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:	Throwable wireless 2.4 GHz microphone system transmitter
Model:	Catchbox 2.4 Transmitter
Type:	-
Manufacturer:	Trick Technologies Oy Betonimiehenkuja 3D 02150 ESPOO FINLAND
Customer:	Trick Technologies Oy Betonimiehenkuja 3D 02150 ESPOO FINLAND
FCC Rule Part:	15.247: 2013
IC Rule Part:	RSS-210, Issue 8, 2010 RSS-GEN Issue 3, 2010
KDB:	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 (April 9, 2013)

Date:	17.6.2014	Date:	17.6.2014
Issued by:	Niko Kotsalo Test Engineer	Checked by:	Jari Merikari Technical Manager

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Equipment Under Test (EUT)

Catchbox 2.4 Throwable wireless microphone transmitter

Model:	Catchbox 2.4 Transmitter
Type:	-
Serial no:	-
HW version:	HCBATX03
SW version:	Catchboc Basic TX
FCC ID:	2AB78CB24TX001
IC:	-

Description of the EUT

The EUT is a throwable wireless microphone operating in the 2.4 GHz frequency band. Microphone system is intended to be used in small and medium sized events. The system also includes a receiver. The test results for receiver are located in the SGS Fimko test report with reference number 274725-2-2.

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:	18
Channel separation:	4 MHz
Channel bandwidth:	4.037626628 MHz
Effective conducted power:	12.67 dBm
Transmission technique:	Digital Transmission
Modulation:	8FSK
Integral Antenna gain:	3.3 dBi

Power Supply

Battery operated	2x 1.5V AA batteries
Operating voltage range	2.5 – 4.0 VDC

Mechanical Size of the EUT

Height: 16 cm	Diameter:11.5 cm

Samples

A commercial sample was used in the tests. During the tests the EUT was set into continuous transmit mode with Texas Instruments PurePath Wireless Commander computer software. Hopping was stopped into the channel under test. Normal test modulation and maximum transmit power was used in all tests. No modifications were done during the tests.

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Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only. This document cannot be reproduced except in full, without prior approval of the Company.

SUMMARY OF TESTING

Test Specification	Description of Test	Result
§15.247(b)(3) / RSS-210 A8.4	Maximum Peak Conducted Output Power	PASS
§15.247(a)(2) / RSS-210 A8.2	6 dB Bandwidth	PASS
§15.247(e) / RSS-210 A8.2	Power Spectral Density	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

EUT Test Conditions During Testing

The EUT was in continuous transmit mode during all tests. Hopping was stopped and the EUT was configured into the wanted channel. Normal modulation and 98 % duty cycle was applied in all tests. Normal duty cycle of the EUT was measured and it was 5.8 % which is the highest possible duty cycle in normal mode.

Average values for transmitter radiated emissions were calculated from measured peak pulse amplitude and by determining the duty cycle correction factor of the pulse modulation. The duty cycle correction expressed in dB was determined as follows:

Duty Cycle Correction = 20log (Dwell Time/100ms)

Calculated Duty Cycle Correction for the EUT is - 24.8 dB

Following channels were used during the tests when the hopping was stopped:
Channel Low (Ch 1) = 2406 MHz
Channel Mid (Ch 9) = 2442 MHz
Channel High (Ch 18) = 2474 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

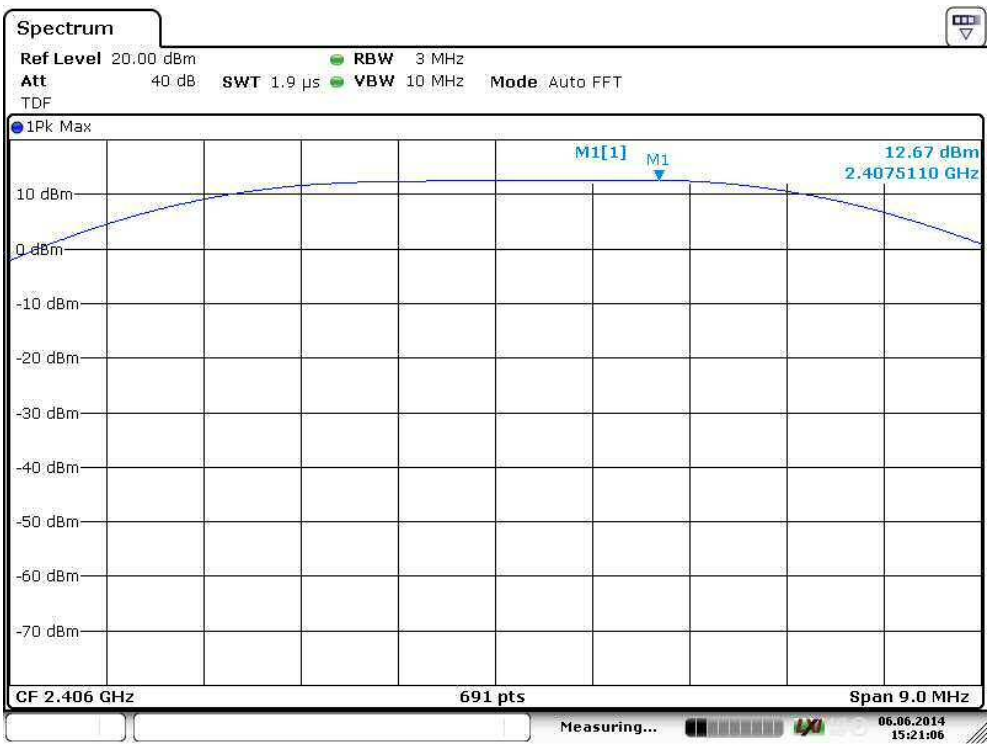
Standard:	ANSI C63.10	(2009)
Tested by:	NKO	
Date:	6.6.2014	
Humidity:	48%	
Temperature:	24.8 °C	
Measurement uncertainty	± 2,87dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.247(b)(3)

For systems using digital modulation in the 2400-2483.5 MHz bands the limit is 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power.

Results:

Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
Low	12.67	30	17.33	PASS
Mid	12.11	30	17.89	PASS
High	11.47	30	18.53	PASS



Date: 6.JUN.2014 15:21:06

Figure 1. Channel Low.

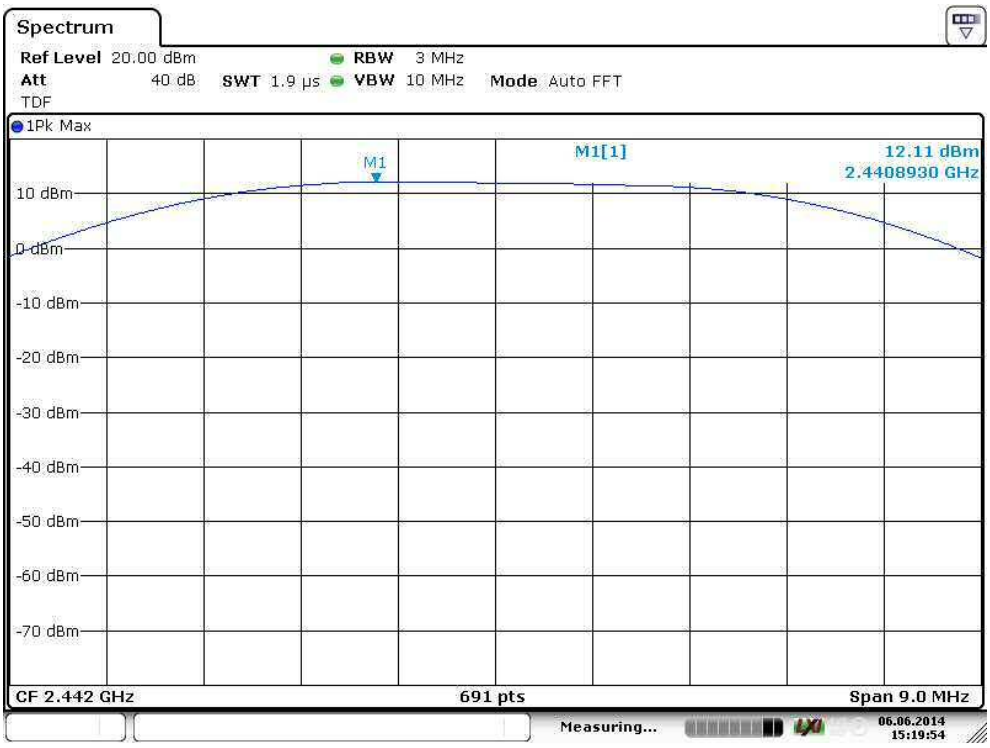


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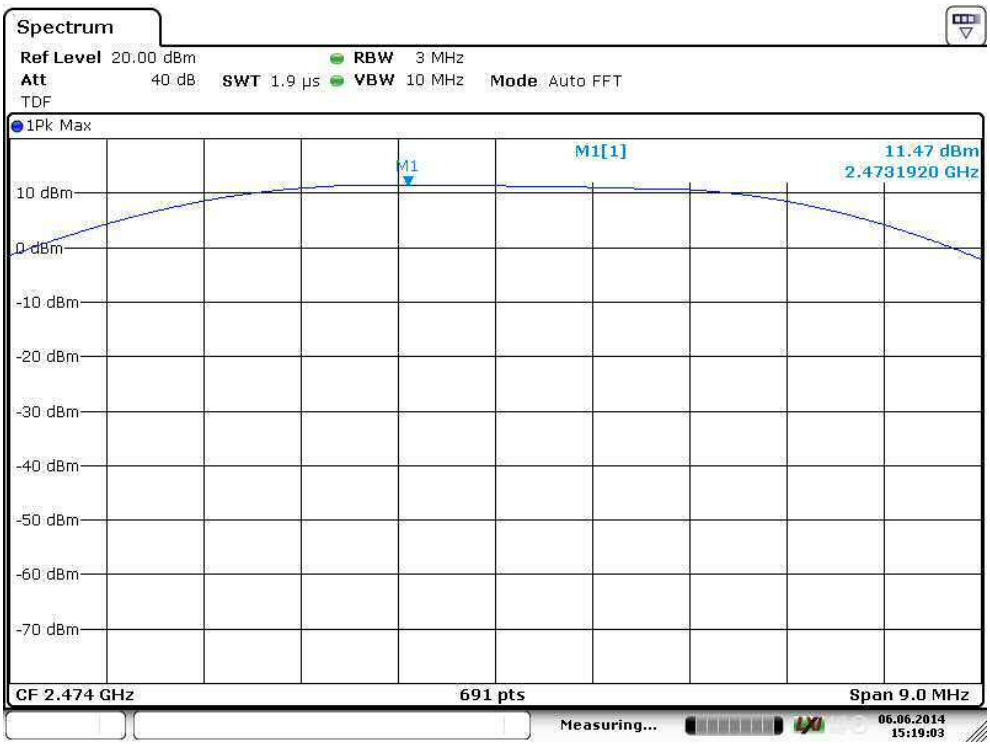
Figure 2. Channel Mid.



Date: 6.JUN.2014 15:19:03

Figure 3. Channel High.

Transmitter Radiated Spurious Emissions 30 – 1000 MHz

Standard:	ANSI C63.10	(2009)
Tested by:	NKO	
Date:	17.4. – 20.5.2014	
Humidity:	20 – 46.5 %	
Temperature:	22.0 – 25.6 °C	
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.

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

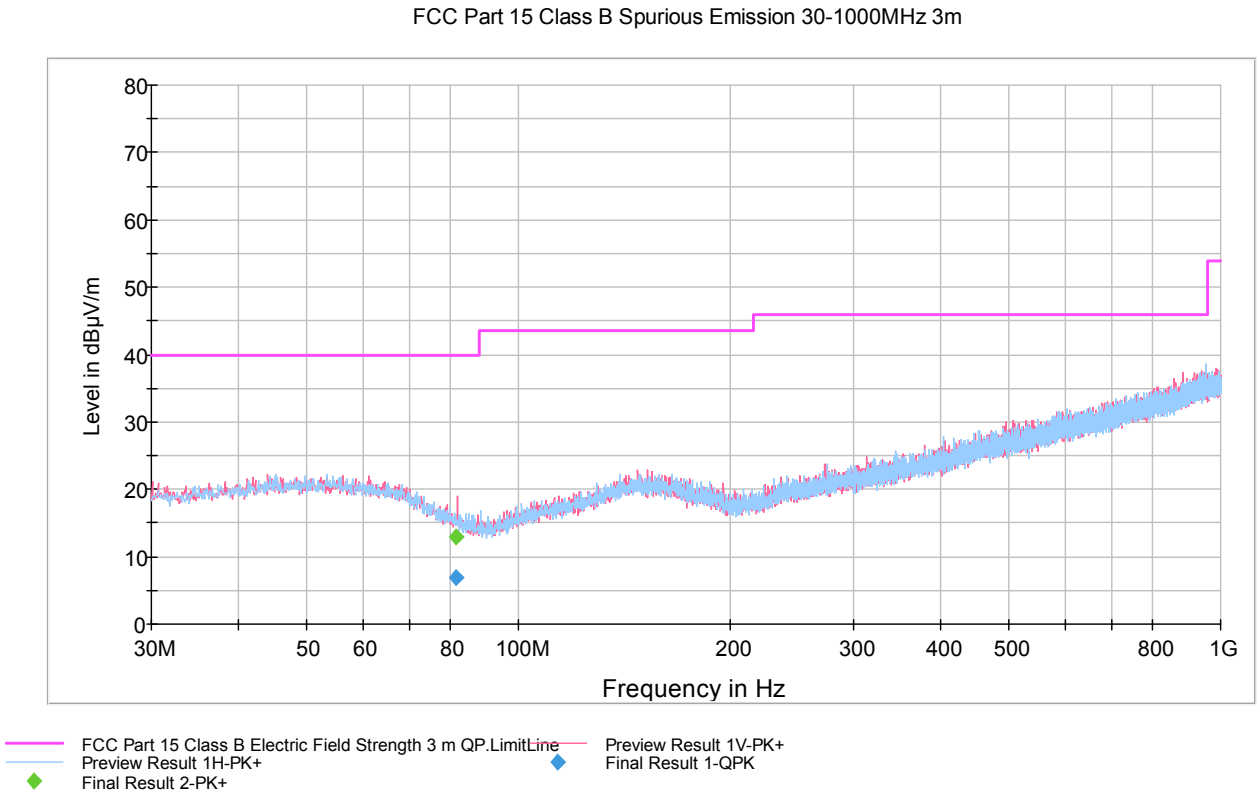


Figure 4. Measured curve with peak-detector. Channel Low.

Final measurements from the worst frequencies

Table 1. Final results.

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
81.418000	7.0	1000.0	120.000	365.0	V	95.0	9.9	33.0	40.0	

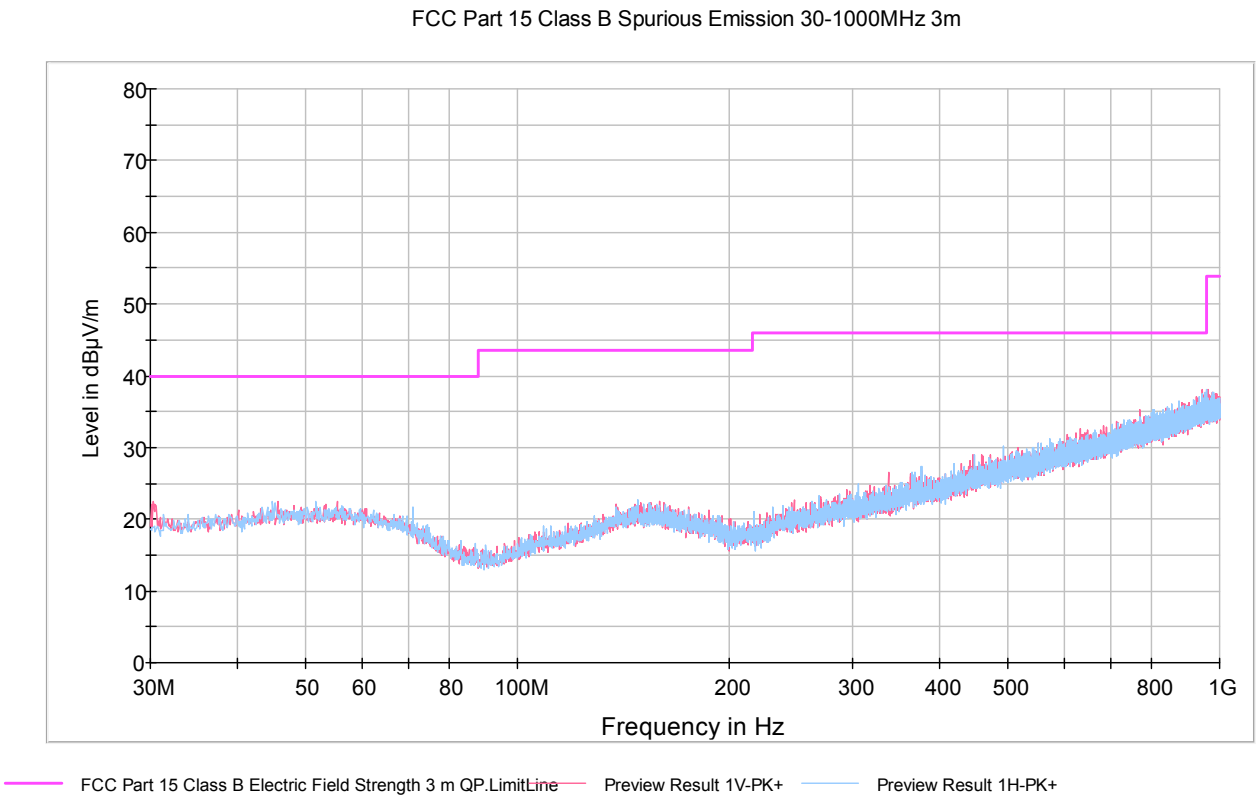


Figure 5. Measured curve with peak-detector. Channel Mid.

Final measurements from the worst frequencies

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

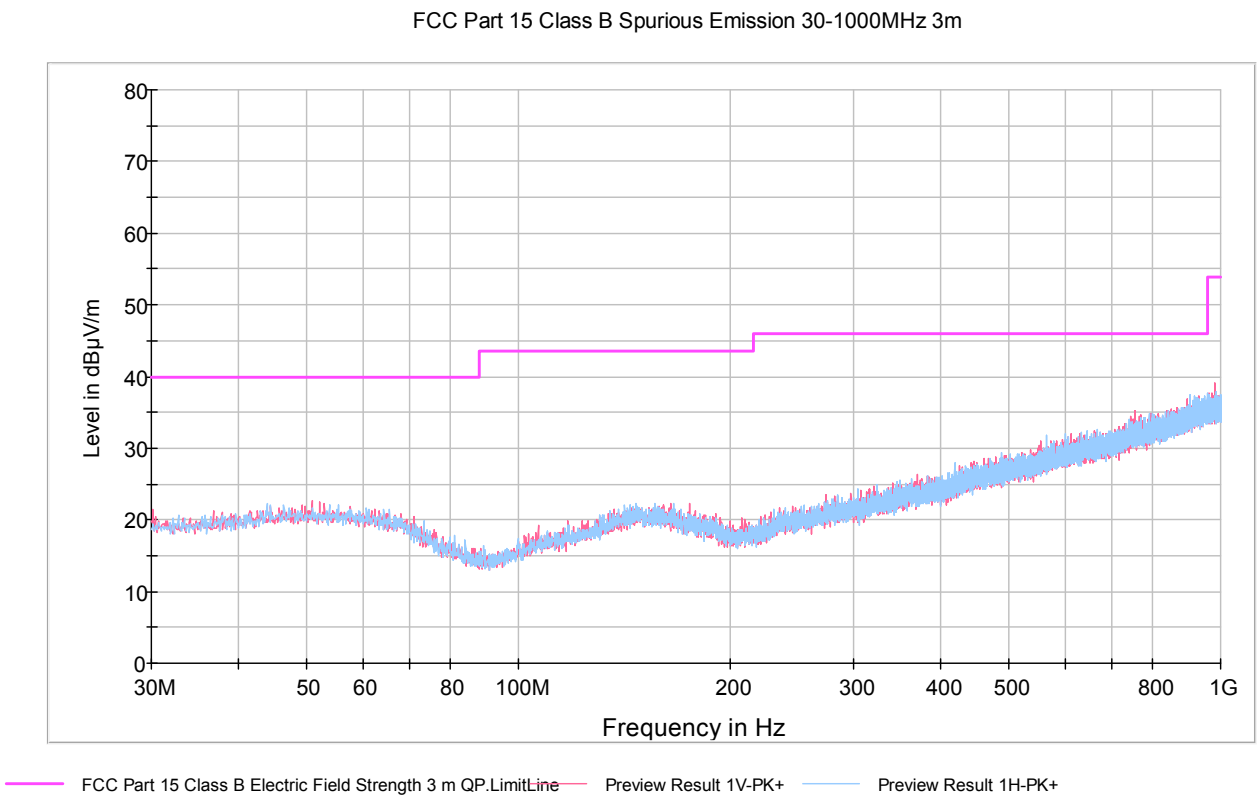


Figure 6. Measured curve with peak-detector. Channel High.

Final measurements from the worst frequencies

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

Transmitter Radiated Spurious 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.

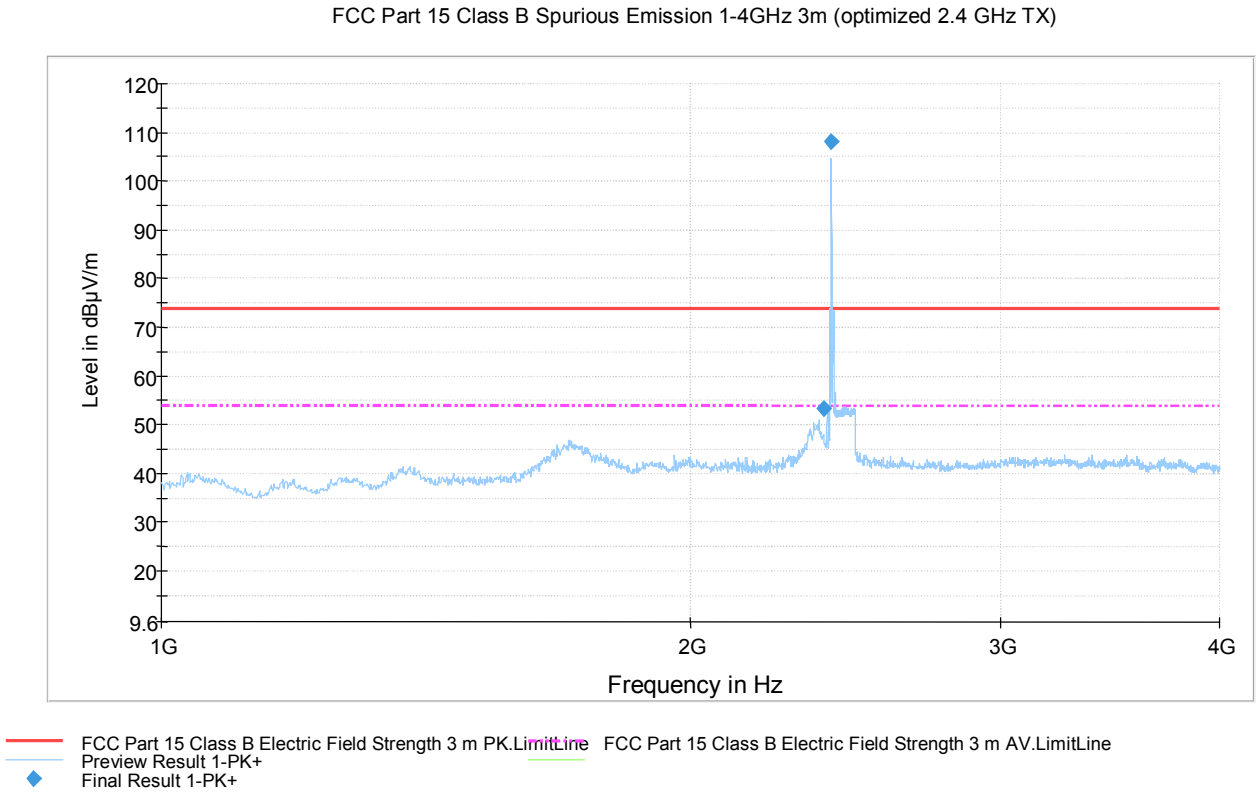


Figure 7. Measured curve with peak detector. Channel Low.

Final measurements from the worst frequencies

Table 2. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Margin (dB)	Limit (dBµV/m)	Comment
2380.200000	53.3	1000.0	1000.000	186.0	V	122.0	20.6	73.9	
2406.000000	108.1	1000.0	1000.000	186.0	V	128.0	-34.2	73.9	Carrier

Table 3. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Margin (dB)	Limit (dBµV/m)	Comment
2380.200000	28.5	1000.000	186.0	V	122.0	25.4	53.9	
2406.000000	83.3	1000.000	186.0	V	128.0	-4.6	53.9	Carrier

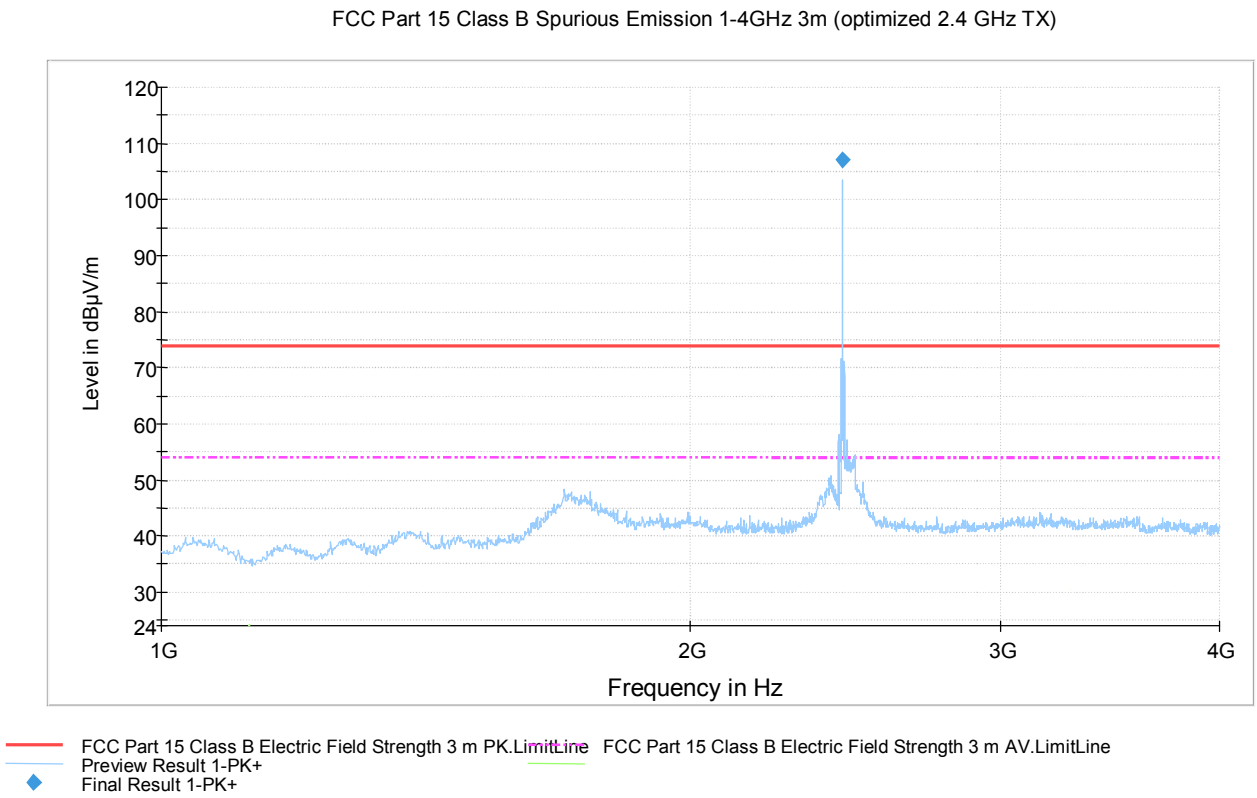


Figure 8. Measured curve with peak detector. Channel Mid.

Final measurements from the worst frequencies

Table 4. 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
2442.000000	107.0	1000.0	1000.000	148.0	V	115.0	4.4	-33.1	73.9	Carrier

Table 5. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Margin (dB)	Limit (dBµV/m)	Comment
2442.000000	82.2	-28.3	53.9	Carrier

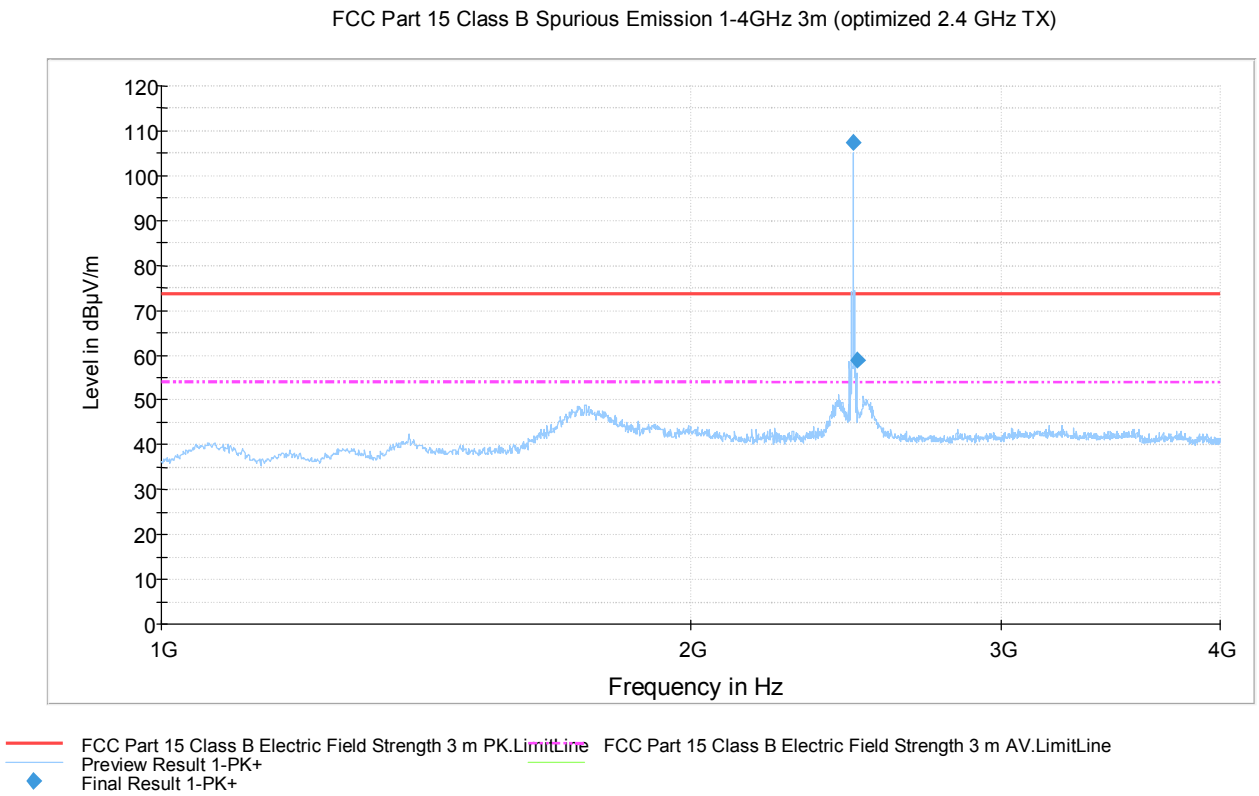


Figure 9. Measured curve with peak detector. Channel High.

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
2474.000000	107.4	1000.0	1000.000	170.0	V	-4.0	4.7	-33.5	73.9	Carrier
2486.100000	58.8	1000.0	1000.000	171.0	V	-4.0	4.8	15.1	73.9	

Table 7. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Margin (dB)	Limit (dBµV/m)	Comment
2474.000000	82.7	-28.8	53.9	Carrier
2486.100000	34	19.9	53.9	

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

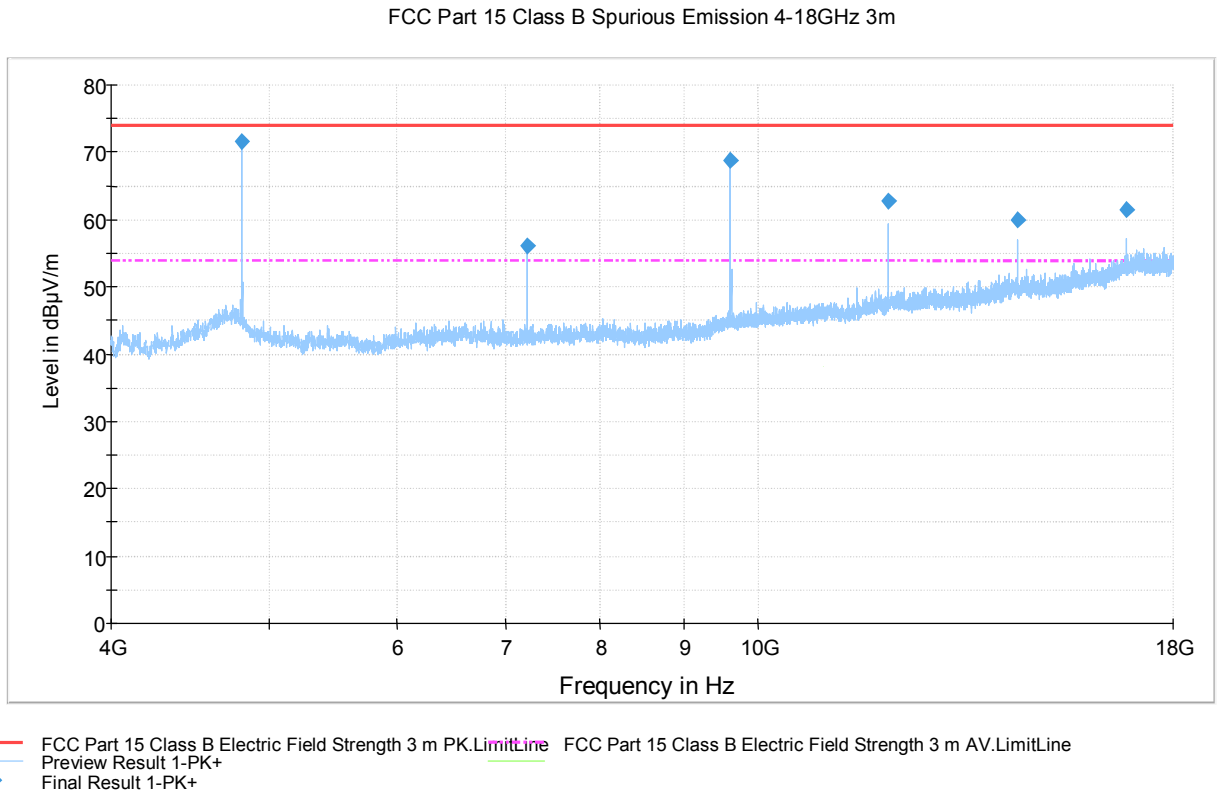


Figure 10. Measured curve with peak detector. Channel Low.

Final measurements from the worst frequencies

Table 8. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Margin (dB)	Limit (dBµV/m)	Comment
4812.200000	71.6	1000.0	1000.000	122.0	H	123.0	2.3	73.9	
7218.200000	56.1	1000.0	1000.000	114.0	V	318.0	17.8	73.9	
9624.400000	68.9	1000.0	1000.000	113.0	H	50.0	5.0	73.9	
12030.600000	62.8	1000.0	1000.000	138.0	H	48.0	11.1	73.9	
14436.600000	60.0	1000.0	1000.000	100.0	H	46.0	13.9	73.9	
16842.400000	61.5	1000.0	1000.000	100.0	H	145.0	12.4	73.9	

Table 9. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Margin (dB)	Limit (dBµV/m)	Comment
4812.200000	46.8	7.1	53.9	
7218.200000	31.3	22.6	53.9	
9624.400000	44.1	9.8	53.9	
12030.600000	38	15.9	53.9	
14436.600000	35.2	18.7	53.9	
16842.400000	36.7	17.2	53.9	

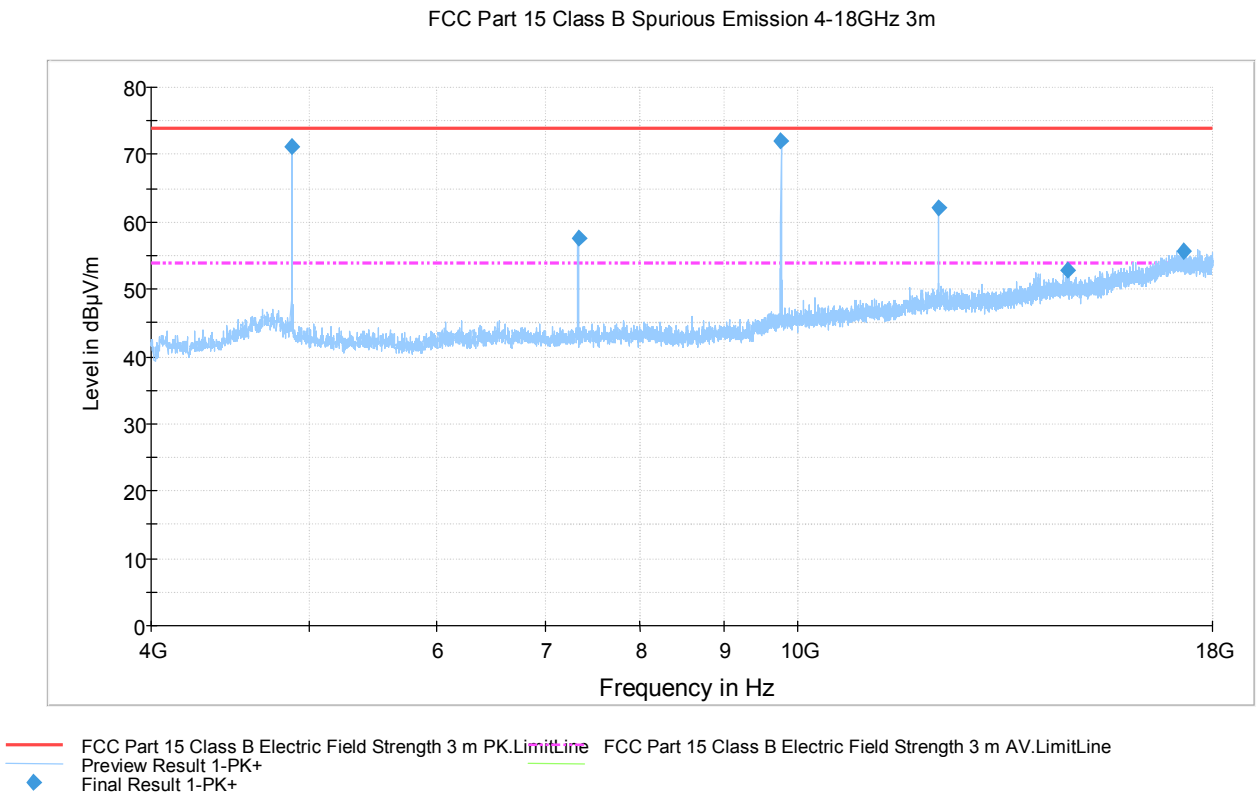


Figure 11. Measured curve with peak detector. Channel Mid.

Final measurements from the worst frequencies

Table 10. Final Max Peak results

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Margin (dB)	Limit (dBµV/m)	Comment
4884.200000	71.1	1000.0	1000.000	100.0	H	41.0	14.9	73.9	
7326.000000	57.5	1000.0	1000.000	100.0	H	343.0	26.8	73.9	
9764.800000	72.1	1000.0	1000.000	100.0	H	71.0	25.8	73.9	
12210.800000	62.0	1000.0	1000.000	100.0	H	327.0	23.2	73.9	
14653.200000	52.9	1000.0	1000.000	100.0	H	314.0	21.0	73.9	
17276.600000	55.7	1000.0	1000.000	100.0	V	177.0	18.2	73.9	

Table 11. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Margin (dB)	Limit (dBµV/m)	Comment
4884.200000	46.3	7.6	53.9	
7326.000000	32.7	21.2	53.9	
9764.800000	47.3	6.6	53.9	
12210.800000	37.2	16.7	53.9	
14653.200000	28.1	25.8	53.9	
17276.600000	30.9	23	53.9	

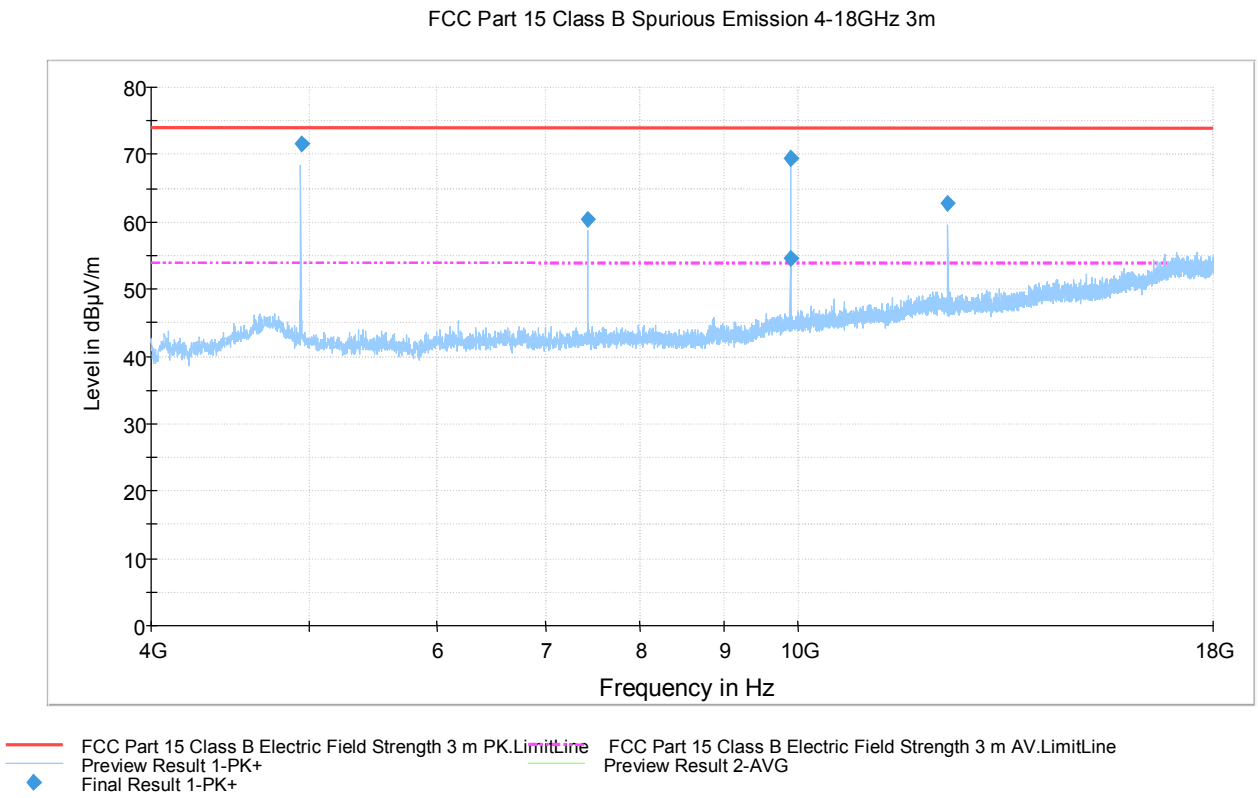


Figure 12. Measured curve with peak- detector. Channel High.

Final measurements from the worst frequencies

Table 12. 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
4948.200000	71.6	1000.0	1000.000	146.0	H	15.0	12.1	2.3	73.9	
7422.200000	60.4	1000.0	1000.000	113.0	H	330.0	13.4	13.5	73.9	
9890.400000	54.5	1000.0	1000.000	100.0	H	43.0	16.8	19.4	73.9	
9896.400000	69.4	1000.0	1000.000	100.0	H	41.0	16.8	4.5	73.9	
12370.600000	62.8	1000.0	1000.000	130.0	H	310.0	21.3	11.1	73.9	

Table 13. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Margin (dB)	Limit (dBµV/m)	Comment
4948.200000	46.8	7.1	53.9	
7422.200000	35.6	18.3	53.9	
9890.400000	29.7	24.2	53.9	
9896.400000	44.6	9.3	53.9	
12370.600000	38	15.9	53.9	

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

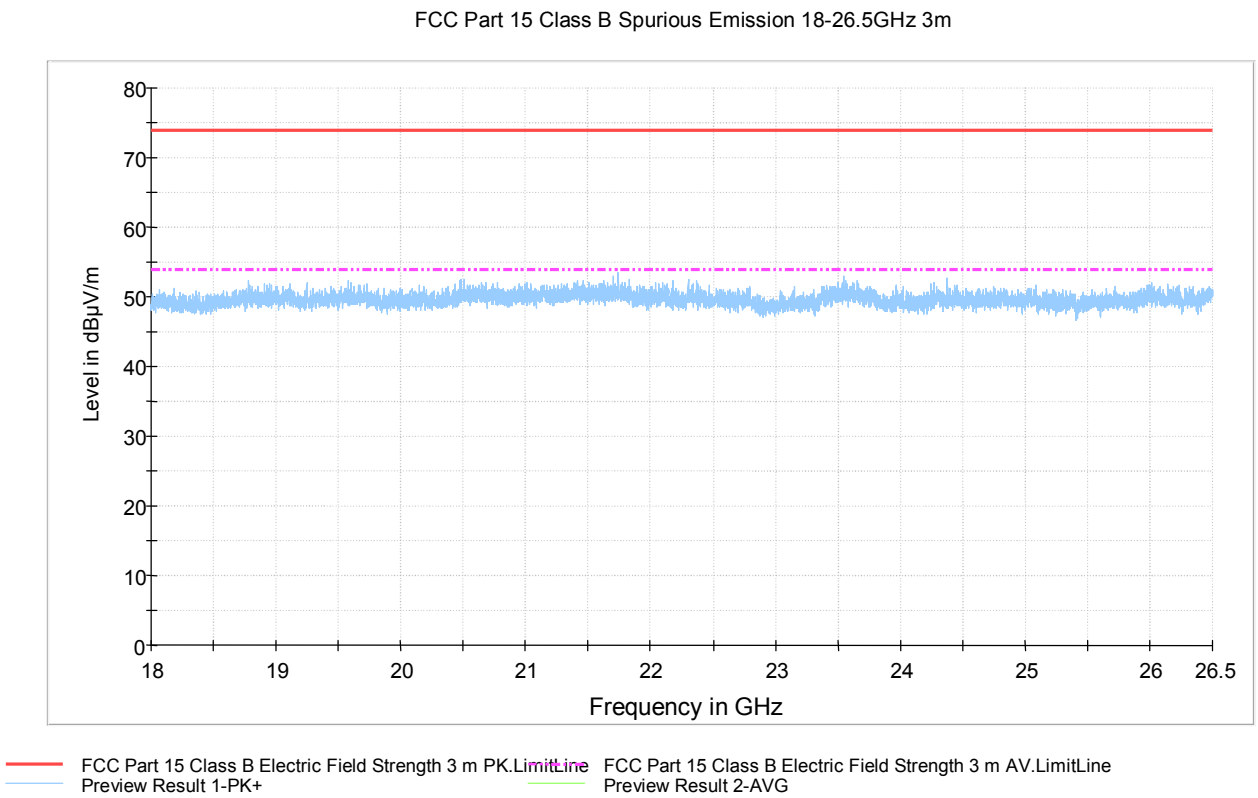


Figure 13. Measured curve with peak- and average detector. Channel Low.

Final measurements from the worst frequencies

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

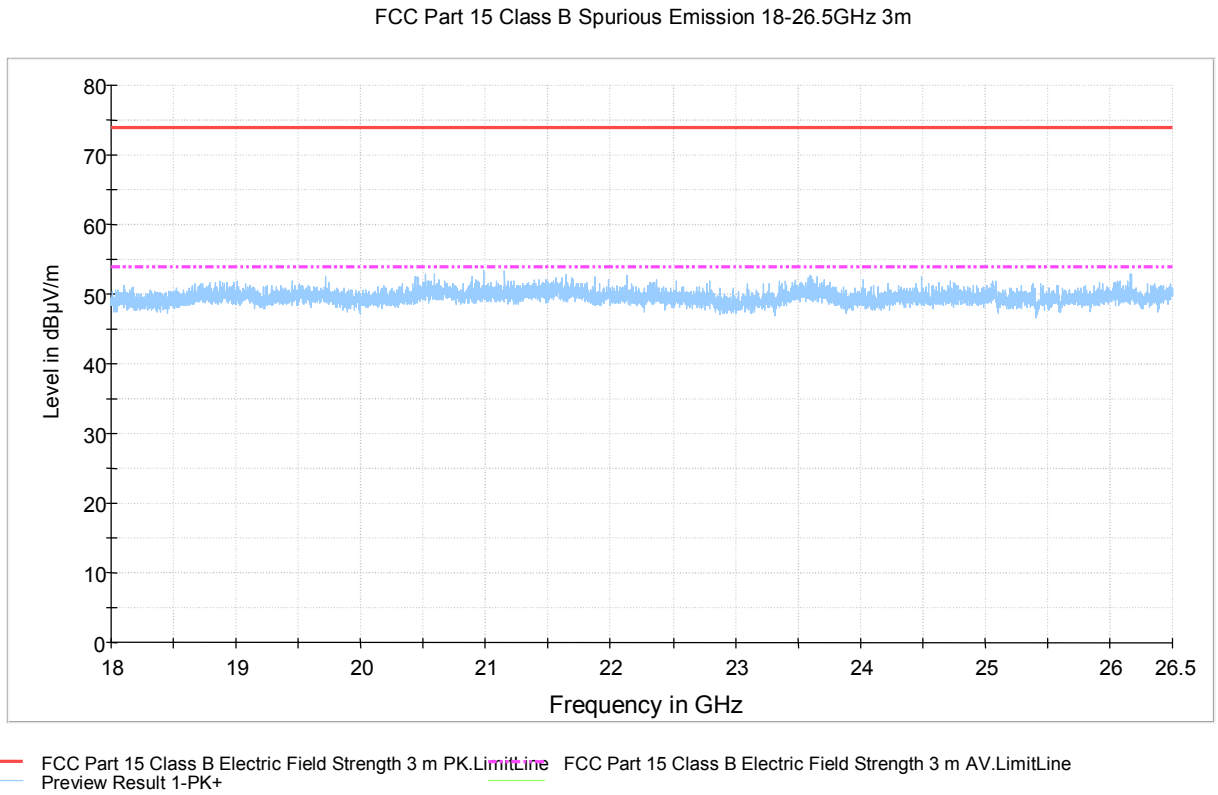


Figure 14. Measured curve with peak- and average detector. Channel Mid.

Final measurements from the worst frequencies

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

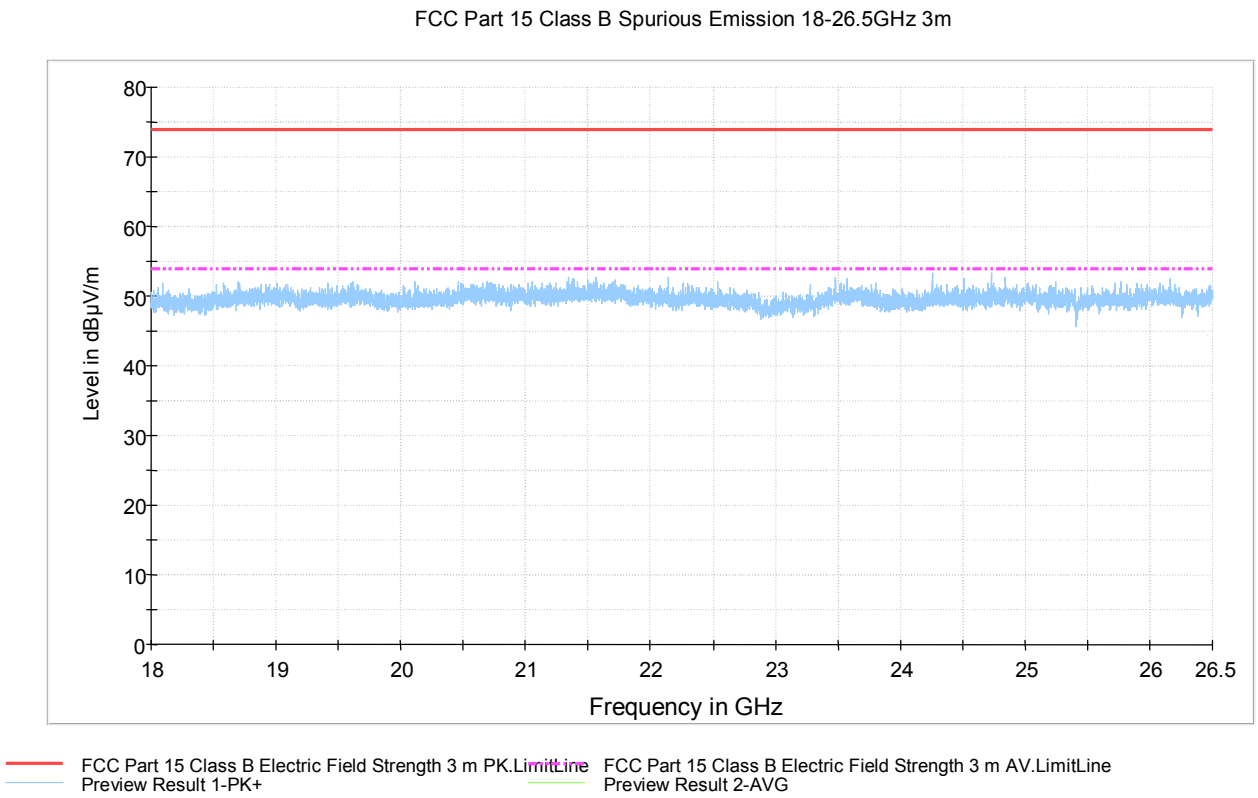


Figure 15. Measured curve with peak- and average detector. Channel High.

Final measurements from the worst frequencies

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

Radiated band edge measurement results

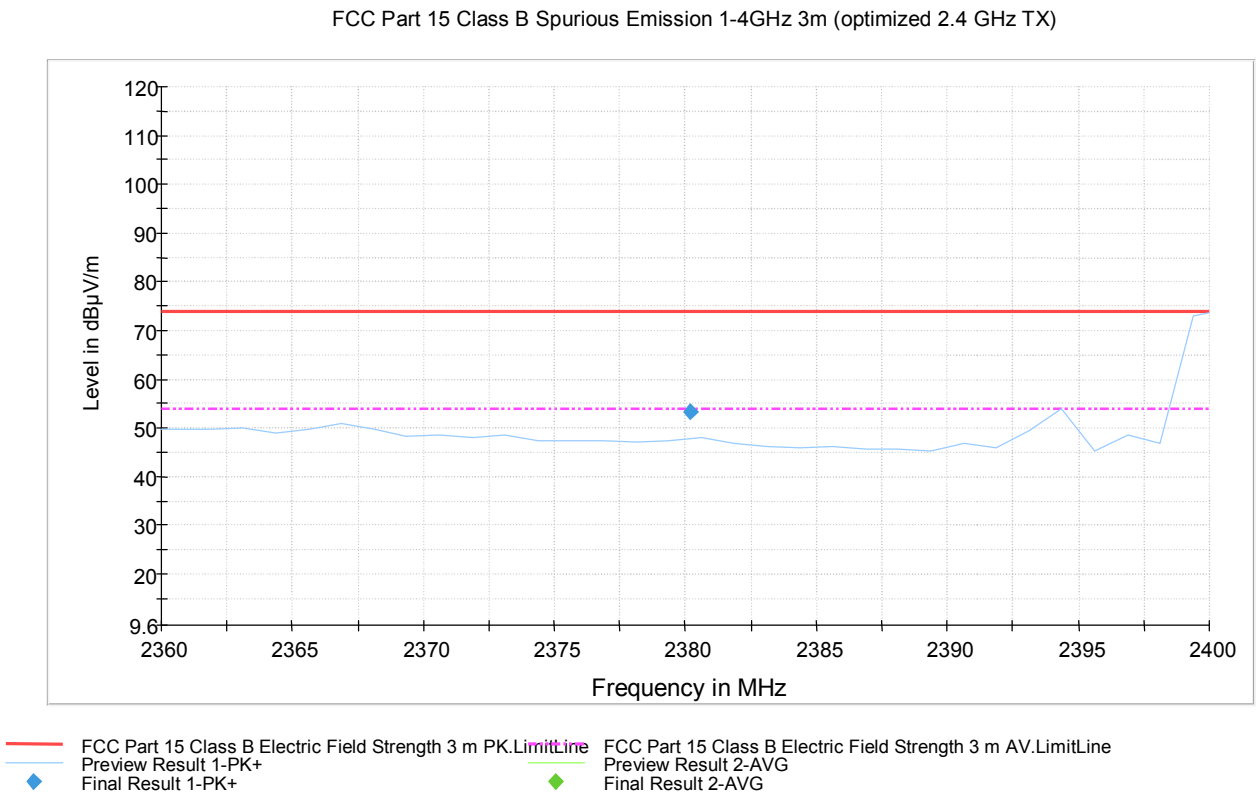


Figure 16. Measured curve with peak- and average detector. Lower band edge.

Final measurements from the worst frequencies

Table 14. 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
2380.200000	53.3	1000.0	1000.000	186.0	V	122.0	4.3	20.6	73.9	

Table 15. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Margin (dB)	Limit (dBµV/m)	Comment
2380.200000	28.5	30.4	53.9	

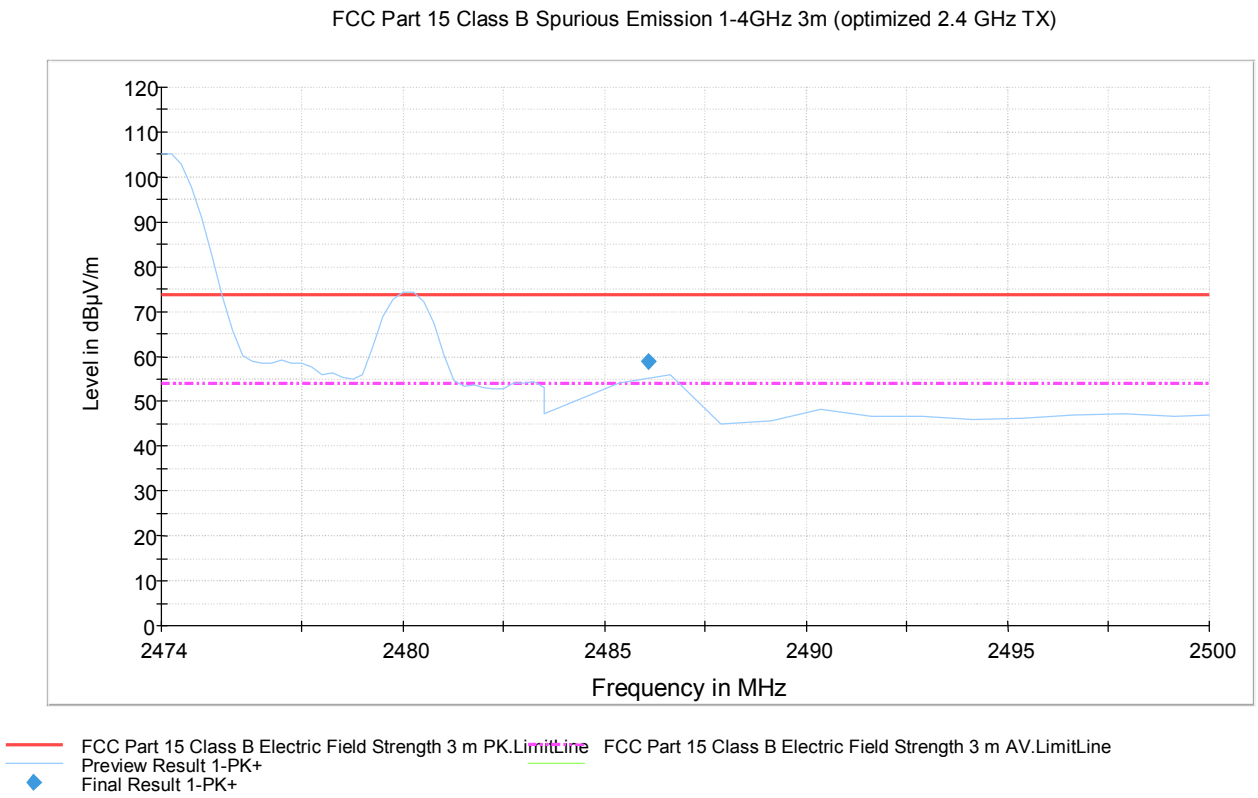


Figure 17. Measured curve with peak- and average detector. Upper band edge.

Final measurements from the worst frequencies

Table 16. 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
2486.100000	58.8	1000.0	1000.000	171.0	V	-4.0	4.8	15.1	73.9	

Table 17. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Margin (dB)	Limit (dBµV/m)	Comment
2486.100000	34	19.9	53.9	

Transmitter Band Edge Measurement and Conducted Spurious Emissions

Standard:	ANSI C63.10	(2009)
Tested by:	NKO	
Date:	6.6.2014	
Humidity:	48 %	
Temperature:	24.8 °C	
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)).

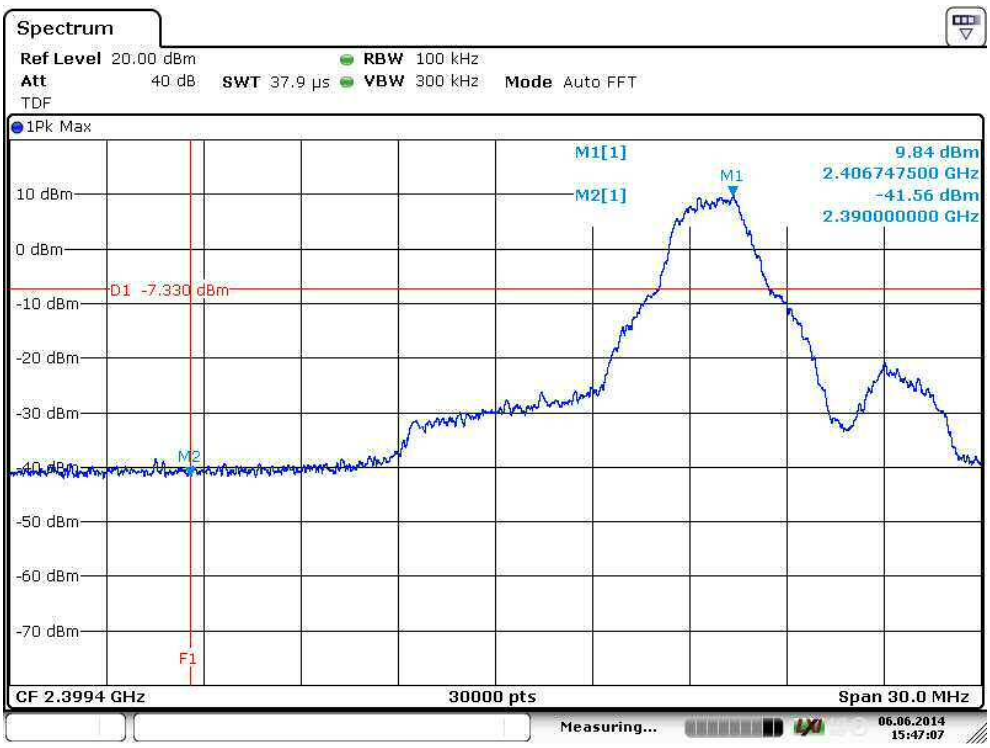
Table 18. Band edge attenuation.

Band Edge Attenuation	
Lower Band Edge	Upper Band Edge
-54.23 dBc	-49.16 dBc
Limit: -20dBc	

Table 19. Conducted spurious emissions.

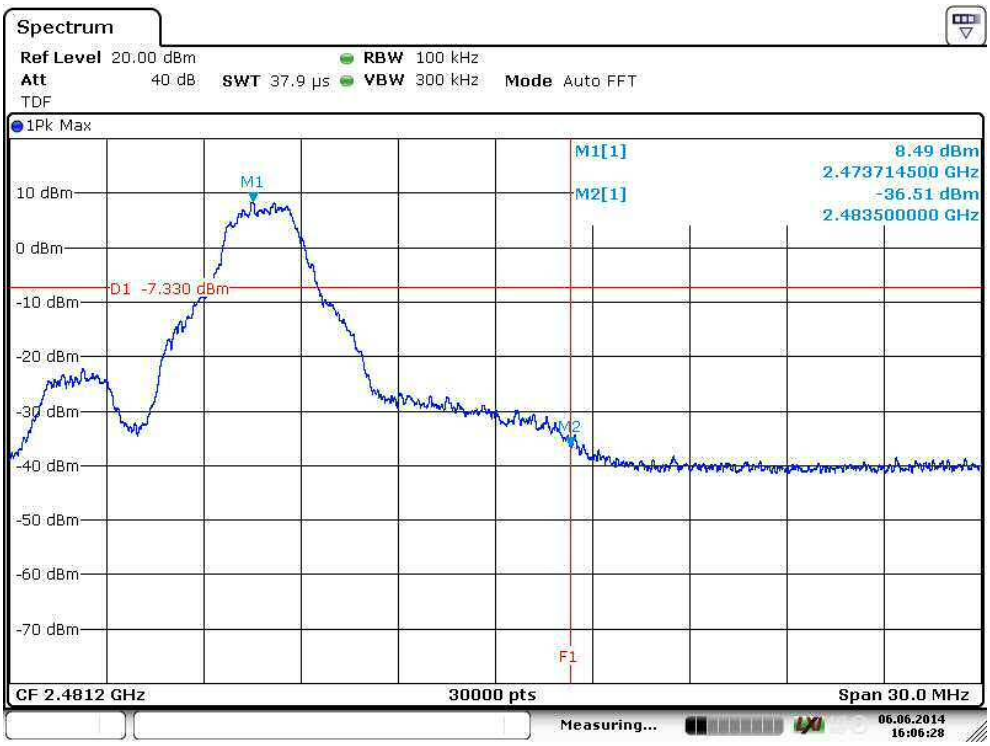
Conducted Spurious Emissions				
Channel	**Measured Attenuation [dB]**	**Limit [dBc]**	**Margin [dB]**	**Result**
Low	-	-20.0	-	-
Mid	-	-20.0	-	-
High	-	-20.0	-	-

No significant emissions were detected close to the limit.



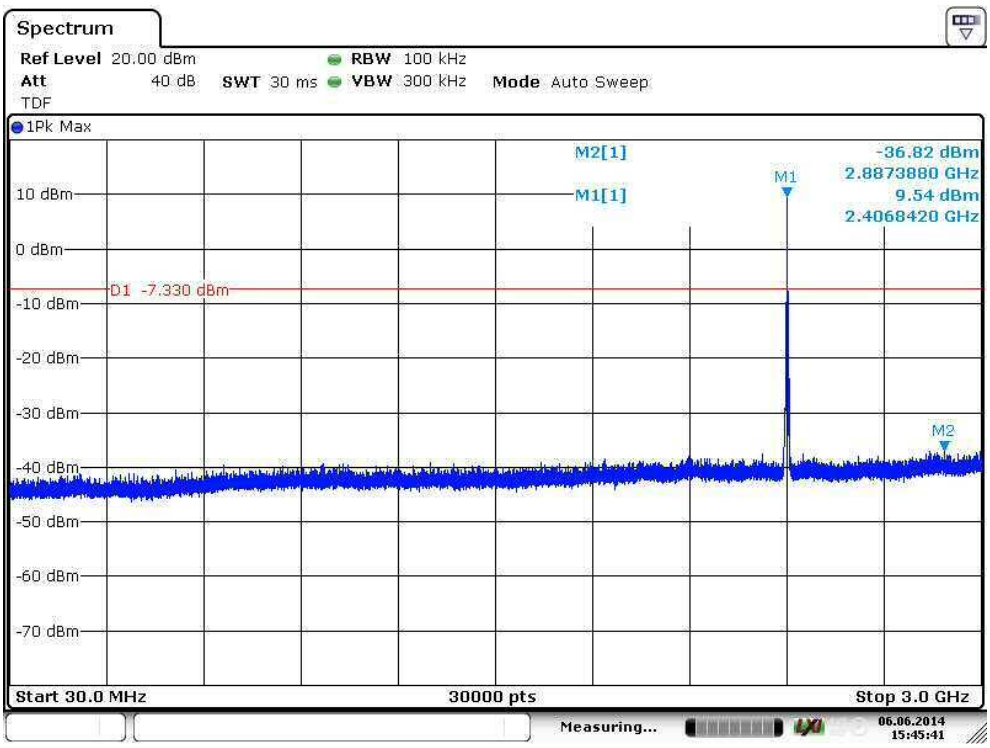
Date: 6.JUN.2014 15:47:07

Figure 18. Lower Band Edge.



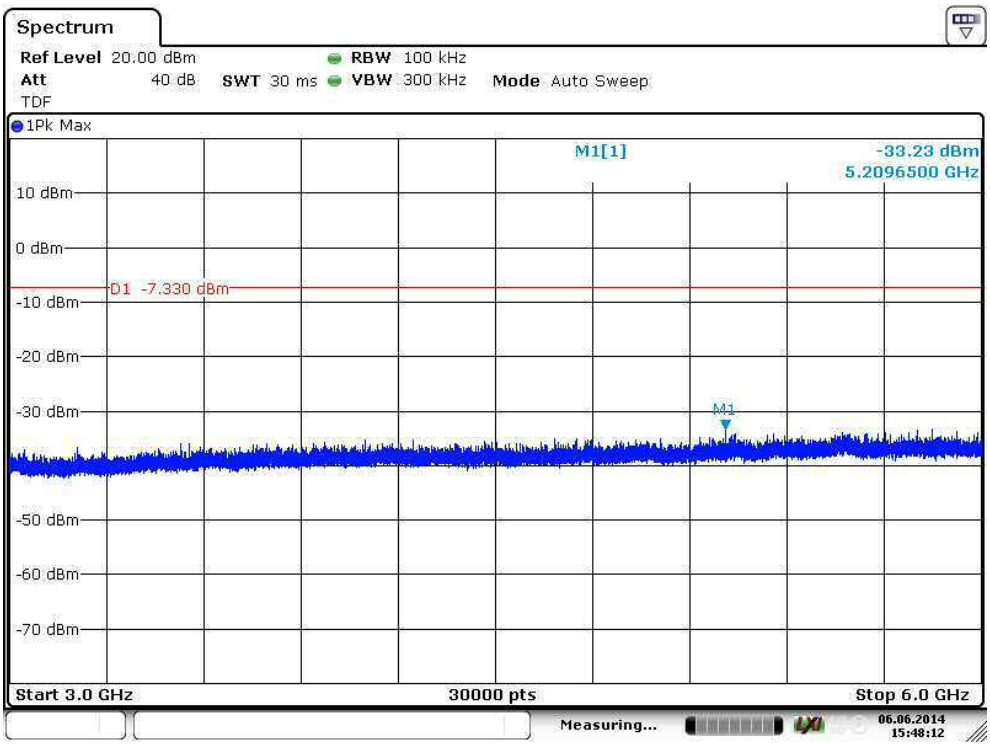
Date: 6.JUN.2014 16:06:28

Figure 19. Upper Band Edge.



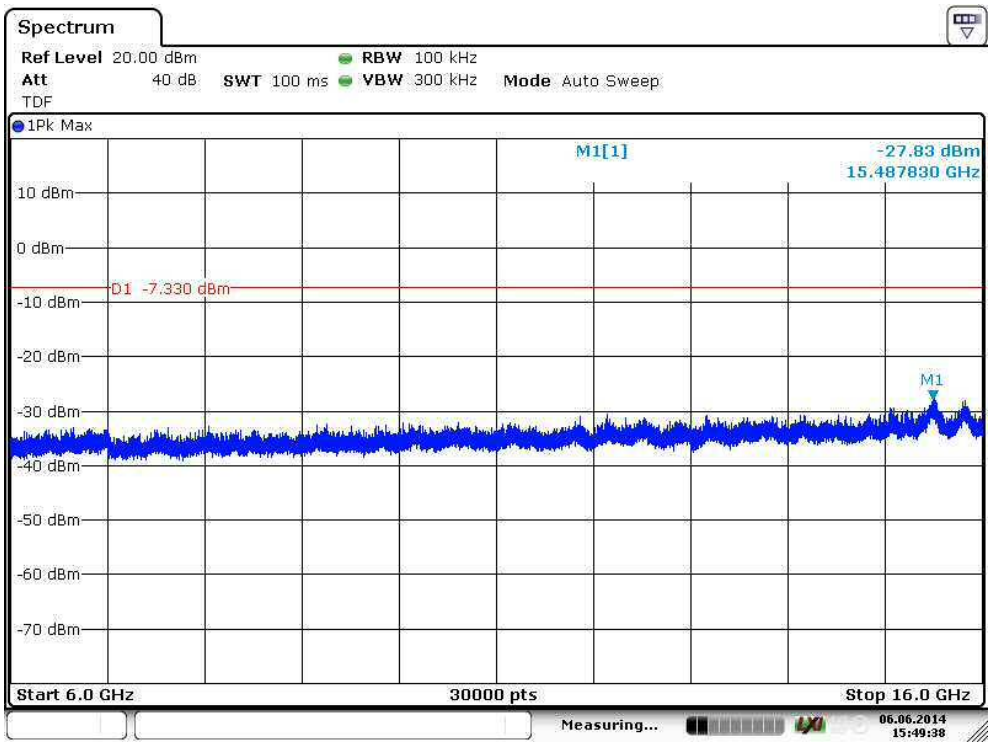
Date: 6.JUN.2014 15:45:42

Figure 20. Conducted Spurious Emissions 30 – 3 000 MHz. Channel Low.



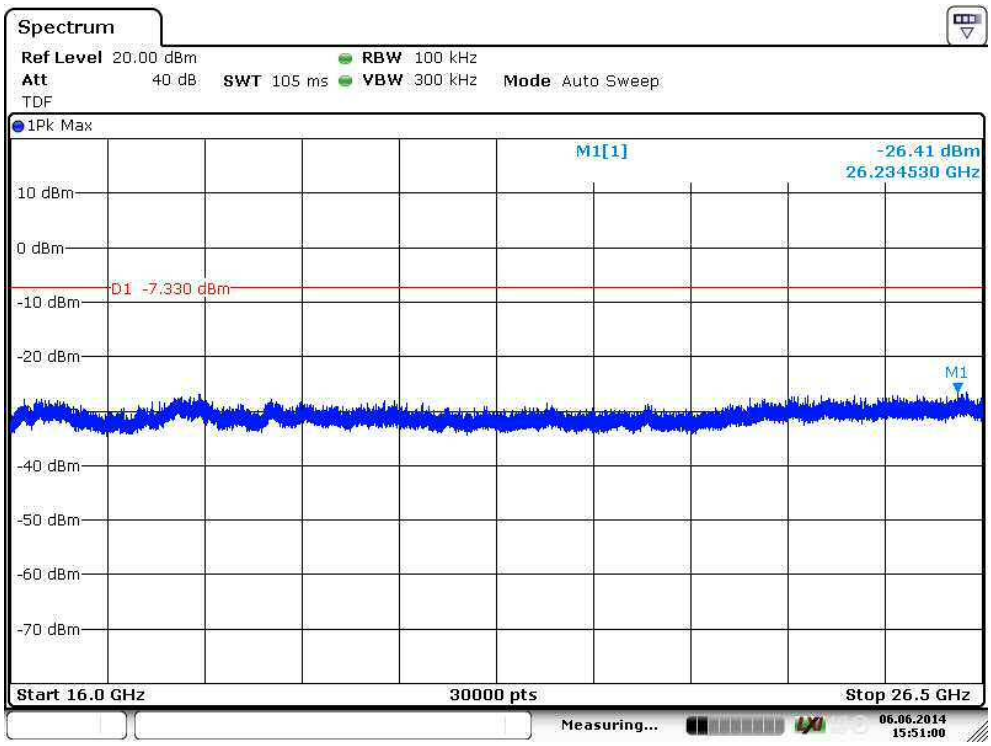
Date: 6.JUN.2014 15:48:11

Figure 21. Conducted Spurious Emissions 3 000 – 6 000 MHz. Channel Low.



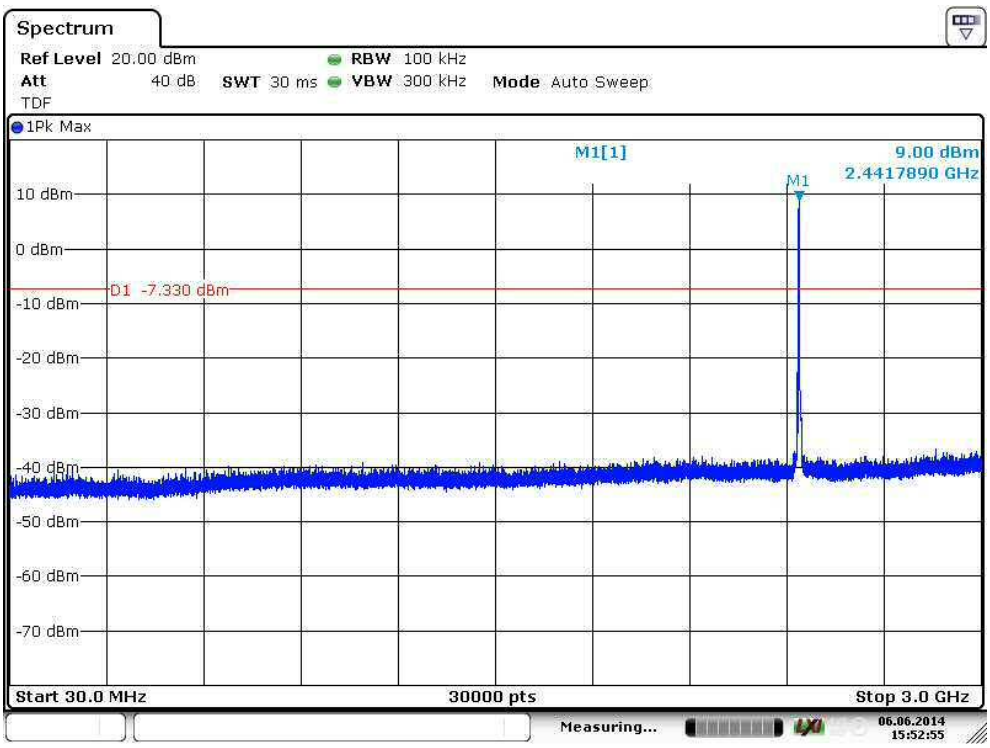
Date: 6.JUN.2014 15:49:38

Figure 22. Conducted Spurious Emissions 6 000 – 16 000 MHz. Channel Low.



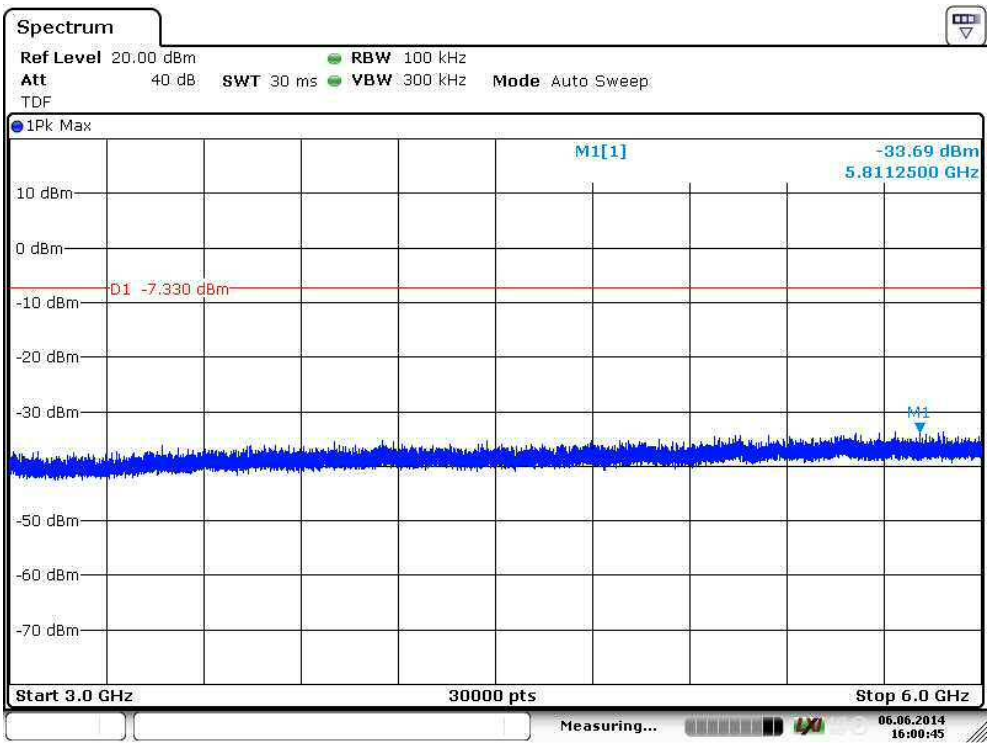
Date: 6.JUN.2014 15:51:01

Figure 23. Conducted Spurious Emissions 16 000 – 26 500 MHz. Channel Low.



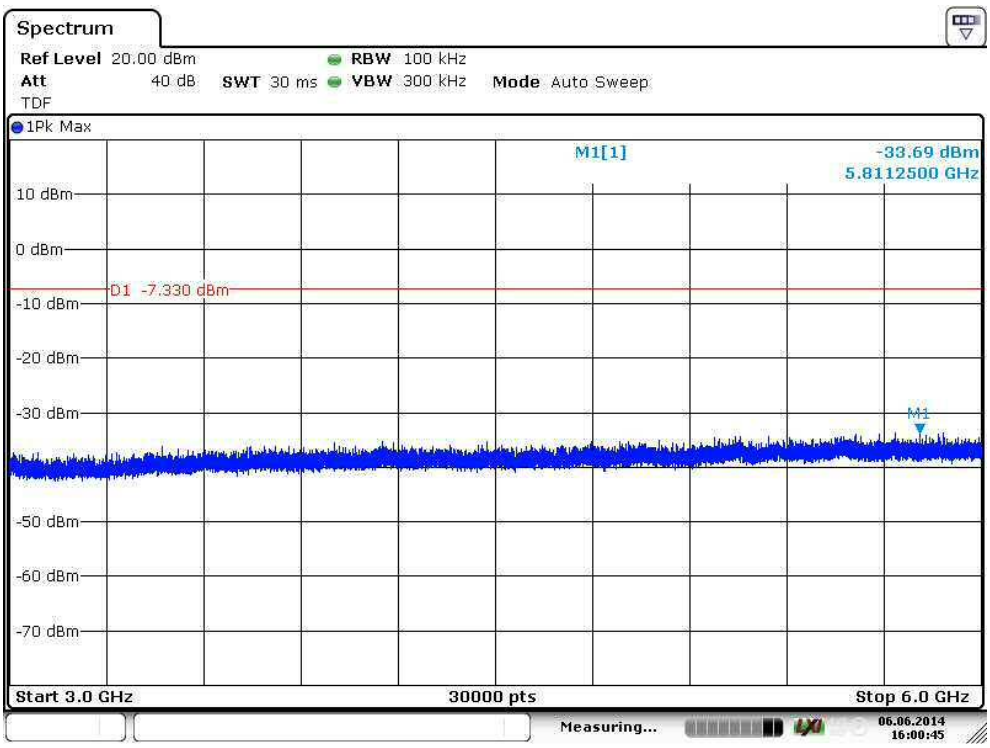
Date: 6.JUN.2014 15:52:55

Figure 24. Conducted Spurious Emissions 30 – 3 000 MHz. Channel Mid.



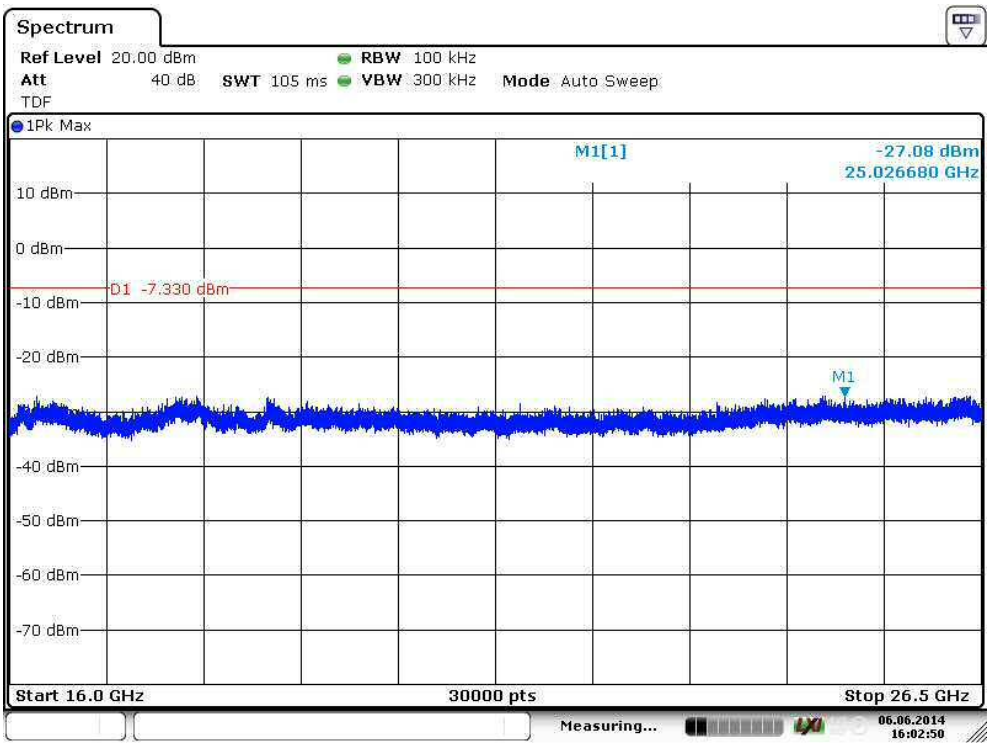
Date: 6.JUN.2014 16:00:45

Figure 25. Conducted Spurious Emissions 3 000 – 6 000 MHz. Channel Mid.



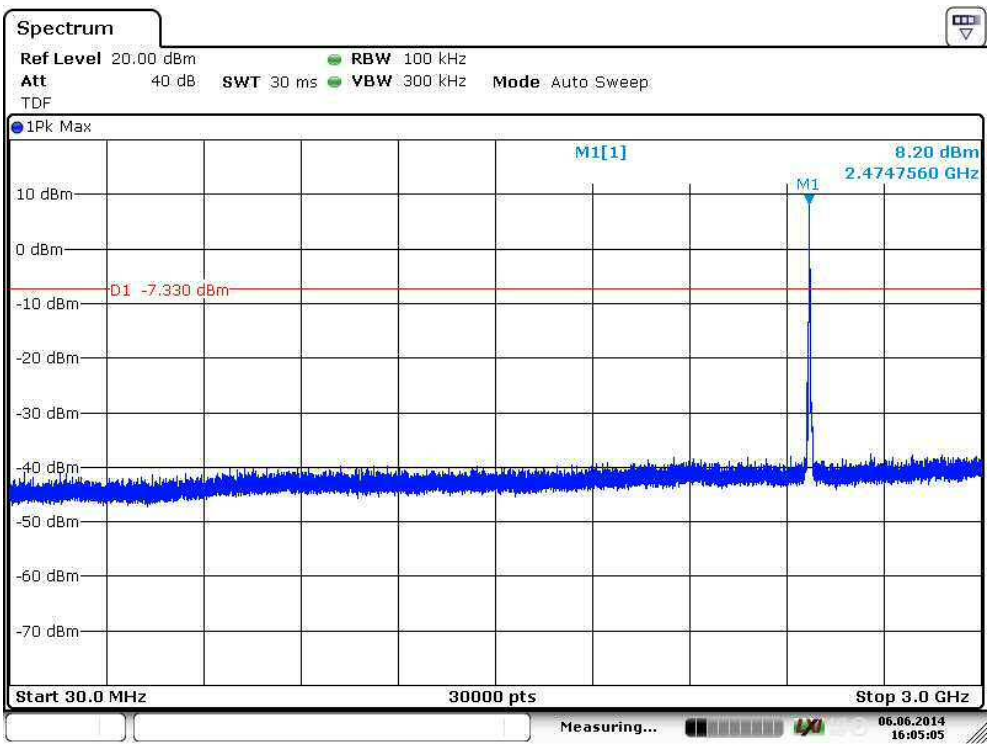
Date: 6.JUN.2014 16:00:45

Figure 26. Conducted Spurious Emissions 6 000 – 16 000 MHz. Channel Mid.



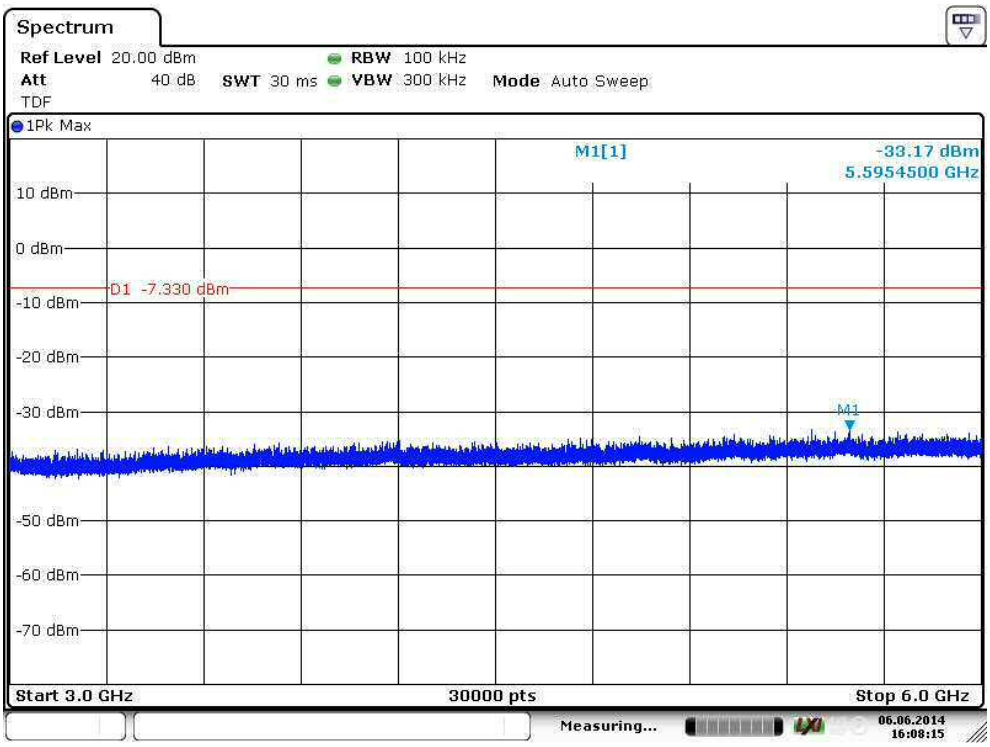
Date: 6.JUN.2014 16:02:50

Figure 27. Conducted Spurious Emissions 16 000 – 26 500 MHz. Channel Mid.



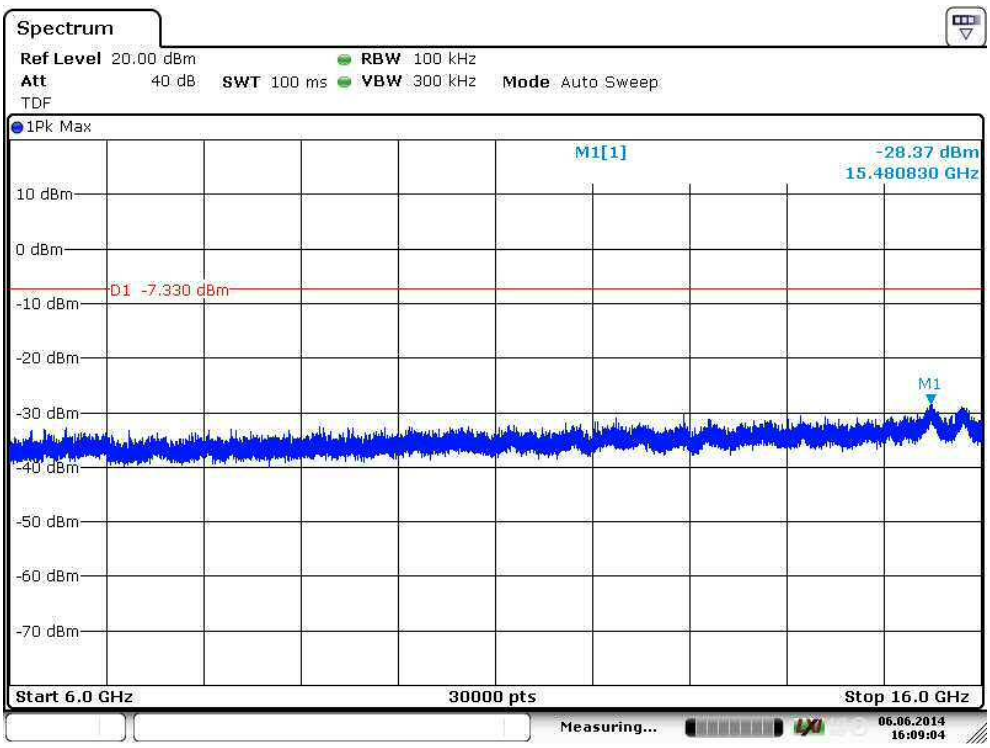
Date: 6.JUN.2014 16:05:04

Figure 28. Conducted Spurious Emissions 30 – 3 000 MHz. Channel High.



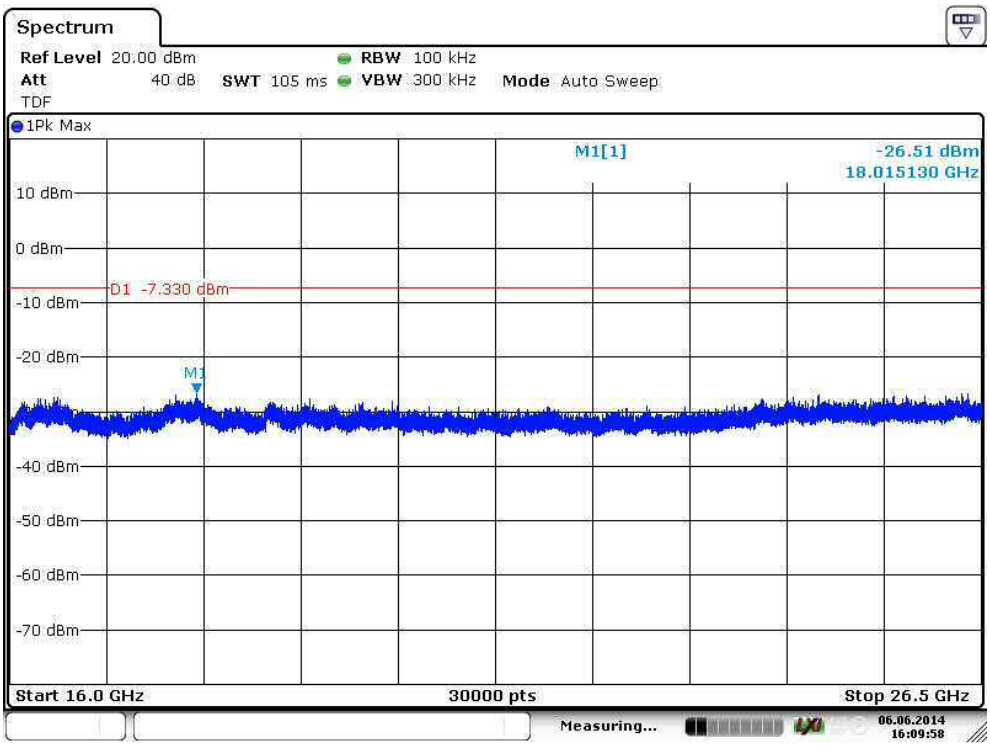
Date: 6.JUN.2014 16:08:15

Figure 29. Conducted Spurious Emissions 3 000 – 6 000 MHz. Channel High.



Date: 6.JUN.2014 16:09:04

Figure 30. Conducted Spurious Emissions 6 000 – 16 000 MHz. Channel High.



Date: 6.JUN.2014 16:09:59

Figure 31. Conducted Spurious Emissions 16 000 – 26 500 MHz. Channel High.

6 dB Bandwidth of the Channel

Standard:	ANSI C63.10	(2009)
Tested by:	NKO	
Date:	6.6.2014	
Humidity:	48 %	
Temperature:	24.8 °C	

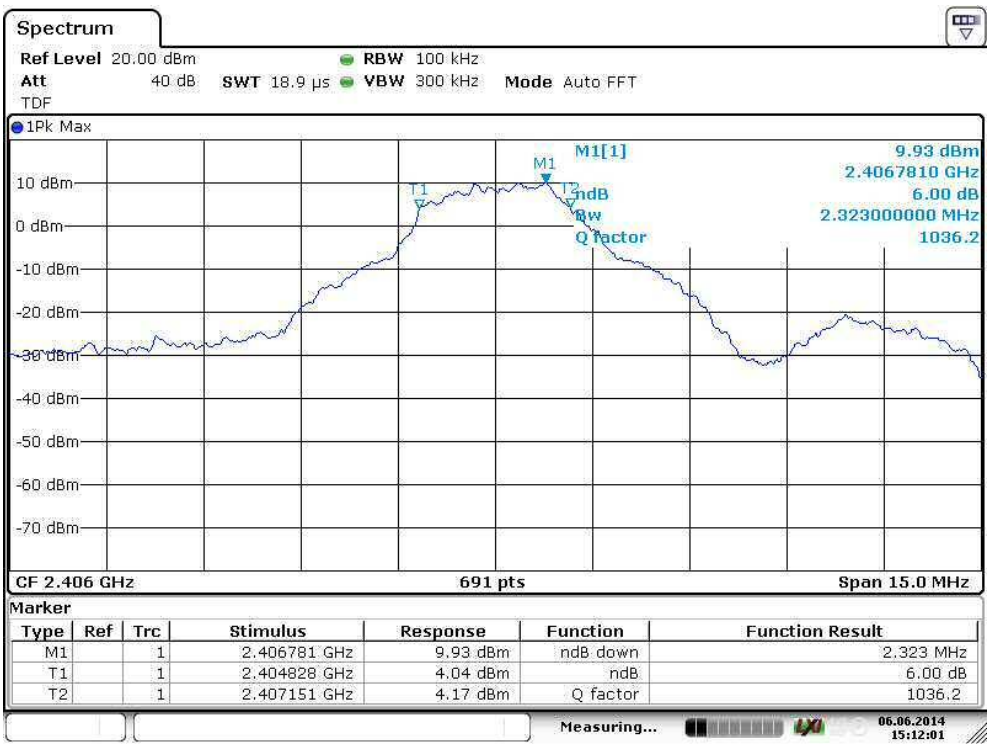
FCC Rule: 15.247(a)(2)
RSS-210 A8.2

Results:

Table 20. 6 dB bandwidth test results.

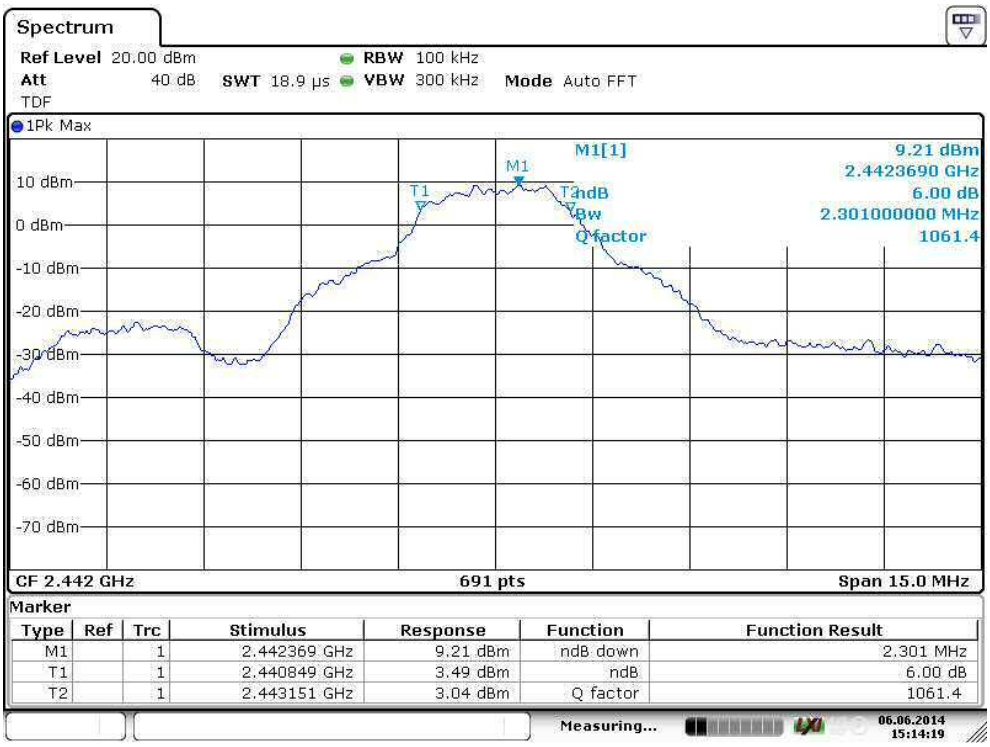
Channel	6 dB BW [kHz]	Minimum limit [kHz]
Low	2323.0	500
Mid	2301.0	
High	2323.0	

6 dB Bandwidth of the Channel



Date: 6.JUN.2014 15:12:01

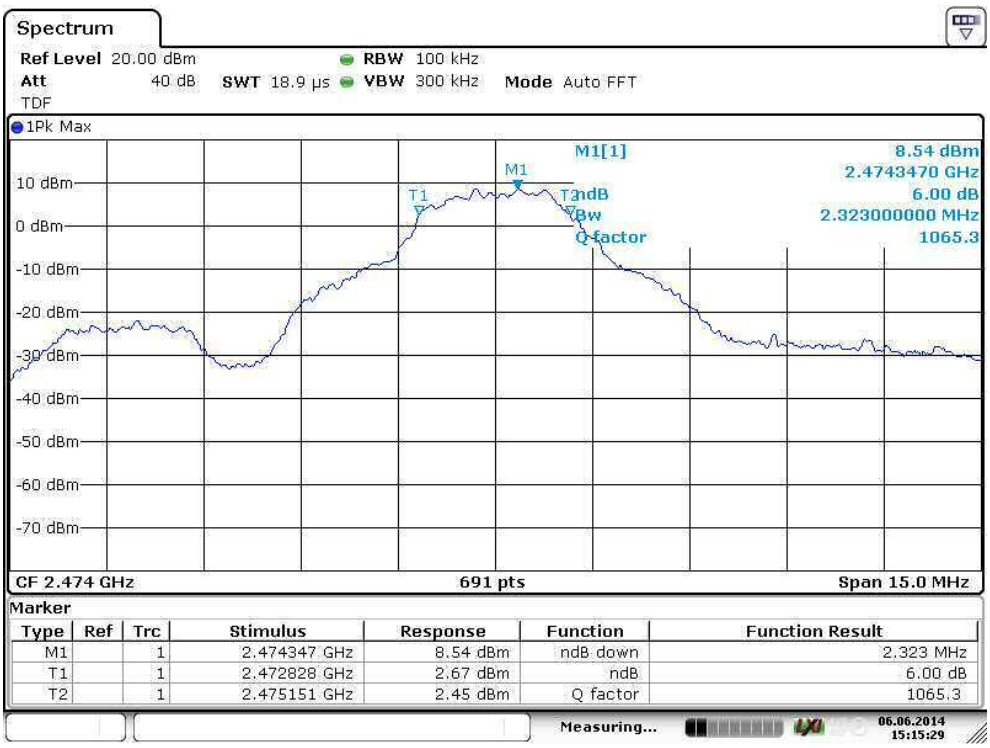
Figure 32. 6 dB bandwidth of the channel Low.



Date: 6.JUN.2014 15:14:20

Figure 33. 6 dB bandwidth of the channel Mid.

6 dB Bandwidth of the Channel



Date: 6.JUN.2014 15:15:30

Figure 34. 6 dB bandwidth of the channel High.

Power Spectral Density

Standard:	ANSI C63.10	(2009)
Tested by:	NKO	
Date:	6.6.2014	
Humidity:	48%	
Temperature:	24.8°C	

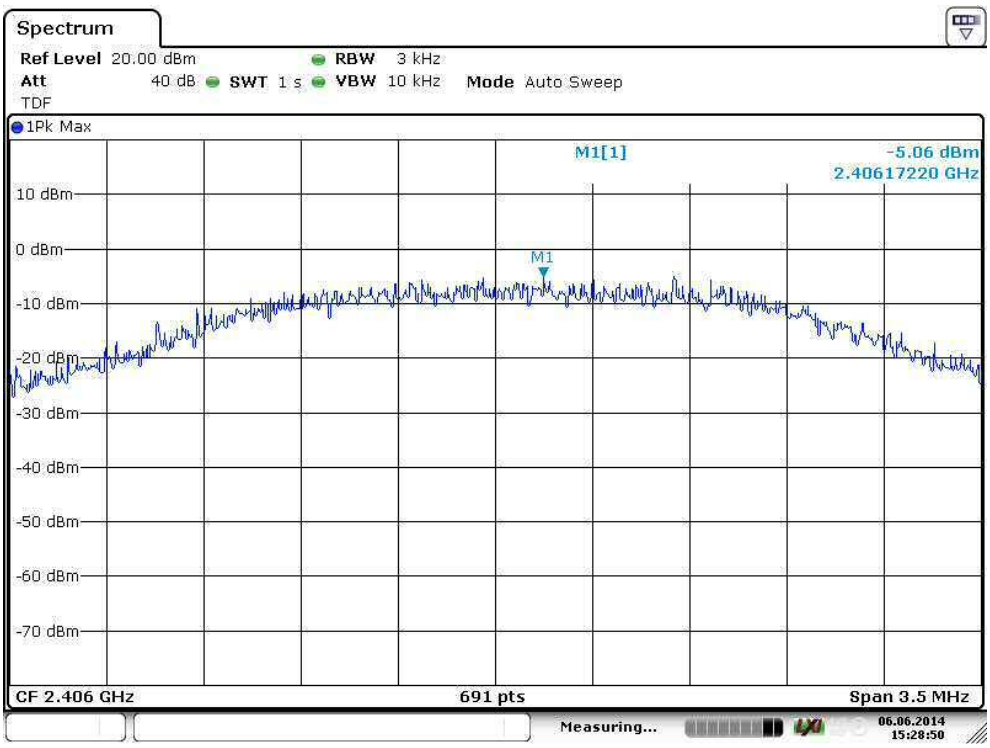
FCC Rule: 15.247(e)
RSS-210 A8.2

Results:

Table 21. Power Spectral Density test results.

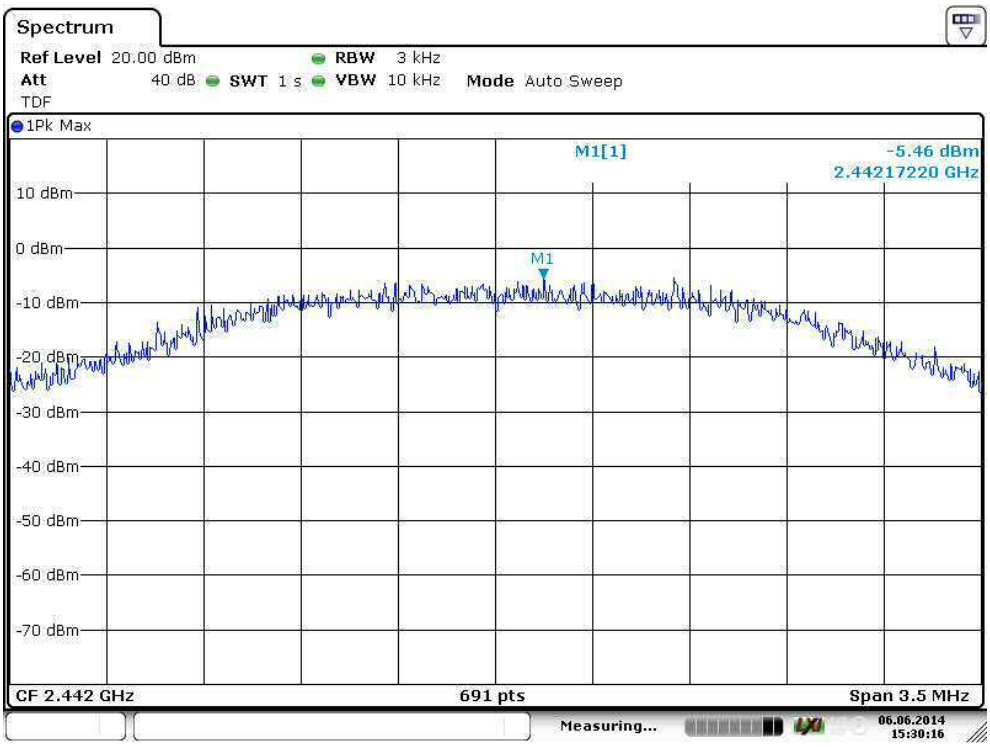
Channel	PSD dBm/3 kHz	Maximum limit [dBm/3kHz]
Low	-4.95	+8.00
Mid	-5.46	
High	-6.15	

Power Spectral Density



Date: 6.JUN.2014 15:28:50

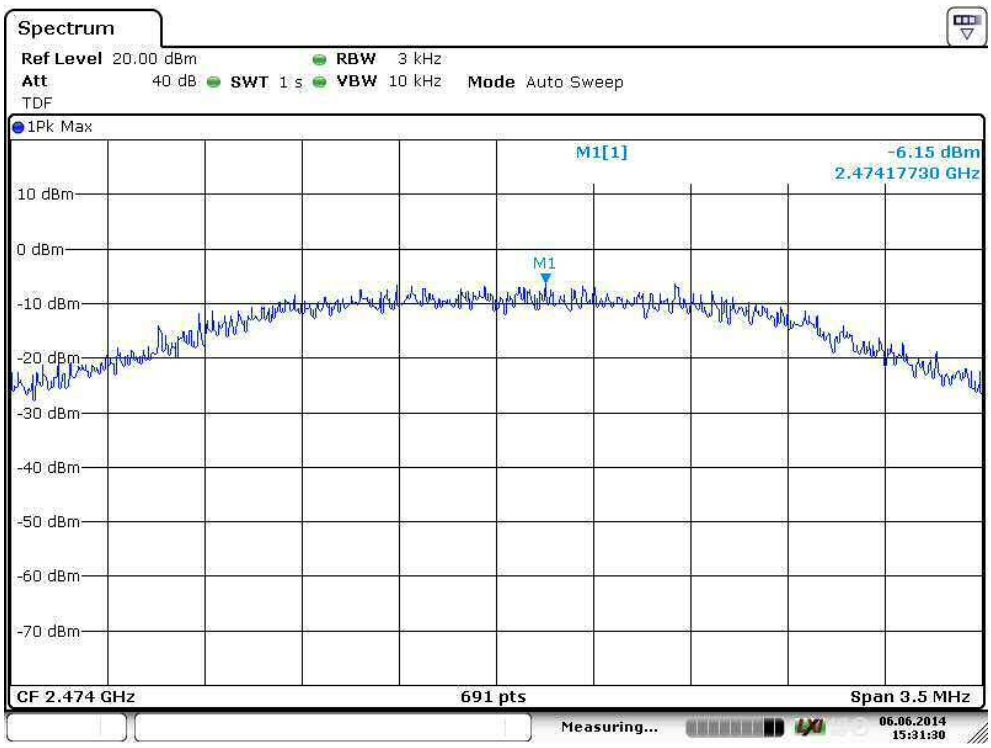
Figure 35. Power Spectral Density of the channel Low.



Date: 6.JUN.2014 15:30:16

Figure 36. Power Spectral Density of the channel Mid.

Power Spectral Density



Date: 6.JUN.2014 15:31:29

Figure 37. Power Spectral Density of the channel High.

99% Occupied Bandwidth

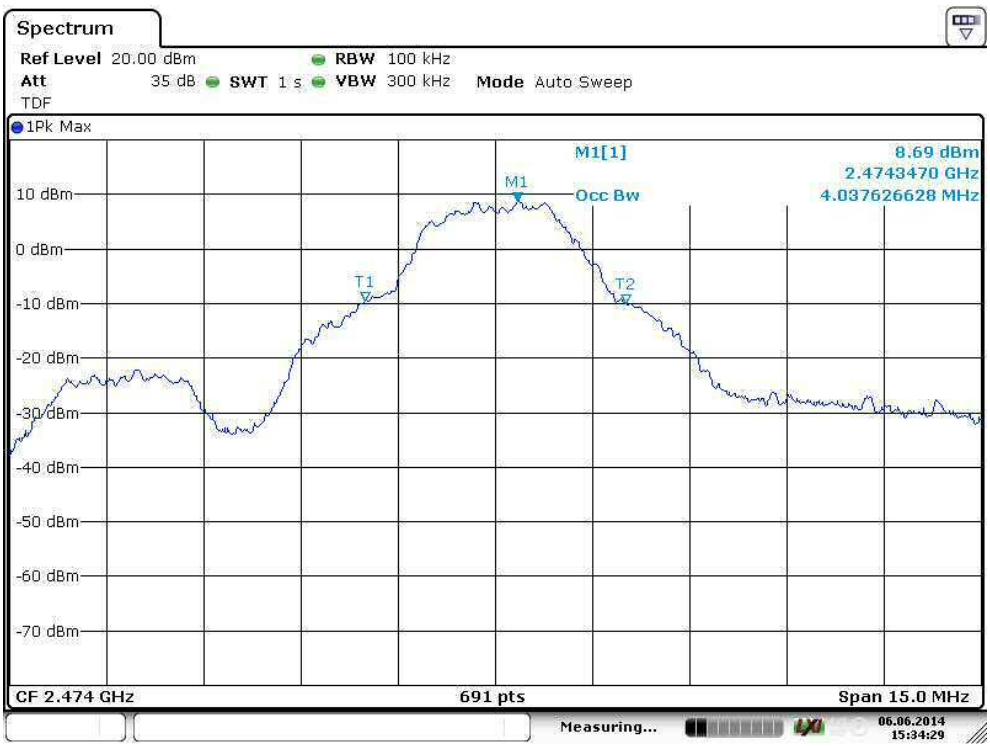
Standard:	RSS-GEN	(2010)
Tested by:	NKO	
Date:	6.6.2014	
Humidity:	48%	
Temperature:	24.8°C	

RSS-GEN 4.7

Table 22. 99 % OBW test results.

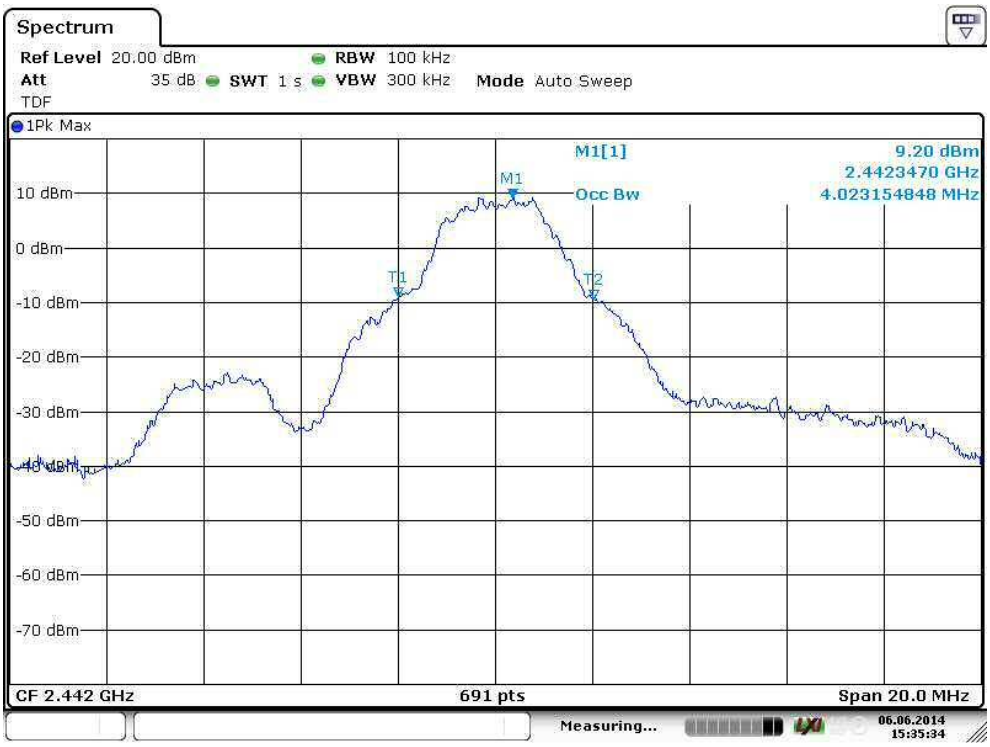
Channel	Limit	99 % BW [MHz]	Result
Low	-	4.037626628	PASS
Mid	-	4.023154848	PASS
High	-	4.023154848	PASS

99 % Occupied Bandwidth



Date: 6.JUN.2014 15:34:29

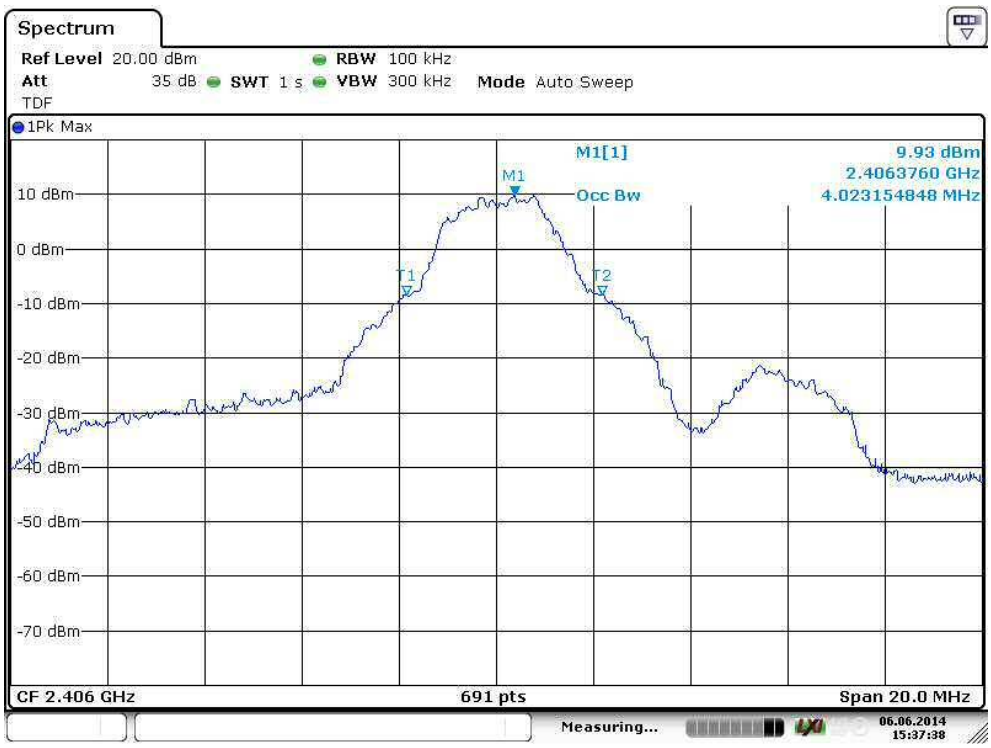
Figure 38. 99 % OBW. Channel Low.



Date: 6.JUN.2014 15:35:34

Figure 39. 99 % OBW. Channel Mid.

99 % Occupied Bandwidth



Date: 6.JUN.2014 15:37:39

Figure 40. 99 % OBW. Channel High.

Time Of Occupancy (Dwell Time)

Standard:	ANSI C63.10	(2009)
Tested by:	NKO	
Date:	14.5.2014	
Humidity:	22 %	
Temperature:	21.5 °C	
Measurement uncertainty	± 2.87 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.247(a)

Table 23. Dwell time of the lowest channel.

Channel	Dwell Time [ms]	Tx off [ms]	Comment
Low	0.42507	6.9507	

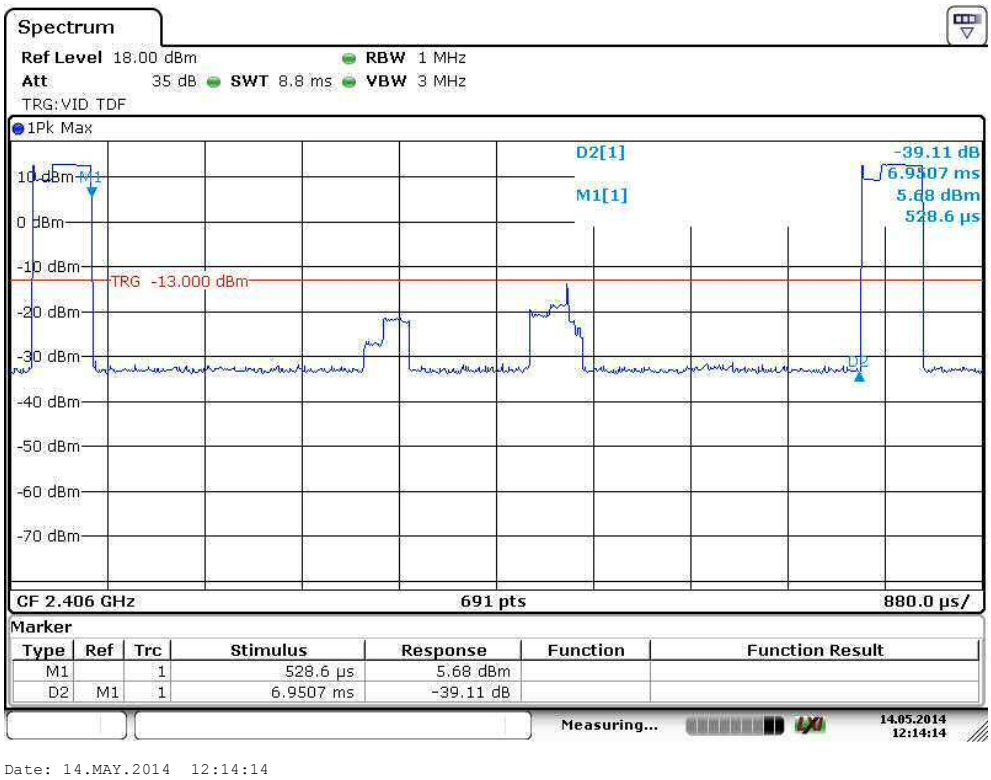
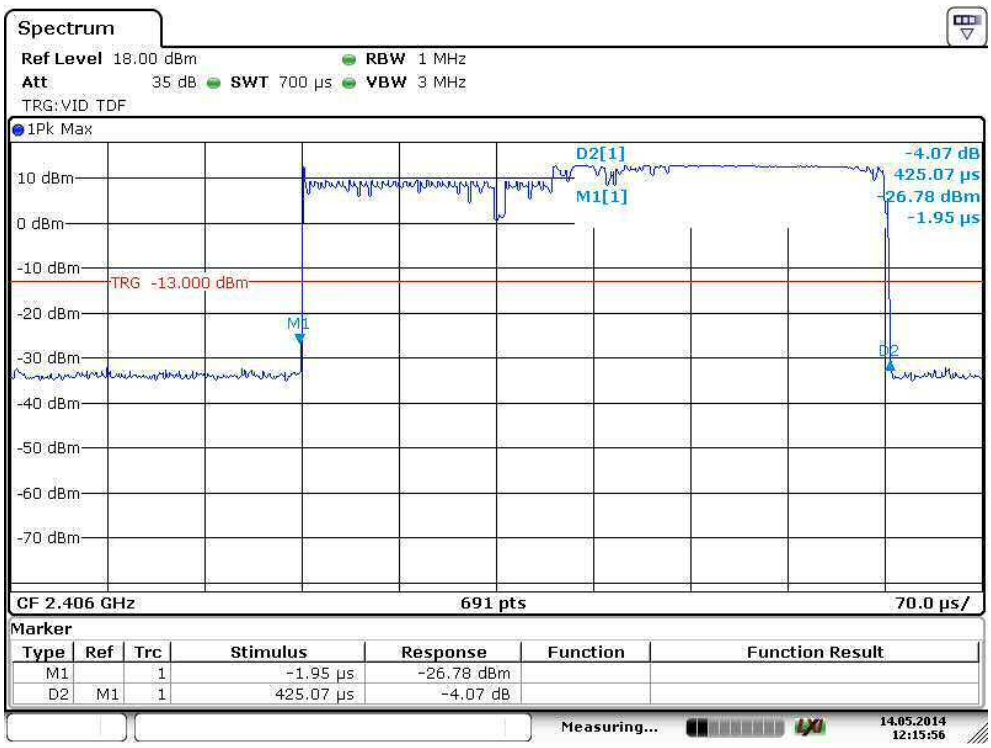


Figure 41. Tx off time Channel Low.



Date: 14.MAY.2014 12:15:56

Figure 42. Dwell Time Channel Low

Test Equipment

Manufacturer	Type	Serial no	Inv. no
ROHDE & SCHWARZ			
Spectrum Analyzer	FSV 40	101068	9093
EMI Test receiver	ESU 26	100185	8453
Test software	EMC32	-	-
DAVIS			
Weather station	Vantage Pro	-	5297
ETS-LINDGREN			
Antenna (18 GHz – 26 GHz)	3160-09	28535	7294
EMCO			
Antenna (1 - 18 GHz)	3117	29617	7293
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).