



FCC PART 15.247
RSS-GEN ISSUE 5, MARCH 2019 AMENDMENT 1
RSS-247, ISSUE 2, FEBRUARY 2017

TEST REPORT
For
Meizhou Guo Wei Electronics Co., Ltd.

AD1 Section, Economic Development Area, Dongsheng Industrial District, Meizhou, Guangdong, China.

FCC ID: 2ARRB-VM64BU
IC: 20353-VM64BU

Report Type: Original Report	Product Type: Video baby monitor
Report Number: SZ1210218-04515EA	
Report Date: 2021-04-13	
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Video baby monitor
Tested Model	VM65 CONNECTBU
Multiple Models	VM64 CONNECTBU, VM60 CONNECTBU, VM65X CONNECTBU
Model Differences	Refer to the DoS letter
HVIN	VM64BU
Frequency Range	2402~2477MHz
Maximum conducted Peak output power	17.71dBm
Modulation Technique	GFSK
Antenna Specification*	0dBi (It is provided by the applicant)
Voltage Range	DC 5.0V from adapter
Date of Test	2021-02-26 to 2021-03-11
Sample serial number	SZ1210218-04515E-RF-S1 (Assigned by BACL, Shenzhen)
Received date	2021-02-18
Sample/EUT Status	Good condition
Adapter1 information	Model: BQ05A-0501000-U Input: 100-240V,50/60Hz Max, 300mA Output: DC 5.0V, 1000mA
Adapter2 information	Model: YWK-AD050100-U Input: 100-240V, 50/60Hz, 0.3A Output: DC 5.0V, 1000mA

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules and RSS-GEN Issue 5, March 2019 Amendment 1 and RSS-247, Issue 2, February 2017 of the Innovation, Science and Economic Development Canada rules

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.207, 15.209, 15.247 rules and RSS-GEN, RSS-247.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and RSS-GEN Issue 5, March 2019 Amendment 1 and RSS-247, Issue 2, February 2017.

For Radiated Emissions testing, please refer to DA 00-705 Released March 30, 2000, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		±5%
RF Output Power with Power meter		±0.73dB
RF conducted test with spectrum		±1.6dB
AC Power Lines Conducted Emissions		±1.95dB
Emissions, Radiated	Below 1GHz	±4.75dB
	Above 1GHz	±4.88dB
Temperature		±1 °C
Humidity		±6%
Supply voltages		±0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 5F(B-West) ,6F,7F,the 3rd Phase of Wan Li Industrial Building D,Shihua Rd, FuTian Free Trade Zone, Shenzhen, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 342867, the FCC Designation No.: CN1221.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0023.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

Frequency List

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2402	12	2445
2	2404	13	2450
3	2406	14	2455
4	2408	15	2460
5	2410	16	2465
6	2415	17	2467
7	2420	18	2469
8	2425	19	2471
9	2430	20	2473
10	2435	21	2475
11	2440	22	2477

EUT was tested with Channel 1, 11 and 22.

EUT Exercise Software

“Teraterm”* software was used and the power level is default*. The software and power level was provided by the applicant.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

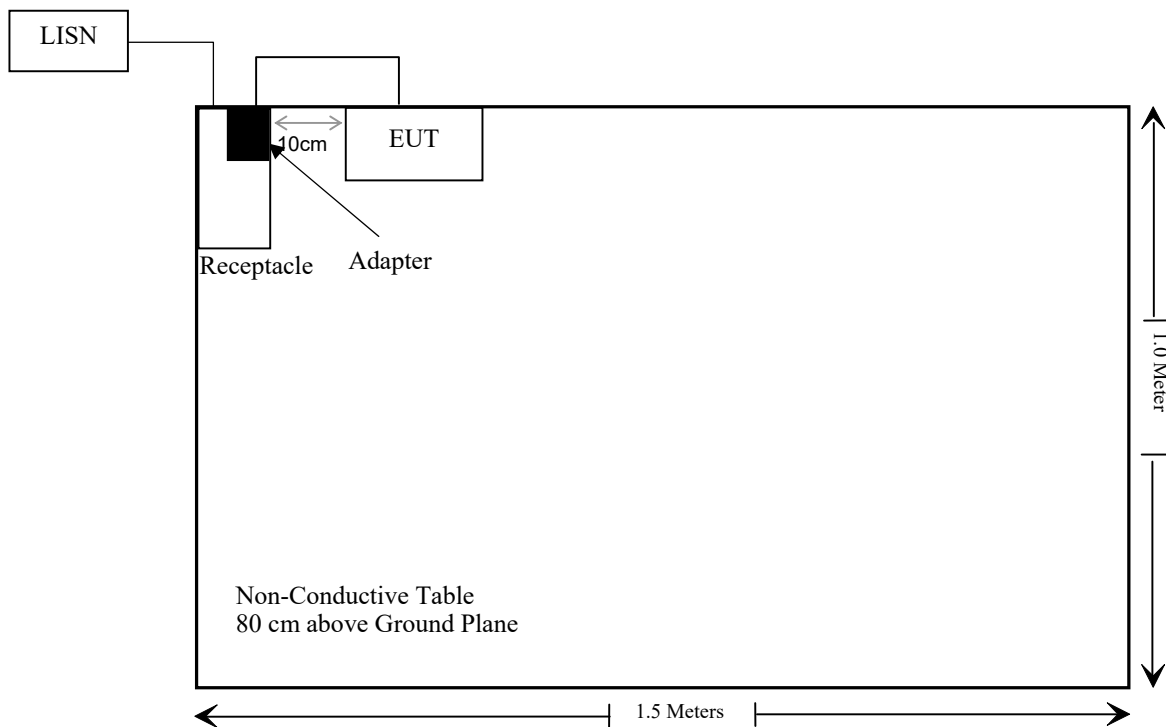
Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

Cable Description	Length (m)	From Port	To
Unshielded Un-detachable DC Cable	1.0	EUT	Adapter

Block Diagram of Test Setup

For conducted emission:



SUMMARY OF TEST RESULTS

FCC Rules	RSS-247/RSS-Gen Rules	Description of Test	Result
§15.247 (i), §2.1091	RSS-102 § 4	Maximum Permissible Exposure(MPE) & RF Exposure Limit	Compliance
§15.203	RSS-Gen §6.8	Antenna Requirement	Compliance
§15.207(a)	RSS-Gen §8.8	AC Line Conducted Emissions	Compliance
§15.205, §15.209 & §15.247(d)	RSS-247 § 5.5	Radiated Emissions	Compliance
§15.247(a)(1)	RSS- Gen§6.7, RSS-247 § 5.1 (a)	99% OCCUPIED BANDWIDTH & 20 dB Emission Bandwidth	Compliance
§15.247(a)(1)	RSS-247 § 5.1 (b)	Channel Separation Test	Compliance
§15.247(a)(1)(iii)	RSS-247 § 5.1 (d)	Time of Occupancy (Dwell Time)	Compliance
§15.247(a)(1)(iii)	RSS-247 § 5.1 (d)	Quantity of hopping channel Test	Compliance
§15.247(b)(1)	RSS-247 § 5.1(b) & § 5.4(b)	Peak Output Power Measurement	Compliance
§15.247(d)	RSS-247 § 5.5	Band edges	Compliance

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2020/08/04	2021/08/03
Rohde & Schwarz	LISN	ENV216	101613	2020/08/04	2021/08/03
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2020/11/29	2021/11/28
Unknown	CE Cable	CE Cable	UF A210B-1-0720-504504	2020/11/29	2021/11/28
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
Radiated Emission Test					
R&S	EMI Test Receiver	ESR3	102455	2020/08/04	2021/08/03
Sonoma instrument	Pre-amplifier	310 N	186238	2020/08/04	2021/08/03
Sunol Sciences	Broadband Antenna	JB1	A040904-2	2020/12/22	2023/12/21
Unknown	Cable 2	RF Cable 2	F-03-EM197	2020/11/29	2021/11/28
Unknown	Cable	Chamber Cable 1	F-03-EM236	2020/11/29	2021/11/28
Rohde & Schwarz	Auto test software	EMC 32	V9.10	NCR	NCR
Rohde & Schwarz	Spectrum Analyzer	FSV40-N	102259	2020/08/04	2021/08/03
COM-POWER	Pre-amplifier	PA-122	181919	2020/11/29	2021/11/28
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2020/11/29	2021/11/28
Sunol Sciences	Horn Antenna	3115	9107-3694	2021/01/15	2024/01/14
Insulated Wire Inc.	RF Cable	SPS-2503-3150	02222010	2020/11/29	2021/11/28
Unknown	RF Cable	W1101-EQ1 OUT	F-19-EM005	2020/11/29	2021/11/28
SNSD	Band Reject filter	BSF2402-2480MN-0898-001	2.4G filter	2020/04/20	2021/04/20
Ducommun Technologies	Horn antenna	ARH-4223-02	1007726-02 1304	2020/12/06	2023/12/05
RF Conducted Test					
Rohde & Schwarz	SPECTRUM ANALYZER	FSU26	200982	2020/08/04	2021/08/03
WEINSCHL	10dB Attenuator	5324	AU3842	2020/11/29	2021/11/28
Unknown	RF Cable	Unknown	2301 276	2020/11/29	2021/11/28

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC §15.247 (i) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

Limits for General Population/Uncontrolled Exposure

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (Minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

Result

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g., mW).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Frequency (MHz)	Antenna Gain		Tune up conducted power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
	(dBi)	(numeric)	(dBm)	(mW)			
2412-2462	0	1.0	17.5	56.23	20	0.011	1
2402-2477	0	1.0	18.0	63.10	20	0.013	1

Note: 1. The tune up conducted power was declared by the applicant
 2. The Wi-Fi can transmit at the same time with the 2.4G hopping radio.

Simultaneous transmitting consideration (worst case):

The ratio= $MPE_{Wi-Fi}/limit + MPE_{Hopping}/limit = 0.011 + 0.013 = 0.024 < 1.0$

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Pass

RSS-102 § 4 –EXPOSURE LIMITS

Applicable Standard

According to RSS-102 §4:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)				
Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ²¹	83	90	-	Instantaneous*
0.1-10	-	0.73/ <i>f</i>	-	6**
1.1-10	87/ <i>f</i> ^{0.5}	-	-	6**
10-20	27.46	0.0728	-2	6
20-48	58.07/ <i>f</i> ^{0.25}	0.1540/ <i>f</i> ^{0.25}	8.944/ <i>f</i> ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 <i>f</i> ^{0.3417}	0.008335 <i>f</i> ^{0.3417}	0.02619 <i>f</i> ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ <i>f</i> ^{1.2}
150000-300000	0.158 <i>f</i> ^{0.5}	4.21 x 10 ⁻⁴ <i>f</i> ^{0.5}	6.67 x 10 ⁻⁵ <i>f</i>	616000/ <i>f</i> ^{1.2}

Note: *f* is frequency in MHz.
 * Based on nerve stimulation (NS).
 ** Based on specific absorption rate (SAR).

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g., mW).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Frequency (MHz)	Antenna Gain		Turn up Power		Evaluation Distance (m)	Power Density (W/m ²)	MPE Limit (W/m ²)
	(dBi)	(numeric)	(dBm)	(W)			
2412-2462	0	1.0	17.5	0.056	0.2	0.112	5.37
2402-2477	0	1.0	18.0	0.063	0.2	0.126	5.35

Note: 1. The tune up conducted power was declared by the applicant
 2. The Wi-Fi can transmit at the same time with the 2.4G hopping radio.

Simultaneous transmitting consideration (worst case):

The ratio= $MPE_{Wi-Fi}/limit + MPE_{Hopping}/limit = 0.112/5.37 + 0.126/5.35 = 0.044 < 1.0$

To maintain compliance with the ISED's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Pass

FCC §15.203 & RSS-Gen §6.8– ANTENNA REQUIREMENT

Applicable Standard

According to FCC § 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. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device. Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

Antenna Connector Construction

The EUT has an internal antenna arrangement which was permanently attached and the antenna gain is 0dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Type	Antenna Gain	Impedance
Monopole	0dBi	50 Ω

Result: Compliance

FCC §15.207 (a) & RSS-Gen §8.8– AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

Unless stated otherwise in the applicable RSS, for radio apparatus that are designed to be connected to the public utility AC power network, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 kHz to 30 MHz shall not exceed the limits in table 4, as measured using a 50 μ H / 50 Ω line impedance stabilization network. This requirement applies for the radio frequency voltage measured between each power line and the ground terminal of each AC power-line mains cable of the EUT.

For an EUT that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits in table 4 shall apply at the terminals of the AC power-line mains cable of a representative support device, while it provides power to the EUT. The lower limit applies at the boundary between the frequency ranges. The device used to power the EUT shall be representative of typical applications.

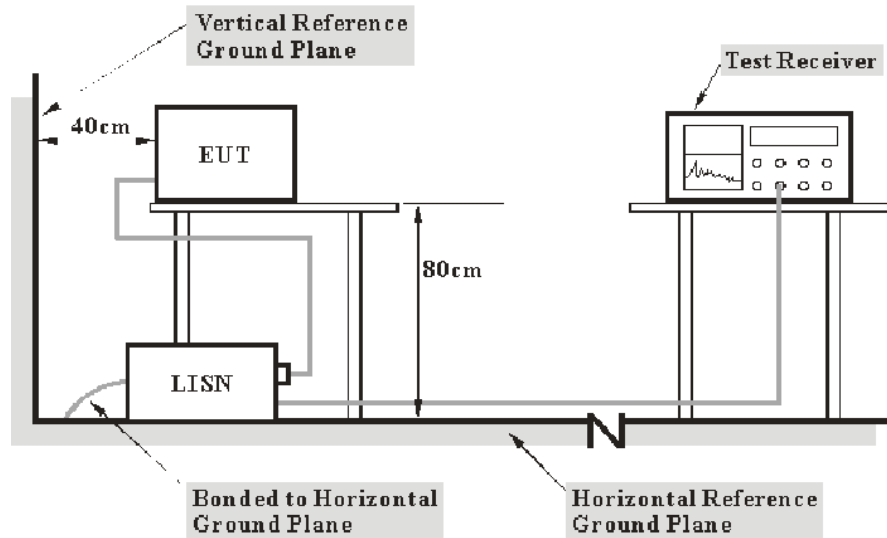
Table 4 - AC Power Lines Conducted Emission Limits		
Frequency range (MHz)	Conducted limit (dBμV)	
	Quasi-Peak	Average
0.15 – 0.5	66 to 56 ¹	56 to 46 ¹
0.5 – 5	56	46
5 – 30	60	50

Note 1: The level decreases linearly with the logarithm of the frequency.

For an EUT with a permanent or detachable antenna operating between 150 kHz and 30 MHz, the AC power-line conducted emissions must be measured using the following configurations:

- (a) Perform the AC power-line conducted emissions test with the antenna connected to determine compliance with the limits of table 4 outside the transmitter's fundamental emission band.
- (b) Retest with a dummy load instead of the antenna to determine compliance with the limits of table 4 within the transmitter's fundamental emission band. For a detachable antenna, remove the antenna and connect a suitable dummy load to the antenna connector. For a permanent antenna, remove the antenna and terminate the RF output with a dummy load or network that simulates the antenna in the fundamental frequency band.

EUT Setup



- Note: 1. Support units were connected to second LISN.
 2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207 & RSS-247/RSS-Gen limits.

The spacing between the peripherals was 10 cm.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

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

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

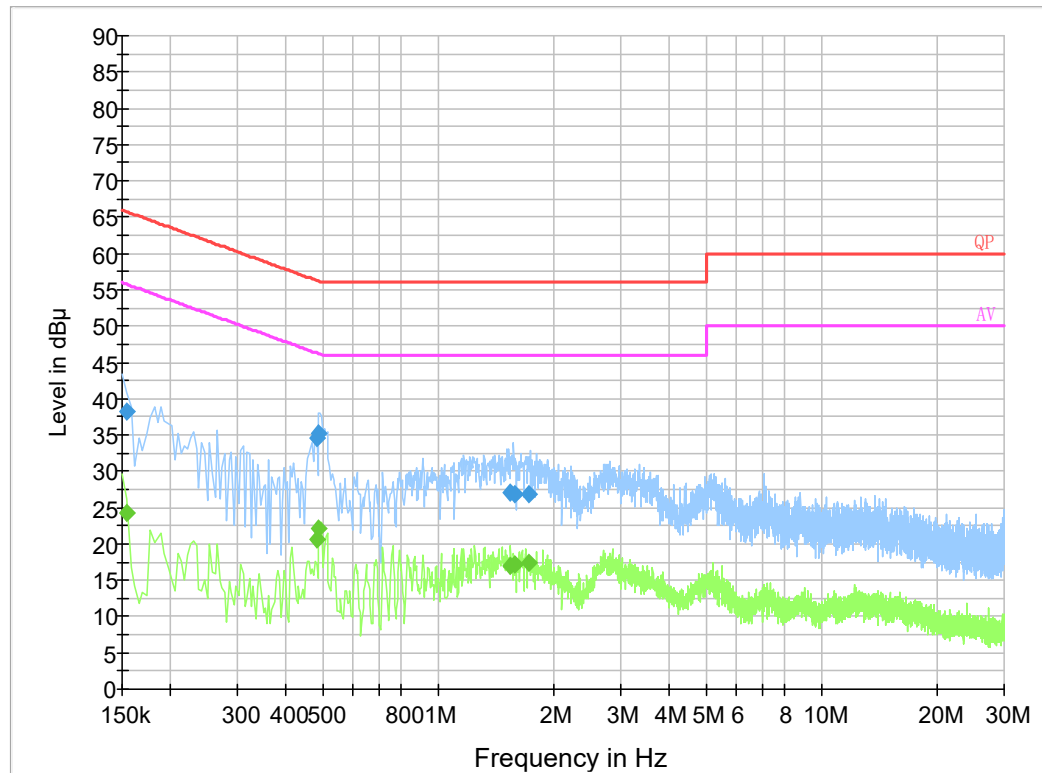
Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	65 %
ATM Pressure:	101.0 kPa

The testing was performed by Haiguo Li on 2021-03-04.

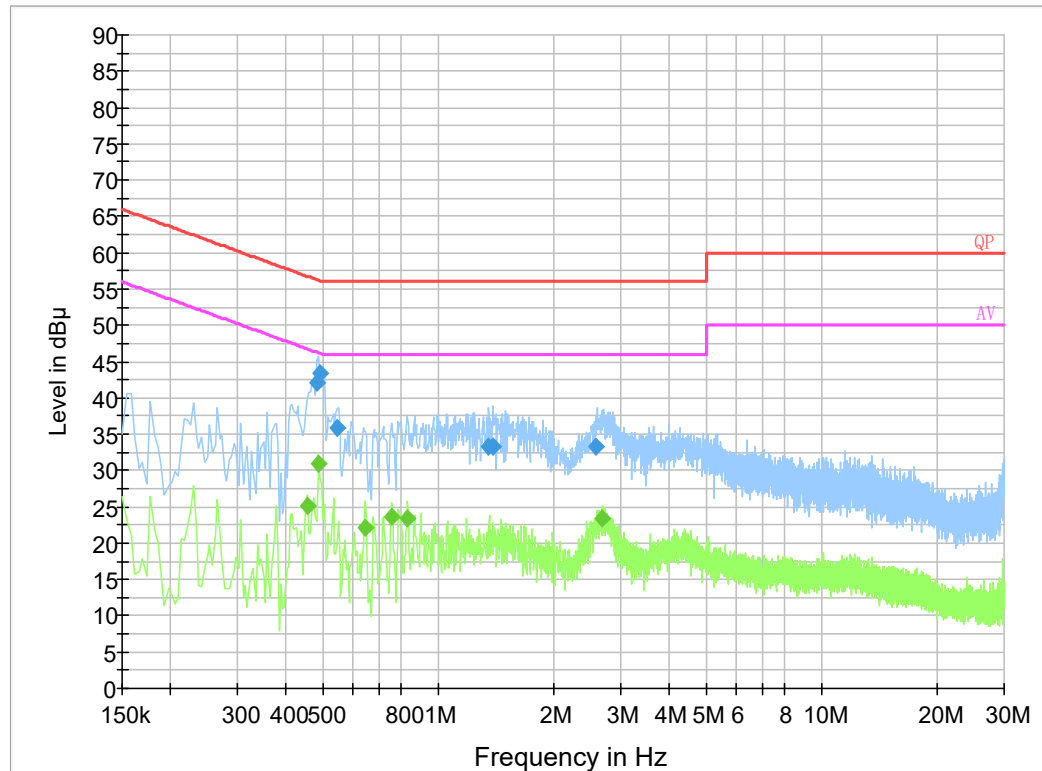
EUT operation mode: Transmitting

*Adapter I-Model: BQ05A-0501000-U***AC 120V/60 Hz, Line****Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.154000	38.2	9.000	L1	19.8	27.6	65.8
0.482830	34.6	9.000	L1	19.8	21.7	56.3
0.486650	35.2	9.000	L1	19.8	21.0	56.2
1.538990	27.0	9.000	L1	19.8	29.0	56.0
1.582330	26.9	9.000	L1	19.8	29.1	56.0
1.727870	26.8	9.000	L1	19.9	29.2	56.0

Final Result 2

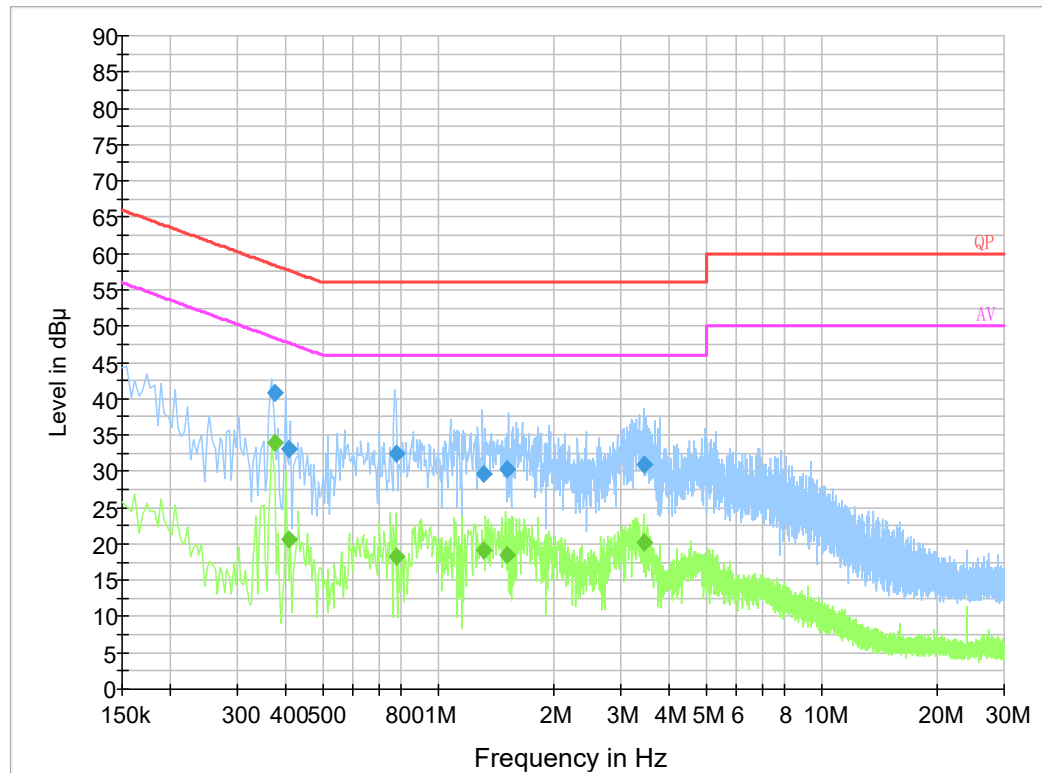
Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.154000	24.4	9.000	L1	19.8	31.4	55.8
0.482830	20.6	9.000	L1	19.8	25.7	46.3
0.486650	22.2	9.000	L1	19.8	24.0	46.2
1.538990	17.1	9.000	L1	19.8	28.9	46.0
1.582330	17.1	9.000	L1	19.8	28.9	46.0
1.727870	17.5	9.000	L1	19.9	28.5	46.0

AC 120V/60 Hz, Neutral**Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.481110	42.1	9.000	N	19.8	14.2	56.3
0.490650	43.4	9.000	N	19.8	12.8	56.2
0.545750	35.9	9.000	N	19.8	20.1	56.0
1.357630	33.4	9.000	N	19.8	22.6	56.0
1.389150	33.3	9.000	N	19.8	22.7	56.0
2.578910	33.3	9.000	N	19.8	22.7	56.0

Final Result 2

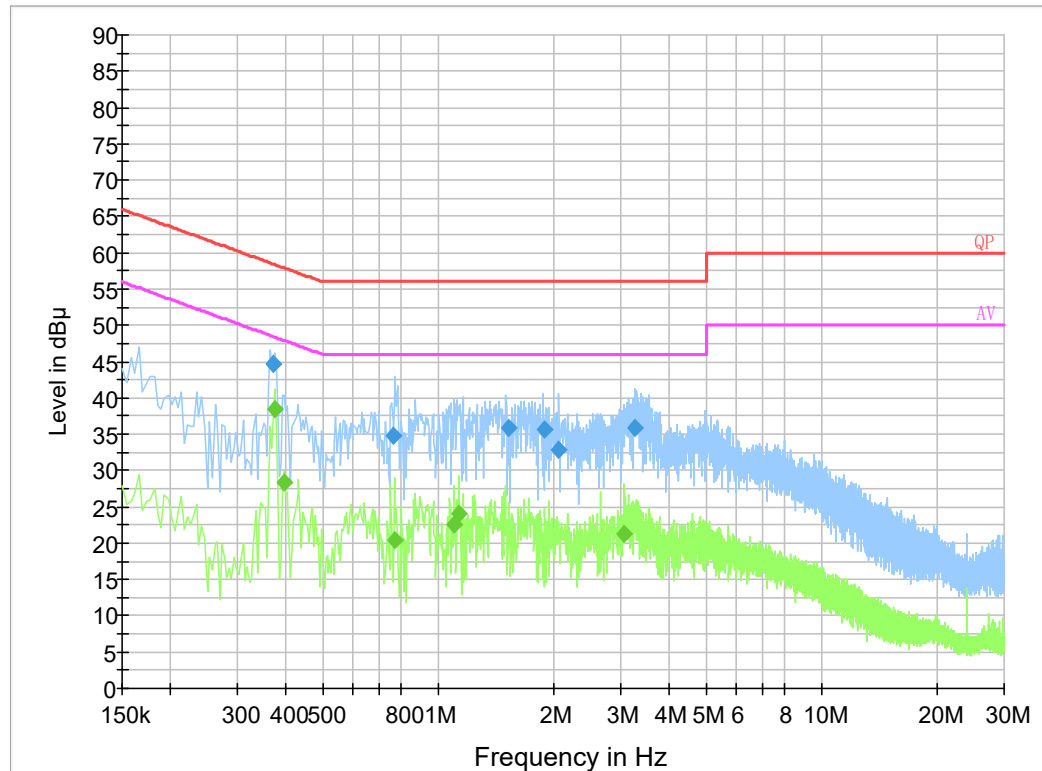
Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.458000	25.0	9.000	N	19.8	21.7	46.7
0.490000	30.9	9.000	N	19.8	15.3	46.2
0.646000	22.1	9.000	N	19.8	23.9	46.0
0.758000	23.6	9.000	N	19.8	22.4	46.0
0.834000	23.3	9.000	N	19.8	22.7	46.0
2.670000	23.4	9.000	N	19.8	22.6	46.0

*Adapter2-Model: YWK-AD050100-U***AC 120V/60 Hz, Line****Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.375550	40.9	9.000	L1	19.9	17.5	58.4
0.408030	33.2	9.000	L1	19.9	24.5	57.7
0.781550	32.5	9.000	L1	19.8	23.5	56.0
1.318410	29.7	9.000	L1	19.8	26.3	56.0
1.515110	30.3	9.000	L1	19.8	25.7	56.0
3.442430	30.9	9.000	L1	19.9	25.1	56.0

Final Result 2

Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.375550	34.0	9.000	L1	19.9	14.4	48.4
0.408030	20.7	9.000	L1	19.9	27.0	47.7
0.781550	18.3	9.000	L1	19.8	27.7	46.0
1.318410	19.1	9.000	L1	19.8	26.9	46.0
1.515110	18.5	9.000	L1	19.8	27.5	46.0
3.442430	20.2	9.000	L1	19.9	25.8	46.0

AC 120V/60 Hz, Neutral**Final Result 1**

Frequency (MHz)	QuasiPeak (dB μV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μV)
0.371490	44.6	9.000	N	19.9	13.9	58.5
0.762390	34.8	9.000	N	19.8	21.2	56.0
1.528590	35.8	9.000	N	19.8	20.2	56.0
1.901710	35.6	9.000	N	19.9	20.4	56.0
2.062950	32.9	9.000	N	19.9	23.1	56.0
3.253070	35.8	9.000	N	19.9	20.2	56.0

Final Result 2

Frequency (MHz)	Average (dB μV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μV)
0.374000	38.4	9.000	N	19.8	10.0	48.4
0.398000	28.4	9.000	N	19.8	19.5	47.9
0.770000	20.5	9.000	N	19.8	25.5	46.0
1.106000	22.6	9.000	N	19.8	23.4	46.0
1.134000	24.1	9.000	N	19.8	21.9	46.0
3.046000	21.3	9.000	N	19.9	24.7	46.0

FCC §15.205, §15.209 & §15.247(d) & RSS-247 § 5.5– RADIATED EMISSIONS

Applicable Standard

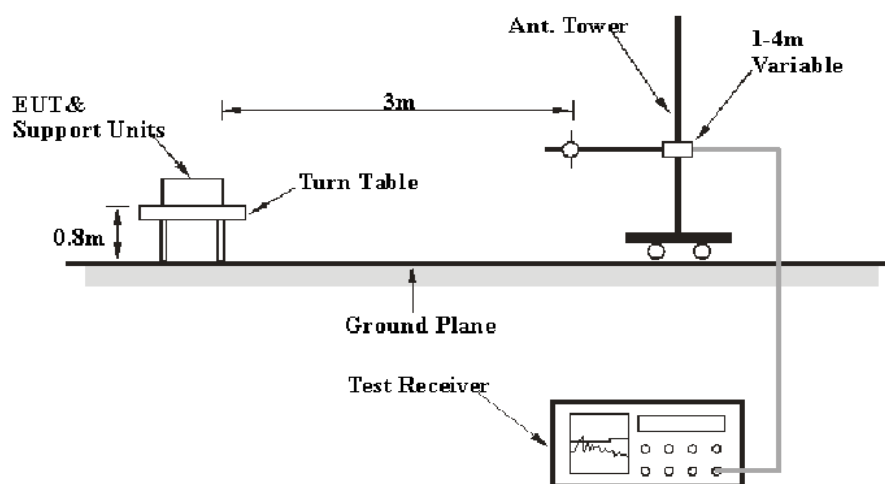
FCC §15.205; §15.209; §15.247(d)

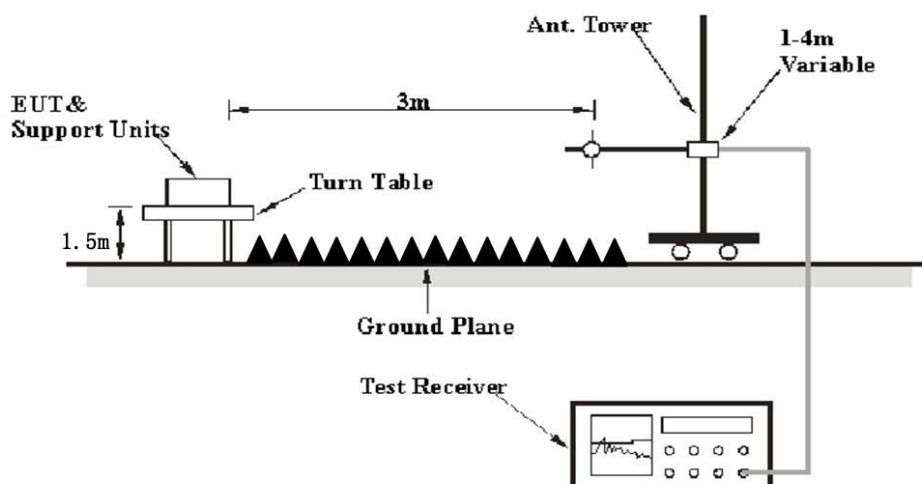
According to RSS-247 §5.5

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

EUT Setup

Below 1 GHz:



Above 1GHz:

The radiated emission tests were performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209 and FCC 15.247 & RSS-247/RSS-Gen limits.

EMI Test Receiver & Spectrum Analyzer Setup

During the radiated emission test, according to the DA 00-705 Released March 30, 2000, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1 MHz	3 MHz	/	PK
	1 MHz	10 Hz	/	Average

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz and peak and Average detection modes for frequencies above 1 GHz.

Corrected Amplitude & Margin Calculation

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

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

Test Data**Environmental Conditions**

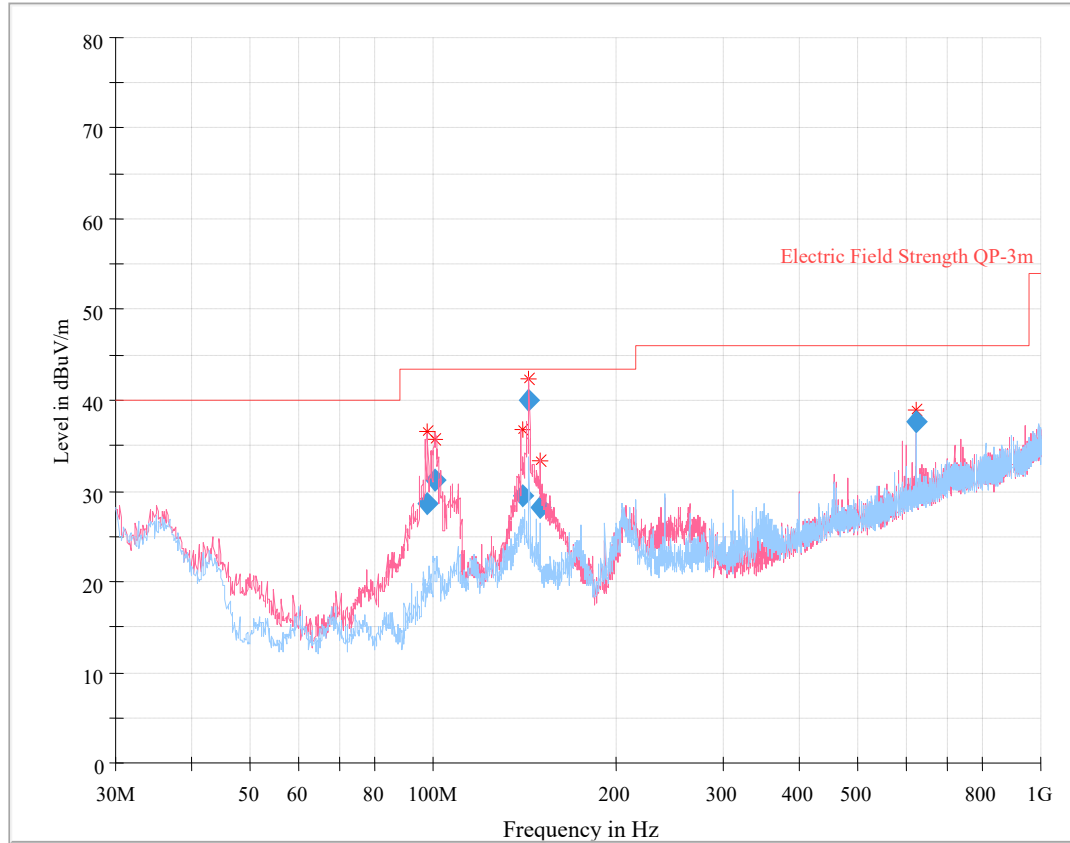
Temperature:	21~24.1 °C
Relative Humidity:	44~52 %
ATM Pressure:	101.0~101.1 kPa

The testing was performed by Andy Yu on 2021-03-03 for below 1GHz and by Alan He from 2021-03-04 to 2021-03-11 for above 1GHz.

EUT operation mode: Transmitting

30 MHz~1 GHz: (worst case at 802.11g mode, low channel + 2.4G Hopping Low channel)

Adapter1-Model: BQ05A-0501000-U

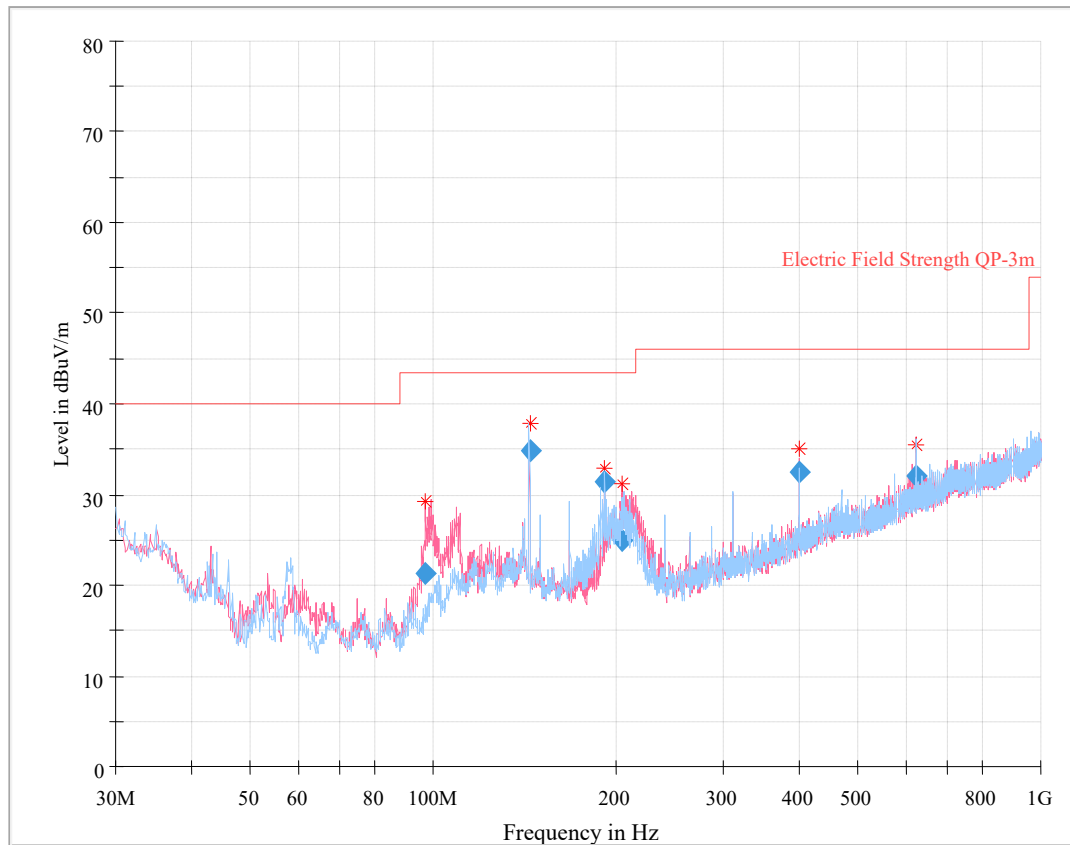


Final Result

Frequency (MHz)	QuasiPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
97.818625	28.64	43.50	14.86	132.0	V	100.0	-8.3
100.527125	31.24	43.50	12.26	103.0	V	104.0	-7.6
139.942250	29.44	43.50	14.06	102.0	V	334.0	-4.7
143.998500	40.06	43.50	3.44	117.0	V	314.0	-5.0
149.560500	28.11	43.50	15.39	99.0	V	286.0	-5.3
624.021750	37.65	46.00	8.35	129.0	V	146.0	3.3

Adapter2-Model: YWK-AD050100-U

30 MHz~1 GHz:



Final Result

Frequency (MHz)	QuasiPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
97.113500	21.28	43.50	22.22	105.0	V	71.0	-8.5
144.037625	34.88	43.50	8.62	316.0	H	357.0	-5.0
192.004875	31.42	43.50	12.08	104.0	V	265.0	-6.0
204.661875	24.93	43.50	18.57	106.0	V	239.0	-5.1
399.996125	32.54	46.00	13.46	156.0	V	57.0	-1.4
623.989875	31.98	46.00	14.02	211.0	V	258.0	3.3

1 GHz - 25 GHz:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2402 MHz)									
2402.00	79.91	PK	273	2.3	H	31.87	111.78	/	/
2402.00	34.14	Ave.	273	2.3	H	31.87	66.01	/	/
2389.59	34.95	PK	46	1.4	H	31.87	66.82	74	7.18
2389.59	14.88	Ave.	46	1.4	H	31.87	46.75	54	7.25
2498.48	28.24	PK	239	1.0	H	32.13	60.37	74	13.63
2498.48	13.69	Ave.	239	1.0	H	32.13	45.82	54	8.18
2291.38	53.78	PK	77	2.1	H	-0.65	53.13	74	20.87
2291.38	32.87	Ave.	77	2.1	H	-0.65	32.22	54	21.78
2547.51	52.97	PK	153	1.7	H	-0.05	52.92	91.78	38.86
2547.51	32.34	Ave.	153	1.7	H	-0.05	32.29	46.01	13.72
4804.00	48.32	PK	71	2.3	H	6.28	54.60	74	19.40
4804.00	31.76	Ave.	71	2.3	H	6.28	38.04	54	15.96
Middle Channel (2440 MHz)									
2440.00	79.60	PK	200	1.8	H	31.97	111.57	/	/
2440.00	34.06	Ave.	200	1.8	H	31.97	66.03	/	/
2312.00	55.77	PK	21	1.5	H	-0.55	55.22	74	18.78
2312.00	33.96	Ave.	21	1.5	H	-0.55	33.41	54	20.59
2568.16	53.9	PK	133	1.6	H	0.04	53.94	91.57	37.63
2568.16	33.74	Ave.	133	1.6	H	0.04	33.78	46.03	12.25
4880.00	46.16	PK	38	1.2	H	6.76	52.92	74	21.08
4880.00	30.70	Ave.	38	1.2	H	6.76	37.46	54	16.54
High Channel (2477 MHz)									
2477.00	79.29	PK	53	1.5	H	32.13	111.42	/	/
2477.00	34.03	Ave.	53	1.5	H	32.13	66.16	/	/
2332.87	27.76	PK	3	1.4	H	31.64	59.40	74	14.60
2332.87	14.23	Ave.	3	1.4	H	31.64	45.87	54	8.13
2483.50	38.69	PK	65	1.1	H	32.13	70.82	74	3.18
2483.50	14.39	Ave.	65	1.1	H	32.13	46.52	54	7.48
2348.95	57.39	PK	294	2.0	H	-1.05	56.34	74	17.66
2348.95	34.39	Ave.	294	2.0	H	-1.05	33.34	54	20.66
2604.99	55.67	PK	221	2.2	H	0.14	55.81	91.42	35.61
2604.99	34.83	Ave.	221	2.2	H	0.14	34.97	46.16	11.19
4954.00	47.03	PK	235	1.8	H	6.80	53.83	74	20.17
4954.00	30.86	Ave.	235	1.8	H	6.80	37.66	54	16.34

Note:

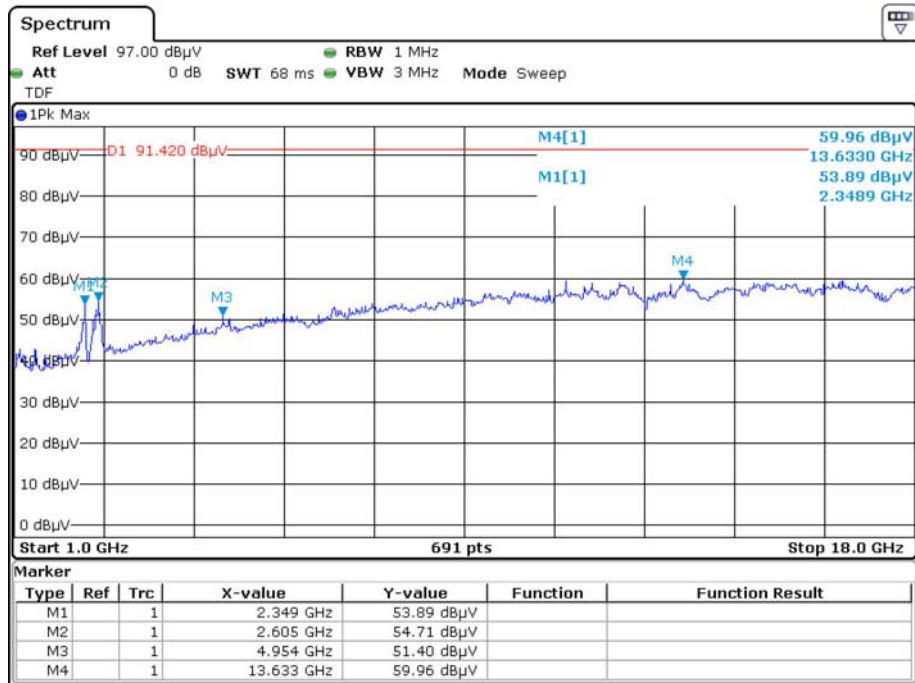
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

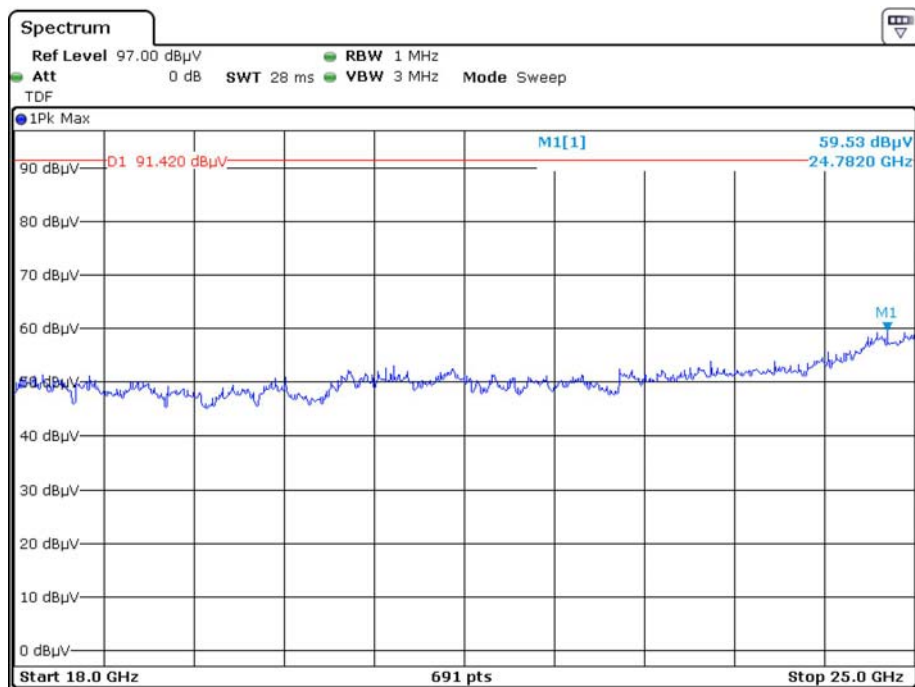
Margin = Limit - Corrected. Amplitude

The other spurious emission which is 20dB to the limit was not recorded.

Pre-scan with High channel Peak Horizontal

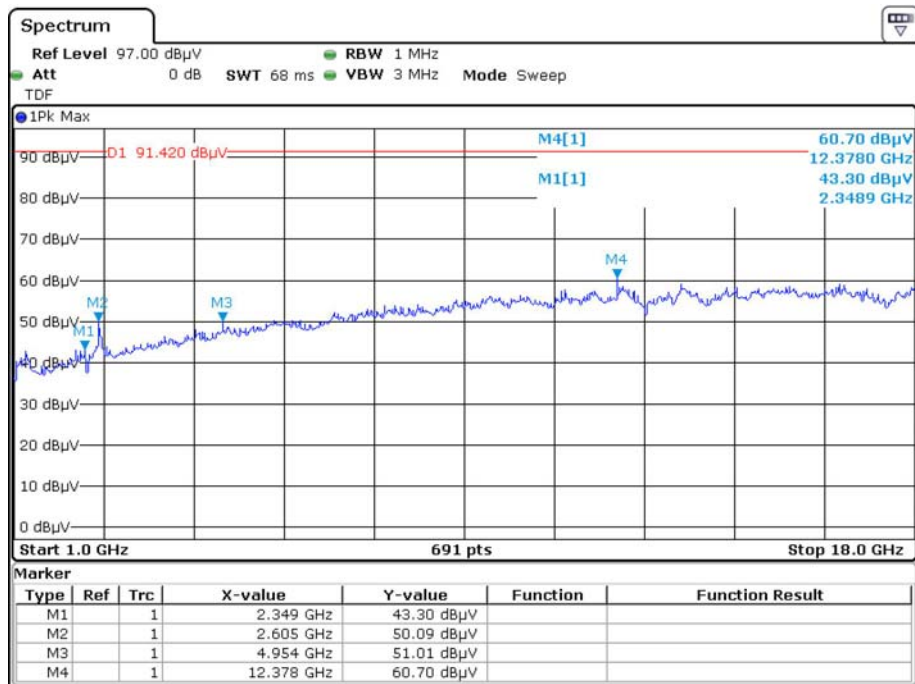


Date: 4.MAR.2021 08:01:18

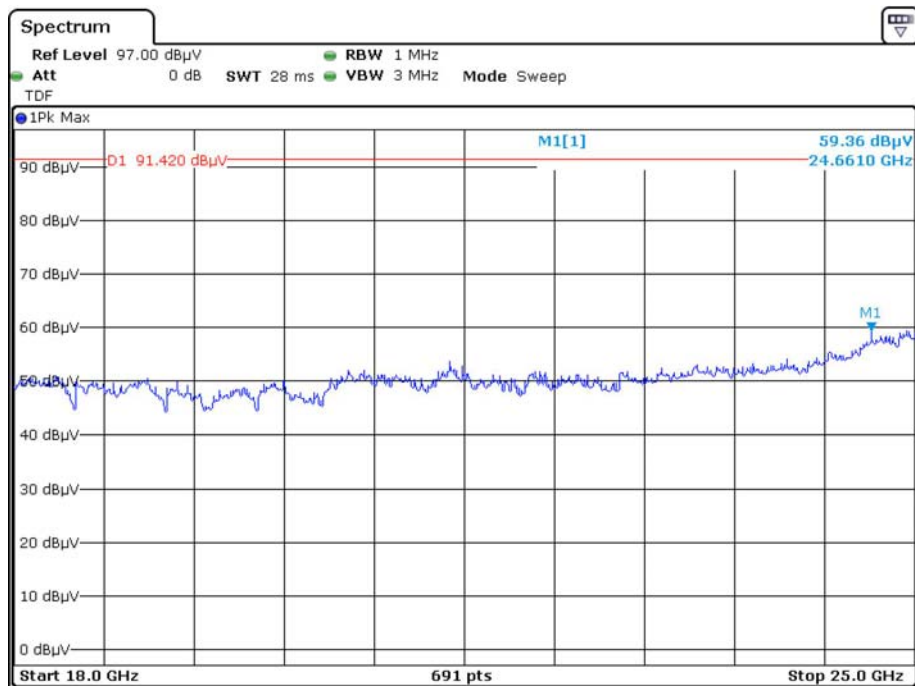


Date: 4.MAR.2021 08:48:03

Vertical

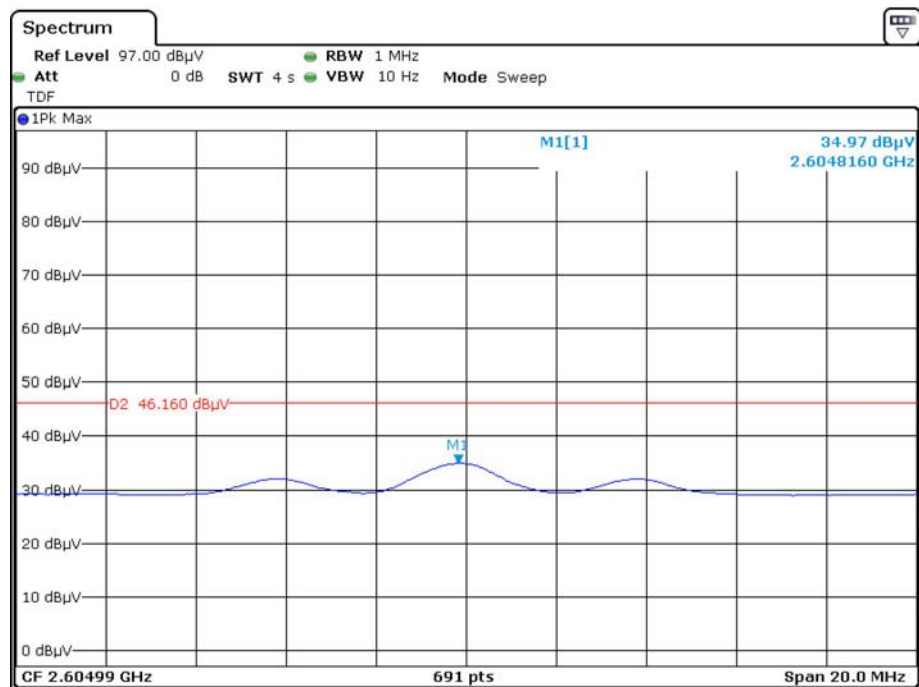


Date: 4.MAR.2021 08:12:42

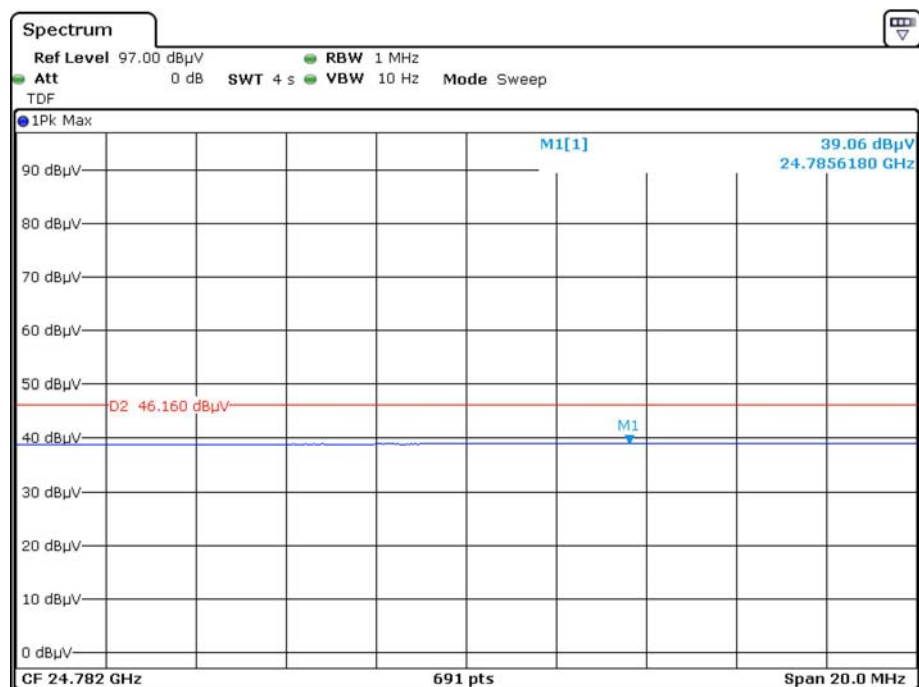


Date: 4.MAR.2021 08:56:57

Average Horizontal

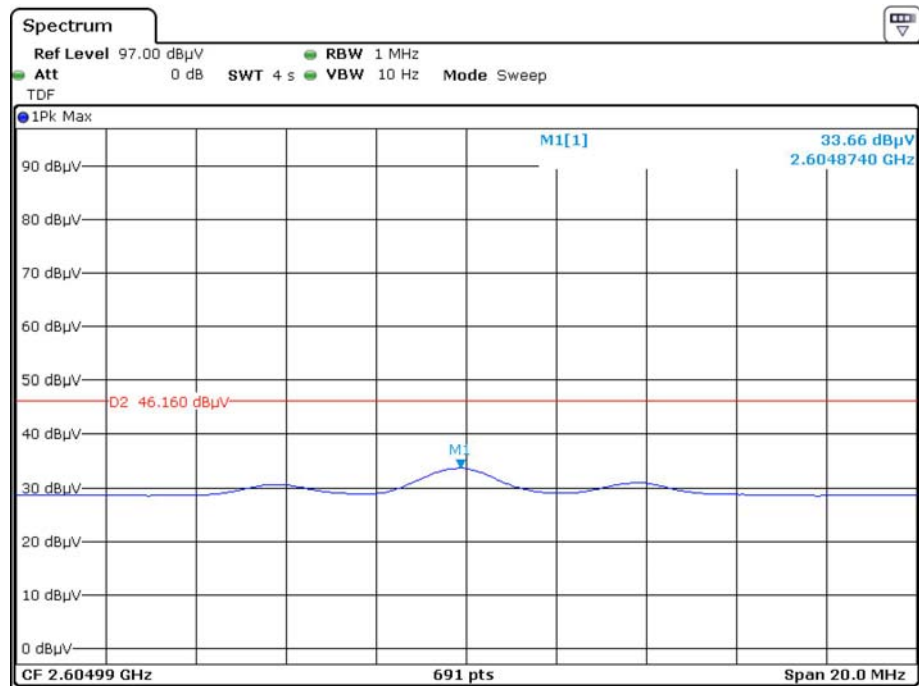


Date: 4.MAR.2021 08:06:27

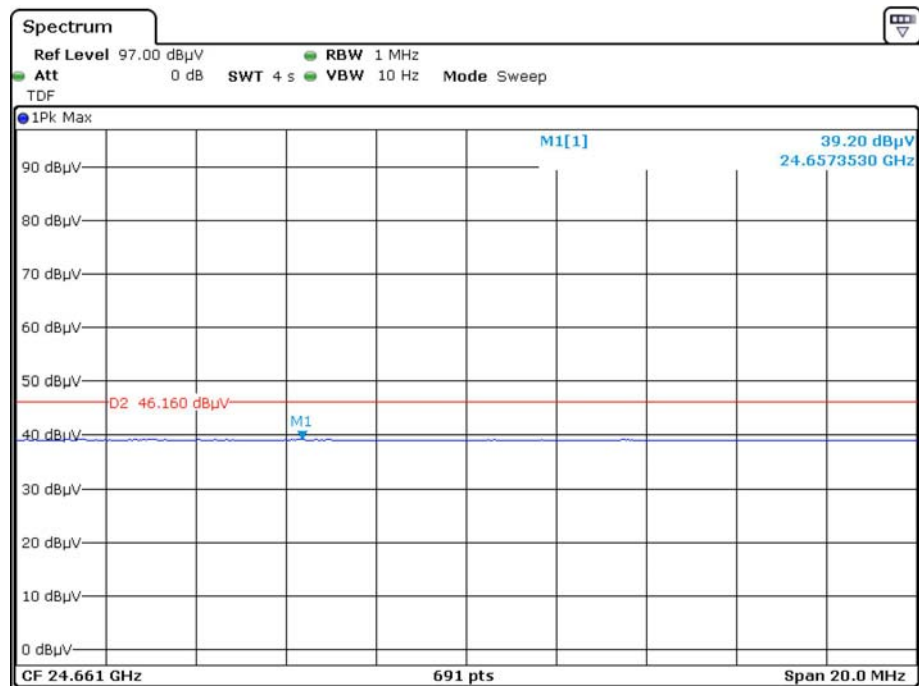


Date: 4.MAR.2021 08:52:45

Vertical



Date: 4.MAR.2021 08:17:19



Date: 4.MAR.2021 09:01:53

FCC §15.247(a) (1) & RSS-247 § 5.1 (b)-CHANNEL SEPARATION TEST**Applicable Standard**

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, 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 provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Frequency hopping systems (FHSs) shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz 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, provided that the systems operate with an output power no greater than 0.125 W. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Test Procedure

1. Set the EUT in transmitting mode, max hold the channel.
2. Set the adjacent channel of the EUT and max hold another trace.
3. Measure the channel separation.

Test Data**Environmental Conditions**

Temperature:	27.8 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

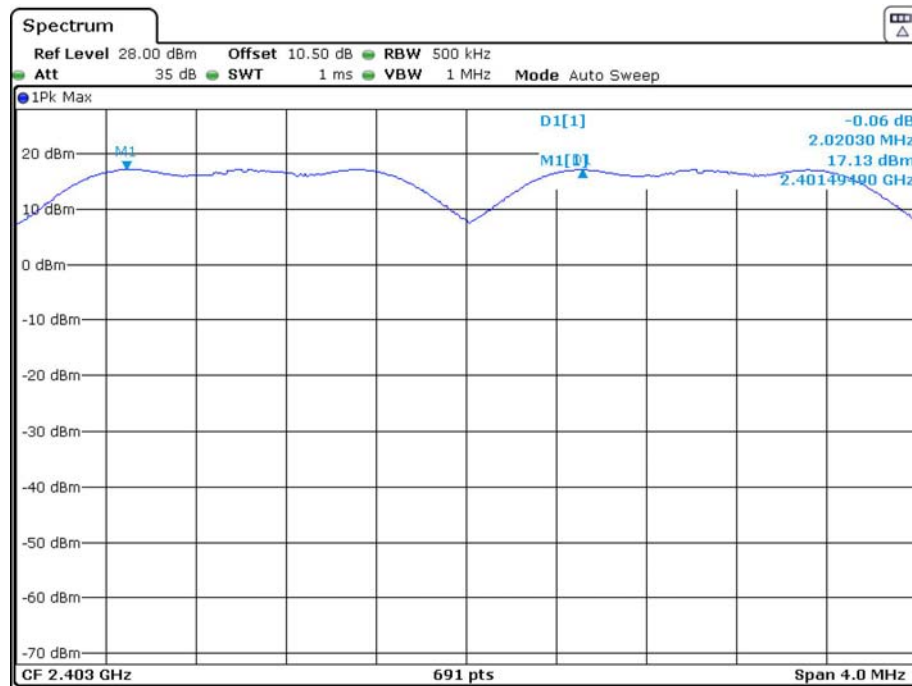
The testing was performed by Coco Liu on 2021-02-26.

EUT operation mode: Transmitting

Test Result: Pass

Please refer to following table and plots.

Channel	Channel Separation (MHz)	20 dBc BW (MHz)	Two-thirds of the 20 dB bandwidth (MHz)	Channel Separation Limit
Hopping	2.02	1.98	1.32	> two-thirds of the 20 dB bandwidth



Date: 26.FEB.2021 12:07:33

FCC §15.247(a) (1) & RSS- Gen § 6.7 & RSS-247 § 5.1 (a) – 99% OCCUPIED BANDWIDTH & 20 dB EMISSION BANDWIDTH

Applicable Standard

Alternatively, 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, provided the systems operate with an output power no greater than 125 mW.

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the “20 dB bandwidth” is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated 20 dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

Test Procedure

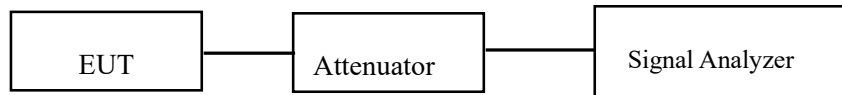
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / 20 dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / 20 dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).



Test Data

Environmental Conditions

Temperature:	27.8 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

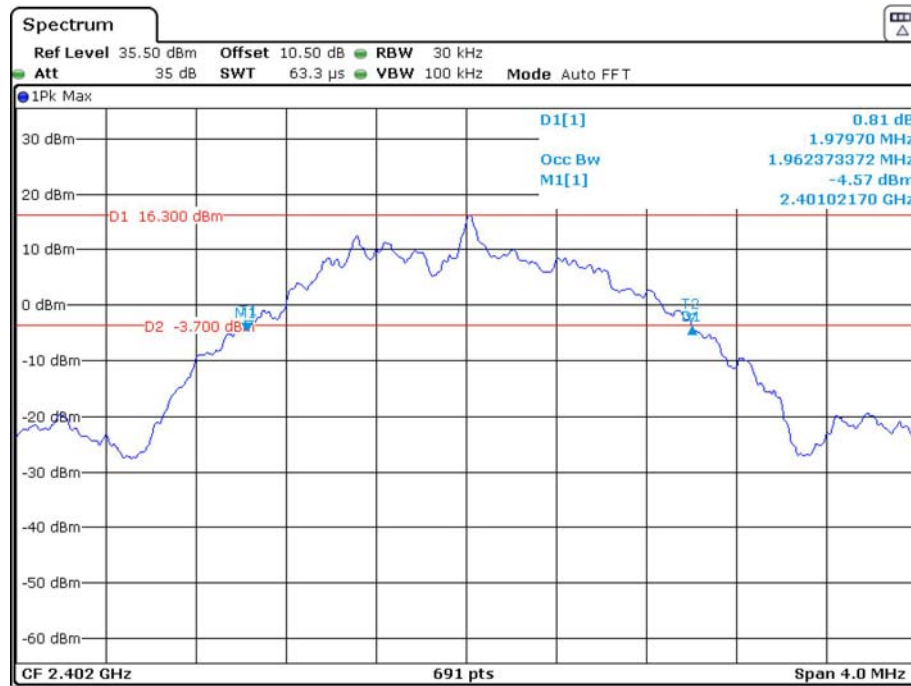
The testing was performed by Coco Liu on 2021-02-27.

EUT operation mode: Transmitting

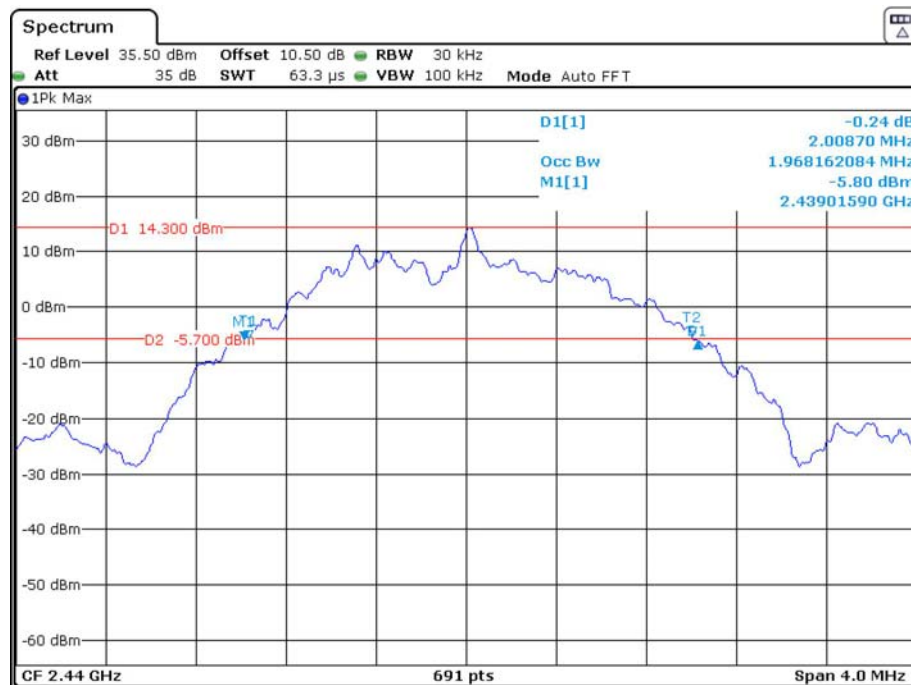
Test Result: Pass

Please refer to following table and plots.

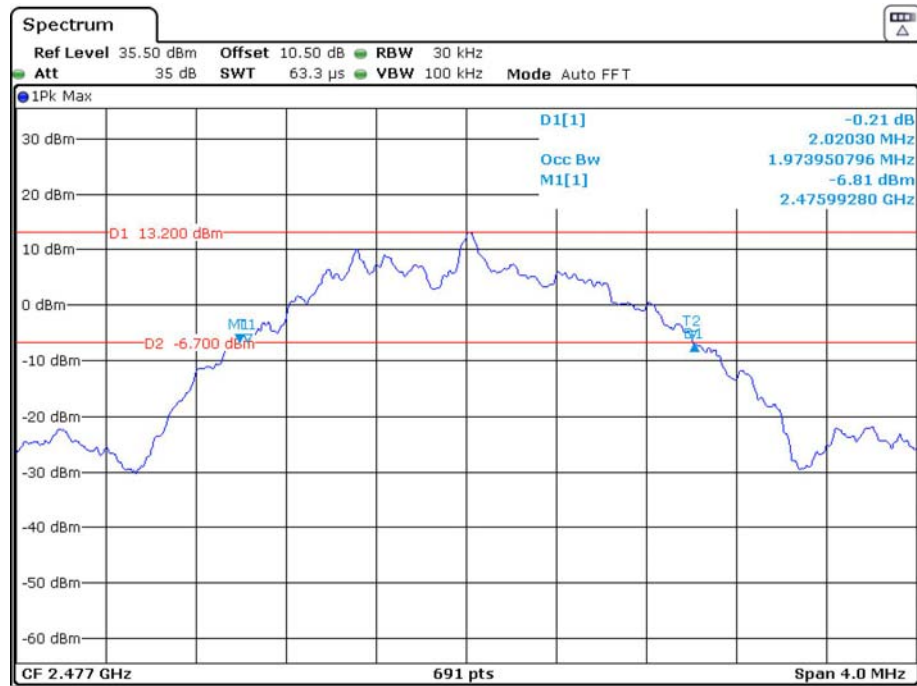
Channel	Frequency (MHz)	99% Emission Bandwidth (MHz)	20 dB Emission Bandwidth (MHz)
Low	2402	1.962	1.980
Middle	2440	1.968	2.009
High	2477	1.974	2.020

20 dB Emission Bandwidth&99% Emission Bandwidth, Low Channel

Date: 27.FEB.2021 10:29:26

20 dB Emission Bandwidth&99% Emission Bandwidth, Middle Channel

Date: 27.FEB.2021 10:30:55

20 dB Emission Bandwidth&99% Emission Bandwidth, High Channel

Date: 27.FEB.2021 10:32:43

FCC §15.247(a) (1) (iii) & RSS-247 § 5.1 (d) - QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

Frequency hopping systems (FHSs) in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Set the EUT in hopping mode from first channel to last.
3. By using the max-hold function record the quantity of the channel.

Test Data

Environmental Conditions

Temperature:	27.8 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Coco Liu on 2021-02-26.

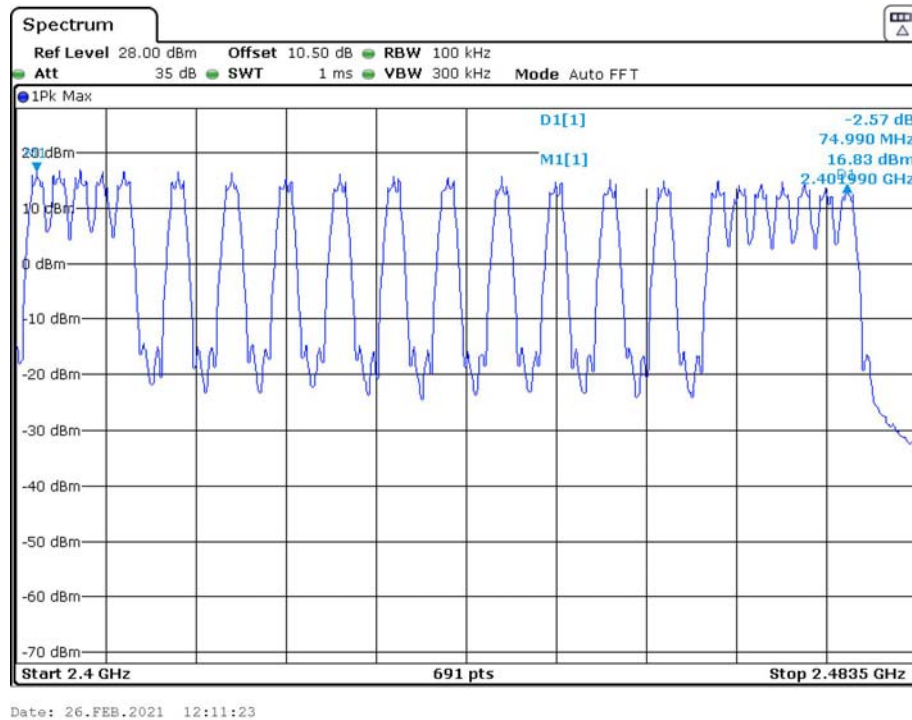
EUT operation mode: Transmitting

Test Result: Pass

Please refer to following table and plots.

Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
2400-2483.5	22	≥15

Number of Hopping Channels



FCC §15.247(a) (1) (iii) & RSS-247 § 5.1 (d) - TIME OF OCCUPANCY (DWELL TIME)**Applicable Standard**

Frequency hopping systems (FHSs) in the 2400-2483.5 MHz shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Procedure

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW $\geq 3 \times$ RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses

Test Data**Environmental Conditions**

Temperature:	27.8 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Coco Liu on 2021-02-26.

EUT operation mode: Transmitting

Test Result: Pass

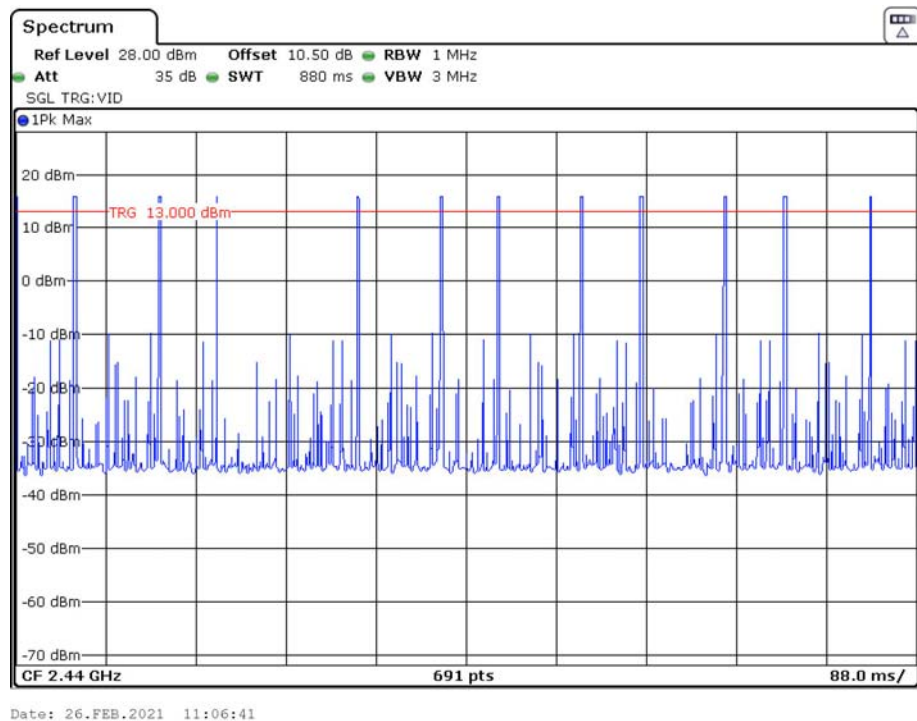
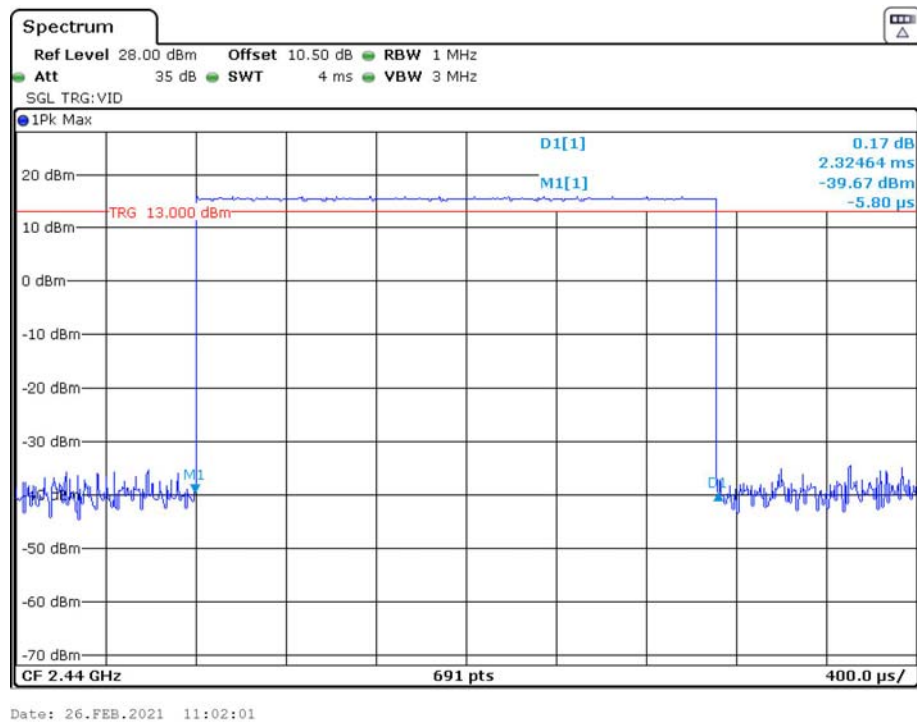
Please refer to following table and plots

Channel	Burst Width [ms]	Total Hops [Num]	Result [s]	Limit [s]	Verdict
Middle	2.325	110	0.256	≤ 0.4	PASS

Note 1: A period time=0.4*22=8.8(S), Result=Burst Width*Total hops

Note 2: Total hops=Hopping Number in 0.88s*10

Note 3: Hopping Number in 0.88s=Total of highest signals in 0.88s (Second high signals were other channel)



FCC §15.247(b) (1) & RSS-247 § 5.1(b) & § 5.4(b) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

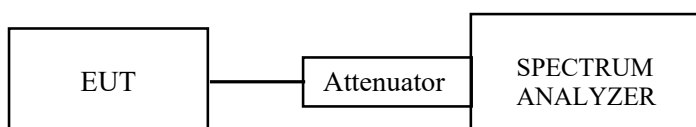
According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

For frequency hopping systems (FHSs) operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W (see Section 5.4(e) for exceptions).

Frequency hopping systems (FHSs) shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz 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, provided that the systems operate with an output power no greater than 0.125 W.

Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.



Test Data

Environmental Conditions

Temperature:	27.8 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Coco Liu on 2021-02-27.

EUT operation mode: Transmitting

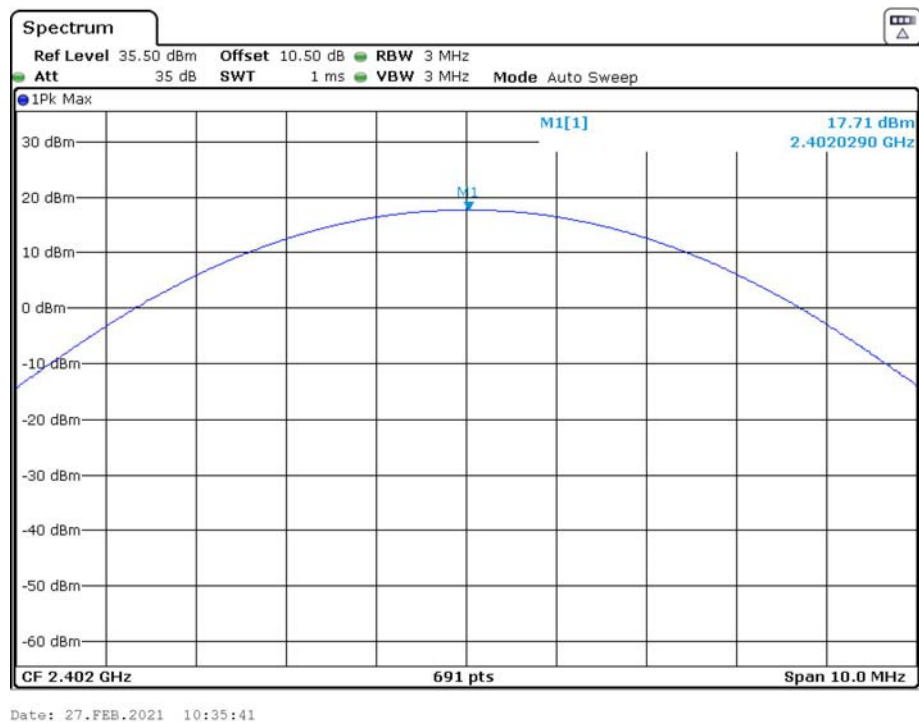
Test Result: Pass

Please refer to following table.

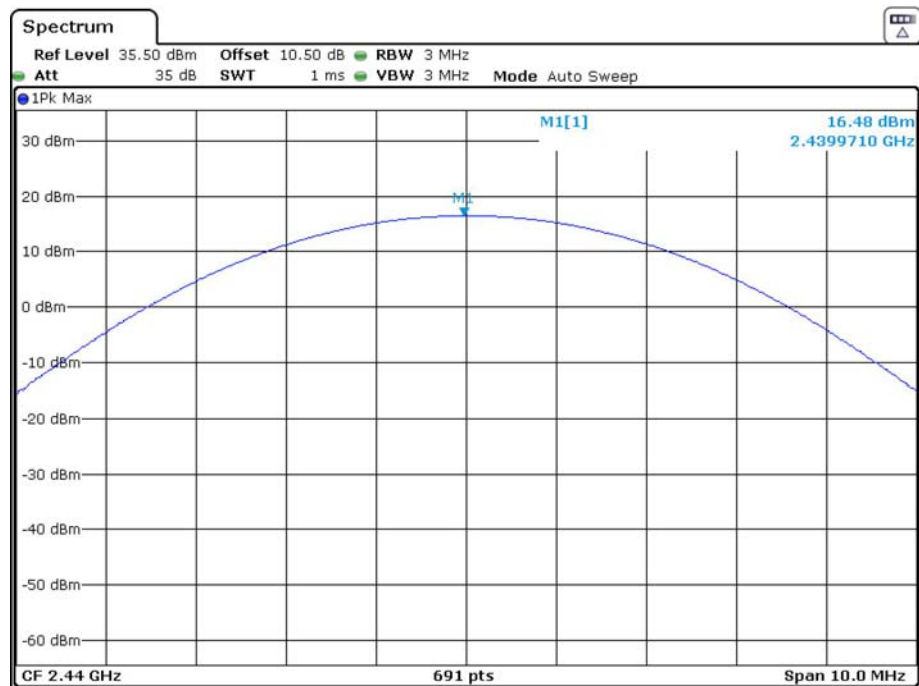
Channel	Frequency (MHz)	Conducted Peak Output Power	Limit (dBm)
		(dBm)	
Low	2402	17.71	21
Middle	2440	16.48	21
High	2477	15.31	21

Note: The antenna gain is 0dBi. The maximum EIRP=17.71dBm+0dBi=17.71dBm, less than 36dBm, so it's compliance with the ISSED EIRP limit.

Low Channel

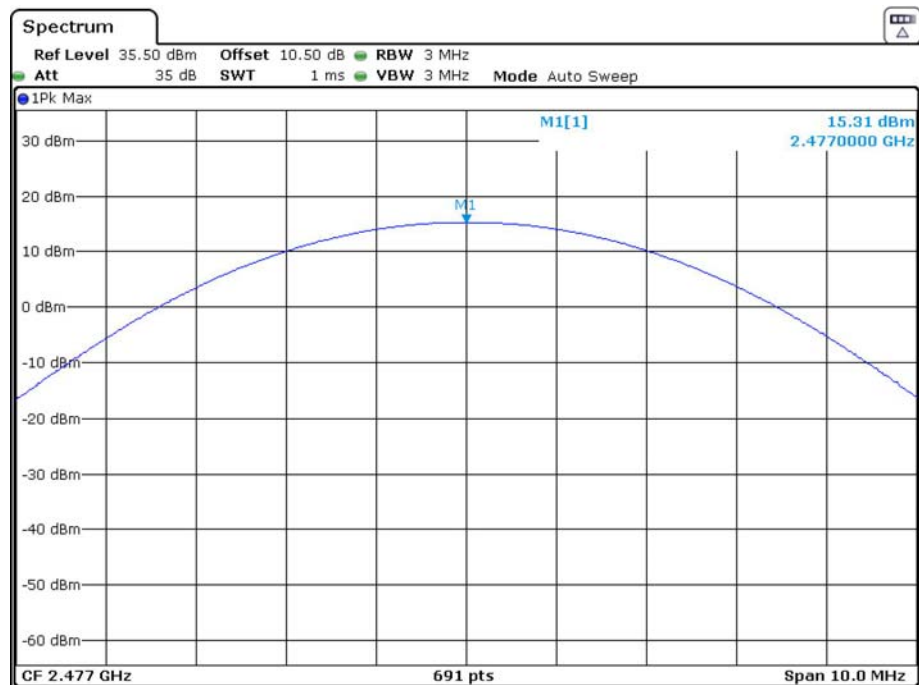


Middle Channel



Date: 27.FEB.2021 10:35:08

High Channel



Date: 27.FEB.2021 10:34:38

FCC §15.247(d) & RSS-247 § 5.5 - BAND EDGES TESTING

Applicable Standard

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

According to RSS-247 § 5.5.

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

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

Test Data**Environmental Conditions**

Temperature:	27.8 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

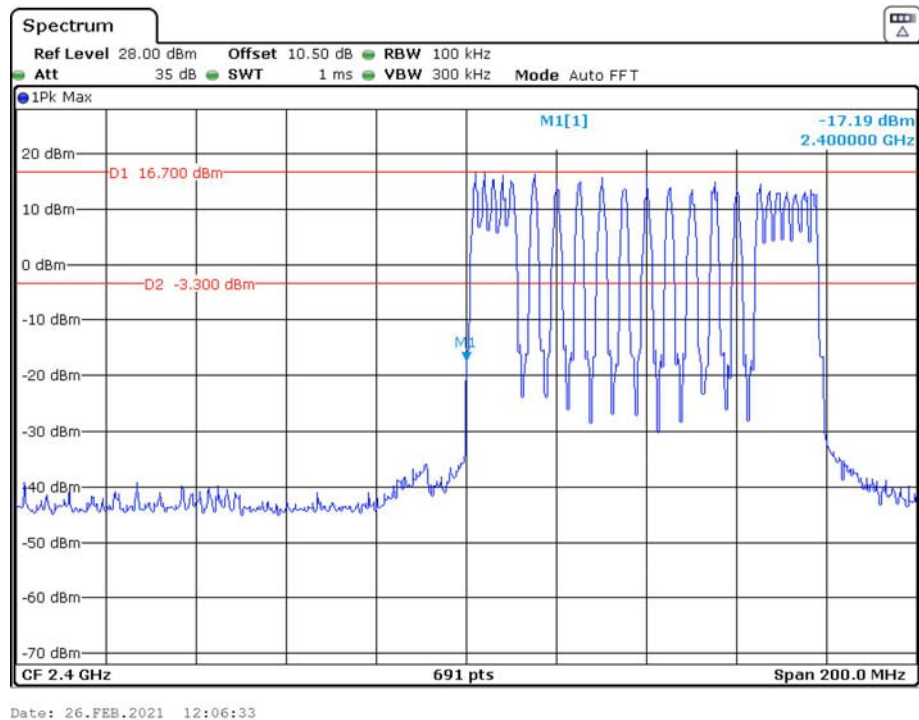
The testing was performed by Coco Liu on 2021-02-26.

EUT operation mode: Transmitting

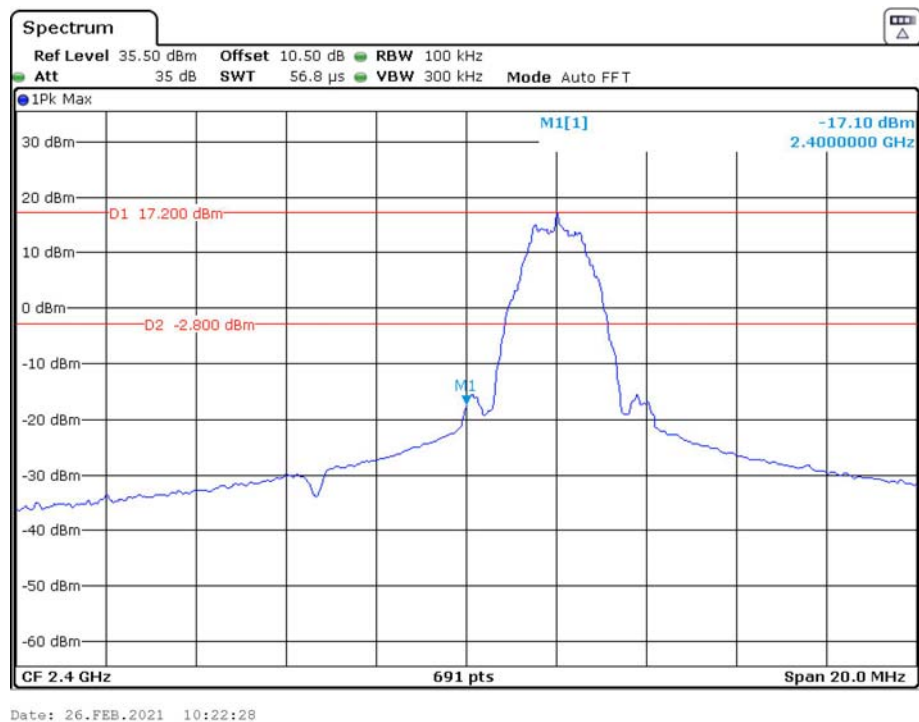
Test Result: Pass

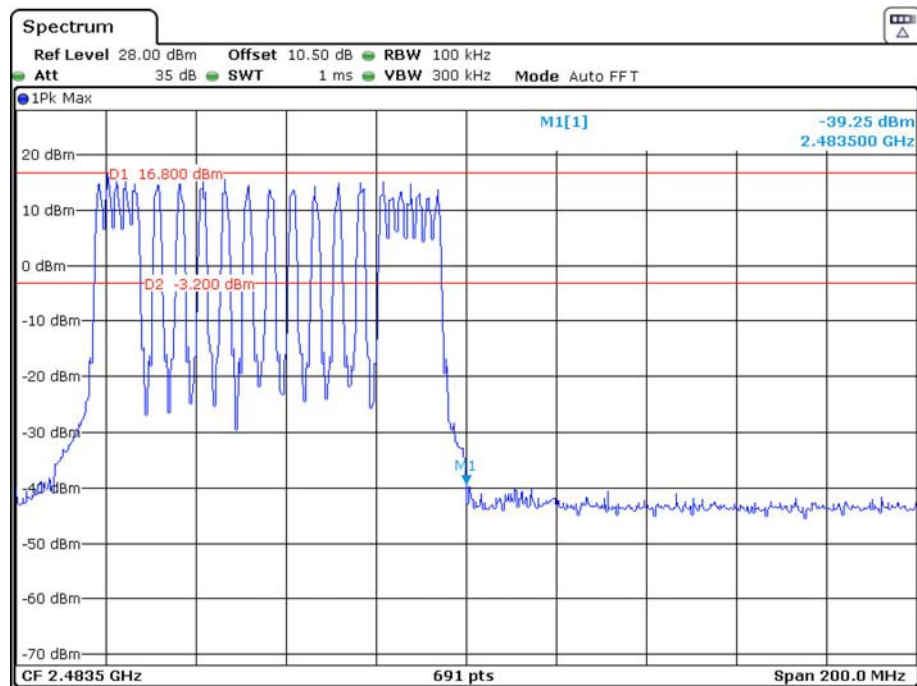
Please refer to following plots.

Band Edge-Left Side Hopping

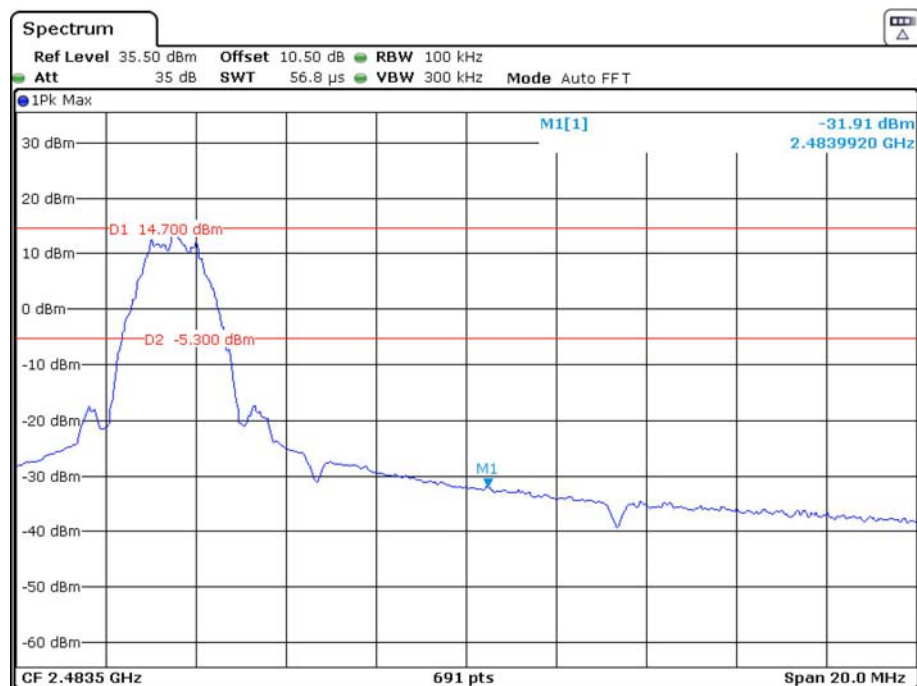


Single



Band Edge-Right Side**Hopping**

Date: 26.FEB.2021 12:05:15

Single

Date: 26.FEB.2021 10:20:57

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