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:	Bluetooth Low Energy Module
Model:	BGM13S32A BGM13S32N BGM13S22A BGM13S22N
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: 26 January 2018
Issued by:
Jani Tuomela
Testing Engineer

Date: 26 January 2018
Checked by:
Rauno Repo
Testing Engineer

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Equipment Under Test (EUT)

Trade mark:	Silicon Labs
Model:	BGM13S32A, BGM13S32N, BGM13S22A, BGM13S22N
Type:	Bluetooth Low Energy Module
Serial no:	-
FCC ID:	QOQ13
IC:	5123A-13

Description of the EUT

BGM13S32 (max power 19 dBm), Bluetooth low energy module with two antenna variants (A / N).
BGM13S22 (max power 10 dBm), Bluetooth low energy module with two antenna variants (A / N).
Variant A is equipped with chip antenna while the N variant has RF pin for the use of external antenna.

Classification of the device

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

Modifications Incorporated in the EUT

One sample was modified to allow conducted measurements to be made.

Ratings and Declarations

Operating Frequency Range (OFR):	2402 - 2480 MHz
Channels:	40
Channel separation:	2 MHz
Effective conducted power:	18.46 dBm (Peak)
Modulation:	GFSK
Integral Antenna gain:	A-variant: 1 dBi
External Antenna gain:	N-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

EUT	Description
1. BGM13S32N	Original N variant with RF pin for external antenna
2. BGM13S32A	Original A variant, equipped with chip antenna
3. BGM13S32A	Modified A variant, Short RF cable added for conducted tests
4. BGM13S22N	Original N variant with RF pin for external antenna

Disclaimer

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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.

During conducted measurements, the EUT was connected to WSTK development board. Conducted measurements were performed to EUT 3 and EUT 4. Conducted measurements were made only for one variant (A / N) because the variants are identical except for the antenna.

During radiated measurements, N variant was connected to WSTK development board and the A variant was having simplified board with reduced functionality.

Following channels and settings were used during the tests

EUT 1. BGM13S32N and EUT 2. BGM13S32A
- Radiated Emissions Within the Restricted Bands (channels: 0, 19, 39)
- Conducted Emissions on Power Supply Lines tests (channel: 19)

Channel	Frequency (MHz)	Power setting	PHY	Low energy transmit	Packet Length
0	2402	200	125K Coded	PRBS9 (GFSK)	255
19	2440	200	125K Coded	PRBS9 (GFSK)	255
39	2478	200	125K Coded	PRBS9 (GFSK)	255

EUT3. BGM13S32A

- Maximum Peak Conducted Output Power (channels: 0, 19, 39)
- 6 dB Bandwidth (channels: 0, 19, 39)
- Power Spectral Density (channels: 0, 19, 39)
- 99% Occupied Bandwidth (channels: 0, 19, 39)
- 100 kHz Bandwidth of Frequency Band Edges and Conducted Spurious Emissions tests (channels: 0, 19, 39)

Channel	Frequency (MHz)	Power setting	PHY	Low energy transmit	Packet Length
0	2402	145	125K Coded	PRBS9 (GFSK)	199
0	2402	200	1M Coded	PRBS9 (GFSK)	199
19	2440	145	125K Coded	PRBS9 (GFSK)	199
19	2440	200	1M Coded	PRBS9 (GFSK)	199
39	2480	145	125K Coded	PRBS9 (GFSK)	199
39	2480	200	1M Coded	PRBS9 (GFSK)	199

EUT4. BGM13S22N

- Maximum Peak Conducted Output Power (channels: 0, 19, 39)
- 99% Occupied Bandwidth (channels: 0, 19, 39)

Channel	Frequency (MHz)	Power setting	PHY	Low energy transmit	Packet Length
0	2402	95	125K Coded	PRBS9 (GFSK)	255
19	2440	95	125K Coded	PRBS9 (GFSK)	255
39	2480	95	125K Coded	PRBS9 (GFSK)	255

Test Facility

Testing Laboratory / address: FCC registration number: **904175** Industry Canada registration number: **8708A-2**	SGS Fimko Ltd Särkiniementie 3 FI-00210, HELSINKI FINLAND
Test Site:	Kara5m

TEST RESULTS

Conducted Emissions In The Frequency Range 150 kHz - 30 MHz

Standard:	ANSI C63.10	(2013)
Tested by:	MIH	
Date:	14 September 2017	
Temperature:	23 ± 3°C	
Humidity:	20 - 60 % RH	
Barometric pressure:	1001 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

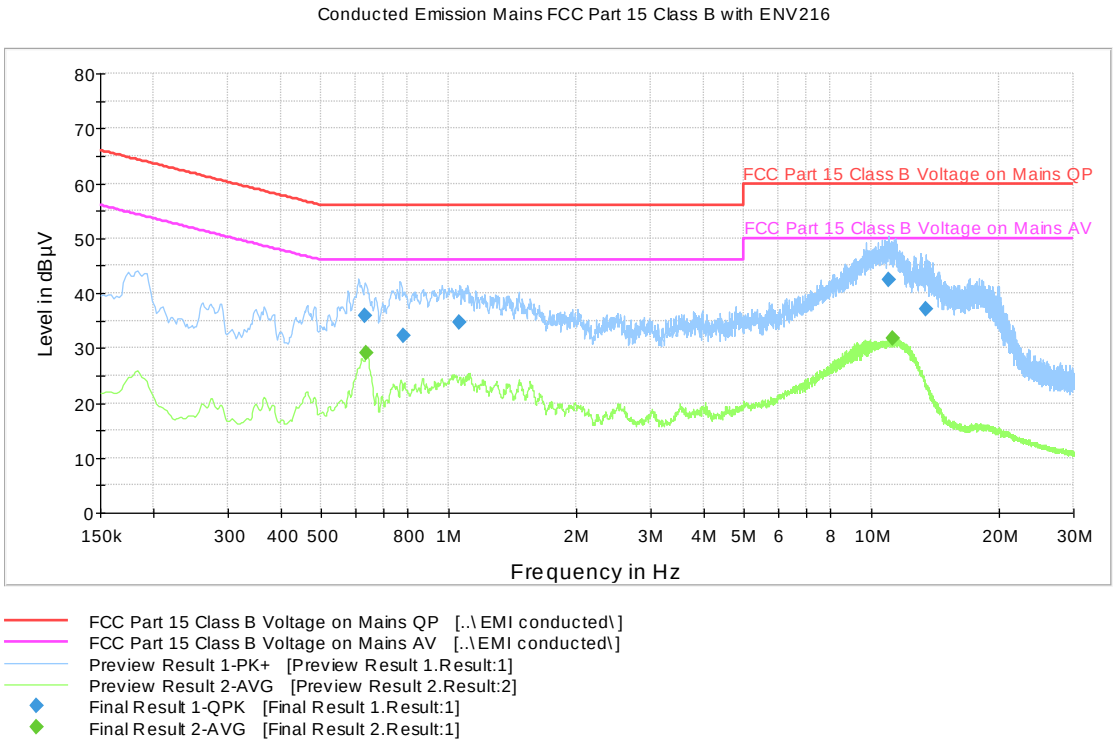

Figure 1: The measured curves with peak- and average detector (A).

Table 1: Final QuasiPeak measurements from the worst frequencies (A)

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.632750	35.9	1000.0	9.000	N	10.3	20.1	56.0
0.779000	32.2	1000.0	9.000	L1	10.0	23.8	56.0
1.062250	34.7	1000.0	9.000	L1	10.0	21.3	56.0
10.989750	42.3	1000.0	9.000	L1	10.3	17.7	60.0
13.471750	37.1	1000.0	9.000	L1	10.4	22.9	60.0

Table 2: Final Average measurements from the worst frequencies (A)

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.638750	29.2	1000.0	9.000	N	10.3	16.8	46.0
11.171250	31.7	1000.0	9.000	L1	10.3	18.3	50.0

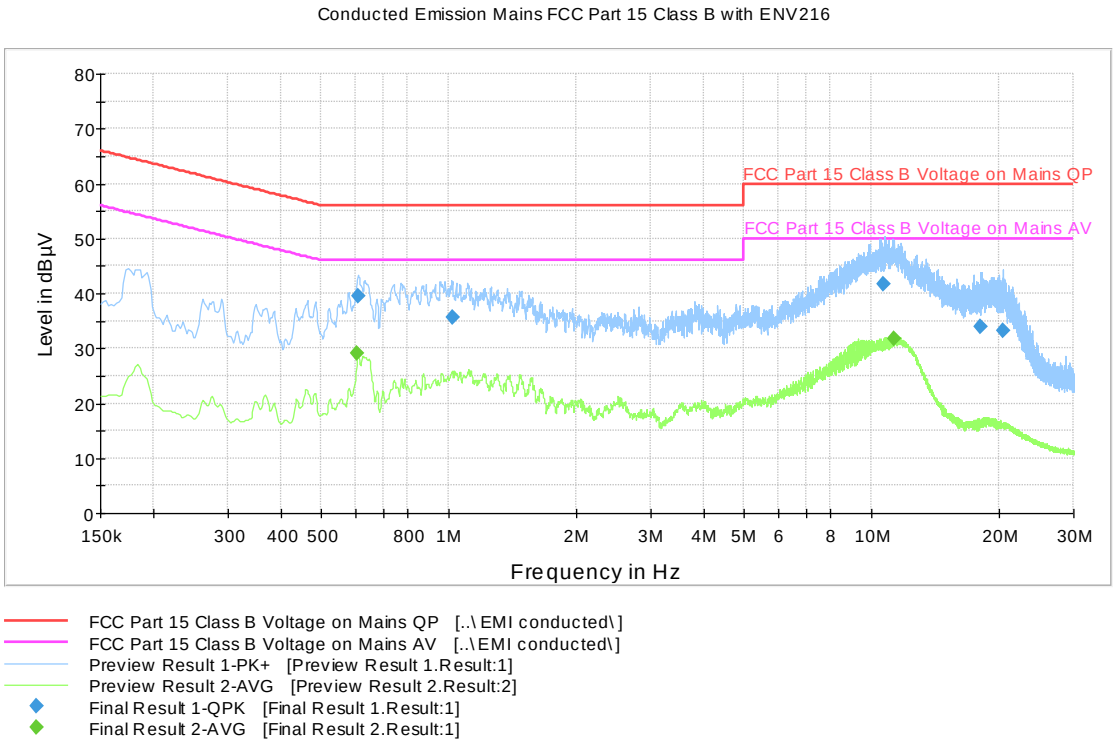

Figure 2: The measured curves with peak- and average detector (N).

Table 3: Final QuasiPeak measurements from the worst frequencies (N)

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.611500	39.5	1000.0	9.000	N	10.3	16.5	56.0
1.019250	35.7	1000.0	9.000	L1	10.0	20.3	56.0
10.694500	41.7	1000.0	9.000	L1	10.3	18.3	60.0
18.068750	34.0	1000.0	9.000	L1	10.5	26.0	60.0
20.497000	33.2	1000.0	9.000	L1	10.6	26.8	60.0

Table 4: Final Average measurements from the worst frequencies (N)

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.608500	29.0	1000.0	9.000	N	10.3	17.0	46.0
11.283250	31.8	1000.0	9.000	L1	10.3	18.2	50.0

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:	JAT / MIH	
Date:	29 September - 21 November 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 5: Maximum conducted output power (EUT 3)

Channel	Power setting	PHY	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
0 Low	145	125k coded	12.86	30	17.14	PASS
19 Mid	145	125k coded	12.78	30	17.22	PASS
39 High	145	125k coded	12.75	30	17.25	PASS
0 Low	200	1M coded	18.46	30	11.54	PASS
19 Mid	200	1M coded	18.31	30	11.69	PASS
39 High	200	1M coded	18.26	30	11.74	PASS

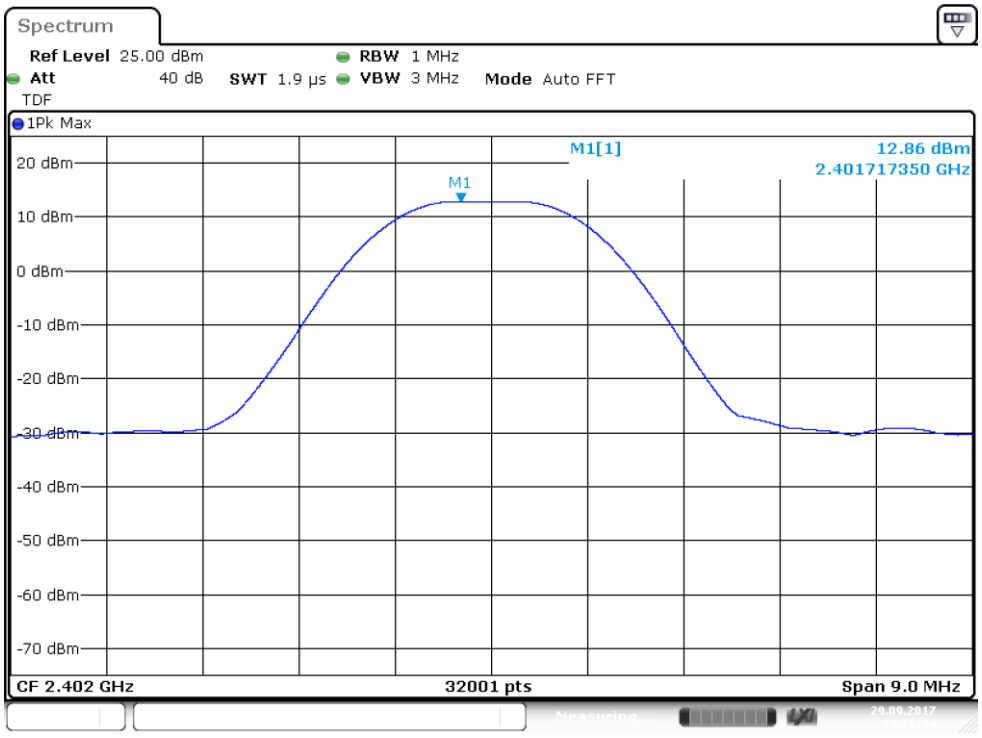

Figure 3: Conducted power, Channel 0 low, power setting 145

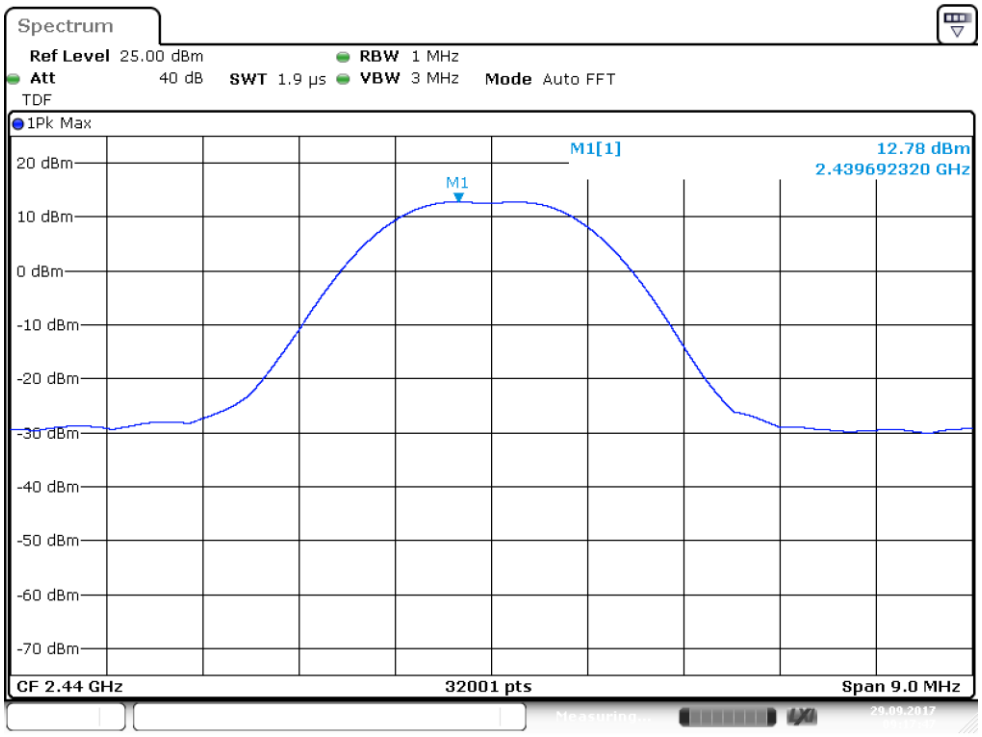

Figure 4: Conducted power, Channel 19 mid, power setting 145

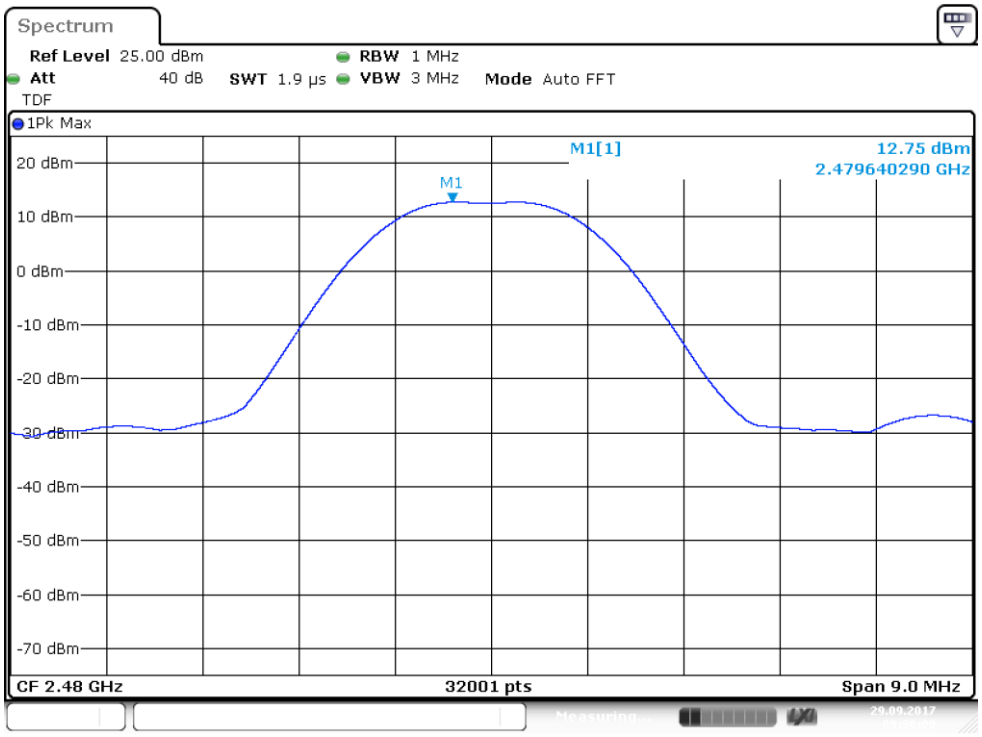

Figure 5: Conducted power, Channel 39 high, power setting 145

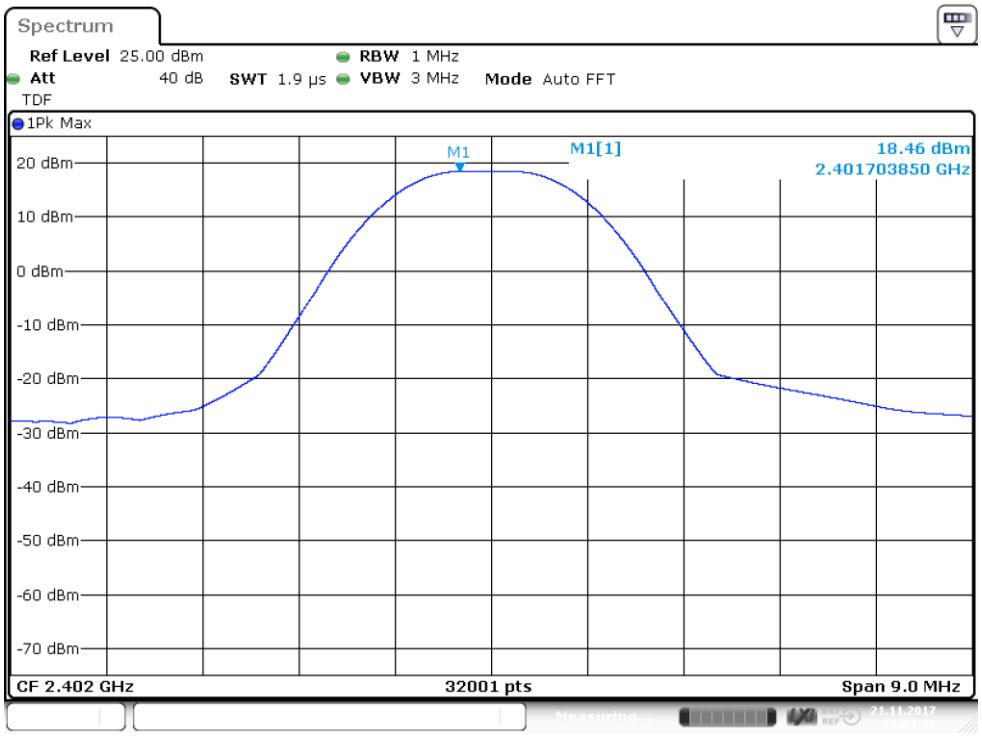

Figure 6: Conducted power, Channel 0 low, power setting 200

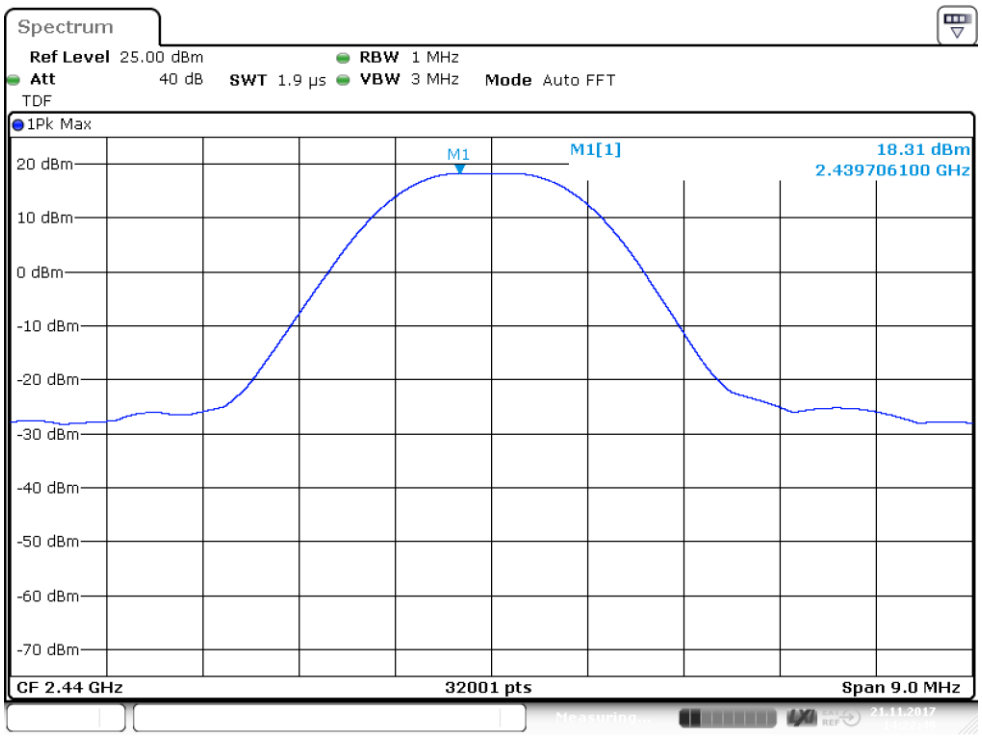

Figure 7: Conducted power, Channel 19 mid, power setting 200

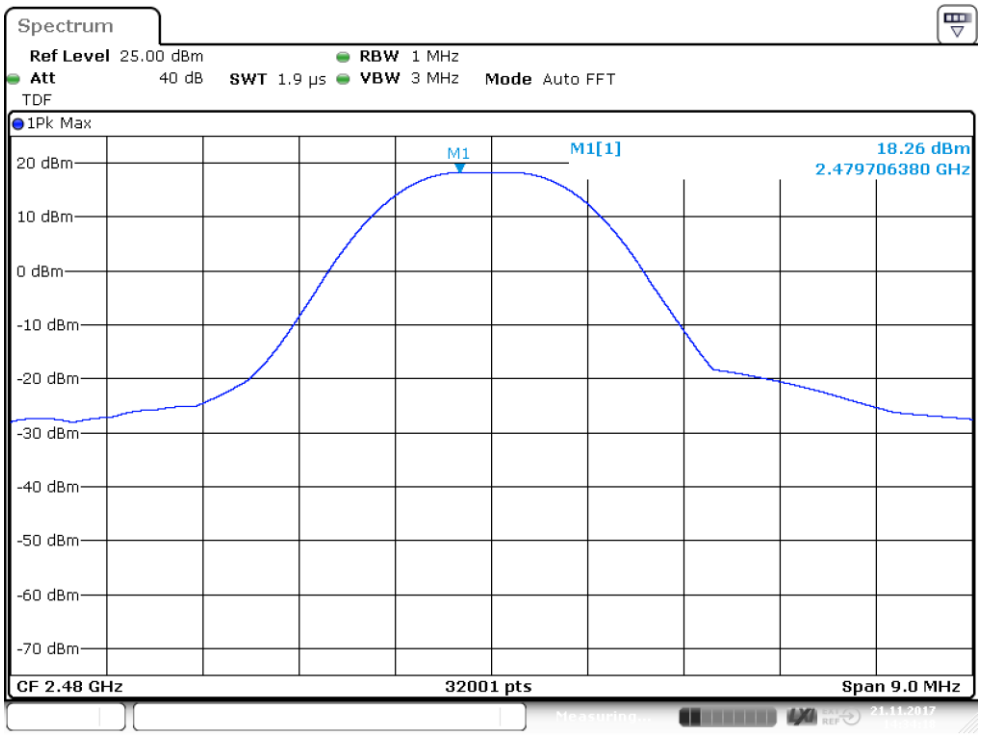

Figure 8: Conducted power, Channel 39 high, power setting 200

Table 6: Maximum conducted output power (EUT 4)

Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
0 Low	8.10	30	21.90	PASS
19 Mid	8.03	30	21.97	PASS
39 High	8.02	30	21.98	PASS

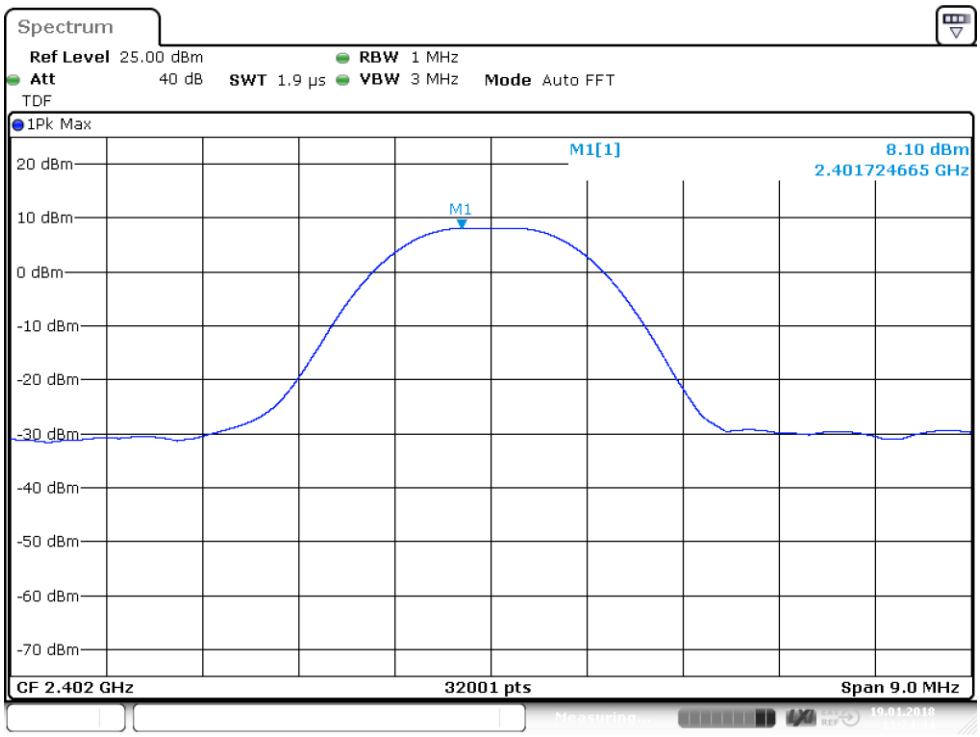

Figure 9: Conducted power, Channel 0 low, Power setting 95

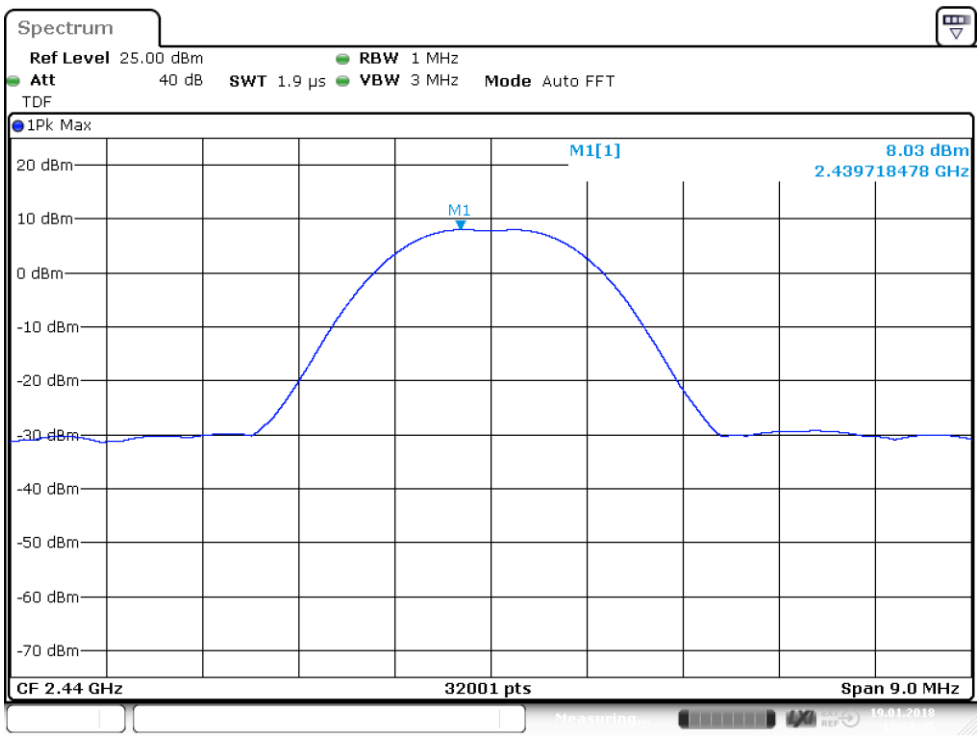

Figure 10: Conducted power, Channel 19 mid, Power setting 95

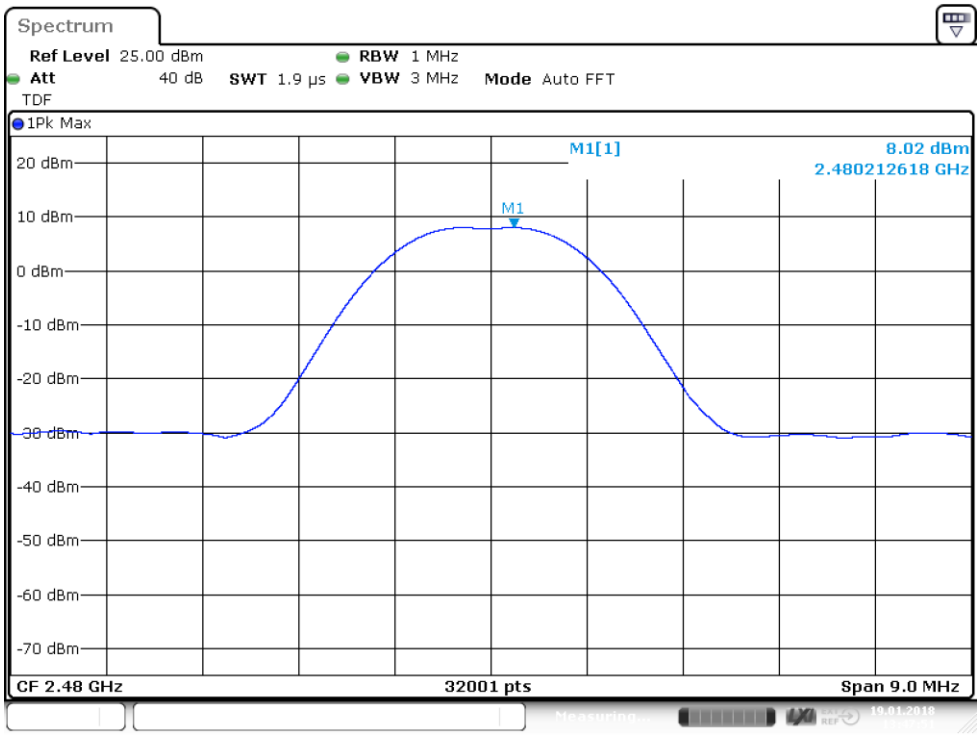

Figure 11: Conducted power, Channel 39 high, Power setting 95

Transmitter Radiated Spurious Emissions 30 - 26500 MHz

Standard:	ANSI C63.10	(2013)
Tested by:	MIH	
Date:	13 - 14 September 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).
Peak values of emissions below 1000 MHz measured for reference as well as transmitter fundamental.

Measurements were performed for both antenna variants.

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 (0)

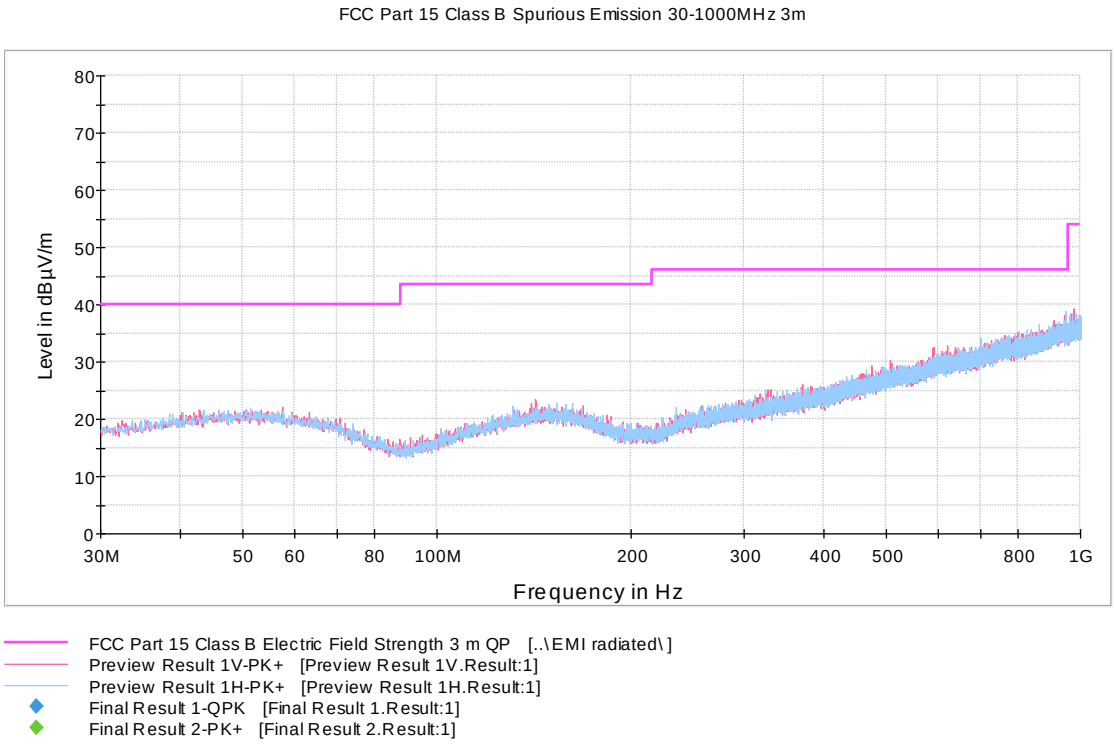

Figure 12: Channel 0 low 30 MHz – 1000 MHz (A)

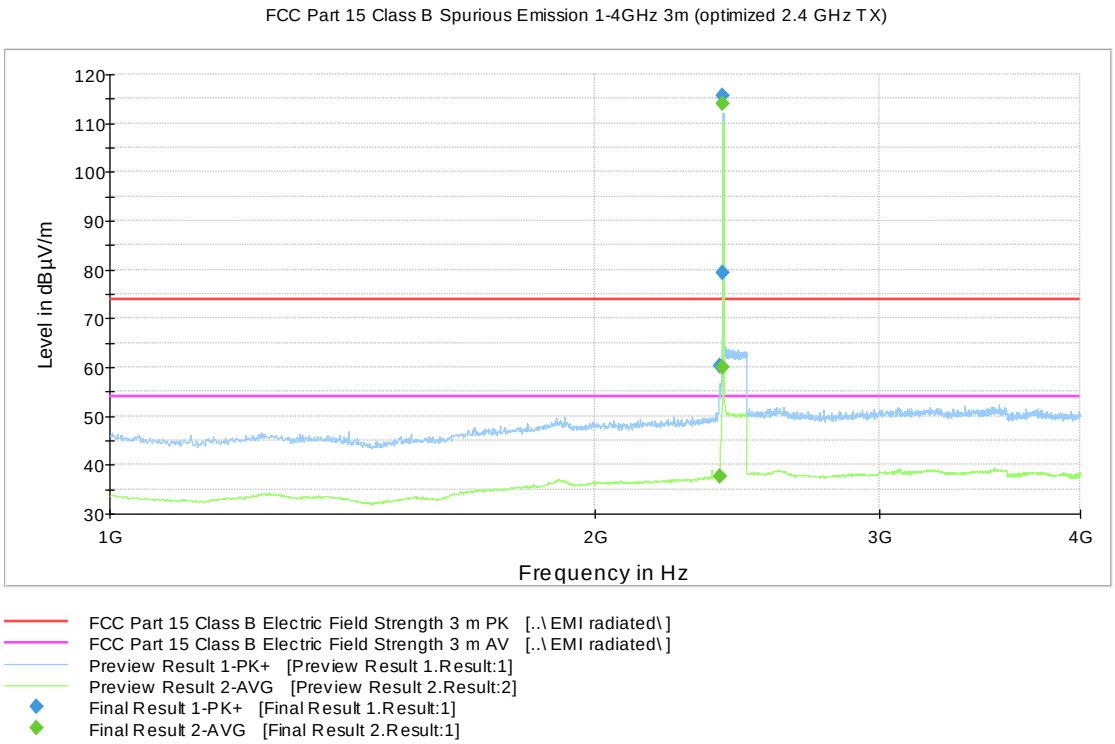

Figure 13: Channel 0 low 1 GHz – 4 GHz (A)

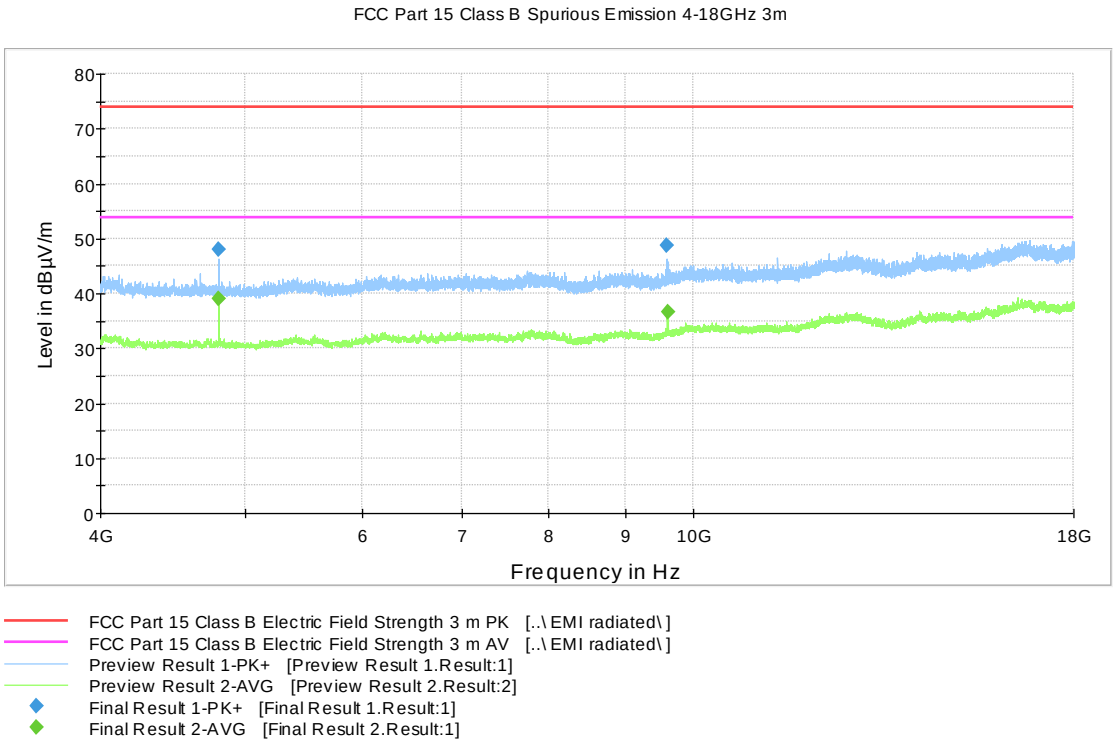

Figure 14: Channel 0 low 4 GHz – 18 GHz (A)

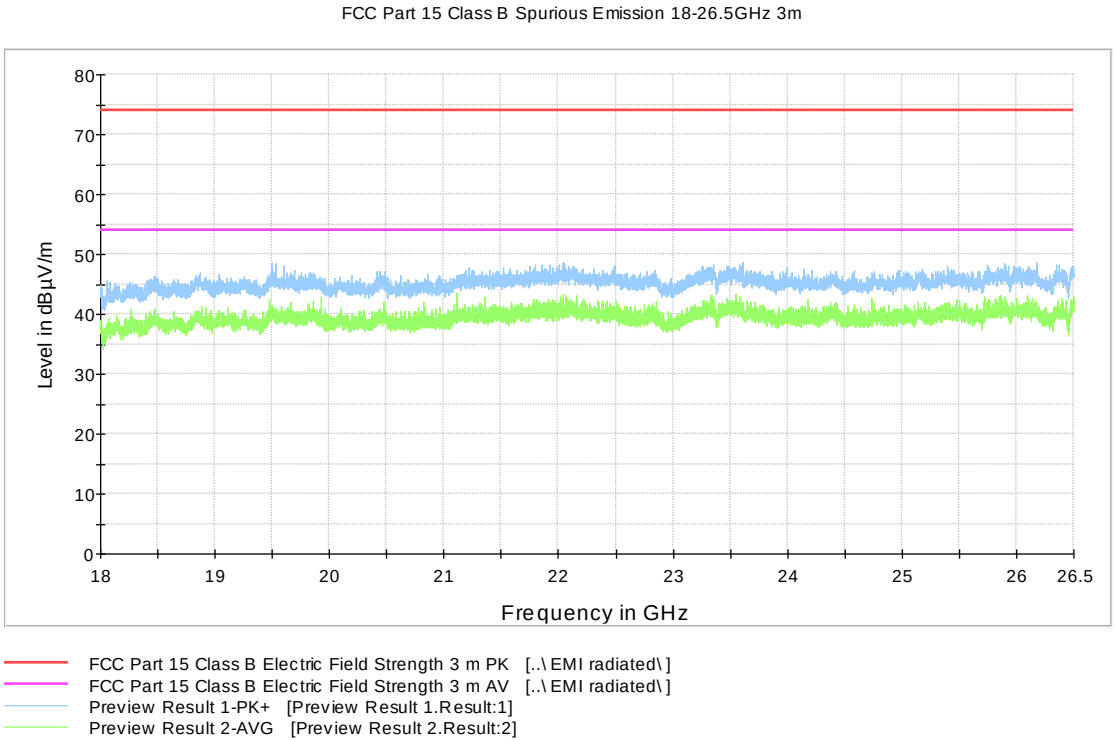

Figure 15: Channel 0 low 18 GHz – 26.5 GHz (A)

Table 7: Peak results, channel 0 low (A)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2390.000000	60.3	1000.0	1000.000	245.0	H	5.0	14.6	13.6	73.9
2400.000000	79.2	1000.0	1000.000	282.0	H	5.0	14.7	16.5	95.7
4803.300000	48.0	1000.0	1000.000	150.0	V	60.0	8.3	25.9	73.9
9606.800000	48.8	1000.0	1000.000	150.0	V	107.0	15.7	25.1	73.9

Table 8: Average results, channel 0 low (A)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.400000	37.6	1000.0	1000.000	277.0	V	253.0	14.6	16.3	53.9
4803.800000	39.0	1000.0	1000.000	150.0	V	60.0	8.3	14.9	53.9
9608.600000	36.7	1000.0	1000.000	150.0	V	89.0	15.7	17.2	53.9

Middle channel (19)

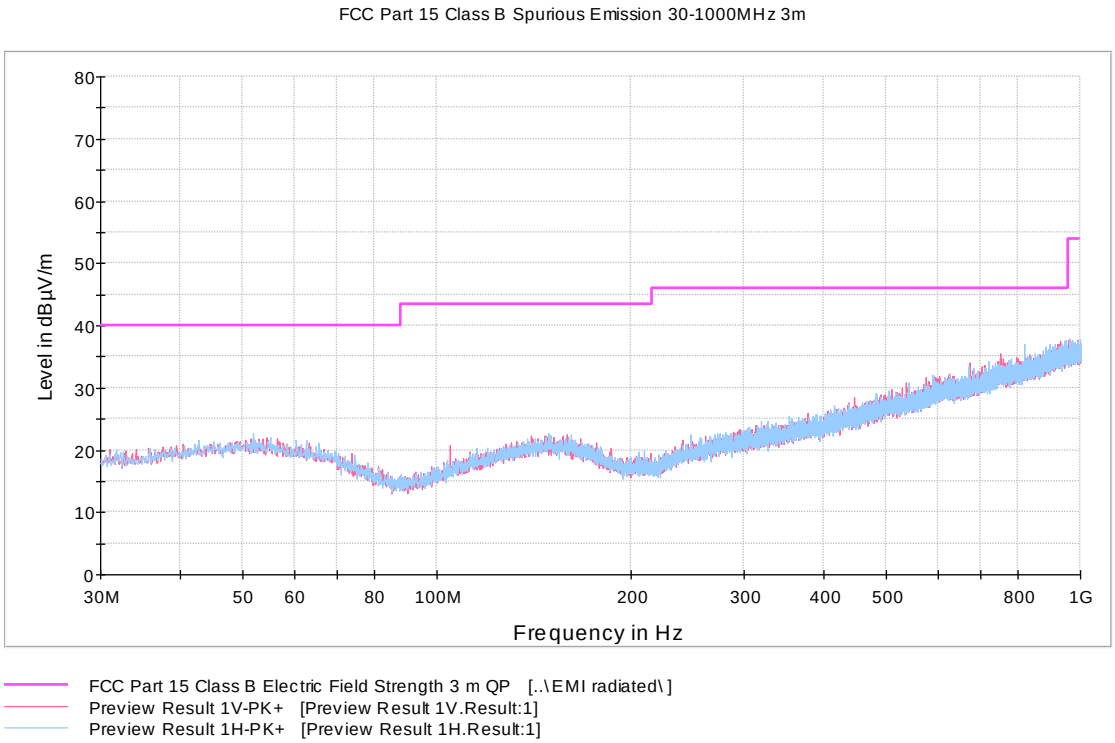

Figure 16: Channel 19 mid 30 MHz – 1000 MHz (A)

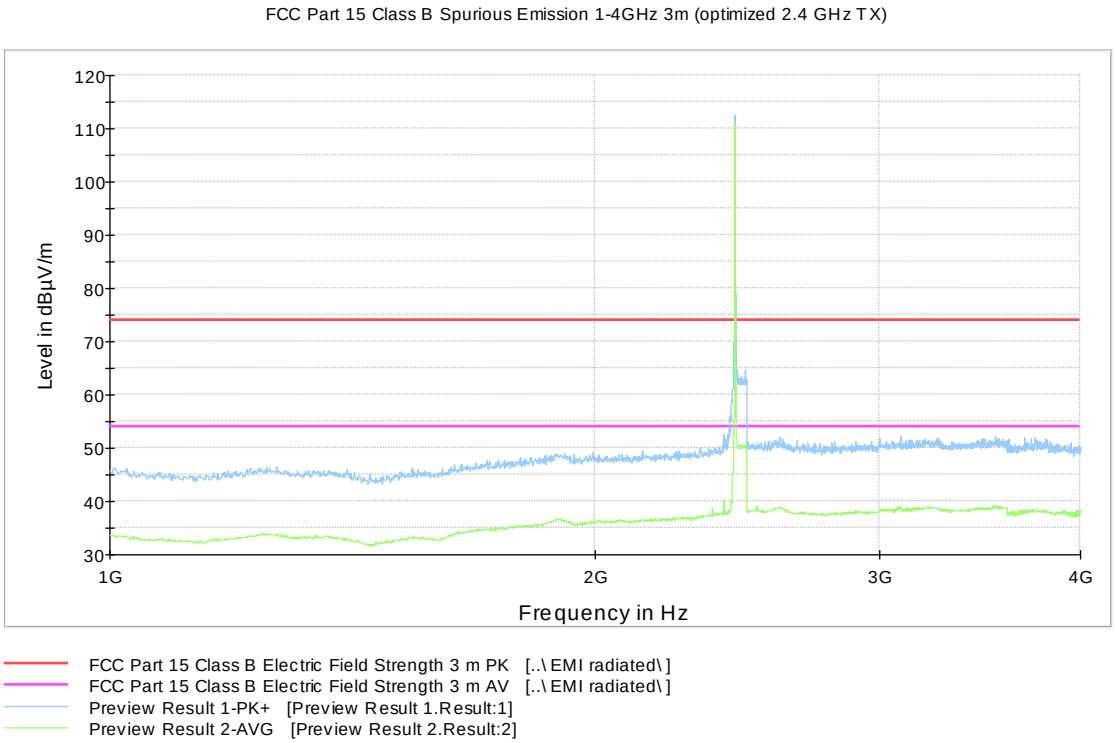

Figure 17: Channel 19 mid 1 GHz – 4 GHz (A)

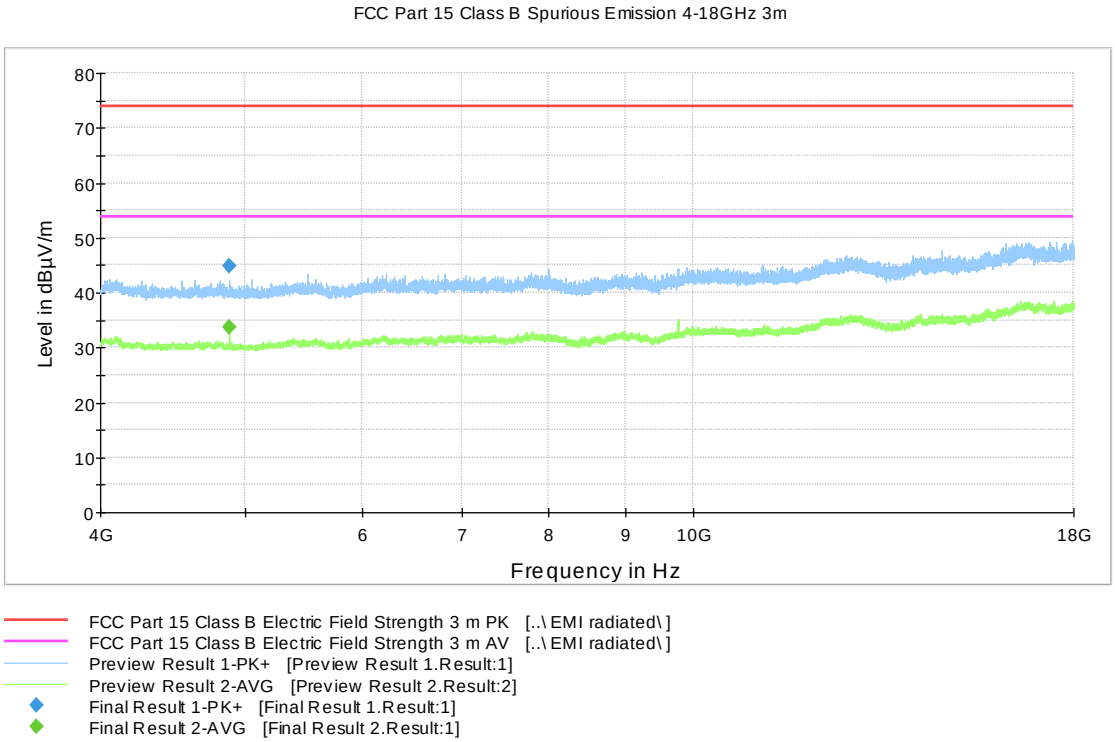

Figure 18: Channel 19 mid 4 GHz – 18 GHz (A)

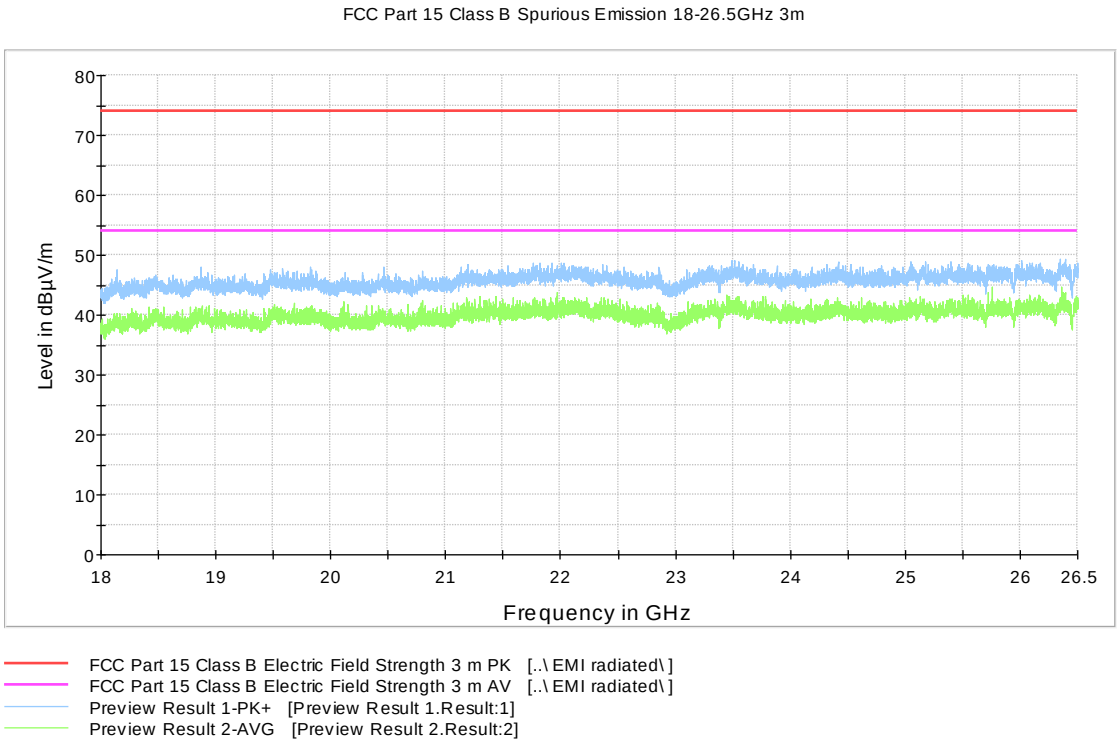

Figure 19: Channel 19 mid 18 GHz – 26.5 GHz (A)

Table 9: Peak results, channel 19 mid (A)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4883.600000	44.9	1000.0	1000.000	150.0	H	5.0	8.3	29.0	73.9

Table 10: Average results, channel 19 mid (A)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4884.200000	33.7	1000.0	1000.000	150.0	H	5.0	8.3	20.2	53.9

High channel (39)

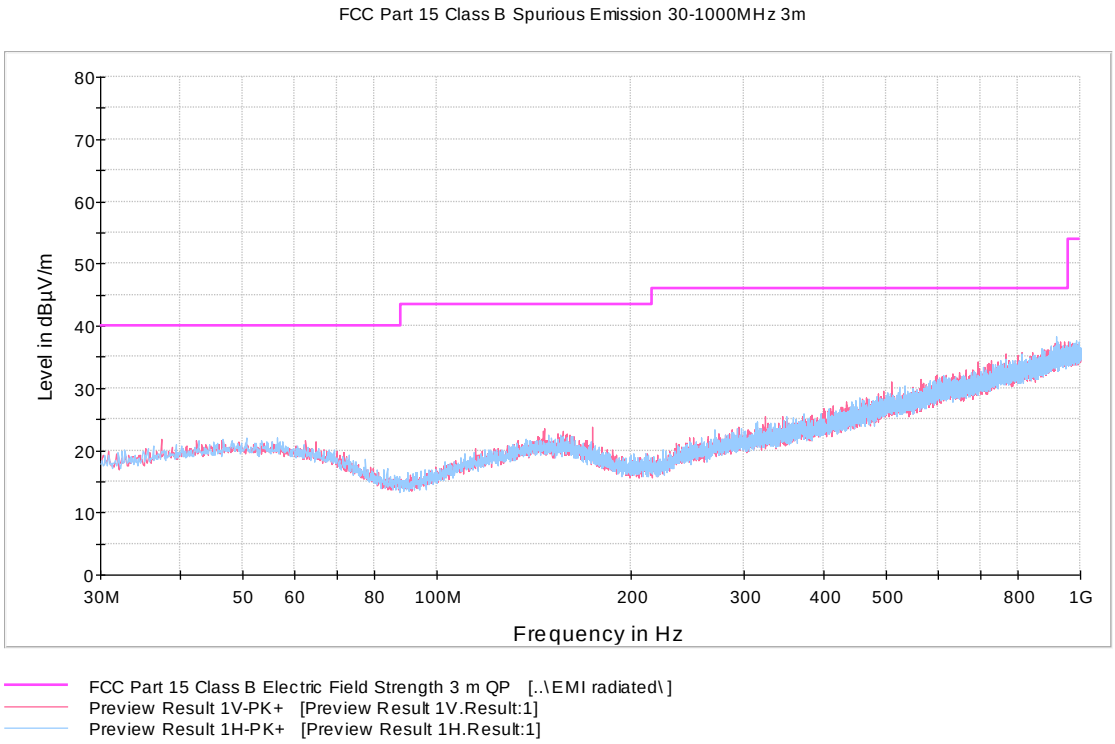

Figure 20: Channel 39 high 30 MHz – 1000 MHz (A)

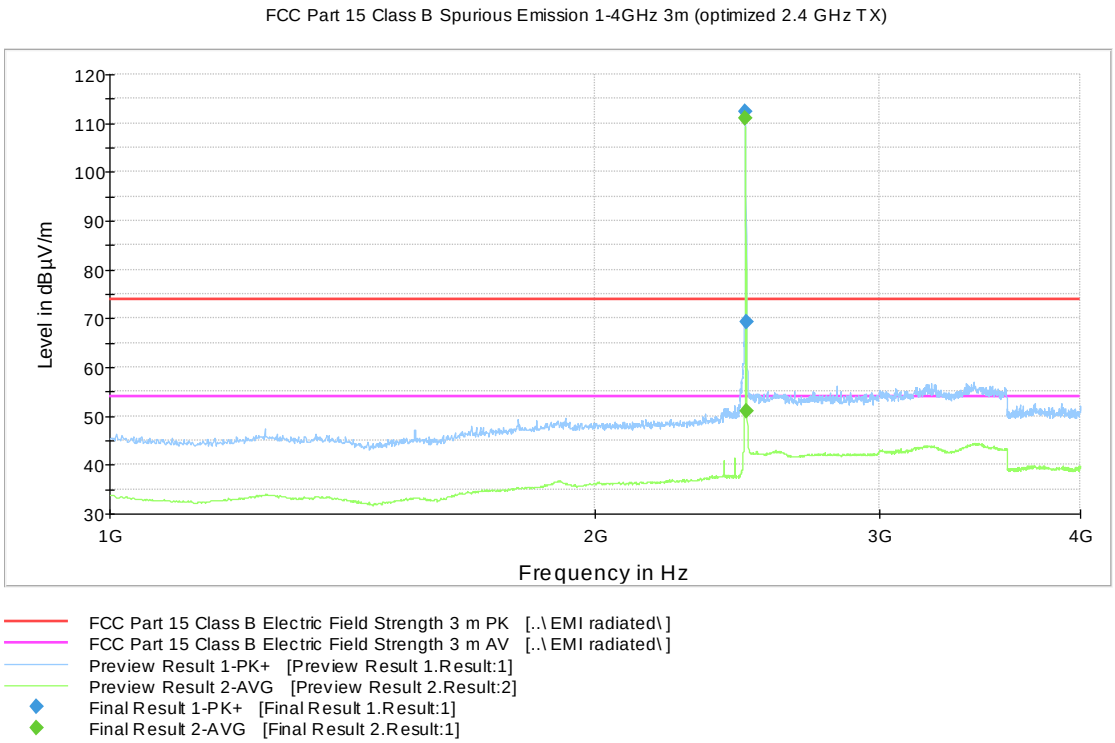

Figure 21: Channel 39 high 1 GHz – 4 GHz (A)

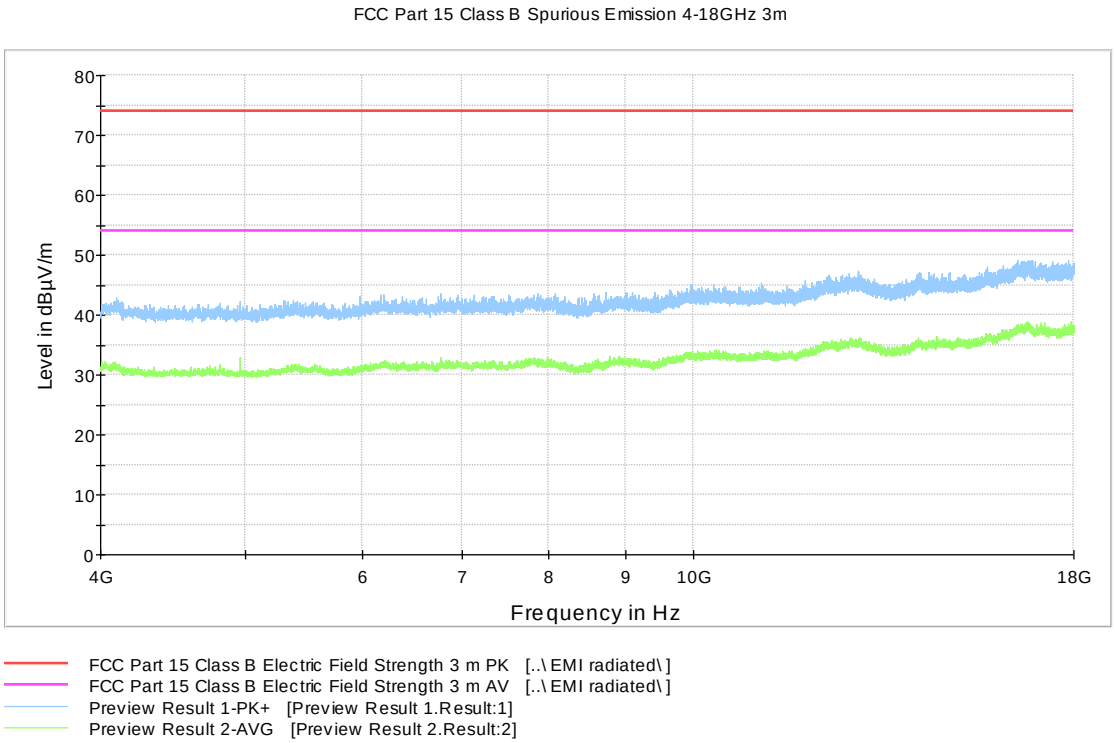

Figure 22: Channel 39 high 4 GHz – 18 GHz (A)

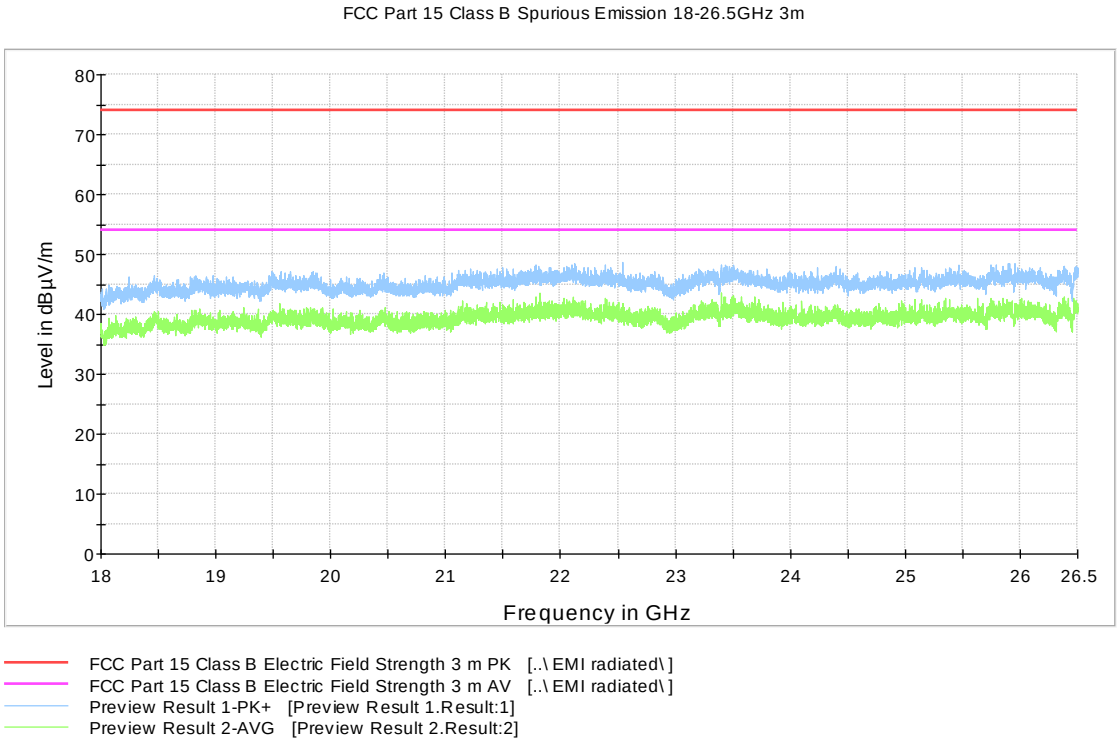

Figure 23: Channel 39 high 18 GHz – 26.5 GHz (A)

Table 11: Peak results, channel 39 high (A)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	69.2	1000.0	1000.000	231.0	H	347.0	14.7	4.7	73.9

Table 12: Average results**, c**hannel 39 high (A)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	51.1	1000.0	1000.000	243.0	H	348.0	14.7	2.8	53.9

Radiated Band Edge results

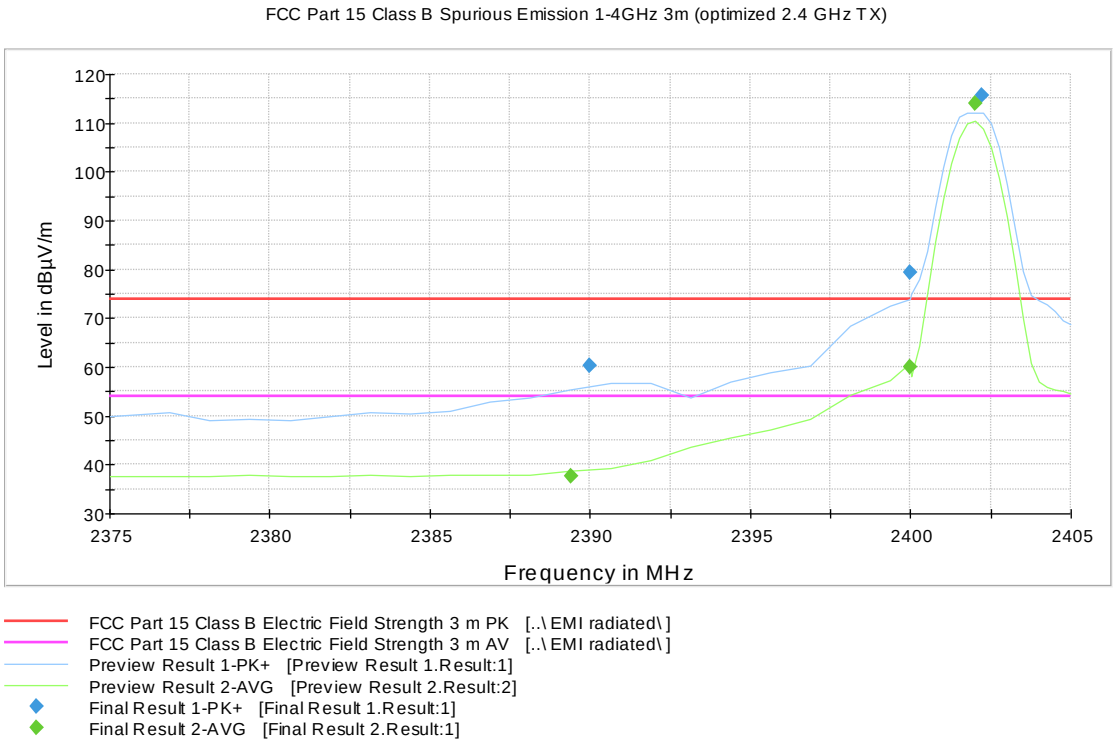

Figure 24: Radiated Band Edge measurement graph, Channel 0 low (A)

Table 13: Peak results, channel 0 low (A)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2390.000000	60.3	1000.0	1000.000	245.0	H	5.0	14.6	13.6	73.9
2400.000000	79.2	1000.0	1000.000	282.0	H	5.0	14.7	16.5	95.7

Table 14: Average results, channel 0 low (A)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.400000	37.6	1000.0	1000.000	277.0	V	253.0	14.6	16.3	53.9

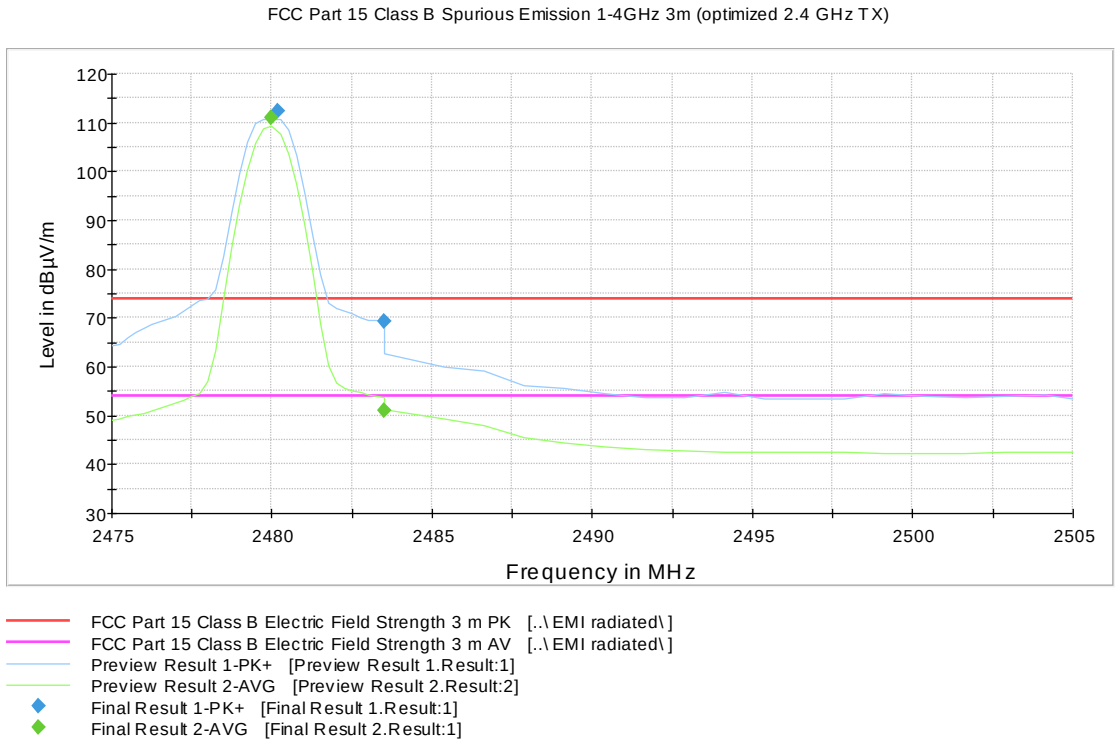

Figure 25: Radiated Band Edge measurement graph, Channel 39 high (A)

Table 15: Peak results, channel 39 high (A)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	69.2	1000.0	1000.000	231.0	H	347.0	14.7	4.7	73.9

Table 16: Average results, channel 39 high (A)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	51.1	1000.0	1000.000	243.0	H	348.0	14.7	2.8	53.9

Low channel (0)

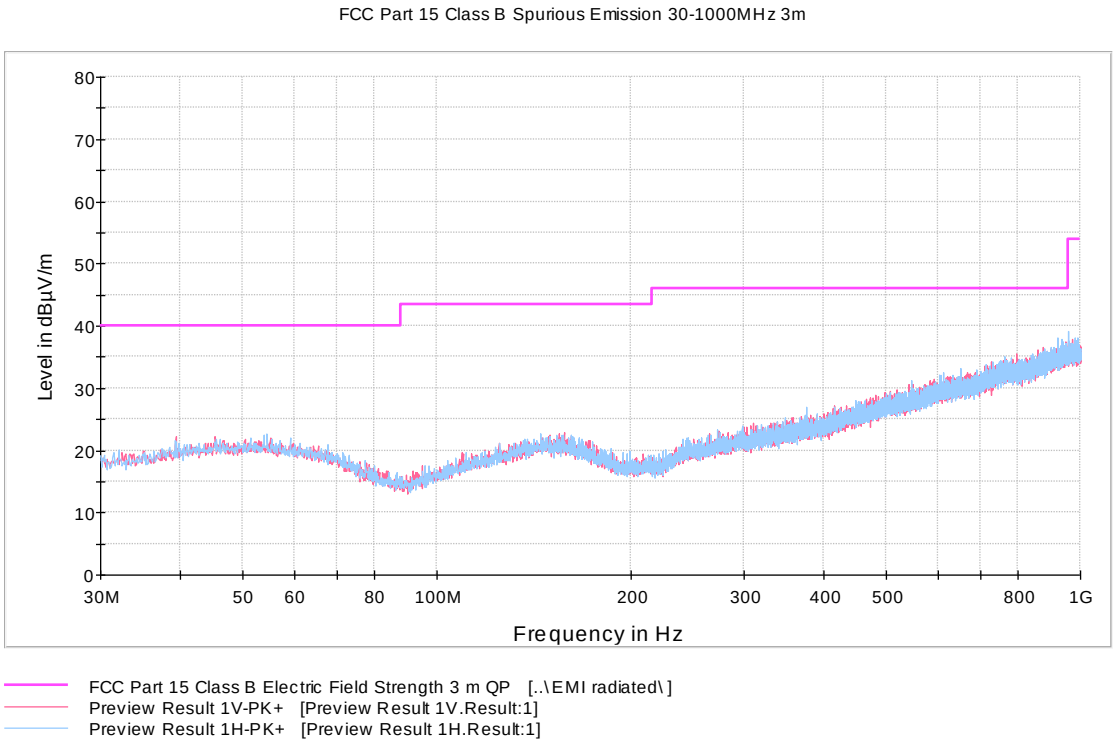

Figure 26: Channel 0 low 30 MHz – 1000 MHz (N)

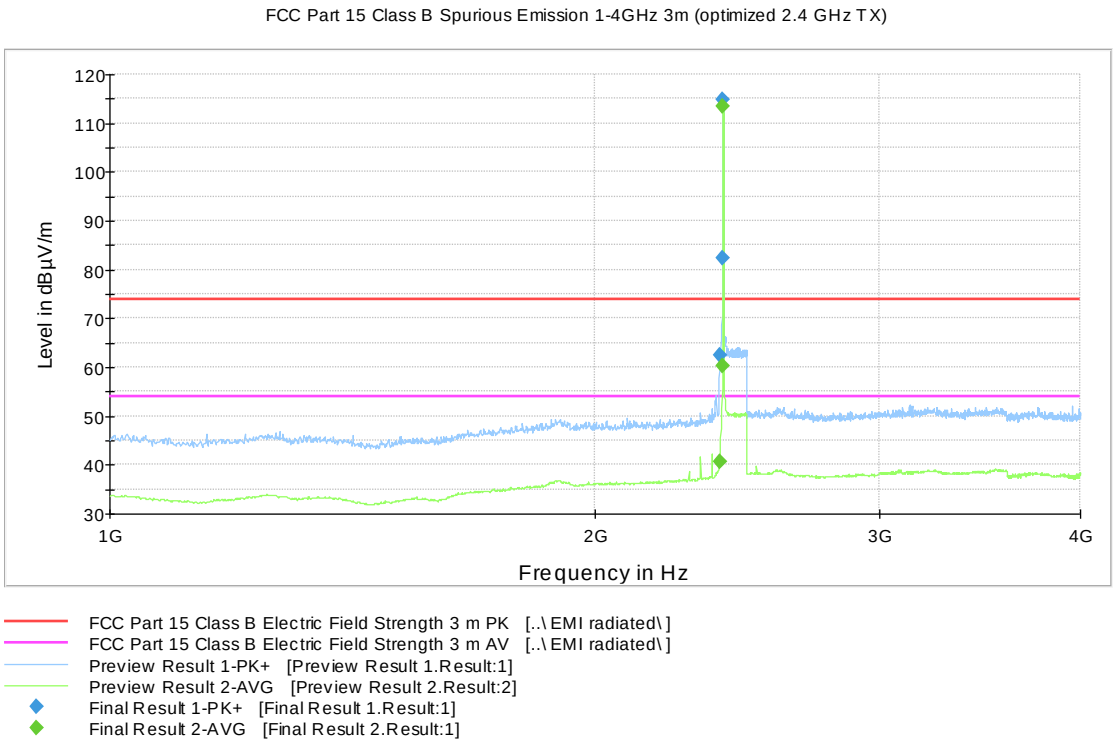

Figure 27: Channel 0 low 1 GHz – 4 GHz (N)

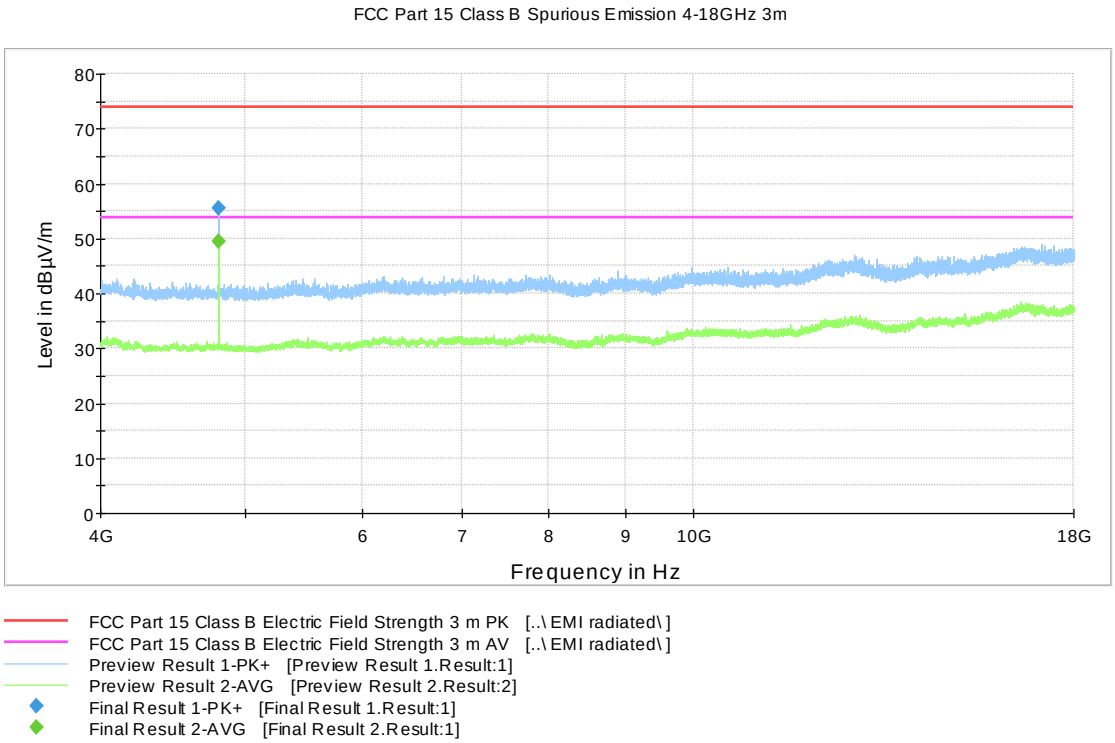

Figure 28: Channel 0 low 4 GHz – 18 GHz (N)

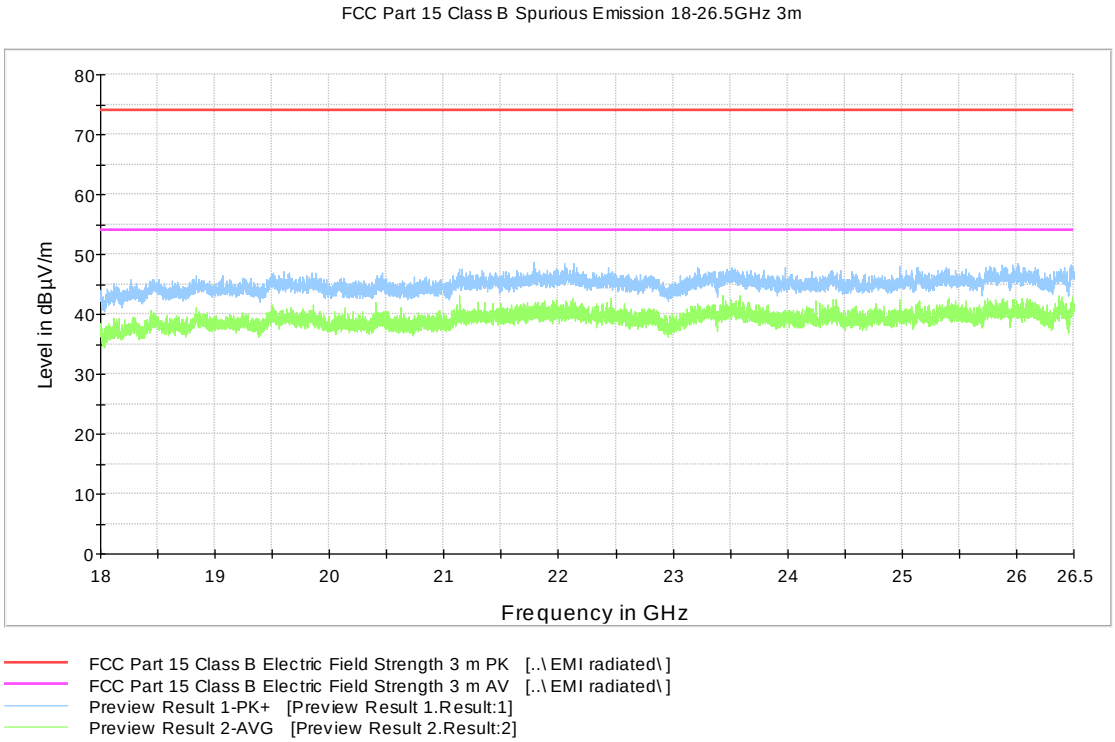

Figure 29: Channel 0 low 18 GHz – 26.5 GHz (N)

Table 17: Peak results, channel 0 low (N)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.400000	62.6	1000.0	1000.000	150.0	V	200.0	14.6	11.3	73.9
2400.000000	82.4	1000.0	1000.000	203.0	V	206.0	14.7	12.4	94.8
4803.500000	55.4	1000.0	1000.000	150.0	V	332.0	8.3	18.5	73.9

Table 18: Average results, channel 0 low (N)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2390.000000	40.6	1000.0	1000.000	150.0	V	203.0	14.6	13.3	53.9
4804.000000	49.5	1000.0	1000.000	150.0	V	333.0	8.3	4.4	53.9

Middle channel (19)

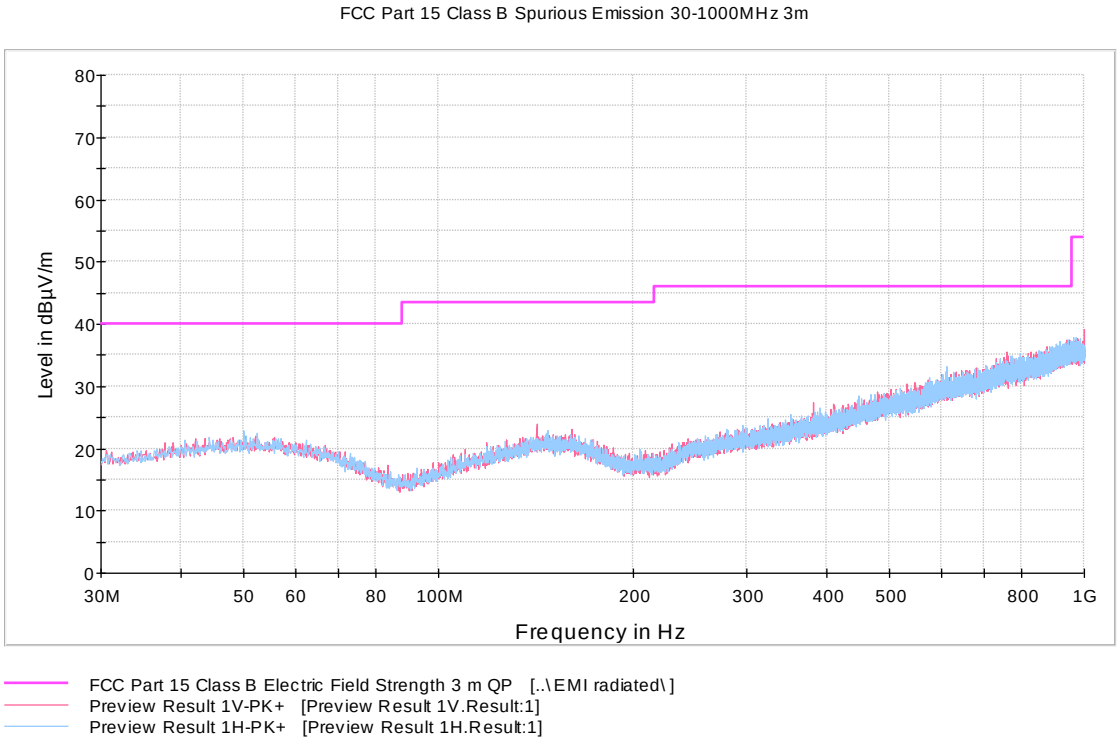

Figure 30: Channel 19 mid 30 MHz – 1000 MHz (N)

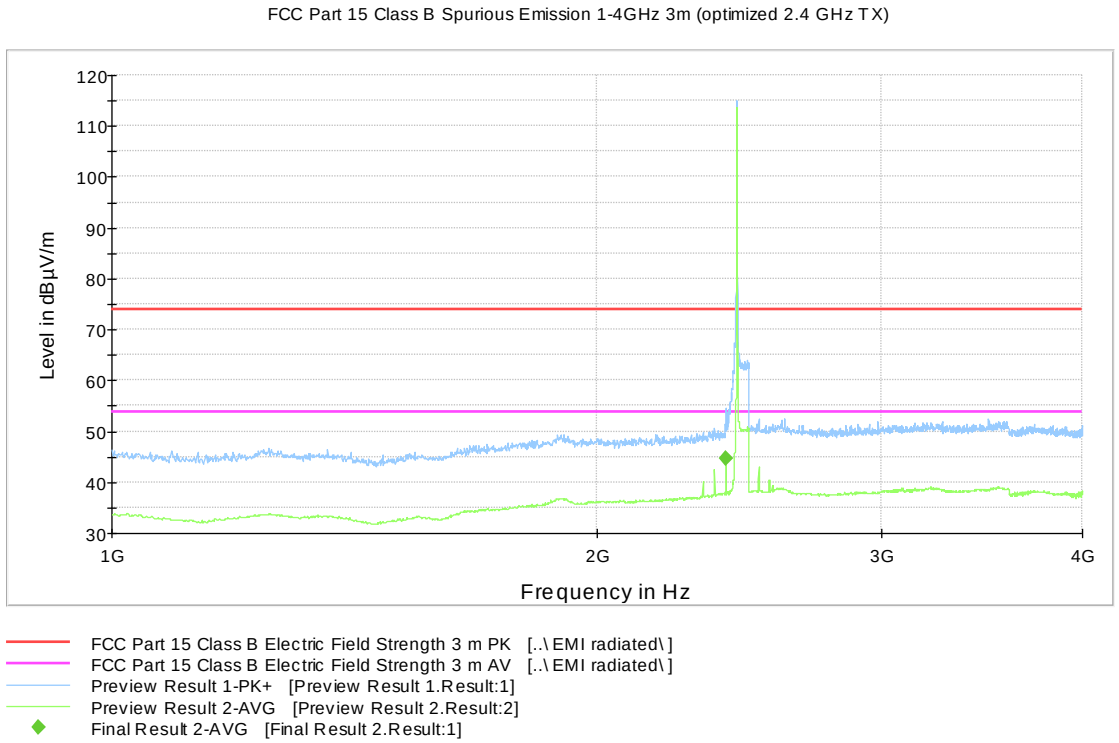

Figure 31: Channel 19 mid 1 GHz – 4 GHz (N)

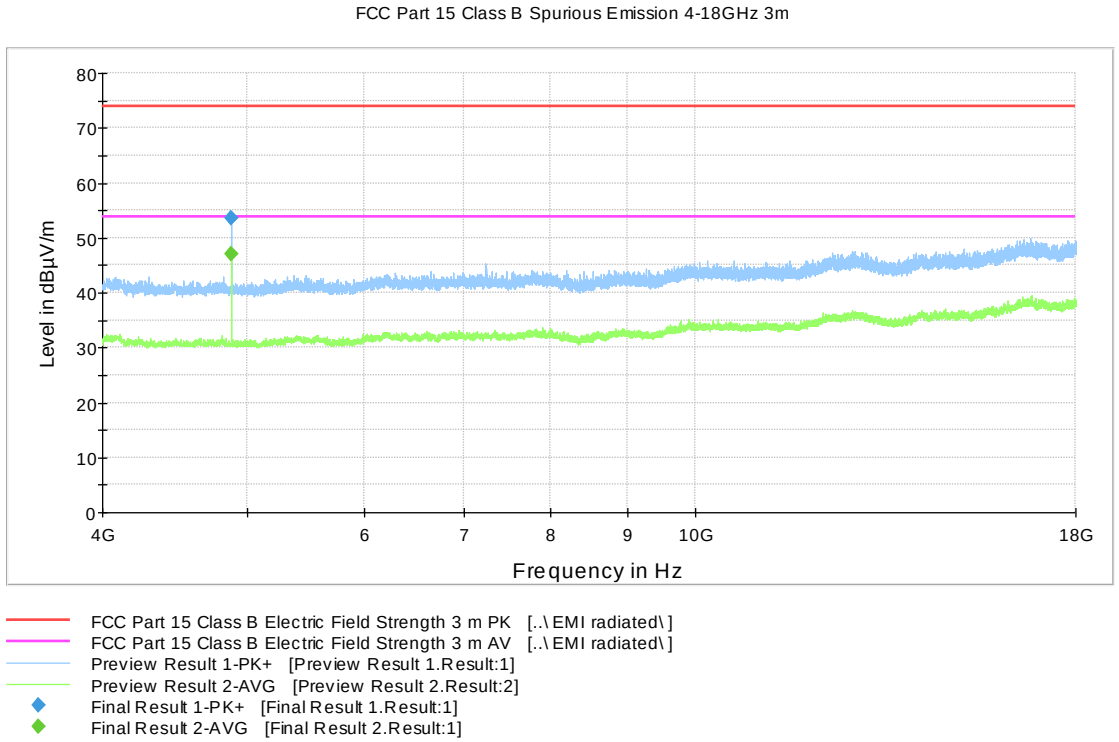

Figure 32: Channel 19 mid 4 GHz – 18 GHz (N)

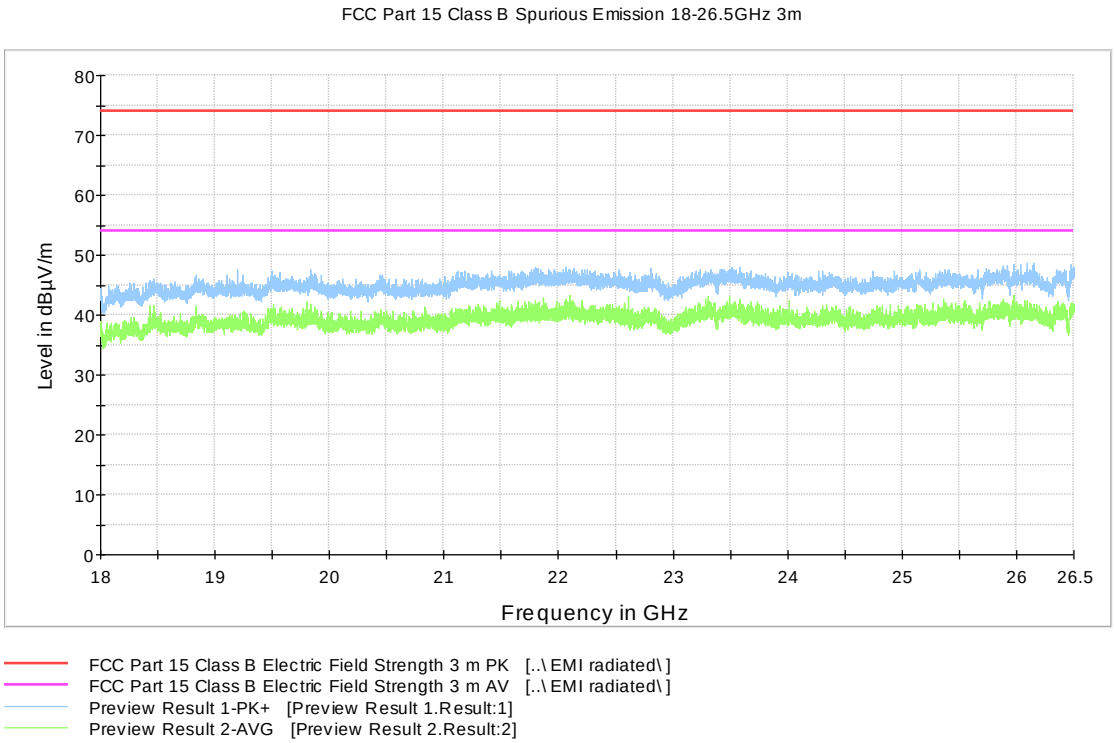

Figure 33: Channel 19 mid 18 GHz – 26.5 GHz (N)

Table 19: Peak results, channel 19 mid (N)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4883.400000	53.6	1000.0	1000.000	150.0	V	283.0	8.3	20.3	73.9

Table 20: Average results, channel 19 mid (N)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2403.600000	44.6	1000.0	1000.000	178.0	V	201.0	14.6	9.3	53.9
4884.000000	47.1	1000.0	1000.000	150.0	V	283.0	8.3	6.8	53.9

High channel (39)

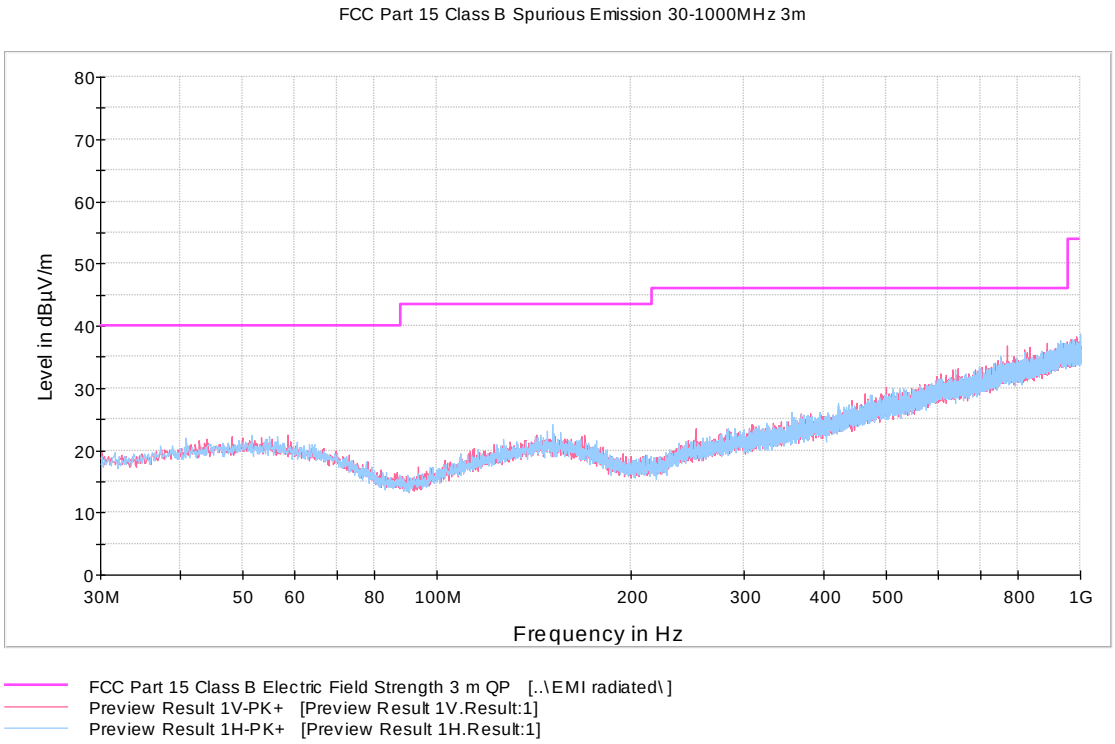

Figure 34: Channel 39 high 30 MHz – 1000 MHz (N)

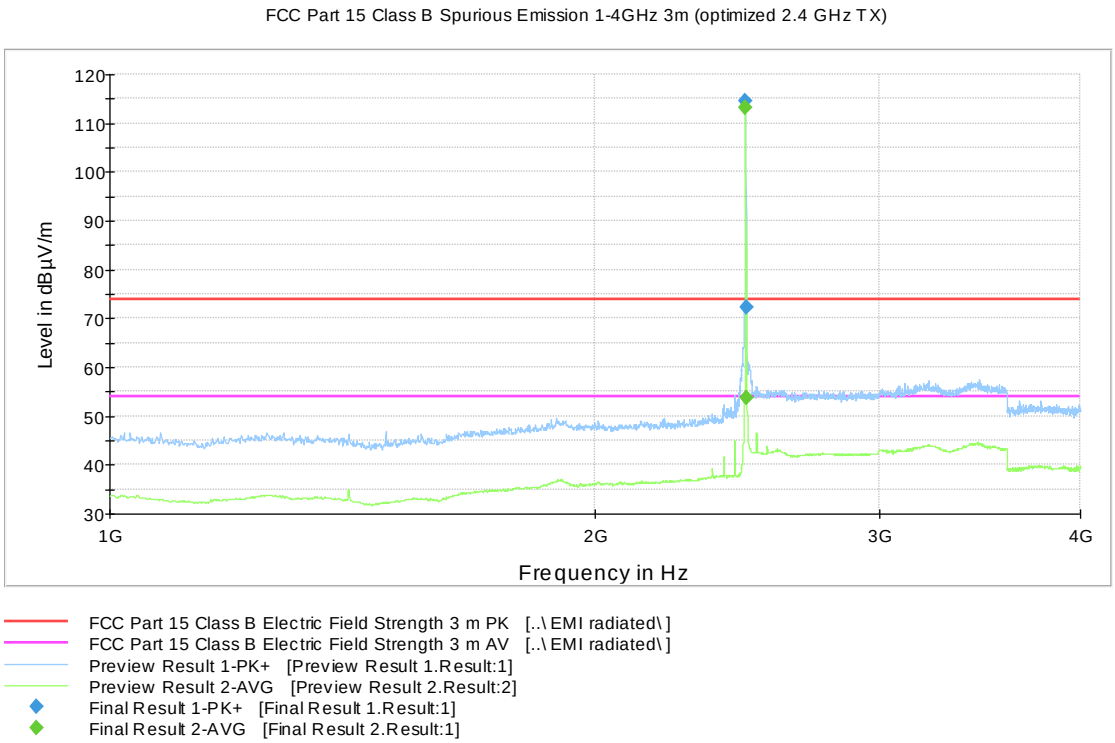

Figure 35: Channel 39 high 1 GHz – 4 GHz (N)

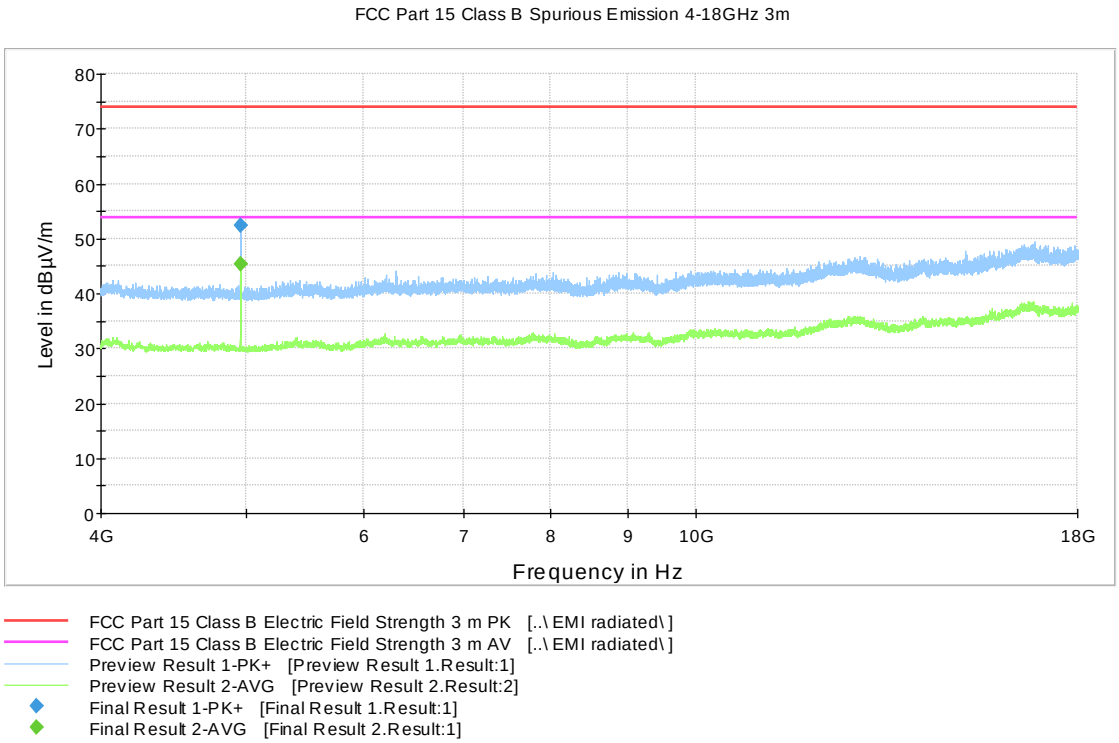

Figure 36: Channel 39 high 4 GHz – 18 GHz (N)

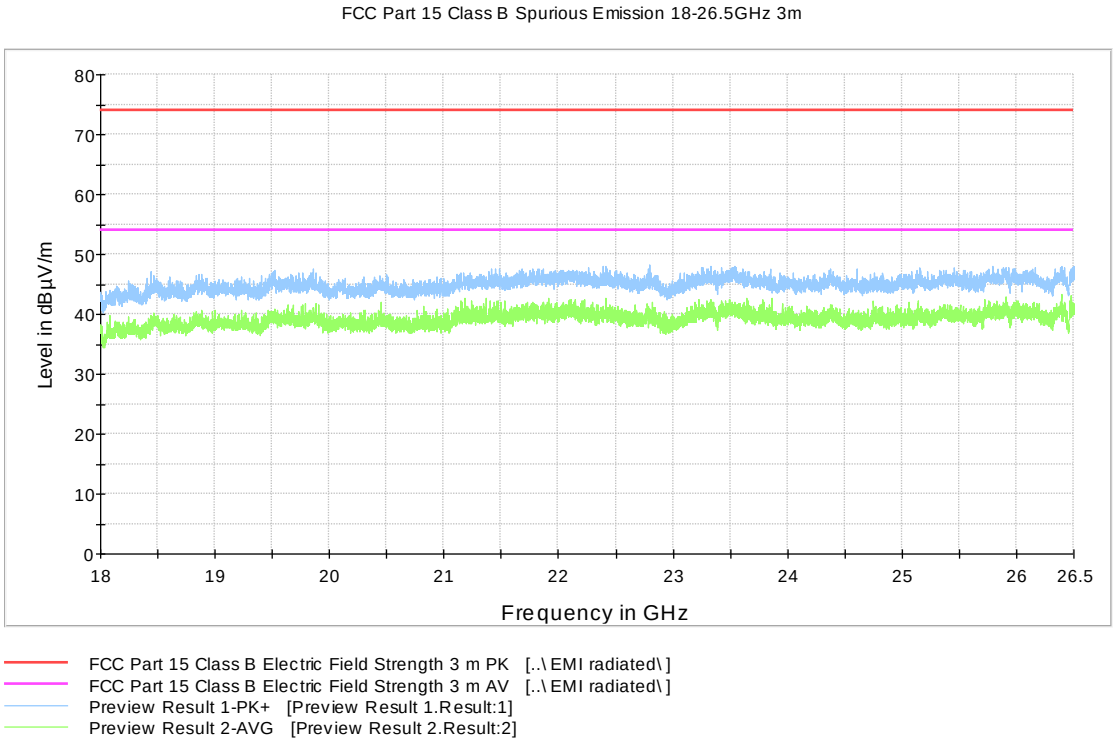

Figure 37: Channel 39 high 18 GHz – 26.5 GHz (N)

Table 21: Peak results, channel 39 high (N)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	72.3	1000.0	1000.000	150.0	V	174.0	14.7	1.6	73.9
4960.400000	52.3	1000.0	1000.000	179.0	V	272.0	8.2	21.6	73.9

Table 22: Average results, channel 39 high (N)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	53.6	1000.0	1000.000	150.0	V	181.0	14.7	0.3	53.9
4959.900000	45.4	1000.0	1000.000	179.0	V	274.0	8.2	8.5	53.9

Radiated Band Edge results

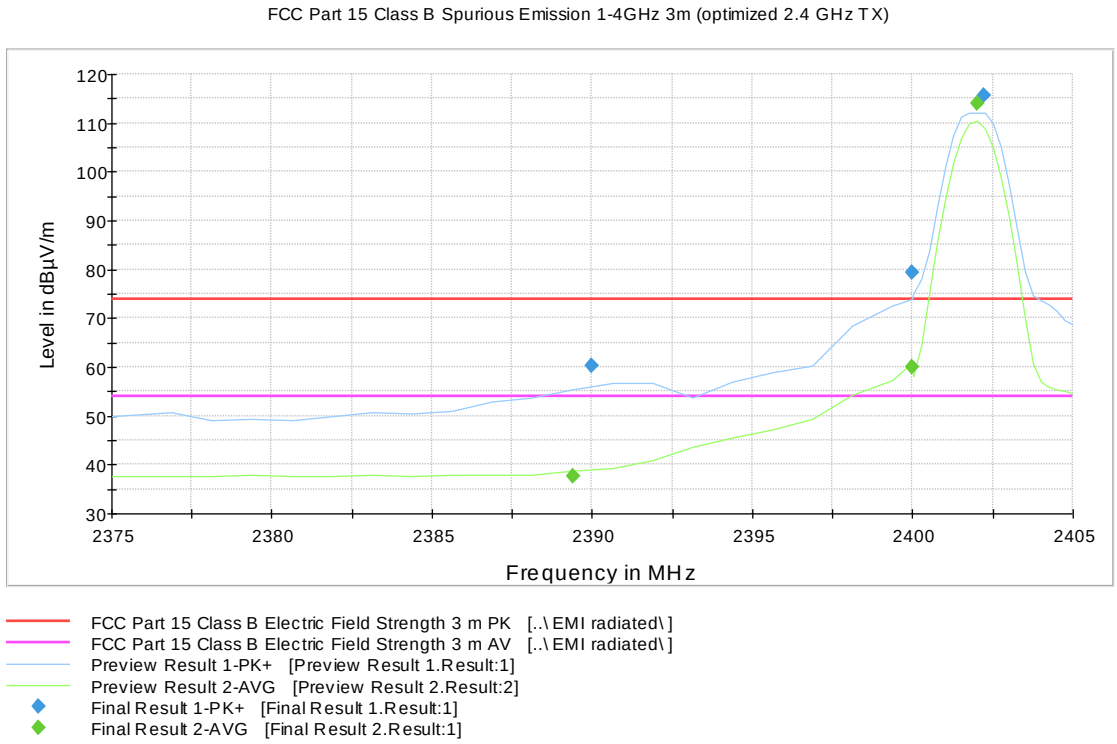

Figure 38: Radiated Band Edge measurement graph, Channel 0 low (N)

Table 23: Peak results, channel 0 low (N)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2390.000000	60.3	1000.0	1000.000	245.0	H	5.0	14.6	13.6	73.9
2400.000000	79.2	1000.0	1000.000	282.0	H	5.0	14.7	16.5	95.7

Table 24: Average results, channel 0 low (N)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.400000	37.6	1000.0	1000.000	277.0	V	253.0	14.6	16.3	53.9

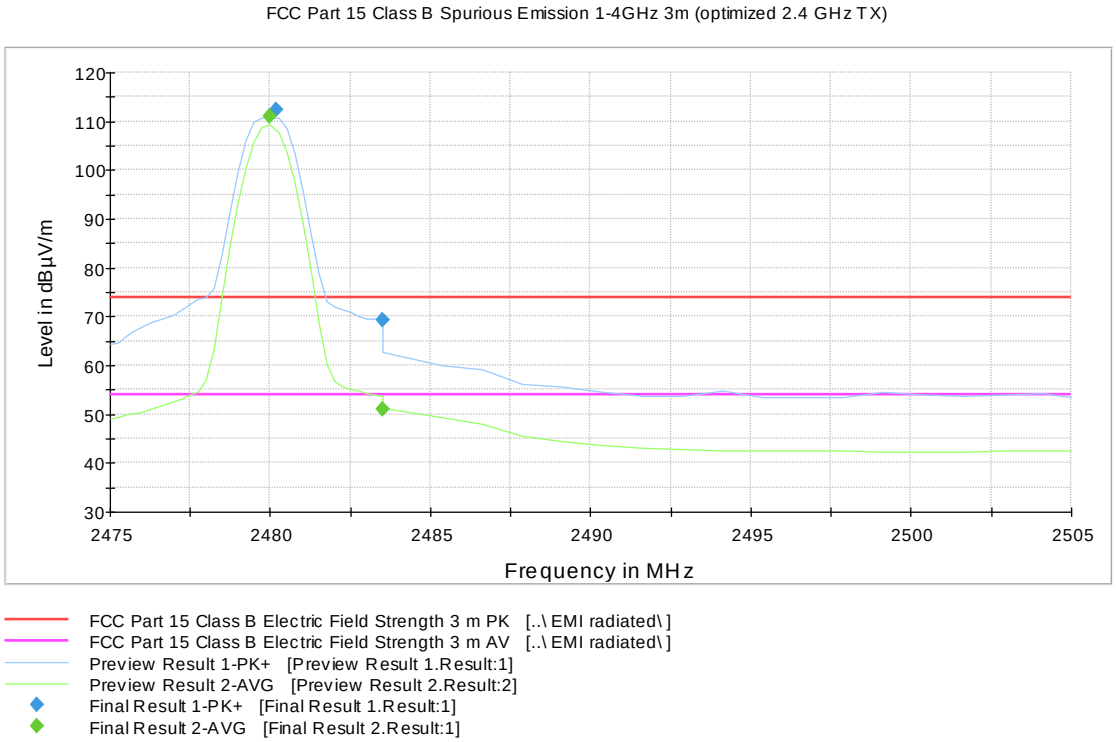

Figure 39: Radiated Band Edge measurement graph, Channel 39 high (N)

Table 25: Peak results, channel 39 high (N)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	69.2	1000.0	1000.000	231.0	H	347.0	14.7	4.7	73.9

Table 26: Average results, channel 39 high (N)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	51.1	1000.0	1000.000	243.0	H	348.0	14.7	2.8	53.9

Transmitter Band Edge Measurement and Conducted Spurious Emissions

Standard:	ANSI C63.10	(2013)
Tested by:	JAT / MIH	
Date:	29 September – 21 November 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 27: Band edge attenuation, power setting 145, PHY 125k coded

Band Edge Attenuation	
Lower Band Edge (ch 0)	**Upper Band Edge (ch 39)**
-47.42 dBc	-46.91 dBc
Limit: -20 dBc	

Table 27: Band edge attenuation, power setting 200, PHY 1M coded

Band Edge Attenuation	
Lower Band Edge (ch 0)	**Upper Band Edge (ch 39)**
-52.87 dBc	-54.64 dBc
Limit: -20 dBc	

Table 28: Conducted spurious emissions, Channel 0 low, power setting 145, PHY 125k coded

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
820.18	-67.96	-10.61	-57.35	PASS
2399.93	-41.61	-10.61	-31.00	PASS
3977.32	-65.17	-10.61	-54.56	PASS
4804.40	-48.91	-10.61	-38.30	PASS
9498.97	-61.67	-10.61	-51.06	PASS
11815.37	-58.97	-10.61	-48.36	PASS
15787.43	-56.27	-10.61	-45.67	PASS
16158.48	-55.42	-10.61	-44.81	PASS
21171.60	-56.98	-10.61	-46.37	PASS
24749.65	-55.33	-10.61	-44.73	PASS
26257.50	-56.20	-10.61	-45.59	PASS

Table 29: Conducted spurious emissions, Channel 19 mid, power setting 145, PHY 125k coded

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
886.89	-68.02	-10.59	-57.43	PASS
2363.40	-60.84	-10.59	-50.26	PASS
2517.03	-61.10	-10.59	-50.52	PASS
4879.49	-48.65	-10.59	-38.06	PASS
9760.80	-60.96	-10.59	-50.37	PASS
12510.31	-59.10	-10.59	-48.51	PASS
15443.75	-57.07	-10.59	-46.49	PASS
16135.23	-55.58	-10.59	-44.99	PASS
19520.34	-57.15	-10.59	-46.56	PASS
24827.74	-56.32	-10.59	-45.73	PASS
25736.27	-55.37	-10.59	-44.78	PASS

Table 30: Conducted spurious emissions, Channel 39 high, power setting 145, PHY 125k coded

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
810.93	-66.99	-10.59	-56.40	PASS
2364.54	-62.56	-10.59	-51.98	PASS
2483.62	-46.80	-10.59	-36.21	PASS
4960.39	-47.89	-10.59	-37.30	PASS
9918.86	-60.63	-10.59	-50.04	PASS
12501.41	-59.53	-10.59	-48.94	PASS
15863.65	-57.00	-10.59	-46.41	PASS
16139.73	-55.26	-10.59	-44.67	PASS
21189.60	-57.23	-10.59	-46.64	PASS
24435.50	-55.17	-10.59	-44.58	PASS
26262.56	-55.58	-10.59	-44.99	PASS

Table 31: Conducted spurious emissions, Channel 0 low, power setting 200, PHY 1M coded

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
937,94	-65,47	-1,88	-63,58	PASS
2399,98	-37,34	-1,88	-35,45	PASS
2517,41	-61,06	-1,88	-59,18	PASS
4804,40	-33,46	-1,88	-31,57	PASS
9608,84	-56,22	-1,88	-54,34	PASS
12514,44	-58,71	-1,88	-56,83	PASS
15525,78	-56,66	-1,88	-54,77	PASS
16133,82	-55,24	-1,88	-53,36	PASS
19196,45	-56,55	-1,88	-54,67	PASS
24147,14	-56,48	-1,88	-54,60	PASS
25574,13	-55,07	-1,88	-53,19	PASS

Table 32: Conducted spurious emissions, Channel 19 mid, power setting 200, PHY 1M coded

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
952,70	-65,11	-2,45	-62,66	PASS
2363,23	-54,19	-2,45	-51,74	PASS
2517,03	-54,31	-2,45	-51,86	PASS
4880,43	-34,49	-2,45	-32,04	PASS
9758,84	-55,22	-2,45	-52,77	PASS
12560,84	-58,53	-2,45	-56,09	PASS
15783,40	-57,02	-2,45	-54,57	PASS
16156,98	-54,34	-2,45	-51,89	PASS
21810,77	-56,87	-2,45	-54,42	PASS
24395,29	-56,05	-2,45	-53,61	PASS
26229,70	-56,40	-2,45	-53,95	PASS

Table 33: Conducted spurious emissions, Channel 39 high, power setting 200, PHY 1M coded

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
954,82	-64,70	-1,97	-62,73	PASS
2364,80	-56,58	-1,97	-54,61	PASS
2483,57	-40,21	-1,97	-38,24	PASS
4959,45	-35,16	-1,97	-33,20	PASS
9920,83	-57,33	-1,97	-55,36	PASS
12449,94	-57,82	-1,97	-55,86	PASS
15838,80	-56,83	-1,97	-54,86	PASS
16148,64	-55,51	-1,97	-53,54	PASS
19511,16	-56,21	-1,97	-54,24	PASS
24818,74	-55,91	-1,97	-53,94	PASS
25616,46	-56,05	-1,97	-54,09	PASS

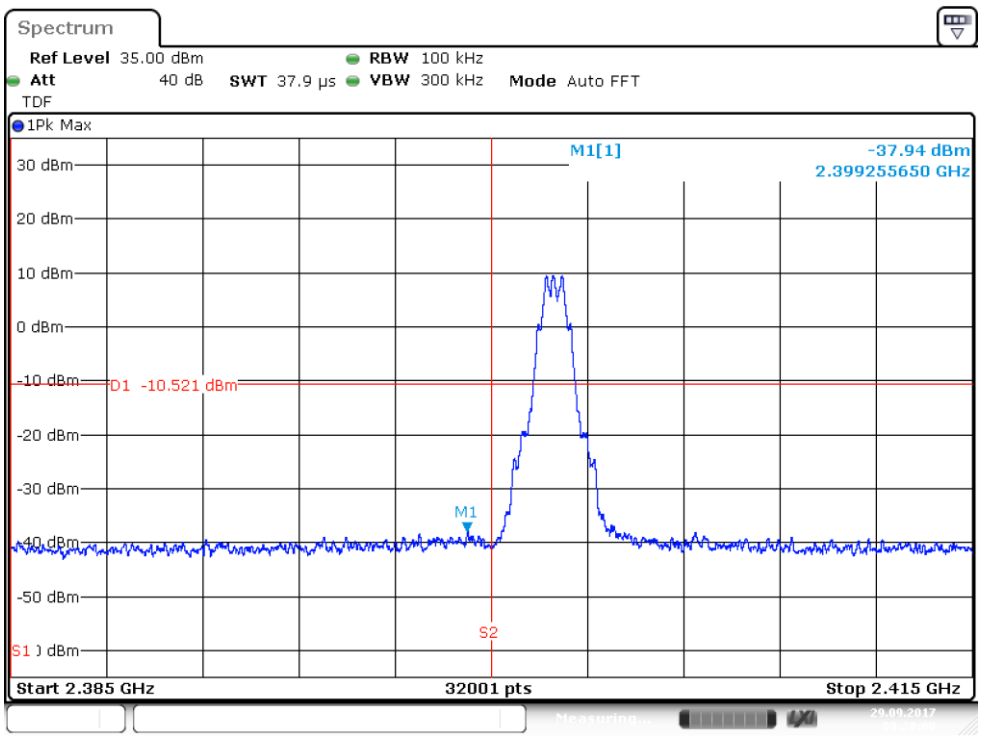

Figure 40: Lower Band Edge, channel 0 low, power setting 145, PHY 125k coded

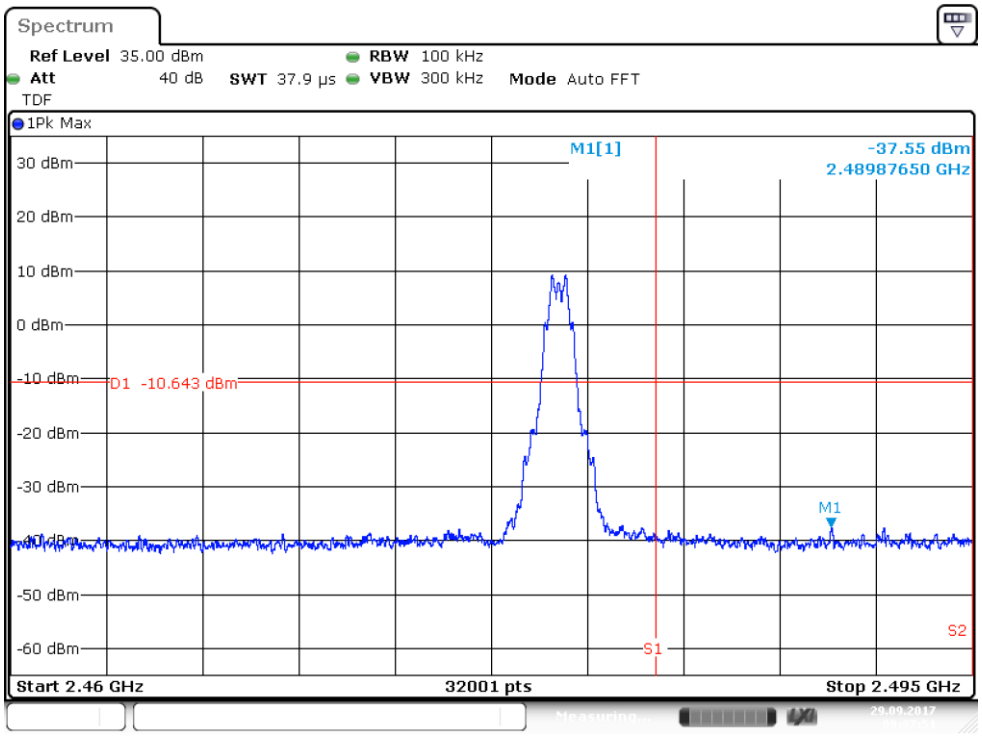

Figure 41: Upper Band Edge, channel 39, power setting 145, PHY 125k coded

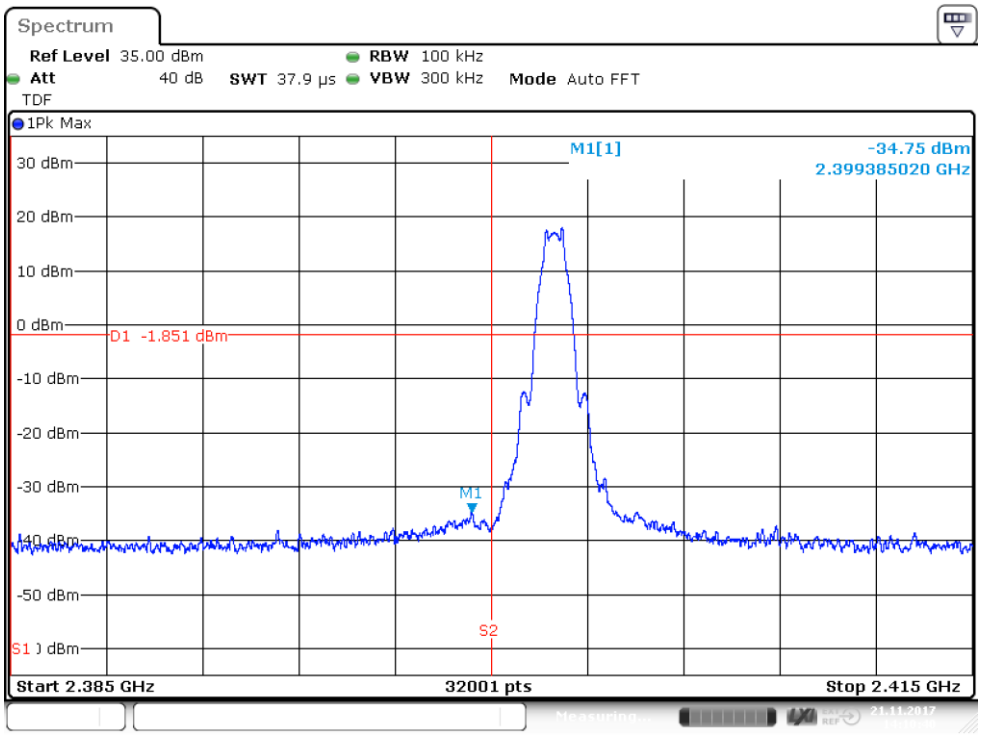

Figure 36: Lower Band Edge, channel 0 low, power setting 200, PHY 1M coded

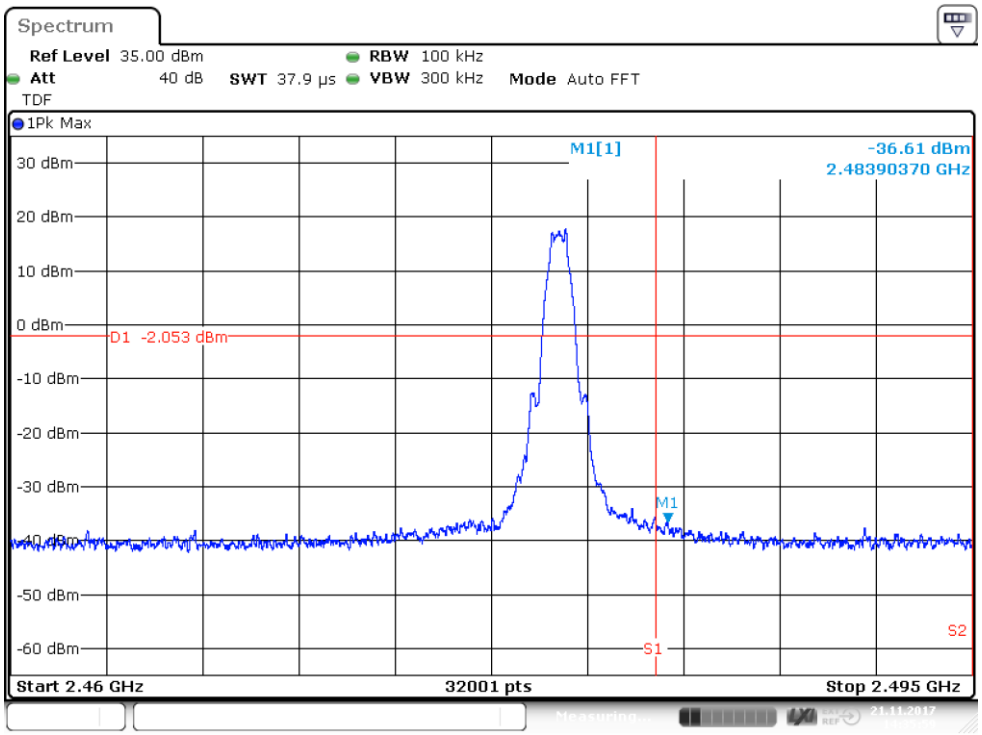

Figure 37: Upper Band Edge, channel 39, power setting 200, PHY 1M coded

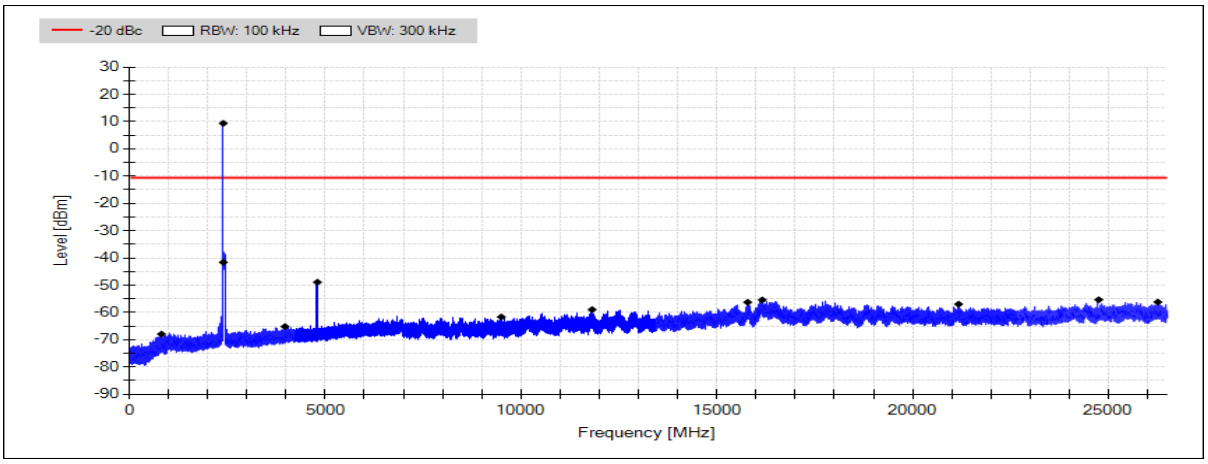

Figure 38: Conducted spurious emissions 30 - 26500 MHz channel 0, power setting 145, PHY 125k

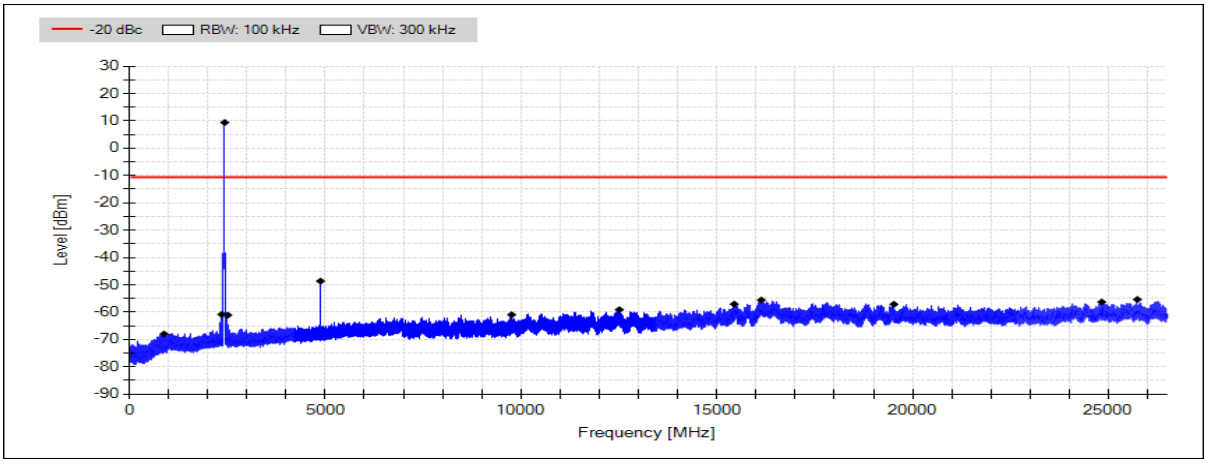

Figure 39: Conducted spurious emissions 30 - 26500 MHz channel 19, power setting 145, PHY 125k

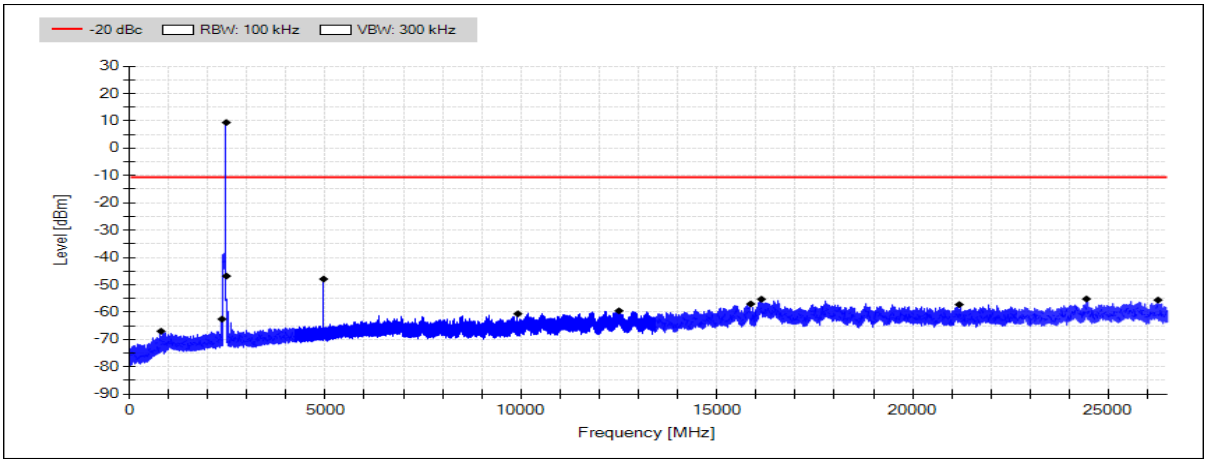

Figure 40: Conducted spurious emissions 30 - 26500 MHz channel 39, power setting 145, PHY 125k

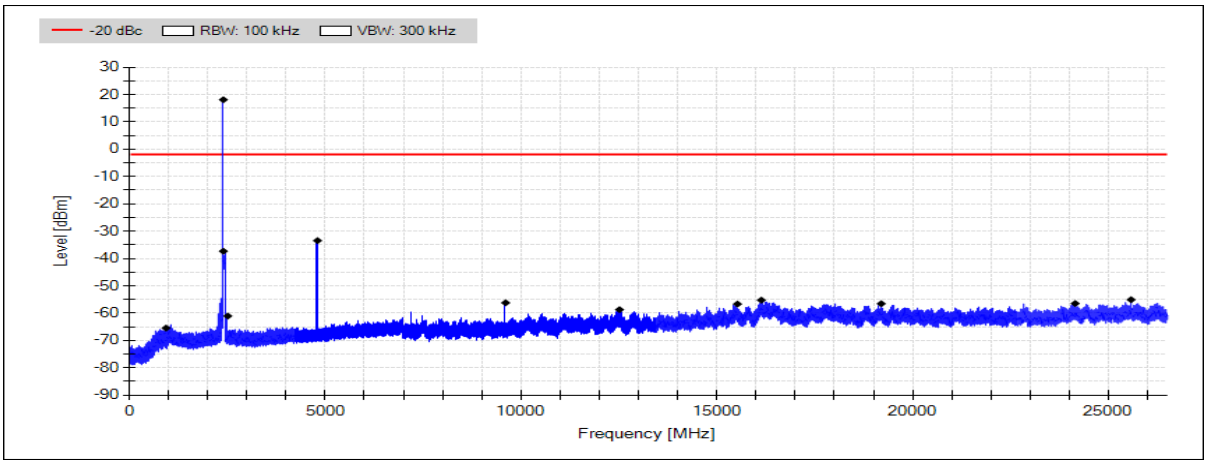

Figure 41: Conducted spurious emissions 30 - 26500 MHz channel 0, power setting 200, PHY 1M

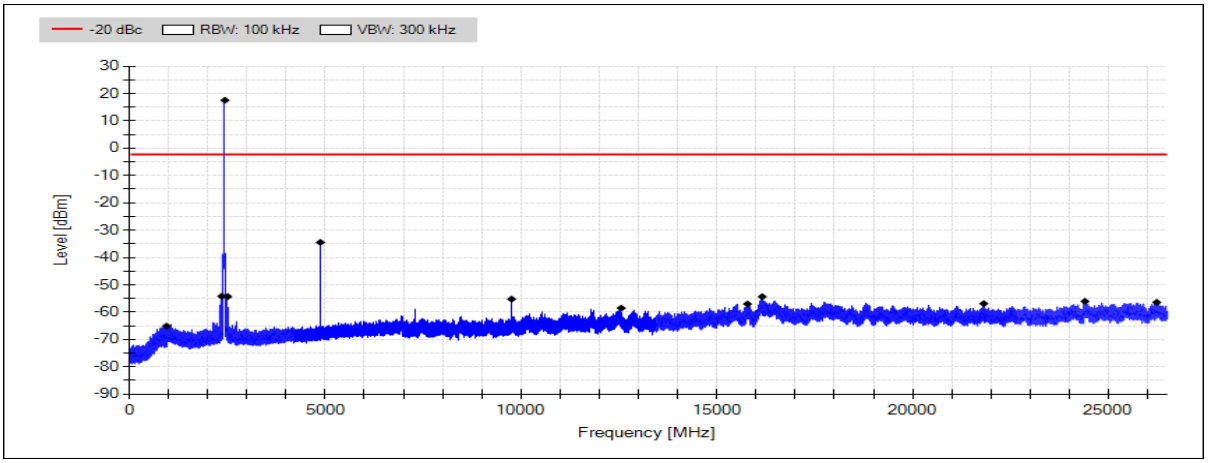

Figure 42: Conducted spurious emissions 30 - 26500 MHz channel 19, power setting 200, PHY 1M

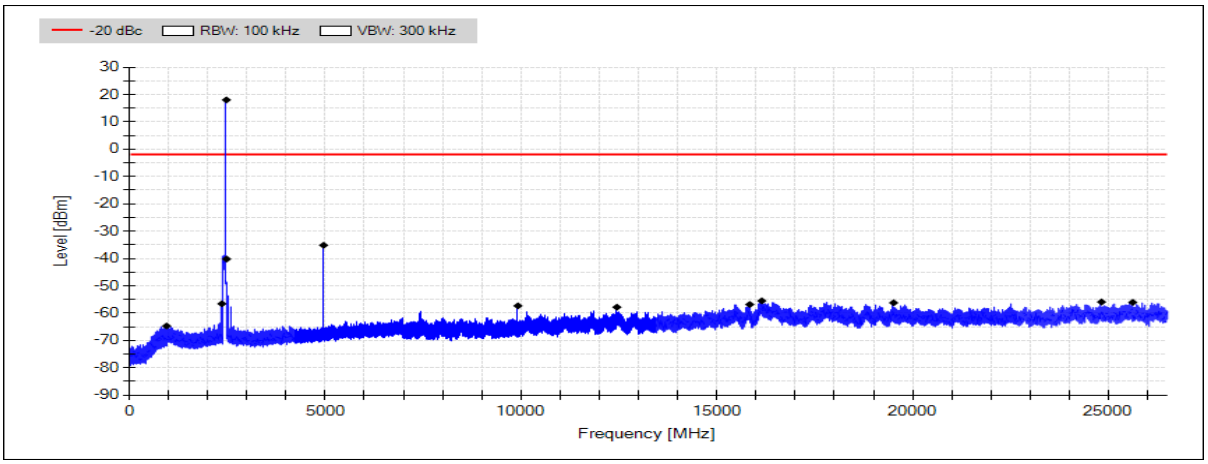

Figure 43: Conducted spurious emissions 30 - 26500 MHz channel 39, power setting 200, PHY 1M

6 dB Bandwidth of the Channel

Standard:	ANSI C63.10	(2013)
Tested by:	JAT / MIH	
Date:	29 September – 21 November 2017	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	

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

Results:

Table 34: 6 dB bandwidth test results

Channel	Power setting	PHY	6 dB BW [kHz]	Minimum limit [kHz]
0 Low	145	125k coded	705.0	500
19 Mid	145	125k coded	693.0	
39 High	145	125k coded	705.0	
0 Low	200	1M coded	654.0	
19 Mid	200	1M coded	658.0	
39 High	200	1M coded	657.0	

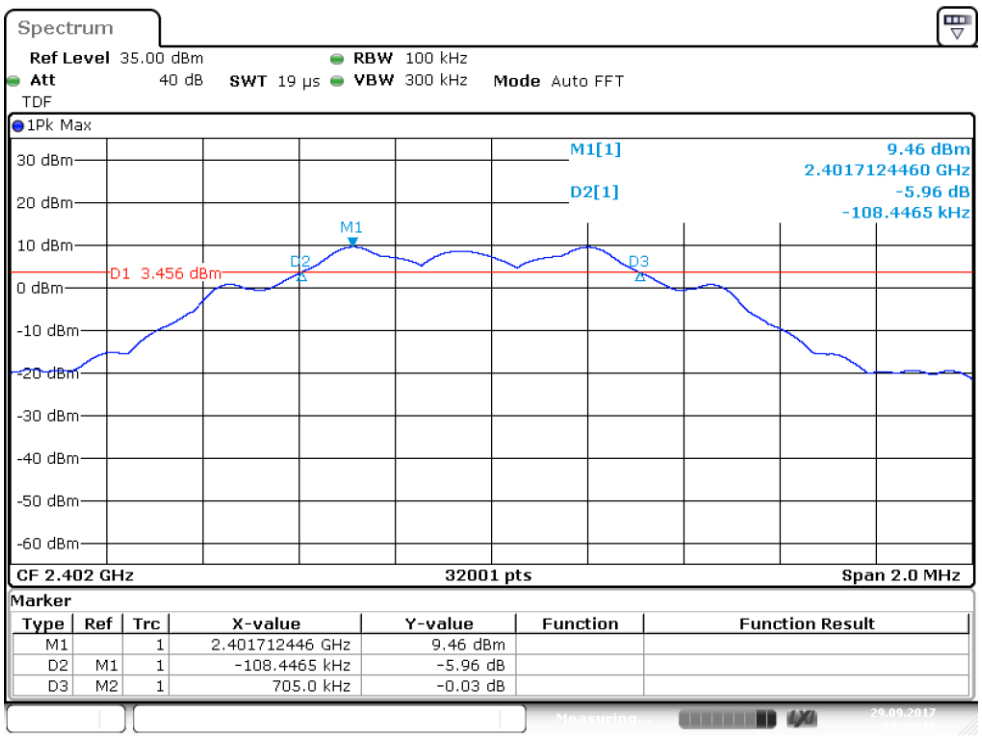

Figure 44: 6 dB bandwidth, channel 0 low, power setting 145, PHY 125k coded

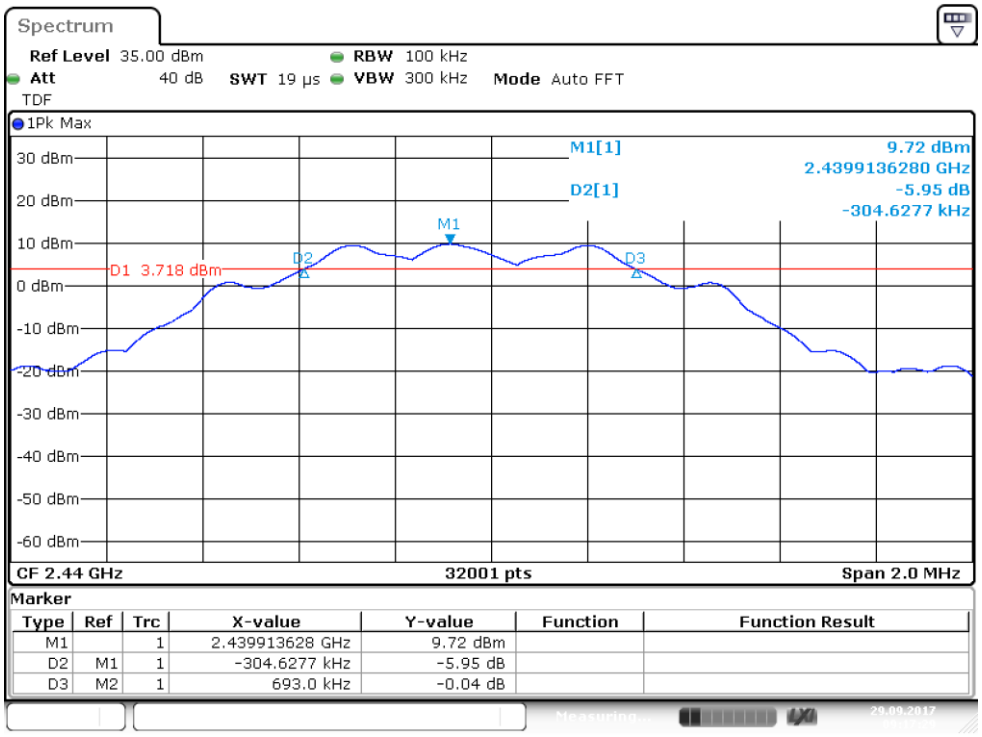

Figure 45: 6 dB bandwidth, channel 19 mid, power setting 145, PHY 125k coded

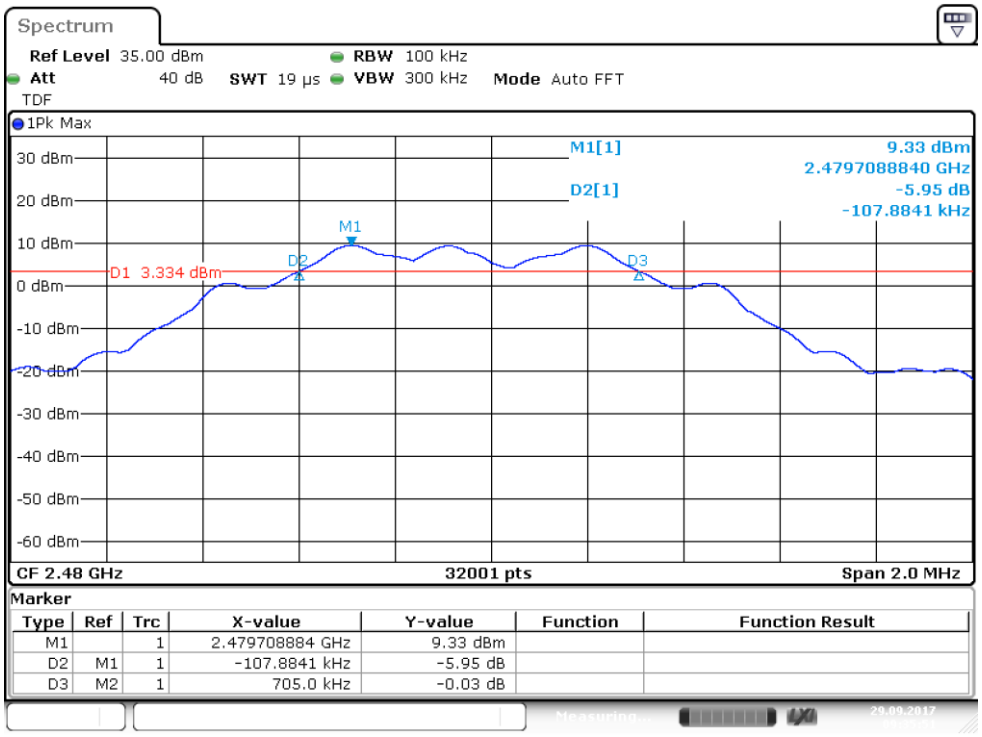

Figure 46: 6 dB bandwidth, channel 39 high, power setting 145, PHY 125k coded

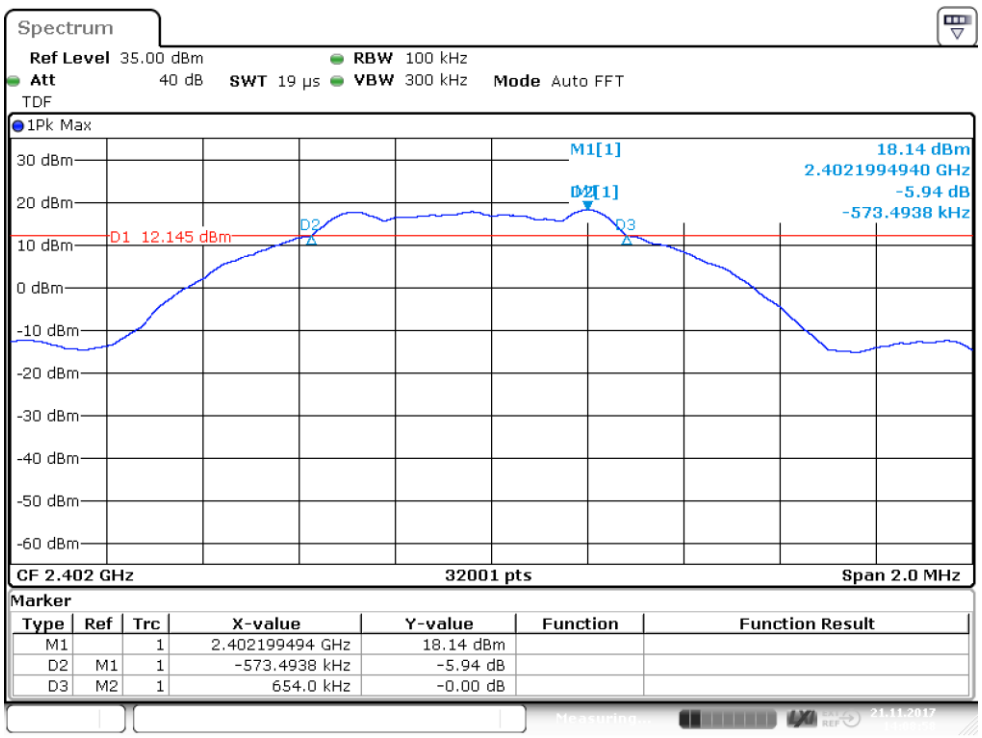

Figure 47: 6 dB bandwidth, channel 0 low, power setting 200, PHY 1M coded

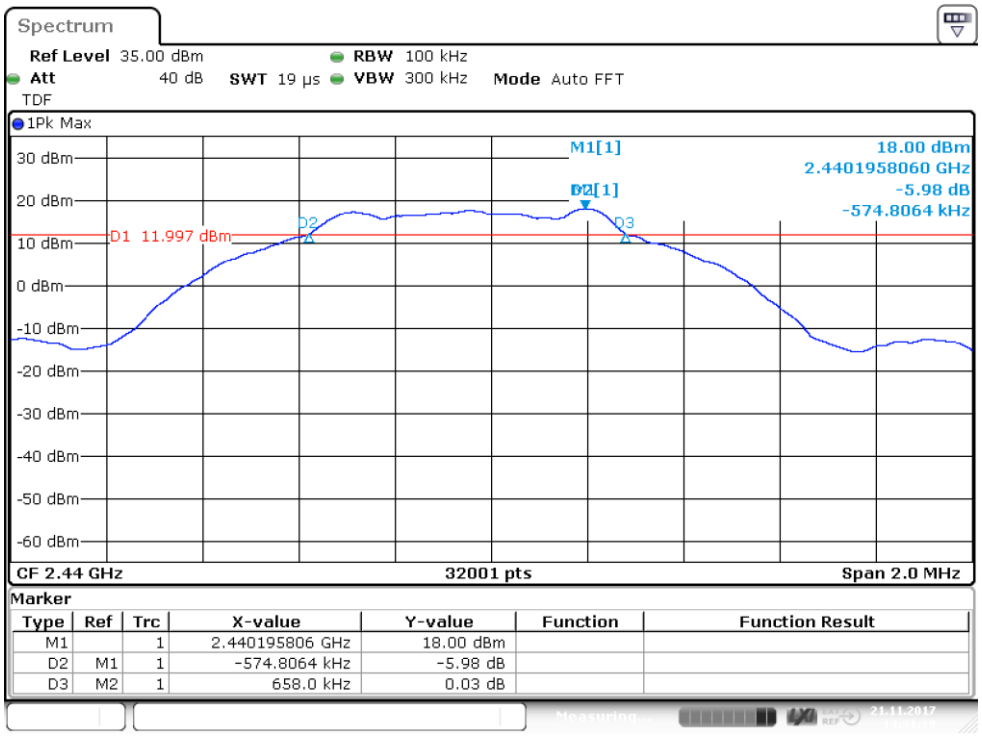

Figure 48: 6 dB bandwidth, channel 19 mid, power setting 200, PHY 1M coded

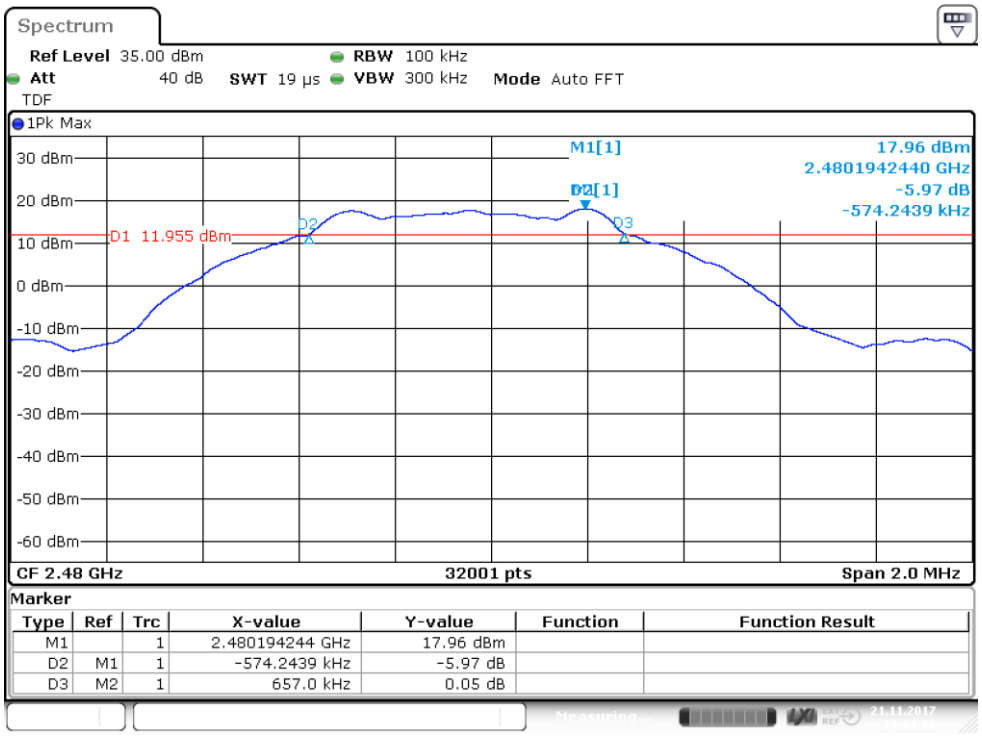

Figure 49: 6 dB bandwidth, channel 39 high, power setting 200, PHY 1M coded

Power Spectral Density

Standard:	ANSI C63.10	(2013)
Tested by:	JAT / MIH	
Date:	29 September – 21 November 2017	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	

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

Results:

Table 35: Power spectral density test results

Channel	Power setting	PHY	PSD dBm/3 kHz	Maximum limit [dBm/3kHz]
0 Low	145	125k coded	7.24	+8.00
19 Mid	145	125k coded	7.17	
39 High	145	125k coded	7.11	
0 Low	200	1M coded	1.61	
19 Mid	200	1M coded	1.54	
39 High	200	1M coded	1.45	

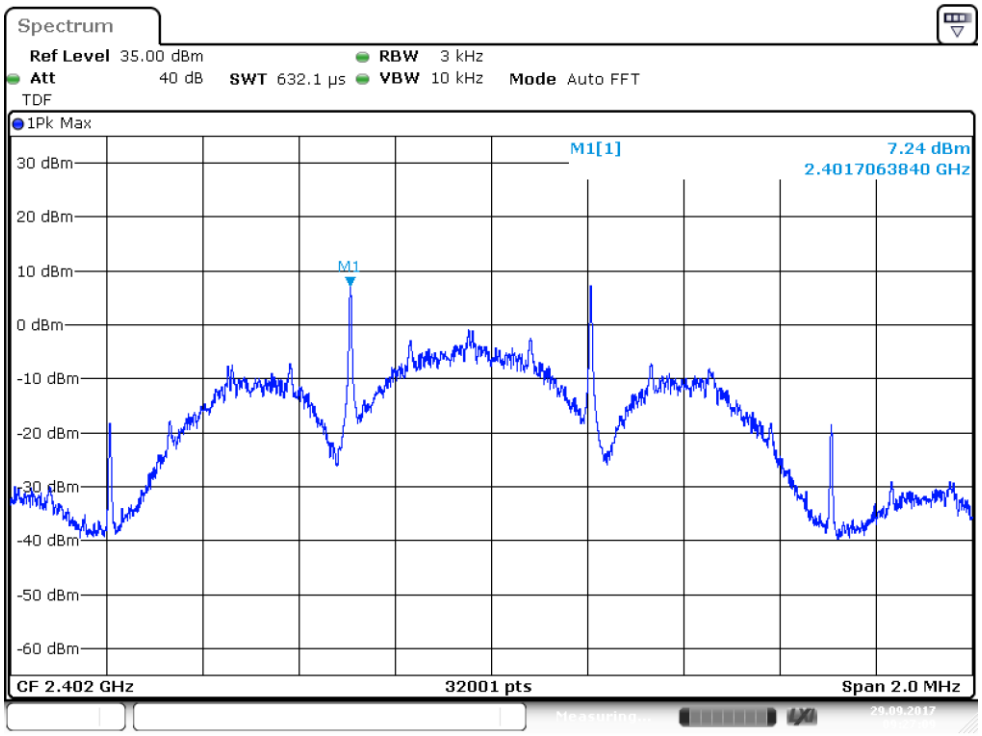

Figure 50: Power spectral density, channel 0 low, power setting 145, PHY 125k coded

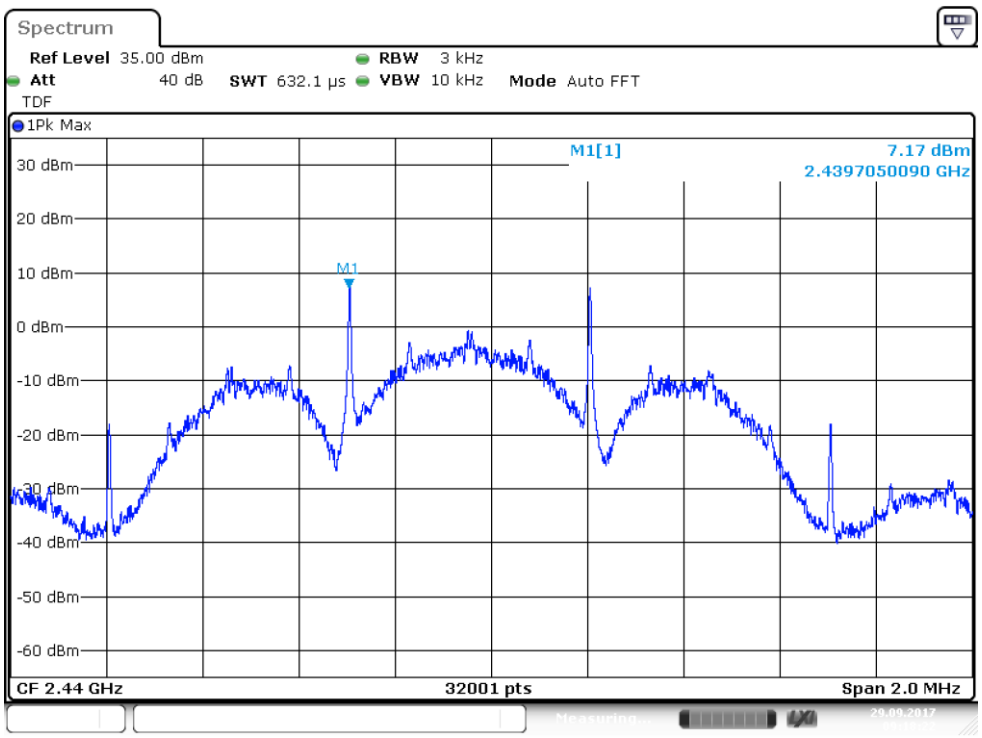

Figure 51: Power spectral density, channel 19 mid, power setting 145, PHY 125k coded

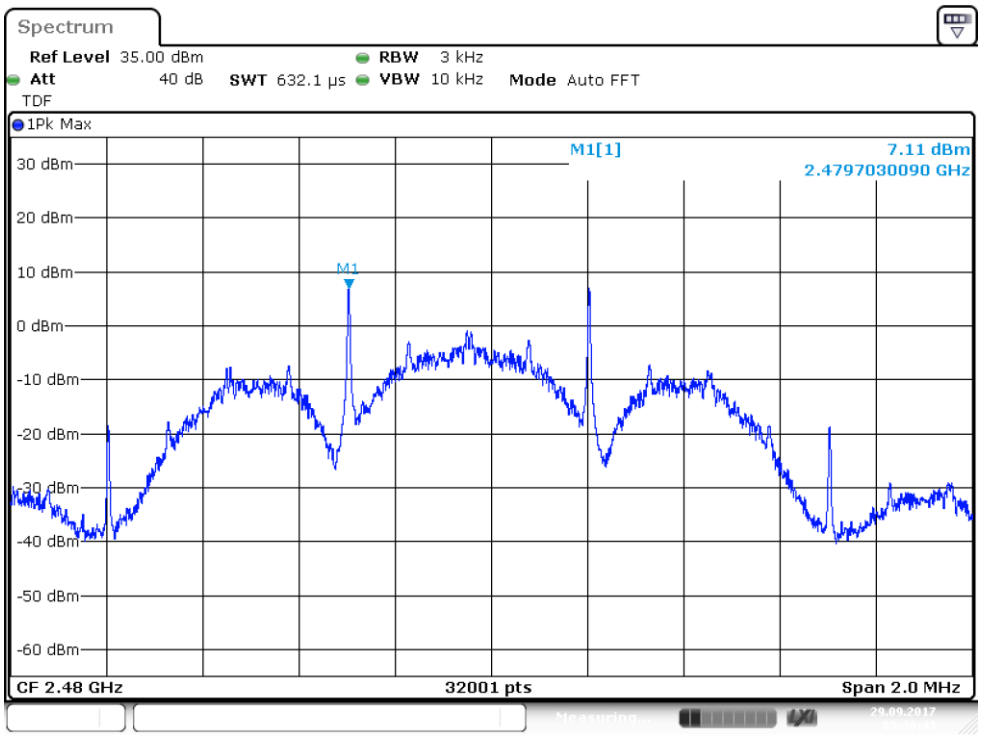

Figure 52: Power spectral density, channel 39 high, power setting 145, PHY 125k coded

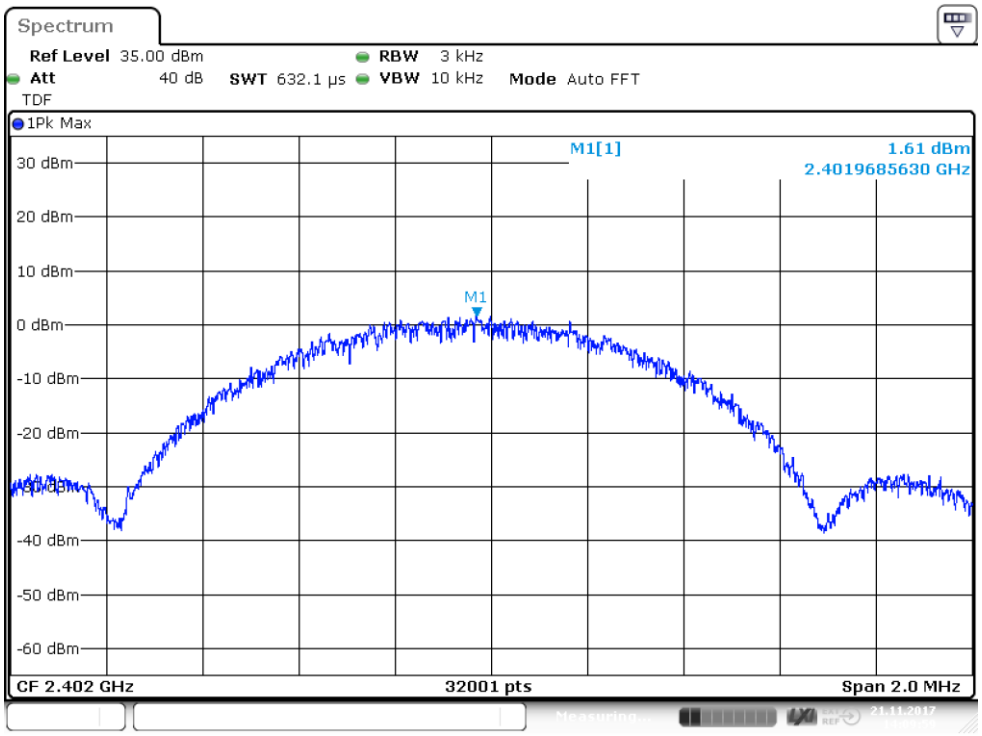

Figure 53: Power spectral density, channel 0 low, power setting 200, PHY 1M coded

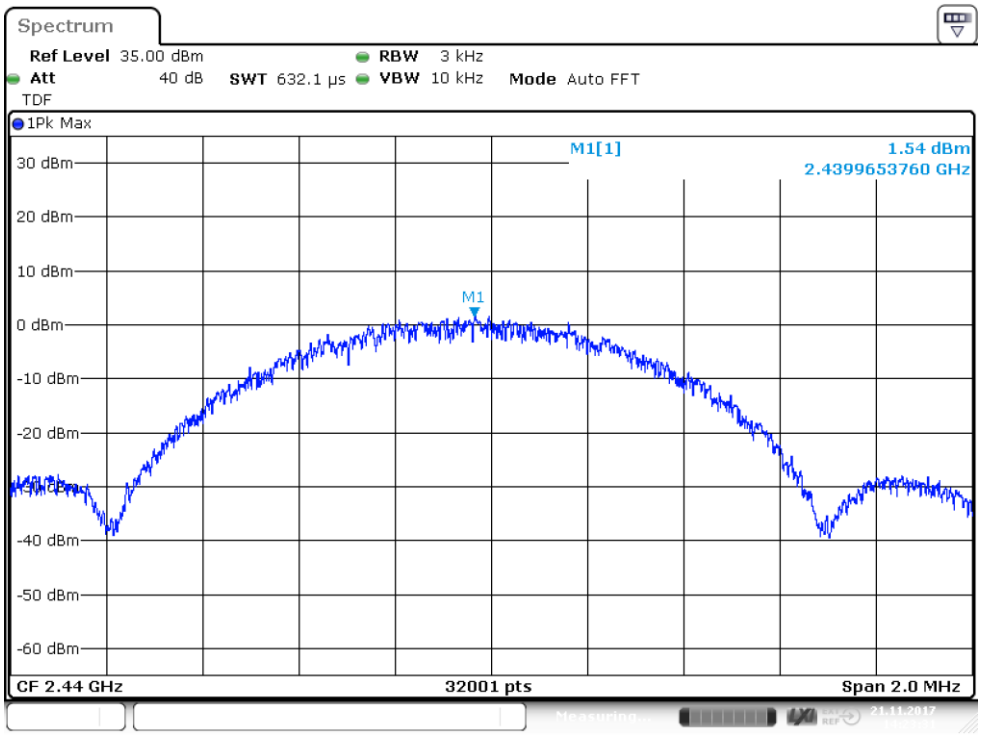

Figure 54: Power spectral density, channel 19 mid, power setting 200, PHY 1M coded

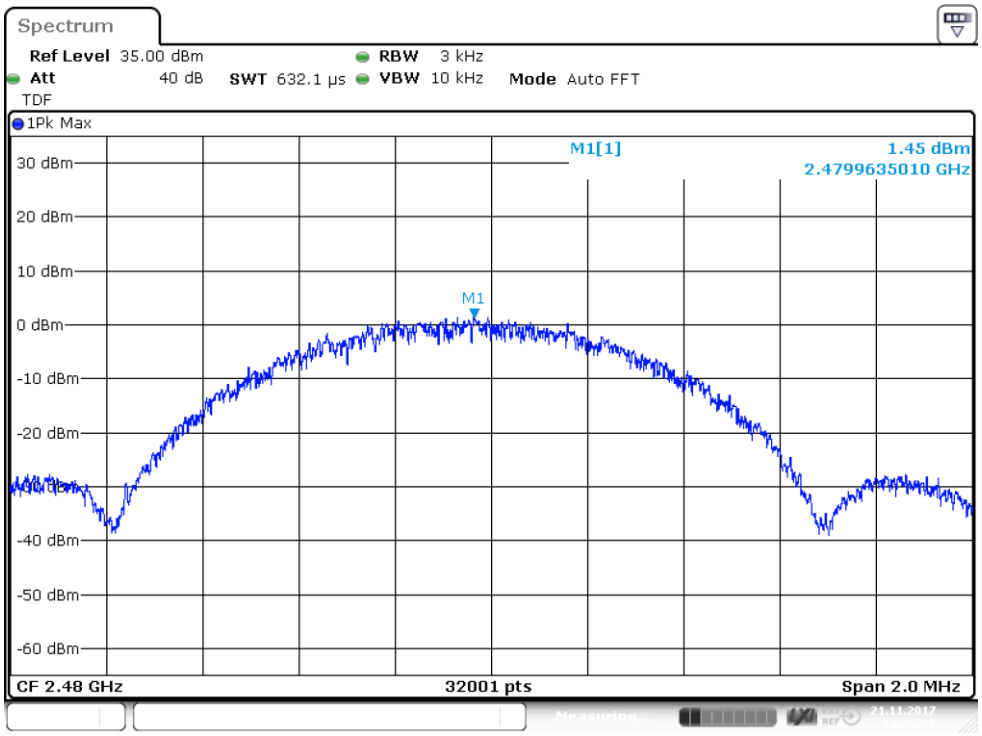

Figure 55: Power spectral density, channel 39 high, power setting 200, PHY 1M coded

99% Occupied Bandwidth

Standard:	RSS-GEN	(2014)
Tested by:	JAT / MIH	
Date:	29 September – 21 November 2017	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	

RSS-GEN 6.6

Results:

Table 36: 99% occupied bandwidth test results (EUT 3)

Channel	Power setting	PHY	Limit	99 % BW [MHz]	Result
0 Low	145	125k coded	-	1.157213837	PASS
19 Mid	145	125k coded	-	1.161713696	PASS
39 High	145	125k coded	-	1.152338989	PASS
0 Low	200	1M coded	-	1.058216931	PASS
19 Mid	200	1M coded	-	1.057466954	PASS
39 High	200	1M coded	-	1.057466954	PASS

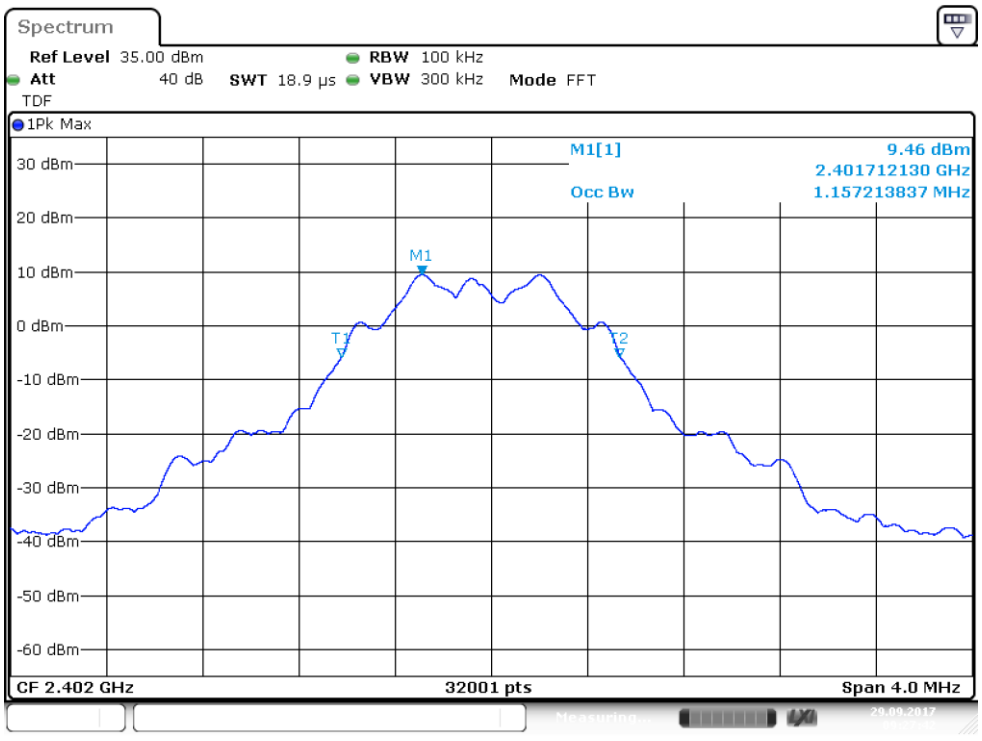

Figure 56: 99% OBW, Channel 0 low, power setting 145, PHY 125k coded

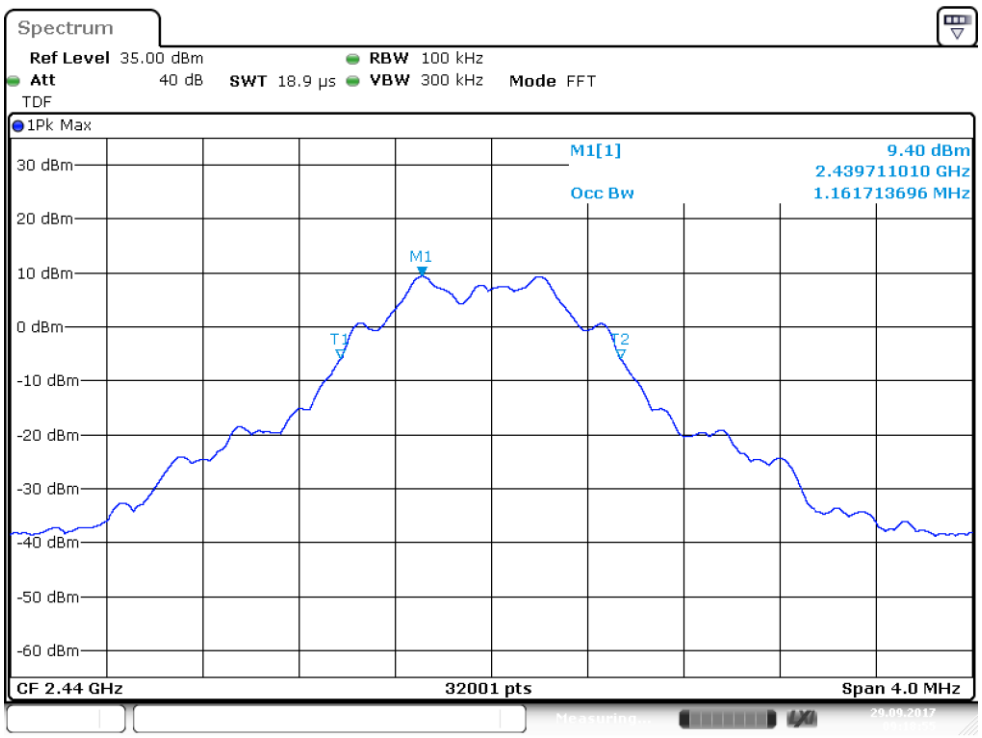

Figure 57: 99% OBW, Channel 19 mid, power setting 145, PHY 125k coded

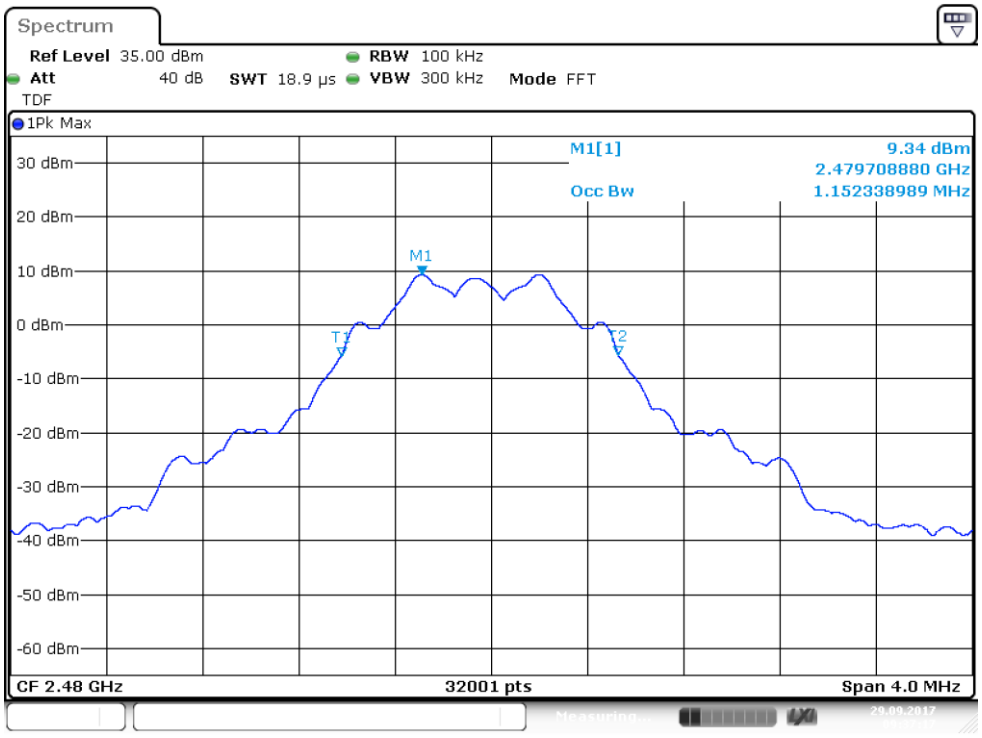

Figure 58: 99% OBW, Channel 39 high, power setting 145, PHY 125k coded

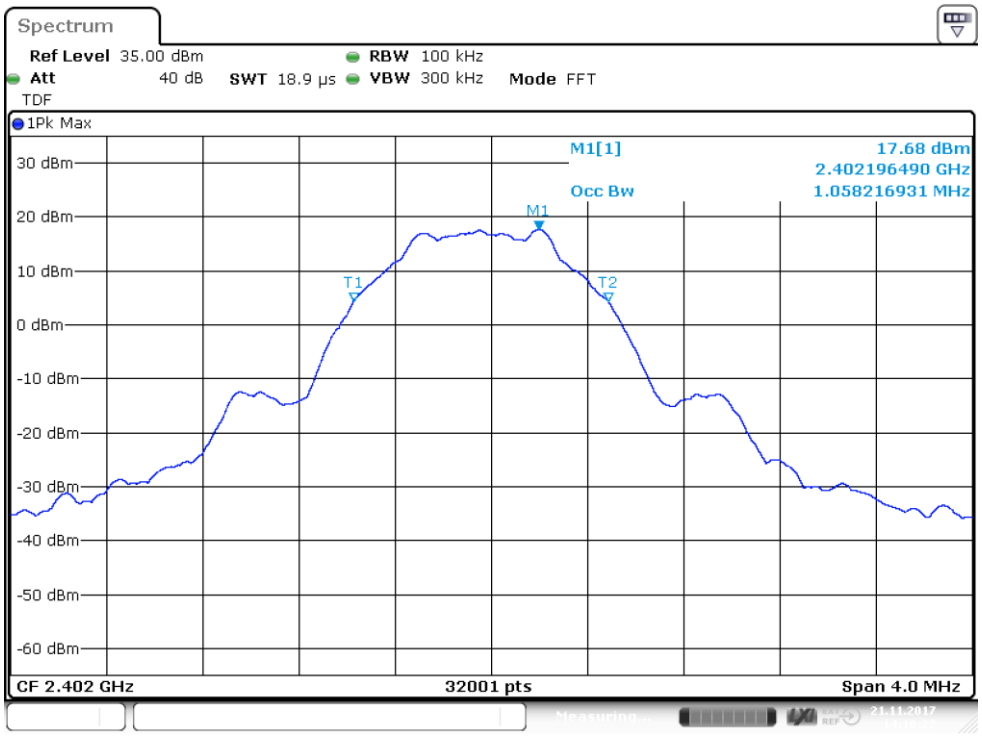

Figure 59: 99% OBW, Channel 0 low, power setting 200, PHY 1M coded

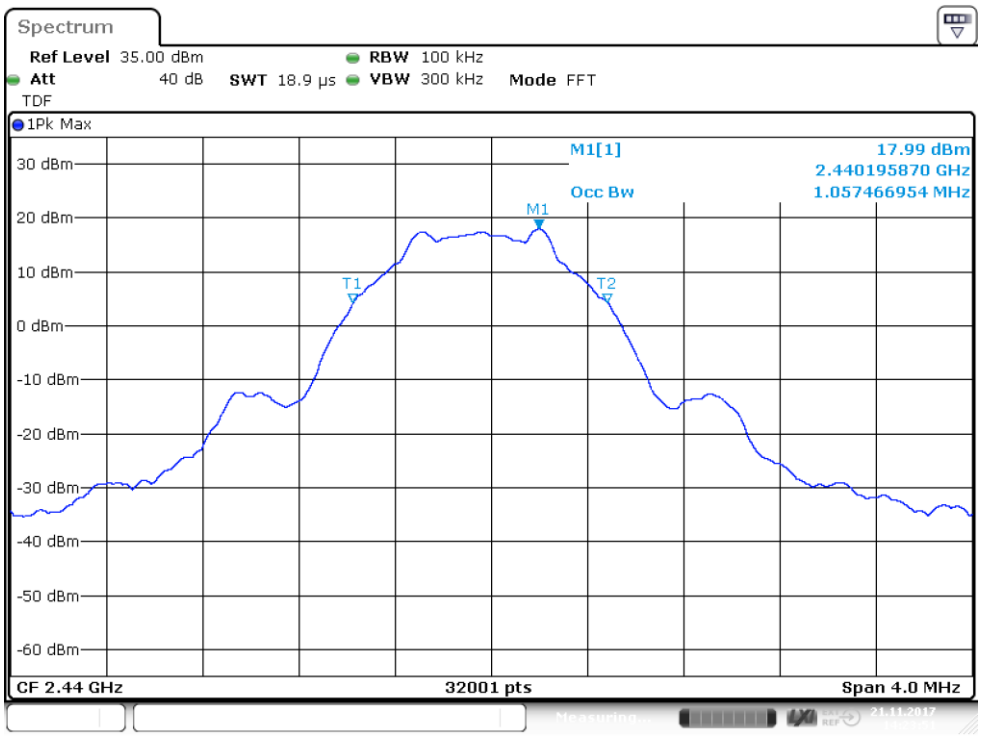

Figure 60: 99% OBW, Channel 19 mid, power setting 200, PHY 1M coded

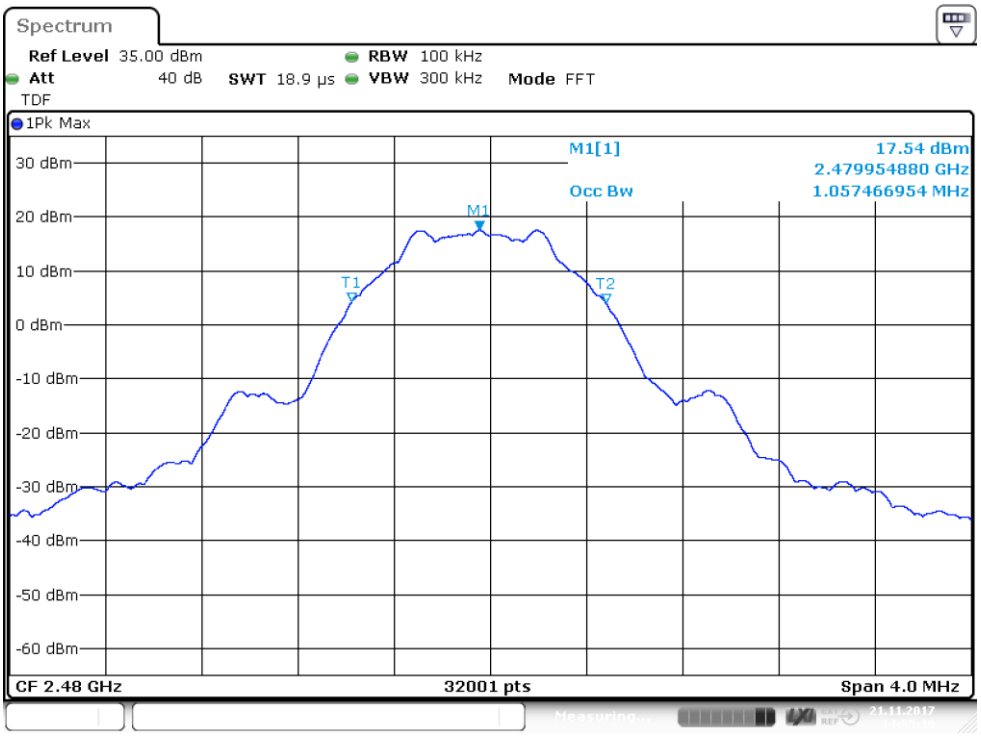

Figure 61: 99% OBW, Channel 39 high, power setting 200, PHY 1M coded

Table 28: 99% occupied bandwidth test results (EUT 4)

Channel	Limit	99 % BW [MHz]	Result
0 Low	-	1.050092185	PASS
19 Mid	-	1.051092153	PASS
39 High	-	1.054092060	PASS

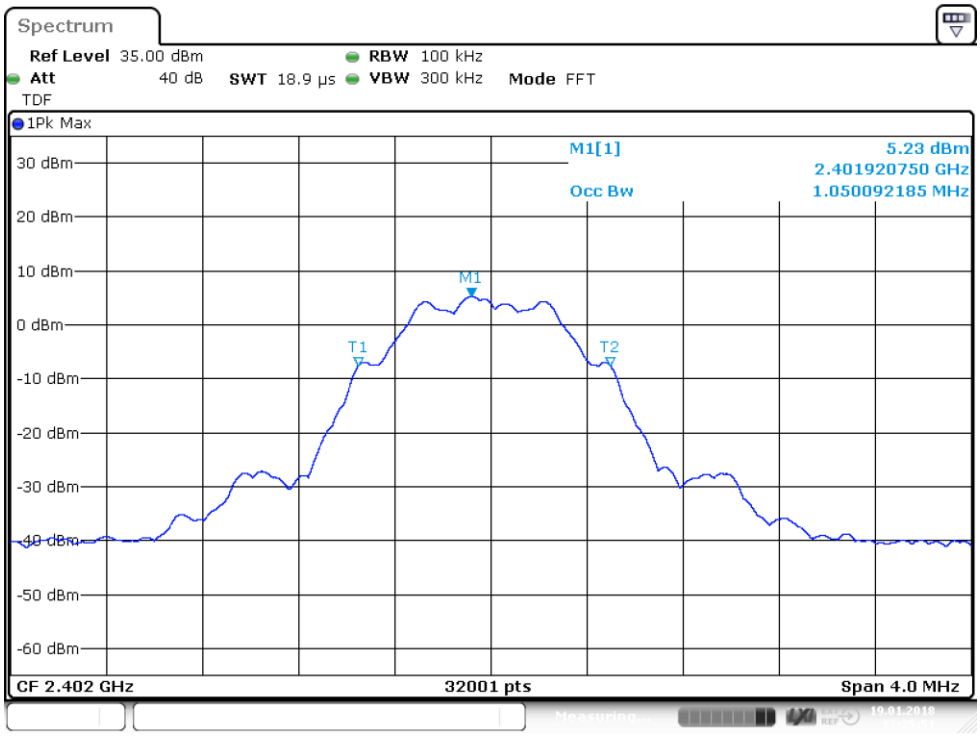

Figure 42: 99% OBW, Channel 0 low, power setting 95

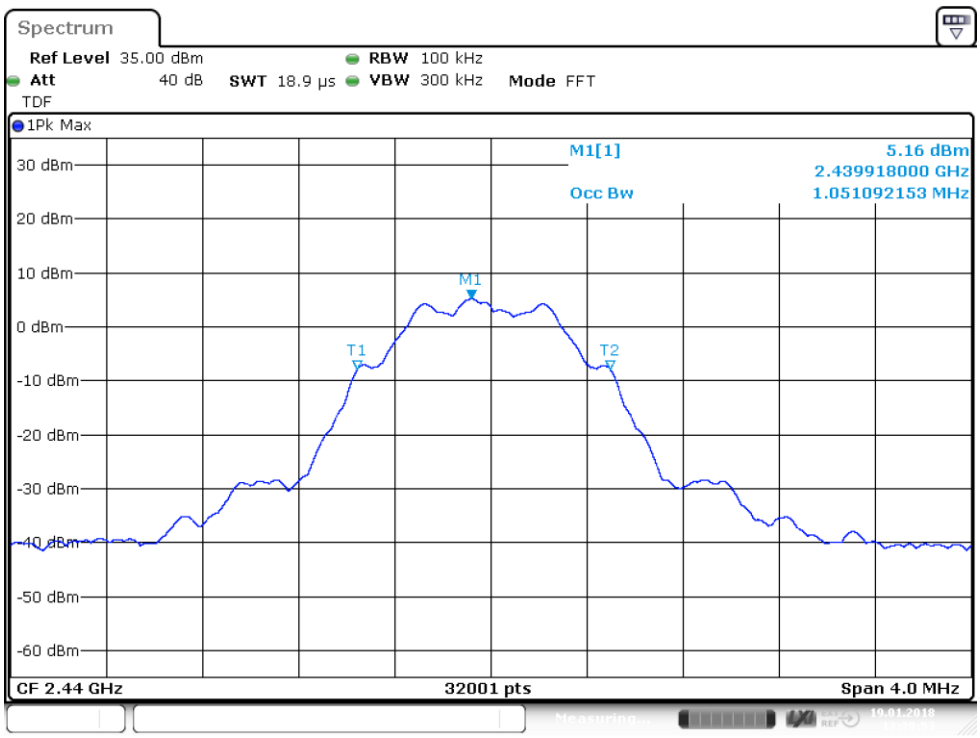

Figure 43: 99% OBW, Channel 19 mid, power setting 95

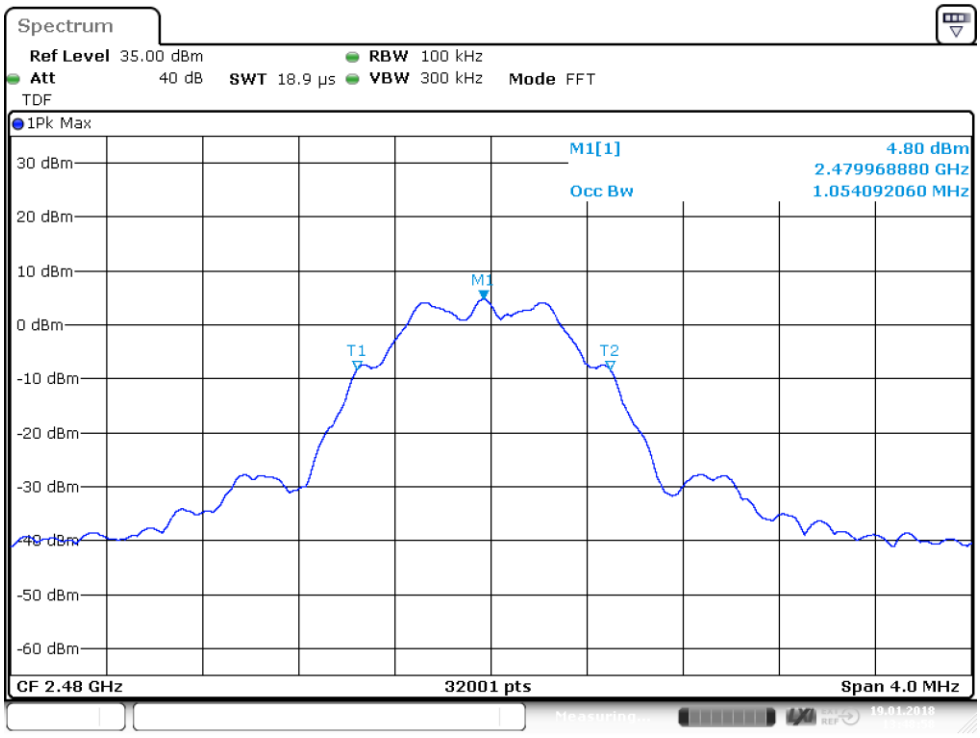

Figure 44: 99% OBW, Channel 39 high, power setting 95

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
ANTENNA	ETS LINDGREN	3160-10	inv:9151	2013-08-06	2018-08-06
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	2017-07-10	2018-07-10
SIGNAL ANALYZER	ROHDE & SCHWARZ	FSV40	inv:9093	2017-07-07	2018-07-07
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