

LumenRadio AB

TEST REPORT

SCOPE OF WORK
FCC TESTING—CRMX Pluggy FX

REPORT NUMBER
240423001SZN-001

ISSUE DATE **[REVISED DATE]**
19 March 2025 [-----]

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LumenRadio AB

Application
For
Certification

FCC ID: XRSPLUGGY101**Radio module****Model: CRMX Pluggy FX****2.4GHz Transceiver****Report No.: 240423001SZN-001**

We hereby certify that the sample of the above item is considered to comply with the requirements of FCC Part 15, Subpart C for Intentional Radiator, mention 47 CFR [10-1-23]

Prepared and Checked by:

Mandy Chen
Engineer

Approved by:

Johnny Wang
Project Engineer
Date: 19 March 2025

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MEASUREMENT/TECHNICAL REPORT

This report concerns (check one): Original Grant Class II Change

Equipment Type: DSS - Part 15 Spread Spectrum Transmitter

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? Yes No

If yes, defer until: _____
date

Company Name agrees to notify the Commission by: _____
date
of the intended date of announcement of the product so that the grant can be issued on that date.

Transition Rules Request per 15.37? Yes No

If no, assumed Part 15, Subpart C for intentional radiator – the new 47 CFR [10-1-23 Edition] provision.

Report prepared by:

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1.0 Summary of Test Results

Applicant: LumenRadio AB

Address: Johan Willins gata 6, 41664 Gothenburg, Sweden

Manufacturer: LumenRadio AB

Address: Johan Willins gata 6, 41664 Gothenburg, Sweden

Model: CRMX Pluggy FX

FCC ID: XRSPLUGGY101

TEST	REFERENCE	RESULTS
Max. Output power / Max. e.i.r.p.	FCC 15.247(b)(1)	Pass
20dB Bandwidth	FCC 15.247(a)(1)	Pass
Channel Separation	FCC 15.247(a)(1)	Pass
Channel Number	FCC 15.247(a)(1) (iii)	Pass
Dwell Time	FCC 15.247(a)(1)(iii)	Pass
Out of Band Antenna Conducted Emission	FCC 15.247(d)	Pass
Radiated Emission in Restricted Bands	FCC 15.247(d), FCC 15.209, FCC 15.205	Pass
Band Edge	FCC 15.247(d), FCC 15.209, FCC 15.205	Pass
AC Conducted Emission	FCC 15.207	Pass

Notes: The EUT uses an Unique (non-standard) antenna connector which in accordance to Section 15.203 is considered sufficient to comply with the provisions of this section.

2.0 General Description

2.1 Product Description

The equipment under test (EUT) is a Radio module with 2.4G FHSS technology operating in 2402-2480MHz. The EUT is powered by DC power supply (5.0V). For more detail information pls. refer to the user manual.

Antenna Type: Unique (non-standard) antenna connector

Antenna Gain: 2.15 dBi (This information is provided by applicant, and the applicant is responsible for the authenticity of the provided information.)

Modulation Type: GFSK

For electronic filing, the brief circuit description is saved with filename: descri.pdf.

2.2 Related Submittal(s) Grants

This is an application for certification of transceiver for the Radio module which has 2.4GHz FHSS function.

2.3 Test Methodology

Both AC mains line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.10 (2013). Radiated emission measurement was performed in semi-anechoic chamber and conducted emission measurement was performed in shield room. For radiated emission measurement, preliminary scans were performed in the semi-anechoic chamber only to determine the worst case modes. All radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Justification Section**" of this Application.

2.4 Test Facility

The Semi-anechoic chamber and shielding room used to collect the radiated data and conducted data are **Intertek Testing Services Shenzhen Ltd. Longhua Branch** and located at 101, 201, Building B, No. 308 Wuhe Avenue, Zhangkengjing Community, GuanHu Subdistrict, LongHua District, Shenzhen. This test facility and site measurement data have been fully placed on file with File Number: CN1188.

3.0 System Test Configuration

3.1 Justification

The system was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in ANSI C63.10 (2013).

The EUT was powered by DC power supply (5.0V) during the test. Only the worst data was reported in this report.

For maximizing emissions below 30 MHz, the EUT was rotated through 360°, the centre of the loop antenna was placed 1 meter above the ground, and the antenna polarization was changed. For maximizing emissions, the EUT was rotated through 360°, the antenna height was varied from 1 meter to 4 meters above the ground plane, and the antenna polarization was changed. This step by step procedure for maximizing emissions led to the data reported in Section 4.

The rear of unit was flushed with the rear of the table.

The equipment under test (EUT) was configured for testing in a typical fashion (as a customer would normally use it). The EUT was placed on a turn table, which enabled the engineer to maximize emissions through its placement in the three orthogonal axes.

3.2 EUT Exercising Software

The EUT exercise program (provided by client) used during radiated and conducted testing was designed to exercise the various system components in a manner similar to a typical use. The worst case configuration is used in all specified testing.

The parameters of test software setting:

During the test, Channel and power controlling software provided by the applicant was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the application and is going to be fixed on the firmware of the end product.

Test Software: CoolTerm

3.3 Special Accessories

No special accessory attached.

3.4 Equipment Modification

Any modifications installed previous to testing by LumenRadio AB will be incorporated in each production model sold / leased in the United States.

No modifications were installed by Intertek Testing Services Shenzhen Ltd. Longhua Branch.

3.5 Measurement Uncertainty

When determining the test conclusion, the Measurement Uncertainty of test has been considered.

3.6 Support Equipment List and Description

Description	Manufacturer	Model No.
Laptop (Provided by Intertek)	DELL	Latitude 3480

4.0 Test Results

Data is included worst-case configuration (the configuration which resulted in the highest emission levels).

4.1 Radiated Test Results

A sample calculation, configuration photographs and data tables of the emissions are included.

4.1.1 Field Strength Calculation

The field strength is calculated by adding the reading on the Spectrum Analyzer to the factors associated with preamplifiers (if any), antennas, cables, pulse desensitization and average factors (when specified limit is in average and measurements are made with peak detectors). A sample calculation is included below.

$$FS = RA + AF + CF - AG + PD + AV$$

Where FS = Field Strength in $\text{dB}\mu\text{V}/\text{m}$

RA = Receiver Amplitude (including preamplifier) in $\text{dB}\mu\text{V}$

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB

AG = Amplifier Gain in dB

PD = Pulse Desensitization in dB

AV = Average Factor in -dB

In the radiated emission table which follows, the reading shown on the data table may reflect the preamplifier gain. An example of the calculations, where the reading does not reflect the preamplifier gain, follows:

$$FS = RA + AF + CF - AG + PD + AV$$

Assume a receiver reading of 62.0 $\text{dB}\mu\text{V}$ is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted. The pulse desensitization factor of the spectrum analyzer was 0 dB, and the resultant average factor was -10 dB. The net field strength for comparison to the appropriate emission limit is 32 $\text{dB}\mu\text{V}/\text{m}$. This value in $\text{dB}\mu\text{V}/\text{m}$ was converted to its corresponding level in $\mu\text{V}/\text{m}$.

$$RA = 62.0 \text{ dB}\mu\text{V}$$

$$AF = 7.4 \text{ dB}$$

$$CF = 1.6 \text{ dB}$$

$$AG = 29.0 \text{ dB}$$

$$PD = 0 \text{ dB}$$

$$AV = -10 \text{ dB}$$

$$FS = 62 + 7.4 + 1.6 - 29 + 0 + (-10) = 32 \text{ dB}\mu\text{V}/\text{m}$$

$$\text{Level in } \mu\text{V}/\text{m} = \text{Common Antilogarithm } [(32 \text{ dB}\mu\text{V}/\text{m})/20] = 39.8 \mu\text{V}/\text{m}$$

4.1.2 Radiated Emission Configuration Photograph

For electronic filing, the worst case radiated emission configuration photograph is saved with filename: radiated photos. pdf.

4.1.3 Radiated Emissions- FCC section 15.209

The data on the following page lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Worst Case Radiated Emission

at 47.912667 MHz

Judgement: Passed by 12.7 dB

TEST PERSONNEL:

Sign on file

Mandy Chen, Engineer
Typed/Printed Name

11 October 2024

Date

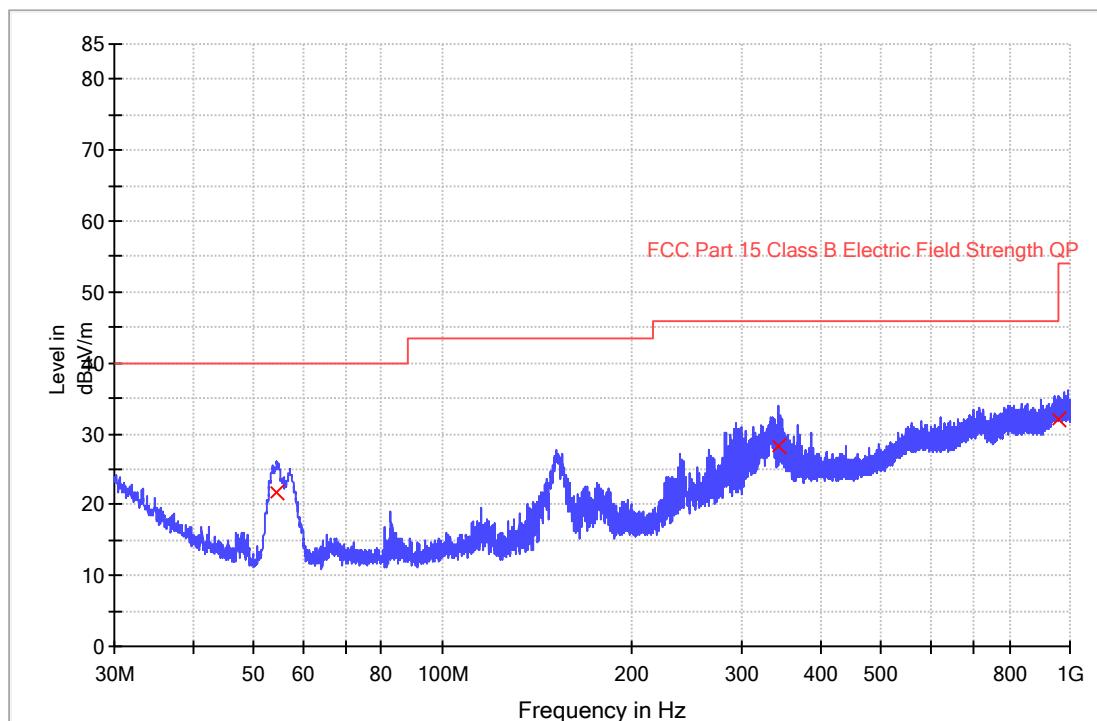
Applicant: LumenRadio AB

Date of Test: 11 October 2024

Model: CRMX Pluggy FX

Worst-case operating Mode: Transmitting (2402MHz)

ANT Polarity: Horizontal



Frequency (MHz)	QuasiPeak (dB μ V/m)	Meas. Time (ms)	Bandwidth (kHz)	Polarization	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dB μ V/m)
54.508667	21.8	1000.0	120.000	H	13.1	18.2	40.0
343.892000	28.2	1000.0	120.000	H	22.4	17.8	46.0
958.257667	32.2	1000.0	120.000	H	33.6	13.8	46.0

Remark:

1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
2. QuasiPeak (dB μ V/m) = Corr. (dB/m) + Read Level (dB μ V)
3. Margin (dB) = Limit Line(dB μ V/m) - Level (dB μ V/m)

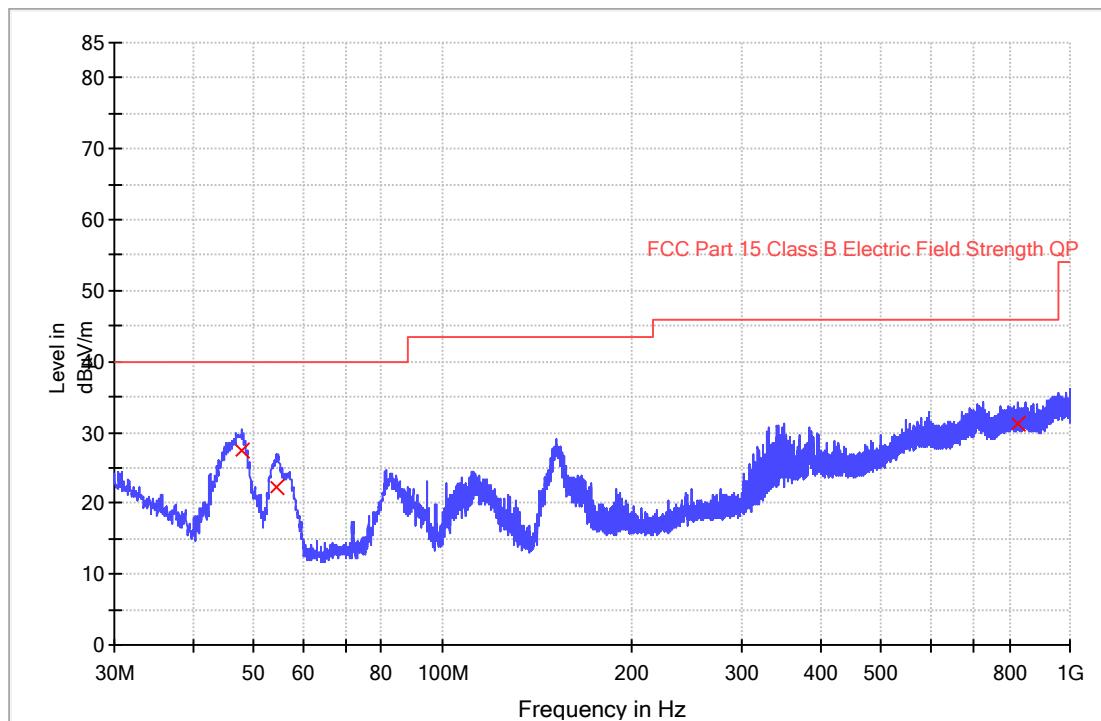
Applicant: LumenRadio AB

Date of Test: 11 October 2024

Model: CRMX Pluggy FX

Worst-case operating Mode: Transmitting (2402MHz)

ANT Polarity: Vertical



Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Polarization	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
47.912667	27.3	1000.0	120.000	V	13.4	12.7	40.0
54.379333	22.3	1000.0	120.000	V	13.0	17.7	40.0
825.335333	31.2	1000.0	120.000	V	31.9	14.8	46.0

Remark:

1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
2. QuasiPeak (dB μ V/m) = Corr. (dB/m) + Read Level (dB μ V)
3. Margin (dB) = Limit Line(dB μ V/m) – Level (dB μ V/m)

4.1.4 Transmitter Spurious Emissions (Radiated) - FCC section 15.209

The data on the following page lists the significant emission frequencies include the radiated emissions which fall in the restricted bands, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Worst Case Radiated Emission

at 9764.000 MHz

Judgement: Passed by 2.4 dB

TEST PERSONNEL:

Sign on file

Mandy Chen, Engineer

Typed/Printed Name

11 October 2024

Date

Applicant: LumenRadio AB

Date of Test: 11 October 2024

Model: CRMX Pluggy FX

Worst-case operating Mode: Transmitting (2402MHz)

Table 1

Radiated Emissions

(2402MHz)

Polarization	Frequency (MHz)	Reading (dB μ V)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dB μ V/m)	Peak Limit at 3m (dB μ V/m)	Margin (dB)
Horizontal	*2390.000	65.0	36.7	28.1	56.4	74.0	-17.6
Horizontal	*4804.000	52.5	36.7	35.5	51.3	74.0	-22.7
Horizontal	*9608.000	53.3	36.7	38.5	55.1	74.0	-18.9

Polarization	Frequency (MHz)	Reading (dB μ V)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Average Factor (-dB)	Net at 3m (dB μ V/m)	Average Limit at 3m (dB μ V/m)	Margin (dB)
Horizontal	*2390.000	65.0	36.7	28.1	5.3	51.1	54.0	-2.9
Horizontal	*4804.000	52.5	36.7	35.5	5.3	46.0	54.0	-8.0
Horizontal	*9608.000	53.3	36.7	38.5	5.3	49.8	54.0	-4.2

NOTES: 1. Peak detector is used for the emission measurement.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.
3. Negative value in the margin column shows emission below limit.
4. Horn antenna used for the emission over 1000MHz.
 - * Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: LumenRadio AB

Date of Test: 11 October 2024

Model: CRMX Pluggy FX

Worst-case operating Mode: Transmit (2441MHz)

Table 2

Radiated Emissions

(2441MHz)

Polarization	Frequency (MHz)	Reading (dB μ V)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dB μ V/m)	Peak Limit at 3m (dB μ V/m)	Margin (dB)
Horizontal	*7323.000	52.6	36.7	37.2	53.1	74.0	-20.9
Horizontal	*9764.000	54.4	36.1	38.6	56.9	74.0	-17.1

Polarization	Frequency (MHz)	Reading (dB μ V)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Average Factor (-dB)	Net at 3m (dB μ V/m)	Average Limit at 3m (dB μ V/m)	Margin (dB)
Horizontal	*7323.000	52.6	36.7	37.2	5.3	47.8	54.0	-6.2
Horizontal	*9764.000	54.4	36.1	38.6	5.3	51.6	54.0	-2.4

NOTES: 1. Peak detector is used for the emission measurement.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.
3. Negative value in the margin column shows emission below limit.
4. Horn antenna used for the emission over 1000MHz.
 - * Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: LumenRadio AB

Date of Test: 11 October 2024

Model: CRMX Pluggy FX

Worst-case operating Mode: Transmit (2480MHz)

Table 3

Radiated Emissions

(2480MHz)

Polarization	Frequency (MHz)	Reading (dB μ V)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dB μ V/m)	Peak Limit at 3m (dB μ V/m)	Margin (dB)
Horizontal	*2483.500	54.4	36.0	36.8	55.2	74.0	-18.8
Horizontal	*7440.000	55.6	36.7	35.5	54.4	74.0	-19.6
Horizontal	*9920.000	54.0	36.1	38.6	56.5	74.0	-17.5

Polarization	Frequency (MHz)	Reading (dB μ V)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Average Factor (-dB)	Net at 3m (dB μ V/m)	Average Limit at 3m (dB μ V/m)	Margin (dB)
Horizontal	*2483.500	54.4	36.0	36.8	5.3	49.9	54.0	-4.1
Horizontal	*7440.000	55.6	36.7	35.5	5.3	49.1	54.0	-4.9
Horizontal	*9920.000	54.0	36.1	38.6	5.3	51.2	54.0	-2.8

NOTES: 1. Peak detector is used for the emission measurement.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.
3. Negative value in the margin column shows emission below limit.
4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

4.2 Conducted Emission at Mains Terminal**4.2.1 Conducted Emissions Configuration Photograph**

For electronic filing, the worst case conducted emission configuration photograph is saved with filename: conducted photos.pdf.

4.2.2 Conducted Emissions

Worst Case Conducted Configuration

at 0.306000 MHz

Judgement: Passed by 11.2 dB margin

TEST PERSONNEL:

Sign on file

Mandy Chen, Engineer
Typed/Printed Name

11 October 2024

Date

TEST REPORT

Intertek Report No.: 240423001SZN-001

Applicant: LumenRadio AB

Date of Test: 11 October 2024

Model: CRMX Pluggy FX

Worst-case and operating Mode: Transmitting (2402MHz)

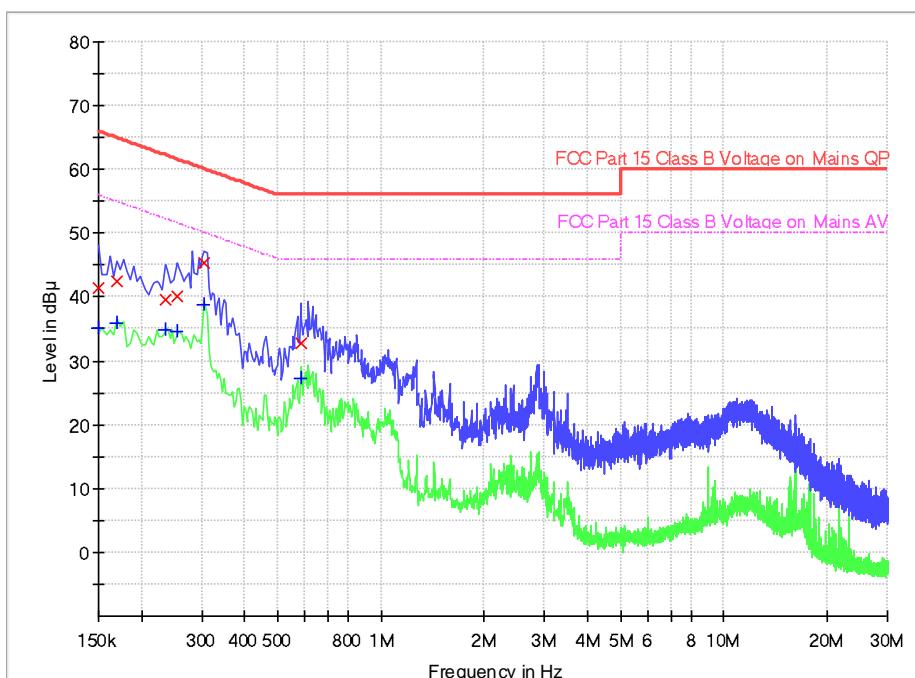
Modulation type: GFSK

Test Voltage: AC 120V/60Hz

Phase: Live

Conducted Emission Test - FCC

Conducted Emission Test FCC Part 15



Result Table QP

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.150000	41.3	9.000	L1	9.6	24.7	66.0
0.170000	42.5	9.000	L1	9.6	22.5	65.0
0.234000	39.7	9.000	L1	9.6	22.6	62.3
0.254000	40.2	9.000	L1	9.6	21.4	61.6
0.306000	45.3	9.000	L1	9.6	14.8	60.1
0.582000	32.8	9.000	L1	9.6	23.2	56.0

Result Table AV

Frequency (MHz)	Average (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.150000	35.1	9.000	L1	9.6	20.9	56.0
0.170000	36.0	9.000	L1	9.6	19.0	55.0
0.234000	34.8	9.000	L1	9.6	17.5	52.3
0.254000	34.5	9.000	L1	9.6	17.1	51.6
0.306000	38.9	9.000	L1	9.6	11.2	50.1
0.582000	27.3	9.000	L1	9.6	18.7	46.0

TEST REPORT

Intertek Report No.: 240423001SZN-001

Applicant: LumenRadio AB

Date of Test: 11 October 2024

Model: CRMX Pluggy FX

Worst-case and operating Mode: Transmitting (2402MHz)

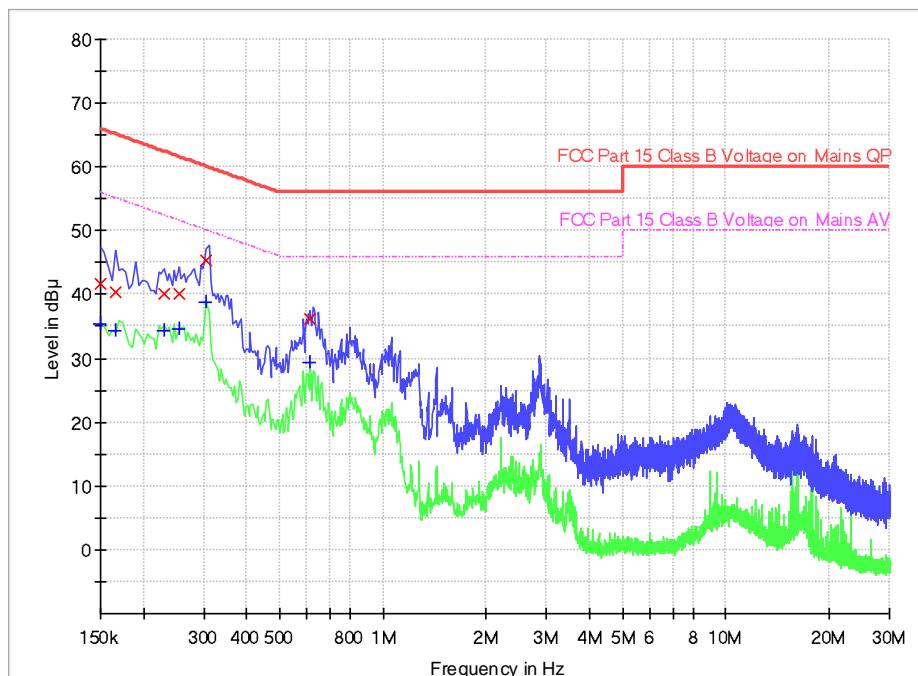
Modulation type: GFSK

Test Voltage: AC 120V/60Hz

Phase: Neutral

Conducted Emission Test – FCC

Conducted Emission Test FCC Part 15



Result Table QP

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.150000	41.8	9.000	N	9.6	24.2	66.0
0.166000	40.5	9.000	N	9.6	24.7	65.2
0.230000	40.1	9.000	N	9.6	22.3	62.4
0.254000	40.2	9.000	N	9.6	21.4	61.6
0.306000	45.3	9.000	N	9.6	14.8	60.1
0.614000	36.2	9.000	N	9.6	19.8	56.0

Result Table AV

Frequency (MHz)	Average (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.150000	35.5	9.000	N	9.6	20.5	56.0
0.166000	34.4	9.000	N	9.6	20.8	55.2
0.230000	34.4	9.000	N	9.6	18.0	52.4
0.254000	34.6	9.000	N	9.6	17.0	51.6
0.306000	38.9	9.000	N	9.6	11.2	50.1
0.614000	29.5	9.000	N	9.6	16.5	46.0

Applicant: LumenRadio AB

Date of Test: October 11, 2024

Model: CRMX Pluggy FX

4.3 Peak Power**Maximum Conducted Output Power at Antenna Terminals, FCC Rules 15.247(b)(1).**

The antenna port of the EUT was connected to the input of a spectrum analyzer. The analyzer was set for RBW > 20dB bandwidth and power was read directly in dBm.

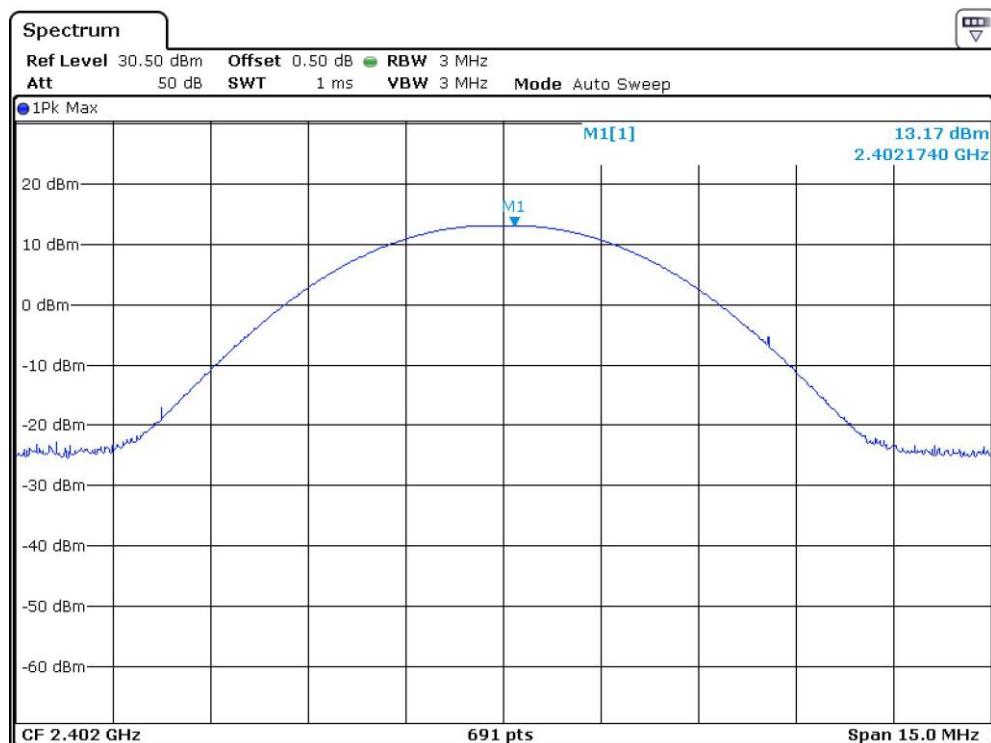
For antenna with gains of 6dBi or less, and frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, the systems operate with an output power no greater than 125 mW.

Antenna Gain = 2.15dBi			
Modulation Type	Frequency (MHz)	Output Power (Peak Reading) (dBm)	Output Power (mW)
GFSK	2402	13.17	20.75
	2441	14.13	25.88
	2480	14.04	25.35

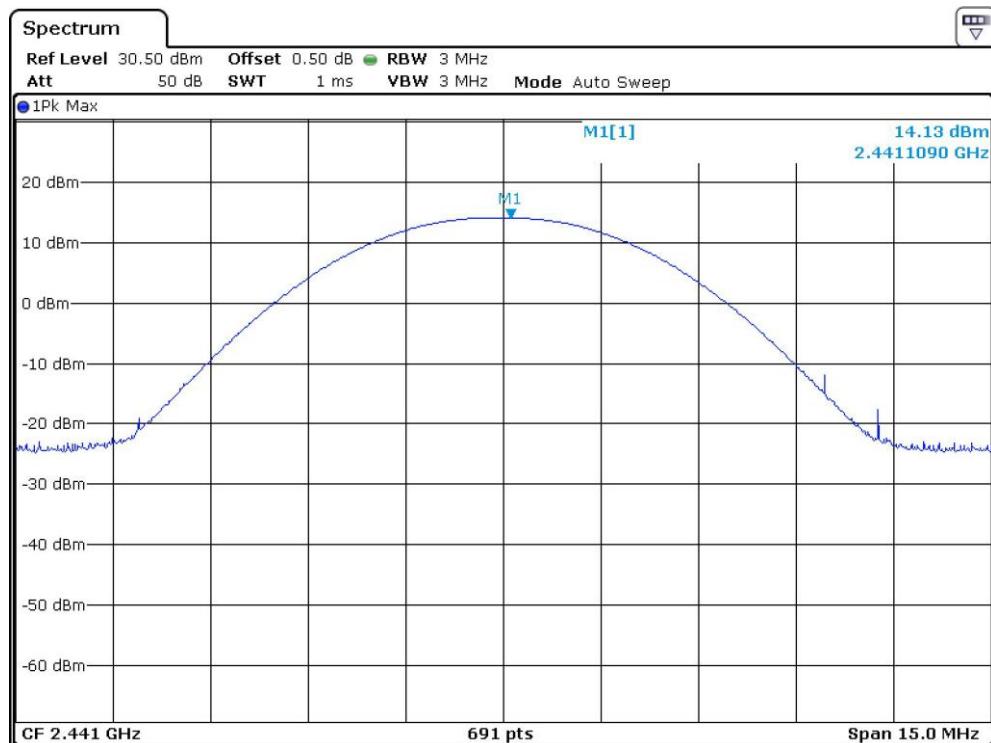
Cable loss: 0.5 dB External Attenuation: 0 dB

Cable loss, external attenuation has been included in OFFSET function

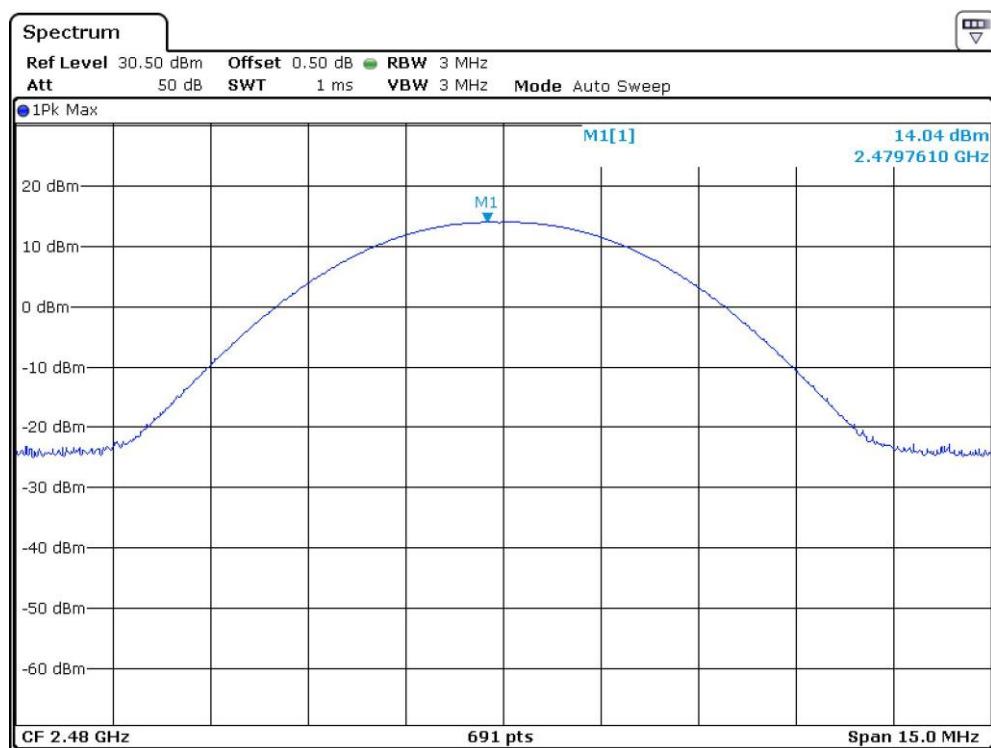
CH00



CH39



CH78



TEST REPORT

Intertek Report No.: 240423001SZN-001

Applicant: LumenRadio AB

Date of Test: October 11, 2024

Model: CRMX Pluggy FX

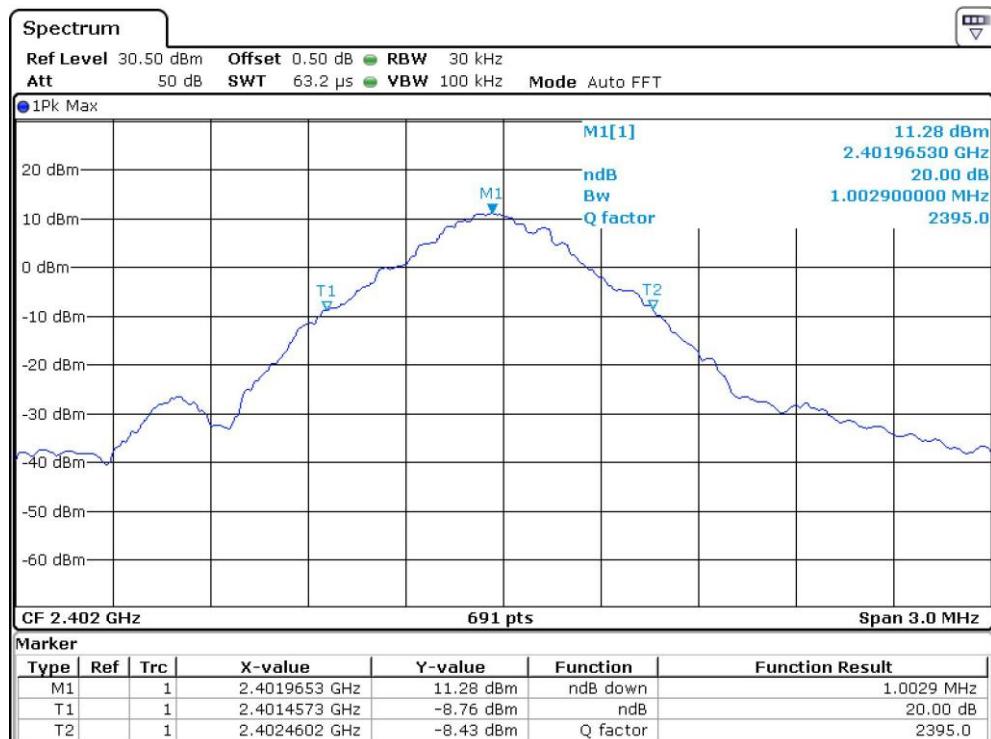
4.4 20dB Bandwidth

Maximum 20dB RF Bandwidth, FCC Rule 15.247(a) (1):

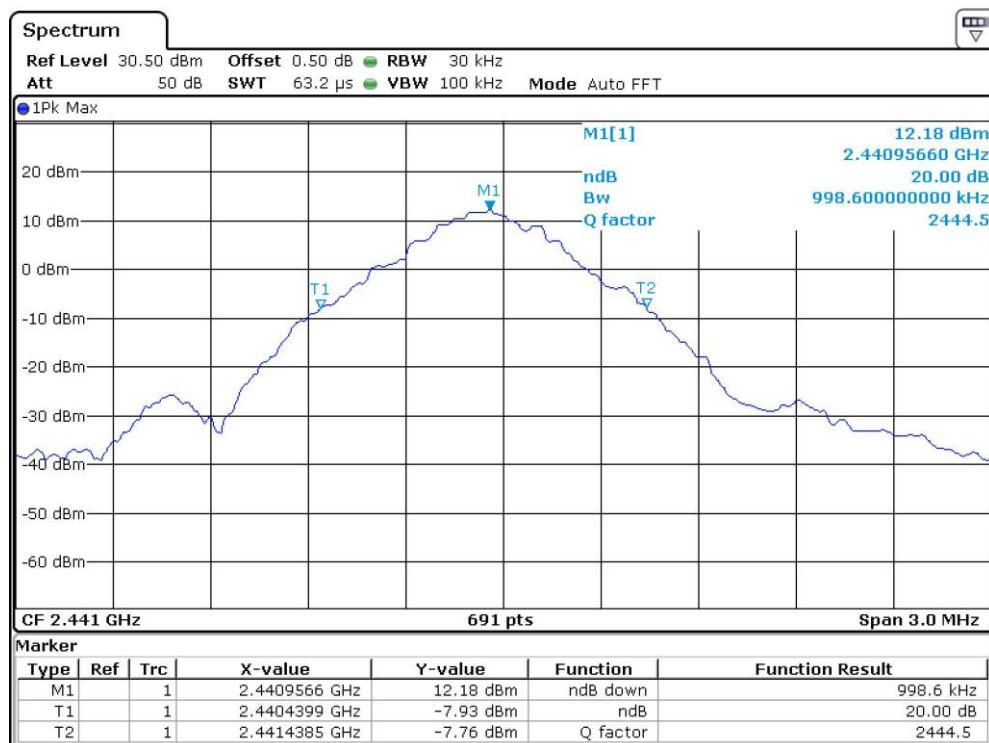
Pursuant to FCC part 15 Section 15.215(c), the 20dB bandwidth of the emission was contained within the frequency band designated (mentioned as above) which the EUT operated. The effects, if any, from frequency sweeping, frequency hopping, other modulation techniques and frequency stability over excepted variations in temperature and supply voltage were considered. The test plots are reported as below.

Frequency (MHz)	20 dB Bandwidth (MHz)
2402	1.0029
2441	0.9986
2480	1.0029

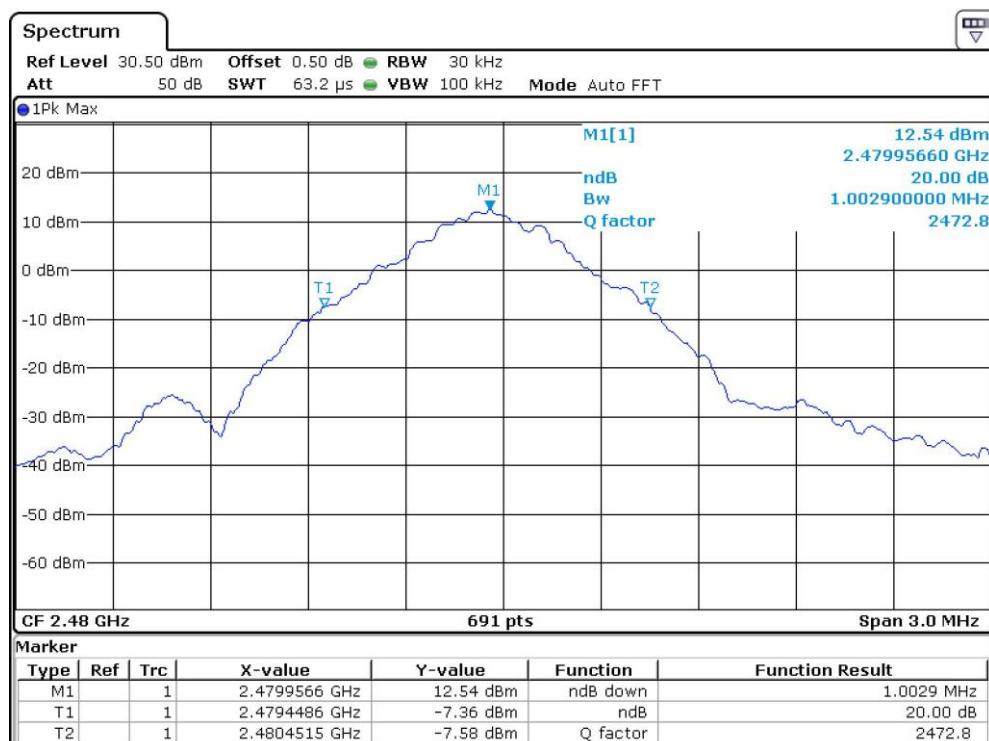
CH00



CH39



CH78



Applicant: LumenRadio AB

Date of Test: October 11, 2024

Model: CRMX Pluggy FX

4.5 Channel Number (Number of Hopping Frequencies)

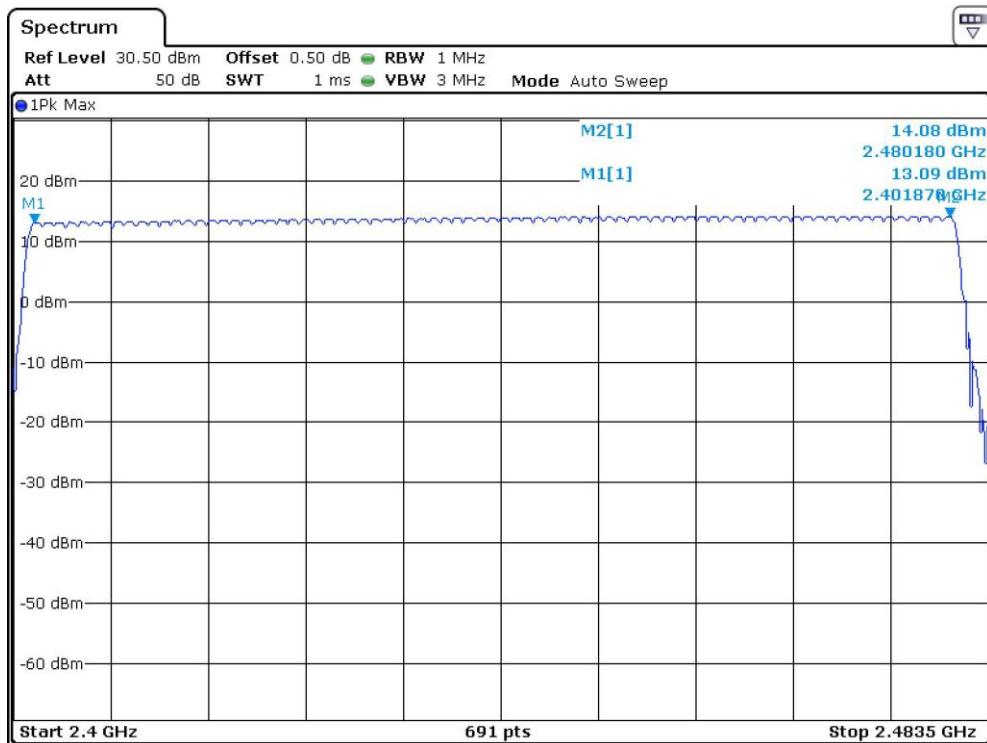
Minimum Number of Hopping Frequencies, FCC Rule 15.247(a) (1) (iii):

The RF passband of the EUT was divided into 3 approximately equal bands. With the analyzer set to MAX HOLD readings were taken for 2-3 minutes. The channel peaks so recorded were added together, and the total number compared to the minimum number of channels required in the regulation.

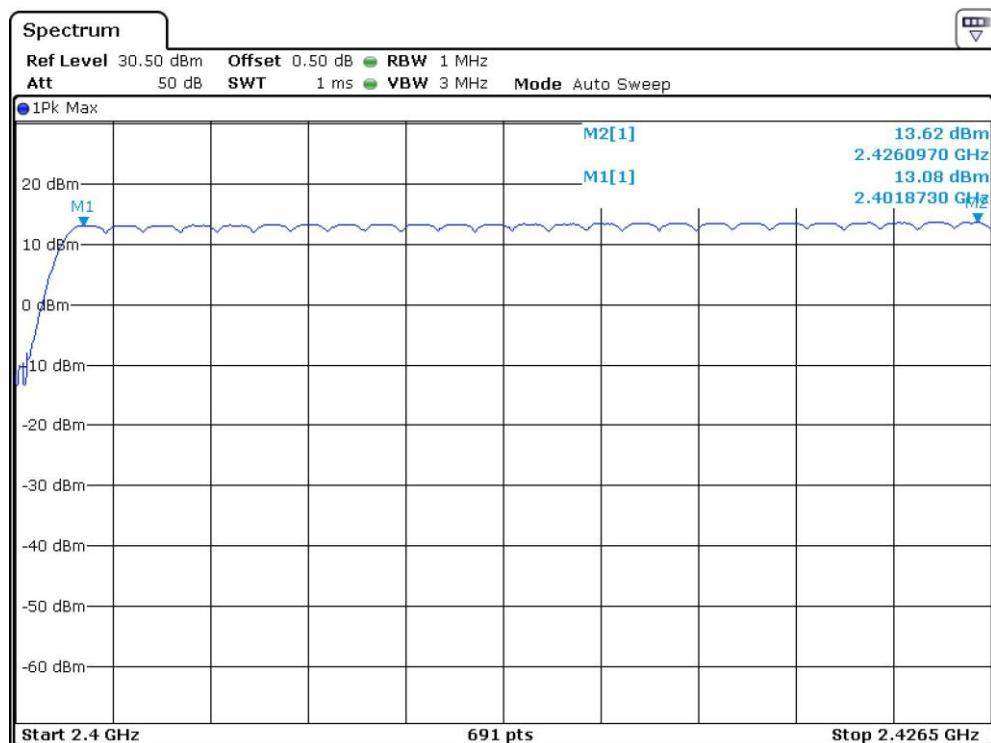
Number of hopping channels =	79
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Note: In AFH mode, this device operates using 20 channels and it's satisfied the requirement of limit of minimum of 15 hopping channels.

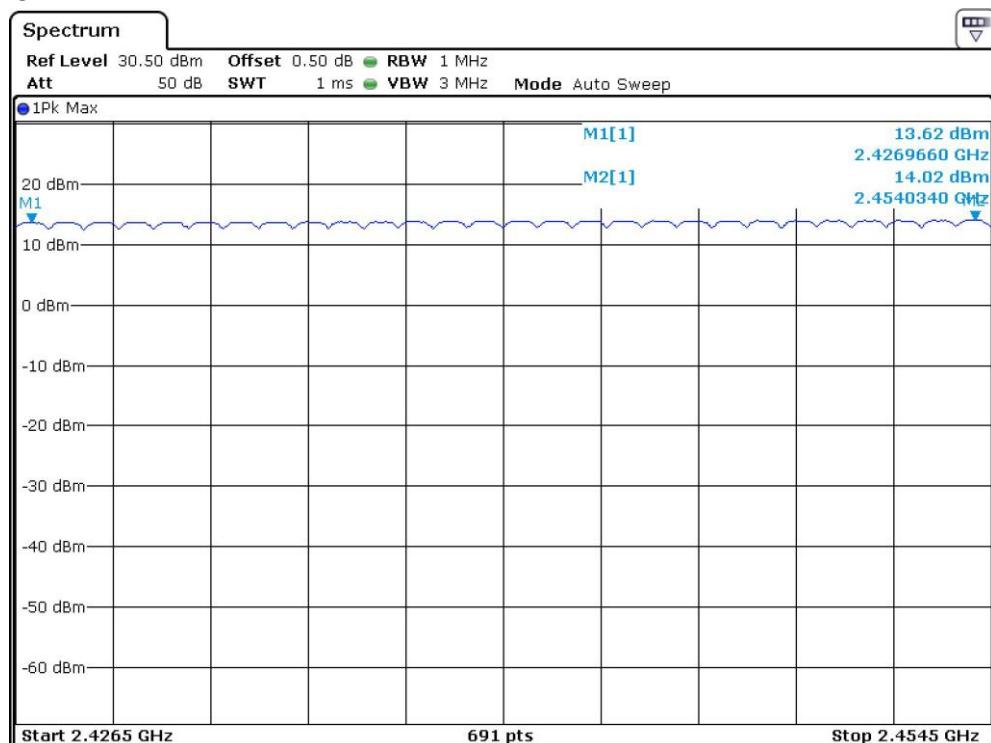
CH00-CH78



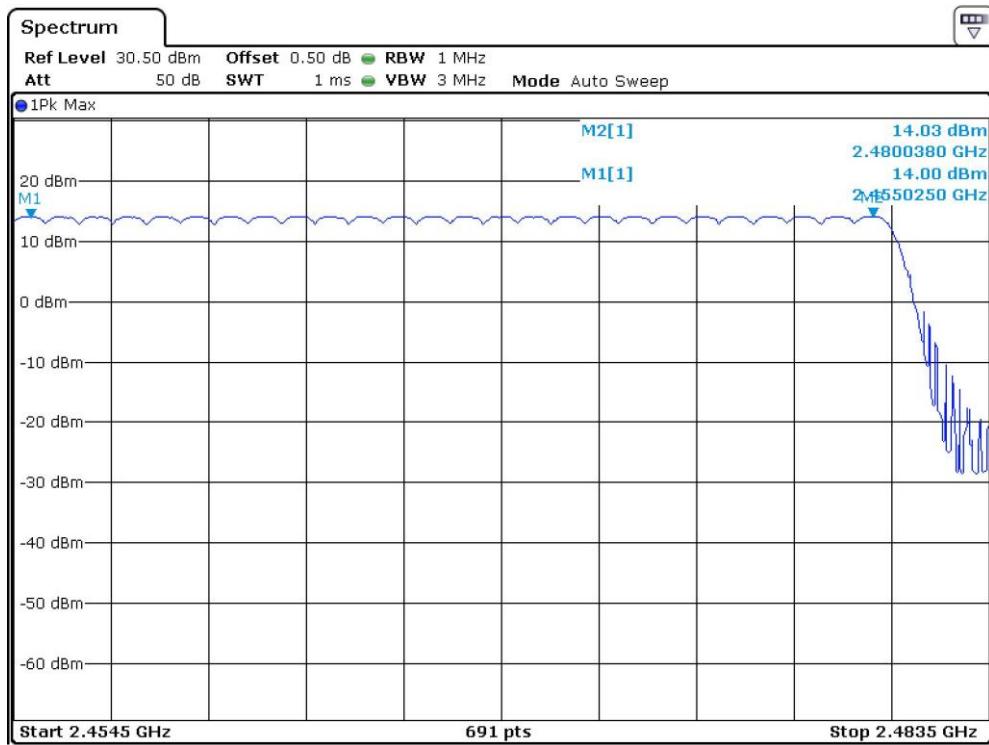
CH00-CH24



CH25-CH52



CH53-CH78



Applicant: LumenRadio AB

Date of Test: October 11, 2024

Model: CRMX Pluggy FX

4.6 Channel Separation (Carrier Frequency Separation)

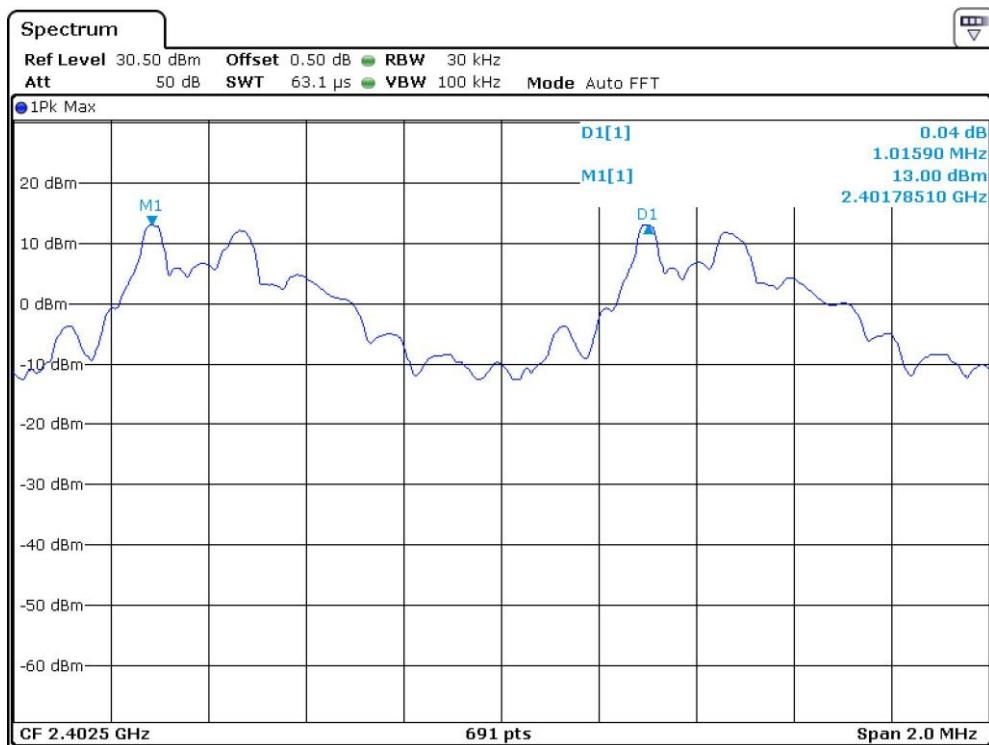
Minimum Hopping Channel Carrier Frequency Separation, FCC Ref: 15.247(a)(1):

Using the DELTA MARKER function of the analyzer, the frequency separation between two adjacent channels was measured and compared against the limit:

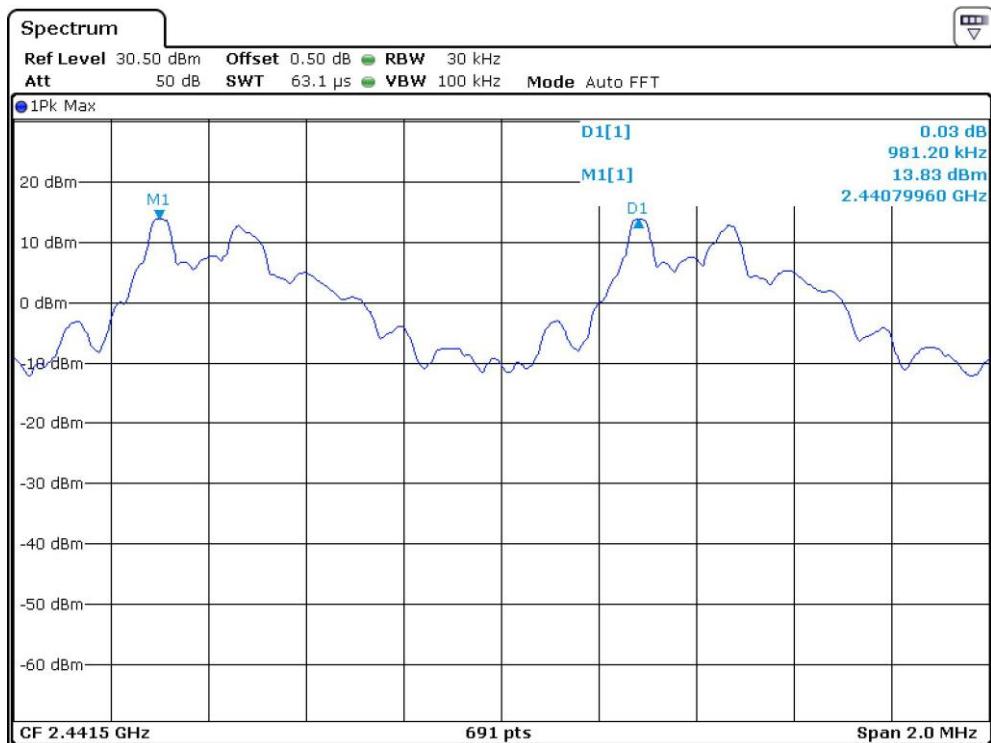
Not less than 2/3 of 20dB bandwidth of hopping channel: $998.6\text{kHz} \times 2/3 = 665.7\text{kHz}$

Minimum Channel Separation	981.20kHz
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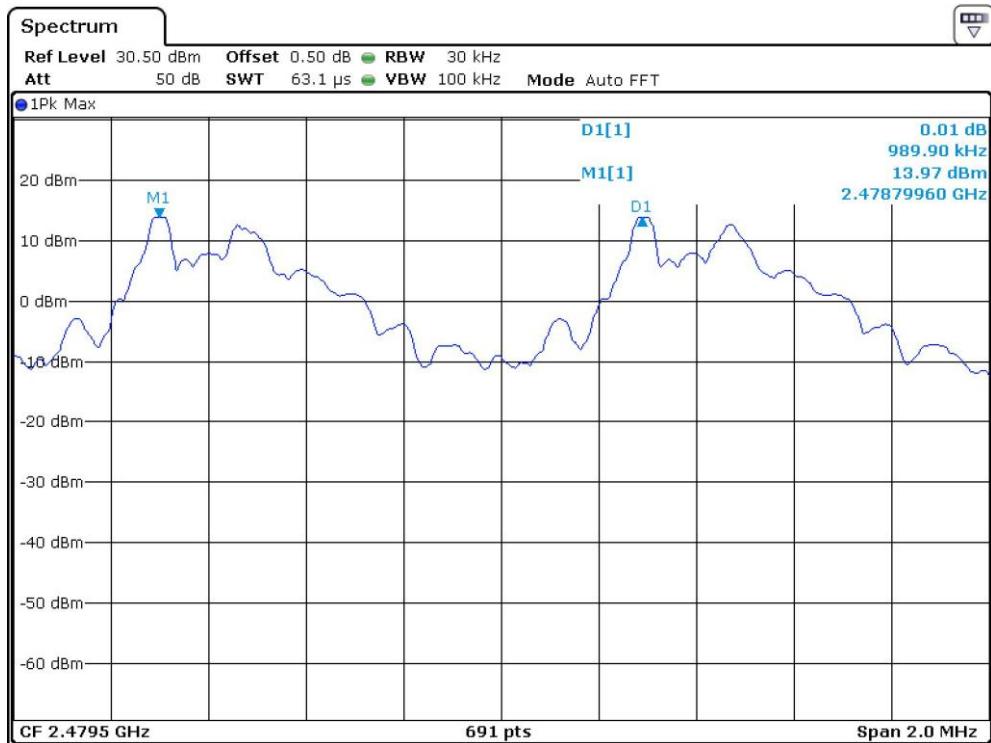
Low Channel



Middle Channel



High Channel



Applicant: LumenRadio AB

Date of Test: October 11, 2024

Model: CRMX Pluggy FX

4.7 Dwell Time (Time of Occupancy)

Average Channel Occupancy Time, FCC Ref: 15.247(a) (1)(iii):

The spectrum analyzer center frequency was set to one of the known hopping channels with a longer sweep time to show two successive hops on a channel; the SPAN was set to ZERO SPAN, and the TRIGGER was set to VIDEO. RBW shall be \leq channel spacing and where possible RBW should be set $>>1/T$, where T is the expected dwell time per channel. The time duration of the transmissions so captured was measured with the MARKER DELTA function.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Different modes of operation were performed and only the worst case data was reported.

(Number of hops in the period specified in the requirements) = (number of hops on spectrum analyzer) \times (period specified in the requirements / analyzer sweep time)

Worst Test Result:

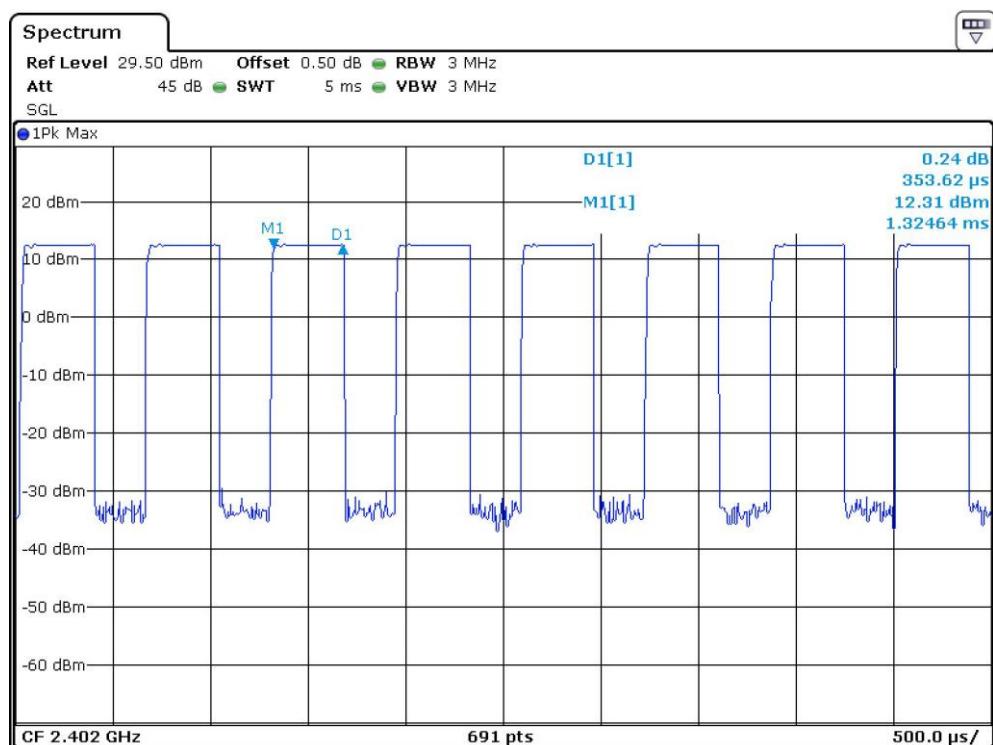
Normal hopping mode:

Modulation Type	Unit	Max Dwell Time	Limit (ms)	Result
GFSK	ms	0.354 * 781 = 276.47	400	Pass

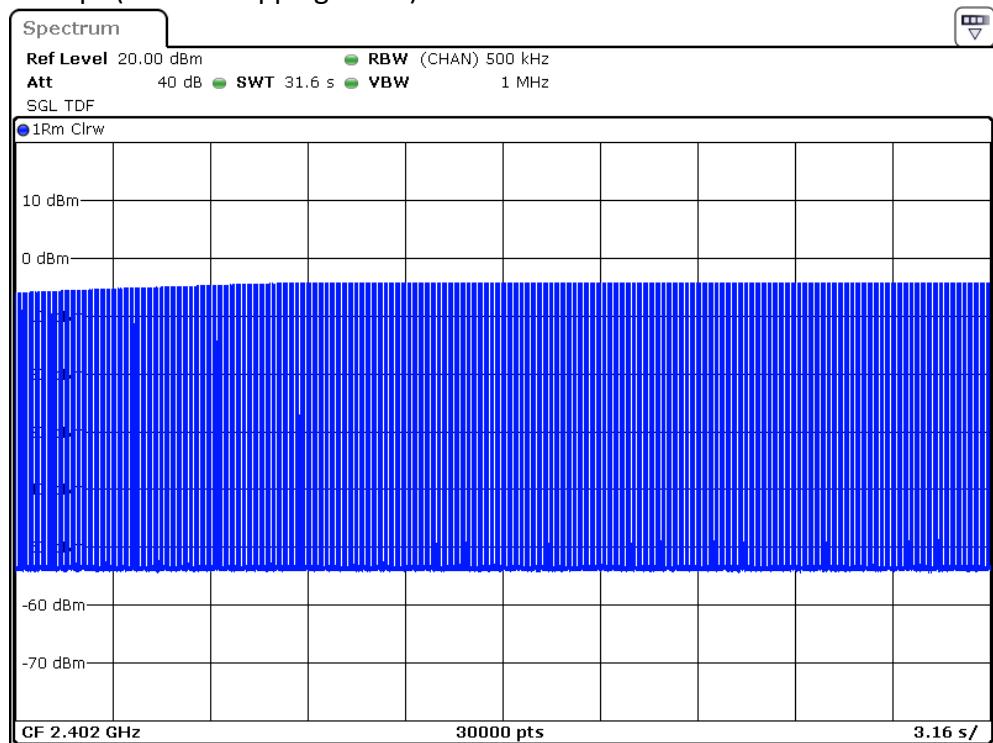
AFH hopping mode:

Modulation Type	Unit	Max Dwell Time	Limit (ms)	Result
GFSK	ms	0.354 * 160 = 56.64	400	Pass

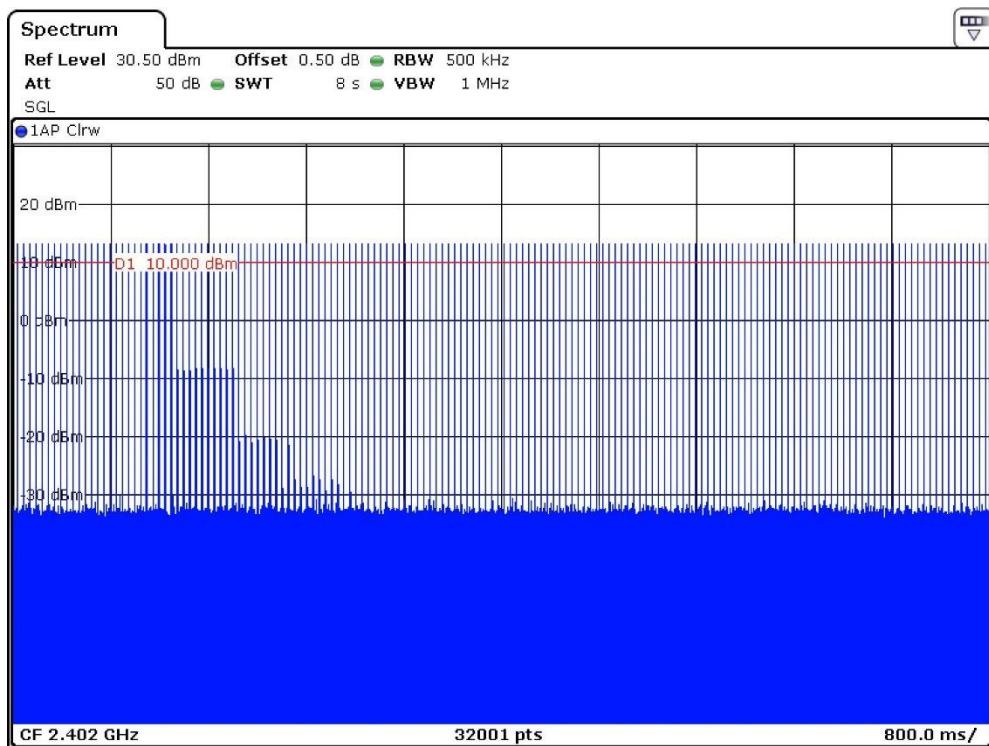
CH00



Number of hops (Normal hopping mode)



Number of hops (AFH mode)



Applicant: LumenRadio AB

Date of Test: October 11, 2024

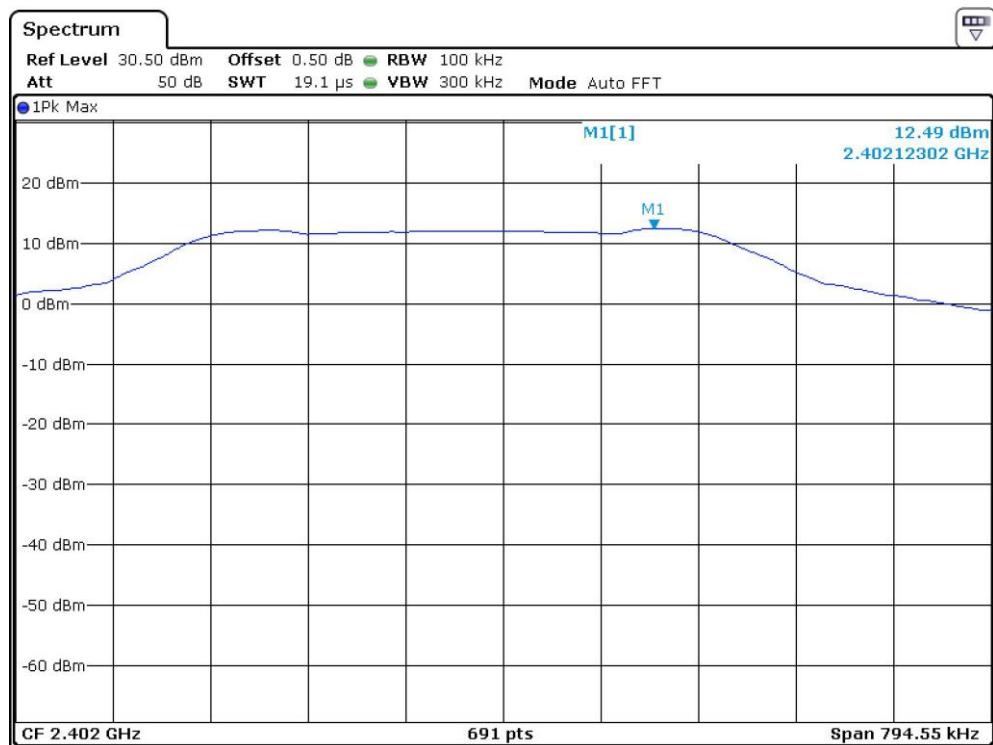
Model: CRMX Pluggy FX

4.8 Transmitter Spurious Emissions & Authorized-band band-edge (Conducted)

Out of Band Conducted Spurious Emissions, FCC Rule 15.247(d):

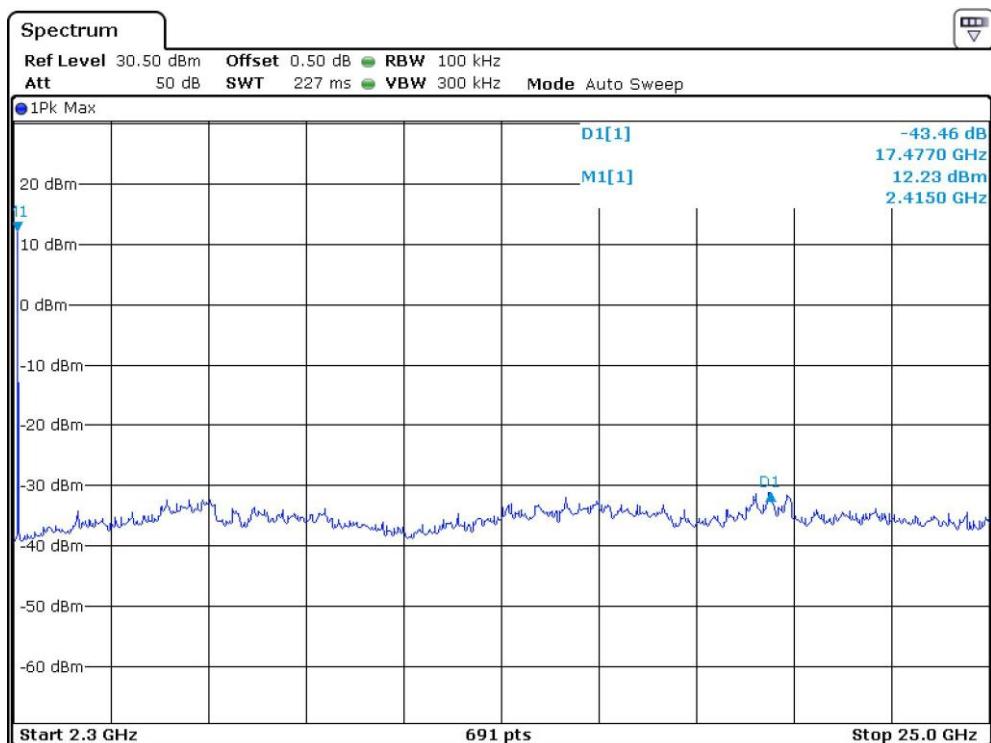
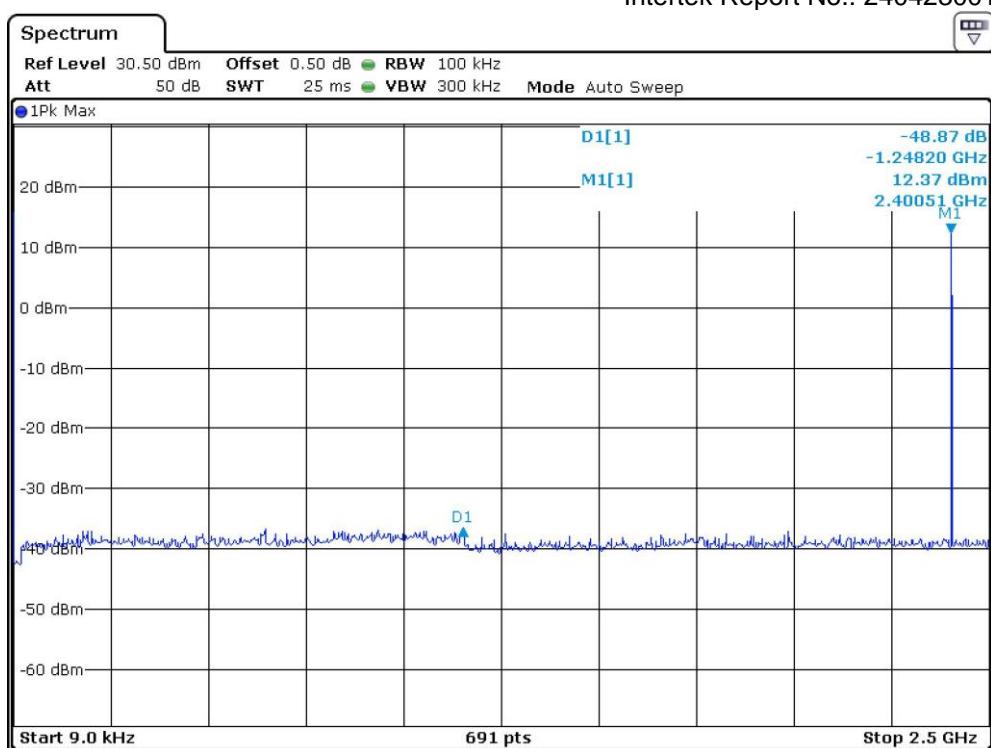
All spurious emission and up to the tenth harmonic was measured and they were found to be at least 20 dB below the highest level of the desired power in the passband.

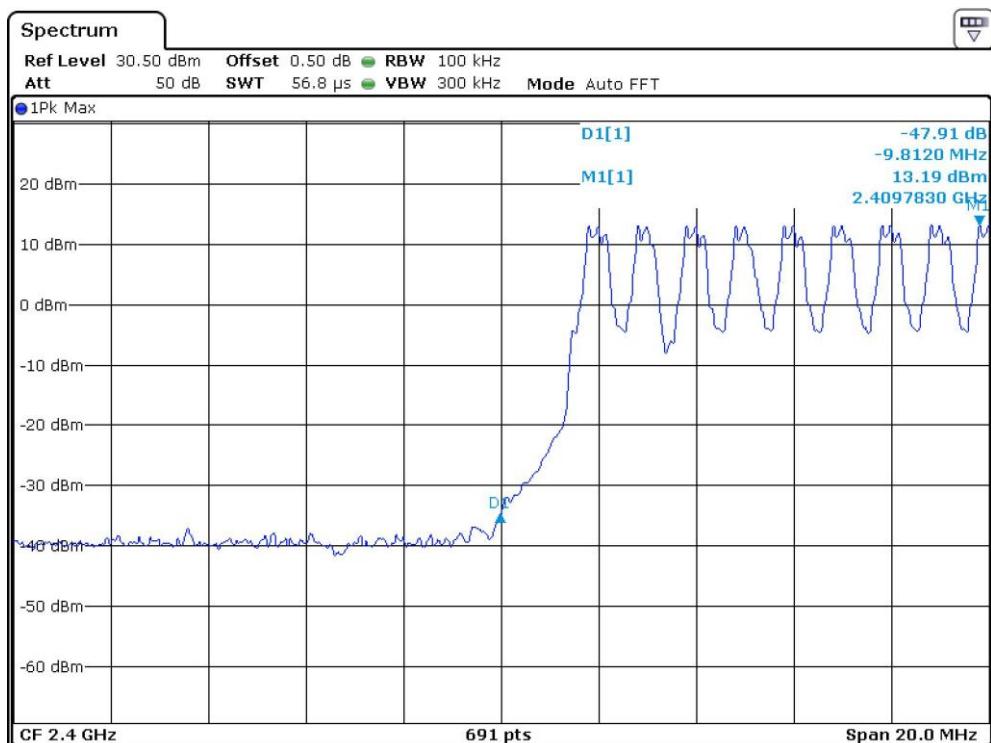
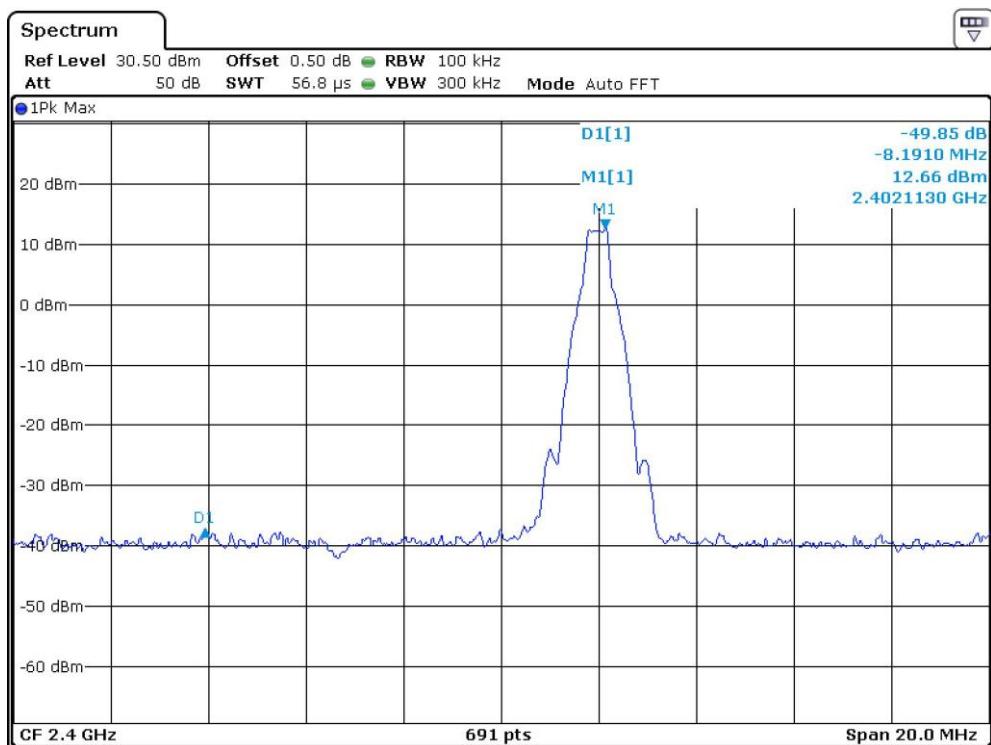
CH00



TEST REPORT

Intertek Report No.: 240423001SZN-001

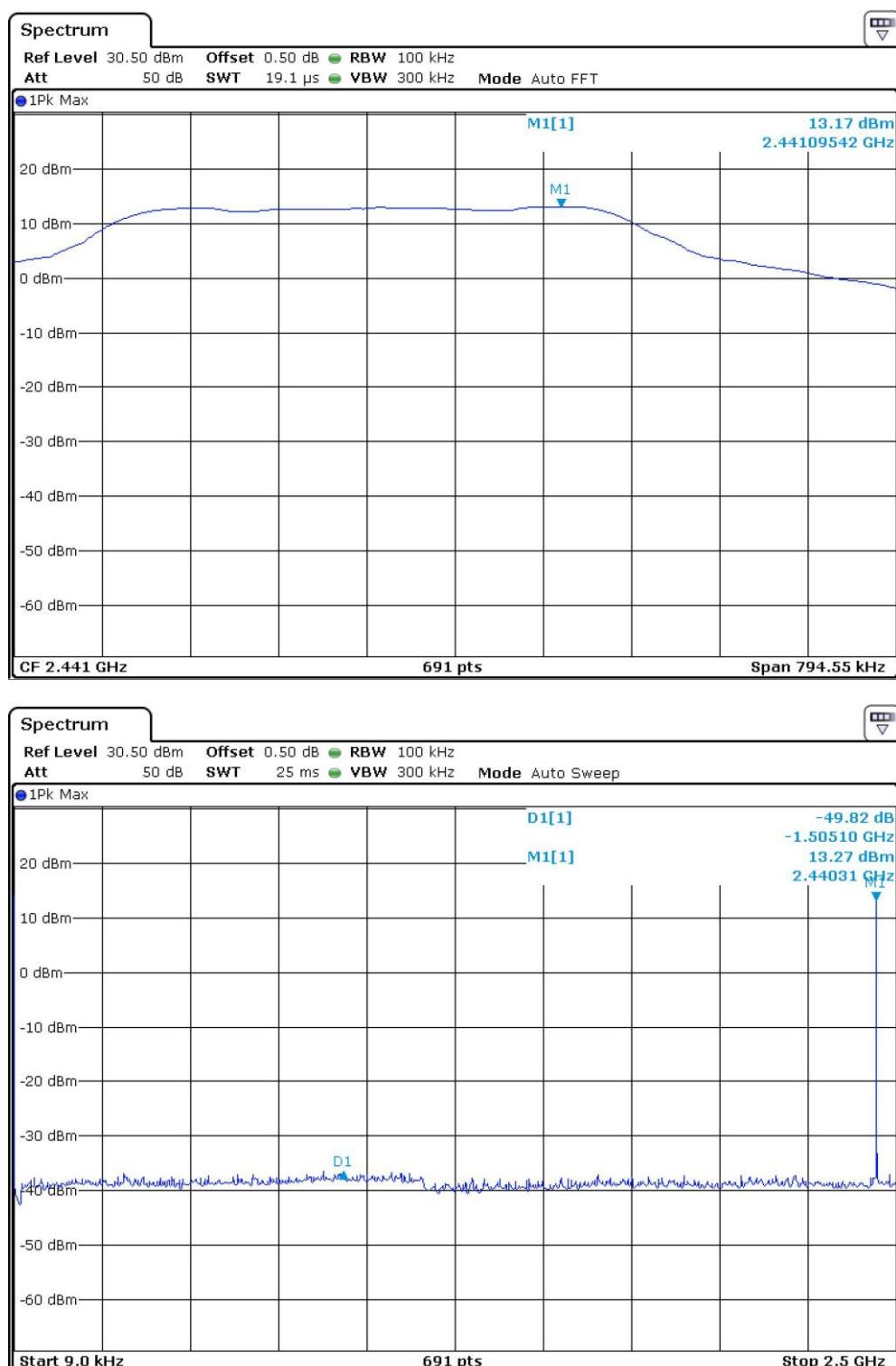




TEST REPORT

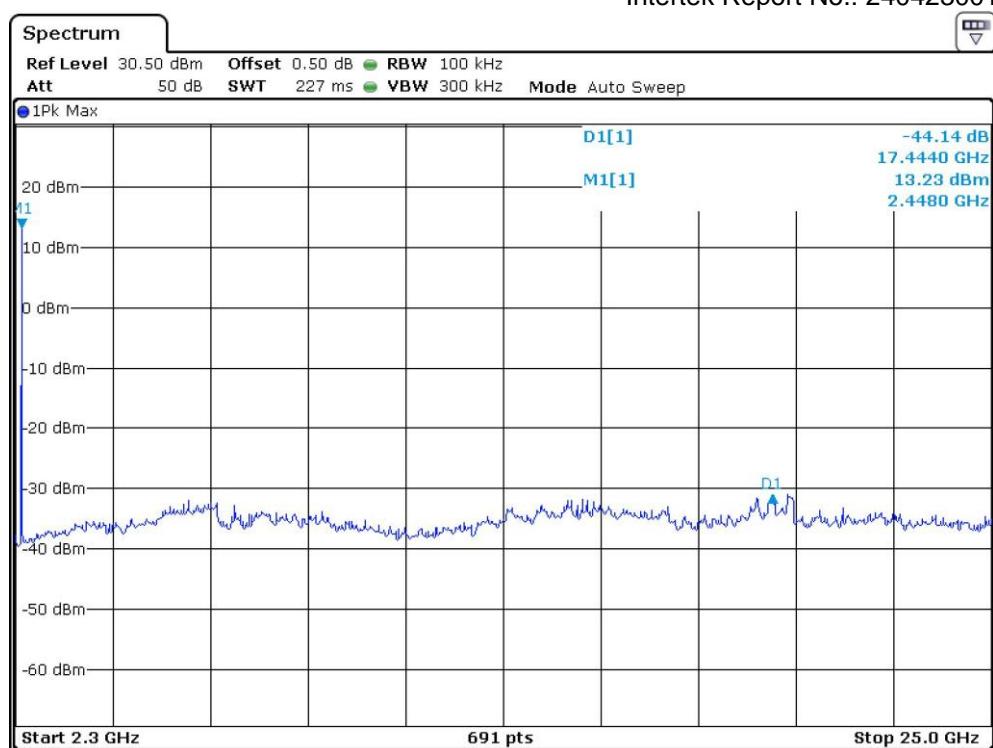
Intertek Report No.: 240423001SZN-001

CH39

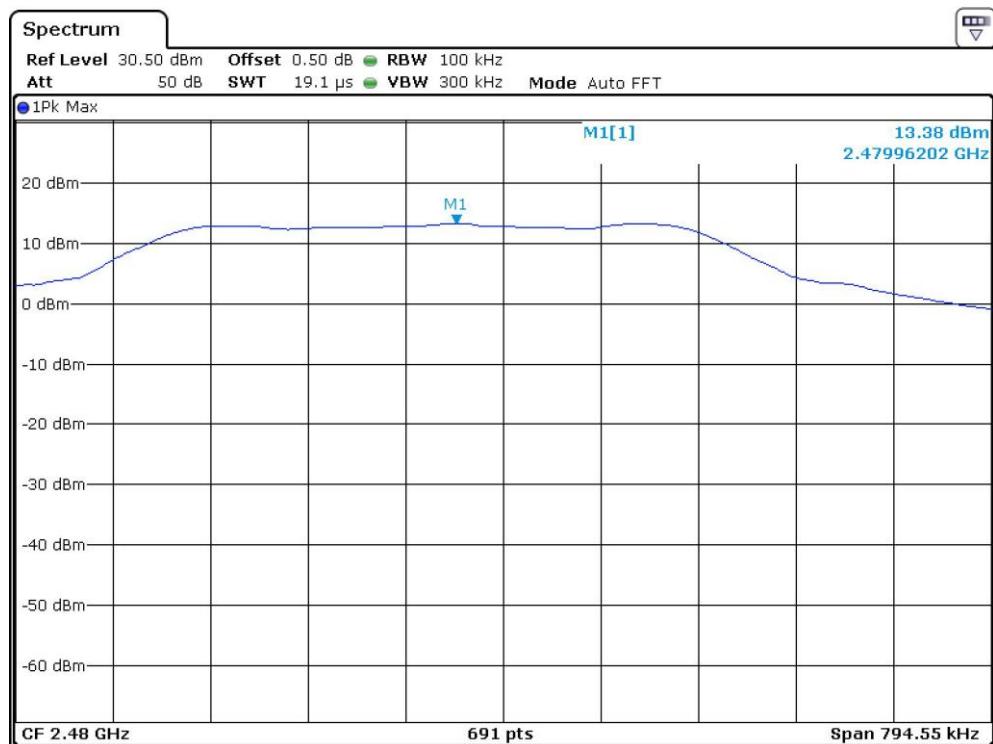


TEST REPORT

Intertek Report No.: 240423001SZN-001

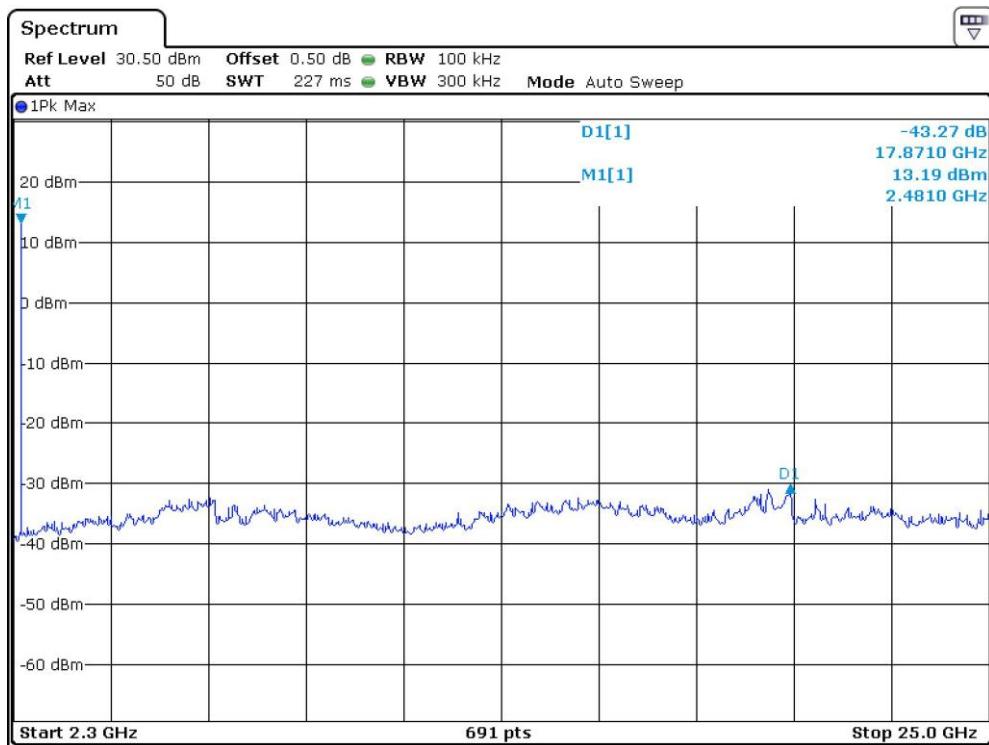
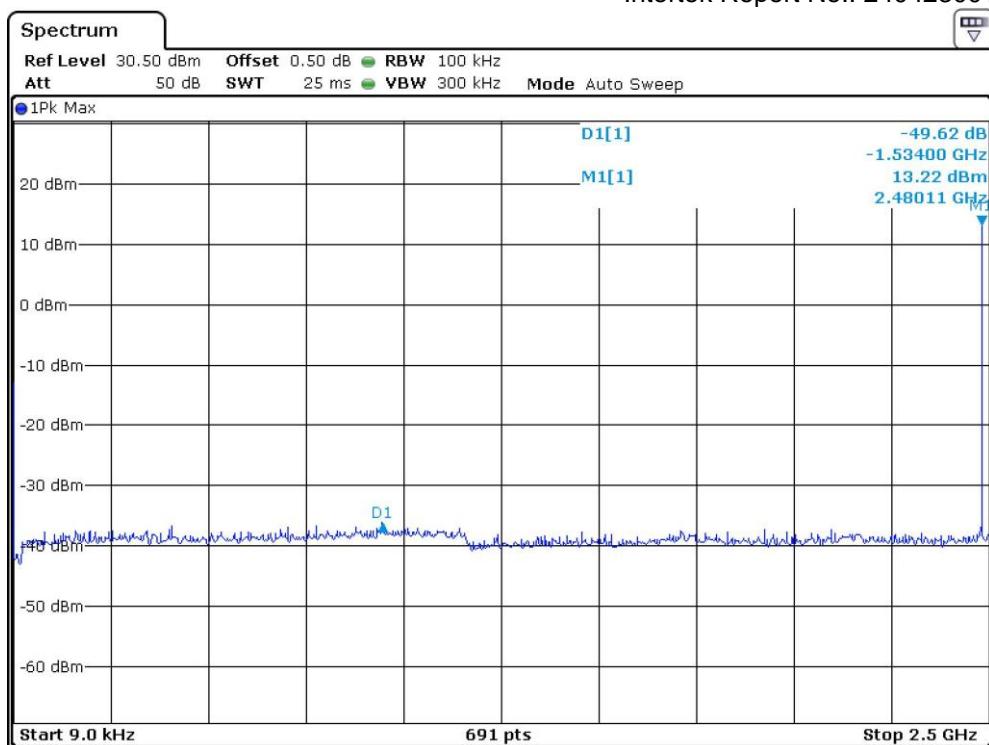


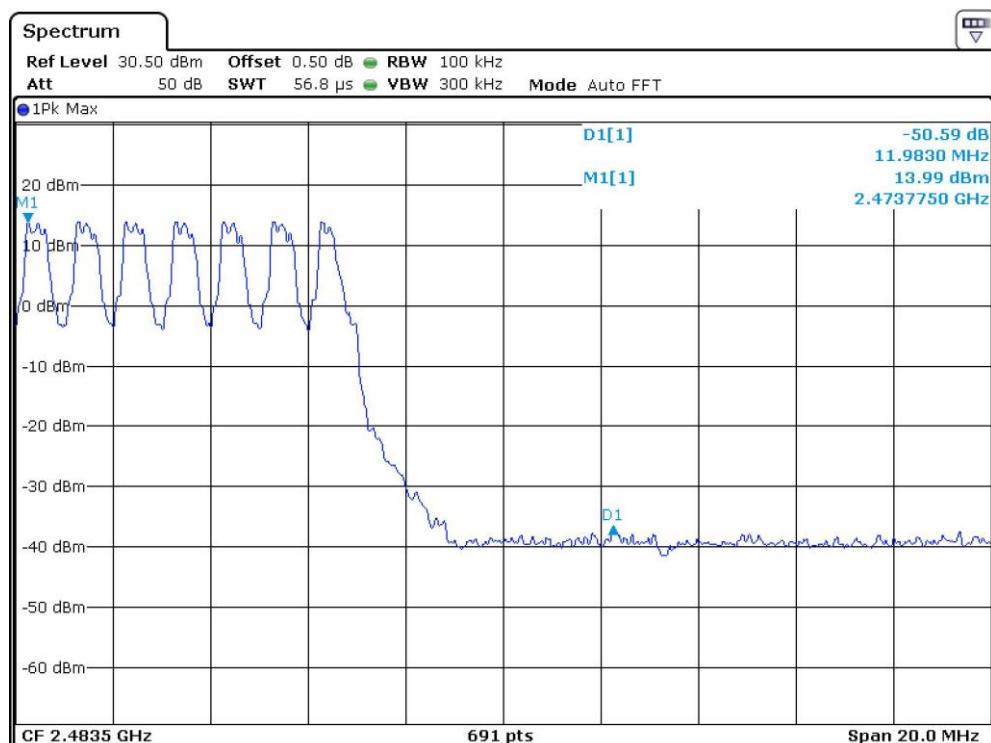
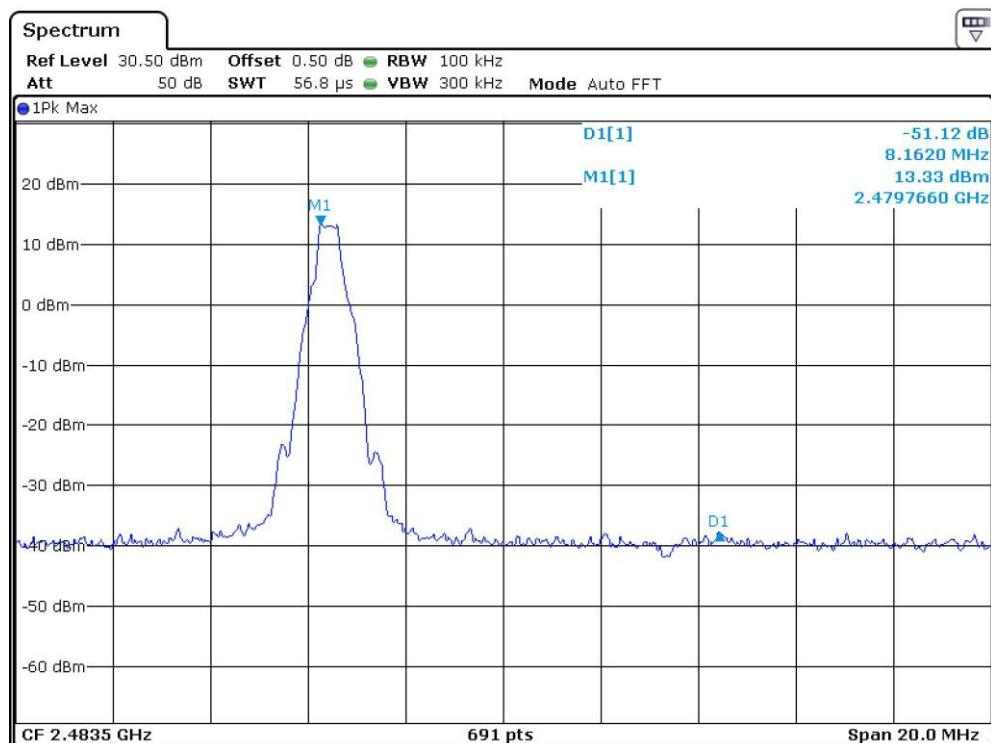
CH78



TEST REPORT

Intertek Report No.: 240423001SZN-001





5.0 Equipment Photographs

For electronic filing, the photographs of the tested EUT are saved with filename: external photos.pdf & internal photos.pdf.

6.0 Product Labelling

For electronic filing, the FCC ID label artwork and the label location are saved with filename: label.pdf.

7.0 Technical Specifications

For electronic filing, the block diagram and schematics of the tested EUT are saved with filename: block.pdf and circuit.pdf respectively.

8.0 Instruction Manual

For electronic filing, a preliminary copy of the Instruction Manual is saved with filename: manual.pdf.

This manual will be provided to the end-user with each unit sold/leased in the United States.

9.0 Miscellaneous Information

This miscellaneous information includes details of discussion of pulse desensitization and the test procedure.

9.1 Discussion of Pulse Desensitization

Pulse desensitivity is not applicable for this device. The frequency spacing of the spectral components of the signal to be measured is approximate 1MHz. With a resolution bandwidth (3dB) of 1MHz, the pulse desensitivity factor is 0dB.

9.2 Calculation of Average Factor

Averaging factor in dB = $20 \log_{10} (\text{duty cycle})$

The specification for output field strengths in accordance with the FCC rules specify measurements with an average detector. During testing, a spectrum analyzer incorporating a peak detector was used. Therefore, a reduction factor can be applied to the resultant peak signal level and compared to the limit for measurement instrumentation incorporating an average detector.

The time period over which the duty cycle is measured is 100 milliseconds, or the repetition cycle, whichever is a shorter time frame. The worst case (highest percentage on) duty cycle is used for the calculation. The duty cycle is measured by placing the spectrum analyzer in zero scan (receiver mode) and linear mode at maximum bandwidth (3 MHz at 3 dB down) and viewing the resulting time domain signal output from the analyzer on a Tektronix oscilloscope. The oscilloscope is used because of its superior time base and triggering facilities.

The duty cycle is simply the on-time divided by the period:

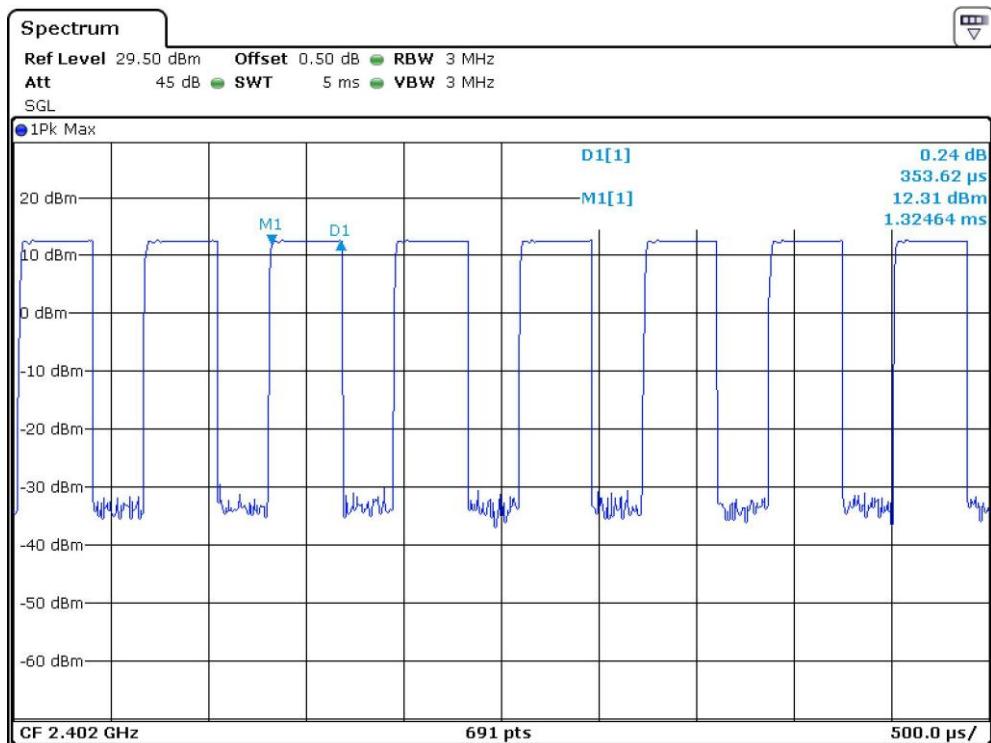
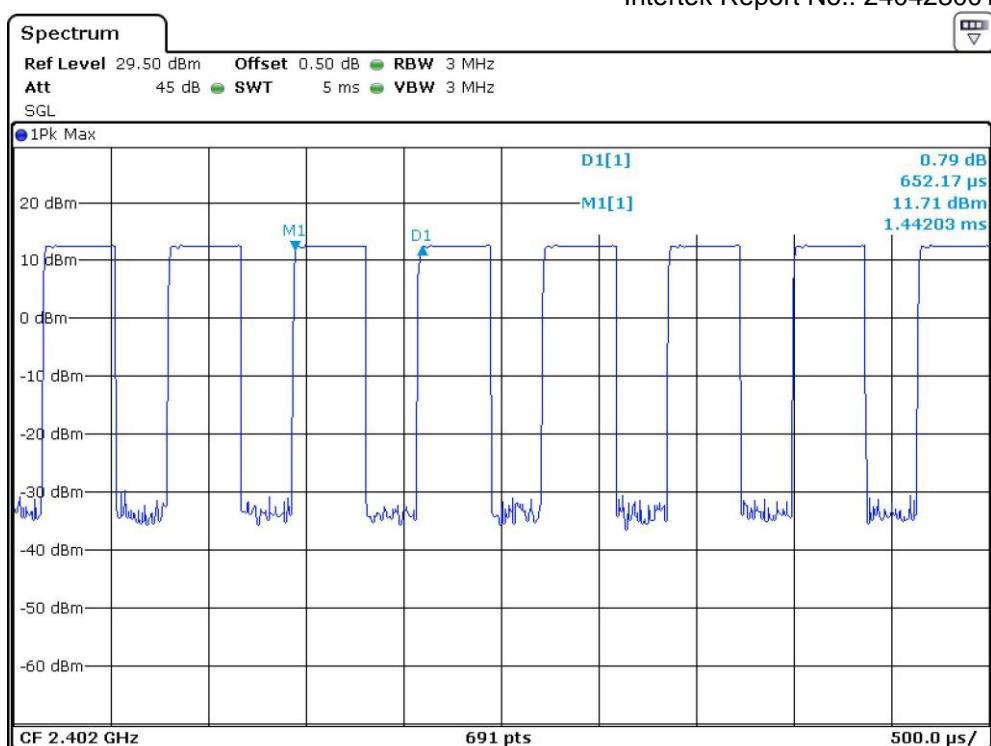
The duration of one cycle = 0.65217ms
Effective period of the cycle = 0.35362ms

DC = 0.35362ms / 0.65217ms = 0.5422 or 54.22%

Therefore, the averaging factor is found by $20 \log_{10} (0.5422) = -5.3 \text{ dB}$

TEST REPORT

Intertek Report No.: 240423001SZN-001



9.3 Emissions Test Procedures

The following is a description of the test procedure used by Intertek Testing Services in the measurements of transmitters operating under Part 15, Subpart C rules.

The test set-up and procedures described below are designed to meet the requirements of ANSI C63.10: 2013.

The transmitting equipment under test (EUT) is placed on a styrene turntable which is four feet in diameter, up to 1GHz 0.8m and above 1GHz 1.5m in height above the ground plane. During the radiated emissions test, the turntable is rotated and any cables leaving the EUT are manipulated to find the configuration resulting in maximum emissions. The EUT is adjust through all three orthogonal axes to obtain maximum emission levels. The antenna height and polarization are varied during the testing to search for maximum signal levels.

Detector function for radiated emissions is in peak mode. Average readings, when required, are taken by measuring the duty cycle of the equipment under test and subtracting the corresponding amount in dB from the measured peak readings. A detailed description for the calculation of the average factor can be found in section 9.2.

The frequency range scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or 40 GHz, whichever is lower. For line conducted emissions, the range scanned is 150 kHz to 30 MHz with RBW 9KHz used.

9.3 Emissions Test Procedures (cont'd)

The EUT is warmed up for 15 minutes prior to the test.

AC power to the unit is varied from 85% to 115% nominal and variation in the fundamental emission field strength is recorded. If battery powered, a new, fully charged battery is used.

Conducted measurements are made as described in ANSI C63.10: 2013.

The IF bandwidth used for measurement of radiated signal strength was 10 kHz for emission below 30 MHz and 120 kHz for emission from 30 MHz to 1000 MHz. Where pulsed transmissions of short enough pulse duration warrant, a greater bandwidth is selected according to the recommendations of Hewlett Packard Application Note 150-2. Above 1000 MHz, a resolution bandwidth of 1 MHz is used (RBW 3MHz used for fundamental emission).

Transmitter measurements are normally conducted at a measurement distance of three meters. However, to assure low enough noise floor in the restricted bands and above 1 GHz, signals are acquired at a distance of one meter or less. All measurements are extrapolated to three meters using inverse scaling, but those measurements taken at a closer distance are so marked.

10 Test Equipment List

Equipment No.	Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Due Date
SZ011-01	Power Meter	Qingdao Qingzhi	8776AT	1302005	2024-09-24	2025-09-24
SZ182-01-01	Power Sensor	BOONTON	51011-EMC	1207429	2023-12-12	2025-12-05
SZ061-03	Biconilog Antenna	ETS	3142C	00078828	2024-07-09	2027-07-09
SZ061-06	Active Loop Antenna	Electro-Metrics	EM-6876	217	2024-05-05	2027-05-05
SZ061-08	Horn Antenna	ETS	3115	00092346	2024-09-13	2027-09-13
SZ061-07	Pyramidal Horn Antenna	ETS	3160-09	00083067	2022-08-31	2025-08-31
SZ056-03	Spectrum Analyzer	R&S	FSP30	101148	2024-04-22	2025-04-22
SZ185-03	EMI Receiver	R & S	ESR7	101975	2024-04-23	2025-04-23
SZ181-04	Preamplifier	Agilent	8449B	3008A02474	2024-04-22	2025-04-22
SZ188-01	Anechoic Chamber	ETS	RFD-F/A-100	4102	2021-12-12	2024-12-12
SZ062-02	RF Cable	RADIALL	RG 213U	--	2024-05-10	2024-11-10
SZ062-05	RF Cable	RADIALL	0.04-26.5GHz	--	2024-05-10	2024-11-10
SZ062-12	RF Cable	RADIALL	0.04-26.5GHz	--	2024-05-10	2024-11-10
SZ067-04	Notch Filter	Micro-Tronics	BRM50702-02	--	2024-05-10	2024-11-10
SZ185-02	EMI Test Receiver	R&S	ESCI	100692	2024-07-09	2025-07-09
SZ187-02	Two-Line V-Network	R&S	ENV216	100072	2024-04-23	2025-04-23
SZ062-16	RF Cable	HUBER+SUHNER	CBL2-BN-1m	110127-2231000	2024-07-10	2025-07-10
SZ188-03	Shielding Room	ETS	RFD-100	4100	2022-12-20	2025-12-20

***** End of Report *****