Test Report

FINAS
Finnish Accreditation Service
T004 (EN ISO/IEC 17025)

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

Equipment Under Test:	Wireless System-on-Module (Classic Bluetooth)
Type/ Model:	WT32i
Manufacturer:	BlueGiga Technologies Oy PO. BOX 120 FI-02631 ESPOO FINLAND
Customer:	BlueGiga Technologies Oy PO. BOX 120 FI-02631 ESPOO FINLAND
FCC Rule Part:	15.247: 2012
IC Rule Part:	RSS-210, Issue 8, 2010 RSS-GEN Issue 3, 2010
KDB:	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems DA 00-705 (March 30, 2000)

Date:	October 25, 2013	Date:	October 25, 2013
Issued by:	Rauno Repo Testing Engineer	Checked by:	Jari Merikari Technical Manager

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Equipment Under Test (EUT)

Wireless System-on-Module

Type/ Model:	WT32i
Serial Number:	-

WT32i is a Bluetooth module that supports Bluetooth 3.0. This report contains the Classic Bluetooth test results.

Two samples were used in tests. The first sample had an integrated antenna and the other sample had an external antenna. Both modules were connected to their own evaluation boards.

Conducted measurements were made with the sample having an external antenna. Measurements were made from the antenna connector (SMA).

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
Conducted power:	7.56 dBm
Transmission technique:	FHSS
Modulation:	GFSK, π/4 DQPSK, 8DPSK
Integrated antenna gain:	3.29 dBi max
External antenna gain:	2.76 dBi

Power Supply

The following wall charger was used during the tests (supplied with 115 V/ 60 Hz).

Charger:

Manufacturer:	PHIHONG
Model:	PSMR11R-120
Serial number:	P73206336A1
Input voltage:	100-240 VAC
Rated current:	0.3A max
Rated frequency:	50-60 Hz
Output voltage:	12 V DC
Output current:	0.84A MAX

Disclaimer

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SUMMARY OF TESTING

Test Specification	Description of Test	Result
§15.207(a) / RSS-GEN 7.2.2	Conducted Emissions on Power Supply Lines	**PASS**
§15.247(b)(1) / RSS-210 8.4	Maximum Peak Conducted Output Power	**PASS**
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(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**
§15.209 / RSS-GEN 7.2.3.2	Unintentional Radiated Emissions	**PASS**

EUT Test Conditions during Testing

The EUT was configured into the wanted channel and was in continuous transmit mode during all the tests.

Following channels were used during the tests:

Channel	Frequency/ MHz
LOW (CH 1)	2402
MID (CH 40)	2441
HIGH (CH 79)	2480

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

Conducted Emissions In The Frequency Range 150 kHz - 30 MHz.

Standard:	ANSI C63.10	(2009)
Tested by:	RRE, NKO	
Date:	11.10.2013	
Temperature:	22.8 °C	
Humidity:	37 % RH	
Barometric pressure:	1004 hPa	
Measurement uncertainty:	± 2.9 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.207 (a)

Conducted disturbance voltage was measured with an artificial main network from 150 kHz to 30 MHz with 4.5 kHz steps and a resolution bandwidth of 9 kHz. Measurements were carried out with peak and average detectors.
During the test the EUT was powered from the separate power supply (115VAC / 60 Hz) through the LISN.

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.

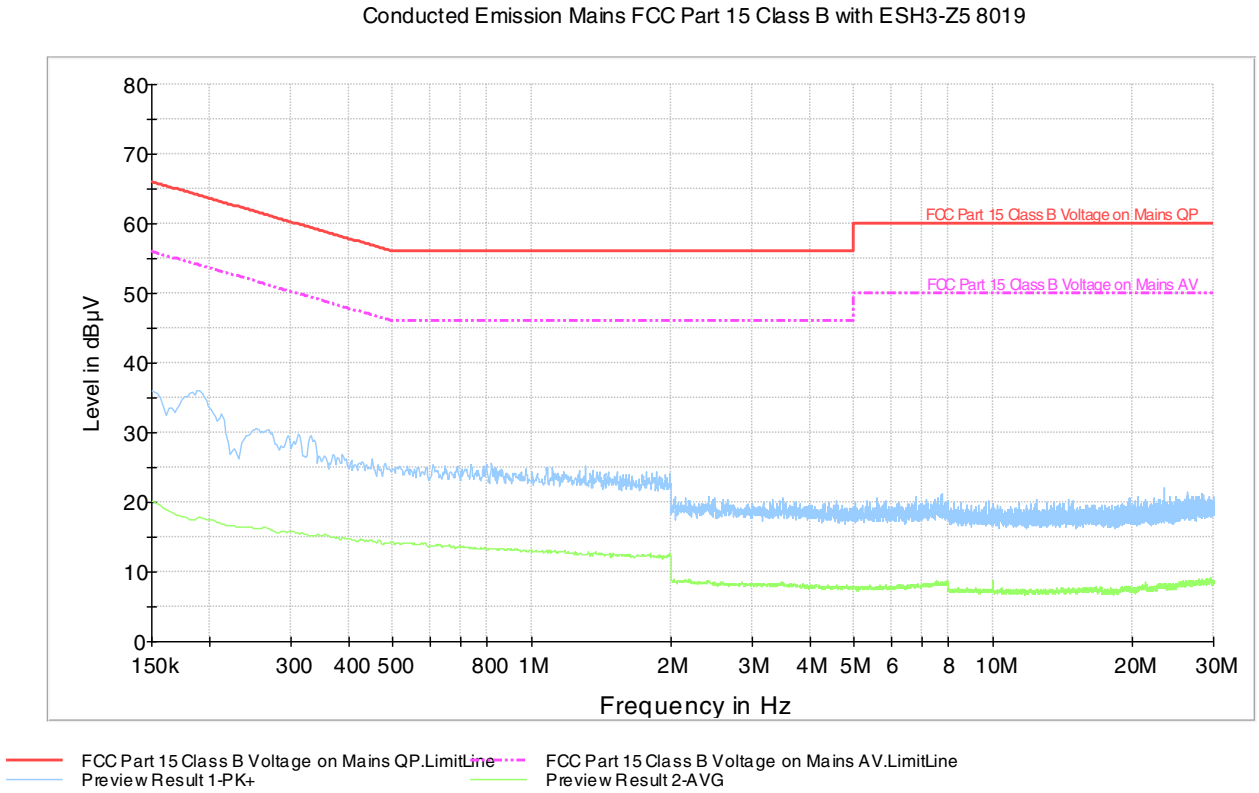

Figure 1. The measured curves with peak- and average detector

Final measurements from the worst frequencies

Due to the low emission level no final measurements were made.

Maximum Peak Conducted Output Power

Standard:	ANSI C63.10	(2009)
Tested by:	NKO	
Date:	24.10.2013	
Humidity:	40 % RH	
Temperature:	22.7 °C	
Measurement uncertainty	± 2.87dB	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	7.56	30	22.44	PASS
Mid	7.41	30	22.59	PASS
High	6.92	30	23.08	PASS

2 Mbps

Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
Low	6.75	30	23.25	PASS
Mid	6.42	30	23.58	PASS
High	5.80	30	24.20	PASS

3 Mbps

Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
Low	6.85	30	23.15	PASS
Mid	6.68	30	23.32	PASS
High	5.82	30	24.15	PASS

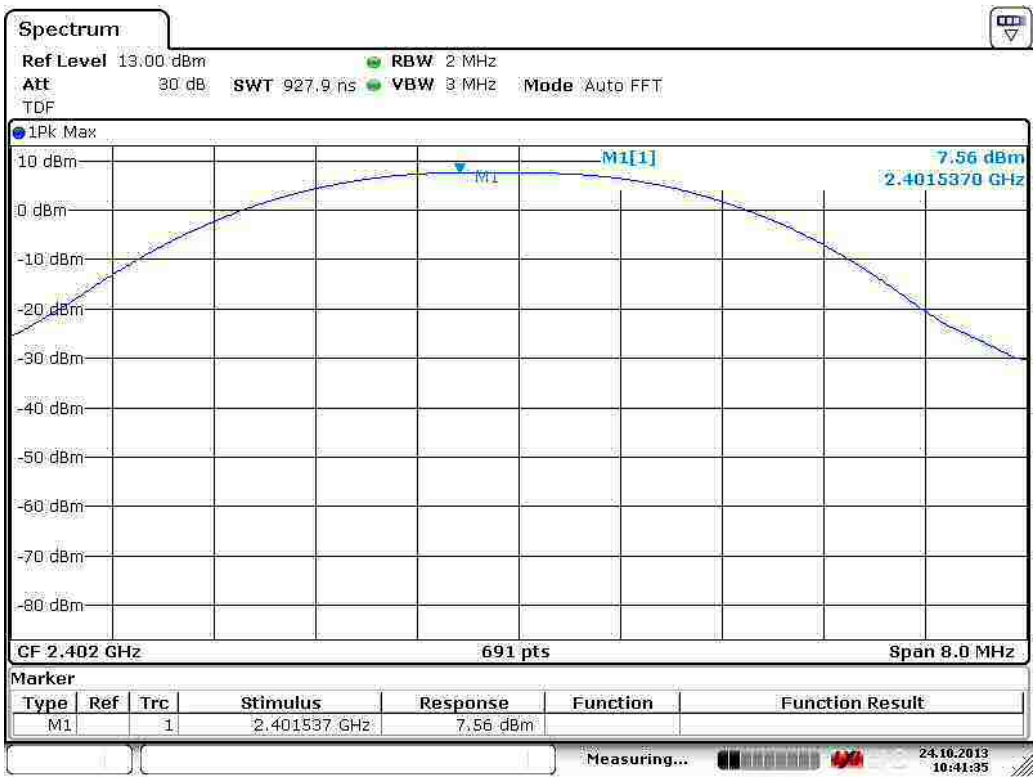

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Figure 2. 1 Mbps Channel LOW.

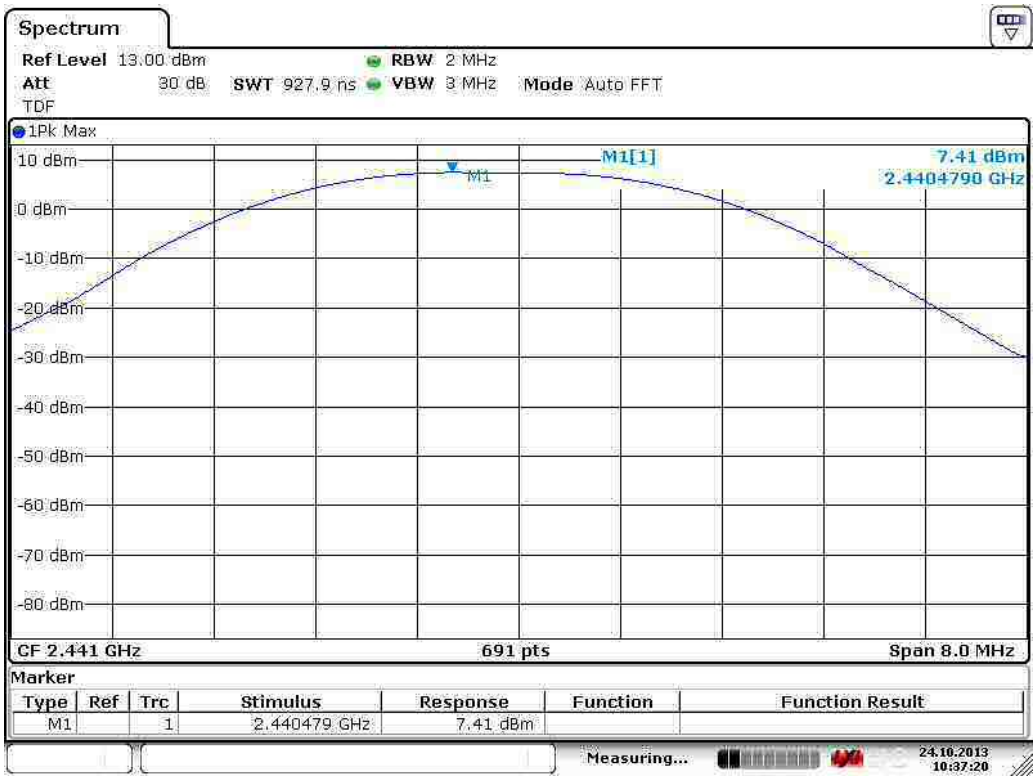

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Figure 3. 1 Mbps Channel MID.

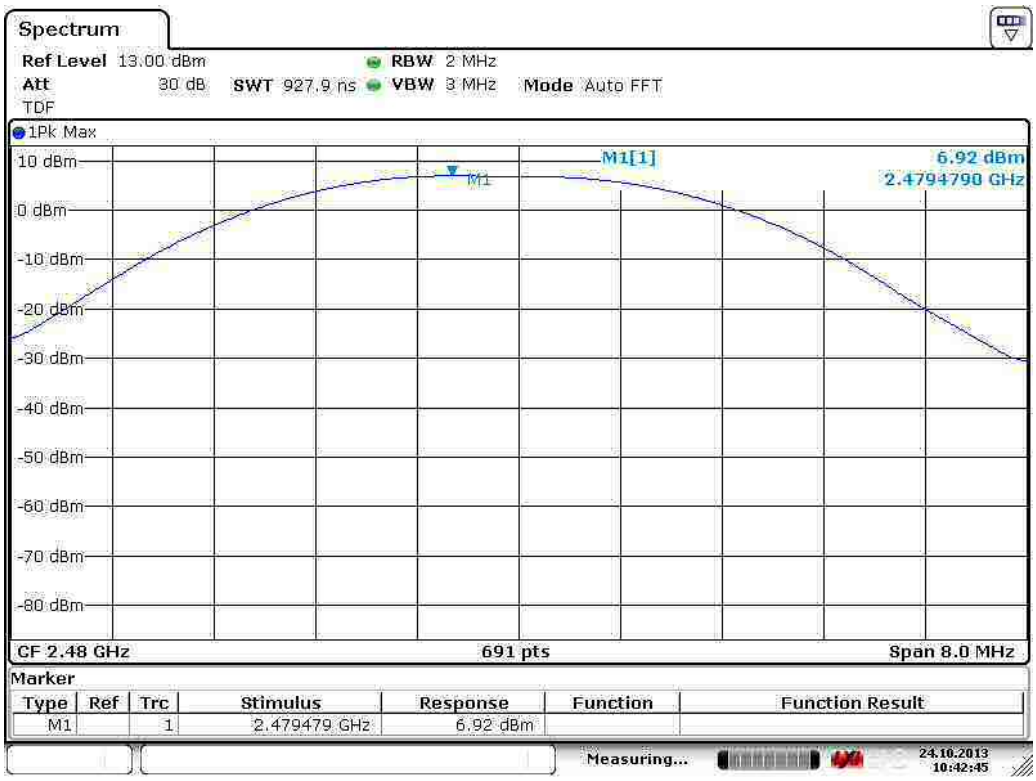

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Figure 4. 1 Mbps Channel HIGH.

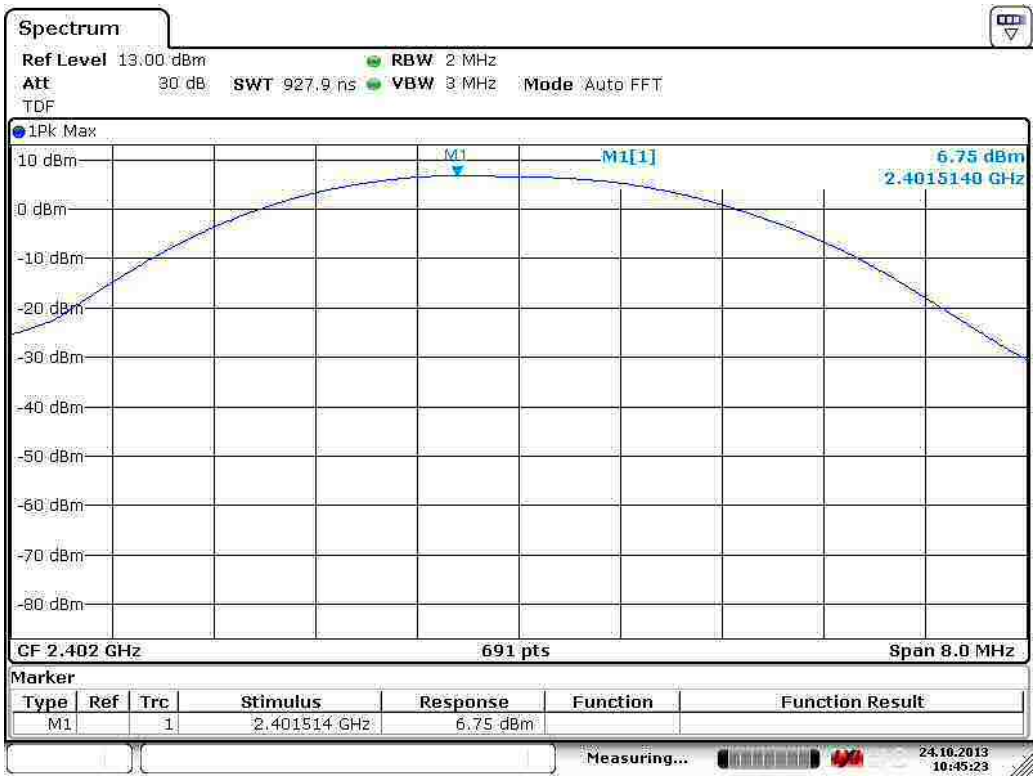

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Figure 5. 2 Mbps Channel LOW.

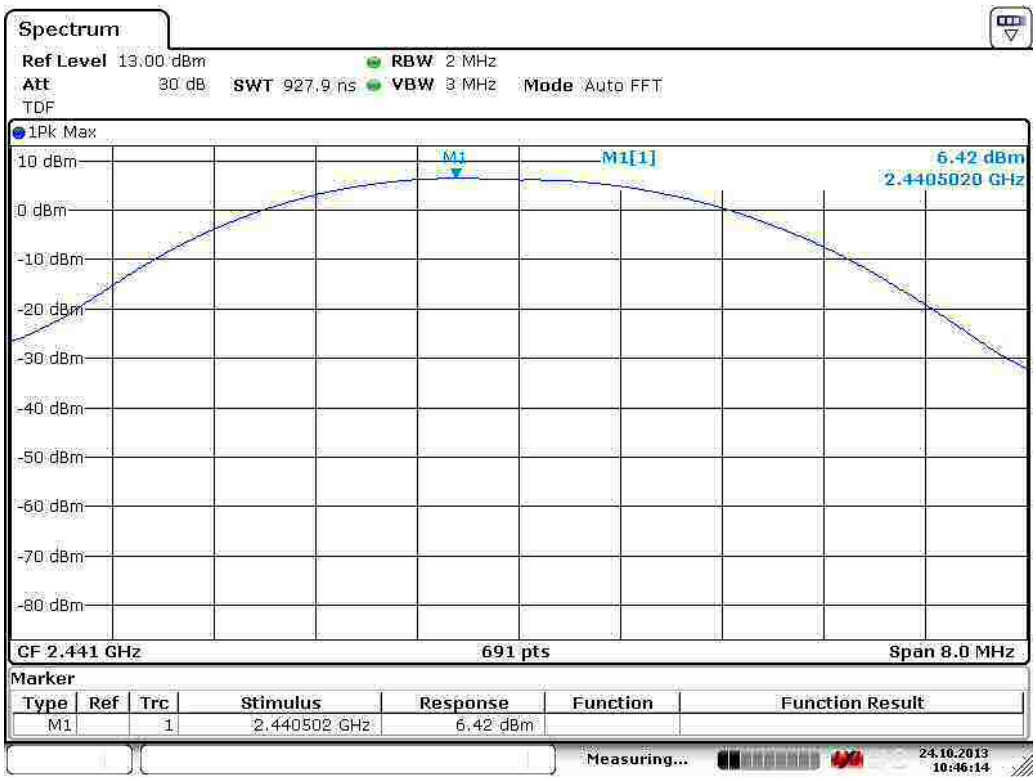

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Figure 6. 2 Mbps Channel MID.

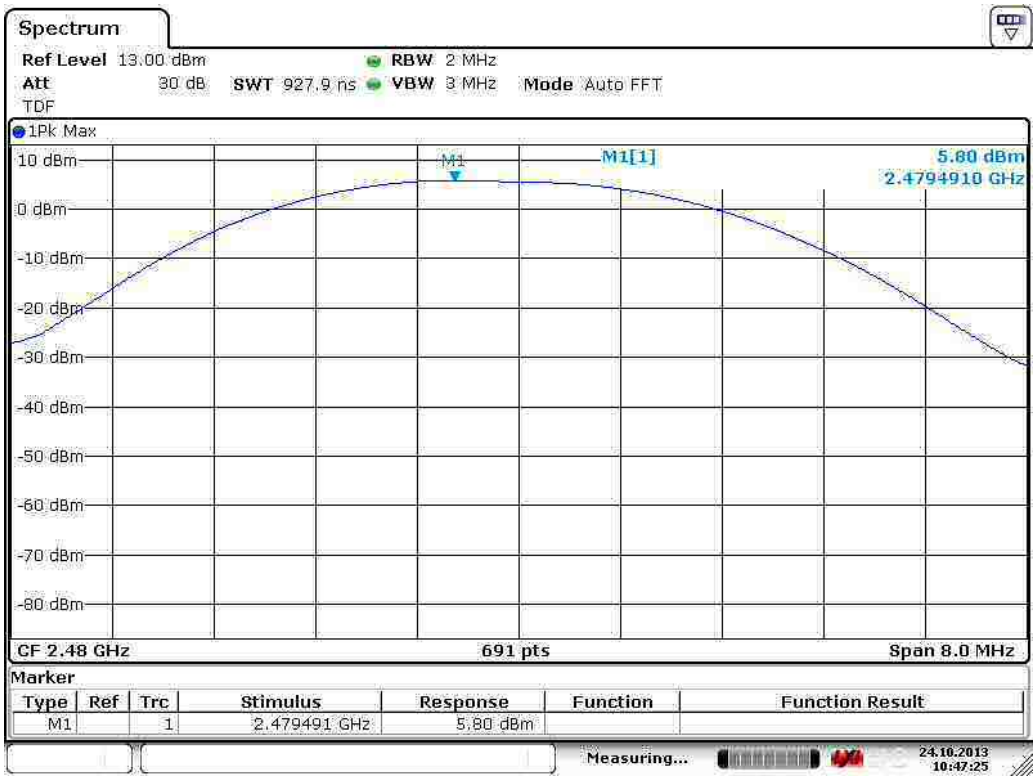

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Figure 7. 2 Mbps Channel HIGH.

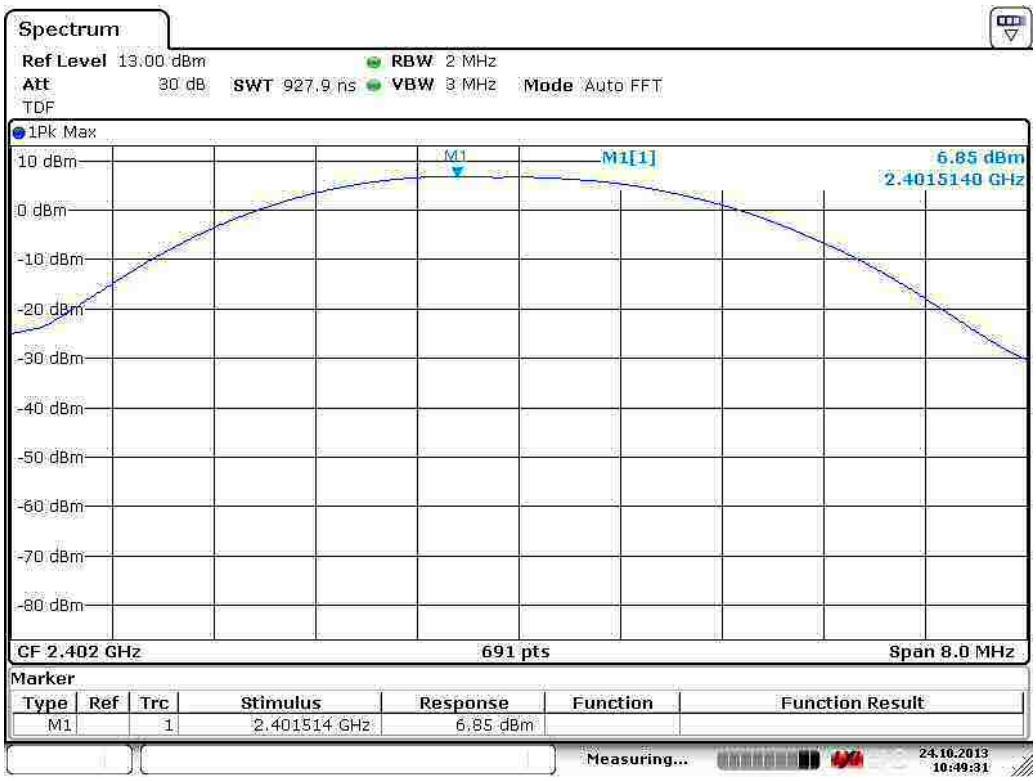

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Figure 8. 3 Mbps Channel LOW.

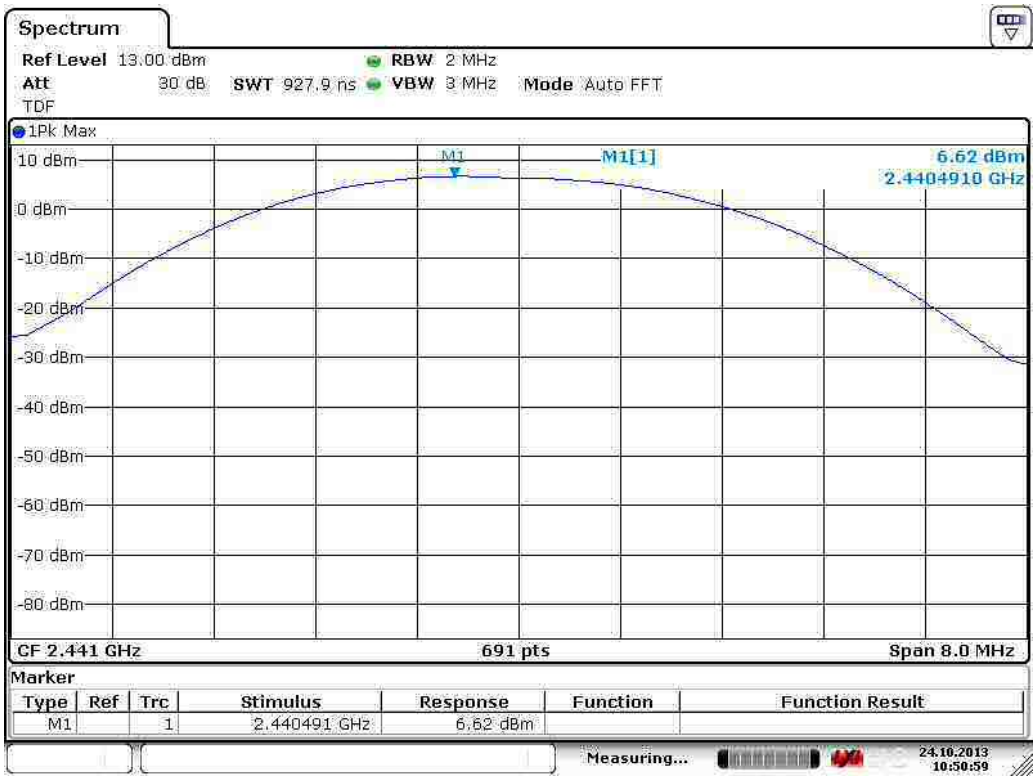

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Figure 9. 3 Mbps Channel MID.

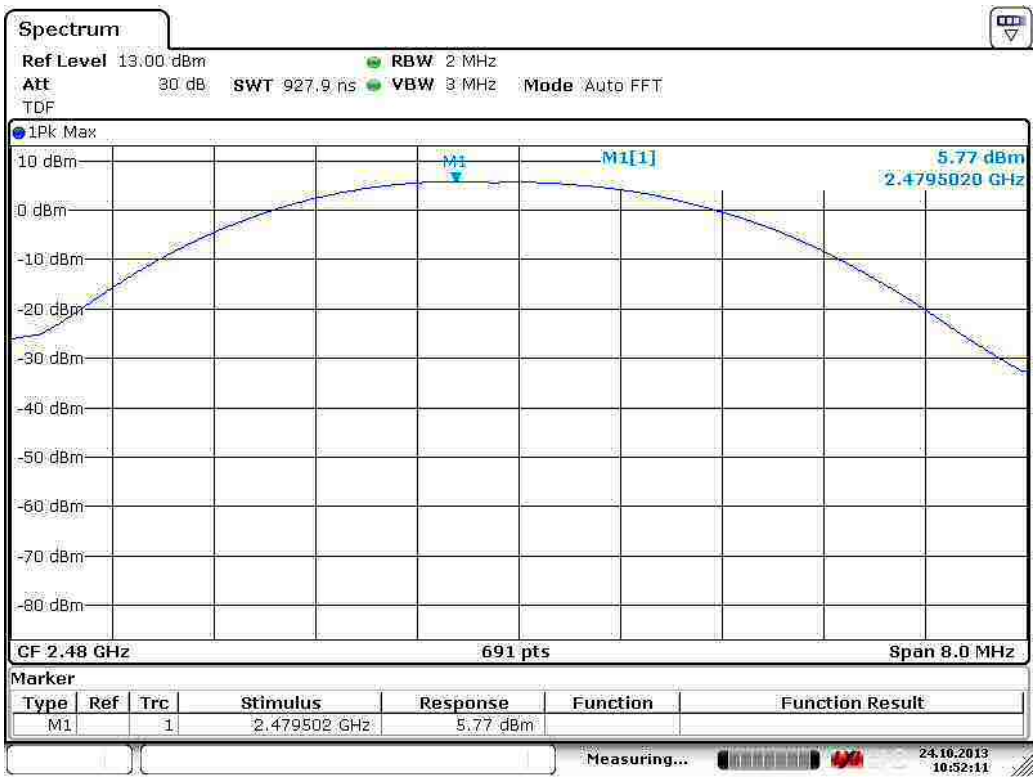

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Figure 10. 3 Mbps Channel HIGH.

Transmitter Radiated Emissions 30 MHz to 26.5 GHz

Standard:	ANSI C63.10	(2009)
Tested by:	RRE	
Date:	7.10.- 8.10.2013	
Temperature:	21 - 22 °C	
Humidity:	35 - 41 % 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 result value is the measured value corrected with the correction factor.

Measurements were done with 1 Mbps (worst case) with intergated and external antenna.

Test results with integrated antenna

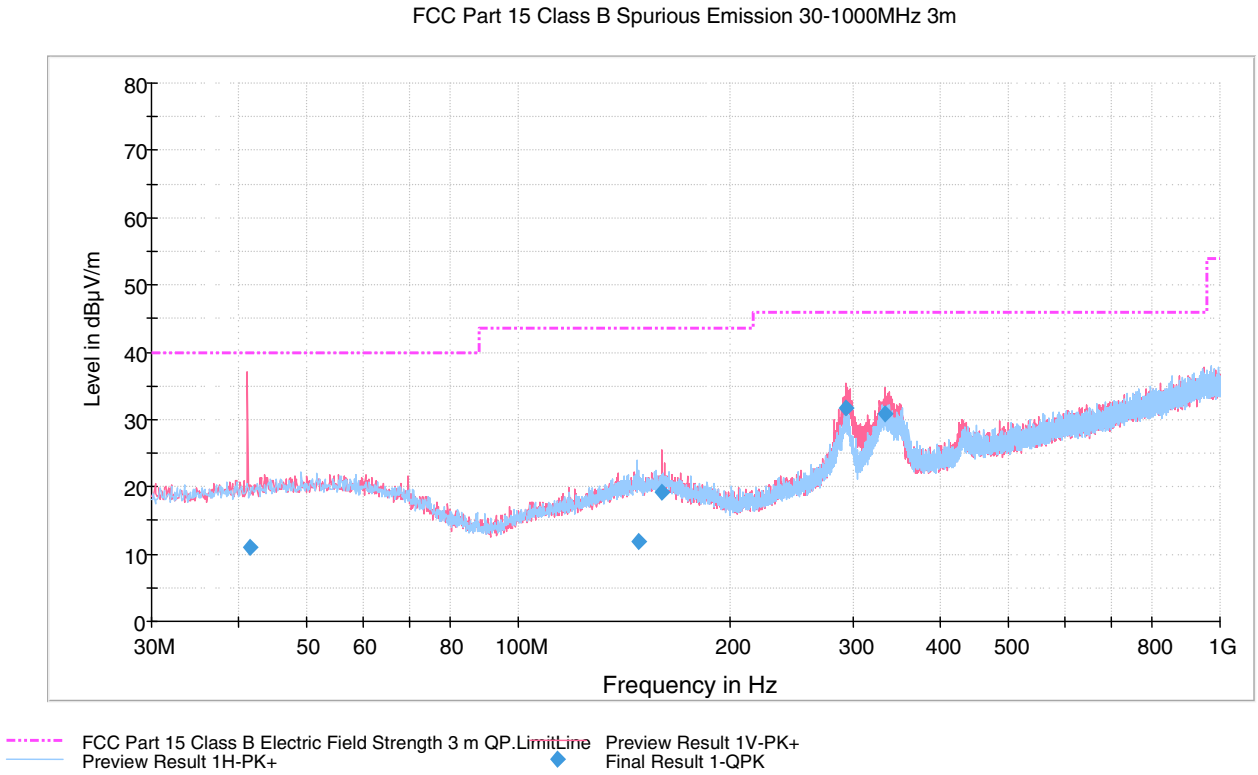


Figure 11. Measured curve with peak-detector. 1 Mbps Channel LOW.

Final measurements from the worst frequencies

Table 1. Final results.

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
41.535000	10.9	1000.0	120.000	100.0	V	5.0	14.9	29.1	40.0	
148.078000	11.9	1000.0	120.000	115.0	H	79.0	14.8	31.6	43.5	
159.980000	19.1	1000.0	120.000	132.0	V	283.0	14.9	24.4	43.5	
292.912000	31.7	1000.0	120.000	132.0	V	150.0	15.6	14.3	46.0	
333.154000	30.9	1000.0	120.000	100.0	V	300.0	16.9	15.1	46.0	

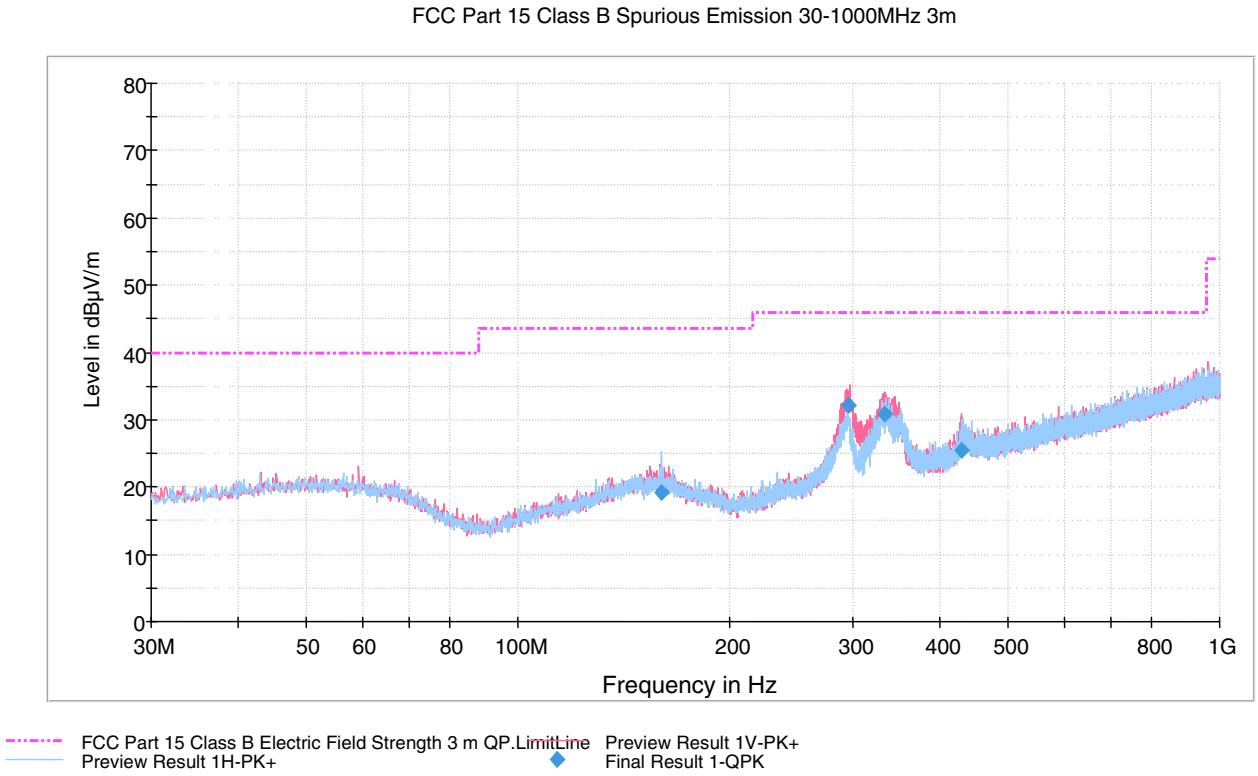


Figure 12. Measured curve with peak-detector. 1 Mbps Channel MID.

Final measurements from the worst frequencies

Table 2. Final results.

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
160.000000	19.1	1000.0	120.000	168.0	H	141.0	14.9	24.4	43.5	
296.447000	32.1	1000.0	120.000	100.0	V	168.0	15.7	13.9	46.0	
333.085000	30.8	1000.0	120.000	100.0	V	297.0	16.9	15.2	46.0	
428.448000	25.5	1000.0	120.000	100.0	V	26.0	19.3	20.5	46.0	

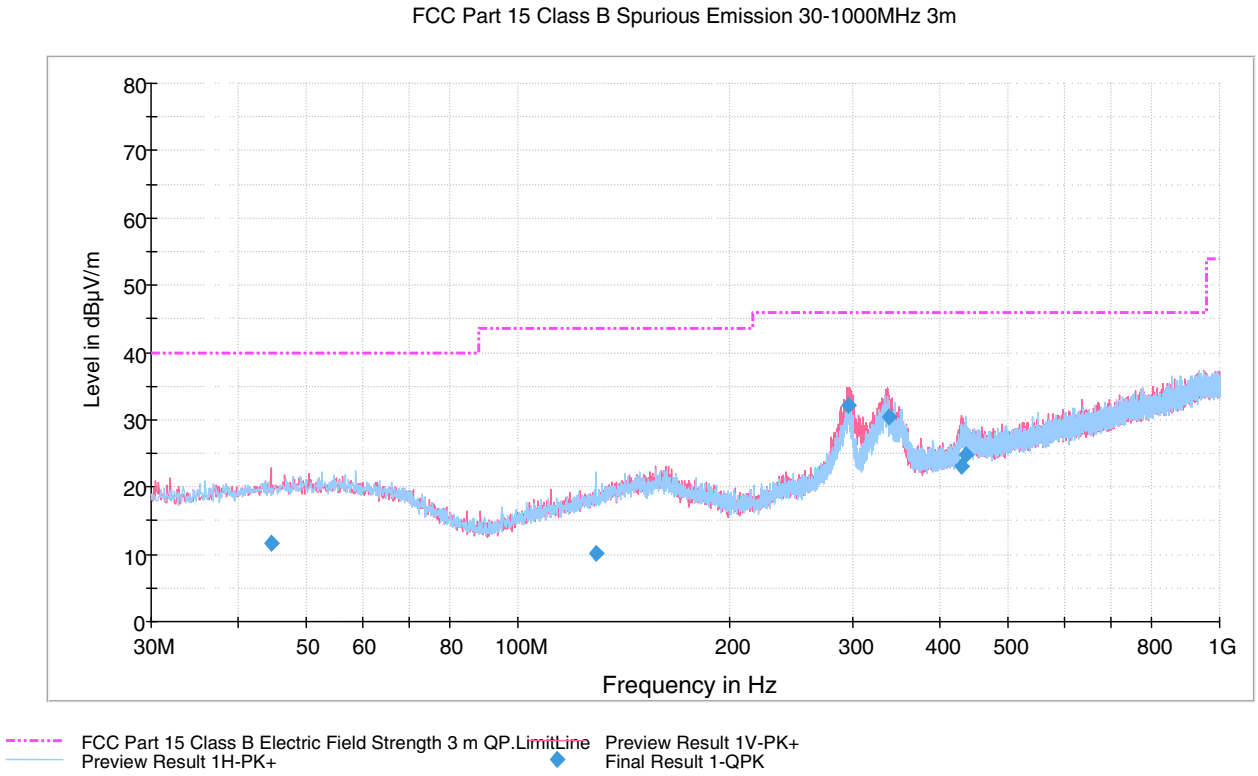


Figure 13. Measured curve with peak-detector. 1 Mbps Channel HIGH.

Final measurements from the worst frequencies

Table 3. Final results.

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
44.613000	11.6	1000.0	120.000	194.0	V	138.0	15.2	28.4	40.0	
129.051000	10.1	1000.0	120.000	196.0	H	129.0	12.8	33.4	43.5	
296.029000	32.1	1000.0	120.000	100.0	V	155.0	15.7	13.9	46.0	
337.311000	30.3	1000.0	120.000	100.0	V	289.0	16.9	15.7	46.0	
429.424000	23.1	1000.0	120.000	100.0	V	281.0	19.4	22.9	46.0	
434.556000	24.8	1000.0	120.000	100.0	H	144.0	19.5	21.2	46.0	

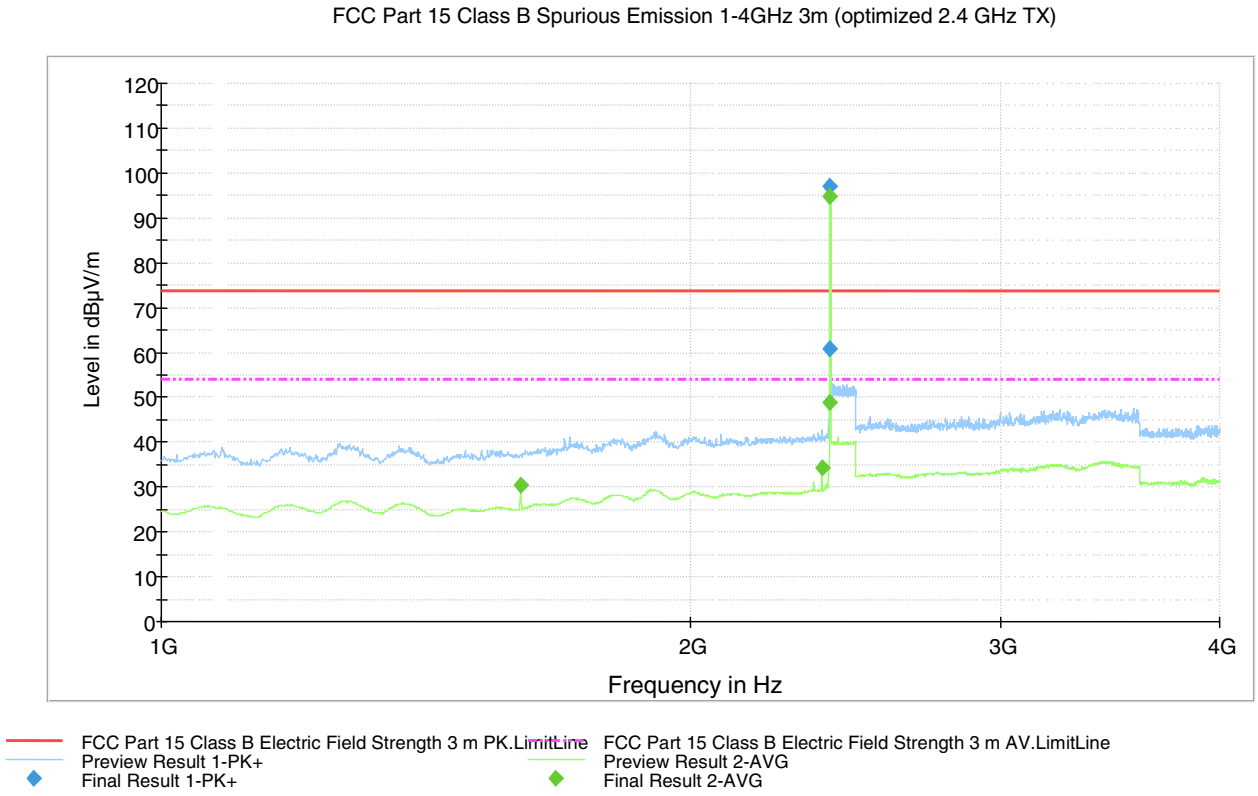


Figure 14. Measured curve with peak- and average detector. 1 Mbps Channel LOW.

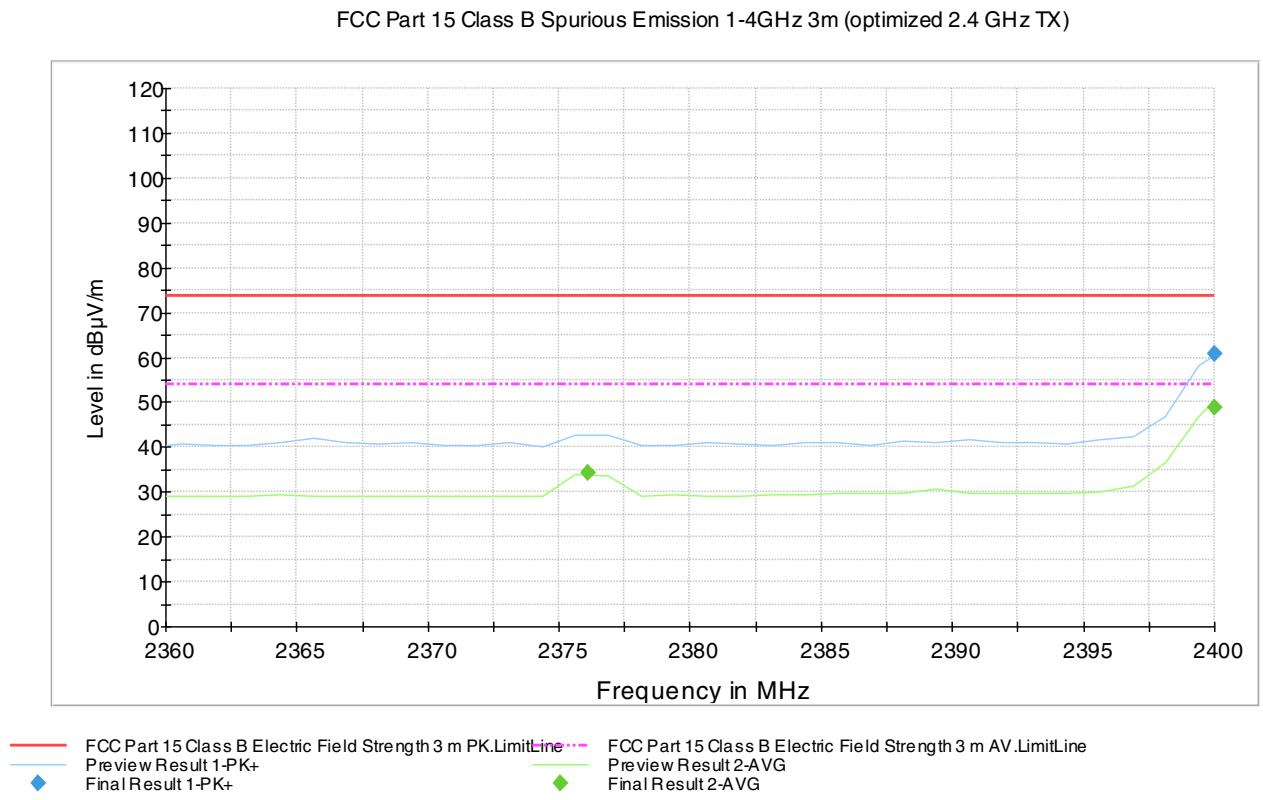


Figure 15. Low channel band edge.

Final measurements from the worst frequencies

Table 4. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
2400.000000	60.7	1000.0	1000.000	196.0	V	104.0	4.5	13.2	73.9	
2402.000000	97.2	1000.0	1000.000	162.0	V	116.0	4.5	-	-	carrier

Table 5. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1601.025000	30.5	1000.0	1000.000	214.0	H	236.0	-1.5	23.4	53.9	
2376.075000	34.3	1000.0	1000.000	203.0	V	99.0	4.2	19.6	53.9	
2400.000000	48.9	1000.0	1000.000	166.0	V	120.0	4.5	5.0	53.9	
2402.000000	94.9	1000.0	1000.000	162.0	V	116.0	4.5	-	-	carrier

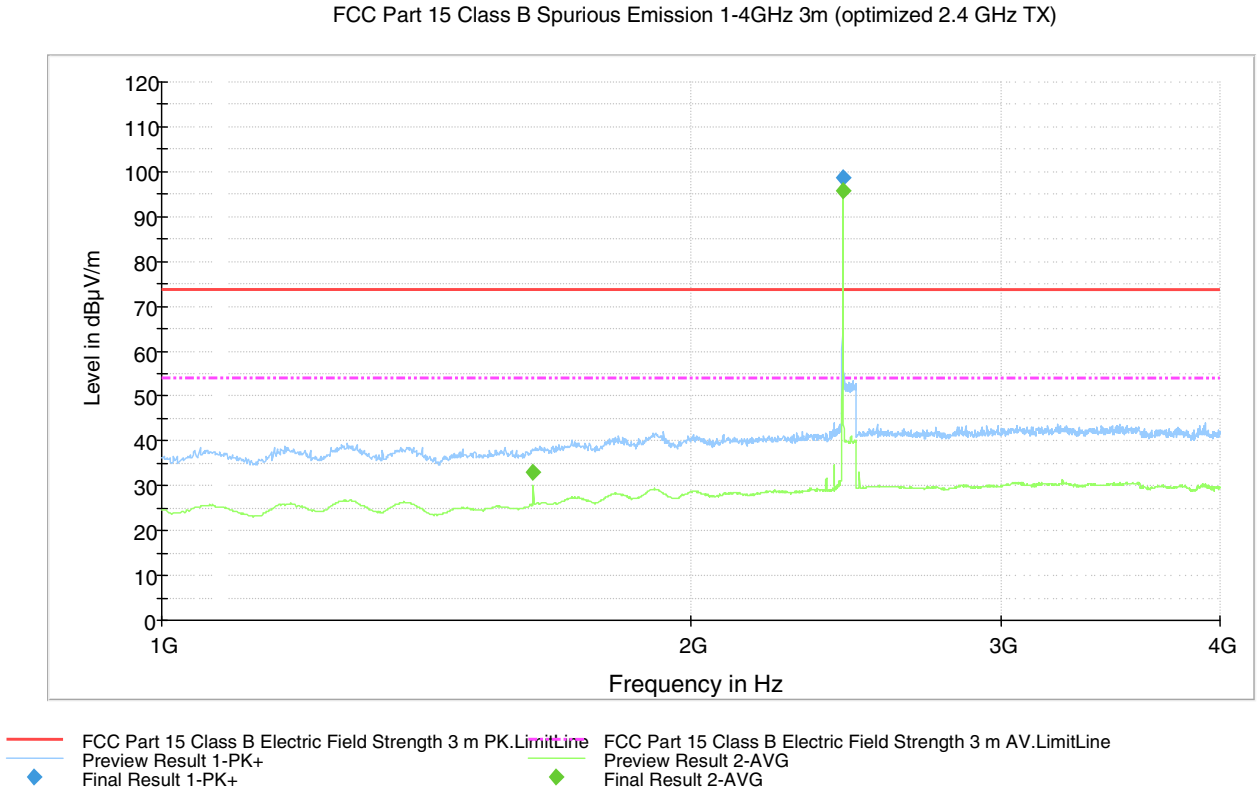


Figure 16. Measured curve with peak- and average detector. 1 Mbps Channel MID.

Final measurements from the worst frequencies

Table 6. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
2441.200000	98.5	1000.0	1000.000	100.0	V	238.0	4.4	-	-	carrier

Table 7. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1627.075000	33.1	1000.0	1000.000	122.0	V	248.0	-0.7	20.8	53.9	
2441.000000	95.8	1000.0	1000.000	100.0	V	238.0	4.4	-	-	carrier

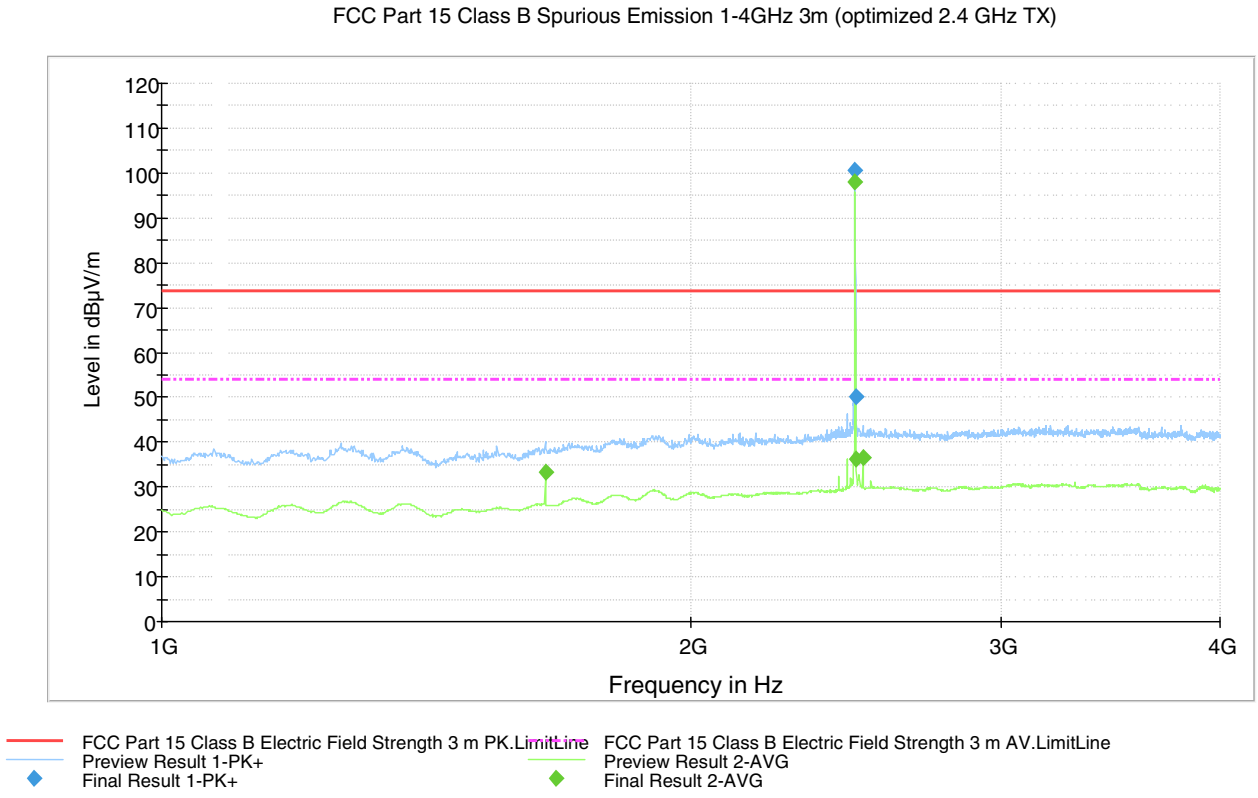


Figure 17. Measured curve with peak- and average detector. 1 Mbps Channel HIGH.

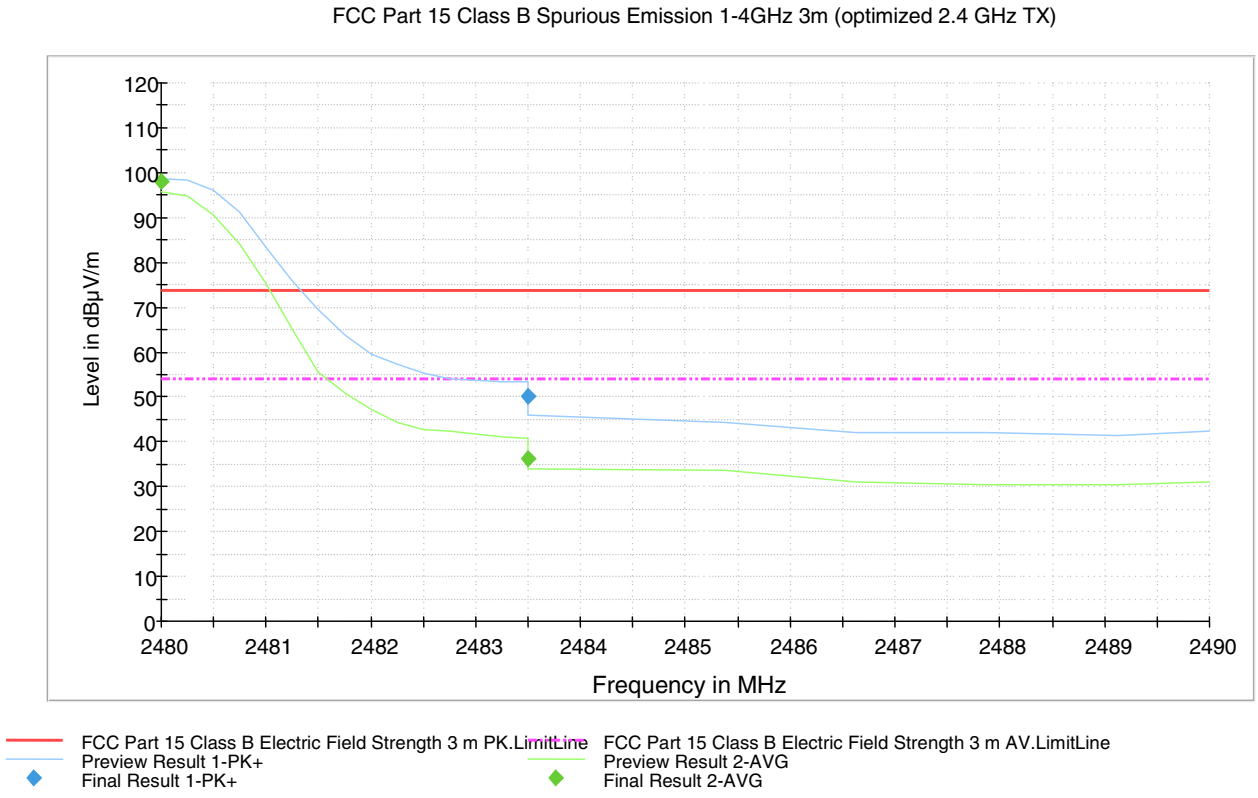


Figure 18. High channel band edge 1 Mbps.

Final measurements from the worst frequencies

Table 8. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
2479.800000	100.5	1000.0	1000.000	191.0	V	242.0	4.7	-	-	carrier
2483.500000	50.2	1000.0	1000.000	162.0	V	236.0	4.8	23.7	73.9	

Table 9. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1652.925000	33.4	1000.0	1000.000	170.0	V	253.0	0.0	20.5	53.9	
2480.000000	97.9	1000.0	1000.000	162.0	V	242.0	4.7	-	-	carrier
2483.500000	36.1	1000.0	1000.000	192.0	V	236.0	4.8	17.8	53.9	
2506.025000	36.5	1000.0	1000.000	192.0	V	242.0	4.9	17.4	53.9	

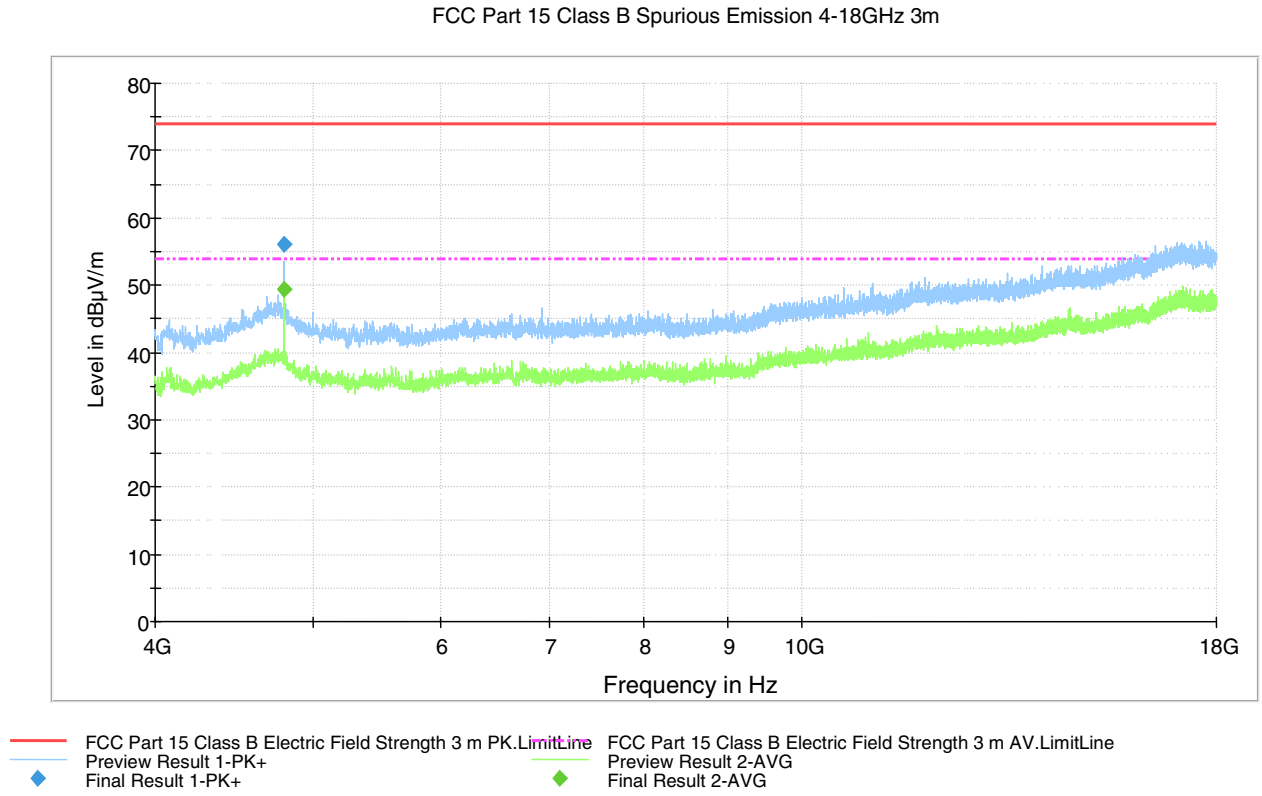


Figure 19. Measured curve with peak- and average detector. 1 Mbps Channel LOW.

Final measurements from the worst frequencies

Table 10. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4804.200000	56.0	1000.0	1000.000	162.0	H	141.0	13.8	17.9	73.9	

Table 11. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4804.000000	49.3	1000.0	1000.000	162.0	H	141.0	13.8	4.6	53.9	

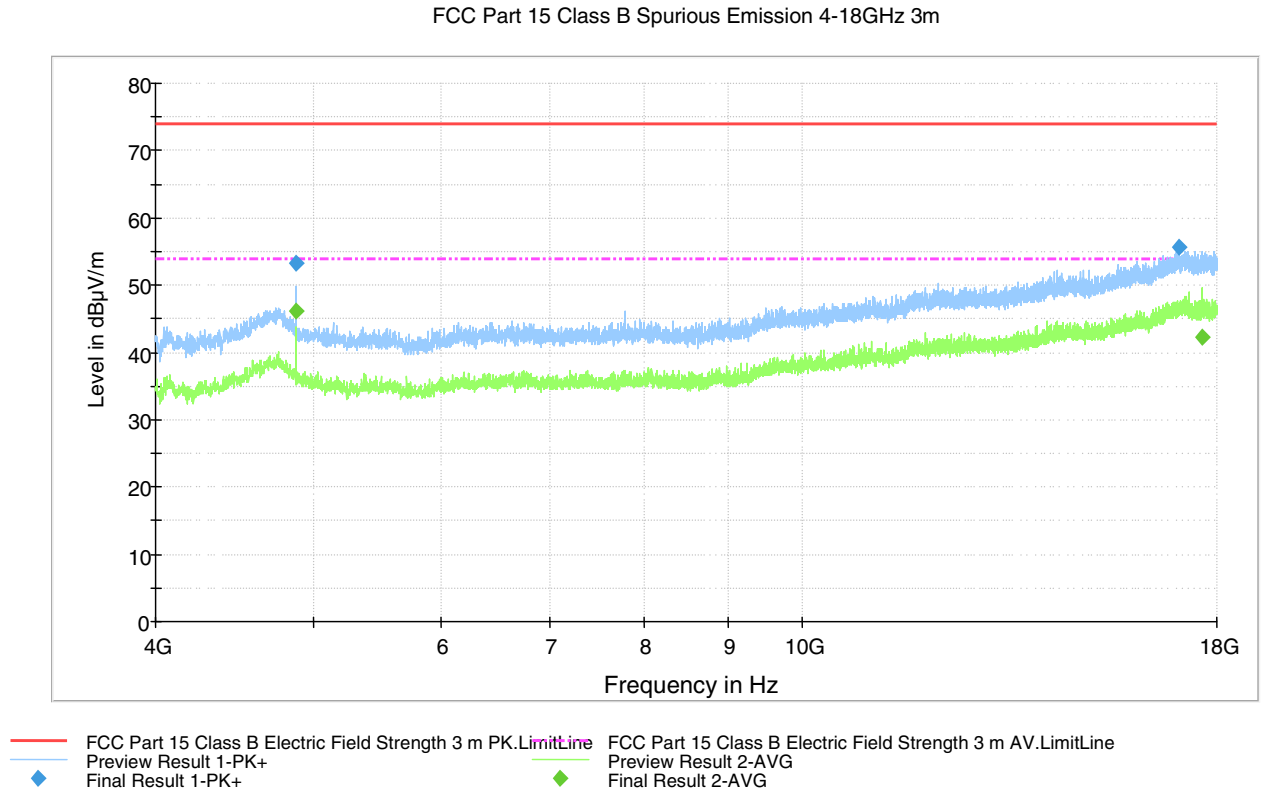


Figure 20. Measured curve with peak- and average detector. 1 Mbps Channel MID.

Final measurements from the worst frequencies

Table 12. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4881.800000	53.2	1000.0	1000.000	122.0	V	113.0	12.8	20.7	73.9	
17080.600000	55.6	1000.0	1000.000	289.0	V	212.0	28.2	18.3	73.9	

Table 13. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4882.000000	46.2	1000.0	1000.000	138.0	V	119.0	12.8	7.7	53.9	
17622.000000	42.2	1000.0	1000.000	100.0	V	313.0	28.3	11.7	53.9	

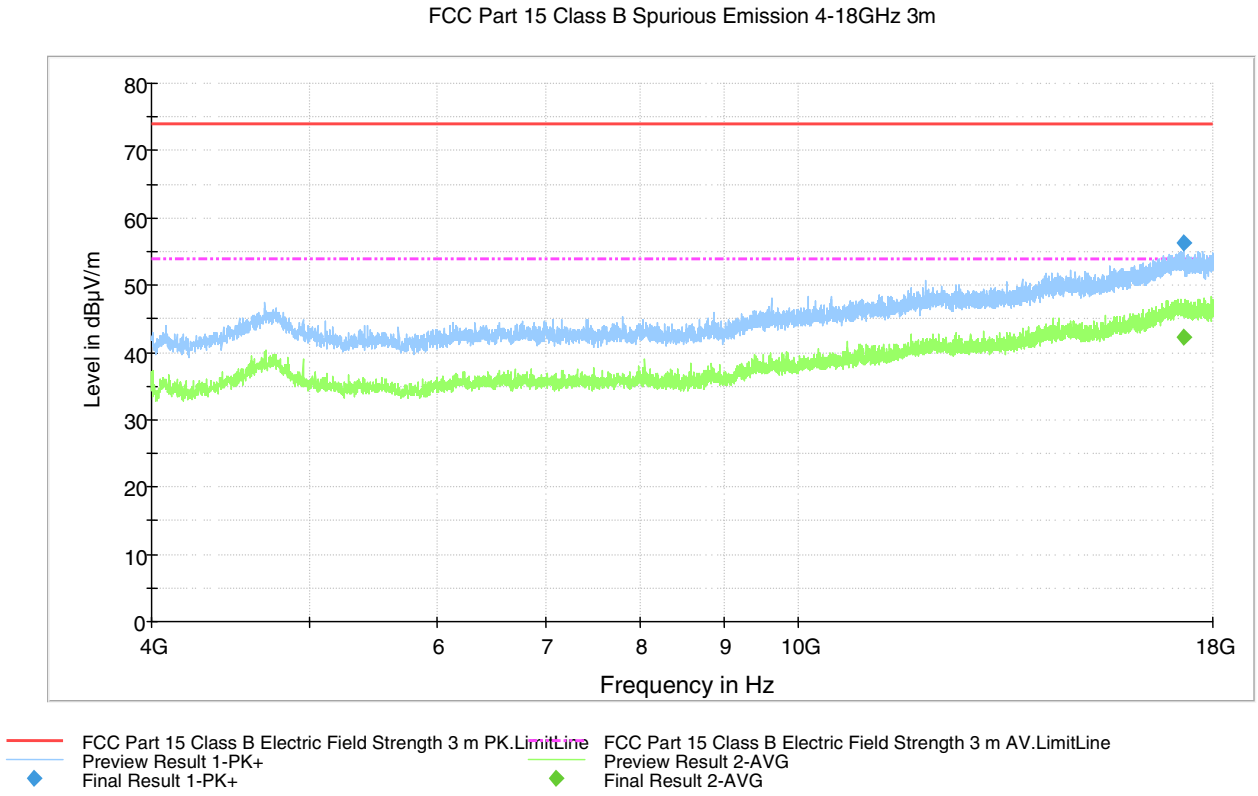


Figure 21. Measured curve with peak- and average detector. 1 Mbps Channel HIGH.

Final measurements from the worst frequencies

Table 14. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
17278.600000	56.3	1000.0	1000.000	382.0	H	187.0	28.2	17.6	73.9	

Table 15. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
17278.600000	42.3	1000.0	1000.000	382.0	H	187.0	28.2	11.6	53.9	

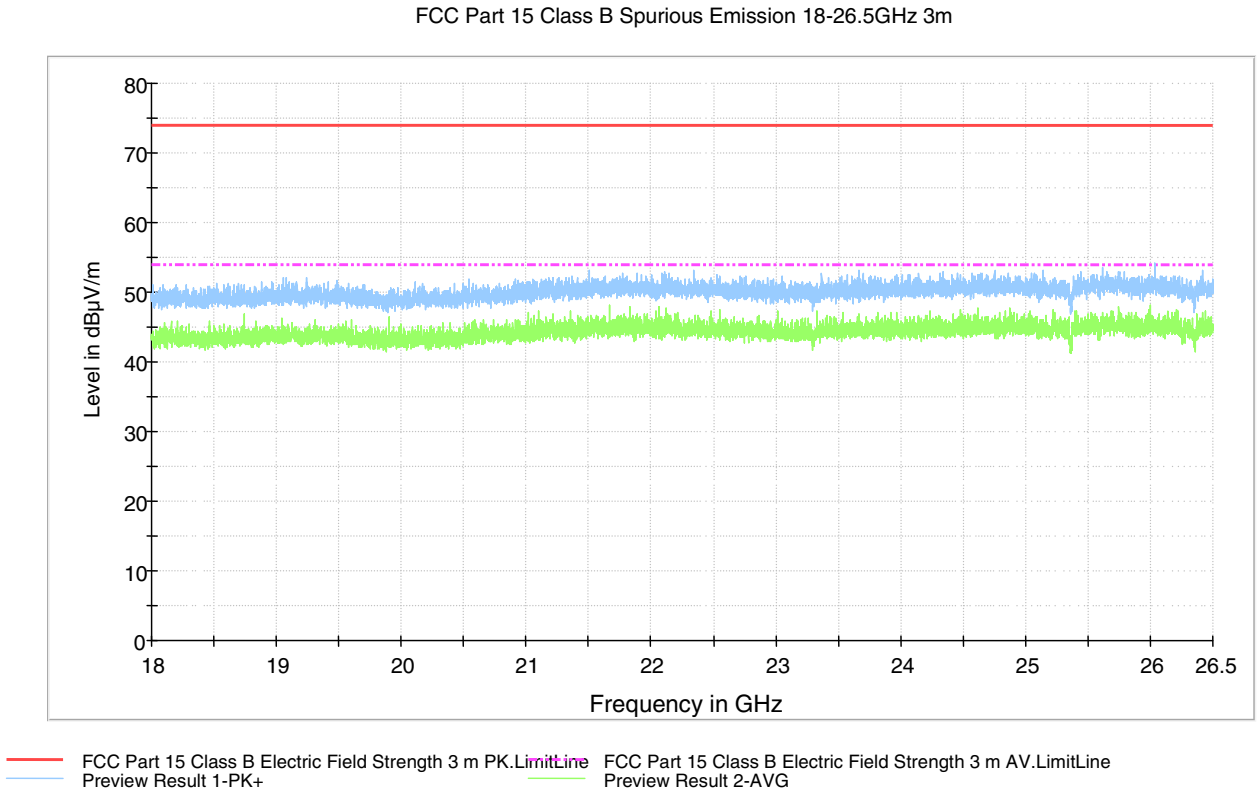


Figure 22. Measured curve with peak- and average detector. 1 Mbps Channel LOW.

Final measurements from the worst frequencies

Due to the low emission level no final measurements were made.

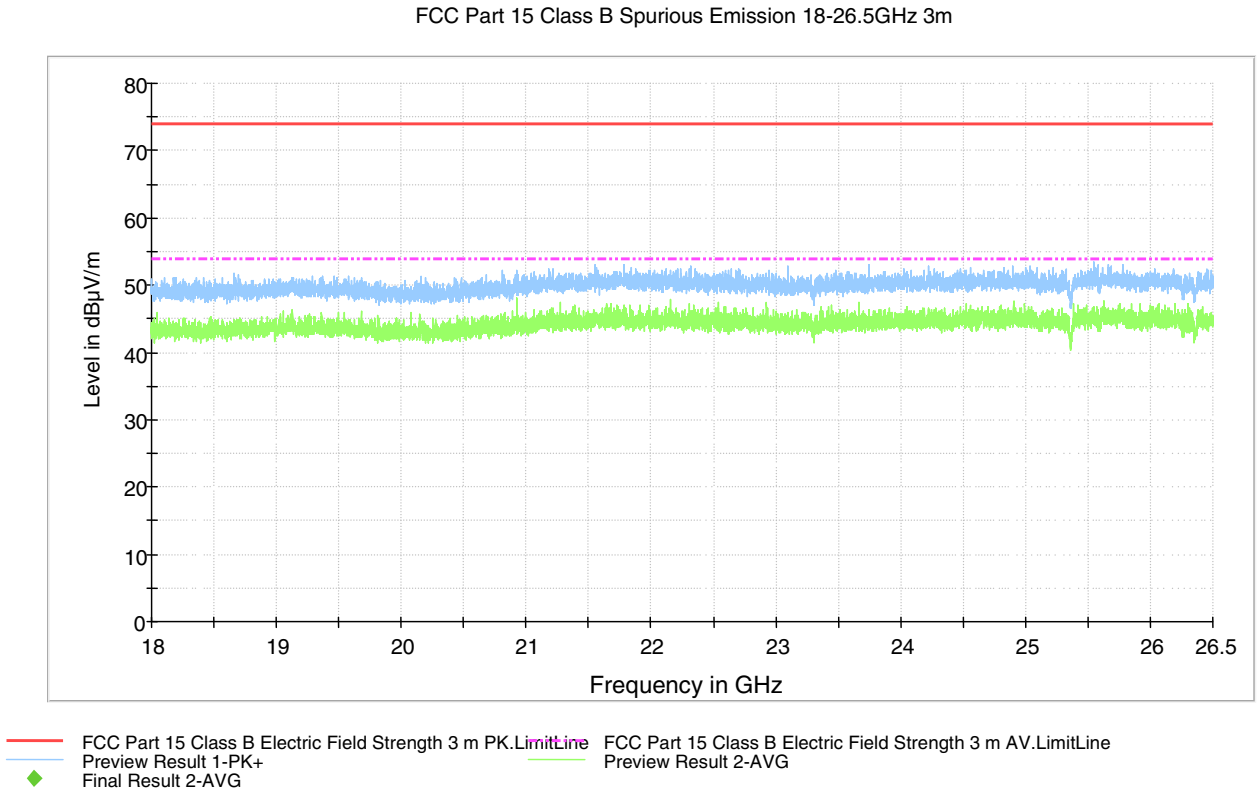


Figure 23. Measured curve with peak- and average detector. 1 Mbps Channel MID.

Final measurements from the worst frequencies

Due to the low emission level no final measurements were made.

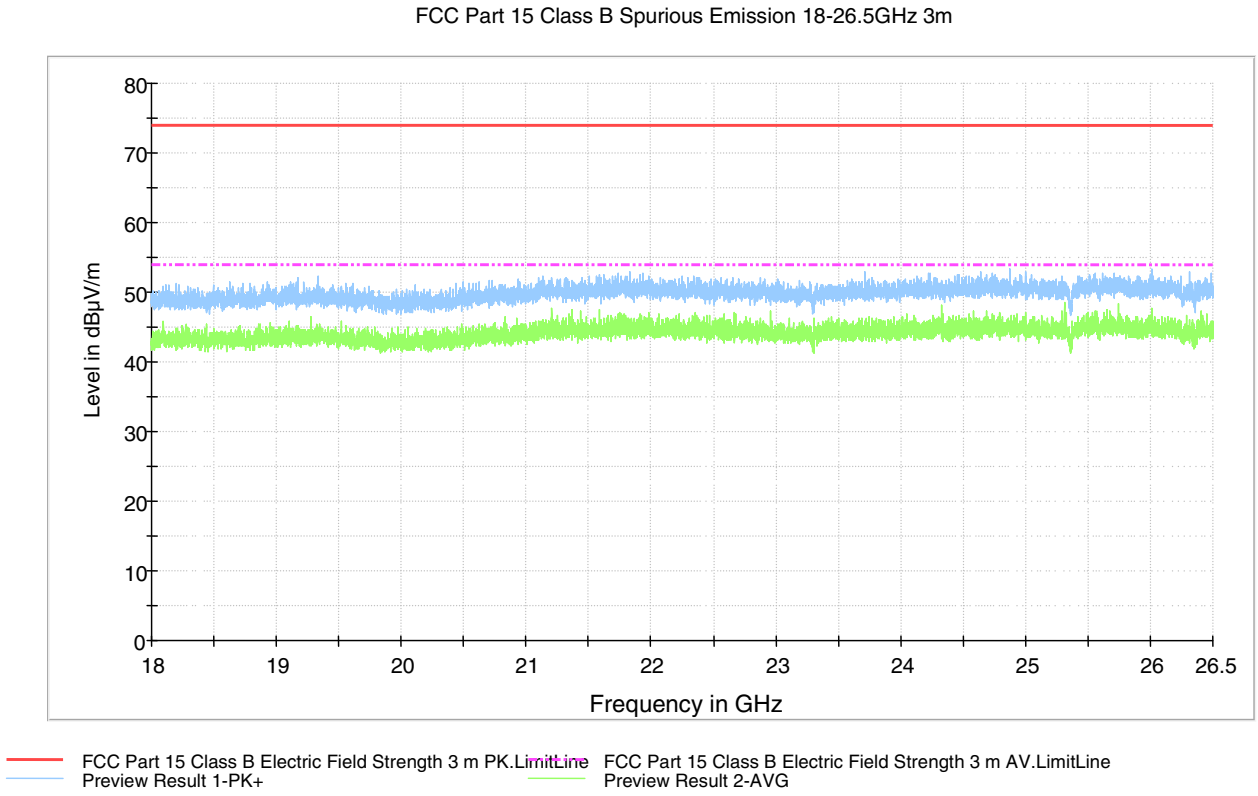


Figure 24. Measured curve with peak- and average detector. 1 Mbps Channel HIGH.

Final measurements from the worst frequencies

Due to the low emission level no final measurements were made.

Test results with external antenna

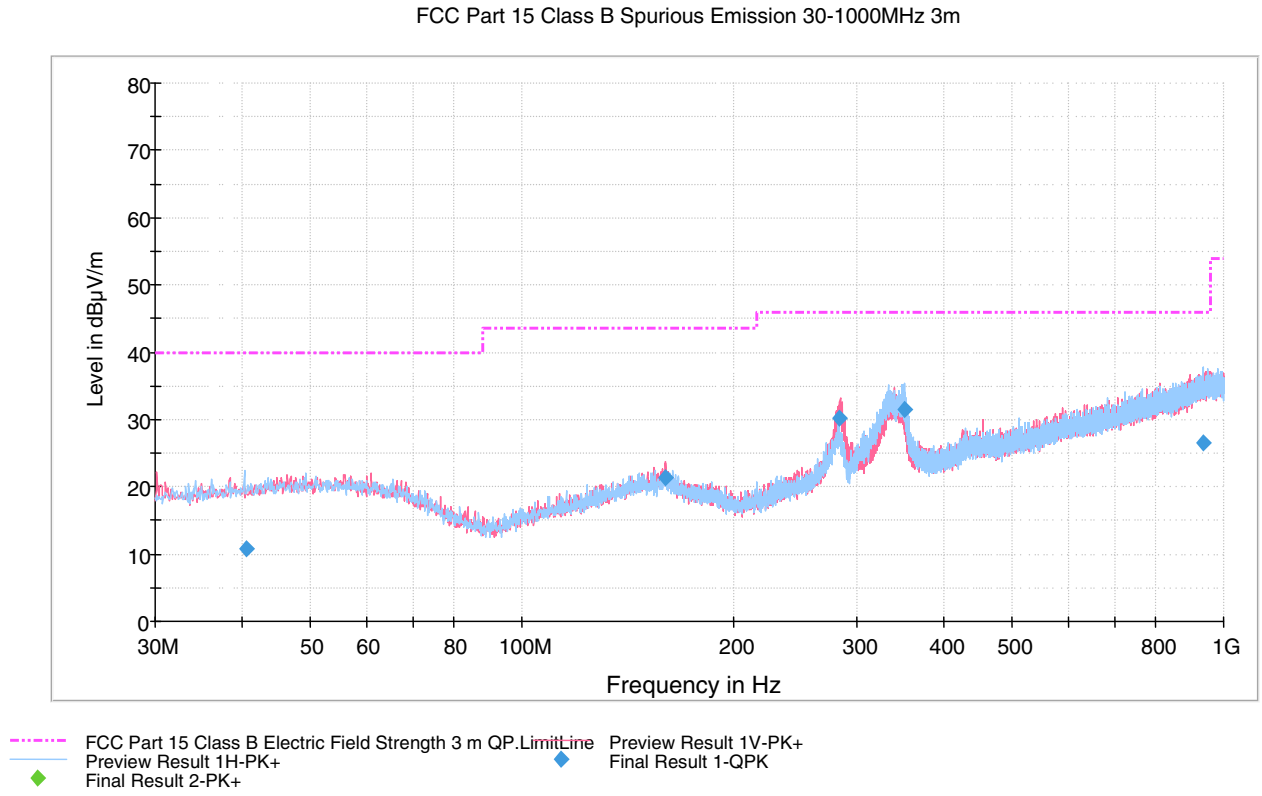


Figure 25. Measured curve with peak-detector. 1 Mbps Channel LOW.

Final measurements from the worst frequencies

Table 16. Final results.

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
40.562000	10.7	1000.0	120.000	115.0	H	14.0	14.8	29.3	40.0	
160.000000	21.4	1000.0	120.000	100.0	V	283.0	14.9	22.1	43.5	
283.720000	30.1	1000.0	120.000	151.0	V	160.0	15.4	15.9	46.0	
350.710000	31.5	1000.0	120.000	100.0	H	320.0	17.4	14.5	46.0	
934.979000	26.6	1000.0	120.000	352.0	H	176.0	27.9	19.4	46.0	

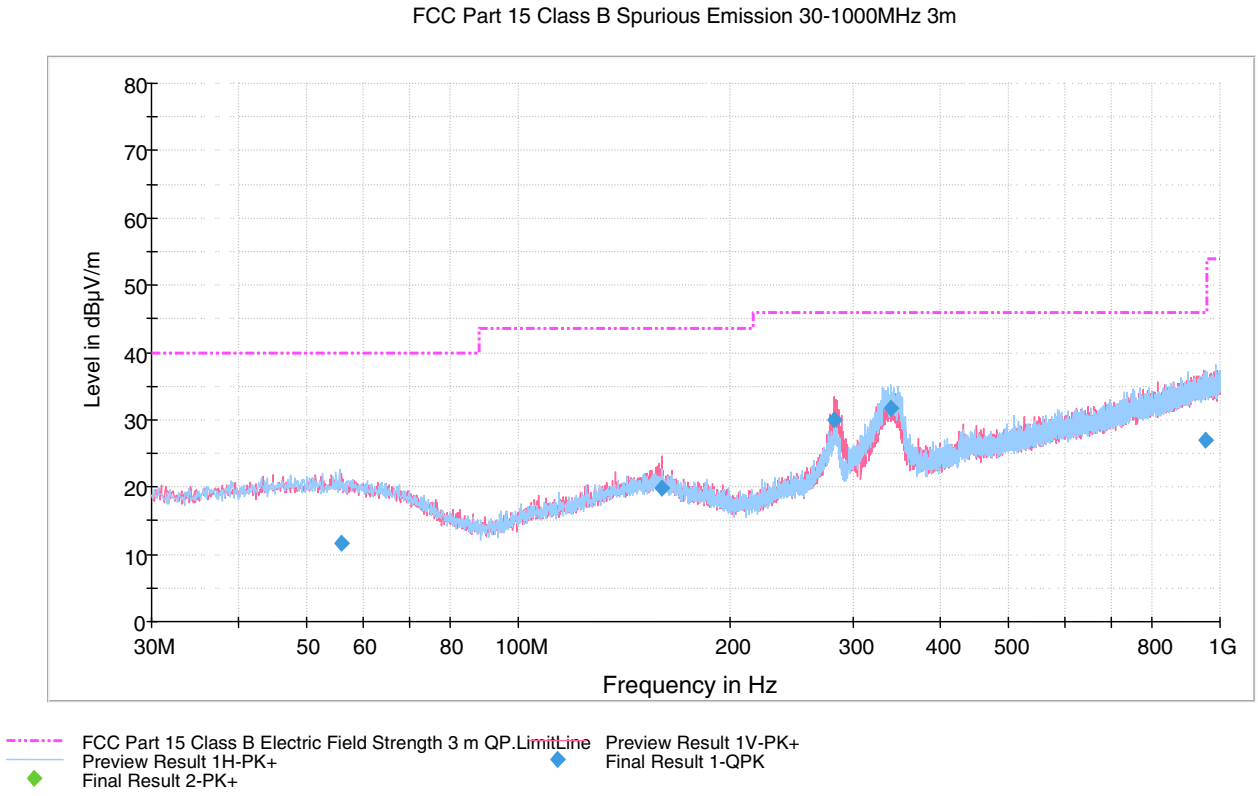


Figure 26. Measured curve with peak-detector. 1 Mbps Channel MID.

Final measurements from the worst frequencies

Table 17. Final results.

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
56.048000	11.6	1000.0	120.000	160.0	H	52.0	15.1	28.4	40.0	
160.000000	19.9	1000.0	120.000	120.0	V	247.0	14.9	23.6	43.5	
282.055000	29.9	1000.0	120.000	127.0	V	152.0	15.4	16.1	46.0	
339.606000	31.7	1000.0	120.000	100.0	H	156.0	16.9	14.3	46.0	
955.086000	26.9	1000.0	120.000	157.0	H	68.0	28.2	19.1	46.0	

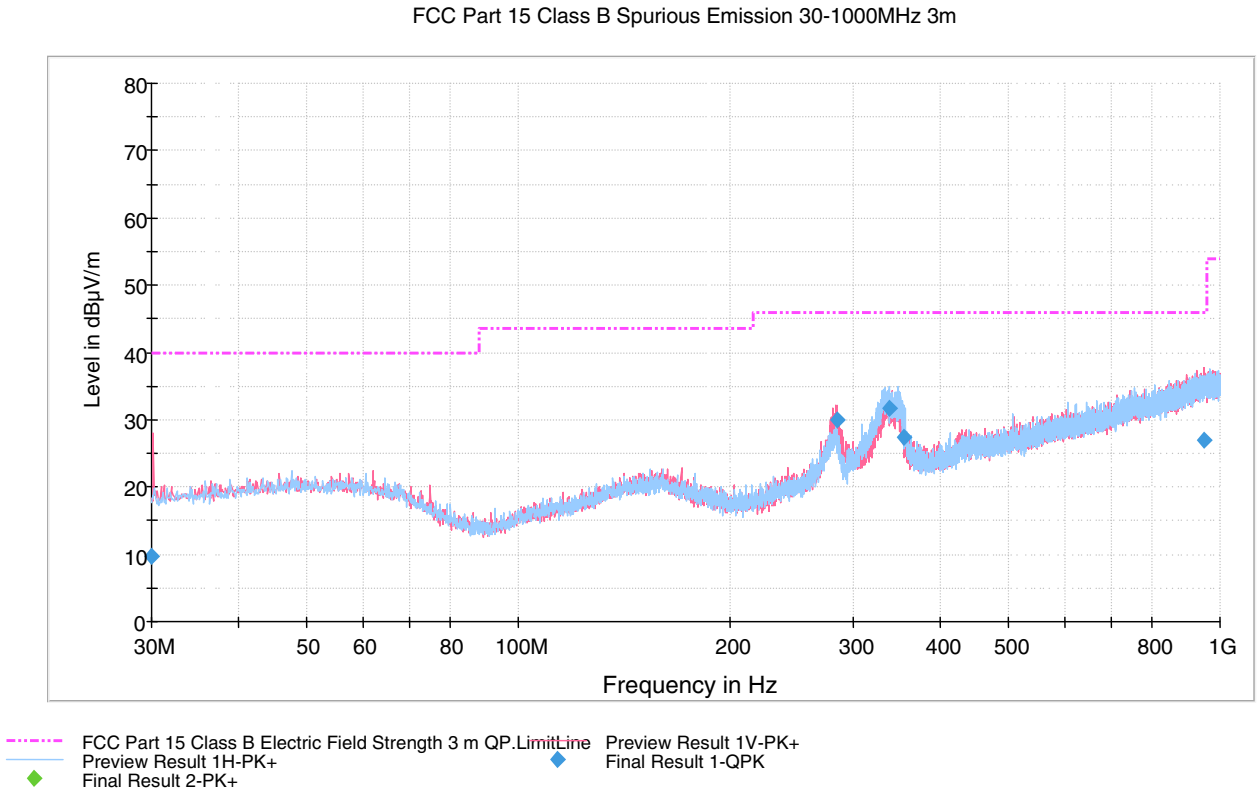


Figure 27. Measured curve with peak-detector. 1 Mbps Channel HIGH.

Final measurements from the worst frequencies

Table 18. Final results.

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
30.060000	9.6	1000.0	120.000	321.0	V	186.0	14.1	30.4	40.0	
284.500000	29.9	1000.0	120.000	116.0	V	150.0	15.4	16.1	46.0	
338.315000	31.7	1000.0	120.000	100.0	H	151.0	16.9	14.3	46.0	
354.964000	27.3	1000.0	120.000	100.0	H	319.0	17.4	18.7	46.0	
947.569000	27.0	1000.0	120.000	149.0	V	76.0	28.2	19.0	46.0	

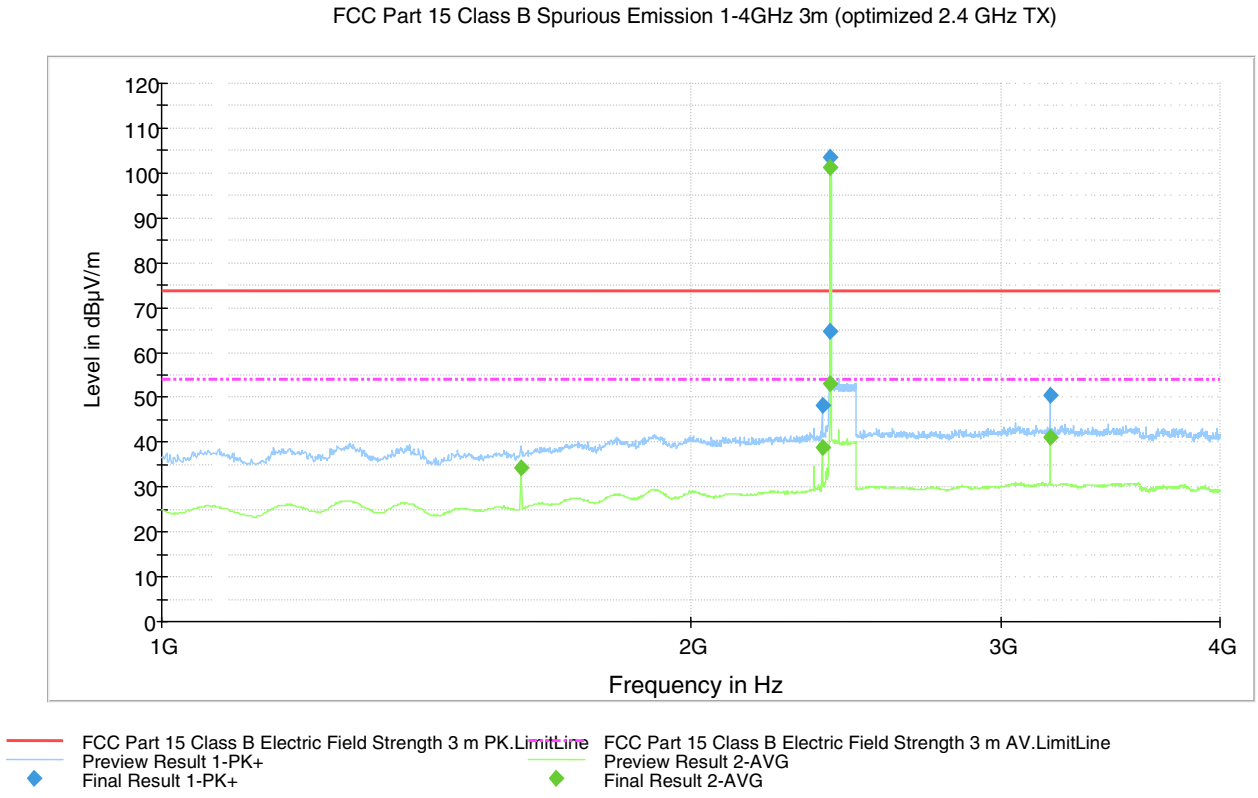


Figure 28. Measured curve with peak- and average detector. 1 Mbps Channel LOW.

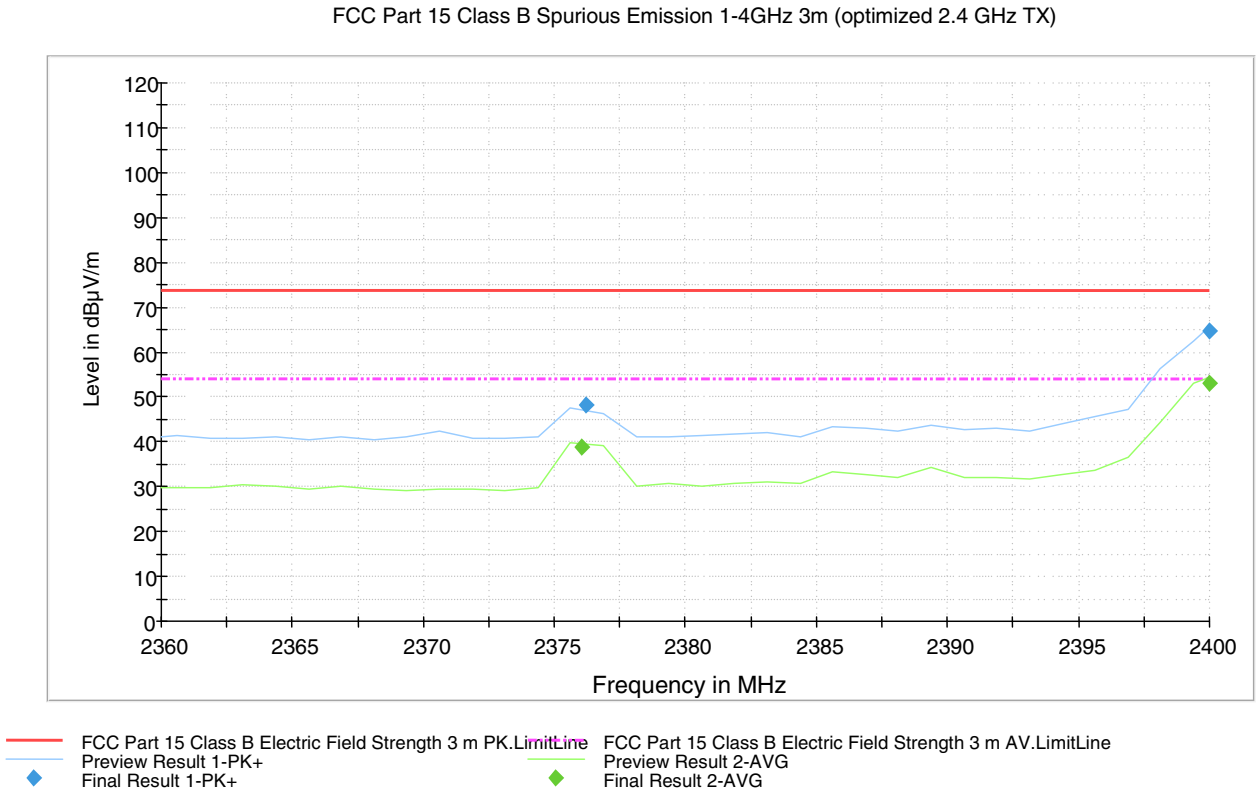


Figure 29. Low channel band edge 1 Mbps.

Final measurements from the worst frequencies

Table 19. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
2376.225000	48.3	1000.0	1000.000	203.0	V	9.0	4.2	25.6	73.9	
2400.000000	64.5	1000.0	1000.000	212.0	V	331.0	4.5	9.4	73.9	
2401.800000	103.5	1000.0	1000.000	203.0	V	309.0	4.5	-	-	carrier
3202.475000	50.6	1000.0	1000.000	239.0	V	240.0	6.4	23.3	73.9	

Table 20. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1601.025000	34.4	1000.0	1000.000	146.0	H	111.0	-1.5	19.5	53.9	
2376.025000	39.0	1000.0	1000.000	209.0	V	-4.0	4.2	14.9	53.9	
2400.000000	53.0	1000.0	1000.000	173.0	V	309.0	4.5	0.9	53.9	
2402.000000	101.1	1000.0	1000.000	173.0	V	308.0	4.5	-	-	carrier
3202.025000	41.1	1000.0	1000.000	146.0	V	86.0	6.4	12.8	53.9	

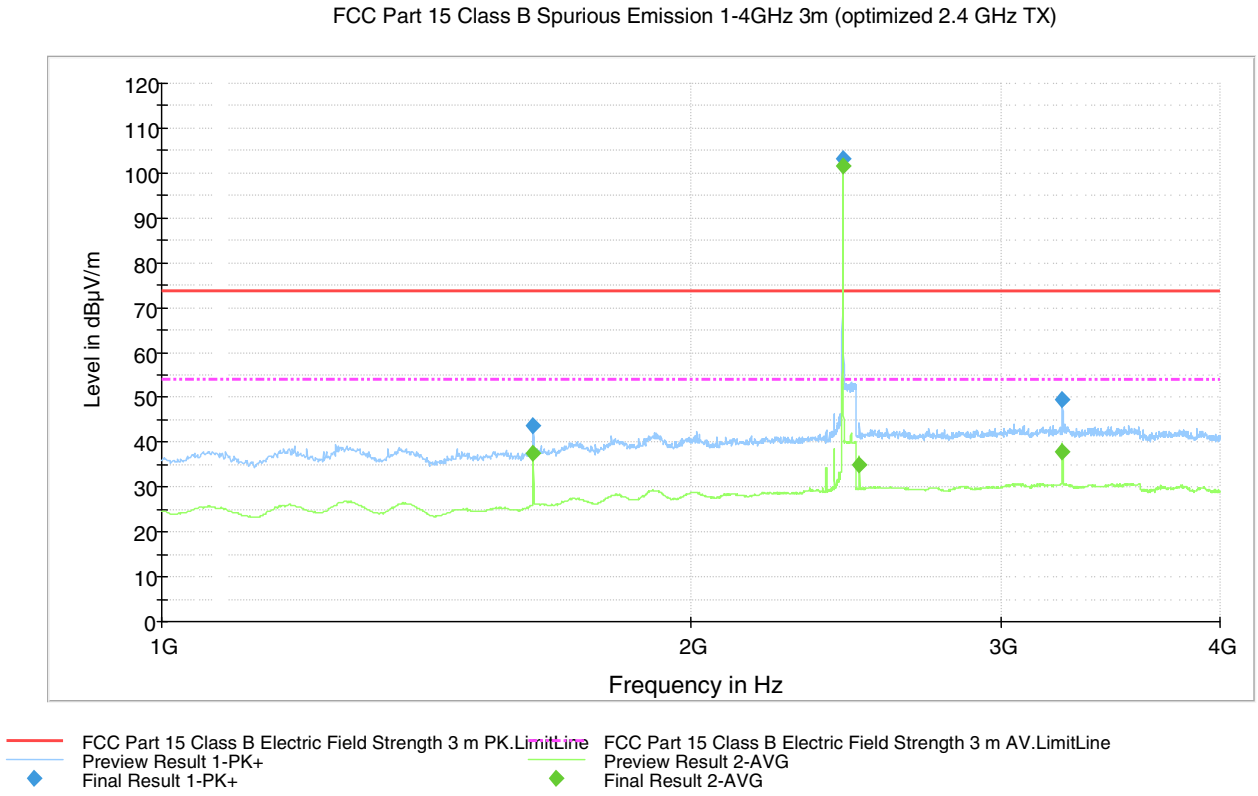


Figure 30. Measured curve with peak- and average detector. 1 Mbps Channel MID.

Final measurements from the worst frequencies

Table 21. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1627.075000	43.6	1000.0	1000.000	138.0	H	98.0	-0.7	30.3	73.9	
2440.800000	103.1	1000.0	1000.000	230.0	V	308.0	4.4	-	-	carrier
3254.325000	49.4	1000.0	1000.000	113.0	V	23.0	6.6	24.5	73.9	

Table 22. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1627.075000	37.5	1000.0	1000.000	203.0	H	104.0	-0.7	16.4	53.9	
2441.000000	101.4	1000.0	1000.000	235.0	V	308.0	4.4	-	-	carrier
2493.275000	34.9	1000.0	1000.000	194.0	V	210.0	4.9	19.0	53.9	
3254.125000	37.9	1000.0	1000.000	100.0	V	-3.0	6.6	16.0	53.9	

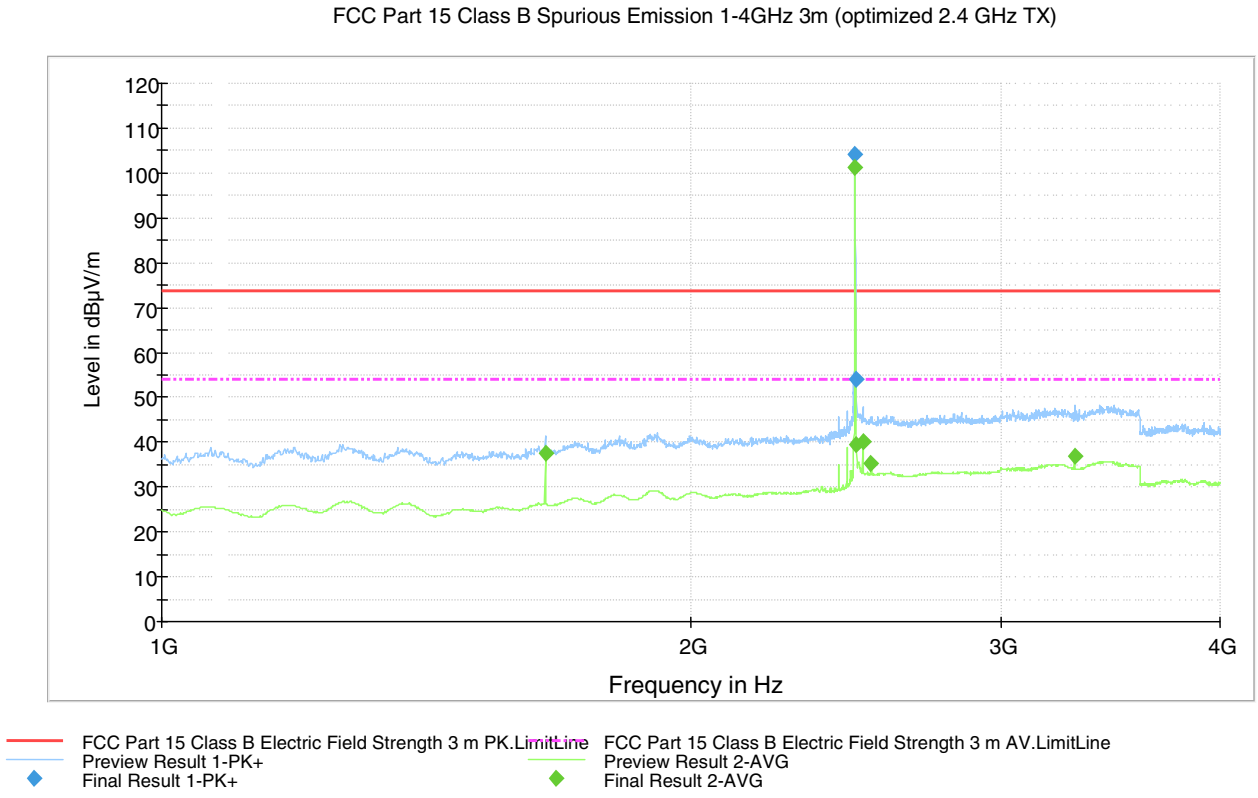


Figure 31. Measured curve with peak- and average detector. 1 Mbps Channel HIGH.

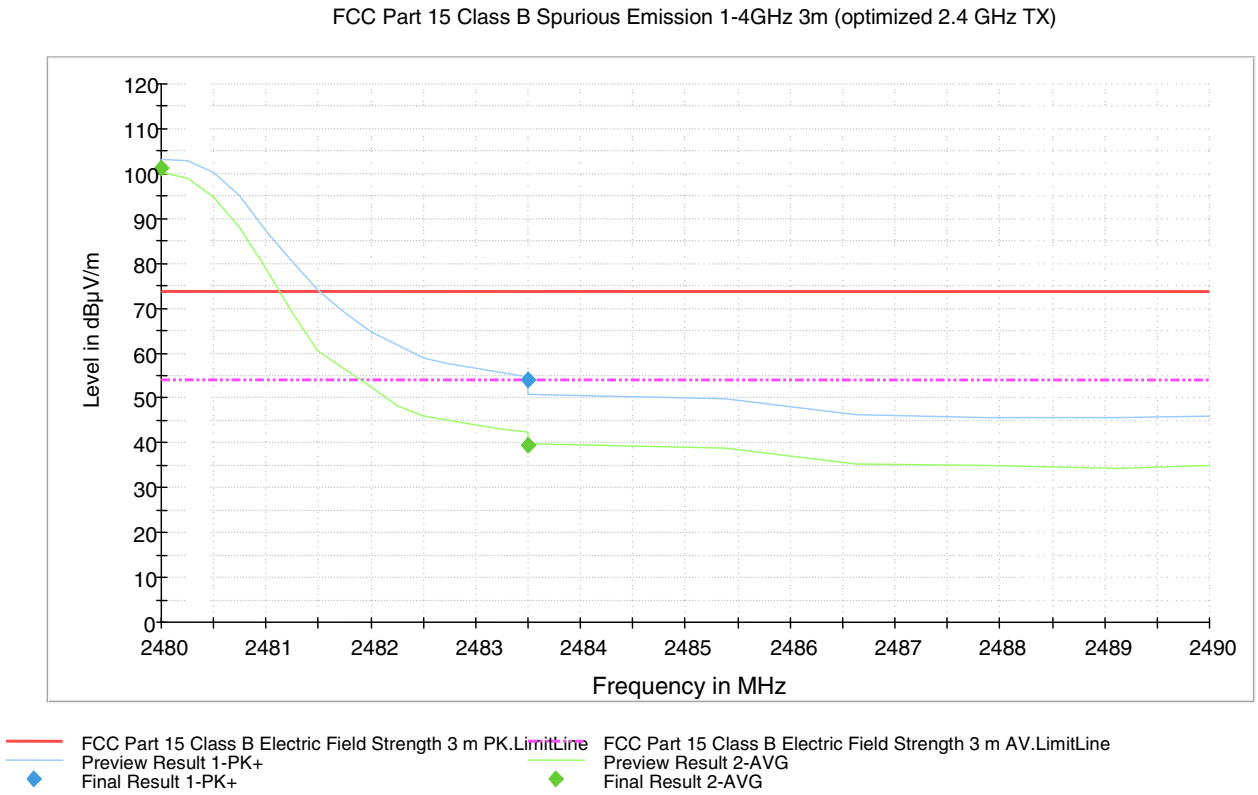


Figure 32. High channel edge 1 Mbps.

Final measurements from the worst frequencies

Table 23. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
2479.800000	104.3	1000.0	1000.000	170.0	V	268.0	4.7	-	-	carrier
2483.500000	54.1	1000.0	1000.000	165.0	V	266.0	4.8	19.8	73.9	

Table 24. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
1652.925000	37.4	1000.0	1000.000	138.0	H	110.0	0.0	16.5	53.9	
2480.000000	101.4	1000.0	1000.000	169.0	V	266.0	4.7	-	-	carrier
2483.500000	39.5	1000.0	1000.000	199.0	V	253.0	4.8	14.4	53.9	
2506.025000	40.2	1000.0	1000.000	201.0	V	230.0	4.9	13.7	53.9	
2533.075000	35.1	1000.0	1000.000	194.0	V	296.0	4.9	18.8	53.9	
3306.225000	36.9	1000.0	1000.000	138.0	V	275.0	6.5	17.0	53.9	

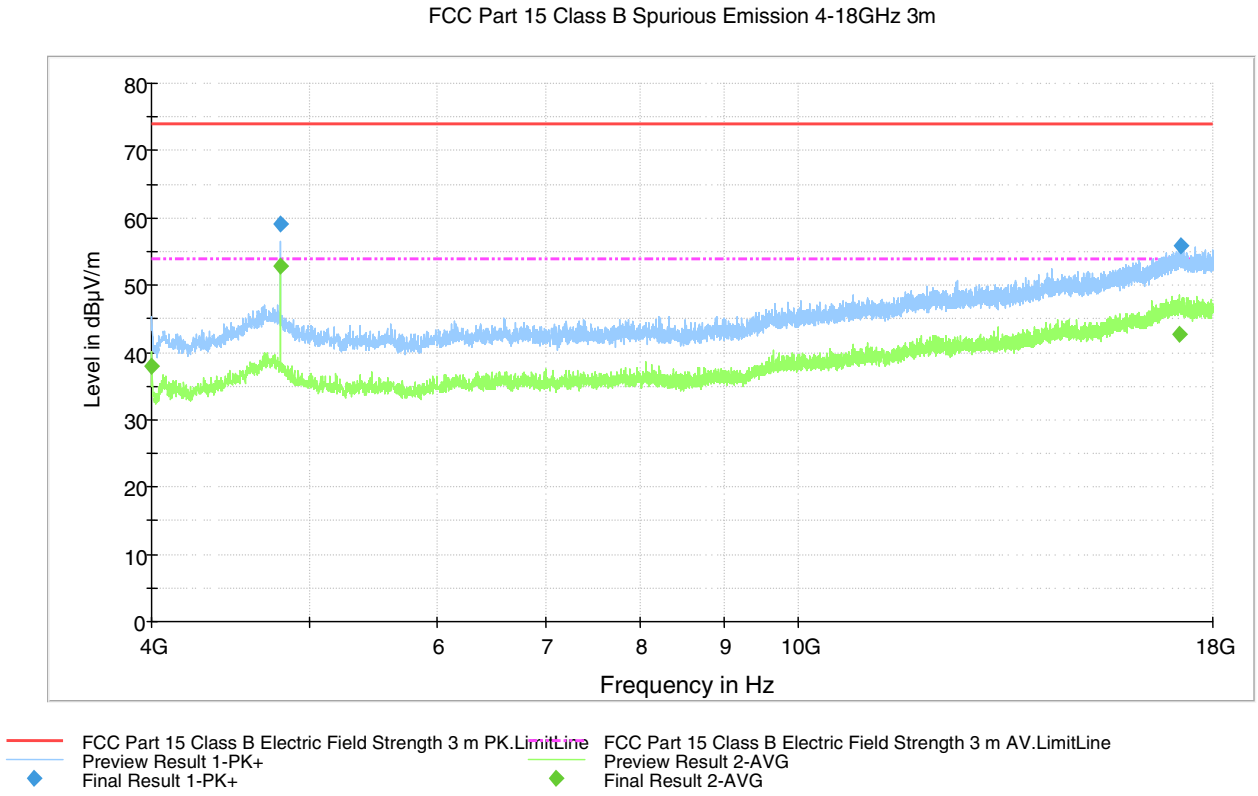


Figure 33. Measured curve with peak- and average detector. 1 Mbps Channel LOW.

Final measurements from the worst frequencies

Table 25. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4803.200000	59.2	1000.0	1000.000	114.0	V	168.0	13.8	14.7	73.9	
17202.400000	55.9	1000.0	1000.000	259.0	V	320.0	28.3	18.0	73.9	

Table 26. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4002.000000	38.0	1000.0	1000.000	122.0	V	94.0	10.1	15.9	53.9	
4804.000000	52.8	1000.0	1000.000	100.0	V	159.0	13.8	1.1	53.9	
17168.600000	42.7	1000.0	1000.000	100.0	V	113.0	28.2	11.2	53.9	

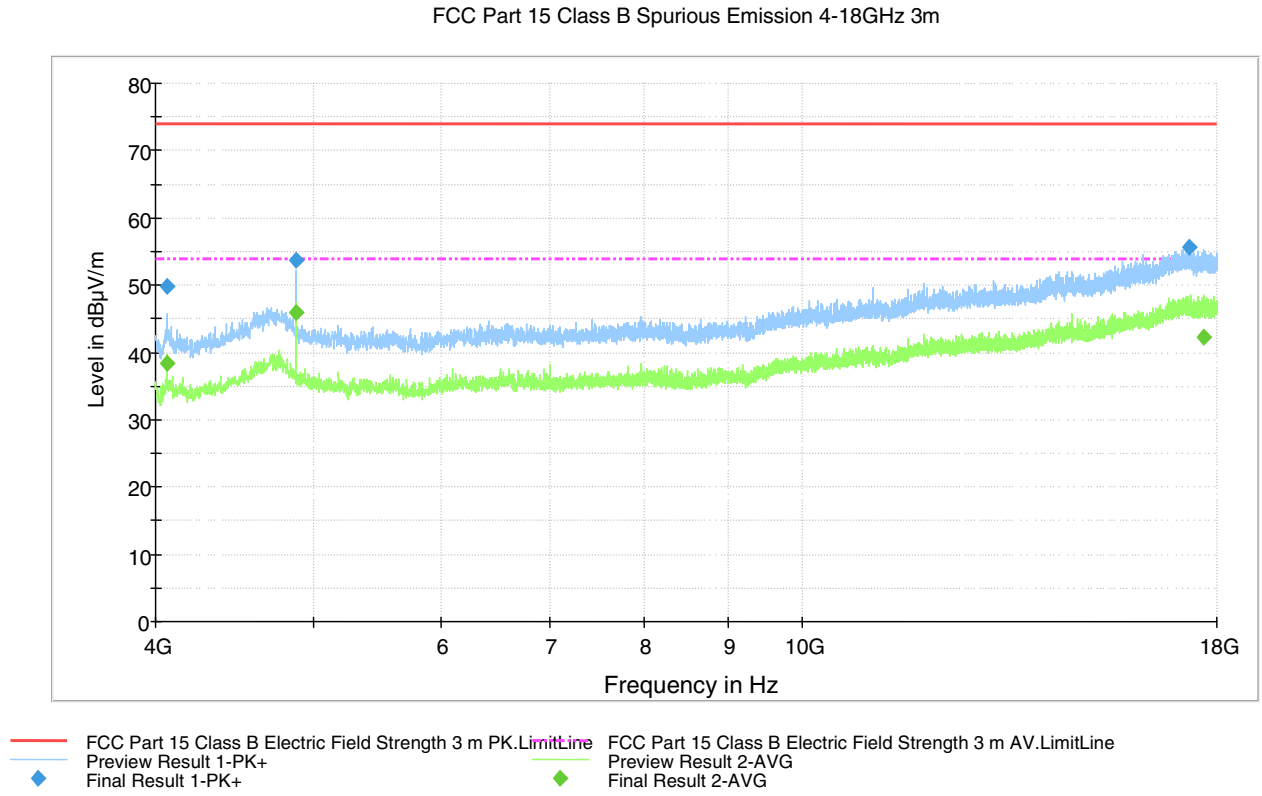


Figure 34. Measured curve with peak- and average detector. 1 Mbps Channel MID.

Final measurements from the worst frequencies

Table 27. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4067.400000	49.9	1000.0	1000.000	125.0	V	157.0	10.1	24.0	73.9	
4881.600000	53.6	1000.0	1000.000	100.0	H	46.0	12.8	20.3	73.9	
17317.000000	55.5	1000.0	1000.000	372.0	H	347.0	28.2	18.4	73.9	

Table 28. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4067.000000	38.3	1000.0	1000.000	100.0	V	157.0	10.1	15.6	53.9	
4882.000000	45.9	1000.0	1000.000	100.0	H	46.0	12.8	8.0	53.9	
17684.400000	42.4	1000.0	1000.000	100.0	H	51.0	28.3	11.5	53.9	

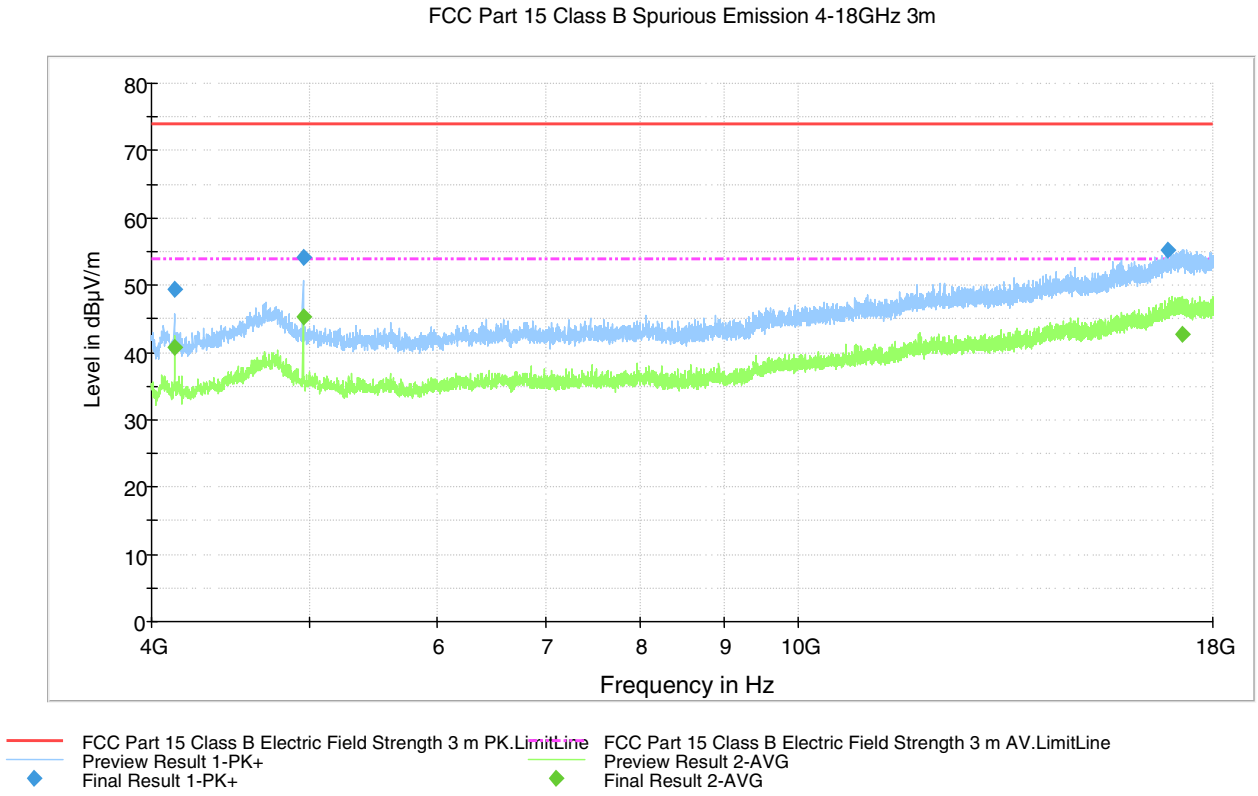


Figure 35. Measured curve with peak- and average detector. 1 Mbps Channel HIGH.

Final measurements from the worst frequencies

Table 29. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4132.600000	49.4	1000.0	1000.000	130.0	V	192.0	9.9	24.5	73.9	
4959.800000	54.2	1000.0	1000.000	227.0	V	260.0	12.0	19.7	73.9	
16883.000000	55.3	1000.0	1000.000	336.0	H	3.0	27.8	18.6	73.9	

Table 30. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time 15x(ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4132.000000	40.7	1000.0	1000.000	122.0	V	160.0	9.9	13.2	53.9	
4960.000000	45.4	1000.0	1000.000	227.0	V	253.0	12.0	8.5	53.9	
17246.200000	42.6	1000.0	1000.000	105.0	V	125.0	28.2	11.3	53.9	

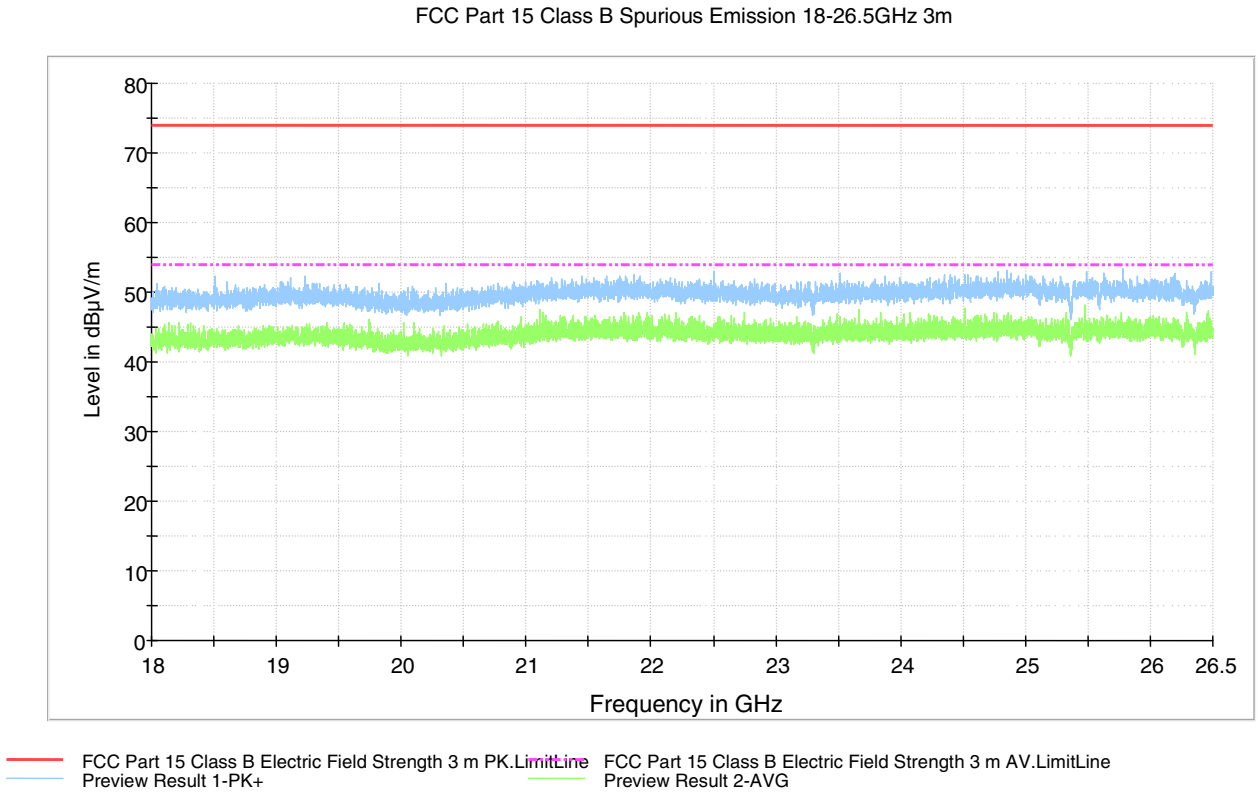


Figure 36. Measured curve with peak- and average detector. 1 Mbps Channel LOW.

Final measurements from the worst frequencies

Due to the low emission level no final measurements were made.

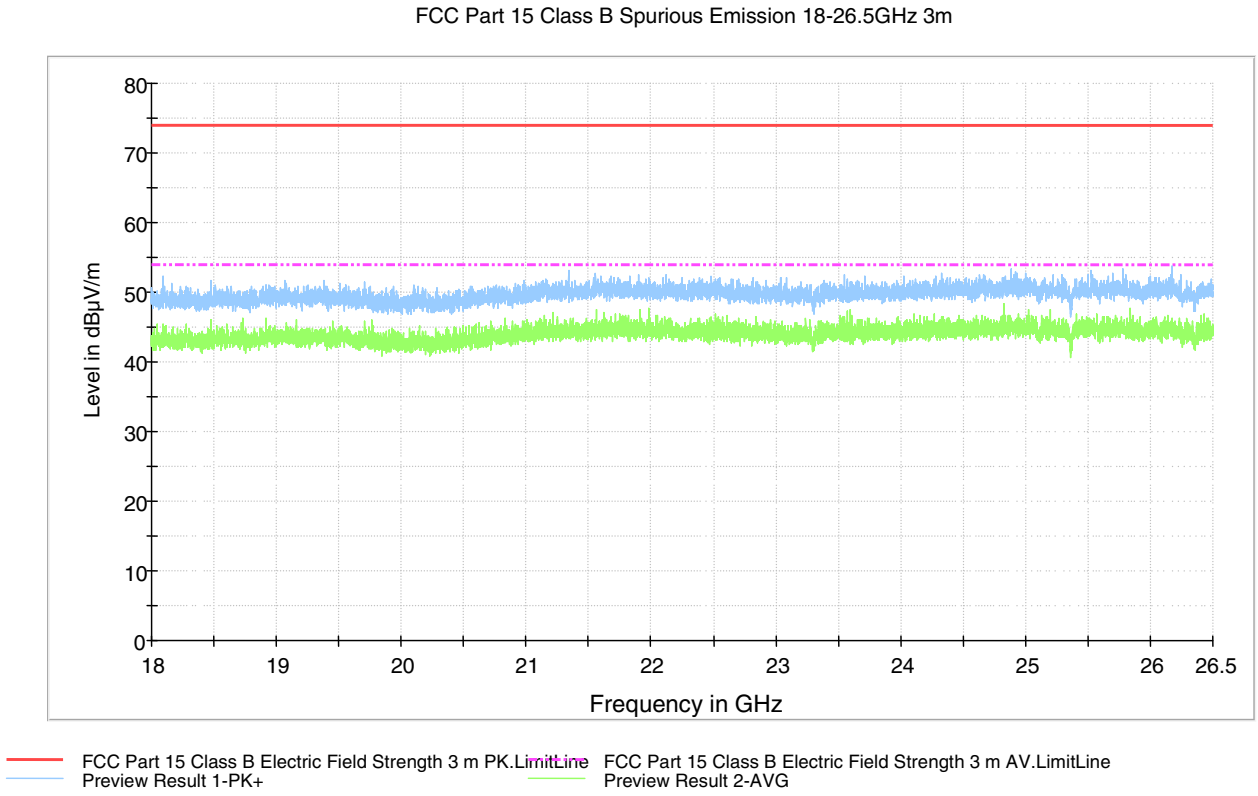


Figure 37. Measured curve with peak- and average detector. 1 Mbps Channel MID.

Final measurements from the worst frequencies

Due to the low emission level no final measurements were made.

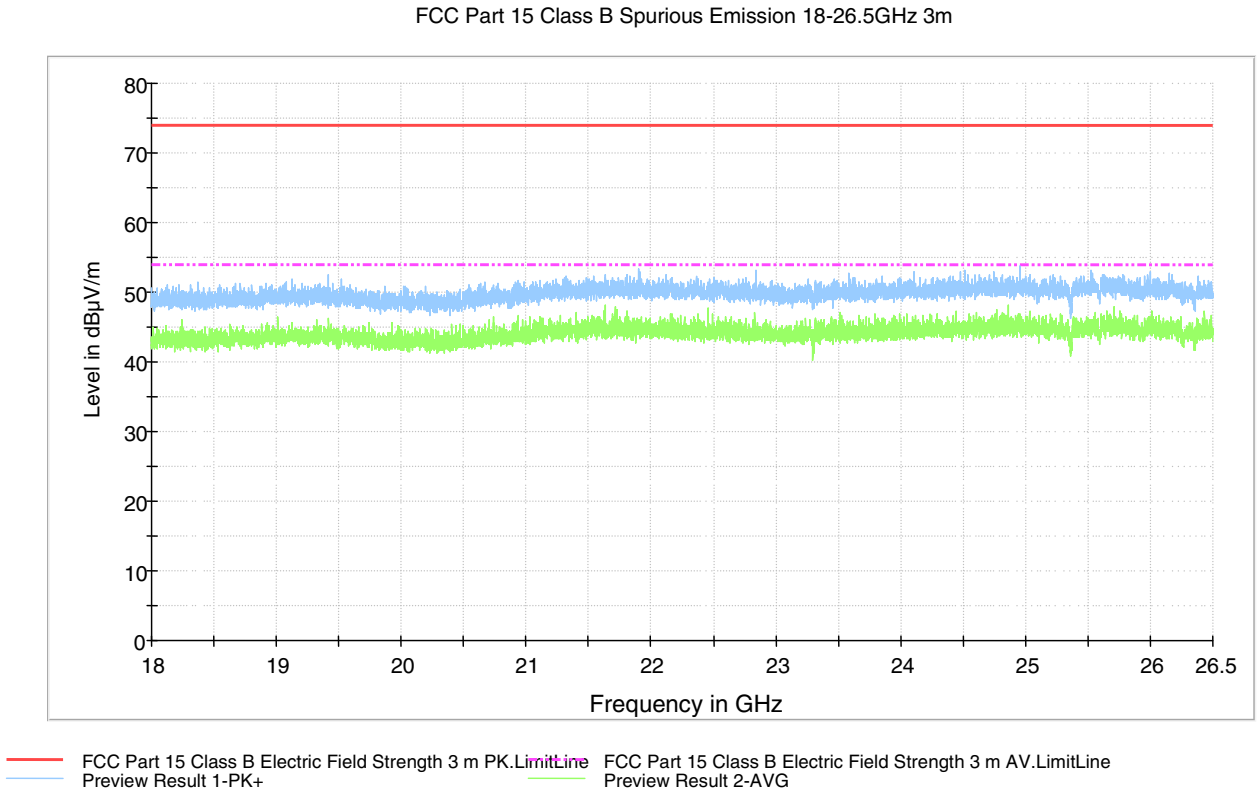


Figure 38. Measured curve with peak- and average detector. 1 Mbps Channel HIGH.

Final measurements from the worst frequencies

Due to the low emission level no final measurements were made.

Conducted Spurious Emissions 30 MHz to 26.5 GHz and Band Edge

Standard:	ANSI C63.10	(2009)
Tested by:	NKO	
Date:	24.10.2013 / 28.10.2013	
Temperature:	22.7 °C / 22.9 °C	
Humidity:	40 % / 41 % RH	

FCC Rule: 15.247 (d)

Data rate 1 Mbps

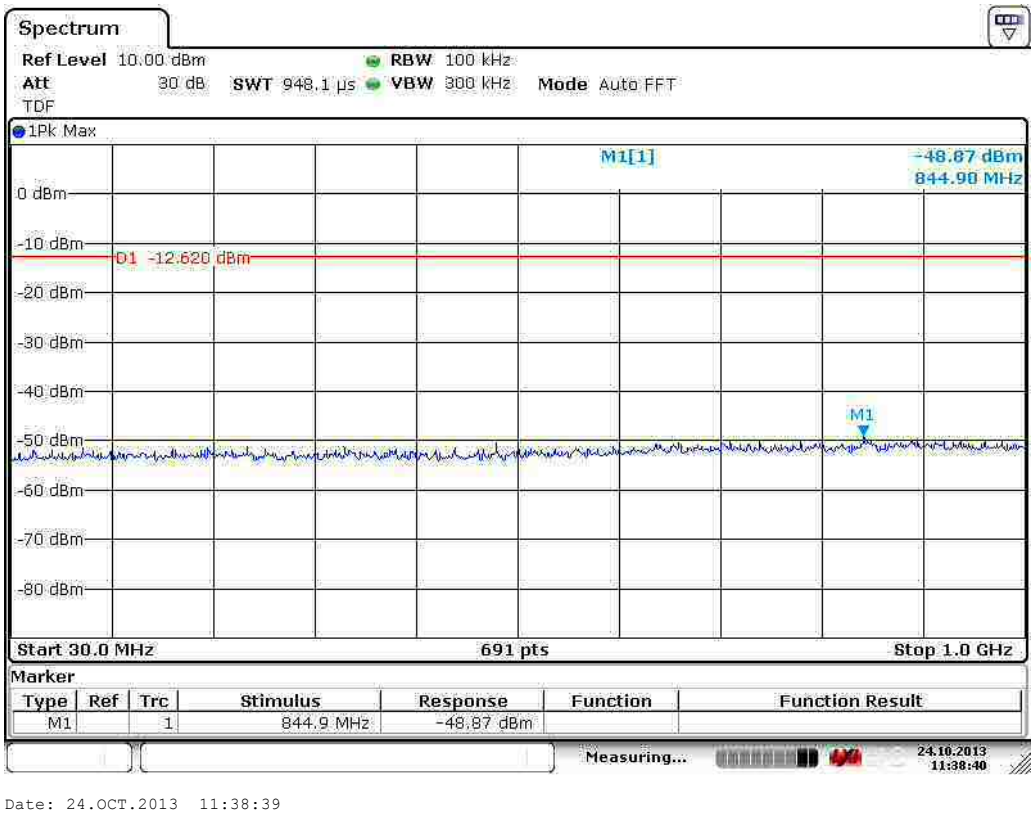
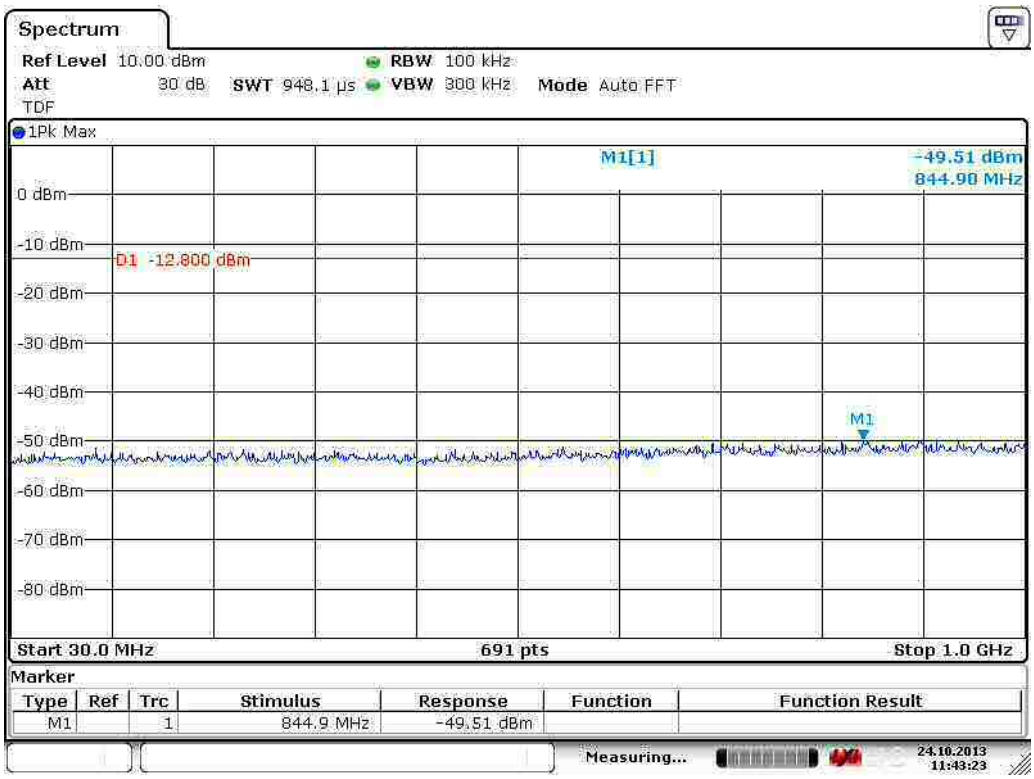
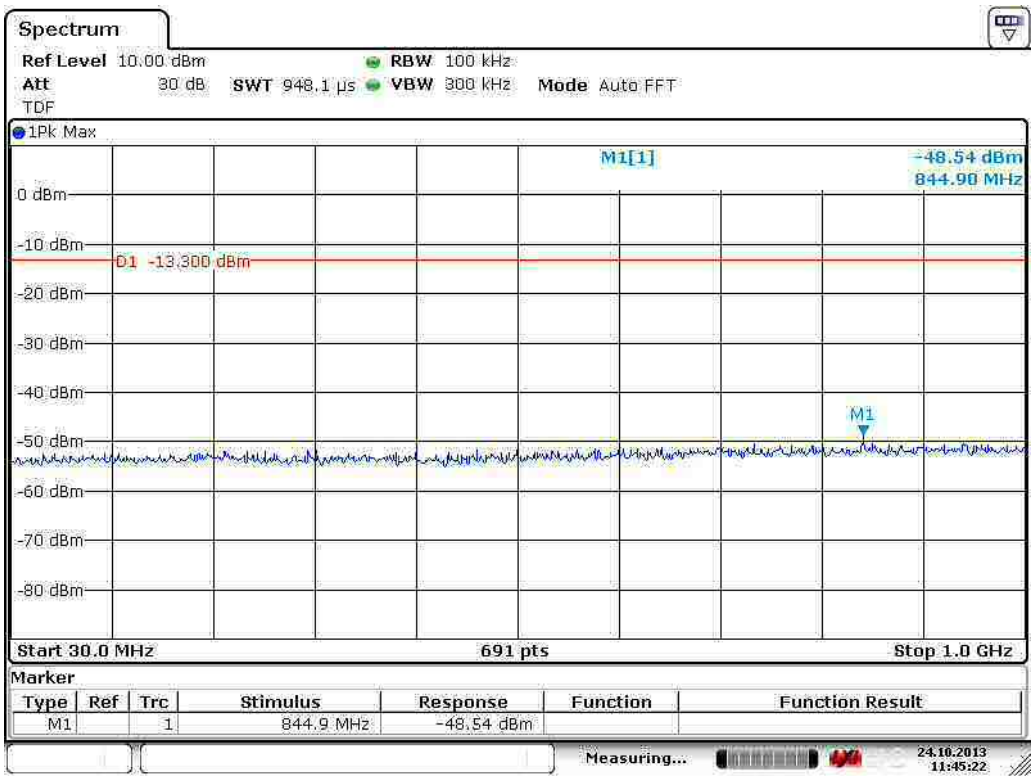


Figure 39. Low channel conductive emission 30 MHz to 1000 MHz (1 Mbps).



Date: 24.OCT.2013 11:43:22

Figure 40. Mid channel conductive emission 30 MHz to 1000 MHz (1 Mbps).

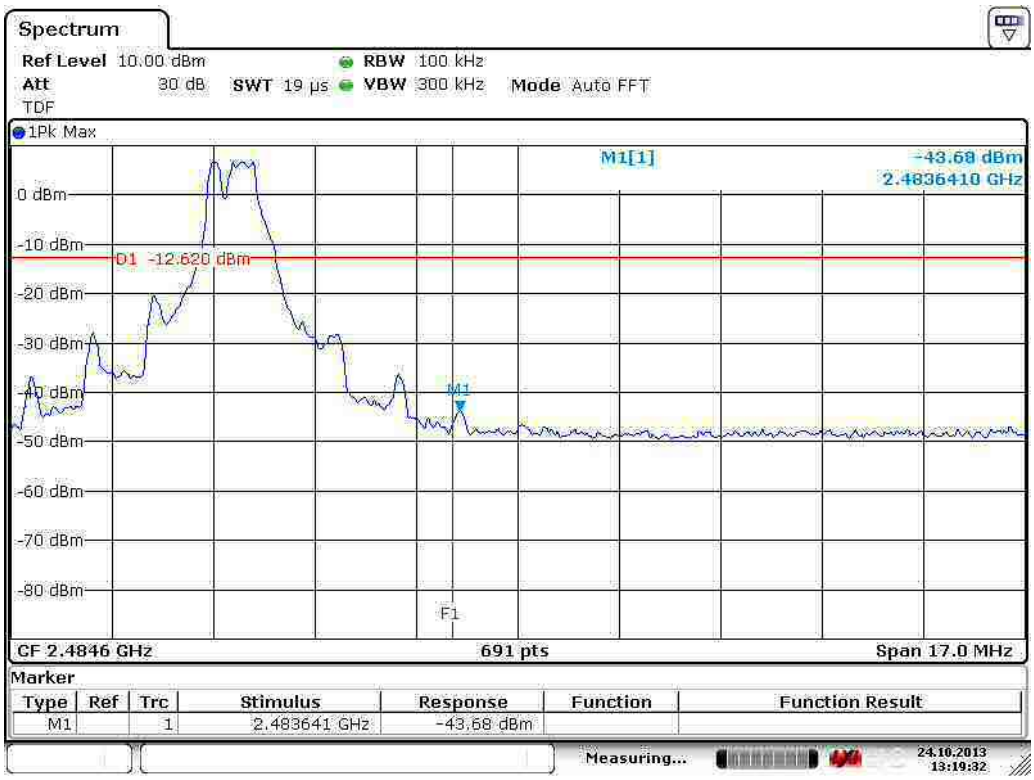


Date: 24.OCT.2013 11:45:21

Figure 41. High channel conductive emission 30 MHz to 1000 MHz (1 Mbps).

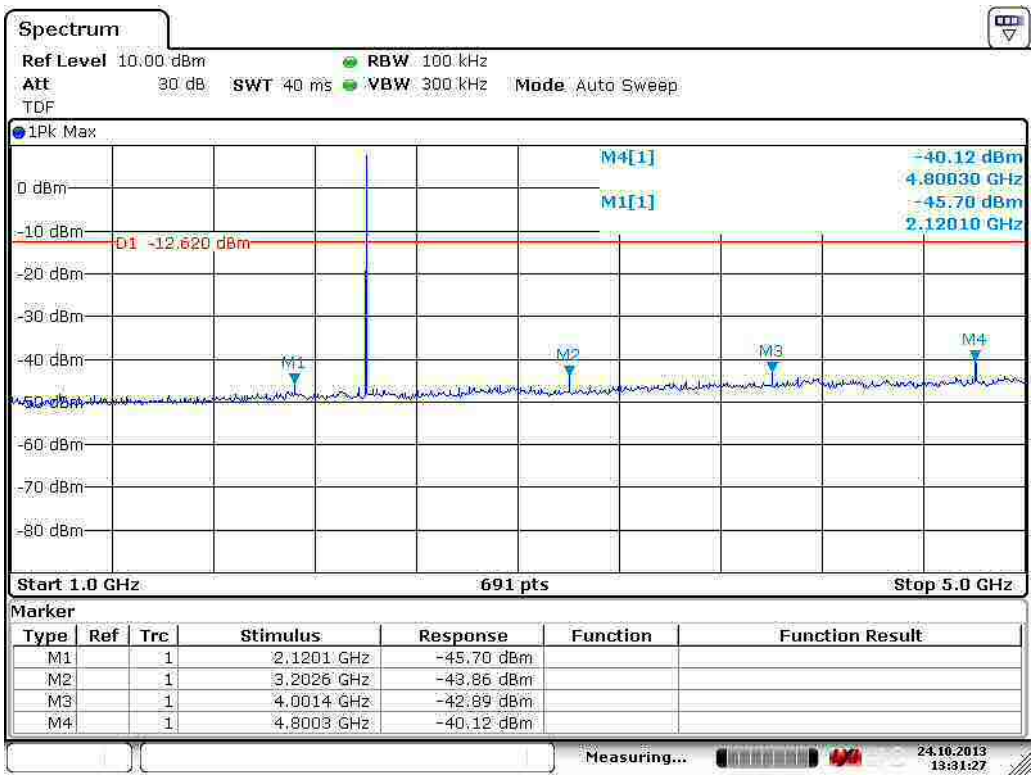
Date: 24.OCT.2013 13:17:41

Figure 42. Low channel conductive emission at low band edge (1 Mbps).



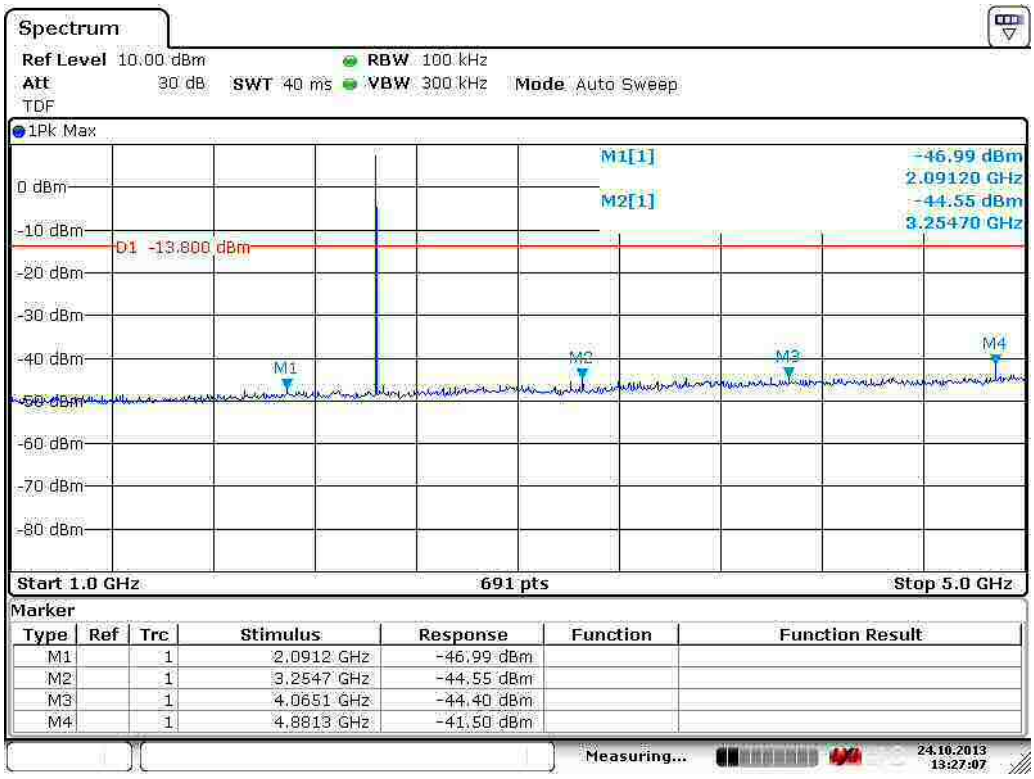
Date: 24.OCT.2013 13:19:31

Figure 43. High channel conductive emission at high band edge (1 Mbps).



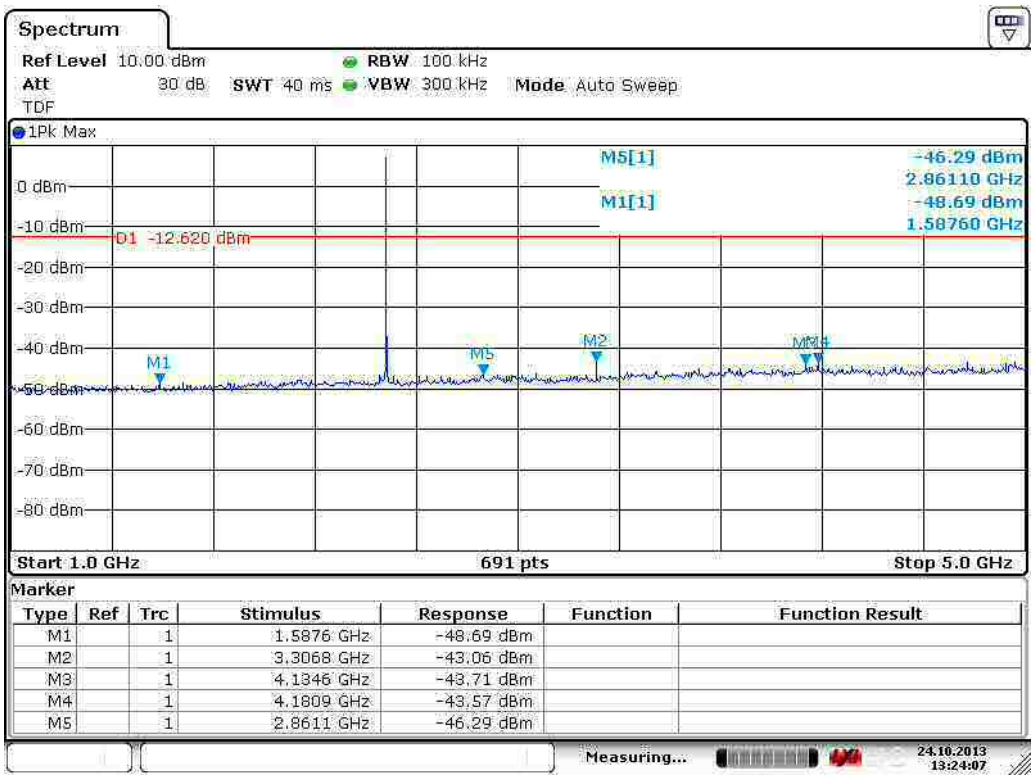
Date: 24.OCT.2013 13:31:27

Figure 44. Low channel conductive emission 1 GHz to 5 GHz (1 Mbps).



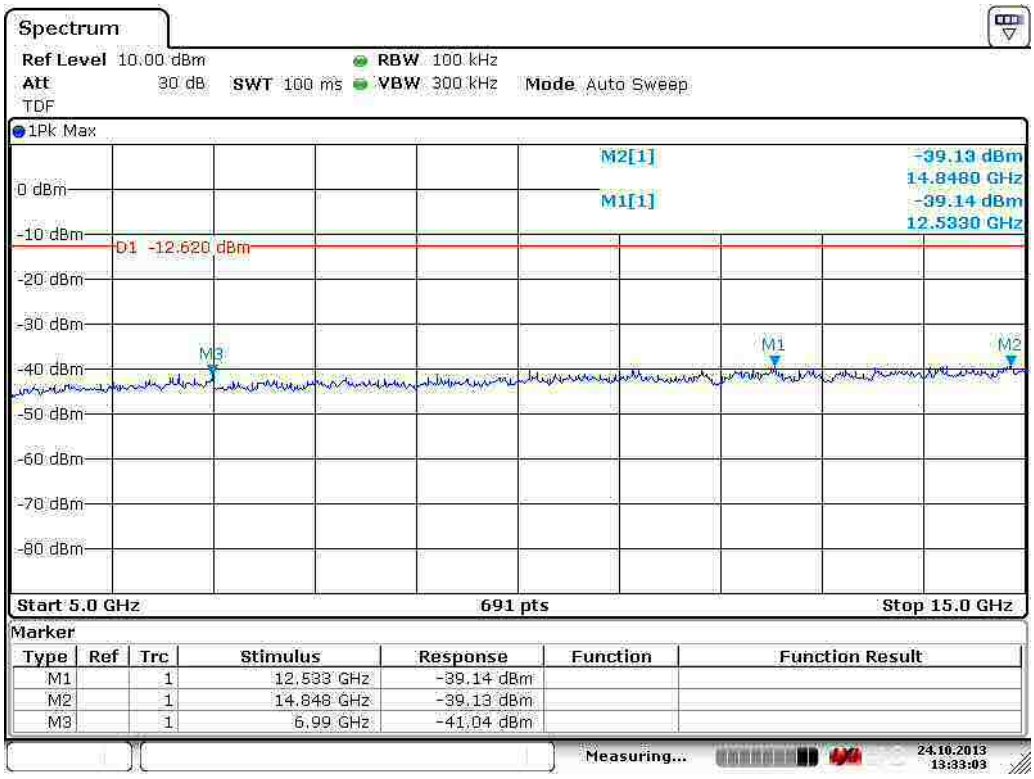
Date: 24.OCT.2013 13:27:07

Figure 45. Mid channel conductive emission 1 GHz to 5 GHz (1 Mbps).



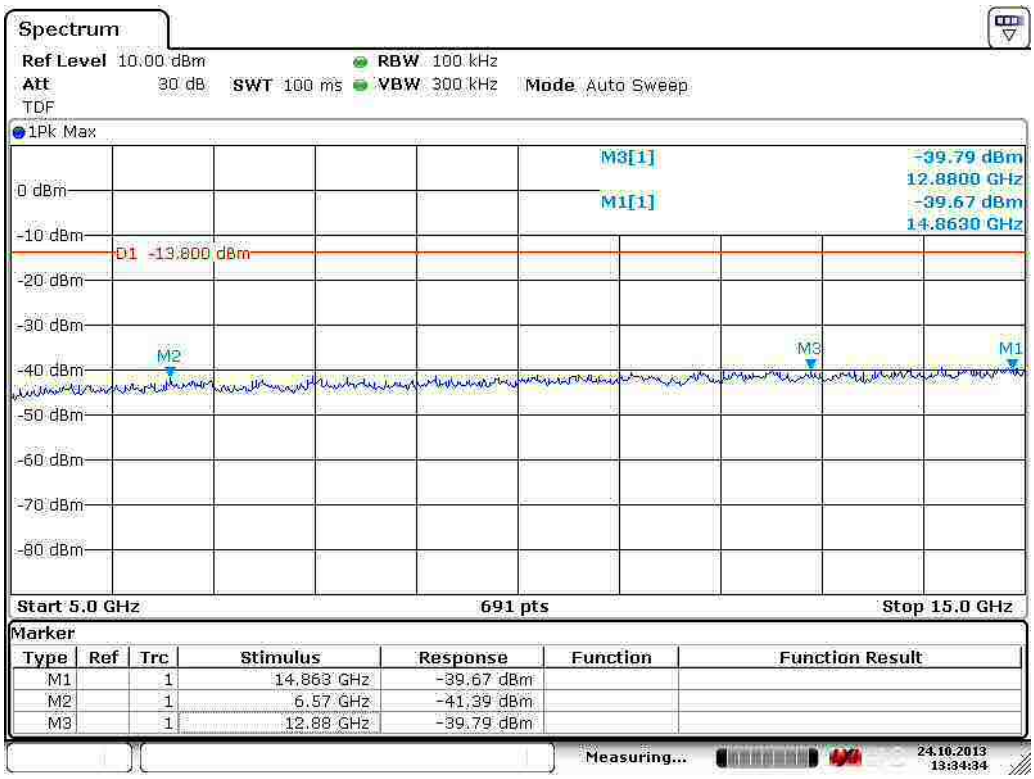
Date: 24.OCT.2013 13:24:07

Figure 46. High channel conductive emission 1 GHz to 5 GHz (1 Mbps).



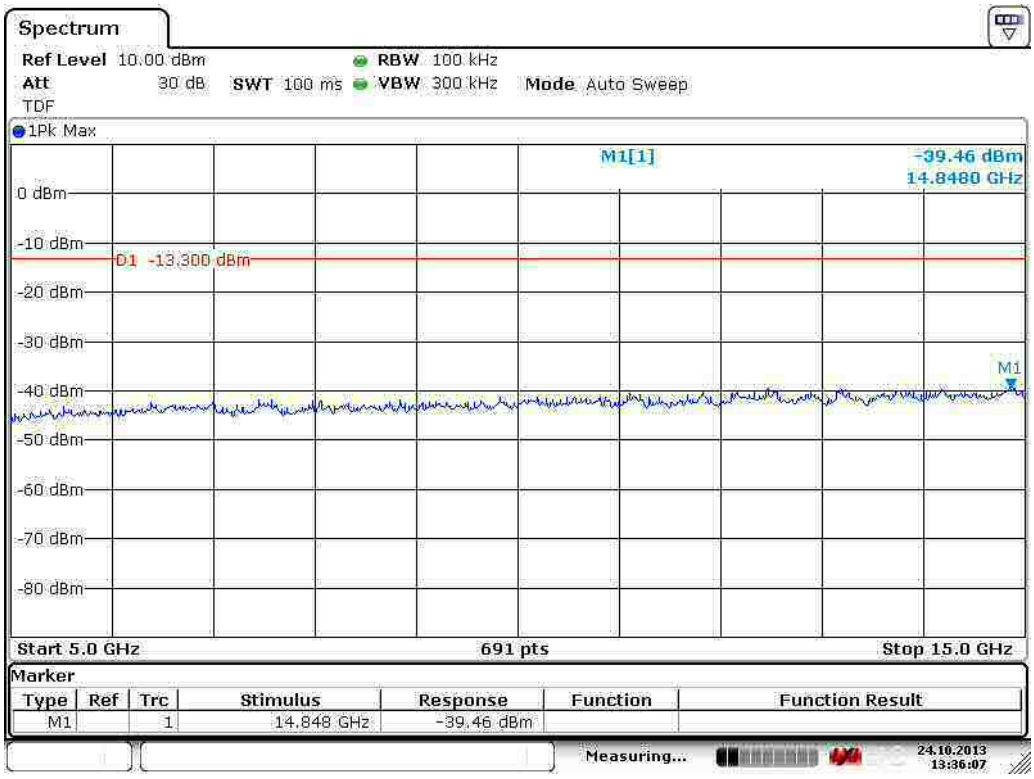
Date: 24.OCT.2013 13:33:02

Figure 47. Low channel conductive emission 5 GHz to 15 GHz (1 Mbps).



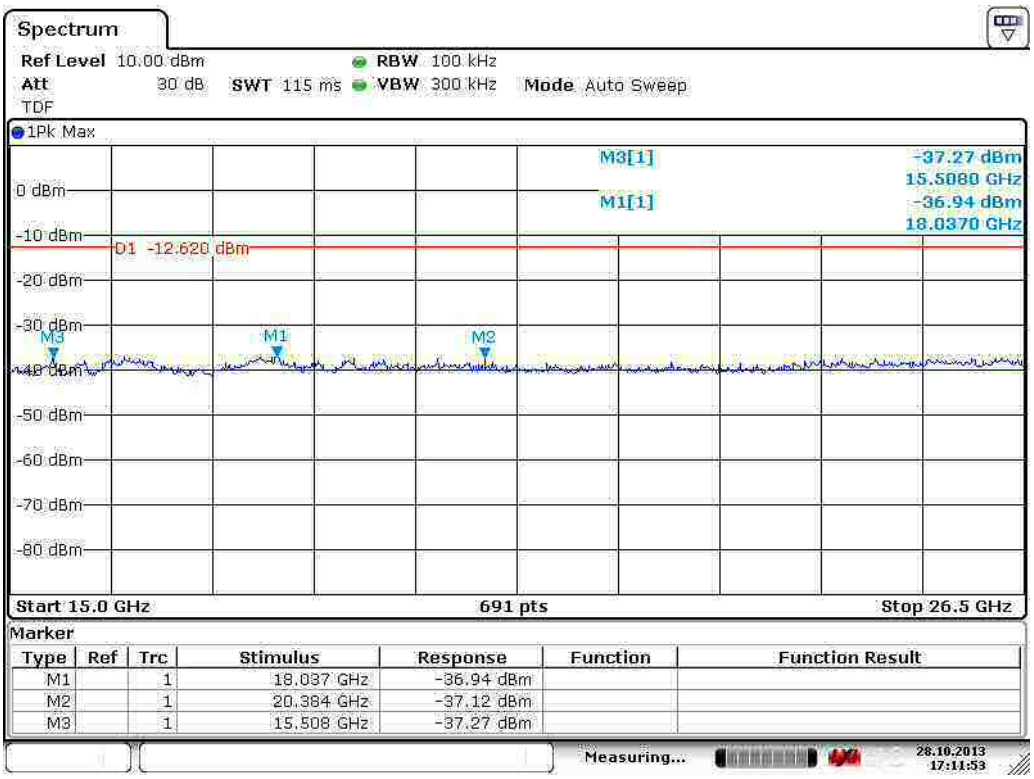
Date: 24.OCT.2013 13:34:33

Figure 48. Mid channel conductive emission 5 GHz to 15 GHz (1 Mbps).



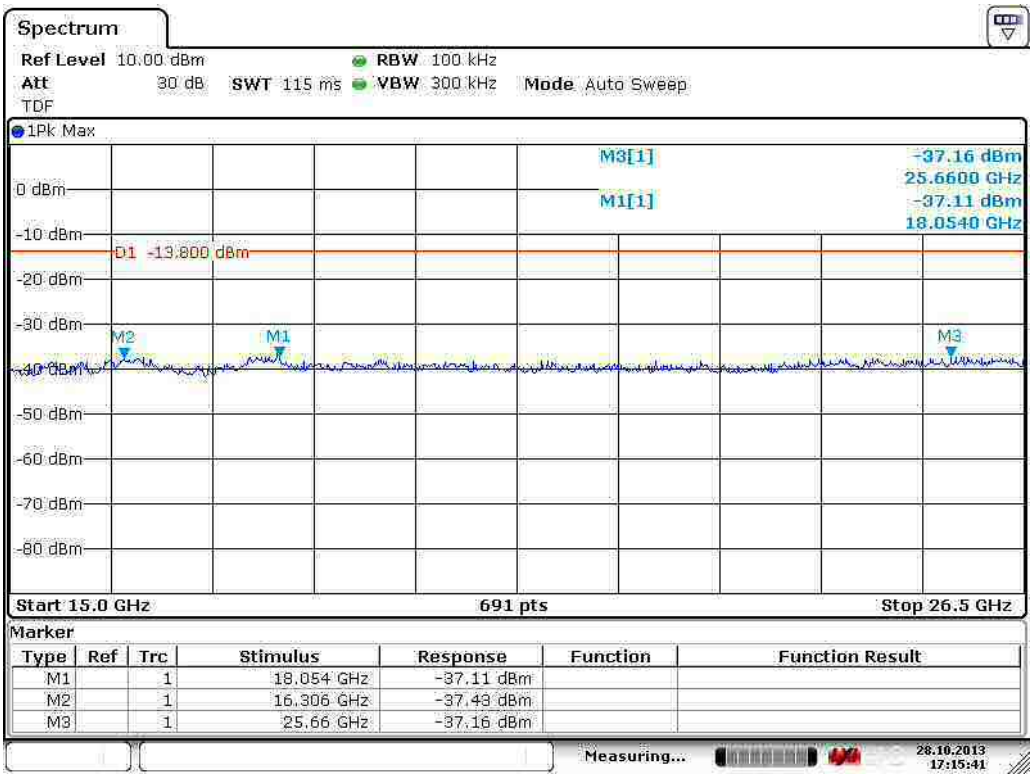
Date: 24.OCT.2013 13:36:07

Figure 49. High channel conductive emission 5 GHz to 15 GHz (1 Mbps).



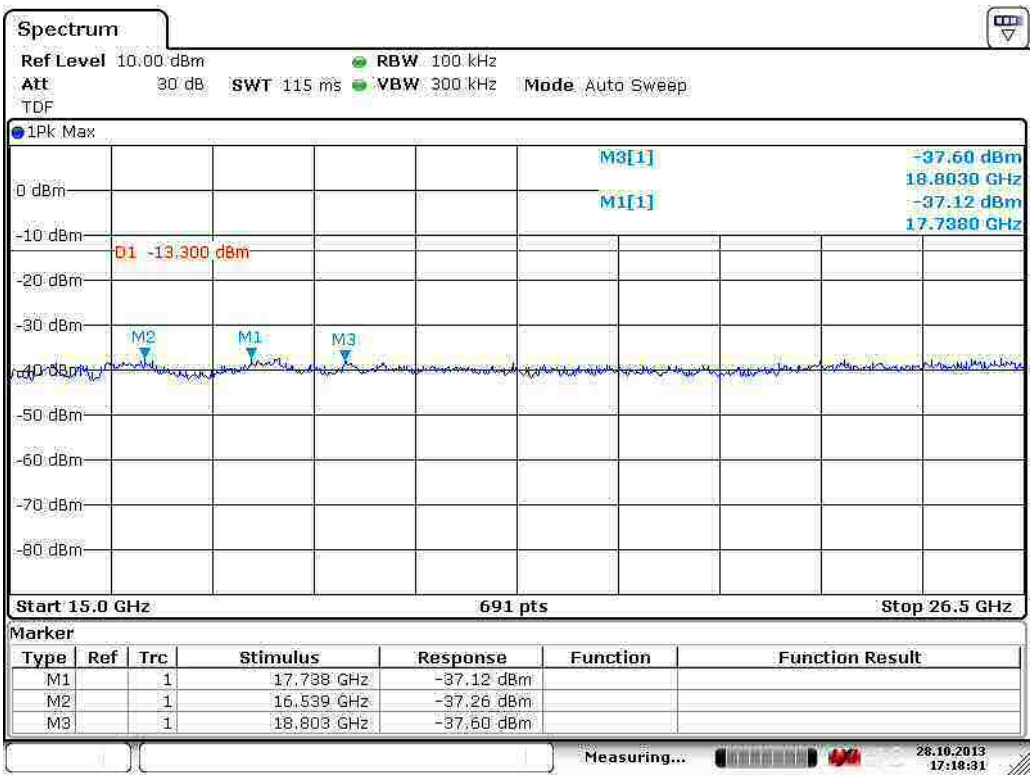
Date: 28.OCT.2013 17:11:52

Figure 50. Low channel conductive emission 15 GHz to 26.5 GHz (1 Mbps).



Date: 28.OCT.2013 17:15:40

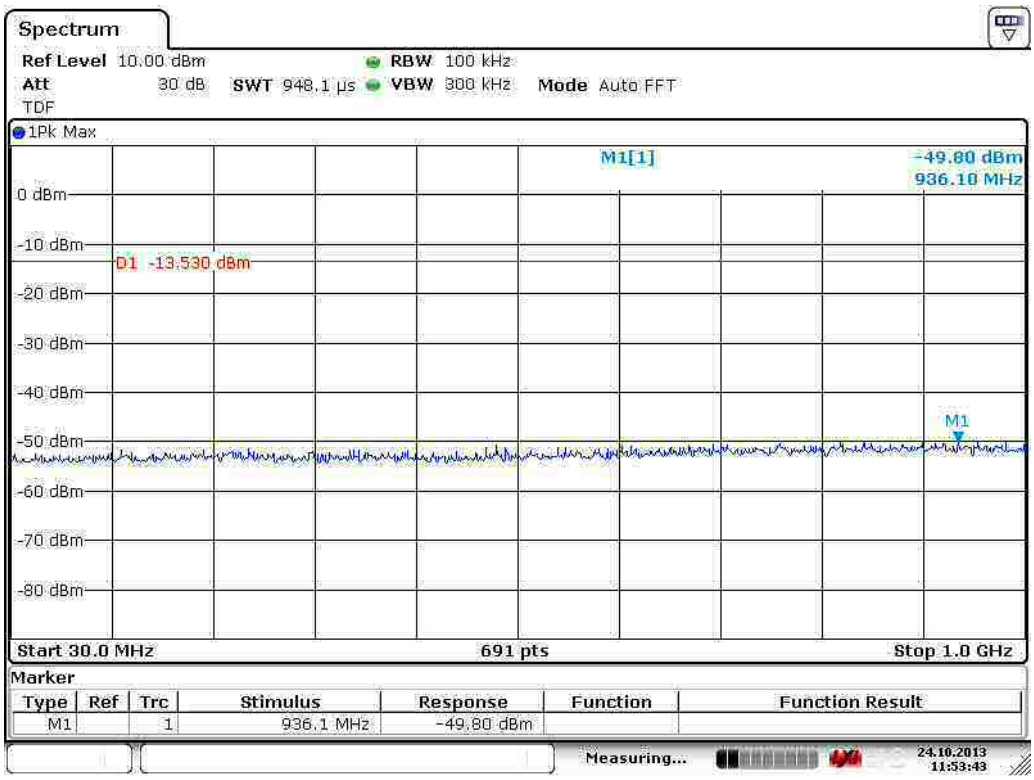
Figure 51. Mid channel conductive emission 15 GHz to 26.5 GHz (1 Mbps).



Date: 28.OCT.2013 17:18:30

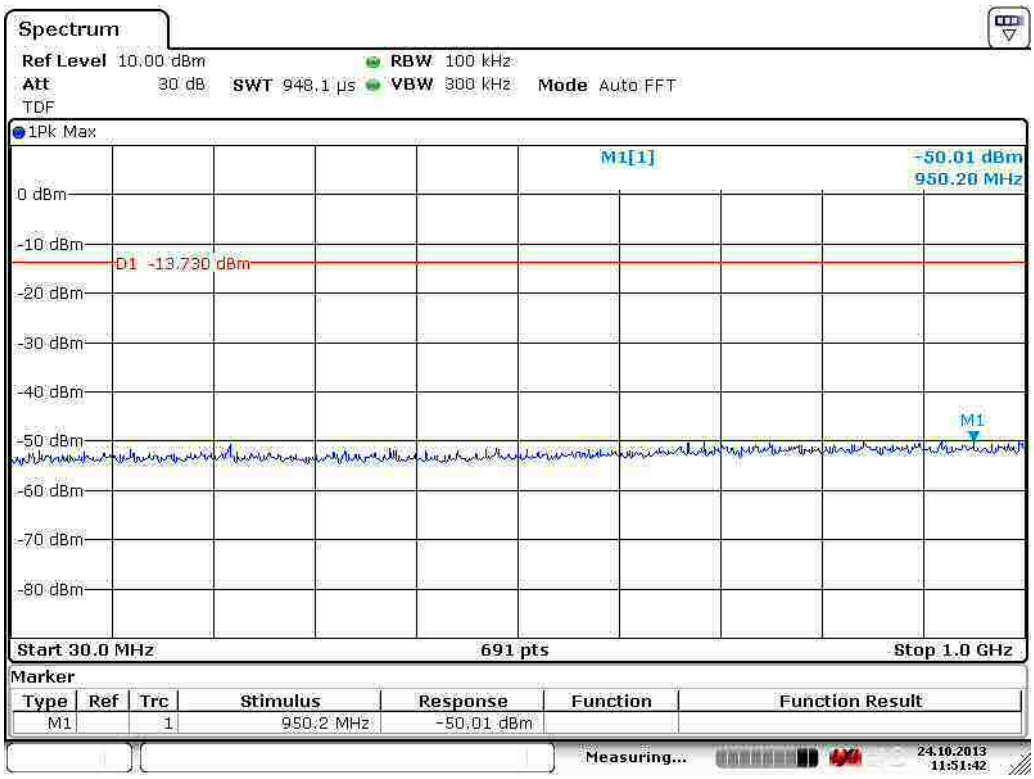
Figure 52. High channel conductive emission 15 GHz to 26.5 GHz (1 Mbps).

Data rate 2 Mbps



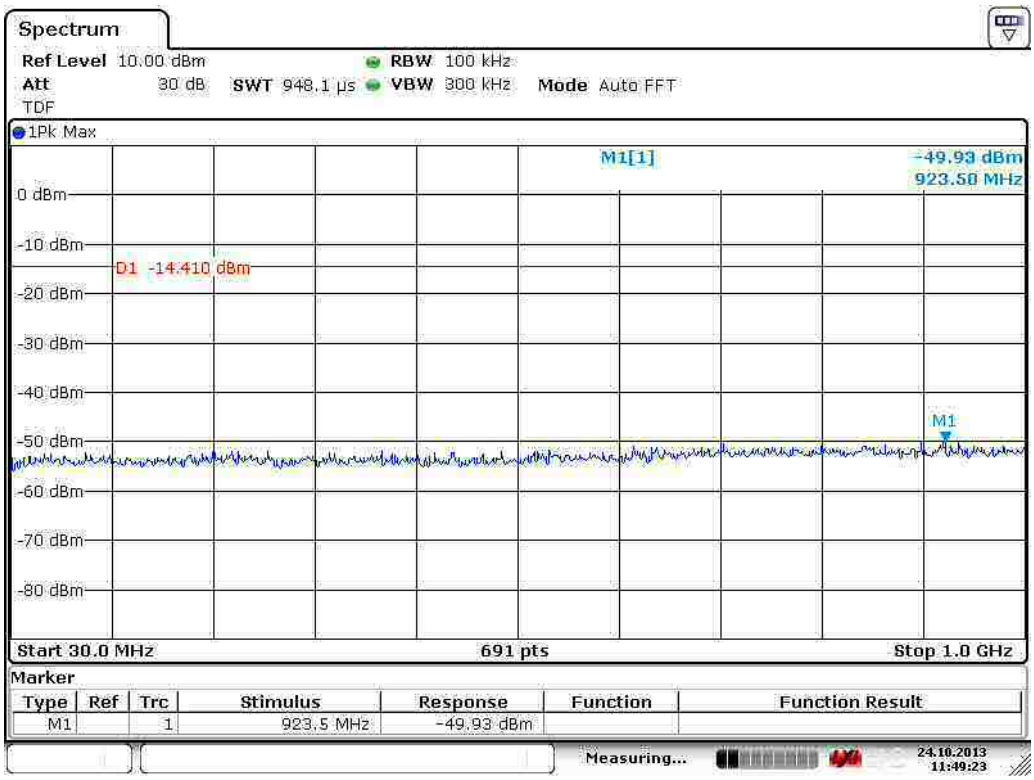
Date: 24.OCT.2013 11:53:42

Figure 53. Low channel conductive emission 30 MHz to 1000 MHz (2 Mbps).



Date: 24.OCT.2013 11:51:42

Figure 54. Mid channel conductive emission 30 MHz to 1000 MHz (2 Mbps).



Date: 24.OCT.2013 11:49:22

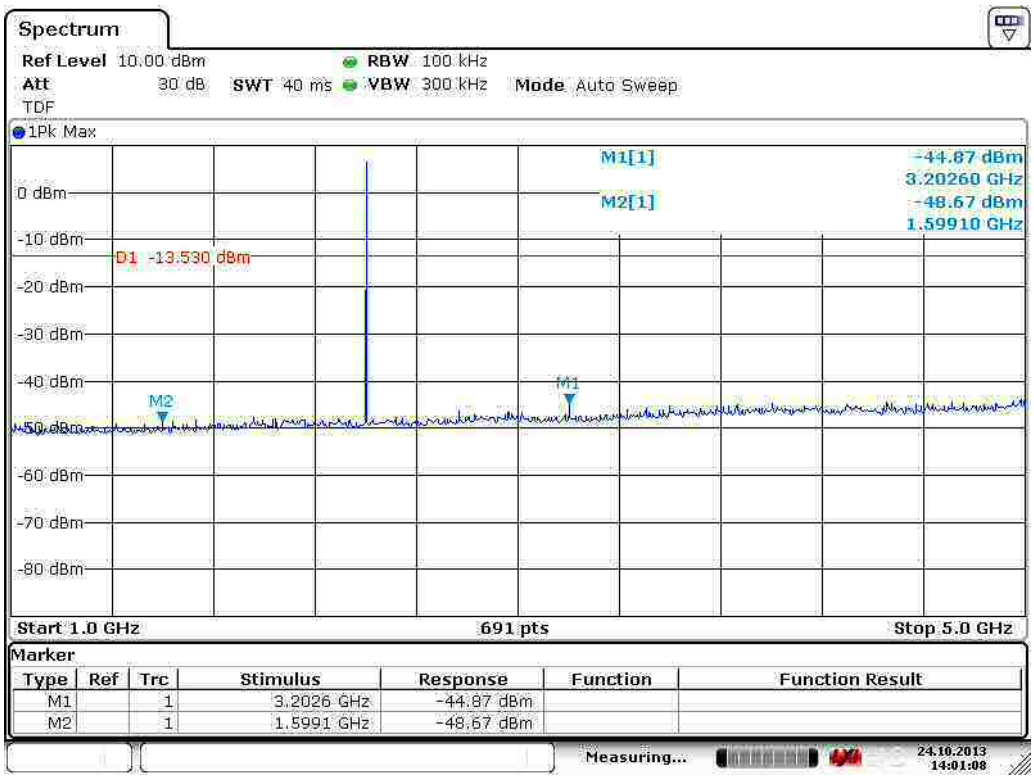
Figure 55. High channel conductive emission 30 MHz to 1000 MHz (2 Mbps).

Date: 24.OCT.2013 13:53:31

Figure 56. Low channel conductive emission at low band edge (2 Mbps).

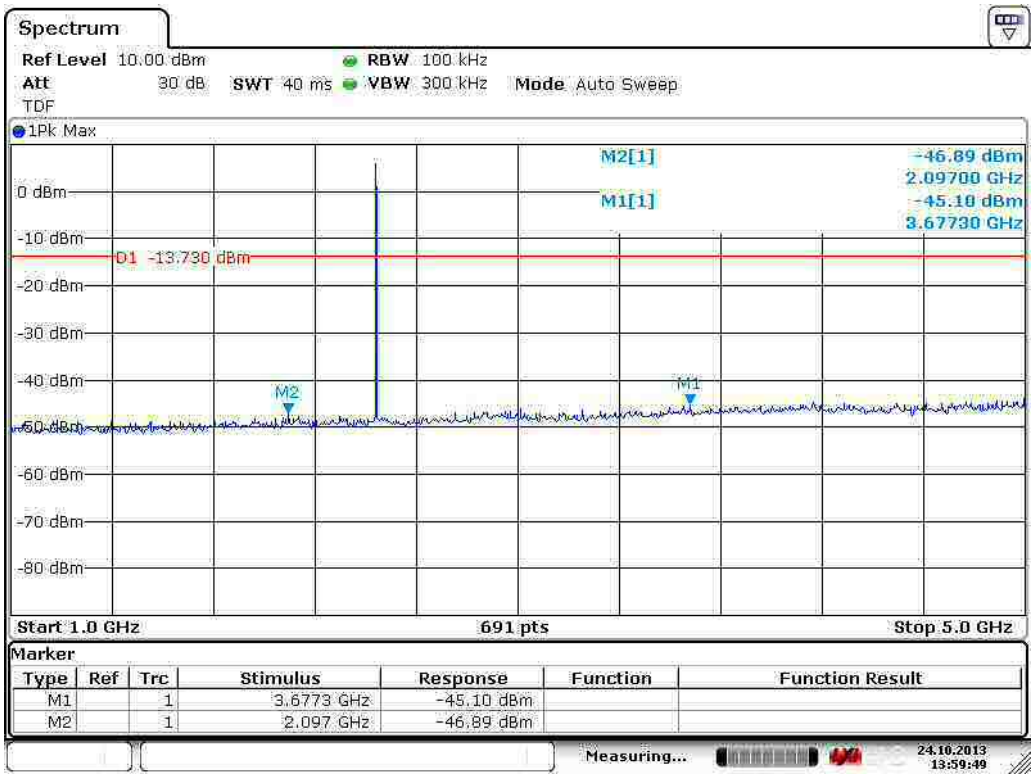
Date: 24.OCT.2013 13:56:38

Figure 57. High channel conductive emission at high band edge (2 Mbps).



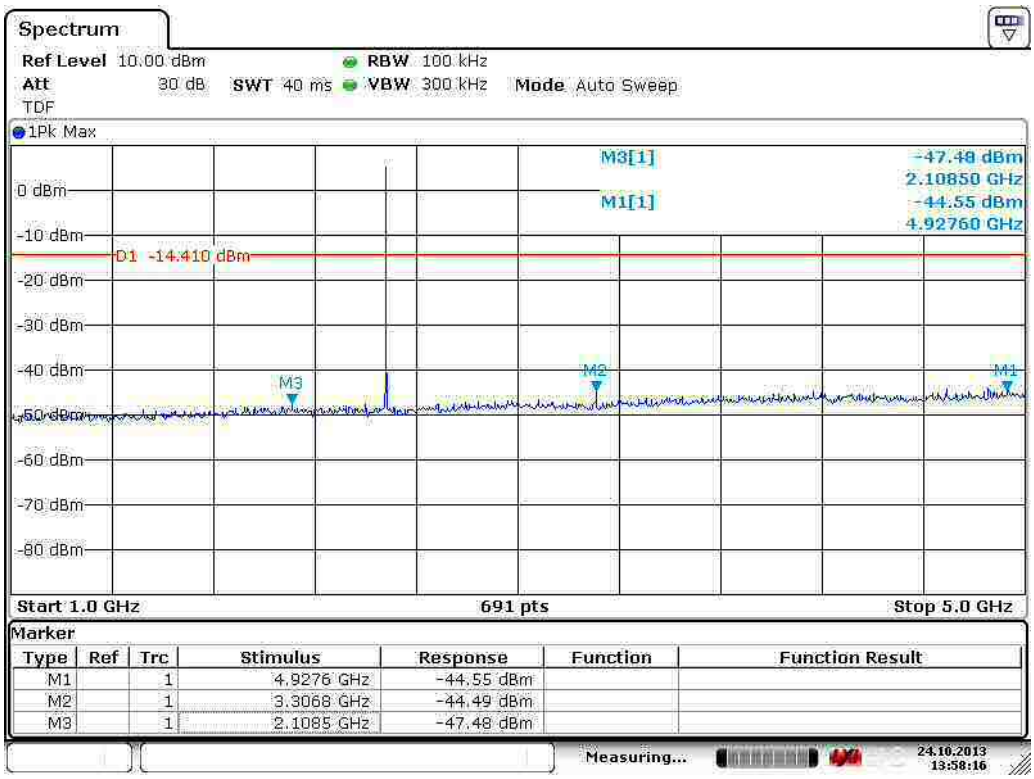
Date: 24.OCT.2013 14:01:07

Figure 58. Low channel conductive emission 1 GHz to 5 GHz (2 Mbps).



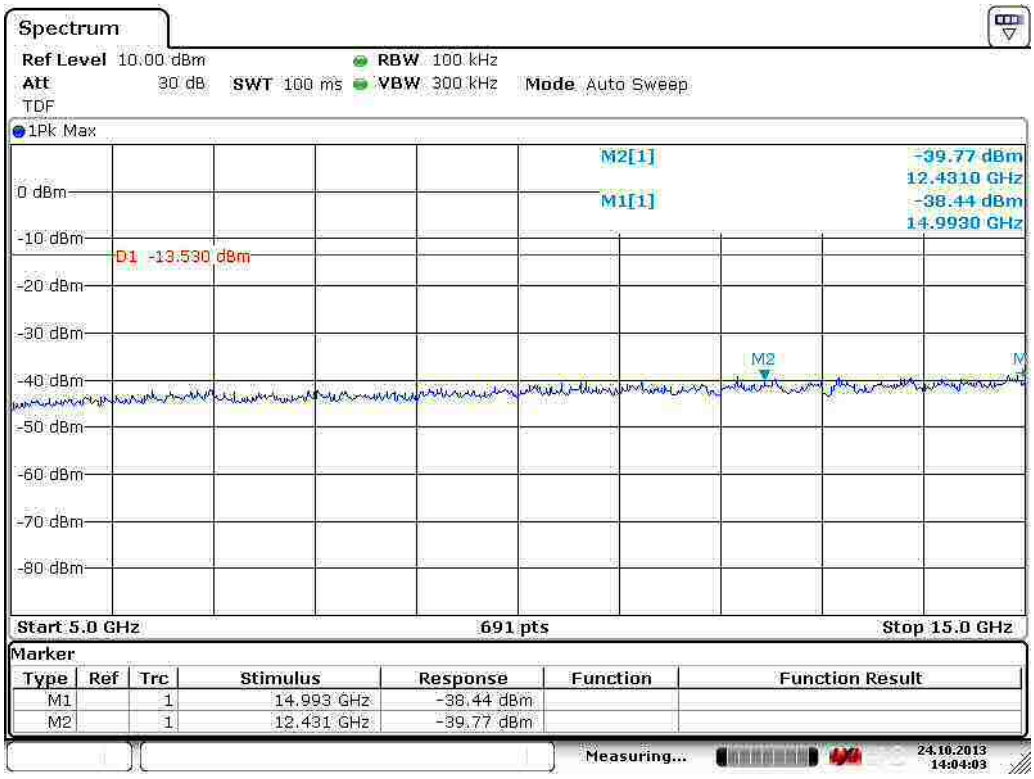
Date: 24.OCT.2013 13:59:49

Figure 59. Mid channel conductive emission 1 GHz to 5 GHz (2 Mbps).



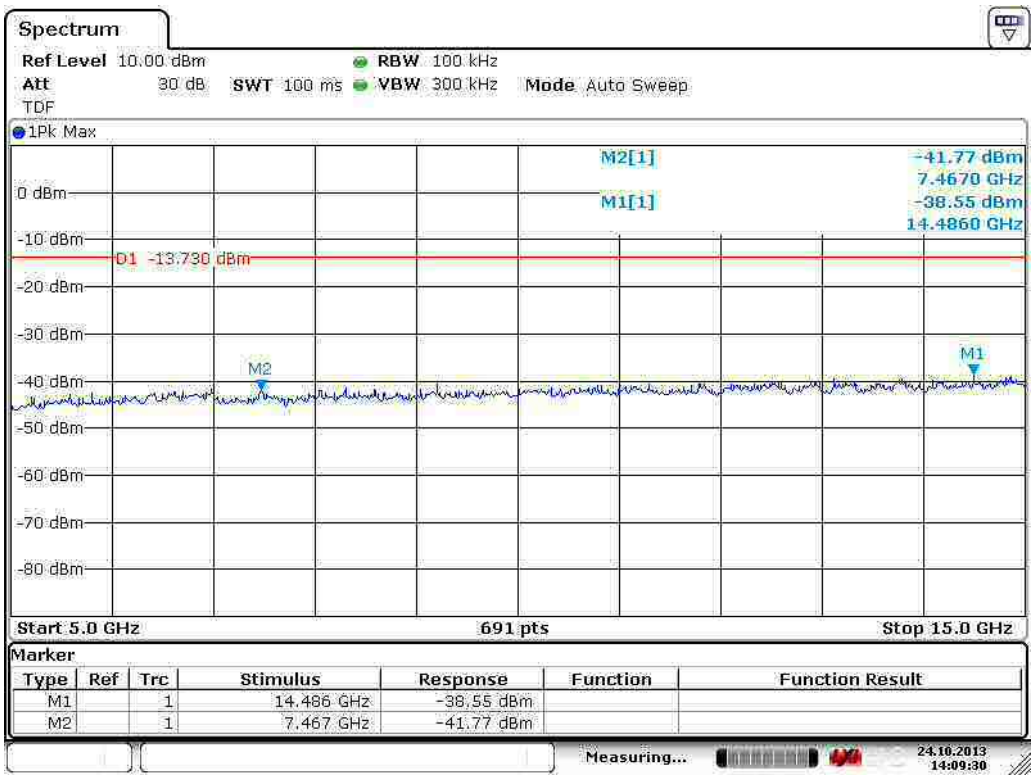
Date: 24.OCT.2013 13:58:16

Figure 60. High channel conductive emission 1 GHz to 5 GHz (2 Mbps).



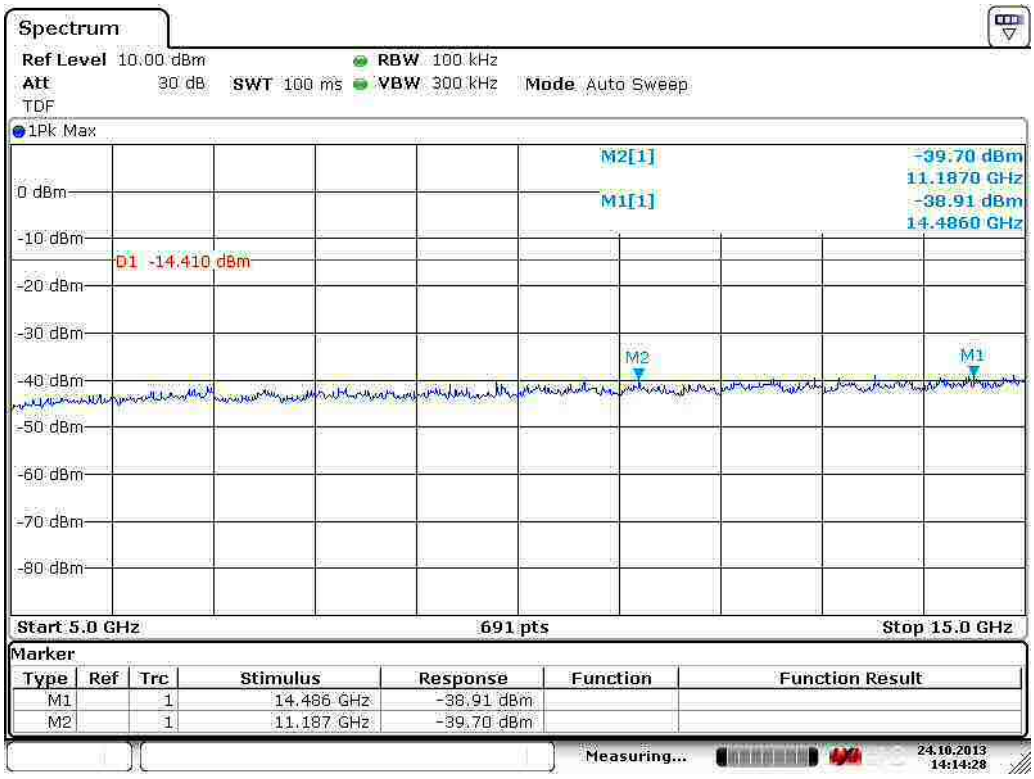
Date: 24.OCT.2013 14:04:02

Figure 61. Low channel conductive emission 5 GHz to 15 GHz (2 Mbps).



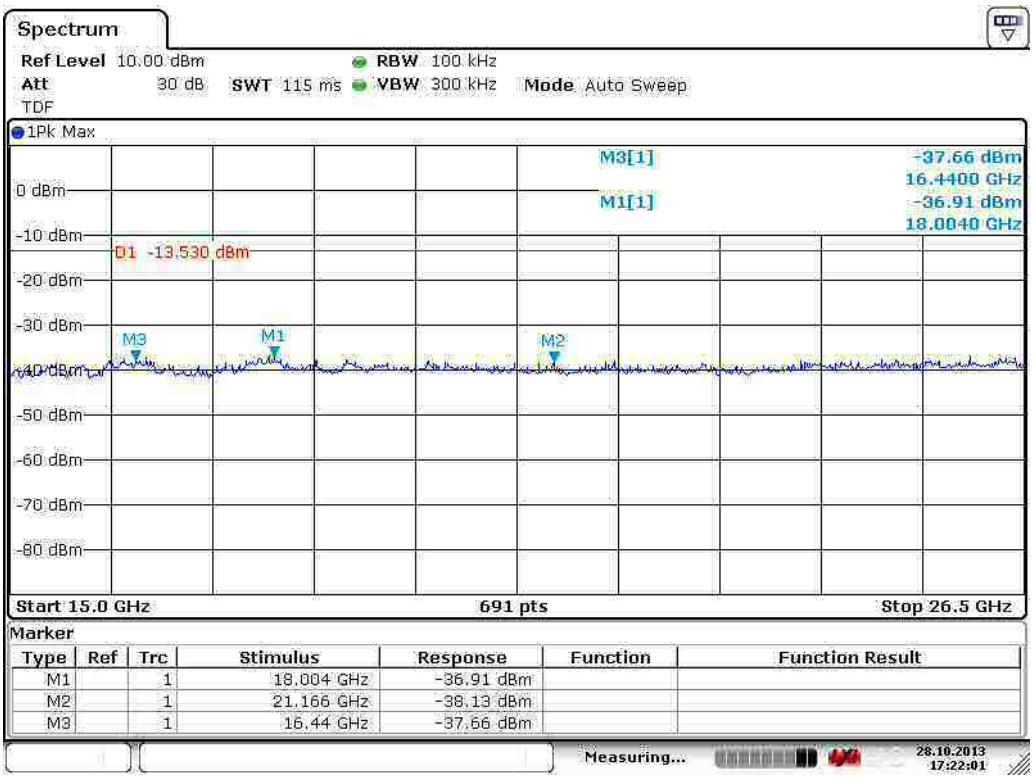
Date: 24.OCT.2013 14:09:30

Figure 62. Mid channel conductive emission 5 GHz to 15 GHz (2 Mbps).



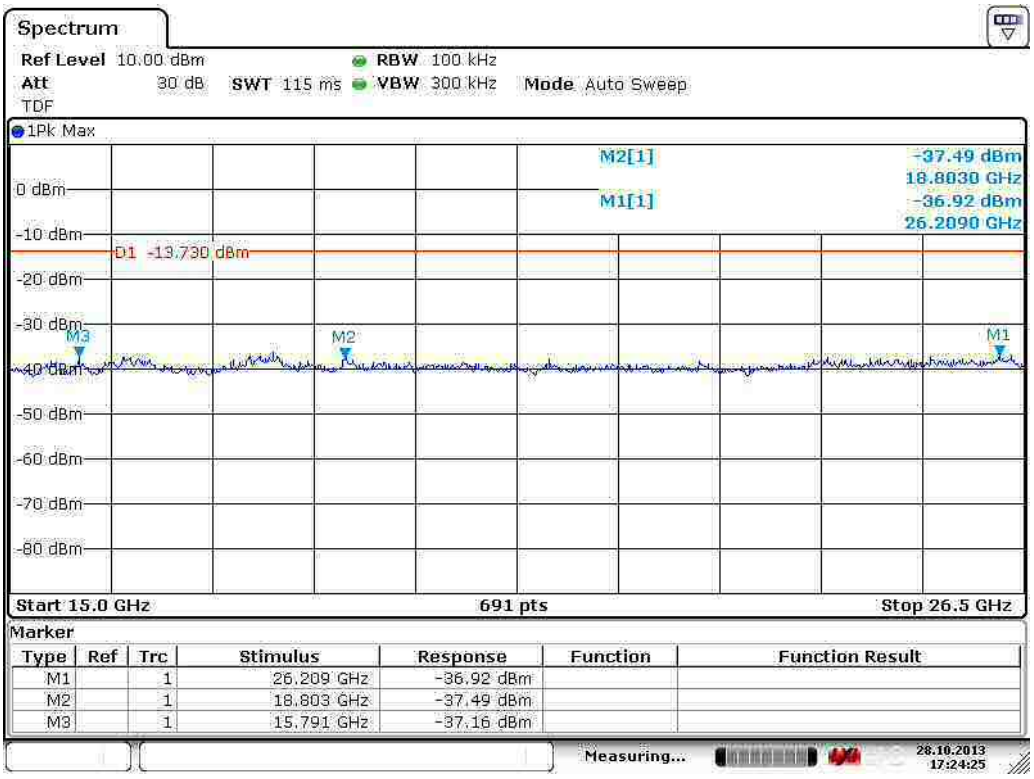
Date: 24.OCT.2013 14:14:28

Figure 63. High channel conductive emission 5 GHz to 15 GHz (2 Mbps).



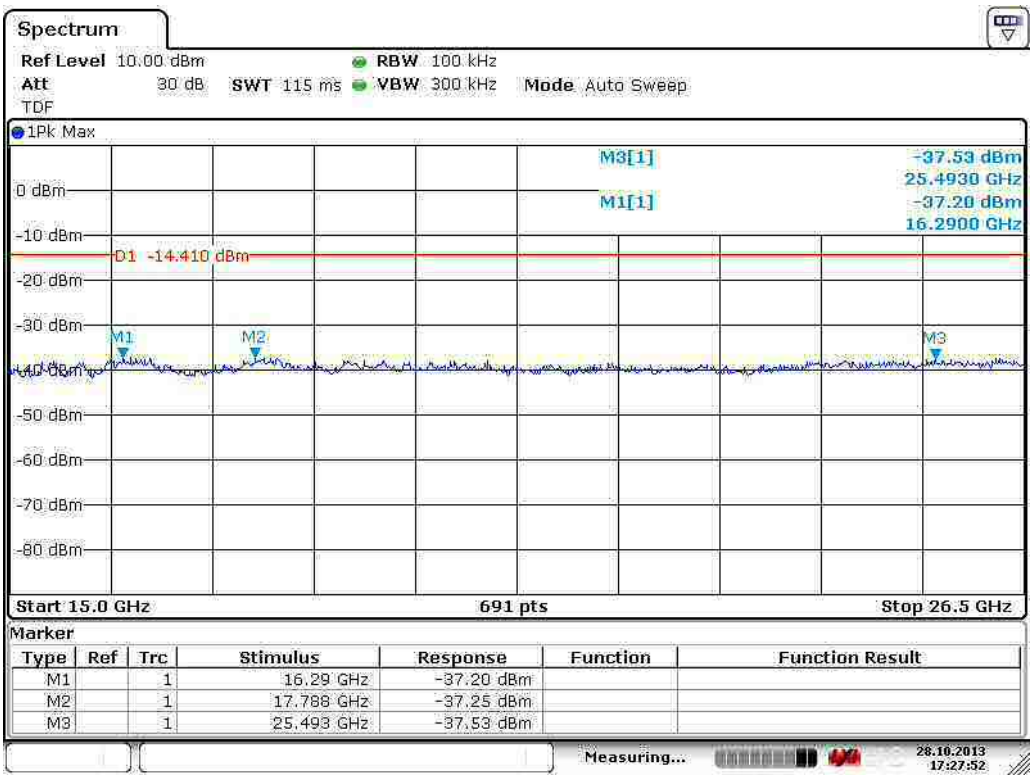
Date: 28.OCT.2013 17:22:00

Figure 64. Low channel conductive emission 15 GHz to 26.5 GHz (2 Mbps).



Date: 28.OCT.2013 17:24:24

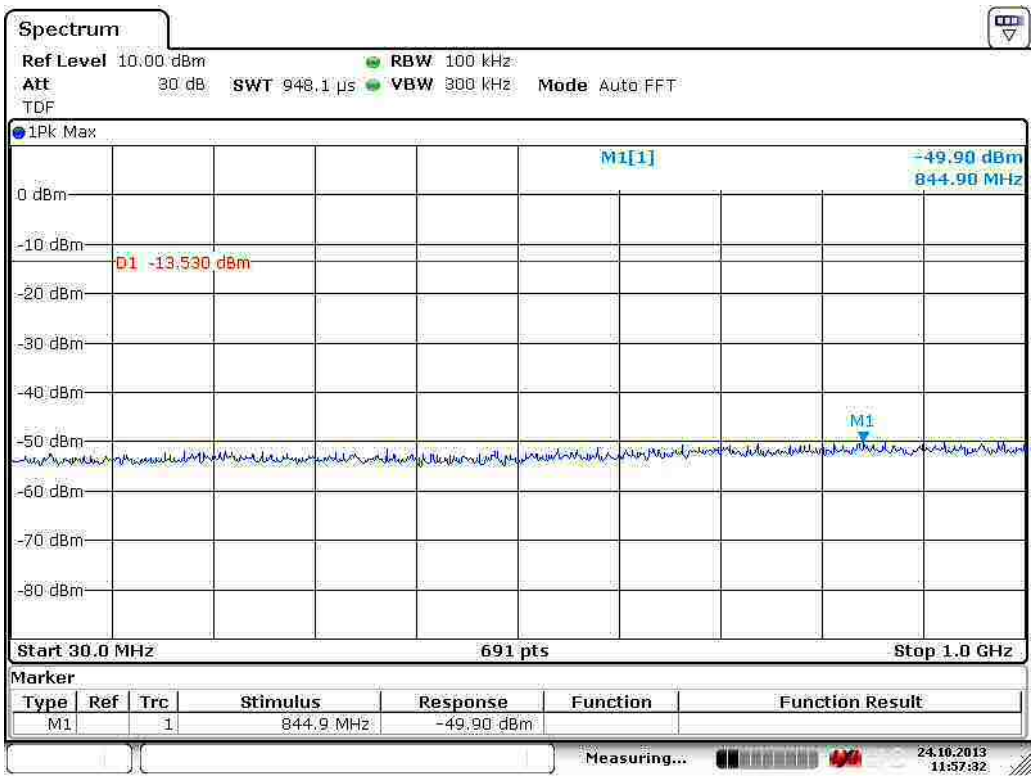
Figure 65. Mid channel conductive emission 15 GHz to 26.5 GHz (2 Mbps).



Date: 28.OCT.2013 17:27:51

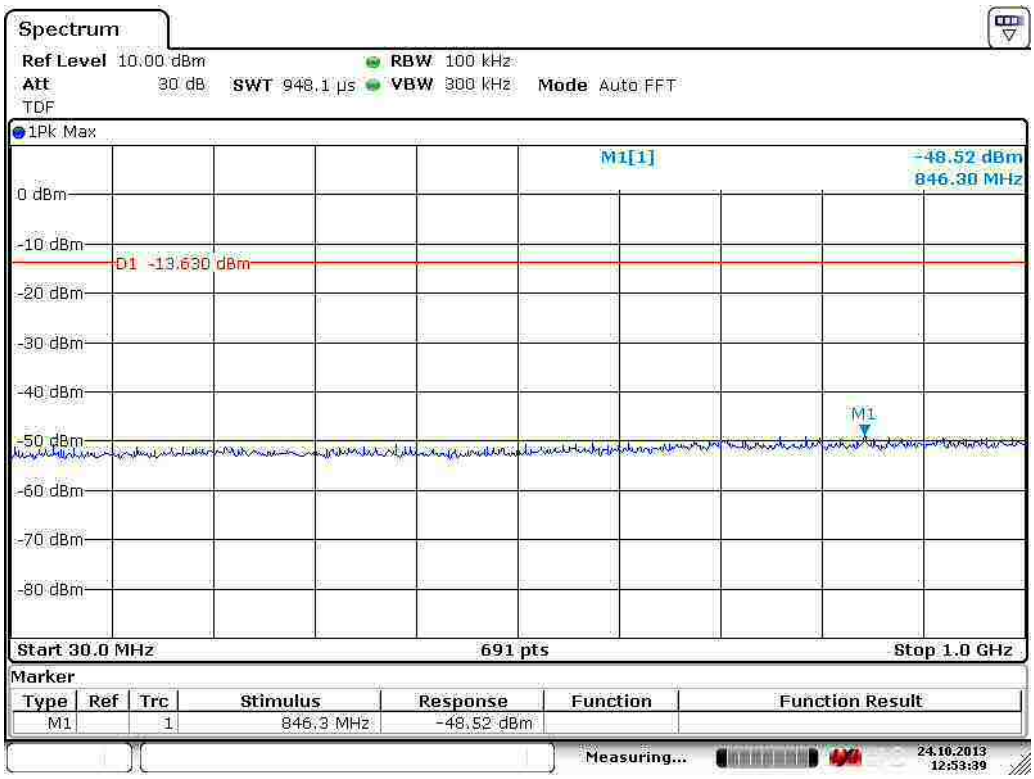
Figure 66. High channel conductive emission 15 GHz to 26.5 GHz (2 Mbps).

Data rate 3 Mbps



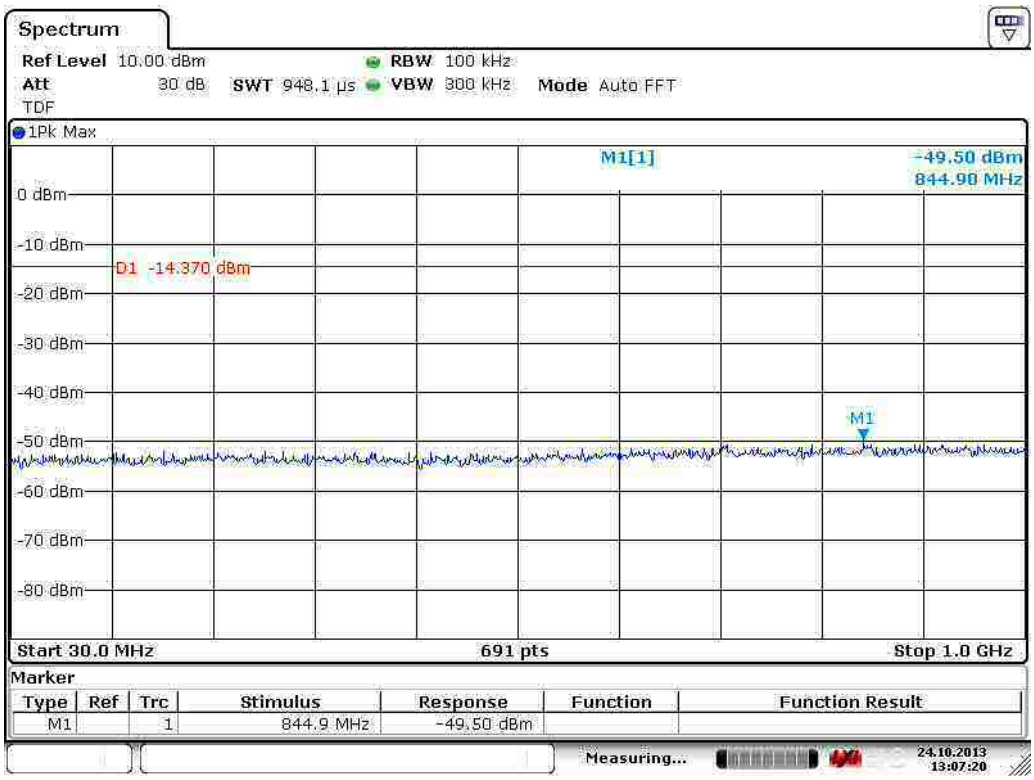
Date: 24.OCT.2013 11:57:31

Figure 67. Low channel conductive emission 30 MHz to 1000 MHz (3 Mbps).



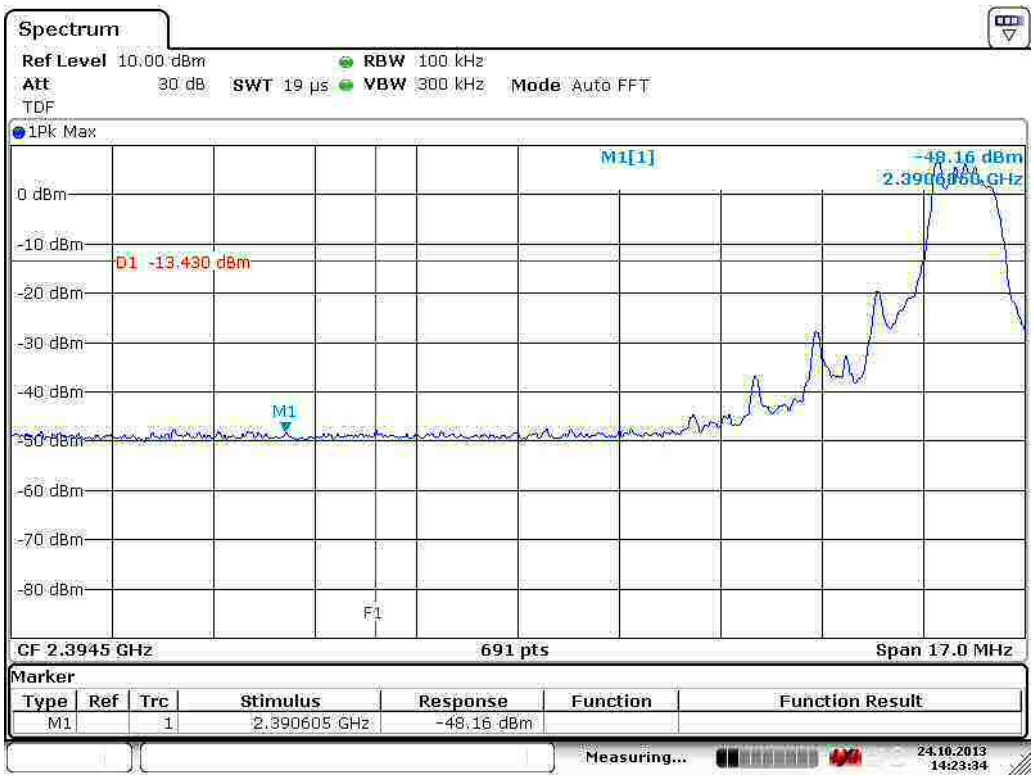
Date: 24.OCT.2013 12:53:38

Figure 68. Mid channel conductive emission 30 MHz to 1000 MHz (3 Mbps).



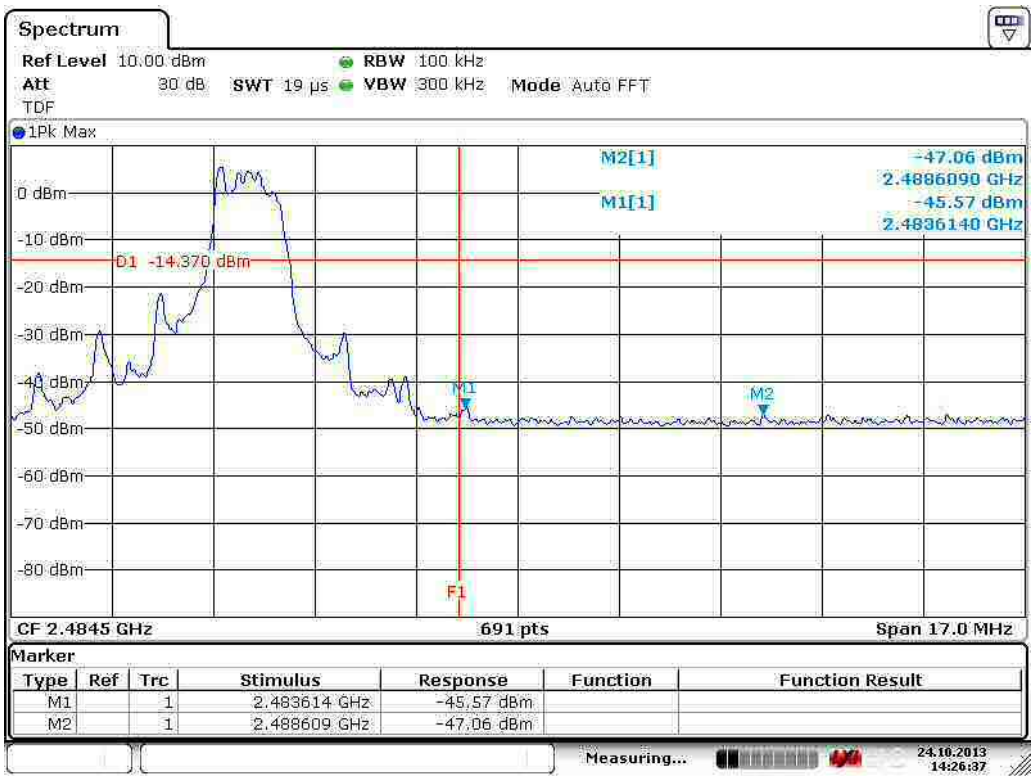
Date: 24.OCT.2013 13:07:20

Figure 69. High channel conductive emission 30 MHz to 1000 MHz (3 Mbps).



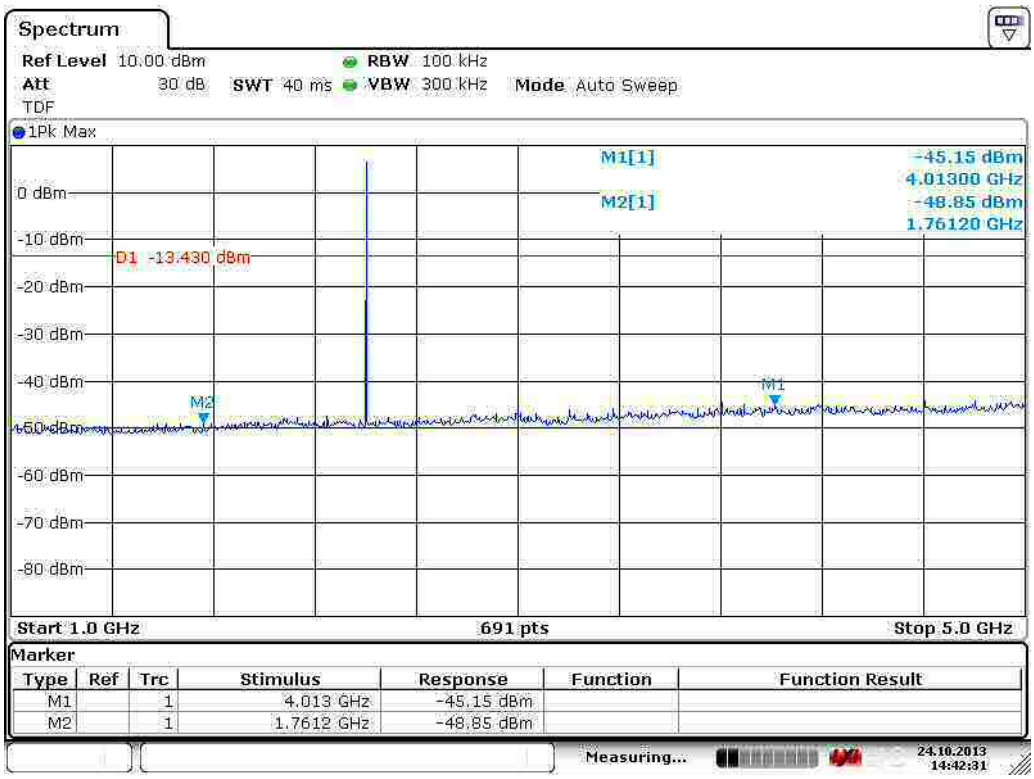
Date: 24.OCT.2013 14:23:34

Figure 70. Low channel conductive emission at low band edge (3 Mbps).



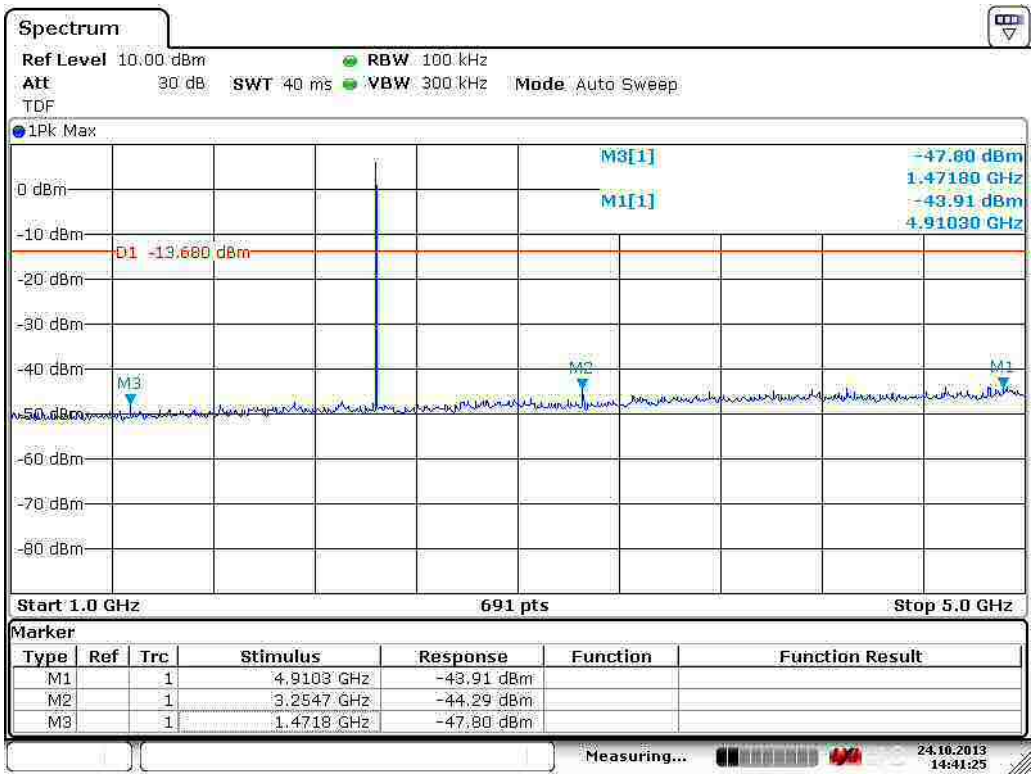
Date: 24.OCT.2013 14:26:37

Figure 71. High channel conductive emission at high band edge (3 Mbps).



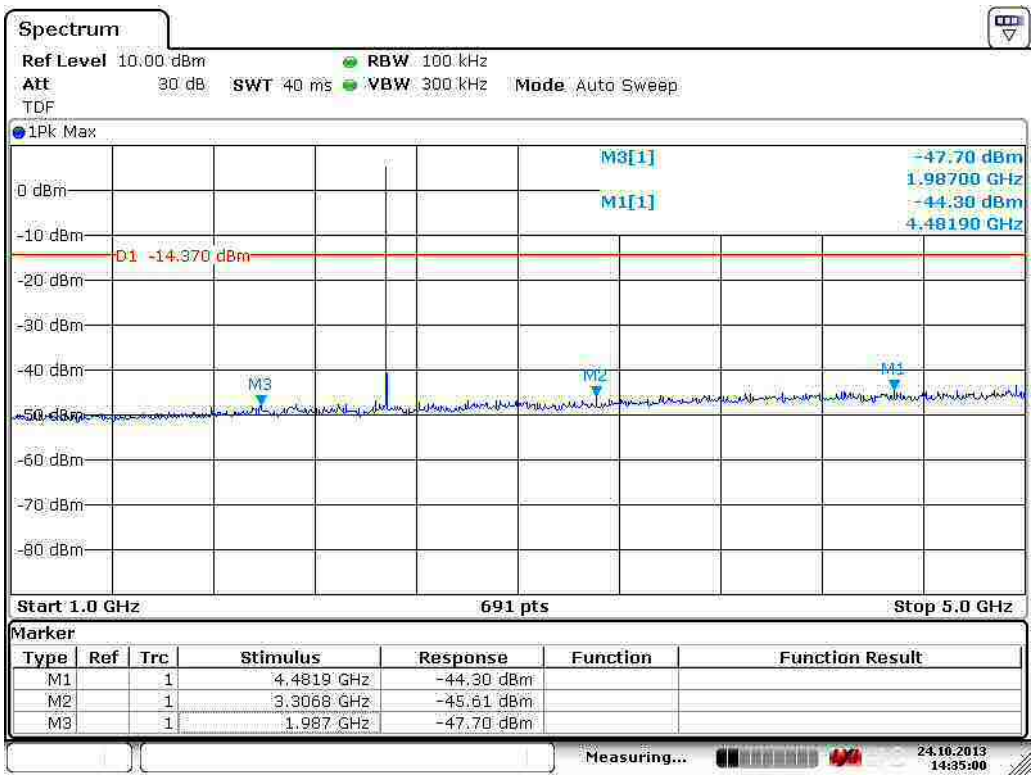
Date: 24.OCT.2013 14:42:31

Figure 72. Low channel conductive emission 1 GHz to 5 GHz (3 Mbps).



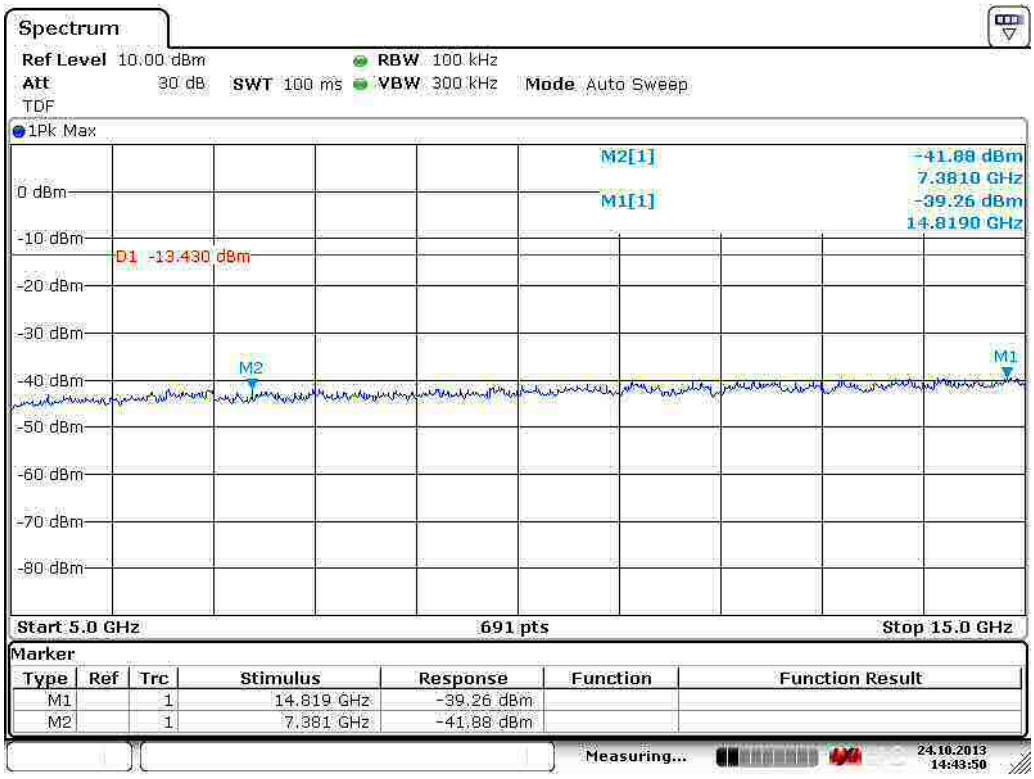
Date: 24.OCT.2013 14:41:24

Figure 73. Mid channel conductive emission 1 GHz to 5 GHz (3 Mbps).



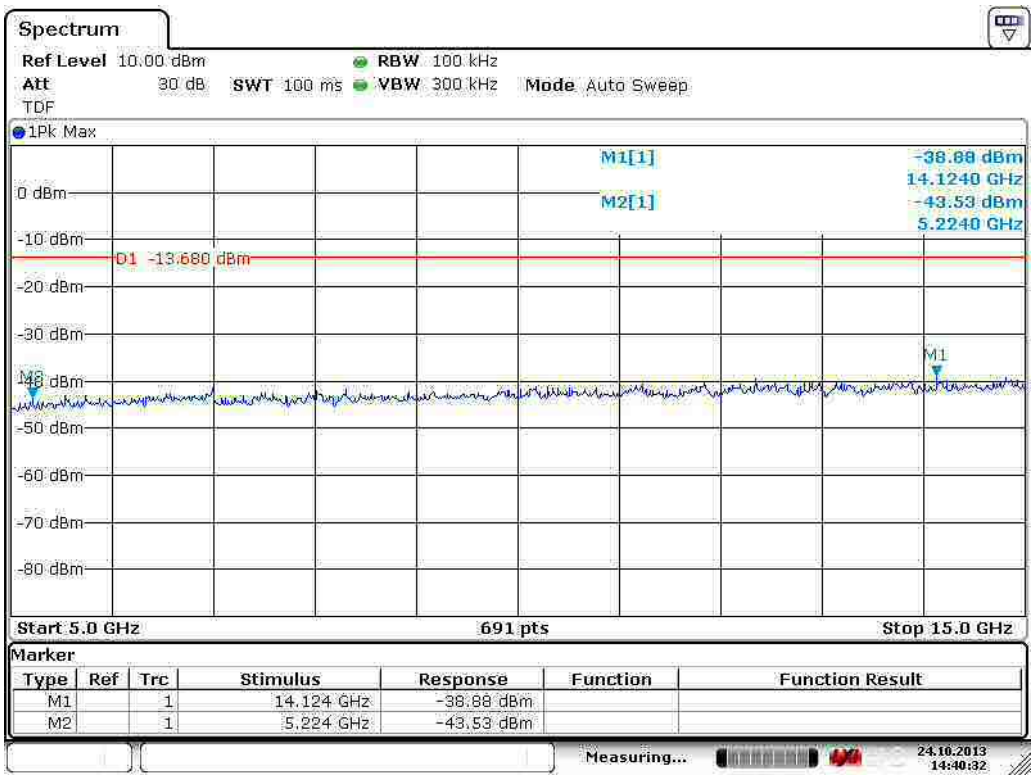
Date: 24.OCT.2013 14:34:59

Figure 74. High channel conductive emission 1 GHz to 5 GHz (3 Mbps).



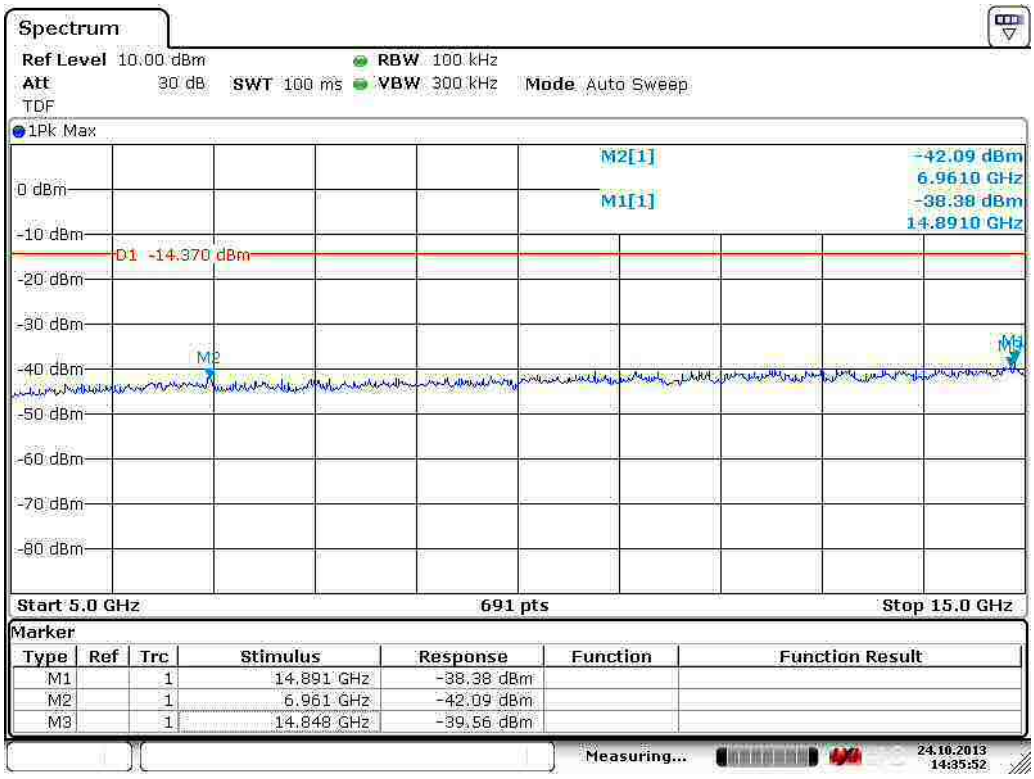
Date: 24.OCT.2013 14:43:50

Figure 75. Low channel conductive emission 5 GHz to 15 GHz (3 Mbps).



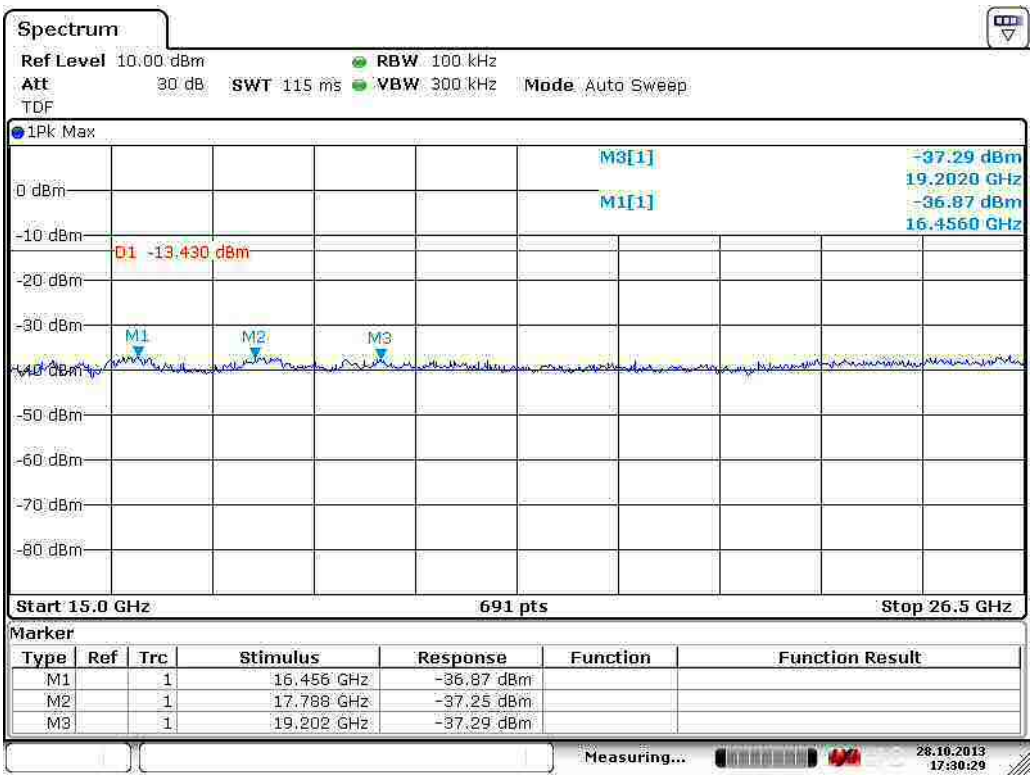
Date: 24.OCT.2013 14:40:31

Figure 76. Mid channel conductive emission 5 GHz to 15 GHz (3 Mbps).



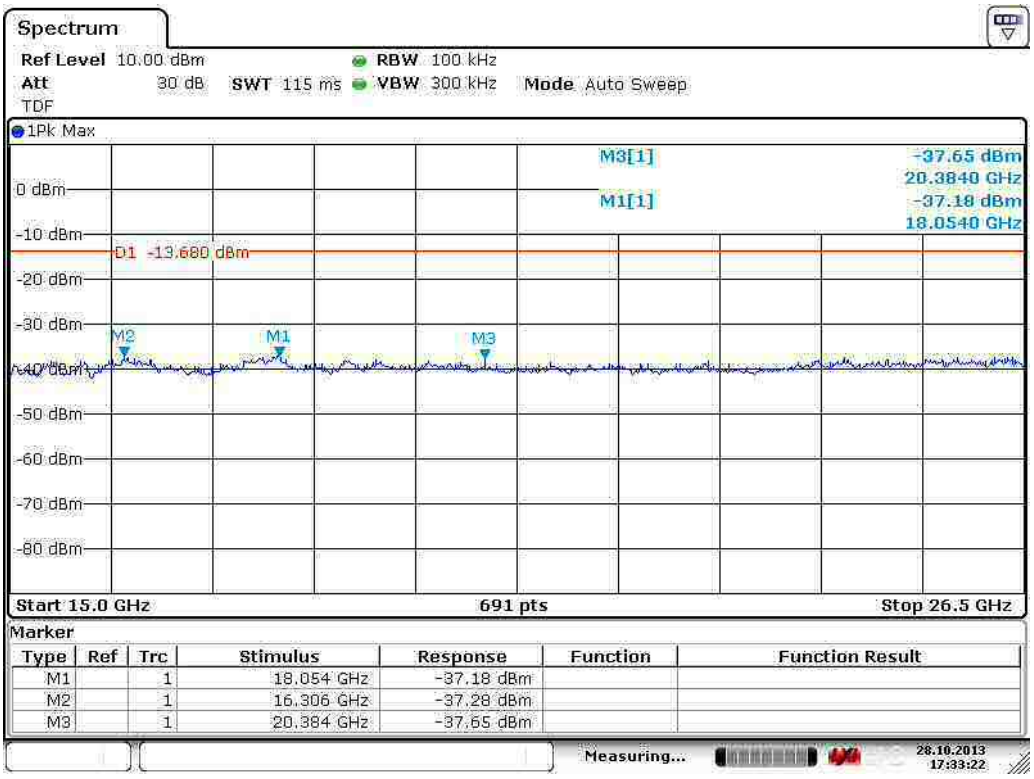
Date: 24.OCT.2013 14:35:52

Figure 77. High channel conductive emission 5 GHz to 15 GHz (3 Mbps).



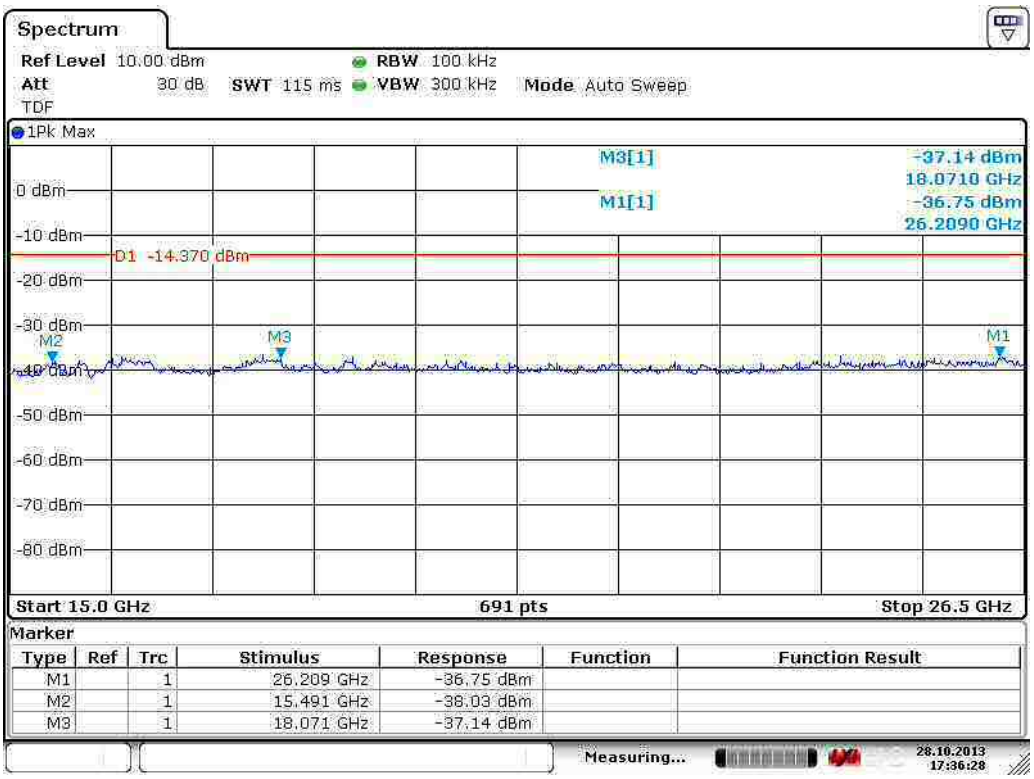
Date: 28.OCT.2013 17:30:29

Figure 78. Low channel conductive emission 15 GHz to 26.5 GHz (3 Mbps).



Date: 28.OCT.2013 17:33:22

Figure 79. Mid channel conductive emission 15 GHz to 26.5 GHz (3 Mbps).



Date: 28.OCT.2013 17:36:27

Figure 80. High channel conductive emission 15 GHz to 26.5 GHz (3 Mbps).

20 dB Bandwidth of the Hopping Channel

Standard:	ANSI C63.10	(2009)
Tested by:	NKO	
Date:	25.10.2013	
Temperature:	22.7 °C	
Humidity:	37 % RH	

FCC Rule: 15.247(a)(1)

Results:

1 Mbps

Table 31. 20 dB bandwidth test results 1 Mbps.

Channel	20 dB BW [kHz]
Low	1302.5
Mid	1319.8
High	1315.5

2 Mbps

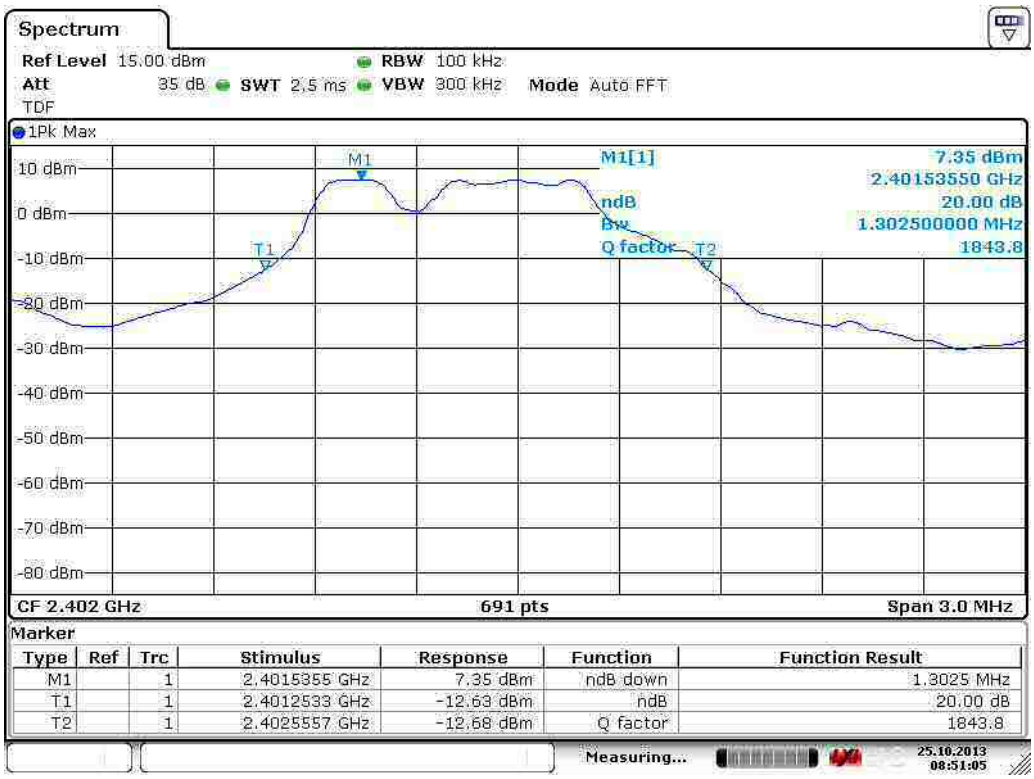
Table 32. 20 dB bandwidth test results 2 Mbps

Channel	20 dB BW [kHz]
Low	1380.6
Mid	1376.3
High	1384.9

3 Mbps

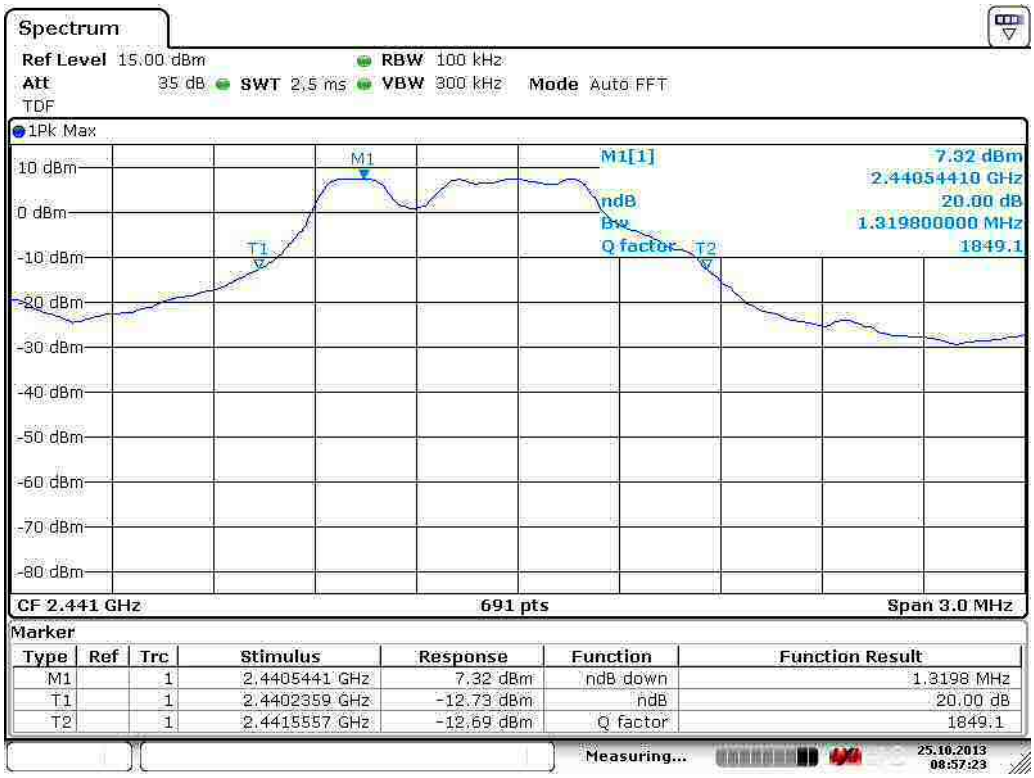
Table 33. 20 dB bandwidth test results 3 Mbps

Channel	20 dB BW [kHz]
Low	1393.6
Mid	1384.9
High	1384.9



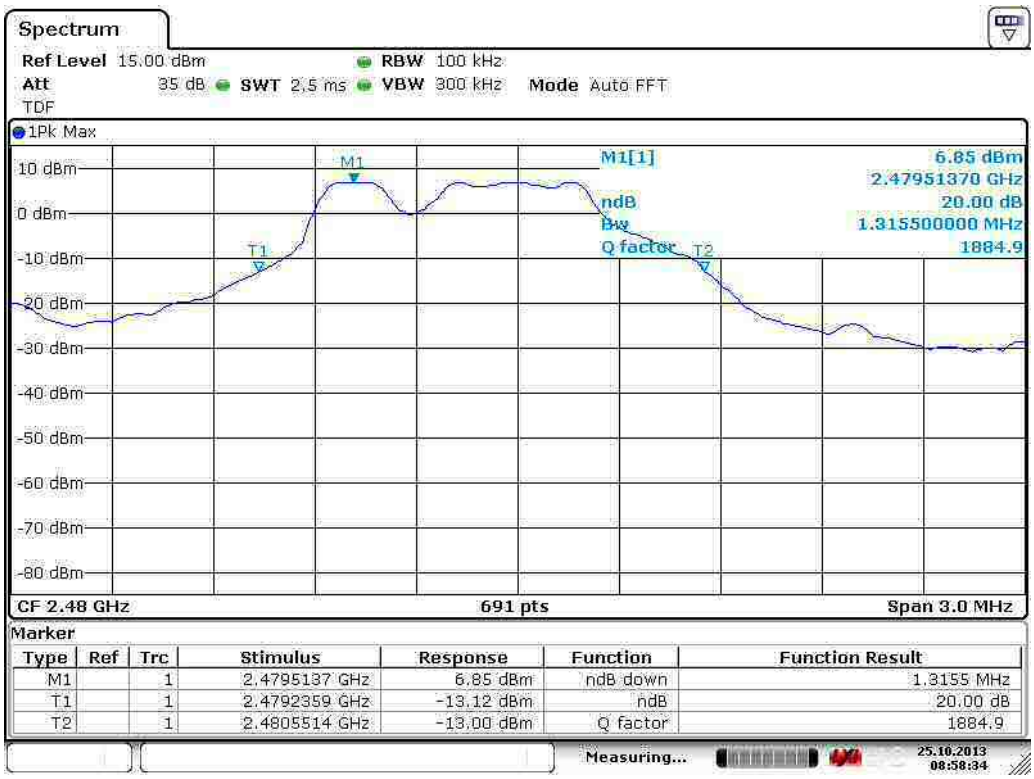
Date: 25.OCT.2013 08:51:05

Figure 81. 20 dB channel BW. 1 Mbps Channel LOW.



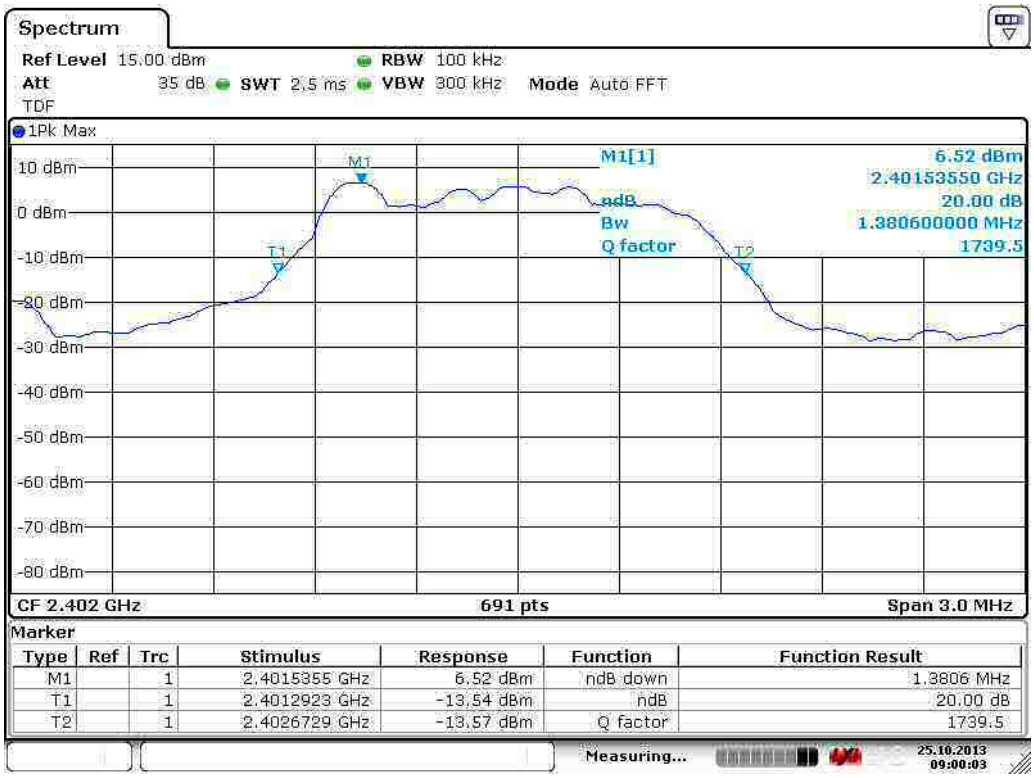
Date: 25.OCT.2013 08:57:23

Figure 82. 20 dB channel BW. 1 Mbps Channel MID.



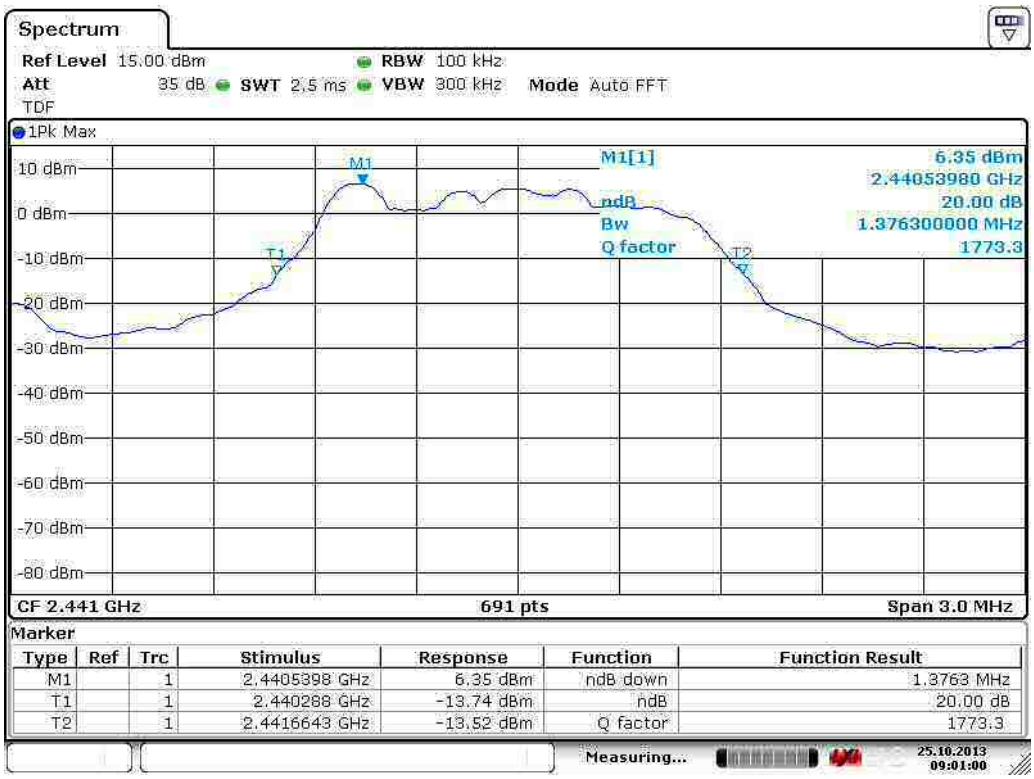
Date: 25.OCT.2013 08:58:34

Figure 83. 20 dB channel BW. 1 Mbps Channel HIGH.



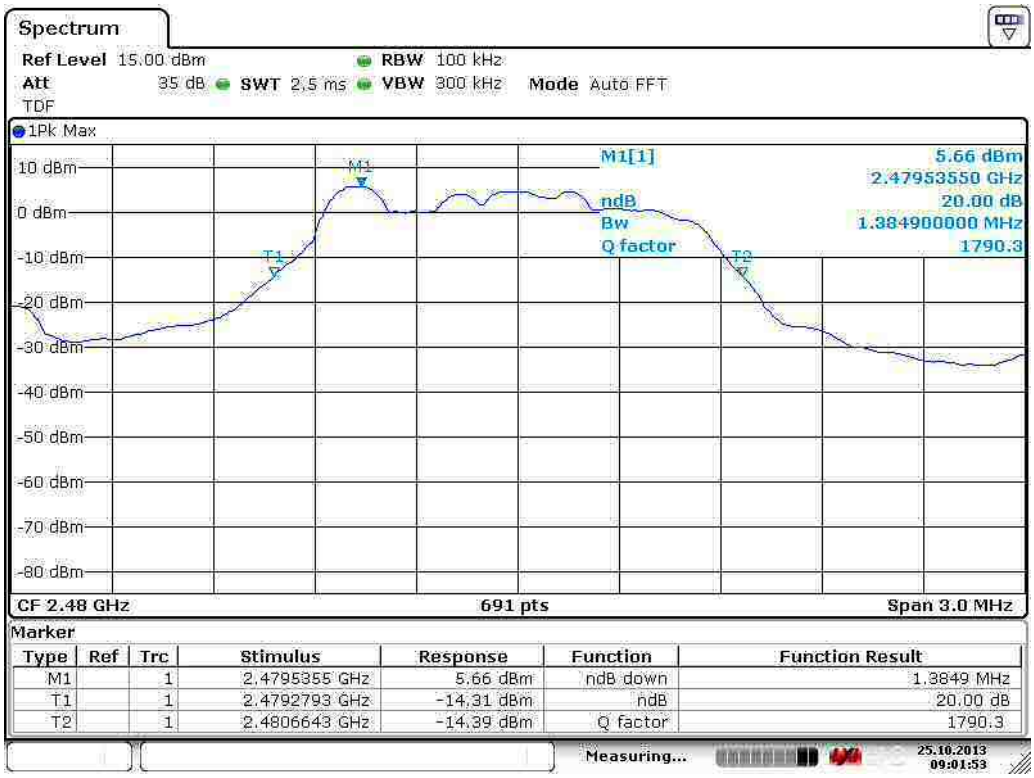
Date: 25.OCT.2013 09:00:03

Figure 84. 20 dB channel BW. 2 Mbps Channel LOW.



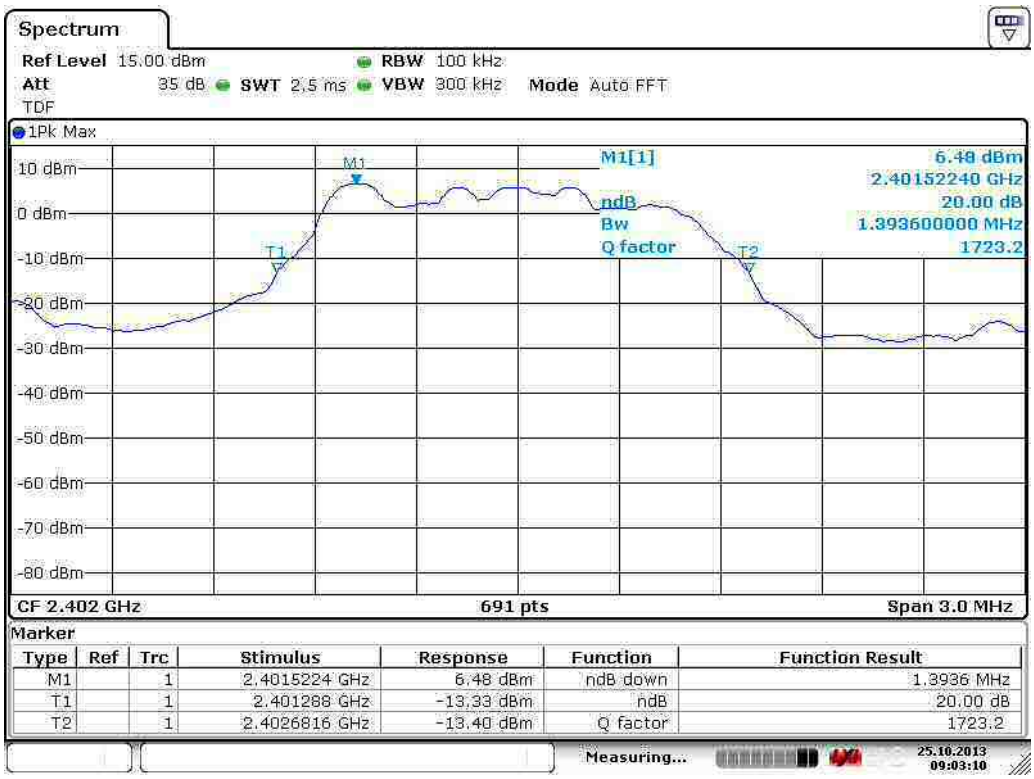
Date: 25.OCT.2013 09:01:00

Figure 85. 20 dB channel BW. 2 Mbps Channel MID.



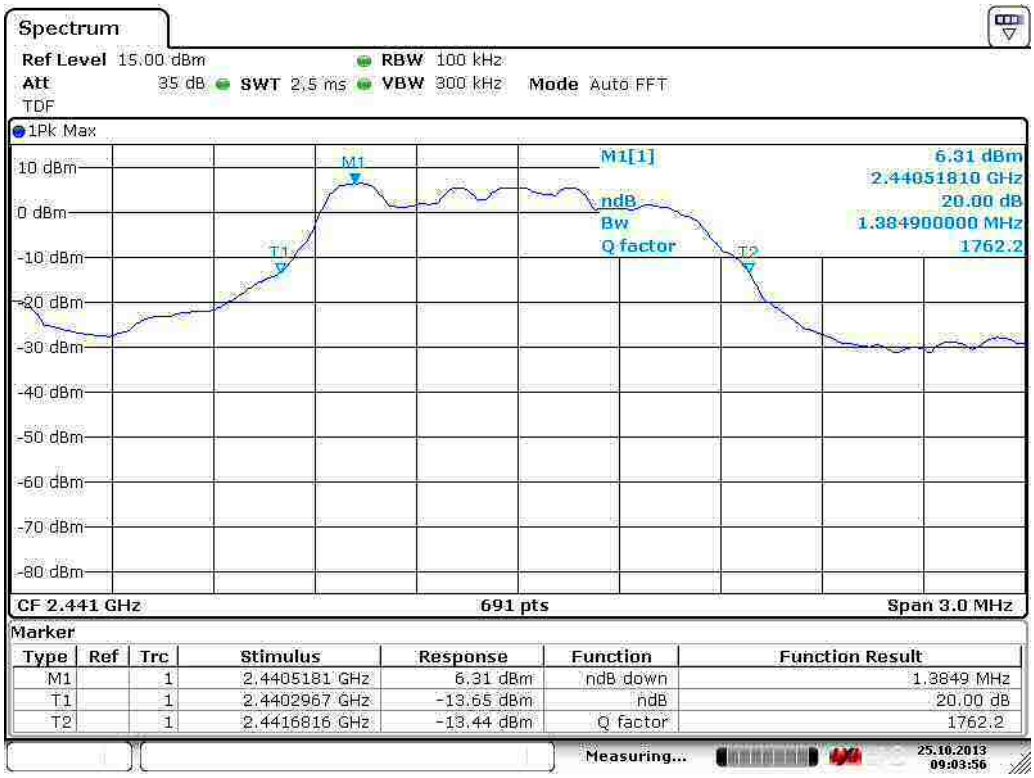
Date: 25.OCT.2013 09:01:53

Figure 86. 20 dB channel BW. 2 Mbps Channel HIGH.



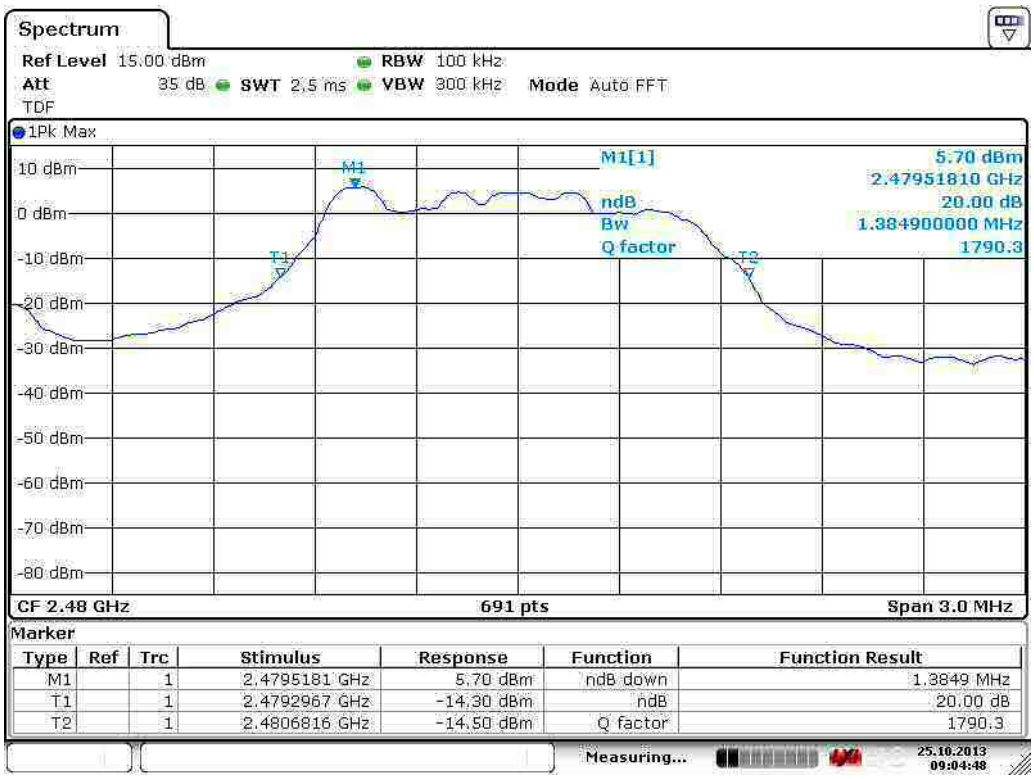
Date: 25.OCT.2013 09:03:10

Figure 87. 20 dB channel BW. 3 Mbps Channel LOW.



Date: 25.OCT.2013 09:03:56

Figure 88. 20 dB channel BW. 3 Mbps Channel MID.



Date: 25.OCT.2013 09:04:48

Figure 89. 20 dB channel BW. 3 Mbps Channel HIGH.

Hopping Channel Carrier Frequencies Separation

Standard:	ANSI C63.10	(2009)
Tested by:	NKO	
Date:	25.10.2013	
Temperature:	22.7 °C	
Humidity:	37 % RH	

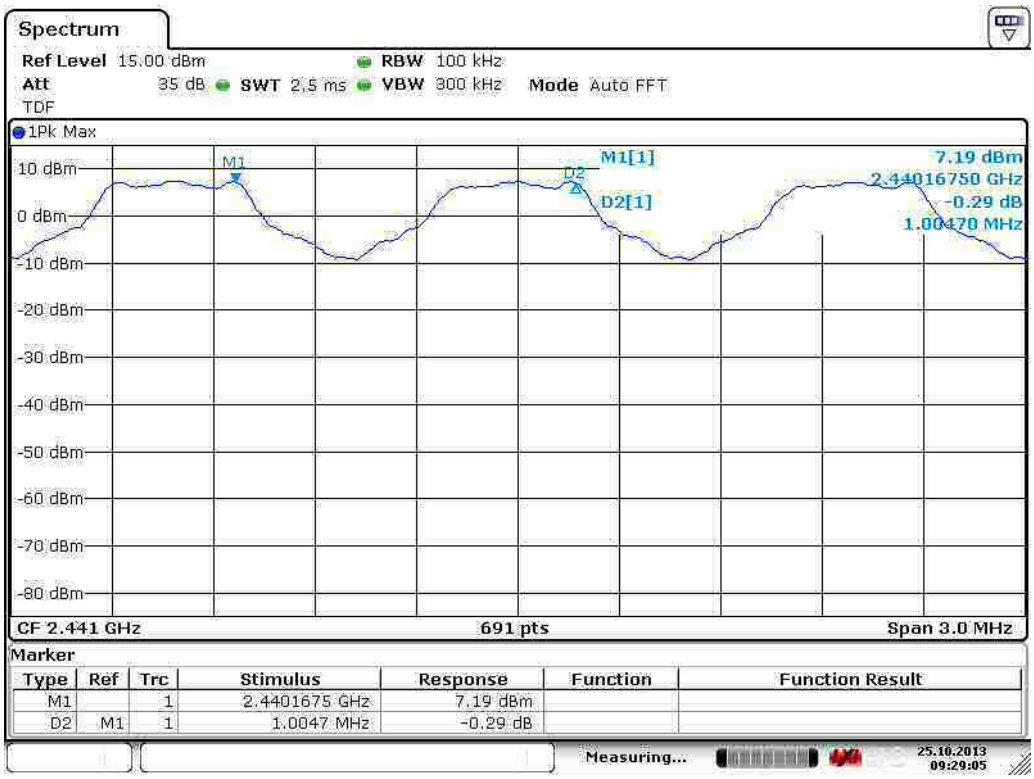
FCC Rule: 15.247(a)(1)

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

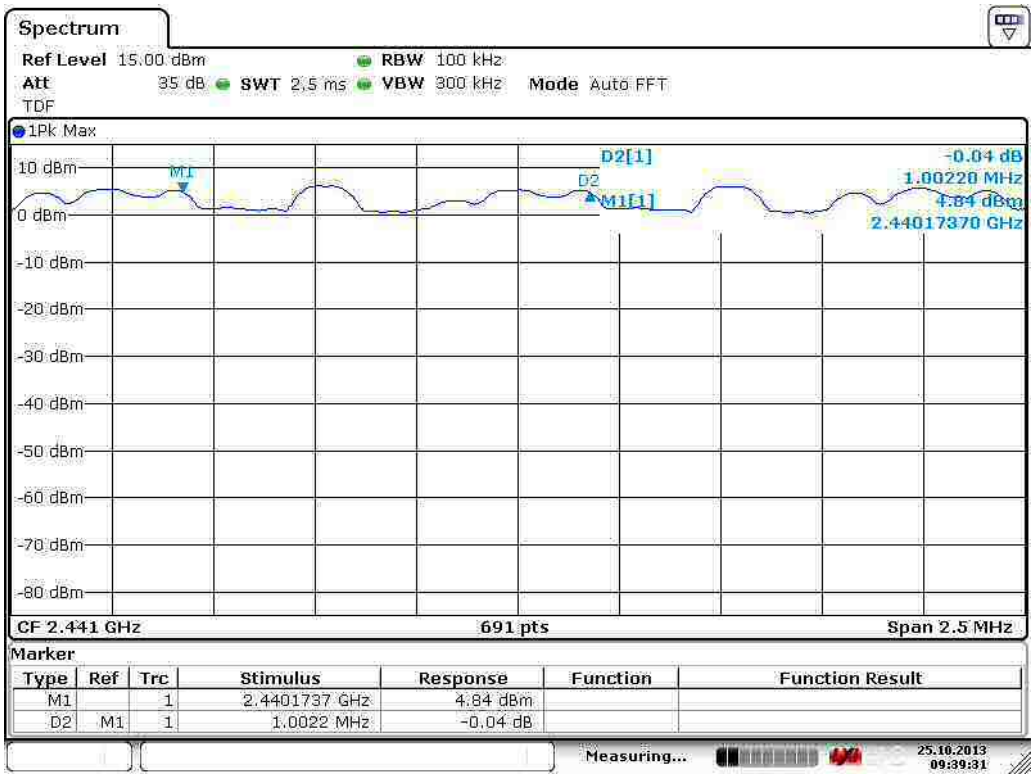
Table 34. Hopping channel carrier frequencies separation test result.

Data rate	Measured separation	Measured 20 dB BW	Limit	Result
1 Mbps	1.00470 MHz	1.3198 MHz	879.8 kHz	PASS
2 Mbps	1.00220 MHz	1.3763 MHz	917.5 kHz	PASS
3 Mbps	1.00940 MHz	1.3849 MHz	923.3 kHz	PASS
Limit:	25 kHz or 2/3 or the 20 dB bandwidth of the hopping channel whichever is greater			



Date: 25.OCT.2013 09:29:05

Figure 90. Measured hopping channels carrier frequency separation 1 Mbps.



Date: 25.OCT.2013 09:39:31

Figure 91. Measured hopping channels carrier frequency separation 2 Mbps.

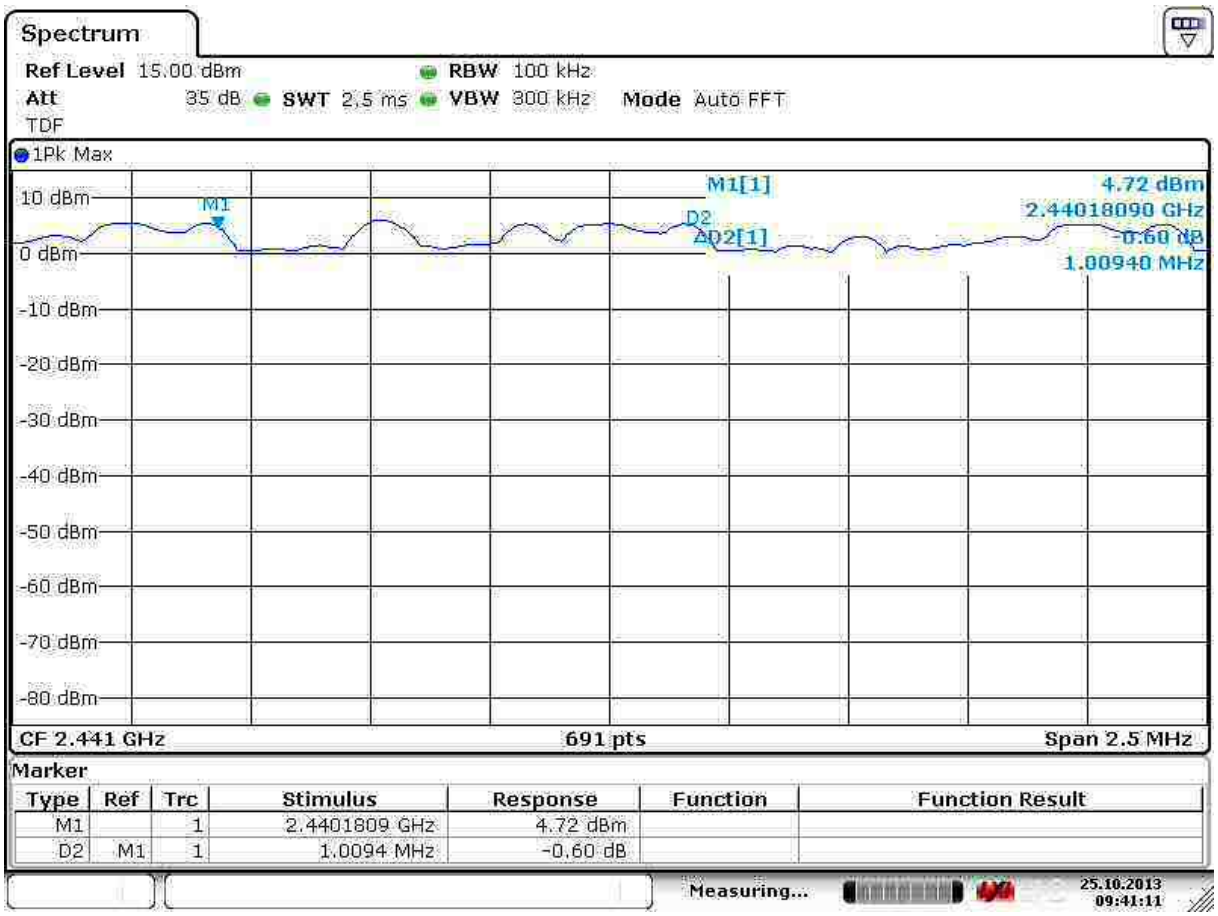


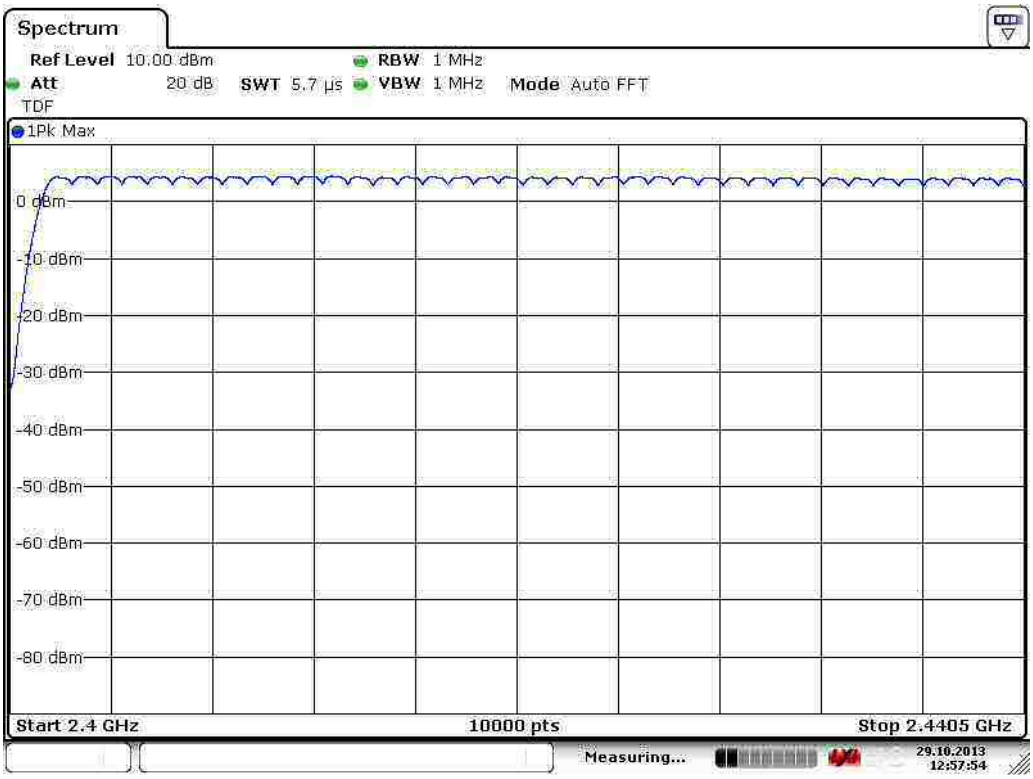
Figure 92. Measured hopping channels carrier frequency separation 3 Mbps.

Number of Hopping Channels

Standard:	ANSI C63.10	(2009)
Tested by:	NKO	
Date:	25.10.2013 / 29.10.2013	
Temperature:	22.7 °C / 23.1 °C	
Humidity:	37 % / 38 % RH	

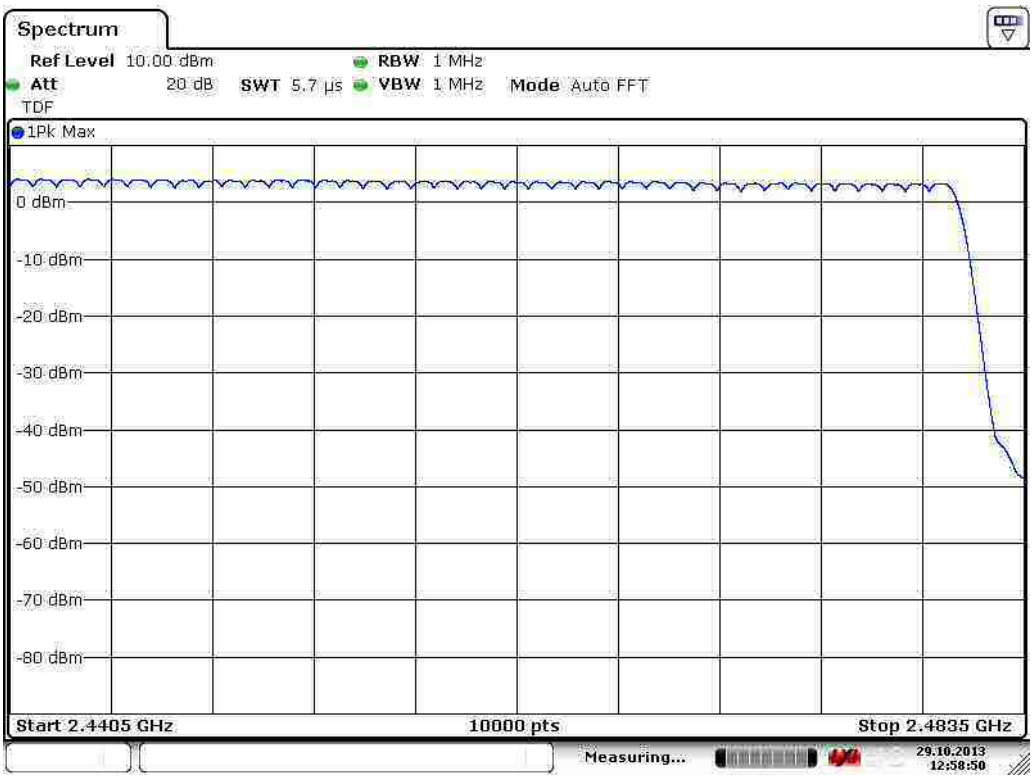
FCC Rule: 15.247(a)(1)(iii)

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



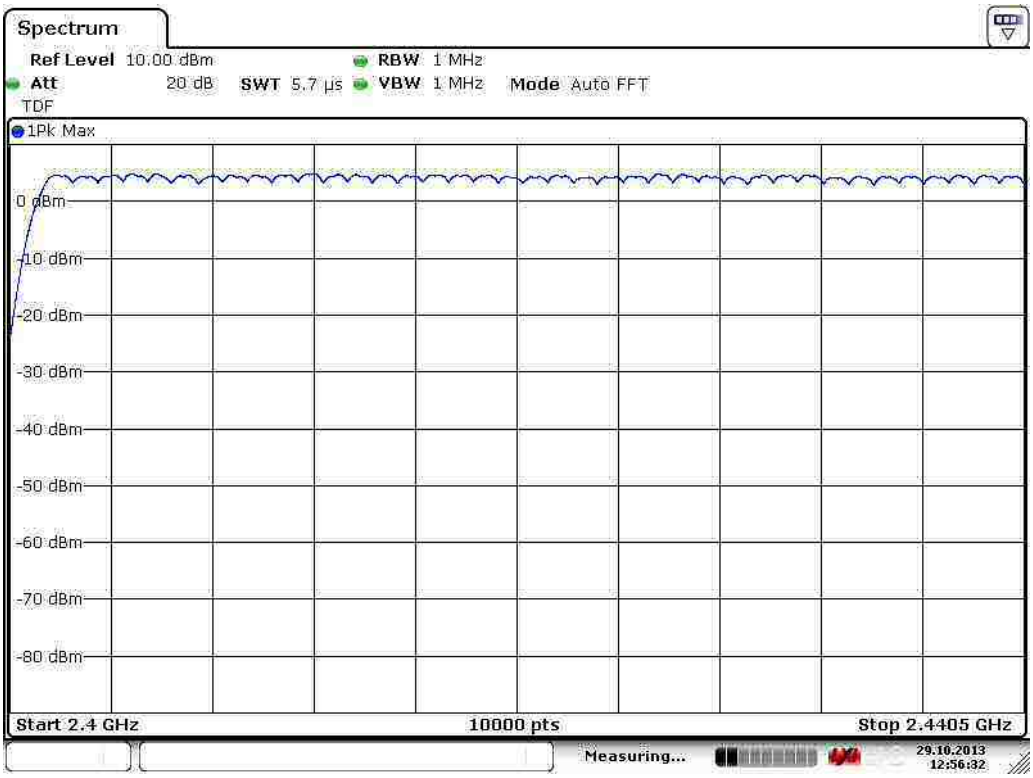
Date: 29.OCT.2013 12:57:54

Figure 93. First 39 channels 1 Mbps.



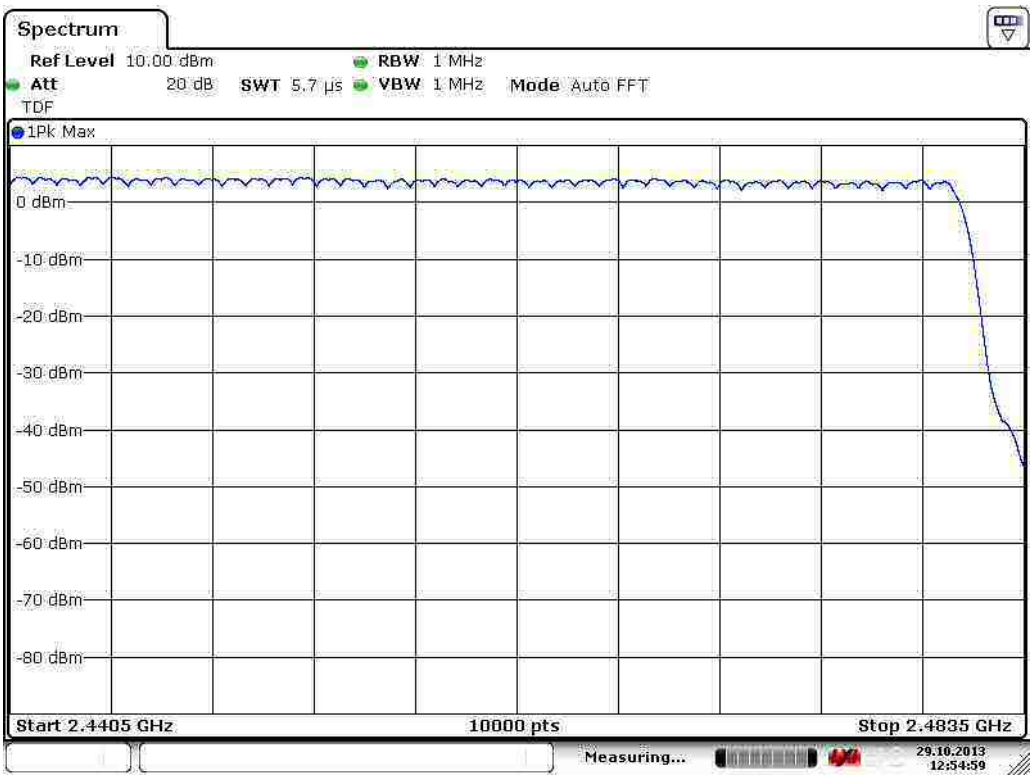
Date: 29.OCT.2013 12:58:50

Figure 94. Second 40 channels 1 Mbps.



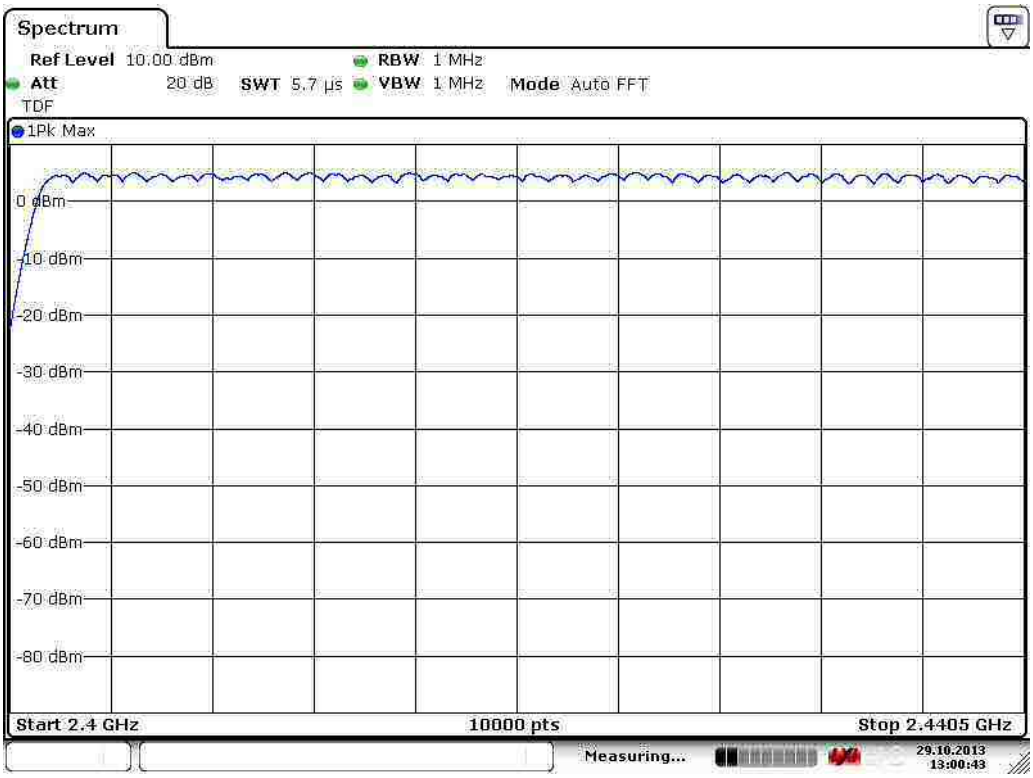
Date: 29.OCT.2013 12:56:32

Figure 95. First 39 channels 2 Mbps.



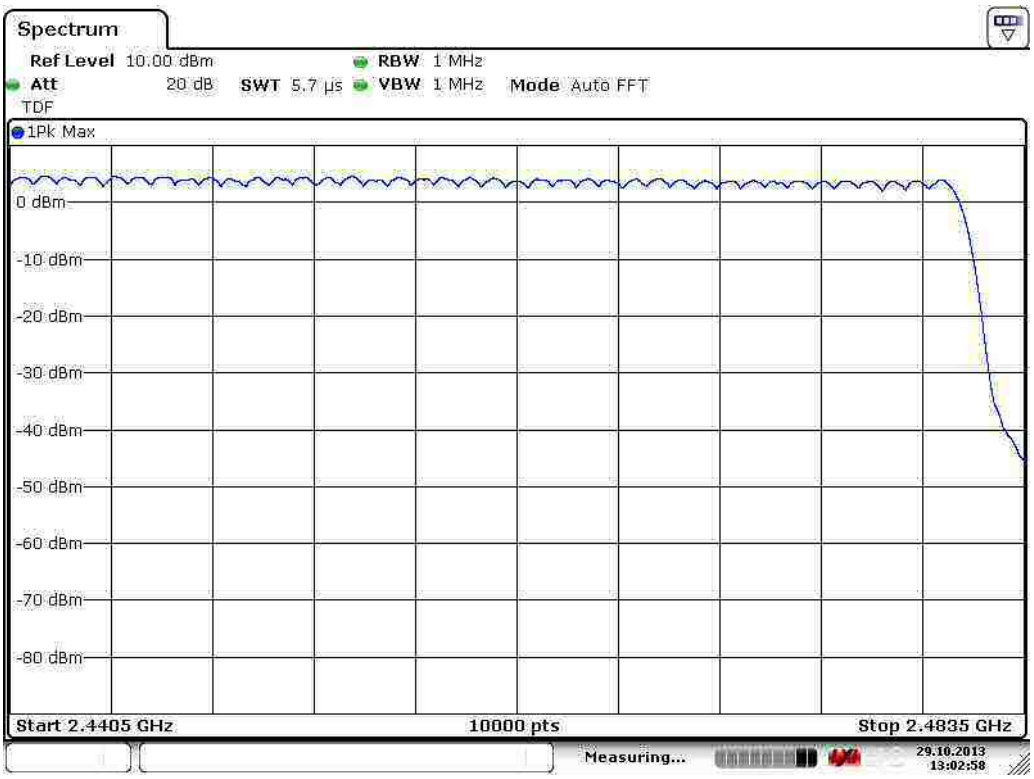
Date: 29.OCT.2013 12:54:58

Figure 96. Second 40 channels 2 Mbps.



Date: 29.OCT.2013 13:00:42

Figure 97. First 39 channels 3 Mbps.



Date: 29.OCT.2013 13:02:58

Figure 98. Second 40 channels 3 Mbps.

Average Time of Occupancy of Hopping Frequency

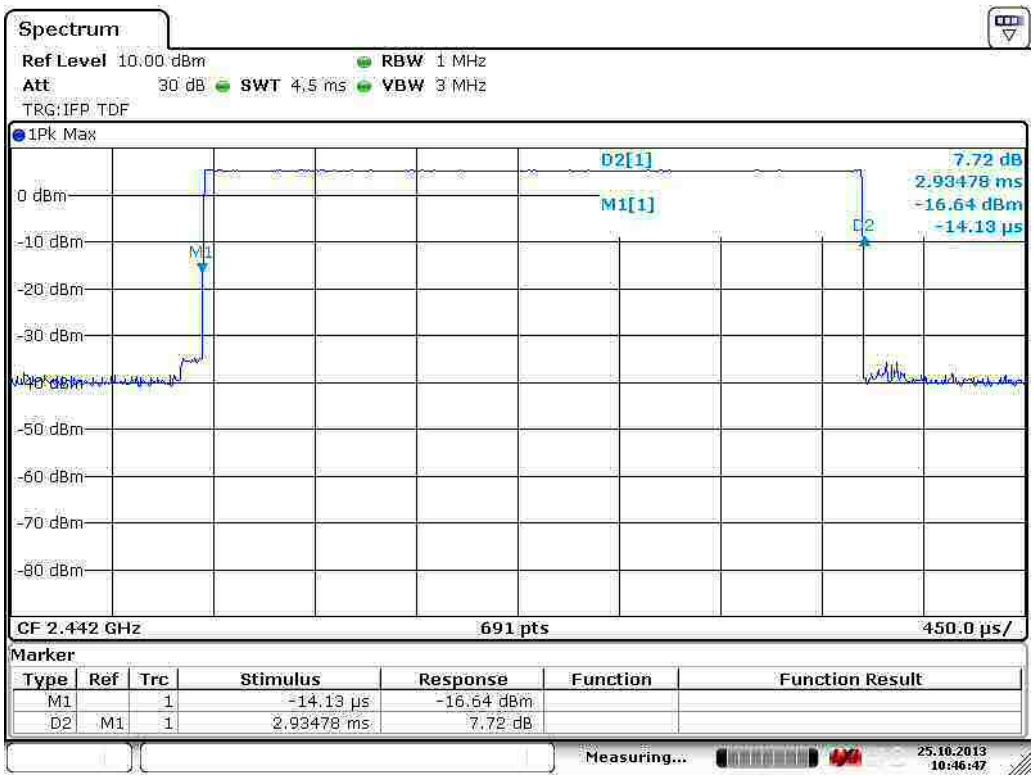
Standard:	ANSI C63.10	(2009)
Tested by:	NKO	
Date:	25.10.2013	
Temperature:	22.7 °C	
Humidity:	37 % RH	

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.

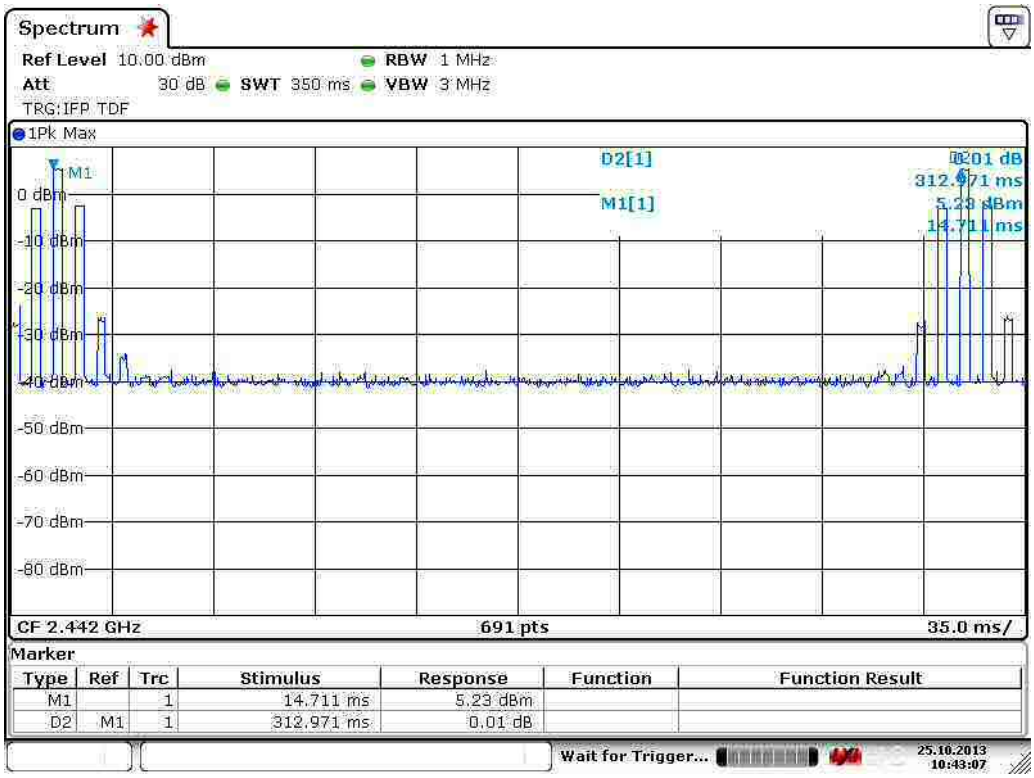
Test was performed in each data rate mode to insure that the all modes are identical.

Time of occupancy calculation:
Number of channels = 79
Measurement period = 0.4 s x 79 = 31.6 s
One channel occupancy time = 312.9 ms
Number of transmission cycles in measurement period = 31.6 / 0.3129 = 100.9
Time of occupancy = (single duration) x (repetition) = 2.93478 ms x 100.9 times = 294.3 ms



Date: 25.OCT.2013 10:46:47

Figure 99. One channel dwell time.



Date: 25.OCT.2013 10:43:07

Figure 100. Measured repetition of the channel occupancy

99% Occupied Power Bandwidth

Standard:	RSS-GEN	(2010)
Tested by:	NKO	
Date:	22.10.2013	
Temperature:	22.7 °C	
Humidity:	37 % RH	

RSS-GEN 4.7.

Table 35. Data rate 1 Mbps

Channel	99% BW [MHz]	Limit	Result
Low	1.085383502	-	PASS
Mid	1.099855282	-	PASS
High	1.099855282	-	PASS

Table 36. Data rate 2 Mbps

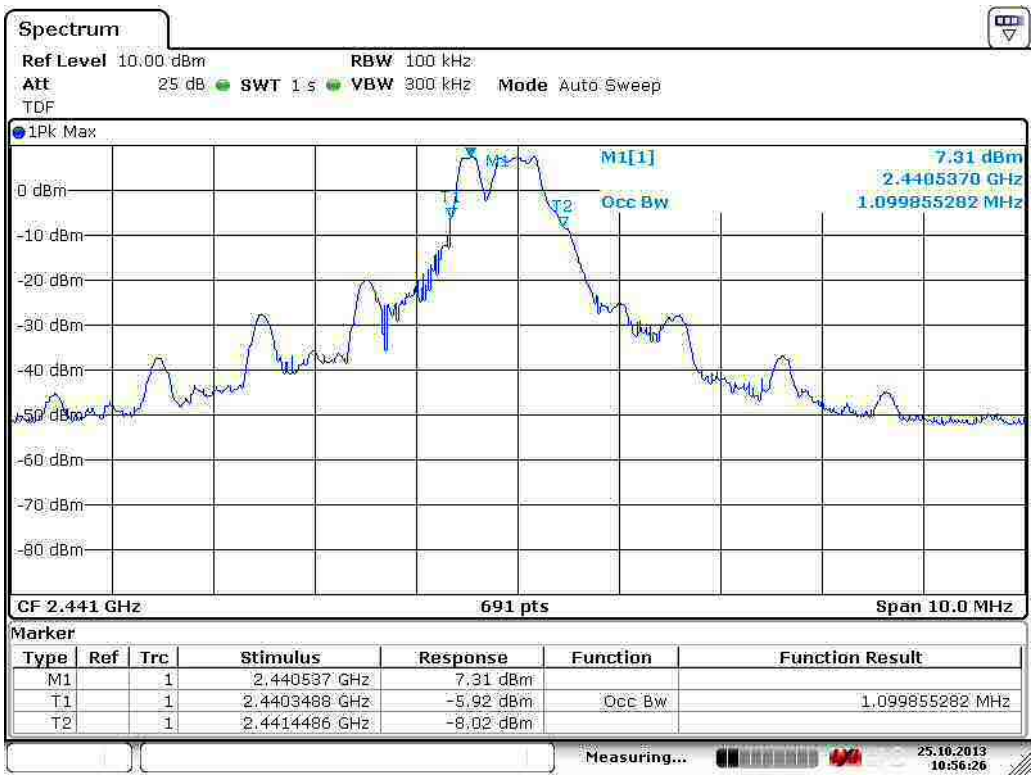
Channel	99% BW [MHz]	Limit	Result
Low	1.230101302	-	PASS
Mid	1.230101302	-	PASS
High	1.201157742	-	PASS

Table 37. Data rate 3 Mbps

Channel	99% BW [MHz]	Limit	Result
Low	1.230101302	-	PASS
Mid	1.215629522	-	PASS
High	1.215629522	-	PASS

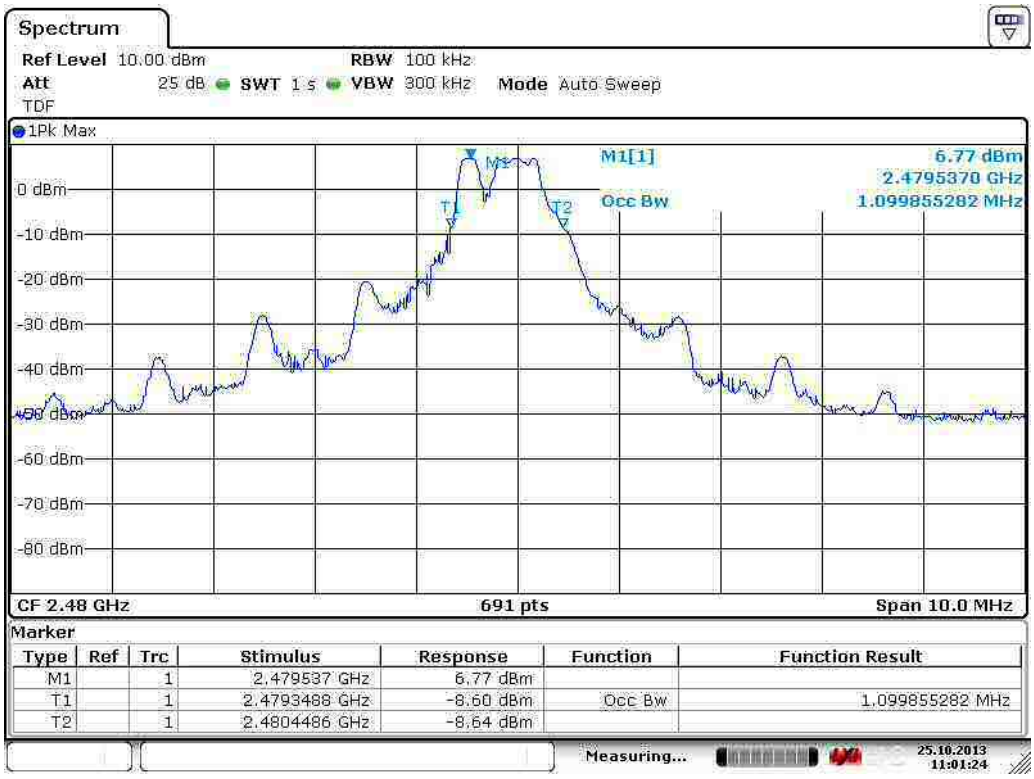
Date: 25.OCT.2013 10:57:44

Figure 101. Low channel 99% Occupied Power Bandwidth (1 Mbps).



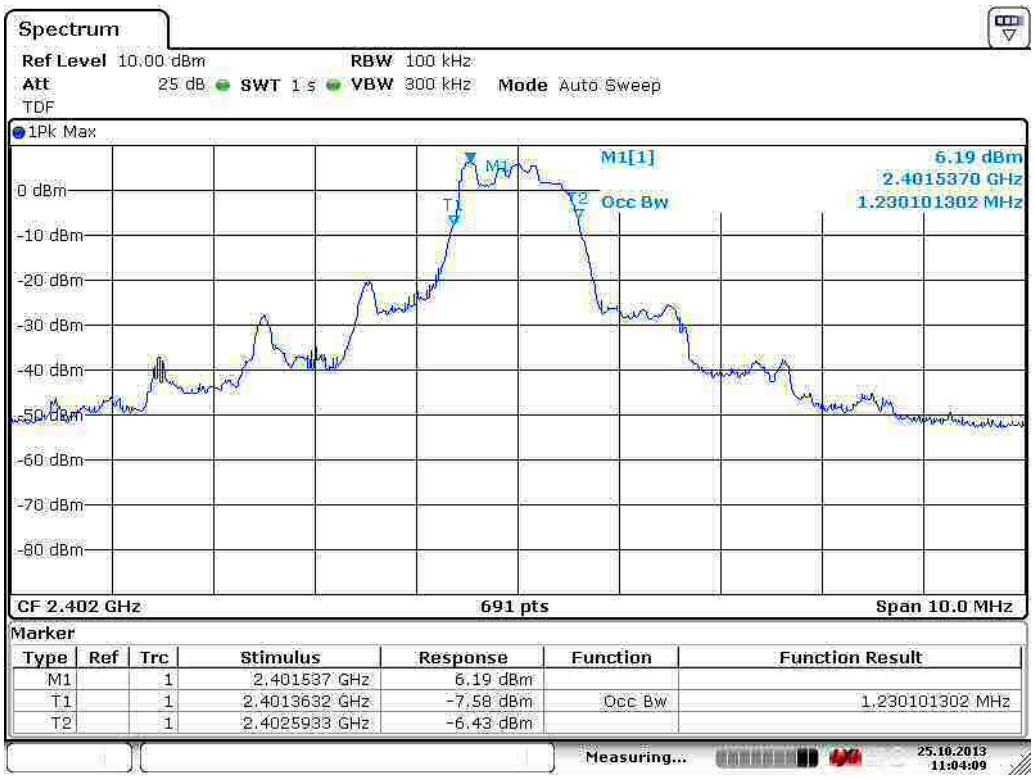
Date: 25.OCT.2013 10:56:26

Figure 102. Mid channel 99% Occupied Power Bandwidth (1 Mbps).



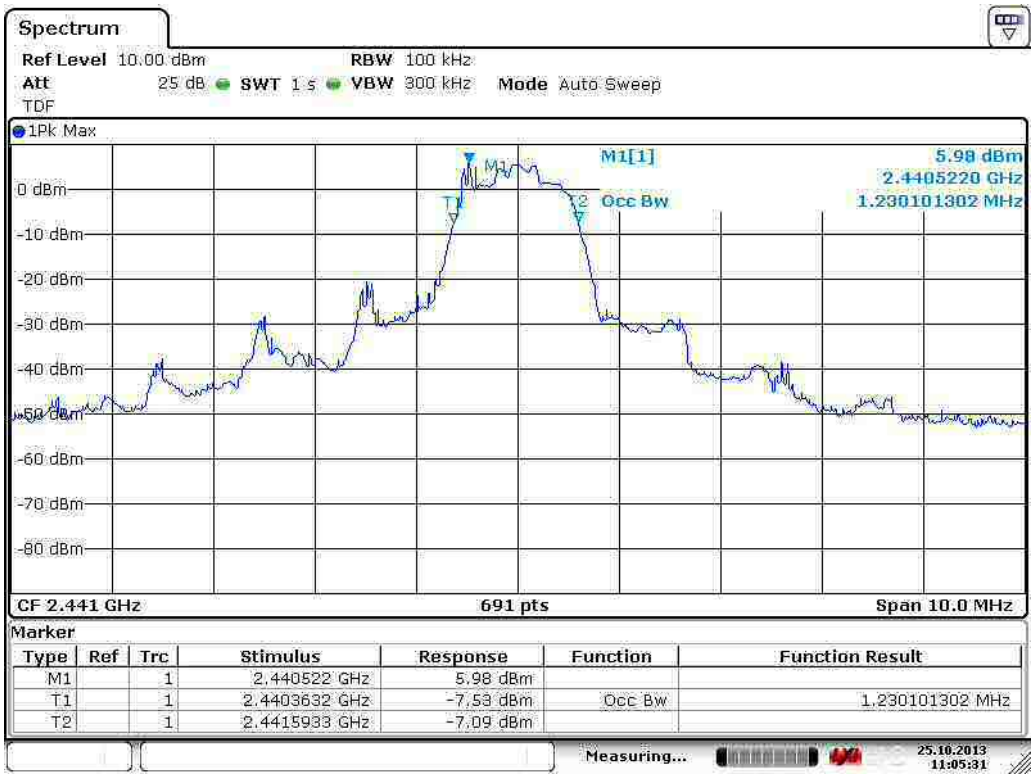
Date: 25.OCT.2013 11:01:24

Figure 103. High channel 99% Occupied Power Bandwidth (1 Mbps).



Date: 25.OCT.2013 11:04:09

Figure 104. Low channel 99% Occupied Power Bandwidth (2 Mbps).

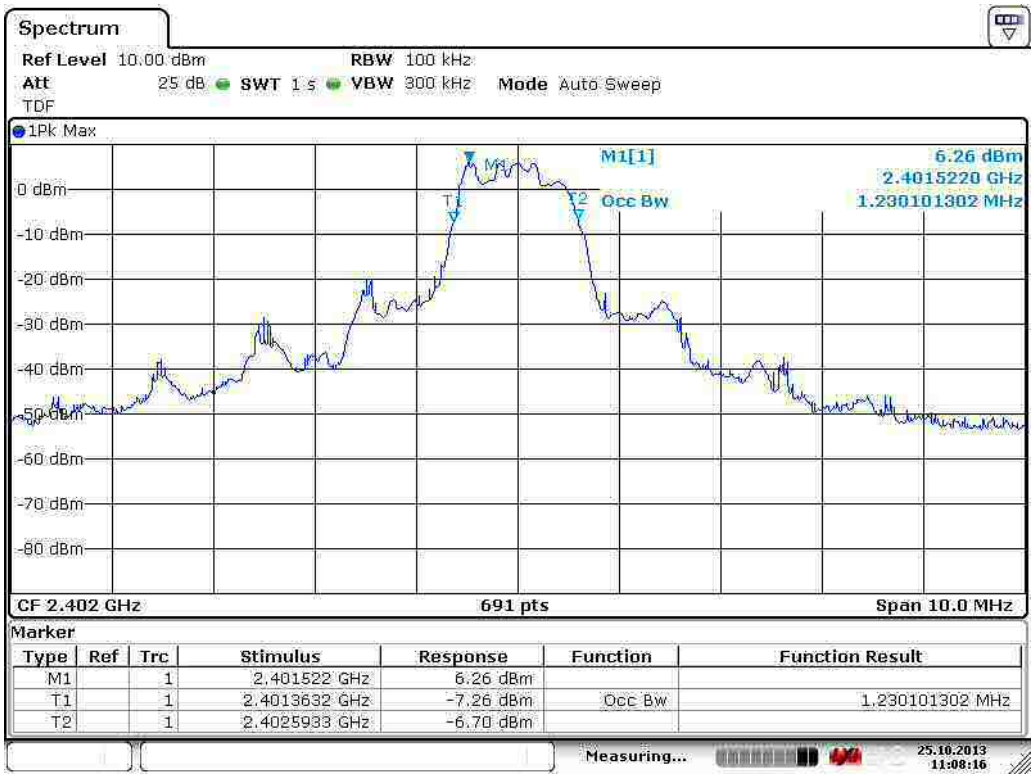


Date: 25.OCT.2013 11:05:31

Figure 105. Mid channel 99% Occupied Power Bandwidth (2 Mbps).

Date: 25.OCT.2013 11:06:46

Figure 106. High channel 99% Occupied Power Bandwidth (2 Mbps).

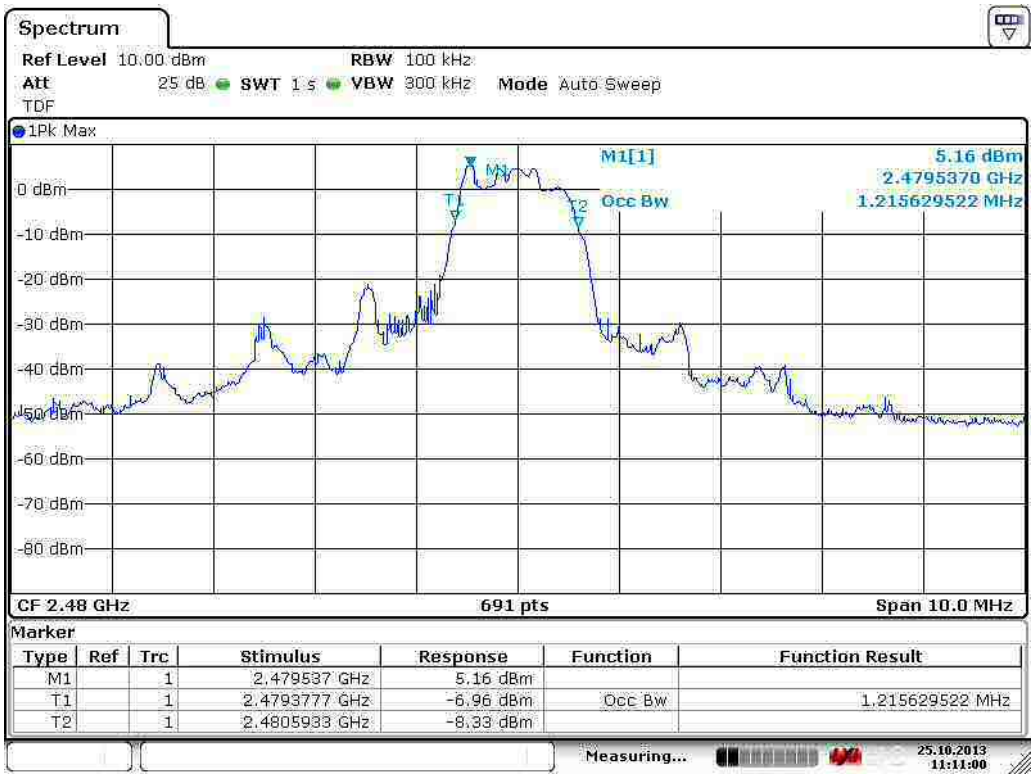


Date: 25.OCT.2013 11:08:16

Figure 107. Low channel 99% Occupied Power Bandwidth (3 Mbps).

Date: 25.OCT.2013 11:09:15

Figure 108. Mid channel 99% Occupied Power Bandwidth (3 Mbps).



Date: 25.OCT.2013 11:11:00

Figure 109. High channel 99% Occupied Power Bandwidth (3 Mbps).

LIST OF TEST EQUIPMENT

Manufacturer	Type	Serial no	Inv. no
ROHDE & SCHWARZ			
Signal Analyzer	FSV40	101068	9093
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
SCHWARZBECK			
Antenna (30 MHz - 1 GHz)	VULB 9168	9168-503	8911
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).