TEST REPORT

Reference No......	:	WTX20X12100042W-1
FCC ID.....	:	2AYTQ-K1
Applicant	:	Uncaged Ergonomics LLC
Address	:	Box 1307. Cumberland, MD 21501 USA
Product Name	:	Wireless Optical Keyboard
Test Model.	:	K1
Standards	:	**FCC Part 15.249**
Date of Receipt sample	:	Dec.21, 2020
Date of Test.....	:	Dec.21, 2020 to Jan.05, 2021
Date of Issue	:	Jan.05, 2021
Test Result.....	:	**Pass**

Remarks:
The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.

Prepared By:

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Report version

Version No.	Date of issue	Description
Rev.00	Jan.05, 2021	Original
/	/	/

1. GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

Client Information

Applicant: Uncaged Ergonomics LLC
Address of applicant: Box 1307. Cumberland, MD 21501 USA

Manufacturer: Uncaged Ergonomics LLC
Address of manufacturer: Box 1307. Cumberland, MD 21501 USA

General Description of EUT	
Product Name:	Wireless Optical Keyboard
Trade Name:	Uncaged Ergonomics
Model No.:	K1
Adding Model(s):	/
Rated Voltage:	DC 1.5V
Battery Capacity	/
Power Adapter Model:	/
Note: The test data is gathered from a production sample, provided by the manufacturer.	

Technical Characteristics of EUT	
Frequency Range:	2402MHz-2479MHz
Max. Field Strength:	82.49dBuV/m
Modulation:	GFSK
Antenna Type:	PCB Antenna
Antenna Gain:	1.65dBi

1.2 Test Standards

The tests were performed according to following standards:

FCC Rules Part 15.249: Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz.
ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product, which results in lowering the emission, should be checked to ensure compliance has been maintained.

1.3 Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013,
The equipment under test (EUT) was configured to measure its highest possible emission level. The test modes were adapted accordingly in reference to the Operating Instructions.

1.4 Test Facility

Address of the test laboratory
Laboratory: Waltek Testing Group (Shenzhen) Co., Ltd.
Address: 1/F., Room 101, Building 1, Hongwei Industrial Park, Liuxian 2nd Road, Block 70 Bao'an District, Shenzhen, Guangdong, China

FCC – Registration No.: 125990
Waltek Testing Group (Shenzhen) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the FCC (Federal Communications Commission). The acceptance letter from the FCC is maintain ed in our files. The Designation Number is CN5010, and Test Firm Registration Number is 125990.

Industry Canada (IC) Registration No.: 11464A
The 3m Semi-anechoic chamber of Waltek Testing Group (Shenzhen) Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 11464A.

1.5 EUT Setup and Test Mode

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. All testing shall be performed under maximum output power condition, and to measure its highest possible emissions level, more detailed description as follows:

Test Mode List		
Test Mode	Description	Remark
TM1	Low Channel	2402MHz
TM2	Middle Channel	2446MHz
TM3	High Channel	2479MHz

Test Conditions	
Temperature:	24 °C
Relative Humidity:	52 %.
ATM Pressure:	1019 mbar

EUT Cable List and Details			
Cable Description	Length (m)	Shielded/Unshielded	With / Without Ferrite
/	/	/	/

Special Cable List and Details			
Cable Description	Length (m)	Shielded/Unshielded	With / Without Ferrite
/	/	/	/

Auxiliary Equipment List and Details			
Description	Manufacturer	Model	Serial Number
/	/	/	/

1.6 Measurement Uncertainty

Measurement uncertainty		
Parameter	Conditions	Uncertainty
RF Output Power	Conducted	±0.42dB
Occupied Bandwidth	Conducted	±1.5%
Conducted Spurious Emission	Conducted	±2.17dB
Conducted Emissions	Conducted	9-150kHz ±3.74dB
		0.15-30MHz ±3.34dB
Transmitter Spurious Emissions	Radiated	30-200MHz ±4.52dB
		0.2-1GHz ±5.56dB
		1-6GHz ±3.84dB
		6-26GHz ±3.92dB

1.7 Test Equipment List and Details

No.	Description	Manufacturer	Model	Serial No.	Cal Date	Due Date
SEMT-1072	Spectrum Analyzer	Agilent	E4407B	MY41440400	2020-04-28	2021-04-27
SEMT-1031	Spectrum Analyzer	Rohde & Schwarz	FSP30	836079/035	2020-04-28	2021-04-27
SEMT-1007	EMI Test Receiver	Rohde & Schwarz	ESVB	825471/005	2020-04-28	2021-04-27
SEMT-1008	Amplifier	Agilent	8447F	3113A06717	2020-04-28	2021-04-27
SEMT-1043	Amplifier	C&D	PAP-1G18	2002	2020-04-28	2021-04-27
SEMT-1011	Broadband Antenna	Schwarz beck	VULB9163	9163-333	2019-05-05	2021-05-04
SEMT-1042	Horn Antenna	ETS	3117	00086197	2019-05-05	2021-05-04
SEMT-1121	Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170582	2019-05-05	2021-05-04
SEMT-1069	Loop Antenna	Schwarz beck	FMZB 1516	9773	2019-05-05	2021-05-04
SEMT-1001	EMI Test Receiver	Rohde & Schwarz	ESPI	101611	2020-04-28	2021-04-27
SEMT-1003	L.I.S.N	Schwarz beck	NSLK8126	8126-224	2020-04-28	2021-04-27
SEMT-1002	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100911	2020-04-28	2021-04-27
SEMT-1168	Pre-amplifier	Direction Systems Inc.	PAP-0126	14141-12838	2020-04-28	2021-04-27
SEMT-1169	Pre-amplifier	Direction Systems Inc.	PAP-2640	14145-14153	2020-04-28	2021-04-27
SEMT-1163	Spectrum Analyzer	Rohde & Schwarz	FSP40	100612	2020-04-28	2021-04-27
SEMT-1170	DRG Horn Antenna	A.H. SYSTEMS	SAS-574	571	2019-05-05	2021-05-04
SEMT-1166	Power Limiter	Agilent	N9356B	MY45450376	2020-04-28	2021-04-27
SEMT-1048	RF Limiter	ATTEN	AT-BSF-2400~2500	/	2020-04-28	2021-04-27
SEMT-1076	RF Switcher	Top Precision	RCS03-A2	/	2020-04-28	2021-04-27
SEMT-C001	Cable	Zheng DI	LL142-07-07-10M(A)	/	2020-03-17	2021-03-16
SEMT-C002	Cable	Zheng DI	ZT40-2.92J-2.92J-6M	/	2020-03-17	2021-03-16
SEMT-C003	Cable	Zheng DI	ZT40-2.92J-2.92J-2.5M	/	2020-03-17	2021-03-16
SEMT-C004	Cable	Zheng DI	2M0RFC	/	2020-03-17	2021-03-16
SEMT-C005	Cable	Zheng DI	1M0RFC	/	2020-03-17	2021-03-16
SEMT-C006	Cable	Zheng DI	1M0RFC	/	2020-03-17	2021-03-16

Software List			
Description	**Manufacturer**	**Model**	**Version**
EMI Test Software (Radiated Emission)*	Farad	EZ-EMC	RA-03A1
EMI Test Software (Conducted Emission)*	Farad	EZ-EMC	RA-03A1

*Remark: indicates software version used in the compliance certification testing

2. SUMMARY OF TEST RESULTS

FCC Rules	Description of Test Item	Result
§15.203	Antenna Requirement	Compliant
§15.205	Restricted Band of Operation	Compliant
§15.207(a)	Conducted Emission	N/A
§15.209(a)(f)	Radiated Spurious Emissions	Compliant
§15.249(a)	Field Strength of Emissions	Compliant
§15.249(d)	Out of Band Emission	Compliant
§15.215(c)	Emission Bandwidth	Compliant

N/A: Not applicable.

3. Antenna Requirements

3.1 Standard Applicable

According to FCC Part 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

3.2 Test Result

This product has a PCB antenna, fulfill the requirement of this section.

4. Radiated Emissions

4.1 Standard Applicable

According to §15.249(a), the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental Frequency	Field strength of fundamental (milli-volts/meter)	Field strength of Harmonics (micro-volts/meter)
902-928 MHz	50	500
2400-2483.5 MHz	50	500
5725-5875 MHz	50	500
24.0-24.25 GHz	250	2500

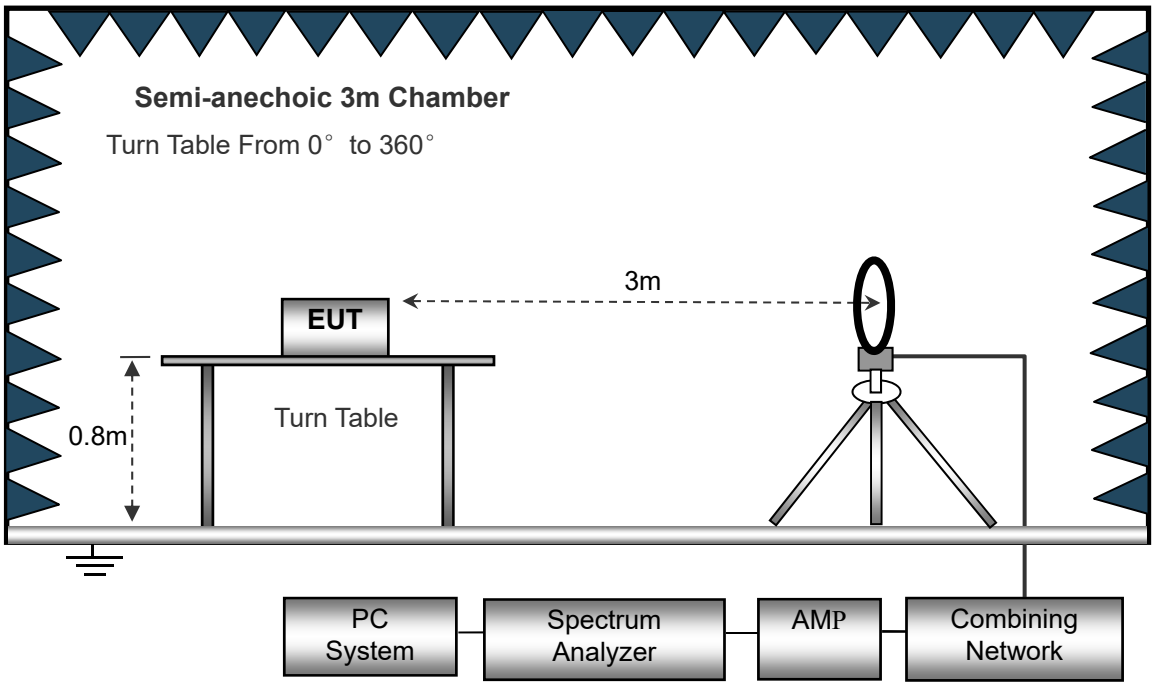
(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply. Spurious Radiated Emissions measurements starting below or at the lowest crystal frequency.

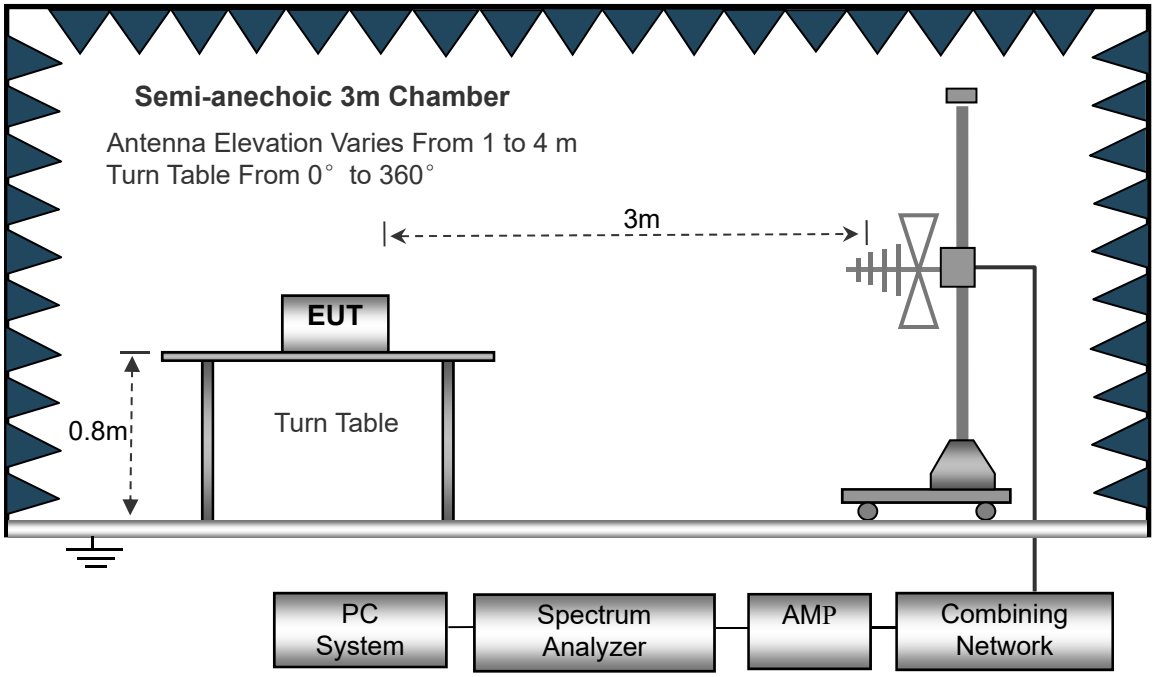
4.2 Test Procedure

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.205 15.249(a) and FCC Part 15.209 Limit.
The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.
The spacing between the peripherals was 10 cm.

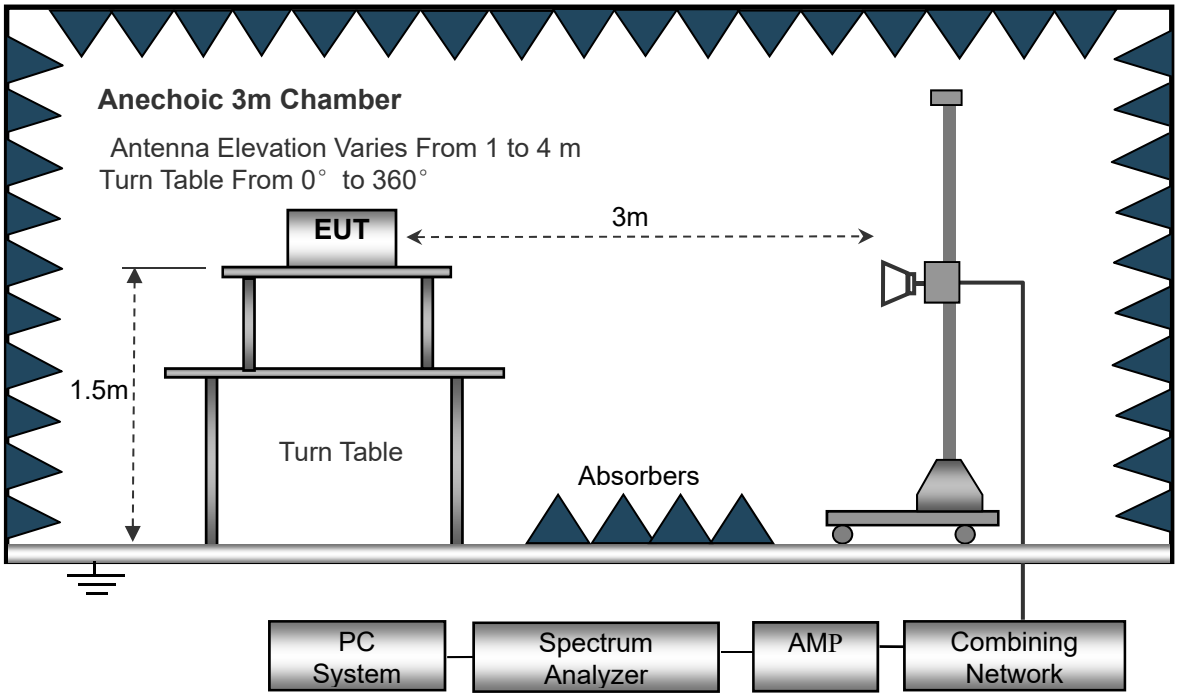
The test setup for emission measurement below 30MHz..



The test setup for emission measurement from 30 MHz to 1 GHz..



The test setup for emission measurement above 1 GHz..



Frequency :9kHz-30MHz	Frequency :30MHz-1GHz	Frequency :Above 1GHz
RBW=10KHz,	RBW=120KHz,	RBW=1MHz,
VBW =30KHz	VBW=300KHz	VBW=3MHz(Peak), 10Hz(AV)
Sweep time= Auto	Sweep time= Auto	Sweep time= Auto
Trace = max hold	Trace = max hold	Trace = max hold
Detector function = peak	Detector function = peak, QP	Detector function = peak, AV

4.3 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and the Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corr. Ampl. = Indicated Reading + Ant. Factor + Cable Loss – Ampl. Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -6dBμV means the emission is 6dBμV below the maximum limit. The equation for margin calculation is as follows:

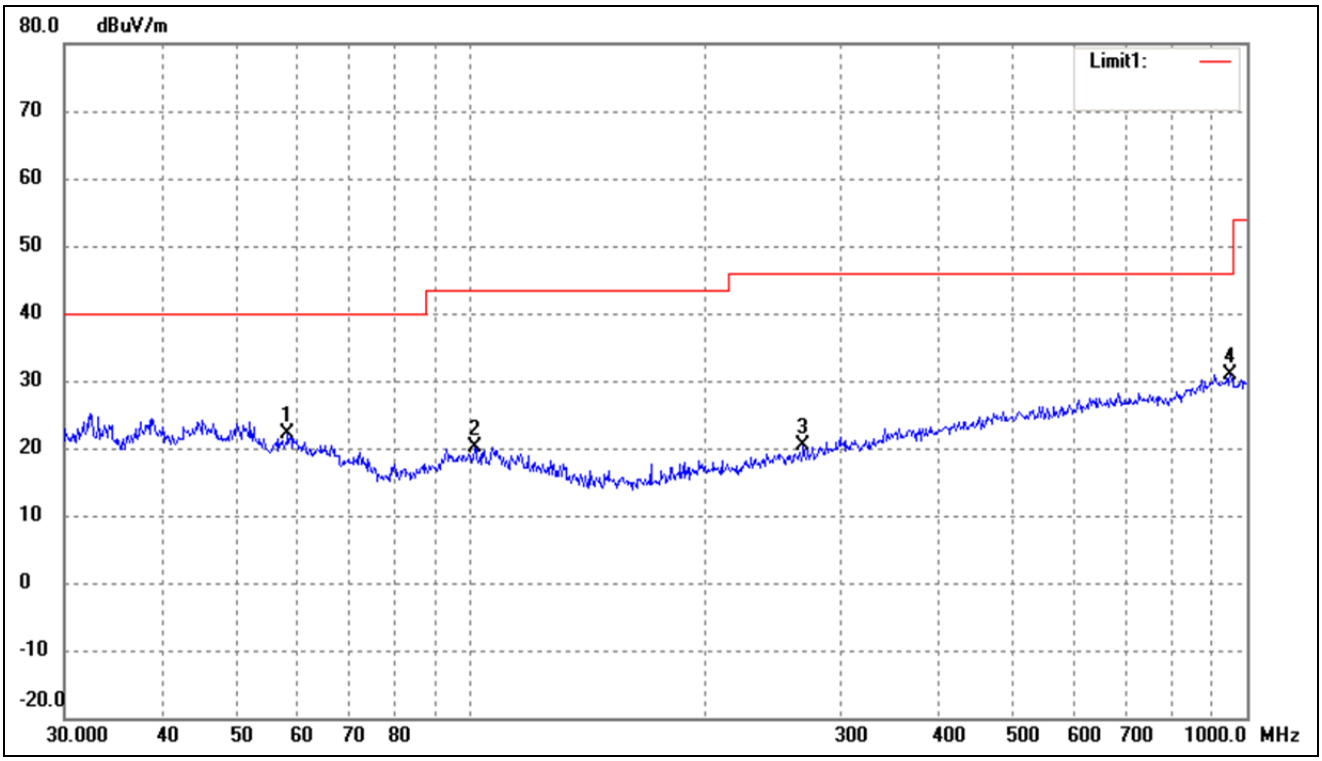
Margin = Corr. Ampl. – FCC Part 15C Limit

4.4 Summary of Test Results/Plots

Note: this EUT was tested in 3 orthogonal positions and the worst case position data was reported.

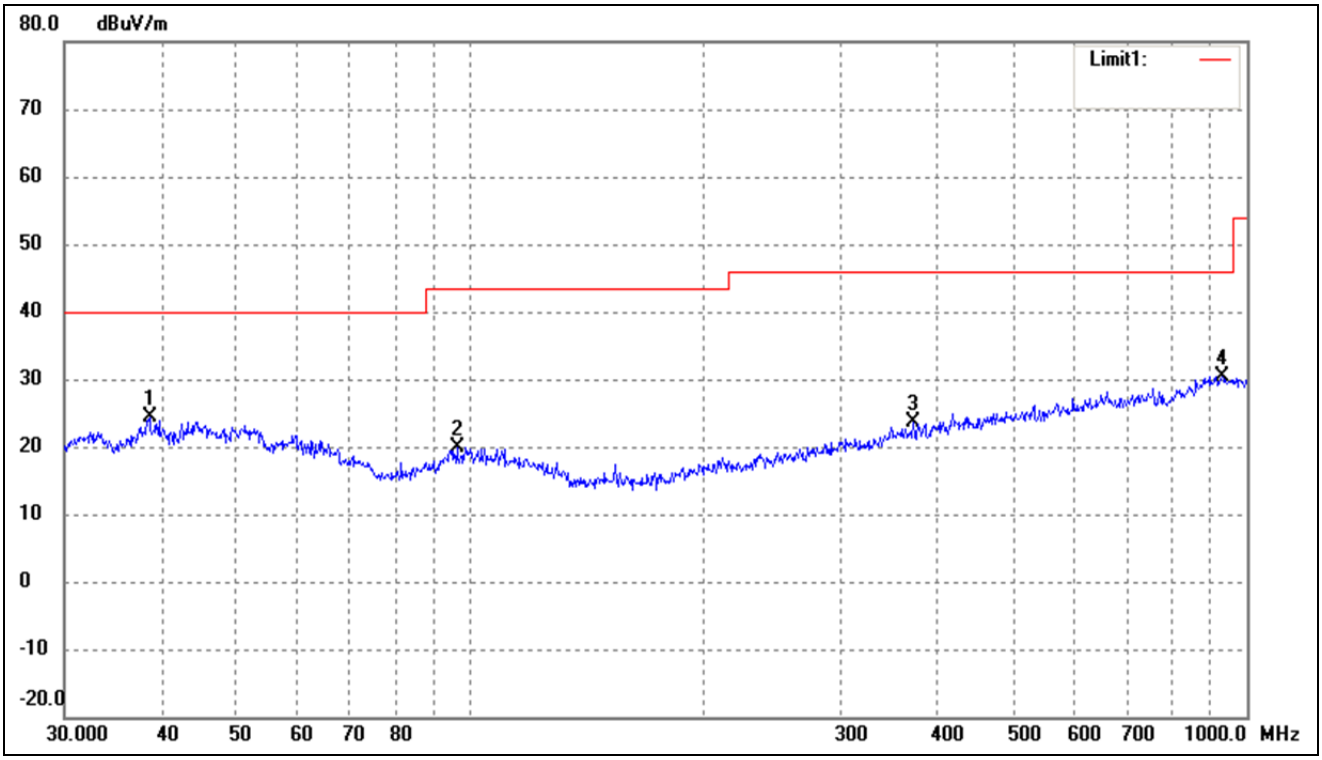
➢ Spurious Emissions Below 1GHz

Test Channel	Low	Polarity:	Horizontal



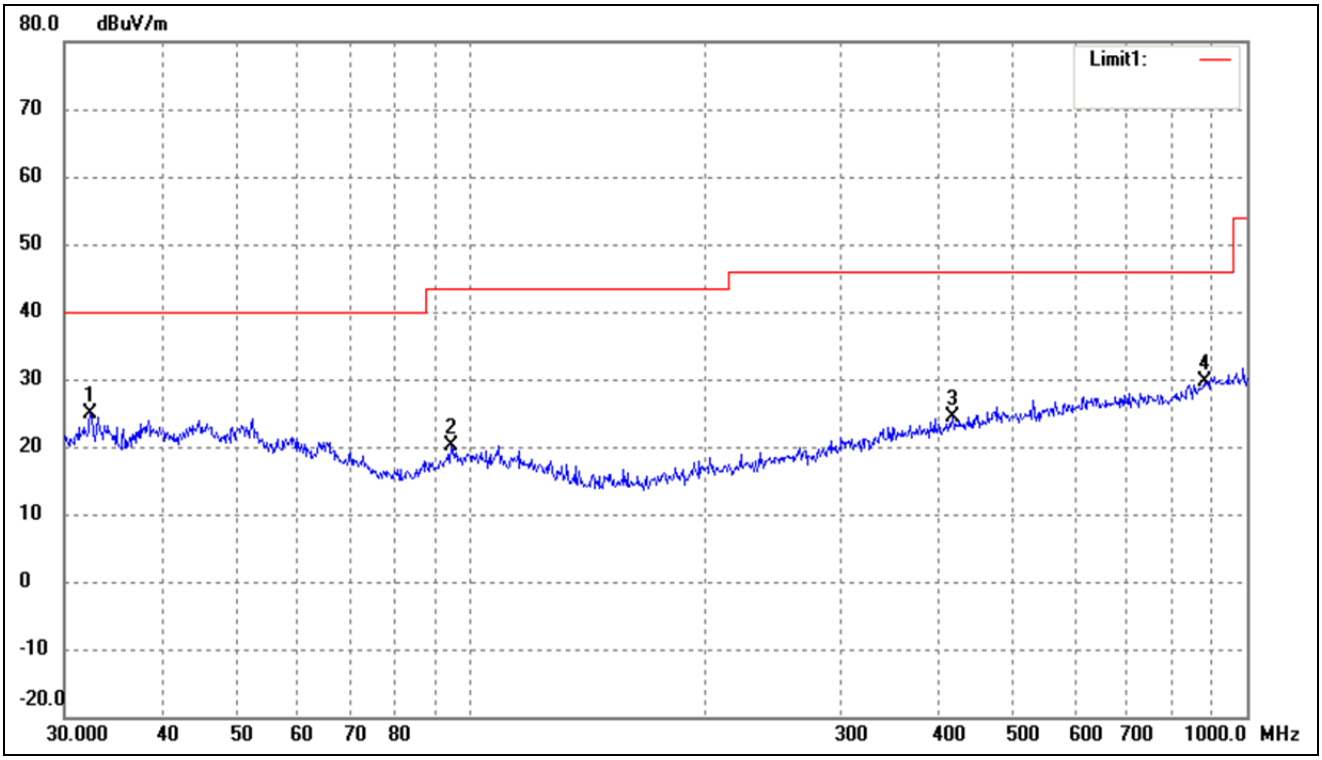
No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	( )	(cm)	
1	58.2030	35.17	-12.97	22.20	40.00	-17.80	-	-	peak
2	101.2885	33.51	-13.31	20.20	43.50	-23.30	-	-	peak
3	268.4853	31.05	-10.78	20.27	46.00	-25.73	-	-	peak
4	952.0937	29.52	1.37	30.89	46.00	-15.11	-	-	peak

Test Channel	Low	Polarity:	Vertical



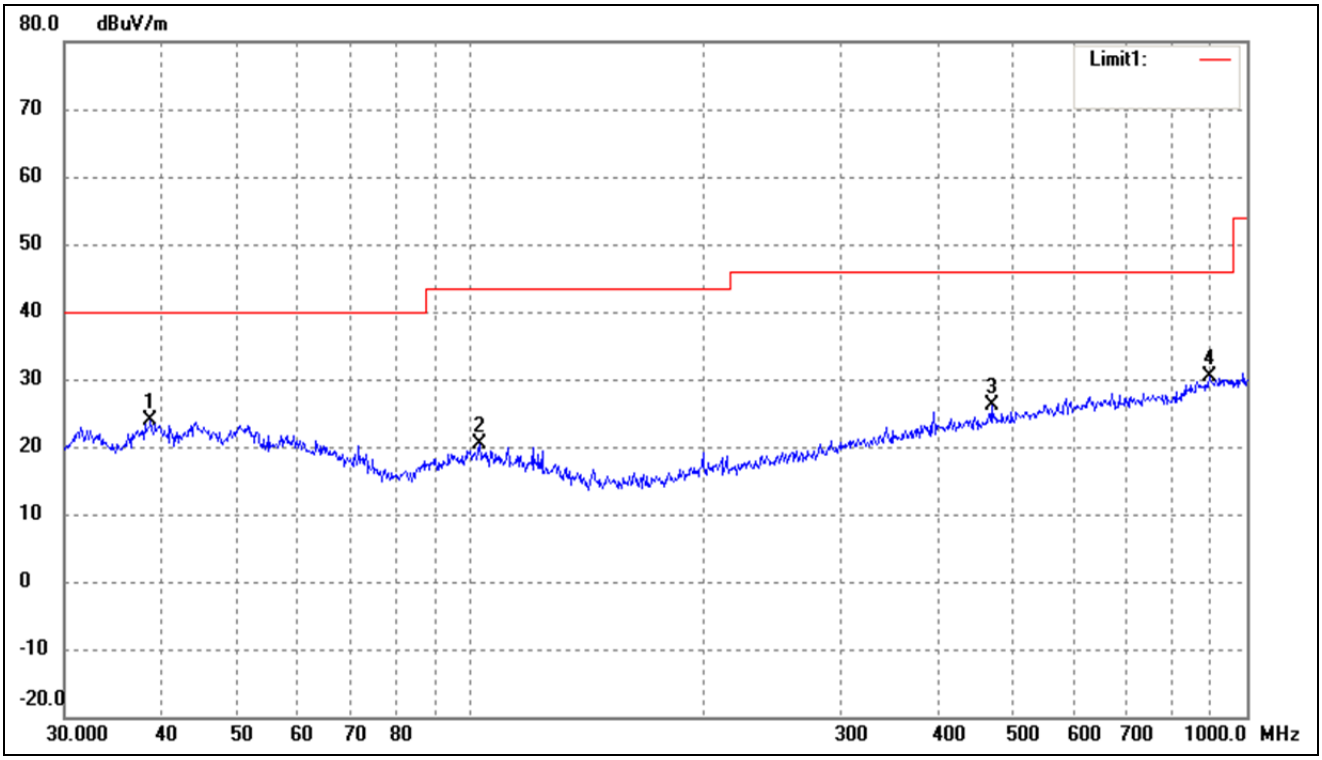
No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	( )	(cm)	
1	38.6160	36.83	-12.51	24.32	40.00	-15.68	-	-	peak
2	96.0986	33.86	-13.96	19.90	43.50	-23.60	-	-	peak
3	372.0045	30.75	-7.22	23.53	46.00	-22.47	-	-	peak
4	929.0082	28.68	1.77	30.45	46.00	-15.55	-	-	peak

Test Channel	Middle	Polarity:	Horizontal



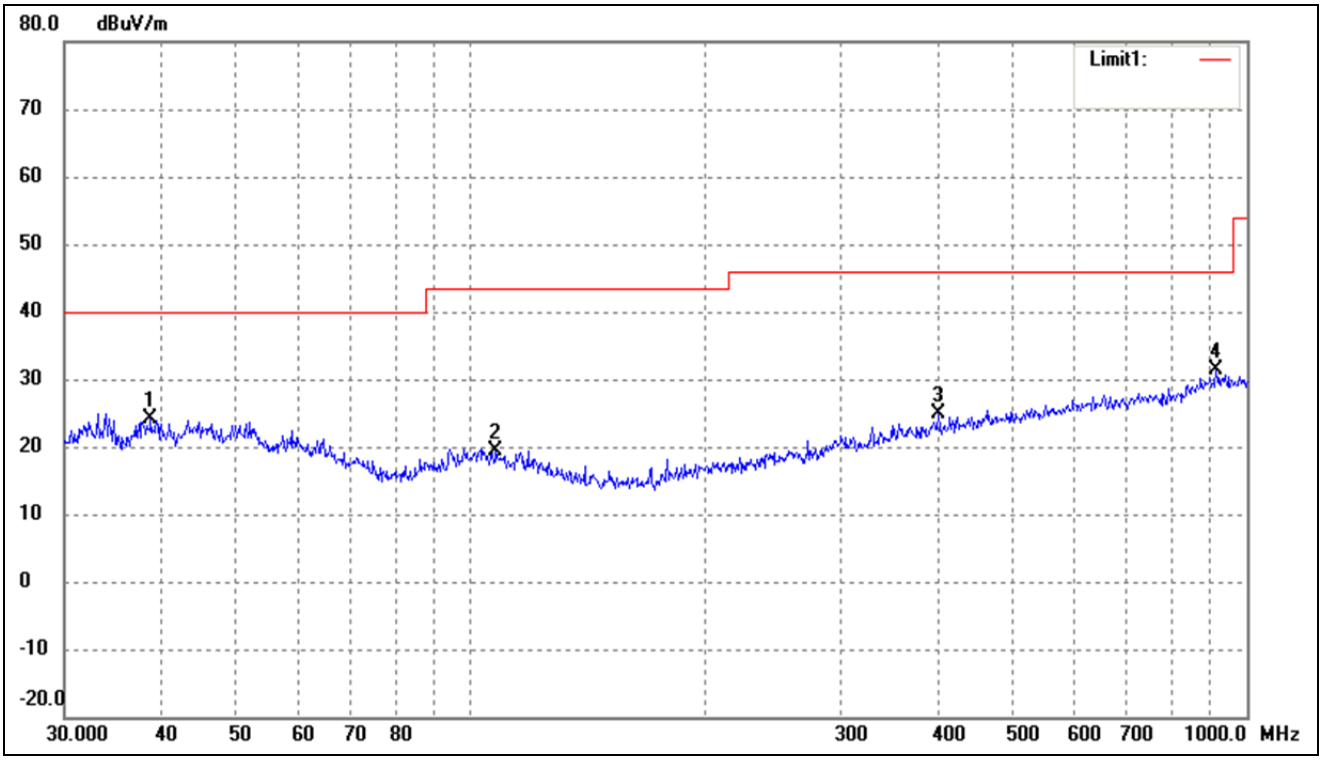
No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	( )	(cm)	
1	32.4059	39.01	-14.02	24.99	40.00	-15.01	-	-	peak
2	94.4284	34.43	-14.24	20.19	43.50	-23.31	-	-	peak
3	417.6411	30.41	-6.05	24.36	46.00	-21.64	-	-	peak
4	881.4067	28.81	0.79	29.60	46.00	-16.40	-	-	peak

Test Channel	Middle	Polarity:	Vertical



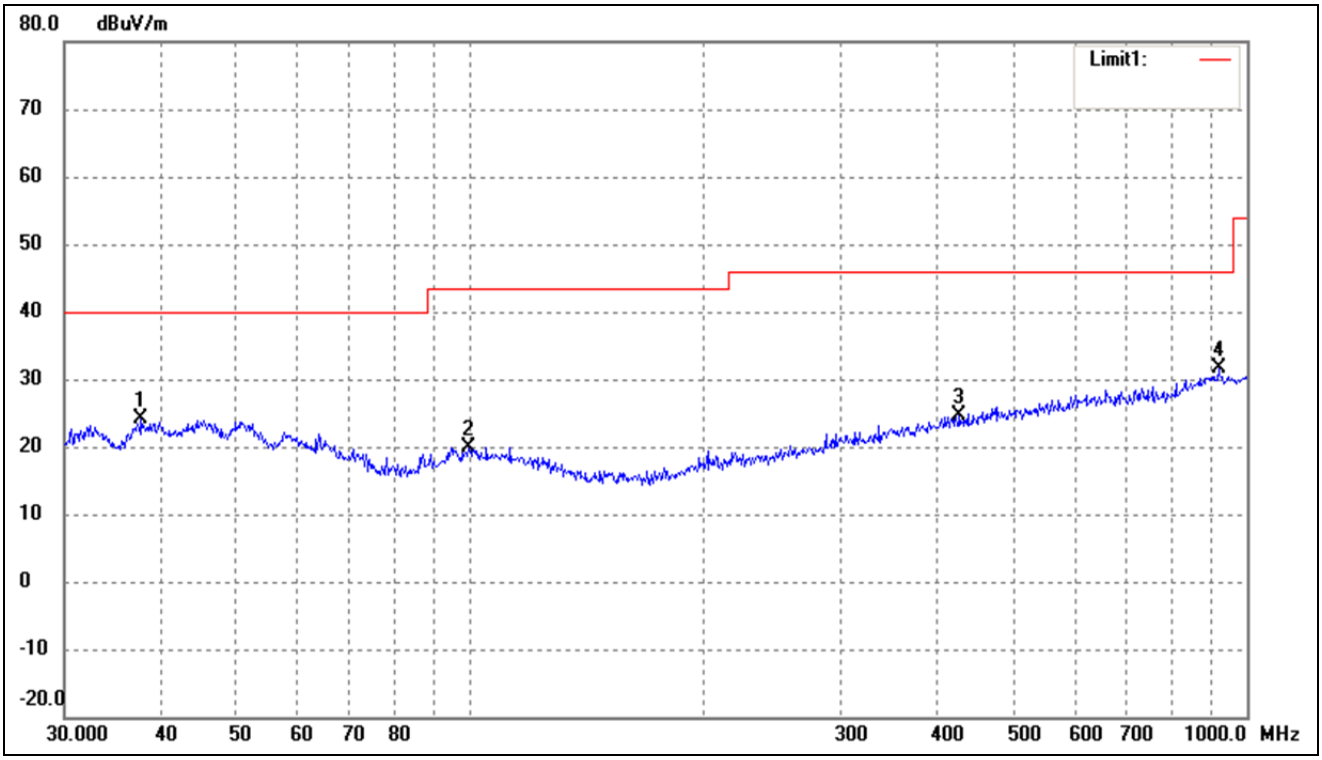
No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	( )	(cm)	
1	38.7518	36.25	-12.45	23.80	40.00	-16.20	-	-	peak
2	102.7192	33.69	-13.32	20.37	43.50	-23.13	-	-	peak
3	468.8762	31.10	-5.00	26.10	46.00	-19.90	-	-	peak
4	893.8567	28.98	1.30	30.28	46.00	-15.72	-	-	peak

Test Channel	High	Polarity:	Horizontal



No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	( )	(cm)	
1	38.7518	36.48	-12.45	24.03	40.00	-15.97	-	-	peak
2	107.8877	32.77	-13.31	19.46	43.50	-24.04	-	-	peak
3	400.4319	31.27	-6.45	24.82	46.00	-21.18	-	-	peak
4	912.8620	29.72	1.71	31.43	46.00	-14.57	-	-	peak

Test Channel	High	Polarity:	Vertical



No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	( )	(cm)	
1	37.6798	37.07	-12.87	24.20	40.00	-15.80	-	-	peak
2	99.5281	33.30	-13.39	19.91	43.50	-23.59	-	-	peak
3	426.5210	30.51	-5.86	24.65	46.00	-21.35	-	-	peak
4	919.2866	29.75	1.78	31.53	46.00	-14.47	-	-	peak

Remark: '-'Means' the test Degree and Height are not recorded by the test software and only show the worst case in the test report.

Spurious Emissions Above 1GHz

Frequency	Reading	Correct	Result	Limit	Margin	Polar	Detector
(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	H/V	
Low Channel-2402MHz							
2401.9	91.93	-9.48	82.45	114	-31.55	H	PK
2401.9	44.58	-9.48	35.1	94	-58.9	H	AV
4804.000	67.34	-4.52	62.82	74.00	-11.18	H	PK
4804.072	48.59	-4.52	44.07	54.00	-9.93	H	AV
7206.000	50.08	-2.20	47.88	74.00	-26.12	H	PK
2401.8	76.62	-9.48	67.14	114	-46.86	V	PK
2402.2	43.12	-9.47	33.65	94	-60.35	V	AV
4803.745	49.86	-4.52	45.34	54.00	-8.66	V	AV
4804.000	69.08	-4.52	64.56	74.00	-9.44	V	PK
7206.000	50.28	-2.20	48.08	74.00	-25.92	V	PK
Middle Channel-2446MHz							
2445.56	88.31	-9.39	78.92	114	-35.08	H	PK
2445.68	42.16	-9.39	32.77	94	-61.23	H	AV
4892.000	68.67	-4.46	64.21	74.00	-9.79	H	PK
4892.051	48.77	-4.46	44.31	54.00	-9.69	H	AV
7338.000	48.22	-2.17	46.05	74.00	-27.95	H	PK
2447.36	85.3	-9.38	75.92	114	-38.08	V	PK
2446.57	40.18	-9.39	30.79	94	-63.21	V	AV
4891.806	49.27	-4.46	44.81	54.00	-9.19	V	AV
4892.000	62.85	-4.46	58.39	74.00	-15.61	V	PK
7338.000	48.35	-2.17	46.18	74.00	-27.82	V	PK

Frequency	Reading	Correct	Result	Limit	Margin	Polar	Detector
(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	H/V	
High Channel-2479MHz							
2479.278	91.09	-9.32	81.77	114	-32.23	H	PK
2479.2	44.1	-9.32	34.78	94	-59.22	H	AV
4957.827	46.32	-4.42	41.90	54.00	-12.10	H	AV
4958.000	58.93	-4.42	54.51	74.00	-19.49	H	PK
7437.000	49.53	-2.14	47.39	74.00	-26.61	H	PK
2479.2	77.52	-9.32	68.2	114	-45.8	V	PK
2478.758	42.79	-9.33	33.46	94	-60.54	V	AV
4958.000	64.36	-4.42	59.94	74.00	-14.06	V	PK
4958.153	48.17	-4.42	43.75	54.00	-10.25	V	AV
7437.000	49.74	-2.14	47.60	74.00	-26.40	V	PK

Note: Testing is carried out with frequency rang 9kHz to the tenth harmonics, which above 5th Harmonics are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
The measurements greater than 20dB below the limit from 9kHz to 30MHz..

5. Out of Band Emissions

5.1 Standard Applicable

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

5.2 Test Procedure

As the radiation test, set the Lowest and Highest Transmitting Channel, observed the outside band of 2400MHz to 2483.5MHz, than mark the higher-level emission for comparing with the FCC rules.

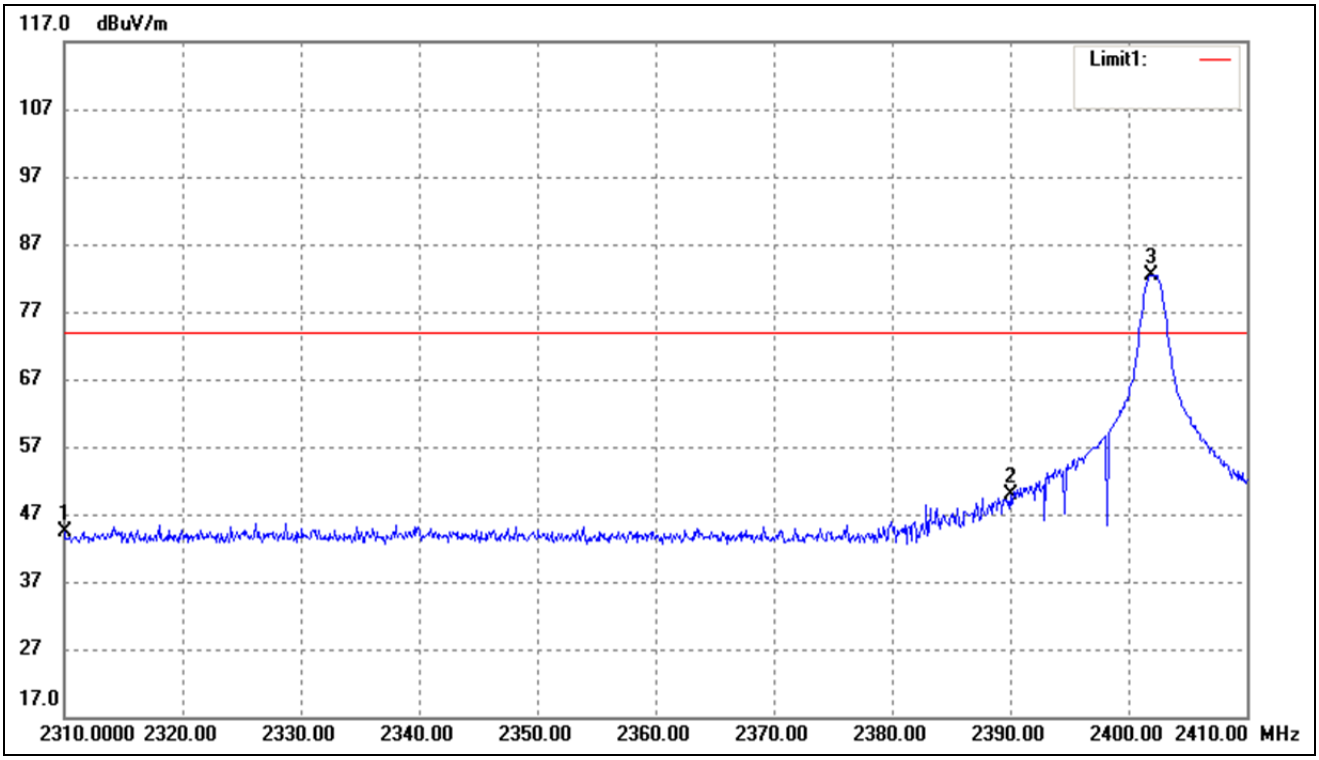
5.3 Summary of Test Results/Plots

Test mode	Frequency	Limit	Result
	MHz	dBuV / dBc	
Lowest	2310.00	<54 dBuV	Pass
	2390.00	<54 dBuV	Pass
	2400.00	<54 dBuV	Pass
Highest	2483.50	<54 dBuV	Pass
	2500.00	<54 dBuV	Pass

The edge emissions are below the FCC 15.209 Limits or complies with the 15.249 requirements.

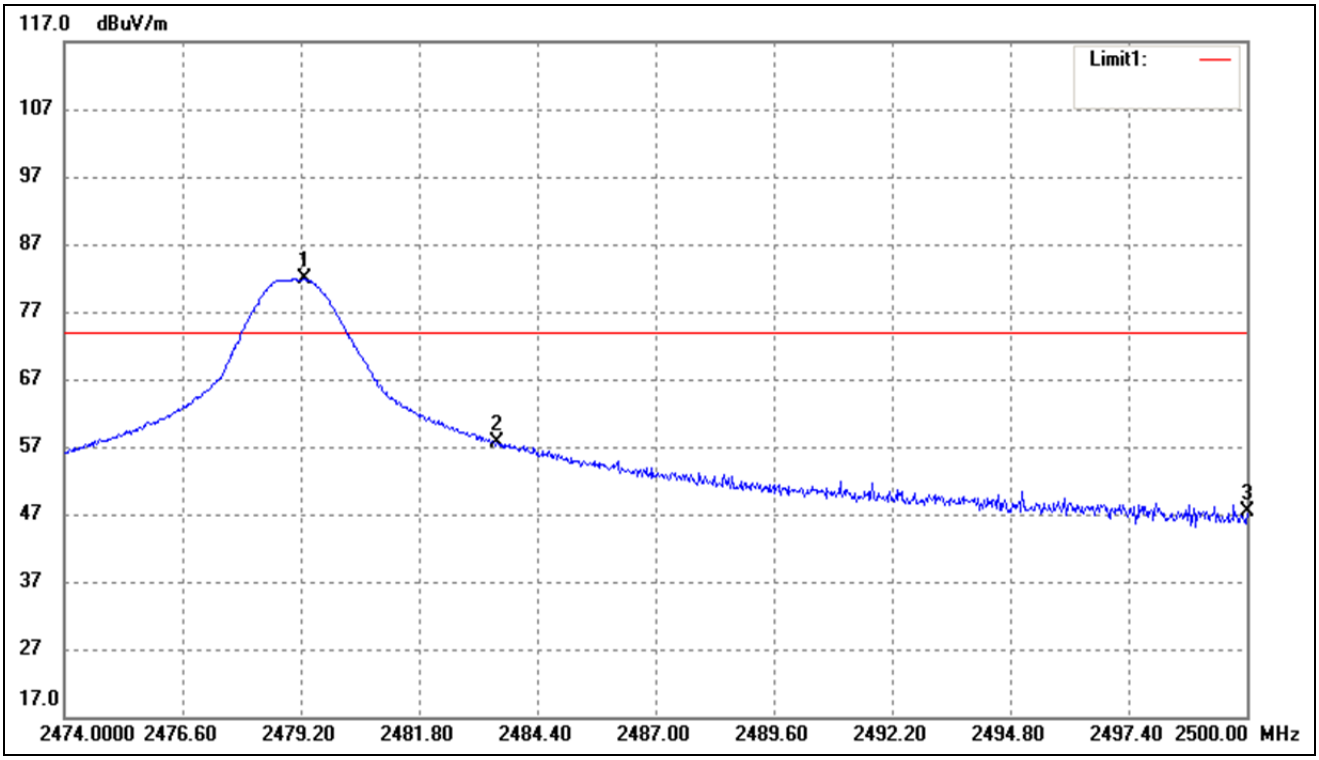
Please refer to the test plots as below.

Test Channel	Low	Polarity:	Horizontal (worst case)



No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
1	2310.000	40.38	-9.66	30.72	54.00	-23.28	Ave Detector
	2310.000	53.98	-9.66	44.32	74.00	-29.68	Peak Detector
2	2390.000	40.12	-9.50	30.62	54.00	-23.38	Ave Detector
	2390.000	59.45	-9.50	49.95	74.00	-24.05	Peak Detector
3	2401.900	44.58	-9.48	35.10	/	/	Ave Detector
	2401.900	91.93	-9.48	82.45	/	/	Peak Detector

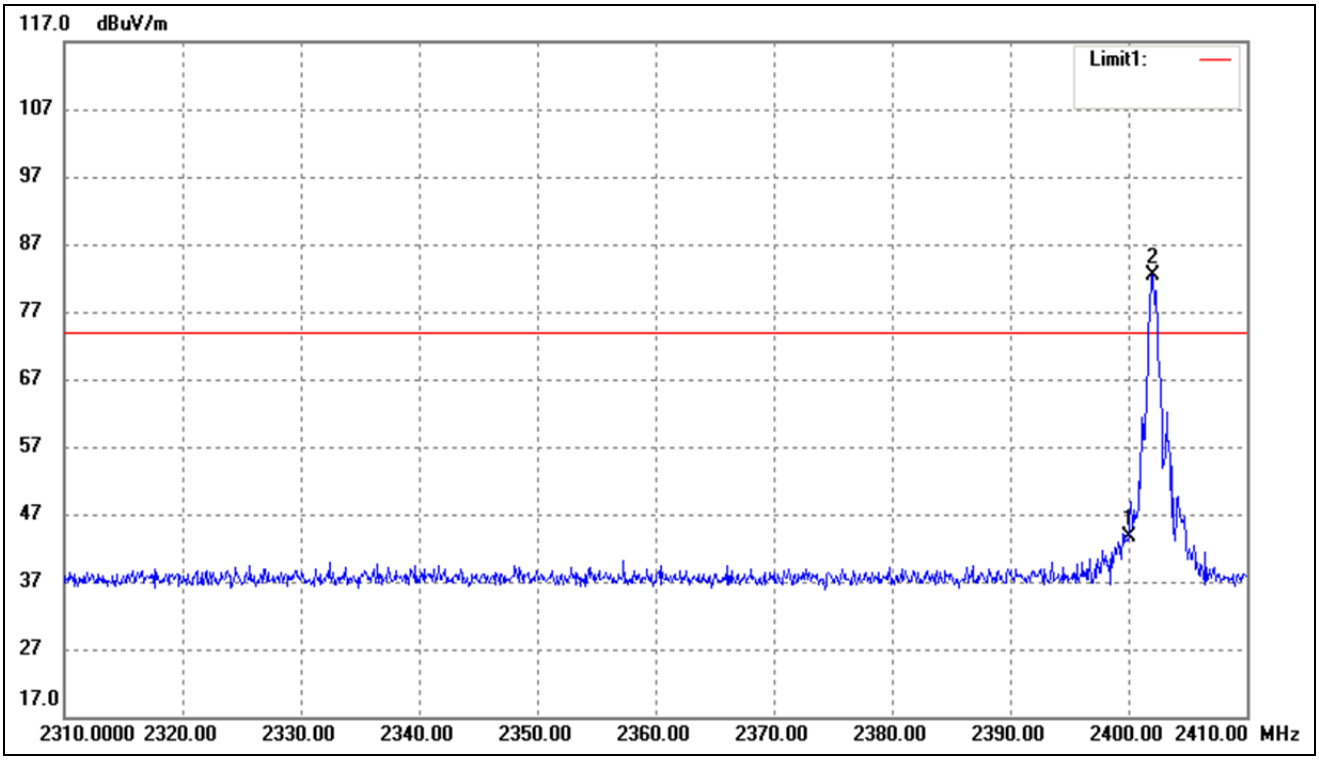
Test Channel	High	Polarity:	Horizontal (worst case)



No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
1	2479.200	44.10	-9.32	34.78	/	/	Ave Detector
	2479.278	91.09	-9.32	81.77	/	/	Peak Detector
2	2483.500	39.82	-9.31	30.51	54.00	-23.49	Ave Detector
	2483.500	66.87	-9.31	57.56	74.00	-16.44	Peak Detector
3	2500.000	39.47	-9.28	30.19	54.00	-23.81	Ave Detector
	2500.000	56.55	-9.28	47.27	74.00	-26.73	Peak Detector

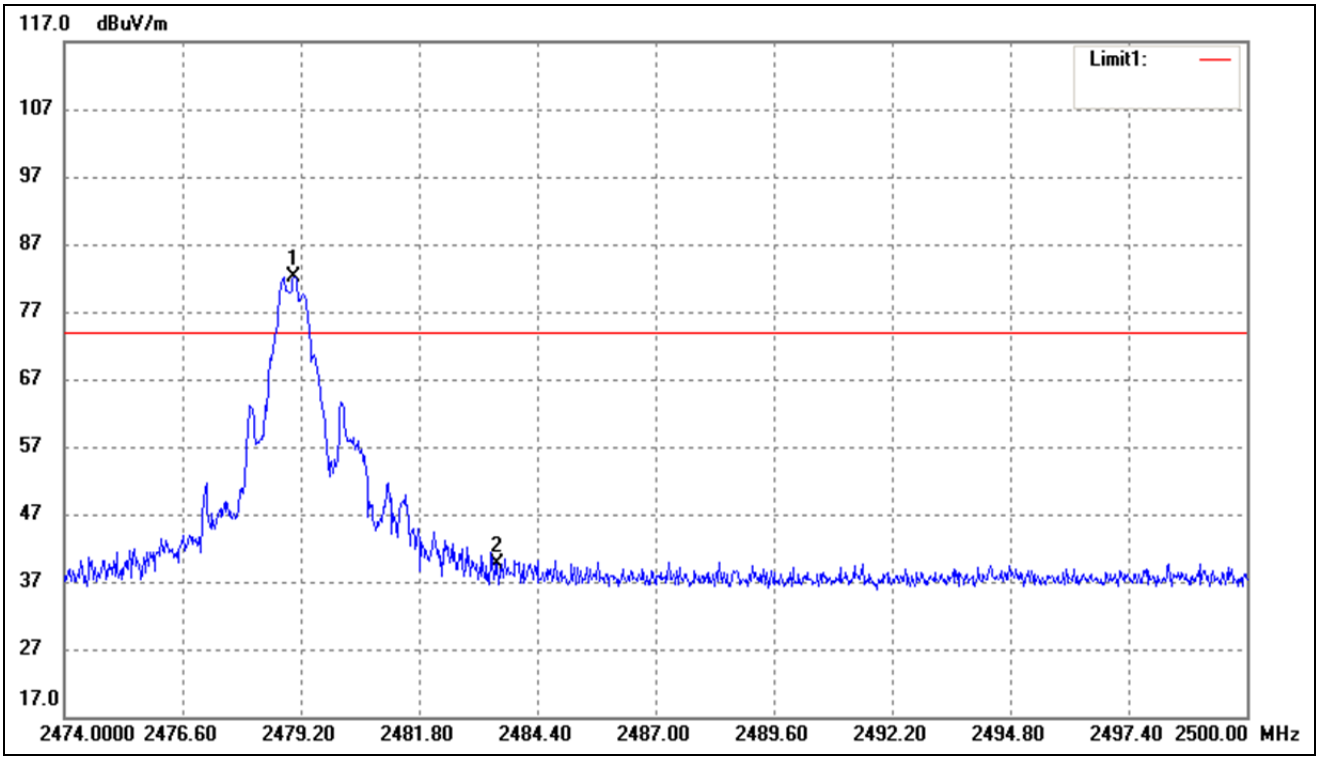
Band edge

Test Channel	Low	Polarity:	Horizontal (worst case)



No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
1	2400.000	53.38	-9.48	43.90	54.00	-10.10	Ave Detector
	2400.000	53.18	-9.48	43.70	74.00	-30.30	Peak Detector
2	2402.100	91.92	-9.47	82.45	/	/	Ave Detector
	2402.100	91.96	-9.47	82.49	/	/	Peak Detector

Test Channel	High	Polarity:	Horizontal (worst case)



No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
1	2479.044	91.36	-9.32	82.04	/	/	Ave Detector
	2479.044	91.41	-9.32	82.09	/	/	Peak Detector
2	2483.500	50.48	-9.31	41.17	54.00	-12.83	Ave Detector
	2483.500	49.05	-9.31	39.74	74.00	-34.26	Peak Detector

6. Emission Bandwidth

6.1 Standard Applicable

According to 15.215(c), intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

6.2 Test Procedure

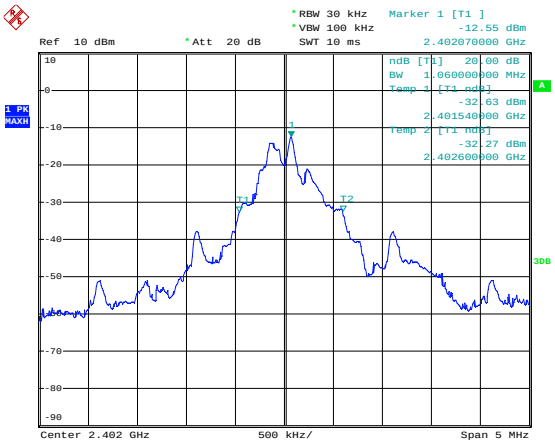
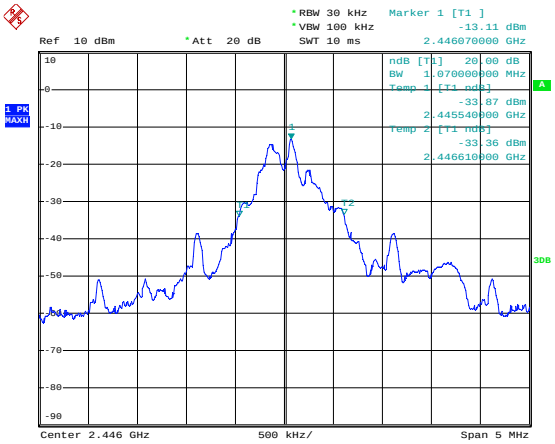
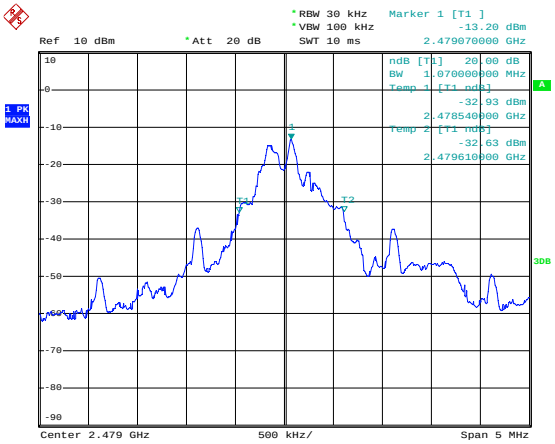
According to the ANSI 63.10-2013, the emission bandwidth test method as follows.

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Set span = 1MHz, centered on a transmitting channel
RBW ≥1% 20dB Bandwidth, VBW ≥RBW
Sweep = auto
Detector function = peak
Trace = max hold
All the trace to stabilize, use the marker-to-peak function to set the marker to the peak of the emission, use the marker-delta function to measure and record the 20dB down and 99% bandwidth of the emission.

6.3 Summary of Test Results/Plots

Test Channel	20dB Bandwidth(kHz)
Low Channel	1068
Middle Channel	1074
High Channel	1416

Please refer to the following test plots

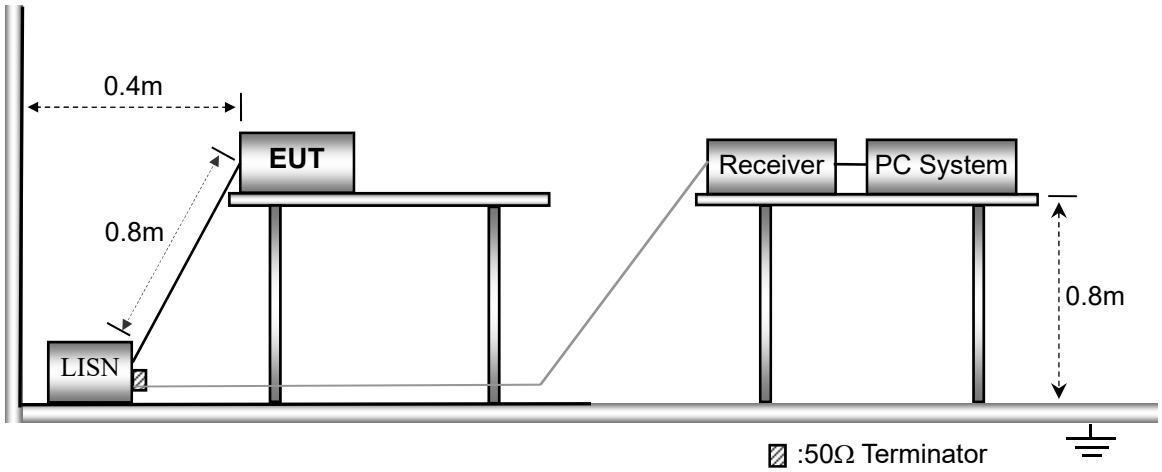
Low Channel	 Date: 23.DEC.2020 16:07:57
Middle Channel	 Date: 23.DEC.2020 16:12:07
High Channel	 Date: 23.DEC.2020 16:13:43

7. Conducted Emissions

7.1 Test Procedure

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 Limit.
The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.
The spacing between the peripherals was 10 cm.

7.2 Basic Test Setup Block Diagram



7.3 Test Receiver Setup

During the conducted emission test, the test receiver was set with the following configurations:

Start Frequency ..... 150 kHz
Stop Frequency ..... 30 MHz
Sweep Speed ..... Auto
IF Bandwidth..... 10 kHz
Quasi-Peak Adapter Bandwidth ..... 9 kHz
Quasi-Peak Adapter Mode ..... Normal

7.4 Summary of Test Results/Plots

Not applicable

APPENDIX PHOTOGRAPHS

Please refer to "ANNEX"

******* END OF REPORT *******