Test Report

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

INTENTIONAL RADIATOR TESTS ACCORDING TO FCC PART 15 C AND ISED CANADA REQUIREMENTS

Equipment Under Test:	ZigBee module
Model:	MGM12P02GA MGM12P02GE
Manufacturer:	Silicon Laboratories Finland Oy Bertel Jungin aukio 3 FI-02600 ESPOO FINLAND
Customer:	Silicon Laboratories Finland Oy Bertel Jungin aukio 3 FI-02600 ESPOO FINLAND
FCC Rule Part:	15.247: 2016
IC Rule Part:	RSS-247, Issue 2, 2017 RSS-GEN Issue 4, 2014
KDB:	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 (April 8, 2016)

Date: 30 June 2017
Issued by:
Emil Haverinen
Testing Engineer

Date: 30 June 2017
Checked by:
Janne Nyman
Compliance Specialist

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Equipment Under Test (EUT)

Trade mark:	Silicon Labs
Model:	MGM12P02GA MGM12P02GE
Type:	ZigBee module
Serial no:	-
FCC ID:	QOQMGM12P0
IC:	5123A-MGM12P0

Description of the EUT

MGM12P02G is a ZigBee module with two variants, one with integrated chip antenna (-A) and one with RF antenna connector for use of external antenna (-E).

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.

Ratings and declarations

Operating Frequency Range (OFR):	2405 - 2480 MHz
Channels:	16
Channel separation:	5 MHz
Effective conducted power:	9.15 dBm (Peak)
Modulation:	OQPSK
Integral Antenna gain:	A-variant: 1 dBi
External Antenna gain:	E-variant: 2.14 dBi

Power Supply

Operating voltage range: 2.0 - 3.8 VDC (tested with 3.3V regulated by the development board)

Separate AC/DC adaptor, Huawei model: HW-050100E01 (115 V, 60 Hz input / 5 V output) was used during the tests to power up the development board which feeds the module (EUT) during AC emissions test. Supply is not provided by the manufacturer. In other tests the development board was supplied with laboratory power supply.

Mechanical Size of the EUT

Height: 2 mm Width: 20 mm Length: 15 mm

Samples

Two samples were used in the tests, one of each variant.

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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
§15.207(a) / RSS-GEN 8.8	Conducted Emissions on Power Supply Lines	**PASS**
§15.247(b)(3) / RSS-247 5.4(d)	Maximum Peak Conducted Output Power	**PASS**
§15.247(a)(2) / RSS-247 5.2(a)	6 dB Bandwidth	**PASS**
§15.247(e) / RSS-247 5.2(b)	Power Spectral Density	**PASS**
RSS-GEN 6.6	99% Occupied Bandwidth	**PASS**
§15.247(d) / RSS-247 5.5	100 kHz Bandwidth of Frequency Band Edges and Conducted Spurious Emissions	**PASS**
§15.209(a), §15.247(d) / RSS-247 5.5	Radiated Emissions Within The Restricted Bands	**PASS**

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 using software provided by the manufacturer. Normal modulation and duty cycle was applied in all the tests.

Conducted measurements were performed while the EUT was connected to WSTK development board.

Radiated measurements were performed while the EUT was placed on simplified board with reduced functionality.

Conducted measurements were performed only to E-variant. Radiated measurements were performed to both antenna variants.

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

Channel Low (Ch 11) = 2405 MHz

Channel Mid (Ch 19) = 2445 MHz

Channel High(1) (Ch 25) = 2475 MHz

Channel High(2) (Ch 26) = 2480 MHz

Two high channels were tested. The power setting was maximum allowable in all channels.

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

TEST RESULTS

Conducted Emissions In The Frequency Range 150 kHz - 30 MHz

Standard:	ANSI C63.10	(2013)
Tested by:	EHA	
Date:	20 March 2017	
Temperature:	21 °C	
Humidity:	25 % RH	
Barometric pressure:	996 hPa	
Measurement uncertainty:	± 2.9 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.207 (a)
RSS-GEN 8.8

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.

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.

Final measurements from the worst frequencies

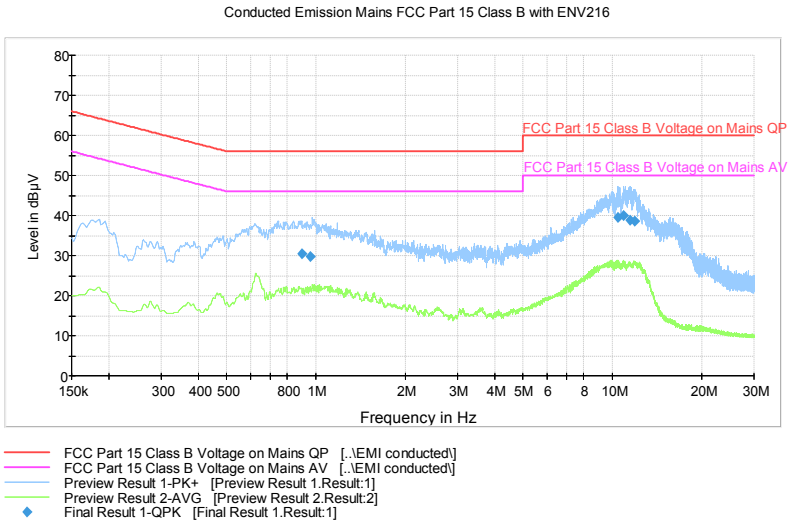

Figure 1: The measured curves with peak- and average detector.

Table 1: Final QuasiPeak measurements from the worst frequencies

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.894000	30.5	1000.0	9.000	N	10.3	25.5	56.0
0.956000	29.8	1000.0	9.000	N	10.3	26.2	56.0
10.463500	39.5	1000.0	9.000	N	10.6	20.5	60.0
10.919500	40.0	1000.0	9.000	N	10.6	20.0	60.0
11.462500	38.9	1000.0	9.000	N	10.6	21.1	60.0
11.873750	38.6	1000.0	9.000	L1	10.3	21.4	60.0

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

Maximum Peak Conducted Output Power

Standard:	ANSI C63.10	(2013)
Tested by:	EHA	
Date:	28 March 2017 - 29 June 2017	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	
Measurement uncertainty:	± 2.87dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.247(b)(3)
RSS-247 5.4(d)

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.

Measured values are peak values.

Results:

Table 2: Maximum conducted output power

Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
Low	9.15	30	20.85	PASS
Mid	8.86	30	21.14	PASS
High(1)	8.81	30	21.19	PASS
High(2)	9.61	30	20.39	PASS

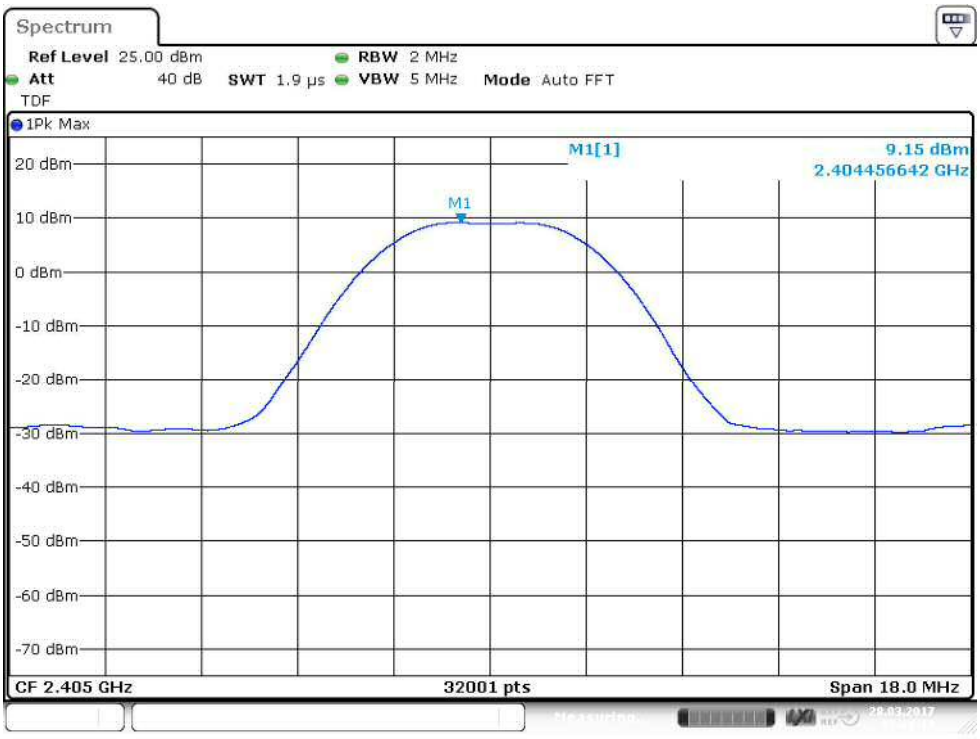

Figure 2: Conducted power (ch low)

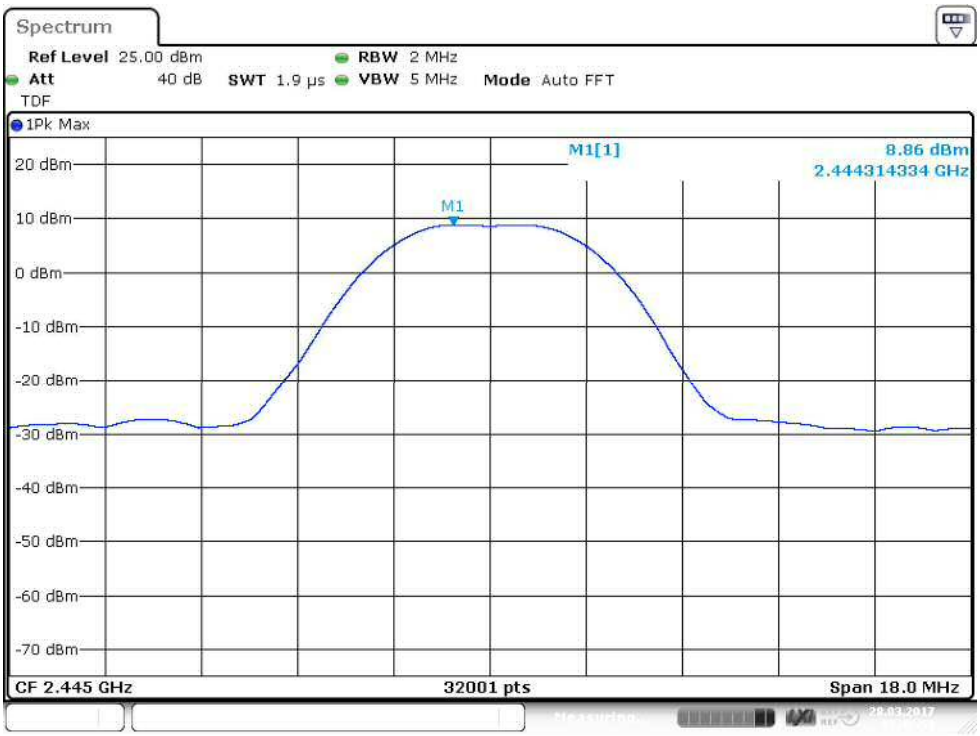

Figure 3: Conducted power (ch mid)

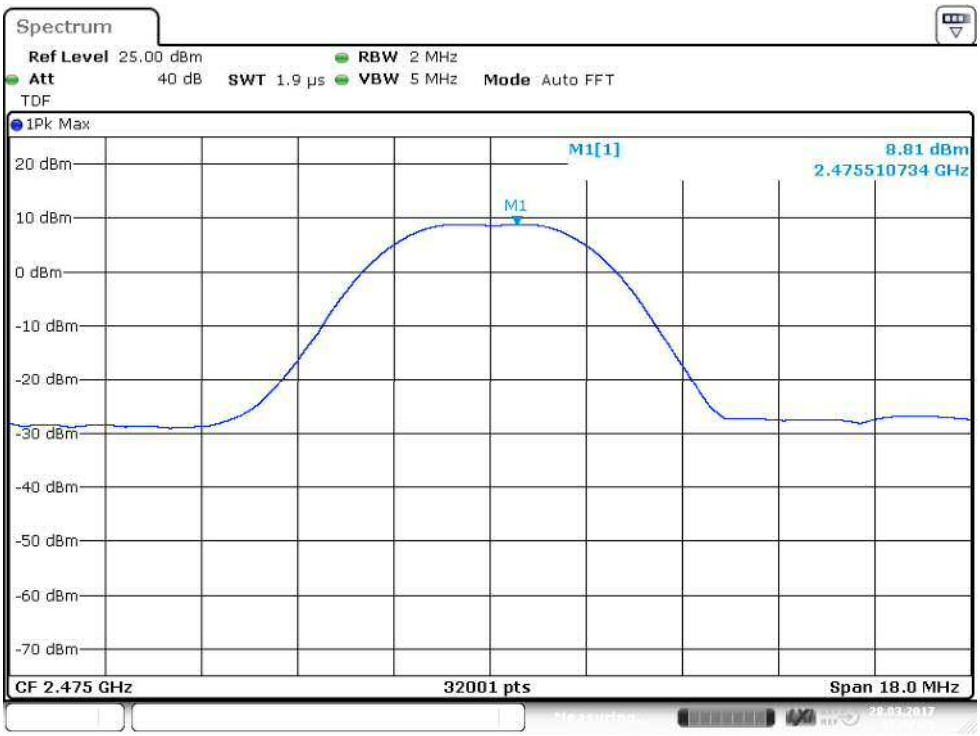

Figure 4: Conducted power (ch high(1))

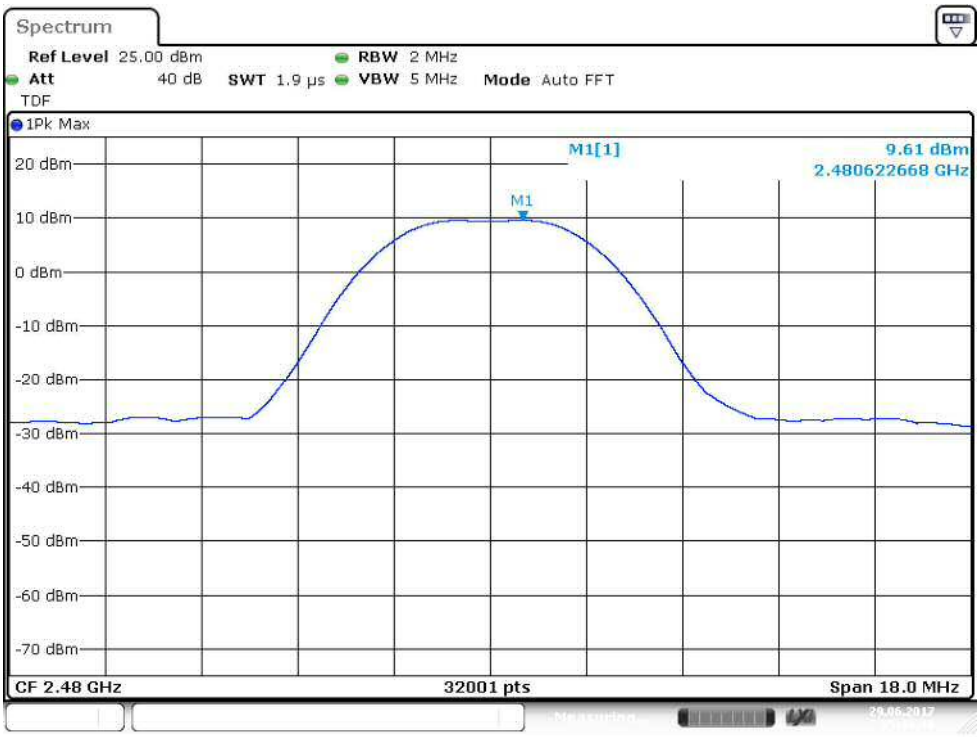

Figure 5: Conducted power (ch high(2))

Transmitter Radiated Spurious Emissions 30 - 26500 MHz

Standard:	ANSI C63.10	(2013)
Tested by:	EHA / JSU / PKA	
Date:	10 - 31 March 2017 12 June 2017	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	
Measurement uncertainty:	± 4.51 dB	Level of confidence 95 % (k = 2)

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

RSS-247 5.5

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. 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).

Measurements were performed for both antenna variants.

Spurious emissions were measured while the EUT was set to fundamental frequencies of 2405 MHz (low), 2445 MHz (mid) and 2475 MHz (high)

Frequency range [MHz]	Limit [µV/m]	Limit [dBµV/m]	Detector
30 - 80	100	40.0	Quasi-peak
88 - 216	150	43.5	Quasi-peak
216 - 960	200	46.0	Quasi-peak
960 - 1000	500	53.9	Quasi-peak
Above 1000	500	53.9	Average
Above 1000	5000	73.9	Peak

Low channel (A-variant)

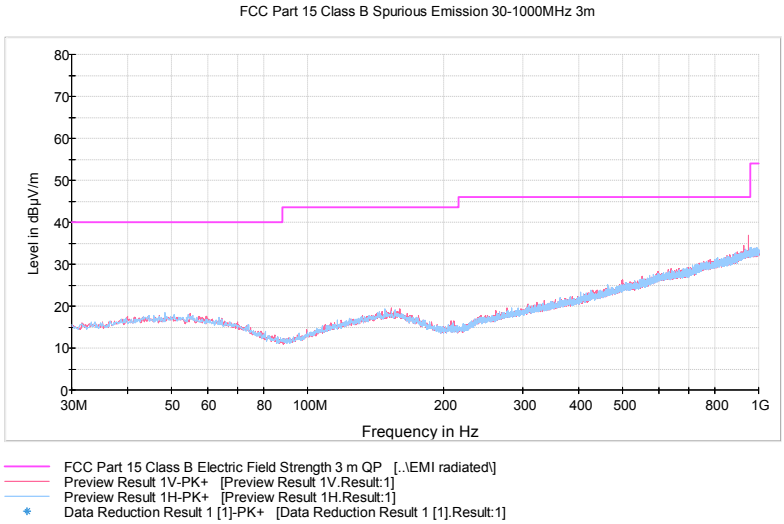

Figure 6: Low channel 30 MHz – 1000 MHz

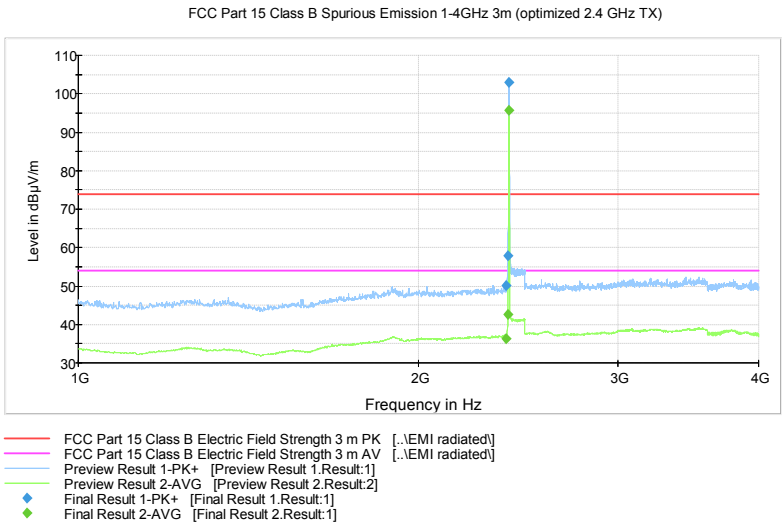

Figure 7: Low channel 1 GHz – 4 GHz

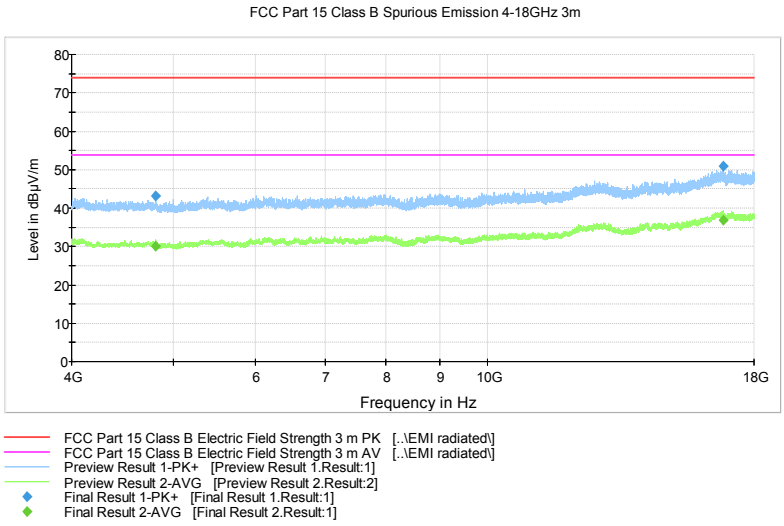

Figure 8: Low channel 4 GHz – 18 GHz

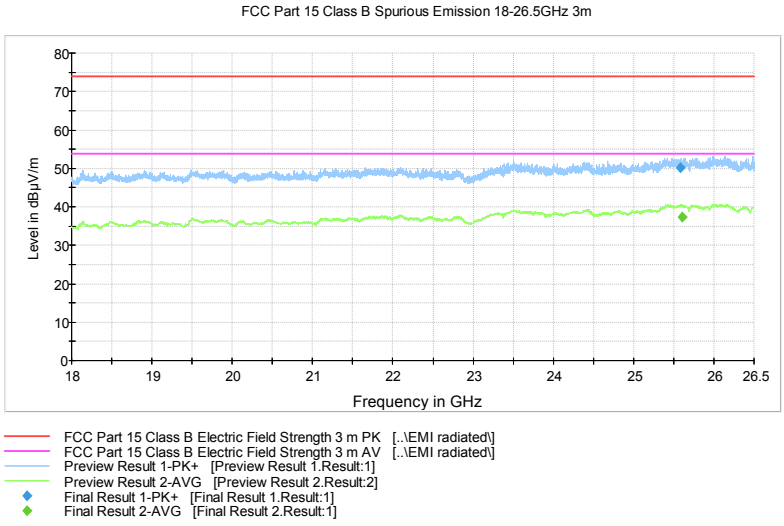

Figure 9: Low channel 18 GHz – 26.5 GHz

Table 3: Quasi-peak results (ch low)

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
-	-	-	-	-	-	-	-	-	-

Table 4: Peak results (ch low)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.000000	50.2	1000.0	1000.000	150.0	H	198.0	14.6	23.7	73.9
2400.000000	57.8	1000.0	1000.000	195.0	H	6.0	14.7	16.1	73.9
4809.400000	43.2	1000.0	1000.000	218.0	V	172.0	8.3	30.7	73.9
16810.40000	50.9	1000.0	1000.000	365.0	H	48.0	26.8	23.0	73.9
25588.22500	50.3	1000.0	1000.000	100.0	V	308.0	26.0	23.6	73.9

Table 5: Average results (ch low)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.600000	36.3	1000.0	1000.000	253.0	V	309.0	14.6	17.6	53.9
2400.000000	42.7	1000.0	1000.000	165.0	H	10.0	14.7	11.2	53.9
4811.000000	30.0	1000.0	1000.000	259.0	V	169.0	8.3	23.9	53.9
16807.10000	36.8	1000.0	1000.000	150.0	V	144.0	26.8	17.1	53.9
25602.32500	37.4	1000.0	1000.000	100.0	V	337.0	25.9	16.5	53.9

Middle channel (A-variant)

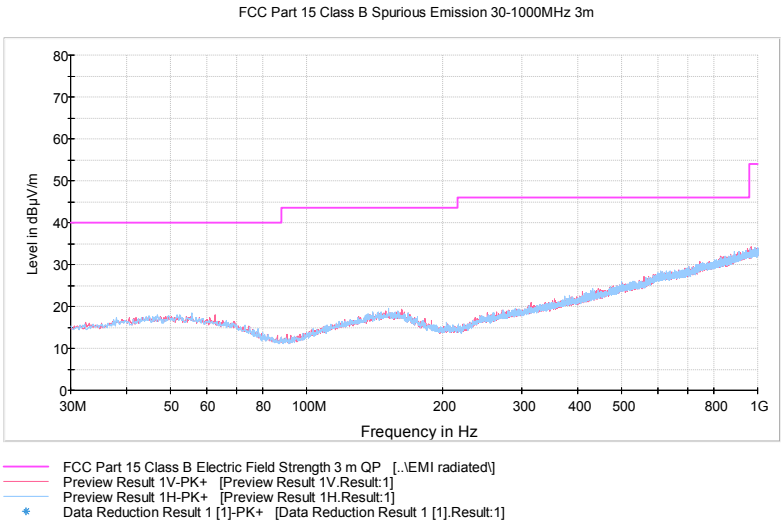

Figure 10: Mid channel 30 MHz – 1000 MHz

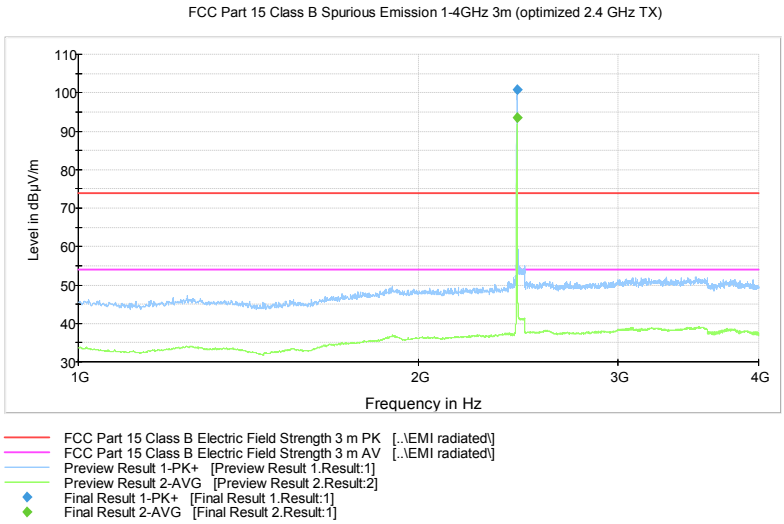

Figure 11: Mid channel 1 GHz – 4 GHz

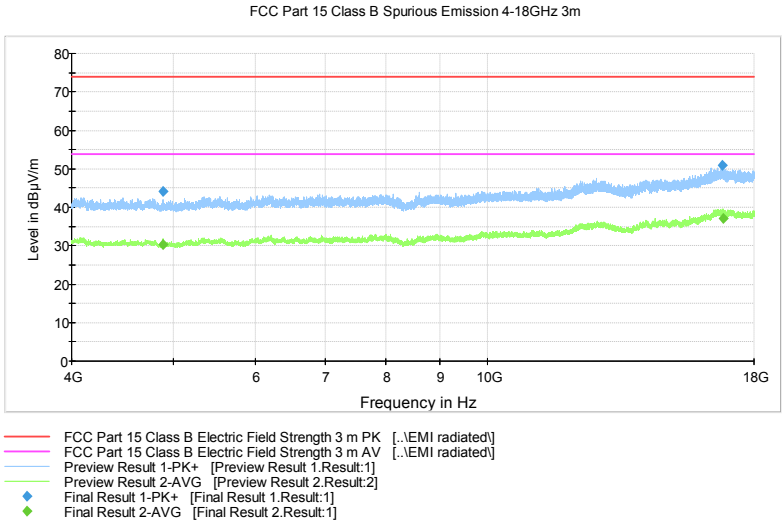

Figure 12: Mid channel 4 GHz – 18 GHz

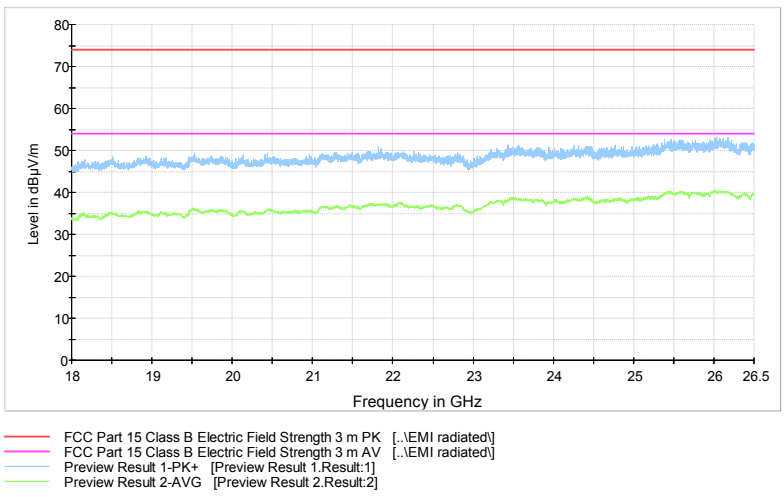

Figure 13: Mid channel 18 GHz – 26.5 GHz

Table 6: Quasi-peak results (ch mid)

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
-	-	-	-	-	-	-	-	-	-

Table 7: Peak results (ch mid)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4888.900000	44.2	1000.0	1000.000	150.0	H	35.0	8.3	29.7	73.9
16794.40000	50.9	1000.0	1000.000	150.0	H	281.0	26.8	23.0	73.9

Table 8: Average results (ch mid)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4891.100000	30.4	1000.0	1000.000	231.0	V	159.0	8.3	23.5	53.9
16815.00000	37.1	1000.0	1000.000	150.0	V	328.0	26.8	16.8	53.9

High channel (A-variant)

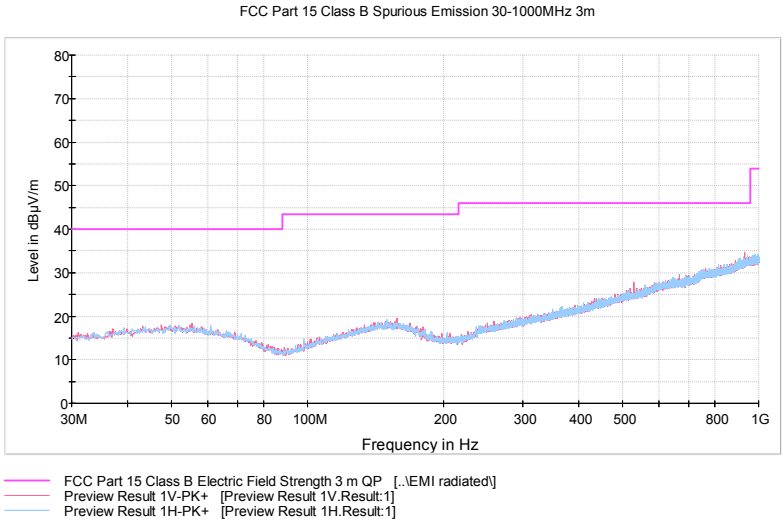

Figure 14: High channel 30 MHz – 1000 MHz

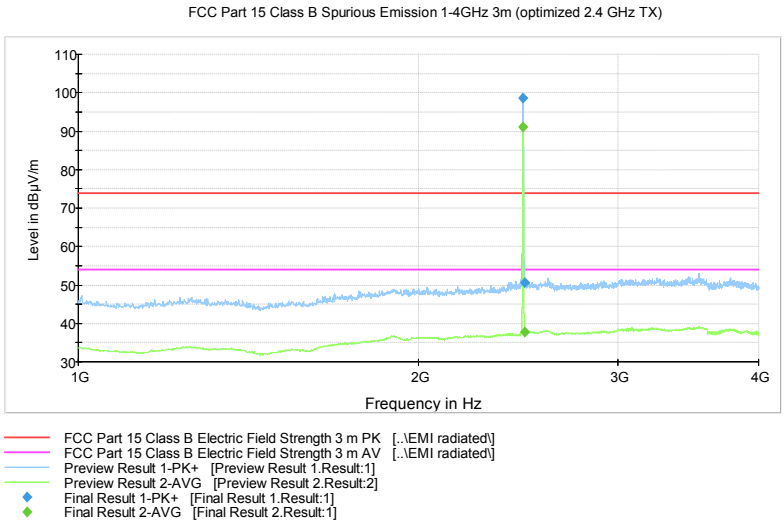

Figure 15: High channel 1 GHz – 4 GHz

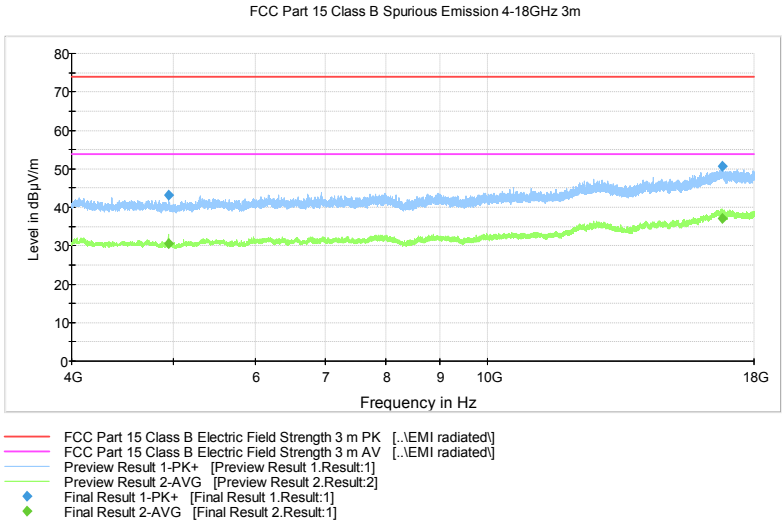

Figure 16: High channel 4 GHz – 18 GHz

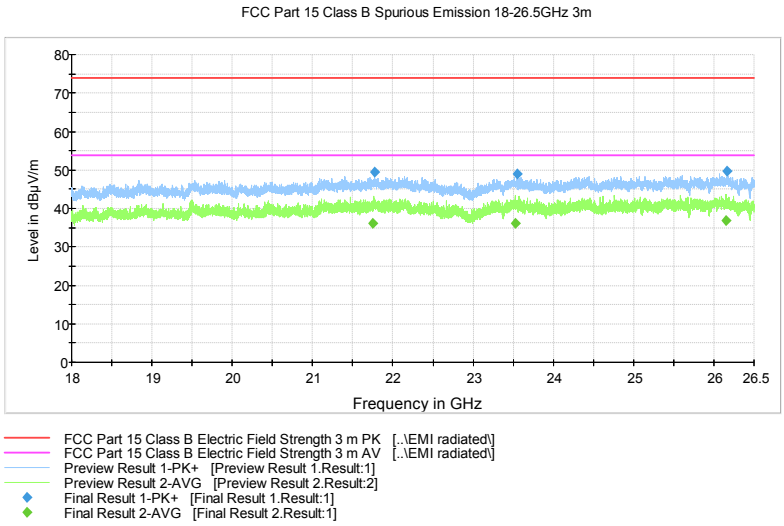

Figure 17: High channel 18 GHz – 26.5 GHz

Table 9: Quasi-peak results (ch high)

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
-	-	-	-	-	-	-	-	-	-

Table 10: Peak results (ch high)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	50.7	1000.0	1000.000	241.0	H	21.0	14.7	23.2	73.9
4951.200000	43.1	1000.0	1000.000	150.0	V	285.0	8.2	30.8	73.9
16791.90000	50.7	1000.0	1000.000	150.0	H	67.0	26.8	23.2	73.9
21769.00000	49.4	1000.0	1000.000	100.0	V	310.0	22.0	24.5	73.9
23552.55000	48.9	1000.0	1000.000	141.0	V	65.0	24.1	25.0	73.9
26159.85000	49.8	1000.0	1000.000	375.0	H	123.0	26.5	24.1	73.9

Table 11: Average results (ch high)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	37.7	1000.0	1000.000	190.0	H	247.0	14.7	16.2	53.9
4951.100000	30.7	1000.0	1000.000	150.0	H	34.0	8.2	23.2	53.9
16768.80000	37.0	1000.0	1000.000	400.0	H	282.0	26.7	16.9	53.9
21756.30000	36.0	1000.0	1000.000	150.0	H	258.0	21.9	17.9	53.9
23522.40000	36.2	1000.0	1000.000	150.0	H	156.0	24.1	17.7	53.9
26152.15000	36.9	1000.0	1000.000	240.0	V	192.0	26.4	17.0	53.9

Radiated Band Edge results (A-variant)

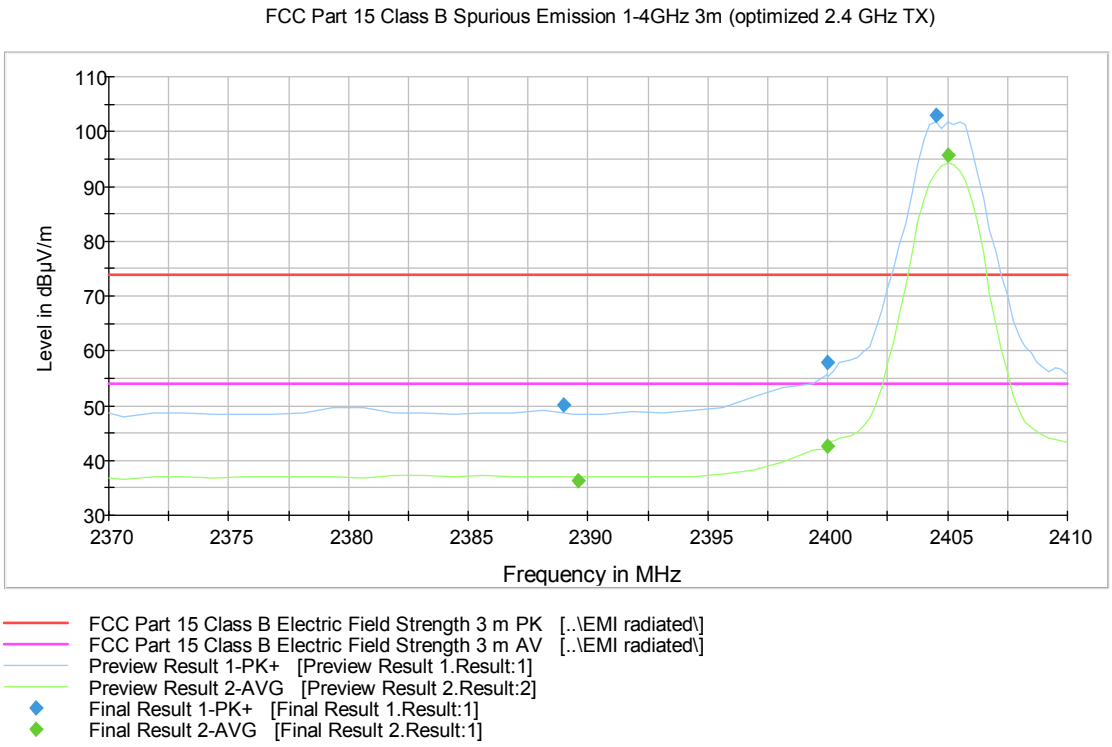

Figure 18: Radiated Band Edge measurement graph (ch low)

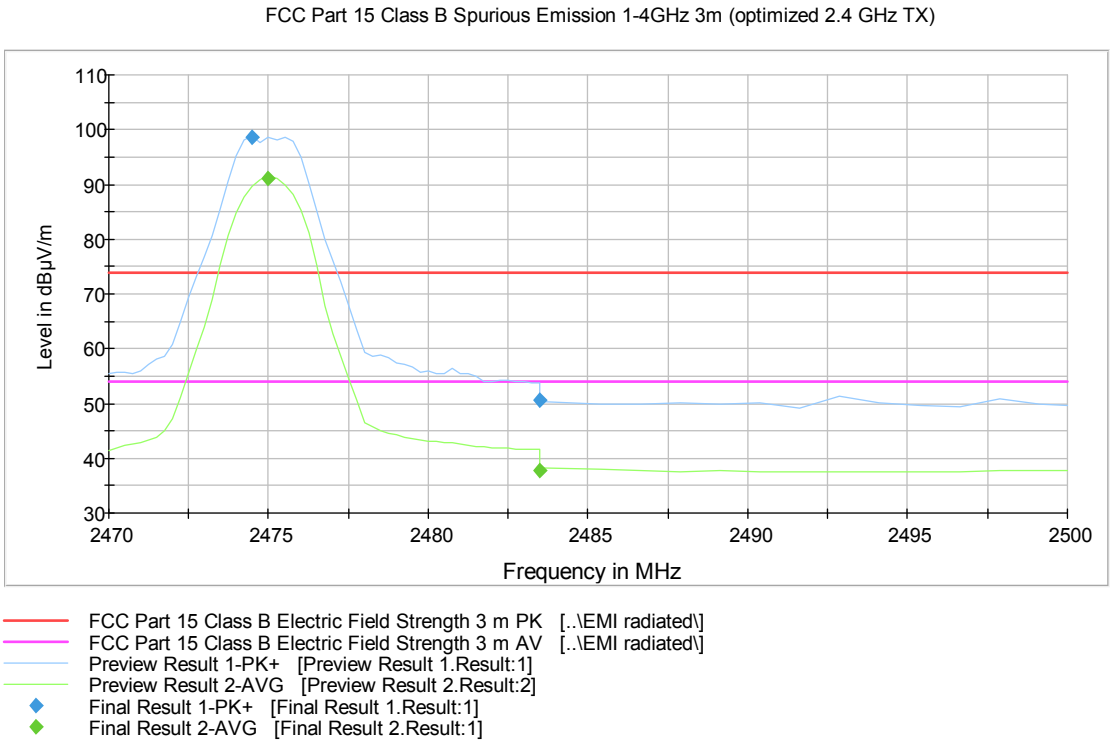

Figure 19: Radiated Band Edge measurement graph (ch high(1))

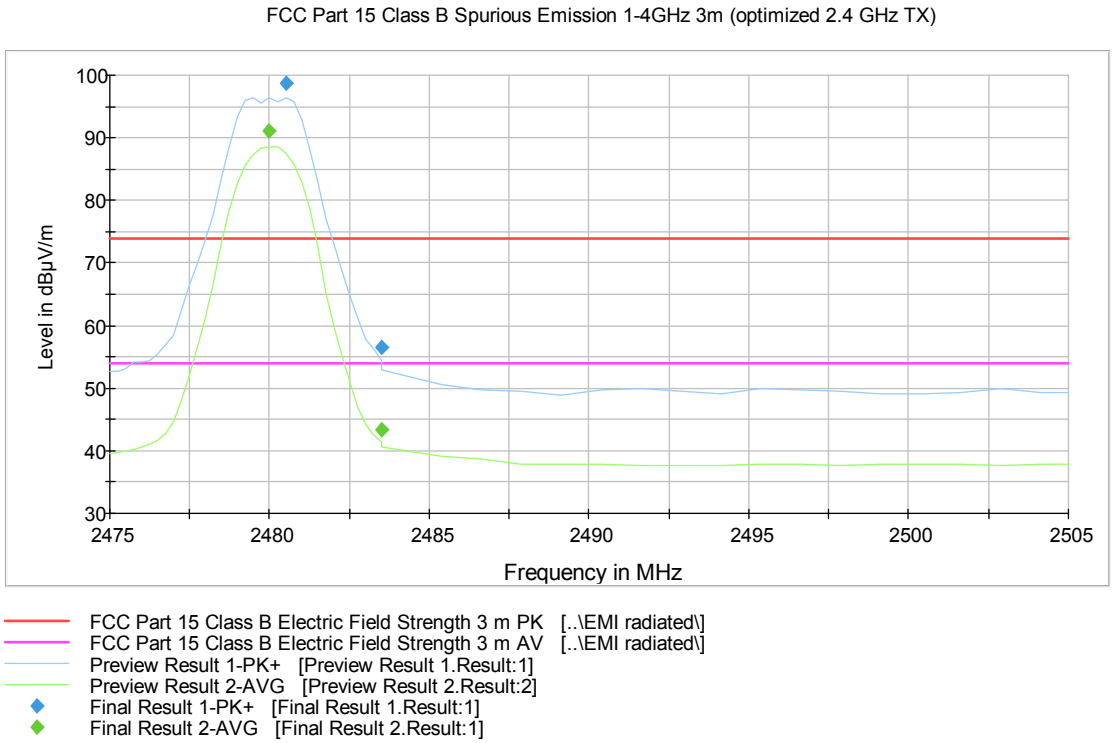

Figure 20: Radiated Band Edge measurement graph (ch high(2))

Table 12: Peak results (2480 MHz)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	56.5	1000.0	1000.000	215.0	H	75.0	14.7	17.4	73.9

Table 13: Average results (2480 MHz)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	43.4	1000.0	1000.000	178.0	H	70.0	14.7	10.5	53.9

Low channel (E-variant)

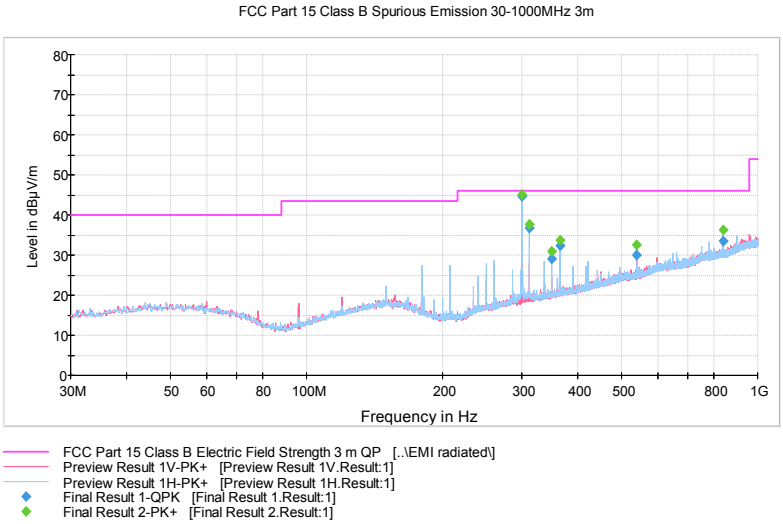

Figure 21: Low channel 30 MHz – 1000 MHz

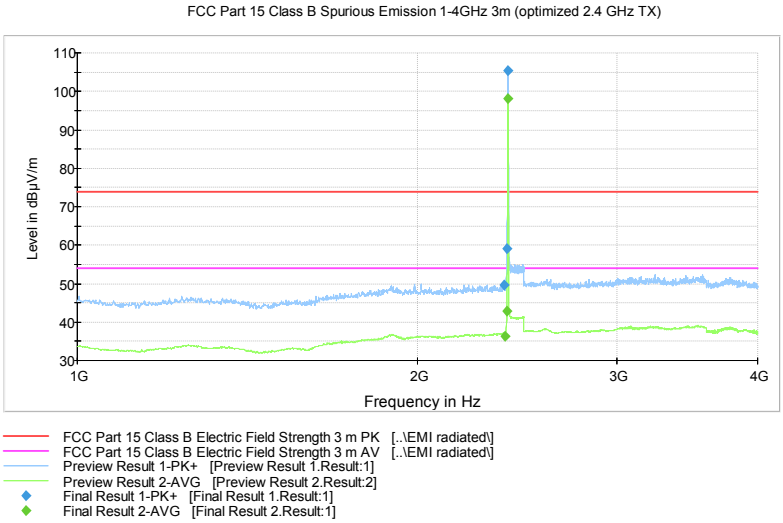

Figure 22: Low channel 1 GHz – 4 GHz

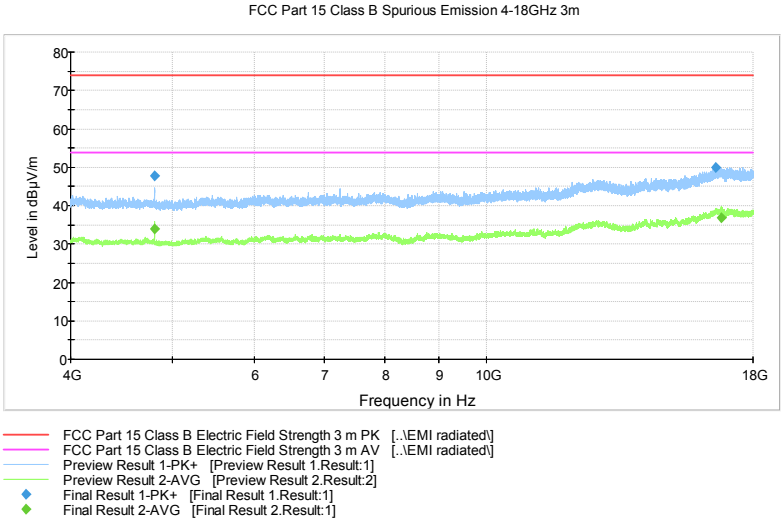

Figure 23: Low channel 4 GHz – 18 GHz

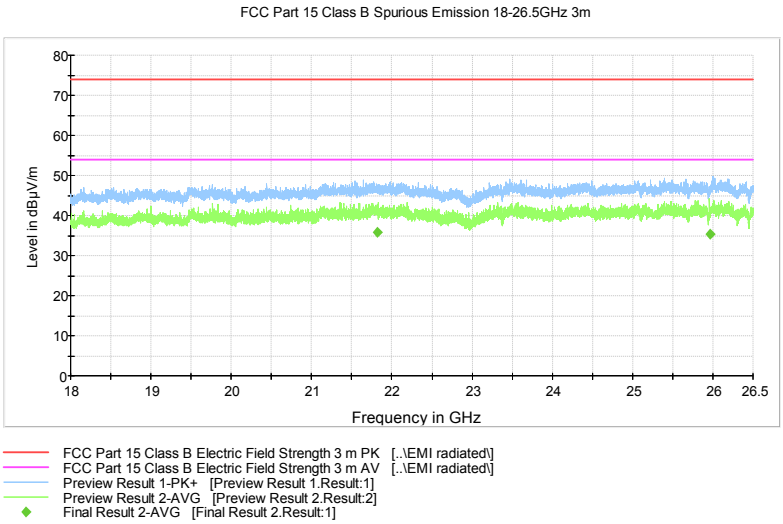

Figure 24: Low channel 18 GHz – 26.5 GHz

Table 14: Quasi-peak results (ch low)

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
300.015000	44.7	1000.0	120.000	100.0	H	85.0	15.3	1.3	46.0
312.015000	36.8	1000.0	120.000	100.0	H	88.0	15.7	9.2	46.0
349.985000	29.1	1000.0	120.000	100.0	H	107.0	16.5	16.9	46.0
364.015000	32.2	1000.0	120.000	100.0	H	104.0	16.9	13.8	46.0
540.015000	30.1	1000.0	120.000	100.0	V	110.0	21.0	15.9	46.0
840.055000	33.5	1000.0	120.000	100.0	H	189.0	26.1	12.5	46.0

Table 15: Peak results (ch low)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2388.400000	49.7	1000.0	1000.000	253.0	H	197.0	14.6	24.2	73.9
2400.000000	59.2	1000.0	1000.000	208.0	V	47.0	14.7	14.7	73.9
4810.100000	47.7	1000.0	1000.000	150.0	V	329.0	8.3	26.2	73.9
16582.10000	49.9	1000.0	1000.000	400.0	H	234.0	26.2	24.0	73.9

Table 16: Average results (ch low)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.400000	36.4	1000.0	1000.000	227.0	V	53.0	14.6	17.5	53.9
2400.000000	42.9	1000.0	1000.000	234.0	V	182.0	14.7	11.0	53.9
4811.000000	33.9	1000.0	1000.000	150.0	V	328.0	8.3	20.0	53.9
16792.00000	36.9	1000.0	1000.000	150.0	H	84.0	26.8	17.0	53.9
21822.95000	35.8	1000.0	1000.000	254.0	V	168.0	22.1	18.1	53.9
25964.40000	35.3	1000.0	1000.000	227.0	H	200.0	26.1	18.6	53.9

Middle channel (E-variant)

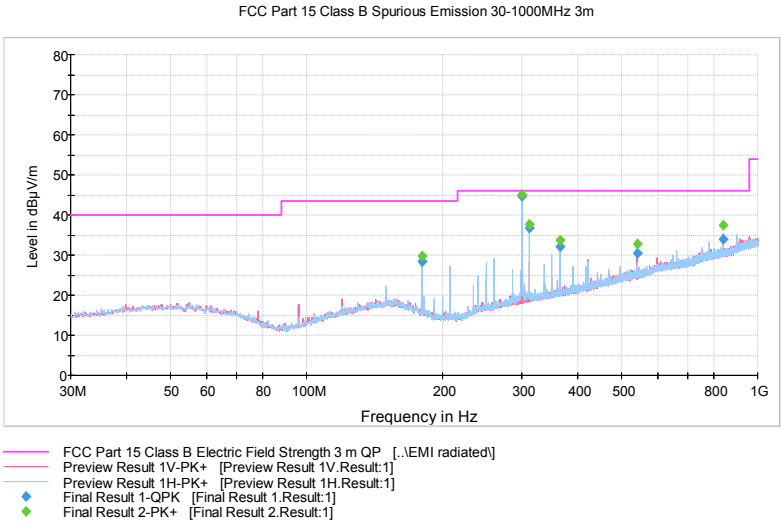

Figure 25: Mid channel 30 MHz – 1000 MHz

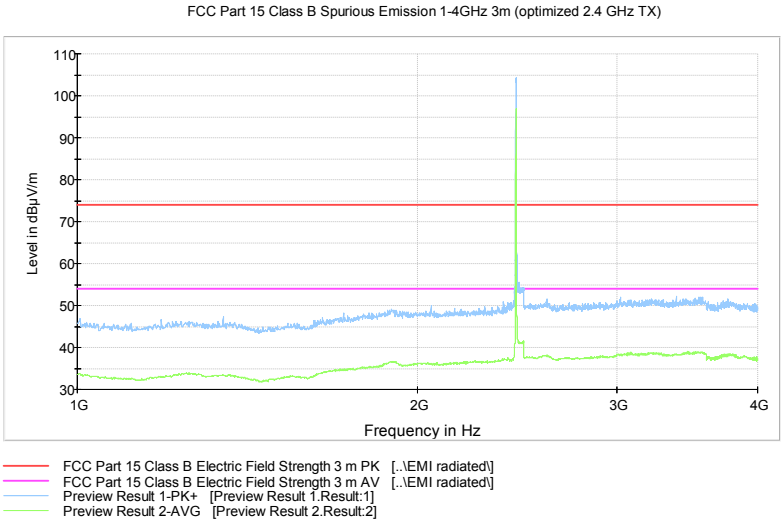

Figure 26: Mid channel 1 GHz – 4 GHz

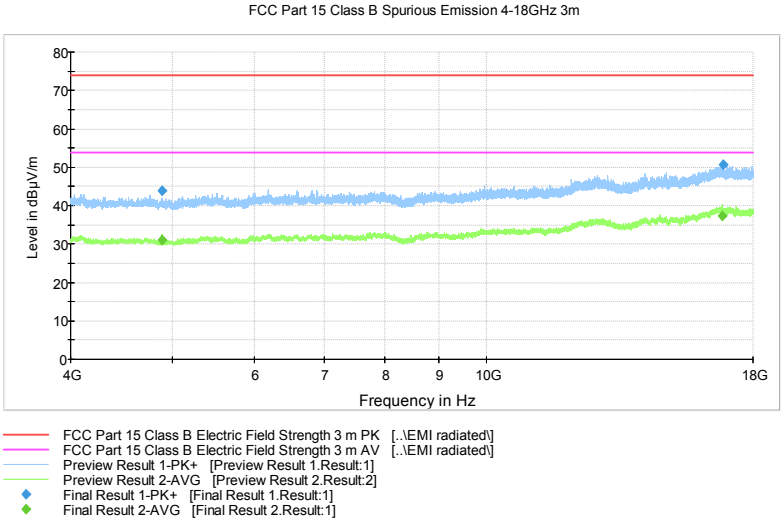

Figure 27: Mid channel 4 GHz – 18 GHz

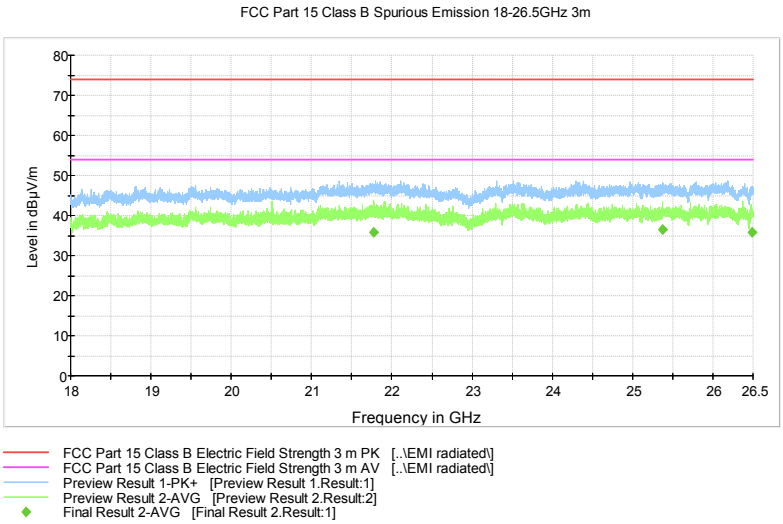

Figure 28: Mid channel 18 GHz – 26.5 GHz

Table 17: Quasi-peak results (ch mid)

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
180.015000	28.4	1000.0	120.000	209.0	H	39.0	13.0	15.1	43.5
300.015000	44.7	1000.0	120.000	100.0	H	93.0	15.3	1.3	46.0
312.015000	36.8	1000.0	120.000	100.0	H	93.0	15.7	9.2	46.0
364.015000	32.1	1000.0	120.000	100.0	H	105.0	16.9	13.9	46.0
540.035000	30.4	1000.0	120.000	100.0	V	113.0	21.0	15.6	46.0
840.035000	34.1	1000.0	120.000	100.0	H	180.0	26.1	11.9	46.0

Table 18: Peak results (ch mid)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4891.200000	43.8	1000.0	1000.000	150.0	V	319.0	8.3	30.1	73.9
16849.40000	50.6	1000.0	1000.000	150.0	V	223.0	26.9	23.3	73.9

Table 19: Average results (ch mid)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4891.000000	31.1	1000.0	1000.000	150.0	V	327.0	8.3	22.8	53.9
16803.60000	37.3	1000.0	1000.000	150.0	V	295.0	26.8	16.6	53.9
21774.90000	35.8	1000.0	1000.000	252.0	V	242.0	22.1	18.1	53.9
25369.85000	36.4	1000.0	1000.000	241.0	H	271.0	25.3	17.5	53.9
26485.45000	35.8	1000.0	1000.000	232.0	H	19.0	26.2	18.1	53.9

High channel (E-variant)

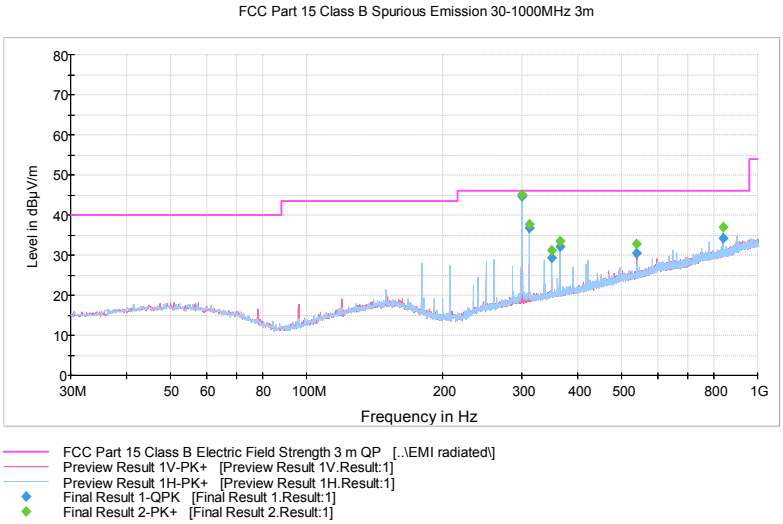

Figure 29: High channel 30 MHz – 1000 MHz

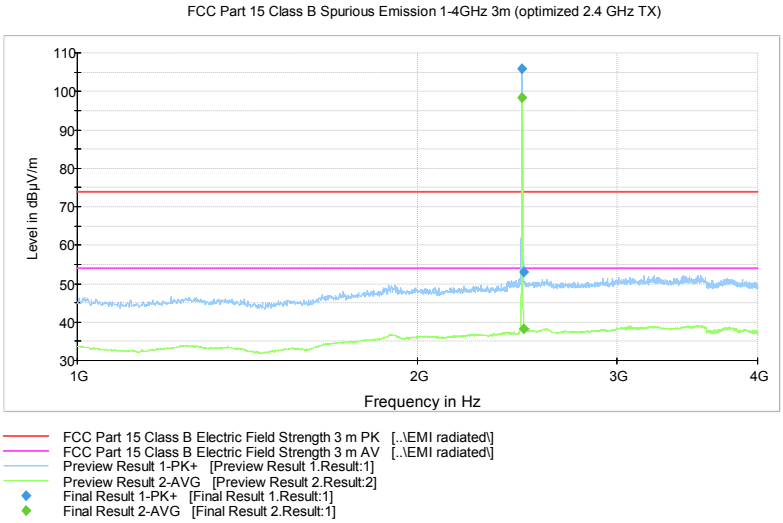

Figure 30: High channel 1 GHz – 4 GHz

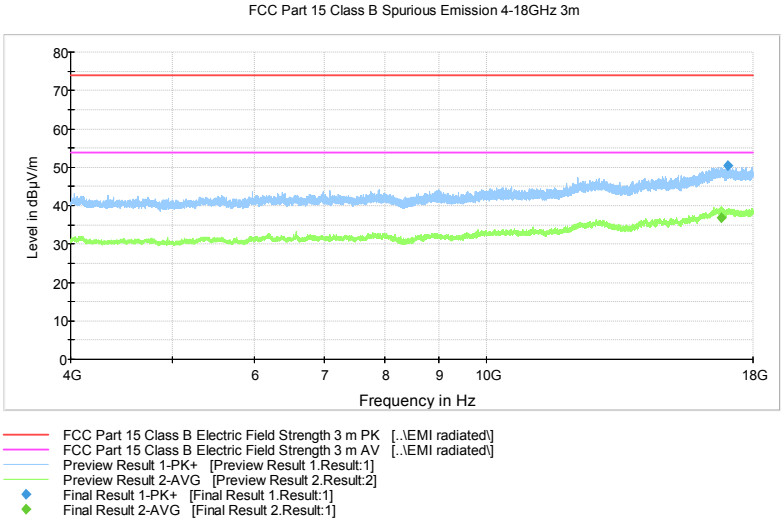

Figure 31: High channel 4 GHz – 18 GHz

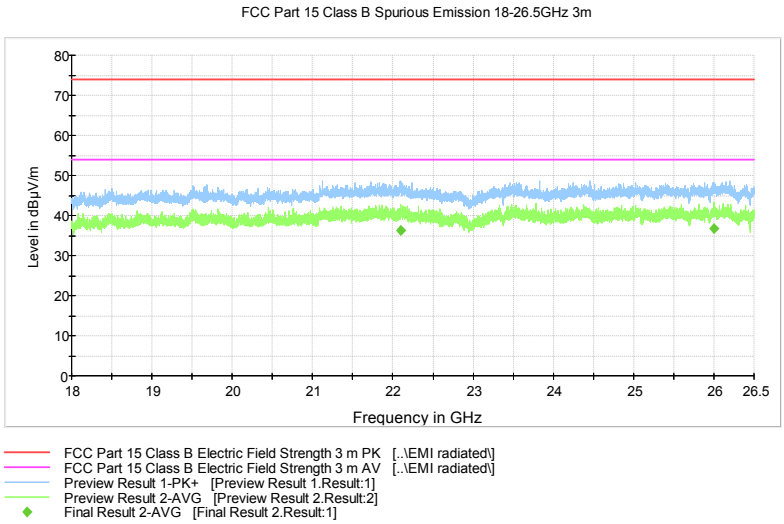

Figure 32: High channel 18 GHz – 26.5 GHz

Table 20: Quasi-peak results (ch high)

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
300.015000	44.7	1000.0	120.000	100.0	H	90.0	15.3	1.3	46.0
312.015000	36.8	1000.0	120.000	100.0	H	90.0	15.7	9.2	46.0
349.985000	29.2	1000.0	120.000	100.0	H	105.0	16.5	16.8	46.0
364.015000	32.1	1000.0	120.000	100.0	H	99.0	16.9	13.9	46.0
540.015000	30.6	1000.0	120.000	100.0	V	113.0	21.0	15.4	46.0
840.055000	34.1	1000.0	120.000	100.0	H	189.0	26.1	11.9	46.0

Table 21: Peak results (ch high)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	53.0	1000.0	1000.000	150.0	V	328.0	14.7	20.9	73.9
17013.00000	50.4	1000.0	1000.000	353.0	V	82.0	26.8	23.5	73.9

Table 22: Average results (ch high)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	38.3	1000.0	1000.000	241.0	V	224.0	14.7	15.6	53.9
16800.70000	36.8	1000.0	1000.000	400.0	V	353.0	26.8	17.1	53.9
22100.15000	36.2	1000.0	1000.000	253.0	H	113.0	22.5	17.7	53.9
26000.35000	36.7	1000.0	1000.000	242.0	V	267.0	26.3	17.2	53.9

Radiated Band Edge results (E-variant)

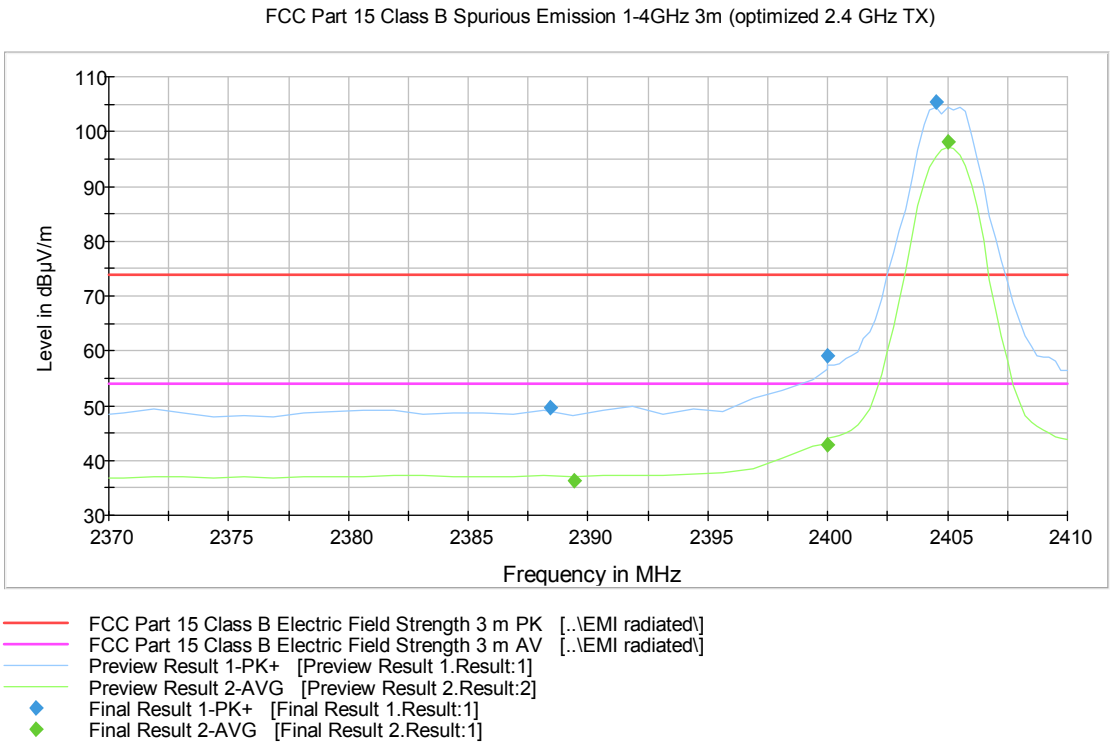

Figure 33: Radiated Band Edge measurement graph (ch low)

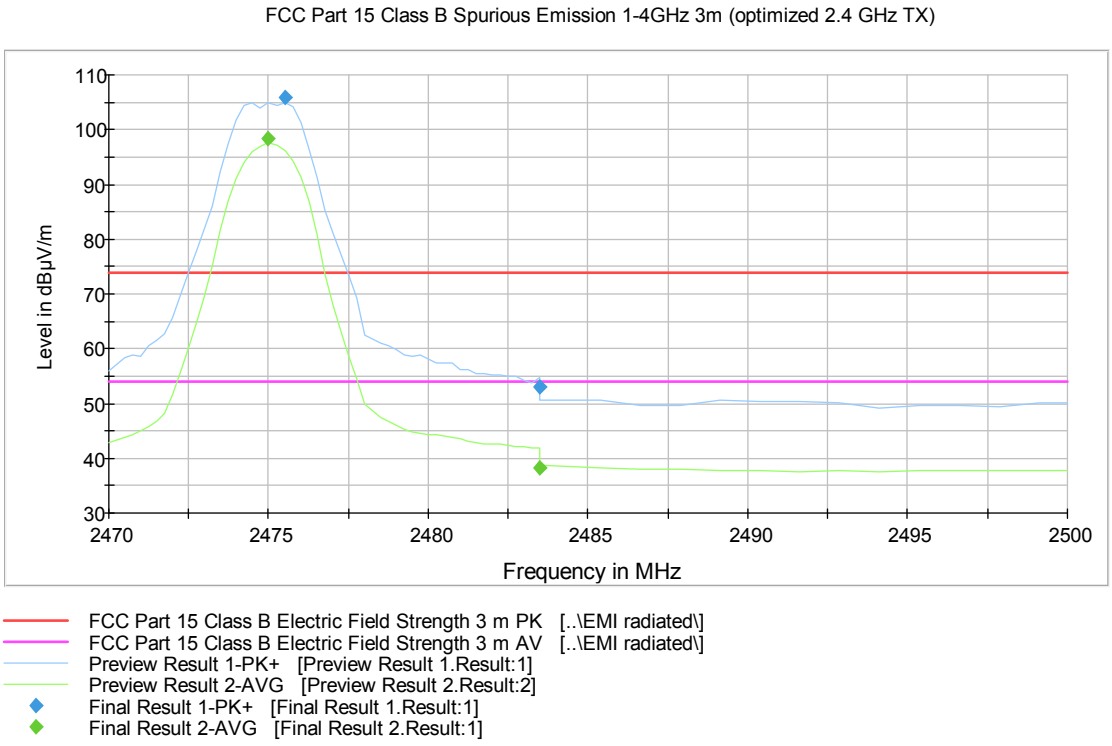

Figure 34: Radiated Band Edge measurement graph (ch high(1))

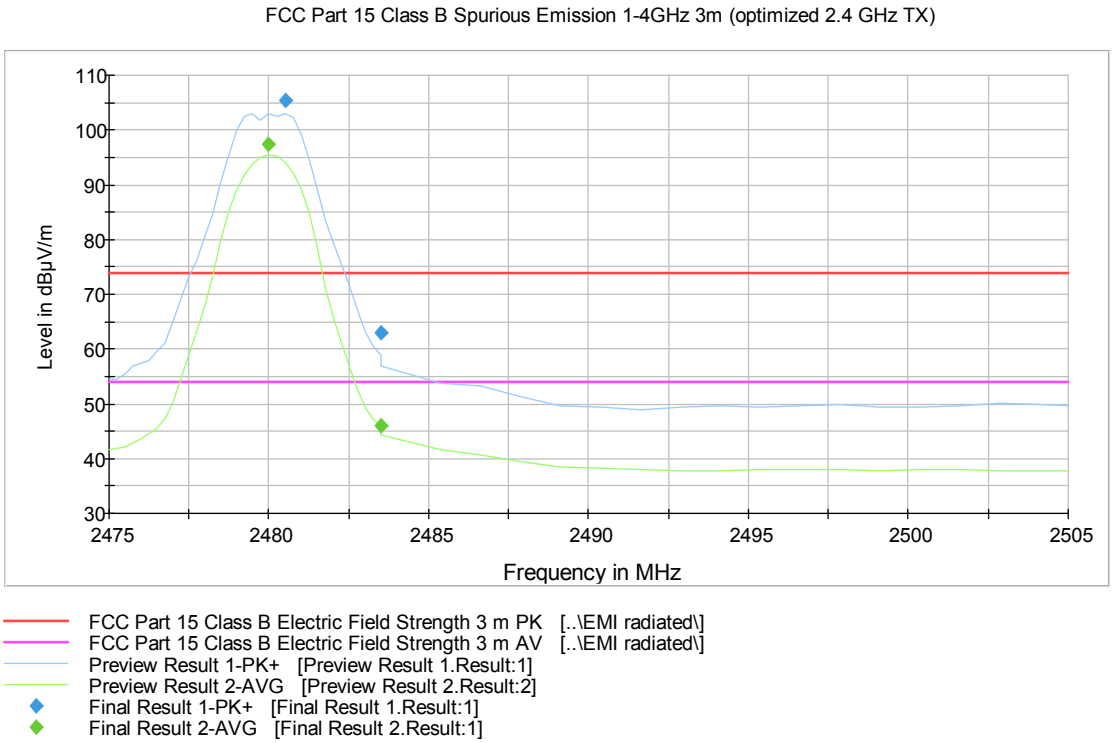

Figure 35: Radiated Band Edge measurement graph (ch high(2))

Table 23: Peak results (2480 MHz)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	63.0	1000.0	1000.000	277.0	V	0.0	14.7	10.9	73.9

Table 24: Average results (2480 MHz)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	45.9	1000.0	1000.000	279.0	V	1.0	14.7	8.0	53.9

Transmitter Band Edge Measurement and Conducted Spurious Emissions

Standard:	ANSI C63.10	(2013)
Tested by:	EHA	
Date:	28 March 2017 - 29 June 2017	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	
Measurement uncertainty:	± 2.87 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.247(d), 15.209(a)
RSS-247 5.5

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 25: Band edge attenuation

Band Edge Attenuation		
Lower Band Edge	**Upper Band Edge (high(1))**	**Upper Band Edge (high(2))**
-47.18 dBc	-46.71 dBc	-46.24
Limit: -20 dBc		

Table 26: Conducted spurious emissions (ch low)

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
788.38	-69.88	-12.39	-57.49	PASS
2399.58	-50.50	-12.39	-38.11	PASS
3985.95	-66.51	-12.39	-54.11	PASS
4808.99	-57.39	-12.39	-45.00	PASS
8481.63	-61.67	-12.39	-49.28	PASS
12841.99	-59.44	-12.39	-47.05	PASS
15501.59	-57.38	-12.39	-44.99	PASS
17734.46	-56.57	-12.39	-44.18	PASS
19797.37	-57.15	-12.39	-44.76	PASS
24440.28	-57.04	-12.39	-44.65	PASS
25757.50	-55.92	-12.39	-43.53	PASS

Table 27: Conducted spurious emissions (ch mid)

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
883.13	-69.92	-12.64	-57.28	PASS
2367.69	-66.35	-12.64	-53.71	PASS
2483.52	-65.77	-12.64	-53.13	PASS
4888.96	-59.40	-12.64	-46.76	PASS
8502.53	-61.12	-12.64	-48.48	PASS
12515.94	-58.90	-12.64	-46.26	PASS
15501.50	-56.92	-12.64	-44.28	PASS
16532.44	-56.06	-12.64	-43.42	PASS
19229.63	-57.85	-12.64	-45.21	PASS
24498.69	-56.59	-12.64	-43.95	PASS
26197.88	-57.14	-12.64	-44.50	PASS

Table 28: Conducted spurious emissions (ch high(1))

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
856.13	-69.85	-12.70	-57.15	PASS
1772.23	-62.62	-12.70	-49.92	PASS
2483.52	-58.92	-12.70	-46.23	PASS
4948.95	-59.24	-12.70	-46.55	PASS
9145.26	-62.07	-12.70	-49.38	PASS
12507.69	-59.25	-12.70	-46.56	PASS
15820.05	-55.82	-12.70	-43.13	PASS
16137.39	-56.00	-12.70	-43.31	PASS
19500.66	-57.96	-12.70	-45.27	PASS
24416.57	-57.46	-12.70	-44.76	PASS
25137.60	-56.32	-12.70	-43.62	PASS

Table 29: Conducted spurious emissions (ch high(2))

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
914.26	-68.73	-12.08	-56.65	PASS
1717.15	-62.87	-12.08	-50.79	PASS
2483.52	-45.13	-12.08	-33.05	PASS
4958.99	-61.10	-12.08	-49.02	PASS
9810.58	-60.55	-12.08	-48.47	PASS
12507.03	-59.22	-12.08	-47.14	PASS
15524.19	-56.66	-12.08	-44.59	PASS
16117.61	-55.51	-12.08	-43.43	PASS
19164.95	-57.18	-12.08	-45.10	PASS
24463.63	-56.78	-12.08	-44.70	PASS
25558.05	-56.74	-12.08	-44.67	PASS

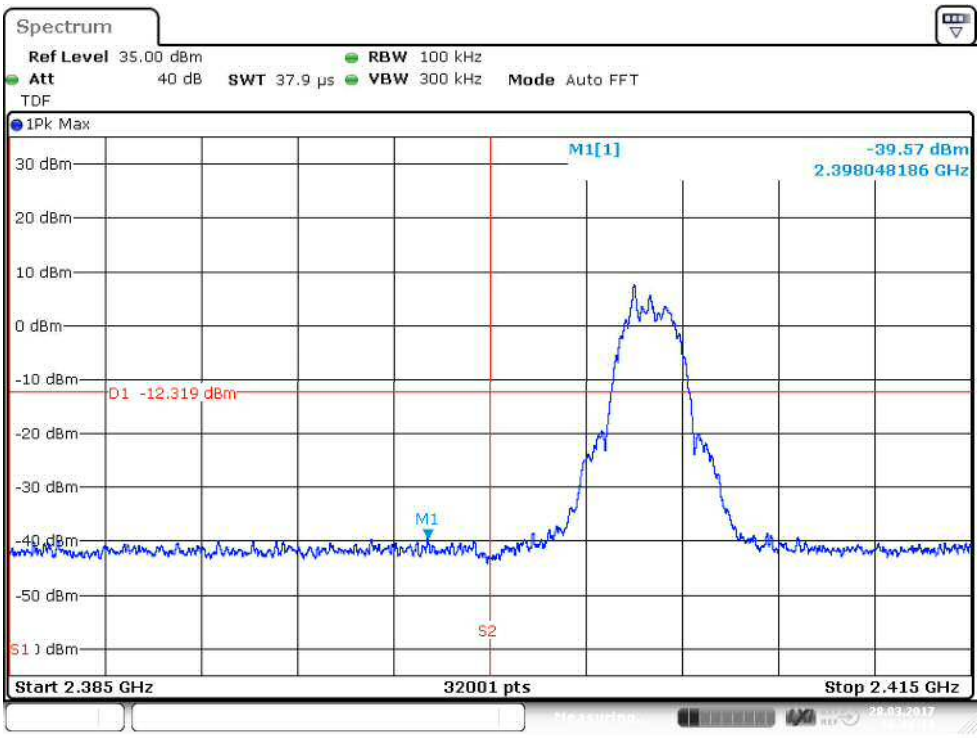

Figure 36: Lower Band Edge

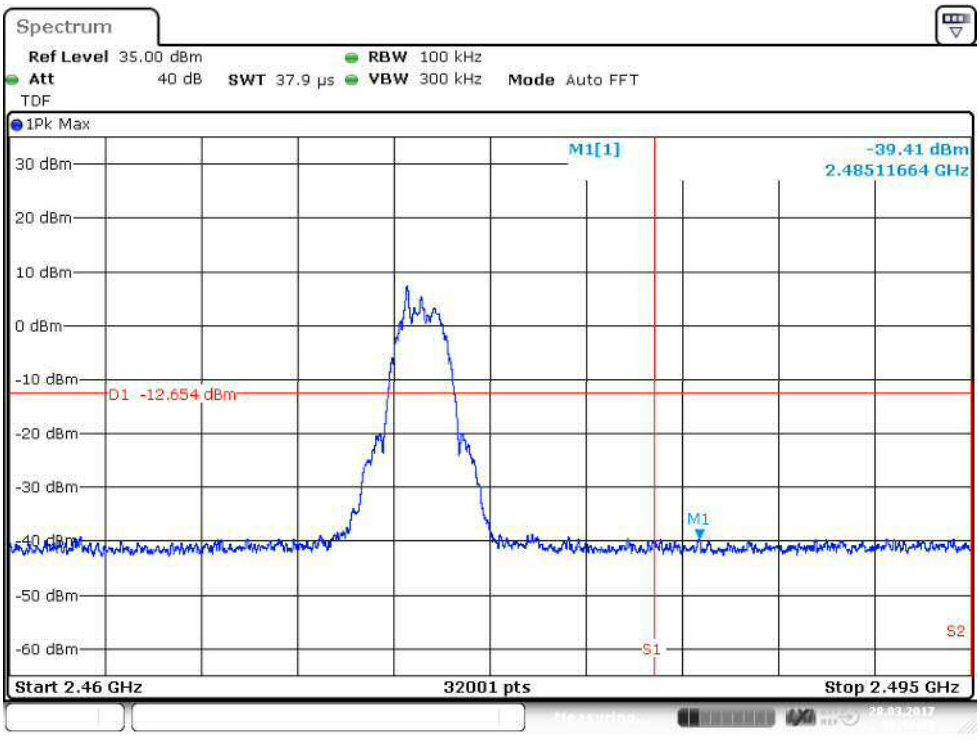

Figure 37: Upper Band Edge (high (1))

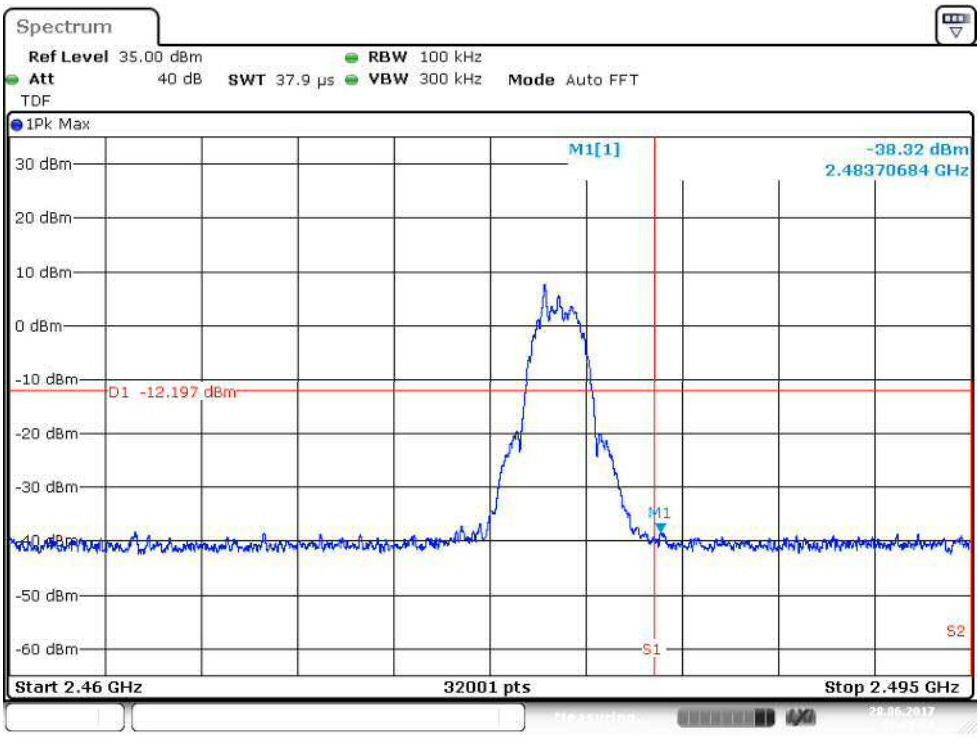

Figure 38: Upper Band Edge (high(2))

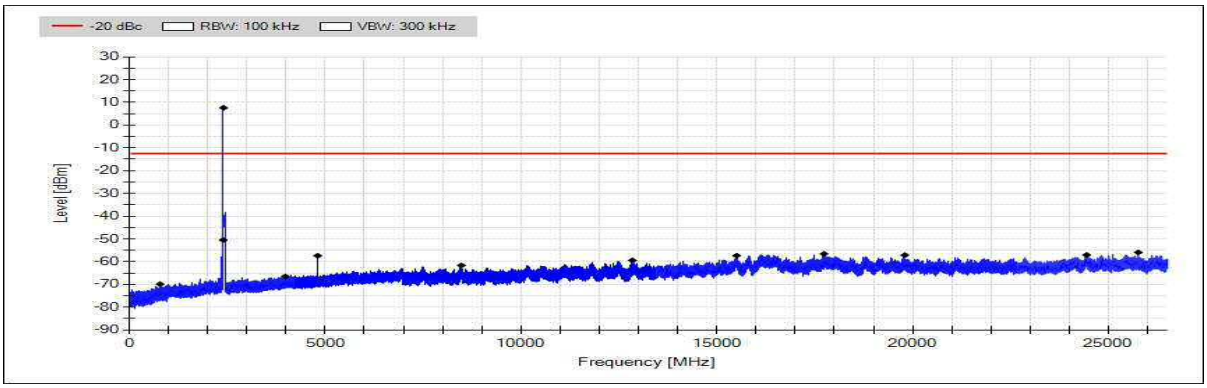

Figure 39: Conducted spurious emissions 30 - 26500 MHz channel low

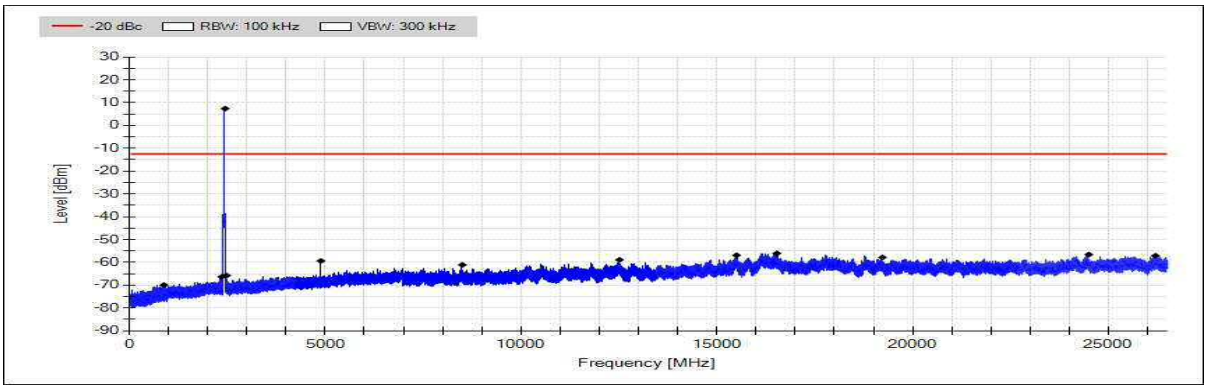

Figure 40: Conducted spurious emissions 30 - 26500 MHz channel mid

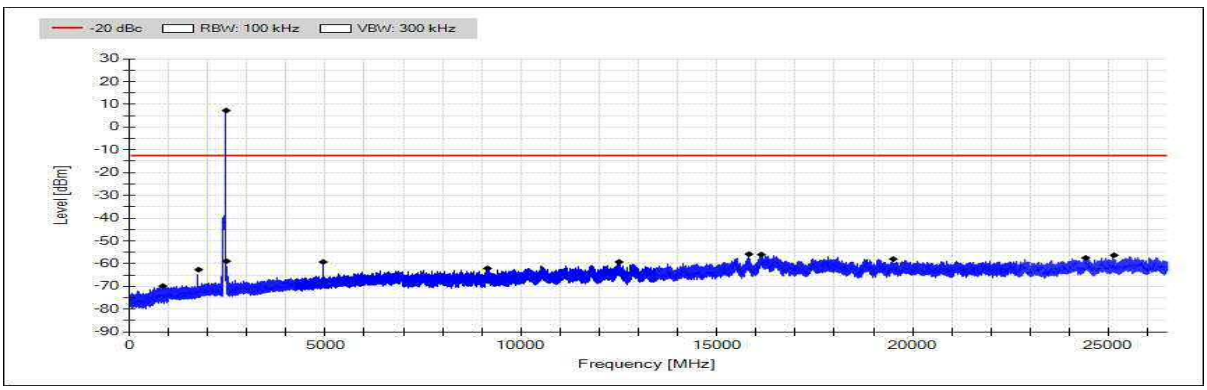

Figure 41: Conducted spurious emissions 30 - 26500 MHz channel high(1)

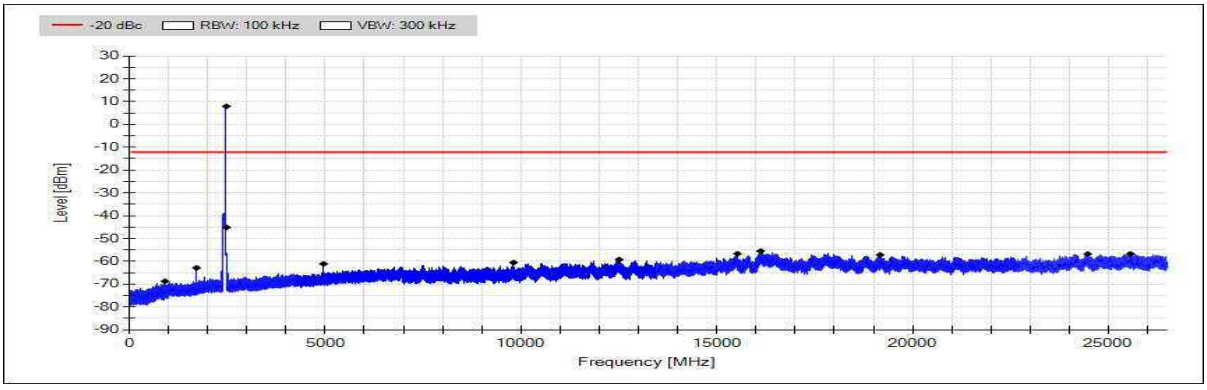

Figure 42: Conducted spurious emissions 30 - 26500 MHz channel high(2)

6 dB Bandwidth of the Channel

Standard:	ANSI C63.10	(2013)
Tested by:	EHA	
Date:	28 March 2017 - 29 June 2017	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	

FCC Rule: 15.247(a)(2)
RSS-247 5.2(a)

Results:

Table 30: 6 dB bandwidth test results

Channel	6 dB BW [kHz]	Minimum limit [kHz]
Low	1323	500
Mid	1321	
High(1)	1321	
High(2)	1320	

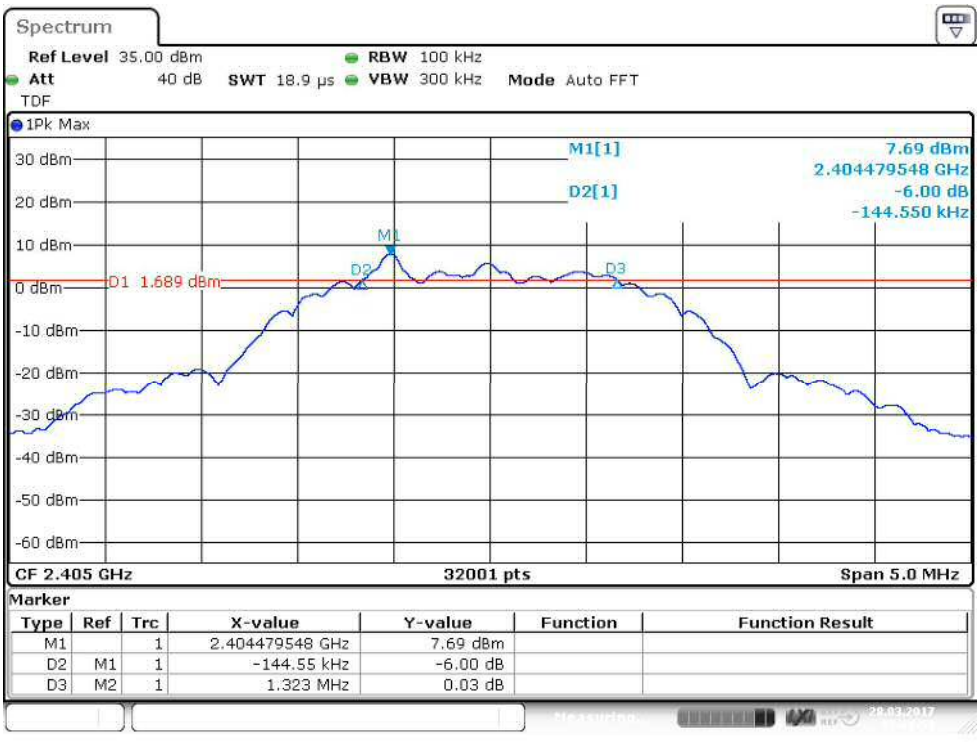

Figure 43: 6 dB bandwidth (ch low)

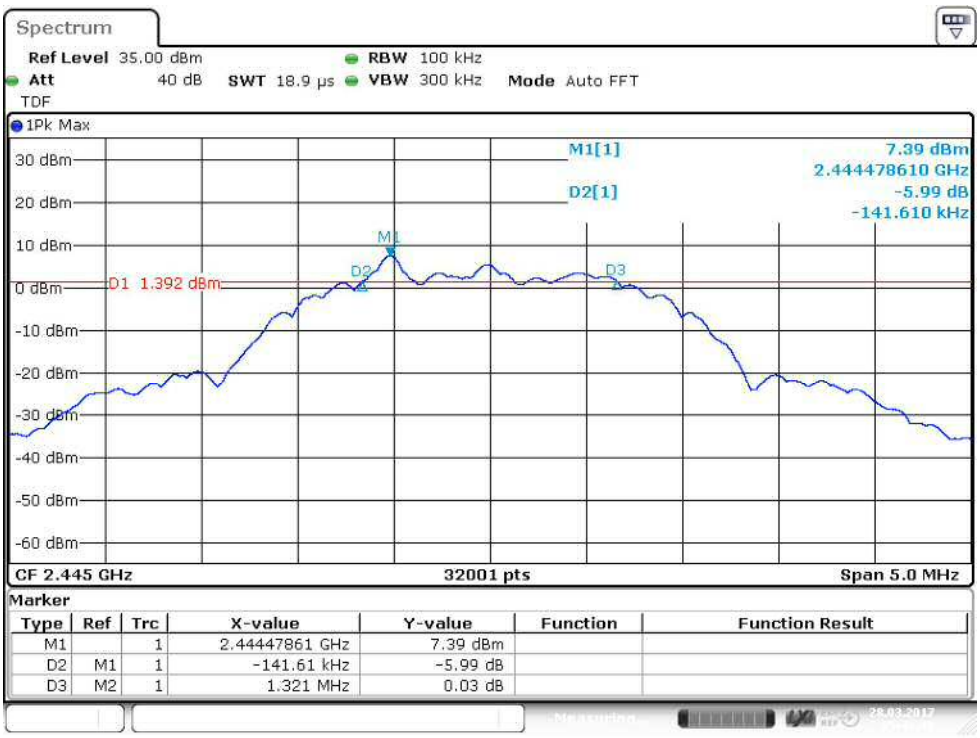

Figure 44: 6 dB bandwidth (ch mid)

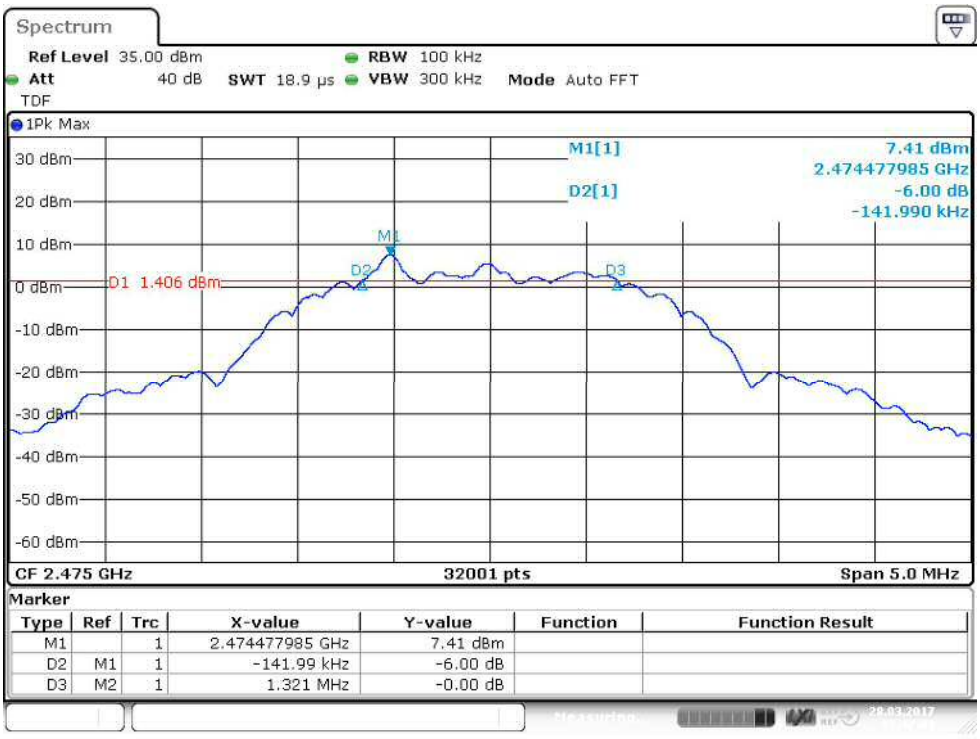

Figure 45: 6 dB bandwidth (ch high(1))

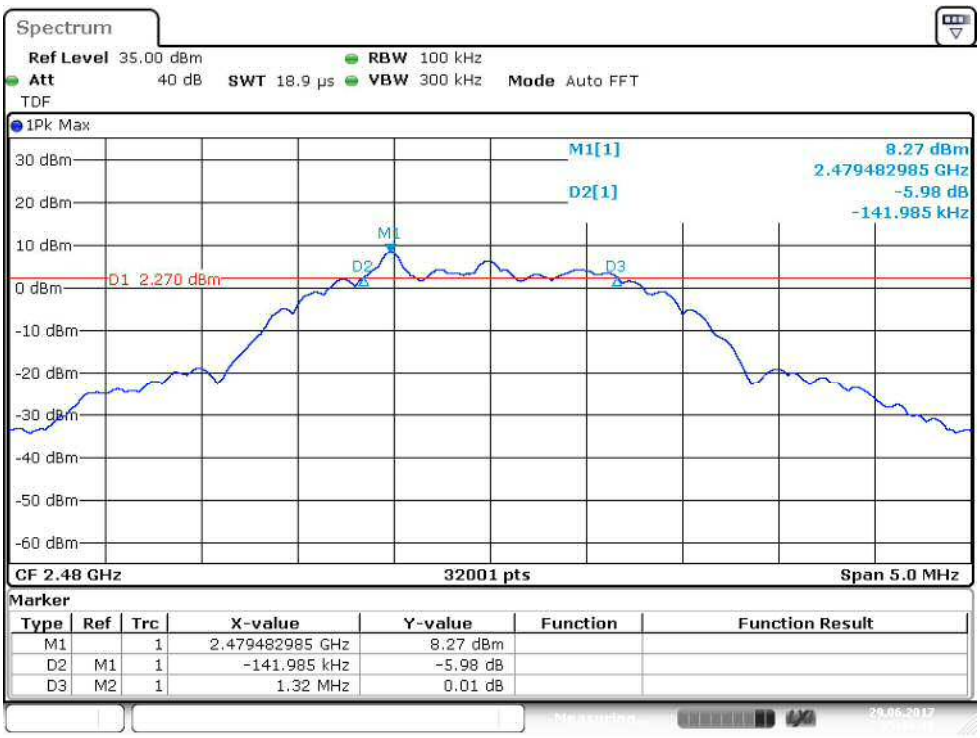

Figure 46: 6 dB bandwidth (ch high(2))

Power Spectral Density

Standard:	ANSI C63.10	(2013)
Tested by:	EHA	
Date:	28 March 2017 - 29 June 2017	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	

FCC Rule: 15.247(e)
RSS-247 5.2(b)

Results:

Table 31: Power spectral density test results

Channel	PSD dBm/3 kHz	Maximum limit [dBm/3kHz]
Low	-1.99	+8.00
Mid	-2.31	
High(1)	-2.30	
High(2)	-1.27	

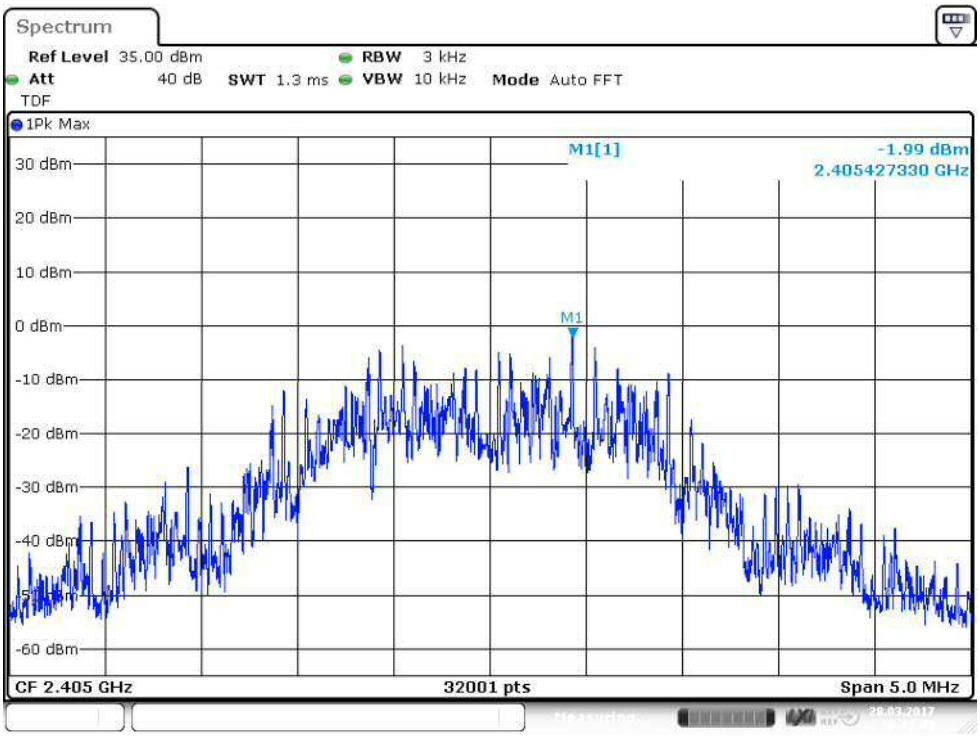

Figure 47: Power spectral density (ch low)

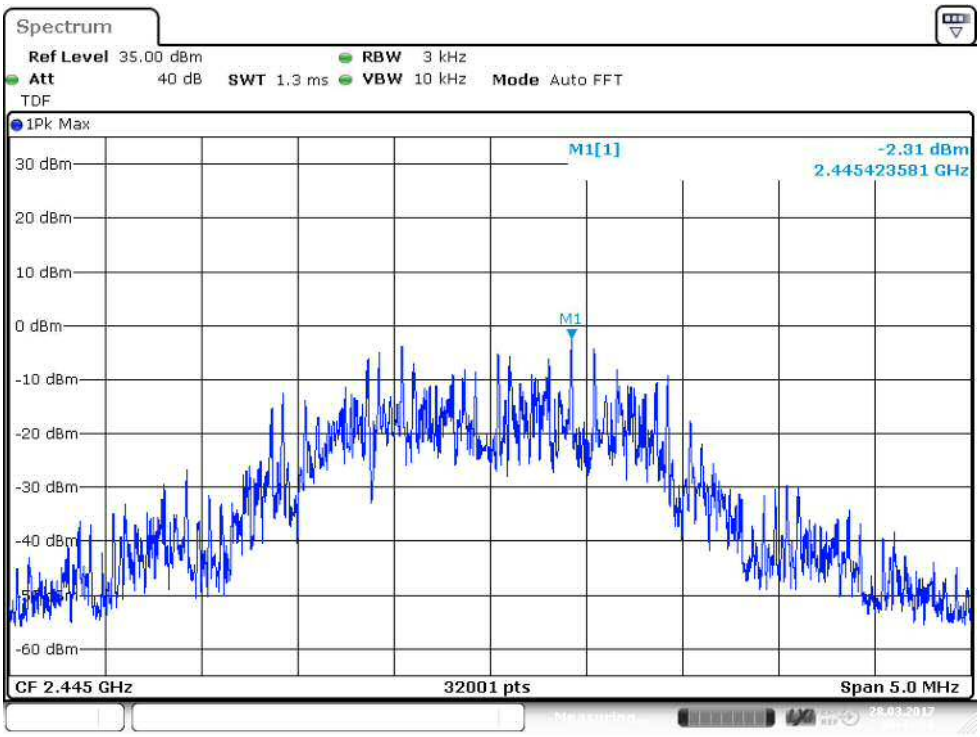

Figure 48: Power spectral density (ch mid)

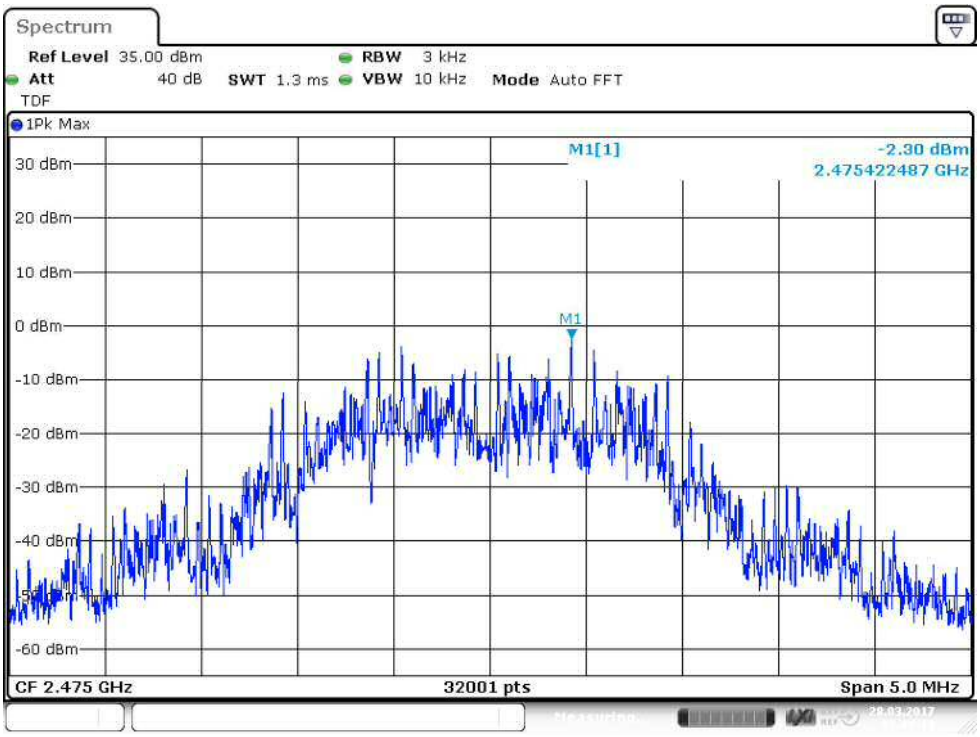

Figure 49: Power spectral density (ch high(1))

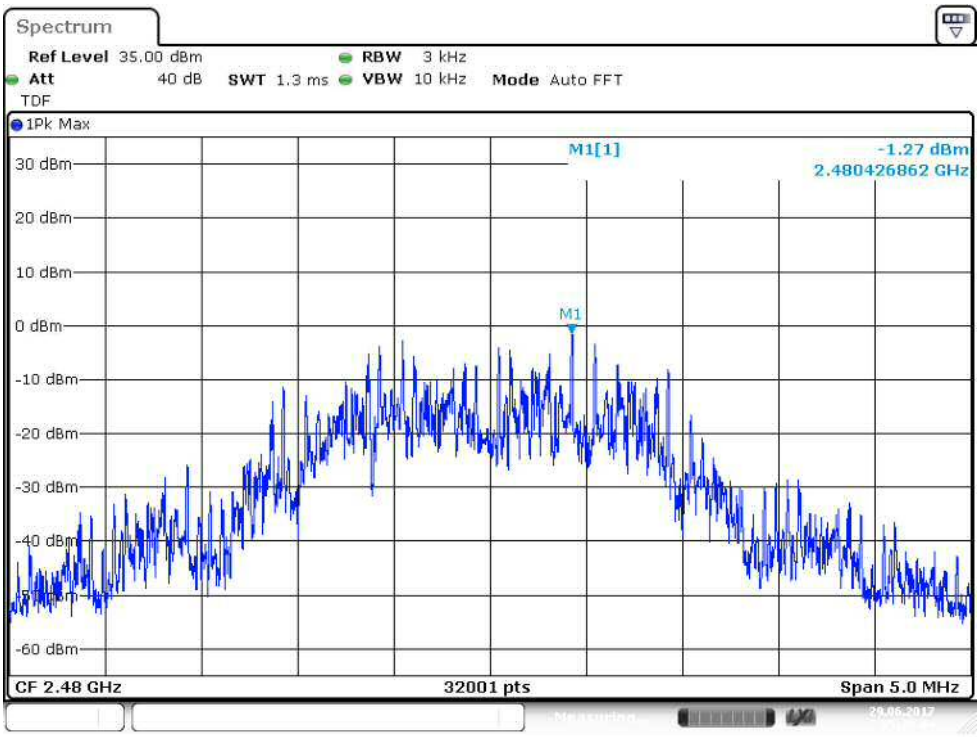

Figure 50: Power spectral density (ch high(2))

99% Occupied Bandwidth

Standard:	RSS-GEN	(2014)
Tested by:	EHA	
Date:	28 March 2017 - 29 June 2017	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	

RSS-GEN 6.6

Table 32: 99% occupied bandwidth test results

Channel	Limit	99 % BW [MHz]	Result
Low	-	2.235242649	PASS
Mid	-	2.234305178	PASS
High(1)	-	2.235555139	PASS
High(2)	-	2.248054748	PASS

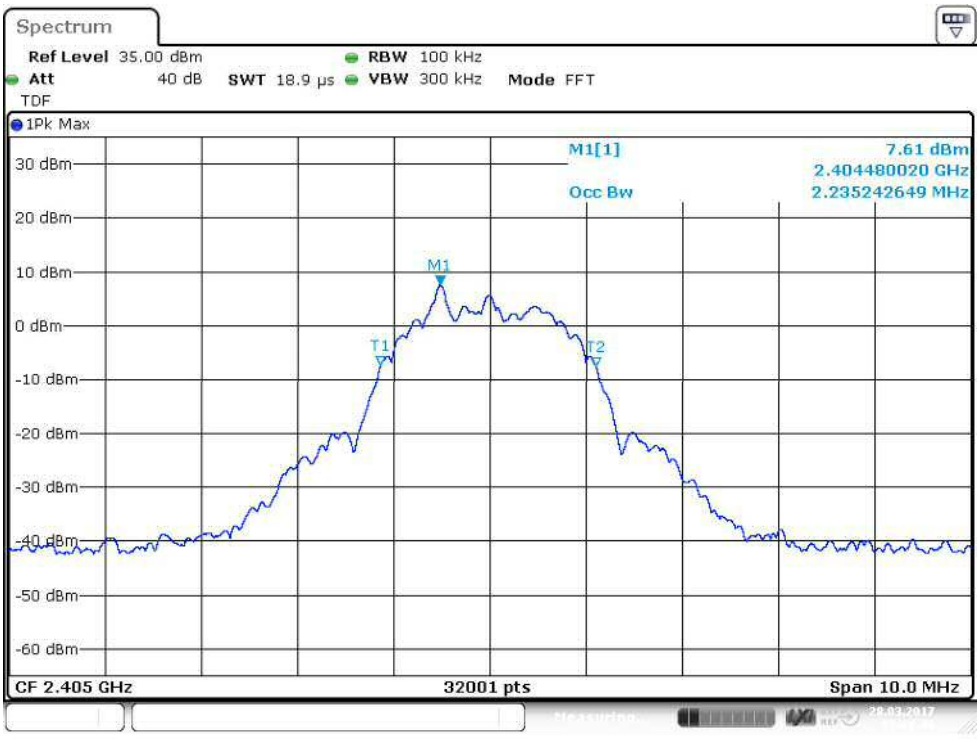

Figure 51: 99% OBW (ch low)

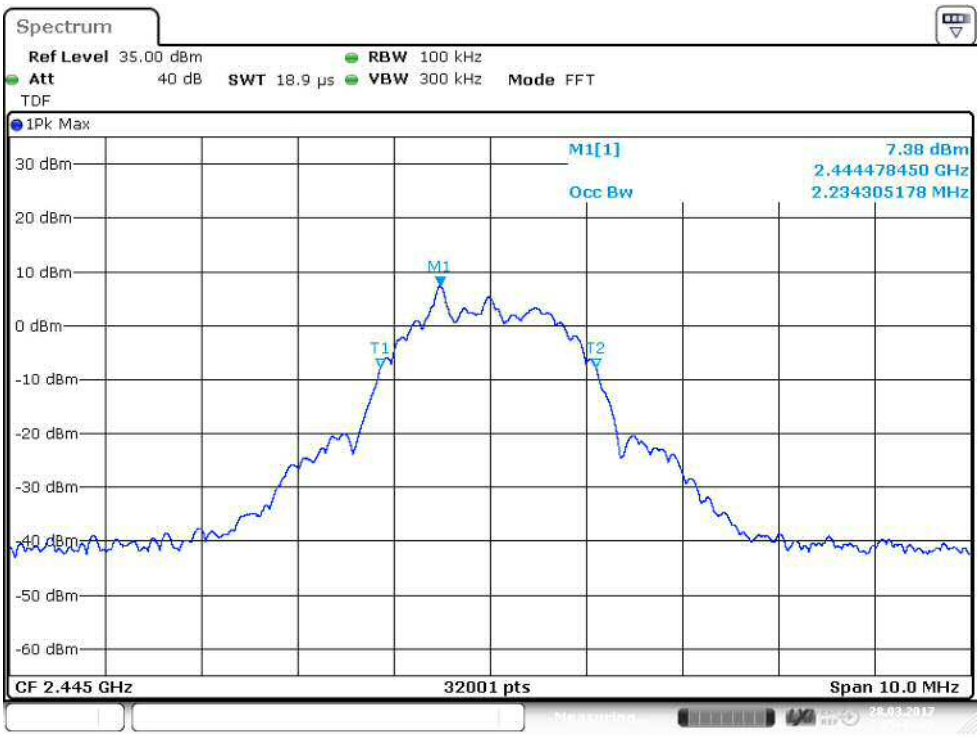

Figure 52: 99% OBW (ch mid)

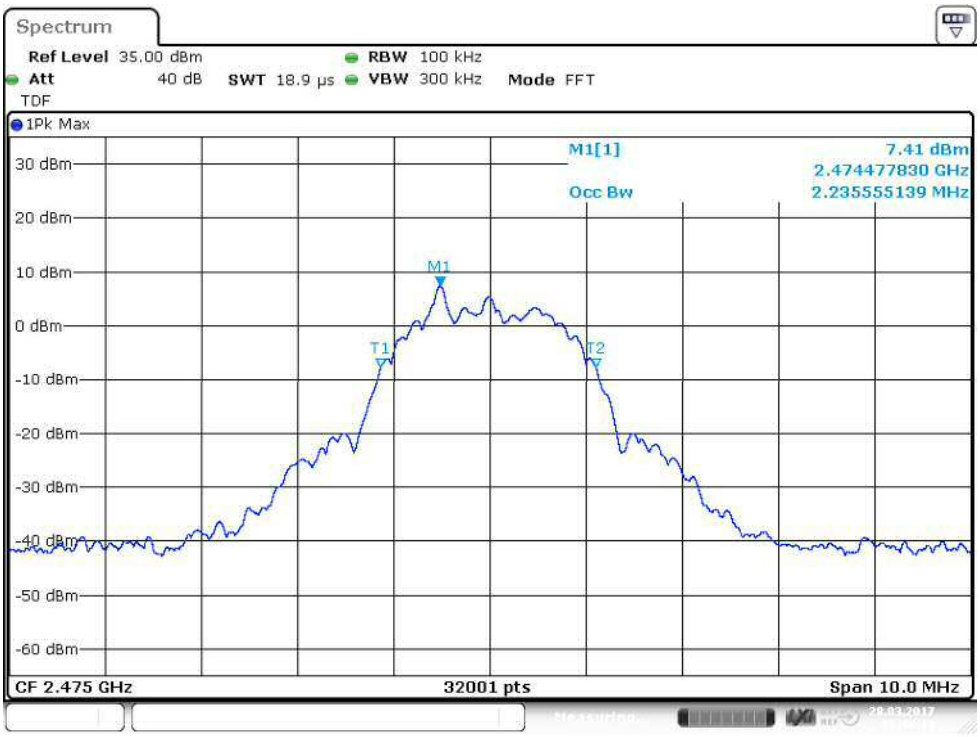

Figure 53: 99% OBW (ch high(1))

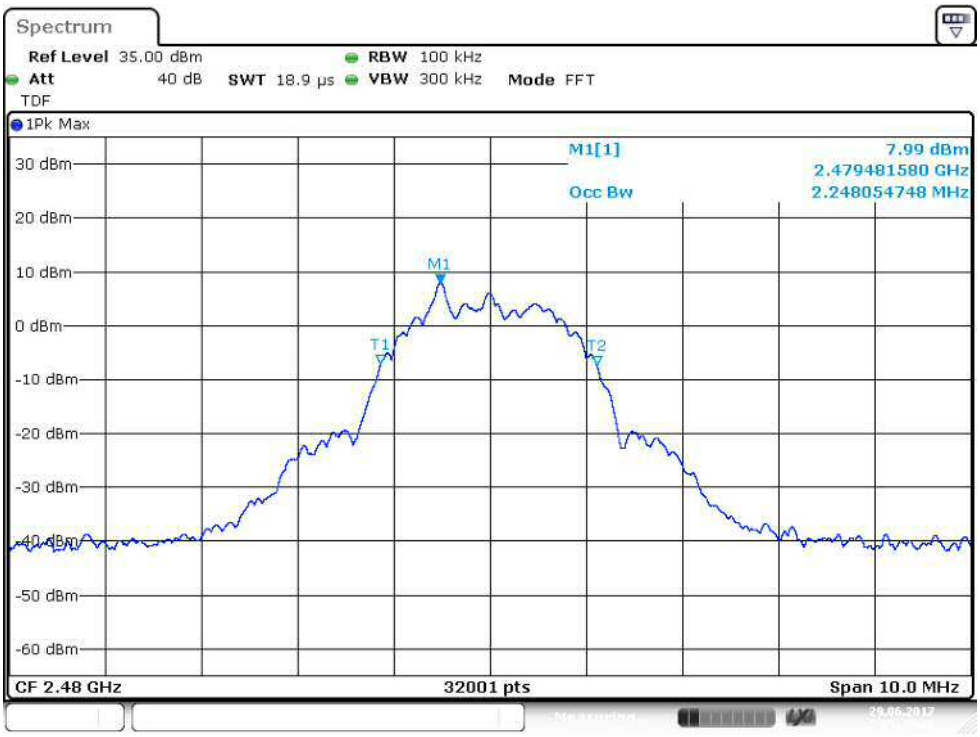

Figure 54: 99% OBW (ch high(2))

TEST EQUIPMENT

RF-Test Equipment

Equipment	Manufacturer	Type	Inv or serial	Prev Calib	Next Calib
ANTENNA	A.H. SYSTEMS	SAS-200/518	inv:7873	-	-
SPECTRUM ANALYZER	AGILENT	E7405A	inv:9746	2016-01-07	2018-01-07
PREAMPLIFIER	CIAO	CA118-3123	inv:10278	2016-11-28	2017-11-28
POWER SUPPLY	DELTA	SM 130-25D	inv:10406	-	-
ANTENNA	EMCO	3117	inv:7293	2016-03-16	2018-03-06
ANTENNA	EMCO	3160-09	inv:7294	2017-03-16	2018-03-16
TURNTABLE	MATURO	DS430 UPGRADED	inv:10182	-	-
MAST & TURNTABLE CONTROLLER	MATURO	NCD	inv:10183	-	-
ANTENNA MAST	MATURO	TAM 4.0E	inv:10181	-	-
ATTENUATOR	PASTERNACK	10dB DC-40GHz	-	-	-
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	-	-
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESU 26	inv:8453	2016-06-10	2017-07-10
SIGNAL ANALYZER	ROHDE & SCHWARZ	FSV40	inv:9093	2016-06-10	2017-07-10
ANTENNA	SCHWARZBECK	VULB 9168	inv:8911	2016-10-25	2018-10-25
TEMPERATURE/ HUMIDITY METER	VAISALA	HMT 333	inv:8638	2017-02-21	2018-02-21
HIGH PASS FILTER	WAINWRIGHT	WHKX4.0/18G-10SS	inv:10403	2017-03-01	2019-03-01