

# Test Report



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

Equipment Under Test: Multi-Protocol Wireless 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 5, 2017)

Date: 4 December 2017

Issued by:

  
Jani Tuomela  
Testing Engineer

Date: 4 December 2017

Checked by:

  
Rauno Repo  
Testing Engineer

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## Equipment Under Test (EUT)

Trade mark:	Silicon Labs
Model:	MGM12P02GA, MGM12P02GE
Type:	Multi-Protocol Wireless Module
Serial no:	-
FCC ID:	QOQMGM12P0
IC:	5123A-MGM12P0

## Description of the EUT

MGM12P02G is a multi-protocol wireless module with two antenna variants. Variant A is equipped with chip antenna while the E variant has RF connector for the use of external antenna.

This test report contains test results for Bluetooth Low Energy.

## Classification of the device

Fixed device	<input type="checkbox"/>
Mobile Device (Human body distance > 20cm)	<input checked="" type="checkbox"/>
Portable Device (Human body distance < 20cm)	<input checked="" type="checkbox"/>

## 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:	8.73 dBm (Peak)
Modulation:	GFSK
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 with original antenna assembly. One sample had RF connector with short RF cable and antenna attached to it.

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

### 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. Conducted measurements were performed to E variant sample.

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

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

Channel Low (Ch 0) = 2402 MHz

Channel Mid (Ch 19) = 2440 MHz

Channel High (Ch 39) = 2480 MHz

Power setting 199 was used for A variant and power setting 186 for E variant during radiated measurements.

Power setting 92 was used for conducted measurements. Other settings in table below were same for all tests.

PHY	Low energy transmit	Packet Length
1M	PRBS9 (GFSK)	255

### Test Facility

Testing Laboratory / address: FCC registration number: <b>904175</b>	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:** EHA  
**Date:** 2 August 2017  
**Temperature:** 22 °C  
**Humidity:** 44 % RH  
**Barometric pressure:** 1001 hPa  
**Measurement uncertainty:** ± 2.9 dB Level of confidence 95 % (k = 2)

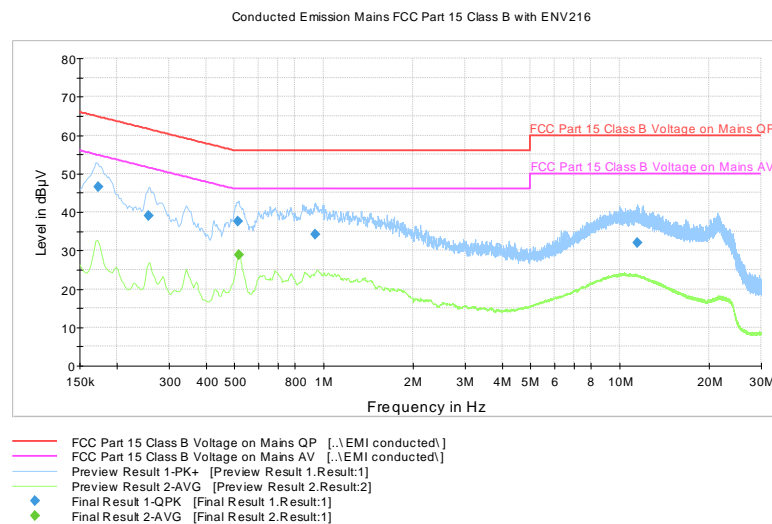
**FCC Rule: 15.207 (a)**  
**RSS-GEN 8.8**

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. Conducted Emission was measured from the highest power level module MGM12P32

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.

**Maximum Peak Conducted Output Power**

**Table 1:** Final QuasiPeak measurements from the worst frequencies

Frequency (MHz)	QuasiPeak (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.173000	46.5	1000.0	9.000	L1	10.3	18.3	64.8
0.256500	38.9	1000.0	9.000	L1	9.7	22.6	61.5
0.515250	37.5	1000.0	9.000	L1	10.1	18.5	56.0
0.938000	34.2	1000.0	9.000	L1	10.0	21.8	56.0
11.470250	32.0	1000.0	9.000	L1	10.3	28.0	60.0

**Table 2:** Final Average measurements from the worst frequencies

Frequency (MHz)	Average (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.517250	28.8	1000.0	9.000	N	10.3	17.2	46.0

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  
**Date:** 23 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)**

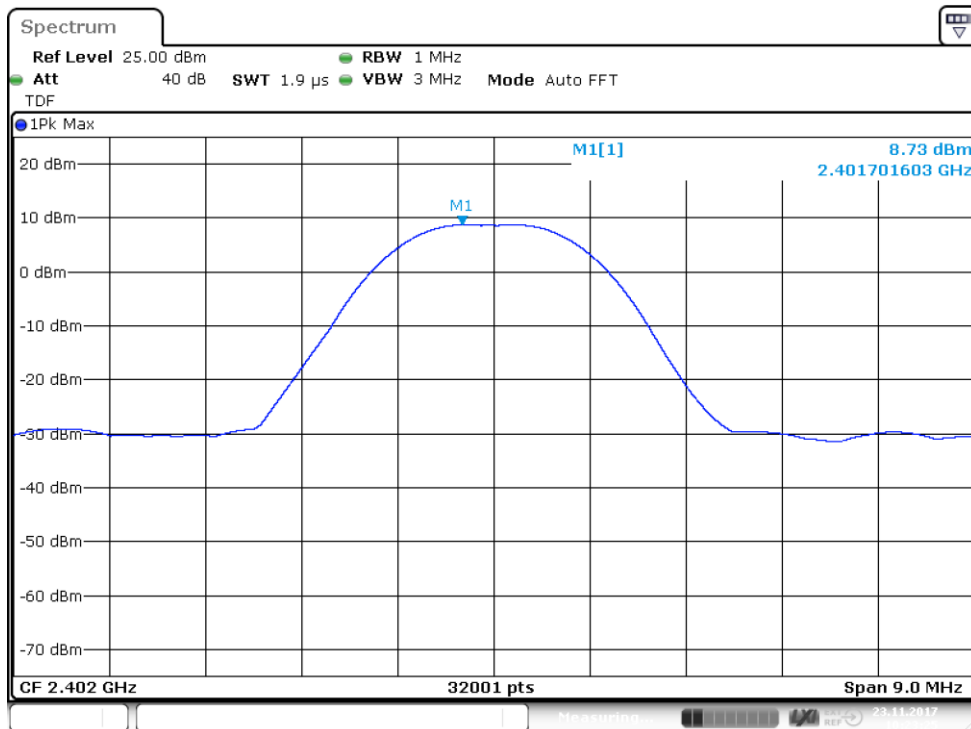
For systems using digital modulation in the 2400-2483.5 MHz bands the limit is 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power.

Measured values are peak values.

**Results:**

**Table 3:** Maximum conducted output power

Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
Low	8.73	30	21.27	PASS
Mid	8.22	30	21.78	PASS
High	7.99	30	22.01	PASS



**Figure 2:** Conducted power (ch low)



## Maximum Peak Conducted Output Power

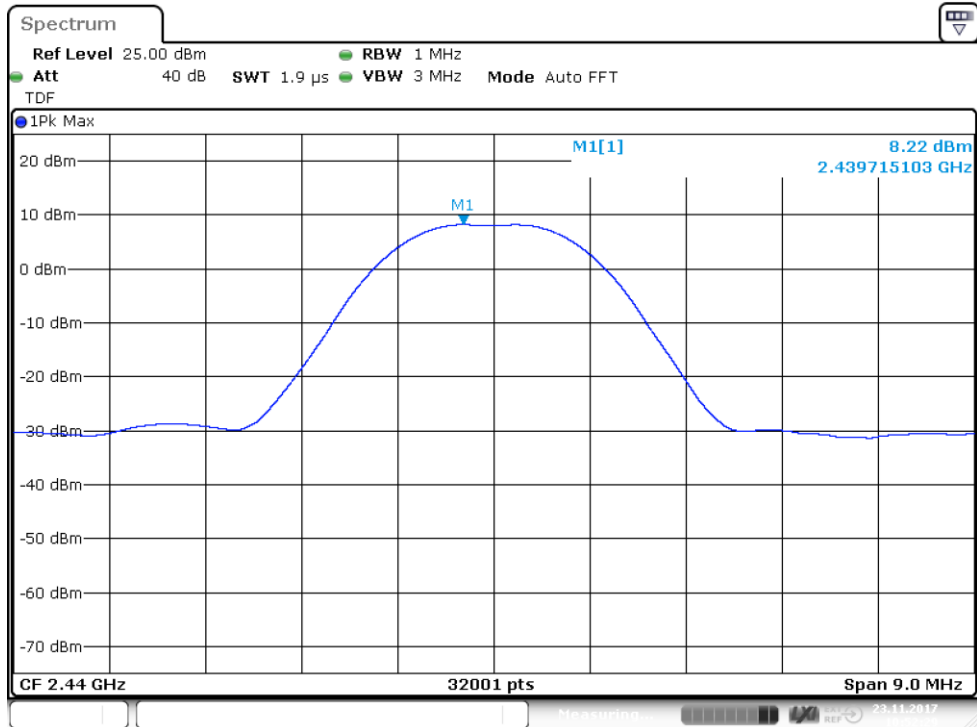


Figure 3: Conducted power (ch mid)

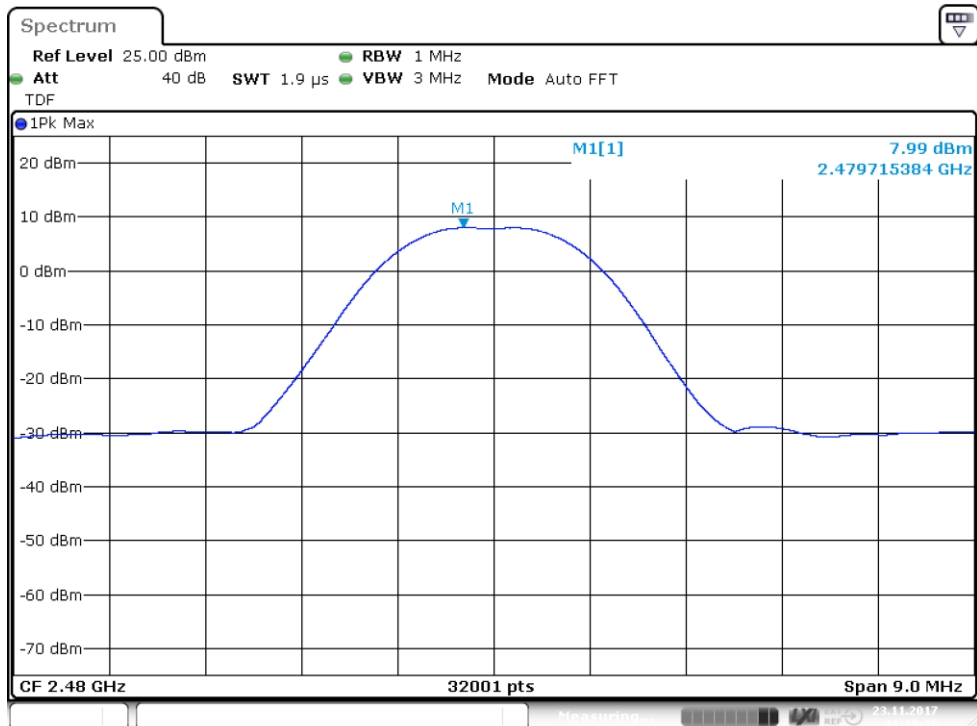


Figure 4: Conducted power (ch high)

**Transmitter Radiated Spurious Emissions 30 - 26500 MHz**

**Standard:** ANSI C63.10 (2013)  
**Tested by:** EHA & JAT  
**Date:** 26 July 2017 - 8 August 2017  
**Temperature:** 23 ± 3 °C  
**Humidity:** 20 - 60 % RH  
**Measurement uncertainty:** ± 4.51 dB Level of confidence 95 % (k = 2)

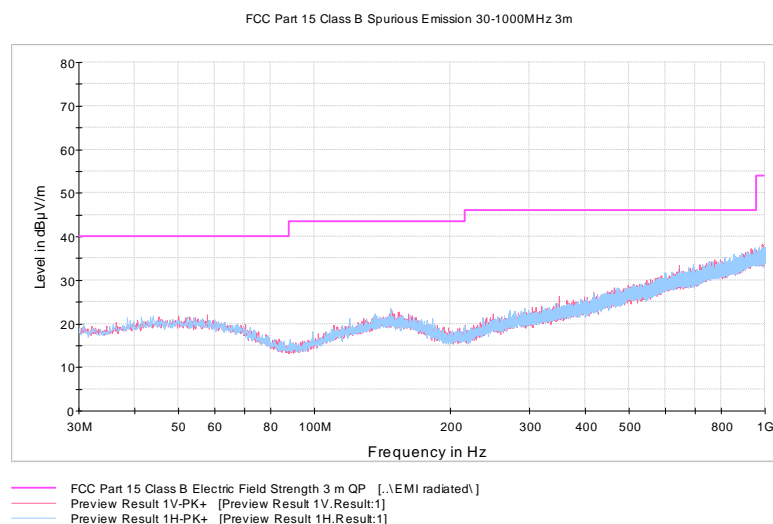
**FCC Rule: 15.247(d), 15.209(a)**  
**RSS-247 5.5**

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.

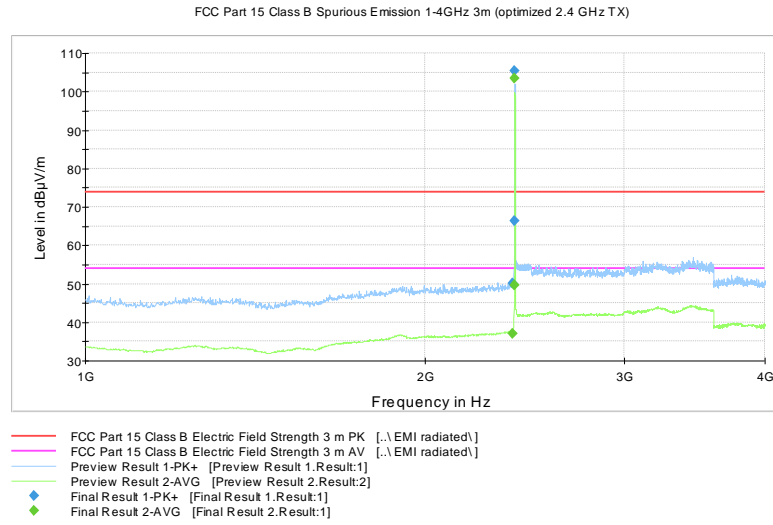
Frequency range [MHz]	Limit [ $\mu\text{V/m}$ ]	Limit [dB $\mu\text{V/m}$ ]	Detector
30 - 80	100	40.0	Quasi-peak
88 - 216	150	43.5	Quasi-peak
216 - 960	200	46.0	Quasi-peak
960 - 1000	500	53.9	Quasi-peak
Above 1000	500	53.9	Average
Above 1000	5000	73.9	Peak

**Low channel**

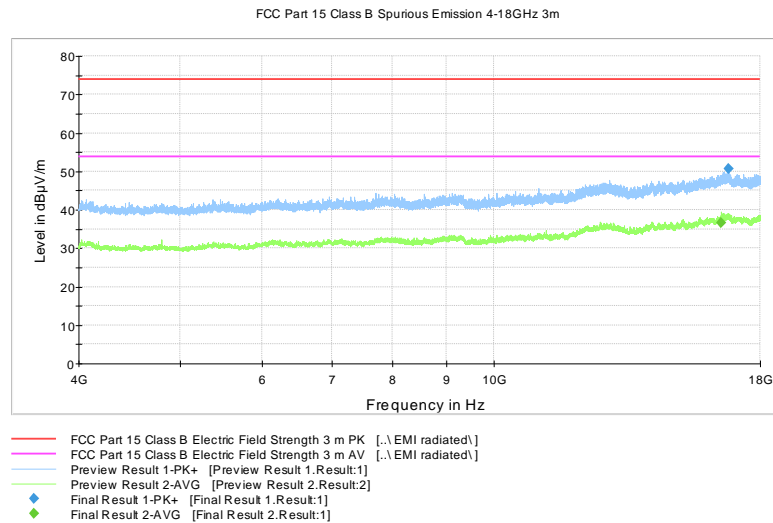


**Figure 5: Low channel 30 MHz – 1000 MHz (A)**

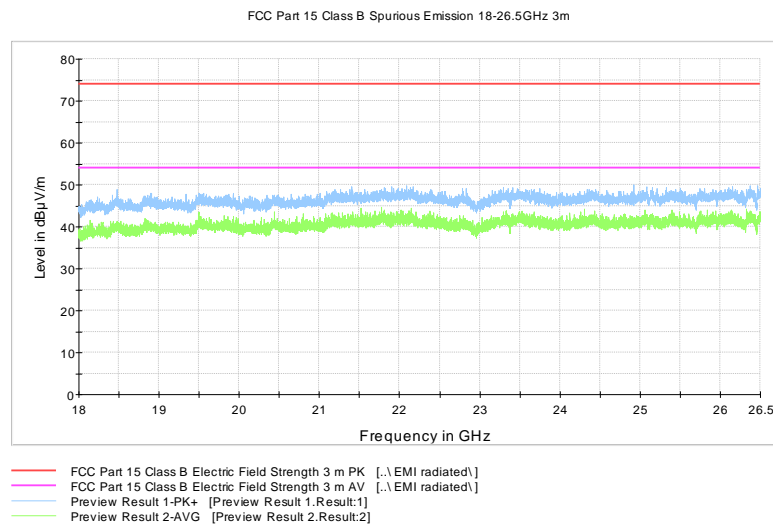
**Transmitter Radiated Spurious Emissions**



**Figure 6: Low channel 1 GHz – 4 GHz (A)**



**Figure 7: Low channel 4 GHz – 18 GHz (A)**



**Figure 8: Low channel 18 GHz – 26.5 GHz (A)**

**Transmitter Radiated Spurious Emissions**

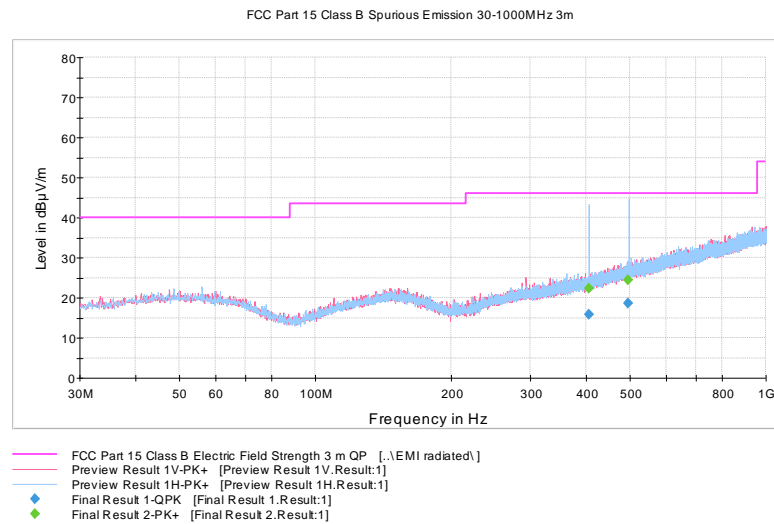
**Table 4: Peak results (ch low) (A)**

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.400000	50.2	1000.0	1000.000	150.0	H	58.0	14.6	23.7	73.9
2400.000000	66.4	1000.0	1000.000	275.0	H	290.0	14.7	18.9	85.3
16798.20000	50.8	1000.0	1000.000	245.0	V	0.0	26.8	23.1	73.9

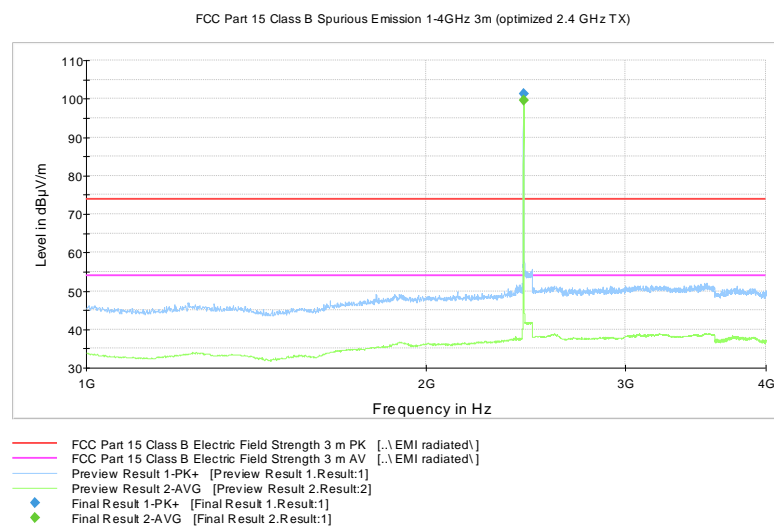
**Table 5: Average results (ch low) (A)**

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.600000	37.0	1000.0	1000.000	380.0	V	180.0	14.6	16.9	53.9
2400.000000	49.7	1000.0	1000.000	197.0	H	253.0	14.7	4.2	53.9
16523.60000	36.6	1000.0	1000.000	166.0	V	187.0	26.1	17.3	53.9

**Middle channel**

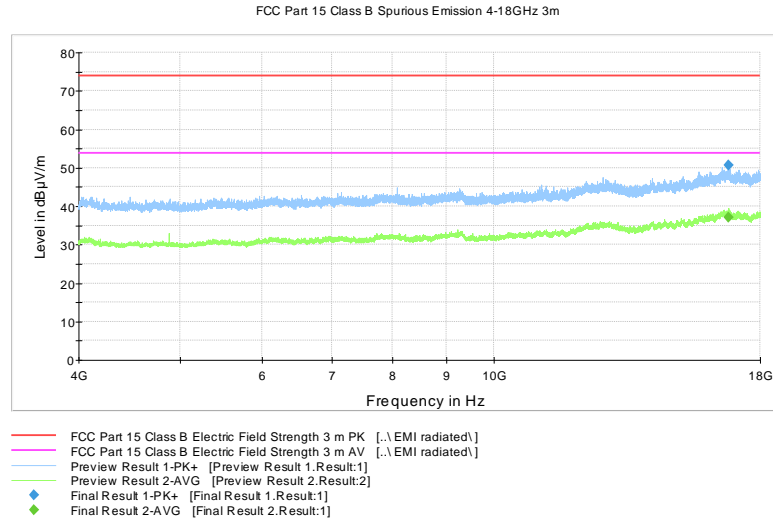


**Figure 9: Mid channel 30 MHz – 1000 MHz (A)**

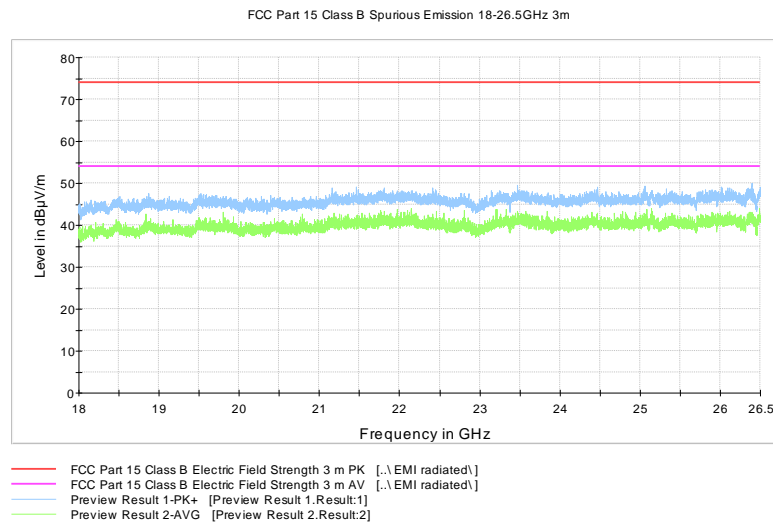


**Figure 10: Mid channel 1 GHz – 4 GHz (A)**

**Transmitter Radiated Spurious Emissions**



**Figure 11: Mid channel 4 GHz – 18 GHz (A)**



**Figure 12: Mid channel 18 GHz – 26.5 GHz (A)**

**Table 6: Peak results (ch mid) (A)**

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
16802.30000	50.6	1000.0	1000.000	400.0	V	113.0	26.8	23.3	73.9

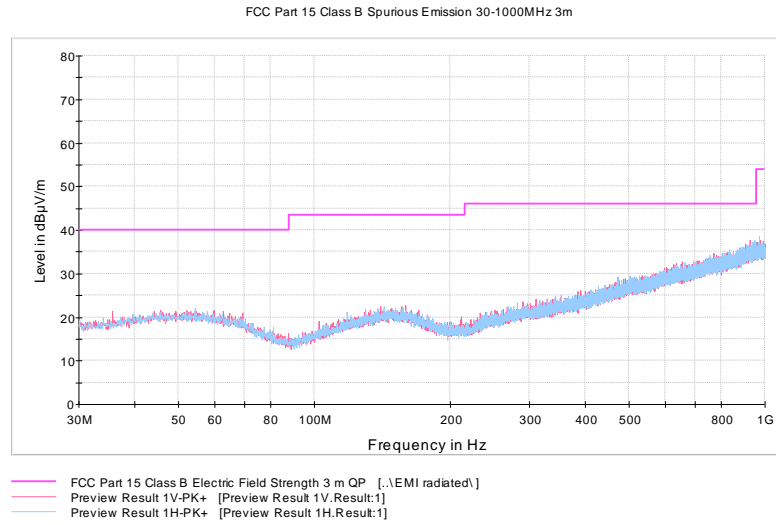
**Table 7: Average results (ch mid) (A)**

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
16793.60000	37.0	1000.0	1000.000	400.0	V	344.0	26.8	16.9	53.9

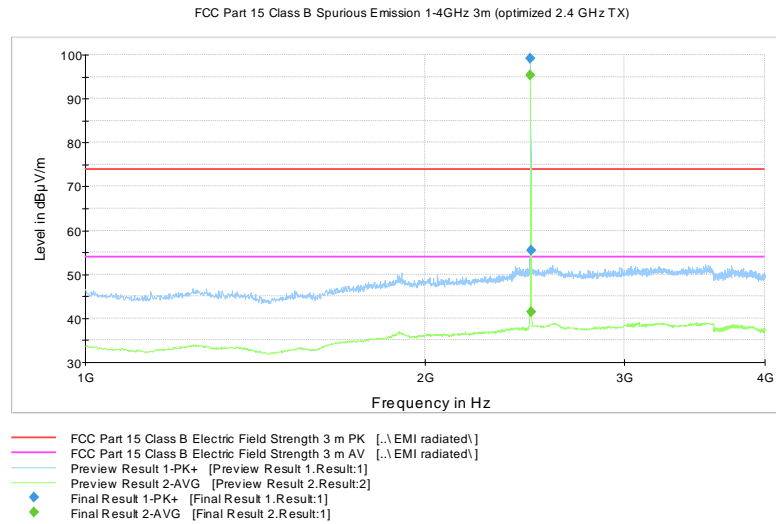
**Table 8: Quasi-peak results (ch mid) (A)**

Frequency (MHz)	QuasiP (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
405.141000	15.8	1000.0	120.000	100.0	H	122.0	17.9	30.2	46.0
495.411000	18.6	1000.0	120.000	178.0	H	209.0	20.2	27.4	46.0

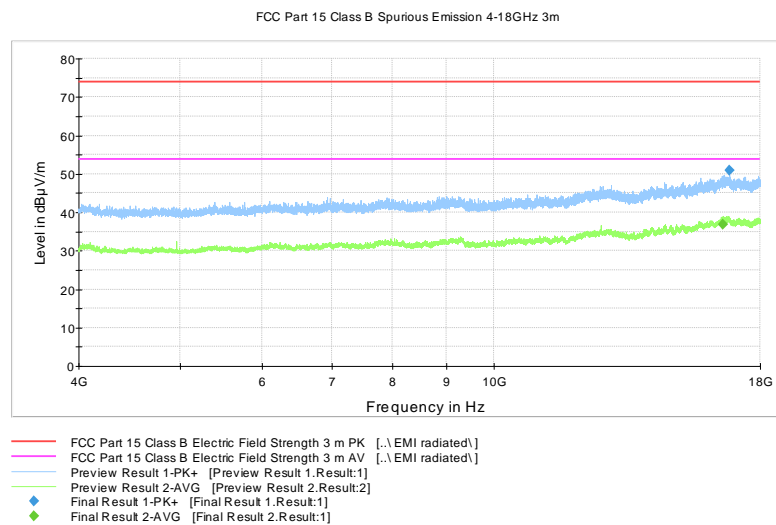
### High channel



**Figure 13: High channel 30 MHz – 1000 MHz (A)**

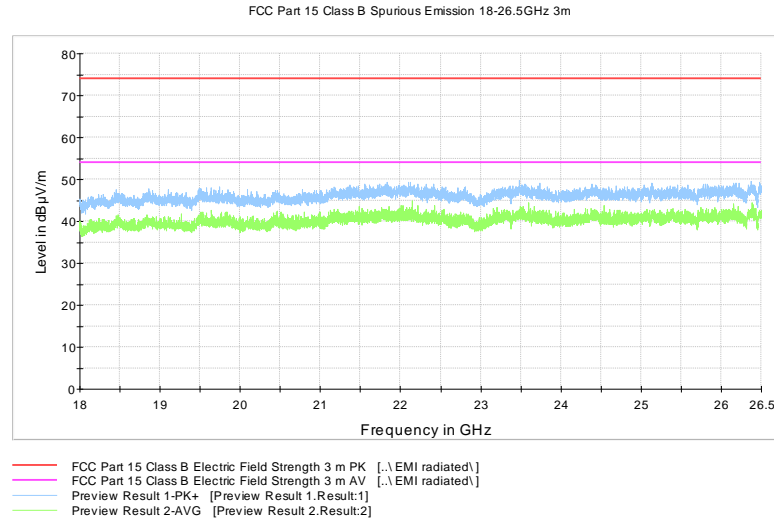


**Figure 14: High channel 1 GHz – 4 GHz (A)**



**Figure 15: High channel 4 GHz – 18 GHz (A)**

**Transmitter Radiated Spurious Emissions**



**Figure 16:** High channel 18 GHz – 26.5 GHz (A)

**Table 9:** Peak results (ch high) (A)

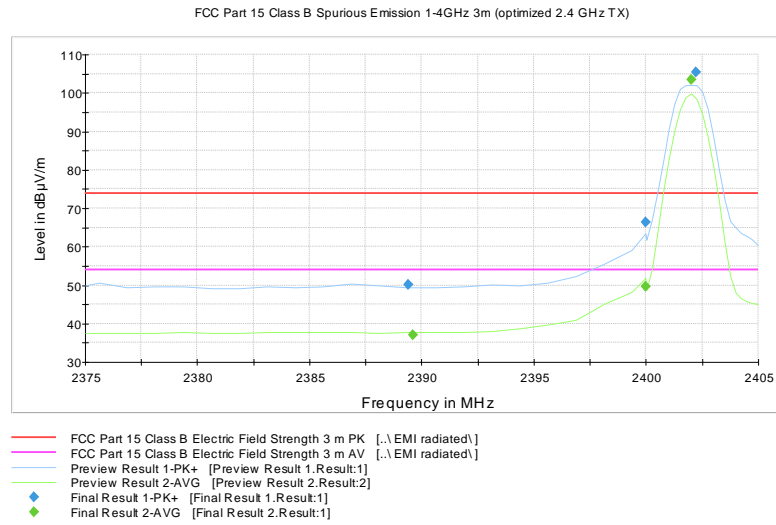
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	55.4	1000.0	1000.000	265.0	H	264.0	14.7	18.5	73.9
16806.40000	50.8	1000.0	1000.000	323.0	V	136.0	26.8	23.1	73.9

**Table 10:** Average results (ch 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	41.4	1000.0	1000.000	254.0	H	263.0	14.7	12.5	53.9
16596.20000	36.8	1000.0	1000.000	150.0	H	119.0	26.2	17.1	53.9

**Transmitter Radiated Spurious Emissions**

**Radiated Band Edge results**



**Figure 17: Radiated Band Edge measurement graph (ch low) (A)**

**Table 11: Peak results (ch low) (A)**

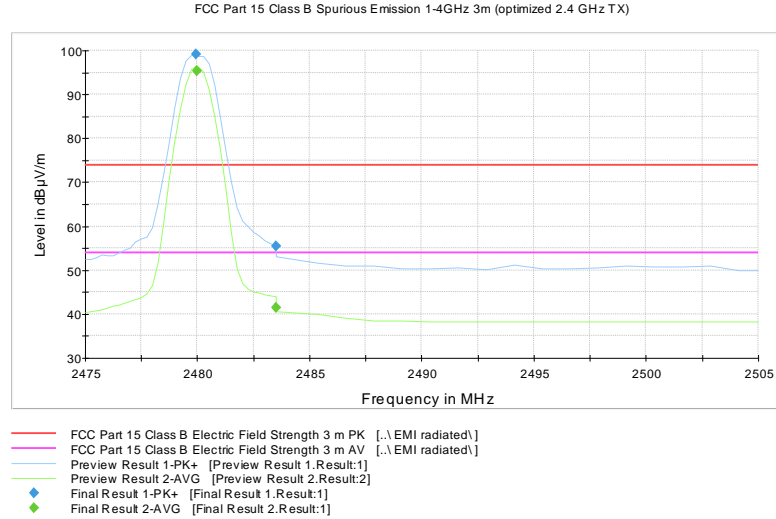
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.400000	50.2	1000.0	1000.000	150.0	H	58.0	14.6	23.7	73.9
2400.000000	66.4	1000.0	1000.000	275.0	H	290.0	14.7	18.9	85.3

**Table 12: Average results (ch low) (A)**

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.600000	37.0	1000.0	1000.000	380.0	V	180.0	14.6	16.9	53.9
2400.000000	49.7	1000.0	1000.000	197.0	H	253.0	14.7	4.2	53.9



**Transmitter Radiated Spurious Emissions**



**Figure 18: Radiated Band Edge measurement graph (ch high) (A)**

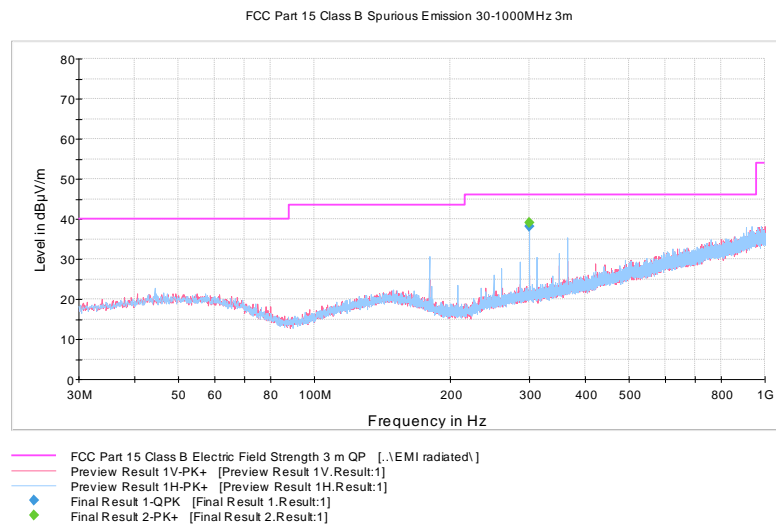
**Table 13: Peak results (ch high) (A)**

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	55.4	1000.0	1000.000	265.0	H	264.0	14.7	18.5	73.9

**Table 14: Average results (ch high) (A)**

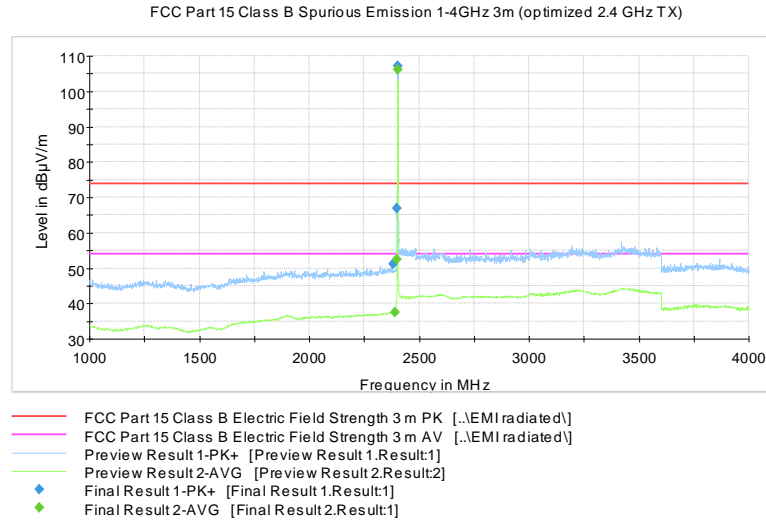
Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	41.4	1000.0	1000.000	254.0	H	263.0	14.7	12.5	53.9

**Low channel**

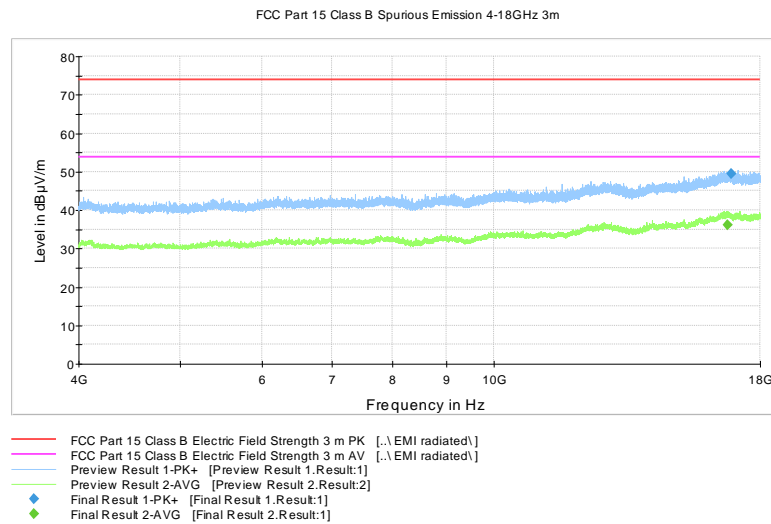


**Figure 19: Low channel 30 MHz – 1000 MHz (E)**

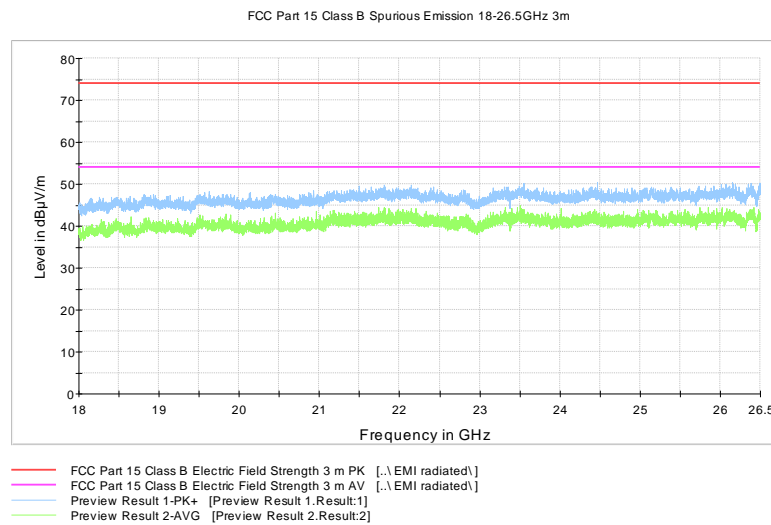
**Transmitter Radiated Spurious Emissions**



**Figure 20: Low channel 1 GHz – 4 GHz (E)**



**Figure 21: Low channel 4 GHz – 18 GHz (E)**



**Figure 22: Low channel 18 GHz – 26.5 GHz (E)**

**Table 15:** Peak results (ch low) (E)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2383.800000	51.1	1000.0	1000.000	379.0	H	33.0	14.5	22.8	73.9
2400.000000	66.8	1000.0	1000.000	236.0	V	291.0	14.7	20.2	87.0
16874.90000	49.5	1000.0	1000.000	150.0	V	82.0	26.8	24.4	73.9

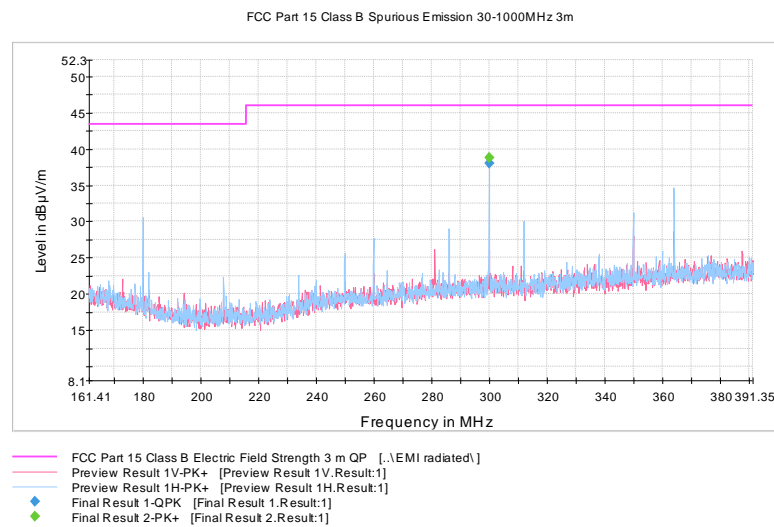
**Table 16:** Average results (ch low) (E)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.800000	37.5	1000.0	1000.000	279.0	V	298.0	14.6	16.4	53.9
2400.000000	52.5	1000.0	1000.000	258.0	V	293.0	14.7	1.4	53.9
16751.60000	36.2	1000.0	1000.000	150.0	V	0.0	26.6	17.7	53.9

**Table 17:** Quasi-peak results (ch low) (E)

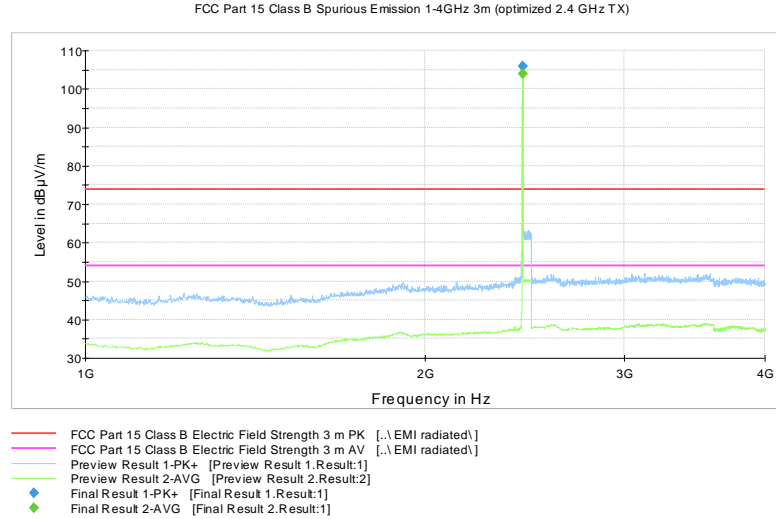
Frequency (MHz)	QuasiP (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
300.011000	38.1	1000.0	120.000	100.0	H	15.0	15.3	7.9	46.0

**Middle channel**

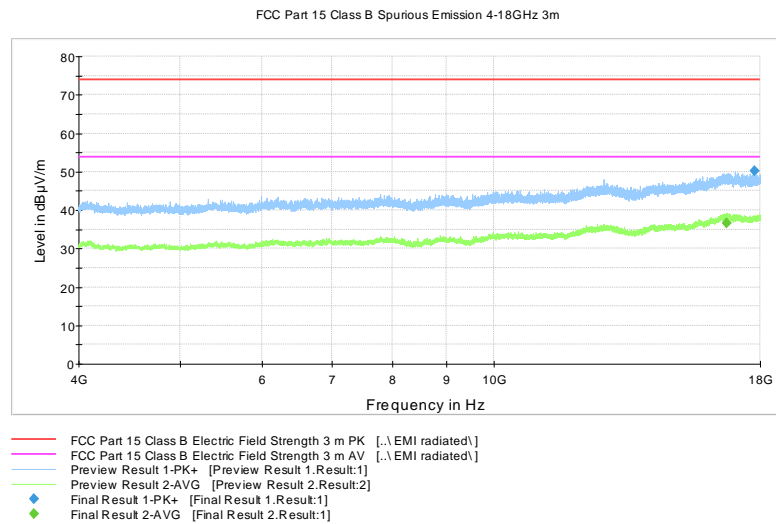


**Figure 23:** Mid channel 30 MHz – 1000 MHz (E)

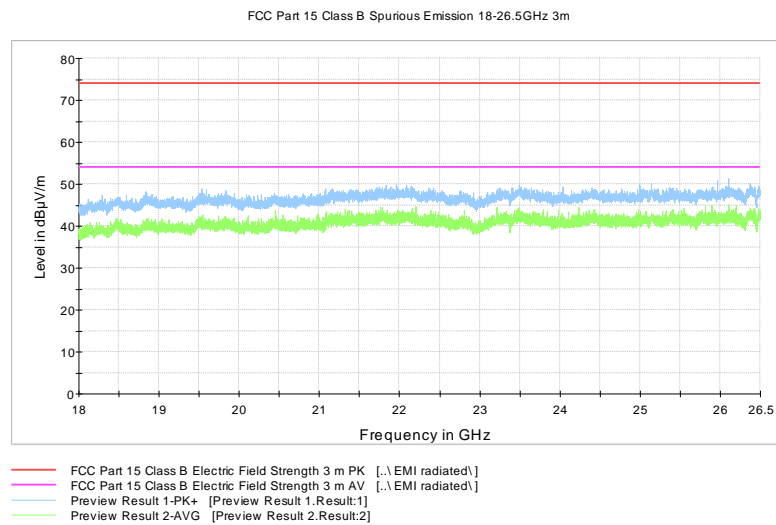
**Transmitter Radiated Spurious Emissions**



**Figure 24: Mid channel 1 GHz – 4 GHz (E)**



**Figure 25: Mid channel 4 GHz – 18 GHz (E)**



**Figure 26: Mid channel 18 GHz – 26.5 GHz (E)**

**Transmitter Radiated Spurious Emissions**

**Table 18:** Peak results (ch mid) (E)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
17781.80000	50.2	1000.0	1000.000	150.0	V	114.0	27.6	23.7	73.9

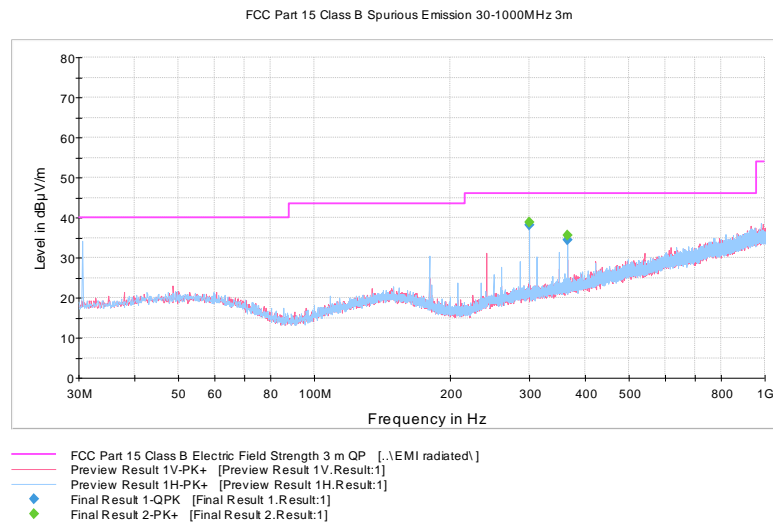
**Table 19:** Average results (ch mid) (E)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
16718.20000	36.7	1000.0	1000.000	400.0	V	220.0	26.5	17.2	53.9

**Table 20:** Quasi-peak results (ch mid) (E)

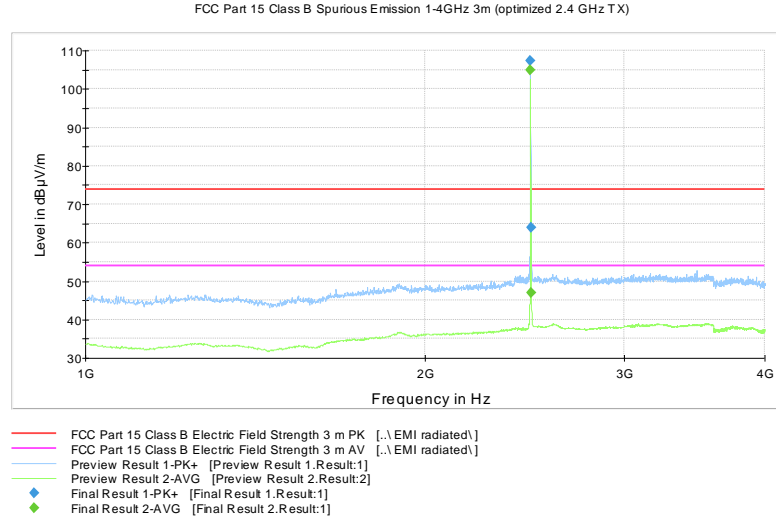
Frequency (MHz)	QuasiP (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
300.008000	38.1	1000.0	120.000	100.0	H	6.0	15.3	7.9	46.0

**High channel**



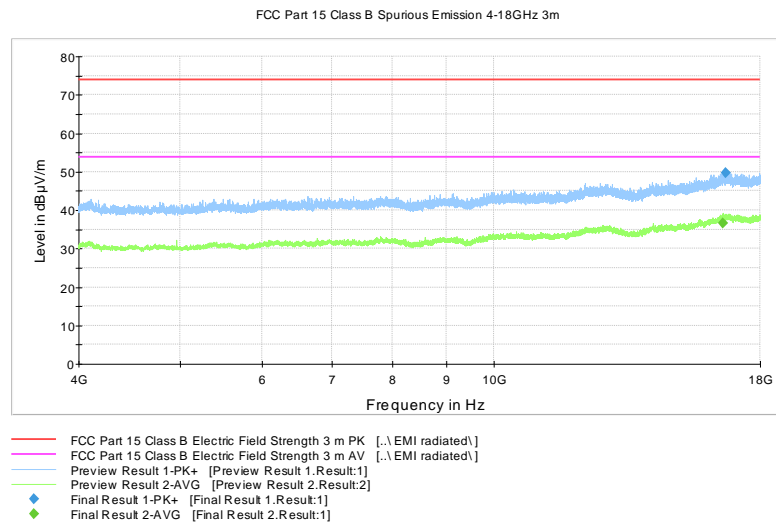
**Figure 27:** High channel 30 MHz – 1000 MHz (E)

**Transmitter Radiated Spurious Emissions**

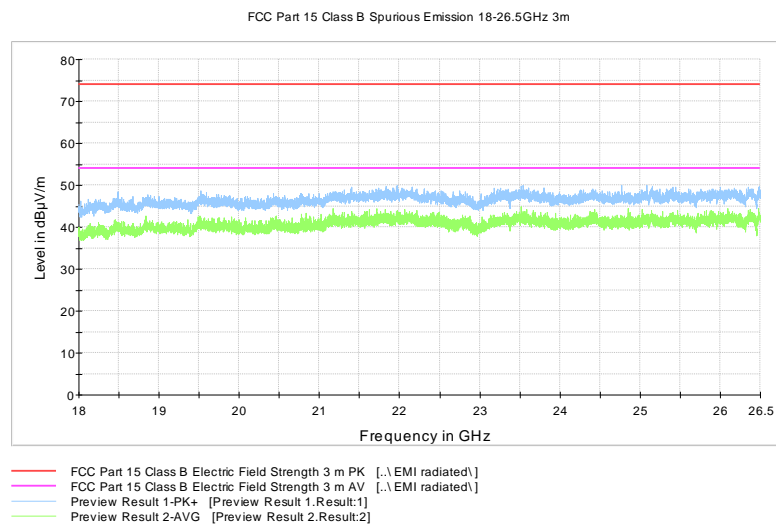


**Figure 28: High channel 1 GHz – 4 GHz (E)**

7



**Figure 29: High channel 4 GHz – 18 GHz (E)**



**Figure 30: High channel 18 GHz – 26.5 GHz (E)**

**Transmitter Radiated Spurious Emissions**
**Table 21:** Peak results (ch high) (E)

Frequency (MHz)	MaxPeak (dB $\mu$ V/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V/m)
2483.500000	63.8	1000.0	1000.000	268.0	V	0.0	14.7	10.1	73.9
16694.50000	49.6	1000.0	1000.000	284.0	V	161.0	26.4	24.3	73.9

**Table 22:** Average results (ch high) (E)

Frequency (MHz)	Average (dB $\mu$ V/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V/m)
2483.500000	47.0	1000.0	1000.000	241.0	V	325.0	14.7	6.9	53.9
16580.80000	36.6	1000.0	1000.000	400.0	V	307.0	26.2	17.3	53.9

**Table 23:** Quasi-peak results (ch mid) (E)

Frequency (MHz)	QuasiP (dB $\mu$ V/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V/m)
300.008000	38.1	1000.0	120.000	100.0	H	6.0	15.3	7.9	46.0
364.011000	34.4	1000.0	120.000	100.0	H	42.0	16.9	11.6	46.0

Radiated Band Edge results

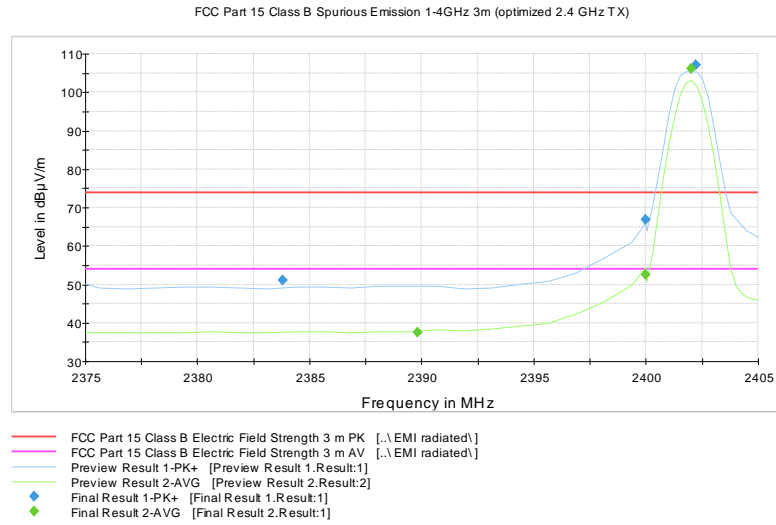


Figure 31: Radiated Band Edge measurement graph (ch low) (E)

Table 24: Peak results (ch low) (E)

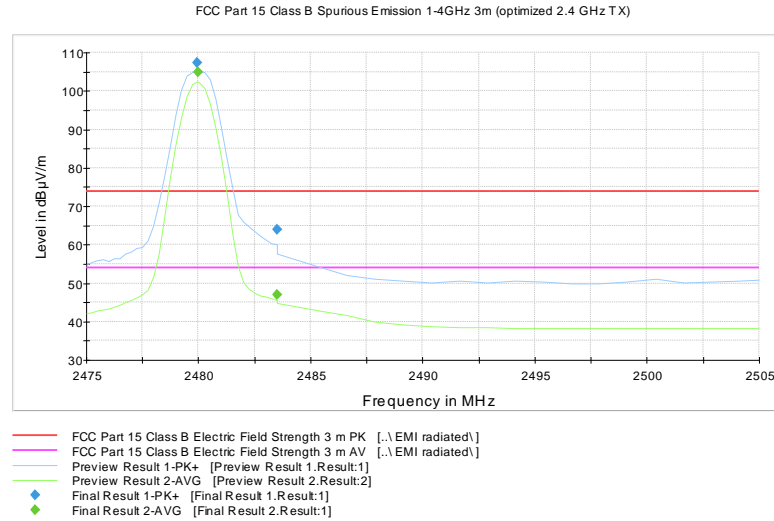
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2383.800000	51.1	1000.0	1000.000	379.0	H	33.0	14.5	22.8	73.9
2400.000000	66.8	1000.0	1000.000	236.0	V	291.0	14.7	20.2	87.0

Table 25: Average results (ch low) (E)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.800000	37.5	1000.0	1000.000	279.0	V	298.0	14.6	16.4	53.9
2400.000000	52.5	1000.0	1000.000	258.0	V	293.0	14.7	1.4	53.9



**Transmitter Radiated Spurious Emissions**



**Figure 32:** Radiated Band Edge measurement graph (ch high) (E)

**Table 26:** Peak results (ch high) (E)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	63.8	1000.0	1000.000	268.0	V	0.0	14.7	10.1	73.9

**Table 27:** Average results (ch high) (E)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	47.0	1000.0	1000.000	241.0	V	325.0	14.7	6.9	53.9

## Transmitter Band Edge Measurement and Conducted Spurious Emissions

<b>Standard:</b>	ANSI C63.10	(2013)
<b>Tested by:</b>	JAT	
<b>Date:</b>	23 November 2017	
<b>Temperature:</b>	23 ± 3 °C	
<b>Humidity:</b>	20 - 60 % RH	
<b>Measurement uncertainty:</b>	± 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 28:** Band edge attenuation

Band Edge Attenuation	
Lower Band Edge	Upper Band Edge
-47.14 dBc	-45.49 dBc
Limit: -20 dBc	

**Table 29:** Conducted spurious emissions (ch low)

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
752.70	-69.31	-11.39	-57.91	PASS
2399.85	-46.66	-11.39	-35.26	PASS
3739.72	-65.38	-11.39	-53.98	PASS
4804.40	-58.45	-11.39	-47.06	PASS
9198.23	-60.97	-11.39	-49.58	PASS
12498.13	-58.91	-11.39	-47.52	PASS
15806.83	-57.11	-11.39	-45.71	PASS
16152.76	-54.93	-11.39	-43.54	PASS
19833.27	-56.28	-11.39	-44.89	PASS
24441.31	-56.22	-11.39	-44.82	PASS
25422.92	-55.45	-11.39	-44.05	PASS

**Transmitter Band Edge Measurement and Conducted Spurious Emissions**

**Table 30:** Conducted spurious emissions (ch mid)

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
945.85	-69.02	-11.85	-57.17	PASS
1780.15	-54.29	-11.85	-42.44	PASS
3759.52	-65.00	-11.85	-53.15	PASS
4879.49	-58.81	-11.85	-46.96	PASS
7509.00	-61.17	-11.85	-49.32	PASS
12877.43	-58.84	-11.85	-46.99	PASS
15836.36	-57.11	-11.85	-45.26	PASS
16304.91	-55.24	-11.85	-43.39	PASS
19159.32	-56.79	-11.85	-44.94	PASS
24455.28	-56.77	-11.85	-44.92	PASS
25870.09	-55.96	-11.85	-44.11	PASS

**Table 31:** Conducted spurious emissions (ch high)

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
789.74	-69.24	-12.11	-57.13	PASS
2331.34	-67.65	-12.11	-55.54	PASS
2483.86	-51.16	-12.11	-39.05	PASS
4960.39	-58.02	-12.11	-45.92	PASS
8481.72	-59.48	-12.11	-47.37	PASS
12442.06	-59.10	-12.11	-46.99	PASS
15531.59	-56.70	-12.11	-44.59	PASS
17752.93	-55.55	-12.11	-43.44	PASS
19161.95	-56.35	-12.11	-44.24	PASS
24143.67	-56.43	-12.11	-44.32	PASS
26203.83	-54.92	-12.11	-42.82	PASS

## Transmitter Band Edge Measurement and Conducted Spurious Emissions

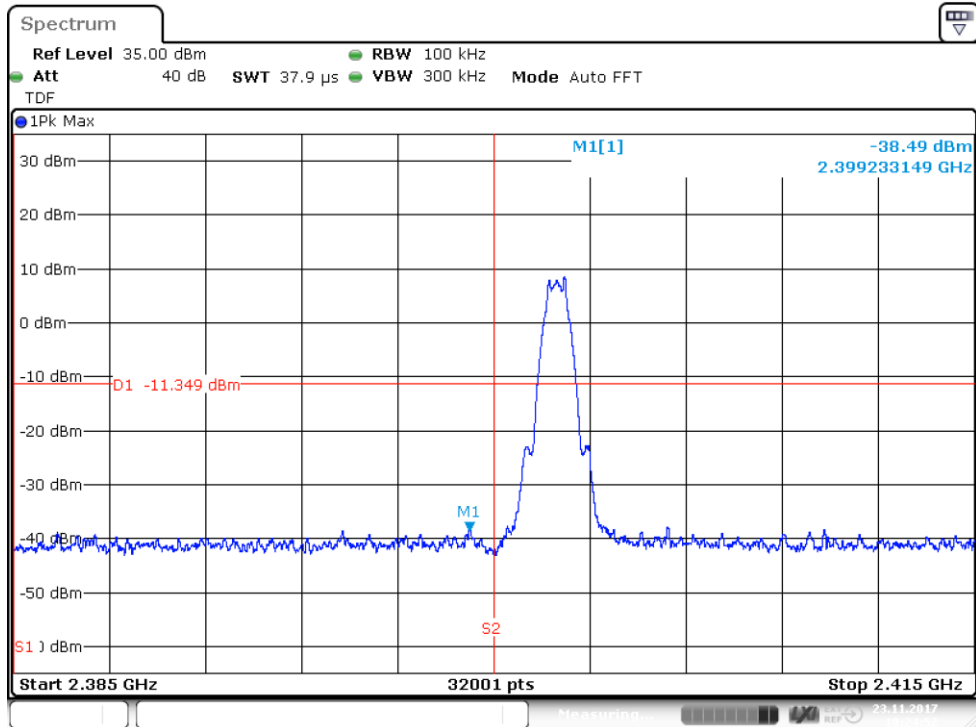


Figure 33: Lower Band Edge

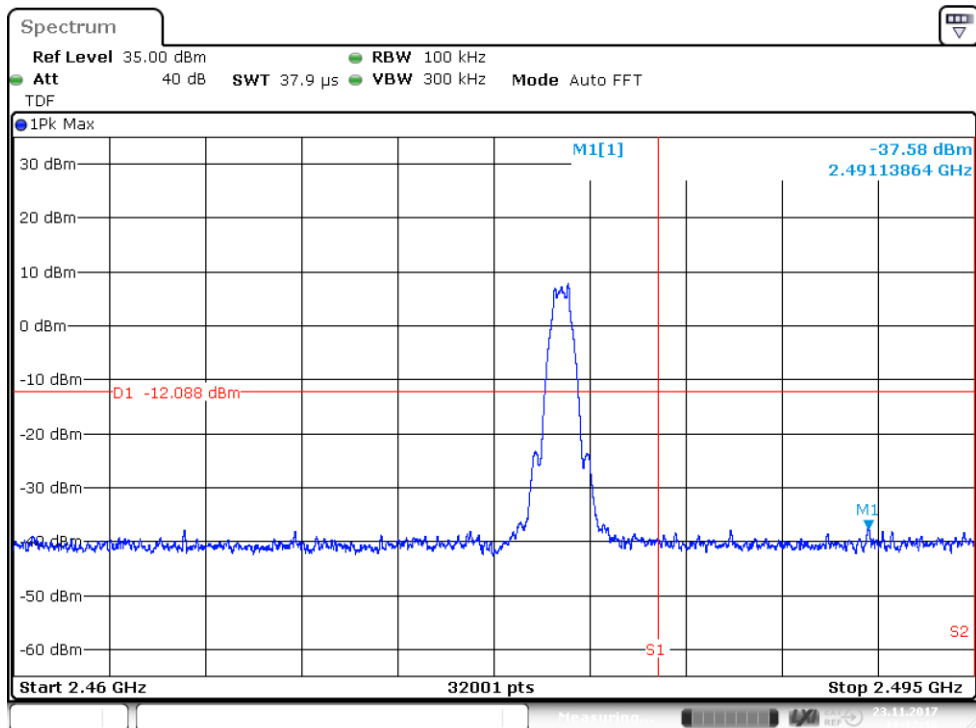
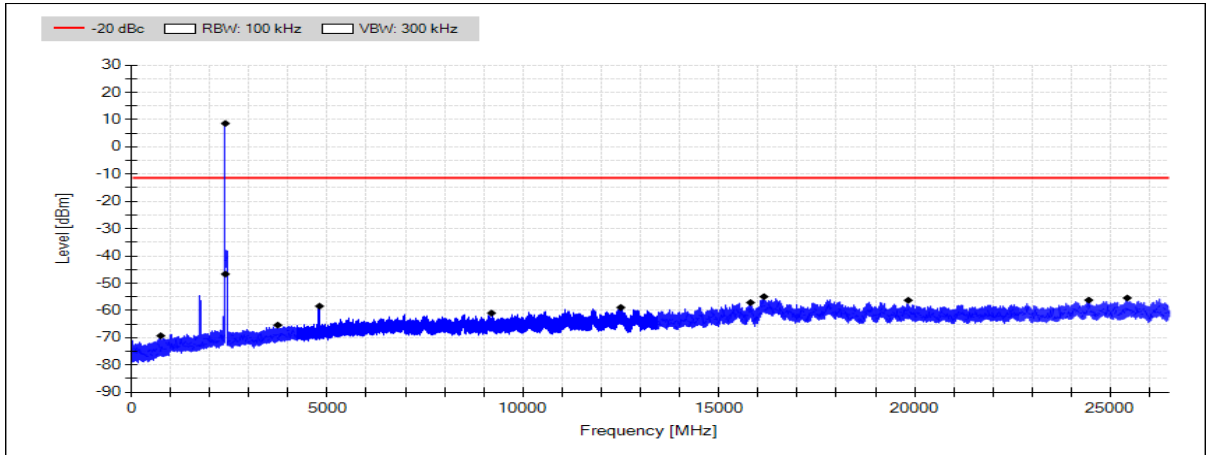
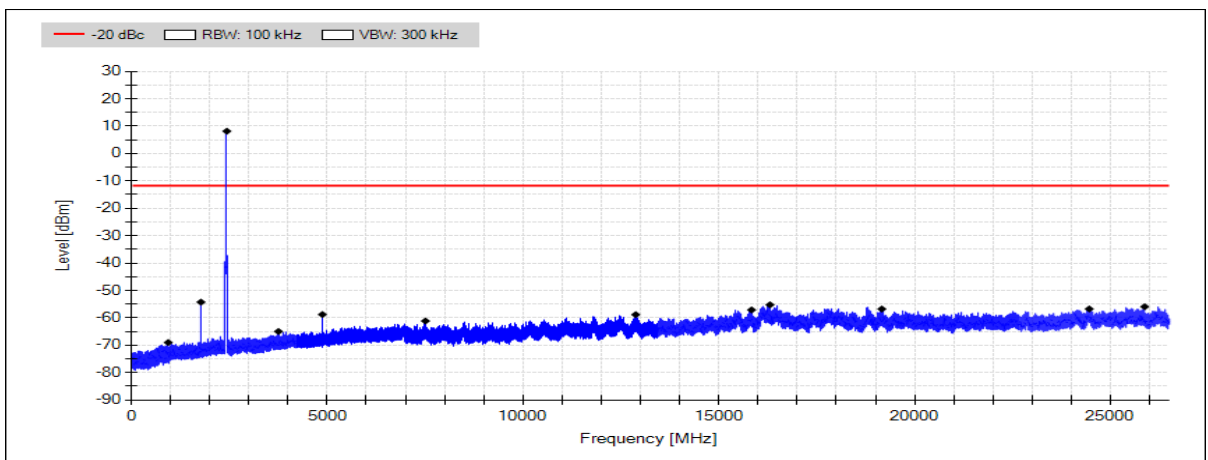


Figure 34: Upper Band Edge

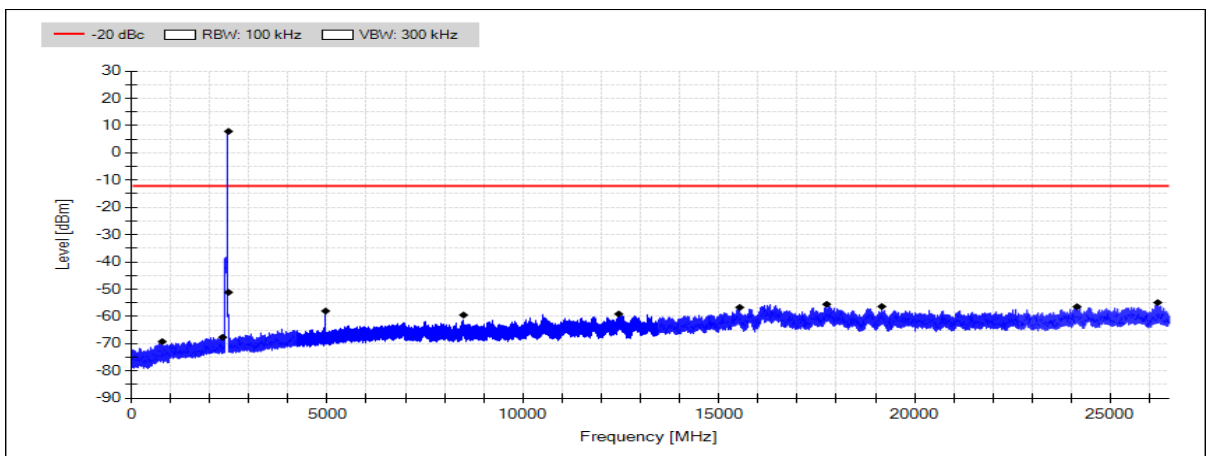
**Transmitter Band Edge Measurement and Conducted Spurious Emissions**



**Figure 35:** Conducted spurious emissions 30 - 26500 MHz channel low



**Figure 36:** Conducted spurious emissions 30 - 26500 MHz channel mid



**Figure 37:** Conducted spurious emissions 30 - 26500 MHz channel high

### 6 dB Bandwidth of the Channel

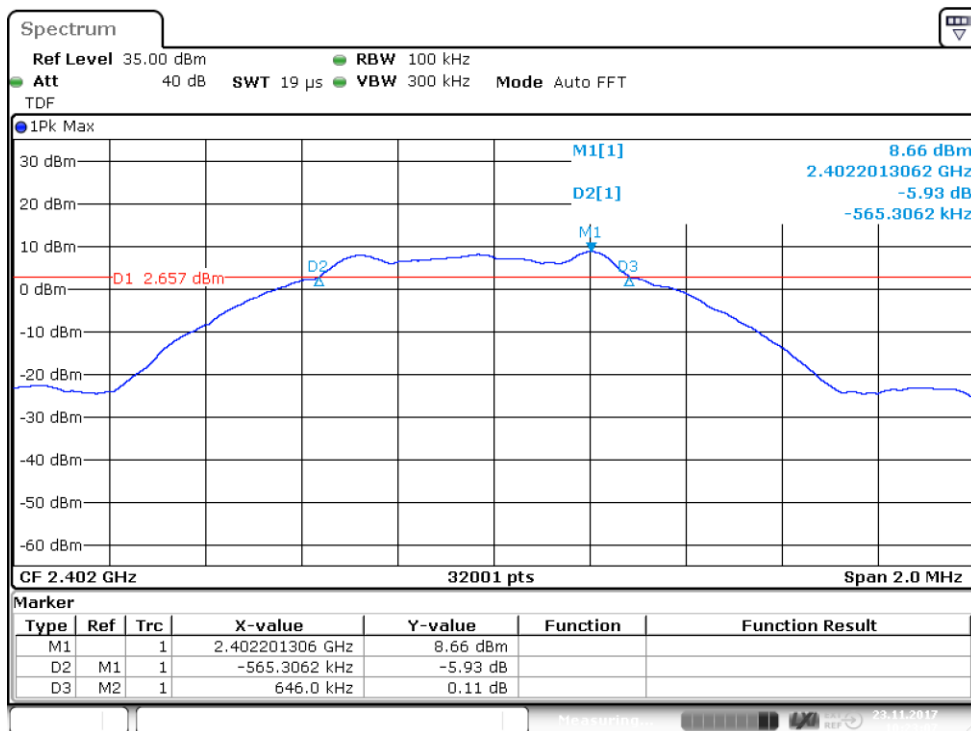
**Standard:** ANSI C63.10 (2013)  
**Tested by:** JAT  
**Date:** 23 November 2017  
**Temperature:** 23 ± 3 °C  
**Humidity:** 20 - 60 % RH

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

**Results:**

**Table 32:** 6 dB bandwidth test results

Channel	6 dB BW [kHz]	Minimum limit [kHz]
Low	646.0	500
Mid	651.0	
High	647.0	



**Figure 38:** 6 dB bandwidth (ch low)

## 6 dB Bandwidth of the Channel

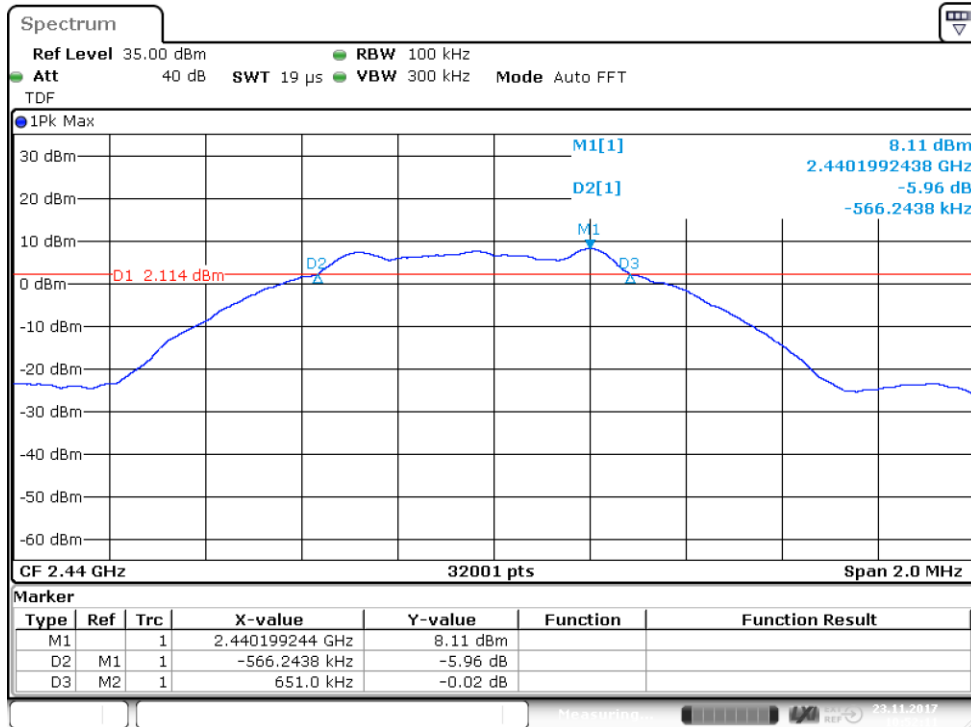


Figure 39: 6 dB bandwidth (ch mid)

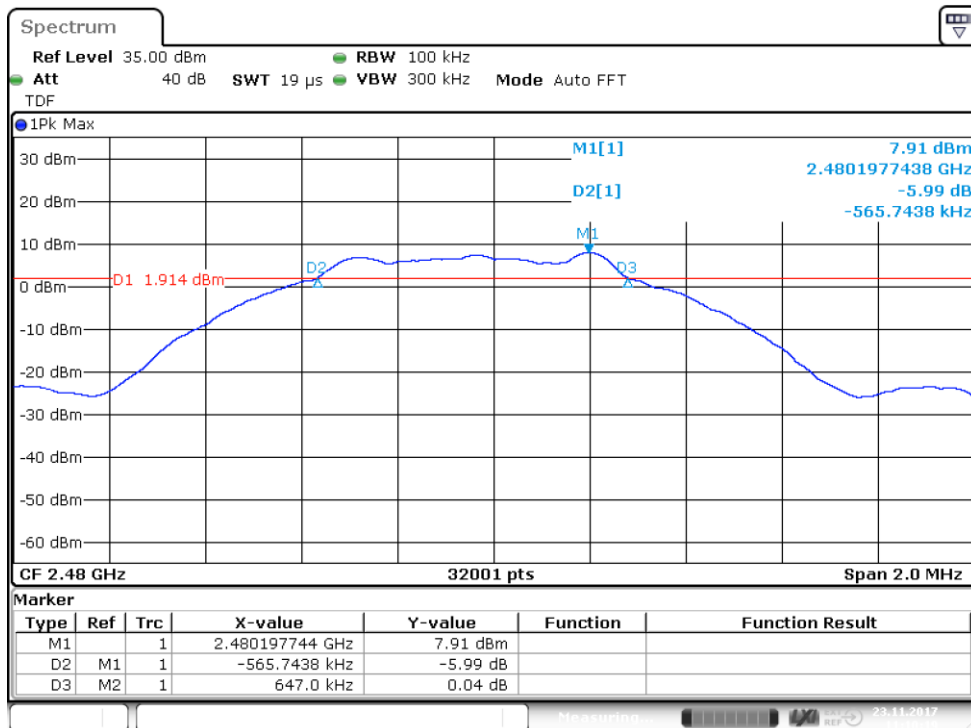


Figure 40: 6 dB bandwidth (ch high)

## Power Spectral Density

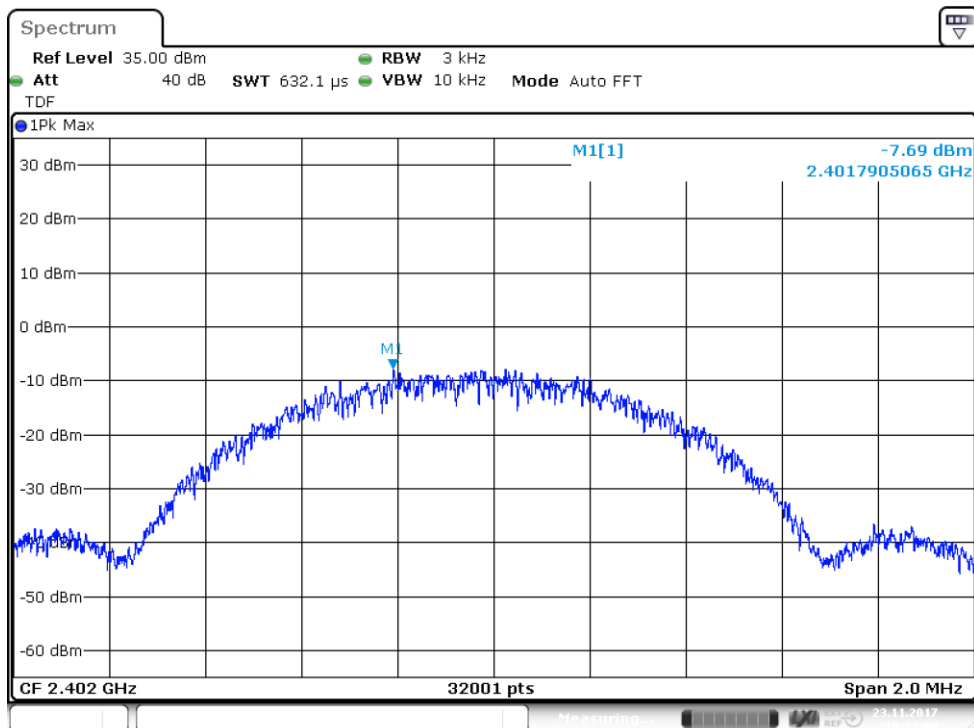
**Standard:** ANSI C63.10 (2013)  
**Tested by:** JAT  
**Date:** 23 November 2017  
**Temperature:** 23 ± 3 °C  
**Humidity:** 20 - 60 % RH

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

### Results:

**Table 33:** Power spectral density test results

Channel	PSD dBm/3 kHz	Maximum limit [dBm/3kHz]
Low	-7.69	+8.00
Mid	-8.24	
High	-8.46	



**Figure 41:** Power spectral density (ch low)



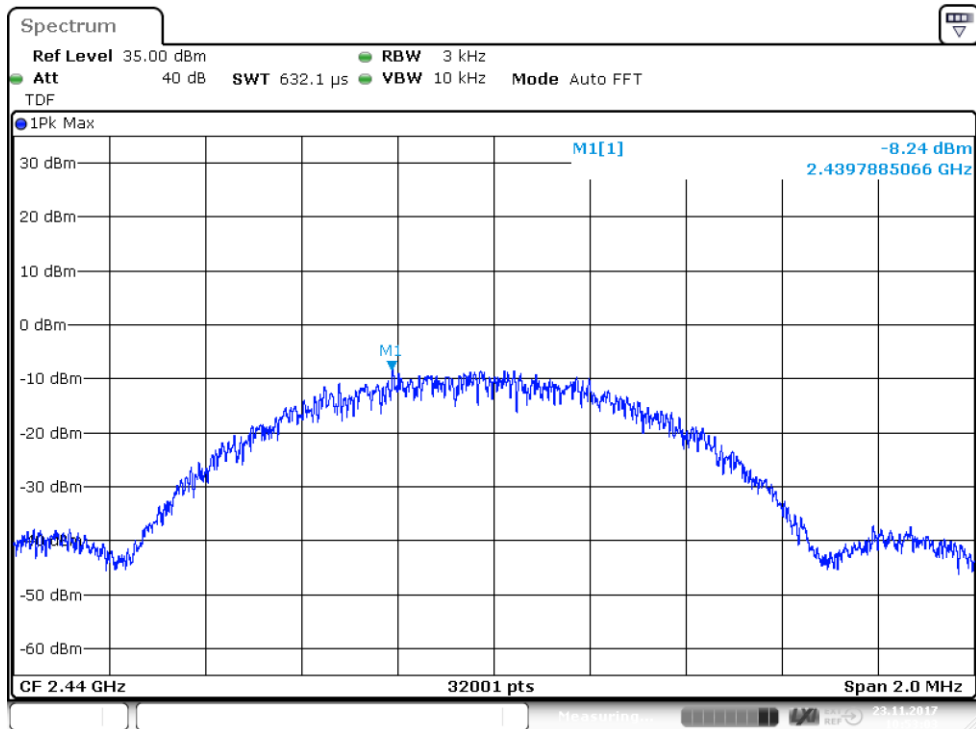


Figure 42: Power spectral density (ch mid)

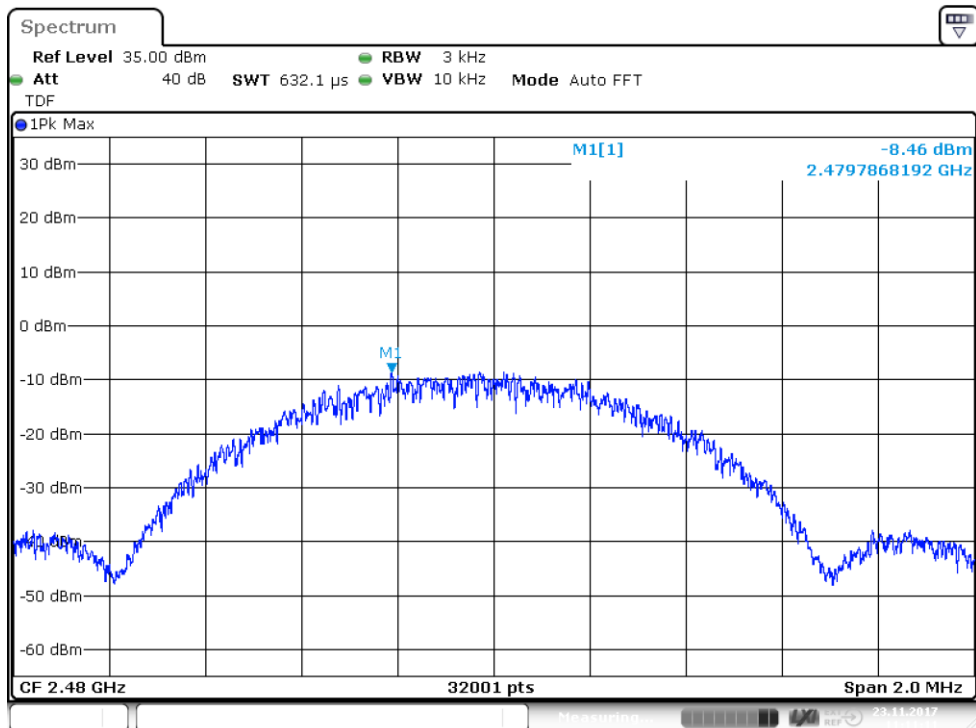


Figure 43: Power spectral density (ch high)

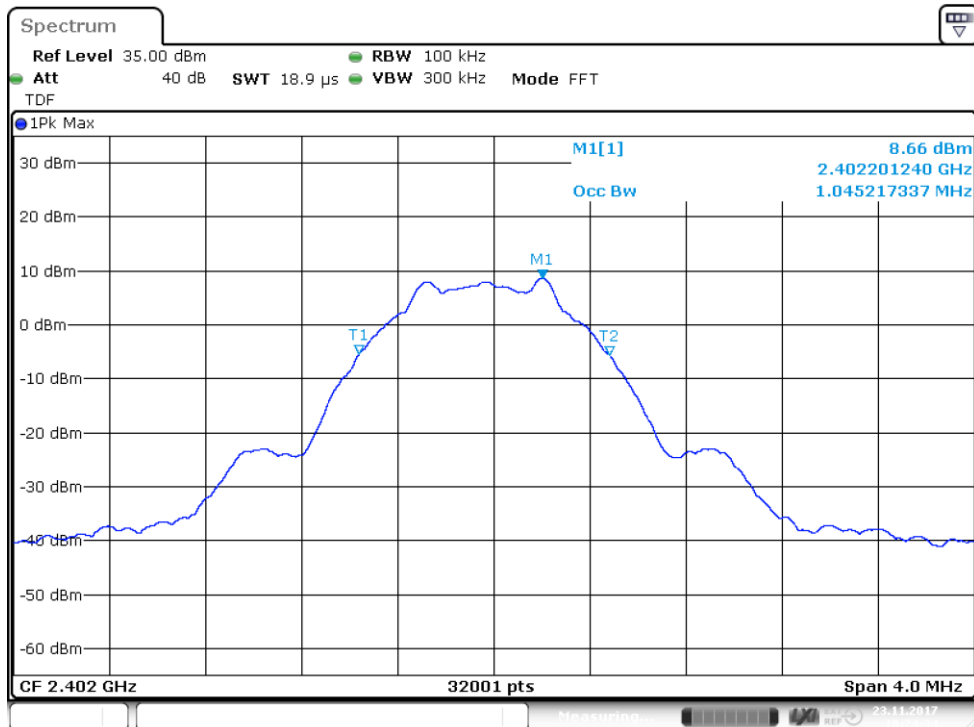
### 99% Occupied Bandwidth

**Standard:** RSS-GEN (2014)  
**Tested by:** JAT  
**Date:** 23 November 2017  
**Temperature:** 23 ± 3 °C  
**Humidity:** 20 - 60 % RH

#### RSS-GEN 6.6

**Table 34:** 99% occupied bandwidth test results

Channel	Limit	99 % BW [MHz]	Result
Low	-	1.045217337	PASS
Mid	-	1.043842380	PASS
High	-	1.049342208	PASS



**Figure 44:** 99% OBW (ch low)

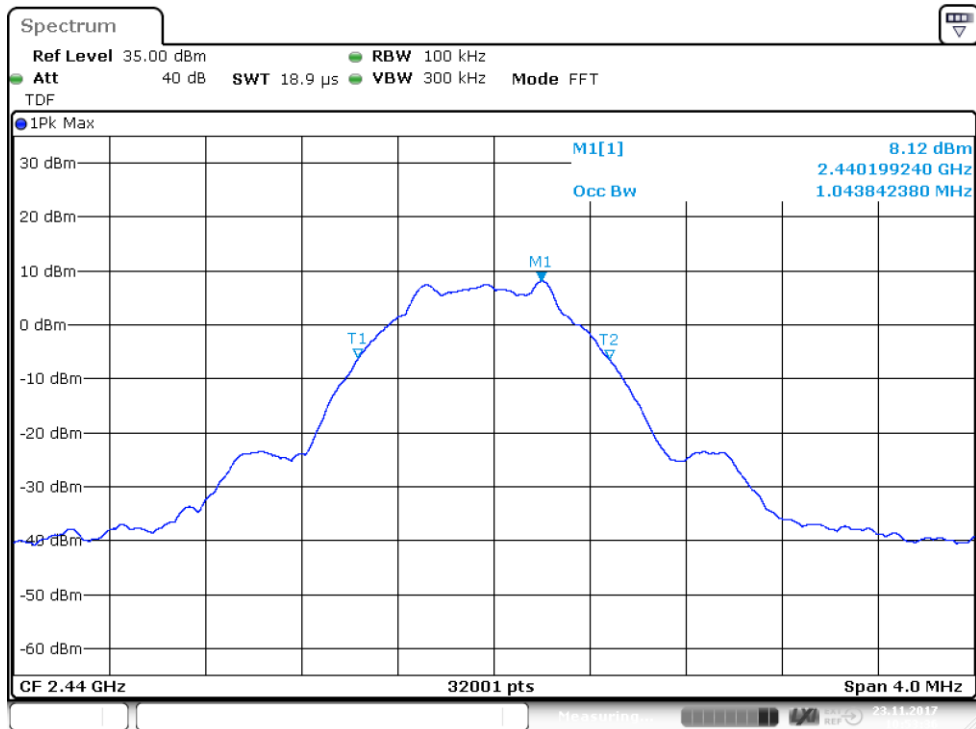


Figure 45: 99% OBW (ch mid)

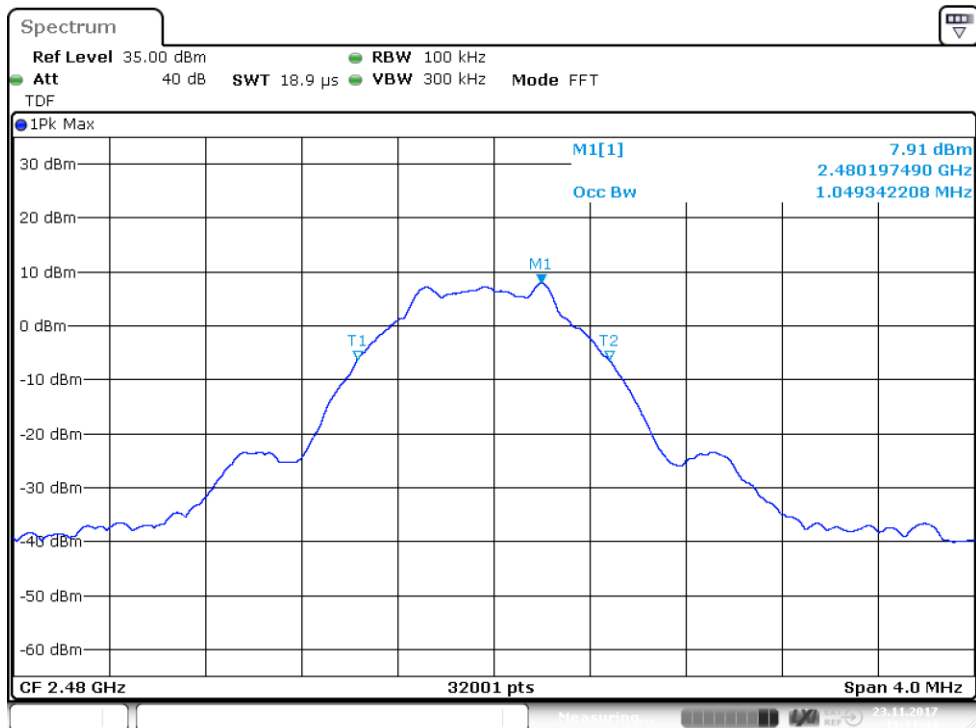


Figure 46: 99% OBW (ch high)

## 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	PASTERNAK	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