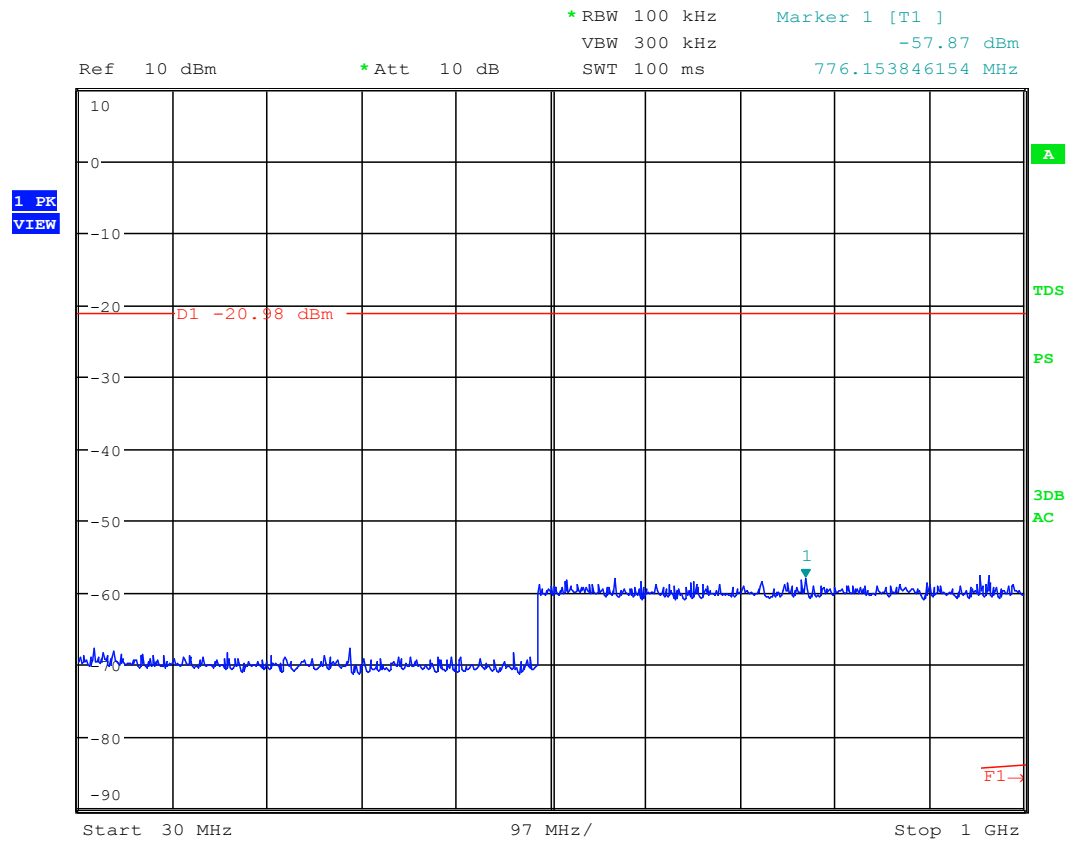
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 08:12:50

Figure 33. Conducted Spurious Emissions 15 000 – 26500 MHz. 1 Mbps Channel LOW.

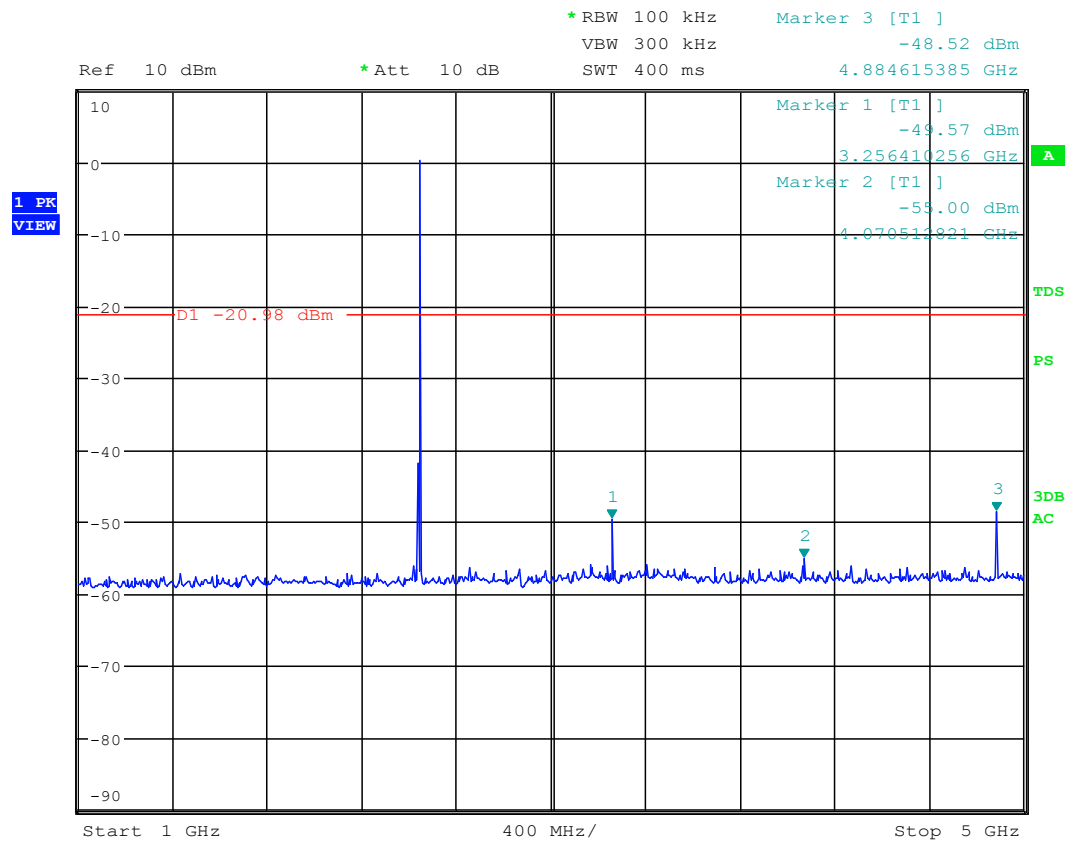
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 08:16:07

Figure 34. Conducted Spurious Emissions 30 – 1 000 MHz. 1 Mbps Channel MID.

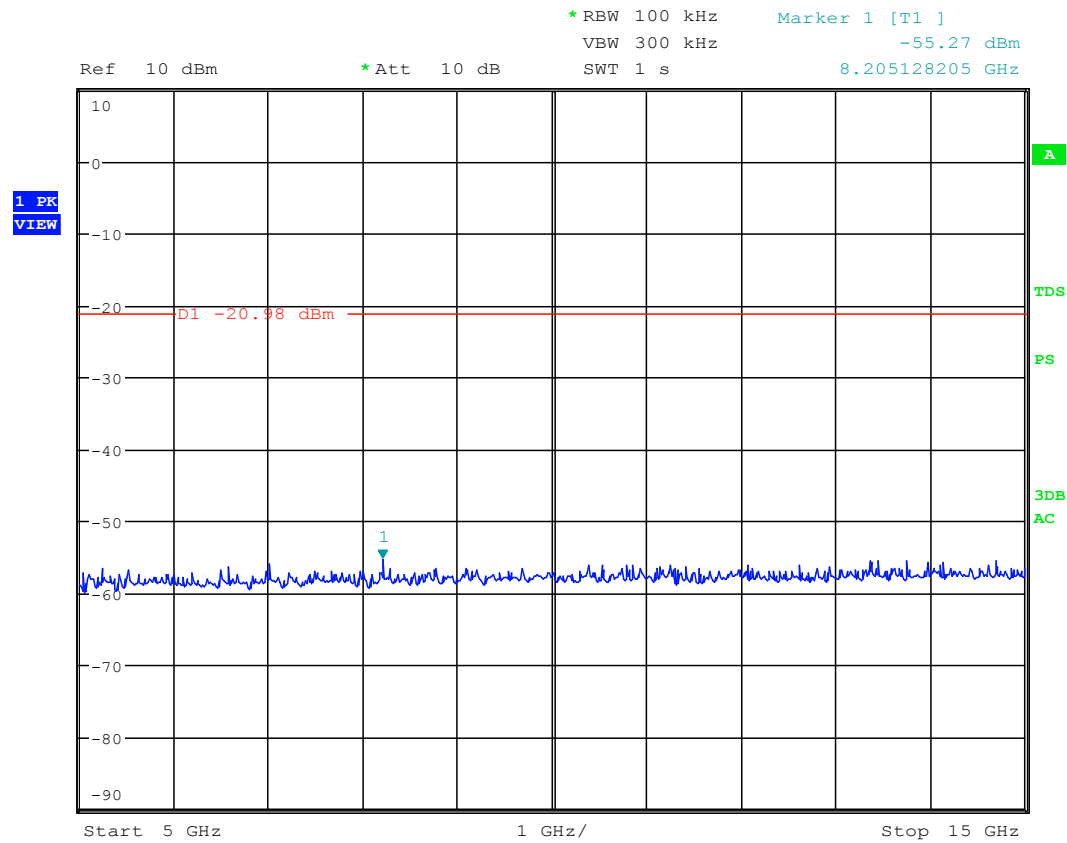
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 08:20:43

Figure 35. Conducted Spurious Emissions 1 000 – 5 000 MHz. 1Mbps Channel MID.

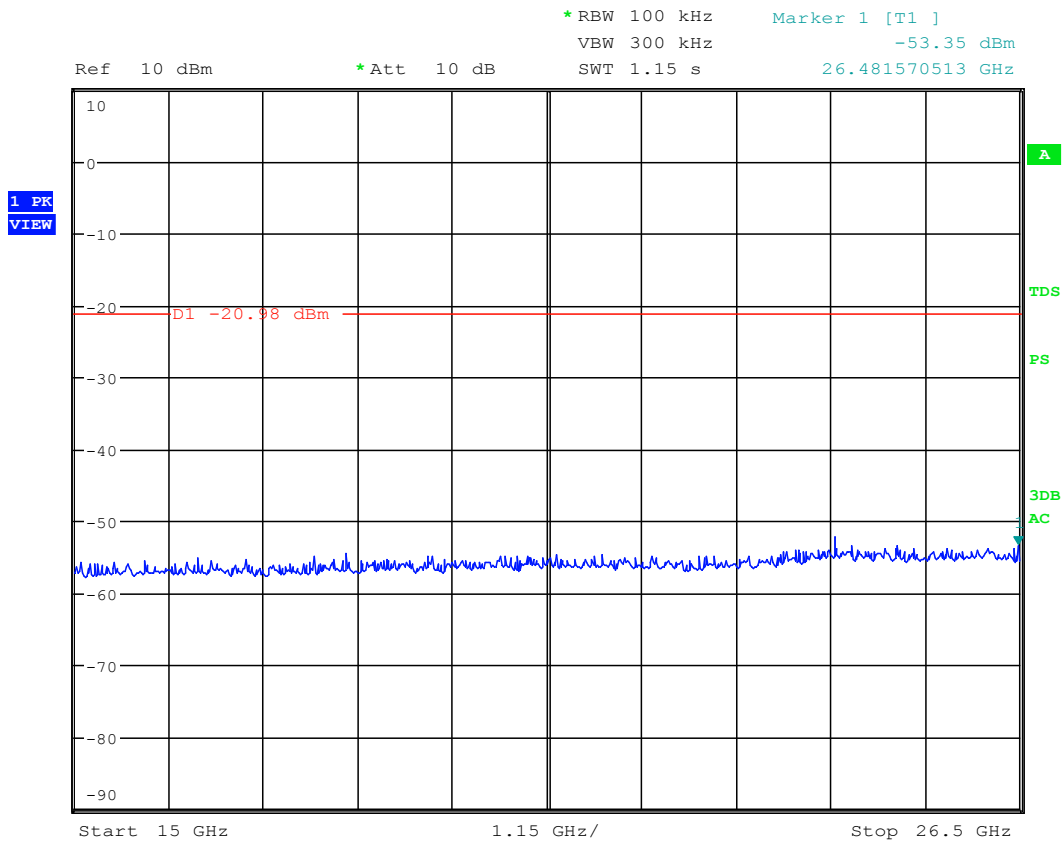
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 08:22:13

Figure 36. Conducted Spurious Emissions 5 000 – 15 000 MHz. 1Mbps Channel MID.

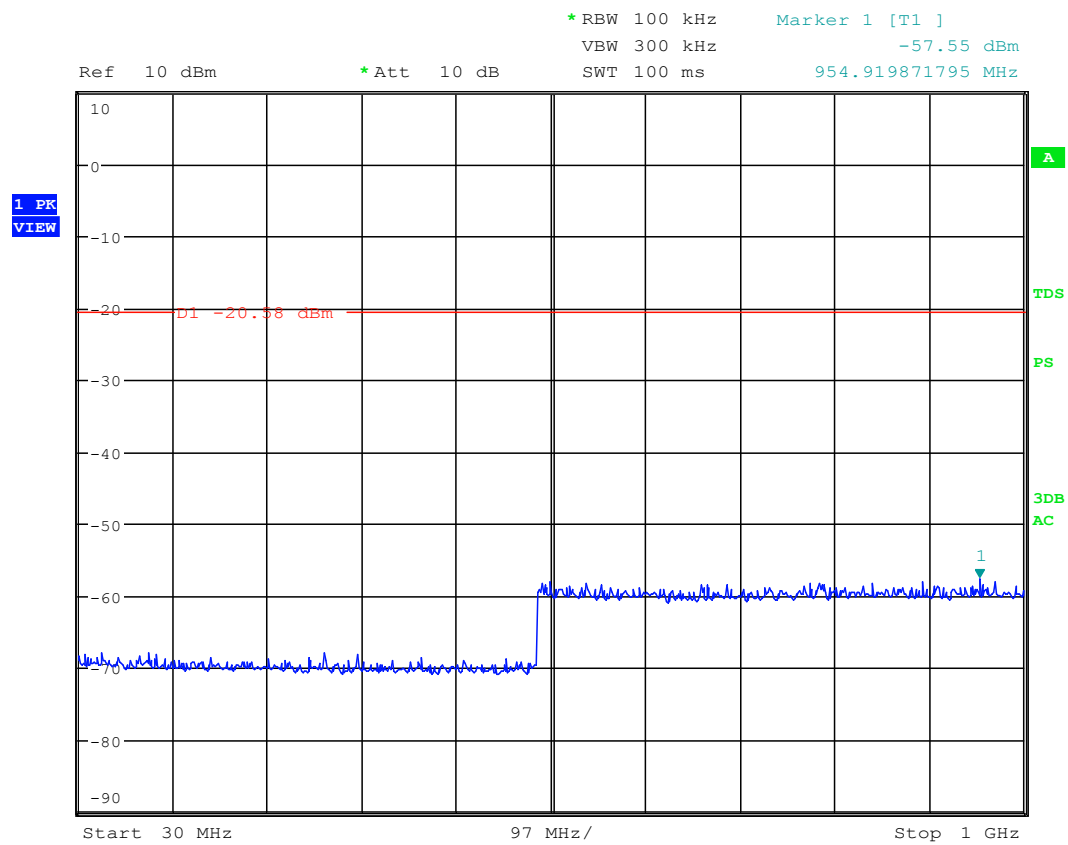
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 08:23:18

Figure 37. Conducted Spurious Emissions 15 000 – 26 500 MHz. 1 Mbps Channel MID.

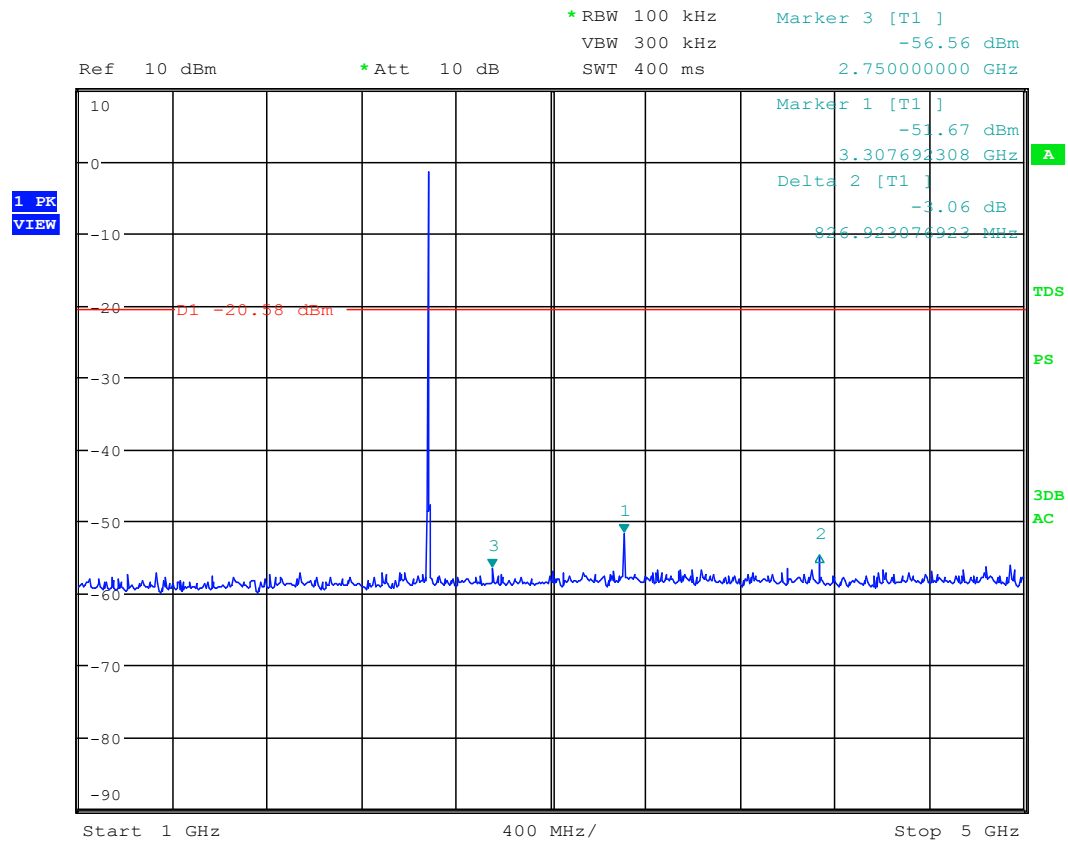
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 08:25:42

Figure 38. Conducted Spurious Emissions 30 – 1 000 MHz. 1 Mbps Channel HIGH.

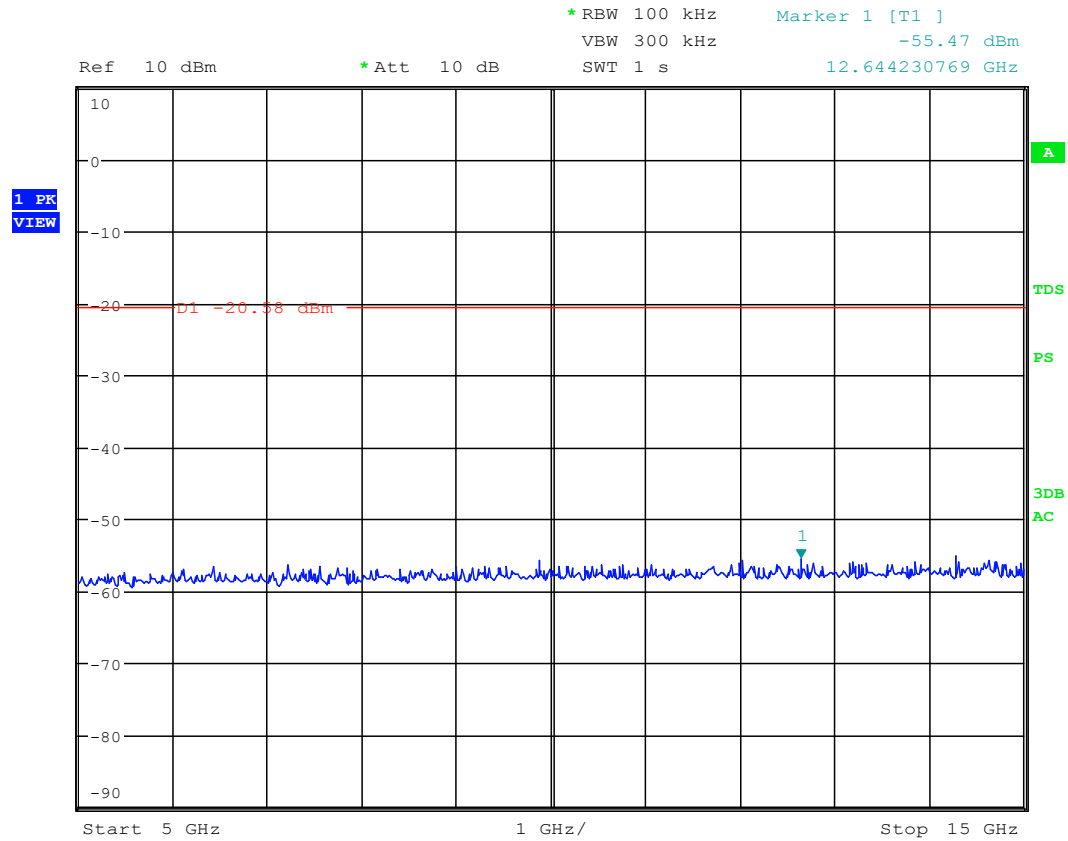
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 08:27:38

Figure 39. Conducted Spurious Emissions 1 000 – 5 000 MHz. 1 Mbps Channel HIGH.

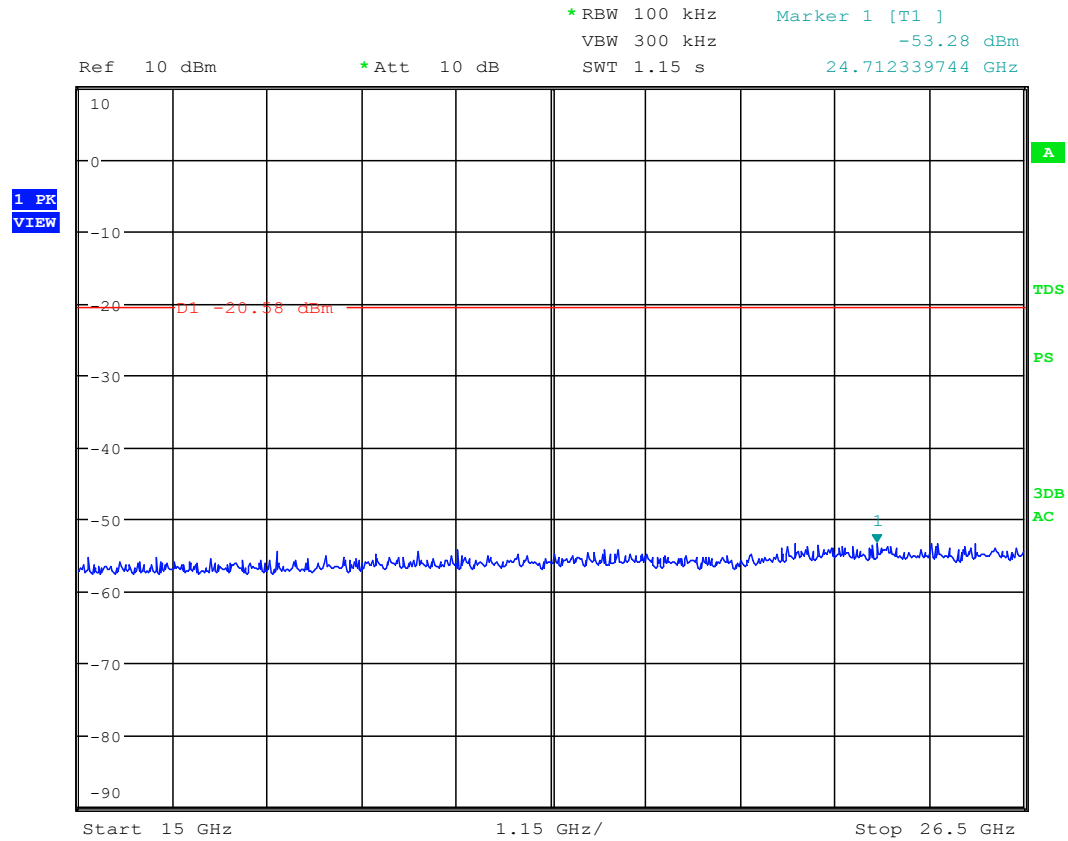
Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 08:28:53

Figure 40. Conducted Spurious Emissions 5 000 – 15 000 MHz. 1Mbps Channel HIGH.

Transmitter Band Edge Measurement and Conducted Spurious Emissions



Date: 23.OCT.2012 08:30:21

Figure 41. Conducted Spurious Emissions 15 000 – 25 000 MHz. 1 Mbps Channel HIGH.

20 dB Bandwidth of the Hopping Channel

Standard: ANSI C63.10 (2009)
Tested by: RRE
Date: 22.10.2012
Temperature: 24 °C
Humidity: 23 % RH

FCC Rule: 15.247(a)(1)

Results:

1 Mbps

Table 22. 20 dB bandwidth test results 1 Mbps.

Channel	20 dB BW [kHz]
Low	1136
Mid	1128
High	1136

2 Mbps

Table 23. 20 dB bandwidth test results 2 Mbps

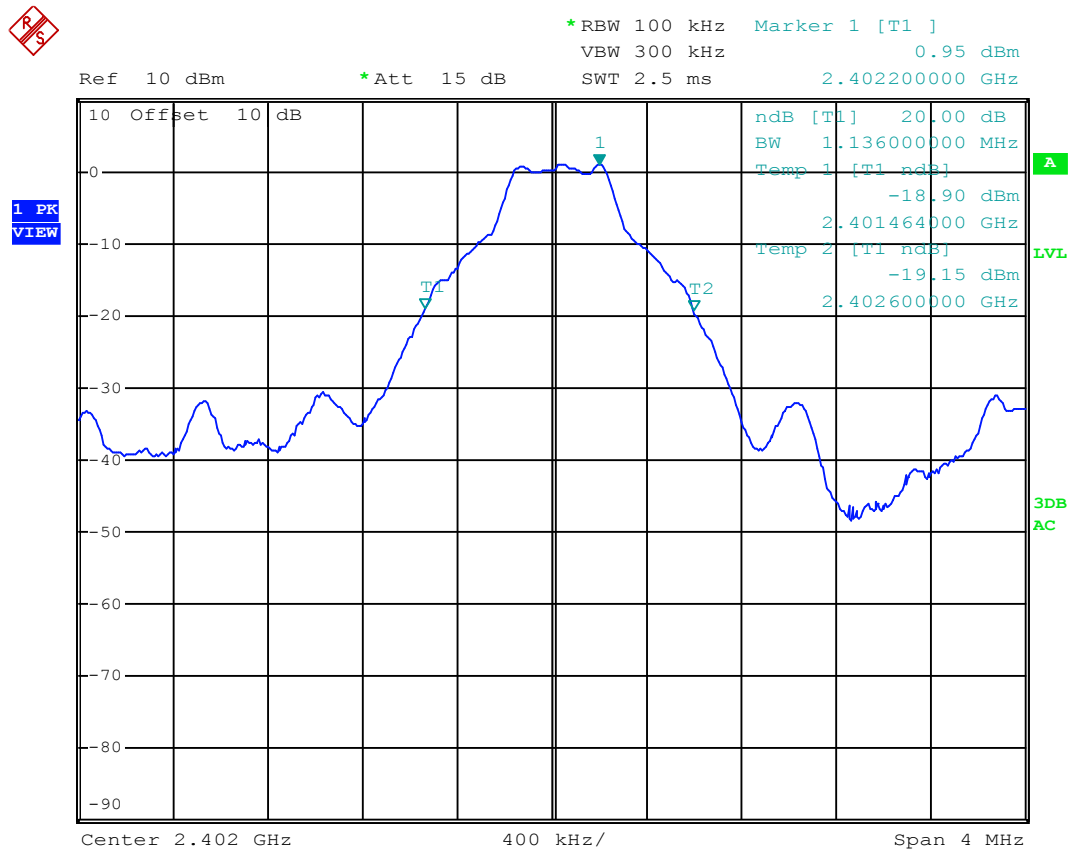
Channel	20 dB BW [kHz]
Low	1376
Mid	1384
High	1368

3 Mbps

Table 24. 20 dB bandwidth test results 3 Mbps

Channel	20 dB BW [kHz]
Low	1376
Mid	1376
High	1376

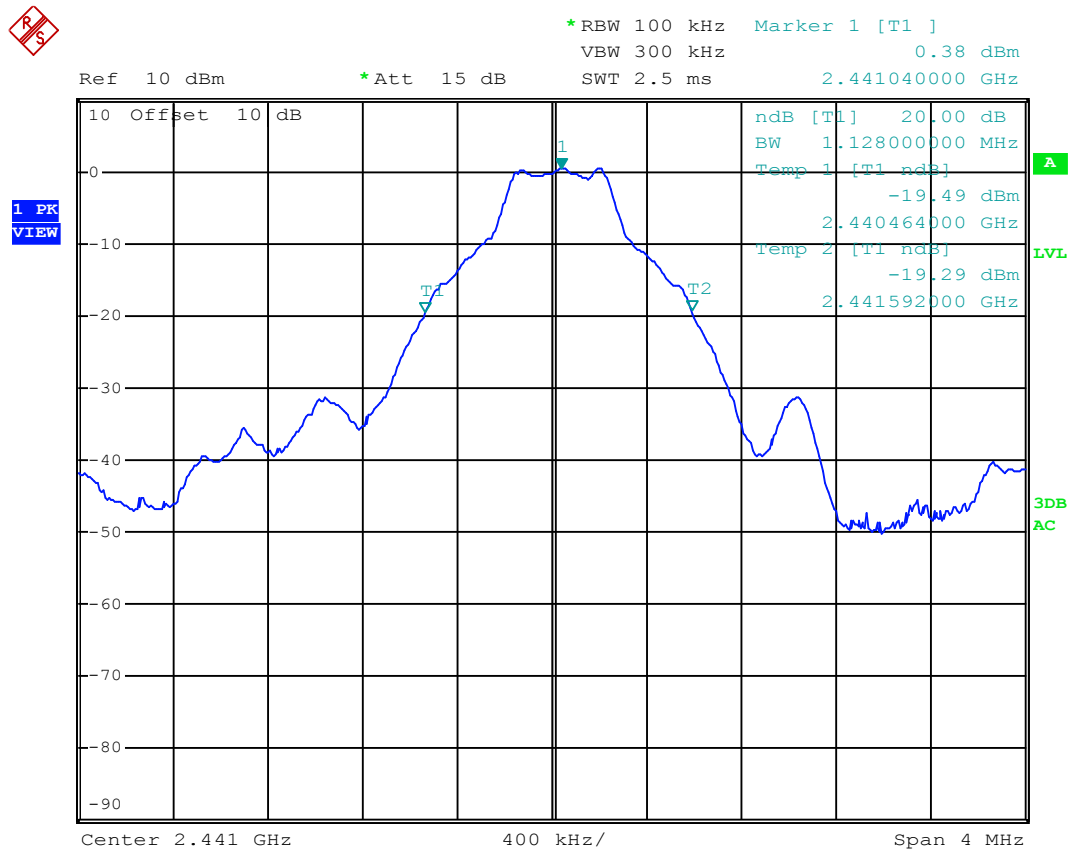
20dB Bandwidth of the Hopping Channel



Date: 22.OCT.2012 12:42:26

Figure 42. 20 dB channel BW. 1 Mbps Channel LOW.

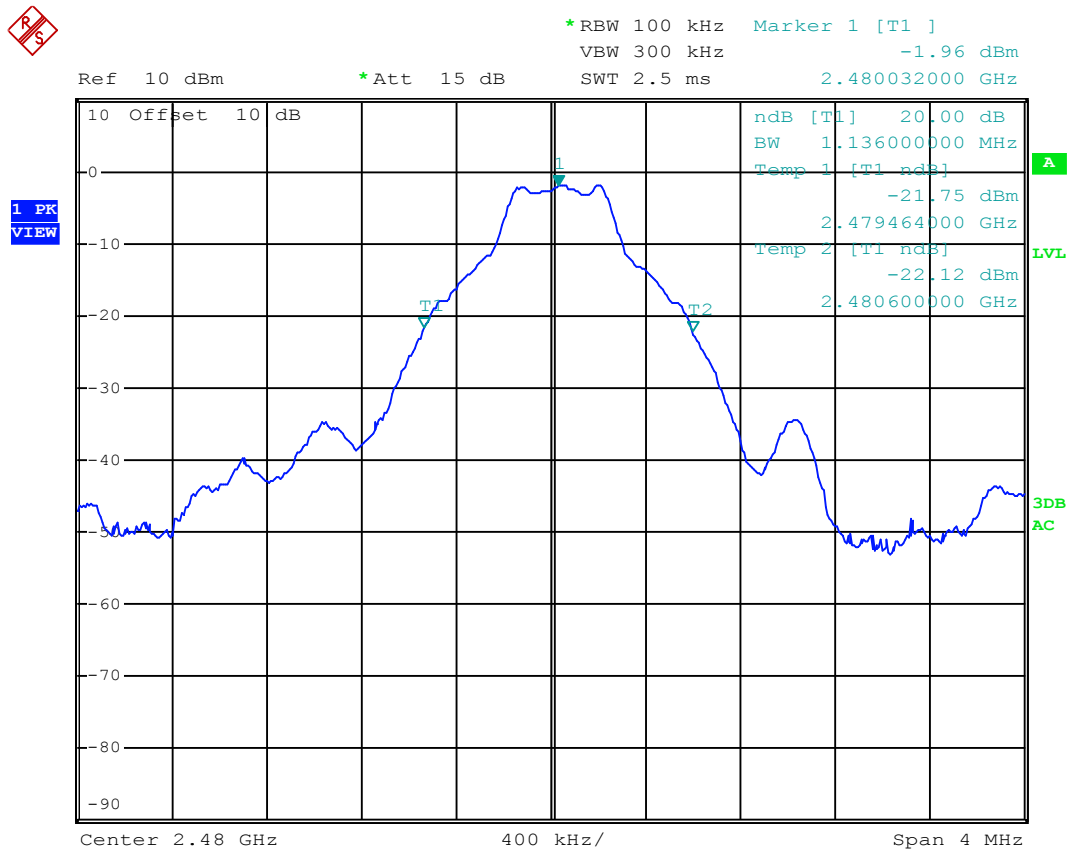
20dB Bandwidth of the Hopping Channel



Date: 22.OCT.2012 12:43:56

Figure 43. 20 dB channel BW. 1 Mbps Channel MID.

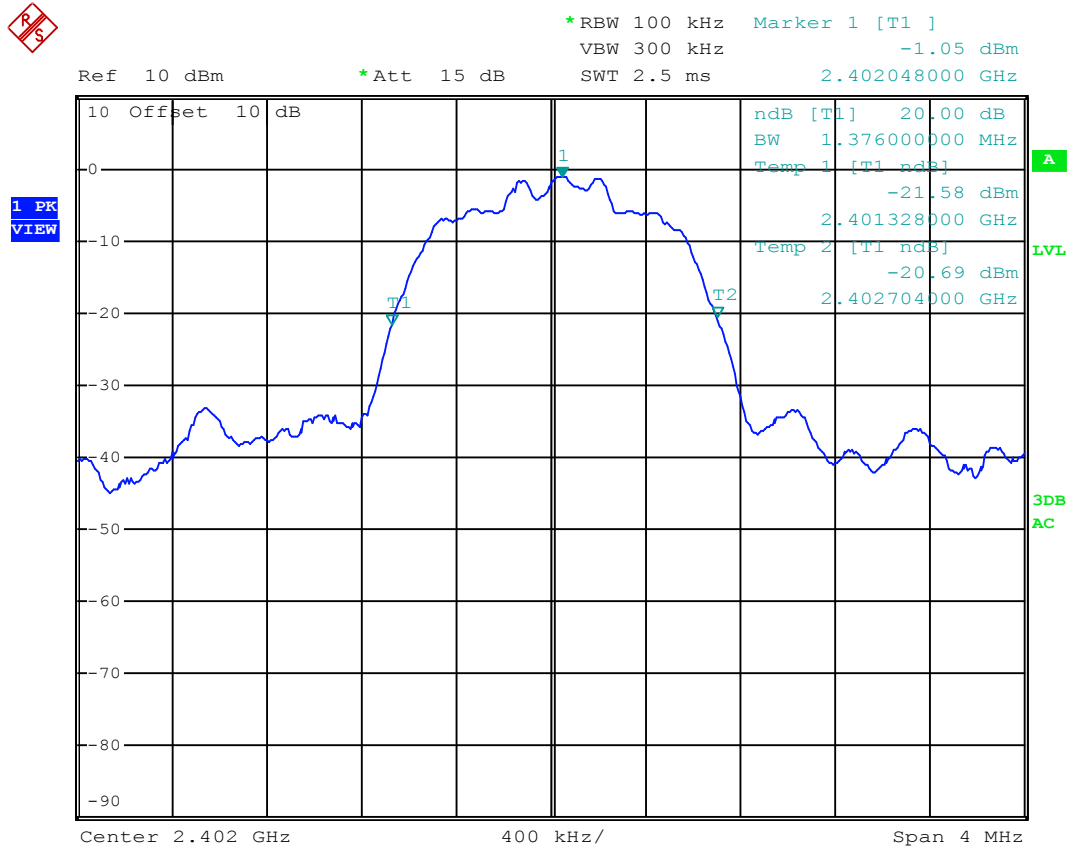
20dB Bandwidth of the Hopping Channel



Date: 22.OCT.2012 12:44:59

Figure 44. 20 dB channel BW. 1 Mbps Channel HIGH.

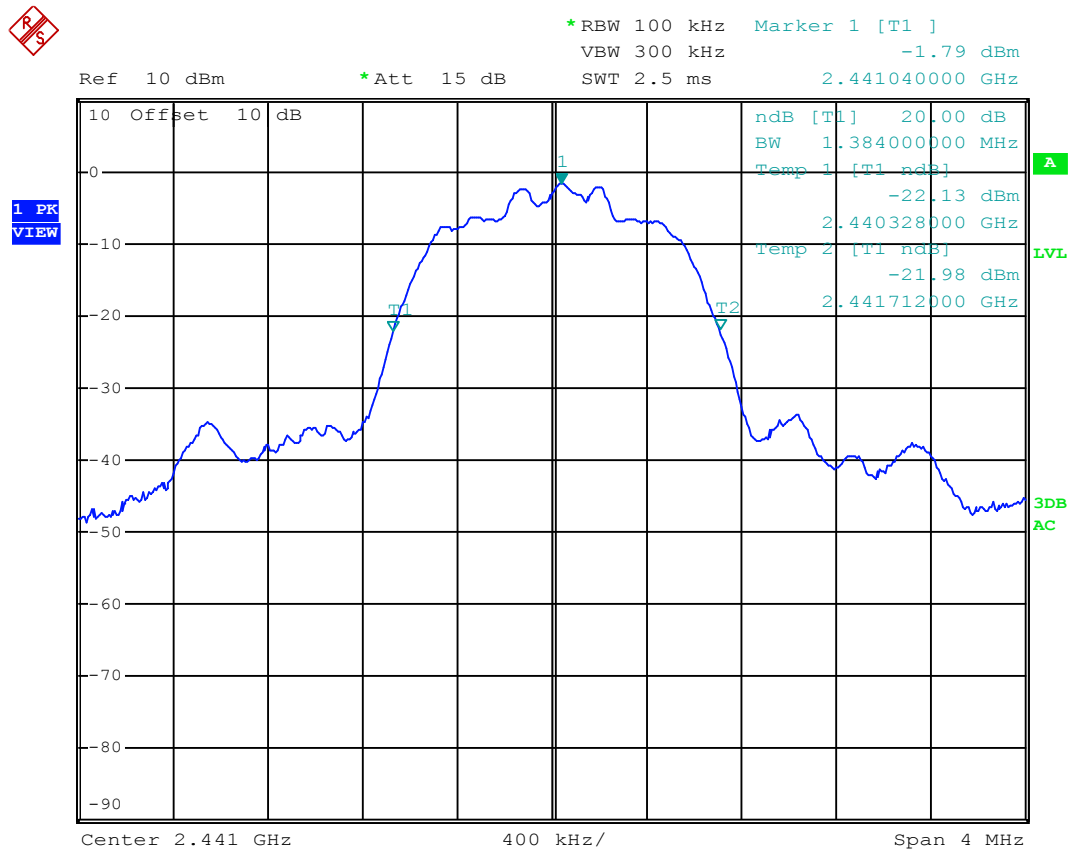
20dB Bandwidth of the Hopping Channel



Date: 22.OCT.2012 12:46:57

Figure 45. 20 dB channel BW. 2 Mbps Channel LOW.

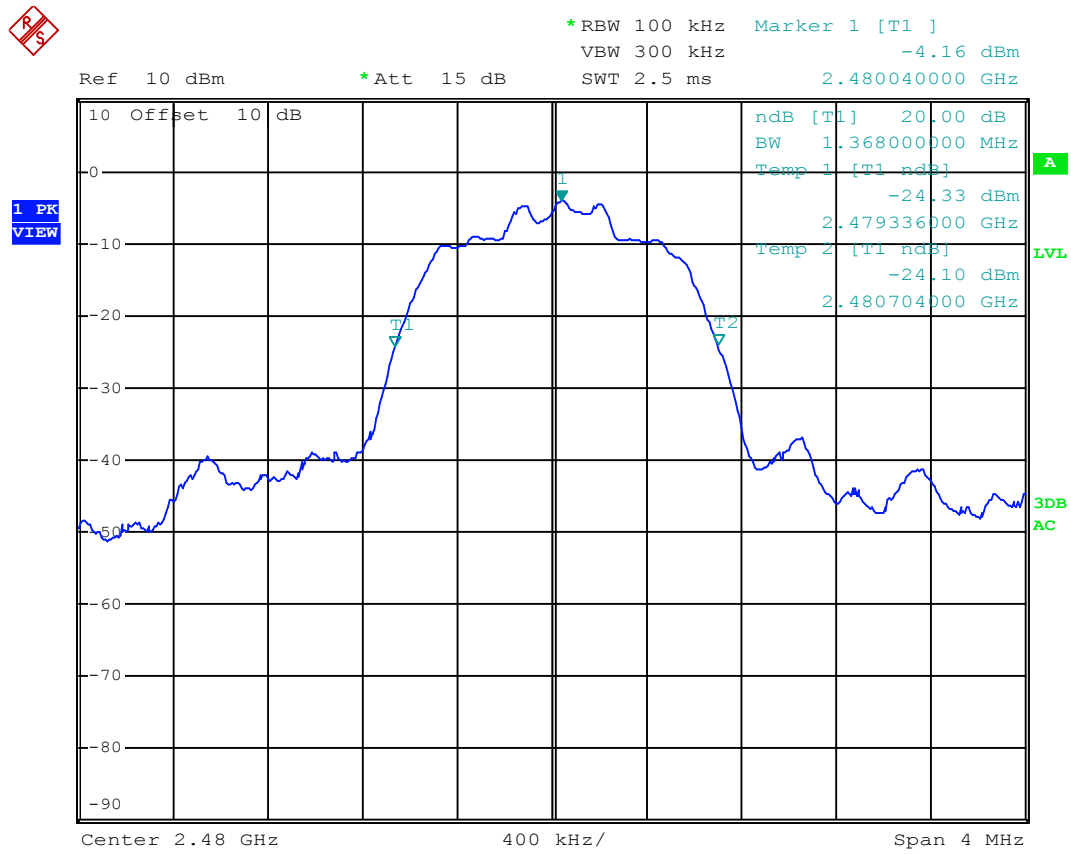
20dB Bandwidth of the Hopping Channel



Date: 22.OCT.2012 12:48:09

Figure 46. 20 dB channel BW. 2 Mbps Channel MID.

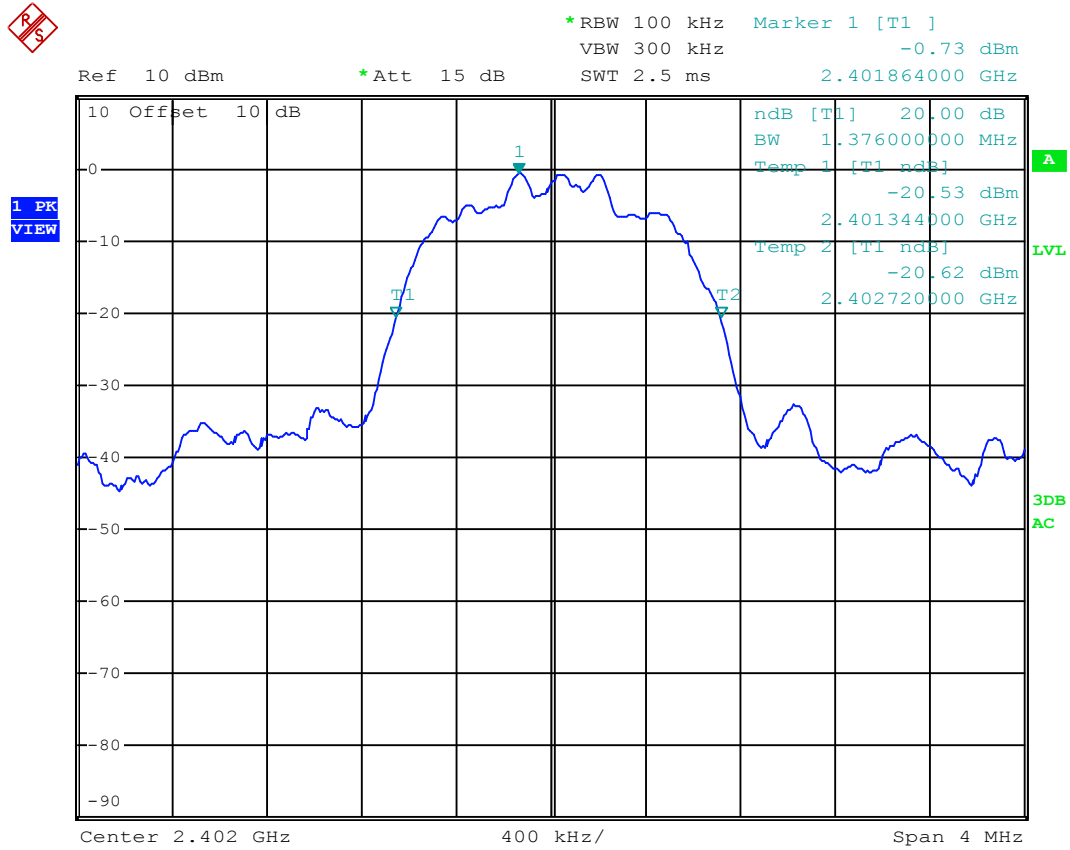
20dB Bandwidth of the Hopping Channel



Date: 22.OCT.2012 12:49:29

Figure 47. 20 dB channel BW. 2 Mbps Channel HIGH.

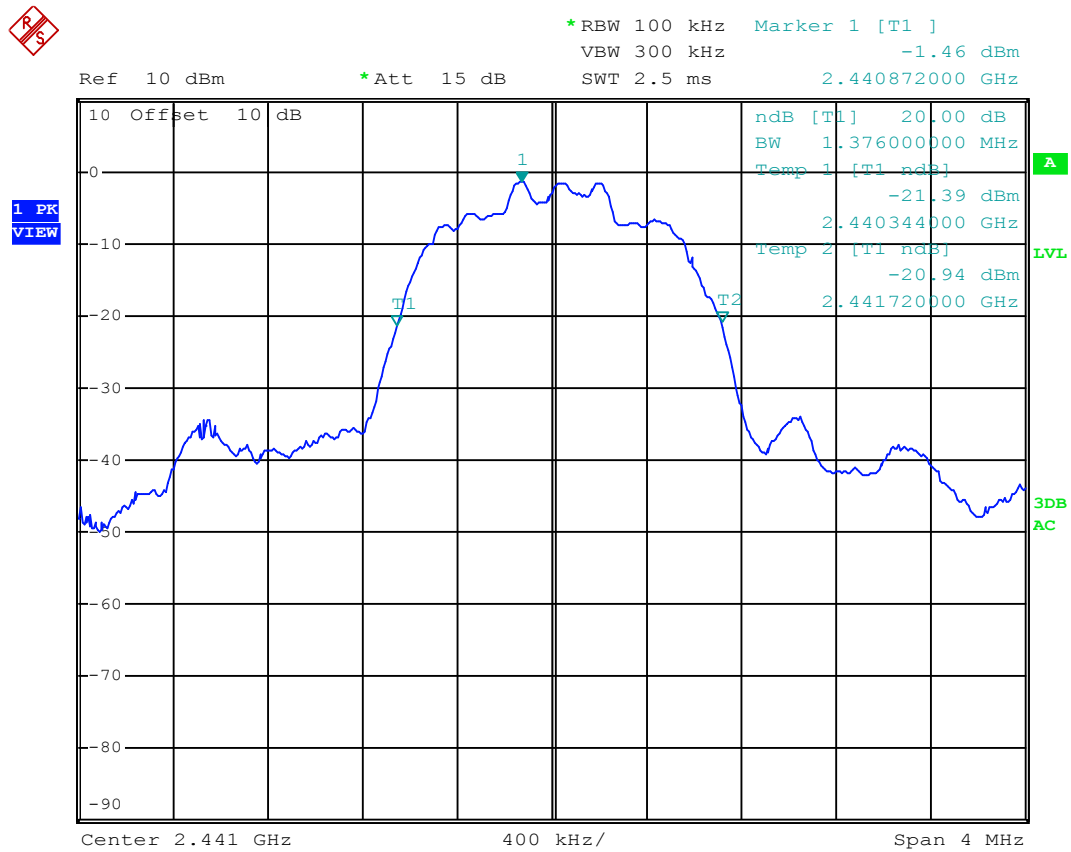
20dB Bandwidth of the Hopping Channel



Date: 22.OCT.2012 12:50:56

Figure 48. 20 dB channel BW. 3 Mbps Channel LOW.

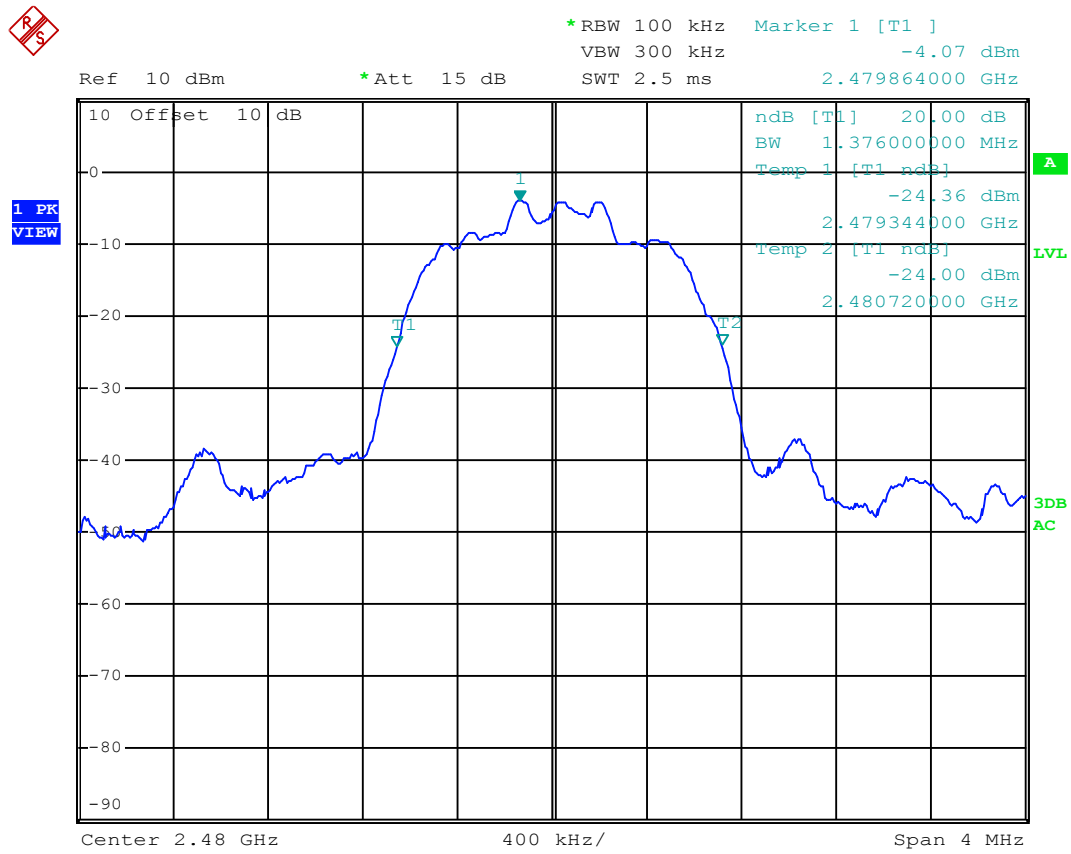
20dB Bandwidth of the Hopping Channel



Date: 22.OCT.2012 12:51:52

Figure 49. 20 dB channel BW. 3 Mbps Channel MID.

20dB Bandwidth of the Hopping Channel



Date: 22.OCT.2012 12:53:17

Figure 50. 20 dB channel BW. 3 Mbps Channel HIGH.

Hopping Channel Carrier Frequencies Separation

Standard: ANSI C63.10 (2009)
Tested by: RRE
Date: 22.10.2012
Temperature: 24 °C
Humidity: 23 % RH

FCC Rule: 15.247(a)(1)

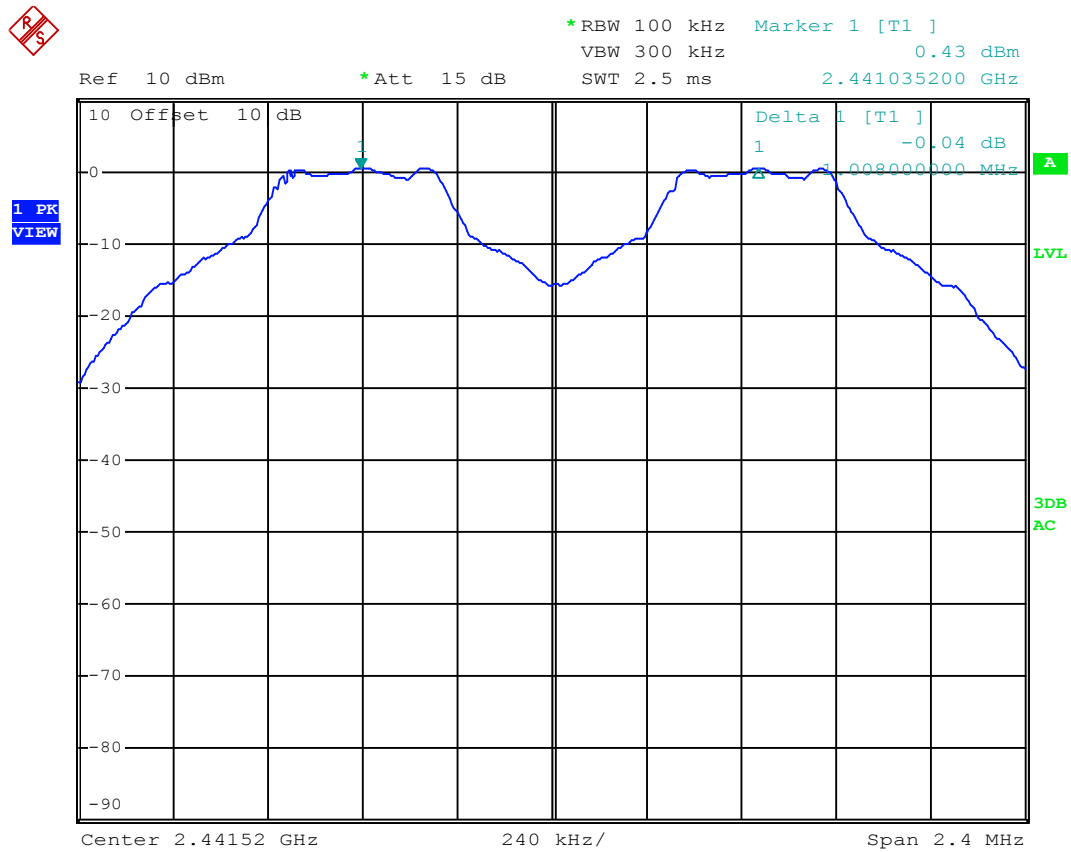
Frequency hopping systems with an output power less than 125mW shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or 2/3 of the 20 dB bandwidth of the hopping channel, whichever is greater.

Test result

Table 25. Hopping channel carrier frequencies separation test result.

Data rate	Measured separation	Measured 20 dB BW	Limit	Result
1 Mbps	1003.2 kHz	1128 kHz	752 kHz	PASS
2 Mbps	998.4 kHz	1384 kHz	923 kHz	PASS
3 Mbps	1176.0 kHz	1376 kHz	917 kHz	PASS
Limit:	25 kHz or 2/3 or the 20 dB bandwidth of the hopping channel which ever is greater			

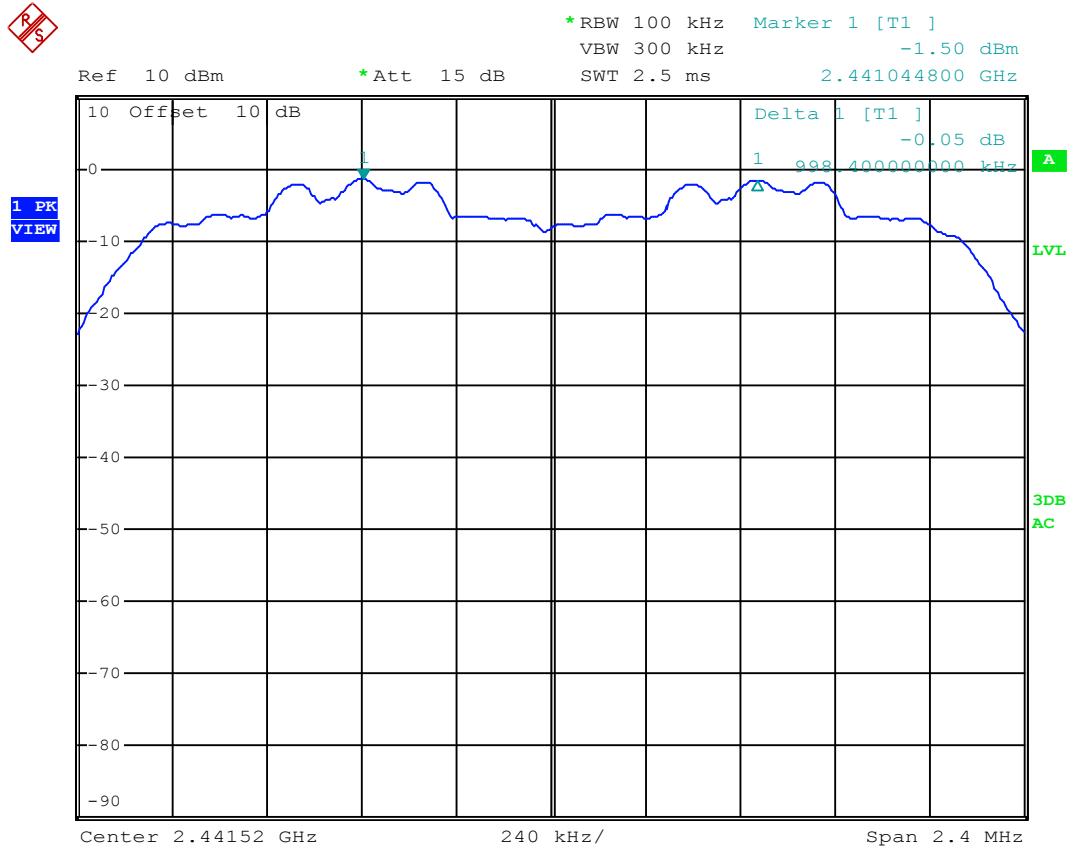
Hopping Channel Carrier Frequencies Separation



Date: 22.OCT.2012 13:26:02

Figure 51. Measured hopping channels carrier frequency separation 1 Mbps.

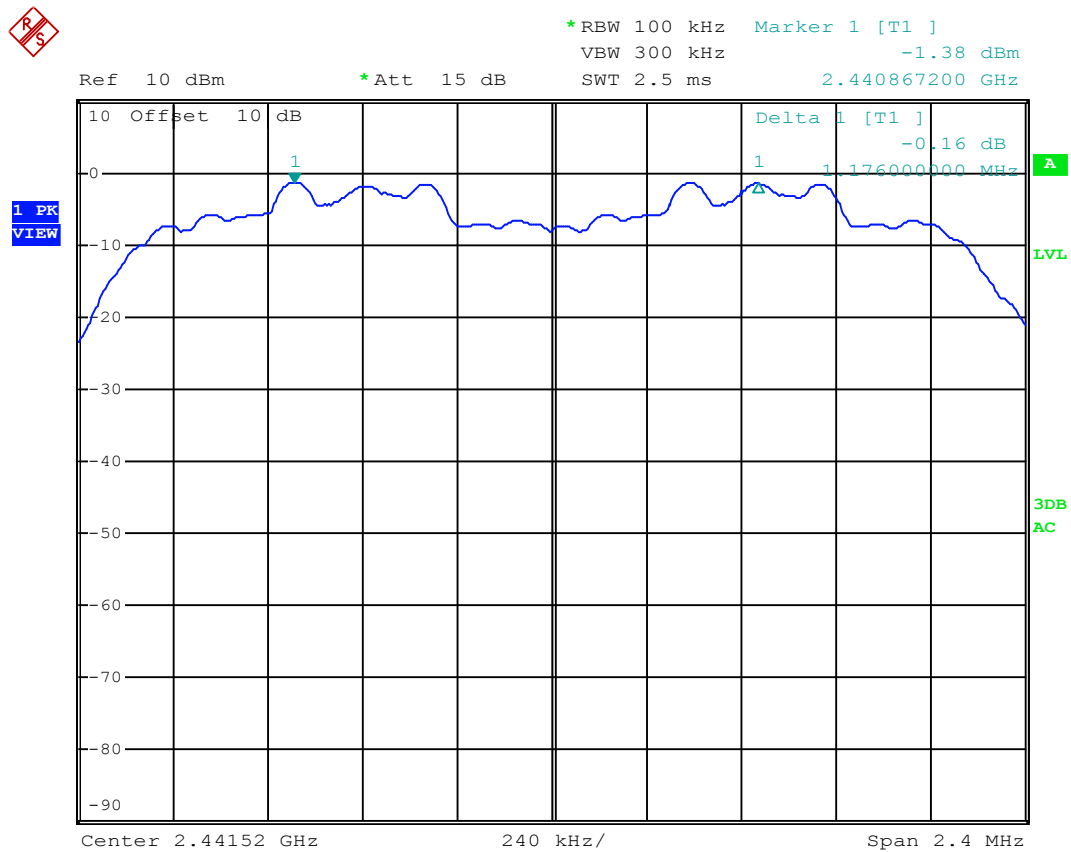
Hopping Channel Carrier Frequencies Separation



Date: 22.OCT.2012 13:21:47

Figure 52. Measured hopping channels carrier frequency separation 2 Mbps.

Hopping Channel Carrier Frequencies Separation



Date: 22.OCT.2012 13:23:56

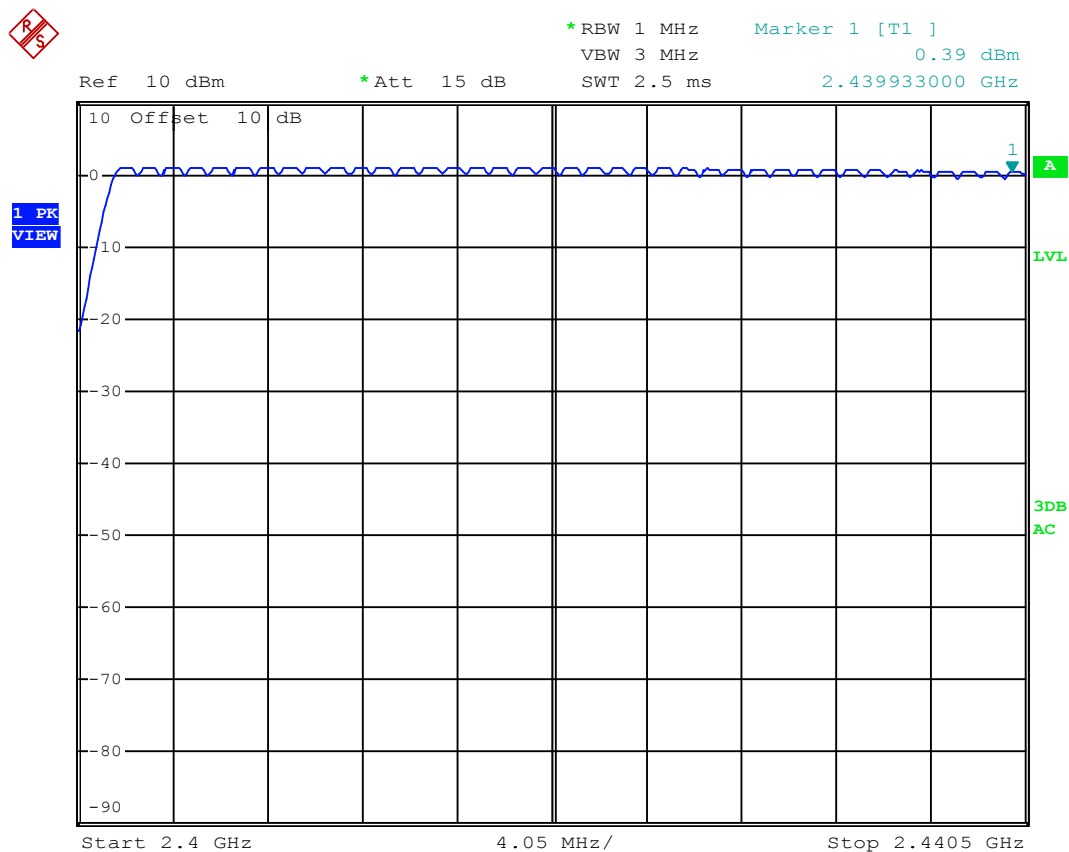
Figure 53. Measured hopping channels carrier frequency separation 3 Mbps.

Number of Hopping Channels

Standard: ANSI C63.10 (2009)
Tested by: RRE
Date: 22.10.2012
Temperature: 24 °C
Humidity: 23 % RH

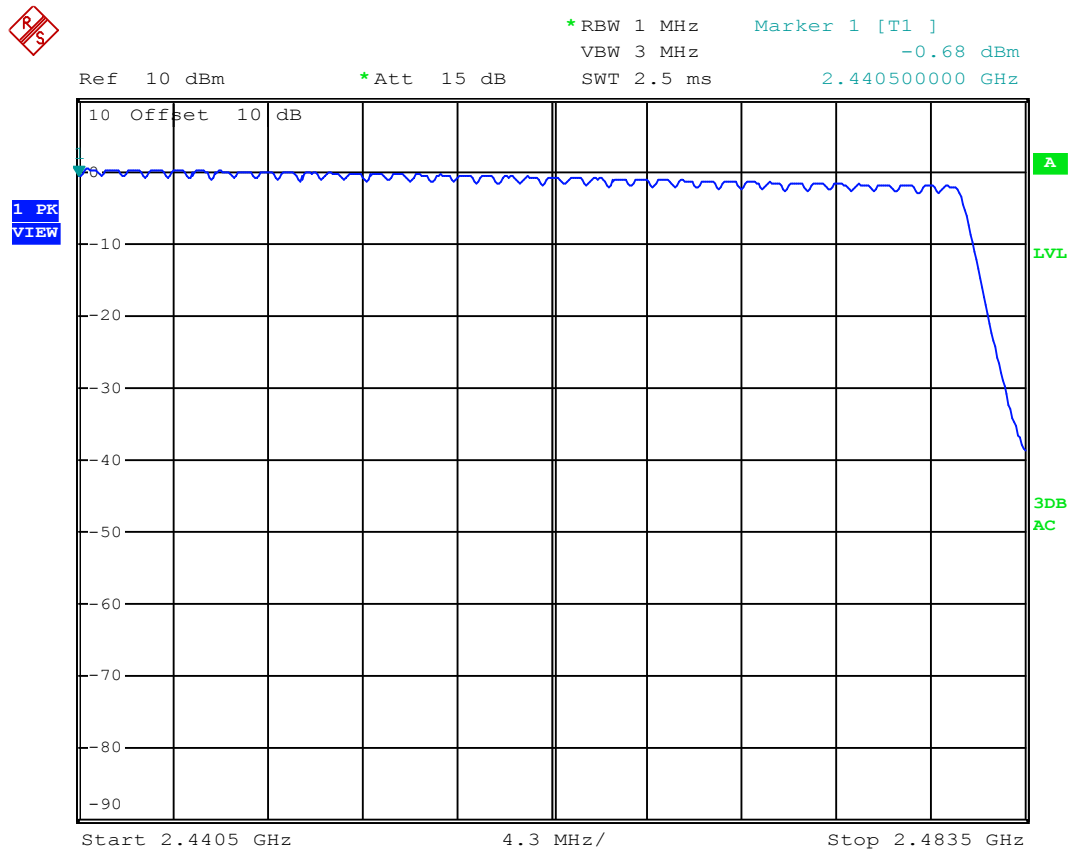
FCC Rule: 15.247(a)(1)(iii)

For frequency hopping systems operating in the 2400 – 2483.5 MHz band shall use at least 15 channels.



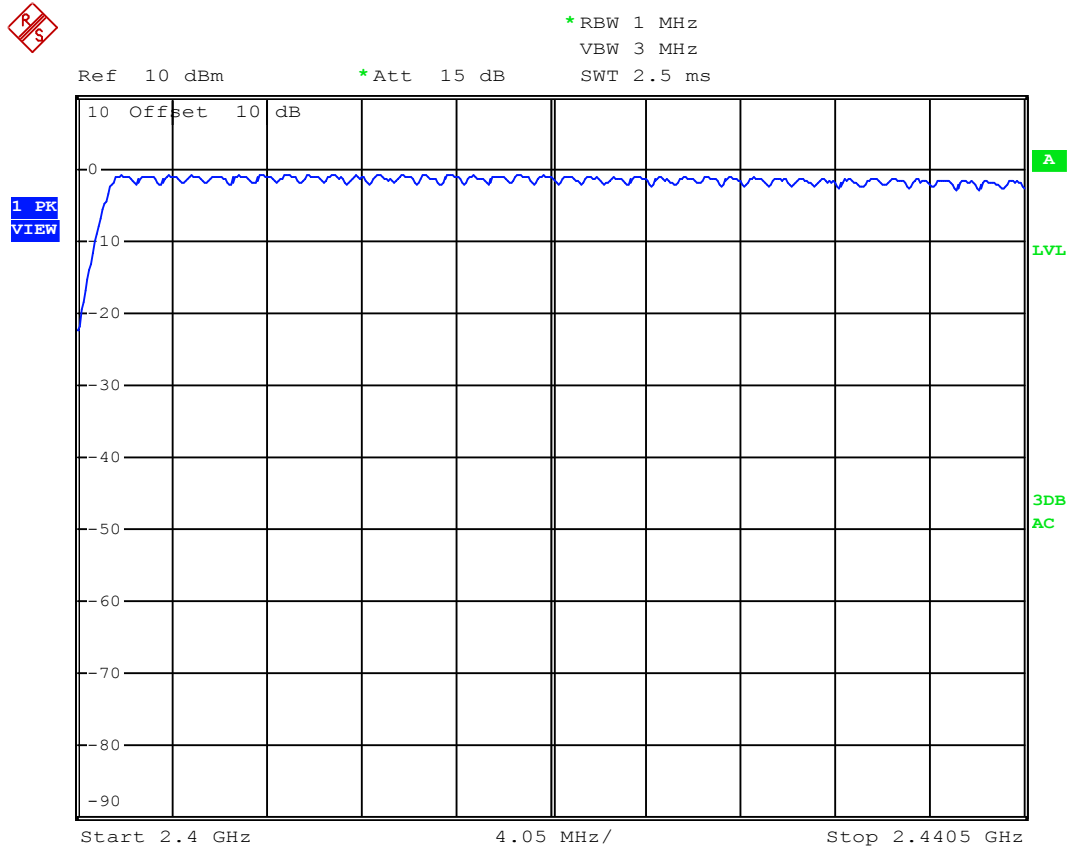
Date: 22.OCT.2012 13:44:58

Figure 54. First 39 channels 1 Mbps.



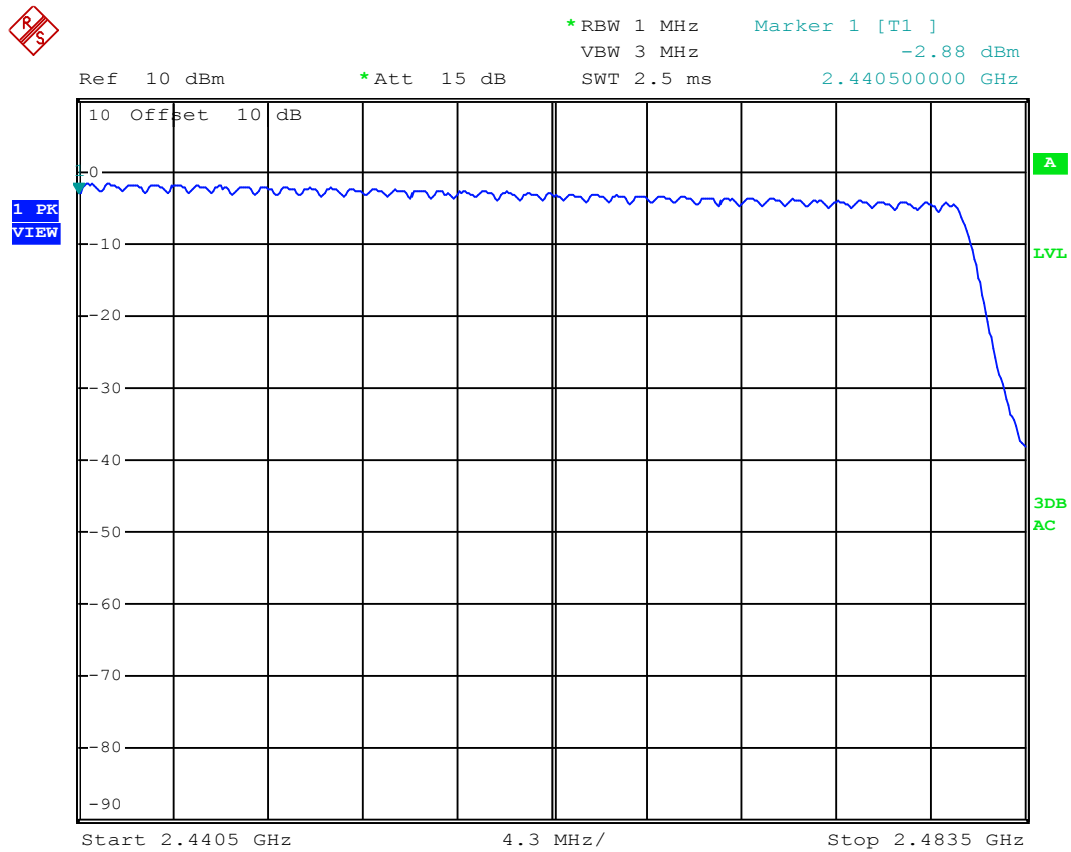
Date: 22.OCT.2012 13:47:01

Figure 55. Second 40 channels 1 Mbps.



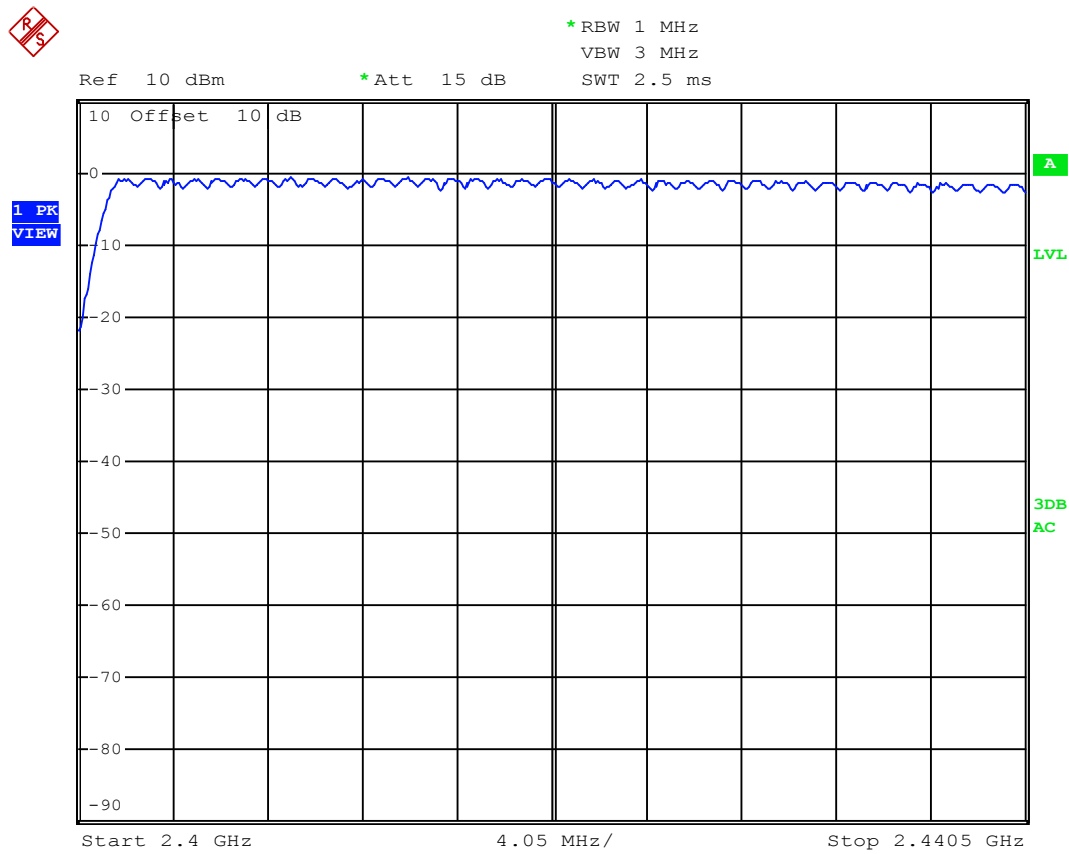
Date: 22.OCT.2012 13:50:34

Figure 56. First 39 channels 2 Mbps.



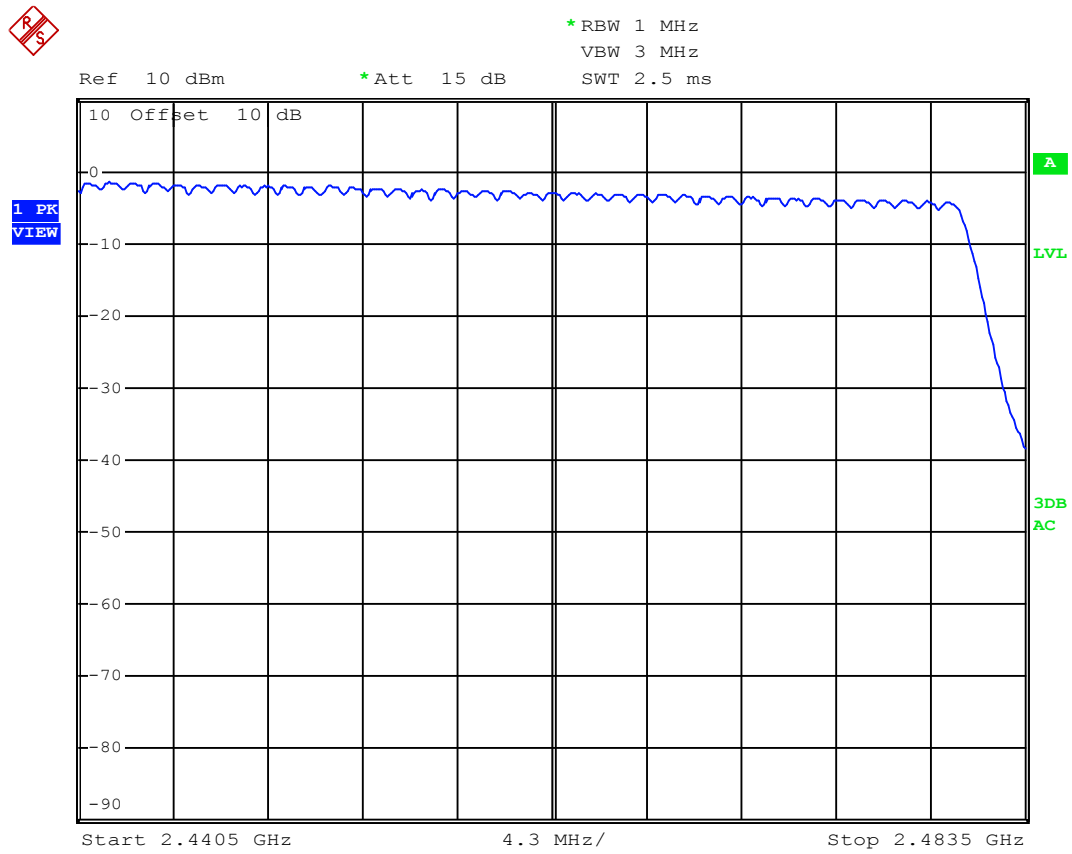
Date: 22.OCT.2012 13:49:05

Figure 57. Second 40 channels 2 Mbps.



Date: 22.OCT.2012 13:51:45

Figure 58. First 39 channels 3 Mbps.



Date: 22.OCT.2012 13:56:12

Figure 59. Second 40 channels 3 Mbps.

Average Time of Occupancy of Hopping Frequency

Standard:	ANSI C63.10	(2009)
Tested by:	RRE	
Date:	22.10.2012	
Temperature:	24 °C	
Humidity:	23 % RH	

FCC Rule: 15.247(a)(1)(iii)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Test was performed in each data rate mode to insure that the all modes are identical.

Time of occupancy calculation:

Number of channels = 79

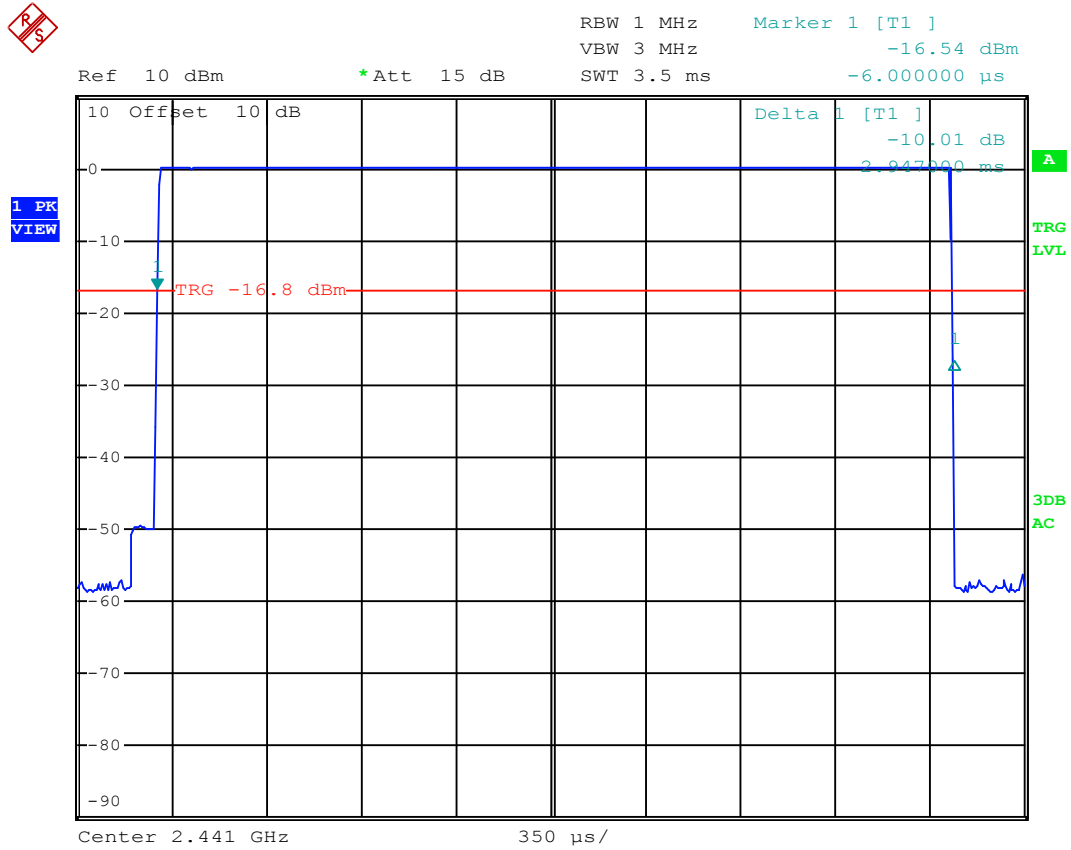
Measurement period = $0.4 \text{ s} \times 79 = 31.6 \text{ s}$

One channel occupancy time = 296.1 ms

Number of transmission cycles in measurement period = $31.6 / 0.2961 = 106.7$

Time of occupancy = (single duration) x (repetition) = $2.947 \text{ ms} \times 106.7 \text{ times} = 314 \text{ ms}$

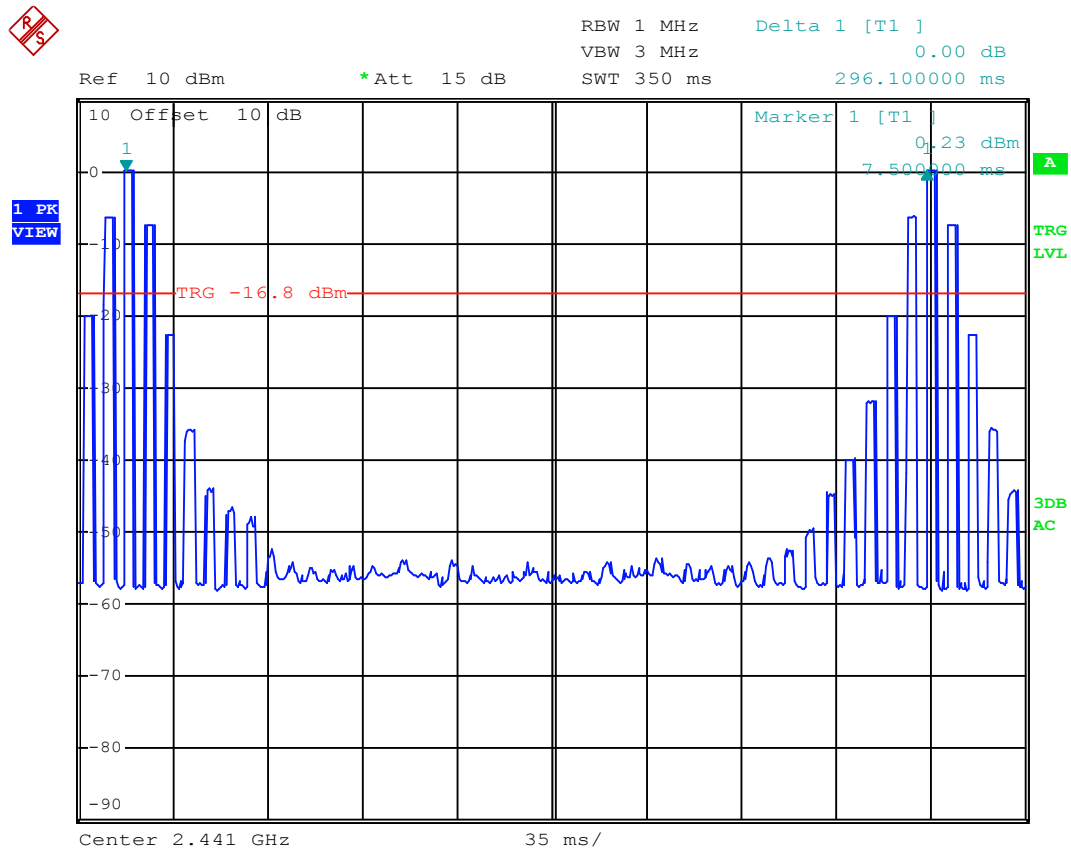
Average Time of Occupancy of Hopping Frequency



Date: 22.OCT.2012 14:18:30

Figure 60. One channel dwell time.

Average Time of Occupancy of Hopping Frequency



Date: 22.OCT.2012 14:23:26

Figure 61. Measured repetition of the channel occupancy

99% Occupied Bandwidth

Standard: RSS-GEN (2010)
Tested by: RRE
Date: 22.10.2012
Temperature: 24 °C
Humidity: 23 % RH

RSS-GEN 4.7

1 Mbps

Table 26. 99 % OBW test results 1 Mbps mode.

Channel	Limit	99 % BW [MHz]	Result
Low	-	1.02000	PASS
Mid	-	0.98000	PASS
High	-	0.98000	PASS

2 Mbps

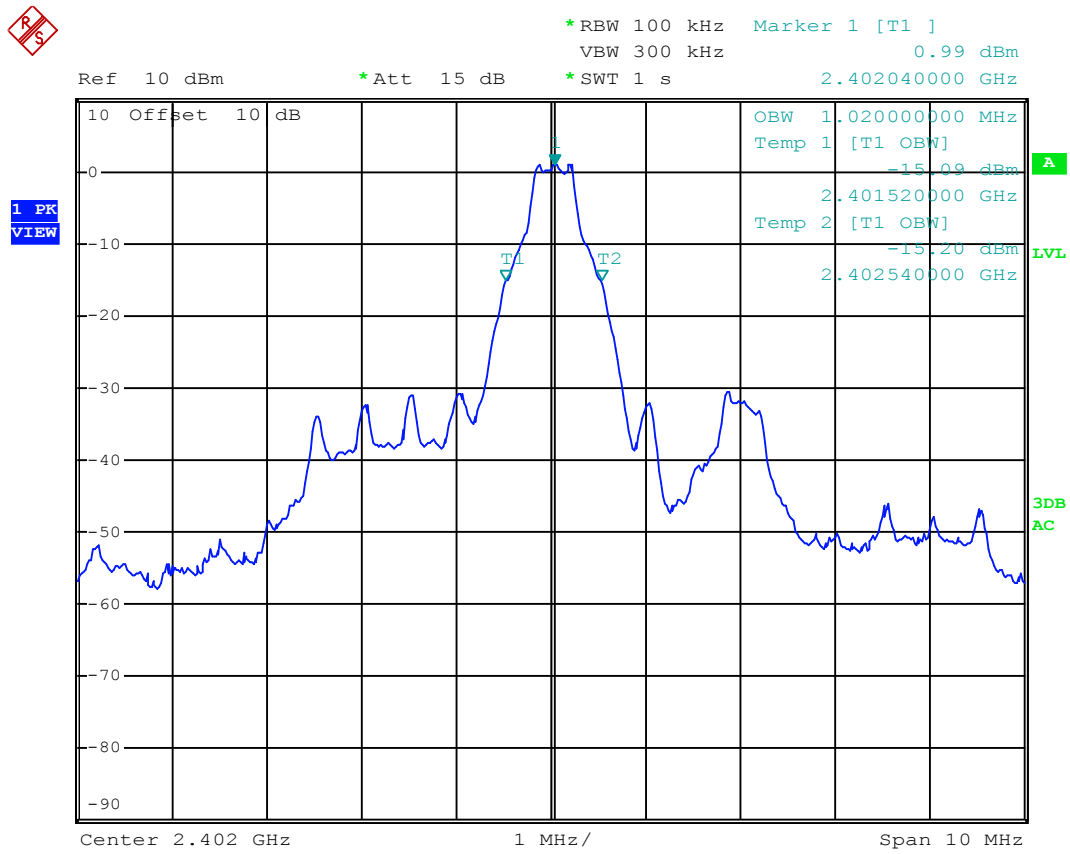
Table 27. 99 % OBW test results 2 Mbps mode.

Channel	Limit	99 % BW [MHz]	Result
Low	-	1.240	PASS
Mid	-	1.240	PASS
High	-	1.220	PASS

3 Mbps

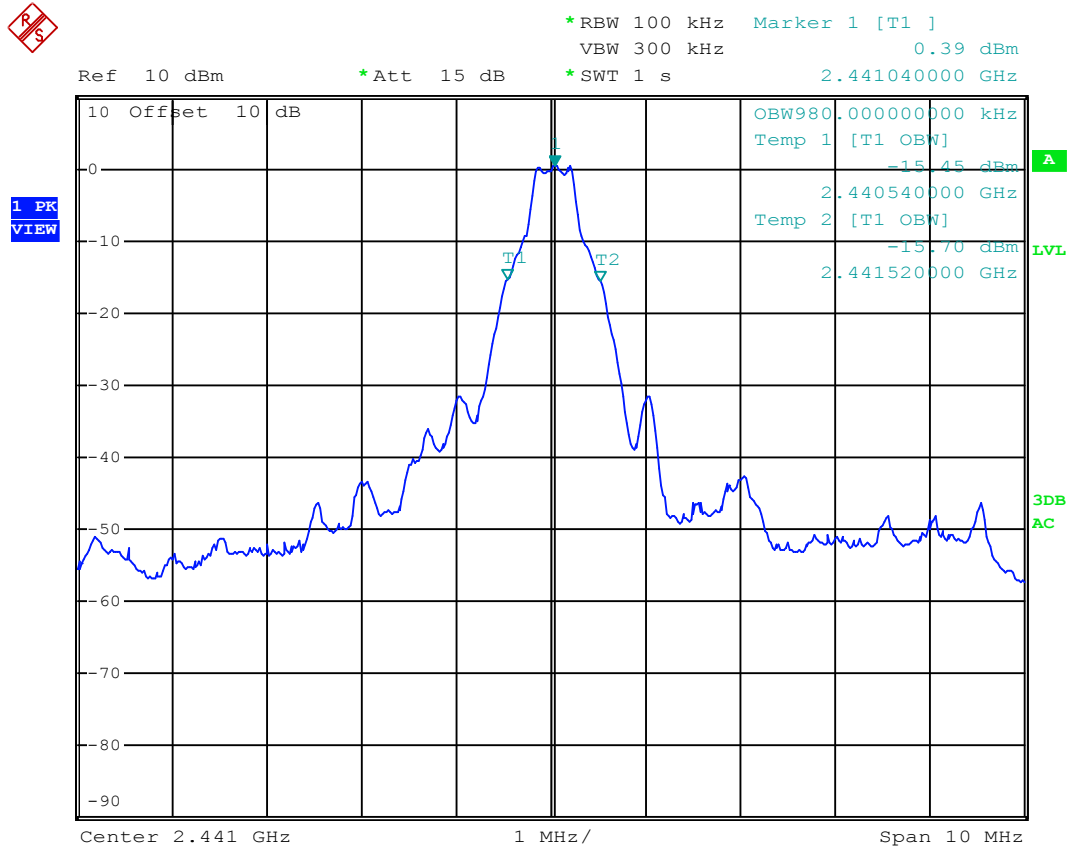
Table 28. 99 % OBW test results 3 Mbps mode.

Channel	Limit	99 % BW [MHz]	Result
Low	-	1.220	PASS
Mid	-	1.220	PASS
High	-	1.220	PASS



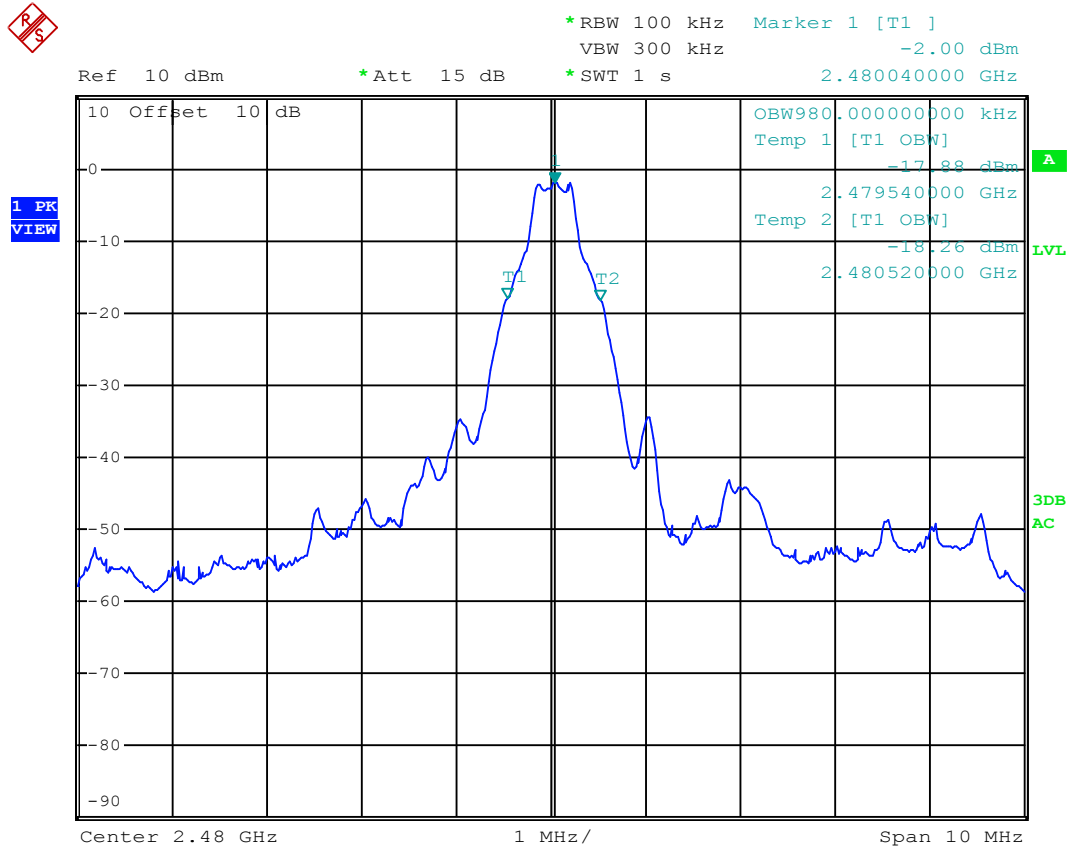
Date: 22.OCT.2012 13:59:32

Figure 62. 99 % OBW. Channel low 1 Mbps.



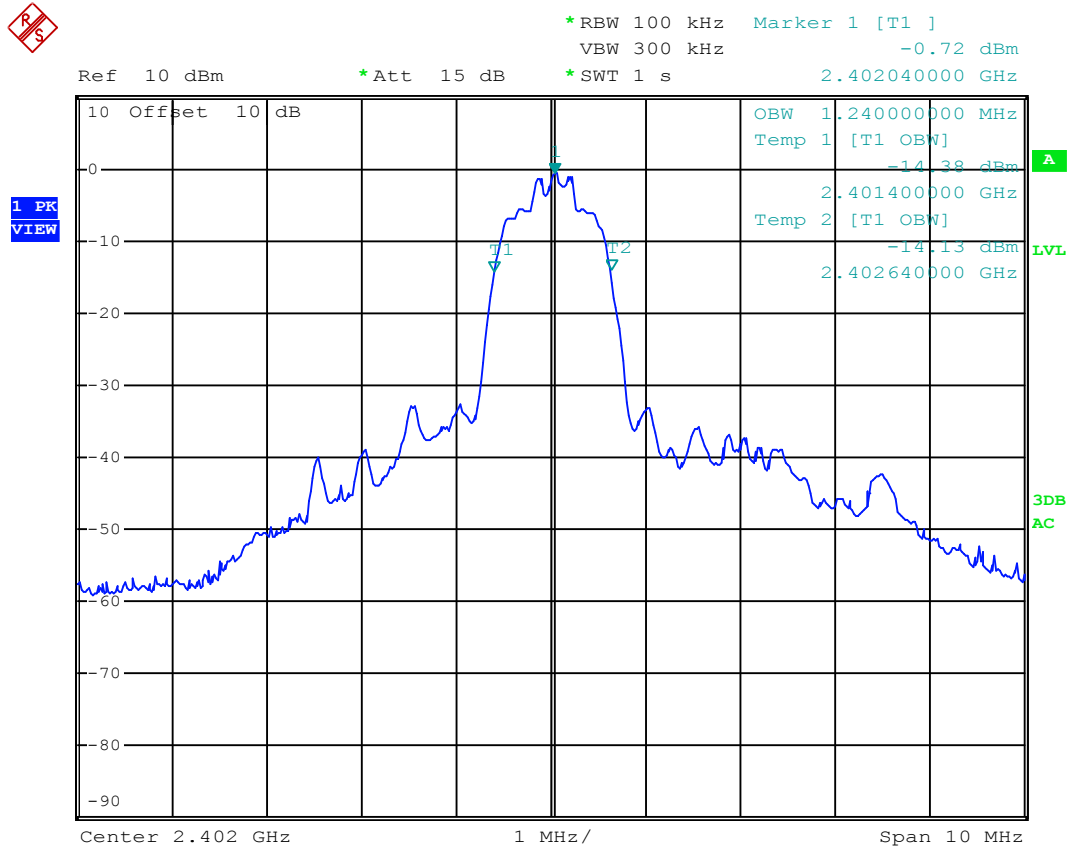
Date: 22.OCT.2012 14:01:41

Figure 63. 99 % OBW. Channel mid 1 Mbps.



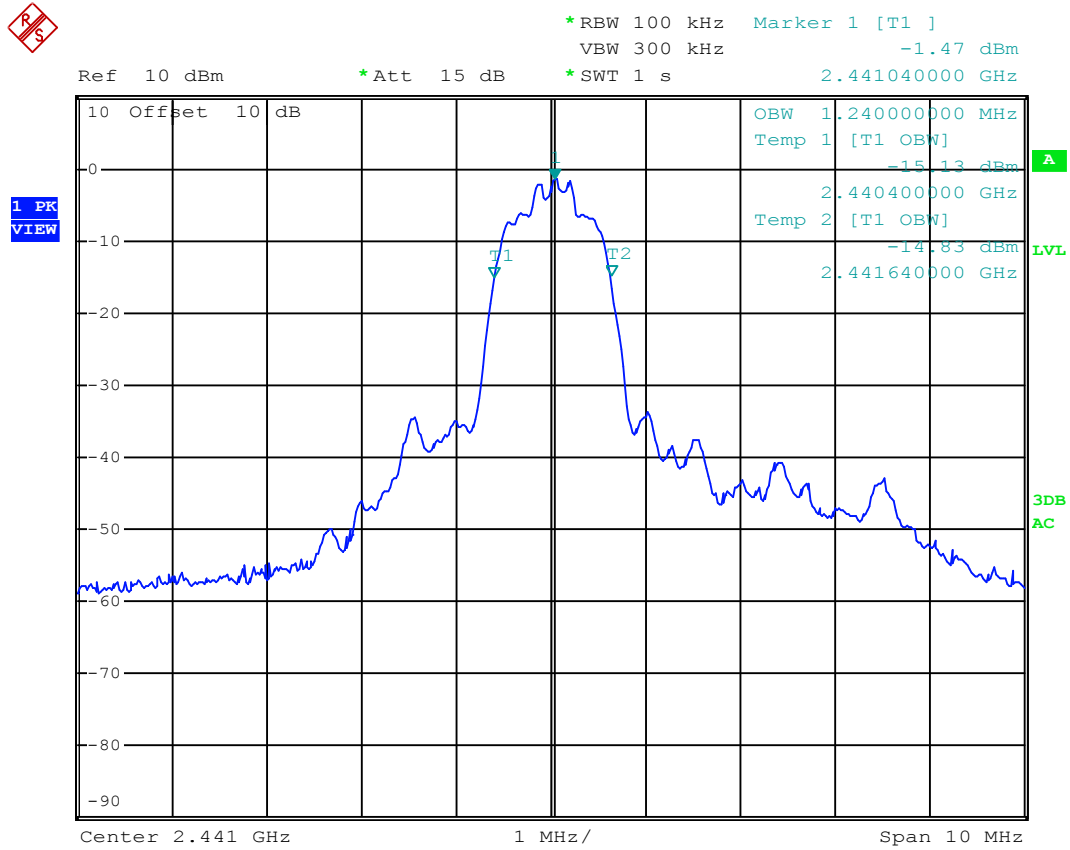
Date: 22.OCT.2012 14:02:38

Figure 64. 99 % OBW. Channel high 1 Mbps.



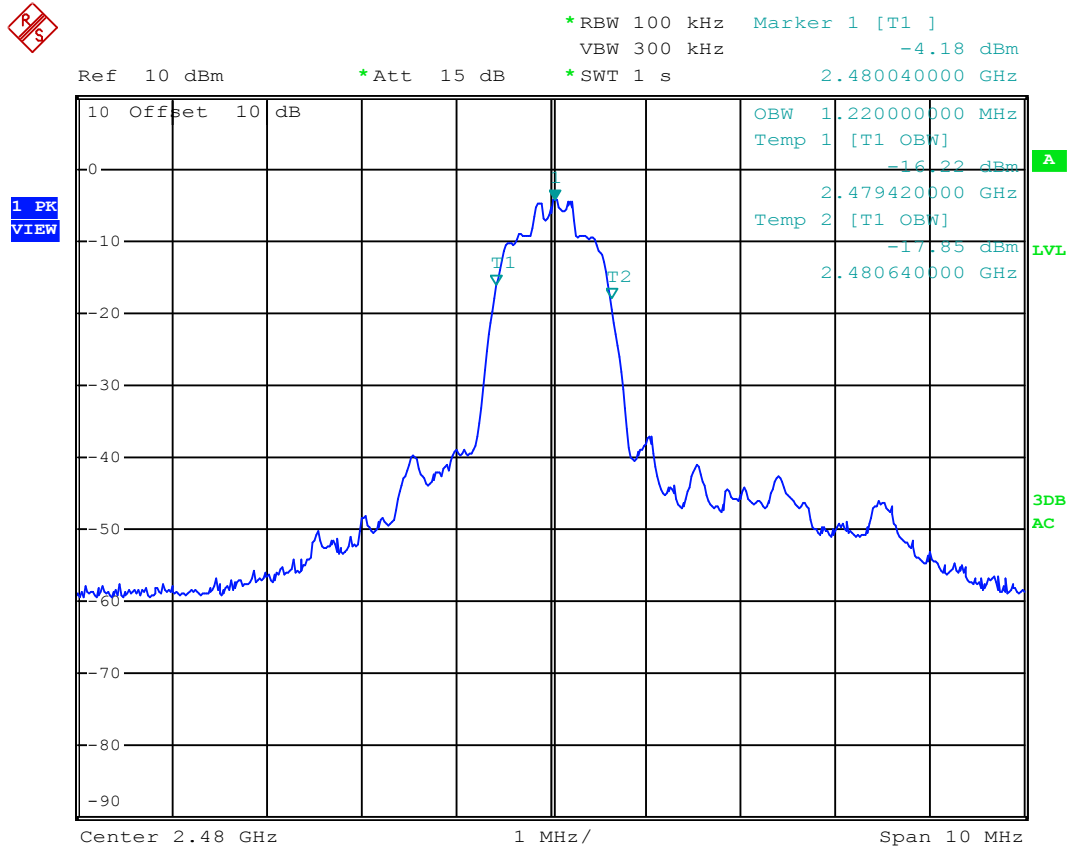
Date: 22.OCT.2012 14:04:17

Figure 65. 99 % OBW. Channel low 2 Mbps.



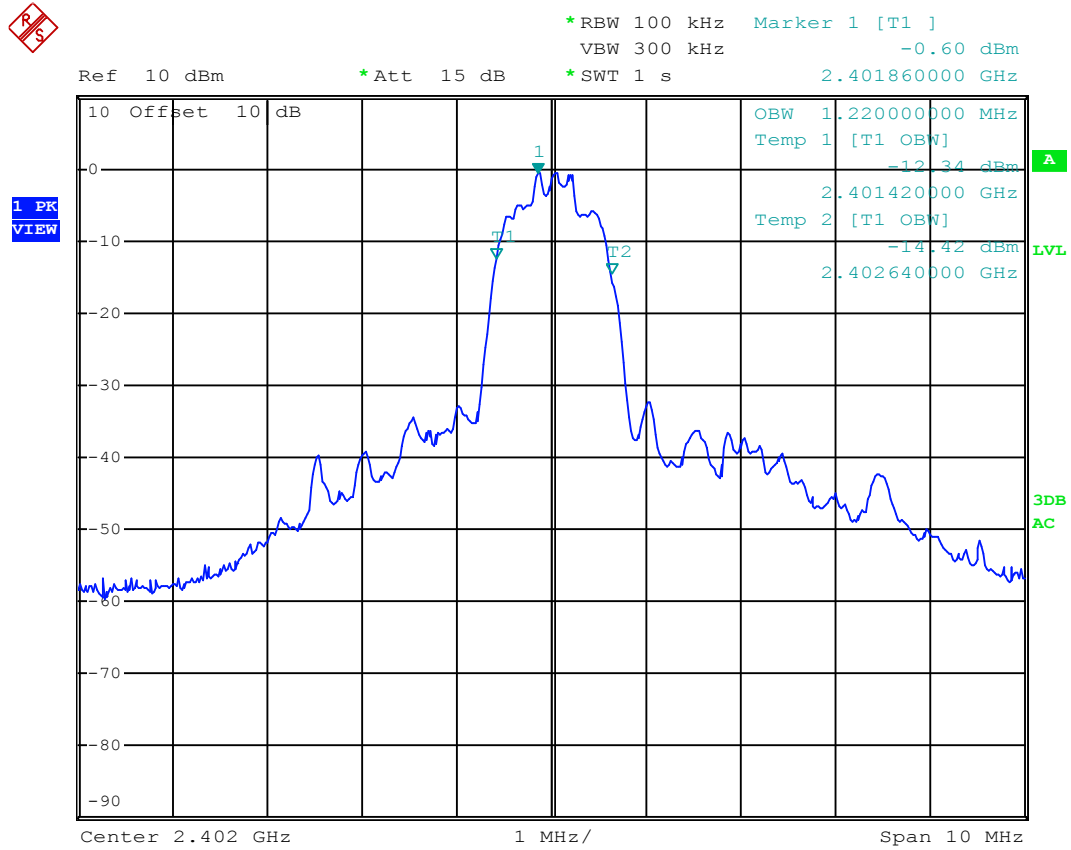
Date: 22.OCT.2012 14:05:31

Figure 66. 99 % OBW. Channel mid 2 Mbps.



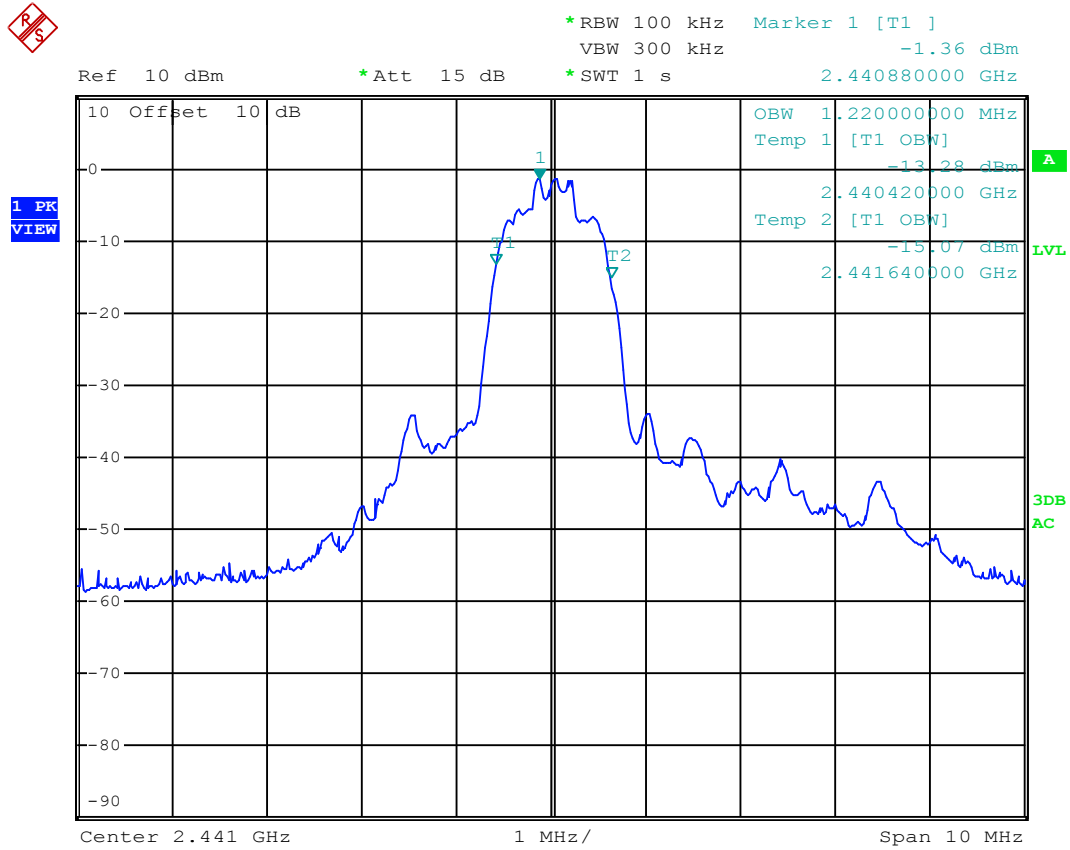
Date: 22.OCT.2012 14:06:34

Figure 67. 99 % OBW. Channel high 2 Mbps.



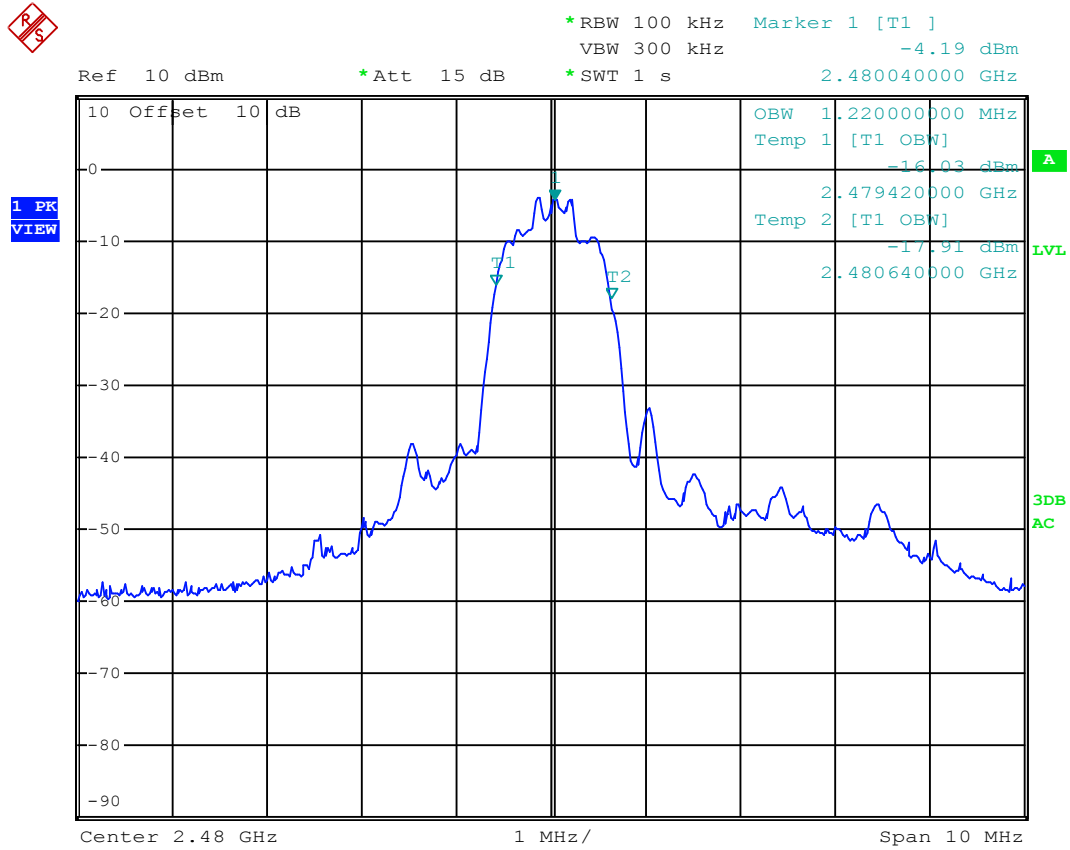
Date: 22.OCT.2012 14:08:27

Figure 68. 99 % OBW. Channel low 3 Mbps.



Date: 22.OCT.2012 14:09:42

Figure 69. 99 % OBW. Channel mid 3 Mbps.



Date: 22.OCT.2012 14:11:18

Figure 70. 99 % OBW. Channel high 3 Mbps.

Receiver Radiated Emissions 30 – 26 500 MHz

Standard: ANSI C63.10 (2009)
Tested by: RRE
Date: 5.11.2012
Temperature: 18 °C
Humidity: 39 % RH
Measurement uncertainty ± 4.51 dB Level of confidence 95 % (k = 2)

FCC Rule: 15.109

The EUT was in a receiving mode and measurement was performed on middle channel only.
 The correction factor in the final result table contains the sum of the transducers (antenna + amplifier + cables).
 The QuasiPeak value is the measured value corrected with the correction factor.

Measured Peak Values In The Frequency Range 30 MHz - 1000 MHz.

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m

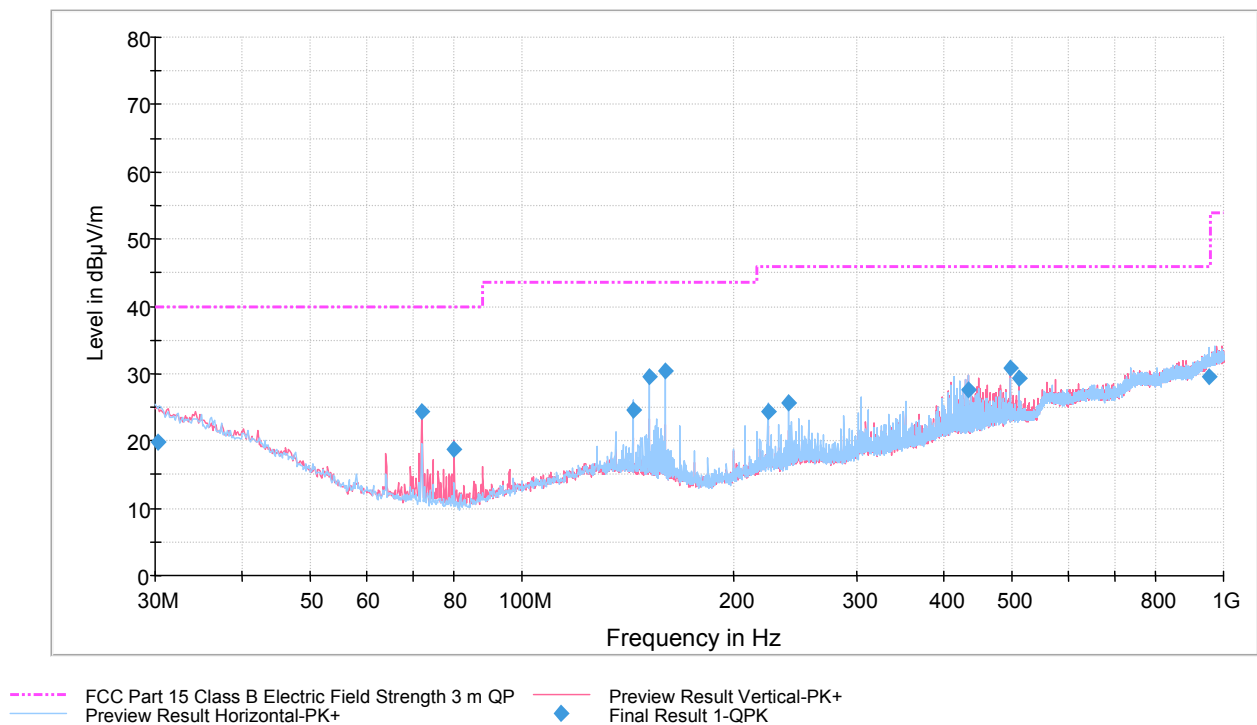


Figure 71. Measured curve with peak-detector.

Final measurements from the worst frequencies

Table 29. Final results with Quasi-Peak detector.

Frequency (MHz)	QuasiPeak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
30.280000	19.9	120.000	183.0	H	165.0	23.6	20.2	40.0	
72.015000	24.3	120.000	100.0	V	229.0	9.1	15.7	40.0	
80.005000	18.7	120.000	100.0	V	165.0	8.4	21.3	40.0	
143.995000	24.5	120.000	298.0	H	269.0	13.0	19.0	43.5	
152.005000	29.6	120.000	150.0	H	110.0	12.7	13.9	43.5	
160.015000	30.4	120.000	160.0	H	109.0	12.5	13.1	43.5	
224.005000	24.4	120.000	109.0	H	263.0	13.9	21.6	46.0	
240.015000	25.6	120.000	110.0	H	259.0	13.9	20.4	46.0	
432.015000	27.6	120.000	100.0	V	181.0	18.9	18.4	46.0	
496.015000	30.8	120.000	100.0	V	161.0	20.2	15.2	46.0	
512.025000	29.3	120.000	100.0	V	156.0	20.3	16.7	46.0	
954.645000	29.5	120.000	110.0	H	230.0	27.8	16.5	46.0	

Measured Peak Values In The Frequency Range 1 000 MHz – 18 000 MHz.

FCC Part 15 Class B Spurious Emission 1-18GHz 3m

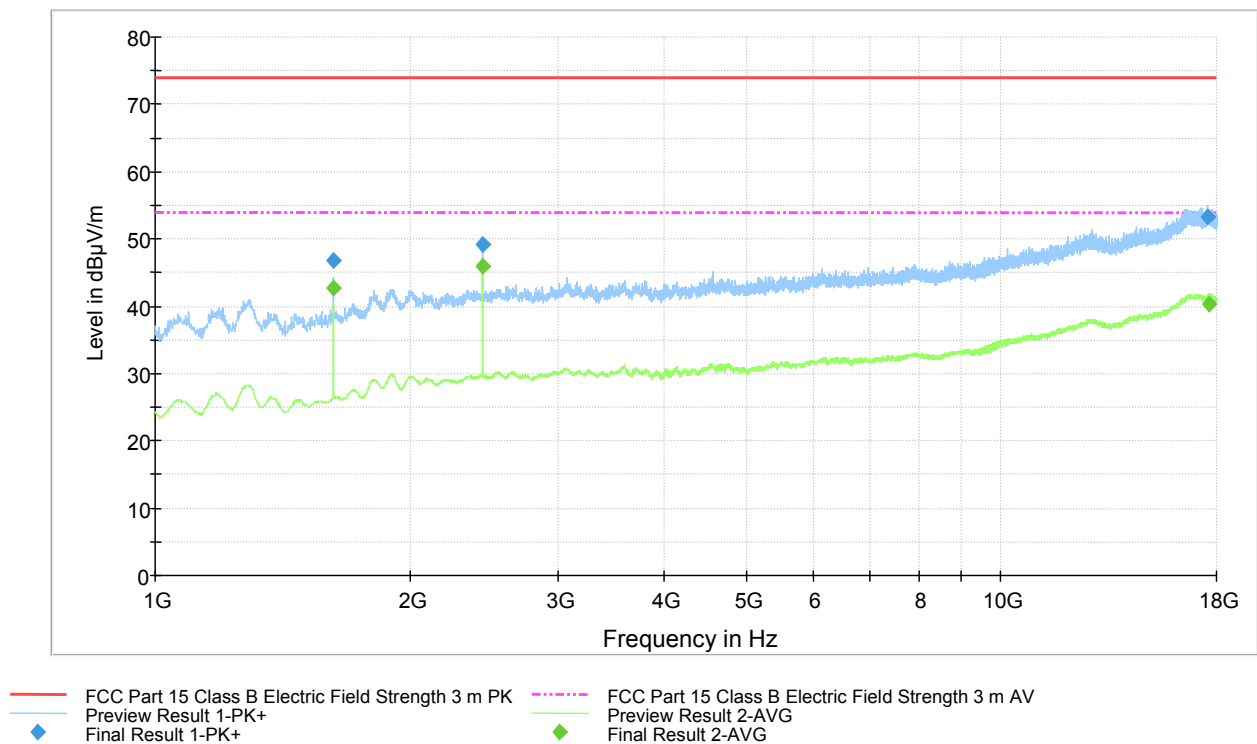


Figure 72. Measured curve with peak-and average detector.

Final measurements from the worst frequencies

Table 30. Final MaxPeak results.

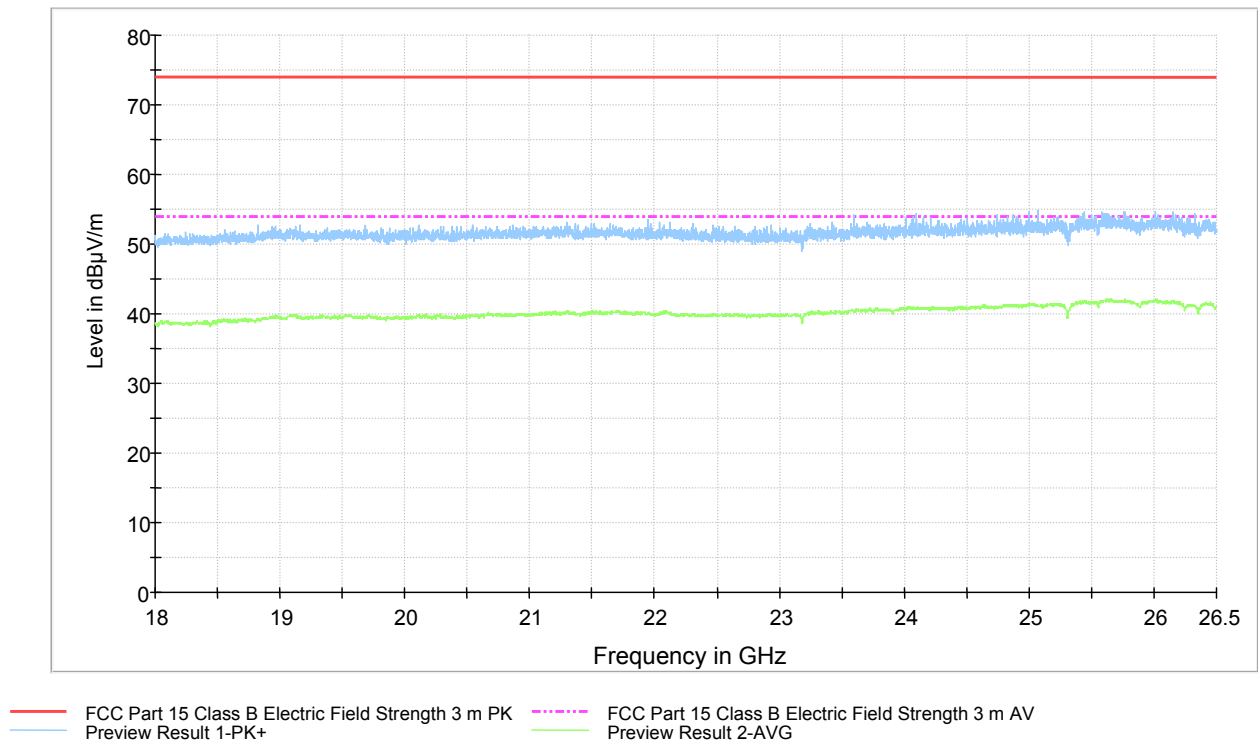
Frequency (MHz)	MaxPeak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1626.475000	46.7	1000.000	141.0	H	179.0	-0.9	27.2	73.9	
2439.575000	49.1	1000.000	116.0	H	208.0	4.1	24.8	73.9	
17602.025000	53.2	1000.000	194.0	V	148.0	24.3	20.7	73.9	

Table 31. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1626.475000	42.7	1000.000	140.0	H	185.0	-0.9	11.2	53.9	
2439.575000	46.0	1000.000	146.0	H	204.0	4.1	7.9	53.9	
17649.725000	40.4	1000.000	100.0	V	121.0	24.6	13.5	53.9	

Measured Peak Values In The Frequency Range 18 000 MHz – 26 500 MHz.

Radiated Emission FCC Part 15 Class B 18-26.5GHz at 3m


Figure 73. Measured curve with peak-and average detector.

List of test equipment

Manufacturer	Type	Serial no	Inv. no
ROHDE & SCHWARZ			
EMI Test receiver	ESCI 3	100885	8264
EMI Test receiver	ESU 26	100185	8453
Test software	EMC32	-	-
DAVIS			
Weather station	Vantage Pro	-	5297
EMCO			
Antenna (1 - 18 GHz)	3117	29617	7293
ETS-LINDGREN			
Antenna (18 GHz – 26 GHz)	3160-09	28535	7294
CHASE			
Antenna (30 MHz - 1 GHz)	6141A	4102	7895
HEWLETT- PACKARD			
Microwave amplifier	83017A	-	5226
HUBER-+ SUHNER			
Attenuator 10dB	6810.17B	-	-
DEISEL			
Antenna mast	MA 240	240/455	7896
Turntable	DS 430	-	-
WAINWRIGHT			
High Pass Filter	WHKX	10	8267

All used measurement equipment was calibrated (if required).