



Test Report



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

Equipment Under Test:	Multi-Protocol Wireless Module
Model:	MGM13S12N MGM13S12A MGM13S02N MGM13S02A
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: 2017
IC Rule Part:	RSS-247, Issue 2, 2017 RSS-GEN Issue 5, 2018
KDB:	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 (August 24, 2018)

Date: 17 October 2018
Issued by: 
Mikko Halonen
Testing Engineer

Date: 17 October 2018
Checked by: 
Rauno Repo
Testing Engineer

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Equipment Under Test (EUT)

Trade mark:	Silicon Labs
Model:	MGM13S12N, MGM13S12A, MGM13S02N, MGM13S02A
Type:	Multi-Protocol Wireless Module
Serial no:	-
FCC ID:	QOQ13
IC:	5123A-13

Description of the EUT

MGM13S is a multi-protocol wireless module with two antenna variants. Variant A is equipped with chip antenna while the N variant has RF pin for the use of external antenna.

This test report contains test results for ZigBee.

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"/>

Ratings and declarations

Operating Frequency Range (OFR):	2405 - 2480 MHz
Channels:	16
Channel separation:	5 MHz
Effective conducted power:	18.38 dBm (Peak)
Modulation:	OQPSK
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

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/module was supplied with laboratory power supply.

- MGM13S12N, MGM13S02N: tested with 3.3V regulated by the development board
- MGM13S12A: tested with 3.3V powered by laboratory power supply

Mechanical Size of the EUT

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

Samples

EUT	Description
1. MGM13S12N	Original N variant, equipped with RF pin for the use of external antenna.
2. MGM13S12A	Original A variant, equipped with chip antenna
3. MGM13S02N	Original N variant, equipped with RF pin for the use of external antenna.
4. MGM13S02A	Original A variant, equipped with chip 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. EUT was configured into the wanted channel using software provided by the manufacturer.

During conducted measurements, the EUT was connected to WSTK development board.

During radiated measurements, N variant was connected to WSTK development board and the A variant was tested without development board.

Following channels and settings were used during the tests;

EUT 1. MGM13S12N

- Conducted Emissions on Power Supply Lines tests (channel: 19)
- Maximum Peak Conducted Output Power (channels: 11, 19, 25, 26)
- 6 dB Bandwidth (channels: 11, 19, 25, 26)
- Power Spectral Density (channels: 11, 19, 25, 26)
- 99% Occupied Bandwidth (channels: 11, 19, 25, 26)
- 100 kHz Bandwidth of Frequency Band Edges and Conducted Spurious Emissions tests (channels: 11, 19, 25, 26)
- Radiated Emissions Within the Restricted Bands (channels: 11, 19, 25, 26), Channel 26 was used only for band edge measurement.

Channel	Frequency (MHz)	Power setting
11	2405	200
19	2445	200
25	2475	200
26	2480	160

EUT 2. MGM13S12A

- Conducted Emissions on Power Supply Lines tests (channel 19)
- Radiated Emissions Within the Restricted Bands (channels: 11, 19, 26)

Channel	Frequency (MHz)	Power setting
11	2405	200
19	2445	200
26	2480	200

EUT 3. MGM13S02N

- Maximum Peak Conducted Output Power (channels: 11, 19, 26)
- 6 dB Bandwidth (channels: 11, 19, 26)
- 99% Occupied Bandwidth (channels: 11, 19, 26)

Channel	Frequency (MHz)	Power setting
11	2405	200
19	2445	200
26	2480	200

Test Facility

Testing Laboratory / address: FCC registration number: 904175	SGS Fimko Ltd Särkiniementie 3 FI-00210, HELSINKI FINLAND
Test Site:	<input type="checkbox"/> Kara 10, ISED Canada registration number: 8708A-1 <input checked="" type="checkbox"/> Kara 5, ISED Canada registration number: 8708A-2 <input type="checkbox"/> Laru 3 <input type="checkbox"/> Kallio 10

TEST RESULTS

Conducted Emissions In The Frequency Range 150 kHz - 30 MHz

Standard: ANSI C63.10 (2013)
Tested by: MIH
Date: 21 March 2018
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.

Conducted Emissions on Power Supply Lines

Final measurements from the worst frequencies

Conducted Emission Mains FCC Part 15 Class B with ENV216

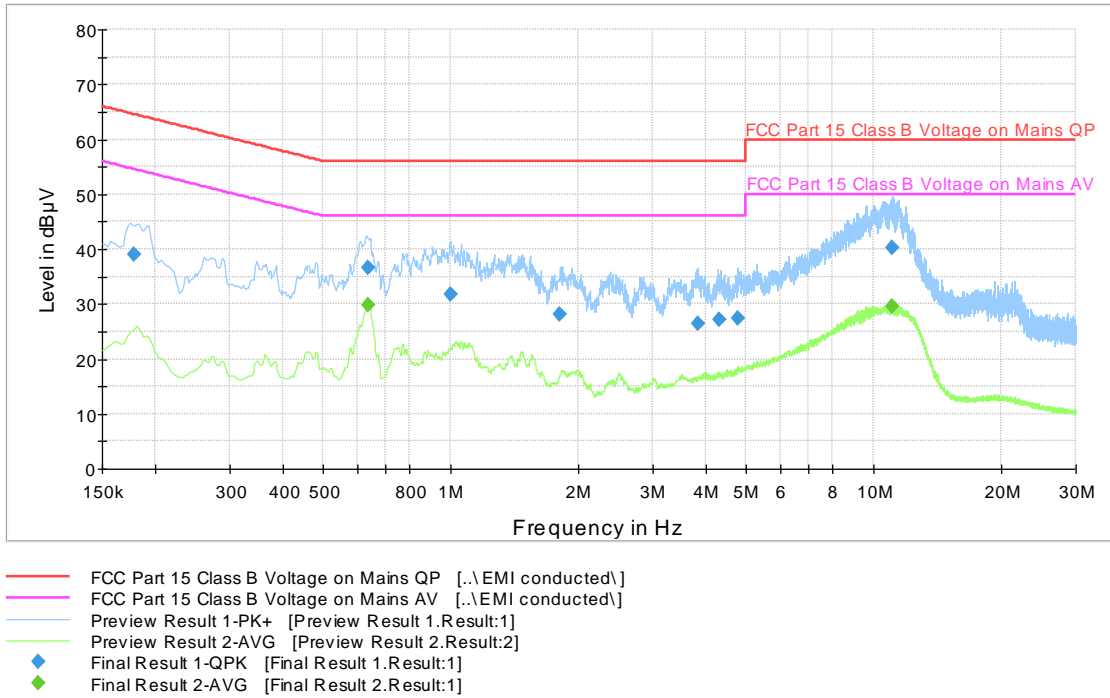


Figure 1: The measured curves with peak- and average detector (EUT 1, MGM13S12N).

Table 1: Final QuasiPeak measurements from the worst frequencies (EUT 1, MGM13S12N)

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.178250	38.9	1000.0	9.000	L1	10.2	25.6	64.6
0.639250	36.5	1000.0	9.000	L1	10.1	19.5	56.0
0.997500	31.7	1000.0	9.000	N	10.3	24.3	56.0
1.814250	28.2	1000.0	9.000	N	10.4	27.8	56.0
3.826750	26.5	1000.0	9.000	N	10.4	29.5	56.0
4.307500	27.1	1000.0	9.000	N	10.4	28.9	56.0
4.763000	27.3	1000.0	9.000	N	10.4	28.7	56.0
11.022250	40.1	1000.0	9.000	N	10.6	19.9	60.0

Table 2: Final Average measurements from the worst frequencies (EUT 1, MGM13S12N)

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.637500	29.7	1000.0	9.000	N	10.3	16.3	46.0
11.048250	29.5	1000.0	9.000	L1	10.3	20.5	50.0

Conducted Emissions on Power Supply Lines

Conducted Emission Mains FCC Part 15 Class B with ENV216

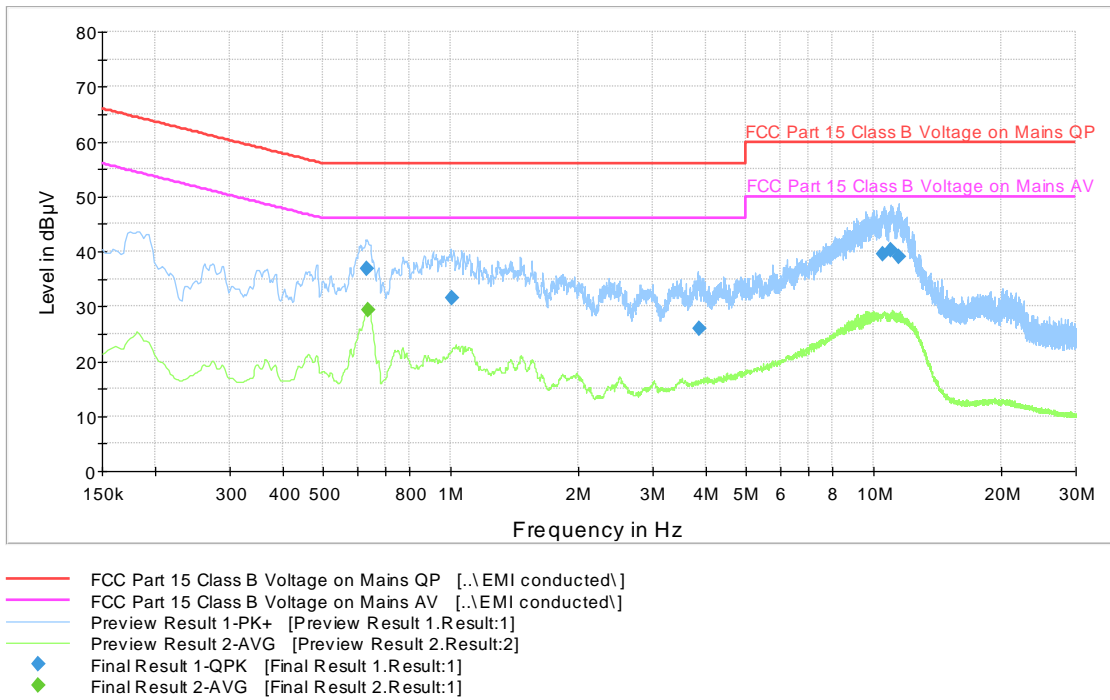


Figure 2: The measured curves with peak- and average detector (EUT 2, MGM13S12A).

Table 3: Final QuasiPeak measurements from the worst frequencies (EUT 2, MGM13S12A)

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.634750	36.7	1000.0	9.000	N	10.3	19.3	56.0
1.005500	31.6	1000.0	9.000	N	10.3	24.4	56.0
3.855250	26.0	1000.0	9.000	N	10.4	30.0	56.0
10.535750	39.6	1000.0	9.000	N	10.6	20.4	60.0
10.938250	40.3	1000.0	9.000	N	10.6	19.7	60.0
11.461250	39.1	1000.0	9.000	N	10.6	20.9	60.0

Table 4: Final Average measurements from the worst frequencies (EUT 2, MGM13S12A)

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.637500	29.4	1000.0	9.000	N	10.3	16.6	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 MIH
Date: 2 - 20 March 2018 17 October 2018
Temperature: 23 ± 3 °C
Humidity: 16 - 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 1, MGM13S12N)

Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
11 Low	18.38	30	11.62	PASS
19 Mid	18.29	30	11.71	PASS
25 High	17.83	30	12.17	PASS
26 High	13.77	30	16.23	PASS

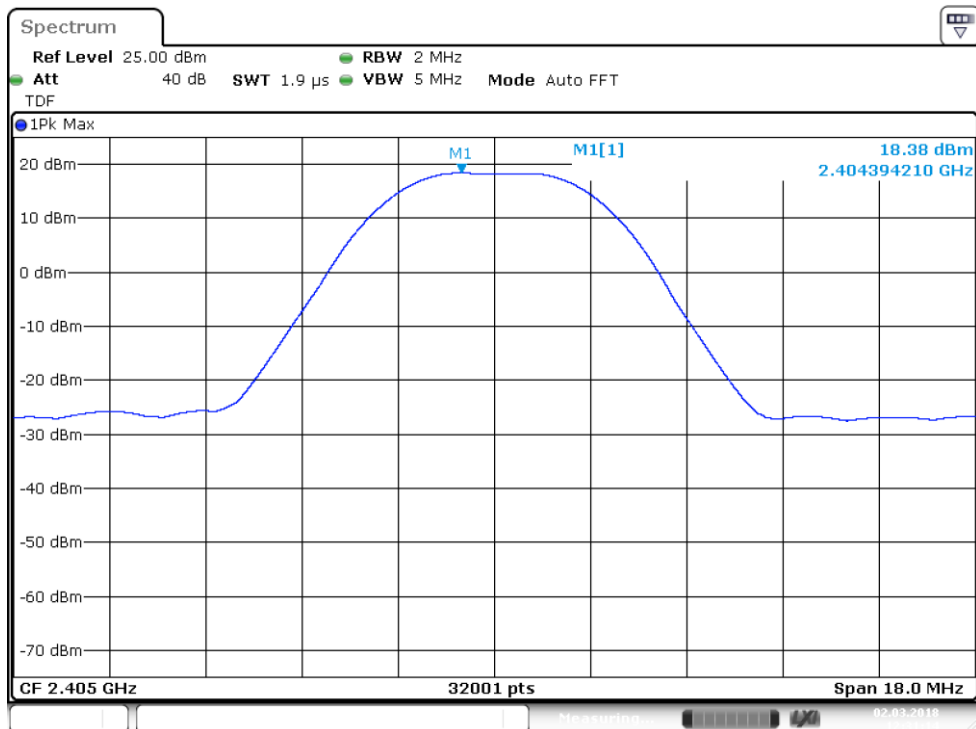


Figure 3: Conducted power, Channel 11 low (EUT 1, MGM13S12N)

Maximum Peak Conducted Output Power

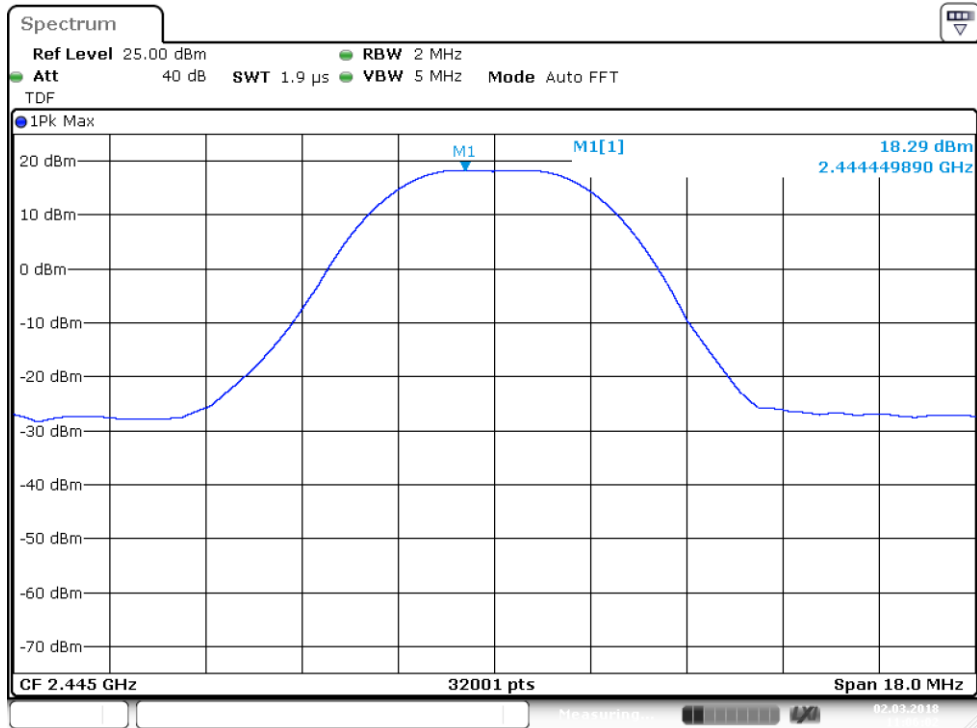


Figure 4: Conducted power, Channel 19 mid (EUT 1, MGM13S12N)

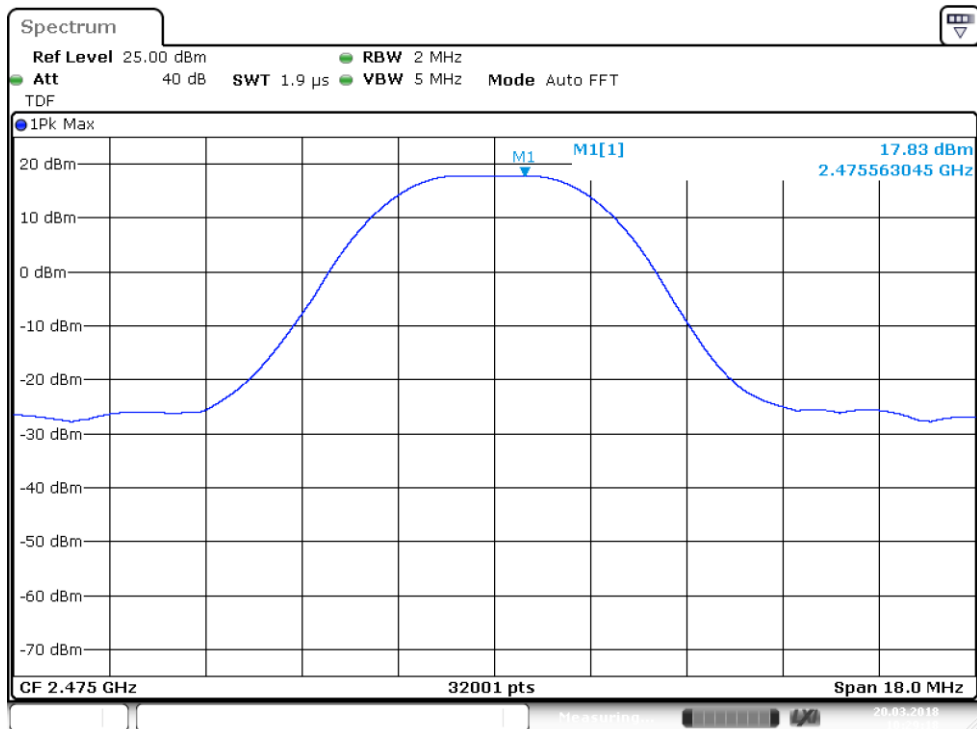


Figure 5: Conducted power, Channel 25 high (EUT 1, MGM13S12N)

Maximum Peak Conducted Output Power

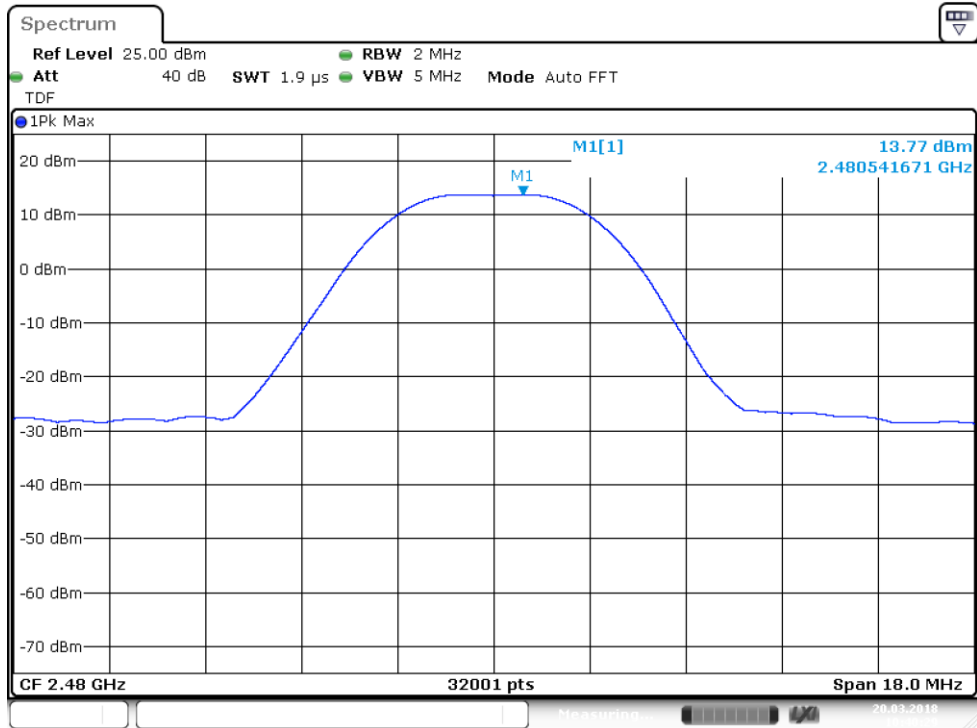


Figure 6: Conducted power, Channel 26 high (EUT 1, MGM13S12N)

Maximum Peak Conducted Output Power

Table 6: Maximum conducted output power (EUT 3, MGM13S02N)

Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
11 Low	10.12	30	19.88	PASS
19 Mid	9.99	30	20.01	PASS
26 High	10.14	30	19.86	PASS

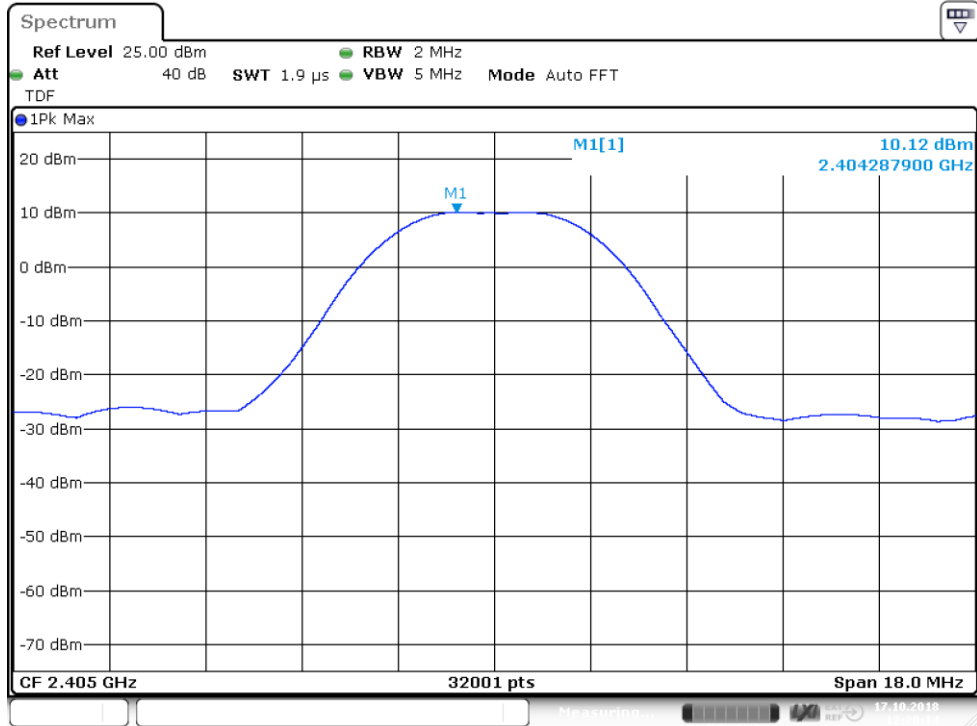


Figure 7: Conducted power, Channel 11 low (EUT 3, MGM13S02N)

Maximum Peak Conducted Output Power

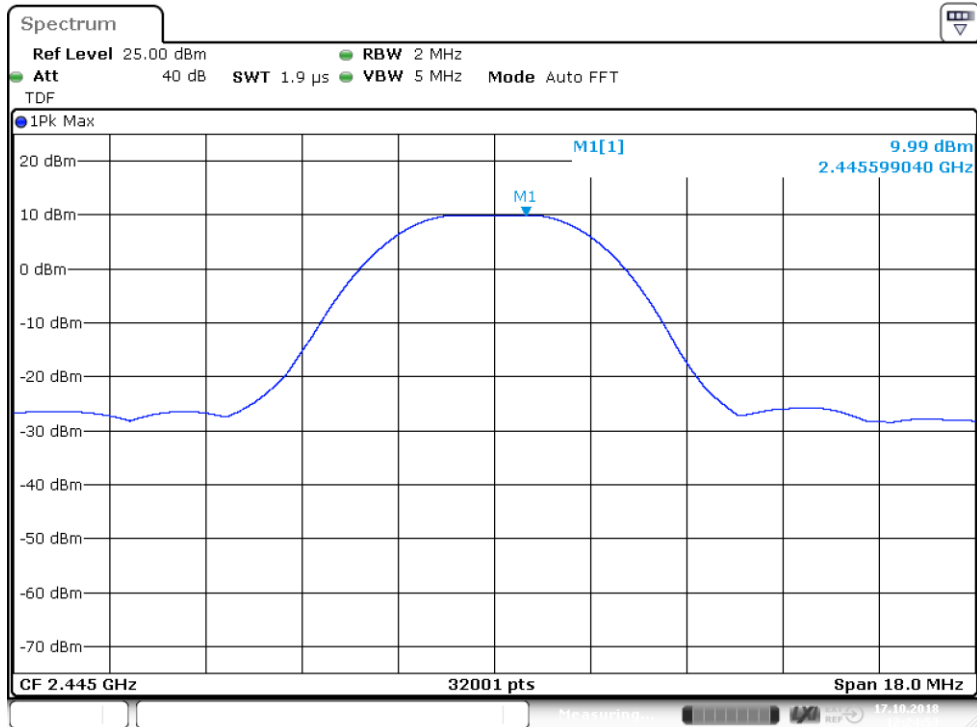


Figure 8: Conducted power, Channel 19 mid (EUT 3, MGM13S02N)

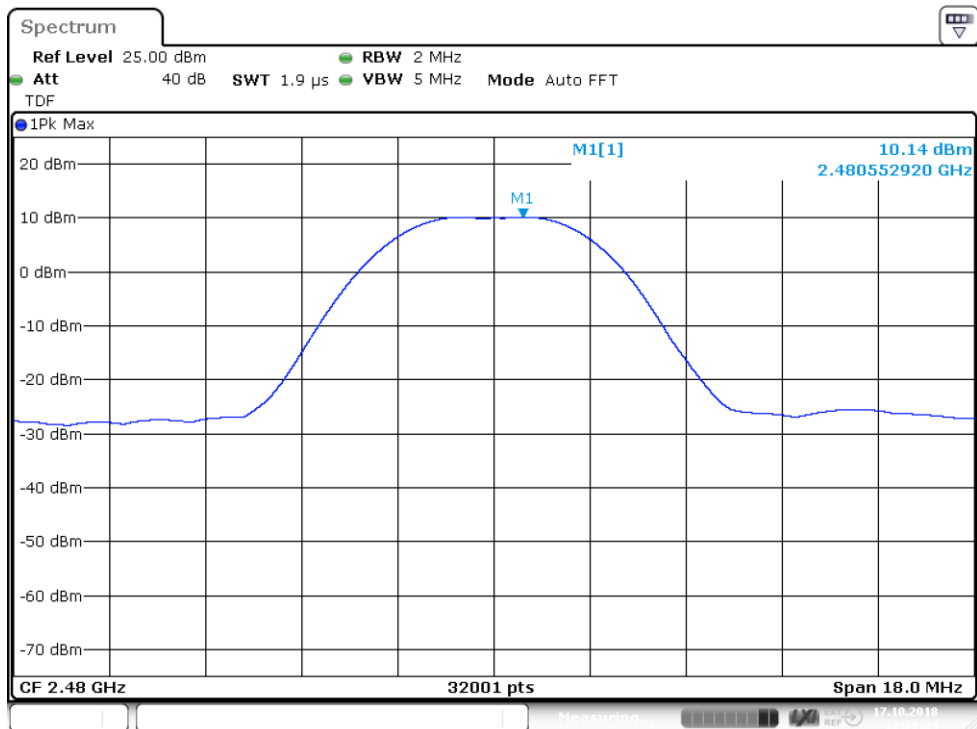


Figure 9: Conducted power, Channel 26 high (EUT 3, MGM13S02N)

Transmitter Radiated Spurious Emissions 30 - 26500 MHz

Standard: ANSI C63.10 (2013)
Tested by: JAT
Date: 2 - 21 March 2018
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 [$\mu\text{V}/\text{m}$]	Limit [$\text{dB}\mu\text{V}/\text{m}$]	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 (11)

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m

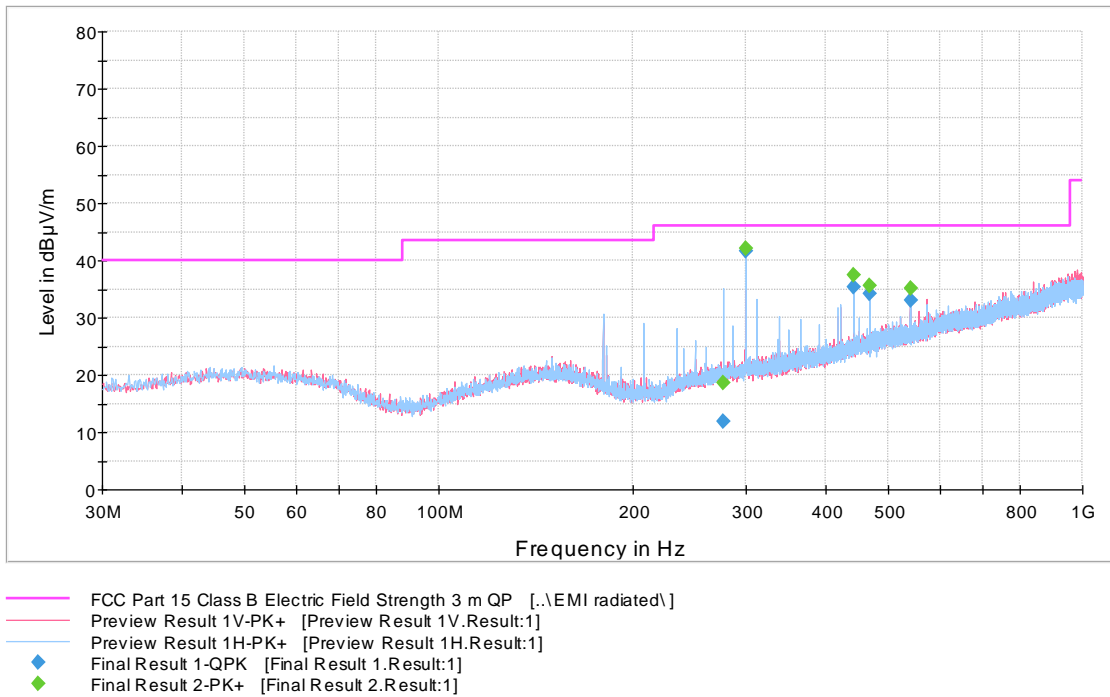


Figure 10: Channel 11 low 30 MHz – 1000 MHz (EUT 1, MGM13S12N)

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

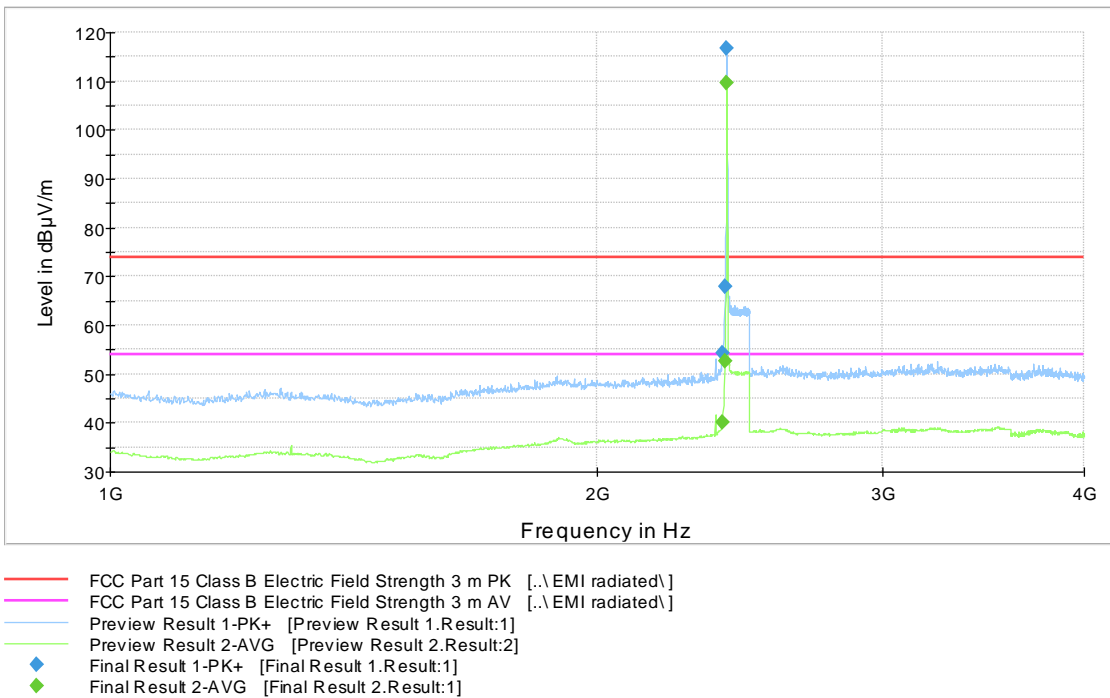


Figure 11: Channel 11 low 1 GHz – 4 GHz (EUT 1, MGM13S12N)

Transmitter Radiated Spurious Emissions

FCC Part 15 Class B Spurious Emission 4-18GHz 3m

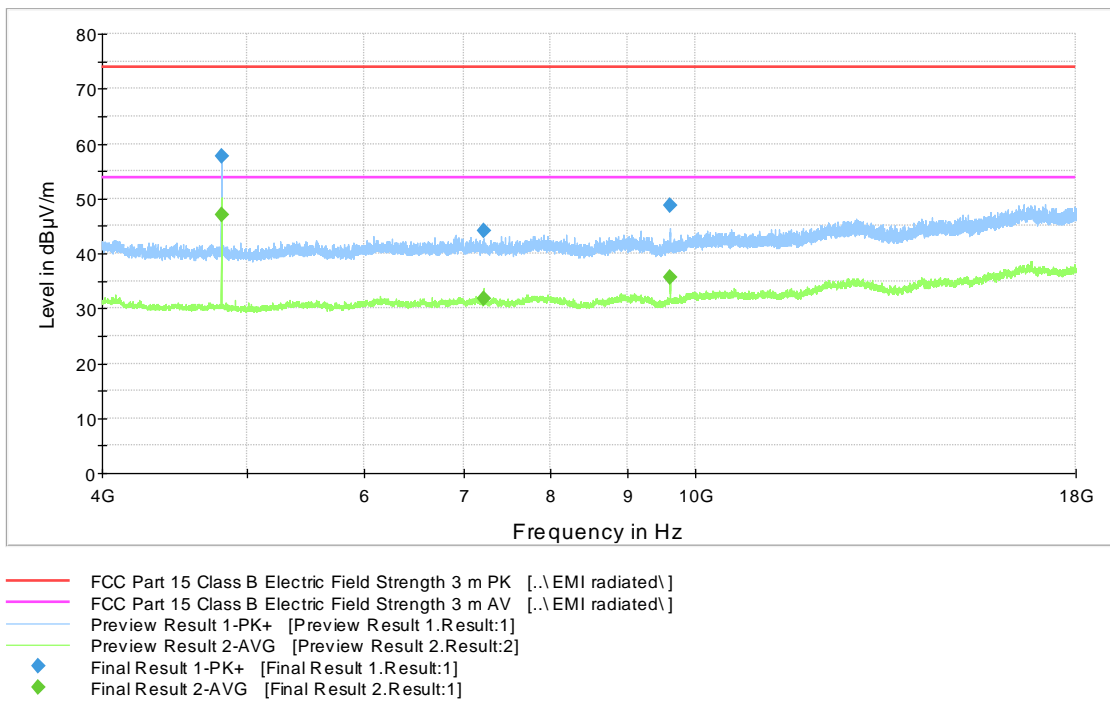


Figure 12: Channel 11 low 4 GHz – 18 GHz (EUT 1, MGM13S12N)

FCC Part 15 Class B Spurious Emission 18-26.5GHz 3m

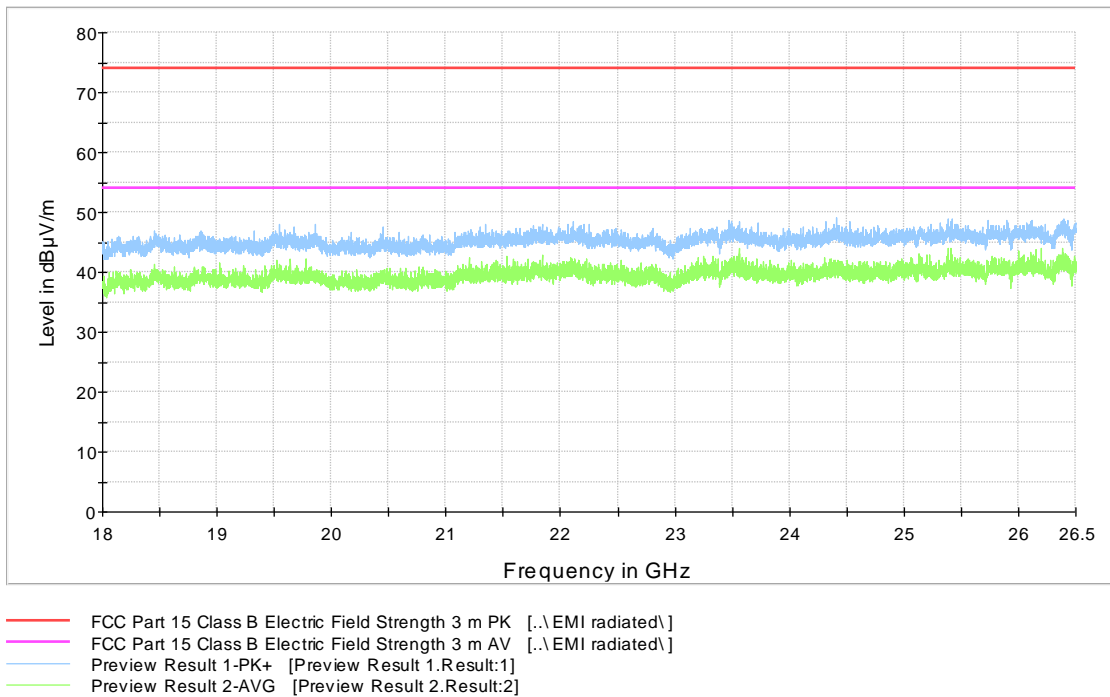


Figure 13: Channel 11 low 18 GHz – 26.5 GHz (EUT 1, MGM13S12N)

Transmitter Radiated Spurious Emissions

Table 7: Peak results, Channel 11 low (EUT 1, MGM13S12N)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.800000	54.3	1000.0	1000.000	150.0	V	242.0	14.6	19.6	73.9
2400.000000	67.9	1000.0	1000.000	219.0	V	235.0	14.7	6.0	73.9
4809.900000	57.7	1000.0	1000.000	179.0	V	192.0	8.3	16.2	73.9
7217.100000	44.1	1000.0	1000.000	150.0	V	161.0	12.1	29.8	73.9
9621.800000	48.6	1000.0	1000.000	150.0	H	209.0	15.7	25.3	73.9

Table 8: Average results, Channel 11 low (EUT 1, MGM13S12N)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.800000	40.1	1000.0	1000.000	190.0	V	233.0	14.6	13.8	53.9
2400.000000	52.7	1000.0	1000.000	210.0	V	235.0	14.7	1.2	53.9
4811.000000	47.1	1000.0	1000.000	166.0	V	192.0	8.3	6.8	53.9
7216.600000	31.8	1000.0	1000.000	150.0	V	168.0	12.1	22.1	53.9
9622.100000	35.6	1000.0	1000.000	150.0	H	208.0	15.7	18.3	53.9

Table 9: Quasi-peak results, Channel 11 low (EUT 1, MGM13S12N)

Frequency (MHz)	QuasiP (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
276.785000	11.8	1000.0	120.000	282.0	H	281.0	14.5	34.2	46.0
300.011000	41.5	1000.0	120.000	100.0	H	63.0	15.2	4.5	46.0
442.036000	35.3	1000.0	120.000	205.0	H	73.0	18.9	10.7	46.0
468.012000	34.1	1000.0	120.000	126.0	V	157.0	19.3	11.9	46.0
540.026000	32.9	1000.0	120.000	100.0	H	140.0	20.7	13.1	46.0

Middle channel (19)

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m

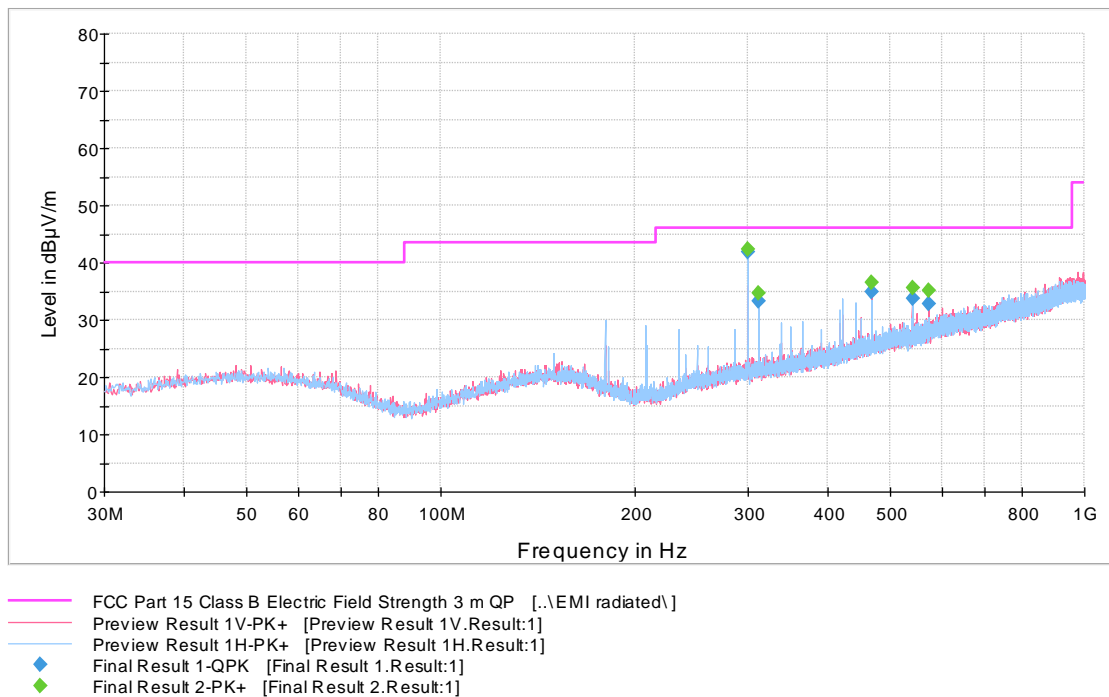


Figure 14: Channel 19 mid 30 MHz – 1000 MHz (EUT 1, MGM13S12N)

Transmitter Radiated Spurious Emissions

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

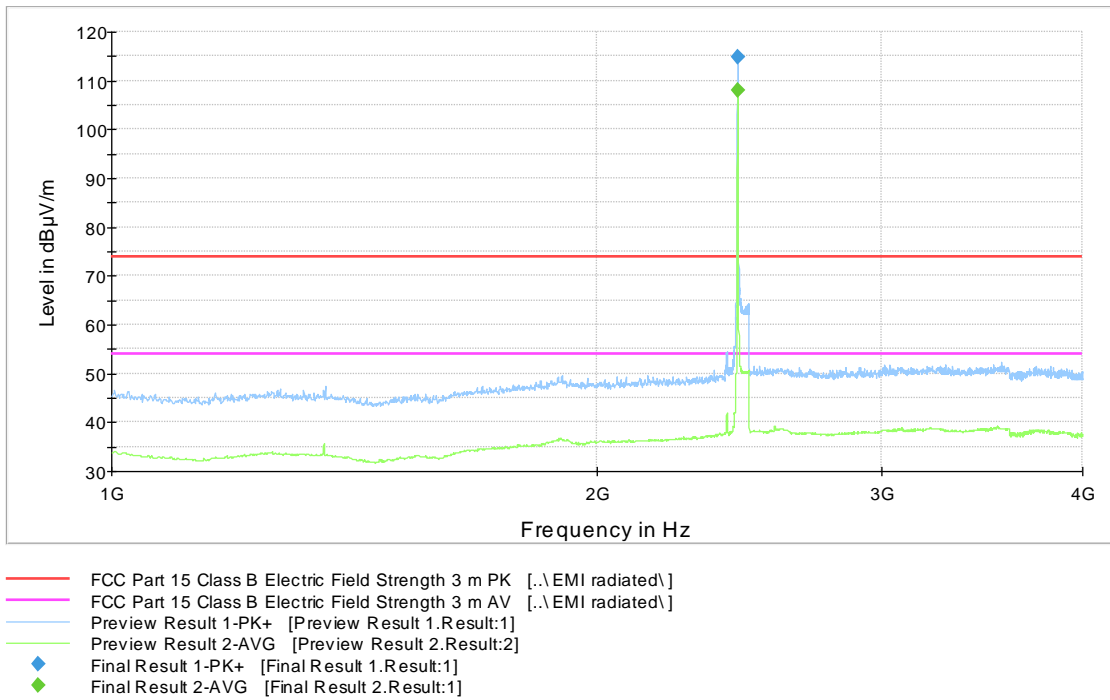


Figure 15: Channel 19 mid 1 GHz – 4 GHz (EUT 1, MGM13S12N)

FCC Part 15 Class B Spurious Emission 4-18GHz 3m

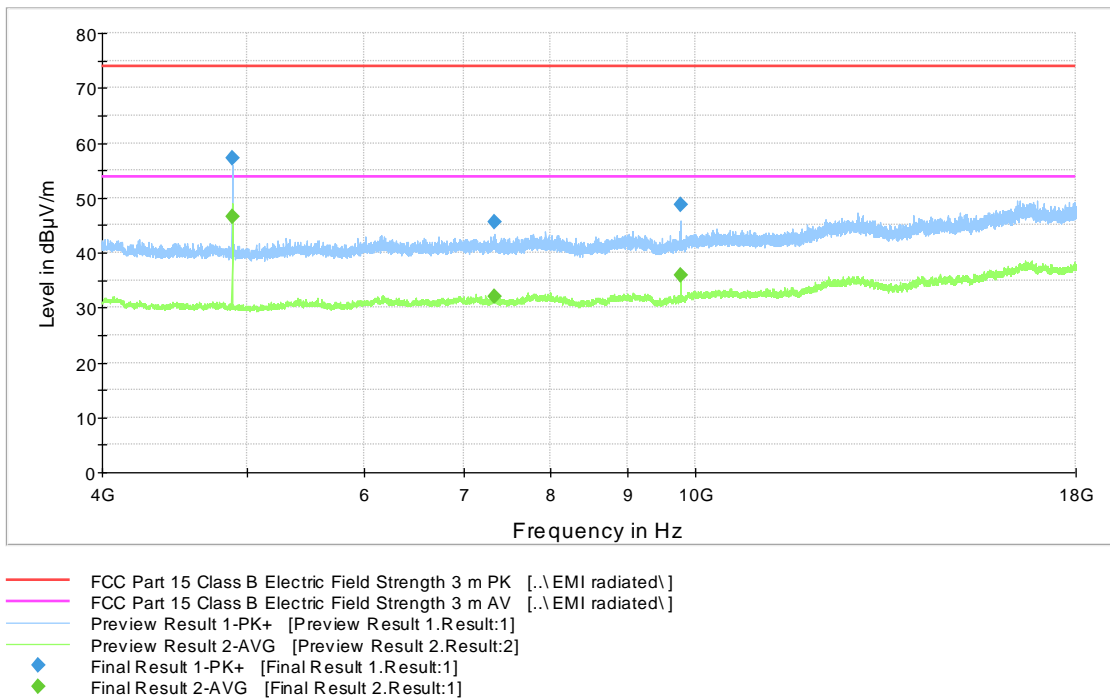


Figure 16: Channel 19 mid 4 GHz – 18 GHz (EUT 1, MGM13S12N)

Transmitter Radiated Spurious Emissions

FCC Part 15 Class B Spurious Emission 18-26.5GHz 3m

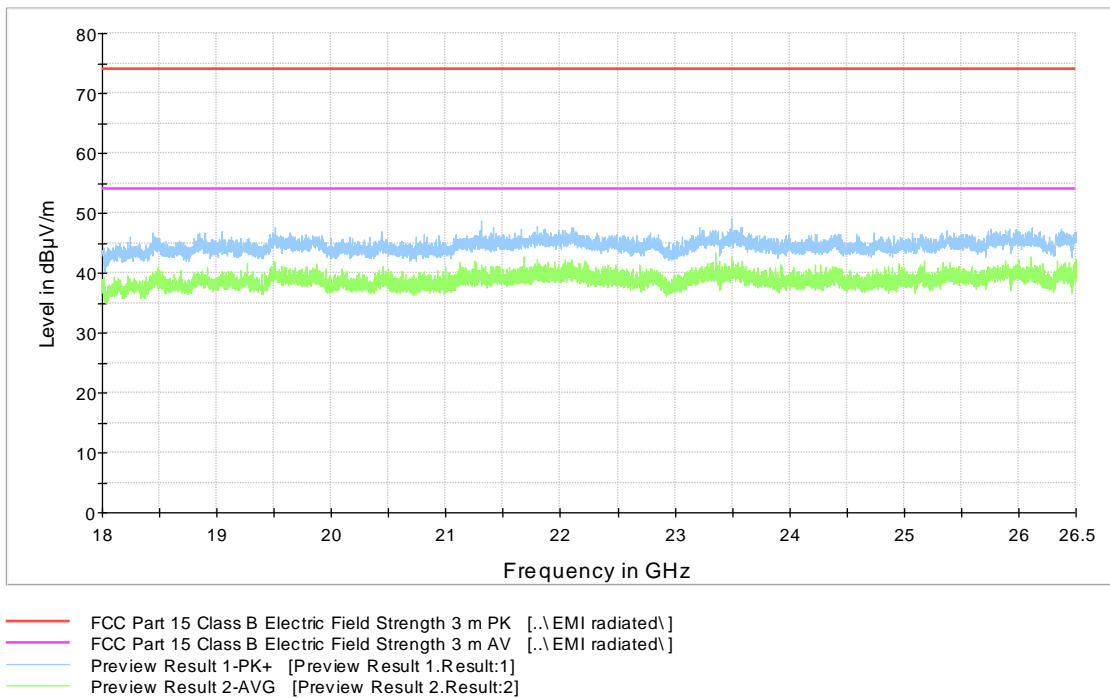


Figure 17: Channel 19 mid 18 GHz – 26.5 GHz (EUT 1, MGM13S12N)

Table 10: Peak results, channel 19 mid (EUT 1, MGM13S12N)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4890.000000	57.3	1000.0	1000.000	166.0	V	192.0	8.3	16.6	73.9
7336.500000	45.6	1000.0	1000.000	179.0	V	189.0	12.2	28.3	73.9
9777.500000	48.8	1000.0	1000.000	150.0	H	210.0	15.9	25.1	73.9

Table 11: Average results, channel 19 mid (EUT 1, MGM13S12N)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4891.000000	46.6	1000.0	1000.000	150.0	V	195.0	8.3	7.3	53.9
7336.600000	31.9	1000.0	1000.000	150.0	V	315.0	12.2	22.0	53.9
9782.000000	35.9	1000.0	1000.000	150.0	H	205.0	15.9	18.0	53.9

Table 12: Quasi-peak results, channel 19 mid (EUT 1, MGM13S12N)

Frequency (MHz)	QuasiP (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
300.011000	41.8	1000.0	120.000	100.0	H	65.0	15.2	4.2	46.0
312.019000	33.2	1000.0	120.000	100.0	H	61.0	15.6	12.8	46.0
468.032000	34.9	1000.0	120.000	126.0	V	156.0	19.3	11.1	46.0
540.026000	33.7	1000.0	120.000	100.0	V	152.0	20.7	12.3	46.0
572.016000	32.8	1000.0	120.000	100.0	V	151.0	21.5	13.2	46.0

High channel (25)

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m

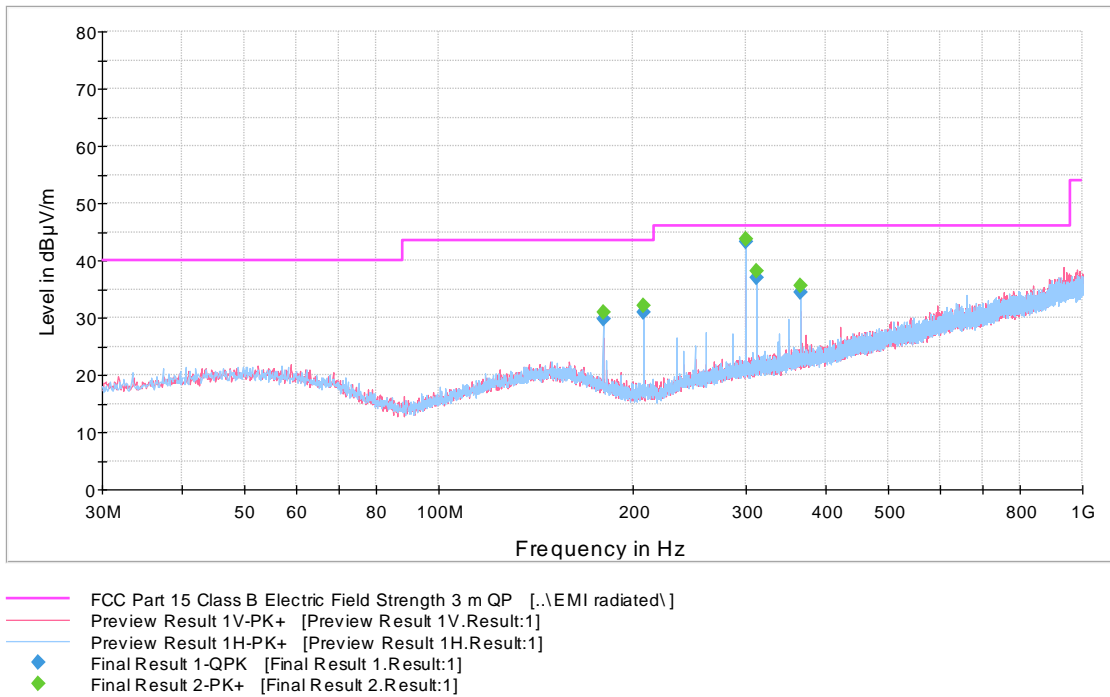


Figure 18: Channel 25 high 30 MHz – 1000 MHz (EUT 1, MGM13S12N)

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

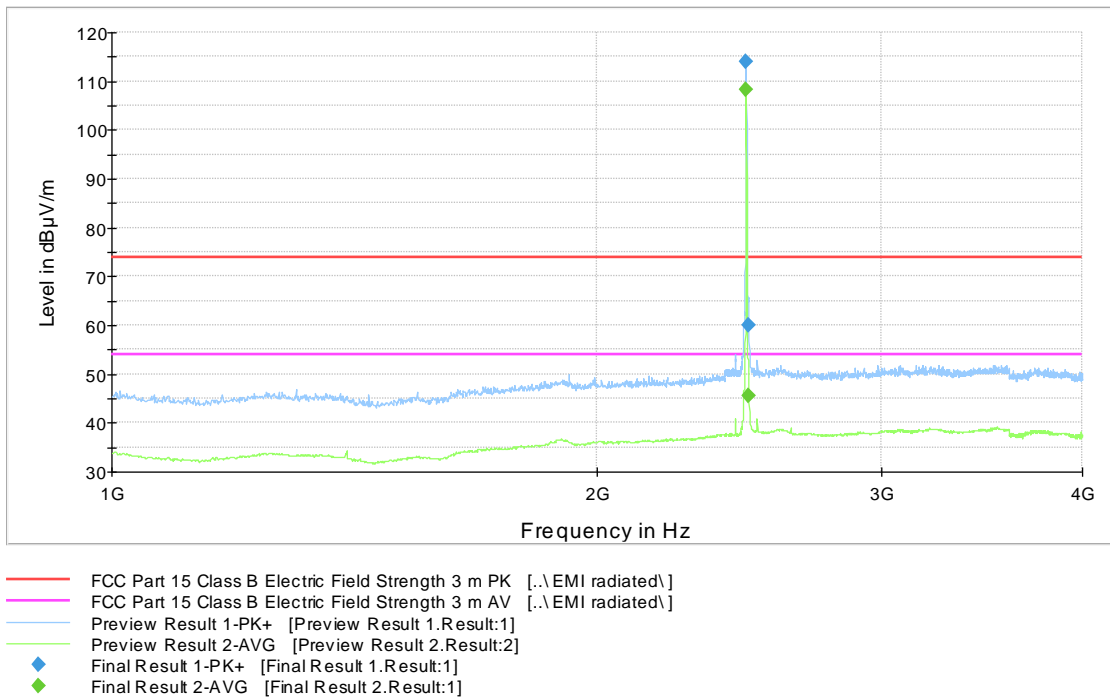


Figure 19: Channel 25 high 1 GHz – 4 GHz (EUT 1, MGM13S12N)

Transmitter Radiated Spurious Emissions

FCC Part 15 Class B Spurious Emission 4-18GHz 3m

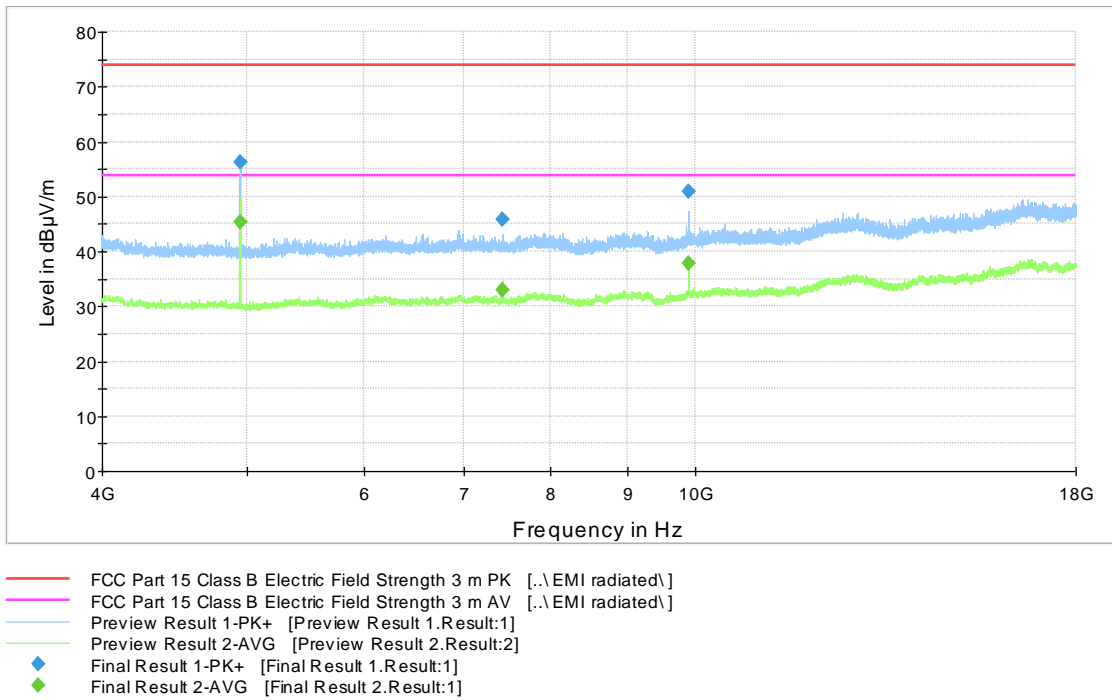


Figure 20: Channel 25 high 4 GHz – 18 GHz (EUT 1, MGM13S12N)

FCC Part 15 Class B Spurious Emission 18-26.5GHz 3m

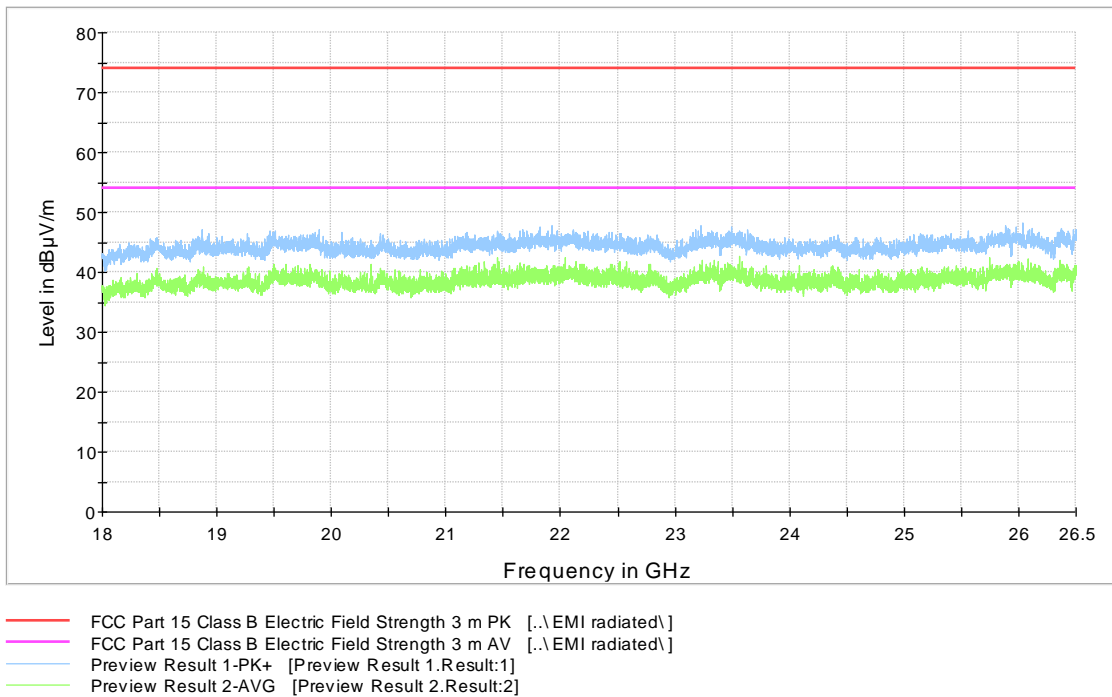


Figure 21: Channel 25 high 18 GHz – 26.5 GHz (EUT 1, MGM13S12N)

Transmitter Radiated Spurious Emissions

Table 13: Peak results, Channel 25 high (EUT 1, MGM13S12N)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.900000	59.9	1000.0	1000.000	150.0	V	279.0	14.7	14.0	73.9
4950.000000	56.3	1000.0	1000.000	150.0	V	191.0	8.2	17.6	73.9
7423.300000	45.8	1000.0	1000.000	150.0	V	315.0	12.1	28.1	73.9
9900.000000	50.9	1000.0	1000.000	150.0	H	206.0	16.4	23.0	73.9

Table 14: Average results, Channel 25 high (EUT 1, MGM13S12N)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	45.6	1000.0	1000.000	246.0	V	226.0	14.7	8.3	53.9
4951.000000	45.4	1000.0	1000.000	179.0	V	189.0	8.2	8.5	53.9
7426.500000	33.0	1000.0	1000.000	150.0	V	316.0	12.1	20.9	53.9
9902.100000	37.8	1000.0	1000.000	150.0	H	210.0	16.4	16.1	53.9

Table 15: Quasi-peak results, channel 25 high (EUT 1, MGM13S12N)

Frequency (MHz)	QuasiP (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
180.002000	29.7	1000.0	120.000	126.0	H	148.0	12.9	13.8	43.5
208.015000	30.9	1000.0	120.000	100.0	H	141.0	11.4	12.6	43.5
300.008000	43.1	1000.0	120.000	100.0	H	65.0	15.2	2.9	46.0
312.019000	37.1	1000.0	120.000	100.0	H	68.0	15.6	8.9	46.0
364.028000	34.4	1000.0	120.000	100.0	H	73.0	16.7	11.6	46.0

Radiated Band Edge results

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

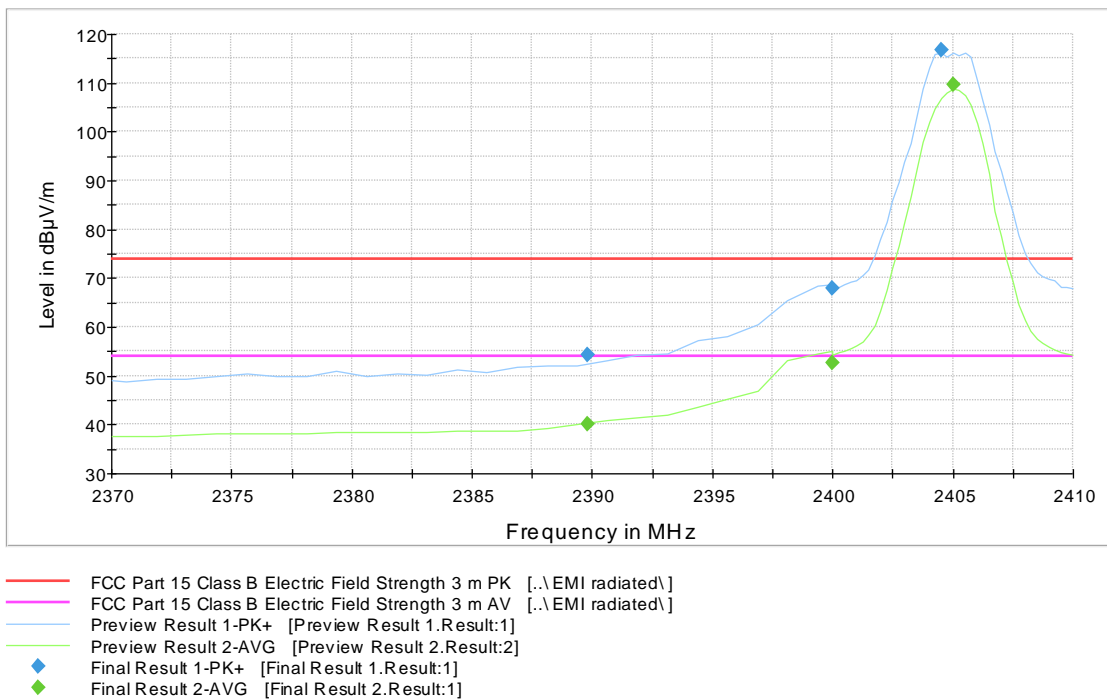


Figure 22: Radiated Band Edge measurement graph, Channel 11 low (EUT 1, MGM13S12N)

Transmitter Radiated Spurious Emissions

Table 16: Peak results, Channel 11 low (EUT 1, MGM13S12N)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.800000	54.3	1000.0	1000.000	150.0	V	242.0	14.6	19.6	73.9
2400.000000	67.9	1000.0	1000.000	219.0	V	235.0	14.7	6.0	73.9

Table 17: Average results, Channel 11 low (EUT 1, MGM13S12N)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.800000	40.1	1000.0	1000.000	190.0	V	233.0	14.6	13.8	53.9
2400.000000	52.7	1000.0	1000.000	210.0	V	235.0	14.7	1.2	53.9

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

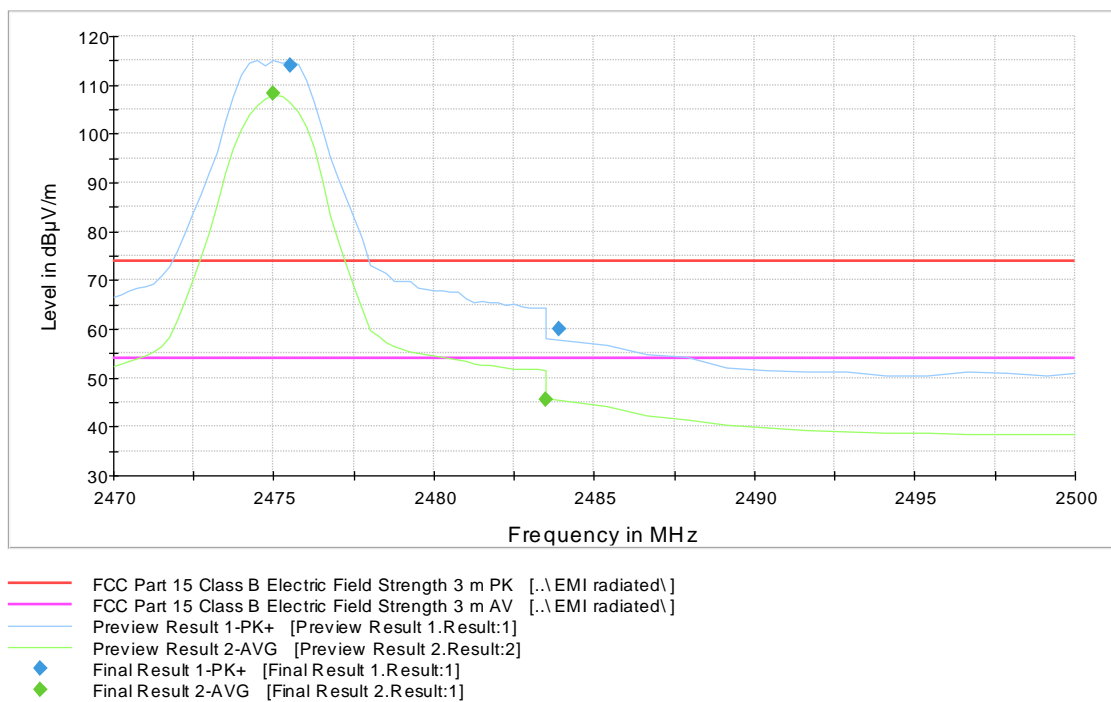


Figure 23: Radiated Band Edge measurement graph, Channel 25 high (EUT 1, MGM13S12N)

Table 18: Peak results, Channel 25 high (EUT 1, MGM13S12N)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.900000	59.9	1000.0	1000.000	150.0	V	279.0	14.7	14.0	73.9

Table 19: Average results, Channel 25 high (EUT 1, MGM13S12N)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	45.6	1000.0	1000.000	246.0	V	226.0	14.7	8.3	53.9

Transmitter Radiated Spurious Emissions

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

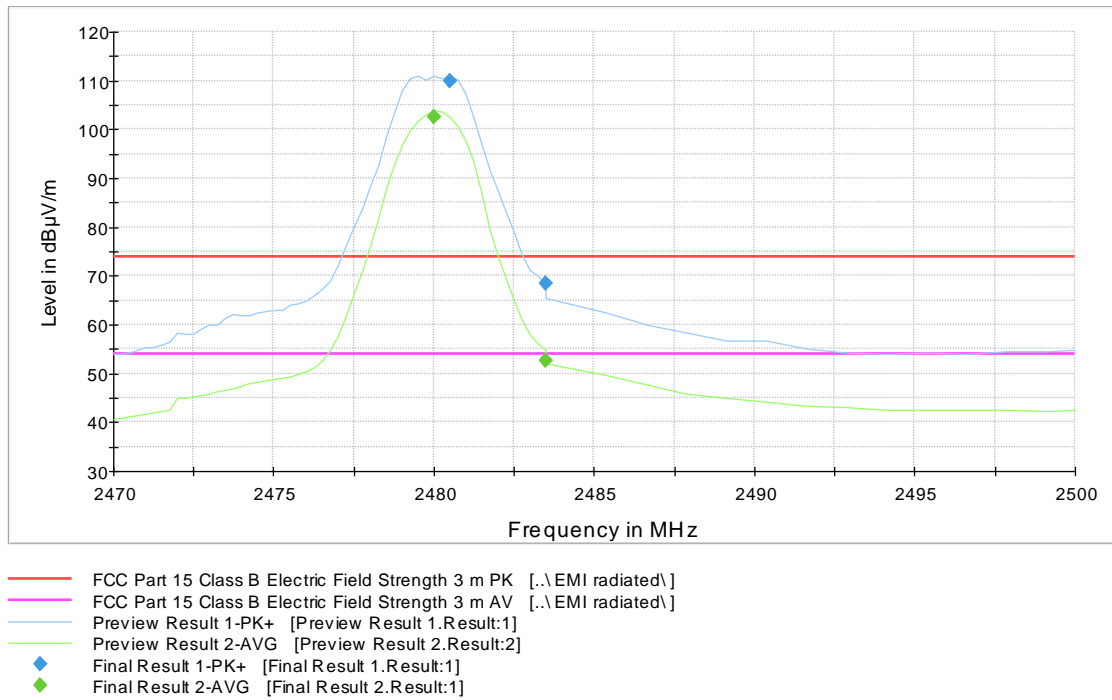


Figure 24: Radiated Band Edge measurement graph, Channel 26 high (EUT 1, MGM13S12N)

Table 20: Peak results, Channel 26 high (EUT 1, MGM13S12N)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	68.6	1000.0	1000.000	166.0	V	232.0	14.7	5.3	73.9

Table 21: Average results, Channel 26 high (EUT 1, MGM13S12N)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	52.7	1000.0	1000.000	165.0	V	227.0	14.7	1.2	53.9

Transmitter Radiated Spurious Emissions

Low channel (11)

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m

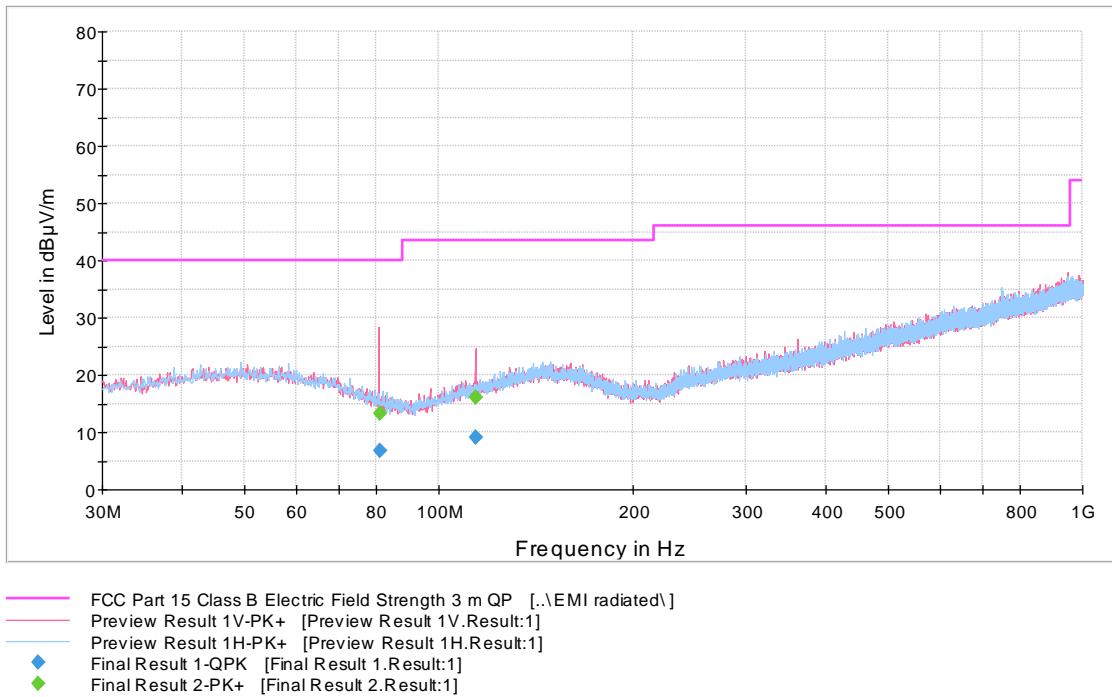


Figure 25: Channel 11 low 30 MHz – 1000 MHz (EUT 2, MGM13S12A)

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

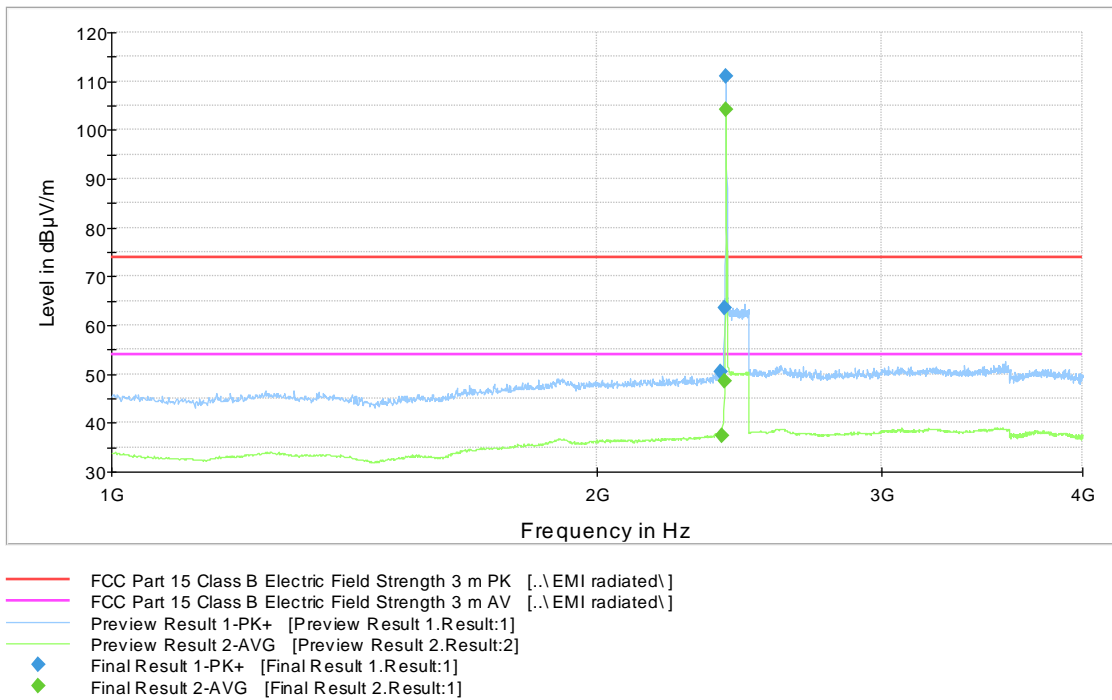


Figure 26: Channel 11 low 1 GHz – 4 GHz (EUT 2, MGM13S12A)

Transmitter Radiated Spurious Emissions

FCC Part 15 Class B Spurious Emission 4-18GHz 3m

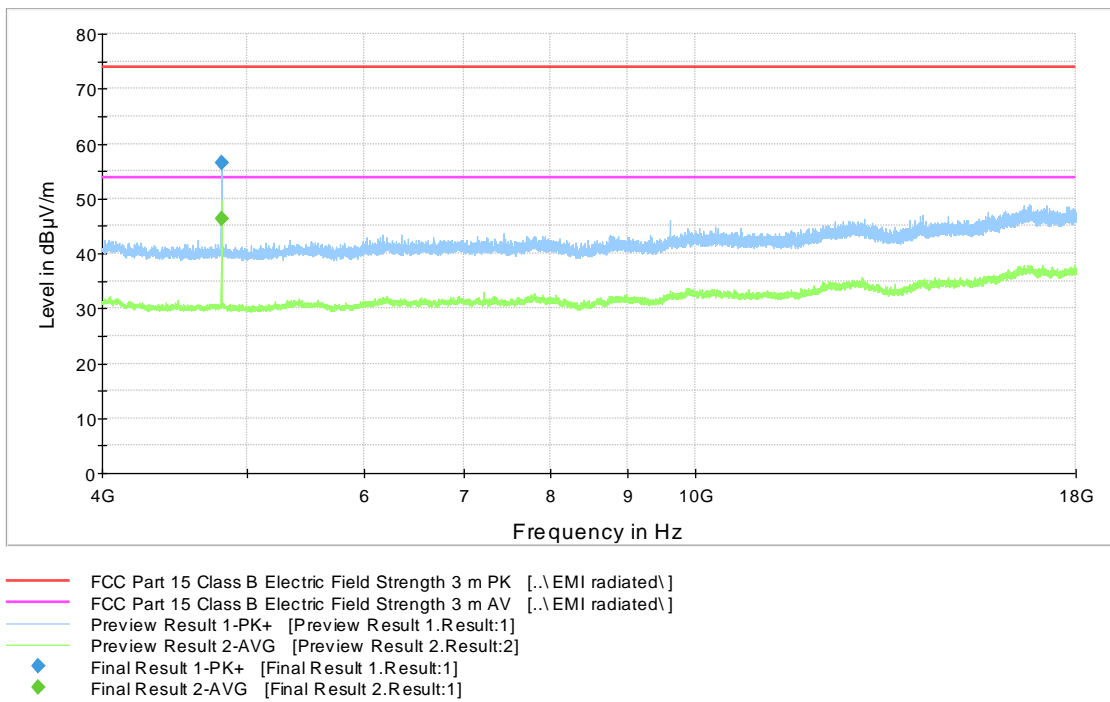


Figure 27: Channel 11 low 4 GHz – 18 GHz (EUT 2, MGM13S12A)

FCC Part 15 Class B Spurious Emission 18-26.5GHz 3m

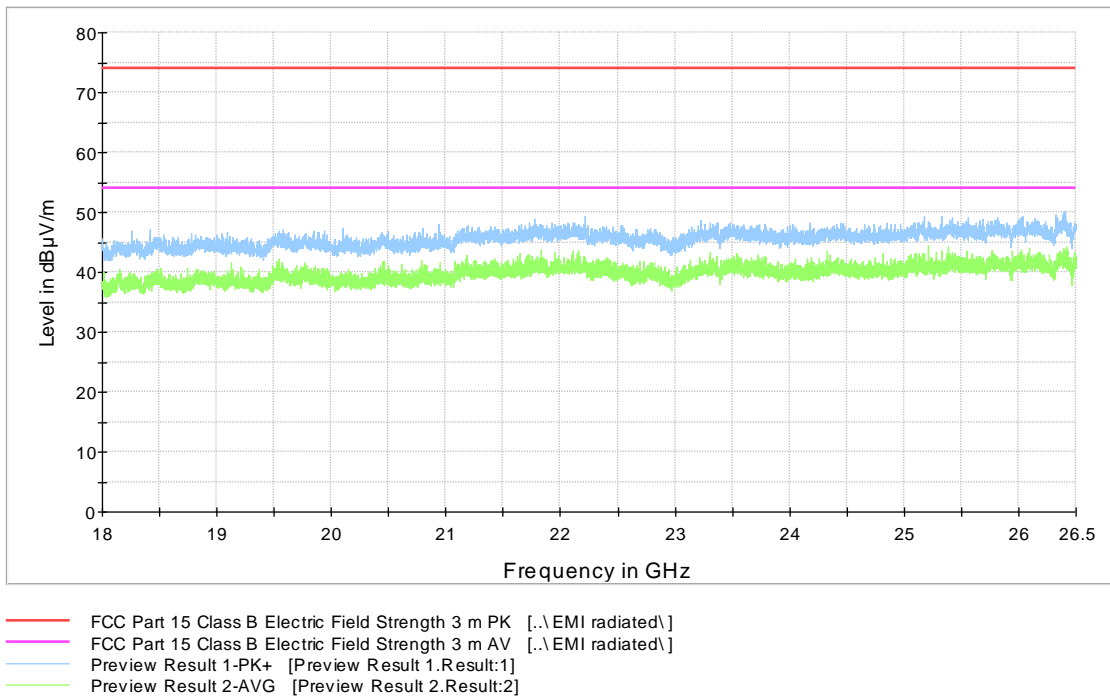


Figure 28: Channel 11 low 18 GHz – 26.5 GHz (EUT 2, MGM13S12A)

Transmitter Radiated Spurious Emissions

Table 22: Peak results, Channel 11 low (EUT 2, MGM13S12A)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2386.000000	50.5	1000.0	1000.000	365.0	V	94.0	14.5	23.4	73.9
2399.800000	63.4	1000.0	1000.000	205.0	H	110.0	14.7	10.5	73.9
4811.000000	56.5	1000.0	1000.000	150.0	H	106.0	8.3	17.4	73.9

Table 23: Average results, Channel 11 low (EUT 2, MGM13S12A)

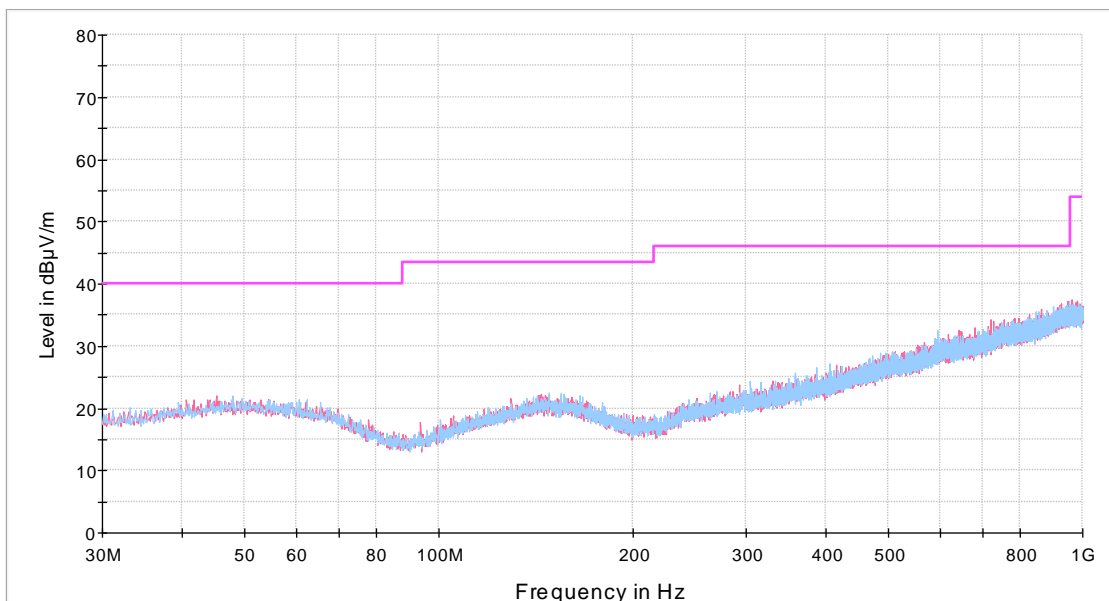
Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.800000	37.4	1000.0	1000.000	317.0	V	103.0	14.6	16.5	53.9
2400.000000	48.5	1000.0	1000.000	311.0	H	120.0	14.7	5.4	53.9
4811.000000	46.3	1000.0	1000.000	150.0	H	106.0	8.3	7.6	53.9

Table 24: Quasi-peak results, Channel 11 low (EUT 2, MGM13S12A)

Frequency (MHz)	QuasiP (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
81.171000	6.7	1000.0	120.000	309.0	V	191.0	9.6	33.3	40.0
114.122000	9.0	1000.0	120.000	257.0	V	218.0	11.8	34.5	43.5

Middle channel (19)

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m



- FCC Part 15 Class B Electric Field Strength 3 m QP [..\EMI radiated\]
- Preview Result 1V-PK+ [Preview Result 1V.Result:1]
- Preview Result 1H-PK+ [Preview Result 1H.Result:1]

Figure 29: Channel 19 mid 30 MHz – 1000 MHz (EUT 2, MGM13S12A)

Transmitter Radiated Spurious Emissions

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

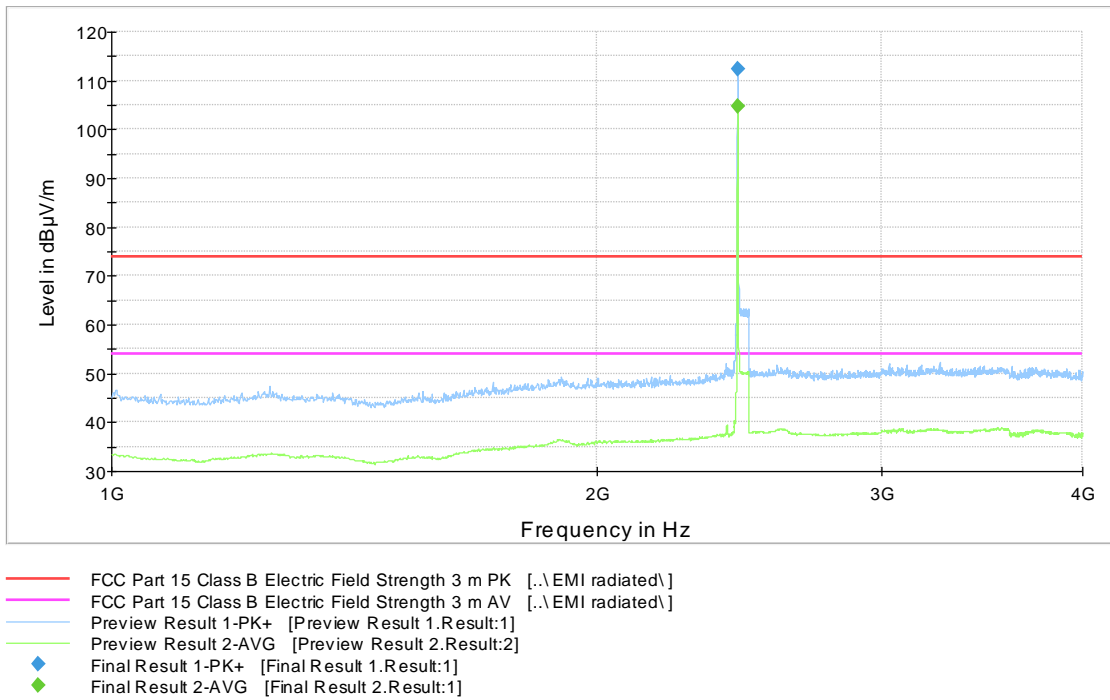


Figure 30: Channel 19 mid 1 GHz – 4 GHz (EUT 2, MGM13S12A)

FCC Part 15 Class B Spurious Emission 4-18GHz 3m

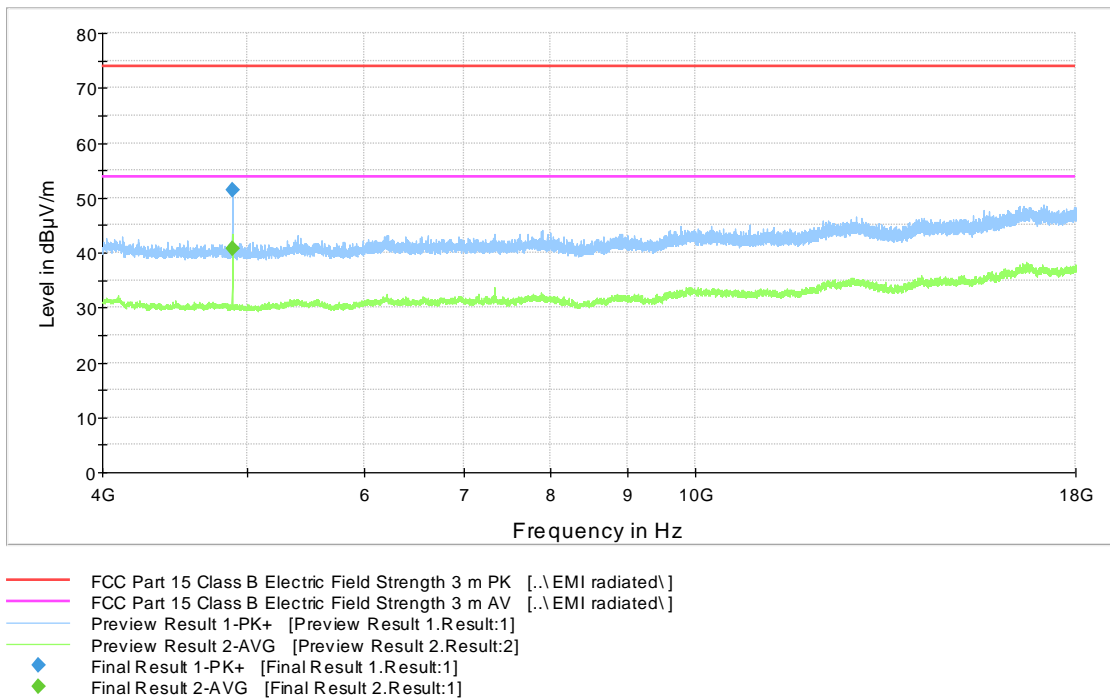


Figure 31: Channel 19 mid 4 GHz – 18 GHz (EUT 2, MGM13S12A)

Transmitter Radiated Spurious Emissions

FCC Part 15 Class B Spurious Emission 18-26.5GHz 3m

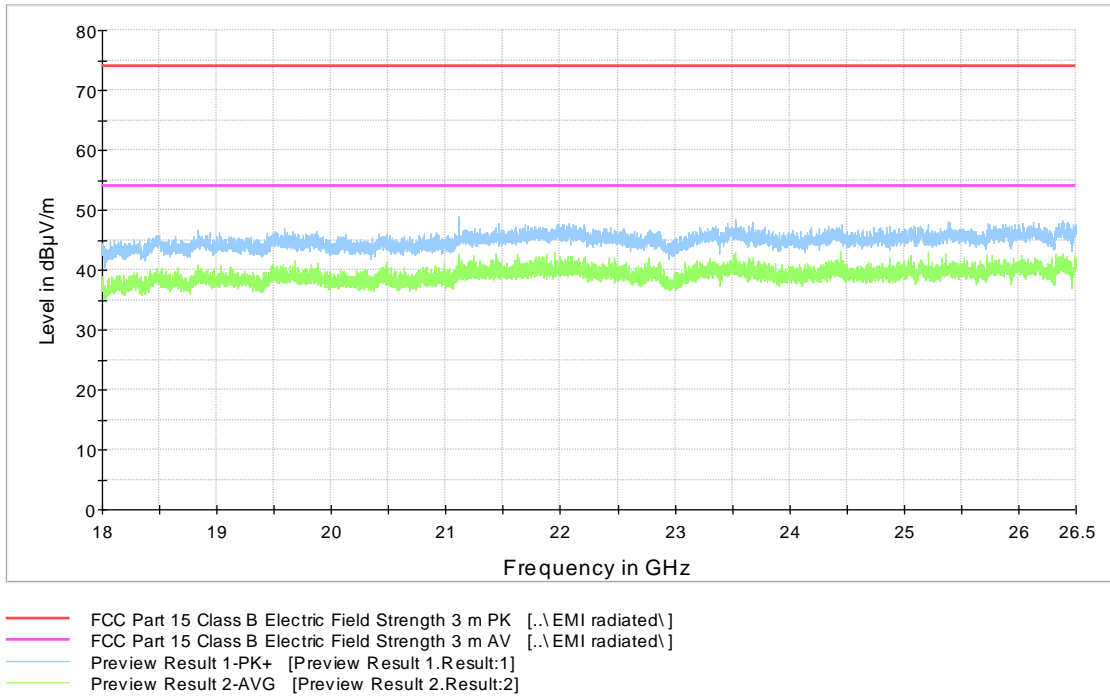


Figure 32: Channel 19 mid 18 GHz – 26.5 GHz (EUT 2, MGM13S12A)

Table 25: Peak results, channel 19 mid (EUT 2, MGM13S12A)

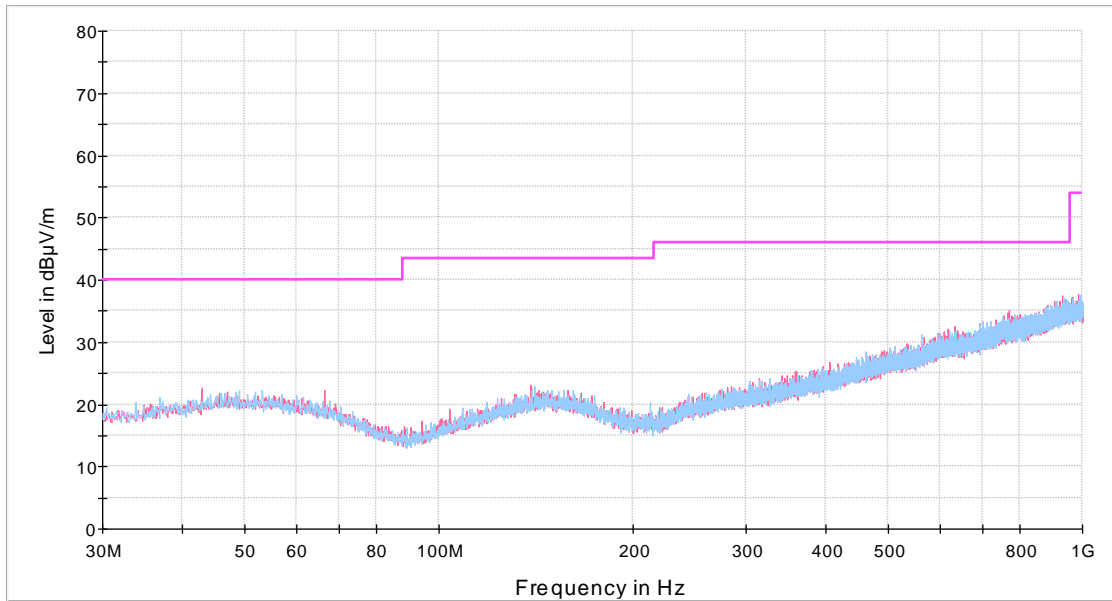
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4890.900000	51.5	1000.0	1000.000	150.0	H	103.0	8.3	22.4	73.9

Table 26: Average results, channel 19 mid (EUT 2, MGM13S12A)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4891.000000	40.8	1000.0	1000.000	150.0	H	103.0	8.3	13.1	53.9

High channel (26)

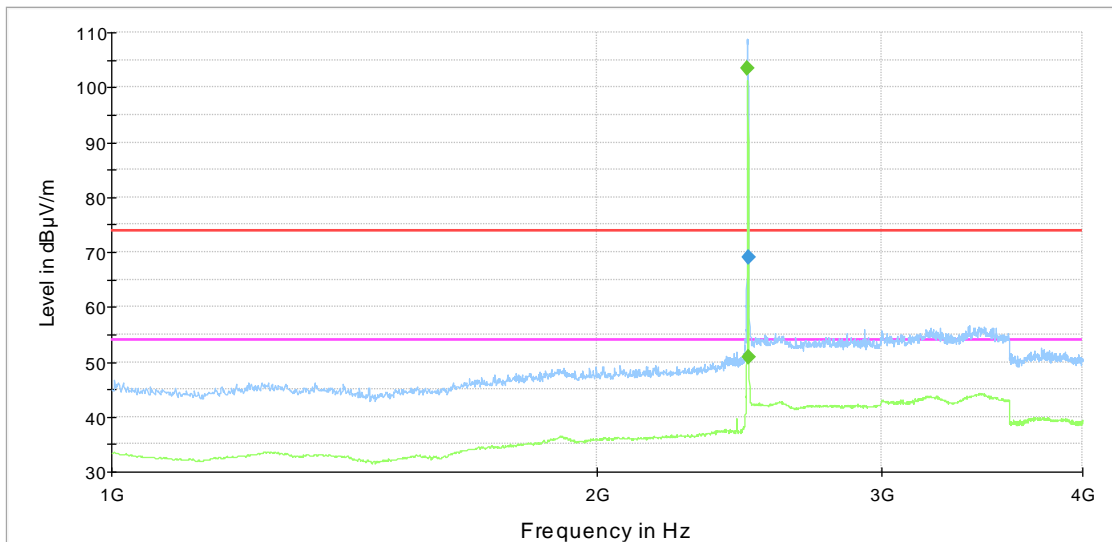
FCC Part 15 Class B Spurious Emission 30-1000MHz 3m



- FCC Part 15 Class B Electric Field Strength 3 m QP [..\EMI radiated\]
- Preview Result 1V-PK+ [Preview Result 1V.Result:1]
- Preview Result 1H-PK+ [Preview Result 1H.Result:1]

Figure 33: Channel 26 high 30 MHz – 1000 MHz (EUT 2, MGM13S12A)

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)



- FCC Part 15 Class B Electric Field Strength 3 m PK [..\EMI radiated\]
- FCC Part 15 Class B Electric Field Strength 3 m AV [..\EMI radiated\]
- Preview Result 1-PK+ [Preview Result 1.Result:1]
- Preview Result 2-AVG [Preview Result 2.Result:2]
- ◆ Final Result 1-PK+ [Final Result 1.Result:1]
- ◆ Final Result 2-AVG [Final Result 2.Result:1]

Figure 34: Channel 26 high 1 GHz – 4 GHz (EUT 2, MGM13S12A)

Transmitter Radiated Spurious Emissions

FCC Part 15 Class B Spurious Emission 4-18GHz 3m

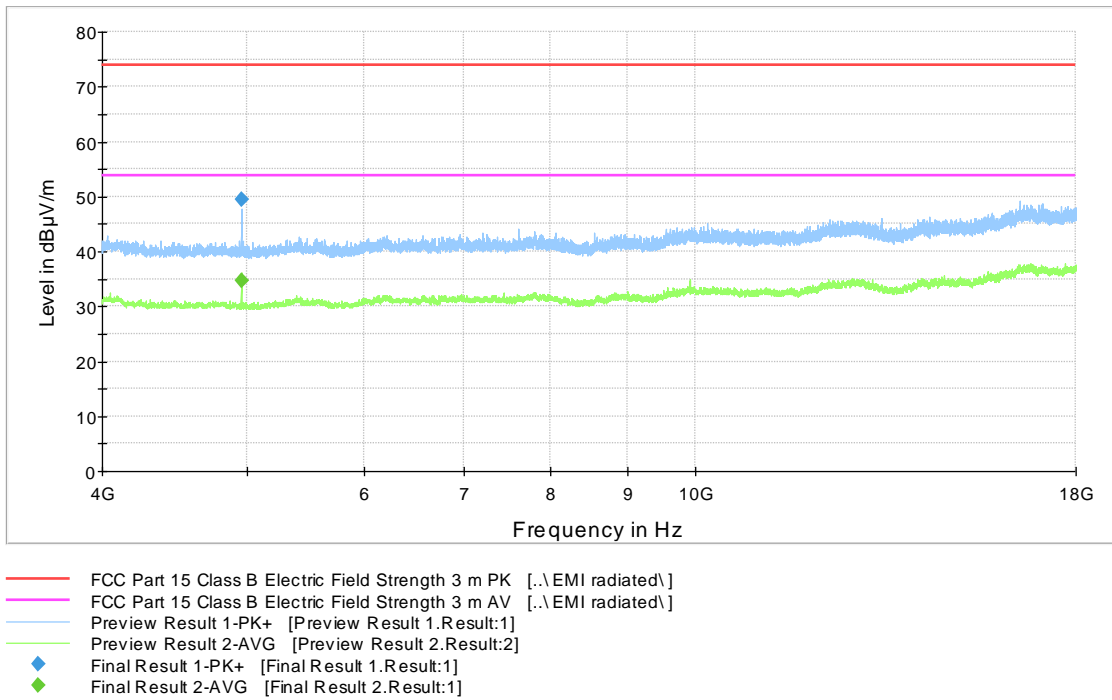


Figure 35: Channel 26 high 4 GHz – 18 GHz (EUT 2, MGM13S12A)

FCC Part 15 Class B Spurious Emission 18-26.5GHz 3m

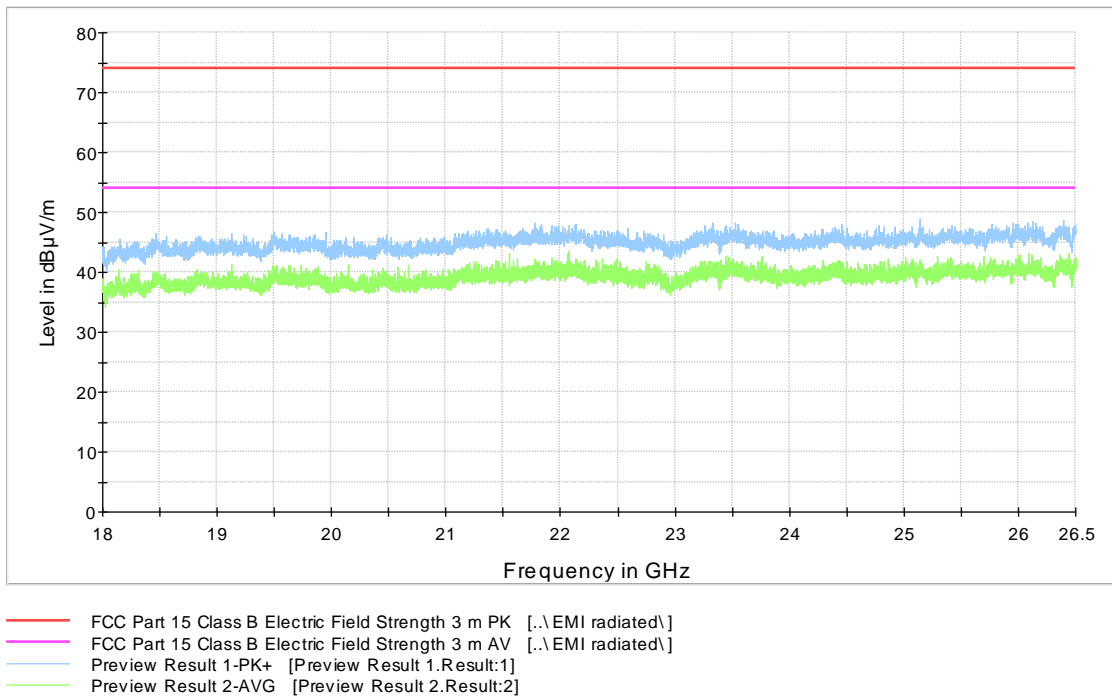


Figure 36: Channel 26 high 18 GHz – 26.5 GHz (EUT 2, MGM13S12A)

Transmitter Radiated Spurious Emissions

Table 27: Peak results, Channel 26 high (EUT 2, MGM13S12A)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	69.0	1000.0	1000.000	269.0	H	231.0	14.7	4.9	73.9
4960.100000	49.4	1000.0	1000.000	166.0	H	198.0	8.2	24.5	73.9

Table 28: Average results, Channel 26 high (EUT 2, MGM13S12A)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	50.8	1000.0	1000.000	275.0	H	230.0	14.7	3.1	53.9
4961.000000	34.6	1000.0	1000.000	150.0	V	304.0	8.2	19.3	53.9

Radiated Band Edge results

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

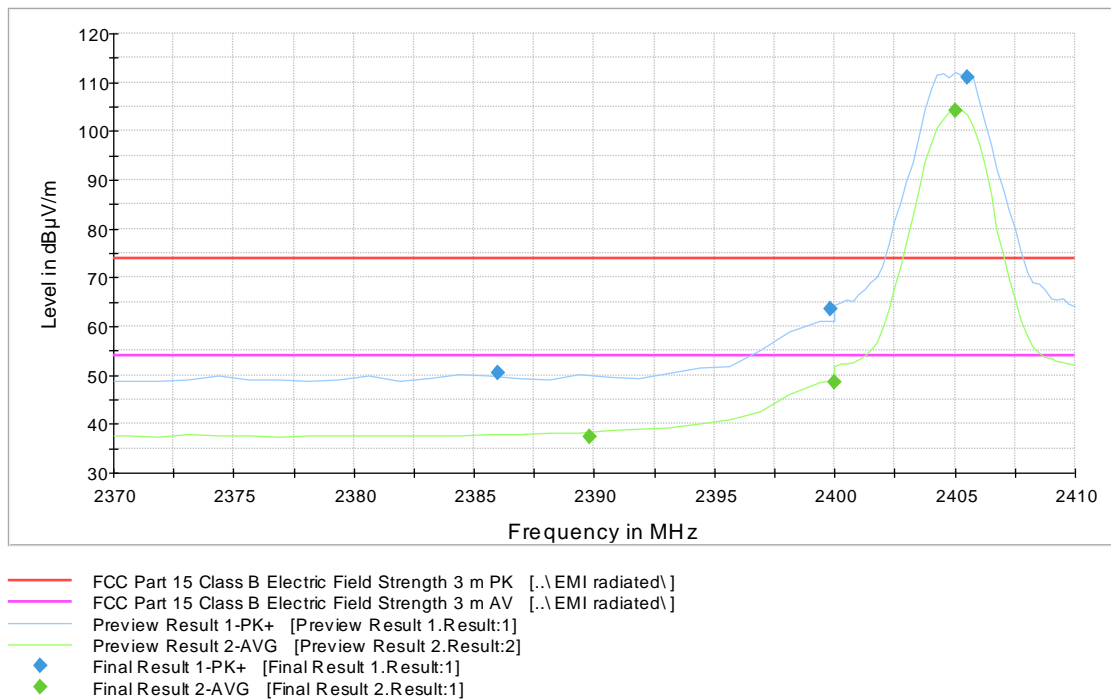


Figure 37: Radiated Band Edge measurement graph, Channel 11 low (EUT 2, MGM13S12A)

Table 29: Peak results, Channel 11 low (EUT 2, MGM13S12A)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2386.000000	50.5	1000.0	1000.000	365.0	V	94.0	14.5	23.4	73.9
2399.800000	63.4	1000.0	1000.000	205.0	H	110.0	14.7	10.5	73.9

Table 30: Average results, Channel 11 low (EUT 2, MGM13S12A)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2389.800000	37.4	1000.0	1000.000	317.0	V	103.0	14.6	16.5	53.9
2400.000000	48.5	1000.0	1000.000	311.0	H	120.0	14.7	5.4	53.9

Transmitter Radiated Spurious Emissions

FCC Part 15 Class B Spurious Emission 1-4GHz 3m (optimized 2.4 GHz TX)

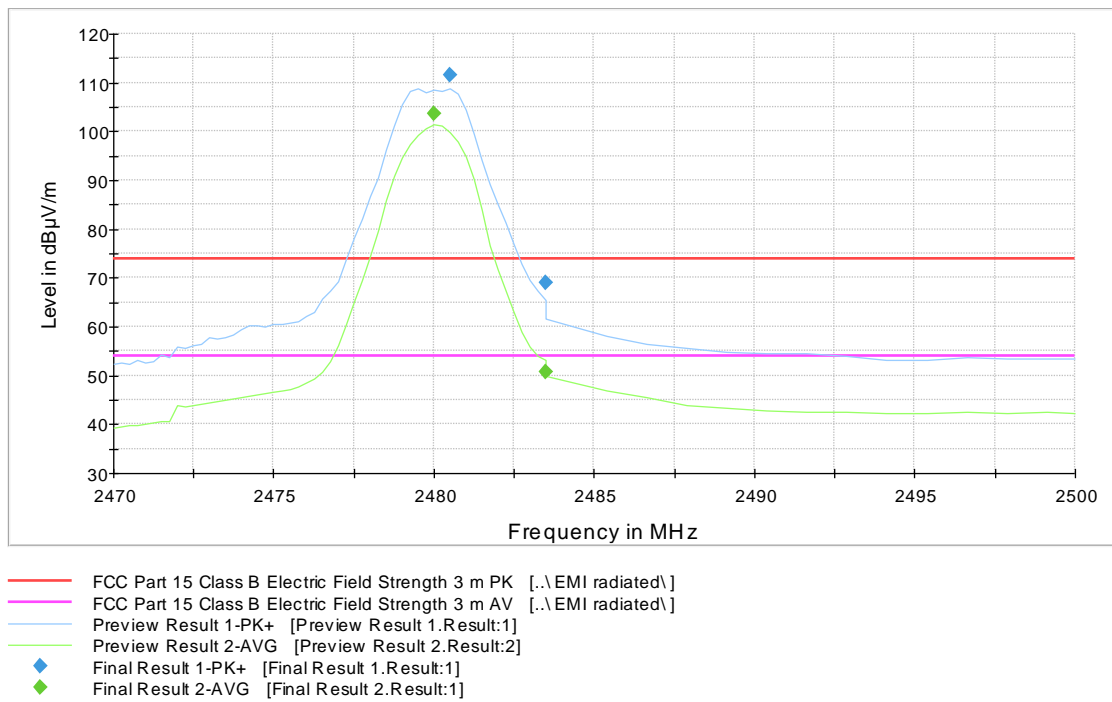


Figure 38: Radiated Band Edge measurement graph, Channel 26 high (EUT 2, MGM13S12A)

Table 31: Peak results, Channel 26 high (EUT 2, MGM13S12A)

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	69.0	1000.0	1000.000	269.0	H	231.0	14.7	4.9	73.9

Table 32: Average results, Channel 26 high (EUT 2, MGM13S12A)

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	50.8	1000.0	1000.000	275.0	H	230.0	14.7	3.1	53.9

Transmitter Band Edge Measurement and Conducted Spurious Emissions

Standard: ANSI C63.10 (2013)
Tested by: JAT
Date: 2 - 20 March 2018
Temperature: 23 ± 3 °C
Humidity: 16 - 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 33: Band edge attenuation (EUT 1, MGM13S12N)

Band Edge Attenuation		
Lower Band Edge (ch 11)	Upper Band Edge (ch 25)	Upper Band Edge (ch 26)
-55.55 dBc	-55.21 dBc	-48.96 dBc
Limit: -20 dBc		

Table 34: Conducted spurious emissions, Channel 11 low (EUT 1, MGM13S12N)

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
829.21	-66.20	-2.91	-63.29	PASS
2399.50	-40.84	-2.91	-37.93	PASS
2520.20	-60.32	-2.91	-57.41	PASS
4810.02	-35.99	-2.91	-33.08	PASS
9619.90	-57.04	-2.91	-54.13	PASS
12501.41	-58.15	-2.91	-55.24	PASS
15498.41	-55.80	-2.91	-52.89	PASS
16147.23	-55.64	-2.91	-52.73	PASS
20761.84	-57.15	-2.91	-54.24	PASS
24457.53	-56.28	-2.91	-53.37	PASS
26296.73	-55.95	-2.91	-53.04	PASS

Transmitter Band Edge Measurement and Conducted Spurious Emissions

Table 35: Conducted spurious emissions, Channel 19 mid (EUT 1, MGM13S12N)

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
921.72	-65.61	-3.26	-62.35	PASS
2396.96	-61.61	-3.26	-58.36	PASS
2484.09	-55.17	-3.26	-51.91	PASS
4889.99	-36.32	-3.26	-33.06	PASS
9779.93	-57.48	-3.26	-54.22	PASS
12515.75	-58.89	-3.26	-55.64	PASS
15504.13	-56.80	-3.26	-53.55	PASS
16143.20	-54.70	-3.26	-51.44	PASS
19180.79	-57.11	-3.26	-53.85	PASS
24430.25	-55.95	-3.26	-52.69	PASS
25596.82	-56.63	-3.26	-53.37	PASS

Table 36: Conducted spurious emissions, Channel 25 high (EUT 1, MGM13S12N)

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
908.75	-65.99	-3.47	-62.52	PASS
2321.41	-64.70	-3.47	-61.23	PASS
2483.52	-48.74	-3.47	-45.27	PASS
4949.99	-37.32	-3.47	-33.85	PASS
9897.77	-59.38	-3.47	-55.91	PASS
12535.44	-59.76	-3.47	-56.29	PASS
15525.12	-57.55	-3.47	-54.08	PASS
16112.64	-55.76	-3.47	-52.29	PASS
19188.48	-57.20	-3.47	-53.72	PASS
24137.48	-56.65	-3.47	-53.18	PASS
25564.05	-56.62	-3.47	-53.15	PASS

Table 37: Conducted spurious emissions, Channel 26 high (EUT 1, MGM13S12N)

Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Result
949.06	-68.12	-7.56	-60.56	PASS
2042.73	-67.19	-7.56	-59.63	PASS
2483.52	-41.45	-7.56	-33.89	PASS
4960.95	-43.69	-7.56	-36.12	PASS
8523.53	-61.52	-7.56	-53.96	PASS
11826.52	-58.71	-7.56	-51.15	PASS
15518.19	-57.26	-7.56	-49.70	PASS
16151.92	-55.54	-7.56	-47.98	PASS
19181.17	-57.58	-7.56	-50.02	PASS
24418.25	-56.51	-7.56	-48.95	PASS
25423.34	-56.63	-7.56	-49.07	PASS

Transmitter Band Edge Measurement and Conducted Spurious Emissions

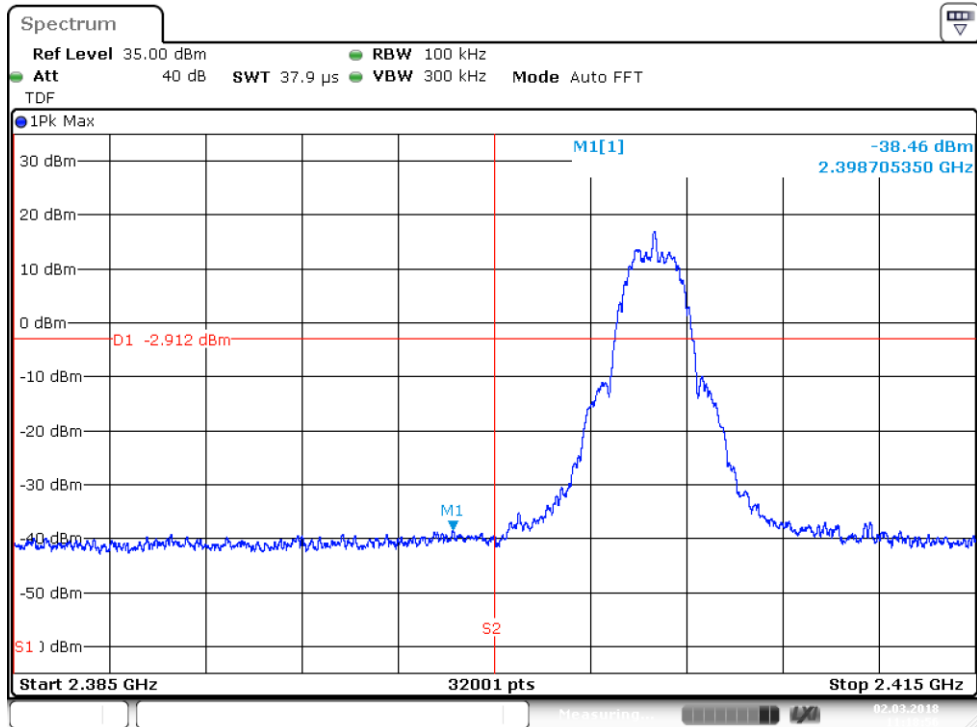


Figure 39: Lower Band Edge, Channel 11 low (EUT 1, MGM13S12N)

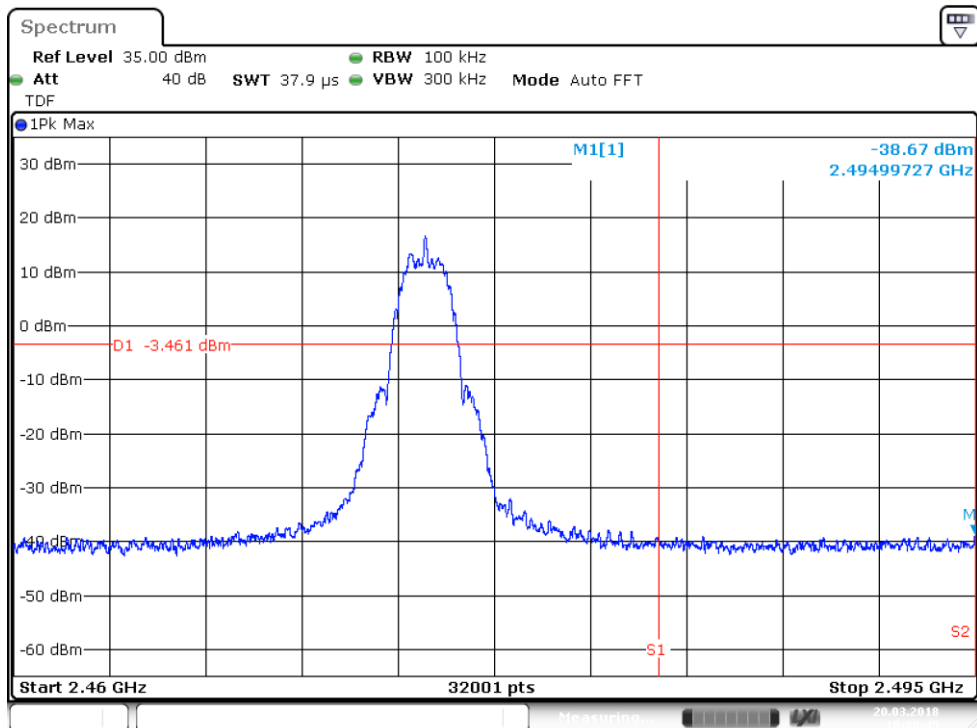


Figure 40: Upper Band Edge, Channel 25 (EUT 1, MGM13S12N)

Transmitter Band Edge Measurement and Conducted Spurious Emissions

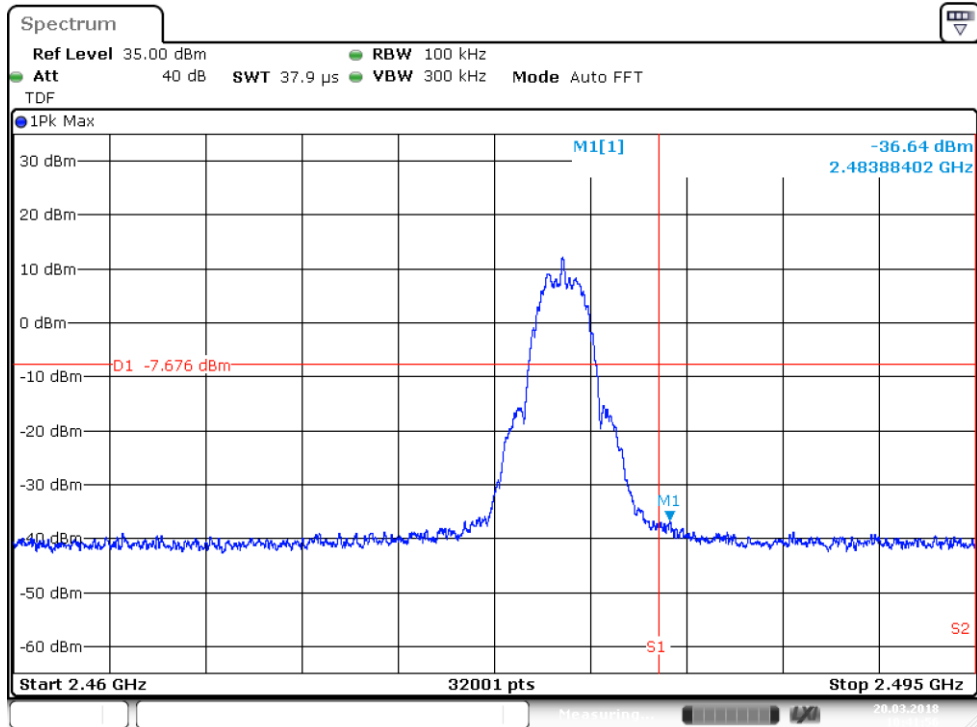


Figure 41: Upper Band Edge, Channel 26 (EUT 1, MGM13S12N)

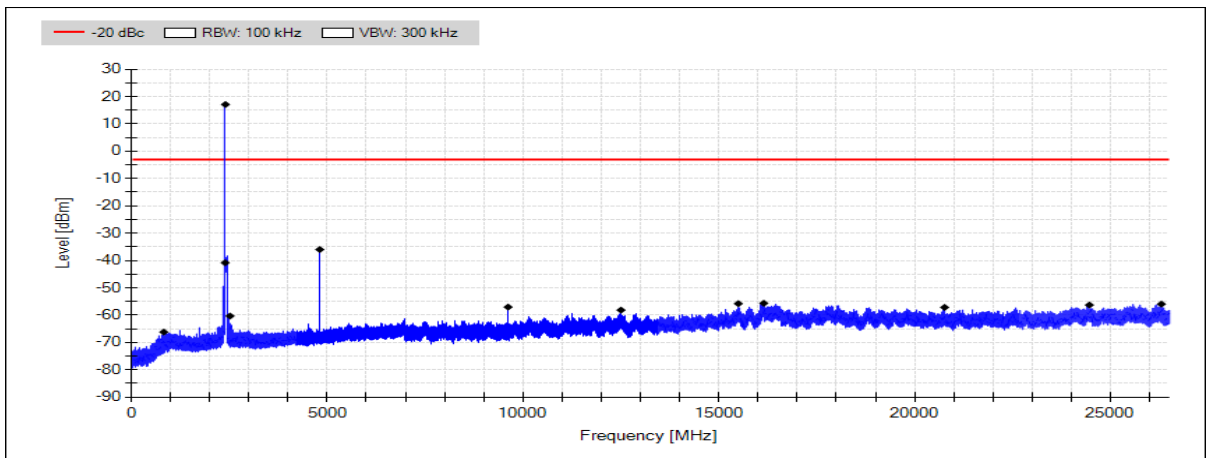


Figure 42: Conducted spurious emissions 30 - 26500 MHz Channel 11 low (EUT 1, MGM13S12N)

Transmitter Band Edge Measurement and Conducted Spurious Emissions

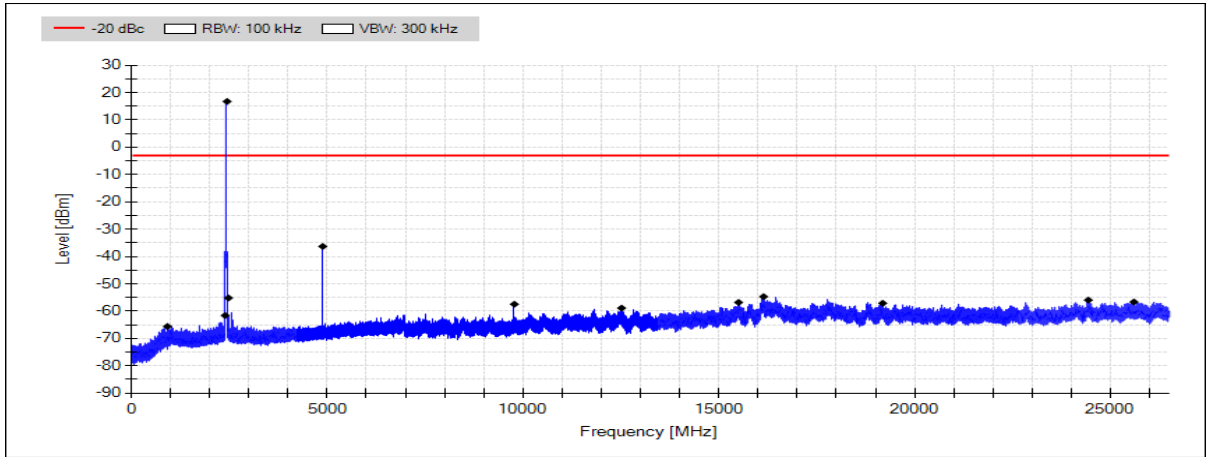


Figure 43: Conducted spurious emissions 30 - 26500 MHz channel 19 mid (EUT 1, MGM13S12N)

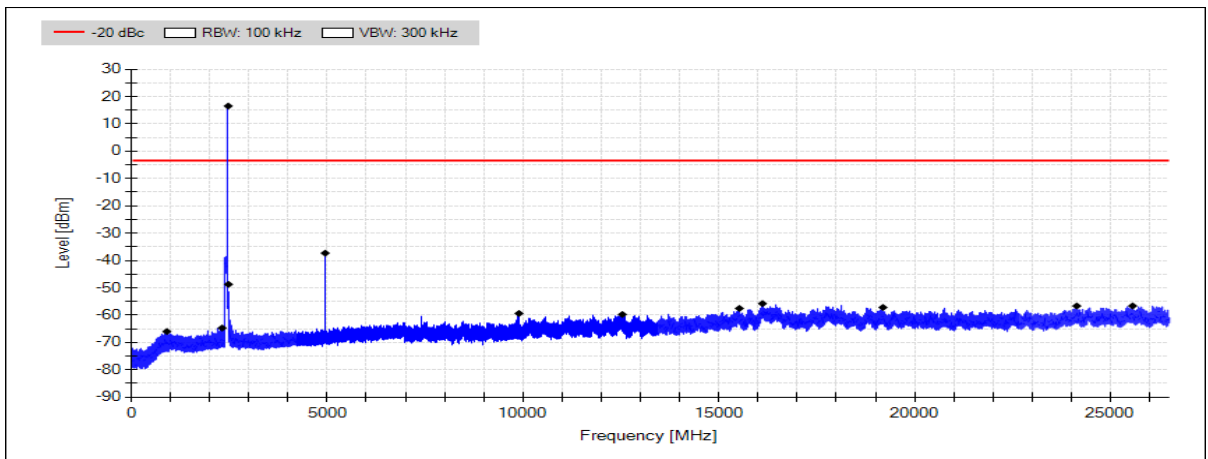


Figure 44: Conducted spurious emissions 30 - 26500 MHz Channel 25 high (EUT 1, MGM13S12N)

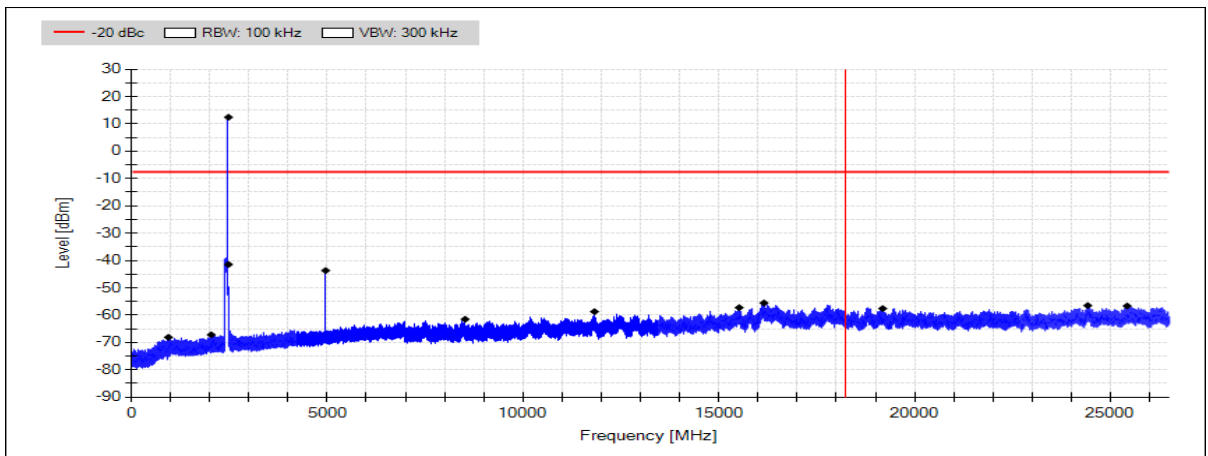


Figure 45: Conducted spurious emissions 30 - 26500 MHz Channel 26 high (EUT 1, MGM13S12N)

6 dB Bandwidth of the Channel

Standard: ANSI C63.10 (2013)
Tested by: JAT MIH
Date: 2 – 20 March 2018 17 October 2018
Temperature: 23 ± 3 °C
Humidity: 16 - 60 % RH

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

Results:

Table 38: 6 dB bandwidth test results (EUT 1, MGM13S12N)

Channel	6 dB BW [kHz]	Minimum limit [kHz]
11 Low	1345	500
19 Mid	1343	
25 High	1341	
26 High	1345	

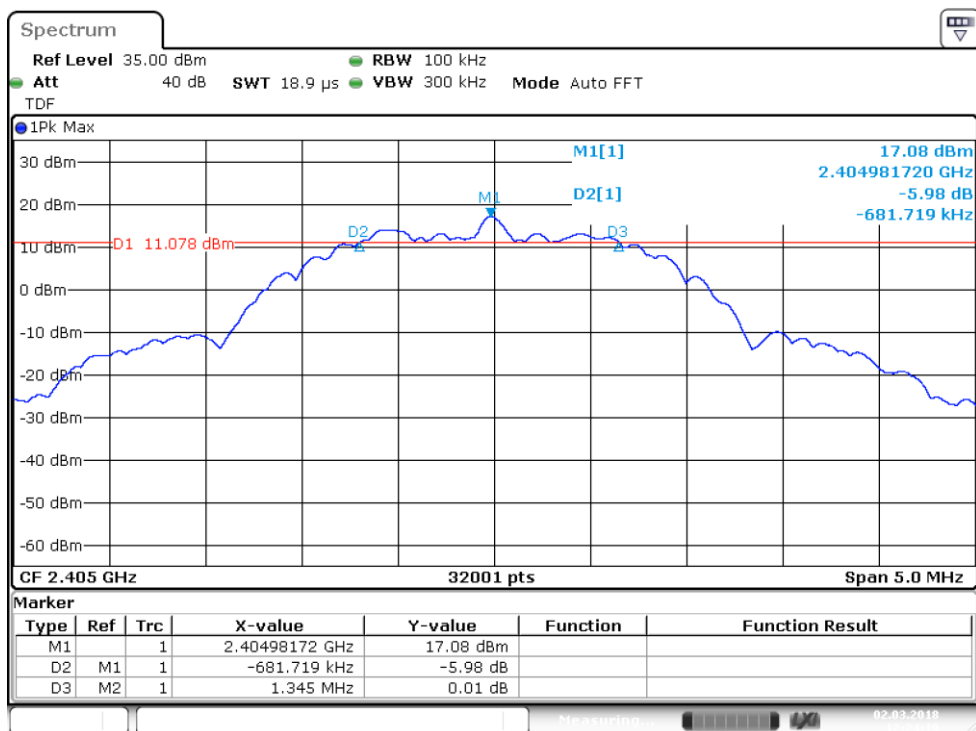


Figure 46: 6 dB bandwidth, Channel 11 low (EUT 1, MGM13S12N)

6 dB Bandwidth of the Channel

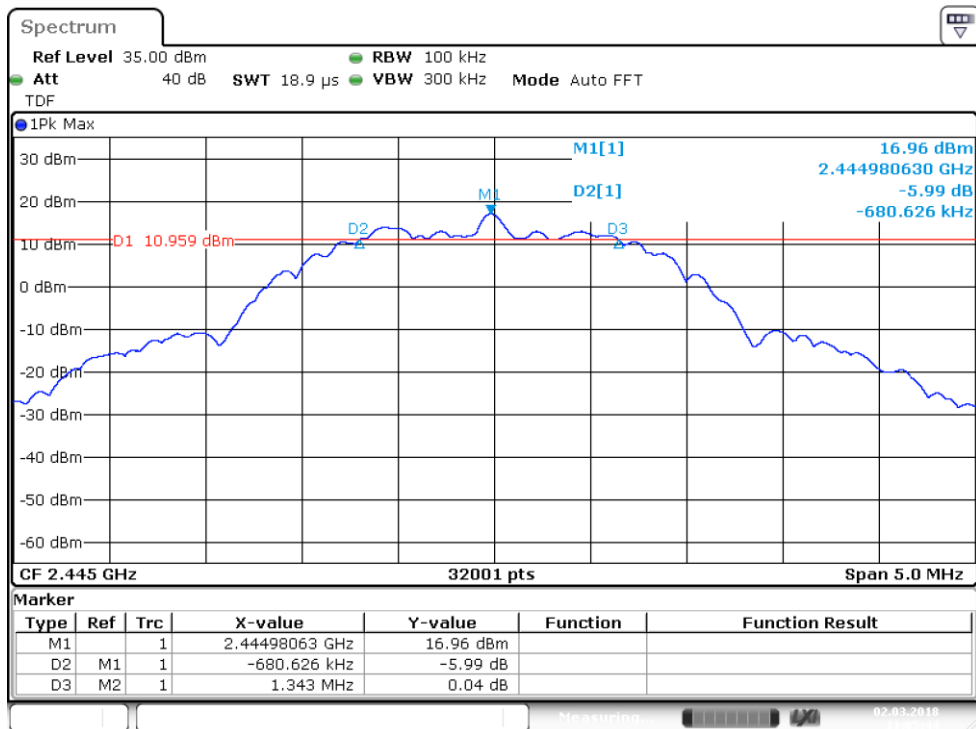


Figure 47: 6 dB bandwidth, channel 19 mid (EUT 1, MGM13S12N)

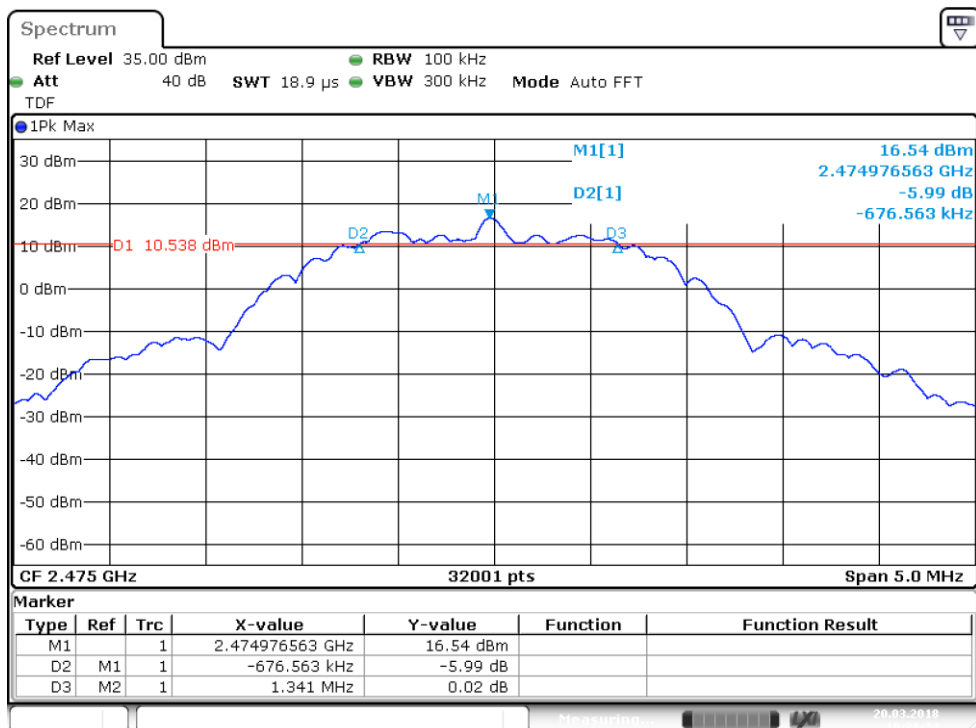


Figure 48: 6 dB bandwidth, Channel 25 high (EUT 1, MGM13S12N)

6 dB Bandwidth of the Channel

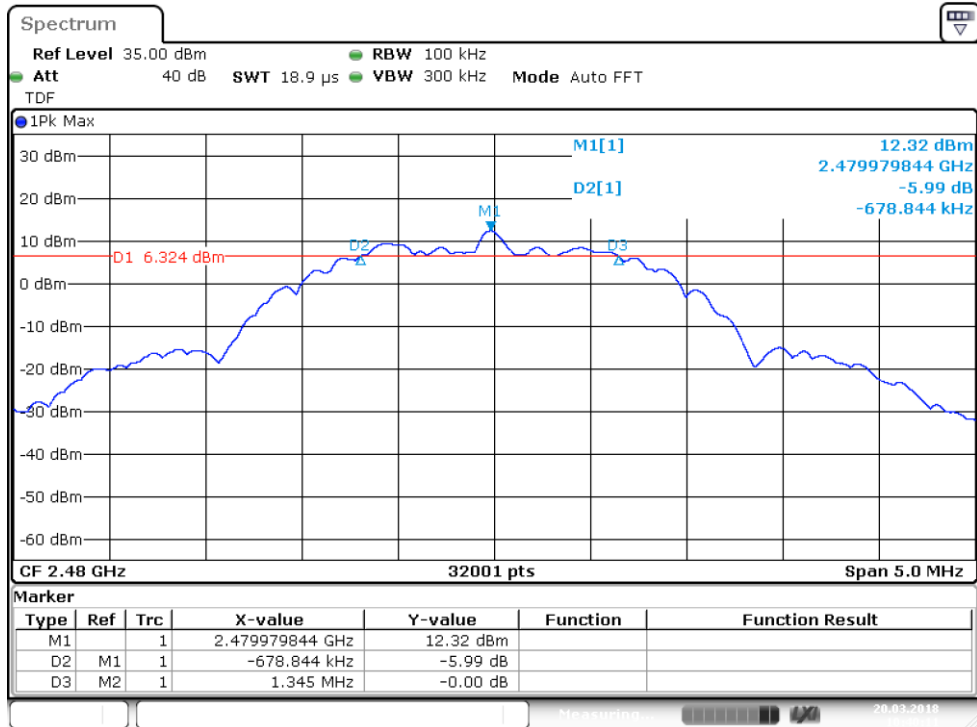


Figure 49: 6 dB bandwidth, Channel 26 high (EUT 1, MGM13S12N)

Table 39: 6 dB bandwidth test results (EUT 3, MGM13S02N)

Channel	6 dB BW [kHz]	Minimum limit [kHz]
11 Low	1285	500
19 Mid	1279	
26 High	1276	

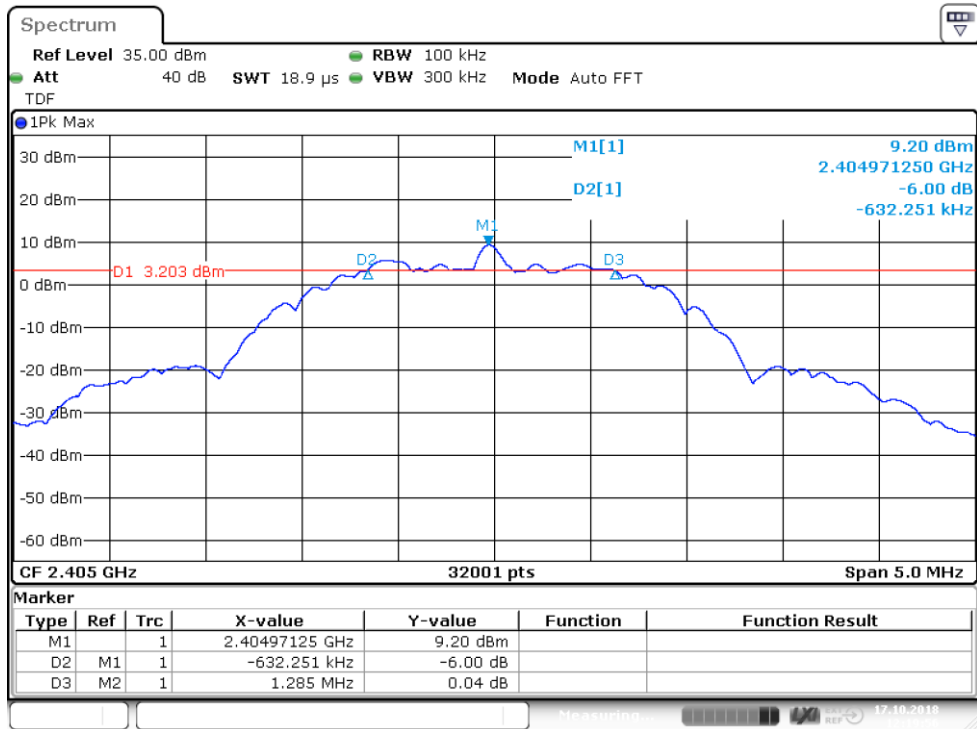


Figure 50: 6 dB bandwidth, Channel 11 low (EUT 3, MGM13S02N)

6 dB Bandwidth of the Channel

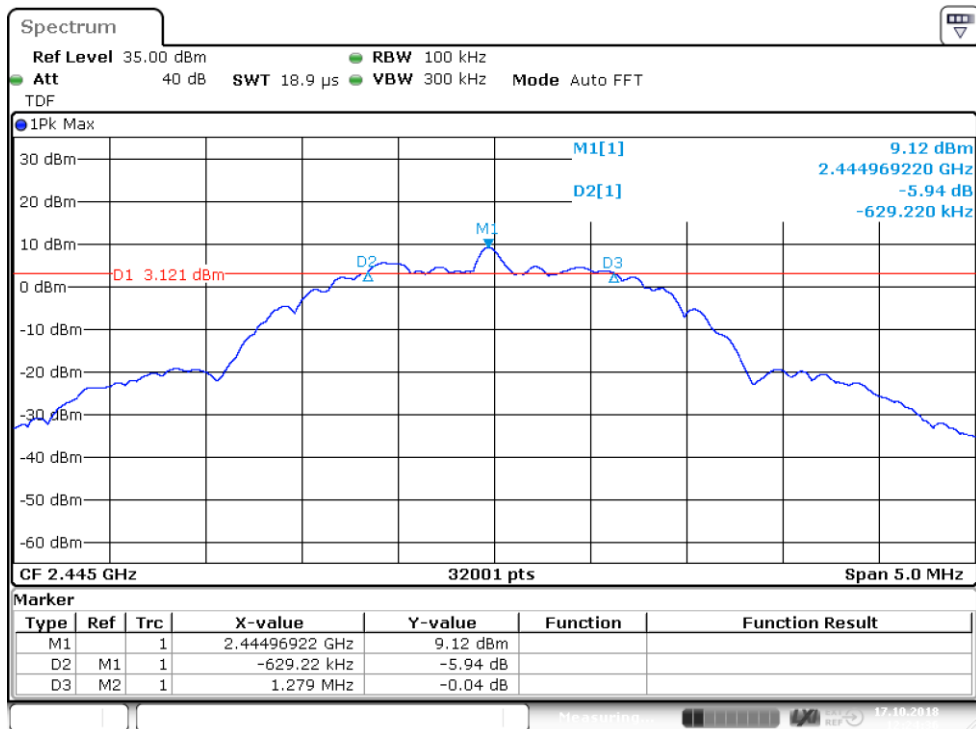


Figure 51: 6 dB bandwidth, channel 19 mid (EUT 3, MGM13S02N)

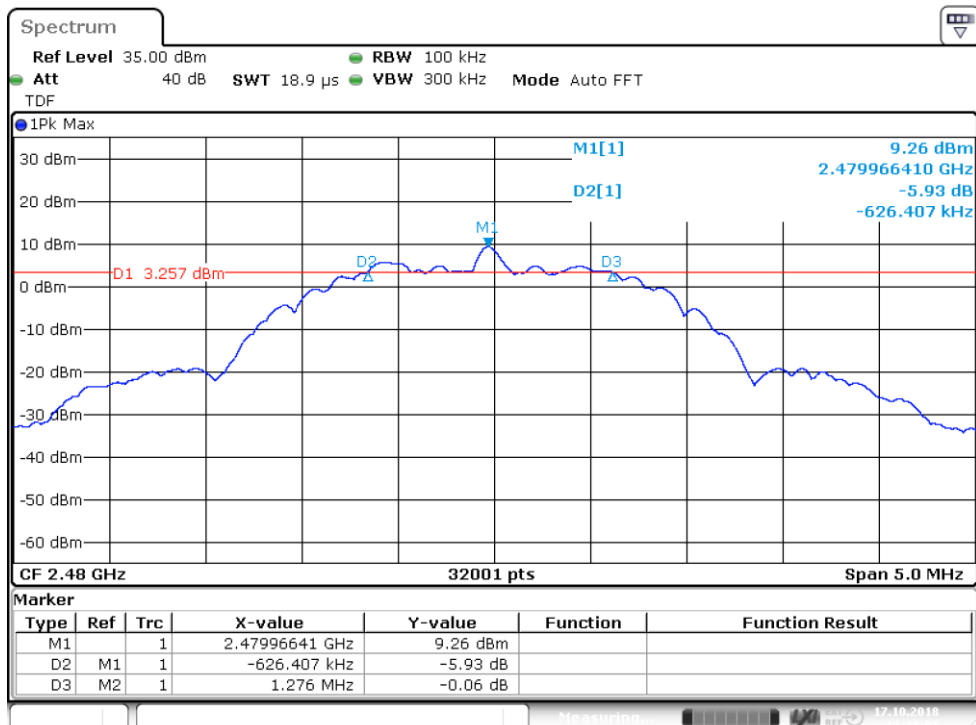


Figure 52: 6 dB bandwidth, Channel 26 high (EUT 3, MGM13S02N)

Power Spectral Density

Standard: ANSI C63.10 (2013)
Tested by: JAT
Date: 2 - 20 March 2018
Temperature: 23 ± 3 °C
Humidity: 16 - 60 % RH

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

Results:

Table 40: Power spectral density test results (EUT 1, MGM13S12N)

Channel	PSD dBm/3 kHz	Maximum limit [dBm/3kHz]
11 Low	6.91	+8.00
19 Mid	6.74	
25 High	6.25	
26 High	2.12	

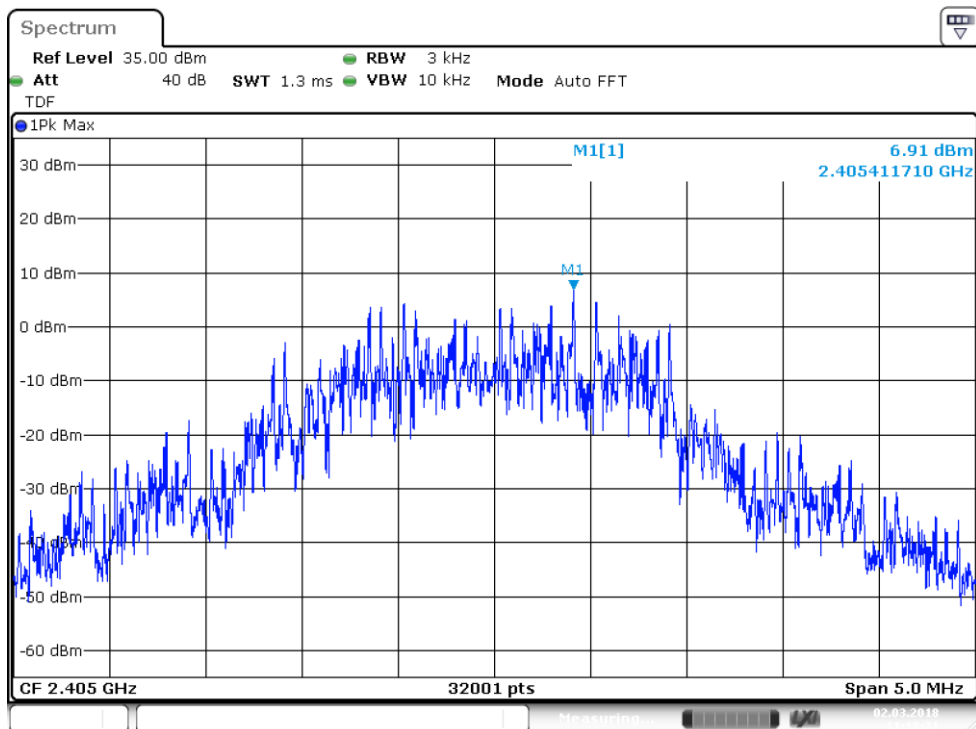


Figure 53: Power spectral density, Channel 11 low (EUT 1, MGM13S12N)

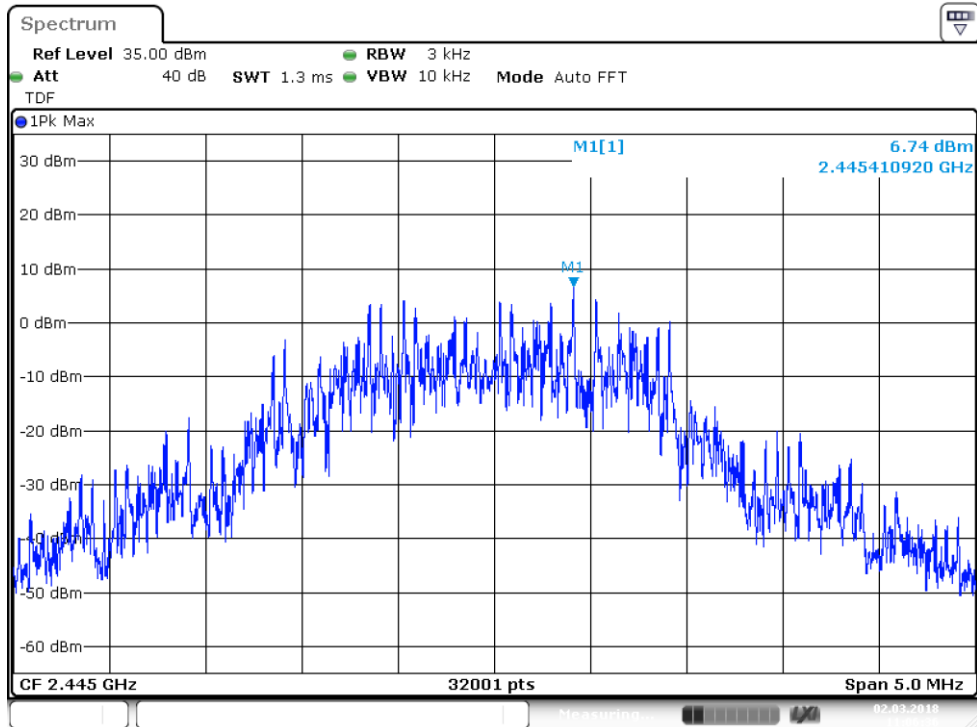


Figure 54: Power spectral density, channel 19 mid (EUT 1, MGM13S12N)

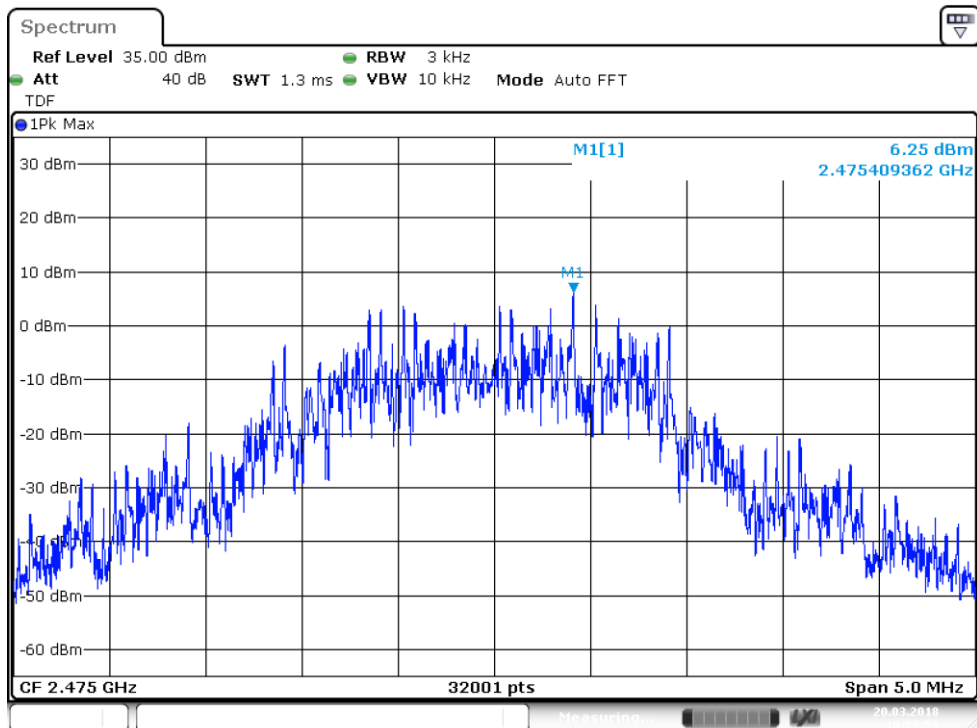


Figure 55: Power spectral density, Channel 25 high (EUT 1, MGM13S12N)

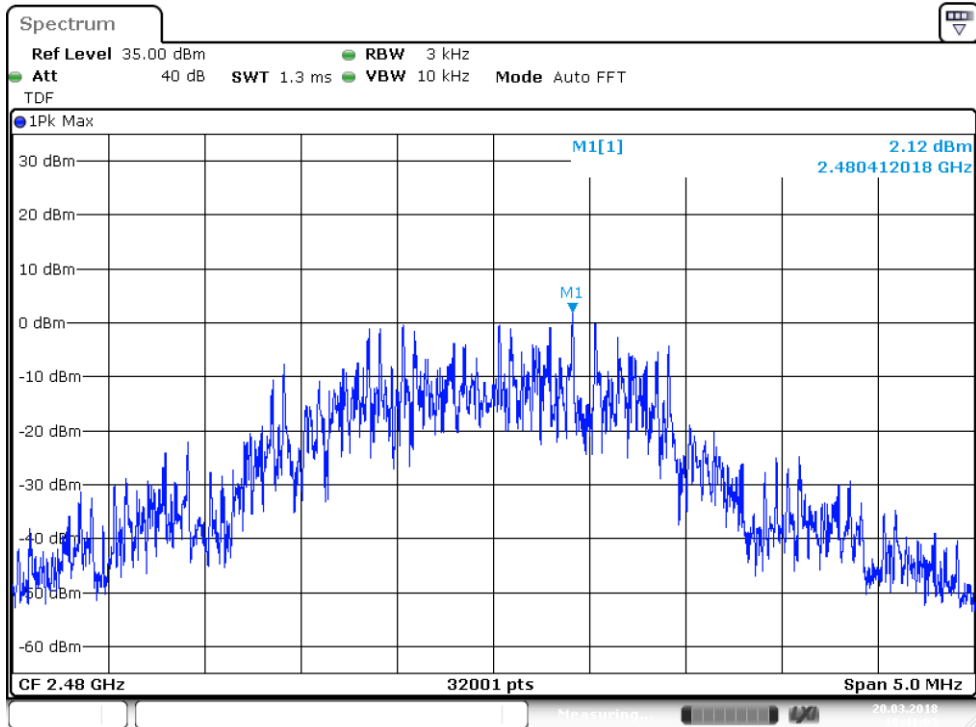


Figure 56: Power spectral density, Channel 26 high (EUT 1, MGM13S12N)

99% Occupied Bandwidth

Standard: RSS-GEN (2014)
Tested by: JAT MIH
Date: 2 - 20 March 2018 17 October 2018
Temperature: 23 ± 3 °C
Humidity: 16 - 60 % RH

RSS-GEN 6.6

Results:

Table 41: 99% occupied bandwidth test results (EUT 1, MGM13S12N)

Channel	Limit	99 % BW [MHz]	Result
11 Low	-	2.238992531	PASS
19 Mid	-	2.228055373	PASS
25 High	-	2.234930158	PASS
26 High	-	2.245554826	PASS

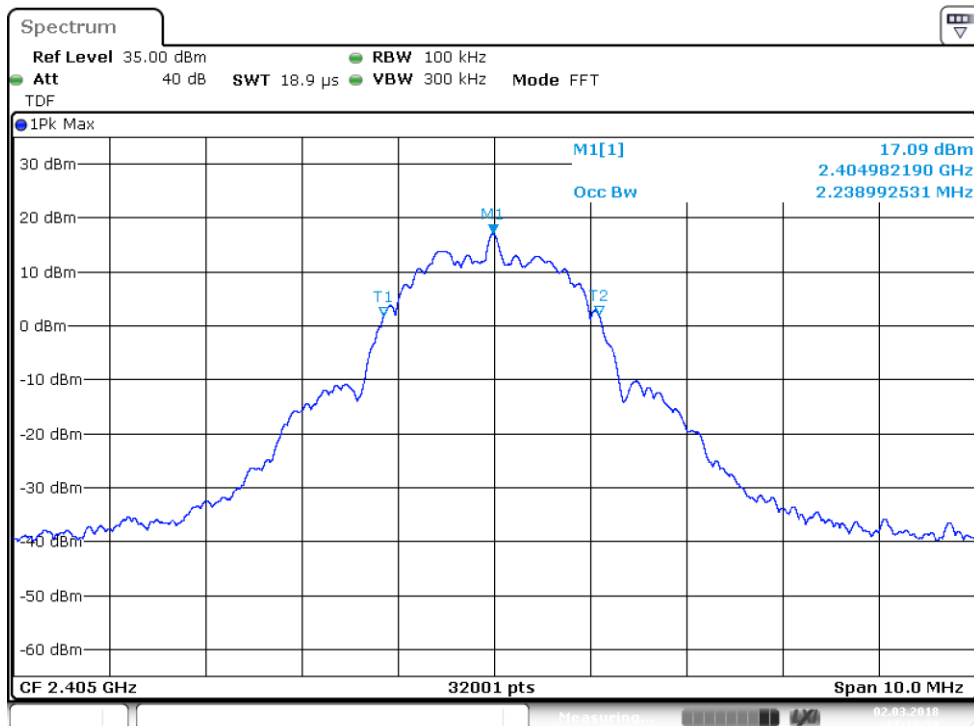


Figure 57: 99% OBW, Channel 11 low (EUT 1, MGM13S12N)

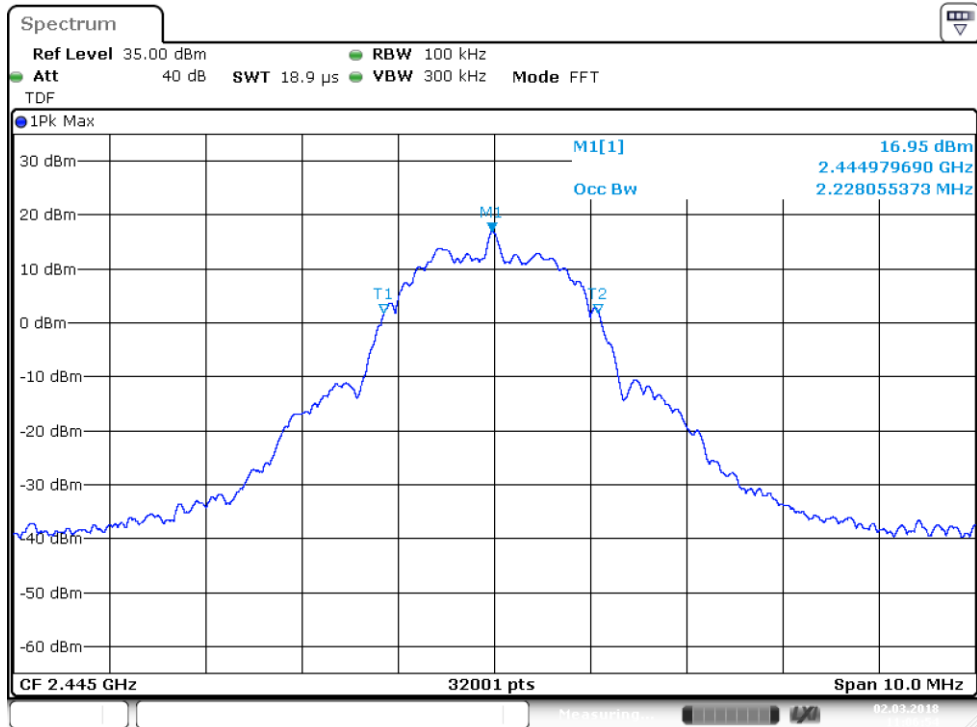


Figure 58: 99% OBW, Channel 19 mid (EUT 1, MGM13S12N)

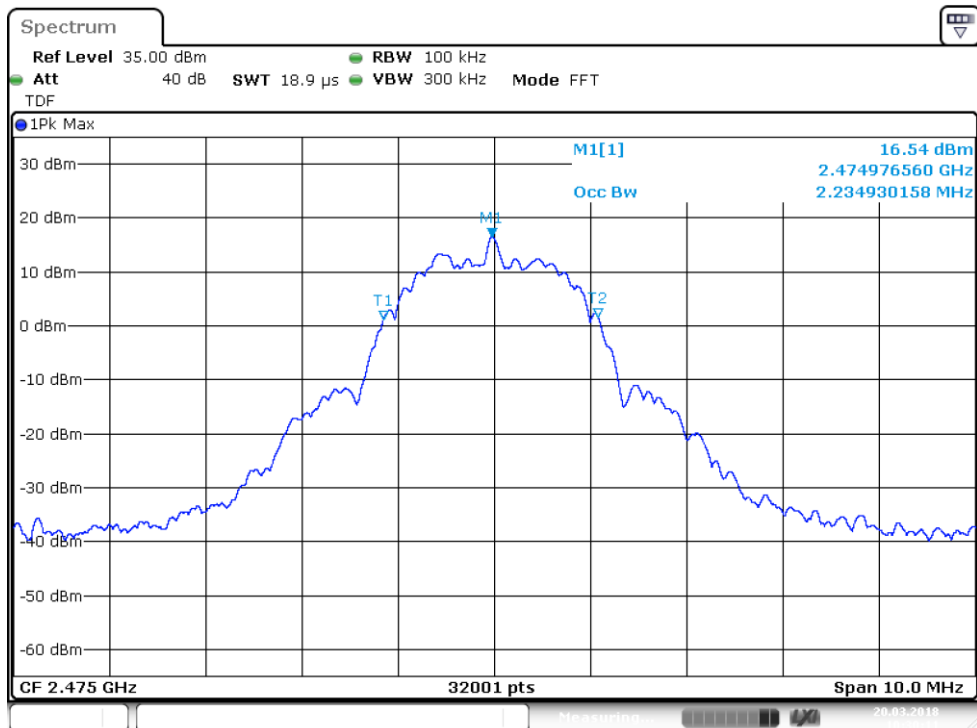


Figure 59: 99% OBW, Channel 25 high (EUT 1, MGM13S12N)

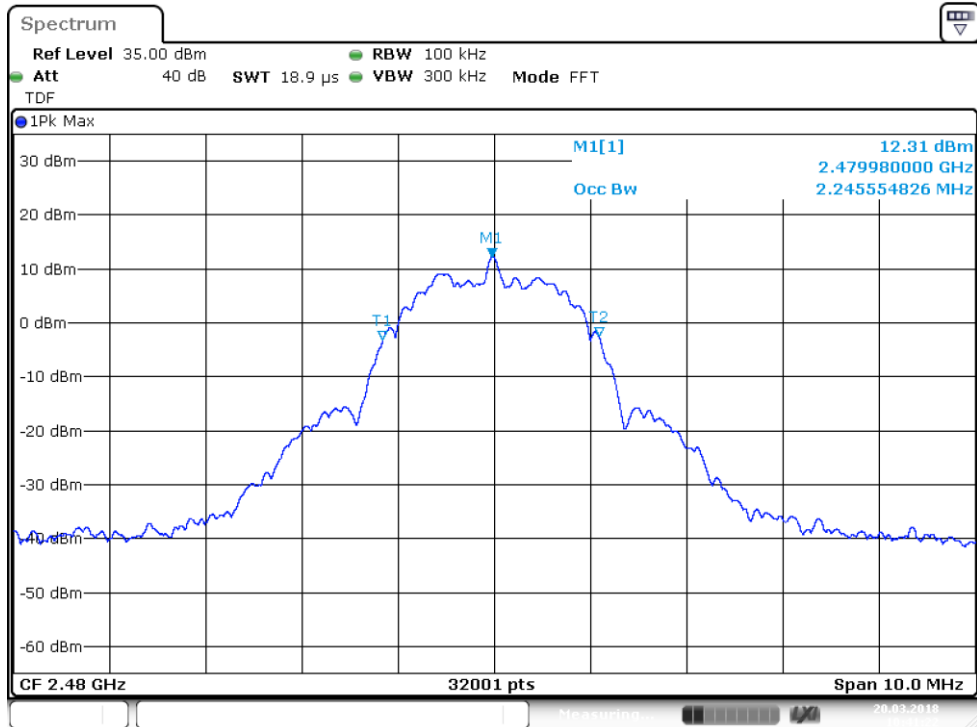


Figure 60: 99% OBW, Channel 26 high (EUT 1, MGM13S12N)

Table 42: 99% occupied bandwidth test results (EUT 3, MGM13S02N)

Channel	Limit	99 % BW [MHz]	Result
11 Low	-	2.237117590	PASS
19 Mid	-	2.244304865	PASS
26 High	-	2.246804787	PASS

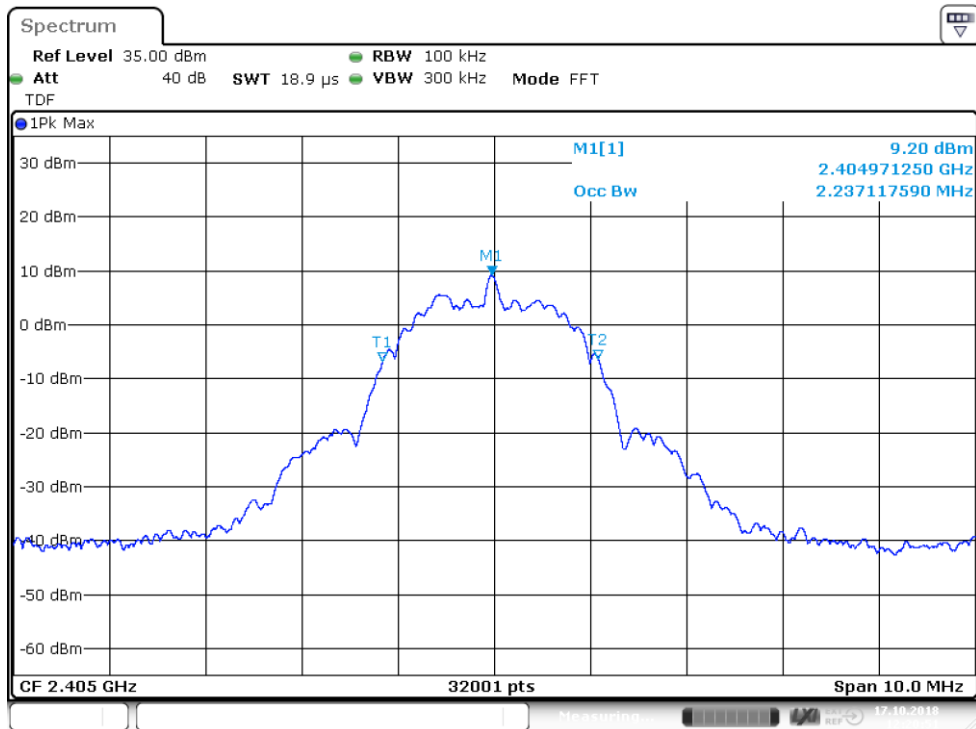


Figure 61: 99% OBW, Channel 11 low (EUT 3, MGM13S02N)

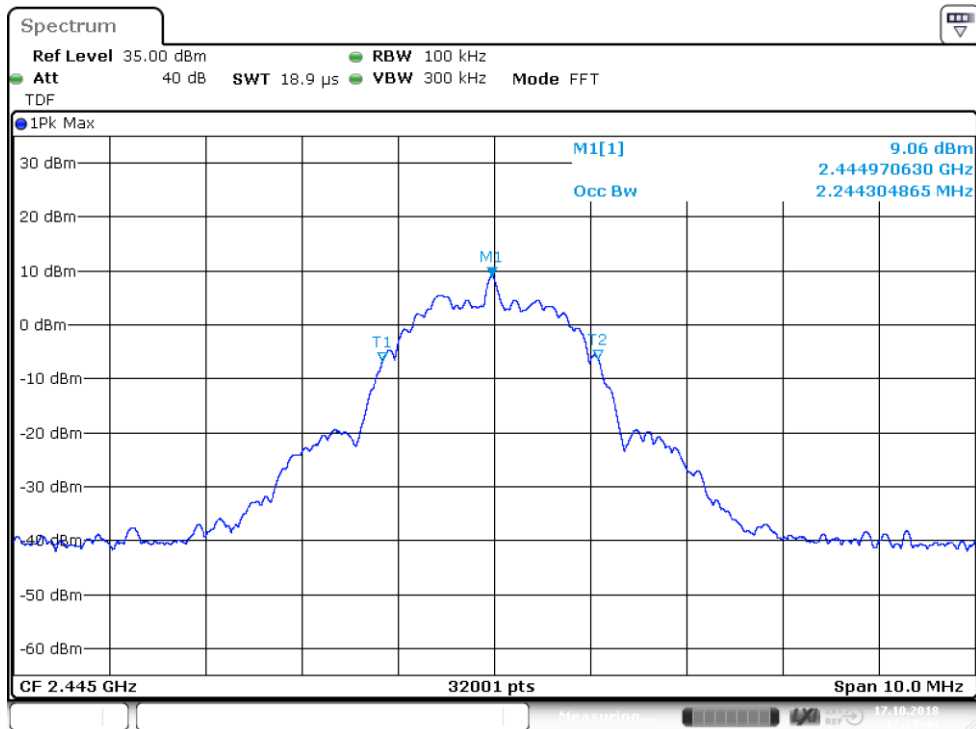


Figure 62: 99% OBW, Channel 19 mid (EUT 3, MGM13S02N)

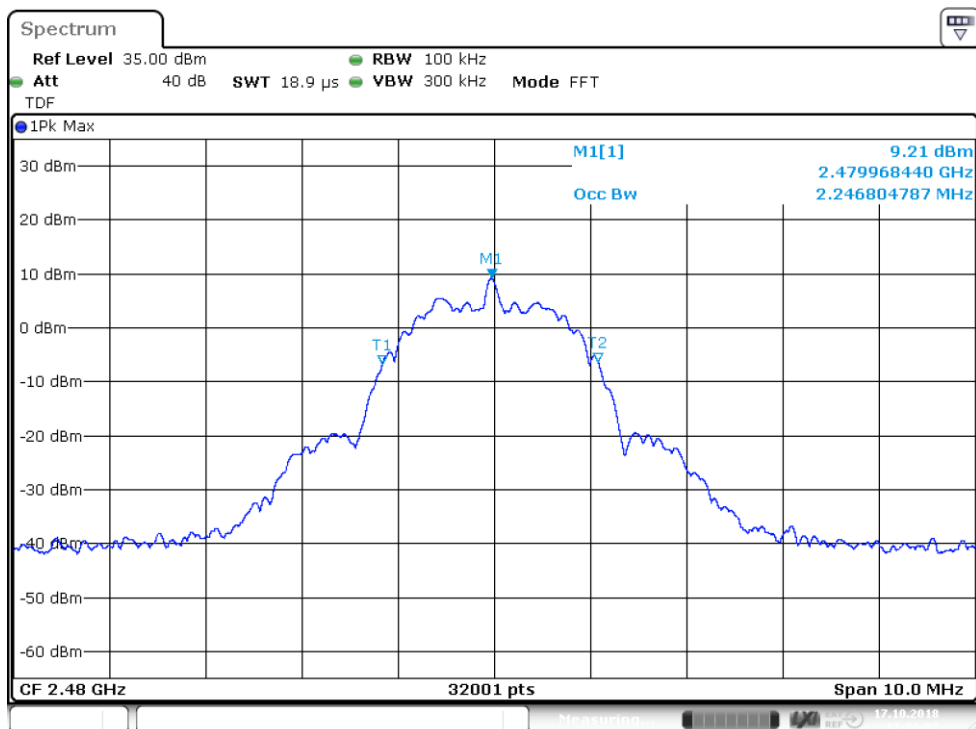


Figure 63: 99% OBW, Channel 26 high (EUT 3, MGM13S02N)

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	2018-01-08	2020-01-08
PREAMPLIFIER	CIAO	CA118-3123	inv:10278	2017-11-16	2018-11-16
PREAMPLIFIER	MICROWAVE	ALS1826-41-12	-	2017-11-16	2018-11-16
POWER SUPPLY	DELTA	SM 130-25D	inv:10406	-	-
ANTENNA	EMCO	3117	inv:9569	2017-03-23	2019-03-06
ANTENNA	EMCO	3160-09	inv:7294	2018-03-16	2019-03-16
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	2018-06-28	2019-06-28
ANTENNA	SCHWARZBECK	VULB 9168	inv:8911	2016-10-25	2018-10-25
TEMPERATURE/ HUMIDITY METER	DAVIS	Vantege PRO	inv:5296	2017-09-27	2018-09-27
HIGH PASS FILTER	WAINWRIGHT	WHKX4.0/18G-10SS	inv:10403	2018-09-18	2019-09-18