Report on the FCC and IC Testing of the Knorr-Bremse Systeme für Nutzfahrzeuge GmbH i-TAP Wireless Interface (ECU). Model: EZ2045 In accordance with FCC 47 CFR Part 15C and Industry Canada RSS-247 and Industry Canada RSS-GEN

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Authorised Signatory	Matthias Stumpe	2018-12-07	Stump

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

ENGINEERING STATEMENT
The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15C and Industry Canada RSS-247 and Industry Canada RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Martin Steindl	2018-12-07	Steindl Martin

Laboratory Accreditation	Laboratory recognition	Industry Canada test site registration
DAkkS Reg. No. D-PL-11321-11-02	Registration No. BNetzA-CAB-16/21-15	3050A-2

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN:2016 and Issue 2 (2017-02) and Issue 4 (2014-11).

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Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	2018-07-09
2	Corrected type designation. Added FCC- und IC-ID.	2018-09-27
3	Added RF-Exposure	2018-11-29
4	Correction of distance of IC limit from 5 mm to 2 cm on page 73.	2018-12-07

Table 1

1.2 Introduction

Applicant	Knorr-Bremse Systeme für Nutzfahrzeuge GmbH
Manufacturer	Knorr-Bremse Systeme für Nutzfahrzeuge GmbH
Model Number(s)	EZ2045
Serial Number(s)	17174 0020
Hardware Version(s)	
Software Version(s)	
Number of Samples Tested	1
Test Specification/Issue/Date	FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN:2016 and Issue 2 (2017-02) and Issue 4 (2014-11)
Test Plan/Issue/Date	N/A
Order Number Date	1054/4221469544 2018-06-07
Date of Receipt of EUT	2018-07-03
Start of Test	2018-07-02
Finish of Test	2018-07-06
Name of Engineer(s)	Martin Steindl
Related Document(s)	ANSI C63.10 (2013) KDB 662911 D01 v02r02

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15C and Industry Canada RSS-247 and Industry Canada RSS-GEN is shown below.

Section	Specification Clause	Test Description	Result	Comments/Base Standard
Configuration and Mode: Stand alone 802.11b				
2.1	15.247 (b), 5.4 and 6.12	Maximum Conducted Output Power	Pass	ANSI C63.10 (2013) KDB 662911 D01 v02r02
2.2	15.247 (e), 5.2 and 6.12	Power Spectral Density	Pass	ANSI C63.10 (2013) KDB 662911 D01 v02r02
2.3	15.247 (a)(2), 5.2 and 6.6	Emission Bandwidth	Pass	ANSI C63.10 (2013)
2.4	15.247 (d), 5.5 and N/A	Authorised Band Edges	Pass	ANSI C63.10 (2013)
2.5	15.205 N/A and 8.10	Restricted Band Edges	Pass	ANSI C63.10 (2013)
2.6	15.247 (d), 15.205, 5.5 and 6.13	Spurious Radiated Emissions	Pass	ANSI C63.10 (2013)
2.7	15.247 (d) and 5.5	Spurious Conducted Emissions	Pass	ANSI C63.10 (2013)

Table 2

1.4 Product Information

1.4.1 Technical Description

Following transmit settings have been used for testing:

Channel: 1/7/11 (see test result)
BandWidth: 0
NumFrames: 99
FrameLen: 1000
TxRate: 0
TxPower 27
DestAddr: 00:11:22:33:44:55
BSSID: 00:50:c2:5e:10:99
GuardInterval: 0
GreenField: 0
Antenna 0

Cca: 0
Agc: 1
ContpreambleMode: 0
Spreader: 1
Scrambler: 1
Preamble: 1
PreambleType: 0
TestPatternType: 3
PhyTestTxRate: 0
ModeSelect: 0/1/2 (g-, b-, n-Mode - see test result)

1.5 EUT Modification Record

The table below details modifications made to the EUT during the test programme.
The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
0	As supplied by the customer	Not Applicable	Not Applicable

Table 3

1.6 Test Location

TÜV SÜD Product Service conducted the following tests at our Straubing Test Laboratory.

Test Name	Name of Engineer(s)
Configuration and Mode: Stand alone 802.11b	
Maximum Conducted Output Power	Martin Steindl
Power Spectral Density	Martin Steindl
Emission Bandwidth	Martin Steindl
Authorised Band Edges	Martin Steindl
Restricted Band Edges	Martin Steindl
Spurious Radiated Emissions	Martin Steindl
Spurious Conducted Emissions	Martin Steindl

Table 4

Office Address:

Äußere Frühlingstraße 45
94315 Straubing
Germany

2 Test Details

2.1 Maximum Conducted Output Power

2.1.1 Specification Reference

FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN, Clause 15.247 (b), 5.4 and 6.12

2.1.2 Equipment Under Test and Modification State

EZ2045, S/N: K131606V00-C - Modification State 0

2.1.3 Date of Test

2018-07-03 to 2018-07-04

2.1.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.9.1.1.

2.1.5 Environmental Conditions

Ambient Temperature 24.0 °C
Relative Humidity 45.0 %

2.1.6 Test Results

Stand alone 802.11b/g/n

Testing was performed on the with the highest conducted output power. This was.

Mode	2412 MHz	2442 MHz	2462 MHz
B	49.5 mW	52.0 mW	54.5 mW
G	29.6 mW	29.0 mW	33.7 mW
N	27.3 mW	30.7 mW	32.7 mW

Table 5

FCC 47 CFR Part 15, Limit Clause 15.247 (b)(3)

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

Industry Canada RSS-247, Limit Clause 5.4 (b)

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e) of the specification.

2.1.7 Test Location and Test Equipment Used

This test was carried out in Non shielded room.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
NRVS	Rohde & Schwarz	838625/016	19362	24	2019-05
NRV-Z31	Rohde & Schwarz	836299/012	19568	24	2019-05

Table 6

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment
N/A - Not Applicable

2.2 Power Spectral Density

2.2.1 Specification Reference

FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN, Clause 15.247 (e), 5.2 and 6.12

2.2.2 Equipment Under Test and Modification State

EZ2045, S/N: K131606V00-C - Modification State 0

2.2.3 Date of Test

2018-07-03 to 2018-07-04

2.2.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.10.2.

2.2.5 Environmental Conditions

Ambient Temperature 24.0 °C
Relative Humidity 45.0 %

2.2.6 Test Results

Stand alone 802.11b/g/n

Mode	2412 MHz	2442 MHz	2462 MHz
B	6.3 dBm	6.9 dBm	6.3 dBm
G	-0.3 dBm	-1.8 dBm	-1.3 dBm
N	-0.4 dBm	-0.5 dBm	-1.0 dBm

Table 7

FCC 47 CFR Part 15, Limit Clause 15.247 (e)

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Industry Canada RSS-247, Limit Clause 5.2(b)

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

2.2.7 Test Location and Test Equipment Used

This test was carried out in Non shielded room.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
FSV40	Rohde & Schwarz	101448	20219	12	2019-01

Table 8

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment
N/A - Not Applicable

2.3 Emission Bandwidth

2.3.1 Specification Reference

FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN, Clause 15.247 (a)(2), 5.2 and 6.6

2.3.2 Equipment Under Test and Modification State

EZ2045, S/N: K131606V00-C - Modification State 0

2.3.3 Date of Test

2018-07-03 to 2018-07-04

2.3.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.8.2.

2.3.5 Environmental Conditions

Ambient Temperature 24.0 °C
Relative Humidity 45.0 %

2.3.6 Test Results

Stand alone 802.11b/g/n

Mode	Frequency (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
B	2412 MHz	10.140	16.483
G	2412 MHz	15.232	16.358
N	2412 MHz	15.523	17.443
B	2442 MHz	10.140	16.358
G	2442 MHz	15.443	16.316
N	2442 MHz	15.398	17.401
B	2462 MHz	12.020	16.313
G	2462 MHz	15.413	16.274
N	2462 MHz	15.398	17.318

Table 9

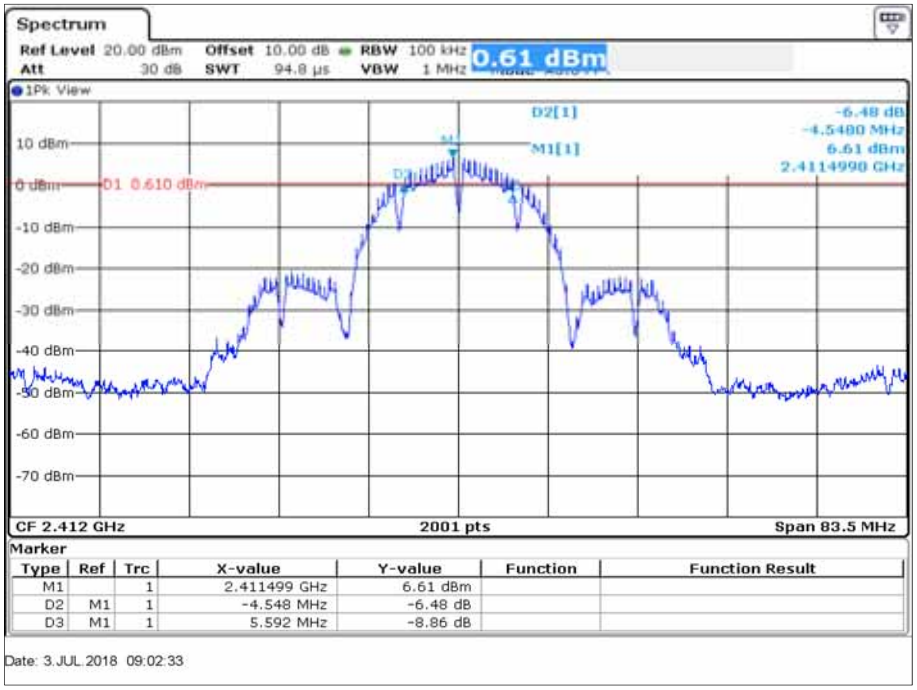

Figure 1 – Mode B – 2412 MHz – 6 dB Bandwidth

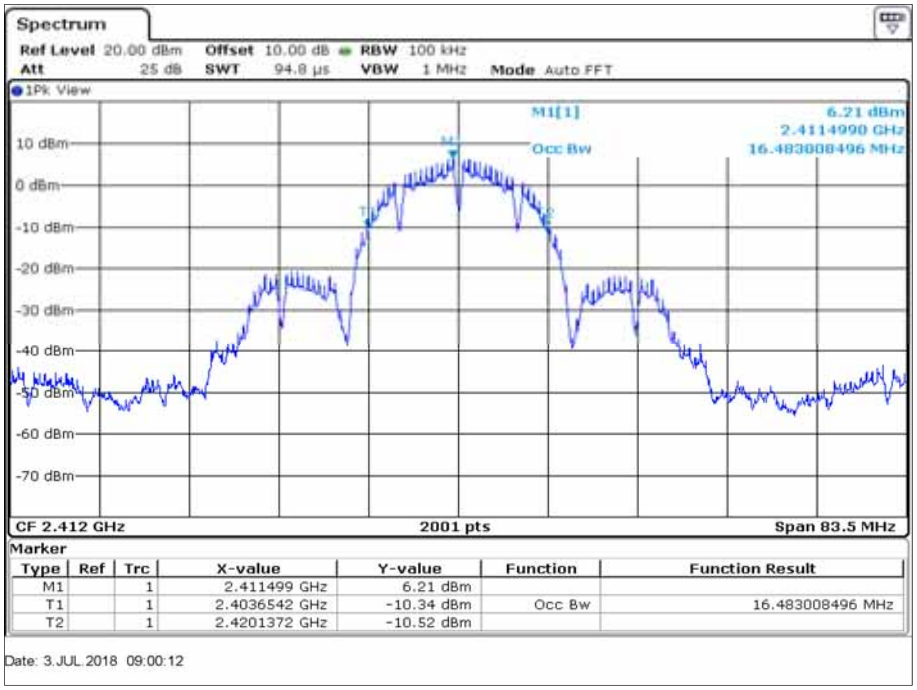

Figure 2 – Mode B – 2412 MHz – 99% Occupied Bandwidth

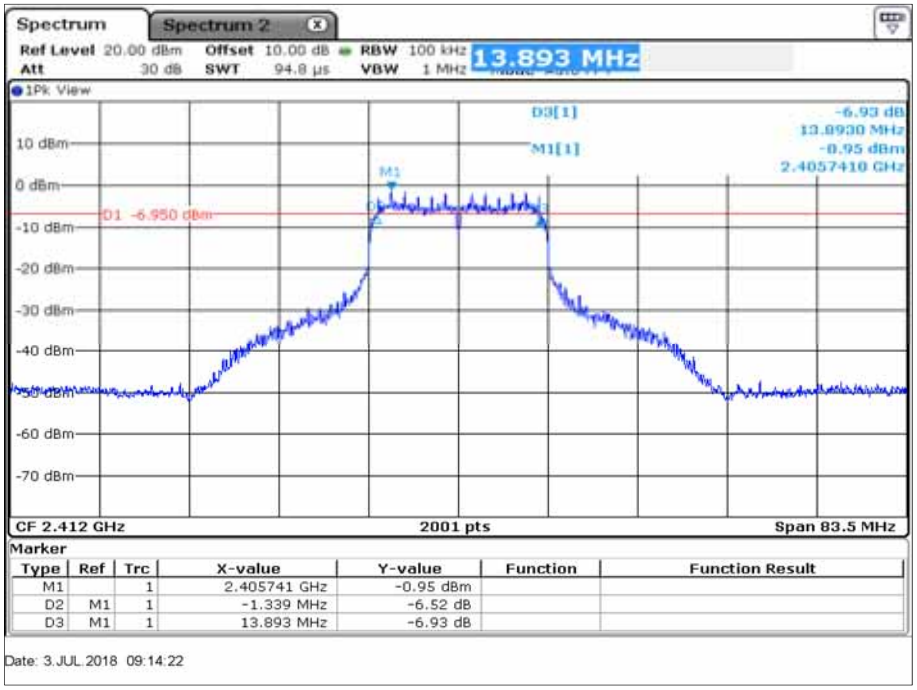

Figure 3 – Mode G – 2412 MHz – 6 dB Bandwidth

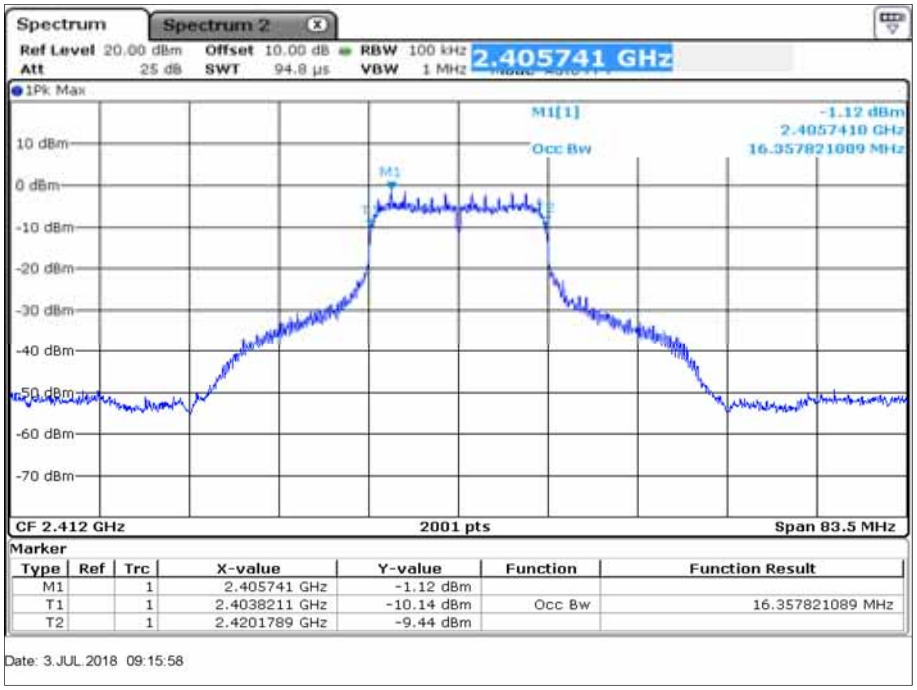

Figure 4 – Mode G 2412 MHz – 99% Occupied Bandwidth

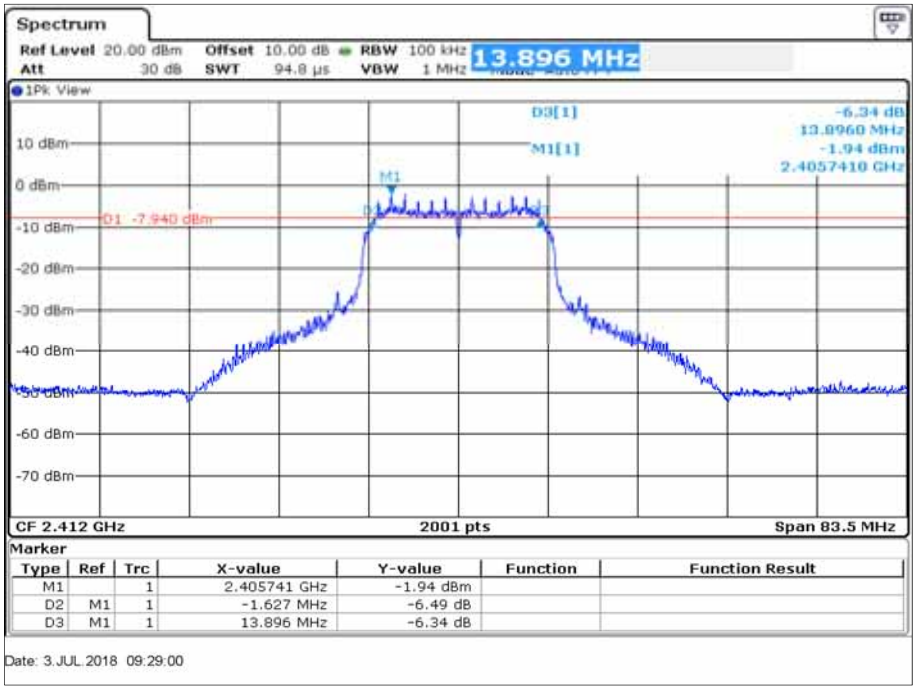

Figure 5 – Mode N – 2412 MHz – 6 dB Bandwidth

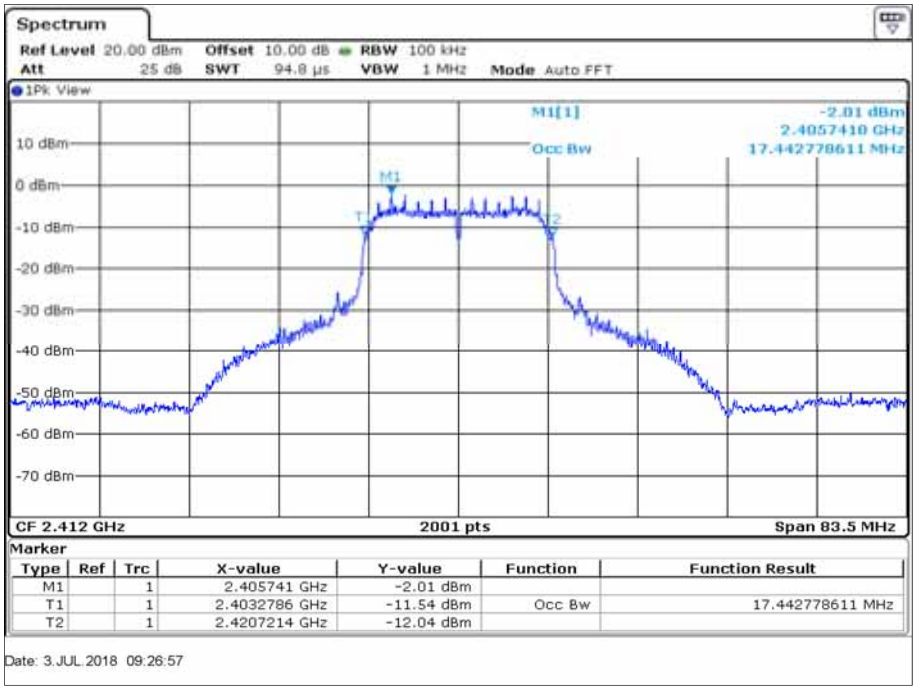

Figure 6 – Mode N – 2412 MHz – 99% Occupied Bandwidth

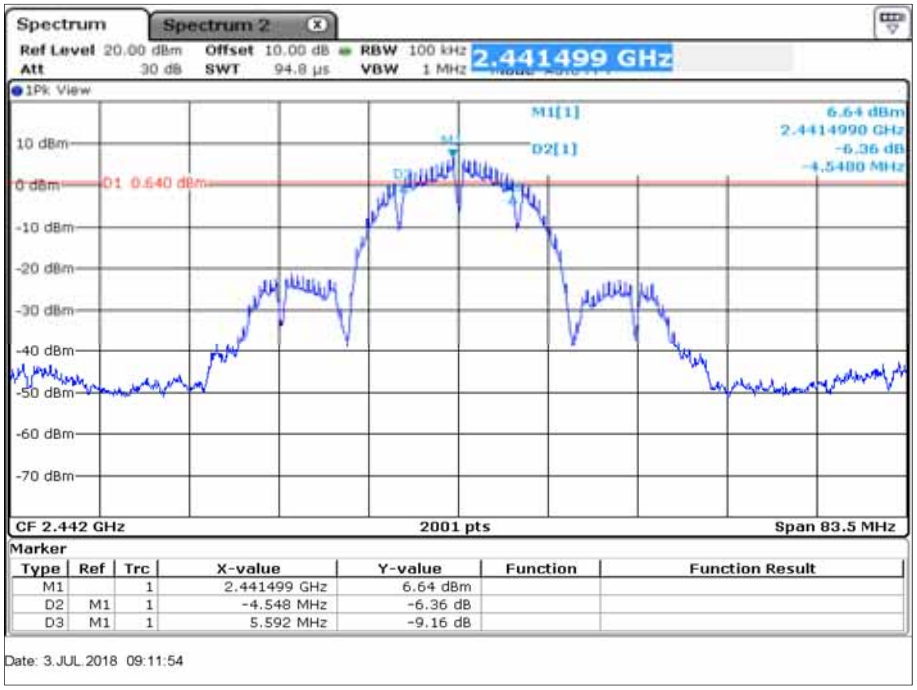

Figure 7 – Mode B – 2442 MHz – 6 dB Bandwidth

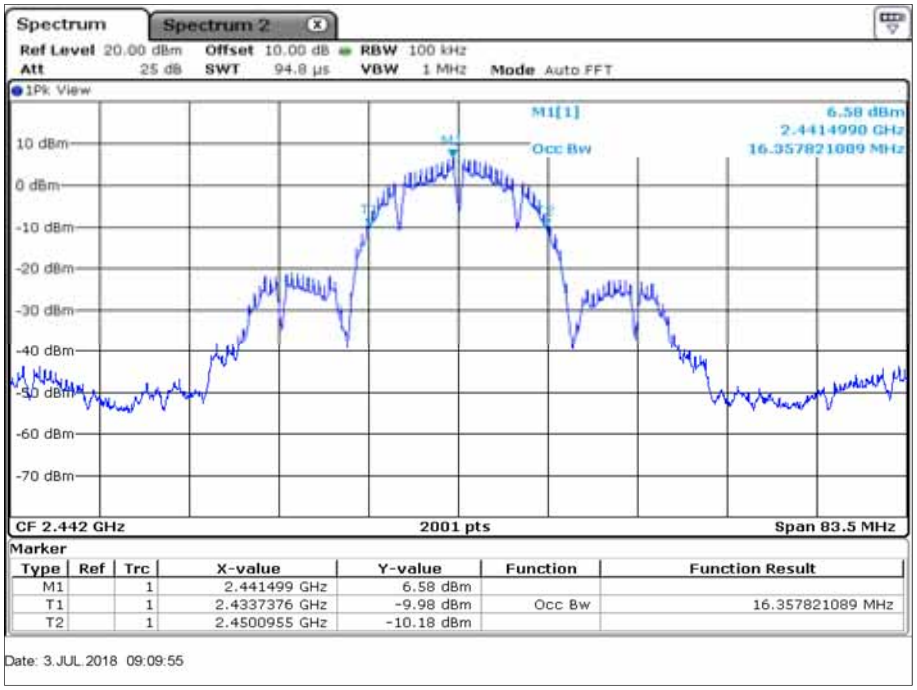

Figure 8 – Mode B – 2442 MHz – 99% Occupied Bandwidth

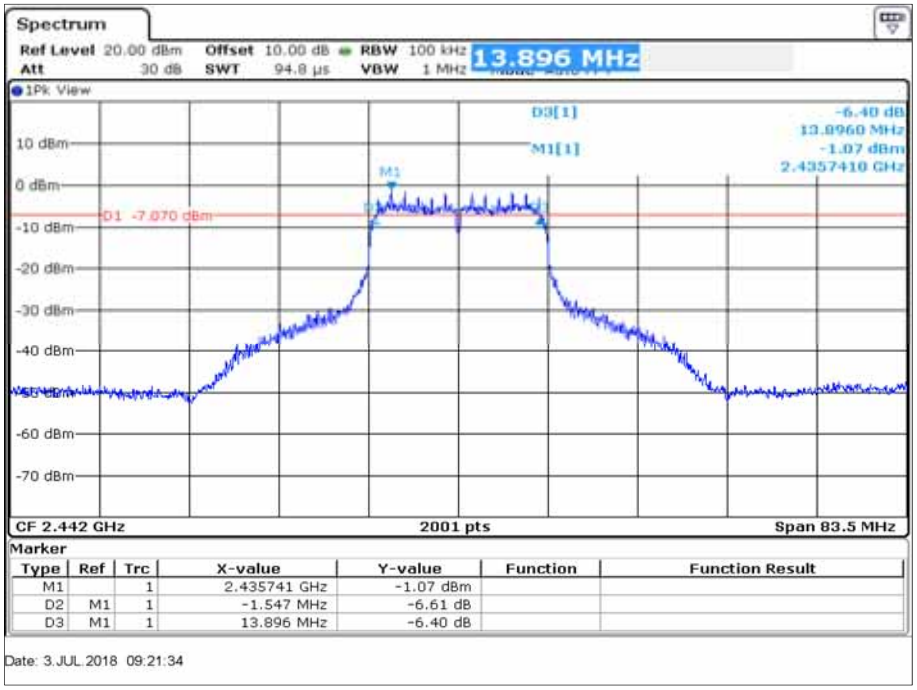

Figure 9 – Mode G – 2442 MHz – 6 dB Bandwidth

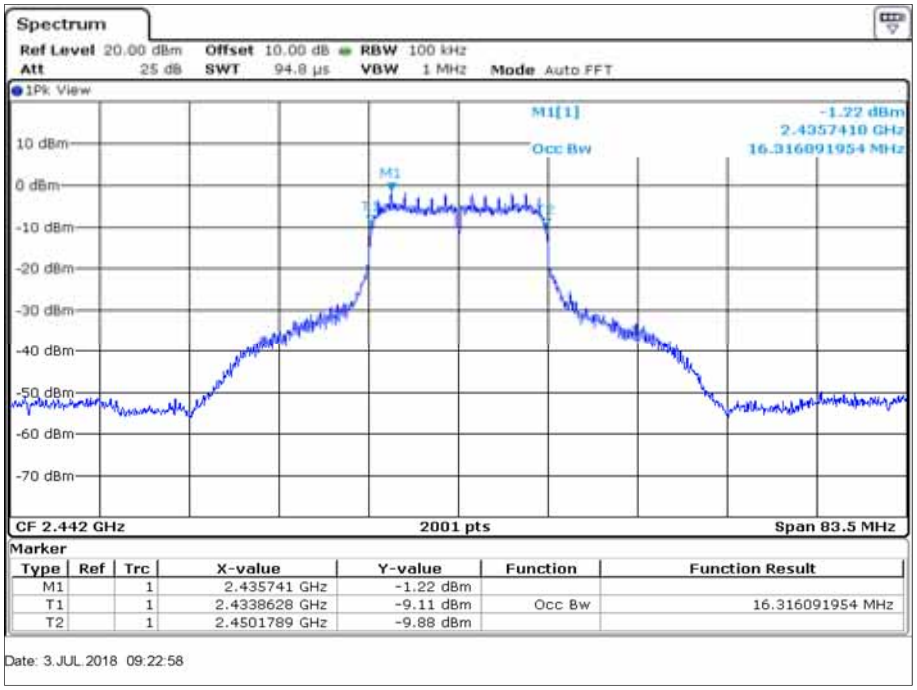

Figure 10 – Mode G – 2442 MHz – 99% Occupied Bandwidth

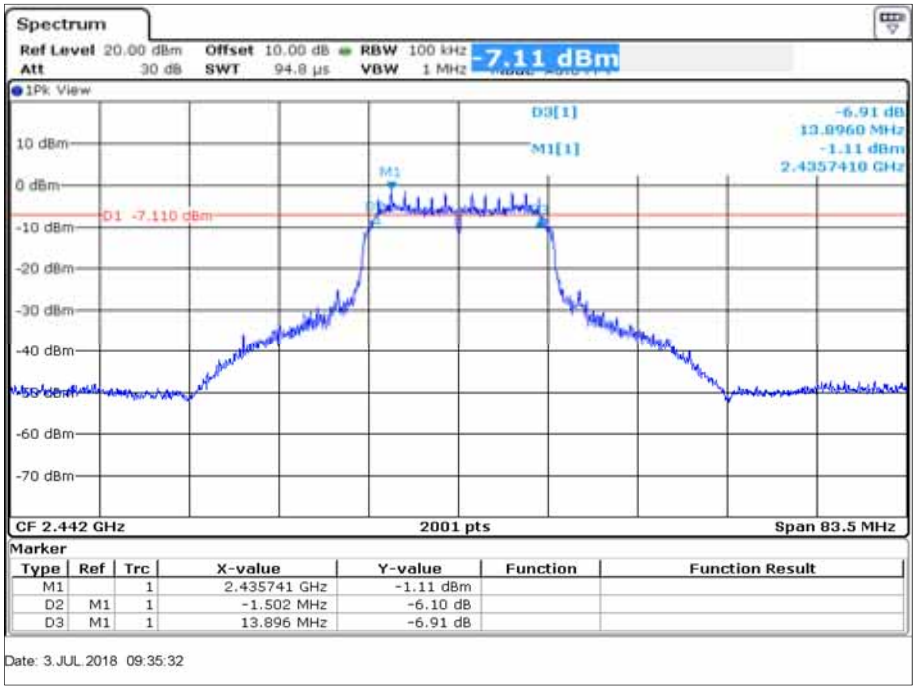

Figure 11 – Mode N – 2442 MHz – 6 dB Bandwidth

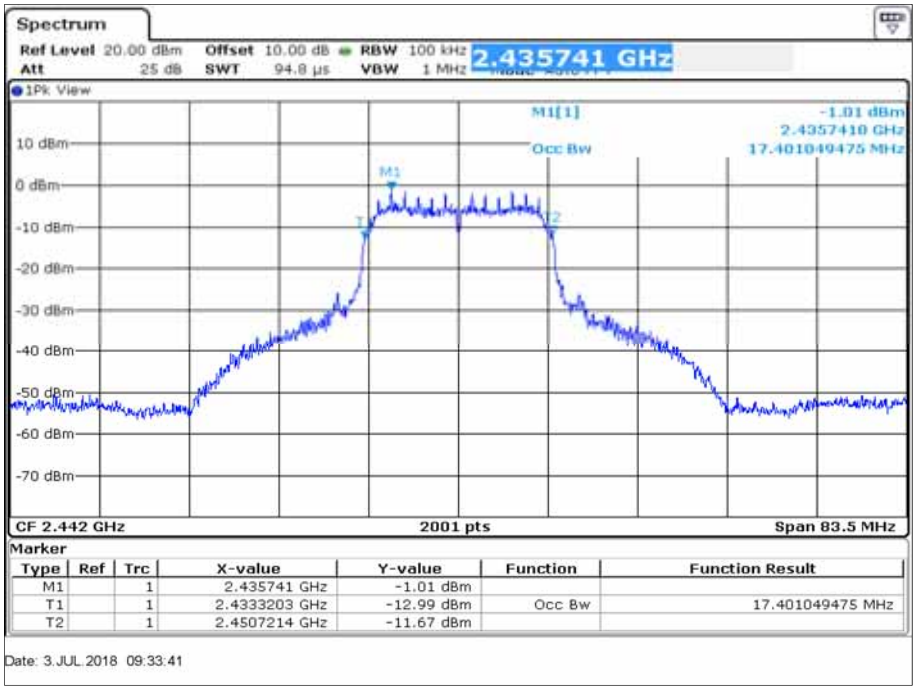

Figure 12 – Mode N – 2442 MHz – 99% Occupied Bandwidth

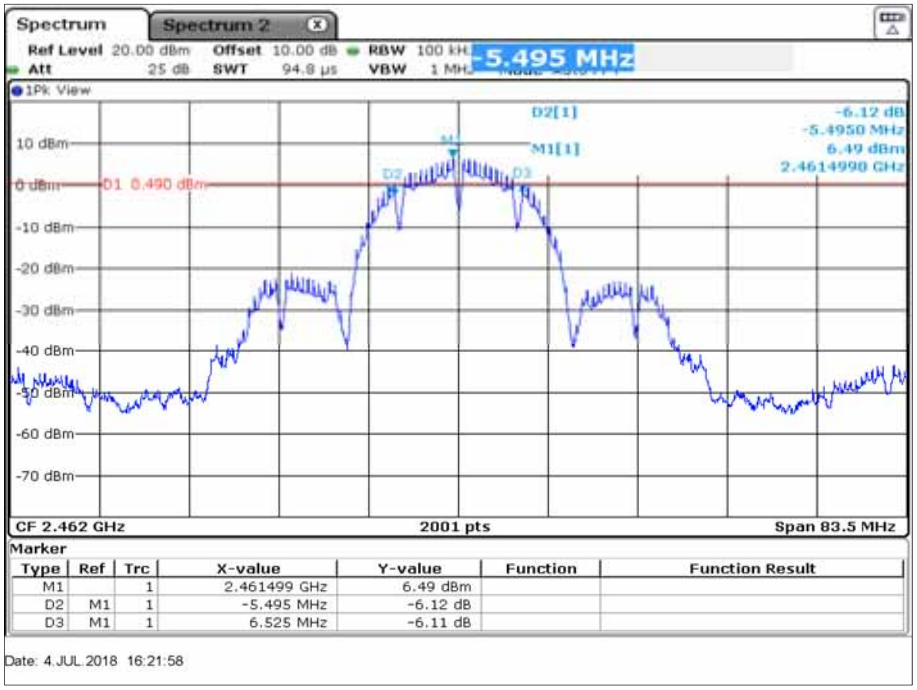

Figure 13 – Mode B – 2462 MHz – 6 dB Bandwidth

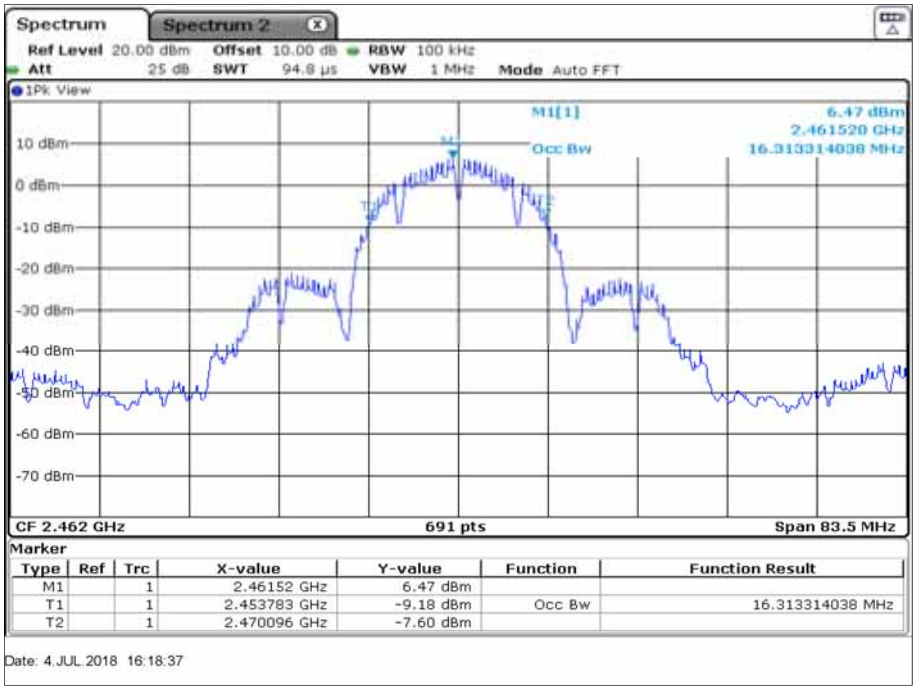

Figure 14 – Mode B – 2462 MHz – 99% Occupied Bandwidth

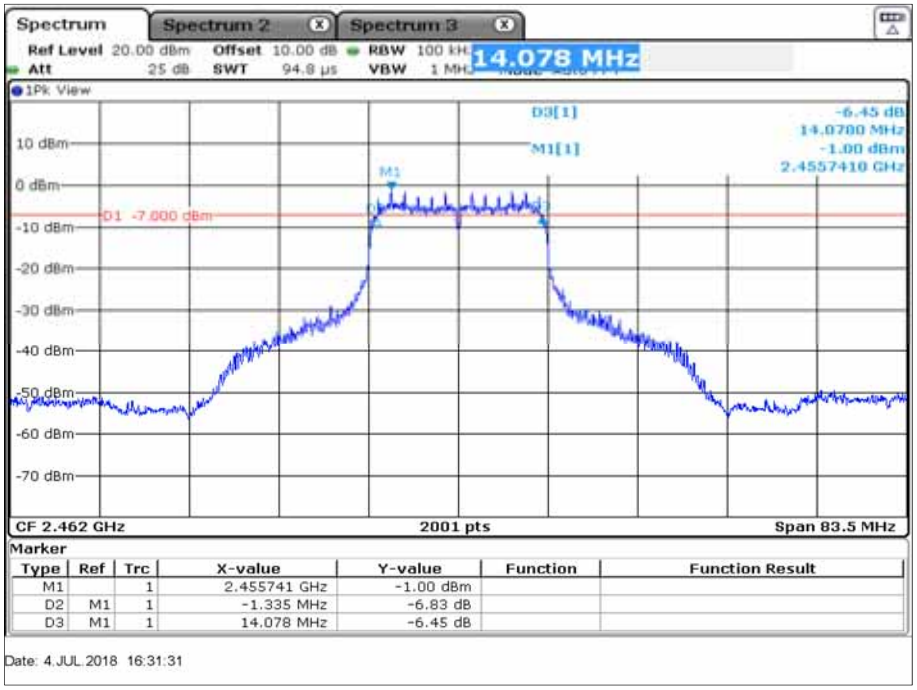

Figure 15 – Mode G – 2462 MHz – 6 dB Bandwidth

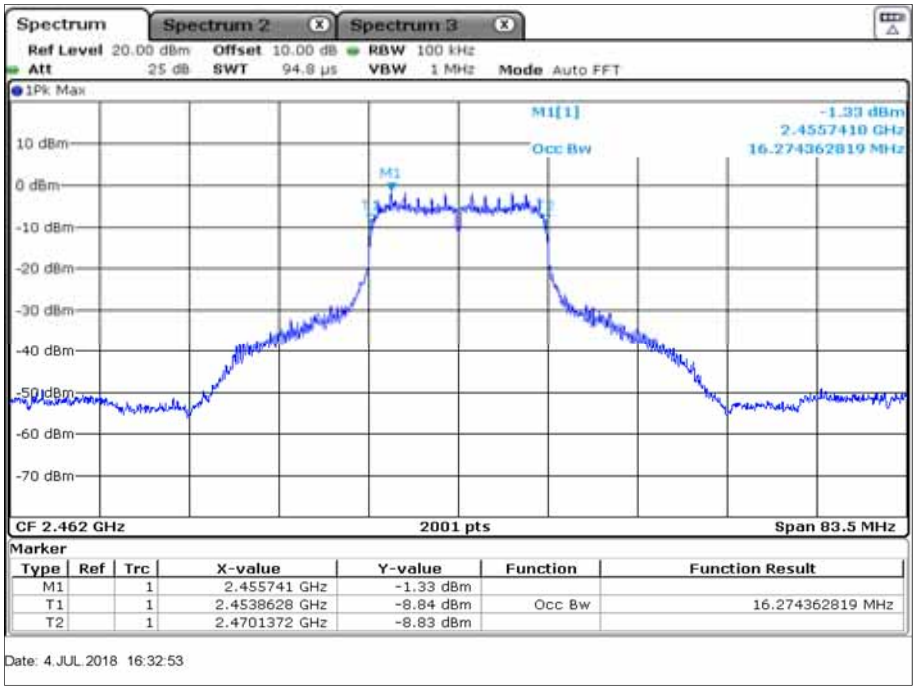

Figure 16 – Mode G – 2462 MHz – 99% Occupied Bandwidth

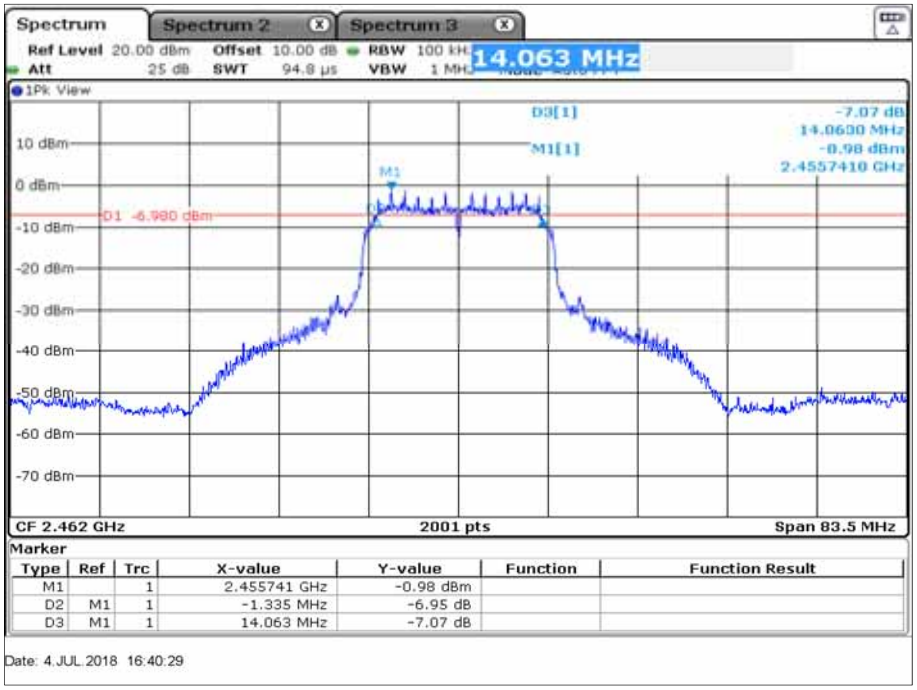

Figure 17 – Mode N – 2462 MHz – 6 dB Bandwidth

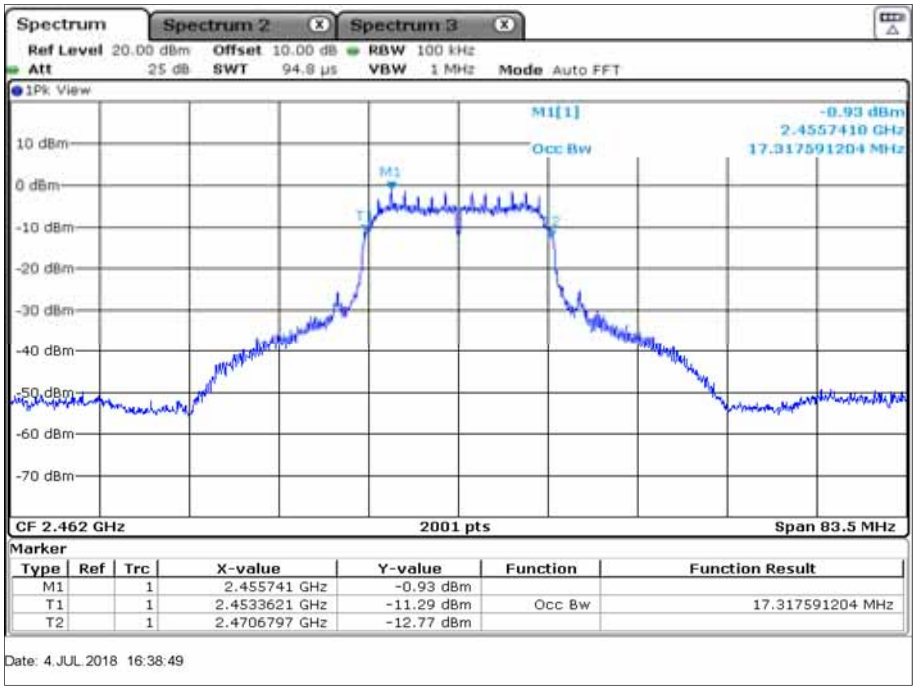

Figure 18 – Mode N – 2462MHz – 99% Occupied Bandwidth

<u>FCC 47 CFR Part 15, Limit Clause 15.247(a)(2) and Industry Canada RSS-247, Clause 5.2(a)</u>

The minimum 6 dB Bandwidth shall be at least 500 kHz.

2.3.7 Test Location and Test Equipment Used

This test was carried out in Non shielded room.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
FSV40	Rohde & Schwarz	101448	20219	12	2019-01

Table 10

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment
N/A - Not Applicable

2.4 Authorised Band Edges

2.4.1 Specification Reference

FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN, Clause 15.247 (d), 5.5 and N/A

2.4.2 Equipment Under Test and Modification State

EZ2045, S/N: K131606V00-C - Modification State 0

2.4.3 Date of Test

2018-07-04

2.4.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 6.10.4.

2.4.5 Environmental Conditions

Ambient Temperature 24.0 °C
Relative Humidity 45.0 %

2.4.6 Test Results

Stand alone 802.11b/g/n

Mode	Frequency (MHz)	Measured Frequency (MHz)	Peak Level
B	2412	2400.0	-26.8 dBc
G	2412	2400.0	-22.2 dBc
N	2412	2400.0	-22.9 dBc
B	2462	2483.5	-41.3 dBc
G	2462	2483.5	-35.6 dBc
N	2462	2483.5	-30.8 dBc

Table 11

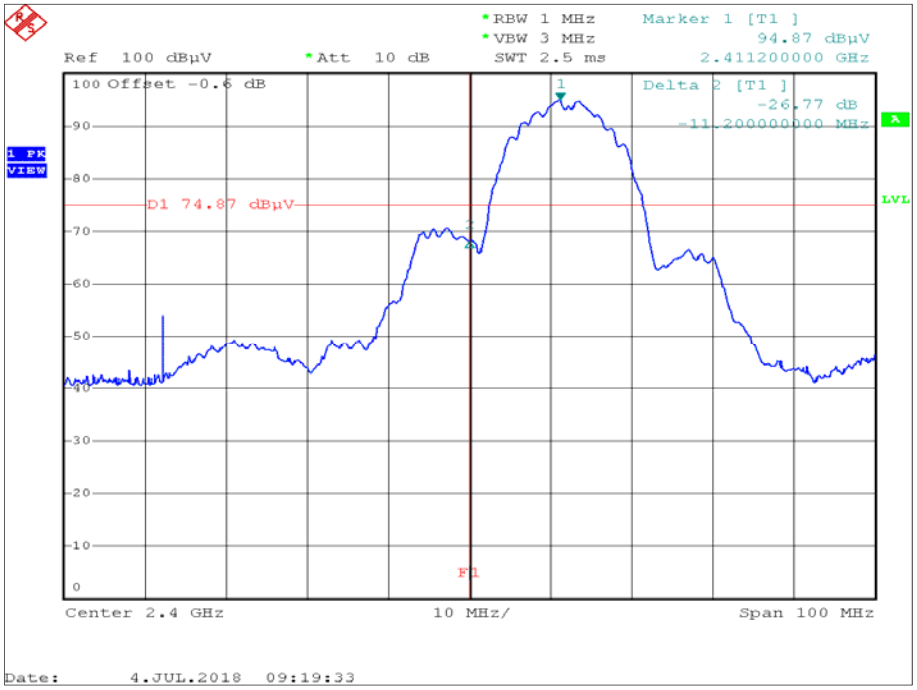

Figure 19 – Mode B - 2412 MHz - Measured Frequency 2400.0 MHz

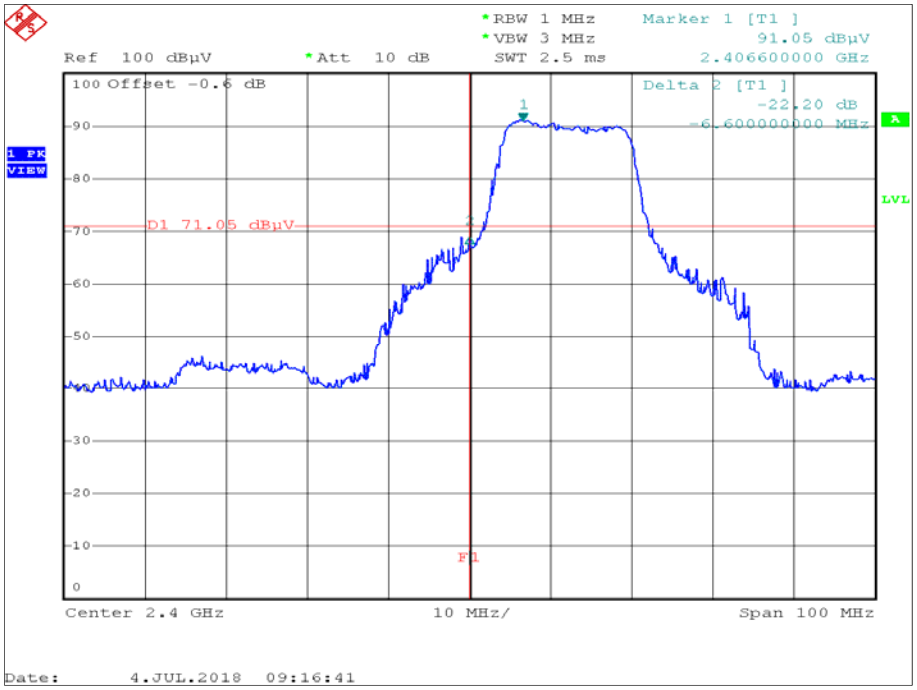

Figure 20 – Mode G - 2412 MHz - Measured Frequency 2400.0 MHz

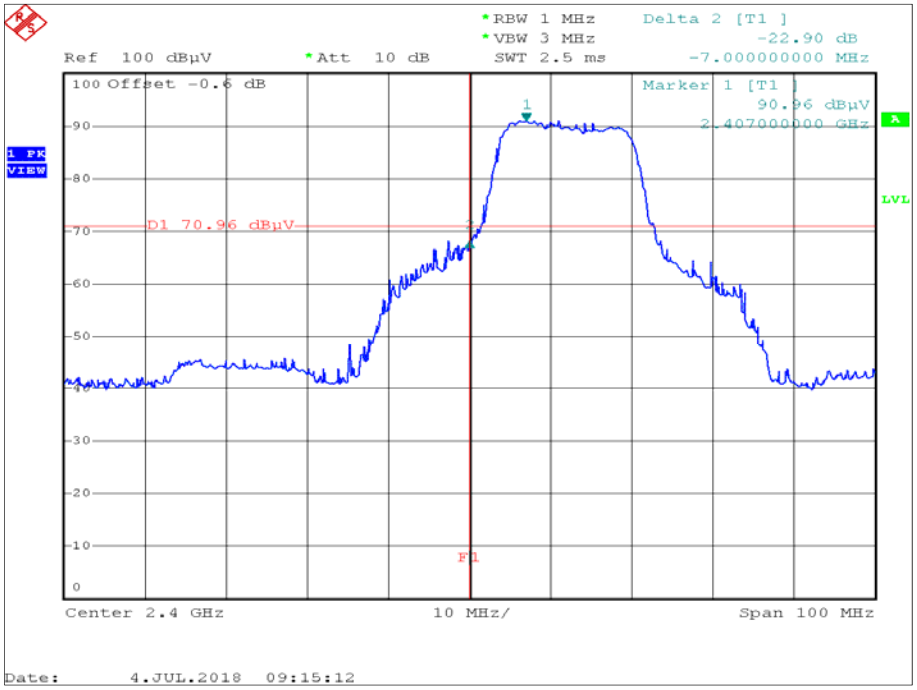

Figure 21 – Mode N - 2412 MHz - Measured Frequency 2400.0 MHz

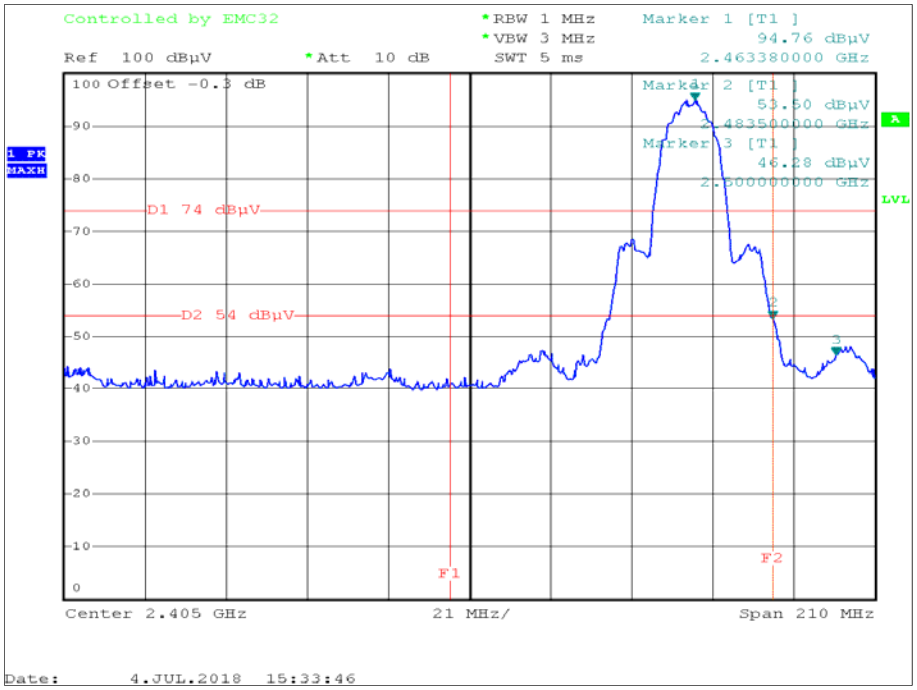

Figure 22 – Mode B - 2462 MHz - Measured Frequency 2483.5 MHz

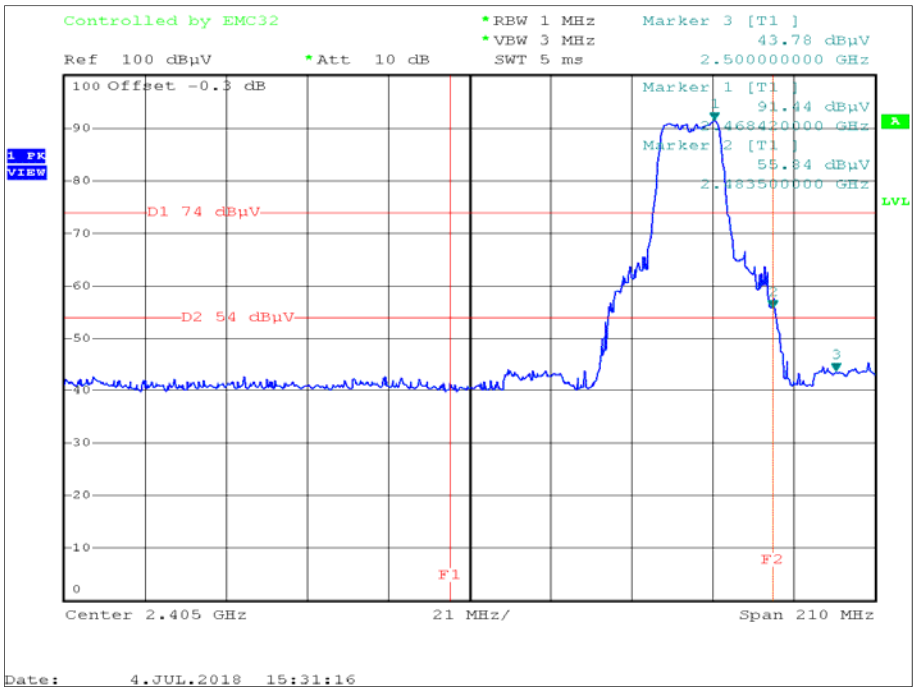

Figure 23 – Mode G - 2462 MHz - Measured Frequency 2483.5 MHz

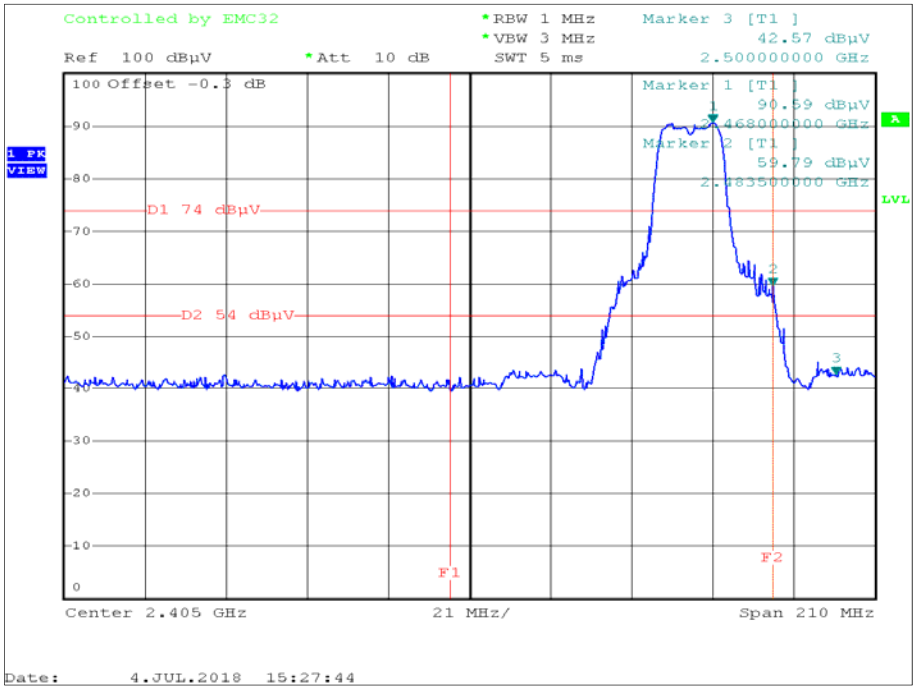

Figure 24 – Mode G - 2462 MHz - Measured Frequency 2483.5 MHz

FCC 47 CFR Part 15, Limit Clause 15.247 (d)

20 dB below the fundamental measured in a 100 kHz bandwidth using a peak detector. If the transmitter complies with the conducted power limits, based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB below the fundamental instead of 20 dB.

Industry Canada RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

2.4.7 Test Location and Test Equipment Used

This test was carried out in Semi anechoic room - cabin no. 8.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
FSP30	Rohde & Schwarz	100063	19533	12	2018-08
3115	EMCO	9508-4553	19383	24	2019-02

Table 12

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment
N/A - Not Applicable

2.5 Restricted Band Edges

2.5.1 Specification Reference

FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN, Clause 15.205 N/A and 8.10

2.5.2 Equipment Under Test and Modification State

EZ2045, S/N: K131606V00-C - Modification State 0

2.5.3 Date of Test

2018-07-04

2.5.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 6.10.5.

Plots for average measurements were taken in accordance with ANSI C63.10 clause 4.1.4.2.3. These are shown for information purposes and were used to determine the worst case measurement point. Final average measurements were then taken in accordance with ANSI C63.10 clause 4.1.4.2.2. to obtain the measurement result recorded in the test results tables.

The following conversion can be applied to convert from dBµV/m to µV/m:
10^(Field Strength in dBµV/m/20).

2.5.5 Environmental Conditions

Ambient Temperature 24.0 °C
Relative Humidity 45.0 %

2.5.6 Test Results

Stand alone 802.11b/g/n

Mode	Frequency (MHz)	Measured Frequency (MHz)	Peak Level (dBµV/m)	Average Level (dBµV/m)
B	2412	2390.0	52.4	---
G	2412	2390.0	55.6	38.1
N	2412	2390.0	56.0	39.8
B	2462	2483.5	53.5	---
G	2462	2483.5	55.8	40.6
N	2462	2483.5	59.8	41.3

Table 13

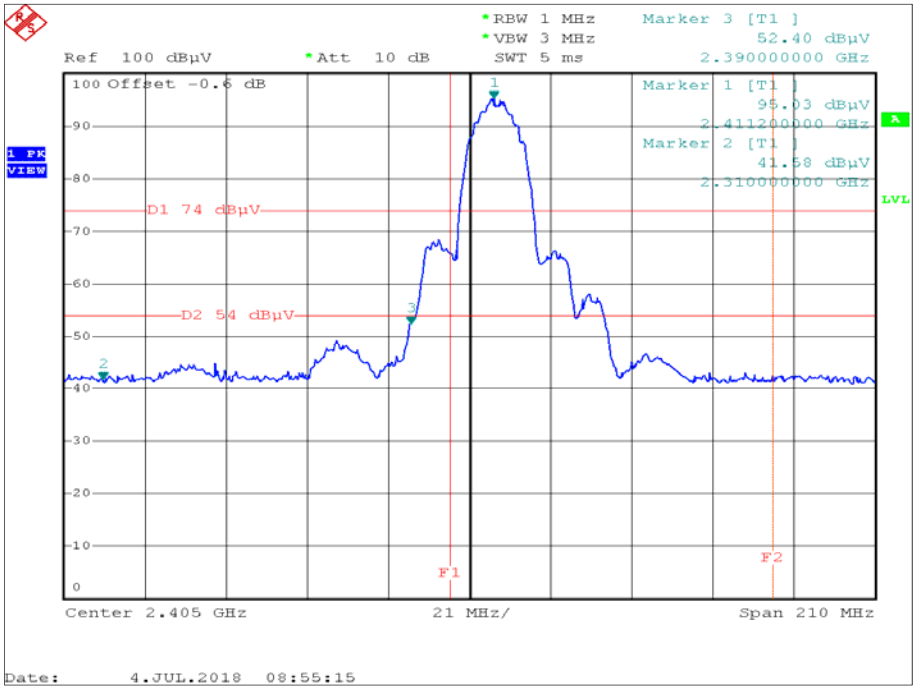

Figure 25 – Mode B - 2412 MHz - Measured Frequency 2390.0 MHz - Peak

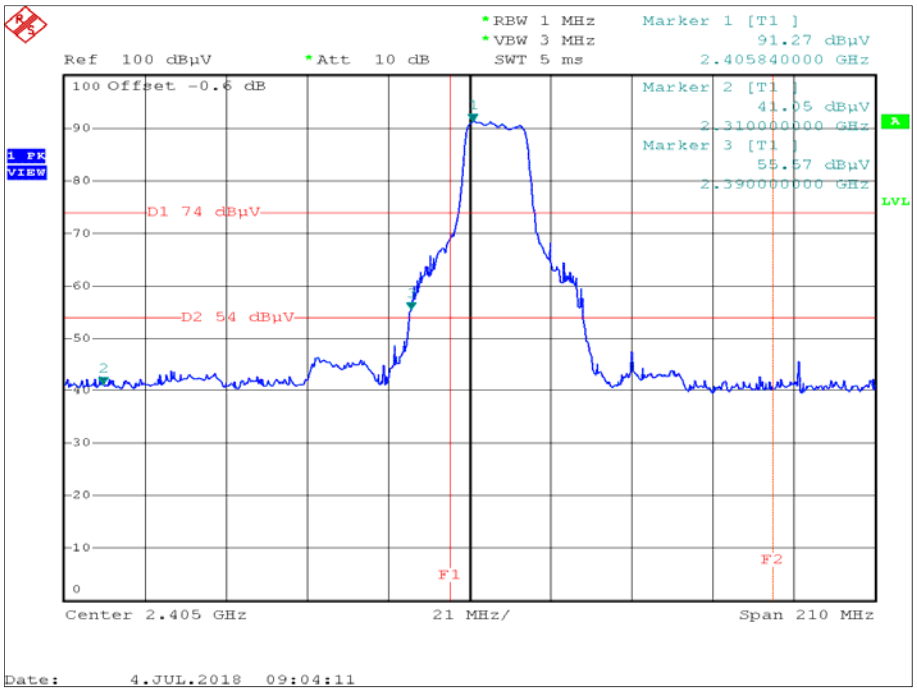

Figure 26 – Mode G – 2412 MHz - Measured Frequency 2390.0 MHz - Peak

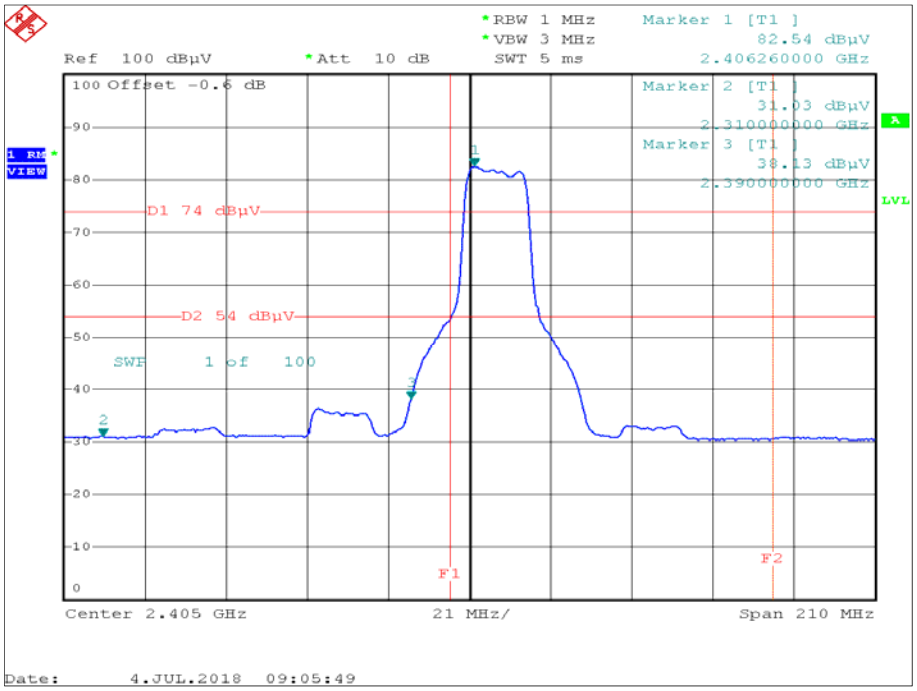

Figure 27 – Mode G – 2412 MHz - Measured Frequency 2390.0 MHz - Average

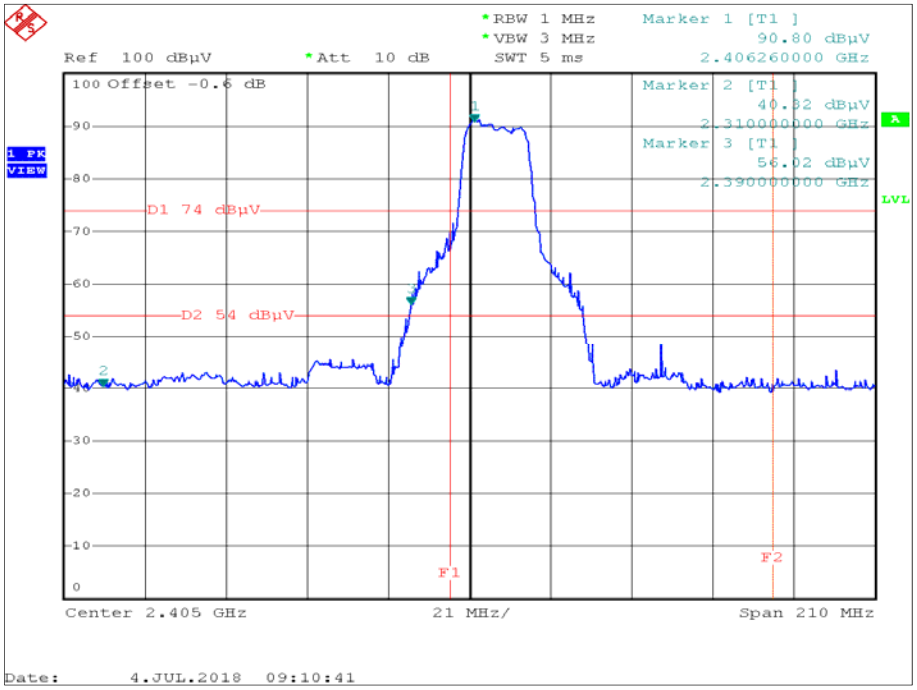

Figure 28 – Mode N – 2412 MHz - Measured Frequency 2390.0 MHz - Peak

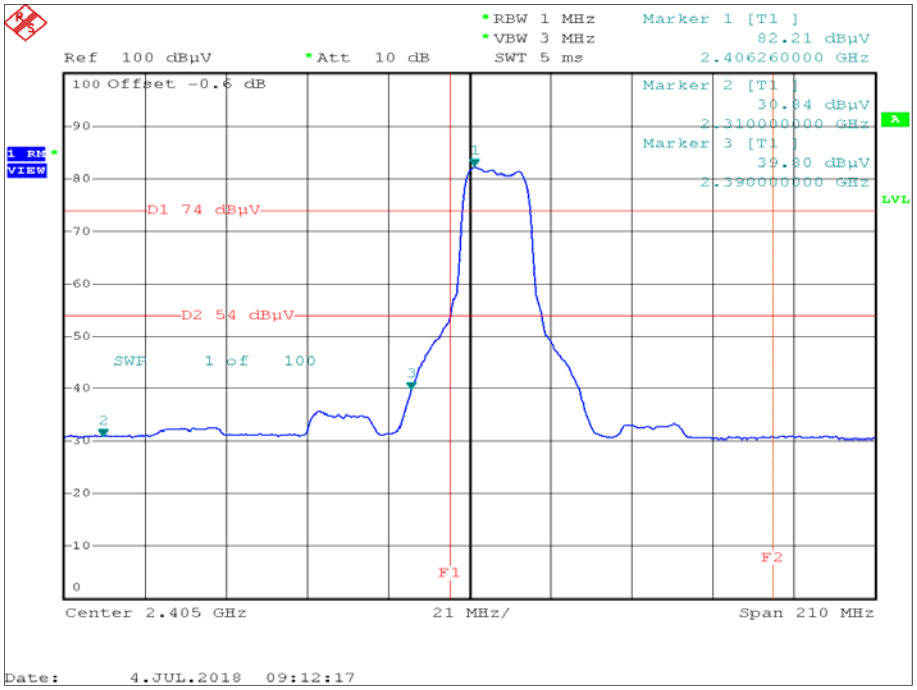

Figure 29 – Mode G – 2412 MHz - Measured Frequency 2390.0 MHz - Average

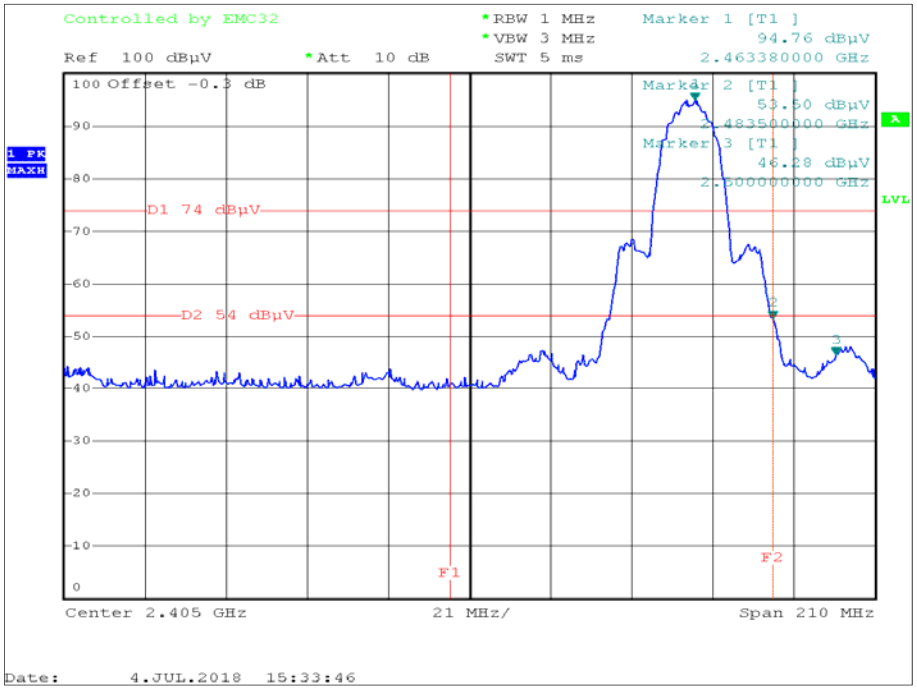

Figure 30 – Mode B – 2462 MHz - Measured Frequency 2483.5 MHz - Peak

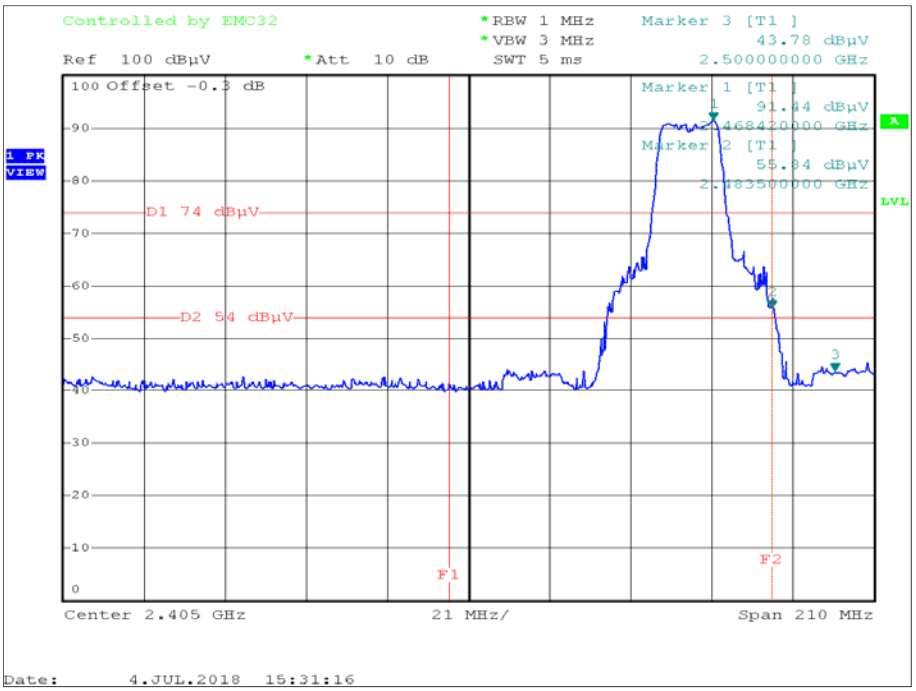

Figure 31 – Mode G – 2462 MHz - Measured Frequency 2483.5 MHz - Peak

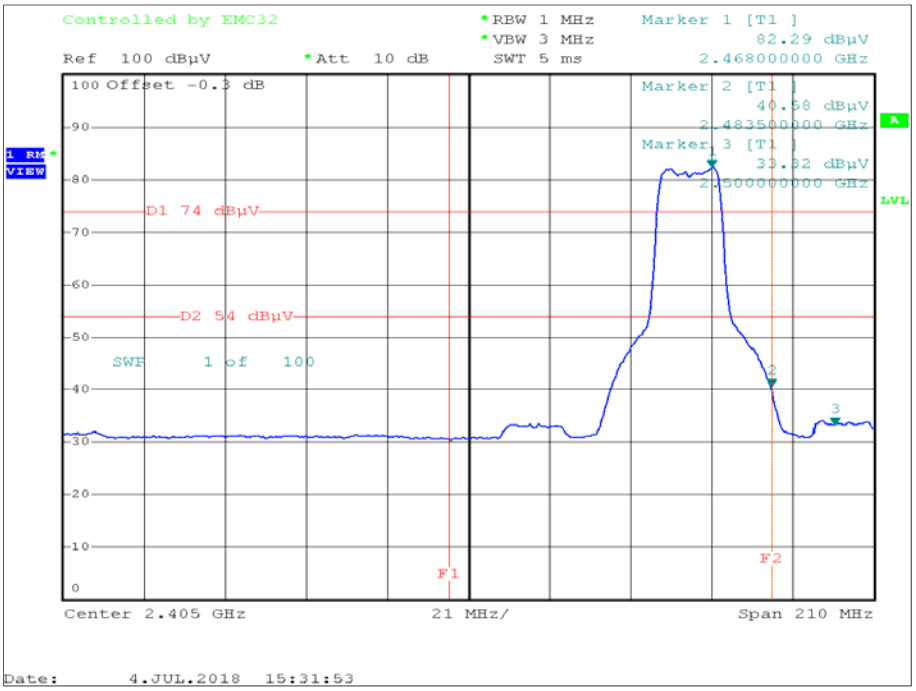

Figure 32 – Mode G – 2462 MHz - Measured Frequency 2483.5 MHz - Average

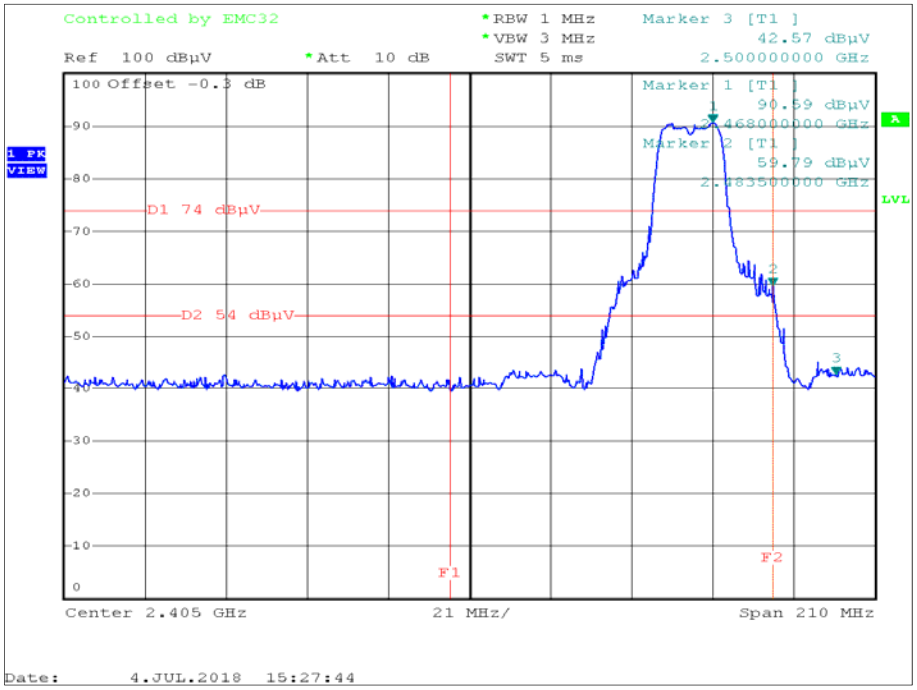

Figure 33 – Mode N – 2462 MHz - Measured Frequency 2483.5 MHz - Peak

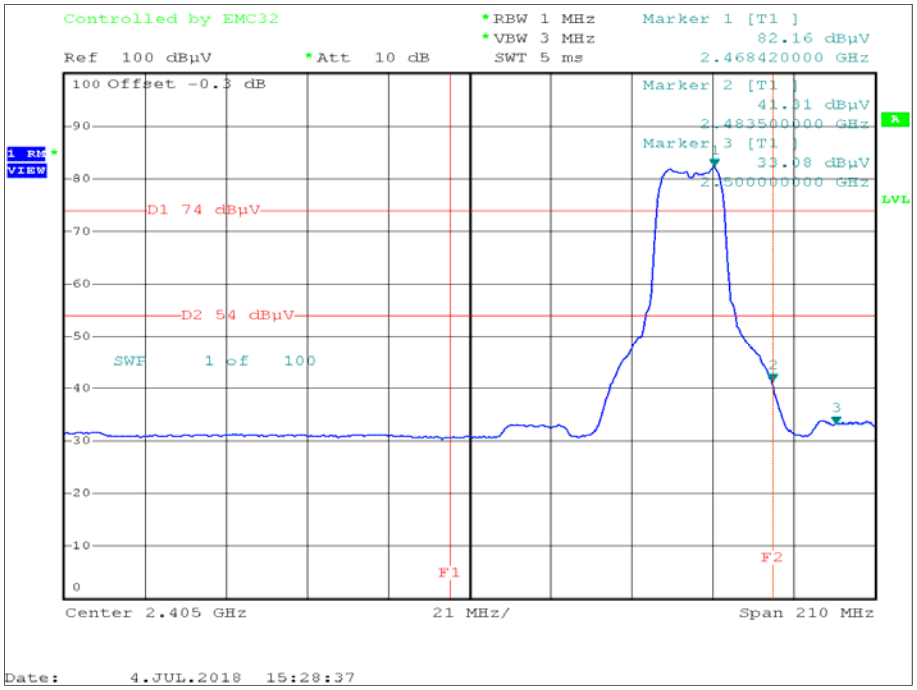

Figure 34 – Mode N – 2462 MHz - Measured Frequency 2483.5 MHz - Average

FCC 47 CFR Part 15, Limit Clause 15.209

Frequency (MHz)	Field Strength (µV/m at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

Table 14

Industry Canada RSS-GEN, Limit Clause 8.9

Frequency (MHz)	Field Strength (µV/m at 3 metres)
30-88	100
88-216	150
216-960	200
Above 960*	500

Table 15

*Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

2.5.7 Test Location and Test Equipment Used

This test was carried out in Semi anechoic room - cabin no. 8.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
FSP30	Rohde & Schwarz	100063	19533	12	2018-08
3115	EMCO	9508-4553	19383	24	2019-02

Table 16

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment
N/A - Not Applicable

2.6 Spurious Radiated Emissions

2.6.1 Specification Reference

FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN, Clause 15.247 (d), 15.205, 5.5 and 6.13

2.6.2 Equipment Under Test and Modification State

EZ2045, S/N: K131606V00-C - Modification State 0

2.6.3 Date of Test

2018-07-02 to 2018-07-06

2.6.4 Test Method

Testing was performed in accordance with ANSI C63.10-2013 clause 6.3, 6.5 and 6.6.

Plots for average measurements were taken in accordance with ANSI C63.10-2013 clause 4.1.4.2.3 to characterize the EUT. Where emissions were detected, final average measurements were taken in accordance with ANSI C63.10-2013 clause 4.1.4.2.2.

The plots shown are the characterization of the EUT. The limits on the plots represent the most stringent case for restricted bands, (54/74 dBuV/m) when compared to 20 dBc outside restricted bands. The limits shown have been used as a threshold to determine where further measurements are necessary. Where results are within 10 dB of the limits shown on the plots, further investigation was carried out and reported in results tables.

The following conversion can be applied to convert from dBµV/m to µV/m:
10^(Field Strength in dBµV/m/20).

2.6.5 Environmental Conditions

Ambient Temperature	24.0 °C
Relative Humidity	45.0 %

2.6.6 Test Results

Full testing was performed on mode B on frequency 2442 MHz which resulted in the highest conducted output power.

Stand alone 802.11b – 2412 MHz

Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
32.005	vertical	Quasi-Peak	13.9	14.8		28.7	82.6	53.9
48.000	vertical	Quasi-Peak	18.0	14.8		32.8	82.6	49.8
54.000	vertical	Quasi-Peak	22.5	14.5		37.0	82.6	45.6
57.425	vertical	Quasi-Peak	18.9	13.7		32.6	82.6	50.0
63.990	vertical	Quasi-Peak	32.9	11.9		44.8	82.6	37.8
119.995	horizontal	Quasi-Peak	16.2	11.8		28.0	43.5	15.5
135.000	horizontal	Quasi-Peak	19.8	10.3		30.1	43.5	**13.4**
194.710	horizontal	Quasi-Peak	20.2	12.5		32.7	82.6	49.9
549.500	vertical	Quasi-Peak	12.4	20.2		32.6	82.6	50.0
593.940	vertical	Quasi-Peak	13.2	21.5		34.7	82.6	47.9
2412.000	vertical	Peak	68.4	34.2		102.6		

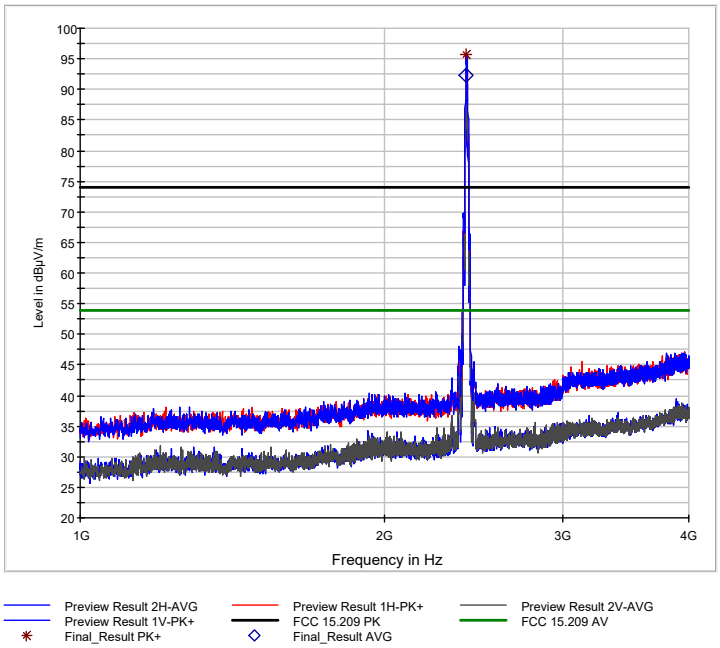

Figure 35 – Mode B – 2412 MHz – 1 GHz – 4 GHz, prescan

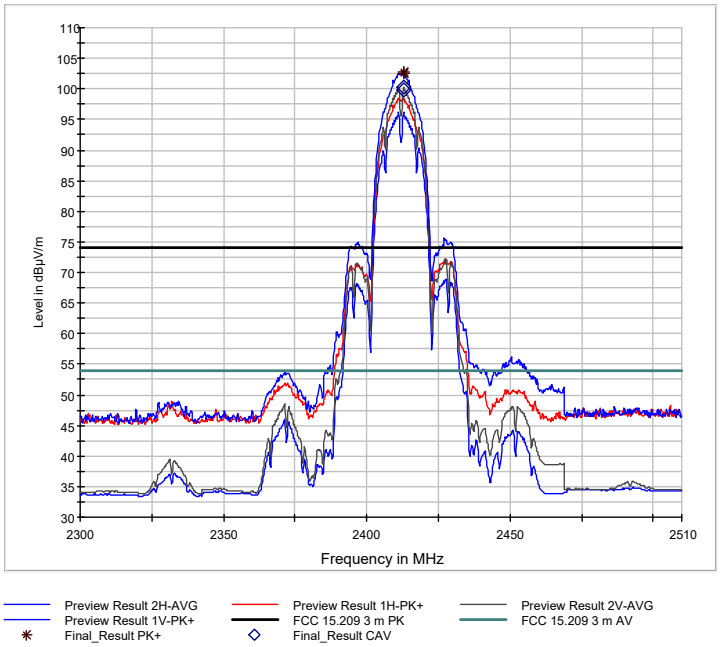

Figure 36 – Mode B – 2412 MHz - final

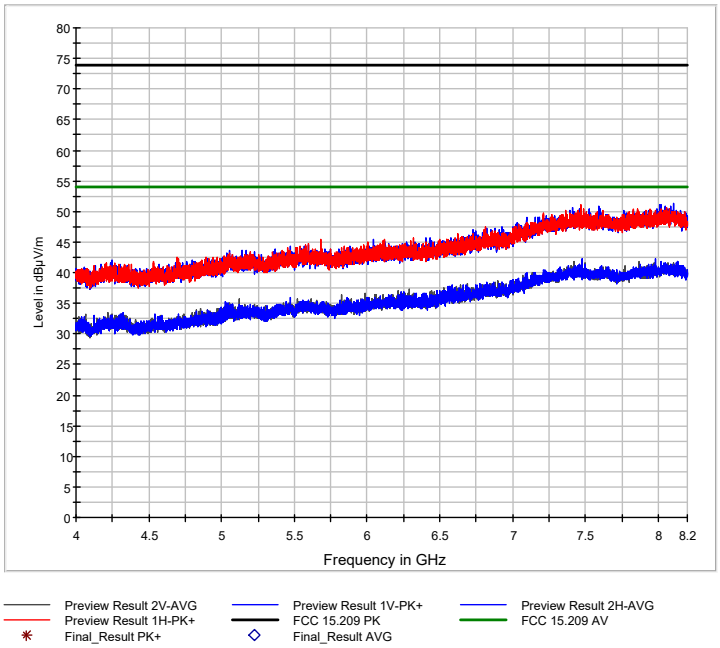

Figure 37 – Mode B – 2412 MHz – 4 GHz – 8.2 GHz

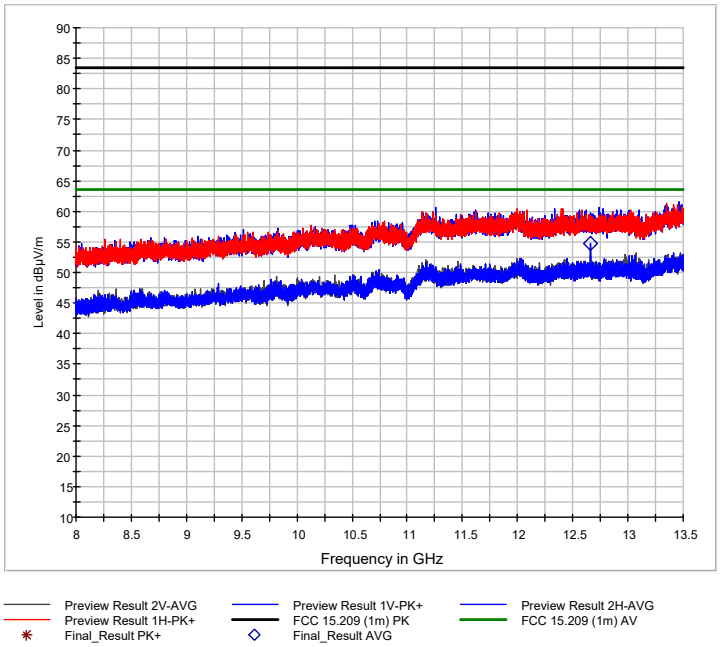

Figure 38 – Mode B – 2412 MHz – 8 GHz – 13.5 GHz

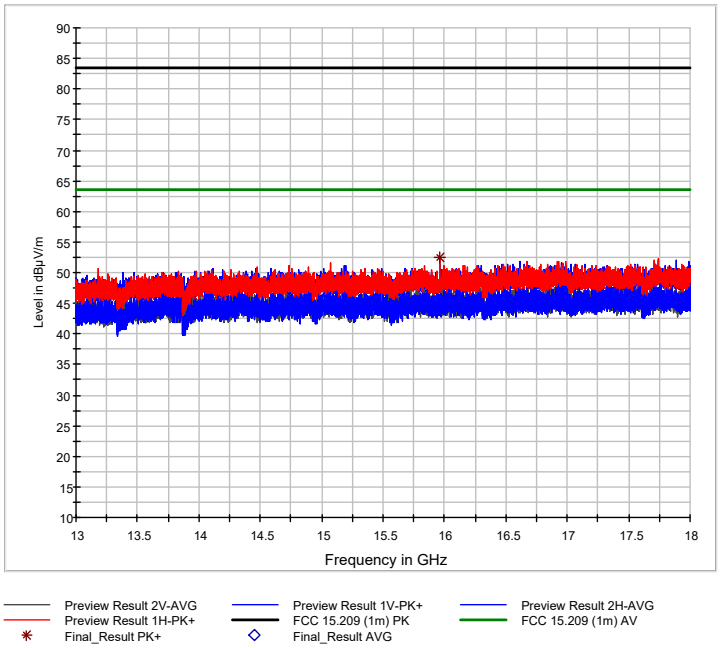

Figure 39 – Mode B – 2412 MHz – 13 GHz – 18 GHz

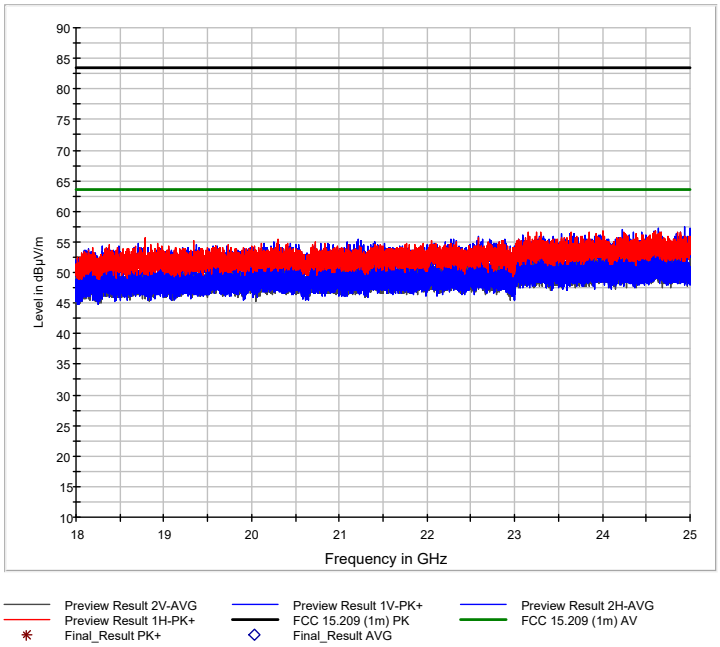

Figure 40 – Mode B – 2412 MHz – 18 GHz – 25 GHz

Stand alone 802.11b – 2442 MHz

Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
32.005	vertical	Quasi-Peak	13.9	14.8		28.7	84.5	55.8
48.000	vertical	Quasi-Peak	18.0	14.8		32.8	84.5	51.7
54.000	vertical	Quasi-Peak	22.5	14.5		37.0	84.5	47.4
57.425	vertical	Quasi-Peak	18.9	13.7		32.6	84.5	51.9
63.990	vertical	Quasi-Peak	32.9	11.9		44.8	84.5	39.6
119.995	horizontal	Quasi-Peak	16.2	11.8		28.0	43.5	15.5
135.000	horizontal	Quasi-Peak	19.8	10.3		30.1	43.5	**13.4**
194.710	horizontal	Quasi-Peak	20.2	12.5		32.7	84.5	51.7
549.500	vertical	Quasi-Peak	12.4	20.2		32.6	84.5	51.9
593.940	vertical	Quasi-Peak	13.2	21.5		34.7	84.5	49.8
2442.000	vertical	Peak	70.1	34.4		104.5		

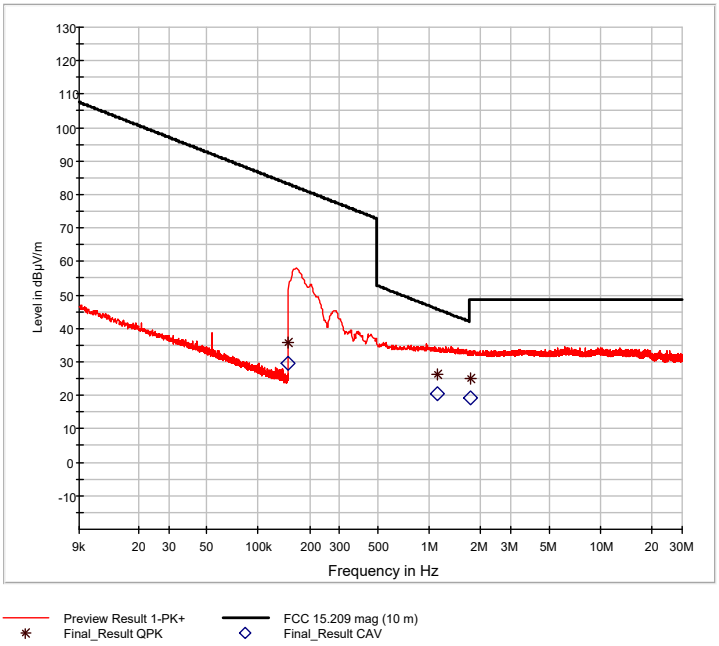

Figure 41 – Mode B – 2442 MHz – 9 kHz – 30 MHz

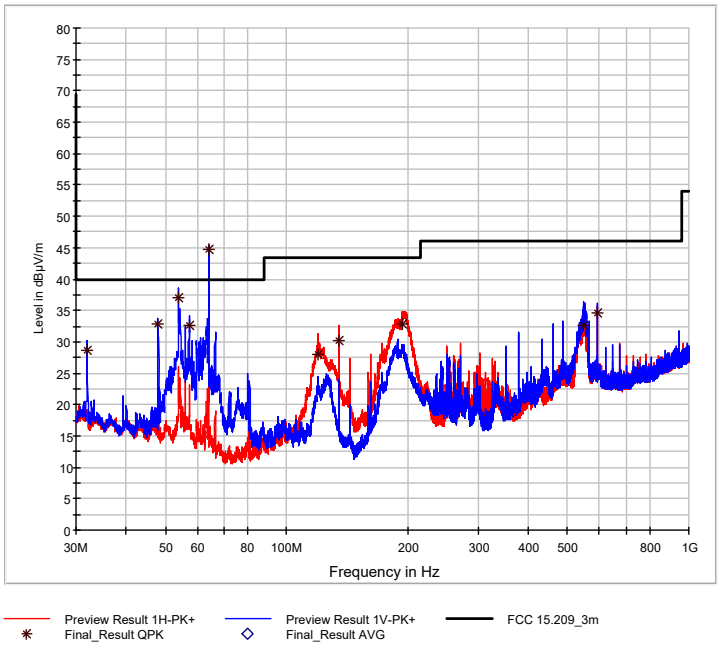

Figure 42 – Mode B – 2442 MHz – 30 MHz – 1 GHz

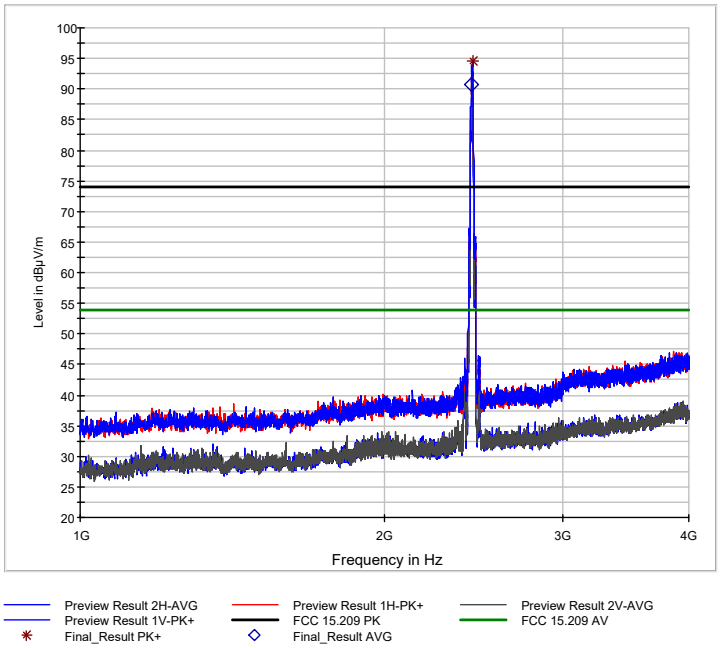

Figure 43 – Mode B – 2442 MHz – 1 GHz – 4 GHz - prescan

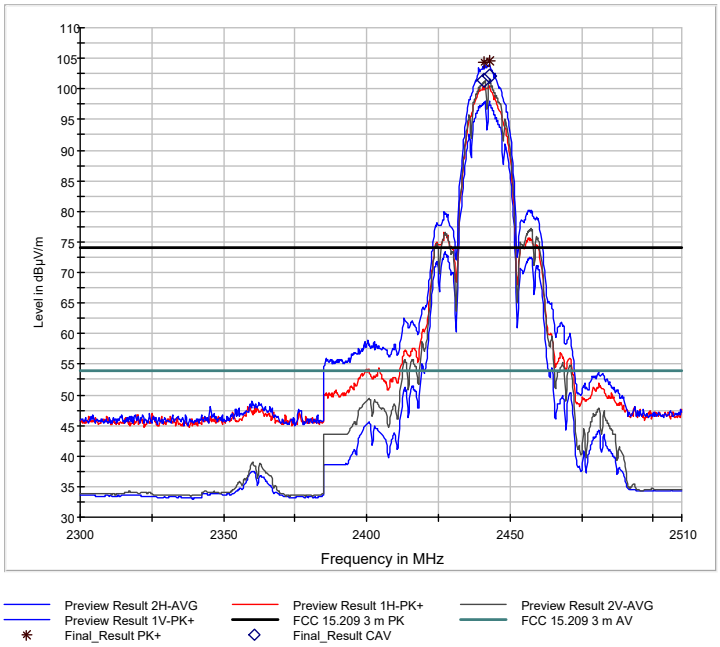

Figure 44 – Mode B – 2442 MHz - final

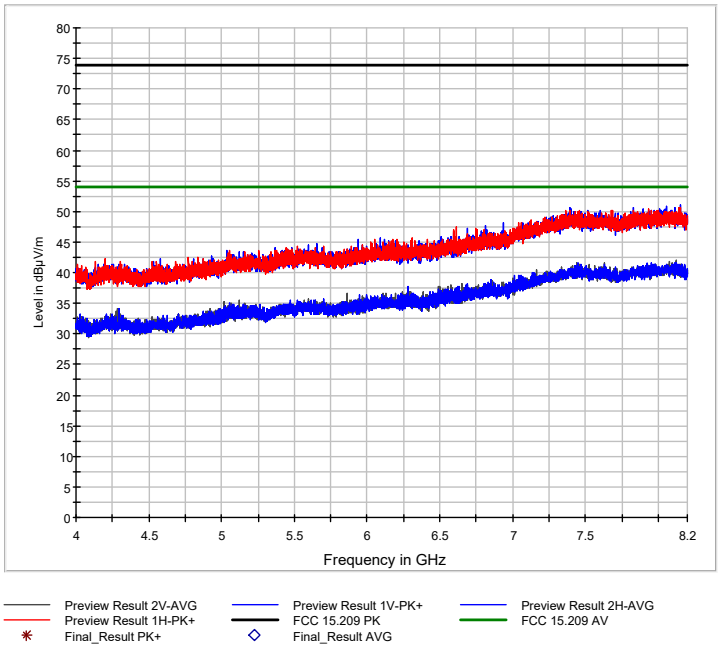

Figure 45 – Mode B – 2442 MHz – 4 Ghz – 8.2 GHz

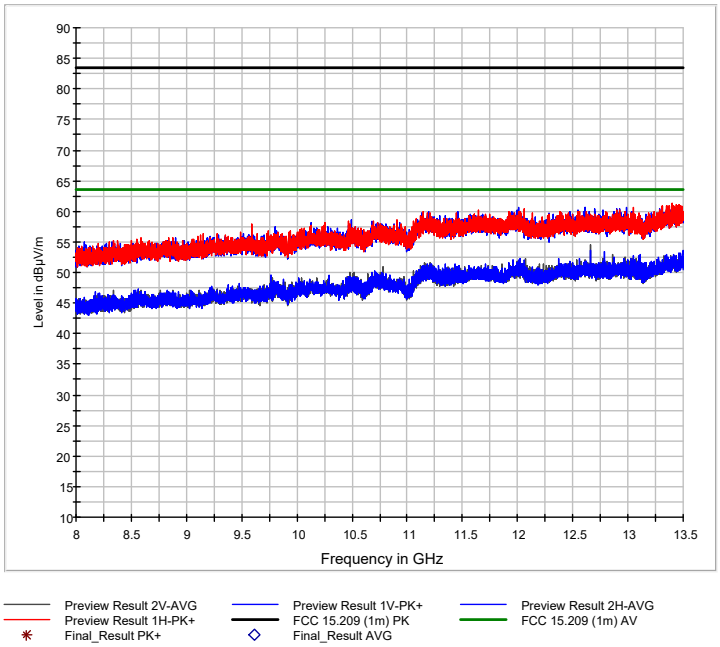

Figure 46 – Mode B – 2442 MHz – 8 GHz – 13.5 GHz

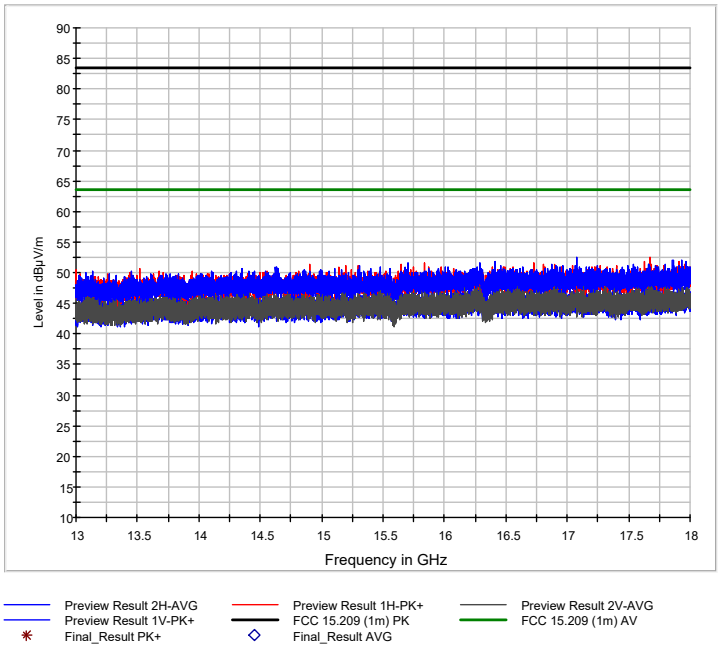

Figure 47 – Mode B – 2442 MHz – 13 GHz – 18 GHz

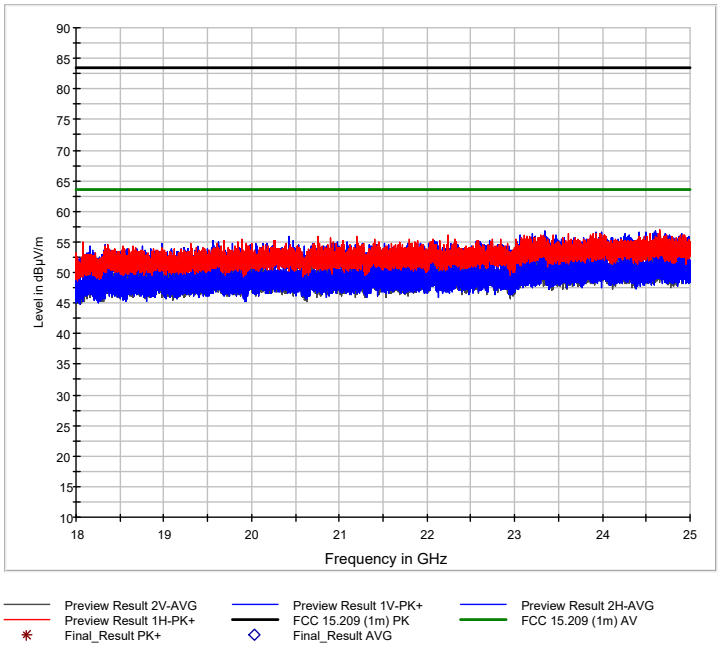

Figure 48 – Mode B – 2442 MHz – 18 GHz – 25 GHz

Stand alone 802.11b – 2462 MHz

Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
32.005	vertical	Quasi-Peak	13.9	14.8		28.7	83.7	54.9
48.000	vertical	Quasi-Peak	18.0	14.8		32.8	83.7	50.8
54.000	vertical	Quasi-Peak	22.5	14.5		37.0	83.7	46.6
57.425	vertical	Quasi-Peak	18.9	13.7		32.6	83.7	51.1
63.990	vertical	Quasi-Peak	32.9	11.9		44.8	83.7	38.8
119.995	horizontal	Quasi-Peak	16.2	11.8		28.0	43.5	15.5
135.000	horizontal	Quasi-Peak	19.8	10.3		30.1	43.5	**13.4**
194.710	horizontal	Quasi-Peak	20.2	12.5		32.7	83.7	50.9
549.500	vertical	Quasi-Peak	12.4	20.2		32.6	83.7	51.0
593.940	vertical	Quasi-Peak	13.2	21.5		34.7	83.7	49.0
2462.000	vertical	Peak	69.1	34.6		103.7		

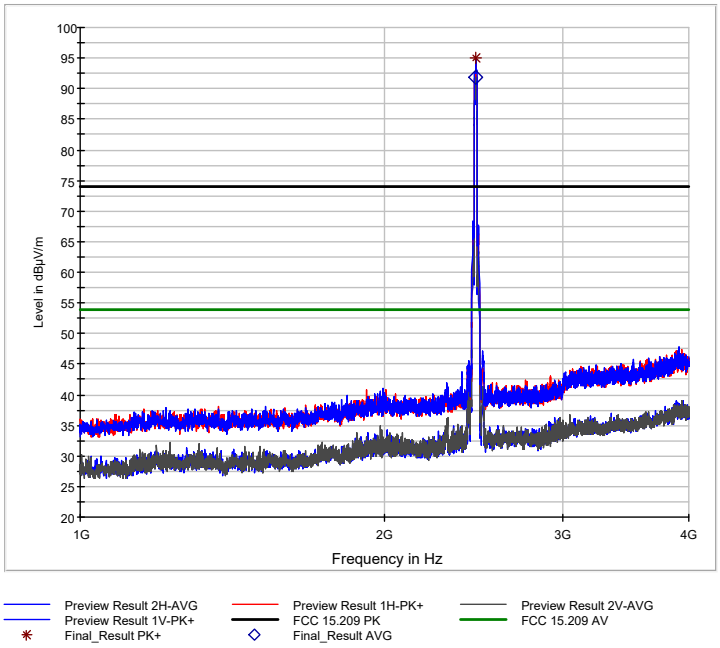

Figure 49 – Mode B – 2462 MHz – 1 GHz – 4 GHz - prescan

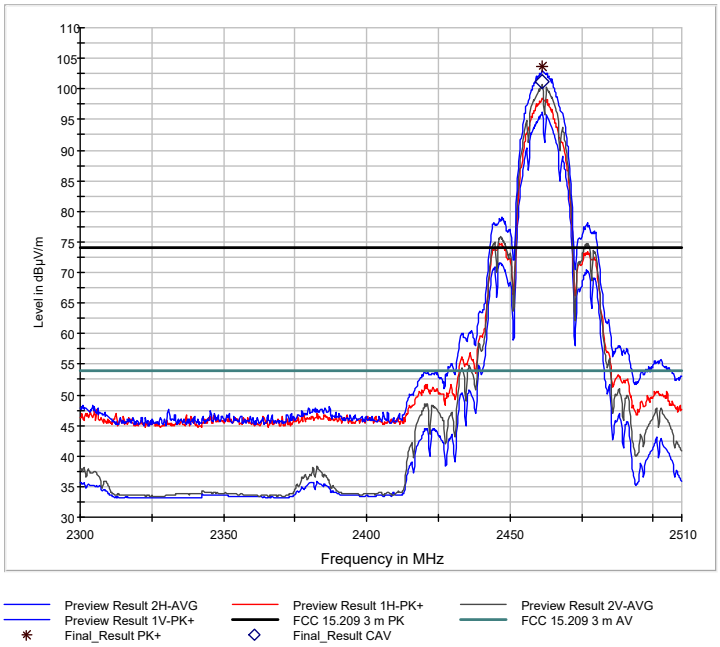

Figure 50 – Mode B – 2462 MHz - final

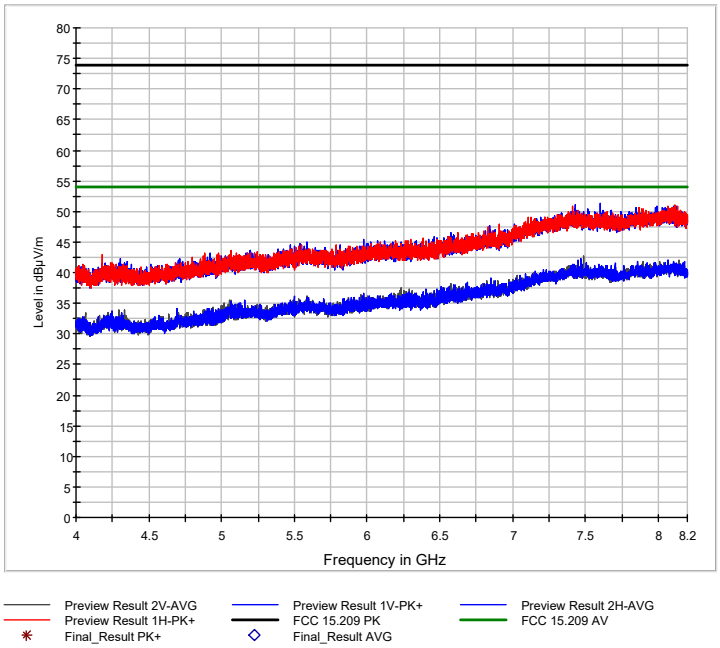

Figure 51 – Mode B – 2462 MHz – 4 GHz – 8.2 GHz

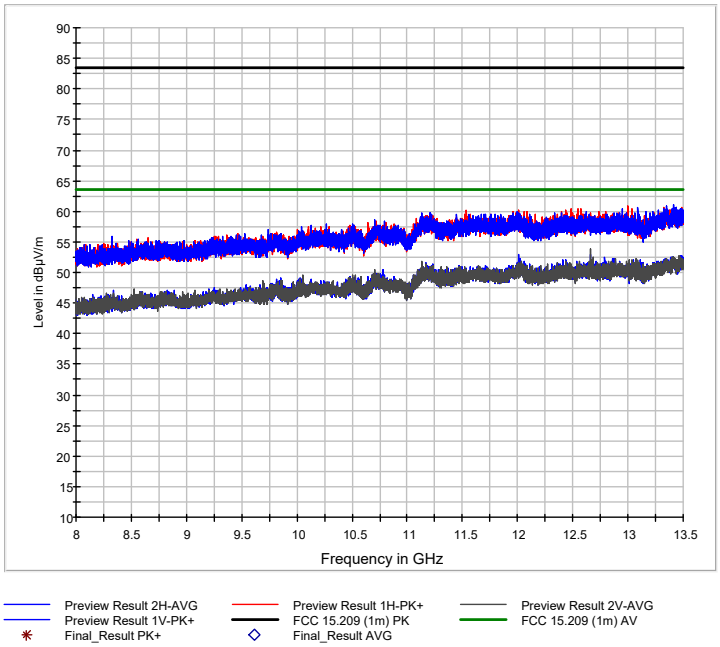

Figure 52 – Mode B – 2462 MHz – 8 GHz – 13.5 GHz

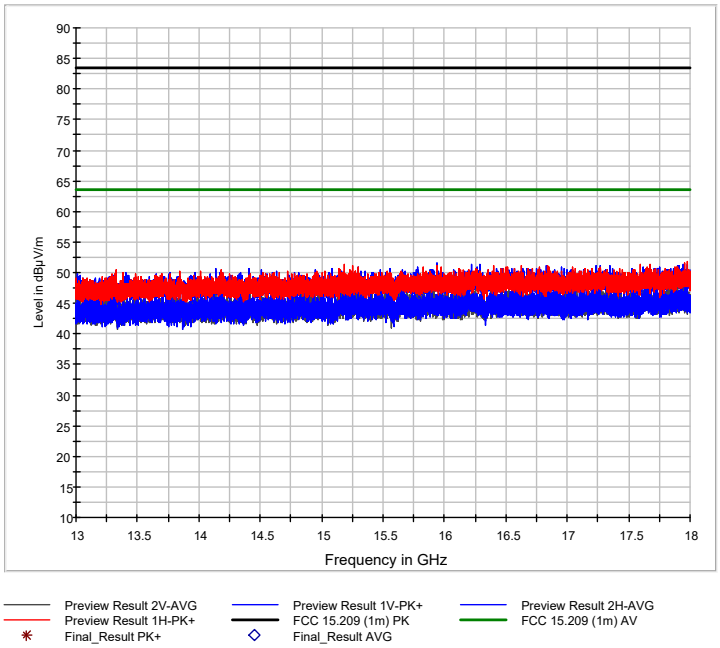

Figure 53 – Mode B – 2462 MHz – 13 GHz – 18 GHz

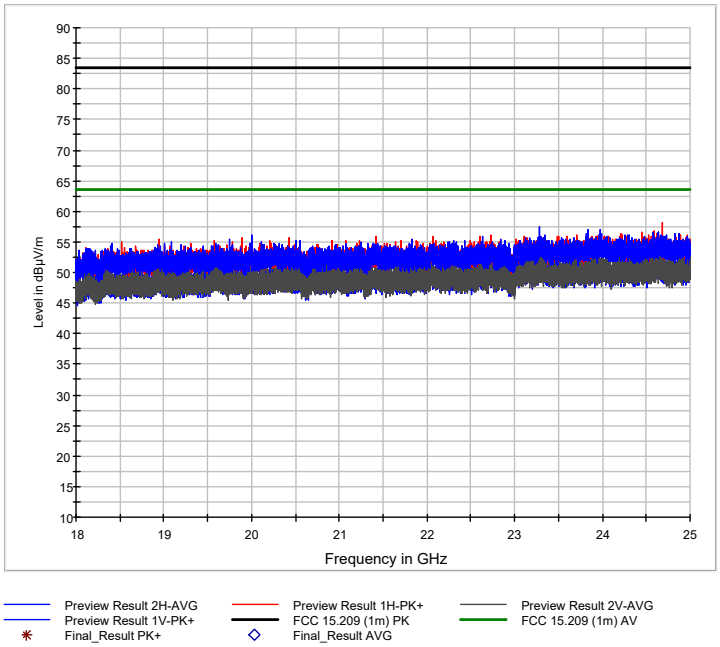

Figure 54 – Mode B – 2462 MHz – 13 GHz – 25 GHz

Stand alone 802.11g – 2412 MHz

Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
32.005	vertical	Quasi-Peak	13.9	14.8		28.7	81.0	52.3
48.000	vertical	Quasi-Peak	18.0	14.8		32.8	81.0	48.2
54.000	vertical	Quasi-Peak	22.5	14.5		37.0	81.0	44.0
57.425	vertical	Quasi-Peak	18.9	13.7		32.6	81.0	48.4
63.990	vertical	Quasi-Peak	32.9	11.9		44.8	81.0	36.2
119.995	horizontal	Quasi-Peak	16.2	11.8		28.0	43.5	15.5
135.000	horizontal	Quasi-Peak	19.8	10.3		30.1	43.5	**13.4**
194.710	horizontal	Quasi-Peak	20.2	12.5		32.7	81.0	48.3
549.500	vertical	Quasi-Peak	12.4	20.2		32.6	81.0	48.4
593.940	vertical	Quasi-Peak	13.2	21.5		34.7	81.0	46.3
2412.000	vertical	Peak	66.7	34.3		101.0		

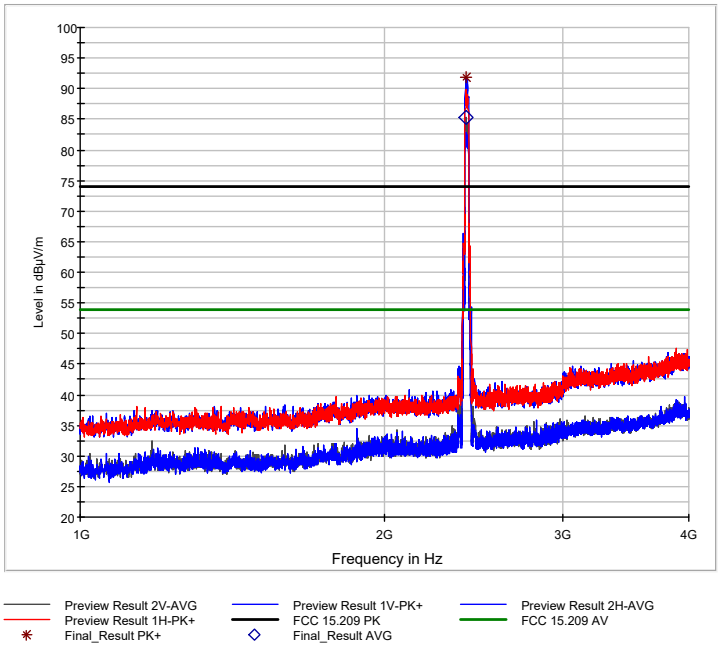

Figure 55 – Mode G – 2412 MHz – 1 GHz – 4 GHz - prescan

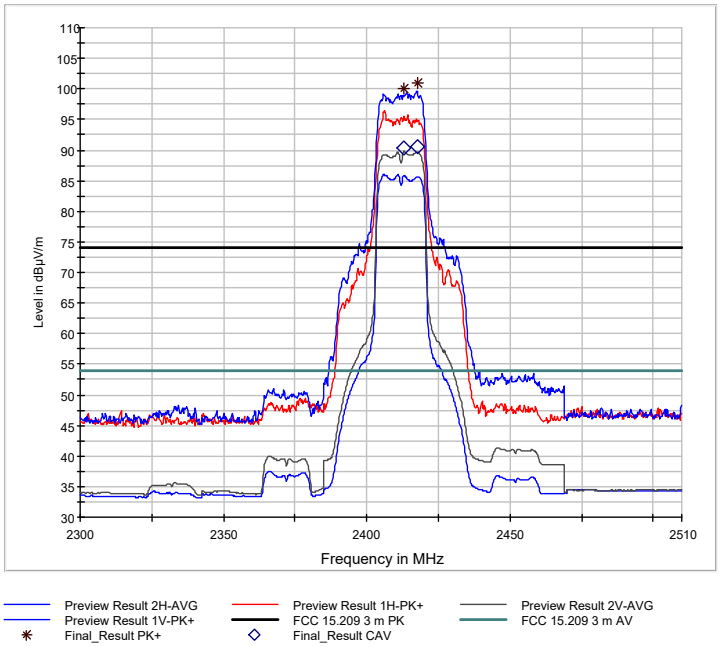

Figure 56 – Mode G – 2412 MHz - final

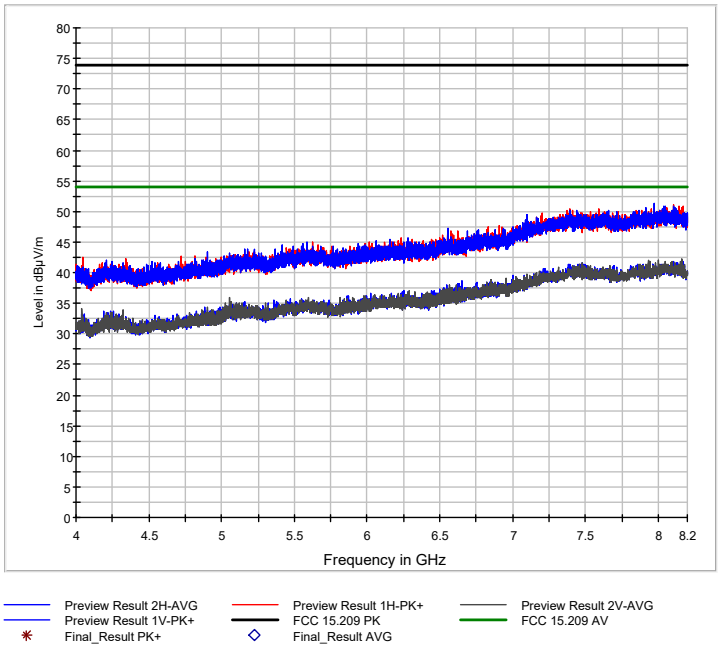

Figure 57 – Mode G – 2412 MHz – 4 GHz – 8.2 GHz

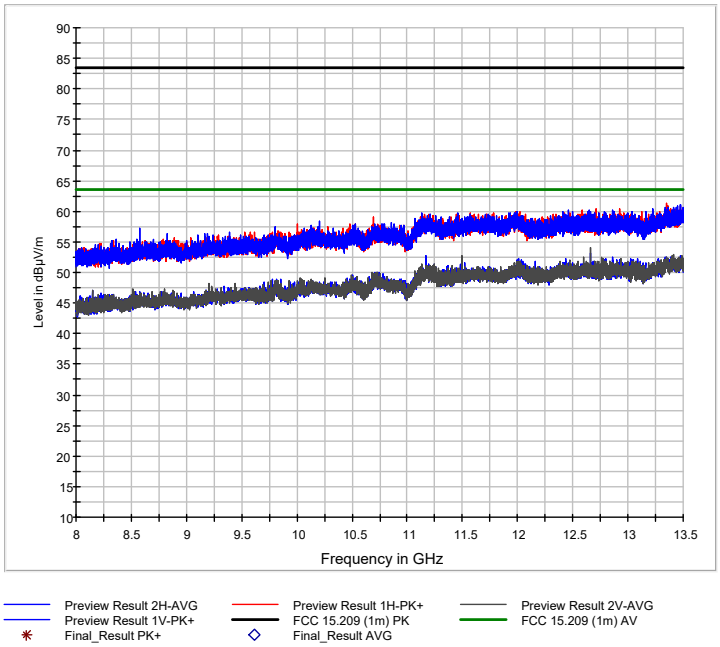

Figure 58 – Mode G – 2412 MHz – 8 GHz – 13.5 GHz

Stand alone 802.11g – 2442 MHz

Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
vertical	Quasi-Peak	13.9	14.8		28.7	80.8	52.1
vertical	Quasi-Peak	18.0	14.8		32.8	80.8	48.0
vertical	Quasi-Peak	22.5	14.5		37.0	80.8	43.8
vertical	Quasi-Peak	18.9	13.7		32.6	80.8	48.2
vertical	Quasi-Peak	32.9	11.9		44.8	80.8	36.0
horizontal	Quasi-Peak	16.2	11.8		28.0	43.5	15.5
horizontal	Quasi-Peak	19.8	10.3		30.1	43.5	**13.4**
horizontal	Quasi-Peak	20.2	12.5		32.7	80.8	48.1
vertical	Quasi-Peak	12.4	20.2		32.6	80.8	48.2
vertical	Quasi-Peak	13.2	21.5		34.7	80.8	46.1
vertical	Peak	66.3	34.5		100.8		

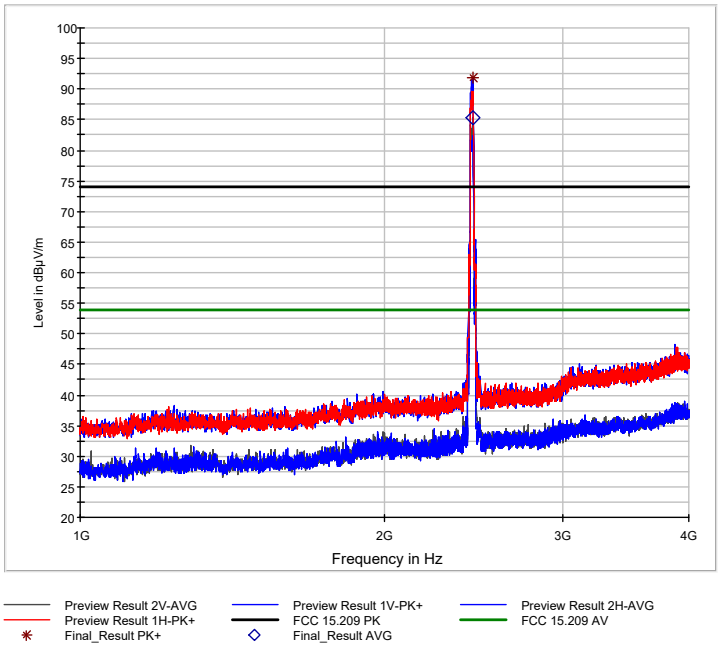

Figure 59 – Mode G – 2442 MHz – 1 GHz – 4 GHz - prescan

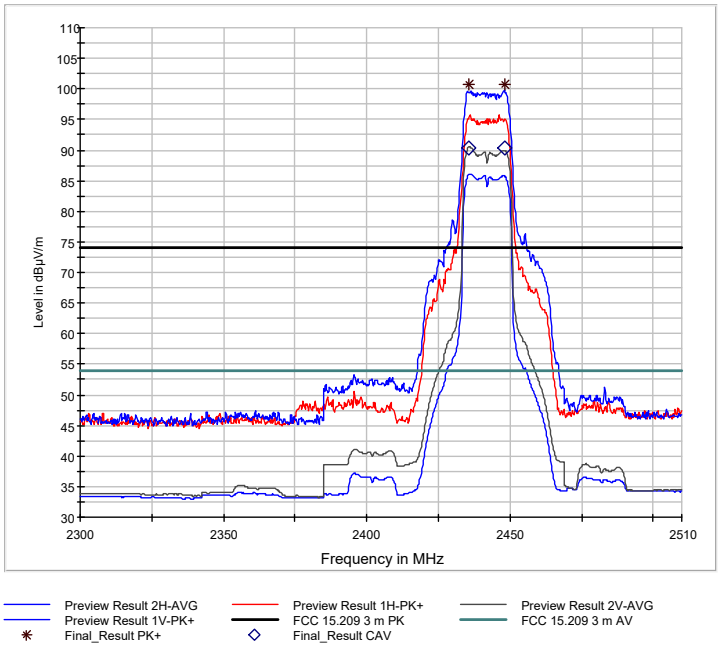

Figure 60 – Mode G – 2442 MHz - final

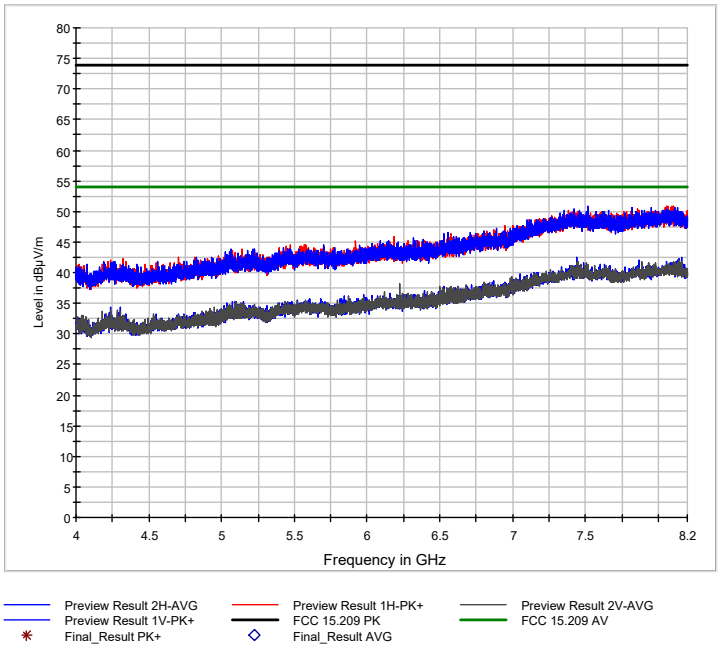

Figure 61 – Mode G – 2442 MHz – 4 GHz – 8.2 GHz

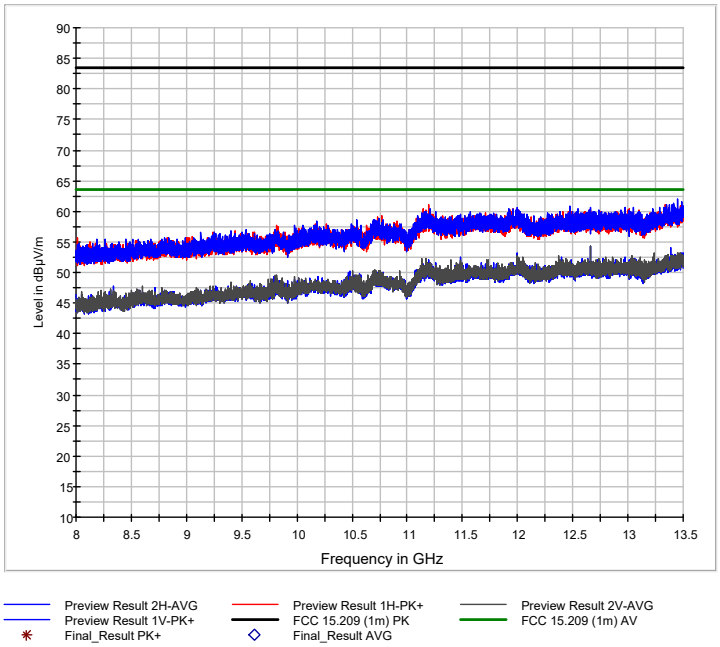

Figure 62 – Mode G – 2442 MHz – 8 GHz – 13.5 GHz

Stand alone 802.11g – 2462 MHz

Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
32.005	vertical	Quasi-Peak	13.9	14.8		28.7	82.7	53.9
48.000	vertical	Quasi-Peak	18.0	14.8		32.8	82.7	49.8
54.000	vertical	Quasi-Peak	22.5	14.5		37.0	82.7	45.6
57.425	vertical	Quasi-Peak	18.9	13.7		32.6	82.7	50.1
63.990	vertical	Quasi-Peak	32.9	11.9		44.8	82.7	37.8
119.995	horizontal	Quasi-Peak	16.2	11.8		28.0	43.5	15.5
135.000	horizontal	Quasi-Peak	19.8	10.3		30.1	43.5	**13.4**
194.710	horizontal	Quasi-Peak	20.2	12.5		32.7	82.7	49.9
549.500	vertical	Quasi-Peak	12.4	20.2		32.6	82.7	50.0
593.940	vertical	Quasi-Peak	13.2	21.5		34.7	82.7	48.0
2462.000	vertical	Peak	102.7	0.0		102.7		

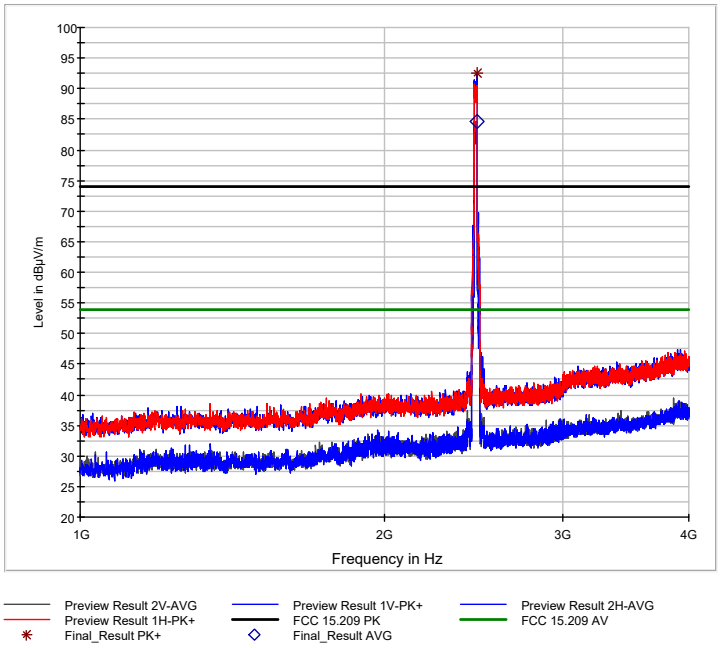

Figure 63 – Mode G – 2462 MHz – 1 GHz – 4 GHz - prescan

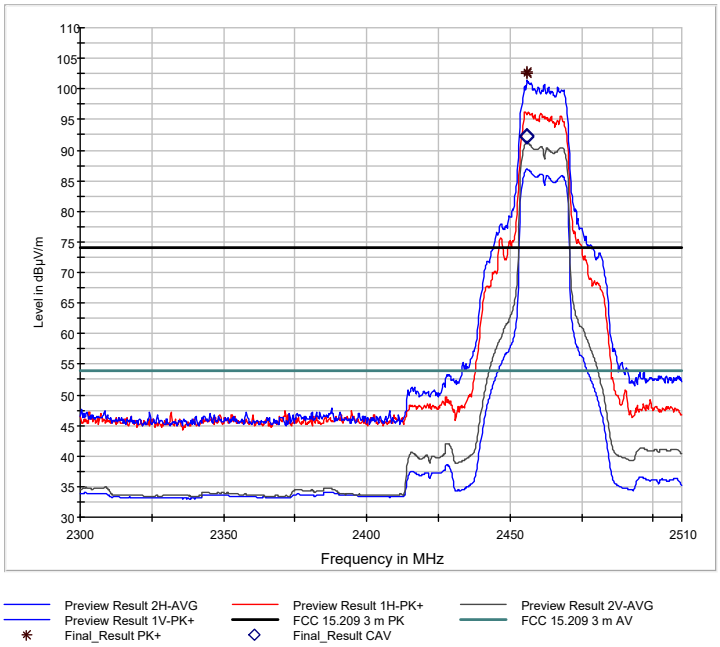

Figure 64 – Mode G – 2462 MHz - final

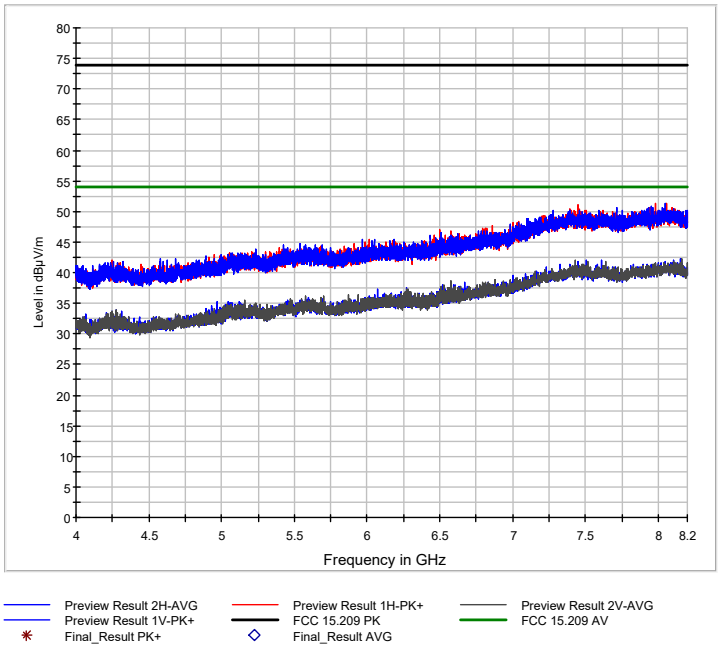

Figure 65 – Mode G – 2462 MHz – 4 GHz – 8.2 GHz

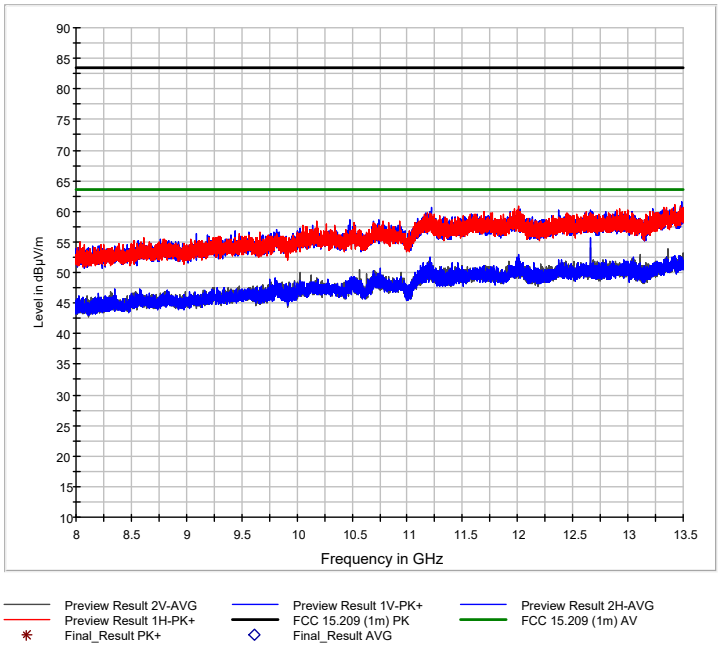

Figure 66 – Mode G – 2462 MHz – 8 GHz – 13.5 GHz

Stand alone 802.11n – 2412 MHz

Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
32.005	vertical	Quasi-Peak	13.9	14.8		28.7	80.4	51.7
48.000	vertical	Quasi-Peak	18.0	14.8		32.8	80.4	47.6
54.000	vertical	Quasi-Peak	22.5	14.5		37.0	80.4	43.4
57.425	vertical	Quasi-Peak	18.9	13.7		32.6	80.4	47.9
63.990	vertical	Quasi-Peak	32.9	11.9		44.8	80.4	35.6
119.995	horizontal	Quasi-Peak	16.2	11.8		28.0	43.5	15.5
135.000	horizontal	Quasi-Peak	19.8	10.3		30.1	43.5	**13.4**
194.710	horizontal	Quasi-Peak	20.2	12.5		32.7	80.4	47.7
549.500	vertical	Quasi-Peak	12.4	20.2		32.6	80.4	47.8
593.940	vertical	Quasi-Peak	13.2	21.5		34.7	80.4	45.7
2412.000	vertical	Peak	66.2	34.2		100.4		

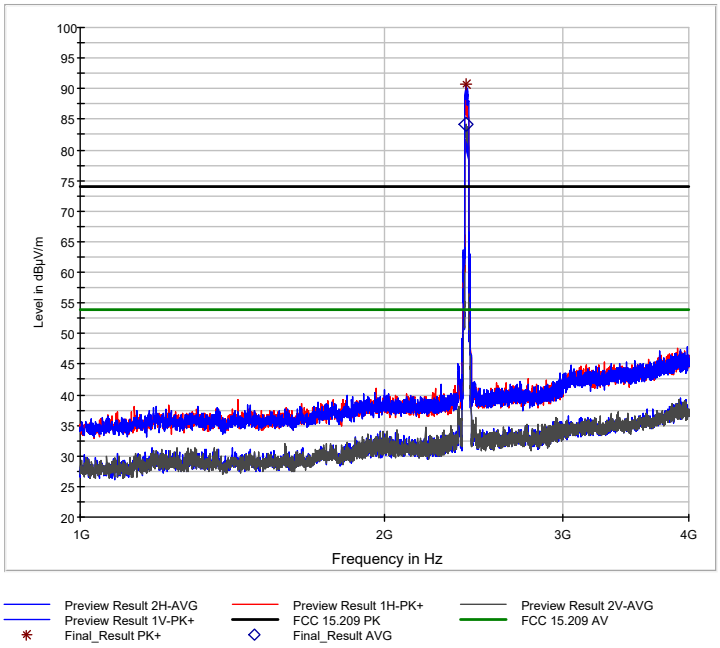

Figure 67 – Mode N – 2412 MHz – 1 GHz – 4 GHz - prescan

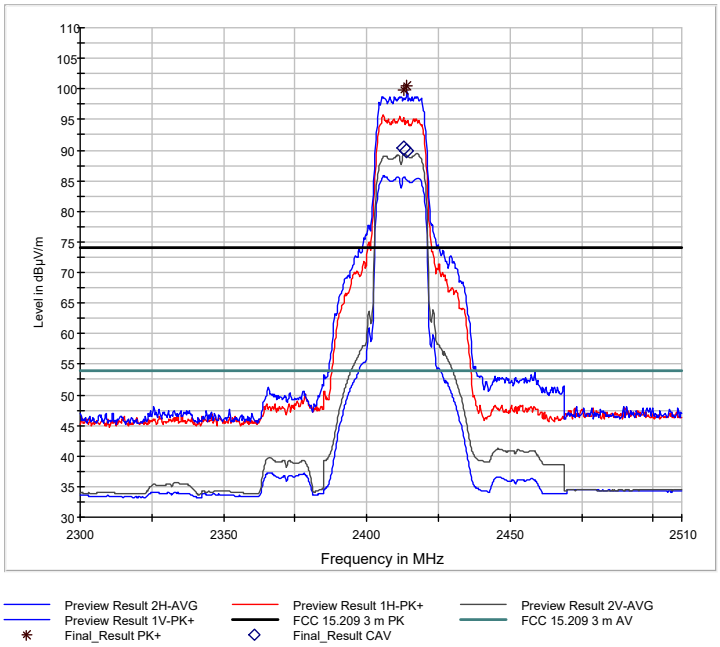

Figure 68 – Mode N – 2412 MHz - final

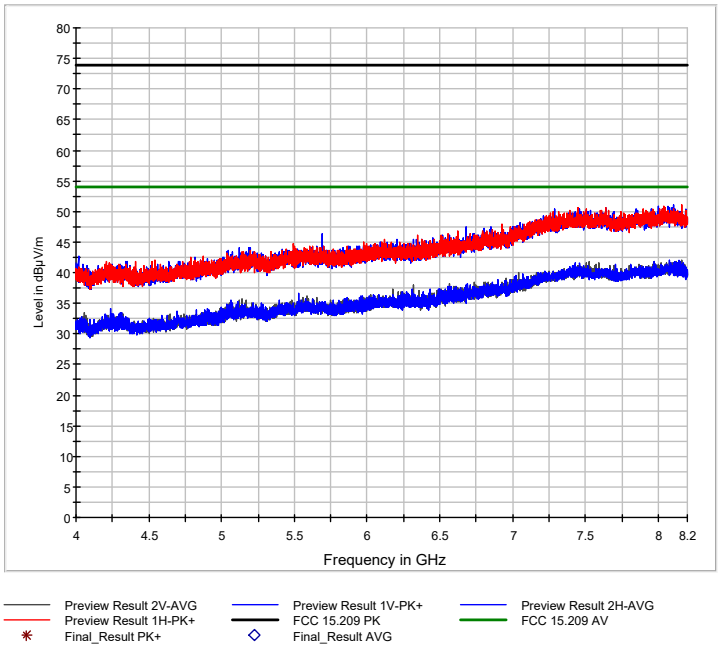

Figure 69 – Mode N – 2412 MHz – 4 GHz – 8.2 GHz

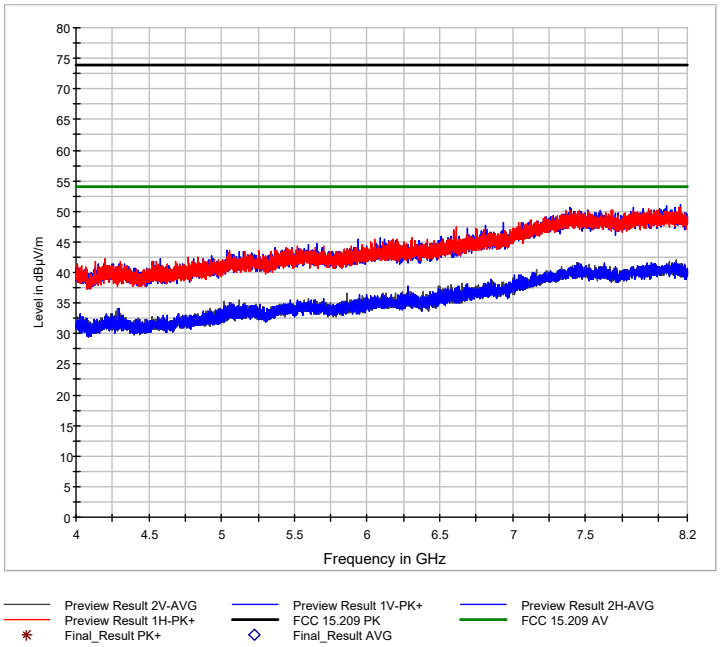

Figure 70 – Mode N – 2412 MHz – 8 GHz – 13.5 GHz

Stand alone 802.11n – 2442 MHz

Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
32.005	vertical	Quasi-Peak	13.9	14.8		28.7	81.0	52.3
48.000	vertical	Quasi-Peak	18.0	14.8		32.8	81.0	48.2
54.000	vertical	Quasi-Peak	22.5	14.5		37.0	81.0	43.9
57.425	vertical	Quasi-Peak	18.9	13.7		32.6	81.0	48.4
63.990	vertical	Quasi-Peak	32.9	11.9		44.8	81.0	36.1
119.995	horizontal	Quasi-Peak	16.2	11.8		28.0	43.5	15.5
135.000	horizontal	Quasi-Peak	19.8	10.3		30.1	43.5	**13.4**
194.710	horizontal	Quasi-Peak	20.2	12.5		32.7	81.0	48.2
549.500	vertical	Quasi-Peak	12.4	20.2		32.6	81.0	48.4
593.940	vertical	Quasi-Peak	13.2	21.5		34.7	81.0	46.3
2442.000	vertical	Peak	66.6	34.4		101.0		

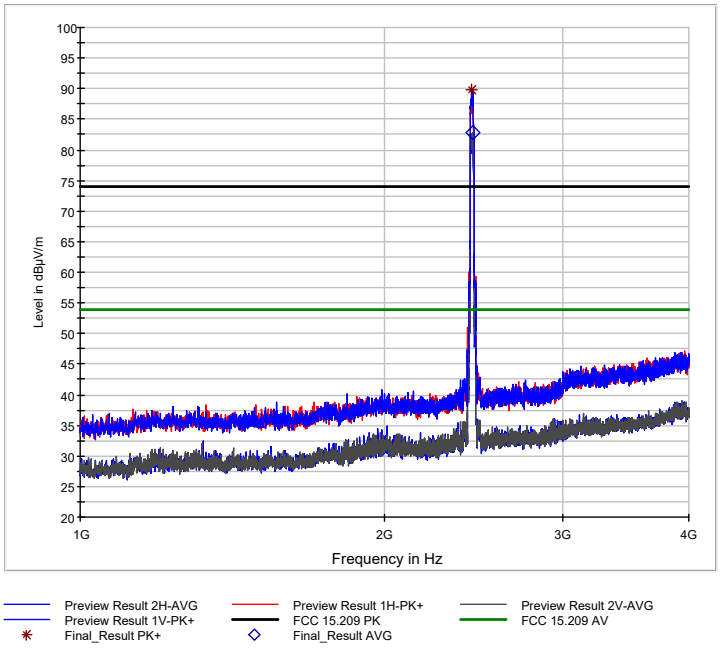

Figure 71 – Mode N – 2442 MHz – 1 GHz – 4 GHz - prescan

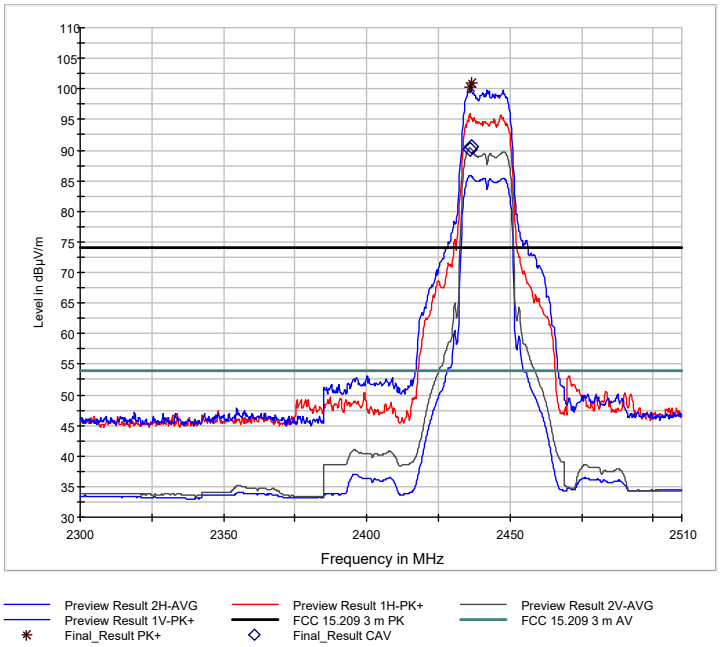

Figure 72 – Mode N – 2442 MHz - final

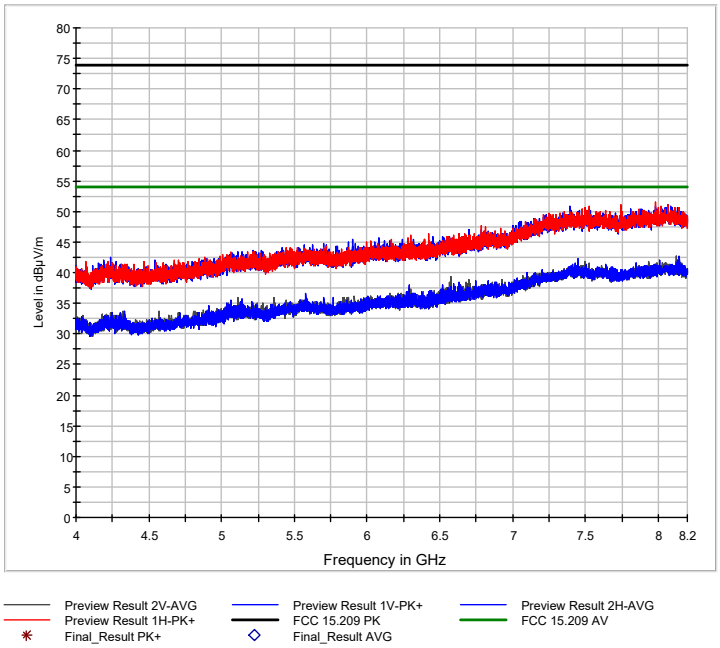

Figure 73 – Mode N – 2442 MHz – 4 GHz – 8.2 GHz

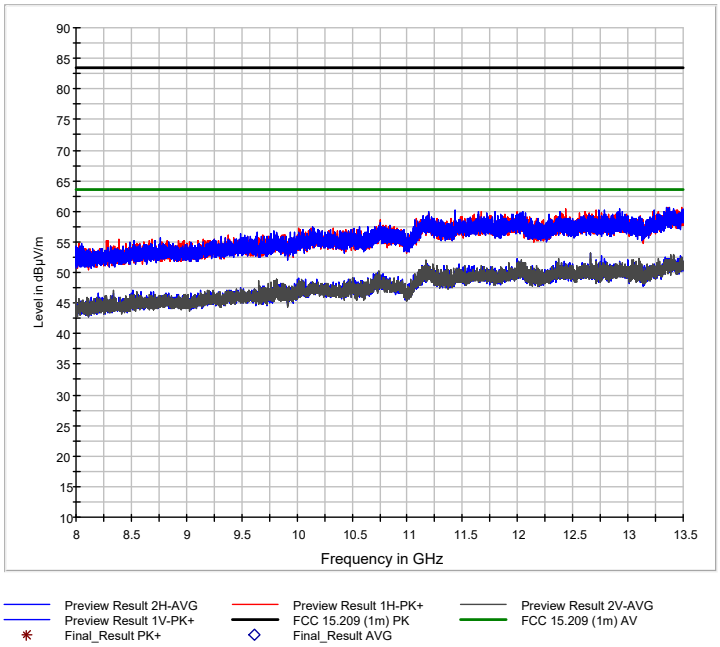

Figure 74 – Mode N – 2442 MHz – 8 GHz – 13.5 GHz

Stand alone 802.11n – 2462 MHz

Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
32.005	vertical	Quasi-Peak	13.9	14.8		28.7	80.5	51.8
48.000	vertical	Quasi-Peak	18.0	14.8		32.8	80.5	47.7
54.000	vertical	Quasi-Peak	22.5	14.5		37.0	80.5	43.5
57.425	vertical	Quasi-Peak	18.9	13.7		32.6	80.5	48.0
63.990	vertical	Quasi-Peak	32.9	11.9		44.8	80.5	35.7
119.995	horizontal	Quasi-Peak	16.2	11.8		28.0	43.5	15.5
135.000	horizontal	Quasi-Peak	19.8	10.3		30.1	43.5	**13.4**
194.710	horizontal	Quasi-Peak	20.2	12.5		32.7	80.5	47.8
549.500	vertical	Quasi-Peak	12.4	20.2		32.6	80.5	47.9
593.940	vertical	Quasi-Peak	13.2	21.5		34.7	80.5	45.9
2462.000	vertical	Peak	66.0	34.5		100.5		

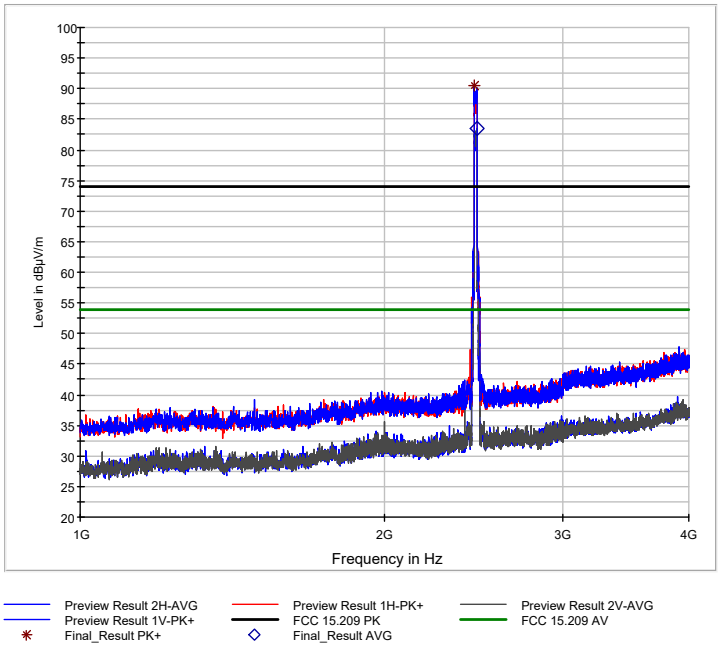

Figure 75 – Mode N – 2462 MHz – 1 GHz – 4 GHz - prescan

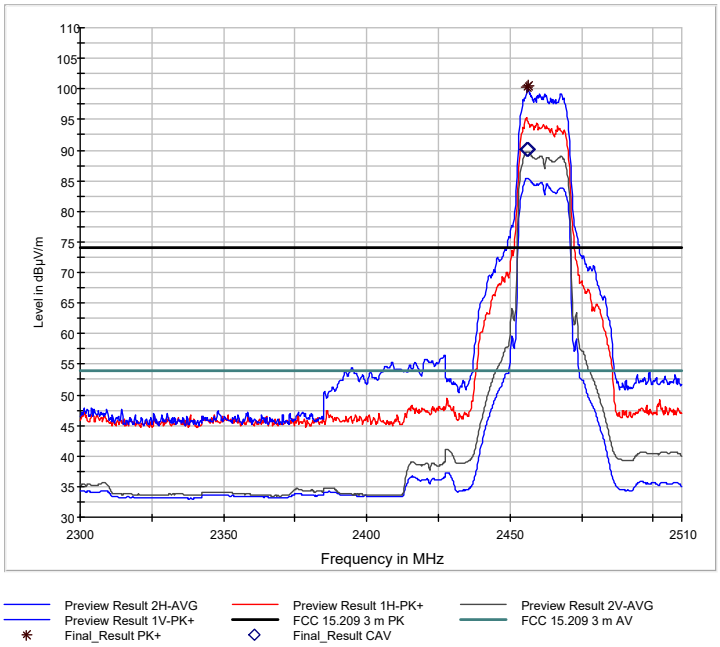

Figure 76 – Mode N – 2462 MHz - final

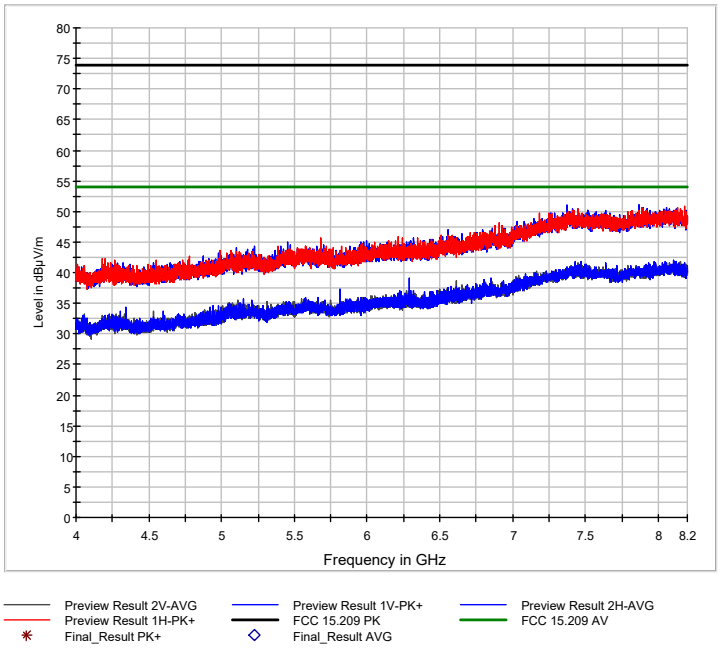

Figure 77 – Mode N – 2462 MHz – 4 GHz – 8.2 GHz

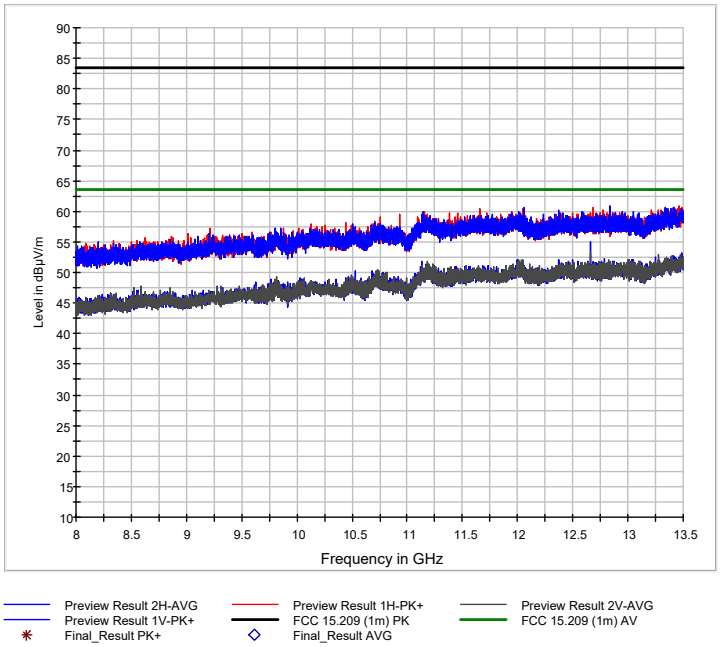

Figure 78 – Mode N – 2462 MHz – 8 GHz – 13.5 GHz

FCC 47 CFR Part 15, Limit Clause 15.247 (d)

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 § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in 15.209(a)

Industry Canada RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

2.6.7 Test Location and Test Equipment Used

This test was carried out in Semi anechoic room - cabin no. 8.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
ESW26	Rohde & Schwarz	101315	28268	12	2019-05
FSV40	Rohde & Schwarz	101448	20219	12	2019-01
HFH2-Z2	Rohde & Schwarz	882964/0001	18876	24	2018-07
VULB9163	Schwarzbeck	9163-233	19691	36	2020-12
3115	EMCO	9508-4553	19383	24	2019-02
3160-08	EMCO	9112-1002	18875	O/P	---
3160-09	EMCO	9403-1025	19125	O/P	---

Table 17

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment
N/A - Not Applicable

2.7 Spurious Conducted Emissions

2.7.1 Specification Reference

FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN, Clause 15.247 (d) and 5.5

2.7.2 Equipment Under Test and Modification State

EZ2045, S/N: K131606V00-C - Modification State 0

2.7.3 Date of Test

2018-07-03 to 2018-07-04

2.7.4 Test Method

WLAN and other
The test was performed in accordance with KDB 558074 D01 v03r02, clause 11.0.

2.7.5 Environmental Conditions

Ambient Temperature	24.0 °C
Relative Humidity	45.0 %

2.7.6 Test Results

<u>Stand alone 802.11b/g/n</u>

Testing was performed on the data rate with maximum conducted output power. This data rate type was:

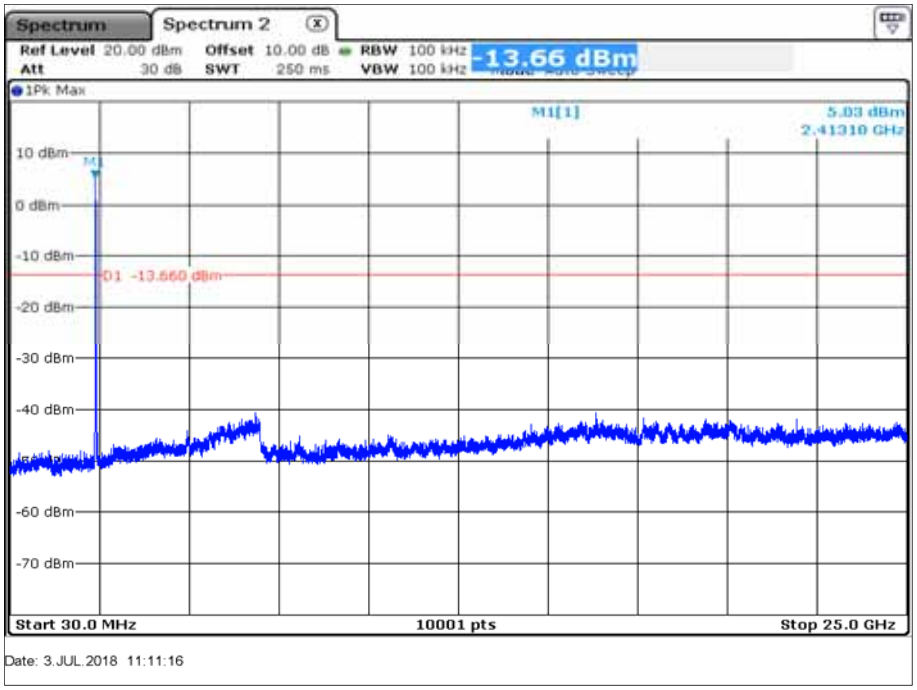

Figure 79 – Mode B - 2412 MHz - 30 MHz - 25 GHz

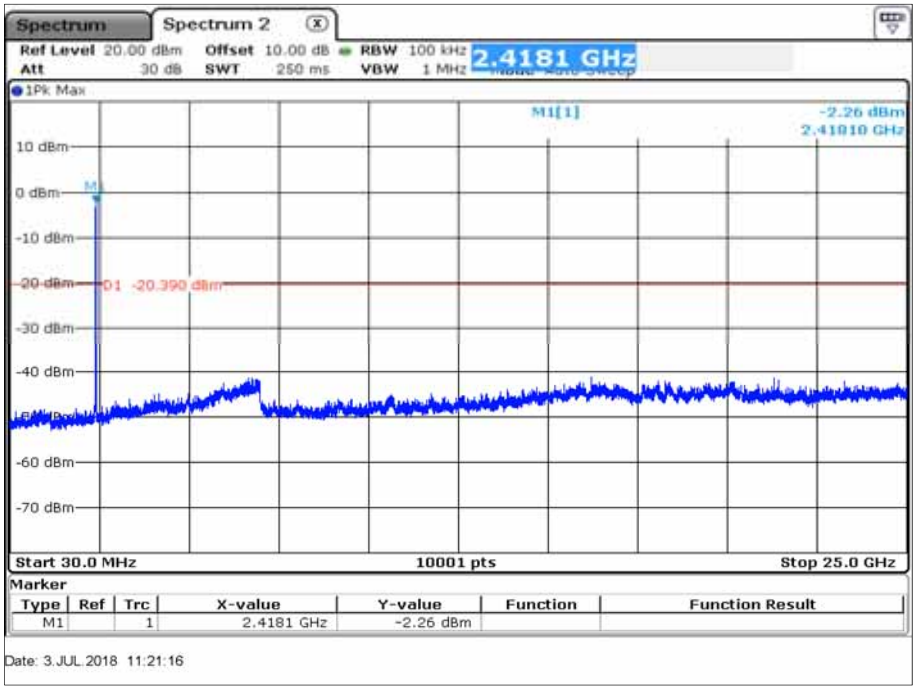

Figure 80 – Mode G - 2412 MHz - 30 MHz - 25 GHz

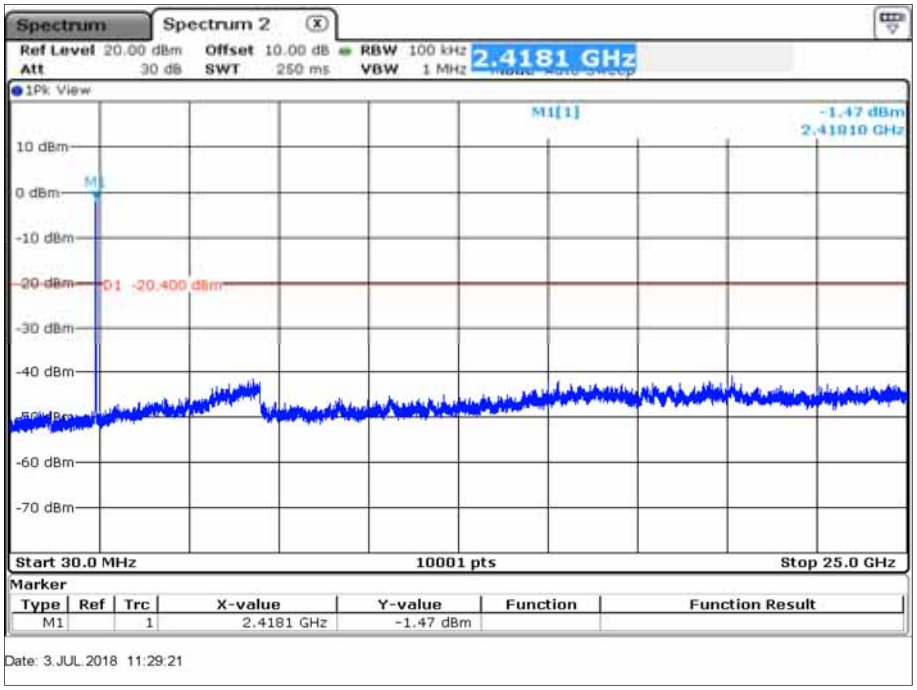

Figure 81 – Mode N - 2412 MHz - 30 MHz - 25 GHz

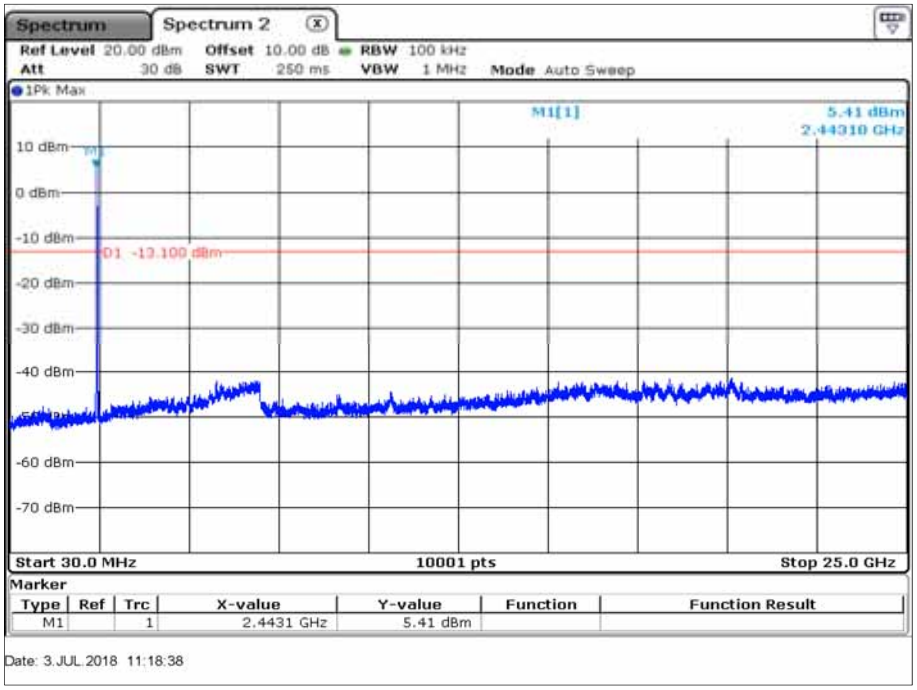

Figure 82 – Mode B - 2442 MHz - 30 MHz - 25 GHz

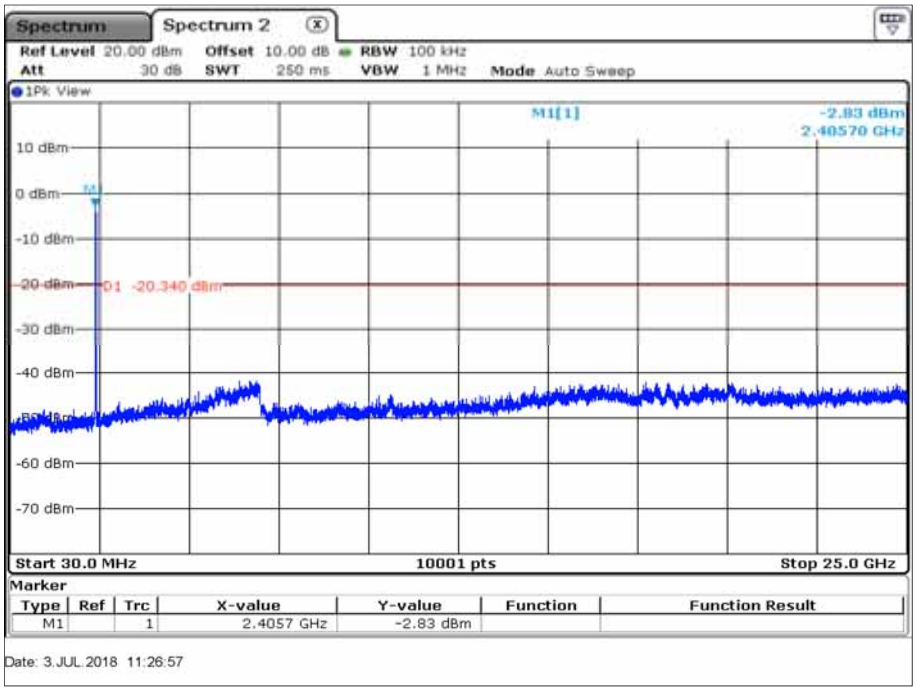

Figure 83 - Mode G - 2442 MHz - 30 MHz - 25 GHz

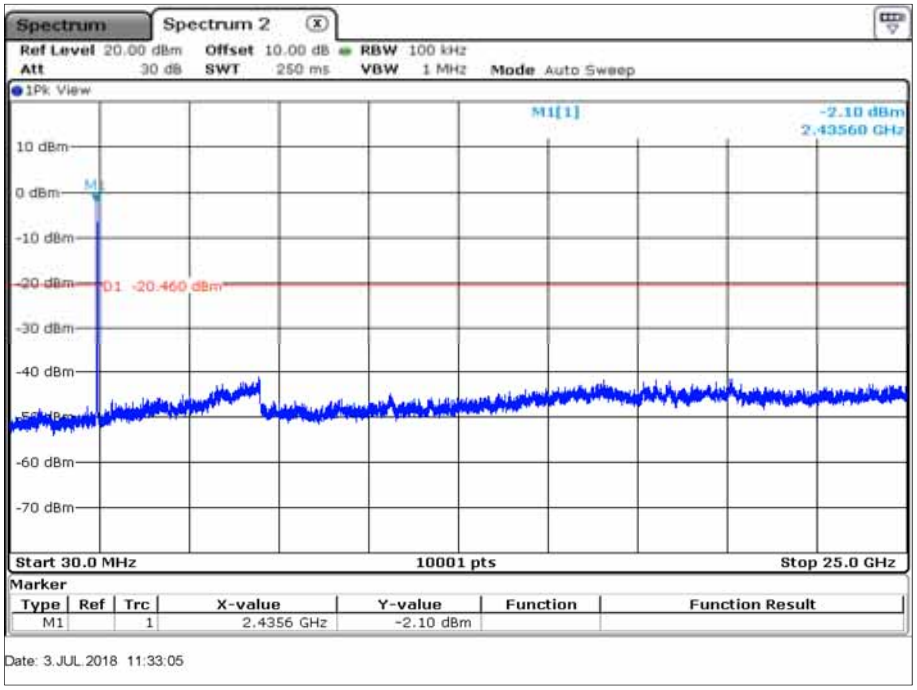

Figure 84 - Mode N - 2442 MHz - 30 MHz - 25 GHz

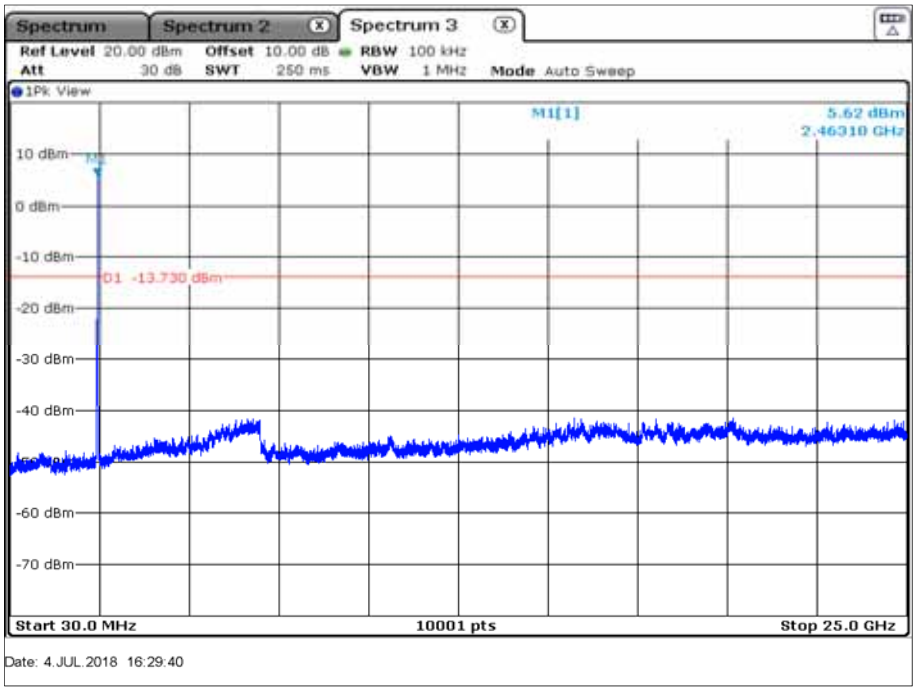

Figure 85 - Mode B - 2462 MHz - 30 MHz - 25 GHz

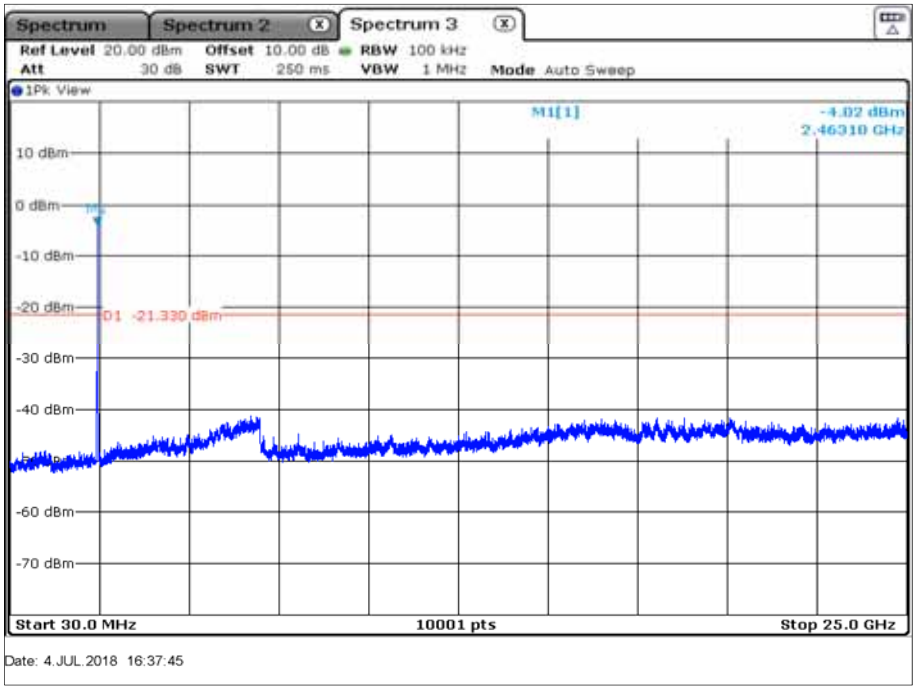

Figure 86 - Mode G - 2442 MHz - 30 MHz - 25 GHz

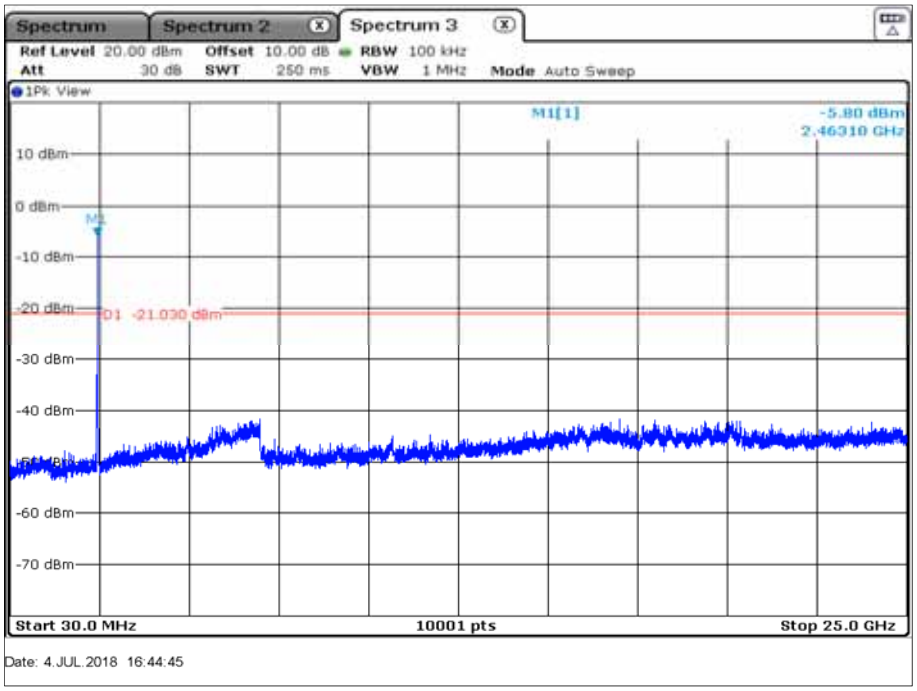

Figure 87 - Mode N - 2462 MHz - 30 MHz - 25 GHz

FCC 47 CFR Part 15, Limit Clause 15.247 (d)

20 dB below the fundamental measured in a 100 kHz bandwidth using a peak detector. If the transmitter complies with the conducted power limits, based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB below the fundamental instead of 20 dB.

2.7.7 Test Location and Test Equipment Used

This test was carried out in Non shielded room.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
FSV40	Rohde & Schwarz	101448	20219	12	2019-01

Table 18

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment
N/A - Not Applicable

2.8 RF Exposure Assessment

2.8.1 Specification Reference

CFR 47 Pt.1.1310, RSS-102 Issue 5

2.8.2 Equipment Under Test and Modification State

EZ2045, S/N: K131606V00-C - Modification State 0

2.8.3 Test Method

The test was performed in accordance with KDB 447498 D01 v06, chapter 4.3.1 a
The test was performed in accordance with RSS-102, Issue 5, chapter 2.5

2.8.4 Test Results

$$EIRP = \frac{(FS \cdot D)^2}{30}$$

<u>In accordance with KDB 447498 D01 v06, chapter 4.3.1 a:</u>

Maximum Radiated Field strength: (see chapter 2.6.6 in this report)	104.5 dBµV/m [at 3m and at 2.442 GHz]
Calculated Equivalent Radiated Power:	8.455 mW (e.i.r.p.)
Minimum separation distance:	20 mm

(8.455 / 20) * (2.442)^$^{0.5}$ = 0.66 (Limit: < 3.0)

<u>In accordance with RSS-102, Issue 5, chapter 2.5:</u>

Maximum Radiated Field strength: (see chapter 2.6.6 in this report)	104.5 dBµV/m [at 3m and at 2.442 GHz]
Calculated Equivalent Radiated Power:	8.455 mW (e.i.r.p.)
Minimum separation distance:	20 mm
SAR evaluation Exemption limit:	30 mW (at 2450 MHz, separation distance 20 mm)

3 Photographs

3.1 Equipment Under Test (EUT)

Figure 88 - EUT

Figure 89 - Test setup ≤ 1 GHz

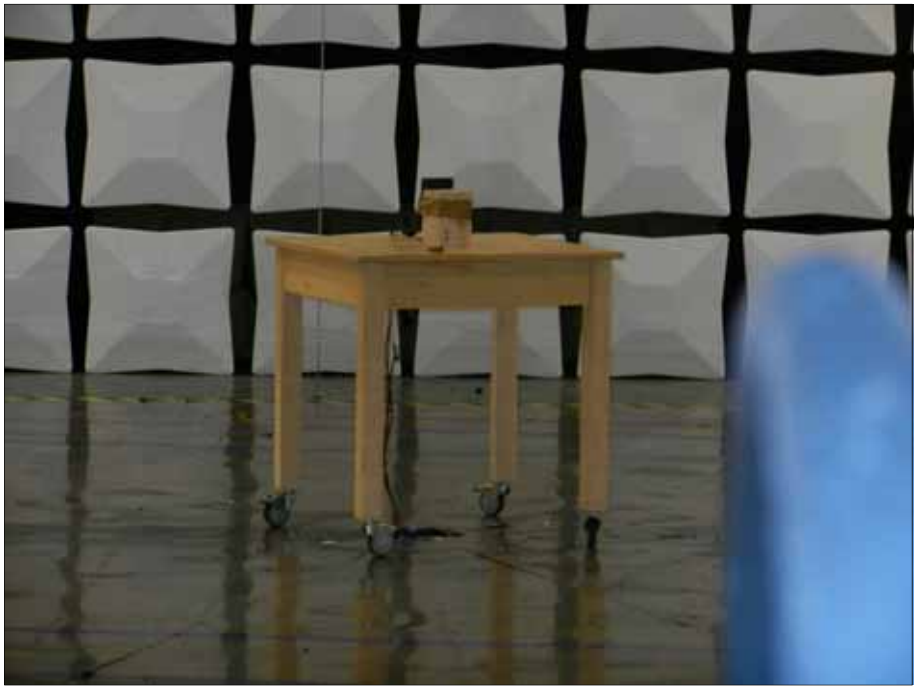

Figure 90 - Test setup 9 kHz - 30 MHz

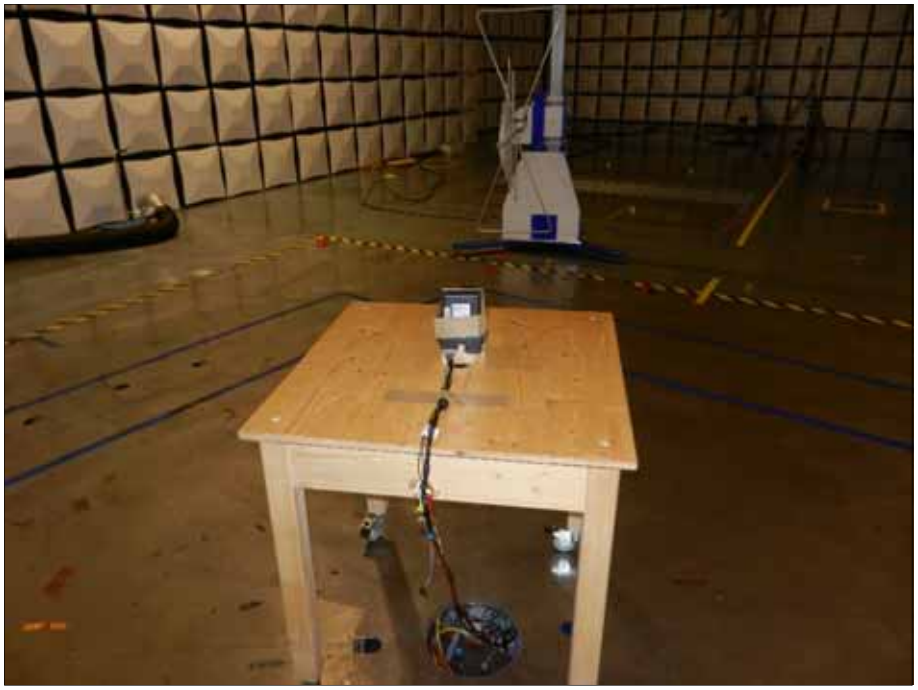

Figure 91 - Test setup 30 MHz - 1 GHz

Figure 92 - Test setup > 1 GHz

4 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Radio Testing			
Test Name	kp	Expanded Uncertainty	Note
Occupied Bandwidth	2.0	±1.14 %	2
RF-Frequency error	1.96	±1 · 10-7	7
RF-Power, conducted carrier	2	±0.079 dB	2
RF-Power uncertainty for given BER	1.96	+0.94 dB / -1.05	7
RF power, conducted, spurious emissions	1.96	+1.4 dB / -1.6 dB	7
RF power, radiated			
25 MHz – 4 GHz	1.96	+3.6 dB / -5.2 dB	8
1 GHz – 18 GHz	1.96	+3.8 dB / -5.6 dB	8
18 GHz – 26.5 GHz	1.96	+3.4 dB / -4.5 dB	8
40 GHz – 170 GHz	1.96	+4.2 dB / -7.1 dB	8
Spectral Power Density, conducted	2.0	±0.53 dB	2
Maximum frequency deviation			
300 Hz – 6 kHz	2	±2,89 %	2
6 kHz – 25 kHz	2	±0.2 dB	2
Maximum frequency deviation for FM	2	±2,89 %	2
Adjacent channel power 25 MHz – 1 GHz	2	±2.31 %	2
Temperature	2	±0.39 K	4
(Relative) Humidity	2	±2.28 %	2
DC- and low frequency AC voltage			
DC voltage	2	±0.01 %	2
AC voltage up to 1 kHz	2	±1.2 %	2
Time	2	±0.6 %	2

Table 19

Radio Interference Emission Testing			
Test Name	kp	Expanded Uncertainty	Note
Conducted Voltage Emission			
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB	1
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB	1
100 kHz to 200 MHz (50Ω/5µH AMN)	2	± 3.6 dB	1
Discontinuous Conducted Emission			
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB	1
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB	1
Conducted Current Emission			
9 kHz to 200 MHz	2	± 3.5 dB	1
Magnetic Fieldstrength			
9 kHz to 30 MHz (with loop antenna)	2	± 3.9 dB	1
9 kHz to 30 MHz (large-loop antenna 2 m)	2	± 3.5 dB	1
Radiated Emission			
Test distance 1 m (ALSE)			
9 kHz to 150 kHz	2	± 4.6 dB	1
150 kHz to 30 MHz	2	± 4.1 dB	1
30 MHz to 200 MHz	2	± 5.2 dB	1
200 MHz to 2 GHz	2	± 4.4 dB	1
2 GHz to 3 GHz	2	± 4.6 dB	1
Test distance 3 m			
30 MHz to 300 MHz	2	± 4.9 dB	1
300 MHz to 1 GHz	2	± 5.0 dB	1
1 GHz to 6 GHz	2	± 4.6 dB	1
Test distance 10 m			
30 MHz to 300 MHz	2	± 4.9 dB	1
300 MHz to 1 GHz	2	± 4.9 dB	1
Radio Interference Power			
30 MHz to 300 MHz	2	± 3.5 dB	1
Harmonic Current Emissions			4
Voltage Changes, Voltage Fluctuations and Flicker			4

Table 20

Immunity Testing			
Test Name	kp	Expanded Uncertainty	Note
Electrostatic Discharges			4
Radiated RF-Field			
Pre-calibrated field level	2	+32.2 / -24.3 %	5
Dynamic feedback field level	2.05	+21.2 / -17.5 %	3
Electrical Fast Transients (EFT) / Bursts			4
Surges			4
Conducted Disturbances, induced by RF-Fields			
via CDN	2	+15.1 / -13.1 %	6
via EM clamp	2	+42.6 / -29.9 %	6
via current clamp	2	+43.9 / -30.5 %	6
Power Frequency Magnetic Field	2	+20.7 / -17.1 %	2
Pulse Magnetic Field			4
Voltage Dips, Short Interruptions and Voltage Variations			4
Oscillatory Waves			4
Conducted Low Frequency Disturbances			
Voltage setting	2	± 0.9 %	2
Frequency setting	2	± 0.1 %	2
Electrical Transient Transmission in Road Vehicles			4

Table 21

Note 1:
The expanded uncertainty reported according to CISPR 16-4-2:2003-11 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%
Note 2:
The expanded uncertainty reported according to UKAS Lab 34 (Edition 1, 2002-08) is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%
Note 3:
The expanded uncertainty reported according to UKAS Lab 34 (Edition 1, 2002-08) is based on a standard uncertainty multiplied by a coverage factor of kp = 2.05, providing a level of confidence of p = 95.45%
Note 4:
It has been demonstrated that the used test equipment meets the specified requirements in the standard with at least a 95%confidence.
Note 5:
The expanded uncertainty reported according to IEC 61000-4-3 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%
Note 6:
The expanded uncertainty reported according to IEC 61000-4-6 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%
Note 7:
The expanded uncertainty reported according ETSI TR 100 028 V1.4.1 (all parts) to is based on a standard uncertainty multiplied by a coverage factor of kp = 1.96, providing a level of confidence of p = 95.45%
Note 8:
The expanded uncertainty reported according to ETSI TR 102 273 V1.2.1 (all parts) is based on a standard uncertainty multiplied by a coverage factor of kp = 1.96, providing a level of confidence of p = 95.45%