



FCC PART 15.247
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RSS-247, ISSUE 2, FEBRUARY 2017

TEST REPORT
For
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Report Number: SZ1210207-04404E	
Report Date: 2021-03-17	
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Baby Monitor
Tested Model	VM5263 BU
Multiple Model	VM5463 BU, VM5463-2 BU, VM5463-ab BU, LM918-2W BU, VM5263-2 BU, VM5263-ab BU (a=any alphanumeric character or blank is presenting number of baby unit; b = any alphanumeric character or blank is presenting color of enclosure.)
Model Differences	Refer to the DoS letter
HVIN	35-201584BU
Frequency Range	2405~2475MHz
Maximum conducted Peak output power	17.07dBm
Modulation Technique	GFSK
Antenna Specification*	Integral Antenna: 0dBi (It is provided by the applicant)
Voltage Range	DC 5.0V from adapter
Date of Test	2021-02-20 to 2021-03-10
Sample serial number	SZ1210207-04404E-RF-S1 (Assigned by BACL, Shenzhen)
Received date	2021-02-07
Sample/EUT Status	Good condition
Adapter1 information	Model:VT05EUS05100 Input: 100-240V, 50/60Hz, 0.15A Output: DC 5.0V, 1.0A, 5.0W
Adapter2 information	Model:S005BNU0500100 Input: 100-240V, 50/60Hz, 150mA 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 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, 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.

32 channels are provided:

Channel	TX Frequency (MHz)	Channel	TX Frequency (MHz)
1	2405	17	2439
2	2407	18	2441
3	2409	19	2444
4	2411	20	2446
5	2413	21	2450
6	2415	22	2452
7	2418	23	2454
8	2420	24	2456
9	2422	25	2458.5
10	2424	26	2460.5
11	2426	27	2462.5
12	2428	28	2467
13	2430	29	2469
14	2433	30	2471
15	2435	31	2473
16	2437	32	2475

EUT was tested with Channel 1, 17 and 32.

The frequency range of the system is operating from 2405MHz to 2475MHz. There are totally 32 non-overlapping channel, and 16 active channels out of the 32 channels at same time. The 16 active channels are selected in pseudo random manner by default. The remaining 16 channels are spare channels which will be exchanged with active channels one at a time when any one of the active channels jamming with noise. Once an active channel has noise jamming during frequency hopping, it will be marked as dirty channel and exchanged with a spare channel after a dwell time. The spare channel is selected randomly so that at any time the active channels are always equally used in a pseudo random manner. The dirty channel become part of spare channels and can be used in active channels again after all the other spare channels have been used.

EUT Exercise Software

“ComTestSerial.exe”* software was made to the EUT tested. The software 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

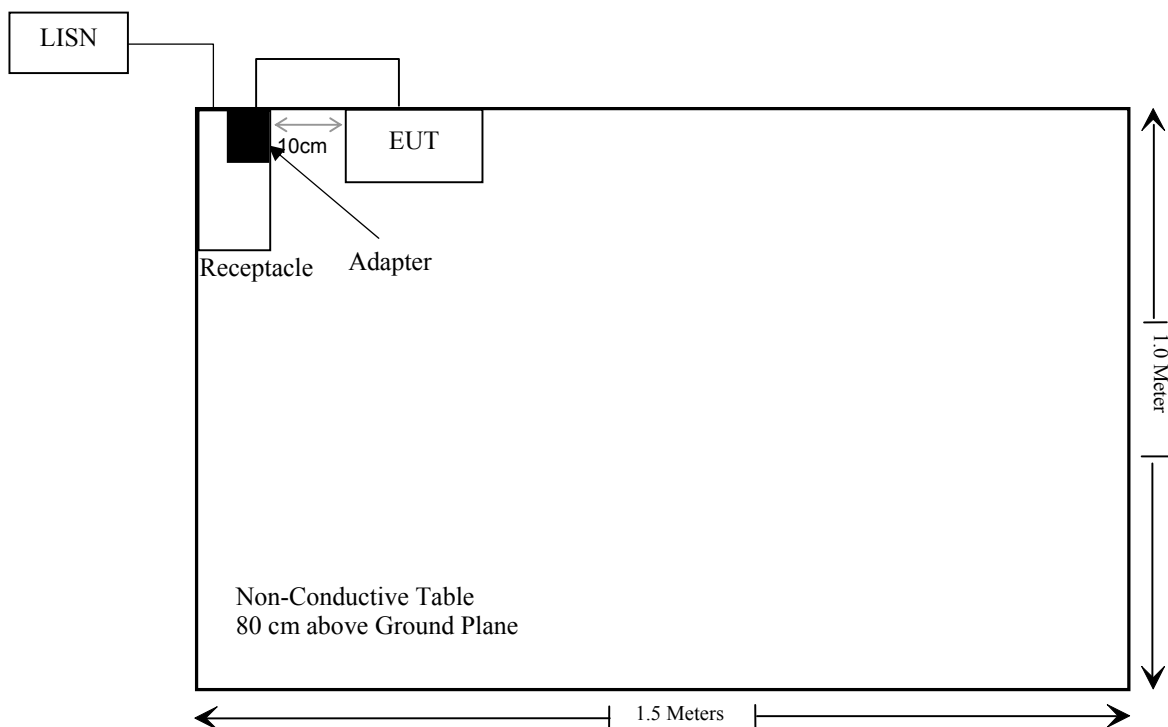
Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

Cable Description	Length (m)	From Port	To
Un-Shielding Detachable DC cable	2.0	Adapter	BU

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 § 2.5.2	Maximum Permissible Exposure(MPE) & RF Exposure Evaluation	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 Limitor	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	1007726-021304	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)

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)			
2405-2475	0	1	17.5	56.23	20	0.011	1.0

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

Result: Pass

RSS-102 § 2.5.2 –EXEMPTION LIMITS FOR ROUTINE EVALUATION-RF EXPOSURE EVALUATION

Applicable Standard

According to RSS-102 § (2.5.2):

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance). In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

Calculated Data:

The worst case is $f = 2405$ MHz:

The limit is $1.31 \times 10^{-2} f^{0.6834}$ W = 2.68W

The antenna gain is 0dBi.

The max tune-up conducted output power is 17.5dBm = 0.056W < 2.68W

So the RF Exposure evaluation can be exempted.

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 one integral 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
Dipole	0dBi	50 Ω

Result: Pass

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.

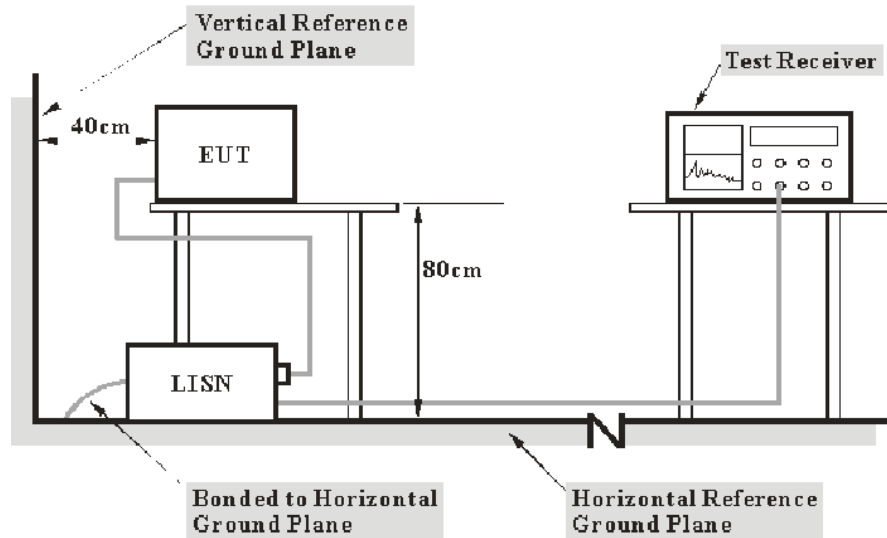
Table 4 - AC Power Lines Conducted Emission Limits		
Frequency range (MHz)	Conducted limit (dBμV)	
	Quasi-Peak	Average
0.15 – 0.5	66 to 56 ¹	56 to 46 ¹
0.5 – 5	56	46
5 – 30	60	50

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:

- 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.
- 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

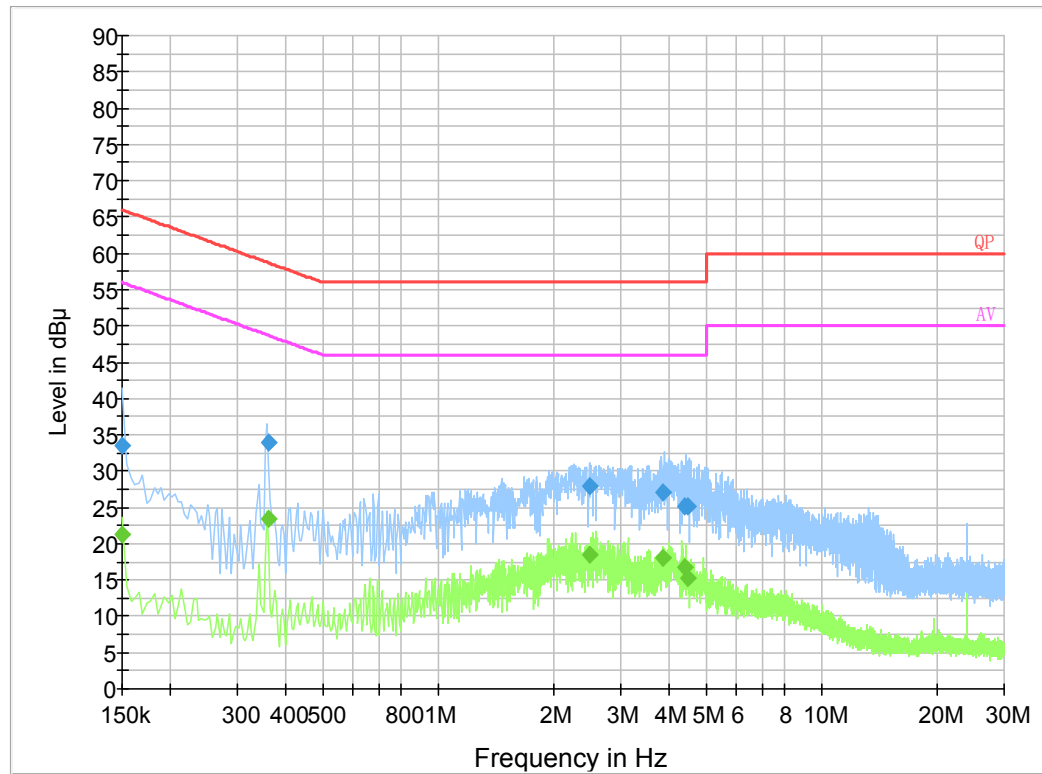
Temperature:	25 °C
Relative Humidity:	65 %
ATM Pressure:	101.0 kPa

The testing was performed by Haiguo Li on 2021-02-20.

EUT operation mode: Transmitting

Adapter1-Model: VT05EUS05100

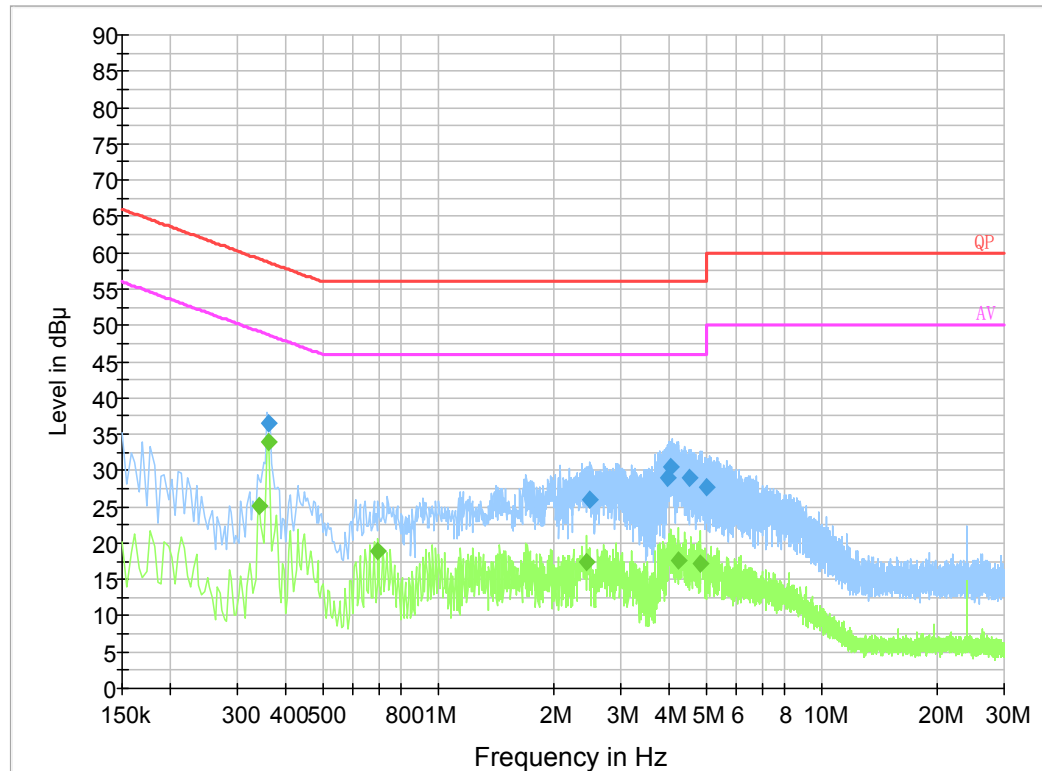
AC 120V/60 Hz, Line

**Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.150000	33.4	0.200	L1	19.8	32.6	66.0
0.360630	33.9	9.000	L1	19.9	24.8	58.7
2.484830	27.9	9.000	L1	19.8	28.1	56.0
3.867530	27.1	9.000	L1	19.9	28.9	56.0
4.383250	25.2	9.000	L1	19.9	30.8	56.0
4.466350	25.1	9.000	L1	19.9	30.9	56.0

Final Result 2

Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.150000	21.2	9.000	L1	19.8	34.8	56.0
0.360630	23.3	9.000	L1	19.9	25.4	48.7
2.484830	18.4	9.000	L1	19.8	27.6	46.0
3.867530	18.0	9.000	L1	19.9	28.0	46.0
4.383250	16.9	9.000	L1	19.9	29.1	46.0
4.466350	15.3	9.000	L1	19.9	30.7	46.0

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

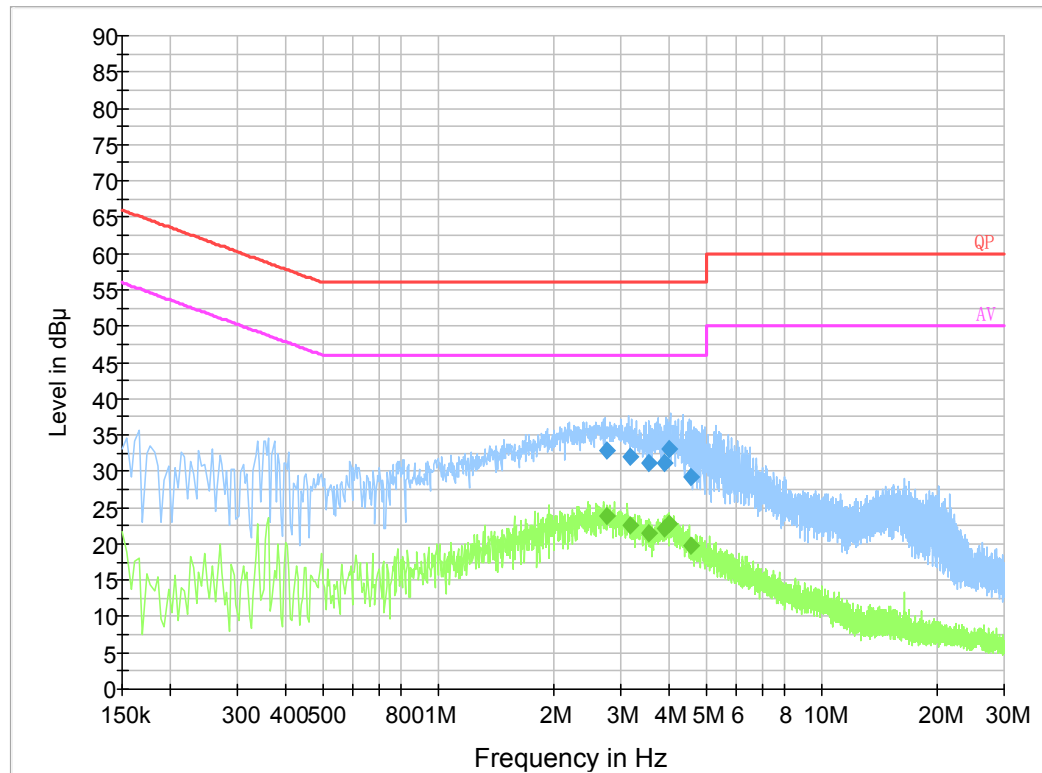
Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.360630	36.4	9.000	N	19.9	22.3	58.7
2.488590	26.0	9.000	N	19.8	30.0	56.0
3.978630	29.0	9.000	N	19.9	27.0	56.0
4.044890	30.5	9.000	N	19.9	25.5	56.0
4.533690	29.0	9.000	N	19.9	27.0	56.0
5.032370	27.7	9.000	N	19.9	32.3	60.0

Final Result 2

Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.342000	25.2	9.000	N	19.8	24.0	49.2
0.362000	34.0	9.000	N	19.9	14.7	48.7
0.698000	18.9	9.000	N	19.8	27.1	46.0
2.438000	17.3	9.000	N	19.8	28.7	46.0
4.242000	17.5	9.000	N	19.9	28.5	46.0
4.838000	17.1	9.000	N	19.9	28.9	46.0

Adapter2-Model: S005BNU0500100

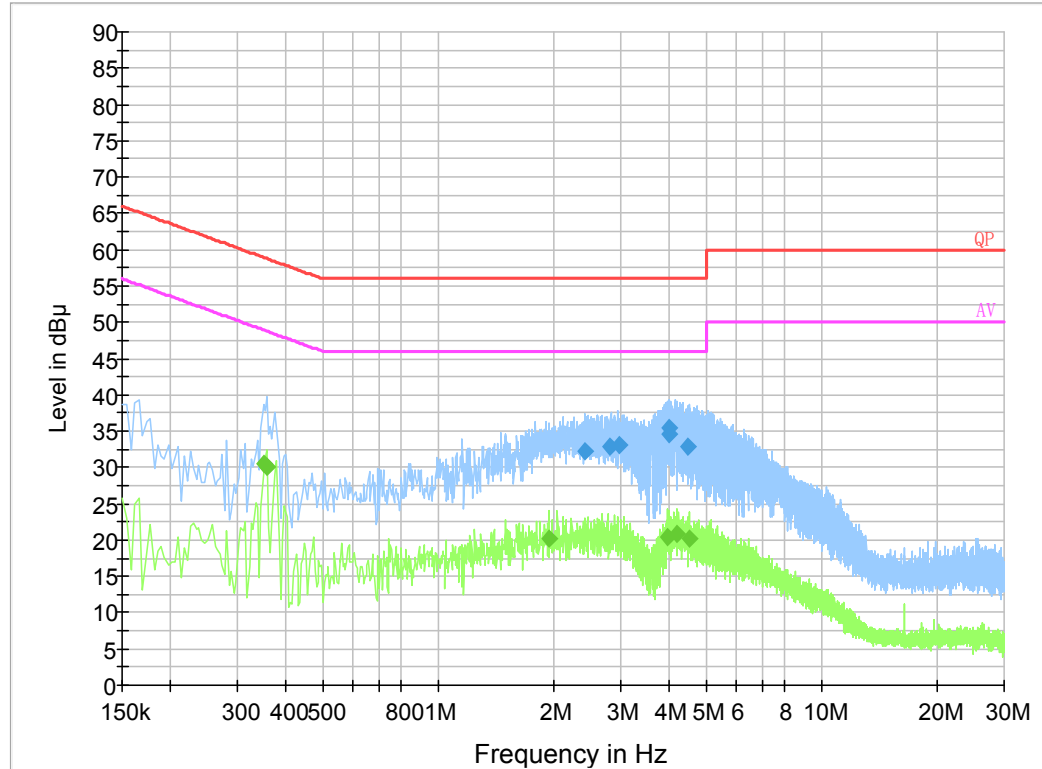
AC 120V/60 Hz, Line

**Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
2.761110	32.9	9.000	L1	19.9	23.1	56.0
3.174930	32.0	9.000	L1	19.9	24.0	56.0
3.564630	31.2	9.000	L1	19.9	24.8	56.0
3.882990	31.1	9.000	L1	19.9	24.9	56.0
3.997550	33.1	9.000	L1	19.9	22.9	56.0
4.558110	29.2	9.000	L1	19.9	26.8	56.0

Final Result 2

Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
2.761110	23.8	9.000	L1	19.9	22.2	46.0
3.174930	22.6	9.000	L1	19.9	23.4	46.0
3.564630	21.4	9.000	L1	19.9	24.6	46.0
3.882990	22.0	9.000	L1	19.9	24.0	46.0
3.997550	22.7	9.000	L1	19.9	23.3	46.0
4.558110	19.7	9.000	L1	19.9	26.3	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)
2.409670	32.3	9.000	N	19.8	23.7	56.0
2.807610	32.9	9.000	N	19.9	23.1	56.0
2.969750	33.1	9.000	N	19.9	22.9	56.0
4.009850	35.4	9.000	N	19.9	20.6	56.0
4.013910	34.6	9.000	N	19.9	21.4	56.0
4.486290	32.8	9.000	N	19.9	23.2	56.0

Final Result 2

Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.350000	30.5	9.000	N	19.9	18.5	49.0
0.358000	30.0	9.000	N	19.9	18.8	48.8
1.950000	20.2	9.000	N	19.9	25.8	46.0
3.986000	20.5	9.000	N	19.9	25.5	46.0
4.190000	20.9	9.000	N	19.9	25.1	46.0
4.514000	20.3	9.000	N	19.9	25.7	46.0

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

Applicable Standard

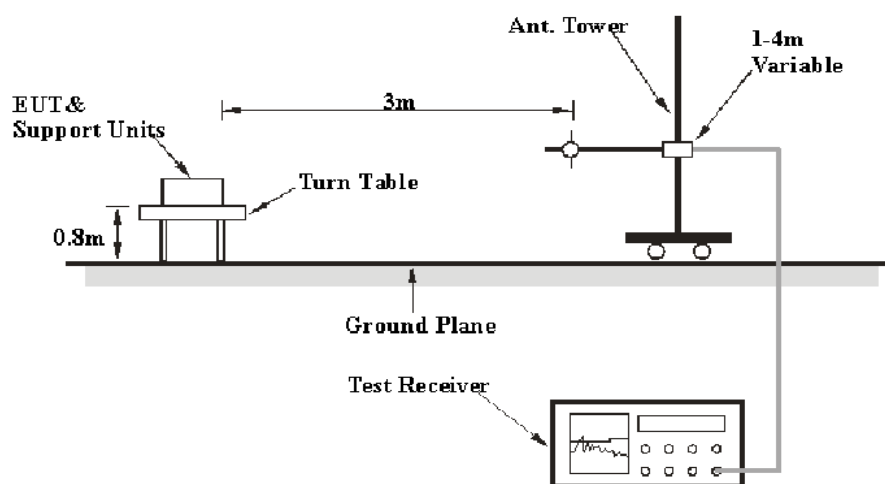
FCC §15.205; §15.209; §15.247(d)

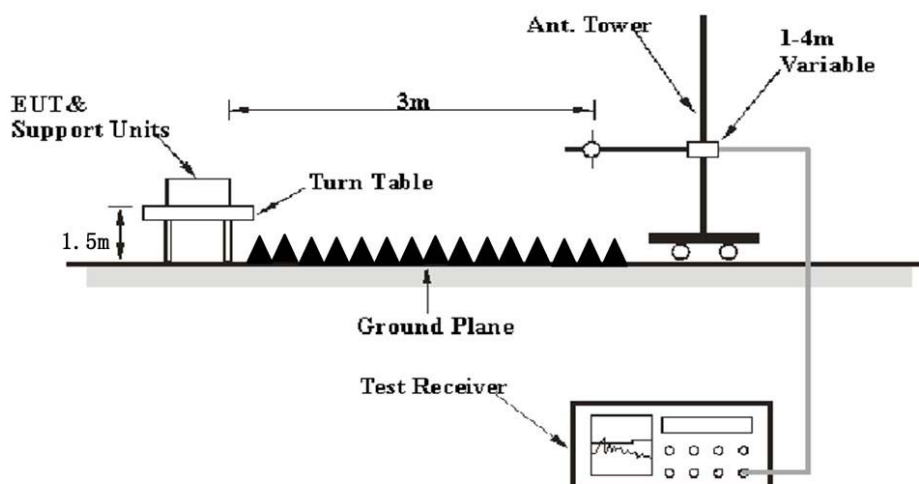
According to RSS-247 §5.5

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**

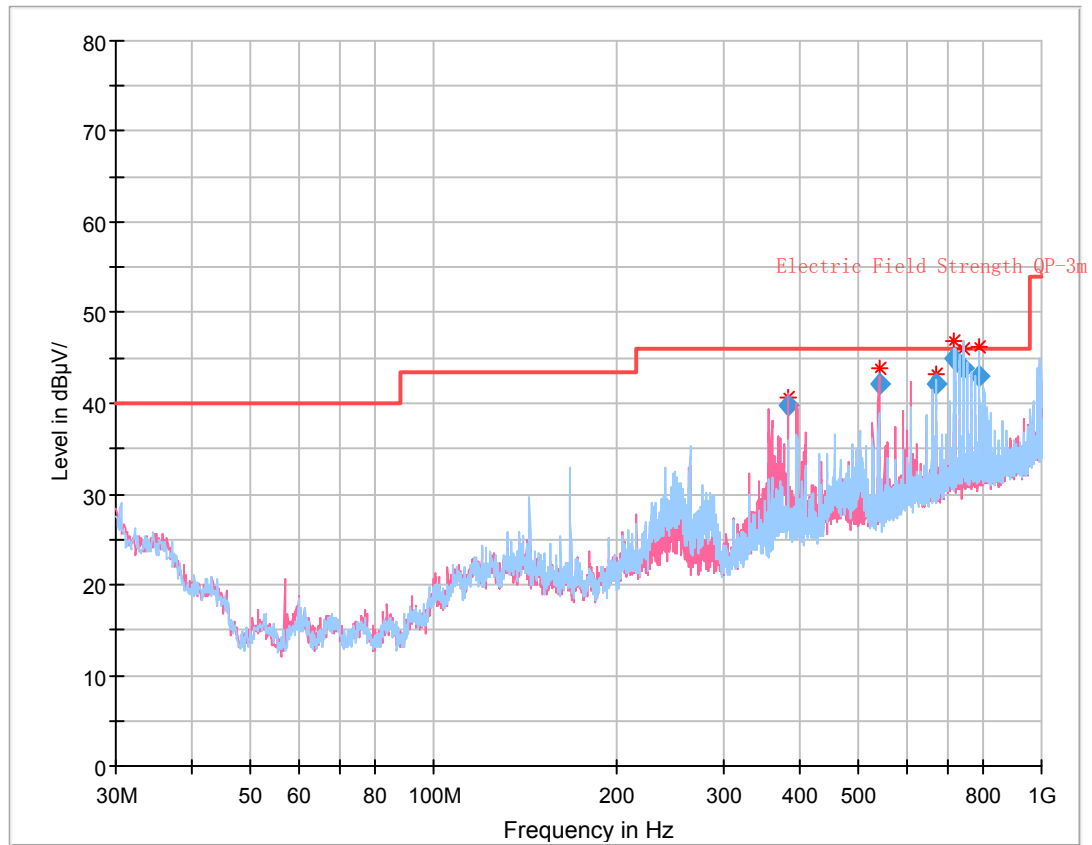
Temperature:	23.0~23.4 °C
Relative Humidity:	52.0~56.0 %
ATM Pressure:	101.1~101.2 kPa

The testing was performed by Kilroy Deng on 2021-03-10 for below 1GHz and by Troy Wang on 2021-03-01 for above 1GHz.

EUT operation mode: Transmitting

Adapter1-Model: VT05EUS05100

30 MHz~1 GHz:

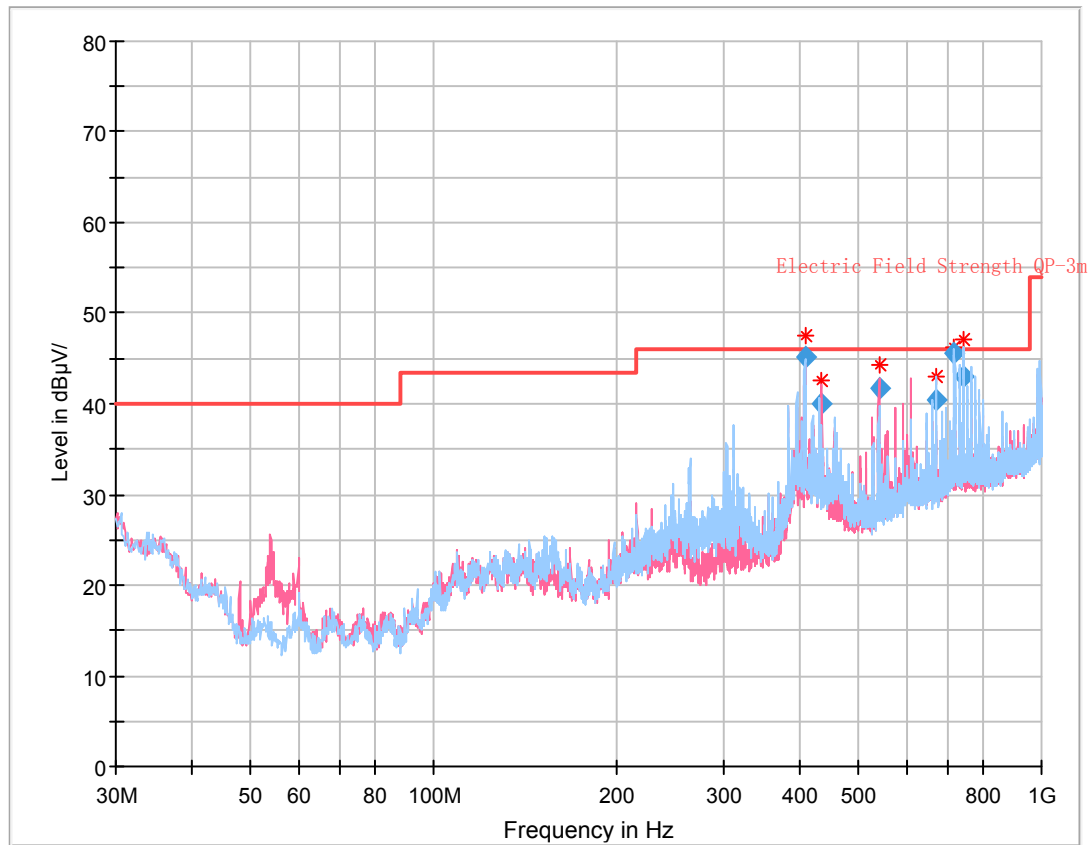


Final Result

Frequency (MHz)	QuasiPeak (dB µ V/m)	Limit (dB µ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
382.874500	39.78	46.00	6.22	145.0	V	264.0	-1.9
540.047125	42.22	46.00	3.78	118.0	V	245.0	1.3
671.911625	42.20	46.00	3.80	120.0	H	109.0	4.0
719.966375	45.04	46.00	0.96	115.0	H	80.0	4.9
743.797875	43.93	46.00	2.07	111.0	H	66.0	5.4
791.899000	43.06	46.00	2.94	110.0	H	67.0	5.5

Adapter2-Model: S005BNU0500100

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)
408.078250	45.07	46.00	0.93	105.0	H	285.0	-1.1
435.567625	39.91	46.00	6.09	114.0	V	213.0	-0.1
540.021125	41.79	46.00	4.21	113.0	V	253.0	1.3
672.113875	40.43	46.00	5.57	119.0	H	99.0	4.0
719.931000	45.49	46.00	0.51	116.0	H	86.0	4.9
743.692500	42.92	46.00	3.08	118.0	H	72.0	5.3

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 (2405 MHz)									
2388.35	29.12	PK	226	1.2	H	31.87	60.99	74	13.01
2388.35	13.85	Ave.	226	1.2	H	31.87	45.72	54	8.28
2485.71	28.76	PK	287	1.2	H	32.13	60.89	74	13.11
2485.71	13.62	Ave.	287	1.2	H	32.13	45.75	54	8.25
4810.00	53.55	PK	151	1.5	H	6.28	59.83	74	14.17
4810.00	38.28	Ave.	151	1.5	H	6.28	44.56	54	9.44
7215.00	47.50	PK	259	1.9	H	11.93	59.43	74	14.57
7215.00	32.98	Ave.	259	1.9	H	11.93	44.91	54	9.09
Middle Channel (2439 MHz)									
4878.00	53.14	PK	187	2.0	H	6.76	59.90	74	14.10
4878.00	37.42	Ave.	187	2.0	H	6.76	44.18	54	9.82
7317.00	48.04	PK	23	1.6	H	11.56	59.60	74	14.40
7317.00	32.81	Ave.	23	1.6	H	11.56	44.37	54	9.63
High Channel (2475 MHz)									
2386.15	28.74	PK	285	2.2	H	31.87	60.61	74	13.39
2386.15	14.32	Ave.	285	2.2	H	31.87	46.19	54	7.81
2483.54	33.89	PK	186	1.1	H	32.13	66.02	74	7.98
2483.54	17.97	Ave.	186	1.1	H	32.13	50.10	54	3.90
4950.00	52.72	PK	158	1.8	H	6.80	59.52	74	14.48
4950.00	37.49	Ave.	158	1.8	H	6.80	44.29	54	9.71
7425.00	48.23	PK	271	1.9	H	12.39	60.62	74	13.38
7425.00	33.68	Ave.	271	1.9	H	12.39	46.07	54	7.93

Note:

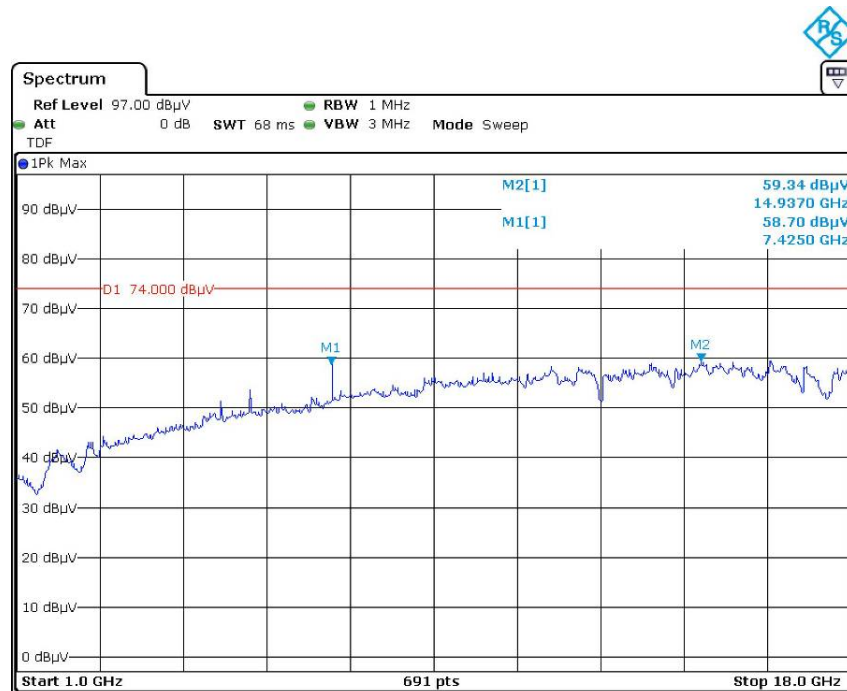
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

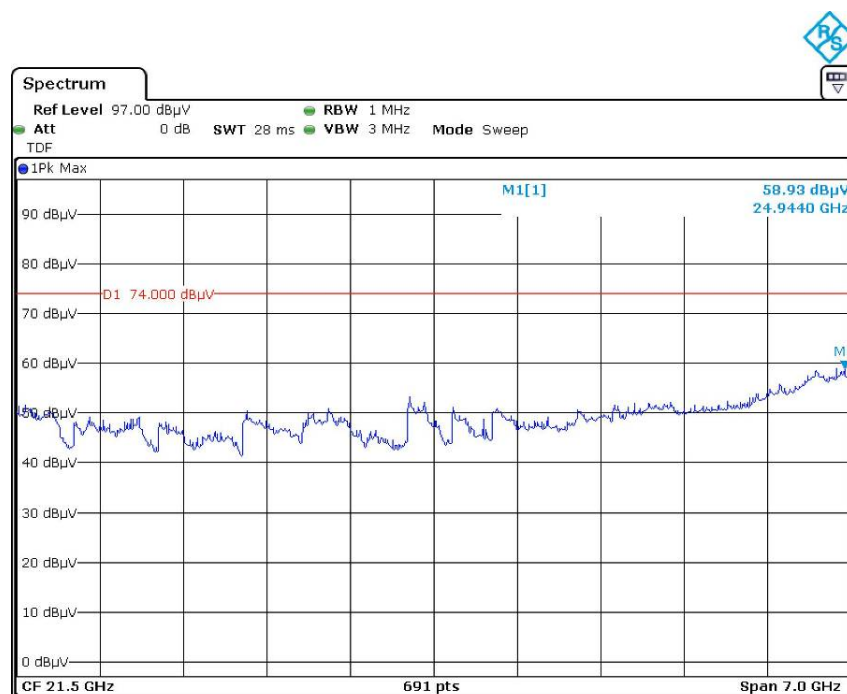
Margin = Limit - Corrected. Amplitude

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

Pre-scan with High channel Peak Horizontal

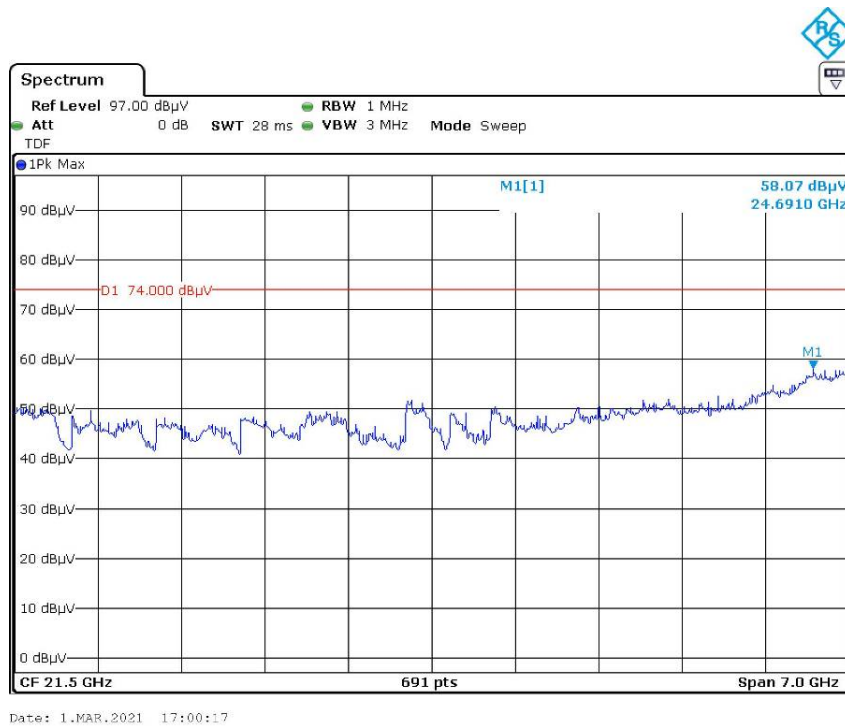
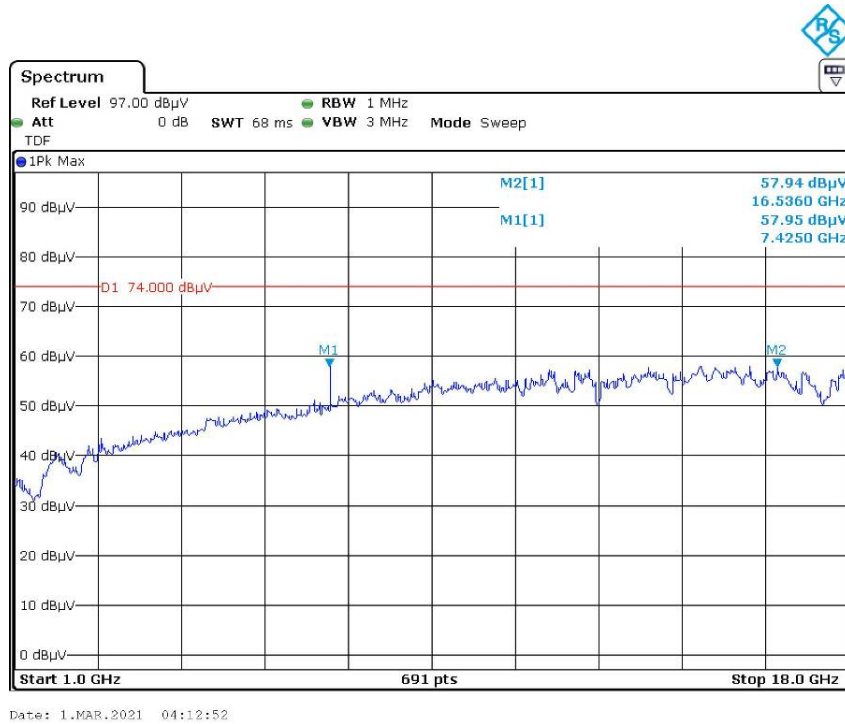


Date: 1.MAR.2021 04:02:16

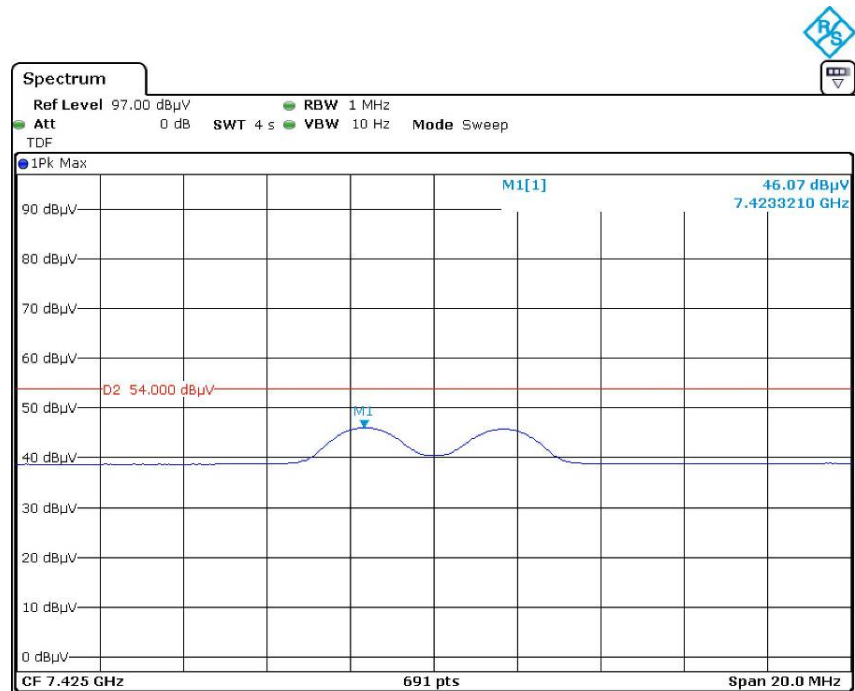


Date: 1.MAR.2021 16:49:46

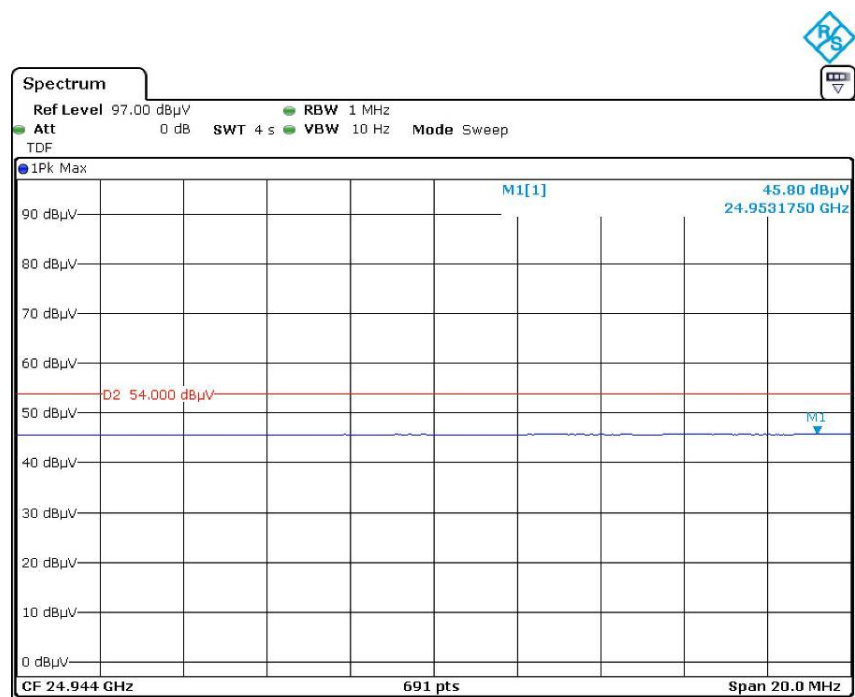
Vertical



Pre-scan for Average Horizontal

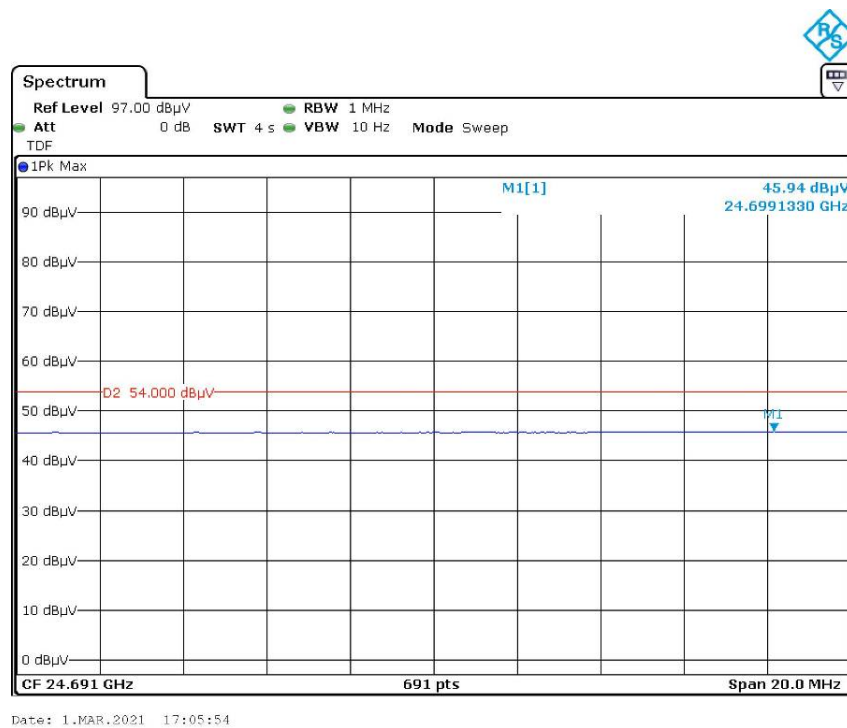
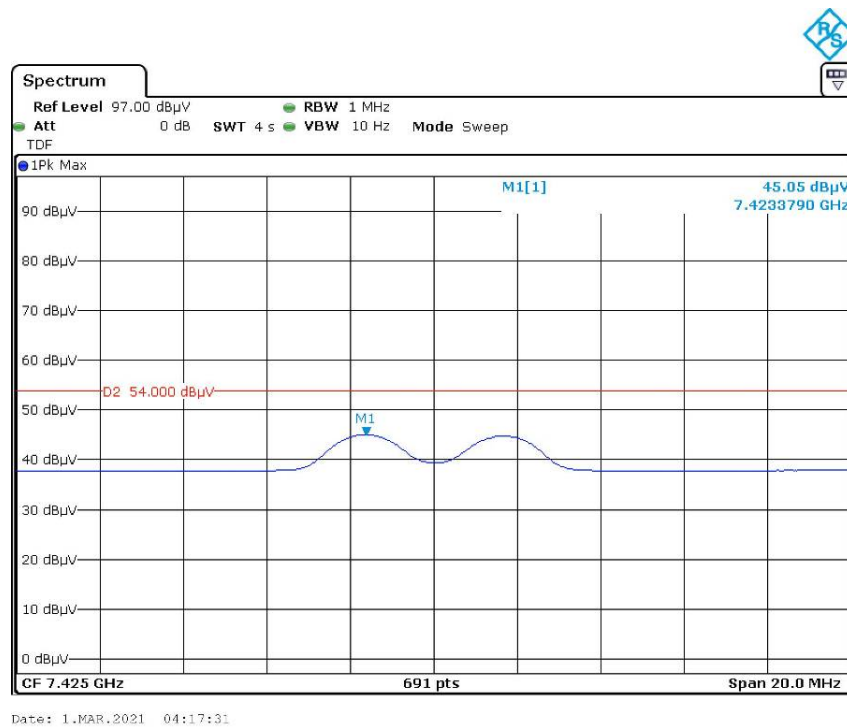


Date: 1.MAR.2021 04:07:56



Date: 1.MAR.2021 16:54:41

Vertical



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:	25.8 °C
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

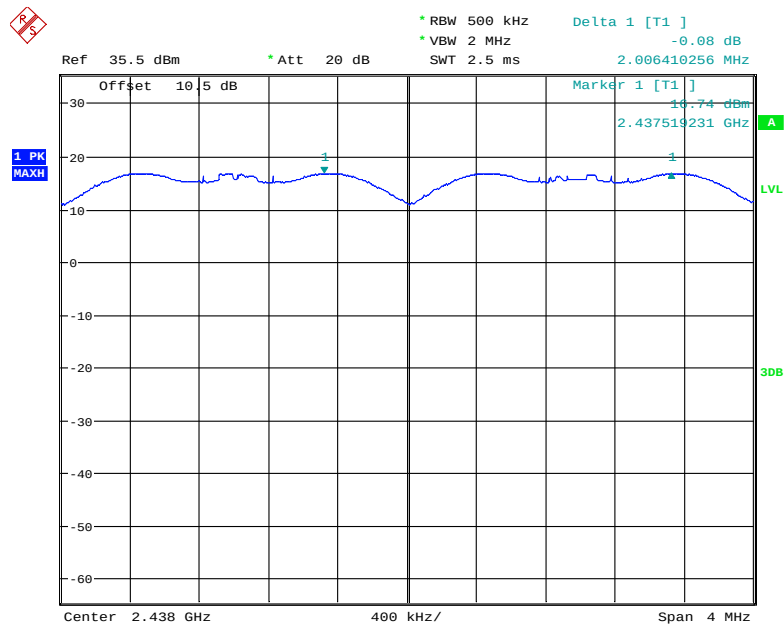
The testing was performed by Blaker Zhang on 2021-02-23.

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	2.006	2.231	1.487	> two-thirds of the 20 dB bandwidth



Date: 23.FEB.2021 23:38:46

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

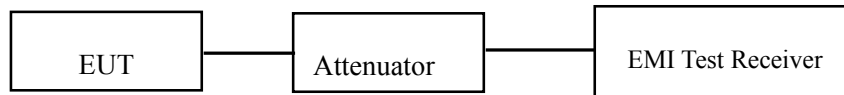
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency 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:	25.8 °C
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Blaker Zhang on 2021-02-23.

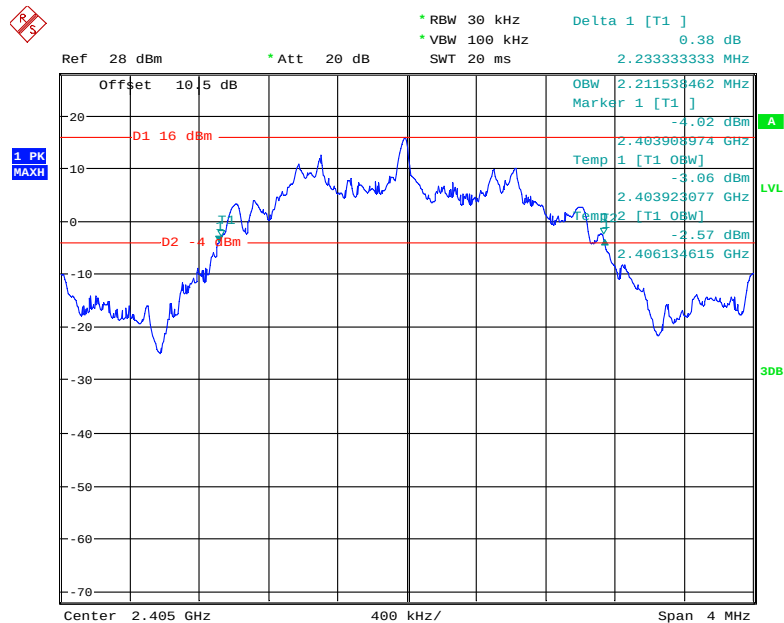
EUT operation mode: Transmitting

Test Result: Pass

Please refer to following table and plots.

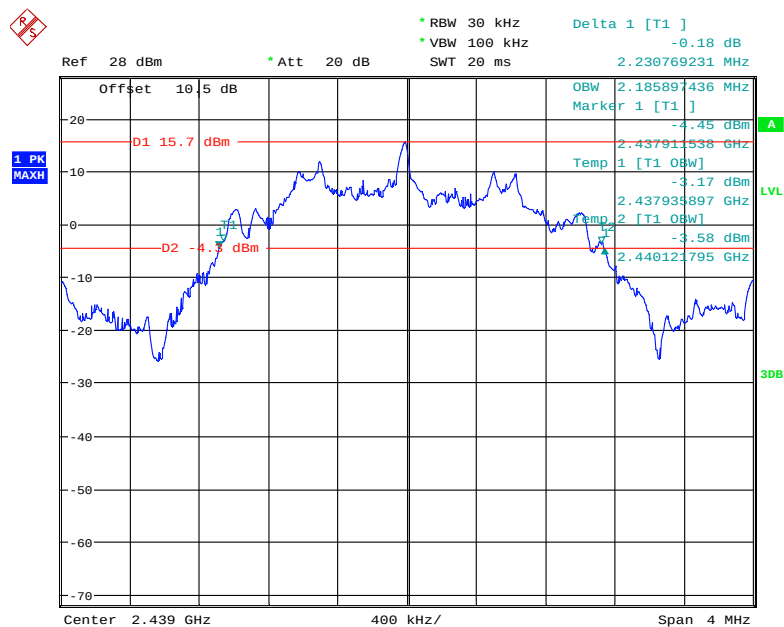
Channel	Frequency (MHz)	99% Emission Bandwidth (MHz)	20 dB Emission Bandwidth (MHz)
Low	2405	2.212	2.233
Middle	2439	2.186	2.231
High	2475	2.173	2.233

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



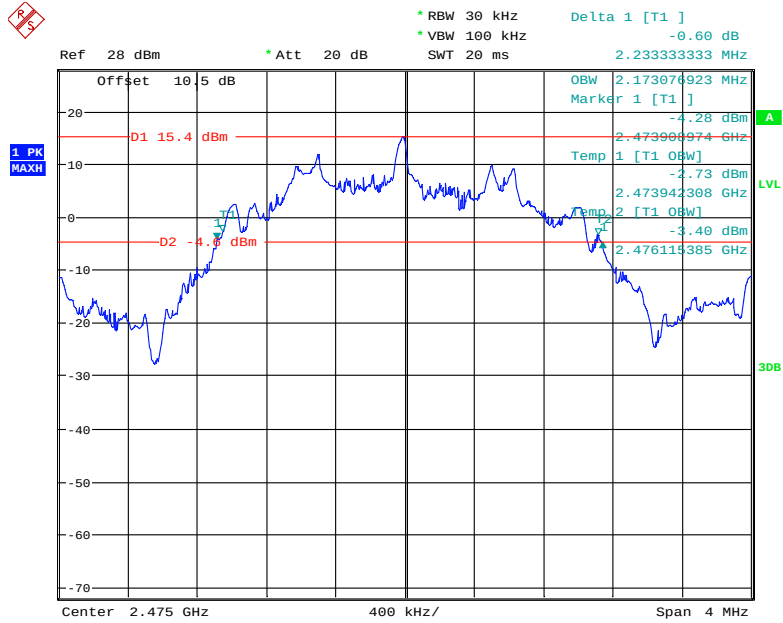
Date: 23.FEB.2021 22:21:55

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



Date: 23.FEB.2021 22:24:15

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



Date: 23.FEB.2021 22:25:46

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:	25.8 °C
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Blaker Zhang on 2021-02-23.

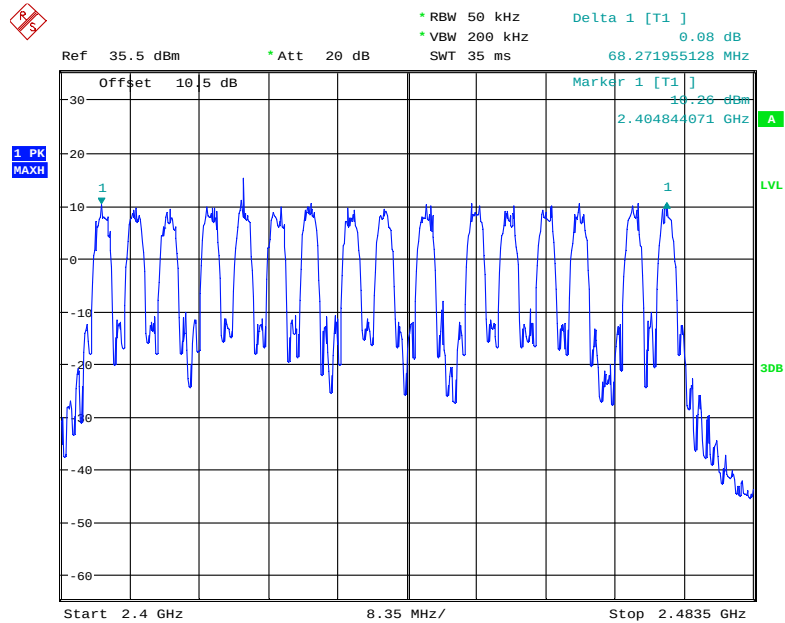
EUT operation mode: Transmitting

Test Result: Pass

Please refer to following table and plots.

Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
2405-2475	16	≥15

Number of Hopping Channels



Date: 23.FEB.2021 23:16:58

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:	25.8 °C
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Blaker Zhang on 2021-02-23.

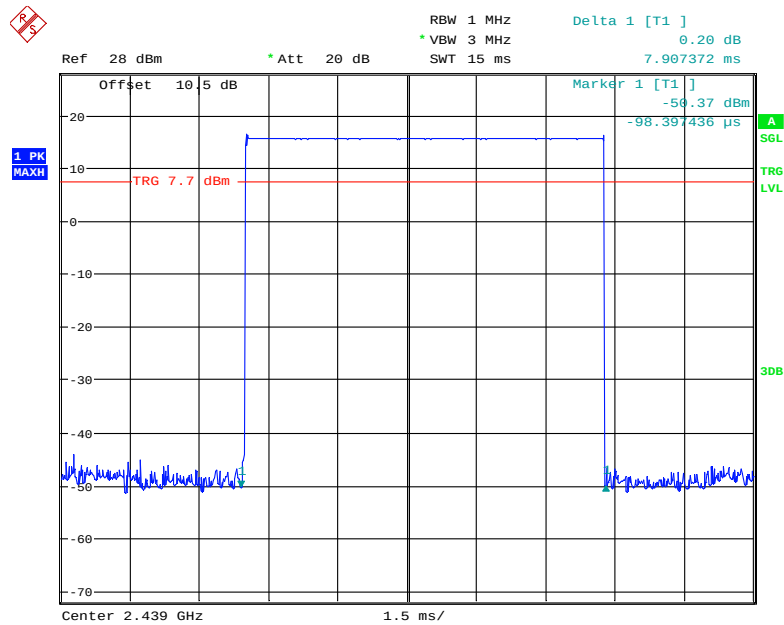
EUT operation mode: Transmitting

Test Result: Pass

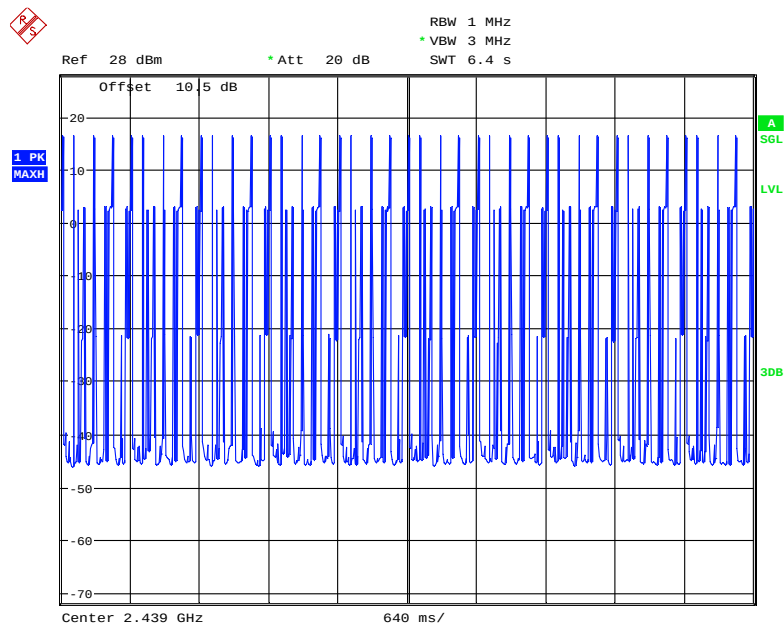
Please refer to following table and plots

Test Mode	Channel	Pulse Time (ms)	Total Hops	Period Time (s)	Dwell Time (ms)	Limit (ms)	Result
Hopping	2439	7.907	40	6.4	316.28	400	Pass

Note: A period time=0.4*16=6.4(S), Result=Pulse Time* Total Hops



Date: 23.FEB.2021 22:38:53



Date: 23.FEB.2021 22:39:57

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

Applicable Standard

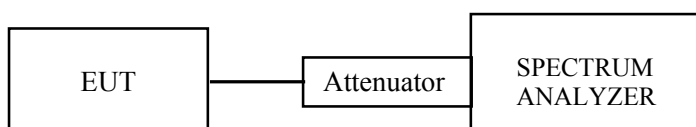
According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 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:	25.8 °C
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Blaker Zhang on 2021-02-23.

EUT operation mode: Transmitting

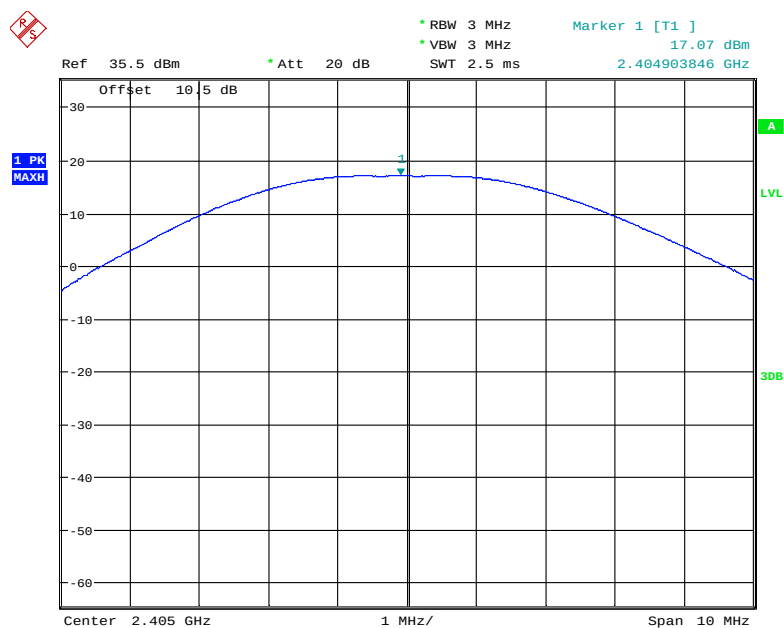
Test Result: Pass

Please refer to following table.

Channel	Frequency (MHz)	Peak Output Power	Limit (dBm)
		(dBm)	
Low	2405	17.07	21
Middle	2439	16.78	21
High	2475	16.54	21

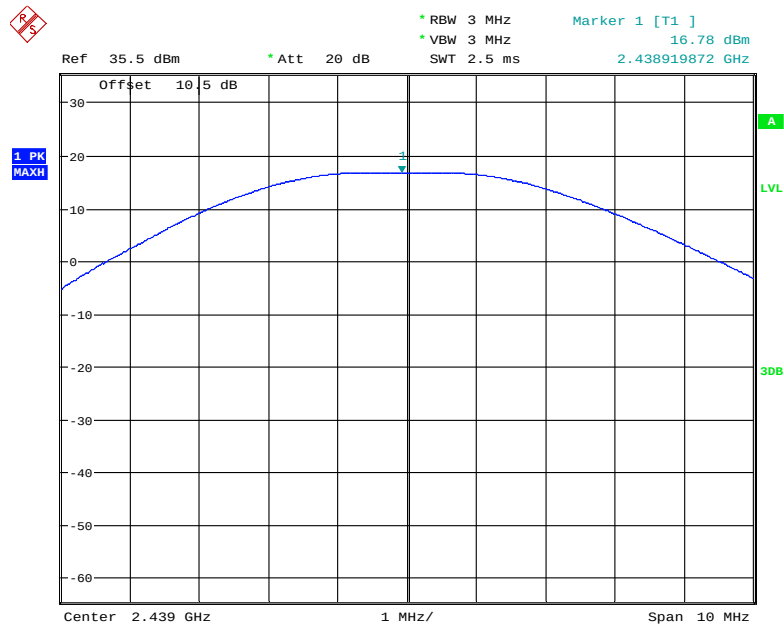
Note: The antenna gain is 0dBi. The maximum EIRP=17.07dBm+0dBi=17.07dBm, less than 36dBm, so it's compliance with the ISSED EIRP limit.

Low Channel



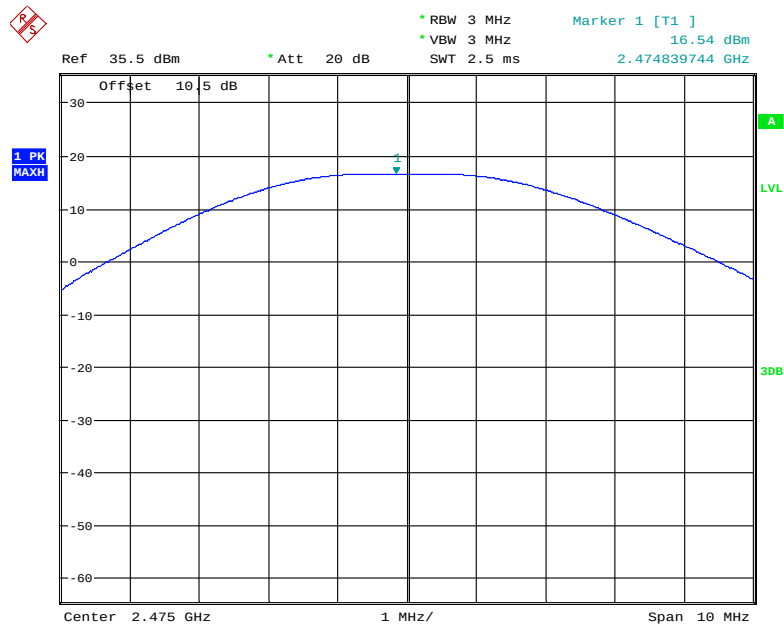
Date: 23.FEB.2021 21:57:34

Middle Channel



Date: 23.FEB.2021 21:58:29

High Channel



Date: 23.FEB.2021 21:59:08

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:	25.8 °C
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

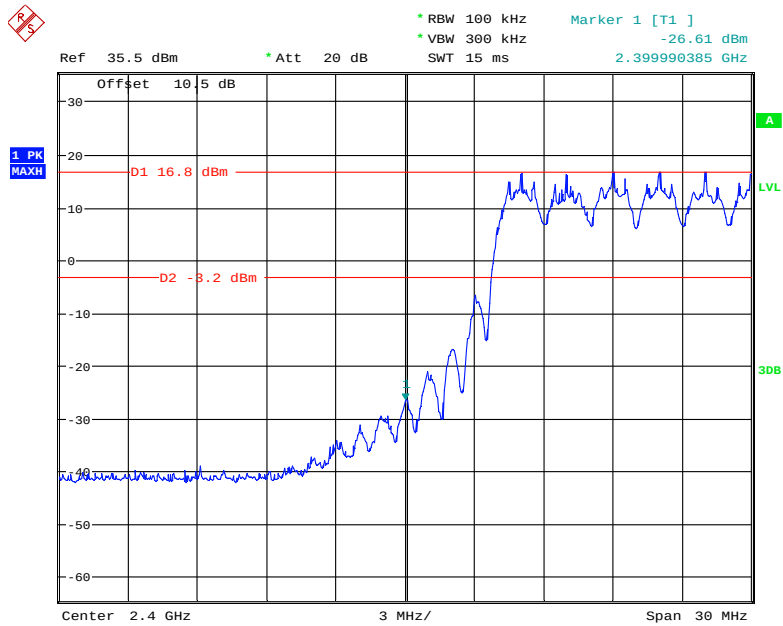
The testing was performed by Blaker Zhang on 2021-02-23.

EUT operation mode: Transmitting

Test Result: Pass

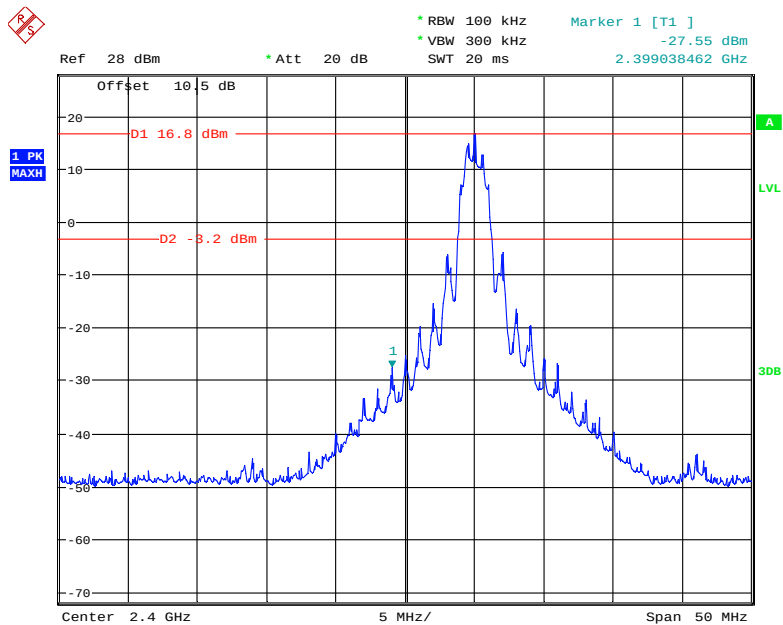
Please refer to following plots.

Band Edge-Left Side Hopping



Date: 23.FEB.2021 23:31:02

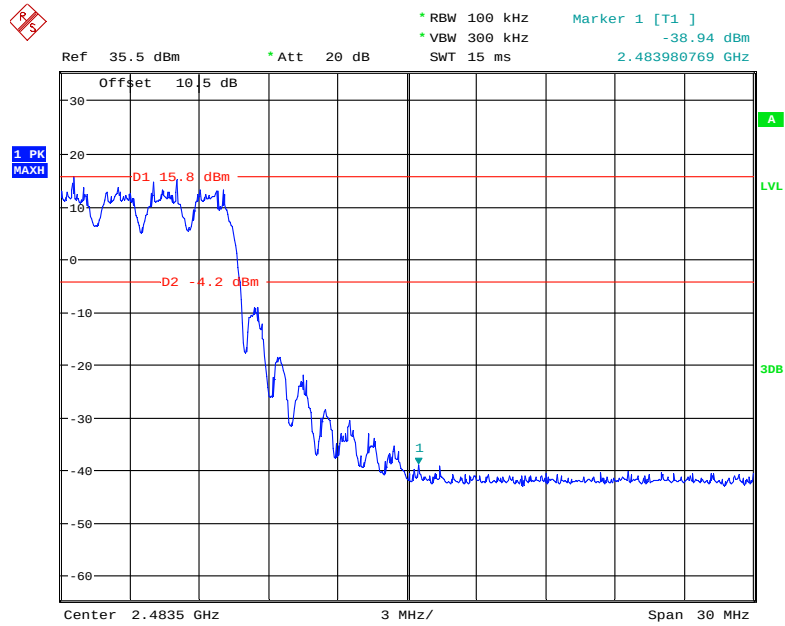
Single



Date: 23.FEB.2021 22:31:42

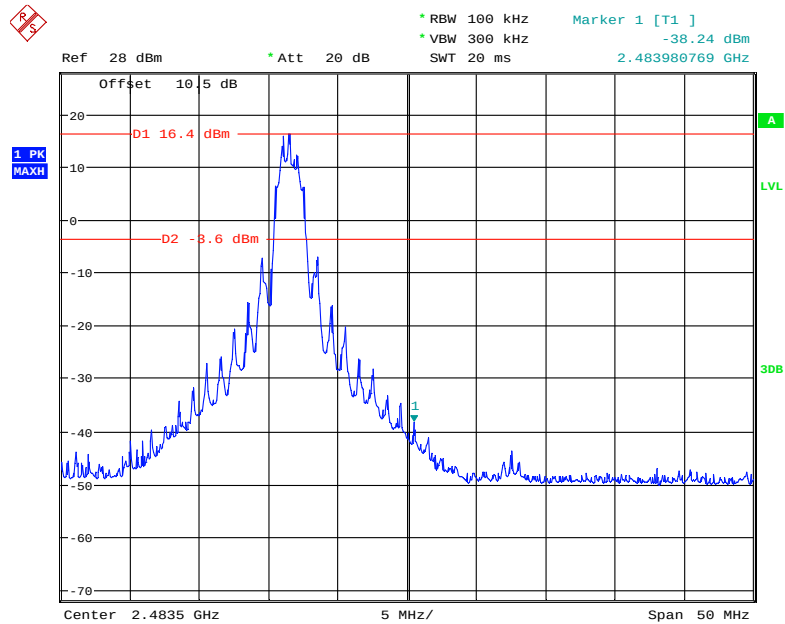
Band Edge-Right Side

Hopping



Date: 23.FEB.2021 23:32:44

Single



Date: 23.FEB.2021 22:29:47

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