Electromagnetic Compatibility Test Report

Description: Biometrically-Secured Ring

Model: Token

Tokenize Inc.
4545 East River Road
West Henrietta, NY, 14586

Prepared by:

TUV Rheinland of North America, Inc.

Client:	Tokenize Inc. 4545 East River Road West Henrietta, NY, 14586	***Contact:*** ***Tel:*** ***Fax:*** ***e-mail:***	Richard Lourette 585-953-5309 -- richard@tokenring.com
Identification:	Biometrically-Secured Ring	***Serial No.:***	0001, 0002
Test item:	Token	***Date Test Completed:***	03/18/2020
Testing location:	TUV Rheinland of North America 710 Resende Road, Building 199 Webster, NY 14580 U.S.A.	Tel: (585) 645-0125 Fax: -	
Test specification:	**Emissions:** FCC CFR 47 §15.247		
Test Result and/or Conclusion:	The above product was found to be **Compliant** to the above test standard(s)		

Report written/updated by: Alexander Sowinski	***reviewed by:*** Rachana Khanduri
2 April 2020 ***Date*** ***Signature***	2 April 2020 ***Date*** ***Signature***

FC	ilac-MRA A2LA ACCREDITED	VCCI	Industry Canada ISED
5253	**3331.08**	**1097 (A-0329)**	**482B-1**

Revisions

Date mm/dd/yy	Name	Page Number of Change	Describe Change
4/2/2020	Rev.0	N/A	Original Document

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1 General Information

1.1 Scope

This report is intended to document the status of conformance based on the results of testing performed on the Biometrically-Secured Ring, Model Number: Token, manufactured by Tokenize Inc.. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT (Equipment Under Test) in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

1.3 *Summary of Test Results*

Applicant:	Tokenize Inc. 4545 East River Road West Henrietta, NY, 14586	**Tel:**	585-953-5309	**Contact:**	Contact Name
		Fax:	--	**e-mail:**	richard@tokenring.com

Description:	Biometrically-Secured Ring	**Model Number:**	Token
Serial Number:	0001, 0002	**Test Voltage/Freq.:**	4 VDC
Test Date Completed:	03/18/2020	**Test Engineer:**	Alexander Sowinski

Standards	Description	Severity Level or Limit	Criteria	Test Result
FCC CFR 47 §15.247 Product Family Standard Emissions	Emissions requirements for devices operating within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz	See Basic Standards Below	See Below	**Complies**
FCC CFR 47 §15.247 (b)	Maximum Output Power	< 1 Watt (30 dBm)	Limit	**Complies**
FCC CFR 47 §15.247 (a.2)	DTS Bandwidth	OBW > 500 kHz	Limit	**Complies**
FCC CFR 47 §15.247 (e)	Peak Power Spectral Density	< 8 dBm in any 3 kHz band	Limit	**Complies**
FCC CFR 47 §15.247 (d)	Out of Band Emissions: Non-restricted	All spurious emissions < 20 dBr	Limit	**Complies**
FCC CFR 47 §15.247 (d)	Out of Band Emissions: Restricted	Peak Detector: < 74 dBµV/m @ 3 meters AVG Detector: < 54 dBµV/m @ 3 meters	Limit	**Complies**
FCC CFR 47 §15.247 (d)	Transmitter Spurious Emissions	Class B 30 – 1000 MHz Class B 1000 – 26500 MHz	Limit	**Complies**

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

TUV Rheinland of North America located at, 710 Resende Road Webster, NY 14580 is accredited by the commission for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (Registration No 5253). The laboratory scope of accreditation includes: Title 47 CFR Part 15, and 18. The accreditation is updated every 3 years.

2.1.2 ILAC/A2LA

This is a program which is administered under the auspices of A2LA. The laboratory has been assessed and accredited in accordance with ISO Standard 17025:2017 (Certificate Number: 3331.08). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 VCCI

VCCI Accredited test lab. Registration numbers A-0329.

2.1.4 Industry Canada

(Registration No.: 482B-1) The 10 meter Semi-Anechoic chamber has been accepted by Industry Canada to perform testing to 3 and to 10m, based on the test procedures described in ANSI C63.4-2014.

2.1.5 BSMI

Registration No.: SL2-IN-E-1159R. The BSMI accreditation was obtained by NIST MRA with the BSMI.

2.1.6 Korea

(Designation No.: US0192). Recognized by National Radio Research Agency (RRA) as an accredited Conformity Assessment Body (CAB) under the terms for Korea Phase I of the APEC TEL.

2.2 Test Software

1) CIGUI 32 Version 1.4 for California Instruments AC power source
2) HP software E7415A Version A.01.45
3) National Instruments 'Measurement & Automation Employer' Version 4.6.2f1
4) TILE version 3.4.K.28
5) Voltech PM 6000 Firmware 1.22.07RC6, Software IEC61000-3 for PM6000 Release 1.24.12
6) California Instruments AC power source MXHCL
7) Rohde & Schwarz EMI Measurement software EMC32 version 8.50.0
8) TILE version 4.0.B
9) Keytek CEWare 2.10

2.3 Measurement Uncertainty

Two types of measurement uncertainty are expressed in this report, per *ISO Guide To The Expression Of Uncertainty In Measurement*, 1st Edition, 1995.

The Combined Standard Uncertainty is the standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities, equal to the positive square root of a sum of terms, the terms being the variances or co-variances of these other quantities weighted according to how the measurement result varies with changes in these quantities. The term standard uncertainty is the result of a measurement expressed as a standard deviation.

The Expanded Uncertainty defines an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand. The fraction may be viewed as the coverage probability or level of confidence of the interval.

2.3.1 Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBµV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBµV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

25 dBuV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBuV/m

2.3.2 Measurement Uncertainty Emissions

Per CISPR 16-4-2	**Ulab**	**Ucispr**
Radiated Disturbance @ 10m		
30 MHz – 1,000 MHz	4.57 dB	5.2 dB
Radiated Disturbance @ 3m		
1.0 GHz – 6.0 GHz	5.18 dB	5.2 dB
6.0 GHz – 18.0 GHz	5.48 dB	5.5 dB
18.0 GHz – 26.5 GHz	5.21 dB	
26.5 GHz – 40.0 GHz	4.99 dB	
Conducted Disturbance @ Mains Terminals		
150 kHz – 30 MHz	2.62 dB	3.6 dB
Disturbance Power		
30 MHz – 300 MHz	3.88 dB	4.5 dB

Measurement Uncertainty Emissions

The estimated combined standard uncertainty for radiated emissions measurements is ± 4.57 dB	Per CISPR16-4-2 Method
The estimated combined standard uncertainty for radiated emissions measurements from 1 GHz to 6 GHz is ± 5.18dB	Per CISPR16-4-2 Method
The estimated combined standard uncertainty for radiated emissions measurements from 6 GHz to 18 GHz is ± 5.48dB	Per CISPR16-4-2 Method
The estimated combined standard uncertainty for conducted emissions measurements is ± 2.62dB.	Per CISPR16-4-2 Method

Expanded measurement uncertainty numbers are shown in the tables above. Compliance criteria are not based on measurement uncertainty.

2.4 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard ISO IEC 17025:2017. Equipment calibration records are kept on file at the test facility.

2.5 Measurement Equipment Identification

Equipment	Manufacturer	Model #	Ref.	Serial #	Last Cal dd/mm/yy	Next Cal dd/mm/yy	Test
Radiated Emissions							
Receiver (20Hz-40GHz)	Rohde & Schwarz	ESU 40		100274	29-Jul-19	29-Jul-20	RE
BiLog	Sunol	JB3		A102115	27-Jun-18	27-Jun-20	RE
Amplifier	EMCO	6502		8901-2302	24-Apr-18	24-Apr-20	RE
Horn(1-18 GHz)	ETS-Lindgren	3117		109306	20-Aug-18	20-Aug-20	RE
Horn (18-26.5 GHz)	EMCO	024083		6707	02-Aug-18	02-Aug-20	RE
General Laboratory Equipment							
Multimeter	Fluke	87		59890224	1-Aug-19	1-Aug-20	
Pressure/Temperature/RH	Control Company	68000-49		181704893	31-Oct-18	31-Oct-20	

Note: RE = Radiated Emissions

3 Product Information

3.1 Test Plan

The EUT product information, test configuration, mode of operation, test types, test procedures, test levels, pass/failure criteria, in this report were carried out per the product test plan located in appendix A of this report.

3.2 EUT Photos

Due to the confidentiality agreement with the client, all pictures of EUT have been placed in document 32051118.001.

4 Emissions

4.1 Maximum Output Power

This test measures the maximum equivalent isotropic radiated power of the EUT during a transmission.

4.1.1 Over View of Test

Results	**Complies** (as tested per this report)					**Date**	03/17/2020
Standard	FCC CFR 47 §15.247 (b)						
Product Model	Token			**Serial#**	0002		
Configuration	See test plan for details.						
Test Set-up	Tested conducted, sample placed on test bench in shielded room, see test plans for details.						
EUT Powered By	4 VDC	**Temp**	23º C	**Humidity**	36%	**Pressure**	1004 mbar
Frequency Range	Channel 0: 2402 MHz Channel 19: 2440 MHz Channel 39: 2480 MHz						
Perf. Criteria	< 1 Watt (30 dBm)			**Perf. Verification**	Readings Under Limit		
Mod. to EUT	None			**Test Performed By**	Alexander Sowinski		

4.1.2 Test Procedure

Maximum output power tests were performed using the procedures of FCC CFR 47 §15.247 (b) and/or ANSI C63.10 including methods for signal maximizations and EUT configuration. Sample was connected directly to spectrum analyzer and measurements were taken per the applicable standard(s).

4.1.3 Deviations

There were no deviations from the test methodology listed in the test plan for the maximum output power test.

4.1.4 Final Test

All final maximum output power measurements were below (in compliance) the limits.

4.1.5 Final Data

Data Rate	Operating Channel [MHz]	Power [dBm]	Limit [dBm]	Margin [dB]
1Mbps	2402	1.08	30	-28.92
	2440	1.38	30	-28.62
	2480	-0.50	30	-30.50

4.1.6 Plots

Figure 1 – Output Power CH0 2402 MHz

Figure 2 – Output Power CH19 2440 MHz

Figure 3 – Output Power CH39 2480 MHz

4.2 DTS Bandwidth (6dB) and Occupied Bandwidth (99%)

The occupied bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency.

4.2.1 Over View of Test

Results	**Complies** (as tested per this report)					**Date**	03/17/2020
Standard	FCC CFR 47 §15.247 (a.2)						
Product Model	Token			**Serial#**	0002		
Configuration	See test plan for details.						
Test Set-up	Tested in shielded room, EUT placed on table. See test plans for details.						
EUT Powered By	4 VDC	**Temp**	23º C	**Humidity**	36%	**Pressure**	1004 mbar
Frequency Range	Channel 0: 2402 MHz Channel 19: 2440 MHz Channel 39: 2480 MHz						
Perf. Criteria	OBW > 500 kHz	**Perf. Verification**		Readings above minimum value			
Mod. to EUT	None	**Test Performed By**		Alexander Sowinski			

4.2.2 Test Procedure

Occupied bandwidth tests were performed using the procedures of FCC CFR 47 §15.247 (a.2) and/or ANSI C63.4 including methods for signal maximizations and EUT configuration. The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied. The 6dB bandwidth is defined the bandwidth of 6 dBr from highest transmitted level of the fundamental frequency. .

4.2.3 Deviations

There were no deviations from the test methodology listed in the test plan for the occupied bandwidth test.

4.2.4 Final Test

All final occupied bandwidth measurements were within (in compliance) the limits.

4.2.5 Final Data

Data Rate	Frequency [MHz]	99% OBW [MHz]	6 dB OBW [MHz]
1Mbps	2402	1.119993	0.7677
	2440	1.113395	0.7627
	2480	1.110506	0.7577

4.2.6 Plots

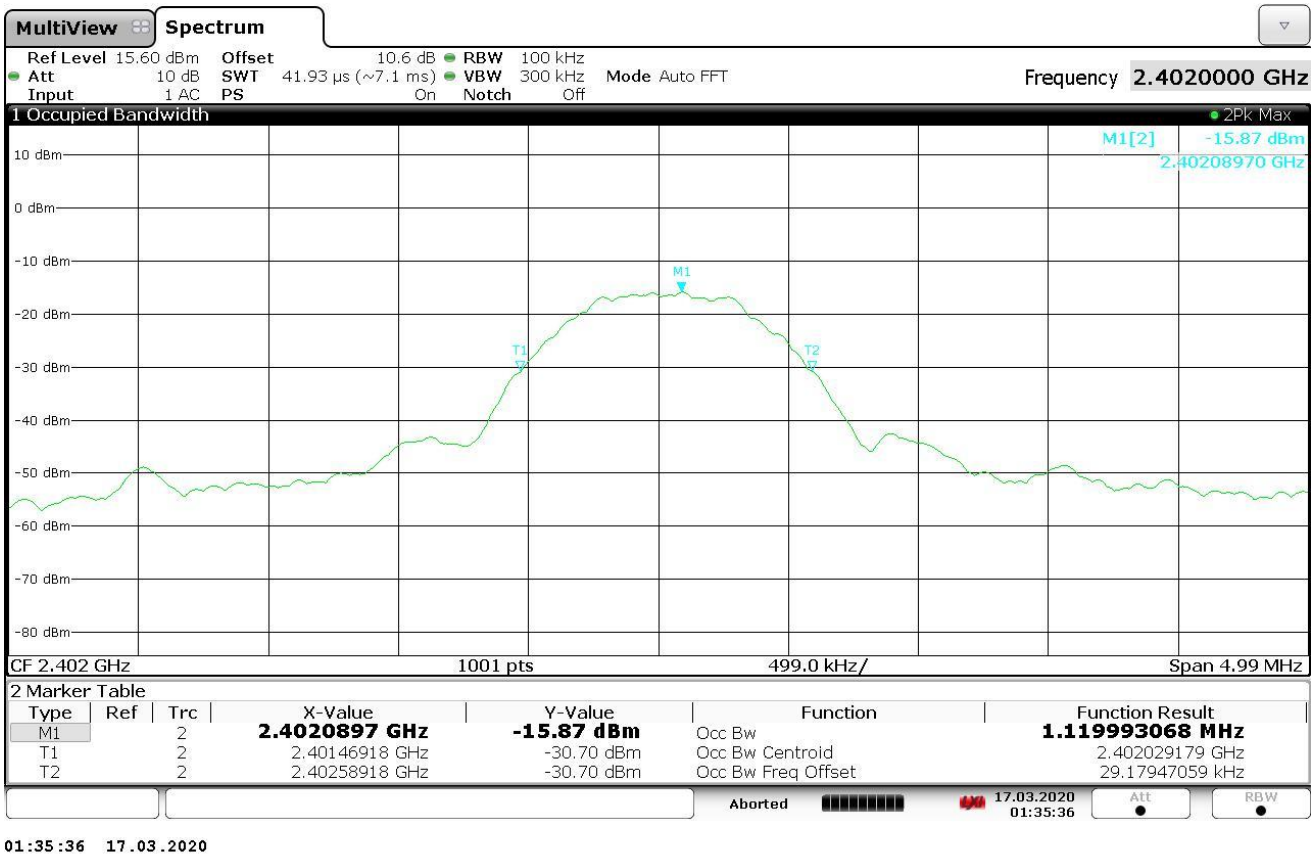


Figure 4 – 99% OBW CH0 2402 MHz

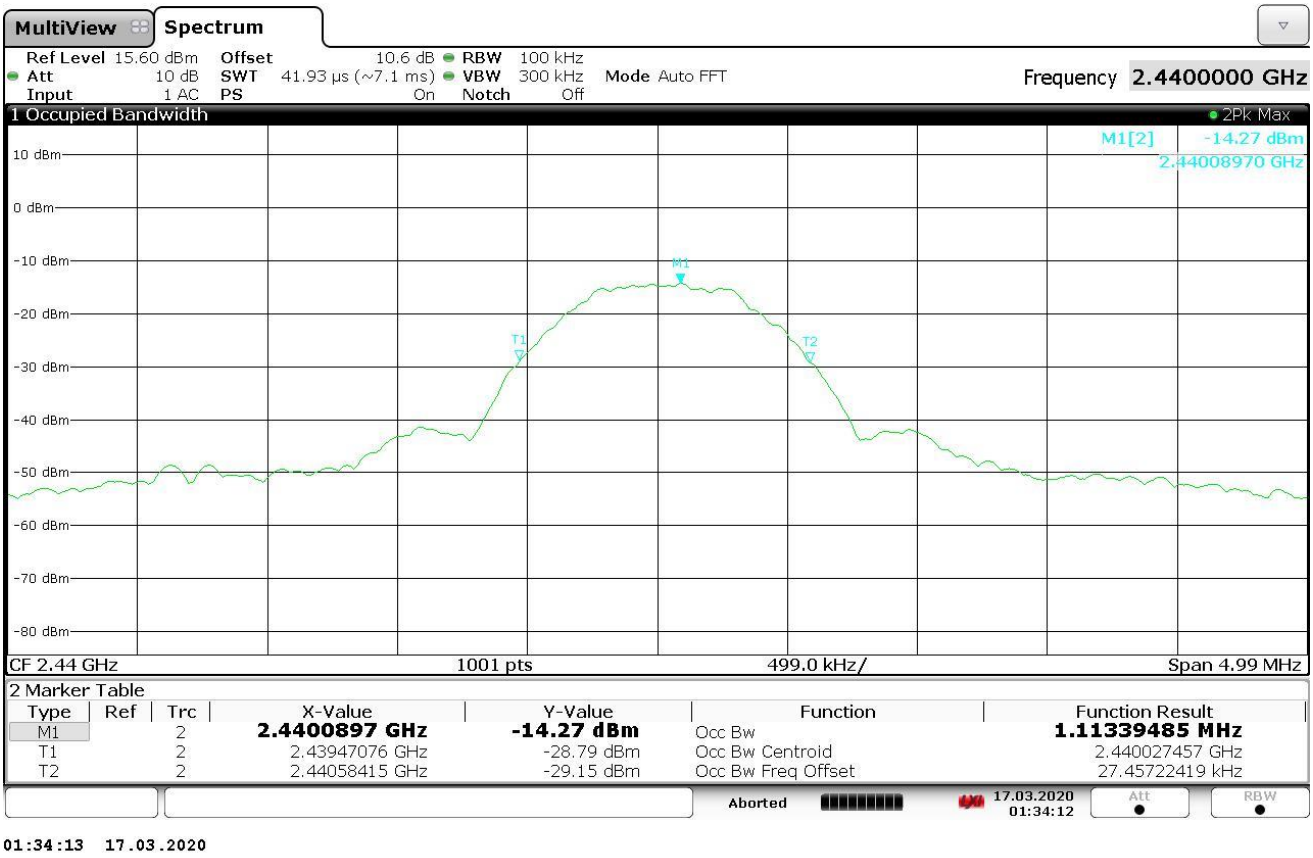


Figure 5 – 99% OBW CH19 2440 MHz

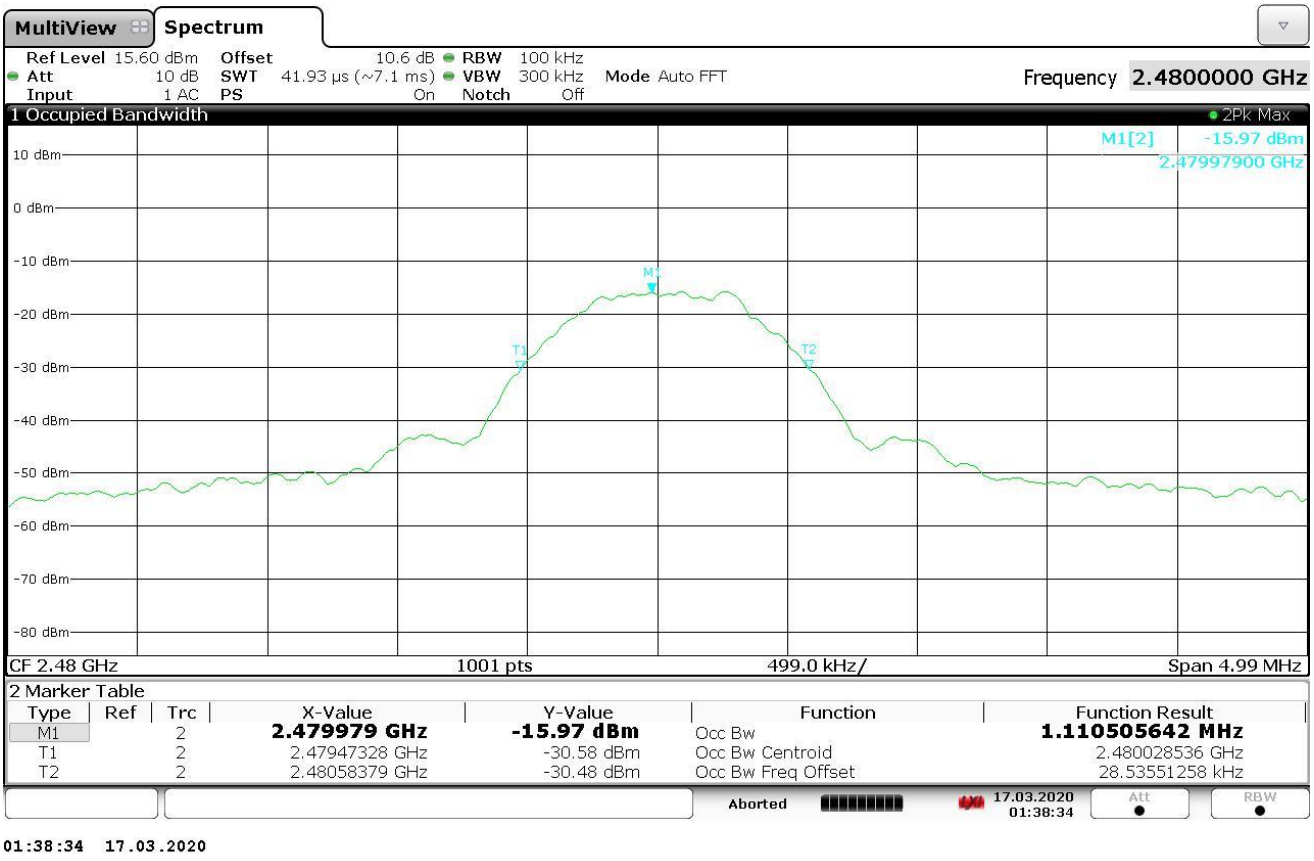


Figure 6 – 99% OBW CH39 2480 MHz

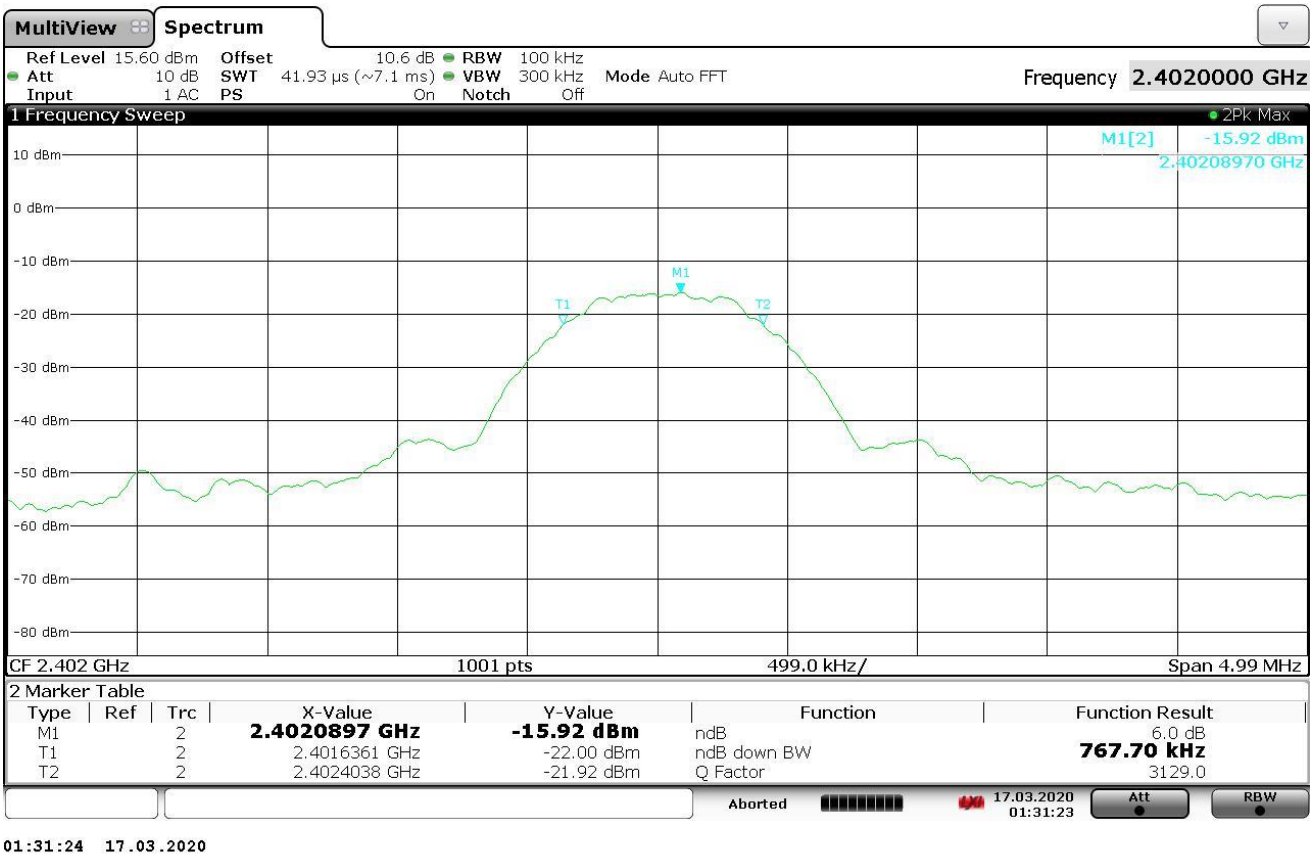


Figure 7 – 6dB OBW CH0 2402 MHz

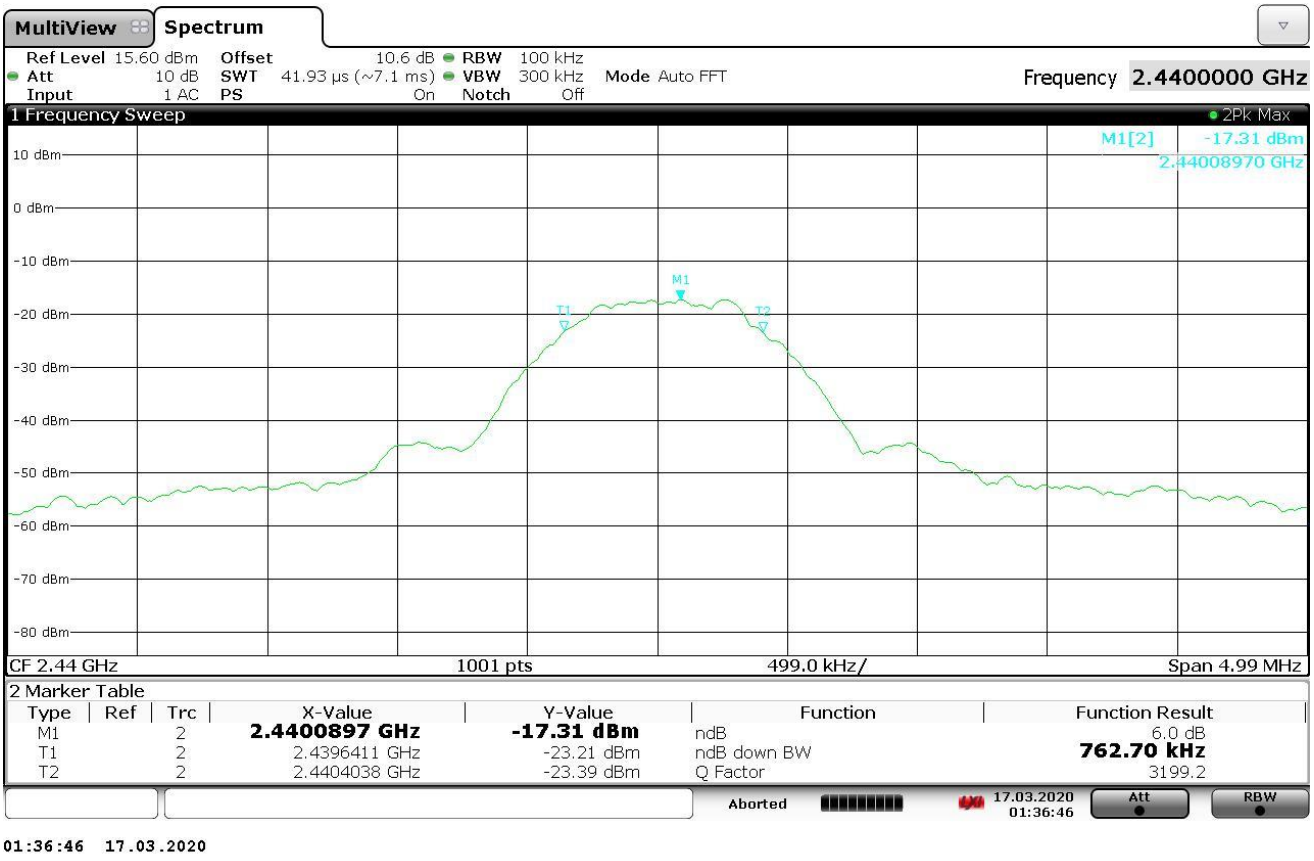


Figure 8 – 6dB OBW CH19 2440 MHz

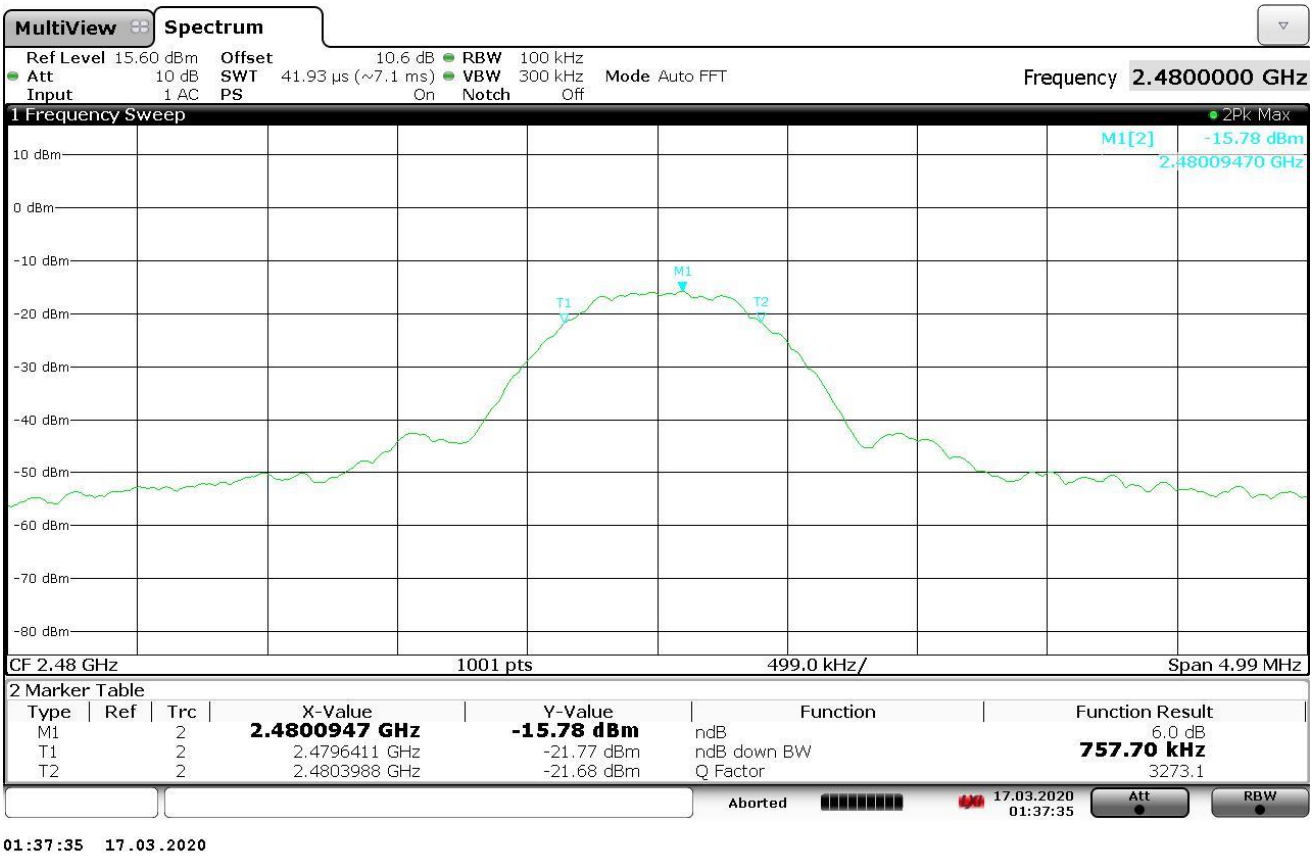


Figure 9 – 6dB OBW CH39 2480 MHz

4.3 Peak Power Spectral Density

This test evaluates the peak power spectral density of the EUT's transmitter across low, mid, and high channels.

4.3.1 Test Over View

Results	**Complies** (as tested per this report)				**Date**	03/17/2020	
Standard	FCC CFR 47 §15.247 (e)						
Product Model	Token			**Serial#**	0002		
Configuration	See test plan for details.						
Test Set-up	Tested in shielded room, EUT placed on table. See test plan for details.						
EUT Powered By	4 VDC	**Temp**	23º C	**Humidity**	36%	**Pressure**	1004mbar
Frequency Range	Channel 0: 2402 MHz Channel 19: 2440 MHz Channel 39: 2480 MHz						
Perf. Criteria	< 8dBm / 3 kHz band (Below Limit)			**Perf. Verification**	Readings under Limit		
Mod to EUT	None			**Test Performed By**	Alexander Sowinski		

4.3.2 Test Procedure

Peak power spectral density was measured conducted via connecting a sample directly to the spectrum analyzer. Measurements were taken per FCC CFR §15.247 and ANSI C63.10.

4.3.3 Deviations

There were no deviations from the test methodology listed in the test plan for the peak power spectral density test.

4.3.4 Final Test

The peak power spectral density of the EUT was below the limits specified in the standard.

4.3.5 Final Data

Data Rate	Frequency [MHz]	Total PSD [dBm]	Limit [dBm]	Margin [dB]
1Mbps	2402	-17.76	8	-25.76
	2440	-17.49	8	-25.49
	2480	-16.95	8	-24.95

4.3.6 Plots

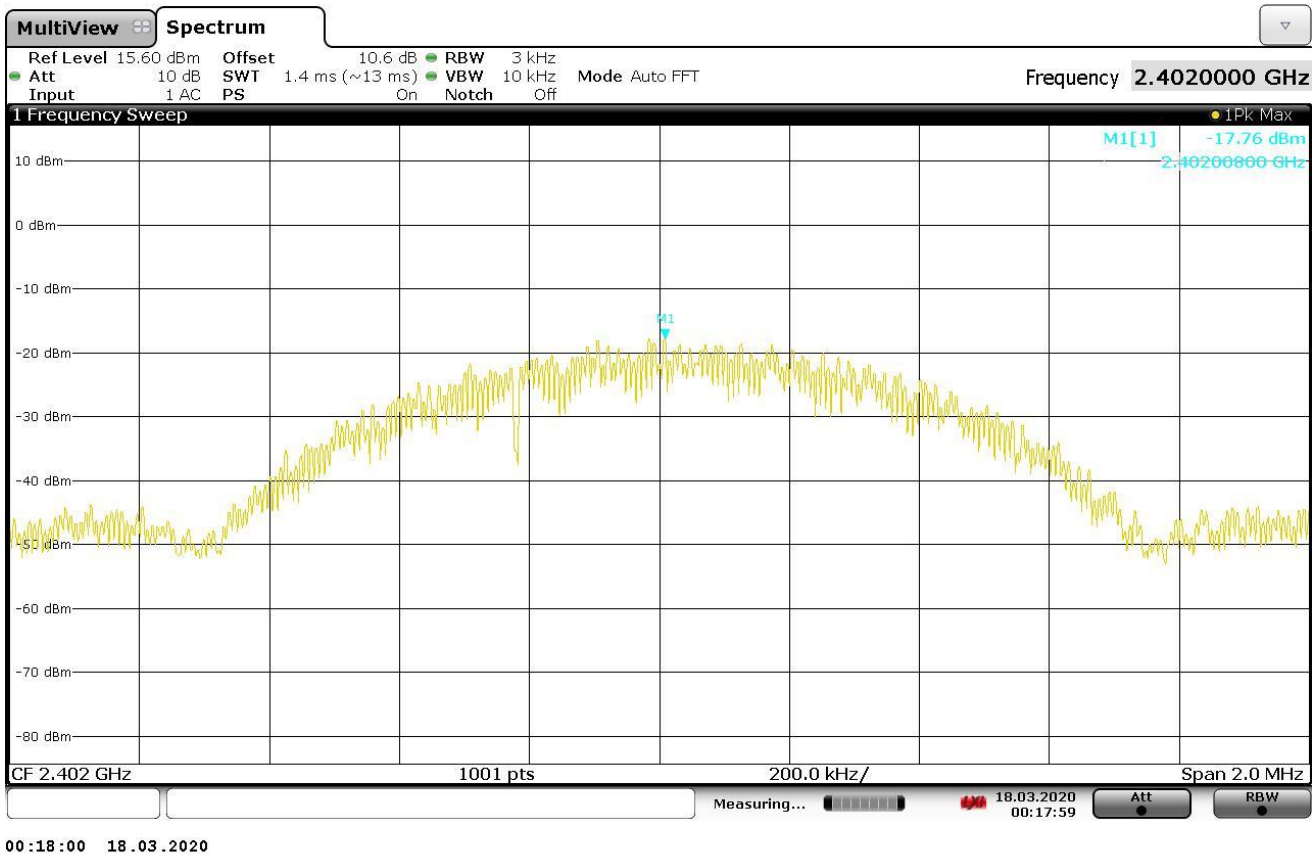


Figure 10 – PSD CH0 2402 MHz

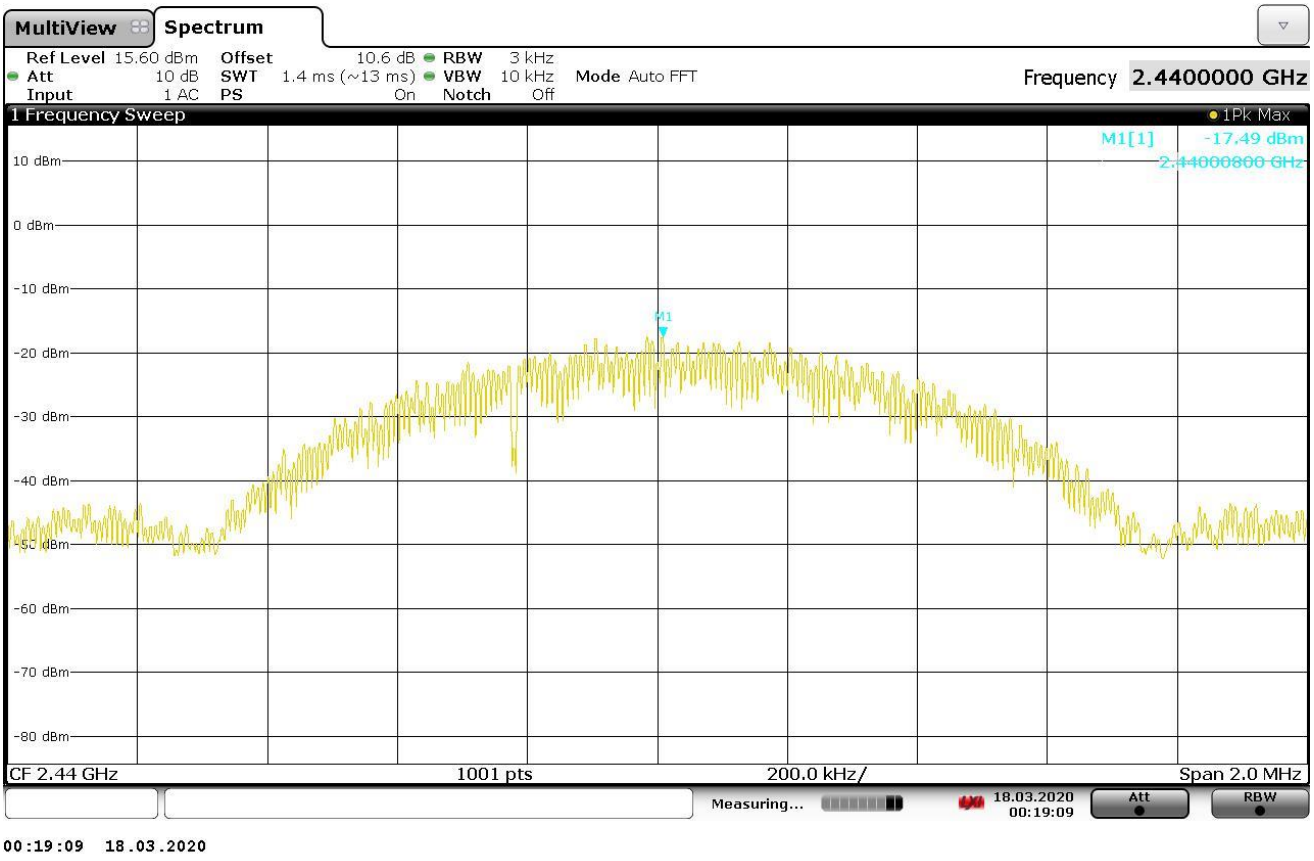


Figure 11 – PSD CH19 2440 MHz

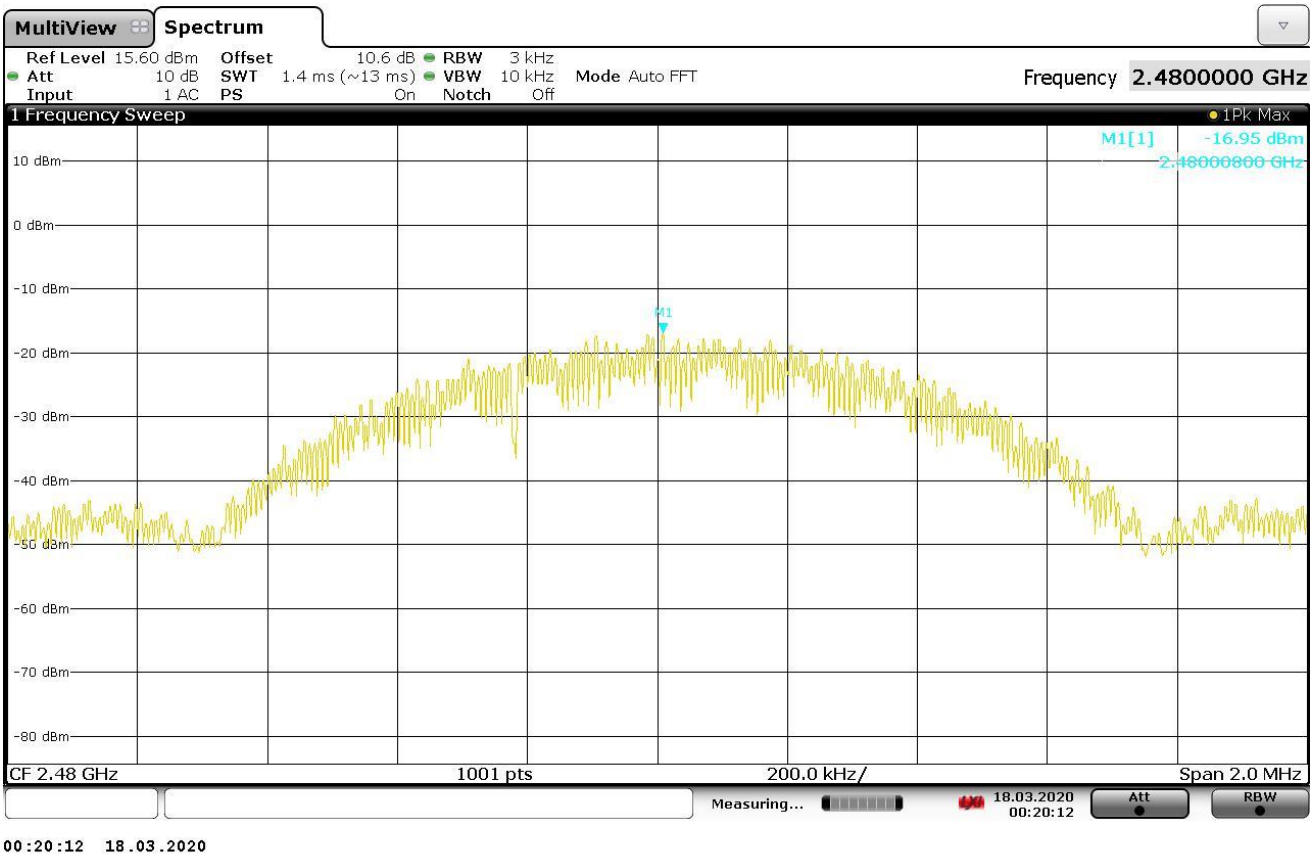


Figure 12 – PSD CH39 2480 MHz

4.4 Out of Band Emissions – Non-restricted bands

This test evaluates the spurious emissions of the EUT in the out of band domain.

4.4.1 Test Over View

Results	**Complies** (as tested per this report)				**Date**	03/17/2020	
Standard	FCC CFR 47 §15.247 (d)						
Product Model	Token			**Serial#**	0002		
Configuration	See test plan for details.						
Test Set-up	Tested in shielded room, EUT placed on table. See test plan for details.						
EUT Powered By	4 VDC	**Temp**	23º C	**Humidity**	36%	**Pressure**	1004mbar
Frequency Range	Channel 0: 2402 MHz Channel 19: 2440 MHz Channel 39: 2480 MHz						
Perf. Criteria	< 20 dBr (20 dB below TX Peak Power) (Below Limit)			**Perf. Verification**	Readings under Limit		
Mod to EUT	None			**Test Performed By**	Alexander Sowinski		

4.4.2 Test Procedure

Conducted measurements per ANSI C63.10-2013 Sections 6.10, 11.11, 14.3.3 were used to measure the undesirable emission requirement in non-restricted bands. The measurement was conducted from 30MHz to 26.5GHz on 3 channels in each mode on the EUT. Band edge tests were conducted on the low and high channel of each mode. The worst case measurement of each mode is recorded in this report.

4.4.3 Deviations

There were no deviations from the test methodology listed in the test plan for the out of band emissions test.

4.4.4 Final Test

The out of band emissions of the EUT were below the limit specified by the standard.

4.4.5 Final Data

Data Rate	Band Edge	Center Freq [MHz]	Measured [dBc]	Limit [dBc]	Freq [MHz]	Result
1 Mbps	Low	2402	32.01	20	2400	Pass
	High	2480	45.11	20	2483.5	Pass

4.4.6 Plots

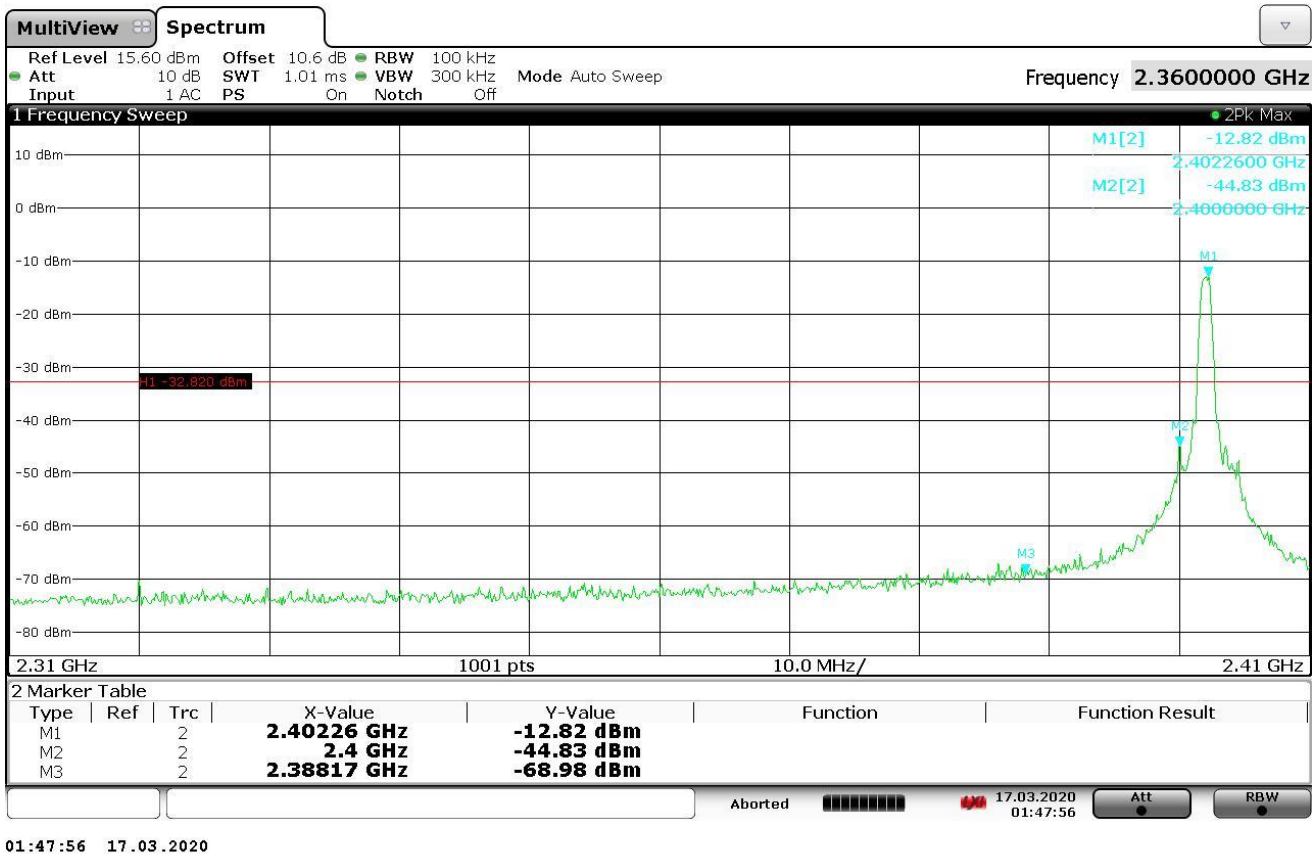


Figure 13 – OOB CH0 2402 Lower Band Edge

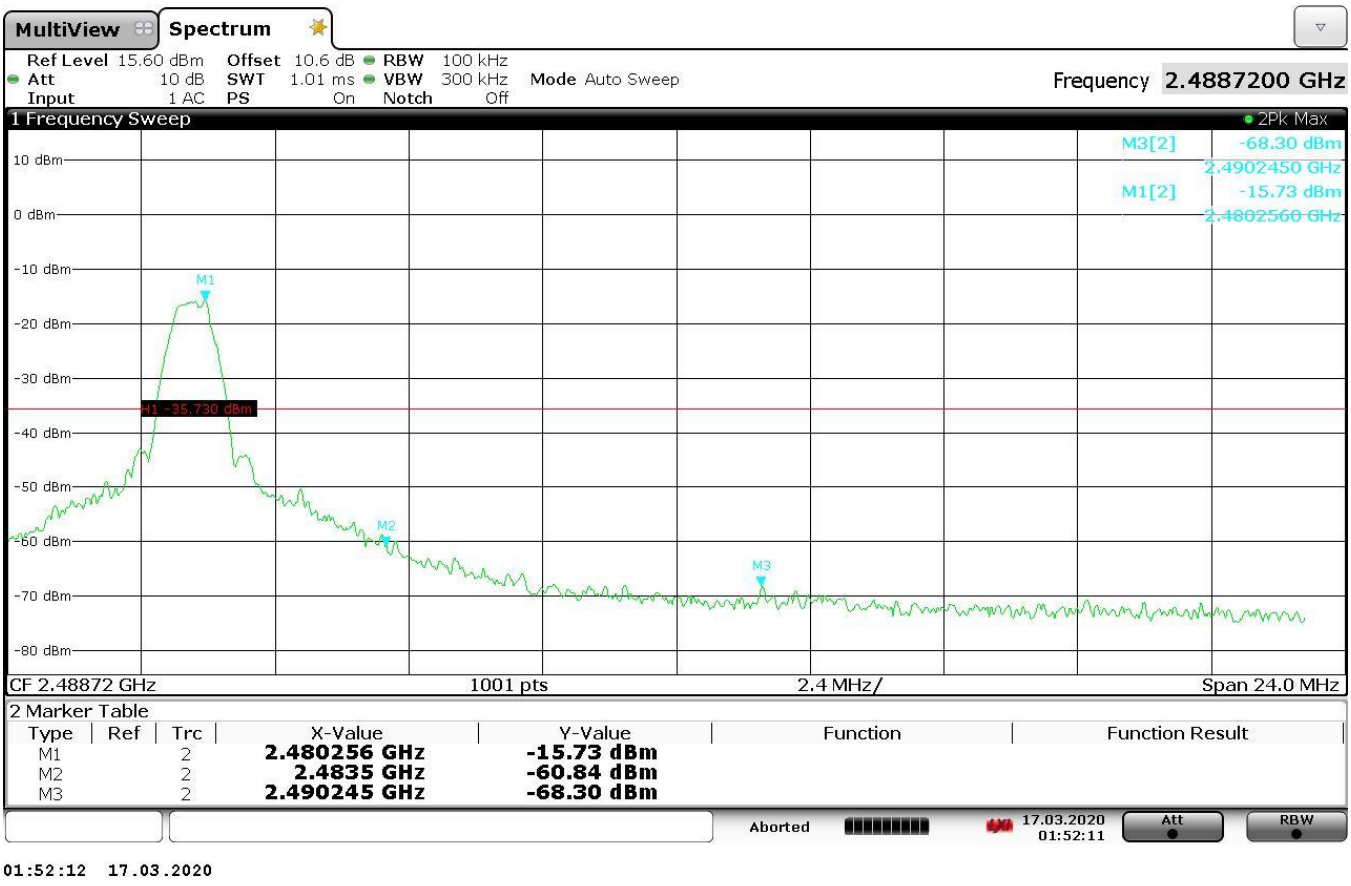


Figure 14 – OOB CH39 2480 Upper Band Edge

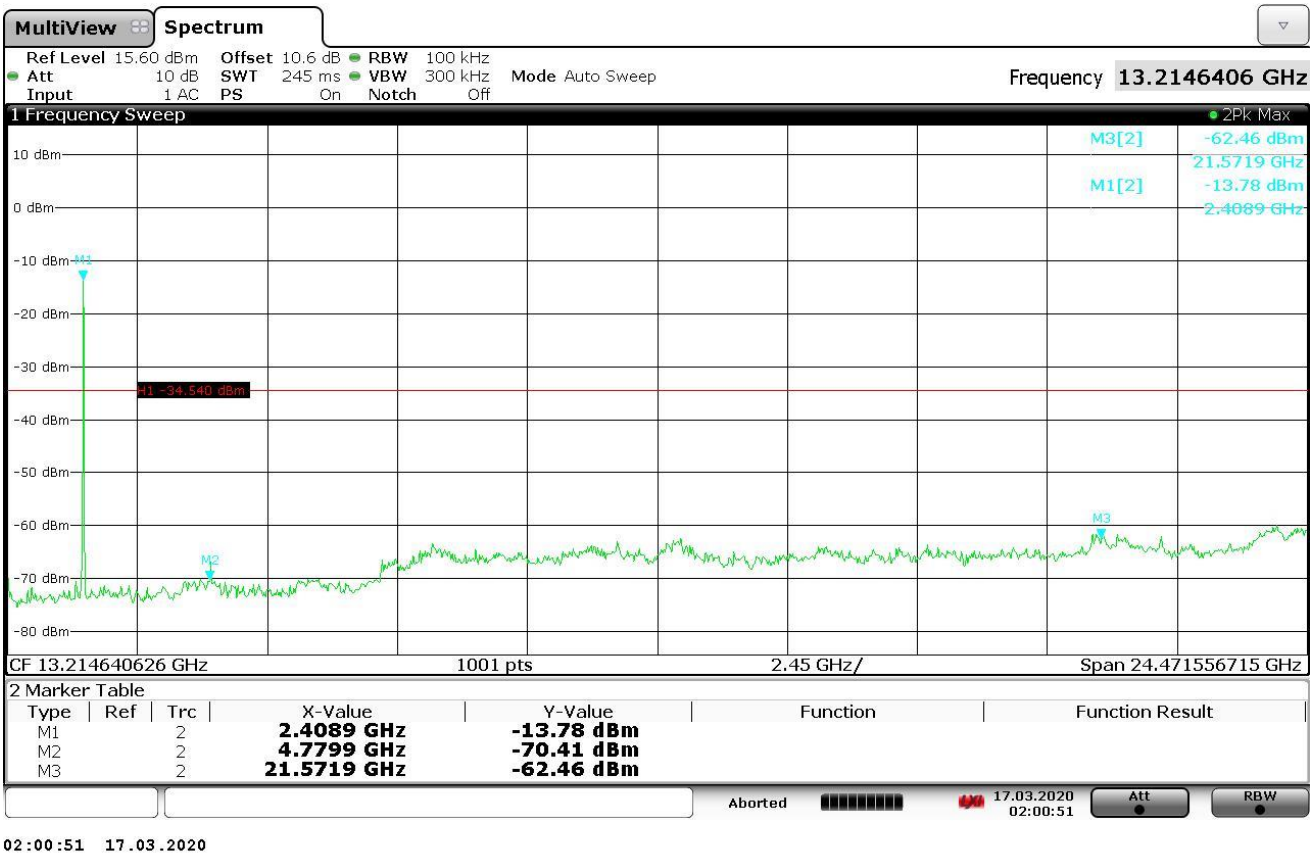


Figure 15 – OOB CH0 2402 30 – 26500 MHz

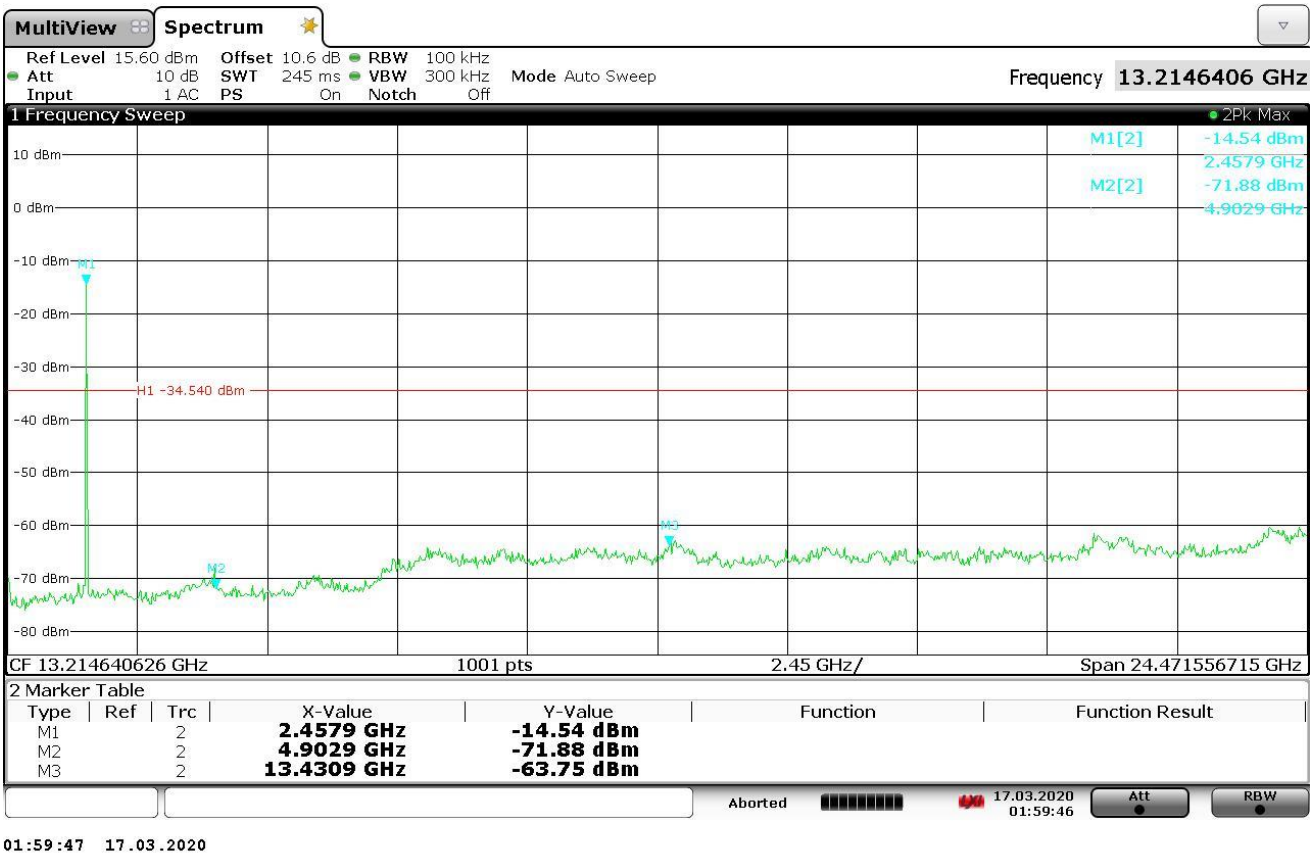


Figure 16 – OOB CH19 2440 30 – 26500 MHz

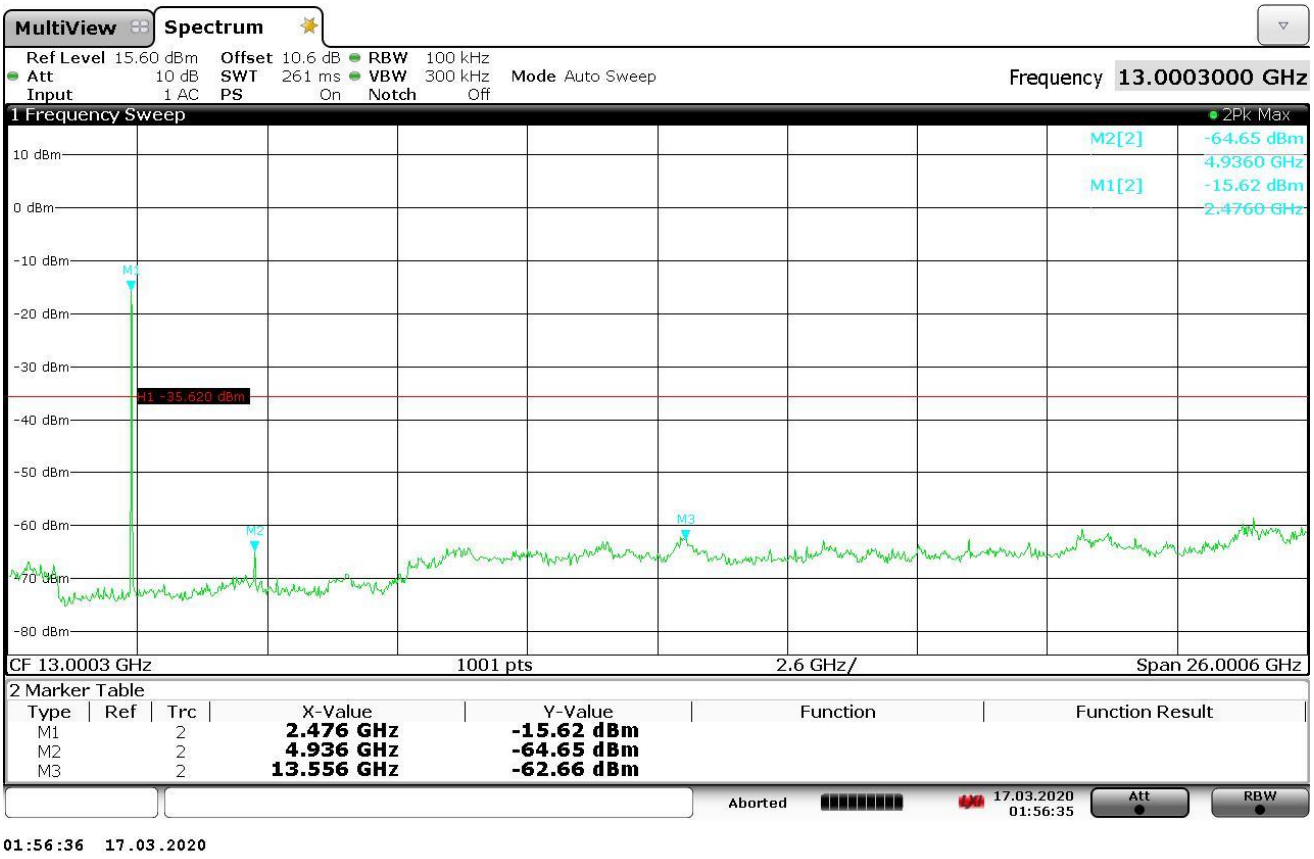


Figure 17 – OOB CH39 2480 30 – 26500 MHz

4.5 Out of Band Emissions – Restricted Bands

This test evaluates the radiated spurious emissions that fall into the restricted bands of the out of band domain.

4.5.1 Test Over View

Results	**Complies** (as tested per this report)				**Date**	03/17/2020	
Standard	FCC CFR 47 §15.247 (d)						
Product Model	Token			**Serial#**	0002		
Configuration	See test plan for details.						
Test Set-up	Tested in shielded room, EUT placed on table. See test plan for details.						
EUT Powered By	4 VDC	**Temp**	23º C	**Humidity**	36%	**Pressure**	1004mbar
Frequency Range	Channel 0: 2402 MHz Channel 39: 2480 MHz						
Perf. Criteria	< 54 dBµV/m @ 3 m (AVG) < 74 dBµV/m @ 3 m (Peak)			**Perf. Verification**	Readings under Limit		
Mod to EUT	None			**Test Performed By**	Alexander Sowinski		

4.5.2 Test Procedure

Radiated measurements per ANSI C63.10-2013 Section 6.10.5 were used to measure the undesirable emission requirement in restricted bands. Peak points were found and RMS Average was taken for each point found. The measurement was performed with modulation. This test was conducted on the upper and lower most channels in each mode on the EUT. The worst case measurement of each channel is recorded in this report. All channels were tested at highest power settings.

4.5.3 Deviations

There were no deviations from the test methodology listed in the test plan for the out of band emissions test.

4.5.4 Final Test

The out of band emissions of the EUT were below the limit specified by the standard. Plots contain a Blue Peak Max-Hold trace, a Red Peak Clear-Write trace, a Cyan AVG Max-Hold trace, and a Magenta AVG Clear-Write trace.

4.5.5 Final Data

No spurious peaks were detected in the restricted bands.

4.5.6 Plots

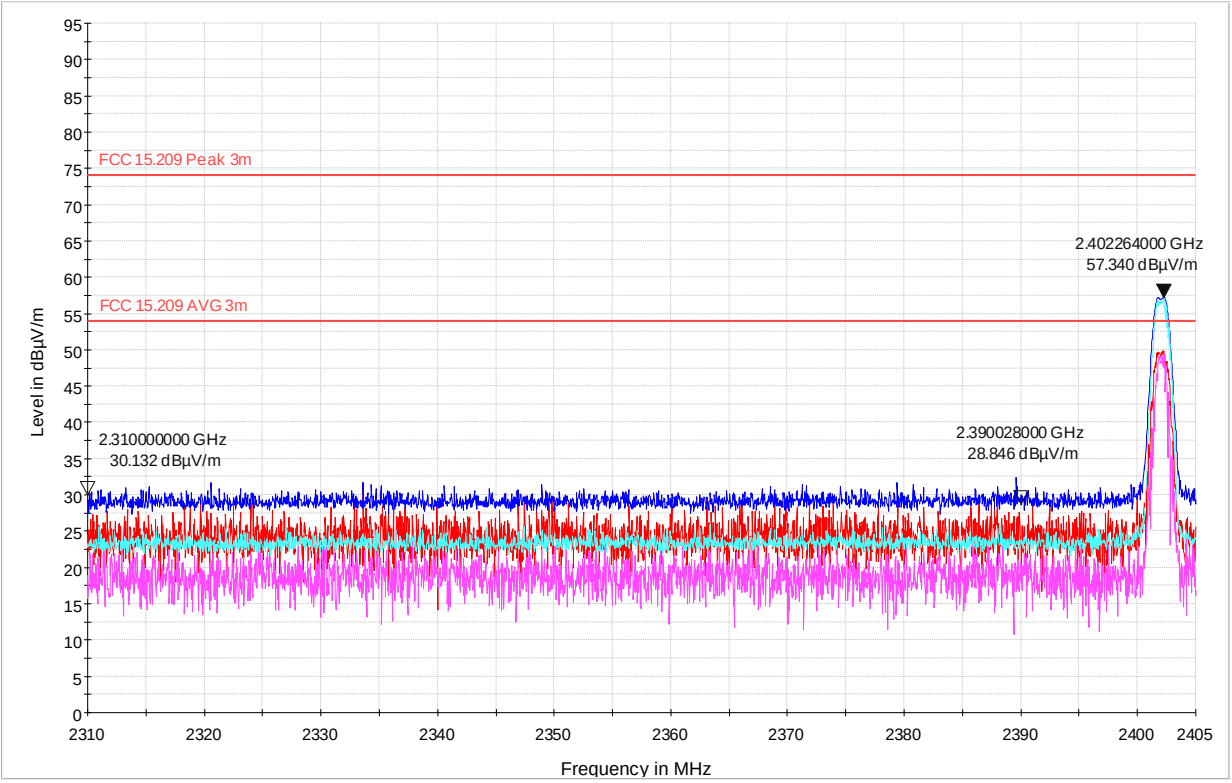


Figure 18 – Lower Band Edge CH0 2402 MHz Antenna Vertical

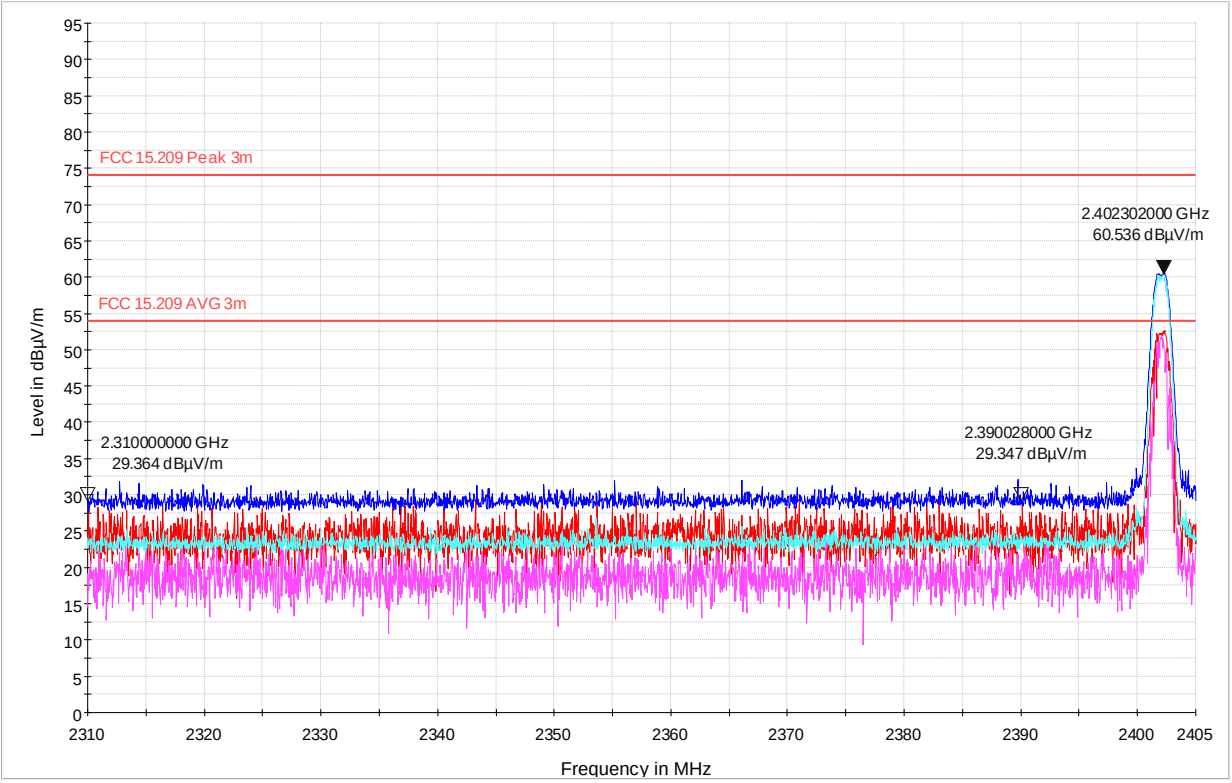


Figure 19 – Lower Band Edge CH0 2402 MHz Antenna Horizontal

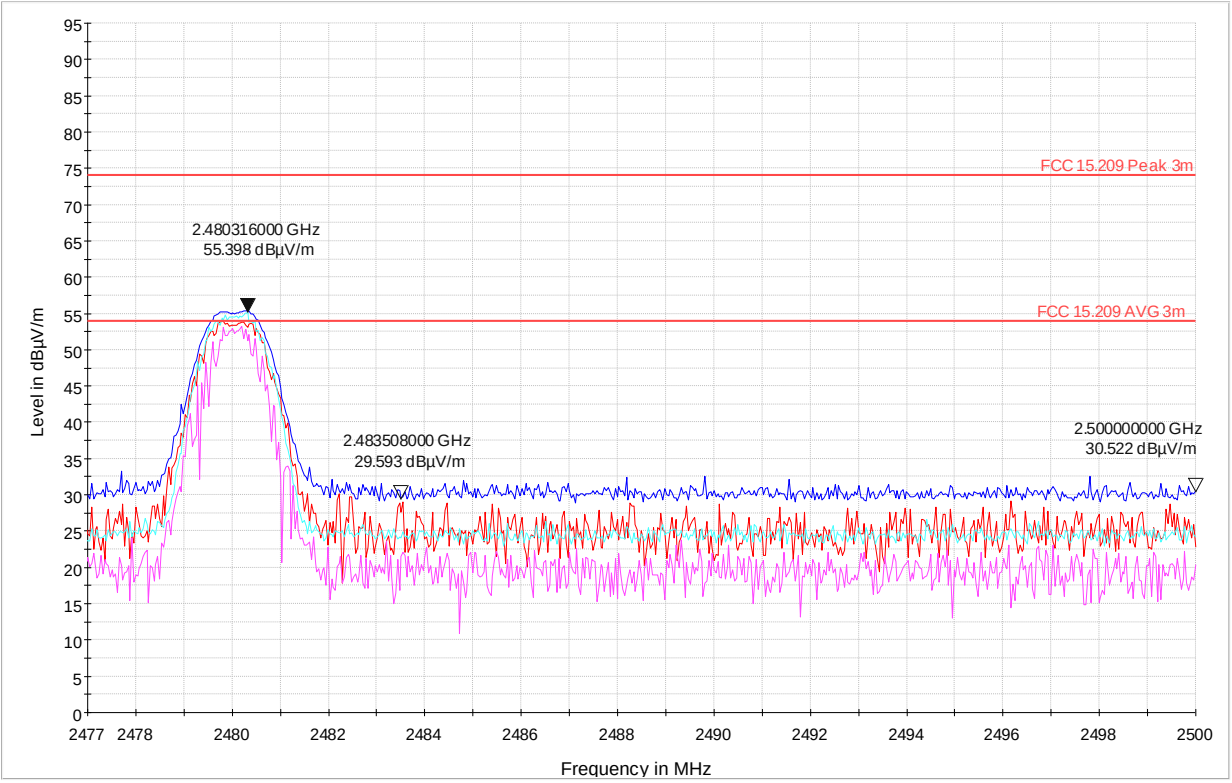


Figure 20 – Upper Band Edge CH39 2480 MHz Antenna Vertical

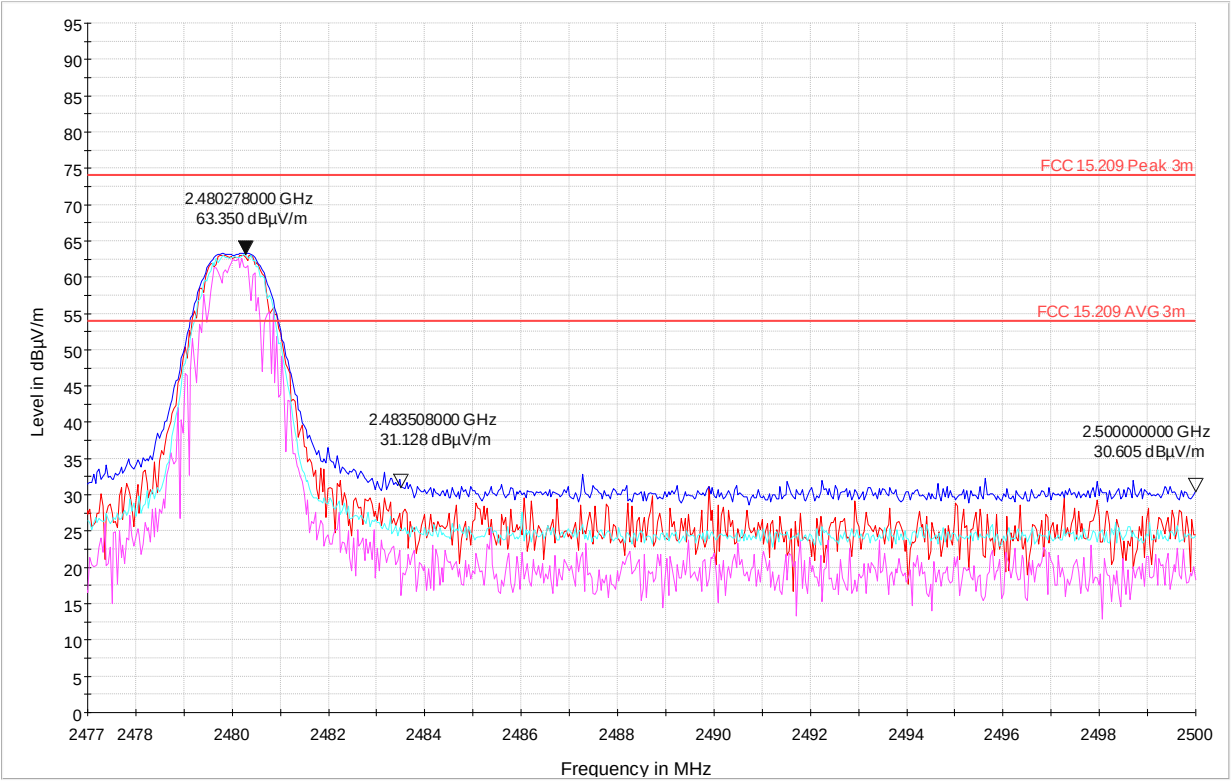


Figure 21 – Upper Band Edge CH39 2480 MHz Antenna Horizontal

4.6 Transmitter Spurious Emission

This purpose of this test is to evaluate the radiated spurious emissions of the EUT.

4.6.1 Test Over View

Results	**Complies** (as tested per this report)				**Date**	03/17/2020	
Standard	FCC CFR 47 §15.247 (d)						
Product Model	Token			**Serial#**	0001		
Configuration	See test plan for details.						
Test Set-up	Tested at 3 meters, semi-anechoic chamber, EUT placed on turntable. See test plan for details.						
EUT Powered By	4 VDC	**Temp**	23º C	**Humidity**	36%	**Pressure**	1004mbar
Frequency Range	Channel 0: 2402 MHz Channel 19: 2440 MHz Channel 39: 2480 MHz						
Perf. Criteria	Class B (Below Limit)			**Perf. Verification**	Readings under Limit		
Mod to EUT	None			**Test Performed By**	Alexander Sowinski		

4.6.2 Test Procedure

Testing was performed in accordance with FCC CFR §15.247 and ANSI C63.10. In the range below 1GHz, sample was place on the turntable at a height of 80 cm. In the range above 1GHz, the EUT was placed on the turntable at a height of 150 cm. Measurements were taken rotating the turntable between 0 and 360° and varying the antenna height between 100 and 400 cm. Worst case results were recorded and reported below. No spurious emissions were detected below 30MHz.

4.6.3 Deviations

There were no deviations from the test methodology listed in the test plan for the transmitter spurious emissions test.

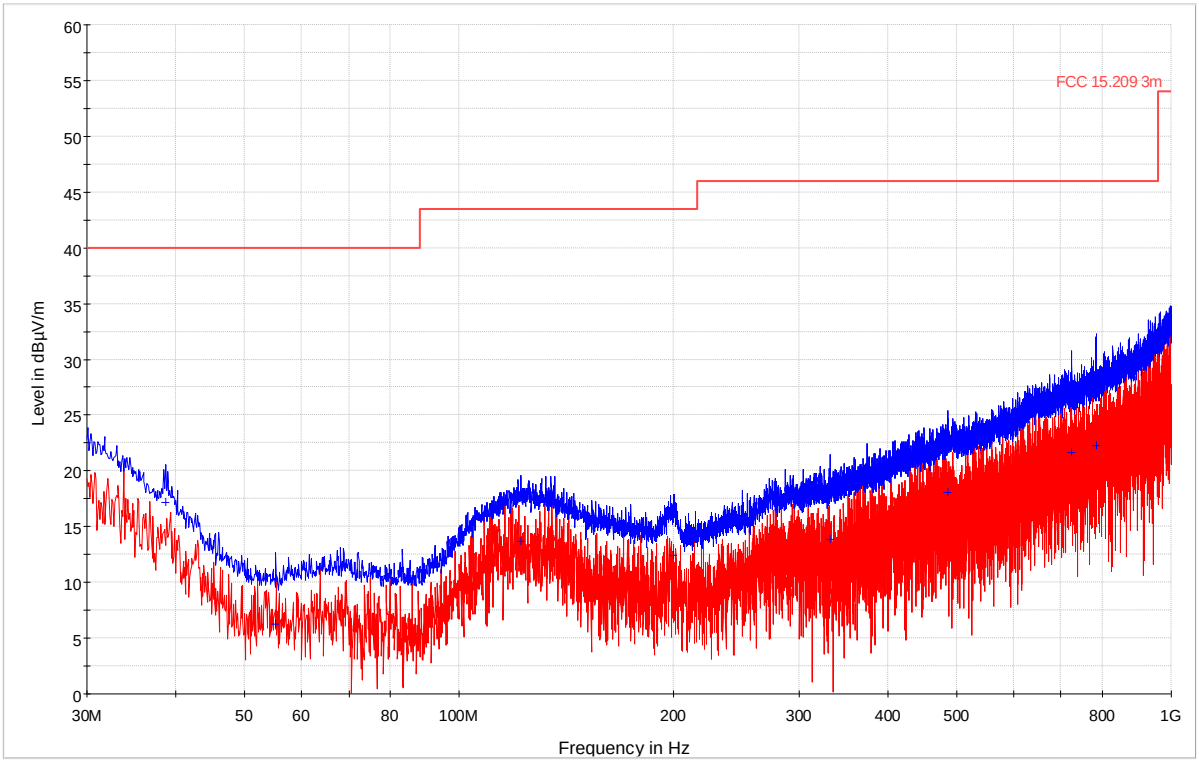
4.6.4 Final Test

The final transmitter spurious emission measurements were below the limit. Plots contain a Blue Peak Max-Hold trace and a Red Peak Clear-Write trace.

4.6.5 Final Data

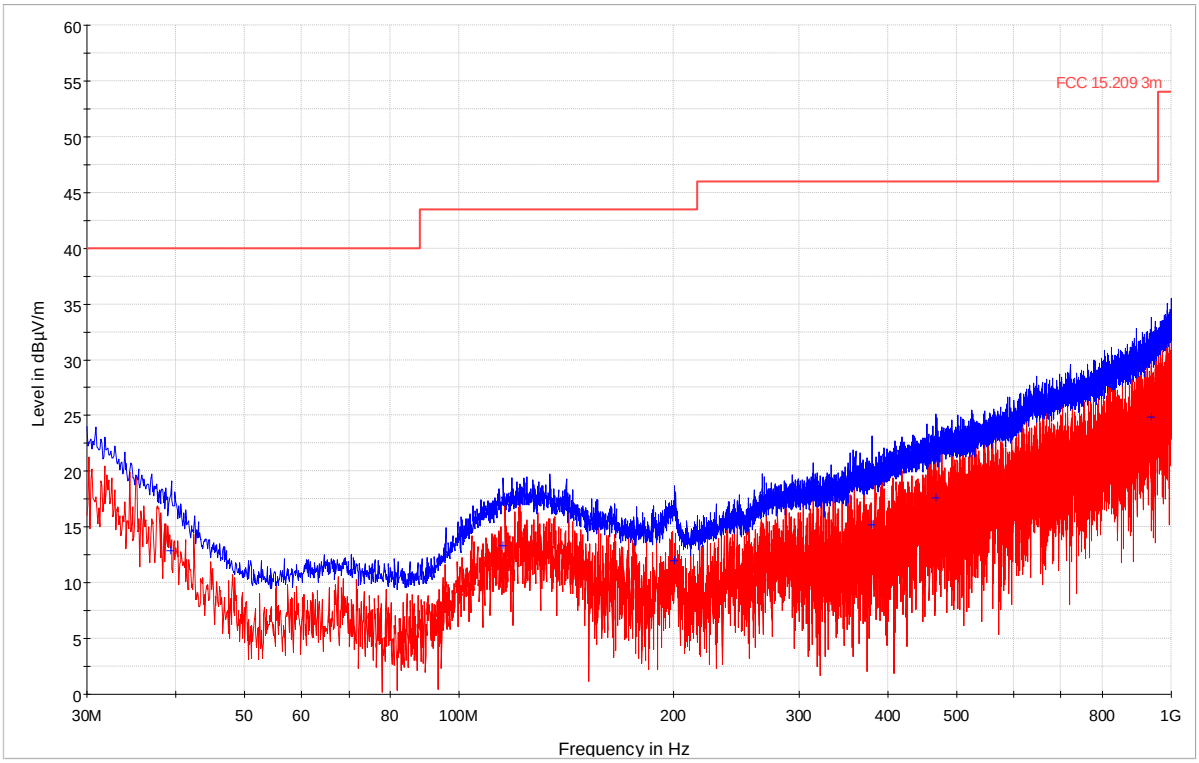
NOTES: 30 – 1000 MHz, CH0-2402 MHz

Radiated Emissions
Vertical



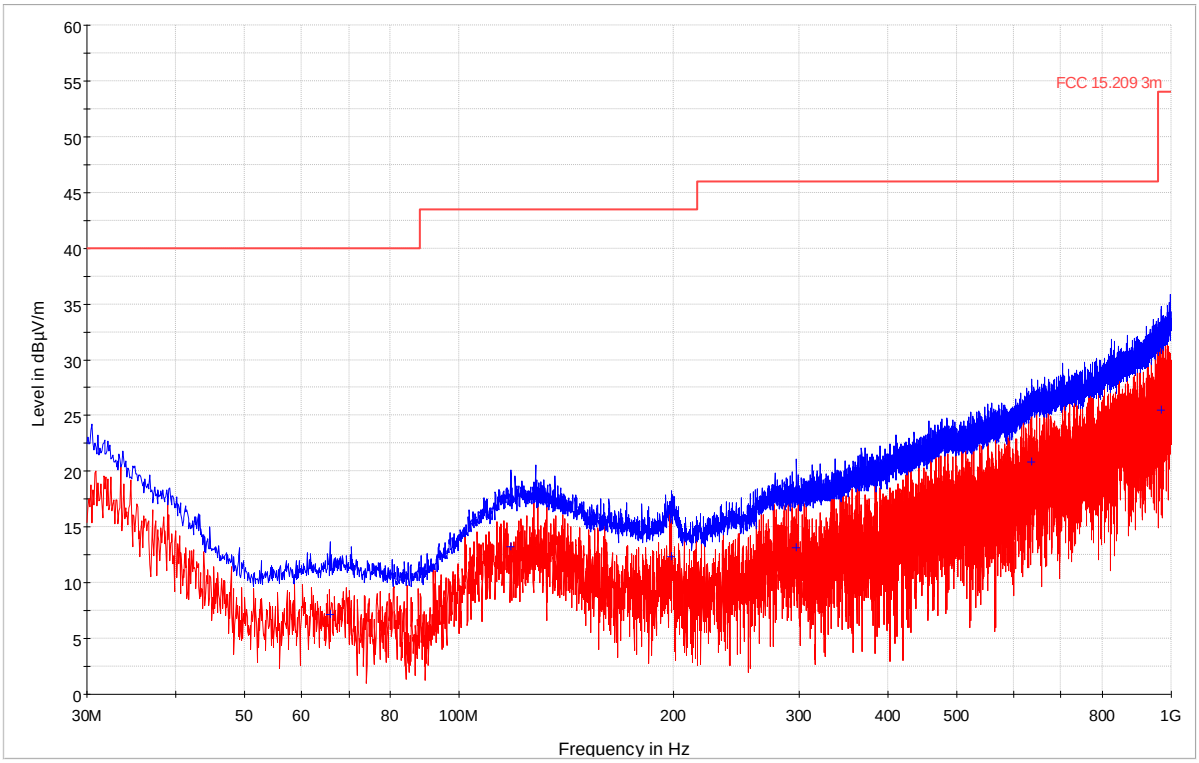
NOTES: 30 – 1000 MHz, CH0-2402 MHz

Radiated Emissions
Horizontal



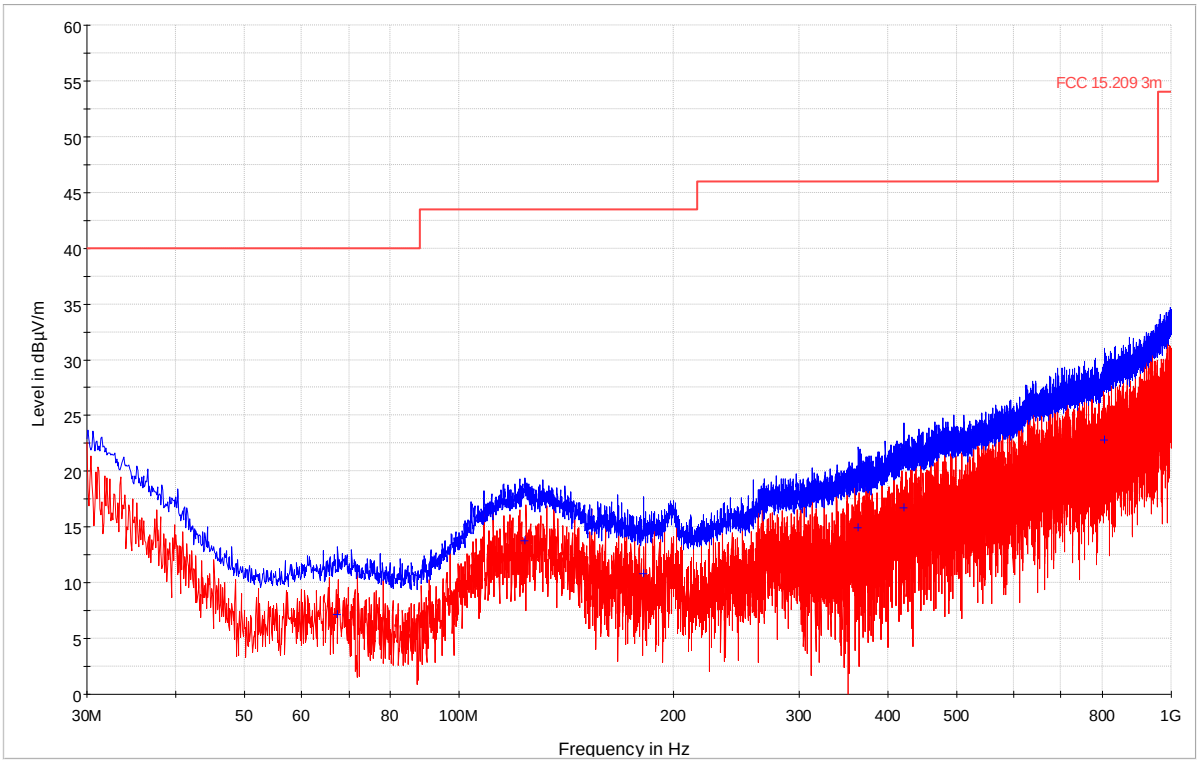
NOTES: 30 – 1000 MHz, CH19-2440 MHz

Radiated Emissions
Vertical



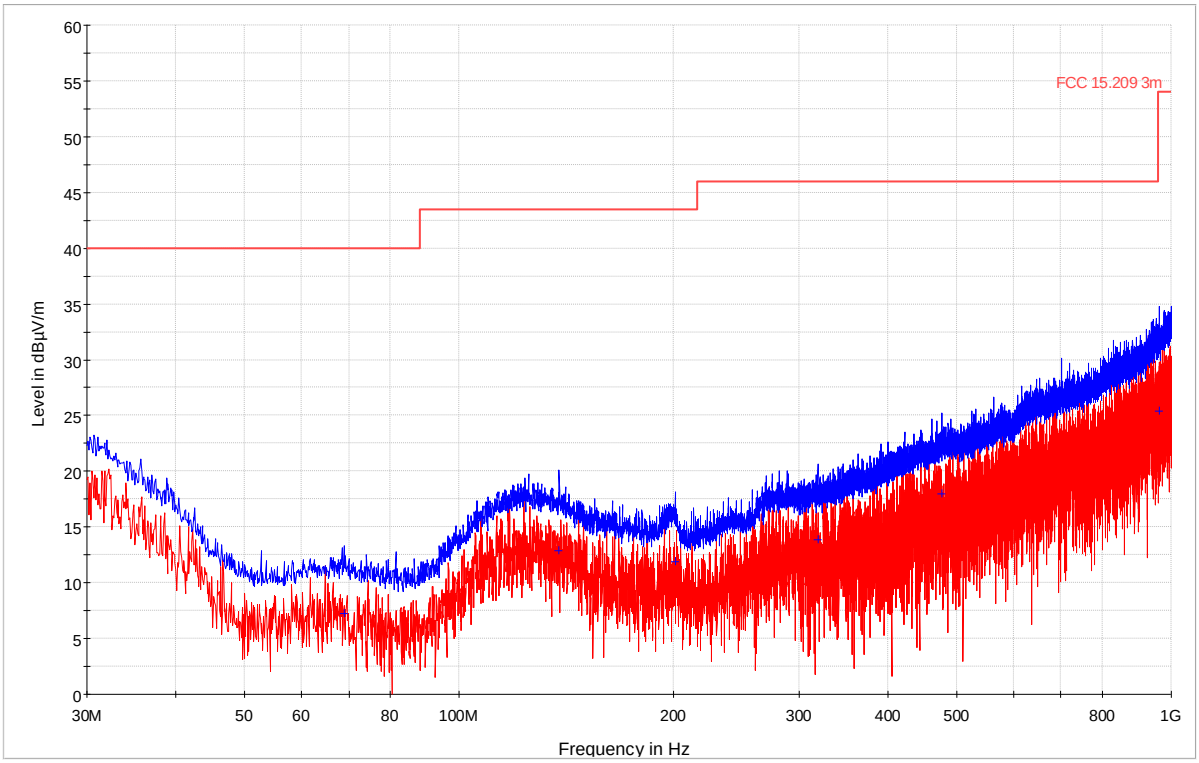
NOTES: 30 – 1000 MHz, CH19-2440 MHz

Radiated Emissions
Horizontal



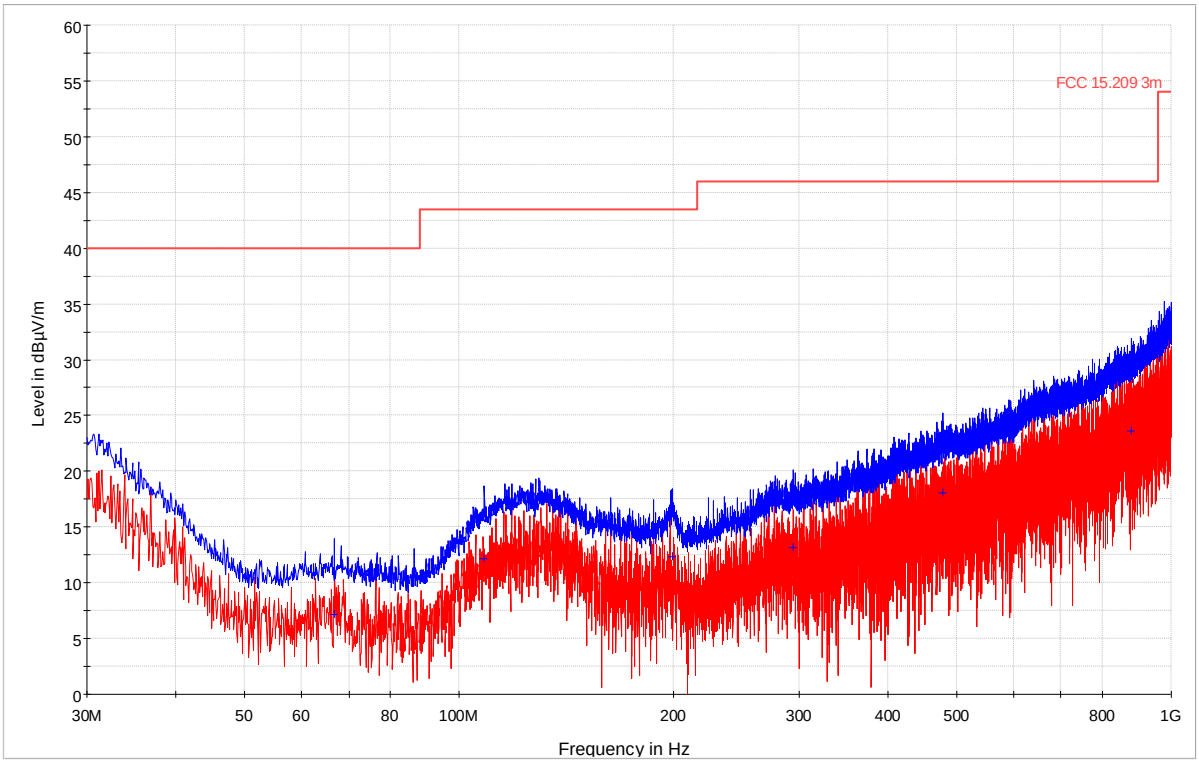
NOTES: 30 – 1000 MHz, CH39-2480 MHz

Radiated Emissions
Vertical



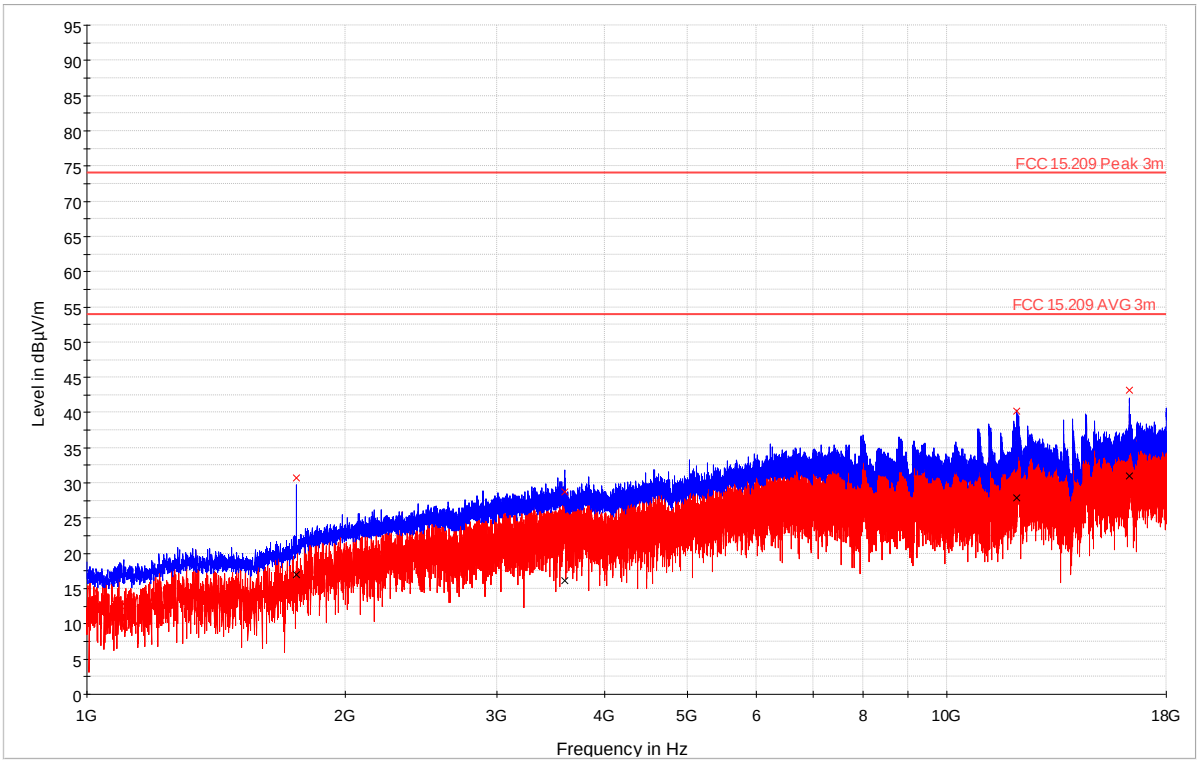
NOTES: 30 – 1000 MHz, CH39-2480 MHz

Radiated Emissions
Horizontal



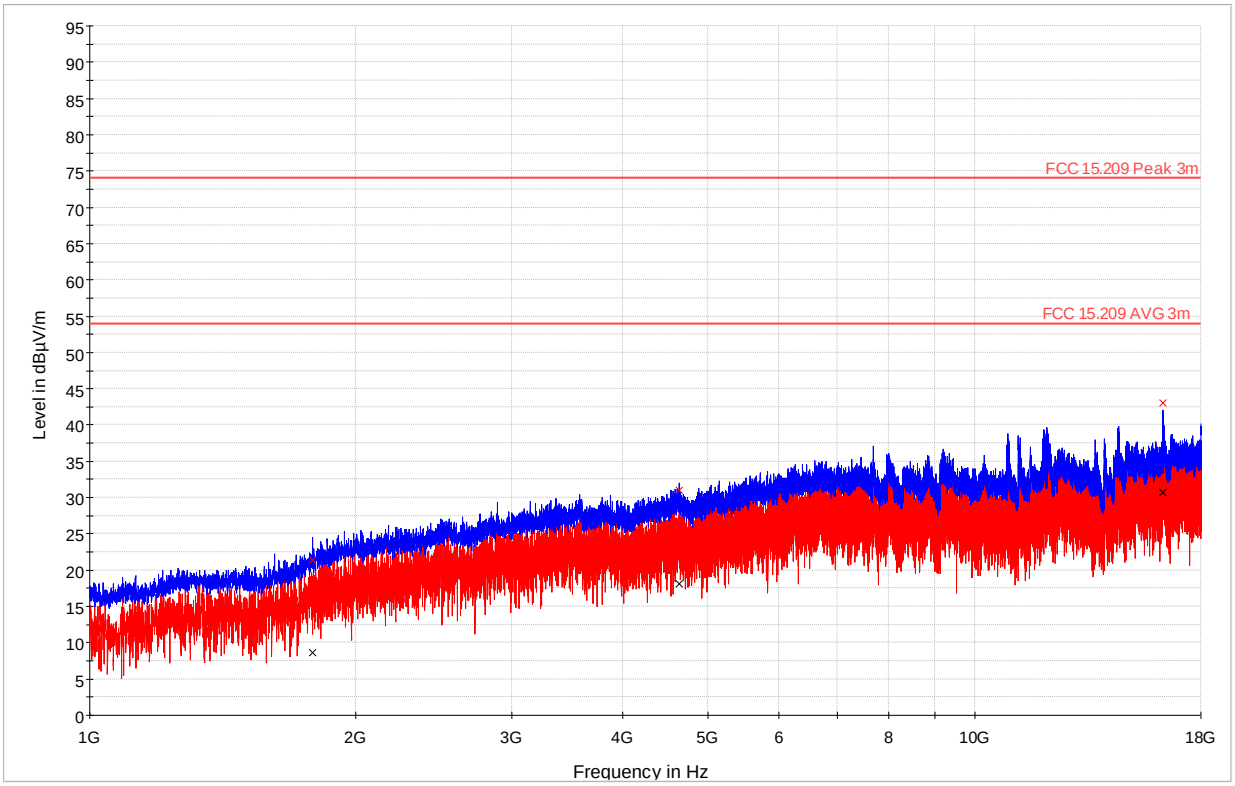
NOTES: 1 – 18 GHz, CH0-2402 MHz

Radiated Emissions
Vertical



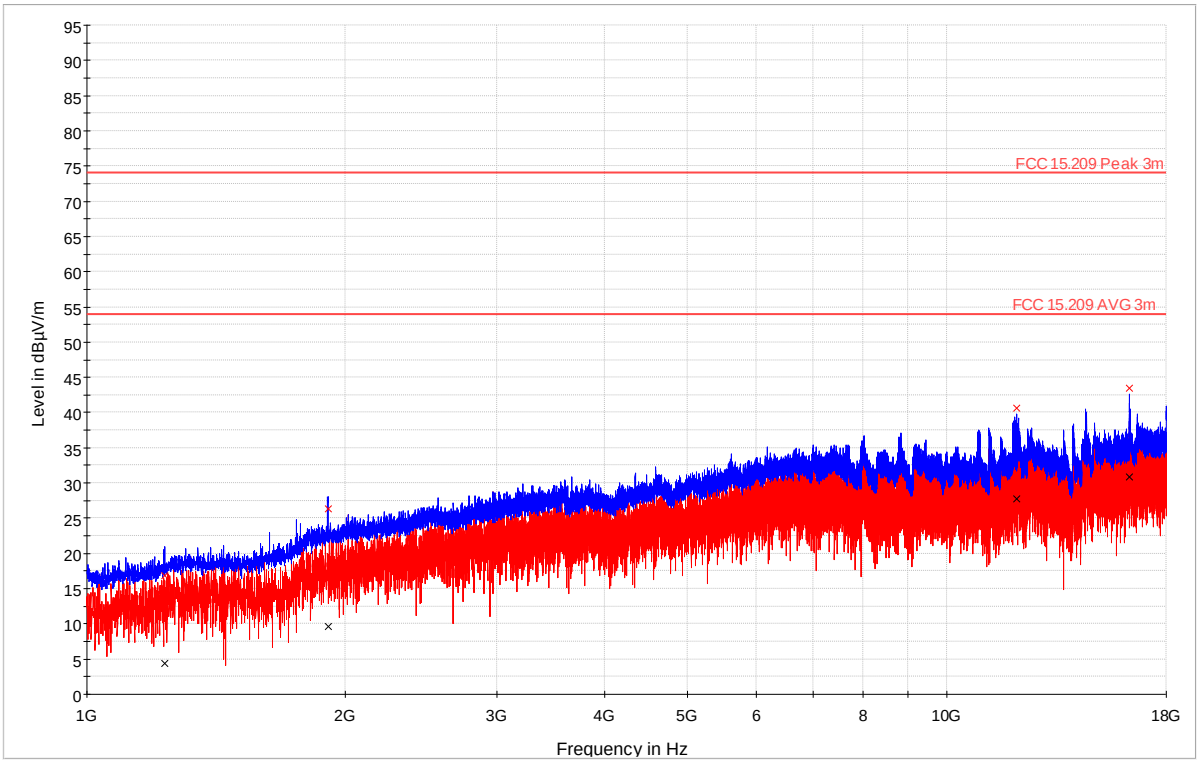
NOTES: 1 – 18 GHz, CH0-2402 MHz

Radiated Emissions
Horizontal



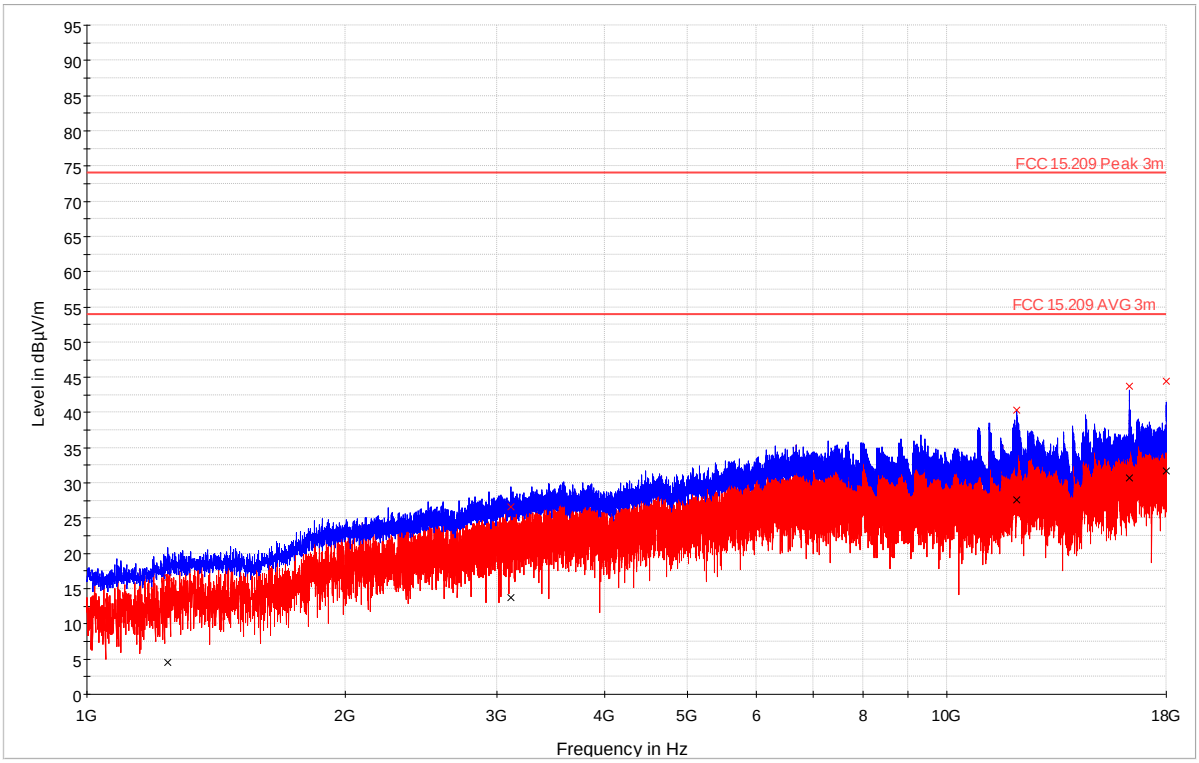
NOTES: 1 – 18 GHz, CH19-2440 MHz

Radiated Emissions
Vertical



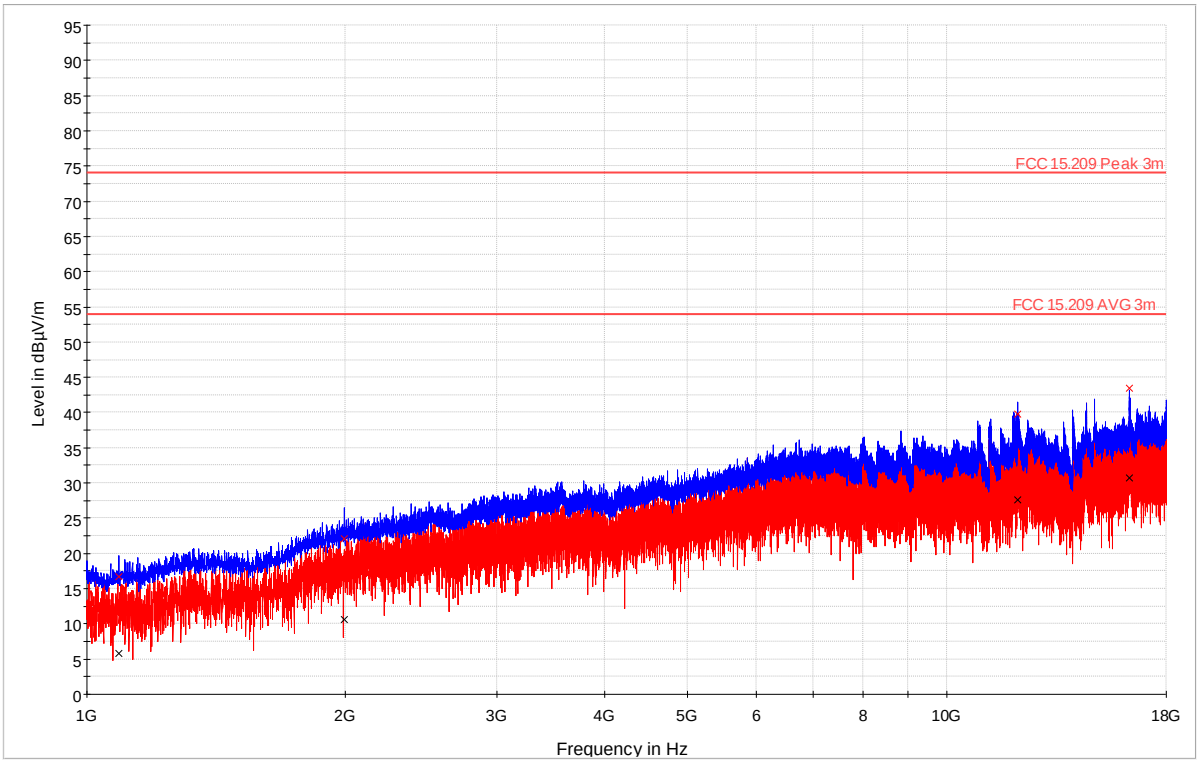
NOTES: 1 – 18 GHz, CH19-2440MHz

Radiated Emissions
Horizontal



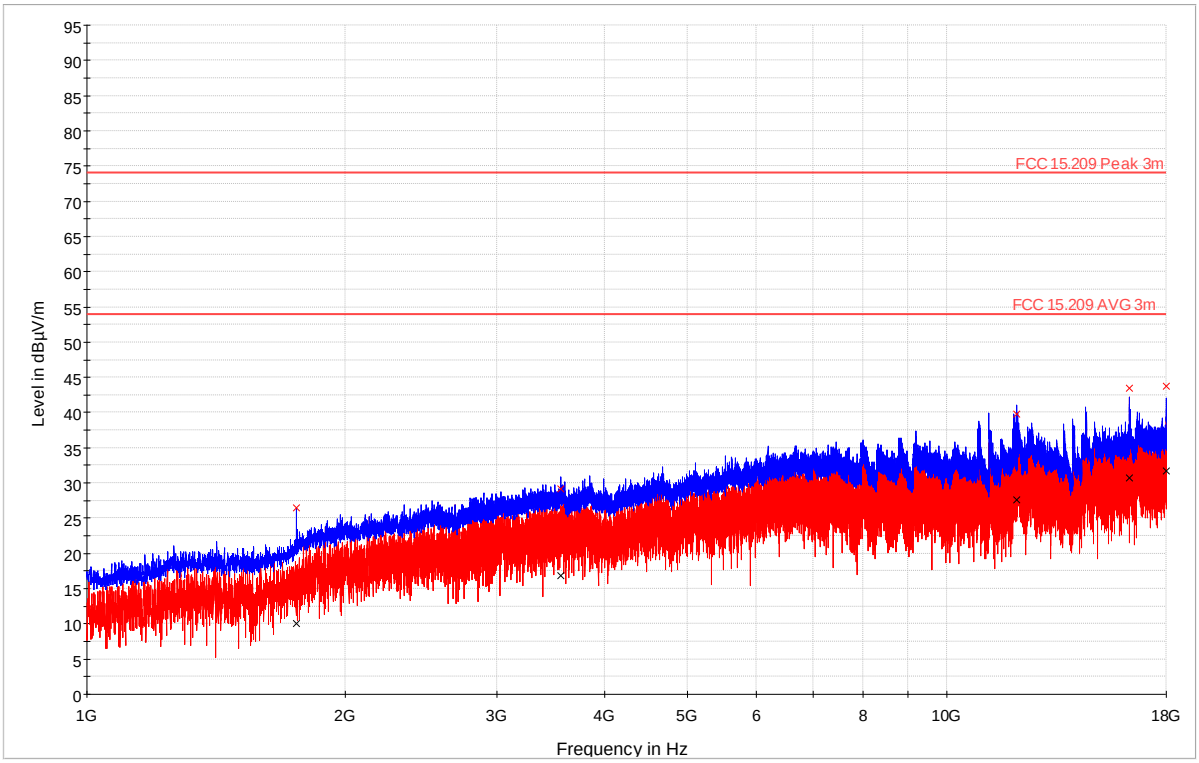
NOTES: 1 – 18 GHz, CH39-2480 MHz

Radiated Emissions
Vertical



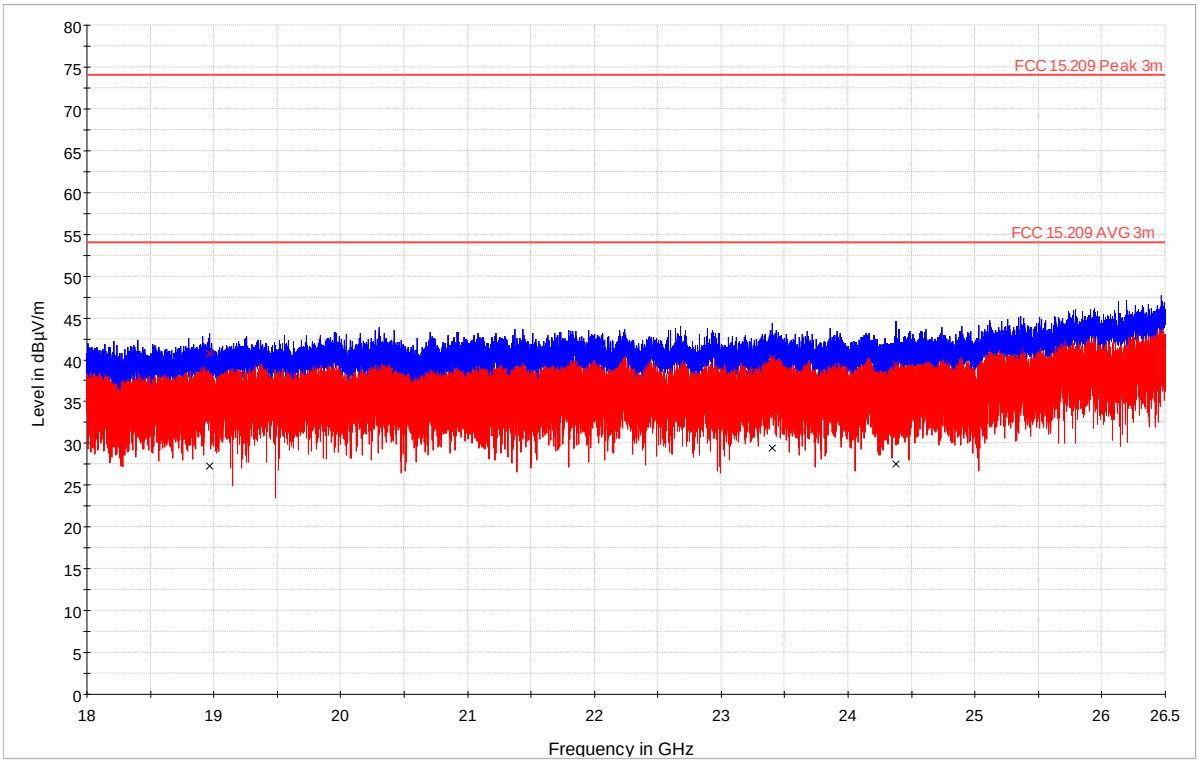
NOTES:1 – 18 GHz, CH39-2480 MHz

Radiated Emissions
Horizontal



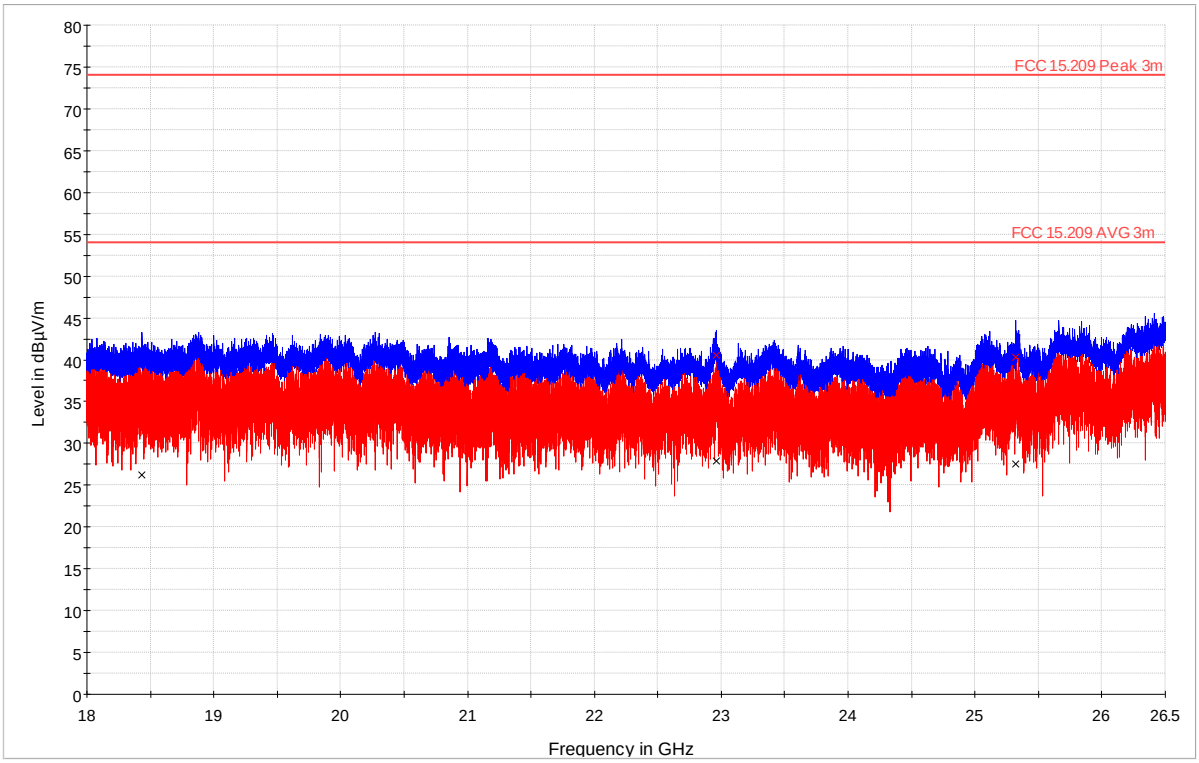
NOTES: 18 – 26.5 GHz, CH0-2402 MHz

Radiated Emissions
Vertical



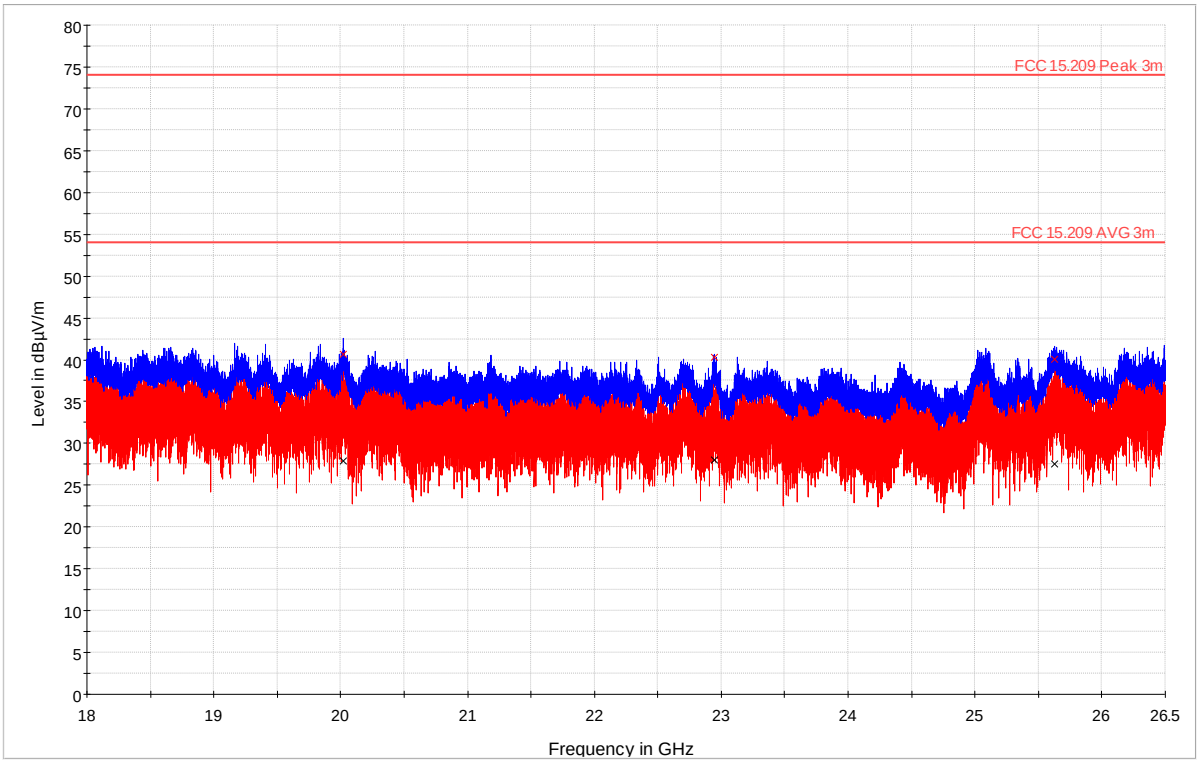
NOTES: 18 – 26.5 GHz, CH0-2402 MHz

Radiated Emissions
Horizontal



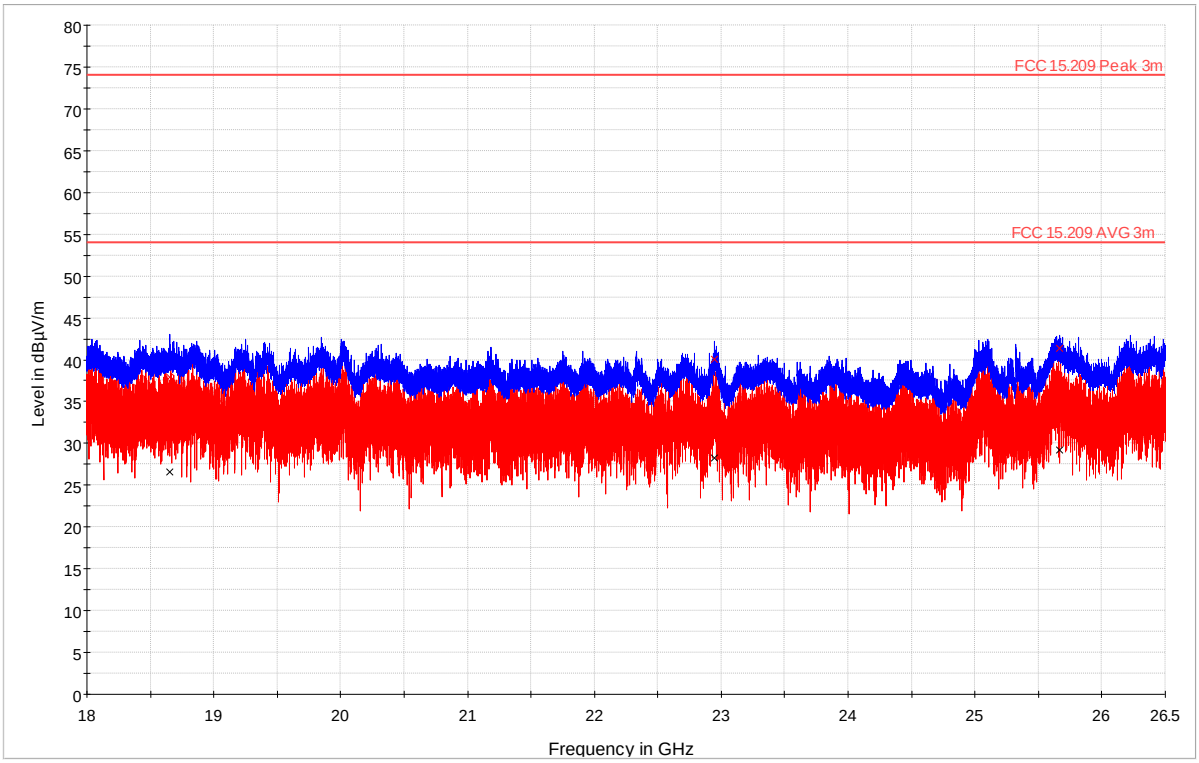
NOTES: 18 – 26.5 GHz, CH19-2440 MHz

Radiated Emissions
Vertical



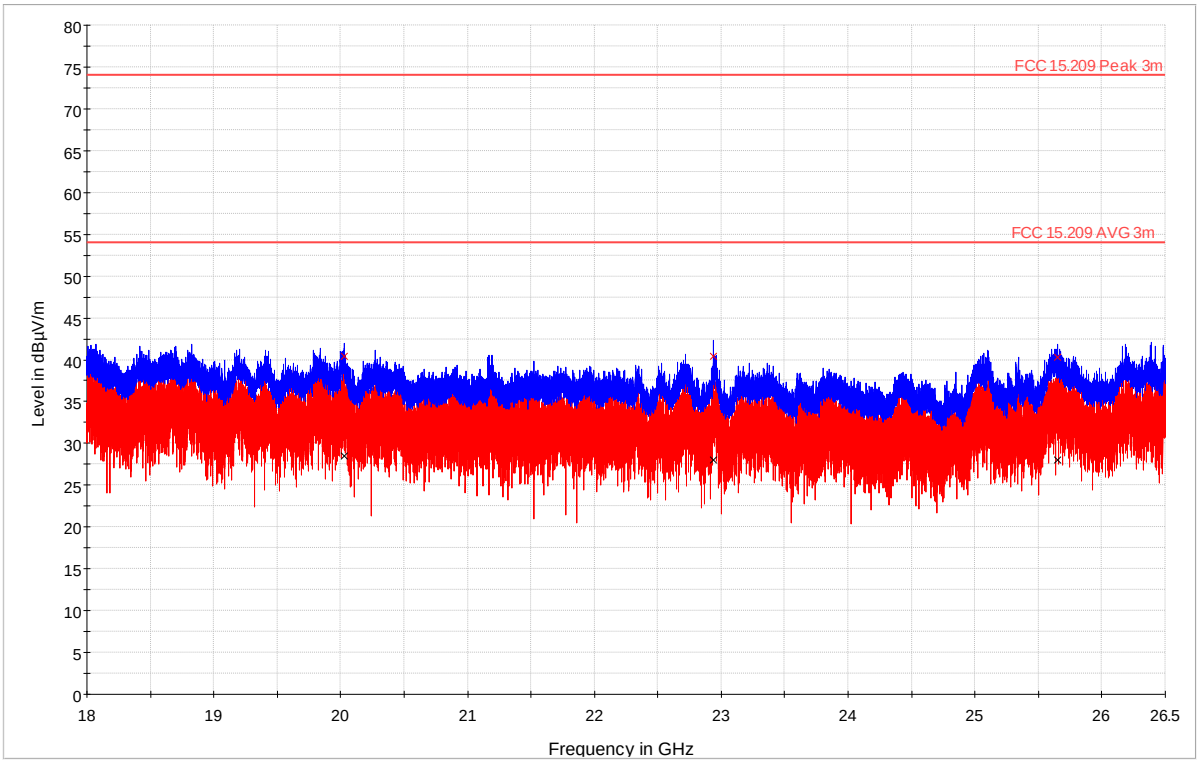
NOTES: 18 – 26.5 GHz, CH19-2440 MHz

Radiated Emissions
Horizontal



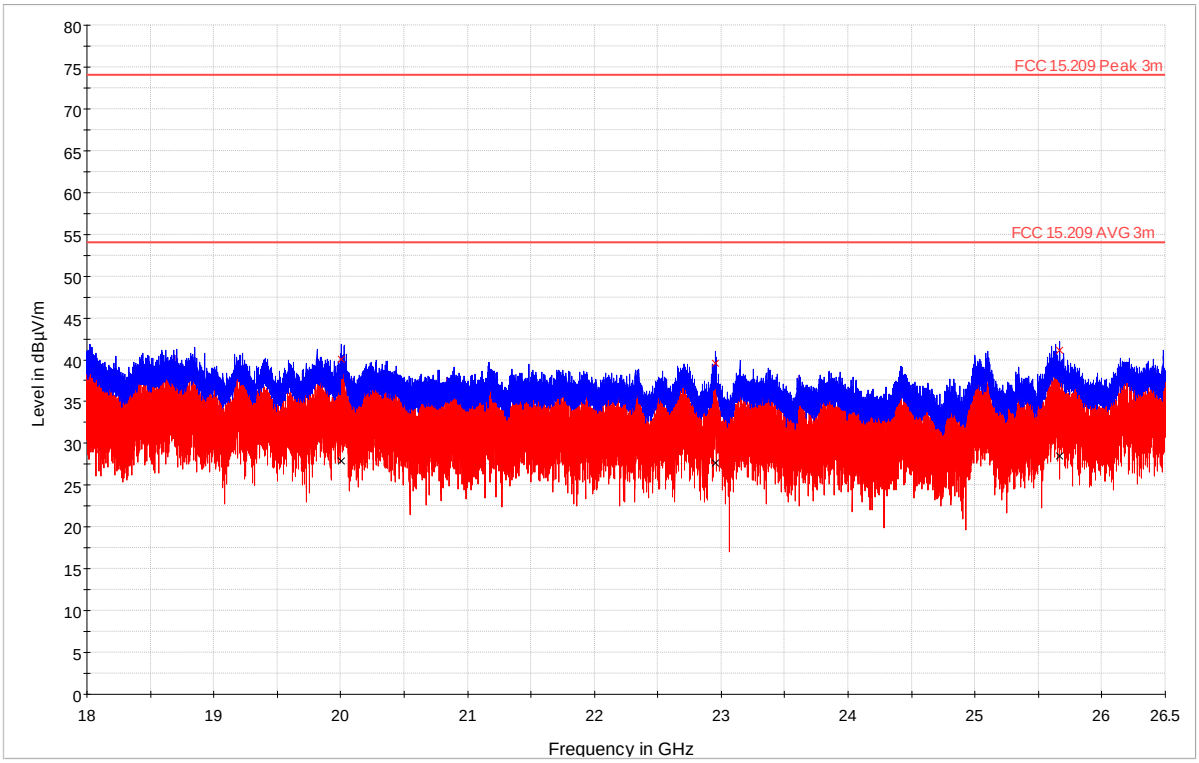
NOTES: 18 – 26.5 GHz, CH39-2480 MHz

Radiated Emissions
Vertical



NOTES: 18 – 26.5 GHz, CH39-2480 MHz

Radiated Emissions
Horizontal



4.6.6 Final Tabulated Data

Table 1: 30 – 1000 MHz CH0 Tabulated Data

Frequency	QuasiPeak	Height	Polarization	Azimuth	Limit - QPK	Margin
MHz	dBµV/m	cm		deg	dBµV/m	dB
38.72	17.2	100.0	V	0.0	40.0	-22.8
39.40	12.9	350.0	H	323.0	40.0	-27.1
55.24	6.3	100.0	V	311.0	40.0	-33.7
115.28	13.3	350.0	H	239.0	43.5	-30.2
122.16	13.6	100.0	V	171.0	43.5	-29.9
199.96	12.4	100.0	V	71.0	43.5	-31.1
200.44	12.0	350.0	H	148.0	43.5	-31.5
331.36	13.9	100.0	V	211.0	46.0	-32.1
380.08	15.2	350.0	H	25.0	46.0	-30.8
466.40	17.6	350.0	H	240.0	46.0	-28.4
485.80	18.1	100.0	V	3.0	46.0	-27.9
725.28	21.7	100.0	V	78.0	46.0	-24.3
784.48	22.2	100.0	V	137.0	46.0	-23.8
938.60	24.9	350.0	H	286.0	46.0	-21.1

Table 2: 30 – 1000 MHz CH19 Tabulated Data

Frequency	QuasiPeak	Height	Polarization	Azimuth	Limit - QPK	Margin
MHz	dBµV/m	cm		deg	dBµV/m	dB
65.88	7.1	100.0	V	21.0	40.0	-32.9
67.44	7.2	350.0	H	32.0	40.0	-32.8
118.08	13.2	100.0	V	198.0	43.5	-30.3
123.80	13.7	350.0	H	204.0	43.5	-29.8
181.52	10.8	350.0	H	283.0	43.5	-32.7
198.48	12.3	100.0	V	260.0	43.5	-31.2
297.72	13.1	100.0	V	34.0	46.0	-32.9
363.68	14.9	350.0	H	157.0	46.0	-31.1
421.80	16.7	350.0	H	21.0	46.0	-29.3
636.24	20.8	100.0	V	71.0	46.0	-25.2
805.32	22.8	350.0	H	195.0	46.0	-23.2
967.60	25.5	100.0	V	256.0	54.0	-28.5

Table 3: 30 – 1000 MHz CH39 Tabulated Data

Frequency	QuasiPeak	Height	Polarization	Azimuth	Limit - QPK	Margin
MHz	dBµV/m	cm		deg	dBµV/m	dB
66.76	7.1	350.0	H	71.0	40.0	-32.9
68.88	7.3	100.0	V	151.0	40.0	-32.7
108.48	12.1	350.0	H	210.0	43.5	-31.4
138.16	12.9	100.0	V	189.0	43.5	-30.6
199.28	12.4	350.0	H	279.0	43.5	-31.1
200.92	11.9	100.0	V	337.0	43.5	-31.6
294.12	13.1	350.0	H	146.0	46.0	-32.9
318.76	13.8	100.0	V	151.0	46.0	-32.2
475.80	17.9	100.0	V	84.0	46.0	-28.1
477.56	18.0	350.0	H	159.0	46.0	-28.0
877.88	23.6	350.0	H	188.0	46.0	-22.4
961.20	25.4	100.0	V	192.0	54.0	-28.6

Table 4: 1 – 18 GHz CH0 Tabulated Data

Frequency	MaxPeak	CAverage	Height	Polarization	Azimuth	Limit - PK+	Margin - PK	Limit - AVG	Margin - AVG
MHz	dBµV/m	dBµV/m	cm		deg	dBµV/m	dB	dBµV/m	dB
1753.00	30.7	16.9	150.0	V	-1.0	74.0	-43.3	54.0	-37.1
1786.50	21.4	8.6	300.0	H	246.0	74.0	-52.6	54.0	-45.4
3591.00	28.8	16.2	150.0	V	333.0	74.0	-45.2	54.0	-37.8
4634.50	30.9	18.1	300.0	H	230.0	74.0	-43.1	54.0	-35.9
12055.00	40.2	27.8	150.0	V	178.0	74.0	-33.8	54.0	-26.2
16302.25	43.2	31.0	150.0	V	255.0	74.0	-30.8	54.0	-23.0
16304.00	43.1	30.7	300.0	H	150.0	74.0	-30.9	54.0	-23.3

Table 5: 1 – 18 GHz CH19 Tabulated Data

Frequency	MaxPeak	CAverage	Height	Polarization	Azimuth	Limit - PK+	Margin - PK	Limit - AVG	Margin - AVG
MHz	dBµV/m	dBµV/m	cm		deg	dBµV/m	dB	dBµV/m	dB
1231.75	16.8	4.5	150.0	V	294.0	74.0	-57.2	54.0	-49.5
1240.75	16.6	4.6	300.0	H	308.0	74.0	-57.4	54.0	-49.4
1907.25	26.3	9.6	150.0	V	276.0	74.0	-47.7	54.0	-44.4
3113.75	26.6	13.7	300.0	H	263.0	74.0	-47.4	54.0	-40.3
12054.00	40.4	27.7	300.0	H	349.0	74.0	-33.6	54.0	-26.3
12054.50	40.7	27.7	150.0	V	133.0	74.0	-33.3	54.0	-26.3
16300.50	43.8	30.8	300.0	H	86.0	74.0	-30.2	54.0	-23.2
16301.25	43.5	30.9	150.0	V	307.0	74.0	-30.5	54.0	-23.1
17996.00	44.5	31.7	300.0	H	64.0	74.0	-29.5	54.0	-22.3

Table 6: 1 – 18 GHz CH39 Tabulated Data

Frequency	MaxPeak	CAverage	Height	Polarization	Azimuth	Limit - PK+	Margin - PK	Limit - AVG	Margin - AVG
MHz	dBµV/m	dBµV/m	cm		deg	dBµV/m	dB	dBµV/m	dB
1089.50	16.7	5.8	150.0	V	24.0	74.0	-57.3	54.0	-48.2
1753.00	26.5	10.0	300.0	H	77.0	74.0	-47.5	54.0	-44.0
1992.75	22.1	10.6	150.0	V	341.0	74.0	-51.9	54.0	-43.4
3558.50	29.2	16.8	300.0	H	100.0	74.0	-44.8	54.0	-37.2
12054.00	39.8	27.6	300.0	H	327.0	74.0	-34.2	54.0	-26.4
12093.00	39.8	27.6	150.0	V	227.0	74.0	-34.2	54.0	-26.4
16300.50	43.5	30.7	300.0	H	249.0	74.0	-30.5	54.0	-23.3
16302.25	43.4	30.7	150.0	V	158.0	74.0	-30.6	54.0	-23.3
17996.50	43.8	31.7	300.0	H	119.0	74.0	-30.2	54.0	-22.3

Table 7: 18 – 26.5 GHz CH0 Tabulated Data

Frequency	MaxPeak	CAverage	Height	Polarization	Azimuth	Limit - PK+	Margin - PK	Limit - AVG	Margin - AVG
MHz	dBµV/m	dBµV/m	cm		deg	dBµV/m	dB	dBµV/m	dB
18436.25	37.8	26.2	250.0	H	92.0	74.0	-36.2	54.0	-27.8
18970.75	40.8	27.3	150.0	V	265.0	74.0	-33.2	54.0	-26.7
22960.50	40.6	27.9	250.0	H	287.0	74.0	-33.4	54.0	-26.1
23400.00	40.1	29.4	150.0	V	-2.0	74.0	-33.9	54.0	-24.6
24376.25	39.5	27.5	150.0	V	109.0	74.0	-34.5	54.0	-26.5
25320.50	40.3	27.6	250.0	H	293.0	74.0	-33.7	54.0	-26.4

Table 8: 18 – 26.5 GHz CH19 Tabulated Data

Frequency	MaxPeak	CAverage	Height	Polarization	Azimuth	Limit - PK+	Margin - PK	Limit - AVG	Margin - AVG
MHz	dBµV/m	dBµV/m	cm		deg	dBµV/m	dB	dBµV/m	dB
18649.75	37.9	26.6	250.0	H	-2.0	74.0	-36.1	54.0	-27.4
20023.50	40.7	28.0	150.0	V	42.0	74.0	-33.3	54.0	-26.0
22943.50	40.0	28.2	250.0	H	62.0	74.0	-34.0	54.0	-25.8
22946.50	40.3	28.0	150.0	V	317.0	74.0	-33.7	54.0	-26.0
25631.00	40.1	27.5	150.0	V	73.0	74.0	-33.9	54.0	-26.5
25667.00	41.4	29.2	250.0	H	79.0	74.0	-32.6	54.0	-24.8

Table 9: 18 – 26.5 GHz CH39 Tabulated Data

Frequency	MaxPeak	CAverage	Height	Polarization	Azimuth	Limit - PK+	Margin - PK	Limit - AVG	Margin - AVG
MHz	dBµV/m	dBµV/m	cm		deg	dBµV/m	dB	dBµV/m	dB
20008.00	40.0	27.9	250.0	H	3.0	74.0	-34.0	54.0	-26.1
20028.00	40.4	28.6	150.0	V	358.0	74.0	-33.6	54.0	-25.4
22940.50	40.4	28.0	150.0	V	170.0	74.0	-33.6	54.0	-26.0
22954.75	39.6	27.7	250.0	H	62.0	74.0	-34.4	54.0	-26.3
25648.25	40.3	28.1	150.0	V	355.0	74.0	-33.7	54.0	-25.9
25667.50	41.1	28.5	250.0	H	122.0	74.0	-32.9	54.0	-25.5

Appendix A

5 Test Plan

This test report is intended to follow the test plan outlined herein unless otherwise stated. The test plan provides product information, reference standards, and testing details. The product information below came via client, product manual, product itself and or the internet. Test procedure information will reference standards or internal TUV Rheinland NA procedures.

5.1 General Information

Client	Tokenize Inc.
Address 1	4545 East River Road
Address 2	West Henrietta, NY, 14586
Contact Person	Contact Name
Telephone	585-953-5309
Fax	--
e-mail	richard@tokenring.com

5.2 Model(s) Name

Token

5.3 Type of Product

Biometrically-Secured Ring

5.4 Equipment Under Test (EUT) Description

Token replaces your keys, cards, passwords, and badges with a biometrically-secured ring, so that you can prove your identity safely and easily.

Token is a ring and is offered in several sizes 6-12 for example, with different finish platings.

Sample "0001" was configured for radiated measurements while sample "0002" was configured for conducted measurements.

5.5 Wireless

☒	**Yes**	☐	**No**

EUT Wireless Details	
FCC ID:	2AVVU-TOKEN-01
Environment:	Portable
Operating Temperature Range:	-20 – 50°C
Multiple Feeds:	☒ No ☐ Yes, and how many:
Hardware Version:	Token1
Software Version:	V1.0
Transmitter Frequency Band:	2400 – 2483.5 MHz
Device Rated Output Power:	4 dBm
Power Setting:	Maximum
Antenna Type and Gain:	PCB, 2.14 dBi
Modulation Type:	BLE - GFSK
Data Rate:	1 Mbps
Max Duty Cycle:	100%
Type of Equipment:	Portable, worn on body (finger).

5.6 General Product Information

Size	**H**	10 mm	**W**	27.6 mm	**L**	27.6 mm	
Weight	< 10 g		**Fork-Lift Needed**		No		
Notes							

5.7 Modifications

For the purpose of testing only an external battery was attached to the sample to maintain continuous transmissions. A LED was also connected to the EUT for easier determination of operating mode.

5.8 EUT Electrical Power Information

5.8.1 Electrical Power Type

☐	**AC**	☐	**DC**	☒	**Batteries**	☐	**Host -**

5.8.2 Electrical Power Information

Name	**Type**	**Voltage**		**Frequency**	**Current**	**Notes**
		min	**max**			
Internal Battery	Li-ion	3.65	4.35	DC	< 20 mA	
Notes	Nominal Voltage 4 VDC					

5.9 EUT Modes of Operation during Testing

For testing the Bluetooth Low Energy transmitter, sample 0002 was used for conducted tests. Power was set to maximum output, 100% duty cycle, and the channels 0, 19, and 39 were examined. For the radiated tests, sample 0001 was used with the same settings.

5.10 EUT Clock/Oscillator Frequencies

Please specify the maximum clock frequency used in the product – 48 MHz

In the table below, please specify other clock frequencies and sensitive operating frequencies in the product.

Clock Frequencies & Sensitive Frequencies
48MHz (CPU)
48MHz (Bluetooth xtal)
27.12MHz (NFC external oscillator)
6.78MHz (charger oscillator)

5.11 Electrical Support Equipment

Type	Manufacturer	Model	Connected To
External Battery	Generic 4000mAh	18650	Token DC supply
Cell Phone	Nokia	TA-1085	Token BLE
LED Indicator	ROHM	SMPL34	Token

5.12 Non - Electrical Support Equipment

Item	Notes
Gas	None
Water	None
Air	None

5.13 EUT Equipment/Cabling Information

EUT Port	Connected To	Location	Cable Type		
			Length	Shielded	Bead
None	N/A	N/A	N/A	N/A	N/A

5.14 Emissions

5.14.1 Maximum Output Power

5.14.1.1 Maximum Output Power Test Set-up

Standard	FCC CFR 47 §15.247 (b)			**TUV Test Procedure**	MS-0005082
Limit	< 1 Watt (30 dBm)	**Emissions Verification**			Emissions Under Limit
Frequency Range	Channel 0 – 2402 MHz Channel 19 – 2440 MHz Channel 39 – 2480 MHz	**Test Type**	Conducted	**Det**	Peak
Configuration	See Appendix A, EUT Configuration				
EUT Powered By	See Appendix A, EUT Electrical Power Information				
Notes	None				

5.14.2 DTS Bandwidth

5.14.2.1 DTS Bandwidth Test Set-up

Standard	FCC CFR 47 §15.247 (a.2)		**TUV Test Procedure**	MS-0005180
Limit	DTS OBW > 500 kHz	Report 99% OBW	**Emissions Verification**	Emissions within Limit
Frequency Range	Channel 0 – 2402 MHz Channel 19 – 2440 MHz Channel 39 – 2480 MHz		**Detector**	Peak
Configuration	See Appendix A, EUT Configuration			
EUT Powered By	See Appendix A, EUT Electrical Power Information			
Notes	None			

5.14.3 Peak Power Spectral Density Test

5.14.3.1 Peak Power Spectral Density Test Set-up

Standard	FCC CFR 47 §15.247 (e)	**TUV Test Procedure**	MS-0005182
Limit	< 8 dBm / 3 kHz band	**Emission Verification**	Emission Under Limit
Frequency Range	Channel 0 – 2402 MHz Channel 19 – 2440 MHz Channel 39 – 2480 MHz	**Detector**	Peak
Configuration	See Appendix A, EUT Configuration		
EUT Powered By	See Appendix A, EUT Configuration		
Notes	None		

5.14.4 Out of Band Emissions: Non-Restricted Bands

5.14.4.1 Out of Band Emissions: Non-Restricted Bands Test Set-up

Standard	FCC CFR 47 §15.247 (d)	**TUV Test Procedure**	MS-0005191
Limit	< 20 dB below Peak output power measured in a 100 kHz band.	**Emission Verification**	Emissions Under Limit
Frequency Range	Channel 0 – 2402 MHz Channel 19 – 2440 MHz Channel 39 – 2480 MHz	**Detector**	Peak
EUT Powered By	See Appendix A, EUT Electrical Power Information		
Configuration	See Appendix A, EUT Configuration		
Notes	None		

5.14.5 Out of Band Emissions: Restricted Bands

5.14.5.1 Out of Band Emissions: Restricted Bands Test Set-up

Standard	FCC CFR 47 §15.247 (d)	**TUV Test Procedure**	MS-0005176
Limit	< 54 dBµV/m @ 3 meters, AVG < 74 dBµV/m @ 3 meters, Peak	**Emission Verification**	Emissions Under Limit
Frequency Range	Channel 0 – 2402 MHz Channel 39 – 2480 MHz	**Detector**	AVG, Peak
EUT Powered By	See Appendix A, EUT Electrical Power Information		
Configuration	See Appendix A, EUT Configuration		
Notes	None		

5.14.6 Transmitter Spurious Emissions

5.14.6.1 Transmitter Spurious Emissions Test Set-up

Standard	FCC CFR 47 §15.247 (d)	**TUV Test Procedure**	MS-0005188
Frequency Range	9 – 490 kHz	**Limit**	< 20log(2400/F) + 80 dBµV/m @ 3m (QP)
	490 – 1705 kHz		< 20log(24000/F) + 80 dBµV/m @ 3m (QP)
	1.705 – 30 MHz		< 69.5 dBµV/m @ 3m (QP)
	30 – 88 MHz		< 40.0 dBµV/m @ 3m (QP)
	88 – 216 MHz		< 43.5 dBµV/m @ 3m (QP)
	216 – 960 MHz		< 46.0 dBµV/m @ 3m (QP)
	960 – 1000 MHz		< 54.0 dBµV/m @ 3m (QP)
	1000 – 26500 MHz		< 54.0 dBµV/m @ 3m (AVG) < 74.0 dBµV/m @ 3m (Peak)
Frequency Range	Channel 0 – 2402 MHz Channel 19 – 2440 MHz Channel 39 – 2480 MHz	**Detector**	AVG, Peak, QP
EUT Powered By	See Appendix A, EUT Electrical Power Information		
Configuration	See Appendix A, EUT Configuration		
Notes	None		

5.15 EUT Configuration

Configuration	Description
Continuous TX Mode	Duty cycle 100%, Output power maximum (4 dBm)
Notes	All configurations are the same except as noted above

5.16 Block Diagram

END OF REPORT